United States Environmental Protection Agency

Air Quality Modeling Technical Support Document: Ozone Source Apportionment Application in Support of the Designation Process for the Ozone NAAQS

EPA-454/R-10-005
November 2010

Air Quality Modeling Technical Support Document: Ozone Source Apportionment Application in Support of the Designation Process for the Ozone NAAQS

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, NC 27711

Contents

1 Background

This document describes the air quality modeling performed by EPA in support of the most recent ozone designations process. A national scale air quality modeling analysis was performed to estimate the impact of county specific anthropogenic NOX and VOC emissions on model estimated ozone concentrations. Source contribution is estimated for the primary and secondary forms of the ozone National Ambient Air Quality Standard (NAAQS). Air quality impacts are estimated with the Comprehensive Air Quality Model with Extensions (CAMx) model. CAMx simulates the numerous physical and chemical processes involved in the formation, transport, and destruction of ozone, particulate matter and air toxics. In addition to the CAMx model, the modeling platform includes the emissions, meteorology, and initial and boundary condition data which are inputs to this model.

Photochemical grid models use state of the science numerical algorithms to estimate pollutant formation, transport, and deposition over a variety of spatial scales that range from urban to continental. Emissions of precursor species are injected into the model where they react to form secondary species such as ozone and then transport around the modeling domain before ultimately being removed by deposition or chemical reaction. Photochemical model source apportionment tracks the formation and transport of ozone from emissions sources and allows the estimation of contributions at receptors. This type of emissions apportionment is useful to understand what types of sources or regions are contributing to ozone estimated by photochemical grid models.

Source apportionment is an alternative approach to zero-out modeling and has the advantage of being much more efficient with computational resources. For instance, to estimate the contribution from 20 source regions a total of 20 individual zero-out simulations would be needed compared to a single source apportionment simulation. The incremental run-time associated with the additional source region tracking is less than performing numerous iterative zero-out simulations.

The Comprehensive Air-Quality Model with extensions is a three-dimensional Eularian “one-atmosphere” photochemical transport model that uses state of the science routines to model ozone and particulate matter formation and removal processes (Nobel, McDonald-Buller et al. 2001; ENVIRON 2008). CAMx contains a variety of ozone source apportionment tools, including the original ozone source apportionment tool (OSAT) and the anthropogenic pre-cursor culpability assessment (APCA) tool (ENVIRON 2008).

Ozone source apportionment in CAMx tracks the contributions to each grid cell from emissions source groups, emissions source regions, initial conditions, and boundary conditions with reactive tracer species. Source apportionment tracers are treated using the standard model algorithms for vertical advection, vertical diffusion, and horizontal diffusion. Horizontal advective fluxes for each of the regular model species that make up nitrogen oxides (NO_X) and volatile organic compounds (VOC) are combined and normalized by a concentration based weighted mean. The estimated normalized fluxes are used to advect the tracer species rather than solving them with the standard model formulation to improve consistency between tracer and regular model concentrations (ENVIRON 2008). The deposition velocities for NO_X tracers are the concentration weighted average of the deposition velocities for NO and NO_2. The deposition velocities for VOC tracers are the concentration weighted average (done on a ppmC basis) of the deposition velocities for each of the CB05 species. Ozone tracers use the same deposition velocities as ozone (ENVIRON 2008).

Separate ozone tracers are used in CAMx to track ozone formation that happens under NO_X and VOC limited conditions. The ozone production regime indicator used in CAMx compares well with sensitivity to NO_X and VOC estimated using the Decoupled Direct Method (DDM) (Dunker, Yarwood et al. 2002). The source apportionment methodology in CAMx compared favorably to sensitivity runs done using the Urban Airshed Model and DDM, particularly for higher estimated ozone concentrations (Yarwood 1996; Dunker, Yarwood et al. 2002). CAMx source apportionment compared well against the sensitivity simulations in terms of spatial impacts of emissions from source regions and the relative contributions for each emission regions (tags) to ozone.

The APCA tool provides information that is most policy relevant when assessing regional and emission sector contribution to ozone formation compared to OSAT. When ozone is formed under VOC limited conditions due to biogenic VOC + anthropogenic NO_X then OSAT attributes it to the biogenic VOC sources. When ozone is formed under NO_X-limited conditions due to biogenic VOC + anthropogenic NO_X then OSAT attributes it to the anthropogenic NO_X sources. APCA is designed to provide more control strategy relevant information and recognizes that there are source categories such as biogenics that can not be controlled so the model only attributes ozone to biogenics when it is due to the interaction of biogenic VOC + biogenic NO_X. In the case where ozone formed to biogenic VOC + anthropogenic NO_X under VOC-limited conditions, OSAT attributes it to biogenic VOC, but APCA redirects the attribution to anthropogenic NO_X. In NO_X-limited conditions both OSAT and APCA attribute the ozone to anthropogenic NO_X (ENVIRON 2008).

2 Limitations

Source apportionment estimates are as good as the inputs to the photochemical model. Any deficiencies with the emissions or meteorological inputs may lead to source contribution estimates that may not fully characterize the source contribution mix at a receptor location. This application used a minimum of a complete year of meteorology to capture the variety of ozone formation regimes. However, it is possible that the meteorology used for these model applications may not represent all ozone formation regimes at every individual receptor location in the continental United States.

3 Derivation of Contribution Estimate

3.1 Primary Standard

The steps used to estimate the source contribution at each receptor location for the primary 8-hr ozone NAAQS are shown below. More details on the model application methodology are available in the next subsection of this document. The policy relevant threshold is defined as the level of the new 8-hr ozone NAAQS.

1. Receptor locations are defined as ozone monitors in the photochemical modeling domain with a 2006-2008 design value exceeding the new 8-hr ozone NAAQS
2. 8-hr averaged source contributions related to the 8-hr average daily maximum model estimate at these receptor locations are extracted from model output files
3. Identify high modeled days at each receptor: predicted 8-hr max ozone > policy relevant threshold
4. Average daily 8-hr maximum contributions over all days with modeled ozone > policy relevant threshold at each receptor
5. The final contribution estimate is an 8-hr average with units of parts per billion (ppb)

3.2 Secondary Standard

The steps used to estimate the final source contribution at each receptor location for the secondary ozone NAAQS are shown below.

1. Receptor locations are defined as ozone monitors in the photochemical modeling domain that were in operation during the time period modeled.
2. Daily index, monthly index, and the 3 month sum W126 ozone estimates at these receptor locations are extracted from standard model output files

3. “Pseudo-output” files are generated for each source region (or tag) by subtracting the source region hourly ozone contribution estimate from the standard model hourly ozone estimate
4. Daily index, monthly index, and the 3 month sum W126 ozone estimates at these receptor locations are extracted from “pseudo” model output files
5. Identify the highest 3 month sum based on standard model output at each monitor location
6. The source area (tag) contribution is the difference between the highest 3 month sum estimated from the standard model output and the corresponding 3 month sum estimated from the “pseudo” model output for that source area
7. The final contribution estimate is a W126 weighted 3 month sum in units of ppm-hours

4 Methodology Details

Additional information is provided in this section regarding the final source contribution estimate from each source area to each receptor. Also, information is given about the selection of source areas, emission preparation, photochemical model application, meteorological inputs, and photochemical model performance evaluation.

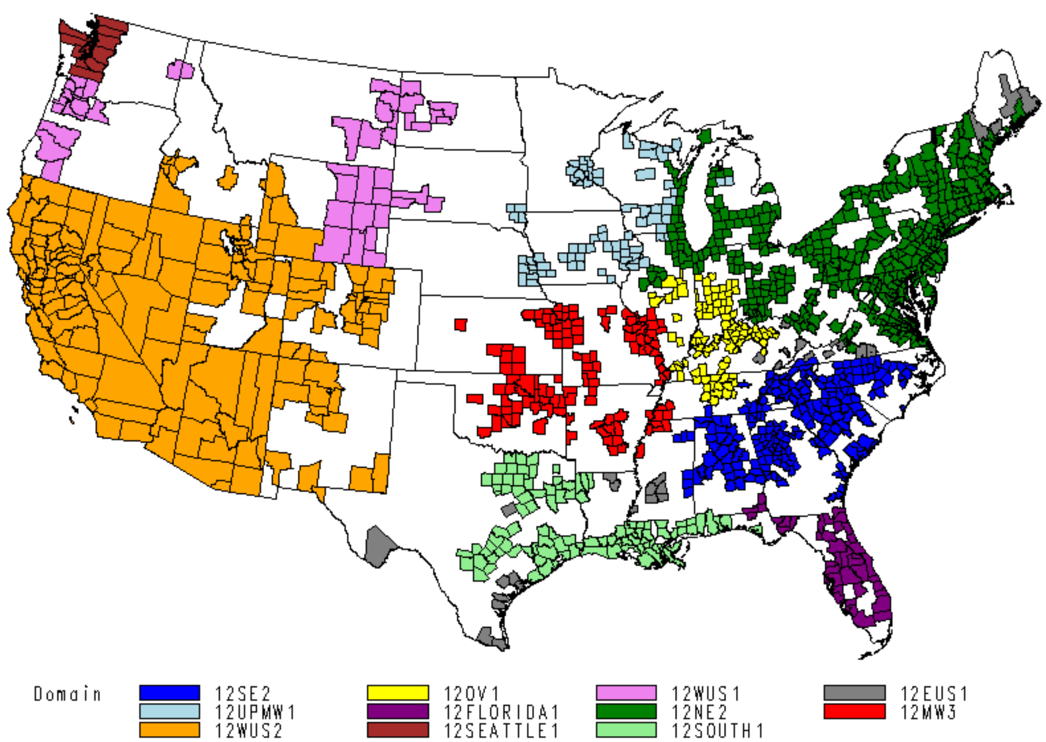
4.1 Identifying Violating Monitors (Receptors)

Receptors are defined as individual model grid cells that contain a monitor with a design value for the 2006 to 2008 time period that is greater than the level of the 8-hr ozone NAAQS. Design values are estimated using methods described in 40 CFR part 50 Appendix P for a 75 ppb 8-hr ozone NAAQS and the proposed revision to Appendix P for alternative lower levels of the 8-hr ozone NAAQS.

4.2 Selection of Sources: Counties

The sources selected for tracking with source apportionment include emissions from specific selected counties. Specific counties were selected if they comprised part of a CSA or CBSA that had a violating monitor for the new 8-hr ozone NAAQS. Counties tracked with source apportionment are shown in Figure 1. Each county is color coded to correspond to the modeling domain used for tracking that particular source area.

Figure 1. Sources selected for tracking with source apportionment



Additional counties were identified for tracking with source apportionment by U.S. EPA Regional offices. The emissions tracked with source apportionment for each county include all VOC and NOX emissions except wildfires, prescribed fires, and biogenics.

4.3 Photochemical Model Application

The CAMx photochemical model is applied for at least one entire calendar year using multiple model domains to track source group emissions. Source group emissions are tracked for ozone contribution using the APCA approach (ENVIRON 2008). CAMx version 5.01 is a freely available computer model that simulates the formation and fate of photochemical oxidants, primary and secondary PM concentrations, and air toxics, over regional and urban spatial scales for given input sets of meteorological conditions and emissions (Nobel, McDonald-Buller et al. 2001; Baker and Scheff 2007; Russell 2008). CAMx includes numerous science modules that simulate the emission, production, decay, deposition and transport of organic and inorganic gas-phase and particle-phase pollutants in the atmosphere. CAMx is applied with Regional Acid Deposition Model (RADM) aqueous phase chemistry (Chang, Brost et al. 1987), and Carbon Bond 05 (CB05) gas-phase chemistry module (Gery, Whitten et al. 1989; ENVIRON 2008).

All model domains (Table 1, Figure 1) were applied for the entire year of 2005 except for 12WUS1 and 12SEATTLE1, which wer only applied for 2006. The 12WUS2 domain was applied for both 2006 and 2005. All model domains are applied with a Lambert projection centered at (-97, 40) and true latitudes at 33 and 45. The specifications for each of the modeling domains are given in Table 1 and shown in Figure 1. Each domain is applied with square 12 km sized grid cells.

Table 1. Model domain specifications (Cell size, X, and Y origins in units of km).

Domain Name	X origin	Y origin	# X cells	# Y cells	Cell size
12FLORIDA2	900	-1620	75	75	12
12SOUTH1	-444	-1620	140	90	12
12NE2	432	-288	156	108	12
12SE2	540	-972	120	72	12
12MW3	-288	-792	93	72	12
12WUS2	-2412	-972	170	150	12
12SEATTLE1	-2196	852	53	40	12
12OV1	468	-648	75	75	12
12UPMW1	-180	-36	114	75	12
12EUS1	-1008	-1620	279	240	12
12WUS1	-2412	-972	213	192	12

4.4 Emissions

The emissions used for the photochemical modeling are based on the 2005 National Emission Inventory version 2 (modeling inventory scenario = 2005cm_05b) for stationary point, onroad and nonroad sources. Day specific biogenic emissions are estimated using hourly gridded day-specific meteorology. Other area sources were grown from the 2002 National Emission Inventory to approximate the level of emissions expected in 2005 (Strum 2008). Average day fire emissions are used for this modeling, but were not tracked as part of any source area (county). Fire emissions are included as part of the non-tagged emissions in the source apportionment modeling. Oil and gas related emissions in the NEI were replaced by more recent inventories made available by the Western Regional Air Partnership for certain States in the western United States (Bar-Ilan 2007).

Table 2. Sectors Used in the Emissions Modeling Platform

Platform Sector	Tagged?	2005 NEI Sector	Description and resolution of the data input to SMOKE
IPM sector: *ptipm*	Y	Point	2005v2 NEI point source EGUs mapped to the Integrated Planning Model (IPM) model using the National Electric Energy Database System (NEEDS, 2006 version 3.02) database. Hourly files for continuous emission monitoring (CEM) sources are included only for the 2005 evaluation case. Day-specific emissions for non-CEM sources created for input into SMOKE.
Non-IPM sector: *ptnonipm*	Y	Point	All 2005v2 NEI point source records not matched to the ptipm sector, annual resolution. Includes all aircraft emissions.
Point source fire sector: *avgfire*	N	Fires	Average wildfires and prescribed fires. Fire emissions based on average of 1996-2002.
Agricultural sector: *ag*	N	Nonpoint	NH_3 emissions from NEI nonpoint livestock and fertilizer application, county and annual resolution.
Area fugitive dust sector: *afdust*	N	Nonpoint	PM_{10} and $PM_{2.5}$ from fugitive dust sources from the NEI nonpoint inventory (e.g., building construction, road construction, paved roads, unpaved roads, agricultural dust), county and annual resolution.
Remaining nonpoint sector: *nonpt*	Y	Nonpoint	Primarily 2002 NEI nonpoint sources not otherwise included in other SMOKE sectors, county and annual resolution. Also includes updated Residential Wood Combustion emissions and year 2005 non-California Western Regional Air Partnership (WRAP) oil and gas “Phase II” inventory. Includes portable fuel container emissions from OTAQ.
Nonroad sector: *nonroad*	Y	Mobile: Nonroad	Monthly nonroad emissions from the National Mobile Inventory Model (NMIM) using NONROAD2005 version nr05c-BondBase for all states except California. Monthly emissions for California created from annual emissions submitted by the California Air Resources Board (CARB) for the 2005v2 NEI.
locomotive, and non-C3	Y	Mobile: Nonroad	Year 2002 non-rail maintenance locomotives, and category 1 and category 2 commercial marine vessel

Platform Sector	Tagged?	2005 NEI Sector	Description and resolution of the data input to SMOKE
commercial marine: *alm_no_c3*			(CMV) emissions sources, county and annual resolution. Unlike prior platforms, aircraft emissions are now included in the ptnonipm sector and category 3 CMV emissions are now contained in the seca_c3 sector
C3 commercial marine: *seca_c3*	Y	Mobile : Nonroad	Annual point source formatted year 2005 category 3 (C3) CMV emissions, developed for the EPA rule called “Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder”, usually described as the Area (ECA) study, originally called SO_2 (“S”) ECA.
Onroad (NMIM-based)	Y	Mobile: onroad	Three, monthly, county-level components: 1) Onroad emissions from NMIM using MOBILE6.2, other than for California. 2) California onroad, created using annual emissions submitted by CARB for the 2005v2 NEI.
Biogenic: *biog*	N	N/A	Hour-specific, grid cell-specific emissions generated from the BEIS3.14 model -includes emissions in Canada and Mexico.
Other point sources not from the NEI: *othpt*	N	N/A	Point sources from Canada’s 2006 inventory and Mexico’s Phase III 1999 inventory, annual resolution. Also includes annual U.S. offshore oil 2005v2 NEI point source emissions.
Other nonpoint and nonroad not from the NEI: *othar*	N	N/A	Annual year 2006 Canada (province resolution) and year 1999 Mexico Phase III (municipio resolution) nonpoint and nonroad mobile inventories, annual resolution.
Other onroad sources not from the NEI: *othon*	N	N/A	Year 2006 Canada (province resolution) and year 1999 Mexico Phase III (municipio resolution) onroad mobile inventories, annual resolution.

Daily hour-specific biogenic emissions based on 2005 and 2006 meteorology data are generated using the BEIS 3.14 model. The BEIS model creates gridded, hourly emissions of CO, VOC, and NO_X from vegetation and soils for the United States, Mexico, and Canada (Guenther, Geron et al. 2000). The inputs to BEIS include shortwave downward solar radiation and temperature data at 10 meters which were obtained from the CMAQ meteorological input files and land-use data from the Biogenic Emissions Landuse Database, version 3 (BELD3). BELD3 data provides data on the 230 vegetation classes at 1 km resolution over most of North America (Kinnee, Geron et al. 1997).

All emissions were processed using the latest version of the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System (Houyoux, Vukovich et al. 2000; UNC 2007). SMOKE has been enhanced with a feature that allows county or state specific emissions to be processed through the emissions model as specific unique pollutants. For example, rather than run SMOKE for specific counties or states then merge the output files into a model ready emissions file, a new input file called the 'GSTAG' file matches specific emissions based on FIPS codes to additional emissions species that are tracked in the source apportionment photochemical model. This type of approach to source apportionment emissions processing is favorable because it is efficient in terms of processing time (compared to running SMOKE for each specific source group individually) and results in precursor emissions specific to the source group. The alternative is using a gridded "mask" field to define source groups, which has much less specificity about allocating emissions to the correct county when multiple county boundaries fall within the same grid cell.

Total county emissions of NO_X and VOC are presented in tabular form in the Appendix. Emission totals are only shown for counties selected to be tracked with source apportionment for contribution to receptor locations of interest.

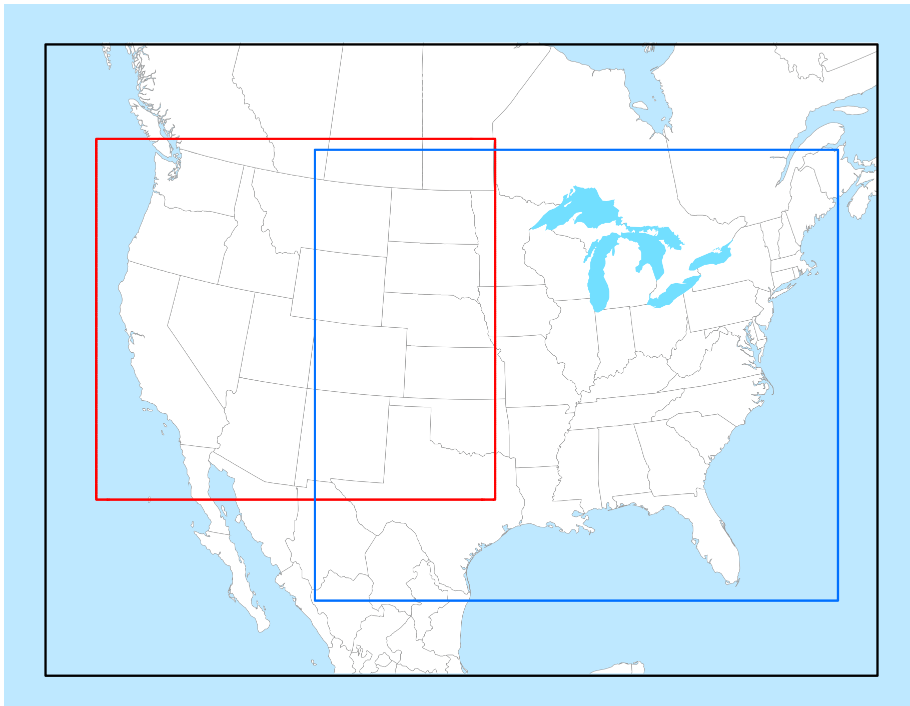
4.5 Meteorological Inputs

The gridded meteorological input data for the entire year of 2005 were derived from simulations of the Pennsylvania State University / National Center for Atmospheric Research Mesoscale Model. This model, commonly referred to as MM5, is a limited-area, nonhydrostatic, terrain-following system that solves for the full set of physical and thermodynamic equations which govern atmospheric motions. Meteorological model input fields were prepared separately for each of the three domains shown in Figure 2 using MM5 version 3.7.4. Meteorological model output for the 36 km continental U.S. domain and 12 km eastern U.S. and 12 km western U.S. are translated to photochemical modeling domains shown in Figure 2 and Table 3. Meteorological modeling domains are several grid cells larger in the X and Y domain than the photochemical model domains. The photochemical model inputs for these domains were windowed to match the smaller 12 km domains listed in Table 1.

Table 3. Geographic elements of domains used in photochemical modeling.

	Photochemical Modeling Configuration		
	National Grid	**Western U.S. Fine Grid**	**Eastern U.S. Fine Grid**
Map Projection	Lambert Conformal Projection		
Grid Resolution	36 km	12 km	12 km
Coordinate Center	97 deg W, 40 deg N		
True Latitudes	33 deg N and 45 deg N		
Dimensions	148 x 112 x 14	213 x 192 x 14	279 x 240 x 14
Vertical extent	14 Layers: Surface to 100 millibar level (see Table II-3)		

Figure 2. Map of the photochemical modeling domain. The black outer box denotes the 36 km national modeling domain; the red inner box is the 12 km western U.S. grid; and the blue inner box is the 12 km eastern U.S. grid.



All meteorological model runs were configured similarly. The selections for key MM5 physics options are shown below:

- Pleim-Xiu PBL and land surface schemes
- Kain-Fritsh 2 cumulus parameterization
- Reisner 2 mixed phase moisture scheme
- RRTM longwave radiation scheme
- Dudhia shortwave radiation scheme

Three dimensional analysis nudging for temperature and moisture was applied above the boundary layer only. Analysis nudging for the wind field was applied above and below the boundary layer. The 36 km domain nudging weighting factors were 3.0×10^4 for wind fields and temperatures and 1.0×10^5 for moisture fields. The 12 km domain nudging weighting factors were 1.0×10^4 for wind fields and temperatures and 1.0×10^5 for moisture fields.

All sets of model runs were conducted in 5.5 day segments with 12 hours of overlap for spin-up purposes. All domains contained 34 vertical layers with an approximately 38 m deep surface layer and a 100 millibar top. The MM5 and CAMx vertical structures are shown in Table 4 and do not vary by horizontal grid resolution. The meteorological outputs from all three MM5 sets were processed to create model-ready inputs for CAMx using the MM5CAMx processor to derive the specific inputs.

Table 4. Vertical layer structure (heights are layer top).

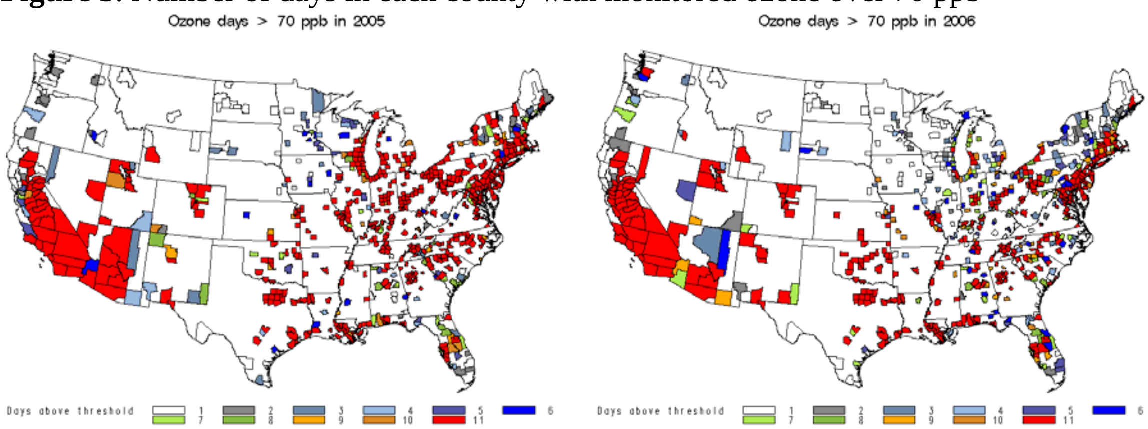
CAMx Layers	MM5 Layers	Sigma P	Approximate Height (m)	Approximate Pressure (mb)
0	0	1.000	0	1000
1	1	0.995	38	995
2	2	0.990	77	991
3	3	0.985	115	987
	4	0.980	154	982
4	5	0.970	232	973
	6	0.960	310	964
5	7	0.950	389	955
	8	0.940	469	946
6	9	0.930	550	937
	10	0.920	631	928
	11	0.910	712	919
7	12	0.900	794	910
	13	0.880	961	892
	14	0.860	1,130	874
8	15	0.840	1,303	856
	16	0.820	1,478	838
	17	0.800	1,657	820
9	18	0.770	1,930	793
	19	0.740	2,212	766
10	20	0.700	2,600	730
	21	0.650	3,108	685
11	22	0.600	3,644	640
	23	0.550	4,212	595
12	24	0.500	4,816	550
	25	0.450	5,461	505
	26	0.400	6,153	460
13	27	0.350	6,903	415
	28	0.300	7,720	370
	29	0.250	8,621	325
	30	0.200	9,625	280
14	31	0.150	10,764	235
	32	0.100	12,085	190
	33	0.050	13,670	145
	34	0.000	15,674	100

Before initiating the air quality simulations, it is important to identify the biases and errors associated with the meteorological modeling inputs. The 2005 MM5 model performance evaluations used an approach which included a combination of qualitative and quantitative analyses to assess the adequacy of the MM5 simulated fields. The qualitative aspects involved comparisons of the model-estimated synoptic patterns against observed patterns from historical weather chart archives. Additionally, the evaluations compared spatial patterns of estimated to observed monthly average rainfall and checked maximum planetary boundary layer (PBL) heights for reasonableness.

Qualitatively, the model fields closely matched the observed synoptic patterns, which is not unexpected given the use of nudging. The operational evaluation included statistical comparisons of model/observed pairs (e.g., mean normalized bias, mean normalized error, index of agreement, root mean square errors, etc.) for multiple meteorological parameters. For this portion of the evaluation, five meteorological parameters were investigated: temperature, humidity, shortwave downward radiation, wind speed, and wind direction. The three individual MM5 evaluations are described elsewhere (Baker 2009; Baker 2009; Baker 2009). It was ultimately determined that the bias and error values associated with all three sets of 2005 meteorological data were generally within the range of past meteorological modeling results that have been used for air quality applications.

Meteorology generated from a prognostic meteorological model is used as input to the photochemical model used to track emissions for source contribution. Most areas in the continental United States have several observed days above 70 ppb in 2005 and 2006 (Figure 3). The photochemical model is applied for the entire year of 2005 for the central and eastern United States and for the entire years of 2005 and 2006 for the western United States. This is done to capture meteorological conditions conducive of ozone formation and account for meteorological factors that drive elevated ozone concentrations.

Figure 3. Number of days in each county with monitored ozone over 70 ppb



4.6 Initial and Boundary Conditions

Annual continental United States simulations using 36 km sized grid cells (see Figure 2) for calendar years of 2005 and 2006 are used to supply hourly boundary condition information for each of the 12 km modeling domains. The lateral boundary and initial species concentrations are provided by a three-dimensional global atmospheric chemistry model, the GEOS-CHEM model (standard version 7-04-11). The global GEOS-CHEM model simulates atmospheric chemical and physical processes driven by assimilated meteorological observations from the NASA's Goddard Earth Observing System (GEOS). This model was run for 2005 with a grid resolution of 2.0 degree x 2.5 degree (latitude-longitude) and 30 vertical layers up to 100 mb. The predictions were used to provide one-way dynamic boundary conditions at three-hour intervals and an initial concentration field for the 36-km CAMx simulations. The 36 km coarse grid modeling was used as the initial/boundary state for all subsequent 12 km grid modeling scenarios.

5 Operational Model Performance Description

Model estimates are compared to observations of ozone collected during 2005 and 2006. Ozone data from the AIRS Network is compared to model predictions to estimate operational model performance. Metrics used to describe model performance include mean bias and gross error (Boylan and Russell 2006). The bias and error metrics describe performance in terms of measured concentration units. The best possible performance is when the metrics approach 0. Bias is estimated as prediction-observation meaning a positive number might suggest a tendency toward over-prediction and a negative value might suggest a tendency toward under-prediction.

Scatter-plots of all daily 8-hr ozone maximum prediction-observation pairs and spatial plots of average bias for model predicted ozone greater than 70 ppb are shown for each modeling domain in Appendix B.

6 References

Baker, K., Dolwick, P. (2009). Meteorological Modeling Performance Evaluation for the Annual 2005 Continental U.S. 36-km Domain Simulation, US Environmental Protection Agency OAQPS.

Baker, K., Dolwick, P. (2009). Meteorological Modeling Performance Evaluation for the Annual 2005 Eastern U.S. 12-km Domain Simulation. RTP, US Environmental Protection Agency OAQPS.

Baker, K., Dolwick, P. (2009). Meteorological Modeling Performance Evaluation for the Annual 2005 Western U.S. 12-km Domain Simulation. U. EPA, US Environmental Protection Agency OAQPS.

Bar-Ilan, A., Friesen, R., Pollack, A., Hoats, A. (2007). WRAP area source emissions inventory projections and control strategy evaluation phase II. C. P. Western Governor's Association, Suite 200, Denver, CO 80202, ENVIRON International Corporation.

Boylan, J. W. and A. G. Russell (2006). "PM and light extinction model performance metrics, goals, and criteria for three-dimensional air quality models." Atmospheric Environment 40(26): 4946-4959.

Chang, J. S., R. A. Brost, et al. (1987). "A 3-DIMENSIONAL EULERIAN ACID DEPOSITION MODEL - PHYSICAL CONCEPTS AND FORMULATION." Journal of Geophysical Research-Atmospheres 92(D12): 14681-14700.

Dunker, A. M., G. Yarwood, et al. (2002). "Comparison of source apportionment and source sensitivity of ozone in a three-dimensional air quality model." Environmental Science & Technology 36(13): 2953-2964.

ENVIRON (2008). User's Guide Comprehensive Air Quality Model with Extensions. Novato, ENVIRON International Corporation.

Gery, M. W., G. Z. Whitten, et al. (1989). "A PHOTOCHEMICAL KINETICS MECHANISM FOR URBAN AND REGIONAL SCALE COMPUTER MODELING." Journal of Geophysical Research-Atmospheres 94(D10): 12925-12956.

Guenther, A., C. Geron, et al. (2000). "Natural emissions of non-methane volatile organic compounds; carbon monoxide, and oxides of nitrogen from North America." Atmospheric Environment 34(12-14): 2205-2230.

Houyoux, M. R., J. M. Vukovich, et al. (2000). "Emission inventory development and processing for the Seasonal Model for Regional Air Quality (SMRAQ) project." Journal of Geophysical Research-Atmospheres 105(D7): 9079-9090.

Kinnee, E., C. Geron, et al. (1997). "United States land use inventory for estimating biogenic ozone precursor emissions." Ecological Applications 7(1): 46-58.

Nobel, C. E., E. C. McDonald-Buller, et al. (2001). "Accounting for spatial variation of ozone productivity in NOx emission trading." Environmental Science & Technology 35(22): 4397-4407.

Strum, M., Houyoux, M., Mason, R. (2008). Technical Support Document: Preparation of Emissions Inventories For the 2002-based Platform, Version 3, Criteria Air Pollutants. U. S. E. P. Agency. Research Triangle Park, NC.

UNC (2007). SMOKE v2.3.2 User's Manual. Chapel Hill, University of North Carolina Institute of the Environment.

Yarwood, G., Stoeckenius, T.E., W ilson, G., Morris, R.E., Yocke, M.A. (1996). Development of a methodology for source apportionment of ozone concentration estimates from a photochemical grid model. 98th AWMA Annual Meeting, Nashville, TN.

APPENDIX A

SOURCE AREA EMISSIONS

FIPS	State	County	NOX(TPY)	VOC(TPY)
1001	AL	Autauga	5,057	1,631
1003	AL	Baldwin	9,362	10,925
1007	AL	Bibb	941	821
1009	AL	Blount	2,499	2,005
1017	AL	Chambers	1,838	1,539
1021	AL	Chilton	2,594	2,011
1027	AL	Clay	911	580
1033	AL	Colbert	20,171	2,986
1037	AL	Coosa	796	830
1043	AL	Cullman	3,508	3,819
1051	AL	Elmore	2,504	3,380
1055	AL	Etowah	6,180	4,107
1061	AL	Geneva	1,170	1,197
1063	AL	Greene	9,043	1,021
1065	AL	Hale	1,000	912
1067	AL	Henry	1,044	1,039
1069	AL	Houston	4,311	4,585
1073	AL	Jefferson	57,582	28,053
1077	AL	Lauderdale	4,120	4,153
1079	AL	Lawrence	4,985	2,000
1081	AL	Lee	4,468	3,730
1083	AL	Limestone	4,542	3,927
1085	AL	Lowndes	1,626	1,124
1087	AL	Macon	1,639	1,304
1089	AL	Madison	11,414	10,310
1095	AL	Marshall	3,519	5,160
1097	AL	Mobile	42,420	14,815
1101	AL	Montgomery	11,536	9,704
1103	AL	Morgan	8,514	4,496
1113	AL	Russell	4,814	2,032
1115	AL	St Clair	6,306	3,199
1117	AL	Shelby	38,427	7,393
1119	AL	Sumter	2,471	1,082
1121	AL	Talladega	4,289	3,815
1125	AL	Tuscaloosa	9,871	7,699
1127	AL	Walker	16,553	3,043
1133	AL	Winston	1,263	1,467
4001	AZ	Apache	26,352	3,354
4003	AZ	Cochise	15,989	6,434
4005	AZ	Coconino	45,933	7,505
4007	AZ	Gila	1,856	4,404
4009	AZ	Graham	996	1,613
4011	AZ	Greenlee	469	199
4012	AZ	La Paz	3,003	2,407
4013	AZ	Maricopa	99,446	88,995
4015	AZ	Mohave	12,716	12,241
4017	AZ	Navajo	24,950	5,008
4019	AZ	Pima	30,349	29,506
4021	AZ	Pinal	12,425	7,395
4023	AZ	Santa Cruz	1,496	1,427
4025	AZ	Yavapai	14,238	7,086
4027	AZ	Yuma	9,211	6,800
5007	AR	Benton	11,161	6,282
5009	AR	Boone	1,282	1,636
5025	AR	Cleveland	777	416
5035	AR	Crittenden	5,824	3,824
5045	AR	Faulkner	3,829	4,714

FIPS	State	County	NOX(TPY)	VOC(TPY)
5053	AR	Grant	783	799
5069	AR	Jefferson	23,253	3,053
5079	AR	Lincoln	991	594
5085	AR	Lonoke	3,416	2,621
5101	AR	Newton	245	824
5105	AR	Perry	347	640
5113	AR	Polk	871	1,088
5119	AR	Pulaski	18,407	18,551
5125	AR	Saline	2,950	2,471
5131	AR	Sebastian	5,285	4,141
5143	AR	Washington	7,318	6,684
5145	AR	White	6,196	2,965
6001	CA	Alameda	43,316	26,321
6003	CA	Alpine	194	219
6005	CA	Amador	2,016	1,744
6007	CA	Butte	9,199	7,004
6009	CA	Calaveras	1,873	3,125
6011	CA	Colusa	4,036	1,643
6013	CA	Contrasta	37,566	19,608
6015	CA	Del Norte	2,510	1,279
6017	CA	El Dorado	3,843	6,001
6019	CA	Fresno	41,167	23,906
6021	CA	Glenn	4,081	1,776
6023	CA	Humboldt	15,011	5,281
6025	CA	Imperial	13,554	6,949
6027	CA	Inyo	1,857	1,650
6029	CA	Kern	89,387	32,413
6031	CA	Kings	10,565	3,634
6033	CA	Lake	2,693	4,158
6035	CA	Lassen	2,165	2,079
6037	CA	Los Angeles	287,426	175,408
6039	CA	Madera	12,180	4,684
6041	CA	Marin	6,863	6,227
6043	CA	Mariposa	713	1,737
6045	CA	Mendocino	15,058	4,592
6047	CA	Merced	20,261	7,360
6049	CA	Modoc	1,348	1,043
6051	CA	Mono	1,088	923
6053	CA	Monterey	16,655	12,966
6055	CA	Napa	4,230	3,889
6057	CA	Nevada	5,027	4,541
6059	CA	Orange	64,995	56,760
6061	CA	Placer	14,130	9,597
6063	CA	Plumas	11,422	2,592
6065	CA	Riverside	67,696	33,171
6067	CA	Sacramento	30,405	25,275
6069	CA	San Benito	4,577	1,704
6071	CA	San Bernardino	121,128	45,581
6073	CA	San Diego	78,452	66,071
6075	CA	San Francisco	32,180	13,083
6077	CA	San Joaquin	38,612	15,970
6079	CA	San Luis Obispo	16,025	8,428
6081	CA	San Mateo	19,342	13,466
6083	CA	Santa Barbara	53,349	14,680
6085	CA	Santa Clara	38,142	31,503
6087	CA	Santa Cruz	8,028	7,917
6089	CA	Shasta	13,646	8,011

FIPS	State	County	NOX(TPY)	VOC(TPY)
6091	CA	Sierra	371	1,133
6093	CA	Siskiyou	7,191	3,422
6095	CA	Solano	17,204	9,494
6097	CA	Sonoma	14,128	11,506
6099	CA	Stanislaus	20,311	11,390
6101	CA	Sutter	7,141	3,417
6103	CA	Tehama	6,900	2,816
6105	CA	Trinity	1,093	1,197
6107	CA	Tulare	17,430	11,580
6109	CA	Tuolumne	3,079	4,114
6111	CA	Ventura	32,980	19,917
6113	CA	Yolo	9,903	5,366
6115	CA	Yuba	2,838	2,432
8001	CO	Adams	23,905	10,642
8005	CO	Arapahoe	12,935	14,482
8007	CO	Archuleta	529	760
8013	CO	Boulder	12,829	9,485
8014	CO	Broomfield	1,643	1,103
8019	CO	Clear Creek	1,801	1,508
8031	CO	Denver	21,058	18,279
8035	CO	Douglas	7,661	6,610
8039	CO	Elbert	1,218	978
8041	CO	El Paso	22,309	20,644
8043	CO	Fremont	3,380	1,228
8045	CO	Garfield	9,738	3,040
8047	CO	Gilpin	588	313
8051	CO	Gunnison	922	1,454
8059	CO	Jefferson	15,801	14,684
8067	CO	La Plata	7,812	2,142
8069	CO	Larimer	11,765	9,534
8077	CO	Mesa	6,641	4,643
8081	CO	Moffat	19,248	918
8083	CO	Montezuma	1,174	1,448
8087	CO	Morgan	7,561	1,334
8093	CO	Park	563	1,178
8101	CO	Pueblo	13,939	5,099
8103	CO	Rio Blanco	3,773	657
8107	CO	Routt	9,543	1,395
8119	CO	Teller	559	1,149
8123	CO	Weld	24,969	9,949
9001	CT	Fairfield	26,532	26,655
9003	CT	Hartford	23,700	22,776
9005	CT	Litchfield	4,385	9,171
9007	CT	Middlesex	6,883	6,921
9009	CT	New Haven	21,665	24,411
9011	CT	New London	11,029	14,040
9013	CT	Tolland	4,059	5,133
9015	CT	Windham	3,638	4,975
10001	DE	Kent	8,329	4,921
10003	DE	New Castle	25,493	13,358
10005	DE	Sussex	20,993	8,598
11001	DC	Washington	14,588	9,898
12001	FL	Alachua	12,879	11,204
12003	FL	Baker	2,083	1,427
12005	FL	Bay	13,732	9,718
12009	FL	Brevard	39,784	28,544
12011	FL	Broward	65,830	49,993

FIPS	State	County	NOX(TPY)	VOC(TPY)
12015	FL	Charlotte	6,219	9,695
12019	FL	Clay	4,749	6,559
12021	FL	Collier	12,784	17,035
12023	FL	Columbia	4,960	4,141
12031	FL	Duval	60,455	37,372
12033	FL	Escambia	22,503	15,727
12035	FL	Flagler	4,844	3,980
12039	FL	Gadsden	4,468	3,043
12041	FL	Gilchrist	623	849
12053	FL	Hernando	6,844	6,571
12055	FL	Highlands	4,550	6,466
12057	FL	Hillsborough	71,783	46,252
12059	FL	Holmes	1,422	1,297
12061	FL	Indian River	7,005	6,896
12065	FL	Jefferson	1,906	1,475
12069	FL	Lake	6,364	12,178
12071	FL	Lee	26,038	29,382
12073	FL	Leon	8,969	10,954
12081	FL	Manatee	22,380	13,052
12083	FL	Marion	12,936	15,296
12085	FL	Martin	16,244	10,385
12086	FL	Miami-Dade	79,694	83,167
12089	FL	Nassau	8,396	3,760
12095	FL	Orange	39,994	42,368
12097	FL	Osceola	5,669	9,185
12099	FL	Palm Beach	45,408	47,568
12101	FL	Pasco	22,415	14,385
12103	FL	Pinellas	35,221	35,961
12105	FL	Polk	26,753	26,571
12109	FL	St Johns	9,232	7,213
12111	FL	St Lucie	9,746	10,477
12113	FL	Santa Rosa	6,605	8,373
12115	FL	Sarasota	13,108	15,940
12117	FL	Seminole	11,723	18,389
12119	FL	Sumter	4,176	4,116
12127	FL	Volusia	21,257	22,539
12129	FL	Wakulla	1,367	2,170
13013	GA	Barrow	2,533	2,068
13015	GA	Bartow	32,666	5,238
13021	GA	Bibb	7,894	7,280
13025	GA	Brantley	791	642
13029	GA	Bryan	1,842	1,812
13033	GA	Burke	1,310	1,243
13035	GA	Butts	1,389	1,211
13045	GA	Carroll	4,247	4,048
13047	GA	Catoosa	2,822	2,658
13051	GA	Chatham	29,315	12,805
13053	GA	Chattahoochee	288	341
13055	GA	Chattooga	1,746	1,469
13057	GA	Cherokee	6,214	5,712
13059	GA	Clarke	3,920	4,075
13063	GA	Clayton	12,318	6,958
13067	GA	Cobb	25,971	21,411
13073	GA	Columbia	3,526	3,960
13077	GA	Coweta	16,881	3,323
13079	GA	Crawford	490	473
13083	GA	Dade	1,431	922

FIPS	State	County	NOX(TPY)	VOC(TPY)
13085	GA	Dawson	715	895
13089	GA	De Kalb	22,497	23,062
13097	GA	Douglas	4,282	3,205
13103	GA	Effingham	5,944	1,941
13113	GA	Fayette	3,559	3,116
13117	GA	Forsyth	4,753	4,654
13121	GA	Fulton	39,064	35,206
13127	GA	Glynn	8,178	4,757
13135	GA	Gwinnett	22,648	24,947
13139	GA	Hall	6,795	8,244
13143	GA	Haralson	1,325	1,290
13145	GA	Harris	1,542	1,642
13149	GA	Heard	15,184	838
13151	GA	Henry	8,919	5,062
13153	GA	Houston	6,566	4,465
13159	GA	Jasper	675	636
13169	GA	Jones	1,276	956
13171	GA	Lamar	775	827
13189	GA	Mc Duffie	1,347	1,270
13191	GA	Mc Intosh	2,306	2,554
13195	GA	Madison	3,181	1,340
13197	GA	Marion	366	388
13199	GA	Meriwether	1,445	1,120
13207	GA	Monroe	20,794	2,010
13213	GA	Murray	1,656	1,447
13215	GA	Muscogee	5,751	6,248
13217	GA	Newton	3,333	3,168
13219	GA	Oconee	1,438	1,413
13221	GA	Oglethorpe	503	666
13223	GA	Paulding	3,196	2,496
13225	GA	Peach	1,697	1,548
13227	GA	Pickens	1,073	1,243
13231	GA	Pike	499	566
13233	GA	Polk	1,648	1,740
13245	GA	Richmond	13,061	7,970
13247	GA	Rockdale	3,123	3,075
13249	GA	Schley	190	276
13255	GA	Spalding	2,215	3,100
13261	GA	Sumter	1,739	1,291
13285	GA	Troup	3,348	4,000
13289	GA	Twiggs	867	752
13293	GA	Upson	1,086	983
13295	GA	Walker	2,125	2,247
13297	GA	Walton	2,590	3,080
13313	GA	Whitfield	7,092	6,071
16001	ID	Ada	18,576	10,280
16015	ID	Boise	719	1,212
16023	ID	Butte	343	270
16027	ID	Canyon	7,348	4,493
16041	ID	Franklin	694	940
16045	ID	Gem	1,243	636
16055	ID	Kootenai	7,519	5,952
16073	ID	Owyhee	652	610
16075	ID	Payette	1,252	962
16081	ID	Teton	401	982
17005	IL	Bond	1,446	1,159
17007	IL	Boone	2,331	3,012

FIPS	State	County	NOX(TPY)	VOC(TPY)
17013	IL	Calhoun	916	439
17019	IL	Champaign	8,919	6,996
17027	IL	Clinton	3,455	2,003
17031	IL	Cook	174,358	121,322
17037	IL	De Kalb	3,888	4,001
17043	IL	Du Page	37,034	25,338
17049	IL	Effingham	2,827	2,270
17053	IL	Ford	1,205	1,120
17057	IL	Fulton	3,814	1,915
17063	IL	Grundy	3,873	2,418
17065	IL	Hamilton	703	721
17073	IL	Henry	7,122	2,787
17081	IL	Jefferson	3,383	2,466
17083	IL	Jersey	1,479	1,070
17089	IL	Kane	16,659	12,338
17091	IL	Kankakee	7,317	5,160
17093	IL	Kendall	4,416	3,138
17097	IL	Lake	29,527	29,437
17111	IL	Mc Henry	9,583	7,925
17113	IL	Mc Lean	9,648	5,887
17115	IL	Macon	12,313	4,300
17117	IL	Macoupin	2,083	2,017
17119	IL	Madison	20,676	7,591
17123	IL	Marshall	2,203	1,372
17127	IL	Massac	12,034	2,014
17129	IL	Menard	567	720
17131	IL	Mercer	1,040	1,130
17133	IL	Monroe	2,939	1,511
17143	IL	Peoria	16,440	6,608
17147	IL	Piatt	4,042	1,074
17157	IL	Randolph	8,923	1,526
17161	IL	Rock Island	6,053	5,371
17163	IL	St Clair	10,184	8,303
17167	IL	Sangamon	16,756	7,778
17175	IL	Stark	490	579
17179	IL	Tazewell	37,744	5,169
17197	IL	Will	46,106	14,878
17201	IL	Winnebago	10,624	10,330
17203	IL	Woodford	2,201	2,184
18001	IN	Adams	2,092	1,786
18003	IN	Allen	16,173	13,482
18005	IN	Bartholomew	3,058	2,455
18007	IN	Benton	1,077	702
18011	IN	Boone	3,505	2,692
18013	IN	Brown	695	1,219
18015	IN	Carroll	1,391	1,237
18019	IN	Clark	5,749	3,203
18021	IN	Clay	1,667	1,527
18029	IN	Dearborn	13,242	1,836
18033	IN	De Kalb	5,289	2,627
18035	IN	Delaware	5,182	4,569
18039	IN	Elkhart	10,210	7,566
18043	IN	Floyd	8,147	2,191
18047	IN	Franklin	1,220	1,300
18051	IN	Gibson	32,699	1,970
18055	IN	Greene	1,559	1,569
18057	IN	Hamilton	7,956	7,263

FIPS	State	County	NOX(TPY)	VOC(TPY)
18059	IN	Hancock	3,140	2,469
18061	IN	Harrison	3,172	1,612
18063	IN	Hendricks	6,093	3,925
18065	IN	Henry	3,373	2,399
18069	IN	Huntington	3,089	2,327
18071	IN	Jackson	3,429	2,495
18073	IN	Jasper	20,104	2,461
18079	IN	Jennings	6,368	1,353
18081	IN	Johnson	4,701	4,186
18089	IN	Lake	42,940	14,882
18091	IN	La Porte	12,017	4,412
18095	IN	Madison	5,447	4,996
18097	IN	Marion	40,646	27,723
18099	IN	Marshall	3,079	2,671
18105	IN	Monroe	3,828	4,364
18107	IN	Montgomery	3,804	2,324
18109	IN	Morgan	6,594	2,925
18111	IN	Newton	1,145	1,862
18113	IN	Noble	3,643	2,884
18115	IN	Ohio	551	249
18119	IN	Owen	1,105	1,237
18123	IN	Perry	2,699	1,253
18127	IN	Porter	27,291	6,981
18129	IN	Posey	11,763	1,721
18133	IN	Putnam	4,703	2,070
18141	IN	St Joseph	10,649	8,312
18143	IN	Scott	1,355	1,355
18145	IN	Shelby	3,603	1,999
18153	IN	Sullivan	11,335	1,170
18157	IN	Tippecanoe	8,677	5,153
18163	IN	Vanderburgh	6,757	5,471
18165	IN	Vermillion	13,902	1,102
18167	IN	Vigo	17,609	4,744
18173	IN	Warrick	18,055	2,446
18175	IN	Washington	1,356	1,291
18179	IN	Wells	1,529	1,398
18183	IN	Whitley	2,355	1,952
19011	IA	Benton	2,467	1,422
19013	IA	Black Hawk	6,755	5,610
19015	IA	Boone	4,182	1,574
19017	IA	Bremer	1,365	1,508
19031	IA	Cedar	3,076	1,513
19045	IA	Clinton	10,640	3,251
19049	IA	Dallas	3,099	2,312
19061	IA	Dubuque	6,122	4,204
19075	IA	Grundy	1,047	999
19077	IA	Guthrie	746	600
19085	IA	Harrison	2,563	1,414
19103	IA	Johnson	5,881	5,980
19105	IA	Jones	1,103	984
19113	IA	Linn	16,168	7,903
19115	IA	Louisa	6,763	791
19121	IA	Madison	791	921
19127	IA	Marshall	6,012	1,677
19129	IA	Mills	4,028	785
19137	IA	Montgomery	1,921	736
19139	IA	Muscatine	10,419	2,451

FIPS	State	County	NOX(TPY)	VOC(TPY)
19153	IA	Polk	17,804	17,248
19155	IA	Pottawattamie	23,399	5,501
19163	IA	Scott	10,337	6,877
19169	IA	Story	6,573	3,734
19177	IA	Van Buren	512	468
19179	IA	Wapello	8,563	1,193
19181	IA	Warren	4,696	1,719
20005	KS	Atchison	1,124	610
20015	KS	Butler	10,444	2,944
20035	KS	Cowley	4,305	1,334
20045	KS	Douglas	8,943	4,579
20059	KS	Franklin	2,805	1,224
20079	KS	Harvey	2,519	1,378
20085	KS	Jackson	1,336	584
20087	KS	Jefferson	1,486	1,293
20091	KS	Johnson	19,471	21,510
20103	KS	Leavenworth	2,847	2,142
20107	KS	Linn	32,793	622
20121	KS	Miami	7,535	1,267
20149	KS	Pottawatomie	35,337	1,155
20155	KS	Reno	6,628	3,325
20173	KS	Sedgwick	20,896	18,185
20177	KS	Shawnee	10,780	6,378
20191	KS	Sumner	4,470	1,447
20195	KS	Trego	1,432	601
20209	KS	Wyandotte	14,691	7,213
21005	KY	Anderson	858	615
21007	KY	Ballard	2,546	880
21011	KY	Bath	1,049	684
21013	KY	Bell	889	1,053
21015	KY	Boone	10,641	4,189
21017	KY	Bourbon	1,274	809
21019	KY	Boyd	8,035	2,223
21023	KY	Bracken	493	433
21029	KY	Bullitt	3,140	2,851
21037	KY	Campbell	4,052	2,554
21043	KY	Carter	2,375	1,503
21047	KY	Christian	3,937	3,009
21049	KY	Clark	6,453	2,033
21059	KY	Daviess	11,704	3,635
21061	KY	Edmonson	571	912
21067	KY	Fayette	9,140	9,838
21073	KY	Franklin	2,133	1,687
21077	KY	Gallatin	2,122	690
21081	KY	Grant	2,746	1,260
21083	KY	Graves	1,699	1,521
21089	KY	Greenup	3,772	1,431
21091	KY	Hancock	8,006	523
21093	KY	Hardin	4,432	3,437
21101	KY	Henderson	5,015	2,342
21103	KY	Henry	1,313	969
21111	KY	Jefferson	57,954	27,868
21113	KY	Jessamine	1,931	2,221
21117	KY	Kenton	6,235	4,834
21123	KY	Larue	804	522
21139	KY	Livingston	1,854	974
21145	KY	Mc Cracken	24,187	5,298

FIPS	State	County	NOX(TPY)	VOC(TPY)
21149	KY	Mc Lean	476	386
21151	KY	Madison	4,872	3,731
21163	KY	Meade	3,021	1,963
21165	KY	Menifee	165	261
21173	KY	Montgomery	1,313	1,266
21179	KY	Nelson	1,744	1,679
21185	KY	Oldham	3,040	1,548
21191	KY	Pendleton	3,482	611
21193	KY	Perry	1,496	1,069
21195	KY	Pike	3,564	2,521
21199	KY	Pulaski	8,012	2,896
21203	KY	Rockcastle	1,902	995
21209	KY	Scott	3,773	1,895
21211	KY	Shelby	2,664	1,901
21213	KY	Simpson	1,461	990
21215	KY	Spencer	416	534
21221	KY	Trigg	1,285	1,417
21223	KY	Trimble	4,940	443
21227	KY	Warren	3,722	3,688
21233	KY	Webster	12,021	557
21239	KY	Woodford	3,105	1,625
22001	LA	Acadia Par	7,200	2,700
22005	LA	Ascension Par	14,288	7,324
22007	LA	Assumption Par	1,841	797
22015	LA	Bossier Par	5,301	3,386
22017	LA	Caddo Par	11,505	10,705
22019	LA	Calcasieu Par	52,705	15,219
22023	LA	Cameron Par	8,087	3,574
22031	LA	De Soto Par	18,084	2,022
22033	LA	East Baton Roug	40,779	16,581
22037	LA	East Feliciana	1,229	923
22045	LA	Iberia Par	6,001	3,032
22047	LA	Iberville Par	28,347	5,683
22051	LA	Jefferson Par	24,170	16,262
22053	LA	Jefferson Davis	3,201	2,327
22055	LA	Lafayette Par	8,051	7,865
22057	LA	Lafourche Par	5,794	4,753
22063	LA	Livingston Par	3,441	3,729
22071	LA	Orleans Par	38,986	11,934
22073	LA	Ouachita Par	13,902	8,026
22075	LA	Plaquemines Par	52,834	7,458
22077	LA	Pointeupee Par	19,242	1,007
22087	LA	St Bernard Par	8,058	3,520
22089	LA	St Charles Par	21,868	6,057
22091	LA	St Helena Par	1,722	668
22093	LA	St James Par	8,992	2,233
22095	LA	St John The Bap	64,272	3,951
22097	LA	St Landry Par	7,277	3,816
22099	LA	St Martin Par	3,563	3,103
22103	LA	St Tammany Par	6,167	9,220
22109	LA	Terrebonne Par	36,658	7,639
22111	LA	Union Par	1,166	1,405
22113	LA	Vermilion Par	12,700	3,684
22117	LA	Washington Par	4,986	1,933
22119	LA	Webster Par	3,707	2,164
22121	LA	West Baton Roug	5,380	1,886
22125	LA	West Feliciana	4,605	770

FIPS	State	County	NOX(TPY)	VOC(TPY)
23001	ME	Androscoggin	4,026	4,055
23005	ME	Cumberland	13,668	13,195
23009	ME	Hancock	4,100	5,839
23011	ME	Kennebec	4,943	6,404
23013	ME	Knox	5,409	3,965
23017	ME	Oxford	3,981	5,237
23019	ME	Penobscot	9,071	8,272
23023	ME	Sagadahoc	1,847	3,143
23029	ME	Washington	3,790	4,816
23031	ME	York	8,618	9,208
24001	MD	Allegany	7,915	3,058
24003	MD	Anne Arundel	35,280	14,857
24005	MD	Baltimore	36,605	23,555
24009	MD	Calvert	2,696	3,265
24013	MD	Carroll	6,669	4,750
24015	MD	Cecil	4,488	4,438
24017	MD	Charles	17,511	4,964
24021	MD	Frederick	11,480	9,175
24023	MD	Garrett	2,318	2,572
24025	MD	Harford	7,730	7,686
24027	MD	Howard	11,097	8,610
24029	MD	Kent	1,073	1,927
24031	MD	Montgomery	30,189	24,905
24033	MD	Prince Georges	36,041	23,120
24035	MD	Queen Annes	2,643	2,922
24043	MD	Washington	9,135	6,096
24047	MD	Worcester	16,457	5,850
24510	MD	Baltimore	19,656	14,265
25001	MA	Barnstable	22,564	15,087
25003	MA	Berkshire	6,123	6,698
25005	MA	Bristol	23,812	13,978
25007	MA	Dukes	4,454	2,302
25009	MA	Essex	22,551	19,477
25011	MA	Franklin	3,971	5,267
25013	MA	Hampden	15,783	11,970
25015	MA	Hampshire	4,338	5,314
25017	MA	Middlesex	43,611	41,006
25021	MA	Norfolk	25,071	23,095
25023	MA	Plymouth	11,244	14,316
25025	MA	Suffolk	20,096	13,794
25027	MA	Worcester	28,051	26,710
26005	MI	Allegan	5,654	7,832
26015	MI	Barry	1,882	3,238
26019	MI	Benzie	1,004	2,521
26021	MI	Berrien	8,968	8,097
26027	MI	Cass	2,131	2,820
26037	MI	Clinton	4,101	3,817
26043	MI	Dickinson	3,620	1,938
26045	MI	Eaton	6,222	4,118
26049	MI	Genesee	17,560	15,604
26055	MI	Grand Traverse	3,584	4,375
26063	MI	Huron	3,978	2,712
26065	MI	Ingham	14,591	8,990
26067	MI	Ionia	2,626	2,796
26077	MI	Kalamazoo	11,047	12,396
26079	MI	Kalkaska	1,840	1,943
26081	MI	Kent	24,363	24,922

FIPS	State	County	NOX(TPY)	VOC(TPY)
26087	MI	Lapeer	3,609	4,424
26089	MI	Leelanau	1,695	3,092
26091	MI	Lenawee	3,934	4,433
26093	MI	Livingston	7,902	7,866
26099	MI	Macomb	26,473	26,283
26101	MI	Manistee	5,472	3,254
26105	MI	Mason	1,896	2,865
26113	MI	Missaukee	795	1,932
26115	MI	Monroe	50,212	7,486
26121	MI	Muskegon	11,842	7,407
26123	MI	Newaygo	1,500	2,715
26125	MI	Oakland	48,594	49,464
26139	MI	Ottawa	27,318	10,347
26147	MI	St Clair	30,127	7,200
26153	MI	Schoolcraft	1,182	3,040
26155	MI	Shiawassee	3,296	3,213
26159	MI	Van Buren	3,627	4,247
26161	MI	Washtenaw	15,202	12,789
26163	MI	Wayne	91,246	65,955
26165	MI	Wexford	1,594	2,253
27003	MN	Anoka	12,250	13,242
27019	MN	Carver	3,245	3,550
27025	MN	Chisago	2,957	3,535
27037	MN	Dakota	26,466	14,432
27053	MN	Hennepin	72,542	40,466
27059	MN	Isanti	1,845	2,261
27123	MN	Ramsey	29,370	17,481
27139	MN	Scott	5,982	5,117
27141	MN	Sherburne	28,270	4,472
27163	MN	Washington	22,184	9,044
27171	MN	Wright	6,698	7,000
28001	MS	Adams	3,380	2,352
28011	MS	Bolivar	4,487	3,250
28023	MS	Clarke	1,690	842
28029	MS	Copiah	2,002	1,815
28033	MS	De Soto	7,874	5,627
28039	MS	George	719	799
28045	MS	Hancock	3,457	2,894
28047	MS	Harrison	21,493	10,839
28049	MS	Hinds	12,854	12,182
28057	MS	Itawamba	981	1,116
28059	MS	Jackson	31,668	8,001
28069	MS	Kemper	572	564
28075	MS	Lauderdale	4,549	4,721
28081	MS	Lee	4,712	5,055
28089	MS	Madison	3,977	3,789
28093	MS	Marshall	2,168	1,881
28115	MS	Pontotoc	1,389	1,487
28121	MS	Rankin	7,420	7,106
28127	MS	Simpson	1,251	1,566
28131	MS	Stone	864	677
28137	MS	Tate	3,228	1,534
28143	MS	Tunica	2,737	1,575
29013	MO	Bates	1,853	1,158
29019	MO	Boone	8,858	5,112
29021	MO	Buchanan	7,424	3,337
29025	MO	Caldwell	981	601

FIPS	State	County	NOX(TPY)	VOC(TPY)
29031	MO	Cape Girardeau	6,493	3,387
29037	MO	Cass	4,025	3,283
29039	MO	Cedar	604	1,249
29043	MO	Christian	2,294	2,267
29047	MO	Clay	8,547	7,407
29049	MO	Clinton	1,073	1,013
29059	MO	Dallas	612	811
29071	MO	Franklin	15,570	4,243
29077	MO	Greene	17,088	9,325
29083	MO	Henry	7,935	2,388
29095	MO	Jackson	38,847	22,640
29099	MO	Jefferson	16,584	6,502
29101	MO	Johnson	2,321	1,929
29107	MO	Lafayette	3,456	2,114
29113	MO	Lincoln	2,715	2,122
29133	MO	Mississippi	3,777	1,223
29137	MO	Monroe	1,125	1,247
29143	MO	New Madrid	36,195	2,384
29157	MO	Perry	2,615	1,377
29163	MO	Pike	9,123	1,623
29165	MO	Platte	14,154	3,938
29167	MO	Polk	1,275	1,462
29175	MO	Randolph	18,265	1,215
29177	MO	Ray	2,960	1,166
29183	MO	St Charles	20,679	9,509
29186	MO	Ste Genevieve	6,327	1,277
29187	MO	St Francois	2,142	2,048
29189	MO	St Louis	55,163	42,728
29201	MO	Scott	6,983	1,896
29209	MO	Stone	1,060	3,033
29213	MO	Taney	1,688	3,535
29219	MO	Warren	1,849	1,833
29221	MO	Washington	688	1,093
29225	MO	Webster	3,066	2,228
29510	MO	St Louis	22,268	12,988
30017	MT	Custer	1,779	613
30021	MT	Dawson	2,294	655
30025	MT	Fallon	2,174	187
30083	MT	Richland	3,700	592
30085	MT	Roosevelt	2,306	456
30087	MT	Rosebud	39,036	646
30109	MT	Wibaux	986	316
31025	NE	Cass	6,843	1,508
31053	NE	Dodge	4,261	1,662
31055	NE	Douglas	21,699	16,972
31109	NE	Lancaster	28,975	10,181
31131	NE	Otoe	12,027	902
31153	NE	Sarpy	4,530	4,493
31155	NE	Saunders	2,070	1,016
31177	NE	Washington	1,696	1,032
32001	NV	Churchill	2,007	1,607
32003	NV	Clark	72,938	37,438
32005	NV	Douglas	2,052	2,068
32007	NV	Elko	8,294	2,928
32009	NV	Esmeralda	99	138
32011	NV	Eureka	1,493	362
32013	NV	Humboldt	12,297	1,097

FIPS	State	County	NOX(TPY)	VOC(TPY)
32015	NV	Lander	1,085	540
32017	NV	Lincoln	1,286	281
32019	NV	Lyon	8,779	2,120
32021	NV	Mineral	190	439
32023	NV	Nye	1,052	1,214
32027	NV	Pershing	2,296	1,109
32029	NV	Storey	1,997	173
32031	NV	Washoe	13,261	13,061
32033	NV	White Pine	487	520
32510	NV	Carson City	1,414	1,390
33001	NH	Belknap	2,935	5,685
33005	NH	Cheshire	2,550	4,524
33007	NH	Coos	1,675	4,154
33009	NH	Grafton	6,000	6,820
33011	NH	Hillsborough	12,960	12,803
33013	NH	Merrimack	12,716	6,909
33015	NH	Rockingham	16,598	12,738
33017	NH	Strafford	2,332	3,067
33019	NH	Sullivan	2,138	3,442
34001	NJ	Atlantic	12,145	11,561
34003	NJ	Bergen	23,591	22,155
34005	NJ	Burlington	15,322	11,542
34007	NJ	Camden	15,371	9,288
34011	NJ	Cumberland	5,837	4,868
34013	NJ	Essex	21,311	12,309
34015	NJ	Gloucester	12,133	7,021
34017	NJ	Hudson	28,960	7,987
34019	NJ	Hunterdon	3,819	3,791
34021	NJ	Mercer	16,771	6,539
34023	NJ	Middlesex	28,059	16,739
34025	NJ	Monmouth	18,919	15,823
34027	NJ	Morris	13,645	13,868
34029	NJ	Ocean	16,113	18,741
34031	NJ	Passaic	8,774	8,663
34033	NJ	Salem	7,328	3,012
34035	NJ	Somerset	7,845	7,328
34037	NJ	Sussex	2,754	5,108
34039	NJ	Union	20,202	10,526
34041	NJ	Warren	5,351	3,932
35001	NM	Bernalillo	23,199	18,248
35013	NM	Dona Ana	9,634	6,822
35015	NM	Eddy	14,772	2,923
35017	NM	Grant	2,288	1,513
35025	NM	Lea	31,794	2,254
35031	NM	Mc Kinley	13,448	4,292
35039	NM	Rio Arriba	18,855	2,295
35043	NM	Sandoval	4,627	3,334
35045	NM	San Juan	103,288	3,950
35049	NM	Santa Fe	5,774	6,183
35057	NM	Torrance	4,607	1,501
35061	NM	Valencia	7,167	2,559
36001	NY	Albany	17,534	12,854
36005	NY	Bronx	14,061	21,882
36009	NY	Cattaraugus	3,031	4,152
36011	NY	Cayuga	3,757	4,259
36013	NY	Chautauqua	18,693	7,130
36015	NY	Chemung	3,413	3,577

FIPS	State	County	NOX(TPY)	VOC(TPY)
36021	NY	Columbia	2,436	3,291
36027	NY	Dutchess	8,044	9,405
36029	NY	Erie	32,876	35,630
36031	NY	Essex	2,807	5,370
36035	NY	Fulton	1,217	3,178
36037	NY	Genesee	4,188	3,389
36039	NY	Greene	5,640	3,141
36041	NY	Hamilton	485	6,763
36043	NY	Herkimer	3,575	4,573
36045	NY	Jefferson	5,668	8,097
36047	NY	Kings	25,287	47,314
36051	NY	Livingston	2,521	3,341
36053	NY	Madison	2,841	2,981
36055	NY	Monroe	38,906	31,846
36057	NY	Montgomery	3,591	3,139
36059	NY	Nassau	34,137	38,869
36061	NY	New York	34,443	39,053
36063	NY	Niagara	11,030	9,844
36065	NY	Oneida	7,535	10,521
36067	NY	Onondaga	16,822	19,294
36069	NY	Ontario	5,012	5,174
36071	NY	Orange	18,555	12,821
36073	NY	Orleans	1,406	2,064
36075	NY	Oswego	5,324	6,390
36079	NY	Putnam	5,322	6,462
36081	NY	Queens	40,551	38,665
36083	NY	Rensselaer	4,163	5,952
36085	NY	Richmond	8,862	12,185
36087	NY	Rockland	12,693	11,291
36091	NY	Saratoga	6,261	9,521
36093	NY	Schenectady	4,735	5,320
36095	NY	Schoharie	1,601	2,280
36099	NY	Seneca	1,525	3,544
36101	NY	Steuben	5,235	4,473
36103	NY	Suffolk	56,042	60,310
36111	NY	Ulster	5,941	7,500
36113	NY	Warren	4,807	5,696
36115	NY	Washington	2,468	2,779
36117	NY	Wayne	3,863	3,659
36119	NY	Westchester	25,275	30,153
37001	NC	Alamance	4,711	5,592
37003	NC	Alexander	835	1,264
37007	NC	Anson	1,394	1,358
37011	NC	Avery	649	954
37021	NC	Buncombe	12,517	8,560
37023	NC	Burke	3,308	3,181
37025	NC	Cabarrus	6,092	5,140
37027	NC	Caldwell	2,512	2,687
37033	NC	Caswell	730	693
37035	NC	Catawba	23,480	5,635
37037	NC	Chatham	5,915	3,005
37045	NC	Cleveland	3,439	5,798
37051	NC	Cumberland	9,091	9,332
37053	NC	Currituck	4,239	2,711
37057	NC	Davidson	6,408	5,317
37059	NC	Davie	1,716	1,583
37063	NC	Durham	8,309	9,444

FIPS	State	County	NOX(TPY)	VOC(TPY)
37065	NC	Edgecombe	2,253	2,289
37067	NC	Forsyth	10,794	10,271
37069	NC	Franklin	1,326	2,045
37071	NC	Gaston	17,147	8,389
37075	NC	Graham	212	351
37077	NC	Granville	2,349	3,740
37079	NC	Greene	701	682
37081	NC	Guilford	14,826	21,834
37085	NC	Harnett	3,167	3,315
37087	NC	Haywood	6,694	2,725
37089	NC	Henderson	3,085	4,139
37093	NC	Hoke	951	1,341
37097	NC	Iredell	8,433	8,224
37099	NC	Jackson	1,602	1,730
37101	NC	Johnston	7,437	6,689
37107	NC	Lenoir	2,128	3,478
37109	NC	Lincoln	1,946	2,402
37115	NC	Madison	911	861
37117	NC	Martin	7,232	1,131
37119	NC	Mecklenburg	26,493	28,808
37127	NC	Nash	4,647	5,866
37129	NC	New Hanover	17,258	7,342
37135	NC	Orange	5,295	3,913
37145	NC	Person	27,566	1,291
37147	NC	Pitt	4,101	5,362
37151	NC	Randolph	4,498	5,056
37157	NC	Rockingham	6,891	3,721
37159	NC	Rowan	7,838	5,894
37167	NC	Stanly	2,109	2,129
37169	NC	Stokes	21,539	1,531
37171	NC	Surry	3,264	3,193
37173	NC	Swain	580	1,490
37175	NC	Transylvania	958	2,971
37179	NC	Union	4,650	5,409
37183	NC	Wake	21,421	25,488
37197	NC	Yadkin	1,655	1,375
37199	NC	Yancey	804	828
38007	ND	Billings	1,826	421
38053	ND	Mc Kenzie	2,548	612
38055	ND	Mc Lean	13,318	1,059
38057	ND	Mercer	44,476	569
38065	ND	Oliver	24,027	246
38089	ND	Stark	3,365	1,268
38105	ND	Williams	5,633	1,179
39003	OH	Allen	7,788	5,329
39007	OH	Ashtabula	14,228	8,135
39011	OH	Auglaize	2,687	2,164
39013	OH	Belmont	9,825	3,880
39015	OH	Brown	2,403	1,744
39017	OH	Butler	16,538	10,024
39019	OH	Carroll	1,519	1,329
39021	OH	Champaign	1,567	1,735
39023	OH	Clark	5,544	5,102
39025	OH	Clermont	35,403	6,071
39027	OH	Clinton	2,732	2,113
39029	OH	Columbiana	4,441	4,409
39035	OH	Cuyahoga	49,165	49,648

FIPS	State	County	NOX(TPY)	VOC(TPY)
39037	OH	Darke	2,437	2,401
39041	OH	Delaware	6,804	5,832
39045	OH	Fairfield	5,764	4,415
39047	OH	Fayette	2,240	1,503
39049	OH	Franklin	37,577	36,689
39051	OH	Fulton	4,471	2,736
39055	OH	Geauga	3,070	4,815
39057	OH	Greene	8,532	5,250
39061	OH	Hamilton	48,326	31,486
39081	OH	Jefferson	45,828	3,039
39083	OH	Knox	2,168	2,802
39085	OH	Lake	22,702	10,874
39087	OH	Lawrence	3,465	2,768
39089	OH	Licking	7,774	6,345
39093	OH	Lorain	22,833	12,869
39095	OH	Lucas	31,318	16,799
39097	OH	Madison	3,125	2,772
39099	OH	Mahoning	10,141	8,781
39101	OH	Marion	3,593	2,244
39103	OH	Medina	6,897	6,519
39109	OH	Miami	3,981	4,145
39113	OH	Montgomery	21,298	17,137
39117	OH	Morrow	2,491	2,084
39123	OH	Ottawa	5,137	4,484
39129	OH	Pickaway	3,689	2,129
39133	OH	Portage	7,364	7,367
39135	OH	Preble	2,739	2,429
39141	OH	Ross	6,731	2,854
39143	OH	Sandusky	7,738	3,599
39151	OH	Stark	12,637	14,152
39153	OH	Summit	17,401	18,862
39155	OH	Trumbull	13,455	7,528
39159	OH	Union	2,401	2,315
39161	OH	Van Wert	1,644	1,292
39165	OH	Warren	7,370	6,156
39167	OH	Washington	24,330	3,596
39173	OH	Wood	9,619	5,272
40001	OK	Adair	1,168	833
40017	OK	Canadian	8,032	4,338
40021	OK	Cherokee	1,090	1,952
40027	OK	Cleveland	4,969	6,708
40031	OK	Comanche	6,310	4,371
40037	OK	Creek	5,385	3,272
40043	OK	Dewey	3,059	350
40047	OK	Garfield	7,734	1,913
40051	OK	Grady	8,804	2,517
40071	OK	Kay	6,542	2,347
40081	OK	Lincoln	3,381	1,678
40083	OK	Logan	4,145	1,481
40087	OK	Mc Clain	3,905	1,557
40097	OK	Mayes	19,969	2,612
40101	OK	Muskogee	24,731	3,015
40103	OK	Noble	16,755	1,059
40109	OK	Oklahoma	27,777	27,110
40111	OK	Okmulgee	3,006	1,607
40113	OK	Osage	5,799	2,337
40115	OK	Ottawa	2,153	2,023

FIPS	State	County	NOX(TPY)	VOC(TPY)
40117	OK	Pawnee	1,377	915
40121	OK	Pittsburg	6,536	2,352
40125	OK	Pottawatomie	3,063	2,779
40131	OK	Rogers	25,690	3,894
40135	OK	Sequoyah	4,293	2,595
40143	OK	Tulsa	31,587	26,128
40145	OK	Wagoner	3,339	2,915
40147	OK	Washington	2,106	1,639
41005	OR	Clackamas	12,077	16,254
41009	OR	Columbia	4,275	2,221
41019	OR	Douglas	7,677	7,795
41029	OR	Jackson	8,099	10,608
41039	OR	Lane	14,653	19,007
41047	OR	Marion	11,103	14,314
41051	OR	Multnomah	42,322	34,689
41053	OR	Polk	2,224	3,017
41065	OR	Wasco	2,907	2,800
41067	OR	Washington	12,438	21,452
41071	OR	Yamhill	4,603	3,972
42001	PA	Adams	3,389	3,495
42003	PA	Allegheny	57,115	28,969
42005	PA	Armstrong	20,333	2,566
42007	PA	Beaver	32,385	4,544
42011	PA	Berks	18,147	11,257
42013	PA	Blair	5,486	3,407
42017	PA	Bucks	16,321	16,169
42019	PA	Butler	7,562	5,985
42021	PA	Cambria	6,427	3,935
42025	PA	Carbon	3,188	3,449
42027	PA	Centre	7,431	4,457
42029	PA	Chester	16,701	13,089
42033	PA	Clearfield	11,404	3,461
42035	PA	Clinton	3,024	2,620
42039	PA	Crawford	4,971	4,432
42041	PA	Cumberland	13,722	6,987
42043	PA	Dauphin	11,504	9,488
42045	PA	Delaware	33,005	12,316
42049	PA	Erie	12,667	8,478
42051	PA	Fayette	4,516	4,315
42055	PA	Franklin	5,809	4,850
42059	PA	Greene	20,544	1,667
42063	PA	Indiana	43,100	3,479
42069	PA	Lackawanna	6,556	5,357
42071	PA	Lancaster	17,412	16,450
42073	PA	Lawrence	9,106	2,731
42075	PA	Lebanon	5,994	4,464
42077	PA	Lehigh	10,890	8,666
42079	PA	Luzerne	10,513	9,434
42081	PA	Lycoming	4,236	4,792
42085	PA	Mercer	5,803	4,403
42089	PA	Monroe	5,574	6,512
42091	PA	Montgomery	23,215	24,252
42093	PA	Montour	14,042	1,496
42095	PA	Northampton	23,850	6,549
42099	PA	Perry	2,838	1,994
42101	PA	Philadelphia	36,639	19,587
42103	PA	Pike	2,508	3,394

FIPS	State	County	NOX(TPY)	VOC(TPY)
42107	PA	Schuylkill	6,486	4,769
42111	PA	Somerset	4,940	4,281
42117	PA	Tioga	2,354	2,395
42125	PA	Washington	16,235	6,499
42129	PA	Westmoreland	16,323	9,970
42131	PA	Wyoming	1,888	2,106
42133	PA	York	33,697	9,848
44001	RI	Bristol	857	1,337
44003	RI	Kent	3,978	5,553
44005	RI	Newport	2,014	3,452
44007	RI	Providence	13,977	14,363
44009	RI	Washington	5,633	4,259
45001	SC	Abbeville	1,064	1,264
45003	SC	Aiken	7,329	6,353
45007	SC	Anderson	9,358	8,480
45015	SC	Berkeley	21,360	8,164
45017	SC	Calhoun	1,394	1,422
45019	SC	Charleston	35,383	16,024
45021	SC	Cherokee	3,377	2,682
45023	SC	Chester	4,065	2,100
45025	SC	Chesterfield	1,643	2,681
45029	SC	Colleton	7,838	3,147
45031	SC	Darlington	6,526	3,088
45035	SC	Dorchester	7,564	3,813
45037	SC	Edgefield	925	1,026
45039	SC	Fairfield	1,883	2,065
45041	SC	Florence	7,026	6,230
45045	SC	Greenville	13,847	16,041
45055	SC	Kershaw	2,422	3,118
45057	SC	Lancaster	3,212	2,940
45059	SC	Laurens	3,211	3,405
45063	SC	Lexington	12,622	11,487
45071	SC	Newberry	2,514	2,705
45073	SC	Oconee	2,808	4,361
45077	SC	Pickens	3,643	5,304
45079	SC	Richland	21,510	13,244
45081	SC	Saluda	803	1,087
45083	SC	Spartanburg	13,650	12,233
45087	SC	Union	1,536	1,326
45091	SC	York	8,393	7,573
46033	SD	Custer	1,118	583
46071	SD	Jackson	893	505
46083	SD	Lincoln	1,826	1,285
46087	SD	Mcok	967	471
46099	SD	Minnehaha	5,867	5,323
46103	SD	Pennington	9,560	3,910
46125	SD	Turner	685	407
47001	TN	Anderson	16,342	9,174
47009	TN	Blount	4,117	5,155
47011	TN	Bradley	4,475	4,888
47013	TN	Campbell	3,483	2,165
47015	TN	Cannon	357	514
47019	TN	Carter	1,474	2,139
47021	TN	Cheatham	2,284	1,955
47029	TN	Cocke	2,357	2,586
47037	TN	Davidson	28,579	24,112
47043	TN	Dickson	3,450	2,519

FIPS	State	County	NOX(TPY)	VOC(TPY)
47047	TN	Fayette	2,993	1,683
47057	TN	Grainger	794	1,478
47063	TN	Hamblen	5,086	4,198
47065	TN	Hamilton	17,447	18,113
47073	TN	Hawkins	15,664	3,350
47075	TN	Haywood	3,300	1,144
47081	TN	Hickman	2,517	1,114
47089	TN	Jefferson	3,882	3,447
47093	TN	Knox	19,852	19,374
47099	TN	Lawrence	1,257	1,739
47105	TN	Loudon	5,341	2,983
47107	TN	Mc Minn	9,893	3,122
47111	TN	Macon	1,629	698
47115	TN	Marion	3,575	2,222
47119	TN	Maury	5,132	3,896
47121	TN	Meigs	704	914
47125	TN	Montgomery	5,411	5,378
47139	TN	Polk	738	930
47141	TN	Putnam	4,412	3,180
47145	TN	Roane	18,289	3,228
47147	TN	Robertson	4,253	2,870
47149	TN	Rutherford	9,474	7,209
47153	TN	Sequatchie	509	524
47155	TN	Sevier	3,129	6,218
47157	TN	Shelby	50,255	32,469
47159	TN	Smith	2,003	1,236
47161	TN	Stewart	28,571	1,327
47163	TN	Sullivan	21,426	13,036
47165	TN	Sumner	13,726	4,211
47167	TN	Tipton	3,541	2,244
47169	TN	Trousdale	430	362
47171	TN	Unicoi	915	969
47173	TN	Union	848	1,121
47179	TN	Washington	4,136	4,911
47187	TN	Williamson	6,555	4,582
47189	TN	Wilson	5,097	3,932
48013	TX	Atascosa	6,170	1,781
48015	TX	Austin	3,209	1,487
48019	TX	Bandera	1,477	1,143
48021	TX	Bastrop	2,915	2,302
48029	TX	Bexar	56,084	42,317
48039	TX	Brazoria	38,604	8,035
48043	TX	Brewster	756	447
48055	TX	Caldwell	2,704	4,304
48057	TX	Calhoun	9,955	5,167
48061	TX	Cameron	12,239	13,324
48071	TX	Chambers	7,359	2,384
48073	TX	Cherokee	2,309	2,081
48085	TX	Collin	17,069	13,789
48091	TX	Comal	7,780	3,865
48097	TX	Cooke	2,973	4,391
48113	TX	Dallas	69,930	56,198
48121	TX	Denton	16,787	12,028
48139	TX	Ellis	18,573	4,263
48141	TX	El Paso	21,921	16,090
48147	TX	Fannin	1,149	1,241
48149	TX	Fayette	12,217	2,834

FIPS	State	County	NOX(TPY)	VOC(TPY)
48157	TX	Fort Bend	15,696	8,481
48161	TX	Freestone	17,850	3,699
48167	TX	Galveston	40,120	9,283
48175	TX	Goliad	5,817	1,230
48181	TX	Grayson	6,291	5,410
48183	TX	Gregg	10,412	4,735
48187	TX	Guadalupe	6,558	3,455
48199	TX	Hardin	2,972	2,480
48201	TX	Harris	171,697	96,358
48203	TX	Harrison	16,043	2,980
48209	TX	Hays	6,281	3,341
48213	TX	Henderson	4,850	4,103
48215	TX	Hidalgo	24,122	20,921
48221	TX	Hood	2,140	1,529
48231	TX	Hunt	3,614	3,193
48245	TX	Jefferson	56,084	15,183
48251	TX	Johnson	7,068	3,676
48257	TX	Kaufman	4,933	3,481
48259	TX	Kendall	1,076	1,384
48291	TX	Liberty	4,736	3,268
48293	TX	Limestone	14,704	2,242
48309	TX	Mc Lennan	11,784	6,876
48321	TX	Matagorda	12,595	5,609
48325	TX	Medina	2,566	1,659
48331	TX	Milam	14,744	2,454
48339	TX	Montgomery	11,575	8,787
48349	TX	Navarro	4,971	3,517
48355	TX	Nueces	46,509	17,401
48361	TX	Orange	13,114	3,059
48363	TX	Palo Pinto	3,004	3,442
48365	TX	Panola	13,545	7,585
48367	TX	Parker	5,560	4,445
48397	TX	Rockwall	1,905	1,698
48401	TX	Rusk	22,953	1,913
48407	TX	San Jacinto	1,245	1,309
48409	TX	San Patricio	6,250	3,437
48423	TX	Smith	9,809	6,763
48425	TX	Somervell	271	522
48439	TX	Tarrant	51,540	34,372
48449	TX	Titus	26,543	1,876
48453	TX	Travis	25,760	25,510
48459	TX	Upshur	4,829	1,304
48469	TX	Victoria	9,547	4,062
48471	TX	Walker	3,254	2,276
48473	TX	Waller	2,375	1,724
48491	TX	Williamson	8,306	7,272
48493	TX	Wilson	1,176	971
48497	TX	Wise	11,060	7,066
49003	UT	Box Elder	6,533	5,235
49005	UT	Cache	3,236	3,513
49007	UT	Carbon	5,832	1,278
49011	UT	Davis	9,584	7,449
49013	UT	Duchesne	2,123	1,173
49015	UT	Emery	30,385	1,196
49021	UT	Iron	4,155	2,310
49023	UT	Juab	4,467	1,256
49027	UT	Millard	29,923	2,052

FIPS	State	County	NOX(TPY)	VOC(TPY)
49029	UT	Morgan	3,356	764
49035	UT	Salt Lake	32,265	25,327
49037	UT	San Juan	1,381	1,369
49043	UT	Summit	5,073	2,165
49045	UT	Tooele	6,310	3,474
49047	UT	Uintah	13,363	1,382
49049	UT	Utah	12,054	11,877
49051	UT	Wasatch	1,051	1,037
49053	UT	Washington	4,787	4,471
49057	UT	Weber	5,895	5,923
50003	VT	Bennington	1,116	1,871
50005	VT	Caledonia	1,352	1,601
50007	VT	Chittenden	4,759	6,256
50009	VT	Essex	370	1,616
50011	VT	Franklin	1,529	2,247
50013	VT	Grand Isle	284	2,280
50017	VT	Orange	1,206	1,724
50027	VT	Windsor	2,500	3,061
51003	VA	Albemarle	4,838	3,549
51007	VA	Amelia	778	654
51013	VA	Arlington	5,235	3,276
51023	VA	Botetourt	6,049	2,050
51033	VA	Caroline	2,620	1,816
51036	VA	Charles City	697	695
51041	VA	Chesterfield	20,939	8,823
51043	VA	Clarke	1,034	862
51045	VA	Craig	120	231
51049	VA	Cumberland	297	355
51053	VA	Dinwiddie	2,440	1,376
51059	VA	Fairfax	22,429	20,709
51061	VA	Fauquier	4,577	3,535
51065	VA	Fluvanna	4,326	736
51067	VA	Franklin	2,178	2,174
51069	VA	Frederick	4,969	5,160
51071	VA	Giles	9,214	1,716
51073	VA	Gloucester	1,280	2,113
51075	VA	Goochland	2,161	1,423
51079	VA	Greene	722	550
51083	VA	Halifax	11,197	2,163
51085	VA	Hanover	6,071	4,178
51087	VA	Henrico	11,079	7,525
51093	VA	Isle Of Wight	5,478	1,715
51095	VA	James City	2,851	1,972
51097	VA	King And Queen	436	605
51101	VA	King William	3,381	644
51107	VA	Loudoun	6,901	5,975
51109	VA	Louisa	1,885	1,594
51113	VA	Madison	698	797
51115	VA	Mathews	450	866
51121	VA	Montgomery	5,660	3,319
51127	VA	New Kent	1,857	1,392
51131	VA	Northampton	6,039	3,911
51139	VA	Page	1,059	1,195
51143	VA	Pittsylvania	3,976	2,638
51145	VA	Powhatan	938	949
51149	VA	Prince George	2,189	1,751
51153	VA	Prince William	10,224	6,860

FIPS	State	County	NOX(TPY)	VOC(TPY)
51161	VA	Roanoke	5,153	6,688
51163	VA	Rockbridge	2,714	1,885
51165	VA	Rockingham	4,598	3,380
51167	VA	Russell	8,706	1,094
51169	VA	Scott	1,076	994
51177	VA	Spotsylvania	4,223	3,212
51179	VA	Stafford	4,308	2,594
51181	VA	Surry	552	598
51183	VA	Sussex	1,603	900
51187	VA	Warren	1,612	1,823
51191	VA	Washington	3,244	2,553
51197	VA	Wythe	2,867	1,962
51199	VA	York	10,158	2,462
51510	VA	Alexandria	5,701	1,877
51520	VA	Bristol	1,187	881
51540	VA	Charlottesville	1,412	1,478
51550	VA	Chesapeake	13,284	5,795
51570	VA	Colonial Height	623	620
51590	VA	Danville	2,585	1,489
51600	VA	Fairfax	369	599
51610	VA	Falls Church	189	252
51630	VA	Fredericksburg	1,163	1,344
51650	VA	Hampton	4,001	3,696
51660	VA	Harrisonburg	1,768	1,266
51670	VA	Hopewell	12,875	1,470
51683	VA	Manassas	1,016	650
51685	VA	Manassas Park	284	212
51700	VA	Newport News	11,162	4,274
51710	VA	Norfolk	18,926	5,593
51730	VA	Petersburg	1,406	1,500
51735	VA	Poquoson	292	359
51740	VA	Portsmouth	7,430	2,085
51760	VA	Richmond	8,113	6,926
51770	VA	Roanoke	3,443	3,440
51775	VA	Salem	1,213	896
51800	VA	Suffolk	2,962	2,690
51810	VA	Virginia Beach	11,216	9,169
51830	VA	Williamsburg	369	311
51840	VA	Winchester	1,202	828
53009	WA	Clallam	17,760	4,072
53011	WA	Clark	13,180	15,784
53015	WA	Cowlitz	10,030	6,268
53029	WA	Island	4,740	3,060
53031	WA	Jefferson	4,774	2,097
53033	WA	King	76,818	76,825
53035	WA	Kitsap	6,901	8,030
53041	WA	Lewis	21,481	4,893
53045	WA	Mason	1,603	2,807
53053	WA	Pierce	32,155	27,917
53057	WA	Skagit	9,741	6,434
53059	WA	Skamania	1,515	1,185
53061	WA	Snohomish	22,697	24,226
53063	WA	Spokane	16,380	19,477
53067	WA	Thurston	8,289	10,769
53073	WA	Whatcom	11,417	8,587
54003	WV	Berkeley	7,828	3,053
54005	WV	Boone	1,322	1,001

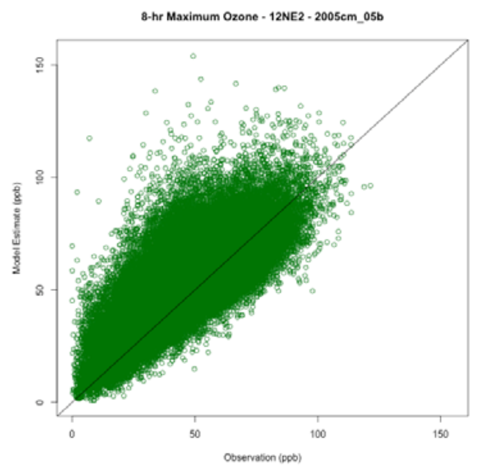
FIPS	State	County	NOX(TPY)	VOC(TPY)
54009	WV	Brooke	2,074	1,025
54011	WV	Cabell	5,239	3,778
54015	WV	Clay	325	394
54023	WV	Grant	24,312	876
54025	WV	Greenbrier	2,136	2,068
54027	WV	Hampshire	831	2,096
54029	WV	Hancock	3,845	1,053
54033	WV	Harrison	23,291	2,593
54035	WV	Jackson	2,876	1,620
54037	WV	Jefferson	2,709	1,671
54039	WV	Kanawha	23,091	9,410
54043	WV	Lincoln	576	647
54049	WV	Marion	2,616	1,802
54051	WV	Marshall	36,079	1,091
54053	WV	Mason	24,204	1,293
54061	WV	Monongalia	12,593	3,495
54065	WV	Morgan	1,054	540
54069	WV	Ohio	2,970	1,955
54073	WV	Pleasants	14,121	567
54077	WV	Preston	3,990	1,332
54079	WV	Putnam	37,461	1,923
54099	WV	Wayne	6,732	1,534
54105	WV	Wirt	142	416
54107	WV	Wood	5,331	3,553
55003	WI	Ashland	3,014	1,907
55009	WI	Brown	24,023	11,499
55015	WI	Calumet	2,117	2,091
55021	WI	Columbia	11,509	4,369
55025	WI	Dane	18,896	19,321
55027	WI	Dodge	3,861	4,000
55029	WI	Door	1,877	3,419
55037	WI	Florence	240	3,028
55039	WI	Fond Du Lac	4,441	4,218
55041	WI	Forest	754	2,422
55049	WI	Iowa	1,021	1,723
55055	WI	Jefferson	4,770	4,416
55059	WI	Kenosha	16,167	4,795
55061	WI	Kewaunee	941	1,697
55071	WI	Manitowoc	5,691	3,898
55073	WI	Marathon	15,895	6,622
55079	WI	Milwaukee	35,493	29,271
55083	WI	Oconto	1,538	2,920
55085	WI	Oneida	3,456	5,008
55087	WI	Outagamie	9,650	7,119
55089	WI	Ozaukee	4,485	3,354
55093	WI	Pierce	2,219	1,940
55101	WI	Racine	5,415	7,402
55105	WI	Rock	6,982	6,873
55109	WI	St Croix	4,609	3,538
55111	WI	Sauk	2,843	3,863
55117	WI	Sheboygan	10,860	5,508
55123	WI	Vernon	5,807	2,048
55125	WI	Vilas	1,087	5,909
55127	WI	Walworth	4,219	5,159
55131	WI	Washington	4,127	4,765
55133	WI	Waukesha	12,087	15,487
56001	WY	Albany	5,719	1,872

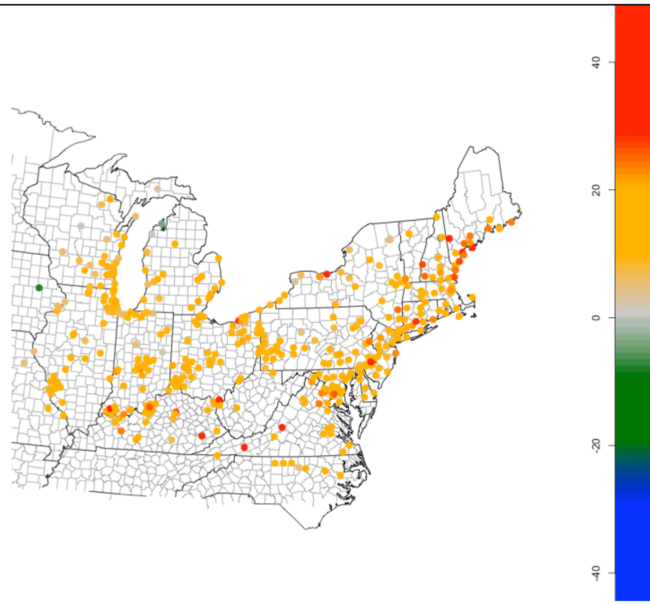
FIPS	State	County	NOX(TPY)	VOC(TPY)
56005	WY	Campbell	14,563	2,207
56007	WY	Carbon	9,317	1,761
56009	WY	Converse	21,371	1,216
56011	WY	Crook	2,399	1,083
56019	WY	Johnson	4,182	1,379
56021	WY	Laramie	8,541	3,934
56023	WY	Lincoln	22,856	1,481
56025	WY	Natrona	7,766	3,389
56027	WY	Niobrara	1,972	976
56031	WY	Platte	23,234	1,153
56033	WY	Sheridan	3,405	1,800
56035	WY	Sublette	9,893	1,098
56037	WY	Sweetwater	59,386	3,513
56039	WY	Teton	1,083	2,165
56041	WY	Uinta	5,678	1,345
56045	WY	Weston	3,918	666

APPENDIX B

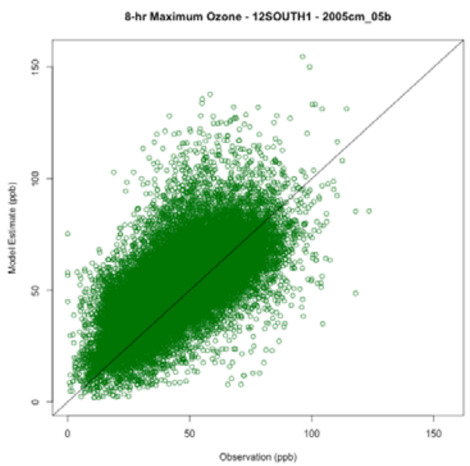
MODEL PERFORMANCE

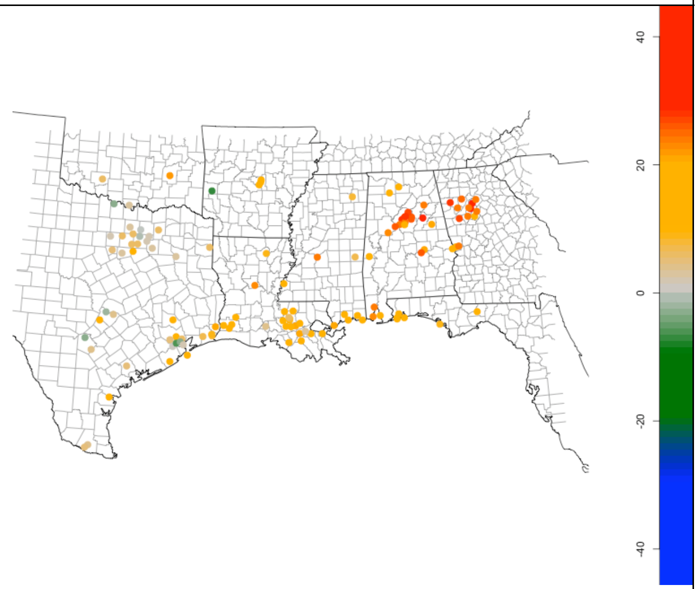
Northeast Domain (12NE2)



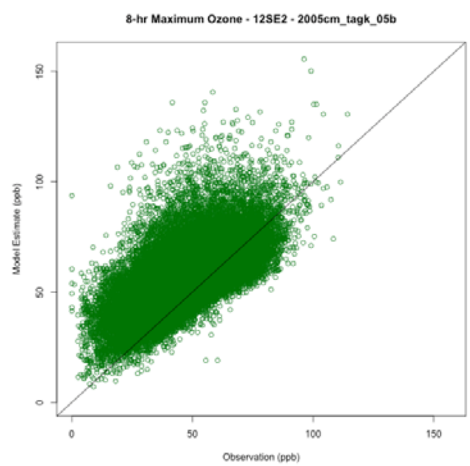


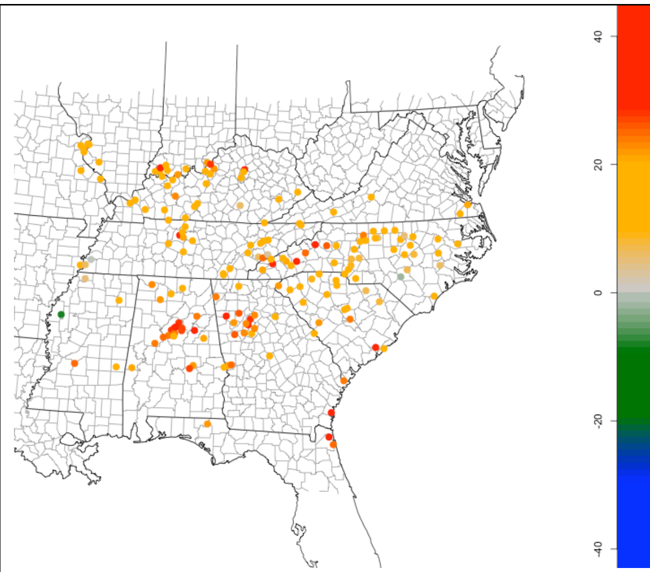
South domain (12SOUTH1)

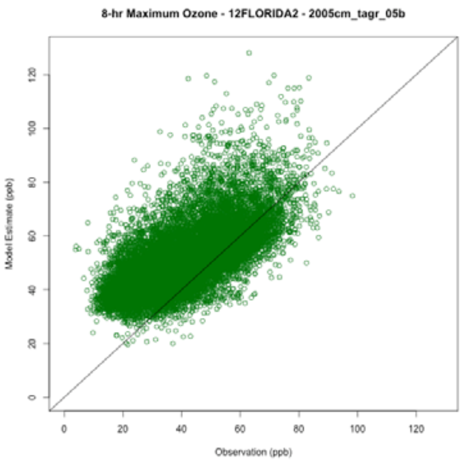
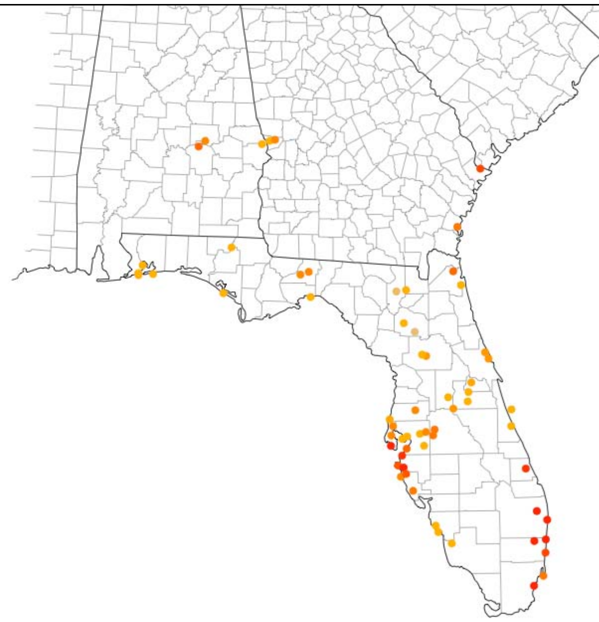




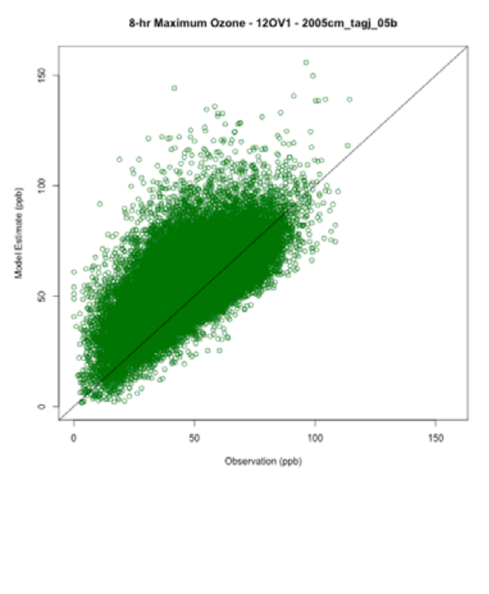
Southeast domain (12SE2)

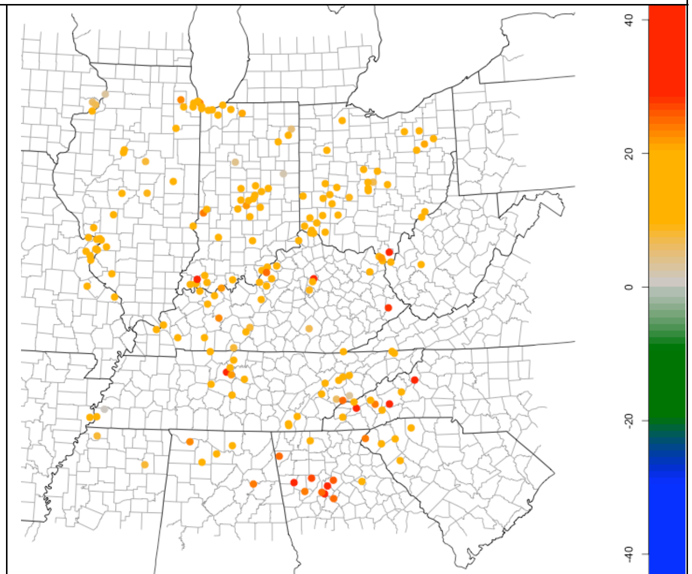


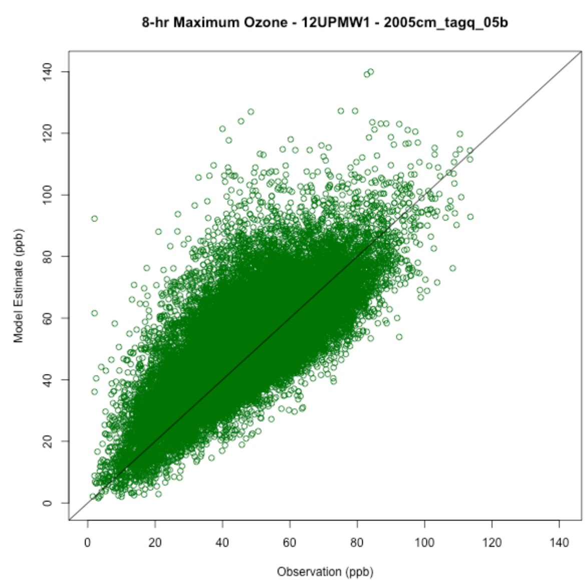
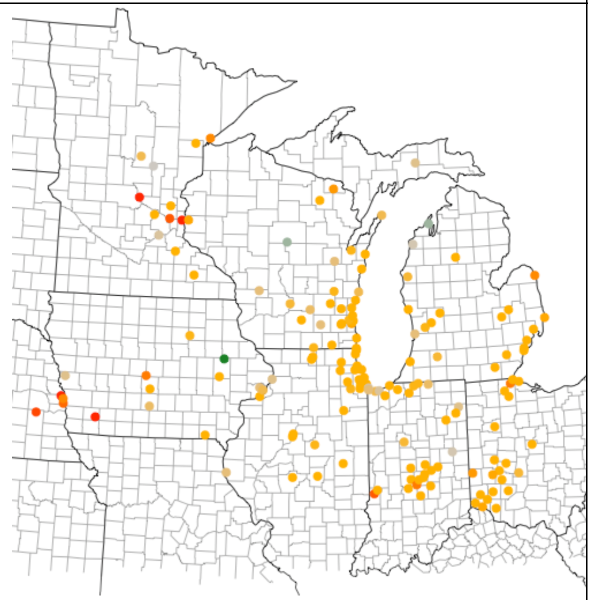


Florida domain (12FLORIDA2)	
	

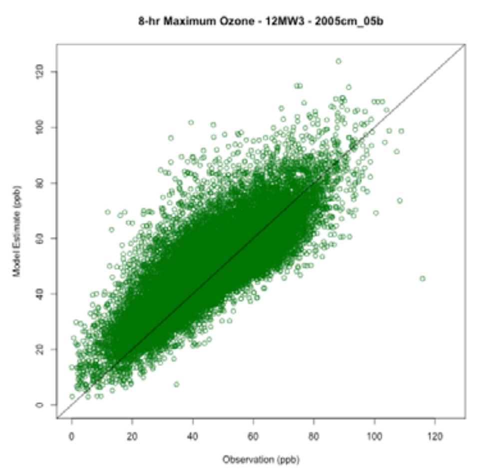
Ohio Valley (12OV1)

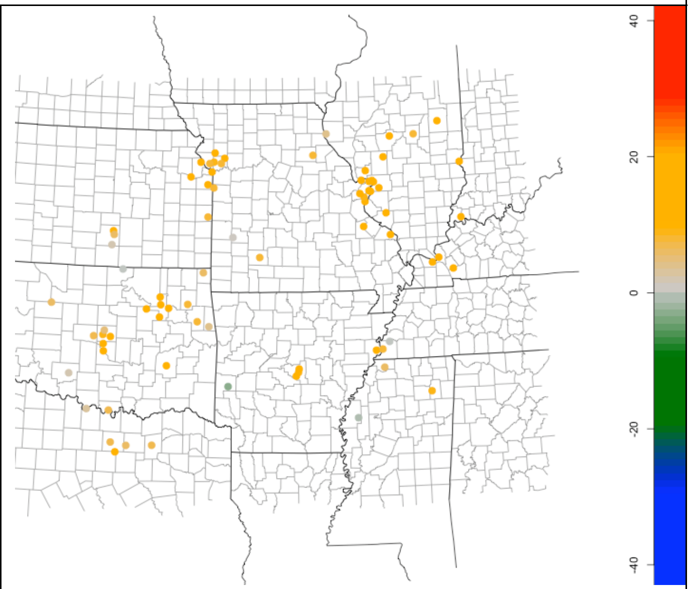


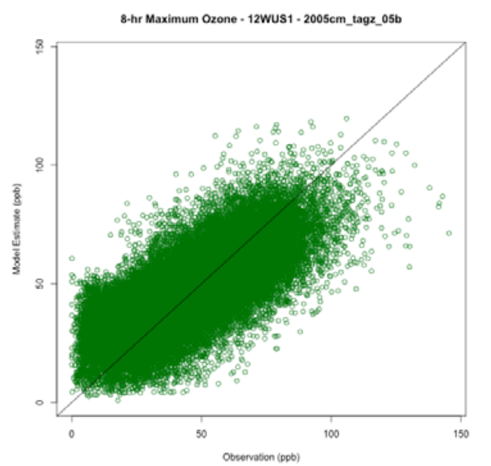
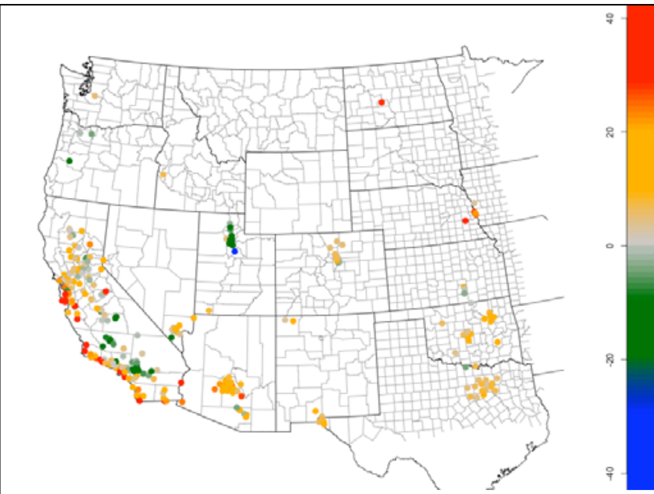


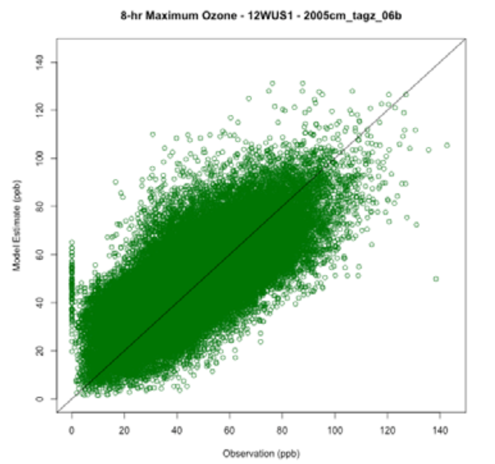
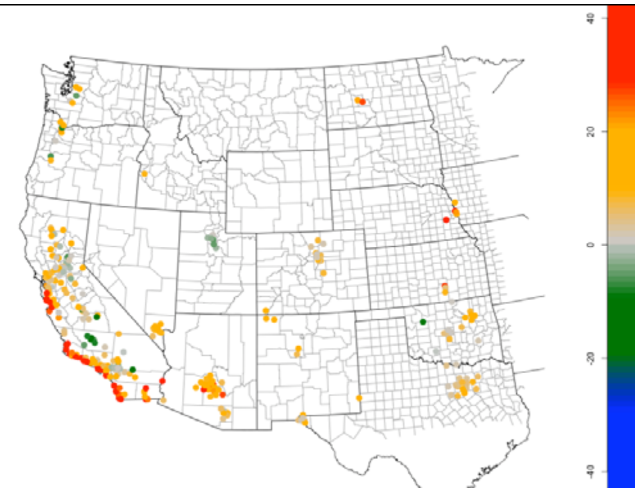
Midwest domain (12MW3)	
	

Midwest domain (12MW3)





Western domain (12WUS1) – 2005 simulation; 12WUS1 includes both 12WUS2 and 12SEATTLE1	
	

Western domain (12WUS1) – 2006 simulation; 12WUS1 includes both 12WUS2 and 12SEATTLE1	
	

United States Environmental Protection Agency	Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/R-10-005 November 2010