Clean Air Action Plan
For
Northeast Texas

Prepared by
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Technical Committee

Prepared for
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Background

On December 20, 2002, Northeast Texas Air Care (NETAC) signed an Early Action Compact (EAC) to address 8-hour ozone air quality issues in Gregg, Harrison, Rusk, Smith and Upshur Counties. The objective of the EAC is to develop and implement a Clean Air Action Plan that includes emission reductions needed to demonstrate attainment of the 8-hour ozone standard by 2007 and maintain the standard beyond that date. Since the EAC was initiated, Northeast Texas has come into compliance with the 8-hour ozone standard based on the most recent monitoring data for the region. By continuing with the EAC, NETAC is developing additional strategies to bring the region further into compliance with the Environmental Protection Agency's (EPA's) 8-hour ozone standard and protect air quality in the region through at least 2012.

The purpose of this Clean Air Action Plan (CAAP) is to lay out NETAC's strategy for improving ozone air quality in Northeast Texas and maintaining future compliance with the 8-hour ozone standard. The CAAP will be finalized by March 31, 2004.

8-Hour Ozone Attainment

EPA's National Ambient Air Quality Standard for ozone includes an 8-hour average standard. The 8-hour standard sets a maximum level (0.08 ppm) for the three year running average of the annual fourth-highest daily maximum 8-hour average concentration.[1] A review of recent air quality data for Northeast Texas shows that ozone levels declined over 1999 to 2003. The current 8-hour ozone design values for Longview and Tyler are 82 parts per billion (ppb) and 81 ppb, respectively, based on the preliminary 2003 monitoring data. These values are below 85 ppb and show that Northeast Texas is now monitoring attainment of the 8-hour standard.

The recent decline in 8-hour ozone levels has affected both the Longview and Tyler monitors, but is more pronounced at Longview. These declines coincide with significant reductions in NOx emissions from major point sources in the Longview area that were made on a voluntary basis by NETAC. These voluntary reductions have since been made enforceable through a Revision to the State Implementation Plan (SIP) For the Control of Ozone Air Pollution - Northeast Texas Region Ozone SIP Revision.

Attainment Demonstration for 2007

NETAC developed an ozone model for an August 1999 episode period. The performance of the ozone model was evaluated and then the model was used to evaluate whether Northeast Texas will remain in compliance with the 8-hour ozone standard through 2007. The ozone modeling for 2007 demonstrates attainment of the 8-hour ozone standard with existing control measures. The existing measures include locally developed NETAC control strategies, Texas State Implementation Plan control strategies and Federal EPA measures such as cleaner vehicles and

[1] Under the rounding conventions specified in the standard, the 8-hour standard is exceeded by a concentration of 85 ppb or greater.

fuels and the NOx SIP Call. The projected 8-hour ozone design values for 2007 at Longview and Tyler are 80 ppb and 77 ppb, respectively, which are lower than the current design values.

Maintenance for Growth Through 2012

NETAC has developed emission inventories for 2012 to complete the "maintenance for growth" analysis called for in the EAC. NOx emissions are projected to decline further between 2007 and 2012, which is expected to lead to further reductions in ozone levels in the Northeast Texas. The maintenance for growth analysis projects that Northeast Texas will still be attaining the 8-hour ozone standard in 2012.

ADDITIONAL NETAC MEASURES

NETAC conducted a study to identify control measures that are likely to be appropriate and effective in Northeast Texas. This assessment looked at strategies that look capable of achieving substantial reductions in NOx and highly reactive VOC (HRVOC) by December 2005. Several of these strategies are being implemented and are described below.

Enforceable NETAC Measures

Two chemical plants near Longview are implementing enhanced Leak Detection and Repair (LDAR) programs to reduce emissions of highly reactive VOC (HRVOC). The current NETAC attainment demonstration for 2007 does not include emissions reductions from these enhanced LDAR programs so these HRVOC reductions will be in addition to the currently modeled local controls.

Eastman Chemical Company, Texas Operations is implementing enhanced LDAR programs in several parts of their facility in Longview. Voluntary LDAR programs in the Polyethylene Division and the Utilities and Feedstocks Division will be enforceable under Voluntary Emissions Reduction Permits 47007, 48588 and 48590. These measures will be implemented before the 2004 ozone season and will result in estimated emissions reductions of 0.63 tons per day of HRVOC. Eastman also will be doing voluntary early implementation of LDAR programs that are required in 2005 under ethylene MACT regulations that will result in estimated emissions reductions of 0.23 tons per day of HRVOC. These emissions reduction estimates may change as the programs are developed further and implemented

Huntsman Chemical owns a polypropylene plant that is co-located with Eastman Chemical Company's facility near Longview. Huntsman's improved LDAR program will be implemented over a four-year period and is expected to reduce VOCs by 29 tons/year by 2005 and 44 tons/year by 2008. These estimates may change as the programs are developed further and implemented. Huntsman volunteered these reductions as part of a new Flexible Plant-wide Applicability Limit (PAL) Permit and convert the LDAR programs from 28M to 28VHP. The State of Texas permit number is #18105.

Voluntary NETAC Measures

Compressor Engines Eligible for TERP Funding

The NETAC control strategy analysis (NETAC, 2003) identified NOx emissions from compressor engines used in natural gas production as a source where significant emission reductions could potentially be achieved. NETAC estimated area source NOx emissions related to oil and gas production to be about 35 tons/day in the 5 County NETAC area in 1999 and these emissions are dominated by gas-fueled compressor engines less than 500 hp. Control technologies are readily available for these engines that can reduce NOx emissions by 50% to 90% depending upon engine type.

NETAC has adopted the following approach to obtaining reductions in NOx emissions from gas compressors in the 5 county NETAC area. The Texas legislature has funded the Texas Emissions Reduction Plan (TERP) that will pay for a variety of NOx reduction strategies at sources not currently subject to regulation including smaller gas compressor engines in the NETAC area. In 2003 and 2004 NETAC has arranged several public meetings with presentations on TERP funding to raise awareness of this program. In addition, NETAC has access to funding that could be used to develop a demonstration program for NOx reductions on gas compressor engines during 2004. NETAC has not yet estimated the amount of NOx reductions that will result from the demonstration program or public response to the TERP funding opportunity. Since the current NETAC attainment demonstration for 2007 does not assume any controls on gas compressors, NOx reductions generated by a demonstration program and TERP funding will be in addition to the currently modeled local controls.

Off-road Vehicle Emission Reductions

Two lignite-mining operations associated with power plants in the NETAC area have applied for Texas Emissions Reduction Plan (TERP) grants to reduce NOx emissions from heavy off-road mining equipment. The Oak Hill Mining Area in Rusk County associated with the Martin Lake plant plans to replace two older backhoe excavators (non-tier rated) with two new, cleaner-burning (tier-1 compliant) backhoe excavators. The TERP application was filed on March 11, 2004. The estimated annual NOx emission reduction at Oak Hill mine will be 21.88 tons. The Sabine Mine associated with the Pirkey plant in Harrison County has submitted TERP applications for funding to replace one dozer and one excavator.

On-road Vehicle Emission Reductions

The Department of Energy (DOE) Clean Cities program is a voluntary mobile source emission reduction program in East Texas. The East Texas Clean Cities Coalition (ETCCC), coordinated by the East Texas Council of Governments (ETCOG), has successfully obtained a Clean Cities Designation for the region from DOE. ETCCC promotes the use of alternative fuels to gasoline and diesel, such as propane, natural gas, ethanol, and biodiesel.

Eighteen new lower emitting propane light heavy-duty (Class 2b) vans were purchased in 2003 and 2004 for the ETCOG's Rural Transportation Program (10 vans), the City of Longview (7 vans), and Tyler Transit (1 van). The average miles per year driven by these vehicles is 36,820.

The emission reduction for each van compared to the average new heavy-duty spark-ignition van available in 2003 and 2004 was 0.021 tons per year VOC and 0.103 tons per year NOx. (based on EPA's MOBILE6 emissions model). The eighteen vans being operated in the NETAC area will provide total emissions reductions of 0.4 tons per year VOC and 2.0 tons per year NOx.

Public Awareness Programs

With funding from NETAC, the East Texas Council of Governments (ETCOG) runs an annual public education and ozone awareness program for the five county Tyler-Longview-Marshall area. The program includes the following elements: an ozone watch and warning communications network between local governments and industries to communicate ozone action day forecasts issued by the TCEQ; a NETAC website (http://www.netac.org); production and distribution of public service announcements; school programs and teacher training workshops; distribution of public information and educational materials; and an Annual Ozone Season Kick-Off meeting for Northeast Texas.

Energy Efficiency Programs

The City of Tyler is carrying out a series of energy efficiency improvements that will reduce electricity consumption. The City of Tyler projects are to be completed by July 2004, and will result in estimated annual energy savings of 4,653,640 kWh. The programs will involve: Building Lighting, HVAC and Controls Upgrades; Traffic Light Upgrades; Park Lighting Upgrades; and Wastewater Plant Motor and Controls Upgrades.

The City of Longview passed a resolution on 8 August 2002 adopting the goals of Senate Bill 5, directing the preparation of an energy efficiency plan and providing for reporting to the State Energy Conservation Office. Since this adoption, the City has undertaken numerous measures to comply with the goal of reducing energy consumption by 5% per year for 5 years. The city has completed an Energy Assessment of Designated Municipal Facilities by the firm of Estes, McClure and Associates, Inc. This document will provide for improved planning as electrical systems are retrofitted. As major systems are renovated / retrofitted, energy consumption is a primary decision factor. Improvements have been made in lighting, HVAC systems, swimming pool operations and the purchase of energy efficiency rated equipment for Public Safety Communications.

The City of Marshall is initiating an energy efficiency plan with assistance from Texas A&M University.

EPA currently is evaluating whether areas can take ozone SIP credit for emissions reductions resulting from energy savings.

1. INTRODUCTION

Background

The Texas Commission on Environmental Quality (TCEQ) monitors air quality in Northeast Texas to determine whether the region is in compliance with EPA's National Ambient Air Quality Standards (NAAQS) for ozone. Historically, ozone levels in Northeast Texas have been close to the level of the ozone NAAQS and the region comprising Gregg, Harrison, Rusk, Smith and Upshur Counties has been considered a "near-nonattainment area" (NNA). With the assistance of funding from the State legislature, a local stakeholder group called North East Texas Air Care (NETAC) has conducted scientific studies and developed control strategies to reduce ozone levels. Ozone levels are reduced by controlling emissions of ozone precursors, namely nitrogen oxides (NOx) and volatile organic compounds (VOCs). NETAC's activities lead to the recent submission of a revised State Implementation Plan (SIP) for 1-hour ozone in Northeast Texas (TNRCC, 2002). The 1-hour SIP revision enforces significant emissions reductions that were entered into on a voluntary basis by several local industries, namely American Electric Power (AEP), Eastman Chemical Company, Texas Operations and TXU.

Early Action Compact

On December 20, 2002, NETAC signed an Early Action Compact (EAC) for 8-hour ozone. The objective of the EAC is to develop and implement a Clean Air Action Plan that includes emission reductions needed to demonstrate attainment of the 8-hour ozone standard by 2007 and maintain the standard beyond that date. Since the EAC was initiated, monitoring data show that Northeast Texas has come into compliance with the 8-hour ozone standard. By continuing with the EAC, NETAC is developing additional strategies to bring the region further into compliance with the EPA's 8-hour ozone standard and protect air quality in the region through at least 2012.

The EAC has a series of milestones that track progress toward developing a Clean Air Action Plan (CAAP) and then a State Implementation Plan (SIP) revision for the region. Key milestones for the Northeast Texas EAC are shown in Table 1-1.

This document is the CAAP for submission to the TCEQ and EPA by March 31, 2004. The purpose of the CAAP is to lay out NETAC's strategy for improving ozone air quality in Northeast Texas and maintaining future compliance with the 8-hour ozone standard.

Table 1-1. Key milestone dates for the Northeast Texas Early Action Compact (EAC).

Date	Item
December 31, 2002	Signed EAC agreement
June 16, 2003	Identify/describe potential local emission reduction strategies
November 30, 2003	Initial modeling emission inventory completed Conceptual model completed Base case (1999) modeling completed
December 31, 2003	Future year (2007) emission inventory completed Emission inventory comparison for 1999 and 2007 Future case modeling completed
January 31, 2004	Schedule for developing further episodes completed Local emission reduction strategies selected One or more control cases modeled for 2007 Attainment maintenance analysis (to 2012) completed Submit preliminary Clean Air Action Plan (CAAP) to TCEQ and EPA
March 31, 2004	Final revisions to 2007 control case modeling completed Final revisions to local emission reduction strategies completed Final attainment maintenance analysis completed Submit final CAAP to TCEQ and EPA
December 31, 2004	State submits SIP incorporating the CAAP to EPA
December 31, 2005	Local emission reduction strategies implemented no later than this date
December 31, 2007	Attainment of the 8-hour ozone standard

2. AIR QUALITY AND TRENDS

Air quality data determine compliance with the National Ambient Air Quality Standards (NAAQS) for ozone and accordingly the TCEQ operates several monitoring sites in Northeast Texas. Additionally, NETAC has collected supplemental data on ozone and precursors through research monitoring and an aircraft study in 2003. The air quality data for Northeast Texas are considered in detail in the recent conceptual model report by Stoeckenius et al. (2004). This section presents an overview of the air quality data, discusses air quality trends and shows the current status of Northeast Texas in attaining both the 8-hour and 1-hour NAAQS at all monitors.

TCEQ MONITORING NETWORK

The TCEQ operates several continuous air monitoring stations (CAMS) in Northeast Texas as shown by the map in Figure 2-1. Historically, the highest ozone concentrations have been recorded at the Longview monitor (CAMS-19) located at the Gregg County airport where ozone data have been collected since the 1970s. Ozone monitoring commenced in 1995 at Tyler Airport (CAMS-86) although the monitor was relocated within the airport in 2000 due to construction and assigned a new number (CAMS-82). A monitoring site was established toward the east of the region in Marion County at the Cypress River Airport (CAMS-50) in 1998. The Cypress River monitor was discontinued in March 2001 and a new site located across the county line in Harrison County (Karnack, CAMS-85) began operating in September 2001. The CAMS 605 monitor was discontinued in October 2001 and the CAMS 133 monitor was discontinued in April 1991.

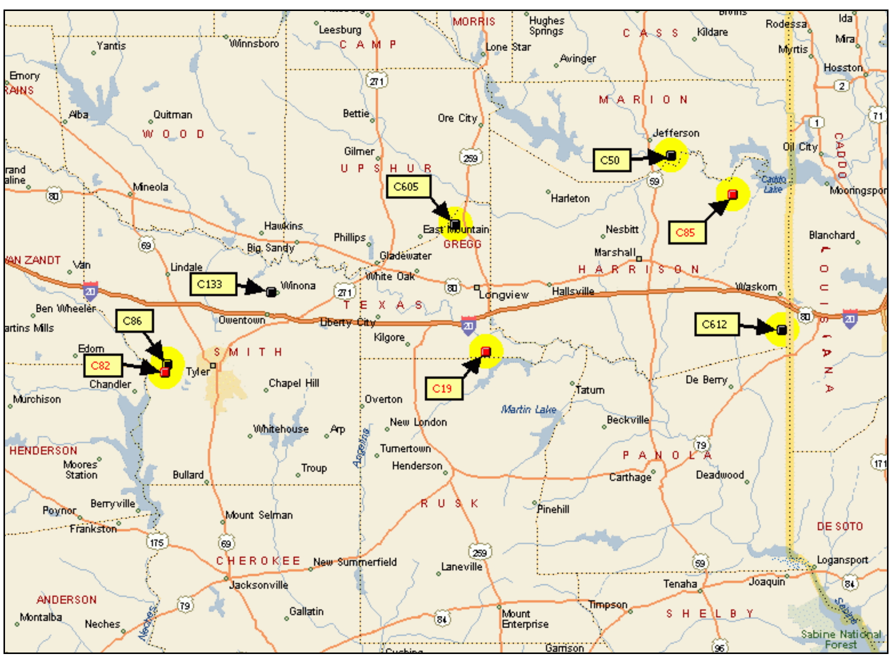


Figure 2-1. Map of Northeast Texas showing locations of air quality monitors (source: TCEQ).

NETAC RESEARCH MONITORING

NETAC has undertaken research monitoring to collect ozone data at additional locations and supplemental precursor data at TCEQ monitoring locations. The NETAC research-monitoring site was located at Waskom in eastern Harrison County for the 2002 and 2003 ozone seasons and data were reported via the TCEQ's data system as CAMS-612, which is shown in Figure 2-1. VOC samples were collected at CAMS19 in Longview in 2002 and 2003.

NETAC AIRCRAFT STUDY IN 2002

Air quality measurements were performed aboard the Baylor Cessna 172 aircraft during August and September 2002 as part of the NETAC Air Quality Study as described by Buhr et al. (2003). Measurements included ozone, NO, NO_2, NOy, SO_2, continuous olefins, VOC canister, light scattering, photolysis rate, and meteorological parameters[1]. Not every parameter was measured on every flight. A total of 33 flight hours were completed.

Flight plans were developed to collect data to address the following issues:

- Background ozone levels entering Northeast Texas during Easterly/Northeasterly wind events frequently associated with high ozone in the region.
- Ozone production associated with major point sources in Northeast Texas.
- Ozone production associated with major urban areas (urban plumes) such as Tyler and Longview.

Actual flights schedules were selected according to the conditions on each day. Several flights observed transport of high background ozone into Northeast Texas, as discussed below. Flights did not find urban plumes that were distinct from plumes downwind of major point sources. Flights found some high ozone downwind of major NOx point sources (utilities) but the levels were lower than observed by a flight during the TexAQS field study, discussed below. One flight using the continuous olefins instrument found an olefins plume downwind of the Eastman/Huntsman chemical plants near Longview that also contained elevated ozone concentrations, but the flight was not on a high ozone day and the ozone levels observed were below the level of the 8-hour ozone standard (see Stoeckenius et al., 2004).

Elevated ozone concentrations were observed upwind of the Northeast Texas under meteorological conditions frequently associated with high ozone. For example, on 28 - 30 August 2002, 70 – 85 ppb of ozone was observed at about 500 - 600 m above ground level all along the Texas-Louisiana state line northeast of the study region (see example for 29 August in Figure 2-2). These flights also traversed various NOx plumes. Winds were generally northeast at 3 – 8 knots throughout these flights and back trajectories for mid afternoon on 29 August 2002 are shown in Figure 2-3. The back trajectories are model results showing the path taken by a hypothetical air parcel to arrive at a specific place and time. Eight-hour daily maximum ozone values on 29 August 2002 ranged from 76 ppb at Tyler to 88 ppb at Karnack. These aircraft data

[1] NO is nitric oxide. NO_2 is nitrogen dioxide. NO_Y is the sum of oxidized nitrogen compounds. SO_2 is sulfur dioxide. VOC is volatile organic compounds.

show that transported ozone can cause near exceedances of the 8-hour ozone standard in Northeast Texas.

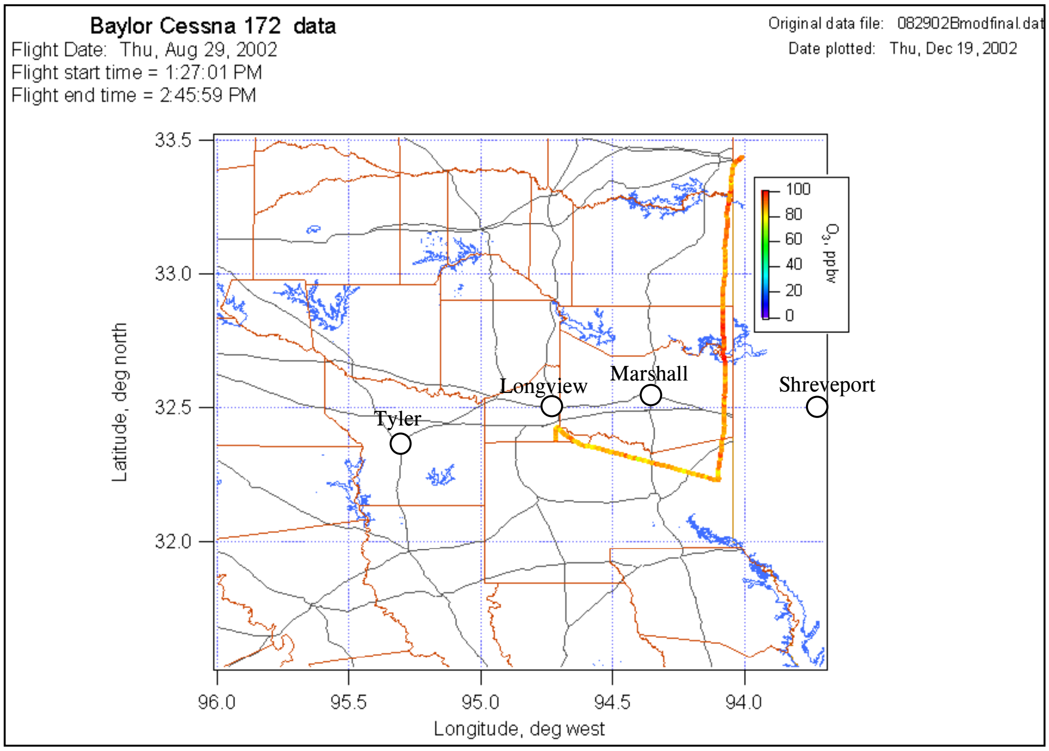


Figure 2-2. Baylor aircraft ozone measurements for early afternoon of 29 August 2002.

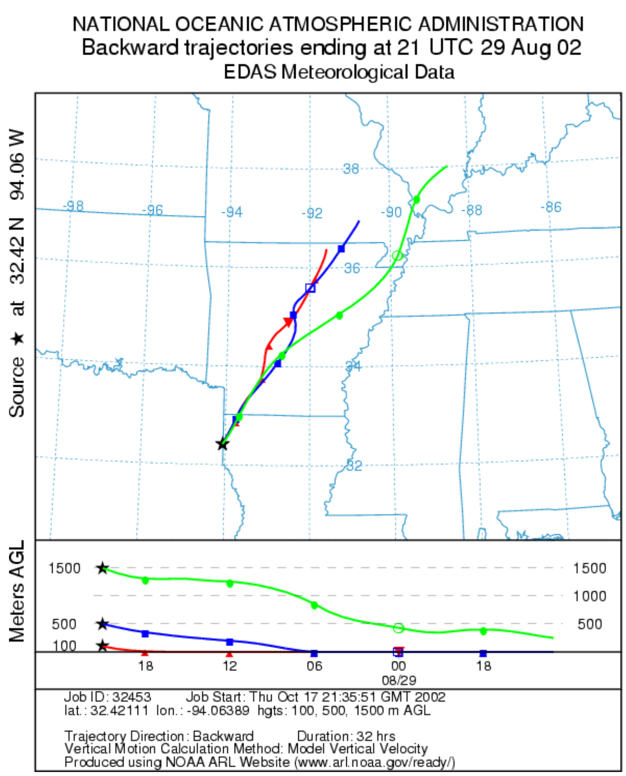
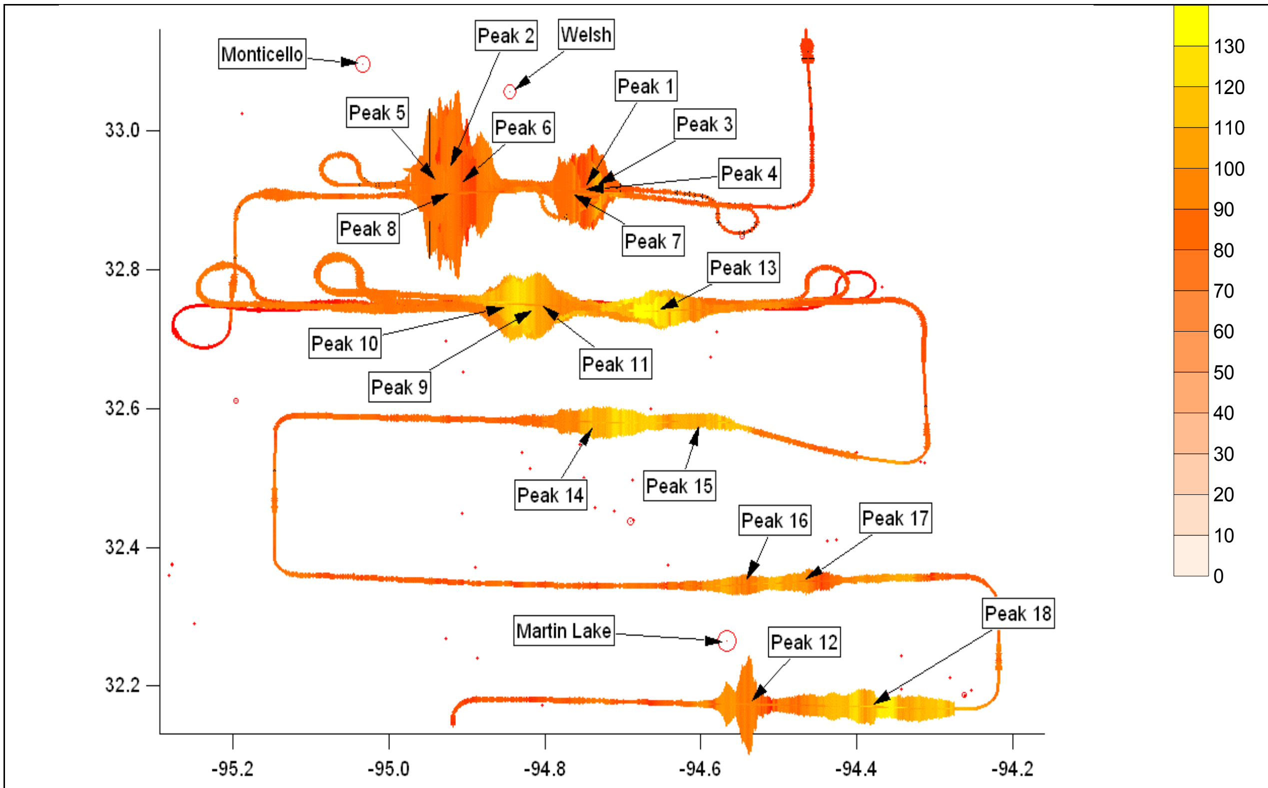


Figure 2-3. Back trajectories for mid afternoon of 29 August 2002.

TEXAQS 2000 AIRCRAFT FLIGHT

Ozone formation in power plant plumes has been studied extensively in Texas and elsewhere. A NOAA Lockheed Electra aircraft collected data in Northeast Texas in connection with the 2000 Texas Air Quality Study (TexAQS2000). A flight on 3 September 2000 provided data on power plant plumes in Northeast Texas and these data were analyzed by NETAC (Vizuete, 2002). Plumes were identified by looking for SO_2 concentration peaks at locations downwind of major NO_x sources such as the Monticello, Welsh, or Martin Lake power plants (see Figure 3-1 for a map showing the locations of these sources). SO_2 and ozone concentrations along the aircraft flight path are shown along with the locations of the NOx point sources in Figure 2-4. Ozone concentrations are indicated by the color scale and the thickness of the line indicates the magnitude of the SO_2 concentration. NOx point sources are indicated by circles with magnitudes proportional to the magnitude of NOx emissions. Winds were out of the northwest during this flight. Varying amounts of ozone formation are evident downwind of the Monticello, Welsh and Martin Lake power plants. As pointed out by Ryerson et al. (2001), ozone formation in NOx point source plumes is sensitive to the amount and overall reactivity of VOCs in the environment into which the plume is dispersing relative to the NOx concentration in the plume since ozone formation efficiency (moles O_3 produced per mole NOx) is a strong function of the VOC/NO_x ratio. This explains why the amount of ozone observed in a plumes from different sources may vary widely even under similar meteorological conditions and why the amount of ozone formed in a plume from a given source will vary from day to day in response to changes in dispersion conditions. Regional background ozone was close to the level of the 8-hr standard (85 ppb) during this flight and the ozone production from power plant emissions resulted in ozone aloft exceeding the level of the 1-hr standard (125 ppb).



Line color indicates the ozone concentration (ppb).
Line thickness indicates the magnitude of the SO_2 concentration.
Circles locate NOx point sources with magnitude indicated by the diameter of the circle

Figure 2-4. TexAQS aircraft flight path on 3 September 2000 showing ozone and SO_2 concentrations downwind of major point sources in Northeast Texas. (Source: Vizuete, 2002).

OZONE TRENDS

Figure 2-5 shows the 1995 – 2003 trend in the annual fourth highest daily maximum 8-hour average ozone concentrations (the "annual design value") at monitoring sites in Northeast Texas and the Shreveport area (Bossier and Caddo parishes). Annual design values are shown here because they are part of the attainment status determination discussed below. In general the trends are similar over all sites, with values generally increasing to a maximum in 1999 before falling again. Sites in Louisiana show the same general trend as the Northeast Texas sites. However, a change appears to have occurred at the Longview monitoring site beginning in 2001. During 1995 – 2000, the highest annual design value always occurred at Longview (except in 1996) but as of 2001, the annual design value at Longview is nearly equal to that at Tyler and is much closer to the levels observed in Louisiana.

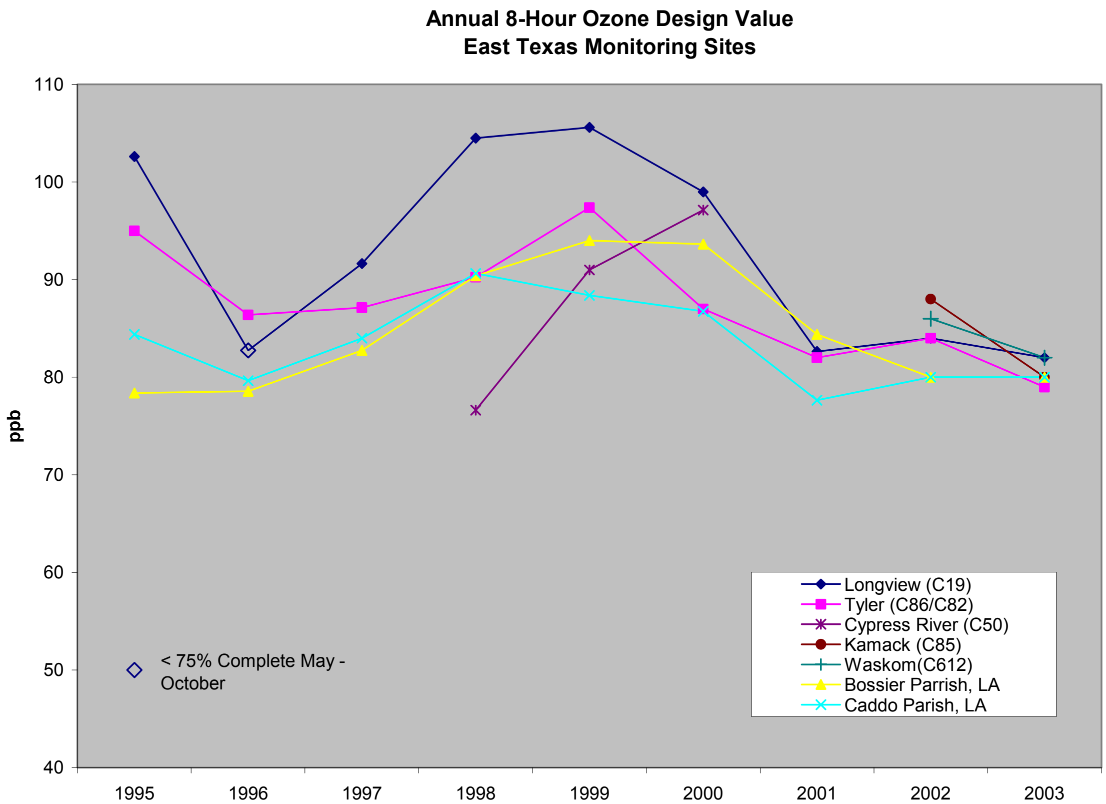


Figure 2-5. Annual 8-hour ozone design values at Northeast Texas and northwestern Louisiana monitoring sites: 1995 – 2003.

Ozone trends for 1995 – 2002 at Longview and Tyler are compared with Dallas and Shreveport in Figure 2-6. Annual 8-hour design values at Shreveport are based on the maximum of the Caddo and Bossier parish design values; annual 8-hour design values for Dallas are based on the maximum over five sites for which valid design values were available in each year. Trends at all locations share similar features. The annual design value in Dallas is higher than at the other locations in every year except 1998 and, in contrast to annual design values in Northeast Texas and Shreveport, did not drop off significantly in 2001 and 2002. Annual design values at Longview were comparable to those in Dallas during 1998 – 2000 but were much lower (and instead comparable to those at Tyler and in Shreveport) in 1996-1997 and 2001-2002.

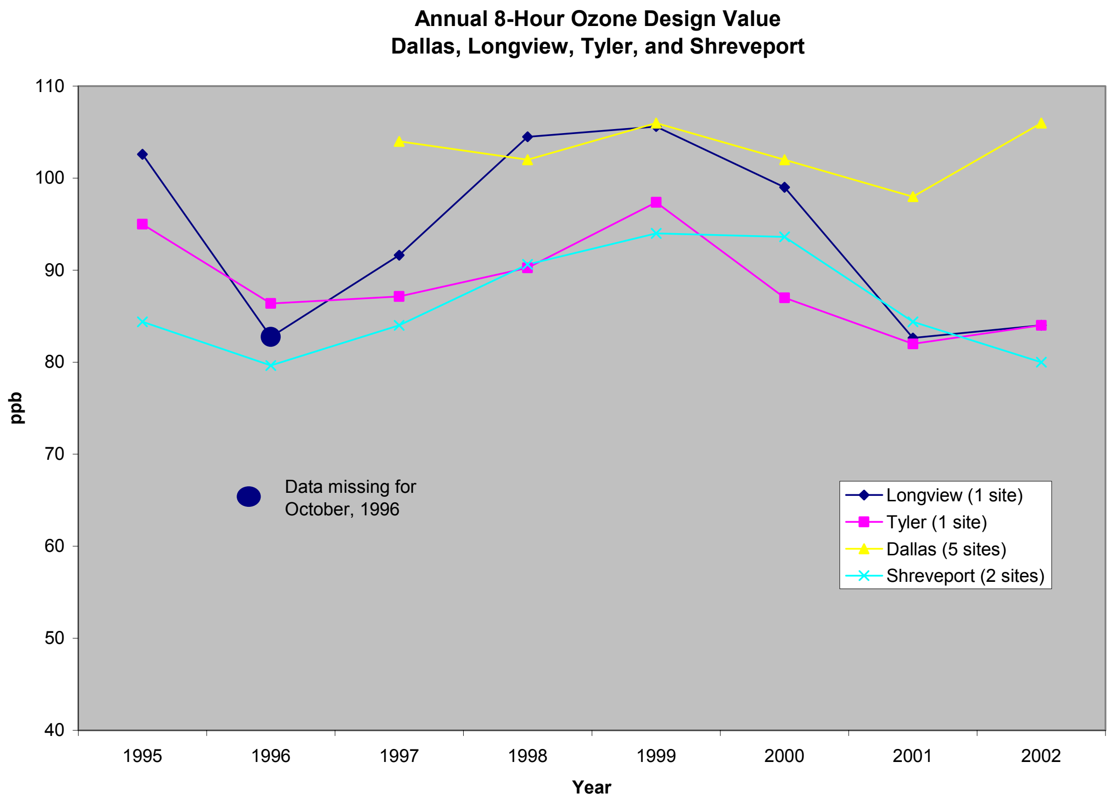


Figure 2-6. Annual 8-hour ozone design values at locations in Northeast Texas, Dallas, and Shreveport, LA.

OZONE ATTAINMENT STATUS

EPA's National Ambient Air Quality Standard for ozone includes both a 1-hour average standard and an 8-hour average standard. The 1-hour standard limits the frequency with which the daily maximum 1-hour average concentration can exceed 0.12 ppm to once per year (averaged over three years) while the 8-hour standard sets a maximum level (0.08 ppm) for the three year running average of the annual fourth-highest daily maximum 8-hour average concentration.[2] The 1-hour standard is violated if the fourth highest concentration in a period of three consecutive years exceeds 0.12 ppm.[3]

No monitor in Northeast Texas recorded a 1-hour ozone level exceeding 125 ppb in 2001 to 2003 and so the area is monitoring attainment of the 1-hour standard.

The annual fourth highest daily maximum 8-hour ozone values for 2001 to 2003 are shown in Table 2-1 for monitors in Northeast Texas. The 2003 data are preliminary until they have been quality assured by the TCEQ and submitted to EPA. The Karnack and Waskom monitors have only 2 years of data and so will not be used by EPA in attainment designations based on 2001 to

[2] Under the rounding conventions specified in the standard, the 1-hour standard is exceeded by a concentration of 125 ppb or greater while the 8-hour standard is exceeded by a concentration of 85 ppb or greater.
[3] Because the 1-hour standard is actually based on the expected value of the annual exceedance rate (which allows for adjustment of the exceedance count for missing data), it is possible under rare circumstances to record a violation of the standard even if the fourth highest daily 1-hour maximum in three years is less than 0.12 ppm.

2003 data. Two-year design values are shown for Karnak and Waskom because they are used in the ozone attainment demonstration modeling (Section 6) and for comparison with Longview and Tyler. The preliminary 2001-2003 8-hour ozone design values for Longview and Tyler are both below 85 ppb and so Northeast Texas is monitoring attainment of the 8-hour standard.

Table 2-1. Annual fourth highest daily maximum 8-hour ozone values and preliminary 2001-2003 8-hour ozone design values for Northeast Texas.

Year	Longview	Tyler	Karnack	Waskom
2001	82	82	Partial Season	Not Operating
2002	84	84	88	86
2003	82	79	80	82
Design Value	**82**	**81**	**(84)**	**(84)**

Notes: 2003 data are preliminary
The two-year design values for Karnack and Waskom will not be used for attainment designation.

3. EMISSIONS INVENTORY AND TRENDS

Emission inventories were developed for photochemical ozone modeling and emissions trends analysis. Both of these activities directly support EAC milestones and are used in the 8-hour ozone attainment demonstration for Northeast Texas. The ozone modeling requires emissions inventories for the 1999 episode year, the 2002 base year for the attainment demonstration and the 2007 future year for the attainment demonstration. The emissions trends analysis uses the 1999, 2002 and 2007 emissions inventories and in addition uses a 2012 inventory in a "maintenance for growth" analysis. This section describes how the emission inventories were developed, shows emission inventory results for Northeast Texas and discusses the trends in Northeast Texas emissions from 1999 through 2012.

INVENTORY DEVELOPMENT

The emission inventory development for the Northeast Texas EAC followed EPA's guidance to local areas in preparing an EAC. Specifically, the emissions inventories used the latest versions of EPA's mobile source emissions models called MOBILE6 and NONROAD2002 and were based on emission inventory data for 1999 or a more recent year. The data sources and modeling procedures are outlined below and discussed in more detail in Yarwood et al., (2004).

In general, the approach was to develop the most detailed emissions data for all sources in Northeast Texas, develop detailed data for the most important sources in areas adjacent to Northeast Texas, and use current, available data elsewhere. The emission inventories for on-road mobile and biogenic sources have known dependencies upon ambient conditions and so were adjusted to account for day specific temperature and humidity conditions. For major point sources equipped with continuous emission monitors (CEMs), the reported data were used to develop day-specific and in some cases hourly-specific emissions.

On-Road Mobile Sources

All on-road mobile source emissions were based on EPA's MOBILE6 model. Control measures for on-road mobile sources were modeled by MOBILE6 and are discussed below in Section 6.

<u>1999 On-Road</u>

NE Texas: Link-based emissions from MOBILE6.2 for 4 day of week scenarios (weekday, Friday, Saturday, Sunday) in 1999 developed by the Texas Transportation Institute (TTI) for the TCEQ with day-specific adjustments for temperature and humidity. Link-based emissions were available for Gregg and Smith counties whereas Harrison, Rusk and Upshur counties had county level activity data.

Rest of Texas: County-level emissions (HPMS format) from MOBILE6 for 4 day of week scenarios developed by TTI with day-specific adjustments for temperature and humidity.

Other States: EPA's ozone season day emissions from the National Emission Inventory version 2 (NEI99v2) based on MOBILE6. For Oklahoma, day specific MOBILE6.2 emission inventories from the Oklahoma Department of Environmental Quality.

2002 On-Road

NE Texas: Link-based emissions from MOBILE6.2 for 4 day of week scenarios and 2002 vehicle miles traveled (VMT) and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.
Rest of Texas: County-level emissions from MOBILE6 for 4 day of week scenarios and 2002 VMT and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.
Other States: MOBILE6.2 county level emissions for typical summer day conditions (as used in the NEI999v2) with EPA data for 2002 VMT and fleet turnover.

2007 On-Road

NE Texas: Link-based emissions from MOBILE6.2 for 4 day of week scenarios and 2007 vehicle miles traveled (VMT) and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.
Rest of Texas: County-level emissions from MOBILE6 for 4 day of week scenarios and 2007 VMT and fleet turnover developed by TTI with day-specific adjustments for temperature and humidity.
Other States: MOBILE6.2 county level emissions for typical summer day conditions (as used in the NEI999v2) with EPA data for 2007 VMT and fleet turnover.

Off-Road Mobile Sources

Off-road mobile source emissions for all categories except aircraft, commercial marine and locomotives were from EPA's 2002 version of the NONROAD model (NONROADv2002). The default data included with the NONROAD model were used except as noted below. The NONROAD model provides estimates of emissions for all of the years needed in this study. Emissions for aircraft, commercial marine and locomotives are not included in NONROAD and so were estimated by NETAC, TCEQ or EPA for 1999 and projected to other years using EPA data including the Economic Growth Analysis System (EGAS). Control measures for off-road mobile sources were modeled by NONROADv2002 and are discussed below in Section 6.

1999 Off-Road

NE Texas: NONROADv2002 with local data for mining and construction equipment as discussed below. Aircraft and railroad emissions estimated by Pollution Solutions (2002) for 1999.
Rest of Texas: NONROADv2002 with input data developed by TCEQ. Aircraft, commercial marine and railroad emissions from TCEQ.
Other States: The NEI99v2 ozone season day inventory, which is based on NONROADv2002.

2002 Off-Road

NE Texas: NONROADv2002 with local data for mining and construction equipment. Aircraft and railroad emissions estimated for 1999 by Pollution Solutions (2002) grown to 2002 with EGAS projections.
Rest of Texas: NONROADv2002 with input data developed by TCEQ. Aircraft, commercial marine and railroad emissions for 1999 from TCEQ grown to 2002 with EGAS projections.
Other States: NONROADv2002 with default input data for 2002. Aircraft, commercial marine and railroad emissions for 1999 from NEI99v2 grown to 2002 with EGAS projections.

2007 Off-Road

NE Texas: NONROADv2002 with local data for mining and construction equipment. Aircraft and railroad emissions estimated for 1999 by Pollution Solutions (2002) grown to 2007 with EGAS projections.
Rest of Texas: NONROADv2002 with input data developed by TCEQ. Aircraft, commercial marine and railroad emissions for 2007 from TCEQ.
Other States: NONROADv2002 with default input data for 2007. Aircraft, commercial marine and railroad emissions for 2007 developed by EPA for a rulemaking on "heavy duty diesel" emissions.

Area Sources

Emissions for stationary sources that are not individually inventoried (area sources) were based on data developed for 1999 by EPA, TCEQ and NETAC. Emissions for years later than 1999 were projected using EGAS and other data. Control measures for area sources are discussed below in Section 6.

1999 Area Sources

NE Texas: NETAC 1999 emission inventory for a typical ozone season day developed by Pollution Solutions (1999).
Rest of Texas: TCEQ 1999 ozone season day inventory.
Other States: EPA NEI99v2 ozone season day inventory.

2002 Area Sources

NE Texas: NETAC 1999 emission inventory grown to 2002 using EGAS except for oil and gas emissions which were grown from 1999 using the ratio of 2002 to 1999 production.
Rest of Texas: TCEQ 1999 emission inventory grown to 2002 using EGAS except for oil and gas emissions which were grown from 1999 using the ratio of 2002 to 1999 production.
Other States: EPA NEI99v2 grown to 2002 using EGAS.

<u>2007 Area Sources</u>

NE Texas: NETAC 1999 emission inventory grown to 2007 using EGAS except for oil and gas emissions which were grown from 1999 using recent production trends.
Rest of Texas: TCEQ 1999 emission inventory grown to 2007 using EGAS except for oil and gas emissions which were grown from 1999 using recent production trends.
Other States: EPA 2007 emission inventory developed for a rulemaking on “heavy duty diesel” emissions.

Point Sources

Emissions for stationary sources that are inventoried individually (point sources) were based on data from EPA, TCEQ the Louisiana Department of Environmental Quality and NETAC. For electrical generating units (EGUs) we used data on actual emissions from continuous emissions monitors (CEMs) as reported to EPA’s Acid Rain Database. Control measures have produced significant reductions in EGU emissions in Northeast Texas since 1999 as discussed below in Section 6.

<u>1999 Point Sources</u>

NE Texas: Day specific emissions for Eastman Chemical Company in Longview provided by NETAC. Hourly, day specific emissions for EGUs provided by TCEQ were reviewed for accuracy by NETAC (no changes were made).
Texas EGU: Hourly, day specific Acid Rain data provided by TCEQ (version 15a).
Texas nonEgu: TCEQ 1999 point source emission inventory (PSDB version 15a).
Texas minor: TCEQ 1999 emission inventory.
LA EGU: Hourly, day specific Acid Rain data provided by TCEQ (version 4).
LA nonEGU: 1999 ozone season day inventory from LDEQ provided by TCEQ (version 4). OK
EGU: Hourly, day specific Acid Rain data from EPA.
OK nonEgu: NEI99v2 ozone season day inventory with ODEQ corrections.
Other States: NEI99v2 ozone season day inventory.

<u>2002 Point Sources</u>

NE Texas: 2002 emissions for Eastman Chemical Company in Longview provided by NETAC.
Texas EGU: 2002, 3rd quarter average Acid Rain data from EPA.
Texas nonEgu: TCEQ 2000 point source emission inventory (PSDB version 12a).
Texas minor: TCEQ 1999 emission inventory.
LA EGU: 2002, 3rd quarter average Acid Rain data from EPA.
LA nonEGU: NEI99v2 ozone season day inventory.
OK EGU: 2002, 3rd quarter average Acid Rain data from EPA.
OK nonEGU: NEI99v2 ozone season day inventory with ODEQ corrections.
AR EGU: 2002, 3rd quarter average Acid Rain data from EPA.
AR nonEGU: NEI99v2 ozone season day inventory.
Other States: NEI99v2 ozone season day inventory with EGUs adjusted so that each State total EGU emissions match the 2002, 3rd quarter average Acid Rain data.

2007 Point Sources

NE Texas: 2002 emissions for Eastman Chemical Company in Longview provided by NETAC. Major EGU emissions at permit limits established in the NE Texas 1hour ozone SIP modeling as described below in Chapter 6. Newly permitted sources expected to be completed by 2007 at permit emission levels.
Texas EGU: Hourly EGU 30-day peak ozone season emission rates based on Acid Rain data for 1997, 1998 and 1999 adjusted by TCEQ to implement Texas NOx rules.
Texas nonEgu TCEQ 2007 nonEGU inventory.
Other States: EPA 2007 emission inventory developed for a rulemaking on "heavy duty diesel" emissions.

Biogenic Emissions

Biogenic emission inventories were developed using version 3.1 of the GloBEIS model (Yarwood et al., 2003) with landcover databases from the TCEQ and EPA. This is the model used by the TCEQ and other groups in Texas for SIP and EAC modeling. The biogenic emission inventories were developed for hourly specific temperature, solar radiation and humidity conditions during the 1999 episode period. The biogenic emissions also accounted for drought conditions during the episode. The biogenic emissions for 2002 and 2007 were unchanged from 1999.

Preparing Inventories for Modeling

Emission inventories for ozone modeling were prepared using the Emissions Processing System version 2 with extensions to improve speed and efficiency (EPS2x). The EPS2x emissions model is used by the TCEQ for SIP modeling and by other near-nonattainment areas in Texas for EAC modeling allowing for easy exchange of modeling information between these groups. EPS2x was used for the following emissions processing tasks as required for each source category:

- Temporal allocation
- Spatial allocation
- Chemical speciation
- Applying growth and controls

NETAC EMISSIONS STUDIES

NETAC has developed complete emission inventories for the 5 County NETAC area for 1995, 1996 and 1999 and these inventories were submitted to the TCEQ. The TCEQ submitted the 1999 emission inventory to EPA for the National Emission Inventory (NEI). These emission inventories were developed according to EPA and TCEQ guidance as described for the 1999 inventory in a report by Pollution Solutions (2002). These studies revealed several source categories where special studies would be valuable to collect local data and improve the emissions inventory.

Oil and Gas Production

Northeast Texas is an oil and gas producing area and a NETAC emission inventory for 1996 suggested that gas production was a significant contributor to stationary source NOx emissions. The 1996 emission inventory was uncertain due to a lack of data on what types of equipment (compressors, dryers, etc.) were typically being used at wells in Northeast Texas. NETAC sponsored a survey to collect local data on equipment types to improve the oil and gas emissions inventory. The survey data for equipment types were combined with emission factor data and gas produced per county to estimate area source emissions in each county. This methodology accounts for emissions from many pieces of equipment that are too small to appear in the point source inventory. Several large compressors on gas pipelines are accounted for separately in the point source inventory. The improved oil and gas emissions estimates are described in the 1999 emission inventory for Northeast Texas (Pollution Solutions, 2002) that was submitted to the TCEQ and EPA.

Construction Equipment

The NONROAD model includes data on the populations of construction equipment by county for the entire US. These default data are necessarily developed using a top down approach that may not accurately represent the actual equipment populations and operating schedules for the construction equipment in Northeast Texas. EPA encourages areas to collect local data to supplement or replace the NONROAD default data. NETAC funded a study to survey the owners of construction equipment including cities and counties, highway maintenance contractors and equipment rental companies. The NONROAD model calculations for emissions from construction equipment were improved by incorporating the local data as described by Lindhjem and Chandraker (2003).

Mining Equipment

There are two large mines in Northeast Texas area that produce lignite fuel for nearby utility boilers. The emissions from the off-road equipment at these mines are estimated using the EPA's NONROAD model. The NONROAD model contains default data for the equipment at the mines, but these data are assembled using a top-down approach that may not accurately represent the actual equipment populations and operating schedules for the mines. NETAC funded a study to survey the mine operators and used the data collected to replace the default NONROAD model data. The off-road mobile source emission inventories were updated using the local data as described by Lindhjem and Chandraker (2003).

EMISSIONS IN THE NETAC AREA

The 1999 emission inventory for the 5 counties in the NETAC area is summarized in Tables 3-1 through 3-3 for NOx, VOC and CO, respectively. These tables show the episode average day emissions for August 13-22, 1999 where the days are weighted together so that weekdays have a weight of 4/7 and Fridays, Saturdays and Sundays each have a weight of 1/7. The episode average emissions are shown to fairly represent emissions over the entire episode period. Table 3-2 shows the dominant role of biogenic sources in the VOC emissions inventory for the 5-county area: biogenics account for 89 percent of the total VOC emissions. For 1999 NOx emissions in the 5county area, point sources account for 50 percent, on-road mobile sources account for 25 percent, area sources for account 16 percent, off-road mobile sources for 8 percent and biogenic sources for less than 1 percent of the total NOx emissions.

Point sources are the largest contributor to the NOx emission inventory in the NETAC 5-county area. The locations and magnitudes of the largest NOx point sources in the 4 km CAMx modeling grid are shown in Figures 3-1 through 3-3 for 1999, 2002 and 2007, respectively. These figures show the episode average emissions calculated as described above and have the 5 NETAC counties shaded in gray. In 1999, four major sources in the 5-county area (Martin Lake, Pirkey, Eastman and Knox Lee) accounted for 127 out of 145 tons/day of point source NOx emissions. The total emissions for these four facilities declined to 81 tons/day in 2002 and 92 tons/day in the 2007 inventory. The emission controls that lead to these reductions are described in Section 6. The fact that the 2007 emissions (92 tons) are higher than the 2002 emissions (88 tons) reflects differing assumptions for the EGU sources (i.e., Martin Lake, Pirkey and Knox Lee). The 2002 EGU emissions are based on actual 3rd quarter (July-September 2002) average emissions reported to EPA's Acid Rain database based on CEM data. The 2007 emissions reflect Permit maximum emission rates which are higher than summer average rates for two reasons: (1) EGU sources are unlikely to operate at permit limits for prolonged periods and; (2) summer average heat input rates tend to be below the episodic heat input rates used to calculate the 2007 emissions. The Permit maximum emission rates were calculated by multiplying the Permit limit emission factors (lb/MMBtu) by episodic heat input rates (MMBtu/hour) from July 1997, as used in the 1-hour SIP revision for Northeast Texas (TNRCC, 2002).

Table 3-1. 1999 episode average day NOx emissions (tons) for the NETAC area.

Source Category	Gregg County	Harrison County	Rusk County	Smith County	Upshur County
Area	12.0	7.8	12.9	5.0	8.3
Off-road	4.4	6.0	2.5	6.5	2.4
On-road	22.9	17.7	4.1	25.5	2.7
Points	14.7	45.5	79.9	3.6	1.0
Subtotal	**54.0**	**77.0**	**99.4**	**40.6**	**14.4**
Biogenics	0.2	0.5	0.5	0.7	0.4
Total	**54.2**	**77.5**	**99.9**	**41.3**	**14.9**

Table 3-2. 1999 episode average day VOC emissions (tons) for the NETAC area.

Source Category	Gregg County	Harrison County	Rusk County	Smith County	Upshur County
Area	13.6	12.7	11.3	13.0	13.1
Off-road	2.5	1.5	1.1	4.2	0.5
On-road	6.5	5.5	3.2	10.5	2.1
Points	3.4	15.3	2.0	8.5	0.8
Subtotal	**26.0**	**34.9**	**17.5**	**36.2**	**16.5**
Biogenics	65.0	316.8	271.8	253.9	157.1
Total	**91.0**	**351.7**	**289.4**	**290.1**	**173.5**

Table 3-3. 1999 episode average day CO emissions (tons) for the NETAC area.

Source Category	Gregg County	Harrison County	Rusk County	Smith County	Upshur County
Area	3.4	6.8	8.0	7.7	5.2
Off-road	44.0	11.6	8.9	56.2	5.3
On-road	82.3	75.7	39.4	135.8	25.9
Points	5.7	12.7	6.1	2.1	0.7
Subtotal	**135.5**	**106.9**	**62.4**	**201.8**	**37.2**
Biogenics	6.0	30.9	27.9	24.2	15.6
Total	**141.5**	**137.8**	**90.3**	**226.0**	**52.8**

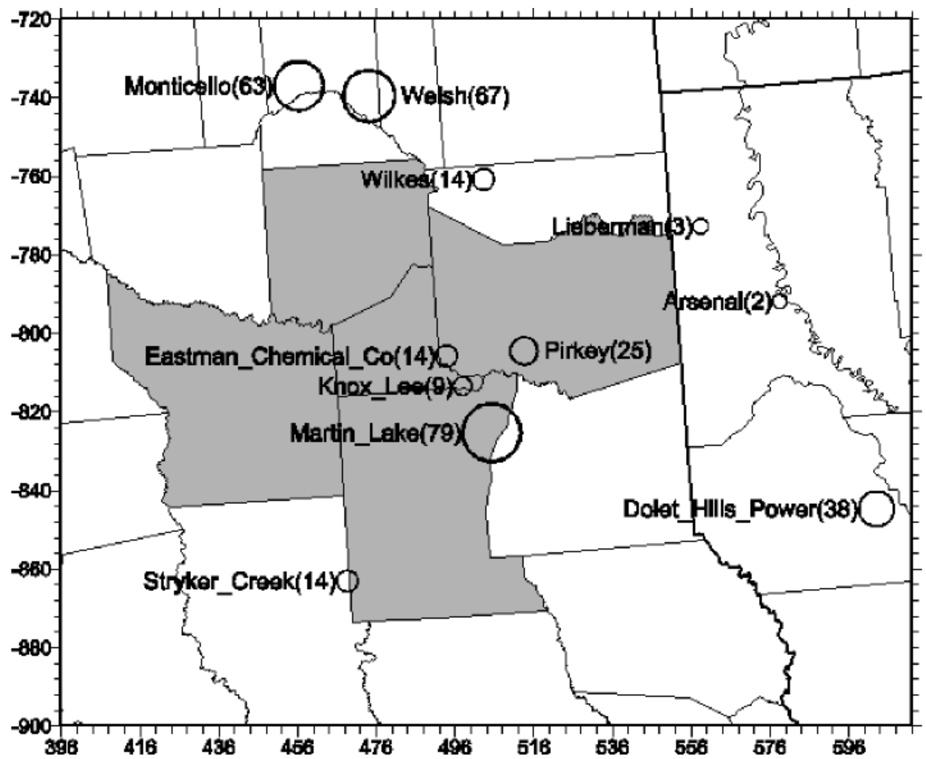


Figure 3-1. Episode average day NOx emissions (tons/day) in 1999 for major point sources in the 4 km grid.

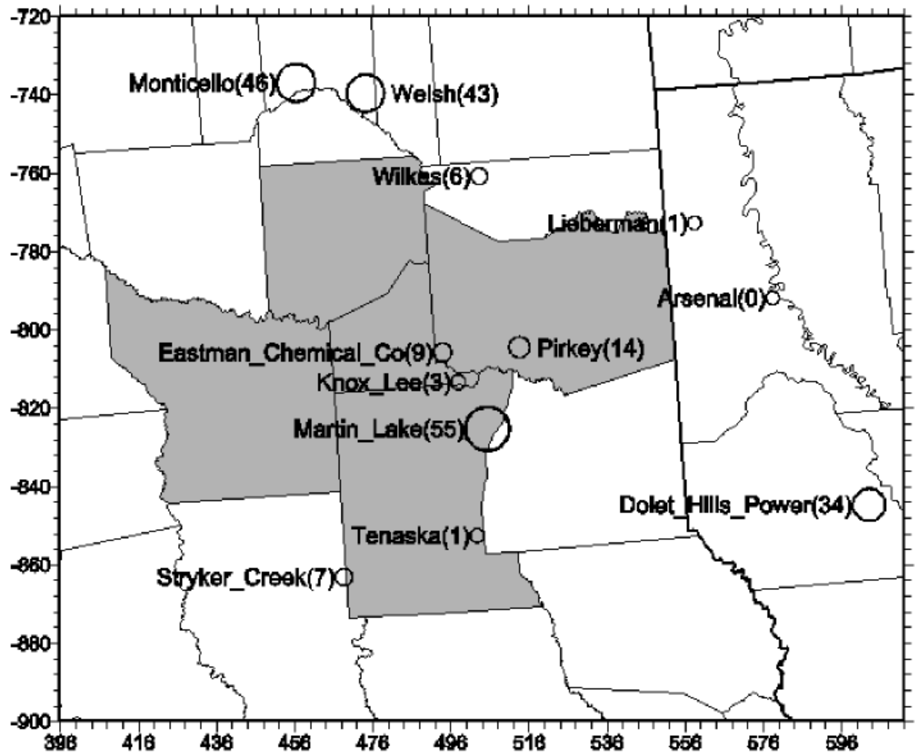


Figure 3-2. Episode average day NOx emissions (tons/day) in 2002 for major point sources in the 4 km grid.

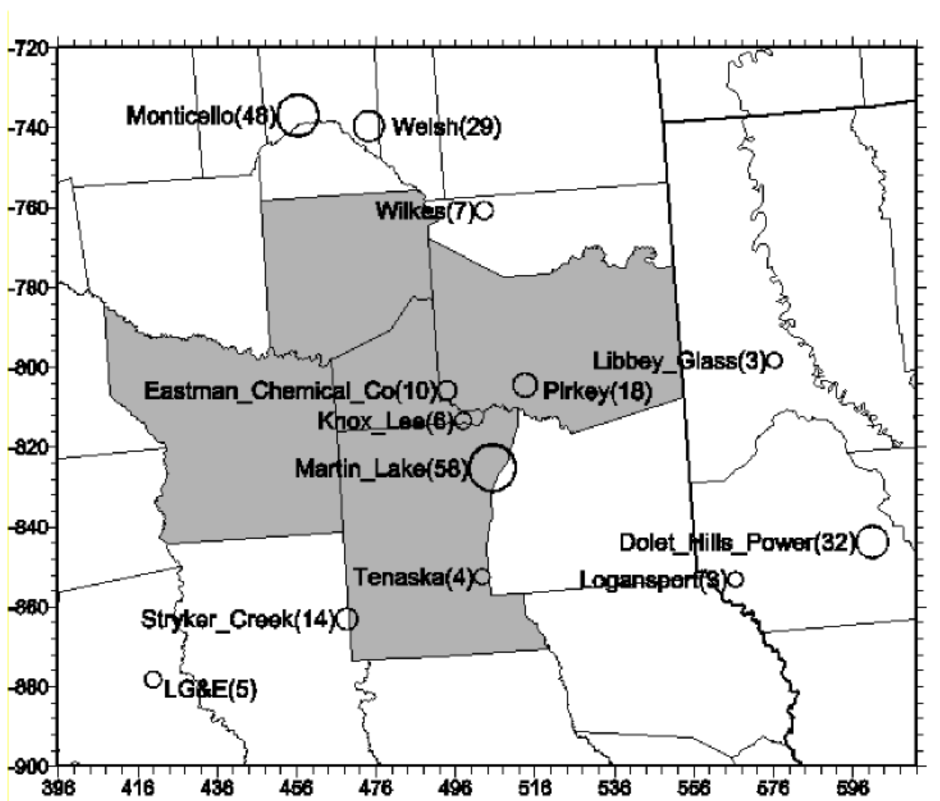
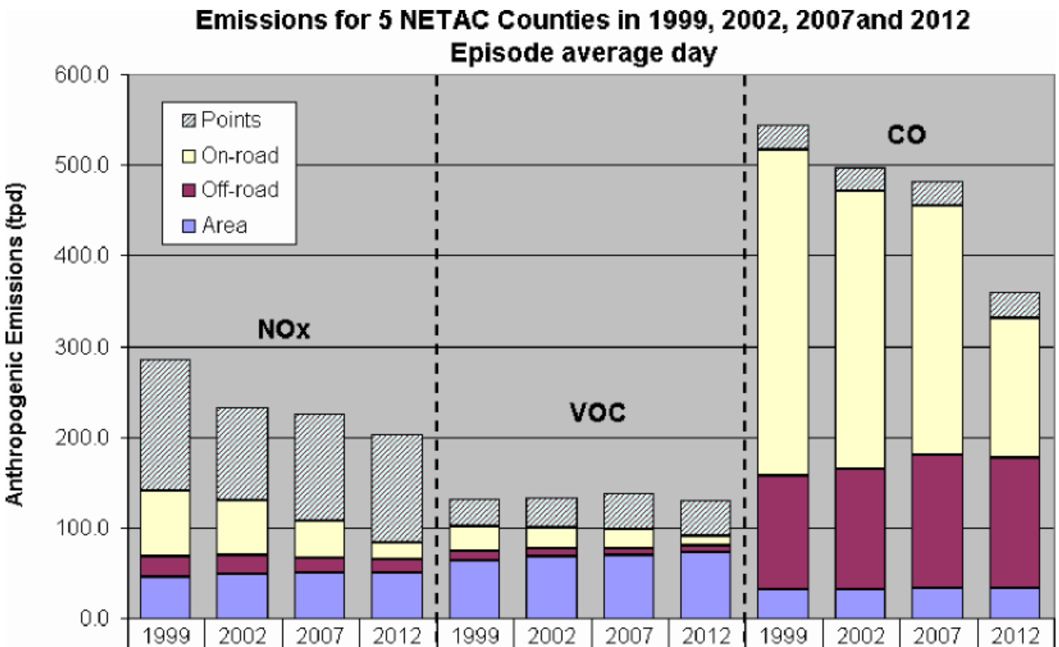


Figure 3-3. Episode average day NOx emissions (tons/day) in 2007 for major point sources in the 4 km grid.

EMISSIONS TRENDS

The trends in anthropogenic emissions from 1999 to 2002 to 2007 to 2012 are shown in Figure 3-4. This figure shows episode average day emissions for the NETAC 5-county area calculated by weighting days of the week as described above. The biogenic emissions are excluded from Figure 3-4 because they do not vary by year.



	1999	2002	2007	2012	1999	2002	2007	2012	1999	2002	2007	2012
Points	144.7	102.1	118.5	118.5	29.9	33.0	39.5	39.5	27.4	25.8	28.3	28.3
On-road	72.9	61.6	40.0	19.2	27.7	23.2	21.3	11.0	359.1	307.5	274.2	154.2
Off-road	21.9	19.9	16.8	13.9	9.8	9.3	7.7	7.8	126.1	132.5	147.1	142.8
Area	46.0	49.0	50.1	50.6	63.7	67.4	69.5	72.1	31.1	32.0	33.0	34.0

Figure 3-4. Trends in Northeast Texas episode average anthropogenic emissions (tons/day) from 1999 to 2012.

Total anthropogenic NOx emissions decrease monotonically from 1999 to 2012 due primarily to decreases in point source NOx in the early years and decreases in mobile source NOx in the later years. As discussed in section 6, the decreases in point source NOx result from NETAC control measures whereas the decreases in mobile source NOx result in Federal control programs for light-duty, heavy-duty and off-road vehicles. The Federal control programs for heavy-duty diesel vehicles have a relatively large impact in the NETAC area because I-20 runs through Smith, Gregg and Harrison Counties.

Total anthropogenic VOC emissions increase slightly from 1999 to 2007 due primarily to increases in area source VOCs, but then decrease from 2007 to 2012 due to decreases in mobile source VOCs. The mobile source control programs are described in Section 6. Remember that anthropogenic VOC emissions were only about 11 percent of total VOCs in 1999 due to the dominant influence of biogenic emissions.

Total anthropogenic CO emissions decrease monotonically from 1999 to 2012 due to sharply decreasing on-road mobile source CO emissions, combined with the fact that on-road sources are the largest contributor to CO emissions.

4. CONCEPTUAL MODEL FOR HIGH OZONE IN NORTHEAST TEXAS

NETAC prepared a conceptual model for ozone formation as part of the technical analyses for the EAC (Stoeckenius et al., 2004). The conceptual model synthesized all of the air quality and emissions data for the region (as summarized in Sections 2 and 3, above) to build an understanding of the conditions that lead to high ozone events and therefore the strategies that are expected to be effective in reducing ozone levels. The conceptual model complements ozone modeling and is used in the ozone modeling for episode selection and model performance evaluation. This section presents the findings from the conceptual model report.

SUMMARY OF FINDINGS

Ozone concentrations in Northeast Texas have historically exceeded the maximum allowable level specified in EPA's 8-hour National Ambient Air Quality Standard (NAAQS), the most recent violation occurred at Longview in the 2000 – 2002 attainment period. However, the annual 8-hour design value at Longview decreased markedly between 2000 and 2001 and this site (along with Tyler) is not in violation of the NAAQS for the 2001 – 2003 period. Other monitoring sites in the area (located at Karnack and Waskom in eastern Gregg county) did not have sufficient data to calculate 2001 – 2003 design values.

Episodes of high ozone concentrations in Northeast Texas occur most often between June and September when the area is under the influence of a semi-permanent subtropical high-pressure system, vertical mixing of pollutants in the atmosphere is restricted, skies are clear to partly cloudy, temperatures are high and winds are light. Most episodes are associated with near-surface winds from either the east/northeast or south/southwest with the latter direction appearing less consistently on the highest days and with greater variability in direction. Episodes can be classified as either "stagnant" with very little inflow of air from outside of Northeast Texas or "transport" with material usually arriving in Northeast Texas from northwestern Louisiana, southern Arkansas or southeastern Texas.

On a regional scale, emissions of ozone precursors in Northeast Texas are dominated by highly reactive biogenic VOCs such as isoprene; anthropogenic sources account for only 9% of total daily VOC emissions in the NETAC 5-county area. The overall VOC:NOx emission ratios in the five county area in 2002 is estimated to be 33:1, well within the NOx limited ozone formation regime. As a result, reductions in NOx will be generally more effective in controlling ozone on a regional basis than reductions in anthropogenic VOC. Under the right conditions, NOx from various sources, which include several large electricity generating units in addition to on- and off-road mobile sources and other stationary sources, combine with the (mostly biogenic) VOC to make significant amounts of ozone. Correlations of hourly ozone with sulfur dioxide (SO_2) peaks at Longview are indicative of the influence of large lignite or coal combustion sources. Limited evidence from aircraft and surface data indicate that significant ozone formation may also be associated with plumes of NOx and anthropogenic highly reactive VOCs (HRVOCs) from point sources in the area. Sources of HRVOCs in the NETAC area include the Eastman/Huntsman complex near Longview. Reductions in HRVOC emissions from this source can be expected to lower ozone levels nearby and at the Longview monitor.

Ozone formed within and just upwind of the NETAC area is often augmented by transport of elevated ozone concentrations from outside the area, almost always from the east/northeast or south/southwest. Aircraft observations have shown large areas with 70 – 85 ppb ozone upwind of Northeast Texas to the east/northeast. Only a small amount of additional local ozone production is needed under such conditions to exceed the level of the 8-hour ozone NAAQS.

Prior to 2002, the maximum 8-hour ozone design value typically occurred at the Longview monitor. With reduction in ozone at Longview and the establishment of the Karnack and Waskom monitoring sites near the TX-LA border, the location of the maximum design value shifted to these new sites in eastern Harrison County in 2003. An analysis of back trajectories for the ten 8-hour exceedance days at these sites in 2002 – 2003 indicates that five of these exceedances appear to be associated with same-day transport from the Shreveport area. Exceedances did not occur at Tyler or Longview on four of these five days. Of the remaining five days, three were associated with transport from the NE; exceedances at Tyler and Longview occurred on one of these three days. These results suggest that the Karnack and Waskom 8-hour design values may be more responsive than the Tyler or Longview design values to future emission reductions in northwestern Louisiana.

Ozone formation is known to be sensitive to meteorological conditions: high ozone in the NETAC zrea is associated with warm, stable air masses and light winds from the east/northeast or south/southwest. EPA has noted that the decrease in ozone design values in Northeast Texas between 1998 – 2000 and 2001 – 2003 is coincident with a drop in the frequency of very hot days (temperatures greater than 100 ºF). However, other meteorological factors, as measured by the frequency with which forecasters predicted Ozone Action days for the area, did not indicate a reduced potential for high ozone in 2001 – 2003. The ozone reductions in 2001 – 2003 also coincide with a sharp decrease in NOx emissions. This decrease is largely due to reductions in point source NOx implemented as part of the 1-hour State Implementation Plan revisions (total VOC emissions were largely unchanged). As noted above, one would expect a causal relationship between NOx reductions and ozone decreases. However, a quantitative evaluation of the relative contributions of emission reductions vs. meteorological conditions to the recent decrease in ozone design values may not be obtainable.

NOx emissions in Northeast Texas are projected to decline further by 2007 due to continued reductions in emissions from on-road mobile sources. These reductions should result in a further decline in local ozone levels. In addition, super-regional emission reductions required by the provisions of EPA's NOx SIP call will continue to take effect in many southeastern states between 2003 and 2007. These regional NOx reductions should result in lower background ozone levels upwind of northeast Texas.

A review of high ozone episodes in 2000 – 2003 shows that meteorological conditions associated with these events are similar to episodes in the 1995 – 1999 period, the reduced frequency of high ozone in the more recent period not withstanding. This suggests that the August 13-22, 1999 episode selected for ozone modeling is still appropriate for purposes of fulfilling requirements of the ozone Early Action Compact. It is therefore not necessary to model new episodes beyond the August 13-22, 1999 episode that is the basis for the EAC modeling.

5. MODELING 8-HOUR OZONE

Modeling for the Northeast Texas EAC followed the EPA's draft guidance for 8-hour ozone modeling (EPA, 1999). The modeling procedures were developed in a modeling protocol (ENVIRON, 2003) and the results described in an ozone modeling report (Yarwood et al., 2004). This section summarizes the modeling procedures and results including the evaluation of model performance for 8-hour ozone.

EPISODE SELECTION

An August 15 – August 22, 1999 ozone episode was selected for evaluating 8-hour ozone in Northeast Texas (Stoeckenius et al., 2004). The modeling period was expanded to August 13 – August 22, 1999 to include 2 spin-up days before the start of the episode to reduce the influence in the modeling of initial conditions. As discussed below, this period includes combined influences from a high regional ozone background and local emissions, and includes a complete cycle of transport winds followed by local stagnation returning to transport winds at the end of the episode. This is a typical pattern for high 8-hour ozone events in Northeast Texas (Stoeckenius et al., 2004).

The ozone data recorded at Continuous Air Monitoring Stations (CAMS) in Northeast Texas during this period are shown in Table 5-1. 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 Cypress River 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 monitored levels on August 16th and 17th that were significantly higher than at Tyler or Cypress River 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.

Table 5-1. Maximum ozone levels and temperatures for the August 1999 episode days.

Date	Longview Maximum Temperature (ºF)	Max 8-hour Ozone (ppb)		
		Longview CAMS 19	Tyler CAMS 82	Cypress River CAMS 50
8/15/99	93	66	73	55
8/16/99	95	105	92	71
8/17/99	96	110	97	90
8/18/99	99	88	74	91
8/19/99	102	91	85	81
8/20/99	97	80	86	70
8/21/99	95	87	92	67
8/22/99	96	91	77	82

Back trajectories 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.

Back trajectories for several days between August 16th and 22nd, 1999 are shown in Figure 5-1. 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 5-1). 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 organized but weak easterly winds on August 16th transitioning to stagnation on August 17th. The stagnation persisted through August 19th. On August 20th the back trajectories become more organized again with winds from the northeast, but the back trajectories for August 20th (and August 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. This pattern shows a complete cycle of an episode beginning with transport winds from the East/Northeast followed by local stagnation returning to transport winds from the East/Northeast at the end of the episode. This is a typical pattern for high 8-hour ozone events in Northeast Texas (Stoeckenius et al., 2004).

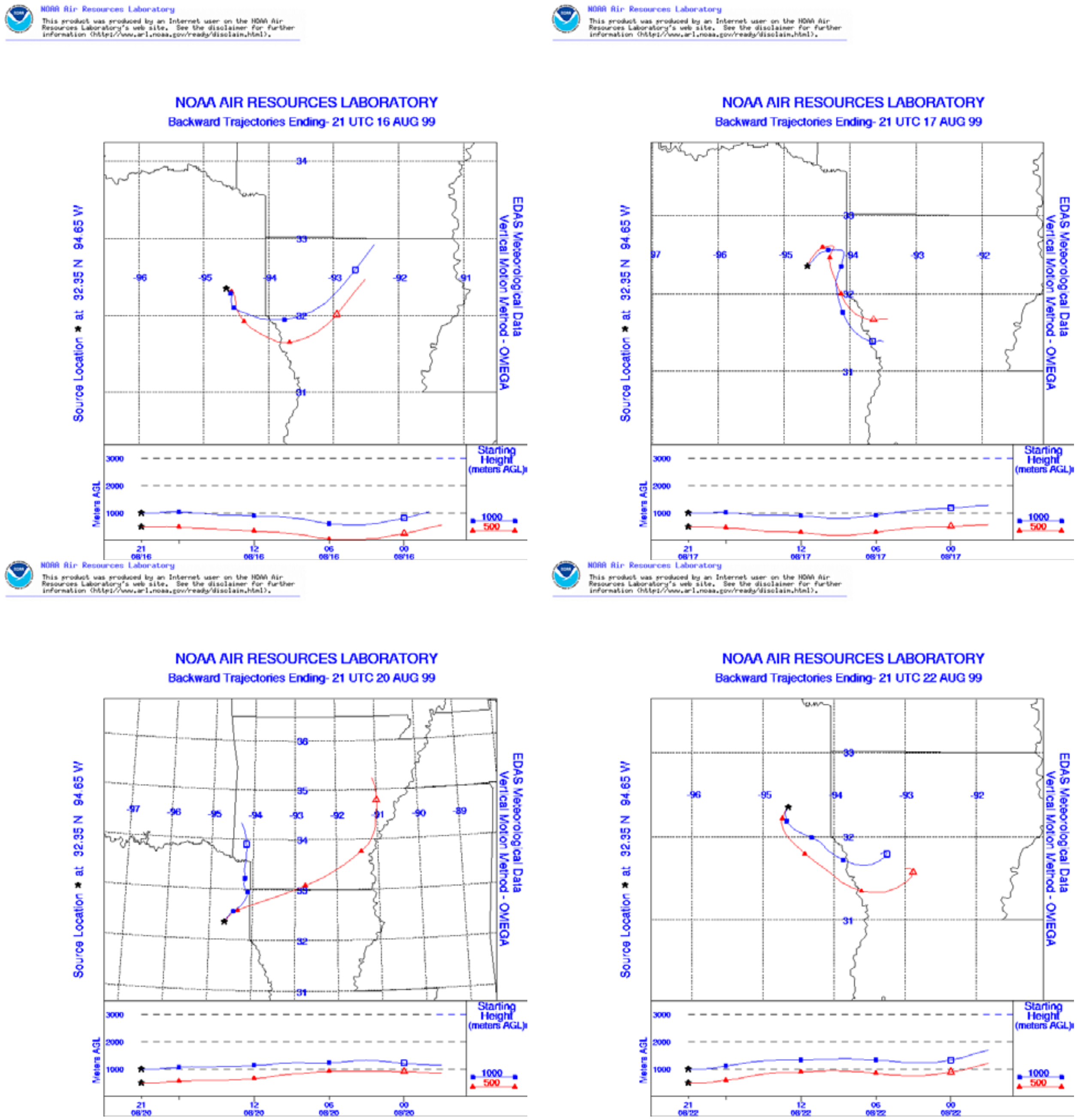


Figure 5-1. Back trajectories ending at Longview at 15:00 CDT on August 16th, 17th, 20th and 22nd, 1999.

MODELING DOMAIN

The following factors were considered in defining the ozone modeling domain:

- Placing a high-resolution (4 km) grid over the key monitors, sources and urban areas in Northeast Texas.
- The Northeast Texas 4 km grid must be large enough to include local and nearby major sources of emissions.
- The regional domain must extend far enough upwind to include all sources that might contribute substantially to elevated ozone levels in Northeast Texas. EPA's guidance (EPA, 1999) is that regional domains should account for potential transport distances of about 2 days upwind. Back trajectory analyses suggest that under high 8-hour ozone conditions in Northeast Texas 2-3 day back trajectories may extend as far as the Midwest.
- The ozone model (CAMx) grid must closely match the meteorological model (MM5) grid to minimize distortion of the meteorological variables in transferring data from MM5 to CAMx.

The ozone modeling domains are shown in Figures 5-2 and 5-3. The ozone modeling uses nested 36 km, 12km and 4 km grids. The 36 km grid extends as far as the Midwest to account for 2-3 days of potential regional transport. The 12 km grid includes all of the areas in eastern Texas that are conducting ozone modeling so that a consistent 12 km grid can be used in all studies. In addition, the 12 km grid includes areas that would be upwind of Texas during an ozone episode with easterly or northeasterly winds. The intention is to accurately model potential transport of ozone from areas at a distance upwind of about one State. The 4 km grid covers Northeast Texas and immediately adjacent major urban areas and major sources.

The vertical grid structure for the ozone model was selected based EPA modeling guidance (EPA, 1999) that has the following recommendations on vertical layer structure:

- Use 7-9 layers in the planetary boundary layer (PBL, the daily maximum mixing depth)
- The surface layer should be no thicker than 50 m
- No layer within the Planetary Boundary Layer (PBL) should be thicker than 300 m
- Add 1 or 2 layers above the PBL.

The ozone modeling used 15 layers that exactly match the meteorological model layers up to approximately 4000 m above ground level. Under typical elevated ozone conditions in Northeast Texas the maximum depth of the PBL (i.e. mixing height) is about 1500-2000 m AGL. This means that modeling had about 10 layers within the typical maximum PBL, including a 20 m surface layer.

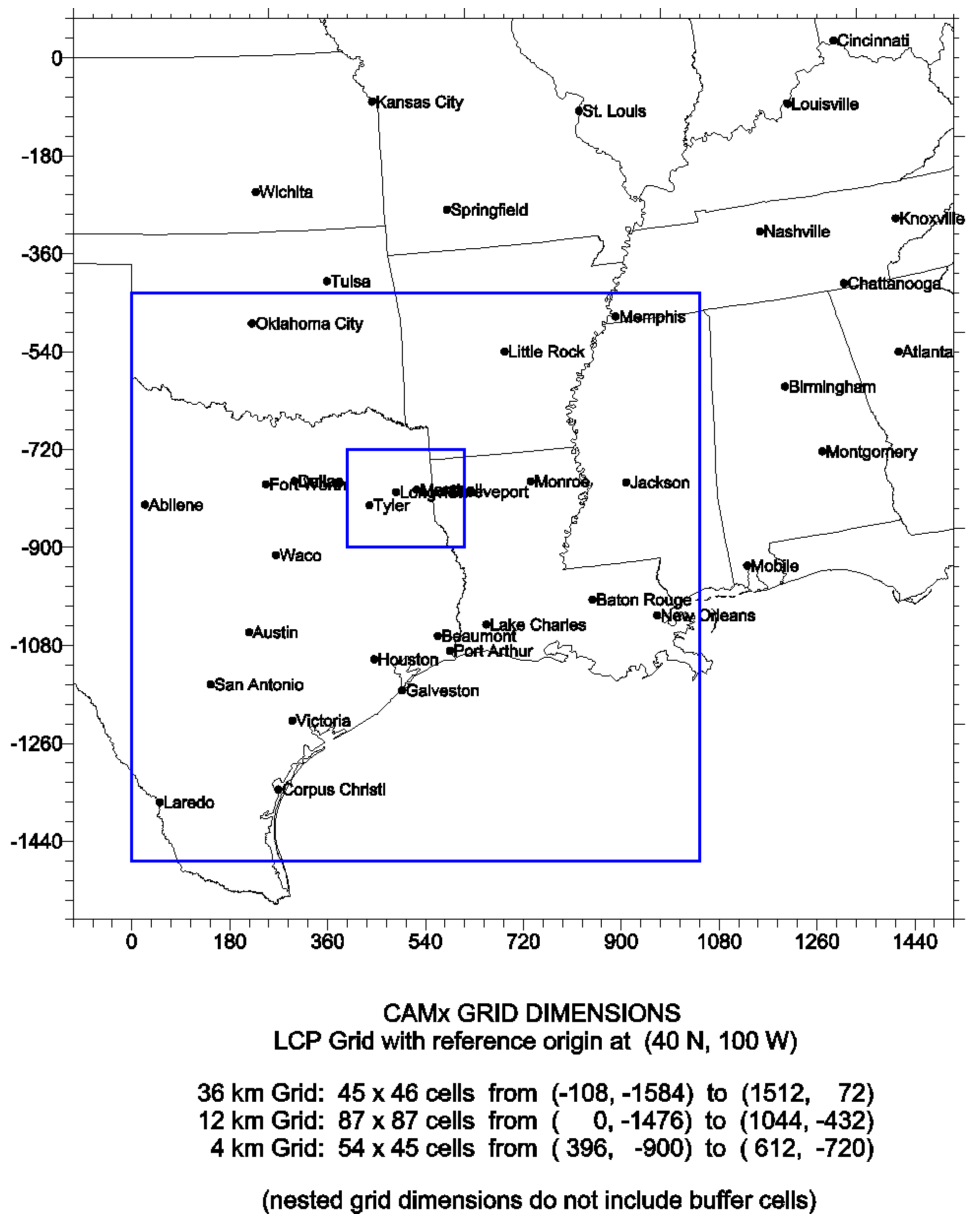


Figure 5-2. CAMx modeling domain for the August 1999 episode showing the 36 km regional grid and the nested 12 km and 4 km fine grids.

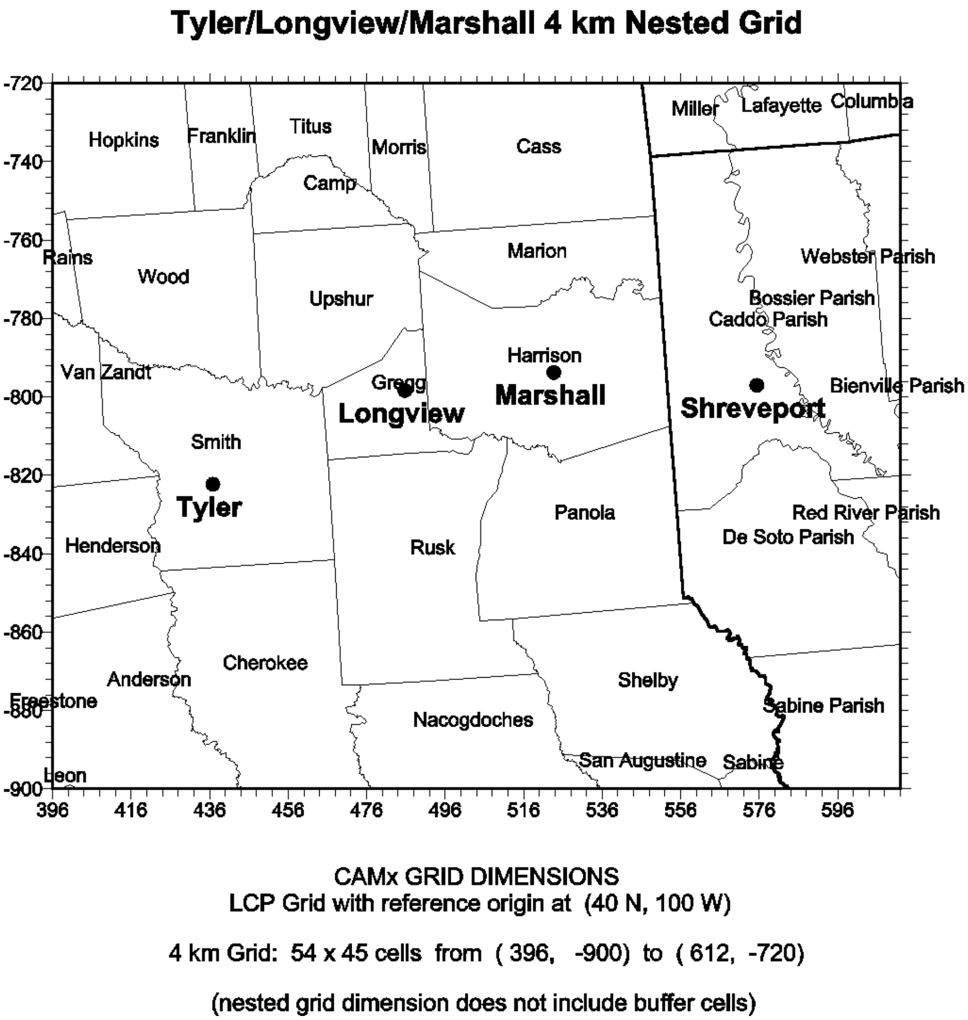


Figure 5-3. CAMx 4 km fine grid covering Northeast Texas for the August 1999 episode.

MODELS AND DATA SOURCES

The models selected for this study include:

- The Fifth Generation PSU/NCAR Mesoscale Model (MM5, version 3.4) meteorological model (Dudhia, 1993)
- Version 2x of the Emissions Processing System (EPS2x)
- The Comprehensive Air quality Model with extensions (CAMx, version 4.03) photochemical grid model (ENVIRON, 2004)

These are the same modeling tools that are being used by the TCEQ for SIP modeling and other areas in Texas for EAC modeling. Further details on the modeling and model input data are given in Yarwood et al., (2004). The emissions inventory data are described above in Section 3.

Boundary and Initial 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 throughout the simulation. The boundary condition assumptions are discussed because they played a role in achieving good ozone model performance. The boundary conditions are shown in Table 5-2. The ozone BC was set to 40 ppb, which is the value commonly considered to be the continental background and used for ozone modeling studies. The NOx BC was set to 1.1 ppb. The VOC BCs varied by boundary segment over a range from 9 to 50 ppbC according to broad differences in land cover. The higher VOC BCs in the Northeast/East boundary segment are for areas with higher biogenic emissions (Goldan et al., 1995; Watkins et al., 1995). The lower VOC BCs along the West boundary segment are for dryer areas with lower biogenic emissions. The lowest VOC BCs are over the Gulf of Mexico and these low values were also used for all boundaries above an altitude of 1700 m. The initial conditions were set to the lowest (Gulf of Mexico) BC values.

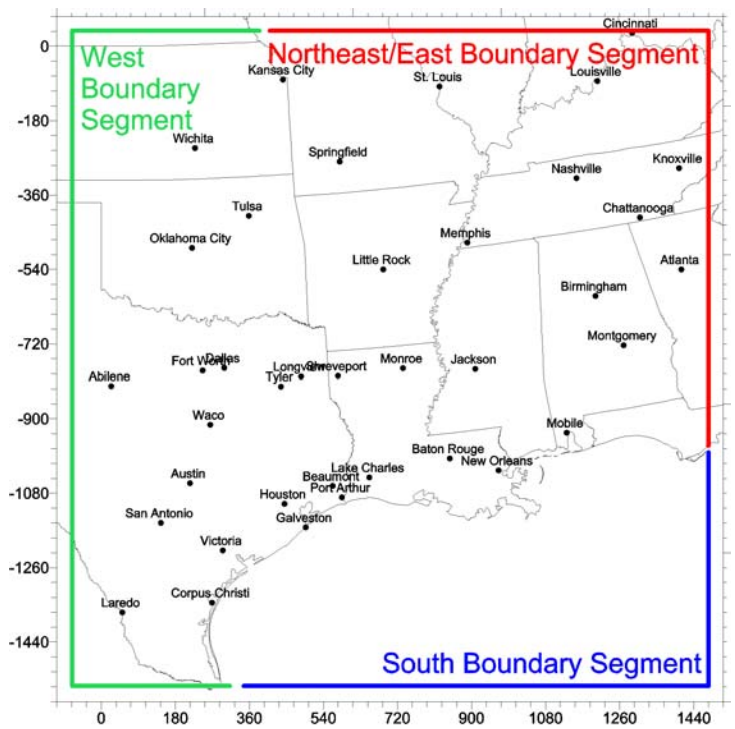


Figure 5-4. CAMx 36 km regional modeling domain showing boundary segments that are assigned different boundary conditions (BCs).

Table 5-2. Boundary concentrations for different boundary segments shown in Figure 5-4.

Species	East/Northeastern Boundary	Western Boundary	Southern Boundary
O3 (ppb)	40.0	40.0	40.0
NOx (ppb)	1.1	1.1	1.1
VOC (ppbC)	50.5	22.3	9.3

MODEL PERFORMANCE EVALUATION

The performance of the ozone modeling for 15-22 August 1999 was evaluated according to EPA's draft guidance for 8-hour ozone modeling (EPA, 1999). This guidance suggests several methods that can be used to evaluate the performance of air quality models and in some cases suggest performance goals. In general, the draft 8-hour guidance differs from earlier EPA modeling guidance by encouraging use of a variety of evaluation methods to seek good performance for the right reasons as opposed to establishing a few rigid criteria. NETAC used several graphical and statistical methods to evaluate performance as listed below.

Graphical Performance Evaluation Methods:

- Isopleth plots of predictions and observations
- Time-series plots of predictions and observations
- Scatter plots of predictions and observations
- Quantile-quantile (Q-Q) plots of predictions and observations

Statistical Performance Evaluation Methods:

- Normalized bias for prediction/observation pairs (goal within 15%)
- Gross error predictions and observations (goal within 35%)
- Peak prediction and observation (goal within 20%)
- Correlation coefficient from prediction/observation scatter plots (goal moderate to large positive correlations)
- Bias in predicted/observed daily maximum near each monitor (goal within 20% at most monitors).

The performance evaluation focused on the NETAC area and statistical measures were calculated for monitors in Northeast Texas that were operating during the episode (Table 5-1). The normalized bias and gross error statistics were calculated for observed values above 60 ppb.

A series of model sensitivity and diagnostic tests was performed to investigate the relationship between model performance and the input data and model configuration. These tests resulted in improvements to the meteorology (from MM5) and the boundary conditions, discussed above.

The main features of the model performance are shown in a series of charts and tables that follow.

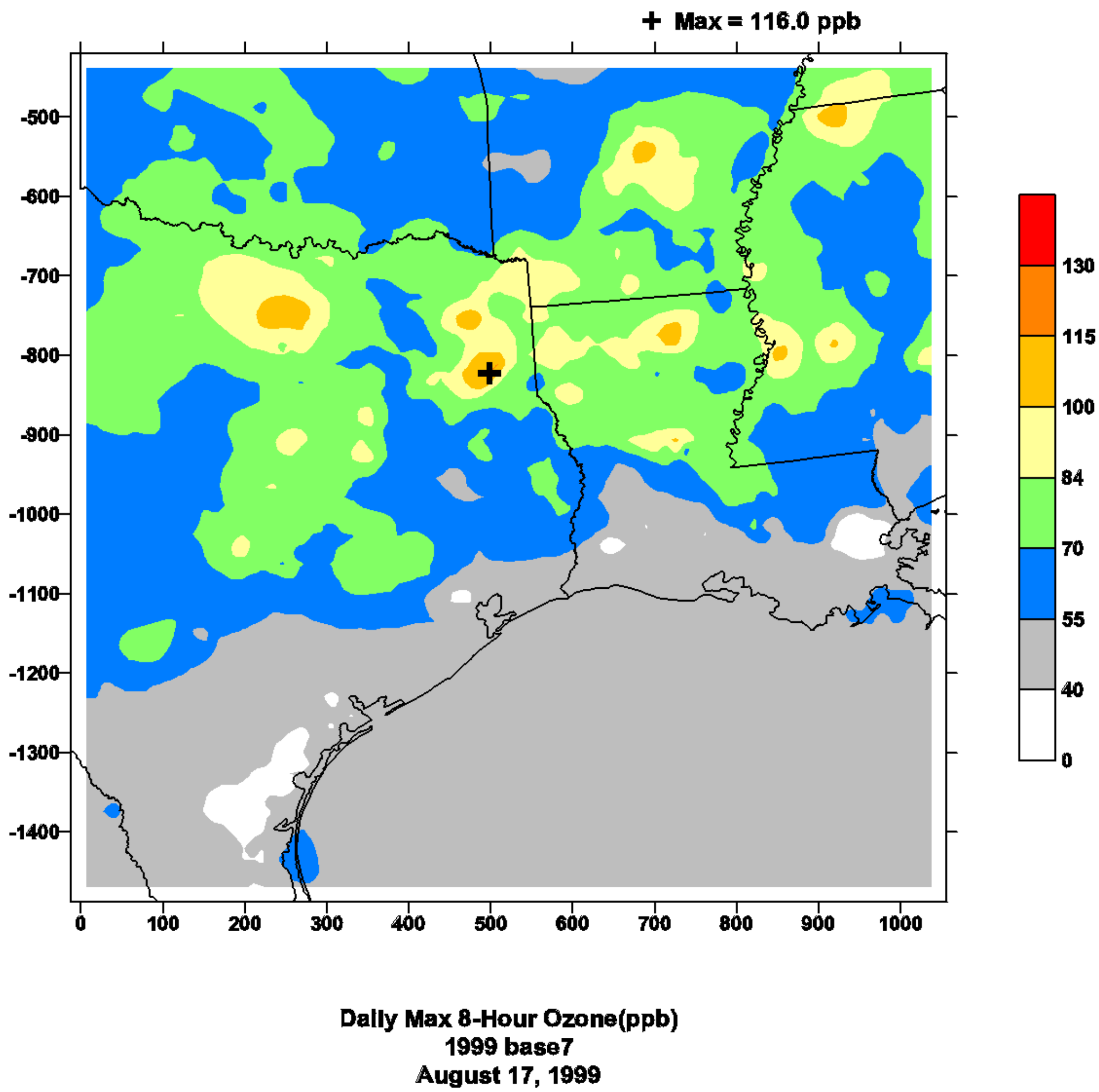


Figure 5-5. Daily maximum 8-hour ozone (ppb) for the 12 km grid on 17 August 1999.

Daily maximum modeled 8-hour ozone levels for the regional 12 km grid are shown for August 17th by the colored shading in Figure 5-5. This day is at the heart of the ozone episode in Northeast Texas and the figure shows high ozone levels covering northern Texas, northern Louisiana and southern Arkansas due to regional weather stagnation. The highest modeled ozone levels are in Northeast Texas because this is near the center of the stagnation allowing local anthropogenic and biogenic emissions to interact under conditions that are conducive to ozone formation. Ozone production within Northeast Texas combined with the regional background lead to the high ozone levels modeled in the region on August 17th and following days. This pattern is consistent with the conceptual model for high 8-hour ozone episodes in Northeast Texas in general and the 15-22 August 1999 ozone episode in particular.

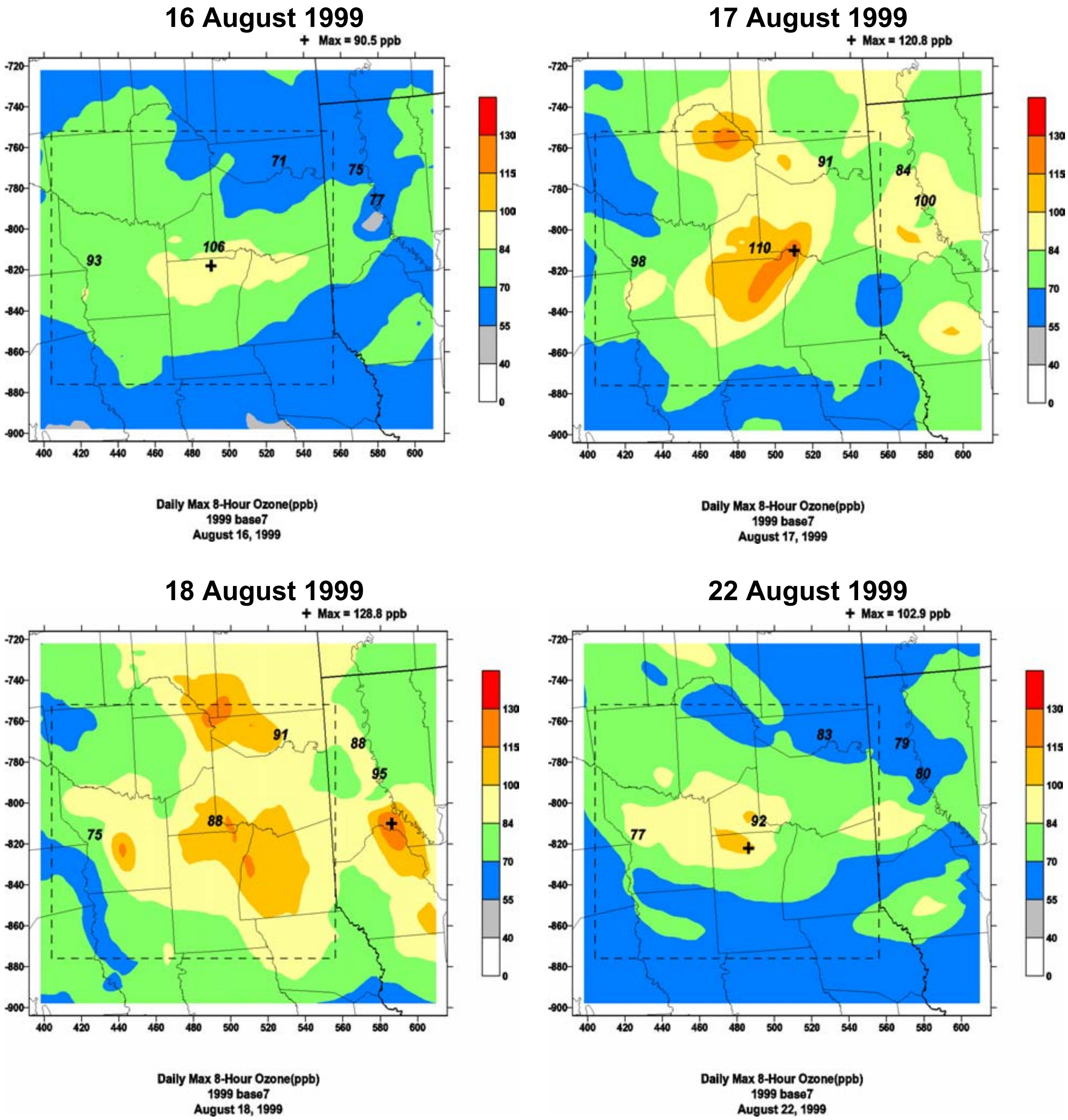


Figure 5-6. Daily maximum 8-hour ozone (ppb) for the 4 km grid.

The modeled and observed daily maximum 8-hour ozone levels for the 4 km grid are shown in Figure 5-6 for the 16th, 17th, 18th and 22nd August 1999. The modeled ozone is shown by the colored shading and monitored values are shown as numbers. The model has a tendency to under predict the observed maximum ozone levels on August 16th at both the upwind monitors (Cypress River and Shreveport) and Longview/Tyler suggesting the background ozone transported into Northeast Texas may be too low in the model. The modeled and observed ozone levels agree better on August 17th and 18th when the modeling does not tend to under predict ozone. On August 22nd the modeled maximum ozone levels at Tyler and Longview agree well with the observed values but at the upwind monitors (Cypress River and Shreveport) the modeling under predicts the maximum ozone levels again suggesting that the background ozone transported into Northeast Texas may be too low in the model. These same model performance features are shown in the time series of 8-hour ozone shown in Figure 5-7. In addition, the time series show that the model performs well in predicting the timing of the daily peak ozone levels. The largest differences in the time series occur at night, especially at the rural Cypress River monitor during the heart of the episode. These differences are not problematic since it can be difficult to obtain good nighttime model performance because limited atmospheric mixing at night means that monitors can be influenced by localized sources and conditions that are not resolved at 4 km grid resolution.

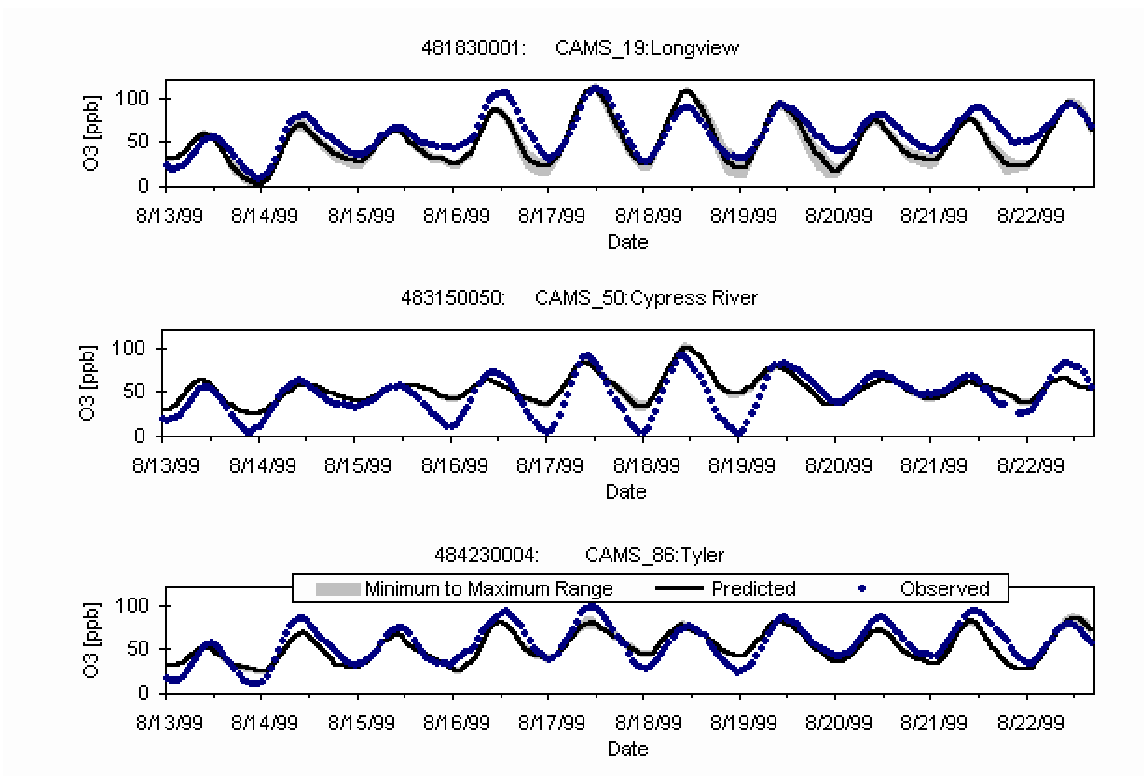


Figure 5-7. Time series of 8-hour ozone (ppb) for monitors in Northeast Texas.

Several model performance statistics were calculated from the data shown in Figure 5-7 and the results are shown in Table 5-3. The “normalized bias” indicates whether there was a tendency to over or under predict observed ozone concentrations greater than 60 ppb at monitor locations on each day. There is an under prediction bias on all days except August 18th but the bias is within the EPA goal on 6 of 8 days. The “accuracy of the peak” indicates whether there was a tendency to over or under predict the highest observed ozone concentrations on each day. The observed peak was over predicted on 6 of 8 days and was outside the EPA goal of 20% on two days. Taken together with the conclusions from the Figure 5-6 isopleth plots discussed above, these results indicate that the negative bias results from too little ozone transport into Northeast Texas rather than a lack of local ozone production. The “normalized gross error” describes the level of agreement between the modeled and observed ozone at the monitor locations and the gross error values shown in Table 5-3 are well within the EPA performance goal on all days.

Table 5-3. Model performance statistics for 8-hour ozone at monitors in Northeast Texas.

CAMx 8-Hour O3 Summary Statistics		Run = base7						Cutoff = 60 ppb	
	EPA Goal	8/15	8/16	8/17	8/18	8/19	8/20	8/21	8/22
Number of valid pairs		13	33	35	28	36	32	34	33
Normalized Bias (%)	< +/-15	-8.6	-18.5	-6.4	14.0	-5.2	-13.3	-20.4	-3.9
Normalized Gross Error (%)	< 35	8.6	18.5	10.0	14.2	8.9	13.3	20.4	10.8
Peak Observed (ppb)		73.0	105.6	110.1	91.0	91.9	86.1	92.9	91.9
Peak Pred (ppb)		78.1	90.5	120.8	121.3	117.9	98.2	90.9	102.9
Accuracy of Peak (%)	< +/-20	6.9	-14.3	9.7	33.3	28.3	14.0	-2.1	12.0

Some of the negative bias values shown in Table 5-3 may result from spatial miss-matches between the locations of modeled and observed high ozone. EPA’s draft 8-hour modeling guidance (EPA, 1999) introduced some new graphical and statistical comparisons that focus on ozone “near” the monitoring locations. The same definition of “near” is used for these new comparisons as for the attainment demonstration methodology and so the new comparisons evaluate the modeling in the way that it will be used. When using a 4 km grid, near the monitor is defined as a block of 7 by 7 grid cells centered on the monitor location.

Figure 5-8 shows a scatter plot of nearest observed and predicted 8-hour ozone (ppb) near monitor locations in Northeast Texas. This figure includes several performance evaluation methods:

- The scatter plot of predicted/observed pairs (blue diamonds) shows values centered on the 1:1 line with no clear tendency toward over or under prediction.
- The predicted/observed values all lay within 20% of the 1:1 line meeting the goal.
- The correlation coefficient (r^2) for the scatter plot of predicted/observed pairs is 0.76, which meets the goal of a moderate to large positive correlation.
- The quantile-quantile plot (circles) lays very close to the 1:1 line showing that the observations and predictions have similar distributions of values.

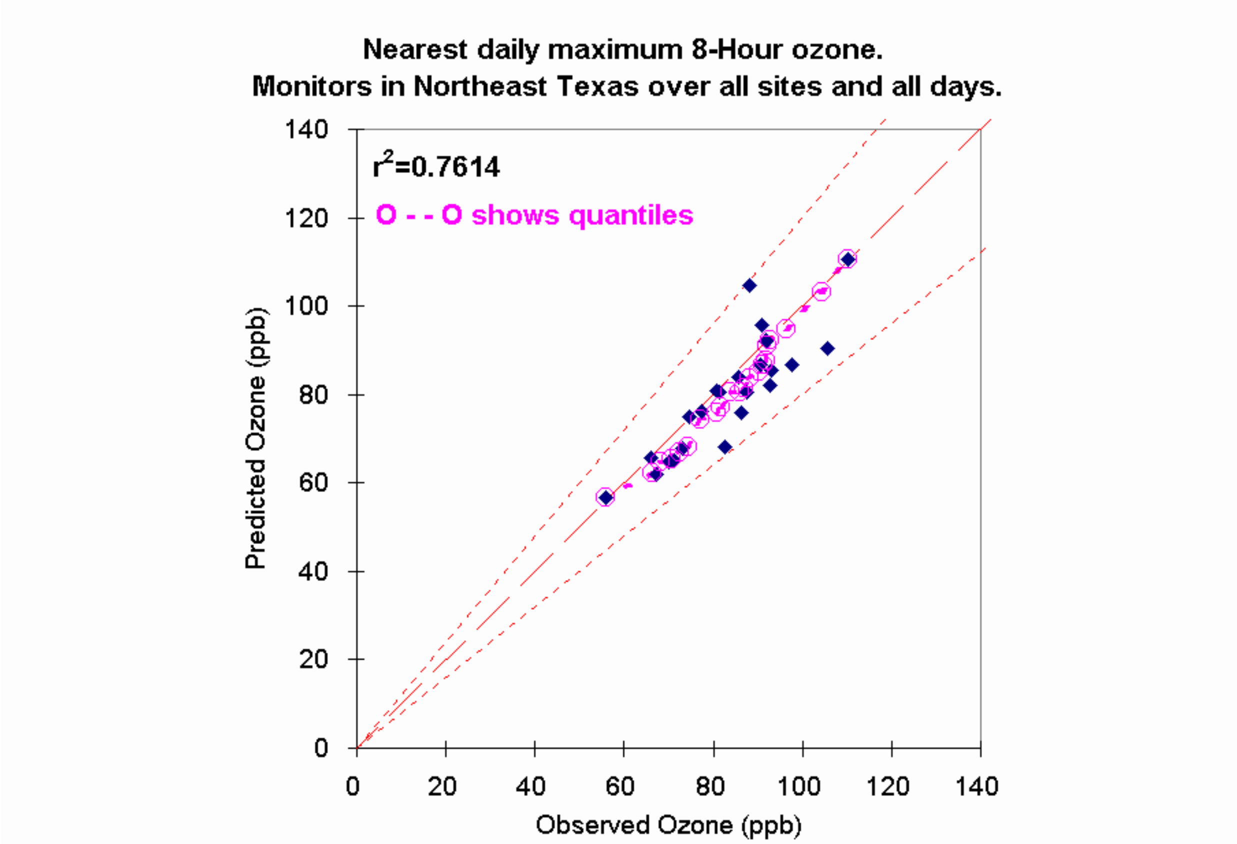


Figure 5-8. Scatter plot of nearest observed and predicted 8-hour ozone (ppb) near monitor locations in Northeast Texas. Quantiles are also shown as circles and the dashed lines show +/- 20% bias. The r^2 value is the correlation coefficient.

Conclusions on Model Performance

The model performance evaluation results presented and discussed above show that the perception of model performance depends upon the methodology used for evaluation. Therefore, it is important to look at the model performance evaluation as a whole and seek to determine whether the model is suitable for use in the intended purpose of an 8-hour ozone attainment demonstration. Overall conclusions from the performance evaluation are:

- Modeled ozone formation is consistent with conceptual model in showing that high ozone levels in Northeast Texas resulted from a combination of production from local emissions sources combined with a regional background and transport of ozone.

- There is some evidence for ozone under prediction near the beginning and end of the episodes and this appears to result from the model having too low ozone transport into Northeast Texas from the east and northeast.

- Model performance is acceptable on most days when evaluated using the more traditional methods developed for 1-hour ozone modeling (such as the normalized bias).

- Model performance is very good when evaluated using newer methods developed in EPA's draft modeling guidance (EPA, 1999) that compare ozone levels near monitor locations and better correspond to the 8-hour ozone attainment demonstration methodology.

The overall conclusion is that the ozone modeling is suitable for use in an 8-hour ozone attainment demonstration for Northeast Texas.

6. ATTAINMENT DEMONSTRATION FOR 8-HOUR OZONE

The ozone model and emissions inventories developed by NETAC were used to evaluate how ozone levels are expected to change by 2007 and whether Northeast Texas will continue to attain the 8-hour ozone standard. The modeling projected that ozone levels will continue to decline and that the area will attain the 8-hour ozone standard in 2007, as it does in 2003. The attainment demonstration for 2007 relied solely upon emissions reduction strategies including local strategies that are already in place. A "weight-of-evidence" analysis was conducted to support the modeling attainment demonstration by considering other relevant factors such as air quality and emissions data and trends. Although the attainment demonstration for Northeast Texas relies upon existing measures, NETAC is continuing to develop additional strategies to secure further progress.

2007 MODELING PROCEDURES

The purpose of the future year ozone modeling is to project whether Northeast Texas will be attaining the 8-hour ozone standard in 2007. This analysis is referred to as an "attainment demonstration" based on ozone modeling. The attainment demonstration depends upon changes in modeled ozone levels between a base and a future year and so it is important that the base and future year modeling be as consistent as possible. The objective is to ensure that modeled ozone changes between the base and future year result from emissions changes and therefore provide an accurate and realistic estimate of the ozone changes that will occur in Northeast Texas.

The only difference between the base and future year ozone modeling was in the anthropogenic emissions inputs to the CAMx model as described in Section 3. Specifically, between the base and future year there were:

- No changes to CAMx model version 4.03 (ENVIRON, 2004)
- No changes to CAMx model options
- No changes to the meteorological input files from the MM5 version 3 (Dudhia, 1993)
- No changes to the initial and boundary conditions
- No changes to the biogenic emissions from GloBEIS version 3.1 (Yarwood et al., 2004).

With these modeling methods and assumptions all changes in ozone levels between the base year and 2007 are due solely to the effects of emissions growth and controls. The emission inventory development was described above in Section 3 and the emissions control measures assumed to be in place for 2007 are described next.

EMISSION CONTROLS FOR 2007

The 2007 emission inventories rely upon emission control measures that are currently enforceable. These measures are a combination of Federal measures developed by EPA, State measures developed by Texas for the State Implementation Plan (SIP) and local measures developed by NETAC that have been made enforceable by agreed orders.

On-road Mobile Sources

The following federal emission reduction programs for on-road vehicles were accounted for using EPA's MOBILE6 model:

- Tier 1 light-duty vehicle standards, beginning with the 1996 model year
- National Low Emission Vehicle (NLEV) standards for light-duty vehicles, beginning with model year 2001
- Tier 2 light-duty vehicle standards, beginning with model year 2005, with low sulfur gasoline beginning in the summer of 2004
- Heavy-duty vehicle standards, beginning with model year 2004
- Heavy-duty vehicle standards (with low sulfur diesel), beginning with model year 2007.

Off-road Mobile Sources

The following federal emission reduction programs for off-road vehicles were accounted for using EPA's NONROAD model:

- Phase 1 and 2 emission standards for new off-road spark-ignition engines at or below 25 horsepower (hp). Different starts and phase-in periods depending on engine size. Earliest start year is 1997 model year.

- Emission standards for new gasoline spark-ignition marine engines. Phase-in starts with 1998 model year.

- Tier 1 and Tier 2 emission standards for new off-road compression-ignition engines below 50 hp, including recreational marine engines less than 50 hp. Phase-in period differs by Tier and engine size. Earliest start year is 1997 model year.

- Tier 1 through Tier 3 emission standards for new off-road compression-ignition engines at or above 50 hp, not including recreational marine engines greater than 50 hp. Phase-in period differs by Tier and engine size. Earliest start year is 1996 model year.

Emissions from aircraft, commercial marine and locomotives are estimated outside of the NONROAD model. Commercial marine emissions in the NETAC area are negligible. No emission controls were assumed for aircraft. Locomotive emissions were adjusted to account for EPA regulations promulgated in 1997.

Stationary Sources

The impact of control programs on stationary sources was modeled separately for Northeast Texas, the rest of Texas and States outside Texas. For stationary (area and point) sources outside of Texas, the 2007 anthropogenic emission inventories were the modeling inventories developed by EPA for a rulemaking on "heavy duty diesel" emissions and include EPA's estimates of emission reductions including the NOx SIP Call.

For area and point sources within Texas, the 2007 emission inventory includes reductions due to all of the TCEQ's State Implementation Plans (SIPs) for the non-attainment areas (Houston-Galveston, Beaumont-Port Arthur, Dallas/Fort Worth) and other areas as published in the Texas Administrative Code (Coulter-Burke et al., 2002). In some cases this tends to under-state the emission reductions because some SIP strategies have yet to be published as rules in the TAC.

Major Point Sources in Northeast Texas

Emissions at several major point sources in Northeast Texas were reduced to reflect control measures implemented in the 1-hour ozone SIP for Northeast Texas adopted by the TCEQ on March 13, 2002. This SIP includes NOx emission reductions from utility sources operated by American Electric Power (AEP) and Texas Utilities (TXU), as well as NOx emission reductions at Eastman Chemical Company, Texas operations (Eastman). These local reductions were developed voluntarily through NETAC and made enforceable through agreed orders.

The NOx emissions for the utility sources affected by NETAC local controls were estimated by multiplying the permit limit emission factors (lb NOx/mmBtu) by heat input values (mmBtu/hour) from a July 1997 ozone episode period. This is the same methodology (and therefore the same emissions) as used in the 1-hour ozone SIP modeling for Northeast Texas (TNRCC, 2002). The resulting daily emission rates and the reductions due to controls in 2007 are shown in Tables 6-1 and 6-2. The dates when these controls were implemented differed by facility as shown in Table 6-3. Most of the reductions in NOx emissions at major point sources in Northeast Texas were implemented by 2002 and, with the exception of one unit, all were implemented by the 2003 ozone season.

Table 6-1. Reductions in AEP 2007 NOx emissions due to NETAC local controls.

Facility	2007 Base Case		2007 Strategy		Reduction	
	lb/mmBtu	ton/day	lb/mmBtu	ton/day	ton/day	Percent
Wilkes						
Unit 1	N/A	1.5	N/A	1.5	0.0	0%
Unit 2	0.31	5.3	0.17	2.9	2.4	45%
Unit 3	0.38	5.8	0.17	2.6	3.2	55%
All units		12.6		7.0	5.6	44%
Knox Lee						
Unit 2	N/A	0.3	N/A	0.3	0.0	0%
Unit 3	N/A	0.3	N/A	0.3	0.0	0%
Unit 4	N/A	2.1	N/A	2.1	0.0	0%
Unit 5	0.24	4.4	0.18	3.2	1.1	26%
All units		7.1		6.0	1.1	16%
Pirkey	0.31	25.4	0.22	17.9	7.5	29%

Note: N/A = information not available

Table 6-2. Reductions in TXU 2007 NOx emissions due to NETAC local controls.

TXU	2007 Base Case		2007 Strategy		Reduction	
	lb/mmBtu	ton/day	lb/mmBtu	ton/day	ton/day	Percent
Martin Lake						
Unit 1	0.34	31.4	0.2	18.5	12.9	41%
Unit 2	0.31	30.5	0.2	19.7	10.8	35%
Unit 3	0.38	36.2	0.2	19.2	17.0	47%
All units		98.1		57.3	40.7	42%
Monticello						
Unit 1	0.29	21.7	0.2	14.9	6.8	31%
Unit 2	0.30	21.6	0.2	14.6	7.0	32%
Unit 3	0.24	22.8	0.2	18.8	4.0	18%
All units		66.1		48.3	17.8	27%

Table 6-3. Implementation schedule for point source NOx reductions in Northeast Texas.

Facility	Implemented
American Electric Power (AEP)	
Pirkey	Fall 2001
Welsh (Unit 1)	Fall 1999
Welsh (Unit 2)	Spring 2005*
Welsh (Unit 3)	Fall 2000
Wilkes (Unit 2)	Fall 1999
Wilkes (Unit 3)	Spring 2000
Knox Lee (Unit 5)	Fall 2000
TXU	
Martin Lake (Unit 1)	Spring 2003
Martin Lake (Unit 2)	Spring 2001
Martin Lake (Unit 3)	Spring 2002
Monticello (Unit 1)	Spring 2002
Monticello (Unit 2)	Spring 2003
Monticello (Unit 3)	Fall 2000
Stryker Creek (Unit 1)	Spring 2003
Stryker Creek (Unit 2)	Spring 2000
Eastman Chemical Company	
Longview	2000 - 2002

*Scheduled

The NOx emission reduction strategies at Eastman comprise numerous measures including the replacement of two large boilers by a co-generation plant, improved compressor engines and other measures. The reductions in NOx emission at Eastman from 1999 to 2002 are shown in

Table 6-4. The NOx totals for 2002 (and 2007) include 2.1 tons/day of emissions from the co-generation unit that is a separate facility but are included in Table 6-4 because Eastman agreed to offset the co-gen emissions as part of their overall NOx reduction commitment. The 2007 Eastman NOx emissions in Table 6-4 were projected from 2002 levels assuming 5% overall growth. Table 6-4 shows an apparent increase in VOC emissions from 1999 to 2002 but this does not reflect any real increase in emissions, but rather is a paper increase due to improved inventory methods for 2002 that result in higher VOC estimates. The 2007 Eastman VOC emissions were projected from 2002 levels assuming 10% growth.

Table 6-4. Emissions (tons/day) for Eastman Chemical Company, Texas operations in Longview.

	NOx	VOC
1999	14.4	10.7
2002	9.3	11.8
2007	9.7	12.9

Note: The NOx totals for 2002 and 2007 include 2.1 tons/day of emissions from a co-generation unit that is a separate facility but are included in this table because Eastman agreed to offset the co-gen emissions as part of their overall NOx reduction commitment.

ATTAINMENT DEMONSTRATION PROCEDURES

The methodology for the 8-hour ozone attainment demonstration follows the draft 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.

Base Year

The base year for the attainment demonstration was 2002. This involved modeling ozone levels with a 2002 emissions inventory and using design values for the 3-year period centered on 2002, i.e., 2001-2003 Design Values. This methodology was used because:

- The 2001-2003 Design Values will be used when EPA determines the attainment status for Northeast Texas under the 8-hour ozone standard.
- There have been substantial emissions reductions in Northeast Texas since the August 15-22, 1999 ozone episode, and these have been accompanied by a decline in 8-hour ozone Design Values.

- Using the most recent emissions (2002) and air quality data (2001-2003) results in less extrapolation in projecting 2007 Design Values than if older emissions/air quality data are used.

The NETAC Technical Committee developed this methodology in early 2003 with approval from the EPA and TCEQ.

Calculating Relative Reduction Factors (RRFs)

RRFs are calculated for each monitor location. In addition, since high ozone can also occur away from monitor locations, a screening calculation is 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. The attainment test is passed when all the future year scaled DVs are less than 85 ppb. Scaled DVs are truncated to the nearest ppb.

Figure 6-1 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.

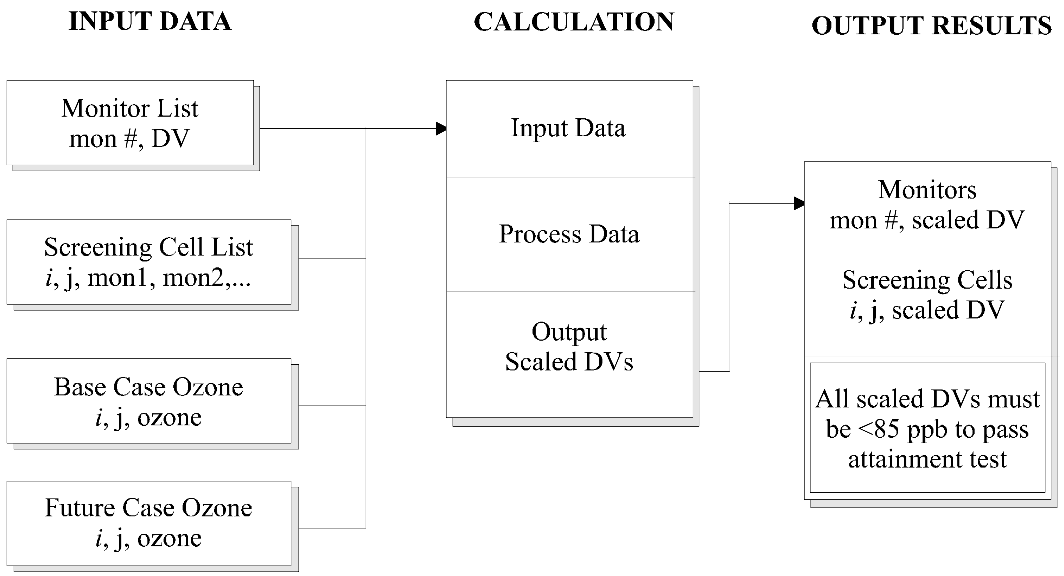


Figure 6-1. Overview of the 8-hour ozone attainment test methodology.

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.

ATTAINMENT DEMONSTRATION

The EPA design value scaling methodology was applied for all ozone monitoring locations in Northeast Texas in 2003. The screening cell methodology described above identified no screening cells to be considered in addition to the monitor locations. The Longview and Tyler monitors have full 2001-2003 DVs whereas the Karnack and Waskom monitors have 2-year (2002-2003) DVs. The RRFs at all four monitor locations are less than 1.0 showing that modeled ozone levels across Northeast Texas decreased from 2002 to 2007.

Table 6-5. Projected 2007 8-hour ozone design values (DV; ppb) for Northeast Texas ozone monitor locations in 2003.

Monitor	Preliminary 2003 Design Value	Modeled Relative Reduction Factor	Projected 2007 Design Value
Longview	82	0.981	80
Tyler	81	0.954	77
Karnack	84	0.966	81
Waskom	84	0.974	82

Notes: 2003 DVs are based on preliminary 2003 monitoring data.
The Longview and Tyler monitors have 2001-2003 DVs.
The Karnack and Waskom monitors have 2002-2003 DVs.

The ozone modeling demonstrates attainment of the 8-hour ozone standard in 2007 because the projected 2007 DVs shown in Table 6-5 are all less than 84 ppb. As discussed above, the 2007 control strategy relies entirely upon measures that are already enforceable including substantial NOx reductions at local point sources developed by NETAC. In addition, NETAC is continuing to develop additional local reductions for Northeast Texas as discussed below.

The conclusion based on modeling that Northeast Texas will continue to demonstrate attainment of the 8-hour ozone standard in 2007 is conservative in several ways:

- The projected 2007 8-hour ozone levels at Longview and Tyler are 4 and 7 ppb below the highest level that would demonstrate attainment (84 ppb) providing a margin of safety.
- Additional emissions reductions beyond those assumed in the modeling are expected to occur by 2007, as discussed in more detail below.
- The relative reduction factors used to project the 2007 design values depend upon ratios of 2007 to 2002 modeled ozone levels. The utility emission estimates for 2007 are more conservative than for 2002 (permit maximum rather than summer average levels, see section 3) which introduces a bias toward higher projected 2007 ozone levels.

WEIGHT-OF-EVIDENCE SUPPORTING THE ATTAINMENT DEMONSTRATION

This section considers whether the weight-of-evidence supports the conclusions from the ozone modeling that ozone levels in Northeast Texas will continue to decline and that consequently the area will move further into compliance with the 8-hour ozone standard by 2007. Given that the ozone control strategy for Northeast Texas focuses on NOx reductions, the weight-of-evidence analysis considers three factors:

1. Evidence that ozone levels in Northeast Texas will respond to reductions in NOx emissions.
2. Trends in NOx emissions.
3. Ozone trends as NOx reductions have been implemented in recent years.

The conceptual model completed by Stoeckenius et al. (2004) considered whether ozone levels are expected to be more responsive to NOx or VOC reductions and concluded that ozone production in Northeast Texas is expected to be NOx limited. This conclusion was based on the high VOC:NOx ratio (greater than 30) in the emission inventory which is well within the NOx-limited regime. The high VOC:NOx ratio results from high biogenic emission levels which are generally considered to lead to NOx-limited ozone formation in forested, predominantly rural areas like Northeast Texas. Emissions sensitivity tests using the August 1999 ozone model also showed that NOx reductions were the most effective way of reducing ozone (Yarwood et al., 2003). Therefore, the weight-of-evidence suggests that ozone will respond to NOx reductions.

The trends in NOx emissions from 1999 to 2012 were discussed in section 3 and shown in Figure 3-4. This analysis showed that total anthropogenic NOx emissions decrease consistently from 1999 to 2012 due primarily to decreases in point source NOx in the early years and decreases in mobile source NOx in the later years. The decreases in NOx emissions from 1999 levels were:

- 18 percent NOx reduction from 1999 levels by 2002
- 21 percent NOx reduction from 1999 levels by 2007
- 29 percent NOx reduction from 1999 levels by 2012

Therefore, the weight-of-evidence is that NOx emission levels have reduced significantly since 1999 will become still lower in the next few years and out to at least 2012.

The trends in annual fourth highest daily maximum 8-hour values for monitors in Northeast Texas were shown in Section 2. All sites show decreases from 1999 to 2003 as NOx reductions were implemented. The monitors in nearby Shreveport also showed decreases over the same time period suggesting that the trend may be, in part, a regional phenomenon. However, the downward trend at the Longview monitor has been steeper than at any other monitor and the ozone levels at Longview are now comparable to Tyler whereas they were consistently higher in the late 1990s and 2000. The ozone trends suggest that emission reductions in Northeast Texas starting in about 2001 have been effective in reducing ozone levels, especially at Longview.

The three factors considered in the weight-of-evidence analysis all support the attainment demonstration based on ozone modeling and suggest that ozone levels will continue to improve over the next few years. The improvement may not be consistent in every year due to variations in weather that affect high ozone levels. Annual variability in ozone levels is the reason why attainment of the ozone standard is determined from 3 years of monitoring data.

MAINTENANCE FOR GROWTH THROUGH 2012

As part of the EAC process local areas are required to consider whether they will attain the 8-hour ozone standard through the year 2012. This is called maintenance for growth analysis. Emission inventories for the NETAC 5 county area were projected to 2012 in section 3 and shown in Figure 3-4. As just discussed, the 2012 NOx emission inventory is projected to be significantly lower than the 2007 NOx emission inventory showing that emissions controls outweigh the effects of emissions growth from 2007 to 2012. The reductions in NOx emissions from 2007 to 2012 result from lower mobile source emissions, especially for on-road vehicles. This analysis suggests that the region will continue to attain the 8-hour ozone standard through the year 2012.

ADDITIONAL EMISSIONS REDUCTIONS GOING BEYOND THE ATTAINMENT DEMONSTRATION

SIP and Other EAC Measures

The ozone modeling attainment demonstration for 2007 shows that the area expects to remain in attainment of the 8-hour ozone standard in 2007 with the control measures that are currently enforceable. The TCEQ continues to develop new SIP rules to further reduce ozone in nonattainment areas and there are other near-nonattainment areas engaged in EACs. Therefore, there will be additional emission reductions by 2007 that are not yet accounted for in the NETAC ozone modeling for 2007, including:

- TCEQ SIP strategies for 8-hour ozone in Houston/Galveston, Beaumont/Port Arthur and Dallas/Fort-Worth that are not yet in the Texas Administrative Code.
- TCEQ rules requiring emission reductions for gas compressor engines greater than 500 horsepower. TCEQ is still evaluating the benefits of this rule, but expects shutdown of at least one compressor in Panola County that had projected 2007 NOx emissions of 0.7 tons per day.
- Emission reductions from the Shreveport EAC. This includes a 2007 NOx reduction of 2.6 tons per day at Center Point Energy's Bossier Parish gas processing facility.
- Emission reductions from the Austin and San Antonio EACs.
- Emission reductions at Alcoa's Rockdale Power Plant in Central Texas.

ADDITIONAL NETAC MEASURES

NETAC conducted a study to identify control measures that are likely to be appropriate and effective in Northeast Texas (NETAC, 2003). This assessment looked at strategies that look capable of achieving substantial reductions in NOx and highly reactive VOC (HRVOC) by December 2005. Several of these strategies are being implemented and are described below.

Enforceable NETAC Measures

Two chemical plants near Longview are implementing enhanced Leak Detection and Repair (LDAR) programs to reduce emissions of highly reactive VOC (HRVOC). The current NETAC attainment demonstration for 2007 does not include emissions reductions from these enhanced LDAR programs so these HRVOC reductions will be in addition to the currently modeled local controls.

The LDAR programs for Eastman Chemical Company, Texas Operations are summarized in Table 6-6 with currently estimated emissions reductions, which may change as the programs are developed further and implemented. Eastman voluntarily agreed to emissions reductions under the Voluntary Emissions Reduction Permits (VERPs). Emissions reductions under ethylene MACT regulations are required, but early implementation by Eastman is voluntary.

Table 6-6. HRVOC Reduction strategies at Eastman Chemical Company, Texas operations.

Emission Reduction Strategy	HRVOC Reduction Tons/day	Enforceability/Timing
Enhanced Leak Detection and Repair Programs for Polyethylene Division	0.41 TPD HRVOC	Voluntary Emissions Reduction Permit # 47007 / Prior to 2004 Ozone Season
Enhanced Leak Detection and Repair Programs for the Utilities and Feedstocks Division	0.22 TPD HRVOC	Voluntary Emissions Reduction Permits 48588 and 48590 / Prior to 2004 Ozone Season
Ethylene MACT Leak Detection and Repair Programs for the Utilities and Feedstocks Division	0.23 TPD HRVOC	Ethylene MACT - Federal Regulation, effective July 1, 2005 with 180 days to complete implementation / Will be implemented before July 1st, 2005, prior to 2005 Ozone Season if possible

Huntsman Chemical owns a polypropylene plant that is co-located with Eastman Chemical Company's facility near Longview. Huntsman's improved LDAR program will be implemented over a four-year period and is expected to reduce VOCs by 29 tons/year by 2005 and 44 tons/year by 2008. These estimates may change as the programs are developed further and implemented. Huntsman volunteered these reductions as part of a new Flexible Plant-wide Applicability Limit (PAL) Permit and convert the LDAR programs from 28M to 28VHP. The State of Texas permit number is #18105.

Voluntary NETAC Measures

Compressor Engines Eligible for TERP Funding

The NETAC control strategy analysis (NETAC, 2003) identified NOx emissions from compressor engines used in natural gas production as a source where significant emission reductions could potentially be achieved. NETAC estimated area source NOx emissions related to oil and gas production to be about 35 tons/day in the 5 County NETAC area in 1999 and these emissions are dominated by gas-fueled compressor engines less than 500 hp. Control technologies are readily available for these engines that can reduce NOx emissions by 50% to 90% depending upon engine type.

NETAC has adopted the following approach to obtaining reductions in NOx emissions from gas compressors in the 5 county NETAC area. The Texas legislature has funded the Texas Emissions Reduction Plan (TERP) that will pay for a variety of NOx reduction strategies at sources not currently subject to regulation including smaller gas compressor engines in the NETAC area. In the 2003 and 2004 NETAC has arranged several public meetings with presentations on TERP funding to raise awareness of this program. In addition, NETAC has access to funding that could be used to develop a demonstration program for NOx reductions on gas compressor engines during 2004. NETAC has not yet estimated the amount of NOx reductions that will result from the demonstration program or public response to the TERP funding opportunity. Since the current NETAC attainment demonstration for 2007 does not assume any controls on gas compressors, NOx reductions generated by a demonstration program and TERP funding will be in addition to the currently modeled local controls.

Off-road Vehicle Emission Reductions

Two lignite-mining operations associated with power plants in the NETAC area have applied for Texas Emissions Reduction Plan (TERP) grants to reduce NOx emissions from heavy off-road mining equipment. The Oak Hill Mining Area in Rusk County associated with the Martin Lake plant plans to replace two older backhoe excavators (non-tier rated) with two new, cleaner-burning (tier-1 compliant) backhoe excavators. The TERP application was filed on March 11, 2004. The estimated annual NOx emission reduction at Oak Hill mine will be 21.88 tons. The Sabine Mine associated with the Pirkey plant in Harrison County has submitted TERP applications for funding to replace one dozer and one excavator.

On-road Vehicle Emission Reductions

The Department of Energy (DOE) Clean Cities program is a voluntary mobile source emission reduction program in East Texas. The East Texas Clean Cities Coalition (ETCCC), coordinated by the East Texas Council of Governments (ETCOG), has successfully obtained a Clean Cities Designation for the region from DOE. ETCCC promotes the use of alternative fuels to gasoline and diesel, such as propane, natural gas, ethanol, and biodiesel.

Eighteen new lower emitting propane light heavy-duty (Class 2b) vans were purchased in 2003 and 2004 for the ETCOG's Rural Transportation Program (10 vans), the City of Longview (7 vans), and Tyler Transit (1 van). The average miles per year driven by these vehicles is 36,820. The emission reduction for each van compared to the average new heavy-duty spark-ignition van available in 2003 and 2004 was 0.021 tons per year VOC and 0.103 tons per year NOx. (based on EPA's MOBILE6 emissions model). The eighteen vans being operated in the NETAC area will provide total emissions reductions of 0.4 tons per year VOC and 2.0 tons per year NOx.

Public Awareness Programs

With funding from NETAC, the East Texas Council of Governments (ETCOG) runs an annual public education and ozone awareness program for the five county Tyler-Longview-Marshall area. The program includes the following elements: an ozone watch and warning communications network between local governments and industries to communicate ozone action day forecasts issued by the TCEQ; a NETAC website (http://www.netac.org); production and distribution of public service announcements; school programs and teacher training workshops; distribution of public information and educational materials; and an Annual Ozone Season Kick-Off meeting for Northeast Texas.

Energy Efficiency Programs

The City of Tyler is carrying out a series of energy efficiency improvements that will reduce electricity consumption. The City of Tyler projects are to be completed by July 2004, and the estimated energy savings are shown in table 6-7.

Table 6-7. The City of Tyler energy efficiency program.

Improvement Measure	Energy Savings (Annual kWh)
Building Lighting, HVAC and Controls Upgrades	1,617,173
Traffic Light Upgrades	1,630,324
Park Lighting Upgrades	60,083
Wastewater Plant Motor and Controls Upgrades	1,346,060
Total	4,653,640

The City of Longview passed a resolution on 8 August 2002 adopting the goals of Senate Bill 5, directing the preparation of an energy efficiency plan and providing for reporting to the State Energy Conservation Office. Since this adoption, the City has undertaken numerous measures to comply with the goal of reducing energy consumption by 5% per year for 5 years. The city has completed an Energy Assessment of Designated Municipal Facilities by the firm of Estes, McClure and Associates, Inc. This document will provide for improved planning as electrical systems are retrofitted. As major systems are renovated / retrofitted, energy consumption is a primary decision factor. Improvements have been made in lighting, HVAC systems, swimming pool operations and the purchase of energy efficiency rated equipment for Public Safety Communications.

The City of Marshall is initiating an energy efficiency plan with assistance from Texas A&M University.

EPA currently is evaluating whether areas can take ozone SIP credit for emissions reductions resulting from energy savings.

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