APPENDIX U

Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document – October 2018 Update

Ozone Transport Commission

2nd Version October 18, 2018

1st Version November 15, 2016

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Preamble

This report is intended to document committee work completed by the Ozone Transport Commission (OTC) and the Mid-Atlantic Northeastern Visibility Union (MANE-VU) using a photochemical modeling platform based on the year 2011. The modeling exercises documented within demonstrate acceptable performance of the platform as required for State Implementation Plans (SIPs), specifically attainment demonstrations owed by New Jersey, New York and Connecticut for the 2008 Ozone National Ambient Air Quality Standard (NAAQS) and the 2028 Regional Haze SIPs. Documented exercises are committee products and are primarily base case runs, with the exception of the MANE-VU control case representing the MANE-VU “Ask.” Unless otherwise indicated, modeling exercises rely on generally accepted conservative assumptions regarding emissions inventories and ozone photochemistry.

This document does not contain every modeling exercise completed by the OTC, MANE-VU, and member states using the OTC/MANE-VU 2011 based modeling platform. Some exploratory screening analyses, modeling performed outside of committee efforts, and work performed in Maryland using a “best science” platform are not included in this documentation. Member states performing additional SIP relevant modeling intend to document those efforts in their individual SIP supporting documentation.

This document will be updated as needed to support state SIP submittals in the future.

Section 1. Introduction

Purpose

The purpose of this report is to technically document the SIP quality modeling efforts undertaken by OTC and MANE-VU for use in regional ozone and haze planning and for inclusion in any member's SIP submittal for either demonstrating ozone attainment or for showing reasonable further progress for haze.

EPA's guidance on modeling for ozone, $PM_{2.5}$, and regional haze includes recommendations for documentation of the modeling platform that should be included in SIP submissions. EPA recommends that the following be included in the technical documentation:

- *Overview of the air quality issue being considered including historical background*
- *List of the planned participants in the analysis and their expected roles*
- *Schedule for completion of key steps in the analysis and final documentation*
- *Description of the conceptual model for the area*
- *Description of periods to be modeled, how they comport with the conceptual model, and why they are sufficient*
- *Models to be used in the demonstration and why they are appropriate*
- *Description of model inputs and their expected sources (e.g., emissions, met, etc.)*
- *Description of the domain to be modeled (expanse and resolution)*
- *Process for evaluating base year model performance (meteorology, emissions, and air quality) and demonstrating that the model is an appropriate tool for the intended use*
- *Description of the future years to be modeled and how projection inputs will be prepared*
- *Description of the attainment test procedures and (if known) planned weight of evidence*
- *Expected diagnostic or supplemental analyses needed to develop weight of evidence analyses*
- *Commitment to specific deliverables fully documenting the completed analysis* (US EPA 2014a).

Document Outline

The remainder of this section will review the items listed above that are not addressed in other sections of the document.

- Section 2 is an assessment of the meteorological model used in the platform in order to determine if many of the mechanisms for predicting ozone formation and regional haze are fundamentally sound.
- Section 3 assesses whether an upgrade to a more recent biogenic emissions model is warranted.
- Section 4 describes the methods used in processing emissions for use in the SIP quality modeling platform for the base year.
- Section 5 describes the setup of the photochemical model.
- Section 6 assesses the model performance for ozone, $PM_{2.5}$, and regional haze in the base year.
- Section 7 describes a methodology for improving performance using nested gridding and analyzed the results from implementing the methodology.
- Section 8 describes the methods used in processing emissions for use in the SIP quality modeling platform for the future years.
- Section 9 describes the development of the emissions inventory for the MANE-VU Regional Haze control case.

- Section 10 describes the method for calculating future projected ozone design values and instances where the default method may not be warranted.
- Section 11 describes the results from future year ozone modeling projections that relied on CMAQ.
- Section 12 describes the results from future year visibility modeling projections.
- Section 13 describes the results from future year ozone modeling projections that relied on CAMx and includes discussion of source apportionment.
- Section 14 describes the methodology for conducting screening analysis using only ozone episodes, and evidence for its reasonability.

History

Clean Air Act

The Clean Air Act was designed to control air pollution in the United States, is administered by the EPA, and its implementing regulations are codified at 40 C.F.R. Subchapter C, Parts 50-97.

The history of national air pollution legislation began with the 1955 Air Pollution Control Act, but the first piece of legislation to control air pollution was the Clean Air Act of 1963. The Air Quality Act of 1967 continued the processes of developing legislation to reduce air pollution, but it was in 1970 that the Clean Air Act in its modern form was adopted. Amendments were added in 1977 and 1990, which further expanded the control of emissions.

One of the programs to come out of the 1970 Clean Air Act Amendments was the creation of NAAQS , thresholds of air pollution considered to be the upper limit of healthy air that are based on the best scientific evidence available that must be met nationally (*Clean Air Act Amendments of 1970*). NAAQS were developed for several pollutants, including ground-level ozone.

The 1970 Clean Air Act also introduced the SIP, which is intended to demonstrate how an area that is not complying with the NAAQS will meet that standard through state programs that become federally enforceable following approval of the SIP. The 1990 amendments expanded the requirements for SIPs, in particular in regards to ground-level ozone (*Clean Air Act Amendments of 1990*).

The 1977 amendments saw the introduction of provisions to reduce visibility impairment at areas termed “Class I” areas, which are significant national parks and other natural areas (*Clean Air Act Amendments of 1977*). This program was further strengthened in 1990 setting requirements for regional haze SIPs, including the setting of RPGs.

The following is an overview of some of the more recent NAAQS that are applicable to this document, as well as an overview of the regional haze program.

1997 8-hour Ozone NAAQS

In 1997 the primary and secondary NAAQS were set to 0.08 ppm for the three year average of the 4th highest 8-hour average ozone concentration, which due to rounding conventions is equivalent to 84 ppb (US EPA 1997). This standard was revoked as of April 6, 2015 and will no longer be considered in this document (US EPA 2015a).

2008 8-hour Ozone NAAQS

In 2008 the primary and secondary NAAQS were set to 0.075 ppm for the three year average of the 4th highest 8-hour average ozone concentration, which is equivalent to 75 ppb (US EPA 2008). After some delays in timeframes outlined in the Clean Air Act, areas were designated for the 2008 NAAQS as seen in Figure 1-1 and Table 1-1 (US EPA 2012).

Following the designation of an area as nonattainment for a criteria pollutant, the Clean Air Act requires submission of a SIP to demonstrate how that area will meet the pollutant standard (NAAQS) in the time period established by the Act. Areas designated as marginal require no air quality modeling (US EPA 2015a). One nonattainment area, Baltimore, MD, was designated moderate, and was expected to require the submission of an attainment demonstration using photochemical modeling, with the attainment demonstration being based on 2018 design values (US EPA 2012). However, following the DC Circuit decision in NRDC vs. EPA on December 23, 2014, the attainment deadline was advanced from December 31, 2018 to July 20, 2018, so that the states now needed to demonstrate attainment using 2017 design values (DC Circuit 2014).

The New York City, NY-NJ-CT nonattainment area, which was originally designated marginal in 2012 was reclassified to moderate effective June 3, 2016 given its continued monitoring of nonattainment (US EPA 2016).

2015 8-hour Ozone NAAQS

In 2015 the primary and secondary NAAQS were set to 0.070 ppm for the three year average of the 4th highest 8-hour average ozone concentration, which is equivalent to 70 ppb (US EPA 2015b). Areas were designated for the 2015 NAAQS as seen in Figure 1-2 and Table 1-1 (US EPA 2018).

Table 1-1: Nonattainment areas and classifications in the OTR for 2008 and 2015 Ozone NAAQS

Area Name	State	No. Counties	2008 NAAQS		2015 NAAQS	
			2012 DVs (ppm)	Classification	2016 DVs (ppm)	Classification
Baltimore, MD	MD	6	0.089	Moderate	0.073	Marginal
Greater Connecticut, CT	CT	5	0.079	Marginal	0.074	Marginal
NYC-N. NJ-Long Island, NY-NJ-CT	CT	3	0.084	Marginal	0.083	Moderate
	NJ	12	0.084	Marginal	0.083	Moderate
	NY	9	0.084	Marginal	0.083	Moderate
Allentown-Bethlehem-Easton, PA	PA	3	0.076	Marginal	n/a	
Dukes County, MA	MA	1	0.076	Marginal	n/a	
Jamestown, NY	NY	1	0.077	Marginal	n/a	
Lancaster, PA	PA	1	0.077	Marginal	n/a	
Phila.-Wilm.-Atl. City, PA-NJ-MD-DE	NJ	9	0.083	Marginal	0.077	Marginal
	DE	1	0.083	Marginal	0.077	Marginal
	MD	1	0.083	Marginal	0.077	Marginal
	PA	5	0.083	Marginal	0.077	Marginal
Pittsburgh-Beaver Valley, PA	PA	7	0.080	Marginal	n/a	
Reading, PA	PA	1	0.077	Marginal	n/a	
Seaford, DE	DE	1	0.077	Marginal	n/a	
Washington, DC-MD-VA	DC	1	0.081	Marginal	0.072	Marginal
	MD	5	0.081	Marginal	0.072	Marginal
	VA	9	0.081	Marginal	0.072	Marginal

Figure 1-1: 2008 Ozone NAAQS Designations in the OTR as originally designated in 2012

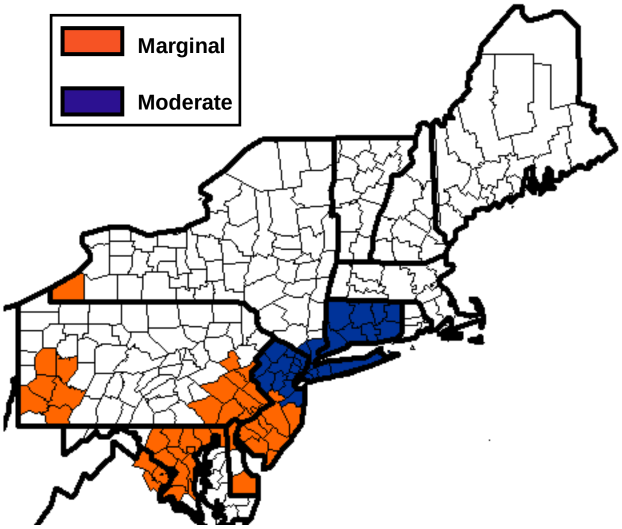
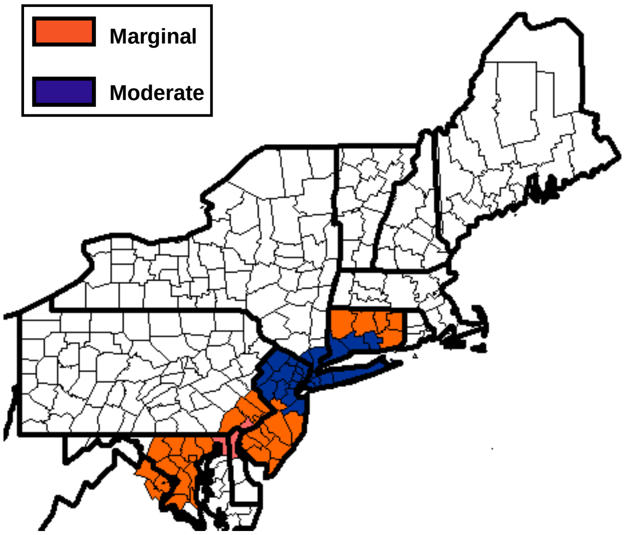


Figure 1-2: 2015 Ozone NAAQS Designations in the OTR as originally designated in 2016



Regional Haze

EPA's regional haze regulations require regional haze SIPs to be updated for the second planning period by July 31, 2018. This SIP requires modeling to demonstrate reasonable further progress towards background visibility conditions at Class I areas and to set 2028 RPGs using estimates of visibility following controls anticipated as the result of the consultation process between the states and FLMs. The controls will be included in each state's long-term strategy and deemed to be reasonable following a four-factor analysis. Effective January 10, 2017, the deadline for haze SIP submittals was extended to July 31, 2021 (US EPA 2017), however MANE-VU states have agreed to meet the 2018 deadline in order to take advantage of the current 2011 modeling platform (which is the subject of this TSD). A list of the Class I areas in MANE-VU is in Table 1-2.

Table 1-2: List of Class I Areas in MANE-VU (40 CFR 81)

State	Area Name	Acreage	FLM	Monitored?
ME	Acadia National Park	37,503	NPS	Yes
	Moosehorn Wilderness Area	7,501	FWS	Yes
NH	Great Gulf Wilderness Area	5,552	FS	Yes
	Presidential Range-Dry River Wilderness Area	20,000	FS	No
NJ	Brigantine Wilderness Area	6,603	FWS	Yes
VT	Lye Brook Wilderness	12,430	FS	Yes
ME & NB, CA	Roosevelt Campobello International Park	2,721	Chairman, RCIP Commission	No

Geographic Definitions

Throughout this document, several geographic definitions will be used that are based on the boundaries of Regional Planning Organizations (RPOs). Table 1-3 shows the RPOs and their member states, though in some cases figures are limited to what is within the OTC modeling domain.

Table 1-3: List of states in geographic areas based on RPOs

OTC	MANE-VU	SESARM	LADCO	CenSARA
Connecticut	Connecticut	Alabama	Illinois	Arkansas
District of Columbia	District of Columbia	Florida	Indiana	Iowa
Delaware	Delaware	Georgia	Michigan	Kansas
Massachusetts	Massachusetts	Kentucky	Minnesota	Louisiana
Maryland	Maryland	Mississippi	Ohio	Missouri
Maine	Maine	North Carolina	Wisconsin	Nebraska
New Hampshire	New Hampshire	South Carolina		Oklahoma
New Jersey	New Jersey	Tennessee		Texas
New York	New York	Virginia		
Pennsylvania	Pennsylvania	West Virginia		
Rhode Island	Rhode Island			
Virginia	Vermont			
Vermont				

Participants

OTC Air Directors

OTC Air Directors serve as overseers of the work products developed by the OTC Modeling Committee. The OTC Air Directors oversee the design of ozone control strategies for the OTR and make decisions surrounding modeling of the air quality impacts of policies. The Air Directors review all OTC SIP quality modeling platform documentation before it is finalized. The state members of the OTC Modeling Committee keep Air Directors informed of the development of the OTC SIP quality modeling platform.

OTC Modeling Committee

The OTC Modeling Committee members serve as first tier reviewers of the work products developed for the SIP quality modeling platform. The OTC Modeling Committee approves technical approaches used in the modeling platform, reviews results, and approves products for review by the Air Directors. Since members of the three EPA regions are members of the OTC Modeling Committee, they provide insights into any issues that may occur involving the acceptability of the OTC SIP quality modeling platform in a SIP so that problems can be corrected at the regional level.

OTC Modeling Planning Group

The OTC Modeling Planning Group is made up of members of the modeling centers and the OTC Modeling Committee leadership. The workgroup reviews technical decisions to bring recommendations on approaches to the OTC Modeling Committee.

OTC Technical Support Document Workgroup

The OTC TSD Workgroup is responsible for compiling drafts of the technical documentation for review by the OTC Modeling Planning Group.

OTC Modeling Centers

The OTC Modeling Centers are the state staff and academics that perform modeling and conduct analyses of modeling results. They include NYSDEC, NJDEP, VADEQ, UMD via MDE, and ORC at Rutgers via NJDEP.

MANE-VU Technical Support Committee

The MANE-VU Technical Support Committee members serve as first tier reviewers of the work products developed for the SIP quality modeling platform with a focus on regional haze issues. Since members of the three EPA regions and the FLMs are members of the TSC, they provide insights into any issues that may occur involving the acceptability of the OTC SIP quality modeling platform in a SIP so that problems can be corrected at the regional level.

MARAMA Emission Inventory Leads Committee

The MARAMA Emission Inventory Leads Committee is made up of state staff that makes technical recommendations involving the multi-pollutant emissions inventory and assures the inventories.

Schedule

Table 1-4 provides an overview schedule intended as a guideline for finalization of the modeling in the document, though given that the SIP quality modeling platform is being used for planning that runs on different timelines some revisions may occur.

Table 1-4: Multi-pollutant modeling schedule using 2011 platform

PROCESS POINT	TIMEFRAME
2011 Alpha 2 Inventory for Regional Haze	June 2015
2011 Base Case Modeling for Regional Haze	August 2015
2018/2028 Alpha 2 Inventory for Regional Haze	December 2015
2011 Base Case Modeling for Ozone	June 2016
Draft TSD (excepting Future results)	August 2016
2017 Beta Inventory for Ozone	August 2016
OTC Stakeholder Meeting	September 2016
2028 Future Case Modeling for Regional Haze	October 2016
2017 Future Case Modeling for Ozone	October 2016
Final TSD (1st Revision)	November 2016
NYC and Greater CT Attainment SIP Due (US EPA 2016a)	January 1, 2017
2011 Gamma Inventory and Modeling	October 2017
2011 Gamma 2 Inventory and Modeling	December 2017
2023 Gamma 2 Inventory and Contribution Modeling	December 2017
2020 Gamma Inventory and Modeling	Early 2018
2028 Gamma Inventory (Base/Control) and Modeling	Early 2018
Good Neighbor SIPs Due for 2015 NAAQS	October 1, 2018
Serious 2008 NAAQS Bump Up Attainment SIPs Due	TBD

Conceptual Model

Ozone

The interaction of meteorology, chemistry, and topography lead to a complex process of ozone formation and transport. Ozone episodes in the OTR often begin with an area of high pressure setting up over the southeast United States. As the air moves around the area of high pressure in a clockwise direction, pollution is transported from the Midwest into the OTR. This pollution is a result of power plants, other stationary sources and mobile sources emissions. This summer time high-pressure system can stay in place for days or weeks. This scenario allows for stagnant conditions at the surface in the OTR to form, and in-turn the transported pollution mixes with the local pollution in the late morning hours as the nocturnal inversion breaks down. With this high pressures system in place the air mass, which is characterized by generally sunny and warm conditions, exacerbates ozone concentrations. This meteorological setup promotes ozone formation, as sunlight, warm temperatures and ozone precursors (NOx and VOCs) interact chemically to form ozone. In addition, ozone precursors and ozone are transported into the OTR during the late night and or early morning hours from the areas to the southeast of the OTR by way of the nocturnal low level jet (NLLJ), a fast moving river of air that resides approximately 1,000 meters above the surface. All this local and transported polluted air can in some instances accumulate along the coastal OTR areas as the air is kept in place due to bay and sea breezes

Some ozone is natural, or transported internationally, leading to ozone that is not considered relatable to human activity. This US Background ozone in the Eastern United States is in the range of 30 to 35 ppb though it can be as high as 50 ppb in the Intermountain West (US EPA 2014b).

Another complexity involves the nonlinear relationship between NO_X and VOC concentrations and ozone formation. Areas such as the majority of the landscape in the OTR that have extensive forests that produce high levels of isoprene and other VOCs during the summer month achieve the best ozone reduction through reductions in regional NO_X, but dense urban areas such as New York City that lack natural VOC production can be VOC limited, and in some cases NO_X reductions increase ozone levels due to less NO_X being available to destroy already formed ozone through titration.

To address the complexity of ozone formation and transport into the OTR that occurs, the modeling exercise will be based on the conceptual model as described in "The Nature of the Ozone Air Quality Problem in the Ozone Transport Region: A Conceptual Description (Hudson et al. October 2006)."

Visibility

Under natural atmospheric conditions, the view in the eastern United States would extend about 60 to 80 miles, whereas in the western United States this can extend from 110 to 115 miles (Malm May 1999). Current visibility conditions result in less distance that can be viewed due to impacts of anthropogenic pollution. However, the current conditions in the Eastern US are remarkably improved from the early 2000's when the regional haze program began.

Anthropogenic visibility impairment in the eastern United States is largely due to the presence of light-absorbing and light-scattering PM of which the impact can be estimated through the IMPROVE algorithm. This impact is sensitive to the chemical composition of the particles involved, and also depends strongly on ambient relative humidity. Secondary particles (e.g., ammonium sulfate, ammonium nitrate), which form in the atmosphere through chemical reactions, tend to fall within a size range that is most effective at scattering visible light (NARSTO February 2003). A great level of complexity occurs when evaluating the conceptual model of fine $PM_{2.5}$. We will be basing the modeling exercise on the conceptual model found in "The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description (Downs et al. 10 August 2010)."

Base Year Selection

Analyses of monitored data and meteorological data concluded that for the OTR, 2010, 2011 and 2012 are the candidate base years to model for future ozone NAAQS planning and 2011 is the best base year for future Regional Haze and annual $PM_{2.5}$ NAAQS planning. Transport patterns of 2011 ozone events in the OTR confirm that using 2011 would be appropriate. When other factors were considered including availability of a national emission inventory, research data availability, and decisions on base years by nearby RPOs and EPA more weight was given to using 2011 as a base year. As a result, 2011 was determined to be the best candidate base year for this multi-pollutant platform (Ozone, Regional Haze and $PM_{2.5}$). More details can be found in the document "Future Modeling Platform Base Year Determination" produced by the MANE-VU Technical Support Committee (MANE-VU Technical Support Committee 9 October 2013).

Future Year Selection

Since a 2018 inventory was needed for Baltimore to demonstrate attainment, OTC developed inventories for that year. However, following the DC Circuit decision discussed earlier, developing a 2017 inventory became necessary. As such the 2018 inventory was no longer needed as an ozone modeling inventory.

To conserve resources through multi-pollutant planning, the region also developed a 2028 inventory required for the submission of regional haze SIPs.

As a result we began our modeling platform using 2018 and 2028 future years, and later migrated 2018 to 2017.

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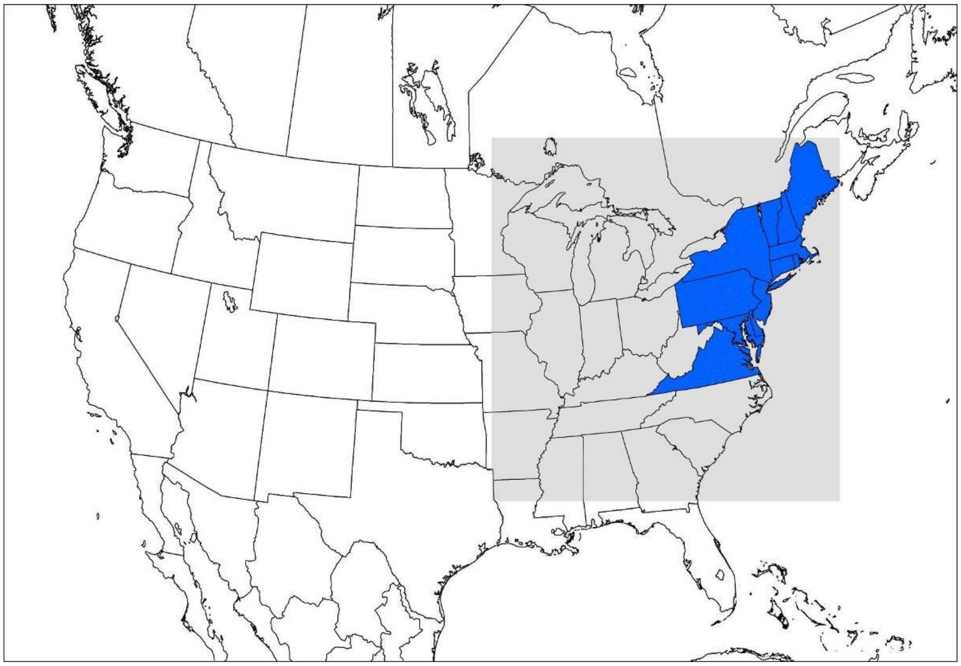
Section 2. Evaluation of Meteorological Modeling using WRF

Overview

The OTC Modeling Committee extracted the meteorological data from EPA's 2011 photochemical modeling of the CONUS. That modeling used WRF v.3.4 to develop meteorological data. The OTC modeling used only a subset of the EPA modeling domain as illustrated in Figure 2-1 (US EPA 2014). The meteorological data for the OTC domain was extracted from the EPA CONUS domain modeling using MCIP (Otte and Pleim 2010). The OTC retained the same 12 km square grid size and 35 layer column depth as was used by EPA.

Figure 2-1: Extent of EPA CONUS domain with the OTR Modeling Domain in grey and the OTR states in blue



Parameters

Table 2-1 shows the parameters used by WRF v. 3.4 and Table 2-2 shows more details of the layers.

Table 2-1: Parameters used by WRF v. 3.4

VARIABLE	PARAMETER
Horizontal Resolution	36 &12-km
Vertical Resolution	35 layers up to 50 mb
Initialization	NAM 12-km
Land Use Data	NLCD 2006
Land Surface Model	Pleim-Xiu
Planetary Boundary Layer	ACM2
Cumulus Parameterization	Kain-Fritsch (trigger 2)
Microphysics	Morrison 2-moment
Radiation	RRTMG (LW & SW)
Nudging	T, Q and winds above PBL

Table 2-2: Layers used in WRF v 3.4

Layer #	Sigma P	Pressure (mb)	Approximate Height (m AGL)
35	0.00	50.00	17,556
34	0.05	97.50	14,780
33	0.10	145.00	12,822
32	0.15	192.50	11,282
31	0.20	240.00	10,002
30	0.25	287.50	8,901
29	0.30	335.00	7,932
28	0.35	382.50	7,064
27	0.40	430.00	6,275
26	0.45	477.50	5,553
25	0.50	525.00	4,885
24	0.55	572.50	4,264
23	0.60	620.00	3,683
22	0.65	667.50	3,136
21	0.70	715.00	2,619
20	0.74	753.00	2,226
19	0.77	781.50	1,941
18	0.80	810.00	1,665
17	0.82	829.00	1,485
16	0.84	848.00	1,308
15	0.86	867.00	1,134
14	0.88	886.00	964
13	0.90	905.00	797
12	0.91	914.50	714
11	0.92	924.00	632
10	0.93	933.50	551
9	0.94	943.00	470
8	0.95	952.50	390
7	0.96	962.00	311
6	0.97	971.50	232
5	0.98	981.00	154
4	0.99	985.75	115
3	0.99	990.50	77
2	1.00	995.25	38
1	1.00	997.63	19

Assessment

Certain critical parameters of the model were assessed for their ability to characterize actual conditions occurring over the base year. EPA provides the following guidance concerning evaluation of meteorological models in section 2.6.3.

> *While the air quality models used in attainment demonstrations have consistently been subjected to a rigorous performance assessment, in many cases the meteorological inputs to these models have received less rigorous evaluation, even though this component of the modeling is quite complex and has the potential to substantially affect air quality predictions (Tesche, 2002). EPA recommends that air agencies devote appropriate efforts to the process of evaluating the meteorological inputs to the air quality model as we believe good meteorological model performance will yield more confidence in predictions from the air quality model. One of the objectives of this evaluation should be to determine if the meteorological model output fields represent a reasonable approximation of the actual meteorology that occurred during the modeling period. Further, because it will never be possible to exactly simulate the actual meteorological fields at all points in space/time, a second objective of the evaluation should be to identify and quantify the existing biases and errors in the meteorological predictions in order to allow for a downstream assessment of how the air quality*

> *modeling results are affected by issues associated with the meteorological data. To address both objectives, it will be necessary to complete both an operational evaluation (i.e., quantitative, statistical, and graphical comparisons) as well as a more phenomenological assessment (i.e., generally qualitative comparisons of observed features vs. their depiction in the model data).*

For our assessment, 2011 WRF modeled data were compared to data for the year. For several factors we relied on EPA's own assessments, while looking more specifically at data in the OTR. We also expanded on EPA's work by looking at the ways WRF modeled temperature, mixing ratio, and the PBL height. Details of the assessment follow.

Model Performance Analyzed by EPA

Wind Speed

EPA found that WRF v. 3.4 slightly over-predicts wind speed in the Eastern United States with the bias being highest during the midday hours. EPA also found that the error in wind displacement tends to be about 5 km, which, being less than the size of a grid cell, should be negligible in affecting position of air masses temporally and spatially (Eyth and Vukovich 2015).

Precipitation comparison

EPA found that WRF v. 3.4 performs adequately in terms of spatial pattern recognition and predicting the amount of precipitation throughout the year when compared to the PRISM climate data. The results compared well in the OTR, including the forecast of a high band of coastal precipitation that occurred during the month of August, although the precipitation in March and September appears to be respectively overestimated and underestimated throughout the OTR (US EPA 2014).

Solar Radiation

Photosynthetically-activated radiation is important in estimating isoprene, which plays an important role in the formation of ozone and secondary organic aerosols in the heavily forested OTR (Carlton and Baker 2011). EPA evaluated the performance of solar radiation using SURFRAD and ISIS network monitors and found little bias during the fall and winter months, but growing bias during the spring with a peak in the summer, "though the spread in over-predictions tends to be less than 100 W/m^2 on average, with a median bias close to zero (US EPA 2014)." WRF also tends to over-predict from about 7 AM to Noon, while under-predicting from 1 PM to 5 PM. Additionally, EPA stated that "radiation performance evaluation also gives an indirect assessment of how well the model captures cloud formation during daylight hours" so cloud cover would be expected to be under-predicted in the morning and over-predicted in the late afternoon.

Model Performance Analyzed by OTC

Temperature and Mixing Ratio

NYSDEC conducted the review of temperature and mixing ratios for the OTC Modeling Committee. NYSDEC relied on RTMA, a component of the NWS Analysis of Record project and produced by NOAA/NCEP.

RTMA provides a high-spatial and temporal resolution analysis/assimilation system for near-surface weather conditions. RTMA produces hourly analyses at 5 km and 2.5 km grid resolution for the CONUS NDFD grid. The parameters in RTMA include pressure height and air pressure at the surface, air temperature, dew point temperature, and specific humidity at 2m, U- and V-components of wind momentum at 10m, along with cloud cover and precipitation. Observational data from the RTMA 2.5 (http://www.nco.ncep.noaa.gov/pmb/products/rtma/#RTMA2p5) is used in this evaluation and interpolated to the 12km WRF grid.

NYSDEC compared the modeled WRF temperature and mixing ratio values with the real world data from RTMA. NYSDEC found that WRF temperature had a low bias in winter months and a high bias in summer months (Figure 2-2) and the WRF mixing ratio had a high bias in winter months and a low bias in summer months (Figure 2-3). When NYSDEC examined the absolute error, they found that WRF had a low absolute error for temperature and a large absolute error for mixing ratios in the summer (Figure 2-4 and Figure 2-5). Additionally, several low correlation coefficients were observed in July and August on grid cells along the coastline (Figure 2-6 and Figure 2-7).

NYSDEC next compared the diurnal modeled WRF temperature and mixing ratio values during the months of February (winter) and August (summer). In February WRF temperature bias was minimal at all times of day (Figure 2-8) and the mixing ratio was biased high throughout the 24 hours (Figure 2-9). In August WRF temperature bias was high in the morning hours and low in the afternoon (Figure 2-10). Mixing ratio for August was biased low in the evening (Figure 2-11). In February the temperature mean absolute error varied between and 1 and 1.5 ^{o}F (Figure 2-12). The mean absolute error for the mixing ratio in February was highest in the evenings with means around 5 g/kg (Figure 2-13). In August the temperature mean absolute error was typically around 1 ^{o}F at all times of the day (Figure 2-14) and was highest in the evening, but had a mean absolute error for the mixing rations that was closer to 1.5 g/kg (Figure 2-15). Correlation coefficients were much closer to 1 in February for both temperature and mixing ratio than in August, when in some cases during the early evening hours zero correlation was found (Figure 2-16-Figure 2-19).

Figure 2-2: Monthly average Bias (RMTA – WRF) for Temp.[1]

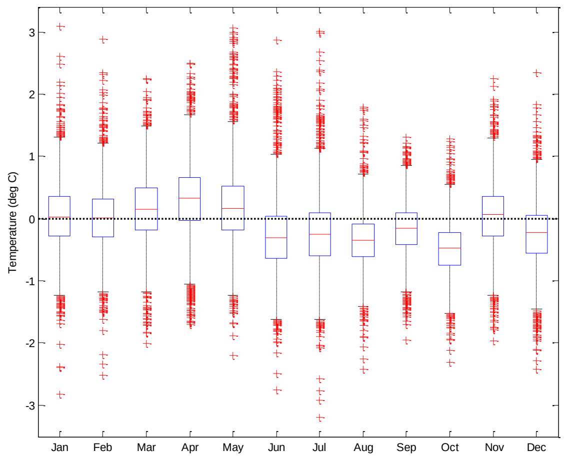


Figure 2-3: Monthly average Bias (RMTA – WRF) for Mixing Ratio[1]

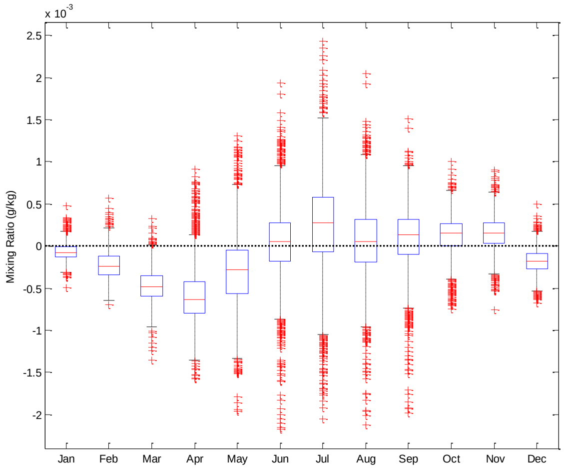


Figure 2-4: Monthly average absolute error for temp.[1]

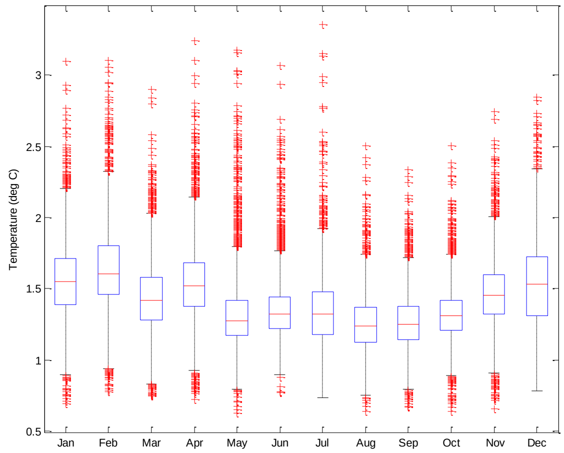


Figure 2-5: Monthly average absolute error for mixing ratio[1]

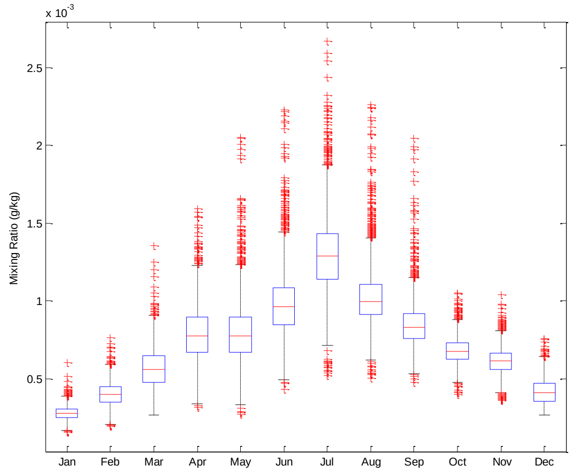


Figure 2-6: Correlation coefficients for temp.[1]

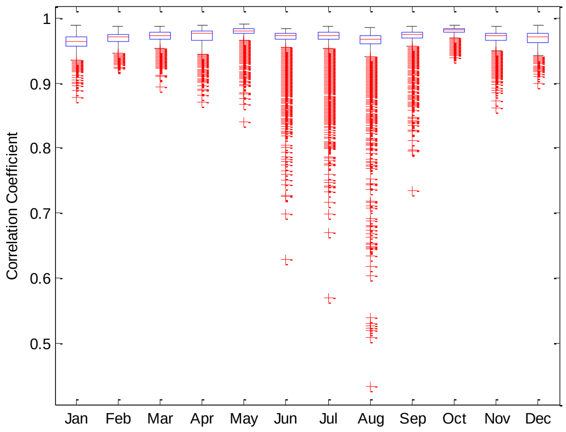
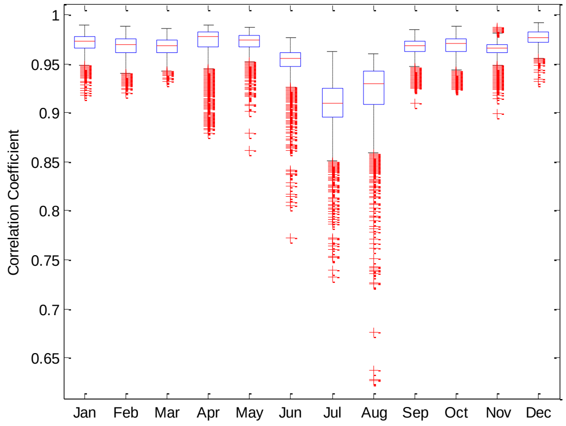


Figure 2-7: Correlation coefficients for mixing ratio[1]



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[1] Box plots demarcations are for the 25th, 50th and 75th percentiles, and red crosses are values greater than 2 standard deviations.

Figure 2-8: Diurnal BIAS (RMTA – WRF) for temp. in Feb.[1]

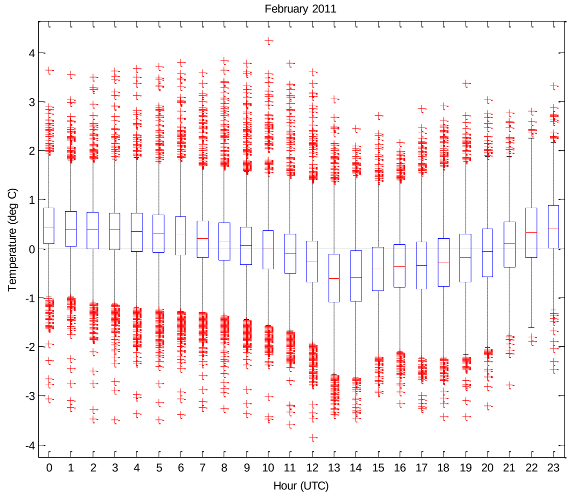


Figure 2-9: Diurnal BIAS (RMTA – WRF) for mixing ratio in Feb.[1]

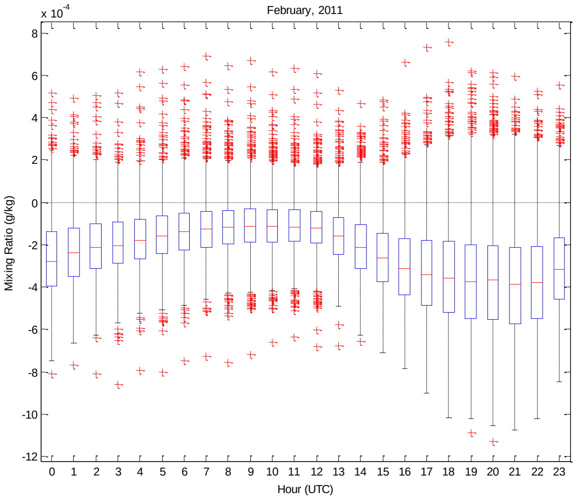


Figure 2-10: Diurnal BIAS (RMTA – WRF) for temp. in Aug.[1]

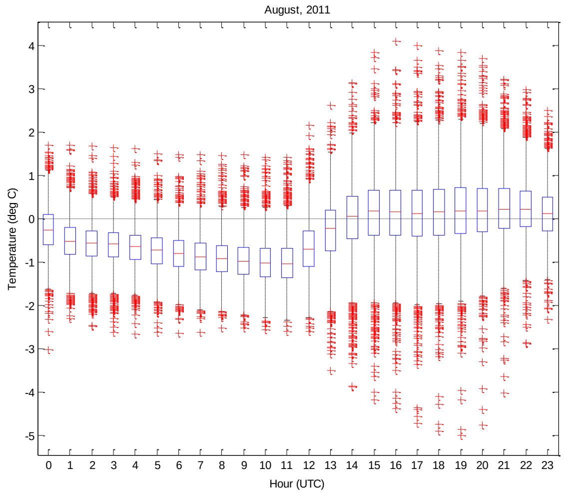


Figure 2-11: Diurnal BIAS (RMTA – WRF) mixing ratio in Aug.[1]

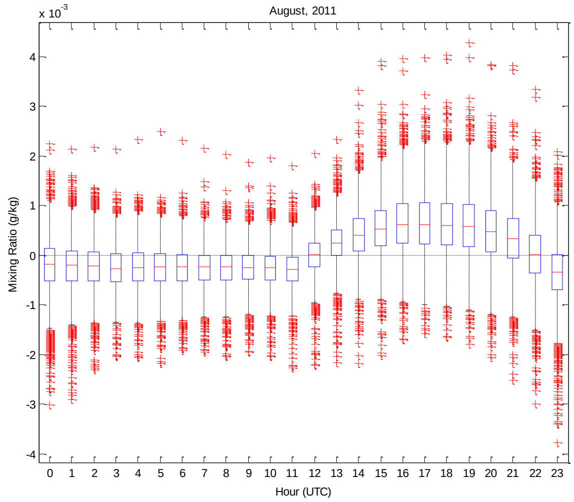


Figure 2-12: Diurnal absolute error for temp. in Feb.[1]

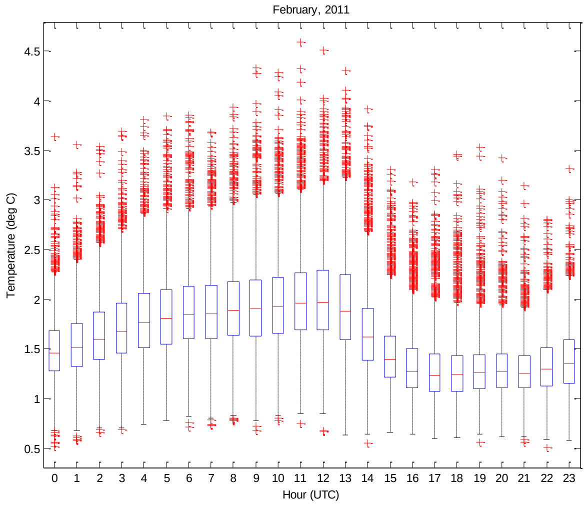


Figure 2-13: Diurnal absolute error for mixing ratio in Feb.[1]

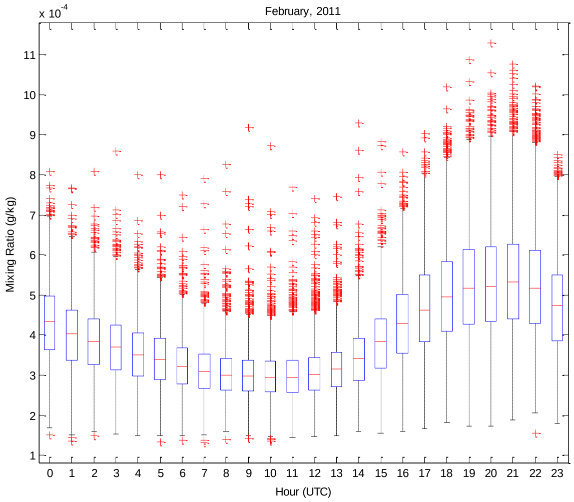


Figure 2-14: Diurnal absolute error for temp. in Aug.[1]

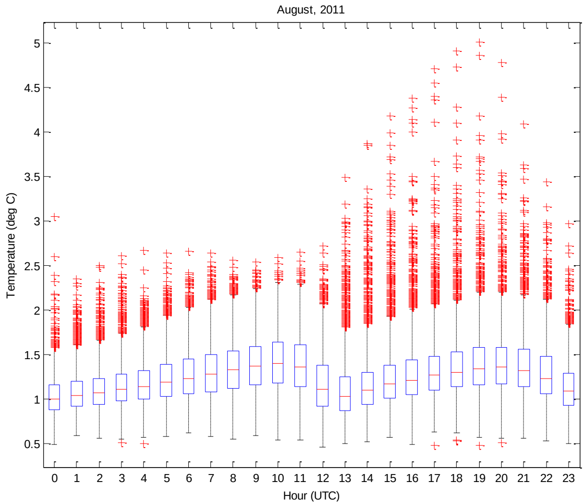


Figure 2-15: Diurnal absolute error for mixing ratio in Aug.[1]

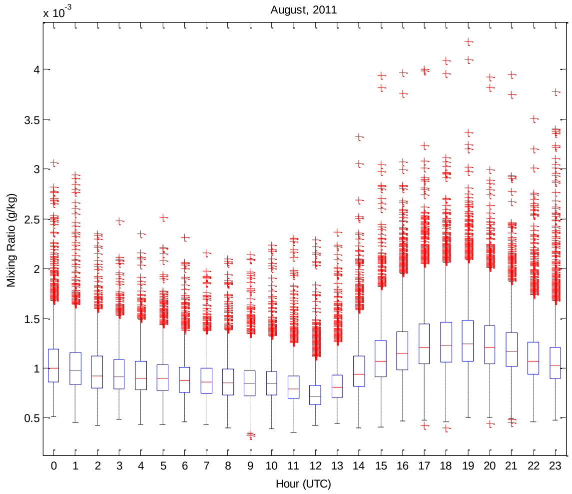


Figure 2-16: Diurnal correlation coefficient for temp. in Feb.[1]

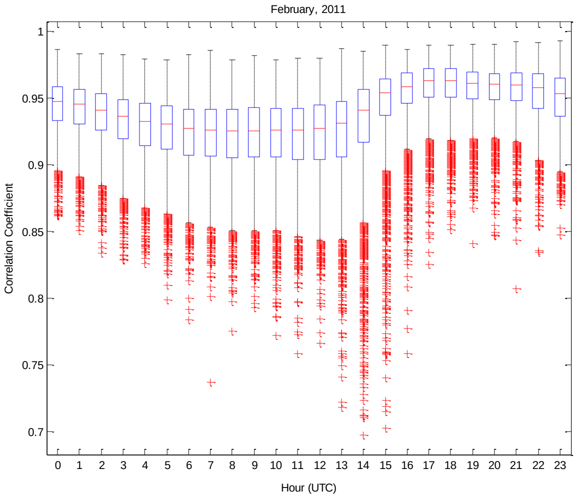


Figure 2-17: Diurnal correlation coefficient for mixing ratio in Feb.[1]

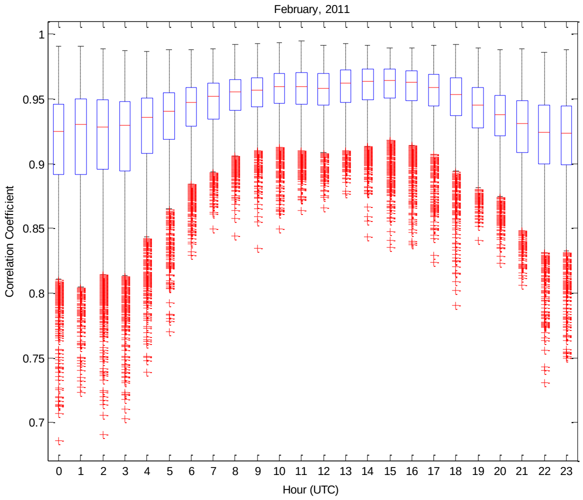


Figure 2-18: Diurnal correlation coefficient for temp. in Aug.[1]

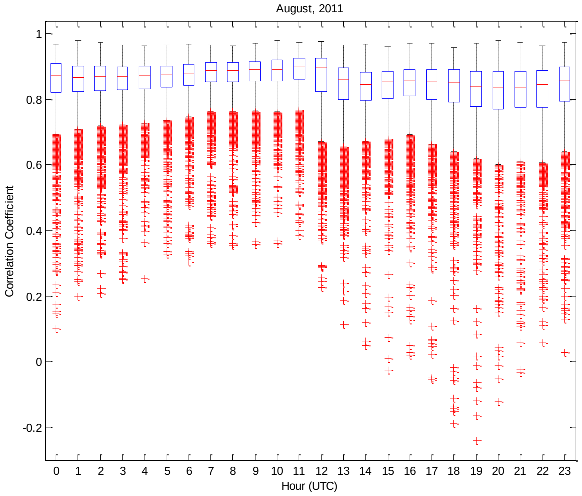
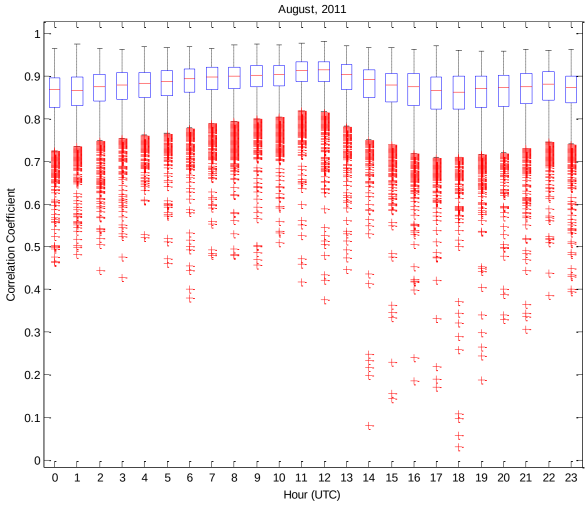


Figure 2-19: Diurnal correlation coefficient for mixing ratio in Au.[1]



Planetary Boundary Layer

The CALIPSO satellite began operation in 2006 with three instruments, the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), the Imaging Infrared Radiometer (IIR), and the Wide Field Camera (WFC). Its repetition cycle is 16 days. CALIOP is a two-wavelength polarization sensitive Lidar (532 nm and 1064 nm). At 532 nm, it has horizontal and vertical resolutions of 333 m and 30 m (up to 8 km), respectively. The CALIPSO aerosol layer product provides data for PBL height covering vast areas on a regular basis.

The NYSDEC derived PBL-height from the CALIPSO Level-1B-attenuated aerosol backscatter profile using the wavelet transform technique, which assumes a structure from the backscatter profile at the height of the air column where the scattering has a strong increase just under the PBL and a strong negative gradient of the backscatter. They averaged the raw signal over 40km to improve signal-to-noise-ratio, and discarded low-cloud data. Then they extracted and refined the CALIPSO Level-2 aerosol layer-top in the lower atmosphere for PBL-height by choosing:

1. single aerosol-layer top, while rejecting multiple layers data;
2. the layer with the base ≤0.3 km above sea level and the top ≤6.0 km above sea level, while rejecting aloft aerosol layers;
3. the layer with the depth > 0.10 km, while rejecting the potentially noisy outlier layers;
4. the layer with cloud-aerosol-discrimination score: -100 ≤ CAD ≤ -20, while rejecting clouds and low-confidence feature layers; and
5. only daytime data to avoid detection of nighttime residual layers.

Figure 2-20: Seasonal Frequency of CALIPSO PBL height

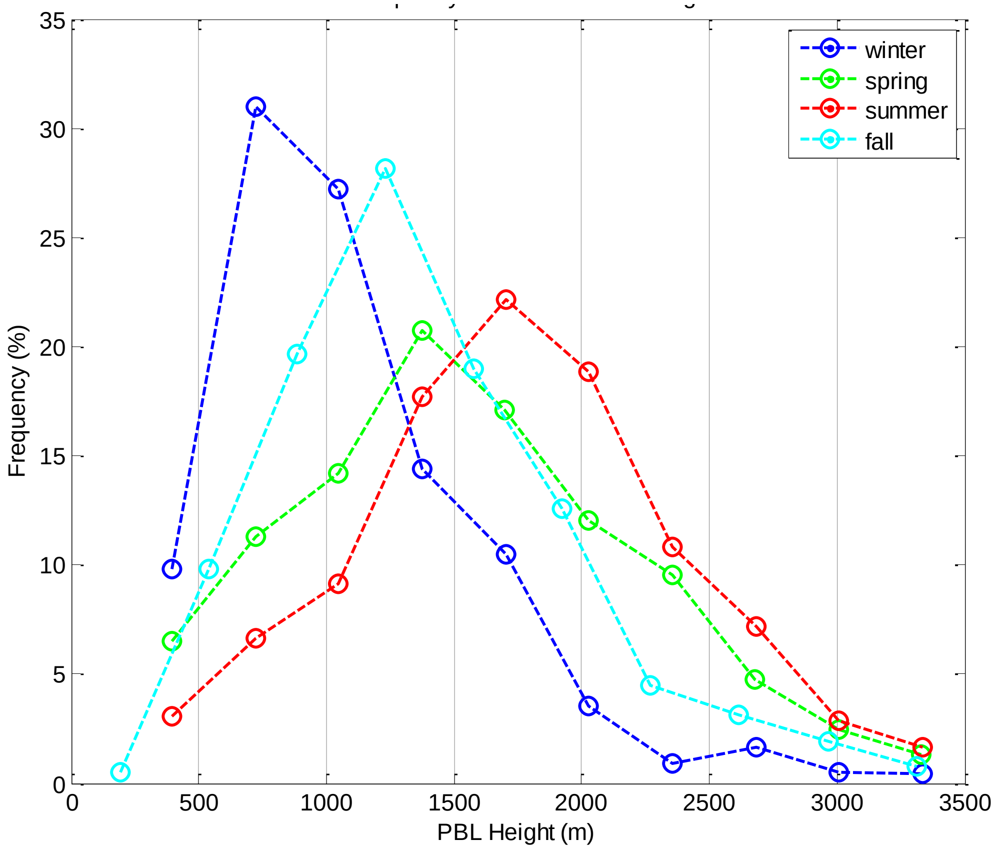


Figure 2-20 showed the frequency distribution of CALIPSO PBL height. The PBL is, on average, lower during the winter at 500 – 1000 meter range and highest during the summer at 1500 – 2000 meter range. WRF underestimated daytime PBL height compared to CALIPSO particularly over water and more so during the summer (Figure 2-21 and Figure 2-22). WRF PBL height showed significantly larger land-water contrast than the CALIPSO data, with the underestimation being larger in summer than in winter (Figure 2-23 - Figure 2-26).

Figure 2-21: CALIPSO to WRF (PBL height ratio) Winter (D/J/F) 2011 (blue and red dots over land and water respectively)

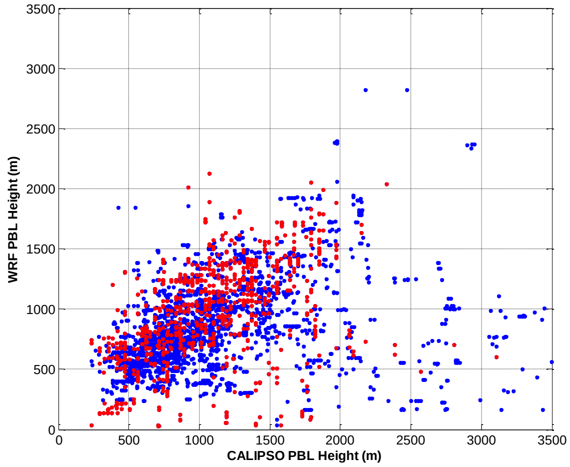


Figure 2-22 CALIPSO to WRF (PBL height ratio) Summer (J/J/A) 2011 (blue and red dots over land and water respectively)

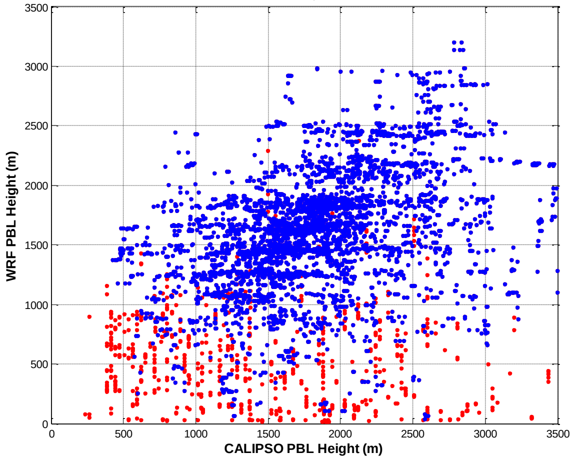


Figure 2-23: CALIPSO to WRF (PBL height ratio) Winter (D/J/F) 2011

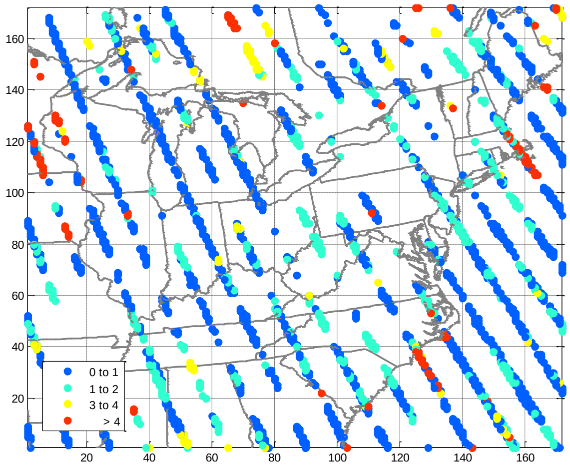


Figure 2-24: CALIPSO to WRF (PBL height ratio) Summer (J/J/A) 2011

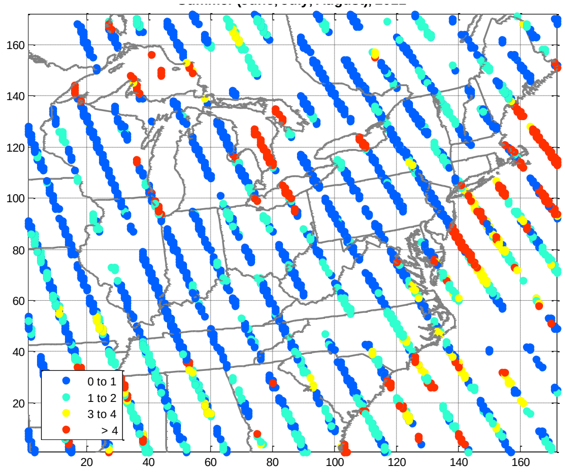


Figure 2-25: CALIPSO to WRF (PBL height ratio) Spring (M/A/M) 2011

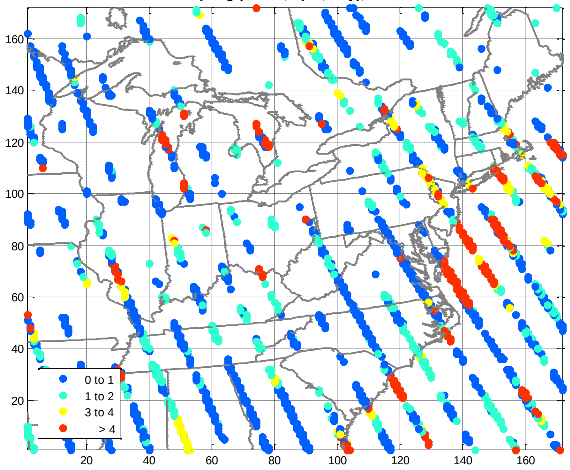
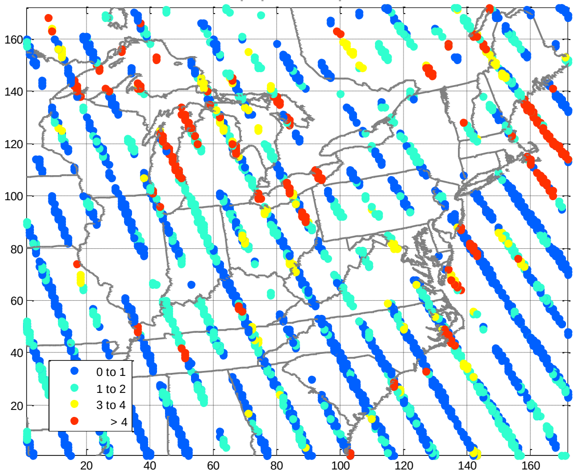


Figure 2-26: CALIPSO to WRF (PBL height ratio) Fall (S/O/N) 2011



One area of uncertainty involves PBL height estimates over bodies of water. CALIPSO data lacks the information necessary to properly evaluate PBL over water.

Summary

EPA has developed a significant look at the WRF v.3.4 model runs that OTC/MANE-VU is employing in its modeling platform and they have found the model to be quite acceptable for use in their national regulatory processes. OTC reviewed EPA's assessment and found that WRF v.3.4 modeled the Eastern US appropriately with regards to the factors EPA analyzed. NYSDEC went further to examine how WRF v.3.4 modeled temperature, mixing ratios, and PBL compared to monitored data and also found the results to be reasonable approximations. The data presented in EPA's documentation as well as OTC's analysis also provide evidence of areas needing further scrutiny (e.g., PBL height over bodies of water). OTC Modeling Committee expects that the 12 km WRF v.3.4 model results will lead to scientifically sound air quality modeling.

References

Carlton, AG and Baker, KR 2011, 'Photochemical Modeling of the Ozark Isoprene Volcano: MEGAN, BEIS, and Their Impacts on Air Quality Predictions', *Environmental Science & Technology*, vol. 45, no. 10, pp. 4438–4445.

Eyth, A and Vukovich, J 2015, 'Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform', accessed March 18, 2016, from <http://www3.epa.gov/ttn/chief/emch/2011v6/2011v6_2_2017_2025_EmisMod_TSD_aug2015.pdf>.

Otte, TL and Pleim, JE 2010, 'The Meteorology-Chemistry Interface Processor (MCIP) for the CMAQ modeling system: updates through MCIPv3.4.1', accessed March 16, 2016, from <http://www.geosci-model-dev.net/3/243/2010/gmd-3-243-2010.pdf>.

US EPA 2014, 'Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation', accessed March 4, 2016, from <https://www3.epa.gov/ttn/scram/reports/MET_TSD_2011_final_11-26-14.pdf>.

Section 3. Evaluation of Biogenic Model Versions

Overview

The modeling platform made available by EPA, v. 6.2, relied on BEIS v. 3.6 for biogenic emissions (Eyth and Vukovich 2015, p.2). More recently BEIS v. 3.6.1 was produced which came with more recent land use data which was expected to lead to more accurate results. OTC expects that in future modeling EPA will upgrade to the more recent version of BEIS, but since that has not yet occurred OTC determined that a brief evaluation of BEIS v. 3.6.1 was warranted.

Assessment

NYSDEC conducted an evaluation of two versions (3.6 and 3.6.1) of the biogenic model BEIS in order to determine which version produced more accurate base year modeling results. The major difference between the two versions of BEIS is the land use data employed by the model: v. 3.6 uses NCLD 2006 and v.3.6.1 uses NCLD 2011 (http://www.mrlc.gov/). The land use data in v. 3.6.1 shows much higher levels of isoprene than v. 3.6 (Bash, Baker and Beaver 2015). It was expected that v. 3.6.1 would produce the more accurate results given that it more accurately reflects the state of land use in the base year and also due to the improvements in isoprene production in the newer version.

In order to test the accuracy of the two biogenic model versions, two base year photochemical modeling runs were completed using CMAQ. The details on how CMAQ was configured for these model runs are in a later section (see Section 5). The model runs were completed using the 2011 Alpha 2 inventory (see Section 4).

Overall the difference between using v. 3.6.1 and v. 3.6 did not change the overall bias and error in the modeled results in the OTR as seen in Figure 3-1 (MFB), Figure 3-2 (MFE), and Figure 3-3 (MAGE), but the improvements in the response at the high ozone monitors warrant upgrading to BEIS v. 3.6.1.

Figure 3-1: MFE % for OTR monitors for CMAQ model runs conducted using BEIS 3.61 (left axis) and BEIS 3.6 (bottom axis)

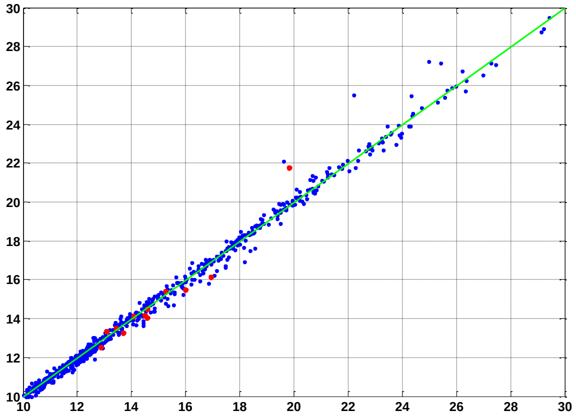


Figure 3-2: MFB % for OTR monitors for CMAQ model runs conducted using BEIS 3.61 (left axis) and BEIS 3.6 (bottom axis)

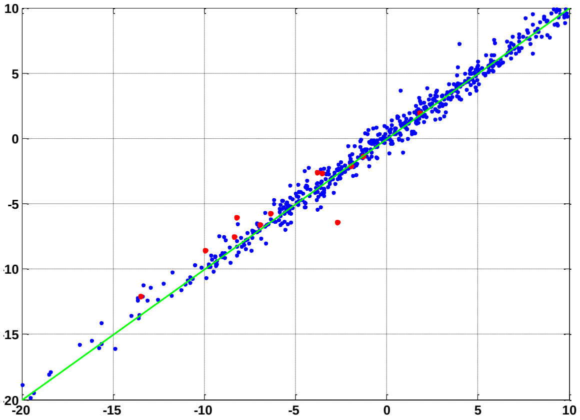
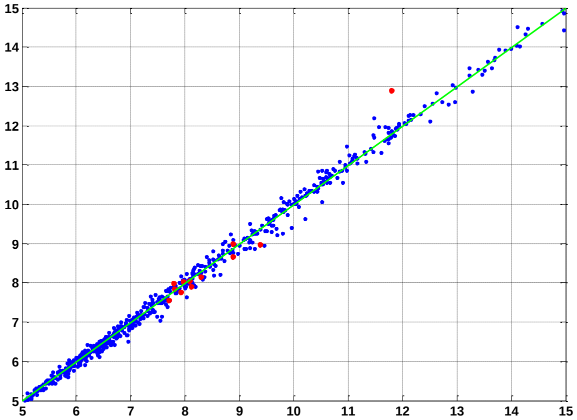


Figure 3-3: MAGE (ppb) for OTR monitors for CMAQ model runs conducted using BEIS 3.61 (left axis) and BEIS 3.6 (bottom axis)



In order to test the impact of design value projections between the two biogenic model versions, two future year photochemical modeling runs were completed using CMAQ. The details on how CMAQ was configured for these model runs are in a later section (see Section 5). The model runs were completed using the 2018 Alpha 2 inventory (see Section 8).

NYSDEC found that using BEIS v. 3.6.1 resulted in a greater response to reductions in NO_X at many higher valued monitors as seen in Table 3-1. One exception to this rule was Sherwood Island, CT (Monitor ID #090019003), which saw increases in ozone in both photochemical model runs.

Four monitors, including Sherwood Island, saw no change in projected ozone when v. 3.6.1 was used, and this is likely due to their proximity to the land-water interface. The highest value in the 9x9 grid surrounding the monitor is used in calculating the projected ozone at a monitor. The highest values at the nearby grid cells to these monitors are likely over water, which means those grid cells, are not impacted by changes in biogenic emissions. As a result we would expect to see little to no change in projected ozone at monitors near to the land-water interface. More details on the issues surrounding projected ozone calculations for monitors near the land-water interface are in Section 10.

Table 3-1: Modeled 2018 DVFs for 12 high ozone monitors in the OTR comparing BEIS v. 3.6 and BEIS v. 3.6.1

AQS Code	Site	DVC2011	DVF BEIS v. 3.6	DVF BEIS v. 3.6.1
090019003	Sherwood Island	83.7	84	84
240251001	Edgewood	90	82	81
361030002	Babylon	83.3	82	77
090010017	Greenwich Point Park	80.3	80	77
090013007	Fairfield	84.3	78	78
360810124	Queens College	78	78	74
361192004	White Plains	75.3	78	74
090099002	Hammonasset State Park	85.7	77	77
360850067	Susan Wagner HS	81.3	77	77
340150002	Clarksboro	84.3	75	75
360050133	Pfizer Lab Site	74	75	72
421010024	North East Airport (NEA)	83.3	75	74

Due to the increased accuracy associated with BEIS v. 3.6.1, this version was used in the OTC/MANE-VU modeling.

References

Bash, JO, Baker, KR and Beaver, MR 2015, ‘Evaluation of improved land use and canopy representation in BEIS v3.61 with biogenic VOC measurements in California’, *Geoscientific Model Development Discussions*, vol. 8, no. 9, pp. 8117–8154.

Eyth, A and Vukovich, J 2015, ‘Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform’, accessed March 18, 2016, from <http://www3.epa.gov/ttn/chief/emch/2011v6/2011v6_2_2017_2025_EmisMod_TSD_aug2015.pdf>.

Section 4. Emissions Inventories and Processing for 2011 12km Base Year Simulation

Overviews

ERTAC EGU

The majority of the tools that OTC/MANE-VU are currently using to develop emissions inventories have already become standards in the field including MOVES for onroad emissions, NONROAD for nonroad emissions, EPA's RWC tool for residential wood combustion, BEIS for biogenic emissions, and EMF for growing inventories for other sectors. However, the ERTAC EGU projection tool is not as well known.

The ERTAC EGU tool has been developed through the ERTAC collaborative process for use in projecting future year EGU emissions. However, some units are partial year reporters or do not have to report SO_2 emissions to CAMD due to only being in the NO_X Budget Trading Program. To resolve these issues the ERTAC EGU group ran ERTAC EGU projecting the CAMD data to the base year with no growth. This run, called Base Year Equals Future Year or "BY=FY", allowed missing emissions to be included, as well as smoothing out erratic data that is often created when missing data are replaced with maximum possible values (McDill et al. 2015).

Alpha

The Alpha version of the inventory was used to generate CMAQ-ready emissions for initial modeling. EPA's 2011 emissions data from nearly every sector were included directly into CMAQ without SMOKE processing since these data were not altered in any way. The inventories were based on v. 6.2 of the EPA modeling inventory (also called v. "eh", which is in turn was based on 2011 NEI v. 2) and were processed through SMOKE v. 3.5.1 (Eyth et al. 2015). Although OTC/MANE-VU did not process most of the emissions using SMOKE, the SMOKE input files are available on the MARAMA EMF system.

The exceptions that NYSDEC did process using SMOKE are the ERTAC EGU, Small EGU, and Non-EGU Point sectors. ERTAC v. 2.3 was used in the Alpha inventory. These were all processed using SMOKE v. 3.6.

Alpha 2

The Alpha 2 version of the inventory was primarily done to correct the C3 Marine sector to rectify double counting that occurred in the inventories used in the Alpha inventory (McDill et al. 2015). In addition, a few other minor corrections were made. This was originally intended to be used in 2018 Regional Haze SIPs, but significant improvements have been made and Gamma will now be used. EPA's 2011 emissions data from nearly every sector were included directly into CMAQ without SMOKE processing since these data were not altered in any way. EPA had processed their inventories using SMOKE v. 3.5.1 (Eyth et al. 2015).

Beta/Beta 2

The Beta 2 version of the inventory is intended to be used in 2008 Ozone SIPs. For the base year there are no differences between Beta and Beta 2, they exist only in the future year work. The Beta 2 inventory uses some of the same files used in Alpha and Alpha 2 inventories that were provided by EPA, but it also relies on files that were updated in EPA's "ek" inventory and new inputs compiled by

MARAMA, which includes states' feedback. The sectors that were updated from EPA's "ek" inventory required SMOKE processing using v. 3.7, and in the case of onroad mobile running SMOKE-MOVES v. 3.7. ERTAC v. 2.3 was upgraded to v. 2.5 for the Beta/Beta 2 inventory, which includes updated stack parameters and the addition of SO_2 emissions for NO_X only reporters. Full descriptions of where each inventory sector was taken from are shown in Table 4-1. The following sectors were reprocessed through SMOKE for the Beta/Beta 2 inventory:

1. Agriculture
2. ERTAC EGU
3. Ethanol
4. Non-EGU Point
5. Non-ERTAC IPM EGUs
6. Non-point Source
7. Nonroad
8. Point Oil & Gas
9. Refueling
10. Residential Wood Combustion
11. Wild Fires

Gamma

The Gamma version of the inventory is intended to be used as the base year inventory for Regional Haze SIPs and any attainment demonstrations needed for areas that are reclassified to serious for the 2008 Ozone NAAQS. The Gamma inventory is based on files developed by MARAMA, the ERTAC EGU Workgroup, and EPA. Details on how the sectors that were updated for the Gamma inventory by MARAMA were developed are available in a separate TSD (McDill et al. 2018). Files taken from EPA primarily use the "el" version of EPA's inventory, which includes feedback provided to EPA by our states and MARAMA (Eyth et al. 2015). However, improvements found in the oil & gas, marine and nonroad inventories from "en" were included (US EPA 2017). Full descriptions of where each inventory sector was taken from are shown in Table 4-1. Sectors taken from EPA inventories needed to be re-gridded in order to match the size of the OTC domain.

Table 4-1: Inventories used at each stage of OTC 2011 base year modeling

SECTOR	Alpha/Alpha 2	Beta/Beta 2	Gamma
Agricultural Fugitive Dust	EPA v6.2 eh	EPA v6.2 eh	EPA v6.2 eh
Agricultural	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek
Agricultural Fire	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek
Biogenics	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek
C1C2 Marine	EPA v6.2 eh	EPA v6.2 eh	EPA v6.3 en
C3 Marine	EPA v6.2 eh (α), EPA v6.3 ej (α 2)	EPA v6.3 ek	EPA v6.3 en
ERTAC EGU	ERTAC v2.3	ERTAC v2.5L	ERTAC v2.5L
Ethanol	MARAMA α	MARAMA β	MARAMA γ
Non-EGU Point	MARAMA α	MARAMA β	MARAMA γ
Point source offsets for DE	n/a	MARAMA β	MARAMA γ
Non-ERTAC IPM EGUs	MARAMA α	MARAMA β	MARAMA γ
Non-Point	MARAMA α	MARAMA β	MARAMA γ
Non-point Oil & Gas	EPA v6.2 eh	MARAMA β	MARAMA γ
Nonroad	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 en
Onroad	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el
Point Oil & Gas	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 en
Prescribed/Wild Fires	EPA v6.2 eh	EPA v6.2 eh	EPA v6.2 eh
Rail	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek

SECTOR	Alpha/Alpha 2	Beta/Beta 2	Gamma
Refueling	MARAMA α	MARAMA β	MARAMA β
RWC	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek
Canadian	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el

Emission Inventory Sectors

This section lists the emission inventory sectors with a brief description of the sector. A full list of all of the files used is in Appendix B.

Agricultural

NH_3 emissions, at the county and annual resolution, from nonpoint livestock and from fertilizer application.

Agricultural Fugitive Dust

PM_{10} and $PM_{2.5}$ at the county and annual resolution from nonpoint fugitive dust sources including building construction, road construction, agricultural dust, and road dust.

Agricultural Fires

Point source daily fires from agricultural burning computed using SMARTFIRE2.

Biogenic Emissions

Non-anthropogenic emissions at the grid cell and hourly resolution, including emissions from Canada, generated with the BEIS v. 3.61.

C1/C2 Marine and Rail

Locomotives and category 1 (C1) and category 2 (C2) commercial marine vessel emissions at the county and annual resolution. This category also includes some Category 3 emissions that were estimated by state agencies. Where these overlapped with the International Marine Organization (IMO) Category 3 sector described in the following section, the IMO Category 3 emissions were deleted to avoid double counting.

C3 Marine (IMO)

IMO Category 3 (C3) commercial marine vessel emissions at annual resolution - in the Alpha inventory distributed throughout the Atlantic Ocean, and in the Alpha 2 and Beta inventories distributed to shipping lanes.

ERTAC EGUs

All EGUs that are projected through the ERTAC projection tool, at the point and hourly resolution. These EGUs are from the universe of units with CEMS that are tracked by CAMD (though several units that meet that description are removed at state request) and were almost entirely found in EPA's sector files projected by IPM.

Ethanol

Point sources that produce ethanol fuel.

Non-EGU Point

All point emissions at the point and annual resolution, not included in other files. Some units were removed from EPA's prepared file since they were included in an ERTAC file. In the Beta inventory some sources were determined to be peaking EGUs and temporalized using an hourly emission file.

Non-ERTAC IPM EGUs

All units, at the point and annual resolution projected by EPA using IPM that were not projected using ERTAC and were also not included in the Non-EGU point sector, In the Beta inventory some sources were confirmed to be peaking EGUs and temporalized using an hourly emission file.

Non-point

All nonpoint emissions, at the county and annual resolution, which were not included in other files. Agricultural burning and portable fuel container emissions are merged into this sector.

Non-point Oil &Gas

Nonpoint emissions from the oil and gas sector at the county and annual resolution.

Nonroad

Mobile emissions, at the county and monthly resolution, processed using NONROAD 2008 from vehicles and equipment that are not included in other files.

Onroad

Mobile emissions, at the grid cell and hourly resolution, from onroad vehicles processed using MOVES and SMOKE-MOVES. The MOVES emission factors used for the Alpha and Alpha 2 inventories were produced using MOVES2014 and the emissions factors used for Beta were produced using MOVES2014a.

Point Oil & Gas

Point emissions from the oil and gas sector at the point and annual resolution.

Prescribed Burn

Point source daily prescribed fires computed using SMARTFIRE2.

Refueling

Non-point source emissions from gas station refueling.

Residential Wood Combustion

Nonpoint emissions from residential wood combustion at the county and annual resolution.

Wild Fires

Point source daily wildfires computed using SMARTFIRE2.

Speciation

The speciation and cross-reference files were taken from EPA's 2011 v. 6.2 modeling platform for the Alpha and Beta modeling and EPA's 2011 v. 6.3 modeling platform for the Gamma modeling and are based on the SPECIATE 4.4 database (Abt Associates 19 February 2014; Eyth et al. 2015; US EPA 2017)

Spatial Allocation

The spatial surrogates for the 12 km domain for both the United States and Canada were extracted from the national grid 12 km U.S. gridding surrogates provided with EPA's 2011 v. 6.2 modeling platform for the Alpha and Beta modeling and the v. 6.3 modeling platform for the Gamma modeling (Adelman 1 July 2015; Eyth et al. 2015; US EPA 2017).

Temporal Allocation

In most cases emissions for the sectors were allocated temporally in the same fashion as done in EPA's 2011 v. 6.2 modeling platform for the Alpha and Beta modeling and in the v. 6.3 modeling platform for the Gamma modeling (Eyth et al. 2015). Exceptions to this are ERTAC EGU in Alpha, Beta, and Gamma, and Non-ERTAC IPM EGUs and Non-EGU Point in Beta and Gamma.

In the case of ERTAC EGU, the ERTAC code produces hourly EGU emissions that are grounded in the base year CEMS data. As mentioned earlier, the hourly results were developed using ERTAC EGU to create the BY=FY run. V. 1.01 of the ERTAC EGU code was used in all inventories. The input files were from ERTAC EGU v. 2.3 for the Alpha and Alpha 2 inventories, and from ERTAC EGU v. 2.5 for the Beta inventory. In all cases they were post-processed using v. 1.02 of the ERTAC to SMOKE conversion tool. Given the fine level of detail that ERTAC EGU produces, the hourly ERTAC EGU results are used to temporalize EGUs in the modeling platform. In order to include the temporalization during SMOKE processing, hourly ff10 files were produced by the ERTAC to SMOKE post processor in addition to the annual ff10 files.

In the case of Non-ERTAC IPM EGUs and Non-EGU Point, some of the units were confirmed to be EGUs <25 MW (Small EGUs) through an MDE research project as outlined in Appendix A of the temporalization documentation (Ozone Transport Commission 10 November 2016). The units were expected to be EGUs based on their SCC and NAICS, and further refinement to the list of EGUs occurred through a state comment period. These units still function as EGUs, but produce too small an amount of power and emissions to be required to report hourly emissions to CAMD and thus are not temporalized through the ERTAC EGU process. MDE has developed a temporalization profile using hourly data from units that burn the same primary fuel and do report to CAMD. The EMF tool was used to create hourly profiles for these units so that they operate during times when electricity demand is highest rather than at a steady rate throughout the year. An example of a gas fired Small EGU in MD is shown in Figure 4-1 and details on the profiles employed are in Appendix C of the documentation developed by MDE (Ozone Transport Commission 10 November 2016). Examples of the change in daily emissions that result from the application of the temporal profiles on three HEDDs in 2011 are in Table 4-2.

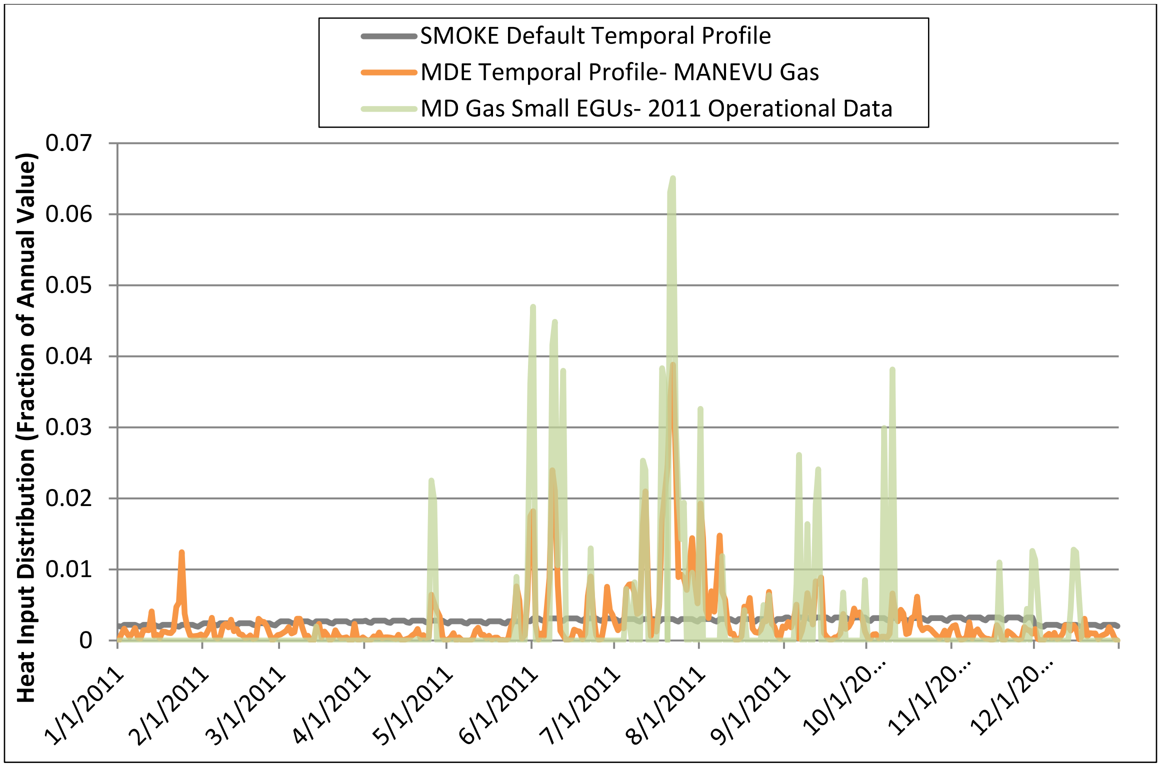
In order to develop the hourly ff10 files for the Small EGUs to process in SMOKE a multistep process was implemented. First, default temporal profiles were developed using SMOKE (TREF and TPRO) and they were then imported into EMF. Next, hourly ff10 files were produced in EMF using the imported profiles. MDE in conjunction with UMD completed this work.

It should be noted that EPA did undertake an approach to temporalizing some non-CAMD EGUs in the 2011 v. 6.2 platform using average fuel-specific season-to-month factors for each of the 64 IPM regions (Eyth et al. 2015). OTC decided our approach was an improvement because it contained a more expansive list of sources that should be temporalized that was confirmed by individual states.

Table 4-2: Change in NO_X emissions (tons) on selected episode days in July 2011 as the result of Small EGU temporalization

	July 20	July 21	July 22
MANE-VU	25	41	48
LADCO	211	230	186
SESARM	20	23	19
CENSARA	83	42	38

Figure 4-1: Comparison of temporalization of SMOKE defaults, MANE-VU gas temporal profile, and operational data from a typical gas fired Small EGU in MD



SMOKE Processed Emission Results

In order to quality assure that the outputs from SMOKE were properly distributed geographically and to develop a better understanding of the geographical and temporalization of emissions, we looked at daily emissions on a typical summer day (June 24, 2011) and during an ozone event (July 22, 2011). We looked at NO_X, VOC (with and without biogenic emissions) and SO_2 gridded emissions. Urban areas, interstates in rural areas, and shipping lanes are clearly distinguishable in the maps of NO_X emissions

(Figure 4-2). There are minor differences at this scale on a peak day where one can notice increases in some grid cells during the ozone event (Figure 4-3). On a typical summer day, VOC emissions are higher as one looks further south, which is expected given the greater biogenic emissions, found in the southern forests (Figure 4-4). It is quite noticeable how much VOC emissions increase on an ozone-conducive day throughout the modeling domain (Figure 4-5). When biogenic emissions are removed from the mapping there is little difference between a typical summer day and an ozone event, but one can clearly distinguish urban cores where the majority of anthropogenic VOCs are produced (Figure 4-6 and Figure 4-7). One can see the importance of point sources in terms of SO_2 emissions and very minor increases throughout the modeling domain during an ozone event (Figure 4-8 and Figure 4-9).

Additionally, summary tables of emissions by RPO, sector, and pollutant were outputted from SMOKE processing. States in an RPO that are fully within the modeling domain are summed separately from states in an RPO outside of the modeling domain due to emission summaries not being available for states partially in the domain for many future years. These results are aggregated for the 2011 Alpha 2 inventory in Table 4-3, the Beta inventory in Table 4-4, and the Gamma inventory in Table 4-5.

Figure 4-2: MARAMA Alpha 2 NO_X SMOKE Gridded Emissions (Typical Summer Day, June 24, 2011)

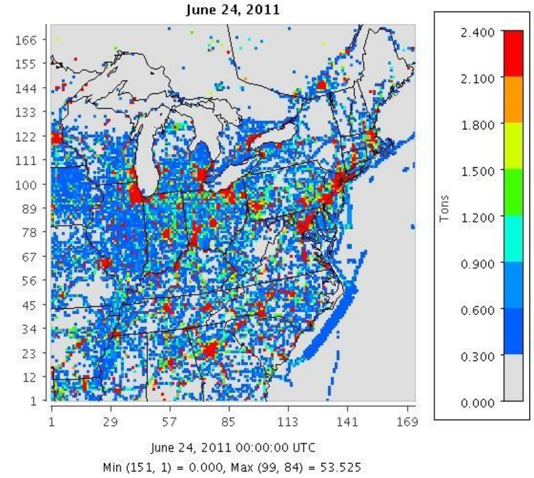


Figure 4-3: MARAMA Alpha 2 NO_X SMOKE Gridded Emissions (High Ozone Day, July 22, 2011)

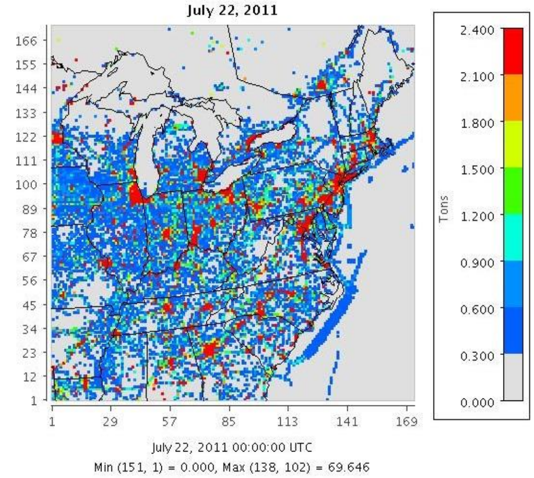


Figure 4-4: MARAMA Alpha 2 VOC All SMOKE Gridded Emissions (Typical Summer Day, June 24, 2011)

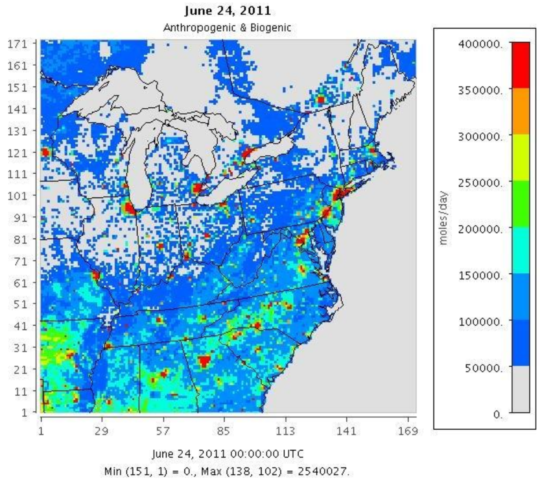


Figure 4-5: MARAMA Alpha 2 VOC All SMOKE Gridded Emissions (High Ozone Day, July 22, 2011)

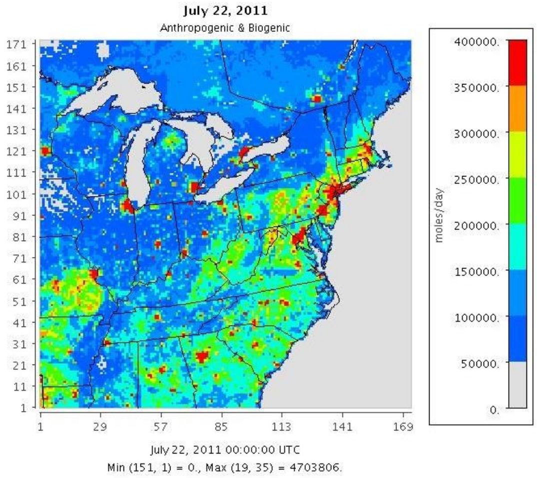


Figure 4-6: MARAMA Alpha 2 VOC Anthropogenic SMOKE Gridded Emissions (Typical Summer Day, June 24, 2011)

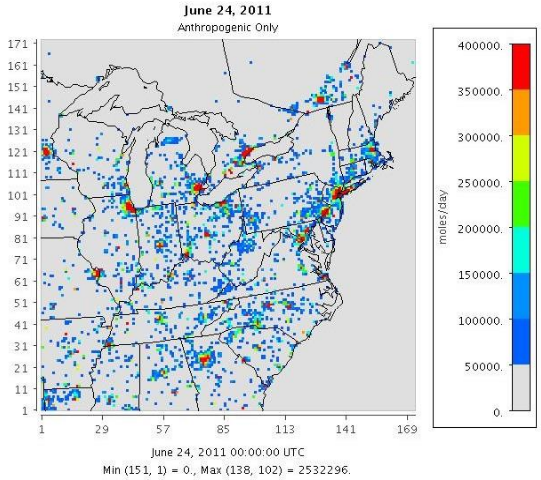


Figure 4-7: MARAMA Alpha 2 VOC Anthropogenic SMOKE Gridded Emissions (High Ozone Day, July 22, 2011)

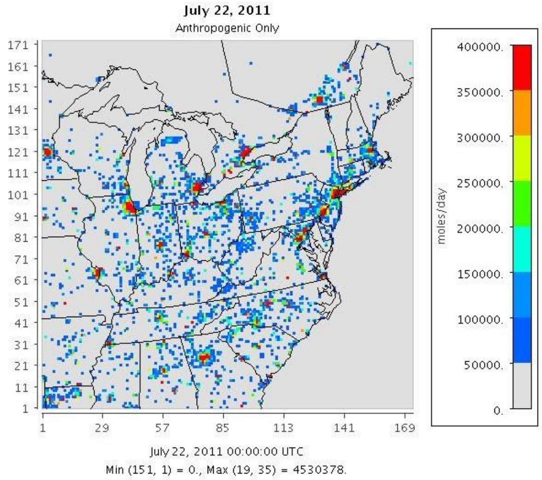


Figure 4-8: MARAMA Alpha 2 SO_2 SMOKE Gridded Emissions (Typical Summer Day, June 24, 2011)

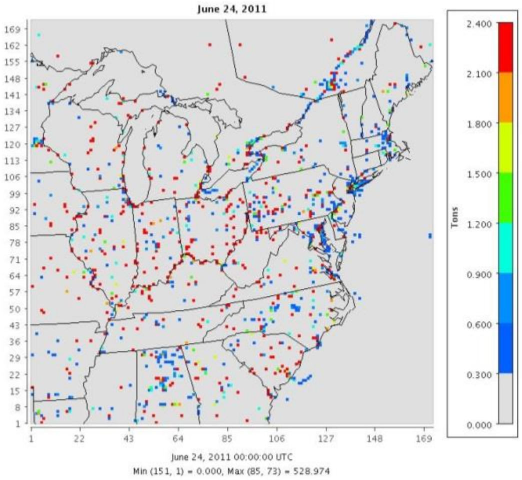


Figure 4-9: MARAMA Alpha 2 SO_2 SMOKE Gridded Emissions (High Ozone Day, July 22, 2011)

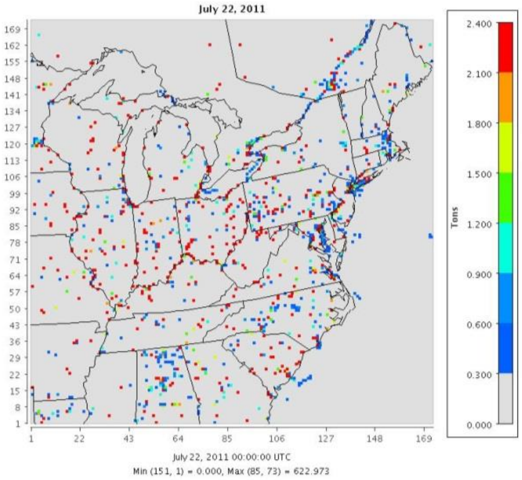


Table 4-3: 2011 base case Alpha 2 emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
NO_X									
Full State	MANE-VU	206,647	158,385	346,366	699,944	195,502	53,407	1,018	**1,661,269**
	LADCO	377,389	250,367	418,740	943,808	155,233	83,107	2,607	**2,231,251**
	SESARM	273,729	175,247	289,050	785,783	71,569	93,586	17,077	**1,706,041**
Partial State	LADCO	48,030	53,301	73,758	121,024	26,138	2,878	9,851	**334,980**
	SESARM	141,297	107,901	146,227	459,332	37,624	58,215	60,218	**1,010,813**
	CENSARA	476,036	325,158	711,395	1,150,395	143,345	626,084	116,659	**3,549,072**
	Canada		159,482	218,823	249,114	59,134			**686,553**
	US EEZ			517,740					**517,740**
	Interntnl.			9,170					**9,170**
NO_X Total		1,523,128	1,523,128	1,229,840	2,731,268	4,409,399	688,544	917,278	**207,430**
VOC									
Full State	MANE-VU	2,482	53,690	366,461	356,969	678,462	29,028	21,238	**1,508,331**
	LADCO	6,047	149,483	392,727	472,135	666,820	85,057	39,304	**1,811,573**
	SESARM	5,064	159,866	235,810	364,008	508,655	94,089	186,020	**1,553,512**
Partial State	LADCO	1,616	20,089	76,960	65,891	120,062	131	188,478	**473,227**
	SESARM	4,155	74,385	131,922	222,323	281,679	50,653	310,917	**1,076,035**
	CENSARA	11,975	209,440	269,531	497,121	875,210	1,520,510	1,635,856	**5,019,642**
	Canada		1,457	157,565	117,735	532,666			**809,423**
	US EEZ			14,792					**14,792**
	Interntnl.			330					**330**
VOC Total		31,339	668,411	1,646,099	2,096,182	3,663,553	1,779,468	2,381,813	**12,266,865**
SO_2									
Full State	MANE-VU	462,603	108,742	25,481	5,069	135,409	2,103	612	**740,020**
	LADCO	1,409,343	336,342	5,794	4,877	19,164	1,362	1,353	**1,778,235**
	SESARM	669,868	170,096	7,888	3,820	31,725	1,762	7,640	**892,799**
Partial State	LADCO	93,275	20,937	644	598	6,385	82	5,687	**127,609**
	SESARM	409,350	90,427	3,944	2,220	30,396	20,854	20,498	**577,688**
	CENSARA	1,087,853	324,686	23,579	5,594	44,155	21,060	58,760	**1,565,688**
	Canada		436,584	36,343	1,380	36,964			**511,271**
	US EEZ			50,654					**50,654**
	Interntnl.			5,775					**5,775**
SO_2 Total		4,132,292	1,487,814	160,102	23,559	304,198	47,222	94,551	**6,249,738**
$PM_{2.5}$									
Full State	MANE-VU	17,952	28,839	27,585	26,839	161,721	1,676	27,277	**291,889**
	LADCO	61,377	53,855	31,401	34,096	156,230	1,518	130,498	**468,975**
	SESARM	43,808	41,690	20,724	24,271	96,005	2,100	110,274	**338,871**
Partial State	LADCO	6,537	15,190	5,866	4,407	43,681	29	91,489	**167,199**
	SESARM	23,368	37,514	10,706	14,186	87,149	1,342	273,774	**448,038**
	CENSARA	77,558	84,589	40,187	38,085	123,174	15,966	1,026,201	**1,405,760**
	Canada		25,777	16,908	8,934	105,607		323,474	**480,700**
	US EEZ			15,722					**15,722**
	Interntnl.			716					**716**
$PM_{2.5}$ Total		230,599	287,454	169,815	150,818	773,568	22,631	1,982,986	**3,617,870**
NH_3									
Full State	MANE-VU	2,925	4,974	380	18,106	14,580	14	165,666	**206,644**
	LADCO	-	7,682	447	18,017	19,727	11	478,355	**524,240**
	SESARM	444	6,735	283	15,543	5,513	4	348,367	**376,889**
Partial State	LADCO	-	1,241	76	2,402	3,240	47	201,881	**208,887**
	SESARM	-	9,762	146	8,858	2,843	2	231,178	**252,789**
	CENSARA	-	22,208	1,121	19,701	17,123	52	1,366,962	**1,427,166**
	Canada		4,983	250	15,303	3,091		183,853	**207,480**
	US EEZ			-					**-**
	Interntnl.			-					**-**
NH_3 Total		3,369	57,585	2,702	97,929	66,117	129	2,976,263	**3,204,094**
CO									
Full State	MANE-VU	41,340	235,436	2,769,526	3,498,866	892,083	40,947	90,739	**7,568,938**
	LADCO	132,762	741,458	2,531,114	4,602,854	951,801	53,071	166,190	**9,179,250**
	SESARM	101,585	328,980	1,650,091	3,519,155	523,080	81,536	842,359	**7,046,786**
Partial State	LADCO	20,662	29,266	354,226	631,171	246,236	552	800,131	**2,082,244**
	SESARM	65,145	160,224	853,844	2,097,741	495,024	28,960	1,972,145	**5,673,083**
	CENSARA	201,076	412,960	1,820,066	4,791,071	783,366	474,018	6,907,096	**15,389,654**
	Canada		585,732	1,889,841	2,204,940	648,333			**5,328,846**
	US EEZ			83,618					**83,618**
	Interntnl.			778					**778**
CO Total		562,570	2,494,057	11,953,104	21,345,799	4,539,922	679,085	10,778,661	**52,353,197**

Table 4-4: 2011 base case Beta emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
					NO_X				
Full State	MANE-VU	206,457	155,892	346,258	717,012	195,137	53,407	1,165	**1,675,326**
	LADCO	381,339	249,658	418,740	902,000	155,219	83,107	2,612	**2,192,675**
	SESARM	273,719	172,613	289,050	778,220	68,694	94,145	18,262	**1,694,703**
Partial State	LADCO	26,996	53,296	73,758	79,420	25,065	2,878	9,926	**271,339**
	SESARM	141,296	107,513	146,227	390,760	33,537	58,219	61,591	**939,143**
	CENSARA	491,941	323,997	805,686	284,258	127,522	626,557	127,577	**2,787,538**
	Canada		159,482	218,823	249,114	59,134			**686,553**
	US EEZ			517,740					**517,740**
	Interntnl.			9,170					**9,170**
NO_X Total		1,521,748	1,222,451	2,825,450	3,400,784	664,307	918,314	221,132	**10,774,186**
					VOC				
Full State	MANE-VU	2,477	53,046	366,247	362,357	701,998	29,028	21,570	**1,536,724**
	LADCO	6,576	148,290	392,727	437,375	700,592	85,057	39,312	**1,809,929**
	SESARM	5,216	159,469	235,810	364,193	533,860	94,138	188,258	**1,580,944**
Partial State	LADCO	499	20,090	76,960	43,299	122,169	131	188,610	**451,758**
	SESARM	2,792	74,096	131,922	189,829	291,912	50,653	313,325	**1,054,530**
	CENSARA	10,069	208,963	327,909	109,269	879,881	1,520,538	1,654,955	**4,711,584**
	Canada		1,457	157,565	117,735	532,666			**809,423**
	US EEZ			14,792					**14,792**
	Interntnl.			1					**1**
VOC Total		27,628	665,412	1,703,934	1,624,056	3,763,079	1,779,546	2,406,029	**11,969,684**
					SO_2				
Full State	MANE-VU	462,551	108,301	25,481	4,793	135,936	2,102	668	**739,833**
	LADCO	1,463,978	336,334	5,794	4,394	19,157	1,362	1,355	**1,832,374**
	SESARM	669,831	169,991	7,888	3,626	26,061	1,761	8,016	**887,174**
Partial State	LADCO	36,332	20,930	644	391	5,894	82	5,721	**69,996**
	SESARM	409,350	85,352	3,944	1,817	28,511	25,913	21,104	**575,989**
	CENSARA	1,088,313	324,666	23,801	1,071	38,551	21,060	62,176	**1,559,638**
	Canada		436,584	36,343	1,380	36,964			**511,271**
	US EEZ			50,654					**50,654**
	Interntnl.			5,775					**5,775**
SO_2 Total		4,130,355	1,482,158	160,324	17,473	291,074	52,279	99,040	**6,232,703**
					$PM_{2.5}$				
Full State	MANE-VU	17,987	28,669	27,582	27,133	159,622	1,676	27,816	**290,486**
	LADCO	49,075	53,709	31,401	30,690	156,199	1,518	130,509	**453,100**
	SESARM	36,920	41,614	20,724	23,652	90,434	2,107	113,554	**329,004**
Partial State	LADCO	2,562	15,190	5,866	2,960	41,492	29	91,658	**159,757**
	SESARM	12,623	37,192	10,706	11,934	78,532	1,345	274,952	**427,284**
	CENSARA	45,622	84,418	48,640	10,236	88,011	15,977	1,048,693	**1,341,597**
	Canada		25,777	16,908	8,934	105,607		323,474	**480,700**
	US EEZ			15,722					**15,722**
	Interntnl.			716					**716**
$PM_{2.5}$ Total		164,788	286,568	178,265	115,539	719,897	22,653	2,010,656	**3,498,366**
					NH_3				
Full State	MANE-VU	2,923	4,950	380	18,094	14,555	14	165,673	**206,588**
	LADCO	891	7,682	447	17,582	19,727	11	478,355	**524,696**
	SESARM	1,498	6,690	283	15,464	5,501	4	348,367	**377,808**
Partial State	LADCO	107	1,240	76	1,555	3,240	47	201,881	**208,147**
	SESARM	1,865	9,667	146	7,602	2,843	2	231,178	**253,302**
	CENSARA	6,488	22,207	1,223	4,131	14,549	52	1,392,026	**1,440,676**
	Canada		4,983	250	15,303	3,091		183,853	**207,480**
	US EEZ			216					**216**
	Interntnl.								
NH_3 Total		13,772	57,419	3,020	79,732	63,507	129	3,001,334	**3,218,912**
					CO				
Full State	MANE-VU	41,310	234,702	2,768,157	3,495,020	881,048	40,947	95,551	**7,556,735**
	LADCO	81,510	740,716	2,531,114	4,277,100	951,474	53,071	166,302	**8,801,287**
	SESARM	76,219	327,271	1,650,091	3,491,900	471,969	81,711	870,770	**6,969,931**
Partial State	LADCO	7,427	29,263	354,226	407,300	222,711	552	801,858	**1,823,338**
	SESARM	28,503	159,809	853,844	1,779,900	404,229	28,963	2,003,907	**5,259,155**
	CENSARA	199,495	412,002	2,279,704	985,507	434,457	474,162	7,145,277	**11,930,605**
	Canada		585,732	1,889,841	2,204,940	648,333			**5,328,846**
	US EEZ			83,618					**83,618**
	Interntnl.			778					**778**
CO Total		434,464	2,489,495	12,411,373	16,641,667	4,014,221	679,407	11,083,666	**47,754,292**

Table 4-5: 2011 base case Gamma emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)*	Onroad	Non-point (including RWC & Refueling)*	Oil/Gas	Other (including biogenic)	Total
NO_X									
Full State	MANE-VU	206,457	155,892	344,671	717,012	194,924	53,405	1,165	**1,673,526**
	LADCO	381,339	249,658	416,060	902,000	155,054	83,106	2,612	**2,189,829**
	SESARM	273,719	172,613	287,687	778,220	68,606	94,145	18,262	**1,693,252**
Partial State	LADCO	26,996	53,296	73,317	79,420	25,038	2,878	9,926	**270,872**
	SESARM	141,296	107,513	145,531	390,760	33,499	58,219	61,591	**938,408**
	CENSARA	491,941	323,997	802,670	284,258	127,377	626,557	127,577	**2,784,378**
	Canada		318,964	218,823	249,114	118,199			**905,100**
	US EEZ			517,740					**517,740**
	Interntnl.			9,170					**9,170**
NO_X Total		1,521,748	1,381,933	2,815,668	3,400,784	722,698	918,311	221,132	**10,982,273**
VOC									
Full State	MANE-VU	2,477	53,046	369,537	362,357	703,086	29,028	21,570	**1,541,101**
	LADCO	6,576	148,290	397,467	437,375	721,835	85,057	39,312	**1,835,912**
	SESARM	5,216	159,469	238,561	364,193	571,496	94,138	188,258	**1,621,331**
Partial State	LADCO	499	20,090	77,797	43,299	122,071	131	188,610	**452,497**
	SESARM	2,792	74,096	133,346	189,829	291,611	50,653	313,325	**1,055,653**
	CENSARA	10,069	208,963	331,322	109,269	879,002	1,520,538	1,654,955	**4,714,118**
	Canada		2,914	157,565	117,735	1,064,690			**1,342,904**
	US EEZ			14,792					**14,792**
	Interntnl.			1					**1**
VOC Total		27,628	666,869	1,720,389	1,624,056	4,353,791	1,779,546	2,406,029	**12,578,308**
SO_2									
Full State	MANE-VU	462,551	108,301	25,477	4,793	135,783	2,102	668	**739,675**
	LADCO	1,463,978	336,334	5,788	4,394	19,144	1,362	1,355	**1,832,354**
	SESARM	669,831	169,991	7,885	3,626	26,017	1,761	8,016	**887,126**
Partial State	LADCO	36,332	20,930	643	391	5,888	82	5,721	**69,988**
	SESARM	409,350	85,352	3,942	1,817	28,477	25,913	21,104	**575,953**
	CENSARA	1,088,313	324,666	23,796	1,071	38,505	21,060	62,176	**1,559,586**
	Canada		873,168	36,343	1,380	73,883			**984,775**
	US EEZ			50,654					**50,654**
	Interntnl.			5,775					**5,775**
SO_2 Total		4,130,355	1,918,742	160,301	17,473	327,697	52,279	99,040	**6,705,886**
$PM_{2.5}$									
Full State	MANE-VU	17,987	28,669	27,442	27,133	160,501	1,676	27,816	**291,225**
	LADCO	49,075	53,709	31,191	30,690	156,178	1,518	130,509	**452,869**
	SESARM	36,920	41,614	20,605	23,652	90,376	2,107	113,554	**328,828**
Partial State	LADCO	2,562	15,190	5,828	2,960	41,547	29	91,658	**159,775**
	SESARM	12,623	37,192	10,646	11,934	78,889	1,345	274,952	**427,581**
	CENSARA	45,622	84,418	48,400	10,236	88,291	15,977	1,048,693	**1,341,637**
	Canada		51,554	16,908	8,934	211,721		323,474	**612,591**
	US EEZ			15,722					**15,722**
	Interntnl.			716					**716**
$PM_{2.5}$ Total		164,788	312,345	177,458	115,539	827,502	22,653	2,010,656	**3,630,942**
NH_3									
Full State	MANE-VU	2,923	4,950	378	18,094	14,552	14	165,673	**206,584**
	LADCO	891	7,682	445	17,582	19,725	11	478,355	**524,691**
	SESARM	1,498	6,690	282	15,464	5,500	4	348,367	**377,805**
Partial State	LADCO	107	1,240	76	1,555	3,239	47	201,881	**208,146**
	SESARM	1,865	9,667	145	7,602	2,843	2	231,178	**253,301**
	CENSARA	6,488	22,207	1,218	4,131	14,546	52	1,392,026	**1,440,668**
	Canada		9,966	250	15,303	6,181		183,853	**215,553**
	US EEZ			216					**216**
	Interntnl.								
NH_3 Total		13,772	62,402	3,010	79,732	66,586	129	3,001,334	**3,226,964**
CO									
Full State	MANE-VU	41,310	234,702	2,766,259	3,495,020	880,902	40,947	95,551	**7,554,690**
	LADCO	81,510	740,716	2,536,119	4,277,100	951,341	53,071	166,302	**8,806,159**
	SESARM	76,219	327,271	1,650,188	3,491,900	471,790	81,710	870,770	**6,969,848**
Partial State	LADCO	7,427	29,263	354,389	407,300	222,691	552	801,858	**1,823,481**
	SESARM	28,503	159,809	854,236	1,779,900	403,996	28,963	2,003,907	**5,259,314**
	CENSARA	199,495	412,002	2,280,730	985,507	434,313	474,162	7,145,277	**11,931,487**
	Canada		1,171,464	1,889,841	2,204,940	1,296,264			**6,562,509**
	US EEZ			83,618					**83,618**
	Interntnl.			778					**778**
CO Total		434,464	3,075,227	12,416,158	16,641,667	4,661,297	679,406	11,083,666	**48,991,883**

*** Note: emissions from the nonroad and nonpoint for states partially in the domain were approximated based on Beta 2 emissions and the ration of Gamma/Beta 2 emissions for states fully in the modeling domain**

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Section 5. 8-hour Ozone/Regional Haze Modeling Using the CMAQ and CAMx Modeling Platforms

Air Quality Modeling Domain

The modeling domain used in this application represented a subset of the EPA continental-modeling domain that covered the entire 48-state region with emphasis on the OTR. The OTC/MANE-VU modeling domain at 12 km horizontal mesh is displayed in Figure 5-1. The 12 km domain used in this analysis includes the eastern US with a 172X172 mesh in the horizontal and 35 vertical layers, the same as WRF setup from surface up to 50 mb. The same domain is used for CMAQ and CAMx Modeling.

Initial/Boundary Conditions/Initial Conditions

The same boundary conditions are used by CMAQ and CAMx modeling, though they differ in format depending on the modeling platform being used.

Alpha, Alpha 2, and Beta/Beta2 Modeling

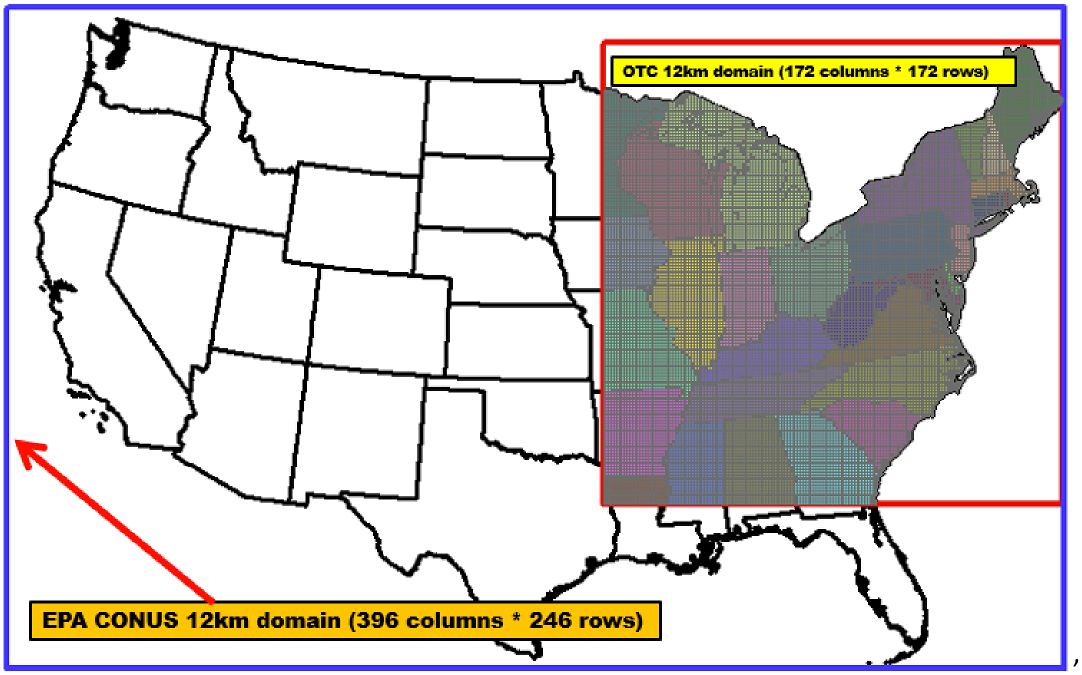
The boundary conditions for the 12 km grid were developed from a 2.5 x 2.5 degree GEOS-Chem (version 8) global simulation produced by EPA for use in the 2011 modeling platform (Eyth et al. 2015). To address the transport of the pollutants through the boundaries, the GEOS-Chem data were used to develop the initial and boundary condition for the 2011 OTC modeling platform. The CMAQ simulations used a 15-day ramp-up period to wash out the effect of the initial fields.

Gamma Modeling

For Gamma modeling a new set of boundary conditions were created by running the CMAQ model on a national scale. CMAQ modeling for the OTC domain previously relied on a GEOS-Chem boundary condition, which did not perform well, especially near the boundaries. It is important to have accurate modeling of boundary conditions because source apportionment work has shown that boundary conditions are modeled to be a significant, and often the largest, contribution to ozone.

Development of improved boundary conditions began with EPA’s 2011 'el' platform and a CAMx run was conducted using the EPA CONUS domain (Figure 5-1) with the 3-D output option. The 3-D results were then trimmed to remove the OTC 12km domain (also Figure 5-1) so that they can function as boundary conditions. The run was completed using CAMx v. 6.3, WRFCAMx v. 4.4, 25 layers, and relied on emissions from EPA’s 2011 ‘el’ platform.

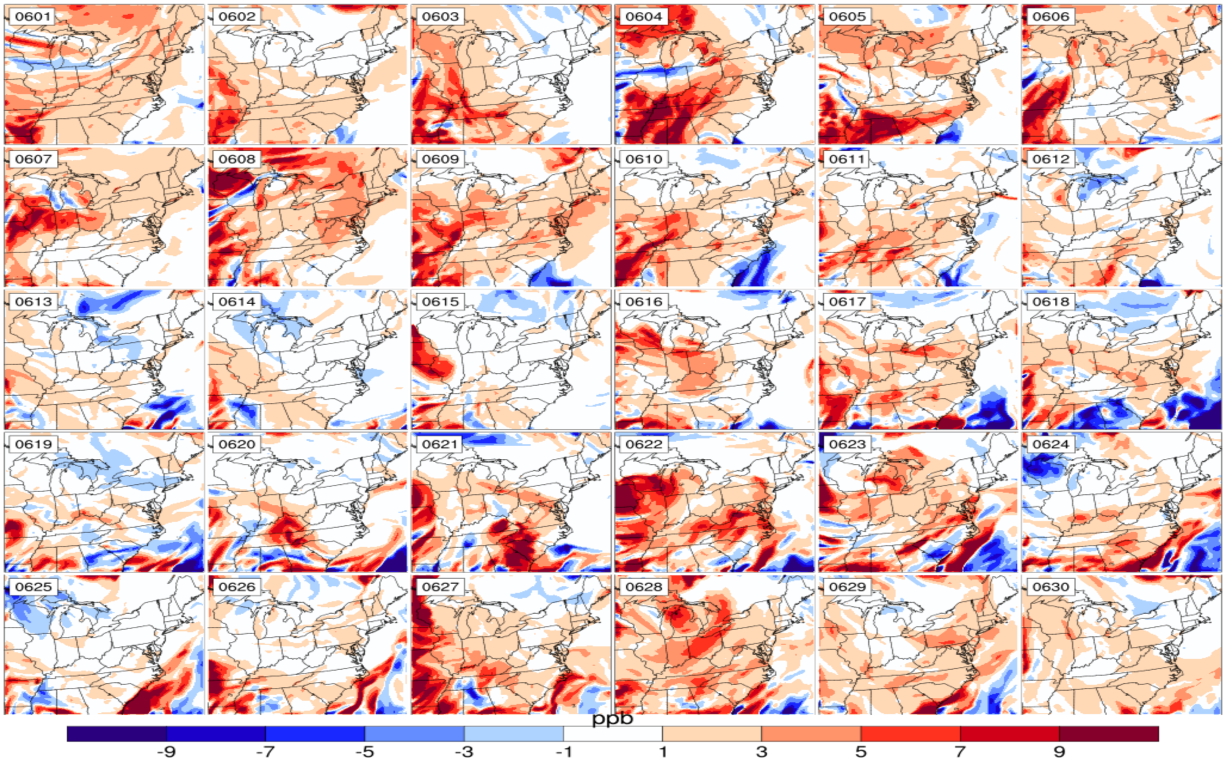
Figure 5-1: EPA and OTC 12 km modeling domains



Following the completion of the CAMx run for use as boundary conditions, two runs were completed for the purposes of testing the improvements in boundary conditions. The first of these relied on the GEOS-Chem boundary conditions used in Alpha and Beta modeling and the second of these relied on this new set of boundary condition data developed in CAMx. Both of these runs were completed using CAMx v. 6.3 and WRF-CAMx v. 4.6, with 25 layers and reprocessed 2011 EPA 'el' emissions. The runs were completed for the time period from May 15 to June 30, with the days in May intended as a ramp up period.

To determine the effect of switching boundary conditions, ozone contribution results were compared and on many days contribution by boundary conditions decreased substantially, in particular in the western portion of the domain as seen in Figure 5-2.

Figure 5-2: Difference in ozone contribution between Alpha/Beta (GEOS-Chem) and Gamma (CAMx 3-D) boundary conditions at 4 PM EST during June simulations.



Vertical Layers

Table 5-1 shows the values for each layer in the photochemical modeling platform, as well as in the meteorological model (WRF). This layer set up was used in all modeling runs discussed.

Table 5-1: Layers used by the photochemical model and meteorological model (WRF)

CMAQ/CAMx Layers	WRF Layers	Sigma P	Pressure (mb)	Approximate Height (m AGL)
25	35	0.00	50.00	17,556
	34	0.05	97.50	14,780
24	33	0.10	145.00	12,822
	32	0.15	192.50	11,282
23	31	0.20	240.00	10,002
	30	0.25	287.50	8,901
22	29	0.30	335.00	7,932
	28	0.35	382.50	7,064
21	27	0.40	430.00	6,275
	26	0.45	477.50	5,553
20	25	0.50	525.00	4,885
	24	0.55	572.50	4,264
19	23	0.60	620.00	3,683
18	22	0.65	667.50	3,136
17	21	0.70	715.00	2,619
16	20	0.74	753.00	2,226
15	19	0.77	781.50	1,941
14	18	0.80	810.00	1,665
13	17	0.82	829.00	1,485
12	16	0.84	848.00	1,308
11	15	0.86	867.00	1,134
10	14	0.88	886.00	964
9	13	0.90	905.00	797
	12	0.91	914.50	714
8	11	0.92	924.00	632

CMAQ/CAMx Layers	WRF Layers	Sigma P	Pressure (mb)	Approximate Height (m AGL)
	10	0.93	933.50	551
7	9	0.94	943.00	470
	8	0.95	952.50	390
6	7	0.96	962.00	311
5	6	0.97	971.50	232
4	5	0.98	981.00	154
	4	0.99	985.75	115
3	3	0.99	990.50	77
2	2	1.00	995.25	38
1	1	1.00	997.63	19

Photochemical Modeling Configurations

Alpha, Alpha 2, and Beta/Beta2 CMAQ Modeling

CMAQ v. 5.0.2 was used for Alpha, Alpha 2 and Beta/Beta 2 modeling. Photochemical modeling was performed with the CCTM software that is part of the CMAQ modeling package. Version 5.0.2 of this modeling software was obtained from the CMAS modeling center (http://www.cmascenter.org). Module options are listed in Table 5-2. It should be noted that the newer version of the gas phase chemical mechanism termed CB06 was not yet available in the CMAQ model at the time of this project.

Table 5-2: Module options used in compiling the CCTM executable

Horizontal advection: yamo	Vertical advection: wrf	Horizontal diffusion: multiscale
Vertical diffusion: ACM2	Gas phase chemical mechanism: CB05	Biogenic Emission: BEIS
Chemical solver: EBI	Aerosol module: aero6	

The following files are saved as running CMAQ:

- Layer 1 hourly-average concentration file (ACONC) which contains whole 154 species
- Dry deposition file (DRYDEP)
- Wet deposition file (WETDEP1)
- Aerosol/visibility file

Gamma and Gamma 2 CMAQ Modeling

CMAQ v. 5.2 was used in the Gamma and Gamma 2 Modeling. Photochemical modeling was performed with the CCTM software that is part of the CMAQ modeling package. Version 5.2.1 of this modeling software was obtained from the CMAS modeling center (http://www.cmascenter.org). Module options are listed in Table 5-3. There was no difference in the files saved for modeling from previous modeling.

Table 5-3: Module options used in compiling the CCTM executable for Gamma Modeling

Horizontal advection: yamo	Vertical advection: wrf	Horizontal diffusion: multiscale
Vertical diffusion: ACM2	Gas phase chemical mechanism: CB06r3	Biogenic Emission: BEIS3 inline
Chemical solver: EBI	Aerosol module: aero6	Deposition velocity: m3dry

CAMx-APCA Modeling

Source apportionment modeling for future year 2023 used CAMx v. 6.40. The modeling software was obtained from Ramboll-Environ (www.camx.com). For consistency with the modeling conducted by EPA, the APCA option was applied instead of OSAT. WRFCAMx v. 4.6 was used with 35 layers. In addition, all emissions (surface and elevated) were converted to point sources with kcell override except sea salts, which were supplied as 2-d surface emissions. Other options used in the modeling are listed in Table 5-4 and the full script is available upon request.

Table 5-4: Runtime options used in the MPI script

ACM2: false	Gas phase chemical mechanism: CB06r4	Biogenic Emission: BEIS
Chemical solver: EBI	Advection solver: PPM	Aerosol module: aero6
Probing tool: SA	Dry deposition model: ZHANG03	

References

Eyth, A and Vukovich, J 2015, ‘Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform’, accessed March 18, 2016, from <http://www3.epa.gov/ttn/chief/emch/2011v6/2011v6_2_2017_2025_EmisMod_TSD_aug2015.pdf>.

Section 6. Model Performance and Assessment of 8-hour Ozone/Regional Haze Modeling

Air Quality Model Evaluation and Assessment

One of the tasks required as part of demonstrating attainment for the 8-hr ozone NAAQS is the evaluation and assessment of the air quality modeling system used to predict future air quality over the region of interest (EPA, 2014). As part of the attainment demonstration, the SMOKE/CMAQ and SMOKE/CAMx modeling systems were applied to simulate the pollutant concentration fields for the base year 2011 emissions with the corresponding meteorological information. The modeling databases for meteorology using WRF, the emissions using SMOKE, and application of CMAQ or CAMx provide simulated pollutant fields that are compared to measurements to establish credibility of the modeling system. In the following section a comparison between the measured and predicted concentrations is performed and the results presented, demonstrating the overall utility of the modeling system in this application.

The results presented here should serve as an illustration of the evaluation and assessment performed on both the base 2011 CMAQ and CAMx simulations. Additional information can be made available by request from the New York State Department of Environmental Conservation.

Simulations

Base case CMAQ simulations were run using each of the 2011 base case inventories (Alpha, Alpha 2, Beta, and Gamma) and base case CAMx simulation was only run using Gamma. Meteorology, boundary conditions, etc. were all held consistent in the base case simulations. The chemistry mechanism was held consistent between the Alpha and Beta platforms, but was upgraded for the Gamma simulations.

Summary of Measured Data

The ambient air quality data for both gaseous and aerosol species for the simulation period were obtained from EPA AQS for ozone, AQS for $PM_{2.5}$ mass, CSN and IMPROVE for $PM_{2.5}$ speciation, and DISCOVER-AQ. Measured data from all sites within the modeling domain are included here. The model-based data were obtained at the grid-cell corresponding to the monitor location and no interpolation was performed.

Ozone

Hourly ozone is measured at a large number of State, Local, and National Air Monitoring Stations (SLAMS/NAMS) across the US on a routine basis, and the data from 226 OTR and 427 non-OTR sites were extracted from the AQS database (https://aqs.epa.gov/api).

Fine Particulate Matter ($PM_{2.5}$)

Federal Reference Method (FRM) $PM_{2.5}$ mass data collected routinely at SLAMS/NAMS sites across the US and the data from 745 sites across the modeling domain were extracted from AQS.

Fine Particulate Speciation

The 24-hour average $PM_{2.5}$ and fine particulate speciation (sulfate (SO_4), nitrate (NO_3), elemental carbon (EC), organic carbon/organic mass (OC/OM), and soil/crustal matter) from Class I areas across the US collected every 3rd day were obtained from the IMPROVE web site (http://vista.cira.colostate.edu/IMPROVE). Additionally, CSN speciated data was downloaded from the AQS system (https://www3.epa.gov/ttnamti1/speciepg.html). Data from 58 IMPROVE sites and 127 CSN sites in the modeling domain were used in this analysis.

DISCOVER-AQ

Two research airplanes (a NASA P-3B and a UC-12) flew 14 days, sampling in coordination with ground sites, monitoring air quality in the Baltimore-Washington corridor in 2011. The NASA P-3B spiraled over six ground stations in Maryland and the UC-12 used a LiDAR to observe "profiles" of particulate pollution in the atmosphere. This data resource was predominantly used to inform a qualitative assessment of vertical ozone profiles.

Evaluation of CMAQ predictions

The following sections provide model evaluation information for the above referenced pollutants over the 12-km modeling domain. Details on the formulas used in this section can be seen in Appendix A.

Daily Maximum 8-hour Ozone Concentration

Model evaluation statistics, based on daily maximum 8-hour average ozone levels on days having: (1) at least 10 valid observations, and (2) an observed daily maximum ozone concentration of at least 60 ppb, are presented here for all sites across the modeling domain. The data covered the period from April 15 through October 30. Modeling results were computed using the Alpha2 platform. There are 226 OTR and 427 non-OTR SLAMS/NAMS sites. The use of the 60 ppb threshold focuses on model performance evaluation on the highest ozone days.

Figure 6-1 and Figure 6-2 display daily averages of observed and predicted daily maximum 8-hour ozone concentrations averaged across all SLAMS/NAMS sites in the OTR and outside of the OTR, respectively. These averages were computed for each day and considered all sites, not just ones that met the threshold. The dashed black line denotes 1:1, colored lines denote linear regression lines, and the green line denotes observed daily maximum ozone ≥60 ppb.

The overall tendency of CMAQ is to over-predict daily maximum ozone – 63% of CMAQ values at OTR sites are higher than observed (Figure 6-1); 60% of CMAQ values at non-OTR sites are higher than observed (Figure 6-1). However, at observed daily maximum ozone concentrations >60 ppb, CMAQ tends to under-predict ozone – on such days 68% of CMAQ values at OTR sites are lower than observed, and 77% of CMAQ values at non-OTR sites are lower than observed. The under-prediction in the OTR is less when solely looking at the 1st high maximum and the 4th high maximum (Figure 6-3). It is also less in the region outside of OTR for the 1st high maximum and the 4th high maximum (Figure 6-3).

Figure 6-1: Comparison of daily maximum 8-hour ozone concentrations at OTR sites

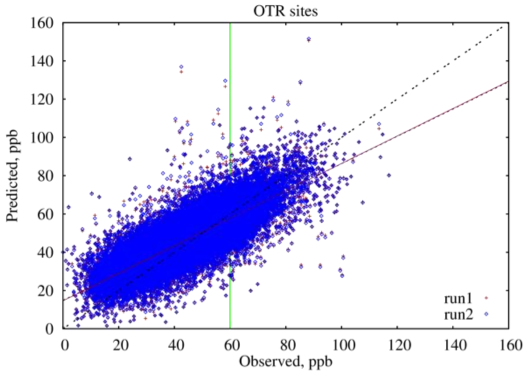


Figure 6-2: Comparison of daily maximum 8-hour ozone concentrations at non-OTR sites

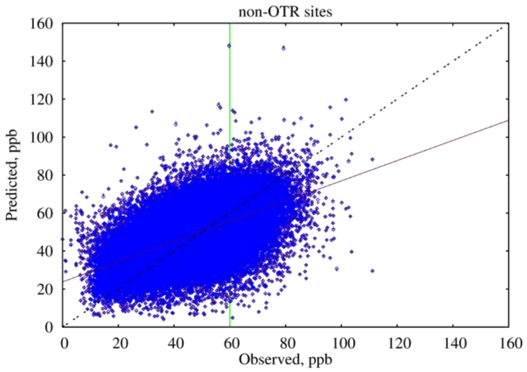


Table 6-1: Correlation coefficients for 1st and 4th highest maximum 8-hour ozone concentrations in 2011 base case modeling

	1st highest maximum	4th highest maximum
OTR	0.68	0.78
Outside-OTR	0.31	0.38

Figure 6-3: Comparison of 1st highest maximum (left) and 4th highest maximum (right) 8-hour ozone concentrations at OTR sites

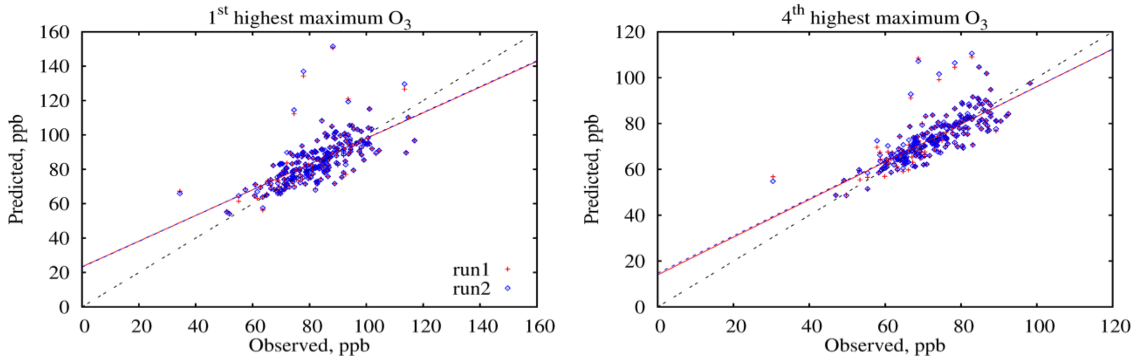
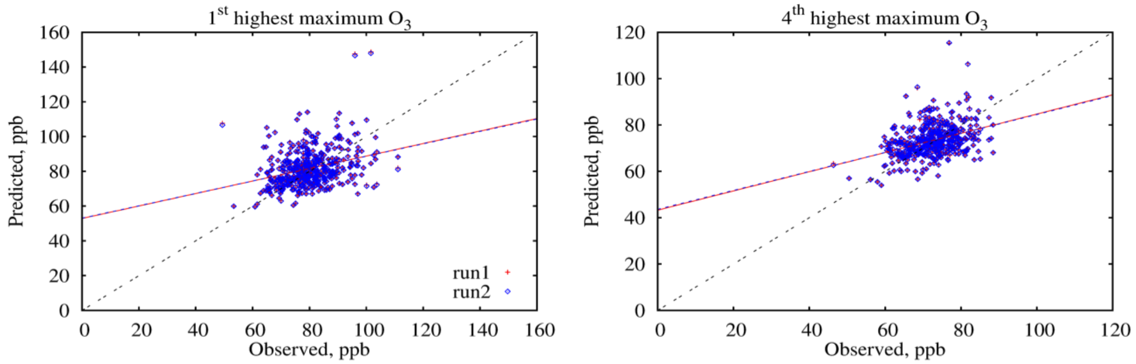


Figure 6-4: Comparison of 1st highest maximum (left) and 4th highest maximum (right) 8-hour ozone concentrations at non-OTR sites



CMAQ captured the observed temporal variation well (Figure 6-5). CMAQ captured the observed temporal variation well with both Alpha 2 and Beta emissions with the Beta emissions yielding comparable 8-hour ozone results to Alpha2 emissions though in a few cases Beta results were slightly higher (Figure 6-5 and Figure 6-6).

Figure 6-5: Observed versus predicted 2011 ozone concentration (ppb; mean ± 1 standard deviation) using Alpha 2 Inventory in the OTR where daily max was greater than 40 ppb

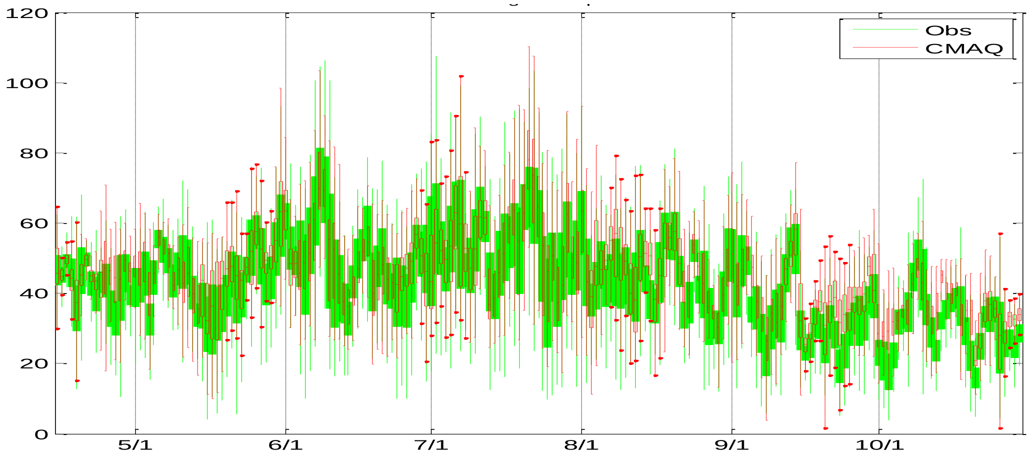
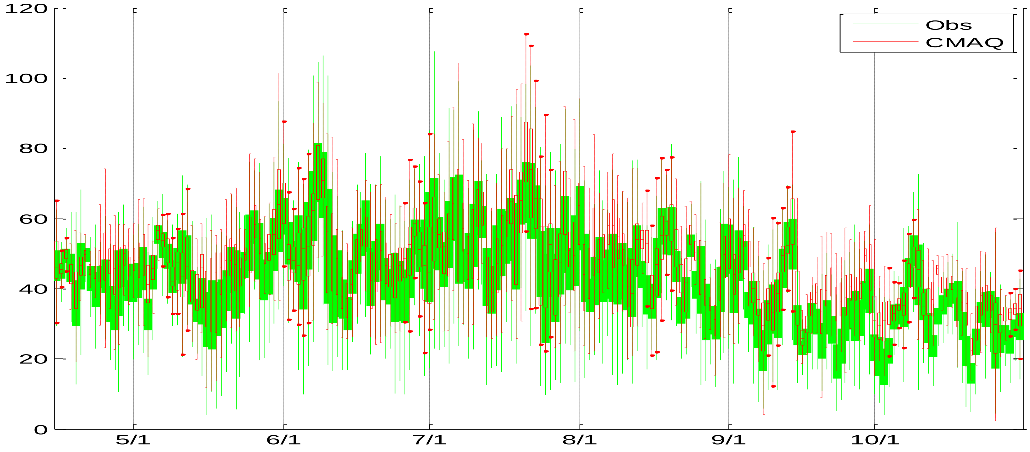


Figure 6-6: Observed versus predicted 2011 ozone concentration (ppb; mean ± 1 standard deviation) using Beta Inventory in the OTR where daily max was greater than 40 ppb



Geographically, the MFE is higher in New England than in the Mid-Atlantic OTR and much higher outside of the region, in particular in LADCO (Figure 6-7). The Beta emissions showed less MFE compared to Alpha2 emissions, especially within the inner-OTR region (Figure 6-8). MFB are small and close to zero bias in the northeast region while in the LADCO region MFB is more negative indicating CMAQ's under-prediction which may be caused by the boundary conditions (Figure 6-9). The Beta emissions also showed improvement in correcting the prediction bias, especially in the inner-OTR region (Figure 6-10). There are several monitors on the Atlantic coast, in particular along the Long Island Sound, that have a positive MFB, and the general under-prediction in the OTR is more prominent in southern New England.

Outside of the region MFB shows the most under-prediction in LADCO and CENSARA states. MAGE is most prominent along the I-95 corridor and along Lake Erie, though the highest MAGE is seen at Mt Washington in New Hampshire (Figure 6-11). Similar to MFE, the Beta emissions also indicated the improvement in reducing error by CMAQ predictions (Figure 6-12). MAGE is also higher outside of the OTR, in particular in the LADCO and CENSARA states. One potential reason for higher MFE and MAGE in the LADCO and CENSARA regions may be boundary conditions.

Figure 6-7: MFE in daily max 8-hr ozone Alpha 2, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)

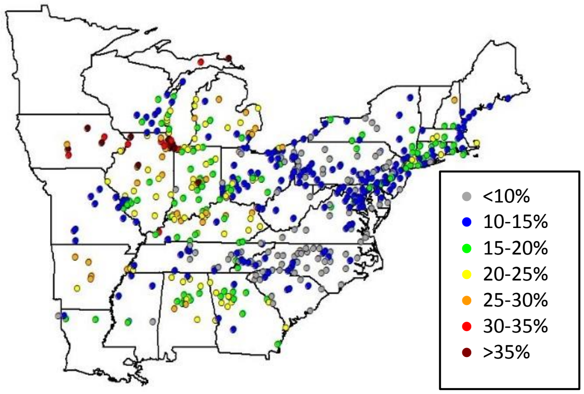
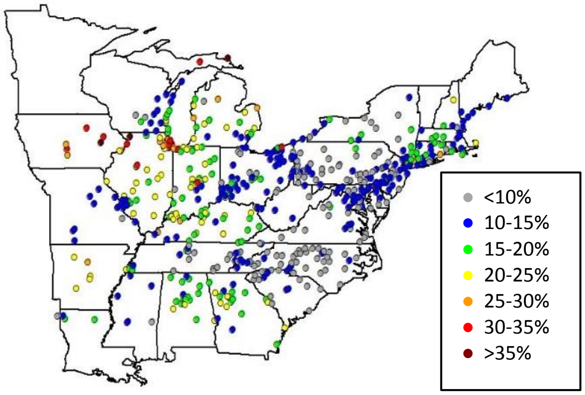


Figure 6-8: MFE in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)



Note: When looking at MFE in the figures above, cooler colors (e.g. gray, blue, green) indicate better model performance.

Figure 6-9: MFB in daily max 8-hr ozone Alpha 2, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)

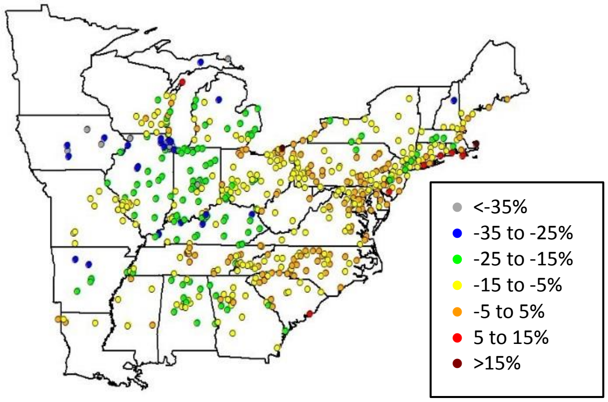
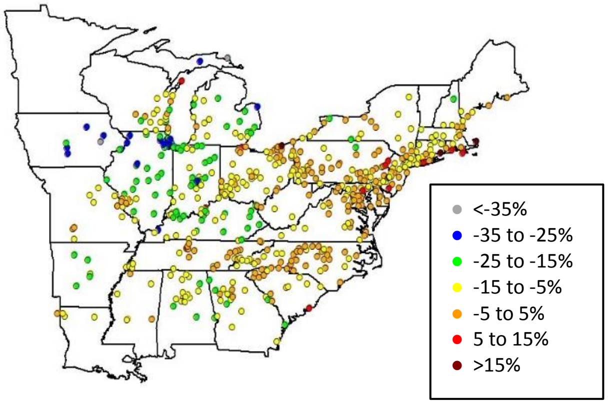


Figure 6-10: MFB in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)



Note: When looking at MFB in the figures above, warm colors (yellow and orange) indicate better model performance.

Figure 6-11: MAGE in daily max 8-hr ozone Alpha 2, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)

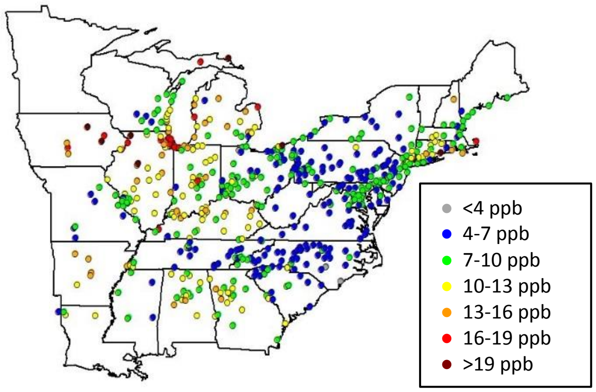
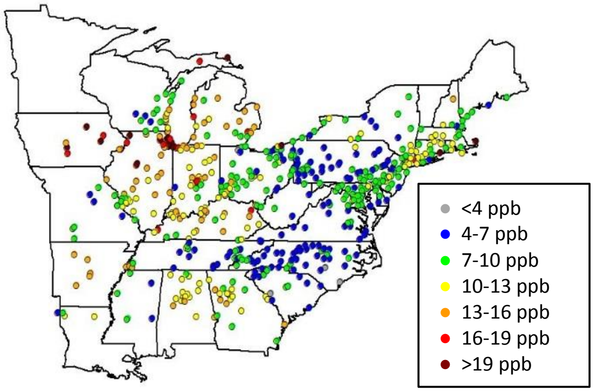


Figure 6-12: MAGE in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold (183 of 226 OTR sites; 372 of 427 non-OTR-sites)



Note: When looking at MAGE in the figures above, cooler colors (e.g. gray, blue, green) indicate better model performance.

Gamma Platform Improvements

For the Gamma modeling platform several improvements were made and evaluated. Firstly the chemistry mechanism was upgraded to CB6 from CB5. Additionally, several inventory sectors were upgraded including onroad mobile (increased penetration of e-85 fuel and speciation updates), nonpoint, oil & gas, portable fuel containers, and agricultural fire sectors. Finally, improvements were made to the way in which marine emissions were modeled.

When comparing the MFE between Beta (Figure 6-13) and Gamma (Figure 6-14) one can see a decrease in error, in particular along I-95 corridor monitors in the OTR. Monitors along the I-95 corridor see MFB that was negative in Beta (Figure 6-15) getting closer to 0 in Gamma (Figure 6-16). Finally there are decreases in MAGE seen in Gamma (Figure 6-18) from what was modeled in Beta (Figure 6-17). Overall the Gamma modeling platform would appear to be an improvement over the Beta platform in key locations in the OTR.

Figure 6-13: MFE in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold

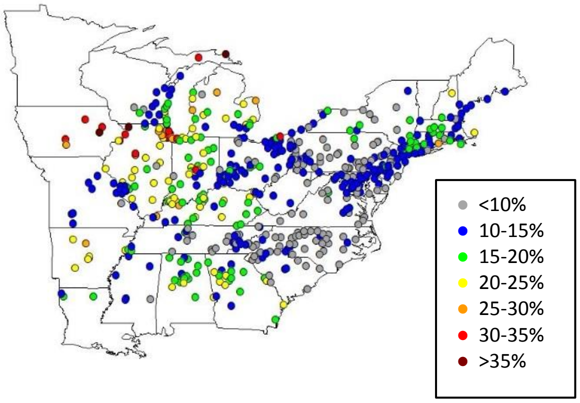
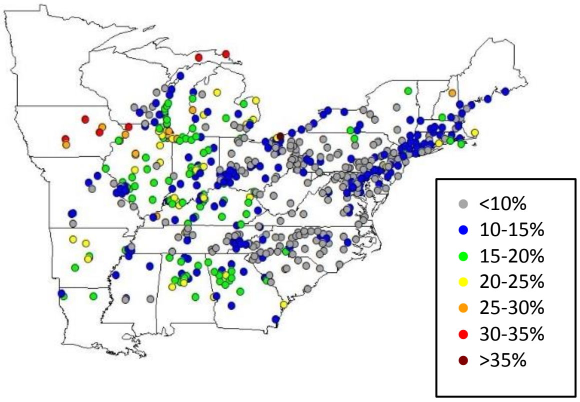


Figure 6-14: MFE in daily max 8-hr ozone Gamma, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold



Note: When looking at MFE in the figures above, cooler colors (gray, blue, green) indicate better model performance.

Figure 6-15: MFB in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold

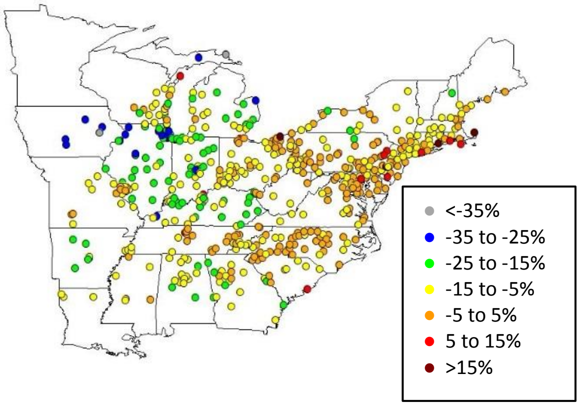
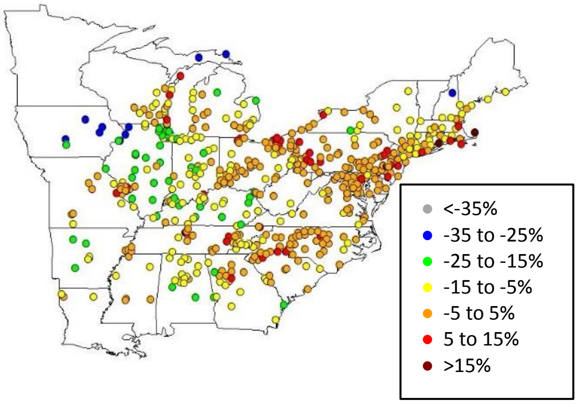


Figure 6-16: MFB in daily max 8-hr ozone Gamma, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold



Note: When looking at MFB in the figures above, warm colors (yellow and orange) indicate better model performance.

Figure 6-17: MAGE in daily max 8-hr ozone Beta, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold

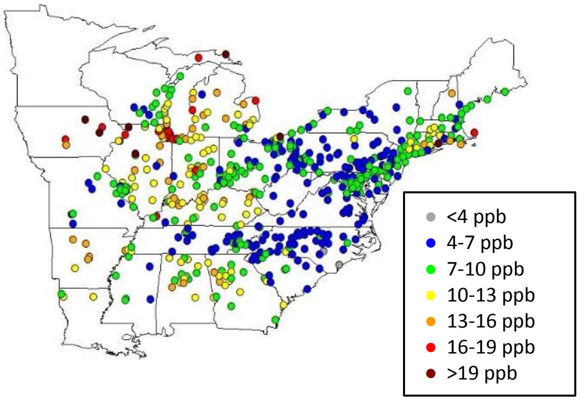
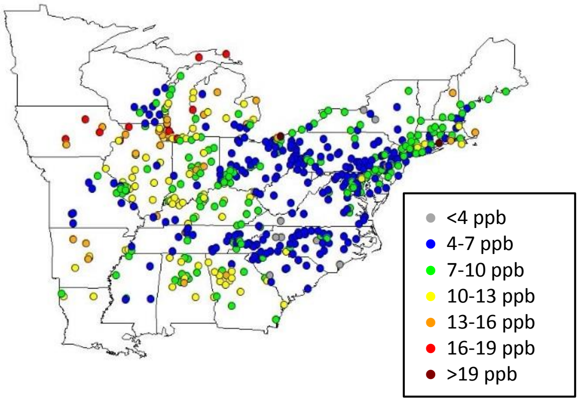


Figure 6-18: MAGE in daily max 8-hr ozone Gamma, 60 ppb threshold, Apr 15-Oct 30; only monitors with 10 days greater than 60 ppb threshold



Note: When looking at MAGE in the figures above, cooler colors (gray, blue, green) indicate better model performance.

In Figure 6-19 one can see how MFB, which tended negative in the Beta platform, improved overall compared to Gamma platform. Figure 6-20 shows a similar comparison or MFE and one can see an overall reduction in MFE moving from the Beta to the Gamma platform.

Figure 6-19: MFB comparison between Gamma (y-axis) and Beta (x-axis)

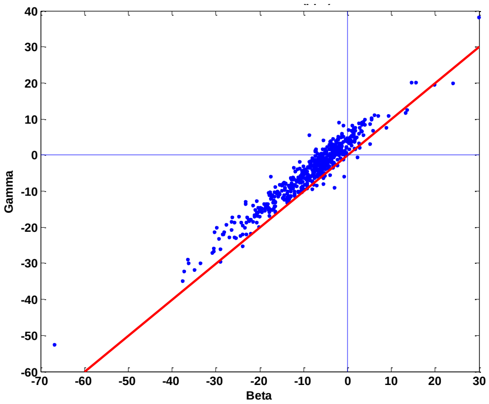
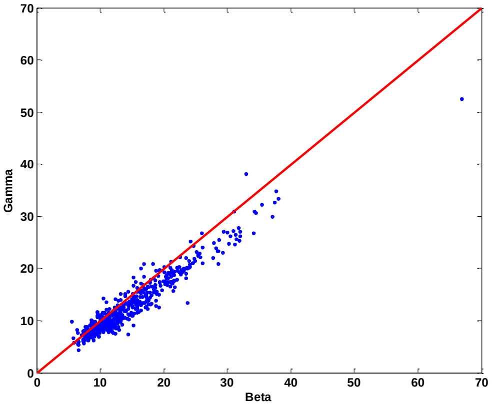


Figure 6-20: MFE: comparison between Gamma (y-axis) and Beta (x-axis)

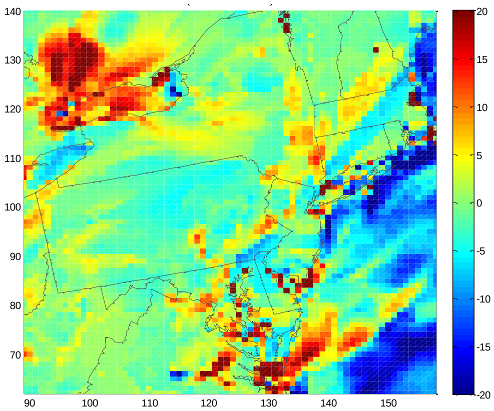


The data presented in Table 6-2 summarizes the improvements seen going from Beta to Gamma. Every category saw an increase in the number of monitors meeting the performance statistics, both inside and outside of the OTR.

Table 6-2: Summary statistics for MFE, MFB, and MAGE from the Beta and Gamma modeling platforms

	MFE ≤ 15%	|MFB| ≤ 15%	MAGE ≤ 10 ppb
Beta, all sites (n=553)	n=346	n=441	n=371
Gamma, all sites (n=553)	n=395	n=483	n=407
Beta, OTR sites (n=183)	n=156	n=176	n=161
Gamma, OTR sites (n=183)	n=171	n=178	n=169

Figure 6-21: Difference in Ozone Seasonal 8-Hour Maximum (Gamma – Beta)



To get an idea of the changes in the baseline results that impact RRF calculations you can examine Figure. There are increases in ozone levels in some grid cells near the Chesapeake and Delaware Bays, decreases in ozone levels in the Atlantic, and increase in ozone levels north of and over Lake Erie.

Finally, we can look at the improvements in modeled diurnal patterns. Five key monitors with typically high ozone values were evaluated (Susan Wagner (Figure 6-22) and Babylon (Figure 6-23) in New York, Greenwich (Figure 6-24) and Westport (Figure 6-25) in Connecticut, and Edgewood (Figure 6-26) in Maryland). The Gamma platform continues to follow the observed diurnal pattern at these five monitors with improvements seen on some days and less accurate predictions than Beta on others. Overall the Gamma platform appears to replicate the diurnal patterns equally as well as the Beta platform did at the five selected monitors.

Figure 6-22: Comparison of hourly ozone modeled with the Gamma and Beta platforms to observed at Susan Wagner, NY (360850067)

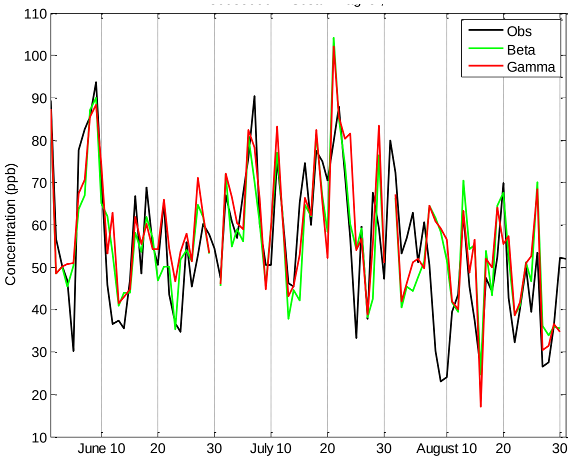


Figure 6-23: Comparison of hourly ozone modeled with the Gamma and Beta platforms to observed at Babylon, NY (361030002)

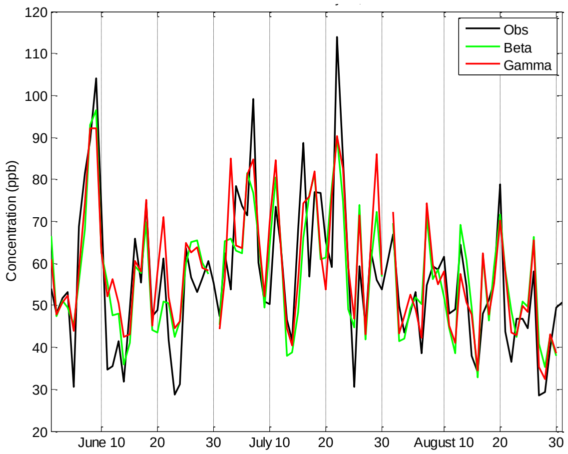


Figure 6-24: Comparison of hourly ozone modeled with the Gamma and Beta platforms to observed at Greenwich, CT (090010017)

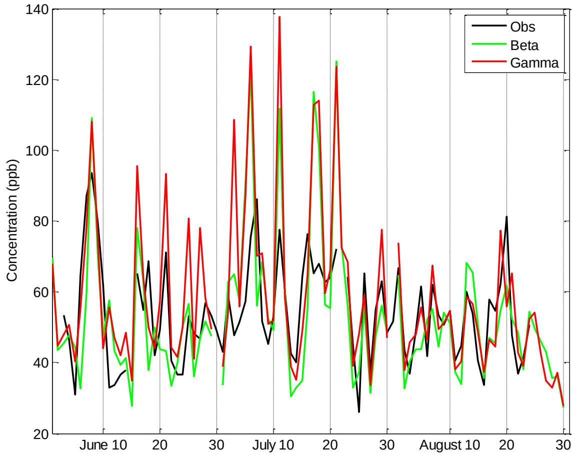


Figure 6-25: Comparison of hourly ozone modeled with the Gamma and Beta platforms to observed at Westport, CT (090190003)

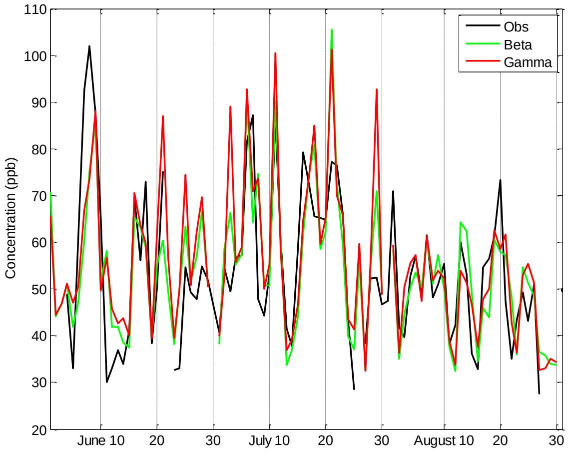
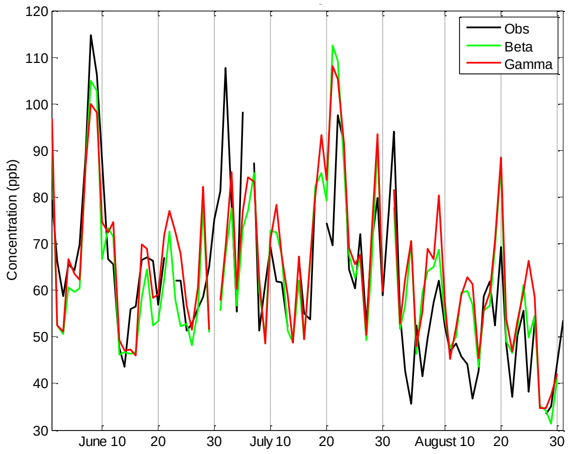


Figure 6-26: Comparison of hourly ozone modeled with the Gamma and Beta platforms to observed at Edgewood, MD (240251001)



Evaluation of Ozone Aloft

On June 8-9 and July 21-23, 2011 ozone sondes were launched at Edgewood, MD (Penn State University), Beltsville, MD (Howard University), and Egbert, ON. UMD flew aircraft spirals over Churchville, MD (0W3), Cumberland, MD (CBE), Easton, MD (ESN), Frederick, MD (FDK), Massey, MD (MD1), Luray, VA (W45), and Winchester, VA (OKV). The NASA P3 from the DISCOVER-AQ program flew spirals over Beltsville, MD, Padonia, MD, Fairhill, MD, Aldino, MD, Edgewood, MD, and Essex, MD.

Averages and standard deviations for the measurements were calculated for each elevation that corresponded to the height of a layer used in CMAQ modeled runs. Grid cells that corresponded temporally and geographically to the measurements from the location of the ozone measurement (e.g., sonde launch site) from DISCOVER-AQ were used as the prediction with which the observed data would be compared.

Predictions above 3 km were generally accurate when compared to the morning profile, but under-predicted, especially above 8 km (Figure 6-27). Between 0.5 km and 3 km CMAQ under-predicted observed concentrations by around 5 ppb during both the morning and evening hours. We found that CMAQ predictions were fairly accurate below approximately 0.5 km. The results are similar with CMAQ run with both inline point sources (Run 1) and SMOKE processed point sources (Run 2).

Figure 6-27: Observed ozone concentration (ppb) layer average and standard deviation compared to CMAQ layers up to 10 km

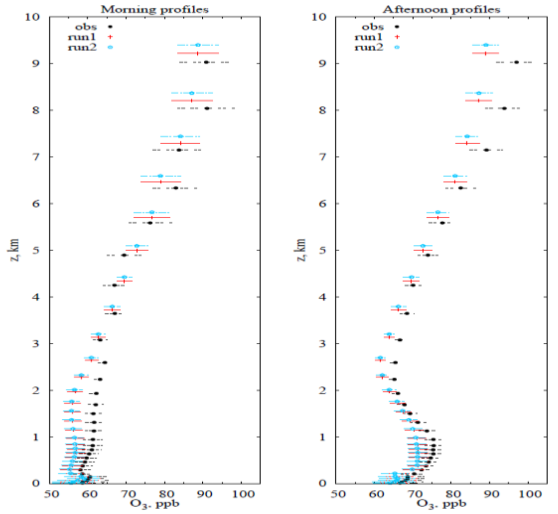
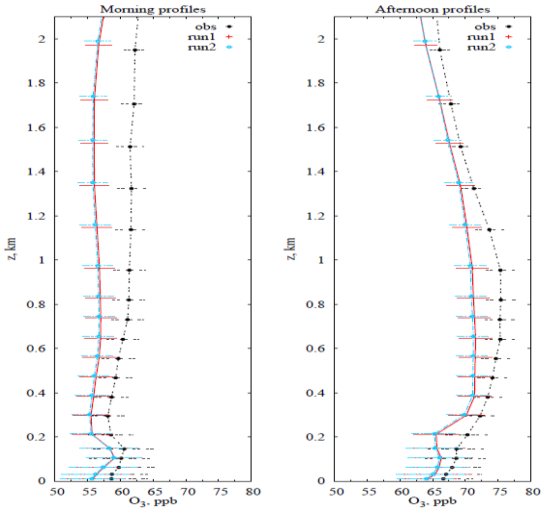


Figure 6-28: Observed ozone concentration (ppb) layer average and standard deviation compared to CMAQ layers up to 2 km



Evaluation of Fine Particulate Matter

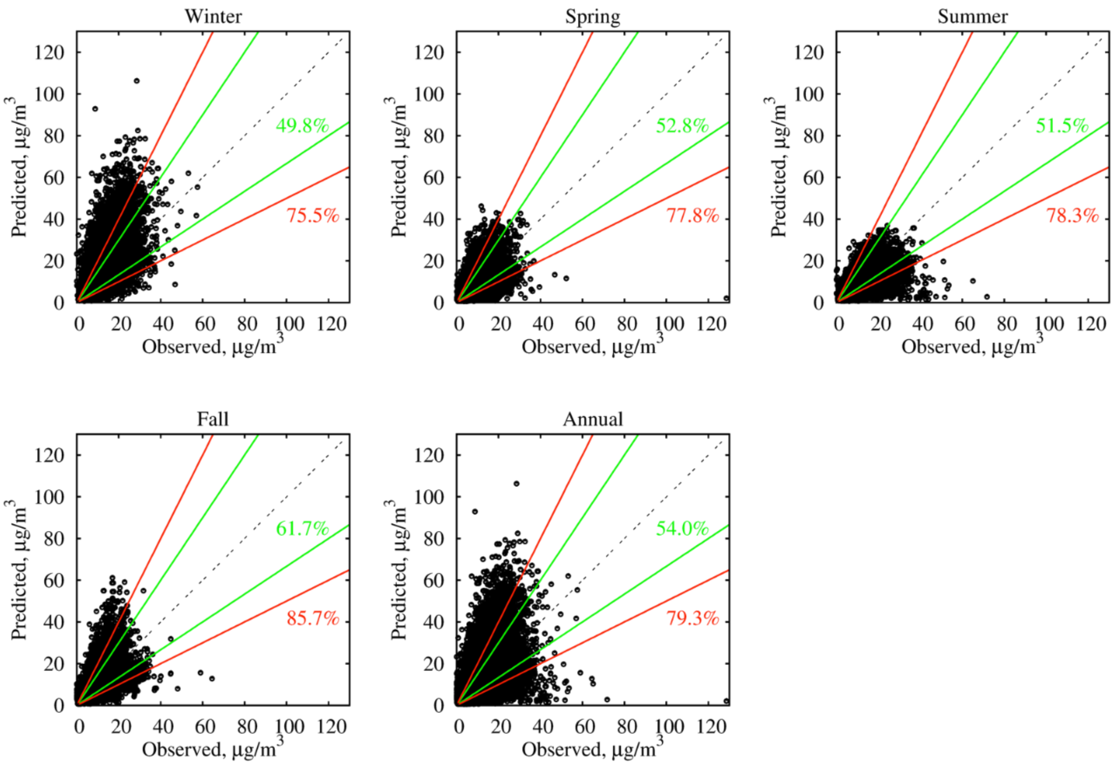
Composite daily average predicted and observed concentrations of $PM_{2.5}$ FRM mass were compared to determine the validity of the modeling results prior to evaluating individual species needed for haze model validation. Our model performance goals of MFB ≤ ±30% and MFE ≤50% as well as model performance criteria of MFB ≤±60% and MFE ≤75% were set by the OTC modeling committee. These performance goals and criteria were also used by other RPOs when evaluating $PM_{2.5}$ model performance (Brewer et al. 2007). CMAQ met the MFB ±30% goal on 63% of days and the MFB ±60%performance criteria nearly every day. CMAQ met the MFE 50% goal on 82% of days and the MFE 75%performance criteria every day as seen in Table 6-3. MAGE was also found to be acceptably low on 64% of days.

Table 6-3: Summary statistics for predicted $PM_{2.5}$ FRM mass

	ALL DAYS (N=365)	1-IN-3-DAY (N=121)
MFB ≤ ±30%	230 (63.0%)	79 (65.3%)
MFB ≤ ±60%	360 (98.6%)	121 (100%)
MFE ≤ 50%	300 (82.2%)	98 (81.1%)
MFE ≤ 75%	365 (100%)	121 (100%)
MAGE ≤ 5 mg/m^3	235 (64.4%)	80 (66.1%)

Annually, $PM_{2.5}$ is over predicted, with the greatest over-prediction occurring during the winter months and the summer months leaning towards a slight under-prediction (Figure 6-29).

Figure 6-29: Comparison of daily observed and predicted $PM_{2.5}$ FRM mass, annual and by season with 1:1 (dashed), 1:1.5 (green) and 1:2 (red) lines for Winter (D/J/F), Spring (M/A/M), Summer (J/J/A), Fall (S/O/N), and Annually.



When looking temporally, one finds the greatest over-prediction during the winter months and slight under-prediction during the summer (Figure 6-30, Figure 6-31) and the result holds for those monitors on the 1 in 3 day schedule. MFE is high throughout the year with the greatest peaks in the summer time

(Figure 6-32, Figure 6-33). MFB is positive in the winter time, which is indicative of under-prediction and negative during the summer time, which is indicative of over-prediction (Figure 6-34, Figure 6-35). MAGE is greatest during the winter and summer (Figure 6-36, Figure 6-37).

Figure 6-30: Observed and predicted $PM_{2.5}$ FRM mass, all days

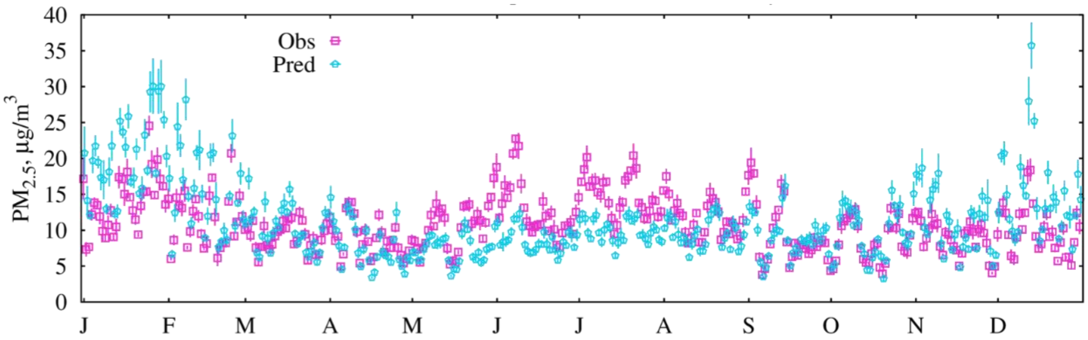


Figure 6-31: Observed and predicted $PM_{2.5}$ FRM mass, 1-in-3 day schedule

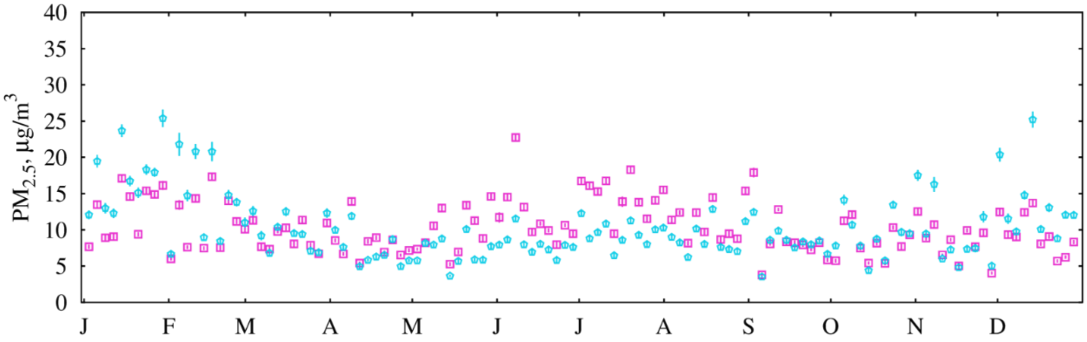


Figure 6-32: MFE $PM_{2.5}$ FRM mass, all days

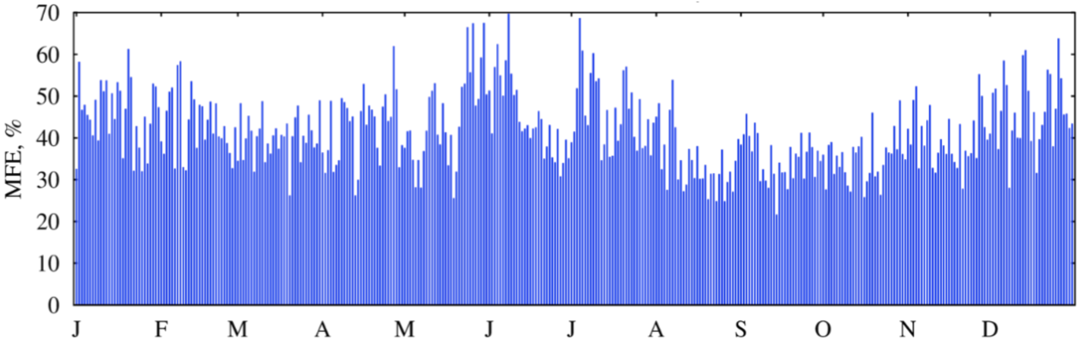


Figure 6-33: MFE PM$_{2.5}$ FRM mass, 1-in-3 day schedule

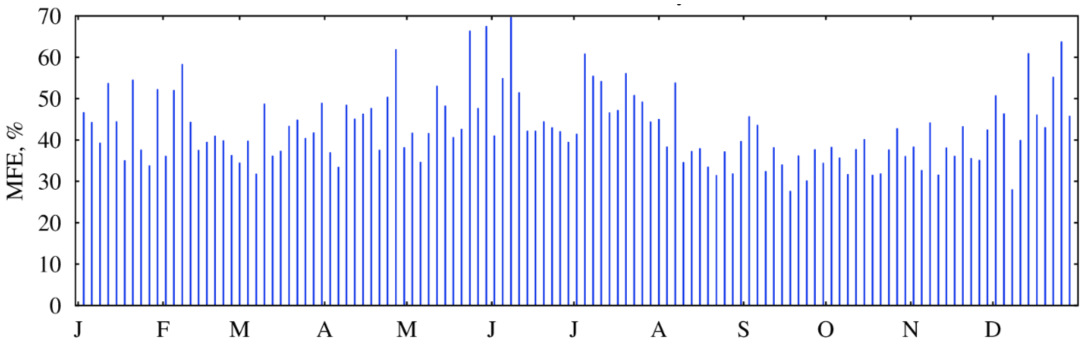


Figure 6-34: MFB PM$_{2.5}$ FRM mass, all days

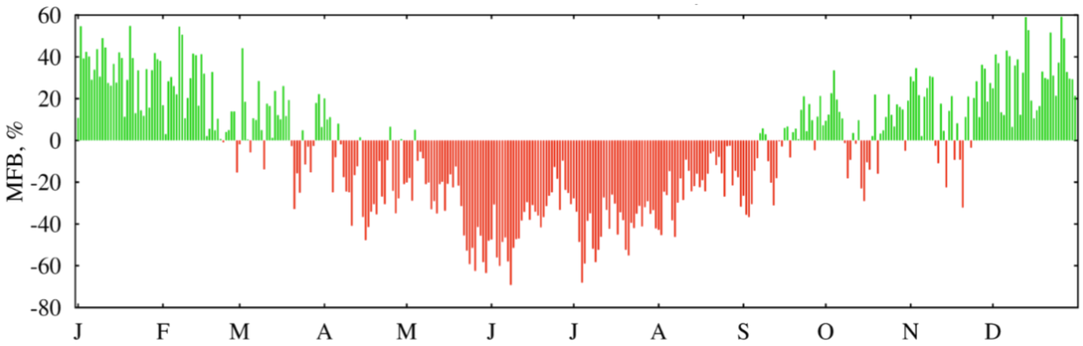


Figure 6-35: MFB PM$_{2.5}$ FRM mass, 1-in-3 day schedule

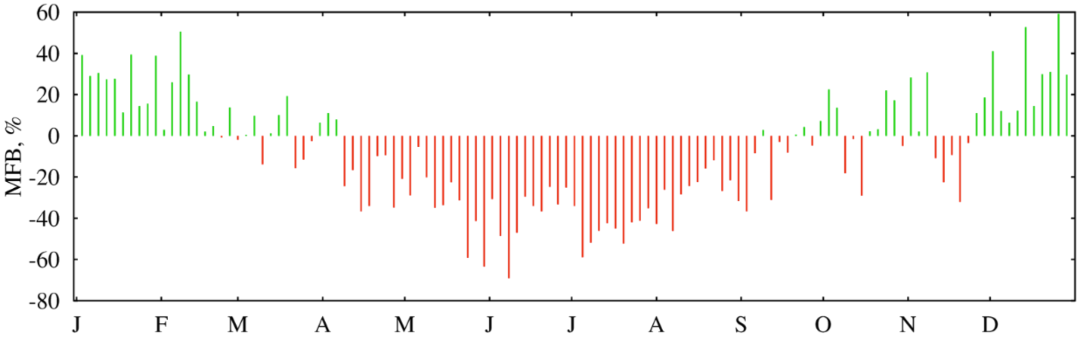


Figure 6-36: MAGE PM$_{2.5}$ FRM mass, all days

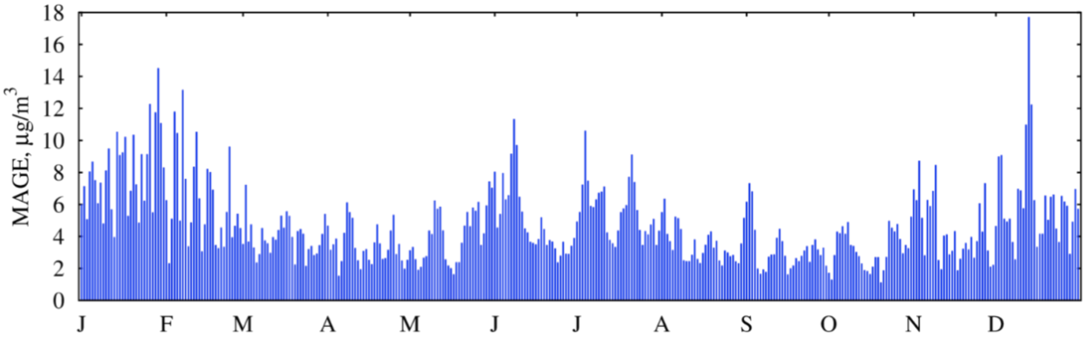
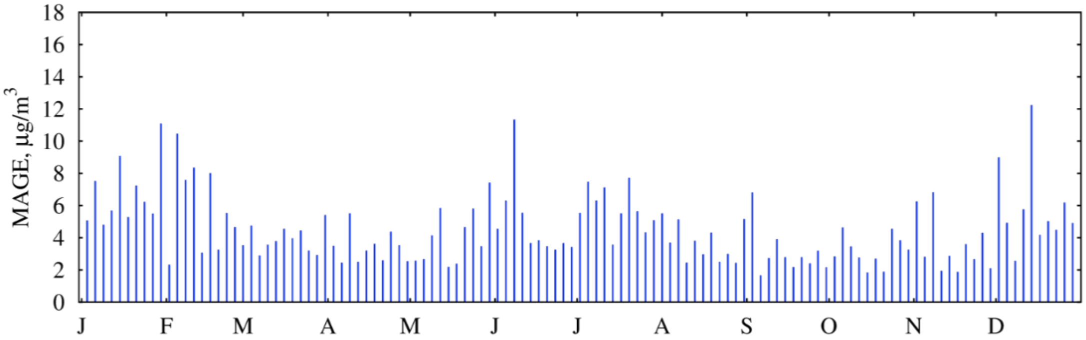


Figure 6-37: MAGE $PM_{2.5}$ FRM mass, 1-in-3 day schedule



As a first step in geographic evaluation we looked at the differences between observed (Figure 6-38) and predicted values (Figure 6-39) and one can see that some areas of MANE-VU are achieving different results annually. The greatest MFE for $PM_{2.5}$ in MANE-VU occurs in northern New England and decreases towards the southern portion of MANE-VU, though there are also some higher MFE values along the coast (Figure 6-40). The same areas in New England are biased towards over-prediction as well, with under-prediction occurring in more populated portions of MANE-VU (Figure 6-41). MAGE remains fairly consistent geographically (Figure 6-42).

Figure 6-38: Observed annual average $PM_{2.5}$ FRM mass, 2011 (only monitors with ≥10 days of data are shown)

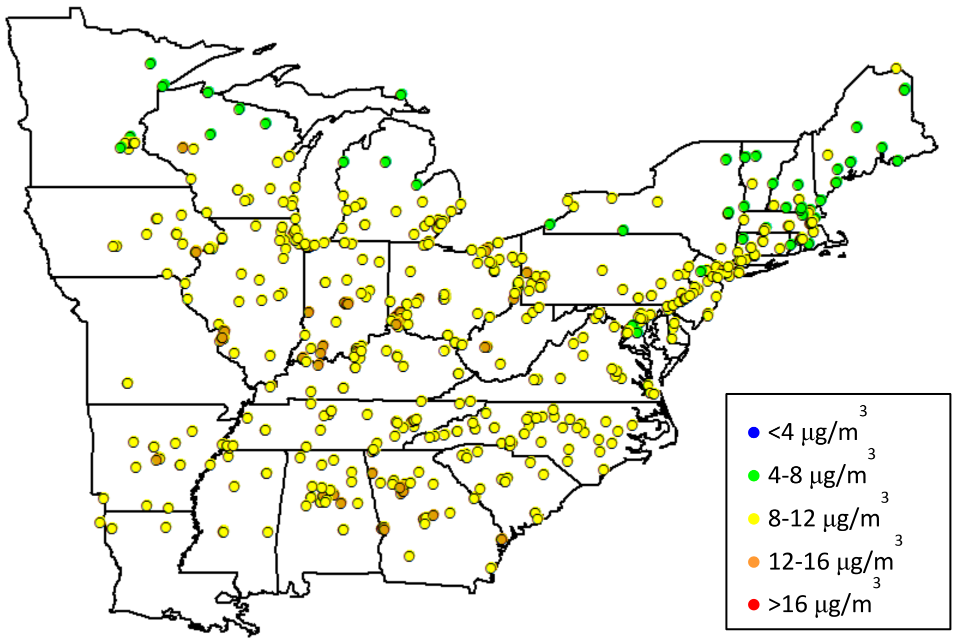


Figure 6-39: Predicted annual average $PM_{2.5}$ FRM mass, 2011 (only monitors with ≥10 days of data are shown)

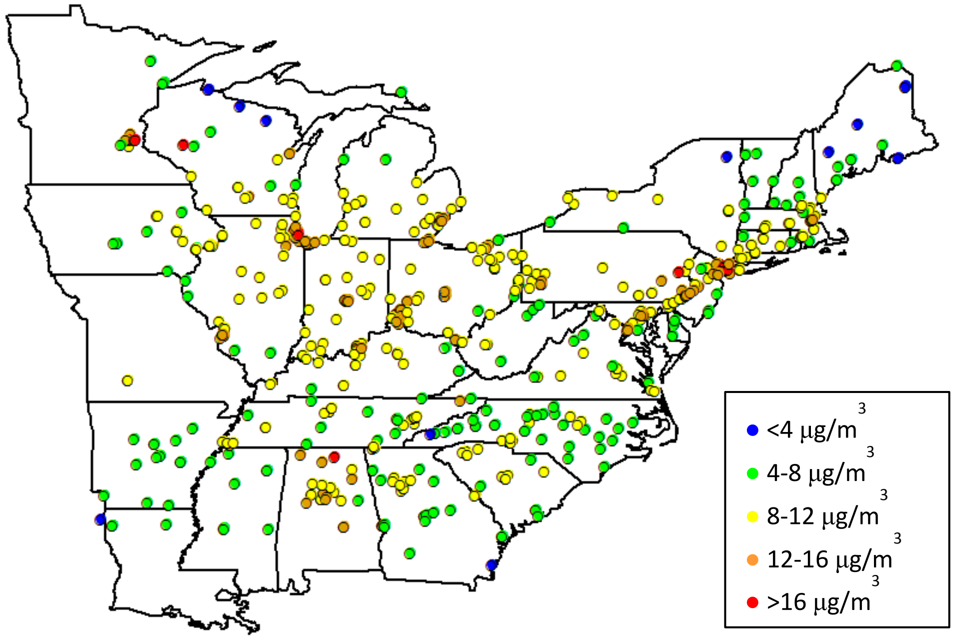
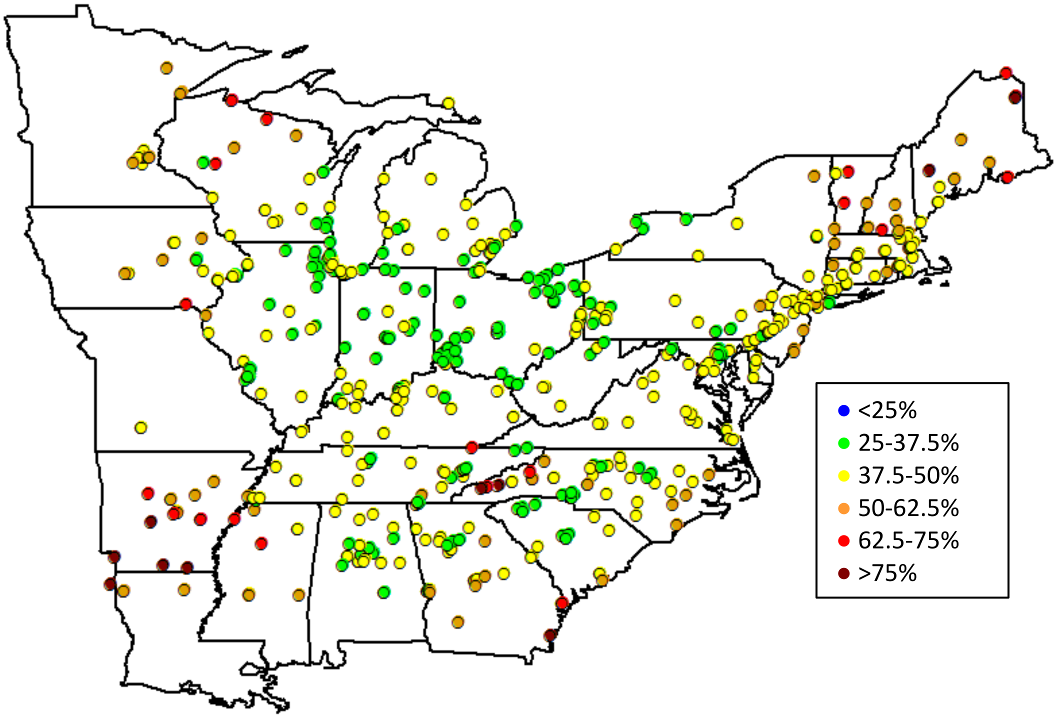
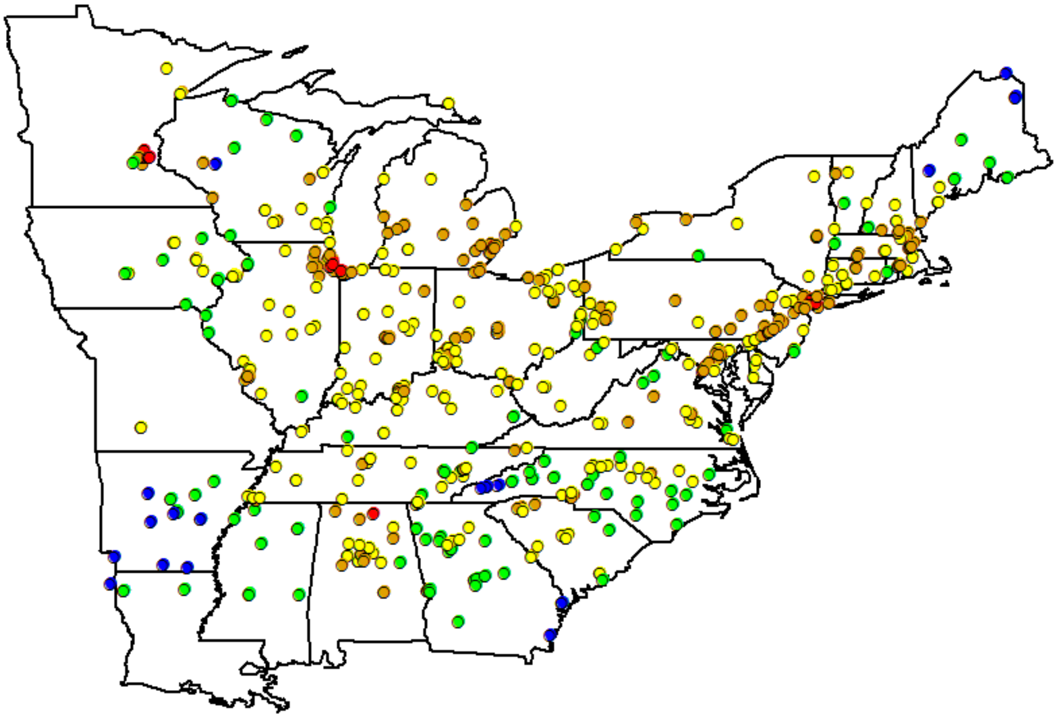


Figure 6-40: MFE in $PM_{2.5}$ FRM mass, 2011 (only monitors with ≥10 days of data are shown)



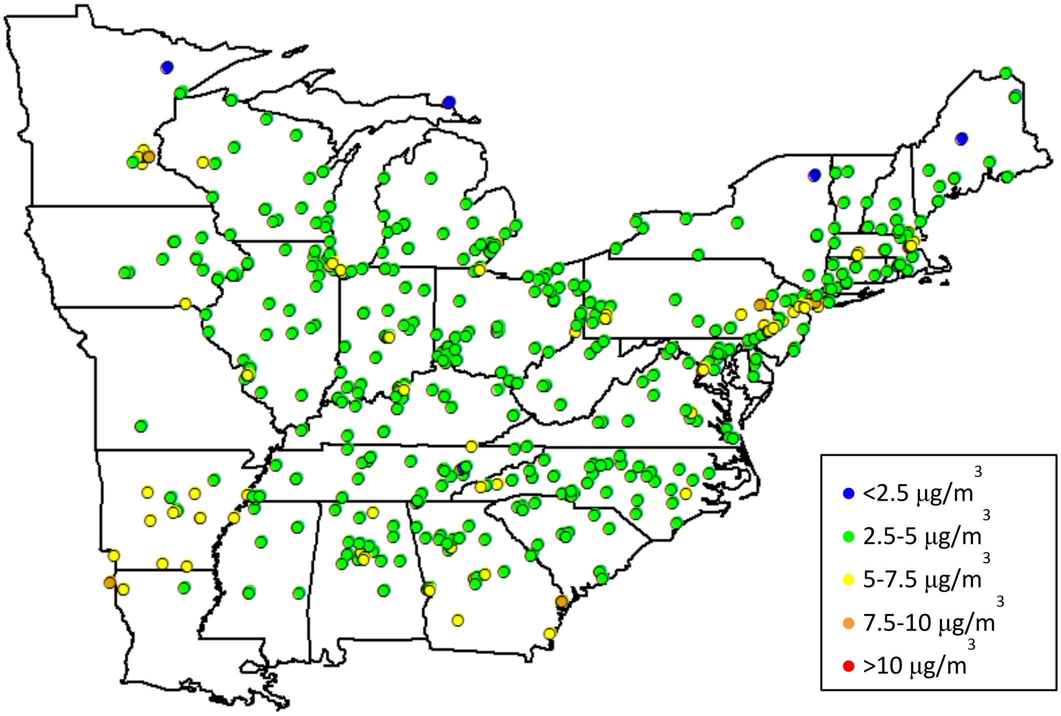
Note: When looking at MFE in the figure above, blue and green colors indicate better model performance.

Figure 6-41: MFB in PM2.5 FRM mass, 2011 (only monitors with ≥10 days of data are shown)



Note: When looking at MFB in the figure above, yellow and orange colors indicate better model performance.

Figure 6-42: MAGE in PM$_{2.5}$ FRM mass, 2011 (only monitors with ≥10 days of data are shown)



Note: When looking at MAGE in the figure above, blue and green colors indicate better model performance.

Evaluation of Visibility

In this section we evaluate the model performance with respect to visibility, in particular of the $PM_{2.5}$ species used in the IMPROVE algorithm to estimate visibility impairment. Data from 58 IMPROVE sites and 127 CSN sites in the modeling domain were used in this analysis and the data cover the entire 2011 year.

Soil/crustal matter is assumed to consist of oxides of Aluminum (Al), Calcium (CA), Iron (Fe), Silicon (Si), and Titanium (Ti). The IMPROVE OC blanks are assumed to equal zero. Since CMAQ was employed, we used 2.5 m "sharp cutoff" variables as opposed to the sum of I+J modes.

CSN reports EC & OC by TOT and TOR, IMPROVE only by TOR; for this analysis, TOR data from CSN and IMPROVE were combined and CSN TOT data were considered separately. IMPROVE reports blank-corrected OC and CSN does not, so for this analysis, annual average site-specific blank values (generally about 0.2-0.3 $\mu g/m^3$) were subtracted from the CSN data.

The equations used to calculate RCFM and light extinction are as follows:

Equation 6-1: Calculation of RCFM

$$RCFM = 1.37Mass_{SO4} + 1.29Mass_{NO3} + Mass_{EC} + 1.8Mass_{OC} + Mass_{Soil} + 1.8Mass_{Cl}$$

Equation 6-2: Calculation of extinction from Ammonium Sulfate

$$Ext_{NH4SO4} = 3f(RH) * 1.37Mass_{SO4}\ (assume\ SO4\ fully\ neutralized\ by\ NH4)$$

Equation 6-3: Calculation of extinction from Ammonium Nitrate

$$Ext_{NH4NO3} = 3f(RH) * 1.2Mass_{NO3}\ (assume\ NO3\ fully\ neutralized\ by\ NH4)$$

Equation 6-4: Calculation of extinction from Elemental Carbon

$$Ext_{LAC} = 10Mass_{EC}$$

Equation 6-5: Calculation of extinction from POM

$$Ext_{POM} = 4 * 1.8Mass_{OC}\ (assume\ Mass_{POM} = 1.8\ Mass_{OC})$$

Equation 6-6: Calculation of extinction from Soil

$$Ext_{SOIL} = Mass_{SOIL}$$

Equation 6-7: Calculation of extinction from Sea Salt

$$Ext_{Salt} = 1.7f(RH) * 1.8Mass_{Cl}$$

Equation 6-8: Calculation of extinction from Coarse PM

$$Ext_{PM10} = 0.6Mass_{PM10}$$

We found that sulfate was under-predicted consistently throughout the year by 1 $\mu g/m^3$ with slightly higher under-prediction during summer (Figure 6-43). Nitrate was over-predicted by small margins during the winter months and very slightly under-predicted during summer (Figure 6-44). Ammonium was under-predicted throughout most of the year, although there was over-prediction during fall (Figure 6-45). Elemental carbon was over-predicted at all times of the year compared to TOR observations, though the over-prediction was less during the summer than other times of year (Figure 6-46). Organic carbon was over-predicted in the winter and under predicted in the summer but compared well during the shoulder months compared to TOR observations (Figure 6-47). Soil was over-predicted throughout the year with the least amount of over-prediction during the spring (Figure 6-48). Elemental carbon was over-predicted even more when compared to TOT observations than TOR (Figure 6-49). Organic carbon was over-predicted less in the winter and under-predicted more in the summer compared to TOT observations than TOR (Figure 6-50). The pattern of over and under-prediction more closely resembles that of organic carbon since the magnitude of organic carbon is much higher than that of elemental carbon (Figure 6-51).

Figure 6-43: SO_4 concentration (observed, CSN and IMPROVE, vs. predicted)

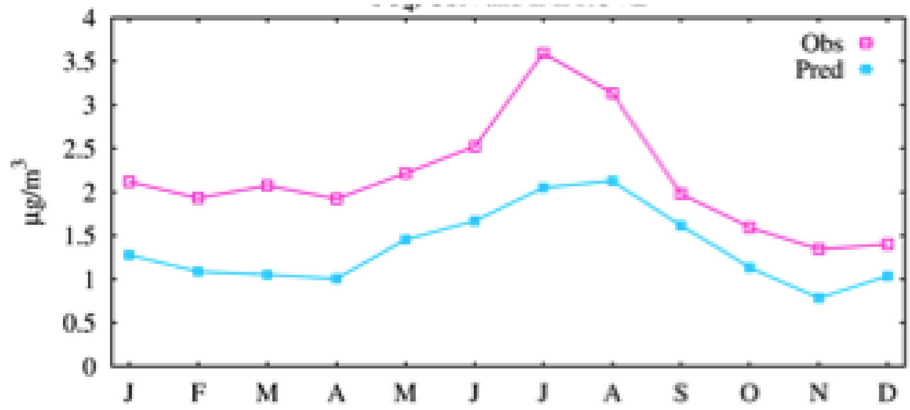


Figure 6-44: NO_3 concentration (observed, CSN and IMPROVE, vs. predicted)

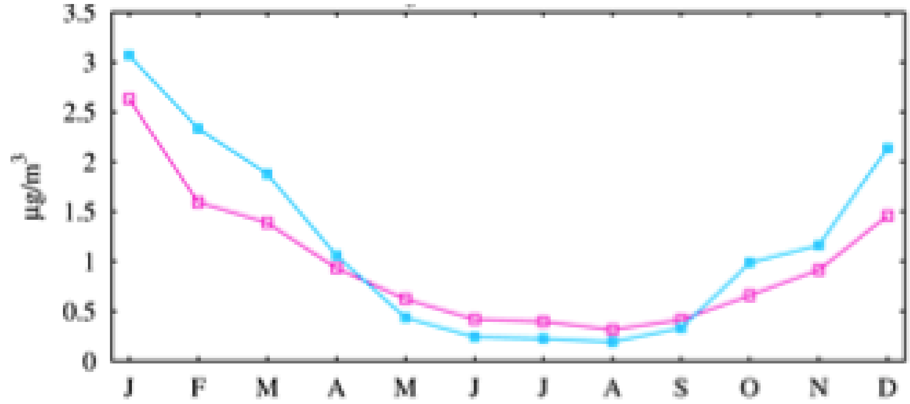


Figure 6-45: NH_4 concentration (observed, CSN only, vs. predicted)

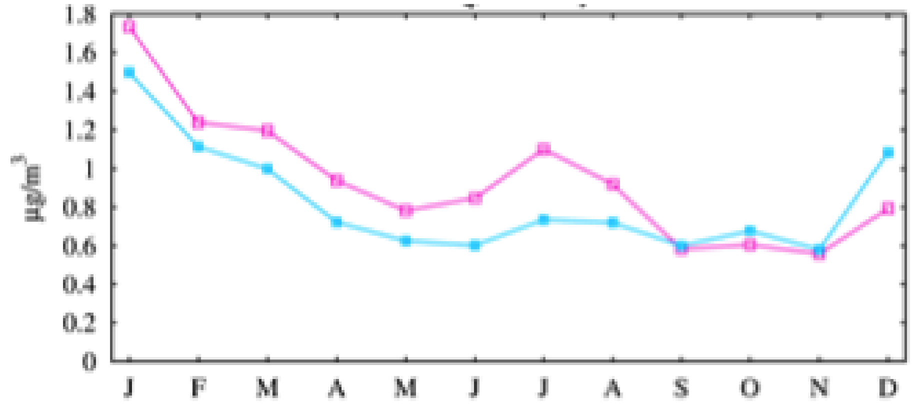


Figure 6-46: EC (TOR) concentration (observed, CSN and IMPROVE, vs. predicted)

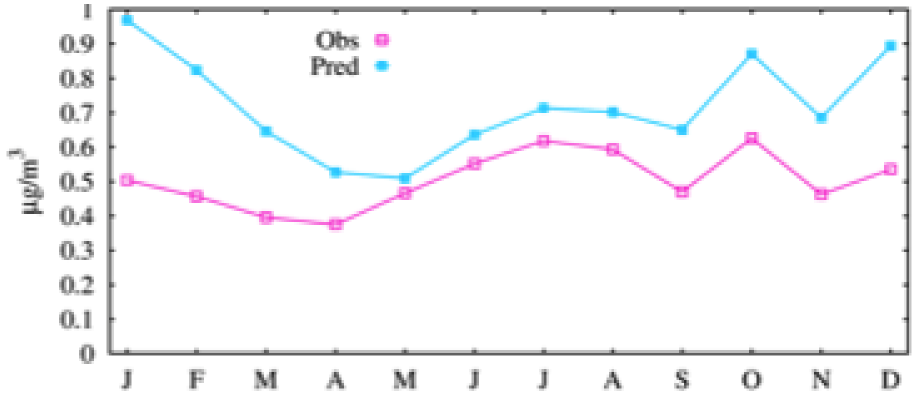


Figure 6-47: OC (TOR) concentration (observed, CSN and IMPROVE, vs. predicted)

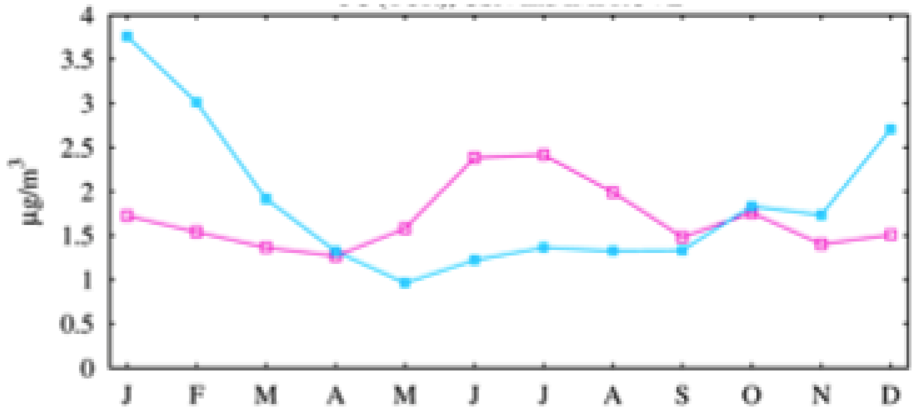


Figure 6-48: Soil concentration (observed, CSN and IMPROVE, vs. predicted)

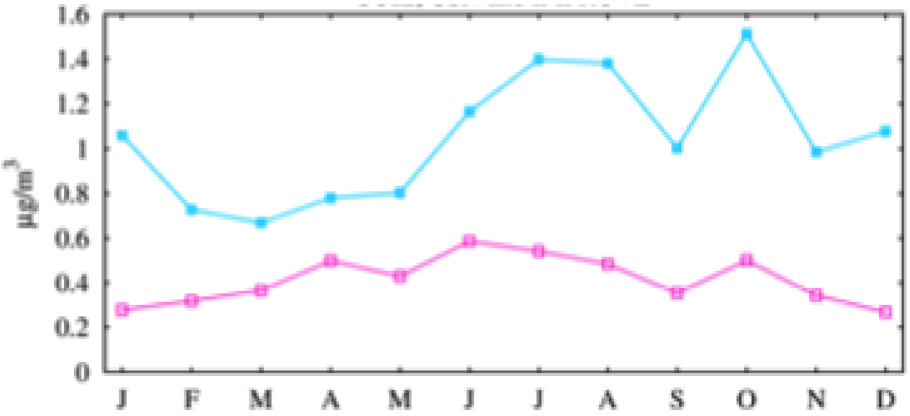


Figure 6-49: EC (TOR & TOT) concentration (observed, CSN only, vs. predicted)

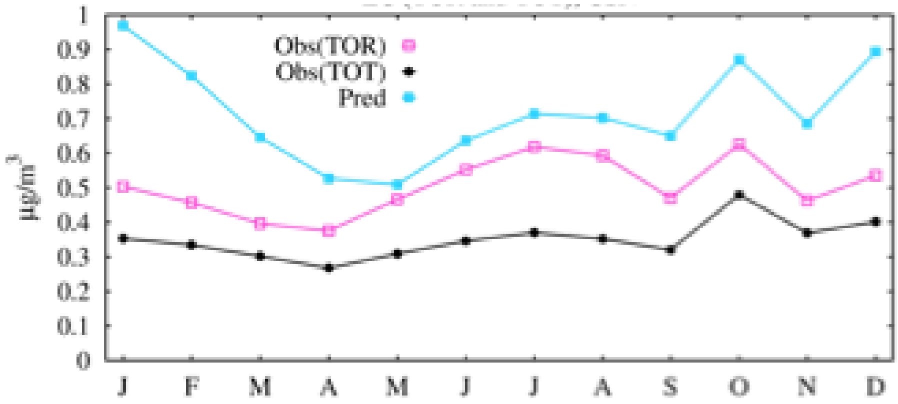


Figure 6-50: OC (TOR & TOT) concentration (observed, CSN only, vs. predicted)

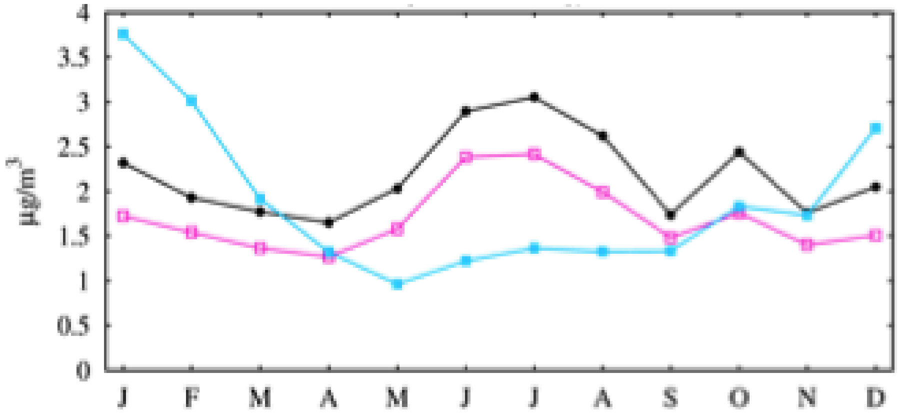
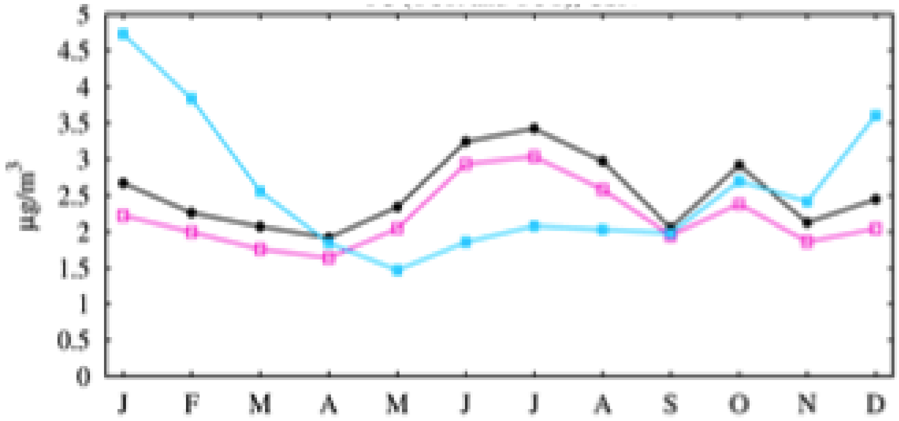


Figure 6-51: Total Carbon (TOR & TOT) concentration (observed, CSN only, vs. predicted)



Geographically MFB and MFE for SO_4 had the highest magnitude in northern New England (Figure 6-52 and Figure 6-53, respectively). MFB for NO_3 was lowest in magnitude in northern New England and biased quite low along the I-95 corridor, whereas MFE for NO_3 was quite high throughout the region (Figure 6-54 and Figure 6-55, respectively). MFB for NH_4 often tended to not be too high or low throughout the region and MFE was higher in New England than in the Mid-Atlantic (Figure 6-56 and Figure 6-57, respectively). MFB was high throughout the region, with the highest levels along the inner corridor and MFE was higher in New England than in the Mid-Atlantic (Figure 6-58 and Figure 6-59, respectively). MFB was high in along the inner corridor and sometimes quite low at more rural sites, and MFE was high throughout the MANE-VU region (Figure 6-60 and Figure 6-61, respectively). MFB and MFE were quite high for soil throughout MANE-VU (Figure 6-62 and Figure 6-63, respectively).

Figure 6-52: MFB SO_4, 2011 (only monitors with ≥10 days of data are shown)

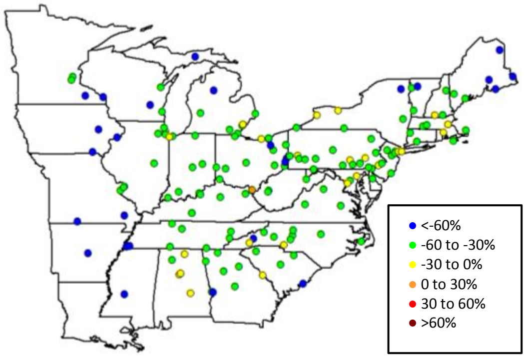


Figure 6-53: MFE SO_4, 2011 (only monitors with ≥10 days of data are shown)

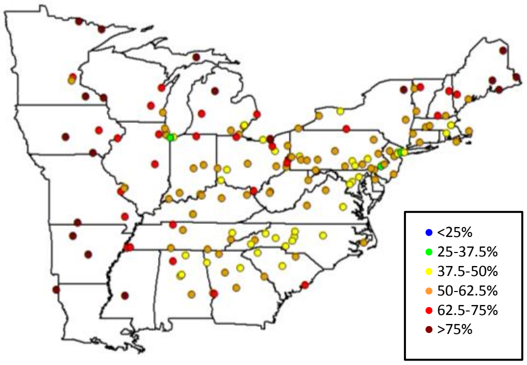


Figure 6-54: MFB NO_3, 2011 (only monitors with ≥10 days of data are shown)

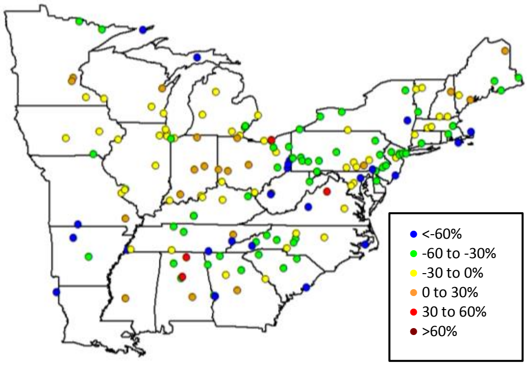


Figure 6-55: MFE NO_3, 2011 (only monitors with ≥10 days of data are shown)

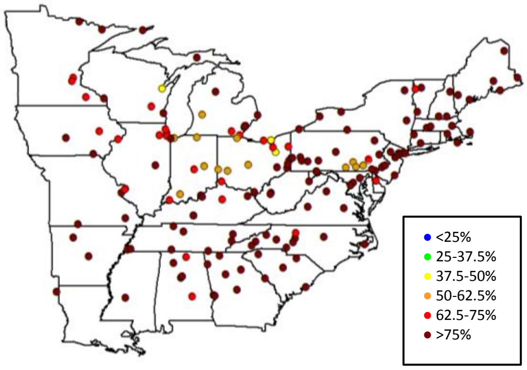


Figure 6-56: MFB NH_4, 2011 (only monitors with ≥10 days of data are shown)

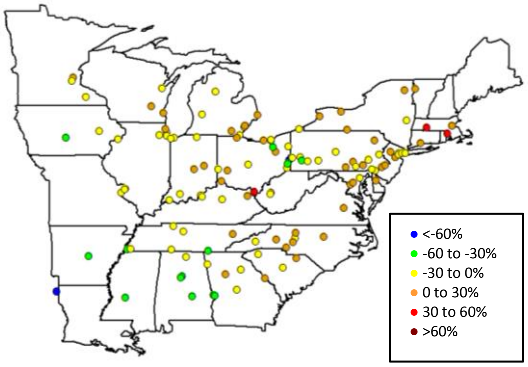


Figure 6-57: MFE NH_4, 2011 (only monitors with ≥10 days of data are shown)

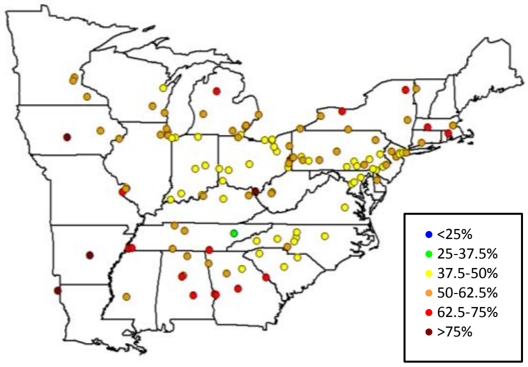


Figure 6-58: MFB EC, 2011 (only monitors with ≥10 days of data are shown)

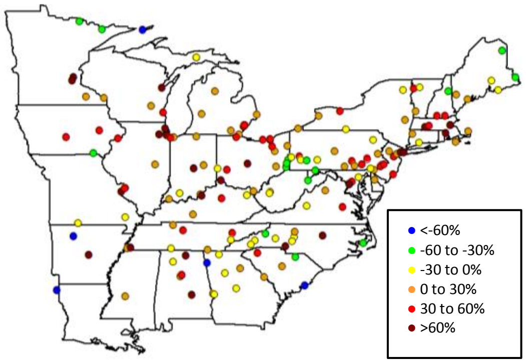


Figure 6-59: MFE EC, 2011 (only monitors with ≥10 days of data are shown)

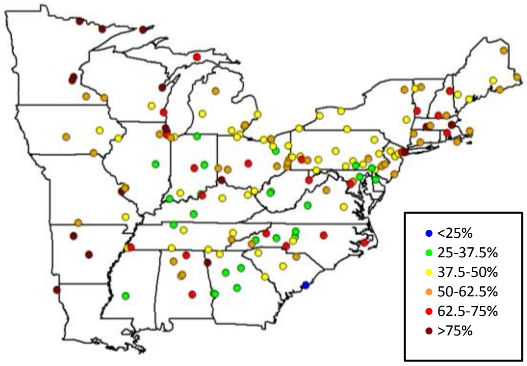


Figure 6-60: MFB OC, 2011 (only monitors with ≥10 days of data are shown)

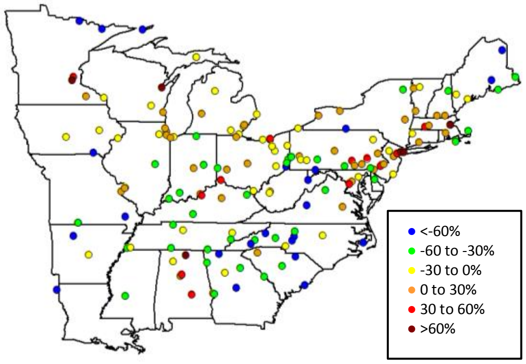


Figure 6-61: MFE OC, 2011 (only monitors with ≥10 days of data are shown)

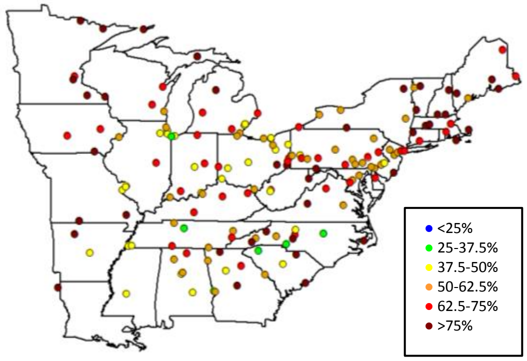


Figure 6-62: MFB Soil, 2011 (only monitors with ≥10 days of data are shown)

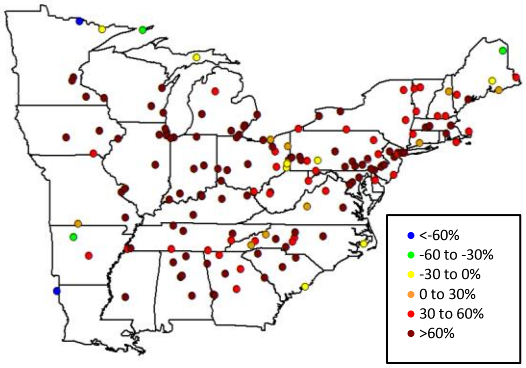
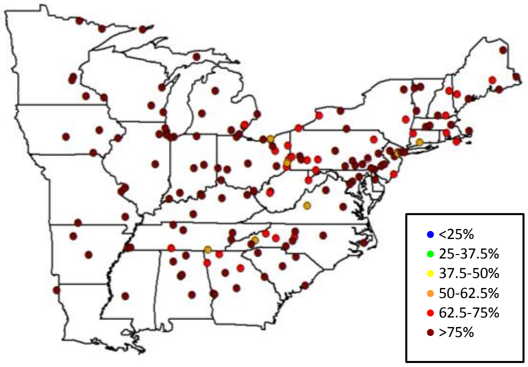


Figure 6-63: MFE Soil, 2011 (only monitors with ≥10 days of data are shown)



Note: When looking at MFB in the figures above, yellow and orange colors indicate better model performance. When looking at MFE, blue and green colors indicate better model performance.

Figure 6-64 shows the comparison of observed versus prediction extinction due to ammonium sulfate. One can see a trend toward under-prediction of extinction by CMAQ throughout the year with the starkest under-prediction occurring during the summer months. The visual observation is backed up by the data in Table 6-4 that shows a negative bias in all seasons and the highest MAGE during the summer months.

Figure 6-65 shows the comparison of observed versus predicted extinction due to ammonium nitrate. One can see a trend toward over-prediction of extinction by CMAQ during the winter months and under-prediction during the summer months. The visual observation is backed up by the data in Table 6-5 that shows high MFE and a strong negative bias in the summer, though this is partially due to such low values occurring during summer months. MFE during the winter is larger than it was for ammonium sulfate, though MFB is of the same relative magnitude.

Figure 6-66 shows the comparison of observed versus prediction extinction due to light absorbing carbon. Overall predictions correspond well with the observations, with a tendency towards under-prediction, excepting during the winter months.

Figure 6-67 shows the comparison between observed versus predicted extinction due to organic matter. The patterns of MFB and MFE follow the pattern observed for ammonium nitrate.

Figure 6-68 shows the comparison between observed versus predicted extinction due to soil, which is overall predicted quite well.

Figure 6-69 shows the comparison between observed versus predicted extinction due to salt, which is overall predicted quite well, but due to its small impact on light extinction, sees high MFB and MFE due to just small variations in the predictions.

Figure 6-70 shows the comparison between observed versus predicted extinction due to coarse mass, which is consistently under-predicted, but also has such a smaller impact on extinction and results in little increase in MAGE.

Figure 6-71 shows the comparison between observed versus predicted extinction when the impact of all of the aerosols is totaled. Overall there is a tendency towards under-predictions, but there are a few data points that are greatly skewed towards over-prediction. The winter months are predicted quite well with an almost 0 MFB, a moderate MFE, and MAGE of 23. Summer months tend to be the most under-predicted with MFE and MAGE that is slightly higher than the winter months. This is supported by the data in Table 6-4 supports these visual observations.

Figure 6-64: Comparison of observed vs. predicted extinction due to NH_4SO_4 daily (top) and averaged monthly (bottom) in MANE-VU

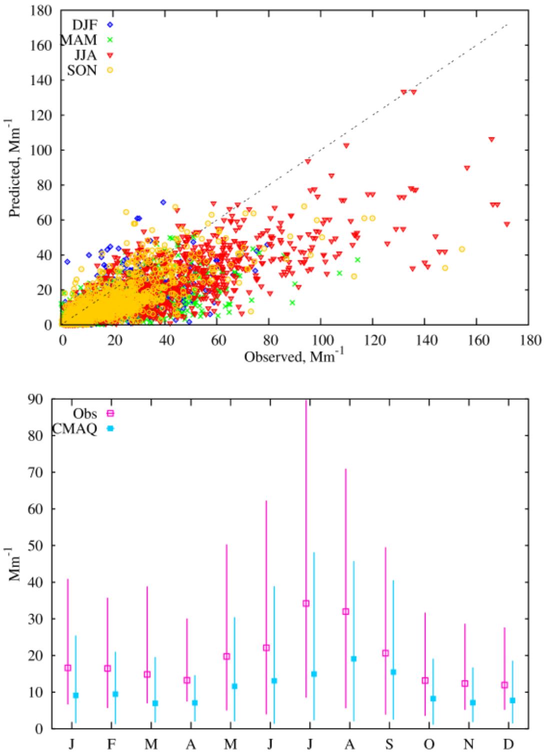


Figure 6-65: Comparison of observed vs. predicted extinction due to NH_4NO_3 daily (top) and averaged monthly (bottom) in MANE-VU

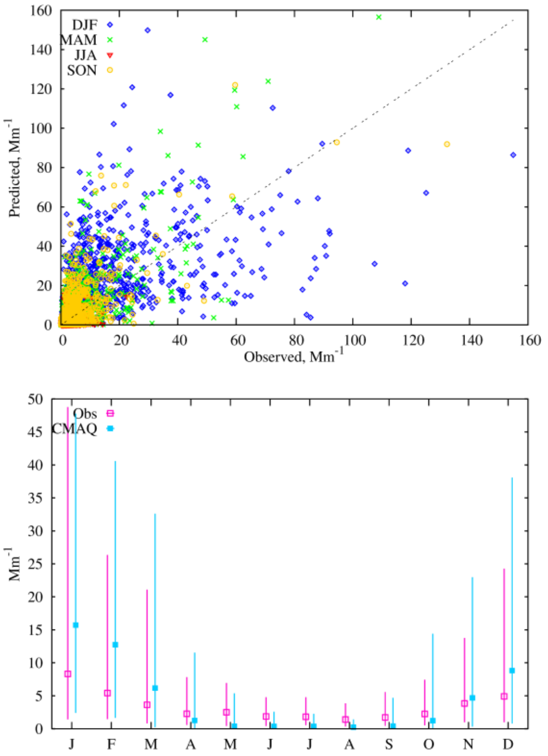


Figure 6-66: Comparison of observed vs. predicted extinction due to LAC daily (top) and averaged monthly (bottom) in MANE-VU

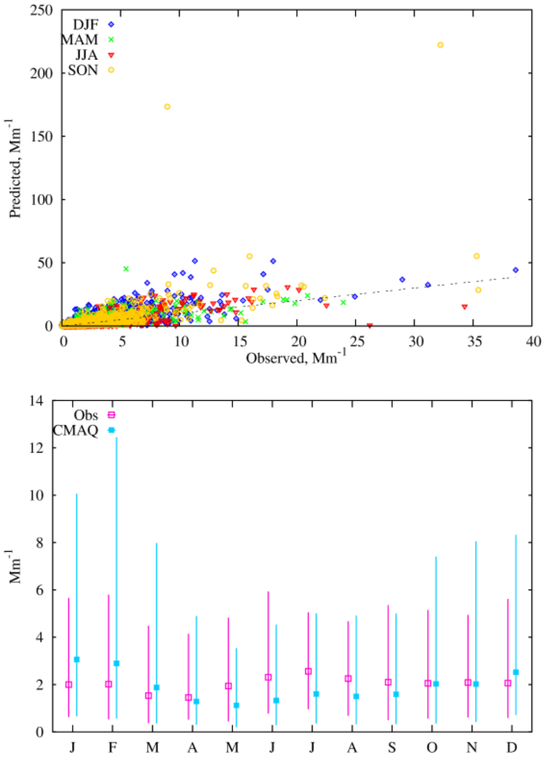


Figure 6-67: Comparison of observed vs. predicted extinction due to POM daily (top) and averaged monthly (bottom) in MANE-VU

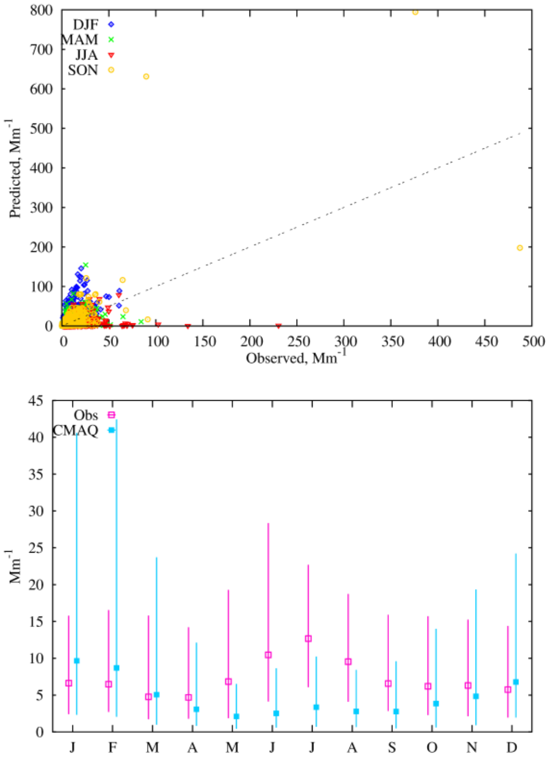


Figure 6-68: Comparison of observed vs. predicted extinction due to Soil daily (top) and averaged monthly (bottom) in MANE-VU

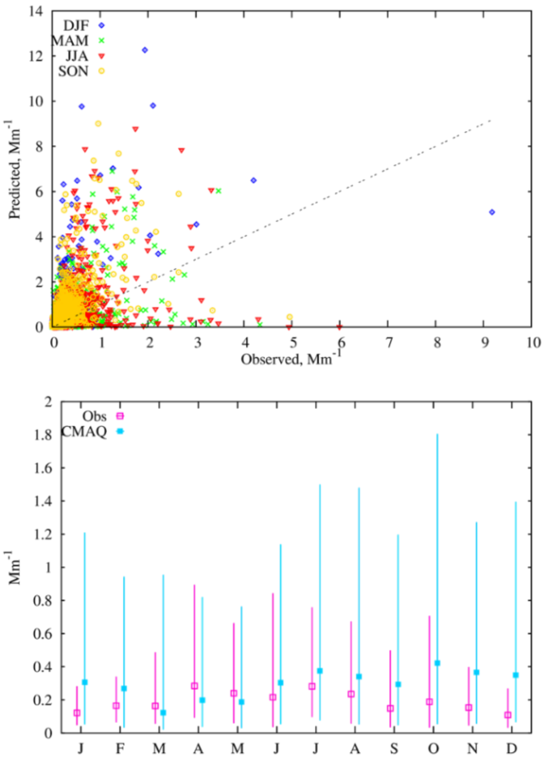


Figure 6-69: Comparison of observed vs. predicted extinction due to Sea Salt daily (top) and averaged monthly (bottom) in MANE-VU

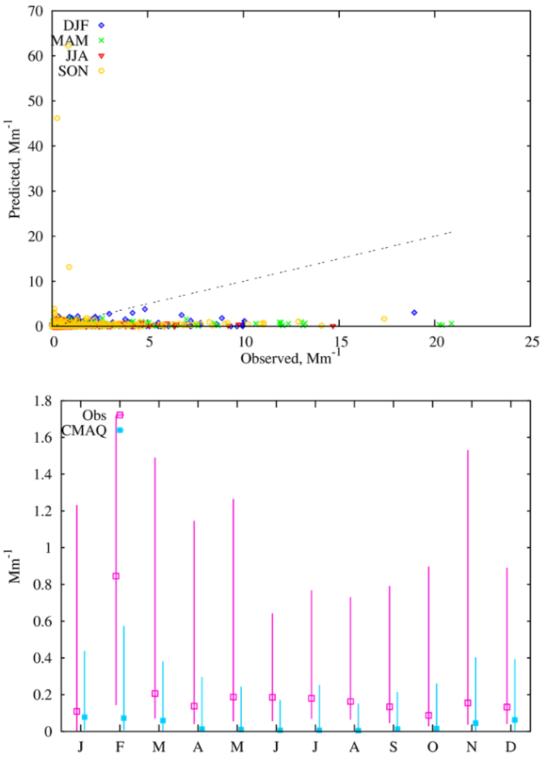


Figure 6-70: Comparison of observed vs. predicted extinction due to CM daily (top) and averaged monthly (bottom) in MANE-VU

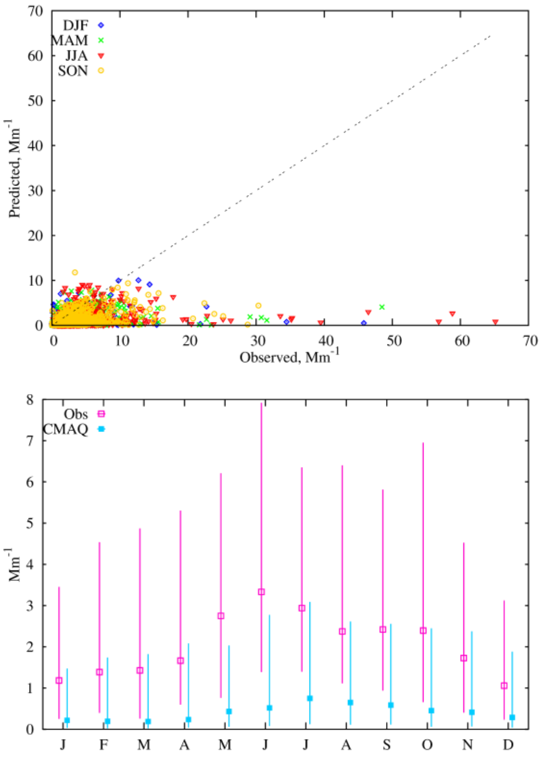


Figure 6-71: Comparison of observed vs. predicted extinction due to total aerosols daily (top) and averaged monthly (bottom) in MANE-VU

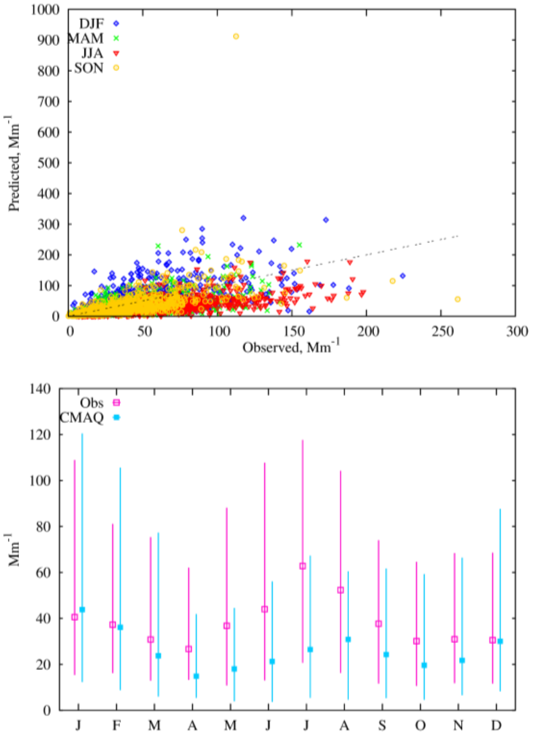


Table 6-4: Seasonal summary statistics (MFB, MFE, MAGE) for light extinction due to aerosol species for IMPROVE monitors in modeling domain

POLLUTANT	METRIC	DJF	MAM	JJA	SON	POLLUTANT	METRIC	DJF	MAM	JJA	SON
NH_4SO_4	MFB, %	-61.9	-67	-58.9	-48.3	NH_4NO_3	MFB, %	34	-40.9	-111.7	-41.1
	MFE, %	69.4	75.8	68.4	63.2		MFE, %	84.4	101.7	128.7	100.1
	MAGE, Mm^{-1}	8.52	10.46	16.31	8.45		MAGE, Mm^{-1}	11.72	4.87	1.8	4.01
LAC	MFB, %	31.1	-13.1	-43.8	-8.4	POM	MFB, %	27.9	-42.3	-107.2	-51.8
	MFE, %	59.8	62.7	55.7	53.3		MFE, %	67.5	82.2	111.6	75.7
	MAGE, Mm^{-1}	2.38	1.37	1.4	1.78		MAGE, Mm^{-1}	8.84	5.76	9.55	6.06
Soil	MFB, %	64.8	-18.2	30.1	60.1	Salt	MFB, %	-74.9	-127.5	-156.9	-117.5
	MFE, %	98.7	78.6	75.7	86.5		MFE, %	119.2	136.5	159.9	133.2
	MAGE, Mm^{-1}	0.44	0.3	0.47	0.44		MAGE, Mm^{-1}	0.57	0.53	0.34	0.57
CM	MFB, %	-106.9	-124.3	-112.5	-107.9	All Aerosols	MFB, %	-2.1	-48.8	-71.4	-37.3
	MFE, %	114.9	126.2	118.9	113.6		MFE, %	49.7	64.3	74.2	54.8
	MAGE, Mm^{-1}	1.35	2.11	2.95	2.1		MAGE, Mm^{-1}	22.94	19.11	28.81	16.81

When the various species are reconstituted as shown in Equation 6-1 over-prediction by about 3 μg/m^3 in the winter months, under-prediction by about 2 μg/m^3 in the summer months, and fairly close results during the shoulder seasons (Figure 6-72) are seen.

Figure 6-72: 2011 RCFM by season (observed values darker shading, predicted values lighter shading)

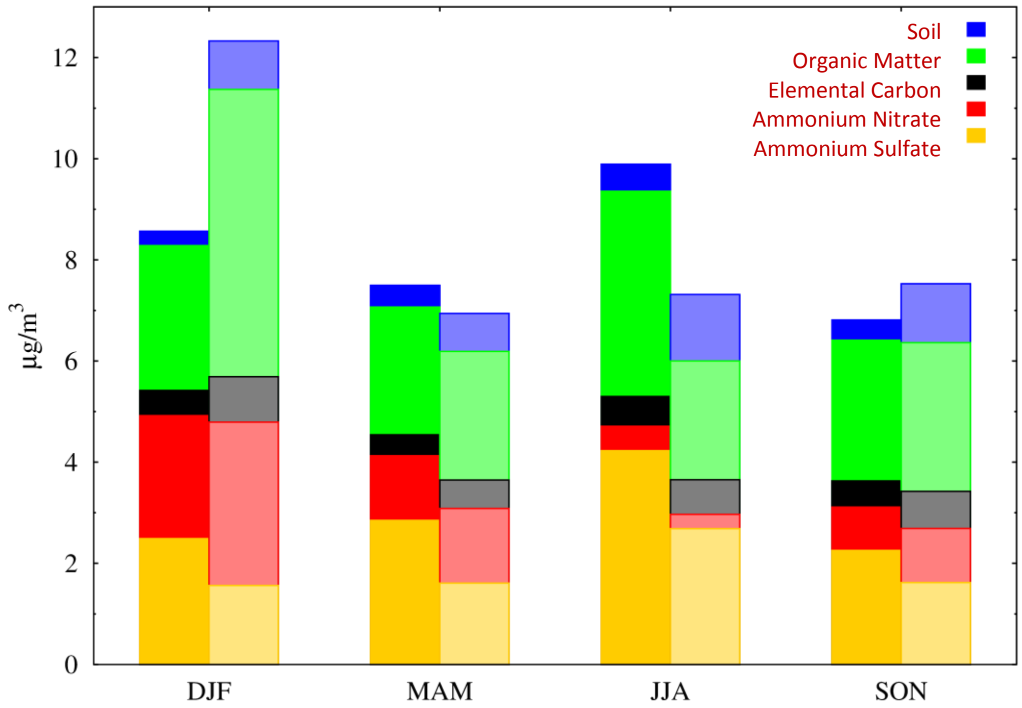
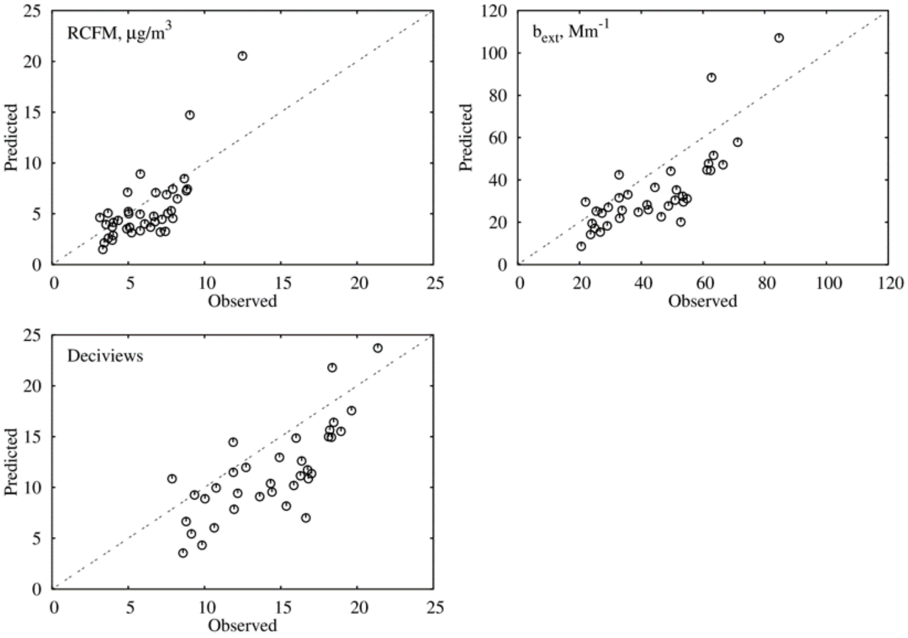


Figure 6-73 shows the annual comparisons of observed versus model predicted RFCM, light extinction (Mm^{-1}), and visibility impairment (deciviews). At most monitors RFCM is under-predicted slightly, though two monitors appear to be quite over-predicted. Light extinction follows the same pattern with most monitors being somewhat under-predicted and two outliers being quite over-predicted. Visibility impairment still shows under-prediction overall, but the transformation to the logarithmic scale for light extinction reduces the appearance of over-prediction for the two outlying monitors.

Figure 6-73: Observed vs. predicted RFCM, light extinction (Mm^{-1}), and visibility impairment (deciviews) at domain IMPROVE monitors



Evaluation of CAMx predictions

The following sections provide model evaluation information for ozone pollution solely over the 12-km modeling domain. Data from May 25 through August 30, 2011 was compared. Details on the formulas used in this section can be seen in Appendix A.

Beta Platform

Firstly comparisons of CMAQ and CAMx were conducted using the MARAMA beta emissions platform. Three runs were completed, one using CMAQ v. 5.0.2 and CB05 chemistry and two using CAMX v. 6.40, one with CB05 and one with CB06r2 chemistry. The full list of run specs is in Table 6-5.

Table 6-5: Run specifications for CMAQ vs CAMx benchmarking runs

	CMAQ v. 5.0.2	**CAMx v. 6.40**
Met Inputs	MCIP	wrfcamx
Emissions	SMOKE (CB5)	cmaq2camx (CB5 & CB6r2)
IC/BC	Geos-Chem	cmaq2camx
PBL Scheme	ACM2	YSU
Kz fix	KzMIN	kvpatch
Chemistry	CB5	CB5/CB6r2
Run Time	45 min/day	10/12 min/day

Evaluation between the model runs focused on the differences that arose between using the two models while maintaining a consistent chemistry and on high ozone days. CB05 was chosen for this purpose given that it was the up to date version of the chemistry module available for CMAQ at the time. Figure 6-74 (CMAQ) and Figure 6-75 (CAMx) compare the results from a high ozone day. Although there are obviously some differences between the two model runs, the same geographic distribution of high levels of ozone are captured between the two model runs. Figure 6-76 (CMAQ) and Figure 6-77

(CAMx) show the same type of comparison on a typical ozone day and there again appears to be no major differences between the two model runs.

Figure 6-74: Daily Max 8-hour Ozone CMAQ v5.02 CB05 MARAMA Beta 2 Emissions (June 8, 2011)

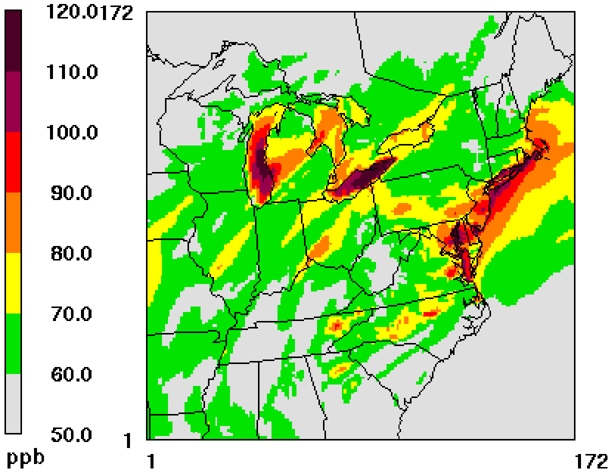


Figure 6-75: Daily Max 8-hour Ozone CAMx b6.40 CB05 MARAMA Beta 2 Emissions (June 8, 2011)

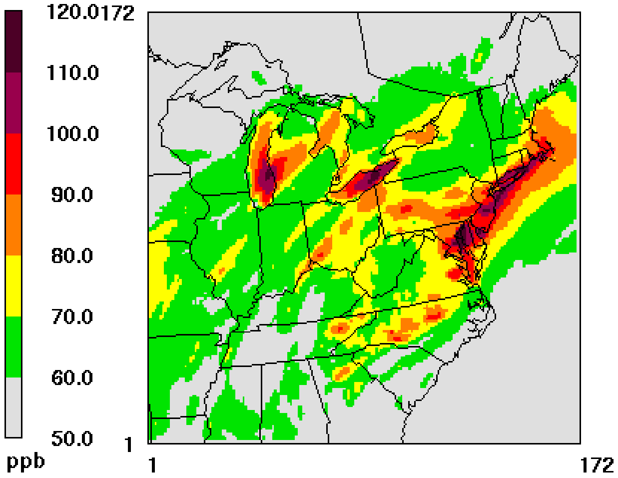


Figure 6-76: Daily Max 8-hour Ozone CMAQ v5.02 CB05 MARAMA Beta 2 Emissions (July 11, 2011)

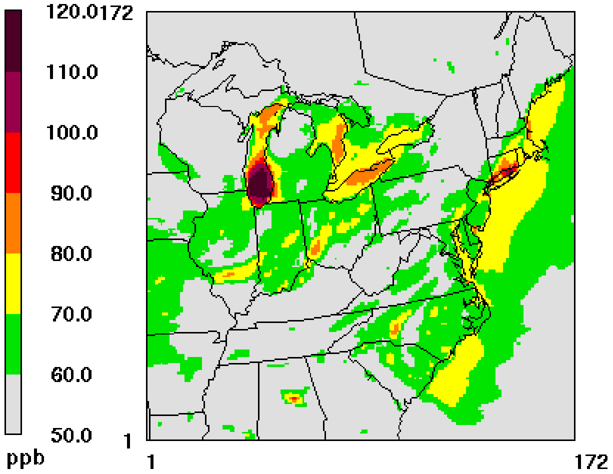
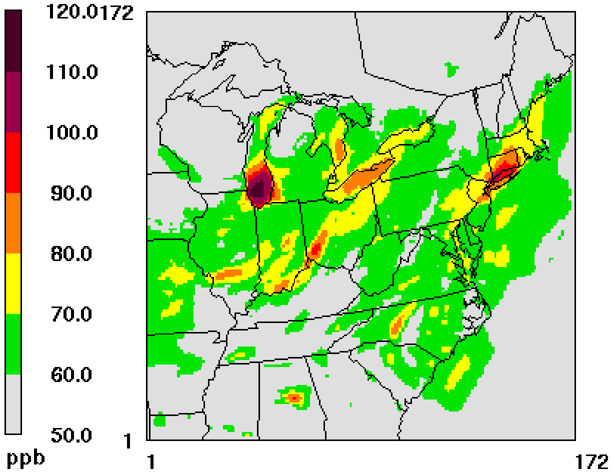


Figure 6-77: Daily Max 8-hour Ozone CAMx v6.40 CB05 MARAMA Beta 2 Emissions (July 11, 2011)



Looking next at several summary statistics one finds general agreement in values on NMB (Figure 6-78), and NME (Figure 6-79) between CMAQ and CAMx, with a few outliers being predicted much higher in CMAQ. However, R values (Figure 6-80) were found to be consistently lower when using the CAMx model than when using CMAQ. The charts also show the comparison between CMAQ when using CB05 and CAMx when using CB06r2. When looking at these results NMB and NME appear to be higher for CAMx compared to CMAQ. R values appear to differ in the same fashion as they did when comparing CAMx with CB05 chemistry.

Figure 6-78: NMB for CMAQ v5.02 CB05 (x-axis) vs CAMx v6.40 CB05 & CB6r2 (y-axis)

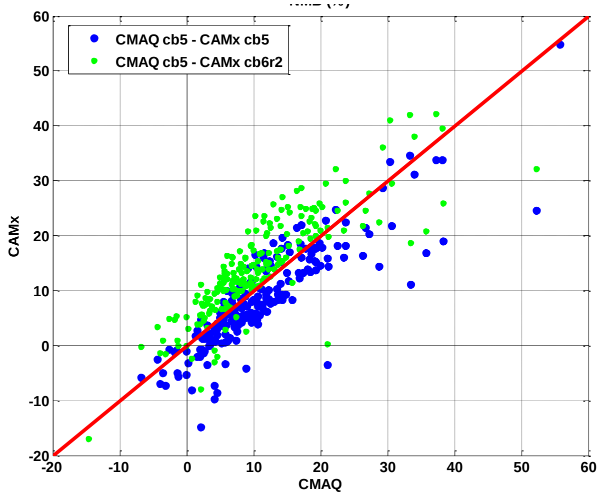


Figure 6-79: NME for CMAQ v5.02 CB05 (x-axis) vs CAMx v6.40 CB05 & CB6r2 (y-axis)

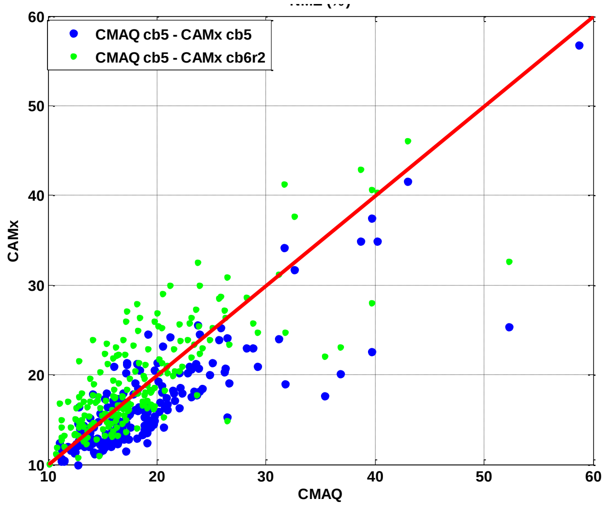
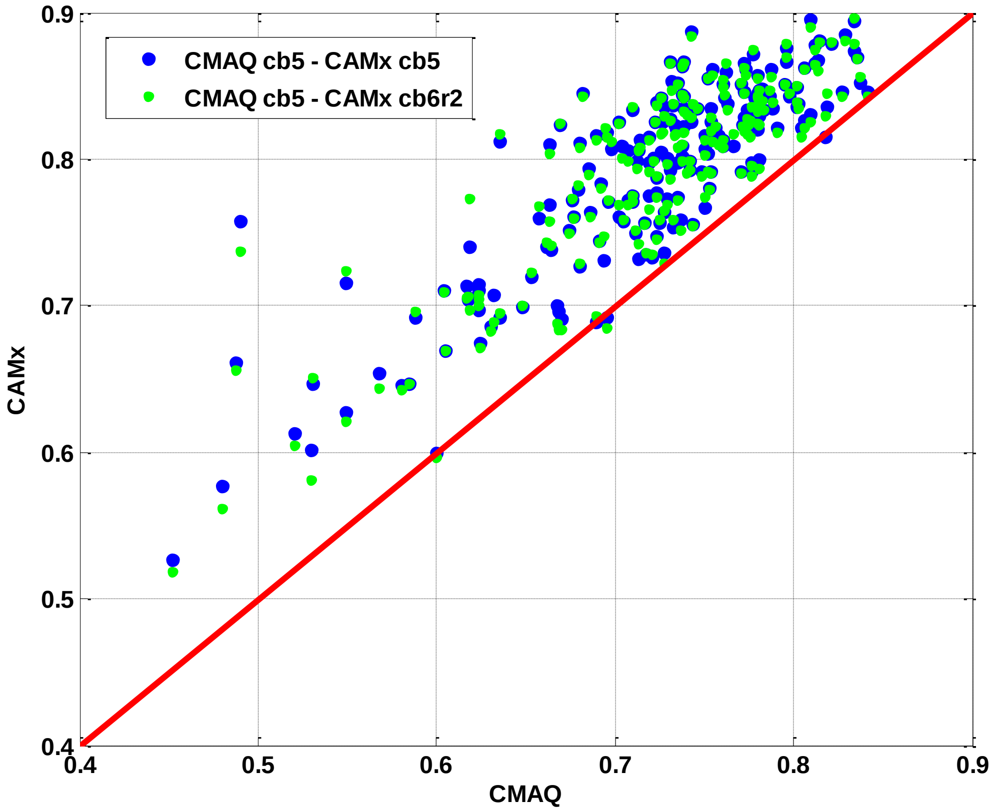


Figure 6-80: : R for CMAQ v5.02 CB05 (x-axis) vs CAMx v6.40 CB05 & CB6r2 (y-axis)



When examining monitors of note in the OTR (Table 6-6) one finds general agreement between the two model results, with a notable exception being Fort Griswold Park, CT (090110124). Overall many of the key monitors were predicted better in CAMx than in CMAQ, which at first glance seems incorrect given that overall CMAQ predictions fared better, but these monitors would be the outliers seen in Figure 6-78 though Figure 6-80.

Table 6-6: CMAQ vs CAMx model performance statistics for key monitors in the OTR using CB05 chemistry

AQS CODE	SITE	CMAQ			CAMX		
		NMB (%)	NME (%)	R	NMB (%)	NME (%)	R
090010017	Greenwich Point Park-Greenwich	3.10	23.62	0.55	-3.56	17.77	0.72
090013007	Lighthouse-Stratford	10.60	17.17	0.80	3.91	13.44	0.84
090019003	Sherwood Island State Park-Westport	4.89	16.38	0.74	5.09	13.85	0.83
090011123	Western Conn State Univ.-Danbury	6.98	16.78	0.78	7.27	14.08	0.87
090110124	Fort Griswold Park-Groton	28.78	31.72	0.79	14.34	18.95	0.84
240053001	Essex	7.04	16.11	0.75	6.43	15.02	0.79
240090011	Calvert	14.14	19.71	0.74	17.77	20.56	0.80
240150003	Fair Hill Natural Resource Management Area	4.48	13.05	0.75	4.08	12.63	0.81
240251001	Edgewood	-1.79	13.48	0.71	-1.21	12.13	0.77
340150002	Clarksboro	1.94	13.57	0.78	-2.06	12.94	0.83
360810124	Queens College 2	8.81	17.30	0.74	-4.12	15.46	0.76
360850067	Susan Wagner HS	5.68	17.15	0.73	-3.37	14.72	0.84
361030002	Babylon	5.19	15.54	0.78	0.42	12.69	0.83

Finally, hourly 8-hour ozone results on the ten days that are factored into calculations were compared for five selected monitors (Greenwich Point and Sherwood Island in CT, Edgewood in MD, and Babylon and Queens College in NY). The results are shown in Figure 6-81 though Figure 6-90 with the figure on the left showing observations compared to CMAQ model runs and the figure on the right CAMx for each of the five monitors.

In general it appears that both models consistently predict the observations and on the days that they do not, they generally over-predict ozone (which is typically two or three of the ten days). The CMAQ predictions for Greenwich Point are the main exception to this generalization with multiple days being under-predicted.

Figure 6-81: Hourly observed vs. CMAQ CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Greenwich Point (090010017)

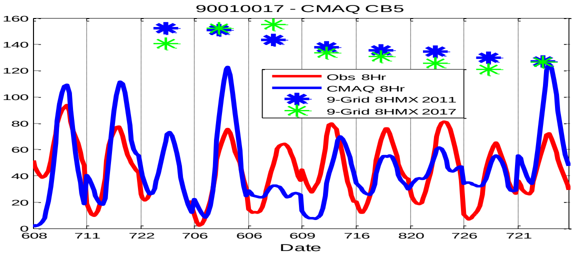


Figure 6-82: Hourly observed vs. CAMx CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Greenwich Point (090010017)

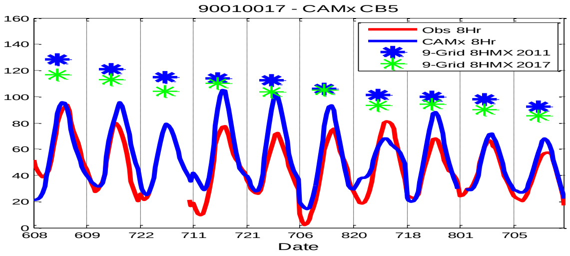


Figure 6-83: Hourly observed vs. CMAQ CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Sherwood Island (090019003)

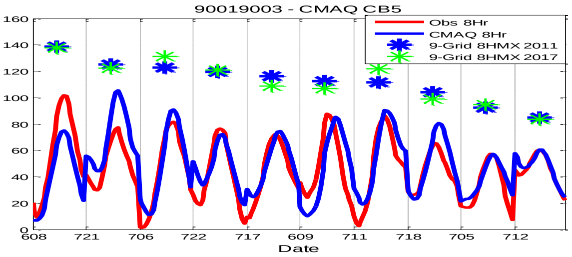


Figure 6-84: Hourly observed vs. CAMx CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Sherwood Island (090019003)

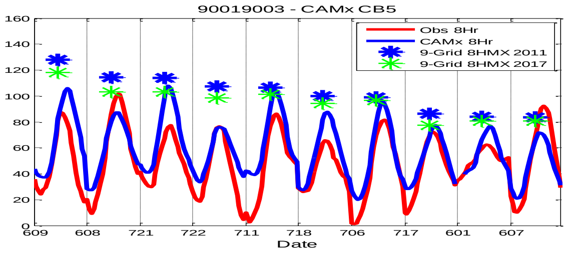


Figure 6-85: Hourly observed vs. CMAQ CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Edgewood (240251001)

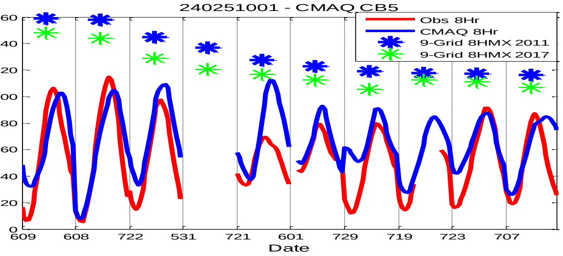


Figure 6-86: Hourly observed vs. CAMx CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Edgewood (240251001)

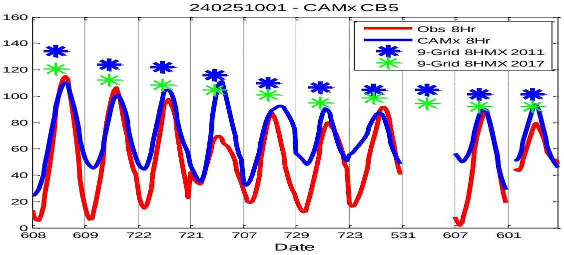


Figure 6-87: Hourly observed vs. CMAQ CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Babylon (360810124)

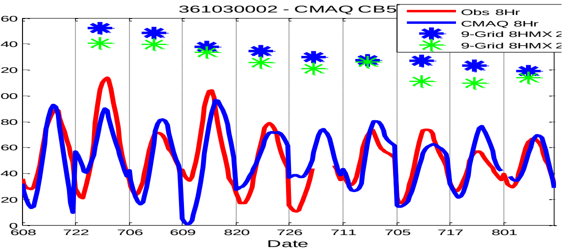


Figure 6-88: Hourly observed vs. CAMx CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Babylon (360810124)

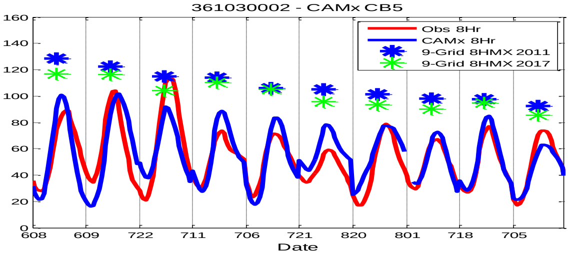


Figure 6-89: Hourly observed vs. CMAQ CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Queens College (361030002)

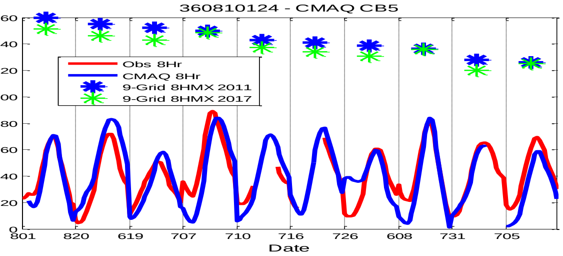
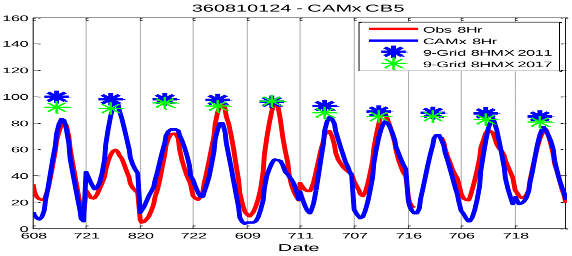


Figure 6-90: Hourly observed vs. CAMx CB05 modeled 8-hour ozone on ten days used in calculation of RRF at Queens College (361030002)



Overall ozone monitors in the OTR saw a similar level of monitor performance between CMAQ and CAMx when chemistry was held constant, with CAMx having a little bit better performance than CMAQ in terms of NMB, NME and R at the monitors with the highest design values in the 2011 base year.

Gamma Platform

Moving onto the Gamma platform we compared CAMx model predictions for 2011 using the Gamma platform to the CMAQ predictions that were modeled using the Gamma platform discussed earlier in the chapter. We can see that CAMx does not predict concentrations as well throughout the OTR, but we still had results within reason. MFE values from the CAMx 2011 base case (Figure 6-91) were found to be slightly higher throughout the OTR compared to the CMAQ 2011 base case (Figure 6-92) (Note: When looking at MFE in the figures above, blue and green colors indicate better model performance). MFB results from CAMx (Figure 6-93) appear to be equivalent to the MFB CMAQ results (Figure 6-94) (Note: When looking at MFB in the figures above, green, yellow, and orange colors indicate better model performance**)**.MAGE values from the 2011 CAMx base case (Figure 6-95), like MFE, were generally higher throughout the OTR compared to the CMAQ results (Figure 6-96) (Note: when looking at MAGE in the figures above, blue and green colors indicate better model performance).

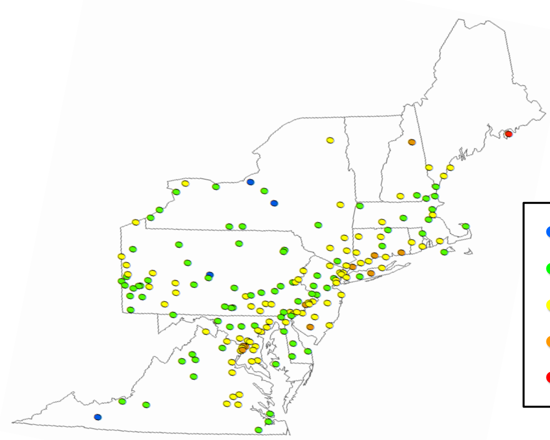


Figure 6-91: MFE in daily max 8-hr ozone Gamma, 60 ppb threshold, May 25-August 30; only monitors with 10 days greater than 60 ppb threshold (CAMx Gamma Run)

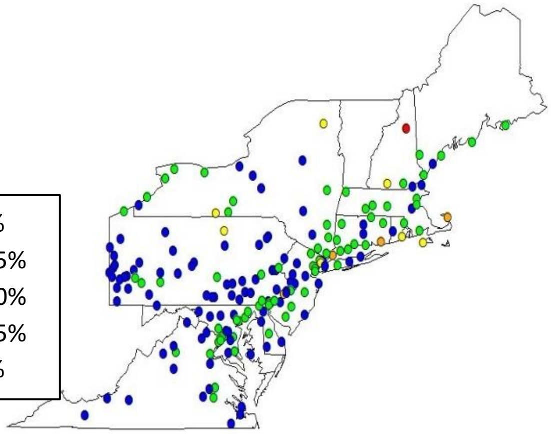


Figure 6-92: MFE in daily max 8-hr ozone Gamma, 60 ppb threshold; only monitors with 10 days greater than 60 ppb threshold (CMAQ Gamma Run)

- 🔵 <10%
- 🟢 10-15%
- 🟡 15-20%
- 🟠 20-25%
- 🔴 >25%

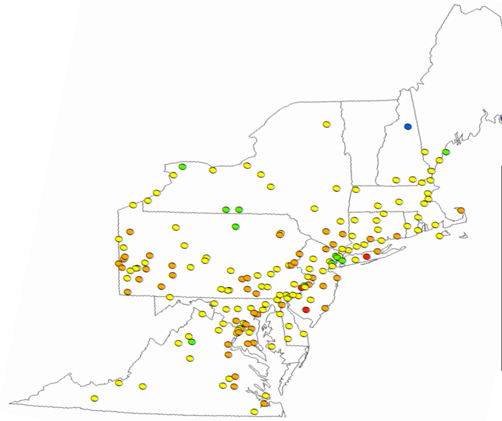


Figure 6-93: MFB in daily max 8-hr ozone Gamma, 60 ppb threshold, May 25-August 30; only monitors with 10 days greater than 60 ppb threshold

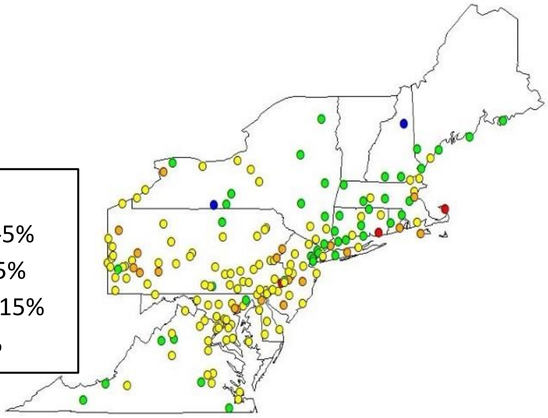


Figure 6-94: MFB in daily max 8-hr ozone Gamma, 60 ppb threshold; only monitors with 10 days greater than 60 ppb threshold (CMAQ Gamma Run)

- 🔵 < -15%
- 🟢 -15 to -5%
- 🟡 -5 to +5%
- 🟠 +5 to +15%
- 🔴 > +15%

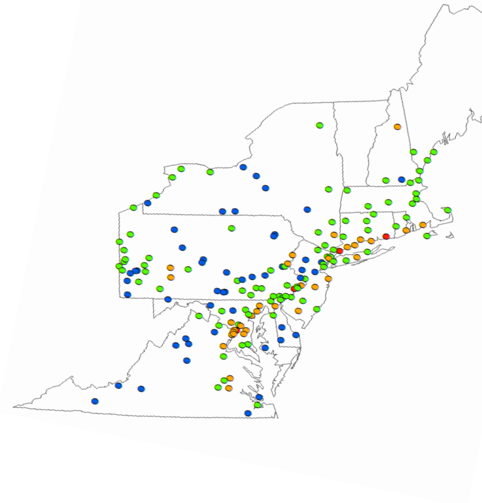


Figure 6-95: MAGE in daily max 8-hr ozone Gamma, 60 ppb threshold, May 25-August 30; only monitors with 10 days greater than 60 ppb threshold

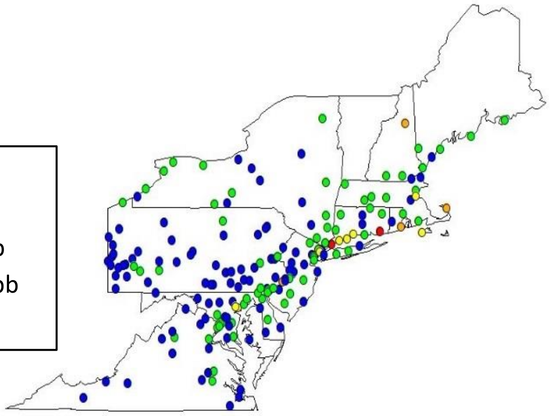


Figure 6-96: MAGE in daily max 8-hr ozone Gamma, 60 ppb threshold; only monitors with 10 days greater than 60 ppb threshold (CMAQ Gamma Run)

- 🔵 <6 ppb
- 🟢 6-9 ppb
- 🟡 9-12 ppb
- 🟠 12-15 ppb
- 🔴 >15 ppb

Summary

Various model evaluation statistics are presented here for a variety of gaseous and aerosol species in addition to O_3. In general, the CMAQ results were best for daily maximum O_3 and daily average $PM_{2.5}$ and SO_4 mass. Other species vary tremendously over the course of a day, or from day to day, and small model over- or under-prediction at low concentrations can lead to large biases on a composite basis. We demonstrate that the model performs reasonably well over the diurnal cycle and not just in terms of daily maximum or average values. Also, we demonstrate that the CMAQ model can reliably reproduce concentrations above the ground level. Though it did not perform as well as CMAQ, the 2011 Gamma CAMx modeling platform was found to model ozone values acceptably. The analyses shown in this section demonstrates that OTC's 2011 based CMAQ and CAMx modeling platform can adequately reproduce air pollution produced through photochemical processes to a degree that will allow states to demonstrate future air pollution levels for ozone, $PM_{2.5}$ and regional haze SIPs.

References

Brewer, P, Tanner, J, Engelbrecht, J, Morris, R and Reynolds, S 2007, 'Carbon Analyses in the VISTAS Region for $PM_{2.5}$ and Haze', accessed August 16, 2006, from <http://www.marama.org/calendar/events/presentations/2007_07Science/BrewerMVScience07.pdf>.

US EPA, 2014, 'Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze' https://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

Section 7. Evaluation of 4km Nested Gridding

Overview

Figure 7-1: OTC 12km modeling domain and 4km nested grid

In previous SIP modeling using the 2007 OTC modeling platform it was found that model performance decreased along the coastal areas. In ozone predictions were less accurate, particularly in terms of MFB, but also MFE and MAGE, at many of the coastal monitors (see Figure 6-7 through Figure 6-12). In particular, very high ozone in the Long Island Sound area showed little response to emission reductions. It was expected that due to the complex meteorology, often due to land-water interface issues, many of the problematic monitors in the OTR that could be improved through better representation of the conditions at those monitors.

One technique to improve model performance in areas with complex meteorology is to conduct photochemical modeling with a finer resolution nested grid in the areas needing improvement. A finer grid allows emissions, particularly from point sources, to be located more precisely. It also allows the greater complexities of meteorology to play a role in modeling. The downside of using a finer grid is the increase in model run time, necessary computing power, and staff resources. Previous research has shown that as the resolution improves from 12 km marginal improvements in results decrease (Thompson and Selin 2012). OTC examined the impact of using a finer, 4km grid in the core of the OTR, as show Figure 7-1 in order to examine the potential benefits of refined grid modeling.

Meteorology Processing

NYSDEC ran WRF v. 3.6.1 using the same process and parameters as EPA used in developing the 12km meteorological data.

We relied on NAM from NCEP in 12km grid spacing to drive the WRF model. The NAM archive was missing during early March of 2011 so only the months of January, February, and April until December were processed. This was not expected to introduce major errors given that March is not typically associated with ozone production in the OTR, nor is it during the required ozone monitoring season. NLCD 2006 land use data was employed in this exercise, as was GHRSST for sea surface temperature. GHRSST has a daily resolution of 0.01 x 0.01 degree (about 1km).

Emission Inventory

We relied on EPA's modeling inventory "eh" that was based on NEI v. 2 for emissions. At the time that SMOKE processing occurred the Alpha 2 inventory was not available, but since the Alpha 2 inventory is largely uses "eh" directly in the base year this was not seen as introducing any major inaccuracies. The differences of note between the Alpha 2 inventory and the inventory used in this exercise are that CEMS data would have been directly used rather than the ERTAC smoothed EGU data. MOVES and biogenic were not processed using SMOKE at the 4km resolution. If MOVES emission factors were used in 4km SMOKE processing the results would resolve better in particular for mobile emissions along the I-95 corridor. Biogenic emissions were re-gridded from 12km to 4km instead of being processed at 4km resolution.

Results

NMB results from the 12km in smaller domain are biased negatively and the 4km gridded results are a marked improvement throughout the entirety of the smaller domain (Figure 7-2 and Figure 7-3). NME on the other hand does not improve throughout the entirety of the smaller domain. NME results do improve along the I-95 corridor but there are increases in NME in the western part of the smaller domain, in particular in the Pittsburgh areas (Figure 7-4 and Figure 7-5).

Figure 7-2: Ozone NMB, July 2011 4 km grid

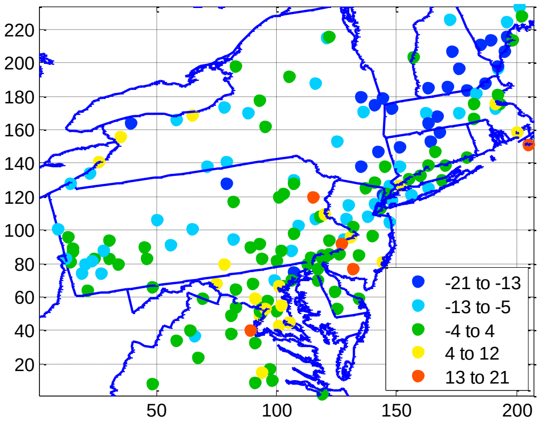


Figure 7-3: Ozone NMB, July 2011 12 km grid

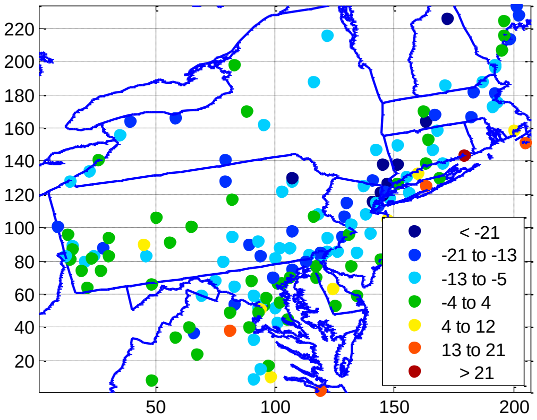


Figure 7-4: Ozone NME, July 2011 4 km grid

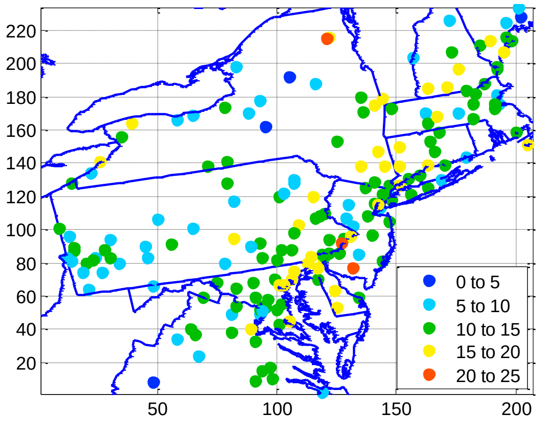
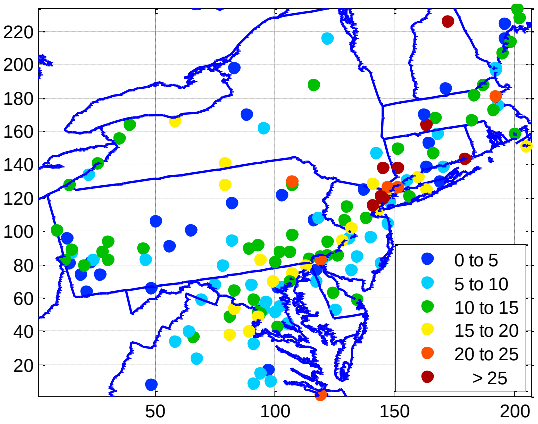


Figure 7-5: Ozone NME, July 2011 12 km grid



We then took a look diurnally for 10 key monitors in the inner corridor (3 in Connecticut, 5 in New York, and 1 each in Maryland and New Jersey). There are clear improvements with predicting average monthly and peak ozone at all ten monitors in the month of June though there are instances such as with monitor 361030002 where the peak is pushed back in the day from where it is observed (Figure 7-6 through Figure 7-15).

Figure 7-6: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #090010017 (thick line: monthly avg., thin line: max day)

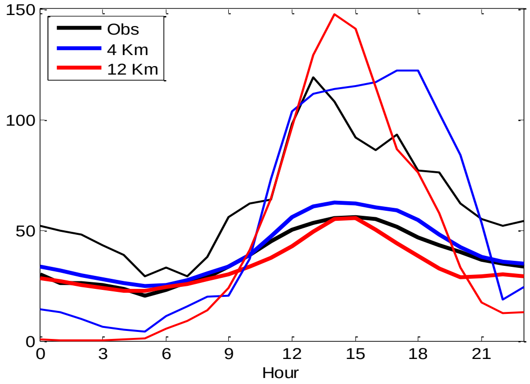


Figure 7-7: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #090013007 (thick line: monthly avg., thin line: max day)

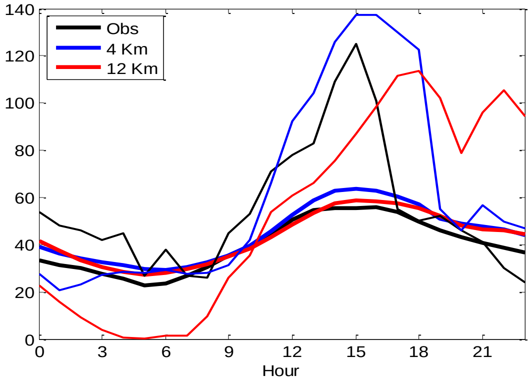


Figure 7-8: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #090019003 (thick line: monthly avg., thin line: max day)

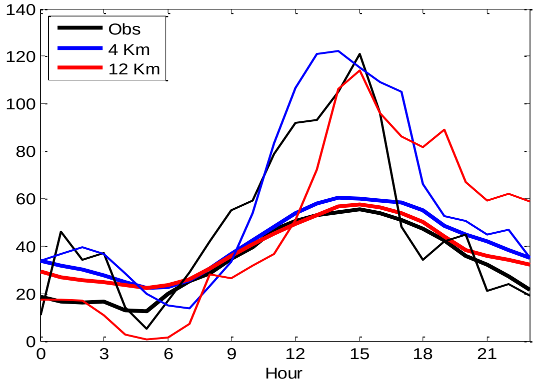


Figure 7-9: Observed and modeled (4km/12km grids) ozone (ppb for June 2011 at monitor #240251001 (thick line: monthly avg., thin line: max day)

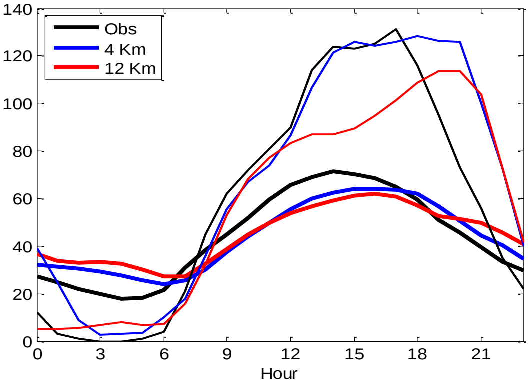


Figure 7-10: Observed and modeled (4km/12km grids) ozone (ppb for June 2011 at monitor #34015002 (thick line: monthly avg., thin line: max day)

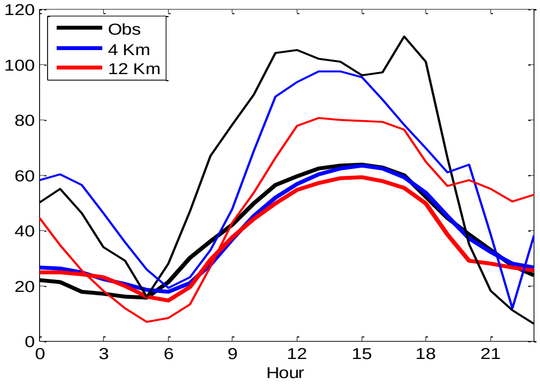


Figure 7-11: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #360050133 (thick line: monthly avg., thin line: max day)

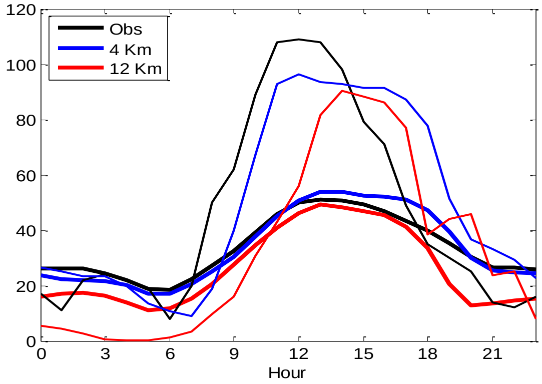


Figure 7-12: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #360810124 (thick line: monthly avg., thin line: max day)

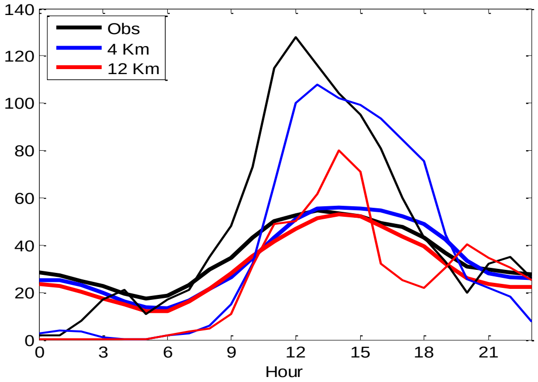


Figure 7-13: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #360850067 (thick line: monthly avg., thin line: max day)

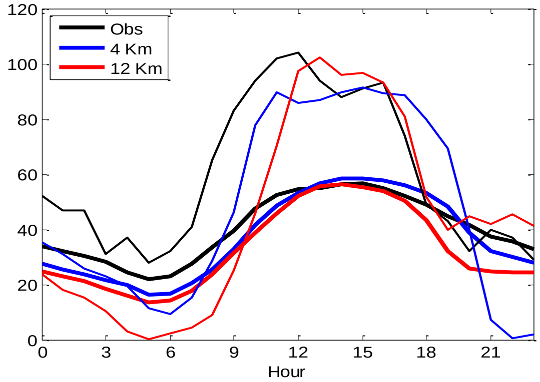


Figure 7-14: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #361030002 (thick line: monthly avg., thin line: max day)

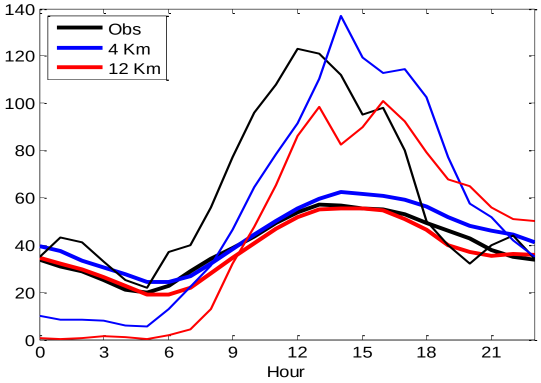
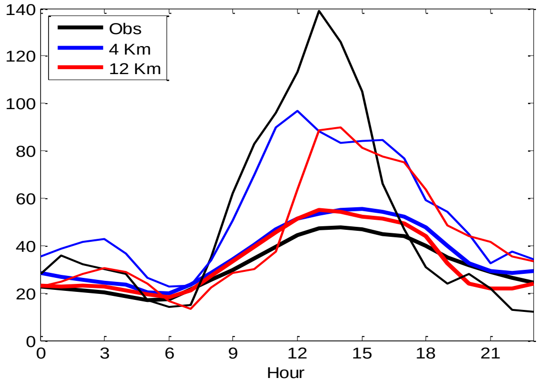


Figure 7-15: Observed and modeled (4km/12km grids) ozone (ppb) for June 2011 at monitor #361192004 (thick line: monthly avg., thin line: max day)



The same pattern holds for July, excepting monitor 240251001, which is under-predicted slightly more on the peak day (Figure 7-16 through Figure 7-25).

Figure 7-16: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #090010017 (thick line: monthly avg., thin line: max day)

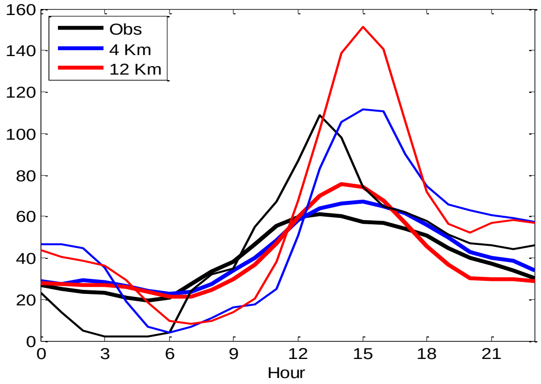


Figure 7-17: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #090013007 (thick line: monthly avg., thin line: max day)

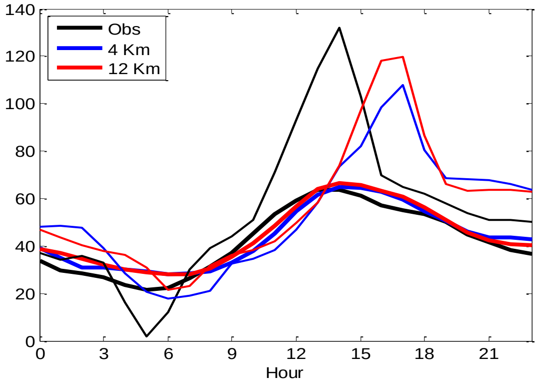


Figure 7-18: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #090019003 (thick line: monthly avg., thin line: max day)

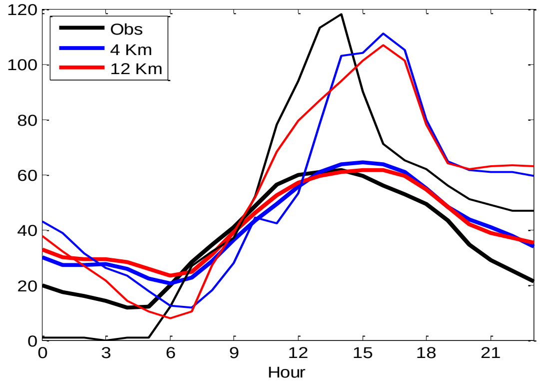


Figure 7-19: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #240251001 (thick line: monthly avg., thin line: max day)

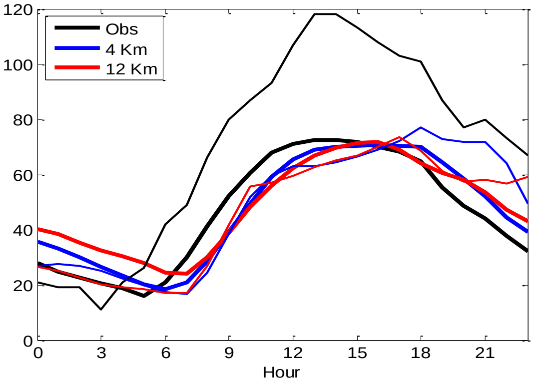


Figure 7-20: Observed and modeled (4km/12km grids) ozone (ppb for July 2011 at monitor #34015002 (thick line: monthly avg., thin line: max day)

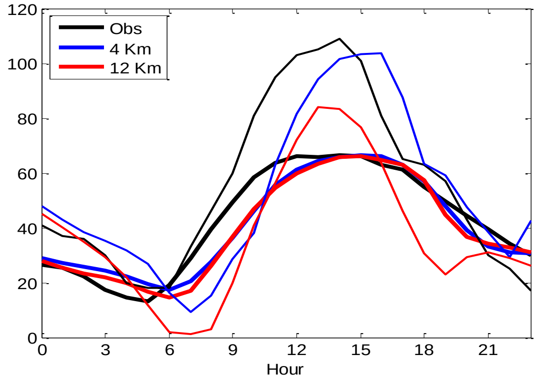


Figure 7-21: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #360050133 (thick line: monthly avg., thin line: max day)

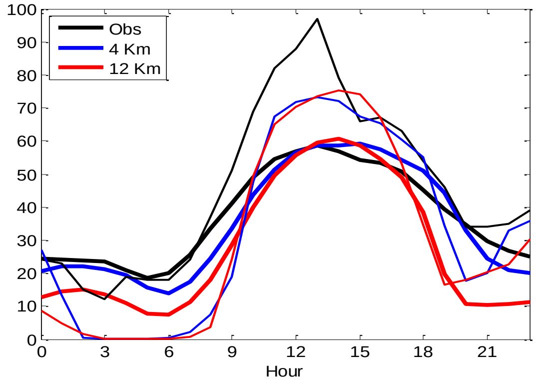


Figure 7-22: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #360810124 (thick line: monthly avg., thin line: max day)

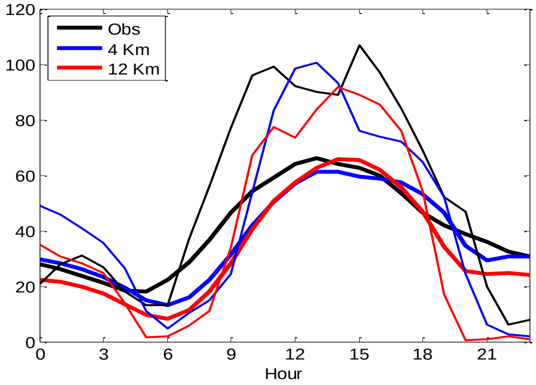


Figure 7-23: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #360850067 (thick line: monthly avg., thin line: max day)

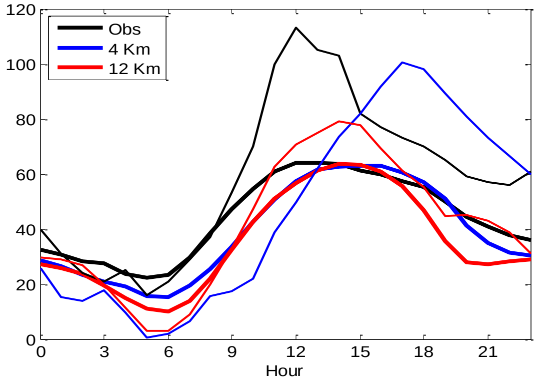


Figure 7-24: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #361030002 (thick line: monthly avg., thin line: max day)

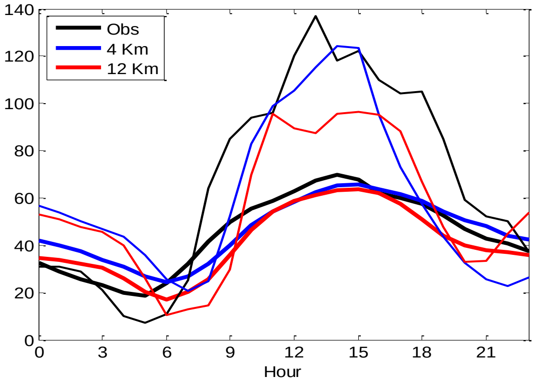
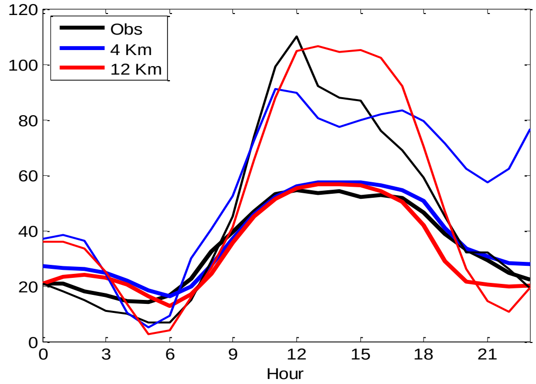


Figure 7-25: Observed and modeled (4km/12km grids) ozone (ppb) for July 2011 at monitor #361192004 (thick line: monthly avg., thin line: max day)



The same pattern also holds for August, with monitors 090019003 and 240251001 having peak concentrations predicted later in the day than observations on the peak day (Figure 7-26 through Figure 7-35).

Figure 7-26: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #090010017 (thick line: monthly avg., thin line: max day)

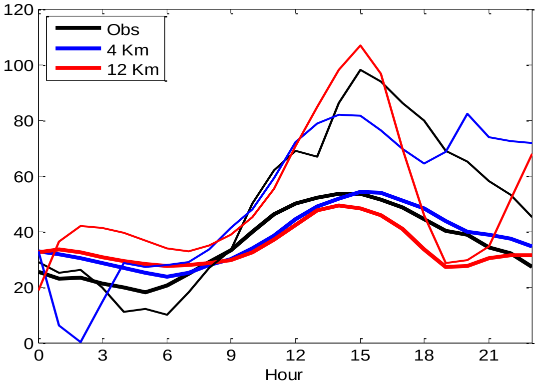


Figure 7-27: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #090013007 (thick line: monthly avg., thin line: max day)

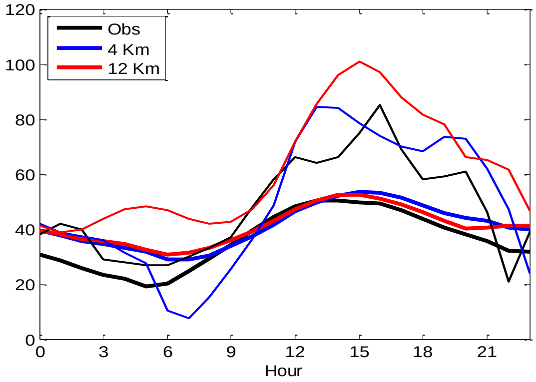


Figure 7-28: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #090019003 (thick line: monthly avg., thin line: max day)

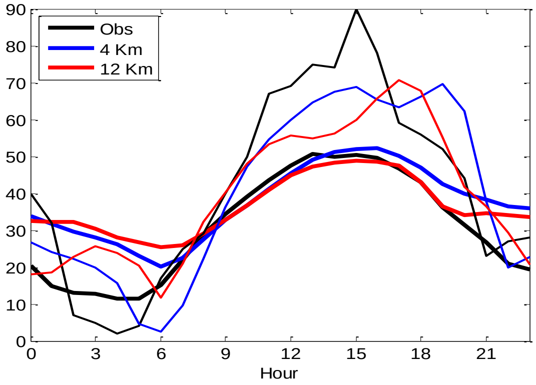


Figure 7-29: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #240251001 (thick line: monthly avg., thin line: max day)

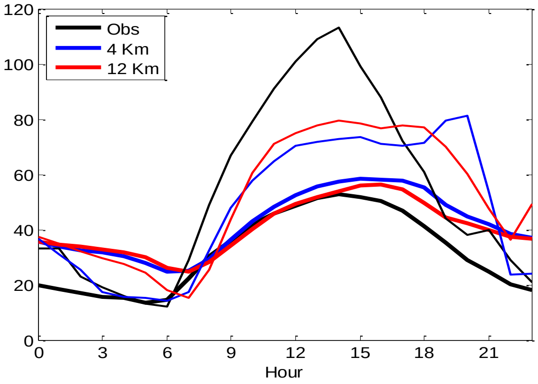


Figure 7-30: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #34015002 (thick line: monthly avg., thin line: max day)

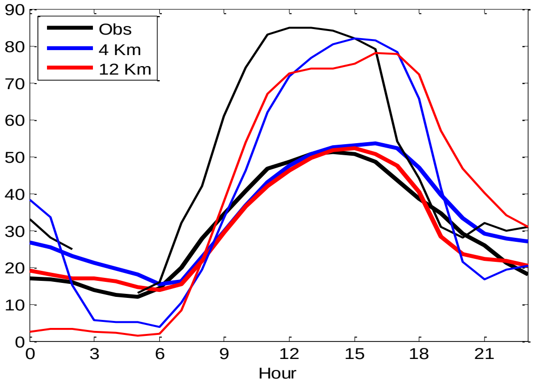


Figure 7-31: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #360050133 (thick line: monthly avg., thin line: max day)

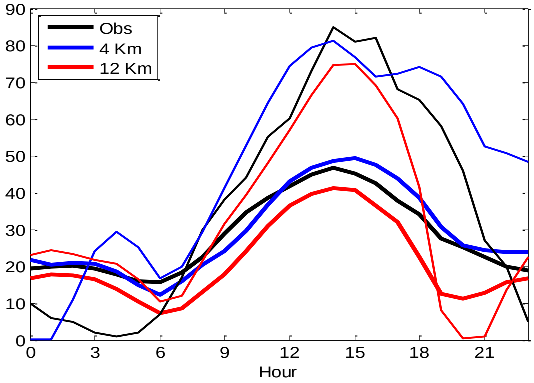


Figure 7-32: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #360810124 (thick line: monthly avg., thin line: max day)

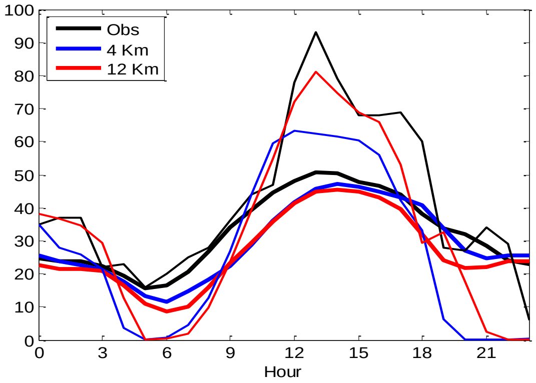


Figure 7-33: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #360850067 (thick line: monthly avg., thin line: max day)

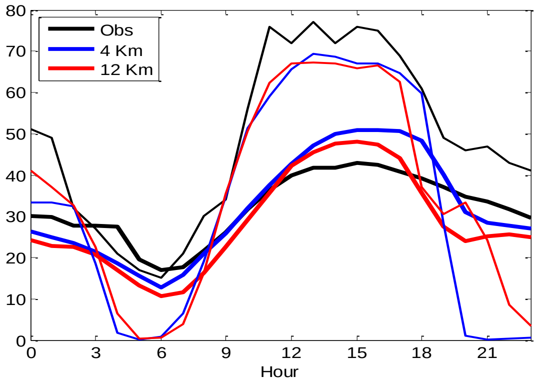


Figure 7-34: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #361030002 (thick line: monthly avg., thin line: max day)

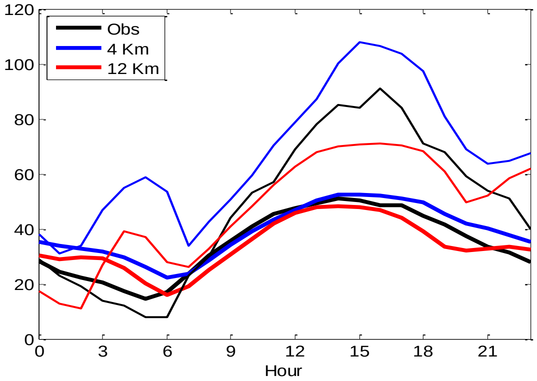
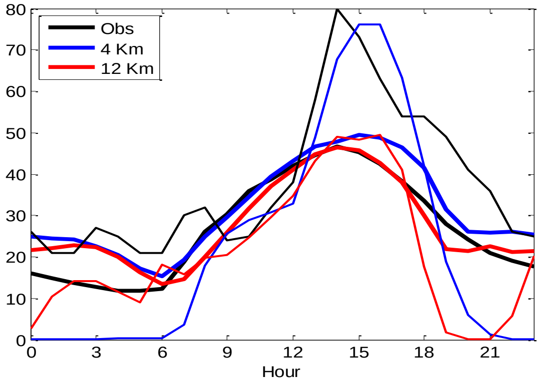


Figure 7-35: Observed and modeled (4km/12km grids) ozone (ppb) for August 2011 at monitor #361192004 (thick line: monthly avg., thin line: max day)



Conclusion

Use of a 4km nested grid in the OTR does lead to improvements in modeled performance, in particular when looking at predictions during peak days at coastal monitors. When looking at the entirety of the smaller domain there are even dis-benefits in terms of model performance in the western portion of the domain. Processing time using the 4km domain described in this section is increased six-fold, which results in a 7-month CMAQ run which takes over a month to complete. If further work is conducted using 4km modeling that relies on use of OTC inventory, to both conserve computing resources and improve model performance, it is recommended that only the inner corridor be modeled with the finer grid.

References

Thompson, TM and Selin, NE 2012, 'Influence of air quality model resolution on uncertainty associated with health impacts', *Atmospheric Chemistry and Physics*, vol. 12, no. 20, pp. 9753–9762.

Section 8. Emissions Inventories and Processing for 2017/2018/2020/2023/2028 12 km Future Year Simulation

Emission Inventory Sectors

All the inventory sectors are the same as in the base year and their brief descriptions can be found in Section 4.

US Future Year Base Case Emissions Inventories

The OTR states, through MANE-VU and MARAMA, developed the portions of the 2023 Gamma, 2020 Gamma, 2017 Beta/Beta 2, 2018 Alpha/Alpha 2, and 2028 Alpha/Alpha 2/Gamma inventories based on 2011 inventories as discussed earlier. The remaining sectors not developed through state processes were taken from US EPA.

MARAMA, through a contractor SRA, in consultation with the states, developed the necessary growth and control factors to project the 2011 inventory to a future year and applied them to develop both 2018 and 2028 Alpha 2 inventories. These growth factors were used for all the jurisdictions in the OTC, in addition to West Virginia, North Carolina, and the rest of Virginia (McDill et al. 2015). Growth rates for the states in LADCO were obtained from LADCO and we relied on default assumptions from EPA for all other states (McDill et al. 2015). The same process was undertaken for the Beta/Beta 2 inventory projections to 2017 (McDill et al. 2016) and for the Gamma inventory projects to 2020 and 2023 (McDill et al. 2018), respectively.

The Gamma inventory for 2028 was developed slightly differently. In this case the inventory sectors provided by EPA as part of their 2028 package were used and compared against the MARAMA Alpha 2 2028. This was possible since EPA relied on the same MARAMA projections discussed earlier when developing the 2028 EPA projections (US EPA 2017). Any units that were not in MARAMA 2028 Alpha 2, but were in EPA's 2028 haze modeling inventory were removed using a closure packet, except ones confirmed by states to still be operating. These sectors were then temporalized in the same fashion as described in Section 4.

It should be noted that future year emissions for the EGUs were projected with the ERTAC EGU tool (please see below) and those for mobile sources were developed under separate efforts from those discussed in this section.

For the sectors that were not projected by MARAMA they were either taken directly from EPA inventories or were interpolated from two distinct EPA inventories. The Beta inventory for 2017 relied on EPA's 'eh' inventory. The Gamma inventory for 2028 was taken from the EPA 'el' inventory. In order to develop the sectors for the 2020 Gamma inventory a grid cell by grid cell interpolation was conducted between the 2017 'eh' and 2023 'el' inventories. The Gamma inventory for 2023 was taken from the EPA 'en' inventory.

EGU emissions were processed using the ERTAC EGU tool v. 1.01 and were post-processed using ERTAC to SMOKE v. 1.02, excepting the Gamma inventories which were processed using the ERTAC EGU tool v2.1. The projections for the Alpha and Alpha 2 inventories were based on growth assumptions from the 2014 AEO and the collection of inputs were termed ERTAC EGU v. 2.3 (ERTAC Workgroup n.d.; US

Energy Information Administration April 2014). The projections for the Beta inventory were upgraded to ERTAC EGU v. 2.5 and to ERTAC EGU v. 2.5L2 for the Beta 2 inventory , which were both processed using the same versions of the code and were based on growth assumptions from the 2015 AEO (ERTAC Workgroup 2016; US Energy Information Administration April 2015). The projections for the Gamma/Gamma 2 inventory were upgraded to the ERTAC EGU v. 2.7 optimized case for 2020, 2023, and 2028, with the optimized case having emission rates that were optimized to comply with the CSPAR Update program (ERTAC EGU Committee DRAFT).

A full table follows in Table 8-1 showing where inventory sectors were taken from and greater details about which inventory files were used are located in Appendix B.

Table 8-1: Inventories used at each stage of OTC 2011 base year modeling

SECTOR	Alpha/Alpha 2	Beta/Beta 2	Gamma 2023	Gamma 2020	Gamma 2028
Ag. Fugitive Dust	EPA v6.2 eh	EPA v6.2 eh	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Agricultural	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Agricultural Fire	2011 EPA v6.2 eh	2011 EPA v6.3 ek	2011 EPA v6.3 ek	2011 EPA v6.3 ek	2011 EPA v6.3 ek
Biogenics	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 ek	EPA v6.3 ek	EPA v6.3 ek
C1C2 Marine	EPA v6.2 eh	EPA v6.2 eh	EPA v6.3 en	2011-23 en v6.3 Interpolation	EPA v6.3 el
C3 Marine	EPA v6.2 eh (α) EPA v6.3 ej (α 2)	EPA v6.3 ek	EPA v6.3 en	2011-23 en v6.3 Interpolation	EPA v6.3 el
ERTAC EGU	ERTAC v2.3	ERTAC v2.5L	ERTAC v2.7	ERTAC v2.7	ERTAC v2.7
Ethanol	MARAMA α	MARAMA β	EPA v6.3 el	EPA v6.3 el	EPA v6.3 el
Non-EGU Point	MARAMA α	MARAMA β	MARAMA γ	MARAMA γ	EPA v6.3 el
Point source offsets	n/a	MARAMA β	MARAMA γ	MARAMA γ	MARAMA γ
Non-ERTAC IPM EGUs	MARAMA α	MARAMA β	MARAMA γ	MARAMA γ	2023 MARAMA β
Non-Point	MARAMA α	MARAMA β	MARAMA γ	MARAMA γ	EPA v6.3 el
Non-point Oil & Gas	EPA v6.2 eh	MARAMA β	EPA v6.3 el	MARAMA γ	EPA v6.3 el
Nonroad	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 en	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Onroad	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Point Oil &gas	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 en	MARAMA γ	EPA v6.3 el
Prescribed/Wild Fires	2011 EPA v6.2 eh	2011 MARAMA β	2011 MARAMA β	2011 MARAMA β	2011 MARAMA β
Rail	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Refueling	MARAMA α	MARAMA β	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
RWC	EPA v6.2 eh	EPA v6.3 ek	EPA v6.3 el	2011 ek - 2023 el v6.3 Interpolation	EPA v6.3 el
Canadian	2011 EPA v6.2 eh	2011 EPA v6.3 ek	EPA v6.3 en	2011-23 en v6.3 Interpolation	2023 EPA v6.3 en

Canadian Future Base Case Emissions

Canadian emissions were estimated in the future years by taking the ratio of US domain 2011 emissions to 2017, 2018, and 2028 emissions and applying that ratio to the 2010 Canadian emissions used in the base year (McDill et al. 2015, 2016).

Application of SMOKE

All of the inventories were processed by NYSDEC using a template similar to that used for processing 2011 base year emissions for the 12 km domain. In particular, all gridding and speciation profiles, cross-reference files, and temporal allocation profiles used in the 2011 processing were also used for future year processing, excepting the hourly temporal files for ERTAC EGUs for all years and small EGUs for 2017, 2020, 2023, and 2028. A full list of files is in Appendix A.

Emissions for all source categories were processed by SMOKE version 3.7 for Beta, Beta 2 and Gamma and SMOKE version 3.6 for Alpha and Alpha 2. The SMOKE programs downloaded from CMAS website have been compiled for LINUX systems and are ready for use.

SMOKE Processed Emission Results

In order to quality assure that the outputs from SMOKE were properly distributed geographically and to develop a better understanding of the geographical and temporalization of emissions, maps of emissions in each grid cell were produced. These maps were produced from the Alpha 2 inventory. We looked at projected daily emissions on a typical summer day during 2011 (June 24) and projected daily emissions during a 2011 ozone event (July 22). We looked at NO_X and SO_2 gridded emissions. We chose not to include VOCs since biogenic emissions are held constant and overwhelm regional anthropogenic VOC emissions. Urban areas, interstate highways in rural areas, and shipping lanes are clearly distinguishable in the maps of NO_X emissions (Figure 8-1). There are minor differences at this scale on a peak day where one can notice increases in some grid cells during the ozone event (Figure 8-2). One can see the importance of point sources in terms of SO_2 emissions and there were increases at some grid cells, particularly in the Long Island Sound, on the New England coast and some Pennsylvanian EGUs, during the projected ozone event (Figure 8-3 and Figure 8-4).

When one compares the projections to the baseline found in Section 4 one notices, that on both the typical summer day and the ozone-conducive day, that emissions of NO_X decrease regionally and that a fair number of SO_2 point sources disappear in the projection because of retirements and shutdowns.

Additionally, summary tables of emissions by RPO, sector, and pollutant were outputted from SMOKE processing. For Alpha 2 and Beta2, states that are fully within the modeling domain are summed separately from states partially in the domain. For the Gamma emission inventories, only the states fully in the modeling domain are included in the summaries. The results are aggregated for the 2018 Alpha 2 inventory in Table 8-2, the 2028 Alpha 2 inventory in Table 8-3, the 2017 Beta 2 inventory in Table 8-4, the 2020 Gamma inventory in Table 8-5, the 2023 Gamma inventory in Table 8-6, and the 2028 Gamma inventory in Table 8-7.

Figure 8-1: MARAMA 2018 Projected Alpha 2 NO_X SMOKE Gridded Emissions (June 24)

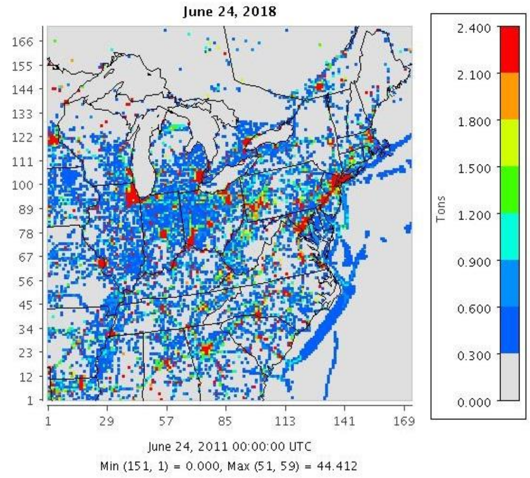


Figure 8-2: MARAMA 2018 Projected Alpha 2 NO_X SMOKE Gridded Emissions (July 22)

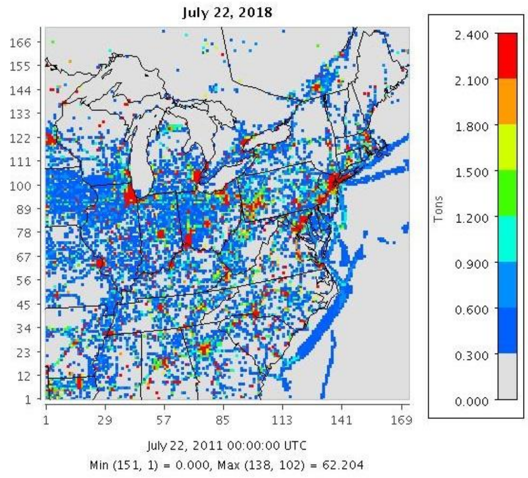


Figure 8-3: MARAMA 2018 Projected Alpha 2 SO_2 SMOKE Gridded Emissions (June 24)

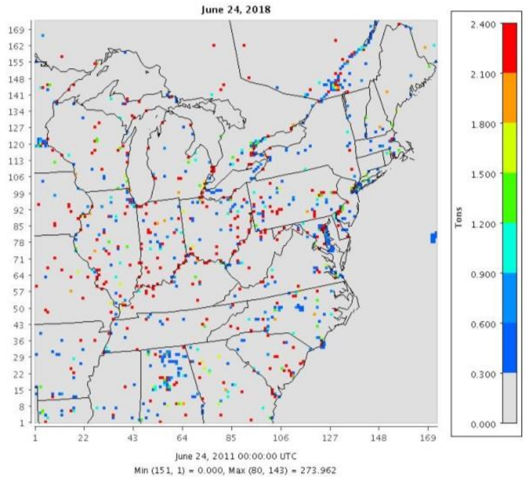


Figure 8-4: MARAMA 2018 Projected Alpha 2 SO_2 SMOKE Gridded Emissions (July 22)

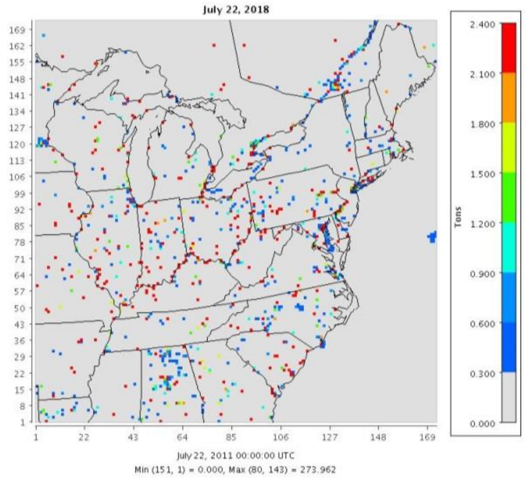


Table 8-2: 2018 base case Alpha 2 emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
NO_X									
Full State	MANE-VU	141,249	161,900	272,855	345,812	195,191	89,499	1,018	**1,207,525**
	LADCO	259,317	244,990	289,808	470,642	155,456	79,332	2,607	**1,502,152**
	SESARM	225,952	177,994	326,069	367,913	71,592	134,970	17,077	**1,321,567**
Partial State	LADCO	35,110	35,890	52,674	56,993	26,176	2,880	9,851	**219,574**
	SESARM	96,887	108,064	194,919	209,158	37,606	59,390	60,218	**766,241**
	CENSARA	403,929	336,448	397,841	574,792	143,136	663,430	116,659	**2,636,234**
	Canada		143,534	189,400	124,557	59,134			**516,625**
	US EEZ			1,016,290					**1,016,290**
	Interntnl.			2,380,100					**2,380,100**
NO_X Total		1,162,444	1,208,820	5,119,956	2,149,867	688,291	1,029,500	207,430	**11,566,309**
VOC									
Full State	MANE-VU	2,266	55,126	250,649	192,119	657,271	47,889	21,238	**1,226,558**
	LADCO	6,866	148,004	262,671	240,565	639,357	55,304	39,304	**1,392,070**
	SESARM	4,907	161,491	161,838	172,752	481,957	151,535	186,020	**1,320,500**
Partial State	LADCO	1,523	19,307	53,517	32,920	117,235	130	188,478	**413,109**
	SESARM	4,429	72,276	89,685	99,553	262,008	60,156	310,917	**899,025**
	CENSARA	12,551	222,180	207,909	254,668	835,803	1,728,134	1,635,856	**4,897,101**
	Canada		193,891	123,156	60,045	532,666			**909,758**
	US EEZ			41,341					**41,341**
	Interntnl.			95,716					**95,716**
VOC Total		32,541	872,277	1,286,483	1,052,622	3,526,297	2,043,148	2,381,813	**11,195,180**
SO_2									
Full State	MANE-VU	239,683	77,689	4,897	1,948	56,235	4,434	612	**385,498**
	LADCO	488,043	237,850	842	2,023	19,404	1,523	1,353	**751,037**
	SESARM	329,298	98,822	1,401	1,614	30,312	3,384	7,640	**472,472**
Partial State	LADCO	67,455	13,470	103	249	6,465	82	5,687	**93,511**
	SESARM	101,181	72,911	721	933	30,363	26,140	20,498	**252,747**
	CENSARA	882,412	233,504	3,016	2,451	43,881	25,286	58,760	**1,249,310**
	Canada		362,365	32,651	607	36,964			**432,586**
	US EEZ			113,282					**113,282**
	Interntnl.			1,672,100					**1,672,100**
SO_2 Total		2,108,072	1,096,611	1,829,013	9,825	223,623	60,849	94,551	**5,422,544**
$PM_{2.5}$									
Full State	MANE-VU	13,776	28,341	19,768	16,436	170,115	2,560	25,958	**276,954**
	LADCO	57,915	50,497	19,831	20,030	166,504	1,387	126,737	**442,902**
	SESARM	44,846	39,231	16,745	13,654	97,554	3,033	110,196	**325,259**
Partial State	LADCO	5,369	14,056	3,743	2,527	45,901	29	90,555	**162,180**
	SESARM	21,615	33,583	9,556	7,999	87,075	1,399	274,013	**435,240**
	CENSARA	73,452	84,040	25,312	21,852	123,688	17,071	1,033,122	**1,378,538**
	Canada		25,261	13,805	5,093	105,607		323,474	**473,240**
	US EEZ			27,544					**27,544**
	Interntnl.			207,330					**207,330**
$PM_{2.5}$ Total		216,972	275,009	343,634	87,590	796,445	25,479	1,984,056	**3,729,185**
NH_3									
Full State	MANE-VU	2,381	5,220	419	13,243	14,920	17	169,173	**205,372**
	LADCO	-	7,713	490	12,522	20,170	12	487,770	**528,677**
	SESARM	275	6,770	374	10,787	5,589	4	360,853	**384,653**
Partial State	LADCO	-	1,210	81	1,614	3,349	47	205,121	**211,422**
	SESARM	-	9,835	232	5,895	2,843	2	244,742	**263,549**
	CENSARA	-	23,279	1,194	14,475	17,190	48	1,394,423	**1,450,609**
	Canada		5,232	203	9,641	3,091		183,853	**202,020**
	US EEZ			216					**216**
	Interntnl.			-					**-**
NH_3 Total		2,656	59,260	3,208	68,176	67,152	130	3,045,936	**3,246,518**
CO									
Full State	MANE-VU	68,463	237,066	2,550,632	2,145,813	884,490	80,265	90,739	**6,057,469**
	LADCO	134,287	706,098	2,187,265	2,570,440	1,015,890	48,517	166,190	**6,828,686**
	SESARM	104,669	315,743	1,514,543	1,929,857	529,343	134,134	842,359	**5,370,648**
Partial State	LADCO	18,677	23,490	309,030	344,820	260,290	551	800,131	**1,756,988**
	SESARM	64,936	139,783	795,971	1,072,390	494,339	30,650	1,972,145	**4,570,214**
	CENSARA	200,347	398,047	1,947,730	2,853,610	787,726	502,020	6,907,096	**13,596,576**
	Canada		568,160	2,003,059	1,300,915	648,333			**4,520,467**
	US EEZ			63,245					**63,245**
	Interntnl.			34,933					**34,933**
CO Total		591,379	2,388,387	11,406,408	12,217,845	4,620,411	796,137	10,778,661	**42,799,227**

Table 8-3: 2028 base case Alpha 2 emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
					NO_X				
Full State	MANE-VU	144,321	169,285	205,249	213,308	192,539	109,952	1,389	**1,036,043**
	LADCO	266,843	251,116	212,570	283,006	156,081	76,551	2,622	**1,248,789**
	SESARM	205,966	186,000	152,705	216,505	69,944	155,843	19,185	**1,006,148**
Partial State	LADCO	19,973	36,926	37,603	32,180	25,312	2,878	10,924	**165,795**
	SESARM	97,741	108,708	80,929	119,168	33,509	60,445	64,305	**564,805**
	CENSARA	429,956	361,080	444,053	351,529	127,495	680,492	132,486	**2,527,092**
	Canada		143,534	189,400	124,557	59,134			**516,625**
	US EEZ			345,540					**345,540**
	Interntnl.			30,139					**30,139**
NO_X Total		1,164,800	1,256,649	1,698,188	1,340,251	664,015	1,086,161	230,911	**7,440,976**
					VOC				
Full State	MANE-VU	2,787	56,238	219,555	132,470	699,334	39,140	22,098	**1,171,623**
	LADCO	7,784	148,692	222,173	157,652	688,641	43,801	39,329	**1,308,072**
	SESARM	4,979	163,643	134,104	107,266	515,026	116,116	190,056	**1,231,191**
Partial State	LADCO	656	19,372	41,648	20,403	122,479	130	190,336	**395,024**
	SESARM	4,878	72,343	74,148	59,997	265,842	61,246	317,985	**856,438**
	CENSARA	15,021	237,729	196,286	163,445	825,579	1,694,250	1,663,414	**4,795,725**
	Canada		193,891	123,156	60,045	532,666			**909,758**
	US EEZ			17,465					**17,465**
	Interntnl.			1,378					**1,378**
VOC Total		36,105	891,908	1,029,915	701,277	3,649,567	1,954,683	2,423,219	**10,686,674**
					SO_2				
Full State	MANE-VU	259,171	78,050	3,598	1,881	39,869	5,837	773	**389,179**
	LADCO	495,592	238,354	3,595	1,961	19,959	1,549	1,360	**762,370**
	SESARM	294,228	100,703	2,890	1,566	29,144	4,308	8,287	**441,125**
Partial State	LADCO	23,609	13,587	211	242	6,082	82	6,178	**49,991**
	SESARM	52,898	74,123	3,232	926	28,516	30,927	22,383	**213,005**
	CENSARA	923,140	239,988	19,337	2,439	38,639	24,168	64,365	**1,312,077**
	Canada		362,365	32,651	607	36,964			**432,586**
	US EEZ			8,916					**8,916**
	Interntnl.			4,377					**4,377**
SO_2 Total		2,048,638	1,107,170	78,806	9,624	199,173	66,870	103,346	**3,613,626**
					$PM_{2.5}$				
Full State	MANE-VU	14,728	28,639	14,941	11,779	170,107	2,986	30,781	**273,961**
	LADCO	62,684	50,480	14,069	13,216	178,806	1,306	136,303	**456,864**
	SESARM	41,008	39,708	10,122	9,158	92,867	3,492	118,883	**315,238**
Partial State	LADCO	4,725	14,070	2,455	1,658	46,254	29	93,842	**163,033**
	SESARM	24,501	33,631	5,397	5,390	78,540	1,429	286,443	**435,332**
	CENSARA	76,811	87,303	22,377	14,569	89,090	17,241	1,105,953	**1,413,345**
	Canada		25,261	13,805	5,093	105,607		323,474	**473,240**
	US EEZ			9,109					**9,109**
	Interntnl.			651					**651**
$PM_{2.5}$ Total		224,457	279,093	92,925	60,861	761,271	26,485	2,095,679	**3,540,771**
					NH_3				
Full State	MANE-VU	1,947	5,265	459	13,087	15,049	17	169,317	**205,140**
	LADCO	172	7,677	546	12,265	20,733	13	499,032	**540,437**
	SESARM	461	6,835	334	10,336	5,654	4	362,702	**386,326**
Partial State	LADCO	16	1,210	90	1,538	3,470	47	210,051	**216,422**
	SESARM	220	9,747	172	5,793	2,852	3	251,392	**270,179**
	CENSARA	1,334	23,705	1,782	14,361	14,673	45	1,423,131	**1,479,031**
	Canada		5,232	203	9,641	3,091		183,853	**202,020**
	US EEZ			216					**216**
	Interntnl.			-					**-**
NH_3 Total		4,150	59,672	3,802	67,021	65,522	127	3,099,478	**3,299,771**
					CO				
Full State	MANE-VU	43,947	247,097	2,712,333	1,561,530	976,393	103,418	101,956	**5,746,674**
	LADCO	148,047	716,781	2,249,485	1,784,447	1,101,658	45,031	166,518	**6,211,968**
	SESARM	94,570	326,583	1,566,483	1,323,816	487,016	160,345	893,773	**4,852,585**
Partial State	LADCO	11,705	25,129	305,806	229,445	254,188	551	823,656	**1,650,480**
	SESARM	72,418	142,227	812,954	739,875	404,411	32,148	2,062,938	**4,266,971**
	CENSARA	223,558	423,986	2,413,115	2,002,015	446,099	513,122	7,256,028	**13,277,922**
	Canada		568,160	2,003,059	1,300,915	648,333			**4,520,467**
	US EEZ			95,287					**95,287**
	Interntnl.			3,245					**3,245**
CO Total		594,244	2,449,964	12,161,766	8,942,042	4,318,099	854,616	11,304,869	**40,625,599**

Table 8-4: 2017 base case Beta 2 emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
NO_X									
Full State	MANE-VU	99,123	151,352	264,570	381,046	180,425	75,550	1,166	**1,153,231**
	LADCO	252,202	236,765	301,961	500,530	156,682	66,279	2,612	**1,517,032**
	SESARM	198,486	158,645	215,201	412,130	69,091	97,726	18,262	**1,169,541**
Partial State	LADCO	19,522	45,149	55,156	44,030	24,374	110	9,926	**198,267**
	SESARM	77,826	105,072	110,032	202,440	33,263	37,035	61,591	**627,259**
	CENSARA	401,928	329,949	622,921	154,499	131,281	588,721	127,577	**2,356,877**
	Canada		143,534	189,400	124,557	59,134			**516,625**
	US EEZ			460,270					**460,270**
	Interntnl.			24,340					**24,340**
NO_X Total		1,049,087	1,170,466	2,243,853	1,819,232	654,251	865,421	221,134	**8,023,443**
VOC									
Full State	MANE-VU	2,576	54,220	260,225	214,498	655,025	50,611	21,570	**1,258,724**
	LADCO	6,319	144,938	275,399	250,864	640,342	84,134	39,312	**1,441,309**
	SESARM	4,559	156,401	164,413	197,893	487,402	179,025	188,260	**1,377,953**
Partial State	LADCO	503	19,446	56,583	25,386	114,846	45	188,610	**405,419**
	SESARM	3,302	72,265	92,072	97,455	259,306	46,635	313,324	**884,360**
	CENSARA	10,135	225,001	226,113	63,870	834,819	1,969,444	1,654,956	**4,984,338**
	Canada		193,891	123,156	60,045	532,666			**909,758**
	US EEZ			15,611					**15,611**
	Interntnl.			962					**962**
VOC Total		27,394	866,162	1,214,536	910,012	3,524,407	2,329,894	2,406,032	**11,278,435**
SO_2									
Full State	MANE-VU	190,640	83,208	1,523	1,922	32,936	6,357	667	**317,253**
	LADCO	542,997	251,809	625	1,927	15,214	1,344	1,355	**815,271**
	SESARM	279,049	133,403	621	1,579	19,893	4,493	8,016	**447,055**
Partial State	LADCO	25,816	16,779	97	175	3,159	3	5,722	**51,752**
	SESARM	42,334	73,052	284	800	9,615	25,853	21,104	**173,043**
	CENSARA	830,790	265,990	1,467	518	6,437	31,987	62,174	**1,199,364**
	Canada		362,365	32,651	607	36,964			**432,586**
	US EEZ			2,803					**2,803**
	Interntnl.			16,830					**16,830**
SO_2 Total		1,911,626	1,186,606	56,901	7,530	124,219	70,037	99,039	**3,455,958**
$PM_{2.5}$									
Full State	MANE-VU	14,234	28,387	18,956	17,186	157,362	3,200	28,756	**268,080**
	LADCO	38,625	51,623	21,027	19,937	159,719	1,374	132,426	**424,730**
	SESARM	29,147	41,289	14,294	14,692	91,055	3,164	114,826	**308,466**
Partial State	LADCO	2,500	14,422	3,997	1,925	43,017	1	91,596	**157,458**
	SESARM	8,326	36,086	7,363	7,410	79,980	924	277,243	**417,330**
	CENSARA	40,942	91,684	31,650	5,742	91,570	17,208	1,066,261	**1,345,057**
	Canada		25,261	13,805	5,093	105,607		323,474	**473,240**
	US EEZ			8,379					**8,379**
	Interntnl.			2,087					**2,087**
$PM_{2.5}$ Total		133,773	288,752	121,557	71,984	728,310	25,871	2,034,582	**3,404,828**
NH_3									
Full State	MANE-VU	2,609	5,151	413	13,738	14,395	17	167,747	**204,069**
	LADCO	832	7,682	483	12,922	19,758	10	485,163	**526,849**
	SESARM	1,313	6,636	305	11,394	5,521	4	362,243	**387,416**
Partial State	LADCO	117	1,327	80	1,160	3,276	2	204,351	**210,313**
	SESARM	1,836	9,496	157	5,360	2,911	2	243,682	**263,443**
	CENSARA	5,627	22,805	1,315	3,117	14,702	51	1,414,226	**1,461,844**
	Canada		5,232	203	9,641	3,091		183,853	**202,020**
	US EEZ			216					**216**
	Interntnl.								
NH_3 Total		12,333	58,329	3,172	57,331	63,654	85	3,061,265	**3,256,170**
CO									
Full State	MANE-VU	38,566	238,478	2,541,821	2,279,190	864,069	73,624	95,550	**6,131,298**
	LADCO	77,938	734,646	2,192,532	2,645,200	952,162	48,739	166,302	**6,817,518**
	SESARM	68,512	320,682	1,487,725	2,065,500	470,919	99,094	870,770	**5,383,203**
Partial State	LADCO	7,666	27,981	311,485	258,700	225,080	24	801,859	**1,632,795**
	SESARM	31,967	161,054	771,901	996,800	405,101	22,773	2,003,907	**4,393,503**
	CENSARA	184,816	436,622	1,997,595	640,342	448,849	472,366	7,145,277	**11,325,866**
	Canada		568,160	2,003,059	1,300,915	648,333			**4,520,467**
	US EEZ			85,941					**85,941**
	Interntnl.			2,267					**2,267**
CO Total		409,465	2,487,623	11,394,325	10,186,647	4,014,513	716,619	11,083,666	**40,292,858**

Table 8-5: 2020 base case Gamma emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports (states fully in the modeling domain only)

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
NO$_X$									
Full State	MANE-VU	82,144	152,978	247,717	306,810	178,114	90,699	365	**1,058,828**
	LADCO	194,033	233,709	281,088	401,002	159,364	68,106	15	**1,337,316**
	SESARM	160,240	153,429	197,644	328,206	70,863	89,367	2,094	**1,001,843**
NO$_X$ Total		436,416	540,117	726,449	1,036,018	408,340	248,172	2,474	**3,397,987**
VOC									
Full State	MANE-VU	4,334	55,114	258,671	181,928	647,818	52,904	846	**1,201,616**
	LADCO	5,338	142,702	267,747	206,689	633,628	66,531	25	**1,322,660**
	SESARM	4,503	156,894	160,865	163,375	481,910	113,136	4,009	**1,084,692**
VOC Total		14,175	354,710	687,284	551,992	1,763,356	232,571	4,881	**3,608,968**
SO$_2$									
Full State	MANE-VU	183,717	83,431	7,749	1,839	26,718	8,114	158	**311,727**
	LADCO	390,373	226,119	1,971	1,858	16,087	3,154	7	**639,570**
	SESARM	203,505	112,064	2,525	1,531	21,419	4,340	643	**346,026**
SO$_2$ Total		777,596	421,613	12,245	5,229	64,224	15,608	809	**1,297,323**
PM$_{2.5}$									
Full State	MANE-VU	13,928	28,545	18,228	14,499	154,712	3,742	21,638	**255,293**
	LADCO	31,650	51,379	19,462	16,164	152,337	1,327	119,705	**392,025**
	SESARM	27,465	39,699	13,248	12,120	91,738	2,990	38,954	**226,215**
PM$_{2.5}$ Total		73,043	119,623	50,939	42,783	398,787	8,060	180,297	**873,532**
NH$_3$									
Full State	MANE-VU	2,963	5,167	431	13,226	14,107	17	166,715	**202,625**
	LADCO	2,018	7,668	504	12,436	19,415	12	483,154	**525,207**
	SESARM	1,476	6,187	317	10,901	5,525	4	351,798	**376,208**
NH$_3$ Total		6,456	19,021	1,251	36,564	39,048	33	1,001,666	**1,104,040**
CO									
Full State	MANE-VU	17,798	37,735	19,400	40,311	163,627	3,841	1,899	**284,610**
	LADCO	43,050	74,891	20,734	41,340	157,228	1,335	57	**338,637**
	SESARM	34,933	57,460	14,043	30,528	103,191	3,017	6,879	**250,051**
CO Total		95,781	170,086	54,177	112,179	424,047	8,193	8,835	**873,297**

Table 8-6: 2023 base case Gamma emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports (states fully in the modeling domain only)

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
NO$_X$									
Full State	MANE-VU	84,525	154,146	214,581	231,542	177,085	70,509	1,384	**933,772**
	LADCO	189,331	241,081	234,670	301,824	160,611	71,222	2,622	**1,201,361**
	SESARM	157,442	160,842	166,868	242,736	71,612	93,432	19,171	**912,103**
NO$_X$ Total		431,298	556,069	616,119	776,102	409,308	235,163	23,177	**3,047,236**
VOC									
Full State	MANE-VU	3,913	55,072	223,788	147,910	661,386	45,121	22,084	**1,159,274**
	LADCO	5,407	146,603	227,762	161,585	666,099	107,523	39,329	**1,354,309**
	SESARM	4,701	160,565	136,708	126,996	530,055	142,310	190,030	**1,291,364**
VOC Total		14,021	362,239	588,258	436,491	1,857,540	294,955	251,443	**3,804,947**
SO$_2$									
Full State	MANE-VU	197,693	83,627	1,837	1,752	28,200	6,052	771	**319,931**
	LADCO	365,687	258,648	693	1,801	15,065	6,577	1,360	**649,832**
	SESARM	195,982	119,045	735	1,480	20,885	621	8,283	**347,032**
SO$_2$ Total		759,362	461,320	3,265	5,034	64,150	13,250	10,414	**1,316,795**
PM$_{2.5}$									
Full State	MANE-VU	14,242	28,585	15,030	11,725	152,689	2,988	29,571	**254,830**
	LADCO	31,505	52,213	15,398	12,743	151,342	1,523	135,543	**400,267**
	SESARM	27,721	40,873	10,690	9,475	92,288	3,400	119,308	**303,754**
PM$_{2.5}$ Total		73,467	121,671	41,118	33,943	396,319	7,911	284,422	**958,851**
NH$_3$									
Full State	MANE-VU	2,900	5,167	446	12,688	13,837	16	169,063	**204,117**
	LADCO	1,984	7,724	520	11,875	19,332	15	489,491	**530,941**
	SESARM	1,795	6,333	327	10,366	5,528	4	368,954	**393,307**
NH$_3$ Total		6,680	19,224	1,292	34,929	38,697	35	1,027,508	**1,128,365**
CO									
Full State	MANE-VU	40,367	245,144	2,653,452	1,687,555	819,303	69,000	101,774	**5,616,594**
	LADCO	54,782	735,900	2,223,409	1,897,936	901,023	43,287	166,518	**6,022,856**
	SESARM	53,826	325,925	1,537,983	1,499,233	466,883	95,247	893,400	**4,872,496**
CO Total		148,974	1,306,969	6,414,844	5,084,724	2,187,209	207,533	1,161,693	**16,511,946**

Table 8-7: 2028 base case Gamma emissions (tons) by pollutant and RPO for aggregated sectors from SMOKE processed emission reports (states fully in the modeling domain only)

Full State/ Partial State	RPO	ERTAC EGU	Non-EGU Point & Small EGU	Nonroad (including M/A/R)	Onroad	Non-point (including RWC & Refueling)	Oil/Gas	Other (including biogenic)	Total
					NO_X				
Full State	MANE-VU	158,837	292,996	386,465	331,491	354,448	141,475	2,767	**1,668,480**
	LADCO	348,231	492,028	405,415	439,823	320,370	224,757	5,244	**2,235,869**
	SESARM	306,427	321,556	288,147	345,055	142,846	242,723	38,343	**1,685,097**
NO_X Total		813,495	1,106,580	1,080,027	1,116,370	817,665	608,955	46,354	**5,589,446**
					VOC				
Full State	MANE-VU	9,742	108,743	439,614	222,301	1,318,126	99,660	44,168	**2,242,354**
	LADCO	10,992	296,598	438,570	239,501	1,322,374	186,831	78,658	**2,573,524**
	SESARM	9,742	303,854	264,776	182,868	1,058,056	392,582	380,059	**2,591,936**
VOC Total		30,476	709,195	1,142,959	644,671	3,698,556	679,073	502,885	**7,407,815**
					SO_2				
Full State	MANE-VU	391,667	151,332	3,934	3,284	44,007	12,739	1,541	**608,504**
	LADCO	683,297	522,171	1,436	3,509	26,741	9,442	2,720	**1,249,316**
	SESARM	396,600	240,078	1,591	2,847	31,083	3,805	16,567	**692,571**
SO_2 Total		1,471,564	913,581	6,962	9,640	101,831	25,986	20,828	**2,550,391**
					$PM_{2.5}$				
Full State	MANE-VU	30,121	56,523	27,546	18,431	301,805	6,202	59,911	**500,540**
	LADCO	63,706	105,032	26,281	19,765	291,813	7,552	275,847	**789,996**
	SESARM	57,372	80,350	18,716	14,618	183,915	11,005	240,548	**606,525**
$PM_{2.5}$ Total		151,200	241,904	72,543	52,814	777,534	24,759	576,306	**1,897,061**
					NH_3				
Full State	MANE-VU	6,227	10,247	951	25,264	27,283	32	338,128	**408,132**
	LADCO	4,225	15,490	1,112	23,972	38,172	72	982,323	**1,065,365**
	SESARM	3,815	12,829	694	20,876	11,046	8	741,999	**791,268**
NH_3 Total		14,268	38,565	2,756	70,112	76,501	112	2,062,451	**2,264,765**
					CO				
Full State	MANE-VU	84,936	481,976	5,614,856	2,507,681	1,613,336	139,925	203,549	**10,646,257**
	LADCO	111,462	1,476,840	4,626,388	2,762,732	1,737,097	190,090	333,036	**11,237,645**
	SESARM	112,798	651,877	3,241,115	2,174,017	928,246	267,613	1,786,801	**9,162,466**
CO Total		309,196	2,610,693	13,482,358	7,444,429	4,278,679	597,628	2,323,386	**31,046,369**

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Section 9. Emissions Inventories and Processing for 2028 Visibility Control 12 km Future Year Simulation

2028 Visibility Control Inventory Development

The basis for the Regional Haze projected inventory is the 2011 Gamma inventory projected to 2028 discussed in Section 9. Only control programs found in the MANE-VU Intra-RPO (Mid-Atlantic Northeast Visibility Union 2017a), Inter-RPO (Mid-Atlantic Northeast Visibility Union 2017b) , and Federal Asks (Mid-Atlantic Northeast Visibility Union 2017c), were modeled as control strategies since this was considered to be a more conservative approach to modeling reasonable progress goals. Control programs were applied to this inventory, in particular the following sectors:

- EGUs
- Non-ERTAC IPM EGUs
- Non-EGU Point
- Non-Point

The following sections desribe how each ask was included in the control inventory for photochemical modeling.

Intra-RPO/Inter-RPO Ask 1

EGUs with a nameplate capacity larger than or equal to 25 MW with already installed NOx and/or SO2 controls - ensure the most effective use of control technologies on a year-round basis to consistently minimize emissions of haze precursors, or obtain equivalent emissions reductions

The control case was taken directly from the projections completed for “Impact of Wintertime SCR/SNCR Optimization on Visibility Impairing Nitrate Precursor Emissions” (Mid-Atlantic Northeast Visibility Union 20 November 2017). There were no expectations of a change in SO_2 emissions, so only NO_X emissions were controlled. Details on projections can be found in the paper and the ERTAC input files for this run were be updated to incorporate the other modeling necessary to complete for the ask.

Intra-RPO/Inter-RPO Ask 2

Emissions sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses - perform a four-factor analysis for reasonable installation or upgrade to emission controls

36 stacks were found to impair visibility by 3Mm^{-1} or more based on CALPUFF modeling and are subject to the Ask (Mid-Atlantic Northeast Visibility Union 4 April 2017). 22 of these are in MANE-VU States and the remaining 14 are outside of the region. 30 of the stacks are in ERTAC and were projected using the ERTAC process; the remaining 6 are non-EGU sources and were projected using EMF.

ERTAC Sources

All of the units at six stacks and one unit at another stack (see Table 9-1) were found to have been retired, leaving 30 stacks that will have to have emission reductions applied.

Table 9-1: Units that are considered retired in ERTAC that were included in Ask 2

State	Facility Name	ORIS ID	Unit IDs	Max Ext.	ERTAC?	Retirement Date
MA	Brayton Point	1619	4	4.3	Y	1/1/2017
NJ	B L England	2378	2,3	5.6	Y	1/1/2020
KY	Big Sandy	1353	BSU2 (BSU1 is active)	3.5	Y	1/1/2015
MI	St. Clair	1743	1,2,3,4,...6	3.1	Y	1/1/2022
OH	Muskingum River	2872	5	7.7	Y	6/1/2015
OH	Muskingum River	2872	1,2,3,4	4.4	Y	6/1/2015
VA	Yorktown Power Station	3809	1,2	7	Y	5/1/2017
WV	Kammer	3947	1,2,3	3.2	Y	6/1/2015

Model units were used to define the rates to utilize for units identified in Ask 2 to reduce their contribution, which will be referred to as the model unit emission rates.

Model units were defined as units whose maximum impact on visibility was less than 1 Mm^{-1}. 1 Mm^{-1} was chosen as to maintain a buffer between the ask level of 3 Mm^{-1} and the “modeling units”.

To begin development of the model unit emission rates we relied on Appendix B.3 and Appendix F of the 2016 MANE-VU Source Contribution Modeling Report (Mid-Atlantic Northeast Visibility Union 4 April 2017) and data collected on individual EGUs (Mid-Atlantic Northeast Visibility Union 2017d). These three data sets were all joined based on a one-to-one relationship using CAMD identifiers and were also linked to impairment values from CALPUFF modeling and other pertinent EGU attributes including retirement date estimations, fuel switch year, primary fuel type, and CAMD unit type. This resulted in 217 units. Units that lacked matches between the datasets were also determined.

First, units were eliminated if the CALPUFF results showed that they impaired visibility by greater than 1 Mm^{-1}. Filters were created looking at fuel type (coal, oil, gas) and two geographies: (1) all MANE-VU states and states with units in Ask 2 and (2) all MANE-VU States and states included in the Inter-RPO consultation. The former filter was needed so that the model emission rate could be applied to a unit burning a similar fuel. The latter was needed so the best determination could be made as to what distance away should model units be since units that are further away may be emitting at a higher emission rate than what is achievable, but are not impairing visibility nearly as much due to the distance from the source. Average emission rates were calculated for SO_2 and NO_X and found in Table 9-2.

Table 9-2: SO_2 and NO_X Model Unit Emission Rates (lb. /hour) for coal and oil-fired EGUs

Geography	Primary Fuel Type	SO_2	NO_X
All MANE-VU states and states with units in Ask 2	**Coal**	1635.47	1106.74
	Oil	367.25	384.889
All MANE-VU states and states included in the Inter-RPO consultation	**Coal**	1542.61	626.25
	Oil	367.25	193.34

The Technical Support Committee chose to use the geography of the MANE-VU states and states with units in the Ask for determining model unit emission rates in terms of lbs. /hour. These rates were then converted to a rate in terms of lbs. /MMBtu to later be compared to already projected emission rates in ERTAC using the following formula:

$$Emission\ Rate\ (\frac{lbs}{MMBtu}) = \frac{Generation\ Capacity\ (MW) * Emission\ Rate\ \left(\frac{lbs}{hour}\right) * 1000}{Ertac\ Heat\ Rate\ (\frac{btu}{kw - hr})}$$

After unit specific emission rates were calculated, a search of the control file that included Ask 1, Ask 3, and Ask 5 was completed for any units that needed the model unit emission rate applied. Any entries in the control file that needed its emission rate adjusted were then removed, which resulted in a control file with 2850 entries. Then entries with the model unit emission rates were appended to the control file which added 31 entries (note some units have several entries in the control file). Additionally, the emission rate for Brunner Island (ORISPL Code - 3140) in PA was updated to reflect an emission rate of 0.12 lb. NO$_X$/MMBtu annually and 0.14 lb. SO$_2$ MMBtu during non-ozone season for this analysis, which was due to a consent decree that occurred after ERTAC v. 2.7 was finalized. A list of the altered emission rates is in Table 9-3 and the full control file can be obtained upon request.

Table 9-3: Projected model emission rate, 2028 base and control case emission rates applied to EGUs subject to Ask 2

Pollutant	ORISPL Code	Unit ID	Facility Name	State	ERTAC Unit Type	2028 Projected Average Emission Rates			
						Base Case	Rate from Ask 1, 3, or 5	Model Unit	Applied ER in Ask 2
NO$_X$	1507	4	William F Wyman	ME	Oil	0.1593		0.0612	0.0612
NO$_X$	1599	1	Canal Station	MA	Oil	0.0821		0.0706	0.0706
NO$_X$	2836	12	Avon Lake Power Plant	OH	Coal	0.2724	0.2842	0.1832	0.1832
NO$_X$	3140	3	Brunner Island	PA	Coal	0.1684	0.3	0.149	0.12
NO$_X$	3809	3	Yorktown Power Station	VA	Oil	0.2318		0.0432	0.0432
NO$_X$	6034	1	Belle River	MI	Coal	0.2111		0.1366	0.1366
NO$_X$	6034	2	Belle River	MI	Coal	0.2123		0.1333	0.1333
NO$_X$	6166	MB1	Rockport	IN	Coal	0.1088	0.15	0.0813	0.0813
NO$_X$	6166	MB2	Rockport	IN	Coal	0.0959	0.12	0.0826	0.0826
SO$_2$	1507	4	William F Wyman	ME	Oil	0.52	0.52	0.0584	0.0584
SO$_2$	1554	3	Herbert A Wagner*	MD	Coal	1.0526		0.5969	0.5969
SO$_2$	1599	1	Canal Station	MA	Oil	0.396	0.3785	0.0674	0.0674
SO$_2$	2836	12	Avon Lake Power Plant	OH	Coal	1.59	1.59	0.2708	0.2708
SO$_2$	3122	3	Homer City	PA	Coal	0.2326		0.2253	0.2253
SO$_2$	3136	1	Keystone	PA	Coal	0.8629		0.1888	0.1888
SO$_2$	3136	2	Keystone	PA	Coal	0.8187		0.1842	0.1842
SO$_2$	3140	3	Brunner Island	PA	Coal	0.1337	0.39	0.2201	0.14
SO$_2$	3149	1	Montour	PA	Coal	0.4164		0.2215	0.2215
SO$_2$	3149	2	Montour	PA	Coal	0.4343		0.2215	0.2215
SO$_2$	3809	3	Yorktown Power Station	VA	Oil	0.7285	0.525	0.0412	0.0412
SO$_2$	6034	1	Belle River	MI	Coal	0.5732		0.2019	0.2019
SO$_2$	6034	2	Belle River	MI	Coal	0.5625		0.197	0.197
SO$_2$	6166	MB1	Rockport	IN	Coal	0.3491		0.1202	0.1202
SO$_2$	6166	MB2	Rockport	IN	Coal	0.3513		0.1221	0.1221
SO$_2$	8102	1	Gen J M Gavin	OH	Coal	0.3731		0.112	0.112
SO$_2$	8102	2	Gen J M Gavin	OH	Coal	0.35		0.1121	0.1121

*** It should be noted that future emissions at Hebert A Wagner are indeterminate because of the SO$_2$ nonattainment area status**

Non-EGU Sources

In the case of non-EGU sources all of the sources that were modeled to not meet the Ask had some type of change of operation planned or implemented following the base year of 2011 intended to meet the Ask. As a result, the approach was taken to elicit feedback from the individual states concerning the appropriate emission rate to use in the control scenario. The units in Maine were found to be lowering their emissions due to low sulfur fuel oil rules in the 2028 base case projections and no additional reductions were included. The units in Maryland and New York were either switching to natural gas or installing scrubbers, but had not included these reductions in the base case inventories. 2028 emissions for SO_2 and NO_X were then used to calculate control efficiencies to apply to the units in Maryland and New York and the control efficiencies are shown in Table 9-4. These control efficiencies were then included in a control packet run through EMF that can be obtained upon request.

Table 9-4: 2028 Base Case Projections and Control Efficiencies (CEFF) for non-EGU sources subject to Ask 2

State	Facility Name	Unit ID	SO_2 CEFF	NO_X CEFF
MD	Luke Paper	18	56.4	56.4
MD	Luke Paper	19	22.7	50.3
ME	Jackson Laboratory		0	0
ME	Woodland Pulp LLC		0	0
NY	Finch Paper LLC	12	20	20
NY	Lafarge Building Materials Inc.	43101	20	53.8

Intra-RPO/Inter-RPO Ask 3

Each state that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows:

a. distillate oil to 0.0015% sulfur by weight (15 ppm),
b. #4 residual oil within a range of 0.25 to 0.5% sulfur by weight,
c. #6 residual oil within a range of 0.3 to 0.5% sulfur by weight

ERTAC Sources

To model oil-fired EGUs in the ERTAC system control entries were developed and incorporated in the control file that was created to model HEDD units. Only changes to SO_2 emissions as the result of switching to low sulfur fuel oil were modeled. All states in MANE-VU and all of the upwind states included in the Inter-RPO consultation had emission rates evaluated in their units.

The following steps were undertaken to calculate default emission rates that would be modeled for units to meet the low sulfur fuel oil ask. First, to account for the conversion of sulfur to SO_2, the ratio of the molecular weight of sulfur to SO_2 was estimated using the following formula:

$MW\ of\ S = 32$
$MW\ of\ O = 16$
$MW\ of\ SO_2 = 32 + (2*16) = 64$
$Conversion\ of\ S\ to\ SO_2 = 64/32 = 2$

Then to calculate the emission rate in lb. /MMBtu for 15 ppm distillate oil the following calculations were conducted:

> *15 ppm could be equal to 15 lb. of S per 1,000,000 lb. of distillate oil*
> *Density of distillate oil = 7.05 lb. /gal*
> *Heating value of distillate oil = 140,000 Btu/gal*
> *(15 lb. S/1,000,000 lb. distillate) x (7.05 lb. /gal) x (1 gal/140,000 Btu) x (1,000,000 Btu/1 MMBtu) x 2 = 0.0015 lb. /MMBtu*

Then to calculate the emission rate in lb. /MMBtu for 0.5% by weight residual oil the following calculations were conducted:

> *0.5% S by weight = 5,000 ppm*
> *5,000 ppm could be equal to 5000 lb. of S per 1,000,000 lb. of residual oil*
> *Density of residual oil = 7.88 lb. /gal*
> *Heating value of residual oil = 150,000 Btu/gal*
> *(5,000 lb. S/1,000,000 lb. residual) x (7.88 lb. /gal) x (1 gal/150,000 Btu) x (1,000,000 Btu/1 MMBtu) x 2 = 0.525 lb. /MMBtu*

These default emission rates were then compared to emission rates in the annual summary for all of the oil units that had non-zero SO_2 emissions in the ERTAC v2.7 base case 2028 projections. If a unit was labeled as having a primary fuel type of “Residual Oil” or “Pipeline Natural Gas” and in the latter case a secondary fuel type of “RFO” then the projected emission rate was compared to 0.525 lb. /MMBtu. Otherwise it was compared to an emission rate of 0.0015 lb. /MMBtu. In cases where the projected emission rate from the base case was higher than the compared emission rate the compared emission rate was used instead of the projected emission rate from the base case. Additionally, Connecticut and Massachusetts provided emission rates to use instead of either the ERTAC v2.7 base case 2028 projected emission rate or the emission rate calculated to meet the ask and these adjustments are shown in Table 9-5.

Table 9-5: State supplied adjustments to oil units modeled to meet the low sulfur fuel oil ask using ERTAC

State	Facility Name	ORIS ID	Unit ID	Primary Fuel	Secondary Fuel	2028 Annual SO_2 Emission Rate (lbs./MMBtu)		
						ERTAC Projection	Calculated Rate to Meet Ask	State Supplied Rate
CT	Tunnel	557	10	Diesel Oil		0.102	0.0015	0.1
CT	Norwich	581	TRBINE	Diesel Oil		0.0086	0.0015	0.008
CT	Bridgeport Harbor Station	568	BHB4	Other Oil		0.074	0.0015	0.016
MA	West Springfield	1642	3	Residual Oil	NG	0.379988	No Change	0.093325873
MA	Mystic	1588	7	Pipeline Gas	RFO	0.035589	No Change	0.268299208
MA	Canal Station	1599	2	Residual Oil	NG	0.393061	No Change	0.215390672
MA	Cleary Flood	1682	8	Residual Oil	DFO	0.56	0.525	0.56
MA	Canal Station	1599	1	Residual Oil		0.396011	No Change	0.378526538

It was also discovered as part of this process that 30 units (Table 9-6), all within MANE-VU, had future year heat input and NO_X emissions, but in both the base year and future year had no SO_2 emissions. This is likely due to a lack of a regulatory requirement to report SO_2 data to CAMD. However, since SO_2 emissions were not included in ERTAC for the base year for these units, less accurate results would occur through the modeling process if the emissions were included in the future year for these units, so the SO_2 emissions were left at 0 for these units.

Table 9-6: Oil Units in ERTAC lacking Base Year and Future Year (FY) SO_2 emissions, but with future year heat input

State	Facility Name	ORIS ID	Unit ID	Primary Fuel	FY Heat Input (MMBtu)
DE	West Substation	597	10	Diesel Oil	1,095.53
DE	Indian River	594	10	Diesel Oil	135.31
DE	Edge Moor	593	10	Diesel Oil	480.74
DE	Delaware City	592	10	Diesel Oil	215.97
MA	Framingham Station	1586	FJ-2	Diesel Oil	52.89
MA	Medway Station	1592	J3T1	Diesel Oil	240.99
MA	Medway Station	1592	J2T2	Diesel Oil	199.87
MA	Medway Station	1592	J2T1	Diesel Oil	266.36
MA	Medway Station	1592	J1T2	Diesel Oil	281.86
MA	Medway Station	1592	J1T1	Diesel Oil	134.72
MA	New Boston	1589	NBJ-1	Diesel Oil	53.40
MA	Medway Station	1592	J3T2	Diesel Oil	205.92
MA	Framingham Station	1586	FJ-3	Diesel Oil	69.78
MA	West Springfield	1642	10	Diesel Oil	283.61
MA	Framingham Station	1586	FJ-1	Diesel Oil	64.96
MA	South Boston Combustion Turbines	10176	B	Other Oil	362.65
MA	Mystic	1588	MJ-1	Diesel Oil	9.60
MA	South Boston Combustion Turbines	10176	A	Other Oil	49.23
MA	Doreen	1631	10	Diesel Oil	30.84
MA	Woodland Road	1643	10	Diesel Oil	49.46
MA	Stony Brook	6081	001	Diesel Oil	11,745.66
MA	Stony Brook	6081	002	Diesel Oil	22,296.81
MA	Stony Brook	6081	003	Diesel Oil	9,184.17
MA	Stony Brook	6081	004	Diesel Oil	592.34
MA	Stony Brook	6081	005	Diesel Oil	479.80
MA	Kendall Square	1595	S6	Diesel Oil	176.59
NY	Hudson Avenue	2496	CT0004	Diesel Oil	4,095.00
NY	Hudson Avenue	2496	CT0005	Diesel Oil	3,990.00
NY	Glenwood Landing Energy Center	7869	UGT011	Oil	271.63
PA	Veolia Energy Philadelphia - Edison Sta.	880006	1	Residual Oil	22,748.09

To develop the control file first a search of the control file that included Ask 1 and Ask 5 was completed for any units that needed an adjusted emission rate. Any entries in the control file that needed their emission rate adjusted were then removed, which totaled 2,868. Then new emission rates were appended to the control file. The new entries to the control file are available upon request.

Non-EGU Sources

EMF was employed to apply controls to the non-point, non-EGU point, and non-ERTAC IPM point files to model the impact of low sulfur fuel oil rules that would be implemented by 2028 to meet the ask. To perform this task a control packet was developed to apply using EMF.

One issue at hand is that the reductions associated with low sulfur fuel oil rules need to be added on to other control factors, since for instance an oil-fired unit could have a scrubber for SO_2 and also switch to burning low sulfur fuel oil, resulting in two separate “controls.” To further complicate the development of the control packet, low sulfur fuel oil controls were already applied in the base case projections so different FIPS will have to be treated differently.

This resulted in three different applications. Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, Rhode Island, Vermont, and Philadelphia County, PA had no reductions applied since they were already meeting the requirements of the ask and were controlled in the inventory. The remaining counties in Pennsylvania had a control packet with adjusted control efficiencies applied (to be discussed later) for #2 distillate oil and no additional reductions since they were already meeting “the Ask” for #4 and #6 residual oil and were controlled in the inventory. The remaining states either were meeting "the Ask" through on the books rules though had not included the reductions in the inventory or did not have on the books rules that met "the Ask." In both cases they had a default control packet applied.

In order to develop control efficiency estimates for the default control packet the control efficiencies in the packet for existing rules were used as the starting point. The maximum reduction for a pollutant and SCC was chosen as the default control efficiency. Reductions associated with going beyond .25% sulfur by weight for #4 fuel oil were not considered. The control efficiencies determined through this process from the existing control packets are in Table 9-7. The control packet was also configured so each control would be an add-on control (“A” flag), have a rule effectiveness and penetration of 100, and have a start date of 12/31/2027.

Table 9-7: Control Efficiencies for each pollutant and SCC in default control packet

Distillate or Residual?	SCC	Pollutant	Control Efficiency		Distillate or Residual?	SCC	Pollutant	Control Efficiency
R	10100401	PM$_{10}$-PRI	33		R	20200501	SO$_2$	77.3
R	10100401	PM25-PRI	33		D	20200901	SO$_2$	99.5
R	10100401	SO$_2$	77.3		D	20200902	NO$_X$	1
R	10100404	PM$_{10}$-PRI	33		D	20200902	SO$_2$	99.5
R	10100404	PM25-PRI	33		D	20300101	NO$_X$	1
R	10100404	SO$_2$	77.3		D	20300101	SO$_2$	99.5
D	10100501	NO$_X$	22		D	20300102	SO$_2$	99.5
D	10100501	SO$_2$	99.5		D	20300105	NO$_X$	1
R	10200401	PM$_{10}$-PRI	33		D	20300105	SO$_2$	99.3
R	10200401	PM25-PRI	33		D	20300106	NO$_X$	1
R	10200401	SO$_2$	77.3		D	20300106	SO$_2$	99.5
R	10200402	PM$_{10}$-PRI	33		D	20300107	NO$_X$	1
R	10200402	PM25-PRI	33		D	20300107	SO$_2$	99.5
R	10200402	SO$_2$	77.3		D	20300109	SO$_2$	99.3
R	10200403	PM$_{10}$-PRI	33		D	20300901	SO$_2$	99.5
R	10200403	PM25-PRI	33		D	20400302	SO$_2$	99.3
R	10200403	SO$_2$	77.3		D	20400303	SO$_2$	99.5
R	10200404	SO$_2$	75		D	20400403	NO$_X$	1
R	10200405	SO$_2$	75		D	20400403	SO$_2$	99.5
D	10200501	NO$_X$	22		D	20400407	NO$_X$	1
D	10200501	SO$_2$	99.5		D	20400407	SO$_2$	99.3
D	10200502	NO$_X$	22		D	30190001	NO$_X$	22
D	10200502	SO$_2$	99.5		D	30190001	SO$_2$	99.5
D	10200503	NO$_X$	22		D	30190011	NO$_X$	22
D	10200503	SO$_2$	99.5		D	30190011	SO$_2$	99.5
R	10200504	SO$_2$	77.3		D	30290001	NO$_X$	22
D	10200505	NO$_X$	22		D	30290001	SO$_2$	99.5
D	10200505	SO$_2$	99.5		R	30290002	SO$_2$	75
R	10300401	PM$_{10}$-PRI	33		D	30390001	NO$_X$	22
R	10300401	PM25-PRI	33		D	30390001	SO$_2$	99.5
R	10300401	SO$_2$	77.3		D	30490031	NO$_X$	22
R	10300402	SO$_2$	77.3		D	30490031	SO$_2$	99.5
R	10300403	SO$_2$	50		D	30590001	NO$_X$	22
D	10300501	NO$_X$	22		D	30590001	SO$_2$	99.5

Distillate or Residual?	SCC	Pollutant	Control Efficiency
D	10300501	SO_2	99.5
D	10300502	NO_X	22
D	10300502	SO_2	99.5
D	10300503	NO_X	22
D	10300503	SO_2	99.5
R	10300504	SO_2	77.3
D	10500105	NO_X	22
D	10500105	SO_2	99.5
D	10500205	NO_X	22
D	10500205	SO_2	99.5
D	20100101	SO_2	99.5
D	20100102	NO_X	1
D	20100102	SO_2	99.5
D	20100105	NO_X	1
D	20100105	SO_2	99.5
D	20100106	NO_X	1
D	20100106	SO_2	99.5
D	20100107	NO_X	1
D	20100107	SO_2	99.5
D	20100108	SO_2	99.5
D	20100109	SO_2	99.5
D	20100901	SO_2	99.5
D	20100902	NO_X	1
D	20100902	SO_2	99.5
D	20100908	SO_2	99.5
D	20100909	SO_2	99.5
D	20200101	SO_2	99.5
D	20200102	NO_X	1
D	20200102	SO_2	99.5
D	20200103	NO_X	1
D	20200103	SO_2	99.5
D	20200104	NO_X	1
D	20200104	SO_2	99.5
D	20200105	NO_X	1
D	20200105	SO_2	99.5
D	20200106	NO_X	1
D	20200106	SO_2	99.5
D	20200107	NO_X	1
D	20200107	SO_2	99.5
D	20200108	NO_X	1
D	20200108	SO_2	99.5
D	20200401	NO_X	1
D	20200401	SO_2	99.5
D	20200402	NO_X	1
D	20200402	SO_2	99.5
R	30590002	SO_2	77.3
R	30600103	PM_{10}-PRI	33
R	30600103	PM25-PRI	33
R	30600103	SO_2	75
D	31000411	NO_X	22
D	31000411	SO_2	99.5
R	39000403	SO_2	77.3
R	39000499	SO_2	66.7
D	39000502	NO_X	22
D	39000502	SO_2	99.5
D	39000503	NO_X	22
D	39000503	SO_2	99.5
D	39000599	NO_X	22
D	39000599	SO_2	99.5
D	39900501	NO_X	22
D	39900501	SO_2	99.5
D	49090011	NO_X	22
D	49090011	SO_2	99.5
D	2102004000	NO_X	22
D	2102004000	SO_2	99.5
D	2102004001	NO_X	22
D	2102004001	SO_2	99.5
D	2102004002	NO_X	1
D	2102004002	SO_2	99.5
R	2102005000	PM_{10}-PRI	33
R	2102005000	PM25-PRI	33
R	2102005000	SO_2	77.3
D	2102011000	NO_X	22
D	2102011000	SO_2	99.5
D	2103004000	NO_X	22
D	2103004000	SO_2	99.5
D	2103004001	NO_X	22
D	2103004001	SO_2	99.5
D	2103004002	NO_X	1
D	2103004002	SO_2	99.5
R	2103005000	PM_{10}-PRI	33
R	2103005000	PM25-PRI	33
R	2103005000	SO_2	77.3
D	2103011000	NO_X	22
D	2103011000	SO_2	99.5
D	2104004000	NO_X	22
D	2104004000	SO_2	99.5
D	2104011000	NO_X	22
D	2104011000	SO_2	99.5

Following the development of the default control efficiency packet, adjusted control efficiencies were calculated for any entries in the base case control packet for the state of Pennsylvania or any of its counties, excepting Philadelphia County (FIPS: 42101). Only SCCs corresponding to the use of distillate oil were adjusted (as denoted in Table 9-77 with a “D”). The control efficiency applied in the base case was adjusted by the default control efficiency in Table 9-77 using the following formula:

$$100 * (1 - \frac{100 - ControllEfficiencyOld}{100 - ControlEfficiencyNew})$$

The control packets were then merged and applied using the EMF system prior to applying the control packets for Ask 2 and Ask 5.

Intra-RPO/Inter-RPO Ask 4

EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels - pursue updating permits, enforceable agreements, and/or rules to lock-in lower emission rates for SO2, NOx, and PM

Modeling was not needed for this since the purpose of this ask is to ensure that emissions already in the future base case are not slid back on and the emissions that are occurring should already be in the future base case.

Intra-RPO Ask 5

Where emission rules have not been adopted, control NOx emissions for peaking combustion turbines that have the potential to operate on high electric demand days by:

> *a. Striving to meet NOx emissions standard of no greater than 25 ppm at 15% O2 for natural gas and 42 ppm at 15% O2 for fuel oil but at a minimum meet NOx emissions standard of no greater than 43 ppm at 15% O2 for natural gas and 96 ppm at 15% O2 for fuel oil, or*
> *b. Performing a four-factor analysis for reasonable installation or upgrade to emission controls, or*
> *c. Obtaining equivalent alternative emissions reductions on high electric demand days*

ERTAC Sources

To model HEDD Units in the ERTAC system control entries were developed and incorporated in the control file that was created to model HEDD units. Only changes to NO_X emissions as the result of meeting “the Ask” were modeled. The ask included two emission rates each for gas-fired and oil-fired HEDD units, one that must be met and one that should be strived to be met. The former was used in modeling. All states in MANE-VU had emission rates evaluated in their units.

To determine which units should be modeled as HEDD units, the SCCs found in the SMOKE ready post processed ERTAC ff10 files for the 2011 base case were compared to the list of SCCs in Table 9-8.

Table 9-8: SCCs considered to be potential HEDD units in ERTAC

SCC	Level One	Level Two	Level Three	Level Four
20100101	Internal Combustion Engines	Electric Generation	Distillate Oil (Diesel)	Turbine
20100109	Internal Combustion Engines	Electric Generation	Distillate Oil (Diesel)	Turbine: Exhaust
20100201	Internal Combustion Engines	Electric Generation	Natural Gas	Turbine
20100209	Internal Combustion Engines	Electric Generation	Natural Gas	Turbine: Exhaust
20100901	Internal Combustion Engines	Electric Generation	Kerosene/Naphtha (Jet Fuel)	Turbine
20100909	Internal Combustion Engines	Electric Generation	Kerosene/Naphtha (Jet Fuel)	Turbine: Exhaust
20101302	Internal Combustion Engines	Electric Generation	Liquid Waste	Waste Oil - Turbine

The units were then evaluated based on nameplate capacity (found in the ERTAC UAF), 2014-2016 average operating hours (drawn from CAMD), and whether the unit went online after May

1, 2007 (found in the ERTAC UAF). This results in the removal of 162 units as shown in Table 9-9 with the reason for the removal in one of the three rightmost columns (note units later reintroduced as HEDD units are not shown).

Table 9-9: Units not considered to be HEDD units due to average operating hours, size, or online date

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type	Avg. Op. Hrs. 2014-16	Size (MW)	Online Yr.
CT	Bridgeport Energy	55042	BE1	CC Gas	6,670.82		
	Bridgeport Energy	55042	BE2	CC Gas	6,670.82		
	Cos Cob	542	13	Oil			2008
	Cos Cob	542	14	Oil			2008
	Kleen Energy Systems Project	56798	U1	CC Gas	6,686.25		
	Kleen Energy Systems Project	56798	U2	CC Gas	7,289.69		
	Middletown	562	12	SC Gas			2011
	Middletown	562	13	SC Gas			2011
	Middletown	562	14	SC Gas			2011
	Middletown	562	15	SC Gas			2011
	Alfred L Pierce Generating Sta.	6635	AP-1	SC Gas			2007
	Devon	544	15	SC Gas			2010
	Devon	544	16	SC Gas			2010
	Devon	544	17	SC Gas			2010
	Devon	544	18	SC Gas			2010
	Milford Power Company LLC	55126	CT01	CC Gas	6,838.12		
	Milford Power Company LLC	55126	CT02	CC Gas	6,880.48		
	Waterbury Generation	56629	10	SC Gas			2009
	Lake Road Generating Company	55149	LRG1	CC Gas	6,830.47		
	Lake Road Generating Company	55149	LRG2	CC Gas	7,271.15		
	Lake Road Generating Company	55149	LRG3	CC Gas	7,478.43		
DE	Edge Moor	593	10	Oil		12.5	
	Hay Road	7153	**3	CC Gas	6,063.60		
	Hay Road	7153	1	CC Gas	5,984.00		
	Hay Road	7153	2	CC Gas	5,843.68		
	Hay Road	7153	5	Oil	4,501.71		
	Hay Road	7153	6	Oil	4,686.43		
	Hay Road	7153	7	Oil	4,601.18		
ME	Westbrook Energy Center	55294	1	CC Gas	5,000.00		
	Westbrook Energy Center	55294	2	CC Gas	4,816.00		
	Androscoggin Energy	55031	CT01	SC Gas	2,567.82		
	Androscoggin Energy	55031	CT02	SC Gas	1,916.00		
	Androscoggin Energy	55031	CT03	SC Gas	3,175.75		
	Rumford Power	55100	1	CC Gas	2,071.17		
	Maine Independence Station	55068	1	CC Gas	2,061.16		
MA	Dartmouth Power	52026	1	CC Gas	5,275.14		
	Dartmouth Power	52026	2	SC Gas			2009
	Dighton	55026	1	CC Gas	5,275.00		
	Berkshire Power	55041	1	CC Gas	5,516.92		
	Masspower	10726	1	CC Gas	3,754.42		
	Masspower	10726	2	CC Gas	3,394.83		
	Framingham Station	1586	FJ-1	Oil		14.2	
	Framingham Station	1586	FJ-2	Oil		14.2	
	Framingham Station	1586	FJ-3	Oil		14.2	
	Kendall Square	1595	4	CC Gas	6,996.95		
	Montgomery L'Energia Power Partners	54586	2	CC Gas			2008
	Mystic	1588	81	CC Gas	3,040.01		
	Mystic	1588	82	CC Gas	3,147.39		
	Mystic	1588	93	CC Gas	3,299.05		
	Mystic	1588	94	CC Gas	3,101.86		
	Mystic	1588	MJ-1	Oil		14.2	
	ANP Bellingham Energy Project	55211	1	CC Gas	5,576.22		
	Bellingham	10307	1	CC Gas	2,649.80		

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type	Avg. Op. Hrs. 2014-16	Size (MW)	Online Yr.
	Bellingham	10307	2	CC Gas	2,816.08		
	Fore River Station	55317	11	CC Gas	6,017.24		
	Fore River Station	55317	12	CC Gas	6,222.46		
	Potter	1660	4	SC Gas			2009
	Potter	1660	5	SC Gas			2009
	ANP Blackstone Energy Co.	55212	1	CC Gas	4,820.25		
	ANP Blackstone Energy Co.	55212	2	CC Gas	4,518.49		
	Milford Power	54805	1	CC Gas	2,560.96		
	Millennium Power Partners	55079	1	CC Gas	6,233.41		
NH	Granite Ridge Energy	55170	0001	CC Gas	6,540.62		
	Granite Ridge Energy	55170	0002	CC Gas	6,445.70		
	Newington Power Facility	55661	1	CC Gas	2,807.30		
	Newington Power Facility	55661	2	CC Gas	2,854.91		
NJ	Bergen	2398	1101	CC Gas	6,085.43		
	Bergen	2398	1201	CC Gas	6,426.61		
	Bergen	2398	1301	CC Gas	5,856.22		
	Bergen	2398	1401	CC Gas	5,968.10		
	Bergen	2398	2101	CC Gas	6,986.52		
	Bergen	2398	2201	CC Gas	6,785.99		
	Camden Plant Holding, LLC	10751	002001	CC Gas	2,662.45		
	Cumberland	5083	05001	SC Gas			2009
	Newark Bay Cogen	50385	1001	CC Gas	3,610.86		
	Newark Bay Cogen	50385	2001	CC Gas	3,529.25		
	Sunoco Power Generation, LLC	50561	0001	CC Gas	3,005.99		
	Sunoco Power Generation, LLC	50561	0002	CC Gas	2,142.19		
	Bayonne Plant Holding, LLC	50497	001001	SC Gas	3,338.70		
	Bayonne Plant Holding, LLC	50497	002001	SC Gas	3,221.74		
	Bayonne Plant Holding, LLC	50497	004001	SC Gas	3,603.48		
	AES Red Oak	55239	1	CC Gas	7,637.33		
	AES Red Oak	55239	2	CC Gas	7,891.65		
	AES Red Oak	55239	3	CC Gas	7,665.53		
	North Jersey Energy Associates	10308	1001	CC Gas	4,217.20		
	North Jersey Energy Associates	10308	1002	CC Gas	4,350.87		
	Lakewood Cogeneration	54640	001001	SC Gas	4,241.82		
	Lakewood Cogeneration	54640	002001	SC Gas	4,375.07		
	Pedricktown Cogeneration Plant	10099	001001	CC Gas	1,989.43		
	E F Kenilworth, Inc.	10805	002001	CC Gas	8,186.13		
	Linden Cogeneration Facility	50006	004001	CC Gas	8,411.49		
	Linden Cogeneration Facility	50006	005001	CC Gas	5,768.24		
	Linden Cogeneration Facility	50006	006001	CC Gas	5,701.92		
	Linden Cogeneration Facility	50006	007001	CC Gas	6,073.14		
	Linden Cogeneration Facility	50006	008001	CC Gas	6,450.46		
	Linden Cogeneration Facility	50006	009001	CC Gas	6,121.65		
	Linden Generating Station	2406	1101	CC Gas	7,309.18		
	Linden Generating Station	2406	1201	CC Gas	7,114.17		
	Linden Generating Station	2406	2101	CC Gas	6,534.45		
	Linden Generating Station	2406	2201	CC Gas	6,726.01		
NY	Bethlehem Energy Center (Albany)	2539	10001	CC Gas	6,989.36		
	Bethlehem Energy Center (Albany)	2539	10002	CC Gas	7,004.12		
	Selkirk Cogen Partners	10725	CTG101	CC Gas	2,887.38		
	Selkirk Cogen Partners	10725	CTG201	CC Gas	3,187.41		
	Allegany Station No. 133	10619	00001	CC Gas	2,032.49		
	Binghamton Cogen Plant	55600	1	CC Gas	4,270.83		
	Athens Generating Company	55405	1	CC Gas	4,270.83		
	Athens Generating Company	55405	2	CC Gas	3,826.84		
	Athens Generating Company	55405	3	CC Gas	3,057.53		
	Empire Generating Company	56259	CT-1	SC Gas	6,850.13		
	Empire Generating Company	56259	CT-2	SC Gas	6,507.34		2010
	Bethpage Energy Center	50292	GT4	CC Gas	4,152.70		

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type	Avg. Op. Hrs. 2014-16	Size (MW)	Online Yr.
	East River	2493	2	CC Gas	7,504.92		
	Astoria Energy	55375	CT1	CC Gas	7,346.49		
	Astoria Energy	55375	CT2	CC Gas	7,487.08		
	Astoria Energy	55375	CT3	CC Gas	6,904.50		
	Astoria Energy	55375	CT4	CC Gas	6,980.33		
	Poletti 500 MW CC	56196	CTG7A	CC Gas	6,945.67		
	Poletti 500 MW CC	56196	CTG7B	CC Gas	7,370.18		
	Caithness Long Island Energy Center	56234	0001	CC Gas			2009
	Pinelawn Power	56188	00001	CC Gas	2,916.25		
	Richard M Flynn (Holtsville)	7314	001	CC Gas	7,982.12		
PA	Hunterstown Combined Cycle	55976	CT101	CC Gas	6,292.64		
	Hunterstown Combined Cycle	55976	CT201	CC Gas	6,096.57		
	Hunterstown Combined Cycle	55976	CT301	CC Gas	6,323.80		
	Allegheny Energy Units 3, 4 & 5	55710	3	CC Gas	7,762.14		
	Allegheny Energy Units 3, 4 & 5	55710	4	CC Gas	7,874.02		
	Armstrong Energy Ltd Part	55347	1	SC Gas	1,858.34		
	Ontelaunee Energy Center	55193	CT1	SC Gas	8,190.16		
	Ontelaunee Energy Center	55193	CT2	SC Gas	8,081.60		
	Fairless Energy, LLC	55298	1A	CC Gas	7,118.74		
	Fairless Energy, LLC	55298	1B	CC Gas	6,923.55		
	Fairless Energy, LLC	55298	2A	CC Gas	7,470.15		
	Fairless Energy, LLC	55298	2B	CC Gas	7,549.73		
	FPL Energy Marcus Hook, LP	55801	0001	CC Gas	6,923.78		
	FPL Energy Marcus Hook, LP	55801	0002	CC Gas	7,054.01		
	FPL Energy Marcus Hook, LP	55801	0003	CC Gas	6,921.39		
	Liberty Electric Power Plant	55231	0001	CC Gas	7,857.58		
	Liberty Electric Power Plant	55231	0002	CC Gas	8,063.54		
	Fayette Energy Facility	55516	CTG1	CC Gas	7,856.79		
	Fayette Energy Facility	55516	CTG2	CC Gas	7,880.00		
	Grays Ferry Cogen Partnership	54785	2	CC Gas	7,893.73		
	Calpine Mid Merit - York Energy	55524	1	CC Gas	4,439.17		
	Calpine Mid Merit - York Energy	55524	2	CC Gas	4,542.27		
	Calpine Mid Merit - York Energy	55524	3	CC Gas	4,332.88		
RI	Tiverton Power	55048	1	CC Gas	6,362.60		
	FPLE Rhode Island State Energy	55107	RISEP1	CC Gas	4,228.86		
	FPLE Rhode Island State Energy	55107	RISEP2	CC Gas	4,064.81		
	Manchester Street	3236	10	CC Gas	5,173.67		
	Manchester Street	3236	11	CC Gas	5,256.83		
	Manchester Street	3236	9	CC Gas	4,440.25		
	Ocean State Power	51030	1	CC Gas	2,579.47		
	Ocean State Power	51030	2	CC Gas	2,640.89		
	Ocean State Power II	54324	3	CC Gas	2,116.38		
	Ocean State Power II	54324	4	CC Gas	2,153.97		

Following this, all states in MANE-VU with units considered to be potential HEDD units reviewed the file to confirm that the universe of units was correct. This resulted in the removal of two units (Table 9-10). This also resulted in the reintroduction of two units in New Jersey due to incomplete information about online dates in ERTAC and five units in New York due to state feedback on how they consider the units for regulatory purposes (Table 9-11).

Table 9-10: Units excluded as HEDD units due to state feedback

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type
NY	Rensselaer Cogen	54034	1GTDBS	Combined Cycle Gas
NY	AG – Energy	10803	2	Combined Cycle Gas

Table 9-11: Units reintroduced as HEDD units due to state feedback

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type
NJ	EFS Parlin Holdings, LLC	50799	001001	Boiler Gas
NJ	EFS Parlin Holdings, LLC	50799	003001	Simple Cycle Gas
NY	Equus Freeport Power Generating Station	56032	0001	Combined Cycle Gas
NY	Glenwood Landing Energy Center	7869	UGT012	Simple Cycle Gas
NY	Glenwood Landing Energy Center	7869	UGT013	Simple Cycle Gas
NY	74th Street	2504	120	Boiler Gas
NY	Bayswater Peaking Facility	55699	1	Simple Cycle Gas

To calculate the emission rates in lbs. /MMBtu we used formulas where the measured O_2 is 15% and 42 ppm and 96 ppm are the stack gas concentrations for natural gas and oil, respectively. This resulted in calculations of emission rates of 0.154 lbs. /MMBtu and 0.371 lbs. /MMBtu for natural gas and oil respectively.

The 2028 annual NO_X emission rates from the non-OS emission rate run for the remaining 344 units were then compared against the must meet emission rates in the ask of 0.154 lb./MMBtu for gas-fired units and 0.371 lb./MMBtu for oil-fired units. 172 of the units were found to meet the applicable emission rate in 2028 already leaving 171 units that needed additional control.

Additionally Connecticut provided emission rates to use instead of either the ERTAC v2.7 base case 2028 projected emission rate or the emission rate calculated to meet the ask and these adjustments are shown in Table 9-12. In all cases an emission rate of 0.19 lb. /MMBtu was applied since these units are required to meet a stricter ozone season limit due to RCSA section 22a-174-22e. The new standard begins on June 1, 2018, but trading is allowed until June 1, 2023 and for this modeling we expect the sources to individually meet that rate by 2028.

Table 9-12: HEDD units required to meet 0.19 lb. /MMBtu in CT

State	Facility Name	ORIS ID	Unit ID	ERTAC Unit Type
CT	Branford	540	10	Oil
CT	Bridgeport Harbor Station	568	BHB4	Oil
CT	Devon	544	10	Oil
CT	Franklin Drive	561	10	Oil
CT	Middletown	562	10	Oil
CT	Norwich	581	TRBINE	Oil
CT	South Meadow Station	563	11A	Oil
CT	South Meadow Station	563	11B	Oil
CT	South Meadow Station	563	12A	Oil
CT	South Meadow Station	563	12B	Oil
CT	South Meadow Station	563	13A	Oil
CT	South Meadow Station	563	13B	Oil
CT	South Meadow Station	563	14A	Oil
CT	South Meadow Station	563	14B	Oil
CT	Torrington Terminal	565	10	Oil
CT	Tunnel	557	10	Oil

To develop the control file first a search of the control file that included Ask 1 was completed for any units that needed an adjusted emission rate. Any entries in the control file that needed their emission rate adjusted were then removed. A total of 118 entries were then added to account for adjusted emission rates due to Ask 5. Then new emission rates were appended to the control file resulting in a control file with 2782 entries. The new entries to the control file are available upon request.

Non-EGU Sources

To model HEDD units that were not in the ERTAC system control entries were developed to be processed as a control packet using EMF. Only changes to NO_X emissions as the result of meeting "the Ask" were modeled. The ask included two emission rates each for gas-fired and oil-fired HEDD units, one that must be met and one that should be strived to be met. The former was used in modeling. All states in MANE-VU had emission rates evaluated in their units.

To determine which units should be modeled as HEDD units, the SCCs found in the SMOKE ready ff10 files for the non-ERTAC IPM EGUs and non-EGU Point for the 2011 base case were compared to the list of SCCs in Table 9-8.

The units were then evaluated based on design capacity (found in ff10 inventory files), 2014-2016 average operating hours, whether the unit went online after May 1, 2007, and whether the unit supplied electricity to the grid. The latter three traits were based on feedback from the state in which the unit was located. This results in the removal of 139 units.

The same emission rate calculations described above in the section on EGUs were used to determine appropriate emission rates for oil- and gas-fired HEDDs. 2011 and 2028 emission rates were calculated for each unit that had a design capacity denoted in MMBtu/hour by dividing the annual emissions by the design capacity and then by the number of hours the unit operated in 2011 (the hours of operation were obtained from the individual state that the unit resided in). For units without known operating hours in 2011 state supplied 2011 emission rates were used. For units with a design capacity in MW conversion factors were obtained from states to convert the design capacity to MMBtu/hour. The SCCs for each unit were then used to compare the 2028 emission rate to the "must meet" emission rate for HEDDs defined in the Ask. If the "must meet" ask emission rate was lower than the chosen emission rate (2028 calculated, 2011 calculated, or state supplied) a control efficiency was calculated for the unit to be included in the EMF control packet. The data needed to calculate control efficiencies is in Table 9-13 and the control efficiencies were included as an add-on control in the EMF control packet.

Table 9-13: Unit level data employed in HEDD control packet development

FIPS	Facility ID	Unit ID	Design Cap. (MMBtu/hr.)	SCC	Control Efficiency	Calc. ER 2028	Calc. ER 2011	State Supplied ER	Applied Rate	2011 Op. Hrs.
24005	5154911	87894813	378	10100504	52.25	n/a	n/a	0.71	0.371	
24005	5154811	87894413	268	20100201	32.56	n/a	0.1853	0.473	0.154	199
24005	5154811	87894013	268	20100201	32.56	n/a	0.1916	0.473	0.154	169
24005	5154811	87894213	268	20100201	32.56	n/a	0.1949	0.473	0.154	196
24005	5154811	87894313	268	20100201	32.56	n/a	0.1952	0.473	0.154	231
24005	5154811	87894613	268	20100201	32.56	n/a	0.1994	0.473	0.154	208
24005	5154811	87894513	268	20100201	32.56	n/a	0.2022	0.473	0.154	245
24005	5154811	87894113	268	20100201	32.56	n/a	0.2047	0.473	0.154	201
24005	5154811	87894713	268	20100201	32.56	n/a	0.2065	0.473	0.154	173
24017	6011511	87935713	250	10100504	33.11	1.1206	1.0825	1.2	0.371	72
24017	6011511	87935613	250	10100504	30.69	1.2089	1.1678	1.2	0.371	69
24033	6011911	88002113	250	10100504	53.82	0.6894	0.6659	0.71	0.371	37
24510	6435511	88059913	258	10100504	67.33	n/a	0.4616	0.551	0.371	85
24510	6435511	88060013	258	10100504	67.33	n/a	0.4732	0.551	0.371	105
24510	6435511	88060213	258	10100504	67.33	n/a	0.4787	0.551	0.371	116
24510	6435511	88060113	258	10100504	67.33	n/a	0.4877	0.551	0.371	98
34005	5086211	65758413	16.43	20100101	11.6	3.1993	3.1993	3.2	0.371	34

FIPS	Facility ID	Unit ID	Design Cap. (MMBtu/hr.)	SCC	Control Efficiency	Calc. ER 2028	Calc. ER 2011	State Supplied ER	Applied Rate	2011 Op. Hrs.
34019	7604111	11863813	404	20100101	86.28	n/a	0.071	0.43	0.371	3
34019	7604111	11864013	404	20100101	86.28	n/a	0.1379	0.43	0.371	14
34019	7604111	11863313	386	20100201	63.64	n/a	0.1693	0.242	0.154	3
34019	7604111	11863613	404	20100101	86.28	n/a	0.1839	0.43	0.371	7
34019	7312511	10666513	458.43	20100201	91.12	n/a	0.1936	0.169	0.154	8
34019	7604111	11863713	404	20100101	86.28	n/a	0.2448	0.43	0.371	9
42001	4713411	28151913	305	20100101	72.87	0.5091	0.4073		0.371	71
42001	4713311	28152013	305	20100101	51.43	0.7213	0.577		0.371	55
42011	3857011	37800113	55	20100101	13.89	2.6705	2.1364		0.371	8
42011	3857011	37799613	58	20100101	13.8	2.6888	2.1511		0.371	21
42045	4724311	27722313	251	20100101	74.18	0.5001	0.4001		0.371	28
42045	4724311	27722413	251	20100101	69.07	0.5371	0.4297		0.371	27
42045	6662011	17765213	58	20100101	13.28	2.7937	2.2349		0.371	15
42045	6662011	17765113	58	20100101	10.81	3.4305	2.7444		0.371	16
42089	3748611	37854913	305	20100101	51.06	0.7265	0.5812		0.371	22
42091	3692211	37043613	284	20100101	59.76	0.6209	0.4967		0.371	189
42091	3692211	37043513	284	20100101	59.43	0.6243	0.4995		0.371	141
42091	3692211	37043713	284	20100101	57.56	0.6445	0.5156		0.371	166
42101	6559811	103757713	233	20100101	54.13	0.6854	0.5483		0.371	25
42117	3878511	37458813	65	20100201	10.68	1.442	1.442		0.154	284
42123	3893511	37450213	194	20100101	11.66	3.1828	2.5462		0.371	63

Intra-RPO Ask 6/Inter-RPO Ask 5

Each state should consider and report in its SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar

Modeling was not needed for this ask since there is no clear enforceable emission reductions.

Federal Ask 1, 2, & 3

Federal Land Managers to consult with Class I area states when scheduling prescribed burns and ensure that these burns do not impact nearby IMPROVE visibility measurements and do not impact potential 20 percent most and least visibility impaired days; EPA to develop measures that will further reduce emissions from heavy-duty onroad vehicles; and EPA to ensure that Class I Area state "Asks" are addressed in "contributing" state SIPs prior to approval

Modeling was not needed for this ask since there is no clear enforceable emission reductions.

Temporalization

Following completion of the non-EGU point source control case inventories the non-EGU point and non-ERTAC IPM inventory sectors were temporalized in the same fashion as in Section 8.

2028 Visibility Control Inventory Results

ERTAC EGU Results

The four ERTAC runs completed to project the MANE-VU Ask in total were completed in the following order: Ask 1 (Non-OS Rate), Ask 5 (HEDD), Ask 3 (LSFO), and Ask 2. Each run adds the additional Ask to the previous run. Ask 2 was completed last to avoid any potential discrepancies where one of the other Asks also impacted a unit included in Ask 2.

Table 9-14 shows the results from the four ERTAC projections that were conducted in order to model the MANE-VU Asks. Only runs that impacted emissions are shown (i.e., the HEDD run only impacted NO_X emissions so it is not shown in the table under SO_2).

One can see that substantial annual reductions in NO_X occur only in the projections for Ask 1 (Non-OS Rate). This would be expected since Ask 5 (HEDD) only impacts units that run infrequently and Ask 2 only impacts NO_X emissions from a few units. In regard to SO_2 reductions, several states in LADCO, as well as Pennsylvania, see a drop in SO_2 emissions from the Ask 2 projections and Ask 3 (LSFO) only results in minor annual reductions, since many oil-fired units run infrequently.

Table 9-14: Annual NO_X and SO_2 results in tons from ERTAC projections for four of the MANE-VU Asks

	FY Annual NO_X (tons)				**Sum of FY Annual SO_2 (tons)**		
	Base	+ Non-OS Rate	+ HEDD	+ Ask 2	Base	+ LSFO	+ Ask 2
MANE-VU	**85,188**	**75,094**	**74,814**	**73,662**	**196,776**	**196,713**	**194,922**
CT	608	608	607	607	158	158	158
DE	1,723	1,641	1,641	1,641	1,522	1,521	1,521
MA*	781	781	770	770	51	53*	50
MD	9,505	6,907	6,900	6,900	19,519	19,463	19,447
ME	248	248	248	248	19	19	13
NH	1,043	809	809	809	1,050	1,050	1,050
NJ	4,666	4,666	4,666	4,666	2,111	2,111	2,111
NY	12,246	12,246	12,001	12,001	22,810	22,807	22,807
PA	54,017	46,837	46,822	45,670	149,526	149,521	147,754
RI	351	351	351	351	11	11	11
VT	0	0	0	0	0	0	0
LADCO	**199,681**	**170,491**	**170,491**	**167,660**	**379,619**	**379,607**	**326,190**
IL	34,266	33,348	33,348	33,348	81,867	81,865	81,865
IN	59,945	50,139	50,139	47,786	114,744	114,744	94,783
MI	29,117	26,784	26,784	26,776	45,885	45,885	29,515
MN	9,549	9,549	9,549	9,549	11,244	11,244	11,244
OH	50,598	34,570	34,570	34,099	114,814	114,804	97,718
WI	16,206	16,101	16,101	16,101	11,065	11,065	11,065
SESARM	**271,178**	**242,544**	**242,544**	**242,544**	**273,628**	**273,490**	**273,213**
AL	24,627	23,866	23,866	23,866	15,717	15,717	15,717
FL	32,211	32,211	32,211	32,211	34,152	34,149	34,149
GA	32,833	23,616	23,616	23,616	15,732	15,732	15,732
KY	54,292	49,204	49,204	49,204	87,529	87,529	87,529
MS	18,963	18,963	18,963	18,963	9,517	9,517	9,517
NC	27,812	24,115	24,115	24,115	19,735	19,735	19,735
SC	9,786	9,167	9,167	9,167	10,093	10,093	10,093
TN	9,617	9,357	9,357	9,357	17,944	17,944	17,944
VA	14,275	14,040	14,040	14,040	5,378	5,244	4,968
WV	46,764	38,005	38,005	38,005	57,831	57,831	57,831
CENSARA	**354,826**	**348,922**	**348,922**	**348,922**	**760,831**	**760,823**	**760,823**
AR	39,750	39,750	39,750	39,750	77,264	77,264	77,264
IA	22,786	22,536	22,536	22,536	34,391	34,391	34,391
KS	25,415	22,742	22,742	22,742	25,237	25,237	25,237
LA	35,446	35,446	35,446	35,446	55,223	55,223	55,223
MO	38,233	35,683	35,683	35,683	134,137	134,129	134,129
NE	37,447	37,447	37,447	37,447	74,770	74,770	74,770
OK	31,099	31,099	31,099	31,099	28,602	28,602	28,602
TX	124,650	124,220	124,220	124,220	331,207	331,207	331,207
Total	**910,874**	**837,051**	**836,771**	**832,788**	**1,610,854**	**1,610,633**	**1,555,148**

*** As part of the review of LSFO rates the future year emission rate in the base case for Mystic (orispl: 1588, unit id: 7) was found to be incorrect and increased.**

EMF Results

The one EMF control strategy was run with three control program packets to estimate the impact of the MANE-VU Ask 2, Ask 5 (HEDD), and Ask 3 (LSFO). Table 9-15 shows the results from the four EMF control packet projections that were conducted in order to model the MANE-VU Asks. Only runs that impacted emissions are shown (i.e., the HEDD run only impacted NO_X emissions so it is not shown in the table under SO_2).

Table 9-15: Annual NO_X and SO_2 results in tons from a EMF control strategy run for three of the MANE-VU Asks

	Point Sources							**Non-Point Sources**			
	SO_2			**NO_X**				**SO_2**		**NO_X**	
	Base	**+ Ask2**	**+ LSFO**	**Base**	**+ Ask2**	**+ HEDD**	**+ LSFO**	**Base**	**+ LSFO**	**Base**	**+ LSFO**
MANE-VU	**82,811**	**69,984**	**68,516**	**148,081**	**144,383**	**144,330**	**144,247**	**26,371**	**13,964**	**166,955**	**165,413**
CT	224	224	224	2,170	2,170	2,170	2,170	221	221	8,992	8,992
DC	21	21	5	554	554	554	551	626	11	1,404	1,385
DE	2,045	2,045	2,045	2,072	2,072	2,072	2,072	16	16	2,064	2,064
MA	1,872	1,872	1,872	12,525	12,525	12,525	12,525	387	387	17,716	17,716
MD	25,076	12,297	11,662	13,479	12,350	12,339	12,319	8,284	1,107	14,274	13,721
ME	2,045	2,045	2,045	10,343	10,343	10,343	10,343	495	495	2,581	2,581
NH	1,307	1,307	530	2,170	2,170	2,170	2,166	2,855	129	3,645	3,393
NJ	1,970	1,970	1,970	11,064	11,064	11,064	11,063	472	388	21,746	21,746
NY	16,066	16,017	16,017	39,698	37,128	37,128	37,128	6,089	6,089	57,610	57,610
PA	31,178	31,178	31,139	51,991	51,991	51,949	51,894	6,515	4,708	30,495	29,778
RI	881	881	881	1,286	1,286	1,286	1,286	98	98	3,726	3,726
VT	127	127	127	730	730	730	730	315	315	2,703	2,703
LADCO	**278,213**	**278,213**	**277,654**	**290,984**	**290,984**	**290,984**	**290,848**	**14,252**	**11,348**	**171,500**	**170,979**
IL	60,809	60,809	60,613	51,706	51,706	51,706	51,683	2,966	2,806	43,409	43,288
IN	72,787	72,787	72,523	65,994	65,994	65,994	65,909	2,042	1,609	16,684	16,624
MI	34,721	34,721	34,650	48,984	48,984	48,984	48,970	1,364	981	29,966	29,848
MN	17,037	17,037	17,037	46,112	46,112	46,112	46,112	2,429	2,429	22,251	22,251
OH	57,865	57,865	57,836	47,653	47,653	47,653	47,640	3,752	1,823	38,670	38,449
WI	34,993	34,993	34,993	30,535	30,535	30,535	30,535	1,699	1,699	20,521	20,521
SESARM	**234,058**	**234,058**	**231,664**	**311,291**	**311,291**	**311,291**	**311,061**	**31,982**	**21,182**	**122,379**	**121,723**
AL	43,926	43,926	43,816	49,967	49,967	49,967	49,944	9,650	9,526	11,895	11,876
FL	35,360	35,360	35,167	40,111	40,111	40,111	40,090	1,868	1,610	20,986	20,951
GA	23,915	23,915	23,915	43,122	43,122	43,122	43,122	573	573	17,271	17,271
KY	18,876	18,876	18,729	23,544	23,544	23,544	23,533	716	318	6,830	6,780
MS	9,770	9,770	9,770	17,126	17,126	17,126	17,126	118	118	4,217	4,217
NC	27,863	27,863	26,476	35,111	35,111	35,111	35,048	6,738	934	13,594	13,348
SC	24,545	24,545	24,545	27,852	27,852	27,852	27,852	1,524	1,524	10,574	10,574
TN	8,776	8,776	8,646	30,884	30,884	30,884	30,820	1,321	1,037	17,218	17,178
VA	24,850	24,850	24,617	32,117	32,117	32,117	32,096	5,101	1,935	14,996	14,795
WV	16,176	16,176	15,982	11,457	11,457	11,457	11,431	4,373	3,606	4,798	4,734
CENSARA	**260,944**	**260,944**	**260,665**	**330,581**	**330,581**	**330,581**	**330,501**	**5,988**	**5,063**	**129,642**	**129,064**
AR	9,960	9,960	9,960	21,823	21,823	21,823	21,823	89	89	3,025	3,025
IA	16,962	16,962	16,962	20,299	20,299	20,299	20,299	2,303	2,303	12,067	12,067
KS	5,134	5,134	5,134	14,644	14,644	14,644	14,644	145	145	9,554	9,554
LA	81,023	81,023	80,889	80,961	80,961	80,961	80,907	1,686	1,067	35,405	35,061
MO	37,608	37,608	37,569	26,391	26,391	26,391	26,385	502	366	13,380	13,357
NE	1,783	1,783	1,783	8,400	8,400	8,400	8,400	81	81	4,159	4,159
OK	20,211	20,211	20,211	18,801	18,801	18,801	18,801	595	595	18,677	18,677
TX	88,264	88,264	88,157	139,262	139,262	139,262	139,241	586	417	33,375	33,164
Total	**856,026**	**843,198**	**838,498**	**1,080,937**	**1,077,238**	**1,077,186**	**1,076,656**	**78,593**	**51,556**	**590,477**	**587,180**

References

Mid-Atlantic Northeast Visibility Union 2017a, ‘Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action within MANE-VU Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)’.

Mid-Atlantic Northeast Visibility Union 2017b, ‘Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action in Contributing States Located Upwind of MANE-VU Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)’.

Mid-Atlantic Northeast Visibility Union 2017c, ‘Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action by the Environmental Protection Agency and Federal Land Managers Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)’.

Mid-Atlantic Northeast Visibility Union 2017d, ‘EGU Data for Four-Factor Analyses (Only CALPUFF Units)’.

Mid-Atlantic Northeast Visibility Union 2017, *2016 MANE-VU Source Contribution Modeling Report*.

Mid-Atlantic Northeast Visibility Union 2017, *Impact of Wintertime SCR/SNCR Optimization on Visibility Impairing Nitrate Precursor Emissions*.

Section 10. Relative Response Factor (RRF) and "Modeled Attainment Test" (MAT)

Overview

EPA guidance requires the use of a modeled attainment test, which is described as a procedure in which an air quality model is used to simulate current and future air quality (US EPA 2014). As an example, if future estimates, after rounding, of ozone concentrations are less than or equal to 75 ppb, then this element of the attainment test would be satisfied for the 2008 ozone NAAQS. A modeled attainment demonstration consists of analyses, which estimate whether selected emissions reductions will result in ambient concentrations that meet the NAAQS or progress goals.

For this modeled attainment test, model estimates are used in a "relative" rather than "absolute" sense. That is, one calculates the ratio of the model's future to current (baseline) predictions at ozone monitors. These ratios are called RRF. Future ozone concentrations are estimated at existing monitoring sites by multiplying modeled RRF at locations "near" each monitor by the observation-based monitor-specific "baseline" ozone design value. The following equation describes the approach as applied to a monitoring site i:

$$DVF_i = RRF_i * DVC_i$$

where DVC_i is the baseline concentration monitored at site i, RRF_i is the relative response factor calculated for site i, and DVF_i is the estimated future design value for site i. The RRF is the ratio of the future 8-hour daily maximum concentration predicted at a monitor to the baseline 8-hour daily maximum concentration predicted at the monitor location averaged over multiple days determined from the base case.

General Design Value Calculation

The following sections describe the calculation of each of the elements in Equation 1 as implemented by NYSDEC through an in-house computer program written in FORTRAN (n.b. the subscript "i" from equation is dropped in the following description). However, all calculations are still performed on a monitor-by-monitor basis.

It should be noted that while this algorithm describes the techniques OTC uses to calculate RRFs for a typical monitor it in no way precludes states from doing so differently in order to evaluate a particular monitor either in their attainment demonstration or for weight-of-evidence. Further information later in this section describes one particular scenario that might lead states to want to adopt a different method for particular monitors.

Step 1 - Calculation of DVC

Design values are calculated in accordance with 40 CFR Part 50.10, Appendix I, as 3-year averages of the fourth highest monitored daily 8-hour maximum value at each monitoring site. For example, the design value for 2009-2011 is the average of the fourth highest monitored daily 8-hour maximum values in 2009, 2010 and 2011. Design values are labeled with the *last* year of the design value period, i.e. the design value for the 2009 – 2011 is labeled as “2011 design value”.

For MAT, the guidance defines DVC in Equation 1 as the average of the design values, which straddle the baseline inventory year. Here the baseline inventory year is 2011, therefore DVC is the average of the “2011 design value” (determined from 2009-2011 observations), the “2012 design value” (determined from 2010-2012 observations), and the “2013 design value” (determined from 2011-2013 observations). Consequently, DVC is derived from observations covering a five-year period and is a weighted average with 2011 observations “weighted” three times, 2010 and 2012 observations weighted twice, and 2009 and 2013 observations weighted once.

The following criteria concerning missing design values were implemented in the FORTRAN code calculating DVC:

a) For monitors with only four years of consecutive data, the guidance allows DVC to be computed as the average of two design values within that period.
b) For monitors with only three years of consecutive data, the DVC is equal to the design value calculated for that three year period
c) For monitors with less than three years of consecutive data, no DVC can be estimated

Step 2 - Calculation of RRF

The guidance requires the calculation of RRF with CMAQ output from grid cells that are “near” a monitor. Because of the 12 km grid spacing used in the CMAQ simulations, model predictions in a 3X3 grid cell array centered on the monitoring location are considered “near” that monitor. For each day, the maximum base case and control case concentration within that array is selected for RRF calculation as set forth in the guidance document.

Because photochemical models were found to be less responsive to emission reductions on days of lower simulated ozone concentrations, the guidance recommends applying screening criteria to the daily model predictions at individual monitors to determine whether that day’s predictions are to be used to calculate the RRF or not. Only “high ozone days” are to be selected, i.e. days with ozone values that are greater than 60ppb.

RRF = (average control case over high ozone days selected based on base case concentrations) / (average base case over selected high ozone days)

In addition, the guidance recommends that preferably ten or more “high ozone days”, as identified below, be selected for RRF calculation. In no case can the RRF be calculated with fewer than five “high ozone days”.

The following describes the logic with which NYSDEC implemented these screening criteria into its FORTRAN code for RRF calculation:

a) <u>Selecting concentrations from grid cells surrounding the monitor</u>
    i. Determine the grid cell in which the monitor is located and include the surrounding 8 grid cells to form a 3X3 grid cell array.

    ii. Determine daily maximum 8-hr ozone concentrations for each day for each of the 9 grid cells for both base case and control case.
    iii. For each day, pick the highest daily maximum 8-hr ozone value out of all 9 grid cells. This is the daily maximum 8-hr ozone concentration for that monitor for that day to be used in RRF calculations (following the screening criteria listed below).
    iv. This is done for the base case only. For the future case the same grid cell is used regardless of whether it is the highest or not.

b) <u>Selecting modeling days to be used in the RRF computation (again done on a monitor-by-monitor basis)</u>
    i. Starting with an ozone threshold (TO_3) of 75 ppb and a minimum required number of days (Dmin) of 10, determine all days for which the simulated base case concentration (as determined in step (a) is at or above the threshold TO_3.
    ii. If the number of such days is greater to or equal Dmin, identify these days and proceed to step (c). Otherwise, continue to b(iii), below.
    iii. Lower the threshold (TO_3) by 1 ppb intervals and go back to b(i) to identify the days. If the minimum number of days is not reached, then reduce that requirement by 1 day (but no lower than 5 days and TO_3 must be ≥60 ppb), and go back to b(i). Otherwise proceed to b(iv) below.
    iv. Stop. No RRF can be calculated for this monitor because there were less than 5 days with base case daily maximum concentration ≥60 ppb.

c) <u>RRF computation:</u> Compute the RRF by averaging the daily maximum 8-hr ozone concentrations for base case and control case determined in step (a) over all of the days determined in step (b). The RRF is the ratio of average control case concentrations over average base case concentrations.

Step 3 - Computation of DVF

Compute DVF as the product of DVC from step (1) and RRF from step (2). Note, the following conventions on numerical precision (truncation, rounding) were applied:

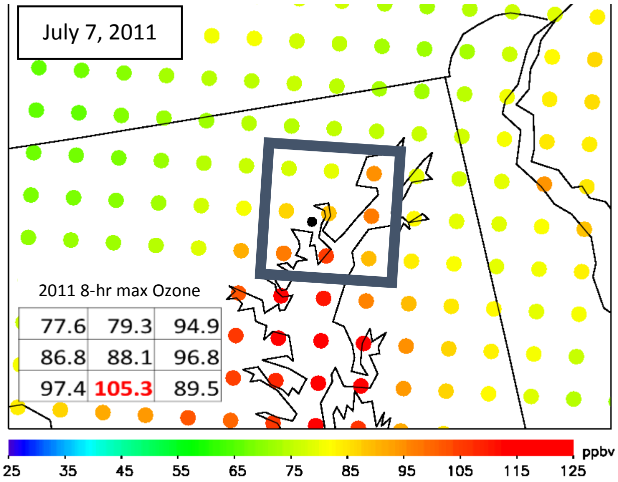
a) DV are truncated in accordance with 40 CFR Part 50.10, Appendix I. This applies to the 2011, 2012, and 2013 design values.
b) DVC (averages of design values over multiple years) are calculated in ppb and carried to 1 significant digit
c) RRF are calculated and carried to three significant digits
d) DVF is calculated by multiplying DVC with RRF, followed by truncation.

Land-Water Interface Issues

When monitors are located so as to result in one or more of the 8 additional grid cells falling over a body of water, OTC has found that those monitors are often not responsive to changes in emissions. Research conducted by the University of Maryland on the calculation of future design values has demonstrated some potential flaws with EPA modeling guidance in regards to calculating RRFs for these particular monitors.

It is often the case that due to slower dry deposition of ozone, fewer clouds being over bodies of water, PBL venting, PBL height, and high emissions from marine vessels, ozone measurements are much higher over bodies of water than nearby land masses (Goldberg et al. 2014; Loughner et al. 2011, 2014). As a result the maximum values in the 3x3 grid occur in a grid cell over water where ozone pollution is higher and less responsive to changes in emissions.

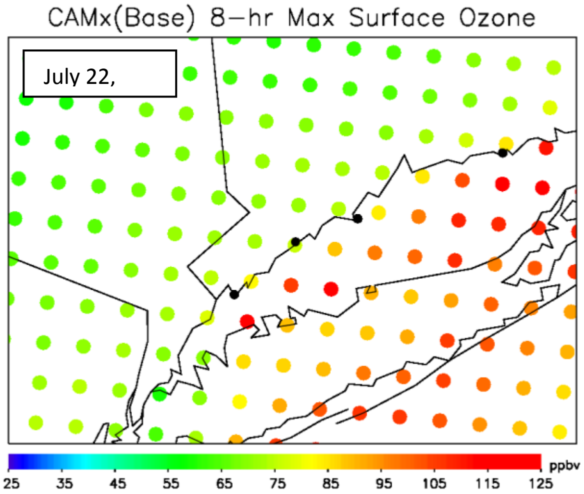
Figure 10-1: Modeled Ozone on July 7, 2011 near Edgewood, MD (Monitor #240251001)



77.6	79.3	94.9
86.8	88.1	96.8
97.4	**105.3**	89.5

Since people are not generally exposed to the high levels of ozone that occurs over bodies of water for eight hours, there is less of a need to evaluate these values in regards to the health based ozone standard, yet they are included in modeled design value calculations due to way the 3x3 grid is employed in the default method for calculated projected ozone values.

Figure 10-2: Modeled Ozone on July 2, 2011 near monitors in Southern Connecticut



An example of the misalignment created by the default modeled attainment test can be seen in Figure 10-1 above. In this case, the grid cell geographically nearest to the monitor models an 8 hour maximum of 88.1ppb, but the maximum grid cell is largely over water and reads 17.2 ppb higher at 105.3ppb. This results in modeled ozone calculations on high ozone days that don't correlate well with monitored data. Similar issues are illustrated in the Long Island Sound in Figure 10-2.

This problem can be seen to a greater extent when comparing Figure 10-3 and Figure 10-4. The former figure relies on the nearest grid cell for calculations and the latter figure relies on the technique recommended in EPA guidance. The former technique results in calculations that are much less biased, have a lower RMSE, and correspond well to the 1:1 line.

Figure 10-3: Modeled vs. Observed 8-hour maximum Ozone at Edgewood, MD calculated using nearest grid cell (Monitor #240251001)

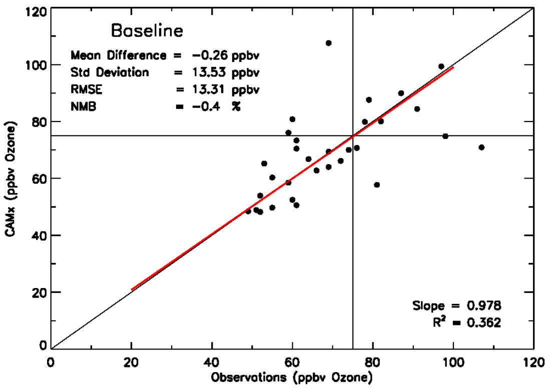
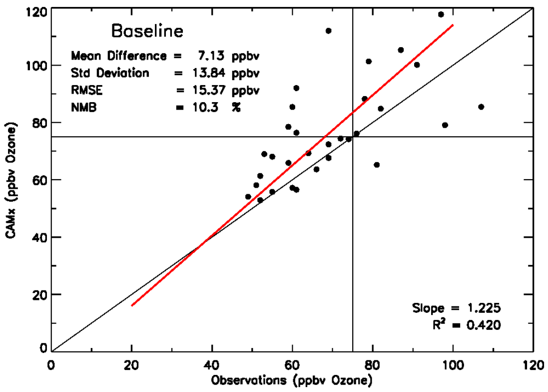


Figure 10-4: Modeled vs. Observed 8-hour maximum Ozone at Edgewood, MD calculated using nearest maximum from 3x3 grid (Monitor #240251001)



Another technique that could be used to correct potential inaccuracies in calculation of design values at monitors at the land-water interface involves removing grid cells that are of a certain percentage of water. This can be done prior to running the algorithm discussed earlier in the document by applying a mask that contains cells considered to be water cells to the grid and zeroing them out so that they cannot be considered the maximum. Determination of what percentage of the grid cell must be water to be removed should be left to the state submitting the demonstration.

To analyze this technique NYSDEC removed any grid cell that was considered water in the mask provided with the WRF 3.4 package and recalculated the design values. This technique was tested using the Alpha 2 inventory. The results are shown for 10 monitors (3 in Connecticut, 5 in New York, and 1 each in Maryland and New Jersey) in Figure 10-5 though Figure 10-24, with the odd numbered figures being those corresponding to values calculated using all of the grid cells and the even numbered figures having the cells containing water removed. The one monitor in New Jersey acts as a control in this case since it is inland and will not be impacted by water grid cells.

At every monitor, except #340150002, removing the water cells resulted in a reduction in the maximum 8-hr ozone on the days examined. #340150002 also happens to be the only one of the 10 monitors examined that had 2011 8-hr maximums that were not grossly over-predicted from the 2011 observed monitors. The other nine monitors saw dramatic improvements in performance on the 10 days examined. When including the water cells the 2011 8-hr modeled values over-predicted observed by as much as 80ppb, often in the 40ppb range, with under-prediction only occurring a few times. However, the over-prediction once the water cells were removed in the worst case was brought down to 40 ppb and some monitors had as many days under-predicted as over-predicted.

Figure 10-5: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090010017 using all grid cells for 10 selected days ordered by 2011 8-hr max

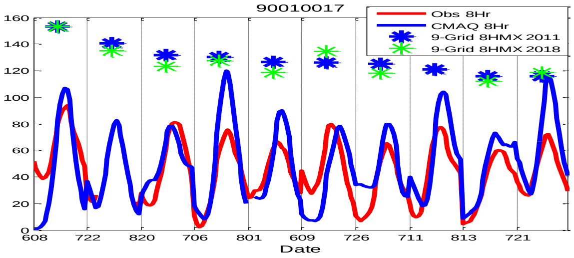


Figure 10-6: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090010017 using less water grid cells for 10 selected days ordered by 2011 8-hr max

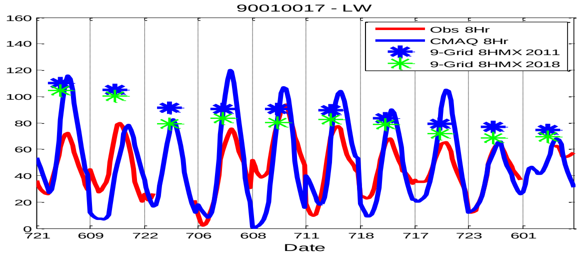


Figure 10-7: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090013007 using all grid cells for 10 selected days ordered by 2011 8-hr max

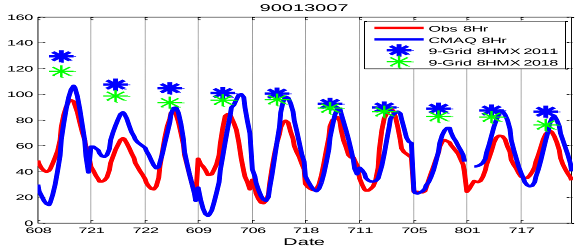


Figure 10-8: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090013007 using less water grid cells for 10 selected days ordered by 2011 8-hr max

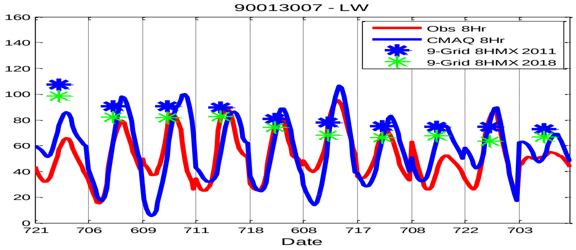


Figure 10-9: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090019003 using all grid cells for 10 selected days ordered by 2011 8-hr max

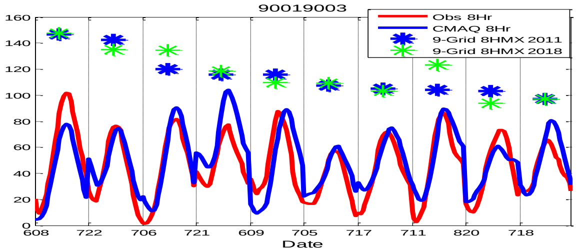


Figure 10-10: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #090019003 using less water grid cells for 10 selected days ordered by 2011 8-hr max

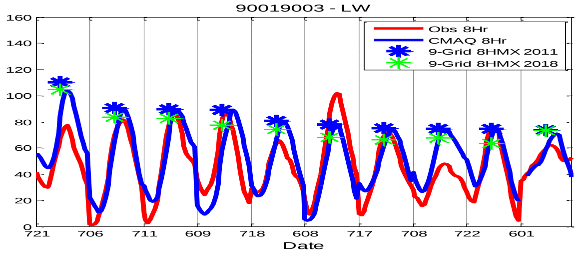


Figure 10-11: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #240251001 using all grid cells for 10 selected days ordered by 2011 8-hr max

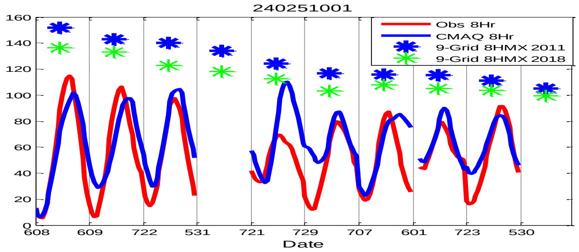


Figure 10-12: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #240251001 using less water grid cells for 10 selected days ordered by 2011 8-hr max

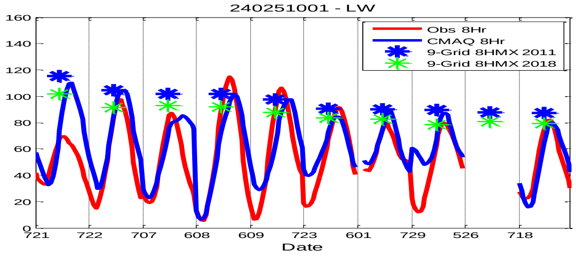


Figure 10-13: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #340150002 using all grid cells for 10 selected days ordered by 2011 8-hr max

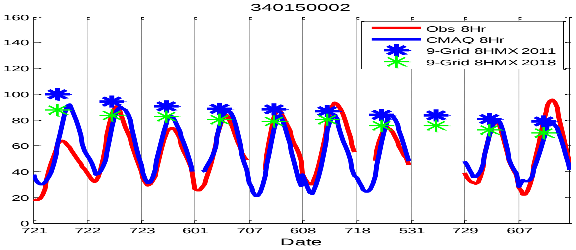


Figure 10-14: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #340150002 using less water grid cells for 10 selected days ordered by 2011 8-hr max

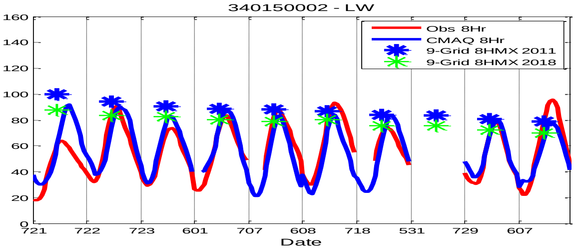


Figure 10-15: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360050133 using all grid cells for 10 selected days ordered by 2011 8-hr max

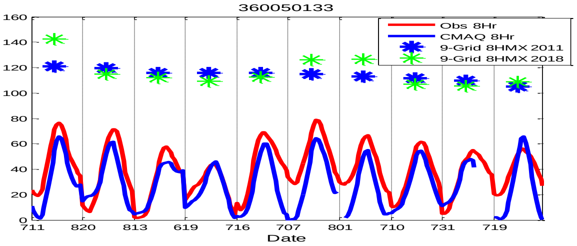


Figure 10-16: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360050133 using less water grid cells for 10 selected days ordered by 2011 8-hr max

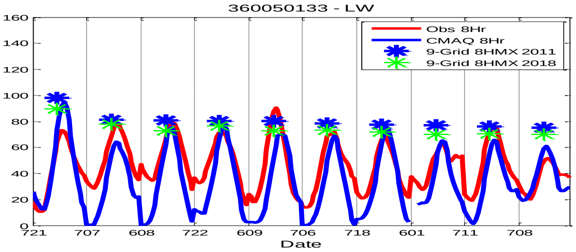


Figure 10-17: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360810124 using all grid cells for 10 selected days ordered by 2011 8-hr max

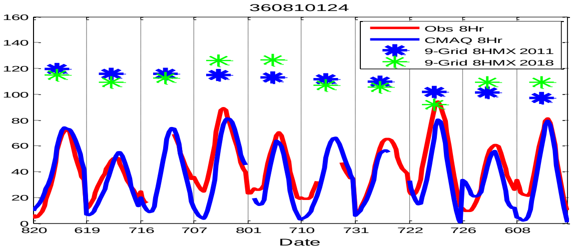


Figure 10-18: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360810124 using less water grid cells for 10 selected days ordered by 2011 8-hr max

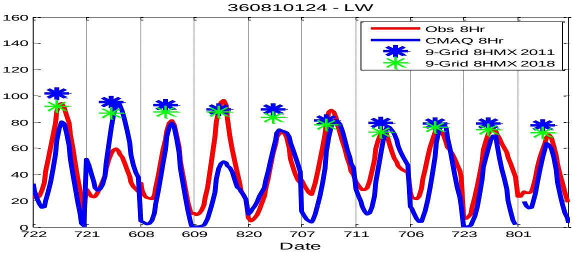


Figure 10-19: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360850067 using all grid cells for 10 selected days ordered by 2011 8-hr max

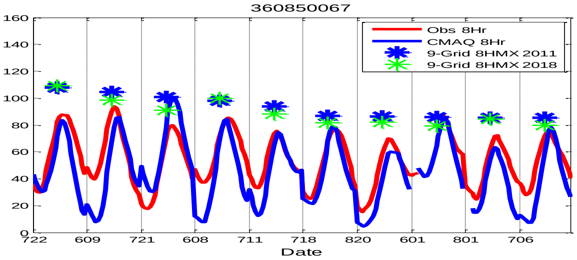


Figure 10-20: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #360850067 using less water grid cells for 10 selected days ordered by 2011 8-hr max

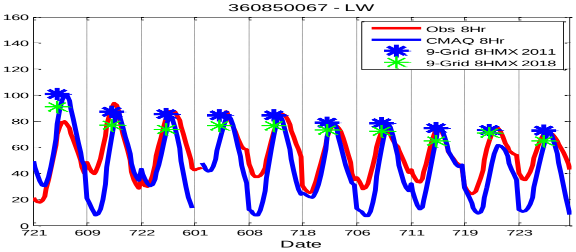


Figure 10-21: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #361030002 using all grid cells for 10 selected days ordered by 2011 8-hr max

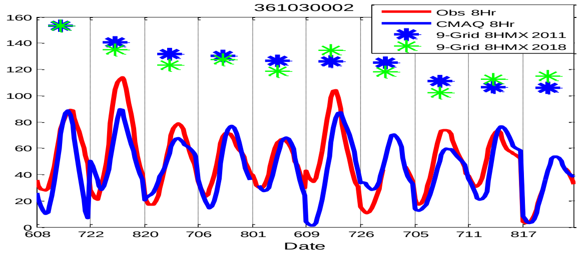


Figure 10-22: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #361030002 using less water grid cells for 10 selected days ordered by 2011 8-hr max

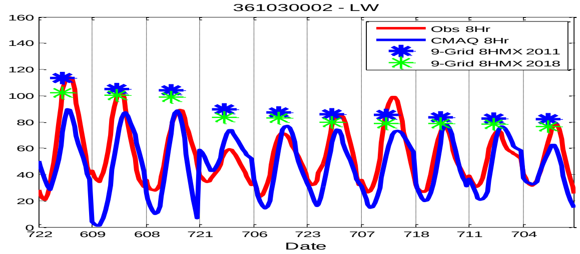


Figure 10-23: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #361192004 using all grid cells for 10 selected days ordered by 2011 8-hr max

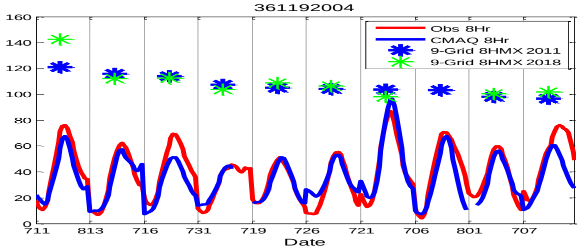
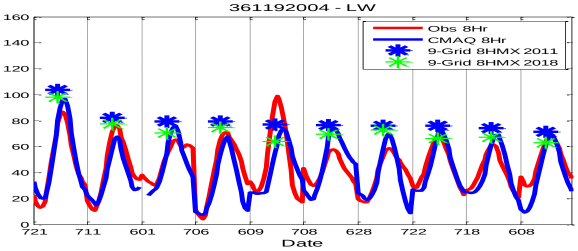


Figure 10-24: Observed and modeled 8-hr ozone (ppb) for 2011/2018 at monitor #361192004 using less water grid cells for 10 selected days ordered by 2011 8-hr max



We also looked at the results at all monitors, comparing modeling statistics for land-water monitors and monitors unaffected by the masking technique. In particular we looked at the deviation between the ten values used in design value calculations for each monitor (Table 10-1). We began by using the same formula as for MAGE presented in Appendix A, but took a slightly different approach. Rather than comparing the values on the same day as is typically done with MAGE and other modeling statistics, we compared the highest, 2nd highest, etc. values onto the tenth highest between observations and modeled values. When those numbers are compared for the monitors impacted by the land-water technique in the OTR+VA the deviation becomes of similar magnitude to those that were not impacted by the land-water technique, whereas using EPA's methods those monitors deviated over three times higher. A similar story occurs for monitors outside of the OTR. A full set of results for every monitor in the modeling domain is available upon request from OTC.

Table 10-1: MAGE for monitors impacted and not impacted by use of the land-water masking technique

REGION	Monitor Status	EPA Method	Less Water
OTR+VA	Impacted	30.7144	9.2985
	Not Impacted	9.3182	9.3182
Non-OTR	Impacted	25.0910	11.8325
	Not Impacted	7.8990	7.8990

When 2018 projections were examined there was a reduction in future projected ozone at all of the monitors, anywhere from 1 to 12 ppb, except the New Jersey monitor, which was not expected to change given its inland location (Table 10-2).

Table 10-2: 2018 ozone projections for 10 key monitors with and without water grids cells

Monitor ID	DVC	DVF 2018	DVF 2018 (less water)
#090010017	80.3	80	73
#090013007	84.3	78	75
#090019003	83.7	84	76
#240251001	90	81	80
#340150002	84.3	75	75
#360050133	74	75	68
#360810124	78	78	73
#360850067	81.3	77	73
#361030002	83.3	82	78
#361192004	75.3	78	68

While the OTC Modeling Committee does not believe that the technique described in EPA's guidance for calculating RRFs is problematic in most instances, monitors such as Edgewood, MD or those along the Long Island Sound should be analyzed in different ways in order to determine a method that produces the least biased results with the lowest error. Examples of some of the methods that could be used to reevaluate monitors at the land-water interface are:

1. Choosing the nearest grid cell to the monitor rather than use the 9 cell grid.
2. Averaging the 9 cell grid rather than using the maximum.
3. Using the maximum value from the 9 cell grid, but exclude grid cells over water though a mask or another technique.

References

Goldberg, DL, Loughner, CP, Tzortziou, M, Stehr, JW, Pickering, KE, Marufu, LT and Dickerson, RR 2014, 'Higher surface ozone concentrations over the Chesapeake Bay than over the adjacent land: Observations and models from the DISCOVER-AQ and CBODAQ campaigns', *Atmospheric Environment*, vol. 84, pp. 9–19.

Loughner, CP, Allen, DJ, Pickering, KE, Zhang, D-L, Shou, Y-X and Dickerson, RR 2011, 'Impact of fair-weather cumulus clouds and the Chesapeake Bay breeze on pollutant transport and transformation', *Atmospheric Environment*, vol. 45, no. 24, pp. 4060–4072.

Loughner, CP, Tzortziou, M, Follette-Cook, M, Pickering, KE, Goldberg, D, Satam, C, Weinheimer, A, Crawford, JH, Knapp, DJ, Montzka, DD, Diskin, GS and Dickerson, RR 2014, 'Impact of Bay-Breeze Circulations on Surface Air Quality and Boundary Layer Export', *Journal of Applied Meteorology and Climatology*, vol. 53, no. 7, pp. 1697–1713.

US EPA 2014, 'Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze', accessed from <https://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf>.

Section 11. Projected 8-hour Ozone Air Quality over the Ozone Transport Region

Overview

The US EPA guidance recommends the use of relative reduction factor (RRF) approach to demonstrate the attainment of the 8-hr ozone NAAQS (US EPA 2014). The OTC Modeling Committee implemented this approach in performing attainment assessment of the OTC areas as well as the approach outlined in Section 10 for removing grid cells over the water ("Less Water").

Ozone Results

As described in Section 10, the RRFs were determined for all monitors for future year simulations with emissions data from the Alpha and Alpha 2 inventories for 2018 and Beta 2 for 2017 inventory (Beta inventories were not included given the lack of difference between Beta and Beta 2). The base DVC for 2011 representing the number of DVs estimated on the basis of 3-year averages available from 2009 to 2013 are listed in Table 11-2 along with the RRF and future year projected ozone concentrations for each monitor identified by its AIRS ID. More information concerning the air quality monitors is in Appendix C. Projected results are provided for Alpha, Alpha 2, and Beta 2 inventories. The values in red represent DVC or DVF that exceed the 75 ppb 8-hr ozone NAAQS. The Beta 2 results are also presented using the technique of removing water grid cells from consideration discussed in Section 7.

When looking at differences in the modeled design values between the Alpha 2 inventories (Figure 11-1) and the Beta 2 inventories (Figure 11-2) in the OTR, one can observe some minor differences. There do appear to be decreases in ozone values throughout the OTR, in particular in the Mid-Atlantic. This would be expected because the use of an updated version of MOVES in Beta 2 decreased NO_X emissions throughout the region and upwind. There do appear to be several monitors in Massachusetts and upstate New York that do increase between Alpha 2 and Beta 2 (Section 6).

Figure 11-1: 2018 Projected Alpha 2 Base Case Design Values (EPA Guidance)

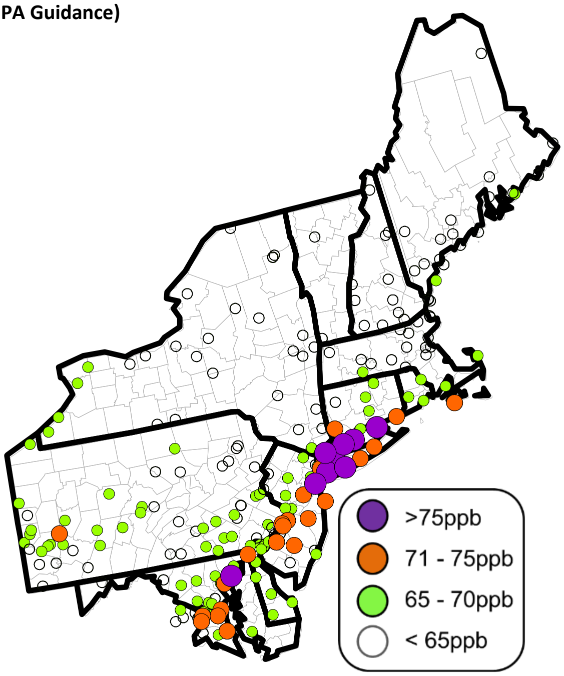
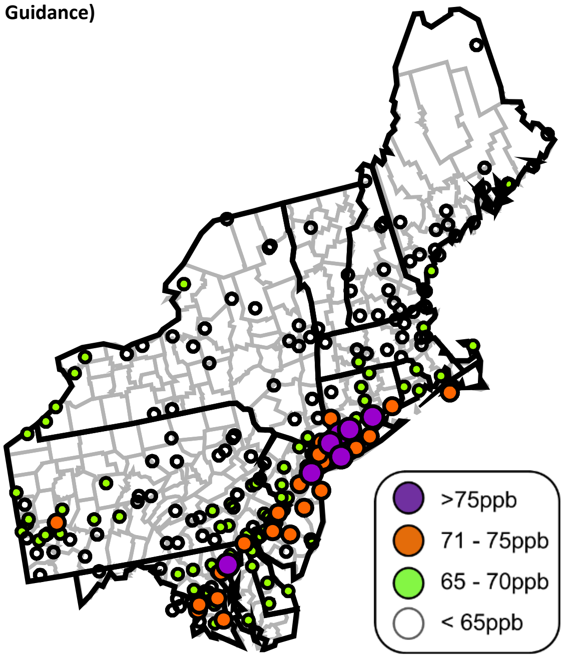
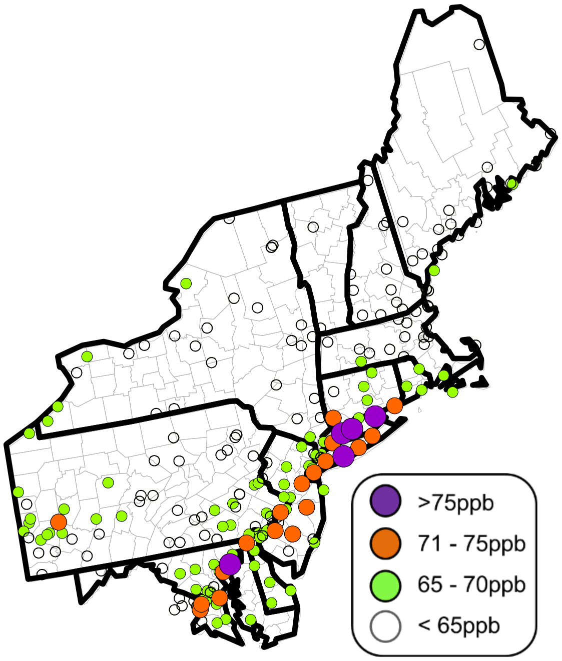


Figure 11-2: 2017 Projected Beta 2 Base Case Design Values (EPA Guidance)



We also examined the impact of using the water masking technique discussed in Section 10 Figure 11-3. One can see some decreases in ozone levels throughout the region when examining the Beta results when water grid cells are removed from calculations.

Figure 11-3: 2017 Projected Beta 2 Base Case Design Values (Less Water)



Moving onto the 2020 Gamma modeling, Figure 11-4 shows the photochemical modeling results for the 2020 base case using the Gamma platform with design values calculated using the techniques found in EPA guidance. One additional monitor in CT is projected to be in attainment of the 75 ppb in this modeling scenario. When the techinque of removing grid cells over the water is included, an additional monitor in Connecticut is projected to come into attainment for the standard, as seen in Figure 11-5.

There are also clear decreases in the number of monitors in each state projected to violate the 70 ppb NAAQS, as shown in the summary found in Table 11-1. DC, NJ, PA, and VA all had monitors projected to violate the 70 ppb NAAQS in the 2017 Beta and or the 2018 Alpha modeling, but no longer are projected to have any monitors above the 70 ppb NAAQS in 2020.

The monitor by monitor results for all future base case runs are presented in Table 11-2.

Figure 11-4: Projected Gamma 2020 Base Case Design Values for 2011 (left) and 2020 (right) (EPA Guidance)

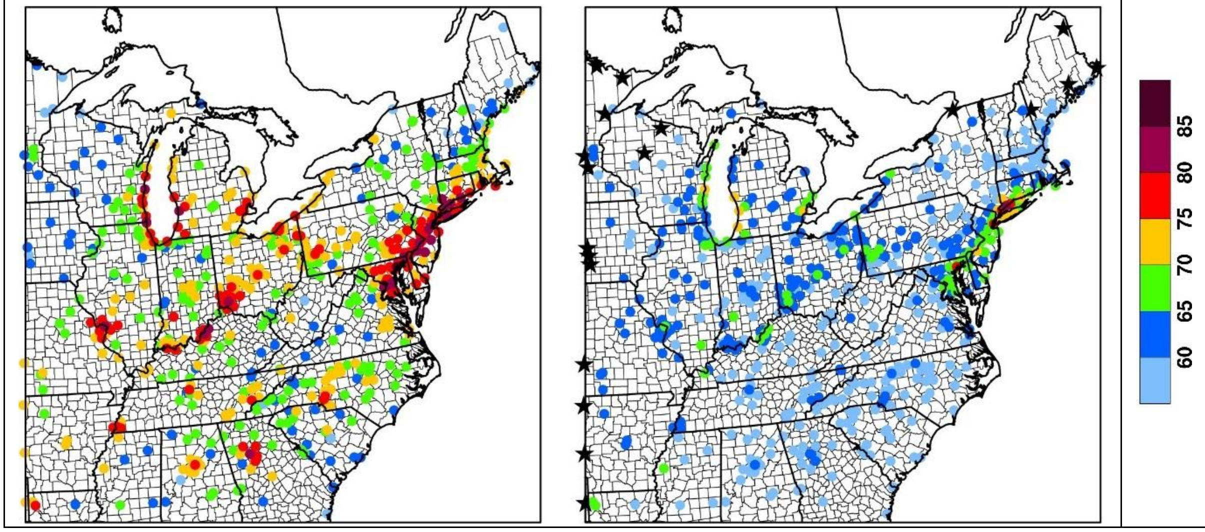


Figure 11-5: Projected Gamma 2020 Base Case Design Values for 2011 (left) and 2020 (right) (Less Water)

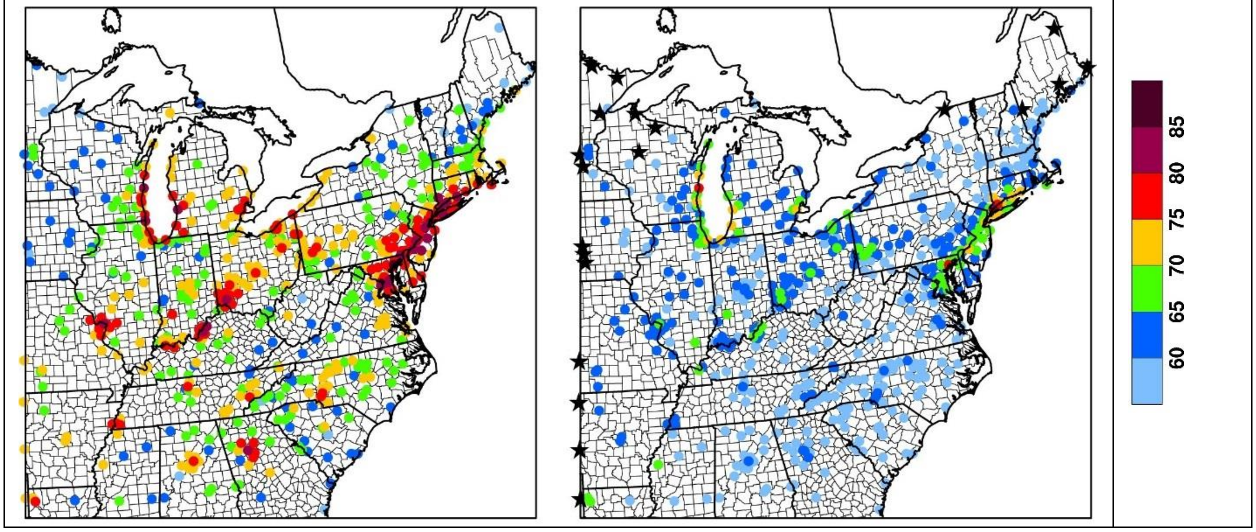


Table 11-1: State summary (max. DVF (ppb), monitors violating 75 ppb, monitors violating 70 ppb) of base case CMAQ modeling for 2018 Alpha and Alpha 2, 2017 Beta, and 2020 and 2023 Gamma platforms calculated using the "EPA Guidance" and "Less Water" techniques.

		Alpha - 2018			Alpha 2 - 2018			Beta 2 - 2017						Gamma - 2020						Gamma - 2023		
		EPA Guidance			EPA Guidance			EPA Guidance			Less Water			EPA Guidance			Less Water			EPA Guidance		
OTR?	State	Max	>75	>70	Max	>75	>70	Max	Max	Max	Max	>75	>70	Max	>75	>70	Max	>75	>70	Max	>75	>70
OTR	CT	84	4	5	84	4	6	83	4	6	76	3	6	83	3	5	83	2	6	81	1	3
	DC	71	0	1	70	0	0	69	0	0	69	0	0	66	0	0	66	0	0	62	0	0
	DE	69	0	0	69	0	0	69	0	0	68	0	0	66	0	0	66	0	0	63	0	0
	MA	70	0	0	72	0	1	71	0	1	70	0	0	67	0	0	67	0	0	64	0	0
	MD	82	1	7	81	1	6	81	1	5	80	1	4	77	1	1	77	1	1	74	0	1
	ME	66	0	0	68	0	0	65	0	0	66	0	0	62	0	0	62	0	0	60	0	0
	NH	64	0	0	63	0	0	64	0	0	64	0	0	62	0	0	62	0	0	60	0	0
	NJ	75	0	5	75	0	5	74	0	5	74	0	4	72	0	1	72	0	1	69	0	0
	NY	82	4	8	82	4	8	78	2	7	77	1	5	79	1	5	75	0	3	76	1	2
	PA	75	0	5	75	0	4	73	0	2	73	0	2	70	0	0	70	0	0	67	0	0
	RI	68	0	0	69	0	0	69	0	0	69	0	0	66	0	0	65	0	0	62	0	0
	VA	72	0	2	72	0	2	72	0	2	72	0	2	69	0	0	69	0	0	66	0	0
	VT	57	0	0	57	0	0	57	0	0	57	0	0	54	0	0	54	0	0	52	0	0
Non-OTR	AL	66	0	0	66	0	0	65	0	0	65	0	0	61	0	0	61	0	0	58	0	0
	AR	72	0	1	72	0	1	72	0	1	72	0	1	64	0	0	64	0	0	63	0	0
	GA	68	0	0	68	0	0	68	0	0	68	0	0	63	0	0	63	0	0	59	0	0
	IA	64	0	0	64	0	0	63	0	0	63	0	0	62	0	0	62	0	0	62	0	0
	IL	69	0	0	69	0	0	68	0	0	73	0	4	66	0	0	71	0	1	65	0	0
	IN	70	0	0	70	0	0	72	0	2	73	0	2	68	0	0	71	0	1	65	0	0
	KY	74	0	4	74	0	3	73	0	4	73	0	4	70	0	0	70	0	0	66	0	0
	LA	73	0	2	73	0	2	72	0	1	72	0	1	70	0	0	70	0	0	68	0	0
	MI	74	0	5	75	0	5	75	0	4	75	0	4	73	0	4	73	0	3	70	0	0
	MN	64	0	0	64	0	0	64	0	0	64	0	0	62	0	0	62	0	0	60	0	0
	MO	72	0	2	72	0	2	72	0	2	72	0	2	69	0	0	69	0	0	67	0	0
	MS	69	0	0	69	0	0	69	0	0	69	0	0	67	0	0	67	0	0	66	0	0
	NC	70	0	0	69	0	0	68	0	0	68	0	0	65	0	0	65	0	0	63	0	0
	OH	73	0	3	74	0	4	72	0	2	72	0	3	68	0	0	68	0	0	65	0	0
	SC	63	0	0	63	0	0	62	0	0	62	0	0	58	0	0	58	0	0	54	0	0
	TN	68	0	0	68	0	0	67	0	0	67	0	0	64	0	0	64	0	0	61	0	0
	VA	67	0	0	67	0	0	67	0	0	67	0	0	64	0	0	62	0	0			
	WI	77	1	3	77	1	3	77	1	4	77	1	6	74	0	1	76	1	3	62	0	0
	WV	68	0	0	67	0	0	67	0	0	67	0	0	64	0	0	64	0	0	71	0	1

Table 11-2: Monitor summary of base case CMAQ modeling for 2018 Alpha and Alpha 2, 2017 Beta, and 2020 and 2023 Gamma platforms calculated using the "EPA Guidance" and "Less Water" techniques (DVF > 75 ppb highlighted in red, DVF > 70 ppb highlighted in green).

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
CT	90010017	80.3	80	0.996	80	0.997	77	0.967	73	0.911	76	0.950	83	1.042	72	0.900
	90011123	81.3	73	0.898	72	0.889	74	0.912	74	0.912	71	0.875	71	0.875	68	0.836
	90013007	84.3	77	0.920	78	0.928	77	0.921	76	0.908	76	0.911	75	0.894	73	0.874
	90019003	83.7	84	1.009	84	1.013	83	1.000	76	0.912	83	0.997	76	0.910	81	0.969
	90031003	73.7	65	0.896	65	0.890	66	0.897	66	0.897	61	0.839	61	0.839	58	0.795
	90050005	70.3	63	0.900	62	0.895	62	0.895	62	0.895	59	0.850	59	0.850	57	0.811
	90070007	79.3	70	0.894	70	0.889	70	0.887	70	0.887	66	0.843	66	0.843	63	0.801
	90090027	74.3	68	0.920	69	0.938	67	0.915	67	0.911	67	0.912	64	0.873	65	0.876
	90099002	85.7	76	0.891	77	0.899	77	0.907	76	0.895	73	0.862	73	0.857	69	0.813
	90110124	80.3	70	0.873	71	0.887	73	0.912	72	0.902	70	0.876	74	0.923	66	0.824
	90131001	75.3	67	0.895	66	0.888	67	0.892	67	0.892	63	0.839	63	0.839	59	0.796
CT Max			**84**	**1.009**	**84**	**1.013**	**83**	**1.000**	**76**	**0.912**	**83**	**0.997**	**83**	**1.042**	**81**	**0.969**
DC	110010041	76	67	0.882	66	0.879	65	0.861	65	0.861	62	0.821	62	0.821	58	0.771
	110010043	80.7	71	0.882	70	0.879	69	0.861	69	0.861	66	0.821	66	0.821	62	0.771
DC Max			**71**	**0.882**	**70**	**0.879**	**69**	**0.861**	**69**	**0.861**	**66**	**0.821**	**66**	**0.821**	**62**	**0.771**
DE	100010002	74.3	67	0.904	67	0.906	66	0.895	65	0.883	63	0.858	62	0.846	60	0.818
	100031007	76.3	68	0.895	68	0.894	67	0.880	67	0.880	64	0.840	64	0.840	61	0.800
	100031010	78	69	0.897	69	0.896	67	0.867	67	0.867	66	0.857	66	0.857	63	0.819
	100031013	77.7	69	0.893	69	0.891	67	0.868	67	0.868	65	0.848	65	0.848	62	0.808
	100032004	75			66	0.891	65	0.868	65	0.868	63	0.848	63	0.848	60	0.809
	100051002	77.3	68	0.887	68	0.886	67	0.873	67	0.873	64	0.839	64	0.839	61	0.797
	100051003	77.7	69	0.896	69	0.900	69	0.895	68	0.883	66	0.854	65	0.848	62	0.807
DE Max			**69**	**0.904**	**69**	**0.906**	**69**	**0.895**	**68**	**0.883**	**66**	**0.858**	**66**	**0.857**	**63**	**0.819**
MA	250010002	73	65	0.904	66	0.911	66	0.906	-8	-9	62	0.859	63	0.870	59	0.810
	250034002	69	62	0.910	62	0.906	62	0.904	62	0.904	60	0.871	60	0.871	58	0.841
	250051002	74	66	0.902	67	0.918	66	0.905	67	0.911	63	0.855	64	0.866	59	0.810
	250070001	77	70	0.919	72	0.938	71	0.926	70	0.913	67	0.877	67	0.881	64	0.838
	250092006	71	61	0.871	62	0.874	65	0.925	63	0.900	54	0.774	60	0.853	49	0.700
	250094005	70			63	0.910	63	0.902	62	0.895	59	0.853	59	0.848	56	0.807
	250095005	69.3	62	0.901	62	0.908	61	0.892	61	0.892	58	0.851	58	0.851	56	0.810
	250130008	73.7	65	0.888	65	0.886	65	0.885	65	0.885	61	0.832	61	0.832	58	0.788
	250150103	64.7	57	0.894	57	0.888	57	0.886	57	0.886	54	0.837	54	0.837	50	0.787
	250154002	71.3	62	0.881	62	0.879	62	0.883	62	0.883	59	0.837	59	0.837	56	0.794
	250170009	67.3	60	0.894	60	0.895	59	0.887	59	0.887	56	0.844	56	0.844	54	0.802
	250171102	67	59	0.887	59	0.887	59	0.881	59	0.881	56	0.841	56	0.841	53	0.800
	250213003	72.3	60	0.840	61	0.856	63	0.881	64	0.886	60	0.835	61	0.852	55	0.773
	250250041	68.3	57	0.839	58	0.851	59	0.876	60	0.888	57	0.838	56	0.835	53	0.779
	250250042	60.7	50	0.839	51	0.855	53	0.880	53	0.887	48	0.801	51	0.853	44	0.730
	250270015	68.3	60	0.892	60	0.890	60	0.885	60	0.885	57	0.844	57	0.844	54	0.802
	250270024	69	60	0.883	60	0.882	60	0.883	60	0.883	57	0.838	57	0.838	55	0.797
MA Max			**70**	**0.919**	**72**	**0.938**	**71**	**0.926**	**70**	**0.913**	**67**	**0.877**	**67**	**0.881**	**64**	**0.841**
MD	240030014	83	72	0.872	72	0.870	71	0.861	71	0.861	68	0.828	68	0.828	64	0.780
	240051007	79	70	0.896	70	0.894	69	0.879	69	0.879	68	0.863	68	0.863	65	0.823
	240053001	80.7	74	0.926	74	0.924	74	0.924	71	0.892	68	0.854	69	0.861	65	0.806
	240090011	79.7	73	0.926	73	0.922	73	0.925	70	0.879	68	0.864	66	0.835	66	0.831
	240130001	76.3	67	0.886	67	0.884	67	0.879	67	0.879	63	0.838	63	0.838	61	0.803
	240150003	83	74	0.898	74	0.897	73	0.886	73	0.886	69	0.842	69	0.842	66	0.799
	240170010	79	70	0.897	70	0.895	69	0.877	69	0.877	65	0.833	65	0.833	62	0.795
	240199991	75			68	0.907	67	0.907	65	0.878	64	0.862	63	0.845	62	0.827
	240210037	76.3	67	0.890	67	0.888	67	0.878	67	0.878	64	0.840	64	0.840	61	0.807
	240230002	72	61	0.851	61	0.850	60	0.837	60	0.837	58	0.810	58	0.810	57	0.800
	240251001	90	82	0.912	81	0.909	81	0.908	80	0.894	77	0.862	77	0.860	74	0.823
	240259001	79.3	71	0.898	70	0.894	70	0.888	70	0.891	67	0.846	67	0.857	63	0.803
	240290002	78.7	69	0.888	69	0.886	68	0.876	68	0.876	66	0.848	66	0.848	63	0.809
	240313001	75.7	66	0.883	66	0.881	65	0.869	65	0.869	63	0.835	63	0.835	59	0.787
	240330030	79	68	0.871	68	0.868	68	0.862	68	0.862	65	0.823	65	0.823	61	0.772
	240338003	82.3	72	0.875	71	0.873	70	0.859	70	0.859	67	0.822	67	0.822	63	0.774
	240339991	80			69	0.871	69	0.865	69	0.865	66	0.829	66	0.829	62	0.780

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	240430009	72.7	63	0.878	63	0.874	63	0.877	63	0.877	60	0.834	60	0.834	58	0.802
	245100054	73.7	68	0.928	68	0.926	68	0.924	65	0.893	62	0.854	63	0.865	59	0.806
MD Max			**82**	**0.928**	**81**	**0.926**	**81**	**0.925**	**80**	**0.894**	**77**	**0.864**	**77**	**0.865**	**74**	**0.831**
ME	230010014	61	56	0.919	56	0.928	54	0.899	55	0.911	51	0.851	51	0.848	49	0.808
	230031100	51.3			-8	-9	-8	-9	-8	-9	-8	-9	-8	-9		
	230052003	69.3	63	0.912	63	0.913	62	0.898	62	0.909	60	0.871	59	0.856	57	0.825
	230090102	71.7	66	0.926	68	0.953	65	0.907	65	0.908	62	0.876	62	0.866	60	0.842
	230090103	66.3	61	0.925	63	0.952	60	0.910	60	0.906	57	0.864	57	0.862	54	0.827
	230112005	62.7	56	0.899	55	0.891	55	0.892	55	0.892	52	0.833	52	0.833	49	0.790
	230130004	67.7	62	0.921	63	0.941	60	0.899	60	0.897	57	0.852	57	0.848	55	0.812
	230173001	54.3	49	0.920	-8	-9	49	0.919	49	0.919	-8	-9	-8	-9		
	230194008	57.7			-8	-9	-8	-9	-8	-9	-8	-9	-8	-9		
	230230006	61	56	0.919	56	0.927	54	0.895	54	0.890	51	0.847	51	0.838	49	0.807
	230290019	58.3	54	0.927	55	0.957	53	0.917	53	0.918	52	0.895	51	0.891	50	0.866
	230290032	53	49	0.936	50	0.962	49	0.929	49	0.929	-8	-9	-8	-9		
	230310038	60.3	54	0.901	-8	-9	54	0.898	54	0.898	51	0.846	51	0.846	48	0.804
	230310040	64.3	58	0.903	58	0.904	57	0.900	57	0.900	54	0.843	54	0.843	51	0.801
	230312002	73.7	66	0.904	65	0.892	65	0.890	66	0.898	62	0.844	61	0.841	58	0.797
ME Max			**66**	**0.936**	**68**	**0.962**	**65**	**0.929**	**66**	**0.929**	**62**	**0.895**	**62**	**0.891**	**60**	**0.866**
NH	330012004	62.3	55	0.895	55	0.892	55	0.895	55	0.895	52	0.850	52	0.843	50	0.803
	330050007	62.3	55	0.888	55	0.884	55	0.887	55	0.887	52	0.844	52	0.844	50	0.806
	330074001	69.3	64	0.928	63	0.916	64	0.927	64	0.927	62	0.905	62	0.905	60	0.876
	330074002	59.7	55	0.928	54	0.916	55	0.927	55	0.927	54	0.905	54	0.905	52	0.876
	330090010	59.7	53	0.903	53	0.900	53	0.902	53	0.902	52	0.872	52	0.872	50	0.838
	330111011	66.3	59	0.895	59	0.895	58	0.889	58	0.889	55	0.844	55	0.844	53	0.802
	330115001	69	61	0.894	61	0.890	61	0.891	61	0.891	58	0.848	58	0.848	55	0.809
	330131007	64.7	58	0.904	58	0.901	57	0.896	57	0.896	54	0.838	54	0.838	51	0.796
	330150014	66	60	0.916	60	0.924	59	0.902	59	0.897	55	0.847	55	0.848	52	0.796
	330150016	66.3	60	0.916	61	0.924	59	0.902	59	0.897	56	0.847	56	0.848	52	0.795
	330150018	68			61	0.899	60	0.889	60	0.889	57	0.842	57	0.842	54	0.800
NH Max			**64**	**0.928**	**63**	**0.924**	**64**	**0.927**	**64**	**0.927**	**62**	**0.905**	**62**	**0.905**	**60**	**0.876**
NJ	340010006	74.3	66	0.893	67	0.905	66	0.890	65	0.882	61	0.834	63	0.855	58	0.781
	340030006	77	69	0.901	69	0.900	68	0.891	68	0.891	66	0.864	66	0.864	63	0.822
	340071001	82.7	74	0.896	73	0.894	72	0.880	72	0.880	70	0.850	70	0.850	66	0.809
	340110007	72	64	0.903	64	0.902	64	0.889	64	0.889	61	0.855	61	0.855	58	0.817
	340130003	78	70	0.903	70	0.905	69	0.890	69	0.890	67	0.862	67	0.862	64	0.821
	340150002	84.3	75	0.900	75	0.898	74	0.884	74	0.884	72	0.858	72	0.858	69	0.820
	340170006	77	70	0.912	70	0.919	69	0.902	69	0.898	69	0.903	67	0.881	67	0.870
	340190001	78	69	0.885	68	0.883	68	0.873	68	0.873	65	0.843	65	0.843	62	0.799
	340210005	78.3	70	0.894	69	0.892	68	0.878	68	0.878	66	0.844	66	0.844	62	0.801
	340219991	76			67	0.893	66	0.875	66	0.875	63	0.840	63	0.840	60	0.795
	340230011	81.3	72	0.891	72	0.888	71	0.884	71	0.884	68	0.843	68	0.843	65	0.800
	340250005	80	72	0.901	72	0.902	71	0.891	69	0.868	69	0.867	67	0.844	66	0.825
	340273001	76.3	67	0.889	67	0.887	67	0.880	67	0.880	64	0.848	64	0.848	61	0.806
	340290006	82	72	0.884	72	0.882	72	0.879	72	0.879	69	0.846	69	0.846	65	0.802
	340315001	73.3	67	0.915	67	0.917	65	0.899	65	0.899	63	0.868	63	0.868	60	0.828
	340410007	66			57	0.878	57	0.874	57	0.874	55	0.847	55	0.847	52	0.797
NJ Max			**75**	**0.915**	**75**	**0.919**	**74**	**0.902**	**74**	**0.899**	**72**	**0.903**	**72**	**0.881**	**69**	**0.870**
NY	360010012	68	61	0.911	61	0.907	61	0.903	61	0.903	58	0.861	58	0.861	56	0.825
	360050133	74	75	1.014	75	1.020	71	0.972	68	0.920	68	0.919	66	0.894	64	0.872
	360130006	73.3	66	0.908	66	0.904	66	0.913	65	0.899	64	0.879	63	0.872	61	0.834
	360130011	74	66	0.898	66	0.896	66	0.901	66	0.905	64	0.878	64	0.869	61	0.834
	360150003	66.5	61	0.926	61	0.923	61	0.919	61	0.919	59	0.893	59	0.893	57	0.865
	360270007	72	63	0.886	63	0.887	64	0.899	64	0.899	60	0.843	60	0.843	58	0.806
	360290002	71.3	65	0.919	65	0.915	65	0.922	64	0.907	64	0.902	62	0.873	61	0.865
	360310002	70.3	64	0.920	-936	1.807	-935	1.835	-935	1.835	-938	1.760	-938	1.760	59	0.848
	360310003	67.3	61	0.920	60	0.904	61	0.917	61	0.917	59	0.880	59	0.880	57	0.848
	360337003	45			-8	-9	-8	-9	-8	-9	-8	-9	-8	-9		
	360410005	66	59	0.904	59	0.898	59	0.903	59	0.903	57	0.874	57	0.874	55	0.842
	360430005	62			-8	-9	-8	-9	-8	-9	54	0.882	54	0.882	52	0.852
	360450002	71.7	63	0.890	62	0.875	65	0.907	65	0.911	60	0.844	63	0.884	57	0.795
	360530006	67	61	0.922	61	0.919	61	0.917	61	0.917	59	0.885	59	0.885	57	0.854
	360610135	73.3	73	1.003	74	1.010	70	0.959	67	0.919	67	0.924	65	0.899	64	0.883

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	360631006	72.3	67	0.936	65	0.912	67	0.934	65	0.900	66	0.918	62	0.869	64	0.887
	360650004	61.5	56	0.915	55	0.906	56	0.913	56	0.913	54	0.882	54	0.882	52	0.852
	360671015	69.3	63	0.917	63	0.913	63	0.916	63	0.916	61	0.886	61	0.886	59	0.857
	360715001	67	60	0.903	60	0.902	60	0.903	60	0.903	57	0.859	57	0.859	55	0.822
	360750003	68	60	0.890	59	0.880	61	0.902	61	0.909	58	0.861	60	0.885	55	0.815
	360790005	70	62	0.890	61	0.884	63	0.908	63	0.908	60	0.864	60	0.864	57	0.824
	360810124	78	78	1.002	78	1.010	74	0.959	72	0.926	72	0.924	72	0.930	68	0.882
	360830004	67	60	0.908	60	0.903	60	0.901	60	0.901	57	0.863	57	0.863	55	0.828
	360850067	81.3	77	0.950	77	0.957	78	0.965	72	0.896	79	0.978	71	0.877	76	0.946
	360870005	75	68	0.907	68	0.907	67	0.903	67	0.903	65	0.873	65	0.873	62	0.832
	360910004	67	60	0.903	60	0.900	59	0.894	59	0.894	57	0.862	57	0.862	55	0.825
	361010003	65.3	61	0.937	60	0.932	60	0.934	60	0.934	58	0.896	58	0.896	56	0.867
	361030002	83.3	82	0.987	82	0.986	77	0.932	77	0.925	75	0.903	75	0.911	71	0.857
	361030004	78	71	0.911	71	0.917	71	0.920	71	0.912	68	0.878	68	0.882	65	0.840
	361030009	78.7	73	0.932	-925	1.906	-926	1.871	-927	1.844	-927	1.853	-929	1.791	70	0.895
	361111005	69	64	0.928	63	0.920	63	0.921	63	0.921	60	0.878	60	0.878	58	0.845
	361173001	65	59	0.910	57	0.891	59	0.911	58	0.906	56	0.876	56	0.876	54	0.837
	361192004	75.3	78	1.042	78	1.041	73	0.976	68	0.911	72	0.967	68	0.914	69	0.923
NY Max			**82**	**1.042**	**82**	**1.041**	**78**	**0.976**	**77**	**0.934**	**79**	**0.978**	**75**	**0.930**	**76**	**0.946**
PA	420030008	76.3	71	0.936	70	0.926	70	0.930	70	0.930	67	0.880	67	0.880	65	0.852
	420030010	73.7	68	0.936	68	0.926	68	0.930	68	0.930	64	0.880	64	0.880	62	0.852
	420030067	75.7	69	0.920	69	0.913	69	0.912	69	0.912	66	0.876	66	0.876	64	0.848
	420031005	80.7	74	0.920	73	0.913	73	0.908	73	0.908						
	420050001	74.3	68	0.924	67	0.915	67	0.908	67	0.908	62	0.847	62	0.847	60	0.817
	420070002	70.7	65	0.928	65	0.927	65	0.922	65	0.922	62	0.888	62	0.888	60	0.860
	420070005	74.7	69	0.935	69	0.930	69	0.935	69	0.935	66	0.890	66	0.890	64	0.866
	420070014	72.3	67	0.931	66	0.923	66	0.925	66	0.925	64	0.887	64	0.887	61	0.856
	420110006	71.7	63	0.887	63	0.885	62	0.870	62	0.870	60	0.838	60	0.838	57	0.798
	420110011	76.3	67	0.880	66	0.878	65	0.861	65	0.861	62	0.820	62	0.820	59	0.781
	420130801	72.7	67	0.935	67	0.933	65	0.898	65	0.898	63	0.872	63	0.872	61	0.840
	420170012	80.3	71	0.891	71	0.890	70	0.877	70	0.877	68	0.847	68	0.847	64	0.805
	420210011	70.3	66	0.939	65	0.931	63	0.899	63	0.899	60	0.857	60	0.857	58	0.831
	420270100	71	66	0.932	66	0.931	64	0.907	64	0.907	62	0.876	62	0.876	60	0.847
	420279991	72			66	0.929	64	0.902	64	0.902	62	0.871	62	0.871	60	0.844
	420290100	76.3	69	0.905	68	0.904	66	0.867	66	0.867	62	0.822	62	0.822	59	0.782
	420334000	72.3	68	0.942	67	0.940	65	0.908	65	0.908	63	0.885	63	0.885	61	0.849
	420430401	69	62	0.909	62	0.907	60	0.875	60	0.875	58	0.846	58	0.846	56	0.816
	420431100	74.7	67	0.900	67	0.897	64	0.866	64	0.866	61	0.827	61	0.827	59	0.790
	420450002	75.7	68	0.899	67	0.898	66	0.880	66	0.880	64	0.855	64	0.855	61	0.815
	420490003	74	65	0.891	66	0.894	66	0.904	67	0.906	65	0.879	64	0.867	61	0.824
	420550001	67	60	0.905	60	0.903	59	0.883	59	0.883	56	0.846	56	0.846	54	0.818
	420590002	69	62	0.906	62	0.902	61	0.890	61	0.890	59	0.857	59	0.857	57	0.835
	420630004	75.7	70	0.930	70	0.926	67	0.898	67	0.898	65	0.866	65	0.866	63	0.834
	420690101	71	63	0.894	63	0.893	62	0.884	62	0.884	59	0.844	59	0.844	57	0.809
	420692006	68.7	61	0.894	61	0.893	60	0.884	60	0.884	57	0.844	57	0.844	55	0.809
	420710007	77	70	0.916	70	0.915	65	0.854	65	0.854	63	0.818	63	0.818	60	0.790
	420710012	78	71	0.911	70	0.909	66	0.858	66	0.858	63	0.818	63	0.818	61	0.783
	420730015	71	65	0.918	64	0.912	64	0.910	64	0.910	61	0.863	61	0.863	58	0.823
	420750100	76			67	0.891	65	0.865	65	0.865	62	0.822	62	0.822	59	0.786
	420770004	76	67	0.886	67	0.884	66	0.875	66	0.875	63	0.838	63	0.838	60	0.795
	420791100	65	57	0.888	57	0.887	56	0.867	56	0.867	52	0.815	52	0.815	50	0.782
	420791101	64.3	56	0.886	56	0.884	56	0.872	56	0.872	53	0.834	53	0.834	51	0.799
	420810100	67	60	0.908	60	0.907	60	0.898	60	0.898	56	0.846	56	0.846	54	0.810
	420850100	76.3	68	0.896	68	0.893	68	0.900	68	0.900	65	0.859	65	0.859	60	0.793
	420890002	66.7	59	0.887	59	0.885	58	0.871	58	0.871	56	0.841	56	0.841	53	0.802
	420910013	76.3	68	0.900	68	0.899	66	0.870	66	0.870	65	0.855	65	0.855	62	0.815
	420950025	76	67	0.885	67	0.884	66	0.873	66	0.873	62	0.838	62	0.838	59	0.778
	420958000	69.7	62	0.890	61	0.889	61	0.877	61	0.877	58	0.837	58	0.837	55	0.793
	420990301	68.3	63	0.923	62	0.920	60	0.890	60	0.890	58	0.851	58	0.851	56	0.821
	421010004	66	59	0.905	59	0.904	58	0.886	58	0.886	56	0.857	56	0.857	53	0.817
	421010024	83.3	75	0.902	75	0.901	73	0.880	73	0.880	70	0.849	70	0.849	67	0.807
	421011002	80			72	0.901	70	0.880	70	0.880	67	0.849	67	0.849	64	0.806
	421119991	65			56	0.865	55	0.850	55	0.850	54	0.835	54	0.835	53	0.815

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	421174000	69.7	65	0.935	65	0.933	64	0.920	64	0.920	61	0.883	61	0.883	59	0.849
	421250005	70	63	0.914	63	0.908	63	0.902	63	0.902	60	0.857	60	0.857	58	0.834
	421250200	70.7	64	0.907	63	0.900	63	0.901	63	0.901	60	0.855	60	0.855	58	0.830
	421255001	70.3	64	0.922	64	0.915	64	0.919	64	0.919	61	0.871	61	0.871	59	0.845
	421290006	71.7	66	0.921	65	0.913	65	0.910	65	0.910	62	0.869	62	0.869	60	0.837
	421290008	71	64	0.911	64	0.905	63	0.898	63	0.898	61	0.860	61	0.860	58	0.830
	421330008	72.3	66	0.920	66	0.919	62	0.858	62	0.858	59	0.819	59	0.819	57	0.788
	421330011	74.3	67	0.915	67	0.913	63	0.859	63	0.859	61	0.826	61	0.826	58	0.791
PA Max			75	0.942	75	0.940	73	0.935	73	0.935	**70**	**0.890**	**70**	**0.890**	**67**	**0.866**
RI	440030002	73.7	67	0.910	67	0.913	66	0.902	66	0.902	63	0.864	63	0.864	60	0.821
	440071010	74	67	0.911	67	0.911	66	0.899	66	0.896	63	0.852	63	0.857	59	0.803
	440090007	76.3	68	0.898	69	0.914	69	0.906	69	0.911	66	0.868	65	0.862	62	0.823
RI Max			**68**	**0.911**	**69**	**0.914**	**69**	**0.906**	**69**	**0.911**	**66**	**0.868**	**65**	**0.864**	**62**	**0.823**
VA-OTR	510130020	81.7	72	0.888	72	0.886	71	0.876	71	0.876	68	0.841	68	0.841	64	0.792
	510590030	82.3	72	0.884	72	0.882	72	0.879	72	0.879	69	0.849	69	0.849	66	0.803
	511071005	73	65	0.899	65	0.896	64	0.889	64	0.889	61	0.841	61	0.841	58	0.800
	511530009	70	63	0.905	63	0.903	62	0.897	62	0.897	59	0.855	59	0.855	57	0.821
	515100009	80	70	0.883	70	0.881	69	0.866	69	0.866	66	0.837	66	0.837	63	0.791
VA Max			72	0.905	72	0.903	72	0.897	72	0.897	**69**	**0.855**	**69**	**0.855**	**66**	**0.821**
VT	500030004	63.7	57	0.910	57	0.905	57	0.904	57	0.904	54	0.860	54	0.860	52	0.824
VT Max			**57**	**0.910**	**57**	**0.905**	**57**	**0.904**	**57**	**0.904**	**54**	**0.860**	**54**	**0.860**	**52**	**0.824**
AL	10331002	65	49	0.754	48	0.751	47	0.737	47	0.737	44	0.685	44	0.685	42	0.657
	10499991	66			58	0.888	58	0.884	58	0.884	55	0.845	55	0.845	53	0.815
	10510001	66.3	57	0.868	57	0.861	56	0.854	56	0.854	54	0.818	54	0.818	51	0.780
	10550011	61.7	52	0.853	52	0.853	52	0.848	52	0.848	50	0.816	50	0.816	48	0.784
	10730023	72.3	62	0.865	62	0.864	61	0.854	61	0.854	58	0.814	58	0.814	55	0.772
	10731003	72	63	0.878	63	0.877	61	0.860	61	0.860	59	0.826	59	0.826	56	0.789
	10731005	75.3	65	0.870	65	0.870	64	0.859	64	0.859	60	0.803	60	0.803	57	0.760
	10731009	72	65	0.908	65	0.912	63	0.879	63	0.879	58	0.811	58	0.811	56	0.786
	10731010	73.7	62	0.854	62	0.854	62	0.849	62	0.849	59	0.809	59	0.809	56	0.771
	10732006	75	63	0.850	63	0.850	63	0.848	63	0.848	60	0.802	60	0.802	56	0.751
	10735002	72	62	0.867	62	0.867	61	0.851	61	0.851	58	0.812	58	0.812	55	0.775
	10735003	71	62	0.883	62	0.887	62	0.874	62	0.874	58	0.831	58	0.831	57	0.803
	10736002	76.7	66	0.871	66	0.871	65	0.852	65	0.852	61	0.807	61	0.807	58	0.767
	10890014	70.7	60	0.858	60	0.857	60	0.854	60	0.854	57	0.810	57	0.810	54	0.771
	11011002	67.3	57	0.857	57	0.857	57	0.862	57	0.862	54	0.808	54	0.808	51	0.762
	11030011	68.7	60	0.883	60	0.883	60	0.875	60	0.875	58	0.847	58	0.847	56	0.818
	11130002	66	57	0.869	57	0.869	57	0.868	57	0.868	54	0.826	54	0.826	52	0.789
	11170004	73.3	61	0.842	61	0.842	61	0.834	61	0.834	57	0.787	57	0.787	54	0.741
	11190002	61	55	0.911	55	0.911	52	0.866	52	0.866	51	0.847	51	0.847	50	0.828
	11250010	58.7	51	0.884	51	0.884	50	0.862	50	0.862	48	0.829	48	0.829	46	0.796
AL Max			**66**	**0.911**	**66**	**0.912**	**65**	**0.884**	**65**	**0.884**	**61**	**0.847**	**61**	**0.847**	**58**	**0.828**
AR	50350005	77.3	68	0.886	68	0.886	67	0.867	67	0.867	63	0.827	63	0.827	61	0.797
	51010002	68	64	0.947	64	0.942	66	0.976	66	0.976	64	0.948	64	0.948	63	0.937
	51130003	72.3	72	0.997	72	0.996	72	0.997	72	0.997	-8	-9	-8	-9		
	51190007	72.3	64	0.885	64	0.885	64	0.886	64	0.886	60	0.833	60	0.833	57	0.790
	51191002	75.7	67	0.890	67	0.890	67	0.889	67	0.889	63	0.838	63	0.838	60	0.797
	51191008	73	65	0.901	65	0.901	65	0.898	65	0.898	62	0.855	62	0.855	59	0.814
	51430005	71	70	0.997	70	0.997	70	1.000	70	1.000	-8	-9	-8	-9		
AR Max			72	0.997	72	0.997	72	1.000	72	1.000	**64**	**0.948**	**64**	**0.948**	**63**	**0.937**
GA	130210012	72.3	60	0.838	60	0.839	60	0.837	60	0.837	57	0.792	57	0.792	54	0.751
	130510021	63.3	57	0.902	57	0.912	57	0.905	57	0.905	53	0.847	53	0.847	51	0.814
	130550001	66.3	57	0.866	57	0.870	57	0.868	57	0.868	54	0.818	54	0.818	51	0.777
	130590002	70.7	59	0.845	59	0.845	59	0.843	59	0.843	55	0.781	55	0.781	51	0.727
	130670003	76	63	0.835	64	0.844	63	0.842	63	0.842	59	0.789	59	0.789	56	0.738
	130730001	68.7	59	0.866	59	0.867	59	0.869	59	0.869	55	0.803	55	0.803	52	0.761
	130770002	65	52	0.808	52	0.808	52	0.802	52	0.802	49	0.755	49	0.755	46	0.714
	130850001	66.3	56	0.853	56	0.851	56	0.855	56	0.855	52	0.797	52	0.797	49	0.750
	130890002	77.3	65	0.849	65	0.849	64	0.829	64	0.829	61	0.789	61	0.789	56	0.730
	130970004	73.3	61	0.836	61	0.840	61	0.834	61	0.834	56	0.775	56	0.775	52	0.720
	131210055	81	68	0.843	68	0.844	68	0.842	68	0.842	62	0.776	62	0.776	58	0.721
	131270006	60	56	0.948	57	0.963	57	0.956	57	0.954	55	0.917	56	0.943	53	0.898
	131350002	76.7	64	0.839	64	0.838	64	0.838	64	0.838	58	0.761	58	0.761	53	0.699
	131510002	80	67	0.849	67	0.849	67	0.843	67	0.843	63	0.793	63	0.793	59	0.744

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	132130003	70.3	60	0.859	60	0.857	59	0.852	59	0.852	55	0.793	55	0.793	52	0.744
	132150008	66	57	0.869	57	0.869	57	0.869	57	0.869	54	0.827	54	0.827	52	0.789
	132230003	70.7	62	0.879	62	0.885	61	0.873	61	0.873	58	0.831	58	0.831	55	0.791
	132319991	72			60	0.844	60	0.840	60	0.840	57	0.795	57	0.795	54	0.751
	132450091	70	60	0.857	60	0.868	60	0.860	60	0.860	56	0.814	56	0.814	54	0.777
	132470001	77	64	0.837	64	0.837	64	0.834	64	0.834	60	0.780	60	0.780	56	0.727
	132611001	64.7	57	0.885	57	0.887	57	0.884	57	0.884	54	0.845	54	0.845	52	0.815
GA Max			**68**	**0.948**	**68**	**0.963**	**68**	**0.956**	**68**	**0.954**	**63**	**0.917**	**63**	**0.943**	**59**	**0.898**
IA	190170011	64	62	0.974	62	0.981	62	0.976	62	0.976	61	0.961	61	0.961	60	0.952
	190450021	66.7	63	0.948	63	0.948	62	0.941	62	0.941	61	0.922	61	0.922	60	0.901
	191130028	64.3	61	0.962	61	0.962	61	0.962	61	0.962	60	0.939	60	0.939	59	0.919
	191130033	64	61	0.960	61	0.958	61	0.959	61	0.959	60	0.939	60	0.939	58	0.916
	191130040	62.7	60	0.965	60	0.965	60	0.966	60	0.966	58	0.941	58	0.941	57	0.916
	191530030	59.7	58	0.980	58	0.980	58	0.983	58	0.983	-8	-9	-8	-9		
	191630014	63	59	0.942	59	0.941	58	0.931	58	0.931	57	0.919	57	0.919	56	0.898
	191630015	66			61	0.938	61	0.938	61	0.938	60	0.920	60	0.920	59	0.897
	191690011	61.3	60	0.985	60	0.985	60	0.981	60	0.981	-8	-9	-8	-9		
	191770006	65.7	64	0.977	64	0.979	63	0.972	63	0.972	62	0.957	62	0.957	62	0.945
	191810022	63.7	63	0.996	63	0.996	63	0.995	63	0.995	-8	-9	-8	-9		
IA Max			**64**	**0.996**	**64**	**0.996**	**63**	**0.995**	**63**	**0.995**	**62**	**0.961**	**62**	**0.961**	**62**	**0.952**
IL	170010007	67	63	0.941	64	0.961	63	0.950	63	0.950	61	0.922	61	0.922	59	0.894
	170190007	71			65	0.921	64	0.915	64	0.915	63	0.896	63	0.896	62	0.873
	170230001	66	60	0.911	59	0.907	60	0.914	60	0.914	55	0.846	55	0.846	54	0.827
	170310001	72	67	0.932	67	0.932	67	0.933	67	0.933	66	0.917	66	0.917	63	0.888
	170310032	77.7	67	0.868	65	0.846	68	0.883	72	0.931	66	0.852	71	0.924	62	0.807
	170310064	71.3	61	0.868	60	0.846	62	0.883	66	0.931	60	0.852	65	0.924	57	0.808
	170310076	71.7	66	0.927	66	0.927	67	0.937	67	0.937	61	0.862	65	0.919	58	0.820
	170311003	69.7	55	0.794	53	0.774	59	0.853	65	0.943	53	0.763	62	0.900	49	0.712
	170311601	71.3	66	0.937	66	0.934	66	0.930	66	0.930	66	0.930	66	0.930	64	0.910
	170314002	71.7	57	0.806	58	0.813	60	0.848	67	0.944	55	0.776	66	0.931	52	0.725
	170314007	65.7	53	0.816	52	0.799	55	0.844	61	0.942	50	0.766	59	0.906	45	0.699
	170314201	75.7	61	0.816	-939	1.599	-936	1.687	-928	1.884	-942	1.532	-931	1.812	52	0.699
	170317002	76	60	0.800	58	0.776	64	0.846	71	0.941	57	0.756	68	0.898	51	0.674
	170436001	66.3	62	0.942	62	0.938	62	0.942	62	0.942	61	0.930	61	0.930	60	0.905
	170491001	68.3	62	0.911	61	0.907	61	0.901	61	0.901	59	0.865	59	0.865	57	0.840
	170650002	74.3	69	0.937	69	0.941	68	0.927	68	0.927	66	0.895	66	0.895	65	0.879
	170831001	76	67	0.886	67	0.887	67	0.886	67	0.886	65	0.858	65	0.858	62	0.822
	170859991	68			64	0.946	63	0.940	63	0.940	62	0.919	62	0.919	61	0.900
	170890005	69.7	66	0.959	66	0.956	66	0.953	66	0.953	64	0.923	64	0.923	62	0.895
	170971007	79.3	61	0.772	61	0.774	64	0.813	73	0.923	60	0.759	68	0.868	54	0.684
	171110001	69.7	65	0.940	65	0.946	66	0.951	66	0.951	64	0.927	64	0.927	62	0.902
	171132003	70.3	64	0.921	65	0.925	64	0.920	64	0.920	62	0.893	62	0.893	61	0.876
	171150013	71.3	65	0.912	65	0.917	64	0.906	64	0.906	64	0.900	64	0.900	62	0.881
	171170002	71.3	62	0.882	63	0.886	62	0.871	62	0.871	59	0.839	59	0.839	57	0.807
	171190008	77	69	0.897	68	0.894	68	0.888	68	0.888	65	0.853	65	0.853	63	0.827
	171191009	78.3	68	0.872	68	0.873	68	0.876	68	0.876	65	0.833	65	0.833	62	0.792
	171193007	76.7	68	0.897	68	0.894	68	0.888	68	0.888	65	0.853	65	0.853	63	0.828
	171199991	76			67	0.892	67	0.882	67	0.882	63	0.842	63	0.842	61	0.803
	171430024	61.7	57	0.925	57	0.925	57	0.924	57	0.924	55	0.899	55	0.899	54	0.878
	171431001	70.7	65	0.925	65	0.925	65	0.924	65	0.924	63	0.899	63	0.899	62	0.878
	171570001	67.7	63	0.932	63	0.932	60	0.887	60	0.887	58	0.857	58	0.857	56	0.830
	171613002	58.3	54	0.941	54	0.938	54	0.938	54	0.938	53	0.920	53	0.920	52	0.897
	171630010	74.7	66	0.888	66	0.888	65	0.880	65	0.880	61	0.826	61	0.826	57	0.772
	171670014	72			64	0.897	64	0.890	64	0.890	62	0.864	62	0.864	60	0.839
	171971011	64	60	0.943	60	0.943	60	0.943	60	0.943	58	0.919	58	0.919	57	0.892
	172012001	67.3	63	0.938	62	0.934	62	0.933	62	0.933	61	0.909	61	0.909	59	0.889
IL Max			**69**	**0.959**	**69**	**0.961**	**68**	**0.953**	**73**	**0.953**	**66**	**0.930**	**71**	**0.931**	**65**	**0.910**
IN	180030002	68.3	61	0.900	61	0.898	61	0.906	61	0.906	59	0.868	59	0.868	56	0.830
	180030004	69.3	62	0.904	62	0.898	62	0.908	62	0.908	60	0.868	60	0.868	57	0.834
	180110001	72.3	65	0.902	65	0.903	65	0.905	65	0.905	61	0.853	61	0.853	59	0.822
	180150002	69	63	0.918	62	0.906	63	0.918	63	0.918	61	0.890	61	0.890	59	0.862
	180190008	78	70	0.898	69	0.890	69	0.887	69	0.887	65	0.840	65	0.840	61	0.794
	180350010	68.7	60	0.882	60	0.879	61	0.890	61	0.890	57	0.837	57	0.837	55	0.801

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	180390007	67.7	62	0.919	61	0.915	61	0.912	61	0.912	59	0.881	59	0.881	57	0.852
	180431004	76	67	0.884	67	0.886	66	0.872	66	0.872	64	0.843	64	0.843	60	0.792
	180550001	77	70	0.921	70	0.920	71	0.925	71	0.925	66	0.860	66	0.860	65	0.848
	180570006	71	63	0.894	63	0.890	63	0.890	63	0.890	59	0.839	59	0.839	57	0.806
	180590003	66.7	59	0.890	58	0.883	60	0.901	60	0.901	56	0.844	56	0.844	53	0.808
	180630004	67	59	0.888	59	0.891	60	0.899	60	0.899	57	0.861	57	0.861	55	0.824
	180690002	65	59	0.909	58	0.907	59	0.919	59	0.919	56	0.874	56	0.874	54	0.834
	180710001	66	59	0.908	59	0.903	60	0.913	60	0.913	56	0.852	56	0.852	54	0.827
	180810002	69	61	0.894	61	0.896	62	0.901	62	0.901	59	0.855	59	0.855	57	0.826
	180839991	73			66	0.916	66	0.917	66	0.917	61	0.849	61	0.849	61	0.840
	180890022	66.7	58	0.883	57	0.862	58	0.884	61	0.924	56	0.847	61	0.923	53	0.801
	180890030	69.7	61	0.878	60	0.873	62	0.890	65	0.934	59	0.857	63	0.916	57	0.819
	180892008	68	59	0.878	59	0.873	60	0.890	63	0.934	58	0.857	62	0.916	55	0.819
	180910005	79.3	69	0.882	69	0.882	72	0.909	73	0.924	68	0.868	71	0.901	65	0.826
	180910010	69.7	62	0.902	62	0.902	64	0.919	64	0.925	60	0.867	62	0.900	57	0.822
	180950010	68.3	60	0.880	60	0.879	60	0.889	60	0.889	57	0.843	57	0.843	55	0.805
	180970050	72.7	65	0.894	64	0.893	66	0.909	66	0.909	61	0.844	61	0.844	58	0.806
	180970057	69	61	0.899	61	0.897	62	0.911	62	0.911	60	0.874	60	0.874	58	0.846
	180970073	72	64	0.897	64	0.894	65	0.914	65	0.914	61	0.859	61	0.859	59	0.825
	180970078	69.7	62	0.899	62	0.897	63	0.911	63	0.911	60	0.874	60	0.874	59	0.847
	181090005	69	61	0.887	60	0.880	61	0.897	61	0.897	59	0.862	59	0.862	56	0.823
	181230009	72.7	67	0.935	67	0.925	67	0.927	67	0.927	57	0.789	57	0.789	55	0.766
	181270024	70.3	61	0.881	61	0.873	63	0.896	64	0.917	59	0.853	62	0.895	56	0.807
	181270026	63	57	0.909	57	0.908	58	0.921	58	0.921	56	0.895	56	0.895	54	0.864
	181290003	70.3	64	0.920	64	0.917	64	0.923	64	0.923	60	0.860	60	0.860	58	0.835
	181410010	62.7	58	0.931	58	0.926	58	0.931	58	0.931	56	0.894	56	0.894	54	0.861
	181410015	69.3	63	0.916	63	0.919	63	0.923	63	0.923	61	0.889	61	0.889	60	0.866
	181411007	64	58	0.916	58	0.919	59	0.923	59	0.923	56	0.889	56	0.889	55	0.867
	181450001	74	65	0.885	65	0.889	67	0.908	67	0.908	63	0.862	63	0.862	61	0.830
	181630013	71.7	65	0.916	65	0.915	65	0.920	65	0.920	60	0.850	60	0.850	59	0.826
	181630021	74	67	0.918	67	0.914	68	0.928	68	0.928	63	0.856	63	0.856	61	0.831
	181670018	65.7	58	0.889	58	0.885	59	0.905	59	0.905	54	0.830	54	0.830	52	0.801
	181670024	64	56	0.880	56	0.878	57	0.905	57	0.905	52	0.817	52	0.817	50	0.791
	181730008	71	66	0.938	66	0.935	66	0.938	66	0.938	62	0.883	62	0.883	61	0.865
	181730009	69.7	64	0.931	64	0.927	64	0.923	64	0.923	61	0.881	61	0.881	59	0.859
	181730011	71	66	0.938	66	0.937	66	0.940	66	0.940	61	0.866	61	0.866	60	0.847
IN Max			**70**	**0.938**	**70**	**0.937**	**72**	**0.940**	**73**	**0.940**	**68**	**0.895**	**71**	**0.923**	**65**	**0.867**
KY	210130002	63.3	56	0.898	57	0.901	56	0.889	56	0.889	54	0.858	54	0.858	52	0.829
	210150003	68	61	0.905	61	0.902	61	0.905	61	0.905	57	0.838	57	0.838	55	0.812
	210190017	70	63	0.902	62	0.897	61	0.878	61	0.878	58	0.840	58	0.840	57	0.817
	210290006	72.3	66	0.913	65	0.909	64	0.897	64	0.897	63	0.877	63	0.877	60	0.837
	210373002	76.7	68	0.890	68	0.894	66	0.868	66	0.868	63	0.830	63	0.830	60	0.793
	210430500	67	60	0.896	59	0.894	58	0.873	58	0.873	54	0.814	54	0.814	53	0.802
	210470006	70.7	62	0.887	62	0.887	62	0.883	62	0.883	55	0.783	55	0.783	54	0.771
	210590005	76.3	71	0.939	71	0.935	71	0.936	71	0.936	62	0.825	62	0.825	61	0.803
	210610501	72	63	0.887	64	0.897	63	0.887	63	0.887	59	0.824	59	0.824	57	0.793
	210670012	71.3	63	0.890	63	0.885	63	0.888	63	0.888	60	0.844	60	0.844	57	0.812
	210890007	69.7	63	0.904	62	0.901	62	0.899	62	0.899	58	0.844	58	0.844	57	0.821
	210910012	73.7	69	0.946	69	0.940	69	0.940	69	0.940	61	0.830	61	0.830	59	0.811
	210930006	70.3	63	0.900	62	0.893	62	0.889	62	0.889	60	0.861	60	0.861	58	0.825
	211010014	76.3	71	0.932	70	0.930	71	0.932	71	0.932	65	0.855	65	0.855	63	0.835
	211110027	77	69	0.901	68	0.896	68	0.894	68	0.894	65	0.850	65	0.850	62	0.805
	211110051	77.3	70	0.915	70	0.909	69	0.898	69	0.898	66	0.859	66	0.859	62	0.812
	211110067	82	74	0.909	74	0.904	73	0.899	73	0.899	70	0.855	70	0.855	66	0.807
	211130001	70	63	0.901	62	0.896	61	0.882	61	0.882	60	0.867	60	0.867	59	0.844
	211390003	72.3	67	0.935	67	0.938	66	0.924	66	0.924	64	0.894	64	0.894	63	0.880
	211451024	73.7	69	0.942	70	0.953	69	0.949	69	0.949	66	0.907	66	0.907	65	0.893
	211850004	82	71	0.875	71	0.872	71	0.876	71	0.876	67	0.826	67	0.826	63	0.779
	211930003	65.3	62	0.954	62	0.952	58	0.901	58	0.901	56	0.867	56	0.867	55	0.852
	211950002	65.7	64	0.977	64	0.981	58	0.897	58	0.897	56	0.866	56	0.866	56	0.852
	211990003	66.7	58	0.882	59	0.886	57	0.859	57	0.859	55	0.829	55	0.829	54	0.816
	212130004	69.3	60	0.877	61	0.883	61	0.881	61	0.881	56	0.818	56	0.818	54	0.779
	212218001	69	61	0.895	62	0.902	61	0.889	61	0.889	58	0.853	58	0.853	57	0.839
	212270008	64	56	0.886	57	0.892	56	0.887	56	0.887	52	0.816	52	0.816	50	0.784

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	212299991	69			61	0.890	61	0.889	61	0.889	59	0.857	59	0.857	57	0.826
KY Max			**74**	**0.977**	**74**	**0.981**	**73**	**0.949**	**73**	**0.949**	**70**	**0.907**	**70**	**0.907**	**66**	**0.893**
LA	220150008	77.3	73	0.957	73	0.957	72	0.941	72	0.941	70	0.914	70	0.914	68	0.891
	220170001	74.7	72	0.968	72	0.968	70	0.938	70	0.938	68	0.912	68	0.912	66	0.890
	220730004	63.3	60	0.961	60	0.955	58	0.925	58	0.925	57	0.901	57	0.901	55	0.871
LA Max			**73**	**0.968**	**73**	**0.968**	**72**	**0.941**	**72**	**0.941**	**70**	**0.914**	**70**	**0.914**	**68**	**0.891**
MI	260050003	82.7	74	0.898	75	0.910	75	0.907	75	0.908	73	0.888	73	0.886	70	0.854
	260190003	73	66	0.906	66	0.906	66	0.915	67	0.918	65	0.893	65	0.892	63	0.866
	260210014	79.7	72	0.904	72	0.912	72	0.908	73	0.918	71	0.903	71	0.892	69	0.868
	260270003	76.7	70	0.916	70	0.924	70	0.917	70	0.917	67	0.881	67	0.881	65	0.849
	260330901	63.5	59	0.944	59	0.945	61	0.962	58	0.923	53	0.844	57	0.908	50	0.792
	260370001	69.3	63	0.915	63	0.912	64	0.924	64	0.924	61	0.882	61	0.882	58	0.840
	260490021	73	66	0.908	66	0.908	66	0.917	66	0.917	64	0.883	64	0.883	60	0.834
	260492001	72.3	65	0.904	65	0.905	65	0.907	65	0.907	62	0.871	62	0.871	59	0.827
	260630007	71.3	64	0.901	64	0.909	64	0.911	64	0.907	62	0.883	63	0.884	60	0.849
	260650012	70.3	64	0.914	63	0.909	64	0.921	64	0.921	61	0.872	61	0.872	58	0.831
	260770008	73.7	67	0.912	67	0.916	67	0.918	67	0.918	64	0.881	64	0.881	62	0.849
	260810020	73	66	0.907	66	0.906	66	0.915	66	0.915	64	0.883	64	0.883	61	0.837
	260810022	72.7	65	0.895	65	0.900	66	0.910	66	0.910	63	0.877	63	0.877	59	0.823
	260910007	75.5	67	0.896	67	0.896	67	0.896	67	0.896	65	0.869	65	0.869	63	0.837
	260990009	76.7	70	0.922	70	0.921	70	0.925	70	0.917	69	0.909	67	0.879	67	0.881
	260991003	77.3	71	0.930	71	0.925	70	0.918	70	0.918	68	0.888	68	0.888	66	0.855
	261010922	72.3	66	0.917	66	0.917	66	0.924	66	0.922	64	0.897	64	0.891	62	0.869
	261050007	73.3	66	0.909	66	0.909	67	0.921	67	0.921	65	0.896	65	0.896	63	0.869
	261130001	68.3	63	0.923	62	0.915	63	0.931	63	0.931	61	0.898	61	0.898	59	0.871
	261210039	79.7	73	0.917	73	0.918	73	0.917	72	0.914	71	0.896	70	0.888	68	0.857
	261250001	76.3	70	0.924	70	0.924	70	0.918	70	0.918	67	0.889	67	0.889	65	0.860
	261390005	76	68	0.907	68	0.907	69	0.917	69	0.917	67	0.888	67	0.888	64	0.847
	261470005	75.3	69	0.917	69	0.920	69	0.918	68	0.908	68	0.909	65	0.875	66	0.881
	261530001	71.7	67	0.935	66	0.926	67	0.938	67	0.938	64	0.901	64	0.901	62	0.876
	261610008	73.3	66	0.907	66	0.903	66	0.904	66	0.904	63	0.871	63	0.871	62	0.849
	261630001	71.7	64	0.899	65	0.907	64	0.899	64	0.899	62	0.876	62	0.876	60	0.841
	261630019	78.7	72	0.921	72	0.925	73	0.935	73	0.935	71	0.904	71	0.904	68	0.870
MI Max			**74**	**0.944**	**75**	**0.945**	**75**	**0.962**	**75**	**0.938**	**73**	**0.909**	**73**	**0.908**	**70**	**0.881**
MN	270031001	67	62	0.940	62	0.940	63	0.952	63	0.952	61	0.925	61	0.925	60	0.897
	270031002	66.3	64	0.974	64	0.974	64	0.966	64	0.966	62	0.939	62	0.939	60	0.916
	270177416	55.5			-8	-9	-8	-9	-8	-9	-8	-9	-8	-9		
	270495302	62.5	60	0.967	60	0.974	60	0.970	60	0.970	59	0.952	59	0.952	58	0.936
	270750005	58	57	0.998	-8	-9	57	0.999	57	0.999	-8	-9	-8	-9		
	271095008	63.5	61	0.966	61	0.969	61	0.973	61	0.973	61	0.961	61	0.961	58	0.920
	271370034	61.3			-8	-9	-8	-9	-8	-9	-8	-9	-8	-9		
	271377550	49.7	46	0.943	46	0.944	47	0.947	47	0.956	45	0.920	50	1.008	44	0.887
	271390505	63.5	61	0.971	61	0.973	61	0.973	61	0.973	-8	-9	-8	-9		
	271713201	63.5	61	0.965	61	0.965	61	0.965	61	0.965	-8	-9	-8	-9		
MN Max			**64**	**0.998**	**64**	**0.974**	**64**	**0.999**	**64**	**0.999**	**62**	**0.961**	**62**	**1.008**	**60**	**0.936**
MO	290190011	69	66	0.958	66	0.958	66	0.967	66	0.967	63	0.927	63	0.927	62	0.900
	290270002	67.7	64	0.957	64	0.957	64	0.958	64	0.958	62	0.925	62	0.925	60	0.886
	290390001	71.7	71	0.997	71	0.998	71	0.999	71	0.999	-8	-9	-8	-9		
	290770036	69.3	65	0.945	65	0.945	65	0.952	65	0.952	63	0.917	63	0.917	60	0.877
	290770042	71.7	67	0.945	67	0.945	68	0.952	68	0.952	65	0.917	65	0.917	62	0.877
	290990019	76.3	67	0.879	67	0.879	66	0.874	66	0.874	64	0.840	64	0.840	60	0.792
	291130003	77	67	0.877	67	0.877	67	0.872	67	0.872	64	0.834	64	0.834	61	0.801
	291370001	68.7	66	0.964	66	0.964	65	0.949	65	0.949	62	0.915	62	0.915	61	0.894
	291570001	74.3	68	0.917	68	0.917	67	0.909	67	0.909	65	0.880	65	0.880	63	0.855
	291831002	82.3	72	0.881	72	0.881	72	0.881	72	0.881	69	0.847	69	0.847	67	0.814
	291831004	77.7	66	0.861	66	0.861	67	0.874	67	0.874	65	0.843	65	0.843	62	0.799
	291860005	72.3	64	0.897	64	0.897	64	0.893	64	0.893	62	0.868	62	0.868	60	0.835
	291890005	71.7	121	1.738	121	1.738	121	1.751	121	1.751	118	1.704	118	1.704	116	1.632
	291890014	79	131	1.712	131	1.712	130	1.706	130	1.706	126	1.651	126	1.651	122	1.557
	292130004	69	67	0.971	67	0.971	67	0.981	67	0.981	65	0.955	65	0.955	65	0.942
	295100085	75.7	65	0.863	65	0.863	65	0.861	65	0.861	62	0.821	62	0.821	58	0.772
MO Max			**72**	**0.997**	**72**	**0.998**	**72**	**0.999**	**72**	**0.999**	**69**	**0.955**	**69**	**0.955**	**67**	**0.942**
MS	280110001	71.7	69	0.965	69	0.969	69	0.962	69	0.962	67	0.943	67	0.943	66	0.933
	280330002	72.3	64	0.897	64	0.897	63	0.874	63	0.874	60	0.841	60	0.841	58	0.811

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	280490010	67	58	0.867	58	0.871	58	0.867	58	0.867	55	0.823	55	0.823	52	0.784
	280750003	62.7	57	0.918	57	0.909	56	0.905	56	0.905	54	0.867	54	0.867	52	0.842
	280810005	65	56	0.874	57	0.885	56	0.869	56	0.869	54	0.842	54	0.842	52	0.811
	281619991	63			58	0.925	57	0.917	57	0.917	55	0.883	55	0.883	55	0.879
MS Max			**69**	**0.965**	**69**	**0.969**	**69**	**0.962**	**69**	**0.962**	**67**	**0.943**	**67**	**0.943**	**66**	**0.933**
NC	370030004	66.7	59	0.890	59	0.895	58	0.877	58	0.877	54	0.820	54	0.820	52	0.784
	370110002	63.3	56	0.890	56	0.898	56	0.890	56	0.890	54	0.862	54	0.862	53	0.837
	370119991	63			55	0.879	54	0.864	54	0.864	53	0.842	53	0.842	51	0.813
	370210030	66.7	57	0.861	57	0.860	56	0.844	56	0.844	53	0.796	53	0.796	50	0.759
	370270003	66	57	0.874	57	0.878	57	0.870	57	0.870	53	0.806	53	0.806	50	0.767
	370330001	70.7	60	0.863	61	0.866	60	0.858	60	0.858	56	0.803	56	0.803	54	0.764
	370370004	64	55	0.875	55	0.874	54	0.854	54	0.854	50	0.792	50	0.792	48	0.756
	370510008	68.7	59	0.862	59	0.866	58	0.846	58	0.846	54	0.797	54	0.797	52	0.758
	370511003	70.7	60	0.857	60	0.855	59	0.843	59	0.843	54	0.770	54	0.770	51	0.733
	370590003	71	62	0.882	62	0.880	62	0.874	62	0.874	57	0.807	57	0.807	55	0.780
	370630015	70	58	0.840	58	0.838	58	0.836	58	0.836	54	0.773	54	0.773	51	0.729
	370650099	70	61	0.879	61	0.878	60	0.868	60	0.868	57	0.824	57	0.824	55	0.791
	370670022	75.3	65	0.875	65	0.875	65	0.871	65	0.871	62	0.830	62	0.830	59	0.796
	370670028	69.7	61	0.886	62	0.891	61	0.878	61	0.878	59	0.850	59	0.850	56	0.815
	370670030	72.7	63	0.869	63	0.872	62	0.864	62	0.864	60	0.830	60	0.830	57	0.796
	370671008	72.3	63	0.873	63	0.874	62	0.863	62	0.863	59	0.817	59	0.817	56	0.782
	370690001	69.3	59	0.865	59	0.864	58	0.848	58	0.848	55	0.795	55	0.795	52	0.756
	370750001	70.3	64	0.914	64	0.918	63	0.900	63	0.900	60	0.868	60	0.868	59	0.839
	370770001	70.7	65	0.922	65	0.921	62	0.891	62	0.891	59	0.837	59	0.837	56	0.802
	370810013	74	63	0.858	63	0.857	62	0.850	62	0.850	59	0.807	59	0.807	56	0.768
	370870008	61			56	0.920	54	0.894	54	0.894	53	0.876	53	0.876	52	0.853
	370870036	67.7	61	0.905	61	0.904	60	0.898	60	0.898	58	0.865	58	0.865	56	0.839
	370990005	67			59	0.894	60	0.898	60	0.898	57	0.860	57	0.860	55	0.833
	371010002	71.7	61	0.854	61	0.853	59	0.836	59	0.836	55	0.772	55	0.772	52	0.728
	371070004	67.7	60	0.887	59	0.885	59	0.880	59	0.880	55	0.827	55	0.827	54	0.799
	371090004	72.7	64	0.883	64	0.888	63	0.867	63	0.867	59	0.821	59	0.821	57	0.785
	371170001	66.3	58	0.887	58	0.886	58	0.887	58	0.887	55	0.843	55	0.843	53	0.807
	371190041	80	68	0.850	67	0.849	68	0.850	68	0.850	65	0.825	65	0.825	63	0.788
	371191005	75	64	0.860	64	0.859	64	0.856	64	0.856	62	0.832	62	0.832	59	0.797
	371191009	79.7	65	0.826	65	0.824	64	0.813	64	0.813	62	0.780	62	0.780	58	0.739
	371239991	66			56	0.856	55	0.843	55	0.843	52	0.792	52	0.792	49	0.750
	371290002	63	54	0.859	55	0.875	52	0.840	52	0.831	47	0.760	48	0.770	45	0.727
	371450003	71	70	0.986	69	0.983	66	0.940	66	0.940	62	0.880	62	0.880	60	0.848
	371470006	69.7	62	0.897	62	0.895	61	0.884	61	0.884	57	0.827	57	0.827	55	0.798
	371570099	71	63	0.890	62	0.886	61	0.870	61	0.870	60	0.854	60	0.854	58	0.821
	371590021	75.3	65	0.869	65	0.868	64	0.857	64	0.857	59	0.792	59	0.792	56	0.752
	371590022	75	64	0.862	64	0.855	63	0.851	63	0.851	60	0.806	60	0.806	57	0.764
	371730002	60.7	55	0.906	54	0.906	54	0.898	54	0.898	52	0.869	52	0.869	51	0.842
	371790003	71	59	0.842	59	0.841	59	0.845	59	0.845	57	0.808	57	0.808	54	0.769
	371830014	70.3	60	0.858	60	0.857	58	0.833	58	0.833	54	0.775	54	0.775	50	0.724
	371830016	73	62	0.862	63	0.870	61	0.837	61	0.837	57	0.787	57	0.787	54	0.743
	371990004	69.7	61	0.883	61	0.880	60	0.871	60	0.871	57	0.829	57	0.829	55	0.801
NC Max			**70**	**0.986**	**69**	**0.983**	**68**	**0.940**	**68**	**0.940**	**65**	**0.880**	**65**	**0.880**	**63**	**0.853**
OH	390030009	73	65	0.896	65	0.895	65	0.901	65	0.901	63	0.866	63	0.866	61	0.837
	390071001	77.3	68	0.880	67	0.869	68	0.892	68	0.892	66	0.858	67	0.876	60	0.783
	390090004	69	61	0.899	62	0.902	61	0.895	61	0.895	58	0.854	58	0.854	57	0.829
	390170004	77	68	0.891	68	0.890	68	0.885	68	0.885	65	0.846	65	0.846	62	0.808
	390170018	79.7	71	0.891	71	0.896	69	0.877	69	0.877	66	0.835	66	0.835	63	0.794
	390179991	77			67	0.880	68	0.886	68	0.886	63	0.826	63	0.826	61	0.799
	390230001	75	66	0.882	65	0.880	66	0.881	66	0.881	62	0.830	62	0.830	59	0.791
	390230003	74	65	0.879	64	0.870	64	0.876	64	0.876	61	0.829	61	0.829	58	0.789
	390250022	78.7	67	0.858	67	0.857	66	0.851	66	0.851	63	0.805	63	0.805	60	0.765
	390271002	78.7	67	0.859	67	0.859	67	0.859	67	0.859	63	0.804	63	0.804	60	0.765
	390350034	77.7	67	0.866	67	0.865	68	0.885	70	0.907	65	0.844	64	0.833	60	0.783
	390350060	68.5	60	0.883	60	0.882	62	0.916	62	0.916	58	0.857	60	0.880	55	0.803
	390350064	70	63	0.902	63	0.900	64	0.920	65	0.934	61	0.883	63	0.900	58	0.830
	390355002	76.7	66	0.864	66	0.863	67	0.884	69	0.912	61	0.803	67	0.874	56	0.739
	390410002	73	64	0.880	64	0.877	64	0.883	64	0.883	61	0.846	61	0.846	59	0.810
	390479991	72			61	0.859	62	0.865	62	0.865	58	0.819	58	0.819	56	0.778

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	390490029	80.3	72	0.899	71	0.895	71	0.888	71	0.888	68	0.848	68	0.848	64	0.801
	390490037	75	66	0.886	66	0.883	65	0.877	65	0.877	63	0.846	63	0.846	59	0.797
	390490081	71	63	0.893	63	0.890	62	0.885	62	0.885	60	0.851	60	0.851	57	0.804
	390550004	74.7	66	0.891	66	0.893	67	0.899	67	0.899	64	0.869	64	0.869	61	0.819
	390570006	73	63	0.867	63	0.864	63	0.870	63	0.870	59	0.821	59	0.821	56	0.780
	390610006	82	73	0.898	74	0.904	72	0.884	72	0.884	68	0.834	68	0.834	65	0.794
	390610010	76.3	68	0.893	68	0.893	67	0.881	67	0.881	64	0.843	64	0.843	62	0.815
	390610040	78.7	70	0.900	71	0.903	69	0.878	69	0.878	65	0.838	65	0.838	63	0.801
	390810017	70.3	64	0.912	63	0.904	64	0.911	64	0.911	60	0.863	60	0.863	58	0.834
	390830002	73.7	65	0.884	64	0.880	64	0.881	64	0.881	62	0.843	62	0.843	59	0.801
	390850003	80	67	0.842	67	0.843	69	0.872	72	0.903	64	0.801	67	0.848	58	0.730
	390850007	71.7	61	0.857	60	0.850	63	0.891	64	0.901	59	0.826	61	0.860	54	0.763
	390870011	65	58	0.902	58	0.898	58	0.895	58	0.895	53	0.823	53	0.823	52	0.800
	390870012	70	63	0.904	63	0.901	62	0.899	62	0.899	59	0.844	59	0.844	57	0.820
	390890005	74.3	65	0.878	64	0.874	65	0.879	65	0.879	62	0.837	62	0.837	58	0.791
	390930018	71.7	60	0.845	60	0.843	61	0.860	65	0.920	59	0.831	63	0.886	54	0.764
	390950024	68	59	0.880	59	0.875	59	0.882	60	0.892	58	0.856	58	0.853	54	0.807
	390950027	66.7	60	0.901	59	0.899	60	0.906	60	0.906	58	0.874	58	0.874	55	0.834
	390950034	73.7	63	0.855	62	0.854	64	0.869	65	0.888	61	0.841	62	0.849	58	0.788
	390970007	74.3	64	0.872	64	0.873	65	0.883	65	0.883	61	0.828	61	0.828	58	0.789
	390990013	70.7	63	0.900	63	0.896	63	0.903	63	0.903	61	0.873	61	0.873	57	0.808
	391030004	69			61	0.898	62	0.908	62	0.908	60	0.871	60	0.871	56	0.823
	391090005	73.3	64	0.886	64	0.882	65	0.888	65	0.888	61	0.845	61	0.845	59	0.810
	391130037	76.7	66	0.873	66	0.868	66	0.871	66	0.871	63	0.829	63	0.829	60	0.790
	391331001	68.3	61	0.895	61	0.895	61	0.903	61	0.903	60	0.880	60	0.880	54	0.802
	391351001	72.3	64	0.889	64	0.895	65	0.899	65	0.899	61	0.850	61	0.850	59	0.820
	391510016	76.7	68	0.889	67	0.884	68	0.899	68	0.899	66	0.873	66	0.873	61	0.807
	391510022	72	64	0.896	64	0.894	65	0.903	65	0.903	62	0.868	62	0.868	58	0.811
	391514005	72.3	64	0.890	64	0.890	65	0.899	65	0.899	62	0.866	62	0.866	57	0.795
	391530020	72	65	0.905	64	0.901	65	0.910	65	0.910	63	0.879	63	0.879	58	0.806
	391550009	71	63	0.892	63	0.892	63	0.899	63	0.899	61	0.862	61	0.862	56	0.800
	391550011	76.3	68	0.895	68	0.894	68	0.901	68	0.901	65	0.864	65	0.864	61	0.801
	391650007	77.7	67	0.870	67	0.866	67	0.865	67	0.865	63	0.820	63	0.820	60	0.777
	391670004	71.3	60	0.850	60	0.843	61	0.868	61	0.868	56	0.793	56	0.793	56	0.785
	391730003	71.3	64	0.899	63	0.897	64	0.902	64	0.902	62	0.872	62	0.872	59	0.837
OH Max			**73**	**0.912**	**74**	**0.904**	**72**	**0.920**	**72**	**0.934**	**68**	**0.883**	**68**	**0.900**	**65**	**0.837**
SC	450010001	62	53	0.866	53	0.865	53	0.868	53	0.868	49	0.801	49	0.801	47	0.761
	450030003	64.3	55	0.862	55	0.865	55	0.867	55	0.867	50	0.792	50	0.792	48	0.761
	450070005	70	59	0.848	59	0.847	60	0.863	60	0.863	55	0.787	55	0.787	52	0.743
	450150002	62.3	55	0.899	55	0.898	56	0.901	56	0.901	51	0.833	51	0.833	49	0.796
	450190046	64.7	58	0.899	60	0.939	59	0.913	57	0.885	54	0.837	53	0.834	52	0.816
	450250001	64.3	56	0.873	56	0.871	56	0.878	56	0.878	53	0.832	53	0.832	51	0.798
	450290002	61	54	0.888	53	0.885	53	0.880	53	0.880	49	0.811	49	0.811	47	0.780
	450310003	68	59	0.876	59	0.873	59	0.872	59	0.872	55	0.822	55	0.822	53	0.787
	450370001	61.3	52	0.863	52	0.863	53	0.868	53	0.868	50	0.822	50	0.822	48	0.785
	450450016	68	57	0.840	57	0.839	58	0.853	58	0.853	53	0.787	53	0.787	50	0.740
	450451003	65.3	55	0.855	55	0.857	55	0.857	55	0.857	52	0.803	52	0.803	49	0.755
	450770002	69.7	59	0.857	60	0.869	60	0.870	60	0.870	56	0.815	56	0.815	53	0.772
	450790007	67.5	57	0.854	58	0.862	57	0.855	57	0.855	53	0.792	53	0.792	50	0.741
	450790021	60	51	0.858	51	0.863	51	0.863	51	0.863	47	0.796	47	0.796	44	0.748
	450791001	71.7	61	0.854	61	0.862	61	0.855	61	0.855	56	0.792	56	0.792	53	0.741
	450830009	73.7	63	0.858	63	0.855	62	0.853	62	0.853	58	0.795	58	0.795	54	0.744
	450910006	64	54	0.857	55	0.864	54	0.856	54	0.856	51	0.811	51	0.811	49	0.770
SC Max			**63**	**0.899**	**63**	**0.939**	**62**	**0.913**	**62**	**0.901**	**58**	**0.837**	**58**	**0.834**	**54**	**0.816**
TN	470010101	70.7	61	0.868	61	0.872	60	0.861	60	0.861	58	0.823	58	0.823	55	0.779
	470090101	76.7	66	0.872	66	0.869	66	0.865	66	0.865	63	0.828	63	0.828	60	0.791
	470090102	66.3	57	0.870	57	0.873	56	0.860	56	0.860	54	0.823	54	0.823	52	0.784
	470259991	62			55	0.892	54	0.878	54	0.878	51	0.839	51	0.839	49	0.805
	470370011	65.7	57	0.875	57	0.874	57	0.882	57	0.882	54	0.836	54	0.836	52	0.792
	470370026	70.3	61	0.878	61	0.874	62	0.882	62	0.882	58	0.832	58	0.832	55	0.791
	470651011	72.3	63	0.875	63	0.876	62	0.870	62	0.870	58	0.813	58	0.813	55	0.773
	470654003	73.3	63	0.869	63	0.865	62	0.859	62	0.859	58	0.804	58	0.804	55	0.759
	470890002	74.7	64	0.861	64	0.861	64	0.862	64	0.862	60	0.810	60	0.810	57	0.766
	470930021	69	60	0.870	59	0.869	59	0.864	59	0.864	56	0.826	56	0.826	54	0.783

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	470931020	71.7	61	0.859	61	0.857	61	0.854	61	0.854	58	0.819	58	0.819	55	0.771
	471050109	72.3	63	0.883	63	0.885	62	0.871	62	0.871	60	0.835	60	0.835	57	0.794
	471210104	71.3	62	0.876	62	0.876	61	0.869	61	0.869	58	0.817	58	0.817	55	0.776
	471490101	68.5	59	0.871	59	0.871	60	0.880	60	0.880	55	0.817	55	0.817	53	0.775
	471550101	74.3	65	0.878	65	0.881	65	0.885	65	0.885	62	0.843	62	0.843	60	0.809
	471570021	76.7	68	0.887	68	0.887	66	0.869	66	0.869	63	0.831	63	0.831	61	0.799
	471570075	78			68	0.880	67	0.862	67	0.862	64	0.831	64	0.831	61	0.792
	471571004	75	65	0.879	66	0.885	64	0.864	64	0.864	61	0.826	61	0.826	59	0.787
	471632002	71.7	64	0.905	64	0.904	62	0.866	62	0.866	62	0.871	62	0.871	61	0.854
	471632003	70.3	63	0.909	63	0.908	60	0.865	60	0.865	61	0.870	61	0.870	59	0.851
	471650007	76.7	66	0.873	66	0.870	67	0.876	67	0.876	63	0.823	63	0.823	59	0.778
	471650101	73	63	0.867	63	0.865	64	0.885	64	0.885	59	0.814	59	0.814	56	0.774
	471870106	70.3	60	0.866	60	0.866	61	0.872	61	0.872	57	0.822	57	0.822	54	0.780
	471890103	71.7	62	0.878	62	0.878	63	0.893	63	0.893	59	0.825	59	0.825	56	0.792
	500070007	61			-8	-9	55	0.907	55	0.907	53	0.881	53	0.881	51	0.849
TN Max			**68**	**0.909**	**68**	**0.908**	**67**	**0.907**	**67**	**0.907**	**64**	**0.881**	**64**	**0.881**	**61**	**0.854**
TX	482030002	72.7	71	0.989	71	0.989	68	0.939	68	0.939	-8	-9	-8	-9		
TX Max			**71**	**0.989**	**71**	**0.989**	**68**	**0.939**	**68**	**0.939**	**-8**	**-9**	**-8**	**-9**		
VA (Non - OTR)	510030001	66.7	59	0.893	59	0.891	59	0.890	59	0.890	56	0.846	56	0.846	54	0.811
	510330001	71.7	63	0.888	63	0.885	62	0.878	62	0.878	59	0.836	59	0.836	56	0.791
	510360002	75.7	67	0.887	66	0.884	66	0.876	66	0.876	61	0.808	61	0.808	59	0.789
	510410004	72	64	0.896	64	0.894	64	0.890	64	0.890	60	0.841	60	0.841	58	0.815
	510610002	62.7	56	0.896	56	0.894	55	0.885	55	0.885	53	0.861	53	0.861	51	0.825
	510690010	66.7	59	0.885	58	0.882	58	0.870	58	0.870	55	0.832	55	0.832	53	0.801
	510719991	63			57	0.909	56	0.897	56	0.897	55	0.882	55	0.882	54	0.865
	510850003	73.7	64	0.878	64	0.875	65	0.884	65	0.884	59	0.813	59	0.813	57	0.783
	510870014	75	66	0.891	66	0.888	67	0.894	67	0.894	61	0.817	61	0.817	59	0.793
	511130003	70.7	64	0.916	64	0.915	64	0.907	64	0.907	62	0.878	62	0.878	60	0.852
	511390004	66.3	60	0.912	60	0.911	60	0.906	60	0.906	58	0.876	58	0.876	56	0.849
	511479991	62			56	0.919	56	0.906	56	0.906	52	0.851	52	0.851	51	0.829
	511611004	67.3	61	0.910	61	0.912	60	0.901	60	0.901	58	0.873	58	0.873	56	0.844
	511630003	62.3	58	0.937	58	0.935	56	0.915	56	0.915	55	0.892	55	0.892	54	0.870
	511650003	66	60	0.914	60	0.913	60	0.909	60	0.909	57	0.875	57	0.875	56	0.849
	511790001	73	63	0.871	63	0.864	62	0.861	64	0.878	59	0.809	62	0.850	55	0.753
	511970002	64.3	59	0.925	59	0.920	58	0.917	58	0.917	56	0.878	56	0.878	54	0.849
	516500008	74	67	0.912	67	0.907	66	0.903	64	0.870	64	0.877	59	0.805	62	0.841
	518000004	71.3	66	0.939	67	0.944	66	0.929	62	0.882	63	0.895	59	0.837	60	0.854
	518000005	69.7	62	0.895	62	0.893	61	0.881	61	0.881	58	0.839	58	0.839	56	0.809
VA Max			**67**	**0.939**	**67**	**0.944**	**67**	**0.929**	**67**	**0.917**	**64**	**0.895**	**62**	**0.892**	**62**	**0.870**
WI	550030010	58.3			55	0.950	56	0.969	-8	-9	56	0.977	-8	-9	56	0.969
	550090026	68.3	61	0.902	62	0.912	62	0.911	63	0.935	58	0.855	62	0.911	55	0.810
	550210015	67	63	0.947	63	0.950	63	0.950	63	0.950	61	0.922	61	0.922	60	0.903
	550250041	66.3	61	0.934	62	0.943	61	0.934	61	0.934	60	0.906	60	0.906	58	0.881
	550270001	71.5	66	0.927	67	0.938	66	0.935	66	0.935	64	0.909	64	0.909	63	0.884
	550290004	75.7	67	0.894	67	0.892	68	0.907	69	0.923	66	0.883	67	0.886	64	0.849
	550350014	62			58	0.949	58	0.947	58	0.947	57	0.928	57	0.928	56	0.910
	550390006	70	65	0.930	65	0.941	65	0.934	65	0.934	64	0.919	64	0.919	62	0.896
	550410007	64.7			-8	-9	60	0.940	60	0.940	59	0.920	59	0.920	58	0.898
	550550002	68.5	64	0.936	64	0.948	64	0.942	64	0.942	62	0.908	62	0.908	60	0.886
	550590019	81	63	0.789	62	0.767	68	0.843	73	0.913	61	0.760	63	0.787	55	0.683
	550610002	75	67	0.900	67	0.901	68	0.910	69	0.922	67	0.897	67	0.903	64	0.865
	550630012	63.3	60	0.948	60	0.958	60	0.948	60	0.948	59	0.944	59	0.944	58	0.921
	550710007	78.7	71	0.911	71	0.913	72	0.918	72	0.922	70	0.902	71	0.908	68	0.872
	550730012	63.3	59	0.934	59	0.939	59	0.937	59	0.937	57	0.914	57	0.914	57	0.902
	550790010	69.7	59	0.853	58	0.846	60	0.871	65	0.936	57	0.826	61	0.889	53	0.766
	550790026	74.7	65	0.871	64	0.870	66	0.884	70	0.947	63	0.844	68	0.922	58	0.789
	550790085	80	70	0.881	70	0.881	71	0.892	75	0.942	69	0.863	73	0.923	65	0.818
	550870009	69.3	64	0.932	64	0.934	64	0.934	64	0.934	63	0.912	63	0.912	61	0.887
	550890008	76.3	71	0.932	71	0.940	71	0.936	71	0.936	68	0.899	69	0.905	65	0.861
	550890009	74.7	68	0.920	68	0.915	69	0.930	69	0.932	67	0.901	67	0.901	64	0.866
	551010017	77.7	64	0.827	63	0.820	66	0.851	71	0.916	61	0.797	63	0.811	56	0.727
	551050024	69.5	64	0.934	64	0.933	64	0.935	64	0.935	63	0.910	63	0.910	61	0.885
	551110007	65	62	0.954	62	0.959	61	0.946	61	0.946	60	0.931	60	0.931	59	0.915
	551170006	84.3	77	0.916	77	0.920	77	0.921	77	0.921	74	0.886	76	0.906	71	0.849

St.	AQS Code	DVC	Alpha		Alpha 2		Beta 2				Gamma					
			2018		2018		2017				2020				2023	
			EPA Guidance		EPA Guidance		EPA Guidance		Less Water		EPA Guidance		Less Water		EPA Guidance	
			DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF	DVF	RRF
	551199991	63			-8	-9	59	0.942	59	0.942	-8	-9	-8	-9		
	551250001	62			-8	-9	58	0.951	58	0.951	-8	-9	-8	-9		
	551270005	69.3	65	0.938	65	0.946	65	0.949	65	0.949	64	0.931	64	0.931	63	0.909
	551330027	66.7	62	0.933	62	0.934	62	0.940	62	0.940	60	0.903	60	0.903	58	0.874
WI Max			**77**	**0.954**	**77**	**0.959**	**77**	**0.969**	**77**	**0.951**	**74**	**0.977**	**76**	**0.944**	**71**	**0.969**
WV	540030003	68	60	0.886	59	0.882	59	0.872	59	0.872	57	0.840	57	0.840	55	0.809
	540110006	69.3	62	0.897	61	0.894	60	0.879	60	0.879	58	0.840	58	0.840	56	0.815
	540219991	60			56	0.944	54	0.903	54	0.903	51	0.862	51	0.862	50	0.848
	540250003	64.7	59	0.927	59	0.924	59	0.919	59	0.919	57	0.891	57	0.891	56	0.872
	540291004	73	67	0.921	66	0.917	67	0.920	67	0.920	64	0.883	64	0.883	62	0.851
	540390010	72.3	68	0.942	67	0.935	66	0.920	66	0.920	61	0.850	61	0.850	60	0.837
	540610003	69.7	64	0.922	64	0.918	63	0.904	63	0.904	60	0.871	60	0.871	60	0.861
	540690010	72.3	64	0.894	64	0.890	65	0.901	65	0.901	61	0.848	61	0.848	59	0.824
	541071002	68.3	58	0.862	59	0.876	58	0.863	58	0.863	56	0.826	56	0.826	55	0.814
WV Max			**68**	**0.942**	**67**	**0.944**	**67**	**0.920**	**67**	**0.920**	**64**	**0.891**	**64**	**0.891**	**62**	**0.872**

Section 12. Projected Visibility Impairment in the MANE-VU Region

Calculation Techniques

For the projections based on the Alpha 2 modeling visibility was calculated using the MATSv2.6.1 visibility tool using the “Revised” IMPROVE calculation for extinction coefficient based on the translations shown in Table 12-1 as had been recommended in EPA guidance during the first planning period (US EPA 2014; Pitchford et al. 2007).

Table 12-1: Model Input for MATS

Model Data Input for MATS	Description	Formula with CMAQ v5.02 PM SPECIES
CM	Coarse PM	ASOIL + ACORS + ASEACAT + ACLK + ASO4K + ANO3K + ANH4K
CRUSTAL	Crustal PM	2.20AALJ + 2.49ASIJ + 1.63ACAJ + 2.42AFEJ + 1.94ATIJ
SO4	Sulfate PM	ASO4I + ASO4J
EC	Elemental Carbon	AECI + AECJ
NO3	Nitrate PM	ANO3I + ANO3J
OC	Organic Mass PM	AXYL1J + AXYL2J + AXYL3J + ATOL1J + ATOL2J + ATOL3J + ABNZ1J + ABNZ2J + ABNZ3J + AISO1J + AISO2J + AISO3J + ATRP1J + ATRP2J + ASQTJ + AALKJ + AORGCJ + AOLGBJ + AOLGAJ + APOCI + APOCJ + APNCOMI + APNCOMJ

In the case of the projections based on the Gamma modeling, visibility was calculated using SMAT-CE v.1.2. This tool is EPA’s replacement to MATS. At this point SMAT-CE is in Beta, but MATS will not be updated with the “RHR III” IMPROVE calculation algorithms that are necessary to calculate the 20% most impaired days. The translations used in SMAT-CE can be found in Table 12-2.

Table 12-2: Model Input for SMAT-CE

Model Data Input for SMAT-CE	Description	Formula with CMAQ v5.2.1 PM SPECIES
CRUSTAL	Crustal PM	2.20*AALJ+2.49*ASIJ+1.63*ACAJ+2.42*AFEJ+1.94*ATIJ
NH4	Ammonium	ANH4I+ANH4J
SO4	Sulfate	ASO4I+ASO4J
EC	Elemental carbon	AECI+AECJ
NO3	Nitrate	ANO3I+ANO3J
OC	Organic Mass PM	ALVPO1I+ASVPO1I+ASVPO2I+ALVPO1J+ASVPO1J+ASVPO2J+ASVPO3J+AIVPO1J+ALVOO1I+ALVOO2I+ASVOO1I+ASVOO2I+AXYL1J+AXYL2J+AXYL3J+ATOL1J+ATOL2J+ATOL3J+ABNZ1J+ABNZ2J+ABNZ3J+AISO1J+AISO2J+AISO3J+ATRP1J+ATRP2J+ASQTJ+AALK1J+AALK2J+APAH1J+APAH2J+APAH3J+AORGCJ+AOLGBJ+AOLGAJ+ALVOO1J+ALVOO2J+ASVOO1J+ASVOO2J+ASVOO3J+APCSOJ
PM25	PM2.5	SO4+NO3+NH4+EC+OC+ANAI+ACLI+AOTHRI+ANAJ+ACLJ+AOTHRJ+AFEJ+ASIJ+ATIJ+ACAJ+AMGJ+AMNJ+AALJ+AKJ-CRUSTAL
CM	Coarse PM	ASOIL+ACORS+ASEACAT+ACLK+ASO4K+ANO3K+ANH4K

Results

The next section will review the results from both the Alpha 2 and Gamma 2028 modeling exercises. In many of the tables and charts the abbreviations for each Class I area will be used. The list of Class I area abbreviations is found in Table 12-3.

Table 12-3: Class I areas in modeling domain

RPO	ID	State	Class I Area	RPO	ID	State	Class I Area
MANE-VU	ACAD	ME	Acadia National Park	SESARM	MACA	KY	Mammoth Cave National Park
MANE-VU	BRIG	NJ	Edwin B. Forsythe National Wildlife Refuge (Brigantine)	SESARM	OTCR	WV	Otter Creek Wilderness
MANE-VU	GRGU	NH	Great Gulf Wilderness	SESARM	ROMA	SC	Cape Romain National Wildlife Refuge
MANE-VU	LYBR	VT	Lye Brook Wilderness	SESARM	SHEN	VA	Shenandoah National Park
MANE-VU	MOOS	ME	Moosehorn Wilderness	SESARM	SIPS	AL	Sipsey Wilderness
MANE-VU	PRRA	NH	Presidential Range-Dry River Wilderness	SESARM	SWAN	NC	Swanquarter National Wildlife Refuge
MANE-VU	ROCA	ME	Roosevelt-Campobello International Park	LADCO	BOWA	MN	Boundary Waters Wilderness
SESARM	COHU	GA	Cohutta Wilderness	LADCO	ISLE	MI	Isle Royale National Park
SESARM	DOSO	WV	Dolly Sodds Wilderness	LADCO	SENE	MI	Seney National Wildlife Refuge
SESARM	GRSM	TN	Great Smoky Mountains National Park	CENSARA	CACR	AR	Caney Creek Wilderness
SESARM	JARI	VA	James River Face Wilderness	CENSARA	HEGL	MO	Hercules-Glades Wilderness
SESARM	JOYC	TN	Joyce Kilmer-Slickrock Wilderness	CENSARA	MING	MO	Mingo National Wildlife Refuge
SESARM	LIGO	NC	Linville Gorge Wilderness	CENSARA	UPBU	AR	Upper Buffalo Wilderness

Alpha 2 Results

The first step in calculating future projected visibility is to calculate the RRFs for each of the constituent PM species that affect visibility. RRFs were calculated separately for 20% best and 20% worst days (it should be noted that Alpha 2 modeling was completed prior to the requirement to rely on the RHR III metric; Gamma modeling to be discussed later will rely on the new metric). The RRF results can be seen in Figure 12-1. On worst visibility days SO_4 concentrations were projected to decrease and on best visibility days it was projected to decrease less, except at Moosehorn and Roosevelt Campobello, where increases were projected. Concerning NO_3, all sites were projected to stay at roughly the same level in 2028 on worst visibility days, except Lye Brook where decreases were more, and there was much variation on best visibility days, with levels projected to almost double at Acadia. Decreases in Elemental Carbon were projected on both best and worst days and Organic Carbon and Crustal components were projected to stay relatively unchanged. Coarse mass was projected to increase at nearly every site on both best and worst days, with increases of up nearly 650% on best visibility days at Acadia. More detailed RRF results, including all Class I areas in the modeling domain, are in Table 12-4.

Figure 12-1: Relative Response Factor (RRF) of PM Species at each MANE-VU Class I area on 20% best and worst days

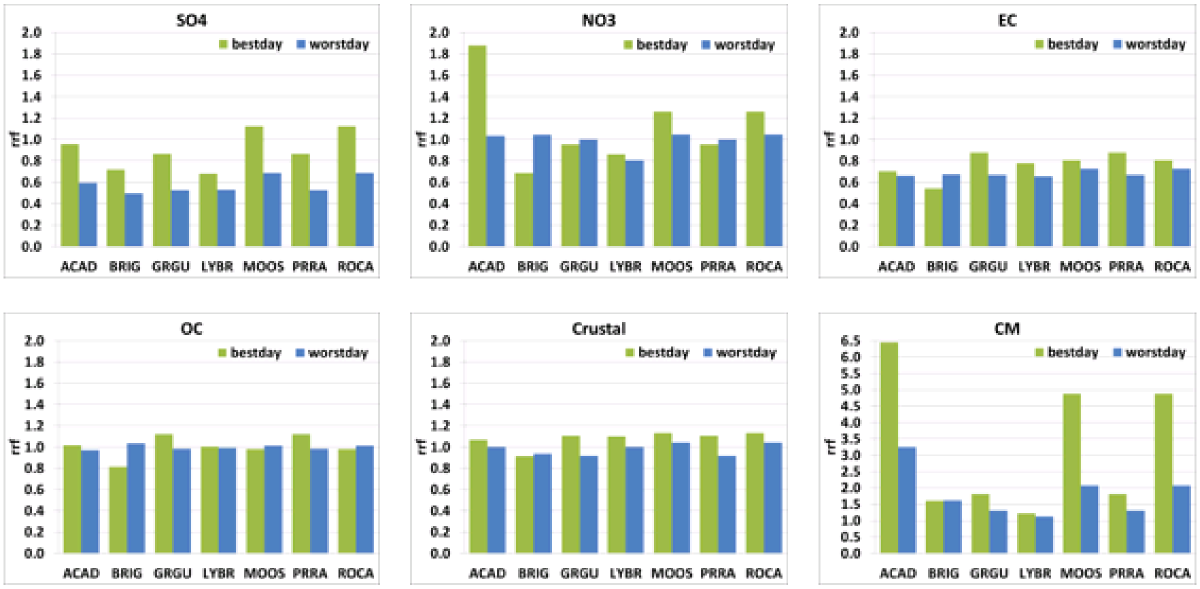


Table 12-4: RRFs of visibility-impairing constituent PM species 20% worst and best days at Class I areas in OTC modeling domain for 2028 Alpha 2 base case modeling

			RRF 20% Worst						RRF 20% Best					
RPO	ID	State	SO_4	NO_3	EC	OC	Crustal	CM	SO_4	NO_3	EC	OC	Crustal	CM
MANE-VU	**ACAD**	**ME**	0.5936	1.0349	0.6612	0.9715	0.9989	3.2418	0.9588	1.8805	0.7067	1.0189	1.0684	6.4513
MANE-VU	**BRIG**	**NJ**	0.4968	1.0451	0.6738	1.0361	0.9395	1.6117	0.7216	0.6886	0.5448	0.8149	0.9137	1.6087
MANE-VU	**GRGU**	**NH**	0.5265	0.9994	0.6685	0.9838	0.9159	1.3099	0.8677	0.9556	0.8802	1.1223	1.1088	1.8138
MANE-VU	**LYBR**	**VT**	0.5314	0.8069	0.6548	0.9902	0.999	1.1216	0.6799	0.8624	0.7809	1.0025	1.1009	1.2262
MANE-VU	**MOOS**	**ME**	0.6891	1.0491	0.7279	1.0147	1.0435	2.0729	1.1247	1.2597	0.8081	0.982	1.1331	4.8745
MANE-VU	**PRRA**	**NH**	0.5265	0.9994	0.6685	0.9838	0.9159	1.3099	0.8677	0.9556	0.8802	1.1223	1.1088	1.8138
MANE-VU	**ROCA**	**ME**	0.6891	1.0491	0.7279	1.0147	1.0435	2.0729	1.1247	1.2597	0.8081	0.982	1.1331	4.8745
SESARM	**DOSO**	**WV**	0.465	1.1132	0.6219	0.88	0.9637	0.996	0.6723	1.128	0.7253	0.9688	1.0167	1.1986
SESARM	**GRSM**	**TN**	0.5613	0.9843	0.6001	0.8707	1.0206	0.9911	0.6676	0.5573	0.4773	0.8429	0.8659	0.8533
SESARM	**JARI**	**VA**	0.5149	0.7984	0.4364	0.9372	1.011	1.0209	0.6798	0.9832	0.5043	1.0198	0.9924	1.172
SESARM	**JOYC**	**TN**	0.5613	0.9843	0.6001	0.8707	1.0206	0.9911	0.6676	0.5573	0.4773	0.8429	0.8659	0.8533
SESARM	**LIGO**	**NC**	0.5154	0.5067	0.5689	0.8969	1.0124	1.109	0.6258	0.766	0.5881	0.9116	0.8759	0.8669
SESARM	**MACA**	**KY**	0.5938	0.9557	0.5364	0.9459	0.9868	0.9699	0.7348	0.7904	0.5883	1.0214	1.0227	1.037
SESARM	**OTCR**	**WV**	0.465	1.1132	0.6219	0.88	0.9637	0.996	0.6723	1.128	0.7253	0.9688	1.0167	1.1986
SESARM	**ROMA**	**SC**	0.5152	1.2723	0.6107	0.8481	0.9202	3.1282	0.7082	1.1699	0.7113	0.9458	1.0434	4.5063
SESARM	**SHEN**	**VA**	0.5055	0.4532	0.5425	0.8864	1.024	1.0491	0.7957	0.6941	0.7234	1.0046	1.1232	1.3039
SESARM	**SIPS**	**AL**	0.5791	0.8634	0.7375	0.953	0.9949	1.0546	0.7505	0.8917	0.7234	0.9406	0.973	0.9695
SESARM	**SWAN**	**NC**	0.4778	0.3008	0.5913	0.8386	0.9384	1.6576	0.7138	0.6598	0.6571	0.9609	0.9253	1.9612
LADCO	**ISLE**	**MI**	0.6098	0.8387	0.7153	1.0102	0.8808	0.8658	1.2009	1.7449	0.9792	1.1827	0.8711	0.856
LADCO	**SENE**	**MI**	0.6477	0.8878	0.7976	1.1487	0.9925	1.0275	0.7895	0.9373	0.6625	0.8726	0.7572	0.836
CENSARA	**CACR**	**AR**	0.9412	0.998	0.8518	1.0018	1.0904	0.9921	0.9815	1.1709	0.8116	1.0938	1.1017	1.2265
CENSARA	**HEGL**	**MO**	0.7723	0.8303	1.0917	1.2895	1.0092	1.0657	1.0538	0.9821	0.8139	1.3097	1.1519	1.1172
CENSARA	**UPBU**	**AR**	0.9176	0.8747	0.9825	1.1774	0.9972	0.9928	0.9817	1.0095	0.6637	0.7716	1.0391	0.9785

As you can see in Figure 12-2 visibility is projected to improve at all of the MANE-VU Class I areas on the 20% worst days. The 20% best days at the Class I areas in Maine are projected to see slight degradation in visibility condition by 2028, and the remainder of the Class I areas in MANE-VU are projected to improve on the best 20% days as well. More details on the deciviews results, including all Class I areas in the modeling domain, are in Table 12-5.

Figure 12-2: Projected change in visibility (deciviews) from 2011 to 2028 at MANE-VU Class I areas

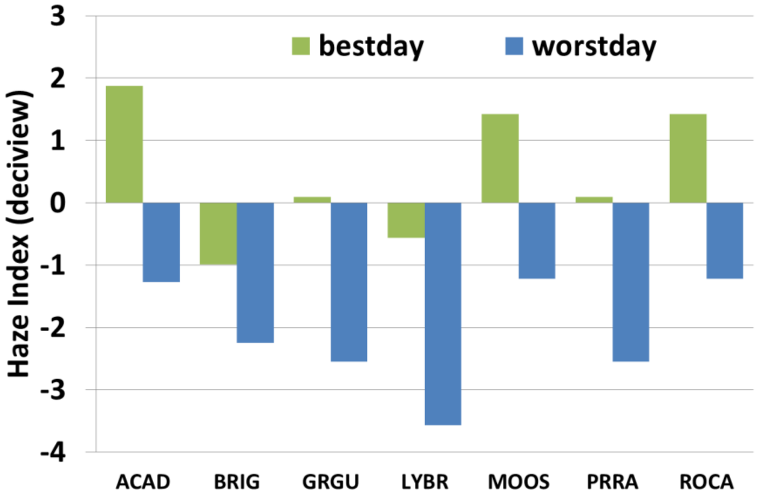


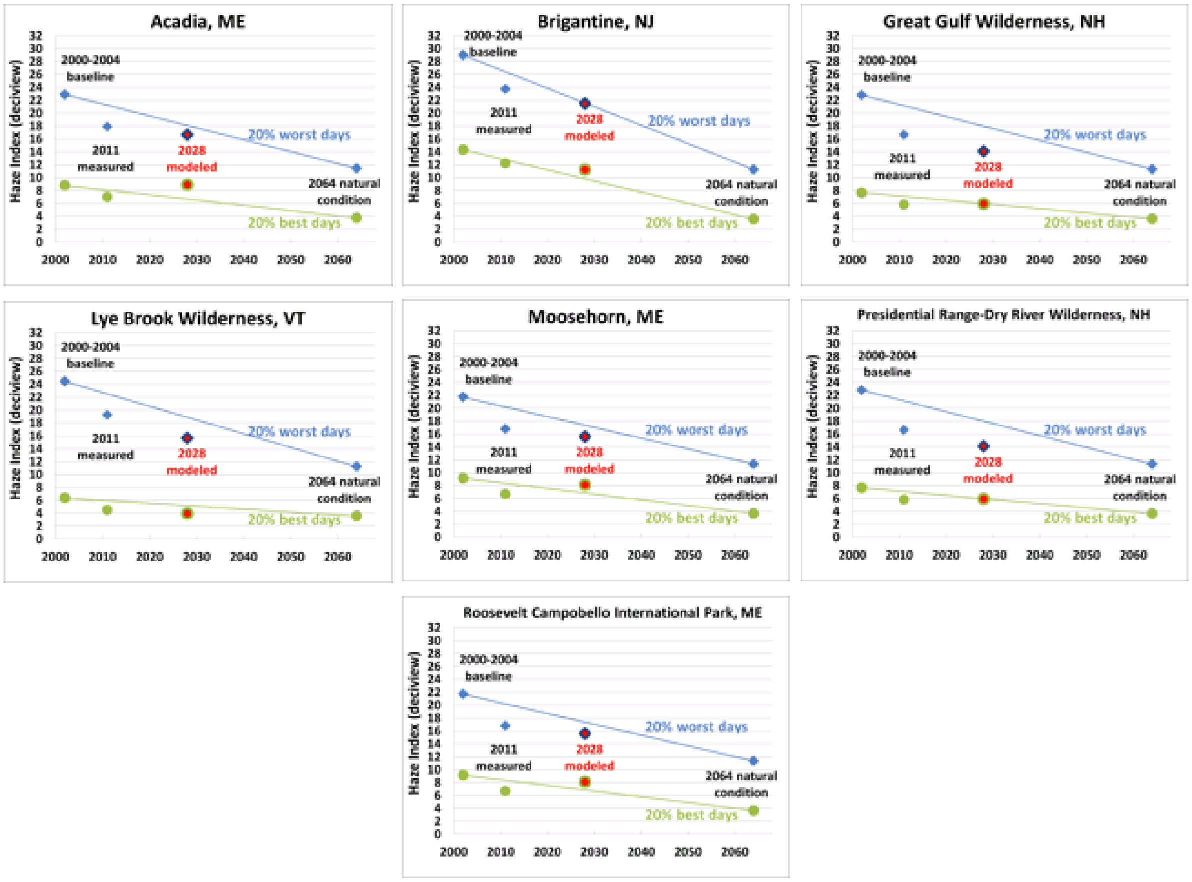
Table 12-5: 2000-2004 baseline, 2011 monitored, and 2028 modeled visibility impairment (deciviews) on 20% worst and best days at Class I areas in OTC modeling domain

			2000-2004		2011		2028 Projection	
RPO	ID	State	Worst 20%	Best 20%	Worst 20%	Best 20%	Worst 20%	Best 20%
MANE-VU	ACAD	ME	22.89	8.78	17.93	7.02	16.66	8.9
MANE-VU	BRIG	NJ	29.01	14.33	23.75	12.25	21.5	11.26
MANE-VU	GRGU	NH	22.82	7.66	16.66	5.86	14.11	5.95
MANE-VU	LYBR	VT	24.45	6.37	19.26	4.53	15.69	3.97
MANE-VU	MOOS	ME	21.72	9.16	16.83	6.7	15.61	8.12
MANE-VU	PRRA	NH	22.82	7.66	16.66	5.86	14.11	5.95
MANE-VU	ROCA	ME	21.72	9.16	16.83	6.7	15.61	8.12
SESARM	DOSO	WV	29.05	12.28	22.4	9.03	16.96	7.86
SESARM	GRSM	TN	30.28	13.58	22.5	10.63	18.42	8.51
SESARM	JARI	VA	29.12	14.21	22.55	11.79	18.36	10.33
SESARM	JOYC	TN	30.28	13.58	22.5	10.63	18.42	8.51
SESARM	LIGO	NC	28.77	11.11	21.6	9.7	17.15	7.89
SESARM	MACA	KY	31.37	16.51	25.09	13.69	21.54	12.17
SESARM	OTCR	WV	29.05	12.28	22.4	9.03	16.96	7.86
SESARM	ROMA	SC	26.48	14.29	23.17	13.59	20.61	14.48
SESARM	SHEN	VA	29.31	10.93	21.82	8.6	16.71	7.68
SESARM	SIPS	AL	29.03	15.57	22.93	12.84	19.6	11.53
SESARM	SWAN	NC	25.49	12.95	21.77	11.74	17.43	11.2
LADCO	ISLE	MI	20.74	6.77	18.92	5.4	16.64	5.91
LADCO	SENE	MI	24.16	7.14	20.56	5.51	18.67	4.95
CENSARA	CACR	AR	26.36	11.24	22.23	9.74	21.86	10.07
CENSARA	HEGL	MO	26.75	12.84	22.89	10.96	21.98	11.51
CENSARA	UPBU	AR	26.27	11.71	22.12	9.92	21.81	9.48

All seven Class I areas in the MANE-VU region are projected to be below the URP on 20% worst visibility days in 2028 as seen in Figure 12-3, excepting Brigantine which is projected to fall on the URP. From 2011 to 2028 projected visibility improvement in MANE-VU varies between 1.2 deciviews and 3.6 deciviews on the 20% worst visibility days.

On the 20% best visibility days, nearly every site is projected to be at or below the 2000-2004 baseline, excepting Acadia, which is projected to experience a slight uptick.

Figure 12-3: Visibility conditions (deciviews), measured (2000-2004, 2011), modeled (2028), and interpolated (2064), at MANE-VU Class I areas



Gamma Results

As with the Alpha 2 results we began by calculating the relative response factors (RRFs) for each of the constituent PM species that affect visibility. RRFs are species-specific average relative change between base year and future year in modeled species concentration for the observed 20% clearest days and 20% most impaired days based on the IMRPOVE data. The RRF results can be seen in Figure 12-4 and more detailed results, including all Class I areas in the modeling domain, for the base case are in Table 12-6 and the control case in Table 12-7.

On the 20% most impaired visibility days SO_4 concentrations were projected to decrease (RRF=0.5~0.6 for MANEVU Class I areas) and on the 20% clearest visibility days SO_4 concentrations were projected to decrease less (RRF=0.6~0.9 for MANEVU Class I areas). The control case modeling showed slightly more improvement (up to 0.02 lower in RRF) in SO_4 concentrations on both the most impaired and the clearest days. Concerning NO_3, nearly all sites were projected to decrease, with smaller decreases on the most impaired days, with the exception at Moosehorn and Roosevelt-Campobello which saw slight increases in NO_3 on the clearest days. Like with SO_4, small improvements in NO_3 concentrations occurred in the control case. Decreases near 50% in Elemental Carbon were projected on both clearest and most impaired days. Decreases were also projected for Organic Carbon on both clearest and most impaired days, but at a lower magnitude than Elemental Carbon. Crustal components and coarse mass were projected to stay relatively unchanged.

Figure 12-4: Relative Response Factor (RRF) of PM Species at each MANE-VU Class I area and nearby sites on 20% clearest and most impaired days for base and control case modeling

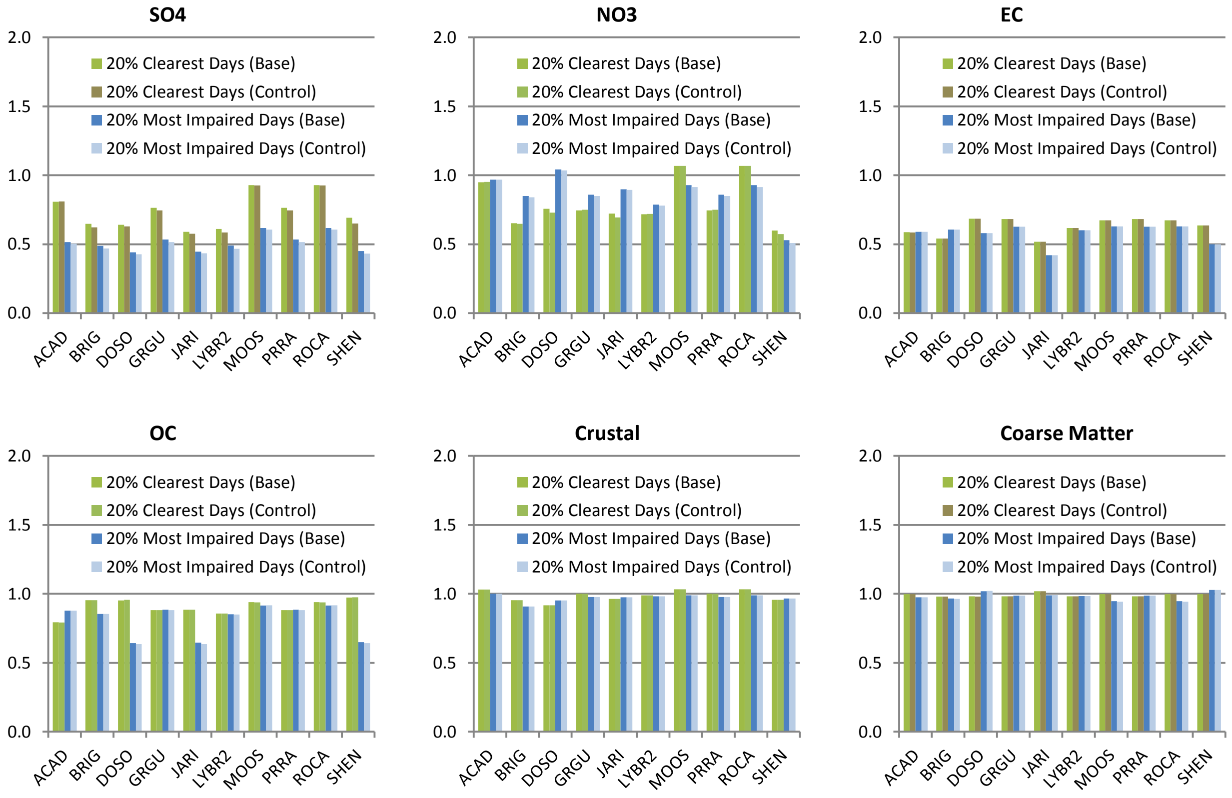


Table 12-6: RRFs of visibility-impairing constituent PM species 20% most impaired and 20% clearest days at Class I areas in OTC modeling domain for 2028 Gamma base case modeling

			RRF 20% Most Impaired						**RRF 20% Clearest**					
RPO	ID	State	SO_4	NO_3	EC	OC	Crustal	CM	SO_4	NO_3	EC	OC	Crustal	CM
MANE-VU	**ACAD**	**ME**	0.52	0.97	0.59	0.88	1.00	0.98	0.81	0.95	0.59	0.79	1.03	1.00
MANE-VU	**BRIG**	**NJ**	0.49	0.85	0.61	0.85	0.91	0.96	0.65	0.65	0.54	0.95	0.95	0.98
MANE-VU	**GRGU**	**NH**	0.53	0.86	0.63	0.88	0.98	0.99	0.76	0.75	0.68	0.88	1.00	0.98
MANE-VU	**LYBR**	**VT**	0.49	0.79	0.60	0.85	0.98	0.98	0.61	0.72	0.62	0.86	0.99	0.98
MANE-VU	**MOOS**	**ME**	0.62	0.93	0.63	0.91	0.99	0.95	0.93	1.07	0.67	0.94	1.03	1.00
MANE-VU	**PRRA**	**NH**	0.53	0.86	0.63	0.88	0.98	0.99	0.76	0.75	0.68	0.88	1.00	0.98
MANE-VU	**ROCA**	**ME**	0.62	0.93	0.63	0.91	0.99	0.95	0.93	1.07	0.67	0.94	1.03	1.00
SESARM	**COHU**	**GA**	0.41	0.49	0.50	0.66	1.03	1.11	0.62	0.58	0.57	0.91	1.05	1.06
SESARM	**DOSO**	**WV**	0.44	1.04	0.58	0.64	0.95	1.02	0.64	0.76	0.69	0.95	0.92	0.98
SESARM	**GRSM**	**TN**	0.41	0.86	0.54	0.62	1.03	1.07	0.62	0.62	0.52	0.94	1.05	1.10
SESARM	**JARI**	**VA**	0.45	0.90	0.42	0.65	0.97	0.99	0.59	0.72	0.52	0.88	0.96	1.02
SESARM	**JOYC**	**TN**	0.41	0.86	0.54	0.62	1.03	1.07	0.62	0.62	0.52	0.94	1.05	1.10
SESARM	**LIGO**	**NC**	0.42	0.74	0.53	0.67	0.99	1.02	0.61	0.69	0.58	0.94	1.03	1.07
SESARM	**MACA**	**KY**	0.56	0.76	0.46	0.79	0.95	1.09	0.63	0.70	0.49	0.94	1.00	1.08
SESARM	**OTCR**	**WV**	0.44	1.04	0.58	0.64	0.95	1.02	0.64	0.76	0.69	0.95	0.92	0.98
SESARM	**ROMA**	**SC**	0.44	0.90	0.52	0.78	0.98	1.01	0.66	0.93	0.65	0.90	1.04	1.00
SESARM	**SHEN**	**VA**	0.45	0.53	0.50	0.65	0.97	1.03	0.69	0.60	0.64	0.97	0.96	1.00
SESARM	**SIPS**	**AL**	0.54	0.67	0.57	0.77	1.04	1.07	0.73	0.80	0.74	0.95	1.08	1.06
SESARM	**SWAN**	**NC**	0.46	0.90	0.57	0.79	0.96	0.97	0.74	0.76	0.62	0.93	1.01	0.99
LADCO	**BOWA**	**MN**	0.72	0.78	0.73	0.91	0.99	1.00	0.86	0.98	0.88	0.92	0.96	0.96
LADCO	**ISLE**	**MI**	0.62	0.81	0.62	0.89	1.01	1.03	0.87	0.95	0.76	0.87	1.00	1.00
LADCO	**SENE**	**MI**	0.57	0.77	0.60	0.88	1.00	1.02	0.90	0.83	0.73	0.85	0.97	1.02
CENSARA	**CACR**	**AR**	0.83	0.87	0.64	0.84	1.06	1.16	0.99	0.99	0.71	0.93	1.13	1.20
CENSARA	**HEGL**	**MO**	0.78	0.84	0.74	0.89	1.12	1.23	0.79	1.03	0.58	0.85	1.14	1.22
CENSARA	**MING**	**MO**	0.80	0.73	0.60	0.91	1.05	1.14	0.83	0.73	0.49	0.91	1.06	1.14
CENSARA	**UPBU**	**AR**	0.76	0.86	0.73	0.88	1.08	1.19	0.89	1.01	0.80	0.93	1.10	1.19

Table 12-7: RRFs of visibility-impairing constituent PM species 20% most impaired and clearest days at Class I areas in OTC modeling domain for 2028 Gamma control case modeling

			RRF 20% Most Impaired						RRF 20% Clearest					
RPO	ID	State	SO_4	NO_3	EC	OC	Crustal	CM	SO_4	NO_3	EC	OC	Crustal	CM
MANE-VU	**ACAD**	**ME**	0.50	0.97	0.59	0.88	1.00	0.98	0.81	0.95	0.59	0.79	1.03	1.00
MANE-VU	**BRIG**	**NJ**	0.47	0.84	0.61	0.86	0.91	0.96	0.62	0.65	0.54	0.95	0.95	0.98
MANE-VU	**GRGU**	**NH**	0.51	0.85	0.63	0.88	0.98	0.99	0.74	0.75	0.68	0.88	1.00	0.98
MANE-VU	**LYBR**	**VT**	0.47	0.78	0.60	0.85	0.98	0.98	0.59	0.72	0.62	0.86	0.99	0.98
MANE-VU	**MOOS**	**ME**	0.61	0.91	0.63	0.92	0.99	0.94	0.93	1.07	0.67	0.94	1.03	1.00
MANE-VU	**PRRA**	**NH**	0.51	0.85	0.63	0.88	0.98	0.99	0.74	0.75	0.68	0.88	1.00	0.98
MANE-VU	**ROCA**	**ME**	0.61	0.91	0.63	0.92	0.99	0.94	0.93	1.07	0.67	0.94	1.03	1.00
SESARM	**COHU**	**GA**	0.39	0.47	0.50	0.65	1.03	1.11	0.61	0.56	0.57	0.91	1.05	1.06
SESARM	**DOSO**	**WV**	0.43	1.04	0.58	0.64	0.95	1.02	0.63	0.73	0.69	0.96	0.92	0.98
SESARM	**GRSM**	**TN**	0.39	0.85	0.54	0.62	1.03	1.07	0.62	0.61	0.52	0.94	1.05	1.10
SESARM	**JARI**	**VA**	0.43	0.89	0.42	0.64	0.97	0.99	0.58	0.69	0.52	0.88	0.96	1.02
SESARM	**JOYC**	**TN**	0.39	0.85	0.54	0.62	1.03	1.07	0.62	0.61	0.52	0.94	1.05	1.10
SESARM	**LIGO**	**NC**	0.40	0.74	0.53	0.66	0.99	1.02	0.59	0.67	0.58	0.94	1.03	1.07
SESARM	**MACA**	**KY**	0.53	0.74	0.46	0.78	0.95	1.09	0.62	0.69	0.49	0.94	1.00	1.08
SESARM	**OTCR**	**WV**	0.43	1.04	0.58	0.64	0.95	1.02	0.63	0.73	0.69	0.96	0.92	0.98
SESARM	**ROMA**	**SC**	0.43	0.88	0.52	0.78	0.98	1.01	0.65	0.91	0.65	0.90	1.04	1.00
SESARM	**SHEN**	**VA**	0.43	0.51	0.50	0.64	0.97	1.03	0.65	0.57	0.64	0.97	0.96	1.00
SESARM	**SIPS**	**AL**	0.53	0.65	0.57	0.77	1.04	1.07	0.72	0.79	0.74	0.95	1.08	1.06
SESARM	**SWAN**	**NC**	0.44	0.88	0.57	0.79	0.96	0.97	0.71	0.76	0.62	0.93	1.01	0.99
LADCO	**BOWA**	**MN**	0.72	0.78	0.73	0.90	0.99	1.00	0.86	0.98	0.88	0.92	0.96	0.96
LADCO	**ISLE**	**MI**	0.61	0.81	0.62	0.89	1.01	1.03	0.87	0.96	0.76	0.87	1.00	1.00
LADCO	**SENE**	**MI**	0.56	0.76	0.60	0.88	1.00	1.02	0.90	0.83	0.73	0.85	0.97	1.02
CENSARA	**CACR**	**AR**	0.82	0.86	0.64	0.84	1.06	1.16	0.99	0.99	0.71	0.93	1.13	1.20
CENSARA	**HEGL**	**MO**	0.78	0.83	0.74	0.89	1.12	1.23	0.79	1.03	0.58	0.85	1.14	1.22
CENSARA	**MING**	**MO**	0.80	0.70	0.60	0.91	1.05	1.14	0.83	0.72	0.49	0.91	1.06	1.14
CENSARA	**UPBU**	**AR**	0.76	0.86	0.73	0.87	1.08	1.19	0.89	1.01	0.80	0.92	1.10	1.19

As you can see in Figure 12-5 visibility is projected to improve at all of the MANE-VU Class I areas on the 20% most impaired days. Even greater improvements are projected for the Class I areas nearby to MANE-VU in Virginia and West Virginia. The 20% clearest days at the Class I areas both inside and outside of MANE-VU are projected to improve as well, although not to the same extent as on the 20% most impaired days. The control case results in slight improvements in visibility beyond those in the base case, on both clearest and most impaired days, except during the clearest days at the Class I areas in Maine. More detailed results, including all Class I areas in the modeling domain, can be found in Table 12-8.

Figure 12-6 illustrates how the modeled 2011 and 2028 results compare to the uniform rate of progress (URP) on most impaired days, no degradation on clearest days, and the rolling 5-year average for both most impaired and clearest days. All sites in MANE-VU are modeled to be (3~6 deciviews) below the URP in 2028 for both the base and control cases. These results all show improvements in visibility occurring between the most recent 5-year most impaired day rolling average and 2028. Improvements are modeled for the best days in 2028 from the most recent 5-year best day rolling averages and all sites are projected to be well below the level that constitutes no degradation from the clearest days from 2000-2004.

Figure 12-5: Projected change in visibility (deciviews) from 2011 to 2028 at MANE-VU Class I area and nearby sites on 20% clearest and most impaired days for base and control case modeling

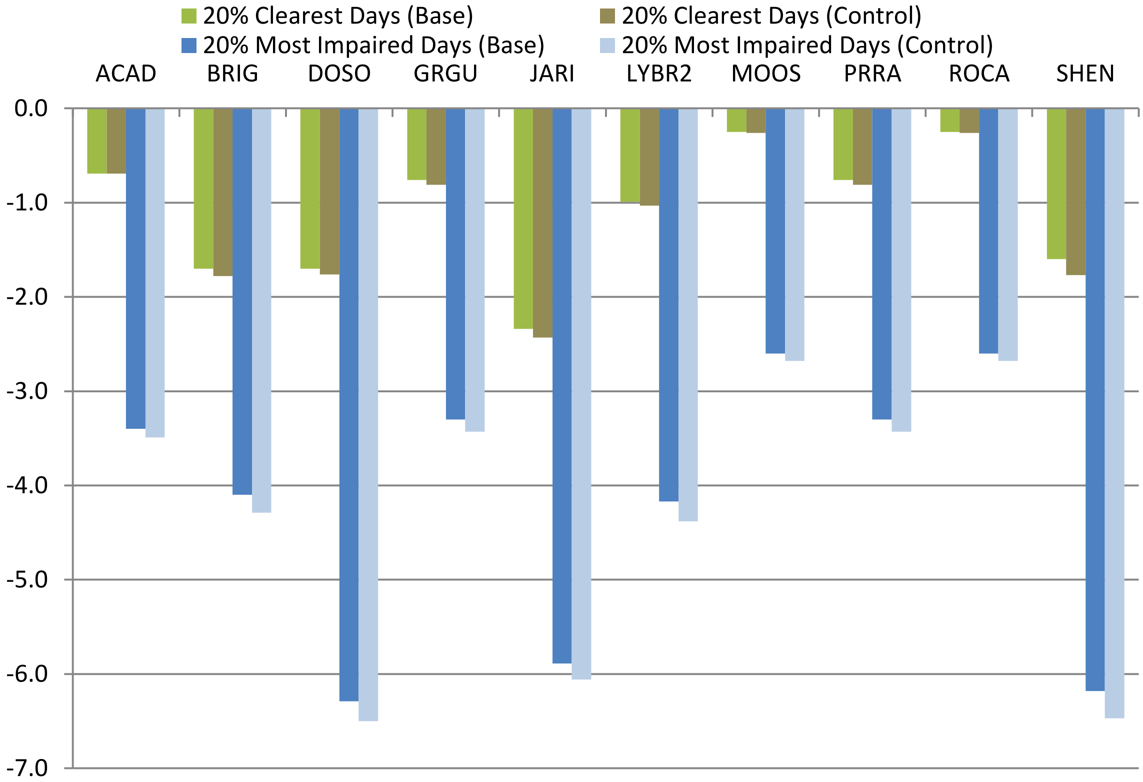
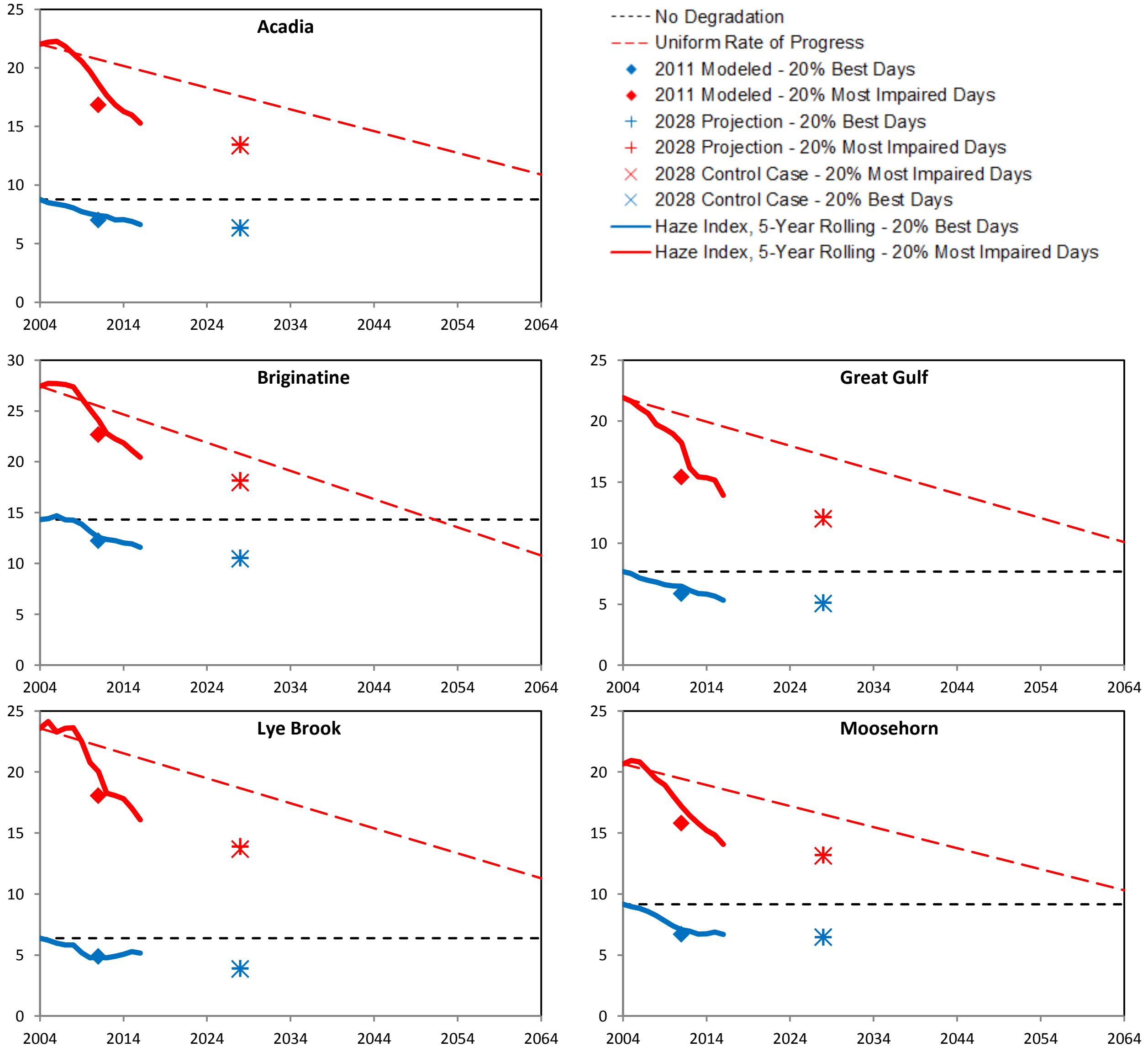


Table 12-8: 2011 monitored, 2028 base case, and 2028 control case modeled visibility impairment (deciviews) on 20% most impaired (MI) and clearest days at Class I areas in OTC modeling domain

			2011		2028 Base Projection		2028 Control Projection	
RPO	ID	State	MI 20%	Best 20%	MI 20%	Best 20%	MI 20%	Best 20%
MANE-VU	**ACAD**	**ME**	16.84	7.02	13.44	6.33	13.35	6.33
MANE-VU	**BRIG**	**NJ**	22.26	12.25	18.16	10.55	17.97	10.47
MANE-VU	**GRGU**	**NH**	15.43	5.87	12.13	5.11	12	5.06
MANE-VU	**LYBR**	**VT**	18.06	4.89	13.89	3.9	13.68	3.86
MANE-VU	**MOOS**	**ME**	15.8	6.71	13.2	6.46	13.12	6.45
MANE-VU	**PRRA**	**NH**	15.43	5.87	12.13	5.11	12	5.06
MANE-VU	**ROCA**	**ME**	15.8	6.71	13.2	6.46	13.12	6.45
SESARM	**COHU**	**GA**	21.19	10.94	14.66	8.82	14.39	8.74
SESARM	**DOSO**	**WV**	21.59	9.03	15.3	7.33	15.09	7.27
SESARM	**GRSM**	**TN**	21.39	10.63	15	8.7	14.77	8.65
SESARM	**JARI**	**VA**	21.37	11.79	15.48	9.45	15.31	9.36
SESARM	**JOYC**	**TN**	21.39	10.63	15	8.7	14.77	8.65
SESARM	**LIGO**	**NC**	20.39	9.7	14.25	7.92	13.99	7.82
SESARM	**MACA**	**KY**	24.04	13.69	19.56	11.39	19.24	11.32
SESARM	**OTCR**	**WV**	21.59	9.03	15.3	7.33	15.09	7.27
SESARM	**ROMA**	**SC**	21.48	13.59	16.28	11.96	16.15	11.9
SESARM	**SHEN**	**VA**	20.72	8.6	14.54	7	14.25	6.83
SESARM	**SIPS**	**AL**	21.67	12.84	17.11	11.43	16.87	11.39
SESARM	**SWAN**	**NC**	19.76	11.76	15.1	10.55	14.86	10.45
LADCO	**BOWA**	**MN**	16.43	4.86	14.41	4.51	14.37	4.51
LADCO	**ISLE**	**MI**	17.63	5.4	15.04	5.06	14.98	5.06
LADCO	**SENE**	**MI**	19.84	5.51	16.56	5.19	16.46	5.18
CENSARA	**CACR**	**AR**	20.87	9.74	19.3	9.69	19.26	9.69
CENSARA	**HEGL**	**MO**	21.63	10.96	19.84	10.19	19.82	10.19
CENSARA	**MING**	**MO**	22.7	12.47	20.56	11.44	20.49	11.42
CENSARA	**UPBU**	**AR**	20.52	9.95	18.69	9.69	18.65	9.69

Figure 12-6: Modeled 2011 base case, 2028 base case, and 2028 control case compared to no degradation on best days, URP on most impaired days, and 5-year rolling haze indices



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US EPA 2014, ‘Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze’, accessed from <https://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf>.

Section 13. Source Apportionment Modeling Results in the Ozone Transport Region

Overview

States are required under section 110(a)(2)(D) of the Clean Air Act to submit SIP revisions that prohibit air pollution from their state from contributing to nonattainment or interfering with maintenance of the NAAQS in a downwind state (*Clean Air Act Amendments of 1990* 1990). These SIPs, called Good Neighbor SIPs, are due three years after a NAAQS is updated, which for the 70ppb 2015 Ozone NAAQS is October 1, 2018, prior to the earliest designated attainment date for that standard.

For the 2008 Ozone NAAQS, multiple states failed to submit timely or approvable Good Neighbor SIPs. This prompted EPA to adopt the CSAPR Update rule as a FIP (US EPA 2016). EPA cautioned that the CSAPR Update was only a “partial remedy,” meaning there are still unfilled Good Neighbor obligations from upwind states beyond meeting the requirements of the CSAPR Update.

For the CSAPR Update, EPA conducted contribution assessment modeling for the year 2017, which is the year that moderate nonattainment areas are required to attain the 2008 ozone standard of 75 ppb. In addition, EPA recently conducted preliminary contribution assessment modeling for the year 2023, which is the year that any area designated as a moderate nonattainment area for the 2015 ozone NAAQS would be required to attain the 70 ppb standard.

OTC has expressed several concerns with EPA’s 2023 contribution assessment approach. Flaws identified by OTC include the use of the IPM model to project future emissions from electricity generating units instead of using the ERTAC EGU model, the use of anticipated future year emissions instead of current emissions, and the use of average ozone season contributions instead of contributions on peak days (US EPA 2017).

OTC is working to provide OTC states with this alternative assessment of 2023 modeling so that the states can consider the technical deficiencies of EPA's approach prior to the October 2018 deadline for submitting Good Neighbor SIPs for the 70 ppb ozone standard.

Tagging Methodology

The modeling runs were tagged in a fashion to allow comparisons to be made at both the state and sector level. It is acknowledged that a sector in a state that is further away might have a completely minimal contribution, but having the ability to aggregate sectors to develop different views was important.

All states in the modeling domain were tagged separately, including states that are only partially in the modeling domain. For most sectors this resulted in 32 tags per sector, but RWC and fires were only tagged by state in the OTR with the other states being combined into one geography making 14 tags for each of these two sectors. Sectors will not be separated out for Canadian emissions or emissions that occur in waters outside of state boundaries.

Concerning sectors to be tagged we tagged EGUs, Nonroad, area, point oil and gas, area oil and gas, marine vessels, RWC, and fires separately. We also subdivided non-EGU point into cement kilns, municipal waste treatment, and other point sources and onroad into diesel and other onroad sources separately based on the SCCs shown in Table 13-1. These sub-sectors were selected based on inventory analyses conducted by the Good Neighbor SIP Workgroup. Natural gas compressors were originally to be separated out as well until it was determined that the point oil and gas sector contained that sub-sector and very few other sources.

Table 13-1: SCC Pattern for Tagging Sub Sectors (with * indicating truncated SCC)

Sector	Truncated SCC
Diesel Vehicles	2202*
Natural Gas Compressors	202002*
Cement Kilns	305006*
Municipal Waste Treatment	501001*, 502001*, and 503005*

Biogenics are tagged separately as well, but not tagged by state. All other emissions not previously mentioned are included in another category that is not separated by state as well. Initial and Boundary Conditions are also each tagged separately.

CAMx cannot computationally handle all of these tags (385 in all). As a result, three separate CAMx runs were completed where the sectors that are being tagged separately by state are being merged geographically with only several of the sectors remaining tagged by state. As an example in one run EGUs, marine vessels, non-point sources, and Nonroad sources were tagged by state and the other sectors are being merged into one tag. This limited the number of tags to a number that CAMx can process, though three runs were needed in order to process all of the tags. The complete list of tags can be seen in Table 13-2 with the tags separated out by state in Run 1 being colored blue, Run 2 green, and Run 3 purple. Tag 130 was used in runs 1 and 2 to tag any state/sector that was not specifically tagged and in run 3 Tag 124 was. An additional Run 4 was completed, though not listed, where EPA's EGU and nonptipm files were substituted for those in the OTC modeling platform.

Table 13-2: Tagging Methodology

State	Bio-genic	Non-point	Non-road	Onroad		Non-EGU Point			EGU	Oil & Gas		CMV	RWC	Other
				Diesel	Non-Diesel	Cement	MWC	Other	ERTAC	Point	Non Point	C1C2C3		
CT	1	R1: 2	R1: 34	R2: 2	R2: 34	R3: 2	R3: 34	R3: 66	R1: 66	R2: 66	R2: 98	R1: 98	R3: 100	Wildfire R3: 118
DE		R1: 3	R1: 35	R2: 3	R2: 35	R3: 3	R3: 35	R3: 67	R1: 67	R2: 67	R2: 99	R1: 99	R3: 101	
DC		R1: 4	R1: 36	R2: 4	R2: 36	R3: 4	R3: 36	R3: 68	R1: 68	R2: 68	R2: 100	R1: 100	R3: 102	
ME		R1: 5	R1: 37	R2: 5	R2: 37	R3: 5	R3: 37	R3: 69	R1: 69	R2: 69	R2: 101	R1: 101	R3: 103	Rail R3: 119
MD		R1: 6	R1: 38	R2: 6	R2: 38	R3: 6	R3: 38	R3: 70	R1: 70	R2: 70	R2: 102	R1: 102	R3: 104	
MA		R1: 7	R1: 39	R2: 7	R2: 39	R3: 7	R3: 39	R3: 71	R1: 71	R2: 71	R2: 103	R1: 103	R3: 105	
NH		R1: 8	R1: 40	R2: 8	R2: 40	R3: 8	R3: 40	R3: 72	R1: 72	R2: 72	R2: 104	R1: 104	R3: 106	Prescribed Fire R3:120
NJ		R1: 9	R1: 41	R2: 9	R2: 41	R3: 9	R3: 41	R3: 73	R1: 73	R2: 73	R2: 105	R1: 105	R3: 107	
NY		R1: 10	R1: 42	R2: 10	R2: 42	R3: 10	R3: 42	R3: 74	R1: 74	R2: 74	R2: 106	R1: 106	R3: 108	
PA		R1: 11	R1: 43	R2: 11	R2: 43	R3: 11	R3: 43	R3: 75	R1: 75	R2: 75	R2: 107	R1: 107	R3: 109	Ag R3: 121
RI		R1: 12	R1: 44	R2: 12	R2: 44	R3: 12	R3: 44	R3: 76	R1: 76	R2: 76	R2: 108	R1: 108	R3: 110	
VT		R1: 13	R1: 45	R2: 13	R2: 45	R3: 13	R3: 45	R3: 77	R1: 77	R2: 77	R2: 109	R1: 109	R3: 111	
VA		R1: 14	R1: 46	R2: 14	R2: 46	R3: 14	R3: 46	R3: 78	R1: 78	R2: 78	R2: 110	R1: 110	R3: 112	Ag Fire R3:122
IL		R1: 15	R1: 47	R2: 15	R2: 47	R3: 15	R3: 47	R3: 79	R1: 79	R2: 79	R2: 111	R1: 111	R3: 114	
IN		R1: 16	R1: 48	R2: 16	R2: 48	R3: 16	R3: 48	R3: 80	R1: 80	R2: 80	R2: 112	R1: 112		
MI		R1: 17	R1: 49	R2: 17	R2: 49	R3: 17	R3: 49	R3: 81	R1: 81	R2: 81	R2: 113	R1: 113		Afdust R3: 123
OH		R1: 18	R1: 50	R2: 18	R2: 50	R3: 18	R3: 50	R3: 82	R1: 82	R2: 82	R2: 114	R1: 114		
WI		R1: 19	R1: 51	R2: 19	R2: 51	R3: 19	R3: 51	R3: 83	R1: 83	R2: 83	R2: 115	R1: 115		
AL		R1: 20	R1: 52	R2: 20	R2: 52	R3: 20	R3: 52	R3: 84	R1: 84	R2: 84	R2: 116	R1: 116	R3: 115	Ocean Cl2 R3: 125
GA		R1: 21	R1: 53	R2: 21	R2: 53	R3: 21	R3: 53	R3: 85	R1: 85	R2: 85	R2: 117	R1: 117		
KY		R1: 22	R1: 54	R2: 22	R2: 54	R3: 22	R3: 54	R3: 86	R1: 86	R2: 86	R2: 118	R1: 118		

State	Bio-genic	Non-point	Non-road	Onroad		Non-EGU Point			EGU	Oil & Gas		CMV C1C2C3	RWC	Other
				Diesel	Non-Diesel	Cement	MWC	Other	ERTAC	Point	Non Point			
MS		R1: 23	R1: 55	R2: 23	R2: 55	R3: 23	R3: 55	R3: 87	R1: 87	R2: 87	R2: 119	R1: 119		
NC		R1: 24	R1: 56	R2: 24	R2: 56	R3: 24	R3: 56	R3: 88	R1: 88	R2: 88	R2: 120	R1: 120		
SC		R1: 25	R1: 57	R2: 25	R2: 57	R3: 25	R3: 57	R3: 89	R1: 89	R2: 89	R2: 121	R1: 121		
TN		R1: 26	R1: 58	R2: 26	R2: 58	R3: 26	R3: 58	R3: 90	R1: 90	R2: 90	R2: 122	R1: 122		
WV		R1: 27	R1: 59	R2: 27	R2: 59	R3: 27	R3: 59	R3: 91	R1: 91	R2: 91	R2: 123	R1: 123	R3: 113	
AR		R1: 28	R1: 60	R2: 28	R2: 60	R3: 28	R3: 60	R3: 92	R1: 92	R2: 92	R2: 124	R1: 124	R3: 116	
IA		R1: 29	R1: 61	R2: 29	R2: 61	R3: 29	R3: 61	R3: 93	R1: 93	R2: 93	R2: 125	R1: 125		
LA		R1: 30	R1: 62	R2: 30	R2: 62	R3: 30	R3: 62	R3: 94	R1: 94	R2: 94	R2: 126	R1: 126		
MN		R1: 31	R1: 63	R2: 31	R2: 63	R3: 31	R3: 63	R3: 95	R1: 95	R2: 95	R2: 127	R1: 127	R3: 114	
MO		R1: 32	R1: 64	R2: 32	R2: 64	R3: 32	R3: 64	R3: 96	R1: 96	R2: 96	R2: 128	R1: 128	R3: 116	
TX		R1: 33	R1: 65	R2: 33	R2: 65	R3: 33	R3: 65	R3: 97	R1: 97	R2: 97	R2: 129	R1: 129		
Offshore						R3: 98						R3: 99		
Can.		R3: 117												
IC	R1 & R2: 131, R3: 126													
BC	R1 & R2: 132, R3: 127													

Ozone Results

2023 Design Value Results

To begin, we analyzed the projected 2023 design values that were modeled using CAMx. By 2023 all monitors in the domain are projected to attain the 75 ppb NAAQS as seen in Figure 13-1, although four monitors are projected to remain in nonattainment for the 70 ppb NAAQS in 2023, all in the OTR. When changing the calculation method to remove over water grid cells an additional monitor is projected to attain the 70 ppb NAAQS by 2023 as seen in Figure 13-2. A state level summary of the 2023 results can be found in Table 13-3 and a monitor level summary in Table 13-4.

Figure 13-1: Projected Gamma 2023 Base Case Design Values for 2011 (left) and 2023 (right) (EPA Guidance)

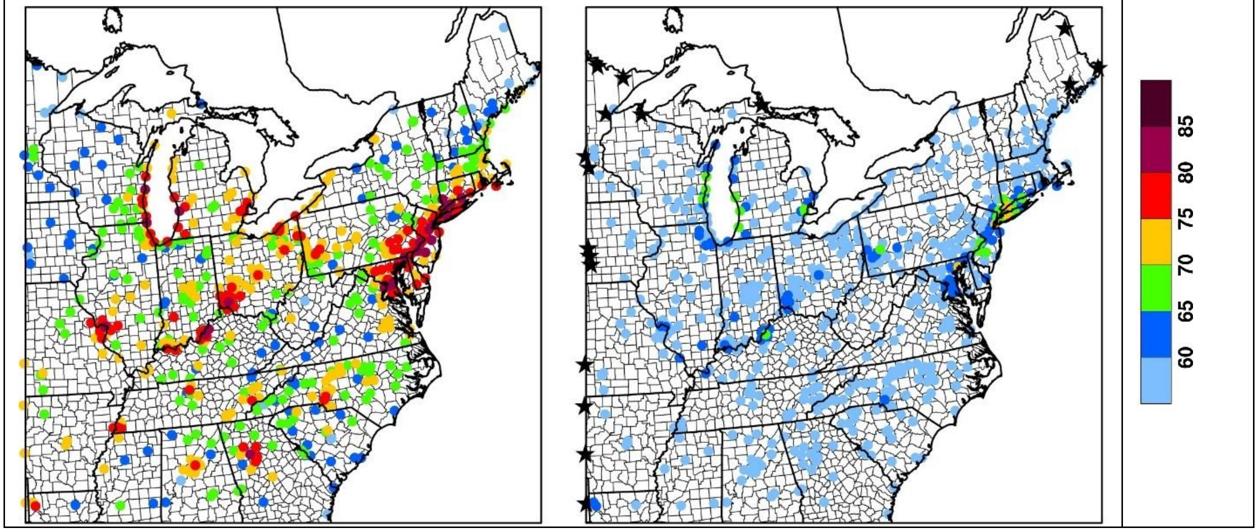


Figure 13-2: Projected Gamma 2023 Base Case Design Values for 2011 (left) and 2023 (right) (Less Water)

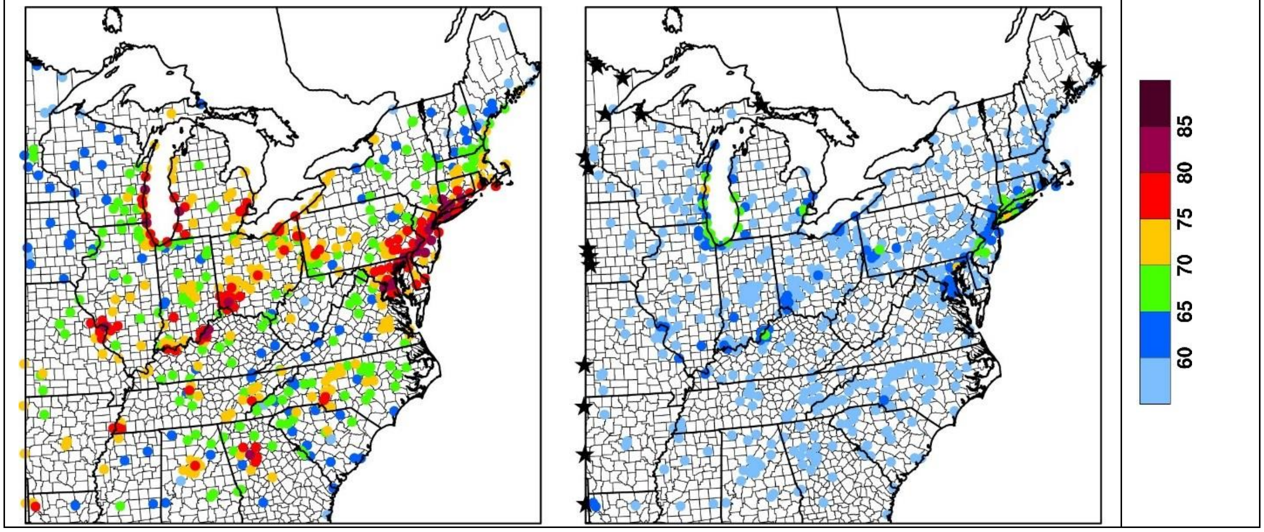


Table 13-3: State summary (maximum DVF, monitors violating 75 ppb, monitors violating 70 ppb) of base case modeling for 2023 Gamma platforms calculated using the "EPA Guidance" and "Less Water" techniques.

OTR							Non-OTR						
	EPA Guidance			Less Water				EPA Guidance			Less Water		
State	Max	>75	>70	Max	>75	>70	State	Max	>75	>70	Max	>75	>70
CT	71	0	1	69	0	0	AL	58	0	0	58	0	0
DC	61	0	0	61	0	0	AR	60	0	0	60	0	0
DE	61	0	0	60	0	0	GA	59	0	0	59	0	0
MA	63	0	0	63	0	0	IA	55	0	0	55	0	0
MD	71	0	1	71	0	1	IL	63	0	0	68	0	0
ME	59	0	0	60	0	0	IN	65	0	0	67	0	0
NH	56	0	0	56	0	0	KY	67	0	0	67	0	0
NJ	67	0	0	67	0	0	LA	64	0	0	64	0	0
NY	72	0	2	73	0	1	MI	69	0	0	69	0	0
PA	67	0	0	67	0	0	MN	56	0	0	56	0	0
RI	62	0	0	61	0	0	MO	64	0	0	64	0	0
VA	64	0	0	64	0	0	MS	60	0	0	60	0	0
VT	51	0	0	51	0	0	NC	62	0	0	62	0	0
							OH	65	0	0	65	0	0
							SC	55	0	0	55	0	0
							TN	60	0	0	60	0	0
							TX	-8	0	0	-8	0	0
							VA	59	0	0	59	0	0
							WI	70	0	0	71	0	1
							WV	59	0	0	59	0	0

Table 13-4: Monitor summary for monitors in the OTR only of base case modeling for 2023 Gamma platforms calculated using the "EPA Guidance" and "Less Water" techniques (DVF > 75 ppb highlighted in red, DVF > 70 ppb highlighted in green).

			EPA Guidance		Less Water					EPA Guidance		Less Water	
State	AQS Code	DVC	DVF	RRF	DVF	RRF	State	AQS Code	DVC	DVF	RRF	DVF	RRF
CT	90010017	80.3	69	0.867	68	0.852	NY	360010012	68	55	0.820	55	0.820
	90011123	81.3	66	0.817	66	0.817		360050133	74	67	0.918	62	0.846
	90013007	84.3	70	0.839	69	0.826		360130006	73.3	59	0.807	59	0.811
	90019003	83.7	71	0.860	69	0.826		360130011	74	59	0.809	59	0.799
	90031003	73.7	58	0.793	58	0.793		360150003	66.5	55	0.829	55	0.829
	90050005	70.3	55	0.796	55	0.796		360270007	72	57	0.797	57	0.797
	90070007	79.3	63	0.797	63	0.797		360290002	71.3	58	0.822	58	0.823
	90090027	74.3	61	0.828	60	0.814		360310002	70.3	48	1.637	48	1.638

State	AQS Code	DVC	EPA Guidance		Less Water	
			DVF	RRF	DVF	RRF
	90099002	85.7	69	0.817	68	0.802
	90110124	80.3	65	0.813	66	0.828
	90131001	75.3	59	0.797	59	0.797
CT Max			**71**	**0.867**	**69**	**0.852**
DC	110010041	76	58	0.767	58	0.767
	110010043	80.7	61	0.767	61	0.767
DC Max			**61**	**0.767**	**61**	**0.767**
DE	100010002	74.3	57	0.776	57	0.776
	100031007	76.3	58	0.765	58	0.765
	100031010	78	60	0.782	60	0.782
	100031013	77.7	60	0.777	60	0.777
	100032004	75	58	0.777	58	0.777
	100051002	77.3	59	0.771	59	0.773
	100051003	77.7	61	0.787	60	0.780
DE Max			**61**	**0.787**	**60**	**0.782**
MA	250010002	73	58	0.803	59	0.818
	250034002	69	56	0.816	56	0.816
	250051002	74	60	0.816	60	0.822
	250070001	77	63	0.829	63	0.821
	250092006	71	56	0.801	57	0.814
	250094005	70	56	0.810	56	0.808
	250095005	69.3	56	0.810	56	0.810
	250130008	73.7	58	0.790	58	0.790
	250150103	64.7	51	0.795	51	0.795
	250154002	71.3	56	0.786	56	0.786
	250170009	67.3	53	0.799	53	0.799
	250171102	67	52	0.790	52	0.790
	250213003	72.3	58	0.814	57	0.799
	250250041	68.3	55	0.810	54	0.804
	250250042	60.7	49	0.814	48	0.802
	250270015	68.3	54	0.792	54	0.792
	250270024	69	54	0.787	54	0.787
MA Max			**63**	**0.829**	**63**	**0.822**
MD	240030014	83	63	0.766	63	0.766
	240051007	79	64	0.813	64	0.813
	240053001	80.7	64	0.801	64	0.801
	240090011	79.7	63	0.792	62	0.779
	240130001	76.3	59	0.773	59	0.773
	240150003	83	64	0.772	64	0.772
	240170010	79	61	0.775	61	0.775
	240199991	75	60	0.800	58	0.778
	240210037	76.3	59	0.780	59	0.780
	240230002	72	56	0.788	56	0.788
	240251001	90	71	0.798	71	0.798
	240259001	79.3	62	0.783	62	0.788
	240290002	78.7	60	0.775	60	0.775
	240313001	75.7	59	0.784	59	0.784
	240330030	79	60	0.769	60	0.769
	240338003	82.3	63	0.767	63	0.767
	240339991	80	61	0.768	61	0.768
	240430009	72.7	56	0.781	56	0.781
	245100054	73.7	60	0.818	59	0.812
MD Max			**71**	**0.818**	**71**	**0.813**
ME	230010014	61	48	0.803	49	0.804
	230031100	51.3	-8	-9	-8	-9
	230052003	69.3	56	0.810	56	0.817
	230090102	71.7	59	0.835	60	0.840
	230090103	66.3	54	0.818	55	0.838
	230112005	62.7	49	0.796	49	0.796
	230130004	67.7	54	0.804	54	0.810
	230173001	54.3	44	0.812	44	0.812

State	AQS Code	DVC	EPA Guidance		Less Water	
			DVF	RRF	DVF	RRF
	360310003	67.3	55	0.819	55	0.819
	360337003	45	37	0.831	37	0.826
	360410005	66	53	0.815	53	0.812
	360430005	62	50	0.820	50	0.822
	360450002	71.7	59	0.827	59	0.831
	360530006	67	54	0.820	54	0.820
	360610135	73.3	66	0.906	62	0.854
	360631006	72.3	60	0.837	59	0.817
	360650004	61.5	50	0.820	50	0.820
	360671015	69.3	57	0.833	57	0.833
	360715001	67	53	0.803	53	0.803
	360750003	68	55	0.818	55	0.822
	360790005	70	56	0.813	56	0.813
	360810124	78	69	0.891	69	0.889
	360830004	67	54	0.817	54	0.817
	360850067	81.3	71	0.876	65	0.808
	360870005	75	61	0.821	61	0.821
	360910004	67	54	0.816	54	0.816
	361010003	65.3	54	0.833	54	0.833
	361030002	83.3	72	0.865	73	0.880
	361030004	78	65	0.842	64	0.824
	361030009	78.7	58	1.723	57	1.693
	361111005	69	56	0.816	56	0.815
	361173001	65	53	0.826	53	0.825
	361192004	75.3	68	0.905	62	0.834
NY Max			**72**	**0.918**	**73**	**0.889**
PA	420030008	76.3	63	0.838	63	0.838
	420030010	73.7	61	0.838	61	0.838
	420030067	75.7	61	0.812	61	0.812
	420050001	74.3	60	0.814	60	0.814
	420070002	70.7	58	0.823	58	0.823
	420070005	74.7	62	0.835	62	0.835
	420070014	72.3	60	0.840	60	0.840
	420110006	71.7	56	0.783	56	0.783
	420110011	76.3	58	0.771	58	0.771
	420130801	72.7	59	0.819	59	0.819
	420170012	80.3	63	0.796	63	0.796
	420210011	70.3	57	0.818	57	0.818
	420270100	71	58	0.828	58	0.828
	420279991	72	59	0.822	59	0.822
	420290100	76.3	58	0.770	58	0.770
	420334000	72.3	60	0.834	60	0.834
	420430401	69	54	0.790	54	0.790
	420431100	74.7	57	0.775	57	0.775
	420450002	75.7	59	0.787	59	0.787
	420490003	74	58	0.797	59	0.799
	420550001	67	53	0.795	53	0.795
	420590002	69	55	0.809	55	0.809
	420630004	75.7	61	0.819	61	0.819
	420690101	71	55	0.788	55	0.788
	420692006	68.7	54	0.788	54	0.788
	420710007	77	59	0.774	59	0.774
	420710012	78	59	0.768	59	0.768
	420730015	71	57	0.807	57	0.807
	420750100	76	58	0.773	58	0.773
	420770004	76	59	0.784	59	0.784
	420791100	65	49	0.767	49	0.767
	420791101	64.3	49	0.777	49	0.777
	420810100	67	53	0.803	53	0.803
	420850100	76.3	58	0.773	58	0.773
	420890002	66.7	51	0.773	51	0.773

State	AQS Code	DVC	EPA Guidance DVF	EPA Guidance RRF	Less Water DVF	Less Water RRF
	230194008	57.7	-8	-9	-8	-9
	230230006	61	48	0.795	48	0.800
	230290019	58.3	49	0.854	49	0.851
	230290032	53	-8	-9	-8	-9
	230310038	60.3	47	0.793	47	0.793
	230310040	64.3	51	0.796	51	0.796
	230312002	73.7	59	0.804	59	0.803
ME Max			**59**	**0.854**	**60**	**0.851**
NH	330012004	62.3	50	0.809	50	0.803
	330050007	62.3	49	0.794	49	0.794
	330074001	69.3	56	0.820	56	0.820
	330074002	59.7	49	0.821	49	0.821
	330090010	59.7	48	0.811	48	0.811
	330111011	66.3	52	0.798	52	0.798
	330115001	69	54	0.796	54	0.796
	330131007	64.7	51	0.793	51	0.793
	330150014	66	53	0.807	53	0.808
	330150016	66.3	53	0.807	53	0.808
	330150018	68	54	0.799	54	0.799
NH Max			**56**	**0.821**	**56**	**0.821**
NJ	340010006	74.3	58	0.788	58	0.786
	340030006	77	62	0.806	62	0.806
	340071001	82.7	66	0.802	66	0.802
	340110007	72	57	0.792	57	0.792
	340130003	78	62	0.802	62	0.802
	340150002	84.3	67	0.802	67	0.802
	340170006	77	63	0.819	63	0.819
	340190001	78	60	0.776	60	0.776
	340210005	78.3	62	0.799	62	0.799
	340219991	76	59	0.785	59	0.785
	340230011	81.3	63	0.783	63	0.783
	340250005	80	64	0.803	63	0.791
	340273001	76.3	59	0.776	59	0.776
	340290006	82	64	0.785	64	0.785
	340315001	73.3	60	0.826	60	0.826
	340410007	66	51	0.774	51	0.774
NJ Max			**67**	**0.826**	**67**	**0.826**
	420910013	76.3	59	0.783	59	0.783
	420950025	76	58	0.782	58	0.782
	420958000	69.7	54	0.783	54	0.783
	420990301	68.3	54	0.801	54	0.801
	421010004	66	53	0.806	53	0.806
	421010024	83.3	67	0.807	67	0.807
	421011002	80	64	0.807	64	0.807
	421119991	65	51	0.797	51	0.797
	421174000	69.7	57	0.832	57	0.832
	421250005	70	57	0.822	57	0.822
	421250200	70.7	57	0.816	57	0.816
	421255001	70.3	57	0.819	57	0.819
	421290006	71.7	59	0.831	59	0.831
	421290008	71	58	0.819	58	0.819
	421330008	72.3	55	0.772	55	0.772
	421330011	74.3	57	0.774	57	0.774
PA Max			**67**	**0.840**	**67**	**0.840**
RI	440030002	73.7	59	0.809	59	0.809
	440071010	74	59	0.802	59	0.801
	440090007	76.3	62	0.821	61	0.810
RI Max			**62**	**0.821**	**61**	**0.810**
VA	510130020	81.7	64	0.793	64	0.793
	510590030	82.3	64	0.789	64	0.789
	511071005	73	57	0.787	57	0.787
	511530009	70	55	0.796	55	0.796
	515100009	80	62	0.785	62	0.785
VA Max			**64**	**0.796**	**64**	**0.796**
VT	500030004	63.7	51	0.813	51	0.813
VT Max			**51**	**0.813**	**51**	**0.813**

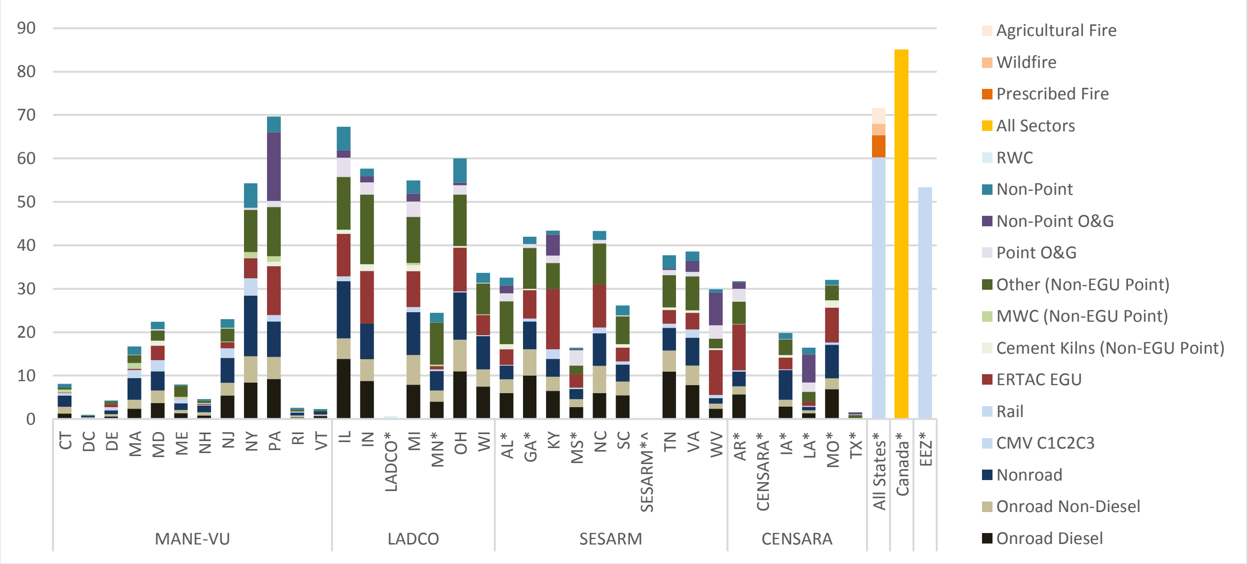
Contribution Assessment Results

The following section will look at the contribution assessment results that were obtained from the 2023 projections. In many cases we will only look at the results for the four monitors (Sherwood Island Connector, CT: 90019003, Edgewood, MD: 240251001, Susan Wagner, NY: 360850067, and Babylon, NY: 361030002) that were found to be projected to violate the NAAQS in 2023; however, monitor specific data for other monitors is available and can be obtained from OTC.

NO_X Emissions Inventories

Figure 13-5 shows the NO_X emission inventories by state and sector that were used in 2023 source apportionment modeling (more details on these inventories are available Section 9) based on how they were tagged and the portion of emissions within the modeling domain that occurred from May 31-August 31. One can see the importance of NO_X emissions from onroad diesel, nonroad, and onroad non-diesel in nearly every state, EGUs and non-EGU point sources in many states, non-point oil & gas in states Marcellus shale states, and commercial marine vessels in the EEZ. It would be expected that these sectors will show up as high contributors when the contribution assessment data is analyzed.

Figure 13-5: NO$_X$ emissions (thousands of tons) included for each state and sector in the 2023 modeling



*** Indicates that only a portion of the geography is included in the modeling domain**

^ SESARM RWC totals do not include VA or WV

Sector Analysis

Figure 13-3 though Figure 13-6 examine each exceedance day at the four monitors of concern and the extent that each sector contributes on each day. Each exceedence day is in order by the total future DVF, though contribution from international emissions and boundary conditions are excluded from display.

One can see that from one exceedance day to the next there is variation in the percentage contribution from various sectors with nonroad, onroad diesel, ERTAC EGU, and non- point being the highest contributors.

Figure 13-3: Anthropogenic US intra-domain contribution by sector on dates projected to exceed the 70 ppb NAAQS in 2023 to Sherwood Island Connector, CT (90019003) ordered by total DVF

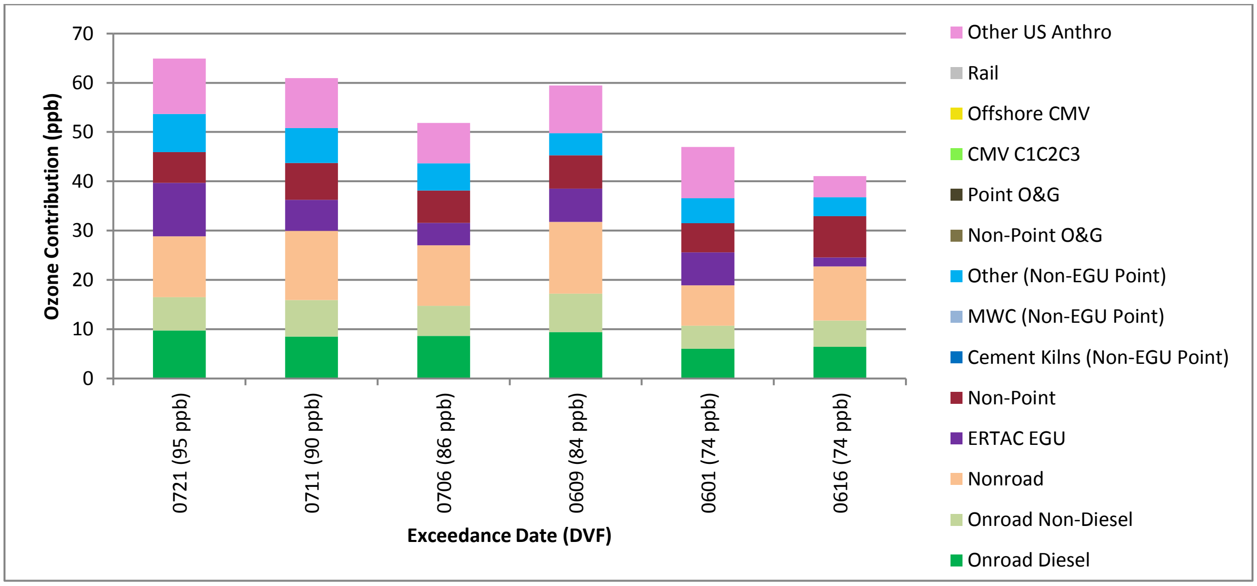


Figure 13-4: Anthropogenic US intra-domain contribution by sector on dates projected to exceed the 70 ppb NAAQS in 2023 to Edgewood, MD (240251001) ordered by total DVF

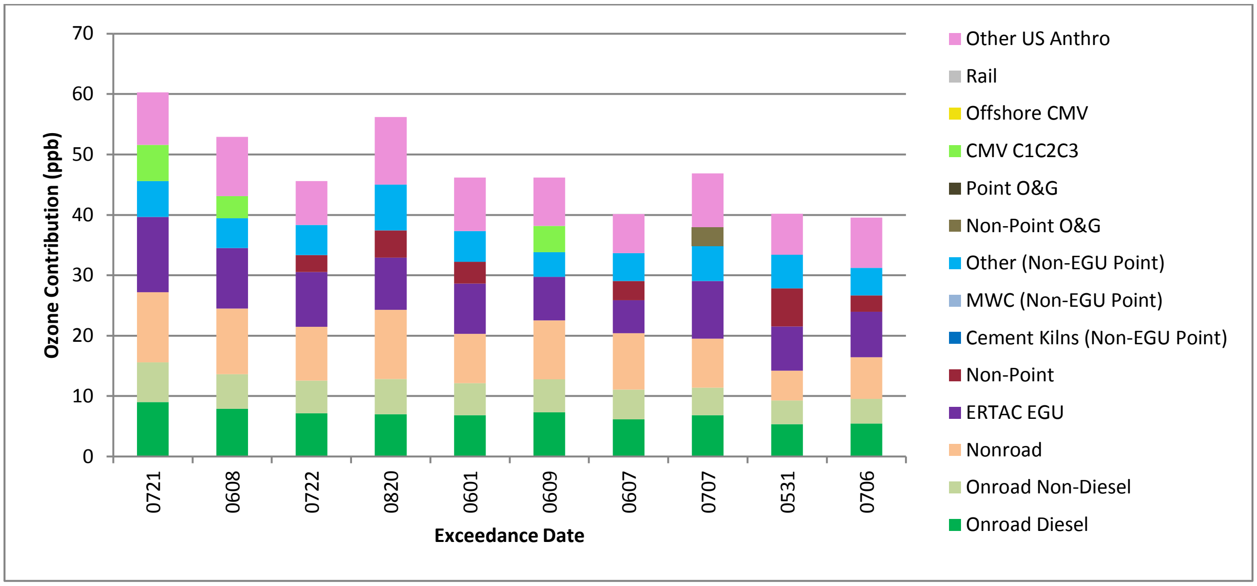
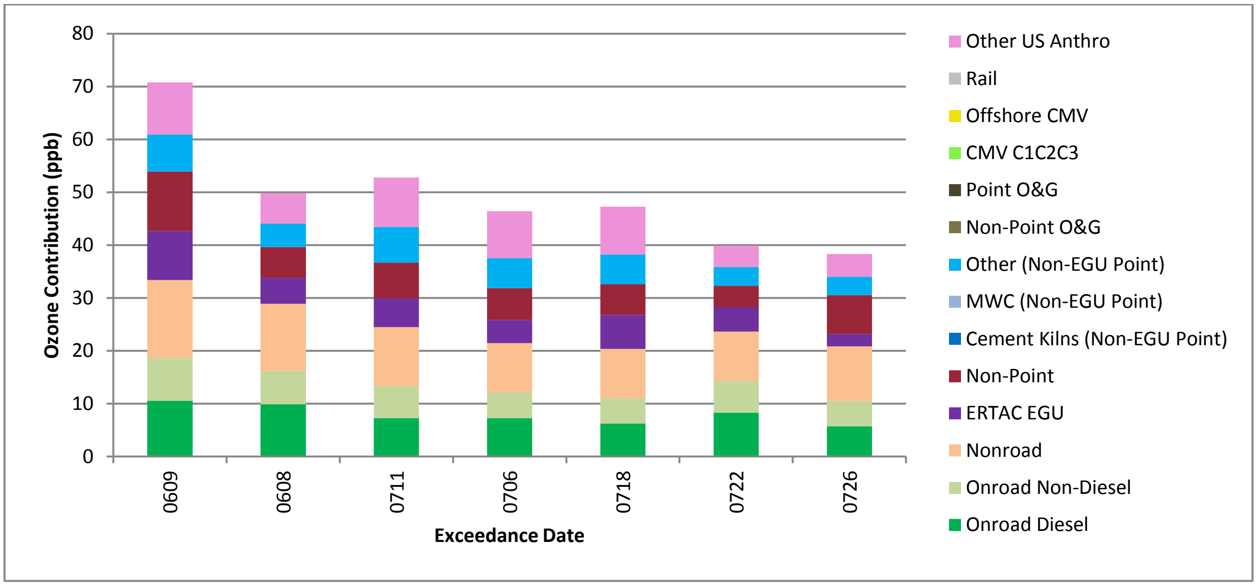


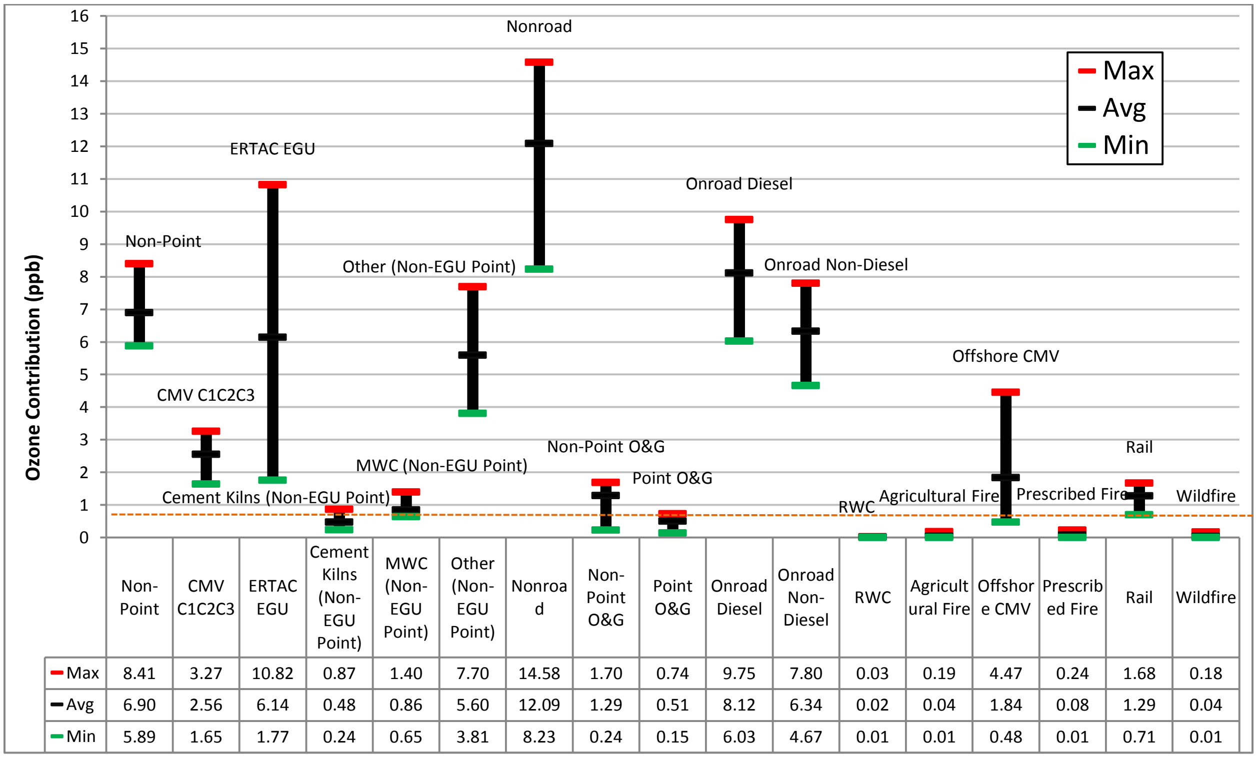
Figure 13-5: Anthropogenic US intra-domain contribution by sector on dates projected to exceed the 70 ppb NAAQS in 2023 to Susan Wagner, NY (360850067) ordered by total DVF

Figure 13-6: Anthropogenic US intra-domain contribution by sector on dates projected to exceed the 70 ppb NAAQS in 2023 to Babylon, NY (361030002) ordered by total DVF



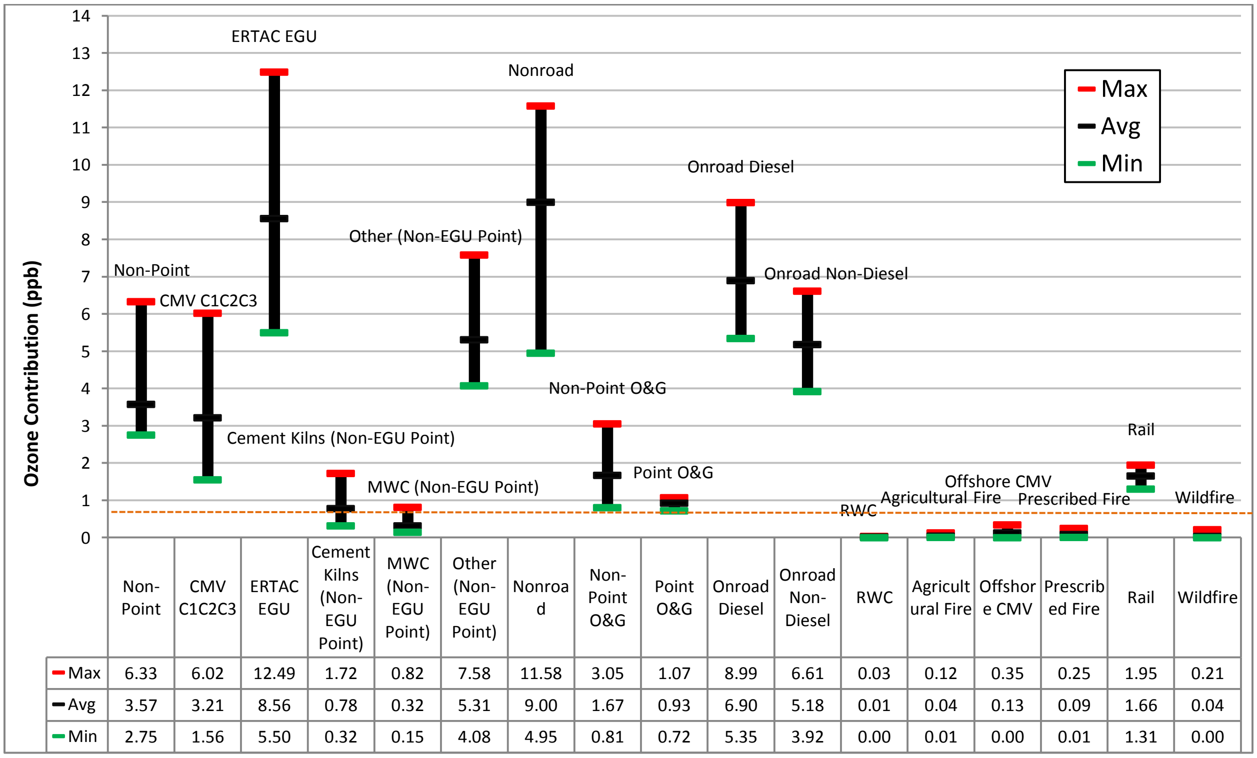
However, this approach hides some of the variability that can be seen in how much a sector can be projected to contribute to nonattainment. Figure 13-7 through Figure 13-10 show the maximum, average and minimum contributions at each monitor on a projected exceedance day. ERTAC EGU and Non-Point sectors typically have a lot of variability at each of these monitors with maximums that show this sector can be the highest contributor on a given day, but barely negligible on others. Mobile sources, nonroad in particular, have less variability and remain consistently high even on the days with the minimum contribution. Non-EGU point, marine vessel, and oil & gas sources can also show up as an important contributor to a particular monitor, but not necessarily at all four of the monitors examined.

Figure 13-7: Maximum, average, and minimum contribution by sector on exceedance days at Sherwood Island Connector, CT (90019003)



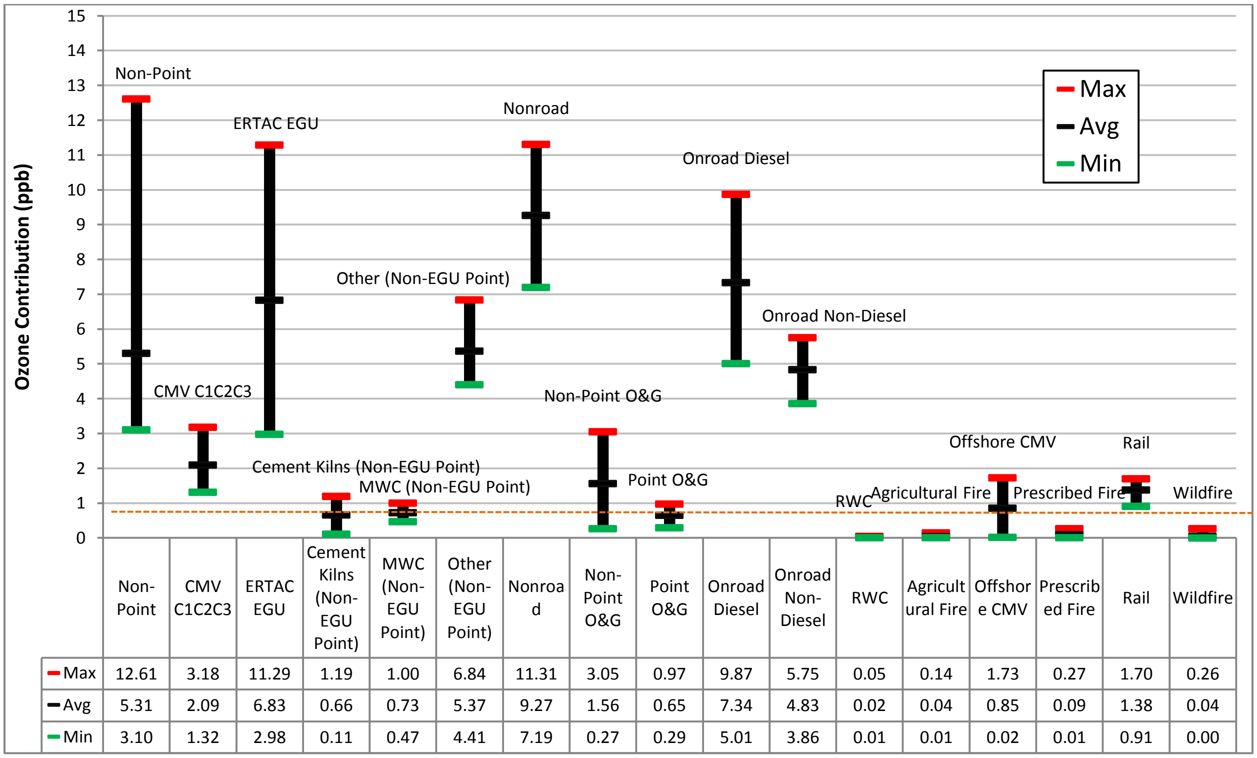
	Non-Point	CMV C1C2C3	ERTAC EGU	Cement Kilns (Non-EGU Point)	MWC (Non-EGU Point)	Other (Non-EGU Point)	Nonroad	Non-Point O&G	Point O&G	Onroad Diesel	Onroad Non-Diesel	RWC	Agricultural Fire	Offshore CMV	Prescribed Fire	Rail	Wildfire
Max	8.41	3.27	10.82	0.87	1.40	7.70	14.58	1.70	0.74	9.75	7.80	0.03	0.19	4.47	0.24	1.68	0.18
Avg	6.90	2.56	6.14	0.48	0.86	5.60	12.09	1.29	0.51	8.12	6.34	0.02	0.04	1.84	0.08	1.29	0.04
Min	5.89	1.65	1.77	0.24	0.65	3.81	8.23	0.24	0.15	6.03	4.67	0.01	0.01	0.48	0.01	0.71	0.01

Figure 13-8: Maximum, average, and minimum contribution by sector on exceedance days at Edgewood, MD (240251001)



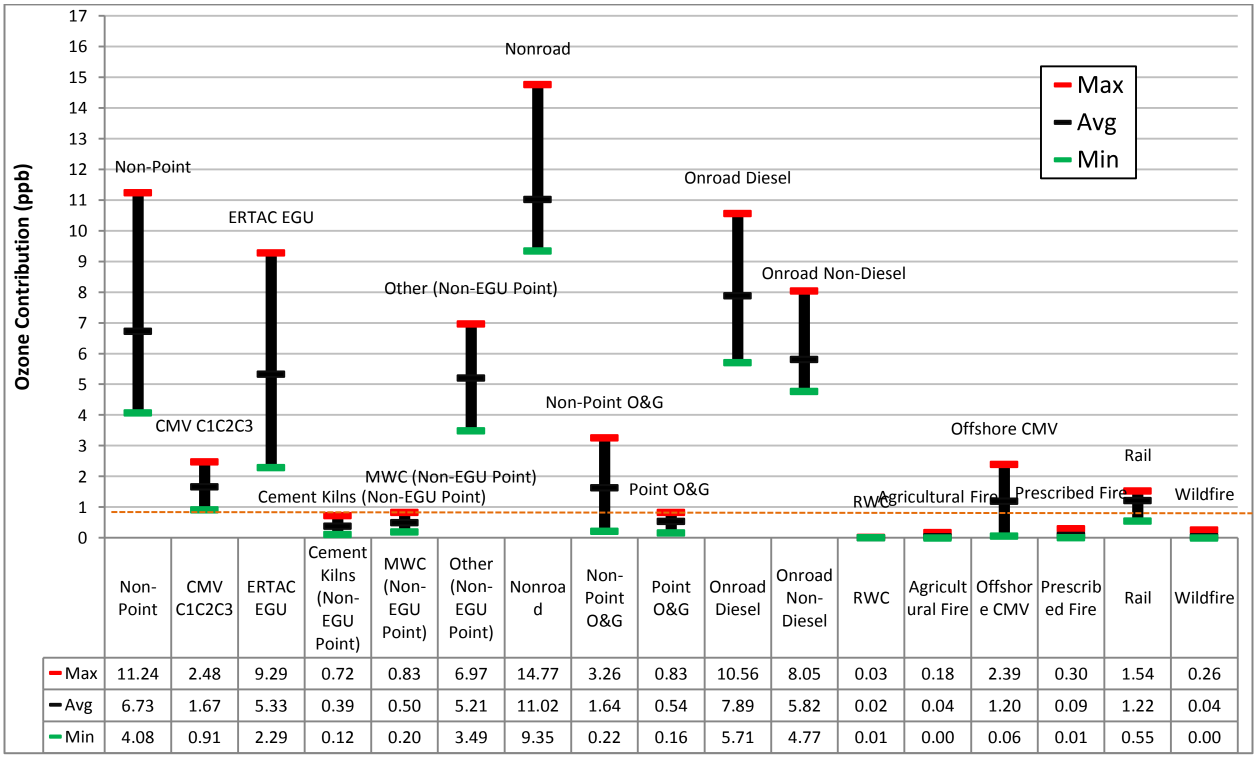
	Non-Point	CMV C1C2C3	ERTAC EGU	Cement Kilns (Non-EGU Point)	MWC (Non-EGU Point)	Other (Non-EGU Point)	Nonroad	Non-Point O&G	Point O&G	Onroad Diesel	Onroad Non-Diesel	RWC	Agricultural Fire	Offshore CMV	Prescribed Fire	Rail	Wildfire
Max	6.33	6.02	12.49	1.72	0.82	7.58	11.58	3.05	1.07	8.99	6.61	0.03	0.12	0.35	0.25	1.95	0.21
Avg	3.57	3.21	8.56	0.78	0.32	5.31	9.00	1.67	0.93	6.90	5.18	0.01	0.04	0.13	0.09	1.66	0.04
Min	2.75	1.56	5.50	0.32	0.15	4.08	4.95	0.81	0.72	5.35	3.92	0.00	0.01	0.00	0.01	1.31	0.00

Figure 13-9: Maximum, average, and minimum contribution by sector on exceedance days at Susan Wagner, NY (360850067)



	Non-Point	CMV C1C2C3	ERTAC EGU	Cement Kilns (Non-EGU Point)	MWC (Non-EGU Point)	Other (Non-EGU Point)	Nonroad	Non-Point O&G	Point O&G	Onroad Diesel	Onroad Non-Diesel	RWC	Agricultural Fire	Offshore CMV	Prescribed Fire	Rail	Wildfire
Max	12.61	3.18	11.29	1.19	1.00	6.84	11.31	3.05	0.97	9.87	5.75	0.05	0.14	1.73	0.27	1.70	0.26
Avg	5.31	2.09	6.83	0.66	0.73	5.37	9.27	1.56	0.65	7.34	4.83	0.02	0.04	0.85	0.09	1.38	0.04
Min	3.10	1.32	2.98	0.11	0.47	4.41	7.19	0.27	0.29	5.01	3.86	0.01	0.01	0.02	0.01	0.91	0.00

Figure 13-10: Maximum, average, and minimum contribution by sector on exceedance days at Babylon, NY (361030002)



	Non-Point	CMV C1C2C3	ERTAC EGU	Cement Kilns (Non-EGU Point)	MWC (Non-EGU Point)	Other (Non-EGU Point)	Nonroad	Non-Point O&G	Point O&G	Onroad Diesel	Onroad Non-Diesel	RWC	Agricultural Fire	Offshore CMV	Prescribed Fire	Rail	Wildfire
Max	11.24	2.48	9.29	0.72	0.83	6.97	14.77	3.26	0.83	10.56	8.05	0.03	0.18	2.39	0.30	1.54	0.26
Avg	6.73	1.67	5.33	0.39	0.50	5.21	11.02	1.64	0.54	7.89	5.82	0.02	0.04	1.20	0.09	1.22	0.04
Min	4.08	0.91	2.29	0.12	0.20	3.49	9.35	0.22	0.16	5.71	4.77	0.01	0.00	0.06	0.01	0.55	0.00

State Analysis

The states listed in Table 13-6 are projected to contribute at least 1% to Sherwood Island Connector monitor in 2023. The nonroad sector is the most consistent category to contribute. Cement kilns play a role in contribution from several states. EGUs also play a role in contribution from many states, but Michigan, Pennsylvania, and West Virginia do not have an EGU contribution in the top three.

Table 13-6: States projected to contribute at least 0.7 ppb in 2023 to Sherwood Island Connector, CT (90019003) and the three sectors that contribute the most from that state

	CT	MD	MI	NJ	NY	OH	PA	VA	WV
1st Most	Nonroad	Non-Point	Nonroad	Non-Point	Non-Point	O&G Non-Point	Cement Kilns	Non-Point	Cement Kilns
2nd Most	Non-Point	Cement Kilns	Non-Point	Nonroad	MWC	ERTAC EGU	Non-Point	CMV C1C2C3	Non-Point
3rd Most	Onroad Non-Diesel	ERTAC EGU	Onroad Non-Diesel	MWC	ERTAC EGU	MWC	Nonroad	Nonroad	Nonroad

The states listed in Table 13-7 are projected to contribute at least 1% to Edgewood, MD in 2023. A similar pattern of source sectors holds up, though in this case EGUs from Pennsylvania and West Virginia show up as important contributors and oil and gas point sources from Pennsylvania do as well.

Table 13-7: States projected to contribute at least 0.7 ppb in 2023 to Edgewood, MD (240251001) and the three sectors that contribute the most from that state

	IN	KY	MD	MI	OH	PA	VA	WV
1st Most	Nonroad	Non-Point	MWC	Non-Point	ERTAC EGU	ERTAC EGU	Non-Point	Cement Kilns
2nd Most	Non-Point	Other Non-EGU Point	Nonroad	Nonroad	O&G Non-Point	Non-Point	Nonroad	Non-Point
3rd Most	Onroad Non-Diesel	Onroad Non-Diesel	CMV C1C2C3	MWC	Non-Point	O&G Point	Onroad Non-Diesel	ERTAC EGU

The states listed in Table 13-8 are projected to contribute at least 1% to Susan Wagner, NY in 2023. Susan Wagner has the most states listed as projected to contribute to nonattainment.

Table 13-8: States projected to contribute at least 0.7 ppb in 2023 to Susan Wagner, NY (360850067) and the three sectors that contribute the most from that state

	IL	IN	KY	MD	MI	NJ	NY	OH	PA	VA	WV
1st Most	ERTAC EGU	Non-Point	Non-Point	MWC	Nonroad	MWC	Non-Point	O&G Non-Point	Cement Kilns	Non-Point	Cement Kilns
2nd Most	Nonroad	Nonroad	Other Non-EGU Point	ERTAC EGU	Non-Point	Non-Point	ERTAC EGU	ERTAC EGU	MWC	ERTAC EGU	Non-Point
3rd Most	Non-Point	Onroad Non-Diesel	Onroad Non-Diesel	Non-Point	Onroad Non-Diesel	ERTAC EGU	Nonroad	MWC	Non-Point	MWC	ERTAC EGU

The states listed in Table 13-9 are projected to contribute at least 1% to Babylon, NY in 2023.

Table 13-9: States projected to contribute at least 0.7 ppb in 2023 to Babylon, NY (361030002) and the three sectors that contribute the most from that state

	IN	MD	MI	NJ	NY	OH	PA	VA	WV
1st Most	Non-Point	Cement Kilns	Nonroad	Non-Point	Non-Point	O&G Non-Point	Cement Kilns	Non-Point	Cement Kilns
2nd Most	Nonroad	Non-Point	ERTAC EGU	Nonroad	Onroad Non-Diesel	ERTAC EGU	Non-Point	CMV C1C2C3	Non-Point
3rd Most	Onroad Non-Diesel	ERTAC EGU	Non-Point	MWC	ERTAC EGU	Nonroad	Nonroad	Nonroad	Nonroad

Another way to examine which sectors from which states are projected to contribute to nonattainment in 2023 is to look individually at each exceedance day. Figure 13-11 through Figure 13-14 shows which sector is projected to impact nonattainment the most on a day that was projected to exceed the 0.7 ppb NAAQS.

The first thing to be noticed is that the list of states is greater for each monitor than in the previous tables. That is because some states, (e.g., AL, DC, DE, GA, NC, TN, and WI) are projected to contribute to an exceedance on a given day even though they don't contribute using the method shown in the preceding tables.

When examining individual days Nonroad and ERTAC EGU are important contributing sectors, with nonroad typically being important in states nearby geographically and ERTAC EGU in states further away. Other Non-EGU Point and onroad diesel also can be important contributing sectors from some sates on certain days. Finally oil & gas emissions, particularly non-point, from Pennsylvania also appear to be an important contributor on certain days.

Figure 13-11: Total days state is projected to contribute at least 0.7 ppb to exceedance in 2023 at Sherwood Island Connector (90019003) and sector that contributes the most during the exceedance date from the state

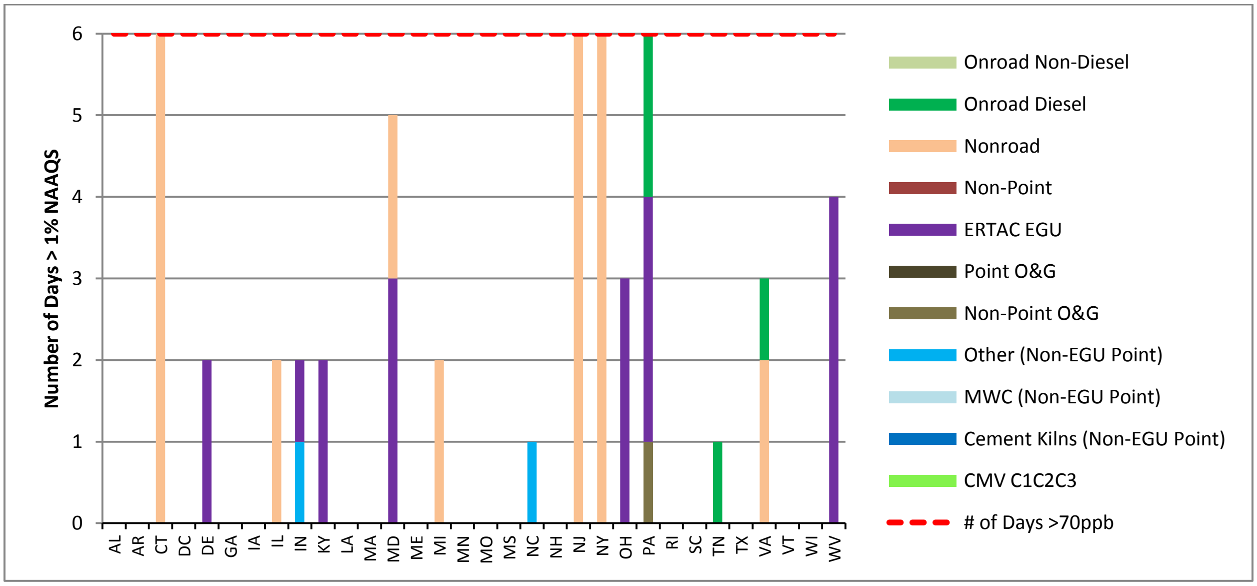


Figure 13-12: Total days state is projected to contribute at least 0.7 ppb to exceedance in 2023 at Edgewood, MD (240251001) and sector that contributes the most during the exceedance date from the state

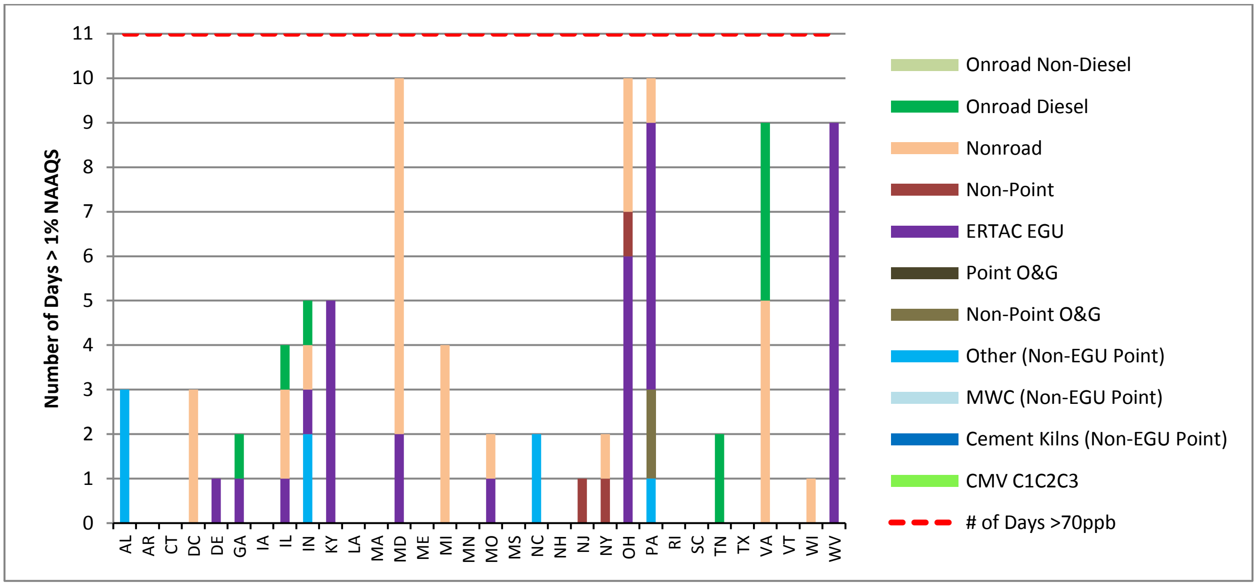


Figure 13-13: Total days state is projected to contribute at least 0.7 ppb to exceedance in 2023 at Susan Wagner, NY (360850067) and sector that contributes the most during the exceedance date from the state

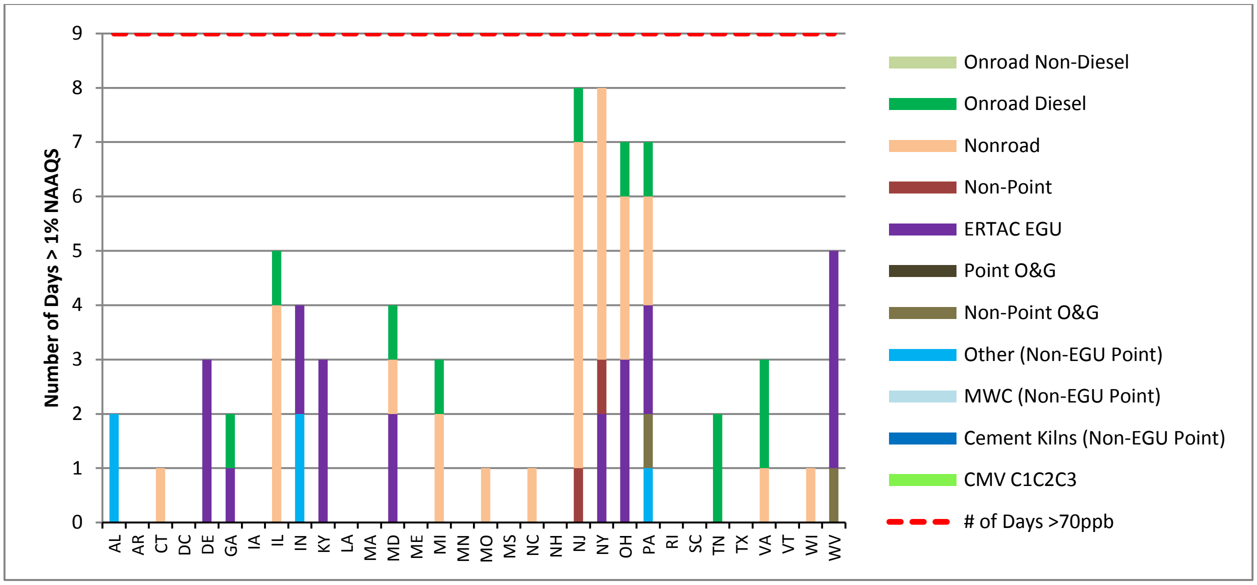
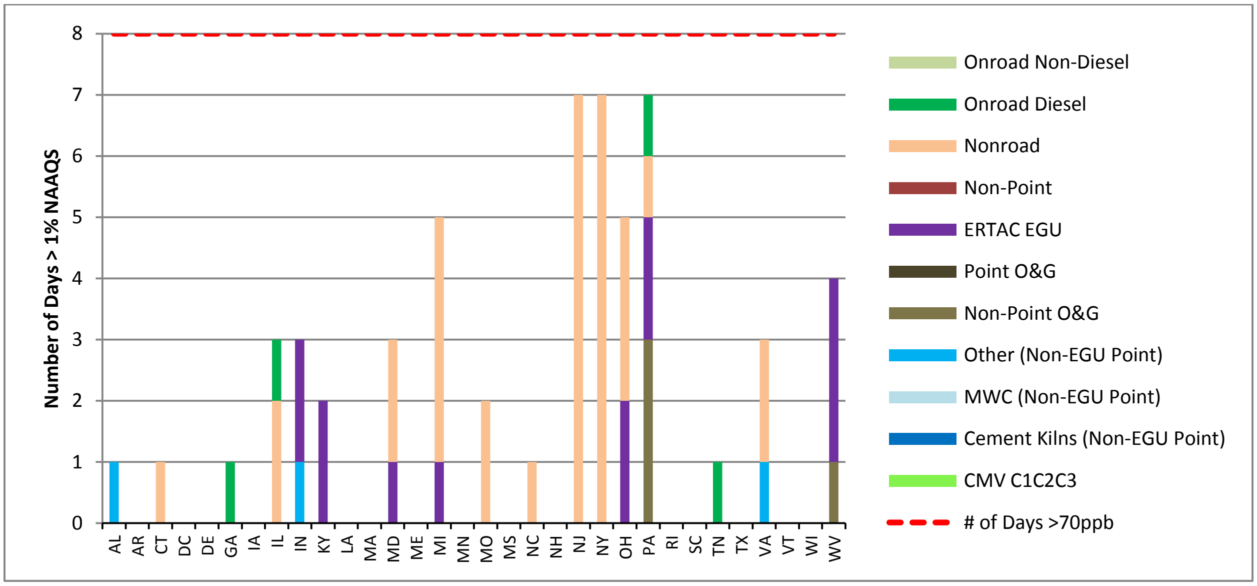


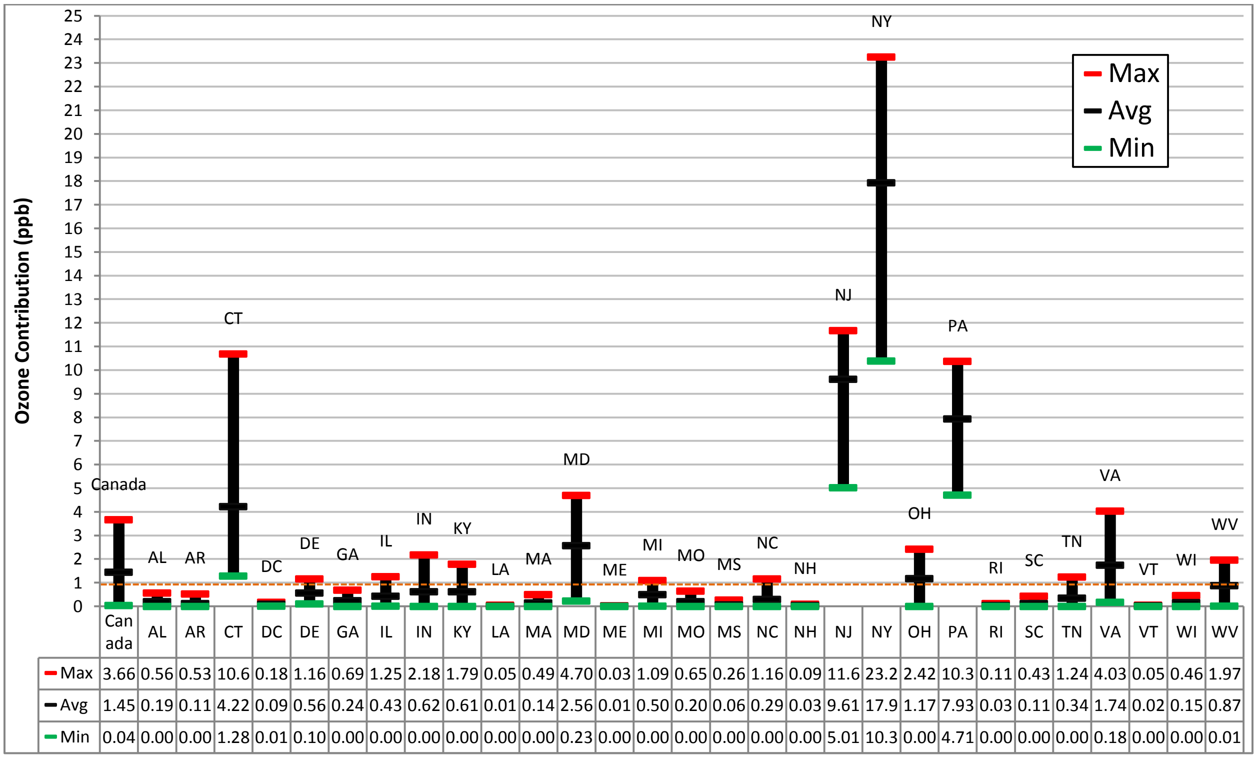
Figure 13-14: Total days state is projected to contribute at least 0.7 ppb to exceedance in 2023 at Babylon, NY (361030002) and sector that contributes the most during the exceedance date from the state



It is also important to look at the variability as to the contribution each state is projected to provide to nonattainment in 2023. Figure 13-15 through Figure 13-18 show the maximum, average, and minimum contribution any individual state makes to one of the four examined monitors. With the exception of Sherwood Island, the home state on maximum contributes the most to nonattainment, and in Edgewood and Babylon even on the average day. For Sherwood Island, New York exhibits that contribution, which would be expected since the monitor is located directly across from New York.

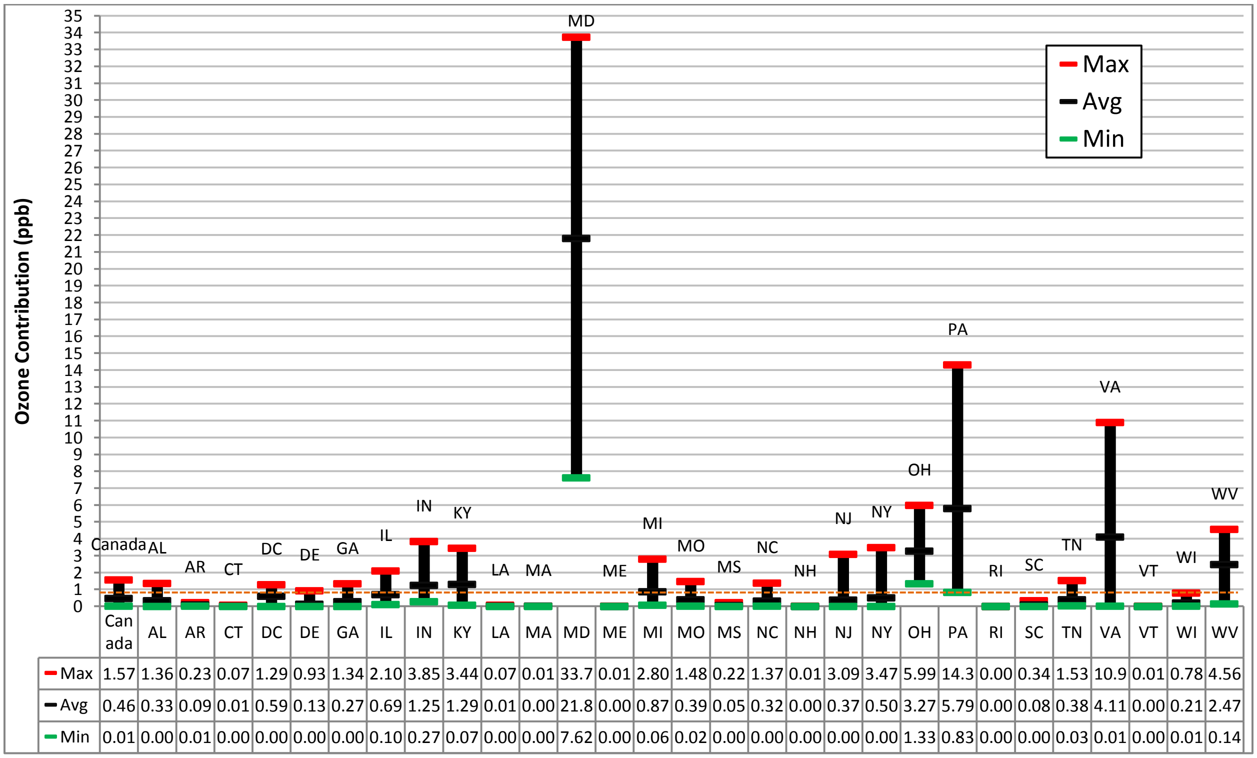
Nearby states make up the next cluster of contributors. This again is to be expected since we saw in the sector analysis that mobile sources are high contributors on many days and more distant states will not provide the same level of mobile emissions to the air mass. Midwestern/Ohio River Valley states make up the next cluster of states, which would be expected as well given the importance of EGU and large non-EGU point sources seen in the previous section.

Figure 13-15: Maximum, average, and minimum contribution by state on exceedance days at Sherwood Island, CT (90019003)



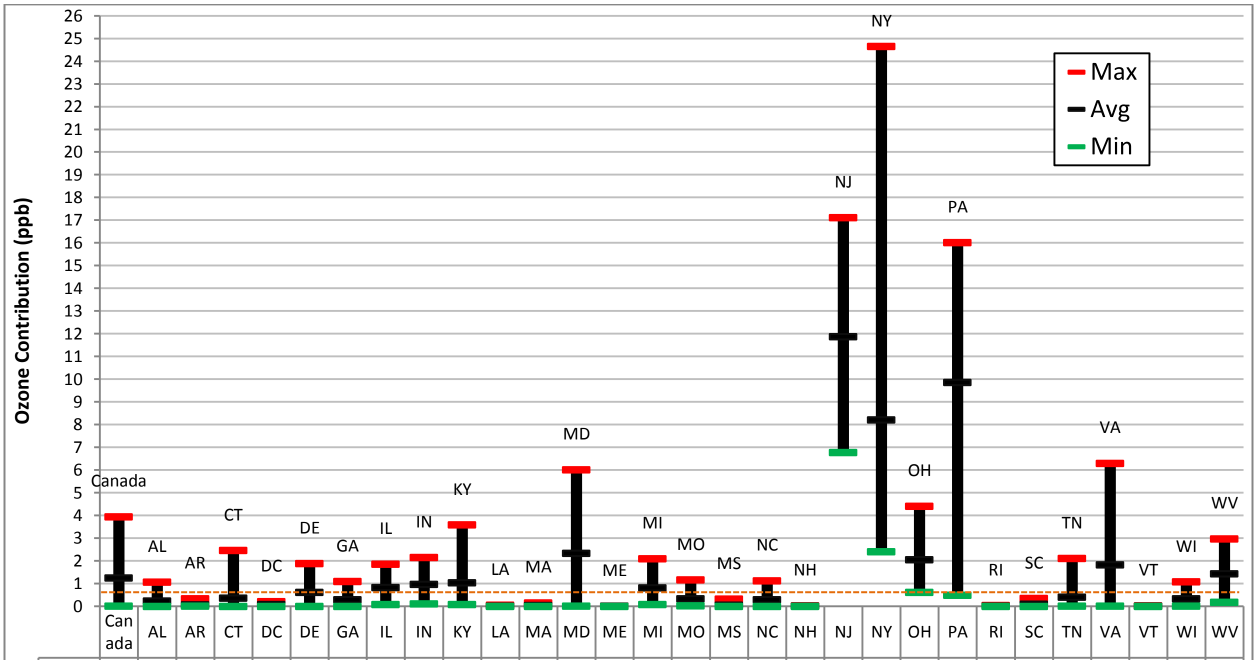
	Canada	AL	AR	CT	DC	DE	GA	IL	IN	KY	LA	MA	MD	ME	MI	MO	MS	NC	NH	NJ	NY	OH	PA	RI	SC	TN	VA	VT	WI	WV
Max	3.66	0.56	0.53	10.6	0.18	1.16	0.69	1.25	2.18	1.79	0.05	0.49	4.70	0.03	1.09	0.65	0.26	1.16	0.09	11.6	23.2	2.42	10.3	0.11	0.43	1.24	4.03	0.05	0.46	1.97
Avg	1.45	0.19	0.11	4.22	0.09	0.56	0.24	0.43	0.62	0.61	0.01	0.14	2.56	0.01	0.50	0.20	0.06	0.29	0.03	9.61	17.9	1.17	7.93	0.03	0.11	0.34	1.74	0.02	0.15	0.87
Min	0.04	0.00	0.00	1.28	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	5.01	10.3	0.00	4.71	0.00	0.00	0.00	0.18	0.00	0.00	0.01

Figure 13-16: Maximum, average, and minimum contribution by state on exceedance days at Edgewood, MD (240251001)



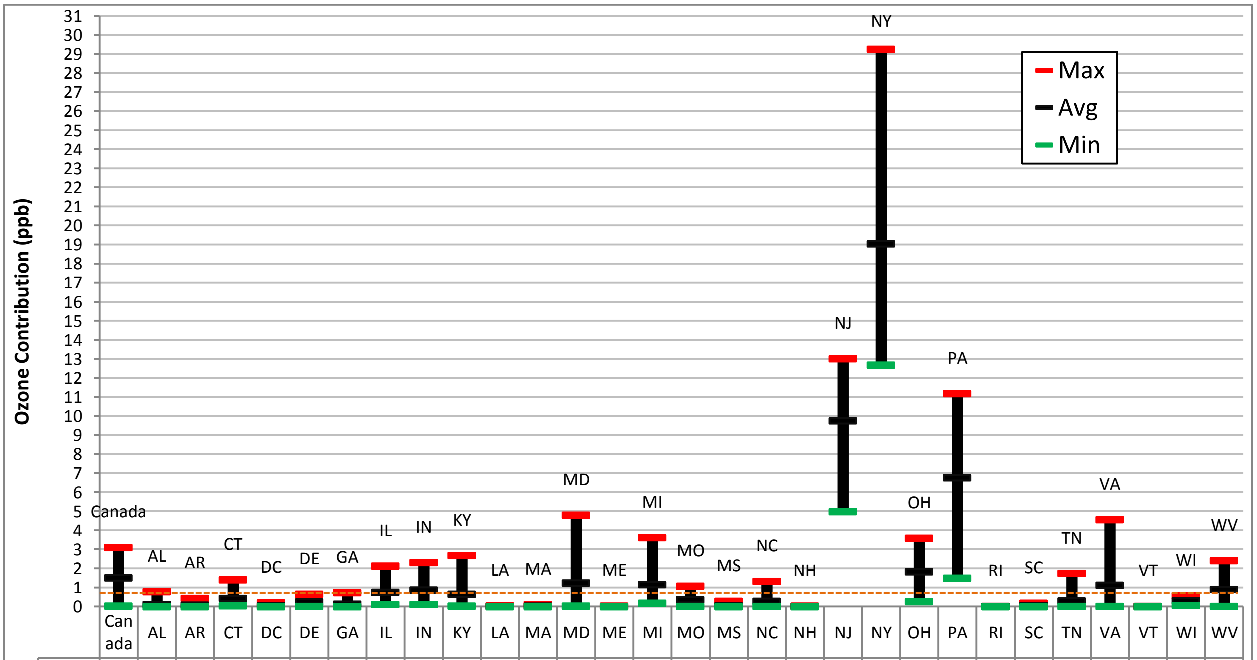
	Canada	AL	AR	CT	DC	DE	GA	IL	IN	KY	LA	MA	MD	ME	MI	MO	MS	NC	NH	NJ	NY	OH	PA	RI	SC	TN	VA	VT	WI	WV
Max	1.57	1.36	0.23	0.07	1.29	0.93	1.34	2.10	3.85	3.44	0.07	0.01	33.7	0.01	2.80	1.48	0.22	1.37	0.01	3.09	3.47	5.99	14.3	0.00	0.34	1.53	10.9	0.01	0.78	4.56
Avg	0.46	0.33	0.09	0.01	0.59	0.13	0.27	0.69	1.25	1.29	0.01	0.00	21.8	0.00	0.87	0.39	0.05	0.32	0.00	0.37	0.50	3.27	5.79	0.00	0.08	0.38	4.11	0.00	0.21	2.47
Min	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.10	0.27	0.07	0.00	0.00	7.62	0.00	0.06	0.02	0.00	0.00	0.00	0.00	0.00	1.33	0.83	0.00	0.00	0.03	0.01	0.00	0.01	0.14

Figure 13-17: Maximum, average, and minimum contribution by state on exceedance days at Susan Wagner, NY (360850067)



	Canada	AL	AR	CT	DC	DE	GA	IL	IN	KY	LA	MA	MD	ME	MI	MO	MS	NC	NH	NJ	NY	OH	PA	RI	SC	TN	VA	VT	WI	WV
🟥 Max	3.94	1.06	0.34	2.46	0.20	1.88	1.09	1.85	2.15	3.58	0.06	0.16	6.01	0.01	2.10	1.16	0.31	1.13	0.03	17.1	24.6	4.40	16.0	0.03	0.35	2.11	6.30	0.03	1.07	2.97
■ Avg	1.25	0.23	0.07	0.35	0.07	0.61	0.29	0.82	0.97	1.04	0.01	0.03	2.33	0.00	0.81	0.33	0.05	0.29	0.00	11.8	8.21	2.05	9.85	0.00	0.10	0.40	1.83	0.01	0.34	1.44
🟩 Min	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.10	0.08	0.00	0.00	0.00	0.00	0.09	0.02	0.00	0.00	0.00	6.76	2.41	0.61	0.49	0.00	0.00	0.01	0.01	0.00	0.01	0.17

Figure 13-18: Maximum, average, and minimum contribution by state on exceedance days at Babylon, NY (361030002)



	Canada	AL	AR	CT	DC	DE	GA	IL	IN	KY	LA	MA	MD	ME	MI	MO	MS	NC	NH	NJ	NY	OH	PA	RI	SC	TN	VA	VT	WI	WV
🟥 Max	3.10	0.79	0.43	1.41	0.19	0.65	0.73	2.13	2.31	2.68	0.04	0.11	4.80	0.03	3.63	1.08	0.28	1.33	0.03	13.0	29.2	3.59	11.1	0.01	0.18	1.73	4.57	0.01	0.57	2.41
■ Avg	1.50	0.12	0.08	0.43	0.04	0.24	0.12	0.75	0.86	0.65	0.01	0.03	1.23	0.01	1.15	0.36	0.04	0.28	0.01	9.75	19.0	1.82	6.76	0.01	0.06	0.29	1.12	0.00	0.32	0.89
🟩 Min	0.03	0.00	0.00	0.05	0.00	0.01	0.00	0.11	0.12	0.03	0.00	0.00	0.02	0.00	0.17	0.01	0.00	0.00	0.00	4.98	12.6	0.27	1.49	0.00	0.00	0.01	0.02	0.00	0.06	0.01

Diurnal Analysis

Figure 13-19 though Figure 13-22 examines the contribution from onroad, nonroad, and ERTAC EGUs on each day of the week through the entirety of the modeled days at four of the monitors of focus. Two monitors, Edgewood, MD and Susan Wagner, NY, are projected to have exceedances on weekend days and overall their concentrations are not projected to differ greatly between weekends and weekdays. There does appear at all four monitors to be a stronger signal from onroad contribution on weekdays than on weekends, but differences are minor.

Figure 13-19: Ozone concentration grouped by day of the week in Julian days at Sherwood Island Connector, CT (90019003)

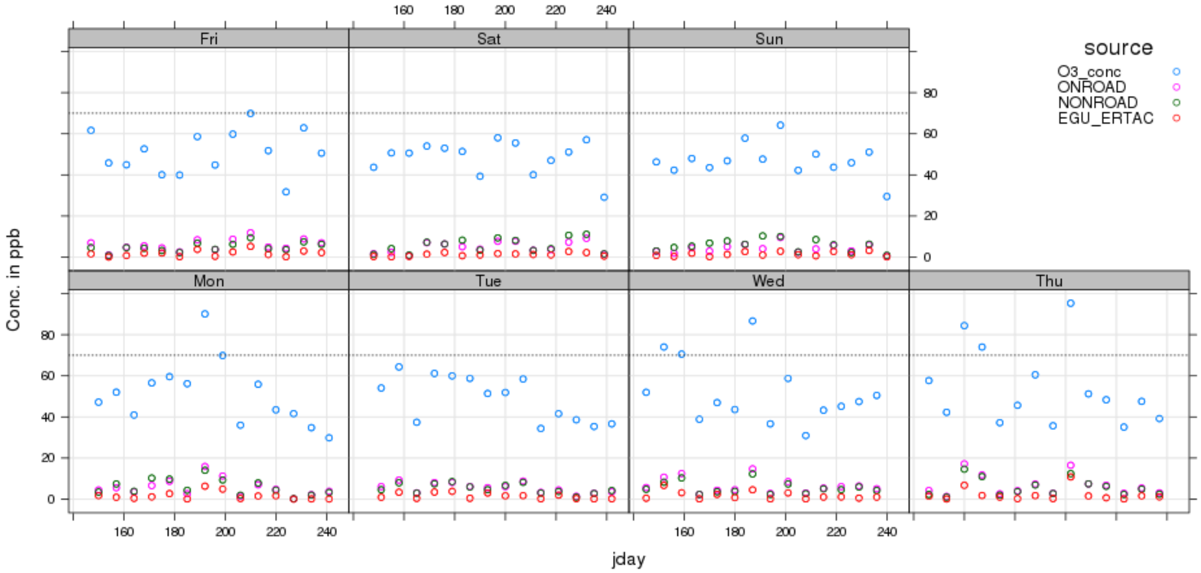


Figure 13-20: Ozone concentration grouped by day of the week in Julian days at Edgewood, MD (240251001)

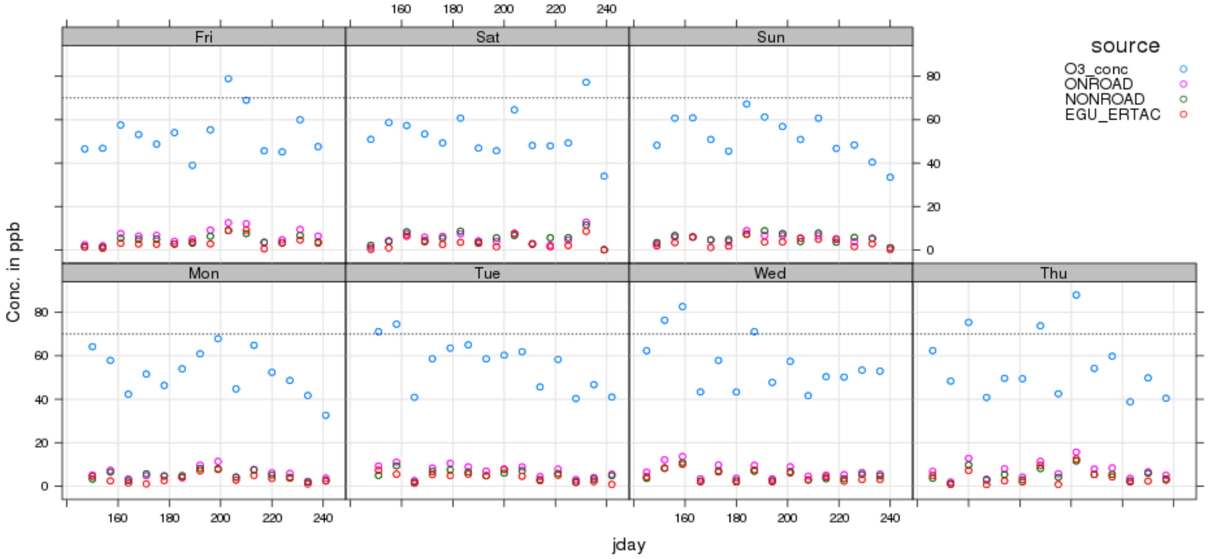


Figure 13-21: Ozone concentration grouped by day of the week in Julian days at Susan Wagner, NY (360850067)

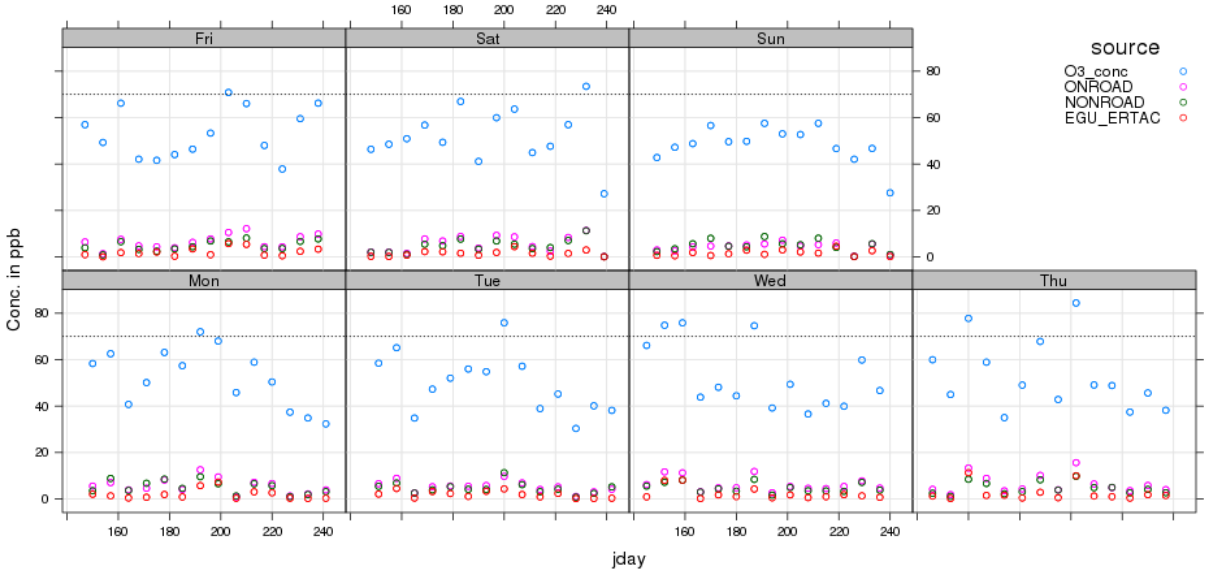
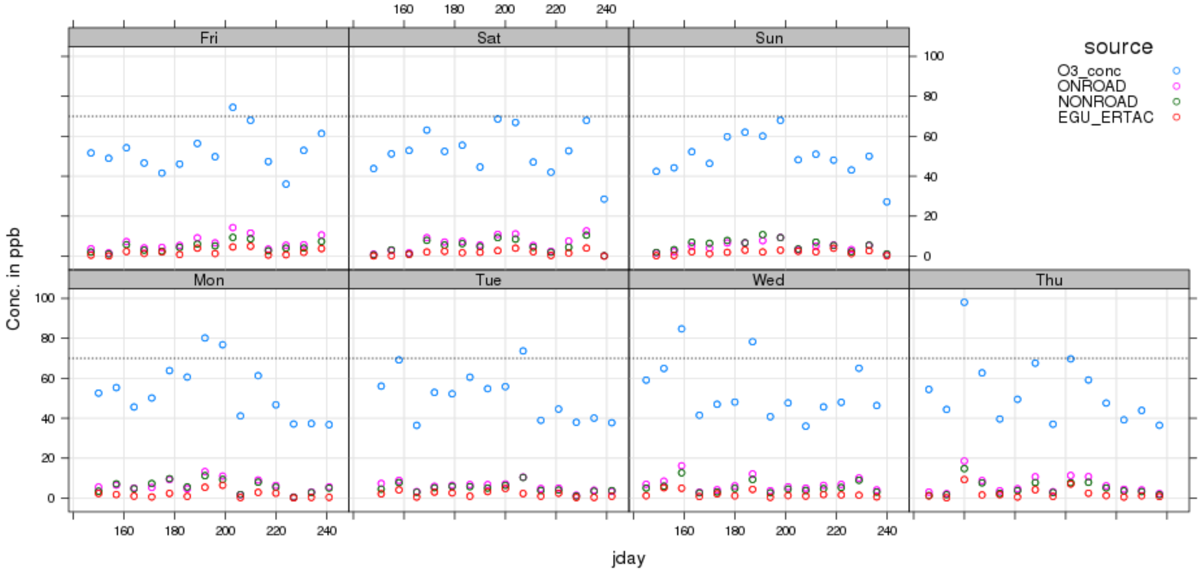


Figure 13-22: Ozone concentration grouped by day of the week in Julian days at Babylon, NY (361030002)



Comparison with EPA Modeling

Finally, to compare the linkages found as a result of the OTC analysis with similar EPA modeling. We used the same technique for calculating linkages to a receptor from EPA’s four step process used in the ‘en’ platform contribution modeling (US EPA December 2016). The first difference as seen in Table 13-10 is concerning which monitors are projected to attain is that the monitoring results are slightly different. EPA’s modeling projects an additional monitor in Connecticut to not attain the NAAQS, while Edgewood, MD and Susan Wagner, NY are projected to attain. Given that OTC relied heavily on EPA’s ‘en’ emission inventories (as shown in Section 9) and that the major differences between the two modeling platforms is the EGU inventory that was used, one might expect that heavy reliance on a particular operating pattern of EGUs in the future year may be somewhat problematic if a bright-line test in employed.

Table 13-10: 1% contribution linkages in EPA 'en' and OTC Gamma 2023 CAMx contribution modeling*

			EPA 'en'		Gamma 2023	
State	**County**	**ID**	**DVF (ppb)**	**1% Linkage**	**DVF (ppb)**	**1% Linkage**
CT	Fairfield	90019003	73	CT, IN, KY, MD, NJ, NY, OH, PA, VA, WV	71	CT, MD, MI, NJ, NY, OH, PA, VA, WV
CT	Fairfield	90013007	71	CT, MD, MI, NJ, NY, OH, PA, WA WV	Attaining	
MD	Harford	240251001	Attaining		71	IN, KY, MD, MI, OH, PA, VA, WV
NY	Queens	360850067	Attaining		71	IL, IN, KY, MD, MI, NJ, NY, OH, PA, VA, WV
NY	Suffolk	361030002	74	CT, IL, IN, KY, MD, NJ, NY, OH, PA, VA	72	CT, MD, MI, NJ, NY, OH, PA, VA, WV

* Red indicates a state that was not found to contribute in both modeling analyses.

There is also a difference in the states linked to each monitor as well. For instance, Indiana and Kentucky are linked to Sherwood Island Connector, CT in the EPA modeling and in the OTC modeling Michigan is linked to the Sherwood Island Connector, CT monitor but Indiana and Kentucky are not. For Babylon, NY, Illinois, Indiana, and Kentucky are linked in EPA modeling and Michigan and West Virginia are linked to the monitor in the OTC modeling. Since meteorology and many of the emissions are consistent between the two platforms this is largely due to projected behavior from EGUs.

State Specific Contribution

This section will walk through the first two steps of the four step process EPA has outlined in previous transport rules to determine which states are projected to contribute to nonattainment or interfere with maintenance using the OTC 2023 CAMx modeling.

Step 1: Identify Downwind Air Quality Problems

The 2023 CAMx modeling identified the monitors listed in Table 13-11 in the Eastern U.S. as being projected to be in nonattainment (an average design value greater than or equal to 71 ppb) or maintenance (a maximum design value greater than or equal to 71 ppb) of the 2015 Ozone NAAQS in 2023.

Table 13-11: Monitors projected to be in nonattainment or to be in maintenance in 2023 in the Eastern US

Site	State	County	Monitor Name	Avg. DV	Max DV	2023 Status
90010017	Connecticut	Fairfield	Greenwich	69.5	71.8	Maintenance
90013007	Connecticut	Fairfield		70.6	74.5	Maintenance
90019003	Connecticut	Fairfield	Sherwood Island	71.9	74.7	Nonattainment
90099002	Connecticut	New Haven	New Haven	69.9	72.6	Maintenance
240251001	Maryland	Harford	Edgewood	71.1	74.2	Nonattainment
360810124	New York	Queens	Queens College	69.4	71.2	Maintenance
360850067	New York	Richmond	Susan Wagner	71.1	72.6	Nonattainment
361030002	New York	Suffolk	Babylon	72.0	73.5	Nonattainment

Step 2: Identify Upwind States

When examining the receptors identified in the 2023 CAMx modeling as projected to be in nonattainment or maintenance of the 2015 Ozone NAAQS we calculated the contribution from upwind states in two fashions. The first approach, defined as "DVF Adjusted Exceedance Average," began by taking all days modeled to be an exceedance at the monitors in Table 13-11. The contribution from each state was averaged across all of those days. The contributions were then adjusted by the ratio of the DVF at the monitor to the 8-hour ozone modeled by CAMx. The second approach, defined as "DVF Adjusted Four Highest Average" began by taking all days modeled to be an exceedance, but in this case averaged the four highest contribution values on any of those days. This average again was adjusted by the ratio of the DVF to the 8-hour ozone modeled by CAMx. The intention of this second approach is to capture contributions by states that contribute significantly to at least 4 exceedances, but may not contribute significantly to every exceedance.

Table 13-12 shows the contribution from upwind states to the four monitors projected to be in nonattainment in 2023 and Table 13-13 shows the same type of data for the monitors projected to be in maintenance in in 2023. Any state-level contribution above 0.7 ppb (1% of the 2015 NAAQS) is highlighted in red. Additional details on selected monitors, for both contributions by state and sector are available in Appendix D.

Table 13-12: State level contribution (ppb) to monitors projected to be in nonattainment in 2023

	Sherwood Island, CT (90019003)		Edgewood, MD (240251001)		Susan Wagner, NY (360850067)		Babylon, NY (361030002)	
State	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.
AL	0.166	0.248	0.307	0.751	0.217	0.433	0.104	0.180
AR	0.098	0.146	0.080	0.146	0.062	0.113	0.072	0.120
CT	3.611	4.751	0.011	0.027	0.330	0.658	0.383	0.630
DC	0.074	0.103	0.551	0.864	0.069	0.135	0.036	0.061
DE	0.481	0.630	0.120	0.295	0.570	1.118	0.211	0.345
GA	0.206	0.306	0.253	0.603	0.271	0.535	0.109	0.187
IA	0.042	0.061	0.103	0.185	0.140	0.256	0.121	0.190
IL	0.371	0.543	0.640	1.189	0.769	1.246	0.670	1.060
IN	0.527	0.770	1.167	2.213	0.908	1.462	0.766	1.247
KY	0.523	0.775	1.206	2.398	0.974	1.786	0.580	0.982
LA	0.012	0.018	0.014	0.033	0.011	0.021	0.006	0.010
MA	0.119	0.177	0.003	0.008	0.031	0.062	0.030	0.053
MD	2.192	2.992	20.349	26.651	2.175	4.264	1.093	1.860
ME	0.007	0.011	0.000	0.001	0.001	0.003	0.008	0.014
MI	0.427	0.594	0.810	1.604	0.760	1.240	1.027	1.484
MN	0.044	0.066	0.051	0.100	0.062	0.103	0.094	0.140
MO	0.168	0.251	0.360	0.781	0.308	0.536	0.320	0.540
MS	0.053	0.080	0.045	0.106	0.048	0.095	0.038	0.066
NC	0.251	0.356	0.297	0.647	0.268	0.450	0.248	0.423
NH	0.025	0.037	0.001	0.002	0.004	0.008	0.009	0.015
NJ	8.217	9.503	0.343	0.856	11.084	13.215	8.677	9.896
NY	15.332	17.111	0.465	1.128	7.671	12.319	16.944	20.045
OH	1.004	1.368	3.054	4.550	1.912	2.794	1.620	2.467
PA	6.784	8.003	5.404	10.740	9.202	12.485	6.012	8.564
RI	0.025	0.038	0.000	0.001	0.004	0.009	0.005	0.008
SC	0.096	0.142	0.078	0.180	0.092	0.172	0.056	0.095
TN	0.292	0.435	0.357	0.793	0.375	0.725	0.259	0.444
TX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VA	1.485	2.104	3.833	6.857	1.711	3.264	0.997	1.691
VT	0.014	0.022	0.001	0.003	0.005	0.011	0.003	0.005
WI	0.131	0.192	0.195	0.375	0.313	0.516	0.285	0.428
WV	0.748	1.065	2.304	3.467	1.342	2.244	0.794	1.266
Max	**15.332**	**17.111**	**20.349**	**26.651**	**11.084**	**13.215**	**16.944**	**20.045**

Table 13-13: State level contribution (ppb) to monitors projected to be in maintenance in 2023

	Greenwich, CT (90010017)		Stratford, CT (90013007)		New Haven, CT (90099002)		Queens College, NY (360810124)	
State	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.	Exceedance Avg.	4th High Avg.
AL	0.062	0.140	0.101	0.126	0.065	0.098	0.015	0.026
AR	0.052	0.116	0.101	0.126	0.069	0.104	0.021	0.030
CT	7.942	9.898	5.343	6.168	6.117	6.865	0.324	0.564
DC	0.046	0.096	0.066	0.081	0.044	0.057	0.052	0.089
DE	0.204	0.412	0.336	0.392	0.326	0.401	0.364	0.631
GA	0.076	0.169	0.125	0.156	0.070	0.105	0.050	0.085
IA	0.057	0.122	0.046	0.058	0.066	0.096	0.186	0.271
IL	0.392	0.850	0.407	0.508	0.518	0.760	0.867	1.287
IN	0.467	1.016	0.532	0.665	0.626	0.926	0.745	1.190
KY	0.347	0.758	0.389	0.486	0.488	0.727	0.296	0.477
LA	0.004	0.010	0.007	0.009	0.005	0.008	0.000	0.000
MA	0.066	0.147	0.066	0.082	0.108	0.161	0.005	0.009
MD	1.240	2.467	1.918	2.328	1.361	1.818	1.549	2.667
ME	0.017	0.037	0.004	0.005	0.009	0.014	0.000	0.000
MI	0.388	0.716	0.463	0.578	0.453	0.635	1.536	2.254
MN	0.037	0.074	0.052	0.065	0.050	0.073	0.113	0.162
MO	0.172	0.383	0.182	0.228	0.229	0.342	0.334	0.570
MS	0.028	0.062	0.047	0.058	0.030	0.045	0.003	0.006
NC	0.277	0.589	0.259	0.324	0.302	0.441	0.262	0.433
NH	0.022	0.048	0.015	0.019	0.023	0.035	0.000	0.000
NJ	6.621	9.388	7.160	8.023	5.734	6.618	8.368	10.431
NY	17.074	19.618	15.453	15.873	15.466	16.971	12.990	16.703
OH	0.992	2.003	0.885	1.106	1.326	1.895	1.855	2.516
PA	5.186	7.499	6.334	6.935	5.746	7.012	6.179	9.080
RI	0.011	0.024	0.014	0.018	0.026	0.039	0.000	0.000
SC	0.059	0.129	0.099	0.124	0.056	0.084	0.073	0.126
TN	0.148	0.327	0.233	0.292	0.200	0.298	0.038	0.057
TX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VA	1.247	2.618	1.338	1.625	0.891	1.228	1.483	2.533
VT	0.010	0.024	0.009	0.012	0.013	0.020	0.000	0.000
WI	0.118	0.241	0.149	0.186	0.154	0.218	0.474	0.660
WV	0.651	1.151	0.552	0.688	0.673	0.957	0.660	1.045
Max	**17.074**	**19.618**	**15.453**	**15.873**	**15.466**	**16.971**	**12.990**	**16.703**

References

Clean Air Act Amendments of 1990 (United States|US 1990).

Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS, 81 (United States|US [Final Rule] 2016).

US EPA 2016, *Air Quality Modeling Technical Support Document for the 2015 Ozone NAAQS Preliminary Interstate Transport Assessment*, Research Triangle Park, NC, accessed January 6, 2017, from <https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2016-0751-0036&disposition=attachment&contentType=pdf>.

Notice of Availability of the Environmental Protection Agency’s Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone National Ambient Air Quality Standard (NAAQS), 82 (United States|US [Notice Of Data Availability] 2017).

Section 14. Episodic Modeling using the 2011 Ozone Transport Commission Modeling Platform

Overview

This section presents procedures the OTC is using or plans to use to for episodic model runs using the CMAQ modeling platform, an acceptable photochemical model. The focus of this modeling is to provide analyses to guide SIP development for the eight-hour ozone standard using a future year of 2018 and potentially be used in the WOE analyses in the aforementioned SIPs. The OTC Commissioners and Air Directors requested that the OTC Modeling Committee develop this tool to allow sensitivity and screening modeling to occur with greater ease and speed than occurred with full year photochemical runs.

The modeling will use a base case episode from June 30 to August 4, 2011. This time period aligns with the Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ) measurement campaign that took place over Maryland. Using a modeling a period of a month will dramatically reduce the time and computing resources necessary to model the extensive number of scenarios needed to properly evaluate control programs that can be included in Ozone SIPs.

The objective of this modeling protocol is to maintain and enhance the technical credibility of the modeling study by describing the procedures that will take place and result in a successful modeling analysis. By including information as to why episodes were selected, the modeling platform used , the model based evaluation of the selected episode, and on how modeling runs should be conducted, the OTC are ensuring a replicable modeling exercise that will stand up to scrutiny.

Selection of Episodes

In recent years the OTC has relied on two modeling platforms for planning work. Both modeling platforms use CMAQ for photochemical modeling. The first of these platforms uses 2007 as a base year for meteorology and emissions inventories, and the second uses 2011. The committee determined that no new modeling platform would be developed as a result of this work thus limiting the choice of episodes of ozone pollution during only those two years. In 2007 and 2011 the modeling committee found four episodes, two per year, that were considered to be worthy of further analysis. These were time periods with high ozone values and a relatively large number of exceedances of the 2008 75 ppb NAAQS, which suggested a sustained ozone episode throughout the OTR.

Given the level of resources available and that this modeling analysis will only be used for screening purposes, screening nature, the OTC determined that only one of four episodes be used. The time periods of the four episodes considered for this screening analysis are in Table 14-1 and general informative maps of the four episodes in question can be seen in Figure 14-1 to Figure 14-8.

Table 14-1: Descriptions of episodes

	TIME SPAN	NUMBER OF DAYS
Episode A	May 25-June 12, 2011	19
Episode B	June 27-August 2, 2011	37
Episode C	June 15-June 28, 2007	19
Episode D	July 30-August 4, 2007	5

The OTC wanted to choose an episode(s) that complies with the primary criteria set forth in EPA's 8-hour ozone modeling guidance for selecting ozone episodes for attainment demonstration modeling:

- Select periods, preferably during NEI years, for which extensive air quality/meteorological databases exist;
- Model a sufficient number of days so that the modeled attainment test can be applied at all of the ozone monitoring sites that are in violation of the NAAQS;
- Model time periods that include pollution concentration episodes to ensure the modeling system appropriately include a mix of high and low periods; and
- Select a mix of episodes reflecting a variety of meteorological conditions that frequently correspond with observed eight-hour daily maximum ozone concentrations greater than the level of the NAAQS at different monitoring sites (US EPA 2014).

Figure 14-1: Monitored Ozone Data for Episode A (May 25-June 12, 2011)

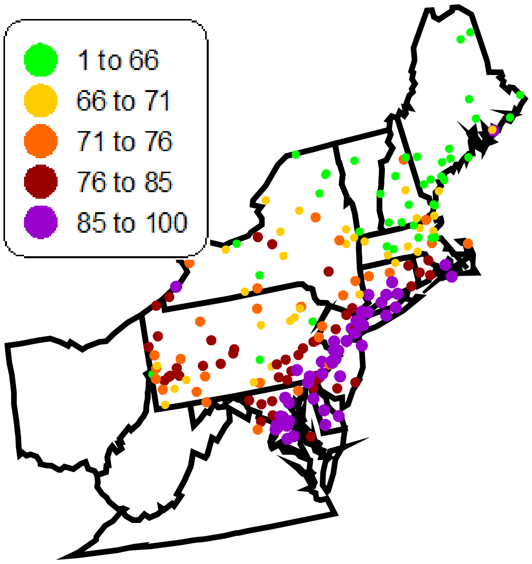


Figure 14-2: Number of Days with Ozone > 75ppb for Episode A (May 25-June 12, 2011)

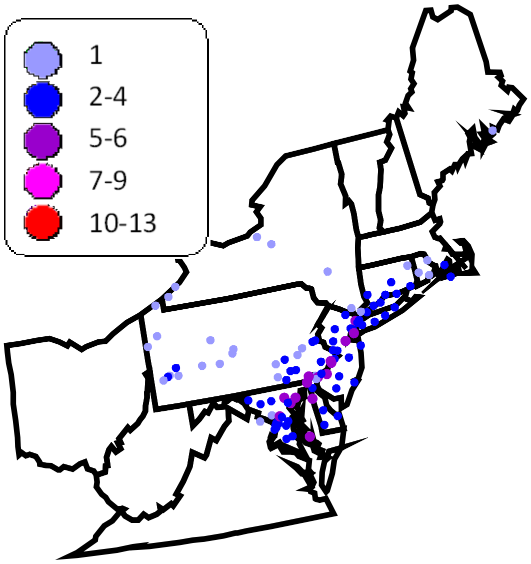


Figure 14-3: Monitored Ozone Data for Episode B (June 27-August 2, 2011)

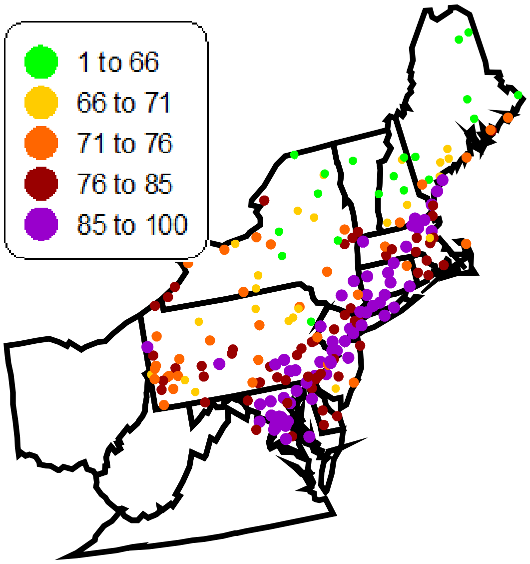


Figure 14-4: Number of Days with Ozone > 75ppb for Episode B (June 27-August 2, 2011)

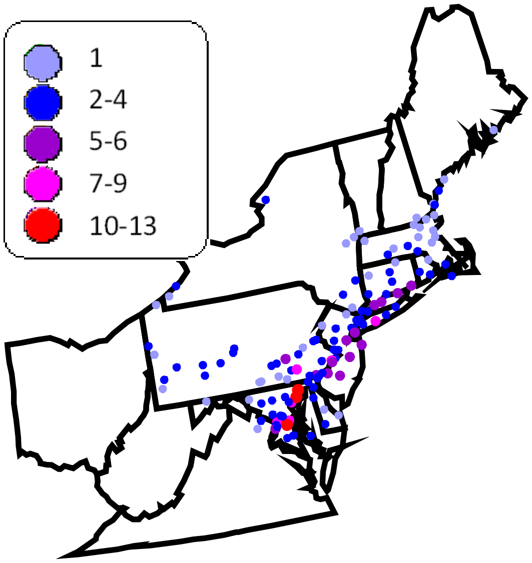


Figure 14-5: Monitored Ozone Data for Episode C (June 15-June 28, 2007)

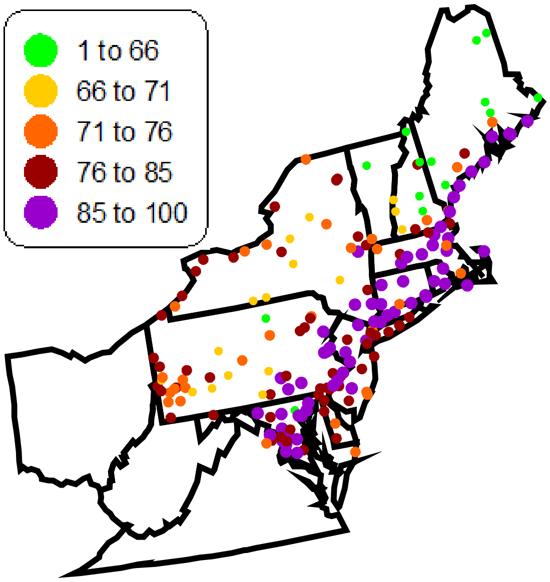


Figure 14-6: Number of Days with Ozone > 75ppb for Episode C (June 15-June 28, 2007)

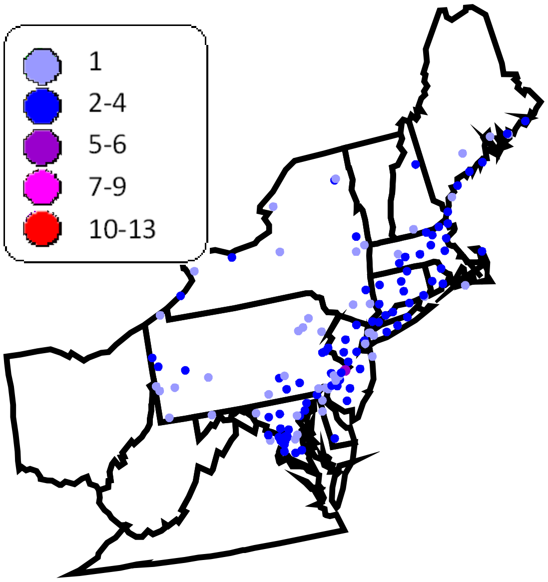


Figure 14-7: Monitored Ozone Data for Episode D (July 30-August 4, 2007)

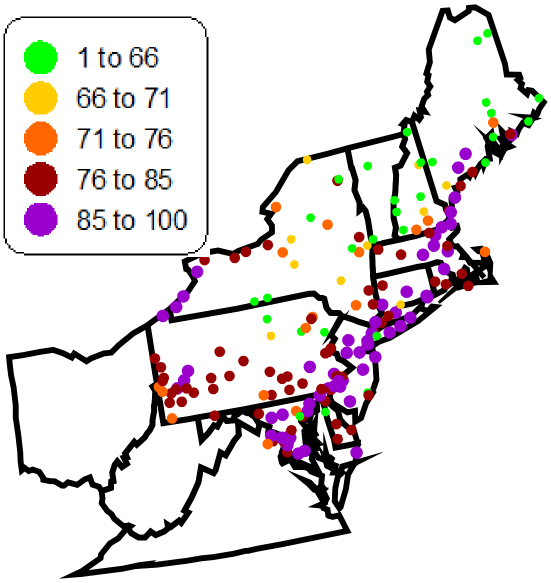
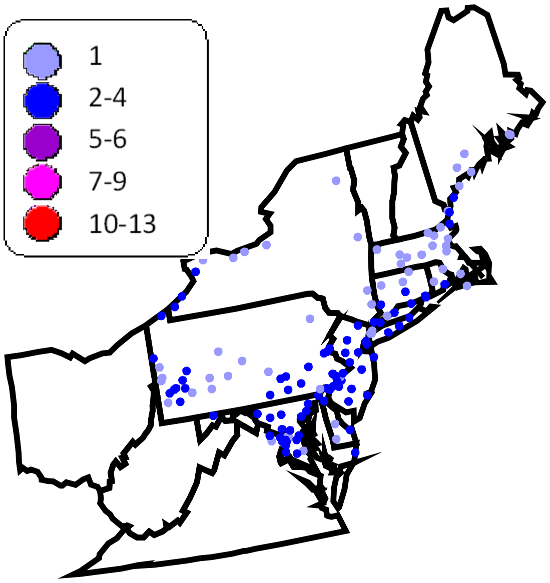


Figure 14-8: Number of Days with Ozone > 75ppb for Episode D (July 30-August 4, 2007)



Available Data Sets

The summer of 2011 was selected as the best time period due to the third criteria. This time period corresponds with the time period studied by the DISCOVER-AQ campaign, which provides an additional wealth of data in regards to air quality than is otherwise available. Given the 2007 episodes do not have the corresponding data sets; OTC determined that use of 2011 is preferable.

Additionally, the inventories available for use in 2011 are more recent, built upon the NEI, developed with more modern tools (e.g. MOVES 2014 rather than MOVES 2010), and are in formats that the states are now more accustomed to work with (e.g. ff10). These factors lead to a narrowing of either Episode A or B being chosen.

Sufficient Time Span

It is important that there are enough days with high ozone that can be used when calculating relative reduction factors. When comparing the four episodes Episode B has a greater magnitude of exceedances in terms of both the number of monitor-days and the maximum number of exceedances at a given monitor. When looking at individual states there are a greater number of exceedances in New England save Connecticut in Episode C, but only one monitor is exceeding in each of those states so focusing on the states from Connecticut south is of greater importance in choosing episodes. Though as a whole Episode B is the most sufficient in terms of exceedances, none of the episodes seem to capture the meteorological conditions found during the 2013, 2014, and 2015 ozone season where exceedances were centered on the New York City nonattainment area rather than the Baltimore nonattainment area. Also since Episode D is so short, only five days long, the additional trait of having days that lack exceedances was not met as well.

Table 14-2: Exceedances of 75ppb by state during episodes in the OTR

	CT	*DC*	*DE*	*MA*	*MD*	*ME*	*NH*	*NJ*	*NY*	*PA*	*RI*	*VT*	*VA*	*Total*
Monitor-Days Ep. A	20	7	17	4	66	1	0	50	30	63	3	0	12	***273***

Max Days/Monitor Ep. A	3	4	5	2	6	1	0	5	5	5	1	0	4	***6***
Monitor-Days Ep. B	41	10	22	19	90	4	5	54	43	79	5	1	17	***390***
Max Days/Monitor Ep. B	6	7	5	2	13	2	2	6	7	7	2	1	6	***13***
Monitor-Days Ep. C	29	6	5	28	38	14	7	25	34	51	8	0	20	***265***
Max Days/Monitor Ep. C	4	2	2	4	4	2	2	3	3	5	3	0	3	***5***
Monitor-Days Ep. D	21	5	11	15	40	9	4	33	36	68	4	0	19	***265***
Max Days/Monitor Ep. D	4	3	3	2	4	2	2	4	4	4	2	0	3	***4***

Meteorological Conditions

Several major transport patterns can play an important role in creating the conditions for ozone exceedances to occur in the OTR; 1) over mountain interregional transport from sources in the Midwest, 2) multi-state transport from the nocturnal low level jet (NLLJ), and 3) local stagnation (Hudson et al. October 2006). Following the determination of which time periods were appropriate for analysis, it was necessary to determine whether these they had an appropriate distribution of the different ozone conducive transport patterns. Selection of an episode that was not representative could have the effect of causing strategies needed to reduce ozone originating from a particular region going unrealized or not being sufficient to overcome situations where all three transport patterns are acting in tandem.

To determine the appropriateness of the episodes in regards to transport patterns HySplit was employed to conduct back trajectory analyses for two monitors, Westport CT and Edgewood, MD, which have particularly persistent ozone problems (Stein, Draxler, Rolph, Stunder, Cohen and Ngan 2015; Rolph, Stein and Stunder 2017). The trajectory analyses were conducted at 100m height level. Figure 14-9 to Figure 14-16 show the trajectory analyses for the four episodes for the two monitors, odd and even figures respectively. Three of the episodes were found to have the necessary transport patterns to result in sufficient analyses, whereas Episode D lacked a southerly airflow.

Figure 14-9: Wind trajectories of ozone (ppb) for Westport, CT monitor during Episode A (May 25-June 12, 2011)

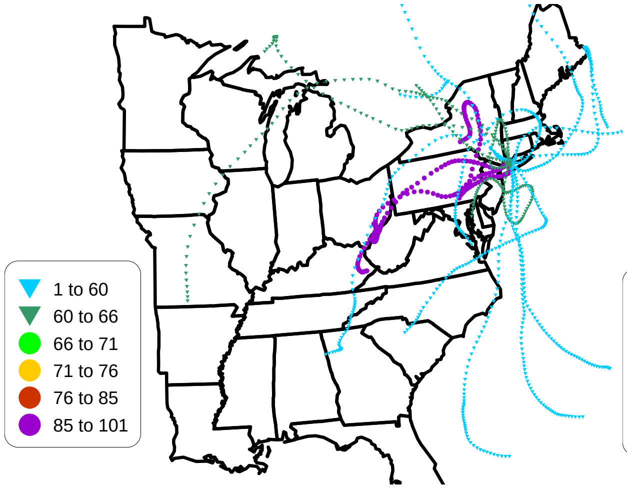


Figure 14-10: Wind trajectories of ozone (ppb) for Edgewood, MD monitor during Episode A (May 25-June 12, 2011)

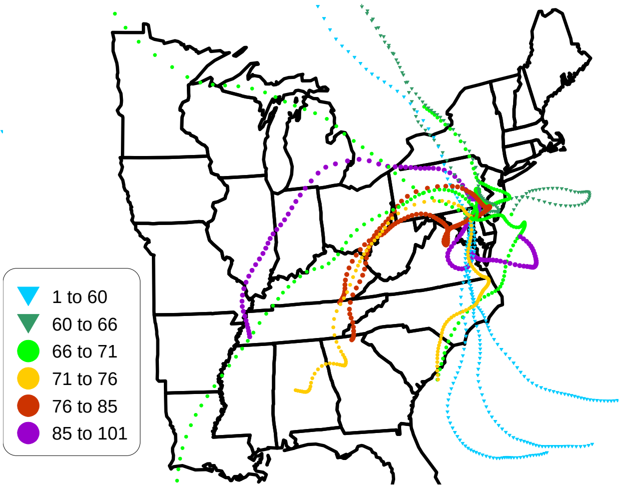


Figure 14-11: Wind trajectories of ozone (ppb) for Westport, CT monitor during Episode B (June 27-August 2, 2011)

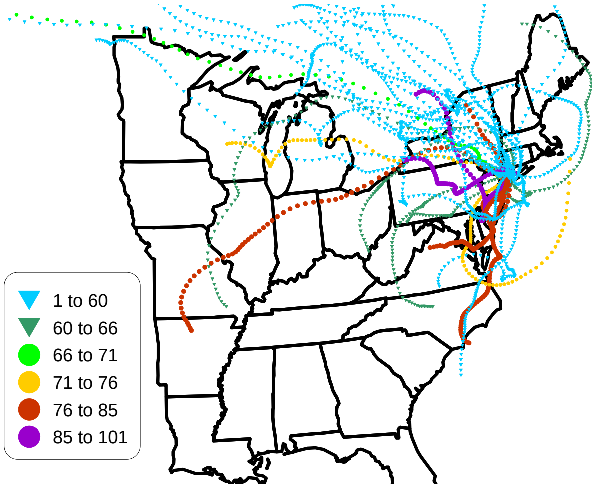


Figure 14-12: Wind trajectories of ozone (ppb) for Edgewood monitor during Episode B (June 27-August 2, 2011)

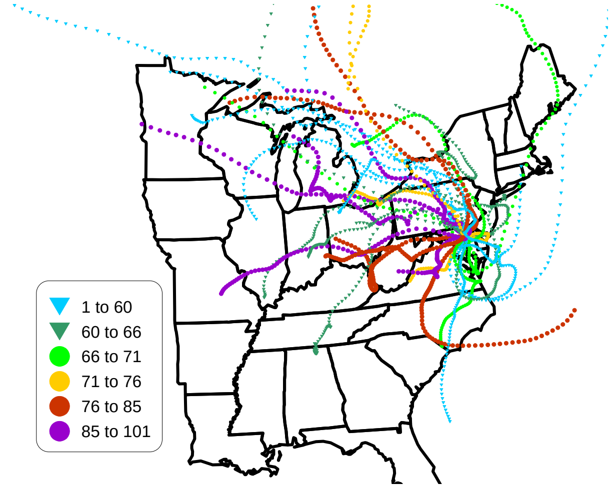


Figure 14-13: Wind trajectories of ozone (ppb) for Westport, CT monitor during Episode C (June 15-June 28, 2007)

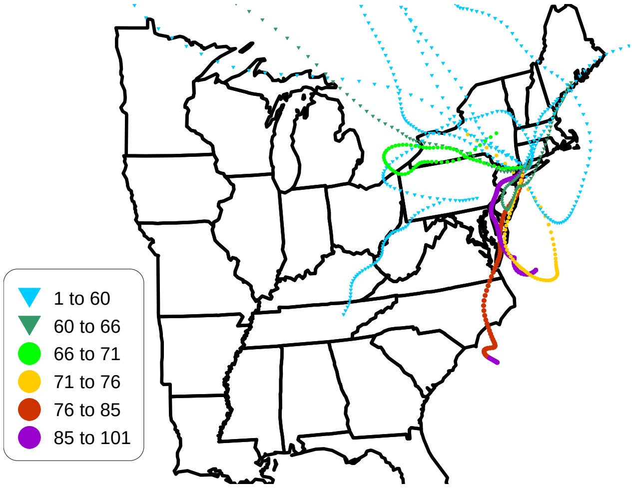


Figure 14-14: Wind trajectories of ozone (ppb) for Edgewood, MD monitor during Episode C (June 15-June 28, 2007)

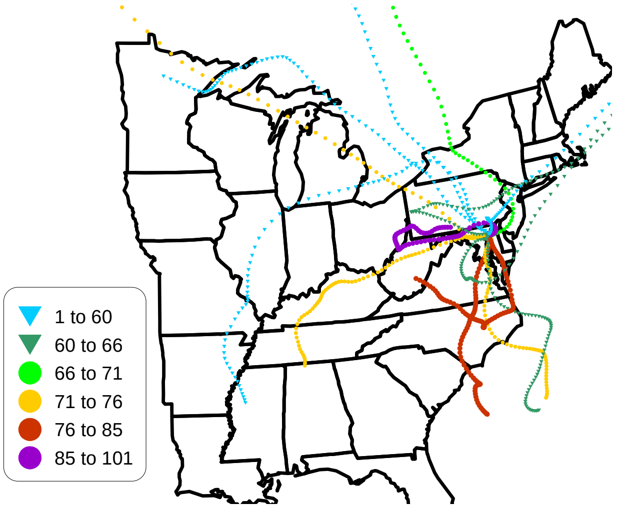


Figure 14-15: Wind trajectories of ozone (ppb) for Westport, CT monitor during Episode D (July 30-August 4, 2007)

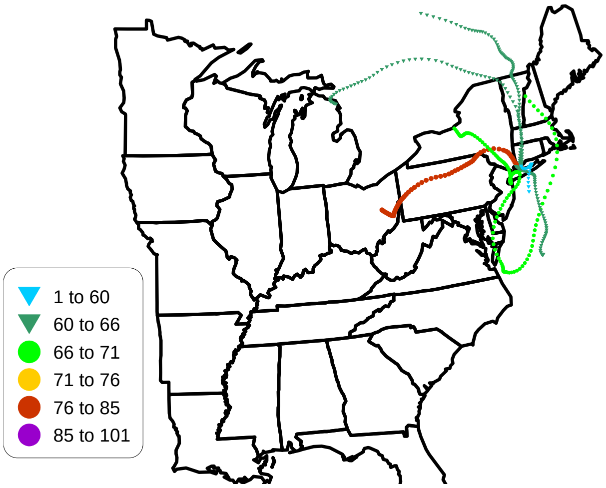
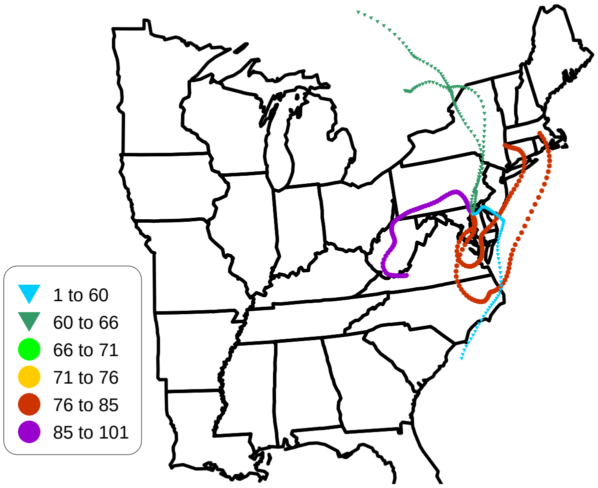


Figure 14-16: Wind trajectories of ozone (ppb) for Edgewood monitor during Episode D (July 30-August 4, 2007)



Summary

After examining each episode according to EPA’s four criteria, Episode B was selected. It occurred during the year where better inventory data is available, contained a high number of ozone exceedances as well as enough days without ozone exceedances, and a fair mix of meteorological conditions.

Modeling Platform

Model Selection

To ensure that a modeling study can be successfully used as technical support for an attainment demonstration SIP, the air quality model must be scientifically sound and appropriate for the intended application, and be freely accessible to all stakeholders. In a regulatory environment, it is crucial that oversight groups (e.g., EPA), the regulated community, and the interested public have access to and also be convinced of the suitability of the model. EPA in guidance cites the Community Multi-scale Air Quality Model (CMAQ) and the CAMx as two appropriate photochemical models to use (US EPA 2014). OTC staff has prior experience using CMAQ, CMAQ is open source allowing for greater scrutiny, and comparisons during prior analyses have shown CMAQ to be superior when analyzing Ozone in the OTR. For these reasons the modeling committee has chosen CMAQ to conduct the episodic modeling analyses. Several other models are needed to provide inputs to the photochemical model including a meteorological model and an emission processing model. The full list of the models used in the analyses is in Table 14-3.

Table 14-3: Model versions used in OTC episodic modeling analyses

	Model and Version
Photochemical Model	CMAQ v. 5.0.2
Meteorological Model	WRF v. 3.4
Emissions Processing:	
Emissions Modeling System	SMOKE v. 3.5.1 (C3 Marine Emissions Processed with SMOKE v. 3.6)
Biogenic Emissions Model	BEIS v. 3.6
Mobile on-road Emissions	MOVES 2014
EGU Emission	ERTAC EGU v. 2.3

More details on the selection of the photochemical modeling platform that the OTC decided to use can found in the OTC modeling protocol.

Emissions Inventory

When work began on episodic modeling the Alpha 2 inventory was used to supply emissions estimates. There were no changes made beyond the Alpha 2 for the episodic modeling runs. Details on the Alpha inventory are located in “Technical Support Document Emission Inventory Development for 2011, 2018, and 2028 for the Northeastern US Alpha 2 Version (McDill, McCusker and Sabo 2015).”

Monitor to Model Comparison

When comparing the modeled ozone values obtained from a run that only contains the days in July (a slightly shorter period than the episode to be modeled) and the full ozone season there is good agreement between the results. Table 14-4, Figure 14-17, July only, compared to Figure 14-18, full ozone season, and Figure 14-19, July only, compared to Figure 14-20, full ozone season, show consistent results for both the 2011 and 2018 modeled results in design value calculations, though in both cases values are higher in the full ozone season, which would be expected since they are based on extreme (4th high) rather than average values.

Table 14-4: Evaluation of Monitors in the OTR

	Count	*% Compared to Monitors with Base*
Monitors with Base Values	193	
Monitors with Future Values	159	83%
Monitors with > 5% differential*	12	6%
Monitors with > 1% differential*	58	30%

*Between July only run and full ozone season run

Figure 14-17: 4th high 8-hour ozone from July only 2011 runs

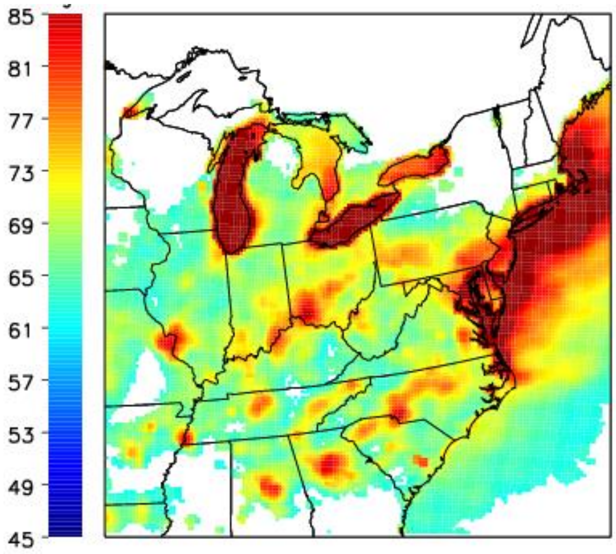


Figure 14-18: 4th high 8-hour ozone from full ozone season 2011 runs

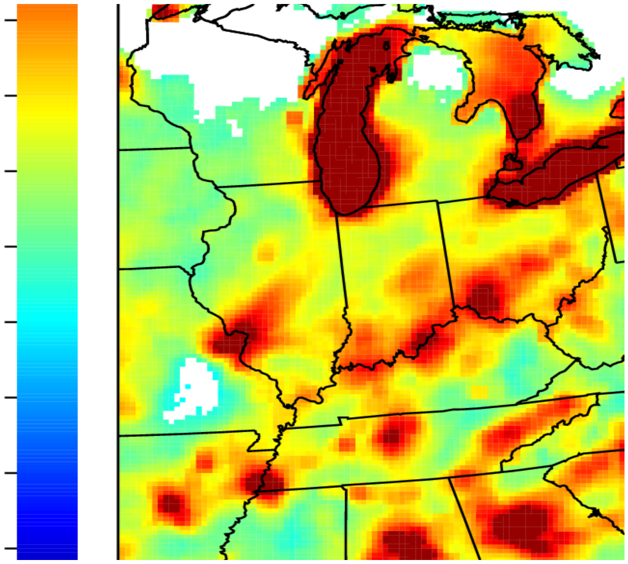


Figure 14-19: 4th high 8-hour ozone from July only 2018 runs

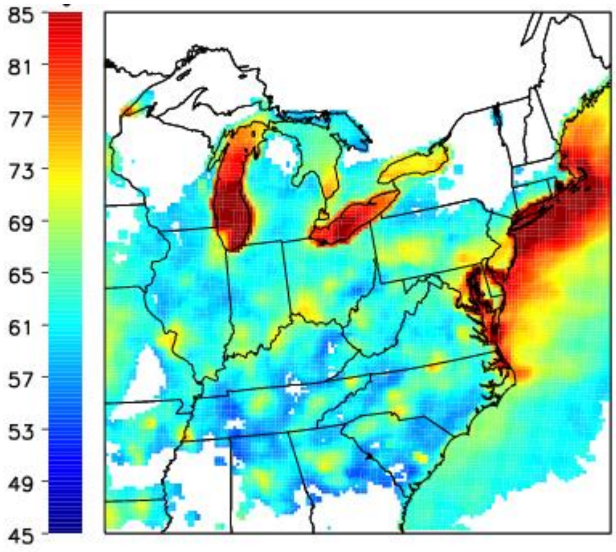
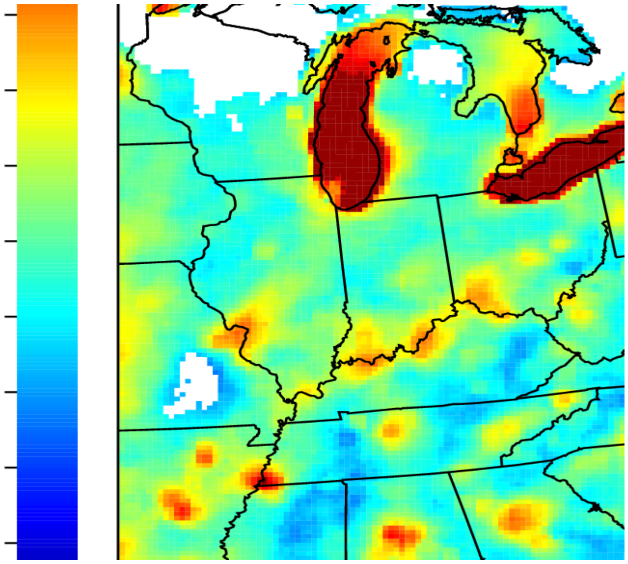


Figure 14-20: 4th high 8-hour ozone from full ozone season 2018 runs



When you begin to examine the geographic span of monitors that have greater differential between the full ozone season and the July run they are largely found along the Southern and coastal OTR, with the highest differentials along the coast as can be seen in Figure 14-21 and more clearly in Figure 14-22. Again this would be expected since these are the areas that are most likely to have higher ozone values in other months during the ozone season and that are no longer being considered in calculating RRFs.

Figure 14-21: Comparison of differences (2018 minus 2011) of 4th high 8-hour ozone from July only and full ozone season

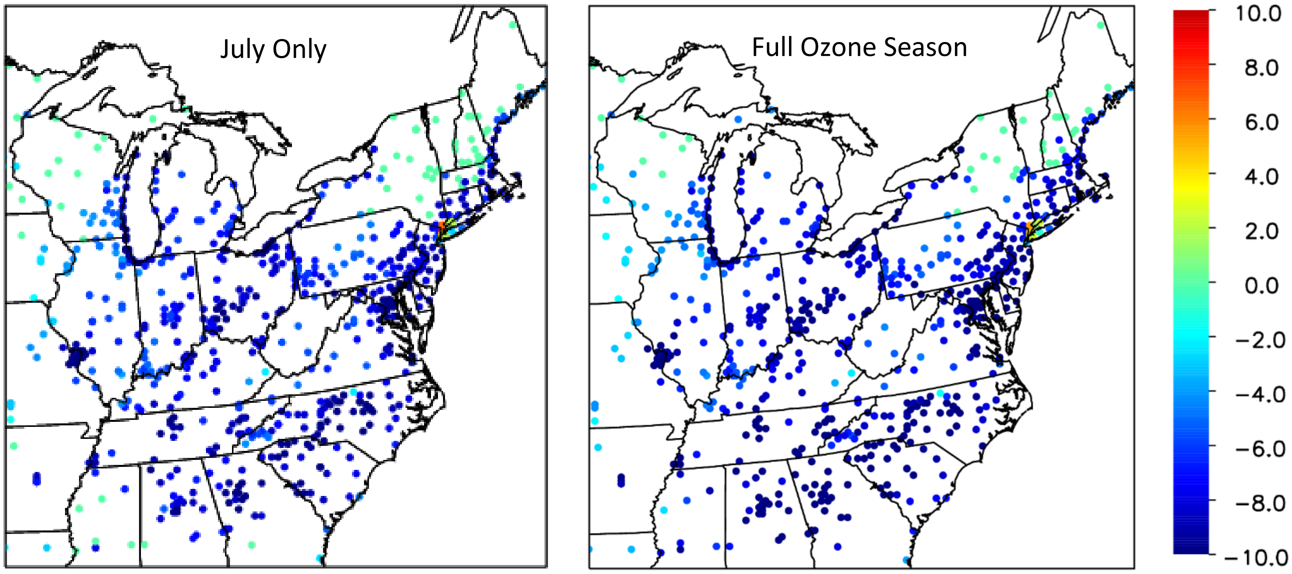
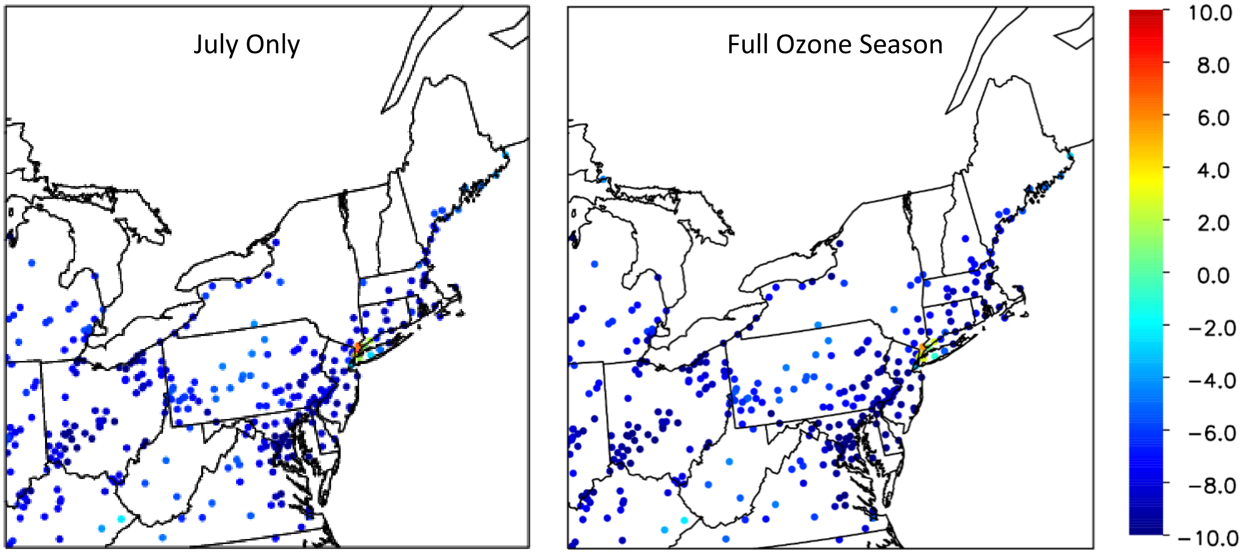


Figure 14-22: Comparison of differences (2018 minus 2011) of 4th high 8-hour ozone from July only and full ozone season (only differences greater than 0.5 ppb)



Protocol

When conducting episodic modeling runs nearly all of the procedures laid out in the OTC modeling protocol should be followed with some exceptions.

Given the shorter time period in question the recommended method of using the “ten highest modeled 8-hour average daily maximum ozone days” to calculate the RRF (US EPA 2014) may not be appropriate for episodic modeling. This would result in nearly one third of all days being included in the calculation and would also likely include days that would not be included in a full ozone season analysis. Thus at least six maximum modeled 8-hour average daily maximum ozone days should be used when calculating RRF.

The modeling runs consisted of a two week spin up period prior to the actual July 1 – 31 episodic modeling run. More information concerning the air quality monitors is in Appendix C.

Table 14-5: Monitor comparison of 4th high 8-hour ozone from July only and full ozone season 2018 runs

State	AQS Code	Design Value			
		2011	2018 July	2018 O.S.	Diff
CT	90010017	80.3	81.034	80.685	-0.349
	90011123	81.3	72.71	72.691	-0.019
	90013007	84.3	77.907	78.452	0.545
	90019003	83.7	85.379	85.602	0.223
	90031003	73.7	64.68	65.415	0.735
	90050005	70.3	61.648	62.902	1.254
	90070007	79.3	69.913	70.257	0.344
	90090027	74.3	68.771	69.849	1.078
	90099002	85.7	77.643	77.319	-0.324
	90110124	80.3	68.68	71.804	3.124
	90131001	75.3	66.485	66.797	0.312
DE	100010002	74.3	67.243	66.842	-0.401
	100031007	76.3	68.343	67.815	-0.528
	100031010	78	69.803	69.463	-0.34
	100031013	77.7	69.349	68.837	-0.512
	100032004	75	66.939	66.445	-0.494
	100051002	77.3	68.855	67.969	-0.886
	100051003	77.7	69.721	69.584	-0.137
DC	110010041	76	66.838	66.439	-0.399
	110010043	80.7	70.971	70.548	-0.423
ME	230010014	61	56.392	56.189	-0.203
	230031100	51.3	-999	-999	NA
	230052003	69.3	63.456	62.939	-0.517
	230090102	71.7	67.621	67.443	-0.178
	230090103	66.3	61.674	61.976	0.302
	230112005	62.7	-999	-999	NA
	230130004	67.7	63.319	62.902	-0.417
	230173001	54.3	-999	-999	NA
	230194008	57.7	-999	-999	NA
	230230006	61	56.283	56.124	-0.159
	230290019	58.3	55.227	54.849	-0.378
	230290032	53	49.992	50.516	0.524
	230310038	60.3	-999	-999	NA
	230310040	64.3	-999	-999	NA
	230312002	73.7	65.971	65.435	-0.536
MD	240030014	83	72.282	71.801	-0.481
	240051007	79	70.839	70.195	-0.644
	240053001	80.7	74.298	74.253	-0.045
	240090011	79.7	72.25	73.125	0.875
	240130001	76.3	68.337	66.945	-1.392
	240150003	83	74.618	73.984	-0.634
NY	360010012	68	-999	61.286	NA
	360050133	74	79.849	76.649	-3.2
	360130006	73.3	66.032	65.967	-0.065
	360130011	74	66.808	66.161	-0.647
	360150003	66.5	-999	-999	NA
	360270007	72	62.813	63.434	0.621
	360290002	71.3	65.728	64.988	-0.74
	360310002	70.3	-999	-999	NA
	360310003	67.3	-999	-999	NA
	360337003	45	-999	-999	NA
	360410005	66	-999	-999	NA
	360430005	62	-999	-999	NA
	360450002	71.7	64.116	62.405	-1.711
	360530006	67	-999	-999	NA
	360610135	73.3	76.408	75.048	-1.36
	360631006	72.3	66.165	65.816	-0.349
	360650004	61.5	-999	-999	NA
	360671015	69.3	63.307	62.962	-0.345
	360715001	67	-999	59.979	NA
	360750003	68	60.928	59.592	-1.336
	360790005	70	61.868	61.867	-0.001
	360810124	78	79.322	79.877	0.555
	360830004	67	-999	60.12	NA
	360850067	81.3	78.321	78.317	-0.004
	360870005	75	66.758	67.648	0.89
	360910004	67	-999	-999	NA
	361010003	65.3	60.963	60.723	-0.24
	361030002	83.3	81.147	82.656	1.509
	361030004	78	71.541	71.143	-0.398
	361030009	78.7	74.622	74.572	-0.05
	361111005	69	-999	63.663	NA
	361173001	65	58.222	57.513	-0.709
	361192004	75.3	80.265	79.146	-1.119
PA	420030008	76.3	70.151	70.966	0.815
	420030010	73.7	67.761	68.548	0.787
	420030067	75.7	69.17	69.108	-0.062
	420031005	80.7	73.668	73.61	-0.058
	420050001	74.3	67.523	68.137	0.614
	420070002	70.7	64.915	65.082	0.167
	420070005	74.7	69.157	69.437	0.28
	420070014	72.3	66.566	66.864	0.298

	240170010	79	70.401	70.232	-0.169
	240199991	75	67.297	67.238	-0.059
	240210037	76.3	68.071	67.169	-0.902
	240230002	72	61.729	60.884	-0.845
	240251001	90	82.131	81.223	-0.908
	240259001	79.3	70.702	70.266	-0.436
	240290002	78.7	70.546	69.287	-1.259
	240313001	75.7	66.522	66.226	-0.296
	240330030	79	68.366	68.156	-0.21
	240338003	82.3	71.777	71.463	-0.314
	240339991	80	69.564	69.317	-0.247
	240430009	72.7	64.268	63.015	-1.253
	245100054	73.7	67.471	67.953	0.482
MA	**250010002**	73	65.947	66.399	0.452
	250034002	69	62.671	62.134	-0.537
	250051002	74	66.958	67.307	0.349
	250070001	77	71.503	71.495	-0.008
	250092006	71	63.903	61.92	-1.983
	250094005	70	62.736	63.56	0.824
	250095005	69.3	63.658	62.581	-1.077
	250130008	73.7	-999	64.893	NA
	250150103	64.7	-999	57.466	NA
	250154002	71.3	62.625	62.259	-0.366
	250170009	67.3	-999	59.921	NA
	250171102	67	59.281	59.053	-0.228
	250213003	72.3	63.731	63.421	-0.31
	250250041	68.3	60.061	59.053	-1.008
	250250042	60.7	53.484	53.21	-0.274
	250270015	68.3	-999	60.426	NA
	250270024	69	60.612	60.41	-0.202
NH	**330012004**	62.3	-999	55.588	NA
	330050007	62.3	-999	-999	NA
	330074001	69.3	-999	-999	NA
	330074002	59.7	-999	-999	NA
	330090010	59.7	-999	-999	NA
	330111011	66.3	-999	58.849	NA
	330115001	69	-999	-999	NA
	330131007	64.7	-999	-999	NA
	330150014	66	59.415	60.786	1.371
	330150016	66.3	59.685	61.063	1.378
	330150018	68	-999	60.802	NA
NJ	**340010006**	74.3	66.127	67.387	1.26
	340030006	77	69.733	68.889	-0.844
	340071001	82.7	73.005	73.557	0.552
	340110007	72	64.716	64.543	-0.173
	340130003	78	71.508	70.249	-1.259
	340150002	84.3	75.284	75.27	-0.014
	340170006	77	71.082	70.64	-0.442
	340190001	78	69.105	68.442	-0.663
	340210005	78.3	69.778	69.481	-0.297
	340219991	76	67.41	67.432	0.022
	340230011	81.3	72.332	71.845	-0.487
	340250005	80	71.841	71.981	0.14
	340273001	76.3	67.585	67.386	-0.199
	340290006	82	72.874	71.9	-0.974
	340315001	73.3	65.293	66.913	1.62
	340410007	66	58.049	57.581	-0.468
	420110006	71.7	63.259	62.976	-0.283
	420110011	76.3	67.191	66.521	-0.67
	420130801	72.7	67.622	67.5	-0.122
	420170012	80.3	71.503	71.116	-0.387
	420210011	70.3	65.447	65.594	0.147
	420270100	71	66.19	65.723	-0.467
	420279991	72	66.653	66.527	-0.126
	420290100	76.3	68.279	68.571	0.292
	420334000	72.3	67.66	67.58	-0.08
	420430401	69	62.368	62.243	-0.125
	420431100	74.7	67.377	66.67	-0.707
	420450002	75.7	67.978	67.573	-0.405
	420490003	74	65.697	65.875	0.178
	420550001	67	60.534	60.071	-0.463
	420590002	69	60.955	61.877	0.922
	420630004	75.7	70.174	69.836	-0.338
	420690101	71	63.517	62.911	-0.606
	420692006	68.7	61.459	60.873	-0.586
	420710007	77	70.214	70.077	-0.137
	420710012	78	70.247	70.555	0.308
	420730015	71	64.039	64.709	0.67
	420750100	76	67.564	67.277	-0.287
	420770004	76	66.909	66.727	-0.182
	420791100	65	58.146	57.156	-0.99
	420791101	64.3	57.46	56.35	-1.11
	420810100	67	60.441	60.133	-0.308
	420850100	76.3	68.463	67.847	-0.616
	420890002	66.7	59.088	58.593	-0.495
	420910013	76.3	68.378	68.141	-0.237
	420950025	76	66.935	66.778	-0.157
	420958000	69.7	61.621	61.599	-0.022
	420990301	68.3	62.277	62.469	0.192
	421010004	66	59.739	59.358	-0.381
	421010024	83.3	75.076	74.66	-0.416
	421011002	80	72.102	71.702	-0.4
	421119991	65	56.723	55.845	-0.878
	421174000	69.7	64.731	64.668	-0.063
	421250005	70	63.416	63.296	-0.12
	421250200	70.7	63.744	63.539	-0.205
	421255001	70.3	63.883	64.289	0.406
	421290006	71.7	64.732	65.446	0.714
	421290008	71	63.148	64.008	0.86
	421330008	72.3	66.991	66.132	-0.859
	421330011	74.3	67.582	67.503	-0.079
RI	**440030002**	73.7	67.261	66.734	-0.527
	440071010	74	67.994	67.339	-0.655
	440090007	76.3	69.022	69.001	-0.021
VT	**500030004**	63.7	-999	57.308	NA
	500070007	61	-999	-999	NA
VA-OTR	**510130020**	81.7	72.35	71.886	-0.464
	510590030	82.3	72.82	72.065	-0.755
	511071005	73	65.663	64.914	-0.749
	511530009	70	62.617	62.726	0.109
	515100009	80	70.794	70.092	-0.702

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Appendix A. Model Evaluation Statistic Formulae

The statistical formulations that have been computed for each species are as follows:

P_i and O_i are the individual (daily maximum 8-hour ozone or daily average for the other species) predicted and observed concentrations respectively, $\overline{P}$ and $\overline{O}$ are the average concentrations, respectively, and N is the sample size.

Observed average, in ppb:

$$\overline{O} = \frac{1}{N}\sum O_i$$

Correlation coefficient, R^2:

$$R^2 = \frac{\left[\sum (P_i - \overline{P})(O_i - \overline{O})\right]^2}{\sum (P_i - \overline{P})^2 \sum (O_i - \overline{O})^2}$$

Root mean square error (RMSE), in ppb:

$$RMSE = \left[\frac{1}{N}\sum (P_i - O_i)^2\right]^{1/2}$$

Mean absolute gross error (MAGE), in ppb:

$$MAGE = \frac{1}{N}\sum \left|P_i - O_i\right|$$

Mean bias (MB), in ppb:

$$MB = \frac{1}{N}\sum (P_i - O_i)$$

Mean fractionalized bias (MFB), in %:

$$MFB = \frac{2}{N}\sum \left[\frac{P_i - O_i}{P_i + O_i}\right] \times 100\%$$

Predicted average, in ppb (only use P_i when O_i is valid):

$$\overline{P} = \frac{1}{N}\sum P_i$$

Normalized mean error (NME), in %:

$$NME = \frac{\sum |P_i - O_i|}{\sum O_i} \times 100\%$$

Fractional error (FE), in %:

$$FE = \frac{2}{N}\sum \left|\frac{P_i - O_i}{P_i + O_i}\right| \times 100\%$$

Mean normalized gross error (MNGE), in %:

$$MNGE = \frac{1}{N}\sum \frac{\left|P_i - O_i\right|}{O_i} \times 100\%$$

Mean normalized bias (MNB), in %:

$$MNB = \frac{1}{N}\sum \frac{(P_i - O_i)}{O_i} \times 100\%$$

Normalized mean bias (NMB), in %:

$$NMB = \frac{\sum (P_i - O_i)}{\sum O_i} \times 100\%$$

Appendix B. Emissions Inventory Files

This section lists the emission inventory sectors with a compilation of all of the SMOKE input files in the EMF system, in FF10 or ORL format, that were used for developing model ready emission files, for the Alpha, Alpha 2, Beta, Beta 2, Gamma inventories for the base year of 2011 and the projected years of 2017, 2018, 2020, 2023, and 2028, though not every projected year has a corresponding inventory level developed for it. The categories are based on the ways sectors are combined when processed through SMOKE by New York.

Agricultural

- 2011
    - Alpha, Alpha 2:
      ag_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
    - Beta, Beta 2, Gamma:
      ag_2011NEIv2_NONPOINT_20141108_04feb2015_v3
      Prepared by EPA, uploaded to MARAMA EMF on February 4, 2015.
- 2017
    - Beta, Beta 2:
      2017_NONPOINT_ag_28jun2016
      Prepared by MARAMA, uploaded to MARAMA EMF on June 28, 2016.
- 2018
    - Alpha, Alpha 2:
      MARAMA_Alpha_2018_ag_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_14jan2015_nf_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on January 14, 2015.
- 2020
    - Gamma:
      2020_ag_2011NEIv2_NONPOINT_04feb2015_v3_13sep2017
      Prepared by MARAMA, uploaded to MARAMA EMF on September 13, 2017.
      Note:New York DEC interpolated gridded emissions between 2017 and 2023 for other states in the domain
- 2023
    - Gamma:
      2023el_ag_MARAMA_2011NEIv2_NONPOINT_20141108_07sep2016_v0
      2023el_ag_2011NEIv2_NONPOINT_20141108_07sep2016_v1
      Prepared by EPA, uploaded to MARAMA EMF on September 9, 2016.
- 2028
    - Alpha 2:
      MARAMA_Alpha_2028_ag_2011NEIv2_NONPOINT_20141108_11nov2014_v0
      Prepared by MARAMA, uploaded to MARAMA EMF on August 20, 2015.
    - Gamma:
      2028el_ag_2011NEIv2_NONPOINT_20141108_23nov2016_v1
      MARAMA_2028el_ag_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Agricultural Fugitive Dust

- 2011
    - Alpha, Alpha 2, Beta, Beta 2, Gamma:
      afdust_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv
      EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_23sep2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014 and September 28, 2014, respectively.
- 2017
    - Beta, Beta 2:

2017_NONPOINT_afdust_unadj_RPOstates_paved_unpaved_28jun2016
2017_NONPOINT_afdust_unadj_NEI_28jun2016
Prepared by MARAMA, uploaded to MARAMA EMF on June 28, 2016.

- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_afdust_2011NEIv2_NONPOINT_20141108_11nov2014_v1
    MARAMA_Alpha_2018_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_23sep2014_v0_csv_v0_20jan2015_nf_v1
    Prepared by MARAMA, uploaded to MARAMA EMF on August 25, 2015 and January 20, 2015, respectively.
- 2020
  - Gamma:
    2020_afdust_2011NEIv2_NONPOINT_11nov2014_v1_13sep2017
    2020_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_23sep2014_v0_13sep2017.csv
    Prepared by MARAMA, uploaded to MARAMA EMF on September 13, 2017.
    Note:New York DEC interpolated gridded emissions between 2017 and 2023 for other states in the domain
- 2023
  - Gamma:
    2023el_from_afdust_2011NEIv2_NONPOINT_20141108_19sep2016_v3
    2023el_from_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_19sep2016_v1
    2023el_MARAMA_from_afdust_2011NEIv2_NONPOINT_20141108_19sep2016_v1
    2023el_MARAMA_from_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_19sep2016_v1
    Prepared by EPA, uploaded to MARAMA EMF on September 20, 2016.
- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_afdust_2011NEIv2_NONPOINT_20141108_11nov2014_v1
    MARAMA_Alpha_2028_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_23sep2014_v0
    Prepared by MARAMA, uploaded to MARAMA EMF on August 20, 2015.
  - Gamma:
    2028el_from_afdust_2011NEIv2_NONPOINT_20141108_17nov2016_v1
    2028el_from_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_17nov2016_v1
    MARAMA_2028el_afdust_2011NEIv2_NONPOINT_20141108_17nov2016_v1
    MARAMA_2028el_EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_17nov2016_v1
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Area Source (Non-Point)

- 2011
  - Alpha, Alpha 2:
    nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv
    pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
    agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
    Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
  - Beta, Beta 2:
    nonpt_2011NEIv2_NONPOINT_20141108_21jan2015_v5_MARAMA
    pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
    agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
    Prepared by EPA and MARAMA, uploaded to MARAMA EMF on September 9, 2015, November 13, 2014 and November 13, 2014, respectively.
  - Gamma:
    nonpt_2011NEIv2_NONPOINT_20141108_25apr2017_v5_MARAMA_v0
    pfc_2011NEIv2_NONPOINT_11dec2015_v1.csv
    agburn_monthly_2011NEIv2_NONPOINT_03dec2015_v1
    Prepared by EPA and MARAMA, uploaded to MARAMA EMF on September 9, 2015, December 28, 2015 and, December 23, 2015, respectively.
- 2017
  - Beta, Beta 2:
    2017_NONPOINT_nonpt_29jun2016
    2017_NONPOINT_pfc_29jun2016
    agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv

cement_newkilns_year_2018_from_ISIS2013_NEI2011v1_NONPOINT_12feb2015_v1_MARAMA
2017_cellulosic_inventory_06jan2014_v1_MARAMA
2017_cellulosic_new_Iowa_plants_from2018docket_2011v6_2_ff10_28jan2015_v0
Prepared by MARAMA, uploaded to MARAMA EMF on June 29, 2016, June, 29, 2016, November 13, 2014, February 25, 2016, and February 25, 2016, respectively.

- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1_csv_v0_21jan2015_nf_v1
    MARAMA_Alpha_2018_pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_21jan2015_nf_v1
    MARAMA_Alpha_2018_agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_20jan2015_nf_v1
    Prepared by MARAMA, uploaded to MARAMA EMF on January 20, 2015.
- 2020
  - Gamma:
    2020_nonpt_2011NEIv2_NONPOINT_20141108_25apr2017_v5_MARAMA
    2020_pfc_2011NEIv2_NONPOINT_11dec2015_v1_13sep2017
    2018_cellulosic_inventory_12sep2016_v2
    agburn_monthly_2011NEIv2_NONPOINT_03dec2015_v1.csv
    Prepared by MARAMA and EPA, uploaded to MARAMA EMF on October 12, 2017, September 13, 2017, October 4, 2016, and December 3, 2015, respectively
    Note:New York DEC interpolated gridded emissions between 2017 and 2023 for other states in the domain, excepting agburn
- 2023
  - Gamma:
    2023_NONPOINT_nonpt_12may2017
    2023el_from_nonpt_2011NEIv2_NONPOINT_2_113907436_14sep2016_v1
    MARAMA_2023_from_pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0_14sep2016_v0
    pfc_2025_2011v6_2_ff10_28jan2015_13sep2016_v2
    2018_cellulosic_inventory_12sep2016_v2
    Cellulosic_new_Iowa_plants_from2018docket_2011v6_2_ff10_28jan2015_v0
    cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_NONPOINT_12sep2016_v3
    agburn_monthly_2011NEIv2_NONPOINT_03dec2015_v1.csv
    Prepared by MARAMA and EPA, uploaded to MARAMA EMF on May 12, 2017 for the first listed file, December 3, 2015, for the last listed file and, October 4, 2016 for the remainder.
- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1
    MARAMA_Alpha_2028_pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0
    MARAMA_Alpha_2028_agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0
    cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_NONPOINT_12feb2015_v1_MARAMA
    2018_cellulosic_inventory_06jan2014_v1_19nov2015_nf_v1_MARAMA
    Cellulosic_new_Iowa_plants_from2018docket_2011v6_2_ff10_28jan2015_v0
    Prepared by MARAMA, uploaded to MARAMA EMF on August 20, 2015, August 20, 2015, August 20, 2015, November 19, 2015, November 19, 2015, and March 17, 2015 respectively.
  - Gamma:
    2023el_from_nonpt_2011NEIv2_NONPOINT_2_113907436_14sep2016_v1
    MARAMA_2028el_nonpt_2011NEIv2_NONPOINT_20141108_mar_23nov2016_v1
    MARAMA_2028el_pfc_2011NEIv2_NONPOINT_20141108_21nov2016_v1
    pfc_2025_2011v6_2_ff10_28jan2015_13sep2016_v2
    2018_cellulosic_inventory_12sep2016_v2
    cellulosic_new_Iowa_plants_from2018docket_2011v6_2_ff10_28jan2015_28jan2015_v0
    cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_NONPOINT_12sep2016_v3
    agburn_monthly_2011NEIv2_NONPOINT_03dec2015_v1.csv
    Prepared by EPA, most files not uploaded to EMF (files listed in other years are), but available on EPA FTP site.

Biogenics

- All Years

    - Alpha, Alpha 2:
      biogenic_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
    - Beta, Beta 2, Gamma:
      biogenic_2011ek_BEIS3_61_BELD4_1_08sep2016.csv
      Prepared by EPA, uploaded to MARAMA EMF on September 6, 2016.

C1/C2 Marine and Rail

- 2011
    - Alpha, Alpha 2, Beta, Beta 2:
      c1c2_offshore_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      c1c2rail_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
    - Gamma:
      cmv_c1c2rail_2011NEIv2_NONPOINT_20141108_02sep2016_v1
      rail_c1c2rail_2011NEIv2_NONPOINT_30nov2015_v1
      Prepared by EPA, uploaded to MARAMA EMF on November 20, 2016 and December 22, 2015, respectively.
- 2017
    - Beta, Beta 2:
      2017_NONPOINT_c1c2rail_27jun2016
      2017_NONPOINT_c1c2offshore_06may2016.csv
      Prepared by MARAMA, uploaded to MARAMA EMF on June 27, 2016 and May 6, 2016, respectively.
- 2018
    - Alpha, Alpha 2:
      MARAMA_Alpha_2018_c1c2_offshore_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_20jan2015_v0
      MARAMA_Alpha_2018_c1c2rail_2011NEIv2_NONPOINT_20141108_11nov2014_v1_csv_v0_20jan2015_nf_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on January 20, 2015 and June 9, 2015, respectively.
- 2020
    - Gamma:
      2020_c1c2_offshore_2011NEIv2_NONPOINT_20141108_11nov2014_v0_14sep2017.csv
      2020_cmv_c1c2rail_2011NEIv2_NONPOINT_20141108_02sep2016_v1_14sep2017
      2020_rail_c1c2rail_2011NEIv2_NONPOINT_30nov2015_v1_14sep2017
      Prepared by EPA, uploaded to MARAMA EMF on September 14, 2017.
- 2023
    - Gamma:
      2023el_cmv_c1c2rail_2011NEIv2_NONPOINT_20141108_07sep2016_v2
      2023el_MARAMA_cmv_c1c2rail_2011NEIv2_NONPOINT_20141108_07sep2016_v0
      2023el_MARAMA_rail_c1c2rail_2011NEIv2_NONPOINT_20141108_07sep2016_v0
      2023el_rail_c1c2rail_2011NEIv2_NONPOINT_20141108_07sep2016_v2
      t_2023el_c1c2_offshore_2011NEIv2_NONPOINT_20141108_07sep2016_v0
      Prepared by EPA, uploaded to MARAMA EMF on September 9, 2016.
- 2028
    - Alpha 2:
      MARAMA_Alpha_2028_c1c2_offshore_2011NEIv2_NONPOINT_20141108_11nov2014_v0
      MARAMA_Alpha_2028_c1c2rail_2011NEIv2_NONPOINT_20141108_11nov2014_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on August 19, 2015 and August 20, 2015, respectively.
    - Gamma:
      2028el_cmv_from_c1c2rail_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      MARAMA_2028el_cmv_c1c2rail_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      2028el_rail_c1c2rail_from_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      MARAMA_2028el_rail_c1c2rail_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      2028el_c1c2_offshore_from_2011NEIv2_NONPOINT_20141108_17nov2016_v0
      Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

C3 Marine

- 2011

  - Alpha:
    c3marine_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
    c3_offshore_2011NEIv2_NONPOINT_20141108_11no v2014_v0.csv
    Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
  - Alpha 2, Beta, Beta 2:
    c3marine_2011NEIv2_NONPOINT_20141108_14nov2014_v1.csv
    eca_imo_nonUS_nonCANADA_caps_vochaps_2011_16jun2015_v1_orl_MARAMA.txt
    Prepared by EPA, uploaded to MARAMA EMF on January 2, 2015 and June 30, 2015 respectively.
  - Gamma:
    c3marine_2011NEIv2_NONPOINT_20141108_ 02sep2016_v2.csv
    eca_imo_nonUS_nonCANADA_caps_vochaps_2011_16jun2015_v1_orl_MARAMA.txt
    Prepared by EPA, uploaded to MARAMA EMF on September 9, 2016 and June 30, 2015 respectively.
- 2017
  - Beta, Beta 2:
    2017_NONPOINT_c3marine_28jun2016
    2017eh_from_eca_imo_nonUS_nonCANADA_caps_vochaps_2011_25feb2015_v0_orl_MARAMA.txt
    Prepared by MARAMA and EPA, respectively, uploaded to MARAMA EMF on June 28, 2016 and August 9, 2016, respectively.
- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_c3marine_2011NEIv2_NONPOINT_20141108_14nov2014_v1_csv
    eca_imo_nonUS_nonCANADA_caps_vochaps_2018_04dec2013_v0
    Prepared by MARAMA and EPA, respectively, uploaded to MARAMA EMF on June 24, 2015 and December 18, 2013, respectively.
- 2020
  - Gamma:
    2020_MARAMA_c3marine_2011NEIv2_NONPOINT_20141108_14nov2014_v1.csv
    c3marine_2011NEIv2_NONPOINT_20141108_02sep2016_v2
    Prepared by EPA, uploaded to MARAMA EMF on November 22, 2017 and November 30, 2016 respectively.
- 2023
  - Gamma:
    2023el_c3marine_2011NEIv2_NONPOINT_20141108_09sep2016_v2
    2023el_MARAMA_c3marine_2011NEIv2_NONPOINT_20141108_07sep2016_v0
    Prepared by EPA, uploaded to MARAMA EMF on September 9, 2016 and June 13, 2017 respectively.
- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_c3marine_2011NEIv2_NONPOINT_20141108_14nov2014_v1
    eca_imo_nonUS_nonCANADA_caps_haps_2025_07mar2014_v0
    Prepared by MARAMA and EPA, respectively, uploaded to MARAMA EMF on August 20, 2015 and November 20, 2014, respectively.
  - Gamma:
    2028el_c3marine_2011NEIv2_NONPOINT_20141108_29nov2016_v2
    MARAMA_2028el_c3marine_2011NEIv2_NONPOINT_20141108_17nov2016_v1
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

ERTAC EGUs

- 2011
  - Alpha, Alpha 2:
    - Annual Files:*OTC_2011_ERTACEGUv23_150227_MENHVTMARICTNYNJDEPAMDDCVA.csv*
      SESARM_2011_ERTACEGUv23_150227_WVNCSCGAKYTNALMS.csv
      LADCO_2011_ERTACEGUv23_150227_MIOHINILWIMN.csv
      CenSARA_2011_ERTACEGUv23_150227_TXOKNEKSIAARLAMO.csv
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on February 27, 2015.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size
  - Beta, Beta 2, Gamma:
    - Annual Files:*OTC_2011_ERTACEGUv25_20160607_MENHVTMARICTNYNJDEPAMDDCVA.csv*
      SESARM_2011_ERTACEGUv25_20160607_WVNCSCGAKYTNALMS.csv

        LADCO_2011_ERTACEGUv25_20160607_MIOHINILWIMN.csv
        CenSARA_2011_ERTACEGUv25_20160607_TXOKNEKSIAARLAMO.csv
        Prepared by ERTAC and OTC, uploaded to MARAMA EMF on June 7, 2016.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
- 2017
  - Beta:
    - Annual Files:*OTC_2017_ERTACEGUv25_20160707_MENHVTMARICTNYNJDEPAMDDCVA.csv*
      SESARM_2017_ERTACEGUv25_20160707_WVNCSCGAFLKYTNALMS_2018.csv
      LADCO_2017_ERTACEGUv25_20160707_MIOHINILWIMN.csv
      CenSARA_2017_ERTACEGUv25_20160707_TXOKNEKSIAARLAMO.csv
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on July 13, 2016.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
  - Beta 2:
    - Annual Files:
      OTC_2017_ERTACEGUv25L2_20160919_MENHVTMARICTNYNJDEPAMDDCVA
      SESARM_2017_ERTACEGUv25L2_20160919_WVNCSCGAKYTNALMS
      LADCO_2017_ERTACEGUv25L2_20160919_MIOHINILWIMN
      CENSARA_2017_ERTACEGUv25L2_20160919_TXOKNEKSIAARLAMO
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on September 22, 2016.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
- 2018
  - Alpha, Alpha 2:
    - Annual Files:
      OTC_2018_ERTACEGUv23_150227_MENHVTMARICTNYNJDEPAMDDCVA.csv
      SESARM_2018_ERTACEGUv23_150227_WVNCSCGAFLKYTNALMS_2018.csv
      LADCO_2018_ERTACEGUv23_150227_MIOHINILWIMN.csv
      CenSARA_2018_ERTACEGUv23_150227_TXOKNEKSIAARLAMO.csv
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on April 2, 2015.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
- 2020
  - Gamma:
    - Annual Files:
      LADCO_2020_ERTACEGUv27_20180110_MIOHINILWIMN
      OTC_2020_ERTACEGUv27_20180110_MENHVTMARICTNYNJDEPAMDDCVA
      SESARM_2020_ERTACEGUv27_20180110_WVNCSCGAKYTNALMS
      CenSARA_2020_ERTACEGUv27_20180110_TXOKNEKSIAARLAMO
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on January 11, 2018.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
- 2023
  - Gamma:
    - Annual Files:
      CENSARA_2023_ERTACEGUv27_20170918_TXOKNEKSIAARLAMO
      LADCO_2023_ERTACEGUv27_20170918_MIOHINILWIMN
      OTC_2023_ERTACEGUv27_20170918_MENHVTMARICTNYNJDEPAMDDCVA
      SESARM_2023_ERTACEGUv27_20170918_WVNCSCGAKYTNALMS
      Prepared by ERTAC and OTC, uploaded to MARAMA EMF on September 26, 2017.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
- 2028
  - Alpha 2:
    - Annual Files:
      OTC_2028_ERTACEGUv23_150611_MENHVTMARICTNYNJDEPAMDDCVA.csv
      SESARM_2028_ERTACEGUv23_150611_WVNCSCGAFLKYTNALMS.csv

        LADCO_2028_ERTACEGUv23_150611_MIOHINILWIMN.csv
        CenSARA_2028_ERTACEGUv23_150611_TXOKNEKSIAARLAMO.csv
        Prepared by ERTAC and OTC, uploaded to MARAMA EMF on July 8, 2015.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.
  - Gamma:
    - Annual Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF.
    - Hourly Files:
      Prepared by ERTAC and OTC, not uploaded to the MARAMA EMF system due to size.

Non-EGU Point

- 2011
  - Alpha, Alpha 2:*MARAMA_Alpha_ptnonipm_2011NEIv2_POINT_20140913_revised_20141007_08oct2014_nf_v1_csv_23oct2014_v0*
    Ethanol_plants_2011_OTAQ_17oct2014_v6.csv
    Prepared by EPA and OTC, uploaded to MARAMA EMF on December 11, 2014 and November 13, 2014, respectively.
  - Beta, Beta 2, Gamma:
    - Annual Files:
      ptnonipm_2011NEIv2_POINT_20140913_revised_20150115_09feb2015_v2_MARAMA.csv
      ethanol_plants_2011NEIv2_POINT_20141123_03feb2015_v1
      Prepared by EPA and MARAMA, uploaded to MARAMA EMF on December 23, 2015 and February 3, 2015, respectively.
    - Hourly Files:
      Prepared by MDE, not uploaded to the MARAMA EMF system due to size.
- 2017
  - Beta, Beta 2:
    - Annual Files:
      2017_POINT_ptnonipm_25jul2016
      Biodiesel_Plants_2018_ff10_11apr2013_v0.csv
      MARAMA_Beta_2017_cement_newkilns_year_2018_from_ISIS2013_NEI2011v1_17mar2015_v2
      2017eh_from_ethanol_plants_2011NEIv2_POINT_20141123_10mar2015_v0_MARAMA
      Prepared by MARAMA, uploaded to MARAMA EMF on July 25, 2016, February 20, 2014, September 14, 2015 and April 23, 2016 respectively.
    - Hourly Files:
      Prepared by MDE, not uploaded to the MARAMA EMF system due to size.
- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_MARAMA_Alpha_ptnonipm_2011NEIv2_POINT_20140913_revised_20141007_08oct2014_nf_v1_csv_23oct2014_v0_mar_v0_01feb2015_nf_v1
    MARAMA_Alpha_2018_Ethanol_plants_2011_OTAQ_17oct2014_v6_csv_06nov2014_v0_v0_01feb2015_nf_v1
    Prepared by MARAMA, uploaded to MARAMA EMF on February 1, 2015.
- 2020
  - Gamma:
    - Annual Files:
      2020_POINT_PTNONIPM_22dec2017
      Biodiesel_Plants_2018_ff10_11apr2013_v0.csv
      2020_from_ethanol_plants_2011NEIv2_POINT_20dec2017_MARAMA
      2023en_ptnonipm_new_units_state_comments_WIonly_09aug2017_v0
      2014_Illinois_WV_new_sources_NODA_29aug2016_v2
      2023_MARAMA_new_sources_2jun2017
      Prepared by EPA and MARAMA, uploaded to MARAMA EMF on December 22, 2018, February 20, 2014, December 20, 2017, November 22, 2017, October 7, 2016, and June 2, 2017,respectively.
    - Hourly Files:
      Gamma_2020_nonCAMD_EGUs_FF10_Hourly_SESARM_01192018.csv
      Gamma_2020_nonCAMD_EGUs_FF10_Hourly_LADCO_01192018.csv

Gamma_2020_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_01192018.csv
Gamma_2020_nonCAMD_EGUs_FF10_Hourly_CENSARA_01192018.csv
Prepared by MDE, uploaded to the MARAMA EMF on January 19, 201.

- 2023
  - Gamma:
    - Annual Files:
      2023_POINT_PTNONIPM_29may2017
      Biodiesel_Plants_2018_ff10_11apr2013_v0.csv
      2023el_from_ethanol_plants_2011NEIv2_POINT_20141123_20sep2016_v0
      2023en_ptnonipm_new_units_state_comments_WIonly_09aug2017_v0
      2014_Illinois_WV_new_sources_NODA_29aug2016_v2
      2023_MARAMA_new_sources_2jun2017
      Prepared by EPA and MARAMA, uploaded to MARAMA EMF on June 2, 2017, February 20, 2016, October 7, 2016, November 22, 2017, October 7, 2016, and June 2, 2017, respectively.
    - Hourly Files:
      Gamma_2023_nonCAMD_EGUs_FF10_Hourly_LADCO_06072017.csv
      Gamma_2023_nonCAMD_EGUs_FF10_Hourly_SESARM_06072017.csv
      Gamma_2023_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_06072017.csv
      Gamma_2023_nonCAMD_EGUs_FF10_Hourly_CENSARA_06072017.csv
      Prepared by MDE, uploaded to the MARAMA EMF on June 8, 2017.

- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_ptnonipm_2011NEIv2_POINT_20140913_revised_20141007_08oct2014_nf_v1
    Biodiesel_Plants_2018_ff10_11apr2013_v0
    cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_30jan2015_v1
    MARAMA_Alpha_2028_Ethanol_plants_2011_OTAQ_17oct2014_v6
    The first file was prepared by MARAMA and the remainder by EPA, uploaded to MARAMA EMF on October 23, 2015, March 12, 2015, November 19, 2015, and August 21, 2015, respectively.
  - Gamma:
    - Annual Files:
      HazeGamma2028_base__MARAMA_2028_ptnonipm_2011NEIv2_POINT_20140913_revised_20150115_mar_18nov2016_v3
      HazeGamma2028_base__2023el_from_ptnonipm_2011NEIv2_POINT_20140913_revised_20150115_20sep2016_v2
      Biodiesel_Plants_2018_ff10_11apr2013_v0.csv
      cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_30jan2015_v1
      2023el_from_ethanol_plants_2011NEIv2_POINT_20141123_20sep2016_v0
      2023en_ptnonipm_new_units_state_comments_WIonly_09aug2017_v0
      2014_Illinois_WV_new_sources_NODA_29aug2016_v2
      2023_MARAMA_new_sources_2jun2017
      Prepared by EPA and OTC, uploaded to MARAMA EMF on April 4, 2018, April 4, 2018, February 20, 2014, March 12, 2015, October 7, 2016, November 22, 2017, October 7, 2016, and June 2, 2017, respectively.
    - Hourly Files:
      HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_SESARM_04042018.csv.csv
      HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_04042018.csv.csv
      HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_LADCO_04042018.csv.csv
      HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_CENSARA_04042018.csv.csv
      Prepared by OTC, uploaded to MARAMA EMF on April 5, 2018.

Non-ERTAC IPM EGUs

- 2011
  - Alpha, Alpha 2:
    MARAMA_Alpha_output_for_NEI_smallEGUpt_from_NEI_EGU_.csv
    Prepared by EPA and OTC, uploaded to MARAMA EMF on December 11, 2014.
  - Beta, Beta 2, Gamma:

        - Annual Files:
          ptnonERTAC_ipm_2011NEIv2_20160512.csv
          Prepared by EPA and OTC, uploaded to MARAMA EMF on May 12, 2016.
        - Hourly Files:
          Prepared by MDE, not uploaded to the MARAMA EMF system due to size.
- 2017
    - Beta, Beta 2:
        - Annual Files:
        2017_POINT_PTNONERTAC_IPM_20jun2016
        Prepared by MARAMA, uploaded to MARAMA EMF on June 20, 2016.
        - Hourly Files:
          Prepared by MDE, not uploaded to the MARAMA EMF system due to size.
- 2018
    - Alpha, Alpha 2:
      MARAMA_Alpha_2018_MARAMA_Alpha_output_for_NEI_smallEGUpt_from_NEI_EGU__csv_v0_01feb2015_nf_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on February 1, 2015.
- 2020
    - Gamma:
        - Annual Files:
          2020_ptnonERTAC_ipm_22dec2017
          Prepared by MARAMA, uploaded to MARAMA EMF on February 5, 2018.
        - Hourly Files:
          Gamma_2020_nonCAMD_EGUs_FF10_Hourly_SESARM_01192018.csv
          Gamma_2020_nonCAMD_EGUs_FF10_Hourly_LADCO_01192018.csv
          Gamma_2020_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_01192018.csv
          Gamma_2020_nonCAMD_EGUs_FF10_Hourly_CENSARA_01192018.csv
          Prepared by MDE, uploaded to MARAMA EMF on January 18, 2018.
- 2023
    - Gamma:
        - Annual Files:
          2023_POINT_PTNONERTAC_IPM_29may2017
          Prepared by MARAMA, uploaded to MARAMA EMF on June 2, 2017.
        - Hourly Files:
          Gamma_2023_nonCAMD_EGUs_FF10_Hourly_LADCO_06072017.csv
          Gamma_2023_nonCAMD_EGUs_FF10_Hourly_SESARM_06072017.csv
          Gamma_2023_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_06072017.csv
          Gamma_2023_nonCAMD_EGUs_FF10_Hourly_CENSARA_06072017.csv
          Prepared by MDE, uploaded to MARAMA EMF on June 8, 2017.
- 2028
    - Alpha 2:
      MARAMA_Alpha_2028_output_for_NEI_smallEGUpt_from_NEI_EGU_v0
      Prepared by MARAMA, uploaded to MARAMA EMF on October 23, 2015.
    - Gamma:
        - Annual Files:
          2023_POINT_PTNONERTAC_IPM_29may2017
          Prepared by MARAMA, uploaded to MARAMA EMF on June 2, 2017.
        - Hourly Files:
          HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_SESARM_04042018.csv.csv
          HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_MANEVU+VA_04042018.csv.csv
          HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_LADCO_04042018.csv.csv
          HazeGamma_2028_nonCAMD_EGUs_FF10_Hourly_CENSARA_04042018.csv.csv
          Prepared by OTC, uploaded to MARAMA EMF on April 5, 2018.

NonPoint Oil &Gas

- 2011

- Alpha, Alpha 2, Beta, Beta 2:
  np_oilgas_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
  Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
  - Alpha, Alpha 2, Beta, Beta 2:
    np_oilgas_2011NEIv2_NONPOINT_14dec2015_v5
    Prepared by EPA, uploaded to MARAMA EMF on December 29, 2015.
- 2017
  - Beta, Beta 2:
    2017_NONPOINT_oilgas_15jul2016
    Prepared by MARAMA, uploaded to MARAMA EMF on July 15, 2015.
- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_np_oilgas_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_21jan2015_nf_v1
    Prepared by MARAMA, uploaded to MARAMA EMF on January 21, 2015.
- 2020
  - Gamma:
    2020_MARAMA_np_oilgas_2011NEIv2_NONPOINT_20141108_21dec2017
    2020_nonMARAMA_np_oilgas_2011NEIv2_NONPOINT_21dec2017
    Prepared by MARAMA, uploaded to MARAMA EMF on December 1, 2017 and December 21, 2017, respectively.
- 2023
  - Gamma:
    2023el_MARAMA_np_oilgas_2011NEIv2_NONPOINT_20141108_mar_14sep2016_v1_MDPAVAWV
    2023en_np_oilgas_2011NEIv2_NONPOINT_07aug2017_v1
    2023en_TCEQ_2014_np_oilgas_ff10_noda_18aug2017_v0
    Prepared by EPA, uploaded to MARAMA EMF on October 5, 2, and 2, 2017, respectively.
- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_np_oilgas_2011NEIv2_NONPOINT_20141108_11nov2014_v0
    Prepared by MARAMA, uploaded to MARAMA EMF on August 20, 2015.
  - Gamma:
    2028el_np_oilgas_2011NEIv2_NONPOINT_20141108_18nov2016_v1
    MARAMA_2028el_np_oilgas_2011NEIv2_NONPOINT_20141108_18nov2016_v1
    2028el_oklahoma_2011_np_oilgas_NODA_18nov2016_v0
    2028el_2011_TCEQ_texas_oil_gas_ff10_18nov2016_v0
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Nonroad

- 2011
  - Alpha, Alpha 2:
    2011NEIv1_nonroad_20130621_04sep2013_v4.csv
    Prepared by EPA, uploaded to MARAMA EMF on March 2, 2014.
  - Beta, Beta 2, Gamma:
    2011NEIv1_nonroad_20130621_17oct2014_v6_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on January 8, 2016.

- 2017
  - Beta, Beta 2:
    2017_nonroad_ff10_adjusted_from_2018_noCalif_23mar2015_v0_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on June 9, 2016.
- 2018
  - Alpha, Alpha 2:
    2018_nonroad_20130829_30oct2013_v2.csv
    Prepared by EPA, uploaded to MARAMA EMF on March 5, 2014.
- 2020
  - Gamma:
    Appendix EE – 2020 Nonroad and Onroad County Summaries (not in EMF)
- 2023
  - Gamma:
    2023el_nonroad_ff10_NCD20160627_05oct2016_v3_part1

  2023el_nonroad_ff10_NCD20160627_05oct2016_v3_part2
  2023el_projection_SLT_nonroad_01feb2013_Texas_monthly_ff10_30aug2016_v0
  Prepared by EPA, uploaded to MARAMA EMF on December 5, 2016, December 5, 2016, and September 9, 2016, respectively.
- 2028
  - Alpha 2:
    2028_from_NEI2025_nonroad_ff10_NCD20130831_23feb2015_v3_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on October 19, 2015.
  - Gamma:
    2028el_nonroad_ff10_NCD20160722_18nov2016_v3_part1.csv
    2028el_nonroad_ff10_NCD20160722_18nov2016_v3_part2.csv
    2028el_projection_SLT_nonroad_01feb2013_Texas_monthly_ff10_30aug2016_v0.csv
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Onroad

- 2011
  - Alpha, Alpha 2:
    2011eh_onroad_SMOKE_MOVES_MOVES2014_no_speciated_pm_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on October 6, 2015.
  - Beta, Beta 2:
    MOVES2014a_ONROAD_EPA2011ek_FF10
    Prepared by EPA, uploaded to MARAMA EMF on July 5, 2016.
  - Gamma:
    MOVES2014a_ONROAD_EPA2011el_FF10
    Prepared by EPA, uploaded to MARAMA EMF on June 13, 2017
- 2017
  - Beta, Beta 2:
    MOVES2014a_ONROAD_EPA2017ek_FF10
    Prepared by EPA, uploaded to MARAMA EMF on July 5, 2016.
- 2018
  - Alpha, Alpha 2:
    2018eh_onroad_SMOKE_MOVES_MOVES2014_no_speciated_pm_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on October 6, 2015.
- 2020
  - Gamma:
    Appendix EE – 2020 Nonroad and Onroad County Summaries (not in EMF)
- 2023
  - Gamma:
    2023el_nonroad_ff10_NCD20160627_05oct2016_v3_part1
    2023el_nonroad_ff10_NCD20160627_05oct2016_v3_part2
    2023el_projection_SLT_nonroad_01feb2013_Texas_monthly_ff10_30aug2016_v0   2023
    MOVES2014a_ONROAD_EPA2023el_FF10
    Prepared by EPA, uploaded to MARAMA EMF on January 19, 2017.
- 2028
  - Alpha 2:
    2028_from_2025eh_onroad_SMOKE_MOVES_MOVES2014_no_speciated_pm_v0_MARAMA
    Prepared by EPA, uploaded to MARAMA EMF on October 22, 2015.
  - Gamma:
    2028el_onroad_SMOKE_MOVES_MOVES2014a_forOTAQ_21nov2016_v0_part1.csv
    2028el_onroad_SMOKE_MOVES_MOVES2014a_forOTAQ_21nov2016_v0_part2.csv
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Point Oil & Gas

- 2011
  - Alpha, Alpha 2:
    othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv

    pt_oilgas_2011NEIv2_POINT_20140913_17oct2014_v2.csv
    Prepared by EPA, uploaded to MARAMA EMF on November 5, 2014.
  - Beta, Beta 2, Gamma:
    othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv
    pt_oilgas_2011NEIv2_POINT_20140913_03feb2015_v4
    Prepared by EPA, uploaded to MARAMA EMF on November 5, 2014 and February 3, 2015, respectively.

- 2017
  - Beta, Beta 2:
    Othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv
    2017_POINT_oilgas_23jul2016
    Prepared by MARAMA, uploaded to MARAMA EMF on July 23, 2016, July 23, 2016, and November 5, 2014, respectively.
- 2018
  - Alpha, Alpha 2:
    MARAMA_Alpha_2018_othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0_csv_v0_01feb2015_v0
    MARAMA_Alpha_2018_pt_oilgas_2011NEIv2_POINT_20140913_17oct2014_v2_csv_v0_01feb2015_nf_v1
    Prepared by MARAMA, uploaded to MARAMA EMF on February 1, 2015.
- 2020
  - Gamma:
    2020_MARAMA_pt_oilgas_2011NEIv2_POINT_20140913_22dec2017
    2020_nonMARAMA_pt_oilgas_2011NEIv2_POINT_20140913_22dec2017
    Prepared by MARAMA, uploaded to MARAMA EMF on February 3, 2018 and January 2, 2018, respectively.
- 2023
  - Gamma:
    2023en_MARAMA_pt_oilgas_2011NEIv2_POINT_21aug2017_v0
    2023en_pt_oilgas_2011NEIv2_POINT_21aug2017_v2
    Prepared by MARAMA, uploaded to MARAMA EMF on December 12, 2017 and September 29, 2017, respectively.
- 2028
  - Alpha 2:
    MARAMA_Alpha_2028_othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv
    MARAMA_Alpha_2028_pt_oilgas_2011NEIv2_POINT_20140913_17oct2014_v2
    Prepared by MARAMA, uploaded to MARAMA EMF on August 18, 2015 and October 23, 2015, respectively.
  - Gamma:
    2028el_pt_oilgas_2011NEIv2_POINT_20140913_02dec2016_v1
    MARAMA_2028el_pt_oilgas_2011NEIv2_POINT_20140913_mar_21nov2016_v1
    Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Prescribed Burn

- All Years
  - Alpha, Alpha 2, Beta, Beta 2, Gamma:
    ptfire_jan_2011v2_prescribed_16jan2015_v0
    ptfire_feb_2011v2_prescribed_16jan2015_v0
    ptfire_mar_2011v2_prescribed_16jan2015_v0
    ptfire_apr_2011v2_prescribed_16jan2015_v0
    ptfire_may_2011v2_prescribed_16jan2015_v0
    ptfire_jun_2011v2_prescribed_16jan2015_v0
    ptfire_jul_2011v2_prescribed_16jan2015_v0
    ptfire_aug_2011v2_prescribed_16jan2015_v0
    ptfire_sep_2011v2_prescribed_16jan2015_v0
    ptfire_oct_2011v2_prescribed_16jan2015_v0
    ptfire_nov_2011v2_prescribed_16jan2015_v0
    ptfire_dec_2011v2_prescribed_16jan2015_v0
    Prepared by EPA, uploaded to MARAMA EMF on January 15, 2015.

Refueling

- 2011
    - Alpha, Alpha 2:
      refueling_refueling_2011NEIv2_POINT_20140913_23sep2014_v0.csv
      refueling_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 6, 2014 and November 13, 2014, respectively.
    - Beta, Beta 2, Gamma:
      refueling_2011NEIv2_POINT_20140913_04dec2014_v2
      refueling_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on February 3, 2015 and November 13, 2014, respectively.
- 2017
    - Beta, Beta 2:
      2017_POINT_refueling_15jul2016
      2017_NONPOINT_refueling_20jun2016
      Prepared by MARAMA, uploaded to MARAMA EMF on July 15, 2016 and June 20, 2016, respectively.
- 2018
    - Alpha, Alpha 2:
      MARAMA_Alpha_2018_refueling_refueling_2011NEIv2_POINT_20140913_23sep2014_v0_csv_v0_02feb2015_nf_v1
      MARAMA_Alpha_2018_refueling_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_21jan2015_nf_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on February 1, 2015 and January 5, 2015, respectively.
- 2020
    - Gamma:
      2020_refueling_2011NEIv2_POINT_20140913_04dec2014_v2_14sep2017
      2020_refueling_2011NEIv2_NONPOINT_11nov2014_v0_13sep2017
      Prepared by MARAMA, uploaded to MARAMA EMF on September 13, 2017.
- 2023
    - Gamma:
      2023el_from_refueling_2011NEIv2_POINT_20140913_20sep2016_v1
      2023el_MARAMA_from_refueling_2011NEIv2_POINT_20140913_15sep2016_v1
      2023el_from_refueling_2011NEIv2_NONPOINT_20141108_14sep2016_v1
      2023el_MARAMA_from_refueling_2011NEIv2_NONPOINT_20141108_mar_13sep2016_v1
      Prepared by EPA, uploaded to MARAMA EMF on October 7, 2016.
- 2028
    - Alpha 2:
      MARAMA_Alpha_2028_refueling_refueling_2011NEIv2_POINT_20140913_23sep2014_v0
      MARAMA_Alpha_2028_refueling_2011NEIv2_NONPOINT_20141108_11nov2014_v0
      Prepared by MARAMA, uploaded to MARAMA EMF on October 23, 2015 and August 20, 2015, respectively.
    - Gamma:
      2023el_from_refueling_2011NEIv2_POINT_20140913_20sep2016_v1
      MARAMA_2028el_refueling_2011NEIv2_POINT_20140913_18nov2016_v1
      2023el_from_refueling_2011NEIv2_NONPOINT_20141108_14sep2016_v1
      MARAMA_2028el_refueling_2011NEIv2_NONPOINT_20141108_21nov2016_v1
      Prepared by EPA, most files not uploaded to EMF (files listed in other years are), but available on EPA FTP site.

Residential Wood Combustion

- 2011
    - Alpha, Alpha 2:
      rwc_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv
      Prepared by EPA, uploaded to MARAMA EMF on November 13, 2014.
    - Beta, Beta 2:
      rwc_2011NEIv2_NONPOINT_20141108_24nov2014_v3
      Prepared by EPA, uploaded to MARAMA EMF on January 5, 2015.
- 2017
    - Beta, Beta 2:
      2017_NONPOINT_RWC_20jun2016
      Prepared by MARAMA, uploaded to MARAMA EMF on June 20, 2016.

- 2018
    - Alpha, Alpha 2:
      MARAMA_Alpha_2018_rwc_2011NEIv2_NONPOINT_20141108_11nov2014_v0_csv_v0_21jan2015_nf_v1
      Prepared by MARAMA, uploaded to MARAMA EMF on January 21, 2015.
- 2020
    - Gamma:
      2020_MARAMA_rwc_2011NEIv2_NONPOINT_20141108_24nov2014_v3
      Prepared by MARAMA, uploaded to MARAMA EMF on November 22, 2017.
      Note:New York DEC interpolated gridded emissions between 2017 and 2023 for other states in the domain
- 2023
    - Gamma:
      2023el_rwc_2011NEIv2_NONPOINT_20141108_080856104_07sep2016_v1
      2023el_rwc_MARAMA_2011NEIv2_NONPOINT_20141108_07sep2016_v0
      Prepared by EPA, uploaded to MARAMA EMF on September 9, 2016.
- 2028
    - Alpha 2:
      MARAMA_Alpha_2028_rwc_2011NEIv2_NONPOINT_20141108_11nov2014_v0
      Prepared by MARAMA, uploaded to MARAMA EMF on August 20, 2015.
    - Gamma:
      2028el_rwc_from_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      MARAMA_2028el_rwc_2011NEIv2_NONPOINT_20141108_17nov2016_v1
      Prepared by EPA, not uploaded to EMF, but available on EPA FTP site.

Wild Fires

- All Years
    - Alpha, Alpha 2:
      ptfire_jan_2011v2_wild_16jan2015_v0
      ptfire_feb_2011v2_wild_16jan2015_v0
      ptfire_mar_2011v2_wild_16jan2015_v0
      ptfire_apr_2011v2_wild_16jan2015_v0
      ptfire_may_2011v2_wild_16jan2015_v0
      ptfire_jun_2011v2_wild_16jan2015_v0
      ptfire_jul_2011v2_wild_16jan2015_v0
      ptfire_aug_2011v2_wild_16jan2015_v0
      ptfire_sep_2011v2_wild_16jan2015_v0
      ptfire_oct_2011v2_wild_16jan2015_v0
      ptfire_nov_2011v2_wild_16jan2015_v0
      ptfire_dec_2011v2_wild_16jan2015_v0
      Prepared by EPA, uploaded to MARAMA EMF on January 15, 2015.
    - Beta, Beta 2, Gamma:
      ptfire_jan_2011v2_wild_16jan2015_v0
      ptfire_feb_2011v2_wild_16jan2015_v0
      ptfire_mar_2011v2_wild_16jan2015_v0
      ptfire_apr_2011v2_wild_16jan2015_v0
      ptfire_may_2011v2_wild_16jan2015_v0_MARAMA
      ptfire_jun_2011v2_wild_16jan2015_v0_MARAMA
      ptfire_jul_2011v2_wild_16jan2015_v0
      ptfire_aug_2011v2_wild_16jan2015_v0
      ptfire_sep_2011v2_wild_16jan2015_v0
      ptfire_oct_2011v2_wild_16jan2015_v0
      ptfire_nov_2011v2_wild_16jan2015_v0
      ptfire_dec_2011v2_wild_16jan2015_v0
      Prepared by EPA and MARAMA, uploaded to MARAMA EMF on January 15, 2015, except the May and June files uploaded March 8, 2016.

Appendix C. List of Air Quality Monitors in OTC Modeling Domain

	State	County	AQS Code	Site	Latitude	Longitude
OTR	**CT**	Fairfield	**90010017**	Greenwich Point Park	41.003613	-73.584999
			90011123	Western Conn State Univ	41.399166	-73.4431
			90013007	Stratford	41.1525	-73.103104
			90019003	Sherwood Island Connector	41.118332	-73.3367
		Hartford	**90031003**	McAuliffe Park	41.784721	-72.631699
		Litchfield	**90050005**	Mohawk Mt-Cornwall	41.821342	-73.297302
		Middlesex	**90070007**	(blank)	41.552223	-72.629997
		New Haven	**90090027**	Criscuolo Park-New Haven	41.301399	-72.902901
			90099002	Hammonasset State Park	41.260834	-72.550003
		New London	**90110124**	Fort Griswold Park	41.353619	-72.078796
		Tolland	**90131001**	(blank)	41.976391	-72.3881
		(blank)	**90110008**		41.317223	-72.065002
	DC	District of Columbia	**110010025**	TAKOMA SCHOOL	38.583225	-77.121902
			110010041	RIVER TERRACE	38.897221	-76.952797
			110010043	MCMILLAN PAMS	38.921848	-77.013199
	DE	Kent	**100010002**	PROPERTY OF KILLENS POND STATE PARK; BEH	38.984749	-75.555199
		New Castle	**100031007**	(blank)	39.551109	-75.730797
			100031010	OPEN FIELD	39.817223	-75.563904
			100031013	BELLEVUE STATE PARK, FIELD IN SE PORTION	39.773888	-75.496399
		Sussex	**100051002**	Seaford Shipley State Service Center	38.644478	-75.612701
			100051003	SPM SITE, NEAR UD ACID RAIN/MERCURY COLL	38.779198	-75.162697
		(blank)	**100031003**	Bellefonte River Road Park	39.761112	-75.491898
			100032004	CORNER OF MLK BLVD AND JUSTISON ST, NO T	39.739445	-75.558098
	MA	Barnstable	**250010002**	TRURO NATIONAL SEASHORE	41.975803	-70.023598
		Berkshire	**250034002**	MT GREYLOCK SUMMIT	42.636681	-73.167397
		Bristol	**250051002**	LEROY WOOD SCHOOL	41.633278	-70.879204
		Dukes	**250070001**	1 HERRING CREEK RD, AQUINNAH (WAMPANOAG	41.330467	-70.785202
		Essex	**250092006**	LYNN WATER TREATMENT PLANT	42.474644	-70.970802
			250094005	Newbury-B	42.814474	-70.817936
			250095005	CONSENTINO SCHOOL.	42.770836	-71.102303
		Hampden	**250130008**	WESTOVER AFB	42.194382	-72.555099
		Hampshire	**250150103**	AMHERST	42.400578	-72.523102
			250154002	QUABBIN RES	42.298492	-72.334099
		Middlesex	**250170009**	USEPA REGION 1 LAB	42.626678	-71.362099
			250171102	inactive military resv 680 hudson rd sud	42.413574	-71.482803
		Norfolk	**250213003**	BLUE HILL OBSERVATORY	42.211773	-71.113998
		Suffolk	**250250041**	BOSTON LONG ISLAND	42.317371	-70.968399
			250250042	DUDLEY SQUARE ROXBURY	42.329498	-71.082603
		Worcester	**250270015**	WORCESTER AIRPORT	42.274319	-71.875504
			250270024	UXBRIDGE	42.099697	-71.6194
		(blank)	**250094004**	SITE LOCATED OFF PARKING LOT 2.	42.790268	-70.808296
	MD	Anne Arundel	**240030014**	Davidsonville	38.9025	-76.653099
		Baltimore	**240051007**	Padonia	39.462025	-76.631302
			240053001	Essex	39.310833	-76.474403
		Baltimore (City)	**245100054**	Furley	39.328892	-76.552498
		Calvert	**240090011**	Calvert	38.53672	-76.617203
		Carroll	**240130001**	South Carroll	39.444168	-77.041702
		Cecil	**240150003**	Fair Hill Natural Resource Management Ar	39.701111	-75.860001
		Charles	**240170010**	Southern Maryland	38.504166	-76.811897
		Dorchester	**240199991**	Blackwater NWR	38.445	-76.1114
		Frederick	**240210037**	Frederick Airport	39.42276	-77.375198
		Garrett	**240230002**	Piney Run	39.705952	-79.012001
		Harford	**240251001**	Edgewood	39.41	-76.2967
			240259001	Aldino	39.563332	-76.203903
		Kent	**240290002**	Millington	39.305199	-75.797203
		Montgomery	**240313001**	Rockville	39.114445	-77.106903
		Prince George's	**240330030**	HU-Beltsville	39.055279	-76.878304
			240338003	PG Equestrian Center	38.811939	-76.744202
			240339991	Beltsville	39.0284	-76.8171
		Washington	**240430009**	Hagerstown	39.565582	-77.721603
		(blank)	**240030019**	FT MEADE LAT/LONG POINT IS OF THE SAMPLI	39.101112	-76.729401
			240330002	LAT/LONG POINT IS OF SAMPLING INLET.....	39.02	-76.827797
	ME	Androscoggin	**230010014**	DURHAM FIRE STATION	43.974621	-70.124603
		Cumberland	**230052003**	CETL - Cape Elizabeth Two Lights (State	43.561043	-70.207298
		Hancock	**230090102**	TOP OF CADILLAC MTN (FENCED ENCLOSURE)	44.351696	-68.226997
			230090103	MCFARLAND HILL Air Pollutant Research Si	44.377048	-68.260902
		Kennebec	**230112005**	Gardiner, Pray Street School (GPSS)	44.230621	-69.785004
		KNO$_X$	**230130004**	Marshall Point Lighthouse	43.917953	-69.260597
		Oxford	**230173001**	(blank)	44.250923	-70.860603
		Sagadahoc	**230230006**	BOWDOINHAM, MERRYMEETING BAY, BROWN'S PT	44.005001	-69.827797

State	County	AQS Code	Site	Latitude	Longitude
	Washington	**230290019**	Harbor Masters Office; Jonesport Public	44.531906	-67.595901
		230290032	(blank)	44.963634	-67.060699
	York	**230310038**	WBFD - West Buxton (Hollis) Fire Departm	43.656765	-70.629097
		230310040	SBP - Shapleigh Ball Park	43.58889	-70.877296
		230312002	KPW - Kennebunkport Parson'd Way	43.343166	-70.471001
	(blank)	**230031100**	MICMAC HEALTH DEPARTMENT	46.69643	-68.032997
		230050027	SHELTER IN PARKING LOT OF INTERSECTION O	43.662373	-70.2649
		230090301	OZONE AND METEOROLOGY MONITORING STARTED	44.423073	-68.805702
		230194008	WLBZ TV Transmitter Building - Summit of	44.735977	-68.670799
		230230004		43.793568	-69.731796
		230313002	____________NO INFORMATION AT THIS TIME	43.083332	-70.75
NH	Belknap	**330012004**	FIELD OFFICE ON THE GROUNDS OF THE FORME	43.566113	-71.496399
	Cheshire	**330050007**	WATER STREET	42.930473	-72.2724
	Coos	**330074001**	(blank)	44.270168	-71.303802
		330074002	CAMP DODGE, GREENS GRANT	44.308167	-71.217697
	Grafton	**330090010**	LEBANON AIRPORT ROAD	43.629612	-72.309601
	Hillsborough	**330111011**	GILSON ROAD	42.718662	-71.5224
		330115001	MILLER STATE PARK	42.861752	-71.878403
	Merrimack	**330131007**	HAZEN DRIVE	43.218498	-71.514503
	Rockingham	**330150014**	PORTSMOUTH - PEIRCE ISLAND	43.075333	-70.748001
		330150016	SEACOAST SCIENCE CENTER	43.045277	-70.713799
		330150018	Londonderry-Moose Hill	42.862536	-71.380172
	(blank)	**330074003**	MONITOR LOCATED IN THE GATEHOUSE FOR THE	45.051109	-71.391899
		330110020	PEARL ST MUNICIPAL PARKING LOT	42.995777	-71.462502
		330190003		43.364445	-72.338303
NJ	Atlantic	**340010006**	Brigantine	39.46487	-74.4487
	Bergen	**340030006**	Leonia	40.870438	-73.991997
	Camden	**340071001**	Ancora State Hospital	39.68425	-74.861504
	Cumberland	**340110007**	Millville	39.422272	-75.0252
	Essex	**340130003**	Newark - Firehouse	40.720989	-74.192902
	Gloucester	**340150002**	Clarksboro	39.800339	-75.212097
	Hudson	**340170006**	Bayonne	40.67025	-74.126099
	Hunterdon	**340190001**	Flemington	40.515263	-74.806702
	Mercer	**340210005**	Rider University	40.283092	-74.742599
		340219991	Wash Crossing	40.3125	-74.8729
	Middlesex	**340230011**	Rutgers University	40.462181	-74.429398
	Monmouth	**340250005**	Monmouth University	40.277645	-74.005096
	Morris	**340273001**	Chester	40.787628	-74.6763
	Ocean	**340290006**	Colliers Mills	40.064831	-74.444099
	Passaic	**340315001**	Ramapo	41.058617	-74.255501
	Warren	**340410007**	Columbia Site	40.924606	-75.067825
	(blank)	**340010005**	NACOTE CREEK RESEARCH STATION	39.530254	-74.460297
		340030005	TEANECK	40.898579	-74.0299
		340070003	CAMDEN LAB	39.923042	-75.097603
NY	Albany	**360010012**	LOUDONVILLE	42.680752	-73.757301
	Bronx	**360050133**	PFIZER LAB SITE	40.867901	-73.878098
	Chautauqua	**360130006**	DUNKIRK	42.49963	-79.318802
		360130011	WESTFIELD	42.29071	-79.5896
	Chemung	**360150003**	ELMIRA	42.110958	-76.8022
	Dutchess	**360270007**	MILLBROOK	41.785549	-73.741402
	Erie	**360290002**	AMHERST	42.993279	-78.7715
	Essex	**360310002**	WHITEFACE SUMMIT	88.732162	-147.806198
		360310003	WHITEFACE BASE	44.393082	-73.858902
	Hamilton	**360410005**	PISECO LAKE	43.44957	-74.516296
	Jefferson	**360450002**	PERCH RIVER	44.087471	-75.973198
	Madison	**360530006**	CAMP GEORGETOWN	42.730461	-75.784401
	New York	**360610135**	CCNY	40.819759	-73.948303
	Niagara	**360631006**	MIDDLEPORT	43.223862	-78.478897
	Oneida	**360650004**	CAMDEN	43.302681	-75.719803
	Onondaga	**360671015**	EAST SYRACUSE	43.052349	-76.059196
	Orange	**360715001**	VALLEY CENTRAL HIGH SCHOOL	41.52375	-74.215302
	Oswego	**360750003**	FULTON	43.284279	-76.463203
	Putnam	**360790005**	MT NINHAM	41.455891	-73.709801
	Queens	**360810124**	Queens College 2	40.736141	-73.821503
	Rensselaer	**360830004**	GRAFTON STATE PARK	42.781891	-73.4636
	Richmond	**360850067**	SUSAN WAGNER HS	40.596642	-74.125298
	Rockland	**360870005**	Rockland County	41.182079	-74.028198
	Saratoga	**360910004**	STILLWATER	43.012089	-73.648903
	Steuben	**361010003**	PINNACLE STATE PARK	42.091419	-77.209801
	Suffolk	**361030002**	BABYLON	40.745289	-73.419197
		361030004	RIVERHEAD	40.960781	-72.712402
		361030009	HOLTSVILLE	81.655982	-146.115006
	Ulster	**361111005**	BELLEAYRE MOUNTAIN	42.144032	-74.494301
	Wayne	**361173001**	WILLIAMSON	43.230862	-77.171402

State	County	AQS Code	Site	Latitude	Longitude
	Westchester	**361192004**	WHITE PLAINS	41.051922	-73.763702
	(blank)	**360050110**	IS 52	40.816181	-73.902
		360337003	Y001	44.980576	-74.695
		360430005	NICKS LAKE	43.68578	-74.985397
		360551007	ROCHESTER 2	43.146179	-77.548203
		360810098	COLLEGE POINT POST OFFICE	40.784199	-73.847603
		360930003	SCHENECTADY	42.799011	-73.938904
PA	Allegheny	**420030008**	Lawrenceville	40.46542	-79.9608
		420030010	LAT/LON IS APPROXIMATE LOCATION OF SCIEN	40.445576	-80.016197
		420030067	South Fayette	40.375645	-80.169899
		420031005	Harrison	40.613949	-79.729401
	Armstrong	**420050001**	LAT/LON IS CENTER OF TRAILER	40.814182	-79.564697
	Beaver	**420070002**	(blank)	40.562519	-80.503899
		420070005	DRIVEWAY TO BAKEY RESIDENCE	40.684723	-80.359703
		420070014	(blank)	40.747795	-80.316399
	Berks	**420110006**	Kutztown	40.51408	-75.789703
		420110011	Reading Airport	40.38335	-75.968597
	Blair	**420130801**	(blank)	40.535278	-78.370796
	Bucks	**420170012**	A420170012LAT/LONG POINT IS OF SAMPLING	40.107224	-74.882202
	Cambria	**420210011**	(blank)	40.309723	-78.915001
	Centre	**420270100**	LAT/LON=POINT SW CORNER OF TRAILER	40.81139	-77.876999
		420279991	Penn State	40.7208	-77.9319
	Chester	**420290100**	CHESTER COUNTY TRANSPORT SITE INTO PHILA	39.834461	-75.768204
	Clearfield	**420334000**	MOSHANNON STATE FOREST	41.1175	-78.526199
	Dauphin	**420430401**	A420430401LAT/LON POINT IS AT CORNER OF	40.24699	-76.847
		420431100	A420431100LAT/LON POINT IS AT CORNER OF	40.272221	-76.681396
	Delaware	**420450002**	A420450002LAT/LON POINT IS OF CORNER OF	39.835556	-75.372498
	Erie	**420490003**	(blank)	42.14175	-80.038597
	Franklin	**420550001**	HIGH ELEVATION OZONE SITE	39.961109	-77.475601
	Greene	**420590002**	75 KM SSW OF PITTSBURGH RURAL SITE ON A	39.80933	-80.265701
	Indiana	**420630004**	(blank)	40.563332	-78.919998
	Lackawanna	**420690101**	A420690101LAT/LON POINT IS AT CORNER OF	41.479115	-75.578201
		420692006	A420692006LAT/LON POINT IS AT CORNER OF	41.44278	-75.6231
	Lancaster	**420710007**	A420710007LAT/LON POINT AT CORNER OF TRA	40.046665	-76.283302
		420710012	Lancaster DW	40.043835	-76.112396
	Lawrence	**420730015**	(blank)	40.99585	-80.346397
	Lebanon	**420750100**	LEBANON	40.337328	-76.383447
	Lehigh	**420770004**	A420770004LAT/LONG POINT IS OF SAMPLING	40.611942	-75.432503
	Luzerne	**420791100**	A420791100LAT/LON POINT IS AT CORNER OF	41.209167	-76.003304
		420791101	A420791101LAT/LON POINT IS AT CORNER OF	41.265556	-75.846397
	Lycoming	**420810100**	MONTOURSVILLE	41.250801	-76.923798
	Mercer	**420850100**	(blank)	41.215015	-80.484802
	Monroe	**420890002**	SWIFTWATER	41.083061	-75.323303
	Montgomery	**420910013**	A420910013LAT/LON POINT IS OF CORNER OF	40.112221	-75.309196
	Northampton	**420950025**	LAT/LON POINT IS CENTER OF TRAILER	40.628056	-75.341103
		420958000	COMBINED EASTON SITE (420950100) AND EAS	40.692223	-75.237198
	Perry	**420990301**	A420990301LAT/LON POINT IS AT CORNER OF	40.456944	-77.165604
	Philadelphia	**421010004**	Air Management Services Laboratory (AMS	40.008888	-75.097801
		421010024	North East Airport (NEA)	40.076401	-75.011497
		421011002	Pennypack Park-Phil	40.035985	-75.002405
	Somerset	**421119991**	Laurel Hill	39.9878	-79.2515
	Tioga	**421174000**	PENN STATE OZONE MONITORING SITE	41.644722	-76.939201
	Washington	**421250005**	(blank)	40.146667	-79.902199
		421250200	(blank)	40.170555	-80.261398
		421255001	(blank)	40.445278	-80.420799
	Westmoreland	**421290006**	(blank)	40.428078	-79.692802
		421290008	LAT/LON POINT IS TRAILER	40.304695	-79.505699
	York	**421330008**	A421330008LAT/LON POINT AT CORNER OF TRA	39.965279	-76.699402
		421330011	York DW	39.86097	-76.462097
	(blank)	**420010002**		39.93	-77.25
		420110001	A420110001LAT/LONG POINT IS OF SAMPLING	40.511112	-75.786102
		420110009	A420110009LAT/LONG POINT IS OF SAMPLING	40.320278	-75.926697
		420274000	PA DEPT CONSERVATION & NATURAL RESOURCES	40.774555	-77.622101
		420290050	LAT/LON POINT IS OF CORNER OF TRAILER	39.935665	-75.604301
		420814000	NEXT TO TIADAGHTON SPORTMANS CLUB - NORT	41.334057	-77.449097
		421010014	Roxborough (ROX)	40.049618	-75.240799
		421010136	ON AMTRAK RIGHT OF WAY - NEAR AIRPORT HI	39.927502	-75.222801
RI	Kent	**440030002**	AJ	41.615238	-71.720001
	Providence	**440071010**	FRANCIS SCHOOL East Providence	41.841572	-71.360802
	Washington	**440090007**	US-EPA Laboratory	41.49511	-71.423698
VA	Alexandria City	**515100009**	Alexandria Health Dept.	38.810402	-77.044403
	Arlington	**510130020**	Aurora Hills Visitors Center	38.8577	-77.059196
	Fairfax	**510590005**	CUB RUN	38.8941	-77.4652
		510590018	MT VERNON	38.74232	-77.07743

	State	County	AQS Code	Site	Latitude	Longitude
Outside-OTR			**510590030**	Lee District Park	38.77335	-77.104698
			510591005	Annandale	38.83738	-77.16338
		Loudoun	**511071005**	Broad Run High School, Ashburn	39.024731	-77.489304
		Prince William	**511530009**	James S. Long Park	38.852871	-77.634598
	VT	Bennington	**500030004**	Morse Airport - State of Vermont Propert	42.887589	-73.249802
	AL	Colbert	**10331002**	MUSCLE SHOALS	34.758781	-87.650597
		DeKalb	**10499991**	Sand Mountain	34.2888	-85.9698
		Elmore	**10510001**	DBT, WETUMPKA	32.498566	-86.136597
		Etowah	**10550011**	SOUTHSIDE	33.904037	-86.053902
		Jefferson	**10730023**	North Birmingham	33.553055	-86.815002
			10731003	(blank)	33.485558	-86.915001
			10731005	McAdory	33.331112	-87.003601
			10731009	(blank)	33.459721	-87.305603
			10731010	Leeds	33.545277	-86.549202
			10732006	(blank)	33.386391	-86.816704
			10735002	(blank)	33.704723	-86.669197
			10735003	(blank)	33.801666	-86.942497
			10736002	(blank)	33.578335	-86.773903
		Madison	**10890014**	HUNTSVILLE OLD AIRPORT	34.687672	-86.586403
		Montgomery	**11011002**	MOMS, ADEM	32.40712	-86.256401
		Morgan	**11030011**	DECATUR, Alabama	34.518734	-86.976898
		Russell	**11130002**	LADONIA, PHENIX CITY	32.467972	-85.083801
		Shelby	**11170004**	HELENA	33.317314	-86.825104
		Sumter	**11190002**	GASTON (SUMTER)	32.36401	-88.201897
		Tuscaloosa	**11250010**	DUNCANVILLE, TUSCALOOSA	33.0896	-87.459702
		(blank)	**10270001**	ASHLAND	33.281261	-85.8022
			10790002	SIPSEY (closed 11-01-2007)	34.342903	-87.339699
			11210003	TALLADEGA, (HONDA) Closed 11/01/06	33.498329	-86.122704
	AR	Crittenden	**50350005**	MARION	35.197289	-90.1931
		Newton	**51010002**	DEER	35.832726	-93.208298
		Polk	**51130003**	EAGLE MOUNTAIN	34.454407	-94.143303
		Pulaski	**51190007**	PARR	34.756187	-92.281303
			51191002	NLR AIRPORT	34.83572	-92.260597
			51191008	DOYLE SPRINGS ROAD	34.681343	-92.328697
		Washington	**51430005**	SPRINGDALE	36.179699	-94.116798
		(blank)	**50970001**		34.649723	-93.816704
			51191005	ADEQ	34.67627	-92.337196
			516500004		37.000984	-76.398598
	GA	Bibb	**130210012**	Macon SE	32.805408	-83.543503
		Chatham	**130510021**	Savannah-E. President Street	32.069229	-81.048798
		Chattooga	**130550001**	Summerville-DNR Fish Hatchery	34.474293	-85.407997
		Clarke	**130590002**	FIRE STATION # 7	33.918068	-83.344498
		Cobb	**130670003**	Kennesaw-National Guard	34.015484	-84.607399
		Columbia	**130730001**	Evans-Riverside Park	33.582146	-82.131203
		Coweta	**130770002**	Newnan	33.404041	-84.746002
		Dawson	**130850001**	Dawsonville, Georgia Forestry Commission	34.376316	-84.059799
		DeKalb	**130890002**	South DeKalb	33.687969	-84.290497
		Douglas	**130970004**	W. Strickland Street	33.743656	-84.779198
		Fulton	**131210055**	Confederate Avenue	33.720192	-84.357101
		Glynn	**131270006**	Risley Middle School	31.169735	-81.495903
		Gwinnett	**131350002**	GWINNETT TECH	33.961269	-84.069
		Henry	**131510002**	McDonough-County Extension Office	33.433575	-84.161697
		Murray	**132130003**	Fort Mountain	34.785198	-84.626404
		Muscogee	**132150008**	Columbus-Airport	32.521301	-84.944801
		Paulding	**132230003**	Yorkville, King Farm	33.928501	-85.045303
		Pike	**132319991**	Georgia Station	33.1787	-84.4052
		Richmond	**132450091**	Bungalow Road	33.43335	-82.022202
		Rockdale	**132470001**	Monastery	33.591076	-84.0653
		Sumter	**132611001**	Leslie-Union High School	31.954298	-84.0811
		(blank)	**130210013**		32.827969	-83.788696
			130893001	Tucker-Idlewood Road	33.845741	-84.213402
			131130001	DOT STORAGE FACILITY	33.455738	-84.418999
			132151003	Columbus-Crime Lab	32.508713	-84.880302
	IA	Bremer	**190170011**	WAVERLY AIRPORT SITE	42.743057	-92.5131
		Clinton	**190450021**	CLINTON, RAINBOW PARK	41.875	-90.177597
		Linn	**191130028**	KIRKWOOD	41.910557	-91.651901
			191130033	COGGON ELEMENTARY SCHOOL BLDG. NORTHERN	42.281013	-91.526901
			191130040	Public Health	41.976768	-91.687698
		Polk	**191530030**	CARPENTER	41.603161	-93.643097
		Scott	**191630014**	SCOTT COUNTY PARK	41.699173	-90.521896
		Story	**191690011**	SLATER CITY HALL	41.882866	-93.687798
		Van Buren	**191770006**	LAKE SUGEMA STATE PARK II	40.69508	-92.006302
		Warren	**191810022**	GRAVEL ROAD IN LAKE AQUABI STATE PARK	41.285534	-93.584
		(blank)	**191530058**		41.607777	-93.571899

State	County	AQS Code	Site	Latitude	Longitude
		191630015	DAVENPORT, JEFFERSON SCH.	41.53001	-90.587601
		191632011	ARGO, HIGHWAY MAINTENANCE	41.647499	-90.430801
		191770005	LAKE SUGEMA STATE PARK I	40.689167	-91.9944
IL	Adams	**170010007**	JOHN WOOD COMMUNITY COLLEGE	39.915409	-91.335899
	Champaign	**170190007**	THOMAS	40.244913	-88.188519
	Clark	**170230001**	416 S. State St. Hwy 1- West Union	39.210857	-87.668297
	Cook	**170310001**	VILLAGE GARAGE	41.670994	-87.732498
		170310032	SOUTH WATER FILTRATION PLANT	41.755833	-87.545303
		170310064	UNIVERSITY OF CHICAGO	41.790787	-87.601601
		170310076	COM ED MAINTENANCE BLDG	41.7514	-87.713501
		170311003	TAFT HS	41.984333	-87.792
		170311601	COOK COUNTY TRAILER	41.668121	-87.990601
		170314002	COOK COUNTY TRAILER	41.855244	-87.752502
		170314007	REGIONAL OFFICE BUILDING	42.060284	-87.863197
		170314201	NORTHBROOK WATER PLANT	42.139996	-87.799202
		170317002	WATER PLANT	42.061855	-87.674202
	DuPage	**170436001**	MORTON ARBORETUM	41.813049	-88.0728
	Effingham	**170491001**	CENTRAL JR HIGH	39.067158	-88.548897
	Hamilton	**170650002**	TEN MILE CREEK DNR OFFICE	38.082153	-88.624901
	Jersey	**170831001**	ILLINI JR HIGH	39.110538	-90.324097
	Jo Daviess	**170859991**	Stockton	42.2869	-89.9997
	Kane	**170890005**	LARSEN JUNIOR HIGH	42.049149	-88.273003
	Lake	**170971007**	CAMP LOGAN TRAILER	42.467571	-87.809998
	Macon	**171150013**	IEPA TRAILER	39.866833	-88.925598
	Macoupin	**171170002**	IEPA TRAILER	39.396076	-89.8097
	Madison	**171190008**	CLARA BARTON SCHOOL	38.890186	-90.148003
		171191009	SOUTHWEST CABLE TV	38.726574	-89.959999
		171193007	WATER PLANT	38.860668	-90.105904
		171199991	Alhambra	38.869	-89.6228
	McHenry	**171110001**	CARY GROVE HS	42.221443	-88.242203
	McLean	**171132003**	ISU HARRIS PHYSICAL PLANT	40.518734	-88.996902
	Peoria	**171430024**	FIRESTATION	40.68742	-89.606903
		171431001	PEORIA HEIGHTS HS	40.745502	-89.585899
	Randolph	**171570001**	IEPA TRAILER	38.176277	-89.788498
	Rock Island	**171613002**	ROCK ISLAND ARSENAL	41.514729	-90.517403
	Saint Clair	**171630010**	IEPA-RAPS TRAILER	38.612034	-90.1605
	Sangamon	**171670014**	SPFD_IB	39.831522	-89.640926
	Will	**171971011**	COM ED TRAINING CENTER	41.221539	-88.191002
	Winnebago	**172012001**	MAPLE ELEMENTARY SCHOOL	42.334984	-89.037804
	(blank)	**170010006**	ST BONIFACE SCHOOL	39.93301	-91.404198
		170190004	BOOKER T. WASHINGTON ES	40.123795	-88.2295
		170310050	SE POLICE STATION	41.707569	-87.568604
		170650001	DALE ELEMENTARY SCHOOL	37.998222	-88.493103
		170971002	NORTH FIRESTATION	42.386707	-87.8414
		171192007	IEPA-RAPS TRAILER	38.793343	-90.039803
		171670010	IDPH WAREHOUSE	39.844124	-89.604797
		171971008	FITNESS FORUM	41.57571	-88.055099
		172010009	WALKER SCHOOL	42.287189	-89.077003
IN	Allen	**180030002**	(blank)	41.221416	-85.0168
		180030004	Ft. Wayne- Beacon St.	41.094967	-85.101799
	Boone	**180110001**	Perry Worth ELEMENTRY SCHOOL, WEST OF WH	39.997482	-86.395203
	Carroll	**180150002**	Flora-Flora Airport	40.540455	-86.553001
	Clark	**180190008**	Charlestown State Park- 1051.8 meters Ea	38.393833	-85.6642
	Delaware	**180350010**	Albany- Albany Elem. Sch.	40.300014	-85.245399
	Elkhart	**180390007**	Bristol- Bristol Elem. Sch.	41.718048	-85.830597
	Floyd	**180431004**	New Albany- Green Valley Elem. Sch.	38.308056	-85.834198
	Greene	**180550001**	Plummer, 2500 S. W- Citizens gas Plummer	38.985577	-86.990097
	Hamilton	**180570006**	Our Lady of Grace- Noblesville	40.068298	-85.9925
	Hancock	**180590003**	Fortville- Fortville Municipal Building	39.93504	-85.8405
	Hendricks	**180630004**	AVON SCHOOL'S BUS BARN	39.759003	-86.397102
	Huntington	**180690002**	Roanoke- Roanoke Elem. School	40.960709	-85.379799
	Jackson	**180710001**	Brownstown- 225 W & 200 N. Water facilit	38.920845	-86.080498
	Johnson	**180810002**	Indian Creek Elementary School in Trafal	39.417244	-86.152397
	KNO$_X$	**180839991**	Vincennes	38.7408	-87.4853
	Lake	**180890022**	Gary-IITRI/ 1219.5 meters east of Tennes	41.606682	-87.304703
		180890030	Whiting- Whiting HS	41.6814	-87.494698
		180892008	HAMMOND CAAP- Hammond- 141st St.	41.639462	-87.493599
	LaPorte	**180910005**	Michigan City- 4th Street NIPSCO Gas St	41.717022	-86.9077
		180910010	LAPORTE OZONE SITE AT WATER TREATMENT PL	41.629097	-86.684601
	Madison	**180950010**	SCHOOL LOCATED ON THE SW CORNER OF US 36	40.002548	-85.656898
	Marion	**180970050**	Indpls.- Ft. Harrison	39.858921	-86.021301
		180970057	Indpls- Harding St.	39.74902	-86.186302
		180970073	Indpls.- E. 16th St.	39.789486	-86.060799
		180970078	Indpls- Washington Park/ in parking lot	39.811096	-86.114502

State	County	AQS Code	Site	Latitude	Longitude
	Morgan	**181090005**	Monrovia- Monrovia HS.	39.575634	-86.477898
	Perry	**181230009**	Leopold- Perry Central HS	38.113159	-86.6036
	Porter	**181270024**	Ogden Dunes- Water Treatment Plant	41.617558	-87.199203
		181270026	VALPARAISO	41.510292	-87.038498
	Posey	**181290003**	ST. PHILLIPS- St. Phillips road CAAP tra	38.005287	-87.718399
	Shelby	**181450001**	TRITON Middle SCHOOL, NORTH OF FAIRLAND	39.613422	-85.870598
	St. Joseph	**181410010**	Potato Creek State Park	41.551697	-86.370598
		181410015	SOUTH BEND-Shields Dr.	41.696693	-86.214699
		181411007	(blank)	41.742599	-86.110497
	Vanderburgh	**181630013**	Inglefield/ Scott School	38.113949	-87.537003
		181630021	Evansville- Buena Vista	38.013248	-87.577904
	Vigo	**181670018**	TERRE HAUTE CAAP/ McLean High School	39.486149	-87.401398
		181670024	Sandcut/ SITE LOCATED BY HOME BEHIND SH	39.560555	-87.313103
	Warrick	**181730008**	Boonville- Boonville HS	38.052002	-87.278297
		181730009	Lynnville- Tecumseh HS	38.1945	-87.3414
		181730011	Dayville	37.95451	-87.321899
	(blank)	**180510011**	TOYOTA SITE	38.425251	-87.465897
		180570005		40.065193	-86.008102
		180890024	LOWELL CITY WASTEWATER TREATMENT PLANT	41.263889	-87.417503
		180970042		39.646255	-86.248802
		181270020		41.63139	-87.086899
KY	Bell	**210130002**	MIDDLESBORO	36.608429	-83.7369
	Boone	**210150003**	EAST BEND	38.918331	-84.8526
	Boyd	**210190017**	ASHLAND PRIMARY (FIVCO)	38.459339	-82.640404
	Bullitt	**210290006**	SHEPHERDSVILLE	37.98629	-85.711899
	Campbell	**210373002**	NORTHERN KENTUCKY UNIVERSITY (NKU)	39.021881	-84.474503
	Carter	**210430500**	GRAYSON LAKE	38.238869	-82.988098
	Christian	**210470006**	HOPKINSVILLE	36.911709	-87.323303
	Daviess	**210590005**	OWENSBORO PRIMARY	37.780777	-87.075302
	Edmonson	**210610501**	Mammoth Cave National Park, Houchin Mead	37.131943	-86.147797
	Fayette	**210670012**	LEXINGTON PRIMARY	38.065029	-84.497597
	Greenup	**210890007**	WORTHINGTON	38.548138	-82.731201
	Hancock	**210910012**	LEWISPORT	37.93829	-86.897202
	Hardin	**210930006**	ELIZABETHTOWN	37.705612	-85.8526
	Henderson	**211010014**	BASKETT	37.871201	-87.463799
	Jefferson	**211110027**	Bates	38.13784	-85.5765
		211110051	Watson Lane	38.060909	-85.898003
		211110067	CANNONS LANE	38.22876	-85.654503
	Jessamine	**211130001**	NICHOLASVILLE	37.891472	-84.588303
	Livingston	**211390003**	SMITHLAND	37.155392	-88.393997
	McCracken	**211451024**	JACKSON PURCHASE (PADUCAH PRIMARY)	37.05822	-88.572502
	Oldham	**211850004**	BUCKNER	38.4002	-85.444298
	Perry	**211930003**	HAZARD	37.283291	-83.209297
	Pike	**211950002**	PIKEVILLE PRIMARY	37.482601	-82.535301
	Pulaski	**211990003**	SOMERSET	37.09798	-84.611504
	Simpson	**212130004**	FRANKLIN	36.708607	-86.566299
	Trigg	**212218001**	OLD DOVER HIGHWAY CADIZ,KY	36.78389	-87.851898
	Warren	**212270008**	OAKLAND	37.035439	-86.250603
	(blank)	**210370003**	SITE LOCATED AT NORTHERN KY WATER SERVIC	39.065556	-84.451897
		210670001		38.125832	-84.4683
		210830003		36.899166	-88.493599
		211111021		38.26355	-85.710297
		211490001		37.606388	-87.253899
		212090001		38.385834	-84.559998
		212210013		36.90139	-88.013603
		212299991	Mackville	37.704601	-85.0485
LA	Bossier	**220150008**	Shreveport / Airport	32.536259	-93.748901
	Caddo	**220170001**	Dixie	32.676388	-93.859703
	Ouachita	**220730004**	Monroe / Airport	32.509712	-92.046097
MI	Allegan	**260050003**	Holland	42.767784	-86.148598
	Benzie	**260190003**	(blank)	44.616943	-86.109398
	Berrien	**260210014**	Coloma	42.197788	-86.3097
	Cass	**260270003**	Cassopolis	41.895569	-86.001602
	Chippewa	**260330901**	NORTH OF EASTERDAY AVENUE	46.49361	-84.364197
	Clinton	**260370001**	ROSE LAKE, STOLL RD.(8562 E.)	42.79834	-84.393799
	Genesee	**260490021**	(blank)	43.047222	-83.670197
		260492001	Otisville	43.168335	-83.461502
	Huron	**260630007**	RURAL THUMB AREA OZONE SITE	43.836388	-82.642899
	Ingham	**260650012**	(blank)	42.738617	-84.534599
	Kalamazoo	**260770008**	KALAMAZOO FAIRGROUNDS	42.278069	-85.541901
	Kent	**260810020**	GR-Monroe	42.984173	-85.671303
		260810022	APPROXIMATELY 1/4 MILE SOUTH OF 14 MILE	43.176674	-85.416603
	Lenawee	**260910007**	6792 RAISIN CENTER HWY, LENAWEE CO.RD.CO	41.995567	-83.946602
	Macomb	**260990009**	New Haven	42.731396	-82.793503

State	County	AQS Code	Site	Latitude	Longitude
		260991003	(blank)	42.51334	-83.005997
	Manistee	**261010922**	(blank)	44.306999	-86.242599
	Mason	**261050007**	LOCATED 550 FT NORTH OF US10	43.953335	-86.294403
	Missaukee	**261130001**	LOCATED ABOUT 1/4 MILE WEST OF SITE	44.310555	-84.891899
	Muskegon	**261210039**	(blank)	43.278061	-86.311096
	Oakland	**261250001**	Oak Park	42.463062	-83.183197
	Ottawa	**261390005**	Jenison	42.894451	-85.852699
	Schoolcraft	**261530001**	Seney	46.288876	-85.950203
	St. Clair	**261470005**	Port Huron	42.953335	-82.4562
	Washtenaw	**261610008**	TOWNER ST, SOUTH; 2 LANE RESIDENIAL - HO	42.240566	-83.599602
	Wayne	**261630001**	Allen Park	42.228619	-83.208199
		261630019	East 7 Mile	42.43084	-83.000099
	(blank)	**260890001**		45.028896	-85.629097
		261630016		42.357807	-83.096001
MN	Anoka	**270031001**	Cedar Creek	45.40184	-93.203102
		270031002	Anoka Airport	45.13768	-93.207603
	Goodhue	**270495302**	Stanton Air Field	44.473755	-93.012604
	Lake	**270750005**	Fernberg Road	47.948624	-91.495598
	Olmsted	**271095008**	Ben Franklin School	43.996906	-92.450401
	Saint Louis	**271377550**	WDSE	46.81826	-92.089401
	Scott	**271390505**	Shakopee	44.791435	-93.512497
	Wright	**271713201**	St. Michael	45.20916	-93.669197
	(blank)	**270177416**	Cloquet	46.705269	-92.523804
		271370034	VOYAGEURS NATIONAL PARK, NEAR SULLIVAN B	48.413334	-92.830597
MO	Boone	**290190011**	Finger Lakes	39.078602	-92.315201
	Callaway	**290270002**	New Bloomfield	38.706081	-92.093102
	Cedar	**290390001**	El Dorado Springs	37.689999	-94.035004
	Greene	**290770036**	Hillcrest High School	37.256138	-93.299896
		290770042	Fellows Lake	37.319511	-93.204597
	Jefferson	**290990019**	Arnold West	38.448631	-90.398499
	Lincoln	**291130003**	Foley	39.044701	-90.8647
	Monroe	**291370001**	MTSP	39.475136	-91.789101
	Perry	**291570001**	(blank)	37.702641	-89.698601
	Saint Charles	**291831002**	West Alton	38.872547	-90.226501
		291831004	Orchard Farm	38.899399	-90.449203
	Saint Louis	**291890005**	Pacific	76.9804	-181.4104
		291890014	Maryland Heights	77.421798	-180.951798
		291893001	Ladue	38.650259	-90.350463
	Sainte Genevieve	**291860005**	Bonne Terre	37.900841	-90.423897
	St. Louis City	**295100085**	Blair Street	38.656498	-90.198601
	Taney	**292130004**	Branson	36.707726	-93.222
	(blank)	**290770026**		37.122631	-93.263397
		291890004	FORMERLY 5962 SOUTH LINDBERGH.	38.53278	-90.382401
		291890006		38.613659	-90.495903
		291895001		38.766159	-90.285896
		291897003	.7 MILES E FROM OLD SITE ON S SIDE OF ST	38.720966	-90.367104
		295100086	MARGARETTA CATEGORY B CORE SLAM $PM_{2.5}$.	38.673222	-90.239197
MS	Bolivar	**280110001**	Cleveland	33.746056	-90.723
	DeSoto	**280330002**	Hernando	34.821659	-89.987801
	Hinds	**280490010**	Jackson FS19	32.385731	-90.141197
	Lauderdale	**280750003**	Meridian	32.364567	-88.731499
	Lee	**280810005**	TUPELO AIRPORT NEAR OLD NWS OFFICE	34.264915	-88.766197
	Yalobusha	**281619991**	COFFEEVILLE	34.0026	-89.799
	(blank)	**280890002**		32.564835	-90.178596
		281490004		32.322834	-90.8871
NC	Alexander	**370030004**	Waggin` Trail	35.929001	-81.189796
	Avery	**370110002**	Linville Falls	35.972221	-81.933098
		370119991	CRANBERRY	36.1058	-82.0454
	Buncombe	**370210030**	Bent Creek	35.500103	-82.599899
	Caldwell	**370270003**	Lenoir (city)	35.935833	-81.530296
	Caswell	**370330001**	Cherry Grove	36.307034	-79.4674
	Chatham	**370370004**	Pittsboro	35.757221	-79.159698
	Cumberland	**370510008**	(blank)	35.158688	-78.727997
		370511003	Golfview	34.968887	-78.962502
	Davie	**370590003**	Mocksville	35.897068	-80.557297
	Durham	**370630015**	Durham Armory	36.032944	-78.905403
	Edgecombe	**370650099**	Leggett	35.988335	-77.582802
	Forsyth	**370670022**	(blank)	36.110558	-80.2267
		370670028	NEW O3 SLAMS SITE 4/1/96; REPLACES FERGU	36.203056	-80.215797
		370670030	(blank)	36.026001	-80.342003
		370671008	(blank)	36.050835	-80.143898
	Franklin	**370690001**	Franklinton	36.096188	-78.463699
	Graham	**370750001**	Joanna Bald	35.257931	-83.795601
	Granville	**370770001**	Butner	36.141109	-78.768097

State	County	AQS Code	Site	Latitude	Longitude
	Guilford	**370810013**	Mendenhall School	36.100712	-79.810501
	Haywood	**370870008**	WAYNSVL ELEM SCH	35.50716	-82.96337
		370870036	Purchase Knob	35.59	-83.077499
	Johnston	**371010002**	West Johnston Co.	35.590832	-78.461899
	Lenoir	**371070004**	Lenoir Co. Comm. Coll.	35.231461	-77.568802
	Lincoln	**371090004**	Crouse	35.438557	-81.276802
	Martin	**371170001**	Jamesville School	35.810692	-76.897797
	Mecklenburg	**371190041**	Garinger High School	35.240101	-80.785698
		371191005	Arrowood	35.113163	-80.919502
		371191009	County Line	35.347221	-80.695
	Montgomery	**371239991**	CANDOR	35.2632	-79.8365
	New Hanover	**371290002**	Castle Hayne	34.364166	-77.8386
	Person	**371450003**	Bushy Fork	36.306965	-79.092003
	Pitt	**371470006**	Pitt Agri. Center	35.638611	-77.358101
	Rockingham	**371570099**	Bethany sch.	36.308887	-79.8592
	Rowan	**371590021**	Rockwell	35.551868	-80.394997
		371590022	Enochville School	35.534481	-80.667603
	Swain	**371730002**	Bryson City	35.435509	-83.443703
	Union	**371790003**	Monroe School	34.973888	-80.540802
	Wake	**371830014**	Millbrook School	35.85611	-78.574203
		371830016	Fuquay-Varina	35.596943	-78.792503
	Yancey	**371990004**	Mt. Mitchell	35.765411	-82.2649
	(blank)	**370590002**	Cooleemee WATER TREATMENT PLANT	35.809288	-80.559097
		370610002	Kenansville	34.954823	-77.9608
		370630013		36.035557	-78.904198
		370670027	NEAR TOWN OF TOBACCOVILLE, BY POLLIROSA	36.236389	-80.410599
		370810011		36.113335	-79.703903
		370870004	SW CORNER OF ROOF HAYWOOD CO HEALTH DEPA	35.50528	-82.964699
		370870035	Frying Pan Mountain	35.379166	-82.792503
		370990005	OZONE MONITOR ON SW SIDE OF TOWER/MET EQ	35.524445	-83.236099
		371310002	SITE IS APPROX1/2DISTANCE BETWEEN GASTON	36.484379	-77.620003
		371470099		35.583332	-77.5989
		371510004	SITE AT NEW MARKET ELEMENTARY SCHOOL	35.830555	-79.865303
		371830015		35.790024	-78.619698
		371830017	TV TOWER LOCATED AT AUBURN NC	35.676388	-78.535301
		371990003		35.737736	-82.285202
OH	Allen	**390030009**	LIMA BATH	40.770943	-84.053902
	Ashtabula	**390071001**	CONNEAUT	41.959694	-80.5728
	Athens	**390090004**	ATHENS OU	39.30798	-82.118202
	Butler	**390170004**	HAMILTON	39.383381	-84.544403
		390170018	MIDDLETOWN	39.52948	-84.393402
		390179991	Oxford	39.5327	-84.7286
	Clark	**390230001**	SPRINGFIELD WELL FIELD	40.00103	-83.804604
		390230003	MUD RUN	39.855671	-83.997704
	Clermont	**390250022**	BATAVIA	39.082802	-84.144096
	Clinton	**390271002**	LAUREL OAKS_JVS	39.430038	-83.788498
	Cuyahoga	**390350034**	5TH DISTRICT	41.555229	-81.575302
		390350060	GT CRAIG	41.492119	-81.678398
		390350064	BEREA	41.361889	-81.864601
		390355002	MAYFIELD	41.537346	-81.458801
	Delaware	**390410002**	DELAWARE	40.356693	-83.064003
	Fayette	**390479991**	Deer Creek	39.6359	-83.2605
	Franklin	**390490029**	NEW_ALBNY	40.084499	-82.815498
		390490037	FRANKLIN_PK	39.965229	-82.955498
		390490081	MAPLE_C	40.0877	-82.959801
	Geauga	**390550004**	GEAUGA	41.515053	-81.249901
	Greene	**390570006**	XENIA	39.665749	-83.942902
	Hamilton	**390610006**	SYCAMORE	39.278702	-84.366096
		390610010	COLERAIN	39.214939	-84.690903
		390610040	TAFT	39.12886	-84.503998
	Jefferson	**390810017**	STEUBEN	40.36644	-80.615601
	KNO$_X$	**390830002**	CENTERBURG	40.310024	-82.691704
	Lake	**390850003**	EASTLAKE	41.673004	-81.422501
		390850007	JFS (PAINSVILLE)	41.72681	-81.242203
	Lawrence	**390870011**	WILGUS	38.629009	-82.4589
		390870012	ODOT (IRONTON)	38.508114	-82.659302
	Licking	**390890005**	HEATH	40.026035	-82.432999
	Lorain	**390930018**	SHEFFIELD	41.420883	-82.095703
	Lucas	**390950024**	ERIE	41.644066	-83.546303
		390950027	WATERVILLE	41.494175	-83.718903
		390950034	LOW_SER	41.675213	-83.3069
	Madison	**390970007**	LONDON	39.788189	-83.476097
	Mahoning	**390990013**	(blank)	41.096142	-80.658897
	Miami	**391090005**	MIAMI EAST	40.084549	-84.114098

State	County	AQS Code	Site	Latitude	Longitude
	Montgomery	**391130037**	EASTWOOD	39.785629	-84.134399
	Portage	**391331001**	Rockwell	41.182465	-81.330498
	Preble	**391351001**	NATIONAL TRAIL SCHOOL	39.835621	-84.720497
	Stark	**391510016**	MALONE_COL	40.828053	-81.378304
		391510022	BREWSTER (WANDLE)	40.712776	-81.598297
		391514005	ALLIANCE	40.931396	-81.123497
	Summit	**391530020**	PATTERSON PARK (PATT_PARK)	41.106487	-81.503502
	Trumbull	**391550009**	KINSMAN	41.454235	-80.591003
		391550011	TCSEG	41.240456	-80.662598
	Warren	**391650007**	LEBANON	39.426891	-84.200798
	Washington	**391670004**	MARIETTA_TWP.	39.432117	-81.460403
	Wood	**391730003**	BOWLING GREEN	41.377686	-83.611099
	(blank)	**390490028**	KOEBEL SCHOOL IN SOUTH COLUMBUS	39.913761	-82.957497
		390870006		38.52079	-82.666397
		390950081	FRIENDSHIP PARK	41.719482	-83.475197
		391030003	MEDINA	41.100868	-81.911598
		391030004	CHIPPEWA	41.060398	-81.923897
		391130019		39.813889	-84.195
		391511009		40.870277	-81.331703
SC	Abbeville	**450010001**	DUE WEST	34.325317	-82.386398
	Aiken	**450030003**	JACKSON MIDDLE SCHOOL	33.342224	-81.788696
	Anderson	**450070005**	Big Creek	34.623238	-82.532097
	Berkeley	**450150002**	BUSHY PARK PUMP STATION	32.987251	-79.936699
	Charleston	**450190046**	CAPE ROMAIN (VISTAS)	32.941025	-79.657204
	Chesterfield	**450250001**	CHESTERFIELD	34.615368	-80.198799
	Colleton	**450290002**	ASHTON	33.007866	-80.964996
	Darlington	**450310003**	Pee Dee Experimental Station	34.285694	-79.744904
	Edgefield	**450370001**	TRENTON	33.739964	-81.8536
	Greenville	**450450016**	Hillcrest Middle School	34.751846	-82.256699
		450451003	FAMODA FARM	35.057396	-82.372902
	Pickens	**450770002**	CLEMSON CMS	34.653606	-82.838699
	Richland	**450790007**	PARKLANE	34.09396	-80.962303
		450790021	CONGAREE BLUFF	33.814678	-80.781097
		450791001	SANDHILL EXPERIMENTAL STATION	34.131264	-80.868301
	Spartanburg	**450830009**	NORTH SPARTANBURG FIRE STATION #2 (Shady	34.988705	-82.075798
	York	**450910006**	YORK CMS	34.935818	-81.228401
	(blank)	**450110001**	BARNWELL CMS	33.320343	-81.4655
		450210002	Cowpens	35.130398	-81.816597
		450230002	Chester	34.792969	-81.203697
		450730001	LONG CREEK	34.80526	-83.237701
		450870001	DELTA	34.539379	-81.560402
		450890001	INDIANTOWN	33.723808	-79.565102
TN	Anderson	**470010101**	Freel's Bend ozone and SO_2 monitoring	35.965221	-84.223198
	Blount	**470090101**	Great Smoky Mountains National Park, Loo	35.631489	-83.943497
		470090102	Great Smoky Mountains National Park, Cad	35.603058	-83.7836
	Claiborne	**470259991**	SPEEDWELL	36.47	-83.8268
	Davidson	**470370011**	(blank)	36.205002	-86.744698
		470370026	(blank)	36.150742	-86.623299
	Hamilton	**470651011**	Soddy-Daisy High School	35.233475	-85.181602
		470654003	(blank)	35.102638	-85.162201
	Jefferson	**470890002**	New Market ozone monitor	36.105629	-83.602097
	KNO_X	**470930021**	East KNO_X Elementary School	36.085506	-83.764801
		470931020	Spring Hill Elementary School	36.019184	-83.873802
	Loudon	**471050109**	Loudon Middle School ozone monitor	35.720894	-84.342201
	Meigs	**471210104**	Meigs County Ozone monitor	35.289379	-84.946098
	Rutherford	**471490101**	Eagleville Ozone Monitor	35.73288	-86.5989
	Sevier	**471550101**	(blank)	35.696667	-83.609703
	Shelby	**471570021**	Frayser Ozone Monitor	35.217503	-90.019699
		471570075	Memphis-NCORE	35.151699	-89.850249
		471571004	Edmund Orgill Park Ozone	35.378155	-89.834503
	Sullivan	**471632002**	Blountville Ozone Monitor	36.541439	-82.424797
		471632003	Kingsport ozone monitor	36.582111	-82.485703
	Sumner	**471650007**	Hendersonville Ozone Site at Old Hickory	36.297562	-86.653099
		471650101	Cottontown Ozone Monitor	36.453976	-86.564102
	Williamson	**471870106**	FAIRVIEW MIDDLE SCHOOL ozone monitor	35.951534	-87.137001
	Wilson	**471890103**	Cedars of Lebanon Ozone Monitor	36.060833	-86.286301
	(blank)	**470750003**	SHELTER IS IN A FLAT GRASSY AREA NEAR US	35.468719	-89.171097
		470990002	Lawrence Co ozone monitor	35.115967	-87.470001
		471410004	TVA PSD SITE IN PUTNAM COUNTY, TN	36.205151	-85.399803
		471550102	Great Smoky Mountains National Park, Cli	35.562778	-83.4981
		500070007	PROCTOR MAPLE RESEARCH CTR	44.528389	-72.868797
TX	Harrison	**482030002**	Karnack	32.668987	-94.167503
VA	Albemarle	**510030001**	Albemarle High School	38.076569	-78.503998
	Caroline	**510330001**	USGS Geomagnetic Center, Corbin	38.200871	-77.377403

State	County	AQS Code	Site	Latitude	Longitude
	Charles	**510360002**	Shirley Plantation	37.344379	-77.2593
	Chesterfield	**510410004**	VDOT Chesterfield Residency Shop	37.357479	-77.593597
	Fairfax	**510595001**	LEWINSVILLE	38.9326	-77.19822
	Fauquier	**510610002**	Chester Phelps Wildlife Management Area,	38.473671	-77.7677
	Frederick	**510690010**	Rest	39.281021	-78.081596
	Giles	**510719991**	Horton Station	37.3297	-80.5578
	Hampton City	**516500008**	NASA Langley Research Center	37.103733	-76.387001
	Hanover	**510850003**	Turner Property, Old Church	37.606129	-77.218803
	Henrico	**510870014**	MathScience Innovation Center	37.556519	-77.400299
	Madison	**511130003**	Shenandoah National Park, Big Meadows	38.521984	-78.435799
	Page	**511390004**	Luray Caverns Airport	38.663731	-78.504402
	Prince Edward	**511479991**	Prince Edward	37.1655	-78.3069
	Roanoke	**511611004**	East Vinton Elementary School	37.283421	-79.884499
	Rockbridge	**511630003**	Natural Bridge Ranger Station	37.626678	-79.512604
	Rockingham	**511650003**	ROCKINGHAM CO. VDOT	38.477531	-78.819504
	Stafford	**511790001**	Widewater Elementary School	38.481232	-77.370399
	Suffolk City	**518000004**	Tidewater Community College	36.90118	-76.438103
		518000005	VA Tech Agricultural Research Station, H	36.665249	-76.730797
	Wythe	**511970002**	Rural Retreat Sewage Treatment Plant	36.891171	-81.254204
WI	Brown	**550090026**	UW GREEN BAY	44.530979	-87.907997
	Columbia	**550210015**	COLUMBUS	43.315601	-89.108902
	Dane	**550250041**	MADISON EAST	43.100838	-89.3573
	Dodge	**550270001**	Horicon Wildlife Area	43.46611	-88.621101
	Door	**550290004**	NEWPORT PARK	45.237	-86.992996
	Eau Claire	**550350014**	Eau Claire DOT	44.7614	-91.413
	Fond du Lac	**550390006**	FOND DU LAC	43.687401	-88.421997
	Jefferson	**550550002**	JEFFERSON	43.001999	-88.818604
	Kenosha	**550590019**	CHIWAUKEE PRAIRIE-STATELINE	42.504723	-87.809303
	Kewaunee	**550610002**	JUMBOS DRIVE-IN PROPERTY, SOUTH END OF K	44.443119	-87.505203
	La Crosse	**550630012**	LACROSSE - DOT BUILDING	43.7775	-91.226898
	Manitowoc	**550710007**	MANITOWOC/WOODLAND DUNES	44.138618	-87.616096
	Marathon	**550730012**	LAKE DUBAY	44.707352	-89.771797
	Milwaukee	**550790010**	HEALTH CENTER	43.016666	-87.933296
		550790026	DNR SER HQRS SITE	43.060974	-87.913498
		550790085	BAYSIDE	43.181	-87.900002
	Outagamie	**550870009**	APPLETON AAL	44.307381	-88.395103
	Ozaukee	**550890008**	(blank)	43.342999	-87.919998
		550890009	HARRINGTON BEACH PARK	43.498058	-87.809998
	Racine	**551010017**	RACINE	42.713898	-87.798599
	Rock	**551050024**	BELOIT-CUNNINGHAM	42.509079	-89.062798
	Sauk	**551110007**	DEVILS LAKE PARK	43.435101	-89.679703
	Sheboygan	**551170006**	SHEBOYGAN KOHLER ANDRE	43.679001	-87.716003
	Taylor	**551199991**	Perkinstown	45.2066	-90.5969
	Walworth	**551270005**	LAKE GENEVA	42.580009	-88.499001
	Waukesha	**551330027**	CLEVELAND SITE	43.020077	-88.215103
	(blank)	**550030010**	BAD RIVER	46.602001	-90.655998
		550270007	MAYVILLE	43.435001	-88.527802
		550370001		45.794998	-88.400002
		550410007		45.563	-88.8088
		550450001	NW CORNER OF TRAILER	42.53389	-89.659401
		550590002	KENOSHA - BARBERSHOP QUARTET SOCIETY	42.559166	-87.826103
		550710004	MOBILE SHELTER, APPROX 3/4 MI E OF COLLI	44.0825	-87.968597
		550790041	MILWAUKEE UWM-NORTH	43.075001	-87.884003
		550790044	APPLETON AVE	43.092777	-88.0056
		550791025		42.896389	-87.878098
		551091002	SOMERSET	45.124435	-92.662697
		551170007	ON ROOF	43.718334	-87.813103
		551230008	ON HILL NEAR PARK OFFICE AND MAINTENANCE	43.702221	-90.568298
		551250001	TROUT LAKE	46.051998	-89.653
		551310009	REPLACED SITE 55-131-0007	43.327221	-88.220299
		551330017	WAUKESHA, CARROLL COLLEGE	43.003887	-88.231903
		551390011	ON SOUTHERN PROPERTY LINE OF PVHC PROPER	44.075279	-88.529701
WV	Berkeley	**540030003**	MARTINSBURG BALL FIELD	39.448006	-77.964104
	Cabell	**540110006**	HENDERSON CENTER/MARSHALL UNIVERSITY - M	38.424133	-82.425903
	Gilmer	**540219991**	Cedar Creek	38.8795	-80.8477
	Greenbrier	**540250003**	SAM BLACK CHURCH - DOH GARAGE - GREENBRI	37.908531	-80.632599
	Hancock	**540291004**	(blank)	40.421539	-80.580704
	Kanawha	**540390010**	CHARLESTON BAPTIST TEMPLE/SITE MOVED FRO	38.3456	-81.628304
	Monongalia	**540610003**	(blank)	39.649368	-79.920898
	Ohio	**540690010**	(blank)	40.114876	-80.700996
	Wood	**541071002**	Neale Elementary School	39.323532	-81.552399

Appendix D. Additional Source Apportionment Modeling Results

Sector Summaries for Select Monitors

Monitor Name/ID		Greenwich Point Park, CT		90010017		Stratford, CT		90013017		Sherwood Island, CT		90019003	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
ERTAC EGU		3.3	4.7%	5.9	6.3%	4.9	7.0%	5.8	7.5%	5.3	7.3%	6.9	8.1%
Marine/Rail	CMV	2.1	3.0%	3.0	3.2%	2.4	3.4%	2.7	3.4%	2.2	3.0%	2.8	3.2%
	Rail	1.0	1.4%	1.2	1.3%	1.1	1.5%	1.2	1.5%	1.1	1.5%	1.3	1.5%
Marine/Rail Total		3.1	4.5%	4.2	4.4%	3.5	4.9%	3.9	5.0%	3.3	4.6%	4.0	4.7%
Non-EGU	Cement	0.3	0.5%	0.6	0.6%	0.4	0.6%	0.5	0.6%	0.4	0.6%	0.6	0.7%
	MWC	0.5	0.7%	0.8	0.8%	1.1	1.6%	1.3	1.6%	0.7	1.0%	0.9	1.1%
	Other	3.8	5.4%	6.1	6.5%	4.5	6.3%	5.1	6.5%	4.8	6.6%	6.0	7.0%
Non-EGU Total		4.6	6.5%	7.5	8.0%	6.0	8.5%	6.8	8.7%	5.9	8.2%	7.5	8.7%
Nonpoint		6.6	9.5%	9.3	9.8%	5.4	7.7%	6.1	7.7%	5.9	8.2%	7.0	8.2%
Nonroad		13.4	19.3%	17.4	18.4%	10.2	14.5%	11.4	14.6%	10.3	14.3%	12.5	14.6%
Offshore		0.6	0.9%	1.1	1.2%	1.2	1.7%	1.4	1.8%	1.6	2.2%	2.1	2.5%
Oil & Gas	Nonpoint	1.1	1.5%	1.8	1.9%	1.1	1.6%	1.3	1.7%	1.1	1.5%	1.5	1.8%
	Point	0.4	0.5%	0.7	0.7%	0.4	0.6%	0.5	0.6%	0.4	0.6%	0.6	0.7%
Oil & Gas Total		1.4	2.0%	2.4	2.6%	1.5	2.1%	1.8	2.3%	1.5	2.1%	2.1	2.5%
Onroad	Diesel	6.5	9.4%	9.3	9.8%	6.8	9.6%	7.5	9.6%	6.9	9.6%	8.4	9.9%
	Non-Diesel	6.1	8.7%	8.1	8.6%	5.4	7.6%	6.0	7.7%	5.4	7.5%	6.6	7.7%
Onroad Total		12.6	18.1%	17.4	18.4%	12.2	17.2%	13.5	17.3%	12.4	17.2%	15.1	17.6%
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		20.3	29.2%	23.3	24.7%	21.3	30.1%	22.2	28.4%	21.5	29.8%	22.9	26.8%
Canada		1.2	1.8%	2.5	2.6%	1.4	2.0%	1.7	2.2%	1.2	1.7%	1.8	2.1%
Biogenic		2.4	3.5%	3.2	3.3%	2.9	4.1%	3.3	4.2%	3.0	4.1%	3.4	4.0%
Other		0.1	0.2%	0.2	0.2%	0.1	0.2%	0.2	0.2%	0.1	0.2%	0.2	0.2%

Monitor Name/ID		Hammonasset S.P. , CT		90099002		Fort Griswold Park, CT		90110124		Bellevue S.P., DE		100031013	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
ERTAC EGU		4.3	6.2%	5.7	6.9%	2.9	4.4%	4.9	5.4%	7.6	12.7%	7.6	12.7%
Marine/Rail	CMV	3.3	4.7%	3.9	4.7%	7.8	11.9%	11.2	12.3%	1.3	2.1%	1.3	2.1%
	Rail	1.2	1.7%	1.4	1.7%	1.0	1.5%	1.3	1.4%	1.2	2.1%	1.2	2.1%
Marine/Rail Total		**4.5**	**6.4%**	**5.2**	**6.4%**	**8.7**	**13.4%**	**12.5**	**13.7%**	**2.5**	**4.1%**	**2.5**	**4.1%**
Non-EGU	Cement	0.3	0.5%	0.5	0.6%	0.2	0.4%	0.4	0.5%	0.4	0.7%	0.4	0.7%
	MWC	0.9	1.3%	1.0	1.2%	0.6	0.9%	0.9	1.0%	0.2	0.3%	0.2	0.3%
	Other	4.3	6.1%	5.5	6.7%	3.5	5.3%	5.4	5.9%	4.2	6.9%	4.2	6.9%
Non-EGU Total		**5.5**	**7.9%**	**6.9**	**8.5%**	**4.3**	**6.6%**	**6.7**	**7.3%**	**4.8**	**8.0%**	**4.8**	**8.0%**
Nonpoint		4.7	6.8%	5.7	7.0%	3.9	6.0%	5.7	6.2%	2.2	3.7%	2.2	3.7%
Nonroad		10.1	14.4%	11.7	14.3%	13.3	20.3%	19.4	21.3%	6.0	9.9%	6.0	9.9%
Offshore		2.1	3.0%	2.6	3.2%	3.0	4.5%	4.1	4.5%	0.2	0.4%	0.2	0.4%
Oil & Gas	Nonpoint	1.3	1.9%	1.7	2.1%	0.7	1.0%	1.3	1.4%	1.2	2.1%	1.2	2.1%
	Point	0.4	0.6%	0.6	0.7%	0.3	0.5%	0.6	0.6%	0.7	1.2%	0.7	1.2%
Oil & Gas Total		**1.7**	**2.5%**	**2.3**	**2.8%**	**1.0**	**1.5%**	**1.9**	**2.0%**	**2.0**	**3.3%**	**2.0**	**3.3%**
Onroad	Diesel	6.4	9.2%	7.4	9.1%	4.3	6.6%	6.7	7.4%	5.3	8.8%	5.3	8.8%
	Non-Diesel	5.1	7.3%	6.0	7.3%	4.0	6.2%	6.0	6.6%	3.7	6.1%	3.7	6.1%
Onroad Total		**11.5**	**16.5%**	**13.4**	**16.3%**	**8.3**	**12.8%**	**12.8**	**14.0%**	**9.0**	**14.9%**	**9.0**	**14.9%**
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		21.3	30.4%	23.2	28.3%	16.7	25.5%	18.6	20.4%	21.9	36.4%	21.9	36.4%
Canada		1.2	1.6%	1.6	2.0%	0.8	1.2%	1.4	1.6%	0.4	0.7%	0.4	0.7%
Biogenic		2.9	4.2%	3.4	4.1%	2.4	3.6%	3.1	3.4%	3.5	5.8%	3.5	5.8%
Other		0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.1	0.2%	0.1	0.2%

Monitor Name/ID		McMillan, DC		110010043		Fair Hill, MD		240150003		Edgewood, MD		240251001	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
ERTAC EGU		4.5	7.3%	7.8	9.0%	8.2	12.9%	8.2	12.9%	8.0	11.1%	12.8	12.5%
Marine/Rail	CMV	0.4	0.7%	0.8	1.0%	1.2	1.9%	1.2	1.9%	3.0	4.2%	4.7	4.5%
	Rail	1.3	2.2%	1.5	1.7%	1.3	2.1%	1.3	2.1%	1.5	2.2%	1.7	1.7%
Marine/Rail Total		1.8	2.9%	2.3	2.7%	2.5	4.0%	2.5	4.0%	4.5	6.3%	6.4	6.2%
Non-EGU	Cement	0.4	0.6%	0.7	0.8%	0.5	0.8%	0.5	0.8%	0.7	1.0%	1.4	1.3%
	MWC	0.1	0.1%	0.1	0.2%	0.2	0.2%	0.2	0.2%	0.3	0.4%	0.5	0.5%
	Other	5.9	9.5%	8.7	10.1%	4.2	6.6%	4.2	6.6%	5.0	6.9%	8.5	8.3%

Monitor Name/ID		McMillan, DC		110010043		Fair Hill, MD		240150003		Edgewood, MD		240251001	
Sector	**Sub Sector**	**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**	
		Total	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
Non-EGU Total		6.3	10.3%	9.5	11.0%	4.9	7.7%	4.9	7.7%	6.0	8.3%	10.4	10.1%
Nonpoint		3.5	5.7%	5.4	6.3%	2.3	3.6%	2.3	3.6%	3.3	4.6%	5.3	5.2%
Nonroad		8.5	13.8%	12.6	14.6%	6.2	9.7%	6.2	9.7%	8.4	11.7%	13.2	12.9%
Offshore		0.2	0.3%	0.4	0.4%	0.2	0.3%	0.2	0.3%	0.1	0.2%	0.3	0.3%
Oil & Gas	**Nonpoint**	1.3	2.1%	2.3	2.6%	1.3	2.1%	1.3	2.1%	1.6	2.2%	3.0	2.9%
	Point	0.7	1.1%	1.2	1.4%	0.9	1.4%	0.9	1.4%	0.9	1.2%	1.5	1.5%
Oil & Gas Total		2.0	3.2%	3.5	4.0%	2.2	3.4%	2.2	3.4%	2.4	3.4%	4.5	4.4%
Onroad	**Diesel**	6.0	9.7%	9.2	10.6%	5.5	8.6%	5.5	8.6%	6.4	9.0%	10.4	10.2%
	Non-Diesel	5.4	8.7%	7.9	9.2%	3.8	5.9%	3.8	5.9%	4.8	6.7%	7.5	7.3%
Onroad Total		11.3	18.3%	17.1	19.8%	9.3	14.5%	9.3	14.5%	11.3	15.7%	17.9	17.4%
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		19.9	32.1%	22.7	26.3%	23.7	37.1%	23.7	37.1%	23.2	32.3%	26.0	25.3%
Canada		0.7	1.1%	1.2	1.4%	0.4	0.6%	0.4	0.6%	0.4	0.6%	0.9	0.8%
Biogenic		3.0	4.8%	3.6	4.1%	3.8	5.9%	3.8	5.9%	3.9	5.5%	4.6	4.5%
Other		0.1	0.2%	0.2	0.2%	0.2	0.3%	0.2	0.3%	0.1	0.2%	0.3	0.3%

Monitor Name/ID		P.G. Equestrian Ctr., MD		240338003		Leroy High School, MA		250051002		Ancora St. Hospital, NJ		340071001	
Sector	**Sub Sector**	**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**	
		Total	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
ERTAC EGU		6.3	10.1%	7.6	10.6%	3.8	6.3%	3.8	6.3%	5.9	8.9%	5.9	8.9%
Marine/Rail	**CMV**	0.7	1.1%	0.9	1.2%	2.7	4.4%	2.7	4.4%	1.6	2.4%	1.6	2.4%
	Rail	1.4	2.2%	1.5	2.1%	1.1	1.8%	1.1	1.8%	1.4	2.1%	1.4	2.1%
Marine/Rail Total		2.1	3.3%	2.3	3.3%	3.7	6.2%	3.7	6.2%	3.0	4.5%	3.0	4.5%
Non-EGU	**Cement**	0.4	0.7%	0.5	0.7%	0.3	0.5%	0.3	0.5%	0.3	0.4%	0.3	0.4%
	MWC	0.1	0.2%	0.2	0.2%	0.6	1.0%	0.6	1.0%	0.8	1.2%	0.8	1.2%
	Other	5.3	8.4%	6.4	8.9%	4.1	6.9%	4.1	6.9%	6.2	9.3%	6.2	9.3%
Non-EGU Total		5.8	9.2%	7.1	9.9%	5.1	8.4%	5.1	8.4%	7.2	10.9%	7.2	10.9%
Nonpoint		3.1	5.0%	3.8	5.3%	3.1	5.2%	3.1	5.2%	2.8	4.2%	2.8	4.2%
Nonroad		7.6	12.1%	9.2	12.8%	7.9	13.1%	7.9	13.1%	6.6	9.9%	6.6	9.9%
Offshore		0.0	0.0%	0.0	0.0%	4.4	7.3%	4.4	7.3%	0.2	0.3%	0.2	0.3%
Oil & Gas	**Nonpoint**	1.5	2.4%	1.9	2.6%	0.8	1.4%	0.8	1.4%	1.6	2.4%	1.6	2.4%
	Point	0.8	1.2%	0.9	1.3%	0.4	0.7%	0.4	0.7%	0.7	1.0%	0.7	1.0%
Oil & Gas Total		2.3	3.6%	2.8	3.9%	1.3	2.1%	1.3	2.1%	2.3	3.4%	2.3	3.4%
Onroad	**Diesel**	6.5	10.3%	7.8	10.8%	4.9	8.1%	4.9	8.1%	6.4	9.7%	6.4	9.7%
	Non-Diesel	4.8	7.5%	5.7	7.9%	3.8	6.3%	3.8	6.3%	3.9	5.8%	3.9	5.8%
Onroad Total		11.3	17.8%	13.4	18.8%	8.7	14.4%	8.7	14.4%	10.3	15.5%	10.3	15.5%
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		20.6	32.6%	21.1	29.5%	18.8	31.2%	18.8	31.2%	22.9	34.6%	22.9	34.6%
Canada		0.2	0.3%	0.2	0.3%	0.4	0.7%	0.4	0.7%	1.1	1.7%	1.1	1.7%
Biogenic		3.5	5.6%	3.8	5.3%	2.9	4.9%	2.9	4.9%	3.9	5.8%	3.9	5.8%
Other		0.2	0.3%	0.2	0.3%	0.2	0.3%	0.2	0.3%	0.3	0.4%	0.3	0.4%

Monitor Name/ID		Collier's Mill, NJ		340290006		Clarksboro, NJ		340150002		Susan Wagner HS, NY		360850067	
Sector	**Sub Sector**	**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**		**Exceedance Avg.**		**4th High Avg.**	
		Total	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
ERTAC EGU		4.7	7.4%	7.8	8.7%	7.2	10.7%	8.8	11.4%	6.4	9.0%	10.3	10.4%
Marine/Rail	**CMV**	1.4	2.2%	2.3	2.6%	2.1	3.1%	2.5	3.2%	2.0	2.7%	2.9	3.0%
	Rail	1.1	1.8%	1.3	1.5%	1.3	2.0%	1.4	1.8%	1.3	1.8%	1.5	1.5%
Marine/Rail Total		2.6	4.0%	3.6	4.0%	3.4	5.1%	3.9	5.1%	3.2	4.6%	4.4	4.5%
Non-EGU	**Cement**	0.3	0.4%	0.5	0.5%	0.4	0.5%	0.4	0.6%	0.6	0.9%	1.1	1.2%
	MWC	0.9	1.4%	1.6	1.8%	0.7	1.0%	0.8	1.1%	0.7	1.0%	1.2	1.2%
	Other	4.6	7.2%	7.5	8.4%	6.2	9.2%	7.4	9.7%	5.0	7.0%	8.0	8.1%
Non-EGU Total		5.8	9.0%	9.5	10.6%	7.3	10.8%	8.7	11.4%	6.3	8.8%	10.4	10.5%
Nonpoint		4.1	6.4%	6.8	7.5%	3.8	5.7%	4.7	6.2%	5.0	7.0%	8.0	8.0%
Nonroad		6.8	10.5%	10.7	11.9%	6.4	9.5%	7.8	10.2%	8.7	12.2%	12.8	13.0%
Offshore		0.5	0.7%	0.8	0.9%	0.3	0.4%	0.3	0.4%	0.8	1.1%	1.3	1.3%
Oil & Gas	**Nonpoint**	1.5	2.3%	2.4	2.7%	1.5	2.3%	1.8	2.4%	1.5	2.1%	2.3	2.3%
	Point	0.6	0.9%	0.9	1.0%	0.8	1.1%	0.9	1.2%	0.6	0.9%	1.0	1.0%
Oil & Gas Total		2.0	3.2%	3.4	3.7%	2.3	3.4%	2.7	3.6%	2.1	2.9%	3.3	3.3%
Onroad	**Diesel**	6.0	9.4%	9.4	10.5%	5.9	8.7%	7.2	9.4%	6.9	9.6%	10.1	10.2%
	Non-Diesel	3.9	6.1%	6.1	6.8%	4.0	5.9%	4.8	6.3%	4.5	6.3%	6.8	6.8%
Onroad Total		9.9	15.4%	15.5	17.3%	9.9	14.6%	12.0	15.7%	11.4	16.0%	16.9	17.1%
Residential Wood Combustion		0.0	0.0%	0.1	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		22.8	35.5%	25.0	27.9%	22.3	33.1%	22.8	29.8%	22.6	31.7%	25.2	25.4%
Canada		1.6	2.5%	2.8	3.1%	0.5	0.7%	0.6	0.8%	1.2	1.6%	2.2	2.2%
Biogenic		3.2	4.9%	3.4	3.8%	3.9	5.8%	4.0	5.2%	3.5	5.0%	4.1	4.1%

Monitor Name/ID		Collier's Mill, NJ		340290006		Clarksboro, NJ		340150002		Susan Wagner HS, NY		360850067	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Other		0.2	0.3%	0.3	0.3%	0.2	0.2%	0.2	0.2%	0.2	0.2%	0.3	0.3%

Monitor Name/ID		Holtsville, NY		361030009		Babylon, NY		361030002		NEA, PA		421010024	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
ERTAC EGU		4.6	7.9%	7.0	9.2%	4.7	6.6%	6.9	7.6%	6.6	9.9%	6.6	9.9%
Marine/Rail	**CMV**	1.9	3.3%	2.8	3.7%	1.5	2.1%	2.0	2.2%	1.4	2.1%	1.4	2.1%
	Rail	1.0	1.6%	1.1	1.4%	1.1	1.5%	1.3	1.4%	1.3	1.9%	1.3	1.9%
Marine/Rail Total		2.9	4.9%	3.9	5.1%	2.6	3.6%	3.3	3.6%	2.7	4.0%	2.7	4.0%
Non-EGU	**Cement**	0.3	0.5%	0.4	0.6%	0.3	0.5%	0.6	0.6%	0.4	0.7%	0.4	0.7%
	MWC	0.7	1.1%	1.0	1.3%	0.4	0.6%	0.6	0.7%	0.6	0.8%	0.6	0.8%
	Other	4.0	6.8%	5.6	7.3%	4.6	6.4%	6.5	7.2%	4.9	7.4%	4.9	7.4%
Non-EGU Total		4.9	8.3%	7.0	9.2%	5.4	7.5%	7.7	8.5%	6.0	8.9%	6.0	8.9%
Nonpoint		4.1	7.0%	5.4	7.1%	6.0	8.3%	7.6	8.4%	2.8	4.2%	2.8	4.2%
Nonroad		7.4	12.7%	10.5	13.7%	9.8	13.6%	12.7	14.0%	6.7	10.0%	6.7	10.0%
Offshore		2.3	3.8%	3.0	3.9%	1.1	1.5%	1.6	1.8%	0.3	0.4%	0.3	0.4%
Oil & Gas	**Nonpoint**	1.0	1.7%	1.5	1.9%	1.5	2.0%	2.1	2.3%	1.7	2.6%	1.7	2.6%
	Point	0.4	0.7%	0.6	0.8%	0.5	0.7%	0.7	0.8%	0.8	1.2%	0.8	1.2%
Oil & Gas Total		1.4	2.4%	2.1	2.7%	1.9	2.7%	2.8	3.1%	2.5	3.7%	2.5	3.7%
Onroad	**Diesel**	5.8	9.9%	8.0	10.4%	7.0	9.7%	9.2	10.1%	6.1	9.1%	6.1	9.1%
	Non-Diesel	4.4	7.4%	6.1	8.0%	5.2	7.2%	6.8	7.5%	4.0	6.0%	4.0	6.0%
Onroad Total		10.2	17.4%	14.1	18.5%	12.2	16.9%	16.0	17.6%	10.2	15.2%	10.2	15.2%
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		17.4	29.6%	18.7	24.4%	23.9	33.1%	26.1	28.8%	25.1	37.4%	25.1	37.4%
Canada		0.9	1.5%	1.6	2.1%	1.3	1.9%	2.2	2.4%	0.4	0.6%	0.4	0.6%
Biogenic		2.5	4.3%	2.9	3.7%	3.0	4.2%	3.5	3.9%	3.7	5.5%	3.7	5.5%
Other		0.1	0.2%	0.2	0.2%	0.2	0.2%	0.3	0.3%	0.1	0.2%	0.1	0.2%

Monitor Name/ID		Baxter, PA		421011002		AJ, RI		440030002		Aurora Hills, VA		510130020	
Sector	Sub Sector	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
ERTAC EGU		6.4	9.9%	6.4	9.9%	4.0	6.6%	4.0	6.6%	5.2	8.1%	7.9	9.2%
Marine/Rail	**CMV**	1.3	2.1%	1.3	2.1%	2.6	4.3%	2.6	4.3%	0.4	0.6%	0.7	0.8%
	Rail	1.2	1.9%	1.2	1.9%	1.2	2.0%	1.2	2.0%	1.5	2.3%	1.6	1.8%
Marine/Rail Total		2.6	4.0%	2.6	4.0%	3.7	6.3%	3.7	6.3%	1.9	2.9%	2.2	2.6%
Non-EGU	**Cement**	0.4	0.7%	0.4	0.7%	0.3	0.5%	0.3	0.5%	0.6	0.9%	1.0	1.1%
	MWC	0.5	0.8%	0.5	0.8%	0.8	1.3%	0.8	1.3%	0.1	0.1%	0.1	0.1%
	Other	4.8	7.4%	4.8	7.4%	4.1	6.9%	4.1	6.9%	5.0	7.7%	7.2	8.5%
Non-EGU Total		5.7	8.9%	5.7	8.9%	5.2	8.7%	5.2	8.7%	5.7	8.7%	8.3	9.7%
Nonpoint		2.7	4.2%	2.7	4.2%	3.1	5.1%	3.1	5.1%	3.9	5.9%	5.5	6.4%
Nonroad		6.4	10.0%	6.4	10.0%	7.5	12.6%	7.5	12.6%	9.8	15.1%	13.5	15.8%
Offshore		0.3	0.4%	0.3	0.4%	2.1	3.6%	2.1	3.6%	0.1	0.2%	0.2	0.2%
Oil & Gas	**Nonpoint**	1.6	2.6%	1.6	2.6%	1.3	2.2%	1.3	2.2%	1.5	2.3%	2.3	2.7%
	Point	0.8	1.2%	0.8	1.2%	0.5	0.9%	0.5	0.9%	0.8	1.2%	1.2	1.4%
Oil & Gas Total		2.4	3.7%	2.4	3.7%	1.9	3.1%	1.9	3.1%	2.2	3.5%	3.5	4.1%
Onroad	**Diesel**	5.9	9.2%	5.9	9.2%	5.0	8.4%	5.0	8.4%	6.4	9.9%	9.1	10.7%
	Non-Diesel	3.9	6.0%	3.9	6.0%	3.9	6.6%	3.9	6.6%	5.9	9.0%	8.1	9.5%
Onroad Total		9.8	15.2%	9.8	15.2%	9.0	15.0%	9.0	15.0%	12.3	18.9%	17.2	20.2%
Residential Wood Combustion		0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Boundary Conditions		24.2	37.4%	24.2	37.4%	19.1	32.1%	19.1	32.1%	19.7	30.4%	22.2	26.1%
Canada		0.4	0.6%	0.4	0.6%	0.7	1.2%	0.7	1.2%	0.5	0.7%	0.8	1.0%
Biogenic		3.5	5.5%	3.5	5.5%	3.2	5.3%	3.2	5.3%	3.5	5.4%	3.8	4.5%
Other		0.1	0.2%	0.1	0.2%	0.2	0.3%	0.2	0.3%	0.1	0.2%	0.2	0.2%

State Summaries for Select Monitors

Monitor Name/ID	Greenwich Point Park, CT		90010017		Stratford, CT		90013017		Sherwood Island, CT		90019003	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
State	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.1	0.1%	0.3	0.2%	0.2	0.2%	0.3	0.3%	0.3	0%	0.5	0.5%
AR (Partial)	0.1	0.1%	0.2	0.2%	0.2	0.2%	0.3	0.3%	0.2	0%	0.3	0.3%
CT	15.9	18.0%	19.9	16.1%	10.7	12.5%	12.3	12.9%	7.2	8%	9.5	8.9%
DC	0.1	0.1%	0.2	0.2%	0.1	0.2%	0.2	0.2%	0.1	0%	0.2	0.2%
DE	0.4	0.5%	0.8	0.7%	0.7	0.8%	0.8	0.8%	1.0	1%	1.3	1.2%
GA (Partial)	0.2	0.2%	0.3	0.3%	0.3	0.3%	0.3	0.3%	0.4	0%	0.6	0.6%
IA (Partial)	0.1	0.1%	0.2	0.2%	0.1	0.1%	0.1	0.1%	0.1	0%	0.1	0.1%
IL	0.8	0.9%	1.7	1.4%	0.8	1.0%	1.0	1.1%	0.7	1%	1.1	1.0%
IN	0.9	1.1%	2.0	1.6%	1.1	1.2%	1.3	1.4%	1.1	1%	1.5	1.4%
KY	0.7	0.8%	1.5	1.2%	0.8	0.9%	1.0	1.0%	1.0	1%	1.5	1.4%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
MA	0.1	0.2%	0.3	0.2%	0.1	0.2%	0.2	0.2%	0.2	0%	0.4	0.3%
MD	2.5	2.8%	5.0	4.0%	3.8	4.5%	4.7	4.9%	4.4	5%	6.0	5.6%
ME	0.0	0.0%	0.1	0.1%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
MI	0.8	0.9%	1.5	1.2%	0.9	1.1%	1.2	1.2%	0.9	1%	1.2	1.1%
MN (Partial)	0.1	0.1%	0.2	0.1%	0.1	0.1%	0.1	0.1%	0.1	0%	0.1	0.1%
MO (Partial)	0.3	0.4%	0.8	0.6%	0.4	0.4%	0.5	0.5%	0.3	0%	0.5	0.5%
MS (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0%	0.2	0.1%
NC	0.6	0.6%	1.2	1.0%	0.5	0.6%	0.6	0.7%	0.5	1%	0.7	0.7%
NH	0.0	0.0%	0.1	0.1%	0.0	0.0%	0.0	0.0%	0.0	0%	0.1	0.1%
NJ	13.2	15.0%	18.8	15.2%	14.3	16.8%	16.0	16.8%	16.4	19%	19.1	17.9%
NY	34.1	38.8%	40.5	32.6%	30.9	36.2%	32.3	33.9%	30.7	35%	34.9	32.7%
OH	2.0	2.3%	4.0	3.2%	1.8	2.1%	2.2	2.3%	2.0	2%	2.8	2.6%
PA	10.4	11.8%	15.3	12.3%	12.7	14.8%	14.1	14.7%	13.6	16%	16.2	15.2%
RI	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.1	0%	0.1	0.1%
SC	0.1	0.1%	0.3	0.2%	0.2	0.2%	0.2	0.3%	0.2	0%	0.3	0.3%
TN	0.3	0.3%	0.7	0.5%	0.5	0.5%	0.6	0.6%	0.6	1%	0.9	0.8%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
VA	2.5	2.8%	5.2	4.2%	2.7	3.1%	3.3	3.4%	3.0	3%	4.2	3.9%
VT	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
WI	0.2	0.3%	0.5	0.4%	0.3	0.3%	0.4	0.4%	0.3	0%	0.4	0.4%
WV	1.3	1.5%	2.4	1.9%	1.1	1.3%	1.4	1.4%	1.5	2%	2.1	2.0%

Monitor Name/ID	Hammonasset S.P. , CT		90099002		Fort Griswold Park, CT		90110124		Bellevue S.P., DE		100031013	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
State	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.1%	0.3	0%	0.3	0.5%
AR (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.1	0%	0.1	0.2%
CT	12.2	14.8%	13.8	14.0%	19.2	23.2%	28.7	23.6%	0.0	0%	0.0	0.0%
DC	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.8	1%	0.8	1.3%
DE	0.7	0.8%	0.8	0.8%	0.7	0.8%	1.0	0.8%	6.3	10%	6.3	9.5%
GA (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.6	1%	0.6	0.9%
IA (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.2	0%	0.2	0.3%
IL	1.0	1.3%	1.5	1.5%	0.7	0.9%	1.6	1.3%	1.1	2%	1.1	1.7%
IN	1.3	1.5%	1.9	1.9%	0.9	1.1%	2.1	1.7%	1.8	3%	1.8	2.8%
KY	1.0	1.2%	1.5	1.5%	0.6	0.7%	1.3	1.0%	2.3	4%	2.3	3.5%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
MA	0.2	0.3%	0.3	0.3%	0.4	0.5%	0.9	0.7%	0.0	0%	0.0	0.0%
MD	2.7	3.3%	3.6	3.7%	2.4	2.9%	4.2	3.5%	20.3	31%	20.3	30.9%
ME	0.0	0.0%	0.0	0.0%	0.0	0.1%	0.1	0.1%	0.0	0%	0.0	0.0%
MI	0.9	1.1%	1.3	1.3%	0.8	1.0%	1.6	1.3%	0.7	1%	0.7	1.1%
MN (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.2	0.2%	0.1	0%	0.1	0.1%
MO (Partial)	0.5	0.6%	0.7	0.7%	0.4	0.4%	0.8	0.7%	0.8	1%	0.8	1.2%
MS (Partial)	0.1	0.1%	0.1	0.1%	0.0	0.0%	0.1	0.1%	0.0	0%	0.0	0.1%
NC	0.6	0.7%	0.9	0.9%	0.6	0.8%	1.4	1.1%	0.5	1%	0.5	0.7%
NH	0.0	0.1%	0.1	0.1%	0.1	0.1%	0.2	0.1%	0.0	0%	0.0	0.0%
NJ	11.5	13.9%	13.4	13.5%	7.9	9.6%	10.9	9.0%	0.4	1%	0.4	0.6%
NY	30.9	37.5%	34.2	34.7%	34.7	41.8%	43.7	35.9%	0.6	1%	0.6	0.9%
OH	2.7	3.2%	3.8	3.9%	1.7	2.0%	3.5	2.9%	4.5	7%	4.5	6.8%
PA	11.5	13.9%	14.1	14.3%	7.1	8.6%	10.4	8.5%	10.5	16%	10.5	15.9%
RI	0.1	0.1%	0.1	0.1%	0.4	0.5%	1.0	0.8%	0.0	0%	0.0	0.0%
SC	0.1	0.1%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.1	0%	0.1	0.2%
TN	0.4	0.5%	0.6	0.6%	0.2	0.3%	0.5	0.4%	0.5	1%	0.5	0.7%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0%	0.0	0.0%
VA	1.8	2.2%	2.5	2.5%	2.1	2.6%	4.3	3.5%	8.2	12%	8.2	12.5%
VT	0.0	0.0%	0.0	0.0%	0.1	0.1%	0.1	0.1%	0.0	0%	0.0	0.0%
WI	0.3	0.4%	0.4	0.4%	0.3	0.3%	0.5	0.4%	0.3	0%	0.3	0.5%
WV	1.3	1.6%	1.9	2.0%	0.8	1.0%	1.7	1.4%	4.7	7%	4.7	7.2%

Monitor Name/ID	McMillan, DC		110010043		Fair Hill, MD		240150003		Edgewood, MD		240251001	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
State	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.4	0.5%	0.7	0.7%	0.4	0.5%	0.4	0.5%	0.6	0.7%	1.5	1.1%
AR (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.2%	0.1	0.2%	0.2	0.2%	0.3	0.2%
CT	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.1	0.0%
DC	8.8	11.9%	11.5	10.3%	0.9	1.4%	0.9	1.4%	1.1	1.3%	1.7	1.3%
DE	0.1	0.1%	0.1	0.1%	0.2	0.3%	0.2	0.3%	0.2	0.3%	0.6	0.4%
GA (Partial)	0.2	0.2%	0.3	0.3%	0.6	0.9%	0.6	0.9%	0.5	0.6%	1.2	0.9%
IA (Partial)	0.1	0.2%	0.2	0.2%	0.2	0.4%	0.2	0.4%	0.2	0.2%	0.4	0.3%
IL	1.1	1.4%	2.0	1.8%	1.2	1.7%	1.2	1.7%	1.3	1.5%	2.4	1.8%
IN	2.4	3.3%	4.5	4.0%	2.2	3.2%	2.2	3.2%	2.3	2.8%	4.5	3.3%
KY	1.9	2.6%	3.5	3.1%	2.6	3.8%	2.6	3.8%	2.4	2.8%	4.8	3.5%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.1	0.0%
MA	0.0	0.0%	0.1	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MD	16.5	22.4%	24.0	21.4%	25.5	37.2%	25.5	37.2%	40.7	48.0%	54.1	39.7%
ME	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MI	1.2	1.6%	2.1	1.9%	0.8	1.1%	0.8	1.1%	1.6	1.9%	3.2	2.4%
MN (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.2	0.1%
MO (Partial)	0.7	1.0%	1.5	1.3%	0.8	1.2%	0.8	1.2%	0.7	0.9%	1.6	1.1%
MS (Partial)	0.0	0.1%	0.1	0.1%	0.0	0.1%	0.0	0.1%	0.1	0.1%	0.2	0.2%
NC	1.5	2.1%	3.0	2.7%	0.4	0.6%	0.4	0.6%	0.6	0.7%	1.3	1.0%
NH	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
NJ	0.2	0.2%	0.3	0.3%	0.2	0.3%	0.2	0.3%	0.7	0.8%	1.7	1.3%
NY	0.5	0.7%	0.9	0.8%	0.5	0.8%	0.5	0.8%	0.9	1.1%	2.3	1.7%
OH	5.3	7.2%	8.8	7.9%	5.0	7.3%	5.0	7.3%	6.1	7.2%	9.3	6.8%
PA	7.5	10.3%	13.4	12.0%	11.4	16.5%	11.4	16.5%	10.8	12.7%	21.5	15.8%
RI	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
SC	0.2	0.3%	0.5	0.4%	0.1	0.1%	0.1	0.1%	0.2	0.2%	0.4	0.3%
TN	0.5	0.6%	0.9	0.8%	0.6	0.8%	0.6	0.8%	0.7	0.8%	1.6	1.2%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
VA	20.0	27.3%	26.3	23.5%	8.9	13.0%	8.9	13.0%	7.7	9.0%	13.8	10.1%
VT	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
WI	0.3	0.4%	0.5	0.4%	0.4	0.5%	0.4	0.5%	0.4	0.5%	0.8	0.6%
WV	3.8	5.2%	6.2	5.5%	5.4	7.9%	5.4	7.9%	4.6	5.4%	7.0	5.1%

Monitor Name/ID	P.G. Equestrian Ctr., MD		240338003		Leroy High School, MA		250051002		Ancora St. Hospital, NJ		340071001	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
Sector	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.9	1.1%	1.1	1.2%	0.2	0.4%	0.2	0.4%	0.1	0.1%	0.1	0.1%
AR (Partial)	0.2	0.3%	0.3	0.3%	0.3	0.4%	0.3	0.4%	0.3	0.4%	0.3	0.4%
CT	0.0	0.0%	0.0	0.0%	6.5	10.0%	6.5	10.0%	0.0	0.1%	0.0	0.1%
DC	4.3	5.8%	5.4	6.0%	0.1	0.2%	0.1	0.2%	0.0	0.0%	0.0	0.0%
DE	0.3	0.4%	0.4	0.4%	0.6	0.9%	0.6	0.9%	3.4	4.6%	3.4	4.6%
GA (Partial)	0.5	0.6%	0.6	0.6%	0.3	0.4%	0.3	0.4%	0.1	0.1%	0.1	0.1%
IA (Partial)	0.1	0.2%	0.2	0.2%	0.2	0.3%	0.2	0.3%	0.6	0.8%	0.6	0.8%
IL	1.2	1.6%	1.4	1.6%	1.4	2.2%	1.4	2.2%	2.7	3.7%	2.7	3.7%
IN	3.3	4.5%	4.0	4.5%	1.9	2.9%	1.9	2.9%	2.6	3.6%	2.6	3.6%
KY	3.8	5.1%	4.7	5.2%	1.1	1.7%	1.1	1.7%	1.5	2.0%	1.5	2.0%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MA	0.0	0.0%	0.0	0.0%	2.9	4.4%	2.9	4.4%	0.0	0.0%	0.0	0.0%
MD	21.2	28.5%	24.0	26.9%	2.8	4.3%	2.8	4.3%	1.3	1.8%	1.3	1.8%
ME	0.0	0.0%	0.0	0.0%	0.1	0.1%	0.1	0.1%	0.0	0.0%	0.0	0.0%
MI	1.3	1.7%	1.6	1.8%	0.9	1.4%	0.9	1.4%	3.1	4.2%	3.1	4.2%
MN (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.2	0.3%	0.2	0.3%
MO (Partial)	1.1	1.5%	1.4	1.5%	0.7	1.0%	0.7	1.0%	1.2	1.7%	1.2	1.7%
MS (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.2%	0.1	0.2%	0.1	0.1%	0.1	0.1%
NC	0.2	0.3%	0.2	0.3%	0.9	1.4%	0.9	1.4%	0.1	0.1%	0.1	0.1%
NH	0.0	0.0%	0.0	0.0%	0.1	0.1%	0.1	0.1%	0.0	0.0%	0.0	0.0%
NJ	0.6	0.8%	0.7	0.8%	7.0	10.7%	7.0	10.7%	14.5	19.8%	14.5	19.8%
NY	0.4	0.6%	0.6	0.6%	17.4	26.7%	17.4	26.7%	3.2	4.3%	3.2	4.3%
OH	6.8	9.2%	8.0	9.0%	2.8	4.4%	2.8	4.4%	6.5	8.9%	6.5	8.9%
PA	8.5	11.5%	10.6	11.9%	8.1	12.5%	8.1	12.5%	27.8	38.0%	27.8	38.0%
RI	0.0	0.0%	0.0	0.0%	3.6	5.6%	3.6	5.6%	0.0	0.0%	0.0	0.0%
SC	0.1	0.2%	0.2	0.2%	0.2	0.3%	0.2	0.3%	0.0	0.0%	0.0	0.0%
TN	1.0	1.3%	1.2	1.3%	0.5	0.8%	0.5	0.8%	0.2	0.2%	0.2	0.2%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
VA	13.3	17.9%	16.6	18.6%	3.0	4.6%	3.0	4.6%	0.7	0.9%	0.7	0.9%
VT	0.0	0.0%	0.0	0.0%	0.0	0.1%	0.0	0.1%	0.0	0.0%	0.0	0.0%
WI	0.2	0.3%	0.3	0.3%	0.3	0.4%	0.3	0.4%	1.0	1.4%	1.0	1.4%
WV	4.8	6.4%	5.8	6.4%	1.1	1.6%	1.1	1.6%	2.1	2.8%	2.1	2.8%

Monitor Name/ID	Collier's Mill, NJ		340290006		Clarksboro, NJ		340150002		Susan Wagner HS, NY		360850067	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
State	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.4	0.5%	0.6	0.6%	0.5	0.6%	0.6	0.7%	0.4	0.5%	0.9	0.7%
AR (Partial)	0.2	0.3%	0.3	0.3%	0.2	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%
CT	0.7	1.0%	1.3	1.1%	0.1	0.1%	0.1	0.2%	0.7	0.8%	1.3	1.0%
DC	0.1	0.1%	0.1	0.1%	0.5	0.6%	0.6	0.6%	0.1	0.2%	0.3	0.2%
DE	1.1	1.5%	1.8	1.6%	4.1	5.2%	4.9	5.2%	1.1	1.4%	2.2	1.8%
GA (Partial)	0.4	0.5%	0.6	0.6%	0.5	0.6%	0.6	0.7%	0.5	0.6%	1.1	0.8%
IA (Partial)	0.4	0.5%	0.6	0.5%	0.3	0.4%	0.4	0.4%	0.3	0.3%	0.5	0.4%
IL	1.3	1.9%	2.0	1.8%	1.6	2.0%	1.9	2.0%	1.5	1.8%	2.5	2.0%
IN	1.4	2.0%	2.2	1.9%	1.8	2.4%	2.1	2.3%	1.8	2.2%	2.9	2.3%
KY	1.9	2.7%	3.1	2.8%	2.2	2.8%	2.7	2.9%	2.0	2.3%	3.6	2.8%
LA (Partial)	0.0	0.0%	0.1	0.1%	0.0	0.0%	0.1	0.1%	0.0	0.0%	0.0	0.0%
MA	0.8	1.1%	1.4	1.2%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%
MD	2.2	3.2%	3.8	3.4%	11.2	14.4%	14.0	14.9%	4.4	5.2%	8.5	6.7%
ME	0.1	0.2%	0.3	0.2%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MI	1.3	1.9%	2.1	1.9%	1.7	2.1%	2.0	2.1%	1.5	1.8%	2.5	2.0%
MN (Partial)	0.1	0.2%	0.2	0.2%	0.1	0.2%	0.1	0.2%	0.1	0.1%	0.2	0.2%
MO (Partial)	0.6	0.9%	1.0	0.9%	0.7	0.9%	0.9	0.9%	0.6	0.7%	1.1	0.8%
MS (Partial)	0.1	0.1%	0.2	0.2%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.2	0.1%
NC	0.7	1.0%	1.2	1.1%	0.5	0.6%	0.6	0.6%	0.5	0.6%	0.9	0.7%
NH	0.2	0.3%	0.3	0.3%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
NJ	15.4	22.1%	20.6	18.4%	7.4	9.5%	8.5	9.1%	22.2	26.6%	27.0	21.3%
NY	10.7	15.3%	18.6	16.6%	2.1	2.7%	2.6	2.8%	15.3	18.4%	24.8	19.5%
OH	3.2	4.5%	4.7	4.2%	5.7	7.3%	6.5	6.9%	3.8	4.6%	5.7	4.5%
PA	20.8	29.8%	35.1	31.5%	26.4	33.9%	31.7	33.6%	18.4	22.1%	26.3	20.7%
RI	0.2	0.2%	0.3	0.3%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
SC	0.2	0.3%	0.3	0.3%	0.1	0.1%	0.1	0.1%	0.2	0.2%	0.3	0.3%
TN	0.8	1.2%	1.4	1.3%	0.6	0.8%	0.8	0.8%	0.8	0.9%	1.5	1.1%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
VA	1.2	1.7%	2.1	1.8%	5.2	6.7%	6.5	6.9%	3.4	4.1%	6.6	5.2%
VT	0.1	0.1%	0.2	0.1%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
WI	0.7	1.0%	1.2	1.1%	0.7	0.9%	0.9	0.9%	0.6	0.8%	1.0	0.8%
WV	2.5	3.6%	4.2	3.8%	3.6	4.6%	4.4	4.7%	2.7	3.2%	4.6	3.6%

Monitor Name/ID	Holtsville, NY		361030009		Babylon, NY		361030002		NEA, PA		421010024	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
State	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.1	0.2%	0.2	0.2%	0.2	0.3%	0.4	0.3%	0.3	0.5%	0.3	0.5%
AR (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.1	0.1%
CT	2.6	3.7%	4.8	4.9%	0.8	0.9%	1.3	1.1%	0.1	0.1%	0.1	0.1%
DC	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.4	0.5%	0.4	0.5%
DE	0.7	1.0%	0.9	1.0%	0.4	0.5%	0.7	0.6%	3.0	4.1%	3.0	4.1%
GA (Partial)	0.2	0.2%	0.3	0.3%	0.2	0.3%	0.4	0.3%	0.6	0.8%	0.6	0.8%
IA (Partial)	0.2	0.3%	0.3	0.3%	0.2	0.3%	0.4	0.3%	0.2	0.3%	0.2	0.3%
IL	1.0	1.4%	1.7	1.7%	1.3	1.6%	2.1	1.9%	1.2	1.6%	1.2	1.6%
IN	1.1	1.6%	1.9	2.0%	1.5	1.8%	2.5	2.3%	1.7	2.4%	1.7	2.4%
KY	0.9	1.2%	1.6	1.6%	1.2	1.4%	2.0	1.8%	2.3	3.2%	2.3	3.2%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MA	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.1	0.1%	0.0	0.0%	0.0	0.0%
MD	2.4	3.5%	3.8	3.9%	2.2	2.6%	3.7	3.4%	11.7	16.2%	11.7	16.2%
ME	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MI	1.5	2.2%	2.5	2.6%	2.1	2.5%	3.0	2.7%	1.1	1.5%	1.1	1.5%
MN (Partial)	0.1	0.2%	0.2	0.2%	0.2	0.2%	0.3	0.3%	0.1	0.1%	0.1	0.1%
MO (Partial)	0.5	0.7%	0.9	0.9%	0.6	0.8%	1.1	1.0%	0.8	1.1%	0.8	1.1%
MS (Partial)	0.0	0.0%	0.1	0.1%	0.1	0.1%	0.1	0.1%	0.0	0.1%	0.0	0.1%
NC	0.6	0.9%	1.0	1.1%	0.5	0.6%	0.8	0.8%	0.4	0.6%	0.4	0.6%
NH	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
NJ	11.9	17.1%	15.7	16.2%	17.4	20.9%	20.2	18.3%	3.0	4.1%	3.0	4.1%
NY	28.8	41.5%	36.5	37.5%	33.9	40.8%	40.8	37.0%	0.5	0.6%	0.5	0.6%
OH	2.6	3.7%	3.9	4.1%	3.2	3.9%	4.9	4.5%	5.1	7.0%	5.1	7.0%
PA	9.6	13.9%	13.0	13.4%	12.0	14.5%	17.1	15.6%	30.0	41.4%	30.0	41.4%
RI	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
SC	0.1	0.2%	0.2	0.2%	0.1	0.1%	0.2	0.2%	0.1	0.2%	0.1	0.2%
TN	0.4	0.5%	0.7	0.7%	0.5	0.6%	0.9	0.8%	0.5	0.7%	0.5	0.7%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
VA	2.1	3.0%	3.4	3.5%	2.0	2.4%	3.4	3.1%	4.5	6.3%	4.5	6.3%
VT	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
WI	0.5	0.7%	0.9	0.9%	0.6	0.7%	0.9	0.8%	0.3	0.4%	0.3	0.4%
WV	1.3	1.8%	2.1	2.1%	1.6	1.9%	2.5	2.3%	4.3	6.0%	4.3	6.0%

Monitor Name/ID	Baxter, PA		421011002		AJ, RI		440030002		Aurora Hills, VA		510130020	
	Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.		Exceedance Avg.		4th High Avg.	
Sector	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
AL (Partial)	0.3	0.5%	0.3	0.5%	0.2	0.3%	0.2	0.3%	0.5	0.6%	0.9	0.8%
AR (Partial)	0.1	0.1%	0.1	0.1%	0.2	0.4%	0.2	0.4%	0.2	0.2%	0.3	0.2%
CT	0.1	0.1%	0.1	0.1%	9.3	14.0%	9.3	14.0%	0.0	0.0%	0.0	0.0%
DC	0.4	0.5%	0.4	0.5%	0.1	0.1%	0.1	0.1%	6.6	8.3%	9.2	8.2%
DE	2.8	4.1%	2.8	4.1%	0.6	0.9%	0.6	0.9%	0.0	0.1%	0.1	0.1%
GA (Partial)	0.6	0.8%	0.6	0.8%	0.2	0.3%	0.2	0.3%	0.2	0.2%	0.3	0.2%
IA (Partial)	0.2	0.3%	0.2	0.3%	0.2	0.2%	0.2	0.2%	0.2	0.2%	0.3	0.2%
IL	1.1	1.6%	1.1	1.6%	1.6	2.3%	1.6	2.3%	1.4	1.8%	2.3	2.0%
IN	1.7	2.4%	1.7	2.4%	1.9	2.8%	1.9	2.8%	3.2	4.1%	5.1	4.5%
KY	2.2	3.2%	2.2	3.2%	1.2	1.8%	1.2	1.8%	2.5	3.2%	4.1	3.6%
LA (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MA	0.0	0.0%	0.0	0.0%	0.2	0.3%	0.2	0.3%	0.0	0.0%	0.0	0.0%
MD	11.3	16.2%	11.3	16.2%	2.4	3.7%	2.4	3.7%	16.2	20.5%	22.9	20.5%
ME	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
MI	1.1	1.5%	1.1	1.5%	1.2	1.9%	1.2	1.9%	1.4	1.8%	2.3	2.0%
MN (Partial)	0.1	0.1%	0.1	0.1%	0.1	0.2%	0.1	0.2%	0.1	0.1%	0.1	0.1%
MO (Partial)	0.8	1.1%	0.8	1.1%	0.6	0.9%	0.6	0.9%	0.9	1.2%	1.6	1.4%
MS (Partial)	0.0	0.1%	0.0	0.1%	0.1	0.2%	0.1	0.2%	0.1	0.1%	0.1	0.1%
NC	0.4	0.6%	0.4	0.6%	0.7	1.1%	0.7	1.1%	1.4	1.8%	2.5	2.2%
NH	0.0	0.0%	0.0	0.0%	0.0	0.1%	0.0	0.1%	0.0	0.0%	0.0	0.0%
NJ	2.9	4.1%	2.9	4.1%	7.1	10.8%	7.1	10.8%	0.1	0.1%	0.1	0.1%
NY	0.5	0.6%	0.5	0.6%	19.1	28.8%	19.1	28.8%	0.3	0.4%	0.5	0.4%
OH	4.9	7.0%	4.9	7.0%	3.7	5.6%	3.7	5.6%	7.2	9.2%	10.0	9.0%
PA	28.8	41.4%	28.8	41.4%	10.0	15.0%	10.0	15.0%	8.6	10.9%	14.0	12.5%
RI	0.0	0.0%	0.0	0.0%	0.9	1.4%	0.9	1.4%	0.0	0.0%	0.0	0.0%
SC	0.1	0.2%	0.1	0.2%	0.1	0.2%	0.1	0.2%	0.2	0.2%	0.3	0.3%
TN	0.5	0.7%	0.5	0.7%	0.5	0.8%	0.5	0.8%	0.5	0.6%	0.8	0.7%
TX (Partial)	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
VA	4.4	6.3%	4.4	6.3%	1.8	2.7%	1.8	2.7%	22.4	28.5%	27.8	24.9%
VT	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
WI	0.3	0.4%	0.3	0.4%	0.4	0.6%	0.4	0.6%	0.4	0.5%	0.6	0.5%
WV	4.2	6.0%	4.2	6.0%	1.5	2.3%	1.5	2.3%	4.3	5.4%	5.8	5.2%