APPENDIX B

Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard

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1.0 INTRODUCTION – GENERAL MODELING EMISSIONS DEVELOPMENT

The EPA's *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze* (EPA, 2007) specifies a procedure for demonstrating attainment through modeling. Instead of using the model results in an absolute sense, the eight-hour ozone procedure uses the modeling results in a relative sense. This relative approach is based on how the model responds to the reduction in emissions between a baseline and a future year. Therefore, the photochemical modeling process for attainment demonstration requires four modeling emissions data sets:

- base case emissions;
- baseline emissions;
- future year emissions; and
- future year control strategy emissions.

1.0.1 Base Case Modeling Emissions

In order for the photochemical model to be used in the attainment demonstration, the model needs to be capable of adequately replicating historical episodes (base cases) for which high daily eight-hour ozone was measured. To maximize model performance, base case emission inputs are estimated as accurately as possible. In the development of the base case modeling emissions, a number of quality assurance techniques are used to evaluate the reasonableness of the emission magnitudes, along with their spatial distribution and temporal profile. Using the quality assured episode-specific emissions along with other modeling inputs (e.g., meteorology), the photochemical model is run and the simulated concentrations of both ozone and ozone precursors (e.g., NO_X, VOC) are compared to the measured concentrations to evaluate the adequacy of the photochemical model in replicating the base case. If the evaluation indicates that the base case is not adequately replicated, then diagnostics are conducted to determine which modeling inputs are insufficient. When the emissions are implicated, the modeling emissions are reviewed and pertinent revisions are made as appropriate. If either the evaluation implicated other inputs or once the photochemical model adequately replicates the base case, then the modeling emissions are considered to be sufficiently representative of the episode.

A summary of the primary data sources for the development of the base case modeling emissions is provided in Table 1.0-1: *Summary of Base Case Emissions Data Sources*. This table is not intended to be exhaustive because episodes in both 2005 and 2006 are being modeled for this Houston-Galveston-Brazoria (HGB) State Implementation Plan (SIP) revision.

Table 1.0-1: Summary of Base Case Emissions Data Sources

Category	Region	Data Source
Point Source Emissions	Texas	2005, 2006 STARS
	LA, AR, OK	2004, 2005 individual NEIs
	Other (Regional)	2002 CenRAP/RPOs EI
	All States	2005, 2006 EPA hourly Acid Rain data
	Texas	2005, 2006 hourly Special Inventory surveys
	Texas	2005, 2006 hourly Harris County Tank Landing Loss surveys
	Texas	2005, 2006 HGB HRVOC reconciliation (PSCF)
	Offshore	2005 MMS GWEI platforms of western Gulf of Mexico
	Mexico	1999 Phase III Mexico NEI
	Canada	1995 from EPA's CAIR 2001 base modeling
On-road Mobile Emissions	HGB & BPA	2005, 2006 based on MOBILE6.2 and local travel demand model (TDM) for vehicle miles traveled (VMT)
	Other Texas	2005, 2006 based on MOBILE6.2 and Highway Performance Monitoring System (HPMS) for VMT
	Outside Texas	2005, 2006 based on EPA's National Mobile Inventory Model (NMIM)
Non-road Mobile Emissions	HGB	2005 TexAER, Texas NONROAD (TexN) model
	Texas	2005 TexAER, TexN model
	Outside Texas	2005, 2006 NMIM
Area Source Emissions	Texas	2005 TexAER
	Outside Texas	2002 EPA NEI
Biogenic Emissions	Texas	GloBEIS3 with TCEQ LULC data and drought adjustment
	Outside Texas	GloBEIS3 with BELD3 LULC data

Emissions are developed for the ozone precursors of NO_X, VOC, and CO. The emission inventories (EIs) are prepared for photochemical modeling input using Version 3 of the Emissions Processing System (EPS3), which is discussed in more detail in Section 1.3.

1.0.2 Baseline Modeling Emissions

As indicated above, the EPA procedure for demonstrating attainment requires the development of modeling emissions for a baseline year to be used with similarly developed future year emissions. In order to keep the baseline and future year modeling emissions commensurate, more generic non-episodic ozone season day (OSD) emissions are developed for the baseline year. The OSD modeling emissions for the baseline and future years are developed using the same averaging and estimating procedures, which provides an appropriate basis for assessing the photochemical model response to emission reductions.

The major difference between the base case and baseline modeling emissions is the treatment of the hourly-specific emissions for point sources, such as electric generating units (EGUs). With the exception of on-road mobile sources within the eight-county HGB area, emissions for the other source categories are identical between the base cases and baseline modeling emissions. 2006 was chosen as the baseline year and Section 2.2 describes the averaging processes used in the development of the baseline inventory.

1.0.3 Future Year Modeling Emissions

With a classification of severe, the eight-hour ozone attainment date for HGB is June 15, 2019, but the year for modeling attainment is 2018 because it is the full ozone season prior to the attainment date. Modeling emissions for the 2018 future year were estimated by applying growth projections and control measures to the 2006 baseline modeling emissions. In addition to newly proposed control measures, the 2018 modeling emissions include the benefits of the Federal

Motor Vehicle Control Program (FMVCP), Mass Emissions Cap and Trade (MECT) Program, and the Highly Reactive VOC Emission Cap and Trade (HECT) Program.

1.1 MODELING DOMAIN AND NESTED GRID STRUCTURE

The emissions modeling and the photochemical model use the same horizontal grid configuration based on a Lambert Conformal Conic (LCC) map projection as defined in Table 1.1-1: *Lambert Conformal Conic Map Projection Parameters*. This coordinate system has been used for several other photochemical modeling studies in the central United States (e.g., CENRAP).

Table 1.1-1: Lambert Conformal Conic Map Projection Parameters

LCC Projection Parameter	LCC Projection Value
First True Latitude (Alpha)	30 degrees north
Second True Latitude (Beta)	60 degrees north
Central Longitude (Gamma)	100 degrees west
Projection Origin	100 degrees west, 40 degrees north
Spheroid	Perfect sphere with radius of 6,370 kilometers

The horizontal modeling domain structure consists of a 36 km by 36 km coarse regional grid for the Eastern U.S. and three sequentially nested fine grid subdomains:

- a 12 km by 12 km subdomain that includes Eastern Texas and adjacent states;
- a 4 km by 4km subdomain that includes HGB, BPA, and Lake Charles, Louisiana; and
- a 2 km by 2 km subdomain that includes portions of the HGB and BPA areas.

A graphical representation of the emissions modeling domains is provided in Figure 1.1-1: *Emissions Modeling Domains*, and the parameters for each of these domains are summarized in Table 1.1-2: *Nested Grid Structure*.

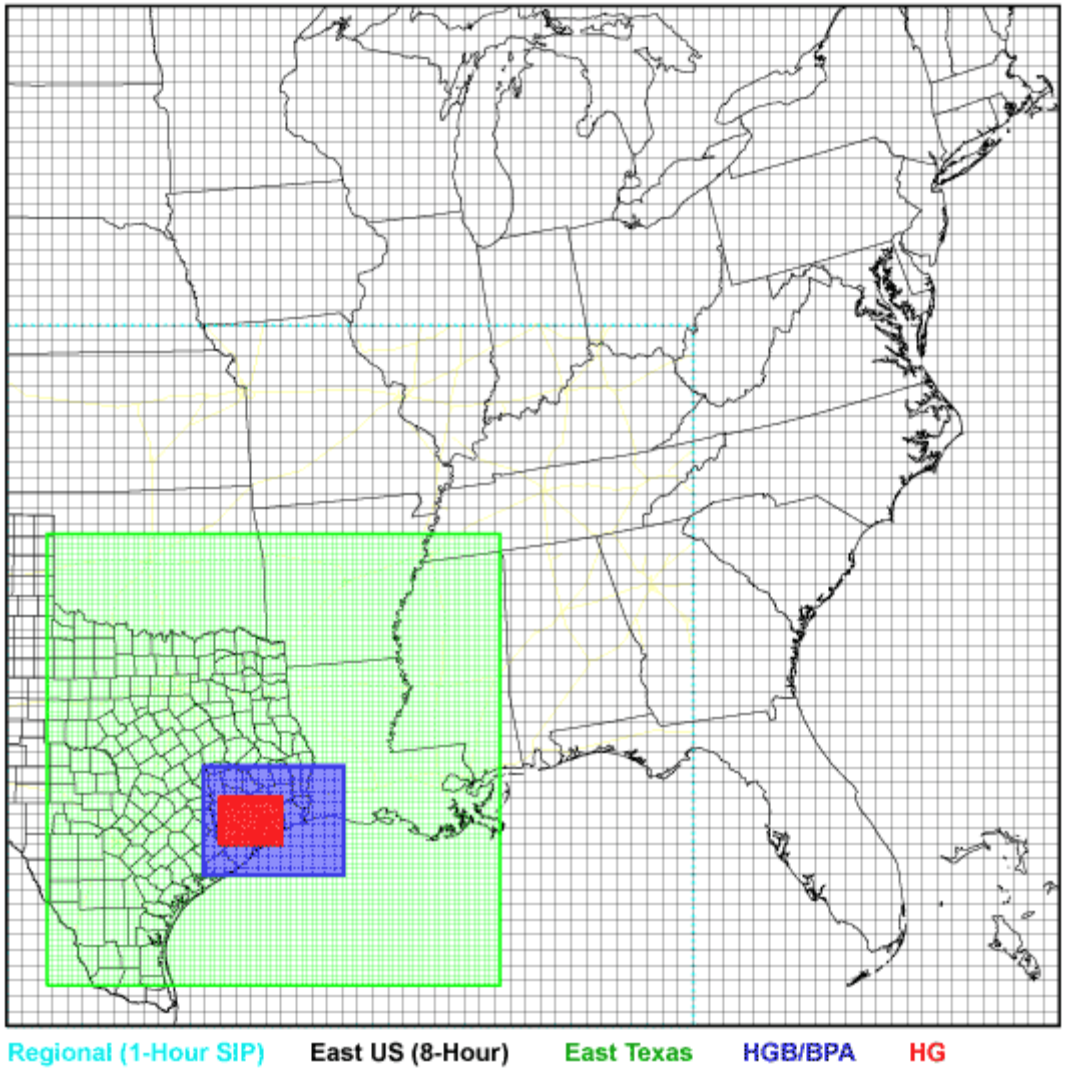


Figure 1.1-1: Emissions Modeling Domains

Table 1.1-2: Nested Grid Structure

Domain Name	**Range** (km)		**Number of Cells**		**Cell Size** (km)		**CAMx Code**
	Easting	Northing	Easting	Northing	Easting	Northing	
East US	(-108, 2376)	(-1584, 828)	69	67	36	36	eus_36km
East Texas	(-12, 1056)	(-1488, -420)	89	89	12	12	etx_12km
HGB/ BPA	(356, 688)	(-1288, -968)	83	65	4	4	hgbp_04km
HGB	(394, 542)	(-1154, -1042)	74	56	2	2	hgb_02km

The vertical configuration for the 2 km and 4 km horizontal domains contains 28 layers of varying depth above ground level (AGL) as shown in Table 1.1-3: *CAMx Vertical Layer Structure for 2 km and 4 km Fine Grids*. The vertical configuration for the 12 km and 36 km horizontal domains contains 17 layers of varying depth as shown in Table 1.1-4: *CAMx Vertical Layer Structure for Intermediate and Coarse Grids*. The additional layers in the fine grid domains are needed, particularly near the ground level, because of:

- the unique mixture of industrial sources in the HGB and BPA area that release pollutants across a wide range of elevations; and

- the unique meteorology induced the close proximity of land to Galveston Bay and the Gulf of Mexico.

Table 1.1-3: CAMx Vertical Layer Structure for 2 km and 4 km Fine Grids

CAMx Layer	MM5 Layer	Top (meters AGL)	Center (meters AGL)	Thickness (meters)
28	38	15179.1	13637.9	3082.5
27	36	12096.6	10631.6	2930.0
26	32	9166.6	8063.8	2205.7
25	29	6960.9	6398.4	1125.0
24	27	5835.9	5367	937
23	25	4898	4502.2	791.6
22	23	4106.4	3739.9	733
21	21	3373.5	3199.9	347.2
20	20	3026.3	2858.3	335.9
19	19	2690.4	2528.3	324.3
18	18	2366.1	2234.7	262.8
17	17	2103.3	1975.2	256.2
16	16	1847.2	1722.2	256.3
15	15	1597.3	1475.3	249.9
14	14	1353.4	1281.6	243.9
13	13	1209.8	1139	143.6
12	12	1068.2	998.3	141.6
11	11	928.5	859.5	137.8
10	10	790.6	745.2	90.9
9	9	699.7	654.7	90.1
8	8	609.5	564.9	89.3
7	7	520.2	476.0	88.5
6	6	431.7	387.8	87.8
5	5	343.9	300.4	87.0
4	4	256.9	213.7	86.3
3	3	170.5	127.7	85.6
2	2	84.9	59.4	51.0
1	1	33.9	16.9	33.9

Table 1.1-4: CAMx Vertical Layer Structure for Intermediate and Coarse Grids

CAMx Layer	MM5 Layer	Top (meters AGL)	Center (meters AGL)	Thickness (meters)
17	38	15179.1	12172.9	6012.5
16	32	9166.6	7501.3	3330.7
15	27	5835.9	4970.9	1730
14	23	4105.9	3565.9	1080
13	20	3025.9	2564.5	922.9
12	17	2103	1728.1	749.8
11	14	1353.2	1210.6	285.2
10	12	1068.2	929.3	277.5
9	10	790.6	700.0	181.0
8	8	609.5	564.9	89.3
7	7	520.2	476.0	88.5
6	6	431.7	387.8	87.8
5	5	343.9	300.4	87.0
4	4	256.9	213.7	86.3
3	3	170.5	127.7	85.6
2	2	84.9	59.4	51.0
1	1	33.9	16.9	33.9

All modeling emissions for the 4 km HGB/BPA domain were developed at a 2 km grid cell resolution and aggregated up to 4 km. In the emissions modeling, the sources are separated between those emitting at the surface (e.g., mobile and low-level point) and those emitted at elevation (e.g., high-level points and ships). Elevated emissions are typically from a source with a fixed location, so a single emissions modeling file can be used for each of the 4 km, 12 km, and 36 km domain inputs. To account for necessary spatial resolution, separate emission modeling files must be developed for the 4 km, 12 km, and 36 km surface level inputs. To facilitate reporting and quality assurance, modeling emissions files were developed specifically eight-county HGB and surrounding areas, which area shown below in Figure 1.1-2: *HGB and BPA Subdomain*.

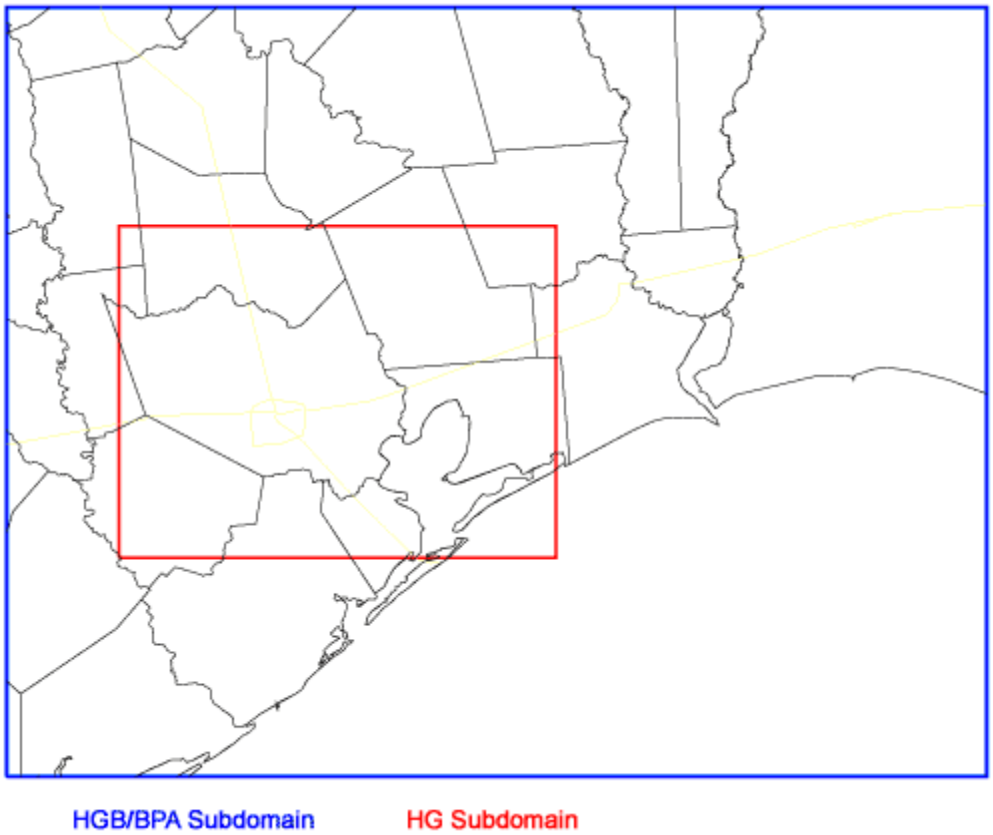


Figure 1.1-2: HGB and BPA Subdomain

1.2 HGB MODELING EPISODES

Three episodes from 2005 and three from 2006 were modeled for this attainment demonstration, as shown in Table 1.2-1: *Modeled Episodes*. Each episode day was modeled with a unique set of low-level and elevated emissions for the biogenic and point source categories.

Table 1.2-1: Modeled Episodes

Episode Name	Common Name	Modeling Period
bc05ep0	May-June 2005	May 19 – June 3, 2005
bc05ep1	June 2005	June 17-30, 2005
bc05ep2	July-August 2005	July 26 – August 8, 2005
bc06ep0	June 2006	May 31 – June 15, 2006
bc06aqs1	2006 AQS-1	August 13 – September 15, 2006
bc06aqs2	2006 AQS-2	September 16 – October 11, 2006

1.3 EMISSIONS PROCESSING SYSTEM

Emission inventory totals for area, biogenic, on-road, non-road, and point sources are not simply input to photochemical models such as CAMx. After the emissions inventories are developed with tools such as MOBILE6.2, NONROAD, etc., the data sets must be:

- spatially allocated to grid cells or assigned to fixed points;
- temporally allocated by hour of day, day of week, etc.; and
- chemically speciated into groups of compounds with similar reactivity for the formation of ozone.

This process is typically referred to as either emissions modeling or emissions processing and is distinctly separate from emissions inventory development. The TCEQ currently uses Version 3 of the Emissions Processing System (EPS3) developed by Environ to apply the necessary spatial, temporal, and chemical species allocation. Environ's *EPS3 User's Guide* provides step-by-step details for emissions modeling with this software, including all the steps necessary for generating a photochemical model-ready emissions input file. A copy of the EPS3 User's Guide is available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/ei/EPS3_manual/.

This document contains a thorough summary of the needs, requirements, and general processing methods for emissions modeling. The remainder of this section is an excerpt from pages 1-2 through 1-5 of Environ's *EPS3 User's Guide.*

> "A photochemical model simulates the hour-by-hour photochemistry occurring for each grid cell in the modeling domain; consequently, the input emissions data must contain a comparable level of resolution. Total VOC and NO_X emissions must be chemically allocated into the chemical classes employed by the model. Additionally, the emissions data must be spatially allocated by grid cell for each hour of the modeling episode. If photochemical modeling is being performed to evaluate potential control strategies, future-year inventories must be projected which incorporate anticipated changes in emissions levels. The following information was extracted from EPA's *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume II: Emission Inventory Requirements for Photochemical Air Quality Simulation Models* (EPA-450/4-91-014, May 1991). Refer to Table 2-2 of Section 2 for an internet link to emission guidance documents.
>
> **Spatial Resolution of Emissions**
> In order for a photochemical model to provide spatially resolved predictions of ozone and various other pollutants at the grid cell level, it must be supplied with emission data that have the same degree of spatial resolution (i.e., by grid cell). The amount of effort required to implement this resolution will vary depending on the type of source. Most existing data bases of point source emissions will contain location data for each source (typically reported to within a fraction of a kilometer), allowing direct assignment of emissions to the appropriate grid cells.
>
> By contrast, spatial resolution of area source emissions requires substantially more effort. Two basic methods can be used to apportion area source emissions to grid cells. The most accurate (and resource-intensive) approach is to obtain area source activity levels for each grid cell. The alternative approach, more commonly employed, is to apportion the county-level emissions from the existing inventory to grid cells using some spatial surrogate indicator of emission levels or activity (e.g., population, census tract data, or type of land use). The major assumption underlying this method is that emissions from each area source behave spatially in the same manner as the surrogate indicator. In developing spatial apportioning factors, the emissions modeler should focus on determining accurate factors for the more significant sources. In most large urban areas local planning agencies can provide the emissions modeler with detailed land use, population, or in some cases, employment statistics at the subcounty level. The U.S. Census Bureau also gathers and reports this type of data for the nation (generally at the subcounty level).
>
> Because of the relative importance of highway motor vehicle emissions (which usually comprise a large fraction of total VOC and NO_X emissions for most urban areas), these sources should be considered separately from other area sources in the modeling inventory. Instead of using county vehicle miles

traveled (VMT) or gasoline sales to estimate highway vehicle emissions (as annual and seasonal inventories sometimes do), urban transportation planning models should be employed to generate VMT on an individual link basis whenever possible. The emissions for each link could then be assigned to the appropriate grid cells based on link location coordinates.

Planning, land use, and transportation models are already in use in many urban areas, and can provide the emissions modeler with much of the data necessary to allocate area source emissions and develop emission estimates by link for highway motor vehicles. Such models may also be capable of forecasting emissions for use in the development of projected inventories. Local agencies (particularly metropolitan planning organizations, or MPOs) should always be contacted during the inventory planning process to determine what planning models are being used and how the data from these models can be used in developing an emission inventory. Independently developed information such as growth forecasts not only may be unnecessary but, when used in photochemical modeling, may be the basis for challenges to the modeling results because of alleged nonconformity with other projections available to the public.

Temporal Resolution of Emissions

In order to accurately predict hourly concentrations of ozone, a photochemical model requires hourly estimates of emissions for each grid cell in the modeling domain. The existing inventory from which the modeling inventory is developed will generally contain annual average or, for the peak ozone season, daily emission rates; the emissions modeler must adjust the emissions in the baseline inventory to reflect the conditions of the ozone episode being modeled, including seasonal adjustments for temperature or activity levels (if baseline emissions are reported as annual averages) as well as adjustments for the day of the week. In addition, they must be allocated to the hours of the modeling episode.

The most accurate approach for temporal distribution of emissions involves determining emission rates (or activity) for specific sources for each hour of a typical day in the time period being modeled. This approach is sometimes employed for point sources, but often proves impractical for all but the major sources in the region. More commonly, point source emissions are allocated by hour using the operating schedule information provided in the existing base-year inventory. Operating schedules for point sources are typically reported only in terms of hours per day, days per week, and weeks per year in operation, with seasonal variations reported in terms of percent of annual throughput. Consequently, the emissions modeler must determine the most representative allocation of emissions to the hours of the modeling episode. If possible, operational hours for major sources in the point source inventory should be obtained to supplement the operational information in the baseline inventory.

For area and mobile sources, the emissions modeler usually develops typical hourly patterns of activity levels for each source category. Typical temporal distribution profiles and adjustment factors for area and mobile source categories are available in the EPS3 software distribution, however, these data may not be representative of a given region, which may differ significantly from national average profiles due to the effects of regional meteorological conditions or activity patterns.

Ideally, locale-specific temporal information should be collected for all sources that contribute significantly to the inventory. Regional weekday/weekend

activity levels and diurnal variations by source category can be determined through special surveys or estimated using engineering judgment.

Chemical Resolution of Emissions

Since every reaction of all of the organic compounds found in an urban atmosphere cannot be considered, photochemical models generally group pollutants to limit the number of reactions and species to a reasonable level while permitting reasonable accuracy in predicting ozone formation. Photochemical models employ a chemical mechanism with a predefined set of air quality modeling compounds. Accordingly, VOC emissions must be disaggregated into chemical mechanism compounds prior to model application. These models also require that NO_X emissions be disaggregated into NO and NO_2.

In the absence of more detailed information, VOC emissions can be speciated using the VOC speciation profiles by source type contained in EPA's SPECIATE 4.0, Volatile Organic Compound (VOC)/Particulate Matter (PM) Speciation Data System (EPA/600/R-06/161, 2006). In some cases, however, source-specific speciation profiles or (less commonly) region-specific speciation profiles by source type may be available. If the latter are available, the splits associated with that source category can be modified to more accurately reflect the profiles of local sources. Issues the emissions modeler should consider when developing or modifying mechanism compound split factors include how hydrocarbon emissions are reported in the inventory (e.g., as VOCs, total hydrocarbons, reactive hydrocarbons, total non-methane hydrocarbons, etc.) and the compatibility of the speciation profile designations with the source classification scheme used in the inventory.

In some instances, data on VOC compounds for individual facilities may be available (perhaps through source tests or material composition considerations), and the emissions modeler may prefer to use these in the modeling inventory instead of an assumed VOC-compound distribution. Generally, however, most industries cannot provide reliable VOC or NO_X compound data or accurately apportion their emissions into appropriate chemical classes. Thus, typical VOC and NO_X distributions for various source categories are usually used. If speciation data are available for some facilities within the modeling domain, the emissions modeler must identify the correct chemical mechanism speciation of each individual hydrocarbon compound in the data. If splits for specific compounds in the speciated emissions data are unavailable, a photochemical modeling specialist familiar with both photochemistry and the chemical mechanism should be consulted to determine appropriate split factors for those compounds.

Development of Projected Inventories

There are basically two types of projections: baseline projections and control strategy projections. Baseline projections are estimates of future-year emissions that account for both expected growth in an area and air pollution control regulations that are in effect at the time the projections are made. If provisions in existing control regulations are to take effect at some future date, the baseline projections should include the effects of these expected changes. By contrast, control strategy projections also include the expected impact of proposed control regulations.

Two general methods can be employed for predicting future-year emissions levels: source-specific projections and aggregate projections. Information regarding projected increases in activity at existing facilities or proposed

construction can be obtained directly from operators. Permit applications also provide a source of information about proposed expansions and new construction. Difficulties encountered in incorporating facility-specific projections into a modeling emissions inventory include differentiating between increased activity at existing facilities and increased activity due to new construction; for proposed facilities, the probable location, stack parameters, and operating schedules, as well as emissions, will need to be estimated for each point source within the facility.

Aggregate growth projections are more commonly employed in estimating future-year inventories. In some cases projection information may be available for types of point sources. Similarly, growth indicators may be employed to estimate future-year emissions for groups of sources. Local metropolitan planning offices regularly project demographic and economic parameters for planning purposes; such data can be used in place of or to supplement projections derived from national data.

Point source projections may be more difficult due to the problem of appropriately representing increased activity at each source. The emissions modeler has three basic options for allocating projected emissions changes for point sources:

1. Apply projected growth in each source category (e.g., electric utilities) equally across all existing plants in the county;

2. Apply projected growth in each source category across existing plants, weighing the growth more heavily in areas of the county targeted for greater industrial activity; or

3. Identify areas where new plant activities are scheduled to reflect growth due to the startup of new facilities as well as increased activity at existing facilities.

If the emissions modeler chooses to allocate projected emissions changes in industrially zoned land by grid cell rather than assuming that all increased activity will occur at existing facilities, hypothetical emission records for the proposed point sources must be developed. For area and mobile sources, the emissions modeler should review the surrogate indicators used to spatially allocate emissions in the base-year inventory and make any necessary modifications to account for anticipated changes in land use patterns or the existing transportation link network (e.g., proposed highway, railway, or airport construction). The user should refer to EPA's *Emission Inventory Improvement Program (EIIP) Document Series - Volume 10 Emissions Projections* (EPA, 1992) for additional guidance. Refer to Table 2-2 of Section 2 for an internet link to emission guidance documents."

2.0 POINT SOURCE MODELING EMISSIONS DEVELOPMENT

The various data sources that went into the development of the point source modeling emissions are summarized in Table 2.0-1: *Sources of Point Source Emissions Data*. The TCEQ compiled and formatted the data to generate modeling datasets for the base case, the baseline, and the future case studies as detailed in Sections 2.1, 2.2, and 2.3, respectively.

Table 2.0-1: Sources of Point Source Emissions Data

Sources of Data	Calendar Year(s) Used
TCEQ State of Texas Air Reporting System (STARS)	2005, 2006
TCEQ Special Inventory (SI) Surveys	2005, 2006 hourly
TCEQ Consolidated Compliance Enforcement Data System (CCEDS) of Emissions Event / Maintenance Startup Shutdown (EE/MMS)	2005, 2006 events
TCEQ Floating Roof Tank Landing Loss (TLL) Surveys	2005, 2006 hourly
TCEQ-derived Highly Reactive VOC (HRVOC) Reconciliation using Potential Source Contribution Factor (PSCF) Methodology	2005, 2006
EPA Clean Air Markets Division (CAMD) Acid Rain Program Continuous Emission Monitors (CEMs) for all states	2005, 2006, 2007
EPA / Texas Clean Air Interstate Rule (CAIR) allocations for entire modeling domain	2009-2014, 2015+
U.S. Department of Energy (DOE) Energy Information Administration (EIA) Annual Energy Outlook Report	2008
Louisiana Department of Environmental Quality (LDEQ)	2004
Oklahoma Department of Environmental Quality (ODEQ)	2005
Arkansas Department of Environmental Quality (ADEQ)	2005
U.S. Department of the Interior Minerals Management Service (MMS) Gulf-Wide Emissions Inventory (GWEI) of Offshore Platforms	2005
Central States Regional Air / Regional Planning Organizations (CenRAP / RPO)	2002, 2018
Canada from The EPA's CAIR 2001 base case	1995
Mexican NEI Phase III	1999

2.1 2005 & 2006 BASE CASE POINT SOURCE MODELING EMISSIONS DEVELOPMENT

The point source emissions inventories are composed of information from several databases. The following subsections describe development of the base case point source modeling emissions for all portions of the domain and for all of the episodes described in Section 1.2. Unless otherwise noted, the same general procedures are used to gather, process, and quality assure (QA) the modeling emissions for each episode.

2.1.1 Texas Point Sources

For Texas point sources, ozone season daily emissions data from STARS and hourly emissions data from the EPA's acid rain database (ARD) provided the basis for modeling the 2005 and 2006 base case episodes. Additionally, a supplemental "extra olefins" file was developed to account for reconciled HRVOC emissions in the HGB 4 km fine grid modeling domain. HRVOC include ethylene, propylene, 1,3- butadiene, and all isomers of butene. Hourly emissions data from reporting surveys were used for specific episodes when available. Episode-specific survey results

of HGB floating roof tank landing losses (TLL) were compiled and used to develop files of hourly emissions for both 2005 and 2006 episodes. An hourly Special Inventory (SI) survey during the intensive period of the Texas Air Quality Study II (TexAQS II) from August 15 through September 15, 2006, was used to develop modeling emissions for selected Texas non-EGUs (NEGUs). In all cases, where more detailed, episode-specific or hourly data were available, hourly emissions were used in lieu of the daily emissions data from STARS. The following subsections describe the development of modeling emissions for all of these components.

2.1.1.1 State of Texas Air Reporting System (STARS)

Point source emissions and industrial process operating data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. To collect data, the TCEQ mails annual emissions inventory questionnaires (EIQs) to all sources identified as meeting the reporting requirements. Subject entities are required to report levels of emissions subject to regulation from all emissions-generating units and emissions points, and also must provide representative samples of calculations used to estimate the emissions. Descriptive information is also required on process equipment, including operating schedules, emission control devices, abatement device control efficiencies, and emission point discharge parameters such as location, height, temperature, and exhaust gas flow rate. All data submitted in the EIQ are subjected to QA procedures. The data are then stored in the STARS database. The TCEQ reports point source emissions data to the EPA for inclusion in the National Emissions Inventory (NEI).

Annually, the TCEQ collects emissions information from approximately 2000 major point sources. In nonattainment areas, major point sources are defined for inventory reporting purposes as industrial, commercial, or institutional sources that emit actual levels of criteria pollutants at or above the following amounts: 10 tpy of VOC; 25 tpy of NO_X; or 100 tpy of any of the other criteria pollutants including CO, SO_2, PM_{10}, or lead. For the attainment areas of the state, any company that emits a minimum of 100 tpy of any criteria pollutant must submit an inventory. Additionally, any source that either generates or has the potential to generate at least 10 tpy of any single Hazardous Air Pollutant (HAP) or 25 tpy of aggregate HAPs is required to report emissions to the TCEQ. The reporting requirements, guidance documents, trends, and summaries of the most recently QAed year of reported data can be found at http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html.

Development of the Texas point source emission modeling files begins with queries of the STARS database. Separate queries were performed for 2005 and 2006 after the reported data were quality assured and approved for inclusion in STARS. Updated modeling query reports are typically run when significant STARS updates are completed. The STARS extract is always a snapshot of Texas emissions, since emissions from previous years can be updated by the regulated entities. The query report is a pipe-delimited ASCII text flat file from the relational STARS database. Each line of this text file typically contains one or two pieces of new information, so that many lines are needed to make up one complete modeling record or "path" of emissions. For one year of emissions for all pollutants, the complete STARS extract query report contains more than 10 million lines. A sample 2006 extract from STARS is provided in Figure 2.1-1: *Sample of STARS Extract Output*.

```
E|ACCOUNT-SITE|RN100216977|LAST EI DATE|20071231|
E|ACCOUNT-SITE|RN100216977|EPA ACCOUNT NUMBER|182|
E|ACCOUNT-SITE|RN100216977|OWNER OPERATOR TYPE|BOTH|
E|ACCOUNT-SITE|RN100216977|MAJOR SOURCE TYPE|B|
E|ACCOUNT-SITE|RN100216977|COUNTY STATUS|NONATTAIN|
E|ACCOUNT-SITE|RN100216977|REGION CODE|10|
E|ACCOUNT-SITE|RN100216977|COUNTY NAME|JEFFERSON|
E|ACCOUNT-SITE|RN100216977|SPRING PERCENTAGE|25|
E|ACCOUNT-SITE|RN100216977|SUMMER PERCENTAGE|25|
E|ACCOUNT-SITE|RN100216977|FALL PERCENTAGE|25|
E|ACCOUNT-SITE|RN100216977|WINTER PERCENTAGE|25|
E|ACCOUNT-SITE|RN100216977|TOTAL OPERATING HOURS|8760|
E|ACCOUNT-SITE|RN100216977|HOURS PER DAY|24|
E|ACCOUNT-SITE|RN100216977|DAYS PER WEEK|7|
E|ACCOUNT-SITE|RN100216977|WEEKS PER YEAR|52|
E|ACCOUNT-SITE|RN100216977|LATITUDE|295704.15|
E|ACCOUNT-SITE|RN100216977|LONGITUDE|935306.01|
. . .
E|EMISSION|B-7240    N-14      567502006|ACCOUNT|RN100216977|
E|EMISSION|B-7240    N-14      567502006|DETERMINATION|S|
E|EMISSION|B-7240    N-14      567502006|CONTAM NAME|PENTANE|
E|EMISSION|B-7240    N-14      567502006|CAS NUMBER|109660|
E|EMISSION|B-7240    N-14      567502006|ANNUAL|0.9134|
E|EMISSION|B-7240    N-14      567502006|OZONE|5.7463|
E|EMISSION|B-7240    N-14      567502006|EE/SMSS|0|
E|EMISSION|B-7240    N-14      567502006|UPSET|0|
E|EMISSION|B-7240    N-14      567752006|ACCOUNT|RN100216977|
E|EMISSION|B-7240    N-14      567752006|DETERMINATION|S|
E|EMISSION|B-7240    N-14      567752006|CONTAM NAME|PROPANE|
E|EMISSION|B-7240    N-14      567752006|CAS NUMBER|74986|
E|EMISSION|B-7240    N-14      567752006|ANNUAL|0.5619|
E|EMISSION|B-7240    N-14      567752006|OZONE|3.5349|
E|EMISSION|B-7240    N-14      567752006|EE/SMSS|0|
E|EMISSION|B-7240    N-14      567752006|UPSET|0|
```

Figure 2.1-1: Sample STARS Extract Output

Custom Statistical Analysis System (SAS) computer programming code was written that performs multiple steps on the STARS modeling extract report:

- parses the extract data file,
- makes datasets of specific variables,
- makes necessary units conversions,
- performs various logical checks and comparisons,
- assigns defaults for missing data,
- applies rule effectiveness to VOC paths with control devices,
- arranges the data into an AIRS Facility Subsystem (AFS) file format, and
- creates a composition file for total VOC emissions from reported pollutants.

STARS contains all the data reported by the regulated entity (RN) on the annual EIQ. The modeling extract query report that is based on SAS has been refined over the years, but is always a snapshot of the dataset. The STARS extract contains all four types of emission rates: annual, ozone season daily (OSD), emission events / scheduled maintenance startup shutdown (EE/SMSS), and upsets. Typically, only the OSD emissions are retained for the resultant AFS file that is developed and further processed into model-ready emissions files. The OSD emission rate is representative of average daily emissions during the summer, where TCEQ defines ozone season for EI reporting purposes as June through August. This is generally the time of the year that monitored ozone concentrations are highest. The annual emission rate is used in cases were OSD rates are not reported. The EE/SMSS and upset emissions are a reported total for the entire year, so a daily rate that could be developed is, in general, not very useful without specific knowledge of the timeframe associated with such events. Instead, a review of data in TCEQ's emission events reporting database was conducted, as described below in Section 2.1.1.8.1.

2.1.1.2 Rule Effectiveness (RE)

As noted in the list above, rule effectiveness (RE) is applied to the STARS VOC emissions where appropriate. RE is a term that describes a method to account for the reality that not all facilities covered by a rule are in compliance with the rule 100% of the time. RE also accounts for the fact that control equipment does not always operate at its assumed control efficiency.

The EPA has provided updated guidance on this topic via *Appendix B: Revised Rule Effectiveness* of the EPA's August 2005 EI Guidance document, "*Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations.*" This document can be found at http://www.epa.gov/ttn/chief/eidocs/eiguid/eiguidfinal_nov2005.pdf
Again, the relevant part of this document is Appendix B, which reiterates previous guidance that RE is required of EIs for SIP modeling purposes, including eight-hour ozone, particulate, and regional haze EIs.

The updated guidance also suggests improved methodology for arriving at RE values, by taking into account several factors including compliance history and inspection intervals. To gather this facility-specific info, conducting local surveys is preferred, but if that is not feasible, analyses performed by others may be compared to similar source types. The EPA guidance suggests RE ranges with proposed criteria being met to move from one range of values to another.

The TCEQ continues to use the EPA-approved RE procedure that it has used for SIP modeling since 1995, which assumes the 80% default on all controlled VOC sources, unless a different RE value for the source category was developed from the 1993 survey. Since a new survey, using the suggested updated EPA criteria, is resource intensive, the TCEQ has and will continue to use the existing RE method until all or some of the source categories RE values have been updated.

Table 2.1-1: *VOC Rule Effectiveness Summary* demonstrates the effect of the application of RE upon STARS VOC emissions for the nonattainment areas of the State and the State as a whole. Note that HGB has the largest amount of VOC and the largest number of controlled sources, resulting in the largest increase due to RE. DFW has the least, with BPA somewhat in the middle, and the Statewide average being 26% and 22% increase in VOC emissions due to the application of RE, for years 2005 and 2006, respectively.

Table 2.1-1: VOC Rule Effectiveness Summary

	Inventory Year	HGB	DFW	BPA	Statewide
STARS VOC (tpd)	2005	141	31	44	434
Added RE (tpd)		60	3	14	111
Total VOC (tpd)		201	34	58	546
% Added		42%	9%	32%	26%
STARS VOC (tpd)	2006	119	35	56	406
Added RE (tpd)		44	3	12	90
Total VOC (tpd)		163	38	68	495
% Added		37%	8%	22%	22%

While the current TCEQ RE algorithms are likely over-predicting actual VOC emissions with rule effectiveness, based on reported emissions trends, ambient monitoring of many VOC compounds indicates that the reported rates should be even greater. Hence, until the TCEQ has collected better data that meet or exceed the EPA's suggested RE criteria, the existing algorithms will continue to be used.

2.1.1.3 Preparation of AFS File for EPS3 Input

The resultant AFS file is in a format ready for input into Version 3 of the Emissions Processor System (EPS3). The STARS-derived AFS file for all criteria pollutants typically has more than 200,000 records. Each point source emissions path contains references for the TCEQ account (RN), equipment (FIN), and exhaust point (EPN). For ozone modeling purposes, values for the ozone precursors of NO_X, VOC, and CO are retained in the AFS file for EPS3 input. An example of a single AFS record for VOC is provided as Figure 2.1-2: *Example of AFS Formatted Record for EPS3 Input.*

```
B 06 06 AC 48201 HGB   2869   40703622 14         131        107
AD 06060100 06090100   481.0641 -1105.9330     12.2 0.915   294 0.003  25
25  25  25 24  0 7 8736 43104    0.00693
RN102574803 HG0229F TK3055     TK3055     N ST TANKS      VERTICAL FIXED
EXXONMOBIL CHEMICAL CO    BAYTOWN CHEMICAL PLANT    HARRIS     BAYTOWN
VOC                              A Pt     STAR  v4b
```

Figure 2.1-2: Example of AFS Formatted Record for EPS3 Input

EPS3 directly uses the information in columns 1 through 219. Columns beyond 219, starting with "RN" in the Figure 2.1-2 example, provide useful identifying data fields from STARS. The AFS file format (field descriptions and options) used by the TCEQ for this modeling can be found on the public TCEQ ftp modeling site,
ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/ei/point/AFS-EPS3-v3.doc.

2.1.1.4 STARS-AFS Quality Assurance (QA)

A QA check is performed where the 100 highest emitting NO_X and VOC sources from the AFS file are compared against the 100 highest emitting NO_X and VOC sources from an independent STARS query. This step is done to ensure that no systematic errors were included in either the original STARS extract or in the subsequent SAS code processing. Both the order of the top 100 sources as well as the emission totals should be identical. The only exceptions occur when some of the VOC figures in the AFS file have rule effectiveness applied to them.

Another quality assurance step is conducted where the number of point sources and overall emission totals of the AFS file is compared against sequential STARS extracts of the same EIQ reporting year. STARS emissions data for a given year are generally fairly stable within 18 months after the end of an EIQ year. For example, the 2006 STARS extract changed only a trivial amount after June of 2008. Different extracts of the same year are incremented by both version number and letter. For example, the number "4" in "v4b" at the end of the line in Figure 2.1-2 indicates that this record was from the fourth STARS extract, and the "b" indicates that this was the second SAS run for production of an AFS file. Multiple extracts of the same year occur when there have been changes or additions to STARS, and multiple SAS runs of the same extract occur when there have been changes in either the SAS processing code or the manner in which the data are being used.

2.1.1.5 Preparation of Photochemical Model Ready Files With EPS3

EPS3 is used to process the emissions in the AFS file into a format ready for photochemical model input. Photochemical model inputs require that the emissions be (in order performed by TCEQ):

- chemically speciated into groups of compounds with similar reactivity for the formation of ozone;
- temporally allocated by hour of day, day of week, etc.; and
- spatially allocated to grid cells or assigned to fixed points.

The *EPS3 User's Guide* referenced in Section 1.3, above, provides additional details for processing the point source emissions for photochemical model input. The remainder of this section discusses some of the specific point source emissions processing procedures with excerpts of the data provided as appropriate for a better understanding of the process.

2.1.1.5.1 *Chemical Speciation With EPS3*

VOC Emissions in STARS can be reported as individual compounds, mixtures, classes of compounds, total VOC, and unclassified VOC. The VOC values that are included in the AFS file must be speciated into compound groups of similar ozone reactivity that will be recognized by the photochemical model. For operational efficiency, photochemical models are not based on separate algorithms for each individual reaction. Instead, groups of compounds with similar reactivity for the formation of ozone are grouped together and input into the photochemical model. The current speciation mechanism used the TCEQ for this purpose is Carbon Bond 2005 (CB05).

When the composition of the VOC reported for a specific source is unknown, a default speciation profile is applied based on the source classification code (SCC). The majority of EIQ responses include constituent VOC emission rates that are used to develop more accurate point-specific speciation profiles. More detail on the source-specific speciation approach taken by the TCEQ is available in a report and presentation given at the 17th Annual International Emission Inventory Conference (http://www.epa.gov/ttn/chief/conference/ei17/) held in Portland, Oregon in 2008. The report is entitled *Emissions Modeling of Specific Highly Reactive Volatile Organic Compounds (HRVOC) in the Houston-Galveston-Brazoria Ozone Nonattainment Area*, and is available at http://www.epa.gov/ttn/chief/conference/ei17/session6/thomas.pdf.

Two primary improvements to the overall speciation procedure were made for this SIP revision. The first is based on the premise that sources which are part of the HRVOC Emission Cap and Trade (HECT) program in Harris County monitor all of their sources of HRVOC, measure them accurately, and report them completely, as required by the HRVOC rules of Chapter 115. The SAS code was modified to ensure that no additional speciation is performed on the reported HRVOC for HECT sources. For example, if a HECT source reported 0.6 tpd of butenes and 0.3 tpd of unclassified VOC, only the unclassified portion needed further speciation. The second speciation improvement was for situations where the VOC constituents of a specific source varied on an hourly basis. More detail on this improvement is described below in Section 2.1.1.7.2, 2006 Special Inventory speciation.

When applying speciation to a VOC emissions record with EPS3, a cross-reference file is needed that links the AFS emissions record to a specific profile that provides the VOC composition. An example for the Figure 2.1-2 AFS record is shown below in Figure 2.1-3: *Sample Speciation Cross-Reference Record*.

```
48201 14          131         107           40703622 HG14__107_131_
```

Figure 2.1-3: Sample Speciation Cross-Reference Record

The unique 14-digit speciation profile code of HG14__107_131_ in this example links this record to the VOC constituent profile contained in a separate file, as shown below in Figure 2.1-4: *Sample Speciation Profiles*.

```
HG14__107_131_   45102   0.8799
HG14__107_131_   45202   0.0626
HG14__107_131_   45203   0.0575
```

Figure 2.1-4: Sample Speciation Profiles

Note that the HG14__107_131_ profile code is the common link between the profile speciation and cross-reference files. In this example, the Storage and Retrieval of Aerometric Data (SAROAD) contaminant codes of 45102, 45202, and 45203 are for xylene, toluene, and ethyl benzene, respectively. The values in the right-hand column are the weight fraction of each contaminant, either as reported for that path or as speciated for that path if a portion of the emissions were reported as unclassified VOC. Note that these are the only three VOC constituents for this path, since the weight fractions add to 1.0. The SAS code does not make cross-reference or profile records for paths that have negligible VOC emissions quantities, and

this omission causes EPS3 to delete these paths. This approach does not result in a loss in accuracy, but is mentioned here to explain why very small reported VOC emissions are not photochemically modeled.

2.1.1.5.2 *Temporal Allocation With EPS3*

Even though ozone season day (OSD) is typically used for processing of photochemical modeling emissions, EPS3 can temporally distribute emissions by month, week, day, and hour of a specific episode, provided that sufficient detail is provided in the EIQ. EPS3 writes temporal information in both profile code and cross-reference files. The cross-reference file attaches a temporal profile code for each path. An example is shown below in Figure 2.1-5: *Sample of Temporal Cross-Reference Records.*

```
00000                                                 00000   1   7  24
48001 ETX  0012     0018     0009      31000203 00000   1   7  25
48001 ETX  0012     0018     0010      31000203 00000   1   7  25
48001 ETX  0012     0018     0011      31000203 00000   1   7  25
48001 ETX  0012     0018     0012      31000203 00000   1   7  26
48001 ETX  0012     0020     0025      40899999 00000   1   7  25
48001 ETX  0012     0021     0026      40899999 00000   1   7  25
48001 ETX  0024     0002     0002      30900201 00000   1   7  27
48001 ETX  0024     0002     0018      40200802 00000   1   7  28
48001 ETX  0024     0008     0007      40282001 00000   1   7  29
48001 ETX  0024     0009     0008      40200101 00000   1   7  27
48001 ETX  0024     0009     0016      40200802 00000   1   7  28
48001 ETX  0024     0010     0009      40200101 00000   1   7  27
48001 ETX  0024     0010     0016      40200802 00000   1   7  28
```

Figure 2.1-5: Sample of Temporal Cross-Reference Records

For the second record in this example, 48001 is the county FIPS code and 0012, 0018, and 0009 are the plant, stack, and point identifiers, respectively.

The entries of 1, 7, and 25 in the three right-hand columns are the codes for the monthly, daily, and hourly temporal profiles, respectively. During processing with the EPS3 TMPRL module, each point source is matched to the cross-reference file that best fits the combination of county FIPS, plant, stack, and point identifiers.

The first line of the cross-reference file with all zeros is for situations when a specific point source does not match any of the other entries in the cross-reference file. In such instances, default profiles of 1, 7, and 24 are applied for the monthly, daily, and hourly temporal allocation, respectively. This designation corresponds to a non-varying or "flat" distribution of emissions for every hour of the year. An example of this approach is shown in Figure 2.1-6: *Excerpt of Temporal Profile Codes File*.

```
/MONTHLY/
 1 1 1 1 1 1 1 1 1 1 1 1 1 12
/END/

/WEEKLY/
 7  14 14 14 14 14 14 14  98
 8   2  2  2  2  2  0  0  14
 9   0  0  0  0  0  5  5  35
10  16 16 16 16 16 16  0 112
/END/

/DIURNAL WEEKDAY/
24 4 4 4 4 4 4 4  4  4  4  4  4  4  4  4  4 4 4 4 4 4 4 4 4 96
25 1 0 0 0 0 0 0  0  0  0  0  0  0  0  0  0 0 0 0 0 0 0 0 0  1
26 0 0 0 0 0 0 0  0  1  0  0  0  0  0  0  0 0 0 0 0 0 0 0 0  1
27 0 0 0 0 0 0 0  0  1  1  1  1  1  1  1  1 1 1 0 0 0 0 0 0 10
28 0 0 0 0 0 0 0  1  1  1  1  1  1  1  1  1 1 0 0 0 0 0 0 0 10
29 1 1 1 1 1 1 1  1  1  1  0  0  0  0  0  0 0 0 0 0 0 0 0 0 10
30 1 1 1 1 1 1 1  0  0  0  0  0  0  0  0  0 0 0 0 0 0 1 1 1 10
31 0 0 0 0 0 0 0 11 11 11 11 11 11 11 11 11 0 0 0 0 0 0 0 0 99
/END/
```

Figure 2.1-6: Excerpt of Temporal Profile Codes File

The numeric character in the first two columns (e.g., 1 in the MONTHLY section, 7 in the WEEKLY section, etc.) corresponds to the monthly, daily, and hourly codes from the temporal cross-reference example in Figure 2.1-5. A path with cross-references of 1, 7, and 24 receives an even temporal distribution of annual emissions by month, day, and hour, respectively. In this case, a path would simply have its OSD emissions divided by 24 to represent the hourly emissions provided to the photochemical model. Most of the point source records from STARS fall into this category, particularly the large continuous processes.

When sufficient data are available, a non-even temporal distribution of emissions is applied. For example, a source that only operates from Monday through Friday would have a WEEKLY temporal code of "8" applied, while one that only operated on Saturday and Sunday would have a WEEKLY temporal code of "9" applied. A source that only operates ten hours per day from 8:00 AM through 6:00 PM would have the DIURNAL WEEKDAY code of "27" applied. The DIURNAL WEEKDAY codes are derived by the EPS3 TMPFAC module based on both the start time and reported hours of operation for that path. Note that the last column of each profile is always the sum of all reported integers. The percent allocation per month, day, or hour for each profile code is obtained by dividing the reported integer by this sum.

2.1.1.5.3 *Spatial Allocation With EPS3*

Photochemical models generally rely on a three-dimensional Eulerian system where emissions are allocated to individual grid cells. Emissions occur at the surface for most source categories such as area, biogenic, on-road, and non-road, and are classified as low-level. Numerous point sources also fall into the low-level surface category, but large combustion sources such as power plants are categorized as elevated because their hot exhaust gases can rise several hundred meters into the atmosphere.

Low-level point sources are allocated to grid cells and merged with the other source categories prior to photochemical model input. Elevated point sources are kept at their reported X-Y locations and assumed to emit from the calculated effective plume height of Z to better simulate physical mixing in the elevated layers of the photochemical model. As with other advanced emissions processors, EPS3 processing of point source emissions is divided into low-level and elevated streams. The advantage of this approach is better simulation of how elevated emissions are distributed prior to mixing and reacting with surface emissions, but the drawbacks are more complicated EPS3 processing and longer photochemical model run times.

The photochemical model inputs for point sources consist of a single low-level gridded merged file and a single file of elevated sources. A plume cutoff height of 30 meters was chosen to divide the point sources into low-level and elevated categories. The emissions from elevated sources can be individually tracked, and NO_X reaction chemistry can be enhanced by treating these plumes as Lagrangian puffs by use of the optional Plume-in-Grid (PiG) treatment. The TCEQ uses the Greatly Reduced Execution and Simplified Dynamics (GREASD) PiG option in CAMx, which is most applicable to large NO_X plumes. More detail on application of the GREASD PiG approach is provided below in Section 2.1.3

2.1.1.6 Hourly Acid Rain Program Database

NO_X emission estimates for electric generating units (EGUs), also known as power plants, were obtained from EPA's Clean Air Markets Division (CAMD) Acid Rain Program Database (ARPDB). EPA's Acid Rain Program affects both new EGUs and existing ones serving generators with an output capacity of greater than 25 megawatts. Under the Acid Rain Program, each unit must continuously measure and record its emissions of sulfur dioxide (SO_2), NO_X, and carbon dioxide (CO_2), as well as volumetric flow and capacity. In most cases, a continuous emission monitoring (CEM) system must be used. EGUs report hourly emissions data to the EPA on a quarterly basis. These data are then stored in the Emissions Tracking System which serves as a repository of data for the utility industry. The EPA quality assures the raw hourly data and provides both datasets and a query wizard on the CAMD website for downloading the data. Missing or invalid hourly data that arise from CEM equipment problems are provided by the EPA using specific substitution criteria. This results in some instances where the EGU-reported data does not match that from EPA's CAMD. The data can be downloaded by orispl (site) and unitid (point) for any state for any quarter. The user has several dataset options, as well as output options within some datasets. The website for these data is
http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=emissions.wizard.

Hourly data were downloaded from ARPDB for both Texas and all other states within the modeling domain for the quarters covering the 2005 and 2006 episodes. An example of two consecutive hourly records with a header is provided below in Figure 2.1-7: *Sample Hourly ARPDB Records*.

```
"STATE","FACILITY_NAME","ORISPL_CODE","UNITID","OP_DATE","OP_HOUR",
"OP_TIME","GLOAD","SLOAD","SO2_MASS","SO2_MASS_MEASURE_FLG","SO2_RATE",
"SO2_RATE_MEASURE_FLG","NOX_RATE","NOX_RATE_MEASURE_FLG","NOX_MASS",
"NOX_MASS_MEASURE_FLG","CO2_MASS","CO2_MASS_MEASURE_FLG","CO2_RATE",
"CO2_RATE_MEASURE_FLG","HEAT_INPUT"

"TX","Sam Seymour","6179","2","07-01-2005","0","1","611","","4082.9",
"Measured",".649","Calculated",".087","Measured","546.978","Calculated",
"645.1","Measured",".103","Calculated","6287.1"

"TX","Sam Seymour","6179","2","07-01-2005","1","1","605","","4042",
"Measured",".645","Calculated",".086","Measured","538.79","Calculated",
"642.8","Measured",".103","Calculated","6265"
```

Figure 2.1-7: Sample Hourly ARPDB Records

Using the header for reference purposes, this example shows that:

- the Sam Seymour power plant in Texas is ORISPL 6179;
- Unit #2 emitted 546.978 pounds of NO_X from 12-1 AM on July 1, 2005; and
- Unit #2 emitted 538.790 pounds of NO_X from 1-2 AM on July 1, 2005.

Use of the hourly emissions data from the ARPDB instead of OSD averages from STARS requires that the unique orispl and unitid identifiers be matched in the AFS file. Use of the ARPDB hourly NO_X data also requires that hourly VOC and CO emissions be estimated separately because these are not reported.

When the STARS and ARPDB datasets are for the same time period, then a STARS record should exist for every ARPDB record. A cross-reference file was developed to link the ARPDB and STARS datasets because the former identifies sources by orispl/unit codes, while the latter uses codes for county FIPS, plant, stack, and point. Additionally, the ARPDB identifies emissions by either boiler or unitid, rather than by the exhaust stack reference in STARS. An example of this cross-reference for the Sam Seymour plant from Figure 2.1-7 is provided below in Figure 2.1-8: *Sample ARPDB-STARS Cross-Reference Record*.

```
6179,2,48149,5,8,8,FC0018G,Sam Seymour,1.00,FAYETTE
```

Figure 2.1-8: Sample ARPDB-STARS Cross-Reference Record

In some cases, one ARPDB record must be matched to two STARS paths because ARPDB tracks units (e.g., a boiler or turbine), but STARS does not always have a one-to-one relationship between an emission unit and an emission stack. Such situations occur when two sources (FINs) discharge through a common stack (EPN), or when one source discharges through multiple stacks. In these situations, the ARPDB emissions are split evenly between the multiple paths. In the Figure 2.1-8 example above, Sam Seymour Unit #2 from ARPDB (6179,2) links to only one STARS path (48149,5,8,8) as denoted by a "1.00" emissions unit factor.

2.1.1.6.1 *Hourly ARPDB Substitution*

Hourly emissions records are generated by substituting ARPDB emissions into the path's AFS record, adjusting the date and hour of the emissions, converting to AFS-required tons of emissions, and changing the "period of emission" indicator. The two records in Figure 2.1-9: *Sample Hourly AFS Records After ARPDB Substitution* are consecutive hourly emission records for the acid rain data of Figure 2.1-7.

```
B 05 05 AC 48149 ETX   4911 10100226   0005       0008       0008
S  05070100 05070101  312.80280 -1094.9120       83 7.012   426 28.96  24
22  29  25 24  0 7 8736 42603   0.273489
RN100226844 FC0018G FPP-2      FPP-2      N ST COMBUSTN   BOILER-ELECTRIC
6179 2      LOWER COLORADO RIVER AUTH Sam Seymour               FAYETTE
LA GRANGE       NOx                              D        STAR  v4a

B 05 05 AC 48149 ETX   4911 10100226   0005       0008       0008
S  05070101 05070102  312.80280 -1094.9120       83 7.012   426 28.96  24
22  29  25 24  0 7 8736 42603   0.269395
RN100226844 FC0018G FPP-2      FPP-2      N ST COMBUSTN   BOILER-ELECTRIC
6179 2      LOWER COLORADO RIVER AUTH Sam Seymour               FAYETTE
LA GRANGE       NOx                              D        STAR  v4a
```

Figure 2.1-9: Sample Hourly AFS Records After ARPDB Substitution

The two records of Figure 2.1-9 are hourly (period of emission = "S") NO_X emissions for the first two hours of July 17, 2005 (begin and end times = 05070100 05070101 and 05070101 05070102, respectively). The typical AFS record of STARS data represents ozone season average daily emissions, whereas substituting hourly emission records generate 24 records for each day of the episode. For modeling purposes, paths that have hourly NO_X emissions receive hourly VOC and CO records by multiplying the STARS OSD VOC-to-NO_X and CO-to-NO_X emissions by the hourly ARPDB NO_X emissions. If the path has ARPDB emissions but does not have a corresponding STARS record (missing, new point source, or different years), then the TCEQ used a default ratio, e.g., an average of similar points. The hourly VOC records link to the same speciation profile used by the STARS OSD record.

In past SIP revisions, the TCEQ divided the point source EI (Texas and the rest of the domain) into EGUs and non-EGUs (NEGUs). Now, the TCEQ has divided the point source EI into hourly and non-hourly files, where OSD is the standard daily (non-hourly) records created from STARS. The ARPDB is only one example of hourly records that the TCEQ is modeling for these current 2005 and 2006 episodes. The acronym "ARD" is used in the filenames to denote hourly "Acid Rain Data" files, and will be used hereafter.

ARD emissions greatly improve the temporal resolution of the point source inventory, because the ARD distinguishes between sources that operate throughout the day as baseload units and sources that operate more intermittently as peaking units. For example, Figure 2.1-10: *Hourly ARD NO_X Emissions for W.A. Parish EGU on August 16, 2006* shows hourly NO_X emissions for the eight individual units of the W.A. Parish power plant. The hourly ARD accounts for emission changes throughout the day. Figure 2.1-10 shows that W.A. Parish EPNs WAP1, WAP2, WAP3 and WAP4 commence operation at approximately 10 AM and shut down in the late evening. The four remaining EPNs operate throughout the day at nearly a constant emission rate – these are the baseload coal units. Without these hourly ARD, the TCEQ would be modeling these units at their reported STARS ozone season daily averages and with their reported operating schedule.

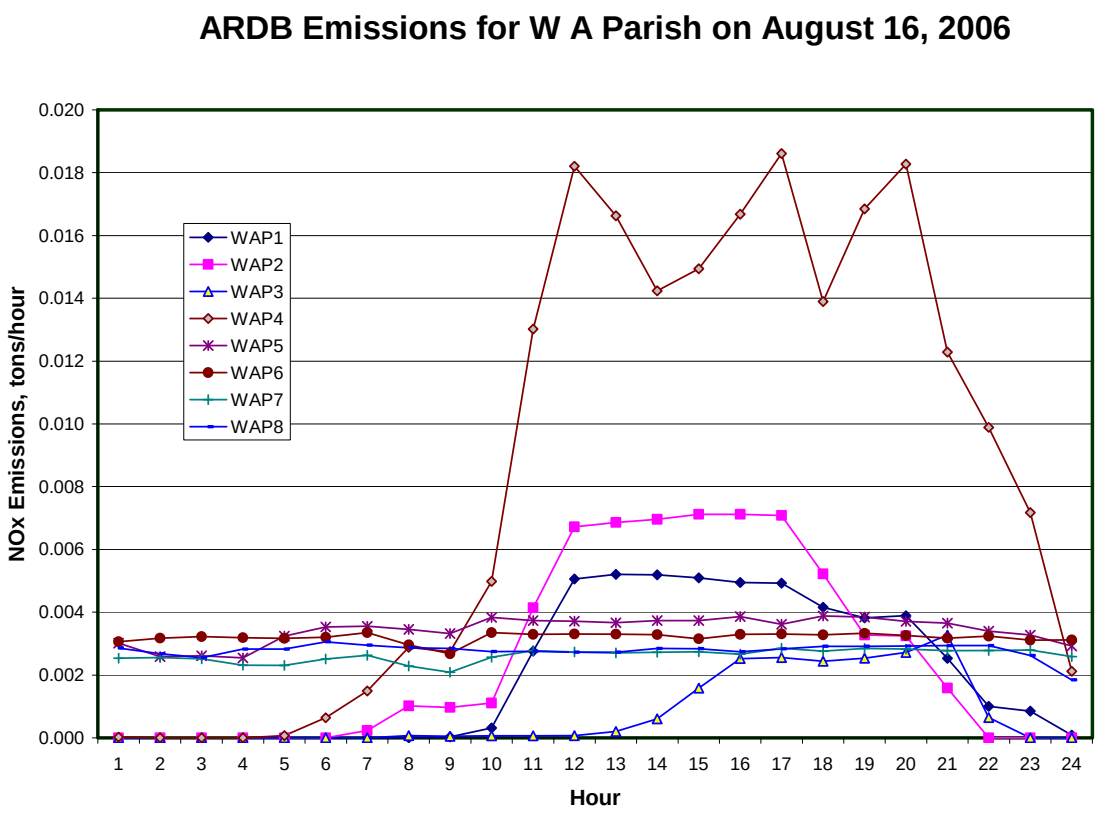


Figure 2.1-10: Hourly ARD NO_X Emissions for W.A. Parish EGU on August 16, 2006

Figure 2.1-11: *Tileplot of HGB ARD NO_X Emissions for August 16, 2006* is a tileplot of ARD NO_X emissions in the eight counties of HGB area for a specific day modeled in 2006. The tileplot is a valuable tool for modelers to graphically QA the modeled emissions. Note the emissions totals by county in the lower left hand corner and the combined diurnal profile of the sources in the lower right corner of the graphic. The colored/shaded tiles on this map represent the quantity of emissions within that grid cell. In this case, a colored/shaded tile represents the ARD EGU NO_X tons for a modeled 2km-by-2km grid cell within the HGB eight-county area.

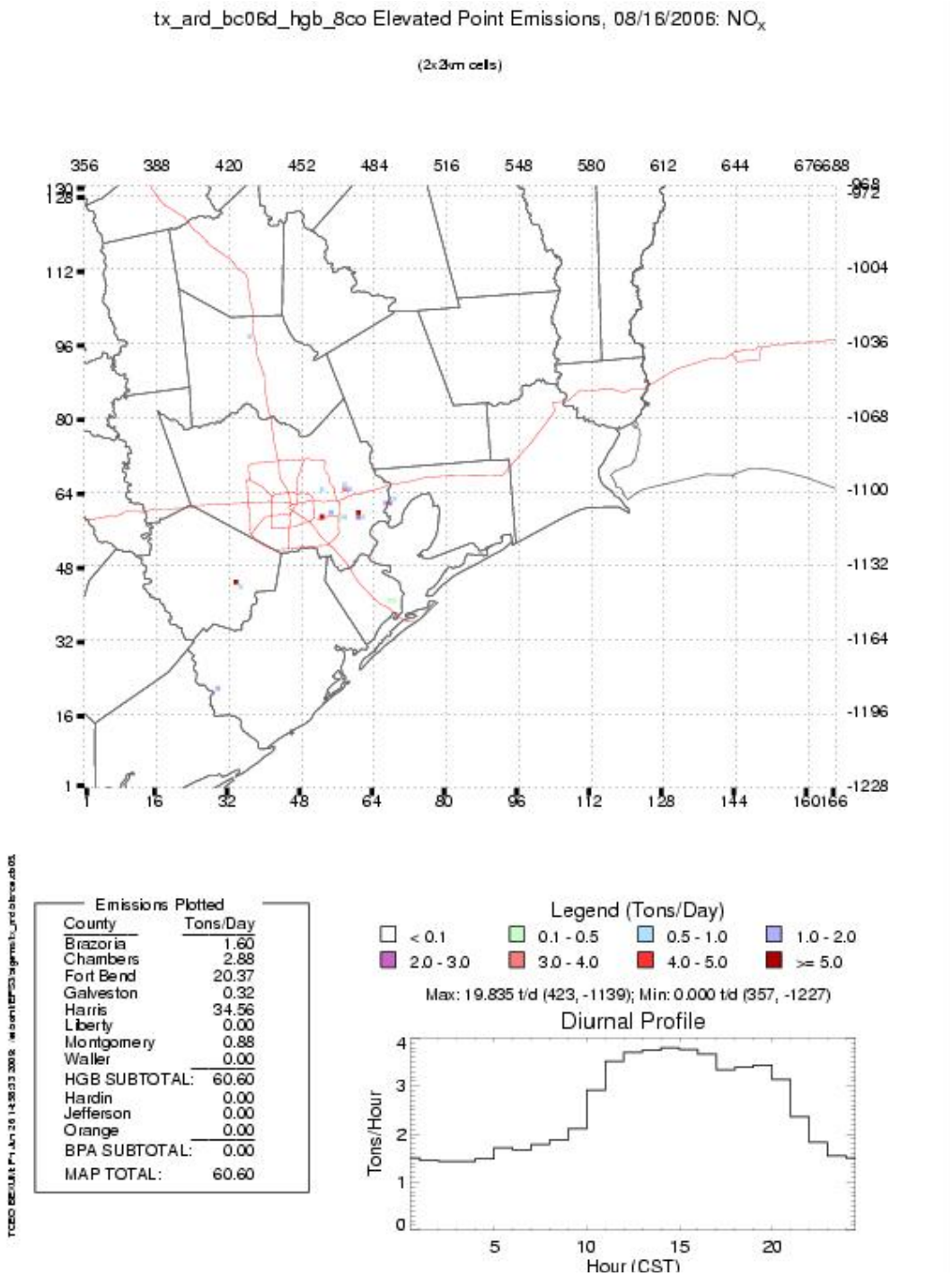


Figure 2.1-11: Tileplot of HGB ARD NO_X Emissions for August 16, 2006

2.1.1.7 Hourly Special Inventories

As with previous attainment demonstration SIP revisions, the TCEQ conducted hourly Special Inventories (SIs) in order to obtain better detail about emissions during potential modeling episodes. The TCEQ conducted a 2005 SI, a 2006 SI, a Tank Landing Loss (TLL) SI, and a 2006 HRVOC SI. All but the HRVOC SI were incorporated into the base case episodic modeling EIs, because the HRVOC SI was less complete than data already available from STARS. The following subsections describe each of these in more detail.

2.1.1.7.1 *2005 Special Inventory (SI)*

The TCEQ expected high ozone in HGB during May of 2005, because there had been such a trend, and the month of May had not been captured in any Special Inventories previously. Additionally, this timeframe provided an opportunity to test new SI handling procedures prior to the 2006 TexAQS II intensive period. In previous SI requests, the TCEQ consolidated many versions of submitted spreadsheets into the modeled SI, after much labor.

For this SI request, there were several new goals: (1) make reporting easier for respondents, (2) limit the number of hours and days of reporting, (3) make reporting and data capture near real-time, (4) capture variability and highly-resolved data, (5) target specific regulated entities that would like to test new software, and (6) compile the results into a consolidated place automatically, to make its use much easier and quicker. After selecting URS as the contractor to assist TCEQ, the goal quickly became to automate the entire SI submittal and retrieval process via software that ultimately created a file that could be uploaded directly into STARS. The contractor developed the Hourly Emission Inventory Reporting System (HEIRS) which allowed regulated entities (SI respondents) to enter data into this new database system online, perform QA checks, and output a file that could be imported by STARS. The TCEQ could then use the existing modeling extract query to generate the report described in Section 2.1.1.1 above. This process took URS and the TCEQ an entire year or more to work out all the bugs.

The 2005 SI request was limited to 22 accounts in Harris County; it addressed VOC, HRVOC, and non-EGU NO_X, and covered only the days which met criteria set by TCEQ modelers to obtain the best data in the shortest amount of time, resulting in less data gathering for the respondent and TCEQ. The reporting criteria were based on eight-hour ozone thresholds, such that as daily ozone levels anywhere in the County approached the standard, data collection began, and data collection ended once the monitored ozone levels everywhere in the County dropped below a lower threshold value. This resulted in SI data being collected for May 3-7 and May 12-June 4, 2005. These periods overlapped with the modeled May 19-June 3, 2005 episode. Ultimately, the 2005 SI data was dropped from modeling files, as the 2005 SI had limited participation (new procedure scared off some respondents), and some of the reported emissions had obvious errors that TCEQ could not resolve with the respondent in a timely manner. The victory of the 2005 SI came in the form of a successful test case study.

2.1.1.7.2 *2006 Special Inventory (SI)*

On the heels of the 2005 SI test study, came the ultimate test for the new HEIRS software, interface (including a web data entry option), and STARS capability. An SI request was made for the intensive period of TexAQS II: August 15 through September 15, 2006. This request targeted non-EGUs that likely had CEMs or PEMs to provide highly-variable and highly-resolved data in near real-time. Additionally, some HRVOC monitoring systems were beginning to come online as respondents were meeting the requirements of the new Chapter 115 HRVOC rules. The webpage, http://www.tceq.state.tx.us/implementation/air/airmod/texaqs/texaqs_data.html, contains information regarding the SI, including data file download.

The TCEQ made this 2006 Special Inventory request to 141 accounts (sites) in 24 counties of Texas. A total of 49 of those accounts were in the HGB eight-county area. The request was for hourly emissions from a specific list of 405 paths (process unit, emission point combinations) that generally have regulatory monitors of some type on their equipment. The emissions requested were specifically HRVOC, other VOC, and NO_X, but all species for all hours of the 32-day period were expected to be reported. Again, the accounts had the option to use the HEIRS software to consolidate and format the data for input to STARS; but, regardless, the accounts had to submit the data in STARS upload format.

STARS was queried for the 2006 hourly SI data, a report was extracted, and a record for each path-hour-contaminant combination was generated. The SI extract pulls data for all SI records in STARS (2005 and 2006), for a total of 15 million lines of pipe-delimited data. The extract SAS

code was modified to filter for the year 2006. Figure 2.1-12: *Sample STARS SI Extracted Data* provides an excerpt of these data.

```
E|ACCOUNT-SITE|RN102204211|ACCT_NUM|HG9625W|
E|SPECIAL EMISSION|14        14        50001200609151|REASON CODE|UI|
E|SPECIAL EMISSION|14        14        50001200609151|QUANTITY|0|
E|SPECIAL EMISSION|14        14        50001200609152|REASON CODE|UI|
E|SPECIAL EMISSION|14        14        50001200609152|QUANTITY|0|
. . .
E|SPECIAL EMISSION|9A        16        500012006091417|QUANTITY|0|
E|SPECIAL EMISSION|9A        16        500012006091419|REASON CODE|UI|
E|SPECIAL EMISSION|9A        16        500012006091419|QUANTITY|0|
E|SPECIAL EMISSION|9A        16        524202006091416|REASON CODE|N|
E|SPECIAL EMISSION|9A        16        524202006091416|QUANTITY|10.05|
E|SPECIAL EMISSION|9A        16        524202006091415|REASON CODE|N|
E|SPECIAL EMISSION|9A        16        524202006091415|QUANTITY|20.1|
E|SPECIAL EMISSION|9A        16        524202006091414|REASON CODE|N|
E|SPECIAL EMISSION|9A        16        524202006091414|QUANTITY|10.05|
E|SPECIAL EMISSION|9A        16        500012006091424|REASON CODE|UI|
E|SPECIAL EMISSION|9A        16        500012006091424|QUANTITY|0|
E|SPECIAL EMISSION|9A        16        500012006091423|REASON CODE|UI|
E|SPECIAL EMISSION|9A        16        500012006091423|QUANTITY|0|
E|SPECIAL EMISSION|9A        16        500012006091422|REASON CODE|UI|
E|SPECIAL EMISSION|9A        16        500012006091422|QUANTITY|0|
```

Figure 2.1-12: Sample STARS SI Extracted Data

Figure 2.1-12, above, shows Special Inventory emissions for two paths of site RN102204211, identified by FIN 14/EPN 14 and FIN 9A/EPN 16. Note that the first two "SPECIAL EMISSION" records of the excerpt, in combination, denote that the unit was idle ("UI"), reporting zero emissions of unclassified VOC (TCEQ Contam code "50001") for Hour 1 of September 15, 2006 (200609151).

Figure 2.1-13: *Hourly SI vs. OSD VOC for September 2, 2006*, below, demonstrates the difference in the hourly SI versus the reported 2006 OSD for all of the SI paths (not just in HGB) for total VOC emissions for a particular day (September 2, 2006) of the SI period. Note that the reported OSD has a flat diurnal profile, and the SI is generally slightly less than the average OSD, except for hour 11 and hours 22 and 23. In fact, a huge spike, approximately three times the average hour was reported in the SI for hour 22.

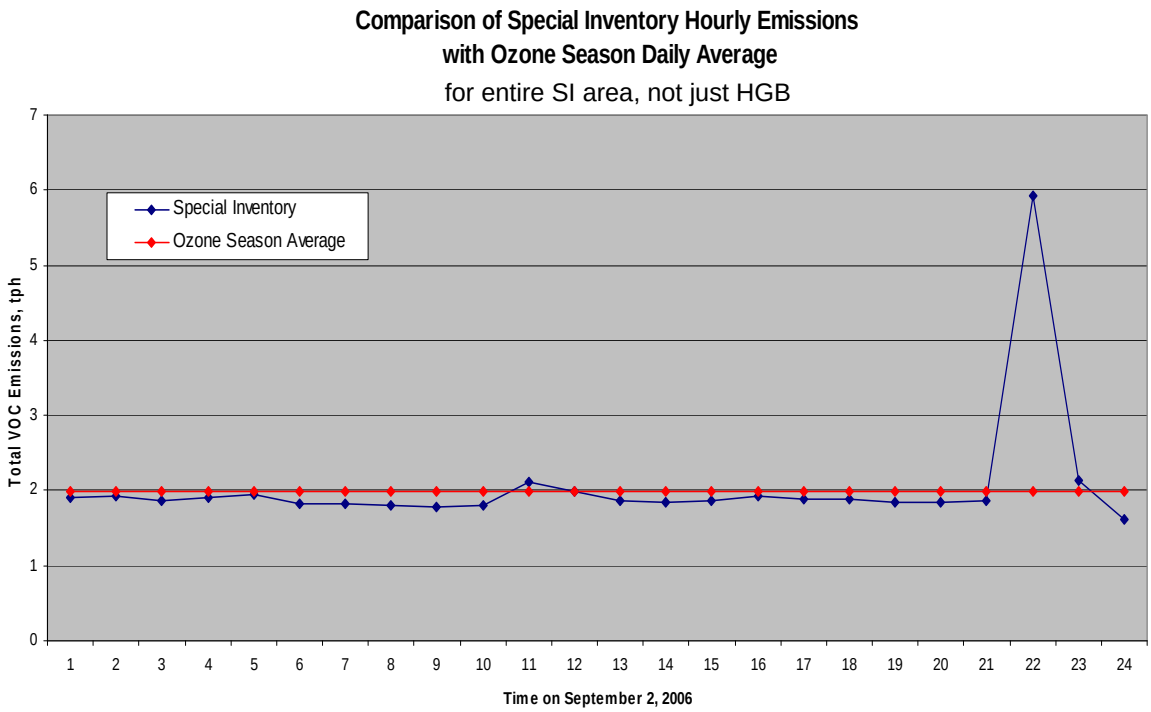


Figure 2.1-13: Hourly SI vs. OSD VOC for September 2, 2006

Figure 2.1-14: *Tileplot of SI NO_X for September 2, 2006* and Figure 2.1-15: *Tileplot of SI VOC for September 2, 2006* are tileplots of the same SI day as represented in Figure 2.1-13 for NO_X and VOC, respectively. Note the one hour time shift most notably in the spike in Figure 2.1-15 as the temporal module of EPS3 converts the daylight time to standard time. Standard time is required input for the photochemical model, in order to match the meteorology. The NO_X SI diurnal profile bobs up and down around an average, not varying by more than ten percent.

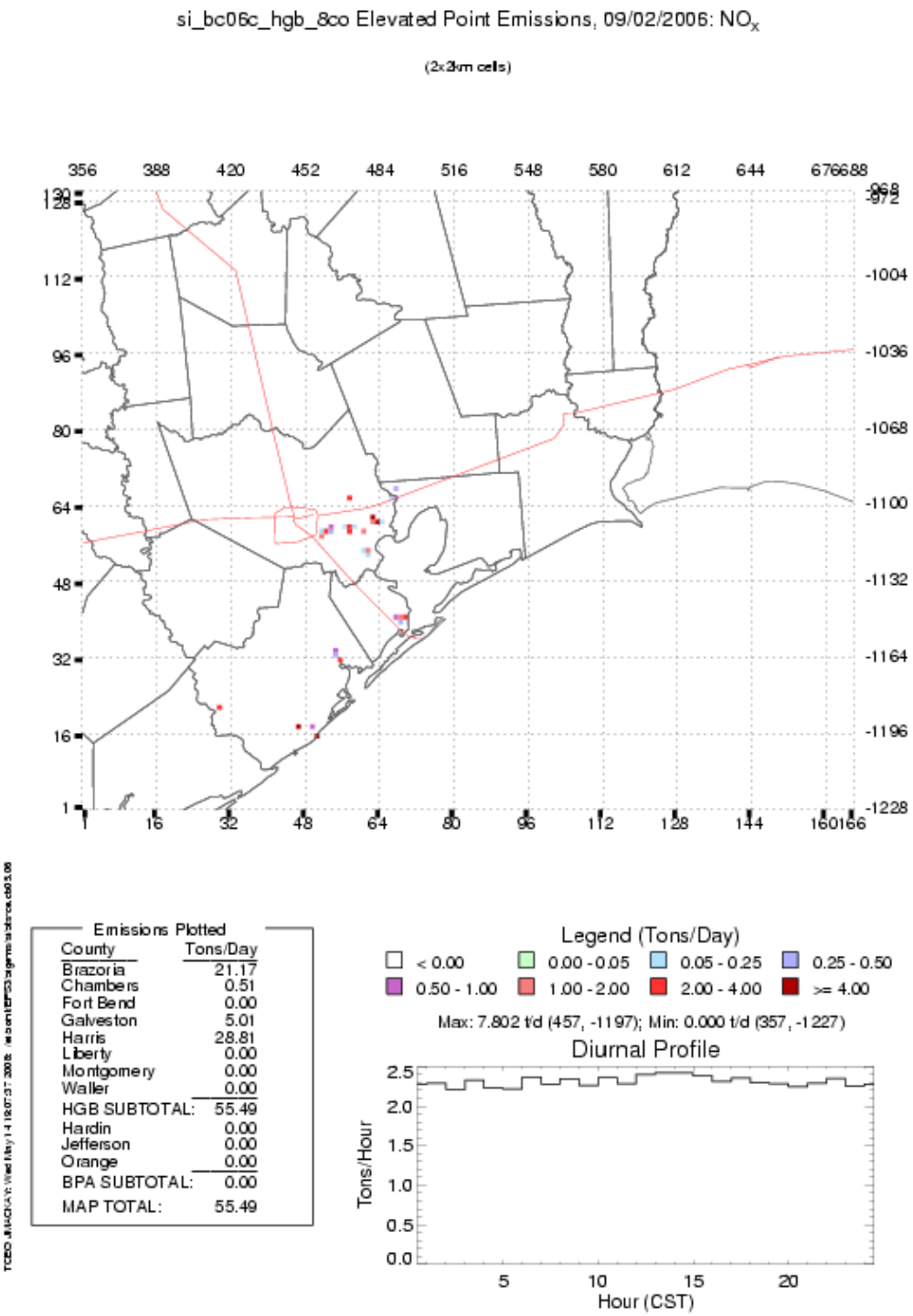


Figure 2.1-14: Tileplot of SI NO_X for September 2, 2006

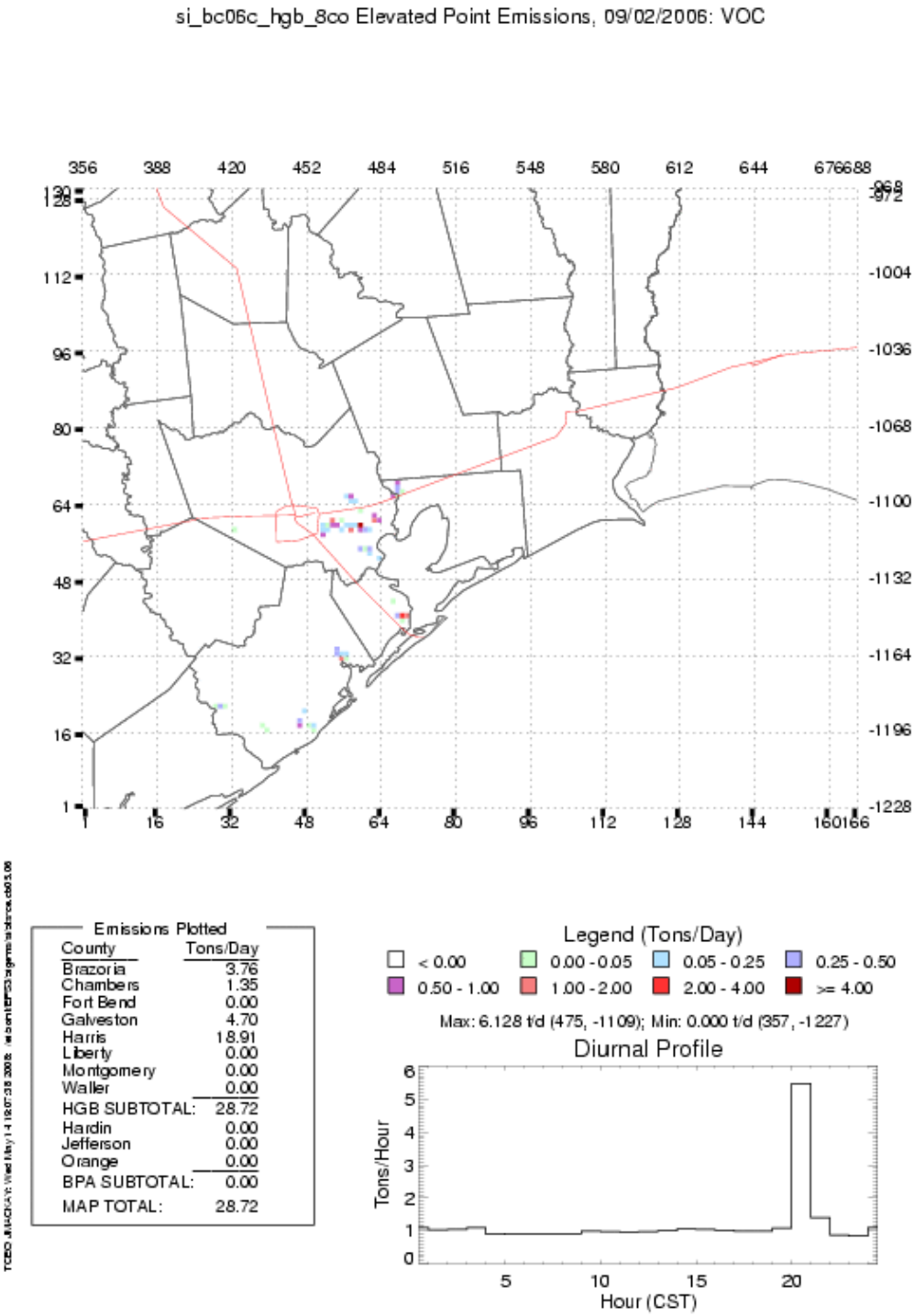


Figure 2.1-15: Tileplot of SI VOC for September 2, 2006

Again, the goal was to replace the corresponding 2006 OSD records with these hourly records for the period August 15 through September 15, 2006. Not only did the TCEQ anxiously await these data, but many TexAQS II scientific participants sought these data, for comparison purposes with their ambient measurements form ships, aircraft, and ground and elevated monitors. To generate the EPS3-ready AFS file, the TCEQ wrote specialized SAS code to parse the extracted data and format for an AFS file, because each line in the emissions record of the extract file represented a single hourly emissions record, as illustrated in Figure 2.1-16: *Example of SI Parsed Extract Emissions Records*.

```
RN000000000   HG0000A   M2A-D-1-5      ES-205         06081520
10.0000     RM   55176

RN000000000   HG0000A   M2A-D-1-5      ES-205         06081521
20.0000     RM   55176
```

Figure 2.1-16: Example of SI Parsed Extract Emissions Records

The records in Figure 2.1-16 are butene (TCEQ contam code 55176) emissions for two consecutive hours (20 and 21) of August 15, 2006, from path RN=RN000000000, FIN=M2A-D-1-5 and EPN=ES-205. As indicated by the records, there is an emission rate change between the two hours (10.0000 to 20.0000 pounds per hour). If there are other contaminants or other hours reported for the two streams, then there will be additional records.

Speciation of the Special Inventory

The TCEQ modeling of the 2000 SI in previous SIP revisions used a calculated episode average composition of the VOC constituents of a reported SI path. In reality, each path can report any number of contaminants in any given hour; so in order to retain as much detail as possible, the TCEQ now generates a unique speciation profile for every hour for every path. Other than this improvement, the speciation process is essentially the same as that for the OSD, in which point-specific profiles are generated for each source, retaining the specific constituents as reported, and applying the SCC default profile (after removing non-VOC and common species from the profiles) for the unspeciated portion.

To generate complete AFS records, the TCEQ matched the extracted hourly SI records with STARS OSD records of the same path. To uniquely identify each VOC emission record, the TCEQ numbered the sites and assigned that number in sequence to the "plant" identifier. The date and hour of the emissions were incorporated into the "stack" and "point" identifiers. Figure 2.1-17: *Example of SI AFS Records* shows two consecutive hours of SI VOC records.

```
B 06 06 AC 48201 HGB   2821 30101802   0999       0815       0020
S  06081519 06081520  474.98390 -1108.9180     69.0   0.1   811  0.01  25
25  25  25 24  0 7 8736 43104   1.200000
RN000000000 HG0000A M2A-D-1-5  ES-205       FL VOCPROCESS OTHER VOC PROCE
TOTAL PETROCHEMICALS USA  LA PORTE PLANT            HARRIS     DEER PARK
VOC                              E EPA    SI06  v3a   V001

B 06 06 AC 48201 HGB   2821 30101802   0999       0815       0021
S  06081520 06081521  474.98390 -1108.9180     69.0   0.1   811  0.01  25
25  25  25 24  0 7 8736 43104   2.000000
RN000000000 HG0000A M2A-D-1-5  ES-205       FL VOCPROCESS OTHER VOC PROCE
TOTAL PETROCHEMICALS USA  LA PORTE PLANT            HARRIS     DEER PARK
VOC                              E EPA    SI06  v3a   V001
```

Figure 2.1-17: Example of SI AFS Records

The two records of Figure 2.1-17 are for the same path in Figure 2.1-16, identified by RN=000000000, FIN=M2A-D-1-5 and EPN=ES-205. In STARS, the path would have different plant, stack and point identifiers. In the SI, the site is uniquely identified by plant=0999. Other sites in the SI are uniquely identified by plant -- "0001", "0002", and so on. Stack = "0815" identifies the date (August 15) and point = "0020" in the first record identifies the hour (19:00 through 20:00). Each hourly emission record links to a speciation cross reference, as shown in Figure 2.1-18: *Example of SI Speciation Cross Reference File.*

```
48201       0999       0815       0017   30101802 SIV99908150017
48201       0999       0815       0018   30101802 SIV99908150018
48201       0999       0815       0019   30101802 SIV99908150019
48201       0999       0815       0020   30101802 SIV99908150020
48201       0999       0815       0021   30101802 SIV99908150021
48201       0999       0815       0022   30101802 SIV99908150022
48201       0999       0815       0023   30101802 SIV99908150023
48201       0999       0815       0024   30101802 SIV99908150024
48201       0999       0816       0001   30101802 SIV99908160001
48201       0999       0816       0002   30101802 SIV99908160002
48201       0999       0816       0003   30101802 SIV99908160003
48201       0999       0816       0004   30101802 SIV99908160004
```

Figure 2.1-18: Example of SI Speciation Cross Reference File

The cross reference file of Figure 2.1-18 links point sources to their composition profile. The profile code entries of Figure 2.1-19: *Examle of Speciation Profile for One SI Path* shows the composition for the point source referenced by SIV999081500 from Figure 2.1-18. In this particular example, the (hypothetical) survey respondent did not include unclassified VOC emissions in the inventory that could have affected the final component and composition profile. (Unclassified VOC get a default composition, and the profile code drops components that do not have a threshold weight fraction.)

```
SIV99908150020 43203 0.2000
SIV99908150020 43204 0.2000
SIV99908150020 43205 0.2000
SIV99908150020 43212 0.1500
SIV99908150020 43213 0.1000
SIV99908150020 43231 0.1500
SIV99908150021 43203 0.2000
SIV99908150021 43204 0.2000
SIV99908150021 43205 0.2000
SIV99908150021 43212 0.2000
SIV99908150021 43213 0.1200
SIV99908150021 43214 0.0400
SIV99908150021 43231 0.0400
```

Figure 2.1-19: Example of Speciation Profile for One SI Path

Values in the second column of Figure 2.1-19 are the AIRS/SAROAD pollutant code (e.g., butene=43213), and the values in the last column are weight fractions. Note that the six records for Hour 20 add to 1.0, as well as the seven hours for Hour 21.

Creating the Composite AFS Files

The complete August 15 through September 15, 2006 AFS files consist of the SI AFS records, along with ARD and OSD records (and Tank Landing Losses – discussed in the next subsection). To ensure no double counting of records, the TCEQ used RN, FIN and EPN path identifiers to link the SI emission records to ARD (none in the 2006 SI) or OSD counterparts. Next, the OSD records having SI were expanded into hourly emission records, and each ARD or OSD emission record was deleted, if there was an SI emission for that path and hour. Thus, the complete set of ARD and OSD records with SI consists of the following files:

- hourly SI VOC emission records with unique path identifiers for each record (for speciation),
- hourly SI NO_X emission records,
- hourly ARD records with SI NO_X records removed,
- daily OSD records with all SI VOC paths removed,
- hourly OSD and ARD emission records for SI paths where the survey respondent did not provide emissions for particular hours.

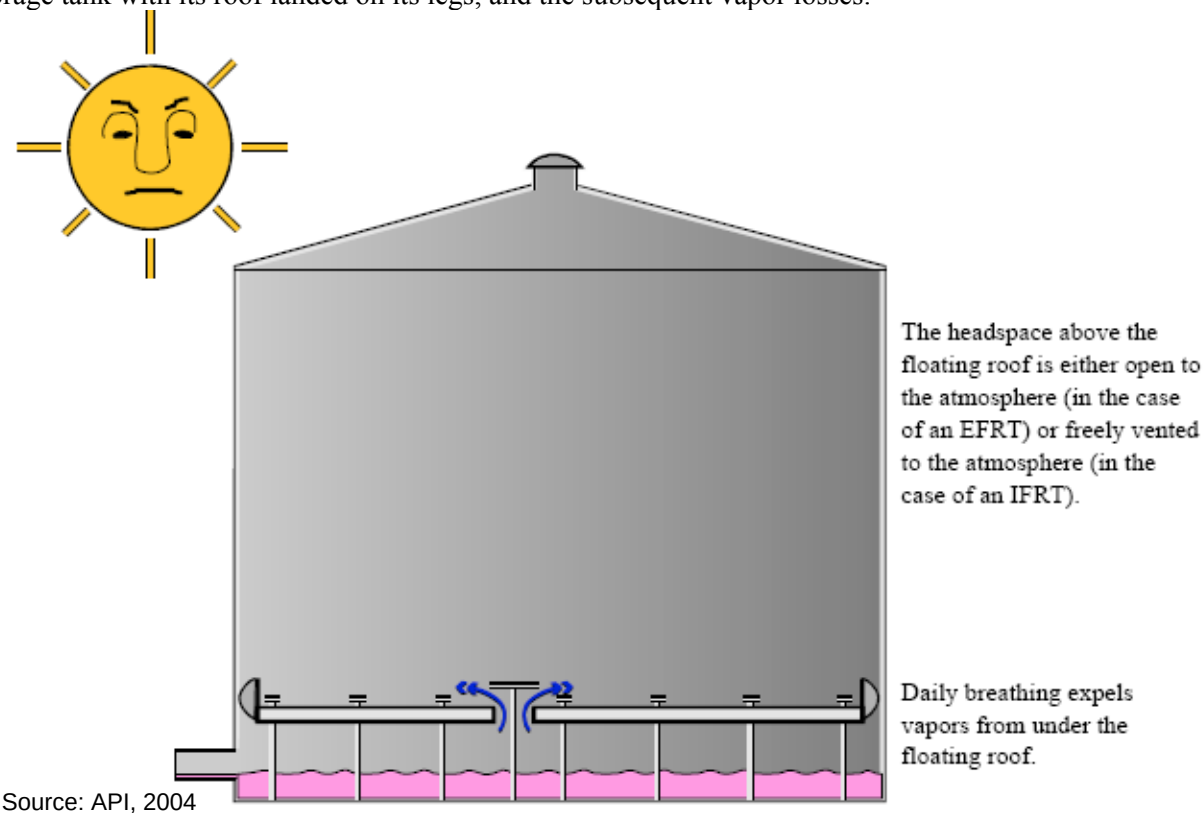
There were more than 30,000 hourly records prior to introducing the hourly SI records. The SI added approximately 350,000 hourly NO_X records and approximately 420,000 hourly VOC records. These values do not include the Tank Landing Losses discussed in the next subsection.

No Acid Rain EGU sources were included in this SI data request, so there happened to be no SI ARD records. For hourly OSD records, there is a difference between the SI survey respondent reporting the value of zero emissions and not providing an emission rate at all. While a missing emission rate might be intended as zero, it remains an unreported value and, in this case, the emission rate is allowed to default back to its hourly OSD or ARD value. To distinguish between these two situations, the SI dataset carried zero emission records, which are normally deleted. Such records do not have profiles (composition) and, even though there is a path, they do not receive cross references.

2.1.1.7.3 *2005 & 2006 Tank Landing Loss (TLL) Surveys*

As a result of a remote sensing VOC project in July 2005, as part of TexAQS II, large storage tanks in specific service (e.g., tanks-for-hire at terminal facilities and crude oil breakout stations) in the Houston Ship Channel (HSC) area were found to be landing their floating roofs (internal and external) on the tank legs and not reporting those vapor space losses. As a result, a TCEQ Chapter 115 rule was written that limits the number of permissible "convenience" roof landings. Additionally, these sources of additional VOC emissions were rarely reported in annual EIQs and were rarely permitted; both of these situations have been remedied.

Figure 2.1-20: *Landed Floating Roof Emissions* is a graphical representation of a floating roof storage tank with its roof landed on its legs, and the subsequent vapor losses.



Source: API, 2004

Figure 2.1-20: Landed Floating Roof Emissions

Landing loss emissions from floating roof storage tanks have two components: standing idle losses and filling losses. When some types of maintenance activities are performed or for some changes in tank liquid, the tank is drained of its contents. When the liquid drops to a level near the bottom of the tank, the roof lands on legs that prevent it from dropping any further as the liquid continues to drain. In this configuration, emissions called "standing idle losses" occur from the vapor space under the landed roof because of a small amount of liquid remaining in the tank. When the tank is refilled and the roof refloated, emissions occur as the liquid displaces the vapor under the roof. These are called "filling losses."

As part of the Second Texas Air Quality Study (TexAQS II), in July 2005 the TCEQ conducted the Remote Sensing Volatile Organic Compound Project in Southeast Texas. For this project, the TCEQ used passive infrared cameras in aerial and ground surveys in areas including the Houston Ship Channel and Texas City. The results of this study indicated that landing loss VOC emissions from floating roof storage tanks generally had been unreported in the TCEQ emissions inventory.

As a result of this study, the TCEQ requested Emissions Inventory Questionnaire (EIQ) revisions accounting for TLLs from 52 sites in the HGB ozone nonattainment area, with a focus on bulk terminals, tank leasing terminals, and pipeline breakout stations. The inventory revisions were requested for the years 2002-2004 and companies were required to incorporate landing loss emissions into their EIQs for subsequent years.

For this SIP revision, hourly TLL VOC emissions were developed for the modeled 2005 and 2006 base case ozone episodes. Before the hourly emissions for the episodes were developed, the TCEQ determined which of the 52 sites in the HGB area had accounted for the majority of landing loss emissions during the period 2002–2004. This screening showed that twelve of these sites had accounted for approximately 97 percent of landing loss emissions reported during those years. The TCEQ thus considered only these twelve sites, listed in Table 2.1-2: *TLL Sites Modeled*, in the development of the hourly episodic landing loss inventory.

Table 2.1-2: TLL Sites Modeled

Regulated Entity Reference Number	Company	Site Name	County	Standard Industrial Classification (SIC)
RN101948883	TEPPCO Crude Oil Pipeline LLC	Seaway Jones Creek Station	Brazoria	4612
RN102180486	Magellan Terminals Holdings LP	Galena Park Terminal	Harris	4612
RN102560182	TEPPCO Crude Pipeline LP	Seaway Texas City Station	Galveston	4612
RN101041598	LBC Houston LP	L.B.C. Houston, L.P.	Harris	4226
RN100224815	Kinder Morgan Operating LP	Pasadena Terminal	Harris	4226
RN100237452	Kinder Morgan Liquids Terminals LLC	Galena Park Terminal	Harris	5171
RN100210806	Intercontinental Terminals Co.	Intercontinental Terminal	Harris	4226
RN101851517	Marathon Ashland Pipe line LLC	Marathon Ashland Pipe Ln	Harris	4613
RN100224740	Oil Tanking Houston LP	Oil Tanking Houston Terminal	Harris	4226
RN100225093	Vopak Terminal	Deer Park Terminal	Harris	4226
RN100219591	TEPPCO	Baytown Terminal	Harris	4789
RN101921781	TEPPCO Crude Oil Pipeline LLC	Seaway Galena Park Station	Harris	4612

Of the twelve sites listed in the table above, one (Marathon Ashland) was not included in the hourly landing loss inventory since the company's records did not show any landings occurring on the ozone episode days of interest.

In the meantime, before these emissions were formally added to STARS, as part of the effort to model the real world emissions, the TCEQ included these events as a portion of the under-reported VOC in HGB. The TCEQ organized and summarized the data in Excel spreadsheets for all of the modeled 2005 and 2006 episodes. In reality, part of these emissions were double-counted in the base cases, as regulated entities also reported these in their 2005 and 2006 annual and ozone season emissions. For the base cases, these TLL emissions were modeled in addition to what was ultimately reported in the 2005 and 2006 EIs, entered into STARS, and subsequently extracted for modeling. This was corrected for the baseline modeling. For the baseline modeling,

the TLL paths were removed from the OSD file and an average of the hourly TLL emissions were modeled. Figure 2.1-21: *Sample of Two TLL and Refilling Events* shows a typical entry documenting landing and refilling losses for one of the survey respondents.

Company	Account #	FIN	EPN	Type of Floating Roof Tank	Landing Start Date and Time	Landing End Date and Time
TEPPCO	BL0571U	SW02TANK01	SW02TANK01	External Floating Roof Tank	6/27/2005 2:26	6/27/2005 11:08
TEPPCO	BL0571U	SW02TANK01	SW02TANK01	External Floating Roof Tank	6/27/2005 20:37	6/28/2005 14:03
Landing Product Contaminant Name	**Refilling Start Date and Time**	**Refilling End Date and Time**	**Refilling Pollutant Contam Code**	**Refilling Vapors - Pollutant Name**	**Standing Idle Losses (lb/hr)**	**Refilling Losses (lb/hr)**
Crude Oil	6/27/2005 11:08	6/27/2005 14:46	59001	Crude Oil	37.5197	1572.9691
Crude Oil	6/28/2005 14:03	6/28/2005 17:41	59001	Crude Oil	31.9739	1572.9691

Figure 2.1-21: Sample of Two TLL and Refilling Events

Temporal Allocation

The two data entries (records) of Figure 2.1-21 detail two events during which a floating roof tank was emptied and then refilled. After the floating roof lands (comes to rest on supports when the tank is empty), the tank is subject to standing idle (breathing) losses. As the tank refills, there are refilling vapor losses as the refilling liquid fills the vapor space prior to refloating the roof. The tank FIN (facility identification number) and EPN (equipment point number) represent the STARS path. Matching the survey results to the STARS AFS records, modelers generated a sequence of hourly emissions records for the days of each of the modeling episodes in which respondents provided data.

The TCEQ allocated tank breathing losses to the eight hours between 8:00 AM and 3:00 PM – the sunny hours. Figure 2.1-22: *Sample TLL Event AFS Record* is an AFS record for the first hour of event one of Figure 2.1-21.

```
B 05 05 AC 48039 HGB   4612 40301132   131        1          1
S  05062711 05062712  446.07150 -1197.1010       15 0.915   298 0.003  25
25  25  25 24  7 7 8736 43104   0.786485
RN101948883 BL0571U SW02TANK01 SW02TANK01 N ST TANKS      EXT FL ROOF: DB
TEPPCO Crude Pipelin      Jones Creek Terminal      BRAZORIA   JONES
CREEK     VOC  59001 Crude Oil (R                 LAND
```

Figure 2.1-22: Sample TLL Event AFS Record

The entire history of a TLL event is a sequence of hourly AFS records. Figure 2.1-23: *Sample of Hourly Consecutive TLL Event AFS Records* is an excerpt from consecutive AFS records, showing the progression of start/end times (05062711 05062712, 05062712 05062713, …) and emission rates (0.786485, 0.786485, …) for path SW02TANK01/SW02TANK01. Each of the records is an hour of VOC emissions. Note that "05062711" is the eleventh hour of June 27, 2005.

```
05062711 05062712  43104  0.786485  SW02TANK01 SW02TANK01 VOC Crude Oil
05062712 05062713  43104  0.786485  SW02TANK01 SW02TANK01 VOC Crude Oil
05062713 05062714  43104  0.786485  SW02TANK01 SW02TANK01 VOC Crude Oil
05062714 05062715  43104  0.786485  SW02TANK01 SW02TANK01 VOC Crude Oil
```

Figure 2.1-23: Sample of Hourly Consecutive TLL Event AFS Records

Speciation

When modeling these TLL VOC emissions, the TCEQ was expecting to need to use the same procedures that were used for the SI, above, for speciation of these events. Each event in the TLL dataset could have its own speciation cross reference and profile. The 2005 and 2006 TLL surveys, however, did not have a composition change in any of the tanks, so a single composition was applicable for every hour across the events for the year for a given tank. Hence, the STARS OSD point-specific profiles were suitable for the TLL AFS file.

Figure 2.1-24: *TLL Tileplot for June 23, 2005* and Figure 2.1-25: *TLL Tileplot for June 28, 2005* are modeling QA tileplots showing total VOC emissions from TLLs for two different days in June of 2005. Note how different these two days are, both in diurnal profile (distribution of emissions across the hours of the day) and total tons of VOC.

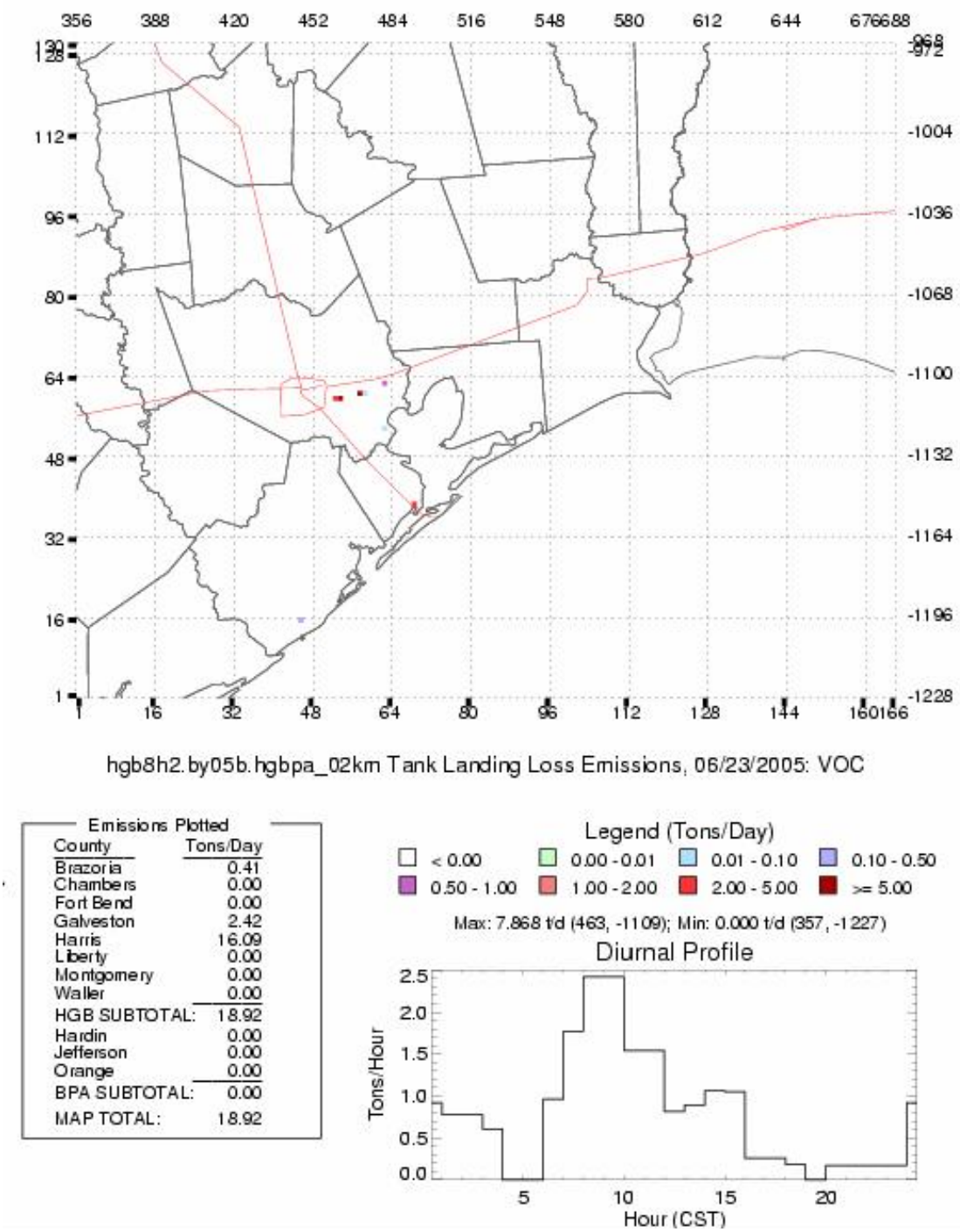


Figure 2.1-24: TLL Tileplot for June 23, 2005

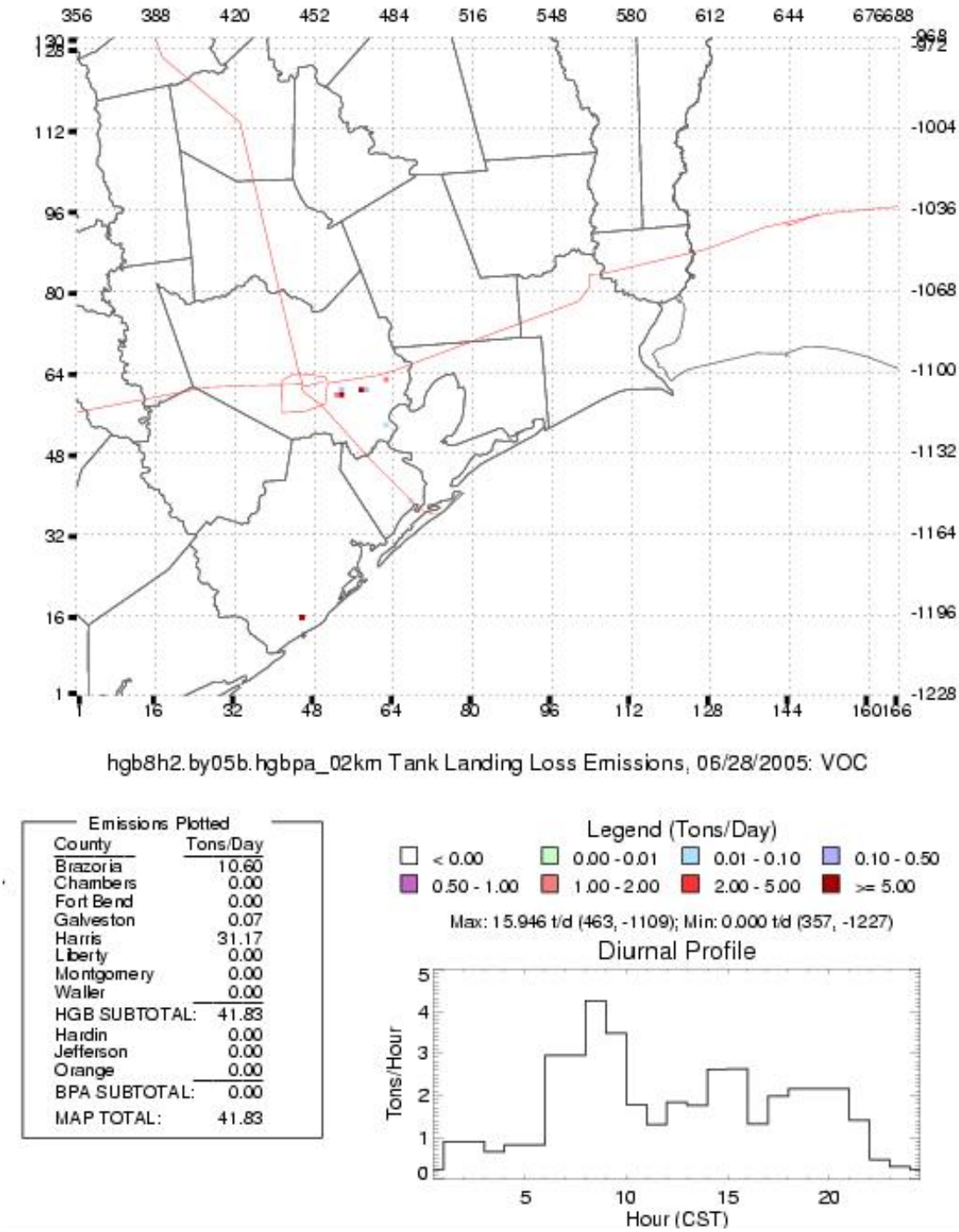


Figure 2.1-25: TLL Tileplot for June 28, 2005

2.1.1.8 Emission Events Inventories

Generally, the more detailed (i.e., temporally, spatially, and chemically resolved) the input data, the more likely the model will appropriately replicate ozone episodes, especially as modelers push the resolution envelope. Additionally, in HGB, recent air quality studies, such as TexAQS II have provided an abundance of ambient measurements of air quality constituents to use in evaluating the photochemical modeling. These measurements indicated the need for a higher temporal resolution of EIs. The addition of the hourly inventories described in the previous sections contributes to this goal. TCEQ modelers tried incorporating at least two other TCEQ databases, as described in the following subsections.

2.1.1.8.1 *Consolidated Compliance and Enforcement Database System (CCEDS)*

CCEDS is one source of data the TCEQ reviewed to potentially improve the point source modeling inventory. CCEDS allows the TCEQ to track, monitor, report and implement enforcement programs across the agency in all business areas. It contains data for maintenance, startups, shutdowns, emission events, and other reports. Reporting entities enter data into the system based on events that are officially declared "reportable":

- 30 TAC 101 Subchapter A 101.1 (28): "unauthorized emissions of air contaminants from one or more emissions points at a regulated entity"
- 30 TAC 101 Subchapter F Division 2 101.211 (a): "any scheduled maintenance, startup, or shutdown activity that is expected to cause an unauthorized emission that equals or exceeds the reportable quantity (RQ) as defined in §101.1 of this title (relating to Definitions)"

These data are electronically submitted by the responsible company representative through the State of Texas Environmental Electronic Reporting System (STEERS) web interface and stored in an Oracle database. The TCEQ staff query the CCEDS database for the period of time and areas of the State that are of interest.

Queries were made for all of 2005 and 2006, and subsequently reduced to the area of interest (HGB 8-county area), pollutants of interest, and modeling episode dates. Reported data includes, among others, details about the reporting entity, the facility or emission point identifier (not necessarily the FIN or EPN from STARS), the beginning and ending times of the event, and the pollutant and quantity released. Figure 2.1-26: *Sample CCEDS Data* is an excerpt of a CCEDS query (seven, 19-field-long records), covering two different days, for a single HGB point source in 2005.

REG_ENT_NUM	REG_ENT_NAME	CITY	COUNTY	REGION	SIC
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869
RN1025xxxxx	CHEMICAL PLANT	TEXAS CITY	GALVESTON	REGION 12 - HOUSTON	2869

FIN_EPN_NUM	UNIT_TYPE	UNIT_NAME	EVENT_TRACK_NUM	EVENT_TYPE	EVENT_START_DT	EVENT_START_TM
FL-401	EPCN	PX-2 Flare	56,855.00	AIR SHUTDOWN	04/15/2005	9:50
FL-401	EPCN	PX-2 Flare	56,855.00	AIR SHUTDOWN	04/15/2005	9:50
FL-401	EPCN	PX-2 Flare	56,855.00	AIR SHUTDOWN	04/15/2005	9:50
FL-401	EPCN	PX-2 Flare	56,855.00	AIR SHUTDOWN	04/15/2005	9:50
FL-401	EPCN	PX-2 FLARE	65,361.00	AIR SHUTDOWN	09/21/2005	12:00
FL-401	EPCN	PX-2 FLARE	65,361.00	AIR SHUTDOWN	09/21/2005	12:00
FL-401	EPCN	PX-2 FLARE	65,361.00	AIR SHUTDOWN	09/21/2005	12:00

EVENT_END_DT	EVENT_END_TM	CONTAMINANT	QUANTITY_RELEASED	UNIT_OF_MEASURE	NOTIF_TYP_CD
04/22/2005	17:14	P-Xylene	29.00	POUNDS	FINAL
04/22/2005	17:14	Ethylbenzene	0.40	POUNDS	FINAL
04/22/2005	17:14	O-Xylene	0.60	POUNDS	FINAL
04/22/2005	17:14	M-Xylene	2.00	POUNDS	FINAL
10/04/2005	12:00	Benzene	0.22	POUNDS	FINAL
10/04/2005	12:00	Propane	1,592.01	POUNDS	FINAL
10/04/2005	12:00	Ethylene (gaseous)	526.48	POUNDS	FINAL

Figure 2.1-26: Sample CCEDS Data

Pollutants include NO_X, CO, CO2, SO_X, PM, various hydrocarbon species, unclassified VOC, and other chemical compounds and elements. For VOC, reports varied in level of detail, with some reporting speciated VOC compounds, others reporting ”VOC”, and others reporting “unclassified VOC”. Similarly, modelers assigned NO_X to the various reported compounds: “nitric oxide”, “nitrogen monoxide”, “nitrogen dioxide”, “nitrogen oxides”, “oxides of nitrogen”, “nitrogen” and “nitrous oxides”. Hence, there was much labor poured into the process of formatting these data into modeling files.

The TCEQ processed the data to create hourly-specific emission records from the reported event-specific records. For each event, the start and end times defined the time frame for which the emissions would be distributed. In some instances the event time frame extended beyond that of the episode; consequently the episode would then limit the event time frame, reducing the actual event length, resulting in an approximate worst case scenario. Once the time frame was established, the emissions were evenly distributed across all hours, for lack of better temporal resolution, resulting in a flat temporal profile for the modeled event. Only records with the pollutants CO, NO_X, VOC species, and unclassified VOC, were formatted for modeling. Where unclassified VOC was reported, propylene was substituted to create a worst case reactivity. The TCEQ generated hourly AFS records for subsequent EPS3 processing.

In an effort to provide the most highly-resolved data for modeling, point-specific and hourly-specific emissions were generated. To accomplish this, assumptions were made where reported data were unclear or vague. As the data carried only one field for the facility and emission point identifier, in some cases, the TCEQ staff took a best guess approach to assign the emissions to a specific STARS path. The path had to be known, so that the TCEQ staff would know which STARS OSD records to potentially replace with these higher-resolved CCEDS records. The temporal resolution of CCEDS events was often too vague for building precise hourly modeling files. The reported data included a beginning and ending time, which often extended for many days or weeks. With the given information, the TCEQ staff assumed an even distribution of emissions over the reported period, thus creating the flat temporal profiles.

As CCEDS and SI datasets both carry emissions for the same paths and pollutants, the TCEQ compared data between CCEDS and SI where overlap existed. The cursory examination found that emissions reported to CCEDS were also included in the more resolute SI; therefore no additional modeling information was easily gleaned from CCEDS during the SI periods. In fact, for the sensitivity model runs that were performed with some of these data, there was insignificant change in ozone production when these data were added. This is not to say that under the right conditions, and with a large enough exceedence that was well defined in CCEDS, that additional ozone could not be generated. Preliminary modeling sensitivity runs did not see enough of a change to justify incorporating CCEDS data for each of the modeled episodes. Figure 2.1-27: *CCEDS VOC Tileplot* is a tileplot of one of the preliminary days with the largest estimated emissions.

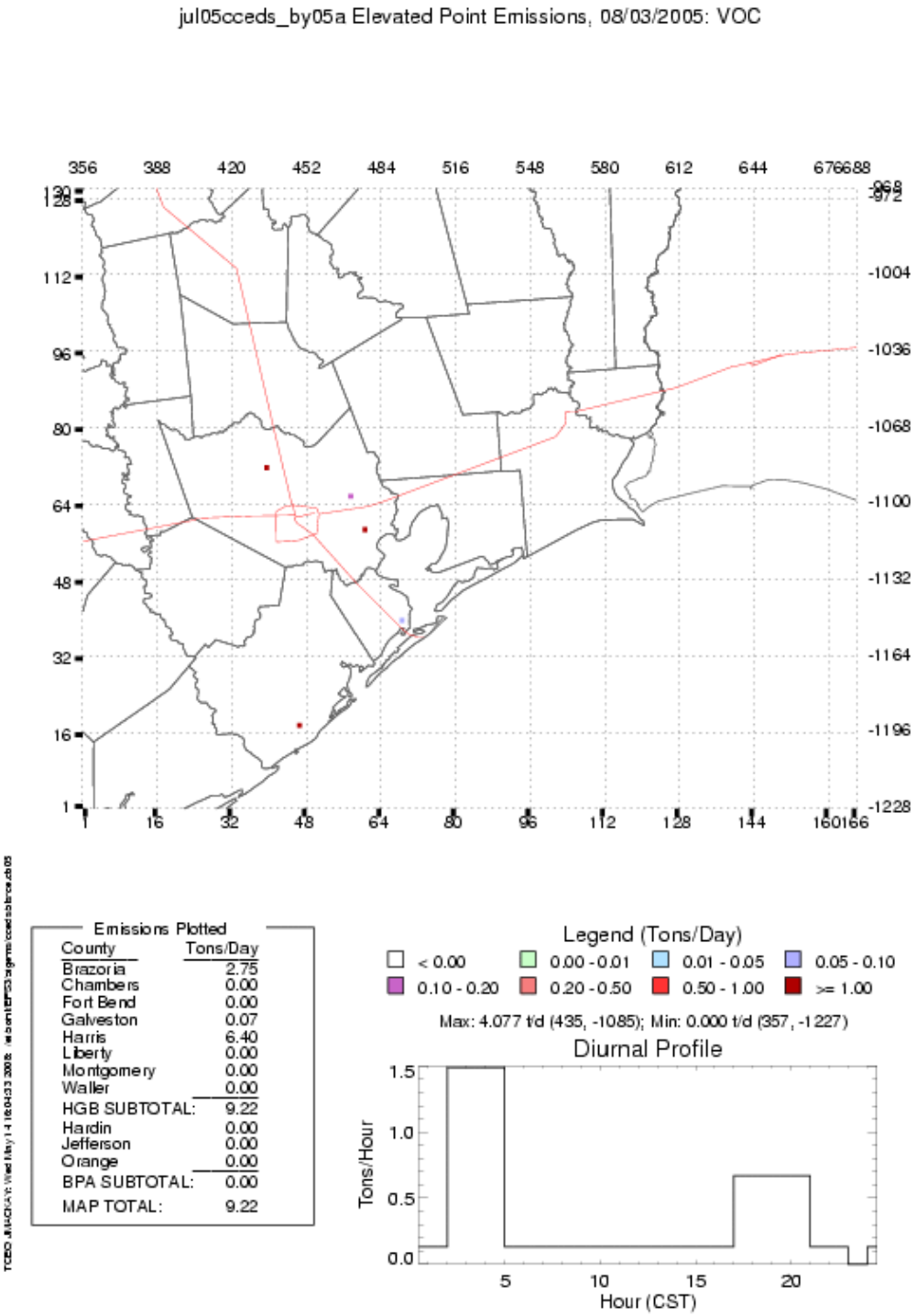


Figure 2.1-27: CCEDS VOC Tileplot

2.1.1.8.2 *Environmental Monitoring and Response System (EMRS)*

EMRS is another data source that the TCEQ staff reviewed as a potential improvement to the modeled point source EI. EMRS is a tool that the TCEQ uses to capture detail regarding excessive emission measurements at monitoring stations, focused in the Houston Ship Channel (HSC) area. It is primarily a monitoring system which notifies upwind entities, who voluntarily participate, when excessive emission measurements are recorded on ambient monitors, and prompts the regulated entity (via email or digital page) to submit a report. Once notified, these respondents have 48 hours to report information about any releases of the four HRVOC species: ethylene, propylene, 1,3-butadiene and butenes. Information submitted in the report includes date of notification, response date, name and account number, quantity (threshold or range) of pollutant discharged, and various activity descriptions.

EMRS reports were generated from a webpage. An excerpt of the database query is provided as Figure 2.1-28: *Sample EMRS Data*.

date of notification	time cdt	notification id no	response no.	response date	pams site	account no.	company name
9/3/2006	3:00	2344	2085	9/3/2006	Deer Park	xxxxx	xxxxxxxxxx
9/3/2006	3:00	2345	2042	9/5/2006	Deer Park	xxxxx	xxxxxxxxxx
9/3/2006	3:00	2346	2044	9/6/2006	Deer Park	xxxxx	xxxxxxxxxx
9/15/2006	12:00	2347	2065	9/19/2006	Milby Park	xxxxx	xxxxxxxxxx

hrvoc	quantity released	EE/ SSM	eqpt clearing	maint activities	loading/ unload	flaring	flaring >100 #s ?	CTower >100 #s ?	remarks
Propylene	10-<100 LB	N	Y	N	N	N	N	N	
Propylene	<10 LB	N	N	N	N	N	N	N	
Propylene	<10 LB	N	N	N	N	N	N	N	
1,3 Butadiene	<10LB	N	Y	N	Y	N	N	N	

Figure 2.1-28: Sample EMRS Data

As with the CCEDS data, data from EMRS reports were scoured for information that could add to the detail already modeled in HGB. The TCEQ determined that EMRS, as currently structured, did not offer modeling EI improvements; the data reported does not include specific parameters required for detailed (high resolution) modeling:

- The reports do not include facility and point identification necessary to define unique STARS emission paths.
- A specific emission rate is not given, rather a threshold or range such as "greater than 10 lbs.", or "greater than 10 lbs. but less than 100 lbs."
- The event timeframe recorded in the report are not specific start and end times for emissions; instead it is a time in which the previous 48 hour cumulative emissions totals are solicited.

Hence, as the reports do not add resolution, the TCEQ did not incorporate EMRS data into the modeling.

2.1.1.9 Emissions Inventory Reconciliation

"EI Reconciliation" is a term the TCEQ uses to identify the process by which the reported EI is adjusted so that modeled emissions more closely match the measured (monitored) VOC concentrations during the 2005 and 2006 modeled episodes. TexAQS II confirmed the need for this, as TexAQS 2000 first affirmed. VOC, and especially HRVOC, continue to be under-reported in the annual EIQs, according to monitors and aircraft measurements.

In previous Attainment Demonstration SIP revisions, the TCEQ generated an "extra olefins" file that was added to the modeling EI to account for the under-reporting, in an effort to true-up the reported EI. The current procedure for emissions reconciliation is a significant departure from the procedure used in previous SIP revision modeling. The details of this Potential Source Contribution Function (PSCF) technique, as applied to the modeled HGB EI, are provided in Attachment 1: *Reconciling Reported VOC Emissions with Ambient Measurements.*

These reconciled HRVOC emissions were modeled as an additional file for the HGB area. Rather than placing the reconciled extra emissions at the locations of existing point sources, the TCEQ placed a single pseudo point in each affected modeling cell (i.e., modeling cells which contain actual point sources), and assigned an emission rate for each HRVOC to best offset the difference between modeled and calculated concentrations. The placement meant creation of a new VOC AFS record for each pseudo point source. The TCEQ placed each pseudo point source geographically in the middle of each affected cell and assigned default stack parameters (e.g., 5.0 meter stack height). Since these reconciled points do not exist in the STARS database, modelers assigned unique plant, stack and point identifiers that link to new speciation cross reference and profile files. The profiles were individually determined during the PSCF procedure, and EPS3 processing was performed for this set of data separately. Figure 2.1-29: *Sample Reconciliation*

Record and Profile is an example of a single inventory reconciliation ("extra alkene" emissions) AFS record, along with its cross reference and profile code, in which VOC emissions are 100% trans-2-butene (43216) released at a (default) height of 5.0 meters.

```
M 05 05 EX 48039 HGB   0000 30119705   0407       1175
5600           S  06080100 06080124  407.00000 -1175.0000
5.0  0.01   294  0.01                    43104   0.001104
BL0000X        VOC            Extra alkene emissions

48039       0407       1175       5179   30119705
BL040711755179

BL040711755179 43216 1.0000
```

Figure 2.1-29: Sample Reconciliation Record and Profile

2.1.1.10 Splitting Texas into 8-county HGB and non-HGB

To facilitate easier summarization of modeled pieces of the EI, the TCEQ split all parts of the Texas EI into 8-county HGB files and non-HGB files, including OSD and ARD sources. This allows for easier tracking of changes to the area of greatest interest – HGB. As many controls have been applied to HGB in the past, this allows for easier QA of the application of those to HGB. This results in nearly twice as many point source EI files that were processed with EPS3 and subsequently merged prior to CAMx modeling. The tables (Tables 2.1-11 and 2.1-12) at the end of this section that list the AFS files that were modeled do not list the "hgb-8co" and "no_hgb_8co" separately for conciseness. The EPS3 processed and merged files that are input to CAMx do have separate files for "hgb-8co" and "no_hgb_8co."

This concludes the discussion of Texas point sources included in the modeling. Tables at the end of this section summarize the Texas datasets used for each base case episode.

2.1.2 Regional (Outside of Texas) Point Sources

This section and its subsections discuss the point source modeling emissions development for all areas outside of Texas within the modeled CAMx domain. The modeled "Regional" area (in order of increasing distance from HGB) includes the following parts:

- Offshore (Gulf of Mexico);
- Oklahoma, Arkansas, and Louisiana (three states adjacent within the modeling domain);
- Remaining U.S. states (within the modeling domain);
- Mexico;
- Canada.

The level of detail applied to the development of the modeling emissions for each of these regions decreases with its distance from Texas and HGB, in general. Each region was modeled using a different source of EI data; each subsection below addresses these data sources.

2.1.2.1 States Adjacent to Texas

The states adjacent to Texas (and within the modeling domain) include Oklahoma, Arkansas, and Louisiana. It is expected that the influence of emissions on HGB from outside of Texas would decrease with distance from HGB, so the TCEQ models with more detail from those sources closest to HGB. As has become custom with TCEQ modeling, TCEQ contacted each of these adjacent states to individually obtain their point source emissions data files.

In general, the emissions files that can be obtained directly from a state are more current than can be obtained from the National Emission Inventory (NEI) maintained by the EPA. Hence, the TCEQ queried the EI staff of the three states independently to ask for their point source EIs that most closely matched TCEQ's episodes to be modeled. The timing was fairly good, as the three states were in the process of QAing their 2005 EIs for electronic submittal to the EPA for compilation into the 2005 NEI. Rather than wait for the official 2005 NEI to be released by the EPA, the TCEQ obtained the most current data that the adjacent states would release to us. Emissions data from other states are generally provided given as annual emissions, whereas the Texas STARS emissions are average ozone season day. When using data from other states, the TCEQ used ozone season data, if provided. When using annual data, however, the TCEQ typically creates daily emission records from the annual data, to be consistent with other datasets. Thus, "daily emissions" may refer to the annual average, if only annual data was provided.

The Louisiana Department of Environmental Quality (LDEQ) provided a 2004 point source annual emissions inventory in AFS EPS2 format; the TCEQ converted the records to EPS3 format and grew the daily emissions to 2005 and 2006 using EPA's Economic Growth Analysis System (EGAS5) growth factors. The LDEQ did not feel comfortable releasing their 2005 EI to the TCEQ, due to the chaos that Hurricane Katrina caused in late August 2005 and the remainder of the year. The LDEQ staff explained to the TCEQ staff that the 2004 emissions were more representative than any 2005 that the LDEQ may have developed later.

The Oklahoma of Environmental Quality (ODEQ) and the Arkansas Department of Environmental Quality (ADEQ) each provided their 2005 point source annual emission inventories in NEI format (as comma delimited and text formatted files, respectively). NEI data is provided in six data files:

- site (SI)
- emission unit (EU)
- emission process (EP)
- emission release point (ER)
- transmittal (TR)
- control equipment (CE)

The data files were provided in the NEI Input Format version 3.0 (NIF3.0) which is documented on the EPA website, http://www.epa.gov/ttn/chief/nif/index.html. These six files can also be downloaded as ".mdb" files for linking in a relational database, such as MS-Access. The SI, EU, EP and ER files contain information to construct AFS formatted emission records. The SI file, for example, provides fips, ORISPL (if that field is filled in), facility identification, and facility name. Using fips and facility as keys, SI records link to unit identification, SIC, and BLRID (if that field is filled in) in the EU file, and so on. Thus, the TCEQ staff constructed AFS-formatted emission records for every NEI point source in the provided EI.

The TCEQ updated their NEI-to-AFS conversion SAS program and tested the results. The TCEQ developed the 2006 datasets for each state using the latest version of EPA's Economic Growth Analysis System (EGAS5, also referred to as simply EGAS). EGAS estimates future growth, based on fips (state and county/parish) and SCC. Table 2.1-3: *Excerpt of EGAS Factors for Base Year=2002* is an excerpt of EGAS growth factors, sorted by SCC, as generated by the TCEQ after running EGAS5. Entries where the fips is truncated are assigned factors by best fit. For example, fips="22" is a fit to all Louisiana parishes.

Table 2.1-3: Excerpt of EGAS5 Factors for Base Year=2002

SCC	FIPS	2004	2005	2006	2018
10100101	1	1.01162	1.03728	1.07100	1.22343
10100101	5	0.98884	1.01519	1.04091	1.01559
10100101	9	1.06889	1.09699	1.12094	1.14163
10100101	10	1.02806	1.06091	1.10250	1.24438
10100101	11	1.02806	1.06091	1.10250	1.24438
10100101	12	1.02806	1.06091	1.10250	1.24438
10100101	13	1.02806	1.06091	1.10250	1.24438
10100101	17	1.04758	1.07592	1.09051	1.25736
10100101	18	1.04758	1.07592	1.09051	1.25736
10100101	19	1.03659	1.07712	1.11602	1.20097
10100101	20	1.03659	1.07712	1.11602	1.20097
10100101	21	1.01162	1.03728	1.07100	1.22343
10100101	22	0.98884	1.01519	1.04091	1.01559
10100101	23005	1.06889	1.09699	1.12094	1.14163
10100101	23017	1.06889	1.09699	1.12094	1.14163
10100101	23023	1.06889	1.09699	1.12094	1.14163
10100101	23031	1.06889	1.09699	1.12094	1.14163
10100101	24	1.02806	1.06091	1.10250	1.24438
10100101	25	1.06889	1.09699	1.12094	1.14163
10100101	26	1.04758	1.07592	1.09051	1.25736
10100101	27	1.03659	1.07712	1.11602	1.20097
10100101	28	1.01162	1.03728	1.07100	1.22343
10100101	29	1.03659	1.07712	1.11602	1.20097
10100101	31	1.03659	1.07712	1.11602	1.20097
10100101	34	0.96887	0.98556	1.02163	1.13020
10100101	36	0.96887	0.98556	1.02163	1.13020
10100101	37	1.02806	1.06091	1.10250	1.24438
10100101	38	1.03659	1.07712	1.11602	1.20097
10100101	39	1.04758	1.07592	1.09051	1.25736
10100101	40	0.98884	1.01519	1.04091	1.01559
10100101	42	0.96887	0.98556	1.02163	1.13020
10100101	44	1.06889	1.09699	1.12094	1.14163
10100101	45	1.02806	1.06091	1.10250	1.24438
10100101	46	1.03659	1.07712	1.11602	1.20097
10100101	47	1.01162	1.03728	1.07100	1.22343
10100101	48	0.98884	1.01519	1.04091	1.01559
10100101	50	1.06889	1.09699	1.12094	1.14163
10100101	51	1.02806	1.06091	1.10250	1.24438
10100101	54	1.02806	1.06091	1.10250	1.24438
10100101	55	1.04758	1.07592	1.09051	1.25736
10100102	1	1.01162	1.03728	1.07100	1.22343
10100102	5	0.98884	1.01519	1.04091	1.01559
10100102	9	1.06889	1.09699	1.12094	1.14163
10100102	10	1.02806	1.06091	1.10250	1.24438
10100102	11	1.02806	1.06091	1.10250	1.24438
10100102	12	1.02806	1.06091	1.10250	1.24438
10100102	13	1.02806	1.06091	1.10250	1.24438
10100102	17	1.04758	1.07592	1.09051	1.25736
10100102	18	1.04758	1.07592	1.09051	1.25736
. . .					

The base year (factor=1.00000) is 2002 in Table 2.1-3, since this dataset was also used for other purposes. Where the table does not have the complete five character fips code, which is common

with EGAS, a best fit of data is applied (51 = 51xxx, the entire state). Thus, from Table 2.1-3, all point sources having SCC=10100101 in Louisiana (state=22) have 2004 and 2006 growth factors of 0.98884 and 1.04091, respectively, for a 2002 base year (factor=1.00000). To start with a base year of 2004 (Louisiana, for example), the growth to 2006 would be the 2006 factor divided by the 2004 factor, or 1.05266.

2.1.2.1.1 *Hourly Acid Rain Substitution*

As with the Texas EI, the TCEQ replaced the daily (or annual) emission records with hourly records for all the Acid Rain EGUs in the adjacent states, as well as the nation. This replacement required matching the ARD identifiers (orispl and unitid) with the daily/annual records that were provided by each state. The AFS records that the LDEQ supplied did not have the acid rain identifiers in it, so the TCEQ used the 2002 NEI as the cross reference for Louisiana, since the NEI contains fields (not always filled in, though) for these identifiers. Since Oklahoma and Arkansas provided their NEI files to us, the match was somewhat easier.

The TCEQ downloaded all the hourly acid rain data from EPA's CAMD query for each of these adjacent states, for the necessary quarters of 2005 and 2006, as it did for Texas. Because the 2002 NEI was used for EGU identifiers for Louisiana, the 2005 and 2006 CAMD queries included some new EGUs (i.e., post 2002). For new Acid Rain EGUs that showed up in the 2005 and 2006 queries, the TCEQ staff was able to manually match some of the new EGUs by site name. For the remainder, the TCEQ created AFS records and assigned new EGUs with default stack parameters to the nearest town. The corresponding hourly VOC and CO records for matched EGUs were generated using their VOC-to-NO_X and CO-to-NO_X ratios. For unmatched points in each state, the TCEQ used VOC and CO ratios larger than roughly two-thirds of the ratios across the state.

As in Texas, this procedure resulted in a daily "OSD" (either provided or estimated from annual) AFS file for each state and an hourly ARD AFS file for each state. The TCEQ compared AFS emission totals to the ARD for each state, making sure all emissions for each were assigned to points within each state. Next, the TCEQ compared AFS and ARD emissions for each day of the episode to make sure that all the emissions were distributed over the entire episode. Figure 2.1-30: *Tileplots of Louisiana, Arkansas, Oklahoma and remaining states ARD NO_X Emissions for June 22, 2005* has tileplots of ARD NO_X emissions for the adjacent states for a specific day modeled in 2005.

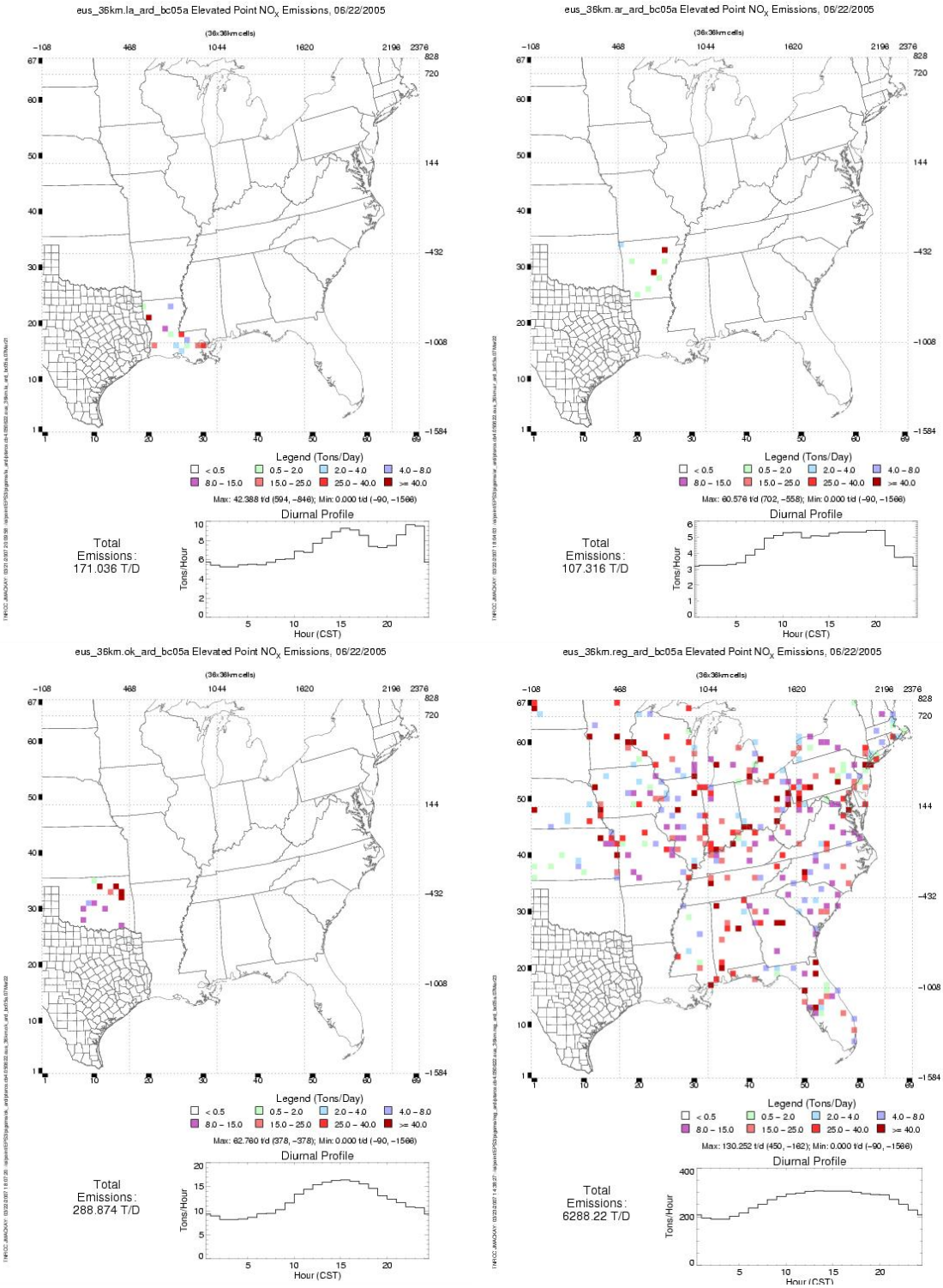


Figure 2.1-30: Tileplots of Louisiana, Arkansas, Oklahoma and remaining states ARD NO_X Emissions for June 22, 2005

2.1.2.2 Remaining States in Modeling Domain

The 2005 and 2006 EIs for the remaining states (states beyond Texas, Louisiana, Arkansas and Oklahoma) within the modeling domain were developed from 2002 data files provided by the Central states Regional Air Planning association (CenRAP) and included all of the Regional Planning Organizations (RPOs) data for the nation, as used for Regional Haze SIP modeling. The TCEQ received the inventory data from CenRAP on a hard drive, in Inventory Data Analyzer (IDA) format, a format suitable for Sparse Matrix Operator Kernel Emissions (SMOKE) processing. The TCEQ extracted data from the CenRAP harddrive that represent the "final 2002

Base g Typical (typ02f)" annual emissions. Figure 2.1-30: *Tileplots of Louisiana, Arkansas, Oklahoma and remaining states ARD NO_X Emissions for June 22, 2005* in the above adjacent states subsection has a tileplot of ARD NO_X emissions for the remaining states for a specific day modeled in 2005.

2.1.2.2.1 *AFS File Creation*

Each of the RPO files was read in and processed with a SAS program that the TCEQ created for converting IDA/SMOKE files to AFS files. This included reading in each of the files, performing minor quality checks and adjustments, and concatenating. The TCEQ extracted the point source data from the EI files, along with the three pollutants of interest for ozone modeling. Emission rates were provided as annual total tons for all RPOs, and tons per average day for some RPOs. Hourly emissions were provided for sources with continuous emission monitors (CEMs) in some RPOs (which was not used since it was for 2002). Because many records did not include average day emissions, but temporal profiles were provided, the TCEQ elected to use the annual emission rates for modeling.

Quality checks included:

- excessive or missing values for stack height, diameter and exit temperature
- erroneous latitude-longitude values
    - plotted the (x,y) to note those that were obviously out of place (only a few were)

Where missing or outlier stack data existed, default values were substituted. Necessary defaults and adjustments included:

- assigned minimum stack height 0.01m,
- assigned minimum stack diameter 0.05m,
- assigned minimum exhaust temperature 294K,
- assigned minimum exit velocity 0.01m/s,
- assigned maximum exit velocity 100m/s,
- corrected lat/long values,
- removed records with 10 digit SCC codes, as these are non-point source units.

Emissions were reported as typical for 2002, so they had to be grown to 2005 and 2006. The TCEQ used EPA's EGAS5 growth factors with a FIPS SCC configuration as was performed for the adjacent states (see the subsection above). An AFS-formatted file, including all necessary and relevant modeling parameters was produced for EPS3 processing.

2.1.2.2.2 *Hourly Acid Rain Substitution*

As with the Texas and the adjacent states, the TCEQ replaced the annual records with hourly records for all the Acid Rain EGUs. This required matching the ARD identifiers (oris and unitid) with the annual records identifiers. The TCEQ acquired the hourly Acid Rain data from EPA's CAMD query webpage for the states within the modeling domain. The ARD download provided records for approximately 3400 EGUs reporting hourly NO_X emissions in 2005 and 2006. Because parts of some states are outside the modeling domain, some of these points were later appropriately discarded by the EPS3 processor.

It was necessary to remove from the annual RPO data those emissions which are ARD to avoid double-counting emissions. Because data came from various RPO sources, inconsistencies in identifiers between the RPO and Acid Rain data prevented a suitable cross reference to be used for removing duplicate emission sources, i.e., names did not match and Acid Rain identifiers were not always provided. Therefore, suitable criteria were established to remove the RPO records that have hourly emissions records in the ARD. Meeting any of the following criteria resulted in removal from the annual AFS file for 2005 and 2006:

- Record had both an Office of the Regulatory Information System identifier (ORIS) and a unit identifier (UNITID).
- Record had an ORIS and a SIC code 4911 (Electric Services).
- Record had an ORIS and a SIC code 4931 (Electric and Other Services Combined, Cogeneration Facility).

2.1.2.2.3 *Speciation and Temporal Allocation*

The CenRAP/RPO data included files for temporal profiles, and the associated cross references. Profiles for monthly, weekly, weekday diurnal and weekend diurnal variations were converted from SMOKE format via SAS programming, and formatted for EPS3 processing. For modeling emissions development from the CenRAP/RPO files, the TCEQ chose to use default speciation assignments, since the conversions from the SMOKE format were not straightforward. In addition, a number of the SMOKE formatted speciation assignments are likely based on default speciation assignments, so any over all differences should be minor.

2.1.2.3 Offshore Point Sources

The TCEQ obtained the 2005 Gulf-Wide Emissions Inventory (GWEI), developed by Eastern Research Group (ERG) under contract to the Minerals Management Service (MMS). This was a significant update to the 2000 GWEI, which the TCEQ modeled in previous SIP revisions. The report and data are divided into two parts: oil and gas exploration and production platform (point) sources and non-platform (area) sources. The TCEQ obtained the 2005 GWEI data and documentation from MMS in Microsoft Access (zipped) and PDF format, respectively. These can all be downloaded from the MMS webpage,
http://www.gomr.mms.gov/homepg/regulate/environ/airquality/gulfwide_emission_inventory/2005GulfwideEmissionInventory.html

The TCEQ reviewed and compared the differences between the 2000 GWEI and the 2005 GWEI. The comparisons show an overall increase in emissions in CO and NO_X in 2005, and a slight decline for VOC. Table 2.1-4: *Comparison of GWEI for Platform and Non-Platform Sources* shows the differences for all GWEI sources. Table 2.1-5: *Comparison of GWEI for Platform (Point) Sources Only* shows results for just the platform sources, and Table 2.1-6: *Comparison of GWEI for Non-Platform (Area) Sources Only* shows results for just the non-platform sources.

Table 2.1-4: Comparison of GWEI for Platform and Non-Platform Sources

Base Year	CO (tpy)	NOx (tpy)	VOC (tpy)
2000	113,303	203,349	85,008
2005	122,295	392,961	80,933
Percent Difference	8%	93%	-5%

Table 2.1-5: Comparison of GWEI for Platform (Point) Sources Only

Base Year	CO (tpy)	NOx (tpy)	VOC (tpy)
2000	92,144	78,049	59,536
2005	89,813	82,581	51,241
Percent Difference	-3%	6%	-14%

Table 2.1-6: Comparison of GWEI for Non-Platform (Area) Sources Only

Base Year	CO (tpy)	NOx (tpy)	VOC (tpy)
2000	21,159	125,300	25,472
2005	32,482	310,380	29,692
Percent Difference	54%	148%	17%

These emissions totals are annual totals and include any decline in emissions due to Hurricane Katrina (end of August 2005) and any other hurricanes that moved into the Gulf of Mexico, such

as Hurricane Rita. With the significant overall increase in NO_X emissions, in concert with the large changes shown in the 2005 non-platform data, the TCEQ decided this was a significant upgrade to the GWEI and opted to use the 2005 GWEI for modeling both platform emissions and non-platform emissions.

ERG used a structure similar to that of the EPA's National Emissions Inventory (NEI) database to compile the 2005 GWEI platform files. The specific data structure used for the 2005 GWEI is based on NEI Input Format (NIF) Version 3.0 for point sources (platform).

The MS-Access database (.mdb files) was comprised of several tables, each with a primary key(s) to create relationships. The NIF tables were joined, and pollutants for ozone modeling were kept. Adjustments and quality checks on modeling parameters were performed on the data to ensure the emissions would be modeled correctly. Emission release points were forced to be stack, flare, or fugitive, so that appropriate default parameters could be assigned to each record in which zero values, missing values or outliers were found. Data retained include monthly records for May through October (spanning the months of the 2005-06 modeling episodes). TCEQ converted the tables to the "flat file" (non-relational) AFS format, including all necessary and relevant modeling parameters for EPS3 processing. Modelers created AFS files with monthly emission rates for each point source for each month, May through October, but only modeled a representative June day, as discussed below in this subsection.

Quality checks included:

- excessive or missing values for stack height, diameter and exit temperature;
- erroneous latitude-longitude values;
    - plotted the (x,y) to note those that were obviously out of place (only a few were).

Where missing or outlier data existed, default values were substituted. Defaults and adjustments included:

- Fugitive defaults:
    - stack height 15m
    - stack diameter 0.01m
    - exhaust temperature 294K
    - minimum exit velocity 0.01m/s
    - maximum exit velocity 300m/s
- Flare defaults:
    - minimum stack height 15m
    - maximum stack height 100m
    - stack diameter 0.1m
    - minimum exhaust temperature 294K
    - maximum exhaust temperature 1273K
    - minimum exit velocity 0.01m/s
    - maximum exit velocity 20m/s
- Stack defaults:
    - stack height 15m
    - stack diameter 0.1m
    - exhaust temperature 294K
    - minimum exit velocity 0.01m/s
    - maximum exit velocity 300m/s

Figure 2.1-31: *2005 GWEI Platform Monthly Emissions from Raw Data Files* shows an emissions summary for the months May through October from the MS-Access database files. Table 2.1-7: *2005 GWEI Platform Monthly Emissions from EPS3 Processing* is a summary of the tons per day of NO_X and VOC that could be modeled for the same months.

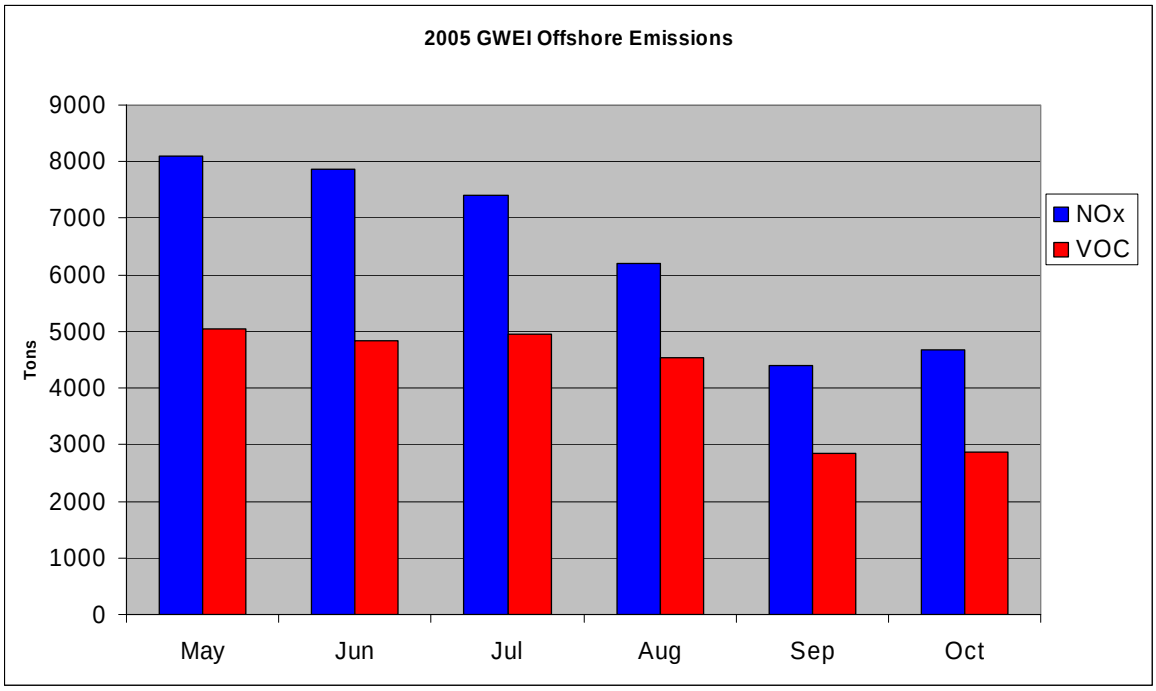


Figure 2.1-31: 2005 GWEI Platform Monthly Emissions from Raw Data Files

Table 2.1-7: 2005 GWEI Platform Monthly Emissions from EPS3 Processing

yymmdd	Month	NO_X (tpd)	VOC (tpd)
050522	May	269.7	168
050622	June	271.4	166.8
050722	July	246.7	164.7
050825	August	206.5	151.0
050922	September	151.3	97.9
051026	October	155.5	95.3

A significant caveat that MMS insists every user of the data keep in mind is the use of the 2005 GWEI data for late August 2005 and the rest of the year, due to the effects of Hurricane Katrina. From the above figure and table, the TCEQ ascertained that using a representative day in June 2005 would be an appropriate ozone season day to model. June had the highest emissions, so it should generate more ozone from offshore and be more conservative, plus modeling with a single day for this category saved hard drive space and emissions processing time. The June VOC value (166.8) in Table 2.1.7, does not precisely match the value in the tileplot of Figure 2.1-33 (163.08), because tileplots represent modeled CB-05 species in methane equivalent.

No temporal profiles were provided with the data files themselves; however, the documentation did provide rudimentary temporal information for groups of offshore activities. Each emission source was categorized into one of these five activity groups provided in the documentation:

- Constant Activity Sources (CAS)
- Boilers/Heaters/Burners (BHB)
- Natural Gas Turbines and Internal Combustion Engines (NGT)
- Temperature Dependent Sources (TDS)
- Helicopters and Supply Vessels (can apply to non-platform, non-point sources)

To facilitate the creation of temporal profiles, an assignment for each emission record was made to one of the groups via its SCC. In some cases, SCCs existed in the data, but not in the temporal

documentation. These were hard-coded as in Table 2.1-8: *Specifically-Assigned SCCs Not Documented*.

Table 2.1-8: Specifically-Assigned SCCs Not Documented

SCC	Assigned Diurnal Code	procid (Process ID)
10201701	BHB	D<600g
20200102	NGT	D>600d
20200251	NGT	NGE-2R
20200252	NGT	NGE-2L
20200253	NGT	NGE-4L
20200254	NGT	NGE-4R
20200255	NGT	NGE-2C
20200256	NGT	NGE-4C
31000123	CAS	VEN
31000146	CAS	FOEo
31000229	CAS	FOEg
31088811	CAS	FFLAo
40400321	TDS	STO-CO
40600248	TDS	LOA

Temporal profiles were made based on these assignments, and a cross reference file was created via SAS programming to join the AFS file to the profiles file.

The 2005 GWEI was used as is for the 2006 modeling episodes, also. Figure 2.1-32: *Tileplot of Offshore NO_X for a representative June day* and Figure 2.1-33: *Tileplot of Offshore VOC for a representative June day* are tileplots of the 2005 GWEI for a representative June 2005 day.

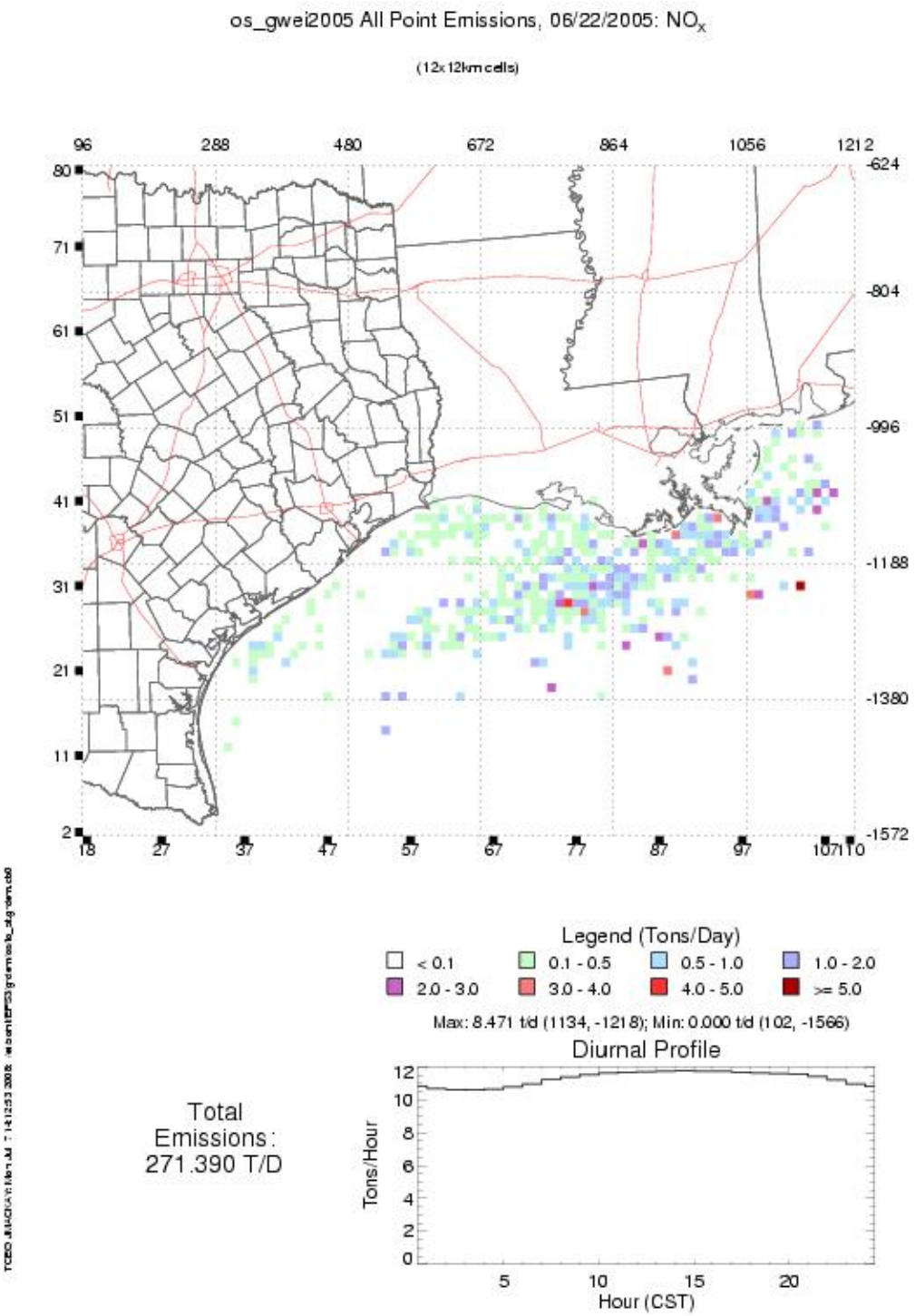


Figure 2.1-32: Tileplot of Offshore NO_X for a representative June day

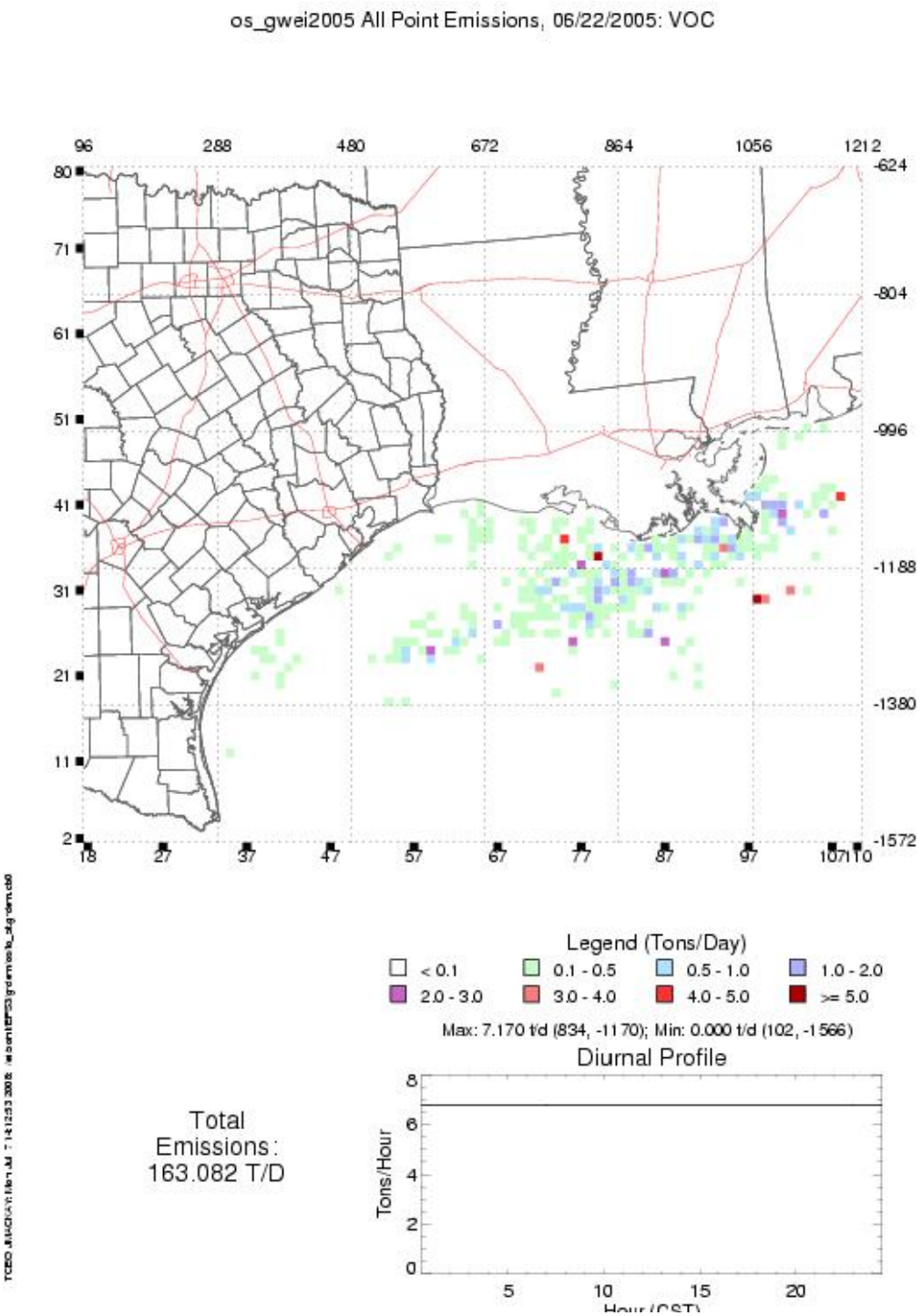


Figure 2.1-33: Tileplot of Offshore VOC for a representative June day

2.1.2.4 Mexican Point Sources

The TCEQ used the data from Phase III of the 1999 Mexico NEI, which was an update from the Mexican EI that TCEQ was using in previous SIP revisions (Phase II). Phase III included all of Mexico, whereas Phase II was just the six northern Mexican states. Even though the TCEQ modeling domain is fully within the Phase II states, TCEQ upgraded to Phase III, because there were updates to some of the data in northern Mexico. TCEQ downloaded the NIF format versions of the files from http://www.epa.gov/ttn/chief/net/mexico.html and parsed the files into AFS files as described in sections above.

The 1999 data was used for 2005 and 2006 episodes without growth, due to a lack of information on growth and controls for Mexican point sources. No temporal allocation or speciation data

were available, so defaults were used. Table 2.1-9: *Comparison of Mexican NEI Phases II & III* shows a comparison of the Mexican emissions as modeled by the TCEQ for Phase II (denoted with "BRAVO") and Phase III ("updated 1999"). The emissions totals in the table represent an area of Mexico that is much larger than the area covered by the modeling domain.

Table 2.1-9: Comparison of Mexican NEI Phases II & III

File	NO_X (tpd)	VOC (tpd)
afs.bravo.Mexico.1999_v1a.lcp.3pols.eps3	549.5	37
afs.Mexico_from_updated1999NEI_lcp_3pols_v1	611.9	230.1

Figure 2.1-34: *Tileplot of representative Mexican OSD* NO_X and Figure 2.1-35: *Tileplot of representative Mexican OSD VOC* are tileplots of Phase III of the 1999 Mexico NEI for a representative ozone season day.

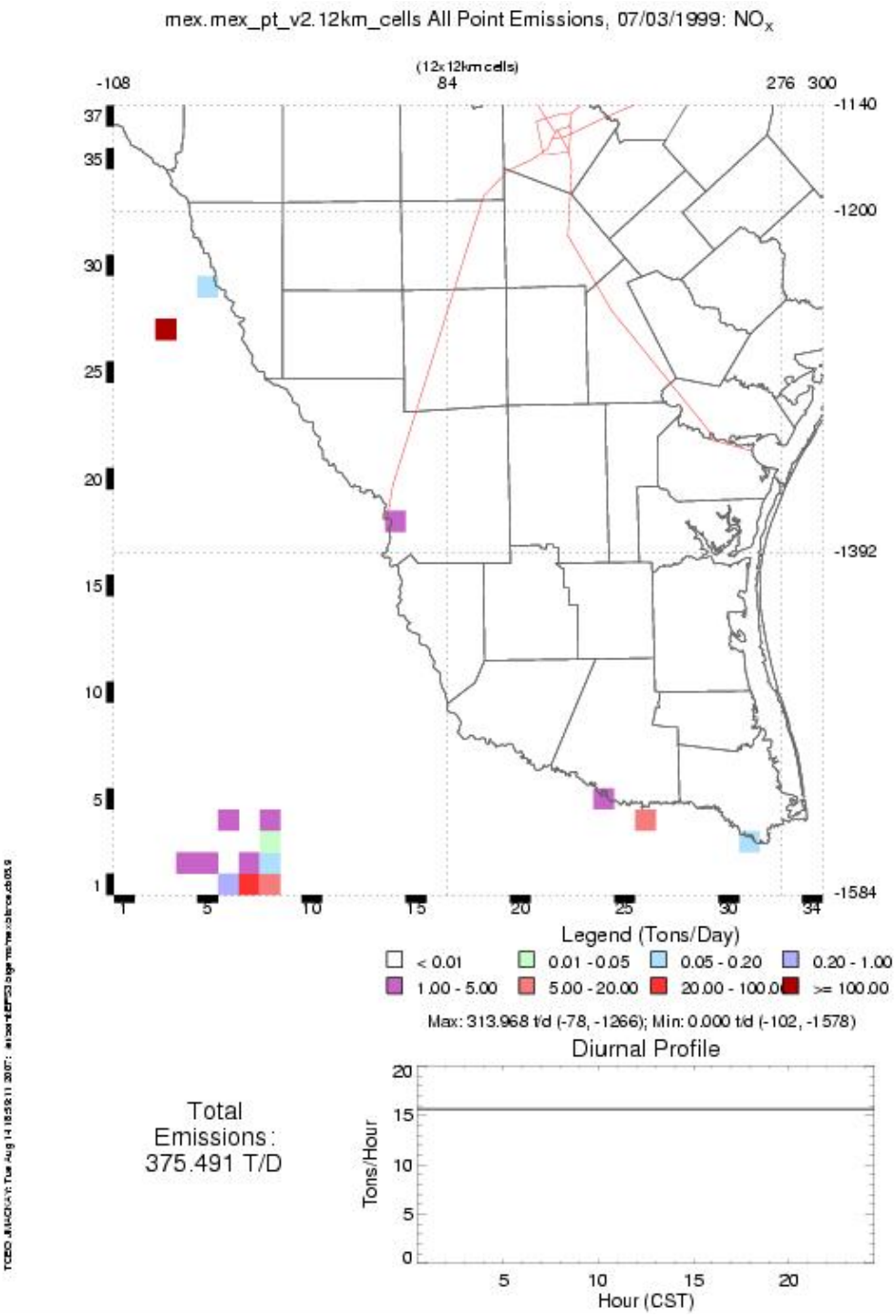


Figure 2.1-34: Tileplot of representative Mexican OSD NO_X

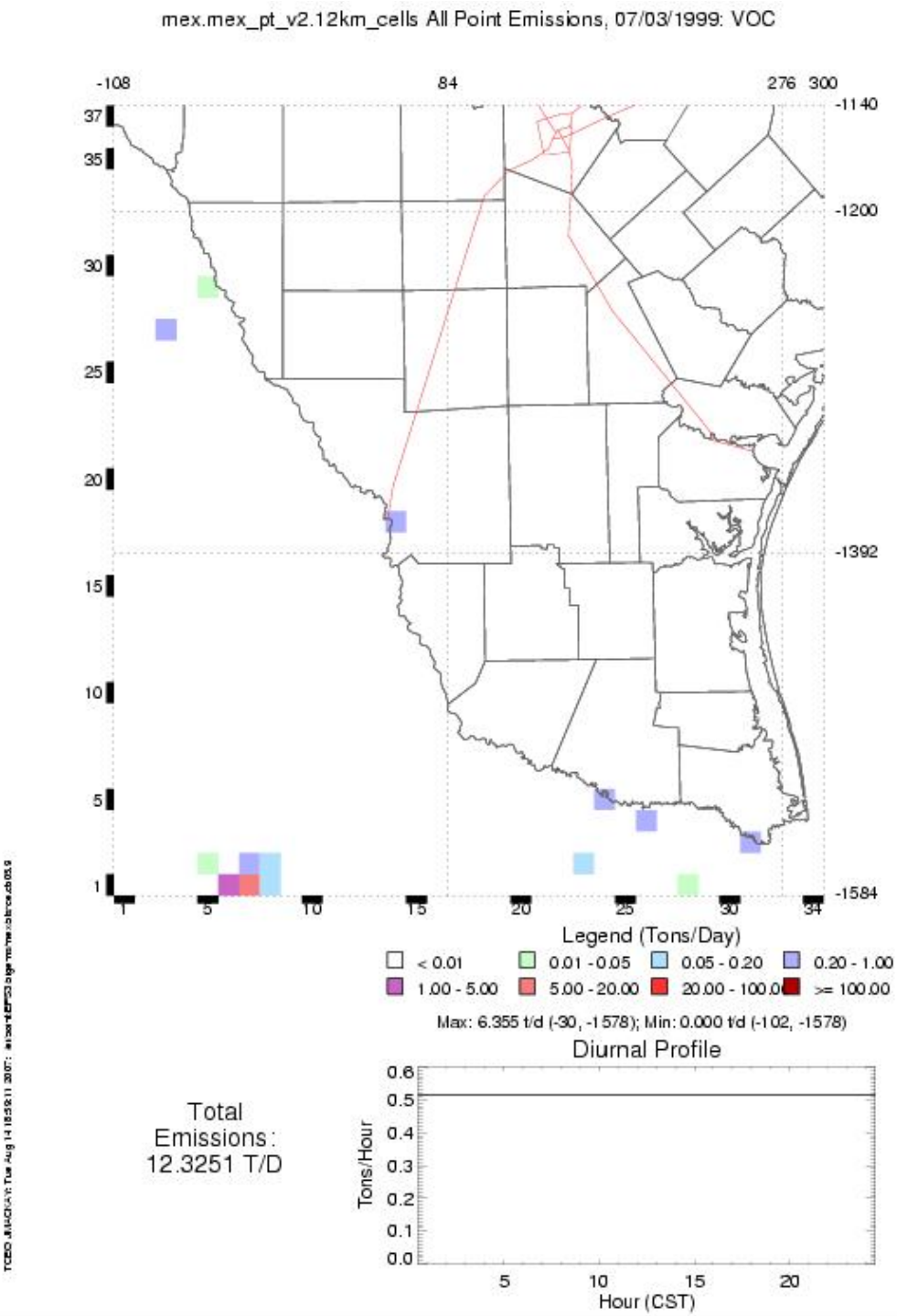


Figure 2.1-35: Tileplot of representative Mexican OSD VOC

2.1.2.5 Canadian Point Sources

As described on the EPA webpage for North American EIs, http://www.epa.gov/ttn/chief/net/canada.html, Canada has not publicly released any updates to their stationary point source EI, due to "Environment Canada's data privacy concerns." In EPA's CAIR 2001 base case modeling, the EPA used a Canadian point source dataset. This was still based on a 1995 Canadian EI. The TCEQ extracted this dataset from EPA's IDA-formatted SMOKE data files that the EPA released with its CAIR modeling files. The TCEQ converted these data to AFS records for further processing with EPS3.

As with Mexico, the TCEQ used these 1995 data for 2005 and 2006 episodes without any adjustment for growth or controls. No temporal allocation or speciation data were available, so

defaults were used. This is the same Canadian dataset used for modeling in the May 2007 DFW SIP revision. The only part of Canada within the modeling domain is the southern part of Ontario province.

2.1.3 Plume-in-Grid (PiG) Source Selection

As mentioned in Section 2.1.1.5.3, above, CAMx provides the option to model selected point sources with a PiG algorithm. NO_X reaction chemistry can be enhanced by treating these selected point source plumes as Lagrangian puffs via the optional use of the PiG. TCEQ continues to use the Greatly Reduced Execution and Simplified Dynamics (GREASD) PiG option in CAMx, which is most applicable to large NO_X plumes. The GREASD PiG option was used for all point sources that met the criteria in Table 2.1-10: *Summary of PiG Thresholds Chosen,* as assigned by the TCEQ.

Table 2.1-10: Summary of PiG Thresholds Chosen

Modeled Area	NO_X Threshold (tpd)
Texas	5.0
Adjacent States (LA, AR, OK) & Mexico	7.5
Next ring of States (MS, etc)	10.0
Next ring of States (AL, etc)	15.0
Other States, Canada & Offshore	25.0

The NO_X threshold of 5.0 tons in Texas denotes that any individual stack or co-located group of nearby stacks that total 5.0 or more tons of NO_X emissions on an episode day were tracked as a PiG source. The TCEQ chose a co-location distance for NO_X of 200 meters, indicating that if multiple stacks were close enough together for their plumes to merge (within 200 meters of each other), and the aggregate NO_X emission rate for the cluster exceeded the threshold value, a new source was created with the combined NO_X emission rate of the cluster, and this source was flagged for PiG treatment. The stack parameters of the new source became an "average" of the stack parameters of all of the sources in the cluster. The TCEQ modeled both individual PiGs and combined PiGs within each of the modeled areas of Table 2.1-10. The EPS3 module, PiGEMS, provides a summary of the PiG treatment that showed a total of 117 PiG sources chosen for the entire domain, 91 of them are from co-located combined new stacks.

2.1.4 Summary of Base Case Point Source Data Files

Snapshots of the point source emission files that were processed with EPS3 for CAMx in each episode are presented in Table 2.1-11: *AFS Files for the 2005 Episodes* and Table 2.1-12: *AFS Files for the 2006 Episodes*. The version number on each dataset indicates a change from the previous version (e.g., "v8"). The FTP download site for these files or their successors is ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/ei/point/
Outdated files are generally not retained on the FTP site.

Table 2.1-11: AFS Files for the 2005 Episodes

Episode	Area	AFS Point Source Emissions File	Hourly	Daily	See Note
May-June 2005 (bc05ep0)	Texas	afs.ard_19May_to_03Jun05_TX_episode_v8	X		
		TX_osd_2005_all_episodes		X	1,2
		afs.aggVOC_extra_alkenes_for_2005_v2		X	1
		afs.landing_losses_19May_to_08Aug05	X		1,2
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_19May_to_03Jun05_episode_v4	X		
		afs.Arkansas_ard_19May_to_03Jun05_episode_v4	X		
		afs.Louisiana_ard_19May_to_03Jun05_episode_v4	X		
		afs.Oklahoma_ard_19May_to_03Jun05_episode_v4	X		
		USA_osd_2005_for_3Q05_generic_from_2005CENRAP.v3		X	2
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
June 2005 (bc05ep1)	Texas	afs.ard_15Jun_to_30Jun05_TX_episode_v11	X		
		TX_osd_2005_all_episodes		X	1,2
		afs.aggVOC_extra_alkenes_for_2005_v2		X	1
		afs.landing_losses_19May_to_08Aug05	X		1,2
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_15Jun_to_30Jun05_episode_v3	X		
		afs.Arkansas_ard_15Jun_to_30Jun05_episode_v5	X		
		afs.Louisiana_ard_15Jun_to_30Jun05_episode_v5	X		
		afs.Oklahoma_ard_15Jun_to_30Jun05_episode_v5	X		
		USA_osd_2005_for_3Q05_generic_from_2005CENRAP.v3		X	
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
July-August 2005 (bc05ep2)	Texas	afs.ard.26Jul_to_08Aug05_TX_episode_v8	X		
		TX_osd_2005_all_episodes		X	1,2
		afs.aggVOC_extra_alkenes_for_2005_v2		X	1
		afs.landing_losses_19May_to_08Aug05	X		1,2

Episode	Area	AFS Point Source Emissions File	Hourly	Daily	See Note
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_26Jul_to_08Aug05_episode_v4	X		
		afs.Arkansas_ard_26Jul_to_08Aug05_episode_v6	X		
		afs.Louisiana_ard_26Jul_to_08Aug05_episode_v8	X		
		afs.Oklahoma_ard_26Jul_to_08Aug05_episode_v6	X		
		USA_osd_2005_for_3Q05_generic_from_2005CENRAP.v3		X	2
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
NOTES:	1	Aggregated VOC records require cross reference and profile code files for composition/speciation			
	2	Same for all 2005 episodes			
	3	AFS file contains monthly emissions; only June was modeled; see temporal profiles; see Section 2.1.2.3			
	4	AFS file contains annual emissions			

Table 2.1-12: AFS Files for the 2006 Episodes

Episode	Area	AFS Point Source Emissions File	Hourly	Daily	See Note
June 2006 (bc06ep0)	Texas	afs.ard.29May_to_16Jun06_TX_episode_v5	X		
		afs.osd_2006_STARS_extract_for_29May06_episode_v5		X	1,2
		afs.aggVOC_extra_alkenes_for_2006_v2		X	1
		afs.landing_losses_all_2006_episodes_v1	X		1,2
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_29May_to_16Jun06_episode_v3	X		
		afs.Arkansas_ard_29May_to_16Jun06_episode_v4	X		
		afs.Louisiana_ard_29May_to_16Jun06_episode_v4	X		
		afs.Oklahoma_ard_29May_to_16Jun06_episode_v4	X		
		USA_osd_2006_for_3Q06_generic_from_2006CENRAP.v1		X	2
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
2006 AQS-1	Texas	afs.ard_minus_SI_for_15Aug2006_episode_v8	X		

Episode	Area	AFS Point Source Emissions File	Hourly	Daily	See Note
(SI period)		afs.osd_minus_SI_for_15Aug2006_episode_v8		X	1,2
(bc06aqs1)		afs.osd_n_ard_SI_paths_for_15Aug2006_episode_v8	X		
		afs.aggVOC_SI_for_15Aug2006_episode_v9	X		
		afs.NOx_SI_for_15Aug2006_episode_v9	X		
		afs.aggVOC_extra_alkenes_for_2006_v2		X	1
		afs.landing_losses_all_2006_episodes_v1	X		1,2
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_15Aug_to_15Sep06_episode_v4	X		
		afs.Arkansas_ard_15Aug_to_15Sep06_episode_v4	X		
		afs.Louisiana_ard_15Aug_to_15Sep06_episode_v4	X		
		afs.Oklahoma_ard_15Aug_to_15Sep06_episode_v4	X		
		USA_osd_2006_for_3Q06_generic_from_2006CENRAP.v1		X	
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
2006 AQS-2	Texas	afs.ard.16Sep_to_16Oct06_TX_episode_v4	X		
(bc06aqs2)		afs.osd_2006_STARS_extract_for_16Sep06_episode_v4		X	1,2
		afs.aggVOC_extra_alkenes_for_2006_v2		X	1
		afs.landing_losses_all_2006_episodes_v1	X		1,2
	Regional	afs.REGIONAL_ard_minus_TXOKARLA_16Sep_to_16Oct06_episode_v2	X		
		afs.Arkansas_ard_16Sep_to_15Oct06_episode_v4	X		
		afs.Louisiana_ard_16Sep_to_15Oct06_episode_v4	X		
		afs.Oklahoma_ard_16Sep_to_15Oct06_episode_v4	X		
		USA_osd_2006_for_3Q06_generic_from_2006CENRAP.v1		X	2
		afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
		afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
		afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
NOTES:	1	Aggregated VOC records require cross reference and profile code files for composition/speciation			
	2	Same for all 2006 episodes			
	3	AFS file contains monthly emissions; only June was modeled; see temporal profiles; see Section 2.1.2.3			
	4	AFS file contains annual emissions			

2.1.5 Emissions Summary for Each Base Case Episode

The TCEQ chose a "representative day" in each episode for which to report base case emissions totals for point sources. A Wednesday was found in each episode that was also an ozone exceedence day for each of the base case episodes in 2005 and 2006. Table 2.1-13: *Point Source Base Case Episodes Emissions Reporting Days* provides a summary of the base case episodes. The emissions summary for these episodes is provided as Table 2.1-14: *2005 & 2006 Base Case Episode Day Emissions Summary*.

Table 2.1-13: Point Source Base Case Episodes Emissions Reporting Days

HGB Modeled Episodes			Reported Point Source Day
Episode Name	**Common Name**	**Days**	
bc05ep0	May-Jun 2005	May 19 - June 3, 2005	June 1, 2005
bc05ep1	June 2005	June 17 - 30, 2005	June 22, 2005
bc05ep2	Jul-Aug 2005	July 26 - August 8, 2005	August 3, 2005
bc06ep0	June 2006	May 31 - June 15, 2006	June 14, 2006
bc06aqs1	2006 AQS-1	August 13 - September 15, 2006	August 16, 2006
bc06aqs2	2006 AQS-2	September 16 - October 11, 2006	September 27, 2006

Table 2.1-14: 2005 & 2006 Base Case Episode Day Emissions Summary

Reported Representative Day	Emissions Source	HGB		Texas minus HGB		USA minus Texas	
		NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)
June 1, 2005	NEGUs (OSD)	147.5	199.2	653.8	332.9	6782.3	3221.5
	EGUs (ARD)	43.9	2.2	459.0	10.3	5626.5	41.9
	Tank Landing Losses	0.0	49.5	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	26.2	0.0	0.0	0.0	0.0
	TOTALS =	*191.4*	*277.1*	*1112.8*	*369.3*	*12408.8*	*3263.4*
June 22, 2005	NEGUs (OSD)	147.5	199.2	653.8	332.9	6782.3	3221.5
	EGUs (ARD)	43.0	2.1	531.8	0.0	6968.0	50.6
	Tank Landing Losses	0.0	17.8	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	26.2	0.0	0.0	0.0	0.0
	TOTALS =	*190.5*	*245.3*	*1185.6*	*345.9*	*13750.3*	*3272.1*

Reported Representative Day	Emissions Source	HGB		Texas minus HGB		USA minus Texas	
		NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)
August 3, 2005	NEGUs (OSD)	147.5	199.2	653.8	332.9	6782.3	3221.5
	EGUs (ARD)	55.3	2.9	528.6	0.0	8428.7	67.3
	Tank Landing Losses	0.0	33.1	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	26.2	0.0	0.0	0.0	0.0
	TOTALS =	*202.8*	*261.4*	*1182.4*	*346.0*	*15211.0*	*3288.8*
June 14, 2006	NEGUs (OSD)	124.1	161.4	617.8	320.6	7644.6	3331.2
	EGUs (ARD)	45.1	1.7	476.7	15.2	6156.0	46.2
	Tank Landing Losses	0.0	17.4	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	20.2	0.0	0.0	0.0	0.0
	TOTALS =	*169.2*	*200.7*	*1094.5*	*335.8*	*13800.6*	*3377.4*
August 16, 2006 (SI day)	NEGUs (OSD)	118.9	152.7	605.3	320.2	7644.6	3331.2
	EGUs (ARD)	60.6	2.6	560.2	16.5	6772.9	46.2
	Tank Landing Losses	0.0	10.4	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	20.2	0.0	0.0	0.0	0.0
	TOTALS =	*179.5*	*185.9*	*1165.5*	*336.7*	*14417.5*	*3377.4*
September 27, 2006	NEGUs (OSD)	124.1	161.4	617.8	320.6	7644.6	3331.2
	EGUs (ARD)	43.4	1.9	475.0	14.4	5384.4	40.9
	Tank Landing Losses	0.0	0.3	0.0	0.0	0.0	0.0
	HRVOC Reconciliation	0.0	20.2	0.0	0.0	0.0	0.0
	TOTALS =	*167.5*	*183.8*	*1092.8*	*335.0*	*13029.0*	*3372.1*

NOTES: These tabulated emissions are AFS (input to EPS3) totals. CAMx input values may differ.
USA minus Texas includes some points outside the modeling domain
Texas minus HGB includes some points in Texas outside the modeling domain
August 16, 2006 emissions data includes Special Inventory

2.2 2006 BASELINE POINT SOURCE MODELING EMISSIONS DEVELOPMENT

The 2006 point sources used in the base case, described above, can be very specific to individual days and hours, especially for the Acid Rain EGU portion of the EI. Therefore, the TCEQ created files that represent a typical summer day in 2006. Again, the baseline is the basis for the Relative Response Factor (RRF) calculation: (1) these baseline emissions, along with the base case meteorology are modeled with CAMx, (2) ozone concentrations are predicted at each monitor and tabulated for comparison to the modeled future case, and (3) baseline predicted ozone is the denominator in the RRF calculation.

The subsections that follow discuss the parts of the inventory and how they may differ from the base case.

2.2.1 Texas Point Sources

2.2.1.1 Ozone Season Daily (OSD)

The OSD point source emissions for the typical 2006 baseline day are, in general, the same as the 2006 base case OSD emissions, as these are the average ozone season daily emissions, as extracted from STARS. There are two exceptions (improvements to the base case) that were modeled: (1) the 2006 baseline includes improved flare exit (initial dispersion) parameters, and (2) the 2006 baseline includes the addition of STARS reported annual upsets and emission events (EE) and scheduled maintenance, startup and shutdown (SMSS) emissions.

The first improvement provided a closer review of modeled flare exhaust parameters due to the renewed scrutiny applied by the TCEQ Flare Task Force Stakeholder Group (see http://www.tceq.state.tx.us/implementation/air/rules/flare_stakeholder.html). Additionally, TCEQ photochemical modelers sought consistent treatment of flares with TCEQ permit dispersion modeling guidance. Modelers calculated an "equivalent diameter" for each flare stack, based on VOC combustion rate. Then, based on typical combustion efficiency and stoichiometry, and on a 20 meters/sec tip velocity, modelers estimated that the exit velocity equivalent for a flare will be 1.0 meters/sec (the 20 mps velocity is a reasonable velocity to avoid stack tip downwash). The new diameter is typically much larger than the internal diameter of the actual flare tip as reported to STARS. Likewise, the exit velocity used in modeling will be much smaller than the velocity of the uncombusted gas as it exits the flare tip. These new modeling parameters are important, because they affect the plume rise of the flare emissions.

The second improvement added the annual EE/SMSS and upset emissions fields from STARS in order to capture upsets and emission events that could not be readily discerned from CCEDS (as discussed in Section 2.1.1.8.1 above) and to assist in the prevention of potential double-counting of tank landing loss emissions (see Section 2.1.1.7.3 above). In past years, these annual emissions fields in STARS had been sparsely populated and of nearly negligible emissions upon conversion to daily emissions (dividing by 365). Adding these converted EE/SMSS and upset emissions to the OSD emissions provided 0.7 tpd more NOx and 19.4 tpd more VOC to the HGB emissions. Over the entire State, adding these fields provided 4.4 tpd more NOx and 41.2 tpd more VOC.

These two improvements have been incorporated into the STARS modeling extract SAS program and are now the default method for processing all future STARS extracts, until revised again. These improvements were not worked back into the base case modeling due to time contraints, but will be included in base case modeling in the future.

Table 2.2-1*: 2006 Baseline OSD Texas Emissions* shows the modeled ozone precursor 2006 baseline totals for point sources in the HGB eight-county nonattainment area (NAA), in the other NAAs of the State, and in the balance of the State.

Table 2.2-1: 2006 Baseline OSD Emissions in Texas

Area	NO_X		VOC		CO	
	#points	tpd	#points	tpd	#points	tpd
HGB	5189	124.77	26699	175.16	5537	94.49
BPA	1229	58.23	6217	76.08	1244	36.22
DFW	1515	41.53	4767	37.28	1576	38.61
Rest of TX	8921	520.01	24055	228.88	9237	415.03
TX Totals		744.54		517.40		584.35

Note that some points in Texas are outside the modeling domain (e.g., points in west Texas). The "#points" entry in Table 2.2-1 is the total number of point sources, summed to give the area total tons per day (tpd), including points with zero emissions. The TCEQ typically eliminates zero emissions records, and, in any case, the EPS3 processor will drop VOC records with zero emissions, because those records will not have a speciation cross reference.

2.2.1.2 Emissions Inventory Reconciliation (aka, HRVOC Reconciliation, Extra Olefins)

As with the OSD point source emissions, the added 2006 HRVOC EI Reconciliation emissions remain unchanged from the 2006 base case. As described in Section 2.1.1.9, above, the PSCF technique used to ascribe the extra HRVOC placed the additional HRVOC in the center of grid cells, and was already an average day for the grid cell. A total of 19.29 tpd of extra HRVOC were assigned to 230 grid cells in HGB. A summary of the reconciled PSCF extra HRVOC is provided as Table 2.2-2: *Summary of HGB Reconciled HRVOC*. The emissions are tabulated in speciated VOC totals, not EPS3-processed CB-05.

Table 2.2-2: Summary of HGB Reconciled HRVOC

HRVOC	#points	tpd
Ethene	124	5.58
Propene	179	11.52
1-butene	68	0.43
c-2-butene	104	0.32
t-2-butene	136	1.04
1,3-butadiene	65	0.40
Total Emissions =		19.29

2.2.1.3 Hourly Acid Rain Data (ARD) Point Sources

In the 2006 base case, the Acid Rain EGUs were modeled for each hour of the episodes. To develop an Acid Rain EGU baseline, the TCEQ averaged the Acid Rain NO_X for each hour of the day for each unit for the third quarter of 2006 (July 1 through September 30). These data records represent a 92-day period of 2006 that simulate a typical ozone season (summer) period, yet they maintain the temporal profile of the individual units. Corresponding hourly average CO and VOC emissions were calculated from STARS ozone season daily (OSD), stack-specific emissions by multiplying CO:NO_X and VOC:NO_X ratios by the hourly NO_X rate for each acid rain unit. A summary of the ARD emissions for the State are presented in Table 2.2-3: *2006 Baseline Hourly Texas Acid Rain EGU Emissions*. The tabulated hourly emissions values in the table are the sum of emissions for all point sources in each NAA and the remainder of the State, although some of the point sources in the attainment areas of Texas are outside of the modeling domain. All hourly values were rounded to one decimal place.

Table 2.2-3: 2006 Baseline Hourly Texas Acid Rain EGU Emissions

hour	NO_X Emissions (tph)				VOC Emissions (tph)				CO Emissions (tph)			
	HGB	BPA	DFW	rest of TX	HGB	BPA	DFW	rest of TX	HGB	BPA	DFW	rest of TX
1	1.50	0.38	0.24	17.00	0.05	0.02	0.01	0.44	1.16	0.16	0.12	34.43
2	1.47	0.34	0.22	16.32	0.05	0.02	0.01	0.42	1.15	0.15	0.11	33.82
3	1.45	0.32	0.20	15.98	0.05	0.02	0.01	0.41	1.13	0.14	0.10	33.46
4	1.45	0.33	0.20	16.01	0.05	0.02	0.01	0.41	1.13	0.15	0.10	33.54
5	1.57	0.35	0.23	16.62	0.06	0.02	0.01	0.43	1.28	0.15	0.10	33.77
6	1.57	0.38	0.21	16.45	0.06	0.02	0.01	0.44	1.22	0.16	0.10	33.52
7	1.59	0.38	0.21	18.41	0.06	0.02	0.01	0.47	1.23	0.16	0.11	34.58
8	1.59	0.39	0.25	17.73	0.06	0.02	0.01	0.48	1.23	0.17	0.13	35.30
9	1.69	0.40	0.32	18.65	0.06	0.02	0.01	0.51	1.29	0.17	0.16	36.30
10	1.84	0.44	0.36	19.53	0.07	0.03	0.02	0.54	1.39	0.19	0.18	37.07
11	2.08	0.53	0.40	20.39	0.08	0.03	0.02	0.56	1.59	0.22	0.21	37.63
12	2.32	0.62	0.45	21.46	0.10	0.04	0.03	0.60	1.83	0.25	0.26	38.03
13	2.61	0.73	0.52	22.65	0.12	0.04	0.03	0.63	2.10	0.30	0.32	38.32
14	2.75	0.78	0.57	23.81	0.13	0.04	0.04	0.66	2.24	0.32	0.34	38.63
15	2.84	0.81	0.62	24.78	0.13	0.05	0.04	0.69	2.32	0.34	0.37	39.11
16	2.82	0.81	0.63	25.22	0.13	0.05	0.04	0.71	2.30	0.34	0.38	39.37
17	2.74	0.75	0.61	24.65	0.12	0.04	0.04	0.69	2.19	0.32	0.36	39.13
18	2.57	0.65	0.55	23.55	0.11	0.04	0.04	0.65	1.96	0.27	0.32	38.72
19	2.38	0.56	0.49	22.27	0.10	0.03	0.03	0.62	1.79	0.24	0.29	38.27
20	2.25	0.54	0.45	21.52	0.09	0.03	0.03	0.59	1.74	0.23	0.27	37.90
21	2.08	0.48	0.41	20.72	0.09	0.03	0.02	0.57	1.62	0.21	0.24	37.55
22	1.79	0.42	0.37	19.96	0.07	0.03	0.02	0.55	1.39	0.18	0.20	37.20
23	1.62	0.41	0.30	18.76	0.06	0.02	0.01	0.51	1.26	0.17	0.15	36.39
24	1.55	0.41	0.27	17.75	0.06	0.03	0.01	0.47	1.22	0.18	0.13	35.43
Total	48.09	12.23	9.09	480.17	1.98	0.72	0.51	13.06	37.76	5.18	5.03	877.46
# pts	74	15	49	231	74	15	49	231	74	15	49	231

2.2.1.4 Hourly Tank Landing Loss (TLL) Survey

The floating roof TLL surveys were compiled into hourly emissions for each of the base case modeling episodes. The 2006 baseline was calculated as the average of the hourly emissions for each tank point source of the survey for all of the modeled episode days of 2006. The TLL emissions occur during tank landings. A TLL point source with intervals (hours) of missing losses may be operating routinely with other emissions that were not reported in the survey because they were not due to a tank landing. This distinction is important, because the intermittent tank landing losses are only a part of the total emissions for each of these tanks and need to be subtracted from the total to prevent double counting. There were a total of 218 point source paths reporting TLLs. A summary of the averaged hourly TLL total VOC emissions data in tons per hour (tph) is presented as Table 2.2-4: *2006 Baseline Hourly Tank Landing Loss Emissions in HGB.*

Table 2.2-4: 2006 Baseline Hourly Tank Landing Loss Emissions in HGB

hour	#points	VOC (tph)
1	58	0.1768
2	54	0.1476
3	44	0.0819
4	44	0.0953
5	37	0.1150
6	41	0.1454
7	61	0.3150
8	58	0.2762
9	199	0.5293
10	200	0.4968
11	201	0.4860
12	201	0.4708
13	202	0.3999
14	204	0.4401
15	202	0.4467
16	204	0.4230
17	50	0.1848
18	50	0.1837
19	56	0.2601
20	54	0.2348
21	55	0.2086
22	60	0.1194
23	56	0.1457
24	59	0.1661
VOC Emissions, tpd =		6.5491

Point source counts ("#points" in Table 2.2-4) less than 218 occur for most hours, because not all tanks reported TLL for each hour of the modeled 2006 episodes. Emissions were assigned to be higher between 8:00 am and 4:00 pm (hours 9 through 16) due to tank breathing losses. This averaged baseline value is much less than the base case episodic emissions -- see Table 2.1-14. Table 2.1-14 also shows that, in general, the TLL emissions were tapering off from Spring 2005 to Fall 2006. r

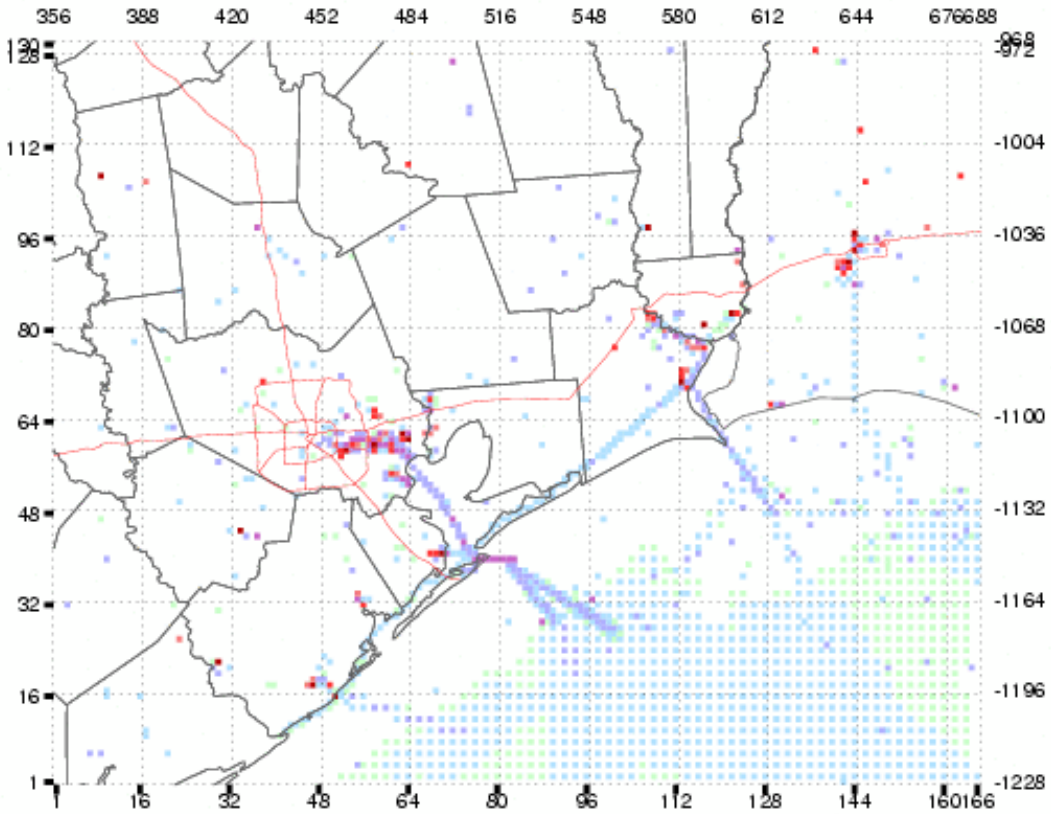
2.2.1.5 Hourly Special Inventory

The 2006 Special Inventory (SI) was not carried into the baseline, because these emissions are not "typical;" they were hourly substitutes for STARS OSD emissions for a specific time period of the base case. The same could be said for the CCEDS data, but they were not modeled in the base case.

2.2.1.6 2006 Baseline Tileplots for Texas

Following are tileplots of 2006 baseline modeling emissions. Included are:
Figure 2.2-1: *Elevated NO_X*
Figure 2.2-2: *Elevated VOC*
Figure 2.2-3: *Low-level NO_X*
Figure 2.2-4: *Low-level VOC*
Figure 2.2-5: *HRVOC Reconciliation*
Figure 2.2-6: *Tank Landing Losses VOC*

Of note is the fact that the elevated NOx and elevated VOC tileplots include ships, which are an area source. TCEQ chooses to include these as elevated point sources since many ship stack heights and emission plume rises exceed the first layer of the modeling domain, and therefore will be captured with the plume-in-grid algorithm of CAMx.



Emissions Plotted

County	Tons/Day
Brazoria	35.46
Chambers	11.16
Fort Bend	18.82
Galveston	25.08
Harris	104.86
Liberty	0.79
Montgomery	1.13
Waller	0.62
HGB SUBTOTAL:	197.92
Hardin	1.26
Jefferson	43.70
Orange	30.01
BPA SUBTOTAL:	74.97
MAP TOTAL:	483.08

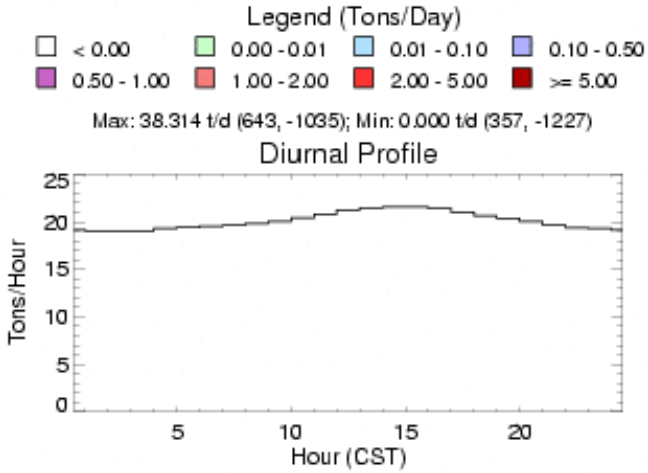
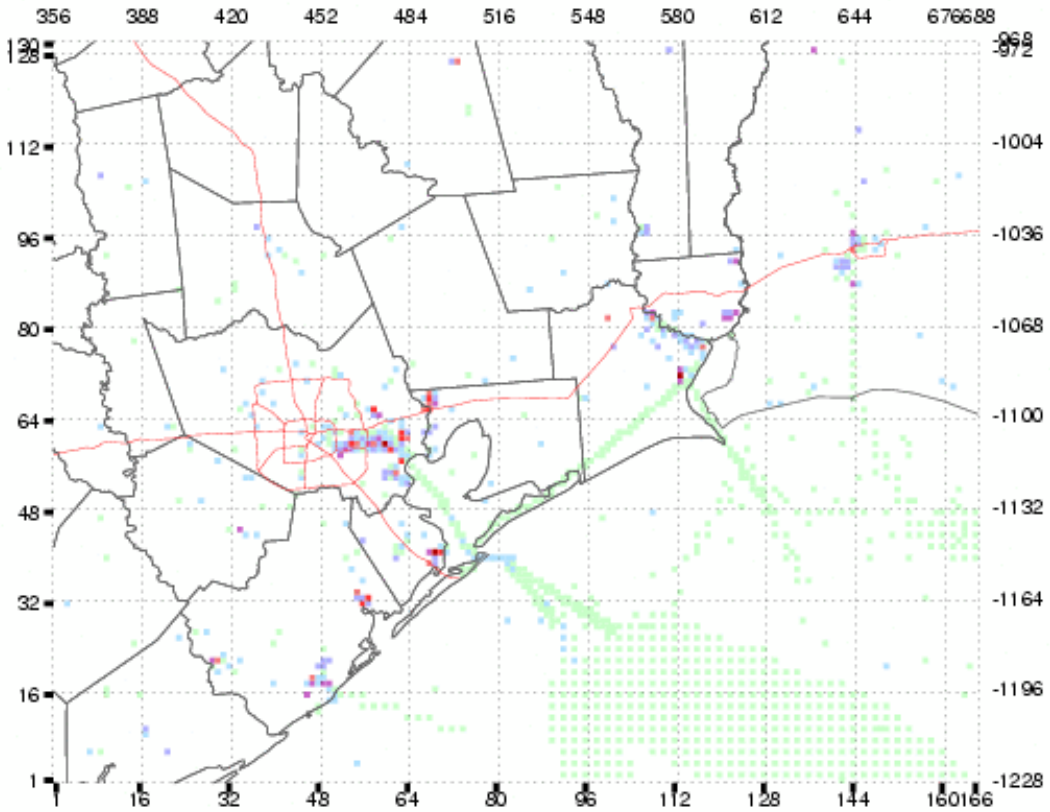


Figure 2.2-1: Elevated NO_X, (includes ships)



hgb8h2.bl06.reg3.hgbpa_02km All Elevated Emissions, 08/07/2006: VOC

Emissions Plotted

County	Tons/Day
Brazoria	16.78
Chambers	9.88
Fort Bend	0.74
Galveston	11.67
Harris	44.58
Liberty	0.13
Montgomery	0.27
Waller	0.02
HGB SUBTOTAL:	84.08
Hardin	0.25
Jefferson	20.56
Orange	4.90
BPA SUBTOTAL:	25.71
MAP TOTAL:	122.33

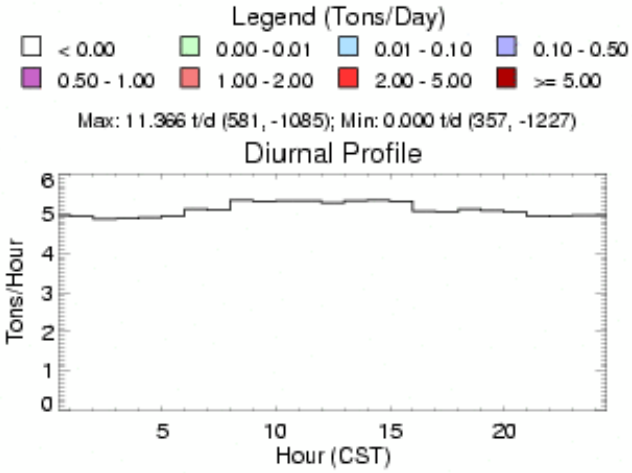
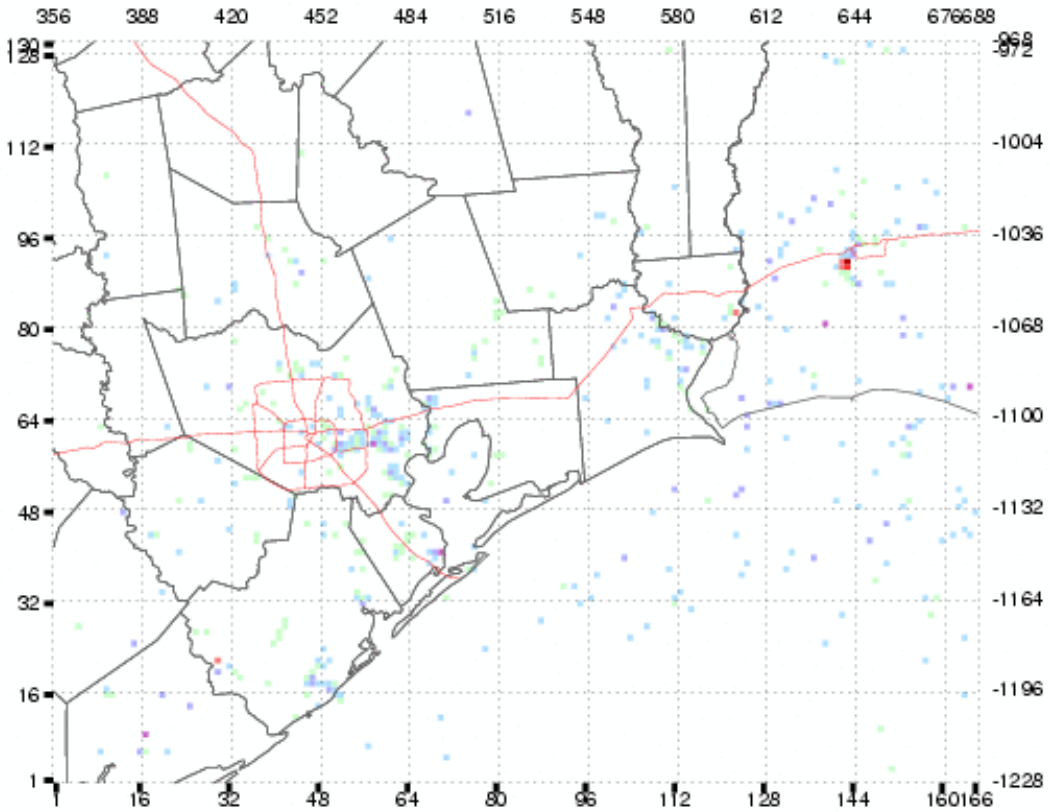


Figure 2.2-2: Elevated VOC, (includes ships)



hgb8h2.bl06.reg3.hgbpa_02km Low Level Point Emissions, 08/07/2006: NO_x

Emissions Plotted

County	Tons/Day
Brazoria	3.83
Chambers	0.53
Fort Bend	0.26
Galveston	1.21
Harris	4.33
Liberty	0.14
Montgomery	0.41
Waller	0.09
HGB SUBTOTAL:	10.81
Hardin	0.18
Jefferson	1.33
Orange	1.95
BPA SUBTOTAL:	3.46
MAP TOTAL:	40.37

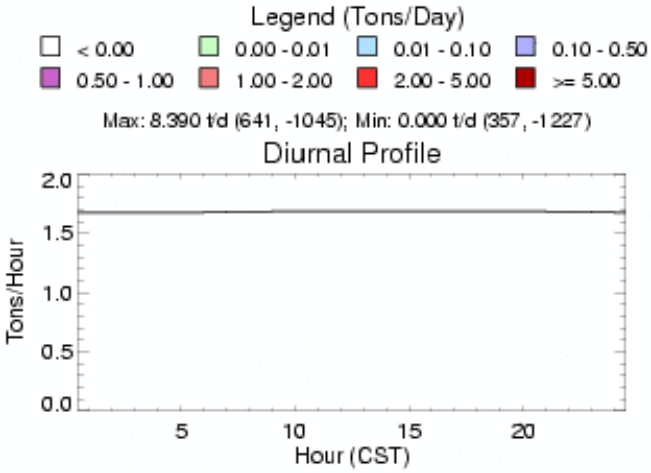
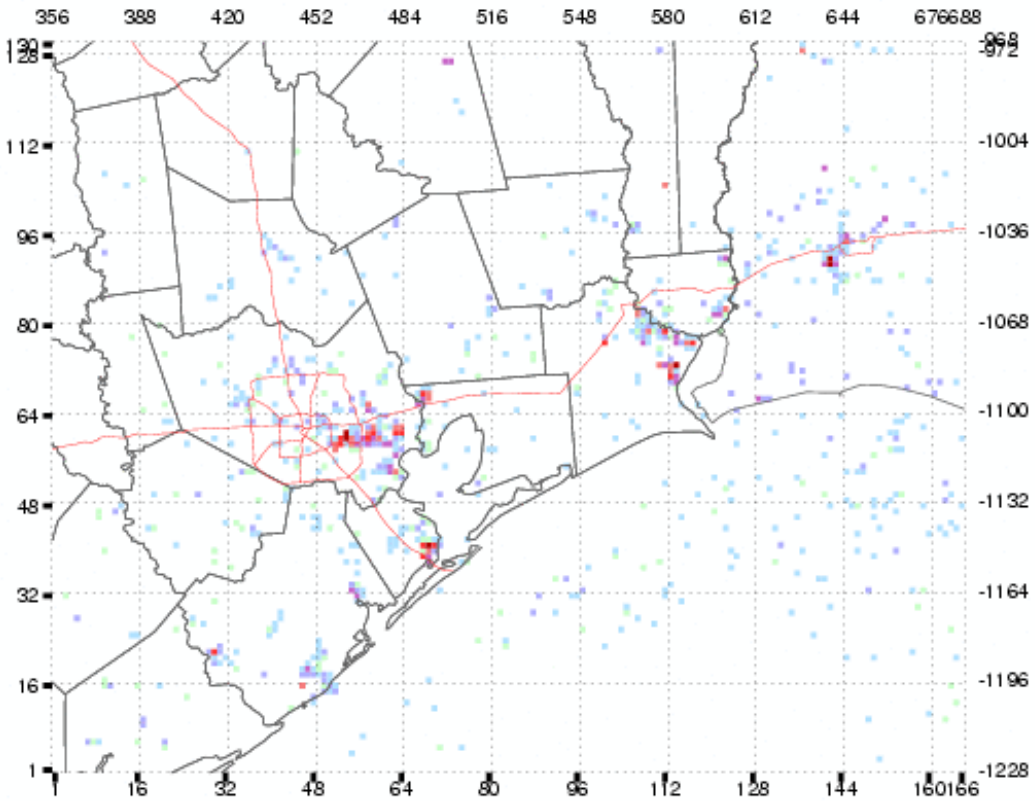


Figure 2.2-3: Low-level NO_X



hgb8h2.bl06.reg3.hgbpa_02km Low Level Point Emissions, 08/07/2006: VOC

Emissions Plotted

County	Tons/Day
Brazoria	13.32
Chambers	8.95
Fort Bend	0.97
Galveston	22.45
Harris	72.16
Liberty	1.84
Montgomery	1.66
Waller	0.14
HGB SUBTOTAL:	121.50
Hardin	1.14
Jefferson	40.72
Orange	6.93
BPA SUBTOTAL:	48.80
MAP TOTAL:	214.14

Legend (Tons/Day)

< 0.00 | 0.00 - 0.01 | 0.01 - 0.10 | 0.10 - 0.50 | 0.50 - 1.00 | 1.00 - 2.00 | 2.00 - 5.00 | >= 5.00

Max: 11.700 t/d (463, -1109); Min: 0.000 t/d (357, -1227)

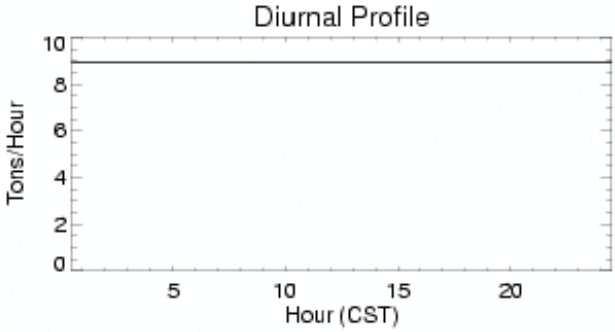
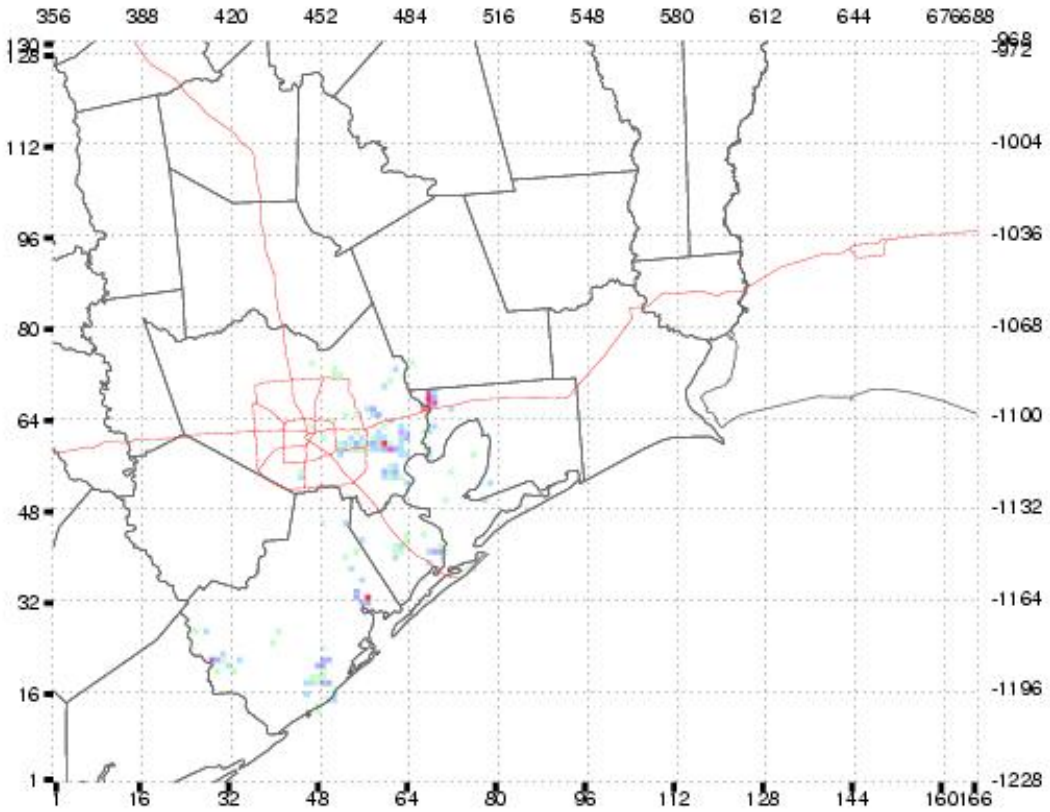


Figure 2.2-4: Low-level VOC



pscfv3.hgbpa_02km PSCF Emissions, 08/01/2006: VOC

Emissions Plotted

County	Tons/Day
Brazoria	6.11
Chambers	6.05
Fort Bend	0.00
Galveston	0.83
Harris	10.08
Liberty	0.00
Montgomery	0.00
Waller	0.00
HGB SUBTOTAL:	23.06
Hardin	0.00
Jefferson	0.00
Orange	0.00
BPA SUBTOTAL:	0.00
MAP TOTAL:	23.06

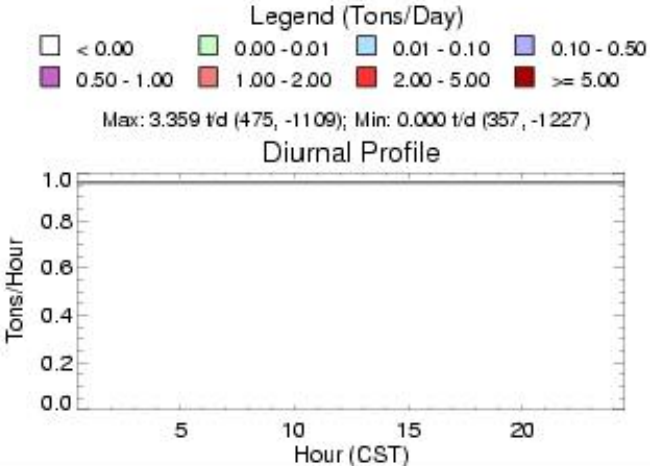


Figure 2.2-5: HRVOC Reconciliation

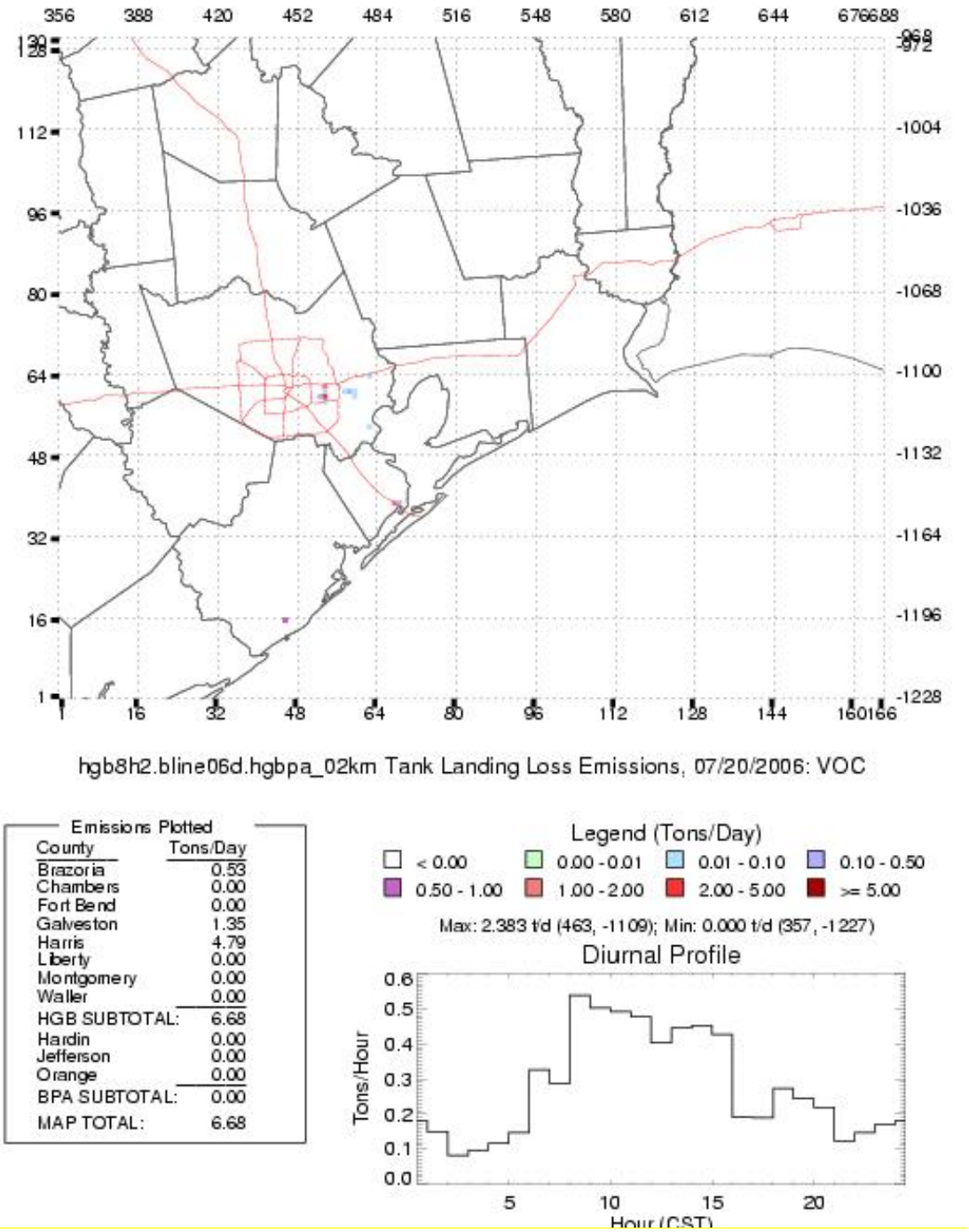


Figure 2.2-6: Tank Landing Losses VOC

2.2.2 Outside Texas

2.2.2.1 Adjacent States and Regional States Non-Acid Rain

As with Texas OSD sources, the TCEQ used the 2006 OSD (or calculated average day if only annual emissions were provided) base case records for the non-ARD 2006 baseline for states outside of Texas. For the three adjacent states, these data were from the 2006 base case as grown from the base data that the individual states provided to TCEQ (2004 for LA, 2005 for OK and AR) with the Acid Rain units removed. For the Regional states, the 2006 baseline (and base case) was the base data (2002 CENRAP/RPO) grown to 2006, with the Acid Rain units removed.

Table 2.2-5: *2006 Baseline Emissions Summary for Non-ARD Points Outside of Texas* summarizes the non-Acid Rain emissions for the 2006 baseline (same as 2006 base case). Emissions in Louisiana, Oklahoma and Arkansas are segregated to illustrate that the composite modeling file has emissions data for all states in the modeling domain. The "Other States" entry in Table 2.2-5 is emissions data for the remaining states within the modeling domain, excluding LA, OK AR, and TX. The photochemical model may not use all of the records in the non-Acid Rain 2006 base case, since some states have a fraction of their area outside of the modeling domain (e.g., the Oklahoma panhandle). EPS3 processing drops these from the modeling EI.

Table 2.2-5: 2006 Baseline Emissions Summary for Non-ARD Points Outside of Texas

Area	NO_X		VOC		CO	
	#points	tpd	#points	tpd	#points	tpd
AR	1036	82	2063	101	1061	157
LA	4090	658	7538	234	3763	389
OK	2338	216	5425	107	2340	155
Other States	78431	6688	159614	2889	73940	7513

2.2.2.2 Adjacent States and Regional States Hourly Acid Rain

As with Texas Acid Rain units, the 2006 baseline for the ARD sources of the states of the rest of the nation is a calculated typical summer day having hourly emissions that are the average for each Acid Rain point source during the third quarter (July 1 through September 30) of 2006. As with Texas, VOC and CO emissions for each hour of the typical summer day come from the hourly NO_X emissions and the VOC:NO_X and CO:NO_X ratios, computed from the daily emissions data, for each Acid Rain point.

Table 2.2-6: *2006 Baseline Hourly Emissions Summary for ARD Points Outside of Texas* summarizes the 2006 baseline Acid Rain emissions within the TCEQ regional modeling domain outside of Texas. Emissions in the adjacent states of Arkansas, Louisiana and Oklahoma are segregated to illustrate that the composite modeling file has emissions for all states in the domain. Only a fraction of the point sources emissions in some states is modeled if part of that state's area is outside the modeling domain, e.g., parts of western Kansas. All hourly values were rounded to one decimal place.

Table 2.2-6: 2006 Baseline Hourly Emissions Summary for ARD Points Outside of Texas

hour	NO_X Emissions (tph)				VOC Emissions (tph)				CO Emissions (tph)			
	AR	LA	OK	Other	AR	LA	OK	Other	AR	LA	OK	Other
1	4.6	6.2	9.2	212.4	0.1	0.1	0.1	1.3	0.5	1.9	1.1	57.4
2	4.3	6.0	8.8	203.0	0.1	0.1	0.1	1.3	0.5	1.9	1.0	54.9
3	4.0	5.9	8.6	196.8	0.1	0.1	0.1	1.2	0.4	1.8	1.0	53.2
4	4.0	5.9	8.6	195.6	0.1	0.1	0.1	1.2	0.4	1.8	1.0	52.9
5	4.1	6.0	8.8	202.4	0.1	0.1	0.1	1.3	0.4	1.9	1.0	54.7
6	4.2	6.4	9.0	214.1	0.1	0.1	0.1	1.4	0.5	2.0	1.1	57.9
7	4.4	6.4	9.2	223.9	0.1	0.1	0.1	1.4	0.5	2.0	1.1	60.5
8	4.9	6.5	9.5	236.3	0.1	0.1	0.1	1.5	0.6	2.1	1.1	63.9
9	5.2	6.7	10.0	249.9	0.1	0.1	0.1	1.6	0.6	2.1	1.2	67.6
10	5.2	6.9	10.7	261.9	0.1	0.1	0.1	1.7	0.6	2.2	1.4	71.0
11	5.1	7.4	11.5	270.5	0.1	0.1	0.2	1.8	0.6	2.3	1.6	73.3
12	5.2	7.8	12.2	276.3	0.1	0.2	0.2	1.9	0.6	2.3	1.8	74.9
13	5.2	8.3	12.9	280.1	0.1	0.2	0.2	1.9	0.6	2.5	2.0	76.0
14	5.2	8.6	13.4	282.4	0.1	0.2	0.2	1.9	0.6	2.5	2.2	76.6
15	5.3	8.7	13.6	283.5	0.1	0.2	0.2	1.9	0.6	2.6	2.3	77.0
16	5.2	8.6	13.9	283.8	0.1	0.2	0.2	1.9	0.6	2.5	2.3	77.0
17	5.1	8.3	13.6	282.8	0.1	0.2	0.2	1.9	0.6	2.5	2.3	76.7

hour	NO_X Emissions (tph)				VOC Emissions (tph)				CO Emissions (tph)			
	AR	LA	OK	Other	AR	LA	OK	Other	AR	LA	OK	Other
18	5.1	7.9	13.1	279.0	0.1	0.2	0.2	1.9	0.6	2.4	2.1	75.7
19	5.0	7.5	12.5	275.4	0.1	0.2	0.2	1.8	0.6	2.3	2.0	74.7
20	5.0	7.3	12.1	274.5	0.1	0.2	0.2	1.8	0.6	2.2	1.8	74.4
21	4.9	7.0	11.7	269.0	0.1	0.1	0.2	1.7	0.5	2.2	1.7	72.9
22	4.7	6.7	11.0	256.4	0.1	0.1	0.1	1.6	0.5	2.1	1.5	69.4
23	4.7	6.5	10.3	240.9	0.1	0.1	0.1	1.5	0.5	2.0	1.3	65.1
24	4.7	6.4	9.7	224.9	0.1	0.1	0.1	1.4	0.5	2.0	1.2	60.8
Totals	115	170	264	5976	2	3	3	39	13	52	37	1619
#points	41	96	71	1351	41	96	71	1351	41	96	71	1351

Note that, as in Texas, the peak hours of emissions (coinciding with peak electrical demand) for the Acid Rain EGUs are between hours 14 and 16, for the summation of the entire country.

2.2.2.3 Offshore, Mexico, and Canada

The Offshore 2005 GWEI, the 1999 Mexican NEI, and the 1995 Canadian baseline point source files are the same as the base case files, since they are already being modeled as an average day.

2.2.3 Summary of 2006 Baseline Point Source Data Files

Snapshots of the point source emission files that were processed with EPS3 for CAMx for the baseline (typical summer day) are presented in Table 2.2-7: *AFS Files for the 2006 Baseline*. The version number on each dataset indicates a change from the previous version (e.g., "v2"). The FTP download site for the point source files or their successors is ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/ei/point/. Outdated files are generally not retained on the FTP site. Table 2.2.8: *2006 Baseline Point Source Emissions Summary* summarizes the baseline emissions.

Table 2.2-7: AFS Files for the 2006 Baseline

Area	AFS Point Source Emissions File	Hourly	Daily	See Note
Texas	afs.ard_generic_episode_3Q2006_aver_day_v1	X		
	afs.osd_2006_STARS_generic_with_upsets_and_routine_TLL		X	1
	afs.landing_losses_3Q06_aver_day_episode_v1	X		1
	afs.aggVOC_extra_alkenes_for_2006_v3		X	1,2
Regional	afs.USA_minusTx_ard_generic_day_v1	X		
	USA_osd_2006_for_3Q06_generic_from_2006CENRAP.v1		X	
	afs.gwei2005.May_Oct_edit.3pol.lcp			2,3
	afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	2
	afs.CAIRCanada.2001.v1a.latlong.lcp			2,4
Notes	1 Aggregated VOC records require cross reference and profile code files for composition/speciation 2 Unchanged from 2006 base case 3 AFS file contains monthly emissions; only June was modeled; see temporal profiles; see Section 2.1.2.3 4 AFS file contains annual emissions			

Table 2.2-8 2006 Baseline Point Source Emissions Summary

Emissions Source	HGB		Texas minus HGB		USA minus Texas	
	NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)	NO_X (tpd)	VOC (tpd)
NEGUs (OSD)	124.8	175.2	619.8	342.2	7644.6	3331.2
EGUs (ARD)	48.1	2.0	501.5	14.3	6524.5	47.1
Tank Landing Losses	0.0	6.5	0.0	0.0	na	na
HRVOC Reconciliation	0.0	19.3	0.0	0.0	na	na
TOTALS =	*172.9*	*203.0*	*1121.3*	*356.5*	*14169.0*	*3378.3*

Notes: These tabulated emissions are AFS (input to EPS3) totals. CAMx input values may differ.
USA minus Texas includes some points outside the modeling domain
Texas minus HGB includes some points in Texas outside the modeling domain

2.3 2018 FUTURE YEAR POINT SOURCE MODELING EMISSIONS DEVELOPMENT

This section describes the development of the 2018 future year point source EI. The eight-hour ozone attainment date for HGB is June 15, 2019 (severe classification). The modeled attainment year is 2018 -- the ozone season prior to the attainment date.

The 2018 case that this section describes is the future base EI development, in which a baseline is projected (”grown”) to the attainment year with on-the-books controls applied that will be in place after the baseline year yet prior to the attainment year. The on-the-books controls are controls for which enforceable emissions reductions rules have been written already; they are not additional proposed rules that result from this SIP proposal and adoption. Additional proposed or adopted rules that would be modeled would be developed in a 2018 control strategy EI (that would be described in a future section) or as part of Reasonably Available Control Measure (RACM) analyses. This 2018 future base EI provides the basis from which to begin testing model sensitivities to determine how sensitive the model is (how much ozone responds) to various EI changes, to determine which control strategies may be needed to reach attainment or can advance the attainment date. The 2018 future base EI is the starting point for any 2018 control strategy modeling.

The TCEQ has prepared a single 2018 future year point source EI for the entire State. In this SIP revision, emphasis is placed on HGB receiving the most detailed attention. Since the baseline year for the future design value calculation is 2006, this future year point source EI has been projected primarily from the 2006 point source baseline EI, as described in Section 2,2 above. As discussed below, not all parts of the 2018 EI were based on 2006 (some based on 2007). The 2018 future base needs to parallel the baseline for an apples-to-apples comparison for the future design value calculation; therefore, the 2018 future base EI needs to represent a typical summer day in 2018.

The format of this section is similar to that of the previous sections, in that we describe the procedures used to develop the EI for Texas, with all the details for the nonattainment areas (NAAs) of the State, then working our way outward to Canada.

2.3.1 Attainment Areas of Texas

The attainment areas of Texas include all of Texas, excluding the ozone NAAs of the State: HGB, Dallas-Fort Worth (DFW), and Beaumont-Port Arthur (BPA). The subsections below address growth projections to 2018 and existing controls separately.

2.3.1.1 Attainment Area 2018 Growth Projections

Growth projections were applied to the baseline EI in the attainment areas of the state to obtain a 2018 grown EI. Different techniques were applied to the Electric Generating Units (EGUs) that have Acid Rain data (ARD) and the non-EGUs (NEGUs) that generally rely on ozone season daily (OSD) emissions. These techniques are similar to EPA projection methods and Regional Planning Organization (RPO) projection methods for modeling future cases.

2.3.1.1.1 *EGUs*

As discussed in the base case and baseline sections above, the ARD provide hourly emissions for EGUs that must comply with the EPA’s Acid Rain Program. The typical summer Acid Rain day is a single day in which every modeled hour of each ARD point source is the average of all days in the third quarter of 2007 (3Q2007) for that hour. The same procedure (see Section 2.2.1.3 above) used to generate the 2006 baseline EGUs for Texas was used for 2007. The TCEQ chose this dataset from which to project, because it is newer, containing more of the actual emissions growth from newer units. Projecting EGUs from the 2006 baseline would inherently have a bit more error in it, since it would begin farther away from the attainment year of 2018. Not all EGUs are Acid Rain sources and not all NO_X point sources at EGU facilities are Acid Rain

sources. The non-Acid Rain EGUs were modeled at their 2006 baseline emissions along with the non-EGU point sources.

The complete set of 2018 EGUs consists of the 3Q2007 ARD EGUs, the 2006 non-Acid Rain EGUs, and post-2007 EGUs that have approved TCEQ permits. As with previous SIP revisions, the TCEQ assumes that the EGU growth in the State comes from the TCEQ newly-permitted EGUs.

Newly-Permitted EGUs

Growth in EGUs in Texas is accomplished with the addition of all newly-permitted EGUs since the baseline, all within the constraint of the EPA's Clean Air Interstate Rule (CAIR), which is described in the controls subsection below. This subsection describes the procedures for developing the newly-permitted EGU EI.

Texas' EGU emissions for 2018 were developed by researching and compiling data from various sources. These sources include:

- Electric Reliability Council of Texas (ERCOT) http://www.ercot.com/content/news/presentations/2008/2008_Capacity,_Demand,_Reserves_Report_FINAL.xls
- Public Utility Commission (PUC) http://www.puc.state.tx.us/electric/maps/gentable.pdf
- Energy Information Administration (EIA). Form 860 is the most useful: http://www.eia.doe.gov/cneaf/electricity/page/eia860.html
- TCEQ Permit Engineers and link to projects with combustion turbines: http://www.tceq.state.tx.us/assets/public/permitting/air/memos/turbine_lst.pdf
- TCEQ New Source Review Permits Information Management System (NSRP IMS) internal document server

Information from these sources include individual units' disposition (i.e., operating status), new units coming online, units to be mothballed, and units to be shut down and retired. The TCEQ assumed that by 2018, all current mothballed and reliability-must-run (RMR) units would be retired. For new units planned to come online, a distinction is made for those that have received a permit, versus those that have pending permits. Reconciliation between all data sources was made to ensure all units were accounted for, and their most current status, as of February 2009, was modeled. As the most recent EGU emissions data for modeling is from 3Q2007 Acid Rain, new EGUs are based on additions and changes subsequent to 2007 ("post 2007").

While the above sources of data provide information on current and planned electric generation, the TCEQ used the ERCOT demand projections to determine a suitable methodology to model 2018 EGU emissions. ERCOT controls the electric grid for approximately 85% of the Texas customers, with the remaining areas controlled by Southwest Power Pool (SPP), Southeastern Electric Reliability Council (SERC), and Western Systems Coordinating Council (WSCC). ERCOT's Capacity, Demand and Reserves (CDR) report (see first bullet above) forecasts a five year demand (load) and capacity (generation) projection to 2013. The TCEQ extrapolated the demand to 2018 by continuing the average growth of approximately 2% per year, based on the Summer Summary portion of the report. This 2018 extrapolated value was also verified by an ERCOT long-term projection chart in the CDR. ERCOT also includes a reserve margin (12.5% is preferred) for capacity, which is accounted for in modeled emissions from future electric generation.

The TCEQ performed a highly detailed study of the EGU growth, capacity, and demand under the scenario that CAIR was vacated – the constraint of CAIR cap and controls was lifted, temporarily. The TCEQ considers the "non-CAIR" scenario a sensitivity test and has not provided any documentation for that scenario. During the process of developing the 2018 future

case EI, the Clean Air Interstate Rule (CAIR) was vacated by the Courts. The TCEQ quickly went down the path of developing a "non-CAIR" version of the 2018 EI for the EGUs in Texas and outside of Texas. As the TCEQ completed the non-CAIR 2018 EI, the Court remanded CAIR back to the EPA. The EPA provided guidance that CAIR is still in effect, as promulgated, until future revision or replacement. Hence, this version of 2018 EI incorporates CAIR Phase II (post 2014 step-down of CAIR). This is handled separately for Texas and states outside of Texas. Details of CAIR (a control program) are provided in Section 2.3.1.2.1 below.

For the newly-permitted (since 2007) EGUs, emissions were calculated based on their permit allowables from the permit Maximum Allowable Emission Rates Table (MAERT). For ozone modeling, pollutants acquired from the permits were NO_X, VOC, and CO. Methods of determining these allowables differ between the types of units and their primary purpose for being constructed. Hence, methods for assigning modeled allowable emissions differ between the types of units. For example, coal plants may have a 30 day rolling average, while gas turbines may have a short term allowable (pounds per hour) and/or a long term allowable (tons per year). In some cases, a unit may have a combination of the above, in addition to maintenance, startup and shutdown (MSS) emission limits.

Whenever available from a permit MAERT, the 30-day pounds-per-hour emissions limitation was used. These were most often available for solid fuel-fired units. These limitations on some MAERTs represent a good compromise between the standard short-term allowable pounds per hour (that sometimes includes maintenance, startup and shutdown emissions) and the standard long-term permit allowable ton per year. The short term, when converted to tpd, is often substantially more than a unit would realistically emit in any day; the long-term, when converted to tpd may often under-represent what a unit could emit during any one day, especially during a summer day during the ozone season. Therefore, a 30-day average pounds-per-hour limitation is a reasonable representation of the emissions during the modeled ozone episode. Again, the 30-day limit was available generally only from the MAERTs of solid fuel-fired units.

MSS permitting is fairly new, but the TCEQ modeling staff saw this as an opportunity to capture a more realistic operating scenario than simply the maximum of the short-term or long-term emission rates alone. This is especially important for those units that have many MSS events during a typical summer, most notably, the peaking units that attempt to capture only the peak demand times. MSS limits vary between permits, with some units having discrete and specific quantities on MAERTs, while others are more ambiguous in the permit Special Conditions or footnotes, usually due to the variety of needs and operating parameters of the equipment. Examples include:

- 3 hour limit per MSS event
- 2500 hours/yr
- MSS event maximum: cold start= 5 hours; warm start= 3 hours; shutdown= 1 hour
- none given

An attempt was made to maintain consistent MSS limits across the different types of units where the assignments were vague. MSS limits were not used for baseload coal units, as it is assumed these operate generally nonstop throughout summer ozone season.

To model the newly-permitted EGU emissions in a somewhat consistent manner, keeping in mind that permitting is performed on a case-by-case basis, a preferred order (given below) was prescribed for using appropriate emission limits, and adherence to this order is kept in most circumstances:

- Use 30 day rolling average emission limit if provided in permit.
- Use higher of the short term or long term limits, and converted to tons per day.

- Incorporate MSS emissions where applicable and available.

The emission rates calculated for these units represent worst case for some units, but for most, it represents a typical summer day during the ozone season, which corresponds to some of the highest days of electricity demand. In developing a future EI, the TCEQ has historically modeled only those units that (1) have been issued a permit, and (2) are expected to be operational prior to the attainment date. The complete list of newly-permitted EGUs (permitted for startup after 2007) that were added as the EGU growth in the State, by area, is provided as Table 2.3-1: *Newly Permitted EGUs (post 2007) in Texas as of November 2009*. This table represents the very most up-to-date list of newly-permitted EGUs, as of November 2009. The version modeled may not be as comprehensive as this list.

Table 2.3-1: Newly-Permitted EGUs (post-2007) in Texas, as of November 2009

Area	Site Name[2]	County	Boiler	Capacity (MW)	Fuel[1]	Emission Rates (tpd)			
						Calculated from Permit			Modeled
						NO_X	VOC	CO	NO_X
HGB	Dow Chemical Cogen	Brazoria	B56CR96	180	G	0.66	0.66	4.32	0.16
	Green Power Unit 1	Brazoria	GT-2	35	G	0.14	0.07	0.80	0.03
	Green Power Unit 1	Brazoria	GT-3	35	G	0.14	0.07	0.80	0.03
	Cedar Bayou	Chambers	CBY41	300	G	0.69	0.15	6.50	0.16
	Cedar Bayou	Chambers	CBY42	300	G	0.77	0.15	6.50	0.18
	NRG Cedar Bayou	Chambers	CBY51	350	G	0.57	0.20	6.22	0.14
	NRG Cedar Bayou	Chambers	CBY52	350	G	0.57	0.20	6.22	0.14
	Deer Park Energy Center	Harris	ST-5	265	G	0.42	0.87	6.68	0.10
	Deer Park Energy Center	Harris	ST-6	265	G	0.42	0.87	6.68	0.10
	TECO Central Plant	Harris	CHP-1	50	G	0.32	0.10	1.63	0.08
	TECO Central Plant	Harris	CHP-2	50	G	0.32	0.10	1.63	0.08
	Lewis Creek	Montgomery	STCK3A	250	G	0.27	0.09	1.07	0.06
	Lewis Creek	Montgomery	STCK3B	250	G	0.27	0.09	1.07	0.06
BPA	East TX Elec Coop Hardin	Hardin	HCCT1	73	G	0.43	0.12	0.80	0.10
	Hardin Facility	Hardin	HCCT2	73	G	0.43	0.12	0.80	0.10
ATTAIN[3]	Lufkin Generating Plant	Angelina	LBLR01	45	R	0.62	0.08	0.62	0.14
	Panda Temple Power	Bell	CTG-1	275	G	0.45	0.60	5.78	0.10
	Panda Temple Power	Bell	CTG-2	275	G	0.45	0.60	5.78	0.10
	Panda Temple Power	Bell	CTG-3	275	G	0.45	0.60	5.78	0.10
	Panda Temple Power	Bell	CTG-4	275	G	0.45	0.60	5.78	0.10
	J K Spruce Unit 2	Bexar	U-6	750	C	6.62	0.35	53.76	1.47
	VH Braunig 5	Bexar	CGT5	50	G	0.32	0.04	1.43	0.07
	VH Braunig 6	Bexar	CGT6	50	G	0.32	0.04	1.43	0.07
	VH Braunig 7	Bexar	CGT7	50	G	0.32	0.04	1.43	0.07
	VH Braunig 8	Bexar	CGT8	50	G	0.32	0.04	1.43	0.07
	Dansby Power Plant	Brazos	6	50	G	0.30	0.03	1.03	0.07
	E.S. Joslin Power Station	Calhoun	ESJ-1A	300	P	2.23	0.16	4.78	0.49
	Formosa Pt.Comfort	Calhoun	CFB-S1	150	C P	1.26	0.10	1.98	0.28
	Formosa Pt.Comfort	Calhoun	CFB-S2	150	C P	1.26	0.10	1.98	0.28
	La Palma Power Station	Cameron	LAP8	273	G	0.74	0.19	4.82	0.16

Area	Site Name[2]	County	Boiler	Capacity (MW)	Fuel[1]	Emission Rates (tpd)			
						Calculated from Permit			Modeled
						NO_X	VOC	CO	NO_X
	Quail Run Energy Center	Ector	CTDB2A	138	G	0.26	0.04	0.82	0.06
	Quail Run Energy Center	Ector	CTDB2B	138	G	0.26	0.04	0.82	0.06
	Quail Run Energy Center	Ector	CTDB3A	113	G	0.13	0.04	0.56	0.03
	Quail Run Energy Center	Ector	CTDB3B	113	G	0.13	0.04	0.56	0.03
	Global Alternative Fuels	El Paso	EPN1_25	55	R	0.68	0.19	0.42	0.15
	Newman Unit 6	El Paso	CC-S6A	144	G	1.42	0.22	5.06	0.31
	Newman Unit 6	El Paso	CC-S6B	144	G	1.42	0.22	5.06	0.31
	Pattillo Branch	Fannin	S-1	350	G	0.86	0.33	3.87	0.19
	Pattillo Branch	Fannin	S-2	350	G	0.86	0.33	3.87	0.19
	Pattillo Branch	Fannin	S-3	350	G	0.86	0.33	3.87	0.19
	Pattillo Branch	Fannin	S-4	350	G	0.86	0.33	3.87	0.19
	Winchester PowerPark	Fayette	CGT1	50	G	0.11	0.05	0.50	0.02
	Winchester PowerPark	Fayette	CGT2	50	G	0.11	0.05	0.50	0.02
	Winchester PowerPark	Fayette	CGT3	50	G	0.11	0.05	0.50	0.02
	Winchester PowerPark	Fayette	CGT4	50	G	0.11	0.05	0.50	0.02
	J L Bates Power Station	Hidalgo	JLBCT1	290	G	0.74	0.19	5.39	0.16
	Cobisa-Greenville	Hunt	GTDB1	300	G	0.69	1.24	5.90	0.15
	Cobisa-Greenville	Hunt	GTDB2	300	G	0.69	1.24	5.90	0.15
	Cobisa-Greenville	Hunt	GTDB3	300	G	0.69	1.24	5.90	0.15
	Cobisa-Greenville	Hunt	GTDB4	300	G	0.68	1.11	4.43	0.15
	Cobisa-Greenville	Hunt	GTDB5	300	G	0.68	1.11	4.43	0.15
	Cobisa-Greenville	Hunt	GTDB6	300	G	0.68	1.11	4.43	0.15
	Jack Co Gen Facility	Jack	HRSG-3	330	G	1.82	0.53	7.67	0.40
	Jack Co Gen Facility	Jack	HRSG-4	330	G	1.82	0.53	7.67	0.40
	Lamar Power Partners II	Lamar	GT-HRSG5	310	G	0.54	0.10	0.89	0.12
	Lamar Power Partners II	Lamar	GT-HRSG6	310	G	0.54	0.10	0.89	0.12
	Madison Bell Partners	Madison	CTDB1-A	138	G	1.00	0.13	2.10	0.22
	Madison Bell Partners	Madison	CTDB1-B	138	G	1.00	0.13	2.10	0.22
	Madison Bell Partners	Madison	CTDB2-A	138	G	1.00	0.13	2.10	0.22
	Madison Bell Partners	Madison	CTDB2-B	138	G	1.00	0.13	2.10	0.22
	Sandy Creek	McLennan	S01	800	C	6.88	0.35	29.47	1.52

Area	Site Name[2]	County	Boiler	Capacity (MW)	Fuel[1]	Emission Rates (tpd)			
						Calculated from Permit			Modeled
						NO_X	VOC	CO	NO_X
	Sandow 5	Milam	17CFB	282	C	3.55	0.18	3.55	0.79
	Sandow 5	Milam	17CFB	282	C	3.55	0.18	3.55	0.79
	Nacogdoches Power	Nacogdoches	BFB-1	100	C P	1.65	0.24	2.72	0.37
	Nacogdoches Power	Nacogdoches	HRSG-1	330	G	3.07	0.34	2.63	0.68
	Barney M Davis	Nueces	BMD3	350	G	1.25	0.47	6.09	0.28
	Barney M Davis	Nueces	BMD4	350	G	1.25	0.47	6.09	0.28
	Lon C. Hill Unit 5	Nueces	LCH5	290	G	0.74	0.19	1.33	0.16
	Nueces Bay WLE	Nueces	NB8	350	G	1.25	0.47	6.09	0.28
	Nueces Bay WLE	Nueces	NB9	350	G	1.25	0.47	6.09	0.28
	Oak Grove 1	Robertson	OGU1	800	C	8.61	0.56	36.60	1.91
	Oak Grove 2	Robertson	OGU2	800	P	8.61	0.56	36.60	1.91
	San Jacinto Facility	San Jacinto	SJCCT1	73	G	0.43	0.12	0.80	0.10
	San Jacinto Facility	San Jacinto	SJCCT2	73	G	0.43	0.12	0.80	0.10
	Sand Hill Energy Ctr	Travis	SH-6	48	G	0.30	0.06	1.41	0.07
	Sand Hill Energy Ctr	Travis	SH-7	48	G	0.30	0.06	1.41	0.07
	Victoria Elec Gen Station	Victoria	VIC7	289	G	0.74	0.19	5.38	0.16
	Laredo Power Station	Webb	LPSCT4	100	G	0.29	0.05	0.34	0.06
	Laredo Power Station	Webb	LPSCT5	100	G	0.29	0.05	0.34	0.06
	Colorado Bend Energy Center	Wharton	CTDB2A	138	G	0.28	0.04	0.89	0.06
	Colorado Bend Energy Center	Wharton	CTDB2B	138	G	0.28	0.04	0.89	0.06
	Colorado Bend Energy Center	Wharton	CTDB3A	113	G	0.14	0.04	0.61	0.03
	Colorado Bend Energy Center	Wharton	CTDB3B	113	G	0.14	0.04	0.61	0.03
	Wise County Power Plant	Wise	CT21	82	G	0.86	0.07	3.62	0.19
	Wise County Power Plant	Wise	CT22	82	G	0.86	0.07	3.62	0.19
	Wise County Power Plant	Wise	CT31	82	G	0.86	0.07	3.62	0.19
	Wise County Power Plant	Wise	CT32	82	G	0.86	0.07	3.62	0.19
			TOTAL =	**18856**		**93.00**	**24.33**	**410.98**	**20.69**

[1] Fuel Types: G – Natural Gas, P – Petroleum, C – Coal, R – Renewables (Biomass)

[2] Some of the Newly Permitted EGUs are located beyond the modeling domain and excluded from the photochemical modeling

[3] "ATTAIN" refers to the attainment areas of Texas.

Table 2.3-1, above, includes two types of emission rates: (1) calculated NO_X, VOC and CO from permit applications and MAERTs, representing realistic average day emissions prior to meeting CAIR Phase II and MECT requirements as discussed below in later subsections; and (2) modeled NO_X rates incorporating CAIR Phase II and MECT. It is assumed NO_X controls, offsets, or credit purchases will be used to meet these NO_X emissions rates, leaving VOC and CO rates modeled at their permitted levels (an artifact modelers are aware of, but worst case).

All of the 87,290 megawatt (MW) demand, including the reserve margin, projected by ERCOT (in its CDR report) to be required by 2018, is satisfied by existing units, planned units, and these newly-permitted units (provided they can run at full load) that are all expected to be operating by 2011 or 2012. Most of the permitted units are expected to be operational by the end of 2010. Historically, some permitted units are never built and some postpone construction; hence, 2011-2012 is simply an estimate. All (or nearly all) of these newly-permitted EGUs, except perhaps the cogeneration (cogen) units, have "interconnect agreements" (put up bond money with ERCOT to connect to the grid), so these are genuine projects acknowledged by ERCOT, PUC, and EIA. The cogen units of Table 2.3-1 include Dow, Formosa, Deer Park Energy, and BP Amoco. The TCEQ has assumed that any remaining deficit to the demand between 2012 and 2018 will be filled with renewable resources that do not involve combustion sources, such as wind and nuclear, which both have huge expansions planned between 2007 and 2018 (see ERCOT CDR Report).

Modeling new (post-2007) EGUs for 2018 requires that their emissions be reduced (about 78%) to comply with CAIR Phase II (and MECT for those in HGB). The corresponding reduction in capacity would result in an approximate 12,000 MW deficit to the 2012 demand. Conceptually, these newly-permitted units will operate at the modeling-restrictive 22% capacity (another artifact of modeling), however, they could operate at a much higher capacity by purchasing credits or providing other offsets. TCEQ maintains that the remaining capacity deficit will likely be filled with renewable resources, some of which are mandated by State legislative action. Note that of the 18,856 MW of new capacity, a portion of it is generated outside of the ERCOT grid. While all new EGU's NO_X emissions are reduced for modeling, the MW assessment considers only those units whose generation is in the ERCOT grid, and only the gridded portion of cogen facilities. For areas outside of the ERCOT grid, TCEQ assumes similar growth rationale to meet the expected demand as for areas in ERCOT's grid (new units and renewable resources).

Pending permits (permit applications under TCEQ review, but not yet granted permits) were not included in this CAIR scenario for several reasons, including:

- These permits are more speculative.
- Adding more units under CAIR does not affect the total modeled EGU emissions, just where the emissions occur.
- These would have been squeezed under the CAIR Phase II 9.5% set-aside, as currently modeled, along with all the other post-2000 EGUs.

See the CAIR discussion below, in Section 2.3.1.2.1. CAIR is technically a control, but it is a serious constraint on the EGU growth in the attainment counties.

The temporal distributions of the newly-permitted EGUs are based on those of existing units of similar equipment type or Source Classification Codes (SCCs). For each SCC included in the newly-permitted EGU list, an average temporal distribution was calculated for these SCCs, based on diurnal profiles of existing units within the State. These average profiles were then used for the new EGUs. For some units on the new EGU list, a corresponding SCC did not exist for existing units. In these cases, the default profile (flat) was assigned. An example diurnal profile of a natural gas turbine is provided as Figure 2.3-1: *Example EGU Diurnal Profile*.

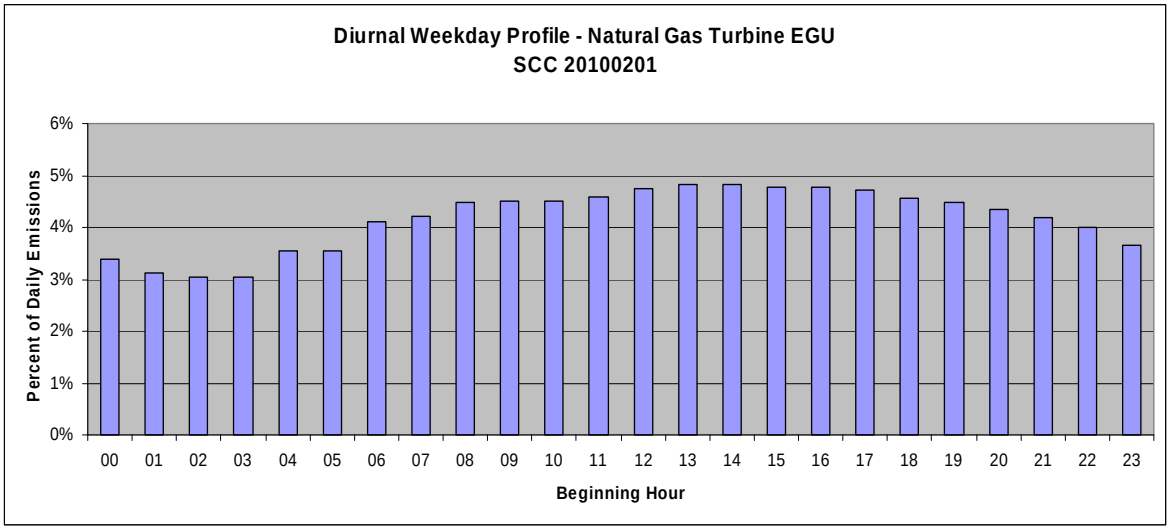


Figure 2.3-1: Example EGU Diurnal Profile

2.3.1.1.2 *Non-EGUs (NEGUs)*

When the Acid Rain units are removed from the point source EI for hourly treatment, the remainder is ozone season daily (OSD). As described previously, the TCEQ is referring to these in the shorthand as non-EGUs (NEGUs). The basis for future growth for NEGUs in the Texas attainment areas was the 2006 OSD emissions, already an average ozone season day from STARS.

Emissions from NEGUs in the attainment areas of the state were projected to 2018 using a combination of projection factors. Projection factors derived from the Dallas Federal Reserve Bank's Texas Industrial Production Index (TIPI) are based on an industry's Standard Industrial Classification (SIC) – the kind of business they are in, e.g., petrochemical manufacturing. TIPI does not cover all of the SICs, so for those not covered, projection factors from EPA's Economic Growth Analysis System version 5.0 (EGAS5) with a Texas-specific version of the Regional Economic Models, Inc (REMI) update were used. This version of EGAS with Texas-specific REMI is hereafter referred to as REMI-EGAS. No individual new permits were modeled as growth for NEGUs.

While there is an argument for using either index, TIPI provided unexpectedly low emission rates for some point sources. The TCEQ chose to use the index that provided the most growth for each point source. Again, there is not a TIPI factor available for all sources (only select SICs), but there is a REMI-EGAS factor for each source (every SCC). For the SICs with missing TIPI factors, a value of 1.2 was assigned (the average of the non-missing factors). Examples of TIPI and REMI-EGAS growth factors are provided as Table 2.3-2: *Sample TIPI Growth Factors for Texas* and Table 2.3-3: *Sample REMI-EGAS Growth Factors for Texas*, respectively. Note that a growth factor less than 1.0 indicates a decline rather than a growth. Also note that the TIPI factor varies only by the two-digit (first two) SIC.

Table 2.3-2: Sample TIPI Growth Factors for Texas

SIC	Source	Growth Factor 2006-2018
1311	TIPI	0.80
1321	TIPI	0.80
1381	TIPI	0.80
1382	TIPI	0.80
1422	TIPI	1.77
1459	TIPI	1.77
2011	TIPI	1.30
2013	TIPI	1.30
2032	TIPI	1.30
2041	TIPI	1.30
2046	TIPI	1.30
2051	TIPI	1.30
2061	TIPI	1.30
2074	TIPI	1.30
2077	TIPI	1.30
2082	TIPI	1.30
2095	TIPI	1.30
2096	TIPI	1.30
2099	TIPI	1.30
...		

SIC	Source	Growth Factor 2006-2018
. . .		
3082	TIPI	1.24
3084	TIPI	1.24
3086	TIPI	1.24
3087	TIPI	1.24
3088	TIPI	1.24
3089	TIPI	1.24
3143	default	1.14
3149	default	1.14
3211	TIPI	1.05
3221	TIPI	1.05
3229	TIPI	1.05
3231	TIPI	1.05
3241	TIPI	1.05
3251	TIPI	1.05
3253	TIPI	1.05
3261	TIPI	1.05
3272	TIPI	1.05
. . .		

Table 2.3-3: Sample REMI-EGAS Growth Factors for Texas

SCC	fips	Growth Factors 2006	Growth Factors 2018	NOTES
10100101	48	1.04091	1.01559	fips = 48, best fit is entire state (48xxx)
10100102	48	1.04091	1.01559	
10100201	48	1.04091	1.01559	
10100202	48	1.04091	1.01559	
10100203	48	1.04091	1.01559	
10100204	48	1.04091	1.01559	
10100205	48	1.04091	1.01559	
...				
10100604	48	0.78445	1.17224	Growth 2006 to 2018 = 1.1722/0.7845=1.4943
10100701	48	0.92453	1.09418	
10100702	48	0.92453	1.09418	
10100703	48	0.92453	1.09418	
10100704	48	0.92453	1.09418	
10100707	48	0.92453	1.09418	
10100711	48	1.33333	1.40741	
10100712	48	0.92453	1.09418	
10100801	48	1.31050	1.40910	
...				

Projection factors were assigned individually to each NEGU path based on its SIC-SCC combination, with the larger of either its SIC-derived factor (TIPI) or its SCC-derived factor (REMI-EGAS) applied. The same factor was applied to all three modeled pollutants. A summary of the EGU and NEGU growth in the Texas attainment areas is provided as Table 2.3-4: *Summary of Texas Attainment Area NO_X Growth Projections to 2018.*

Table 2.3-4: Summary of Texas Attainment Area Growth Projections to 2018

EI	Base			GROWTH METHOD	2018 Growth Projection		
	Source	# points	NO_X (tpd)		# points	NO_X (tpd)	% Growth
NEGUs	2006 STARS	8914	519	Apply TIPI or REMI-EGAS growth factor to existing point sources that don't have existing rule limitations	8914	608	17.1
EGUs	2007 ARD	221	379	Addition of newly-permitted point sources	293	398	5.1

As explained in the controls section below, in reality, the TCEQ took this EGU growth (newly-permitted) from the CAIR cap (along with the 2001-07 new units), which affects the entire State. The TCEQ accounts for EGU growth by adding new facilities at locations where the facilities are permitted, not by growing emissions from existing facilities. The net reduction in EGU NO_X emissions is a testament to Best Available Control Technology (BACT) as implemented by the New Source Review (NSR) permitting program of the TCEQ. CAIR Phase II limitations may further reduce NO_X emissions.

Again, only a subset of the Texas attainment area sources received growth from the procedures above. Any source that had an existing rule applied to it was capped at that rule level for the future, so only the "no rule" sources had growth factors applied to them. See the next subsection for the discussion of controls.

2.3.1.2 Texas Attainment Areas 2018 Existing Controls

Existing on-the-books controls are incorporated into the 2018 future base. For the EGUs of the State, the control modeled was the EPA's Clean Air Interstate Rule (CAIR) program. For the NEGUs in the attainment areas of the State, several existing controls were modeled.

2.3.1.2.1 *EGUs*

During the process of applying CAIR in Texas to simulate 2018, the TCEQ learned that CAIR was vacated by the Court (July 2008). The TCEQ then went down the path of developing a "non-CAIR" version of the 2018 EI for the EGUs in Texas and outside of Texas, after numerous conversations with the EPA and other RPOs. As modeling staff completed the non-CAIR 2018 EI, the Court remanded CAIR back to the EPA (late December 2008). The EPA provided guidance that CAIR would still be in effect, as promulgated, until future revision or replacement. For more information on the ruling, see the EPA's CAIR webpage, http://www.epa.gov/cair/, or the TCEQ CAIR/CAMR webpage, http://www.tceq.state.tx.us/implementation/air/sip/caircamr.html. Hence, CAIR Phase II was applied for 2018. The following paragraphs describe this federal program and how the TCEQ is dealing with CAIR.

Under CAIR, 28 eastern states (plus the District of Columbia) are required to comply with a cap on sulfur dioxide (SO_2) and NO_X EGU emissions, where the definition of an "EGU" for the CAIR program is approximately the same definition as that for a Federal Clean Air Act Title IV Acid Rain unit (i.e., larger than 25 MW and more than one-third of its generation going to the public grid for sale). CAIR is a cap-and-trade program, with each of the CAIR-applicable states given a calculated NO_X budget and a calculated SO_2 budget by the EPA. The EPA modeled all

of these states in order to test the effectiveness of controls. A result of the EPA's CAIR modeling was that Texas "significantly contributed" to the nonattainment of the particulate matter of 2.5 microns and less ($PM_{2.5}$) standard of two counties in Illinois; therefore, Texas was included in CAIR for the transport of $PM_{2.5}$. Texas was not covered under the CAIR program for eight-hour ozone contribution. Texas is not part of the ozone season (May through September) NO_X budget part of CAIR, only the annual NO_X budget program. For more details on these CAIR issues, see EPA's CAIR Texas webpage, http://www.epa.gov/cair/tx.html. Arkansas and Louisiana have ozone season NO_X caps, and Oklahoma is not a CAIR state.

CAIR is implemented in two phases: for NO_X, Phase I covers the years 2009-2014 and Phase II is for the years 2015 and later; for SO_2, Phase I covers the years 2010-2014 and Phase II is for the years 2015 and later. The Phase I NO_X budget calculated and assigned to Texas was 181,014 tons per year, and the Phase II NO_X budget was 150,845. The Phase II annual NO_X budgets for all states was originally assigned to be five-sixths of the Phase I NO_X budget. Because 2018 is the HGB ozone attainment year, this SIP revision incorporates CAIR Phase II (post 2014 step-down of CAIR) which provides for a Texas state-wide NO_X budget of 150,845 tons per year, or 413.3 tons per day. Even though Phase II begins in 2015, allocations have to be provided to the EPA to populate the accounts in 2011. The CAIR allocations (and past transactions) for all relevant states can be found from the CAMD Allowances data query wizard website, http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=allowances.wizard.

For implementing EPA's CAIR program in Texas, the State Legislature mandated that TCEQ allocate 90.5% of the CAIR budget to the EGUs in the State that were operating on or before January 1, 2001 (call these "existing" units in the "general pool") for control periods 2009-2014. Those EGUs that reported emissions in 2000 and earlier were given, in aggregate, 90.5% of Texas' allocation of the CAIR NO_X budget for control periods 2009-2014. Each "existing" EGU was apportioned its allowance based on fuel type and historical (2000-2004) heat input. The remaining 9.5% of the State CAIR budget cap was set aside for "new" (post-2000) EGUs, in the "new unit pool". New units are eligible to receive allowances from the general pool starting with the 2015 control period if the new units have an appropriate baseline, as determined under 30 TAC §101.506, CAIR NO_X Allowance Allocations. The following paragraphs discuss the modeling of the "existing" EGUs and the "new" EGUs separately. Section 2.3.1.1.1, above, discussed the newly-permitted units that were added on top of these. Ultimately the newly-permitted EGUs obtain allowances from the "new unit pool" until these units have the appropriate baseline (i.e., five years of actual emissions) used for the allocation of CAIR NO_X allowances from the general pool.

For existing Acid Rain EGUs, the TCEQ applied the assigned allowance cap for each unit in the "general pool" to the hourly average day 3Q2007 data file, scaling HGB emissions by 120% and the rest of the State by 112%. This scaling is required, because the CAIR cap is an annual limit, yet summer (3rd quarter) Acid Rain NO_X emissions that are modeled in the 3Q2007 for HGB and the remainder of Texas are 20% and 12% higher than the annual average, respectively. In other words, TCEQ expects that EGUs will continue to emit these higher percentages of their total annual NO_X emissions during the summer (peak electricity demand) of 2018, which happens to be the time of the year that we are modeling (ozone season) and when we have the vast majority of monitored ozone exceedences; hence, we expect the EGUs to use these higher percentages of the cap during these times. Note that scaling the emissions affects neither the general pool cap nor the new unit pool cap; EGUs would use more of the cap during ozone season and less in the non-ozone season.

Under CAIR, when an EGU shuts down or curtails its use, the allowances for that unit can be banked for later use or sold to an EGU that needs more allowances (e.g., increased its load or capacity). If an existing EGU site wants to add a new unit to that site, it will have to operate that

new unit within the new unit pool. To obtain allowances from the new unit pool (9.5% of total Texas allocation), a site that commenced operation after January 1, 2001 must complete and submit (by May 1 of each year) the appropriate TCEQ application form each year until the new unit starts to receive its allowances from the general pool. It receives allowances from the general pool once it has established a "baseline", determined from the first five years of operation. The program's intent is for a unit to move seamlessly from the new unit pool to the general pool. If the requested amount of allowances from the new unit pool in any one year exceeds the pool allocation (9.5%, or 14,330 tons per year for 2015 and beyond), then the allowances are proportioned according to each unit's requested amount. Hence, the total new unit pool is always used completely. If the requested amount for any one year is less than the pool allocation, then those leftover allowances are distributed proportionally to the units in the general pool. Once allowances are allocated, trading can occur between any CAIR EGUs.

Under CAIR, EGUs have the option to hold, transfer or sell allowances, but at the end of each year's reconciliation period, each EGU must have enough allowances in its compliance account to cover emissions during the previous control period (previous calendar year). Hence, in reality, Texas can trade NO_X emissions with any other CAIR state, since CAIR is a federal trading program. Yet, the TCEQ assumed that Texas will not be trading with other states, because we can not predict whether Texas will have more emissions credits than it needs, or whether Texas will need to purchase emission credits from the federal CAIR annual NO_X bank in 2018.

For modeling purposes, the 9.5% set-aside cap for the "new" EGUs was applied to all post-2000 point sources that began operation in the 2001-2007 time period (as evidenced by their Acid Rain emissions) and to post-2007 EGUs that have been permitted by TCEQ (see the "newly-permitted" units of Section 2.3.1.1.1). The TCEQ distributed the new unit pool to the 2001-2007 startups at their average 3Q2007 Acid Rain emission rates divided by 1.12 for attainment county EGUs (ozone season scaling factor as described above). In actuality, according to the TCEQ CAIR rules, the first allocation of new unit allowances must be requested by July 2009, at approximately the same time the TCEQ had to finalize the modeling for these sources, and the allowances will likely equal the units' NO_X tons reported to the EPA's CAMD for 2008. Hence, the TCEQ could only model an estimate of the CAIR program and the new unit pool.

A small amount of new unit pool CAIR allowance remained after the 2001-2007 new unit distribution, and the TCEQ spread the remaining allowance among all the newly-permitted (post-2007) EGU permits according (proportional) to the modeling permitted rate, compressing their permitted NO_X rates to approximately one-quarter in order to fit within the new unit pool. Again, in actuality, the TCEQ CAIR SIP revision provides conversion timeline tables that denote that units commencing operation between January 1, 2001 and December 31, 2008 will all be in the general pool in the year 2018, assuming all units submit the required data. Yet, even newer units will be allocated new unit pool allowances by then. So, for 2018 modeling, it does not matter which pool the emissions will be in, and the TCEQ could only estimate this complex program. This modeling of the CAIR Phase II cap is made even more complicated by the MECT program in HGB; this will be discussed in a later subsection. A list of the CAIR Phase II allocations by site, in descending order of allocated tons of NO_X, is provided as Table 2.3-5: *Texas NO_X CAIR Allocations*. These are the only units for which the TCEQ has provided allowances (the 90.5% general pool). The 9.5% new pool is not allocated specifically, and not included in Table 2.3-5.

Table 2.3-5: Texas NO_X CAIR Phase II Allocations

TCEQ RN#	Site Name	ORISPL	#Units	NO_X CAIR Cap (tpy)
RN100888312	WA Parish	3470	8	11648
RN102583093	MARTIN LAKE	6146	3	10475
RN102285921	MONTICELLO	6147	3	8722
RN100213370	WELSH POWER PLANT	6139	3	7104
RN100226844	SAM SEYMOUR	6179	3	7000
RN100542927	LIMESTONE	298	2	6699
RN101198059	BIG BROWN	3497	2	5568
RN100224849	HARRINGTON STATION	6193	3	5453
RN100224534	TOLK STATION	6194	2	4909
RN100217975	JT DEELY	6181	2	3897
RN102147881	SANDOW	6648	1	2882
RN100214287	PIRKEY	7902	1	2870
RN100217975	JK SPRUCE	7097	1	2753
RN101062255	OKLAUNION	127	1	2694
RN100226919	COLETO CREEK	6178	1	2577
RN102513041	Sabine Plant	3459	5	2563
RN100226539	SAN MIGUEL	6183	1	2006
RN100825371	CEDAR BAYOU	3460	3	1897
RN101062826	PH ROBINSON	3466	4	1872
RN100214550	GIBBONS CREEK	6136	1	1843
RN100226570	TWIN OAKS POWER (TNP	7030	2	1456
RN100217033	SWEENY COGENERATION	55015	4	1422
RN102566494	TRADINGHOUSE	3506	2	1370
RN100210863	COGEN LYONDELL	50815	6	1153
RN102336906	HANDLEY	3491	6	1092
RN100664812	DeCordova	8063	5	1083
RN100218882	Lamar Power Project	55097	4	1028
RN100222041	Pasadena Cogeneratio	55047	3	1003
RN102547957	GREGORY POWER FAC	55086	2	984
RN100245539	Tenaska Frontier Gen	55062	3	966
RN100642040	BARNEY M DAVIS	4939	2	922
RN100224245	Texas City Cogenerat	52088	3	917
RN100217835	VH BRAUNIG	3612	5	892
RN100233998	Bayou Cogeneration P	10298	4	881
RN102183969	Permian Basin	3494	7	861
RN100226877	LEWIS CREEK SES	3457	2	849
RN100239672	Clear Lake Cogenerat	10741	3	840
RN102285855	VALLEY	3508	3	796
RN100224765	JONES STATION	3482	2	779
RN102596400	MIDLOTHIAN ENERGY	55091	4	777
RN102285848	Morgan Creek	3492	10	757
RN100673490	LAKE HUBBARD	3452	2	728
RN100211309	NEWMAN STATION	3456	5	702
RN101286433	Mustang Station	55065	2	697
RN100225820	GUADALUPE POWER PART	55153	3	696
RN100542885	TH Wharton	3469	14	693
RN100217298	Black Hawk Station	55064	2	685
RN100542596	WILKES	3478	3	674
RN100219872	Decker Creek	3548	6	670
RN101621449	Stryker Creek	3504	2	596
RN101559235	MOUNTAIN CREEK	3453	6	583

TCEQ RN#	Site Name	ORISPL	#Units	NO_X CAIR Cap (tpy)
RN100217975	OW SOMMERS	3611	2	548
RN100552181	NUECES BAY	3441	3	544
RN102038486	SIM GIDEON	3601	3	527
RN101559854	NORTH LAKE	3454	3	520
RN100542901	SAN JACINTO SES	7325	2	516
RN102563426	GRAHAM	3490	2	514
RN100224989	Hidalgo Energy Cente	55545	2	481
RN100825389	Sam Bertron	3468	4	438
RN102033891	RW Miller	3628	5	433
RN100224419	PLANT X	3485	4	414
RN100216555	Tenaska III TX Partn	50109	2	407
RN100223312	Ponderosa Pine Energ	54817	1	407
RN100215557	FORT PHANTOM	4938	2	393
RN100215896	CR Wing Cogeneration	52176	2	392
RN100224641	NICHOLS STATION	3484	3	363
RN100215979	LON C HILL	3440	4	358
RN100219468	TC FERGUSON	4937	1	355
RN100693308	EAGLE MOUNTAIN	3489	3	343
RN100219203	RAY OLINGER PLANT -	3576	3	341
RN102344645	Frontera Generation	55098	2	341
RN102156916	KNOX LEE	3476	4	337
RN100223395	SWEETWATER	50615	3	326
RN100216837	AES Deepwater Incorp	10670	1	278
RN100220045	HOLLY STREET	3549	4	274
RN100209766	Sabine Cogeneration	55104	2	258
RN100213909	Laredo Power Station	3439	3	250
RN100542851	Greens Bayou	3464	7	238
RN100214980	VICTORIA	3443	3	219
RN102565843	JL BATES	3438	2	216
RN101698520	Lake Creek	3502	2	211
RN101531226	SAN_ANGELO	3527	1	209
RN102688835	Rio Pecos	3526	2	150
RN100226638	ES JOSLIN	3436	1	146
RN100804301	PARKDALE	3455	3	145
RN100542992	Webster	3471	1	127
RN100542885	TH WHARTON	3469	1	124
RN101943868	Trinidad	3507	1	120
RN100215300	PAINT CREEK	3524	4	118
RN102166576	ROLAND C DANSBY POWE	6243	1	109
RN100226232	BOSQUE COUNTY PEAKIN	55172	2	103
RN102688439	Oak Creek Power Stat	3523	1	85
RN102545142	HOLLY AVE PLANT	3602	2	75
RN100214766	Spencer Station	4266	2	72
RN100784735	COLLIN	3500	1	72
RN100217611	WB TUTTLE	3613	4	65
RN100217678	J Robert Massengale	3604	1	59
RN100542877	DEEPWATER	3461	1	48
RN100215490	Copper	9	1	36
RN100219450	Silas Ray Power Plan	3559	2	30
RN102764933	NORTH MAIN	3493	1	29
RN101983344	RIVER CREST	3503	1	24
RN101612851	Bryan	3561	1	20

TCEQ RN#	Site Name	ORISPL	#Units	NO_X CAIR Cap (tpy)
RN100217439	LEON CREEK	3609	2	17
RN100224955	MOORE COUNTY	3483	1	16
RN100223023	POWERLANE UNITS 2&3	4195	2	13
RN102560687	La Palma	3442	1	13
RN100217173	MISSION ROAD	3610	1	9
RN100542620	LONE_STAR	3477	1	9
RN102528510	CE NEWMAN 5	3574	1	7
RN100226554	NEWGULF POWER	50137	1	5
RN100216993	NORTH TX STATION	3627	1	3
	SHUTDOWN SITES		29	1941

"SHUTDOWN SITES" are facilities that received an original CAIR allocation from the general pool, but have since officially shutdown. Those allocations are available for distribution among the other sites in the general pool. Additionally, other facilities that are no longer operating (e.g., have zero Acid Rain emissions), similarly, had their allocations re-distributed. Table 2.3-5, above, does not represent the emissions modeled for each of these sites, because it does not include the ozone season scaling factor for HGB or the State, nor does it include the redistribution from the shutdown units. A summary of the distribution of the general and new CAIR pools to areas of Texas is provided as Table 2.3-6: *Distribution of NO_X CAIR Allowances in Texas*.

Table 2.3-6: Distribution of NO_X CAIR Allowances in Texas

Area	Base	Modeled Allowances (tyd)		
		Existing	2001-2007	post2007
HGB	Acid Rain (hourly)	25.0		
	STARS OSD (daily)	4.9		1.3
BPA	Acid Rain (hourly)	10.0	1.3	
	STARS OSD (daily)	0.0	0.3	0.2
DFW	Acid Rain (hourly)	17.4	4.2	
	STARS OSD (daily)	0.0	0.0	0.0
Attain	Acid Rain (hourly)	361.0	17.5	
	STARS OSD (daily)	0.0	0.0	19.2

Note that the EGU portion of HGB MECT program also counts against the CAIR budget. MECT is more restrictive than CAIR (lower controlled allowable emission rate, ignoring trading), so the difference between CAIR and MECT was also modeled as a redistribution addition to CAIR EGUs. Also note that the NO_X emissions in the table do not total to the CAIR allowance, because the cap is an annual limit, and emissions are higher during ozone season. Thus, a point source should use more of its cap during the summer than in other times of the year. In the HGB region, for example, acid rain NO_X emissions are 20% higher than the annual average.

2.3.1.2.2 *NEGUs*

Several existing control programs are still expecting reductions between the baseline and 2018 in the attainment areas of the State. These include: the East Texas Combustion Rule, Agreed Orders, and the Refinery Initiative.

East Texas Combustion Rule

The East Texas Combustion rule was applied to rich-burn stationary gas-fired point source and area source engines in 33 identified attainment counties of East Texas. This Chapter 117 NO_X rule was shown to benefit DFW in a recent SIP revision. Almost three-quarters of the reductions came from point sources. Its full compliance date is not until March 2009; therefore it qualifies as an existing rule with a future (post-baseline) compliance date. If a rule has a complete (all

applicable sources) compliance date of 2006 or earlier, then compliance with the rule is assumed to have been incorporated in the baseline. To model this rule for this HGB SIP revision, the TCEQ assumed the rule was essentially a cap on the applicable sources and modeled those point sources at the 2009 rule emissions level.

Agreed Orders
Federally-enforceable emissions reductions due to agreed orders and/or consent decrees were incorporated into the 2018 point source EI. The included the Eastman and ALCOA agreed orders as were modeled in previous SIP revisions.

Refinery Initiative
Since the late 1990s, petroleum refineries have been the focus of an EPA enforcement initiative. This initiative alleges that, in general, petroleum refineries violated and/or continue to violate one or more of the following regulatory Clean Air Act provisions, or parts thereof:

- Prevention of Significant Deterioration (PSD) requirements, 40 CFR 51-52
- New Source Performance Standards (NSPS) requirements, 40 CFR 60
- Leak Detection and Repair (LDAR) requirements, 40 CFR 60,61,63
- National Emission Standards for Hazardous Air Pollutants (NESHAP) for Benzene Waste Operation, 40 CFR 61, Subpart FF

In the interest of settling these allegations, without admitting to the alleged violations, many petroleum refiners have entered into consent decrees with EPA. Since March 2000, the EPA has entered into settlements with petroleum refiners that, collectively, represent nearly 80 percent of U.S. petroleum refining capacity. According to the EPA, these settlements, covering 86 refineries in 25 states, will result in a reduction of approximately 80,000 tons per year of nitrogen oxides (NO_X) and 235,000 tons per year of sulfur dioxide (SO_2) upon full implementation. See EPA's webpage at http://www.epa.gov/compliance/resources/cases/civil/caa/oil/index.html for this and more details.

The TCEQ has not modeled any reductions for these consent decrees, because most of the agreements do not require NO_X reductions, and most of them lack enforceable requirements of quantified reductions. The TCEQ can verify that several refineries (some in HGB and BPA NAAs) have modified permits to comply with their consent decrees, but permit reductions do not always result in actual reported emission reductions.

2.3.2 Nonattainment Areas (NAAs) of Texas
The section above discussed the general growth and controls for the attainment counties of the State; this section describes the specific growth and controls applied to the three ozone NAAs: HGB, DFW, and BPA. There is much commonality between the three NAAs in the way that they were modeled; much of this section discusses the procedures used in modeling all three NAAs, with emphasis on HGB.

2.3.2.1 HGB
The area of the modeling domain demanding the highest level of detail is the HGB NAA. It also happens to be the most complex of the areas modeled, due to the number of TCEQ programs that apply to HGB. As with all the other parts of the 2018 EI, we describe the growth projections to 2018 and any existing controls that will affect the area between the baseline and 2018. DFW and BPA NAAs are discussed in subsections that follow this HGB modeling description.

2.3.2.1.1 *HGB 2018 Growth Projections*
Growth projections were applied to the baseline EI in HGB to obtain a 2018 grown EI. Different techniques were applied to the EGUs and the NEGUs. Some of these techniques are very similar to those applied to the attainment areas of the State as described in the previous section.

EGU Projections
As with the attainment areas of the State, the future base for EGUs in the NAAs of the State is the typical summer Acid Rain day having hourly emissions that are the average of all days in the third quarter of 2007 (3Q2007). As described for the attainment areas, not all EGUs are Acid Rain units. The non-Acid Rain EGUs were modeled at their 2006 ozone season daily (OSD) emissions, as if they were NEGUs.

The complete set of 2018 EGUs consists of the 3Q2007 Acid Rain EGUs, the 2006 non-Acid Rain EGUs, and post-2007 EGUs that have approved TCEQ permits. As with previous SIP revisions, TCEQ assumes that the EGU growth in the State comes from the TCEQ newly-permitted EGUs. This is a very similar assumption that the Integrated Planning Model (IPM) would make, as the EPA has used in all of its recent regional modeling studies, e.g., CAIR. In Texas, the TCEQ knows where the growth is likely to occur, via permits.

Newly-Permitted EGUs in Nonattainment Areas (NAAs)
As with the attainment areas, discussed above, some of the newly-permitted EGUs are planned to operate in the NAAs of HGB, DFW, and BPA. Table 2.3-1, above, lists all of the newly-permitted EGUs in each of the areas of the State. In fact there are thirteen newly-permitted units in HGB, two in BPA, and no units in DFW. In these areas, CAIR limitations are superceded by more stringent nonattainment NO_X rules (TCEQ Chapter 117), although all EGU emissions must fit under the CAIR cap and absorb a share of the CAIR cap. Technically, NAAs cannot grow in ozone precursors (NO_X and VOC) from major source modifications or new major sources. These emissions would need to be offset during the permitting process, either by contemporaneous creditable reductions already performed at that site, or by purchasing emissions credits from the bank. If emissions were purchased from the bank, such were included in the permit application and already removed from the bank by the time the TCEQ modeled the bank. If contemporaneous reductions were taken, then the TCEQ assume these were already accounted for in the 2006 EI or 3Q2007 Acid Rain. If the reductions were not already accounted for in a reported EI, then a worst case is being modeled by keeping those emissions in the EI and adding emissions from newly-permitted EGUs.

Specifically, in HGB, adding newly-permitted EGUs is more complex, since all EGUs (and almost all combustion sources) must comply with the HGB Chapter 117 Mass Emission Cap and Trade (MECT) program for NO_X . For each new MECT-applicable source added to HGB, the available MECT NO_X cap gets smaller, to the point that the TCEQ squeezed new MECT sources under the cap and reallocated. In reality, the MECT cap is not reallocated for every new source, but rather as some sources shutdown or reduce, their part of the MECT cap is made available for use; yet, there is no easy way to predict or model how that occurs. Instead, the TCEQ has assumed it is more important to place the new sources at the correct location with approximately the correct emissions, rather than not include them in the model at all (and assume that the cap is the cap as it existed years ago, looking back from 2018). Yet, to maintain the integrity of the cap, and model the MECT cap, the TCEQ reallocated the cap slightly to make room for the new sources.

The newly-permitted post-2007 EGUs in HGB are all MECT sources, as well as CAIR sources, and emissions from these points are reconciled with the MECT. MECT is technically a control (that will be addressed in more detail in the controls subsection), but it is a serious constraint on the growth in HGB. The HGB modeled NO_X emissions of Table 2.3-1 reflect MECT, absorbing part of that cap, while also absorbing their share of the CAIR cap.

NEGU Projections

The basis for future growth for NEGUs in the Texas NAAs was the 2006 OSD emissions, already an average ozone season day – the 2006 baseline. No individual new permits were modeled as growth for NEGUs, except in BPA (see Section 2.3.2.2.1). Emissions from NEGUs in the NAAs of the state were projected to 2018 using the higher of the TIPI-REMI-EGAS factors (as described in the previous section) or the emission credits in the bank (described in the following paragraphs), except for HGB NO_X, which is tightly regulated under the MECT program.

Again, technically, ozone nonattainment counties can not grow (expand facilities) in major sources of emissions of ozone precursors, NO_X and VOC, except by purchasing from the bank to obtain emissions offsets during New Source Review of permit applications or by sitewide contemporaneous period reductions. The TCEQ has assumed that all of the emissions in the bank can come back into the airshed. As in previous TCEQ SIP modeling, the TCEQ has assumed the worst case -- that all the emissions in the TCEQ Emissions Banking and Trading (EBT) Registry can be emitted into the airshed during the ozone season of 2018, without expiration of any of the credits in the bank. The exception to this is HGB NO_X.

The procedure for incorporating the banked emissions in the future base is as follows. Banked emissions were extracted from the TCEQ's EBT Emission Reduction Credit (ERC) and Discrete Emission Reduction Credit (DERC) Registries, which can be found on EBT's Registry webpage: http://www5.tceq.state.tx.us/airperm/index.cfm?fuseaction=registry.registry .
ERC and DERC totals for each of the NAAs, as of October 2009, were extracted, tabulated, and summarized in a spreadsheet. According to 30 TAC §101.378, DERCs generated from shutdown strategies prior to September 30, 2002 are no longer available after September 8, 2010. Hence, these retiring DERCs were removed from the HGB modelable total for 2018. Table 2.3-7: *Banked Emissions as of October 2009* summarizes these results.

Table 2.3-7: Banked Emissions as of October 2009

NAA	ERCs		DERCs			Total Bank Modelable		
	NO_X (tpy)	VOC (tpy)	NO_X (tons)	VOC (tons)	CO (tons)	NO_X (tpd)	VOC (tpd)	CO (tpd)
HGB Registry	41.5	1044.9	48765.1	1050.0	1488.4			
HGB Modelable	36.1	908.6	1000.0	945.0	1339.6	9.6	5.1	3.7
BPA Registry	1179.1	134.0	2926.4	0	2591.8			
BPA Modelable	1071.9	121.8	2633.8	0.0	2332.6	10.2	0.3	6.4
DFW Registry	616.1	203.9	9084.7	5.0	0			
DFW Modelable	535.7	177.3	8176.2	4.5	0.0	23.9	0.5	0.0

"Modelable" emissions in Table 2.3-7 refers to the maximum amount of emissions that could be added as growth to the area from banked emissions (with the exception of HGB as noted below).

Chapter 101 of 30 TAC requires that an ERC must be surplus to any federal, state or local rule. Also, the Chapter 101 MECT program DERC-use restrictions for HGB were incorporated in the NO_X total. The recent DFW DERC-use restrictions were not modeled, as we have no idea what will be necessary in 2018, as that rule dealt with 2009, so the full DERC registry was modeled for DFW as worst case. The totals indicated in Table 2.3-7 incorporate the originally-designated eight-hour ozone offset ratios (for worst case) for each of the NAAs, where an offset ratio of 1.15:1 for moderate areas indicates that the purchaser of ERCs must buy 11.5 ton per year of credits for each 10 tons per year of increase proposed. Additionally, the modeled bank took into account the requirement of Chapter 101 to retire 10 percent of the DERCs, as an environmental contribution, upon DERC usage.

The HGB MECT program limits the amount of NO_X from all applicable sources with a cap. Yet, in HGB, DERCs can be used to comply with MECT during the control period, up to a maximum of 10,000 but at a 10:1 usage ratio -- hence the 1000 tons of modelable HGB DERCs listed in Table 2.3-7. This provides for some growth in the MECT Cap, up to 2.74 tpd NO_X (1000/365). This growth in MECT was attributed back to all MECT sources based on their portion of the overall cap.

There are many MECT-exempt sources, sources of NO_X within HGB that are specifically exempt from the MECT program. These were separated into an AFS file processing stream of their own. These MECT-exempt sources were allowed to grow as part of the "no rules" sources, since their NO_X is not capped. Minor modifications can still occur to these MECT-exempt sources, and permits by rule (PBRs) may still allow new sources to come online within the NAAs. By adding the banked emissions back into the airshed and assuming the banked emissions can reappear in the airshed during the attainment year, this procedure is very likely overpredicting emissions growth. For HGB NO_X, the TCEQ has assumed that this bank (both ERCs and DERCs) growth will be limited by the amount of TIPI or REMI-EGAS growth predicted by the larger of the indexes. Table 2.3-7, above, represents this overall growth in HGB. Hence, the 9.6 tpd is the sum of the ERCs and MECT-convertible DERCs divided by 365, plus the remainder of DERCs limited by the predicted TIPI/REMI-EGAS growth.

For the other HGB pollutants and the rest of the NAAs, the TCEQ modeled even more margin of safety, erring on the side of more growth is better than not enough (an approach EPA prefers), by including as growth the greater of the banked emissions or the combined TIPI/REMI-EGAS factors for each path for each of the NAAs, excluding MECT sources, where TIPI/REMI-EGAS is the larger of the TIPI or REMI-EGAS growth factors, as described in the previous section. Table 2.3-8: *Texas NEGU Growth Summary* shows the growth projected in each of the NAAs from each of the indexes. Again, the growth was only applied to the sources that were not already limited by existing TCEQ SIP rules.

Table 2.3-8: Texas NEGU "No-Rules" Growth Summary

		NO_X (tpd)		VOC (tpd)	
Area	**Projection Index**	**2006 STARS**	**2018**	**2006 STARS**	**2018**
HGB	from EGAS	3.1	3.7	22.2	27.8
	from TIPI	15.7	21.8	135.0	166.4
BPA	from EGAS	7.9	9.1	3.0	3.7
	from TIPI	31.5	45.3	73.0	102.7
DFW	from EGAS	8.3	9.9	24.5	30.8
	from TIPI	2.6	3.2	11.0	15.5
Attain	from EGAS	315.8	357.4	94.5	112.0
	from TIPI	193.8	248.5	134.4	182.2

Again, the comparison between the bank and the TIPI/REMI-EGAS was performed on a path-by-path basis, and was automated with SAS programming. The bank growth in each NAA was the bank divided by the total emissions in the NAA. A path's share of the bank was based on its fractional emissions of the total, and was added to that path. Again, only the "no rule" paths were allowed to grow via the bank or TIPI/REMI-EGAS. A few examples of the results of this process for HGB are provided in Table 2.3-9: *Sample Growth Applied to HGB Paths*.

Table 2.3-9: Sample Growth Applied to HGB Paths

Owner/Site Name	FIN	EPN	FIN Profile	NO_X Emissions (tpd)				
				2006	2006 to 2018 Growth Projection			2018
					TIPI	EGAS	BANK	
TEXAS PETROLEUM INVESTMENT ANAHUAC COMPRESSOR STATION	RB1	RB1	BOILER	0.0023	0.0002	0.0002	0.0002	0.0002
TEXAS PETROLEUM INVESTMENT ANAHUAC COMPRESSOR STATION	RB2	RB2	BOILER	0.0023	0.0002	0.0002	0.0002	0.0002
TEXAS EASTERN TRANSMISSION MT. BELVIEU COMPRESSOR ST	UNIT-6	UNIT-6	I.C. ENGINE	0.0004	0.0004	0.0004	0.0004	0.0004
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	THERM OX	428	INCINER ATOR	0.0490	0.0783	0.0782	0.0490	0.0783
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	BOIL4	129	BOILER	0.0020	0.0032	0.0021	0.0020	0.0032
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	HFTREA T	419	HEATER	0.0001	0.0001	0.0001	0.0001	0.0001
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	DFP	448	I.C. ENGINE	0.0003	0.0005	0.0005	0.0003	0.0005
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	B1GEN	451	I.C. ENGINE	0.0015	0.0024	0.0016	0.0015	0.0024
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	CES GEN	453	I.C. ENGINE	0.0005	0.0008	0.0005	0.0005	0.0008
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	B2GEN	226	I.C. ENGINE	0.0009	0.0014	0.0010	0.0009	0.0014
TEXAS INSTRUMENTS INC TEXAS INSTRUMENTS STAFFORD	BOIL8	332	BOILER	0.0003	0.0004	0.0003	0.0003	0.0004

Although Table 2.3-9 provides a NO_X example for selected paths in HGB, the same procedure applies to other paths in HGB, paths in BPA and DFW, and to VOC and CO emissions in the three nonattainment areas. In attainment areas (outside HGB, DFW and BPA), growth was based on the larger of TIPI or REMI-EGAS, as described in the subsection above. Results of this procedure include:

- DFW NO_X growth came almost exclusively (all but one path) from the bank, as alluded to earlier, due to the many accumulated DERCs.
- DFW VOC growth was split between TIPI and the bank.
- BPA and HGB growth was split between TIPI and the bank.
- MECT NO_X was capped (not grown, except as noted above).
- VOC and CO for MECT paths was allowed to grow.
- HECT HRVOC was capped (not grown).
- MECT-exempt paths were allowed to grow. (Exempt paths are point sources in MECT accounts, but are not one of the points limited by the cap.)

The HRVOC Reconciliation emissions (via the PSCF technique) were not grown to 2018. See the *2018 Reconciled HRVOC* subsection below.

The Tank Landing Loss emissions in HGB are only expected to become less with time and were not grown to 2018.

Again, any source that had an existing rule applied to it was capped at that rule level for the future, so only the "no rule" sources had growth factors applied to them.

2.3.2.1.2 *HGB Existing (Future Base) Controls for 2018*

The existing NO_X rules for HGB, most notably the Chapter 117 MECT program, has been discussed in some context in the above sections, and will be discussed a bit more here. The primary existing VOC program is the HRVOC Emission Cap and Trade (HECT) program, where HRVOC is defined in Ch. 115 to be the Highly Reactive VOC compounds: ethylene, propylene, 1,3-butadiene, and the butenes. As in the above sections, these control programs are on-the-books rules for which the final compliance dates are after the baseline year and prior to 2018. Again, these will be discussed in terms of their effects on EGUs and NEGUs.

EGUs

As discussed above, CAIR applies to all the EGUs in the entire state, but in HGB, the Mass Emission Cap and Trade (MECT) program also applies to EGUs. MECT is more restrictive than CAIR, since MECT applies to almost all of the NO_X sources at an EGU account, and MECT defines a lower NO_X standard that must be met. MECT NO_X annual allowances are provided on an emissions unit (FIN) basis. Essentially, every NO_X-emitting FIN at an EGU account is covered under the MECT program, except for maybe the smallest of engines.

Trades can also be conducted under MECT, when a NO_X-emitting unit subject to the program emits more NO_X for the year than it had allowances for that year, and when another MECT-applicable unit did not use its allowances of NO_X and wishes to sell some of its allowances. A modeling snapshot of the EI might indicate that not all the MECT cap is being used, so the TCEQ increased all the modeled MECT units to the MECT cap, since that's the amount of NO_X each FIN could ultimately emit.

Since the CAIR NO_X allocations are generally so much greater than the MECT allowances on the same units, a surplus CAIR allowance is actually generated by applying the more restrictive MECT limit for units in HGB. This CAIR NO_X "credit" can then made available for use by other CAIR EGUs in the State outside HGB, allocated proportionally by their CAIR allowance for modeling purposes; whereas, in reality this CAIR credit will not be equally portioned out,

because of trading and differing NO_X control strategies. These weren't actually reallocated by the TCEQ, since the CAIR cap was applied after the MECT cap was applied. The caps were modeled. For example, Clear Lake Cogeneration, RN100239672, in Harris County receives 474.6 NO_X tons of MECT allowances each year. This site will also receives a total of 840 NO_X tons of CAIR annual allowances from 2009 through 2014. Because the MECT program is more stringent, the 474.6 number was modeled. The additional CAIR annual allowances (365.4 NO_X tons) are then available for trade or retained for use in future control periods.

The MECT allowances were allocated on a unit basis, because each type of equipment has a specific Chapter 117 ESAD (Emission Standard for Attainment Demonstration). Hence, this generation of CAIR NO_X credits from HGB (and the other NAAs also, but to a lesser extent) will help Texas attain the CAIR Phase II cap, because units in the less-strictly-regulated attainment areas of the state will be able to use (purchase) these.

As discussed in previous subsections, for the Acid Rain EGUs ("ARD"), the TCEQ used the hourly average 3Q2007 NO_X emissions (and scaled the VOC and CO) for the entire State, including HGB. For the non-Acid Rain units, the TCEQ used the 2006 OSD base emissions as the starting point. The MECT compliance date for all the MECT-specific 11 EGF (Electric Generating Facilities) accounts was May 2005 (or after the reconciliation period for 2004); therefore, all of these units were assumed to be already complying with MECT. The non-11 EGF accounts technically had until April 2008, the date of the final MECT NO_X phased step-down reconciliation period, to comply with MECT, but likely all were actually complying by the third quarter of 2007, or were complying in aggregate (since it is a cap and trade program).

Again, a modeling snapshot of the EI indicated that not all the MECT cap was being used, so the TCEQ assigned the MECT cap to each path, with the left-over cap applied to the post-2006 MECT paths. The EGU growth was first applied. All of the Newly-Permitted (post-2007) EGUs in HGB will have to comply with MECT, as well as CAIR, and emissions from these points were reconciled with (credited against) MECT by forcing these thirteen newly-permitted units (see Table 2.3-1) under MECT, and reallocating the MECT cap. After the addition of these newly-permitted EGUs under the MECT cap, there was a very small amount of MECT cap still left (about 6.7 NO_X tpd) that was distributed between approximately 1950 NEGU (non-ARD) MECT paths.

NEGU Future Base Controls in HGB

MECT applies to many more NEGU paths in HGB than EGU paths. The future base emissions for all of the NEGUs (except HECT sources – see next paragraph) were taken from their 2006 OSD emission rates. The final phase (after reconciliation) of the MECT cap step-down for NEGUs was April 2008, so there was still time for the units to reach overall compliance levels; therefore, the TCEQ could not assume that MECT had total compliance by 2006. Instead, the TCEQ brought the overall non-Acid Rain MECT units to the level of the MECT cap by scaling the 2006 emissions for each MECT-applicable path, according to its final MECT compliance allowance, resulting in each path being placed at its MECT cap, and the left-over allocated between those units as MECT growth. These excess MECT allotments are available for purchase by one or more of the existing MECT cap owners, or the allotment can be purchased in the future by a new point source. Distributing the cap among existing points spreads the excess over the entire area while assuring that TCEQ is modeling the MECT cap. In reality, the final MECT amount for each FIN in not known, since there are still flexible and allowable allowances that are being converted to actuals (certifying five years of actual operating emissions for a MECT baseline). The TCEQ modeling can only simulate the MECT program (as with CAIR) with a snapshot of data, yet modeling has incorporated all of the allowables-to-actuals "recertifications" from the TCEQ EBT program as of November 2009.

The other cap-and-trade program within HGB that applies to NEGUs is the HRVOC Emissions Cap and Trade (HECT) program. The compounds specifically regulated by HECT are the four HRVOC species: ethylene, propylene, 1,3-butadiene, and the butenes, where butenes includes all isomers of butene.

The background and speciation procedure for the HRVOC (see the base case speciation of Section 2.1) and the HECT cap have been provided in a presentation that was given at the 17th Annual International EI Conference, in Portland, Oregon, in 2008. The presentation can be found at the conference webpage, http://www.epa.gov/ttn/chief/conference/ei17/session6/thomas_pres.pdf, and the detailed paper from the conference proceedings can be found at http://www.epa.gov/ttn/chief/conference/ei17/session6/thomas.pdf

The TCEQ recently improved the speciation procedure for the HECT sources, as described in the base case modeling in Section 2.1.

HECT-applicable units include units in Harris County that emit HRVOC from point sources that are flares, process vent stacks, or cooling towers that have the potential to emit more than ten tons per year of HRVOC. Smaller sites in Harris County could opt-in to the HECT program. These are all primary sources, not secondary (e.g., result of combustion byproducts) HRVOC emissions. HECT allowances were allocated to applicable sites in proportion to the site's level of activity, determined from each site's selection of a twelve-consecutive-month baseline from 2000 through 2004. HECT sites were given the greater of 5.0 tons of HECT allowances or the allocation from the site, determined from using the equation listed in 30 TAC §101.394(a)(1). This procedure has recently been updated ("reallocated") via rule changes brought forth to the Commissioners for proposal. These rule changes will be discussed in Section 2.4, below. HECT participants report the total HRVOC emissions from qualifying point sources. Again, this is a trading program, so HECT-applicable sites may bank or trade HRVOC between other HECT sites, as long as the account is reconciled at or below its allowance level before the end of the HECT reconciliation period each year.

Modeling the 2018 future case HECT involved calculating the HRVOC emissions for each source based on composition and total flow rate, allocating the cap to points in accounts that have an allowance, and distributing any unused portion (due to shutdowns, primarily) of the cap to points in other HECT-qualifying accounts that do not have a cap. The first step was to match the 2006 modeled HECT paths to the tabulated HECT allowances. For HECT cap accounts, the TCEQ distributed the HRVOC cap between the qualifying HECT paths within the account, based on their total (all four species) HRVOC emission rate. Only the HRVOC components of the VOC emissions records were "controlled"; the flow rate of all other (non-HRVOC) constituents remained unchanged. Thus, a change in HRVOC emissions – due to "control" to the HECT allocation limit -- required a change in the VOC record of the modeled AFS file and the speciation profile (composition) for each of the HECT-applicable path of all of the HECT accounts. For vacated HECT accounts – accounts shutdown or otherwise not reporting HRVOC emissions – the unused cap is available to distribute ("sell") to 2006 HECT accounts that exceeded their allowance for that control period (calendar year). The TCEQ distributed these left-over HRVOC emissions to paths based (proportionally) on the reported 2006 HRVOC emissions rate. A summary of the 2006 reported HRVOC emissions and the HECT Cap for all of the HECT accounts (applicable in Harris County only) is provided as Table 2.3-10: *HECT Accounts*. Note that the totals at the bottom of the table for HECT Cap and modeled HRVOC Emissions are identical. Also note that each HECT account is actually modeled at somewhat higher HRVOC than allocated by the Cap, due to the fact that the HRVOC allowances for those accounts that reported zero emissions in 2006 accounts have been allocated to all the HECT accounts that did report VOC emissions in 2006.

Table 2.3-10: HECT Accounts

RN	Owner	HECT Cap (tpd)	# HECT allocated paths	Total VOC Emissions (tpd)		HRVOC Emissions (tpd)	
				Reported 2006	2018	Reported 2006	2018
RN100210319	EQUISTAR LYONDELL CH	0.2782	11	1.2338	0.8016	0.7170	0.2849
RN100210806	INTERCONTINENTAL TER	0.0364	4	0.0346	0.0372	0.0346	0.0372
RN100211879	SHELL OIL DEER PARK	0.9601	60	1.0938	1.5443	0.5326	0.9831
RN100212109	TOTAL PETROCHEMICALS	0.3226	120	2.1981	1.0517	1.4767	0.3303
RN100213958	Georgia Gulf Pasaden	0.0505	4	0.0243	0.0643	0.0117	0.0517
RN100214212	Targa Galena Park	0.0433	2	0.1246	0.1203	0.0486	0.0443
RN100216761	Basell Bayport	0.2057	5	0.5367	0.4134	0.3339	0.2107
RN100218130	Lyondell Citgo Houst	0.3046	42	0.8973	1.0801	0.1290	0.3119
RN100218247	Albemarle	0.0139	9	0.1014	0.0575	0.0581	0.0142
RN100218411	Odjfell Terminals	0.0139					
RN100218841	Kaneka Texas	0.0139	4	0.1418	0.1272	0.0288	0.0142
RN100219237	Johann Haltermann 1	0.0139	2	0.0033	0.0157	0.0018	0.0142
RN100219310	Valero Houston Refin	0.3268	24	0.3461	0.5680	0.1127	0.3346
RN100219526	Texas Petrochemicals	0.5275	6	0.2110	0.6602	0.0909	0.5401
RN100221589	Lubrizol Corporation	0.0264	10	0.0142	0.0370	0.0042	0.0270
RN100224450	Millenium LaPorte	0.0289	3	0.0643	0.0538	0.0401	0.0296
RN100225085	DuPont LaPorte	0.0455	6	0.0889	0.0891	0.0464	0.0466
RN100225689	BASF Pasadena	0.0236	4	0.0951	0.0983	0.0210	0.0242
RN100227016	Celanese Clear Lake	0.0719	16	0.1547	0.1055	0.1229	0.0736
RN100229905	INEOS Polyethylene	0.1788	9	0.4669	0.4122	0.2378	0.1831
RN100524008	Sunoco Bayport Polyp	0.0494	9	0.3349	0.1406	0.2448	0.0506
RN100542224	Nova Chemicals Baypo	0.0322	1	0.0162	0.0491	0.00002	0.0330
RN100542281	Equistar Channelview	1.2092	13	2.7993	3.0360	1.0013	1.2381
RN100633650	Lyondell Channelview	0.3207	11	0.5241	0.7567	0.0957	0.3283
RN100683952	NATURAL GAS ODORIZIN	0.0139	2	0.0119	0.0142	0.0119	0.0142
RN100716661	Pasadena Refining	0.1666	20	1.4590	1.3745	0.2551	0.1706
RN100870898	Goodyear Houston Che	0.0361	9	0.2595	0.2796	0.0168	0.0370
RN100909373	Total Bayport HDPE	0.0805	14	0.1536	0.2015	0.0345	0.0824

RN	Owner	HECT Cap (tpd)	# HECT allocated paths	Total VOC Emissions (tpd)		HRVOC Emissions (tpd)	
				Reported 2006	2018	Reported 2006	2018
RN101041598	LBC Houston Bayport	0.0139					
RN101058410	Lubrizol Corporation	0.0139	1	0.0005	0.0147	0.00003	0.0142
RN101379287	American Acryl Pasad	0.0139					
RN102018322	Cheveron Phillips	0.2488	56	1.0478	0.9894	0.3132	0.2547
RN102204211	Kirby Inland Marine	0.0230	1	0.0959	0.0533	0.0661	0.0236
RN102212925	ExxonMobil Baytown O	0.7933	30	2.4220	2.1283	1.1058	0.8122
RN102523107	Lyondell Chemical Ba	0.1083	5	0.3474	0.3873	0.0709	0.1109
RN102537289	INEOS Polypropylene	0.1088	3	0.3851	0.2227	0.2738	0.1114
RN102574803	ExxonMobil Baytown C	0.5317	32	0.5216	0.7667	0.2993	0.5444
RN102579307	ExxonMobil Baytown R	1.1759	142	4.0044	4.7524	0.4560	1.2039
RN102580834	Enterprise HSC	0.0139					
RN102608932	GOODYEAR TIRE & RUBB	0.0139	1	0.0012	0.0153	0.0001	0.0142
RN102610912	HALTERMANN	0.0139					
RN102887270	Nisseki Bayport	0.0139					
RN102888328	Sunoco LaPorte	0.1116	4	0.1261	0.1232	0.1172	0.1143
RN102926920	Equistar Bayport	0.0514	3	0.0368	0.0696	0.0198	0.0526
RN102940103	ENTERPRISE PRODUCTS	0.0139					
RN103773206	EQUISTAR (Sunoco) Ba	0.0572					
RN103919817	Chevron Phillips Ced	0.6739	21	1.1841	1.3288	0.5453	0.6900
RN104150123	Dow Chemical Clear Lake	0.0661					
	TOTALS =	**9.4562**		**23.5619**	**24.0415**	**8.9765**	**9.4562**

2018 Reconciled HRVOC
2006 was the first full year for reporting of monitored HRVOC, as required by 30 TAC Chapter 115. Additionally, 2006 was the year of the HRVOC survey. Section 2.2.1.2 above showed that a total of 19.29 tpd of HRVOC were added to grid cells in HGB as the reconciled HRVOC (extra olefins). Of this, 9.03 tpd of the reconciled HRVOC were covered by the HECT program in Harris County.

TCEQ analysis showed that approximately 60% of the HRVOC in Harris County are covered by HECT (non-fugitive). If we assume that HECT will control (or has already controlled) all the non-fugitive HRVOC in Harris County, then 60% of the Harris Co reconciled (extra olefin) HRVOC will be gone in the future, given that we're already modeling the HECT cap in Harris County. Putting all of this together, the TCEQ modeled the reconciled HRVOC in the 2018 future case by multiplying emissions in the 2006 "extra olefins" file by 0.4065 to remove the estimated 60% that come from HECT point sources. Thus, there is no 2018 extra olefins AFS modeling file, just the 2006 file and the reduction factor that converts the emissions to 2018.

2018 Tank Landing Losses (TLL)
The emissions used for the hourly TLL for this 2018 future base is the same as the baseline: the sum of the three 2006 episodes divided by the number of days of the three episodes, for each hour.

It is likely that future VOC reductions will be actualized from the Chapter 115 rules (compliance date of January 1, 2009) that limit "convenient" floating roof tank landings, as witnessed from TLL decreasing trends reported for the years 2004-2007, as sites were made aware of the reporting problem and the rule. Yet it is difficult to quantify the emissions reductions expected from these "best practices" improvements at these accounts. The number of landings per year will decrease, but not necessarily the magnitude of the emissions on any given day. Hence, the TCEQ decided to take no "credit" for any future convenience landing reductions that may be made at the accounts discussed in Section 2.1.1.7.3.

HGB 2018 EI Summary
In summary, for HGB, the future base EI is composed of two datasets: hourly average 3Q2007 for the ARDs and 2006 OSD for the HECT sources and the remainder of the point sources in HGB. The 2018 future base is built upon these datasets by incorporating the changes expected due to growth and emission caps. Table 2.3-11: *Detailed NO_X and VOC 2018 Emissions Summary by Area* provides a 2018 emissions summary for HGB.

Table 2.3-11: Detailed NO_X and VOC 2018 Emissions Summary by Area

Detailed NOx Emissions (tpd)					
Region	**Projection**	**Affected Sources**	**2006 STARS**	**2007 ARD**	**2018**
HGB	MECT	OSDs getting MECT CAP	105.99		84.22
	"	ARDs getting MECT CAP		49.65	36.52
	Permitted Growth	Post-2007 EGUs in MECT			1.32
	"	Cap available for growth			6.75
	nonMECT Growth	from TIPI	15.69		21.85
	"	from EGAS	3.07		3.69
	"	from BANK	0.01		0.01
BPA	CAIR	ARDS, existing in 2000		9.36	9.97
	"	OSDs, existing in 2000	0.26		0.26
	"	ARDs, 2000-2007		1.31	1.31
	Permitted Growth	Post-2007 EGUs			0.19
	Controls	BPA NO_X Controls	18.61		19.28
	nonCAIR Growth	from TIPI	31.46		45.28
	"	from EGAS	7.90		9.12
	"	from BANK	0.00		0.00
DFW	CAIR	ARDs, existing in 2000		5.00	17.44
	"	ARDS, 2000-2007		4.23	4.23
	Permitted Growth	Post-2007 EGUs			0.00
	Controls	DFW major NO_X	8.69		4.34
	"	Midlothian Kilns Cap	21.99		16.37
	nonCAIR Growth	from TIPI	2.57		3.18
	"	from EGAS	8.28		9.86
	"	from BANK	0.00		0.00
ATTAIN	CAIR	ARDS, existing in 2000		429.84	360.96
	"	ARDs, 2000-2007		17.54	17.54
	"	OSDs in CAIR	4.31		1.14
	Permitted Growth	Post-2007 EGUs			19.19
	Controls	ETX Combustion NO_X	5.48		1.02
	nonCAIR Growth	from TIPI	193.84		248.47
	"	from EGAS	315.77		357.41
		TOTAL =	1260.86		1300.92

Detailed VOC Emissions (tpd)					
Region	**Projection**	**Affected Sources**	**2006 STARS**	**2007 ARD**	**2018**
HGB	HECT HRVOC	Harris Co. HRVOC	23.56		24.04
	Reconciliation	Extra Alkenes (PSCF)	19.29		7.84
	Growth	Tank Landing Losses			6.55
	Growth	from TIPI	135.03		166.44
	"	from EGAS	22.18		27.82
	"	from BANK	0.05		0.05
	CAIR	ARDs (NO_X/VOC ratio)		2.76	2.76
	Permitted Growth	Post-2007 EGUs			3.63
BPA	Growth	from TIPI	73.03		102.66
	"	from EGAS	3.05		3.74
	"	from BANK	0.00		0.00
	CAIR	ARDs (NO_X/VOC ratio)		0.79	0.79
	Permitted Growth	Post-2007 EGUs			0.24
DFW	Controls	Midlothian Kilns Cap	1.81		2.00
	Growth	from TIPI	11.01		15.46
	"	from EGAS	24.45		30.84
	"	from BANK	0.00		0.00
	CAIR	ARDs (NO_X/VOC ratio)		0.43	0.43
ATTAIN	Growth	from TIPI	134.40		182.24
	"	from EGAS	94.47		111.96
	CAIR	ARDs (NO_X/VOC ratio)		11.49	11.49
	Permitted Growth	Post-2007 EGUs			20.44
		TOTAL =	557.87		719.05

2.3.2.2 BPA and DFW Nonattainment Areas

As stated in the previous subsection, there is much commonality in how HGB, BPA, and DFW were modeled, so much of this subsection refers to the procedural descriptions above. This subsection describes the growth projections to 2018 and any existing controls that affect the BPA and DFW NAAs between the baseline and 2018.

2.3.2.2.1 *BPA and DFW 2018 Growth Projections*

Growth projections were applied to the baseline EI for BPA and DFW to obtain a 2018 grown EI. Different techniques were applied to the EGUs/ARDs and the NEGUs.

EGU Projections

The complete set of 2018 EGUs consists of the 3Q2007 ARD EGUs, the 2006 non-Acid Rain EGUs, and post-2007 EGUs that have approved TCEQ permits. As documented in previous sections above, TCEQ assumes that the EGU growth in the State comes from the TCEQ newly-permitted EGUs. Table 2.3-1, above, lists all of the newly-permitted EGUs in the NAAs -- none in DFW and one project (two units) in BPA. As in all areas of the State, these units must fit within the CAIR cap (discussed below as a control).

NEGU Projections
As with HGB and the rest of the State, the basis for future growth for NEGUs in BPA and DFW NAAs was the 2006 OSD emissions, already an average day in the ozone season. As with HGB, no individual new permits were modeled as growth for NEGUs, except the known refinery expansions for BPA that were already quantified in a recent SIP revision (see discussion below). Additionally, as with HGB, the other NAAs were projected to 2018 using the greater of the TIPI/REMI-EGAS factors or the emission credits in the bank. Table 2.3-7, above, provides the banked emissions for BPA and DFW individually. Table 2.3-8, above, provides the TIPI/REMI-EGAS growth factors applicable to BPA and DFW individually. See Section 2.3.2.1.1 for discussion and results of these procedures.

Note that by adding the banked emissions back into the airshed and assuming all of the banked emissions can reappear in the airshed during and just prior to the attainment date, this procedure likely overpredicts emissions growth, especially in DFW, where the NO_X bank credits (refer to Table 2.3-7) represents approximately a 50percent growth factor for the NEGUs. The DFW DERC-use restrictions, developed for the recent DFW SIP revision and codified in Chapter 101, were not accounted-for in this modeling, since we do not know what will be necessary in 2018; hence, the full DERC registry was modeled for DFW as worst case.

As with HGB and the rest of the State, any source that had an existing rule applied to it was capped at that rule level for the future, so only the "no rule" sources had growth factors applied to them.

Known Refinery Expansions in BPA
Three refineries in BPA have proposed increasing daily production levels, according to recent permit actions. Motiva Enterprises, LLC (Motiva) is doubling the capacity at its Port Arthur refinery to 600,000 barrels per day, the Premcor Refining Group (Valero) is expanding its capacity to 420,000 from 300,000 barrels per day, and Total Petrochemicals USA Incorporated (Total) is increasing the capacity of its Port Arthur refinery by 50,000 barrels per day. The following paragraphs and resultant projections were implemented first in the December 2008 BPA SIP revision and are applicable to this SIP revision as well. The details can be found in Appendix E of that BPA SIP revision, at
http://www.tceq.state.tx.us/assets/public/implementation/air/sip/bpa/App_E_pro.pdf .

To account for the expansion at these refineries, projected emissions were developed by multiplying the 2005 actual emissions by the ratio of the future allowable emissions to the 2005 allowable emissions. This is consistent with the recent BPA Maintenance Plan. For sites where future allowable emissions appeared to decrease compared to the 2005 allowable emissions, no change from 2005 actual emissions was projected. These data were arrived at via detailed permit reviews to collect 2005 allowable emissions data from available New Source Review (NSR) permits that authorize ozone precursor emissions for the sites. Future allowable data associated with the Motiva and Total refineries were obtained from a TCEQ contract with Environ (contract number 582-07-84005-FY08-08). For Valero, sitewide emissions were determined from flexible permit 6825A and a table of exempted units provided by the Air Permits Division. While it is true that permit allowable increases percentages generally will not be the same as the future actual emissions increase percentages, modeling these percentage increases should provide a good estimate. Table 2.3-12: *Permitted Refinery Expansions* is a summary of the findings that were modeled, where "Allowable ratio" is the growth factor applied to that account. These emissions were not further grown or controlled for this 2018 case.

Table 2.3-12: Permitted Refinery Expansions

Company	2005 tpd		Allowable ratio	
	NO_X	VOC	NO_X	VOC
Motiva	6.73	3.69	1.00	1.30
Total	2.19	1.39	1.04	1.23
Valero	5.42	1.10	1.00	1.18

2.3.2.2.2 *BPA and DFW Existing (Future Base) Controls for 2018*

There are several existing NO_X rules for BPA and DFW, most notably Chapter 117 NO_X rules that were previously implemented via SIP rules in each NAA for attainment demonstration. Additionally, there are Agreed Orders for BPA and a Cement Kiln cap to apply for DFW. The most recent BPA attainment demonstration SIP revision and its associated rules were adopted by the Commission in September 2005. The most recent DFW attainment demonstration SIP revision was adopted by the Commission in May 2007. As in the above sections, these control programs are on-the-books rules for which the final compliance dates are after the baseline year and prior to 2018. Again, these will be discussed in terms of their effects on EGUs/ARDs and NEGUs.

EGUs

As discussed above, CAIR applies to all the EGUs in the entire state, but in BPA and DFW, more restrictive emissions limits were placed on EGUs via Chapter 117 NO_X rules. Yet, all of these rules for EGUs were already in place with a compliance date prior to the 3Q2007 baseline for the Acid Rain EGUs. The exception to this is a recent NO_X rule for DFW EGUs that was expected to achieve only a small amount of reductions. For the non-Acid Rain EGUs, the baseline is 2006. The TCEQ has assumed no EGU reductions for BPA and DFW.

NEGUs

This subsection discusses the modeling of two sets of existing control programs for BPA and three sets for DFW. These were modeled as essentially a cap on the specific sources affected. We start with the oldest and work to the most recent.

BPA Agreed Orders

A sites-specific SIP revision adopted by the Commission in December 2004 was approved to make federally enforceable certain voluntary emissions reductions, projects, or activities by six BPA companies at eight sites. Most of these were through permit revisions. The TCEQ determined the ones that were likely to produce actual emissions reductions, not just reductions in permit allowables. See http://www.tceq.state.tx.us/assets/public/implementation/air/sip/agreements/bpa_ao_sip_041217.pdf and http://www.tceq.state.tx.us/implementation/air/sip/dec2004bpa.html .

The reductions modeled were the ones that provided "shutdown equipment" language in the Agreed Order. These were the same ones modeled for the most recent DFW SIP revision that represented Agreed Orders for three companies in Jefferson County: Premcor, Exxon Chemicals, and Motiva. These reductions were generally not in place by 2005, so these were modeled as reductions that will occur prior to 2018.

BPA Chapter 117 Rules

The TCEQ applied Chapter 117 NO_X emissions limits to BPA point sources over 25 tpy, as specified in the most recent BPA Attainment Demonstration with rules package.

DFW 5% IOP Rules
The DFW 5% Increment of Progress (IOP) SIP revision identified required emissions reductions in the added five counties for the DFW eight-hour ozone NAA. These included VOC reductions from the DFW Surface Coating rule. There were also NO_X reductions from ICI (Industrial, Commercial, Institutional) reciprocating gas-fired engines in the nine-county area, but the NO_X rules were generally made more strict by the Major Source Rule (see next paragraph). So only the VOC controls were specifically modeled in this "control packet", as was done for the most recent DFW SIP revision. These rules were adopted by the Commission in April 2005.

DFW 2009 Ch. 117 Major Source Rule
The DFW major source rule controls ICI (Industrial, Commercial, Institutional) NEGU point sources. It approximates the Chapter 117 NO_X Emission Standards for Attainment Demonstration (ESADs) that are in place in HGB, plus some new ESADs for source categories that didn't exist or were otherwise not regulated in HGB. The compliance dates for these were March 2009. The paths affected by this rules are those modeled for the most recent DFW SIP revision.

DFW 2009 Cement Kiln Cap
The level of controls applied to the Midlothian (Ellis County) cement kilns are those recommended as the low level of controls by the ERG "Study", as described in more detail in the May 2007 (most recent) DFW SIP revision. Additionally, site-wide (by account) "alternative" NO_X caps were part of this rule, as modified by baseline changes reported by the sites. These updated ozone season (March 1 through October 1) caps, totaling 17.6 tpd for the ten kilns at the three sites, should have been modeled, but as Table 2.3-11 shows, only 16.37 tpd NOx were modeled for these ten kilns (accidentally reverted back to the pre-adoption rule file). This difference in DFW emissions is considered extremely insignificant for impact upon HGB ozone concentrations and was not corrected. The compliance date for this rule was March 2009.

BPA and DFW 2018 EI Summary
In summary, for BPA and DFW, the 2018 future base EI is composed of two datasets: hourly average 3Q2007 for the ARDs and 2006 OSD for the remainder of the point sources in these NAAs. The 2018 future base is built upon these datasets by incorporating the changes expected due to growth/bank and emissions budgets/controls for certain source categories that were developed for previous SIP revisions. See Table 2.3-11, above, for the 2018 emissions summary for BPA and DFW.

2.3.3 Regional (Outside of Texas) Point Sources
To parallel the base case and baseline sections, "regional" includes the states adjacent to Texas, the remaining eastern half of the USA within our modeling domain, offshore (Gulf of Mexico), and the parts of Mexico and Canada within our modeling domain. Since the same procedure was used to model 2018 adjacent states as the remainder of the states beyond Texas, these areas have been combined in the subsection below.

2.3.3.1 States Outside of Texas
Since the 2018 projections of the states adjacent to Texas (Louisiana, Arkansas, and Oklahoma) were treated just as the remainder of the United States, they are discussed in this subsection as a whole, with any differences specifically identified. To parallel the other sections above, the development of the 2018 EGU EI is discussed first, then NEGUs.

2.3.3.1.1 *EGUs*
Here again, the TCEQ makes the distinction between EGUs and Acid Rain units. Not all EGUs (SIC 4911 and 4939) are Acid Rain units, e.g., true cogeneration units are not Acid Rain units, but large cogens that supply more than one-third of their electricity to the public electrical grid are Acid Rain units. Non-Acid Rain EGUs are treated as NEGUs. This is the same definition

that the EPA applies to EGUs for CAIR purposes, i.e., an EGU, as defined by CAIR, is an Acid Rain EGU, which we could also call a CAIR EGU.

The TCEQ built future case 2018 emission records for Acid Rain EGUs using the same data source as used for Texas: the 2007 third quarter (3Q2007) hourly data downloaded from the EPA's Clean Air Markets Division (CAMD) website (see Section 2.1.2.1). A brief description is given here again. The downloaded data consisted of hourly NO_X emission rates for point sources identified by ORISPL and UNITID. To develop modeling AFS records, these emissions were joined to the 2002 NEI point source records that provided location, stack, and other parameters needed for AFS records. In addition, the NO_X-to-CO and NO_X-to-VOC emission ratios from the 2002 NEI provided a way to estimate hourly CO and VOC emissions for each point.

The goal is to substitute the newest Acid Rain data (ARD) into the 2018 NEI to retain the average hourly emissions profile for each EGU, even though the emission rates will change in the future case. The CenRAP/RPO AFS records would have been used if they had contained the ORISPL and UNITID identifiers that are necessary to link the ARD to the AFS. For EGUs, for which the goal is substituting hourly data anyway, only the stack parameter data are necessary, and these should not vary from NEI to CenRAP/RPO files. Hence, the NEI was used for purpose, because it contained the identifiers necessary.

Less than 5% of Acid Rain EGUs did not match an NEI source record. Again, the TCEQ were using 2007 ARD and comparing it to the 2002 NEI (grown to 2018 using EGAS). Since the TCEQ did not have time to develop and QA an updated 2007 Acid Rain-to-NEI cross reference, all new EGUs that came online between 2002 and 2007 had to be dealt with. Add to this the issue that not every Acid Rain EGU in every state filled in the ORIS/UNITID field during their NEI submittal. For Acid Rain EGUs in Louisiana, Arkansas and Oklahoma that did not match, the TCEQ manually created ARD records using "nearest town" for the location, default parameters for the stack exhaust, and averages for the CO and VOC emission ratios. For the other states in the USA within the modeling domain, the TCEQ distributed the unmatched emissions of each state to the matched ARD records in each state, so that all of the emissions would be accounted for. As was done for the baseline, the TCEQ built a single 2007 typical summer acid rain day having average hourly emissions for each Acid Rain EGU.

Next, the 3Q2007 emissions were "grown" to 2018 using the Department of Energy's (DOE's) Energy Information Administration (EIA) 2008 Annual Energy Outlook (AEO) report. Specifically, the TCEQ referred to EIA's *2008 AEO spreadsheet, April 2008, Table 76*, which provided electricity generation by electricity market region of the country and fuel type for the years 2005-2030; this can be found at http://www.eia.doe.gov/oiaf/archive/aeo08/supplement/index.html. The growth from 2007 to 2018 for areas outside of Texas was derived from this table by taking the 2018 value and dividing by the 2007 value for each region of the country for each fuel type. The results of this are shown in Table 2.3-13: *2007 to 2018 EGU Growth Factors, EIA's 2008 AEO*, broken out by each state in the modeling domain.

Table 2.3-13: 2007 to 2018 EGU Growth Factors, EIA's 2008 AEO

State	Fuel		
	Coal	Natural_Gas	Oil
AL	4.59	-6.44	-6.15
AR	7.57	1.97	-39.6
CT	19.73	-4.78	-6.69
DC	2.37	-32.28	15.34
DE	2.37	-32.28	15.34
FL	61.79	1.18	7.81
GA	4.59	-6.44	-6.15
IA	13.52	-6.08	-32.89
IL	13.52	-6.08	-32.89
IN	8.89	21.67	-3.07
KS	7.57	1.97	-39.6
KY	8.89	21.67	-3.07
LA	4.59	-6.44	-6.15
MA	19.73	-4.78	-6.69
MD	2.37	-32.28	15.34
ME	19.73	-4.78	-6.69
MI	8.89	21.67	-3.07
MN	15.17	99.43	-19.48
MO	13.52	-6.08	-32.89
MS	4.59	-6.44	-6.15
NC	4.59	-6.44	-6.15
ND	15.17	99.43	-19.48
NE	15.17	99.43	-19.48
NH	19.73	-4.78	-6.69
NJ	2.37	-32.28	15.34
NY	-1.39	14.73	7.14
OH	8.89	21.67	-3.07
OK	7.57	1.97	-39.6
PA	2.37	-32.28	15.34
RI	19.73	-4.78	-6.69
SC	4.59	-6.44	-6.15
SD	15.17	99.43	-19.48
TN	4.59	-6.44	-6.15
VA	4.59	-6.44	-6.15
VT	19.73	-4.78	-6.69
WI	13.52	-6.08	-32.89
WV	8.89	21.67	-3.07
Note:	includes all other solid fuels	includes all other vapor fuels	includes all other liquid fuels

Note that many of the growth factors in Table 2.3-13 are negative. This indicates negative growth, or a projected shrinking of demand for that fuel in that region of the country.

After "growing" these regional state EGUs, the TCEQ applied controls to them to complete the projection to 2018. The controls assumed are the CAIR NO_X budgets for each state for 2009-14, as defined by EPA's Notice of Data Availability (NODA) allocations spreadsheet, obtained from EPA's website, http://www.epa.gov/airmarkt/progsregs/cair/noda.html .
If the state had an ozone season budget, then that was the assumed budget; otherwise, the annual budget was converted to a ton per day limit. These state allocations were then multiplied by the presumptive five-sixths to obtain the Phase II budgets for 2015 and beyond.

The TCEQ then "controlled" the grown non-Texas EGUs to the CAIR Phase II NO_X emissions level for each state. As with Texas, no trading was assumed. The TCEQ went to the trouble of "growing" the EGUs first with the AEO data to assist with projecting the fuel types that may be present in 2018, to get the mix of fuels as accurate as possible. Then the CAIR Phase II caps were applied.

A CenRAP and other RPOs EI was available for 2018 in SMOKE files format (IDA). These files were built by a contractor for the purpose of Regional Haze modeling. The TCEQ gathered and converted the IDA-formatted files for the nation (actually, from just the RPOs within the modeling domain) into AFS files and associated temporal files. The TCEQ used these data for NEGUs. Yet, ultimately, for the EGUs, TCEQ only used these files to compare with the aforementioned 2018 EGU files generated by the TCEQ. In comparing the two, the AEO/CAIR approach that was modeled does have slightly higher emissions. The CenRAP/RPO EGU files incorporated IPM with growth and control scenarios based on projected fuel type prices/demand, plus CAIR trading that included Texas buying CAIR credits. Since the TCEQ can not predict the form of final CAIR or its replacement program, the TCEQ felt validated by using the AEO/CAIR approach that it modeled, because it did provide slightly higher emissions for the modeling domain as a whole.

The TCEQ applied CAIR Phase II to all states, as for Texas -- distributing the cap between point sources according to their grown averaged hourly 3Q2007 Acid Rain emissions. When modeling the CAIR cap, the ozone season cap applies (if one exists), otherwise the annual cap applies. States not in the CAIR program were modeled at their grown 2018 emissions. Table 2.3-14; *Modeled CAIR Phase II NO_X Allocations for States in the Modeling Domain* is a listing of states in the modeling domain with their associated presumptive annual and/or ozone season CAIR Phase II allocations (EPA's NODA). The last column of Table 2.3-14 is the 3Q2007 with 2008 AEO growth applied to it.

Table 2.3-14: Modeled CAIR Phase II NO_X Allocations for States in the Modeling Domain

State	Allocated CAIR Cap (tpy)		Modeled CAIR Cap (tpd)		Projected 2018 Emissions, without CAIR (tpd)
	Annual	Ozone Season	Annual	Ozone Season	
AL	65569	30573	179.64	199.82	279.56
AR		10939		71.50	129.01
CT		2431		15.89	16.43
DC	137	106	0.38	0.69	0.55
DE	3958	2115	10.84	13.82	39.55
FL	94473	45516	258.83	297.49	689.39
GA	63005		172.62		238.20
IA	31057	13550	85.09	88.56	172.94
IL	72419	29166	198.41	190.63	276.35
IN	103488	43654	283.53	285.32	411.87
KS					197.95
KY	79045	34243	216.56	223.81	298.79
LA	33736	16231	92.43	106.08	172.59
MA		7173		46.88	27.60
MD	26338	12192	72.16	79.69	114.14
MD	26338	12192	72.16	79.69	114.14
ME					1.58
MI	62039	27522	169.97	179.88	282.51
MN	29871		81.84		243.05
MO	56877	25344	155.83	165.65	221.72
MS	16917	8278	46.35	54.10	175.00
NC	59074	26972	161.85	176.29	203.88
ND					225.99
NE					143.18
NH					15.74
NJ	12037	6321	32.98	41.31	58.56
NY	43336	19600	118.73	128.10	175.90
OH	103234	43381	282.83	283.54	428.95
OK					252.60
PA	94097	40062	257.80	261.84	396.36
RI					1.32
SC	31029	14487	85.01	94.69	131.28
SD					42.49
TN	48424	21700	132.67	141.83	163.86
VA	34270	15194	93.89	99.31	166.66
VT					1.19
WI	38721	17088	106.08	111.69	166.04
WV	70509	25516	193.18	166.77	206.80

Note: An empty cell indicates no CAIR cap (not applicable) for that state.

Table 2.3-15***:*** *Modeled 2018 Typical Day Acid Rain EGU Emissions for Regional States* summarizes the Acid Rain EGU emissions data for point sources outside Texas. The "bal USA" totals are for all states in the modeling domain, excluding Texas, Arkansas, Louisiana and Oklahoma, although parts of some states may extend outside the modeling domain. Hence, photochemical model (CAMx) inputs would be expected to be less than the totals above.

Table 2.3-15: Modeled 2018 Typical Day Acid Rain EGU Emissions for Regional States

hour	NO_X Emissions (tph)				VOC Emissions (tph)				CO Emissions (tph)			
	AR	LA	OK	Rest of USA	AR	LA	OK	Rest of USA	AR	LA	OK	Rest of USA
1	2.5	3.1	8.4	133.9	0.1	0.1	0.1	1.8	0.6	0.7	1.0	59.0
2	2.3	3.1	8.1	128.4	0.1	0.1	0.1	1.7	0.5	0.6	1.0	56.2
3	2.2	3.1	8.0	125.0	0.1	0.1	0.1	1.7	0.5	0.6	0.9	54.3
4	2.2	3.1	8.0	124.7	0.1	0.1	0.1	1.7	0.5	0.6	0.9	53.9
5	2.2	3.1	8.2	129.0	0.1	0.1	0.1	1.7	0.5	0.6	1.0	55.9
6	2.4	3.1	8.5	135.6	0.1	0.1	0.1	1.8	0.5	0.7	1.0	59.1
7	2.4	3.1	8.9	141.2	0.1	0.1	0.1	1.9	0.5	0.7	1.1	61.7
8	2.5	3.2	9.0	148.1	0.1	0.1	0.1	2.0	0.6	0.7	1.1	65.1
9	2.5	3.3	9.5	155.3	0.1	0.1	0.1	2.1	0.6	0.7	1.2	68.7
10	2.5	3.5	10.3	160.7	0.1	0.1	0.1	2.2	0.6	0.8	1.4	71.8
11	2.6	3.8	11.2	165.6	0.1	0.1	0.1	2.3	0.6	0.9	1.6	74.5
12	2.6	4.0	12.0	169.0	0.1	0.1	0.1	2.4	0.6	1.1	1.8	76.4
13	2.6	4.3	12.8	171.6	0.1	0.1	0.2	2.4	0.6	1.2	2.0	77.7
14	2.6	4.4	13.2	173.2	0.1	0.1	0.2	2.5	0.6	1.3	2.1	78.5
15	2.6	4.5	13.6	174.0	0.1	0.1	0.2	2.5	0.6	1.4	2.2	78.8
16	2.6	4.8	13.8	173.8	0.1	0.1	0.2	2.5	0.6	1.4	2.3	78.8
17	2.6	4.4	13.4	172.8	0.1	0.1	0.2	2.4	0.6	1.3	2.2	78.5
18	2.6	4.5	12.8	170.5	0.1	0.1	0.2	2.4	0.6	1.2	2.0	77.4
19	2.6	4.5	12.1	168.0	0.1	0.1	0.2	2.4	0.6	1.0	1.8	76.4
20	2.6	3.8	11.7	166.6	0.1	0.1	0.1	2.3	0.6	1.0	1.7	75.8
21	2.5	3.6	11.0	163.3	0.1	0.1	0.1	2.3	0.6	0.9	1.5	74.1
22	2.5	3.5	10.0	156.8	0.1	0.1	0.1	2.2	0.6	0.8	1.3	70.7
23	2.5	3.4	9.2	149.2	0.1	0.1	0.1	2.1	0.6	0.7	1.2	66.6
24	2.5	3.2	8.8	141.2	0.1	0.1	0.1	1.9	0.6	0.7	1.1	62.5
Totals	**59.6**	**88.4**	**252.6**	**3697.6**	**1.6**	**2.3**	**3.1**	**51.1**	**13.4**	**21.4**	**35.5**	**1652.5**
#points	17	61	69	1201	17	61	69	1201	17	61	69	1201

NOTE: "bal USA" denotes the remainder of the states in the region, regardless of whether the EGU is located within the modeling domain

2.3.3.1.2 *NEGUs*

The 2018 NEGU file for states beyond Texas was the remainder of the 2018 CenRAP/RPO (described in the subsection above) file after the EGUs were removed. Table 2.3-16: *2018 Regional States NEGU Emissions* represents the NEGU emissions for states beyond Texas, but within our modeling domain. Again, parts of some states may extend outside the modeling domain; hence, photochemical model (CAMx) inputs would be expected to be less than the totals tabulated here.

Table 2.3-16: 2018 Regional States NEGU Emissions

State	NO_X		VOC		CO	
	#points	tpy	#points	tpy	#points	tpy
AL	1805	83819	3192	56018	1817	216573
AR	1075	38304	2106	41815	1101	69153
CT	854	8981	1203	4331	832	11582
DE	386	4166	1009	1994	383	8988
DC	44	744	61	90	43	485
FL	1766	82572	3154	44255	1611	140447
GA	1749	67655	2509	41129	1651	198301
IL	6175	98249	15080	69608	5898	99252
IN	3154	83037	7674	74111	3059	448868
IA	2907	51382	6683	43886	2744	52498
KS	2698	96929	4391	37005	2610	123990
KY	2812	43327	8320	55949	2717	141027
LA	4073	242029	7489	108589	3748	182196
ME	807	26532	1180	6640	797	26934
MD	715	26472	1263	6411	675	150020
MA	5551	29841	8596	10843	4502	25487
MI	3439	95577	8935	42526	2866	101156
MN	4847	74426	8593	46968	4604	59488
MS	1458	64020	2437	46094	1441	79548
MO	4152	58336	8384	44560	3878	187043
NB	911	22363	1172	10461	852	9185
NH	207	1696	233	1246	206	1572
NJ	5120	28192	10508	18457	4650	19601
NY	2092	58717	2644	8187	2074	100171
NC	2619	56736	4992	71322	2630	71341
ND	126	92098	96	2493	130	22589
OH	2067	71948	3244	33370	1871	290157
OK	2379	95719	5475	48085	2385	86566
PN	6990	133641	11807	44645	6716	167483
RI	139	2479	259	1798	140	3337
SC	2729	54672	4541	44091	2676	79704
SD	79	24726	88	3523	67	6853
TN	1744	65556	4901	93366	1661	141943
VT	89	991	73	1734	85	842
VA	2248	76898	3898	53637	2106	87985
WV	1167	46877	2728	16621	1206	120640
WI	4373	43770	9666	43692	4097	45403

Table 2.3-17: *2018 Regional States Emissions Summary*, below, provides an overall summary of the 2018 emissions for all the states within the modeling domain, outside of Texas. Again, parts of some states may extend outside the modeling domain; hence, photochemical model (CAMx) inputs would be expected to be less than the totals tabulated here.

Table 2.3-17: 2018 Regional States Emissions Summary

		NO_X (tpd)	VOC (tpd)	CO (tpd)
2006 Baseline	EGU	6524	47	1720
	NEGU	7645	3331	8213
2018 Future Case	EGU	4089	58	1723
	NEGU	5900	3506	9804

2.3.4 Offshore, Mexico, and Canada

The GWEI 2005 report did mention declines in the number of platforms between 2000 and 2005, and platforms have been tending to be located farther offshore in deeper water, so the impact to onshore areas may be decreasing. Yet MMS has not provided projections for the offshore EI. For lack of projections data, the 2018 EIs for the offshore area (Gulf of Mexico), Mexico, and Canada were the same as those used in the 2006 baseline and the 2005-06 base cases, as described in previous sections.

2.3.5 Summary of Future Case Point Source Data Files

Snapshots of the point source emission files that were processed with EPS3 for CAMx in each episode are presented in Table 2.3-18: *AFS Files for the 2018 Future Case Episode.* The version number on each dataset indicates a change from the previous version (e.g., "v8"). The FTP download site for these files or their successors is ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/ei/point/. Outdated files are generally not retained on the FTP site.

Table 2.3-18: AFS Files for the 2018 Future Case Episode

Area	AFS Point Source Emissions Dataset	Hourly	Daily	See Note
Texas	afs.ard_MECT_with_season_adjustment_v12	X		
	afs.ard_2007_sans_mhc_no_NOx_recs_v9	X		
	afs.ard_CAIR_with_season_adjustment_v11	X		
	afs.osd_MECT_for_HGB_NOx_pts_v10		X	
	afs.osd_MECT_exempt_growth_to_2018.v8		X	
	afs.osd_growth_under_MECT_v15b		X	
	afs.2018_HECT_HarrisCo_2006_basis_all_pts_0.75sens_v11		X	
	afs.osd_CAIR_with_pathway_allowances_v10		X	
	afs.00to07_egus_getting_new_CAIR_allowances_v13	X	X	
	afs.osd_post07_egus_getting_CAIR_from_permit_v12b		X	
	afs.osd_2009_controls_v4		X	
	afs.osd_no_rules_growth_to_2018_routTLL.v12		X	
	afs.landing_losses_3Q06_aver_day_episode_v1	X		
	afs.aggVOC_extra_alkenes_for_2006_v3		X	
Regional	afs.ard_USAmTX_generic_CAIR_based_on_pt_caps.v1	X		
	afs.osd_NEGUs_split_out_of_2018_CENRAP		X	
Canada	afs.CAIRCanada.2001.v1a.latlong.lcp			1
Mexico	afs.Mexico_from_updated_1999_NEI.lcp_3pols_v1		X	
Offshore	afs.gwei2005.May_Oct_edit.3pol.lcp			2
Notes:	1 Records are tons per year (tpy) 2 Records are tons per month			

2.4 2018 FUTURE YEAR POINT SOURCES CONTROL STRATEGY MODELING EMISSIONS DEVELOPMENT

This section describes the modeling of the final newly-proposed rules/controls that were applied to the 2018 future point source EI, necessary/assisting for attainment demonstration.

2.4.1 HECT Reallocation and 25% Cap Reduction Rule

Since a portion of the original HECT cap was not being utilized, and the TCEQ confirmed such directly with the HECT allowance holders via the 2006 HRVOC Special Inventory, the TCEQ proposed a rule that would reallocate the HECT cap and limit the overall cap to 75% of its reallocated value. (That is, the HECT allocation used in the initial 2018 modeling studies differs from the allocations in later studies, although the total cap is unchanged. The 25% HECT cap reduction comes off the more recent allocation.) The TCEQ must include the full cap allowances in the future case, because the emissions level in the future could technically reach the full cap in a given year.

The new rule was modeled with an across-the-board reduction of HRVOC, except that accounts were constrained at a minimum of 10 tpy. As with the previous HECT modeling, any cap assigned to accounts without qualifying point sources is distributed proportionally (by emissions) to the remainder of the accounts. This treatment explains why the emissions from some of the accounts exceed their HECT allocation. For the new control strategy, each HRVOC species was reduced by 25% within the 2006 STARS reported HECT accounts. This necessitated the re-speciation of the VOC distribution within the HECT accounts. New speciation profiles were generated using the procedure outlined in Section 2.1, and a model run was performed to determine the benefit to ozone at monitors in the area. Table 2.4-1: *HECT Accounts with Cap Reallocation and 25% Cap Reduction* shows the resulting VOC and HRVOC emissions.

Table 2.4-1: HECT Accounts with Cap Reallocation and 25% Cap Reduction

RN	Owner	HECT Cap (tpd)	# HECT allocated paths	Total VOC Emissions (tpd)			HRVOC Emissions (tpd)		
				Reported 2006	2018	2018 with 25% Reduction	Reported 2006	2018	2018 with 25% Reduction
RN100210319	EQUISTAR LYONDELL CH	0.4222	11	1.2338	0.9567	0.8435	0.7170	0.4399	0.3268
RN100210665	Enterprise Products	0.0274							
RN100210806	INTERCONTINENTAL TER	0.0528	4	0.0346	0.0550	0.0409	0.0346	0.0550	0.0409
RN100211879	SHELL OIL DEER PARK	1.2535	60	1.0938	1.8673	1.5314	0.5326	1.3061	0.9702
RN100212109	TOTAL PETROCHEMICALS	0.3783	120	2.1981	1.1156	1.0142	1.4767	0.3942	0.2928
RN100212216	Kuraray America Inc	0.0608	1	0.0364	0.0691	0.0528	0.0307	0.0633	0.0471
RN100213958	Georgia Gulf Pasaden	0.0274	4	0.0243	0.0411	0.0413	0.0117	0.0285	0.0287
RN100214212	Targa Galena Park	0.0610	2	0.1246	0.1395	0.1232	0.0486	0.0635	0.0472
RN100216761	Basell Bayport	0.2755	5	0.5367	0.4897	0.4159	0.3339	0.2870	0.2132
RN100218130	Lyondell Citgo Houst	0.0432	42	0.8973	0.8133	0.8017	0.1290	0.0450	0.0334
RN100218247	Albemarle	0.1416	9	0.1014	0.1908	0.1529	0.0581	0.1475	0.1096
RN100218411	Odjfell Terminals	0.0274							
RN100218841	Kaneka Texas	0.0274	4	0.1418	0.1416	0.1417	0.0288	0.0285	0.0287
RN100219237	Johann Haltermann 1	0.0274	2	0.0033	0.0300	0.0302	0.0018	0.0285	0.0287
RN100219310	Valero Houston Refin	0.1491	24	0.3461	0.3887	0.3487	0.1127	0.1553	0.1154
RN100219526	Texas Petrochemicals	0.2124	6	0.2110	0.3414	0.2845	0.0909	0.2213	0.1644
RN100221589	Lubrizol Corporation	0.0274	10	0.0142	0.0385	0.0387	0.0042	0.0285	0.0287
RN100224450	Millenium LaPorte	0.0466	3	0.0643	0.0728	0.0603	0.0401	0.0486	0.0361
RN100225085	DuPont LaPorte	0.1617	6	0.0889	0.2110	0.1677	0.0464	0.1685	0.1252
RN100225689	BASF Pasadena	0.0492	4	0.0951	0.1254	0.1122	0.0210	0.0513	0.0381
RN100227016	Celanese Clear Lake	0.0971	16	0.1547	0.1330	0.1070	0.1229	0.1012	0.0752
RN100229905	INEOS Polyethylene	0.3171	9	0.4669	0.5595	0.4745	0.2378	0.3304	0.2454
RN100524008	Sunoco Bayport Polyp	0.2088	9	0.3349	0.3076	0.2516	0.2448	0.2176	0.1616
RN100542224	Nova Chemicals Baypo	0.0274	1	0.0162	0.0447	0.0449	0.00002	0.0285	0.0287
RN100542281	Equistar Channelview	0.7348	13	2.7993	2.5636	2.3667	1.0013	0.7657	0.5687
RN100633650	Lyondell Channelview	0.1059	11	0.5241	0.5387	0.5103	0.0957	0.1103	0.0819
RN100683952	NATURAL GAS ODORIZIN	0.0274	2	0.0119	0.0285	0.0287	0.0119	0.0285	0.0287

RN	Owner	HECT Cap (tpd)	# HECT allocated paths	Total VOC Emissions (tpd)			HRVOC Emissions (tpd)		
				Reported 2006	2018	2018 with 25% Reduction	Reported 2006	2018	2018 with 25% Reduction
RN100716661	Pasadena Refining	0.1651	20	1.4590	1.3759	1.3317	0.2551	0.1721	0.1278
RN100870898	Goodyear Houston Che	0.0274	9	0.2595	0.2712	0.2714	0.0168	0.0285	0.0287
RN100909373	Total Bayport HDPE	0.1746	14	0.1536	0.3011	0.2543	0.0345	0.1820	0.1352
RN101041598	LBC Houston Bayport	0.0274							
RN101058410	Lubrizol Corporation	0.0274	1	0.0005	0.0290	0.0292	0.00003	0.0285	0.0287
RN101379287	American Acryl Pasad	0.0274							
RN102018322	Cheveron Phillips	0.6226	56	1.0478	1.3834	1.2166	0.3132	0.6487	0.4819
RN102204211	Kirby Inland Marine	0.0497	1	0.0959	0.0816	0.0682	0.0661	0.0518	0.0385
RN102212925	ExxonMobil Baytown O	0.7043	30	2.4220	2.0500	1.8613	1.1058	0.7339	0.5451
RN102523107	Lyondell Chemical Ba	0.2088	5	0.3474	0.4940	0.4381	0.0709	0.2176	0.1616
RN102528197	BP Amoco Chemical Co	0.0274	7	0.0234	0.0326	0.0328	0.0193	0.0285	0.0287
RN102537289	INEOS Polypropylene	0.3802	3	0.3851	0.5075	0.4056	0.2738	0.3962	0.2943
RN102574803	ExxonMobil Baytown C	0.4467	32	0.5216	0.6877	0.5680	0.2993	0.4654	0.3457
RN102576063	PL Propylene LLC*	0.0699							
RN102579307	ExxonMobil Baytown R	0.3028	142	4.0044	3.8639	3.7828	0.4560	0.3155	0.2344
RN102580834	Enterprise HSC	0.0274							
RN102887270	Nisseki Bayport	0.0274							
RN102888328	Sunoco LaPorte	0.2989	4	0.1261	0.3204	0.2403	0.1172	0.3114	0.2314
RN102926920	Equistar Bayport	0.0685	3	0.0368	0.0884	0.0700	0.0198	0.0714	0.0530
RN103773206	Sunoco Bayport Polye	0.1193							
RN103919817	Chevron Phillips Ced	0.6349	21	1.1841	1.3004	1.1302	0.5453	0.6616	0.4914
RN104150123	Dow Chemical Clear L	0.0274							
	TOTALS =	**9.4562**		**23.6205**	**24.0502**	**21.6862**	**9.0265**	**9.4562**	**7.0922**

3.0 ON-ROAD MOBILE SOURCE MODELING EMISSIONS DEVELOPMENT

3.1 On-Road Mobile Source Emissions Inventories for Eight-County HGB

The purpose of this section is to provide a brief overview of the eight-county Houston-Galveston-Brazoria (HGB) area on-road mobile source emissions inventory data that were input into the photochemical model for both the 2005 and 2006 base case episodes, along with the 2018 future case. These inventory data were developed under contract by the Texas Transportation Institute (TTI) based on travel demand model output from the Houston-Galveston Area Council (H-GAC). For each of the eight HGB counties, TTI combined MOBILE6.2 emissions rate output with vehicle miles traveled (VMT) estimates from H-GAC's travel demand model. The net result is referred to as a "link-based" inventory because both hourly VMT and emissions estimates are developed for each roadway segment or "link." For each year, both school and summer (i.e., non-school) season on-road emissions inventories were developed for the four "day types" of weekday (i.e., Monday-Thursday), Friday, Saturday, and Sunday.

Table 3.1-1: *VMT, NO_x, VOC, & CO Summary for 2005 HGB On-Road Inventory*, Table 3.1-2: *VMT, NO_x, VOC, & CO Summary for 2006 HGB On-Road Inventory*, and Table 3.1-3: *VMT, NO_x, VOC, & CO Summary for 2018 HGB On-Road Inventory* provide summaries of the total VMT, NO_x, VOC, and CO emissions for the entire eight-county HGB area for each combination of season and day type for the 2005 base case, the 2006 base case, and the 2018 future case, respectively. For a specific season in both the base and future cases, the weekday inventories have similar VMT totals. Fridays have the highest total VMT of the week, while Saturdays and Sundays have the lowest total daily VMT. Greater detail on the activity differences with respect to school and summer seasons can be found in an August 2007 TTI report entitled *Development and Production of VMT Profiles for Non-School, Memorial Day, and Labor Day Weekends*, which is available at
http://www.tceq.state.tx.us/implementation/air/airmod/project/pj_report_mob.html.

While overall VMT increases with future growth, total emissions decrease from 2005/2006 to 2018 as a result of more stringent emissions standards for newer vehicles entering the fleet, combined with the simultaneous attrition of older, higher-emitting vehicles. Consistent with current federal and state rules, the on-road inventories from TTI include the benefits of reformulated gasoline (RFG), the inspection and maintenance (I/M) Program in five of the eight HGB counties, and the use of Texas Low Emission Diesel (TxLED) for 2006 and 2018.

Table 3.1-1: VMT, NO_x, VOC, & CO Summary for 2005 HGB On-Road Inventory

Season Type	Day Type	Eight-County VMT Total	On-Road Emissions (tpd)		
			NO_x	VOC	CO
Summer	Weekday	131,238,085	233.48	95.14	1,244.97
	Friday	141,870,236	233.10	103.75	1,353.90
	Saturday	114,562,063	190.03	73.15	1,031.97
	Sunday	96,699,512	151.49	61.90	880.50
School	Weekday	138,466,395	245.76	100.62	1,307.40
	Friday	153,208,899	251.08	112.57	1,451.45
	Saturday	122,299,838	202.54	78.10	1,098.61
	Sunday	100,639,776	157.50	64.39	914.70

Table 3.1-2: VMT, NO_x, VOC, & CO Summary for 2006 HGB On-Road Inventory

Season Type	Day Type	Eight-County VMT Total	On-Road Emissions (tpd)		
			NO_x	VOC	CO
Summer	Weekday	133,868,661	206.74	90.71	1,115.28
	Friday	144,714,731	207.36	98.94	1,212.59
	Saturday	116,859,389	168.18	69.49	920.02
	Sunday	98,638,659	134.48	58.79	784.73
School	Weekday	141,240,451	217.59	95.96	1,171.31
	Friday	156,278,685	223.32	107.40	1,300.20
	Saturday	124,750,764	179.23	74.21	979.50
	Sunday	102,656,939	139.81	61.16	815.29

Table 3.1-3: VMT, NO_x, VOC, & CO Summary for 2018 HGB On-Road Inventory

Season Type	Day Type	Eight-County VMT Total	On-Road Emissions (tpd)		
			NO_x	VOC	CO
Summer	Weekday	180,993,087	52.55	45.97	733.18
	Friday	197,299,034	54.70	50.59	804.87
	Saturday	157,889,621	42.95	35.07	597.65
	Sunday	132,325,767	34.82	29.39	505.01
School	Weekday	189,613,165	54.88	48.25	764.81
	Friday	209,417,787	57.87	53.86	849.66
	Saturday	164,569,357	44.65	36.52	620.84
	Sunday	136,020,863	35.73	30.18	517.86

For photochemical modeling applications, the HGB on-road emission inventories were matched to specific ozone episodes by season and day type. Table 3.1-4: *School Year Start & Stop Days for the Houston Independent School District* provides a summary of the dates in 2005 and 2006 when school ended in May, and then started up again in August. This information was obtained from the Houston Independent School District (HISD) website at http://www.houstonisd.org/.

Table 3.1-4: School Year Start & Stop Days for the Houston Independent School District

School Year Start/Stop	Date
2004-2005 School Year Ends	Thursday May 26, 2005
2005-2006 School Year Begins	Monday August 15, 2005
2005-2006 School Year Ends	Thursday May 25, 2006
2006-2007 School Year Begins	Monday August 14, 2006

Even though all of the season and day type on-road inventory combinations were used, only the summer weekday will be detailed here. For the 2005 base case, 2006 base case, and 2018 future case, Table 3.1-5: *Summary of 2005 HGB Summer Weekday On-Road Inventory by County*, Table 3.1-6: *Summary of 2006 HGB Summer Weekday On-Road Inventory by County*, and Table 3.1-7: *Summary of 2018 HGB Summer Weekday On-Road Inventory by County* present respective summaries of the VMT, NO_x, VOC, and CO emissions for each of the eight counties in the HGB area.

Table 3.1-5: Summary of 2005 HGB Summer Weekday On-Road Inventory by County

HGB County	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NO_x	VOC	CO
Brazoria	5,632,467	4.29%	9.81	3.92	53.43
Chambers	2,463,364	1.88%	5.78	1.98	34.08
Fort Bend	7,770,902	5.92%	13.41	4.90	69.26
Galveston	5,799,633	4.42%	9.94	4.17	54.20
Harris	95,386,290	72.68%	166.90	69.45	882.83
Liberty	2,476,652	1.89%	4.97	2.39	32.32
Montgomery	9,817,032	7.48%	18.35	6.50	92.20
Waller	1,891,745	1.44%	4.32	1.82	26.65
Total	131,238,085	100.00%	233.48	95.14	1,244.97

Table 3.1-6: Summary of 2006 HGB Summer Weekday On-Road Inventory by County

HGB County	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NOx	VOC	CO
Brazoria	5,728,510	4.28%	8.70	3.66	47.04
Chambers	2,519,042	1.88%	5.07	1.82	29.62
Fort Bend	7,994,337	5.97%	11.97	4.66	62.02
Galveston	5,850,101	4.37%	8.70	3.89	47.37
Harris	97,155,857	72.58%	147.48	66.43	792.44
Liberty	2,529,328	1.89%	4.50	2.29	29.30
Montgomery	10,141,863	7.58%	16.42	6.17	82.88
Waller	1,949,623	1.46%	3.90	1.79	24.60
Total	133,868,661	100.00%	206.74	90.71	1,115.28

Table 3.1-7: Summary of 2018 HGB Summer Weekday On-Road Inventory by County

HGB County	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NO_x	VOC	CO
Brazoria	9,116,171	5.04%	2.61	2.17	36.60
Chambers	3,998,297	2.21%	1.76	1.24	24.85
Fort Bend	14,058,858	7.77%	3.82	3.24	53.11
Galveston	6,750,271	3.73%	1.89	1.70	26.46
Harris	125,484,043	69.33%	35.10	31.62	491.05
Liberty	3,751,678	2.07%	1.71	1.41	23.64
Montgomery	15,273,310	8.44%	4.39	3.59	59.96
Waller	2,560,459	1.41%	1.27	1.00	17.52
Total	180,993,087	100.00%	52.55	45.97	733.18

Table 3.1-8: *Summary of 2005 HGB On-Road Inventory by Vehicle Type*, Table 3.1-9: *Summary of 2006 HGB On-Road Inventory by Vehicle Type*, and Table 3.1-10: *Summary of 2018 HGB On-Road Inventory by Vehicle Type* present respective summaries for 2005, 2006, and 2018 of the VMT, NO_x, VOC, and CO emissions for each of the 28 vehicle classes in MOBILE6.2.

Table 3.1-8: Summary of 2005 HGB Summer Weekday On-Road Inventory by Vehicle Type

MOBILE6.2 Vehicle Type	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NO_x	VOC	CO
LDGV	78,139,639	59.54%	56.12	58.67	762.11
LDGT1	7,026,183	5.35%	5.07	5.44	74.83
LDGT2	23,390,024	17.82%	23.01	18.88	266.82
LDGT3	7,179,960	5.47%	6.16	3.60	63.98
LDGT4	3,301,919	2.52%	3.99	1.80	30.36
HDGV2b	916,044	0.70%	3.86	0.64	7.64
HDGV3	321,103	0.24%	1.63	0.29	3.32
HDGV4	127,139	0.10%	0.61	0.11	1.13
HDGV5	45,637	0.03%	0.26	0.07	0.79
HDGV6	123,880	0.09%	0.75	0.20	2.00
HDGV7	40,749	0.03%	0.29	0.07	0.68
HDGV8a	47,270	0.04%	0.39	0.12	1.30
HDGV8b	8,148	0.01%	0.08	0.02	0.22
LDDV	104,876	0.08%	0.16	0.06	0.17
LDDT12	17,269	0.01%	0.05	0.05	0.08
HDDV2b	1,978,078	1.51%	7.11	0.35	1.87
HDDV3	565,868	0.43%	2.61	0.13	0.62
HDDV4	339,522	0.26%	1.91	0.09	0.44
HDDV5	241,108	0.18%	1.41	0.07	0.34
HDDV6	723,328	0.55%	6.13	0.31	1.09
HDDV7	354,283	0.27%	3.91	0.20	0.70
HDDV8a	718,404	0.55%	13.32	0.44	2.52
HDDV8b	4,766,120	3.63%	86.91	2.52	14.04
MC	131,238	0.10%	0.16	0.37	2.00
HDGB	55,530	0.04%	0.53	0.29	4.45
HDDBT	155,519	0.12%	3.14	0.09	0.68
HDDBS	269,621	0.21%	3.75	0.20	0.70
LDDT34	149,626	0.11%	0.17	0.06	0.11
Total	131,238,085	100.00%	233.48	95.14	1,244.97

Table 3.1-9: Summary of 2006 HGB Summer Weekday On-Road Inventory by Vehicle Type

MOBILE6.2 Vehicle Type	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NO_x	VOC	CO
LDGV	79,713,513	59.55%	51.28	55.48	673.55
LDGT1	7,166,631	5.35%	4.80	5.28	67.15
LDGT2	23,857,629	17.82%	22.48	18.42	244.17
LDGT3	7,324,561	5.47%	5.98	3.45	59.33
LDGT4	3,368,346	2.52%	3.94	1.74	28.21
HDGV2b	934,741	0.70%	3.41	0.58	6.71
HDGV3	327,657	0.24%	1.50	0.27	2.87
HDGV4	129,734	0.10%	0.59	0.11	1.01
HDGV5	46,569	0.03%	0.24	0.07	0.66
HDGV6	126,408	0.09%	0.69	0.18	1.64
HDGV7	41,581	0.03%	0.28	0.07	0.60
HDGV8a	48,234	0.04%	0.38	0.12	1.07
HDGV8b	8,315	0.01%	0.08	0.02	0.20
LDDV	92,401	0.07%	0.11	0.05	0.13
LDDT12	15,280	0.01%	0.05	0.04	0.07
HDDV2b	2,018,614	1.51%	6.42	0.34	1.91
HDDV3	577,464	0.43%	2.32	0.12	0.63
HDDV4	346,479	0.26%	1.71	0.09	0.44
HDDV5	246,049	0.18%	1.26	0.07	0.35
HDDV6	738,151	0.55%	5.43	0.29	1.08
HDDV7	361,543	0.27%	3.50	0.19	0.69
HDDV8a	733,126	0.55%	11.56	0.42	2.38
HDDV8b	4,863,149	3.63%	71.54	2.37	13.68
MC	133,869	0.10%	0.16	0.37	1.84
HDGB	50,184	0.04%	0.47	0.25	3.42
HDDBT	158,782	0.12%	2.86	0.08	0.65
HDDBS	281,531	0.21%	3.55	0.20	0.72
LDDT34	158,122	0.12%	0.16	0.06	0.11
Total	133,868,661	100.00%	206.74	90.71	1,115.28

Table 3.1-10: Summary of 2018 HGB Summer Weekday On-Road Inventory by Vehicle Type

MOBILE6.2 Vehicle Type	Vehicle Miles Traveled		On-Road Emissions (tpd)		
	Total	Distribution	NO_x	VOC	CO
LDGV	108,995,558	60.22%	17.35	25.85	439.58
LDGT1	8,888,147	4.91%	1.72	2.67	42.13
LDGT2	29,588,480	16.35%	8.41	9.98	160.85
LDGT3	11,625,768	6.42%	2.29	2.33	47.41
LDGT4	5,346,330	2.95%	1.60	1.17	22.84
HDGV2b	1,487,577	0.82%	0.47	0.24	7.41
HDGV3	383,753	0.21%	0.27	0.09	2.57
HDGV4	107,797	0.06%	0.05	0.02	0.70
HDGV5	38,805	0.02%	0.03	0.02	0.29
HDGV6	77,613	0.04%	0.07	0.03	0.60
HDGV7	21,562	0.01%	0.02	0.01	0.19
HDGV8a	34,496	0.02%	0.14	0.05	0.34
HDGV8b	4,315	0.00%	0.01	0.00	0.06
LDDV	97,920	0.05%	0.01	0.01	0.06
LDDT12	0	0.00%	0.00	0.00	0.00
HDDV2b	3,390,752	1.87%	1.18	0.36	0.40
HDDV3	820,990	0.45%	0.43	0.10	0.13
HDDV4	387,133	0.21%	0.34	0.06	0.10
HDDV5	340,412	0.19%	0.26	0.05	0.07
HDDV6	780,943	0.43%	0.95	0.16	0.21
HDDV7	300,363	0.17%	0.54	0.08	0.12
HDDV8a	654,123	0.36%	2.07	0.21	0.51
HDDV8b	6,567,971	3.63%	10.83	1.94	2.80
MC	180,993	0.10%	0.12	0.25	2.86
HDGB	23,282	0.01%	0.09	0.03	0.25
HDDBT	220,737	0.12%	1.03	0.05	0.22
HDDBS	433,371	0.24%	2.25	0.18	0.41
LDDT34	193,899	0.11%	0.03	0.02	0.06
Total	180,993,087	100.00%	52.55	45.97	733.18

The MOBILE6.2 input files used to develop these inventories, along with detailed reports and tab-delimited summary output data, can be found on the following FTP sites for 2005, 2006, and 2018, respectively:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/m62/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/m62/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/m62/2018/

The on-road emissions inventory data provided by TTI were prepared for input into the photochemical model using Version 3 of the Emissions Processing System (EPS3). When input into EPS3, the inventory data are in a "readable" text-based format. However, once within EPS3, the emissions data are maintained in a binary format. Table 3.1-11: *EPS3 Modules Used to*

Process Eight-County HGB On-Road Emissions Data summarizes the EPS3 modules that were used to process the eight-county HGB on-road inventories.

Table 3.1-11: EPS3 Modules Used to Process Eight-County HGB On-Road Emissions Data

EPS3 Module	Description
LBASE	Spatially allocate link-based emissions among grid cells
PREAM	Prepare non-link "roadway type" emissions for further processing
PREPNT	Prepare stationary extended idling emissions for further processing
CNTLEM	Apply controls to model strategies, apply adjustments, etc.
TMPRL	Apply temporal profiles to extended idling emissions
CHMSPL	Chemically speciate emissions into NO, NO_2, Olefins, Parrafins, etc.
GRDEM	Sum emissions by grid cell for photochemical model input
MRGUAM	Merge and adjust multiple gridded files for photochemical model input

The EPS3 CNTLEM module was used to:

- Remove 3.4 percent of the HDDV8a and HDDV8b ("18-wheeler") emissions for separate processing as "extended idling" emissions in accordance with the January 2004 EPA *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity*; and

- Apply a temperature/humidity NO_X correction to both diesel and heavy-duty gasoline vehicles.

The MOBILE6.2 model accounts for the effects that changes in hourly temperature and humidity have on NO_x emissions for only six of the 28 total vehicle types. These vehicle types are the MOBILE6.2 light-duty gasoline vehicle (LDGV), light-duty gasoline trucks 1-4 (LDGT1-4), and motorcycle (MC) classes. There is no temperature/humidity NO_x correction in MOBILE6.2 for the remaining 22 vehicle classes, which include all 13 of the diesel-powered vehicle classes and the nine heavy-duty gasoline vehicle classes. Under contract to the Houston Advanced Research Center (HARC), Environ worked with the Southwest Research Institute (SwRI) to develop temperature/humidity NO_x correction equations to apply to both the 13 diesel and nine heavy-duty gasoline vehicle classes in MOBILE6.2. These equations reflect the fact that as ambient temperature increases, tailpipe NO_x emissions increase. However, as ambient humidity increases, tailpipe NO_x emissions decrease. Greater detail on the development of these correction equations can be found in Appendices F.4 and F.5 of the December 2004 HGB SIP revision, which can be found at http://www.tceq.state.tx.us/implementation/air/sip/dec2004hgb_mcr.html.

The EPS3 CNTLEM module referenced above in Table 3.1-11 allows the user to apply a different NO_x, VOC, and/or CO correction for each hour, episode day, county, and vehicle type combination. TCEQ modeling staff developed Statistical Analysis Software (SAS) code to calculate the appropriate NO_X adjustment factors for each county and vehicle type using hourly inputs for temperature, relative humidity, and barometric pressure. The hourly temperature, relative humidity, and barometric pressure inputs used by the SAS software were also used by TTI in its development of the 2005, 2006, and 2018 HGB on-road inventories. These meteorological data were obtained from National Weather Service (NWS) and TCEQ monitors in the HGB area for the time periods of May 15-September 15, 2005 and May 15-September 15, 2006. The spreadsheets that were developed to obtain the final hourly inputs are available at:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/m62/2005/; and
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/m62/2006/.

Table 3.1-12: *Summary of 2005 Temperature/Humidity On-Road NO_x Correction*, Table 3.1-13: *Summary of 2006 Temperature/Humidity On-Road NO_x Correction*, and Table 3.1-14: *Summary*

of 2018 Temperature/Humidity On-Road NO_x Correction present the temperature and humidity corrections applied to each combination of season and day type for the 2005 base case, 2006 base case, and 2018 future case, respectively. For each episode day, there are greater NO_x reductions during the overnight and early morning hours when the temperature is at its minimum and the relative humidity is at its maximum. However, during the hottest hours of the afternoon when the relative humidity is at its lowest, the temperature/humidity NO_x correction either decreases NO_x very slightly or increases it somewhat, depending upon the specific conditions for that hour. Overall, the temperature/humidity NO_x correction procedure allows not only for improved estimates of the total on-road NO_x emissions, but also for improved spatial and temporal allocation of those emissions.

Table 3.1-12: Summary of 2005 Temperature/Humidity On-Road NO_x Correction

Season Type	Day Type	Temperature/Humidity NO_X Reduction (tpd)
Summer	Weekday	11.79
	Friday	11.11
	Saturday	9.28
	Sunday	6.73
School	Weekday	12.39
	Friday	11.96
	Saturday	9.86
	Sunday	6.97

Table 3.1-13: Summary of 2006 Temperature/Humidity On-Road NO_x Correction

Season Type	Day Type	Temperature/Humidity NO_X Reduction (tpd)
Summer	Weekday	9.45
	Friday	8.91
	Saturday	7.40
	Sunday	5.40
School	Weekday	9.93
	Friday	9.59
	Saturday	7.87
	Sunday	5.59

Table 3.1-14: Summary of 2018 Temperature/Humidity On-Road NO_x Correction

Season Type	Day Type	Temperature/Humidity NO_X Reduction (tpd)
Summer	Weekday	1.78
	Friday	1.70
	Saturday	1.37
	Sunday	0.99
School	Weekday	1.86
	Friday	1.80
	Saturday	1.43
	Sunday	1.01

The 2005, 2006, and 2018 on-road inventories for the eight-county HGB area include the benefits of RFG and I/M. The summer weekday RFG benefits for 2005, 2006, and 2018 are provided in Table 3.1-15: *Summary of 2005 Summer Weekday RFG Benefits by County*, Table 3.1-16: *Summary of 2006 Summer Weekday RFG Benefits by County*, and Table 3.1-17: *Summary of 2018 Summer Weekday RFG Benefits by County*, respectively.

Table 3.1-15: Summary of 2005 Summer Weekday RFG Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	0.08	0.69	4.79
Chambers	0.04	0.28	2.40
Fort Bend	0.09	0.90	6.08
Galveston	0.08	0.74	4.61
Harris	1.31	12.93	81.13
Liberty	0.03	0.39	2.87
Montgomery	0.11	1.18	8.62
Waller	0.02	0.29	2.34
Total	1.75	17.40	112.84

Table 3.1-16: Summary of 2006 Summer Weekday RFG Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	0.08	0.62	4.50
Chambers	0.04	0.25	2.14
Fort Bend	0.11	0.82	5.88
Galveston	0.09	0.67	4.33
Harris	1.54	11.92	77.42
Liberty	0.04	0.36	2.67
Montgomery	0.14	1.08	8.26
Waller	0.03	0.27	2.24
Total	2.07	15.97	107.45

Table 3.1-17: Summary of 2018 Summer Weekday RFG Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	0.04	0.39	3.63
Chambers	0.02	0.15	1.58
Fort Bend	0.05	0.64	5.51
Galveston	0.03	0.31	2.46
Harris	0.57	6.18	50.37
Liberty	0.02	0.20	1.82
Montgomery	0.05	0.68	6.15
Waller	0.01	0.13	1.31
Total	0.78	8.69	72.84

The summer weekday I/M program benefits for 2005, 2006, and 2018 are provided in Table 3.1-18: *Summary of 2005 Summer Weekday I/M Program Benefits by County* , Table 3.1-19: *Summary of 2006 Summer Weekday I/M Program Benefits by County*, and Table 3.1-20: *Summary of 2018 Summer Weekday I/M Program Benefits by County*, respectively.

Table 3.1-18: Summary of 2005 Summer Weekday I/M Program Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	0.60	0.52	9.36
Fort Bend	0.76	0.66	11.58
Galveston	0.62	0.55	9.48
Harris	10.47	9.28	159.57
Montgomery	1.02	0.85	15.74
Total	13.47	11.86	205.72

Table 3.1-19: Summary of 2006 Summer Weekday I/M Program Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	0.62	0.51	9.03
Fort Bend	0.80	0.68	11.60
Galveston	0.62	0.55	9.14
Harris	10.75	9.39	156.22
Montgomery	1.06	0.86	15.53
Total	13.86	11.99	201.52

Table 3.1-20: Summary of 2018 Summer Weekday I/M Program Benefits by County

HGB County	**Emission Benefits** (tpd)		
	NO_X	VOC	CO
Brazoria	1.01	0.72	13.98
Fort Bend	1.49	1.09	20.29
Galveston	0.73	0.54	10.08
Harris	14.30	10.45	192.09
Montgomery	1.61	1.13	22.03
Total	19.14	13.93	258.47

Based on an EPA memorandum entitled *Texas Low Emission Diesel (LED) Fuel Benefits*, September 27, 2001, a 4.8 percent NO_x TxLED benefit should be claimed for 2002-and-newer diesel vehicles and a 6.2 percent NO_x TxLED benefit should be claimed for 2001-and-older diesel vehicles. In order to determine the specific TxLED adjustment factors that should apply to each of the 13 diesel vehicle types, MOBILE6.2 runs were performed for the HGB area to determine both VMT and NO_x emissions rates by model year. By using these data, the 4.8 percent and 6.2 percent reduction factors were weighted according to NO_x model year contributions for each vehicle type. The resulting TxLED adjustment factors and benefits for both 2006 and 2018 are summarized in Table 3.1-21: *Summary of 2006 Summer Weekday TxLED Benefits by Vehicle Type* and Table 3.1-22: *Summary of 2018 Summer Weekday TxLED Benefits by Vehicle Type*, respectively. The TxLED adjustment factors were incorporated by TTI into the on-road inventories by post-processing the MOBILE6.2 diesel NO_x emission rates.

Since the TxLED rule was not in effect in the summer of 2005, adjustment factors were not applied to the 2005 on-road inventory.

Table 3.1-21: Summary of 2006 Summer Weekday TxLED Benefits by Vehicle Type

Diesel Vehicle Type	2006 TxLED Benefits		
	NO_X Reduction	Adjustment Factor	Benefit (tpd)
LDDV	6.14%	0.9386	0.0069
LDDT12	6.20%	0.9380	0.0027
HDDV2b	5.13%	0.9487	0.3215
HDDV3	5.45%	0.9455	0.1235
HDDV4	5.58%	0.9442	0.0937
HDDV5	5.47%	0.9453	0.0676
HDDV6	5.69%	0.9431	0.3032
HDDV7	5.75%	0.9425	0.1979
HDDV8a	5.95%	0.9405	0.6760
HDDV8b	5.78%	0.9422	4.0481
HDDBT	5.87%	0.9413	0.1647
HDDBS	5.87%	0.9413	0.2040
LDDT34	5.53%	0.9447	0.0082
Total Diesel	5.75%	0.9425	6.2180

Table 3.1-22: Summary of 2018 Summer Weekday TxLED Benefits by Vehicle Type

Diesel Vehicle Type	2018 TxLED Benefits		
	NO_X Reduction	Adjustment Factor	Benefit (tpd)
LDDV	5.39%	0.9461	0.0003
LDDT12	6.20%	0.9380	0.0000
HDDV2b	4.88%	0.9512	0.0556
HDDV3	4.90%	0.9510	0.0206
HDDV4	4.96%	0.9504	0.0163
HDDV5	5.08%	0.9492	0.0126
HDDV6	5.05%	0.9495	0.0464
HDDV7	5.09%	0.9491	0.0263
HDDV8a	5.30%	0.9470	0.1063
HDDV8b	4.96%	0.9504	0.5179
HDDBT	5.05%	0.9495	0.0499
HDDBS	5.63%	0.9437	0.1231
LDDT34	4.91%	0.9509	0.0016
Total Diesel	5.08%	0.9492	0.9769

The on-road control strategy benefits referenced above are summarized below in Table 3.1-23: *Summary of 2005 Summer Weekday On-Road Control Strategy Benefits*, Table 3.1-24: *Summary of 2006 Summer Weekday On-Road Control Strategy Benefits*, and Table 3.1-25: *Summary of 2018 Summer Weekday On-Road Control Strategy Benefits*. When determining the amount of benefit assigned to specific on-road control strategies, the sequence in which they are modeled

with MOBILE6.2 is important. For example, the RFG benefit for each county was determined by calculating the difference between a MOBILE6.2 run with conventional gasoline and a run with RFG. For both runs, the I/M program was not modeled and all other inputs were held constant. Then, the I/M program benefits were determined by calculating the difference between a MOBILE6.2 run with RFG and a run with both RFG and I/M. Please note that if the benefits were calculated in a different order, the benefit assigned to each individual strategy would vary, but the magnitude of the combined benefits would not change. Since RFG and I/M affect gasoline-powered vehicles only, it does not matter where in the sequence TxLED is modeled because it only affects diesel-powered vehicles.

Table 3.1-23: Summary of 2005 Summer Weekday On-road Control Strategy Benefits

2005 On-Road	**Emission Benefits** (tpd)		
Control Strategy	NO_X	VOC	CO
RFG	1.75	17.40	112.84
I/M	13.47	11.86	205.72
Total	15.21	29.26	318.56

Table 3.1-24: Summary of 2006 Summer Weekday On-road Control Strategy Benefits

2006 On-Road	**Emission Benefits** (tpd)		
Control Strategy	NO_X	VOC	CO
RFG	2.07	15.97	107.45
I/M	13.86	11.99	201.52
TxLED	6.22	0.00	0.00
Total	22.14	27.96	308.96

Table 3.1-25: Summary of 2018 Summer Weekday On-road Control Strategy Benefits

2018 On-Road	**Emission Benefits** (tpd)		
Control Strategy	NO_X	VOC	CO
RFG	0.78	8.69	72.84

I/M	19.14	13.93	258.47
TxLED	0.98	0.00	0.00
Total	20.90	22.62	331.31

EPA issued a document in January 2004 entitled *Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity.* This EPA guidance states that extended idling emissions account for 3.4 percent of the total emissions calculated with MOBILE6.2 for the HDDV8a and HDDV8b vehicle classes. As previously stated, the CNTLEM module was used to remove 3.4 percent of the hourly NO_x, VOC, and CO emissions from the "running" emissions prepared for photochemical model input from the HDDV8a and HDDV8b classes. Using a combination of SAS and UNIX code, these extended idling emissions were aggregated into an eight-county 24-hour total and spatially assigned to known truck stop locations. The extended idling emissions were then processed through EPS3 as if they were stationary low-level point sources. The emissions were temporally allocated as the inverse of HDDV8a/HDDV8b VMT. Consequently, more of the extended idling emissions were allocated during overnight hours rather than daytime hours. The extended idling emissions were also run through the CNTLEM module to receive a temperature/humidity NO_x correction. The summer weekday extended idling emissions by county are presented below in Table 3.1-26: *2005 HDDV8a & HDDV8b Extended Idling Emissions for the Eight-County HGB*, Table 3.1-27: *2006 HDDV8a & HDDV8b Extended Idling Emissions for Eight-County HGB*, and Table 3.1-28: *2018 HDDV8a & HDDV8b Extended Idling Emissions for Eight-County HGB.* Greater detail on heavy-duty vehicle idling activity specific to Texas metropolitan areas can be found in reports located on the following web site:
http://www.tceq.state.tx.us/implementation/air/airmod/project/pj_report_mob.html

Table 3.1-26: 2005 HDDV8a & HDDV8b Extended Idling Emissions for Eight-County HGB

HGB County	**Extended Idling Emissions** (tpd)		
	NO_x	VOC	CO
Brazoria	0.0145	0.0005	0.0027
Chambers	0.1793	0.0061	0.0343
Fort Bend	0.2940	0.0098	0.0547
Galveston	0.0502	0.0016	0.0093
Harris	1.8163	0.0605	0.3380
Liberty	0.0468	0.0015	0.0086
Montgomery	0.3967	0.0131	0.0730
Waller	0.2297	0.0075	0.0421
Total	3.0275	0.1006	0.5627

Table 3.1-27: 2006 HDDV8a & HDDV8b Extended Idling Emissions for Eight-County HGB

HGB County	**Extended Idling Emissions** (tpd)		
	NO_x	VOC	CO
Brazoria	0.0122	0.0005	0.0026
Chambers	0.1506	0.0058	0.0333
Fort Bend	0.2462	0.0092	0.0532

HGB County	Extended Idling Emissions (tpd)		
	NO_x	VOC	CO
Galveston	0.0419	0.0015	0.0090
Harris	1.5224	0.0569	0.3280
Liberty	0.0393	0.0014	0.0083
Montgomery	0.3327	0.0122	0.0708
Waller	0.1906	0.0071	0.0410
Total	2.5359	0.0946	0.5462

Table 3.1-28: 2018 HDDV8a & HDDV8b Extended Idling Emissions for Eight-County HGB

HGB County	Extended Idling Emissions (tpd)		
	NO_x	VOC	CO
Brazoria	0.0019	0.0003	0.0006
Chambers	0.0231	0.0044	0.0069
Fort Bend	0.0378	0.0071	0.0110
Galveston	0.0064	0.0012	0.0019
Harris	0.2335	0.0438	0.0676
Liberty	0.0061	0.0011	0.0018
Montgomery	0.0510	0.0094	0.0146
Waller	0.0295	0.0054	0.0084
Total	0.3893	0.0727	0.1128

The summer weekday on-road emissions by county that were input into the photochemical model are summarized below in Table 3.1-29: *2005 Summer Weekday On-Road Mobile Source Inventory by County*, Table 3.1-30: *2006 Summer Weekday On-Road Mobile Source Inventory by County*, and Table 3.1-31: *2018 Summer Weekday On-Road Mobile Source Inventory by County*. The on-road inventory summaries in Tables 3.1-29, 3.1-30, and 3.1-31 are a combination of both running and extended idling emissions. In addition, the temperature/humidity NO_x correction has been applied as summarized above in Tables 3.1-12, 3.1-13, and 3.1-14.

Table 3.1-29: 2005 Summer Weekday On-Road Mobile Source Inventory by County

HGB County	On-Road Emissions (tpd)		
	NO_x	VOC	CO
Brazoria	9.19	3.92	53.41
Chambers	5.55	1.98	34.10
Fort Bend	12.74	4.91	69.27
Galveston	9.26	4.17	54.18
Harris	158.29	69.44	882.75
Liberty	4.75	2.38	32.32
Montgomery	17.60	6.51	92.24
Waller	4.31	1.83	26.68
Total	221.68	95.14	1,244.95

Table 3.1-30: 2006 Summer Weekday On-Road Mobile Source Inventory by County

HGB	On-Road Emissions (tpd)

County	NO_x	VOC	CO
Brazoria	8.24	3.66	47.02
Chambers	4.90	1.82	29.63
Fort Bend	11.46	4.66	62.03
Galveston	8.16	3.89	47.36
Harris	140.45	66.42	792.36
Liberty	4.34	2.29	29.30
Montgomery	15.87	6.18	82.91
Waller	3.88	1.79	24.63
Total	197.29	90.71	1,115.26

Table 3.1-31: 2018 Summer Weekday On-Road Mobile Source Inventory by County

HGB County	**On-Road Emissions** (tpd)		
	NO_x	VOC	CO
Brazoria	2.50	2.17	36.59
Chambers	1.72	1.25	24.85
Fort Bend	3.67	3.24	53.11
Galveston	1.80	1.69	26.46
Harris	33.90	31.62	491.04
Liberty	1.67	1.41	23.64
Montgomery	4.25	3.59	59.97
Waller	1.26	1.01	17.52
Total	50.76	45.97	733.18

The total eight-county HGB on-road emissions input to the photochemical model by combination of season and day type are summarized below in Table 3.1-32: *2005 On-Road Mobile Source Inventory by Season and Day Type*, Table 3.1-33: *2006 On-Road Mobile Source Inventory by Season and Day Type*, and 3-34: *2018 On-Road Mobile Source Inventory by Season and Day Type*.

Table 3.1-32: 2005 On-Road Mobile Source Inventory by Season and Day Type

Season Type	Day Type	**On-Road Emissions** (tpd)		
		NO_x	VOC	CO
Summer	Weekday	221.68	95.14	1,244.95
	Friday	223.69	103.76	1,359.37
	Saturday	180.74	73.07	1,032.64
	Sunday	143.18	61.86	873.70
School	Weekday	233.36	100.61	1,307.38
	Friday	241.07	112.59	1,457.81
	Saturday	192.68	78.00	1,099.40
	Sunday	148.69	64.32	906.88

Table 3.1-33: 2006 On-Road Mobile Source Inventory by Season and Day Type

Season Type	Day Type	**On-Road Emissions** (tpd)		
		NO_x	VOC	CO

Summer	Weekday	197.29	90.71	1,115.26
	Friday	199.93	98.94	1,217.38
	Saturday	160.78	69.41	920.60
	Sunday	127.69	58.76	778.75
School	Weekday	207.66	95.96	1,171.29
	Friday	215.44	107.41	1,305.79
	Saturday	171.38	74.10	980.17
	Sunday	132.60	61.12	808.41

Table 3.1-34: 2018 On-Road Mobile Source Inventory by Season and Day Type

Season Type	Day Type	On-Road Emissions (tpd)		
		NO_x	VOC	CO
Summer	Weekday	50.76	45.97	733.18
	Friday	53.35	50.61	808.09
	Saturday	41.59	35.03	597.98
	Sunday	33.48	29.34	500.97
School	Weekday	53.02	48.25	764.81
	Friday	56.46	53.89	853.13
	Saturday	43.25	36.48	621.40
	Sunday	34.32	30.12	513.33

An additional post-processing step for the 2018 emission inventories was necessary to apply the 1.55 NO_X tpd of voluntary mobile source emission reduction program (VMEP) on-road benefits submitted by H-GAC. The non-idling NO_X emissions are broken into both light-duty and heavy-duty categories in Table 3.1-35: *2018 Distribution of Summer Weekday On-Road Running Emissions*.

Table 3.1-35: 2018 Distribution of Summer Weekday On-Road Running Emissions

Vehicle Grouping	On-Road NO_X (tpd)	
	Emissions	Contribution
Light-Duty	31.53	62.58%
Heavy-Duty	18.85	37.42%
Total "Running" Emissions	50.37	100.00%

Table 3.1-36: *Allocation of 2018 On-Road VMEP NO_X Benefits* demonstrates how the relative contributions from Table 3.1-35 were used to split the regional traffic flow improvements into light-duty and heavy-duty categories. Alternative commuting benefits were applied only to the light-duty portion of the fleet, while retrofit and replacement benefits were applied only to the heavy-duty portion. These VMEP benefits were incorporated into the on-road emission inventories with the EPS3 CNTLEM module by using the NO_X adjustment factors shown.

Table 3.1-36: Allocation of 2018 On-Road VMEP NO_X Benefits

On-Road VMEP Parameter	On-Road NO_X Emissions (tpd)		
	Light-Duty	Heavy-Duty	Total
Regional Traffic Flow Improvements	0.03	0.02	0.05
Alternative Commuting	0.20	0.00	0.20
Vehicle Retrofit and Replacement	0.00	1.30	1.30

On-Road VMEP Parameter	On-Road NO_X Emissions (tpd)		
	Light-Duty	Heavy-Duty	Total
Total On-Road VMEP	0.23	1.32	1.55
Running Emissions Without VMEP	31.53	18.85	50.37
Running Emissions With VMEP	31.29	17.53	48.82
Relative NO_X Reduction	0.73%	7.00%	3.08%
EPS3 CNTLEM NO_X Adjustment Factors	0.99266	0.93004	

After application of the VMEP adjustment factors, the 2018 county-level emissions figures from Table 3.1-31 were modified as presented in Table 3.1-37: *2018 Summer Weekday On-Road Mobile Source Inventory by County With VMEP*. The same set of VMEP adjustment factors were applied to all of the season and day types, which resulted in the 2018 emissions from Table 3.1-34 modified as presented in Table 3.1-38: *2018 On-Road Mobile Source Inventory by Season and Day Type With VMEP*.

Table 3.1-37: 2018 Summer Weekday On-Road Mobile Inventory by County With VMEP

HGB County	On-Road Emissions (tpd)		
	NO_x	VOC	CO
Brazoria	2.42	2.17	36.59
Chambers	1.67	1.25	24.85
Fort Bend	3.55	3.24	53.11
Galveston	1.74	1.69	26.46
Harris	32.86	31.62	491.04
Liberty	1.63	1.41	23.64
Montgomery	4.11	3.59	59.97
Waller	1.23	1.01	17.52
Total	49.21	45.97	733.18

Table 3.1-38: 2018 On-Road Mobile Source Inventory by Season and Day Type With VMEP

Season Type	Day Type	On-Road Emissions (tpd)		
		NO_x	VOC	CO
Summer	Weekday	49.21	45.97	733.18
	Friday	51.84	50.61	808.09
	Saturday	40.37	35.03	597.98
	Sunday	32.56	29.34	500.97
School	Weekday	51.40	48.25	764.81
	Friday	54.86	53.89	853.13
	Saturday	41.98	36.48	621.40
	Sunday	33.37	30.12	513.33

For the on-road mobile inventory portion of the HGB subdomain, the EPS3 message files along with the gridded files input into the photochemical model for 2005, 2006, and 2018 are available on the following FTP sites, respectively:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/eps3/2005/

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/eps3/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/HGB/eps3/2018/

Similar on-road mobile EPS3 message and gridded files for the Texas-only portion of the larger 12 km modeling domain are available for 2005, 2006, and 2018, respectively, on the following FTP sites:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/eps3/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/eps3/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/eps3/2018/

Similar on-road mobile EPS3 message and gridded files for both the Texas and non-Texas portions of the larger 12 km modeling domain are available for 2005, 2006, and 2018, respectively, on the following FTP sites:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2018/

By definition, the future case on-road emissions inventory input into the final attainment demonstration photochemical modeling run should establish the motor vehicle emissions budget (MVEB). However, use of the EPS3 processor introduces unique adjustments to the on-road emissions inventory that are necessary for photochemical modeling efforts. An EPS3 processing step necessary for photochemical model input involves the use of Central Standard Time (CST) instead of Central Daylight Time (CDT). All photochemical modeling inventory files must be in CST to be consistent with the way meteorological data are reported and modeled. However, emissions inventory files are typically developed in CDT.

When governmental organizations need to demonstrate conformity to the MVEB, they will not be developing photochemical modeling inventories and therefore will not apply this time-shift step. Consequently, the 2018 MVEB for the eight-county HGB area will start with the summer weekday on-road inventory as received from TTI in CDT format. Then, adjustments for the temperature/humidity NO_x correction are applied outside of EPS3, but in a manner consistent with the descriptions included above. This approach is summarized below in Table 3.1-39: *2018 Attainment Demonstration Motor Vehicle Emissions Budget for Eight-County HGB Area*. The slight differences between the MVEB and the eight-county NO_x and VOC totals in Tables 3.1-37 and 3.1-38 are due solely to the manner in which the EPS3 system converts text-based, non-speciated inventory data in CDT into a binary, gridded, and speciated format in CST appropriate for photochemical model input.

Table 3.1-39: 2018 Attainment Demonstration MVEB for the Eight-County HGB Area

Eight-County HGB Area	**Total Emissions** (tpd)	
	NO_x	VOC
On-Road Inventory From TTI (Table 3.1-3) Includes I/M, RFG, & TxLED	52.55	45.97
Temperature/Humidity NO_x Correction (Table 3.1-14)	1.78	0.00
On-Road VMEP Benefits (Table 3.1-36)	1.55	0.00
Final Eight-County HGB MVEB	49.22	45.97

The following pages contain graphical plots of the 2018 on-road summer weekday NO_X and VOC emissions for a combination of the HGB and Beaumont/Port Arthur (BPA) areas. These plots are respectively entitled Figure 3.1-1: *2018 HGB & BPA Summer Weekday NOx Emissions* and Figure 3.1-2: *2018 HGB & BPA Summer Weekday VOC Emissions*.

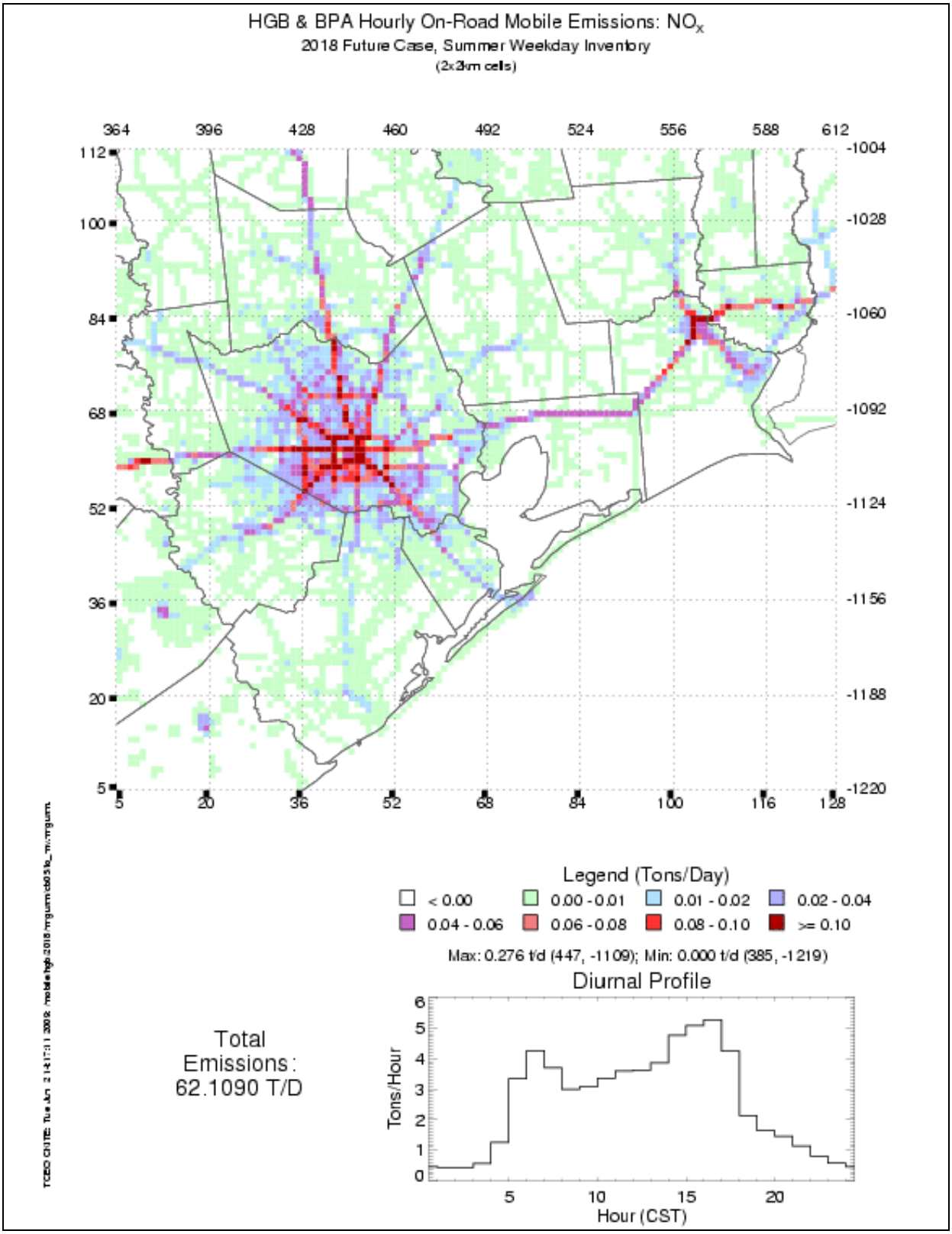


Figure 3.1-1: 2018 HGB & BPA Summer Weekday NO_X Emissions

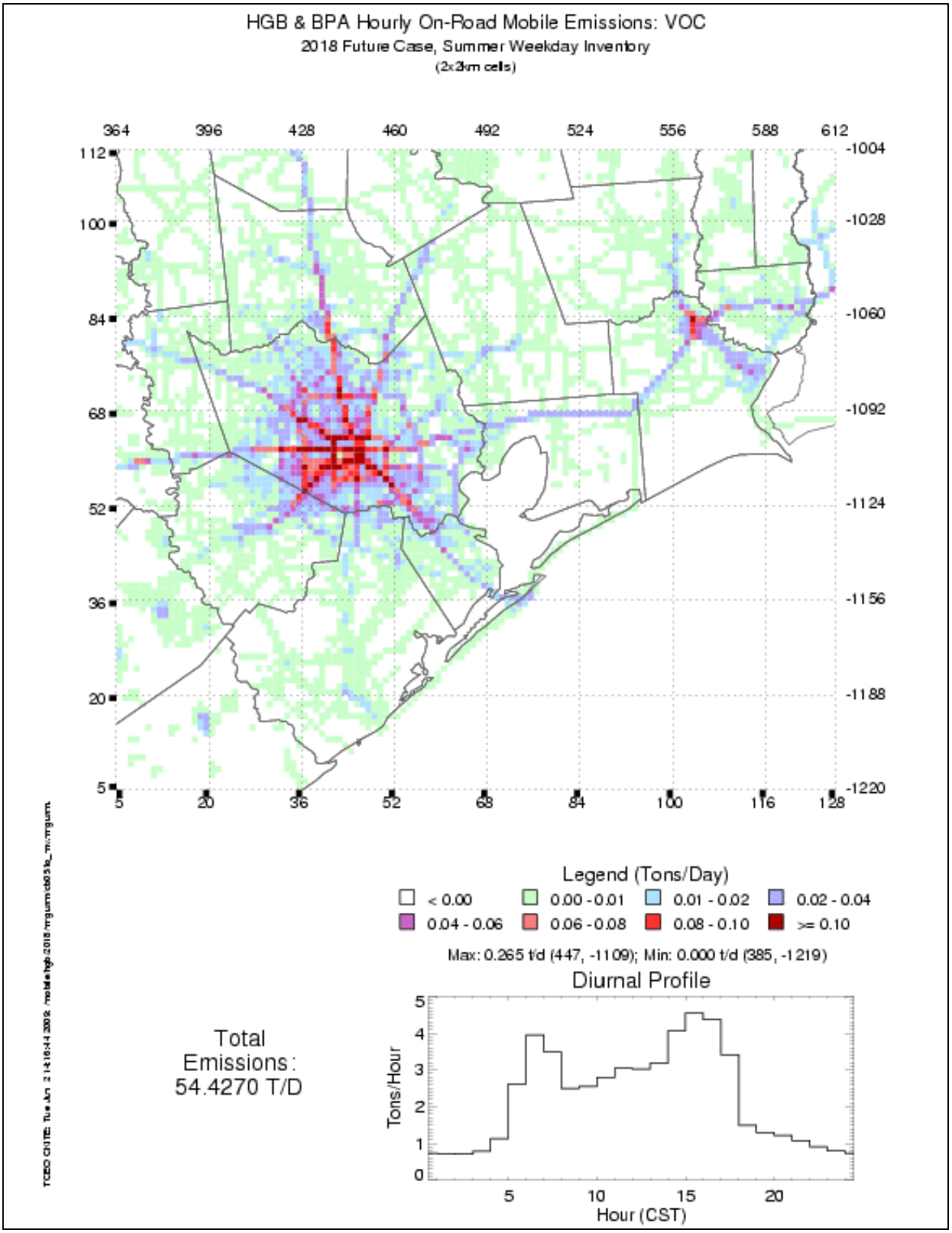


Figure 3.1-2: 2018 HGB & BPA Summer Weekday VOC Emissions

3.2 On-Road Mobile Source Emissions Inventories for Non-Eight-County HGB Areas

On-road emission inventories for 2005, 2006, and 2018 were also developed for portions of the modeling domain outside of the eight-county HGB area. For the three Beaumont-Port Arthur (BPA) area counties of Hardin, Jefferson, and Orange, a similar link-based inventory development approach was taken by TTI based on TDM output available from local transportation agencies. Similar to the HGB on-road emissions development, both school and summer season on-road inventories were developed for the four day types of weekday, Friday, Saturday, and Sunday. More detail on the development of these BPA inventories with the MOBILE6.2 model is available on the following FTP sites:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/BPA/m62/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/BPA/m62/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/BPA/m62/2018/

For the Texas counties outside of the eight-county HGB and three-county BPA areas, on-road emissions were developed by TTI using Highway Performance Monitoring System (HPMS) data as the basis for VMT estimates. Summer season emission estimates were developed for the four day types of weekday, Friday, Saturday, and Sunday. Hourly emission rates from MOBILE6.2 were coupled with county-level VMT estimates by roadway type for 2005, 2006, and 2018. More detail on the development of these HPMS-based on-road inventories is available on the following FTP sites:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/m62/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/m62/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/Statewide/m62/2018/

On-road emission estimates for non-Texas states within the photochemical modeling domain were developed for 2005, 2006, and 2018 using the EPA National Mobile Inventory Model (NMIM), which is available at http://www.epa.gov/otaq/nmim.htm and can be used to develop on-road county-level emission estimates for every year from 1999-2050. However, the NMIM activity database is only populated with county-level VMT figures for 1999 and 2002. Historical annual VMT figures by state from 1980-2006 were obtained from the Federal Highway Administration (FHWA) Highway Statistics Series webpage, which is available at (http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm). Linear trends were established with these data to project 2018 VMT for each state and roadway type. NMIM was run for 2005, 2006, and 2018 for all non-Texas states after inclusion of these FHWA-based VMT figures into the NMIM activity tables, and the results are available at:

- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2005/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2006/
- ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/US/eps3/2018/

Since only average weekday emissions can easily be obtained with NMIM, Friday, Saturday, and Sunday day type emissions were estimated for the non-Texas area by applying adjustment factors with the EPS3 TMPRL module. These adjustment factors were based on the ratios of Friday/weekday, Saturday/weekday, and Sunday/weekday emissions from the statewide inventories developed by TTI for Texas. More detail on this approach is documented in a report entitled *Use of the National Mobile Inventory Model for Photochemical Modeling Applications in Texas*, which was presented at the 17th International Emissions Inventory Conference and is available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Mobile_EI/NMIM/.

A summary of the different emission estimation approaches taken for this HGB SIP revision is provided in Table 3.1-40: *On-Road Emission Inventory Development by Area Within the Modeling Domain*.

Table 3.2-1: On-Road Inventory Development by Area Within the Modeling Domain

On-Road Inventory Development Parameter	HGB and BPA	Non-HGB and Non-BPA	Non-Texas States/Counties
VMT Source	Travel Demand Models (TDMs)	HPMS Data Sets	NMIM Database/ FHWA Statistics
VMT Resolution	Roadway Links From TDM	19 Roadway Types	12 Roadway Types
Season Types	School and Summer (i.e., non-School)	Summer Only	Summer Only
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday
Hourly VMT?	Yes	Yes	No
VMT Mix Variation By Day/Time Period?	Yes	Yes	No
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOBILE6.2 Default
Spatial Resolution	Excellent	Very Good	Good
Temporal Resolution	Excellent	Very Good	Good
MOBILE6.2 Vehicle Types	28	28	12
Temperature/Humidity Diesel NO_X Correction	Yes	Yes	No
"18-Wheeler" Idling Emissions Separation	Yes	No	No

4.0 NON-ROAD, OFF-ROAD, AND AREA SOURCE MODELING EMISSIONS

For the purposes of this Houston-Galveston-Brazoria (HGB) modeling emissions summary, non-road vehicles and equipment refer to those categories whose emissions can be estimated with EPA's NONROAD model (http://www.epa.gov/otaq/nonrdmdl.htm). Off-road vehicles and equipment refer to the aircraft, locomotive, and commercial marine categories that are not covered by the NONROAD model. Area sources cover a wide range of remaining categories. Emission estimates are summarized below in Table 4.0-1: *2005 HGB Non-Road, Off-Road, and Area Source Modeling Emissions*, Table 4.0-2: *2006 HGB Non-Road, Off-Road, and Area Source Modeling Emissions*, and Table 4.0-3: *2018 HGB Non-Road, Off-Road, and Area Source Modeling Emissions*. Greater detail on each category is contained within the following sections.

Table 4.0-1: 2005 HGB Non-Road, Off-Road, and Area Source Modeling Emissions

Source Category Description	**Summer Weekday Emissions** (tpd)	
	NO_X	VOC
Non-Road Equipment	77.74	58.29
Oil and Gas Exploration	6.49	0.25
Aircraft	7.55	1.90
Airport Ground Support Equipment	1.89	0.76
Locomotives	30.32	1.83
Commercial Marine	34.47	0.97
Area Sources	36.20	427.79
Grand Total	194.66	491.79

Table 4.0-2: 2006 HGB Non-Road, Off-Road, and Area Source Modeling Emissions

Source Category Description	**Summer Weekday Emissions** (tpd)	
	NO_X	VOC
Non-Road Equipment	73.47	54.58
Oil and Gas Exploration	5.87	0.24
Aircraft	7.77	1.96
Airport Ground Support Equipment	1.83	0.73
Locomotives	28.53	1.79
Commercial Marine	35.10	0.99
Area Sources	36.36	431.66
Grand Total	188.93	491.95

Table 4.0-3: 2018 HGB Non-Road, Off-Road, and Area Source Modeling Emissions

Source Category Description	**Summer Weekday Emissions** (tpd)	
	NO_X	VOC
Non-Road Equipment	30.58	27.17
Oil and Gas Exploration	2.34	0.14
Aircraft	11.36	2.44
Airport Ground Support Equipment	0.86	0.30
Locomotives	34.22	2.35
Commercial Marine	39.24	1.18
Area Sources	42.06	530.25
Grand Total	160.66	563.83

4.1 Non-Road Mobile Source Modeling Emissions for Eight-County HGB

Non-road emissions for 2005, 2006, and 2018 for the eight-county HGB area were estimated with a customized version of EPA's NONROAD model called Texas NONROAD (TexN), which is available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Nonroad_EI/TexN/. For each county specified in a TexN scenario, 25 separate runs of the NONROAD model are performed for the following non-road categories outlined in Table 4.1-1: *Summary of TexN Model Diesel Construction Equipment Subcategories*. Runs 1-25 (excluding 24) are for specific diesel construction equipment (DCE) categories, while the numeric code of 0 is for all non-DCE categories.

Table 4.1-1: Summary of TexN Model Diesel Construction Equipment Subcategories

Numeric Code	NONROAD Model Subsector Description (Diesel Construction Equipment for 1-24)
0	Other - Non-Diesel Construction Equipment
1	DCE - Agricultural Activities
2	DCE - Boring and Drilling Equipment
3	DCE - Brick and Stone Operations
4	DCE - City and County Road Construction
5	DCE - Commercial Construction
6	DCE - Concrete Operations
7	DCE - County-Owned Construction Equipment
8	DCE - Cranes
9	DCE - Heavy Highway Construction
10	DCE - Landfill Operations
11	DCE - Landscaping Activities
12	DCE - Manufacturing Operations
13	DCE - Municipal-Owned Construction Equipment
14	DCE - Transportation/Sales/Services
15	DCE - Residential Construction
16	DCE - Rough Terrain Forklifts
17	DCE - Scrap/Recycling Operations
18	DCE - Skid Steer Loaders
19	DCE - Special Trades Construction
20	DCE - Trenchers
21	DCE - TxDOT Construction Equipment
22	DCE - Utility Construction
23	DCE - Mining and Quarry Operation
25	DCE - Off-Road Tractors, Miscellaneous, & Equipment Under 25 Horsepower

2005, 2006, and 2018 summer weekday scenarios were run with the TexN model for all eight counties in the HGB area. 25 DCE subcategories for each of the eight counties resulted in a total of 200 NONROAD model runs for each calendar year. The NONROAD input files, output files, and Excel spreadsheet summary tables for these analyses are available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Nonroad_EI/HGB/.

The NO_X, VOC, and CO emissions by county along with associated non-road equipment population figures are presented below in Table 4.1-2: *2005 HGB Summer Weekday Non-Road*

Equipment and Emissions by County, Table 4.1-3: *2006 HGB Summer Weekday Non-Road Equipment and Emissions by County*, and Table 4.1-4: *2018 HGB Summer Weekday Non-Road Equipment and Emissions by County*.

Table 4.1-2: 2005 HGB Summer Weekday Non-Road Equipment and Emissions by County

County Name	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Brazoria	97,840	5.14	3.89	29.25
Chambers	21,159	1.29	1.18	6.05
Fort Bend	111,040	5.79	3.24	38.38
Galveston	129,000	3.18	4.01	25.14
Harris	1,252,383	58.47	39.70	462.16
Liberty	24,140	1.99	0.73	6.69
Montgomery	134,457	4.70	5.00	37.55
Waller	13,420	1.39	0.54	5.02
Total	1,783,439	81.96	58.29	610.23

Table 4.1-3: 2006 HGB Summer Weekday Non-Road Equipment and Emissions by County

County Name	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Brazoria	99,911	4.94	3.63	26.97
Chambers	21,565	1.26	1.11	5.68
Fort Bend	113,816	5.89	2.96	35.28
Galveston	131,905	3.39	3.79	23.09
Harris	1,279,801	56.84	37.20	429.22
Liberty	24,790	1.88	0.67	6.17
Montgomery	137,521	4.55	4.72	34.47
Waller	13,798	1.36	0.50	4.60
Total	1,823,106	80.11	54.58	565.47

Table 4.1-4: 2018 HGB Summer Weekday Non-Road Equipment and Emissions by County

County Name	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Brazoria	122,941	2.22	1.76	19.14
Chambers	25,611	0.48	0.52	3.61
Fort Bend	143,242	2.76	1.60	26.38
Galveston	159,796	1.50	1.98	18.70
Harris	1,599,823	24.05	18.03	317.57
Liberty	31,257	0.71	0.38	4.19
Montgomery	170,929	2.19	2.62	28.74
Waller	17,488	0.53	0.28	3.29
Total	2,271,087	34.46	27.17	421.63

Even with overall growth in the non-road equipment population from roughly 1.8 million in 2005/2006 to 2.3 million in 2018, total NO_X and VOC emissions decrease due to the more stringent emissions standards for new equipment purchases, combined with the simultaneous

attrition of older, higher-emitting pieces of non-road equipment. The eight-county non-road emissions are summarized by aggregate equipment category in Table 4.1-5: *2005 HGB Summer Weekday Non-Road Inventory by Equipment Category*, Table 4.1-6: *2006 HGB Summer Weekday Non-Road Inventory by Equipment Category*, and Table 4.1-7: *2018 HGB Summer Weekday Non-Road Inventory by Equipment Category*.

Table 4.1-5: 2005 HGB Summer Weekday Non-Road Inventory by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	6,335	6.76	0.85	9.98
Commercial	183,218	8.27	11.98	238.20
Construction	69,450	35.30	6.95	57.30
Industrial	30,241	28.59	7.83	118.48
Lawn and Garden	1,323,636	1.83	15.77	146.82
Logging	1,538	0.28	0.17	1.18
Pleasure Craft	117,863	0.68	10.21	22.53
Railway Maintenance	90	0.08	0.01	0.06
Recreational	51,068	0.16	4.52	15.66
Total	1,783,439	81.96	58.29	610.23

Table 4.1-6: 2006 HGB Summer Weekday Non-Road Inventory by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	6,443	6.41	0.68	8.86
Commercial	188,842	8.44	11.46	217.19
Construction	72,021	34.69	6.39	52.71
Industrial	30,929	27.36	7.39	118.17
Lawn and Garden	1,349,719	1.92	14.06	131.63
Logging	1,586	0.26	0.15	1.09
Pleasure Craft	118,745	0.77	9.75	20.79
Railway Maintenance	93	0.07	0.01	0.06
Recreational	54,728	0.18	4.70	14.99
Total	1,823,106	80.11	54.58	565.47

Table 4.1-7: 2018 HGB Summer Weekday Non-Road Inventory by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	7,957	2.42	0.30	2.28
Commercial	256,241	5.60	6.35	201.05
Construction	92,055	16.72	3.64	36.34
Industrial	39,145	7.51	1.35	30.83
Lawn and Garden	1,664,135	1.15	7.96	113.48
Logging	2,154	0.05	0.13	1.13
Pleasure Craft	129,479	0.81	4.35	17.72
Railway Maintenance	126	0.05	0.01	0.04
Recreational	79,794	0.15	3.08	18.77

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Total	2,271,087	34.46	27.17	421.63

The eight-county non-road emissions are summarized by fuel and engine type in Table 4.1-8: *2005 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type,* Table 4.1-9: *2006 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type*, and Table 4.1-10: *2018 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type*.

Table 4.1-8: 2005 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type

Fuel/Engine Type	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Two-Stroke Gasoline	590,850	0.38	22.61	41.88
Four-Stroke Gasoline	1,081,799	4.77	22.70	426.59
Diesel	84,555	51.87	5.62	26.28
Compressed Natural Gas	1,543	1.33	0.94	8.83
Liquefied Petroleum Gas	24,692	23.61	6.42	106.65
Total	1,783,439	81.96	58.29	610.23

Table 4.1-9: 2006 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type

Fuel/Engine Type	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Two-Stroke Gasoline	602,224	0.44	20.50	37.83
Four-Stroke Gasoline	1,105,617	5.07	21.76	385.19
Diesel	88,256	50.98	5.45	25.78
Compressed Natural Gas	1,556	1.15	0.73	8.23
Liquefied Petroleum Gas	25,452	22.46	6.14	108.45
Total	1,823,106	80.11	54.58	565.47

Table 4.1-10: 2018 HGB Summer Weekday Non-Road Inventory by Fuel and Engine Type

Fuel/Engine Type	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Two-Stroke Gasoline	732,797	0.61	12.11	42.00
Four-Stroke Gasoline	1,380,034	2.35	10.79	334.84
Diesel	121,853	25.97	3.02	13.05
Compressed Natural Gas	1,909	0.26	0.08	1.22
Liquefied Petroleum Gas	34,493	5.27	1.17	30.51
Total	2,271,087	34.46	27.17	421.63

The eight-county non-road emissions are summarized by the 25 DCE subcategory codes from Table 4.1-1 in Table 4.1-11: *2005 HGB Summer Weekday Non-Road Inventory by DCE Subcategory*, Table 4.1-12: *2006 HGB Summer Weekday Non-Road Inventory by DCE Subcategory*, and Table 4.1-13: *2018 HGB Summer Weekday Non-Road Inventory by DCE Subcategory*.

Table 4.1-11: 2005 HGB Summer Weekday Non-Road Inventory by DCE Subcategory

Non-Road DCE Subsector Code	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
0	1,738,334	47.33	54.63	592.51
1	823	1.18	0.13	0.63
2	215	0.22	0.02	0.08
3	110	0.36	0.03	0.14
4	678	0.26	0.02	0.11
5	11,913	2.83	0.27	1.25
6	71	0.18	0.01	0.08
7	254	0.20	0.02	0.09
8	2,107	6.56	0.41	1.45
9	429	0.58	0.05	0.27
10	123	0.90	0.05	0.31
11	1,049	0.53	0.11	0.47
12	132	0.30	0.02	0.13
13	1,075	0.62	0.11	0.49
14	1,203	2.42	0.22	1.15
15	2,235	4.06	0.31	1.60
16	2,294	2.28	0.24	1.39
17	160	0.51	0.04	0.16
18	8,087	2.59	0.78	3.24
19	77	0.05	0.01	0.03
20	5,965	4.75	0.49	3.02
21	191	0.08	0.01	0.04
22	1,741	0.68	0.05	0.29
23	110	0.55	0.04	0.17
25	4,063	1.96	0.23	1.14
Total	1,783,439	81.96	58.29	610.23

Table 4.1-12: 2006 HGB Summer Weekday Non-Road Inventory by DCE Subcategory

Non-Road DCE Subsector Code	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
0	1,775,504	46.09	51.02	548.13
1	817	1.10	0.12	0.60
2	233	0.23	0.02	0.08
3	105	0.32	0.02	0.12
4	688	0.25	0.02	0.11
5	13,580	3.11	0.29	1.37
6	72	0.17	0.01	0.08
7	258	0.19	0.02	0.09
8	2,336	6.79	0.42	1.50
9	411	0.53	0.04	0.25
10	125	0.84	0.05	0.30
11	1,077	0.52	0.11	0.47
12	130	0.28	0.02	0.12
13	1,093	0.61	0.10	0.48
14	1,264	2.40	0.22	1.16
15	2,408	4.15	0.32	1.60
16	2,551	2.43	0.24	1.47
17	162	0.48	0.04	0.16
18	8,879	2.77	0.81	3.45
19	80	0.05	0.01	0.03
20	4,879	3.73	0.37	2.35
21	191	0.08	0.01	0.04
22	2,026	0.76	0.06	0.32
23	72	0.32	0.02	0.11
25	4,164	1.92	0.22	1.10
Total	1,823,106	80.11	54.58	565.47

Table 4.1-13: 2018 HGB Summer Weekday Non-Road Inventory by DCE Subcategory

Non-Road DCE Subsector Code	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
0	2,204,337	17.97	25.15	412.73
1	744	0.29	0.04	0.17
2	346	0.17	0.01	0.05
3	75	0.05	0.01	0.02
4	817	0.14	0.01	0.05
5	20,431	2.40	0.22	1.01
6	91	0.05	0.01	0.03
7	311	0.10	0.01	0.04
8	3,428	2.23	0.29	0.56
9	489	0.22	0.02	0.10
10	149	0.11	0.03	0.04
11	1,375	0.32	0.05	0.26
12	175	0.09	0.01	0.04
13	1,318	0.34	0.04	0.22
14	2,320	1.14	0.16	0.63
15	2,301	1.16	0.13	0.48
16	4,024	1.17	0.13	0.78
17	187	0.09	0.02	0.03
18	12,869	2.32	0.45	2.56
19	101	0.03	0.00	0.02
20	6,387	2.18	0.16	0.87
21	191	0.04	0.00	0.02
22	3,162	0.60	0.05	0.24
23	79	0.05	0.01	0.02
25	5,381	1.19	0.14	0.64
Total	2,271,087	34.46	27.17	421.63

The non-road emissions data output from TexN were prepared for photochemical model using Version 3 of the Emissions Processing System (EPS3). When input into EPS3, the inventory data are in a "readable" text-based format. However, once within EPS3, the emissions data are maintained in a binary format. Table 4.1-14: *EPS3 Modules Used to Process Eight-County HGB Non-Road Emissions Data* summarizes the steps that were taken to process the 2005, 2006, and 2018 non-road inventories.

Table 4.1-14: EPS3 Modules Used to Process Eight-County HGB Non-Road Emissions

EPS3 Module	Emissions Processing Description
PREAM	Convert text-based input files to binary format for further processing
CNTLEM	Apply adjustments for TxLED and temperature/humidity NO_X correction
TMPRL	Apply profiles to temporally allocate daily emission totals
CHMSPL	Chemically speciate emissions into NO, NO_2, Olefins, Parrafins, etc.
GRDEM	Spatially allocate emissions using surrogates and prepare photochemical inputs
MRGUAM	Merge and adjust multiple GRDEM output files for photochemical model input

The 2006 and 2018 non-road NO_X emission totals presented above in Tables 4.1-3 through 4.1-13 exclude the benefits of Texas Low Emission Diesel (TxLED) fuel. Instead, TxLED benefits were accounted for by applying a NO_X reduction to the diesel non-road equipment categories through use of the EPS3 CNTLEM module. The specific adjustment factors vary by horsepower range and certification standard, as summarized in Table 4.1-15: *Non-Road TxLED Adjustment Factor Summary*. More detail on development of these post-processing adjustments can be found in a September 27, 2001 EPA memorandum *Texas Low Emission Diesel (LED) Fuel Benefits*.

Table 4.1-15: Non-Road TxLED Adjustment Factor Summary

Non-Road Diesel Equipment Standard/Category	TxLED NO_X Reduction Factor
Under 50 Horsepower	0.0%
Base, Tier 0, Tier 1, Tier 2	6.2%
Tier 3, Tier 4	4.8%

Since the TxLED rule was not in effect in the summer of 2005, adjustment factors were not applied to the 2005 non-road inventory. The 2006 and 2018 non-road TxLED benefits for the eight-county HGB area are presented in Table 4.1-16: *HGB Summer Weekday Non-Road TxLED Benefits by Calendar Year.*

Table 4.1-16: HGB Summer Weekday Non-Road TxLED Benefits by Calendar Year

Calendar Year	Summer Weekday TxLED Benefits (tpd)		
	NO_X	VOC	CO
2006	3.00	0.00	0.00
2018	1.29	0.00	0.00

When running a summer weekday scenario, the NONROAD model reports 24-hour emission totals and does not account for the effects of hourly variation in temperature and humidity on NO_X emissions. Greater detail on the development of correction equations to account for these effects can be found in Appendices F.4 and F.5 of the December 2004 HGB SIP revision, which can be found at http://www.tceq.state.tx.us/implementation/air/sip/dec2004hgb_mcr.html. During EPS3 processing, the CNTLEM module is also used to apply an hourly temperature/humidity NO_X correction and the impacts on the 2005, 2006, and 2018 non-road inventories are presented in Table 4.1-17: *HGB Summer Weekday Non-Road Temperature/Humidity NO_X Correction*.

Table 4.1-17: HGB Summer Weekday Non-Road Temperature/Humidity NO_X Correction

Calendar Year	Temperature/Humidity NO_X Reduction (tpd)		
	NO_X	VOC	CO
2005	4.21	0.00	0.00
2006	3.64	0.00	0.00
2018	1.88	0.00	0.00

After application of the TxLED and temperature/humidity NO_X adjustments with the CNTLEM module, the non-road emissions are spatially allocated with surrogates and prepared for photochemical model input using the EPS3 GRDEM module. The summer weekday emissions that were output from GRDEM are summarized by aggregate equipment category in Table 4.1-18: *2005 HGB Adjusted Non-Road Inventory by Equipment Category*, Table 4.1-19: *2006 HGB Adjusted Non-Road Inventory by Equipment Category*, and Table 4.1-20: *2018 HGB Adjusted Non-Road Inventory by Equipment Category*. Comparison with Tables 4.1-2 through 4.1-13 will indicate that the VOC and CO totals remain unchanged, while the NO_X totals are reduced by the

TxLED and temperature/humidity adjustments presented in Tables 4.1-16 and 4.1-17, respectively.

Table 4.1-18: 2005 HGB Adjusted Non-Road Emissions by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	6,335	6.29	0.85	9.98
Commercial	183,218	7.83	11.98	238.20
Construction	69,450	32.49	6.95	57.30
Industrial	30,241	28.16	7.83	118.48
Lawn and Garden	1,323,636	1.79	15.77	146.82
Logging	1,538	0.27	0.17	1.18
Pleasure Craft	117,863	0.68	10.21	22.53
Railway Maintenance	90	0.07	0.01	0.06
Recreational	51,068	0.16	4.52	15.66
Total	1,783,439	77.74	58.29	610.23

Table 4.1-19: 2006 HGB Adjusted Non-Road Emissions by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	6,443	5.67	0.68	8.86
Commercial	188,842	7.80	11.46	217.19
Construction	72,021	30.21	6.39	52.71
Industrial	30,929	26.68	7.39	118.17
Lawn and Garden	1,349,719	1.85	14.06	131.63
Logging	1,586	0.24	0.15	1.09
Pleasure Craft	118,745	0.77	9.75	20.79
Railway Maintenance	93	0.06	0.01	0.06
Recreational	54,728	0.18	4.70	14.99
Total	1,823,106	73.47	54.58	565.47

Table 4.1-20: 2018 HGB Adjusted Non-Road Emissions by Equipment Category

Aggregate Equipment Category	Equipment Population	Summer Weekday Emissions (tpd)		
		NO_X	VOC	CO
Agricultural	7,957	2.14	0.30	2.28
Commercial	256,241	5.13	6.35	201.05
Construction and Mining	92,055	14.68	3.64	36.34
Industrial	39,145	7.20	1.35	30.83
Lawn and Garden	1,664,135	1.09	7.96	113.48
Logging	2,154	0.04	0.13	1.13
Pleasure Craft	129,479	0.81	4.35	17.72
Railway Maintenance	126	0.04	0.01	0.04
Recreational	79,794	0.15	3.08	18.77
Pre-VMEP Total	2,271,087	31.28	27.17	421.63
H-GAC Non-Road VMEP		0.70		
Total	2,271,087	30.58	27.17	421.63

As shown in Table 4.1-20, an additional post-processing step for the 2018 modeling emissions was necessary to apply the 0.7 NO_X tpd of voluntary mobile source emission reduction program (VMEP) non-road benefits submitted by H-GAC.

Drilling rig emissions from oil and gas exploration equipment were estimated separately from the TexN model and are available in the Texas Air Emissions Repository (TexAER) system, which is available at http://texaerweb.tceq.state.tx.us/texaer/index.cfm. These estimates are summarized below in Table 4.1-21: *HGB Oil and Gas Exploration Emissions for 2005, 2006, and 2018*.

Table 4.1-21: HGB Oil and Gas Exploration Emissions for 2005, 2006, and 2018

Calendar Year	Summer Weekday Oil & Gas Emissions (tpd)		
	NO_X	VOC	CO
2005	6.49	0.25	7.35
2006	5.87	0.24	7.23
2018	2.34	0.14	6.20

The non-road emissions were spatially allocated using the EPS3 GRDEM module with surrogates that vary as a function of source category code (SCC). The following pages contain graphical plots of the 2005, 2006, and 2018 non-road summer weekday NO_X and VOC emissions for the HGB area. These plots are respectively entitled Figure 4.1-1: *2005 HGB Summer Weekday Non-Road NO_X Emissions*, Figure 4.1-2: *2006 HGB Summer Weekday Non-Road NO_X Emissions*, Figure 4.1-3: *2018 HGB Summer Weekday Non-Road NO_X Emissions*, Figure 4.1-4: *2005 HGB Summer Weekday Non-Road VOC Emissions*, Figure 4.1-5: *2006 HGB Summer Weekday Non-Road VOC Emissions*, and Figure 4.1-6: *2018 HGB Summer Weekday Non-Road VOC Emissions*.

For two primary reasons, the eight-county HGB NO_X and VOC totals in these plots do not exactly match the totals in the tables shown above. First, these graphical plots report Carbon Bond 2005 (CB-05) mass, while the data tables show VOC mass. The photochemical model requires that VOC emissions be speciated into categories of differing reactivity with a mechanism such as CB-05. Second, the reported emissions for the entire domain on the plots are correct, but the county totals are only approximate. A concentration of emissions near county borders leads to some inaccuracy in the reported totals on these plots because emissions in a grid cell are allocated among counties based on relative area. For example, if a grid cell is evenly divided

between two counties, the plotting routine will evenly divide the reported emissions even if the EPS3 spatial surrogate correctly allocated all of the emissions to just one of those counties.

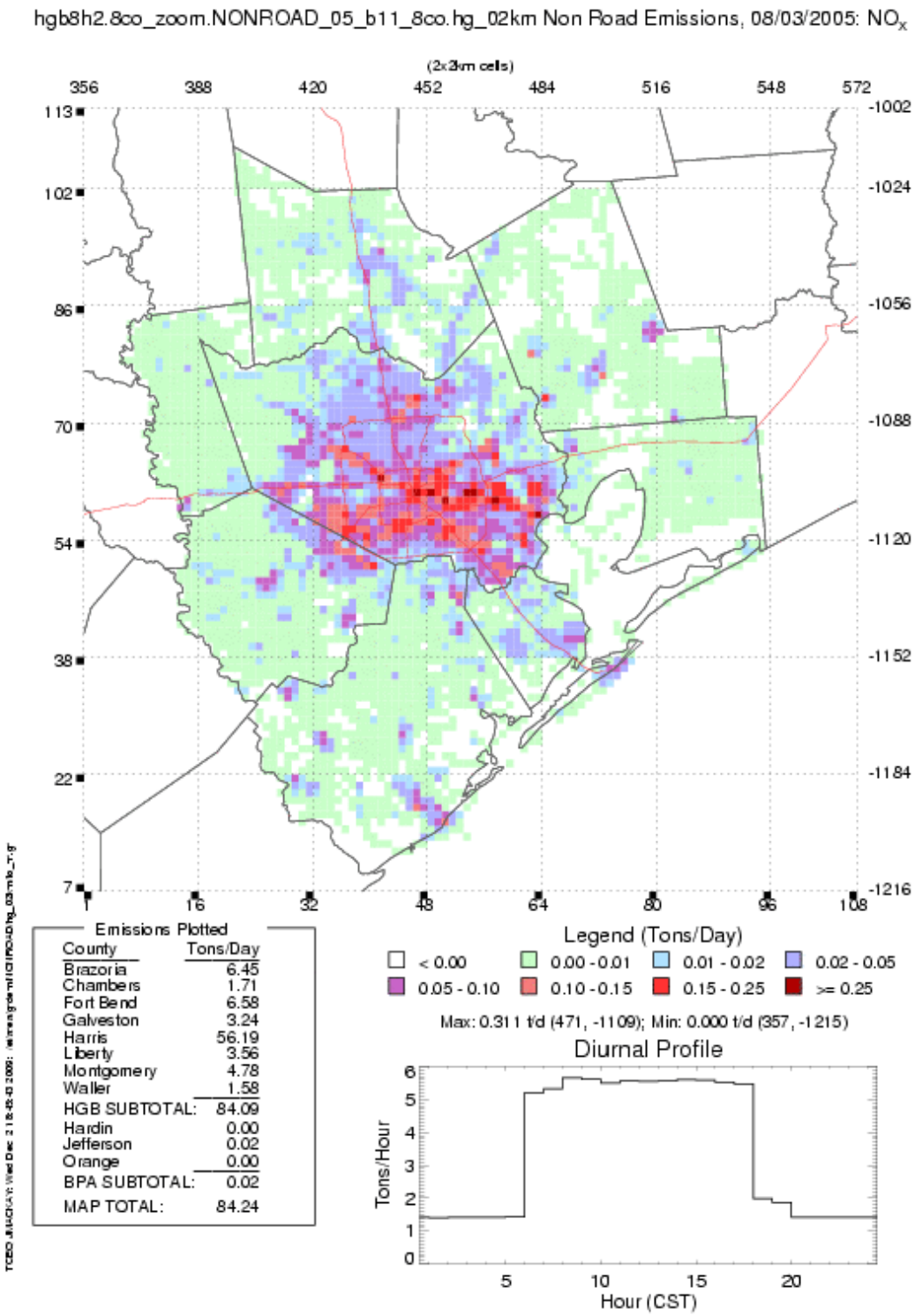


Figure 4.1-1: 2005 HGB Summer Weekday Non-Road NO_X Emissions

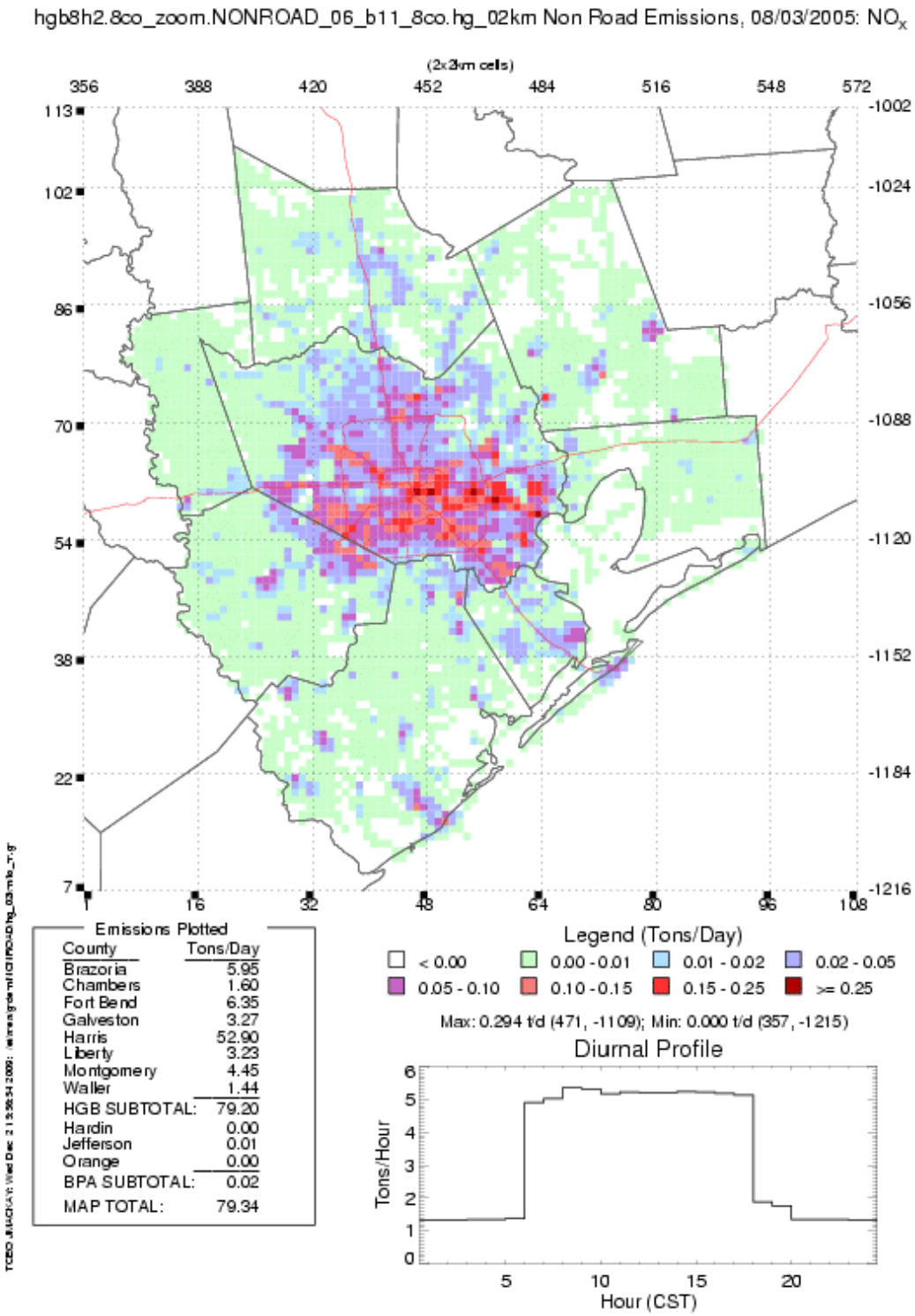


Figure 4.1-2: 2006 HGB Summer Weekday Non-Road NO_X Emissions

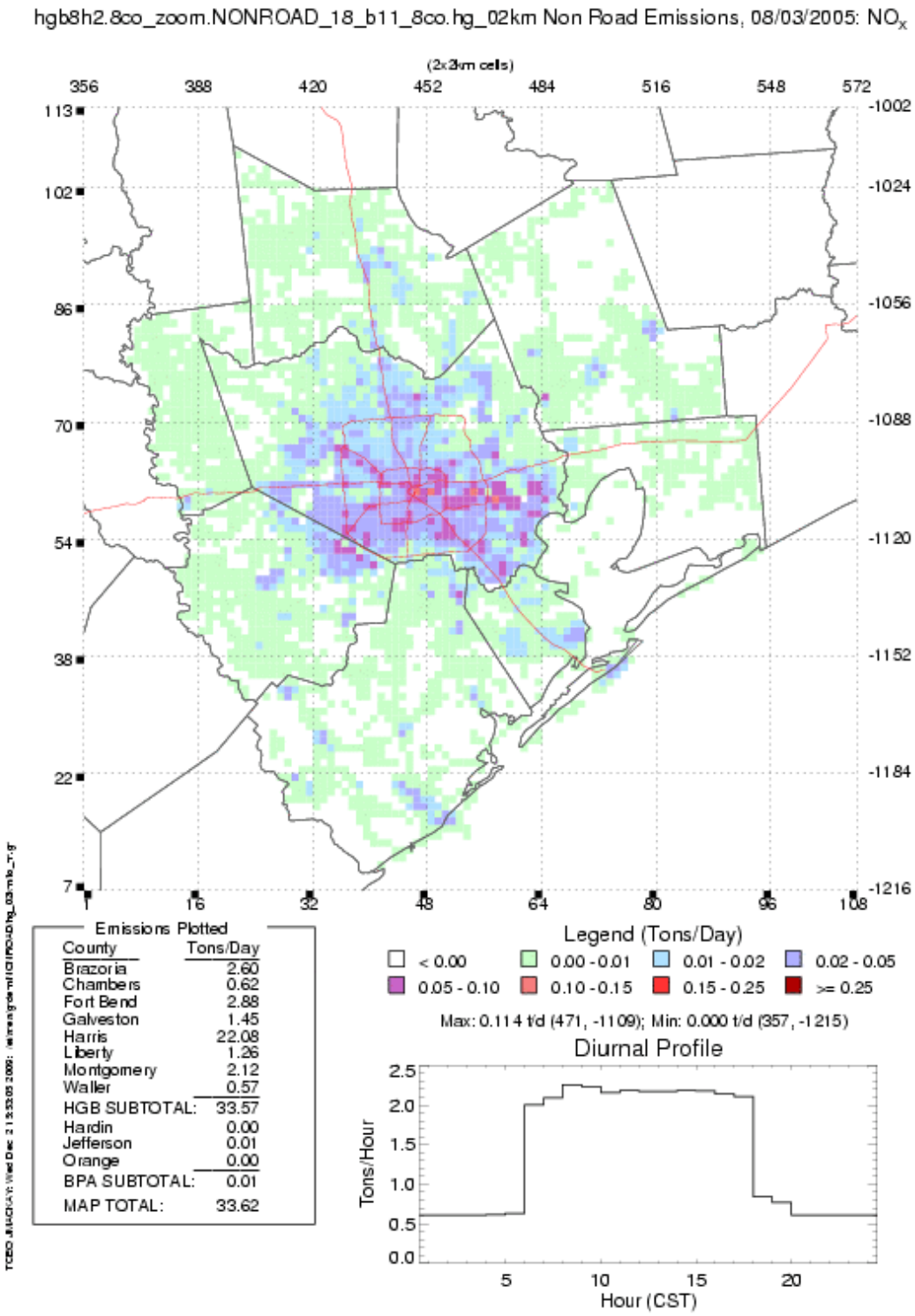


Figure 4.1-3: 2018 HGB Summer Weekday Non-Road NO_X Emissions

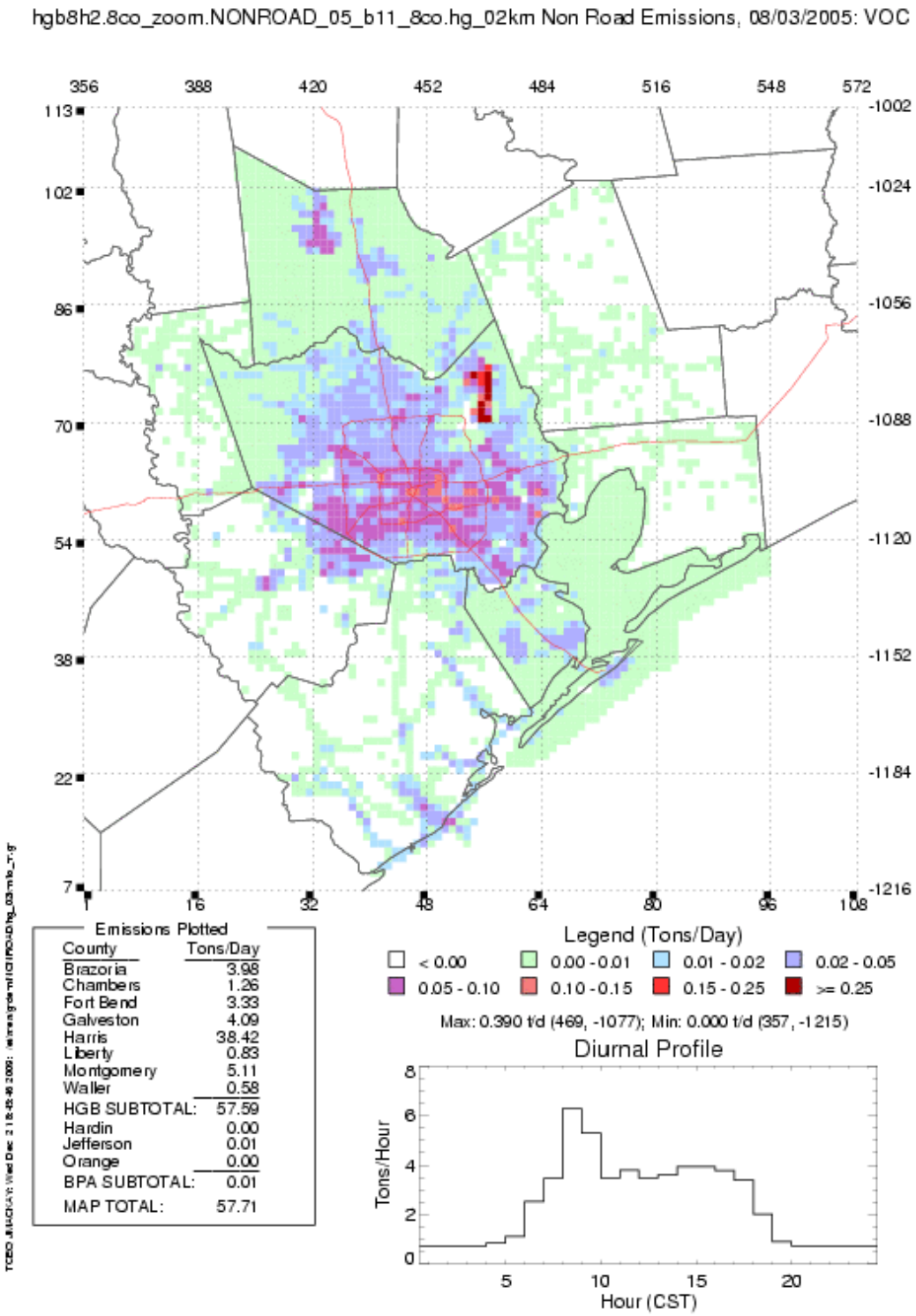


Figure 4.1-4: 2005 HGB Summer Weekday Non-Road VOC Emissions

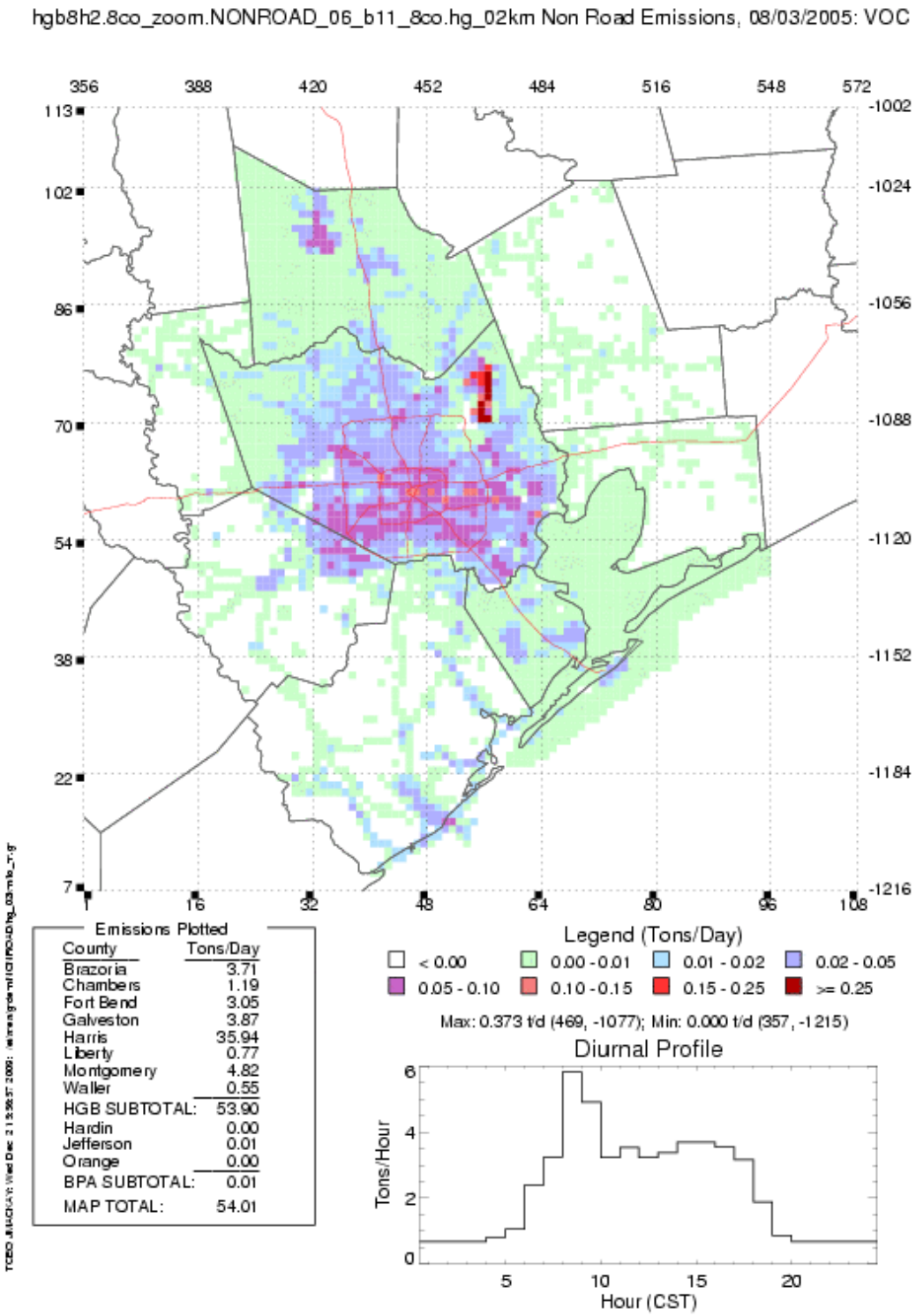


Figure 4.1-5: 2006 HGB Summer Weekday Non-Road VOC Emissions

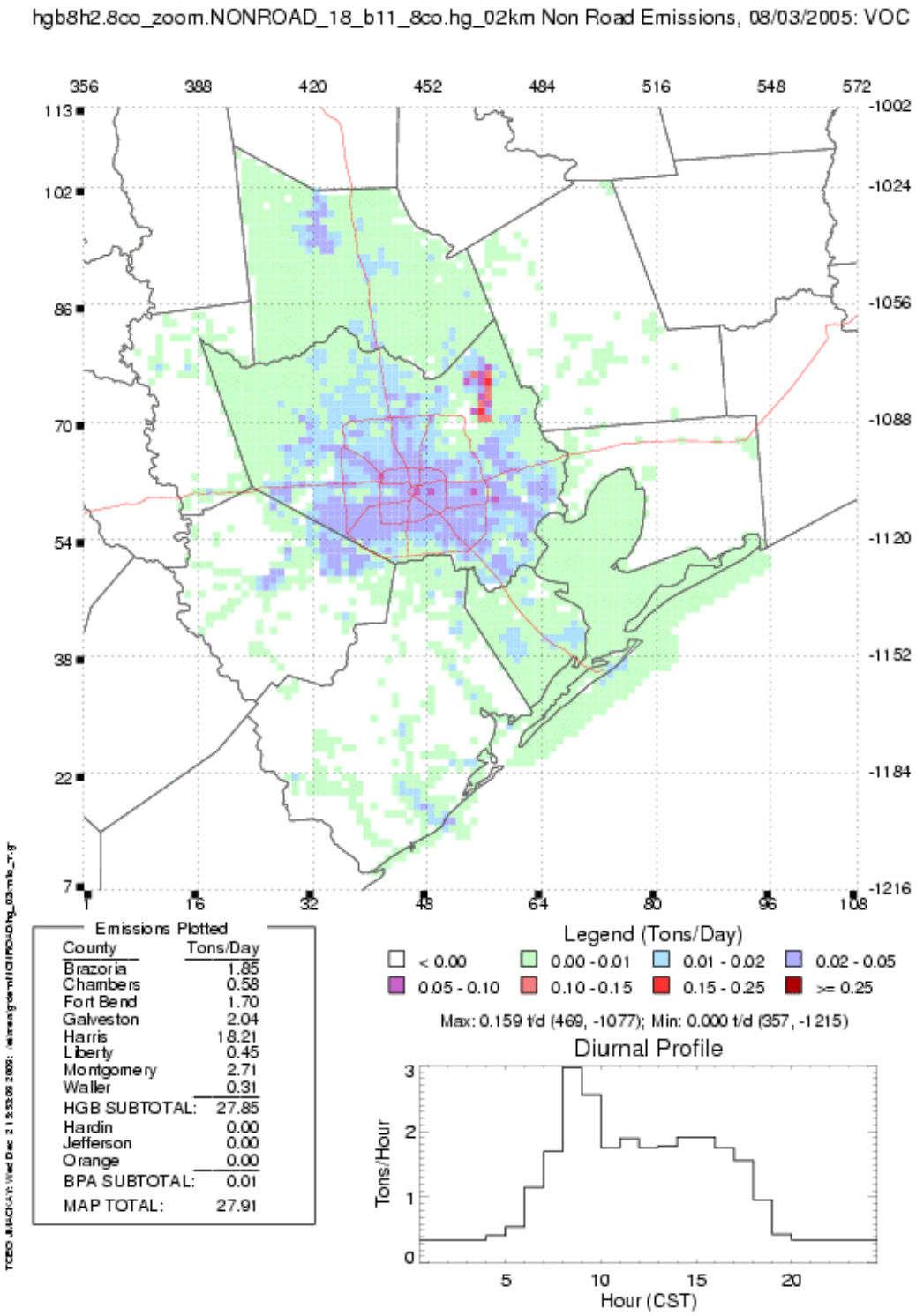


Figure 4.1-6: 2018 HGB Summer Weekday Non-Road VOC Emissions

4.2 Aircraft and Ground Support Equipment Modeling Emissions for Eight-County HGB

The aircraft inventory was developed using the U.S. Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS) by Jacobs Consultancy under contract to the Houston Airport System (HAS). The results of these analyses by HGB area airport are presented below in Table 4.2-1: *2005 Ozone Season Day Aircraft Emissions by HGB Airport*, Table 4.2-2: *2006 Ozone Season Day Aircraft Emissions by HGB Airport*, and Table 4.2-3: *2018 Ozone Season Day Aircraft Emissions by HGB Airport*. The 2006 figures were linearly interpolated between available estimates for 2005 and 2011.

Table 4.2-1: 2005 Ozone Season Day Aircraft Emissions by HGB Airport

HGB Area Airport	**2005 Ozone Season Day** (tpd)		
	NO_X	VOC	CO
Ellington Field	0.17	0.34	3.25
Hobby	1.46	0.48	2.54
Intercontinental	5.91	1.08	7.42
Total	7.55	1.90	13.20

Table 4.2-2: 2006 Ozone Season Day Aircraft Emissions by HGB Airport

HGB Area Airport	**2006 Ozone Season Day** (tpd)		
	NO_X	VOC	CO
Ellington Field	0.18	0.35	3.33
Hobby	1.45	0.48	2.50
Intercontinental	6.14	1.13	7.56
Total	7.77	1.96	13.39

Table 4.2-3: 2018 Ozone Season Day Aircraft Emissions by HGB Airport

HGB Area Airport	**2018 Ozone Season Day** (tpd)		
	NO_X	VOC	CO
Ellington Field	0.23	0.45	4.23
Hobby	1.55	0.55	2.90
Intercontinental	9.58	1.44	7.74
Total	11.36	2.44	14.87

Airport ground support equipment (GSE) emission estimates were developed using the EDMS model by the following entities:

- Landrum & Brown for Continental Airlines operations at Intercontinental Airport;
- Southwest Airlines and the TCEQ for Southwest operations at Hobby Airport; and
- Jacobs Consultancy for all non-Continental and non-Southwest operations at Intercontinental and Hobby Airports, respectively.

These GSE estimates are presented below in Table 4.2-4: *2005 Ozone Season Day GSE Emissions by HGB Airport*, Table 4.2-5: *2006 Ozone Season Day GSE Emissions by HGB Airport*, and Table 4.2-6: *2018 Ozone Season Day GSE Emissions by HGB Airport*. The 2006 figures were linearly interpolated between available estimates for 2005 and 2011.

Table 4.2-4: 2005 Ozone Season Day GSE Emissions by HGB Airport

HGB Area		2005 Ozone Season Day (tpd)		
Airport	Airline	NO_X	VOC	CO
Hobby Airport	Southwest	0.15	0.01	0.09
	Other	0.08	0.01	0.25
Intercontinental Airport	Continental	1.19	0.61	20.96
	Other	0.46	0.12	3.10
Total		1.89	0.76	24.41

Table 4.2-5: 2006 Ozone Season Day GSE Emissions by HGB Airport

HGB Area		2006 Ozone Season Day (tpd)		
Airport	Airline	NO_X	VOC	CO
Hobby Airport	Southwest	0.15	0.01	0.10
	Other	0.08	0.01	0.23
Intercontinental Airport	Continental	1.17	0.60	20.52
	Other	0.43	0.11	2.89
Total		1.83	0.73	23.73

Table 4.2-6: 2018 Ozone Season Day GSE Emissions by HGB Airport

HGB Area		2018 Ozone Season Day (tpd)		
Airport	Airline	NO_X	VOC	CO
Hobby Airport	Southwest	0.18	0.02	0.11
	Other	0.02	0.00	0.04
Intercontinental Airport	Continental	0.55	0.25	8.70
	Other	0.11	0.03	0.72
Total		0.86	0.30	9.57

For more detail, ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Nonroad_EI/Airports/HGB/ can be consulted for the electronic EDMS output files for the HGB area analyses, along with a detailed report from Jacobs Consultancy and a memorandum from Landrum & Brown. Additional estimates for GSE equipment were made for small regional airports outside of Harris County, but those figures are not reported here because they range from only 1-2 pounds of NO_X and 0-1 pounds of VOC. General aviation aircraft emissions for the smaller regional airports were also developed and presented below in Table 4.2-7: *General Aviation Emissions for 2005, 2006, and 2018*.

Table 4.2-7: General Aviation Emissions for 2005, 2006, and 2018

Calendar Year	General Aviation Emissions (tpd)	
	NO_X	VOC
2005	0.024	0.410
2006	0.025	0.420
2018	0.037	0.610

The TCEQ developed special surrogates to spatially allocate the aircraft and GSE emissions to grid cells covering the Ellington Field, Hobby, and Intercontinental airports. The following pages contain graphical plots of the 2005, 2006, and 2018 airport summer weekday NO_X emissions for the HGB area. These plots are respectively entitled Figure 4.2-1: *2005 HGB Summer Weekday*

Airport NO_X Emissions, Figure 4.2-2: *2006 HGB Summer Weekday Airport NO_X Emissions*, and Figure 4.2-3: *2018 HGB Summer Weekday Airport NO_X Emissions*.

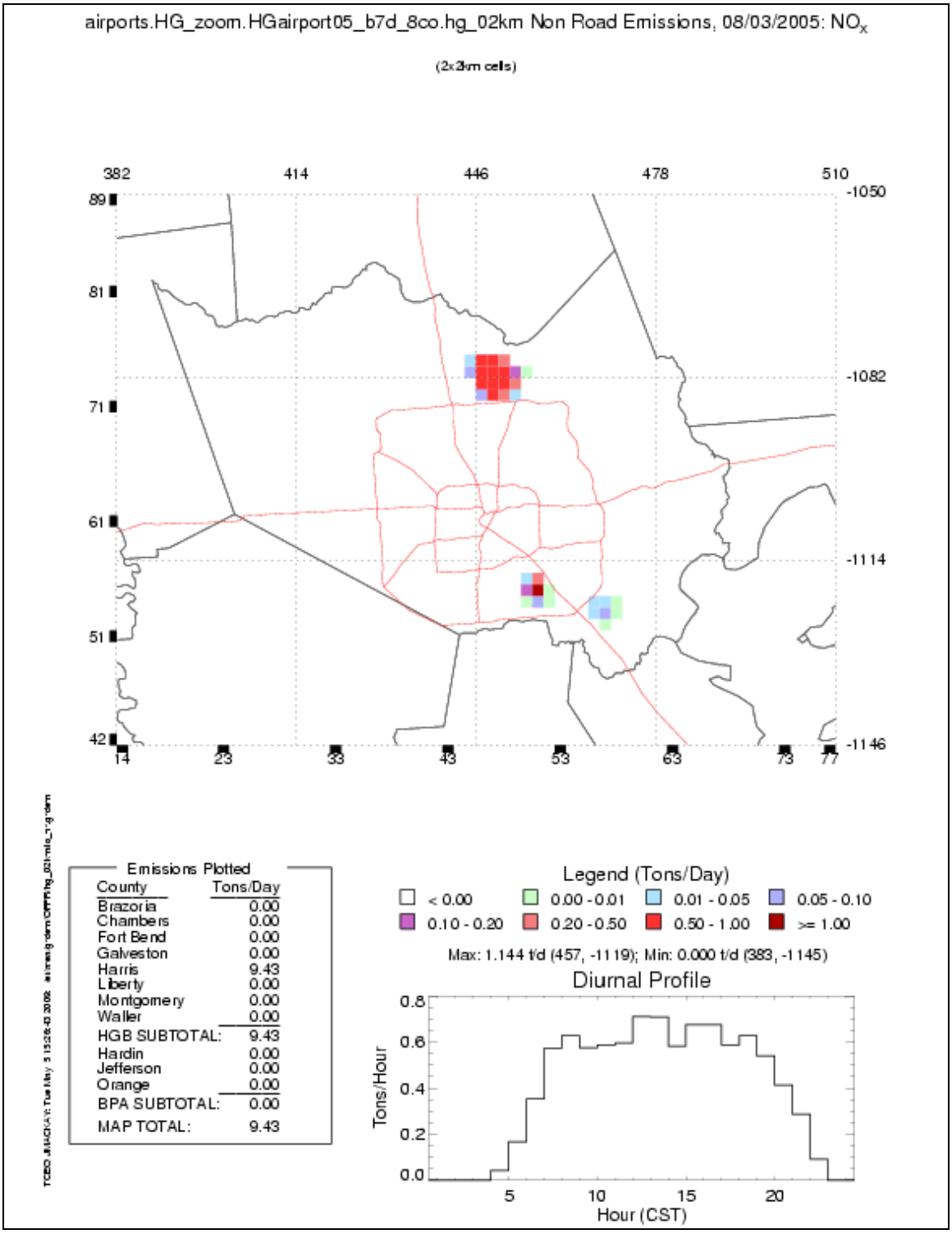


Figure 4.2-1: 2005 HGB Summer Weekday Airport NO_X Emissions

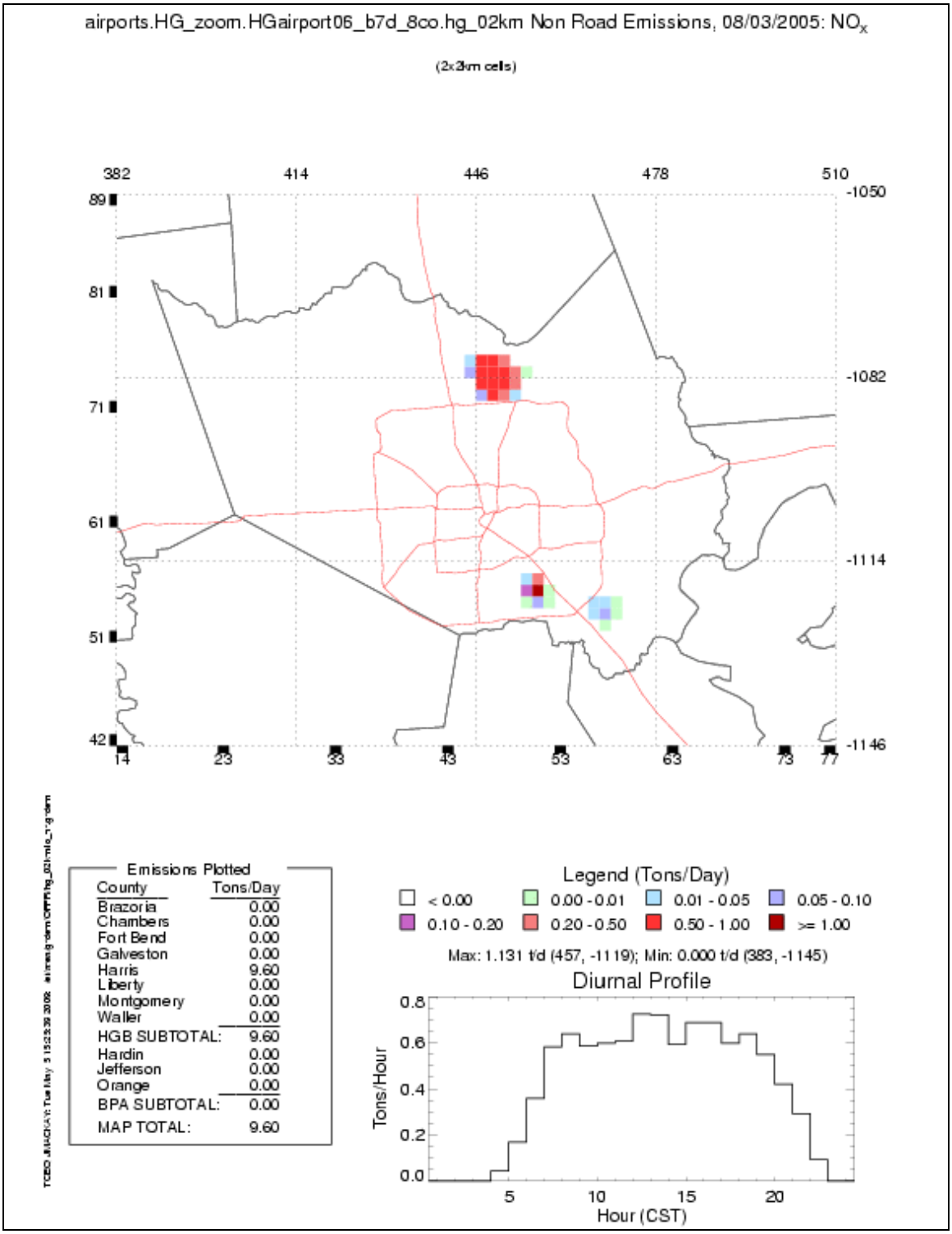


Figure 4.2-2: 2006 HGB Summer Weekday Airport NO_X Emissions

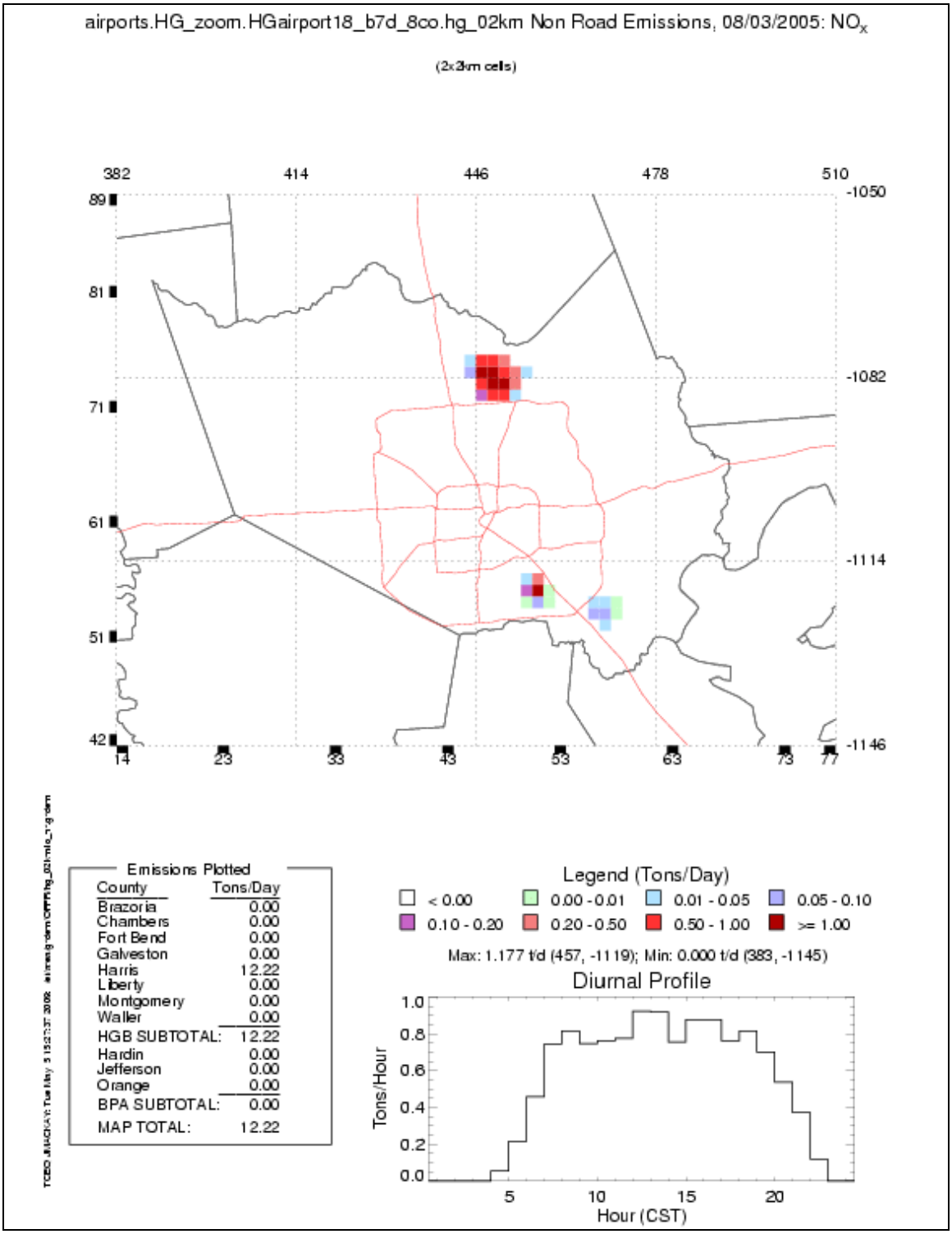


Figure 4.2-3: 2018 HGB Summer Weekday Airport NO_X Emissions

4.3 Locomotive Modeling Emissions for Eight-County HGB

2005, 2006, and 2018 line-haul and switcher locomotive emission estimates for the eight-county HGB area were obtained from the Texas Air Emissions Repository (TexAER) system, which is available at http://texaerweb.tceq.state.tx.us/texaer/index.cfm. These locomotive emission estimates available in TexAER were originally developed with the Texas Railroad Emission Inventory Model (TREIM), which is a Microsoft Access application developed by Eastern Research Group (ERG) under contract to the TCEQ. These locomotive emissions are separate from the railway maintenance equipment emissions that are estimated with the NONROAD model. A summary is provided in Table 4.3-1: *Eight-County HGB Locomotive Emissions for 2005, 2006, and 2018*.

Table 4.3-1: Eight-County HGB Locomotive Emissions for 2005, 2006, and 2018

Calendar Year	**Summer Weekday Locomotive Emissions** (tpd)	
	NO_X	VOC
2005	30.32	1.83
2006	28.53	1.79
2018	34.22	2.35

The locomotive emissions were spatially allocated with the EPS3 GRDEM module to grid cells containing known railway tracks in the eight-county HGB area. The following pages contain graphical plots of the 2005, 2006, and 2018 locomotive summer weekday NO_X emissions for the HGB area. These plots are respectively entitled Figure 4.3-1: *2005 HGB Summer Weekday Locomotive NO_X Emissions*, Figure 4.3-2: *2006 HGB Summer Weekday Locomotive NO_X Emissions*, and Figure 4.3-3: *2018 HGB Summer Weekday Locomotive NO_X Emissions*.

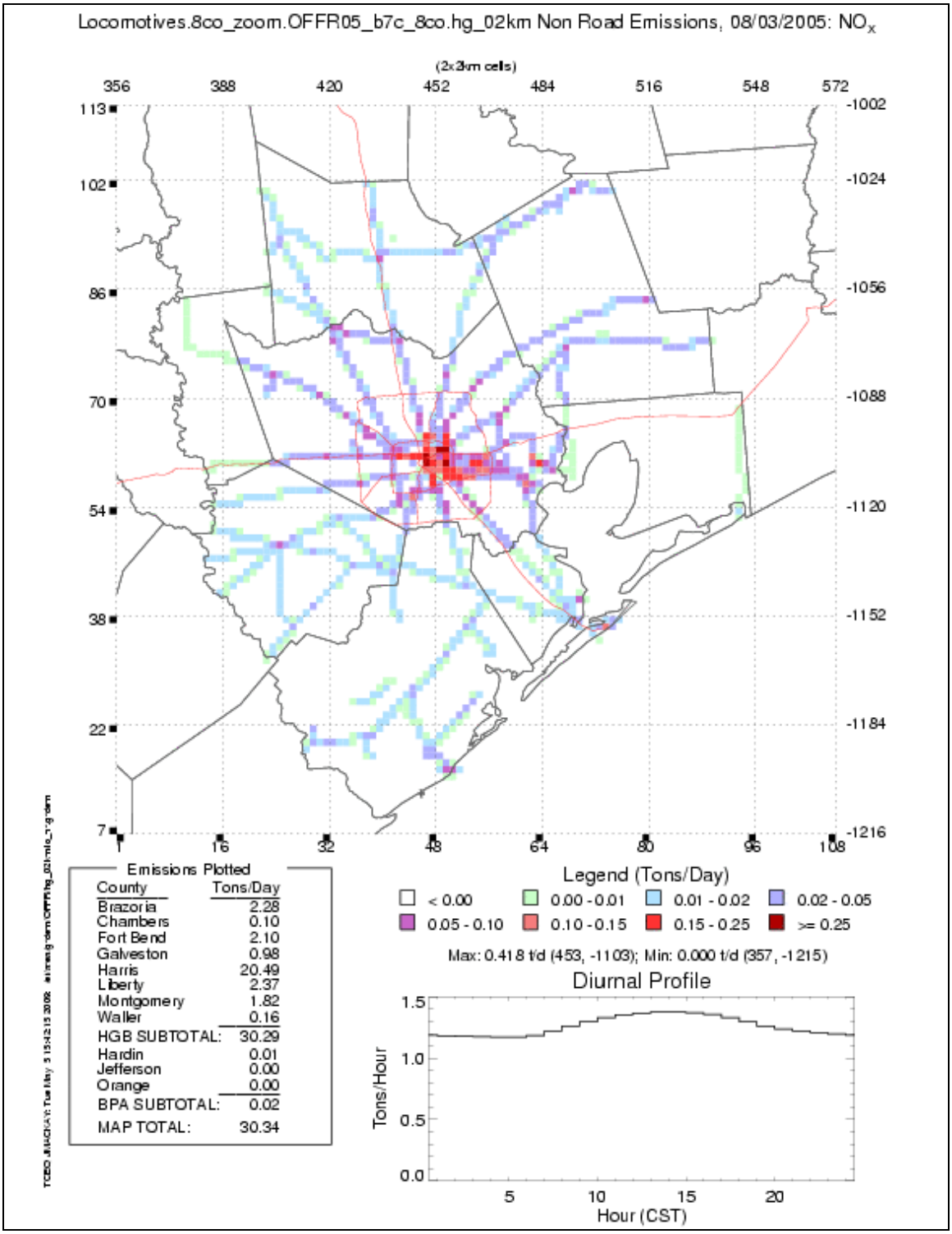


Figure 4.3-1: 2005 HGB Summer Weekday Locomotive NO_X Emissions

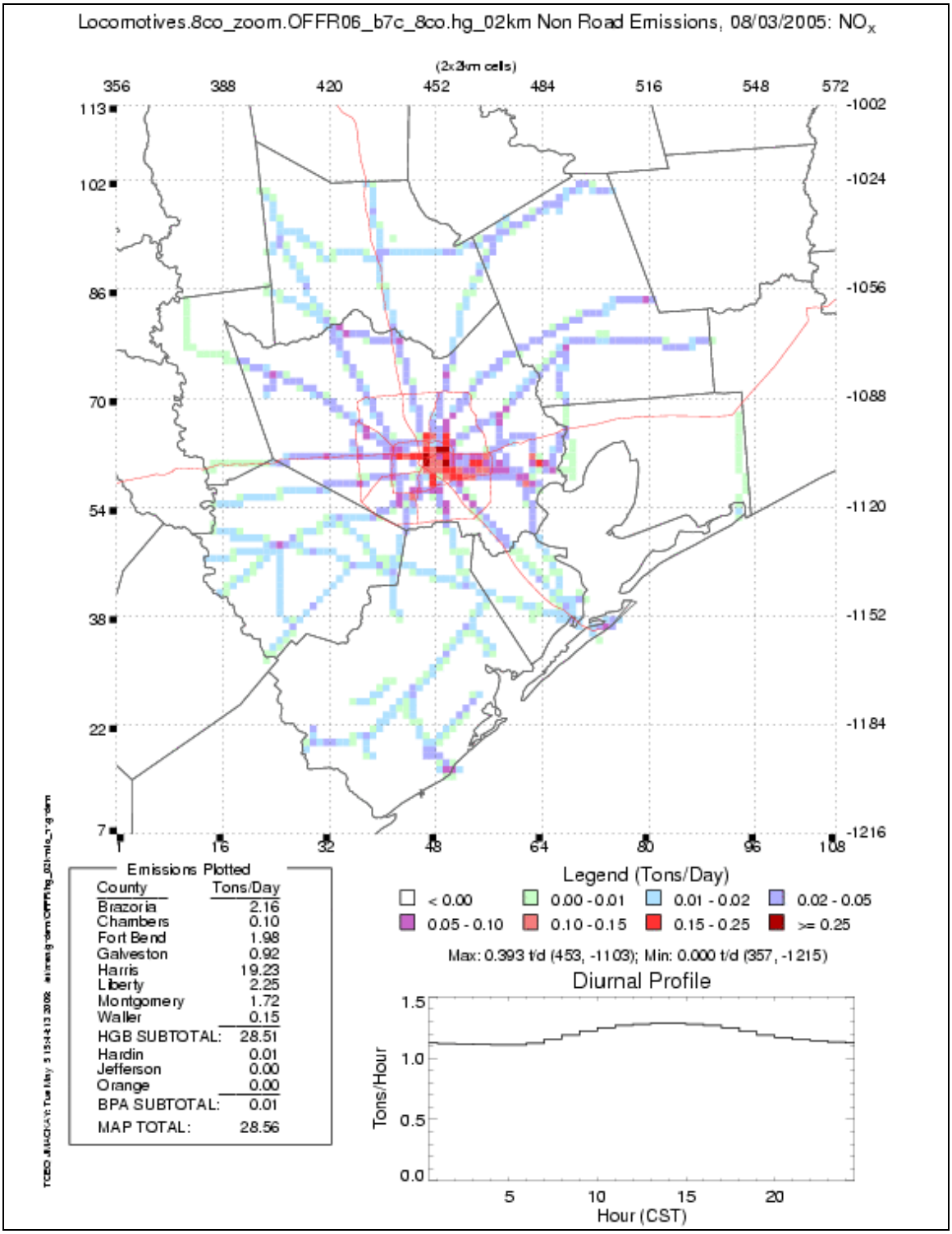


Figure 4.3-2: 2006 HGB Summer Weekday Locomotive NO_X Emissions

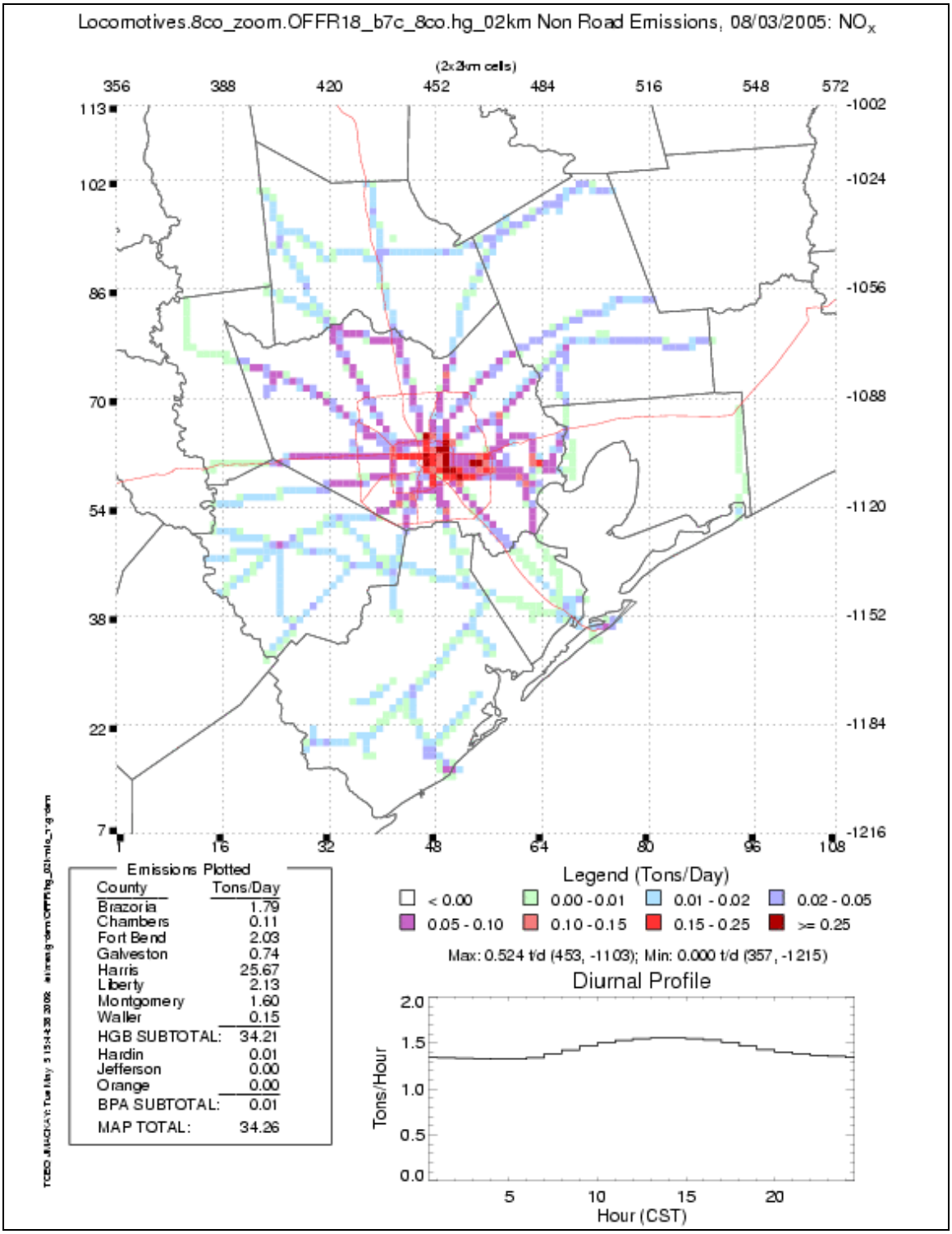


Figure 4.3-3: 2018 HGB Summer Weekday Locomotive NO_X Emissions

4.4 Commercial Marine Modeling Emissions for Eight-County HGB

When modeling emissions were being developed for this SIP revision, the latest available detailed commercial marine inventories were for the 1997 and 2007 calendar years. Development of these data sets is documented in a Starcrest Consulting Group report entitled *Houston-Galveston Area Vessel Emissions Inventory*, which is available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Nonroad_EI/Marine/. A summary of this work is available in Table 4.4-1: *HGB Commercial Marine NO_X Emissions Inventory for 1997 and 2007*.

Table 4.4-1: HGB Commercial Marine NO_X Emissions Inventory for 1997 and 2007

Commercial Marine Vessels		**NO_X Emissions** (tpd)	
Description	Source Category Code	1997	2007
Assist Tugboats	2280002021	2.01	2.28
Ferries	2280002022	0.88	1.16
Towboats	2280002023	9.51	8.66
Dredging Emissions	2280002025	0.88	0.65
Barge Pumps	2280002026	1.55	1.20
Ocean Going Vessels	2280003010	3.80	4.77
Bulk Cargo Vessels	2280003011	1.92	2.52
General Cargo Vessels	2280003012	3.20	4.21
Container Ships	2280003013	1.07	1.40
Liquefied Gas Carriers	2280003014	1.36	1.80
Oil/Chemical Tankers	2280003015	8.13	10.71
Other Ocean Going Vessels	2280003016	0.73	0.96
Cruise Ships	2280003017	0.00	1.34
Grand Total		35.04	41.65

Total tonnage handled by the Port of Houston from 1996-2005 was reported on their website (http://www.portofhouston.com/busdev/tradedevelopment/tradestatistics.html) as shown in Table 4.4-2: *Annual Tonnage Handled by Port of Houston*.

Table 4.4-2: Annual Tonnage Handled by Port of Houston

Calendar Year	**Annual Tonnage** (short tons)
1996	148,183
1997	165,456
1998	169,070
1999	158,828
2000	186,567
2001	185,050
2002	177,561
2003	190,923
2004	202,047
2005	215,000

Trends were established with the 1996-2005 data to project annual tonnage from 2006-2018. Ratios of these annual tonnage figures were then applied to the reported 2007 figures from Table 4.4-1 to establish commercial marine emission estimates for 2005, 2006, and 2018. An additional

set of adjustments was applied to the 2018 harbor vessel emission estimates to account for a Federal Register notice entitled *Control of Emissions of Air Pollution From New Compression Ignition Marine Engines at or Above 37 Kilowatts*, December 11, 1998, which is available at http://www.epa.gov/fedrgstr/EPA-AIR/1998/December/Day-11/a32304.htm. The results of this approach are shown in Table 4.4-3: *Harbor Vessel Emission Rate Adjustments From 2007 to 2018*.

Table 4.4-3: Harbor Vessel Emission Rate Adjustments From 2007 to 2018

Diesel-Powered Harbor Vessels	2007 to 2018 Emission Rate Adjustments		
	NO_X	VOC	CO
Assist Tugboats	17.70 percent reduction with adjustment factor of 0.8230	3.63 percent reduction with adjustment factor of 0.9637	1.55 percent reduction with adjustment factor of 0.9845
Ferries			
Towboats			
Dredging Emissions			
Barge Pumps			

Application of the steps described above resulted in the commercial marine modeling emission estimates shown in Table 4.4-4: *HGB Commercial Marine Modeling Emissions for 2005, 2006, and 2018*.

Table 4.4-4: HGB Commercial Marine Modeling Emissions for 2005, 2006, and 2018

Calendar Year	Commercial Marine Emissions (tpd)	
	NO_X	VOC
2005	34.47	0.97
2006	35.10	0.99
2018	39.24	1.18

The exhaust emissions from all vessels were processed through EPS3 as if they were coming from a series of elevated point sources located along the shipping lanes, major waterways, and docks within both Galveston Bay and the Houston Ship Channel. The exhaust stack parameters assigned to each of these sequential point sources varied by the different vessel types shown in Table 4.4-1. The magnitude of emissions allocated to each sequential point is proportional to specific trips from the off-shore sea buoy to the various docks located within Galveston Bay and along the Houston Ship Channel. A similar approach has been taken in the past and is documented in Appendix F of the HGB SIP revision (http://www.tceq.state.tx.us/implementation/air/sip/dec2000hgb.html) dated December 6, 2000.

This custom spatial allocation approach can be seen on the following pages that contain graphical plots of the 2005, 2006, and 2018 commercial marine summer weekday NO_X emissions for the HGB area. These plots are respectively entitled Figure 4.4-1: *2005 HGB Summer Weekday Commercial Marine NO_X Emissions*, Figure 4.4-2: *2006 HGB Summer Weekday Commercial Marine NO_X Emissions*, and Figure 4.4-3: *2018 HGB Summer Weekday Commercial Marine NO_X Emissions*. Grid cells in dark red indicate the highest concentration of shipping emissions where the greatest amount of activity was identified by the Starcrest study referenced above.

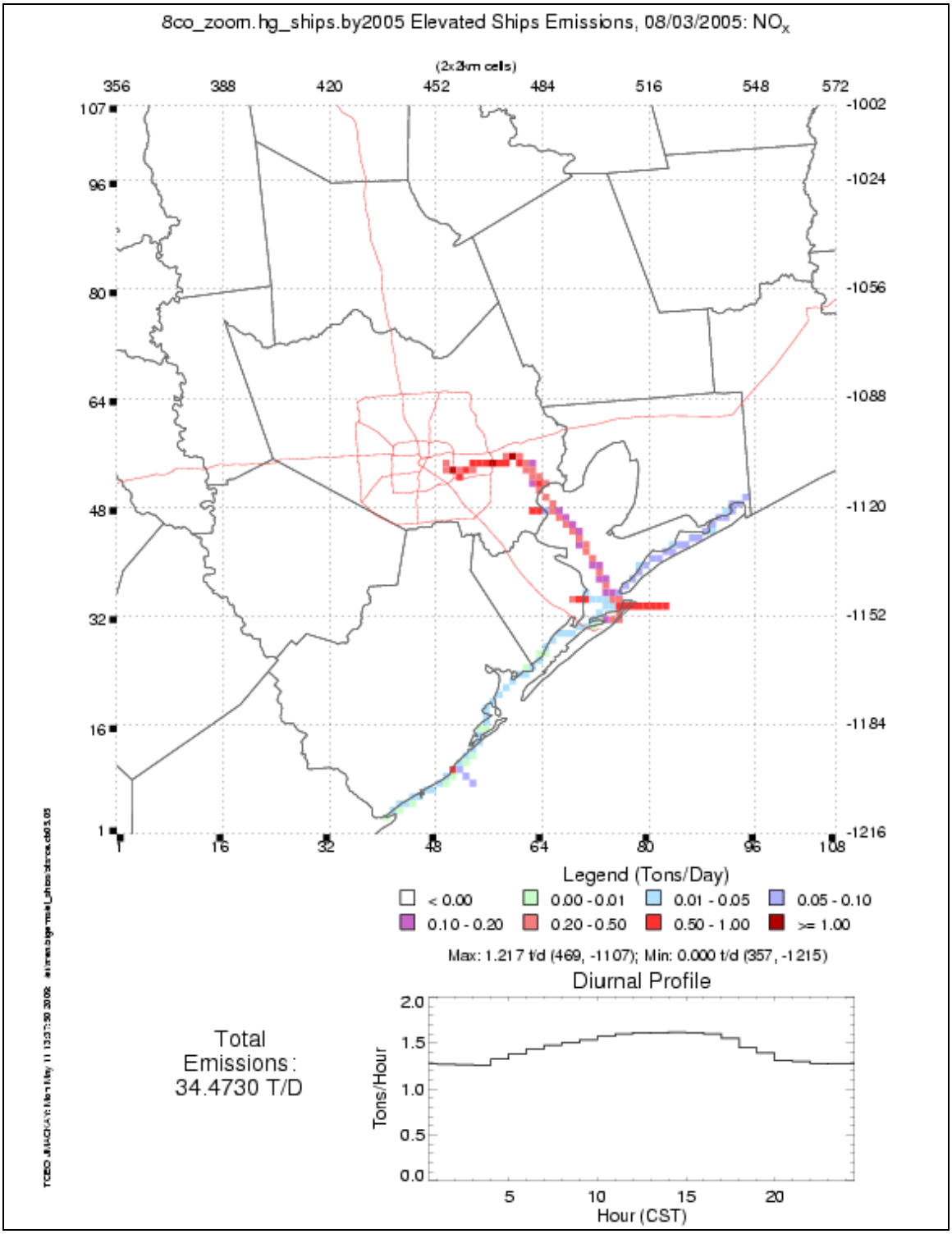


Figure 4.4-1: 2005 HGB Summer Weekday Commercial Marine NO_X Emissions

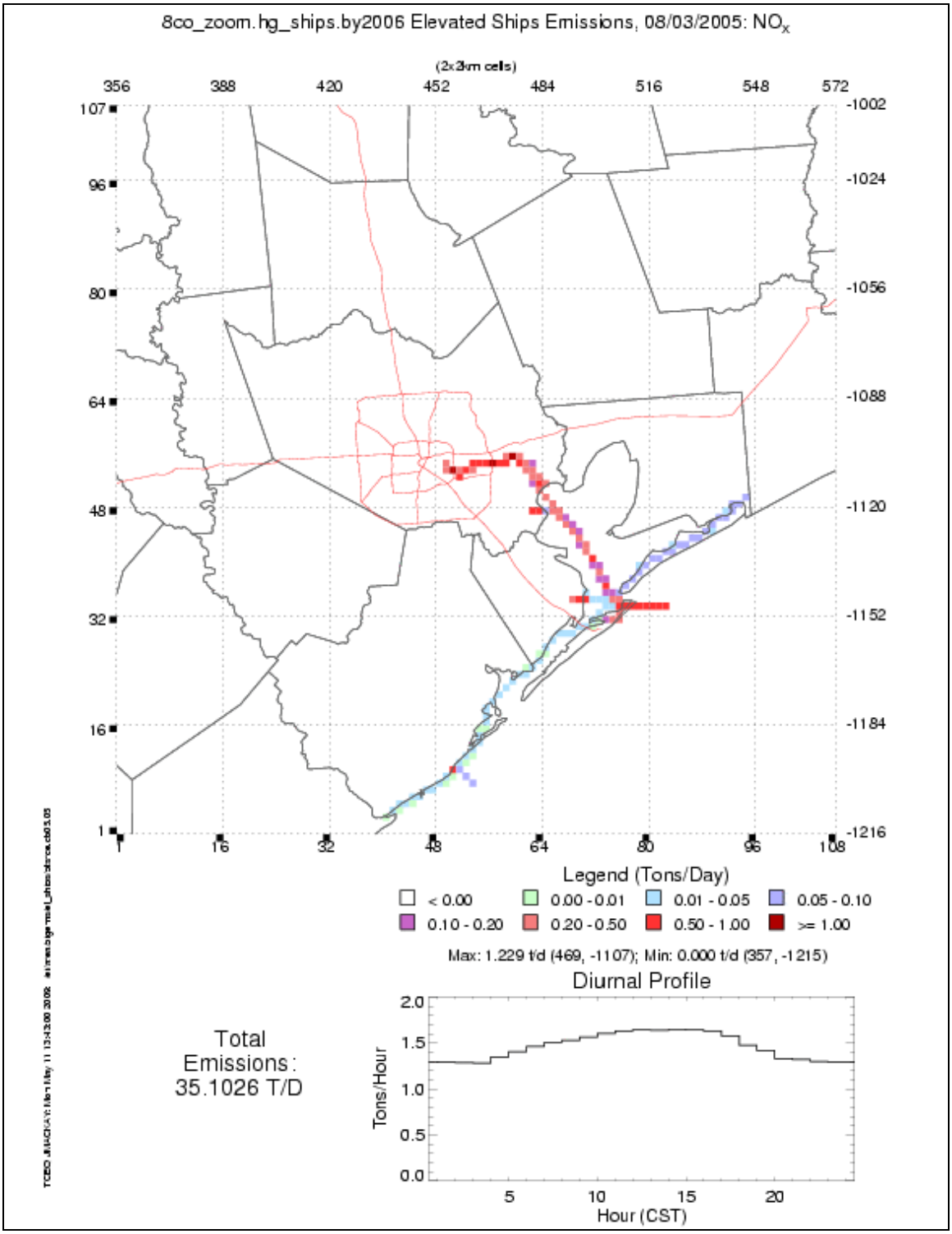


Figure 4.4-2: 2006 HGB Summer Weekday Commercial Marine NO_X Emissions

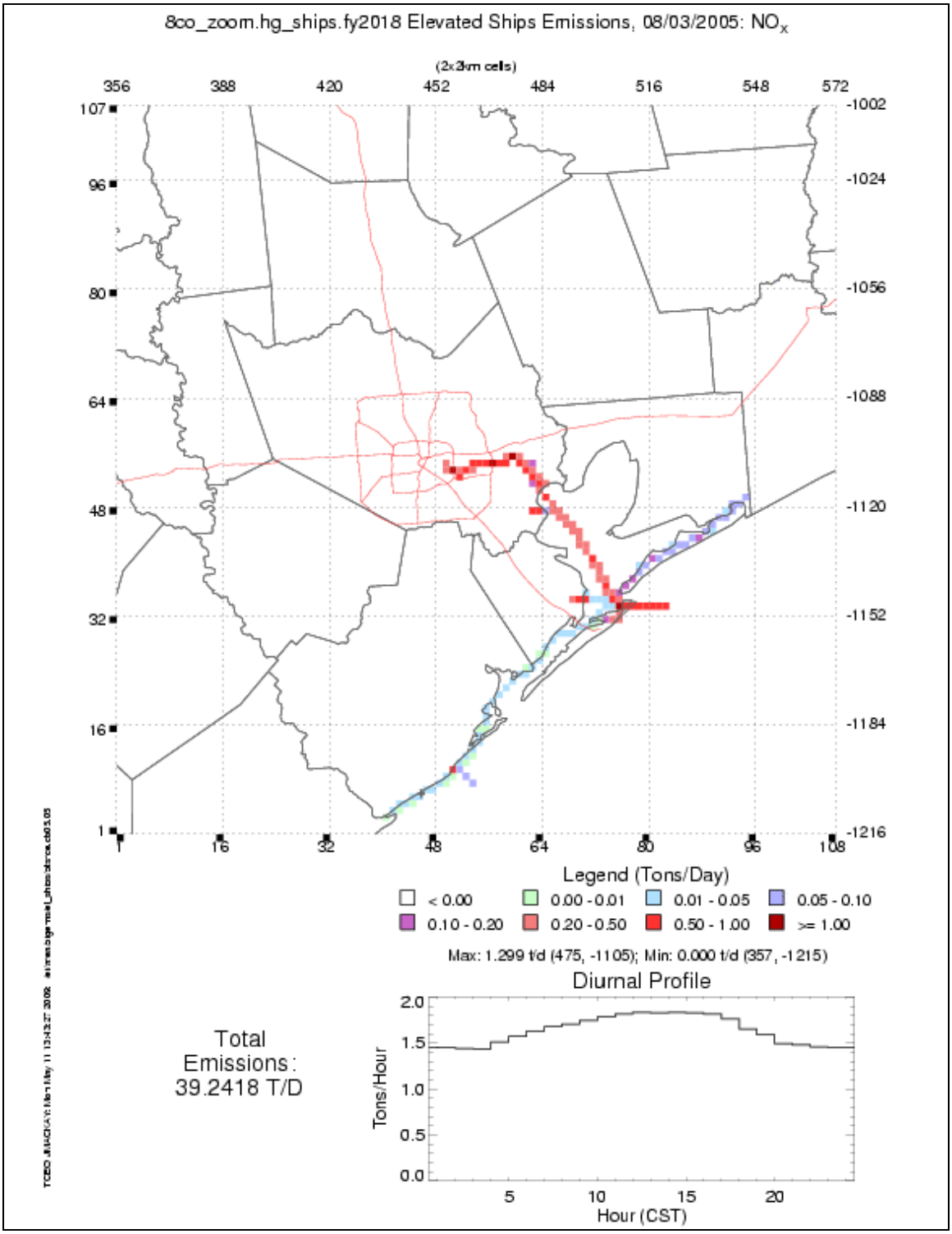


Figure 4.4-3: 2018 HGB Summer Weekday Commercial Marine NO_X Emissions

4.5 Area Source Modeling Emissions for Eight-County HGB

Area sources include commercial, small-scale industrial, and residential categories of sources that use materials or operate processes that can generate emissions. These sources of emissions fall below the point source reporting levels and are either too numerous or too small to identify individually. Emissions from these sources are estimated on either a source category or group basis. Area source emissions result from either hydrocarbon evaporation or fuel combustion. Examples of sources of evaporative losses include printing operations, industrial coatings, degreasing solvents, house paints, leaking underground storage tanks, underground tank filling at gasoline service stations, and vehicle refueling operations. Fuel combustion sources include stationary source fossil fuel combustion at residences and businesses, along with outdoor burning and structural fires. With some exceptions, area source emission estimates are obtained by multiplying an established emission factor by the appropriate activity or activity surrogate responsible for generating the emissions. Human population is the most commonly used activity surrogate for many area source categories, while other activity data include the amount of gasoline sold in an area, employment by industry type, acres of cropland, etc.

Area source modeling estimates were based primarily on data from the 2005 periodic emissions inventory (PEI) that is available in the TCEQ TexAER database, which is available at http://texaerweb.tceq.state.tx.us/texaer/index.cfm. The area source emissions inventories were compiled by using the EPA Economic Growth Analysis System (EGAS) model with Texas-specific growth factors for each area source category supplied by Regional Economic Models, Inc. (REMI). Projections to 2006 and 2018 were accomplished with individual growth factors for each area source category by county and year available with the REMI-EGAS system. The results of these efforts are summarized in Table 4.5-1: *HGB Area Source NO_X Emissions for 2005, 2006, and 2018* and Table 4.5-2: *HGB Area Source VOC Emissions for 2005, 2006, and 2018*.

Table 4.5-1: Eight-County HGB Area Source NO_X Emissions for 2005, 2006, and 2018

Area Source Category	Summer Weekday NO_X Emissions (tpd)		
	2005	2006	2018
Architectural Coatings	0.00	0.00	0.00
Asphalt Paving	0.00	0.00	0.00
Auto Refinishing	0.00	0.00	0.00
Dry Cleaning	0.00	0.00	0.00
Food / Brewing	0.00	0.00	0.00
Graphic Arts	0.00	0.00	0.00
Industrial Fuel Use	9.13	9.13	9.13
Leaking Underground Storage Tanks	0.00	0.00	0.00
Oil and Gas Production	24.28	24.43	30.05
Open Burning	0.50	0.51	0.59
Pesticide Use	0.00	0.00	0.00
Petroleum / Gasoline	0.00	0.00	0.00
Residential Fuel Use	2.29	2.29	2.29
Solvent Use	0.00	0.00	0.00
Surface Cleaning	0.00	0.00	0.00
Surface Coating	0.00	0.00	0.00
Traffic Marking	0.00	0.00	0.00
Waste Treatment	0.00	0.00	0.00
Grand Total	36.20	36.36	42.06

Table 4.5-2: Eight-County HGB Area Source VOC Emissions for 2005, 2006, and 2018

Area Source Category	Summer Weekday VOC Emissions (tpd)		
	2005	2006	2018
Architectural Coatings	30.35	31.24	40.07
Asphalt Paving	0.92	0.95	1.31
Auto Refinishing	3.32	3.41	4.64
Dry Cleaning	2.40	2.41	2.97
Food / Brewing	0.73	0.72	0.87
Graphic Arts	0.65	0.65	0.80
Industrial Fuel Use	0.39	0.39	0.39
Leaking Underground Storage Tanks	2.34	2.26	2.37
Oil and Gas Production	238.48	239.82	295.02
Open Burning	7.06	7.25	8.48
Pesticide Use	0.01	0.01	0.02
Petroleum / Gasoline	61.02	60.45	68.74
Residential Fuel Use	0.13	0.13	0.13
Solvent Use	49.22	50.80	60.70
Surface Cleaning	0.90	0.94	1.35
Surface Coating	22.51	22.81	33.32
Traffic Marking	0.43	0.42	0.44
Waste Treatment	6.93	7.00	8.63
Total	427.79	431.66	530.25

These area source categories were processed with EPS3 for photochemical model input. Spatial allocation was performed with surrogates appropriate for each category. For example, residential fuel use was spatially allocated to grid cells as a function of residential area. As Tables 4.5-1 and 4.5-2 demonstrate, oil and gas production is a dominant contributor of area source NO_X and VOC emissions. The TCEQ developed special surrogates to spatially allocate the oil and gas production emissions using well-head location data obtained from the Texas Railroad Commission.

The following pages contain graphical plots of the 2005, 2006, and 2018 area source summer weekday NO_X and VOC emissions for the HGB area. These plots are respectively entitled Figure 4.5-1: *2005 HGB Summer Weekday Area Source NO_X Emissions*, Figure 4.5-2: *2006 HGB Summer Weekday Area Source NO_X Emissions*, Figure 4.5-3: *2018 HGB Summer Weekday Area Source NO_X Emissions*, Figure 4.5-4: *2005 HGB Summer Weekday Area Source VOC Emissions*, Figure 4.5-5: *2006 HGB Summer Weekday Area Source VOC Emissions*, and Figure 4.5-6: *2018 HGB Summer Weekday Area Source VOC Emissions*.

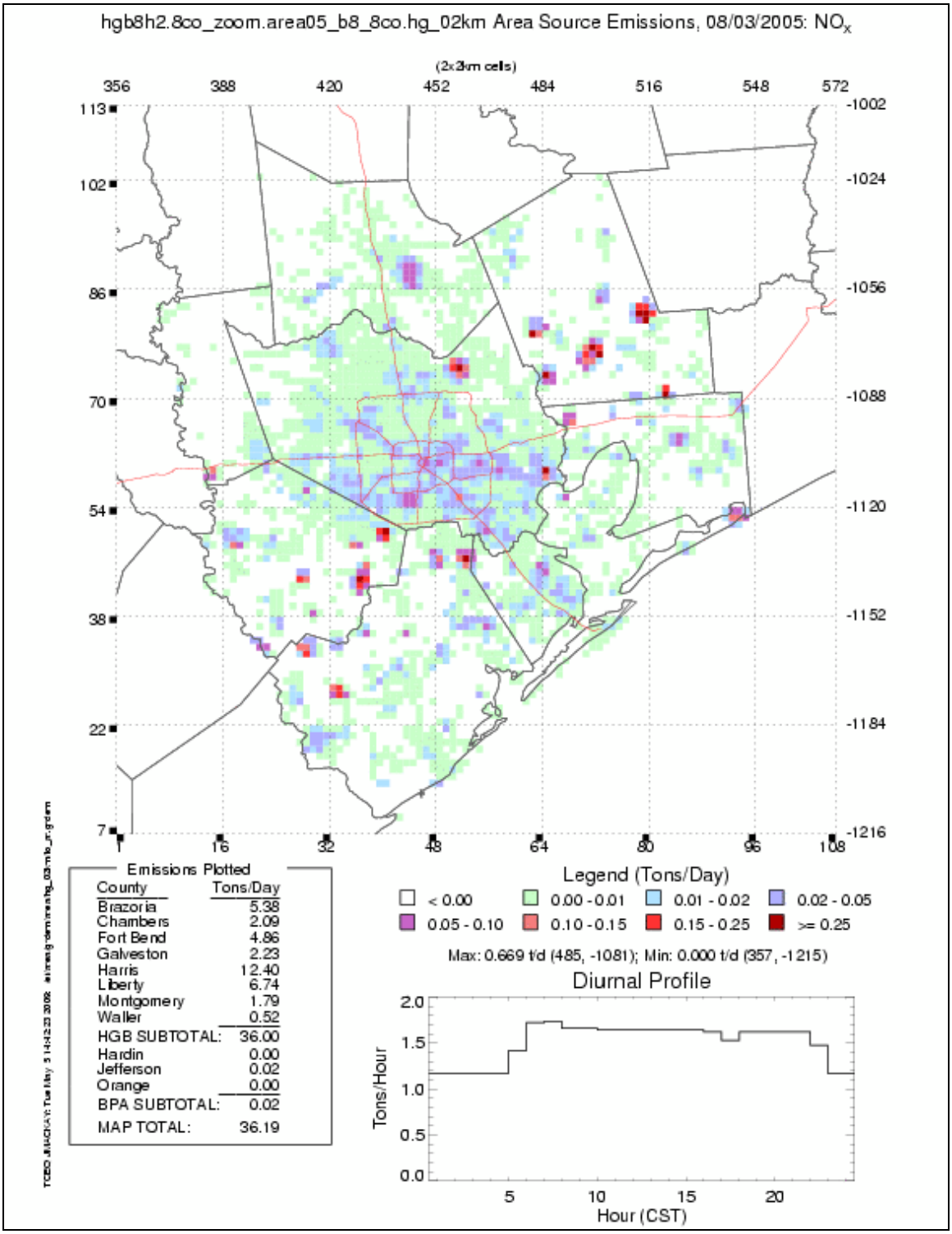


Figure 4.5-1: 2005 HGB Summer Weekday Area Source NO_X Emissions

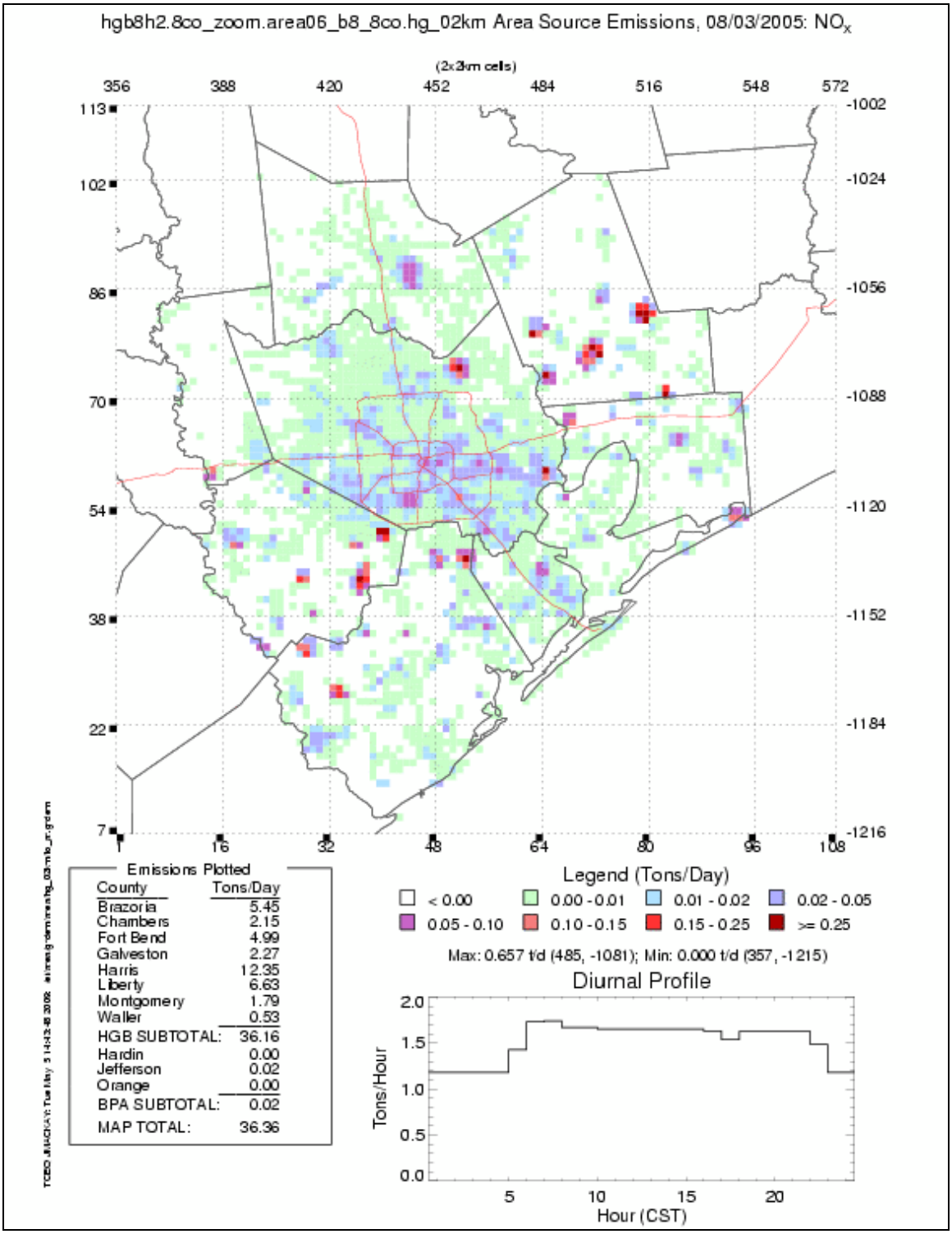


Figure 4.5-2: 2006 HGB Summer Weekday Area Source NO_X Emissions

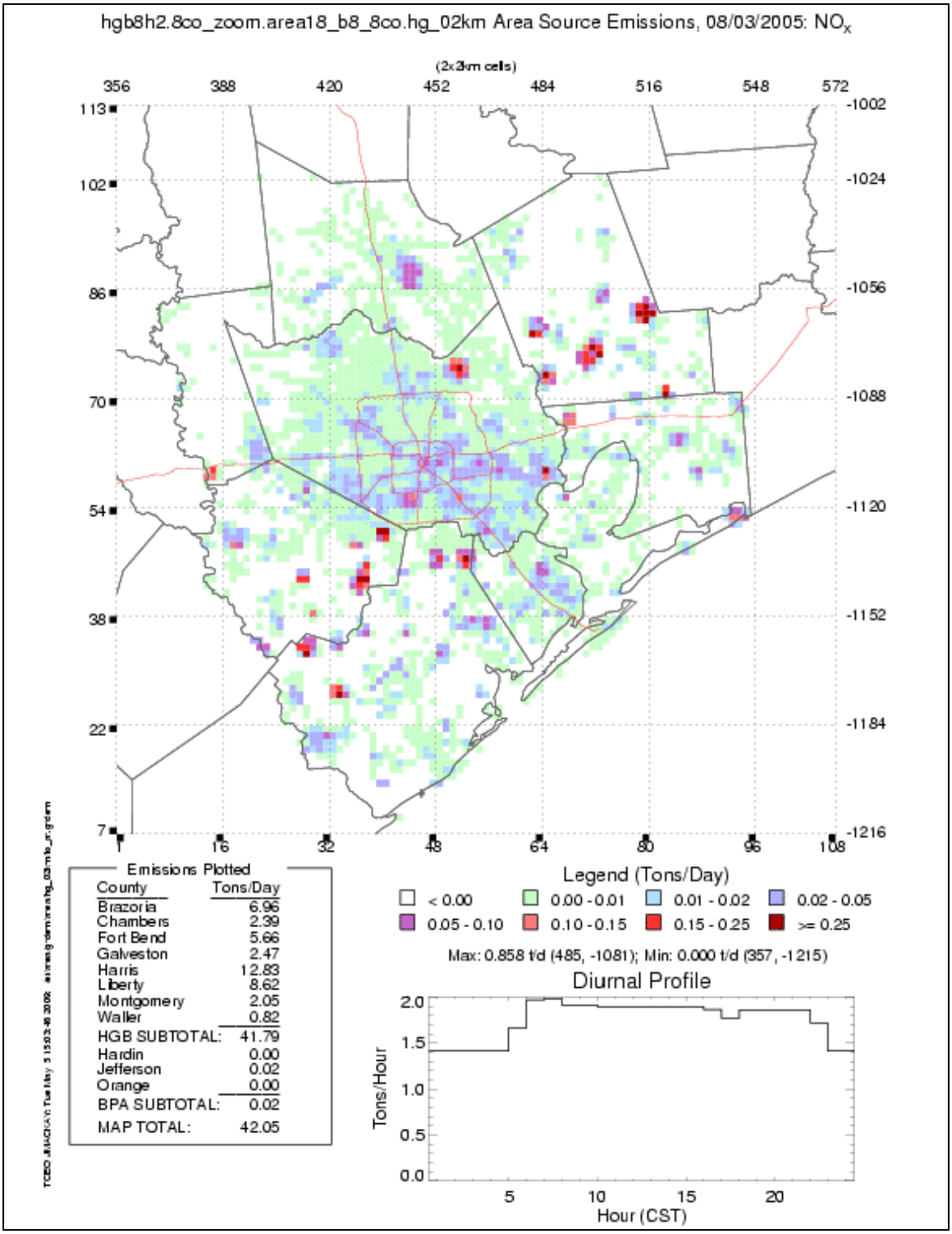


Figure 4.5-3: 2018 HGB Summer Weekday Area Source NO_X Emissions

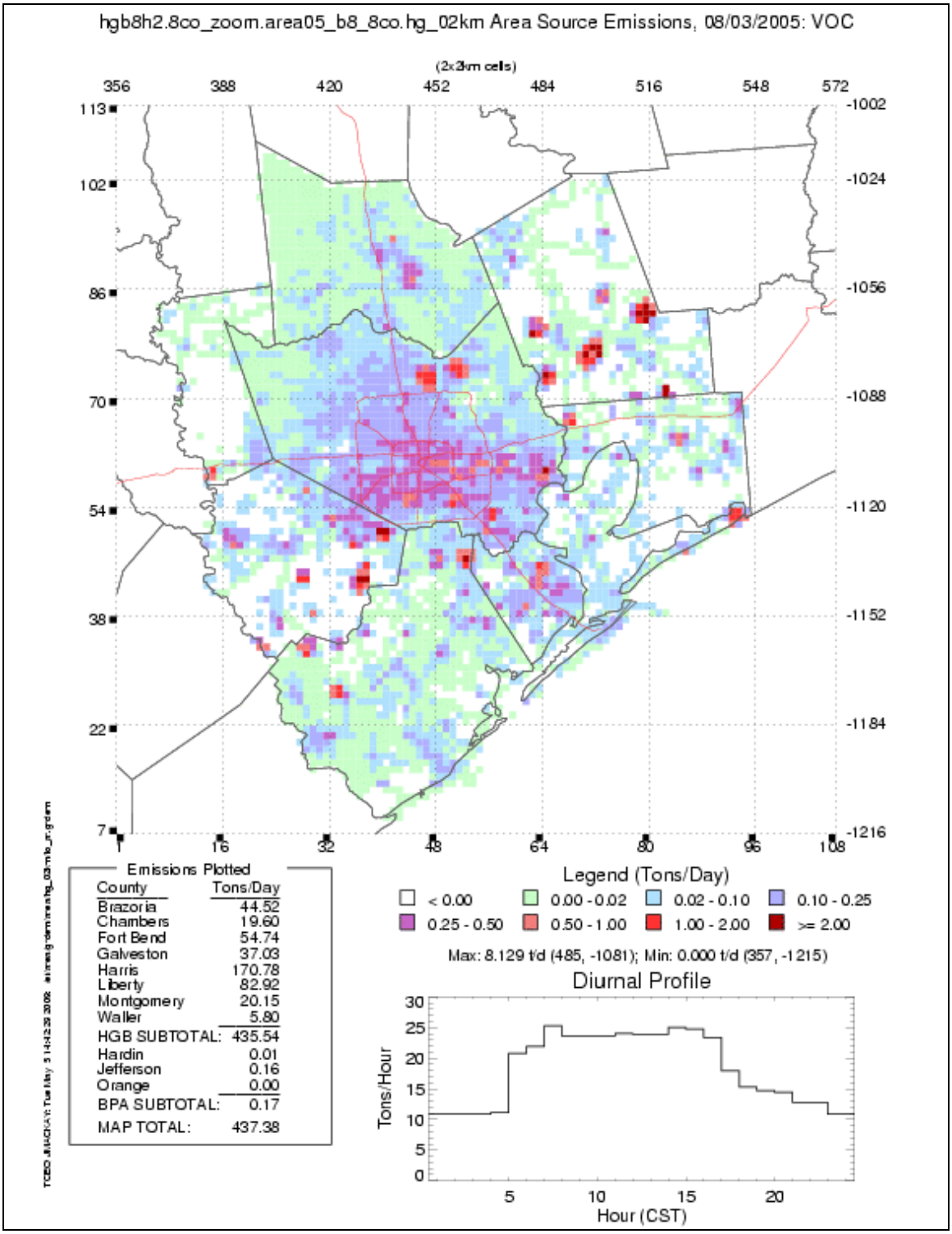


Figure 4.5-4: 2005 HGB Summer Weekday Area Source VOC Emissions

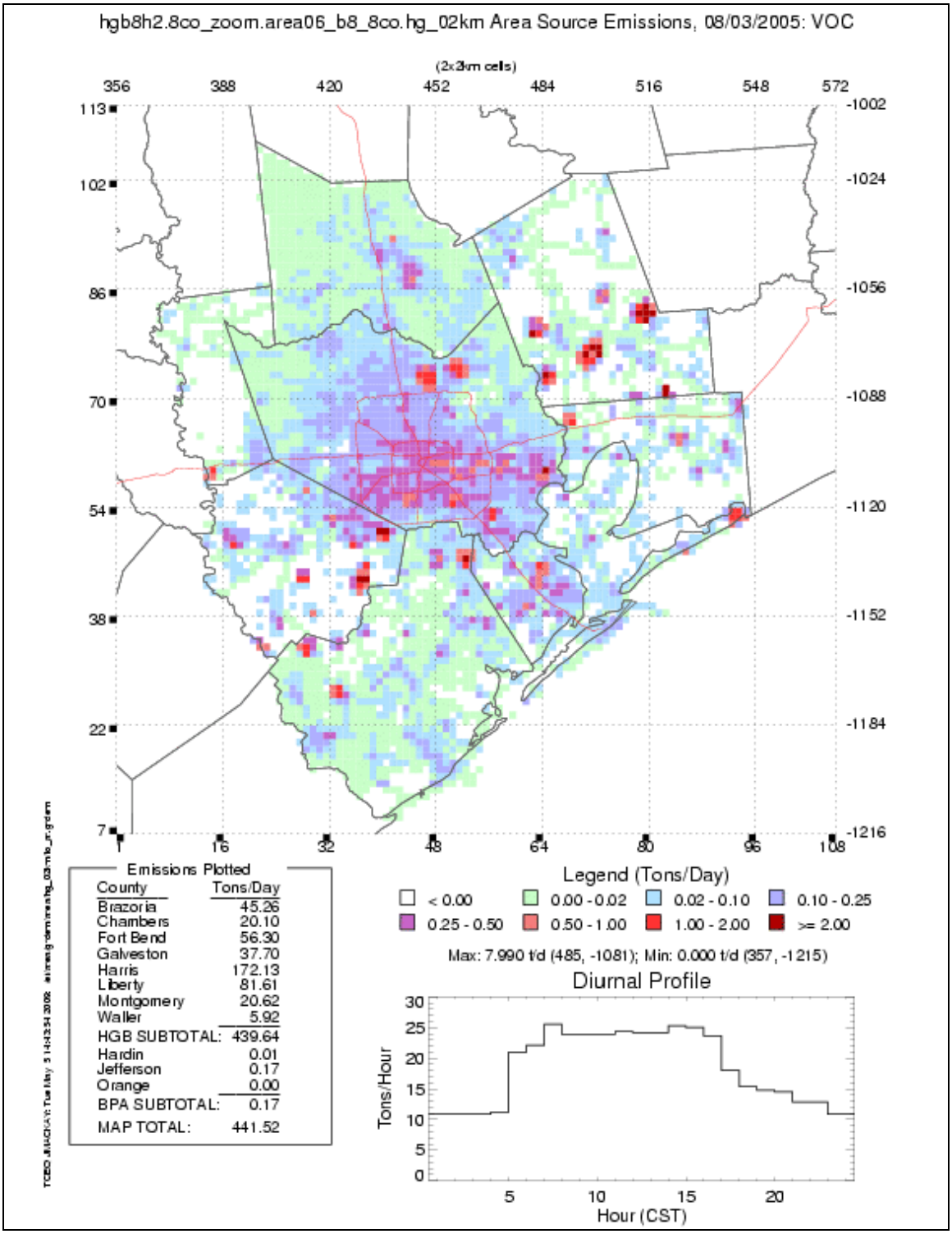


Figure 4.5-5: 2006 HGB Summer Weekday Area Source VOC Emissions

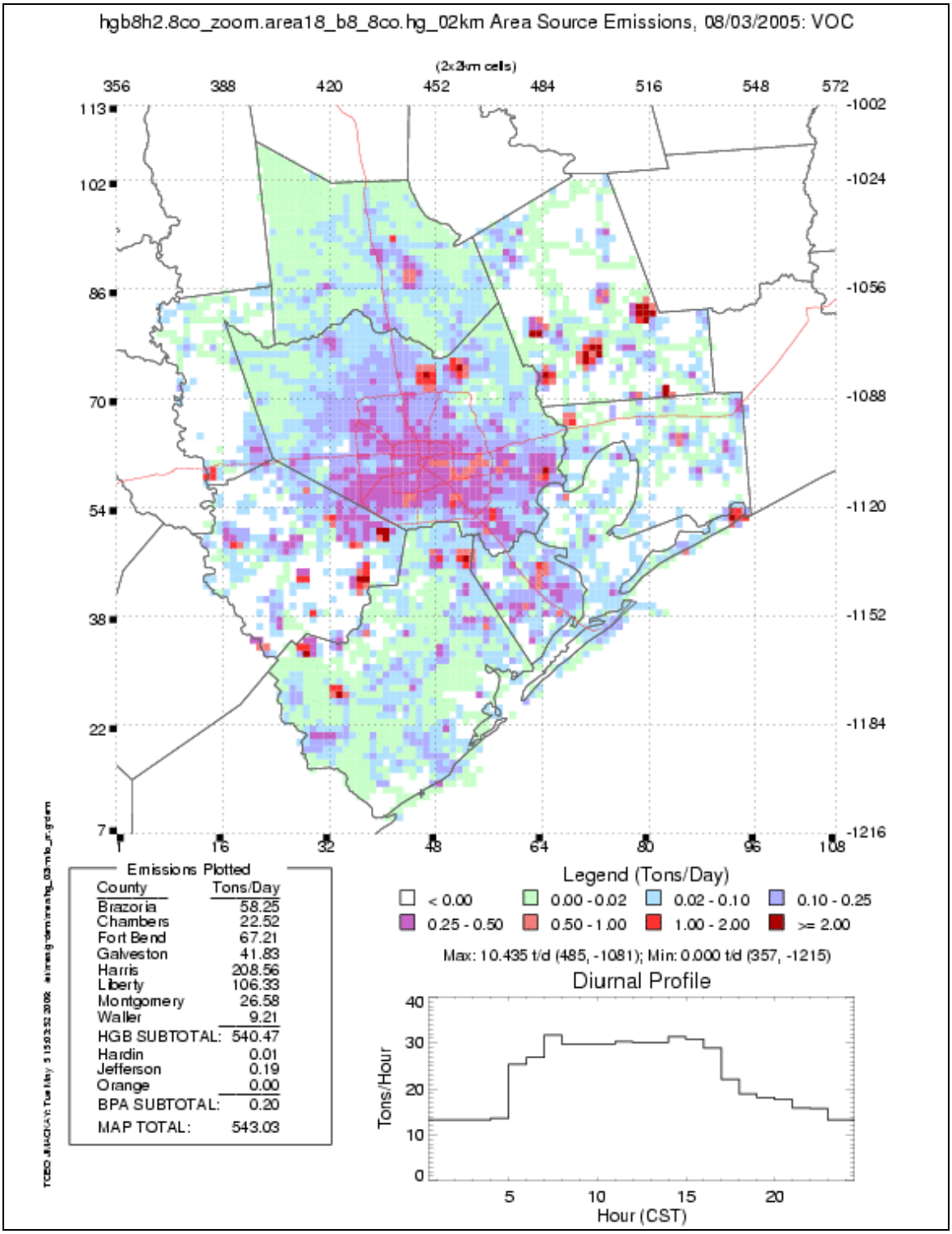


Figure 4.5-6: 2018 HGB Summer Weekday Area Source VOC Emissions

4.6 Off-Shore Oil and Gas Production Emissions

2005 emission estimates from oil and gas production in the Gulf of Mexico is detailed in a Minerals Management Service (MMS) study. Environ provided TCEQ with non-platform surrogates that allow for improved spatial distribution of this off-shore emissions activity. These 2005 estimates were held constant for 2006 and 2018 modeling and are graphically presented in Figure 4.6-1: *2005 Gulf of Mexico Oil and Gas Production NO_X Emissions.*

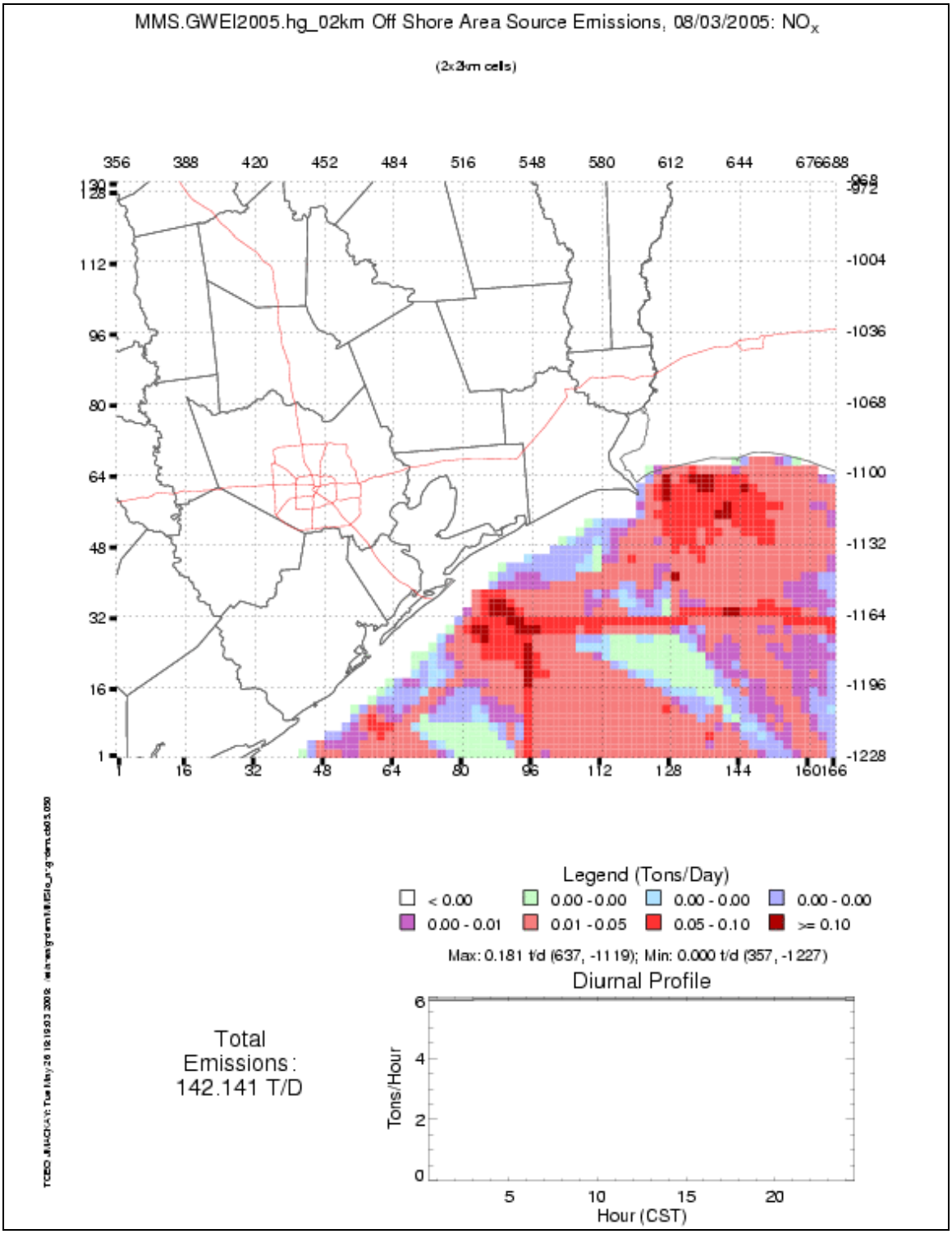


Figure 4.6-1: 2005 Gulf of Mexico Oil and Gas Production NO_X Emissions

4.7 Non-Road, Off-Road, and Area Source Emissions Outside of Eight-County HGB

Photochemical modeling inputs were also developed for the non-road, off-road, and area source categories outside of the eight-county HGB area. All non-road emission estimates within Texas were estimated with the TexN model already discussed above in Section 4.1. Similar to the approach taken with HGB, summer weekday emission estimates were developed with TexN for every Texas county, and the results have been posted to the TCEQ FTP site at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/Nonroad_EI/. Non-road emission estimates for non-Texas states within the photochemical modeling domain were developed for 2005, 2006, and 2018 using the EPA National Mobile Inventory Model (NMIM), which is available at http://www.epa.gov/otaq/nmim.htm and can be used to develop non-road county-level emission estimates for every year from 1999-2050.

In general, 2005 non-HGB county emission estimates within Texas for the off-road and area source categories were obtained from the TCEQ TexAER system. 2006 and 2018 projections of these 2005 figures were done with the REMI-EGAS projection factors discussed above in Section 4.5. Off-road and area source emission estimates for the non-Texas portions of the modeling domain were obtained from EPA's 2005 National Emissions Inventory (NEI), which is available at http://www.epa.gov/ttn/chief/net/2005inventory.html. Growth factors from EGAS were used to project the non-Texas 2005 NEI data to both 2006 and 2018. A summary of these data sources for the non-HGB areas is provided in Table 4.7-1: *Non-Road, Off-Road, are Area Source Emission Sources for Non-HGB Area*.

Table 4.7-1: Non-Road, Off-Road, and Area Source Emission Sources for Non-HGB Areas

Source Category Description	Data Source(s)	
	Non-HGB Texas	Non-Texas
Non-Road Equipment	TexN Model	NMIM
Oil and Gas Exploration	TexAER	NMIM
Aircraft	TexAER	NMIM
Airport Ground Support Equipment	TexAER	NMIM
Locomotives	TexAER	NEI
Commercial Marine	TexAER / Starcrest	NEI
Area Sources	TexAER	NEI

5.0 BIOGENIC MODELING EMISSIONS

For development of the biogenic emissions, the TCEQ used version 3.1 of the Global Biosphere Emissions and Interactions System (GloBEIS3.1), which is available at http://www.globeis.com/. GloBEIS3.1 incorporates detailed locality-specific land-use data to generate the mix and density of vegetative species. In addition, solar radiation data from Geostationary Operational Environmental Satellite (GOES) satellite imagery, which is used to generate the photosynthetically-active solar radiation (PAR), can be input to the GloBEIS3.1 model. Further, the GloBEIS3.1 model can accept hourly temperature data generated from weather station data.

Land-use data for the 12 km and 36 km non-Texas portions of the modeling domain were obtained from Version 3 of the Biogenic Emissions Landuse Data (BELD3; Kinnee et al., 1997), which is a vegetation database for the entire North American continent prepared specifically for creating biogenic emission inventories. Land-use data for the Mexico portion of the 12 km modeling domain were obtained from a joint effort between the University of Monterrey and Georgia Tech (Mendoza-Dominguez et al., 2000). Land-use data for the Texas portion of the 12 km domain were obtained from the Texas vegetation database (Wiedinmyer et al., 2001), which was derived from:

- Texas Parks and Wildlife vegetation data;
- agricultural statistics from the National Agricultural Statistics Survey; and
- field surveys carried out in 1999.

Within the 4 km nested domain surrounding the Houston-Galveston-Brazoria (HGB) area, a new land-cover database from the University of Texas Center for Space Research (UT-CSR) was used (Feldman et al., 2007) that was developed from:

- classification of recent Landsat 7 data;
- Shuttle Radar Topography Mission and National Elevation datasets to identify wetlands; and
- U.S. Department of Agriculture Common Land Unit (CLU) data for identification of agricultural lands.

The episode-specific PAR data input to GloBEIS3.1 were obtained from the website (http://metosrv2.umd.edu/~srb/gcip/cgi-bin/historic.cgi) operated by the Global Energy and Water Cycle Experiment (GEWEX) Continental International Project (GCIP) and GEWEX Americas Prediction Project (GAPP). These data were available at half-degree resolution and were reprocessed to spatially match the grid structure of the modeling domain. These data are derived from hourly GOES satellite imagery of cloud cover, which have been processed with a solar irradiation model (Pinker and Laszlo, 1992).

The episode-specific temperature data were obtained from weather stations throughout the U.S., including data from the National Weather Service (NWS), the EPA Aerometric Information Retrieval System (AIRS) air quality database, the National Buoy Data Center, the Texas A&M Crop Weather Program, the Louisiana Agricultural Information Service, and the Texas Coastal Oceanographic Observation Network. The organizations providing these meteorological data sets typically run thorough quality assurance checks, but a further review for possible anomalies was done by the TCEQ. Kriging algorithms were used with Statistical Analysis Software (SAS) to prepare the hourly temperature fields. The estimated hourly values were interpolated with a variogram that appropriately fits the inherent degree of variation.

The GloBEIS3.1 model was run for each of the ozone episode days listed in Table 5.0-1: *2005 and 2006 Ozone Episode Days for Emissions Modeling*. The date ranges that coincide with the 2006 Texas Air Quality Study (TexAQS) are appropriately noted.

Table 5.0-1: 2005 and 2006 Ozone Episode Days for Emissions Modeling

Common Name	Modeling Period	Number of Ozone Exceedance Days
May-June 2005	May 19 – June 3, 2005	8
June 2005	June 15-30, 2005	9
July-August 2005	July 26 – August 8, 2005	9
June 2006	May 31 – June 15, 2006	12
2006 TexAQS-1	August 15 – September 14, 2006	10
2006 TexAQS-2	September 19 – October 11, 2006	5

For quality assurance purposes, an emissions summary file was created showing the hourly domain-wide total emissions of NO_X, CO, isoprene, monoterpenes, and other VOCs to allow quick comparisons over different episode days. An additional quality assurance step involved review of the model configuration file that lists the various GloBEIS3.1 input settings. Since biogenic emissions are dependent upon the meteorological conditions on a given day, the same episode-specific emissions for the 2006 baseline were used in the 2018 future case modeling scenarios. A demonstration of how total biogenic emissions vary as a function of temperature and other meteorological conditions is provided in Table 5.0-2: T*otal Biogenic Emissions for 2005 Episode Days in the HGB Fine Grid Domain*.

Table 5.0-2: Total Biogenic Emissions for 2005 Episode Days in the HGB Fine Grid Domain

Ozone Episode Day	**Biogenic Emissions** (tpd)			
	Isoprene	Total Monoterpenes	Other VOC	NO_X
5/19/2005	990.52	251.84	319.54	24.80
5/20/2005	1,109.71	278.04	352.36	26.44
5/21/2005	1,541.05	348.85	440.39	30.20
5/22/2005	1,532.87	344.62	435.81	30.16
5/23/2005	1,354.11	322.04	405.24	28.59
5/24/2005	1,192.72	292.19	369.07	27.09
5/25/2005	1,195.11	279.15	356.74	27.05
5/26/2005	881.18	246.16	312.06	24.20
5/27/2005	1,113.46	270.14	343.22	25.98
5/28/2005	1,022.86	260.69	334.74	25.88
5/29/2005	890.56	243.62	310.22	24.26
5/30/2005	695.74	219.55	280.17	23.04
5/31/2005	967.94	255.76	327.19	25.44
6/1/2005	736.14	231.56	294.77	23.64
6/2/2005	1,276.95	296.01	375.71	27.39
6/3/2005	1,227.64	305.24	386.17	27.74
6/15/2005	1,610.00	367.55	464.54	31.40
6/16/2005	1,587.98	353.77	451.58	31.34
6/17/2005	1,528.45	354.31	450.87	31.04
6/18/2005	1,301.66	314.68	405.57	29.89
6/19/2005	1,345.59	316.52	405.68	29.54
6/20/2005	1,304.66	298.36	382.29	28.23

Ozone Episode Day	**Biogenic Emissions** (tpd)			
	Isoprene	Total Monoterpenes	Other VOC	NO_X
6/21/2005	1,405.17	317.71	403.96	28.68
6/22/2005	1,458.86	339.87	430.24	29.90
6/23/2005	1,465.39	342.09	433.44	30.21
6/24/2005	1,516.43	346.50	437.62	30.17
6/25/2005	1,365.38	332.40	421.48	29.71
6/26/2005	1,342.27	326.56	414.27	29.42
6/27/2005	1,431.97	341.17	430.62	29.87
6/28/2005	1,565.05	363.93	459.58	31.14
6/29/2005	1,645.34	383.84	484.11	32.17
6/30/2005	1,719.80	406.90	513.57	33.42
7/26/2005	1,477.01	358.21	452.81	30.87
7/27/2005	1,461.15	356.60	451.20	30.75
7/28/2005	1,485.12	353.40	450.08	30.80
7/29/2005	1,331.62	325.84	413.26	29.06
7/30/2005	1,373.65	323.38	411.48	29.36
7/31/2005	1,486.39	346.78	441.26	30.47
8/1/2005	1,448.97	347.40	439.20	30.12
8/2/2005	1,317.70	326.88	417.80	29.75
8/3/2005	1,317.06	324.84	415.99	29.74
8/4/2005	1,232.77	313.11	400.39	28.70
8/5/2005	1,272.09	321.72	405.66	28.44
8/6/2005	1,455.58	345.82	437.99	30.02
8/7/2005	1,362.22	317.55	407.52	29.54
8/8/2005	1,016.61	281.15	360.45	27.35

A sample plot showing the magnitude and spatial distribution of biogenic emissions for the 4 km fine grid modeling domain is available in Figure 5.0-1: *Representative Biogenic VOC and NO_X Emissions for August 2, 2005*. Please note that the total VOC reported in Figure 5.0-1 will not match the total VOC reported from Table 5.0-2 because the figure contains emission speciated for photochemical model input with the Carbon Bond 2005 (CB-05) chemical mechanism.

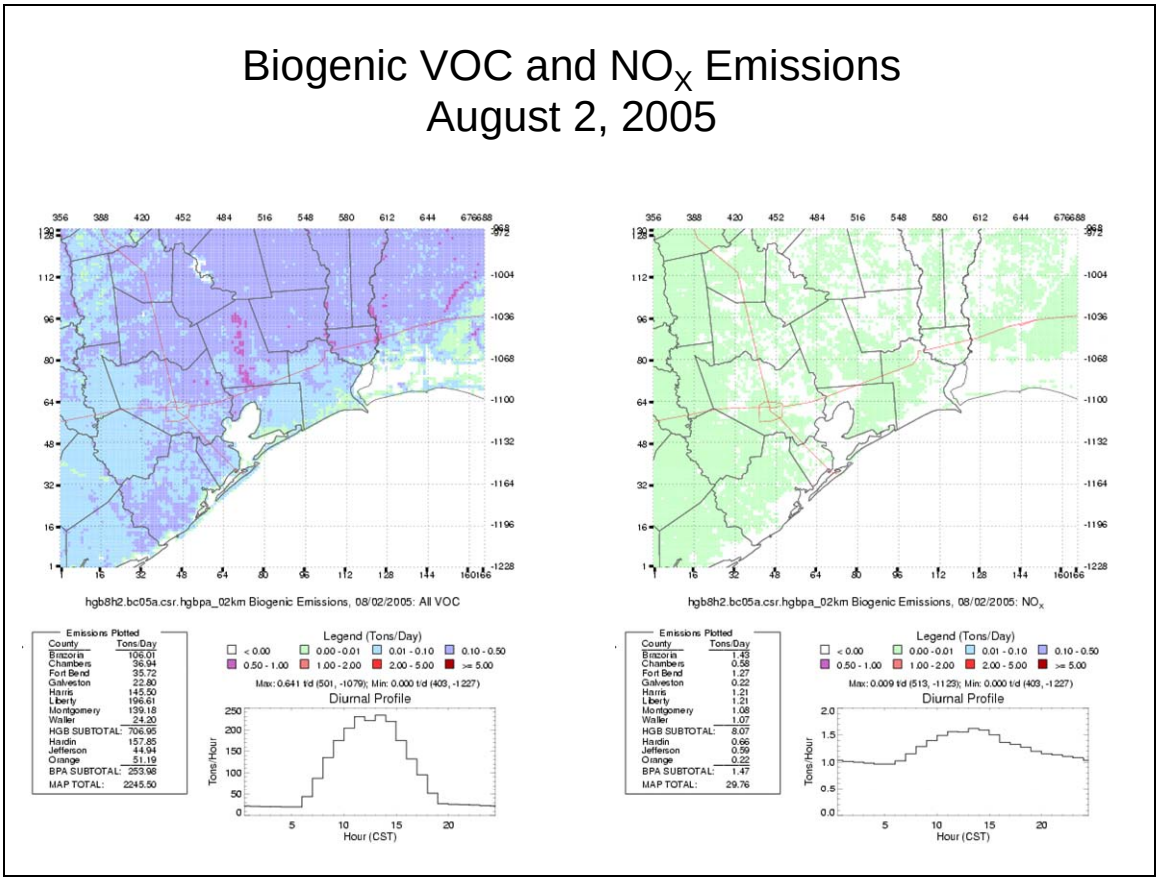


Figure 5.0-1: Representative Biogenic VOC and NO_X Emissions for August 2, 2005

ATTACHMENT 1

Reconciling Reported VOC Emissions with Ambient Measurements

Background

Historically, reported emissions of VOC have been insufficient to explain concentrations measured in the HGB area. Specifically, Highly-Reactive VOC (HRVOC – Ethylene, Propylene, Butenes, and 1,3-Butadiene) may have been under-reported in some areas by as much as an order of magnitude. TexAQS-II data suggest that the discrepancy between reported emissions and observed concentrations of ethylene are smaller than was the case in 2000. The discrepancy for propylene appears to have changed little.

Since 2003, the HGB area has had an extensive network of Automatic Gas Chromatographs, which measure ambient concentrations of individual hydrocarbon species. In 2005 and 2006, twelve sites operated in Harris (8), Galveston (1), and Brazoria (3) counties. This work uses the Auto-GC data from 2005 and 2006 to attempt to reconcile the reported emissions with measured concentrations.

Emissions data (in units of tons per day, or tpd) are fundamentally incommensurate with ambient concentration data (in units of parts/billion carbon, or ppbC), i.e. they cannot be directly compared. One way to make such a comparison is to use a dispersion model which estimates ambient concentrations resulting from specified emission rates. A wide variety of models could be employed, ranging from simple steady-state models such as the Industrial Source Complex (ISC) model to three-dimensional photochemical grid models including the Community Model for Air Quality (CMAQ) and the Comprehensive Air Quality Model with extensions (CAMx). The TCEQ chose the ISCST3 (ISC Short Term, Version 3) model for the analyses reported here since this model has been widely tested and used for Air Permit Applications. A large number of model runs was required and the development of input data and the running of ISC were done with relative ease compared to CAMx or CMAQ. These latter models and their input data would have been too unwieldy for the scope of this project.

The ISC-ST3 Model

The ISC-ST3 (EPA, 1992) model is widely used in modeling for air permit applications. For each hour simulated, it takes as input emission rates from point, area, and mobile sources, stack parameters, wind speed and direction, mixing depth, ambient temperature, and stability class. Emission rates can be specified as constant throughout the simulation, or can be hour-specific. The model assumes steady-state conditions, straight-line winds, no atmospheric chemistry, and Gaussian dispersion of airborne contaminants. ISC outputs hourly average pollutant concentrations at specified locations, in this case at the location of the 12 Auto-GCs operating in the HGB area, shown in Figure 1: *HGB Auto-GC Sites and Reported 2006 Daily Propylene Emissions*. For reference purposes, the figure also shows 2006 reported daily emissions of propylene.

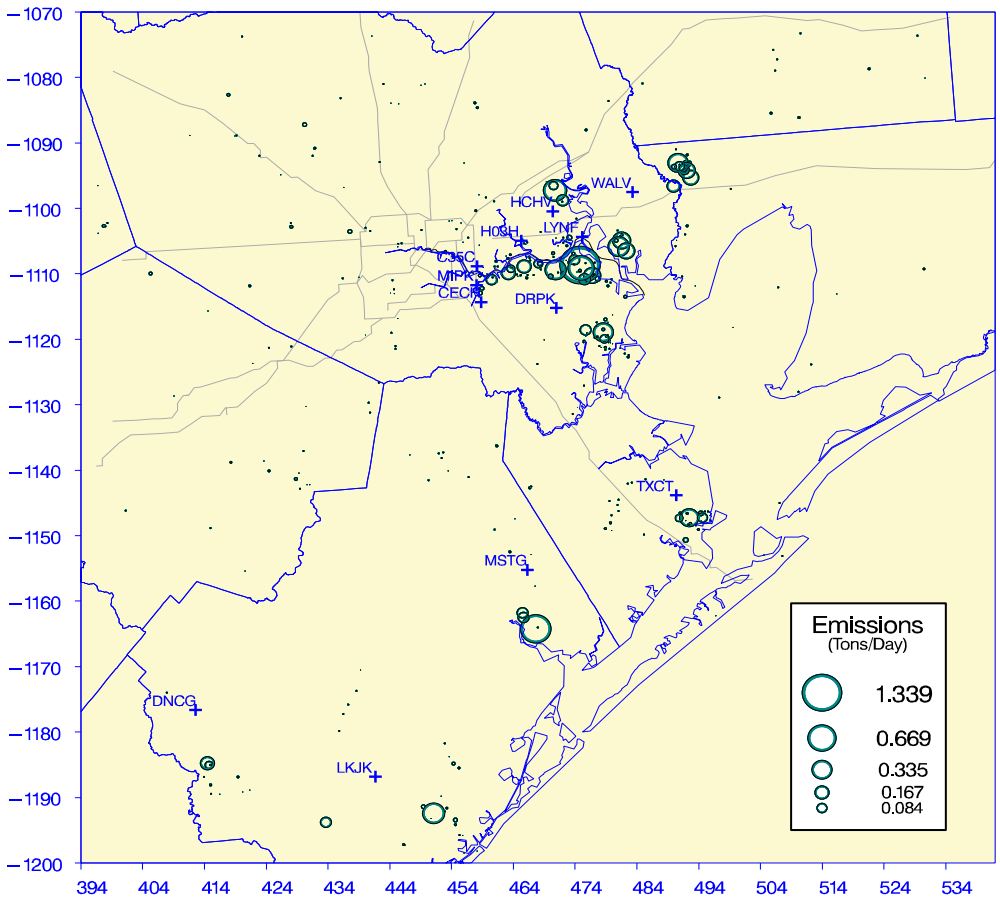


Figure 1: HGB Auto-GC Sites and Reported 2006 Daily Propylene Emissions

The ISC model was run for every hour in both 2005 and 2006, producing predicted concentrations of six HRVOC species: ethylene, propylene, 1,3-butadiene, 1- butene, t-2-butene, and c-2-butene, along with two species of relatively low reactivity: isobutane and n-butane. The resulting modeled concentrations could then be compared directly with the concentrations measured by the 12 auto-GCs at the same hours.

Selecting Hours for Comparison

Since ISC is a steady-state model that assumes straight-line winds, it is necessary to limit the comparison with measurements to those hours where the winds have been relatively constant. To exclude trajectories that are too "curvy", we examined five-minute back trajectories terminating at the auto-GC sites and calculated two parameters:

- A sinuosity value, which is the straight-line distance from the start of the trajectory to its endpoint, divided by the actual trajectory length. For perfectly straight trajectories this value is unity, and is < 1 for all others. The TCEQ chose a relatively tight criterion of sinuosity ≥ 0.95.

- A maximum variation of wind direction, in degrees. This latter condition is needed to avoid situations where the sinuosity would otherwise be acceptable, but the trajectory makes a sharp turn near the monitoring site. In this case, the sinuosity could be close to unity, yet the sources along the path may lie in a direction markedly different from the wind direction measured at the monitor. For this work, we required all trajectory points to lie within a 15° "wedge" with its apex at the monitor site.

Another assumption of ISC is that species are conserved chemically, clearly not the case for HRVOC, which break down quickly in sunlight and also tend to react with other atmospheric contaminants even at night. The TCEQ experimented with using back trajectories of up to six hours in length, but ultimately chose two-hour trajectories for several reasons: first, beyond two hours significant fractions of the emitted HRVOC will have reacted, and second, longer trajectories tend to develop more curvature, reducing the number of hours with relatively straight trajectories available for comparison. Third, the farther the source is from the receptor, the greater the uncertainty in the wind trajectories.

Emissions for ISC Modeling

HGB-area 2005 and 2006 point source emissions in tpd were extracted from the State of Texas Air Reporting System (STARS) and formatted for input into ISC. The emissions were processed into the EPS3 input format known as AFS (AIRS facility system). It is important to note that these emissions are adjusted for rule-effectiveness (RE) during this process, which increased emissions from many sources for modeling purposes. Because there is almost no routinely-collected information available about hourly point source emissions, each hour's emissions for each source are just the daily tons/day divided by 24. Area, on-road mobile, and non-road mobile source emissions previously developed for the upcoming HGB eight-hour ozone attainment demonstration SIP revision were allocated to a 2 km grid using the SPLTEM program. This program provides hourly emissions of each component chemical species by grid cell, using the spatial and temporal allocations developed for use in photochemical modeling conducted in support of the SIP revision. The program also adjusts daily emissions by day-of-week. Biogenic emissions were not considered, since these sources are not associated with HRVOC emissions (isoprene, although highly reactive, is not regulated as an HRVOC since it is primarily of biogenic origin).

ISC Results

Figure 2: *Measured and Modeled Median Concentrations by Wind Direction and Emissions for Propylene in the 2005 Ship Channel Area* shows a comparison of modeled concentrations (what would be expected, based on the RE-adjusted reported emissions) with measured concentrations (what was actually seen) for 2005 in the Houston Ship Channel area. The radar plots at each monitor location convey both measured and modeled propylene concentrations as a function of wind direction. Note that the scales are logarithmic, with the darker circles representing concentrations of 1, 10, and 100 ppbC. The red pie slices represent the median measured concentration of propylene (propylene) coming from the indicated direction (each wedge represents ten degrees) over all trajectories that met the straightness criteria described above. The corresponding blue slices represent median modeled concentrations. Slices shown in lighter shading indicate no significant difference between the measured and modeled medians, using a simple sign test [Conover, 1971]. Some directions are not represented, having fewer than 15 trajectories meeting the criteria for inclusion. Because of its close proximity with the Clinton Drive and Caesar Chavez monitors, the plot for the Milby Park site is omitted from the figure, but is included in all subsequent analyses. To illustrate the relationship between the sources and receptors, reported 2005 point source propylene emissions are represented as circles of varying size and color.

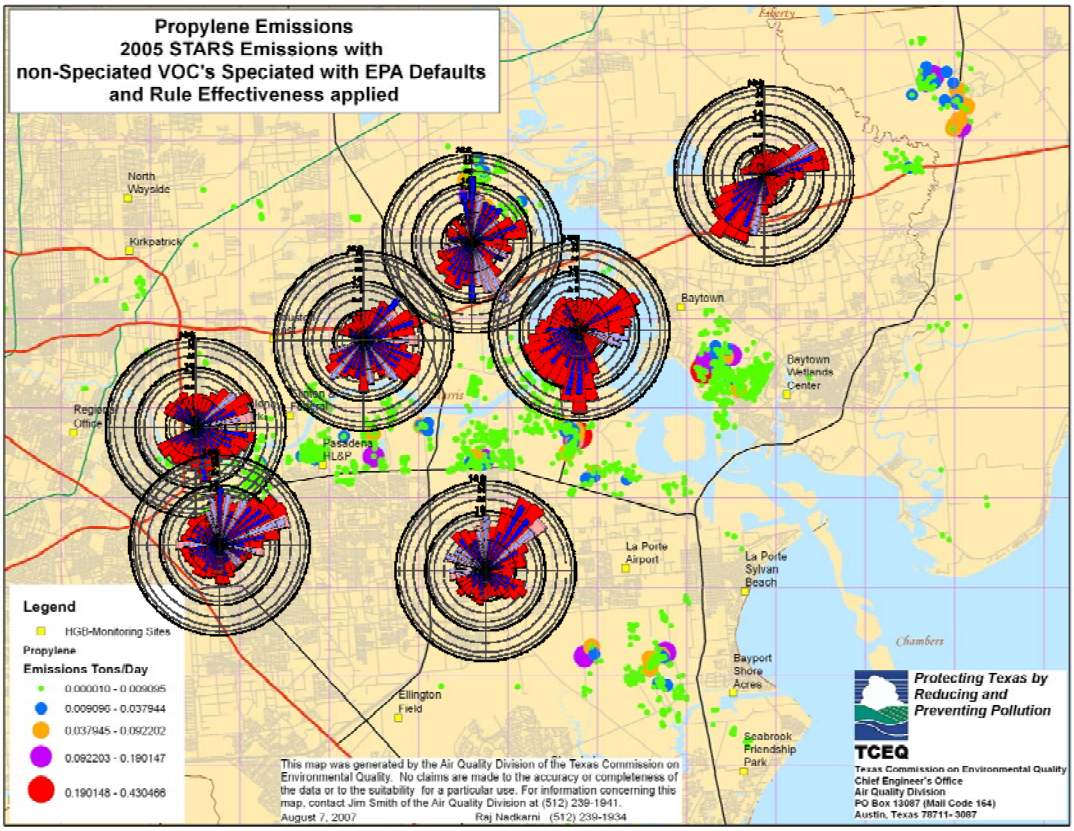


Figure 2: Measured and Modeled Median Concentrations by Wind Direction and Emissions for Propylene in the 2005 Ship Channel Area

Figure 3: *Measured and Modeled Median Concentrations by Wind Direction and Emissions for Propylene in the 2005 Galveston and Brazoria Counties* below is similar to Figure 2, except it shows monitoring sites in Galveston and Brazoria counties. In both figures, it is clear that the longer slices generally point towards inventoried point sources, sometimes with several monitors pointing to the same source. In the case of the Galveston and Brazoria county monitors, there are lobes pointing towards local sources, but each also has lobe pointing towards the Ship Channel. With a few exceptions, the red slices are usually longer than the blue slices, indicating that median monitored propylene concentrations are greater than can be explained by the RE-adjusted reported propylene emissions in STARS. In fact, the discrepancy may be even greater than seen on the plots, since some fraction of the emitted propylene will react before it reaches the monitor locations.

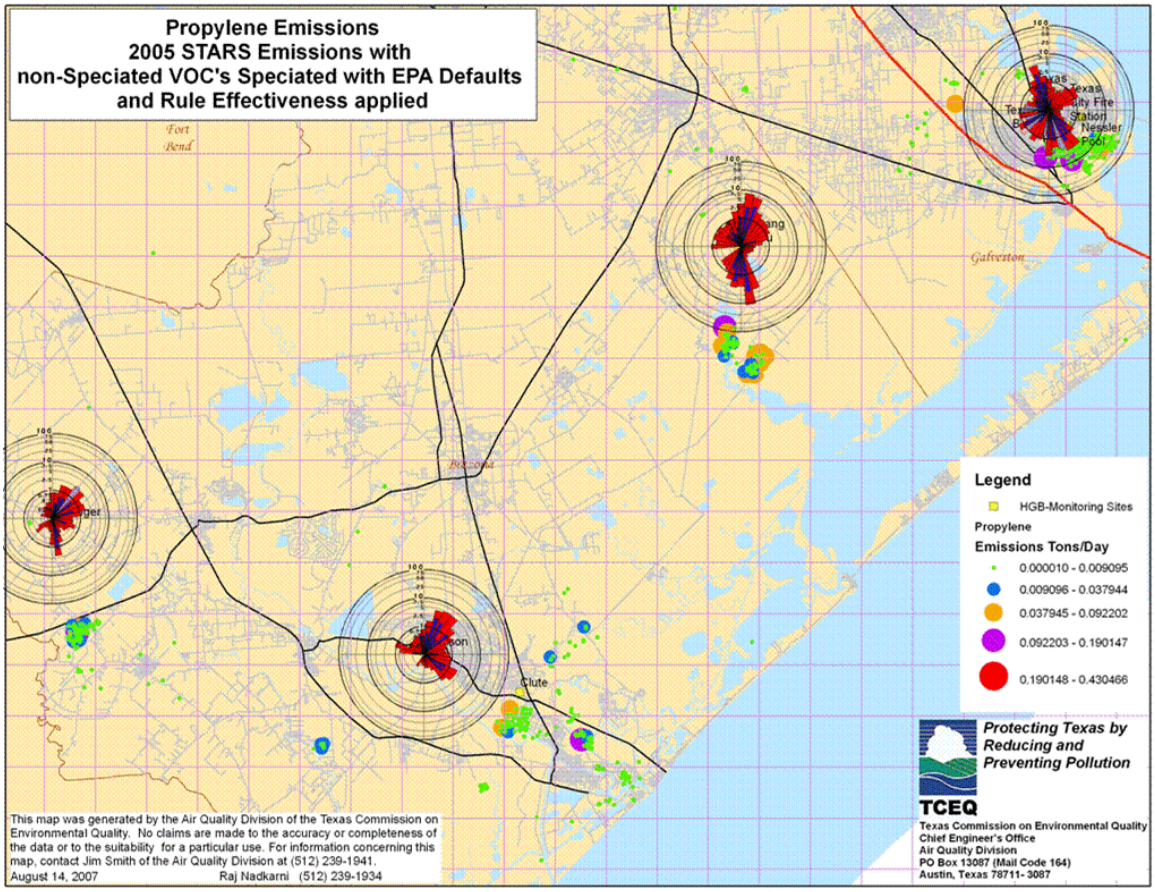


Figure 3: Measured and Modeled Median Concentrations by Wind Direction and Emissions for Propylene in the 2005 Galveston and Brazoria Counties

The ISC comparison illustrated in this section provides a means for quantifying possible discrepancies between reported emissions and actual emissions; if a red pie slice is significantly longer than the corresponding blue pie slice, then there is evidence that the emissions from that direction may be under-reported. Conversely, if a blue slice is longer than it's red counterpart, the source may be over-reported, but this could also result because some fraction of the emitted pollutant reacted away en route to the monitor. Simply ratioing the lengths of the red and blue slices provides a factor that could be applied to upwind sources to reconcile reported emissions with observed atmospheric concentrations. This factor is referred to as an Emission Reconciliation Factor (ERF).

The above technique would be appropriate for isolated sources, but not in areas like the Houston Ship Channel which has hundreds of sources clumped together along its length and in nearby industrial areas. One option in this case would be to apply some weighted average of individual ERFs, but this approach becomes unwieldy when accounting for the number of observations and source-receptor distances. A more elegant approach based on the Potential Source Contribution Function (Ashbaugh, et al 1985, Hopke et al 1995) that is described in the following section.

Potential Source Contribution Function

The Potential Source Contribution Function (PSCF) is a technique which uses back-trajectories to attempt to pinpoint source regions for observed atmospheric contaminants. While generally applied over regional scales, PSCF is an ideal technique for use in complex urban-scale applications like the HGB area. First, a grid is placed over the source region, then points along the back-trajectories which fall into each grid cell are counted (in the case of HGB, each point represents a five-minute interval along the trajectory track). Of these points, some will be from trajectories which are associated with particularly large concentrations (e.g., above the 75th

percentile of all observations). Grid cells with unusually high percentage of these high-concentration trajectory points are good candidates to contain emission sources. Xie and Berkowitz (2006) used this technique to identify potential source regions in the Houston Ship Channel area, and, not unexpectedly, these source regions largely coincided with reported emission sources.

An illustration of the PSCF as applied by Xie and Berkowitz is shown below in Figure 4: *PSCF Illustration*. In the figure three trajectories pass through the grid cell outlined in blue, two associated with low concentration readings at the monitor (Auto GC), shown in green, and one ending in a high concentration (shown in red). Since one of the five trajectory points is from a "high" trajectory, the PSCF score for the grid cell outlined in blue is 1/5 = 0.2.

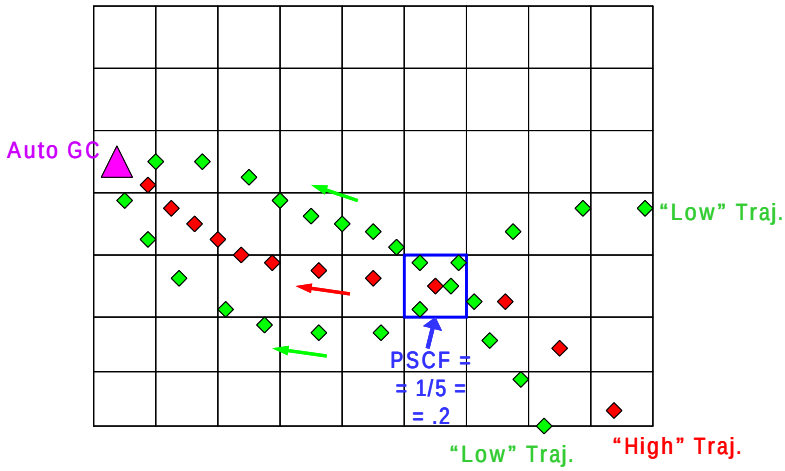


Figure 4: PSCF Illustration

One feature of this technique is that it is actually self-weighting in terms of wind speed; slower moving trajectories will spend more time in each grid cell than faster-moving ones, which implies that more trajectory points will accrue for the slower ones. So in effect the trajectories (or more accurately, the concentrations associated with the trajectories) are weighted proportionately to the amount of time the trajectory spends in a grid cell.

Figure 5: *Summer Daytime PSCF Probabilities for Propylene at Channelview and Combined for Five Sites*, reproduced from work performed under contract to the TCEQ by Xie and Berkowitz, shows the PSCF analysis for propylene at the Channelview auto-GC, (right), and a combined analysis for five auto-GCs (left) for 2003 summer daytime observations. The shading in the plots represents the empirical probability that an air parcel passing through a specific location will deliver a high (i.e. greater than the 75th percentile) concentration of propylene to the Channelview site.

The right-hand picture shows that most of the high-probability trajectories at Channelview come from the east-to-northeast and southwest-to-southeast directions, which, not surprisingly, correspond with locations of reported propylene sources. The long tails in most cases do not represent distant emission sources; rather, they represent locations traversed by a large number of six-hour trajectories that eventually passed over a source near the monitor and terminated at the monitor. The left-hand picture, using the combined PSCF analyses for five sites, still show evidence of artificially long tails like those seen in the right-hand picture, but use of multiple sites has clearly focused the highest PSCF probabilities into areas that more closely correspond with known propylene sources.

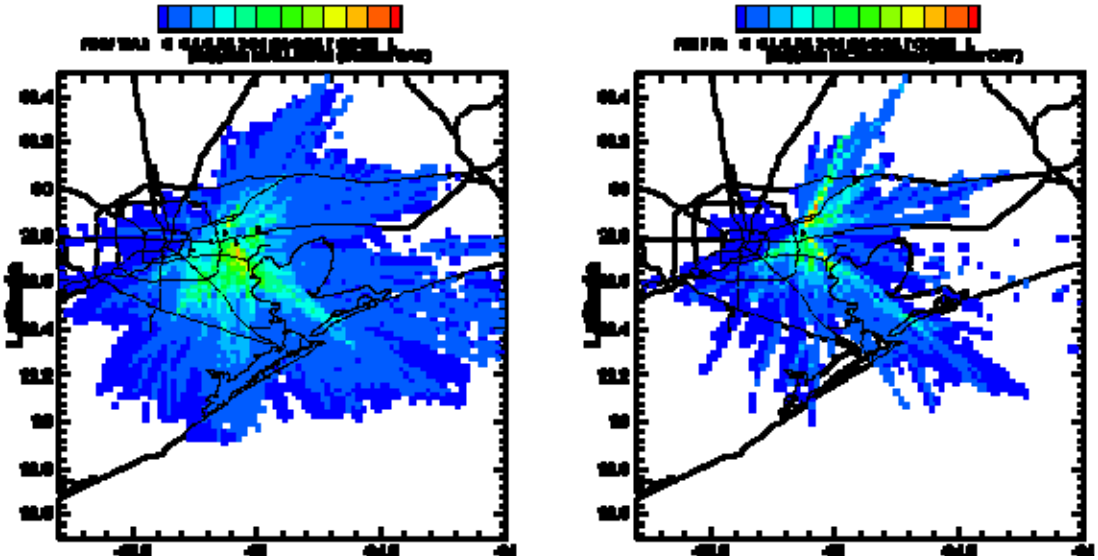


Figure 5: Summer Daytime PSCF Probabilities for Propylene at Channelview (r) and Combined for Five Sites

Modified Point Source Contribution Function

While the PSCF technique is seen to successfully locate potential emission sources, it does not provide quantification for the emission rates. In pursuit of a means to quantify emissions, the PSCF approach was modified as follows: instead of simply computing the fraction of trajectories associated with high concentrations in each grid cell, the median of the concentrations associated with each trajectory point was calculated. This value will be referred to as a pseudo-concentration, since it is not the concentration in the grid cell but rather represents the median concentration at the endpoint of the trajectories passing through the cell.

Figure 6: *Modified PSCF Technique* illustrates the modified PSCF technique. The left-hand figure is the same as Figure 4 except that instead of simply labeling the trajectories as "high" and "low", the recorded concentrations are maintained when the trajectories arrive at the monitoring location. The right-hand portion of the figure expands the grid cell marked in blue and shows the five concentration values associated with the three trajectories with points inside the cell. The median of these five values is the modified PSCF value for this cell. Note that the median was used instead of the mean due to the highly skewed nature of the concentration data (an alternative would be to use the geometric mean).

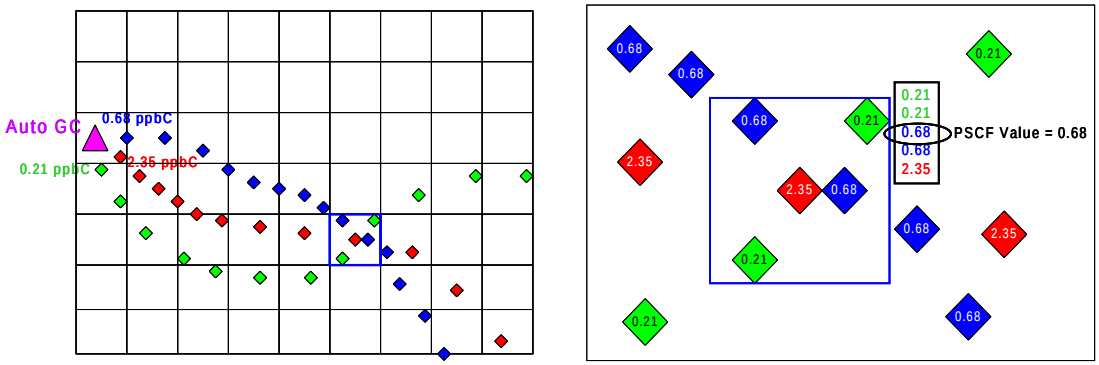


Figure 6: Modified PSCF Technique

Figure 7: *2005 Propylene Pseudo-Concentrations Using Channelview Observed Concentrations* presents the results of applying the modified PSCF analysis to back trajectories ending at the

Channelview Auto-GC, using the same back trajectories used to create Figure 2 (i.e., 2005 two-hour back-trajectories with sinuosity 2km grid cell having at least 100 trajectory points.

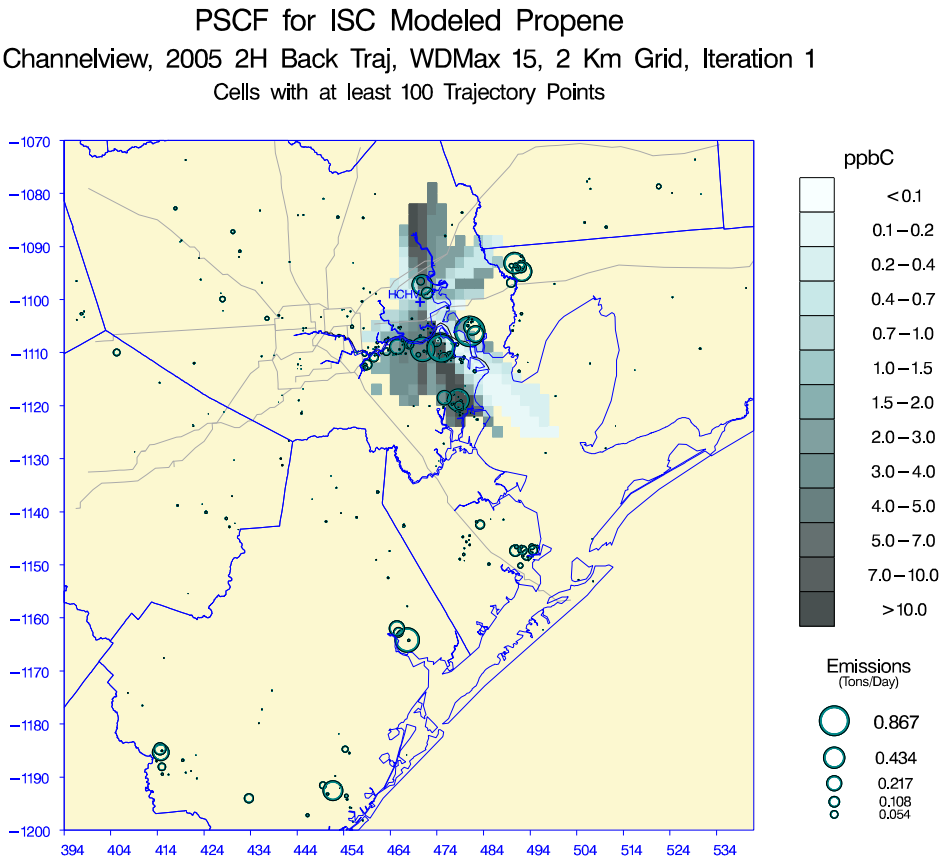


Figure 7: 2005 Propylene Pseudo-Concentrations Using Channelview Observed Concentrations

Note the similarity between Figure 7 and the right-hand side of Figure 5. Both figures identify sources in the north-to-northeast and southwest-to-southeast sectors, even though the tails in Figure 5 are much longer because of the longer trajectories.

As was done in the original PSCF analysis, the PSCF analysis was re-run, but this time all 12 auto-GC sites were included together. In this case, the interpretation of the pseudo concentrations changes slightly – instead of representing the median concentration associated with points of trajectories ending at a single monitor, the pseudo-concentrations shown in Figure 8: *2005 Propylene Pseudo-Concentrations Using Observed Concentrations at 12 Auto-GC Sites* represent the median concentration associated with points of trajectories ending at any monitor.

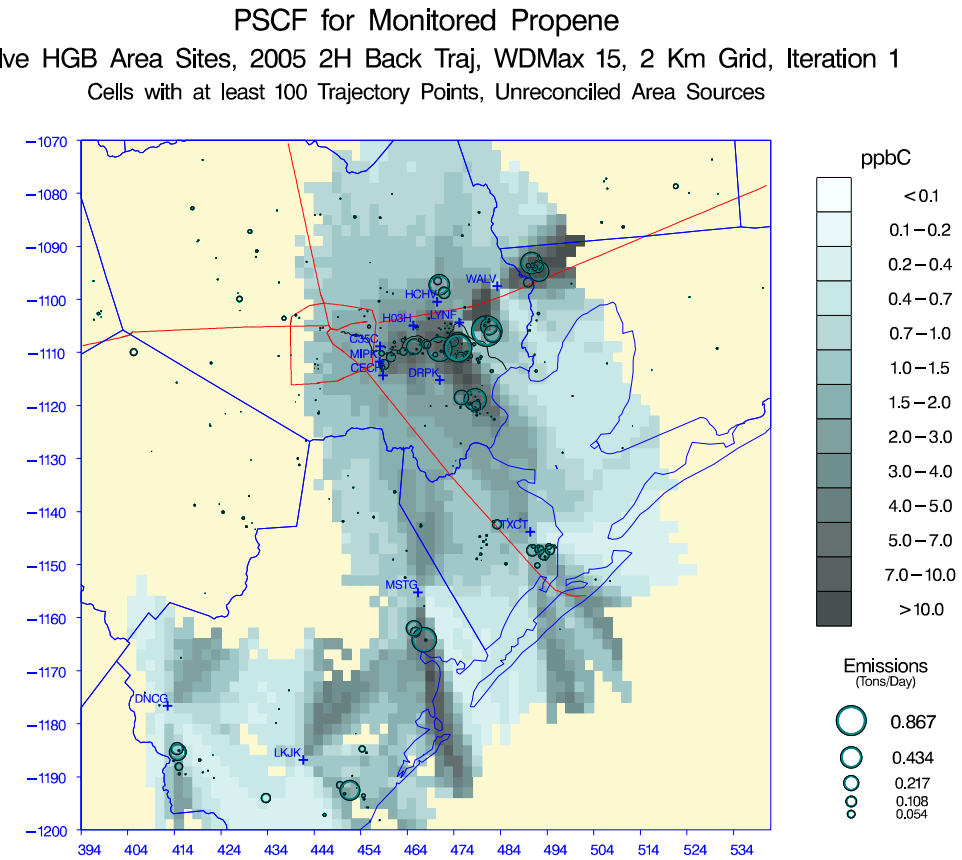


Figure 8: 2005 Propylene Pseudo-Concentrations Using Observed Concentrations at 12 Auto-GC Sites

At this point, the median concentrations can be quantified for air parcels moving over the monitoring locations identified on the graphic, but still have no means to quantify emissions themselves. But the same analysis depicted in Figure 8 can be performed using the modeled concentrations at the monitor locations, instead of the measured concentrations. Figure 9: *2005 Pseudo-Concentrations of Propylene Using Modeled Concentrations at 12 Auto-GC Sites* thus shows the median concentrations over the sources that we would expect to see based on the RE-adjusted reported emissions.

While the darker areas in Figure 9 correspond well with those in Figure 8, clearly the areas are generally much lighter in Figure 9. This implies that reported emissions, even adjusted for RE, are not sufficient to explain the concentrations of propylene seen at the Auto-GC sites.

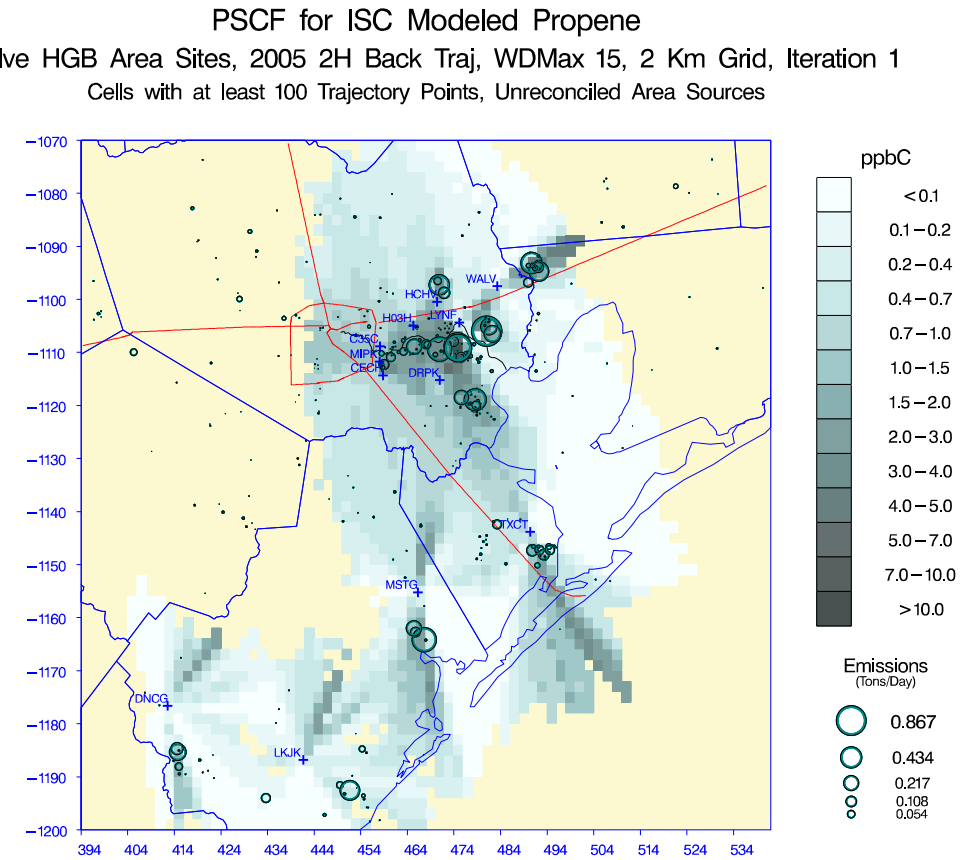


Figure 9: 2005 Pseudo-Concentrations of Propylene Using Modeled Concentrations at 12 Auto-GC Sites

The comparison of the modeled and measured PSCF pseudo-concentration values leads naturally to a means for quantifying any discrepancies between them. Figure 10: *Ratios of 2005 Propylene Pseudo-Concentrations Based on Measurements to Pseudo-Concentrations Based on Modeling* presents the ratio of median measured PSCF pseudo-concentrations by grid cell to their median modeled counterparts. Red areas indicate source regions where reported emissions are not sufficient to explain the measured concentrations, while blue areas indicate the converse. White areas indicate relatively close agreement.

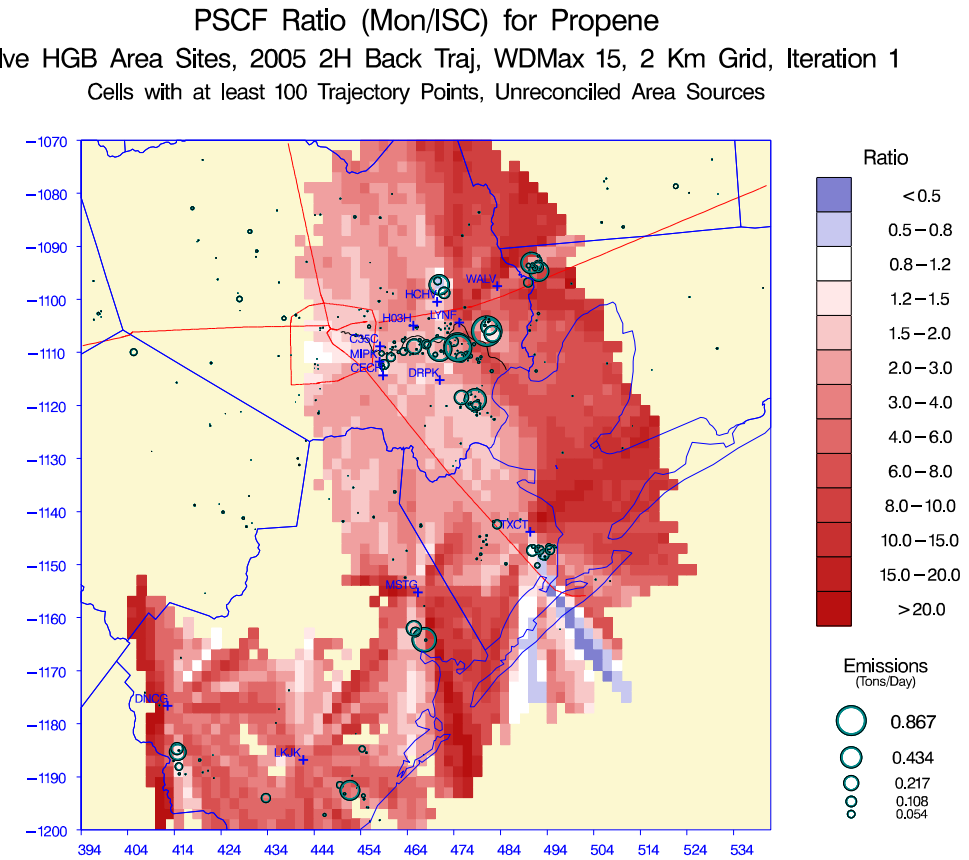


Figure 10: Ratios of 2005 Propylene Pseudo-Concentrations Based on Measurements to Pseudo-Concentrations Based on Modeling

Emissions Reconciliation

After calculating the pseudo-concentration ratios depicted in Figure 10, the next logical step is to apply the ratios to the RE-adjusted reported emissions by grid cell. This approach is valid because of the assumption of steady-state, non-reactive conditions. Point sources reported in the 2005 STARS database were identified by grid cell, and their RE-adjusted emissions were multiplied by the indicated ratio. Even though the ratios for a small number of sources were less than unity, only reconciliation factors greater than one were applied since some reduction in propylene concentration would be expected due to reactions in the atmosphere. Some early applications of the technique applied reconciliation factors to other types of sources, but this procedure was rejected because it resulted in spuriously large increases to area and mobile source emissions which happened to be near point sources. In 2005, the emissions reconciliation added 15 tpd of propylene emissions to the RE-adjusted reported total of 10 tpd, resulting in an increase of 150 percent.

After performing the reconciliation, it is natural to re-run the analysis using the reconciled point source emissions to see if the reconciled emissions really are more congruent with measurements than were the reported emissions. Figure 11: *Modified PSCF Analysis Using Observed and Modeled Concentrations at 12-Auto GC-Sites* shows a six-panel comparison between the before-and-after reconciliation PSCF plots. The top row reproduces the plots in Figures 8-10 using RE-adjusted reported emissions, and the bottom row shows the same plots using the reconciled emissions (the leftmost plots in each row are identical to each other). It is apparent that the PSCF pseudo concentrations based on reconciled emissions (bottom center) match the observation-based PSCF pseudo-concentrations in the left panel much better than do those based on RE-adjusted reported emissions (top center), and the ratios based on reconciled emissions (bottom right) show ratios generally much closer to unity than do those in the row above. It can then be

concluded that the reconciled emissions do a better job of explaining the observed concentrations than do the RE-adjusted reported emissions.

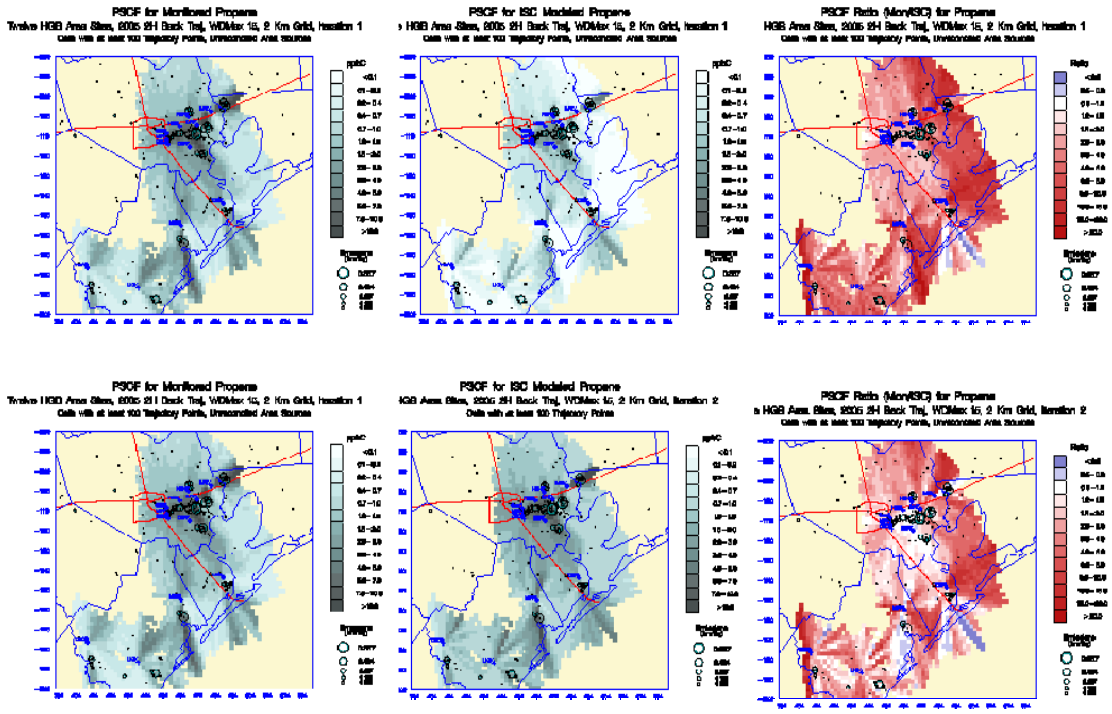


Figure 11: Modified PSCF Analysis Using Observed and Modeled Concentrations at 12-Auto GC-Sites. Top Row: (L) PSCF pseudo-concentrations of propylene using monitored concentrations as 12 auto-GC sites; (C) PSCF pseudo-concentrations of propylene using modeled concentrations at 12 auto-GC sites, calculated using RE-adjusted reported emissions; (R) Ratio of monitoring-based PSCF pseudo-concentrations to model-based pseudo-concentrations using RE-adjusted reported emissions. Bottom Row: (L) PSCF pseudo-concentrations of propylene using monitored concentrations at 12 auto-GC sites; (C) PSCF pseudo-concentrations of propylene using modeled concentrations at 12 auto-GC sites, calculated using reconciled emissions; (R) Ratio of monitoring-based PSCF pseudo-concentrations to model-based pseudo-concentrations using reconciled emissions

After performing a second round of PSCF analysis, it would, of course, be possible to make a second round of emission adjustments, and repeat the process again ad infinitum. In this work, additional iterations were found to add little value and so multiple iterations are not being run at this time, although this may be investigated in future work.

Summary of Reconciled Emissions

Table 1: *RE-Adjusted 2005 and 2006 Emissions of Six HRVOC Species, Reconciled Emission Totals, and Percent Change* below shows totals of emissions before and after reconciliation for the six regulated HRVOC for 2005 and 2006. Comparing the two years shows that all species except t-2-butene required smaller relative adjustments in 2006 than in 2005, consistent with enhanced monitoring and control of previously unaccounted-for emission sources.

Table 1: RE-Adjusted 2005 and 2006 Emissions of Six HRVOC Species, Reconciled Emission Totals, and Percent Change

HRVOC Species	2005			2006		
	RE-Adjusted Reported Emissions	Reconciled Emissions	Percent Change	RE-Adjusted Reported Emissions	Reconciled Emissions	Percent Change
Propylene	10.03	25.07	149.8%	9.65	21.92	127.1%
Ethylene	10.96	18.72	70.8%	10.10	15.80	56.4%
1,3-Butadiene	2.22	3.02	35.7%	1.53	1.97	28.3%
1-Butene	2.59	3.96	52.8%	2.70	3.13	16.2%
t-2-Butene	0.58	1.38	135.4%	0.50	1.55	210.9%
c-2-Butene	0.33	0.74	126.8%	0.54	0.86	58.1%
TOTAL	**26.72**	**52.89**	**97.9%**	**25.02**	**45.23**	**80.7%**

Model Performance Evaluation

This section presents model performance comparisons between CAMx runs using the unreconciled and reconciled emissions. Since the current base case, Reg 10 already included the PSCF-based emission reconciliation, a special version of Reg 10 without the emission reconciliation, Reg 10 NOPSCF, was created for purposes of this evaluation.

HRVOC Performance

This section compares modeled and observed concentrations of the CB-05 species ETH, OLE, and IOLE before and after emission reconciliation[1]. The observed data consists of observations made at four Ship Channel auto-GC sites: Deer Park, Wallisville, HRM-3, and Lynchburg Ferry, as well as aircraft observations made by the NOAA P3 in the Houston urban and industrial areas. Comparisons for surface data are shown for three episodes: June 2005, June 2006, and AQS-1. Scatter plots for a complete set of CB-05 hydrocarbon species at all twelve HGB auto-GC sites for each episode are available at ftp://ftp.tceq.state.tx.us/pub/OEPAA/TAD/Modeling/HGB8H2/. Note that concentrations in this section are displayed in ppb instead of ppbC, since the output CAMx concentrations are always in ppb.

The scatter plots displayed in this section use a log-log scale, which is useful when analyzing data that is approximately log-normally distributed. Also note the red dots plot the ordered values of observed and modeled concentrations against each other (e.g., smallest observed concentration is paired with smallest modeled concentration). This quantile-quantile (Q-Q) plot shows how well the distribution of modeled concentrations matches that of the observations (i.e., the model generates the correct proportions of small, medium, and large values). The closer the red dots lie to the one-one line, the better the distributions match.

Figure 12: *Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Deer Park for Three Episodes* shows that the PSCF-based emission reconciliation improves the comparison between modeled and measured ethylene (ETH) concentrations at Deer Park for all three episodes, except for slightly increasing the positive bias for concentrations less than 1 ppb during the AQS-1 episode. Figure 13: *Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Wallisville for Three Episodes* shows that at Wallisville, the reconciliation improves the comparison between measured and modeled ethylene for the June, 2005 episode, but increases the positive bias seen during the other two episodes. At HRM-3 (Figure 14: *Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at HRM-3 for Three Episodes*), reconciliation improves the comparison during the June 2005 episode. For the June 2006 episode, the reconciliation does not visibly improve nor degrade the model's performance, but it does add to the positive bias seen during the AQS-1 episode. At Lynchburg Ferry (Figure 15: *Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Lynchburg Ferry for Three Episodes*), the reconciliation improves the comparison between modeled and observed ethylene for concentrations above 1 ppb for the June

[1] Because of the vast number of hydrocarbon species and potential reactions, the CB-05 mechanism deals only with a limited number of species classified by carbon bonds. Emissions are transformed during pre-processing into these CB-05 species before being input into CAMx. For comparison purposes, measured concentrations of sampled hydrocarbon species may also be transformed into CB-05 species. There is a close (though not exact) correspondence between the TCEQ's list of HRVOCs (ethylene, propylene, 1,3-butadiene, and butenes) and the three CB-05 species ETH, OLE, and IOLE. Ethylene is treated explicitly by CB-05, so the ETH CB-05 species compares directly with measured ethylene concentrations. The OLE species represents a large collection of olefins (alkenes), but in practice (at least in the industrial areas in the HGB region) largely consists of propylene. The IOLE species represents a relatively small number of olefins with internal double bonds, including butenes.

2005 and June 2006 episodes, and above 2 ppb for the AQS-1 episode. The reconciliation adds to the positive bias below 2 ppb for the AQS-1 episode.

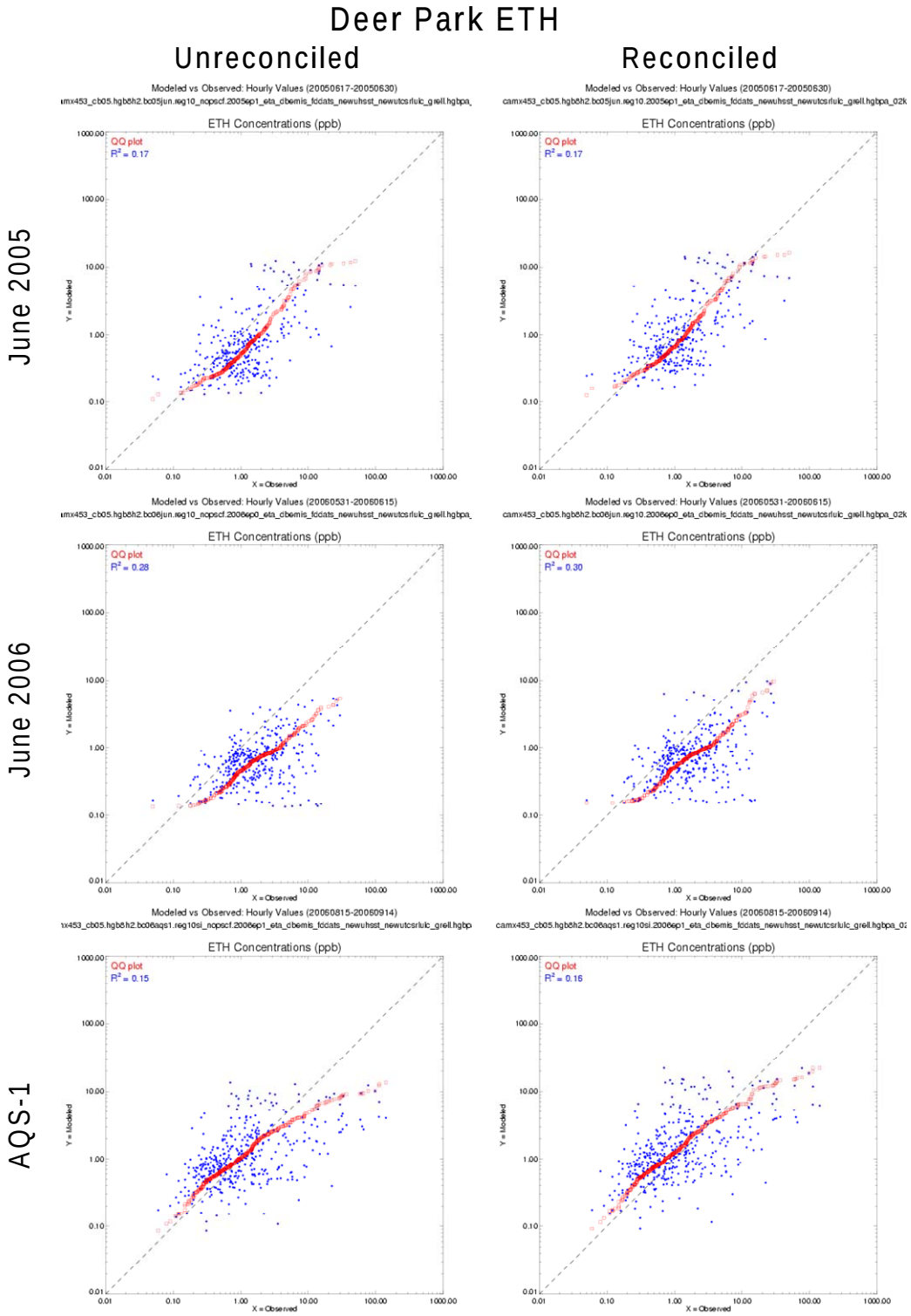


Figure 12: Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Deer Park for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

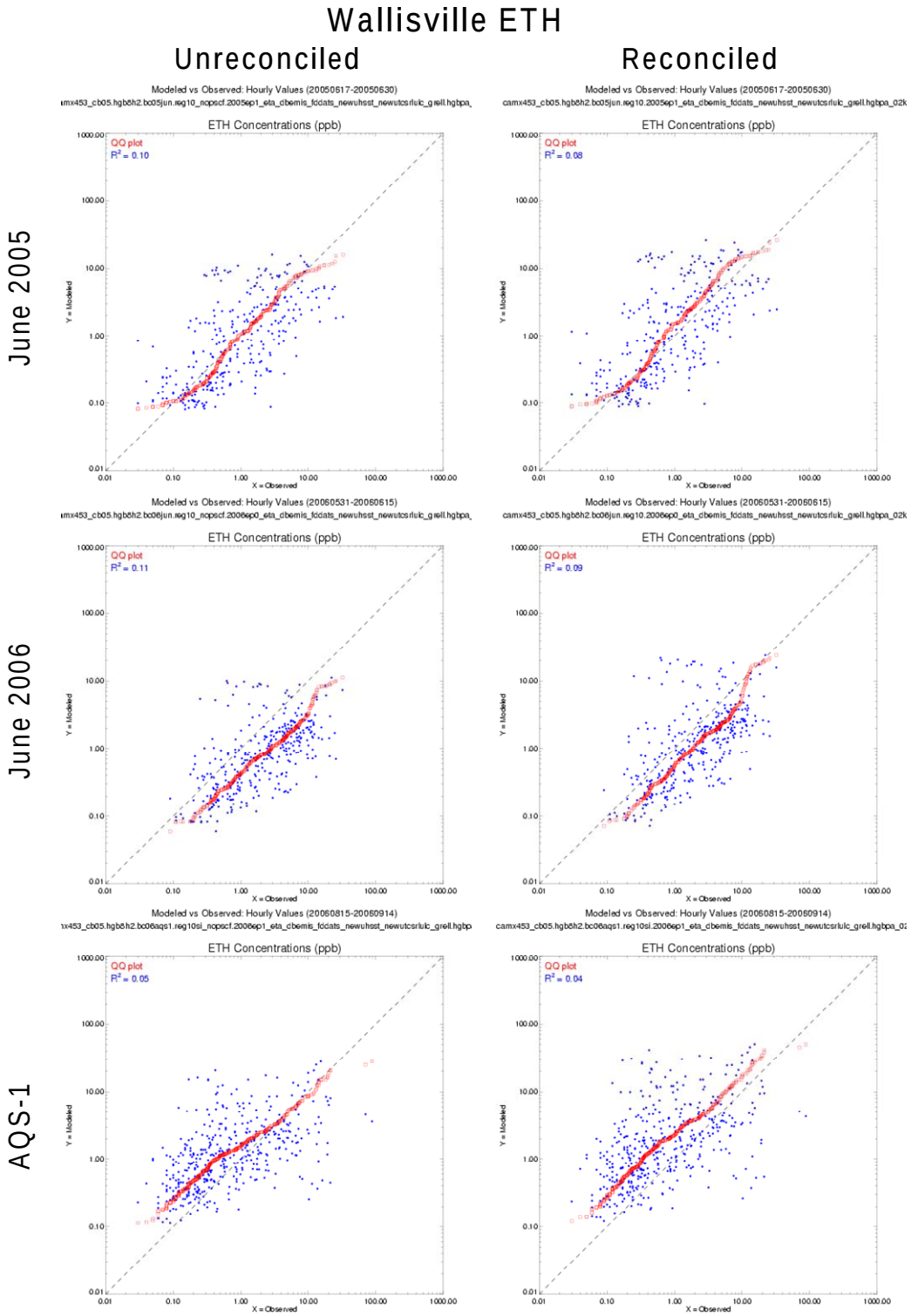


Figure 13: Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Wallisville for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

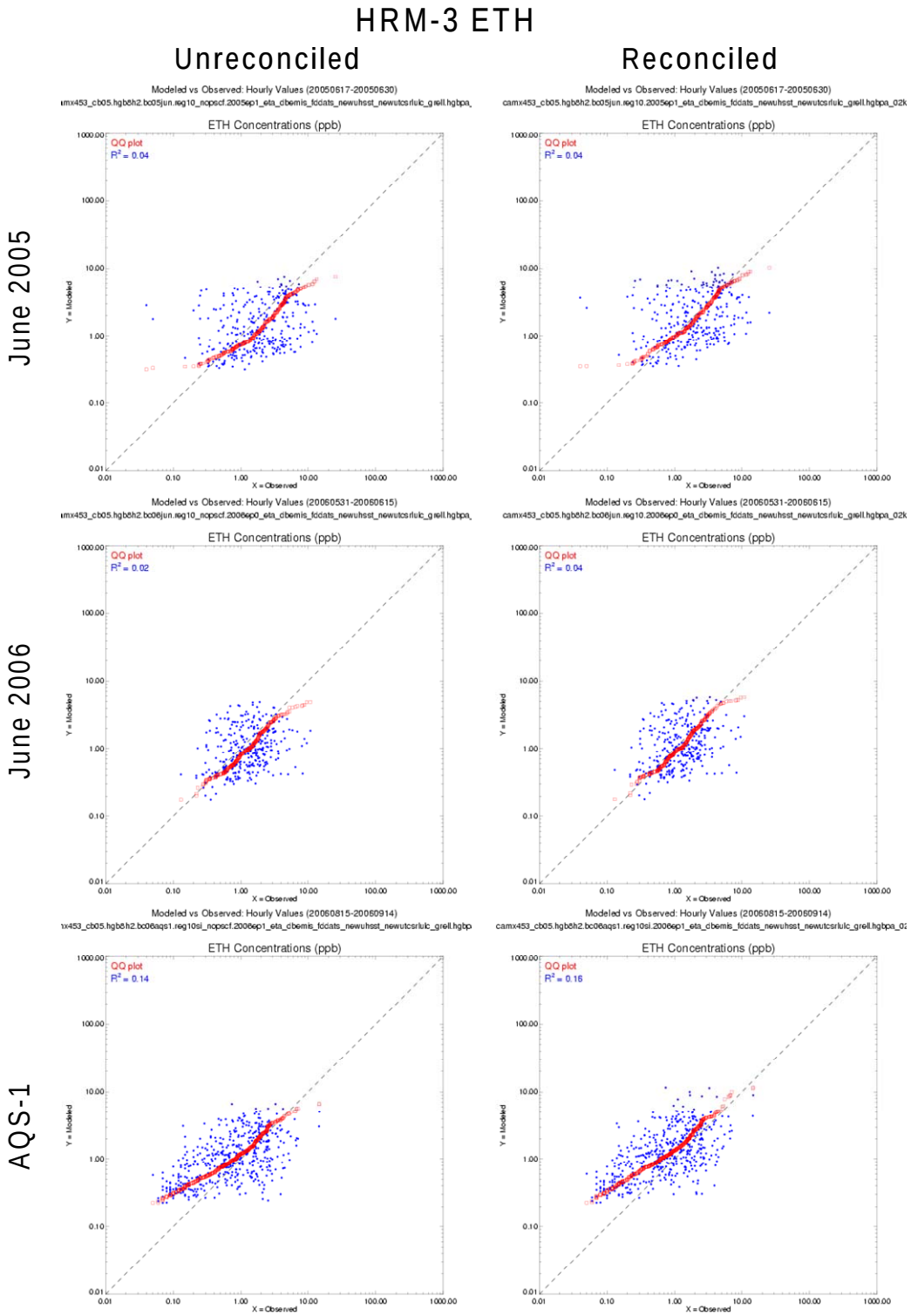


Figure 14: Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at HRM-3 for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

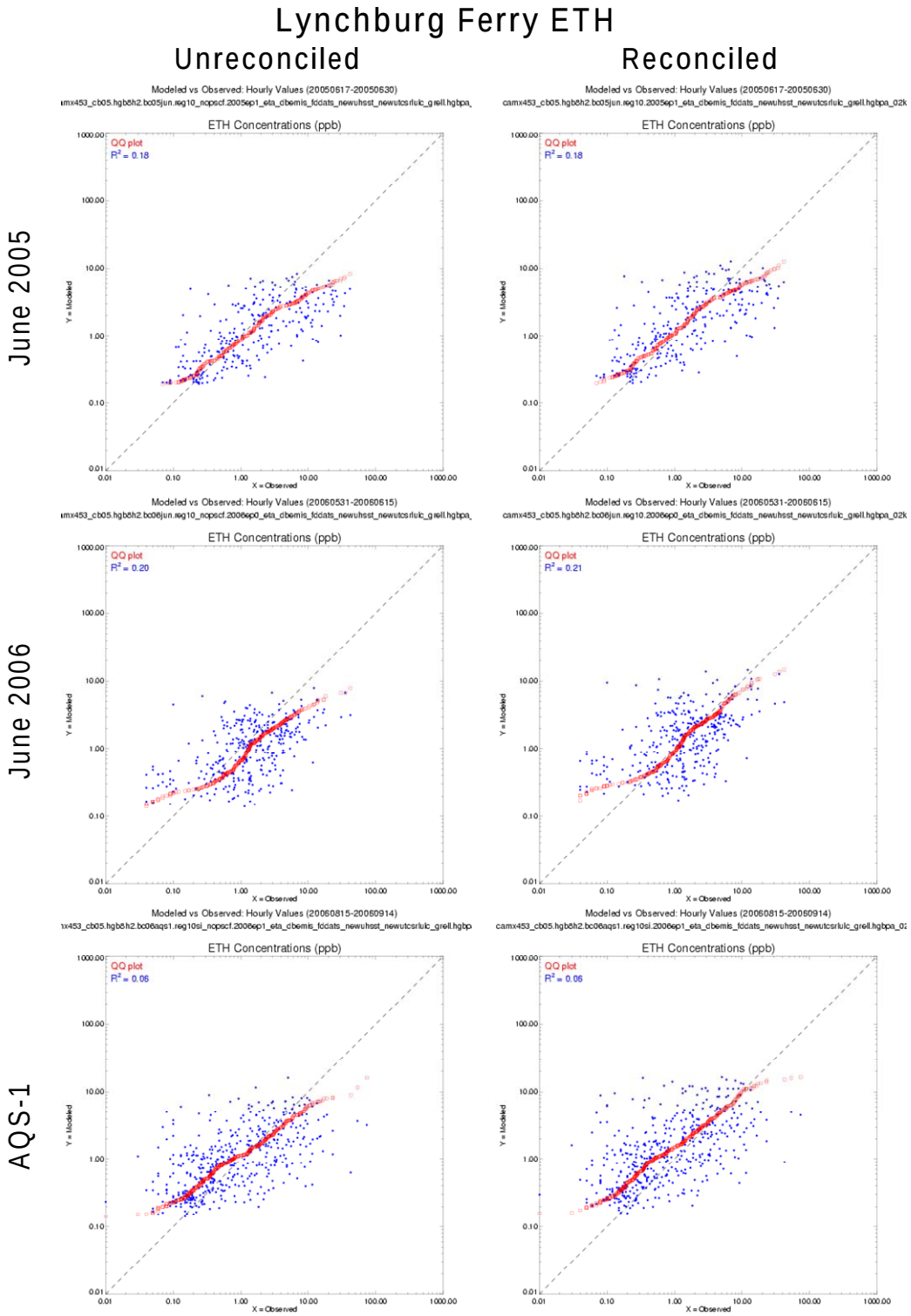


Figure 15: Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations at Lynchburg Ferry for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

Figure 16: *Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid* compares modeled ethylene concentrations with ethylene concentrations observed by the NOAA WP-3D Orion (P3) aircraft within the 2 km X 2 km HG fine grid shown in Figure 1.1-1. The aircraft sampled ethylene continuously along its route and for purposes of comparison with modeled output, the data were averaged over one-minute intervals. The mid-point in space and time of each interval was located within the modeling grid, and the modeled value for that grid cell and hour was paired with the observation; no spatial or temporal interpolation was performed. The P3 flew missions between August 31, 2006 and October 13, 2006, but most of the observations were taken during the AQS-2 episode period September 19 - October 12, 2006.

The figure shows that the model generally under-estimated the P3-observed ethylene concentrations within the Houston urban and industrial areas. Adding in the PSCF-based emissions reconciliation improves the comparison, but the model still under-predicts the observations by about a factor of two. The aircraft data gives a somewhat different picture from that portrayed by the surface monitors, where in some cases the unreconciled model predicted the observations well or even over-predicted concentrations in some cases.

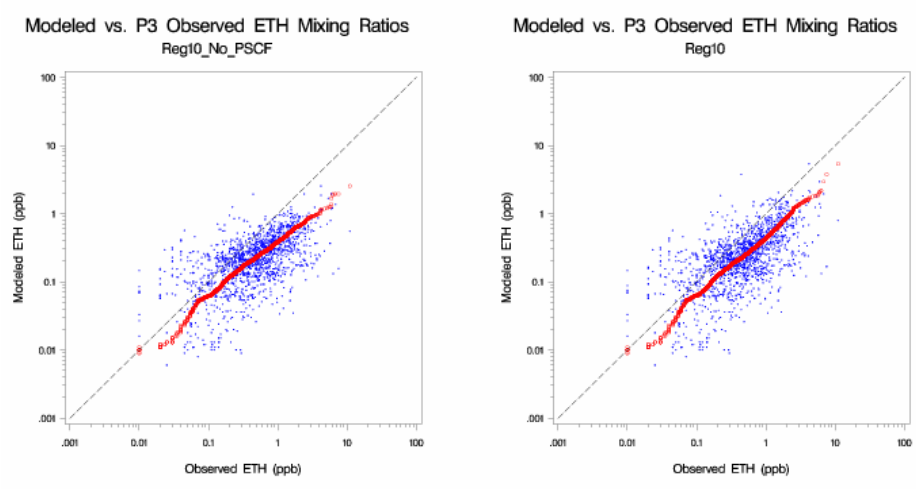


Figure 16: Scatter Plots Comparing Reg10 Base Case Modeled ETH Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation.

Figures 17-20 compare modeled and measured concentrations of the CB-05 OLE species at the same four monitors and for the same three episodes depicted above. Here, the picture is fairly consistent, with the unreconciled model under-predicting the observed concentrations in the majority of cases, often by a factor of twp to three, and showing no tendency towards over-predicting the observations in any case. The reconciliation improves the comparison with few exceptions, and in some cases causes the distribution of modeled values to match almost exactly that of the observations.

At Deer Park (Figure 17: *Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at Deer Park for Three Episodes*), the reconciliation improved, but did not completely correct, the model's under-prediction of observed concentrations less than one ppb, and causes a small over-prediction for observations in the 2-10 ppb range during the June, 2005 and AQS-1 episodes. At Wallisville (Figure 18: *Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at Wallisville for Three Episodes*), the reconciliation caused some over-prediction between about 0.5 and 10 ppb for June, 2005, but improved the comparison for June, 2006 (although still under-

predicting), and for the AQS-1 episode, the distribution of modeled concentrations after reconciliation matched the observed distribution extremely well. At HRM-3 (Figure 19: *Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at HRM-3 for Three Episodes*), the comparison between the unreconciled model and the observations was fairly good to begin with, with only a small under-predictive bias evident. After reconciliation, though, the comparisons were very good for all three episodes. For Lynchburg Ferry (Figure 20: *Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at Lynchburg Ferry*), the reconciliation caused a small over-predictive bias between 0.2 and 5 ppb during the June, 2005 episode, but improved concentrations in all ranges during the June, 2006 episode and delivered a very good comparison between the modeled and measured concentration distributions during the AQS-1 episode.

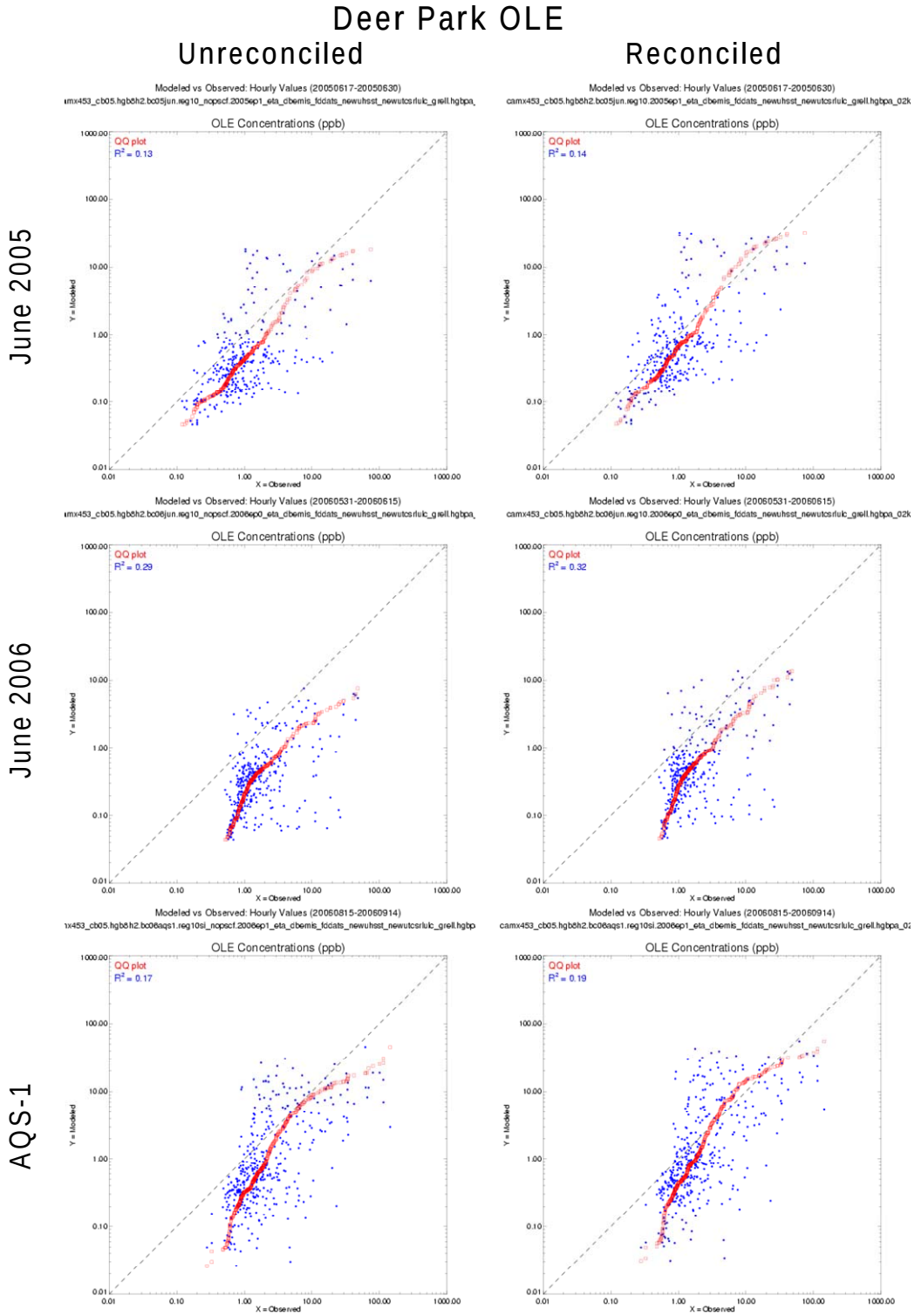


Figure 17: Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with observed concentrations at Deer Park for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

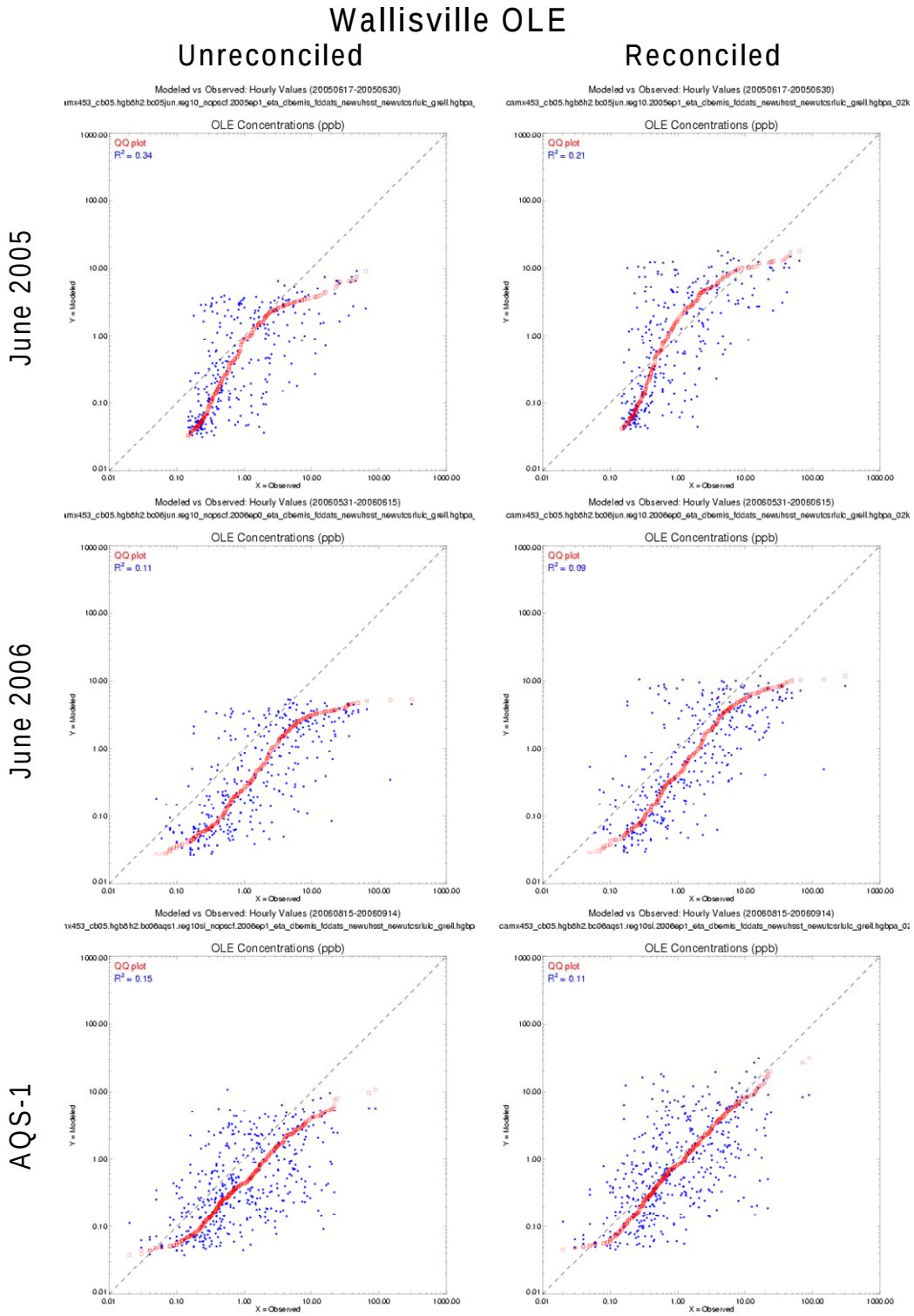


Figure 18: Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with observed concentrations at Wallisville for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

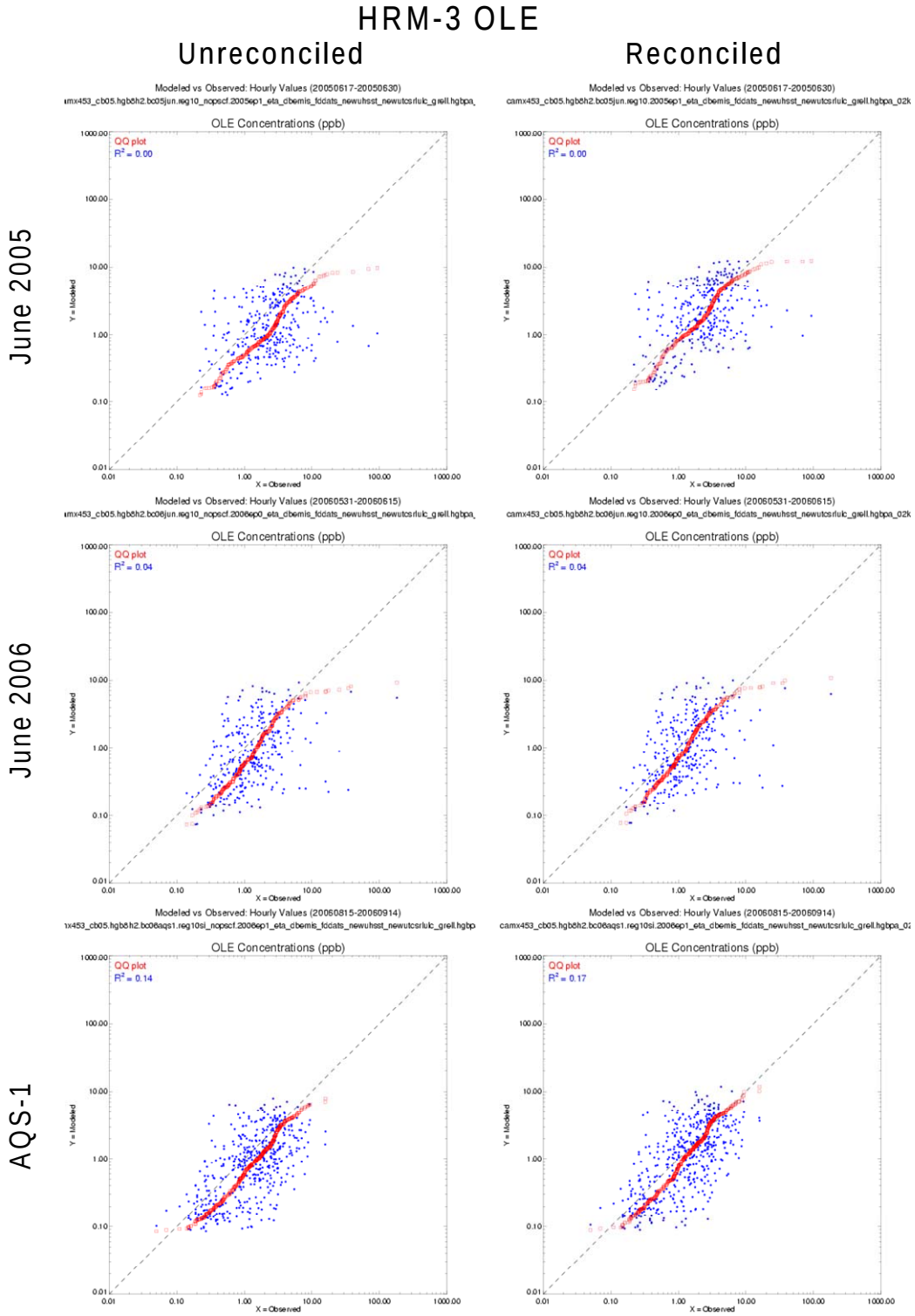


Figure 19: Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at HRM-3 for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

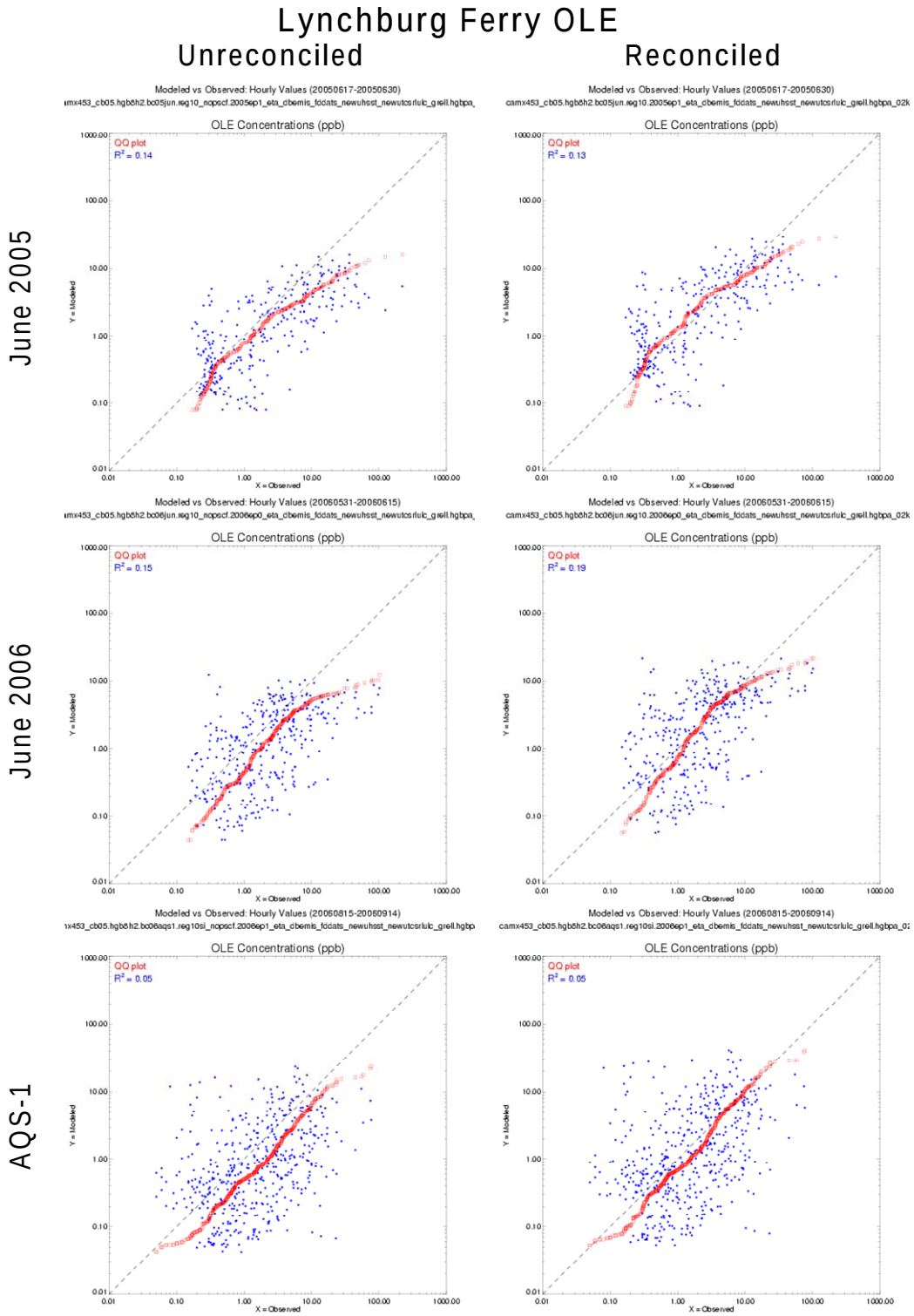


Figure 20: Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations at Lynchburg Ferry for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

Figure 21: *Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid* compares modeled concentrations of OLE with concentrations observed by the NOAA P3 aircraft within the 2 km X 2 km HG fine grid. The aircraft collected hundreds of Whole-Air Samples (WAS) in canisters which were analyzed to derive concentrations of hydrocarbon species. These concentrations were then transformed into CB-05 species concentrations in the same fashion that reported emissions are transformed in preparation for input to CAMx. In most circumstances, especially in the Houston industrial areas, OLE consists largely of propylene. The mid-point in space and time of each sample (usually about 7 or 12 seconds) was located within the modeling grid, and the modeled value for that grid cell and hour was paired with the observation; as with the continuously-sampled ethylene data, no spatial or temporal interpolation was performed, and again most of the observations were taken during the AQS-2 episode period September 19 - October 12, 2006.

The figure shows that the model under-estimated the aircraft-observed OLE concentrations within the Houston urban and industrial areas by about a factor of three. Adding in the PSCF-based emissions reconciliation noticeably improves the comparison, but even after the reconciliation the observations are still substantially under-predicted by about a factor of two for most of the observed range. While the surface observations also were under-predicted, the magnitude of the under-prediction was considerably smaller than seen by the aircraft, and in that case the reconciliation produced modeled concentrations distributions very comparable to those observed.

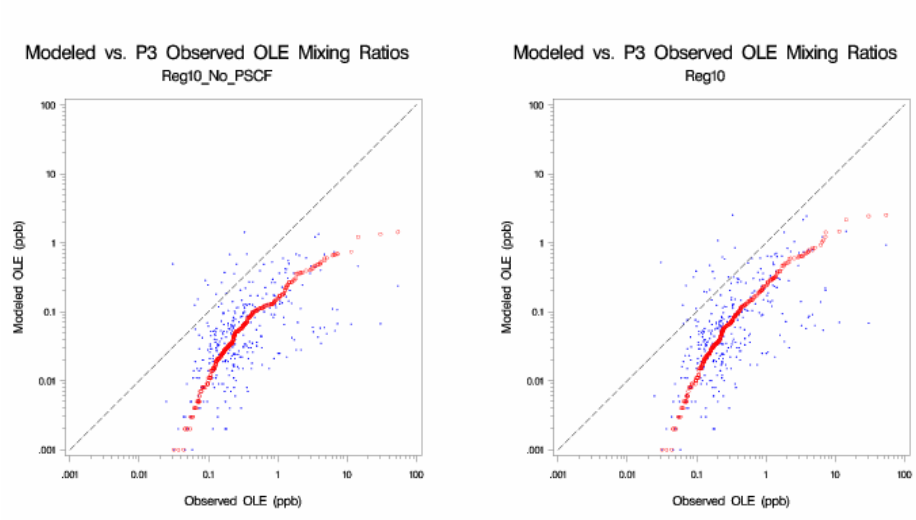


Figure 21: Scatter Plots Comparing Reg10 Base Case Modeled OLE Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation.

Figures 22-25 show effects of emission reconciliation on the IOLE species. First note that for all four sites, the June 2005 observations are almost all greater than 0.1 ppb, probably indicating that some of the compounds that are allocated to the IOLE composite species were being reported at threshold quantities. This effect is particularly dramatic at Wallisville, where it appears that the model dramatically under-predicts very low concentrations of IOLE, but in reality probably is just an artifact. For later episodes, the measured IOLE concentrations appear to represent a more reasonable concentration range, but comparisons for very low observed concentrations are still questionable.

For Deer Park (Figure 22: *Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Deer Park Using RE-Adjusted Reported Emissions for Three Episodes*), the model under-predicts the observed IOLE concentrations except for the range of around 0.2 to 0.6 during the AQS-1 episode. Adding the emission reconciliation only changes the modeled concentrations very subtly. Similarly, at Wallisville (Figure 23: *Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Wallisville Using RE-Adjusted Reported Emissions for Three Episodes*), the reconciliation makes little difference, except for improving the predictions for observations between 0.1 and 0.3 ppb during the June, 2006 episode. At both HRM-3 (Figure 24: *Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at HRM-3 Using RE-Adjusted Reported Emissions for Three Episodes*)) and Lynchburg Ferry (Figure 25: *Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Lynchburg Ferry Using RE-Adjusted Reported Emissions for Three Episodes*)), the reconciliation makes a slight improvement during the June 2005 episode, but makes little noticeable change elsewhere.

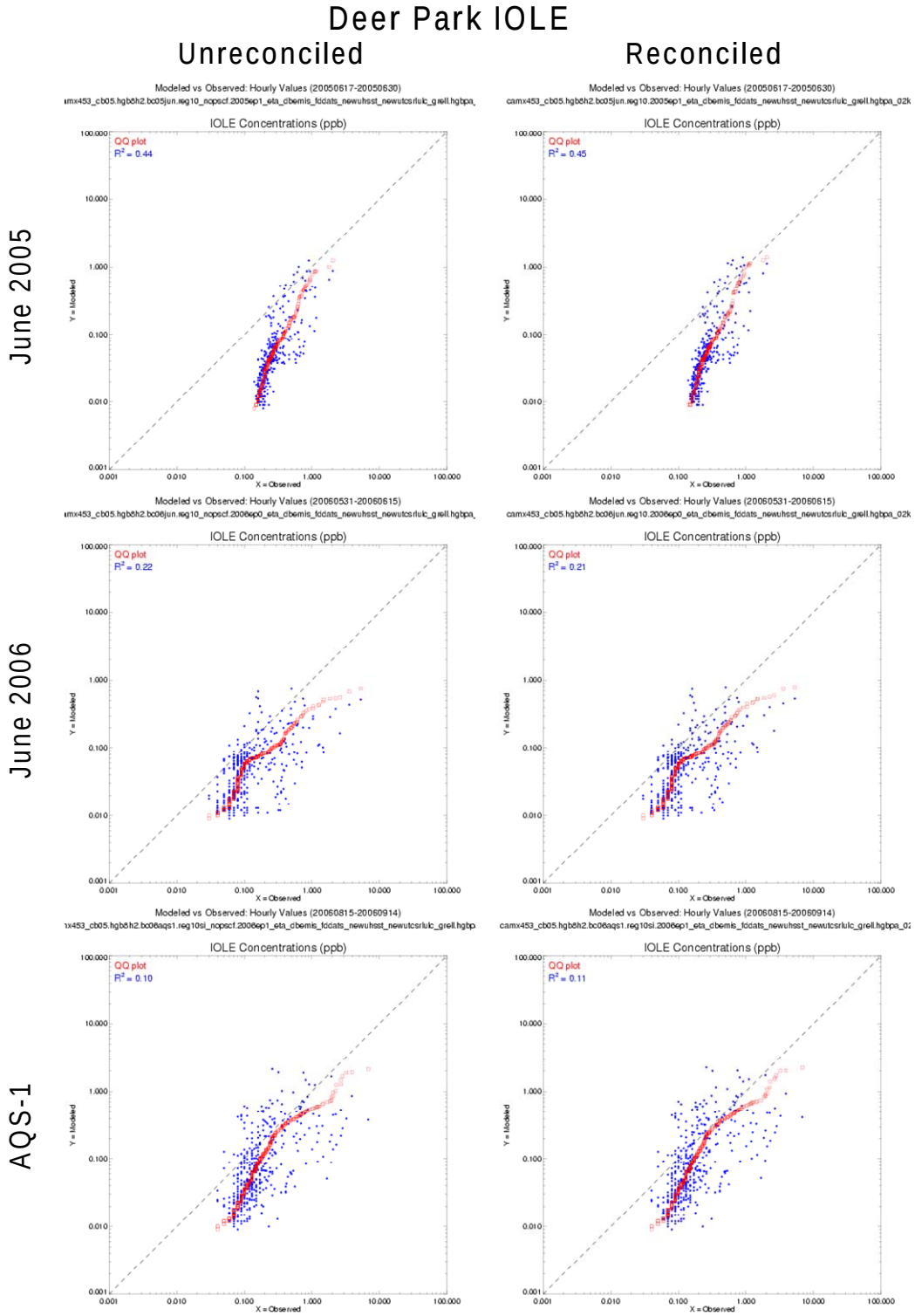


Figure 20: Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Deer Park Using RE-Adjusted Reported Emissions for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

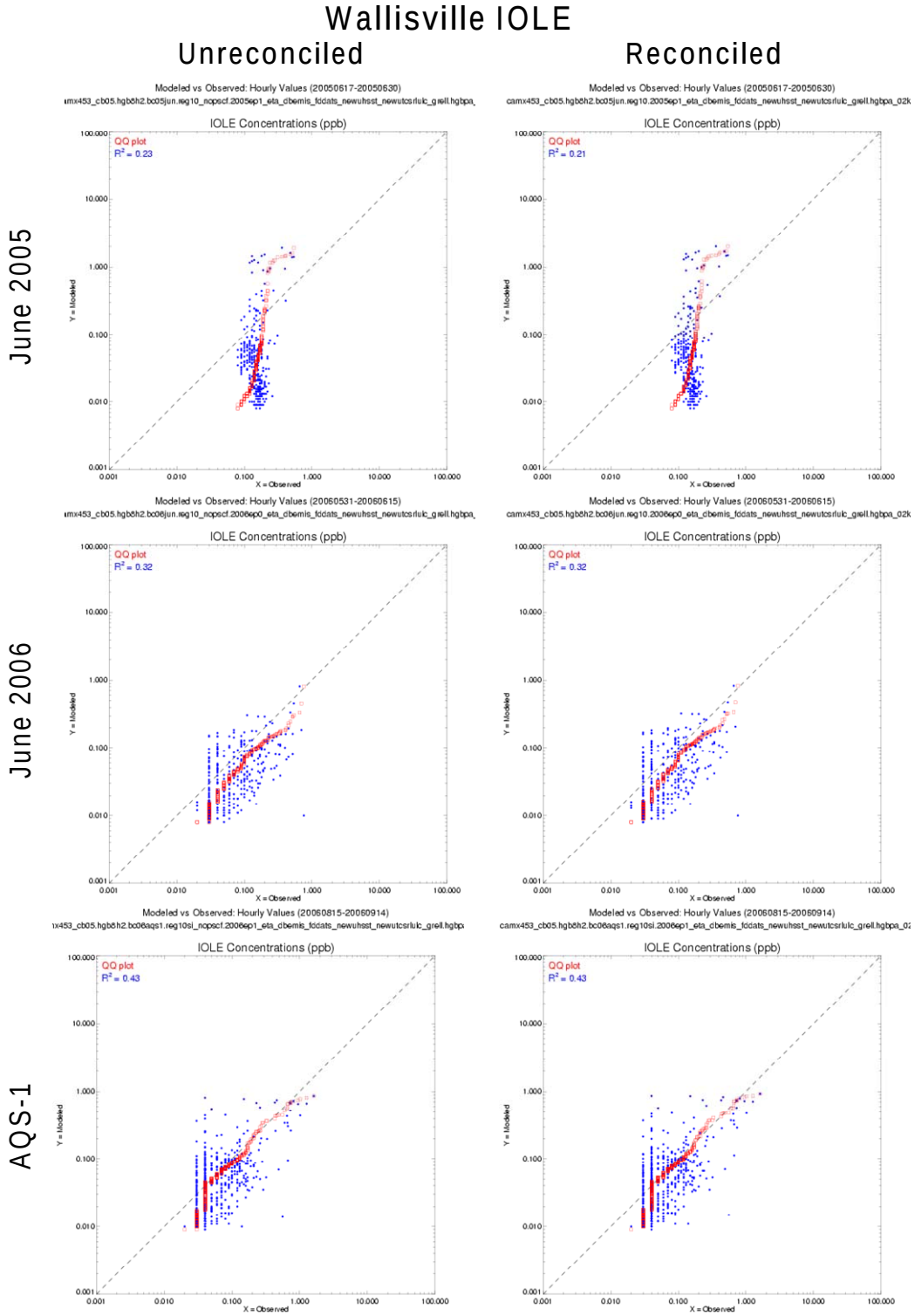


Figure 21: Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Wallisville Using RE-Adjusted Reported Emissions for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

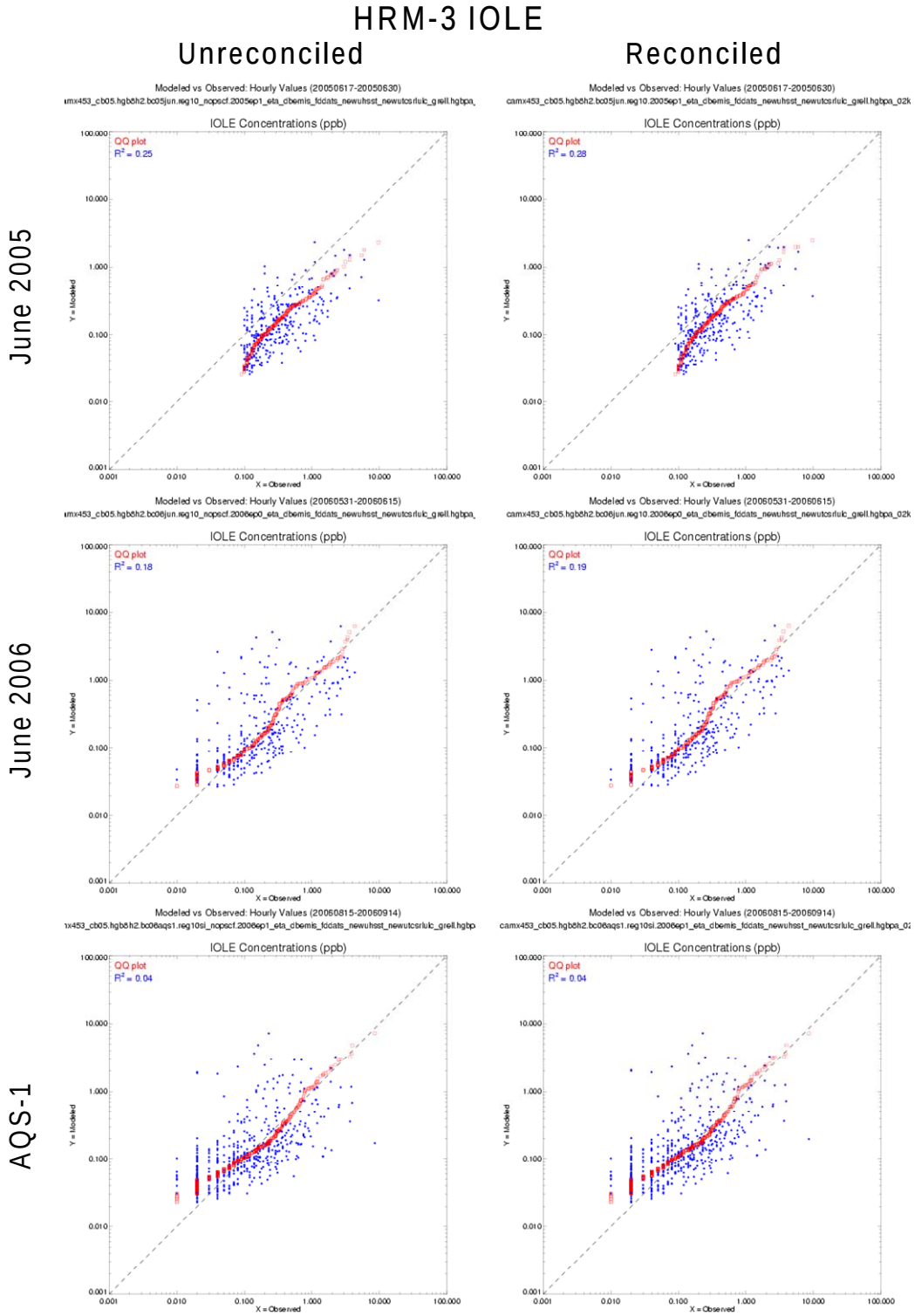


Figure 22: Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at HRM-3 Using RE-Adjusted Reported Emissions for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

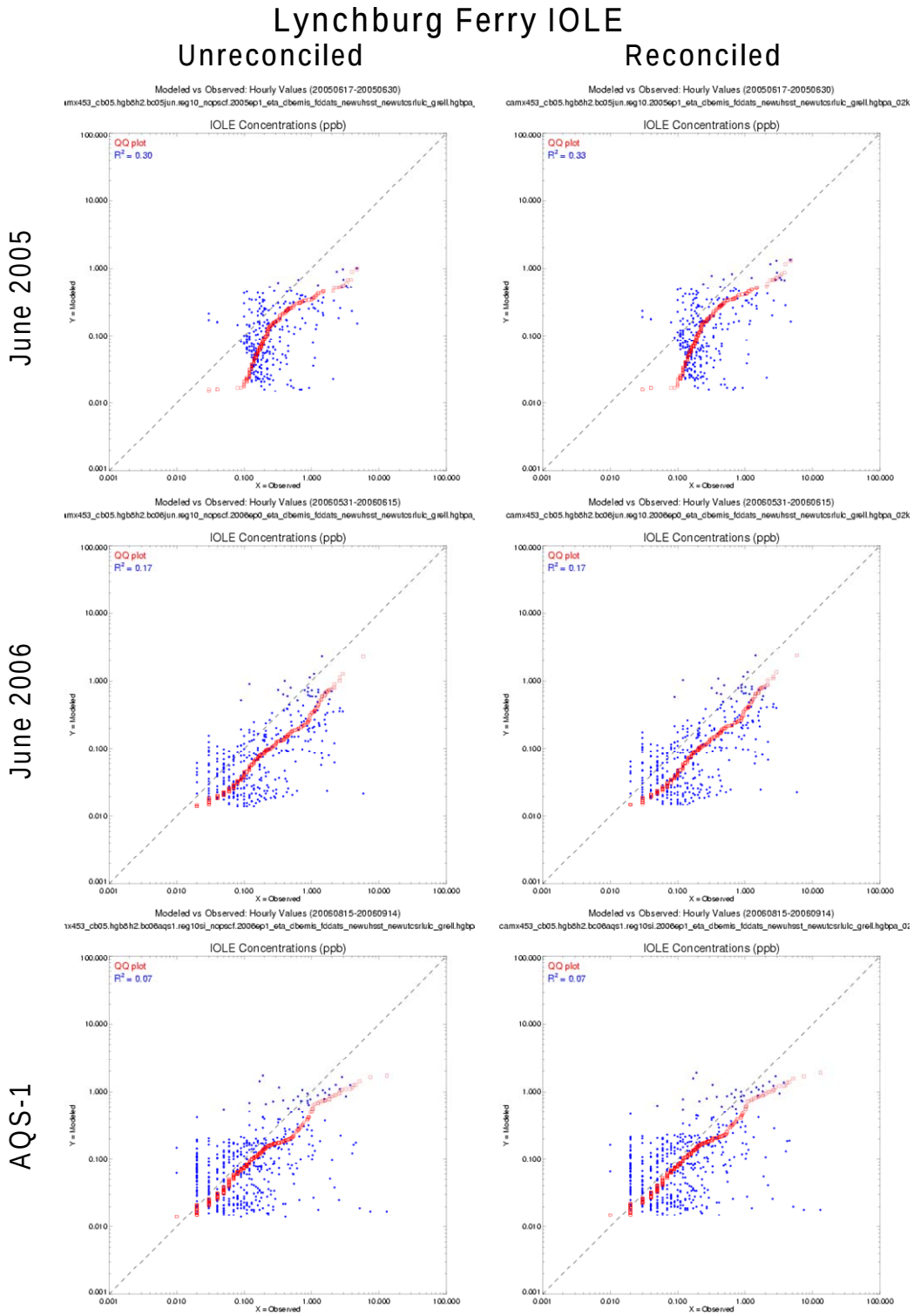


Figure 23: Scatter Plots Comparing Reg8 Base Case Modeled IOLE Concentrations at Lynchburg Ferry Using RE-Adjusted Reported Emissions for Three Episodes - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation: (top to bottom row) June 2005, June 2006, and AQS-1

Figure 24: *Scatter Plots Comparing Reg10 Base Case Modeled IOLE Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid* compares modeled IOLE concentrations with concentrations calculated from the WAS samples taken aboard the NOAA P3 aircraft in the HG 2 km X 2 km grid. Like the surface observations, the effect of adding in the emission reconciliation is quite subtle, with only a slight improvement in the comparison noticeable for measured concentrations of around 0.01 ppb.

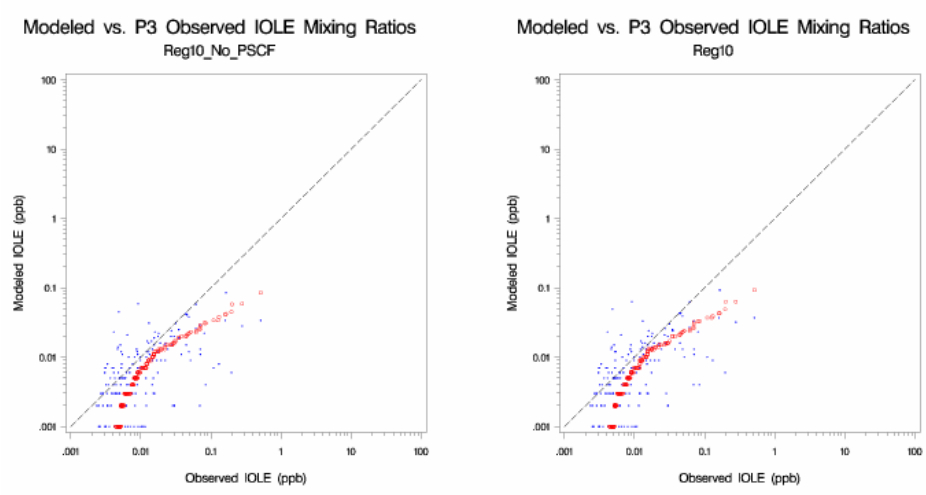


Figure 24: Scatter Plots Comparing Reg10 Base Case Modeled IOLE Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation.

Formaldehyde Performance

Formaldehyde is produced in the photochemical oxidation of ethylene and other VOCs, and is in turn a significant source of radicals that lead to ozone formation. Figure 25: *Scatter Plots Comparing Reg10 Base Case Modeled Formaldehyde (FORM) Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid* compares scatter plots of modeled vs. observed concentrations of formaldehyde (FORM in CB-05 parlance) from the continuous monitoring instrument aboard the NOAA P3 aircraft, before and after the PSCF-based emission reconciliation. Though subtle, there is a distinguishable improvement in the concentrations in the Reg 10 base case compared to the case without reconciliation, particularly for concentrations above 5 ppb. Note the use of linear instead of logarithmic axes on the plots; linear scales are appropriate for species whose concentration distributions are close to normal (as opposed to lognormal). Since ozone and (most) formaldehyde are formed through atmospheric reactions, their concentrations generally do not vary across several orders of magnitude as is the case with primarily-emitted species sampled close to their sources.

At three surface sites where formaldehyde data were collected during the TexAQS-II (Moody Tower, HRM-3, and Lynchburg Ferry), a comparison of the scatter plots with and without the PSCF-based reconciliation reveals very minor differences. Instead, Figure 26: *Time Series Plot Comparing Reg10 Base Case Modeled Formaldehyde (FORM) Concentrations with Observed Concentrations at Moody Tower during the AQS-1 Episode* shows a time-series plot of modeled vs. observed formaldehyde at the Moody Tower for the AQS-1 episode. The with the two model runs shown: the blue line shows modeled formaldehyde concentrations before reconciliation and the green line shows modeled concentrations after reconciliation; observaed concentrations are shown in red. For most hours, the green line is hidden, indicating only very small differences in concentrations between the two runs. But on August 20 and 21, and to a lesser degree September 14, the reconciliation does noticeably improve the model's replication of large daytime peaks.

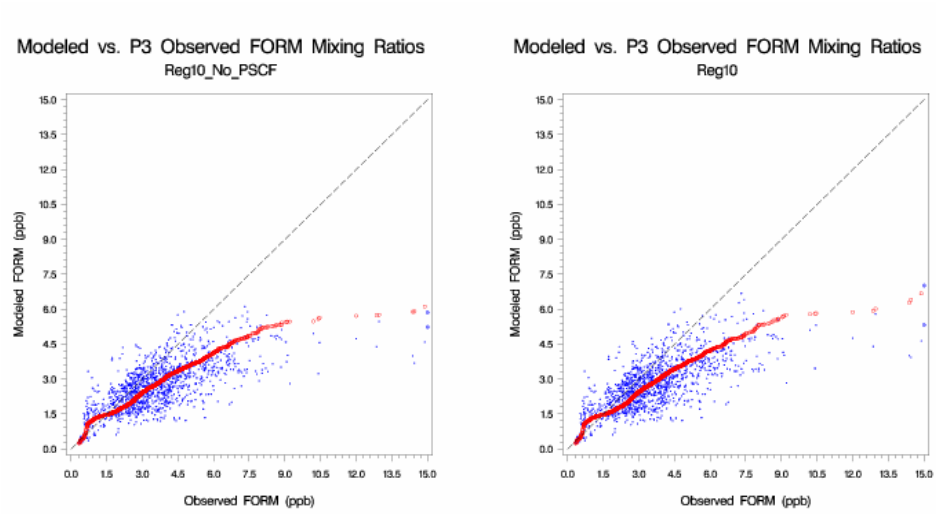


Figure 25: Scatter Plots Comparing Reg10 Base Case Modeled Formaldehyde (FORM) Concentrations with Observed Concentrations Sampled by the P3 Aircraft in the HG 2 Km X 2 Km Grid - (L) Without PSCF-Based Emissions Reconciliation; (R) With Emissions Reconciliation.

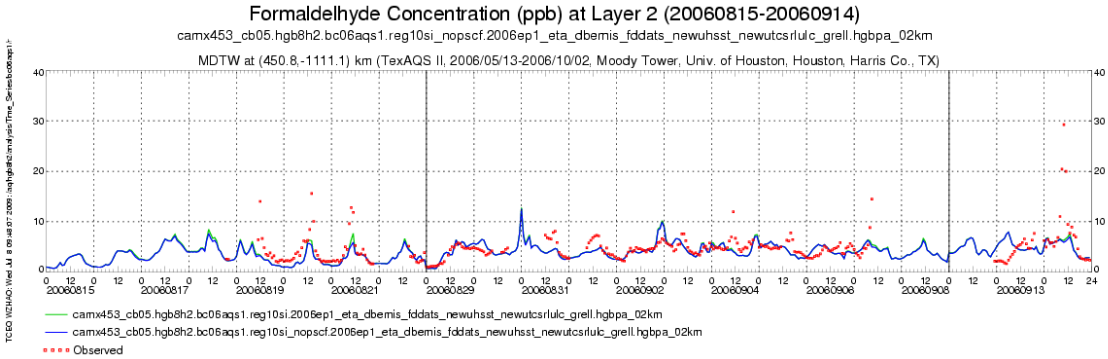


Figure 26: Time Series Plot Comparing Reg10 Base Case Modeled Formaldehyde (FORM) Concentrations with Observed Concentrations at Moody Tower during the AQS-1 Episode: Blue Line – Reg 10 Base Case Before PSCF-Based Emission Reconciliation; Green Line Reg 10 Base Case After Reconciliation; Red Squares: Observed Concentrations

<u>Ozone Performance</u>

Figure 27: *Daily Maximum One-Hour Modeled Ozone Concentrations for August 16, 2006* shows an example of a plume of ozone traveling northeast from Houston, with the most intense concentrations downwind from the Ship Channel area. The left-hand plot shows daily maximum modeled one-hour ozone concentration by grid cell without emissions reconciliation (since the local maxima do not occur simultaneously across the domain, the plot represents a composite across several hours), and the center plot shows the same image but with emissions reconciliation. The right-hand plot shows the difference. While the differences between the first two plots are subtle, they are important. The reconciled emissions produced higher concentrations than the unreconciled emissions (139.2 ppb vs. 136.3 ppb, with the observed maximum at 141.9) and the maximum ('+' sign on the plot) occurred closer to the observed maximum (the orange circle just SSE of the modeled maximum).

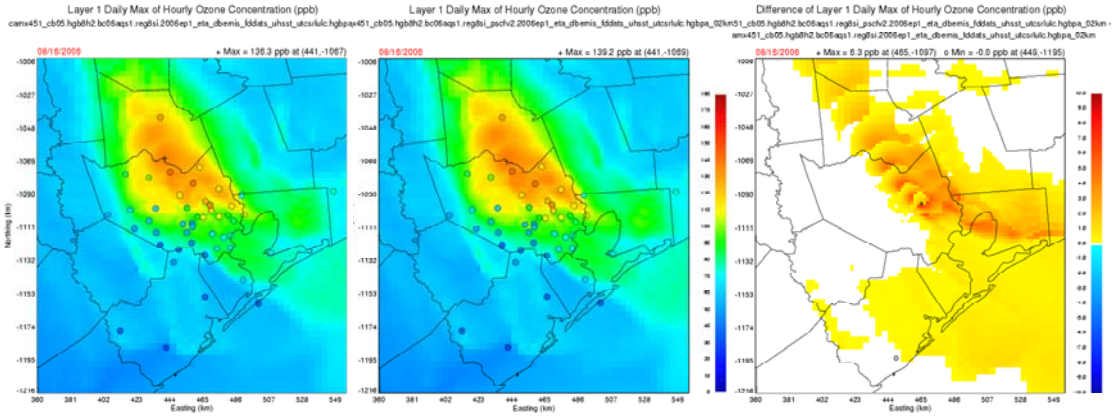


Figure 27: Daily Maximum One-Hour Modeled Ozone Concentrations for August 16, 2006, No Emissions Reconciliations (L), With Emissions Reconciliation (C), and The Difference Between The Two (L)

Figure 28: *1-Hour Ozone Mean Relative Bias, Reg 8 Base Case With and Without PSCF-Based Emission Reconciliation* and Figure 29: *1-Hour Ozone Mean Relative Error, Reg 8 Base Case With and Without PSCF-Based Emission Reconciliation* provide side-by-side comparisons of one-hour model relative bias and relative error, summarized over all sites used in the MPE across all days in each episode, and also summarized by year. These plots show that in every case but July of 2005, model relative bias improves with the emission reconciliation. On average, model relative bias for 2005 improved by 0.5 ppb, and by nearly 0.4 ppb for 2006. Model relative error improves marginally in the May and June 2005 episodes and increases slightly in July 2005, yielding a very modest overall improvement for 2005 of 0.08 ppb. For 2006, model relative error for two of the three episodes improved marginally, and for one (AQS-1) model relative error showed an equally marginal increase, leaving overall 2006 relative error with a fairly negligible improvement of less than 0.05 ppb.

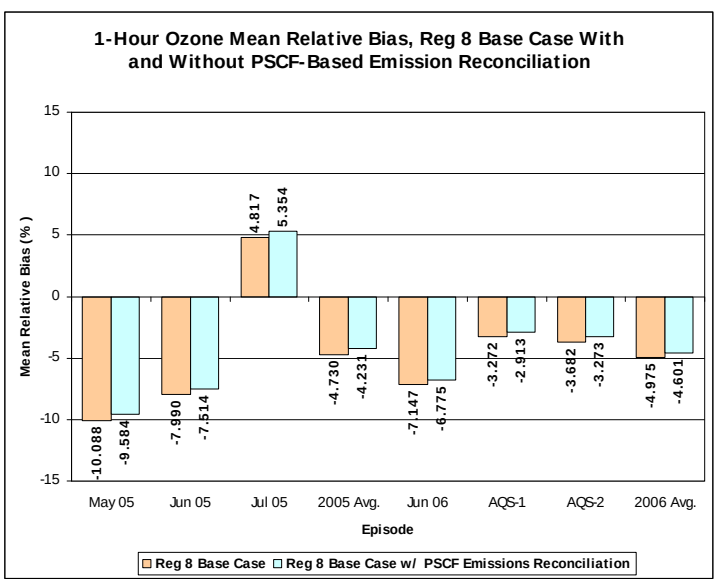


Figure 28: 1-Hour Ozone Mean Relative Bias, Reg 8 Base Case With and Without PSCF-Based Emission Reconciliation

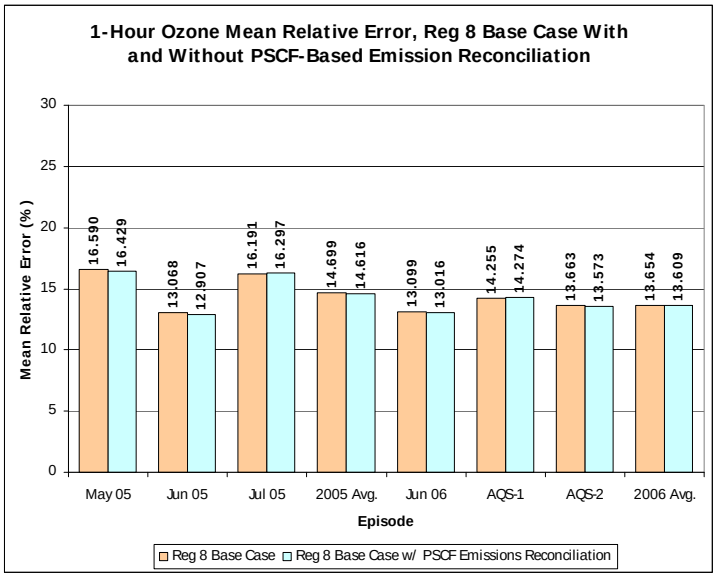


Figure 29: 1-Hour Ozone Mean Relative Error, Reg 8 Base Case With and Without PSCF-Based Emission Reconciliation

Conclusions and Future Research

The PSCF-based reconciliation process produces emissions which are more congruent with ambient measurements, as evidenced by comparing the pseudo-concentrations created from modeled and observed concentrations at the auto-GC sites. Direct comparisons between CAMx modeled concentrations with auto-GC observations for a subset of monitors and episodes shows that modeled concentration distributions distinctly improved for OLE, which was underestimated in the model without reconciliation. Adding in the reconciliation increased modeled concentrations and improved performance almost universally at the sites and episodes shown in the comparison. Comparing observed OLE concentrations with those sampled by the P3 aircraft showed even greater under-prediction. After reconciling the emissions, the modeled concentrations increased somewhat, but still were a factor of two to three lower than observed concentrations

Results for ETH were somewhat mixed. For several site/episode combinations, the modeled concentrations exceeded the observed concentrations for some or all of the range of observations, and in these cases reconciling the emissions degraded performance. But in at least as many instances, the model under-predicted ethylene concentrations before reconciliation, and in these cases the resonciliation improved model performances. The aircraft data, however, shows that at the flight altitude the model under-predicted the observations, and even after reconciliation the modeled concentrations were lower than observed by half.

In most, but not all, cases, IOLE concentrations were under-predicted by the model, and the reconciliation made some barely discernable improvements in model performance in some cases, including the aircraft data.

The emissions reconciliation noticeably reduced the model's under-prediction of formaldehyde concentrations in the aircraft data, and improved the model's ability to replicate daytime peak formaldehyde concentrations in some cases.

Overall ozone performance improved slightly with the emissions reconciliation, more so in 2005 than in 2006. While it may seem like the modest improvement seen in ozone performance obviates the need for emission reconciliation, it is still important to develop the best possible set of model inputs to help insure the model "gets the right answer for the right reason", and to

provide more confidence in the model's future predictions. Additionally, TCEQ plans to continue to investigate ways to improve the emissions reconciliation methodology which may lead to more substantive improvements in ozone performance.

As noted in the Model Performance Evaluation section of Appendix C: *Photochemical Modeling for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard*, adding HRVOC emissions to flares can significantly improve performance of these species concentrations compared with aircraft observations. Future research plans include investigating application of the PSCF-based reconciliation technique specifically to flares. Additional goals include applying the technique to additional pollutants (in particular, NO_X) and looking at additional years beyond 2005 and 2006.

References

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