Infrastructure/110(a) requirements for the 2015 Ozone National Ambient Air Quality Standard

This State Implementation Plan (SIP) revision addresses the infrastructure requirements of sections 110(a)(1) and 110(a)(2) of the Clean Air Act (CAA) in regards to the National Ambient Air Quality Standards (NAAQS) for ozone, promulgated in 2015.

Contents

Introduction

The Minnesota Pollution Control Agency (MPCA) is, via submission of this document, requesting the revision of Minnesota's State Implementation Plan (SIP) under Sections 110(a)(1) and 110(a)(2), as well as Section 128 [as they are related to Section 110(a)(2)(E)(ii)] of the Clean Air Act (CAA). Sections 110(a)(1) and 110(a)(2) of the Act require that states prepare and submit to the U. S. Environmental Protection Agency (EPA) an "infrastructure" SIP (iSIP) within three years of the EPA's issuance of a new National Ambient Air Quality Standard (NAAQS) to demonstrate their continued ability to implement, maintain, and enforce the revised standards. Infrastructure SIP elements include requirements for limiting the interstate transport of air pollution under Section 110(a)(2)(D)(i)(I), commonly called "good neighbor requirements." Section 128 of the CAA mandates that members of boards governing state agencies that implement the Act represent the public interest and disclose any conflict of interest. This iSIP submittal addresses the 2015 ozone NAAQS revision.

The majority of this iSIP revision was written based on EPA's September 12, 2013 guidance document regarding multi-pollutant iSIPs, "Guidance on Infrastructure State Implementation Plan (SIP) Elements under Clean Air Act Sections 110(a)(1) and 110(a)(2)". The 2013 guidance did not address good neighbor elements.

Section 110(a)(2)(D)(i)(I) requires that states ensure that emissions within the state do not contribute significantly to nonattainment in, or interfere with maintenance by, any other state. This requirement means that Minnesota must show that emissions from within its borders are not significantly contributing to air pollution problems or violations in other states. In order to address the good neighbor requirements of this iSIP revision, MPCA referred to EPA's March 27, 2018 memo, "Information on the Interstate Transport State Implementation Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards under Clean Air Act Section 110(a)(2)(D)(i)(I)". Appendices B and C of the 2018 memo, and associated May 18, 2018 updates to modeling activities, provided states with modeled downwind contribution results for receptors that EPA expects will be nonattainment or maintenance areas in 2023. MPCA used the results of EPA's modeling exercise, in addition to modeling conducted by the Lake Michigan Air Directors Consortium (LADCO), to affirm that Minnesota does not contribute to any downwind receptors above the one percent threshold used by EPA to determine significant impact.

The iSIP below discusses each Section under 110(a) and provides information on how Minnesota meets the requirements for each. Based on information set forth in the 2013 guidance, the 2018 memo, previously approved iSIP submittals, and conversations with Region 5 staff, the MPCA believes that this iSIP submittal meets all of the requirements of CAA Sections 110(a)(1) and 110(a)(2).

Section 110(a)(1): A plan which provides for implementation, maintenance, and enforcement

The Minnesota Pollution Control Agency (MPCA) has, in prior submittals, documented its authority and ability to provide for the implementation, maintenance, and enforcement of primary and secondary air quality standards, as well as to adopt enforceable emission limitations and control measures to meet the primary and secondary standard and to update both state rules and the SIP, as necessary.

Various Minnesota statutes, addressed below, authorize the MPCA to adopt air quality standards.

Minn. Statute § 116.07, subd. 2(a) states:

> "The agency shall improve air quality by promoting, in the most practicable way possible, the use of energy sources and waste disposal methods which produce or emit the least air contaminants consistent with the agency's overall goal of reducing all forms of pollution. The agency shall also adopt standards of air quality…, recognizing that due to variable factors, no single standard of purity of air is applicable to all areas of the state…"

Minn. Stat. § 116.07, subd. 4(a), authorizes the agency to "…adopt, amend and rescind rules and standards having the force of law relating to any purpose… for the prevention, abatement, or control of air pollution…"

Under Minn. Stat. 116.07 § subd. 9, the MPCA is granted the authority to enter into or enforce orders, schedules of compliance, and stipulation agreements; to require owners or operators of emission facilities to install and operate monitoring equipment and to conduct tests; and to conduct investigations, issue notices, and order hearings, as deemed necessary, to discharge the MCPA's duties.

Minn. Stat. § 116.072 authorizes the MPCA to issue orders and assess administrative penalties to correct violations of the MPCA's statutes, rules, and permits. The statute also authorizes administrative penalties up to a maximum of $10,000 for all violations identified during an inspection or compliance review.

Minn. Stat. § 115.071, subd. 1 provides that violations of the MPCA's statutes, rules, standards, orders, stipulation agreements, schedules of compliance, and permits may be remedied with criminal prosecution, action to recover civil penalties, injunction, and action to compel performance, other appropriate action, or any combination of the above. Relatedly, Minn. Stat. § 115.071, subd. 3 indicates that civil penalties may be recovered up to a maximum of $10,00 per day of violation, except for violations related to hazardous waste, the maximum for which is $25,000 per day of violation.

Minnesota's SIP-approved air quality rules are established under the above statutory authorities, and broadly cover the criteria pollutants listed, as defined in Minn. R. Ch. 7005.0100: "sulfur dioxide, particulate matter, nitrogen oxides, carbon monoxide, ozone, lead, and any other pollutants for which national ambient air quality standards have been established…" Primary and secondary ambient air quality standards are defined in Minn. R. Ch. 7009.0010 subp. 2 and 3; Minn. R. Ch. 7009.0020 prohibits emissions that cause or contribute to the violation of any ambient air quality standard. The NAAQS are incorporated by reference in Minn. R. Ch. 7009.0090.

We assert that the above statutory and regulatory authorities fulfill the requirements of Section 110(a)(1).

Section 110(a)(2)(A): Emission limits and other control measures

Minn. Stat. Ch. 116 gives the MPCA the authority to develop rules and regulations and also allows the MPCA to implement current rules and apply existing controls and emissions limits to help maintain new standards. Minn. Stat. § 116.07, subd. 4(a) gives the MPCA the authority to "adopt, amend and rescind rules and standards having the force of law relating to any purpose… for the prevention, abatement, or control of air pollution."

Minn. Stat. § 116.07, subd. 4a(a), gives the MPCA authority to "issue, continue in effect or deny permits, under such conditions as it may prescribe for the prevention of pollution, for the emission of air contaminants, or for the installation or operation of any emission facility, air contaminant treatment facility, treatment facility, potential air contaminant storage facility, or storage facility…"

Minnesota does not have any nonattainment or maintenance areas for the 2015 ozone NAAQS; however, there are methods in place to address emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs), which are considered by EPA to be the primary precursors to ground-level ozone formation.

Nitrogen oxides (NO_x)

State rules that limit NO_x, as well as nitrogen dioxide (NO_2) emissions, include Minn. R. Ch. 7011.0500 through 7011.0553, which address Indirect Heating Fossil-Fuel-Burning Equipment, and Minn. R. Ch. 7011.1700 through 7011.1730, which address Nitric Acid Plants in Minnesota.

Volatile organic compounds (VOCs)

In order to minimize the formation of ground-level ozone, we limit the emissions of volatile organic compounds (VOCs), which are the primary ozone precursors, through our Part 70 permit program. In addition, Minnesota's state rules incorporate, by reference, the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which, with Part 70 permits, limit VOC emissions. These limits help to protect the 2015 ozone NAAQS.

More information about emissions limits and other control measures can be found in the discussion of Section 110(a)(2)(D)(i)(I) of this document, which reviews Minnesota's interstate transport obligations.

We assert that the above statutory and regulatory authorities fulfill the requirements of Section 110(a)(2)(A).

Section 110(a)(2)(B): Ambient air quality monitoring/data system

Minnesota monitors for ambient ozone levels at 17 locations throughout the state. Minnesota's ambient air quality monitoring network is designed and operated to meet the requirements of 40 CFR Part 58, "Ambient air quality surveillance". Data from the monitors are submitted to the U.S Environmental Protection Agency's (EPA) Air Quality System (AQS) in a timely manner.

The MPCA completes an annual air monitoring network plan for the state, required under 40 CFR § 58.10, which describes the existing air monitoring network, as well as planned and proposed changes. These network plans are available on the MPCA's website, at https://www.pca.state.mn.us/air/air-monitoring-network-plan. The 2019 Annual Air Monitoring Network Plan for Minnesota was posted and available for public comment from May 1 through June 1, 2018, and will be submitted to EPA prior to the July 1, 2018 deadline. The 2019 plan includes a new Appendix D that describes the MPCA's Photochemical Assessment Monitoring Station (PAMS) Network Implementation Plan, which reflects changes in EPA's ambient ozone monitoring requirements that were made as part of the 2015 ozone NAAQS revision. The PAMS Network Implementation Plan has been tentatively approved by EPA per the early review of the 2019 plan.

Minn. Stat. § 116.07, subd. 9(b) gives the MPCA authority "to require the owner or operator of any emission facility, air contaminant treatment facility, potential air contaminant storage facility, or any system or facility related to the storage, collection transportation, processing, or disposal of waste… to install, use, and maintain monitoring equipment or methods…". Information about the industrial monitoring network in Minnesota is available in Appendix B of annual monitoring plan updates.

We assert that the above statutory requirements and associated ambient air quality monitoring practices at MPCA fulfill the requirements of Section 110(a)(2)(B).

Section 110(a)(2)(C): Programs for enforcement and for regulation of PSD and NSR

As described above, Minn. Stat. §§ 116.07, subd. 9, 116.072, and 115.071 give MPCA the authority to enforce any provisions of section 116 and the rules, standards, orders, stipulation agreements, schedules of compliance, and permits adopted or issued thereunder, or under any other law relating to air contamination.

These sections include, but are not limited to, the following authorities:

- Entering into orders
- Schedules of compliance
- Stipulation agreements
- Requiring owners or operators of emissions facilities to install and operate monitoring equipment
- Conduction of investigations

Minn. Stat. § 116.072 authorizes the MPCA to issue orders and assess administrative penalties to correct violations of MPCA's rules, statutes, and permits; Minn. Stat. § 115.071 outlines the remedies that are available to address such violations. Additionally, Minn. R. 7009.0030 and 7009.0040 provide for enforcement measures related to the violation of ambient air quality standards.

Minn. R. Ch. 7007 contains the requirements of the MPCA's permitting program, through which enforceable emission limitations are placed on facilities.

Minnesota previously used delegated authority, under 40 CFR § 52.21, to permit Prevention of Significant Deterioration (PSD) sources through a Federal Implementation Plan (FIP). On October 4, 2016, the MPCA submitted a SIP revision to incorporate new PSD rules, which incorporated federal PSD rules by reference in Minn. R. Ch. 7007.3000. EPA approved the SIP revision, and the new PSD rules, on September 26, 2017 (82 FR 44734); these rules have been incorporated into Minnesota's SIP at 40 CFR § 52.1220.

Although Minnesota does not have any nonattainment or maintenance areas for the 2015 ozone NAAQS, we have an approved nonattainment New Source Review (NSR) program, which was approved by EPA on May 24, 1995 (60 FR 27411). Minn. R. Ch. 7007.4000 through 7007.4030 incorporates, by reference, the NSR requirements specified in 40 CFR Part 51, Appendix S.

To address the pre-construction regulation of the modification and construction of minor stationary sources and minor modifications of major stationary sources, EPA approved Minnesota's minor NSR program on May 24, 1995 (FR notice citation). Since then, MPCA and EPA have relied on these existing provisions to ensure that new and modified sources not captured by the major NSR permitting programs do not interfere with attainment and maintenance of the ozone and other NAAQS.

We assert that the above statutory and regulatory authority fulfill the requirements of Section 110(a)(2)(C).

Section 110(a)(2)(D): Interstate transport provisions ("good neighbor SIPs")

Section 110(a)(2)(D)(i)(I): Prongs 1 (significant contribution to nonattainment) and 2 (interference with maintenance)

This section requires iSIPs to have provisions prohibiting sources from emitting air pollutants in amounts that would contribute significantly to nonattainment or interfere with maintenance in any other state. These interstate transport requirements are often referred to as "good neighbor SIPs". The analyses conducted to support the 2015 ozone good neighbor SIPs show Minnesota does not contribute significantly to air quality problems in any downwind nonattainment or maintenance area. Therefore, no additional controls or emissions limits are required to fulfill Minnesota's good neighbor obligations.

On March 27, 2018, the EPA published a memo, entitled "Information on the Interstate Transport State Implementation Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards under Clean Air Act Section 110(a)(2)(D)(i)(I)" (Memo). The Memo built off another, published on October 27, 2017, which provided guidance to air agencies regarding the development of ozone interstate transport components of iSIPs for the 2008 ozone NAAQS.

EPA's Memo includes new transport modeling data for the year 2023 (the Moderate Attainment deadline for the 2015 ozone NAAQS). These data are provided to assist states in completing the "good neighbor" SIPs for the 2015 ozone NAAQS, and to thereby address interstate transport obligations.

EPA identifies a four-step framework in the Memo, intended to guide states on how to go about developing good neighbor SIPs:

1. Identify downwind air quality problems;
2. Identify upwind states that contribute enough to those downwind air quality problems to warrant further review and analysis;
3. Identify the emissions reductions necessary (if any), considering cost and air quality factors, to prevent an identified upwind state from contributing significantly to those downwind air quality problems; and
4. Adopt permanent and enforceable measures needed to achieve those emissions reductions.

EPA and states have applied this four-tiered approach, shaped by public notice and comment and refined in response to court decisions, to address good neighbor obligations for previous NAAQS revisions.

1. Identify downwind air quality problems

In the Memo, EPA identifies parts of the country projected to have difficulty attaining or maintaining the 2015 ozone NAAQS by the 2023 moderate attainment deadline. To extrapolate ozone design values (DVs) to 2023, EPA used the Comprehensive Air Quality Model with Extensions (CAMx v6.40) to model 2011 and 2023 emissions. EPA used the outputs from the 2011 and 2023 model simulations to create relative response (of air quality to emission changes) factors. EPA applied the relative response factors to project base period 2009-2013 average and maximum ozone DVs to 2023 at monitoring sites across the country. EPA used the projected future year DVs to identify potential 2023 nonattainment and maintenance receptors for the 2015 ozone NAAQS.

In projecting future year DVs, EPA applied its own modeling guidance and an alternative approach suggested during the January 2017 notice of data availability comment period and backed by other relevant analyses. The alternative excludes from the analysis grid cells positioned over water from the 3 x 3 array of model grid cells surrounding monitoring sites in coastal areas. In the upper Midwest, excluding grid cells positioned over water projects Milwaukee Wisconsin (monitoring site 550790085) as a downwind nonattainment receptor. This means EPA expects the Milwaukee site may have difficulty meeting the ozone NAAQS in 2023 without additional control measures applied in culpable States. Including model grid cells over water projects the Milwaukee site as an attainment receptor. This perspective means the Milwaukee site may achieve ozone design values below the NAAQS without additional controls beyond those addressed in the modeled projections.

The Memo outlines possible alternatives when modeling interstate transport. The Lake Michigan Air Directors Consortium (LADCO), a multi-jurisdictional organization comprised of EPA Region V States, provides modeling support for those states, including Minnesota. LADCO has conducted modeling[1] incorporating alternative bullet #4 in the Memo Analytics section to support 2015 ozone good neighbor SIPs.

Specifically, LADCO replicated EPA's 2023EN platform with the exception of substituting Eastern Regional Technical Advisory Committee (ERTAC) [2] EGU estimates for EPAs engineering analysis estimates. The MPCA believes power sector emissions forecasts must address economic factors, preserve system reliability, and include controls or emission reduction measures justified through some legal framework. It is our understanding that the engineering analysis used by EPA to project EGU emissions to 2023 (version EN of the modeling platform) does not comply with these key requirements. The ERTAC estimates incorporate the key requirements. Table 1 outlines the primary differences between the EPA "engineering analysis" and ERTAC handling of the key requirements. The incorporation of ERTAC in the model simulation produces some new, and changes the status of some, nonattainment or maintenance receptors downwind of Minnesota. Tables 2 and 3 (columns 3 through 6) show the differences.

Table 1. Primary differences between EPA's engineering analysis and LADCO's ERTAC analysis.

Key requirement	EPA engineering analysis	ERTAC
Economic factors	Minimal Economic factors considered. No growth from 2016 to 2023.	Complex growth algorithm based on Annual Energy Outlook (AEO) projections for annual growth and North American Electric Reliability Corporation (NERC) for peak day growth. Growth applied by fuel type and region based on AEO splits.
Preservation of system reliability	No implicit check for reliability.	Complex set of algorithms check system wide capacity against the demand plus safety margins to verify if there is a lack of generation in a region.
Controls or emission reduction measures justified through a legal framework	Applied emission reductions by optimizing existing controls that in 2016 were not optimized without justification the controls will be optimized.	Only applied emission reduction estimates with justification.

2. Upwind states' contributions to downwind air quality problems

EPA has previously determined that a state contribution to downwind air quality problems below one percent of the applicable NAAQS is insignificant. This screening method was used in previous good neighbor SIP approvals, including (most notably) the Cross-State Air Pollution Rule (CSAPR), and the CSAPR update for the 2008 ozone NAAQS and 2012 NAAQS for particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$). The one percent screening method was developed through several previous federal notice and comment rulemakings. One percent of the 2015 ozone NAAQS (70 ppb) is 0.70 ppb. Therefore, any state that contributes less than 0.70 ppb to a projected nonattainment or maintenance area in another state is not culpable for those air quality problems.

EPA and LADCO implemented the Anthropogenic Precursor Culpability Analysis (APCA) technique in CAMx to identify upwind states culpable for downwind ozone air quality problems. The method accounts for human-made nitrogen oxides (NO_x) and volatile organic carbon (VOC) emissions from all sources in each upwind state affecting projected 2023 ozone concentrations at each downwind air quality monitoring site designated a nonattainment or maintenance receptor. EPA and LADCO conducted the culpability analysis for the period May 1 through September 30, using the 2023 future emission estimates and 2011 meteorology. Refer to pages 5 and 6 of the Memo for more information regarding EPA's culpability analysis.

[1] See Attachment 1, "Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard: Technical Support Document". The TSD includes text about excluding data from the design value calculation based on model performance. The data in this iSIP, Tables 2 and 3, do not reflect this feature.
[2] See Attachment 2, "Documentation of ERTAC EGU CONUS Versions 2.7 Reference and CSAPR Update Compliant Scenario".

Both analyses conclude Minnesota is not culpable for ozone nonattainment, or interference with maintenance, in any downwind states. As shown in Table 2, EPA's analysis indicates Minnesota contributes most to Milwaukee, Wisconsin monitor site 550790085. At a concentration of 0.40 ppb, this contribution is roughly equal to 0.57% of the 2015 ozone NAAQS (70 ppb). LADCO's analysis corroborates EPA's results, showing a concentration of 0.45 ppb, roughly equal to 0.64% of the NAAQS.

While there are some differences in the list of receptors identified as nonattainment or maintenance receptors between the EPA and LADCO modeling exercises, there are no significant differences in Minnesota's contribution to any of the receptors identified by either EPA or LADCO. Although Minnesota 2023 emission estimates with ERTAC are lower than the EPA engineering analysis estimates, Minnesota's downwind culpability remains the same – negligible – as shown in Tables 2 and 3.

Table 2. Minnesota's projected 2023 ozone contributions, from human-made NO_x and VOC emissions, to states with nonattainment or maintenance receptors, based on the "no water" alternative. Source of EPA model data: "March 2018 Memo and Supplemental Information Regarding Interstate Transport SIPs for the 2015 Ozone NAAQS", https://www.epa.gov/airmarkets/march-2018-memo-and-supplemental-information-regarding-interstate-transport-sips-2015; these data include the May 18, 2018 updates. ERTAC-substituted model and data sourced from LADCO – see Attachments 1 and 2. Values in gray did not exceed the 70 ppb modeling threshold used to identify projected 2023 nonattainment or maintenance areas.

AQS Site ID	Monitor Location	EPA 2023en Average (ppb)	EPA 2023en Maximum (ppb)	LADCO 2023en Average (ppb)	LADCO 2023en Maximum (ppb)	EPA Contribution from Minnesota (ppb)	Percent of 2015 ozone NAAQS	LADCO Contribution from Minnesota (ppb)	Percent of 2015 ozone NAAQS
550790085	Milwaukee, WI	71.2	73.0	68.0	71.2	0.40	0.57	0.45	0.64
180910005	LaPorte, IN	67.2	70.4	65.6	68.6	0.36	0.51	0.34	0.49
480391004	Brazoria, TX	74.0	74.9	73.6	74.4	0.34	0.49	0.33	0.47
170317002	Cook, IL	66.8	70.3	64.7	68.1	0.33	0.47	0.32	0.46
211110027	Jefferson, KY	70.1	70.1	61.7	64.1	0.32	0.46	0.22	0.31
261630019	Wayne, MI	69.0	71.0	67.7	69.7	0.31	0.44	0.30	0.43
551170006	Sheboygan, WI	72.8	75.1	70.9	73.2	0.28	0.40	0.27	0.39
550890008	Ozaukee, WI	67.2	70.5	65.7	68.9	0.26	0.37	0.24	0.34
482010026	Harris, TX	67.6	70.0	66.8	69.1	0.24	0.34	0.27	0.39
482011034	Harris, TX	70.8	71.6	70.2	71.0	0.23	0.33	0.30	0.43
482450101	Jefferson, TX	68.2	70.0	67.8	69.5	0.23	0.33	0.23	0.33
482011039	Harris, TX	71.8	73.5	71.0	72.7	0.20	0.29	0.26	0.37
90099002	New Haven, CT	69.9	72.6	66.8	69.4	0.19	0.27	0.16	0.23
340150002	Gloucester, NJ	68.2	70.4	65.9	68.0	0.18	0.26	0.17	0.24
361030002	Suffolk, NY	74.0	75.5	70.8	72.2	0.18	0.26	0.16	0.23
90010017	Fairfield, CT	68.9	71.2	65.8	68.0	0.17	0.24	0.17	0.24
360810124	Queens, NY	70.2	72.0	67.1	68.8	0.17	0.24	0.16	0.23
90013007	Fairfield, CT	71.0	75.0	68.1	71.9	0.15	0.21	0.15	0.21
484392003	Tarrant, TX	72.5	74.8	72.1	74.3	0.15	0.21	0.15	0.21
90019003	Fairfield, CT	73.0	75.9	70.1	72.9	0.14	0.20	0.11	0.16
484393009	Tarrant, TX	70.6	70.6	70.3	70.3	0.14	0.20	0.14	0.20
240251001	Harford, MD	70.9	73.3	69.2	71.5	0.13	0.19	0.12	0.17
484393011	Tarrant, TX	68.0	70.0	67.6	69.5	0.13	0.19	0.14	0.20
360850067*	Richmond, NY	67.1	68.5	64.5	65.8	0.12	0.17	0.12	0.17
260050003	Allegan, MI	69.0	71.7	67.4	70.1	0.11	0.16	0.11	0.16
481210034	Denton, TX	69.7	72.0	69.4	71.7	0.11	0.16	0.11	0.16
90110124	New London, CT	67.3	70.4	63.9	66.9	0.09	0.13	0.09	0.13
220330003	East Baton Rouge, LA	67.8	70.6	66.6	69.4	0.07	0.10	0.07	0.10
421010024	Philadelphia, PA	67.3	70.3	65.3	68.2	0.07	0.10	0.09	0.13
480290052	Bexar, TX	68.4	70.4	68.3	70.3	0.06	0.09	0.06	0.09
482010024	Harris, TX	70.4	72.8	69.7	72.1	0.06	0.09	0.06	0.09

*The Richmond, NY site was first included by EPA in the March 27 memo, as it was shown to be a nonattainment receptor in the "water" modeling approach. See Table 3 for projected DV information.

Table 3 shows the list of receptors EPA identified in Appendix B of the Memo using the "water" (non-alternative) cell approach. EPA did not identify state-by-state contributions for this approach, but we include those receptors here for comparison to LADCO's modeling.

Table 3. Minnesota's projected 2023 ozone contributions, from human-made NO_X and VOC emissions, to states with nonattainment or maintenance receptors, based on the "water" alternative. Source of EPA model data: Memo, Attachment B, "Projected ozone design values at potential nonattainment and maintenance receptors based on EPA's updated 2023 transport modeling", p. B-3. Updates to these values were not provided with the other May 18, 2018 updates under the "no water" alternative. ERTAC-substituted model and data sourced from LADCO – see Attachments 1 and 2. Values in gray did not exceed the 70 ppb modeling threshold used to identify projected 2023 nonattainment or maintenance areas.

AQS Site ID	Monitor Location	EPA 2023en Average (ppb)	EPA 2023en Maximum (ppb)	LADCO 2023en Average (ppb)	LADCO 2023en Maximum (ppb)	EPA Contribution from Minnesota (ppb)*	Percent of 2015 ozone NAAQS*	LADCO Contribution from Minnesota (ppb)	Percent of 2015 ozone NAAQS
550790085**	Milwaukee, WI	65.4	67.0	62.1	65.1	---	---	0.41	0.59
480391004	Brazoria, TX	74.0	74.9	73.6	74.4	---	---	0.33	0.47
261630019	Wayne, MI	69.0	71.0	67.7	69.7	---	---	0.30	0.43
482011034	Harris, TX	70.8	71.6	70.2	71.0	---	---	0.30	0.43
551170006	Sheboygan, WI	70.8	73.1	69.3	71.5	---	---	0.27	0.39
482011039	Harris, TX	71.8	73.6	71.0	72.7	---	---	0.26	0.37
90099002	New Haven, CT	71.2	73.9	67.9	70.5	---	---	0.17	0.24
90010017	Fairfield, CT	69.8	72.1	67.2	69.4	---	---	0.17	0.24
361030002	Suffolk, NY	72.5	74.0	69.8	71.3	---	---	0.16	0.23
360810124	Queens, NY	70.1	71.9	67.5	69.2	---	---	0.16	0.23
484392003	Tarrant, TX	72.5	74.8	72.1	74.3	---	---	0.15	0.21
90013007	Fairfield, CT	71.2	75.2	67.8	71.6	---	---	0.15	0.21
484393009	Tarrant, TX	70.6	70.6	70.3	70.3	---	---	0.14	0.20
360850067	Richmond, NY	71.9	73.4	69.1	70.6	---	---	0.13	0.19
240251001	Harford, MD	71.4	73.8	69.4	71.8	---	---	0.12	0.17
90019003	Fairfield, CT	72.7	75.6	69.6	72.4	---	---	0.11	0.16
260050003	Allegan, MI	69.0	71.8	67.1	69.8	---	---	0.11	0.16
481210034	Denton, TX	69.7	72.0	69.4	71.7	---	---	0.11	0.16
480290052	Bexar, TX	---	---	68.3	70.3	---	---	0.06	0.09
482010024	Harris, TX	70.4	72.8	69.7	72.1	---	---	0.06	0.09

*Although EPA modeled projected ozone values and identified potential nonattainment and maintenance receptors for both the "water" and "no water" alternatives, EPA did not provide state-by-state contributions to the 2023 8-hour ozone DVs for the "water" scenario in Appendix C or the excel files accompanying the Memo.
**Although the Milwaukee, WI site was not identified as a potential nonattainment or maintenance receptor by either EPA or LADCO under the "water" alternative, we've included it here to demonstrate that it is still the receptor for which Minnesota's contribution is highest.

LADCO's analyses have, in addition to EPA's, concluded that Minnesota is not culpable for ozone nonattainment, or interference with maintenance, in any downwind states.

3. Identify emissions reductions necessary (if any)

Neither the EPA or the LADCO analyses identified any potential nonattainment or maintenance receptors significantly impacted by ozone transport from Minnesota in 2023. For previous good neighbor SIP submittals, the EPA has relied on a one percent threshold to determine significant downwind contributions of regional pollutants. As stated previously and shown in Tables 1 and 2, the highest contribution from Minnesota modeled by EPA and LADCO was at Site 550790085 in Milwaukee, WI; all models showed our contributions to be significantly below the one percent (0.70 ppb) threshold for the 2015 ozone NAAQS. Therefore, Minnesota does not have a responsibility to identify or implement any further controls or emissions limits to reduce downwind ozone contribution.

The following information provides strengthening evidence to the above modeling analysis.

Ambient ozone concentrations in Minnesota

Minnesota has never been in nonattainment for any promulgated ozone NAAQS, and ambient ozone concentrations in Minnesota have consistently been near or below the NAAQS. Figure 1 shows ozone concentrations as a percent of the NAAQS for each given year. Figure 1 shows data starting in 1997, which was the year that the form of the standard changed to represent the "annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years". This continues to be the current form, although the level of the standard has been lowered twice since that first change.

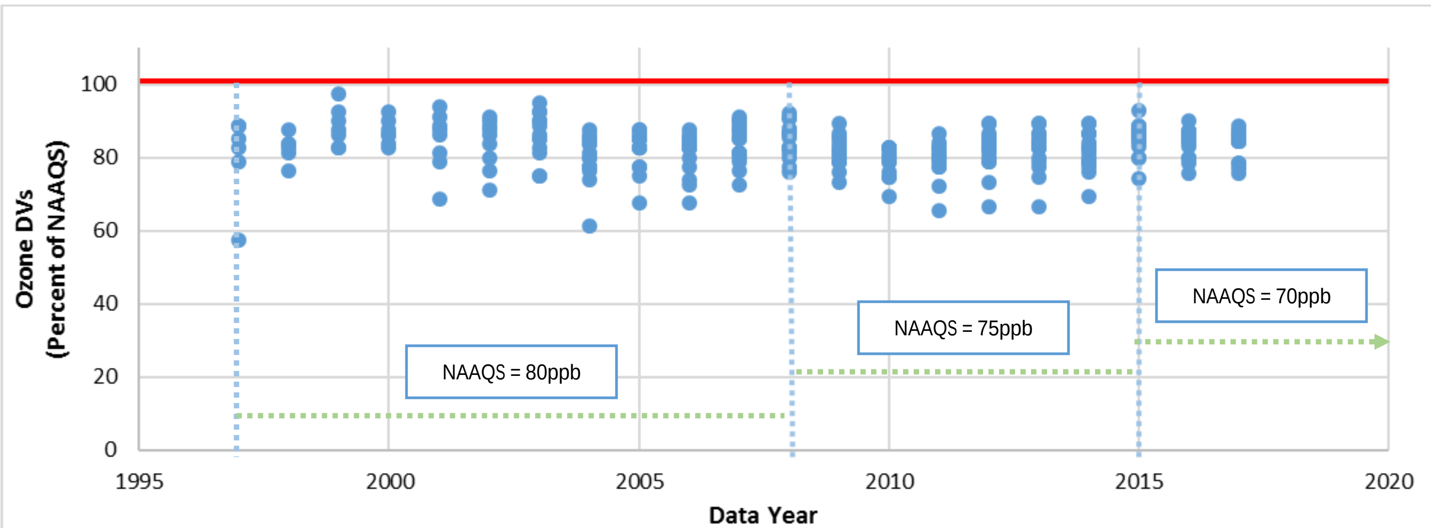


Figure 1. 8-hour (annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years) ozone DVs from Minnesota ambient ozone monitors, shown as percentage of NAAQS, from 1997-2017. Although monitors throughout the state show a range of ambient concentration values, Minnesota has never had an exceedance of any promulgated ozone NAAQS.

As discussed above in Section 110(a)(2)(B), there are currently 17 ozone monitors located throughout the state. Monitoring data from 2015-2017, as shown in Figure 2, indicate that the highest ozone concentration is at Site 27-003-1002, the Anoka Airport in Blaine. At 62ppb, the 2015-2017 DV was at approximately 89 percent of the 70ppb NAAQS.

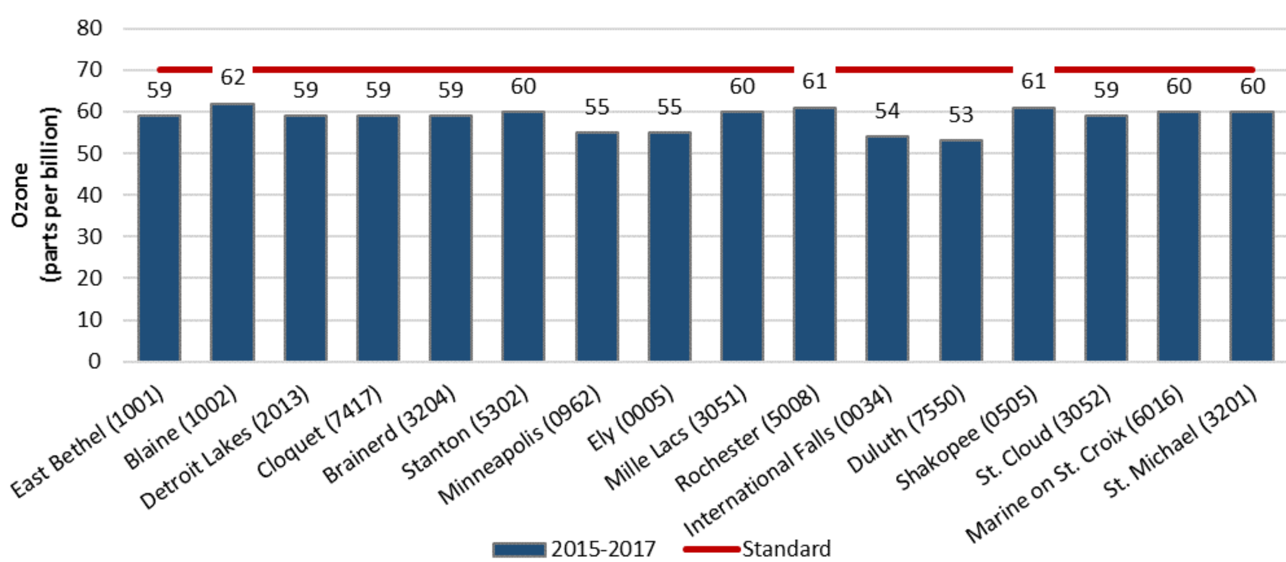


Figure 2. 8-hour average ozone concentrations compared to the 2015 ozone NAAQS, 2015-2017

Minnesota's ambient ozone concentrations are steadily decreasing; it would be reasonable to assume that Minnesota is, therefore, contributing less to ozone concentrations in other states.

Nitrogen oxides (NO_x) and volatile organic compound (VOC) emissions in Minnesota

When conducting modeling with the CAMx APCA platform, EPA identified anthropogenic (human-made) NO_x and VOCs as the primary precursors to ground-level ozone formation. Thus, we will focus our discussion of emissions reductions in Minnesota on NO_x and VOC emissions data.

NO_x emissions have been steadily declining in Minnesota over the past several years. Figure 3 demonstrates the steady decline of emissions from point (permitted), non-point (neighborhood), on-road mobile, and non-road equipment. The largest reductions in emissions have come as a result of emissions limits and reductions at point sources, particularly electric generating utilities (EGUs). Point source emissions reporting is required annually.

Every three years MPCA collects expanded emissions inventories from non-point, on-road, and mobile sources, and works with EPA to identify emissions categories and to verify state-collected data, if necessary. NO_x emissions from these traditionally non-permitted sources have also been declining, though less rapidly than for point sources.

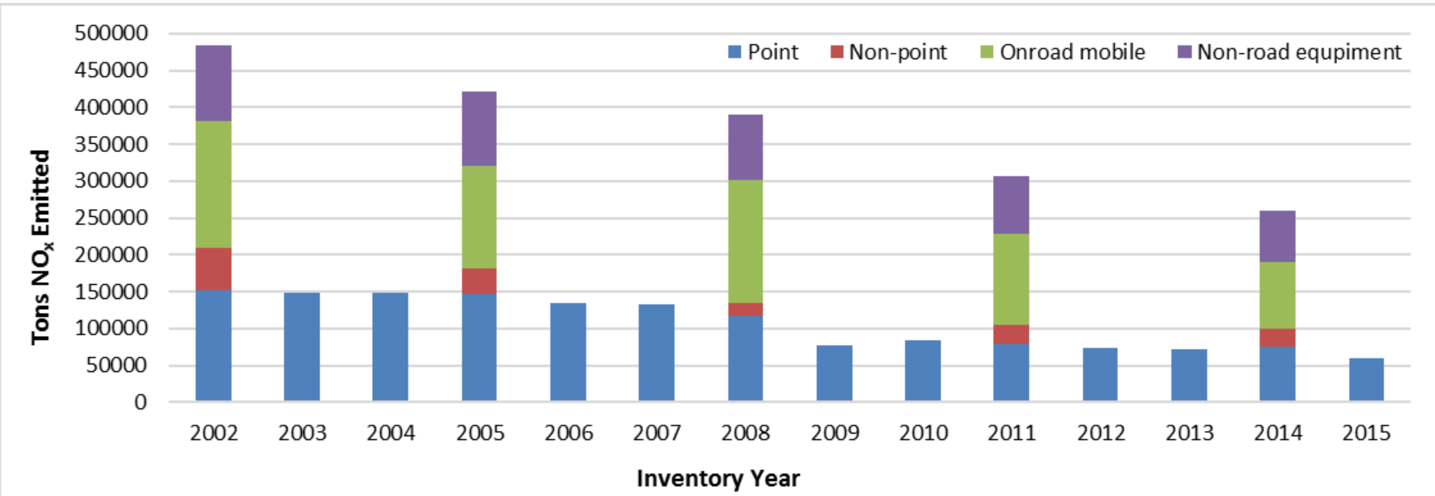


Figure 3. Reported (actual) NO_x emissions for the state of Minnesota, 2002-2015. Inventory data for 2014 are preliminary.

As with NO_x emissions, VOC emissions have been steadily declining in Minnesota over the past several years. Figure 4 shows emissions from point (permitted), non-point (neighborhood), on-road mobile, and non-road equipment.

Again, as with NO_x, MPCA collects expanded emissions inventories from non-point, on-road, and mobile sources every three years. Although some VOC emission reductions have resulted as a co-benefit of emissions limits on point sources, the majority of VOC emission reductions in recent years has come from lower on-road mobile source emissions, primarily through Minnesotans' use of cleaner, more fuel efficient vehicles.

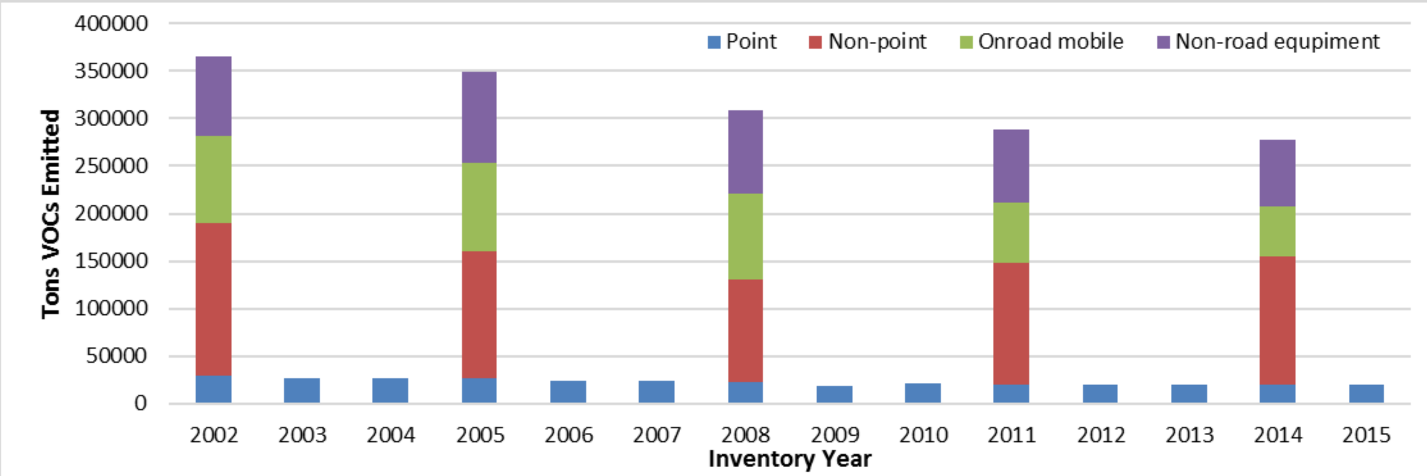


Figure 4. Reported (actual) VOC emissions for the state of Minnesota, 2002-2015. Inventory data for 2014 are preliminary.

4. Adopt permanent and enforceable measures needed to achieve reductions identified in item 3.

Since NO_x and VOC emissions in Minnesota continue to decrease, ozone formation is also declining; ozone is not directly emitted by any sources. This, in combination with the fact that Minnesota is not expected to contribute to any nonattainment or maintenance issues downwind by the year 2023, makes it such that no additional permanent or enforceable measures, beyond those already implemented in the state, are needed at this time.

Current measures that limit emissions of these pollutants and therefore help maintain Minnesota's insignificant contribution to downwind air quality concerns are discussed below.

Multi-pollutant limits

Minnesota has several methods of limiting emissions from facilities in the state. The primary way in which emissions of NO_x and VOCs are limited in Minnesota is through emissions limits described in Part 70 permits.

Minnesota is subject to CSAPR's annual NO_x programs, which were developed to address the 1997 and 2006 $PM_{2.5}$ NAAQS. The CSAPR regulations have resulted in a reduction of NO_x emissions from power plants subject to the rule (see Figure 3, above). In addition, many of Minnesota's coal-fired boilers have been converting to natural and/or fuel gas over the past several years, in response to state regulations to reduce mercury emissions (Mercury Emissions Reduction Act of 2006), as well as more recent Mercury and Air Toxics Standards (MATS). Although intended to reduce mercury emissions, these regulations have also resulted in reductions in co-pollutants, like NO_x and SO_2.

Pollutant-specific limits

Minnesota has, in addition to multi-pollutant limits, pollutant-specific methods of limiting emissions. Most of our pollutant-specific limits are for SO_2 and particulate matter, as those are the two pollutants for which we have had nonattainment (and subsequently, maintenance) areas.

NO_x

State rules that limit NO_x and NO_2 emissions include:

- Minn. R. Ch. 7011.0500 to 7011.0553, for Indirect Heating Fossil Fuel Burning Equipment

- Minn. R. Ch. 7011.1700 to 7011.1705, for Nitric Acid Plants

Minnesota has issued an Administrative Order (AO) to Xcel Energy – Northern States Power Company, Sherburne County Generating Station, as part of Minnesota's Regional Haze SIP. The AO includes NO_x emissions limits.

VOCs

The majority of VOC emissions in Minnesota come from nonpoint (neighborhood) and small point sources. Minnesota's state rules incorporate, by reference, the National Emission Standards for Hazardous Air Pollutants (NESHAPs), which limit VOC emissions. The primary method by which we limit VOC emissions is through the issuance of Part 70 permits and Title I emissions limits in permits, which can help small sources avoid classification as major sources when unnecessary.

The MPCA has statewide partnerships with non-profit organizations, the University of Minnesota, state contractors, and local governments to promote the voluntary reduction of VOCs through education programs and the administration of grants to small businesses, particularly auto body and coating shops.

Summary: Prongs 1 and 2

It can be reasonably concluded from the above analyses that Minnesota does not, and will not by 2023, significantly contribute to nonattainment or interfere with maintenance of the 2015 ozone NAAQS at any of EPA's identified receptors. Minnesota has not historically contributed significantly to any of the monitors projected to have nonattainment or maintenance issues in 2023. Our emissions of ozone precursors, NO_x and VOCs, are on a downward trend, and our emissions sources currently have limits and controls that will continue to reduce ozone concentrations via a reduction in precursors.

EPA's own modeling showed a downwind contribution of less than one percent at all examined receptors, which has historically been accepted as a demonstration that ozone transport will not affect any nonattainment or maintenance receptors, as identified, for the year 2023.

It follows that the limits and controls that Minnesota already has in place across the state are sufficient to make it reasonably certain that Minnesota will not significantly contribute to nonattainment or interfere with maintenance in any other state. We assert that no further controls or emissions limits are required to fulfill our responsibilities under the interstate transport provisions for the 2015 ozone NAAQS under prongs 1 and 2 of Section 110(a)(2)(D)(i)(I).

Section 110(a)(2)(D)(i)(II): Prongs 3 (interference with PSD) and 4 (interference with visibility protection)

This section requires iSIPs to include provisions prohibiting any source or other type of emissions activity in one state from interfering with measures required to prevent significant deterioration of air quality or the protection of visibility in another state.

As mentioned above, Minnesota has recently had its PSD program (at Minn. R. Ch. 7007.3000) approved into the SIP at 40 CFR § 52.1220, and so continues to operate a federally-approved nonattainment NSR (NNSR) permitting program. Thus, all new major sources and major modifications are subject to a comprehensive, EPA-approved permitting program that applies to all NSR pollutants. These programs require the consideration of emission impacts on the air quality of other states. Minn. R. Ch. 7007.0900 provides for the review of Part 70 permits by affected states.

Minnesota does not have any nonattainment areas for the 2015 ozone NAAQS; however, NNSR rules have been promulgated, and are contained in Minn. R. Ch. 7007.4000-7007.4030. These rules ensure that, if there ever is an instance where an area in the state becomes nonattainment, the sources located in those areas would not interfere with neighboring states' PSD programs.

EPA approved significant portions of Minnesota's Regional Haze (RH) SIP on June 12, 2012 (77 FR 34801); however, due to the disapproval of various components, Minnesota is currently subject to a Federal Implementation Plan (FIP) for unapproved sources. Sources that are within Minnesota's jurisdiction – that that were approved in the RH SIP – are not interfering with neighboring states' abilities to protect visibility. Visibility in the two Class I areas within the state of Minnesota continues to improve, as well. Interim visibility goal targets, which show 2018 as a target year, are being met in both locations.

Based on our discussed PSD and RH program components, we assert that Minnesota meets the requirements of prongs 3 and 4 of Secion 110(a)(2)(D)(i)(II).

Section 110(a)(2)(D)(ii): Interstate pollution abatement and international air pollution

Minnesota administers a federally-approved PSD program through Minn. R. Ch. 7007.3000, which incorporates, by reference, 40 CFR § 52.21. Subsequently, new or modified sources are required to notify neighboring states of potential negative air quality impacts. Our previous iSIP submittal for this section was disapproved due to the underlying issues with the PSD program. Now that Minnesota's PSD program has been approved, we assert that Minn. R. Ch. 7007.3000 fulfills the requirements of Section 110(a)(2)(D)(ii), as well as interstate pollution abatement requirements under Section 126(a). Minnesota has no other obligations under Section 126, nor under the international pollution abatement components of Section 115.

We assert that the above regulatory authority fulfills the requirements of Section 110(a)(2)(D)(i)(II).

Section 110(a)(2)(E): Adequate resources and authority, conflict of interest, and oversight of local governments and regional agencies

Per Minn. St. § 116.07, the MPCA is granted the authority and responsibility for developing, implementing, and enforcing rules that allow Minnesota to comply with the Clean Air Act (CAA), including maintenance of the SIP. MPCA's Performance Partnership Agreement (PPG) with EPA provides MPCA the assurances to the availability of resources needed to carry out certain air programs.

MPCA's authority to enforce the NAAQS has been demonstrated previously in this document.

Minnesota's satisfaction of section 110(a)(2)(E)(ii), as it relates to state board requirements of Section 128, is discussed near the end of this document. The rules submitted in this iSIP in order to meet the requirements of Section 128 also satisfy any applicable requirements related to section 110(a)(2)(E)(ii) for the 2015 ozone NAAQS. To the extent that the state board requirements are non-NAAQS specific, we request that EPA also approve these rules as satisfying the applicable Section 110(a)(2)(E)(ii) requirements for any NAAQS for which final action has not been taken.

We assert that the above statutory authority, in tandem with that presented below for Section 128, fulfills the requirements of Section 110(a)(2)(E).

Section 110(a)(2)(F): Stationary source monitoring and reporting

Minn. Stat. § 116.07, subd. 9(b) gives the MPCA authority "to require the owner or operator of any emission facility, air contaminant treatment facility, potential air contaminant storage facility, or any system or facility related to the storage, collection transportation, processing, or disposal of waste… to install, use, and maintain monitoring equipment or methods…".

Minn. R. Ch. 7007.0800, subp. 4 describes the minimum monitoring requirements included in each permit for major stationary sources. Minn. R. Ch. 7011, which includes standards for stationary sources, also lists monitoring requirements for each applicable source category.

Minn. R. Ch. 7017 contains Minnesota's air monitoring and testing requirements, including for continuous monitoring.

Minn. R. Ch. 7019 contains emissions reporting requirements for applicable facilities, which must submit annual emissions inventories to MPCA. The inventory reports must contain information on all criteria pollutants for which a NAAQS has been promulgated. The MPCA also collects emissions inventory for air toxics, including VOCs, on a triennial basis.

The majority of applicable rules in Chs. 7007, 7011, 7017, and 7019 have been previously approved by EPA and subsequently incorporated into Minnesota's SIP at 40 CFR § 52.1220.

We assert that the above statutory and regulatory authorities fulfill the requirements of Section 110(a)(2)(F).

Section 110(a)(2)(G): Emergency episodes

Although historic ambient monitoring data does not indicate a need for specific contingency measures for ozone, Minn. Stat. § 116.11 was promulgated to allow the MPCA to halt or abate specific sources of pollution during an emergency.

Minn. Stat. § 116.11 reads:

> "If there is imminent and substantial danger to the health and welfare of the people of the state, or of any of them, as a result of the pollution of air, land, or water, the agency may by emergency order direct the immediate discontinuance or abatement of the pollution without notice and without a hearing or at the request of the agency, the attorney general may bring an action in the name of the state in the appropriate district court for a temporary restraining order to immediately abate or prevent the pollution. The agency order or temporary restraining order shall remain effective until notice, hearing, and determination pursuant to other provisions of law, or, in the interim, as otherwise ordered. A final order of the agency in these cases shall be appealable in accordance with chapter 14."

Minn. R. Ch. 7000.5000 elaborates on specific actions to be taken to notify and communicate about any emergency declared by the commissioner. Further instruction and requirements for owners and operators of any facility or stationary source during air pollution episodes are provided in Minn. R. Ch. 7009.1000 through 7009.1110.

We assert that the above statutory and regulatory authorities fulfill the requirements of Section 110(a)(2)(G).

Section 110(a)(2)(H): Future SIP revisions

The MPCA has submitted many updates to the SIP at 40 CFR § 52.1220 in the last several years, in addition to iSIPs when required by the Clean Air Act. We intend to continue to submit updates, as needed, in order to ensure changes at existing facilities will not jeopardize the NAAQS, to comply with new or revised NAAQS, or as requested by EPA (e.g., during a "SIP call"). Language confirming the MPCA's ability to adopt or rescind rules and standards related to air pollution can be found in Minn. Stat. § 116.07, subd. 4.

MPCA's authority to issue permits to regulate air pollution can be found in Minn. Stat. § 116.07, subd. 4a.

We assert that the above statutory authority fulfills the requirements of Section 110(a)(2)(H).

Section 110(a)(2)(I): Plan revisions for nonattainment areas

Per EPA's interpretation of the CAA and direction provided in the 2013 iSIP guidance document[3], states are not required to address this Section, as SIP submissions for specific nonattainment areas, as required under the CAA Title I, part D, are subject to a different submission schedule. The MPCA, is not, therefore, addressing Section 110(a)(2)(I) as a part of this iSIP.

Section 110(a)(2)(J): Consultation with government officials, public notification, and PSD and visibility protection

Consultation with government officials

Historically, MPCA actively participated in the Central Regional Air Planning Association, as well as the Central States Air Resource Agencies. MPCA is now a full-time member of the Lake Michigan Air Director's Consortium (LADCO), and has demonstrated that it frequently consults and discusses air quality issues with pertinent Tribes. In addition to LADCO, MPCA is an active participant in the National Association of Clean Air Agencies (NACAA), which has a member total of 185 air agencies, including representatives from all EPA regional offices and headquarters, across the United States.

Public notification

Minnesota dedicates portions of the MPCA website to enhancing public awareness of measures that can be taken to prevent exceedance of all NAAQS generally. Information for non-point (neighborhood), vehicle, and traditionally permitted sources can be found on MPCA's website, at https://www.pca.state.mn.us/air/sources-air-pollution. Information regarding the health impacts of air pollution, especially particulate matter and ozone, can be found at https://www.pca.state.mn.us/air/air-quality-and-health; current air quality and air quality forecasting for the entire state of Minnesota, new in 2017, is also available, at https://www.pca.state.mn.us/air/current-air-quality. MPCA staff developed a free mobile app that provides the same forecasting information as the website, but in a more mobile-friendly format; the app, Minnesota Air, is available for both iOS (Apple) and Android platforms, and can be download through the iOS App Store or Android's Google Play.

Minnesota's procedural rules, applicable across all MPCA media programs, are established in Minn. R. Ch. 7000; these rules include general guidelines, as well as information about contested case hearings (7000.1750 through 7000.2200), emergency and variance procedures (7000.5000 and 7000.7000), and ethical conduct and standards (7000.9000 and 7000.9100).

[3] Memorandum dated September 13, 2013, "Guidance on Infrastructure State Implementation Plan (SIP) Elements under Clean Air Act Sections 110(a)(1) and 110(a)(2)".

Minn. R. Ch. 7007.0850 lists public notice and comment procedures for the issuance of air quality permits. The public may petition for meetings and hearings, including for a contested case hearing, as it relates to any air permit (with reference back to Minn. R. Ch. 7000.1800). In addition to public notice of each air permit being issued by the MPCA, each SIP revision is put on notice, and the public is provided the opportunity to comment and/or request public hearings regarding proposed SIP revisions. This includes iSIPs, any SIP updates at 40 CFR § 52.1220, and site-specific SIP conditions incorporated into air permits at individual facilities (under title I and title 5).

Minn. R. Ch. 7007.0900 also provides for the review of part 70 permits by affected states. Specifically, "[t]he agency shall give notice of each draft part 70 permit, or major amendment to a part 70 permit, to any affected state on or before the time that the agency provides this notice to the public as required by part 7007.0850."

PSD and visibility protection

As described previously in greater detail, Minnesota's PSD program was recently approved by EPA and has been incorporated into the SIP at 40 CFR § 52.1220.

MPCA works with Federal Land Managers on a regular basis to discuss issues impacting Minnesota's Class I areas, including the U.S. Forest Service and the National Park Service.

MPCA is not, however, addressing visibility protection any further in this portion of the iSIP, per EPA's 2013 SIP guidance. The guidance states, on p. 55, that "[t]he EPA believes that there are no new visibility protection requirements under part C [of CAA title I, which is implemented through 40 CFR part 51 subp. P] as a result of a revised NAAQS. Therefore, there are no newly applicable visibility protection obligations pursuant to Element J after the promulgation of a new or revised NAAQS. Air agencies do not need to address the visibility subelement of Element J in an infrastructure SIP submission."

Summary

We assert that the above regulatory authority fulfills the requirements of Section 110(a)(2)(J).

Section 110(a)(2)(K): Air quality modeling and submission of modeling data

MPCA reviews the potential impact of major and some minor new sources.

Under Minn. R. Ch. 7007.0500, MPCA may require applicable major sources to perform modeling in order to demonstrate that emissions do not cause or contribute to a violation of any NAAQS. Minn. R. Ch. 7007.0500, subp. 1E, states that MPCA may notify an applicant that they are required to demonstrate that their emissions do not cause a violation of ambient air quality standards. Such information is mandatory for applicants subject to PSD requirements (Minn. R. Ch. 7007.3000) and/or NNSR requirements (Minn. R. Ch. 7007.4000 through 7007.4030).

The MPCA routinely requests and requires emissions information from air permit applicants. MPCA also maintains expert staff that conduct permit-related (and other) modeling, to support facilities and ensure modeling accuracy, as needed. More information on the MCPA's air modeling program can be found at https://www.pca.state.mn.us/air/air-quality-modeling.

Section 110(a)(2)(L): Permitting fees

The MPCA implements and operates Minnesota's Title V permit program, which EPA approved in full on December 4, 2001 (66 FR 62967). Included in our permit program are Minn. R. Ch. 7002.0005 through 7002.0085, Air Emission Permit Fees, which contain the provisions, requirements, and procedural structures associated with the costs for reviewing, approving, implementing, and enforcing various types of air permits.

We assert that the above regulatory authority, in addition to the approved Title V permit program, fulfills the requirements of Section 110(a)(2)(L).

Section 110(a)(2)(M): Consultation and participation by affected local entities

The MPCA develops, implements, and enforces Minnesota's air quality program and, in doing so, regularly consults with local political subdivisions affected by the SIP.

Under Minn. Stat. § 116.05, other departments and agencies are directed to cooperate with the MPCA, and the MPCA is granted the authority to work with those agencies.

Specifically, Minn. Stat. § 116.05, subd. 1, states that MPCA is "…authorized to cooperate and to enter into necessary agreements with other departments and agencies of the state, with municipalities, with other states, with the federal government and its agencies and instrumentalities in the public interest and in order to control pollution…"

The Minnesota Administrative Procedures Act (Minn. Stat. Ch. 14) provides general notice and comment procedures that govern rulemaking for all state agencies, which the MPCA follows during SIP development. For example, all SIP revisions are put on public notice in the state register; in doing so, the public is provided the opportunity to request a public meeting or comment on the SIP document. If a public meeting is requested, the MPCA will hold one.

We assert that the above statutory and regulatory authorities fulfill the requirements of Section 110(a)(2)(M).

Section 128: State board requirements [as related to Section 110(a)(2)(E)(ii)]

Section 128(a) of the CAA has two requirements:

> (1) that any board or body which approves permits or enforcement orders under this chapter shall have a majority of members who represent the public interest and do not derive any significant portion of their income from persons subject to permits and enforcement orders under this chapter, and
> (2) that any potential conflicts of interest by members of such board or body or the head of an executive agency with similar powers be adequately disclosed. Section 110(a)(2)(E)(ii) requires that states demonstrate compliance with section 128 as part of their Infrastructure SIP (see above).

Per statutory changes from the 2015 legislative session, the state of Minnesota no longer has any board or body which approves permits or enforcement orders in relation to the CAA. We do, however, have rules and statutes which address any potential conflicts of interest by the head of executive agencies that are applicable under the CAA.

The MPCA submitted the following statutes and rules to EPA on May 26, 2016, in addition to the Section 110(a)(2)(D) provisions for the 2008 ozone NAAQS. Per 82 FR 50807, published November 2, 2017, Minnesota's state board requirements – including the elements below – were approved for our previous multi-pollutant iSIP (effective December 4, 2017).

Section 128(a)(1)

Minnesota has no board or body which approves permits or enforcement orders in relation to the CAA. Instead, Minn. Stat. § 116.02, subd. 5, and Minn. Stat. § 116.03, subd. 1 provide the MPCA's Commissioner with the authority, powers, and duties to make decisions on behalf of the agency.

Section 128(a)(2)

Minnesota's statutes and rules require disclosure of any potential conflict of interest by public officials. Under Minn. Stat. Ch. 10A, matters of disclosure and public interest are governed by the Minnesota Campaign Finance and Public Disclosure Board (Board). Additional information about how the board makes decisions regarding disclosure is available at https://cfb.mn.gov/citizen-resources/board-programs/overview/government-officials-disclosure/. The Board's Public and Local Officials Handbook is available at https://cfb.mn.gov/pdf/publications/handbooks/Public_officials_handbook.pdf?t=1527106838 (updated 05/16/2018).

Minn. Stat. §10A.07 requires that, if the Commissioner has a financial interest relating to a matter before the agency, they must make this interest known, in writing. The decision-making responsibility regarding the matter must be either assigned by the Governor to another employee, or the Commissioner must abstain from influence over the matter in a manner prescribed by the Board.

Minn. Stat. § 10A.09 requires that statements of economic interest be filed with the Board upon the nomination of the Commissioner, and a supplementary statement must be submitted annually thereafter.

Minn. R. Ch. 7000.0300 further clarifies the need for candor and disclosure by the Commissioner, stating that:

> "In all formal or informal negotiations, communications, proceedings, and other dealings between any person and any member, employee, or agent of the board or commissioner, it shall be the duty of each person and each member, employee, or agent of the board or commissioner to act in good faith and with complete truthfulness, accuracy, disclosure, and candor."

Minn. Stat. § 10A.07, Minn. Stat. § 10A.09, and Minn. R. Ch. 7000.0300 were incorporated into Minnesota's SIP at § 52.1220 per 82 FR 50807.

Summary

Minnesota has no board governing activities related to the CAA. Our statutes and rules address any foreseeable issues of conflict, disclosure, and the public interest as they relate to the MPCA's commissioner. We therefore assert that the above statutory and regulatory authorities fulfill the requirements of Section 128, as it relates to 110(a)(2)(E)(ii).

Conclusions

Based on the information provided in the 2013 iSIP guidance, the 2018 Memo (and associated data updates), and previous iSIP submissions, the MPCA feels confident that the rules and statutes in place in Minnesota are more than sufficient to support our state's ambient air quality program, and to demonstrate that Minnesota is able to meet and comply with the 2015 ozone NAAQS.

Thus, all Section 110(a) iSIP requirements for the 2015 ozone NAAQS, including the interstate transport requirements, are met for the state of Minnesota.

Attachments

Attachment 1: Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard: Technical Support Document (from LADCO)
Attachment 2: Documentation of ERTAC EGU CONUS Versions 2.7 Reference and CSAPR Update Compliant Scenario (from LADCO)
Attachment 3: Public notice
Attachment 4: Completeness review

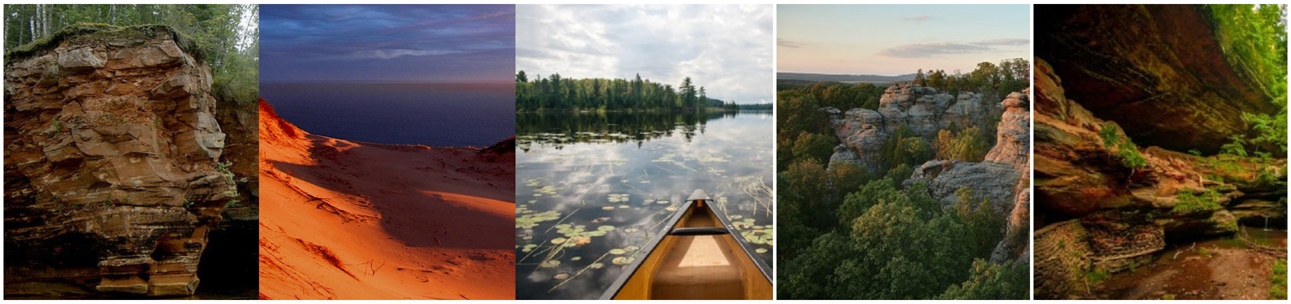
MINNESOTA POLLUTION CONTROL AGENCY

Attachment 1:

Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard

Technical Support Document

Lake Michigan Air Directors Consortium (LADCO) | 54 pages | June 2018



Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard

Technical Support Document

Lake Michigan Air Directors Consortium
9501 W. Devon Ave., Suite 701
Rosemont, IL 60018

June 1, 2018

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Executive Summary

1 Introduction

The Lake Michigan Air Directors Consortium (LADCO) was established by the states of Illinois, Indiana, Michigan, and Wisconsin in 1989. The four states and EPA signed a Memorandum of Agreement (MOA) that initiated the Lake Michigan Ozone Study and identified LADCO as the organization to oversee the study. Additional MOAs were signed by the states in 1991 (to establish the Lake Michigan Ozone Control Program), January 2000 (to broaden LADCO's responsibilities), and June 2004 (to update LADCO's mission and reaffirm the commitment to regional planning). In March 2004, Ohio joined LADCO. Minnesota joined the Consortium in 2012. LADCO consists of a Board of Directors (i.e., the State Air Directors), a technical staff, and various workgroups. The main purposes of LADCO are to provide technical assessments for and assistance to its member states, and to provide a forum for its member states to discuss regional air quality issues.

1.1 Project Overview

LADCO conducted regional air quality modeling to support the statutory obligations of the LADCO states under Clean Air Section 110(a)(2)(D)(i)(i), which requires states to submit "Good Neighbor" state implementation plans (SIPs). These SIP revisions are plans to prohibit emissions in one state from interfering with the attainment or maintenance of the National Ambient Air Quality Standards (NAAQS) in another state. LADCO used the Comprehensive Air Quality Model with Extensions (CAMx) to support these analyses. The CAMx Anthropogenic Precursor Culpability Assessment (APCA) tool was used to assess the impacts of interstate transport of air pollution on ground level ozone (O_3) concentrations in the Midwest and Northeast U.S.

In support of previous rulemakings (CSAPR, 2011; CSAPR Update, 2016), the U.S. EPA in partnership with states developed a four-step interstate transport framework to address the "Good Neighbor" provisions of the O_3 and $PM_{2.5}$ NAAQS. This framework established the following four steps to identify and mitigate high O_3 concentrations at locations that were at risk of violating the NAAQS in the future: (1) identify monitors with predicted air quality problems in the future year, (2) identify the upwind states that are "linked" through air mass transport to the problem monitors, (3) identify emissions reductions necessary to prevent upwind states from contributing significantly to NAAQS violations at a downwind monitor, and (4) adopt permanent and enforceable measures needed to achieve the identified emissions reductions. Recently, EPA (2018) issued a memo describing a series of potential flexibilities in this four step framework that states could consider in developing a transport SIP.

LADCO used CAMx to predict O_3 concentration in 2023 to address steps (1) and (2) of the four-step interstate transport framework. The LADCO CAMx modeling results are used here to identify O_3 monitoring sites that may have nonattainment or maintenance problems for the 2015 O_3 NAAQS in 2023. The modeling outputs are also used to quantify the contributions of emissions in upwind states to the monitors in downwind states that are projected to have NAAQS attainment problems in 2023. LADCO presents several "flexibilities" in the analytic approaches used to quantify transport and state linkages per a March 2018 U.S. EPA (2018) memo. These alternatives include a comparison between EPA and LADCO CAMx modeling for 2023, exploring the impacts of including or removing water cells in future design values, and exploring the influence of model bias on future design values. All of the alterative analyses presented here are in the context of establishing links between an upwind state and downwind nonattainment or maintenance problems at surface O_3 monitors in the Midwest and Northeast U.S.

This document describes how LADCO used CAMx source apportionment modeling to link upwind and downwind states and to identify upwind emissions sources that significantly contribute to downwind NAAQS attainment issues. The CAMx APCA modeling outputs of this work are being presented to the LADCO states to support the "Good Neighbor" SIP provisions of their 2015 O_3 NAAQS Infrastructure SIPs (iSIP) that are due to EPA in October 2018.

1.2 Organization of the Technical Support Document

This technical support document (TSD) is presented to the LADCO states for estimating year 2023 O_3 design values and source-receptor relationships using the CAMx APCA technique. The TSD is organized into the following sections. Section 0 describes the 2023 Air Quality Modeling Platform that LADCO used to forecast 2023 O_3. Section 0 describes the approach used for estimating Future Ozone Design Values. This section also includes a discussion on the methods used for identifying sites that are forecast to have O_3 NAAQS attainment problems. Section 0 describes the Ozone Source Apportionment modeling used to link source regions with problem monitors in the future year. Section 0 presents the modeling results that the LADCO states can use to support their 2015 O_3 NAAQS Good Neighbor SIPs. This section includes the following results:

- LADCO benchmarking of the EPA modeling platform on the LADCO computing system;
- Future year air quality forecasts from the LADCO CAMx modeling;
- Interstate transport linkages estimated with the LADCO forecasts;
- Alternative attainment test results of future year design values computed with different analysis flexibilities

2 2023 Air Quality Modeling Platform

LADCO based our 2023 O_3 air quality and interstate transport forecasts on the CAMx modeling platform released by the U.S. EPA in October 2017 in support of the Interstate Transport SIPs for the 2008 O_3 NAAQS (US EPA, 2017). The EPA 2023EN modeling platform was projected from a 2011 base year and included a complete set of CAMx inputs, including meteorology, initial and boundary conditions, and emissions data. The future year, or 2023, component of the air quality modeling platform refers to the emissions data only. All other CAMx inputs, including the meteorology data simulated with the Weather Research Forecast (WRF) model, represented year 2011 conditions. LADCO used the majority of the data and software provided by EPA for this platform, with a few exceptions described below.

2.1 Modeling Year Justification

LADCO selected 2011 as a modeling year for this study because CAMx input data for 2011 were widely available and relatively well-evaluated. 2011 had also been identified as a good year for studying O_3 in the Eastern U.S. The US EPA (2015) noted that year 2011 meteorology in the Eastern U.S., including the LADCO region, was warmer and drier than the climatic norm. As compared to other recent years, the summer of 2011 represented typical conditions conducive to high observed O_3 concentrations in the Midwest and Northeast U.S.

Figure 1 shows the 2009-2013 base year O_3 design values for the modeling period selected for this study. Each bubble on the plot represents an Air Quality System (AQS) O_3 surface monitor. Orange, red, and purple colors indicate monitors that were nonattainment (>=71.0 ppbV) for the 2015 O_3 NAAQS during this period. High O_3 concentrations were observed throughout the domain, with particularly high values along the Lake Michigan shoreline, St. Louis, southern Indiana, and the Northeast Corridor from Washington D.C. to Connecticut.

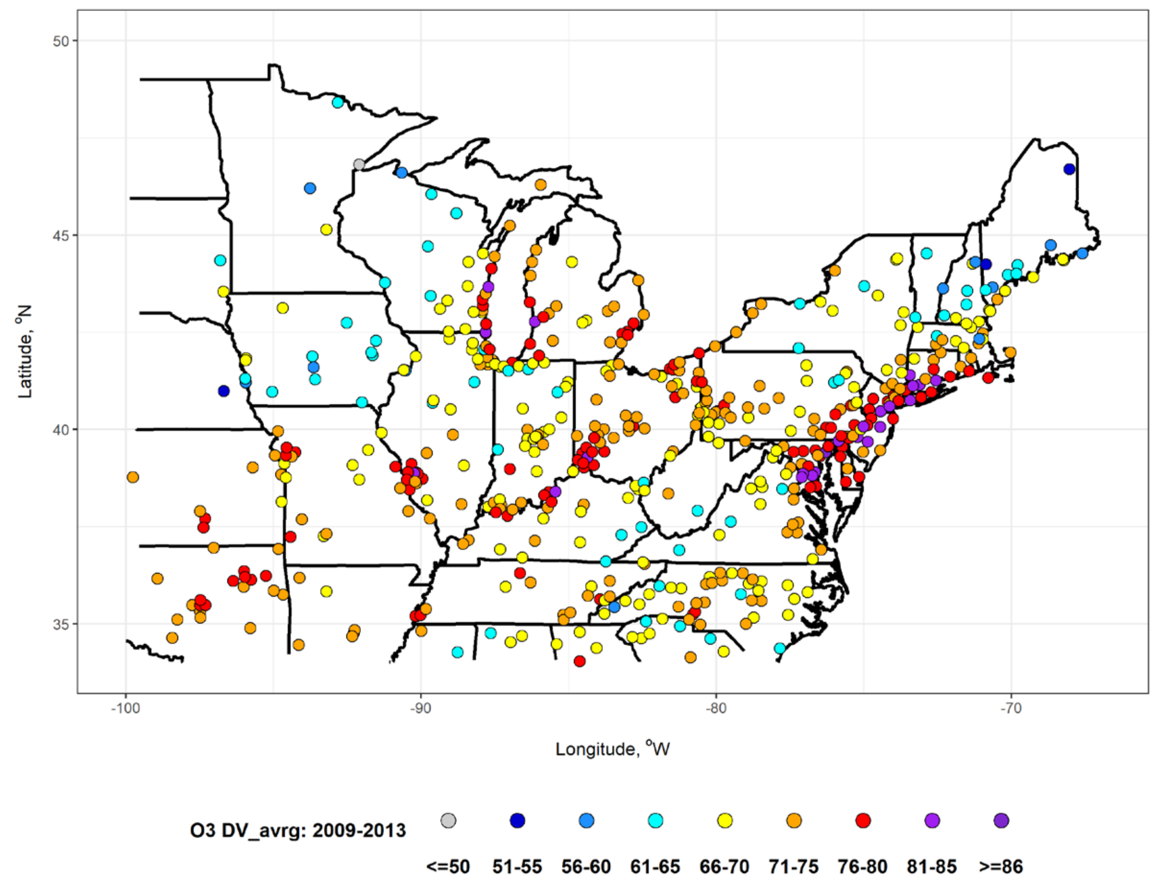

Figure 1. 2011 (2009-2013) O_3 design values for the eastern U.S.

The triennial National Emissions Inventory (NEI) also synchronized with 2011. Since its first release in 2014, the NEI2011 has undergone several revisions, with the most recent updates to version 6.3 released in October 2017 as part of the U.S. EPA's final 2008 O_3 NAAQS interstate transport assessment (US EPA, 2017). The 2011-based emissions modeling platforms are currently the best available national-scale datasets for simulating air quality in the U.S. The U.S. EPA used version 6.3 of the NEI2011-based emissions modeling platform for their preliminary assessment of O_3 transport for the 2015 O_3 NAAQS (US EPA, 2016). Given recent use of 2011-based data for evaluating interstate transport by the U.S. EPA and the lack of a more contemporary national emissions modeling platform, LADCO believes that using 2011-based data and emissions projections are justified for assessing interstate O_3 transport.

LADCO selected 2023 as the future project year based on the availability of data from EPA. EPA selected 2023 for 2015 O_3 NAAQS modeling because it "aligns with the anticipated attainment year for moderate O_3 nonattainment areas" (US EPA, 2018).

2.2 Air Quality Model Configuration

LADCO based the CAMx air quality modeling platform for this study on the configuration that the U.S. EPA used to support both their October 2017 memo on

Interstate Transport SIPs for the 2008 O_3 NAAQS (US EPA, 2015) and their December 2016 technical support document on a preliminary assessment of Interstate Transport for the 2015 O_3 NAAQS (US EPA, 2016). LADCO used CAMx v6.40 (Ramboll-Environ, 2016) as the photochemical grid model (PGM) for this study. CAMx is a three-dimensional, Eulerian air quality model that simulates the chemical transformation and physical transport processes of air pollutants in the troposphere. It includes capabilities to estimate the concentrations of primary and secondary gas and particle phase air pollutants, and dry and wet deposition, from urban to continental spatial scales. As CAMx associates source-level air pollution emissions estimates with air pollution concentrations, it can be used to design and assess emissions reduction strategies pursuant to NAAQS attainment goals.

LADCO selected CAMx for this study because it is a component of recent U.S. EPA modeling platforms for investigating the influence of interstate transport on O_3, and because it has source apportionment capabilities for quantifying air pollution source-receptor relationships. As CAMx is a component of U.S. EPA studies with a similar scope to this project, LADCO was able to leverage the data and software elements that are distributed with U.S. EPA regulatory modeling platforms. Using these elements saved LADCO significant resources relative to building a modeling platform from scratch. CAMx is also instrumented with source apportionment capabilities that allowed LADCO to investigate the sources of air pollution impacting O_3 monitors within and downwind of the LADCO region.

Figure 2 shows the U.S. EPA transport modeling domain for the continental U.S. A 12-km uniform grid (CONUS12) covers all of the continental U.S. and includes parts of Southern Canada and Northern Mexico. The domain has 25 vertical layers with a model top at about 17,550 meters (50 mb). LADCO used the same U.S. EPA 12-km domain for this project because it supported the use of meteorology, initial and boundary conditions, and emissions data that were freely available from U.S. EPA.

As the focus of this study is on O_3, LADCO used CAMx to simulate the O_3 season. LADCO simulated May through September 2011 as individual months using 10-day model spin-up periods for each month.

Complete details of the EPA 2011 CAMx simulation, including a performance evaluation of the model are available from the U.S. EPA (2016).

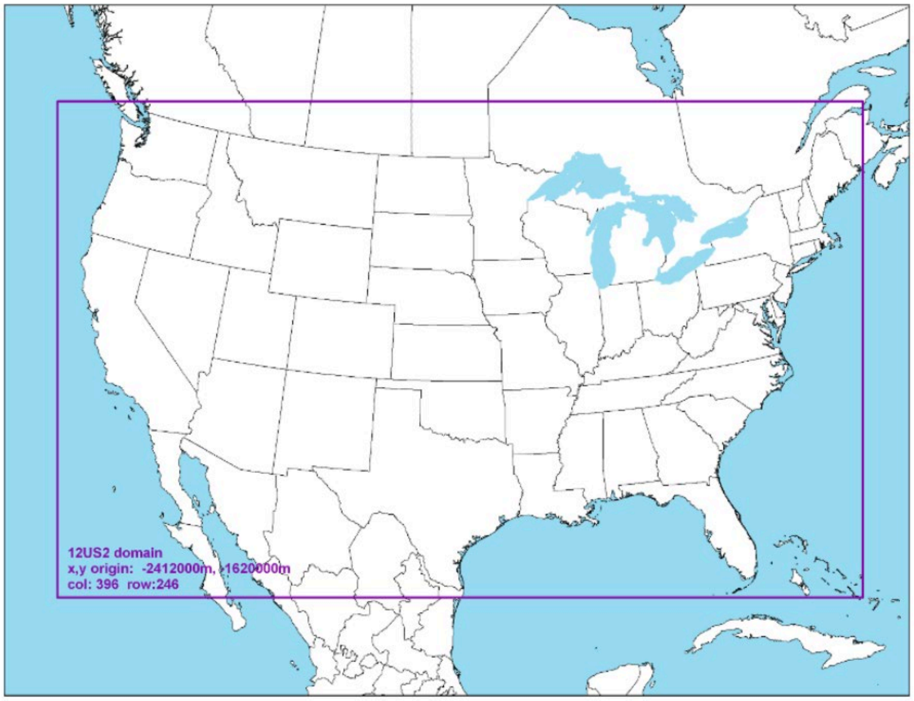

Figure 2. CAMx 12-km modeling domain (CONUS12)

2.3 Meteorology Data

LADCO used the U.S. EPA 2011 WRF data for this study (US EPA, 2017). The U.S. EPA used version 3.4 of the WRF model, initialized with the 12-km North American Model (NAM) from the National Climatic Data Center (NCDC) to simulate 2011 meteorology. Complete details of the WRF simulation, including the input data, physics options, and four-dimensional data assimilation (FDDA) configuration are detailed the EPA 2008 Transport Modeling technical support document (US EPA, 2015). U.S. EPA prepared the WRF data for input to CAMx with version 4.3 of the WRFCAMx software.

2.4 Initial and Boundary Conditions

LADCO used 2011 initial and boundary conditions for CAMx generated by the U.S. EPA from the GEOS-Chem Global Chemical Transport Model (US EPA, 2017). EPA generated hourly, one-way nested boundary conditions (i.e., global-scale to regional-scale) from a 2011 2.0 degree x 2.5 degree GEOS-Chem simulation. Following the convention of the U.S. EPA O_3 transport modeling, year 2011 GEOS-Chem boundary conditions were used by LADCO for modeling 2023 air quality with CAMx.

2.5 Emissions Data

The 2023 emissions data for this study were based on the U.S. EPA 2011v6.3 ("EN") emissions modeling platform (US EPA, 2017b). US EPA generated this platform for their final assessment of Interstate Transport for the 2008 O_3 NAAQS. Updates from earlier 2011-based emissions modeling platforms included a new engineering approach for forecasting emissions from Electricity Generating Units (EGUs). The U.S. EPA made several changes to the base 2011 and forecasted 2023 emissions in the "EN" platform relative to the earlier "EL" platform (US EPA, 2017b).

LADCO replaced the EGU emissions in the EN platform with 2023 EGU forecasts estimated with the ERTAC EGU Tool version 2.7[1]. The ERTAC EGU Tool provided more accurate estimates of the growth and control forecasts for EGUs in the Midwest and Northeast states than the EPA approach used for the "EN" platform. LADCO used the EPA EN Platform emissions estimates for all other inventory sectors.

2.5.1 Electricity Generating Unit Emissions

The ERTAC EGU model for growth was developed around an activity pattern matching algorithm deliberately built to provide hourly EGU emissions data for air quality planning. The original goal of the model was to create low cost software that air quality planning agencies could use for developing EGU emissions projections. States needed a transparent model that was numerically stable and did not change dramatically with small changes in inputs. A key feature of the model includes data transparency, where all inputs are publicly available. The code is also operationally transparent, which includes extensive documentation, open source code, and a diverse user community to support new users of the software.

Operation of the model is straightforward given the complexity of the projection calculations and inputs. The model imports base year Continuous Emissions Monitoring data from US EPA and sorts the data from peak to the lowest generation hour. It applies hour specific growth rates that include peak and off peak rates. The model then balances the system for all units and hours that exceed physical or regulatory limits. Finally, future year controls are applied to the emissions estimates and tests for reserve capacity, final reporting, and conversion to a SMOKE ready modeling files is done.

ERTAC EGU has distinct advantages over other growth methodologies because it is capable of generating hourly future year estimates which are key to understanding O_3 episodes. Additionally it does not shutdown or mothball existing units because economics algorithms suggest they are not economically viable. Additionally, alternate control scenarios are easy to simulate with the model. Full documentation for the ERTAC Emissions model and 2.7 simulations are available through the MARAMA website[1].

2.5.2 LADCO 2023 Emissions Summary

The tables and figures in this section summarize the emissions used in the LADCO and EPA 2023 CAMx simulations. Table 1 shows the annual NOx and SO_2 EGU emissions for the base year (2011), ERTAC EGU 2023, and the EPA EN 2023 inventories. LADCO state and regional total emissions are presented in this table. Figure 3 and Figure 4 summarize the NOx and SO_2 emissions graphically for the LADCO states. The ERTAC EGU 2023 and EPA EN 2023 EGU emissions estimates differ across the LADCO states. ERTAC estimates 3,314 tons/year more NOx and 8,152 tons/year more SO_2 for IL EGUs than the EPA EN projections. ERTAC estimates 12,567 tons/year more NOx and 24,356

[1] http://www.marama.org/2013-ertac-egu-forecasting-tool-documentation

tons/year more SO_2 in OH than the EPA EN projections. The MI EGU projections are lower from ERTAC by 5,731 tons/year NOx and 23,434 tons/year SO_2 than the EPA EN projections. The differences for IN EGUs are mixed with ERTAC projecting 2,083 tons/year less NOx and 34,393 tons/year more SO_2 than the EPA EN projections.

Regionally, ERTAC projects lower NOx but higher SO_2 emissions in the Northeast and Southeast relative to the EPA EN projections. ERTAC EGU projects higher NOx and SO_2 emissions across the CENSARA and WESTAR states relative to the EPA 2023 projections.

While these annual summaries mask the fine scale temporal differences between the EGU projection methodologies, in general the differences in O_3 projections between the LADCO and EPA simulations (Section 5.4.1,) are consistent with the differences in annual total NOx emissions between the EGU projections used in each simulation. The LADCO 2023 simulation generally forecasted lower O_3 in the Northeast and Southeast than the EPA 2023 EN simulation, consistent with the lower EGU NOx emissions predicted by ERTAC EGU in these regions.

Table 1. EGU sector emissions annual NOx and SO_2 totals (tons/year)

State/ Region	NEIv6.3 2011		ERTAC2.7 2023		EPA EN 2023	
	NOx	SO2	NOx	SO2	NOx	SO2
LADCO States						
IL	142,582	432,902	34,078	81,899	30,764	73,747
IN	228,895	725,652	61,314	114,865	63,397	80,472
MI	149,802	452,352	27,977	43,818	33,708	67,252
MN	62,033	77,134	14,600	14,904	21,919	15,606
OH	204,874	1,168,733	50,140	114,289	37,573	89,933
WI	62,585	183,179	15,829	10,826	15,419	7,623
Regional Totals						
LADCO	850,771	3,039,951	203,938	380,601	202,780	334,634
MARAMA/ OTC	441,004	941,121	84,533	197,712	97,903	112,429
SESARM	1,079,697	2,564,573	291,058	320,508	328,132	297,145
CENSARA	827,715	1,867,451	274,253	624,243	221,846	406,174
WESTAR	841,803	769,929	298,107	234,680	201,044	185,593

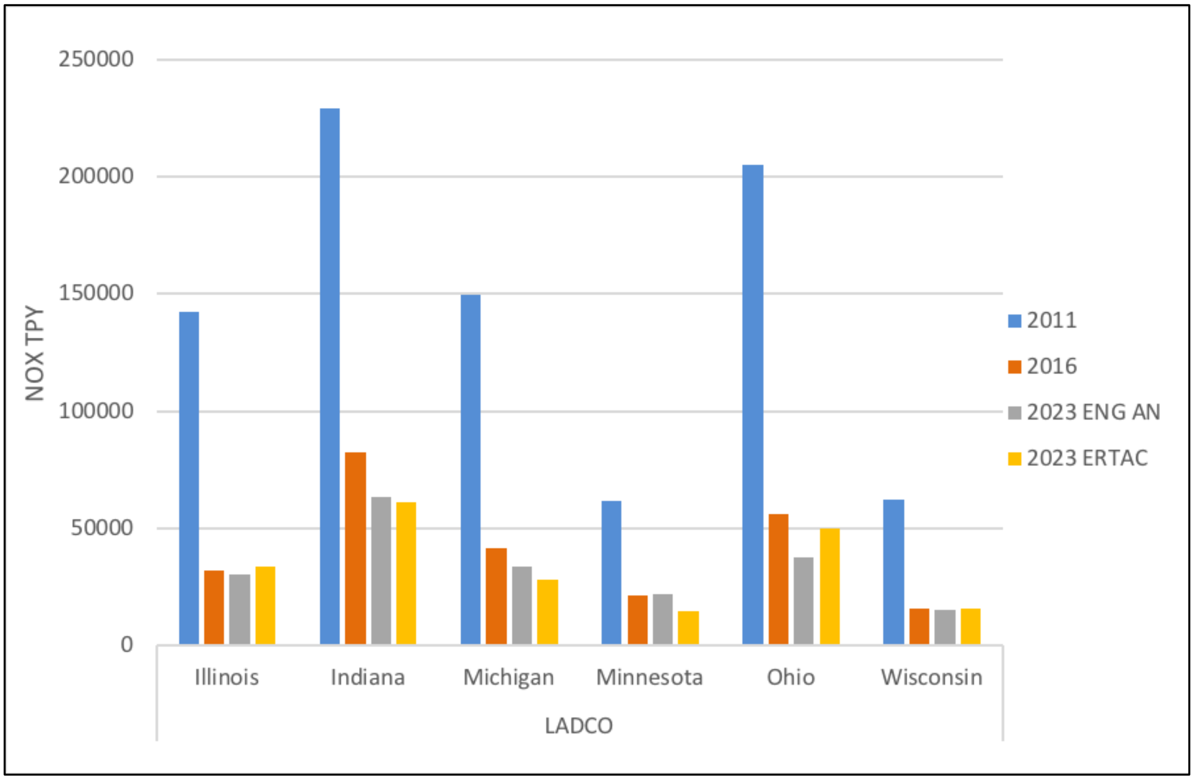

Figure 3. EGU NOx emissions comparison (tons/year)

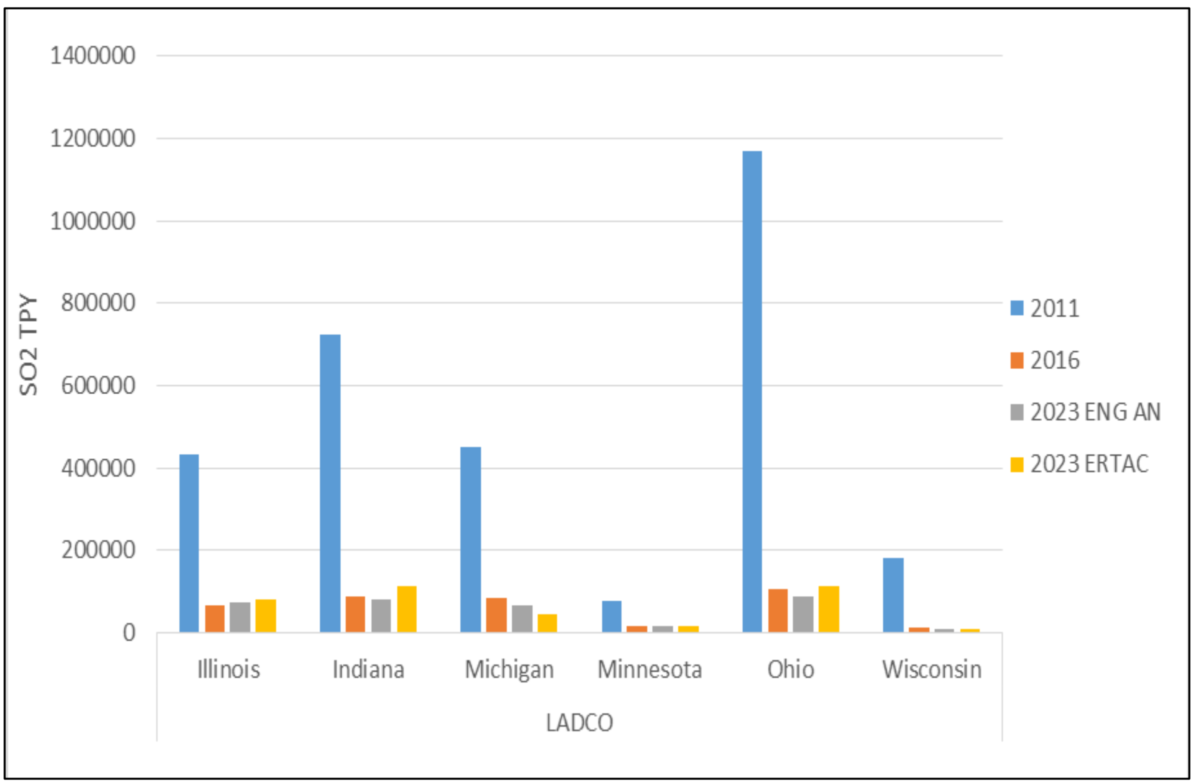

Figure 4. EGU SO_2 emissions comparison (tons/year)

Table 2. Total O_3 season day emissions for the LADCO 2023 simulations (tons/day)

State/ Region	CO	NOx	VOC	SO_2	NH_3	$PM_{2.5}$
LADCO States						
IL	607,125	143,052	497,088	44,492	47,348	41,223
IN	513,679	110,536	327,044	65,725	61,564	28,785
MI	632,948	102,683	609,349	43,644	39,374	25,621
MN	984,896	95,232	661,274	16,987	103,977	82,507
OH	687,300	115,544	424,614	58,947	62,778	32,843
WI	417,474	69,094	504,084	13,832	74,005	20,940
Region Totals						
LADCO	3,843,423	636,140		243,628	389,046	231,919
MARAMA/ OTC	2,635,608	503,960		123,407	115,592	77,799
SESARM	7,159,486	974,250		294,760	442,054	420,764
CENSARA	5,046,349	903,500		289,903	635,259	390,384
WESTAR	10,584,500	1,289,397		179,681	709,998	778,381

2.6 U.S. EPA Modeling Platform Benchmarking

LADCO benchmarked both the U.S. EPA 2011 and 2023 CAMx "EN" modeling platforms on our computing cluster. The benchmark simulation used the exact same CAMx version and configuration as was used by U.S. EPA. The purpose of these simulations was to confirm that LADCO correctly installed and configured the EPA data and software on our cluster. We needed to verify our installation of the modeling platform on the LADCO computing cluster in order to take advantage of the extensive vetting and evaluation of the platform by U.S. EPA. By reproducing the U.S. EPA CAMx modeling results on the LADCO computer, we inherited the model evaluation completed by the U.S. EPA, thereby validating the use of the platform for this study.

LADCO verified the platform installation on our computing systems by comparing the results of the U.S. EPA and LADCO 2011 and 2023 EN simulations. We simulated the entire O_3 season, with spin up, for both 2011 and 2023 for comparison with the U.S. EPA modeling. The LADCO benchmarking results for the 2011 simulation are presented in Section 5.1.

2.7 Evaluation of the LADCO 2023 CAMx Simulation

As future year air quality forecasts cannot be compared to observations for evaluation, LADCO relied on the model performance evaluation (MPE) conducted by the U.S. EPA on the base modeling platform that we used for this study (US EPA, 2016). In addition to the MPE for the base year CAMx simulation, the U.S. EPA reported full MPE results for the 2011 WRF modeling (US EPA, 2014) used to drive the CAMx simulations.

LADCO compared the 2023 O_3 forecasts that we generated in this study against the 2023 U.S. EPA "EN" platform results. We compared daily average and daily maximum 1-

hour and 8-hour O_3 concentrations at monitoring locations in the Midwest and Northeast. The purpose of this comparison was to evaluate the changes in the LADCO forecasts that result from the change in the EGU emissions forecasts used for this study relative to the U.S. EPA 2023 modeling. The comparisons of the 2023 O_3 forecasts for the LADCO and EPA CAMx simulations are presented in Section 5.2.

3 Future Year Ozone Design Values

LADCO followed the U.S. EPA Draft Guidance for Attainment Demonstration Modeling (US EPA, 2014b), herein referred to as the U.S. EPA Guidance, to calculate future year design values (DVFs) for monitors in the Midwest and Northeast U.S. As we used a base year of 2011, we estimated the base year design values (DVCs) using surface observations for the years 2009-2013. LADCO estimated the DVFs with version 1.2 of the Software for Modeled Attainment Test Community Edition (SMAT-CE)[2]. SMAT-CE was configured to use the average O_3 concentration in a 3x3 matrix around each monitor across the 10 highest modeled days, per the U.S. EPA Guidance.

SMAT-CE uses a four step process to estimate DVFs:

1. Calculate DVC for each monitor
    - For O_3, the design values is a three-year average of the 4th highest daily maximum 8 hour average O_3 ($MDA8_4$):

$$DV_{2011} = (MDA8_{4,2009} + MDA8_{4,2010} + MDA8_{4,2011})/3$$

    - Weighted 5-year average of design values centered on the base model year (2011):

$$DVC_{2011} = (DV_{2011} + DV_{2012} + DV_{2013})/3$$

2. Find top 10 base year modeled days surrounding each monitor
    - Find ten days with the highest base year modeled MDA8 from within a 3x3 matrix of grid cells surrounding each monitor
    - Only days with modeled MDA8 >= 60 ppb are used
3. Calculate relative response factor (RRF) for each monitor
    - Calculate averaged MDA8 for the base and future years from the average of the values in the 3x3 matrix in each of the selected top 10 modeled days
    - Calculate the RRF as the ratio of the future to base year averaged MDA8:

$$RRF = MDA8_{2023,avg}/MDA8_{2011,avg}$$

4. Calculate DVF for each monitor

$$DVF = RRF * DVC_{2011}$$

Following from the U.S. EPA March 2018 Ozone Transport Memo, we also calculated DVFs to account for the influence of surface water on CAMx performance over coastal regions. The alternative DVF calculation approach presented by EPA excludes from the 3x3 matrix around a monitor those model grid cells that are dominated by water (> 50% water by landuse coverage). In the case of water-dominated grid cells that include a monitor, the monitor cell is included in the alternative calculation.

[2] https://www.epa.gov/scram/photochemical-modeling-tools

Additional details of the EPA approaches that LADCO used for calculating DVFs are provided in the U.S. EPA's Ozone Transport Modeling Assessments (US EPA 2018; US EPA, 2016; US EPA, 2015).

LADCO employed another alternative for calculating DVFs that considers the skill of CAMx in reproducing the base year observations near a monitor. The standard EPA DVF approach uses the ten modeled days with the highest MDA8 concentrations around a monitoring location to estimate the relative response factor (RRF) for a monitor. In this approach, the top ten days are selected irrespective of the ability of the model to reproduce the observations during the selected days. Table 3 illustrates an example of the MDA8 modeled and observed concentrations at the Chiwaukee Prairie, WI monitor on the top 10 modeled days from the LADCO 2011 CAMx simulation. The table shows that 6 of the top 10 modeled days correspond with days that are in the top 10 observed days (yellow shading); two of the top 10 modeled days are in the top 15-20 observed days (orange shading). Four of the top 10 modeled days also have percent biases greater than 15%, with one day exhibiting a model overprediction of greater than 134%.

Table 3. Chiwaukee Prairie, WI (AQS ID: 550590019) top 10 modeled MDA8 days

Date	OBS*	MOD*	BIAS*	BIAS%
7/4/2011	79.25	105.63	26.38	33.29%
7/9/2011	83.00	101.03	18.03	21.72%
7/24/2011	41.63	97.69	56.06	134.69%
7/30/2011	51.75	91.22	39.47	76.26%
9/1/2011	96.00	91.21	-4.79	4.99%
7/17/2011	88.25	82.95	-5.30	6.01%
7/10/2011	77.38	78.89	1.52	1.96%
7/23/2011	74.88	77.36	2.49	3.32%
6/7/2011	68.38	73.93	5.55	8.12%
9/2/2011	71.13	73.75	2.62	3.69%

*Units = ppbV

The alternative DFV calculation explored by LADCO filtered the model results by bias, selecting the top 10 model days only from days when the bias falls below a certain threshold. As the EPA Modeling Guidance (2014b) sets the model performance goal for O_3 at 15% mean bias, LADCO excluded days with a bias greater than 15% in an alternative "bias filtered" DVF calculation. Table 4 extends the example for the Chiwaukee Prairie, WI monitor by showing the top 10 modeled days with absolute modeled bias less than 15%. Filtering out the high bias days results in all of the top 10 modeled days corresponding to days in which the observations were in the top 20 concentrations of all days. With this approach, not only will more of the highest concentration observed days be included in the RRF calculation but the days that are included will be those in which the model was able to better reproduce the observations. In exhibiting better skill on these days, the model has a better chance of capturing the causes of the high O_3 and subsequently simulating the sensitivity of changes in emissions on the O_3 concentrations.

Table 4. Chiwaukee Prairie, WI top 10 modeled MDA days with bias <= 15%

Date	OBS	MOD	BIAS	BIAS%
9/1/2011	96.00	91.21	-4.79	4.99%
7/17/2011	88.25	82.95	-5.30	6.01%
7/10/2011	77.38	78.89	1.52	1.96%
7/23/2011	74.88	77.36	2.49	3.32%
6/7/2011	68.38	73.93	5.55	8.12%
9/2/2011	71.13	73.75	2.62	3.69%
8/31/2011	70.38	72.49	2.12	3.01%
6/6/2011	75.29	71.73	-3.56	4.73%
8/2/2011	75.50	69.47	-6.03	7.98%
7/15/2011	65.75	67.48	1.73	2.63%

*Units = ppbV

The DVFs at nonattainment and maintenance monitors in the Midwest and Northeast U.S. from the three alternative comparisons: EPA vs LADCO, LADCO water vs no water, and LADCO bias filtered are presented in Section 0.

LADCO used the DVFs to identify nonattainment and maintenance sites in 2023 using the most recent 3-year monitored design values (2015-2017) per the CSAPR Update methodology (CSAPR Update, 2016). Under this methodology sites with average DVFs that exceed the 2015 NAAQS (71 ppb or greater) and that are currently measuring nonattainment would be considered nonattainment receptors in 2023. Further, monitoring sites with maximum DVFs that exceeds the NAAQS would be considered a maintenance receptor in 2023. Under the CSAPR Update, maintenance only receptors include both those sites where the average DVF is below the NAAQS, but the maximum DVF is above the NAAQS; and monitoring sites with average DVFs above the NAAQS but with DVCs that are below the NAAQS.

The sites that LADCO identified through this process as having potential for nonattainment and maintenance designations for the 2015 O_3 NAAQS in 2023 were the focus of our source apportionment analyses. LADCO used the CAMx source apportionment APCA technique to assess the impacts of upwind sources on nonattainment and maintenance monitors in downwind states. Section 5.3 presents the results of the linkages of LADCO states to downwind maintenance and nonattainment monitors using a threshold of 1% of the NAAQS (0.70 ppb).

4 Ozone Source Apportionment Modeling

LADCO used the CAMx Anthropogenic Precursor Culpability Assessment (APCA) tool to calculate emissions tracers for identifying upwind sources of O_3 at downwind monitoring sites. We selected the APCA technique because it more appropriately associates O_3 formation to anthropogenic sources than the CAMx Ozone Source Apportionment Technique (OSAT). If any anthropogenic emissions are involved in a reaction that leads to O_3 formation, even if the reaction occurs with biogenic VOC or NOx, APCA tags the O_3 as anthropogenic in origin.

In the LADCO 2023 CAMx Source Apportionment modeling protocol (LADCO, 2018), we presented a configuration to tag both source regions and emissions inventory sectors for our APCA modeling. In the final APCA configuration, we primarily tagged only source regions in order to better leverage both the EPA 2023 EN CAMx modeling platform and to optimize the simulation on the LADCO computing cluster. We consolidated the 54 source tracers used by EPA into 32 tracers (Figure 5) based on an analysis of the linkages in the EPA modeling results. We maintained explicit O_3 tracers for only those states that had CSAPR linkages (at least 0.7 ppb MDA8) to nonattainment and maintenance monitors in the latest EPA 2023 modeling (US EPA, 2018). For the rest of the states, such as New England, most of the Southeast, and the West, we grouped them into single tracers for computational efficiency. Following from the EPA 2023 EN modeling platform, in addition to each source region, LADCO created explicit tags for fire emissions, biogenic emissions, offshore emissions, tribal emissions, Canada/Mexico emissions, and Initial/Boundary Conditions.

LADCO used the EPA 2023 EN data processing methods for preparing emissions for the APCA simulation. EPA developed a technique to convert all of the emissions data, including non-point sources such as biogenics and onroad mobile, to CAMx point source formatted data. Tagging of the emissions by state FIPs code is done during the emissions processing sequence to ensure that all of the emissions are properly attributed to the state from which they originate. This tagging is done to avoid the conventional problem in source apportionment modeling of mismatches between grid cell-based source regions and actual political boundaries. Additional details of the EPA emissions tagging approach are in U.S. EPA (2016).

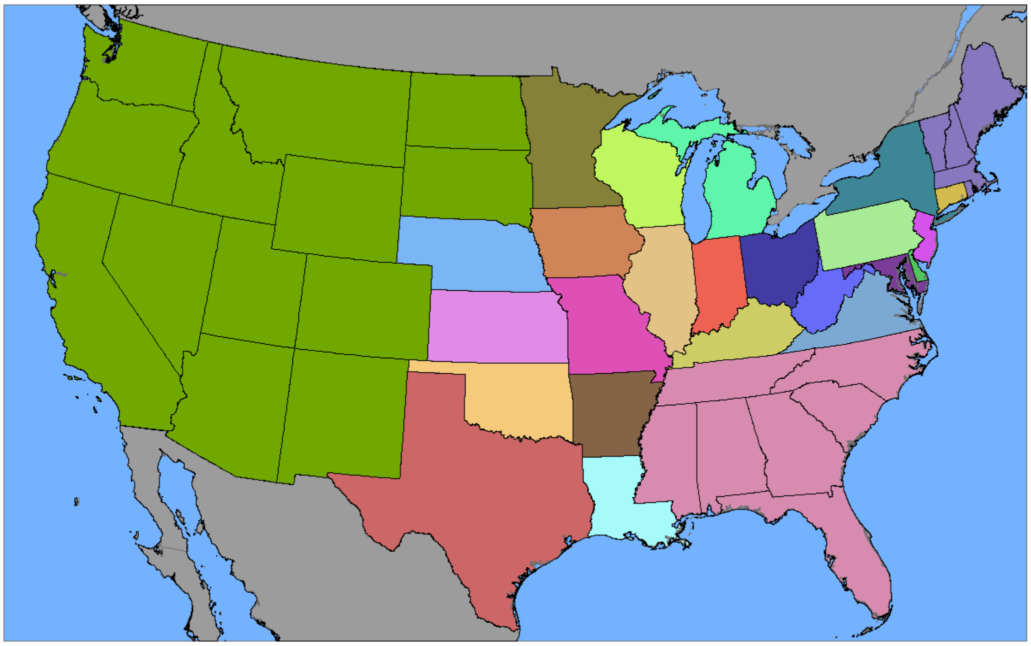

Figure 5. CAMx APCA Source Regions

We used the CAMx APCA results to calculate an O_3 contribution metric for each potential nonattainment and maintenance monitor in the Midwest and Northeast U.S. (US EPA, 2016). The contribution metric is designed to provide a reasonable representation of individual states and sources to the design values at downwind monitors in future years. In particular, per the CSAPR methodology, downwind monitors are considered to be linked to upwind sources if a modeled contribution assessment shows impacts at a monitor that equal or exceeds 1% of the NAAQS. For the 2015 O_3 NAAQS, source regions (and inventory sectors) that contribute 0.70 ppb or more to a monitor would be considered significant contributors to a nonattainment or maintenance monitor.

In Section 0 LADCO presents alternative design values and source apportionment modeling results for different transport modeling flexibilities. This section shows how the 2023 contributions and design values change with different EGU emissions, considerations of whether or not water cells are included in DVF calculations, and considerations of the model bias in the DVF calculations.

5 Results and Discussion

5.1 EPA 2011 EN Platform Benchmarking Results

LADCO simulated the entire O_3 season (May 1 – September 30, 2011) with CAMx using the EPA 2011 EN modeling platform. The purpose of the benchmarking simulation was to demonstrate that LADCO could closely reproduce the EPA results using the same model inputs and configuration used by EPA on a different computing infrastructure. By demonstrating that LADCO can reproduce the EPA results, we establish the validity of the EPA modeling platform on the LADCO systems and inherit the full model performance evaluation and vetting process used by EPA for the 2011 EN platform (US EPA, 2016).

Figure 6 and Figure 7 compare O_3 season MDA8 O_3 between the LADCO 2011 (LADCO_2011en) and the EPA 2011 EN simulations at the locations of all of the AQS and CASTNET monitors in the CONUS12 domain, respectively. The data for these figures are paired in space and time, meaning that each symbol on the plot represents a comparison of the two simulations at the same monitor on the same day. While there is some variability between the two runs (AQS maximum absolute MDA8 difference is 7.06 ppbV), the runs are not expected to be exactly the same due to numerical differences in computing architectures between the EPA and LADCO computing systems. For 194,953 AQS data pairs, the Pearson correlation coefficient for the LADCO and EPA simulations is 0.99969 and the coefficient of determination (R^2) is 0.999, indicating that the two simulations produced very similar results. The comparison of predicted O_3 concentrations at the rural CASTNET monitors shows similar correspondence between the runs ($R^2 = 0.999$).

Figure 8 shows a timeseries comparison of MDA8 O_3 for the EPA and LADCO 2011 simulations at a single monitor location. Each data point on this figure represents the daily MDA8 for the two simulations at the Chiwaukee Prairie monitor in southeastern Wisconsin. This figure also shows a very close correspondence between the EPA (blue line) and LADCO (red line) simulations relative to the observations (black line).

The close correspondence in predicted O_3 between the EPA and LADCO 2011 simulations illustrated in these figures is consistent across states, monitoring networks and time periods. These results demonstrate the LADCO was able to effectively port the EPA 2011 EN modeling platform to the LADCO computing cluster and use the platform as the basis for projecting future year O_3 concentrations. Despite the numerical differences introduced into the 2011 EN simulation by the LADCO computing architecture, LADCO will forecast 2023 O_3 on the same computing architecture as the 2011 benchmark simulation to ensure comparability between the LADCO 2011 and 2023 simulations.

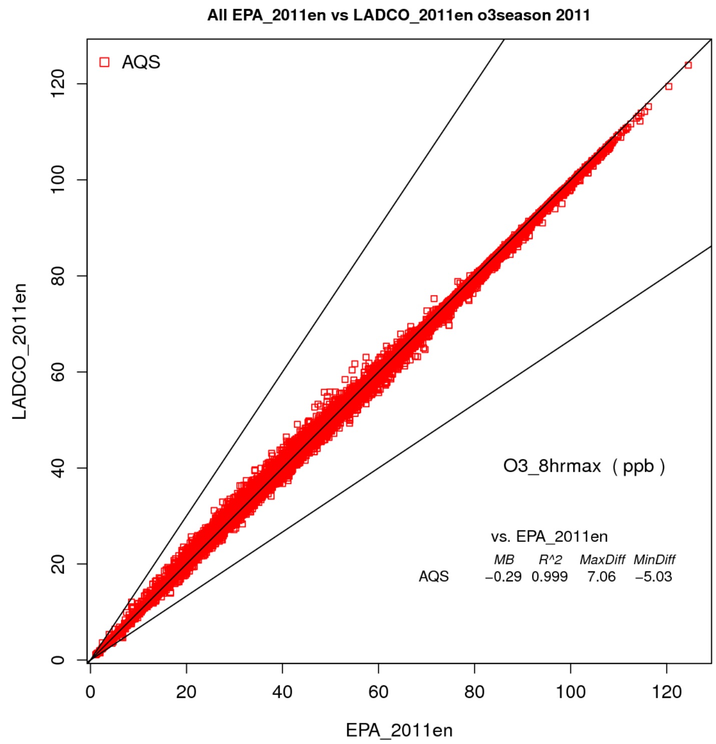

Figure 6. LADCO vs EPA 2011 EN summer season AQS MDA8 O_3

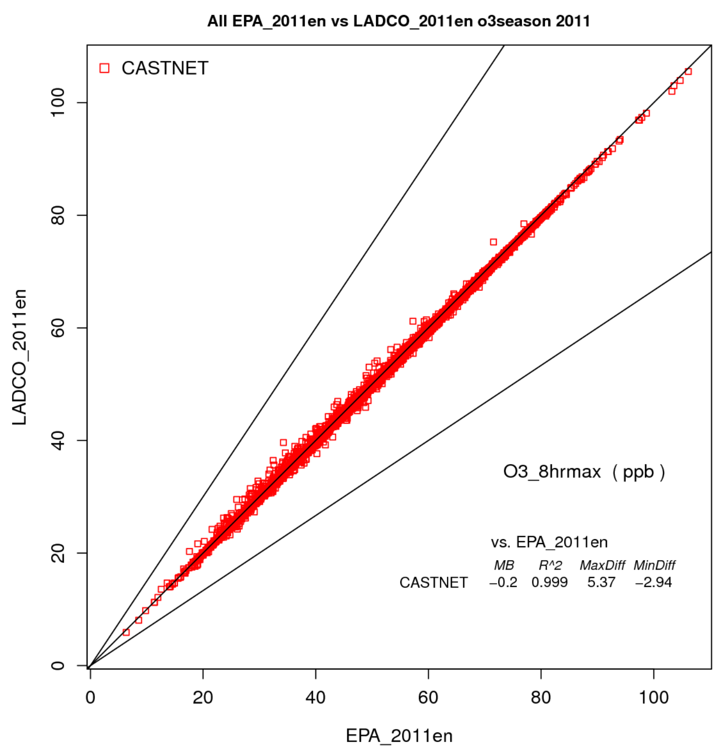

Figure 7. LADCO vs EPA 2011 EN summer season CASTNET MDA8 O_3

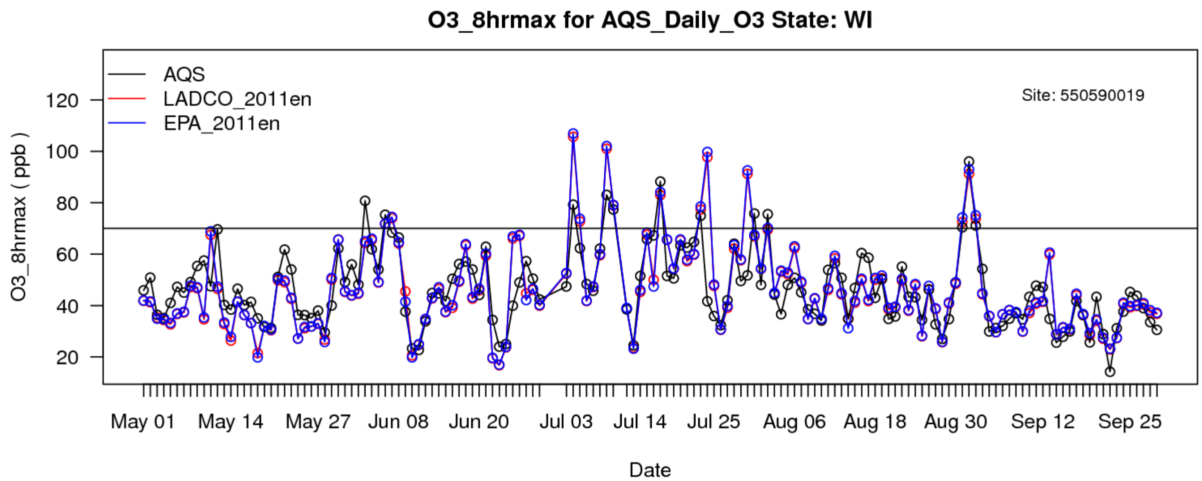

Figure 8. Timeseries of MDA8 O_3 at Chiwaukee Parairie, WI comparing EPA and LADCO 2011 simulations.

5.2 LADCO 2023 Air Quality Projections

LADCO modified the emissions in the EPA 2023 EN platform to create a LADCO 2023 modeling platform (see Section 2.5). The LADCO 2023 simulation forecasts air quality for the continental U.S. using the best available information for North American emissions, including EGU emissions forecasts from the ERTAC v2.7 model. Figure 9 shows the O_3 season (May through September) maximum of MDA8 O_3 for the LADCO and EPA 2023 CAMx simulations on the CONUS12 modeling domain. Figure 10 shows the difference in O_3 season maximum (LADCO – EPA) between the two simulations. Cool colors indicate that the EPA simulation forecasts higher O_3 than the LADCO simulation; warm colors indicate higher O_3 in the LADCO forecast. In general, the EPA simulation predicts higher O_3 in the Midwest, Northeast, Gulf Coast, and Pacific Coast states; the LADCO simulation predicts higher O_3 in the Four Corners region and Central Arkansas. Note that the trends shown in these figures mask finer temporal resolution features (i.e., hourly and daily) that also exist between the LADCO and EPA 2023 simulations.

Figure 11 and Figure 12 compare O_3 season MDA8 O_3 between the LADCO 2023 (LADCO_2023en) and the LADCO 2011 (LADCO_2011en) simulations at the locations of all of the AQS and CASTNET monitors in the CONUS12 domain, respectively. As both of these simulations were run on the LADCO computing cluster, the differences in the runs are due entirely to the emissions projections from 2011 to 2023. The LADCO simulation forecasts MDA8 O_3 to decrease in 2023 by an average of 5.34 ppbV across all AQS monitors and by an average of 6.13 ppbV across all CASTNET monitors. These changes are similar to the EPA forecasts, which estimated average decreases in MDA8 O_3 of 5.23 ppbV at the AQS monitors and 6.15 ppbV at the CASTNET monitors.

Figure 13 shows the O_3 DVFs and RRFs from the LADCO 2023 simulation. LADCO generated these results with SMAT-CE using the standard US EPA attainment test configuration (top 10 modeled days, 3x3 cell matrix around the monitor, including water cells). ***The LADCO 2023 CAMx simulation forecasts that no monitors in the Midwest or Northeast will be nonattainment (orange) for the 2015 O_3 NAAQS.*** The highest mean DVF in these regions is the Suffolk County, NY (AIRS ID: 36103002) monitor at 69.8 ppbV; the highest maximum DVF is Fairfield, CT (AIRS ID: 90019003) at 72.4 ppbV. The RRF plot indicates that the largest reductions (25-30%) in DVFs are forecasted to occur in Chicago, Louisville, Cincinnati, and North Carolina. Regionally, the Mid-Atlantic and Northeast are forecasted to experience widespread reductions in O_3 DVFs in the range of 20-25%.

Figure 14 shows the LADCO DVFs zoomed in on the Lake Michigan region. This plot highlights that only two Lake Michigan shoreline monitors, Sheboygan Co., WI and Allegan Co., MI are at or near maintenance of the 2015 O_3 NAAQS. A third monitor in Wayne Co., MI is also forecast to be near maintenance status.

Table 5 presents the average and maximum DVFs for the near nonattainment and maintenance monitors in the Midwest and Northeast. The red highlighted values indicate forecasted maintenance status for the 2015 O_3 NAAQS. The Kohler Andre monitor in Sheboygan, WI (AIRS ID: 551170006) is the only forecasted maintenance monitor in the LADCO region with a maximum DVF of 71.5 ppbV.

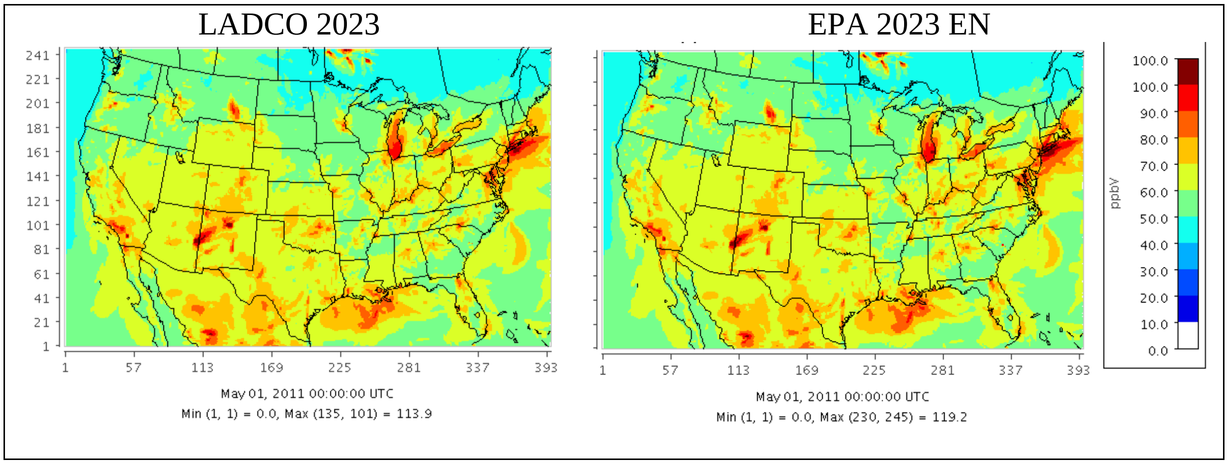

Figure 9. LADCO and EPA CAMx May - Sept maximum 2023 MDA8 O_3

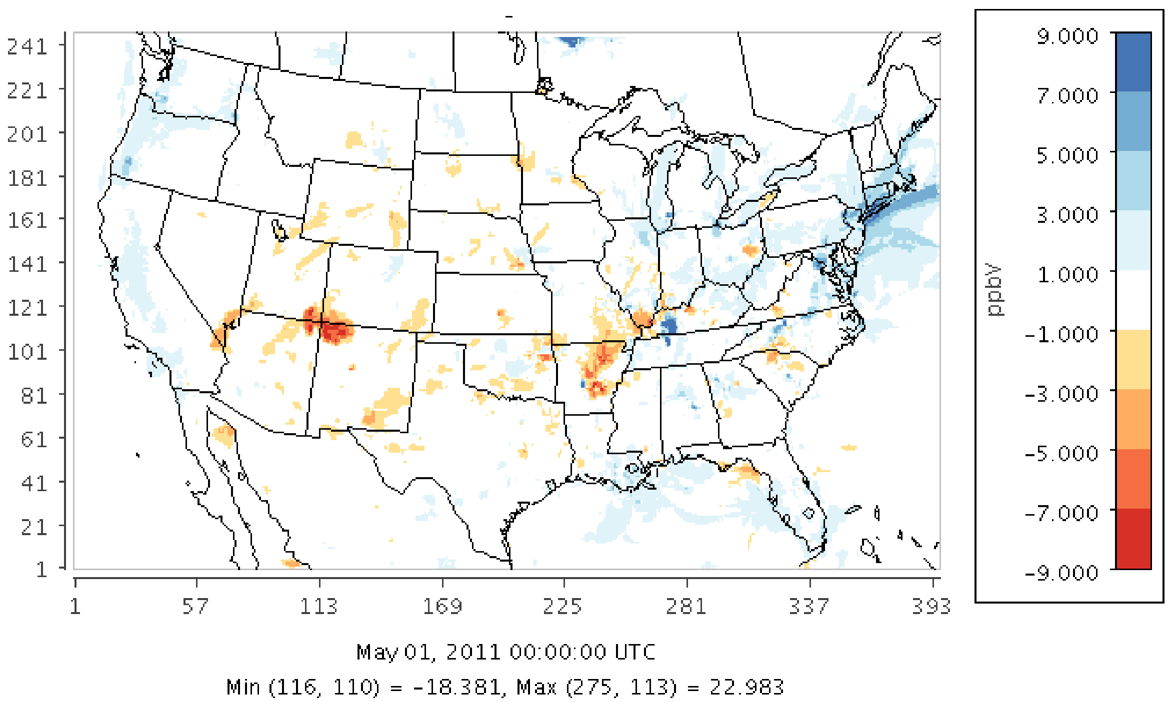

Figure 10. CAMx May - Sept difference (LADCO-EPA) in maximum 2023 MDA8 O_3

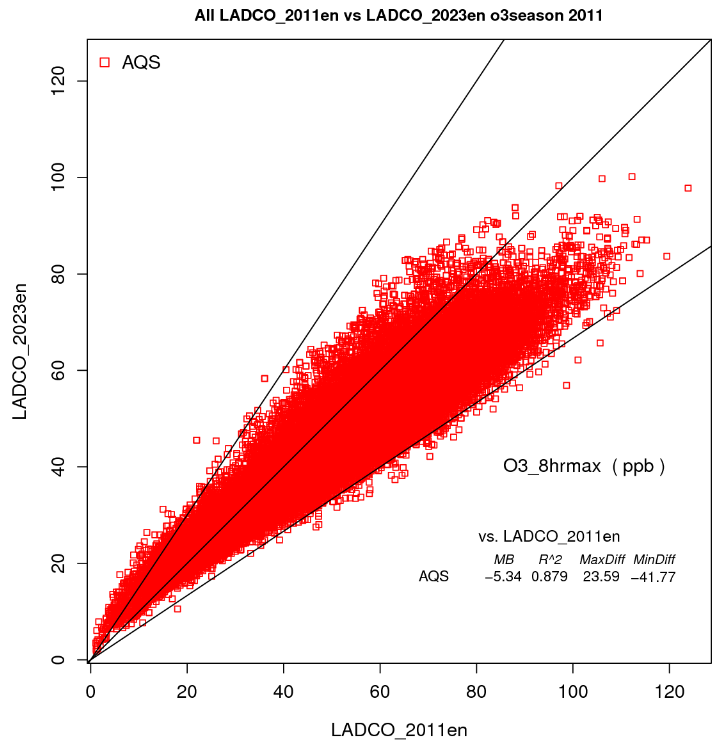

Figure 11. LADCO 2023 vs 2011 summer season AQS MDA8 O_3

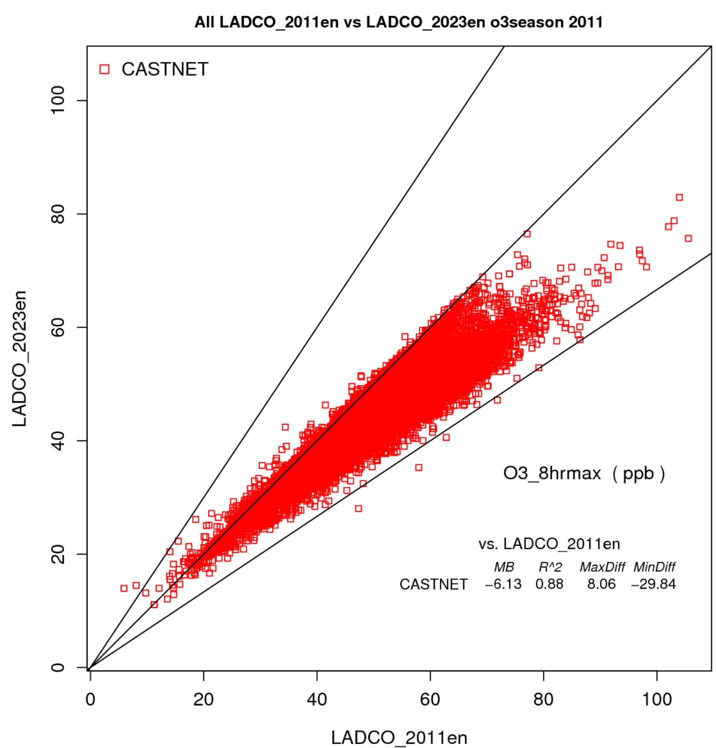

Figure 12. LADCO 2023 vs 2011 summer season CASTNET MDA8 O_3

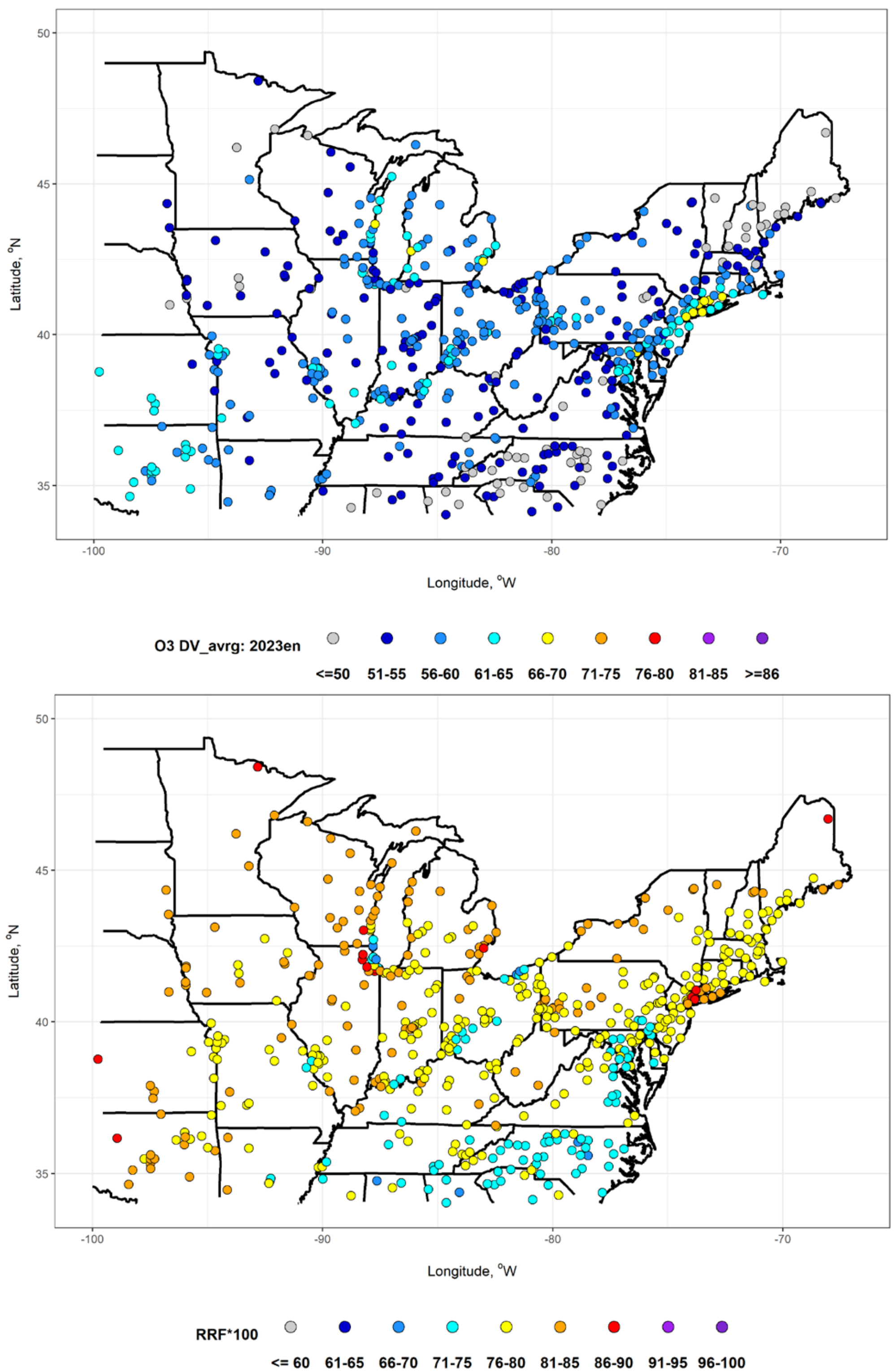

Figure 13. Future year O_3 design values (top) and relative response factors (bottom) calculated with water cells included from the LADCO 2023 CAMx simulation.

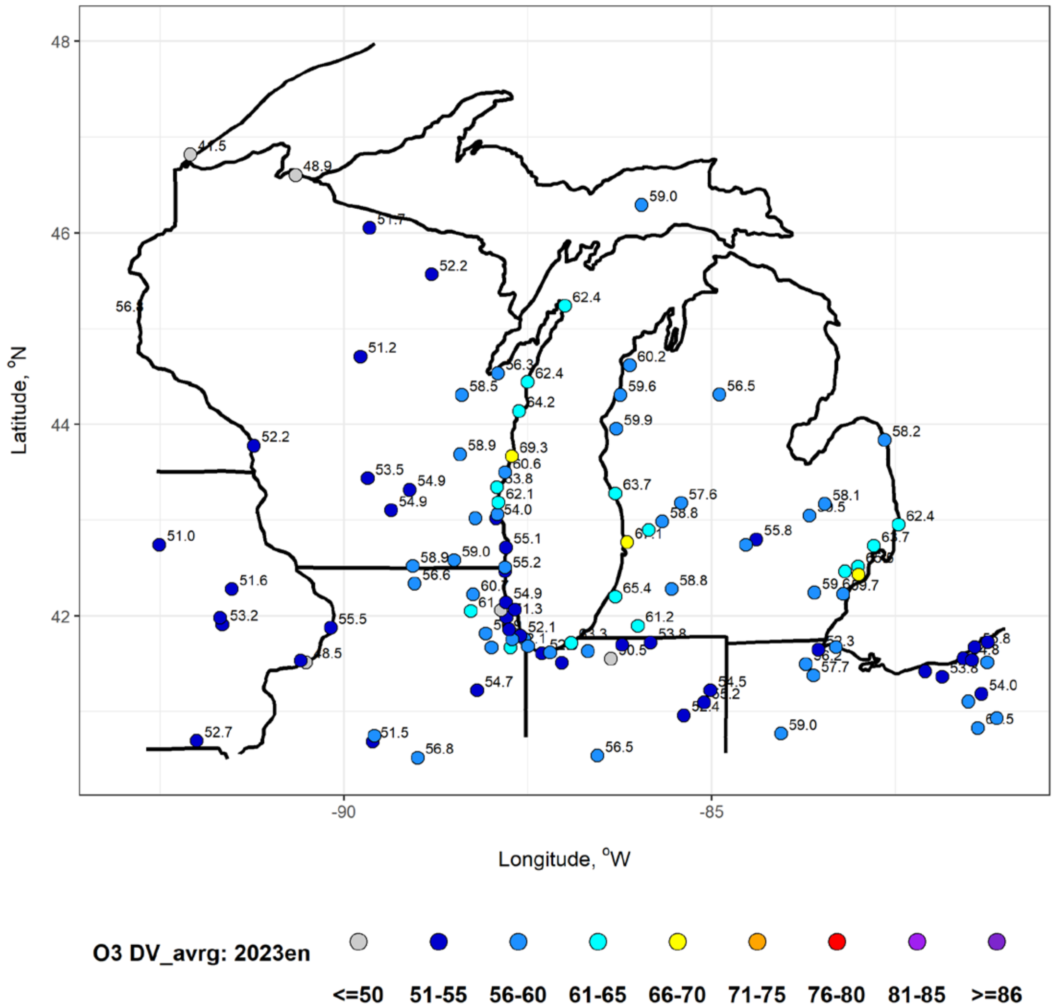

Figure 14. Future year O_3 design values calculated with water cells included from the LADCO 2023 CAMx simulation; Lake Michigan zoom.

Table 5. LADCO 2023 O_3 design values at nonattainment and maintenance monitors in the Midwest and Northeast

AQS ID	County	ST	LADCO 2023		2009-2013	
			3x3 avrg	3x3 max	3x3 avrg	3x3 max
361030002	Suffolk	NY	69.8	71.3	83.3	85.0
90019003	Fairfield	CT	69.6	72.4	83.7	87.0
240251001	Harford	MD	69.4	71.8	90.0	93.0
551170006	Sheboygan	WI	69.3	71.5	84.3	87.0
360850067	Richmond	NY	69.1	70.6	81.3	83.0
90099002	New Haven	CT	67.9	70.5	85.7	89.0
90013007	Fairfield	CT	67.8	71.6	84.3	89.0
261630019	Wayne	MI	67.7	69.7	78.7	81.0
360810124	Queens	NY	67.5	69.2	70.0	71.0
90010017	Fairfield	CT	67.2	69.4	78.0	80.0
260050003	Allegan	MI	67.1	69.8	80.3	83.0
550790085	Milwaukee	WI	62.1	65.1	78.3	82.0

5.3 Interstate Transport Linkages

Table 6 shows the MDA8 O_3 DVF CSAPR linkages between states and monitors estimated by the LADCO 2023 simulation. These linkages are derived from the standard EPA attainment test that includes water cells in the 3x3 matrix surrounding each monitor. The linkages in Table 6 are provided for the same monitors highlighted in Table 5. While there are no projected nonattainment monitors in the LADCO 2023 simulation, the maintenance monitors are highlighted in red text. The states with contributions that equal or exceed 1% of the 2015 O_3 NAAQS (0.70 ppbV) are highlighted with yellow shading.

As described above, the only monitor in the LADCO region projected to be in maintenance for the 2015 O_3 NAAQS by the LADCO 2023 modeling is the Kohler Andre monitor in Sheboygan, WI with a maximum DVF of 71.5 ppbV. Illinois is the highest contributing source region linked to this monitor (14.13 ppbV) followed by WI (9.54 ppbV), IN (6.24 ppbV), MI (2.15 ppbV), and TX (2.02 ppbV). While all of the LADCO states, with the exception of MN, have CSAPR-significant linkages to the maintenance monitors in the Northeast, OH has the largest single contribution to a monitor outside of the LADCO region (2.88 ppbV at Harford, MD). Despite projected attainment, the Wayne Co., MI monitor experiences the largest influence from outside of the U.S. (CNMX = 3.22 ppbV) of all of the monitors in Table 6.

Figure 15 through Figure 23 show the 2023 ozone season maximum of the CAMx APCA O_3 tracers for the LADCO states, Texas, Offshore (commercial marine) sources, and Canada+Mexico. While these plots do not indicate the conditions in which these maximum values occur (i.e., on high or low O_3 days), they do show the maximum magnitudes and spatial extents of the influence of each state on regional O_3 concentrations. Figure 15 shows that CAMx estimated that IL contributes a domain maximum O_3 concentration of 70.8 ppbV. The maximum influence of IL emissions on O_3 is near Chicago and over Lake Michigan. Within the LADCO region, IL sources have the greatest influence on O_3 concentrations in southeast WI, northwest IN, and the Lower Peninsula of MI. CAMx estimated that IL contributes a maximum of 2-4 ppbV O_3 to the coastal areas in the Northeast and up to 8 ppbV O_3 as far south as the Louisiana Gulf Coast.

Figure 16 shows that CAMx estimated that IN contributes a domain maximum 46.6 ppbV O_3. The highest contributed O_3 concentrations from IN sources are in southern Lake Michigan. Within the LADCO region, IN sources have the greatest influence on O_3 concentrations in southern IL, southern MI, and central OH. CAMx estimated similar O_3 impacts for IN as for IL in the coastal areas in the Northeast and in the Gulf Coast.

The CAMx estimates for MI O_3 tracers in Figure 17 show a domain maximum contribution of 38.4 ppbV with the greatest impacts over Lakes Michigan, Ontario, and Erie. Within the LADCO states, MI sources have the greatest influence on O_3 concentrations in northern IN and OH. MI is also estimated to have a slightly greater impact on O_3 in the Northeast than both IL and IN, with maximum O_3 tracer concentrations of 4-6 ppbV extending off the Northeast coast.

Figure 18 shows that the maximum O_3 impact from MN sources is estimated to be 50.1 ppbV and occurs around the Twin Cities. MN has the greatest regional influence on O_3 concentrations in northern WI. The MN O_3 tracers are estimated to extend as far south as Dallas and east into central PA.

Figure 19 shows that OH sources have the greatest impact on O_3 over Lake Erie with a domain maximum tracer concentration of 63.1 ppbV. Within the LADCO region, OH sources are estimated to have the greatest impact on O_3 in eastern IN and southeastern MI. As the easternmost LADCO state, OH is estimated to have the greatest impact on O_3 in the Northeast, with maximum OH tracer concentrations of 8-10 ppbV extending to the Northeast

As shown in Figure 20, WI sources are estimated by CAMx to have the greatest impact on O_3 concentrations along the WI shoreline of Lake Michigan. The highest WI O_3 tracer concentration of 41.2 ppbV occurs over Lake Michigan off the southeast coast of the state. Within the region, WI sources have the greatest influence on O_3 concentrations in western MI and the far northeast corner of IL. CAMx estimates that WI sources influence O_3 concentrations as far away as northeast TX and along the Northeast U.S. coast by a maximum range of 2-4 ppbV.

Figure 21 shows that TX sources are estimated to impact O_3 concentrations in all of the LADCO states. The great influence from TX sources on O_3 in the region are estimated by CAMx to be in southern IL and southern WI by a maximum of 8-10 ppbV. The O_3 tracer from offshore sources shown in Figure 22 has relatively small impacts on O_3 in the LADCO states. Figure 23 shows that sources in Canada and Mexico are estimated by CAMx to influence O_3 concentrations through most of the Continental U.S. The largest influence in the LADCO region is near the Canadian border in eastern MI. Canadian emissions are estimated to impact most of the LADCO states by a seasonal maximum of 2-10 ppbV.

Table 6. MDA8 O_3 (ppbV) DVF (with WATER) CSAPR linkages to monitors in the LADCO 2023 simulation

AIRS ID	361030002	90019003	240251001	551170006	360850067	90099002	90013007	261630019	360810124	90010017	260050003
STATE	NY	CT	MD	WI	NY	CT	CT	MI	NY	CT	MI
2009-13 AVG	83.3	83.7	90.0	84.3	81.3	85.7	84.3	78.7	78.0	80.3	82.7
2009-13 MAX	85.0	87.0	93.0	87.0	83.0	89.0	89.0	81.0	80.0	83.0	86.0
2023 AVG	69.8	69.6	69.4	69.3	69.1	67.9	67.8	67.7	67.5	67.2	67.1
2023 MAX	71.3	72.4	71.8	71.5	70.6	70.5	71.6	69.7	69.2	69.4	69.8
IL	0.65	0.62	0.85	14.13	0.85	0.42	0.71	1.83	0.69	0.39	18.31
WI	0.24	0.17	0.23	9.54	0.31	0.24	0.23	0.94	0.36	0.25	1.73
IN	0.75	0.78	1.36	6.24	0.97	0.46	0.94	2.18	0.64	0.45	6.61
OH	1.71	1.43	2.88	0.60	2.17	1.08	1.77	3.72	1.63	1.02	0.19
MI	0.95	0.49	0.66	2.15	1.01	0.65	0.66	19.68	1.12	0.47	3.20
MN	0.16	0.11	0.12	0.27	0.13	0.17	0.15	0.30	0.16	0.17	0.11
IA	0.19	0.15	0.23	0.48	0.24	0.14	0.16	0.40	0.24	0.11	0.70
MS	0.39	0.36	0.58	1.34	0.50	0.27	0.38	0.70	0.36	0.21	2.46
AR	0.14	0.15	0.22	0.52	0.16	0.09	0.15	0.25	0.11	0.08	1.87
LA	0.11	0.10	0.24	0.98	0.17	0.07	0.11	0.15	0.13	0.05	0.68
TX	0.58	0.45	0.86	2.02	0.79	0.40	0.45	0.86	0.56	0.32	2.41
OK	0.34	0.22	0.38	1.38	0.41	0.24	0.23	0.52	0.31	0.17	1.39
KS	0.19	0.14	0.24	0.64	0.24	0.13	0.14	0.36	0.17	0.09	0.75
CT	0.57	3.48	0.01	0.00	0.24	6.14	3.81	0.00	0.57	8.20	0.00
NY	16.47	13.76	0.46	0.02	6.65	14.00	12.69	0.06	13.92	15.92	0.00

NJ	7.96	7.22	0.33	0.00	10.04	5.24	6.39	0.00	7.89	5.87	0.00
PA	5.96	6.12	4.87	0.18	9.45	5.01	5.82	0.17	5.53	4.77	0.05
DE	0.18	0.31	0.11	0.00	0.41	0.31	0.30	0.00	0.34	0.16	0.00
MD	1.03	1.52	17.79	0.02	1.61	1.30	1.46	0.02	1.33	1.00	0.01
WV	0.75	1.04	2.39	0.27	1.55	0.57	1.02	0.20	0.69	0.65	0.11
VA	0.89	1.72	3.96	0.07	1.56	1.20	1.30	0.15	1.26	1.15	0.04
SE	0.82	1.24	1.97	1.37	1.59	0.68	1.23	0.80	0.80	0.75	1.75
KY	0.51	0.76	1.62	0.58	0.93	0.32	0.89	0.64	0.40	0.36	0.59
WRAP	0.98	0.60	1.01	1.12	1.04	0.68	0.64	1.18	0.87	0.55	1.13
CNMX	1.75	1.26	0.84	0.60	1.54	1.64	1.34	3.22	1.89	1.64	0.56
OFFSHORE	2.02	2.64	3.35	0.89	1.85	4.16	2.88	0.31	2.17	1.46	0.47
TRIBAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIRE	0.28	0.32	0.45	0.54	0.37	0.21	0.33	0.40	0.22	0.20	0.89
ICBC	18.71	18.14	15.20	15.97	16.89	17.65	17.25	22.22	18.21	17.09	12.32
BIOG	4.12	3.82	5.31	7.18	5.01	3.85	3.90	6.14	4.20	3.27	8.44

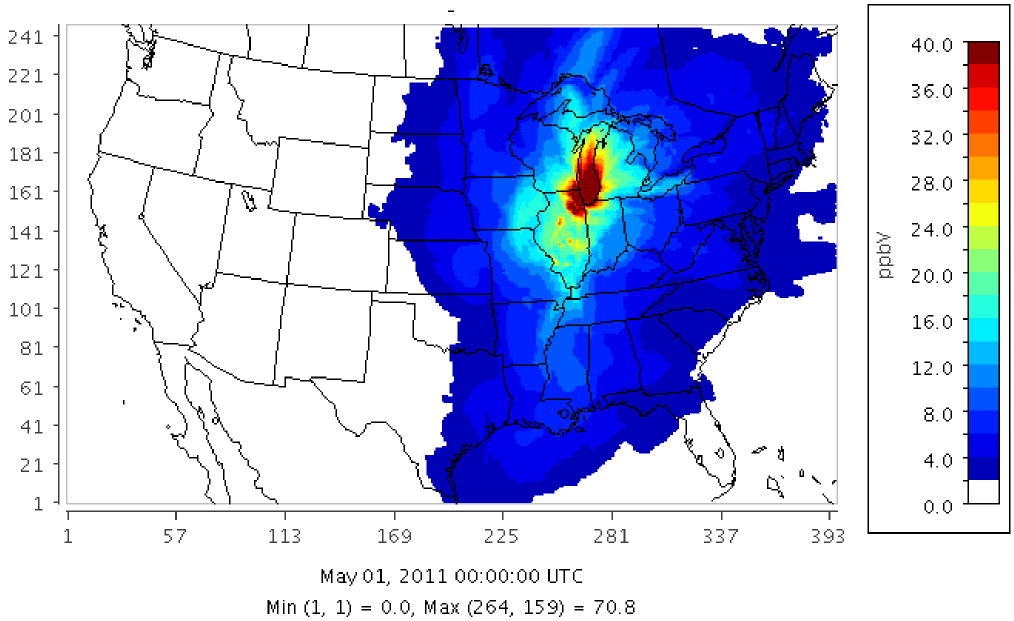

Figure 15. Ozone season maximum CAMx APCA O_3 tracers – Illinois

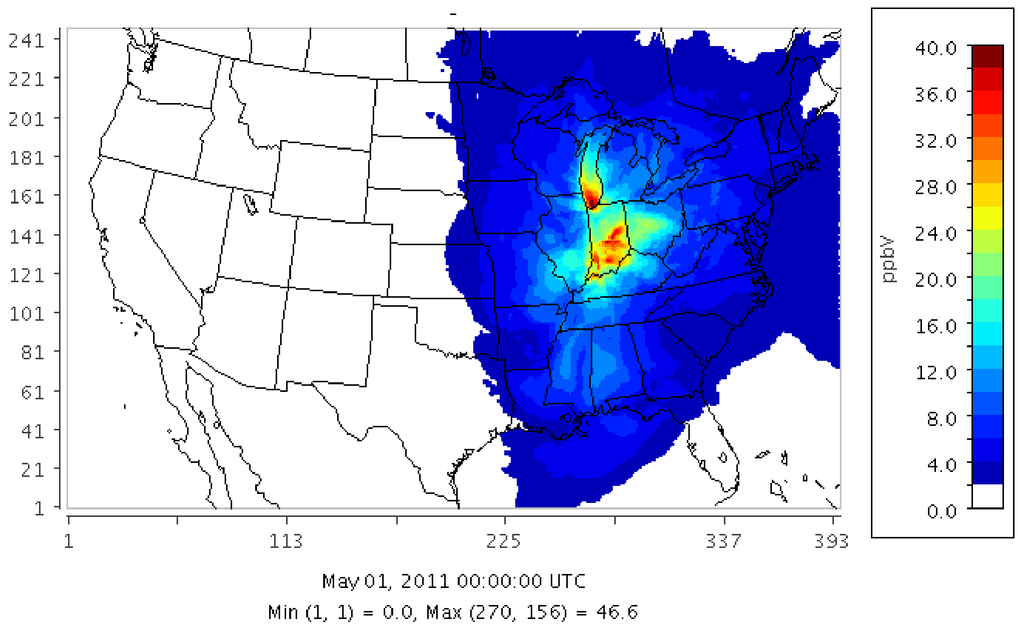

Figure 16. Ozone season maximum CAMx APCA O_3 tracers – Indiana

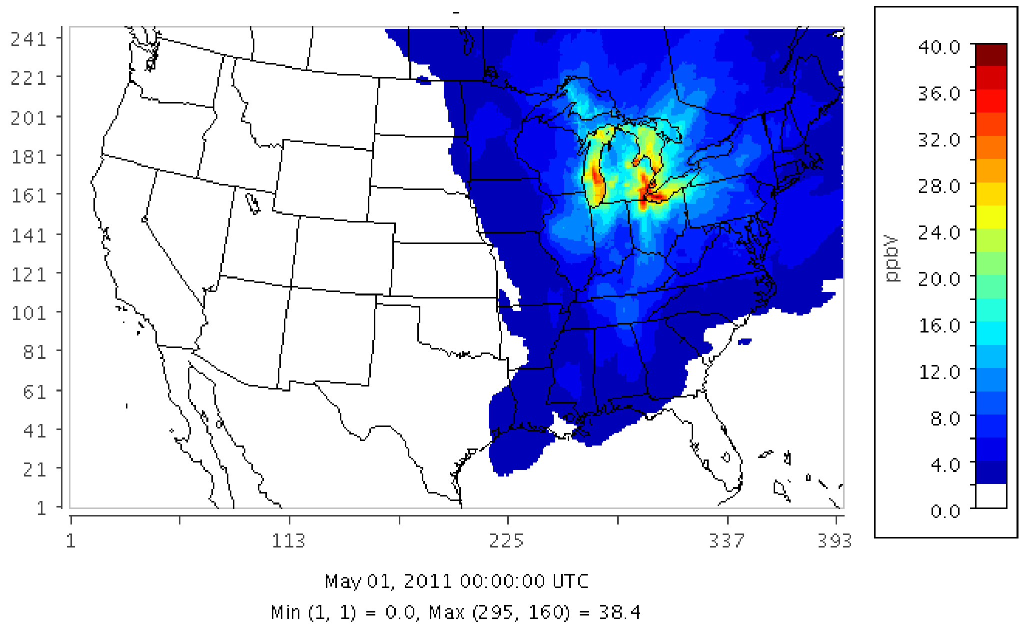

Figure 17. Ozone season maximum CAMx APCA O_3 tracers – Michigan

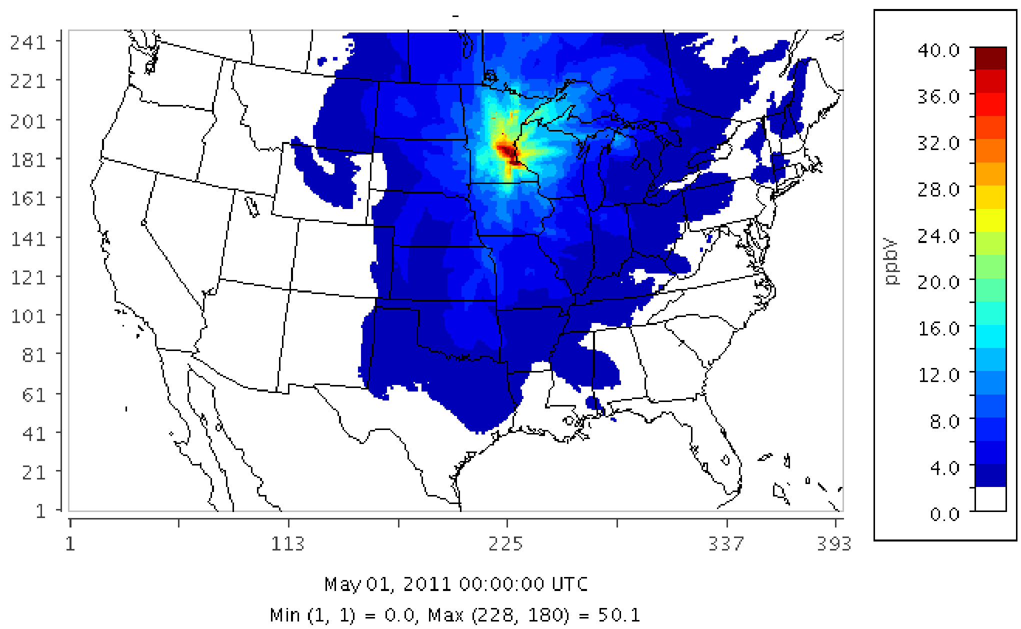

Figure 18. Ozone season maximum CAMx APCA O_3 tracers – Minnesota

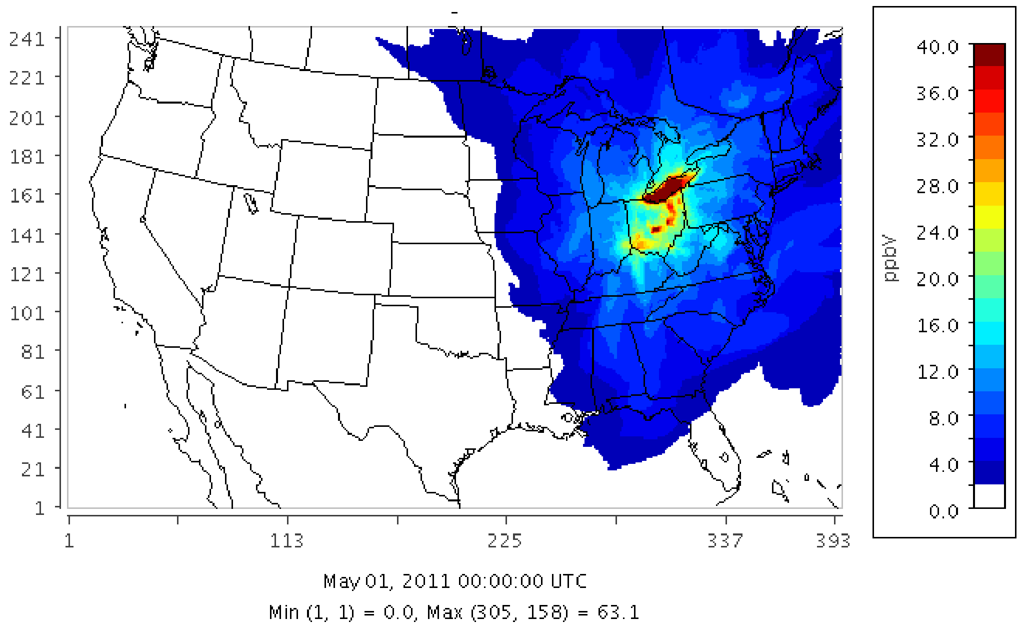

Figure 19. Ozone season maximum CAMx APCA O_3 tracers – Ohio

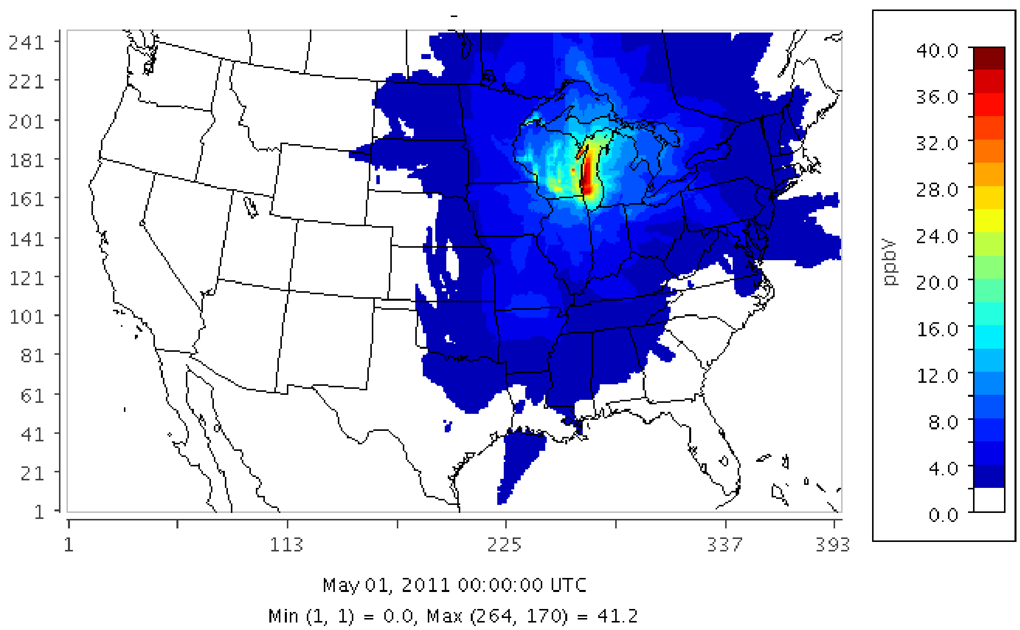

Figure 20. Ozone season maximum CAMx APCA O_3 tracers – Wisconsin

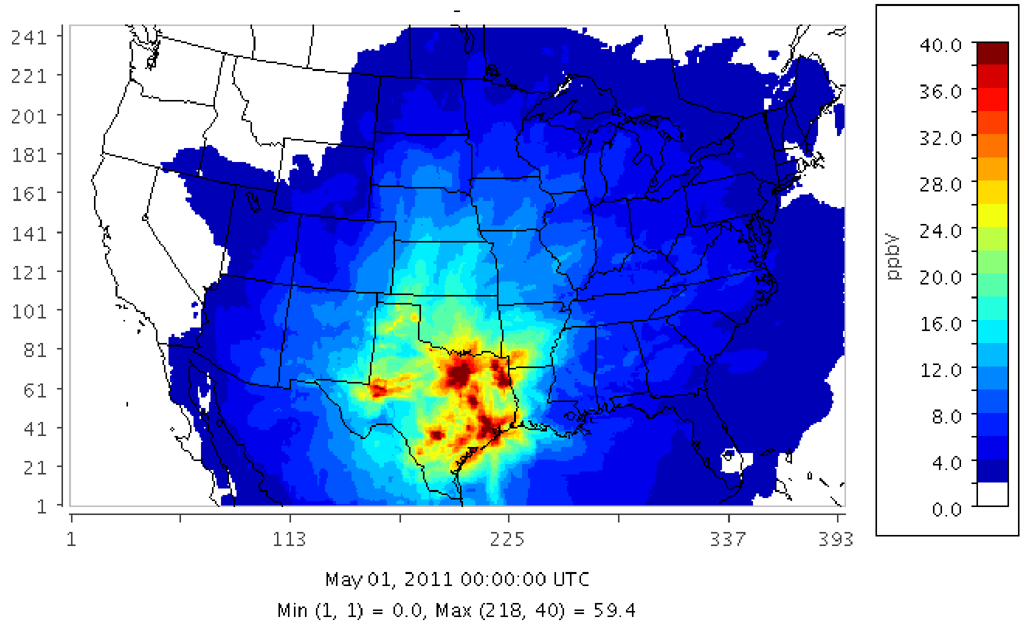

Figure 21. Ozone season maximum CAMx APCA O_3 tracers – Texas

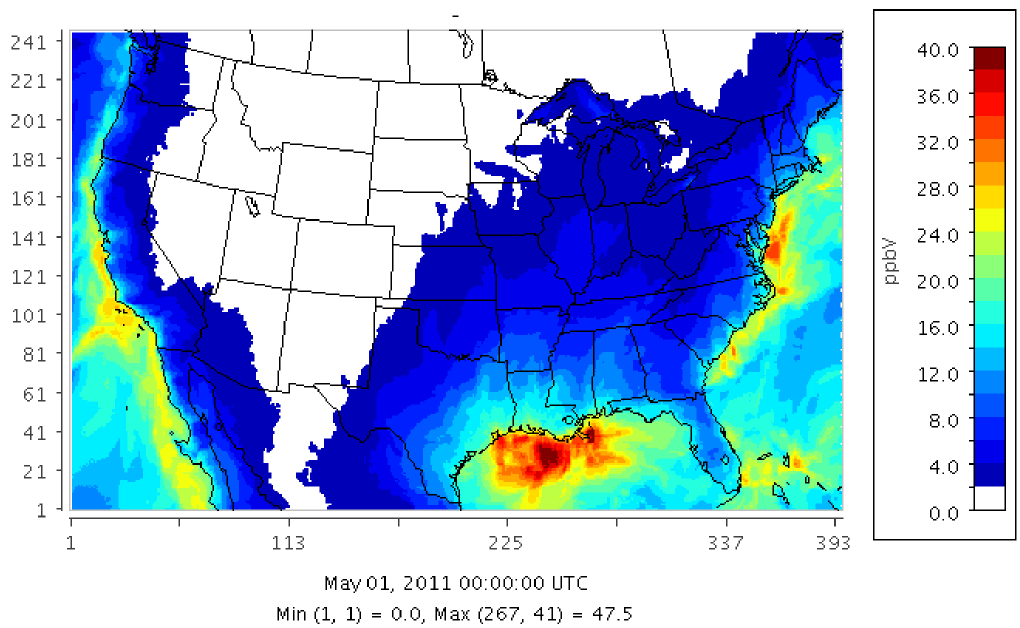

Figure 22. Ozone season maximum CAMx APCA O_3 tracers – Offshore

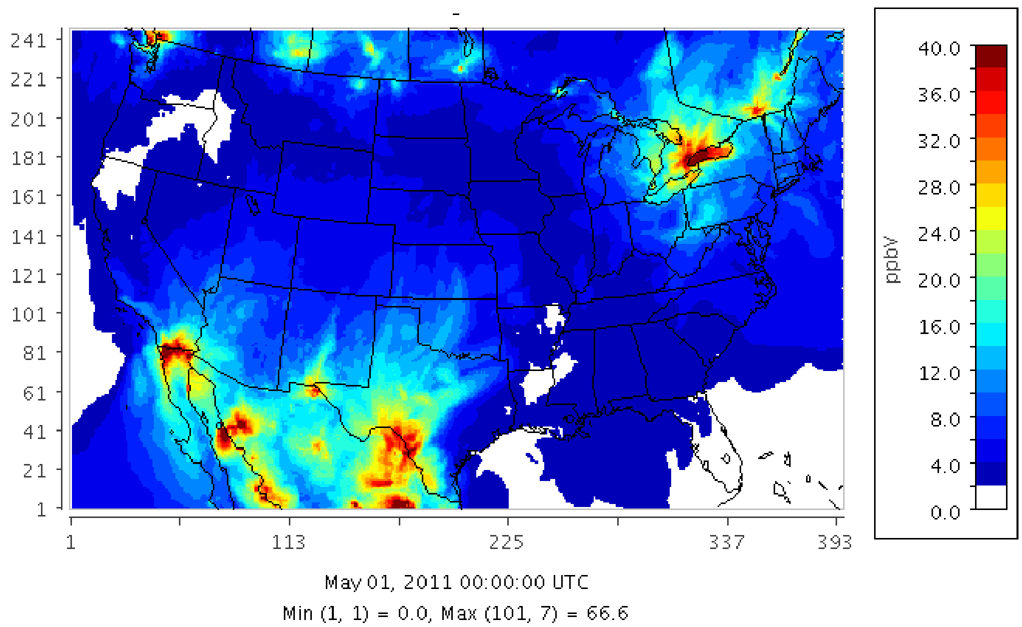

Figure 23. Ozone season maximum CAMx APCA O_3 tracers – Canada and Mexico

5.4 Interstate Transport Assessment Flexibilities

In March 2018 EPA released a memo (US EPA, 2018) the described a series of flexibilities that states could consider in developing Good Neighbor SIPs for the 2015 O_3 NAAQS. In this section LADCO presents a series of alternatives for calculating DVFs. We compare the results against the standard US EPA attainment test configuration (top 10 modeled days, 3x3 cell matrix around the monitor, including water cells) to demonstrate how the air quality projections and conclusions may change with each approach.

5.4.1 Alternative Power Sector Modeling

The "[u]se of alternative power sector modeling consistent with EPA's emissions inventory guidance" is presented in the Analytics section of EPA's March 2018 memo as a flexibility to consider in preparing a Good Neighbor SIP. This flexibility supports LADCO's use of the ERTAC EGU model for projecting EGU emissions to 2023. As described in Section 2.5.1, we consider the emissions projections from ERTAC EGU to be more representative of the sources in the Midwest and Northeast than the approach used by EPA in their 2023 EN modeling platform. As ERTAC EGU is developed in collaboration between regional and state air planning agencies, it includes algorithms and data that have been reviewed by many of the states impacted by interstate O_3 transport in the Eastern U.S.

The LADCO 2023 CAMx simulation relative to the EPA 2023 EN simulation is an example of an alternative power sector modeling flexibility. The only configuration difference between these simulations is in the EGU emissions used with CAMx to project future year air quality. This sensitivity is slightly confounded by differences in the EPA and LADCO computing platforms when directly comparing the runs. The computing system porting differences between the two runs is relatively small (see Section 5.1) compared to the differences introduced by changing the EGU emissions.

Figure 9 and Figure 10 illustrate the differences in 2023 MDA8 O_3 that result from changing the EGU projection methodology. As described in Section 5.2, the EPA simulation predicts higher O_3 in the Midwest, Northeast, Gulf Coast, and Pacific Coast states; the LADCO simulation predicts higher O_3 in the Four Corners region and Central Arkansas. Figure 24 and Figure 25 compare summer season MDA8 O_3 between the LADCO and EPA 2023 simulations for monitors in the AQS and CASTNET networks, respectively. The LADCO simulation (y-axis) predicts slightly lower O_3 concentrations across all sites (AQS NMB = -0.89%, CASTNET NMB = -0.4%).

Figure 26 and Figure 27 compare the EPA and LADCO 2023 DVFs for the Eastern US and the LADCO region, respectively. Table 7 shows the DVFs and DVCs for the nonattainment and maintenance monitors in the Eastern U.S. ***The LADCO simulation that used ERTAC EGU emissions projections forecasts lower DVFs than the EPA 2023 EN simulation. All six of the projected nonattainment monitors in the EPA simulation are forecasted by the LADCO simulation to be in attainment.*** The RRF plots in Figure 28 further show the regional O_3 reductions in the LADCO simulation relative to the EPA 2023 EN simulation. More yellow and blue colors, representing lower RRFs or greater reductions in future year O_3, are seen in the LADCO simulation through the Great Lakes, Mid-Atlantic, and Northeast regions.

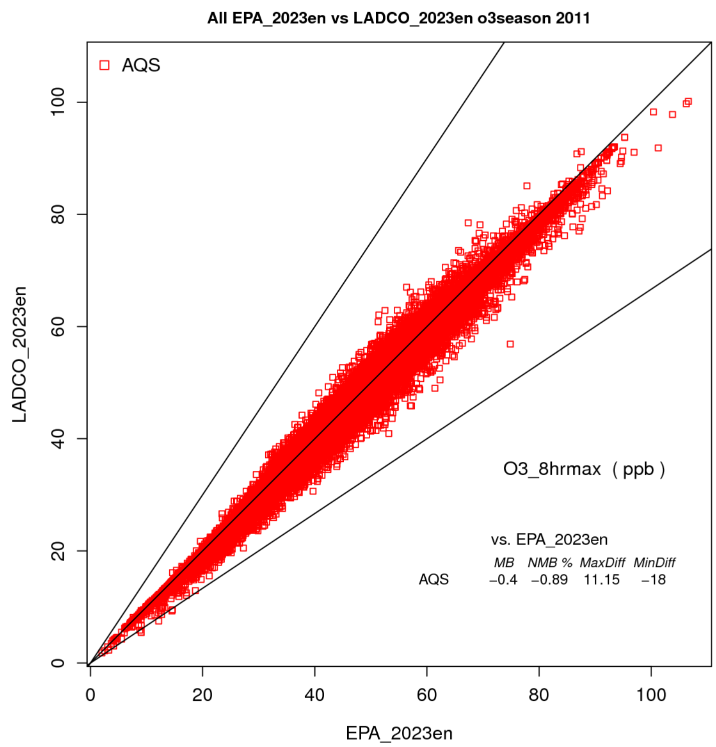

Figure 24. LADCO 2023 vs EPA 2023 summer season AQS MDA8 O_3

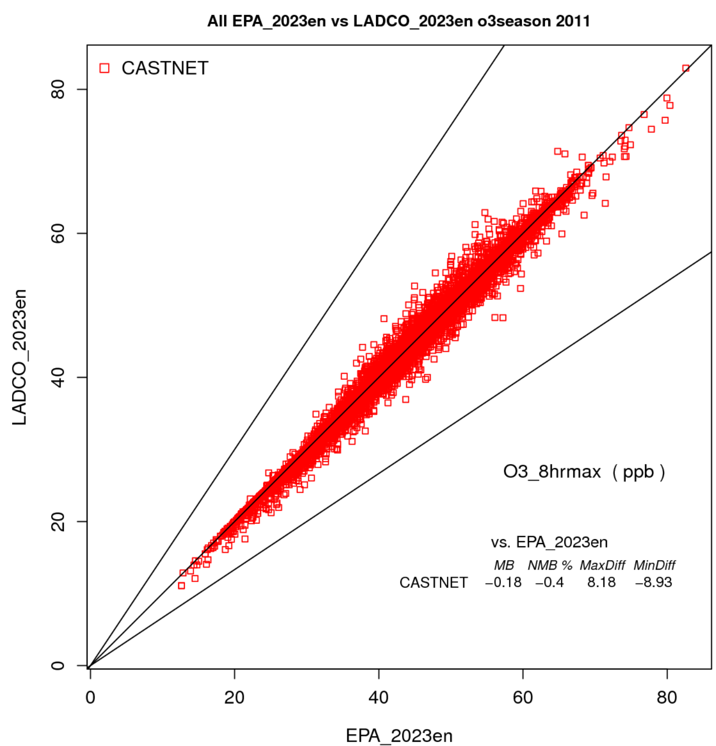

Figure 25. LADCO 2023 vs EPA 2023 summer season CASTNET MDA8 O_3

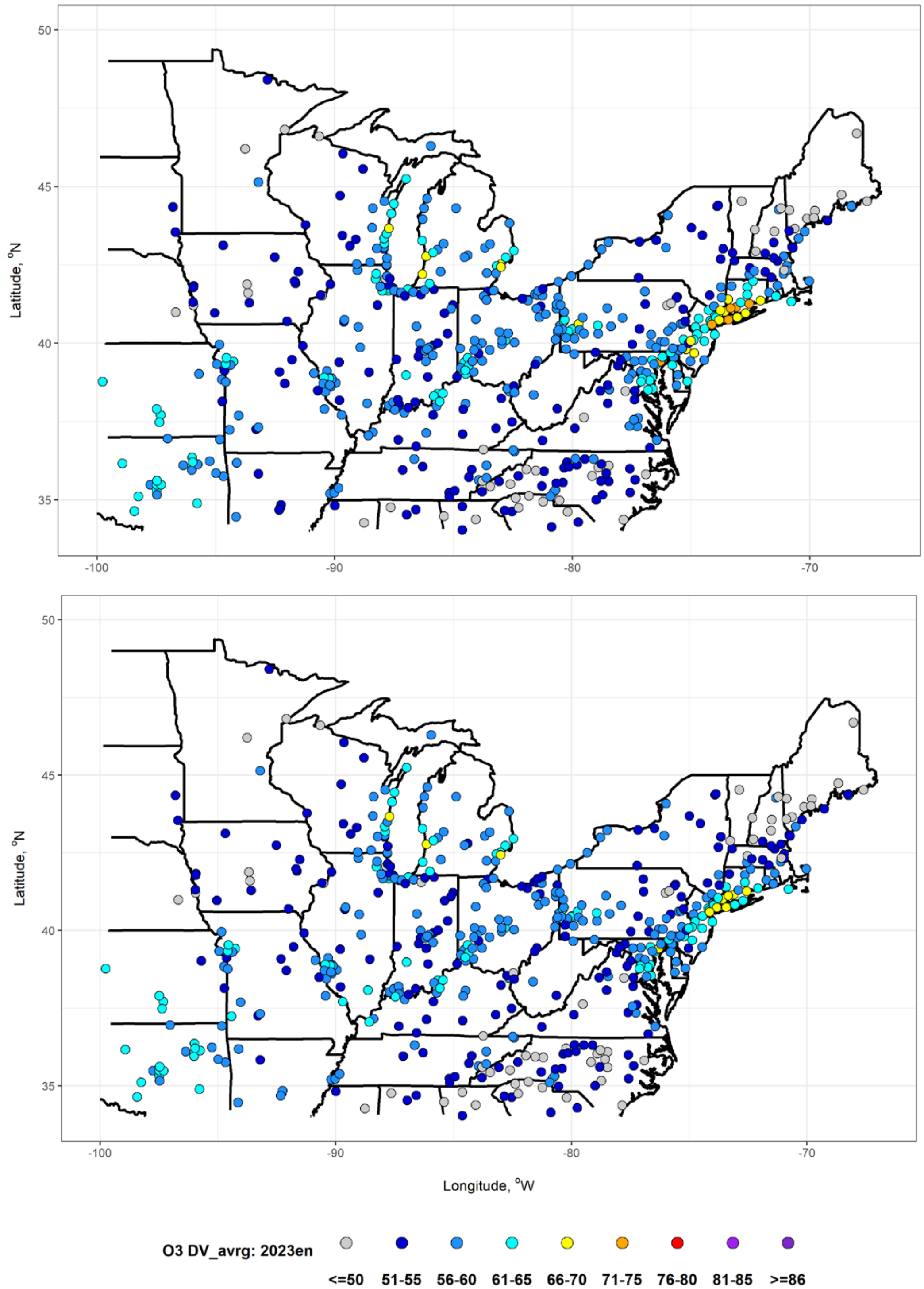

Figure 26. EPA (top) and LADCO (bottom) 2023 DVFs.

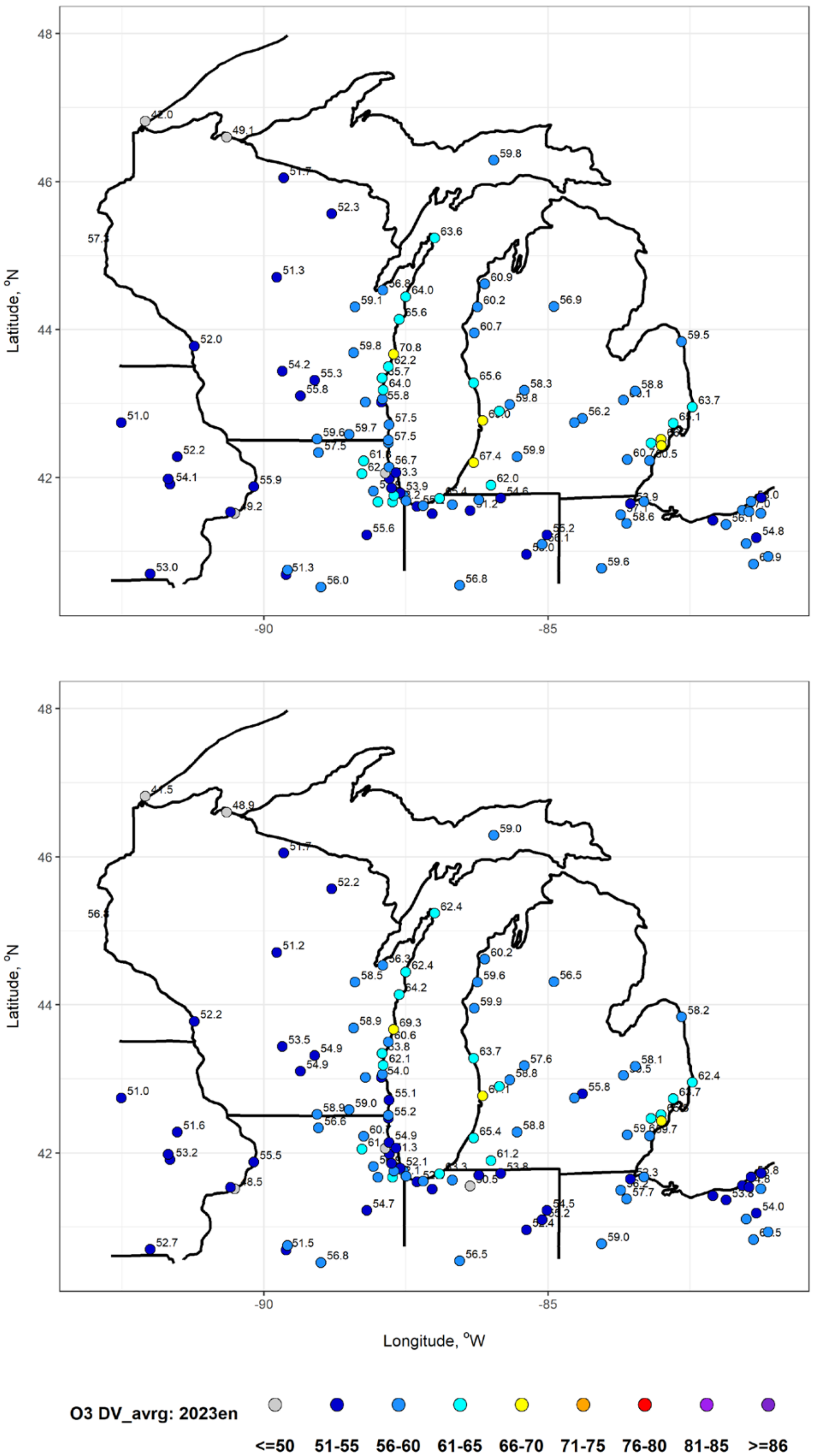

Figure 27. EPA (top) and LADCO (bottom) 2023 DVFs; LADCO zoom.

Table 7. LADCO and EPA 2023 O_3 design values at nonattainment and maintenance monitors in the Midwest and Northeast

AQS ID	County	ST	LADCO 3x3 avrg	LADCO 3x3 max	EPA 3x3 avrg	EPA 3x3 max	2009-2013 3x3 avrg	2009-2013 3x3 max
361030002	Suffolk	NY	69.8	**71.3**	**72.5**	**74.0**	83.3	85.0
90019003	Fairfield	CT	69.6	**72.4**	**72.7**	**75.6**	83.7	87.0
240251001	Harford	MD	69.4	**71.8**	**71.4**	**73.8**	90.0	93.0
551170006	Sheboygan	WI	69.3	**71.5**	70.8	**73.1**	84.3	87.0
360850067	Richmond	NY	69.1	70.6	**71.9**	**73.4**	81.3	83.0
90099002	New Haven	CT	67.9	70.5	**71.2**	**73.9**	85.7	89.0
90013007	Fairfield	CT	67.8	**71.6**	**71.2**	**75.2**	84.3	89.0
261630019	Wayne	MI	67.7	69.7	69.0	**71.0**	78.7	81.0
360810124	Queens	NY	67.5	69.2	70.1	**71.9**	70.0	71.0
90010017	Fairfield	CT	67.2	69.4	69.8	**72.1**	78.0	80.0
260050003	Allegan	MI	67.1	69.8	69.0	**71.8**	80.3	83.0
550790085	Milwaukee	WI	62.1	65.1	64.0	67.0	78.3	82.0

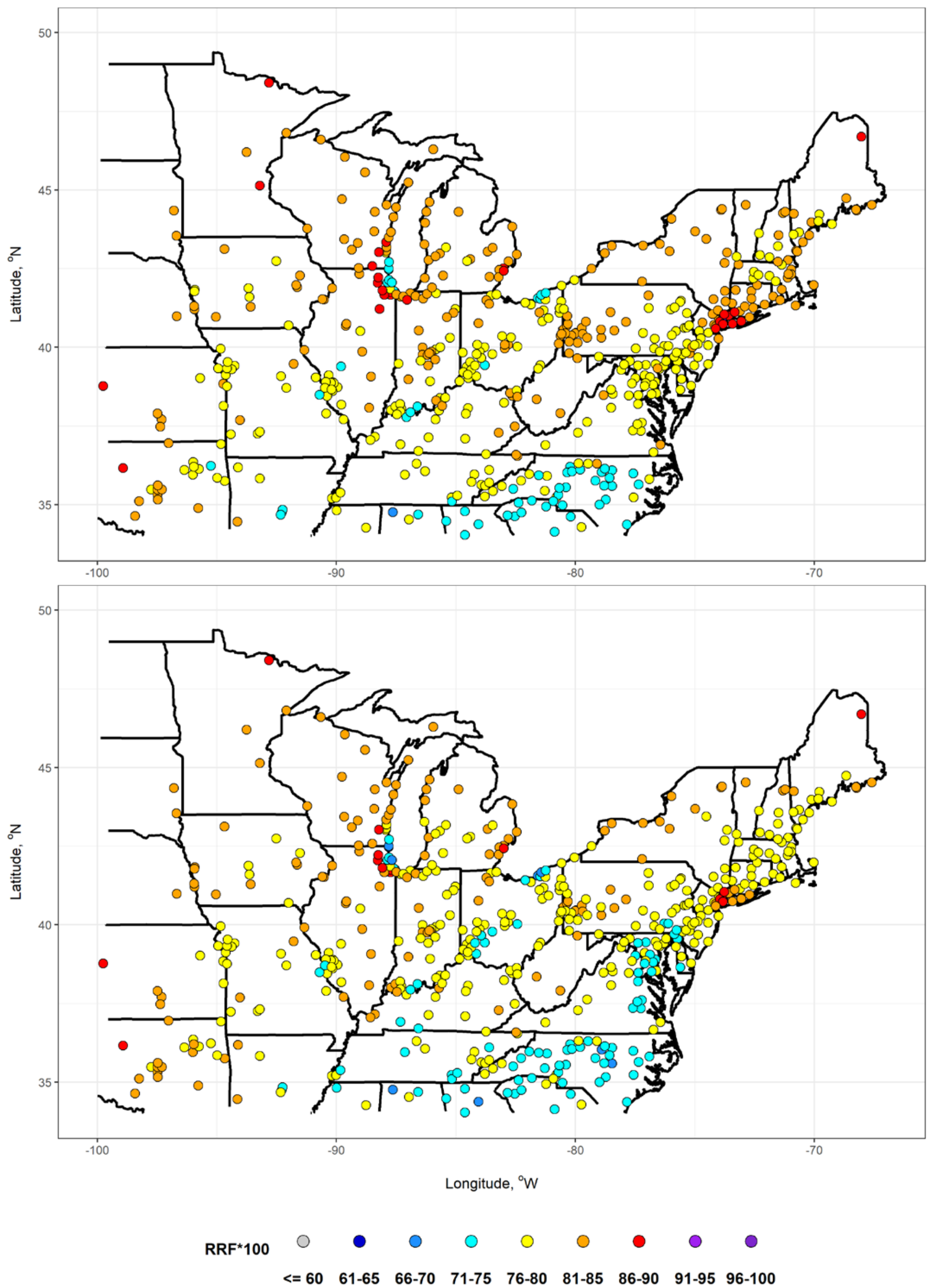

Figure 28. EPA (top) and LADCO (bottom) 2023 RRFs.

5.4.2 Impacts of Water Cells on Design Values

Confidence in the ability of photochemical models to accurately estimate O_3 over water is a persistent concern with the use of the models for air quality planning. This concern recently prompted measurement campaigns in the Eastern U.S. to address the issue (see Lake Michigan Ozone Study and Long Island Sound Tropospheric Ozone Study). The meteorology and chemistry processes in model grid cells that are dominated by water (> 50% landuse area) are a challenge to simulate because the conventional technical formulations of the models were not optimized for water cells. Even with the introduction of new algorithms to simulate the dynamical and chemical features of water cells, a lack of over-water observations hinders our ability to verify the accuracy of the models in simulating these conditions. In consideration that the models may not perform well in simulating water cells, EPA and others have presented alterative DVF calculation approaches that exclude water cells. Although not explicitly listed in Attachment A of the EPA's March 2018 memo on O_3 Transport Modeling as a flexibility to consider in developing a Good Neighbor SIP, the EPA used the exclusion of water cells in their own DVF calculations (US EPA, 2017a; US EPA, 2018). EPA implicitly endorses the exclusion of water cells when calculating DVFs in their most recent technical guidance for Good Neighbor SIPs (US EPA, 2018).

Exercising this flexibility does not require additional CAMx simulations. It is implemented through a postprocessing sequence per EPA (2018) in which model grid cells that are dominated by water (> 50% landuse area) are removed from the 3x3 matrix in the RRF and DVF calculation. One important modification to this process is to override the exclusion condition for cells that contain monitors; in other words, grid cells that contain monitors will be included in the 3x3 matrix regardless of the amount of water coverage in the cell. For the results presented here, LADCO used EPA postprocessing utilities and scripts that were developed to support their March 2018 memo.

Figure 29, Figure 30, and Table 8 present the impacts of excluding water cells in the DVF calculations for the LADCO and EPA 2023 simulations. Figure 29 and Figure 30 compare the water/no-water DVFs and RRFs for the LADCO simulation, respectively. ***In general, including water cells in the attainment test calculation results in lower DVFs for the lakeshore monitors in the LADCO region.*** A few key downwind monitors (Harford, MD; Richmond, NY; New Haven, CT) have higher DVFs when water cells are included in the calculation.

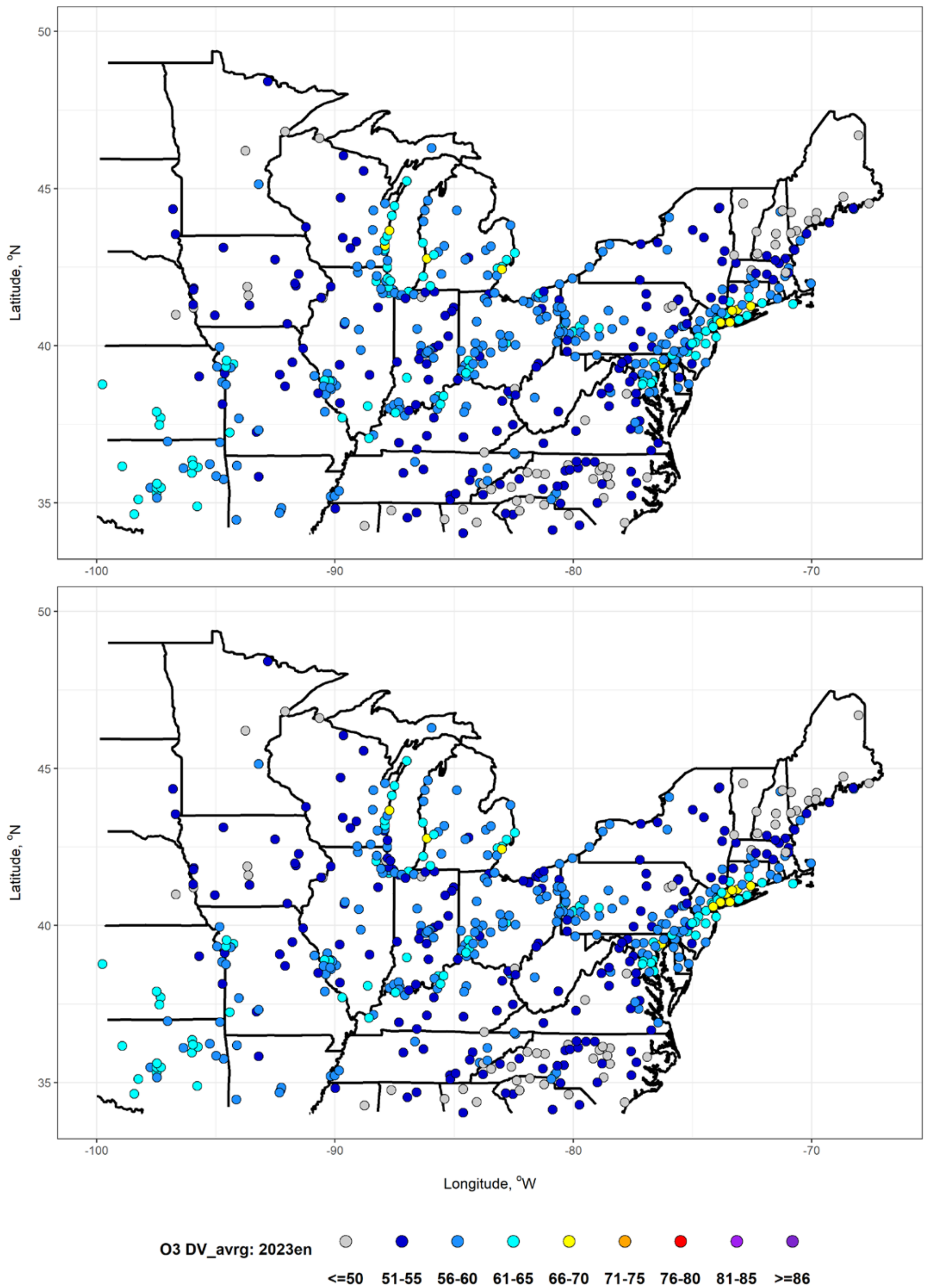

Figure 29. Ozone DVFs calculated with water cells excluded (top) and included (bottom) for the LADCO 2023 CAMx simulation.

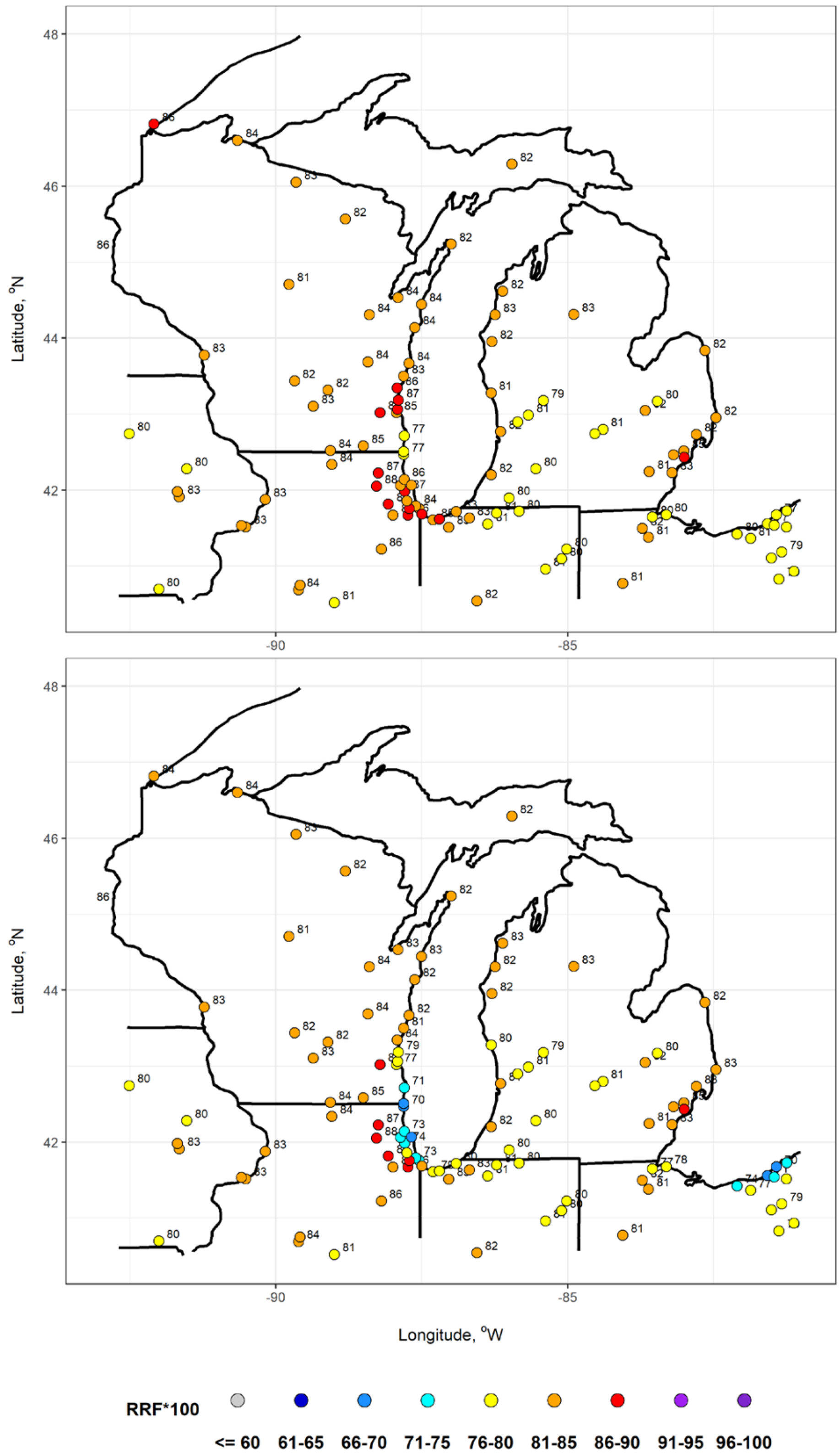

Figure 30. Ozone RRFs calculated with water cells excluded (top) and included (bottom) for the LADCO 2023 CAMx simulation.

Table 8. LADCO and EPA 2023 O_3 DVFs with and without water cells

AQS ID	County, ST	LADCO Water		LADCO No Water		EPA Water		EPA No Water	
		3x3 avrg	3x3 max	3x3 avrg	3x3 max	3x3 avrg	3x3 max	3x3 avrg	3x3 max
361030002	Suffolk, NY	69.8	71.3	70.8	72.2	72.5	74.0	74.0	75.5
90019003	Fairfield, CT	69.6	72.4	70.1	72.9	72.7	75.6	73.0	75.9
240251001	Harford, MD	69.4	71.8	69.2	71.5	71.4	73.8	70.9	73.3
551170006	Sheboygan, WI	69.3	71.5	70.9	73.2	70.8	73.1	72.8	75.1
360850067	Richmond, NY	69.1	70.6	64.5	65.8	71.9	73.4	67.1	68.5
90099002	New Haven, CT	67.9	70.5	66.8	69.4	71.2	73.9	69.9	72.6
90013007	Fairfield, CT	67.8	71.6	68.1	71.9	71.2	75.2	71.0	75.0
261630019	Wayne, MI	67.7	69.7	67.7	69.7	69.0	71.0	69.0	71.0
360810124	Queens, NY	67.5	69.2	67.1	68.8	70.1	71.9	70.2	72.0
90010017	Fairfield, CT	67.2	69.4	65.8	68.0	69.8	72.1	68.9	71.2
260050003	Allegan, MI	67.1	69.8	67.4	70.1	69.0	71.8	69.0	71.7
550790085	Milwaukee, WI	62.1	65.1	68.0	71.2	64.0	67.0	69.7	73.0

5.4.3 Model Bias Filtering

Under the Step 1 flexibilities for Good Neighbor SIP analyses in the EPA March 2018 memo, EPA says that states may "[c]onsider removal of certain data from modeling analysis for the purposes of projecting design values and calculating the contribution metric where data removal is based on model performance and technical analyses support the exclusion." Per this flexibility, for the monitors analyzed in this document LADCO filtered the days used for calculating RRFs and DVFs with an absolute bias threshold of 15%. Instead of calculating RRFs at each monitor from the 10 highest concentration MDA8 modeled days in the base year, we used the 10 highest days with absolute biases <= 15%. We applied the bias filtering to the attainment test calculations that include water cells.

Table 9 and Table 10 compare the LADCO and EPA O_3 DVFs and RRFs with and without bias filtering. The change in the LADCO average DVFs from applying the bias filtering ranged from a 2.2% decrease for the Fairfield, CT (AIRS ID: 90019003) monitor to a 4.8% increase for the Milwaukee, WI (AIRS ID: 550790085) monitor. Although the percentage differences from applying the bias filters are not exactly the same between the two CAMx simulations, the impacts to the EPA average DVFs was proportional to the LADCO DVF calculations. In other words, the bias filtering causes the DVFs to change in the same direction for both simulations. The bias filtering also had comparable impacts on both the average and maximum DVFs. ***Applying the bias filter increases the DVFs at the Sheboygan, WI; Allegan, MI, and Milwaukee, WI monitors; the DVF at the Wayne, MI monitor decreases with the application of the bias filter.*** It should be noted that the bias filtering has more of an impact on the DVFs when water cells are included in the attainment test calculations (these results are not shown here).

Table 9. LADCO 2023 O_3 DVFs and RRFs with and without bias filtering

AQS ID	County, ST	LADCO Water 3x3 avrg	LADCO Water 3x3 max	LADCO Water RRF	Bias < 15% 3x3 avrg	Bias < 15% 3x3 max	Bias < 15% RRF
361030002	Suffolk, NY	69.8	**71.3**	0.8390	70.5	**71.9**	0.8465
90019003	Fairfield, CT	69.6	**72.4**	0.8327	68.1	70.8	0.8139
240251001	Harford, MD	69.4	**71.8**	0.7721	69.7	**72.1**	0.7755
551170006	Sheboygan, WI	69.3	**71.5**	0.8224	70.7	**73.0**	0.8391
360850067	Richmond, NY	69.1	70.6	0.8510	69.6	**71.1**	0.8573
90099002	New Haven, CT	67.9	70.5				
90013007	Fairfield, CT	67.8	**71.6**	0.8048	67.1	70.8	0.7965
261630019	Wayne, MI	67.7	69.7	0.8613	66.4	68.3	0.8443
360810124	Queens, NY	67.5	69.2	0.8658	66.5	68.2	0.8530
90010017	Fairfield, CT	67.2	69.4	0.8371	67.2	69.5	0.8381
260050003	Allegan, MI	67.1	69.8	0.8117	67.9	70.6	0.8219
550790085	Milwaukee, WI	62.1	65.1	0.7943	65.1	68.2	0.8325

Table 10. EPA 2023 O_3 DVFs and RRFs with and without bias filtering

AQS ID	County, ST	EPA Water 3x3 avrg	EPA Water 3x3 max	EPA Water RRF	Bias < 15% 3x3 avrg	Bias < 15% 3x3 max	Bias < 15% RRF
361030002	Suffolk, NY	**72.5**	**74.0**	0.8710	**73.2**	**74.7**	0.8795
90019003	Fairfield, CT	**72.7**	**75.6**	0.8690	70.7	**73.5**	0.8456
240251001	Harford, MD	**71.4**	**73.8**	0.7939	**71.7**	**74.1**	0.7968
551170006	Sheboygan, WI	70.8	**73.1**	0.8409	**72.9**	**75.2**	0.8651
360850067	Richmond, NY	**71.9**	**73.4**	0.8850	**73.1**	**74.6**	0.8992
90099002	New Haven, CT	**71.2**	**73.9**				
90013007	Fairfield, CT	**71.2**	**75.2**	0.8451	69.9	**73.8**	0.8293
261630019	Wayne, MI	69.0	**71.0**	0.8768	67.6	69.6	0.8593
360810124	Queens, NY	70.1	**71.9**	0.8998	69.1	70.8	0.8860
90010017	Fairfield, CT	69.8	**72.1**	0.8697	69.5	**71.8**	0.8657
260050003	Allegan, MI	69.0	**71.8**	0.8349	69.3	**72.1**	0.8388
550790085	Milwaukee, WI	64.0	67.0	0.8179	68.1	**71.4**	0.8710

6 Significant Findings

References

Cross State Air Pollution Rule (CSAPR), 76 Fed. Reg. § 48,208 (final rule Aug 8, 2011)(to be codified at 40 C.F.R. pts. 51, 52, 72, 78, 97).

Cross State Air Pollution Rule (CSAPR) Update, 81 Fed. Reg. § 74,504 (final rule Oct. 26, 2016)(to be codified at 40 C.F.R. pts. 52, 78, 97).

LADCO. 2018. Interstate Transport Modeling for the 2015 Ozone NAAQS, CAMx Source Apportionment Modeling Protocol. Rosemont, IL. [Add Link]

US EPA. 2018. Memorandum: Information on the Interstate Transport State Implementation Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards under Clean Air Act Section 110(a)(2)(D)(i)(I), Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2018-03/documents/transport_memo_03_27_18_1.pdf

US EPA. 2017. Memorandum: Supplemental Information on the Interstate Transport SIP Submissions for the 2008 Ozone NAAQS under Clean Air Act Section 110(a)(2)(D)(i)(I), Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2017-10/documents/final_2008_o3_naaqs_transport_memo_10-27-17b.pdf.

US EPA. 2017b. Technical Support Document: Additional Updates to Emissions Inventories for the Version 6.3 Emissions Modeling Platform for the Year 2023. Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2017-11/documents/2011v6.3_2023en_update_emismod_tsd_oct2017.pdf

US EPA. 2016. Air Quality Modeling Technical Support Document for the 2015 Ozone NAAQS Preliminary Interstate Transport Assessment. Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2017-01/documents/aq_modeling_tsd_2015_o3_naaqs_preliminary_interstate_transport_assessmen.pdf

US EPA. 2015. Air Quality Modeling Technical Support Document for the 2008 Ozone NAAQS Cross-State Air Pollution Rule Proposal. Research Triangle Park, NC. https://www.epa.gov/sites/production/files/2015-11/documents/air_quality_modeling_tsd_proposed_rule.pdf

US EPA. 2014. Meteorological Model Performance for Annual 2011 WRFv3.4 Simulation. Research Triangle Park, NC. https://www3.epa.gov/ttn/scram/reports/MET_TSD_2011_final_11-26-14.pdf.

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

Ramboll-Environ. 2016. User's Guide: Comprehensive Air Quality Model with Extensions version 6.40. Novato, CA. http://www.camx.com/files/camxusersguide_v6-40.pdf

Table 11. APCA Source Regions

FIPS	APCA Region ID	NAME
N/A	1	Biogenic
17	2	Illinois
55	3	Wisconsin
18	4	Indiana
39	5	Ohio
26	6	Michigan
27	7	Minnesota
19	8	Iowa
29	9	Missouri
5	10	Arkansas
22	11	Louisiana
48	12	Texas
40	13	Oklahoma
20	14	Kansas
31	15	Nebraska
Multiple	16	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island
9	17	Connecticut
36	18	New York
34	19	New Jersey
42	20	Pennsylvania
10	21	Delaware
24	22	Maryland
	23	Washington DC
54	24	West Virginia
51	25	Virginia
Multiple	26	North Carolina, South Carolina, Tennessee, Georgia, Alabama, Mississippi, Florida
21	27	Kentucky
Multiple	28	Arizona, Colorado, Utah, Wyoming, Montana, North Dakota, South Dakota, Idaho,

FIPS	APCA Region ID	NAME
		Washington, Oregon, California, Nevada
N/A	29	Canada/Mexico
N/A	30	Offshore
N/A	31	Tribal
N/A	32	Fire

MINNESOTA POLLUTION CONTROL AGENCY

Attachment 2:

Documentation of ERTAC EGU CONUS Versions 2.7 Reference and CSAPR Update Compliant Scenario

Lake Michigan Air Directors Consortium (LADCO) | 17 pages | September 2017

Documentation of ERTAC EGU CONUS Versions 2.7 Reference and CSAPR Update Compliant Scenario

9/23/2017

ERTAC EGU Committee

Contents

Introduction

The ERTAC Electricity Generating Unit (EGU) Committee develops reference runs for the continental United States (CONUS). CONUS 2.7 is based on 2011 base year continuous emission monitoring (CEM) data and growth factors from the AEO2017 projection that does not include the Clean Power Plan (US Energy Information Administration January 2017). Input files to version 2.7, were developed using input received by June 2017 from a significant outreach effort to states and stakeholders. Final V2.7 runs were done by VA DEQ and OTC in September 2017. The contact person for questions about these run files is Doris McLeod (804-698-4197) for all runs except 2023. For 2023, the contact person is Joseph Jakuta (jjakuta@otcair.org). CONUS 2.7 includes both a reference run and a Cross State Air Pollution Update (CSAPR Update) Rule (81 FR 74504) compliant scenario. The reference run includes only unit change information provided by states. The CSAPR Update compliant run include additional unit adjustments, described further in this text, agreed upon by the ERTAC EGU committee to represent the EGU sector operating in compliance with the CSAPR Update rule. Projections for reference case runs have been prepared for years 2017, 2018, 2019, 2020, 2023, 2025, and 2030. Projections for CSAPR Update compliant scenario have been prepared for years 2020, 2023, 2025, 2028, and 2030. The CSAPR Update compliant files are described also as optimized runs. File names that pertain to the CSAPR Update compliant run include the “opt” identifier in file names.

The ERTAC EGU Committee maintains and distributes reference runs for the continental United States (CONUS), including the hourly input, output, summary, and documentation files for each run. These reference runs and the CSPR Update Compliant Scenario and complete documentation of the ERTAC EGU Tool is located on the MARAMA web site located here:

http://www.marama.org/2013-ertac-egu-forecasting-tool-documentation

ERTAC Input Files

The ERTAC EGU Tool input files are built by the ERTAC leadership committee from a wide variety of existing data. These input files are subject to periodic quality assurance and updating by state agency staff. Agencies provide information on new units and controls, fuel switches, shutdowns and other unit-specific changes. In addition, the ERTAC EGU growth committee prepares updates to the growth factors when new versions of the Energy Information Agency (EIA) Annual Energy Outlook (AEO) become available. Periodic updates of these input files drive creation of new run versions. The ERTAC EGU tool projects fossil fuel fired units that report emissions to USEPA Clean Air Markets Division (CAMD) and serve a generator of at least 25 MW (there are some exemptions in the North East where units are sized less than 25 MW).

A key data source are the hourly reports of generation and emissions collected by CEM and electronically reported to CAMD by facilities for the base year, in this case 2011. Base year SO_2 and NO_X emission rates (lb/mmbtu) are calculated from this data. Future emission rates are developed from base year rates adjusted to account for state knowledge of expected emission controls, fuel switches, retirements, and new units.

The primary sources of expected future change in generation is the Energy Information Agency (EIA) annual projection of future generation and the National Energy Reliability Corporation (NERC) projection of peak generation rates. This information is available by region and fuel type. Where states have local projections these are preferred over national sources. Future generation by unit is estimated by merging these national, regional and state growth files with state knowledge of unit level changes. Hourly future emissions of NO_X and SO_2 are calculated by multiplying hourly projected future heat input by future emission rates.

ERTAC EGU Tool input files are as follows:

- **Base Year Hourly CEM data** – This comma separated file contains hourly unit level generation and emissions data extracted from EPA's CAMD database. In unit-specific situations where base year hourly data needs to be modified, users provide a non-CAMD hourly file, which may be used to adjust or add data to the base year hourly CEM file.
- **Unit Availability File (UAF)** – This tabular file contains descriptions of each generating unit derived from a variety of sources, including the CAMD NEEDS database, state input, EIA Form 860, and NERC data. Each row in the table represents a single generating unit. This file is maintained and updated by the ERTAC committee and provides information on changes to specific units from the base to the future year. For example, the UAF captures actual or planned changes to utilization fractions, unit efficiency, capacity, or fuels. State/Local/Tribal (S/L/T) agencies also add information on actual and planned new units and shutdowns.
- **Control File** – This tabular file contains known future unit specific changes to SO_2 or NO_X emission rates (in terms of lbs/mmBtu) and/or control efficiencies (for example, addition of a scrubber or selective catalytic reduction system). This information is provided by S/L/T agency staff. This file also provides emission rates for units that did not operate in the base year.
- **Seasonal Controls File** – This optional tabular file may be used by S/L/T agencies to enter seasonal or periodic future year emissions rates for specific units for use in future year runs. This file may be used in addition to, or as an alternative to, the Control File.
- **Input Variables File** – This tabular file specifies values for a number of variables used in a particular projection run.
    - **Regions and Fuel Characteristics** are not hardwired into the model. Rather, the regions and their characteristics are specified in the Input Variables File. This file allows the S/L/T agencies to specify variables such as the size, fuel type and location for new units. In addition, the regional scheme and fuel types are specified in this file.
    - **Default New Unit Emission Rates.** Percentile of best performing existing unit emission rates for use in new units. Default is 90th percentile.
    - **New Unit Hourly Profile Characteristics.** For new planned units and generation deficit units (GDUs), users may specify in this file the percentile ranking of the existing unit (operated in the base year) used to create a representative future profile of activity for new units and GDUs.
- **Growth Factor File** – This tabular file contains the annual, nonpeak and peak electrical generation growth factors delineated by geographic region and generating unit type used in a particular run.
    - **Peak Growth and Transition Hours**. The number of peak and transition hours, differentiated by fuel and region, are assigned in the Growth Factor File.
- **Demand Transfer File** – This optional file allows users to transfer power, on an hourly basis, from one region/fuel-unit type to another. It also allows transfer to or from other, non-fossil fuel fired systems such as nuclear and renewables.

Growth factors

Generation for future years by fuel type are based on growth rates which are differentiated by annual, nonpeak, and peak rates.

Annual growth rates are developed by the ERTAC EGU Growth subcommittee from the EIA Annual Energy Outlook (AEO) and NERC projections. In certain cases, S/L/T agencies have developed more refined region specific growth factors which are then used to replace the EIA/NERC factors developed from other information sources, along with supporting documentation for those growth rates. EIA annual average regional growth factors are calculated by dividing AEO future projected generation by base year generation.

Peak growth rates are derived by determining relative peak growth from NERC Electricity Supply & Demand (ES&D) data and applying it to the annual growth rates. The derived relative peak growth rates are not delineated by fuel so the ratio of peak to nonpeak growth rates for each fuel within a single region is constant.

Nonpeak growth rates are calculated within the ERTAC EGU Tool using annual and peak growth rates. Annual average regional growth rates are adjusted to account for the peak hours.

Peak and nonpeak growth is assigned to every hour by ordering all hours of the year by base year utilization. The peak growth factor is assigned by fuel to a limited number of hours with the highest utilization in the base year. Growth is then transitioned gradually to non-peak growth rate. The number of peak and transition hours are differentiated by fuel and region and are assigned in the Input Variables File. Figure 1 shows graphically the relationship between annual, peak and nonpeak growth rates.

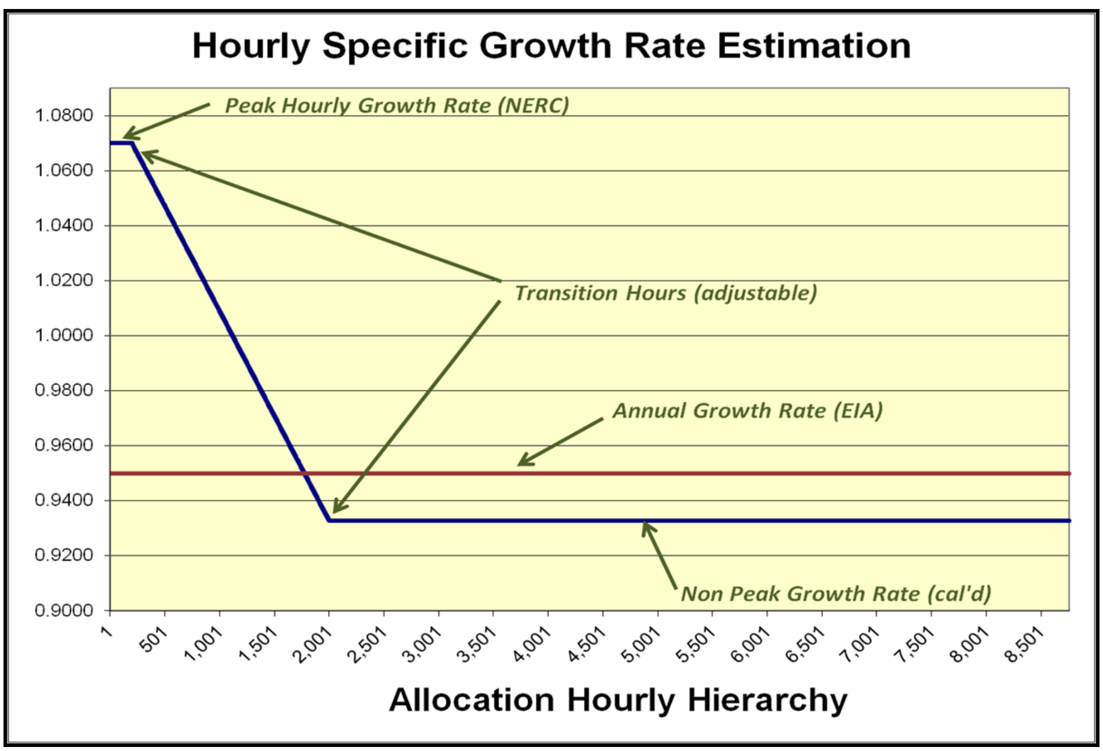

Figure 1. Relationship between the annual, peak, and nonpeak growth rates

Finally, fuel specific hourly regional growth factors are adjusted to account for activity from new units and shutdowns. The tool then applies the adjusted hourly growth factors to the base year hourly generation data to estimate hourly future generation. This generation is assigned to the units burning the specified fuel within the region. After generation is assigned, the tool confirms that unit capacity is not exceeded. If the available capacity is fully utilized new, generic units ("Generation Deficit Units") are created to carry demand that exceeds known unit capacity.

NO_X and SO_2 Emissions

For base year runs, actual CAMD data is averaged to calculate base year ozone season and non-ozone season emission rates.

For future year runs, calculated base year average emission rates for existing units are adjusted to account for new control equipment or other changes provided in the input files.

For new units, two approaches are employed. First, if a state provides new unit emission rates those are used directly. Where emission rates are not provided, these are estimated based on the 90th percentile best performing existing unit for that fuel type and region. The user may adjust this percentile within the input variables file. These rates are applied to each unit's future generation to calculate NO_X and SO_2 emissions.

Output

The ERTAC tool generates hourly generation and emissions for each unit included in the system. In addition, post processors create summary files to facilitate review of the results, as follows:

- Annual base and future year generation (MW-hrs), heat input (mmbtu), SO_2, NO_X emission (tons) and average emission rate (lbs/mmbtu)
- Ozone season base and future year generation and heat input, NO_X emission (tons) and average emission rate (lbs/mmbtu)

Post processors are also available to generate CO_2 estimates.

Geographic Regional System

Each EGU unit included in the model is assigned to a geographic region and fuel type bin in the Unit Availability File. The geographic regional system provided in Figure 2 is used in versions 2.7 reference and CSAPR Update compliant runs is the EIA Electricity Market Module (EMM) regional system. One adjustment that the EIA EMM system for the ERTAC EGU system is that SPNO and SPSO have been combined into a single region.

Because the EIA EMM and NERC regions are not identical, adjustment is required to align these regional systems to develop annual and peak growth rates. To match EIA and NERC, a "best fit" NERC regional growth factor is assigned to each EMM region. In the simplest case, where a clear match between EIA and NERC regional schemes exists, for example NPCC-New England, the NERC relative peak growth rate is assigned to the corresponding EMM region. In more complicated cases, where multiple EMM regions corresponded to a single NERC region, or where regions were organized along substantially different geographic boundaries, the NERC ES&D data was aggregated and averaged to generate a relative peak growth factor for the (usually larger) corresponding NERC region and was applied to the corresponding ERTAC region (which closely resemble the EMM regions). As an example, the EIA SRVC, RFCW, and RFCE regions corresponds to two NERC regions, PJM and SERC East. In this case, the relative peak growth factors were derived from PJM and SERC East and applied to SRVC, RFCW, and RFCE ERTAC regions.

Within each region, individual generation units are further delineated into five unit types as follows:

- Coal;
- Oil;
- Natural Gas – Combined Cycle;
- Natural Gas – Single Cycle;
- Natural Gas – Boiler gas.

Figure 2: Regional boundaries for coal generation, CONUSv2.7

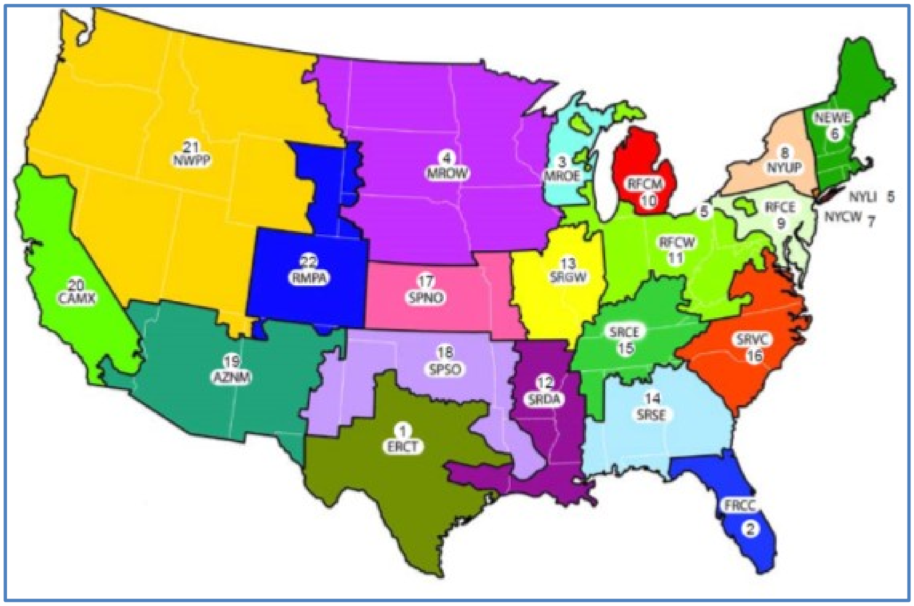

Figure 4: EMM to NERC Crosswalk – ERTAC EGU V2.7

EMM Fuel Region #	Fuel	EMM Region Name	ERTAC Regional Code	Single "Best-Fit" NERC Subregion Peak Growth Code
1	Coal, NG, Oil	Texas Regional Entity (ERCT)	ERCT	ERCOT
2	Coal, NG, Oil	Florida Reliability Coordinating Council (FRCC)	FRCC	FRCC
3	Coal, NG, Oil	Midwest Reliablity Council / East (MROE)	MROE	MISO / SPP / SERC-N
4	Coal, NG, Oil	Midwest Reliablity Council / West (MROW)	MROW	MISO / SPP / SERC
5	Coal, NG, Oil	Northeast Power Coordinating Council / Northeast (NEWE)	NEWE	NPCC - NE
6	Coal, NG, Oil	Northeast Power Coordinating Council / NYC Westchester (NYCW)	NYCW	NPCC - NY
7	Coal, NG, Oil	Upstate New York (NYUP)	NYUP	NPCC – NY
8	Coal, NG, Oil	Long Island (NYLI)	NYLI	NPCC - NY
9	Coal, NG, Oil	Reliability First Corporation / East (RFCE)	RFCE	PJM / SERC - E
10	Coal, NG, Oil	Reliability First Corporation / Michigan	RFCM	MISO / SPP / SERC
11	Coal, NG, Oil	Reliability First Corporation / West	RFCW	PJM / SERC - E
12	Coal, NG, Oil	SERC Reliability Corporation / Delta (SRDA)	SRDA	MISO / SPP / SERC
13	Coal, NG, Oil	SERC Reliability Corporation / Gateway (SRGW)	SRGW	MISO / SPP / SERC
14	Coal, NG, Oil	SERC Reliability Corporation / Southeastern (SRSE)	SRSE	SERC - SE
15	Coal, NG, Oil	SERC Reliability Corporation / Central (SRCE)	SRCE	MISO / SPP / SERC
16	Coal, NG, Oil	SERC Reliability Corporation / Virginia Carolina (SRVC)	SRVC	PJM / SERC - E
17+18	Coal, NG, Oil	SouthWest Power Pool / North (SPNO) + South (SPSO)	SPPR	MISO / SPP / SERC
19	Coal, NG, Oil	Western Electricity Coordinating Council / Southwest (AZNM)	AZNM	WECC-WECC-SWSG
20	Coal, NG, Oil	Western Electricity Coordinating Council / California (CAMX)	CAMX	WECC-CAMX US
21	Coal, NG, Oil	Western Electricity Coordinating Council / Northwest Power Pool Area (NWPP)	NWPP	WECC-NWPP US
22	Coal, NG, Oil	Western Electricity Coordinating Council / Rockies (RMPA)	RMPA	WECC-WECC-RMRG

Details of Version 2.7 Reference and CSAPR Update compliant Runs

ERTAC EGU v2.7 was built on improvements to prior runs and included updates to the UAF and control file from states received as of July. A summary of the inputs used to develop the ERTAC EGU v2.7 Reference and CSPAR Compliant runs for the continental United States are shown in Figures 5 and 6 respectively. Details of these changes may be found in the change log document. (ERTAC 2017a)

ERTAC EGU Code 2.1 – Both V2.7 Reference and CSAPR Update compliant Scenario

Version 2.7 was the first usage of the ERTAC EGU v2.1 code. V2.1 added a new functionality, including the ability to transfer of load between fuel types and regions. Use of this transfer functionality is described later in this document. (ERTAC 2017b)

Regional Boundaries Growth Rates– Both V2.7 Reference and CSAPR Update compliant Scenario

AEO regions SPSO and SPNO were aggregated into a single region called SPPR for the coal fuel type only. - SPP operates as a single balancing authority and single wholesale market for the SPPR region. Hence growth in wholesale power production occurs within that single market construct. Application of differential growth rates by fuel type between SPPS and SPPN obscures that single market construct and can produce counter-intuitive fuel-specific emissions forecasts. Combining the individual net generation forecasts for a single fuel type allows for an accurate averaging of the growth rates into an integrated whole. The anticipated outcome will be more reflective of the generation efficiencies and relative fuel balance based on the application of a single wholesale market construct. Since there have been issues of predicted over-emissions in one or more of the states (most notably Oklahoma) when forecasting the two independent smaller regions within the ERTAC construct, the bigger regional footprint partially alleviates this specific problem due to the rebalanced loading for each fuel-unit type.

Growth Rates – Both V2.7 Reference and CSAPR Update compliant Scenario

Growth factors used in both v2.7 reference and CSAPR Update compliant scenario were developed based on AEO2017 No Clean Power Plan Case. Relative peak factors were derived from 2016 NERC Electricity Supply & Demand (ES&D). The file containing annual and peak growth factors was provided by Tom Shanley of the ERTAC EGU Growth committee and is named:

CONUSv2.7_AEO2017Ref_noCPP_SPPR_T2017_2030_ertac_growth_rates_7-17-2017.xlsx

These growth factors and default growth curve parameters were used with the following exceptions:

- **SRVC**[1] replaced AEO growth rates and growth curve shape with values based on regional knowledge for combined cycle, Boiler gas and simple cycle fuel bins. The updated local values were used for all future year projections. Development of the local values is described in a memo included as an appendix to this document. Specific changes include:
    - **Combined Cycle** peak to nonpeak growth transition points were set to 200 and 2000 to reflect the fairly large difference in average and peak growth rates (AGR and PGR).
    - **Boiler Gas and Simple Cycle** transition points were set to 100 and 1000 to reflect the large difference in AGR and PGR and ameliorate the Generation Deficit Units (GDU)
    - Any year not included in the SRVC memo was interpolated between SRVC information.

[1] updated using PGR/AGR information in email dated August 8, 2017, transmitted via email from Ming Xie of NC on August 9, 2017.

- o **NYCW**[2] replaced AEO annual growth rates with values based on regional knowledge for all fuel bins. The updated local values were developed for 2020 and 2025 and interpolated[3] for use for all future year projections. Development of the local values is described in a memo included as an appendix to this document. Specific changes include: xxx
- o **RFCE and RFCM** default growth curve transition points for the combined cycle fuel bin (CC) were replaced with 100 and 1000 to reflect the large growth and increased reliance on CC for base loaded operation in those regions.
- o **SRGW** boiler gas peak growth rate for 2028 and 2030 was reduced to 0.98 so that the infinite GDU bug is not triggered. Annual growth rate was not affected.

ERTAC Demand Transfer– Both V2.7 Reference and CSAPR Update compliant Scenario

Demand transfer is a new concept made possible by use of the new v2.1 ERTAC EGU code. The concept is to transfer some demand for particular hours from one fuel bin to alleviate the generation of a GDU. Another use for a demand transfer is the case where a significant system change occurs which was not anticipated by the EIA in the AEO. The example in V2.7 is the retirement of a large nuclear power plant near New York City. This results in other fuel bins having to provide a large amount of generation that was unanticipated by the EIA in the AEO.

Transfers to prevent a coal fired GDU

- o **NEWE** 300 MW-hrs was transferred from coal to combined cycle fuel bins in 861 deficit hours to prevent a coal fired GDU. There were 2000 MWs of unused CC capacity in NEWE. This transfer was done in every future year projected.
- o **FRCC** Coal generation was transferred to the combined cycle fuel bin for certain hours to prevent a coal fired GDU. There was significant unused combined cycle capacity in FRCC.[4] This transfer was done in every future year projected. However, the amount of generation transferred, and the number of hours required varied by projection year as follows:
    - § 2017 – No transfer required
    - § 2018 – 2500 MW-hr coal to CC in 1259 deficit hours
    - § 2019 – 1000 MW-hr coal to CC in 241 deficit hours
    - § 2020 – 1300 MW-hr coal to CC in 444 deficit hours
    - § 2023 – 600 MW-hr coal to CC in 59 deficit hours
    - § 2025 – 600 MW-hr coal to CC in 90 deficit hours
    - § 2028 – 1000 MW-hr coal to CC in 2040 deficit hours
    - § 2030 – 1000 MW-hr coal to CC in 239 deficit hours

[2] NY memo to MARAMA, dated 02-11-2016

[3] 2020 interpolated growth rates were approved by Ona Papageorgiou (NY) in an email dated 8/1/2017 from Ona to D. McLeod (VA)

[4] FL staff (Hastings Read) approved this approach in an email dated August 9, 2017, to D. McLeod, titled, "RE: FRCC updates for ERTAC CONUS2.7.

Transfers to ameliorate disappearing generation bug

- **RFCE** – In the 2023 and 2025 projection 300 MWh of coal generation in RFCE was transferred to Combined Cycle for each of 4 hours to ameliorate missing generation due to Utilization Fraction limitations on coal fired units. The table below shows the 4 hours. RFCE combined cycle has significant new capacity in 2023, and at least 1000 MW of unused capacity.

Figure XXX Coal Generation in RFCE Transferred to Combined Cycle to Ameliorate Missing Generation

	B	C	D	E	F	H	I	J	O	P	Q
	ertac_fuel_unit_type_bin	op_date	op_hour	calendar_hour	temporal_allocation_order	base_actual_generation	base_retired_generation	future_projected_generation	afygr	excess_generation_pool	
56	Coal	8/14/2011	14	5415	3471	11353	719.7	10048.17034	0.944971959	39.09317901	
57	Coal	8/14/2011	15	5416	3472	11678.6	718.5	10336.34829	0.943088866	128.5455752	
58	Coal	8/14/2011	16	5417	3473	11809.4	710.3	10452.1151	0.941708346	120.9371685	
59	Coal	8/14/2011	17	5418	3474	11830.9	696.9	10471.14405	0.940465606	82.56722527	
02											
03											

Transfers to address nuclear retirement

- **NYCW** - Indian Point nuclear power plant is scheduled to retire in 2021. John Barnes of NY (email dated 7/13/2017) advised that the nuclear transfers should be limited to years after 2021. (2021/2023/2028)

INPUT VARIABLES – BOTH V2.7 REFERENCE AND CSAPR UPDATE COMPLIANT SCENARIO

In SRVC the combined cycle percentile was set at 50th, coal to 70%, and simple cycle to 70th. This was based on region specific sizes, capacities, and characteristics.

NON-CAMD HOURLY FILE– BOTH V2.7 REFERENCE AND CSAPR UPDATE COMPLIANT SCENARIO

A small group of units with abnormal or missing base year hourly data are not assigned any generation by the tool in the future year. To correct this issue, these units are assigned one hour of reasonable, minimal activity in the non-CAMD hourly file to ensure processing. This improvement has negligible impact on base year data.

For ORIS 55178, CT-1 it appears in some hours this unit reported in KW-hr rather than MW-hr, so that certain hours had more than 20,000 MW-hr of production. To correct this issue, any reported load greater than 300 was changed to 300 to fix the 2011 anomalous data. This issue was not discovered in previous runs because the unit had been marked "non-EGU" in prior runs. The state updated this designation to "Full" in the 2.7 comment period, so that the anomalous data became apparent in trial runs[5].

MI and FL supplied gross load data for combined cycle units that did not report power produced from steam generation in the BY CAMD data.

[5] See email from Adel Alsharafi (MO) dated 7/20/2017 to D. McLeod (VA)

Negative emissions and load values are replaced with zero.

Added a full year of data for:

- ORIS 8906 (Astoria) Unit IDs 30, 40, and 50—summed reheat and superheat reported data to create the pseudo units.
- ORIS 7839 (Ladysmith) Unit 5, which is equivalent to that reported in 2011 for 7838 (Remington) Unit 5. 7838, 5 does not exist. This is a 2011 CAMD reporting error.

Other similar anomalies were corrected and are documented in the Run Log.

Unit Availability File – Both V2.7 Reference and CSAPR Update compliant Scenario

Numerous detailed corrections and adjustments to these files were made for both v2.7 reference and CSAPR Update compliant runs based on S/L/T agency comments regarding the configuration, characteristics, and utilization estimates of their units. The file name for the final unit availability file is: 2011BASEUnit_Availability_v2.7_17noCPPSeptember 192017_code2_1.xls.

Boiler gas treatment: Many coal fired EGU units have recently announced conversions to firing as boiler gas units. This trend results in a future over-capacity of boiler gas capacity and shortfall of coal capacity compared with projected generation in many regions. These conversions have been left in the coal bin in several cases for two reasons:

- To address shortfall created in coal bin resulting in GDU formation to meet coal fired demand.
- To create a reasonable future year generation profile for the unit.

To address the shortfall the tool created coal fired Generation Deficit Units to meet the demand for coal fired generation. To ameliorate this imbalance, a decision was made to assign boiler gas characteristics, including emission rates to these units, but to leave them in the coal fuel bin. These units were assigned Utilization fractions typical of existing natural gas-fired boilers in their region. The following units were treated in this fashion:

- 6055, 2B1 (Big Cajun 2, LA) in SRDA. Coal to boiler gas conversion assigned a UF limitation of 0.5
- Xxxx We need a complete list of the units treated in this fashion.

Controls File/Seasonal Controls File - Application of Best Practices NO_X Control Rates to EGU Units With Existing Control Devices – V2.7 CSAPR Update compliant Scenario Only

ERTAC EGU V2.7 reference runs did not result in NO_X emissions that met the regulatory requirement to meet the 2017/2018 CSAPR Update budgets in FY 2023. Due to the conservative nature of SIP development and therefore inventory development, states may not always include lower ozone season NO_X rates in projections for units that have flexibility in how they run controls or combustion processes. To address this issue, the ERTAC committee developed the CSAPR Update scenario to reflect reasonable estimates of improved NO_X rates driven by the requirement to purchase allowances under CSAPR Update in future year projections to demonstrate a first-cut estimate of compliance with state level budgets, assurance levels, or regional budgets associated with the CSAPR Update rule addressing the 2008 ozone NAAQS. Files resulting from this approach to editing the control file and seasonal control file for each run are referred to as the “optimized files.” These changes are fully described in the control documentation file titled, “2011BASEControl File-v2.7_17noCPPSeptember 19,2017_code2_1.xls.” The descriptions below are background and summaries of the control documentation file.

Development of optimized emission rates. - MD staff prepared an analysis of historical unit performance from 2005-2016 ozone seasons to determine historically best-observed NO_X emission rates for coal-fired units controlled by SCR or SNCR. (Vinciguerra et al 2017) This analysis was based on ERTAC 2.6 results. Based on this analysis it was estimated that 19 units fitted with SNCR could meet an average NO_X rate of 0.125 lbs/mmbtu in the ozone season. Also 141 units fitted with SCR were identified that could meet an average NO_X rate of 0.064 lbs/mmbtu in the ozone season. These average values were selected to represent optimized NO_X rates during the ozone season in the absence of a state-provided optimized NO_X rate. These values may be further updated in later runs to reflect rates from unit-specific analyses.[6] Additionally, OK staff prepared an analysis of ozone season NO_X rates for units within OK not equipped with post-combustion controls but that have reduced NO_X emissions in 2016 based on CAMD data.[7]

Units for which the optimized control rate were applied - To determine which units would receive optimized NO_X rates, Maryland developed a list of coal-fired EGUs within CSAPR states equipped with SCR or SNCR, and matched this list to the ERTAC 2.7 2023 results. The optimized NO_X rates were applied to SNCR units with a 2023 ozone season NO_X emission rate > 0.125 lbs/mmbtu and SCR units with a 2023 ozone season NO_X rate > 0.064 lbs/mmbtu unless the state already provided an ozone season controlled NO_X rate in the seasonal control file. This resulted in optimized OS rates for 163 units – 124 SCR and 39 SNCR units.

Oklahoma Units – Oklahoma submitted optimized ozone season NO_X rates for the CSAPR Update compliant run for the following additional units not included in Maryland’s analysis. These rates are based on 2016 ozone season NO_X data as reported by the Oklahoma units to CAMD. For all units except 2952 Unit 6, the non ozone season rates were based on submitted data in the documentation controls file. For 2952, Unit 6, which had no submitted data, the non-ozone season rates were those supplied by the tool as the non-ozone season average in 2011.

Optimized control emission rates were only applied in the ozone season - The optimized rates were included in the seasonal controls files and applied from May 1 through Sept 30 each year, beginning in 2017. In other periods of the year emission factors were equivalent to the 2011 data for the non-ozone season unless states had provided controlled NO_X rates as inputs. Where states provided a future year controlled NO_X rate that controlled rate was used for the non-ozone season. State provided annual NO_X control information for optimized units was removed from the annual control file to ensure that the ERTAC EGU tool would correctly select the NO_X rate supplied in the optimized seasonal controls file. However, state comments concerning annual controls were preserved in the non-ozone seasonal control file records. The optimized controls file and seasonal controls file can be used for years 2020 and beyond with no further modifications to the files.

- **Controls file:**
  Based on 2011BASEControl File-v2.7_17noCPPSeptember 192017_code2_1.xls.

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[6] Email dated 7/12/2017 from H. Ashenafi-MD to D. McLeod-VA contained the updated rates for the various ORIS code/Unit ID combinations.
[7] Email dated 8/3/2017 from T. Richardson-OK to D. McLeod-VA contained the updated rates for the various ORIS code/Unit ID combinations.

- **Seasonal Controls File:**
  Based on 2011BASEControl File-v2.7_17noCPPSeptember 1922017_code2_1.xls.
  The following items are documented in the controls file but are also worthy of explanation here:
    - o North Carolina submitted a large number of new seasonal control records. For units with a pollutant in the seasonal controls file, those line items were deleted from the controls file. [8]

Figure XXX New Oklahoma Emission Rates based on 2016 CAMD

ORIS	Unit ID	Facility	State	ERTAC Region	Fuel/Unit Type Bin	Previously Submitted or Calculated OS NOx Rate, (lbs/mmbut)	Calc. 2016 CAMD OS NOx Rate (lb/MMBtu)
165	2	Grand River Dam Authority	OK	SPPR	Coal	0.1600	0.1461
2952	6	Muskogee	OK	SPPR	Coal	0.3391	0.2813
2956	1	Seminole (2956)	OK	SPPR	boiler gas	0.2030	0.1061
2956	2	Seminole (2956)	OK	SPPR	boiler gas	0.2120	0.0954
2963	3313	Northeastern	OK	SPPR	Coal	0.1500	0.1317
10671	1A	AES Shady Point	OK	SPPR	Coal	0.1225	0.0712
10671	1B	AES Shady Point	OK	SPPR	coal	0.1245	0.0716
10671	2A	AES Shady Point	OK	SPPR	coal	0.1262	0.0669
10671	2B	AES Shady Point	OK	SPPR	coal	0.1268	0.0662
50558	CC01	Oklahoma Cogeneration LLC	OK	SPPR	combined cycle gas	0.2000	0.1222

[8] See Ming Xie's email from NCDENR, dated 5/26/2017.

Prior Runs

Prior reference runs files and documentation using 2011 base year data are as follows:

v2.6 – Run in March, 2017, using input files current as of January 2017, and run by VA DEQ, IN DEP, and OTC in March 2017. Significant change in this run is that boiler gas units in many states, including PA were left in the coal bin and more seasonal controls were added, including MD. Growth factors are based on AEO2015 High Oil and Gas Scenario.

v2.5L2 - Run in August, 2016, using input files current as of August 2016, and run by VA DEQ. Growth factors are based on AEO2015 High Oil and Gas Scenario.

v2.4 – Run in August, 2015, using input files current as of July 2015, and run by VA DEQ. As occurred with v2.3, growth factors are based on AEO2014

v2.3 – Run in October 2014. This run included major updates to the UAF and Control files received as of August 24, 2014. This is the first use of growth rates from AEO2014.

v2.2 – Run in June 2014. Same as v2.1. This run included major updates to the UAF and Control files received as of March 31, 2014. This is the first use of the new code 1.01. Growth rates were from AEO2013.

v2.1L1 – Run in April 2014. Same as 2.1 except this run included updates from Midwest to UAF and control file for Indiana, Illinois, Wisconsin, Michigan and Ohio primarily for coal fired units received dated March 3, 2014.

v2.1 – Run in March 2014. This run included updates to the UAF and control file from several states. UAF updated with adequate data to calculate an ERTAC heat rate. Negative values in CAMD replaced with zero. An adjustment to implement zero growth for the Boiler gas was included. Combustion turbines and combined cycle units were adjusted in the 2.1 factors to account for the boiler-gas generation.

v2.0 – Run in January 2014. This run was the first using base year 2011. In addition, the Midwest states provided updates to the UAF and control files. These updates were completed by the Northeast in prior runs.

Figure 3 and summarize the inputs to v2.7 Reference and CSAPR Update compliant runs, respectively.

Figure 3: Inputs to ERTAC EGU v2.7 Projection Runs

ERTAC File Name	Description	Run Notes
OVERVIEW	Version 2.7	Run by VA DEQ - Doris McLeod , OTC-Joseph Jakuta in Aug-Sep 2017
	Code: 2.1	New code, with new ertac_demand_transfer feature. Also, used a file converter for the new code to update to v2.1 format the UAF and input variables. This set of runs will be the only set using the file converter. Next runs will start with the v2 formats.
	Base Year: 2011	
	Future Years: 2017, 2018, 2019, 2020, 2023, 2025, 2030 (in nomenclature of files, XX denotes year, example 17 = 2017)	Note that years 2020-2030 have both ref and opt runs. Ref indicates all inputs are based on state supplied data. Opt indicates that state supplied data was augmented with MD optimization control strategy, and OK supplied unit-specific data solely for optimization runs.
camd_hourly_base.csv	Hourly CAMD CEM data	Same for all years.
ertac_hourly_noncamd.csv	Hourly CEM data replacing data in CAMD	C2.1CONUSv2.7_ertac_nonCAMD_hourly.csv Same for all years
	Added MO unit to correct hourly data that was reported in the wrong units (kW instead of GW)	
ertac_initial_uaf.csv	Unit Availability File	C2.1CONUSv2.7_20XX_ertac_initial_uaf.csv (based on final Sept 2017 documentation file.) Same for all years Files were run through the file converter to create the new code input file, ertac_initial_uaf_v2.csv
ertac_control_emissions.csv	Annual Control File	C2.1CONUSv2.7ref_20XX_ertac_control_emissions.csv, C2.1CONUSv2.7opt_ertac_control_emissions.csv (based on final Sept2017 controls file) Same for all years.
	For 2.7, two control files were used. One is the reference case (ref) that includes only those controls supplied by states. One is an optimized file (opt) that removes certain SCR/SNCR coal fired units and certain OK units since they were moved to the seasonal controls file.	
ertac_seasonal_control_emissions.csv	Seasonal Control File	C2.1CONUSv2.7ref_20XX_ertac_control_emissions.csv (based on final Sept2017 controls file) and C2.1CONUSv2.7opt_20XX_ertac_control_emissions.csv Same for all years. For 2.7, two seasonal control files were used. One is the reference case (ref) that includes only those controls supplied by states. One is an optimized file (opt) that includes state data as well as additional ozone season information for certain SCR/SNCR coal fired units and certain OK units. For the optimized units, only OS NOx rates were reduced. NOx rates in other months were left equivalent to reference case information.
	For 2.7, two seasonal control files were used. One is the reference case (ref) that includes only those controls supplied by states. One is an optimized file (opt) that includes state data as well as additional ozone season information for certain SCR/SNCR coal fired units and certain OK units. For the optimized units, only OS NOx rates were reduced. NOx rates in other months were left equivalent to reference case information.	
ertac_growth_rates.csv	Growth Files	C2.7CONUSv2.7ref_20XX_ertac_growth_rates.csv
	Based on AEO 2017 no CPP rates. Used NYCW and SRVC specific growth rates. NYCW did not have updated values. SRVC provided updated values.	
ertac_input_variables.csv	Input Variables File	C2.7CONUSv2.7ref_20XX_ertac_input_variables.csv Code 1.01 files were run through the file converter to create the Code 2.1 input file called ertac_input_variables_v2.csv
ertac_demand_transfer.csv	Transfers of power between regions, fuel/unit types, into or out of systems from renewables and nuclear, etc	C2.7CONUSv2.7ref_20XX_ertac_demand_transfer.csv. Different for all years.
group_total_listing.csv	Aggregation scheme for multi-state caps	C2.7CONUSv2.7ref_20XX_group_total_listing.csv (same for all years) Updated to include latest CSAPR update values
state_total_listing.csv	Aggregation scheme for state level caps	C2.7CONUSv2.7ref_20XX_state_total_listing.csv (same for all years) Updated to include latest CSAPR update assurance level values.

ERTAC File Name	Description	Run Notes
OVERVIEW	Version: 2.7 Reference	Run by VA DEQ - Doris McLeod Sep 2017.
	Code: 2.1	
	Base Year: 2011	Update to UAF, Controls, and nonCAMD hourly. States feedback deadline: June, 2017.
	Future Years: 2020, 2021, 2023, 2025, 2028, and 2030	
camd_hourly_base.csv	Hourly CAMD CEM data	
ertac_hourly_noncamd.csv	Hourly CEM data replacing data in CAMD	C2.1CONUSv2.7_ertac_nonCAMD_hourly.csv
	Updates include adding one hour of reasonable, minimal data to approximately 44 units that Emily Bull (MDE) identified as missing in output files to allow the tool to process these units fully.	
ertac_initial_uaf.csv	Unit Availability File (XX denotes year, example 17 = 2017)	C2.1CONUS2.7_20XX_ertac_initial_uaf.csv: Updates include state inputs and regional boundaries for MROS.
ertac_control_emissions.csv	Annual Control File (XX denotes year, example 17 = 2017)	CONUSv2.7ref_20XX_05052016_ertac_control_emissions.csv
ertac_seasonal_control_emissions.csv	Seasonal Control File (XX denotes year, example 17 = 2017)	C2.1CONUSv2.7_20XX_ertac_seasonal_control_emissions.csv
	Seasonal controls provided by VA, GA, PA (Brunner Island Units 1, 2 & 3 have lower NOX and SO2 rates during the ozone season to represent NG firing.) and MD & NJ	
ertac_growth_rates.csv	Growth Files (XX denotes year, example 17 = 2017)	CONUSv2.7ref_20XX_05052016_ertac_growth_rates.csv
	ANNUAL GROWTH rates spreadsheet supplied by T. Shanley of MI DEQ called AEO2017 GRs.xlsx. Adjustments to	
		SRVC - Peak and annual growth rates supplied by NC for SC, NC, VA and WV.
		NYCW - GRs supplied by NY in memo to MARAMA.
	PEAK GROWTH Rate spreadsheet supplied by T. Shanley (MI) called Gas_Adj_AEO2014_NERC2013 Growth Rates v4	
		SRGW peak growth rate for oil was set to 2.0 to ameliorate an extremely high peak rate, per LADCO.
		SRSE peak GRs and transition hours adjusted for Coal, CC, SC, BG as in Lopez (MI) email to Byeong Kim (GA) 7/20/2017 with subject "SRSE Peak Growth Rate Adjustments"
		COMBINED CYLE GAS: Ameleoration of GDUs created solely for Peak hour demand deficits
		RFCM, MROZ, and MROW combined cycle peak growth rate set to 1.3 and transition hours peak->formula set to 200; formula-> nonpeak set to 2000 based on LADCO, WI, and MI input. All other transition hours remain at default levels.
		CAMX, ; NWPP; RFWZ; SRCE; SRGW Combined cycle gas peak 2028 GR set to 1.3 and transition hours set to 200 and 2000.
	EMM to NERC Crosswalk	SPPR – Two AEO regions, SPPN and SPPS, were aggregated for the coal fuel type only.
ertac_input_variables.csv	Input Variables File (XX denotes year, example 17 = 2017)	C2.1CONUSv2.7_20XX_ertac_input_variables.csv
group_total_listing.csv	Aggregation scheme for multi-state caps (XX denotes year, example 17 = 2017)	C2.1CONUSv2.7_20XX_group_total_listing.csv
state_total_listing.csv	Aggregation scheme for state level caps (XX denotes year, example 17 = 2017)	C2.1CONUSv2.7_20XX_state_total_listing.csv

References

ERTAC 2017a – Change log

ERTAC 2017b – New Code Document.

Vinciguerra et al., Expected Ozone Benefits of Reducing Nitrogen Oxide (NOx) Emissions from Coal-Fired Electricity Generating Units in the Eastern United States.

US Energy Information Administration 2017, *Annual Energy Outlook 2017 with Projections to 2050*, accessed from https://www.eia.gov/outlooks/aeo/.

MINNESOTA POLLUTION CONTROL AGENCY

Attachment 3:

Public notice

Minnesota Pollution Control Agency
Environmental Analysis and Outcomes Division
Public Notice on State Implementation Plan Revision

NOTICE IS HEREBY GIVEN that the Commissioner of the Minnesota Pollution Control Agency (MPCA) has determined that a State Implementation Plan (SIP) revision must be submitted to meet Minnesota's requirements under sections 110(a)(1), 110(a)(2), and 128 of the Clean Air Act (the Act). The draft SIP revision is now available for public comment.

Background. Sections 110(a)(1) and 110(a)(2) of the Act require that states prepare and submit to the U. S. Environmental Protection Agency (EPA) an "infrastructure" SIP within three years of the EPA's issuance of a new National Ambient Air Quality Standard (NAAQS) to demonstrate their continued ability to implement, maintain, and enforce the revised standards. This infrastructure SIP submission addresses the 2015 ozone NAAQS.

Purpose of the SIP revision. The purpose of this SIP revision is to fulfill Minnesota's responsibility under the Act to demonstrate its ability to implement, maintain, and enforce the revised ozone NAAQS cited above. This includes information about Minnesota's air quality programs such as monitoring, permitting, and modeling. Many of these requirements have already been submitted as part of the SIP.

The MPCA will consider changing the contents of the proposed SIP revision based on comments received during the comment period. Following the end of the comment period, the Commissioner will decide whether to submit the proposed SIP revision to the EPA.

MPCA contact person. The MPCA contact person is Christine Steinwand. Written comments, requests, and petitions should be mailed to: Christine Steinwand, Minnesota Pollution Control Agency, Environmental Analysis and Outcomes Division, 520 Lafayette Road North, St. Paul, Minnesota 55155-4194; telephone: 651-757-2327 or toll free 1-800-657-3864; fax: 651-297-8324; and email: Christine.Steinwand@state.mn.us. TTY users may call the MPCA at TTY 651-252-5332 or 1-800-657-3864.

Availability of SIP. A copy of the proposed SIP revision is available on the MPCA's web site at http://www.pca.state.mn.us/public-notices. A copy of the proposed SIP revision is also available upon request by contacting Christine Steinwand at 651-757-2327 or Christine.Steinwand@state.mn.us, or can be mailed to any interested person upon the MPCA's receipt of a written request. Additional materials relating to the SIP revision are available for inspection by appointment at the MPCA, 520 Lafayette Road North, St. Paul, Minnesota 55155-4194, between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday. To examine these materials, or for more information, please contact Christine Steinwand. All MPCA offices may be reached by calling 1-800-657-3864.

Public comment period and potential public meeting. The public comment period begins July 9, 2018 and ends on August 10, 2018. Your comments must be in writing and received by Christine Steinwand by 4:30 p.m. on August 10, 2018. Written comments may be submitted to them at the mailing address, facsimile number, or e-mail address listed above.

As this SIP revision does not include any substantive changes to the Minnesota's SIP, a public information meeting will only be held if one is requested by 4:30 p.m. on August 10, 2018. If such a meeting is requested, it will be held on August 16, 2018 from 9:00 a.m. to 11:00 a.m. at the MPCA St. Paul Office, 520 Lafayette Road North, St. Paul, Minnesota 55155-4194. To find out if a public information meeting will be held, please contact Christine Steinwand at 651-757-2327 or Christine.Steinwand@state.mn.us after August 10, 2018 at 4:30 p.m. The public information meeting, if one is requested, will provide information, receive public input, and answer questions about the proposed SIP revision. If the public information meeting is held, additional written comments on the proposed documents will be accepted until 4:30pm on August 24, 2018, following the same guidelines described above.

MINNESOTA POLLUTION CONTROL AGENCY

Attachment 4:

Completeness review

Attachment 4: Completeness Review

Contents

A. Administrative Materials (40 CFR pt. 51, Appendix V, Part 2.1)

The EPA's Criteria for Determining the Completeness of Plan Submittals, published at 40 CFR part 51, Appendix V, requires states to provide the basic documents that show that the State has properly followed the administrative requirements called for by the CAA for the adoption of SIPs. The requirements, and how this SIP revision complies with these requirements, are discussed here:

1) Formal Letter of Submittal:

> "A formal letter of submittal from the Governor or his designee, requesting EPA approval of the plan or revision thereof."

Attached to this SIP revision request is a formal letter of submittal from the MPCA Commissioner, John Linc Stine, to the EPA Region V Administrator, Cathy Stepp. The office of the Commissioner of the MPCA is statutorily created in Minnesota Statute § 116.03, subd. 1 (a). The Commissioner is appointed by the Governor, and the duties of the position include acting as the state agent to "apply for, receive, and disburse federal funds made available to the state by federal law or rule and regulations promulgated thereunder for any purpose related to the power and duties of the MPCA or the Commissioner. The Commissioner shall comply with any and all requirements of such federal law or such rules and regulations promulgated thereunder to facilitate application for, receipt, and disbursement of such funds." Minn. Stat. § 116.03 subd. 3.

2) Evidence of State Adoption of Plan and Issuance of Orders in Final Form:

> "Evidence that the State has adopted the plan in the State code or body of regulations; or issued the permit, order, consent agreement (hereafter 'document') in final form. That evidence shall include the date of adoption or final issuance as well as the effective date of the plan, if different from the adoption/issuance date."

The rules and statutes documented in this submittal have previously been incorporated into Minnesota's SIP, and/or approved under the auspices of an iSIP [Sections 110(a)(1) and 110(a)(2) of the Clean Air Act].

3) Legal Authority Documentation:

> "Evidence that the State has the necessary legal authority under State law to adopt and implement the plan."

This SIP submittal documents the MPCA's legal authority in addressing the requirements of Section 110(a)(1) of the Clean Air Act.

4) Compliance with State Procedures:

> "Evidence that the state followed all of the procedural requirements of the State's laws and constitution in conducting and completing the adoption/issuance of the plan."

MPCA complied with all relevant state procedures for issuing the permit as well as the SIP revision.

5) Public Notice:

> "Evidence that public notice was given of the proposed change consistent with the procedures approved by the EPA, including the date of the publication of the notice."

The public notice for the SIP revision was published in the State Register on July 9, 2018 with the public comment period commencing on July 9, 2018 and ending on August 10, 2018. During the public comment period, a copy of the SIP revision was made available at the MPCA office located in St. Paul and on the MPCA's website. A copy of the public notice is attached (Attachment 3).

6) Public Hearing Certification:

> "Certification that public hearing(s) were held in accordance with the information provided in the public notice and the State's laws and constitution, if applicable."

The public notice states: "As this SIP revision does not include any substantive changes to the Minnesota's SIP, a public information meeting will only be held if one is requested by 4:30 p.m. on August 10, 2018. If such a meeting is requested, it will be held on August 16, 2018 from 9:00 a.m. to 11:00 a.m. at the MPCA St. Paul Office, 520 Lafayette

Road North, St. Paul, Minnesota 55155-4194. To find out if a public information meeting will be held, please contact Christine Steinwand at 651-757-2327 or Christine.Steinwand@state.mn.us after August 10, 2018 at 4:30 p.m. The public information meeting, if one is requested, will provide information, receive public input, and answer questions about the proposed SIP revision. If the public information meeting is held, additional written comments on the proposed documents will be accepted until 4:30pm on August 24, 2018, following the same guidelines described above."

[This section will be completed after the comment period ends to reflect whether or not a public hearing was requested and/or held.]

7) Public Comments and State Response:

> "Compilation of the public comments and State's response thereto."

[This section will be completed after the comment period ends to reflect what, if any, comments were received.]

B. Technical Support

1) Pollutants Regulated:

> "Identification of all regulated pollutants affect by the plan."

This infrastructure SIP submission addresses the 2015 ozone NAAQS.

2) Source Identification:

> "Identification of the locations of affected sources including the EPA attainment/nonattainment designation of the locations and the state of the Attainment Plan for the affected area(s)."

Does not apply to this SIP submittal.

3) Emissions Quantification:

> "Quantification of the changes in the plan; allowable emissions from the affected sources; estimates of changes in current actual emissions from affected sources or, where appropriate, quantification of the changes in actual emissions through calculations of the differences between certain baseline levels and allowable emissions anticipated as a result of the revision."

Does not apply to this SIP submittal.

4) NAAQS Protections:

> "The State's demonstration that the NAAQS, prevention of significant deterioration increments, reasonable further progress demonstration, and visibility, as applicable, are protected if the plan is approved and implemented."

The purpose of this SIP submittal is to demonstrate Minnesota's ability to implement, maintain, and enforce the revised NAAQS.

5) Modeling Information:

> "Modeling information required to support the proposed revision, including input data, output data, models used, justification of the model selections, ambient monitoring data used, meteorological data used, justification for use of off-site data (where used), modes of models used, assumptions, and other information relevant to the determination of adequacy of the modeling analysis."

Does not apply to this SIP submittal.

6) Continuous Emission Reduction:

> "Evidence, where necessary, that emission limitations are based on continuous emission reduction technology."

Does not apply to this SIP submittal.

7) Emission Level Assurance:

> "Evidence that the plan contains emission limitations, work practice standards and recordkeeping/requirements, where necessary, to ensure emissions levels."

The purpose of this SIP submittal is to demonstrate Minnesota's ability to implement, maintain, and enforce the revised NAAQS.

8) Compliance/Enforcement:

> "Compliance and enforcement strategies, including how compliance will be determined in practice."

The purpose of this SIP submittal is to demonstrate Minnesota's ability to implement, maintain, and enforce the revised NAAQS.

9) Special Economic and Technological Justifications:

> "Special economic and technological justifications required by any applicable EPA policies, or an explanation of why such justifications are not necessary."

Does not apply to this SIP submittal.