west virginia department of environmental protection

Appendix G

DRAFT

Redesignation Request
and Maintenance Plan
for the Ohio Portion of the
Parkersburg-Marietta, WV-OH
Annual $PM_{2.5}$ Nonattainment Area

Washington, Ohio

January 2012

Promoting a healthy environment.

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REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE OHIO PORTION OF THE PARKERSBURG-MARIETTA, WV-OH ANNUAL $PM_{2.5}$ NONATTAINMENT AREA

Washington, Ohio

Prepared by:
Ohio Environmental Protection Agency
Division of Air Pollution Control

January 2012

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REDESIGNATION REQUEST AND MAINTENANCE PLAN FOR THE OHIO PORTION OF THE PARKERSBURG-MARIETTA ANNUAL $PM_{2.5}$ NONATTAINMENT AREA

Washington County, Ohio

CHAPTER ONE

Introduction

The Clean Air Act (CAA), as amended, requires each State with areas failing to meet the annual $PM_{2.5}$[1] National Ambient Air Quality Standard (NAAQS) to develop State Implementation Plans (SIPs) to expeditiously attain and maintain the standard. The United States Environmental Protection Agency (U.S. EPA) revised the NAAQS for particulate matter in July 1997. It replaced the existing PM_{10} standard with a health based $PM_{2.5}$ standard and retained the PM_{10} standard as a particulate standard protecting welfare. The standards include an annual standard set at 15.0 micrograms per cubic meter ($\mu g/m^3$), based on the 3-year average of annual mean $PM_{2.5}$ concentrations and a 24-hour standard of 65 $\mu g/m^3$, based on the 3-year average of the 98th percentile of 24-hour concentrations.

The revised NAAQS was legally challenged in the U.S. Court of Appeals for the District of Columbia Circuit (the D.C. Circuit). On May 14, 1999, the D.C. Circuit remanded, without vacatur, the standard back to U.S. EPA. The remand did not question the level at which U.S. EPA set the standards but rather the constitutionality of the CAA provision that authorizes U.S. EPA to set national air quality standards. U.S. EPA requested a rehearing which the D.C. Circuit denied. Therefore, in December 1999, U.S. EPA appealed the D.C. Circuit decision to the U.S. Supreme Court. The U.S. Supreme Court issued a decision on February 27, 2001 that unanimously affirmed the constitutionality of the CAA provision but did remand several other issues back to the D.C. Circuit, including the issue of whether U.S. EPA acted arbitrarily and capriciously in establishing the specific levels of the standards.

The D.C. Circuit heard arguments in this remanded case in December 2001, and issued its decision on March 26, 2002. The D.C. Circuit rejected the claims that the U.S. EPA had acted arbitrarily and capriciously in setting the levels of the standards.

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[1] Particle pollution is a mixture of microscopic solids and liquid droplets suspended in air. This pollution, also known as particulate matter, is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). Fine particle pollution or $PM_{2.5}$ describes particulate matter that is 2.5 micrometers in diameter and smaller - 1/30th the diameter of a human hair. Fine particle pollution can be emitted directly or formed secondarily in the atmosphere.

On December 17, 2004, U.S. EPA promulgated the initial $PM_{2.5}$ nonattainment areas designations for the $PM_{2.5}$ standards across the country. Modifications to those designations were made and an effective date was set at April 5, 2005. Unlike Subpart 2 of the CAA Amendments of 1990 which defined five ozone nonattainment classifications for the areas that exceed the NAAQS based on the severity of the ozone levels, $PM_{2.5}$ nonattainment designations are simply labeled "nonattainment." The CAA Amendments require states with $PM_{2.5}$ nonattainment areas to submit a plan within three years of the effective date of the designations (April 5, 2008) detailing how the $PM_{2.5}$ standards will be attained by April 5, 2010. Ohio EPA submitted its attainment demonstration for the entire State of Ohio on July 16, 2008.

Section 107(d)(3)(E) of the CAA allows states to request nonattainment areas to be redesignated to attainment provided certain criteria are met. The following are the criteria that must be met in order for an area to be redesignated from nonattainment to attainment:

- A determination that the area has attained the $PM_{2.5}$ standard.
- An approved State Implementation Plan (SIP) for the area under Section 110(k).
- A determination that the improvement in air quality is due to permanent and enforceable reductions in emissions resulting from implementation of the SIP and other federal requirements.
- A fully approved maintenance plan under Section 175(A).
- A determination that all Section 110 and Part D requirements have been met.

This document addresses each of these requirements, and provides additional information to support continued compliance with the annual $PM_{2.5}$ standard.

Geographical Description and Background

The current Parkersburg-Marietta nonattainment area is located in south-eastern Ohio and includes the following counties: Washington in Ohio; and Pleasants (partial nonattainment of Grant Tax district) and Wood in West Virginia. This area is shown in Figure 1 under Chapter Three.

The Parkersburg-Marietta area has not previously been subject to nonattainment area rulemakings for fine particles.

As a result of the 2005 $PM_{2.5}$ designations, U.S. EPA designated the Parkersburg-Marietta area nonattainment for the 15.0 $\mu g/m^3$ annual standard[2], and Ohio EPA was required to develop a plan to reduce oxides of nitrogen (NO_x), sulfur dioxide (SO_2) and direct $PM_{2.5}$ emissions and to demonstrate that

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[2] There were no monitors in Ohio that violated the 1997 24-hour $PM_{2.5}$ standard of 65$\mu g/m^3$.

the area will meet the federal annual air quality standard by April 5, 2010. Ohio's main $PM_{2.5}$ components are primary particles (organic carbon, crustal material, and elemental carbon), SO_2 and NO_x, which were included in the attainment demonstration analysis. Volatile organic compounds (VOCs) and ammonia (NH3) were not included in the analysis since they were not part of Ohio's current attainment strategy for $PM_{2.5}$ (although controls for VOCs have been implemented for ozone nonattainment). This is consistent with U.S. EPA's "Clean Air Particle Implementation Rule" [74FR 20856] (hereafter referred to as "Implementation Rule"). In the Implementation Rule U.S. EPA presumes NH3 emissions are not a $PM_{2.5}$ attainment plan precursor and that States are not required to address VOC unless the State or U.S. EPA makes a technical demonstration that emissions of VOCs significantly contribute to nonattainment of the annual $PM_{2.5}$ standard.

This document is intended to support Ohio's request that the Ohio portions of the Parkersburg-Marietta area be redesignated from nonattainment to attainment for the annual $PM_{2.5}$ standard. In addition, the State of West Virginia may also submit a request for their respective portions of the Parkersburg-Marietta area.

Status of Air Quality

$PM_{2.5}$ complete quality-assured ambient air quality monitoring data for the most recent three (3) years, 2008 through 2010, demonstrate that the air quality has met the NAAQS for annual $PM_{2.5}$ in this nonattainment area. The NAAQS attainment, accompanied by decreases in emission levels discussed in Chapter Four, supports a redesignation to attainment for the Parkersburg-Marietta area based on the requirements in Section 107(d)(3)(E) of the CAA as amended.

CHAPTER TWO

Requirements for Redesignation

U.S. EPA has published detailed guidance in a document entitled *Procedures for Processing Requests to Redesignate Areas to Attainment* (redesignation guidance), issued September 4, 1992, to Regional Air Directors. The redesignation request and maintenance plan are based on the redesignation guidance, supplemented with additional guidance received from staff of U.S. EPA Region 5.

Below is a summary of each redesignation criterion as it applies to the Parkersburg-Marietta area.

i.) Attainment of the standard (CAA Section 107(d)(3)(E)(i))

There are two components involved in making this demonstration. The first component relies on ambient air quality data. The data that are used to demonstrate attainment should be the product of ambient monitoring that is representative of the area of highest concentration. The data should be collected and quality-assured in accordance with 40 CFR 58 and recorded in the Air Quality System (AQS) in order for it to be available to the public for review.

The second component relies upon supplemental U.S. EPA-approved air quality modeling. While no modeling is required for redesignating nonattainment areas, the redesignation guidance states it is “generally necessary” for particulate matter redesignations. Appendix C and Appendix D contains the most recent modeling results showing future attainment and maintenance are provided. Chapter Three discusses this requirement in more detail and provides the attainment demonstration.

ii.) Permanent and enforceable improvement in air quality (CAA Section 107(d)(3)(E)(iii))

The state must be able to reasonably attribute the improvement in air quality to emission reductions which are permanent and enforceable. The state should estimate the percent reduction achieved from federal measures as well as control measures that have been adopted and implemented by the state.

It was not necessary for Ohio to adopt or implement control measures for these counties beyond the federal measures.

Ohio EPA has adopted several rules recently that will have an impact on statewide $PM_{2.5}$ emissions in the future:

- Clean Air Interstate Rule (CAIR)
- NO_x SIP Call Rules

Ohio was also subject to a Federal Implementation Plan under the CAIR replacement rule, the Cross-State Air Pollution Rule (CSAPR) that could have resulted in even greater reductions than the CAIR program. However, on December 30, 2011, the D.C. Circuit Court stayed CSAPR and ordered U.S. EPA to continue administering CAIR pending the court's resolution.

In addition, since the initial designations were made federally enforceable consent decrees have resulted in reductions in emissions from utilities within Washington County and across the state, including this area.

Chapters Four and Five discuss this requirement in more detail.

iii.) Section 110 and Part D requirements (CAA Section 107(d)(3)(E)(v))
For purposes of redesignation, a state must meet all requirements of Section 110 and Part D that were applicable prior to submittal of the complete redesignation request.

Subpart 1 of Part D consists of general requirements applicable to all areas which are designated nonattainment based on a violation of the NAAQS. Subpart 4 of Part D consists of more specific requirements applicable to particulate matter (specifically to address PM_{10}). However, for the purpose of implementing the 1997 $PM_{2.5}$ standard, U.S. EPA's Implementation Rule stated Subpart 1, rather than Subpart 4, is appropriate for the purpose of implementing $PM_{2.5}$.[72 FR 20589]

Section 110(a) requirements
Section 110(a) of Title I of the CAA contains the general requirements for a SIP. Section 110(a)(2) provides that the implementation plan submitted by a state must have been adopted by the state after reasonable public notice and hearing, and that, among other things, it must include enforceable emission limitations and other control measures, means or techniques necessary to meet the requirements of the CAA; provide for establishment and operation of appropriate devices, methods, systems and procedures necessary to monitor ambient air quality; provide for implementation of a source permit program to regulate the modification and construction of any stationary source within the areas covered by the plan; include provisions for the implementation of Part C, prevention of

significant deterioration (PSD) and Part D, NSR permit programs; include criteria for stationary source emission control measures, monitoring, and reporting; include provisions for air quality modeling; and provide for public and local agency participation in planning and emission control rule development. In Ohio's December 5, 2007 and September 4, 2009 infrastructure SIP submissions, Ohio verified that the State fulfills the requirements of Section 110(a)(2) of the Act.

Section 110(a)(2)(D) also requires State plans to prohibit emissions from within the State which contribute significantly to nonattainment or maintenance areas in any other State, or which interfere with programs under Part C to prevent significant deterioration of air quality or to achieve reasonable progress toward the national visibility goal for Federal class I areas (national parks and wilderness areas). In order to assist States in addressing their obligations regarding regionally transported pollution, U.S. EPA finalized CAIR to reduce SO_2 and NO_x emissions from large electric generating units (EGU). Ohio has met the requirements of the federal CAIR to reduce NO_x and SO_2 emissions contributing to downwind states. On February 1, 2008, U.S. EPA approved Ohio's CAIR program, which can be found in Ohio Administrative Code (OAC) Chapter 3745-109[3]. On July 6, 2011, U.S. EPA finalized a replacement to the CAIR program, the CSAPR. CSAPR could further assist States in addressing their obligations regarding regionally transported pollution by providing reductions in NO_x and SO_2 emissions in 2012 and 2014. However, on December 30, 2011, the D.C. Circuit Court stayed CSAPR and ordered U.S. EPA to continue administering CAIR pending the court's resolution.

iv.) <u>Section 172(c) requirements</u>

This Section contains general requirements for nonattainment plans. The requirements for reasonable further progress, identification of certain emissions increases, and other measures needed for attainment will not apply for redesignations because they only have meaning for areas not attaining the standard. The requirements for an emission inventory will be satisfied by the inventory requirements of the maintenance plan. Chapters Four and Five discuss this requirement in more detail.

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[3] http://www.epa.ohio.gov/dapc/regs/regs.aspx#3745-109

v.) Conformity

The state must work with U.S. EPA to show that its SIP provisions are consistent with the Section 176(c)(4) conformity requirements. The redesignation request should include conformity procedures, if the state already has these procedures in place. If a state does not have conformity procedures in place at the time that it submits a redesignation request, the state must commit to follow U.S. EPA's conformity regulation upon issuance, as applicable.

vi.) Maintenance plans (CAA Section 107(d)(3)(E)(iv))

Section 107(d)(3)(E) stipulates that for an area to be redesignated, U.S. EPA must fully approve a maintenance plan that meets the requirements of Section 175(A). The maintenance plan will constitute a SIP revision and must provide for maintenance of the relevant NAAQS in the area for at least 10 years after redesignation. Section 175 (A) further states that the plan shall contain such additional measures, if any, as may be necessary to ensure such maintenance.

In addition, the maintenance plan shall contain such contingency measures as the Administrator deems necessary to ensure prompt correction of any violation of the NAAQS. At a minimum, the contingency measures must include a requirement that the state will implement all measures contained in the nonattainment SIP prior to redesignation.

States seeking redesignation of a nonattainment area should consider the following provisions:

a.) attainment inventory;
b.) maintenance demonstration;
c.) monitoring network;
d.) verification of continued attainment; and
e.) contingency plan.

Chapter Six discusses this requirement in more detail.

CHAPTER THREE

PM$_{2.5}$ MONITORING

CAA Section 107(d)(3)(E)(i)

Requirement 1 of 4

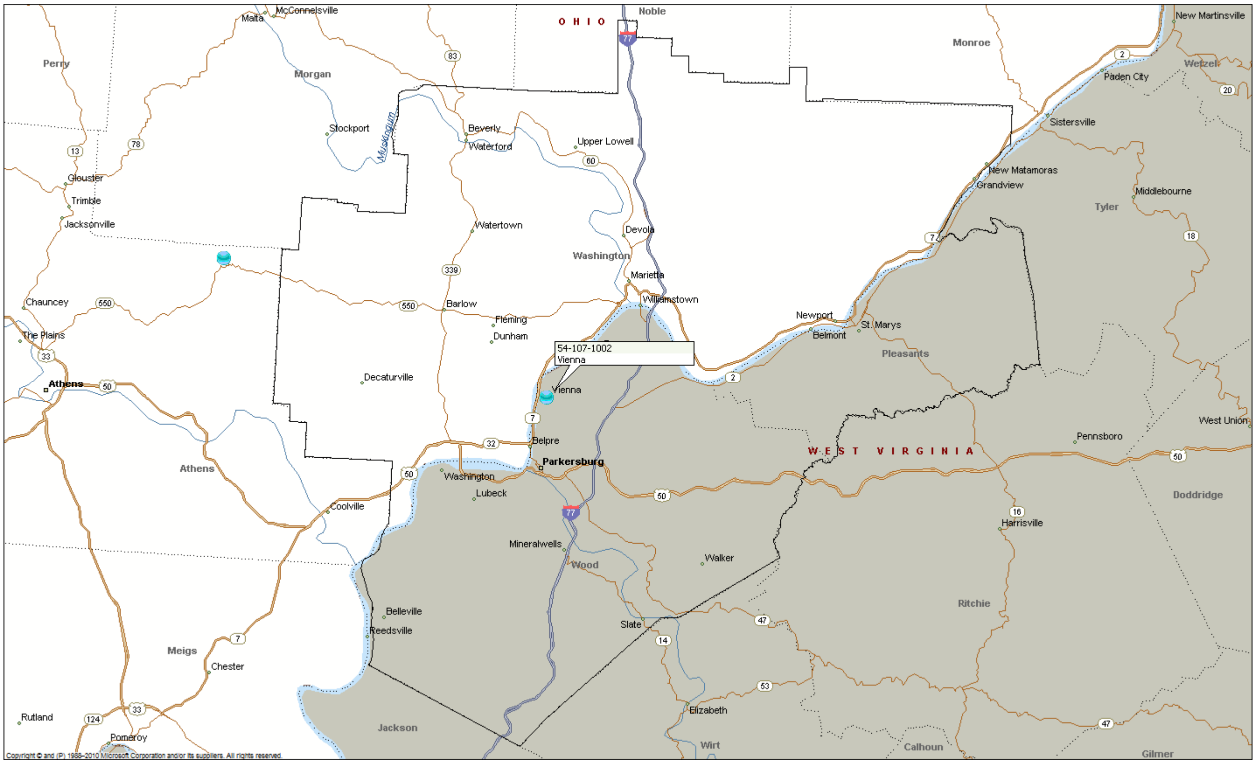
A demonstration that the NAAQS for annual PM$_{2.5}$, as published in 40 CFR 50.7, has been attained.

Background

There is one monitor measuring PM$_{2.5}$ concentrations in this nonattainment area located in Wood County, West Virginia. This monitor is operated by the WVDAQ (West Virginia Division of Air Quality). A listing of the design values based on the three-year average of the annual mean concentrations from 2008 through 2010 is shown in Table 1. The location of the monitoring site for this nonattainment area is shown on Figure 1.

Demonstration

Figure 1 - Map of the Parkersburg-Marietta, WV-OH nonattainment area and monitor locations



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Requirement 2 of 4

Ambient monitoring data quality assured in accordance with 40 CFR 58.10, recorded in the U.S. EPA air quality system (AQS) database, and available for public view.

Demonstration

Ohio EPA has quality assured all data shown in Appendix A in accordance with 40 CFR 58.10 and all other federal requirements. Ohio EPA has recorded the data in the AQS database and, therefore, the data are available to the public.

Requirement 3 of 4

A showing that the three-year average of the annual mean values, based on data from all monitoring site in the area or its affected downwind environs, are below 15.0 µg/m^3. (This showing must rely on three complete, consecutive calendar years of quality assured data.)

Background

The following information is taken from U.S. EPA's "Guideline on Data Handling Conventions for the PM NAAQS," U.S. EPA-454/R-99-008, April 1999.

In accordance with the CAA Amendments, three complete years of monitoring data are required to demonstrate attainment at a monitoring site. The annual PM$_{2.5}$ primary and secondary ambient air quality standards are met at an ambient air quality monitoring site when the three-year average of the annual average is less than 15.0 µg/m^3. While calculating design values, three significant digits must be carried in the computations, with final values rounded to the nearest 0.1 µg/m^3. Decimals 0.05 or greater are rounded up, and those less than 0.05 are rounded down, so that 15.049 µg/m^3 is the largest concentration that is less than, or equal to 15.0 µg/m^3. Values at or below 15.0 µg/m^3 meet the standard; values equal to or greater than 15.1 µg/m^3 exceed the standard. An area is in compliance with the annual PM$_{2.5}$ NAAQS only if every monitoring site in the area meets the NAAQS. An individual site's 3-year average of the annual average concentrations is also called the site's design value. The air quality design value for the area is the highest design value among all sites in the area.

Table 1 shows the monitoring data for 2008 – 2010 that were retrieved from the U.S. EPA AQS.

Demonstration

Table 1 - Monitoring Data for the Parkersburg-Marietta, WV-OH area for 2008 – 2010

		Annual Standard			
Site	County	Year			Average
		2008	2009	2010	2008-2010
54-029-1002	Wood, WV	13.8	12.0	13.4	13.1
🟨	Less than 75% capture in at least one quarter				

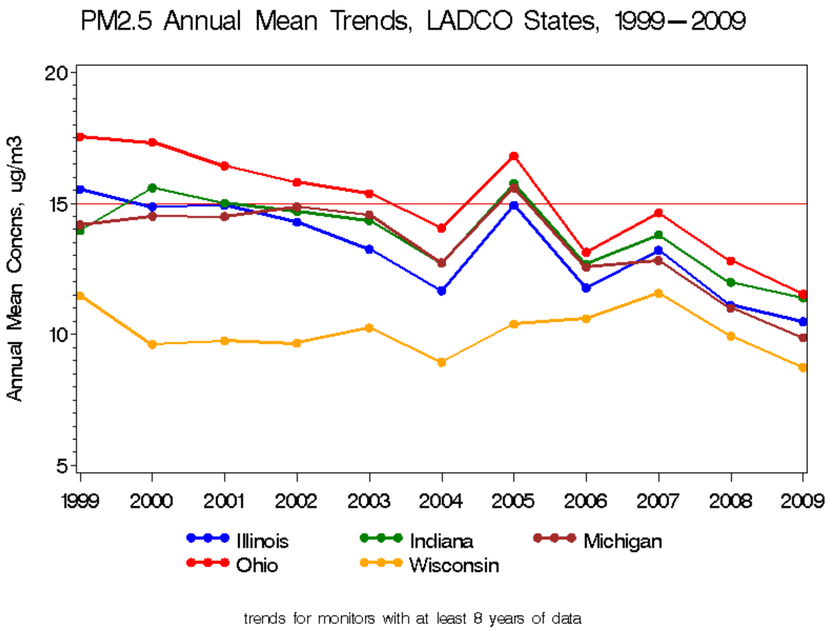
Source: U.S. EPA Air Quality System (AQS); http://www.epa.gov/ttn/airs/airsaqs/index.htm

The design value calculated for the Parkersburg-Marietta area demonstrates that the annual PM$_{2.5}$ NAAQS has been attained. The area's design value has trended downward as emissions have declined due to such factors as cleaner automobiles and fuels, and controls for EGUs, at the national, regional and local level.

National monitoring for PM$_{2.5}$ began in 1999. With respect to each of the

Lake Michigan Air Directors Consortium (LADCO) states, there has been a clear downward trend in design values:

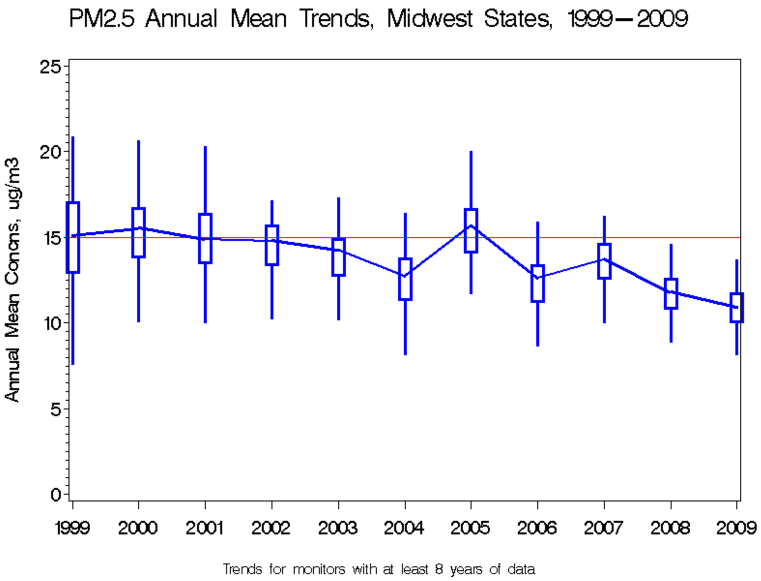
Figure 2 - PM$_{2.5}$ Annual Mean Trends LADCO States



Source: LADCO; Recent Ozone and PM2.5 Trends – Aug 26 2010.pptx

The same trend can be seen within the Midwest States as a whole:

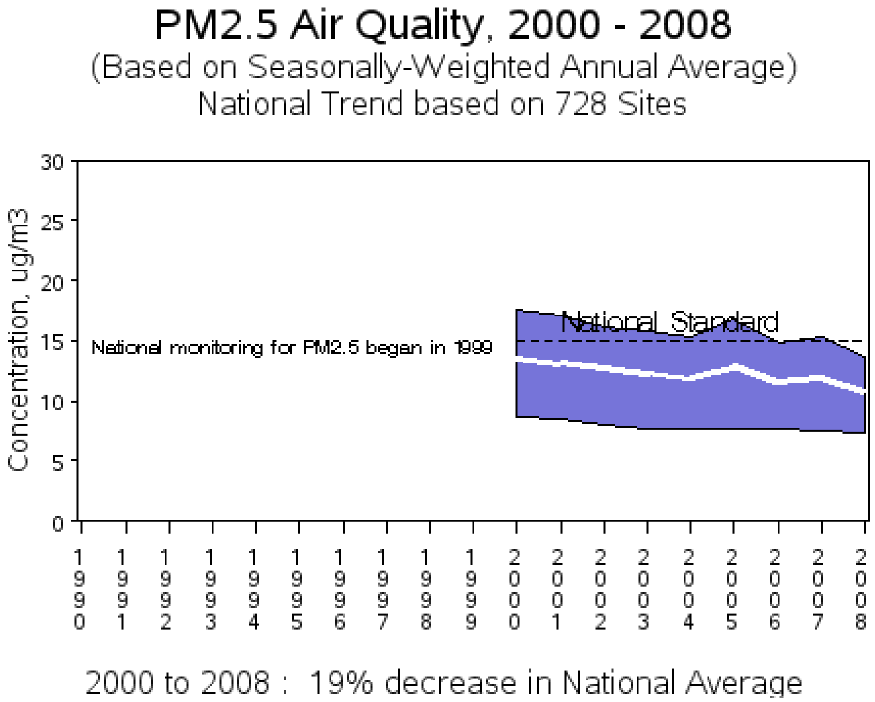
Figure 3 - PM$_{2.5}$ Annual Mean Trends Midwest States



Source: LADCO; Recent Ozone and PM2.5 Trends - Aug 26 2010.pptx

Design values have also trended downward nationally:

Figure 4 - $PM_{2.5}$ Annual Mean National Trends



Source: http://www.epa.gov/airtrends/pm.html

<u>Requirement 4 of 4</u>

A commitment that once redesignated, the state will continue to operate an appropriate monitoring network to verify the maintenance of the attainment status.

<u>Demonstration</u>

Ohio EPA does not currently operate any monitors in this area. Ohio EPA will consult with U.S. EPA Region 5 prior to making changes to the existing monitoring network, should changes become necessary in the future.

CHAPTER FOUR

EMISSION INVENTORY

CAA Section 107(d)(3)(E)(iii)

U.S. EPA's redesignation guidance requires the submittal of a comprehensive inventory of $PM_{2.5}$ precursor emissions (primary particles (organic carbon, crustal matter, and elemental carbon), SO_2 and NO_x[4]) representative of the year when the area achieves attainment of the annual $PM_{2.5}$ air quality standard. Ohio also must demonstrate that the improvement in air quality between the year that violations occurred and the year that attainment was achieved is based on permanent and enforceable emission reductions. Other emission inventory related requirements include a projection of the emission inventory to a year at least 10 years following redesignation; a demonstration that the projected level of emissions is sufficient to maintain the annual $PM_{2.5}$ standard; and a commitment to provide future updates of the inventory to enable tracking of emission levels during the 10-year maintenance period.

The emissions inventory development and emissions projection discussion below, with the exception of the mobile (on-road) emissions inventory and projections, identifies procedures used by Ohio EPA and the LADCO regarding emissions from Ohio's portion of the Parkersburg-Marietta area. Specific emissions data are provided for all counties, including those in Ohio and West Virginia. West Virginia emissions data were obtained though the West Virginia Department of Environmental Protection (WVDEP). All of these inventories and emissions projections were prepared using similar methodologies, unless otherwise noted. Mobile emissions inventories and projections for all counties were prepared by the Wood-Washington-Wirt Interstate Planning Commission (WWW) and the Ohio Department of Transportation (ODOT), with data provided by Ohio EPA, West Virginia Department of Transportation (WVDOT), and WVDEP.

Requirement 1 of 5

A comprehensive emission inventory of $PM_{2.5}$, SO_2 and NO_x completed for the base year.

Background

The 2005 periodic inventory has been identified as one of the preferred databases for SIP development and coincides with nonattainment air quality in the Parkersburg-Marietta area.

Periodic inventories, which include emissions from all sectors are prepared every three years by Ohio EPA. Ohio's 2005 emissions

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[4] VOC and NH_3 are not addressed.

data for all sources (Electrical Generating Unit (EGU-Point); Non-Electrical Generating Unit (Non-EGU); Non-road Mobile (Non-road); Other Area (Area); and Marine; Aircraft; Rail (MAR)) are derived from this inventory. Ohio's point source data derived from this periodic inventory is actual source reported emissions under Ohio's annual emissions reporting program.

West Virginia's point source data are taken from U.S. EPA's CSAPR estimates (EGU) and actual reported data under West Virginia's emissions reporting program (non-EGUs). West Virginia's emissions data for MAR and Area is derived from the 2005 National Emissions Inventory (NEI) while Non-road emissions are derived from NONROAD modeling conducted by WVDAQ.

Demonstration

Ohio's 2005 inventory is used as the base year for the purpose of this submittal and was submitted to U.S. EPA with Ohio's $PM_{2.5}$ attainment demonstration SIP submitted on July 18, 2008 and revised on June 7, 2010. The detailed emission inventory information for Ohio's portion of the Parkersburg-Marietta area is provided in Appendix B. Emissions of $PM_{2.5,}$ SO_2 and NO_x for 2005 are identified under Requirement Three of this Chapter.

Requirement 2 of 5

A projection of the emission inventory to a year at least 10 years following redesignation.

Background

Ohio EPA prepared a comprehensive inventory for the Ohio portion of the Parkersburg-Marietta area including area, mobile, and point sources for $PM_{2.5}$, SO_2 and NO_x for base year 2005. The 2005 inventory was submitted to U.S. EPA on July 18, 2008 as part of Ohio's $PM_{2.5}$ attainment demonstration SIP for this area. The information below describes the procedures Ohio EPA used to generate the 2005 base year inventory and to develop SIP-ready modeling inventories and future year projections (Pechan Report[5]) based on a 2005 base year inventory. The report by Pechan generated future year estimates of annual emissions for each source sector using accepted growth surrogates. These inventories were provided to the LADCO and have been processed to develop average daily emissions for use in the air quality analyses. These

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[5] http://www.ladco.org/tech/emis/r5/reports/LADCO%202005%20Base%20Yr%20Growth%20and%20Controls%20Report_Final.pdf

processed modeling inventories have been identified as the correct iteration of the inventory for use in the redesignation. In this document, references to LADCO include the Midwest Regional Planning Organization. Note, that the on-road mobile source sector was addressed by specific modeling as discussed below.

- Area source and MAR emissions were taken from the Ohio 2005 periodic inventory submitted to U.S. EPA. These projections were made from the U.S. Department of Commerce Bureau of Economic Analysis (BEA) growth factors, with some updated local information.
- Mobile source emissions were calculated from MOVES2010 produced emission factors. In Ohio's July 6, 2008 $PM_{2.5}$ Attainment Demonstration SIP[6], Ohio found that the regional highway emissions of $PM_{2.5}$, NO_x SO_2 were insignificant contributors to the nonattainment problems and, therefore, none of the three pollutants necessitated emissions inventory analysis. As documented in Ohio EPA's attainment demonstration SIP, Ohio EPA in consultation with U.S. EPA determined that the Parkersburg-Marietta nonattainment area is not significantly impacted by on-road mobile emissions as compared to other source emissions; in addition, mobile source emissions in the area were expected to decrease. Based on the results of mobile source emission projections prepared as a part of this redesignation and maintenance plan, Ohio EPA is again making a finding that the regional highway emissions of $PM_{2.5}$, NO_x, and SO_2 continue to be insignificant contributor to the nonattainment problems in this area, as discussed below.
- Point source information was compiled from Ohio EPA's 2005 annual emissions inventory database and the 2005 U.S. EPA Air Markets acid rain database[7].
- Biogenic emissions are not included in these summaries.
- Non-road emissions were generated using U.S. EPA's National Mobile Inventory Model (NMIM) 2002 application. To address concerns about the accuracy of some of the categories in U.S. EPA's non-road emissions model, LADCO contracted with two (2) companies to review the base data and make recommendations. One of the contractors also estimated emissions for three (3) non-road categories not included in U.S. EPA's non-road model. Emissions were estimated for aircraft, commercial marine

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[6] http://www.epa.ohio.gov/portals/27/SIP/Attain/PM2_5/PM25Doc.pdf
[7] http://www.epa.gov/airmarkets/acidrain

vessels, and railroads. Recreational motorboat population and spatial surrogates (used to assign emissions to each county) were significantly updated. The populations for the construction equipment category were reviewed and updated based upon surveys completed in the Midwest, and the temporal allocation for agricultural sources also was updated.

West Virginia emission projections were provided by the WVDAQ as summarized below:

- Area source and MAR emissions were compiled from the 2008 NEI and 2015 and 2022 projections were grown using Workforce data.
- Mobile source emissions were calculated using the same methodology as described above for Ohio's portion.
- EGU point source information was compiled from U.S. EPA's CSAPR inventories.
- Non-EGU point source information was compiled from West Virginia's 2008 actual emissions inventory and 2015 and 2022 projections were grown using Workforce data.
- Non-road emissions were generated are derived from NONROAD modeling conducted by WVDAQ.

Demonstration

On-Road Emission Estimations

The ODOT, Division of Transportation System Development-Modeling and Forecasting Section and the Wood-Washington-Wirt Interstate Planning Commission (WWW), defined the underlying planning assumptions for the annual $PM_{2.5}$ on-road mobile source emission inventories for the Parkersburg-Marietta, OH-WV nonattainment area. The WWW Region is comprised of Washington County, Ohio, Wood County, West Virginia, and the Grant Tax district of Pleasant county, West Virginia. The Grant Tax district in Pleasant County, West Virginia (shown above and adjacent to Wood County) is considered a "doughnut area" for planning purposes. For the most part, roadways within this district are not included in the travel demand model network. The WVDOT provided WWW with the VMT on the roads in this district by federal functional class for the year 2004. Based upon the advice of the WVDAQ, the modeling area's growth factor was used to calculate future year VMT within this Tax district by functional class.

In coordination with the ODOT and WVDOT, WWW utilizes a regional travel demand forecast model to simulate traffic in the area and to forecast traffic flows for given growth expectations. The model is primarily used as a long range planning tool to evaluate the transportation system including determination of locations where additional travel capacity may be needed and to determine the infrastructure requirements necessary to meet that need. It is also used as a tool for air quality purposes to estimate the total emissions of pollution caused by vehicles in the area. The travel demand forecasting model is used to predict traffic volumes vehicle miles traveled (VMT), travel speeds, and a U.S. EPA computer program called MOVES is used to calculate emissions per mile. The product of these is the total amount of pollution emitted by the on-road vehicles for the area.

Overview

U.S.EPA published a Federal Register notice[8] of availability on March 2, 2010, to approve MOVES2010 (Motor Vehicle Emissions Simulator), hereafter referred to as MOVES. Upon publication of the Federal Register notice, MOVES became U.S. EPA's approved motor vehicle emission factor model for estimating VOCs, NO_x, CO, PM_{10} and $PM_{2.5}$ and other pollutants and precursors from cars, trucks, motorcycles, and buses by state and local agencies. MOVES is a computer program designed by the U.S. EPA to estimate air pollution emissions from mobile sources. MOVES replaces U.S. EPA's previous emissions model for on-road mobile sources, MOBILE6.2. MOVES can be used to estimate exhaust and evaporative emissions as well as brake and tire wear emissions from all types of on-road vehicles.

The CAA requires U.S. EPA to regularly update its mobile source emission models. U.S. EPA continuously collects data and measures vehicle emissions to make sure the Agency has the best possible understanding of mobile source emissions. This assessment, in turn, informs the development of U.S. EPA's mobile source emission models. MOVES represents the Agency's most up-to-date assessment of on-road mobile source emissions. MOVES also incorporates several changes to the U.S. EPA's approach to mobile source emission modeling based upon recommendations made to the Agency by the National Academy of Sciences.

U.S.EPA believes that MOVES should be used in ozone, CO, PM, and nitrogen dioxide SIP development as expeditiously as

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[8] http://www.regulations.gov/search/Regs/home.html#documentDetail?R=0900006480ab1f98

possible. The CAA requires that SIP inventories and control measures be based on the most current information and applicable models that are available when a SIP is developed. Regarding transportation conformity, U.S. EPA and U.S. DOT intend to establish a two-year grace period before MOVES is required for new transportation conformity analyses.

The MOVES more detailed approach (when compared with the previous MOBILE model) to modeling allows U.S. EPA to easily incorporate large amounts of in-use data from a wide variety of sources, such as data from vehicle inspection and maintenance (I/M) programs, remote sensing device (RSD) testing, certification testing, portable emission measurement systems (PEMS), etc. This approach also allows users to incorporate a variety of activity data to better estimate emission differences such as those resulting from changes to vehicle speed and acceleration patterns. MOVES has a graphical user interface which allows users to more easily set up and run the model. MOVES database-centered design provides users much greater flexibility regarding output choices. Unlike earlier models which provided emission factors in grams-per-mile in fixed output formats, MOVES output can be expressed as total mass (in tons, pounds, kilograms, or grams) or as emission factors (grams-per-mile and in some cases grams-per-vehicle). Output can be easily aggregated or disaggregated to examine emissions in a range of scales, from national emissions impacts down to the emissions impacts of individual transportation projects. The database-centered design also allows U.S. EPA to update emissions data incorporated in MOVES more easily and will allow users to incorporate a much wider array of activity data to improve estimation of local emissions. For example, the improvements in MOVES will allow project-level PM2.5 emissions to be estimated.

The annual on-road inventory runs meet the latest planning assumption requirement, utilizing the latest population and land use data available. WWW's utilized U.S.EPA's emissions model MOVES to develop emissions factors for SO_2, NO_x and $PM_{2.5}$. Further details on the use of MOVES are found on Appendix C.
Travel analysis zones (376 in the 2-county area) and external roadway "stations" (34) are the basic geographic units for estimating travel patterns. Socioeconomic data used to forecast these patterns include household population, household vehicles, and employment by category and location. Sources for year 2000 data include the 2000 Census and QCEW/ES202 employment data adjusted to Year 2005 county-level control totals. All data sources were geocoded to the zone level. Future year data for each

variable were projected through various methods. The forecasted distribution of land use by industry and traffic zone was developed in 2003 by WWW staff working in conjunction with West Virginia University's Regional Research Institute and a consulting firm, as documented in their 2002 Transportation Plan update

A travel demand model (TDM) is the traditional tool used to examine potential changes in future travel patterns. The road networks within them include all planned federal-aid projects as well as any regionally significant projects found in the Transportation Improvement Program (TIP) and Long Range Transportation Plan (LRTP) expected to be open for traffic by the end of each respective analysis year. All projects identified in the LRTP having an impact on travel time and/or vehicle carrying capacity regardless of funding source were included in the air quality analysis.

The WWW region area TDM network covers about 1000 miles of streets and highways in the 2-county area including all collector and arterial streets, and has been validated to observed traffic for year 2005. The hourly distribution of trips by trip purpose and direction are constrained to match the hourly distribution of traffic counts. Trip distribution also begins with a trip-length distribution by purpose borrowed from another urban area and adjusted to ensure modeled VMT matched HPMS estimates of VMT within 1% in the model base year of 2005. (Home-based work trips were separately constrained to a target average value based on the 2000 Census.)

On-Road Mobile Emission Estimations

Tables 2 through 7 contain the results of the emissions analysis for the appropriate years. All emissions estimations are expressed in tons per year (tpy).

Table 2 - Washington County, Ohio Emissions Estimations for On-Road Mobile Sources

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	90.45	75.52	41.68	25.22
NO_x (tpy)	2,687.09	2,247.41	1,200.52	572.25
SO_2 (tpy)	26.97	8.54	6.46	6.31
Annual VMT	787,956,160	804,042,805	880,728,940	947,254,205

Table 3 – Summary of Ohio Emissions Estimations for On-Road Mobile Sources

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	90.45	75.52	41.68	25.22
NO_x (tpy)	2,687.09	2,247.41	1,200.52	572.25
SO_2 (tpy)	26.97	8.54	6.46	6.31
Annual VMT	787,956,160	804,042,805	880,728,940	947,254,205

Table 4 – Wood County, West Virginia Emissions Estimations for On-Road Mobile Sources

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	81.43	66.32	33.62	24.16
NO_x (tpy)	2,459.26	2,122.62	992.62	538.59
SO_2 (tpy)	31.13	10.37	7.88	7.70
Annual VMT	878,434,550	987,566,995	1,089,633,405	1,175,437,970

Table 5 – Pleasants County (partial only), West Virginia Emissions Estimations for On-Road Mobile Sources

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	1.61	1.20	0.55	0.37
NO_x (tpy)	54.17	42.41	19.05	9.96
SO_2 (tpy)	0.69	0.22	0.18	0.15
Annual VMT	22,094,910	22,362,455	22,984,415	23,568,050

Table 6 – Summary of West Virginia Emissions Estimations for On-Road Mobile Sources

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	83.04	67.52	34.17	24.53
NO_x (tpy)	2,513.43	2,165.03	1,011.67	548.55
SO_2 (tpy)	31.82	10.59	8.06	7.85
Annual VMT	900,529,460	1,009,929,450	1,112,617,820	1,199,006,020

Table 7 – Emissions Estimations Totals for On-Road Mobile Sources for the Parkersburg-Marietta Area

	2005	2008	2015	2022
$PM_{2.5}$ (tpy)	173.49	143.04	75.85	49.75
NO_x (tpy)	5,200.52	4,412.44	2,212.19	1,120.80
SO_2 (tpy)	58.79	19.13	14.52	14.16
Annual VMT	1,688,485,620	1,813,972,255	1,993,346,760	2,146,260,225

The following table identifies the percentage of mobile emissions of all emissions, as identified under Appendix E, for each pollutant in the entire Parkersburg-Marietta area and Ohio's portion of this area for 2015 and 2022.

Table 8 – Percent of Mobile Emissions for the Parkersburg-Marietta Area in 2015 and 2022 – With Apportionment Analysis for Partial Nonattainment Areas

		NO_x		SO_2		$PM_{2.5}$	
		2015	**2022**	**2015**	**2022**	**2015**	**2022**
Parkersburg-Marietta Area	**Total (tpy)**	18,491.26	12,968.52	77,293.31	48,438.63	3,536.75	3,446.56
	Mobile (tpy)	2,212.19	1,120.80	14.52	14.16	75.85	49.75
	% Mobile	11.96%	8.64%	0.02%	0.03%	2.14%	1.44%
Ohio Portion	**Total (tpy)**	11,439.41	6,417.53	67,625.84	37,351.17	1,198.61	1,181.01
	Mobile (tpy)	1,200.52	572.25	6.46	6.31	41.68	25.22
	% Mobile	10.49%	8.92%	0.01%	0.02%	3.48%	2.14%

SO_2 constitutes less than one percent (<1%) of the area's total SO_2 emissions in the 2015 and 2022 horizon years.

$PM_{2.5}$ constitutes just over two percent (2.14%) of the area's total $PM_{2.5}$ emissions in the 2015 horizon year and less than two percent (1.44%) of the area's total $PM_{2.5}$ emissions in the 2022 horizon year.

NO_x emissions are just under twelve percent (11.96%) of the area's total NO_x emissions in the 2015 horizon year and less than nine percent (8.64%) in the 2022 horizon year.

Therefore, the Ohio EPA is herein making a finding that the area's highway emissions for $PM_{2.5}$, NO_x, and SO_2 continue to be insignificant contributors to the nonattainment problem of the Parkersburg-Marietta area, as agreed upon as a part of the interagency consultation process. Because of this finding it is not necessary to establish mobile emission budgets for this area in the 2015 and 2022 horizon years. The nonattainment area meets the 40 CFR 93.109(m) criteria for $PM_{2.5}$, NO_x, and SO_2. Throughout this document Ohio EPA demonstrates that it would be unreasonable to expect that the Parkersburg-Marietta area would experience enough motor vehicle emissions growth in $PM_{2.5}$, NO_x, and SO_2 for a $PM_{2.5}$ NAAQS violation to occur. Moreover, Ohio EPA demonstrates that the percentage of motor vehicle emissions in the context of the total SIP inventory, the current state of air quality as determined by monitoring data, the absence of SIP motor vehicle control measures, and historical trends and future projections of the growth of motor vehicle emissions, are evidence enough to consider mobile source $PM_{2.5}$, NO_x, and SO_2 insignificant contributors to fine particles.

Requirement 3 of 5

A demonstration that the projected level of emissions is sufficient to maintain the $PM_{2.5}$ standard.

Background

In consultation with U.S. EPA, Ohio EPA selected the year 2022 as the maintenance year for this redesignation request. This document contains projected emissions inventories for 2015 and 2022.

Emission projections for the Parkersburg-Marietta area were performed using the following approaches:

- As performed by ODOT and WWW (for the entire nonattainment area), mobile source emission projections are based on the U.S. EPA MOVES model. The analysis is described in more detail in Appendix C. All projections were made in accordance with "Procedures for Preparing Emissions Projections" U.S. EPA-45/4-91-019. As discussed above, it was determined that the mobile emission contribution as a percent of the total emission inventory from the area is not significant.

- Emissions inventories are required to be projected to future dates to assess the influence growth and future controls will have. LADCO has developed growth and control files for point, area, and non-road categories. These files were used to develop Ohio's portion of this nonattainment area future-year emissions estimates used in this document. This was done so the inventories used for redesignation are consistent with modeling performed in the future. Appendix D contains LADCO's technical support document detailing the analysis used to project emissions (Base M[9]).

- For the 2008 attainment year emissions were grown from the 2005 LADCO modeling inventory, using LADCO's growth factors, for all sectors except point sources (electrical generating units and non-electrical generating units). Point source emissions for 2008 were compiled from Ohio EPA's 2008 annual emissions inventory

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[9] http://www.ladco.org/tech/emis/current/index.php

database. The 2015 interim year emissions were estimated based on the 2009 and 2018 LADCO modeling inventory, using LADCO's growth factors, for all sectors except non-EGU $PM_{2.5}$. The 2022 maintenance year is based on emissions estimates from the 2018 LADCO modeling, for all sectors except non-EGU $PM_{2.5}$. Non-EGU $PM_{2.5}$ emissions for 2015 and 2022 were grown from 2005 and 2009 emissions estimates.

Ohio EPA is identifying emissions projections for 2015 and 2022 for EGUs with implementation of the CAIR program. U.S. EPA has raised concerns regarding the CAIR program and its remand. However, Ohio EPA believes these are the most appropriate and accurate future projections. Although CSAPR has been stayed by the D.C. Circuit Court (December 30, 2011), the Court has ordered U.S. EPA to continue administering CAIR pending the court's resolution. It is believed CSAPR will provide even greater reductions in emissions than the CAIR program once resolved; therefore, these emissions projections will be conservative.

On March 10, 2004, the U.S. EPA promulgated the CAIR. Beginning in 2009, U.S. EPA's CAIR rule requires EGUs in 28 eastern states and the District of Columbia to significantly reduce emissions of NO_x and SO_2. CAIR replaced the NOx SIP Call for EGUs. The intent of the CAIR program is for national NO_x emissions to be cut from 4.5 million tons in 2004, to a cap of 1.5 million tons by 2009, and 1.3 million tons in 2018 in 28 states. States were required to submit a CAIR SIP as part of this effort. Ohio submitted a CAIR SIP which was approved by U.S. EPA on February 1, 2007. Revisions to the CAIR SIP were again submitted on July 15, 2009. The revised CAIR SIP was approved as a direct final action on September 25, 2009 (74 FR 48857). As a result of CAIR, U.S. EPA projects that in 2009 emissions of NO_x will decrease from a baseline of 264,000 tons per year to 93,000 tons per year while in 2010 emissions of SO_2 will decrease from a baseline of 1,373,000 tons per year to 298,000 tons per year, within Ohio. And by 2015 U.S. EPA projects emissions of NO_x will decrease to 83,000 tons per year while emissions of SO_2 will decrease to 208,000 tons per year, within Ohio[10]. On December 23, 2008, U.S. EPA's CAIR program was remanded without vacatur by the D.C. Circuit Court.

As can be seen in Table 9 below, Ohio has seen a significant decline in the 264,000 tons of NO_x and 1,373,000 tons of SO_2

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[10] http://www.epa.gov/CAIR/oh.html

emitted in 2005. In 2008 and 2009 facilities began preparing for and implementing control programs to address CAIR[11] and consent decrees.

Table 9 - Reductions in SO_2 and NO_x EGU Emissions Between 2008 and 2009

	SO_2			NO_x		
	2008	**2009**	**Change**	**2008**	**2009**	**Change**
Ohio	709,444	601,101	15%	235,018	96,351	59%
LADCO States	2,019,036	1,620,071	20%	702,384	393,930	44%
National	7,616,262	5,747,353	25%	2,996,287	1,990,385	34%

Source: Clean Air Markets Quarterly Emissions Tracking[12]

Significant reductions also occurred regionally and nationally as can be seen from the above. Data is also available for the first two quarters of 2010, the year SO_2 reductions are to be implemented under CAIR:

Table 10 – Reductions in SO_2 and NO_x EGU Emissions Between the First Half of 2008 and 2010

	SO_2			NO_x		
	2008 (1st half)	**2010 (1st half)**	**Change**	**2008 (1st half)**	**2010 (1st half)**	**Change**
Ohio	373,798	279,854	25%	130,598	53,187	59%
LADCO States	1,190,497	854,282	28%	419,114	220,907	47%
National	3,895,472	2,502,965	36%	1,487,179	930,148	37%

Source: Clean Air Markets Quarterly Emissions Tracking[13]

The following was reported by U.S. EPA's Clean Markets Division:

"Based on emissions monitoring data, EPA has observed substantial reductions in SO_2 emissions from 2005 to 2009 and in the first two quarters of 2010 as companies installed more controls, electric demand declined, and low natural gas prices made combined-cycle gas-fired units more competitive in several parts of the country. Thus, even after CAIR's vacatur and subsequent remand in late 2008, the controls in place generally have continued to operate, helping to drive continued progress in reducing emissions.[14]"

Ohio EPA is in agreement with the analysis by U.S.EPA that the CAIR program is providing real reductions at this time, Ohio

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[11] Under CAIR, NOx reductions are to occur beginning in 2009 while SO2 reductions are to occur beginning in 2010.

[12] http://www.epa.gov/airmarkets/quarterlytracking.html

[13] http://www.epa.gov/airmarkets/quarterlytracking.html

[14] http://www.epa.gov/airmarkets/background.htm

believes these reductions have assisted with $PM_{2.5}$ attainment in this nonattainment area and throughout Ohio.

On July 6, 2011, U.S. EPA finalized a replacement to the CAIR program, the CSAPR. CSAPR would preserve those initial reductions achieved under CAIR and provide even greater reductions in NO_x and SO_2 emissions in 2012 and 2014, ahead of the 2015 CAIR Phase 2. As a result of CSAPR, U.S. EPA projected that in 2012 emissions of NO_x will decrease to 90,842 tons per year and in 2014 to 85,744 tons per year while SO_2 will decrease to 304,022 tons per year in 2012 and 134,333 tons per year in 2014, within Ohio. In addition, U.S. EPA projections indicated that as a result of implementation of CSAPR, there will be no maintenance issues within this entire nonattainment area. However, on December 30, 2011, the D.C. Circuit Court stayed CSAPR and ordered U.S. EPA to continue administering CAIR pending the court's resolution.

Therefore, it is Ohio EPA's belief it is most appropriate to evaluate Ohio EPA's demonstration that the projected level of emissions is sufficient to maintain the annual $PM_{2.5}$ standard by assessing future year emissions that include the CAIR program.

The detailed inventory information for the Ohio portion of the Parkersburg-Marietta area for 2005 is in Appendix B. Emission trends are an important gauge for continued compliance with the $PM_{2.5}$ standard. Therefore, Ohio EPA performed an initial comparison of the inventories for the base year and maintenance years. Mobile source emission inventories are described in Appendix C.

Sectors included in the following tables are: Electrical Generating Unit (EGU-Point); Non-Electrical Generating Unit (Non-EGU); Non-road Mobile (Non-road); Other Area (Area); Marine; Aircraft; Rail (MAR); and On-road Mobile (On-road).

Maintenance is demonstrated when the future-year (2022) projected emission totals are below the 2008 attainment year totals.

Demonstration

$PM_{2.5}$

The 2005 and 2008 actual $PM_{2.5}$ emissions data below generally contains particulate fraction emissions only and not the condensable fractions as

Ohio EPA did not have a consistent reporting requirement during those years. U.S. EPA IPM modeling was used to generate future year EGU emissions with the CAIR program. The IPM modeling added additional $PM_{2.5}$ condensable emissions into future years. Therefore, comparing base and attainment year emissions with the future year predictions is not accurate in the IPM CAIR modeling. This step leads to a false perception of significant $PM_{2.5}$ emissions growth. Modeling performed by LADCO, without CAIR, did not incorporate added condensable fraction emissions. Although Ohio EPA has stated that it is most appropriate to evaluate future year emissions that include the CAIR program, because of this flaw it will be more accurate and appropriate for the purposes of $PM_{2.5}$ to evaluate future year emissions without the CAIR program.

Table 11 - Washington County, Ohio $PM_{2.5}$ Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – Without CAIR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	384.81	392.62	407.19	418.67	-26.05
Non-EGU	472.37	471.72	470.21	468.70	3.02
Non-road	35.53	30.63	21.19	11.55	19.08
Area	148.43	222.16	251.82	254.36	-32.20
MAR	11.76	10.70	6.52	2.51	8.19
On-road	90.45	75.52	41.68	25.22	50.30
TOTAL	1,143.35	1,203.35	1,198.61	1,181.01	22.34

Table 12 - Wood County, West Virginia $PM_{2.5}$ Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	0.00	0.00	0.00	0.00	0.00
Non-EGU	176.51	182.34	174.02	166.12	16.22
Non-road	36.85	33.25	25.02	17.51	15.74
Area	921.41	694.95	686.19	684.48	10.47
MAR	46.05	25.56	25.72	25.88	-0.32
On-road	81.43	66.32	33.62	24.16	42.16
TOTAL	1,262.25	1,002.42	944.57	918.15	84.27

Table 13 - Pleasants County, West Virginia $PM_{2.5}$ Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	1,360.23	1,287.83	1,330.92	1,286.59	1.24
Non-EGU	198.72	159.57	143.78	141.49	18.08
Non-road	8.32	8.19	5.96	3.73	4.46
Area	143.43	121.73	116.47	113.48	8.25
MAR	28.83	12.30	12.38	12.45	-0.15
On-road	1.61	1.20	0.55	0.37	0.83
TOTAL	1,741.14	1,590.82	1,610.06	1,558.11	32.71

Table 14 – Parkersburg-Marietta Area $PM_{2.5}$ Emission Inventory Totals for Base Year 2005, Estimated 2008, and projected 2015 and 2022 (tpy) – Without CAIR (Ohio) and With CSAPR (West Virginia)

PM2.5	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
Washington	1,143.35	1,203.35	1,198.61	1,181.01	22.34
Wood, WV	1,262.25	1002.42	944.57	918.15	84.27
Pleasants, WV	1,741.14	1,590.82	1,610.06	1,558.11	32.71
COMBINED $PM_{2.5}$ TOTAL	4,146.74	3,796.59	3,753.24	3,657.27	139.32

NO_x

Table 15 - Washington County, Ohio NO_x Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	16,137.09	17,168.69	7,505.59	3,364.26	13,804.43
Non-EGU	1,748.86	1,941.94	2,019.31	2,052.47	-110.53
Non-road	425.97	356.74	224.17	88.88	267.86
Area	168.44	178.66	183.96	191.01	-12.35
MAR	500.78	472.52	305.86	148.66	323.86
On-road	2,687.09	2,247.41	1,200.52	572.25	1,675.16
TOTAL	21,668.23	22,365.96	11,439.41	6,417.53	15,948.43

Table 16 - Wood County, West Virginia NO_x Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	0.00	0.00	0.00	0.00	0.00
Non-EGU	943.43	859.44	818.79	780.12	79.32
Non-road	406.22	361.87	231.95	168.36	193.51
Area	704.32	397.82	393.72	389.62	8.20
MAR	1,246.83	754.15	758.90	763.65	-9.50
On-road	2,459.26	2,122.62	992.62	538.59	1,584.03
TOTAL	5,760.06	4,495.90	3,195.98	2,640.34	1,855.56

Table 17 - Pleasants County, West Virginia NO_x Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	12,318.14	8,251.74	3,733.99	3,798.80	4,452.94
Non-EGU	639.94	156.90	22.73	21.64	135.26
Non-road	38.49	37.72	31.31	26.65	11.07
Area	174.42	43.54	42.80	42.07	1.47
MAR	799.88	362.14	364.42	366.70	-4.56
On-road	54.17	42.41	19.05	9.96	32.45
TOTAL	14,025.04	8,894.45	4,214.30	4,265.82	4,628.63

Table 18 - Parkersburg-Marietta Area NO_x Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR (Ohio) and With CSAPR (West Virginia)

NOx	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
Washington	21,668.23	22,365.96	11,439.41	6,417.53	15,948.43
Wood, WV	5,760.06	4,495.90	3,195.98	2,640.34	1,855.56
Pleasants, WV	14,025.04	8,894.45	4,214.30	4,265.82	4,628.63
COMBINED NOx TOTAL	41,453.33	35,756.31	18,849.69	13,323.69	22,432.62

SO_2

Table 19 - Washington County, Ohio SO_2 Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	140,957.01	133,348.05	61,849.00	31,206.55	102,141.50
Non-EGU	5,200.90	5,372.72	5,744.96	6,122.46	-749.74
Non-road	41.04	15.08	2.47	0.49	14.59
Area	9.78	10.56	10.51	10.15	0.41
MAR	44.48	31.29	12.44	5.21	26.08
On-road	26.97	8.54	6.46	6.31	2.23
TOTAL	146,280.18	138,786.24	67,625.84	37,351.17	101,435.07

Table 20 - Wood County, West Virginia SO_2 Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	0.00	0.00	0.00	0.00	0.00
Non-EGU	5,231.51	3,175.37	3,018.61	2,869.59	305.78
Non-road	31.18	5.53	0.67	0.72	4.81
Area	715.82	521.01	493.53	466.05	54.96
MAR	58.80	39.60	39.85	40.09	-0.49
On-road	31.13	10.37	7.88	7.70	2.67
TOTAL	6,068.44	3,751.88	3,560.54	3,384.15	367.73

Table 21 - Pleasants County, West Virginia SO_2 Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
EGU Point	52,295.78	15,803.98	6,090.44	7,687.48	8,116.50
Non-EGU	5,623.32	1,175.69	1.11	1.08	1,174.61
Non-road	2.42	0.47	0.12	0.13	0.34
Area	97.76	55.40	52.50	49.60	5.80
MAR	38.47	19.29	19.41	19.53	-0.24
On-road	0.69	0.22	0.18	0.15	0.07
TOTAL	58,058.44	17,055.05	6,163.76	7,757.97	9,297.08

Table 22 - Parkersburg-Marietta Area SO_2 Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR (Ohio) and With CSAPR (West Virginia)

SO2	2005 Base	2008 Attainment	2015 Interim	2022 Maintenance	Safety Margin
Washington	146,280.18	138,786.24	67,625.84	37,351.17	101,435.07
Wood, WV	6,068.44	3,751.88	3,560.54	3,384.15	367.73
Pleasants, WV	58,058.44	17,055.05	6,163.76	7,757.97	9,297.08
COMBINED SO2 TOTAL	210,407.06	159,593.17	77,350.14	48,493.29	111,099.88

$PM_{2.5}$, NO_X, and SO_2

Table 23 - Parkersburg-Marietta Area Comparison of 2008 Attainment Year and 2015 and 2022 Projected Emission Estimates (tpy)

	2008 Attainment	2015 Interim	2015 Projected Decrease	2022 Maintenance	2022 Projected Decrease
$PM_{2.5}$	4,146.74	3,753.24	393.50	3,657.27	489.47
NO_x	35,756.31	18,849.69	16,906.62	13,323.69	22,432.62
SO_2	159,593.17	77,350.14	82,243.03	48,493.29	111,099.88

As shown in the table above (Table 23), $PM_{2.5}$ emissions in the nonattainment area are projected to decrease by 393.50 tpy in 2015 and 489.47 tpy in 2022. NO_X emissions in the nonattainment area are projected to decrease by 16,906.62 tpy in 2015 and 22,432.62 tpy in 2022. SO_2 emissions in the nonattainment area are projected to decline by 82,243.03 tpy in 2015 and 111,099.88 in 2022.

In addition to the above, additional reductions from Ohio's utilities have been occurring:

- Muskingum River AEP Station in Washington County has implemented important changes in 2008. Unit #5 (as required through a federally enforceable consent decree) began continuous operation of their advanced NO_X control device. Unit #5 is the largest (600 MW) of five units at this facility. The remaining four units are 205 to 240 MWs (2 each). In addition, by the close of 2015, all units at the Muskingum

River AEP Station are required to retire, repower or retrofit the unit (as required through a federally enforceable consent decree) and initial plans indicate AEP will install advanced SO_2 controls (FGD scrubber) on unit #5.

- R.H.Gorsuch AMP Station in Washington County permanently shut down at the end of 2010. This facility operated four 53 MW units.

Requirement 4 of 5

A demonstration that improvement in air quality between the year violations occurred and the year attainment was achieved is based on permanent and enforceable emission reductions and not on temporary adverse economic conditions or unusually favorable meteorology.

Background

Ambient air quality data from all monitoring sites indicate that air quality met the NAAQS for $PM_{2.5}$ in 2008-2010. U.S. EPA's redesignation guidance (p 9) states: "A state may generally demonstrate maintenance of the NAAQS by either showing that future emissions of a pollutant or its precursors will not exceed the level of the attainment inventory, or by modeling to show that the future mix of sources and emissions rates will not cause a violation of the NAAQS."

Demonstration

Permanent and enforceable reductions of $PM_{2.5}$, NO_x, and SO_2 emissions have contributed to the attainment of the annual $PM_{2.5}$ standard. Some of these reductions were realized due to the application of tighter federal standards on new vehicles. Also Title IV of the CAA, the NO_x SIP Call, CAIR, and federal consent decrees required the reductions of SO_2 and NO_x emissions from utility sources. Reductions achieved are discussed in greater detail under Chapter Five.

Table 24 - Parkersburg-Marietta Area Comparison of 2005 base year and 2008 attainment year on-road and EGU reductions

	2005	2008
On-road $PM_{2.5}$	173.49	143.04
On-road NO_x	5,200.52	4,412.44
On-road SO_2	58.79	19.13
EGU $PM_{2.5}$	1,745.04	1,680.45
EGU NO_x	28,455.23	25,420.43
EGU SO_2	193,252.79	149,152.03

Requirement 5 of 5
Provisions for future annual updates of the inventory to enable tracking of the emission levels, including an annual emission statement from major sources.

Demonstration
In Ohio, major point sources in all counties are required to submit air emissions information annually, in accordance with U.S. EPA's Consolidated Emissions Reporting Rule (CERR). Ohio EPA prepares a new periodic inventory for all $PM_{2.5}$ precursor emission sectors every three years. These $PM_{2.5}$ precursor inventories will be prepared for future years as necessary to comply with the inventory reporting requirements established in the CFR. Emissions information will be compared to the 2005 base year and the 2022 projected maintenance year inventories to assess emission trends, as necessary, and to assure continued compliance with the annual $PM_{2.5}$ standard.

CHAPTER FIVE

CONTROL MEASURES AND REGULATIONS

CAA Section107 (d)(3)(E)(ii), 107(d)(3)(iv), and 107(d)(3)(E)(v)

Requirement 1 of 6

Section 172(c)(1) of the 1990 Clean Air Act Amendments requires states with nonattainment areas to implement RACM and RACT.

Background

Section 172(c)(1) of the 1990 Clean Air Act Amendments requires states with nonattainment areas to submit a SIP providing for implementation of all reasonably available control measures and as expeditiously as practicable (including such reductions in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonable available control technology).

U.S. EPA's Implementation Rule interprets this requirement in great detail. Under U.S. EPA's approach, RACT is determined as part of the broader RACM analysis and identification of all measures (for stationary, mobile, and area sources) that are technically and economically feasible, and that would collectively contribute to advancing the attainment date (i.e. by one year or more). States are required to use a combined approach to RACT and RACM, that (1) identifies potential measures that are reasonable, (2) uses modeling to identify the attainment date that is as expeditious as practicable, and (3) selects the appropriate RACT and RACM.

The Implementation Rule also provides for a presumption that in States that fulfill their CAIR emission reduction requirements, EGU compliance with CAIR is equivalent to RACM/RACT.

Demonstration

In 1972, 1980, and 1991, Ohio promulgated rules requiring reasonably available controls measures for particulate emissions from stationary sources.

Statewide RACT rules have been applied to all new sources locating in Ohio since that time. RACT requirements are incorporated into permits along with monitoring, recordkeeping, and reporting necessary to ensure ongoing compliance. Ohio EPA also has an active enforcement program to address violations discovered by field office staff. The Ohio RACT rules for particulate matter are found in OAC Chapter 3745-17[15].

In addition, Ohio EPA promulgated NO_x SIP Call rules (OAC Chapter 3745-14[16]), CAIR (OAC Chapter 3745-109[17]), and NO_x Reasonably Available Control Technology rules (OAC Chapter 3745-110[18]) over the past five years. Emissions from EGUs make up a significant contribution to Ohio's inventory. Beginning in 2009, Ohio implemented CAIR which has, and will, provide for significant reductions in NO_x, $PM_{2.5}$, and SO_2 until such time CSAPR is implemented. Then the CSAPR will provide for even greater reductions.

As part of a larger initiative, LADCO, in consultation with two contractors, performed a series of studies exploring control measures for reducing both ozone precursors and $PM_{2.5}$ precursors in Ohio, Illinois, Indiana, Michigan, and Wisconsin area. The first consultant, MACTEC, prepared a series of white papers[19] researching different stationary source categories. The results were compiled into two reports[20]. The second consultant, Environ, investigated control options for mobile sources. The results were compiled into two reports[21]. The stationary and mobile source sectors (and associated control measures) were selected by the LADCO States based on several factors presented in the report (See Chapter 2).

Photochemical modeling was then conducted (as part of LADCO Round 4 modeling) to assess the air quality benefit of the candidate control measures and a modeling report was developed[22]. Based on the results, the LADCO project team felt it would not be possible to advance the attainment date for $PM_{2.5}$. Ohio EPA, in its attainment demonstration submitted on July 18, 2008, demonstrated (using a weight of evidence approach) that

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[15] http://www.epa.ohio.gov/dapc/regs/3745_17.aspx

[16] http://www.epa.ohio.gov/dapc/regs/3745_14.aspx

[17] http://www.epa.ohio.gov/dapc/regs/3745_109.aspx

[18] http://www.epa.ohio.gov/dapc/regs/3745_110.aspx

[19] http://www.ladco.org/reports/control/white_papers

[20] http://www.ladco.org/reports/control/final_reports/identification_and_evaluation_of_candidate_control_measures_i_april_2005.pdf; http://www.ladco.org/reports/control/final_reports/identification_and_evaluation_of_candidate_control_measures_ii_june_2006.pdf

[21] http://www.ladco.org/reports/control/final_reports/final_report_evaluation_of_candidate_mobile_source_control_measures_february_2006.pdf; http://www.ladco.org/reports/control/final_reports/final_report_evaluation_of_candidate_mobile_source_control_measures_for_ladco_states_in_2009_and_2012_march_2007.pdf

[22] http://www.ladco.org/reports/control/modeling/round4_modeling.pdf

attainment would be achieved in this area by 2009. Because of a projected 2009 attainment date, it would not have been reasonably possible or practicable for Ohio to develop RACT/RACM requirements, promulgate regulations and implement a control program prior to the projected attainment date.

Requirement 2 of 6

Section 172(c)(2) of the 1990 CAA Amendments requires attainment demonstration SIPs for nonattainment areas to show reasonable further progress (RFP).

Background

U.S. EPA's Implementation Rule requires RFP only for any area which a State projects an attainment date beyond 2010. The RFP would provide emission reductions showing linear progress between 2002 and 2009. If a State demonstrates attainment will occur by 2010 or earlier, U.S. EPA considers the attainment demonstration to demonstrate achievement of RFP.

Demonstration

In Ohio's attainment demonstration submitted on July 18, 2008, Ohio demonstrated (using a weight of evidence approach) that attainment would be achieved in this area by 2009; and therefore, it was not necessary to submit a separate RFP plan.

Requirement 3 of 6

Section 172(c)(3) requires states to submit a comprehensive inventory of actual emissions.

Background

Section 172(c)(3) requires states to submit a comprehensive inventory of actual emissions in the area, including the requirement for periodic revisions as determined necessary. 40 CFR 51.1008 requires such inventory to be submitted within three years of designation and requires a baseline emission inventory for calendar year 2002 or other suitable year to be used for attainment planning.

Demonstration

The 2005 comprehensive inventory was submitted to U.S. EPA with Ohio's $PM_{2.5}$ attainment demonstration SIP submitted on July 18, 2008. It was then subsequently revised and resubmitted on June 7, 2010.

Ohio also updates its inventory in accordance with U.S. EPA's CERR rule (i.e. emissions statements). Ohio EPA submitted its emissions statement SIP on March 18, 1994 which was approved by U.S. EPA on October 13, 1995 (59 FR 51863). As discussed in Chapter 4 (Requirement 4), Ohio EPA submits, and commits to submit, emission inventories (statements) every three years.

Requirement 4 of 6

Evidence that control measures required in past $PM_{2.5}$ SIP revisions have been fully implemented.

Background

In addition to the historic RACT requirements for PM, the U.S. EPA NO_x SIP Call required 22 states to pass rules that would result in significant emission reductions from large EGUs, industrial boilers, and cement kilns in the eastern United States. Ohio passed this rule in 2001. NOx SIP Call requirements are incorporated into permits along with monitoring, recordkeeping, and reporting necessary to ensure ongoing compliance. Ohio EPA also has an active enforcement program to address violations discovered by field office staff. Compliance is tracked through the Clean Air Markets data monitoring program. Beginning in 2004, this rule accounts for a reduction of approximately 31 percent of all NO_x emissions statewide compared to previous uncontrolled years. The other 21 states also have adopted these rules.

On March 10, 2004, the U.S. EPA promulgated the CAIR. Beginning in 2009, U.S. EPA's CAIR rule requires EGUs in 28 eastern states and the District of Columbia to significantly reduce emissions of NO_x and SO_2. CAIR replaced the NOx SIP Call for EGUs. National NO_x emissions will be cut from 4.5 million tons in 2004, to a cap of 1.5 million tons by 2009, and 1.3 million tons in 2018 in 28 states. States were required to submit a CAIR SIP as part of this effort. Ohio submitted a CAIR SIP which was approved by U.S. EPA on February 1, 2007. Revisions to the CAIR SIP were again submitted on July 15, 2009. The revised CAIR SIP was approved as a direct final action on September 25, 2009 (74 FR 48857).

Demonstration

Controls for EGUs under the NO_x SIP Call formally commenced May 31, 2004. Emissions covered by this program have been generally trending downward since 1998 with larger reductions occurring in 2002 and 2003. Data taken from the U.S. EPA Clean Air Markets web site, quantify the gradual NO_x reductions that have occurred in Ohio as a result of Title IV of the 1990 CAA Amendments and the beginning of the NO_x SIP Call Rule. Ohio developed the NO_x Budget Trading Program rules in OAC Chapter 3745-14[23] in response to the SIP Call. OAC Chapter 3745-14 regulates EGUs and certain non-EGUs under a cap and trade program based on an 85 percent reduction of NOx emissions from EGUs and a 60 percent reduction of NO_x emissions from non-EGUs, compared to historical levels. This cap was in place through 2008, at which time the CAIR program superseded it as discussed above. Requirement 3 of 5 under Chapter 4 above discussed the reductions Ohio has seen as a result of CAIR.

On April 21, 2004, U.S. EPA published Phase II of the NO_x SIP Call that establishes a budget for large (greater than 1 ton per day emissions) stationary internal combustion engines. Ohio EPA's OAC rule 3745-14-12 addresses stationary internal combustion engines, all used in natural gas pipeline transmissions. U.S. EPA approved this revision to the SIP on April 4, 2008. An 82 percent NO_x reduction from 1995 levels is anticipated. Completion of the compliance plan occurred by May 1, 2006, and the compliance demonstration began May 1, 2007.

Tier II Emission Standards for Vehicles and Gasoline Sulfur Standards

In February 2000, U.S. EPA finalized a federal rule to significantly reduce emissions from cars and light trucks, including sport utility vehicles (SUVs). Under this proposal, automakers will be required to sell cleaner cars, and refineries will be required to make cleaner, lower sulfur gasoline. This rule will apply nationwide. The federal rules will phase in between 2004 and 2009. U.S. EPA has estimated that NO_x emission reductions will be approximately 77 percent for passenger cars, 86 percent for smaller SUVs, light trucks, and minivans, and 65 to 95 percent reductions for larger SUVs, vans, and heavier trucks. The sulfur content of gasoline is estimated to be reduced by up to 90 percent. VOC emission reductions will be approximately 12 percent for passenger cars, 18 percent for smaller SUVs, light trucks, and minivans, and 15 percent for larger SUVs, vans, and heavier trucks.

Heavy-Duty Diesel Engines

In July 2000, U.S. EPA issued a final rule for Highway Heavy Duty Engines, a program which includes low-sulfur diesel fuel standards, which will be phased in from 2004 through 2007. This rule applies to heavy-duty gasoline and diesel trucks and buses.

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[23] http://www.epa.ohio.gov/dapc/regs/3745_14.aspx

This rule will result in a 40 percent reduction in NO_x from diesel trucks and buses, a large sector of the mobile sources NO_x inventory. It also estimated the level of sulfur in highway diesel fuel will be reduced by 97 percent by mid-2006.

Clean Air Non-road Diesel Rule
In May 2004, U.S. EPA issued the Clean Air Non-road Diesel Rule. This rule applies to diesel engines used in industries such as construction, agriculture, and mining. It also contains a cleaner fuel standard similar to the highway diesel program. The new standards will cut emissions from non-road diesel engines by more than 90 percent. Non-road diesel equipment, as described in this rule, currently accounts for 47 percent of diesel particulate matter (PM) and 25 percent of NO_x from mobile sources nationwide. Sulfur levels will be reduced in non-road diesel fuel by 99 percent from current levels, from approximately 3,000 parts per million (ppm) now to 15 ppm in 2009. New engine standards take effect, based on engine horsepower, starting in 2008. Together, these rules will substantially reduce local and regional sources of $PM_{2.5}$ precursors.

Requirement 5 of 6

Acceptable provisions to provide for new source review.

Background

Ohio has a longstanding and fully implemented New Source Review (NSR) program. This is addressed in OAC Chapter 3745-31[24]. The Chapter includes provisions for the Prevention of Significant Deterioration (PSD) permitting program in OAC rules 3745-31-01 to 3745-31-20. Ohio's PSD program was conditionally approved on October 10, 2001 (66 FR 51570) and received final approval on January 22, 2003 (68FR 2909) by U.S. EPA as part of the SIP.

Demonstration

Any facility that is not listed in the 2005 emission inventory, or for the closing of which credit was taken in demonstrating attainment, will not be allowed to construct, reopen, modify, or reconstruct without meeting all applicable NSR requirements. Once the area is redesignated, Ohio EPA will implement NSR through the PSD program.

Requirement 6 of 6

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[24] http://www.epa.ohio.gov/dapc/regs/3745_31.aspx

Assure that all existing control measures will remain in effect after redesignation unless the State demonstrates through modeling that the standard can be maintained without one or more control measures.

Demonstration

Ohio commits to maintaining the aforementioned control measures after redesignation. Ohio hereby commits that any changes to its rules or emission limits applicable to $PM_{2.5}$, SO_2, and NO_x as required for maintenance of the annual $PM_{2.5}$ standard in the Parkersburg-Marietta area, will be submitted to U.S. EPA for approval as a SIP revision.

Ohio, through Ohio EPA's Legal office, has the legal authority and necessary resources to actively enforce any violations of its rules or permit provisions. After redesignation, it intends to continue enforcing all rules that relate to the emission of $PM_{2.5}$ precursors in the Parkersburg-Marietta area.

CHAPTER SIX

CONTINGENCY MEASURES

CAA Section 107(d)(3)(E)(v)

Requirement 1 of 4

A commitment to submit a revised plan eight years after redesignation.

Demonstration

Ohio hereby commits to review its maintenance plan eight years after redesignation, as required by Section 175(A) of the CAA.

Requirement 2 of 4

A commitment to expeditiously enact and implement additional contingency control measures in response to exceeding specified predetermined levels (triggers) or in the event that future violations of the ambient standard occur.

Demonstration

Ohio hereby commits to adopt and expeditiously implement necessary corrective actions in the following circumstances:

Warning Level Response:

A warning level response shall be prompted whenever the $PM_{2.5}$ average of the weighted annual mean of 15.5 µg/m^3 occurs in a single calendar year within the maintenance area. A warning level response will consist of a study to determine whether the $PM_{2.5}$ value indicates a trend toward higher $PM_{2.5}$ values or whether emissions appear to be increasing. The study will evaluate whether the trend, if any, is likely to continue and, if so, the control measures necessary to reverse the trend taking into consideration ease and timing for implementation as well as economic and social considerations. Implementation of necessary controls in response to a warning level response trigger will take place as expeditiously as possible, but in no event later than 12 months from the conclusion of the most recent calendar year.

Should it be determined through the warning level study that action is necessary to reverse the noted trend, the procedures for control selection and implementation outlined under "action level response" shall be followed.

Action Level Response:

An action level response shall be prompted whenever a two-year average of the weighted annual means of 15.0 µg/m^3 or greater occurs within the maintenance area. A violation of the standard (three-year average of the weighted annual means of 15.0 µg/m^3 or greater) shall also prompt an action level response. In the event that the action level is triggered and is not found to be due to an exceptional event, malfunction, or noncompliance with a permit condition or rule requirement, Ohio EPA in conjunction with the metropolitan planning organization or regional council of governments, will determine additional control measures needed to assure future attainment of the NAAQS for annual $PM_{2.5}$. In this case, measures that can be implemented in a short time will be selected in order to be in place within 18 months from the close of the calendar year that prompted the action level. Ohio EPA will also consider the timing of an action level trigger and determine if additional, significant new regulations not currently included as part of the maintenance provisions will be implemented in a timely manner and will constitute our response.

Control Measure Selection and Implementation

Adoption of any additional control measures is subject to the necessary administrative and legal process. This process will include publication of notices, an opportunity for public hearing, and other measures required by Ohio law for rulemaking.

If a new measure/control is already promulgated and scheduled to be implemented at the federal or State level, and that measure/control is determined to be sufficient to address the upward trend in air quality, additional local measures may be unnecessary. Furthermore, Ohio will submit to U.S. EPA an analysis to demonstrate the proposed measures are adequate to return the area to attainment.

Requirement 3 of 4

A list of potential contingency measures that would be implemented in such an event.

Demonstration

Contingency measures to be considered will be selected from a comprehensive list of measures deemed appropriate and effective at the time the selection is made. The selection of measures will be based on cost-effectiveness, emission reduction potential, economic and social considerations or other factors that Ohio EPA deems appropriate. Ohio EPA will solicit input from all interested and affected persons in the maintenance area prior to selecting appropriate contingency measures. Because it is not possible at this time to determine what control measures will be appropriate at an unspecified time in the future, the list of contingency measures outlined below is not exhaustive.

1) Diesel reduction emission strategies.
2) Alternative fuel (e.g., liquid propane and compressed natural gas) and diesel retrofit programs for fleet vehicle operations.
3) Tighter $PM_{2.5}$, SO_2, and NO_x emissions offsets for new and modified major sources.
4) Impact crushers located at recycle scrap yards – upgrade wet suppression.
5) Concrete manufacturing – upgrade wet suppression.
6) Additional NO_x RACT statewide.

No contingency measure shall be implemented without providing the opportunity for full public participation during which the relative costs and benefits of individual measures, at the time they are under consideration, can be fully evaluated.

Requirement 4 of 4

A list of $PM_{2.5}$, SO_2, and NO_x sources potentially subject to future additional control requirements.

Demonstration

The following is a list of $PM_{2.5}$, SO_2, and NO_x sources potentially subject to future controls.

- ICI Boilers - SO_2 and NO_x controls;
- EGUs;
- process heaters;
- internal combustion engines;
- combustion turbines;
- other sources greater than 100 tons per year;
- fleet vehicles;
- concrete manufacturers;
- aggregate processing plants;

CHAPTER SEVEN

PUBLIC PARTICIPATION

Ohio published notification for a public hearing and solicitation for public comment concerning the draft redesignation petition and maintenance plan in the widely distributed county publications on _____________.

The public hearing to receive comments on the redesignation request was held on _____________, at the Ohio EPA's Southeast District Office, Logan, Ohio. The public comment period closed on _____________. Appendix F includes a copy of the public notice, certification of publication, and the transcript from the public hearing.

CHAPTER EIGHT

CONCLUSIONS

The Parkersburg-Marietta annual $PM_{2.5}$ nonattainment area has attained the 1997 annual NAAQS for $PM_{2.5}$ and complied with the applicable provisions of the 1990 Amendments to the CAA regarding redesignations of $PM_{2.5}$ nonattainment areas. Documentation to that effect is contained herein. Ohio EPA has prepared a redesignation request and maintenance plan that meet the requirements of Section 110 (a)(1) of the 1990 CAA.

Based on this presentation, the Parkersburg-Marietta annual $PM_{2.5}$ nonattainment area meets the requirements for redesignation under the CAA and U.S. EPA guidance. Ohio has performed an analysis that shows the air quality improvements are due to permanent and enforceable measures. Furthermore, because this area is subject to significant transport of pollutants, significant regional SO_2 and NO_x reductions will ensure continued compliance (maintenance) with the standard with an increasing margin of safety.

The State of Ohio hereby requests that the Parkersburg-Marietta annual $PM_{2.5}$ nonattainment area be redesignated to attainment simultaneously with U.S. EPA approval of the maintenance plan provisions contained herein.

Appendix A-1

Air Quality System
(AQS)
Data

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

User ID: GYE

DESIGN VALUE REPORT

Report Request ID: 944177

Report Code: AMP480

Jan. 4, 2012

GEOGRAPHIC SELECTIONS

Tribal Code	State	County	Site	Parameter	POC	City	AQCR	UAR	CBSA	CSA	EPA Region	Method	Duration	Begin Date	End Date
	54	107	1002												

PROTOCOL SELECTIONS

Parameter Classification	Parameter	Method	Duration
DESIGN VALUE	88101		

SELECTED OPTIONS

Option Type	Option Value
USER SITE METADATA	COUNTY NAME
MERGE PDF FILES	YES
QUARTERLY DATA IN WORKFILE	NO
WORKFILE DELIMITER	,
SINGLE EVENT PROCESSING	EXCLUDE REGIONALLY CONCURRED EVENTS

GLOBAL DATES

Start Date	End Date
2010	2010

APPLICABLE STANDARDS

Standard Description
PM25 24-hour 2006
PM25 Annual 2006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
PRELIMINARY DESIGN VALUE REPORT

Report Date: Jan. 4, 2012

Notes:

1. Warning: Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
PRELIMINARY DESIGN VALUE REPORT

Report Date: Jan. 4, 2012

Pollutant: Site-LevelPM2.5 - Local Conditions(88101)
Standard Units: Micrograms/cubic meter (LC)(105)
NAAQS Standard: PM25 24-hour 2006 / PM25 Annual 2006
Statistic: Annual Weighted Mean **Level:** 15
Statistic: Annual 98th Percentile **Level:** 35

Design Value Year: 2010

REPORT EXCLUDES MEASUREMENTS WITH REGIONALLY CONCURRED EVENT FLAGS.

State Name: West Virginia

Site_ID / COUNTY NAME	2010					2009					2008					24-Hour		Annual	
	Cred. Days	Comp. Qrtrs	98th Perctil	Wtd. Mean	Cert.	Cred. Days	Comp. Qrtrs	98th Perctil	Wtd. Mean	Cert.	Cred. Days	Comp. Qrtrs	98th Perctil	Wtd. Mean	Cert.	Design Value	Valid Ind.	Design Value	Valid Ind.
54-107-1002 Wood	117	4	28.4	13.4	N	350	4	26.5	12.0	N	113	4	28.2	13.8	Y	28	Y	13.1	Y

Notes:
1. Warning: Computed design values are a snapshot of the data at the time the report was run (may not be all data for year).
2. Annual Values not meeting completeness criteria are marked with an asterisk ('*').

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Appendix A-2
SLAMS Letter

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Ohio | **Environmental Protection Agency**
John R. Kasich, Governor
Mary Taylor, Lt. Governor
Scott J. Nally, Director

CERTIFIED MAIL

March 10, 2011

Cheryl L. Newton, Director
Air and Radiation Division
U.S.EPA, Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

RE: 2010 SLAMS $PM_{2.5}$ and Ozone Data Certification

Dear Ms. Newton:

Please find enclosed our SLAMS Report (AMP-450, AMP-450NC and AMP-255) for calendar year 2010 as required in 40 CFR, Part 58, Section 58.15. The ambient concentration and the quality assurance data have been completely submitted to the AQS database.

The remaining criteria pollutant data will be certified within the month of April.

I certify that the Ozone and $PM_{2.5}$ data in the report are accurate to the best of our knowledge taking into consideration the quality assurance findings and only to the extent of the activities performed by Ohio EPA.

There were no incidents of air pollution that reached or exceeded levels as specified by Section 51.151 which could cause significant harm to the health of persons.

Sincerely,

Robert Hodanbosi
Chief, Division of Air Pollution Control

Enclosure

50 West Town Street, Suite 700
P.O. Box 1049
Columbus, OH 43216-1049

614 | 644 3020
614 | 644 3184 (fax)
www.epa.ohio.gov

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Appendix B

2005 Base Year
$PM_{2.5}$ SIP Inventory

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OHIO
2005 Base Year PM2.5 SIP Inventory

Ohio Environmental Protection Agency
Lazarus Government Center
50 West Town Street, Suite 700
Columbus Ohio 43215

Prepared by Ohio EPA

Division of Air Pollution Control
Emissions Inventory Unit
February 2008

Table of Contents

2005 Base Year PM2.5 SIP Inventory for Ohio

Introduction

The State of Ohio has a number of counties with air quality data showing non-attainment for the following $PM_{2.5}$ standard:

- Annual Standard = 15.0 ug/m3

The Clean Air Act Amendments (CAAA) requires all states to revise and submit State Implementation Plans (SIP) for areas which are classified as non-attainment of the 1997 Fine Particle ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). The Federal Register (Vol. 72, No. 79/ Wednesday, April 25, 2007) provides the emissions inventory rules and regulations for the $PM_{2.5}$ Clean Air Fine Particle implementation rule. An electronic version of the document can be found at http://www.epa.gov/fedrgstr/EPA-AIR/2007/April/Day-25/a6347.pdf.

As part of the designation of non-attainment areas for $PM_{2.5}$ standards, a new attainment demonstration SIP will be necessary. A key element in the overall SIP planning process is the need for an updated emissions inventory. This document presents the 2005 Base Year Particulate SIP Emissions Inventory for Ohio as required by the CAAA. It includes emissions for point, area, on-road mobile and non-road mobile for the State of Ohio.

This technical report documents the procedures and the methodologies that were used in the development of daily emissions for all counties in Ohio. This report describes the following:

1. Identification of stationary and mobile sources included in the inventory;
2. Sources of data, and data collection methods used in the development of the inventory;
3. Methods and procedures used to estimate emissions; and
4. Assumptions considered in the development of the emissions inventories.

The intent of this report is to describe how the inventory was prepared, and what information was considered in the inventory development.

This document is comprised of 5 sections, one section for each inventory type. The biogenic inventory is not being discussed in this document because Ohio EPA did not participate in the generation of this inventory. Lake Michigan Air Directors Consortium (LADCO) ran EPA's BEIS model in the Emission Modeling System (EMS) to generate Summer Weekday emissions for VOC and NOx.

SECTION 1

POINT SOURCES

Emissions and source specific data for point sources are collected for the 2005 base-year SIP inventory by the Ohio Environmental Protection Agency (Ohio EPA.) The primary source of data for point sources is facility reported STARShip files. STARShip is a software package developed by Ohio EPA, Division of Air Pollution Control (DAPC), to assist the regulated community in preparing and submitting a variety of electronic permit applications and reports to the DAPC. These data are reported by the Title V facilities annually as part of the emissions fee/inventory process conducted by Ohio EPA and include emissions, process rates, operating schedules, emissions control data and other relevant information.

The STARShip files are electronically transferred to the DAPC and stored into the Division's Oracle database, STARS. The files are reviewed by the local air agencies and Ohio EPA district and central office staff. After review, the data are imported into Excel and linked with an Access® database to further process the information into the federally approved National Emission Inventory (NEI) database format in version 3.0. The files are quality assured again using the United States Environmental Protection Agency's (U.S.EPA) QA/QC software for format and content. The data is finally submitted to LADCO for emissions processing through the Emissions Modeling System. The State provided inventory for Electric Generating Units (EGU) is replaced with the Federal EGU inventory. The EGU inventory is compiled by U.S. EPA's Acid Rain Program. It is based on facility reported emissions as measured by continuous emissions monitors. In conclusion, the final point source inventory is a hybrid of the federal EGU inventory and the state provided non-EGU units.

A major distinction typically made in emissions inventories is that between point and area sources. In this inventory, point sources are sources for which individual records are maintained for that source. Such records are maintained for all Ohio Title V facilities (706 facilities statewide). The area source inventory accounts for facilities from non-Title V facilities and calculates emissions information using surrogate emissions factors based on energy usage, population, employment records, or other reliable data. A more detailed discussion of the area source inventory is provided in Section 2. The point source inventory described herein is considered to be the most current and accurate source of emissions data available for 2005.

1.1 Point Source Process Emissions

Ohio EPA defines point source process emissions as those which occur at an identifiable Title V stationary stack or vent. Point source emissions not emitted from discrete stacks or vents are termed fugitive emissions and are discussed in Section 1.2.

1.1.1 Source Identification and Data Collection

The sources to be included in the 2005 base year inventory are identified using the Title V STARS database. Facility production and emissions data are included in this database. This information is facility-reported actual 2005 emissions.

1.1.2 Non-reactive VOC Emissions Adjustments

This section is primarily applicable for VOC pollutants. Sources are required to identify emissions of photochemically non-reactive Volatile Organic Compounds (VOC.) Based upon this information, those emissions have been specifically excluded from the 2005 base line inventory in accordance with U.S. EPA's "Recommended Policy on the Control of Volatile Organic Compounds." A complete list of the compounds that U.S. EPA has identified as being photochemically non-reactive, and therefore not included in the inventory, are listed below:

- Methane
- Ethane
- Methylene chloride
- Methyl chloroform
- Trichlorofluoromethane (CFC-11)
- Dichlorodifluoromethane (CFC-12)
- Chlorodifluoromethane (CFC-22)
- Trifluoromethane (HFC-23)
- Chlorofluoromethance (HCFC-31)
- Difluoromethane (HFC-32)
- Decafluoropentane (HFC-43-10mee)
- Ethylfluoride (HFC-161)
- Trichlorotrifluoroethane (CFC-113)
- Dichlorotetrafluoroethane (CFC-114)
- Chloropentafluoroethane (CFC-115)
- 2,2-Dichloro-1,1,1-trifluoroethane (HCFC-123)
- 1,1,2-Trifluoroethane (HCFC-123a)
- 2-Chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
- Pentafluoroethane (HFC-125)
- 1,1,2,2,-Tetrafluoroethane (HFC-134)
- 1,1,1,2-Tetrafluoroethane (HFC-134a)
- 1,1-Dichloro-1-fluoroethane (HCFC-141b)
- 1-Chloro-1,1,-difluoroethane (HCFC-142b)
- 1,1,1-Trifluoroethane (HFC-143a)
- Fluoroethane (HCFC-151a)
- 1,1-Difluoroethane (HFC-152a)
- Pentafluoropropane (HFC-225ca)
- Pentafluoropropane (HFC-225cb)
- Hexafluoropropane (HFC-236ea)
- Hexafluoropropane (HFC-236fa)
- Pentafluoropropane (HFC-245ca)
- Pentafluoropropane (HFC-245ea)
- Pentafluoropropane (HFC-245eb)

- Pentafluoropropane (HFC-245fa)
- Pentafluorobutane (HFC-365mfc)
- Parachlorobenzotrifluoride (PCBTF)
- Methoxybutane
- Nonaflourobutane
- Heptafluoropropane $((CF_3)_2CFCF_2OCH_3)$
- Heptafluoropropane $((CF_3)CFCF_2OC_2H_5)$
- Perchloroethylene
- Cyclic, branched or linear completely methylated siloxanes
- Methyl acetate
- Volatile methyl siloxanes
- Acetone

1.1.3 Emissions Estimation Methodologies

Since source reported actual annual emissions are used in the 2005 base year inventory, no estimation methods are necessary. The reports are provided to LADCO in National Emissions Inventory Input Format (NIF) 3.0 format. LADCO imported and processed the NIF files in EMS and applied temporal and spatial profiles to the annual emissions to calculate weekday emissions rates. The final point source inventory is split into two separate reports, the Electric Generating Units (EGU) which is the U.S. EPA inventory for electric generating units and the non-EGU which is the state inventory minus the EGU units.

1.2 Point Source Fugitive Emissions

Another type of emissions data which is required to be filed from point sources is fugitive emissions. Before 1990, fugitive emissions were categorized as area sources due to the lack of detailed information available for fugitive sources. However, since these emissions are now electronically reported in the State's ORACLE database, STARS, these emissions can be classified as point sources.

1.3 References

Getting Started: Emissions Inventory Methods for PM2.5 U.S. Environmental Protection Agency, Research Triangle Park, NC, September, 1999.

Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Qaulity Standards (NAAQS) and Regional Haze Regulations, Office of Air Quality Planning & Standards Research, Triangle Park, NC. November 2005.

Compilation of Air Pollution Emission Factors, Fourth Edition and Supplements, AP-42. U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1985.

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Documentation for the 2002 Electric Generating Unit National Emissions Inventory (NEI). Eastern research group, Inc., 1600 Perimeter Park Drive, Morrisville, NC 27560 and E.H. Pechan and Associates, Inc., 5528–B Hempstead Way

SECTION 2

AREA SOURCES

Area sources are sources which are typically small, individual, numerous, and have not been inventoried as specific point, mobile, or biogenic sources. For inventory purposes, they are grouped with other like sources into categories that allow emissions to be calculated collectively using one methodology. Since area sources are traditionally defined at the county level, most methods are designed to estimate area source emissions at the county level.

Ohio EPA has either used published Emission Inventory Improvement Program (EIIP)[6] methodologies or selected other methodologies which are shared by other states. The decision of which methodology to use was largely based on Ohio's data availability. Data which was not available on a county-level is estimated by assigning a percentage of the state's total activity to each county based on the state's population or employment information. If Ohio county specific activity data is available through Ohio EPA or other State Agencies, that data is used rather than allocating activity by percentage. Table 2-1 lists the sources which emit $PM_{2.5}$, NO_x and SO_2 along with the respective EFs used to calculate each pollutant.

Table 2-1 Categories in the 2005 $PM_{2.5}$ SIP Area Source inventory

Area Source	NO_x	$PM_{2.5}$	SO_2	Section
Commercial Natural Gas Combustion	94 lb/MMSCF	7.6 lb/MMSCF	0.6 lb/MMSCF	2.1
Industrial Distillate Oil Combustion	20 lb/E3gal fuel	0.25 lb/E3gal fuel	42.6 lb/E3gal fuel	2.2
Industrial Residual Oil Combustion	55 lb/E3gal fuel	4.67 lb/E3gal fuel	157 lb/E3gal fuel	2.2
Industrial Natural Gas Combustion	94 lb/MMSCF	7.6 lb/MMSCF	0.6 lb/MMSCF	2.2
Residential Coal Combustion	9.1 Lb/Ton Coal	3.8 Lb/Ton Coal	31 Lb/Ton Coal	2.3
Residential Distillate Oil Combustion	18 lb/E3gal fuel	0.83 lb/E3gal fuel	42.6 lb/E3gal fuel	2.3
Residential Natural Gas Combustion	94 lb/MMSCF	7.6 lb/MMSCF	0.6 lb/MMSCF	2.3
Residential LPG Combustion	13 lb/E3gal fuel	0.17 lb/E3gal fuel	0.1 lb/E3gal fuel	2.3
Human Cremation	1.01E+01 lb/Ton cremated	0.0637 lb/Ton cremated	NA	2.4
Structure Fires	1.4 Lb/Ton burned	10.8 Lb/Ton burned	NA	2.5
Outdoor Wood Boilers	2.8 Lb/Ton	2.76E+1 Lb/Ton	4 E-1 Lb/Ton	2.6

Residential Wood Combustion				2.3
Non-Certified	2.80E+00 lb/Ton	3.06E+01 lb/Ton	4.00E-01 lb/Ton	
Non-Catalytic	2.80E+00 lb/Ton	1.96E+01 lb/Ton	4.00E-01 lb/Ton	
Catalytic	2.00E+00 lb/Ton	2.04E+01 lb/Ton	4.00E-01 lb/Ton	

2.1 Commercial Natural Gas Combustion (SCC 2103006000)

The 2005 total state-level commercial sector energy consumption is obtained from the Energy Information Administration (EIA)'s State Energy Data System (SEDS), and apportioned per county based on population[4]. Emissions factors are given in table 2-1. The area source emissions are calculated based on an adjusted value by subtracting the emissions due to point sources.

2.2 Industrial Fuel Combustion

Industrial Distillate Oil Combustion (SCC 2102004000)

Ohio's fuel consumption is apportioned per county based on the county's population[4]. The area source NO_X emissions are calculated and adjusted by subtracting the emissions due to point sources. A heating value of 140 MMBTU/1000 Gal is used and 84,408 thousand gallons are consumed in 2005. [MMBTU stand for Million British Thermal Units]. Emissions factors are given in table 2-1.

SO_2 emissions were calculated using EF 42.6 Lb/1000 Gal. PM_{10} and $PM_{2.5}$ emissions are calculated using 1Lb/1000 Gal and 0.25 Lb/1000 Gal respectively. All Factors are obtained from AP-42[19]

Industrial Residual Oil Combustion (SCC 2102005000)

Ohio's fuel consumption is apportioned per county based on the county's population[4]. The area source NO_X emissions are calculated and adjusted by subtracting the emissions due to point sources. 54,652 thousand gallons[14] are consumed in 2005 and a heating value of 140 MMBTU/1000 Gal is used. The SO_2 emissions are calculated using EF 157 Lb/1000 Gal. PM_{10} and $PM_{2.5}$ emissions are calculated using 7.17 Lb/1000 Gal and 4.67 Lb/1000 Gal respectively. All factors are obtained from AP-42[19]

Industrial Natural Gas Combustion (SCC 2102006000)

Ohio's fuel consumption is apportioned per county based on the county's population[4]. The area source NO_X emissions are calculated and adjusted by subtracting the emissions due to point sources. 293,857 MMCF[14] are consumed in 2005. The SO_2

emissions are calculated using EF 0.6 Lb/MMBTU. The PM_{10} and $PM_{2.5}$ emissions are calculated using 7.6 Lb/MMBTU. All factors were obtained from AP-42[19]

2.3 Residential Fuel Combustion

Residential Coal Combustion (SCC 2104001000)

Ohio's household consumption of coal is apportioned per county based on county population[4]. NO_X emissions are calculated using EF of 9.1 of coal. The SO_2 emissions are calculated using EF 31Lb/1000 Gal. The PM_{10} and $PM_{2.5}$ emissions are calculated using 6.2Lb/Ton and 3.8 Lb/Ton respectively. All factors were obtained from AP-42[19]

Residential Distillate Oil Combustion (SCC 2104004000)

Ohio's household consumption of distillate oil is apportioned per county based on county population[4]. NO_X emissions are calculated using EF of 18 lb/1000 gallons distillate fuel respectively. A heating value of 140 MMBTU/1000 Gal is used. The SO_2 emissions are calculated using EF 42.6 Lb/1000 Gal. The PM_{10} and $PM_{2.5}$ emissions are calculated using 1.08Lb/1000 Gal and 0.83 Lb/1000 Gal respectively. All factors are obtained from AP-42[19]

Residential Liquid Petroleum Gas Combustion (LPG)
(SCC 2104007000)

Ohio's household consumption of LPG is apportioned per county based on county population[4]. NO_X emissions are calculated using EF of 13 lb/1000 gallons LPG. The SO_2 emissions are calculated using EF 0.1 Lb/1000 Gal. The PM_{10} and $PM_{2.5}$ emissions are calculated using 0.17Lb/1000 Gal. All factors are obtained from AP-42[19]

Residential Natural Gas Combustion (SCC 2104006010)

Ohio's household consumption of LPG is apportioned per county based on county population[4]. NO_X emissions are calculated using EF of 94 lb/MMSCF. MMSCF stands for Million Standard Cubic Feet. This source also emits SO_2 emissions which are calculated using EF 0.6 Lb/MMBTU. The PM_{10} and $PM_{2.5}$ emissions are calculated using 7.6Lb/MMBTU. All factors are obtained from AP-42[19]

Residential Wood Combustion

NO_X emissions from this area source are calculated for seven types of residential heating units that utilize wood for fuel. They are listed below with the appropriate SCC:

Fireplaces without inserts	2104008001
Fireplaces with inserts catalytic (non-U.S. EPA cert)	2104008002
Fireplaces with inserts non -catalytic	2104008003
Fireplaces with inserts catalytic (U.S. EPA cert)	2104008004
Wood stoves – Conventional	2104008010
Woodstoves – Catalytic	2104008030
Wood stoves – Non catalytic	2104008050

The number of Ohio homes with fireplaces are adjusted for those that burn wood. The following assumptions are applied to those adjusted homes:

92 percent of wood combusted in non-certified units
5.7 percent of wood combusted in non-catalytic units
2.3 percent of wood combusted in catalytic units

A state consumption value is applied which is apportioned to each county based on its population[4]. Table 2-2 shows the EF used for each of the seven types of indoor wood burners which make-up this category:

Table 2-2 Emission Factors Used for Wood Burners

SCC	**2104008002**	**2104008003**	**2104008004**	
SCC	**2104008010**	**2104008050**	**2104008030**	
SCC	**2104008001**			
RAPIDS Code	**Non-Certified**	**Non-Catalytic**	**Catalytic**	**Units**
SO_2	4.00E-01	4.00E-01	4.00E-01	Lb/ton
NO_X	2.80E+00	2.80E+00	2.00E+00	Lb/ton
$PM_{2.5}$	3.06E+01	1.96E+01	2.04E+01	Lb/ton

To avoid double counting of wood consumption for fuel, this category is adjusted by subtracting the wood consumption from OWB to allow this category to account only for indoor wood burning emissions.

Residential Wood combustion also emits SO_2 which is calculated using EF 0.4 Lb/Ton EF. The $PM_{2.5}$ emissions are calculated using EF as shown in table 2-2. All factors are obtained from AP-42[19]

2.4 Human Cremation (SCC 2810060200)

Not all Ohio counties possess a crematory so only those counties with crematories are used to calculate the number of cremations and their resulting NOx emissions. The 2005 cremation data is obtained from the Ohio Department of Health, Vital Statistics[17]. It is estimated that 3% of deaths occur outside the State of Ohio with no available data to account for their disposition at the time this area source is being calculated. Therefore, those deaths are not accounted for in this category.
The methodology does not offer an EF for NOx for this category nor is NOx required to be calculated for this area source. Ohio feels that it is a combustion source and NOx needs to be included in the inventory along with the other combustion sources. Through its Permits-to-Install for human cremation, Ohio has selected a NOx EF of 10.13lb/ton cremated to calculate emissions from this area source.

This source also emits PM, PM_{10}, and $PM_{2.5}$ emissions which are calculated using EF 0.1 Lb/Ton, 0.071Lb/Ton and, 0.0637 Lb/Ton respectively. All factors are obtained from AP-42[19]

2.5 Structure Fires (SCC 2810030000)

The Structure Fires category includes residential and commercial fires resulting from unintentional actions. Intentional fires, forest and wildfires, agricultural, and vehicle burning are not included in this area source. The State Fire Marshall Office, Fire Prevention Bureau[15] provided data on the number of structure fires per county in 2005.

This area source is considered a combustion source for NO_X emissions which are calculated using EF 1.4 lb/ton burned. The residential and commercial structures fires for each county are tabulated and a fuel loading of 1.15 Ton/fire is applied. This source also emits PM, PM_{10}, and $PM_{2.5}$ emissions which are calculated using EF 10.8 Lb/Ton. This factor was obtained from AP-42[19]

2.6 Outdoor Wood Boilers (SCC 2104008070)

Outdoor Wood Boilers (OWB), are also known as outdoor water stoves and outdoor wood furnaces, are used as outdoor residential heaters. These boilers have wood burning fireboxes surrounded by a water reservoir vented by a chimney stack. The combustion of the wood in the firebox heats the water in the surrounding reservoir and the heated water is pumped to the residence. OWB units can also supply residential hot water. The water capacity ranges from 60 gallons to 764 gallons. The operational design creates long periods where the fire smolders and creosote is formed[13].

When the water circulating through the furnace reaches an upper set point, the air supply to the fire is cut-off, cooling the fire so the water will not overheat. The furnace operates in this "idle" mode until the water temperature hits a lower set point and the air supply is re-established. The OWB may be in idle mode far longer than in operating mode. This type of operating causes very poor combustion and heavy foul smoke. Most of the smoke emitted is fine condensed organic material that does not burn under cool, oxygen starved conditions. In addition, many owners burn green wood full of moisture which also causes poor combustion[12]. The smoke created from these outdoor wood burning units can contain several pollutants that are harmful to breathe, including fine particle pollution such as $PM_{2.5}$[11] in addition to NOx (research assisted by Deborah Lucas, DAPC intern, 2007)

This new area source category has many unknowns and variables associated with it and Ohio does not possess accurate OWB unit sales data available to calculate emissions on the county level. Therefore, several assumptions are made in agreement with the Great Lake States in order to formulate a homogeneous inventory for the region.

The assumptions are as follows:

- 100% of wood combusted in non-certified units.
- OWB units to be 90% in rural counties and 10% in urban counties
- 11.68 cords of wood consumption per unit per year (includes heating efficiency of 30-40%)
- 5 months heating season = 3650 hours (24/7)
- $PM_{2.5}$ emissions factor (g/kg wood) =13.82 (Average of indoor and outdoor) or 27.64 lb/ton of wood

The agreed upon methodology requires that total number of OWB sold in Ohio be apportioned to each county based on rural or urban designation while observing the 9:1 ratio in area sales. The guesstimated factors (see above) are applied to calculate the emissions from this outdoor wood burner. Total emissions obtained from this category are subtracted from the Residential Wood Combustion category to allow for accurate emissions from the indoor wood burning units.

2.7 References

1. Documentation For the 2002 Non-Point Source National Emission Inventory For CAPS and HAPS. U.S. Environmental Protection Agency. Emissions Factor and inventory Group. E.H Pechan and Associates, Inc. January 2004.

2. United States Census Bureau. Population Division. **http://eire.census.gov/popest/data/counties/tables/CO-EST2002/CO-EST2002-01-39.php** (Accessed 2003)

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4. Ohio Department of Development, Office of Strategic Research. *Population Projects by Age and Sex: 2005-2030.* http://www.odod.ohio.gov/research/files/p200.htm (Accessed August 2006)

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15. State Fire Marshal Office. Fire Prevention Bureau, Columbus, Ohio.
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16. Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) For Criteria Air Pollutants and Ammonia. Area Sources. E. H. Pechan & Associates, Inc. March 3, 2003

17. Ohio Department of Health, Vital Statistics

18. Environmental Protection Agency. STAPPA-ALAPCO-EPA Emission Inventory Improvement Program (EIIP). Volume X – Emissions Projections. December 1999.
http://www.epa.gov/ttn/chief/eiip/techreport/volume10/x01.pdf
(Accessed 2/2007)

19. Environmental Protection Agency. AP-42. http://www.epa.gov/ttn/chief/ap42/

SECTION 3

NON-ROAD SOURCES

The non-road inventory is generated regionally by running U.S. EPA's National Mobile Inventory Model (NMIM) model. The Wisconsin Department of Natural Resources undertook the responsibility of customizing the NMIM input files and submitting the output file in NIF format to LADCO and U.S. EPA. LADCO processed the NMIM files in their emissions model and generated daily emissions rates. Grant Heatherington from the Wisconsin Department of Natural Resources provided the following descriptions…

The National Mobile Inventory Model (NMIM) developed by USEPA was used to estimate emissions for all other non-road mobile categories. NMIM consolidates non-road mobile emissions and on-road emissions modeling into a single modeling system. Only the non-road emissions modeling portion of NMIM was used in the development of this emission's inventory. NMIM uses the USEPA's NONROAD model to calculate non-road mobile emissions. The basic NONROAD algorithm for calculating emissions uses base year equipment populations, average load factors, available engine powers, activity hours and emission factors. Before NMIM was run, modifications and additions were made to the NMIM input data.

a. Added emission factors for diesel tampers/rammers provided by E.H. Pechan & Associates, Inc. Diesel tampers/rammers are a type of construction equipment.

b. Revised $PM_{2.5}$ ratios in SCC table to correctly calculate $PM_{2.5}$ diesel emissions. This error was introduced with NMIM2005 and didn't exist in NMIM2004.

c. Revised gasoline parameters using updates provided by the states and E.H. Pechan & Associates, Inc. Gasoline parameters include Reid Vapor Pressure (RVP), oxygenate content and sulfur content.

The NMIM NEI NIF files are on the LADCO ftp site at:
ftp://ftp.airtoxics.org/inv2005/nonroad/NMIM/Base_L_ph2/2005/

Revised NMIM2005 Input Data

Emission Factor Data

All States: Pechan revised the brake specific fuel consumption (BSFC) emission factor data to include diesel tampers/rammers (2270002006). The revised NMIM file is saved as revBSFC.EMF.

Population Data

For 26000.pop, replaced default file supplied with NMIM2005 with 26000_rev_NMIM05.pop that contains revised construction data missing from 26000.pop external file provided with NMIM2005. This Michigan construction data should have been added with the other LADCO states modified construction data but was overlooked.

SCC Data

The default SCC table of NCD20060201 is replaced by a version that contains corrections to the PM25fac field that earlier NCDs contained (i.e. changed from 0.92 to 0.97 for diesel non-road equipment) in NONROAD2004.

Fuel Data

LADCO States: Pechan revised four tables (countyyear, countyyearmonth, datasource and gasoline) in the National County Database (NCD) used by NMIM to incorporate new fuel data. AIR revised gasoline characteristics per instructions from the states. Also, gasoline characteristic revisions for 2005 provided by states were incorporated. Additional revisions were incorporated into 2002 data for non-road Stage 2 controls. Depending on the year being modeled, different versions of the revised tables are used. Also, the countynrfile, countyyear and datasource tables were revised to reference the new activity, allocation, growth, population and seasonality files described above. NCD tables with names ending in “def” are default versions of the table. See table below for the appropriate versions of the tables for the selected years.

Non-LADCO States: The countynrfile, countyyear and datasource tables were revised to reference the new activity, allocation and seasonality files described above. See table below for the appropriate versions of the tables for the selected years.

Table 3-1 NMIM National County Database Tables for Specific Years and States

States	**Years**	
	1999 (WI only)	**2002, 05, 07, 08, 09, 12 and 18**
LADCO states	countynrfile_NMIM05_rev, countyyear_NMIM05_rev, countyyearmonth_NMIM05_w_05_12_18_rev, datasource_NMIM05_rev, gasoline_NMIM05_def SCC_NCD20060201_rev (used when NCD20060201 is used)	countynrfile_NMIM05_rev, countyyear_NMIM05_rev , countyyearmonth_NMIM05_w_05_12_18_rev, datasource_NMIM05_rev, gasoline_NMIM05_w_05_12_18_rev SCC_NCD20060201_rev (used when NCD20060201 is used)

SECTION 4

ON-ROAD SOURCES

A mobile source of air pollution is a self-propelled or portable emitter of air pollutants, and mobile source emissions are those generated by the engines or motors that power such sources. Most mobile sources, except jet or turboprop aircraft, are powered by internal combustion (IC) piston engines, and nearly all use liquid fuels.

Gaseous fuels, such as compressed natural gas (CNG) or liquefied petroleum gas (LPG), had only a very small fraction of the motor fuel market in Ohio in 2005. Solid fuels have not been used by mobile sources in significant amounts since railroads retired their coal-powered steam locomotives in the 1950s.

4.1 Categories of Mobile Sources

For inventory and planning purposes, mobile sources are divided into two major categories.

1. **On-highway** mobile sources (usually referred to as **on-road**), e.g., motor vehicles such as cars, vans, trucks, buses and motorcycles used for transportation of goods and passengers on roads and streets

2. **Off-highway** (usually referred to as **non-road**) mobile sources including:

    - Modes of powered transportation that do not use roads, such as aircraft, trains, ships and boats, and motor vehicles used off-road.

    - Self-propelled or portable motorized machines or equipment not used for transportation, ranging from construction equipment and farm tractors to lawnmowers and hand-held power weed choppers.

Mobile Sources: All on-road mobile sources are self-propelled.

Non-road Mobile Sources: Some non-road mobile sources (e.g., farm tractors), are self-propelled, but many non-road sources are not. A gasoline-powered chain saw is a familiar example of a non-self-propelled non-road mobile source.

Stationary Sources: Not all movable or portable emission sources are mobile sources, however. A small truck-portable cement or hot-mix asphalt plant, for example, may be set up near a construction or road-building site. Such plants are classified as stationary sources, not mobile sources for two reasons: (1) they may operate for weeks or months at a single location, and (2) the trucks that move the plants do not supply power for them.

NOTE: Not all Internal Combustion engines (IC) or turbine engines are mobile sources. Fixed IC engines, such as those that power pipeline compressors or standby generators in electricity plants and elsewhere, are also classified as stationary sources.

4.1.1 Categories and Components of Mobile Source Emissions

There are three categories of mobile source emissions:

- *Exhaust or tailpipe emissions*, which result from the combustion of fuel in the source's engine
- *Evaporative emissions*, which result from evaporation of fuel from the engine or its fuel system
- *Refueling emissions*

Exhaust Emissions: Are the result of fuel combustion and occur only when the engine is running.

Evaporative emissions: Are Volatile Organic Compound (VOC) based only and are continuously emitted from an engine's fuel system, whether the engine is running or not. Gasoline is a very volatile fuel, so total VOC emissions from gasoline powered vehicles have a large evaporative component. Diesel and jet fuels are of very low volatility, so evaporative emissions from diesel and turbine engines are a much smaller part of their total VOC emissions. Evaporative emissions for CNG or LPG powered vehicles are negligible because their fuel tanks and systems are of necessity, sealed.

Evaporative and exhaust VOC emissions can be calculated separately for most mobile source categories. Evaporative emissions do not include VOC emissions that occur during refueling.

Refueling Emissions: These emissions are the third category of mobile source emissions. Refueling emissions are entirely VOC. Although they result from the evaporation of fuel, they are distinct from, and not directly related to, evaporative emissions as defined above.

Refueling emissions have two subcomponents:

- <u>Displacement emissions</u>. These occur when new fuel is transferred into a partly filled tank--be it a service station storage tank, a portable fuel container (gas can), or a vehicle or engine's fuel tank; displacing the air in the tank and forcing that vapor-rich air out the inlet pipe or other vent. There are two stages of displacement emissions:
    - "**Stage I**" emissions occur when the underground storage tanks at a service station are being refilled;

  - “**Stage II**” emissions occur when a motor vehicle (or gas can) is being refueled.

  NOTE: These emissions are covered in, “Area Sources,” section 3.6.

- Spill emissions. These occur when drops of fuel drip or splash on the ground during or after refueling and evaporate away.

4.2 Ohio On-Road Mobile Source Inventory

The inventory of on-road mobile source emissions was developed in conjunction with the Ohio Department of Transportation (ODOT), Lake Michigan Air Director’s Consortium (LADCO), United States Environmental Protection Agency (USEPA), and the Ohio EPA (OEPA). Estimates of the amounts of NOx and VOC are reported by county in tons per day. Emissions are reported for a typical ozone season weekday in the summer of 2005.

4.2.1 Emission Inventories Developed with MOBILE6 Model

MOBILE6 Overview:

MOBILE6 is a computer program that estimates hydrocarbon (HC), carbon monoxide (CO), oxides of nitrogen (NO_x), exhaust particulate matter (which consists of several components), tire wear particulate matter, brake wear particulate matter, sulfur dioxide (SO_2), ammonia (NH_3), six hazardous air pollutant (HAP), and carbon dioxide (CO_2) emission factors for gasoline-fueled and diesel highway motor vehicles, and for certain specialized vehicles such as natural-gas-fueled or electric vehicles that may replace them. The program uses the calculation procedures presented in technical reports posted on EPA's MOBILE6 Web page http://www.epa.gov/otaq/models.htm.

MOBILE6 emission factor estimates depend on various conditions, such as ambient temperatures, travel speeds, operating modes, fuel volatility, and mileage accrual rates. Many of the variables affecting vehicle emissions can be specified by the user. MOBILE6 will estimate emission factors for any calendar year between 1952 and 2050, inclusive. Vehicles from the 25 most recent model years are considered to be in operation in each calendar year.

4.2.2 MOBILE6 Defaults:

MOBILE6 includes default values for a wide range of conditions that affect emissions. These defaults are designed to represent “national average” input data values. Users who desire a more precise estimate of local emissions can substitute information that more specifically reflects local conditions. Use of local input data will be particularly common when the local emission inventory is to be constructed from separate estimates of roadways, geographic areas, or times of day, in which fleet or traffic conditions vary considerably.

A list of MOBILE6 input parameters is provided below. Most of these inputs are optional because the model will supply default values unless **alternate data** are provided.

4.2.3 MOBILE6 Input Parameters

- Calendar year
- Month (January, July)
- Hourly Temperature
- Altitude (high, low)
- Weekend/weekday
- Fuel characteristics (Reid vapor pressure, sulfur content, oxygenate content, etc.)
- Humidity and solar load
- Registration (age) distribution by vehicle class
- Annual mileage accumulation by vehicle class
- Diesel sales fractions by vehicle class and model year
- Average speed distribution by hour and roadway
- Distribution of vehicle miles traveled by roadway type
- Engine starts per day by vehicle class and distribution by hour
- Engine start soak time distribution by hour
- Trip end distribution by hour
- Average trip length distribution
- Hot soak duration
- Distribution of vehicle miles traveled by vehicle class
- Full, partial, and multiple diurnal distribution by hour
- Inspection and maintenance (I/M) program description
- Anti-tampering inspection program description
- Stage II refueling emissions inspection program description
- Natural gas vehicle fractions
- HC species output
- Particle size cutoff
- Emissions factors for PM and HAP
- Output format specifications and selections

4.2.4 MOBILE6 References

The following publications provide much of the guidance for the preparation of the on-highway inventory.

> **EPA-450/4-81-026d (Revised), now EPA/450-R-92-009, *Procedures for Emission Inventory Preparation***, *Volume IV: Mobile Sources*, December 1992. Hereafter, “Procedures Vol. IV”. The 1992 version is still the definitive document on

inventories. If a previous edition is referred to, the fact will be noted as, for example, "the 1989 Procedures Vol. IV" or "Volume IV, 1989 edition".

EPA420-R-03-010, *User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model*, August 2003. This is the User's Guide for the official MOBILE6.2.03 on-highway mobile source emission factor model and will usually be referred to as the M6.2 (or simply M6) User's Guide (UG). The M6 model in its various versions was developed and published by Assessment & Modeling Division (AMD) of the National Vehicle & Fuels Emissions Laboratory (NVFEL) in Ann Arbor, Michigan. The NVFEL is part of USEPA Office of Transportation & Air Quality (OTAQ), formerly the Office of Mobile Sources (OMS).

Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, August 2004. Hereafter, the M6 "Technical Guidance [Document]" or "TGD". The TGD is the primary source of guidance on M6 inputs and an invaluable adjunct to the M6 User's Guide.

USEPA document "Frequently Asked Questions on MOBILE6", 16 January 2002. Hereafter, [M6] "FAQ". This document was published along with the M6 TGD.

USEPA memo, "Policy Guidance on the Use of MOBILE6 for SIP Development and Transportation Conformity", dated 18 January 2002, from John Seitz, Director of OAQPS, and Margo Oge, Director of OTAQ, to Regional Air Division Directors.

4.3 Ohio's Alternate Data for MOBILE6

Alternative data is state-specific data that is used in the Mobile6 runs. Using local data is preferred to using the default data in Mobile6. Efforts are made to collect as much local data as possible.

4.3.1 Vehicle Registration Distribution by Age

Overview:

The vehicle age distribution determines the fraction of vehicles operating within each emissions control requirement standard and the deterioration of the emission control technology.

Emission rates vary widely between new and older vehicles. Thus, even small changes in fleet age, particularly for older vehicles, may result in large changes in emission totals.

The MOBILE6 model requires estimates of a distribution of registered vehicles by age and vehicle category for current and future years. MOBILE6 default values were developed using national level vehicle registration data by age and class for July 1, 1996. EPA developed a methodology to convert the July 1, 1996 registration profile into a general registration distribution by age and by vehicle category for some 6 composite (gasoline and diesel) vehicle types plus motorcycles. To project future changes, EPA evaluated general sales growth and vehicle scrappage trends for the total light-duty vehicle in-use fleet and the total heavy-duty vehicle in-use fleet, and made minor adjustments, where possible, to reflect some of the differences between vehicle categories.

Description: The MOBILE6 model requires estimates of a distribution of registered vehicles by age and vehicle category for current and future years. OEPA chose to use local vehicle registration data provided by the Ohio Bureau of Motor Vehicles (BMV) which was sent to the Lake Michigan Air Directors Consortium (LADCO) to develop these inputs. LADCO then contracted with a subcontractor to breakout the age distribution data from the Vehicle Identification Numbers (VIN).

Note: It was learned during the course of this inventory that there were some discrepancies in the age distribution data. But it was too large of a project to reevaluate the data prior to this inventory. This will be corrected in the next inventory (2008).

Method Applicability: This approach is most applicable in areas where there are significant differences in the local vehicle fleet age distribution relative to the national average.

Data Sources and Procedures: This approach involves using local vehicle registration data. This is typically available at the county level, but may also be applied using statewide data from the state motor vehicle registration office. The fleet age should be representative of the vehicle fleet over the small urban or rural area under question.

Advantages:

- Uses locally specific registration data, which is likely more representative of the local area than the national default.
- Requires minimal additional resources, particularly if data is readily available at the county or local level from the State department of motor vehicle registration.
- Recommended by EPA and generally is encouraged as a preferred approach over the national default approach.

4.3.2 Daily Vehicle Miles Traveled (DVMT)

Overview:

In coordination with Ohio Metropolitan Planning Organizations (MPOs), the Ohio Department of Transportation (ODOT) provided Daily Vehicle Miles Traveled (DVMT) data and travel demand model (TDM) data. TDM data will be covered in another section. Because TDM results are used by the state and MPOs to forecast traffic for a variety of reasons, undergo rigorous calibration and validation checks, and are sensitive to roadway capacity/travel time improvements, the TDMs are considered the best tool for emissions forecasting. Therefore, the DVMT data discussed in this section is not used directly for all areas of Ohio. In counties where it is not used directly it is used for making rough emissions estimates where models do not exist or where time prohibits the use of TDMs. DVMT is a simple mechanism to measure how much traffic is flowing along a roadway during an average 24 hour period. This simple formula multiplies Average Annual Daily Traffic (AADT) by the length of the roadway. For example; if a roadway is 2 miles in length and the AADT is 4000 vehicles per day the DVMT would be computed by multiplying 2*4,000 =8,000 or 8,000 DVMT.

County-By-County DVMT is computed using the State of Ohio, Department of Transportation’s Roadway Information Files and the annual Highway Performance Monitoring System (HPMS) Summary Reports. DVMT’s are computed for all of the Federal Functional Class (FC) categories within each of Ohio’s 88 counties.

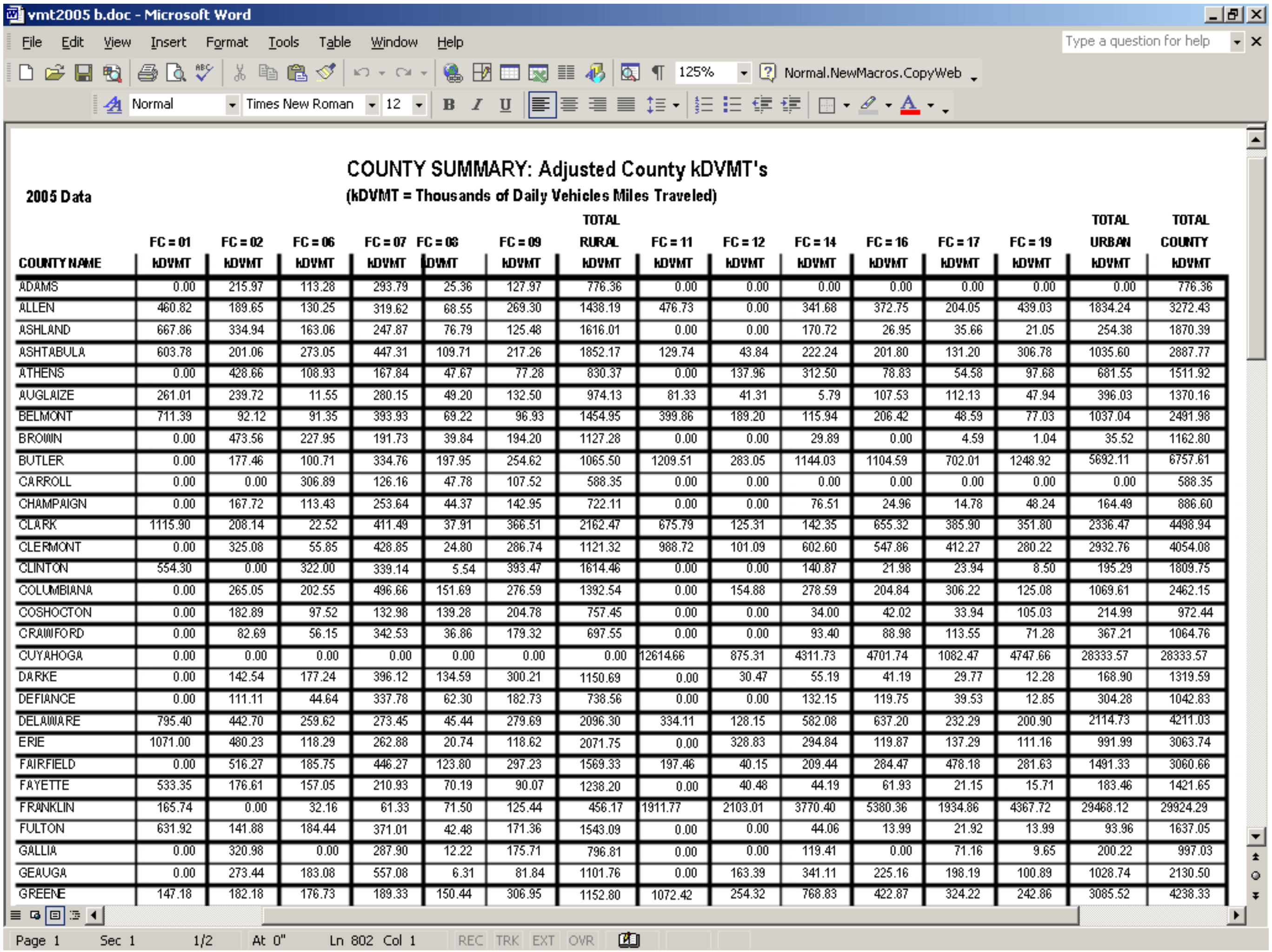
The AADT and Roadway length information provides a very accurate estimate of statewide total DVMT for The State Highway System (Interstate, US and State Routes). County total DVMT are consistent and considered a good source of county level DVMT for countywide emissions estimates. For roadways that are not part of the State Highway System, various representative counts were used, such as: railroad crossing counts, HPMS Sample Section Counts, etc. All traffic count data that was not collected during the current year has had statewide growth factors applied to account for systematic growth.

Given the previously mentioned methodologies, the DVMT data is more accurate on roads functionally classified as collector or above.

Table 4-1 Federal Functional Class Categories:

01 - Rural Interstate	11 - Urban Interstate
02 - Rural Principal Arterial	12 - Urban Freeway & Expressway
06 - Rural Minor Arterial	14 - Urban Principal Arterial
07 - Rural Major Collector	16 - Urban Minor Arterial
08 - Rural Minor Collector	17 - Urban Collector
09 - Rural Local	19 - Urban Local

Table 4-2 DVMT County Summary:



COUNTY SUMMARY: Adjusted County kDVMT's

(kDVMT = Thousands of Daily Vehicles Miles Traveled)

2005 Data

COUNTY NAME	FC = 01 kDVMT	FC = 02 kDVMT	FC = 06 kDVMT	FC = 07 kDVMT	FC = 08 kDVMT	FC = 09 kDVMT	TOTAL RURAL kDVMT	FC = 11 kDVMT	FC = 12 kDVMT	FC = 14 kDVMT	FC = 16 kDVMT	FC = 17 kDVMT	FC = 19 kDVMT	TOTAL URBAN kDVMT	TOTAL COUNTY kDVMT
ADAMS	0.00	215.97	113.28	293.79	25.36	127.97	776.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	776.36
ALLEN	460.82	189.65	130.25	319.62	68.55	269.30	1438.19	476.73	0.00	341.68	372.75	204.05	439.03	1834.24	3272.43
ASHLAND	667.86	334.94	163.06	247.87	76.79	125.48	1616.01	0.00	0.00	170.72	26.95	35.66	21.05	254.38	1870.39
ASHTABULA	603.78	201.06	273.05	447.31	109.71	217.26	1852.17	129.74	43.84	222.24	201.80	131.20	306.78	1035.60	2887.77
ATHENS	0.00	428.66	108.93	167.84	47.67	77.28	830.37	0.00	137.96	312.50	78.83	54.58	97.68	681.55	1511.92
AUGLAIZE	261.01	239.72	11.55	280.15	49.20	132.50	974.13	81.33	41.31	5.79	107.53	112.13	47.94	396.03	1370.16
BELMONT	711.39	92.12	91.35	393.93	69.22	96.93	1454.95	399.86	189.20	115.94	206.42	48.59	77.03	1037.04	2491.98
BROWN	0.00	473.56	227.95	191.73	39.84	194.20	1127.28	0.00	0.00	29.89	0.00	4.59	1.04	35.52	1162.80
BUTLER	0.00	177.46	100.71	334.76	197.95	254.62	1065.50	1209.51	283.05	1144.03	1104.59	702.01	1248.92	5692.11	6757.61
CARROLL	0.00	0.00	306.89	126.16	47.78	107.52	588.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	588.35
CHAMPAIGN	0.00	167.72	113.43	253.64	44.37	142.95	722.11	0.00	0.00	76.51	24.96	14.78	48.24	164.49	886.60
CLARK	1115.90	208.14	22.52	411.49	37.91	366.51	2162.47	675.79	125.31	142.35	655.32	385.90	351.80	2336.47	4498.94
CLERMONT	0.00	325.08	55.85	428.85	24.80	286.74	1121.32	988.72	101.09	602.60	547.86	412.27	280.22	2932.76	4054.08
CLINTON	554.30	0.00	322.00	339.14	5.54	393.47	1614.46	0.00	0.00	140.87	21.98	23.94	8.50	195.29	1809.75
COLUMBIANA	0.00	265.05	202.55	496.66	151.69	276.59	1392.54	0.00	154.88	278.59	204.84	306.22	125.08	1069.61	2462.15
COSHOCTON	0.00	182.89	97.52	132.98	139.28	204.78	757.45	0.00	0.00	34.00	42.02	33.94	105.03	214.99	972.44
CRAWFORD	0.00	82.69	56.15	342.53	36.86	179.32	697.55	0.00	0.00	93.40	88.98	113.55	71.28	367.21	1064.76
CUYAHOGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12614.66	875.31	4311.73	4701.74	1082.47	4747.66	28333.57	28333.57
DARKE	0.00	142.54	177.24	396.12	134.59	300.21	1150.69	0.00	30.47	55.19	41.19	29.77	12.28	168.90	1319.59
DEFIANCE	0.00	111.11	44.64	337.78	62.30	182.73	738.56	0.00	0.00	132.15	119.75	39.53	12.85	304.28	1042.83
DELAWARE	795.40	442.70	259.62	273.45	45.44	279.69	2096.30	334.11	128.15	582.08	637.20	232.29	200.90	2114.73	4211.03
ERIE	1071.00	480.23	118.29	262.88	20.74	118.62	2071.75	0.00	328.83	294.84	119.87	137.29	111.16	991.99	3063.74
FAIRFIELD	0.00	516.27	185.75	446.27	123.80	297.23	1569.33	197.46	40.15	209.44	284.47	478.18	281.63	1491.33	3060.66
FAYETTE	533.35	176.61	157.05	210.93	70.19	90.07	1238.20	0.00	40.48	44.19	61.93	21.15	15.71	183.46	1421.65
FRANKLIN	165.74	0.00	32.16	61.33	71.50	125.44	456.17	1911.77	2103.01	3770.40	5380.36	1934.86	4367.72	29468.12	29924.29
FULTON	631.92	141.88	184.44	371.01	42.48	171.36	1543.09	0.00	0.00	44.06	13.99	21.92	13.99	93.96	1637.05
GALLIA	0.00	320.98	0.00	287.90	12.22	175.71	796.81	0.00	0.00	119.41	0.00	71.16	9.65	200.22	997.03
GEAUGA	0.00	273.44	183.08	557.08	6.31	81.84	1101.76	0.00	163.39	341.11	225.16	198.19	100.89	1028.74	2130.50
GREENE	147.18	182.18	176.73	189.33	150.44	306.95	1152.80	1072.42	254.32	768.83	422.87	324.22	242.86	3085.52	4238.33

For PDF web based tables of 2005 DVMT by county see:

http://www.dot.state.oh.us/techservsite/availpro/Road_%20Infor/KDVMT/vmt2005.pdf

Disclaimer by ODOT:

The above PDF web based tables contain the State of Ohio's adjusted county DVMT's and road mileage for the years 1990 - 2005. Please be aware that the numbers are estimates only. The factoring process used annual, estimated, and statewide ADT (Average Daily Traffic) growth factors, derived from the output of a limited number of traffic counting stations around the state. Although the growth factors are available by functional class, they are more reliable for major roads such as interstates or expressways, which are relatively well-sampled, than for local roads or collectors. The numbers also do no allow for periodic, large-scale functional reclassification actions *which reassign selected roads or road segments from one functional class to another.*

The Ohio Department of Transportation therefore does not warrant the accuracy, completeness, or reliability of these estimates for your research. We also do not assume responsibility for any incorrectness that may occur.

4.3.3 VMT From Travel Demand Models (TDM)

Overview:

Travel demand forecast modeling is performed by the Ohio Metropolitan Planning Organizations (MPOs) and ODOT for a multitude of purposes including the preparation of regional emissions estimates. The ODOT Office of Technical Services' Modeling & Forecasting Section recommends that Ohio's TDMs and ODOT's conformity analysis methods be used to establish the roadway mobile source portion of Ohio's SIP budget to assure consistent methods are used for transportation conformity analysis and budgets. Therefore, ODOT provided both MPO regional TDM runs and statewide TDM runs with associated data to OEPA and LADCO. The ODOT provided model run data for years 2002, 2005, 2009, 2012, and 2018.

Data provided included loaded networks in both CSV format and GIS shape files, trip end summaries, zone boundary GIS shape files, intra-zonal trip VMT estimates, and VMT summaries for each of the loaded networks. Additional post processing data was provided including but not limited to metadata describing the loaded networks, Hourly distribution by functional class, speed profiles, day of week / weekend / monthly car and truck traffic profiles, 2009 & 2018 VMT RPO data sets, statewide VMT growth rates for local traffic, and a 2005 VMT summary comparison spreadsheet. It should be noted that among other things, the loaded TDM Networks contain distance and daily volumes from which VMT is computed.

Network volumes are post processed to estimate VMT by hour of day. The hourly volumes and capacity, posted speed limit, and type of roadway for each roadway segment are then used to estimate average hourly speeds needed for MOBILE6 based emissions estimates. Modeling by segment by hour of day in this way makes emissions estimates more sensitive to the effects of roadway improvements. This allows transportation planners to evaluate the relative emissions affect of improvements to individual roadways as well as packages of improvements and the entire set of planned roadway improvement projects air quality impacts of construction programs.

4.3.4 Speed Distribution Profiles

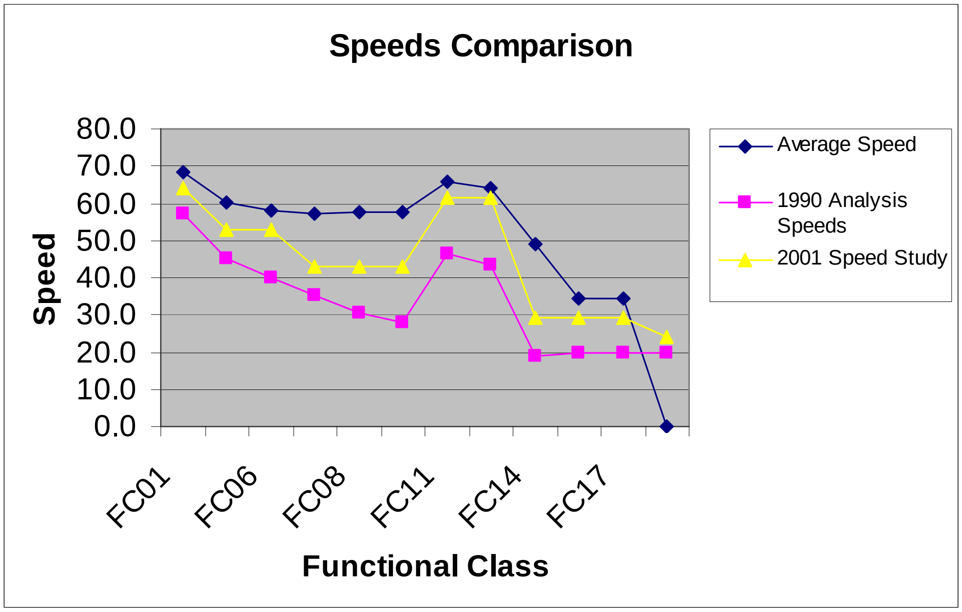
Overview:

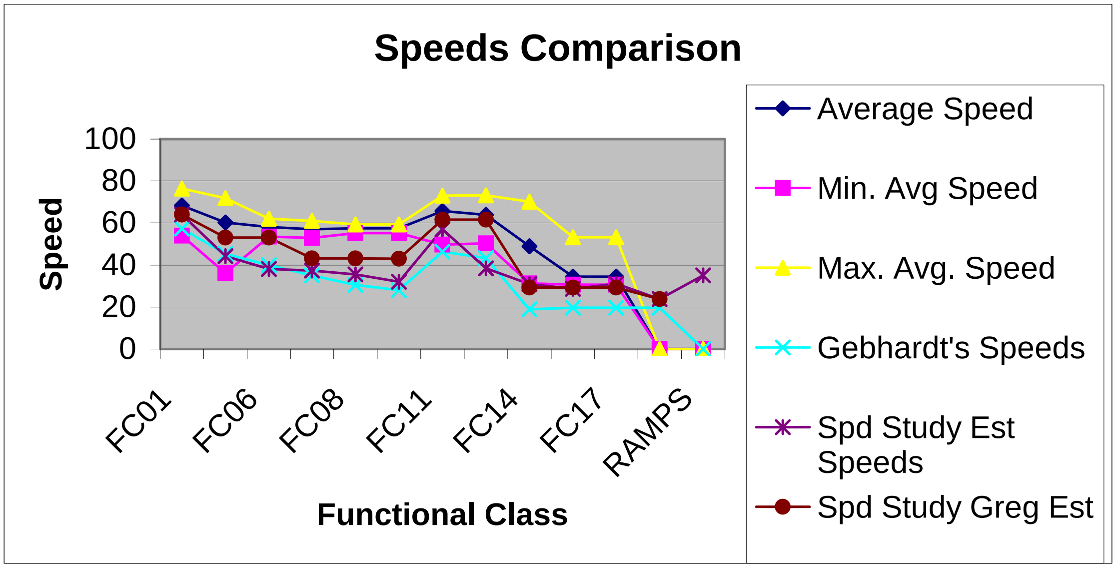
ODOT provided speed distribution profiles to LADCO. A couple of different sets of speed distribution profiles were provided to OEPA and LADCO for their use, a table of space mean speeds by functional class for use with DVMTs and link group speed curves for post processing travel demand model traffic forecasts. Both sets of speed profiles are based on the same speed study conducted by ODOT. The speed study is documented in "Statewide Travel Time Study, May 2001 by Greg Giaimo, Ohio Department of Transportation". When OEPA asked for speeds for use with MOBILE6 for development of CERR, ODOT provided a set of speeds based on that statewide travel time study. Those speeds are documented in a technical memorandum titled "Estimation of Average Speed by Functional Class for MOBILE6 Runs" dated 5/27/2004. Readers should refer to those documents for the details. Here the contents of the technical memo, Estimated Average Speed by Functional Class, are summarized.

Space Mean Speeds by Functional Class for Use with County Level DVMT, HPMS:

The memo states that the speeds which the Ohio Department of Transportation (ODOT) had been using prior to that date, 2004, for air quality analysis estimates based on County DVMT summaries, were developed by a former ODOT employee for addressing the one (1) hour standards conformity rules established due to 1990 emissions exceedances. No documentation was found in ODOT's files on the origin of these average speed values or how they were estimated. In addition, EPA has requirements for using latest planning assumptions for air quality conformity analyses. Therefore, ODOT believed that it was in the state's best interest to use the most recent available data to provide a new set of estimated average speeds consistent with those used for urban area travel demand models which were under development at that time. The memo contains comparisons of 2002 speed data obtained from traffic count equipment, automatic traffic recorders (ATRs) which collect data continuously throughout the year. It also contains comparisons of the new speeds with those used to address the one hour standard Gebhart's. The graphs shown in figure 1, taken from the memo, illustrate the comparisons. The first graph compares time mean speeds from the ATRs with space mean speeds from ODOTs travel time study done in 2001and with the speeds used for addressing the one hour standard.

Figure 1 - Speed Comparison Graphs





The following caution statement was taken from the Estimation of Average Speed by Functional Class memo.

CAUTION: *It should be noted that speeds on facilities falling in any one of the federal functional classifications vary greatly between roadways, between hour of the day, and day of the week. So these provide only very rough estimates of speed and should be used with caution. In addition, it is expected that these average statewide speeds are higher than the average speeds in the non-attainment areas because the non-*

attainment counties tend to be more populated and more congested. The document "Highway Vehicle Speed Estimation Procedures For Use in Emission Inventories", September 1991 by Earl Ruiter of Cambridge Systematics Inc. is referenced by EPA's documented procedures for emission inventory preparation. This document suggests post processing travel demand model traffic assignment results to estimate average speeds.

Final space mean speeds that ODOT provided are summarized in the Table 1 below:

Table 4-3 Speed by Federal Functional Class

Functional Class	1990 Analysis	2001 Speed Study
	Speeds	Speeds
FC01	57.3	64.0
FC02	45.3	53.0
FC06	39.9	53.0
FC07	35.1	43.1
FC08	30.5	43.1
FC09	28.0	43.1
FC11	46.3	61.6
FC12	43.3	61.6
FC14	18.9	29.3
FC16	19.6	29.3
FC17	19.6	29.2
FC19	19.6	23.8

It was decided by mutual agreement among individuals within the ODOT Office of Technical Services that these new space mean speed based average speed estimates were reproducible and defensible since they are well documented and should therefore be the speeds used with HPMS** VMT if any year 2002 emissions budget work is done using only the county level VMT summaries discussed in section 5.3.2 Daily Vehicle Miles Traveled (DVMT).

** Note that HPMS VMT is a statewide VMT estimate and the county level DVMT summaries are consistent with the HPMS VMT so the county level DVMT summaries are loosely referred to as HPMS VMTs even though in fact they are not.

4.3.5 Link Group Speed Curves:

The ODOT Modeling & Forecasting Section recommends that Ohio's travel demand forecasting models and ODOT's conformity analysis methods be used to establish the roadway mobile source portion of Ohio's SIP budget for reasons already mentioned in 5.3.2 and to assure consistent methods are used for transportation conformity demonstration analyses and budgets. Therefore, ODOT provided travel demand model runs and the speed curves by link group that ODOT uses for the speed estimates within the post processing of travel demand model runs for estimating regional emissions. Table 2 shows these link group curves.

Table 4-4 Link Group Codes & Associated BPR Curves

Link Group	Facility Type	Free Flow Speed	Areatype	a	b
1	Freeway	75	Any	0.39	6.3
2	Freeway	70	Any	0.32	7.0
3	Freeway	65	Any	0.25	9.0
4	Freeway	60	Any	0.18	8.5
5	Freeway	55	Any	0.10	10.0
6	Multi-Lane	60	Rural	0.09	6.0
7	Multi-Lane	55	Rural	0.08	6.0
8	Multi-Lane	50	Rural	0.07	6.0
9	Multi-Lane	45	Rural	0.07	6.0
10	2 Lane	Any	Rural	0.34	4.0
10	Urban Street	50	Suburban	0.34	4.0
11	Urban Street	50	Urban	0.74	5.0
12	Urban Street	50	CBD	1.16	6.0
13	Urban Street	40	Suburban	0.38	5.0
14	Urban Street	40	Urban	0.70	5.0
15	Urban Street	40	CBD	1.00	5.0
16	Urban Street	35	Suburban	0.96	5.0
17	Urban Street	35	Urban	1.00	5.0
18	Urban Street	35	CBD	1.40	5.0
19	Urban Street	30	Suburban	1.11	5.0
20	Urban Street	30	Urban	1.20	5.0
21	Urban Street	30	CBD	1.50	5.0

Note: a and b are the BPR curve parameters for the equation

$$T = T_0\{1 + a * (V/C)\text{^}b]$$

More complete details about emissions modeling process employed by ODOT may be found in ODOT documentations. The document titled “Congestion Management & Air Quality Analysis (CMAQ) Program Documentation” dated December 2005 may be obtained from the ODOT web site at www.dot.state.oh.us/urban/data/cmaq.doc (Microsoft Word document)

4.4 Mobile6 Inputs:

The following table contains the inputs supplied to LADCO to process our mobile inventory.

4.4.1 Ohio’s 2005 MOBILE6 Inputs

The following tables are the result of a joint meeting between Ohio EPA, ODOT, and MPOs from around the state. At that meeting Mobile6 inputs were discussed and efforts were made to verify the sources of data inputs for Moble6. Dialogue has continued between the parties.

For historical reference:

>>> Dave Moore <Dave.Moore1@dot.state.oh.us> 4/10/2006 2:13 PM >>>

All,

An air quality coordination meeting has been scheduled for April 27, 2006 at 10:00 AM at ODOT Central Office conference room GA. The primary purpose of this meeting is to discuss development of 2002 mobile source inventories for use in developing the Ohio 2007 8-Hour Ozone SIP Attainment Demonstrations. See meeting agenda below. OEPA is working toward a June 15, 2006 schedule for submitting the 2002 inventories to US EPA.

A key component of the meeting will be to review and confirm the MOBILE6.2 input parameters, by Ohio a/q area, for use in developing the 2002 mobile inventories. See draft template below. The Ohio MPO travel demand models will be used to generate the 2002 VMT inputs to MOBILE. Thanks, DM
DM

IMPORTANT NOTICE: The following tables are not to be used for inventory purposes as the data is subject to change. For the current input table, contact Ohio EPA, Division of Air Pollution Control.

Table 4-5 Mobile Inputs

Cleveland-Akron 2005 Ozone M6.2 Inputs

Includes the following counties:
Ashtabula, Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit

State Programs

	Input
Stage II Refueling	93/3/86/86
Anti-tampering Programs	96/78/50/22222/21111111/1/12/098./12111112
I/M Programs	Yes
Exclude Ashtabula County - No I/M program	
Program	1 2004 2050 2 T/O OBD I/M
Model Years	1 1996 2050
Vehicles	1 22222 21111111 1
Stringency	1 30.0
Compliance	1 98.0
Waiver Rates	1 1.0 1.0
Cutpoints	
Exemption Age	1 25
Grace Period	1 4
NO TTC Credits	
Effectiveness	
DESC file	
Program	2 2004 2050 2 T/O EVAP OBD & GC
Model Years	2 1996 2050
Vehicles	2 22222 11111111 1
Stringency	
Compliance	2 98.0
Waiver Rates	2 1.0 1.0
Cutpoints	
Exemption Age	2 25
Grace Period	2 4
NO TTC Credits	
Effectiveness	
DESC file	
Program	3 2001 2003 2 T/O ASM 2525 PHASE-IN

```
Model Years         3  1996  2003
Vehicles            3  22222  21111111  1
Stringency          3  30.0
Compliance          3  98.0
Waiver Rates        3  3.0  1.0
Cutpoints
Exemption Age       3  25
Grace Period        3  2
NO TTC Credits
Effectiveness
DESC file

Program             4  2001  2050  2  T/O  ASM  2525  PHASE-IN
Model Years         4  1975  1995
Vehicles            4  22222  21111111 1
Stringency          4  30.0
Compliance          4  98.0
Waiver Rates        4  3.0  1.0
Cutpoints
Exemption Age       4  25
Grace Period        4  4
NO TTC Credits
Effectiveness
DESC file

Program             5  1998  2000  2  T/O  LOADED/IDLE
Model Years         5  1975  2000
Vehicles            5  22222  21111111  1
Stringency          5  30.0
Compliance          5  98.0
Waiver Rates        5  3.0  1.0
Cutpoints
Exemption Age       5  25
Grace Period        5  2
NO TTC Credits
Effectiveness
DESC file

Program             6  1996  1997  2  T/O  IM240
Model Years         6  1975  1997
Vehicles            6  22222  21111111 1
Stringency          6  30.0
Compliance          6  98.0
Waiver Rates        6  3.0  1.0
Cutpoints           6  CUTPOINT.D
Exemption Age       6  25
Grace Period        6  2
NO TTC Credits
Effectiveness
DESC file
```

Program	7 1996 2050 2 T/O GC
Model Years	7 1975 1995
Vehicles	7 22222 21111111 1
Stringency	
Compliance	7 98.0
Waiver Rates	7 3.0 1.0
Cutpoints	
Exemption Age	7 25
Grace Period	7 2
NO TTC Credits	
Effectiveness	
DESC file	

Fuel Commands

Fuel Program	1
Oxygenated Fuels	0.00 0.42 0.00 0.036 2
Fuel RVP	9

Alternative Emission Regulations and Control Measures

Rebuild Effects	0.1

External Conditions Commands

Calendar Year	2005
Evaluation Month	7
Min/Max Temperature	National Climatic Data Center

Vehicle Fleet Characteristic Commands

Registration Distribution	Variable

Cincinnati-Dayton-Springfield 2005 Ozone M6.2 Inputs

Includes the following counties:
Ohio: Butler, Clark, Clermont, Clinton, Greene, Hamilton, Miami, Montgomery, Warren
Indiana: Lawrenceburg Twp., Dearborn County
Kentucky: Boone, Campbell and Kenton counties

State Programs

	Input
Note: Indiana and Kentucky inputs may not coincide with Ohio inputs	
Stage II Refueling	93/3/86/86
Anti-tampering Programs	96/78/05/22222/21111111/1/12/098./12111112
I/M Programs	Yes
Excludes Clinton Co. and Miami Co., OH, Dearborn County, IN - No I/M program	
Note: I/M inputs for Kentucky counties are not included	
Program	1 2004 2050 2 T/O OBD I/M
Model Years	1 1996 2050
Vehicles	1 22222 21111111 1
Stringency	1 30.0
Compliance	1 98.0
Waiver Rates	1 1.0 1.0
Cutpoints	
Exemption Age	1 25
Grace Period	1 2
NO TTC Credits	
Effectiveness	
DESC file	
Program	2 2004 2050 2 T/O EVAP OBD & GC
Model Years	2 1996 2050
Vehicles	2 22222 11111111 1
Stringency	
Compliance	2 98.0
Waiver Rates	2 1.0 1.0
Cutpoints	
Exemption Age	2 25
Grace Period	2 2
NO TTC Credits	
Effectiveness	
DESC file	
Program	3 2001 2003 2 T/O ASM 2525 PHASE-IN
Model Years	3 1996 2003
Vehicles	3 22222 21111111 1
Stringency	3 30.0
Compliance	3 98.0

Waiver Rates	3 3.0 1.0
Cutpoints	
Exemption Age	3 25
Grace Period	3 2
NO TTC Credits	
Effectiveness	
DESC file	

Program	4 2001 2050 2 T/O ASM 2525 PHASE-IN
Model Years	4 1975 1995
Vehicles	4 22222 21111111 1
Stringency	4 30.0
Compliance	4 98.0
Waiver Rates	4 3.0 1.0
Cutpoints	
Exemption Age	4 25
Grace Period	4 4
NO TTC Credits	
Effectiveness	
DESC file	

Program	5 1998 2000 2 T/O LOADED/IDLE
Model Years	5 1975 2000
Vehicles	5 22222 21111111 1
Stringency	5 30.0
Compliance	5 98.0
Waiver Rates	5 3.0 1.0
Cutpoints	
Exemption Age	5 25
Grace Period	5 2
NO TTC Credits	
Effectiveness	
DESC file	

Program	6 1996 1997 2 T/O IM240
Model Years	6 1975 1997
Vehicles	6 22222 21111111 1
Stringency	6 30.0
Compliance	6 98.0
Waiver Rates	6 3.0 1.0
Cutpoints	6 CUTPOINT.D
Exemption Age	6 25
Grace Period	6 2
NO TTC Credits	
Effectiveness	
DESC file	

Program	7 1996 2050 2 T/O GC
Model Years	7 1975 1995
Vehicles	7 22222 21111111 1

Stringency	
Compliance	7 98.0
Waiver Rates	7 3.0 1.0
Cutpoints	
Exemption Age	7 25
Grace Period	7 2
NO TTC Credits	
Effectiveness	
DESC file	

Fuel Commands

Fuel Program	1
Oxygenated Fuels	0.00 0.42 0.00 0.036 2
Fuel RVP	9

Alternative Emission Regulations and Control Measures

Rebuild Effects	0.1

External Conditions Commands

Calendar Year	2005
Evaluation Month	7
Min/Max Temperature	National Climatic Data Center

Vehicle Fleet Characteristic Commands

Registration Distribution	Variable

Other Areas (excluding NOACA/AMATS and OKI/MVRPC) Ozone M6.2 Inputs

Includes the following counties:
Ohio: Belmont, Columbiana, Delaware, Fairfield, Franklin, Jefferson, Knox, Licking, Lucas,Madison, Mahoning, Pickaway, Trumball, Wood

Fuel Commands

	Input
Fuel Program	1
Oxygenated Fuels	0.00 0.42 0.00 0.036 2
Fuel RVP	9

Alternative Emission Regulations and Control Measures

Rebuild Effects	0.1	(0.30 for 2018)

External Conditions Commands

Calendar Year	All
Evaluation Month	7
Min/Max Temperature	National Climatic Data Center

Vehicle Fleet Characteristic Commands

Registration Distribution	Variable

4.5 Ohio's Mobile Emission Data Processed by LADCO (Lake Michigan Air Director's Consortium):

2005 TDM and Mobile6 input data were provided to LADCO for processing. The data was processed by LADCO with T3 to prepare it as an input into the ConCEPT model. T3 and ConCEPT are described as follows.

4.5.1 T3--Development of Link-Level Mobile Source Emission Inventories:

Highly resolved emission inventories for on-road mobile sources are needed for air quality modeling to develop the necessary technical support for new State Implementation Plans (SIPs) for regional haze, fine particles, and ozone. Emissions for on-road motor vehicles are estimated using vehicle miles traveled, trip starts and ends, speed, and other activity data developed by State Agencies and Metropolitan Planning Organizations (MPOs) using transportation demand models (TDMs), and emission factors from EPA's MOBILE6 model. To support this modeling in the upper Midwest, ENVIRON, working with LADCO, State DOTs, and local MPOs, has developed a software tool (the TDM Transformation Tool, or "T3") that takes TDM output from approximately twenty transportation networks using a variety of models, applies appropriate data transformations, and outputs link- and county-level activity data in a uniform format for input to the CONCEPT emissions processing model (a new emissions processing model also developed with funding from LADCO). In a parallel effort, analyses of extensive automatic traffic recorder (ATR) data collected by State DOTs were conducted to develop temporal profiles (hour of day, day of week, and month of year) of vehicle counts and vehicle mix by roadway type for developing the detailed on-road emission inventories.

T3 provides a conduit from the projections of traffic demand modelers regarding vehicle types, road networks, and vehicle activity to the activity data required by emissions modelers. The primary goals of T3 are to provide an easy mechanism for incorporating TDM model outputs in as "raw" a format as possible, while simultaneously providing a great degree of flexibility in representing the TDM projections in terms acceptable to most air quality models. These goals have been achieved through the use of a dimensional transformation approach, where the dimensions of the various transformations are user-defined - hence the name of the tool.

By Stella Shepard, Alison K. Pollack, John Haasbeek, ENVIRON International

Corporation, 101 Rowland Way, Suite 220, Novato, CA. 94945
& Mark Janssen, Lake Michigan Air Directors Consortium (LADCO), 2250 E. Devon Avenue # 250, Des Plaines, IL 60018, janssen@ladco.org

4.5.2 ConCEPT--Consolidated Community Emissions Processing Tool an Open-Source Tool for the Emissions Modeling Community:

The new CONCEPT (CONsolidated Community Emissions Processing Tool) Emissions Processor is now available for use by the emissions modeling community. Developed as joint project between Alpine Geophysics, LLC and ENVIRON Corporation, with Midwest RPO and joint RPO funding, the CONCEPT model combines the best attributes of current emissions modeling systems into an open source model highlighting the following features:

- Open Source. Written primarily in PostgreSQL, the software required for running

CONCEPT is in the public domain. The model itself is GNU Public License (GPL) compliant and users are encouraged to make additions and enhancements to the modeling system.

- Transparent. The database structure of the model makes the system easy to understand, and the modeling codes themselves are extremely well documented to encourage user participation in the customizing the system for specific modeling requirements.

- Quality Control. The CONCEPT model structure and implementation allows for multiple levels of QA analysis during every step of the emissions calculation process. Using the database structures, an emissions modeler can easily trace a process or facility and review the calculation procedures and assumptions for any emissions value.

The CONCEPT model includes modules for the major emissions source categories: area source, point source, on-road motor vehicles, non-road motor vehicles and biogenic emissions, as well as a number of supporting modules, including spatial allocation factor development, speciation profile development, growth and control for point and area sources, and CEM point source emissions handling. The emissions modeling community has already begun development of additional CONCEPT support modules including CEM preprocessing software, graphical QA tools, and an interface to the traffic demand models for on-road motor vehicle emissions estimation.

By Cyndi Loomis, James G. Wilkinson, Alpine Geophysics, LLC, & John Haasbeek, Alison Pollack, ENVIRON Corporation. & Mark Janssen, Lake Michigan Air Directors Consortium (LADCO), 2250 E. Devon Avenue # 250, Des Plaines, IL 60018, janssen@ladco.org

4.5.3 LADCO Ohio Data Outputs for 2005:

The following LADCO outputs and documents can be found at: www.ladco.org/tech/emis/net05/index.html

Table 4-6 LADCO Data Output

State	Network	T3 Description DOC	M6 Inputs	VMT vs HPMS Excel	Average Day VMT (this should match conformity inventory)	County Emissions Report	All Pollutants After Speciation	Dropped VMT	M6 Run Summary	Pollutant Totals (Short)	Raw Summary (pol,veh, etype)	Hourly Temporal Summary	Hourly Veh Mix Summary	Hourly Speed Summary (with volume/ capacity)
OH	AKRON	AKRON	OH	OH	AKRON	1	1	1	1	1	1	1	1	1

OH	CANTON	CANTON	OH	OH	CANTON	1	1	1	1	1	1	1	1	1
OH	CINCI	CINCI	OH	OH	CINCI	1	1	1	1	1	1	1	1	1
OH	CLEVE	CLEVE	OH	OH	CLEVE	1	1	1	1	1	1	1	1	1
OH	COLUMBUS	COLUMBUS	OH	OH	COLUMBUS	1	1	1	1	1	1	1	1	1
OH	SPRING FLD	SPRING FLD	OH	OH	SPRING FLD	1	1	1	1	1	1	1	1	1
OH	TOLEDO	TOLEDO	OH	OH	TOLEDO	1	1	1	1	1	1	1	1	1
OH	YNGSTOWN	YNGSTOWN	OH	OH	YNGSTOWN	1	1	1	1	1	1	1	1	1
OH	STATEWD	STATEWD	OH	OH	STATEWD	1	1	1	1	1	1	1	1	1

Additional Documents on LADCO Web Page:

“Comparison to EPA's Default Model NMIM”

“How we Build the 2005 Vmt/Networks”

“Spreadsheet/Graphics on Vehicle Mix”

“Background on the T3 Tool “

4.6 MPO Contact Table

Table 4-7 County Summary Table of MPOs by County

FIPS	County	Model Network	MPO	Contact Person
39001	Adams	Statewide		
39003	Allen	Statewide	Lima Allen County Regional Planning Commission	Tom Mazur
39005	Ashland	Statewide		
39007	Ashtabula	Statewide		
39009	Athens	Statewide		
39011	Auglaize	Statewide		
39013	Belmont	Statewide	Bel-O-Mar Regional Council and Interstate Planning Commission	Rakesh Sharma
39015	Brown	Statewide		
39017	Butler	Cincinnat/Dayton	Ohio-Kentucky-Indiana Regional Council of Governments	Andy Reser
39019	Carroll	Statewide		
39021	Champaign	Statewide		
39023	Clark	Springfield	Coordinating Committee of the Clark County-Springfield	Eric Ottoson

			Transportation Study	
39025	Clermont	Cincinnat/Dayton	Ohio-Kentucky-Indiana Regional Council of Governments	Andy Reser
39027	Clinton	Statewide		
39029	Columbiana	Statewide		
39031	Coshocton	Statewide		
39033	Crawford	Statewide		
39035	Cuyahoga	Cleveland	Northeast Ohio Areawide Coordinating Agency	Bill Davis
39037	Darke	Statewide		
39039	Defiance	Statewide		
39041	Delaware	Columbus	Mid-Ohio Regional Planning Commission	Nick Gill
39043	Erie	Statewide		
39045	Fairfield	Statewide		
39047	Fayette	Statewide		
39049	Franklin	Columbus	Mid-Ohio Regional Planning Commission	Nick Gill
39051	Fulton	Statewide		
39053	Gallia	Statewide		
39055	Geauga	Cleveland	Northeast Ohio Areawide Coordinating Agency	Bill Davis
39057	Greene	Cincinnat/Dayton	Miami Valley Regional Planning Commission	Ana Ramirez
39059	Guernsey	Statewide		
39061	Hamilton	Cincinnat/Dayton	Ohio-Kentucky-Indiana Regional Council of Governments	Andy Reser
39063	Hancock	Statewide		
39065	Hardin	Statewide		
39067	Harrison	Statewide		
39069	Henry	Statewide		
39071	Highland	Statewide		
39073	Hocking	Statewide		
39075	Holmes	Statewide		
39077	Huron	Statewide		
39079	Jackson	Statewide		
39081	Jefferson	Statewide	Brooke-Hancock-Jefferson Transportation Study Policy Committee	Mike Proprocki
39083	Knox	Statewide		
39085	Lake	Cleveland	Northeast Ohio Areawide Coordinating Agency	Bill Davis
39087	Lawrence	Statewide	KYOVA Interstate Planning Commission	
39089	Licking	Columbus	Licking County Area Transportation Study	Matthew Hill
39091	Logan	Statewide		
39093	Lorain	Cleveland	Northeast Ohio Areawide	Bill Davis

			Coordinating Agency	
39095	Lucas	Toledo	Toledo Metropolitan Area Council of Governments	Sujatha Mohanakrishnan
39097	Madison	Statewide		
39099	Mahoning	Youngstown	Eastgate Regional Council of Governments	R.P. Samulka
39101	Marion	Statewide		
39103	Medina	Cleveland	Northeast Ohio Areawide Coordinating Agency	Bill Davis
39105	Meigs	Statewide		
39107	Mercer	Statewide		
39109	Miami	Cincinnat/Dayton	Miami Valley Regional Planning Commission	Ana Ramirez
39111	Monroe	Statewide		
39113	Montgomery	Cincinnat/Dayton	Miami Valley Regional Planning Commission	Ana Ramirez
39115	Morgan	Statewide		
39117	Morrow	Statewide		
39119	Muskingum	Statewide		
39121	Noble	Statewide		
39123	Ottawa	Statewide		
39125	Paulding	Statewide		
39127	Perry	Statewide		
39129	Pickaway	Statewide		
39131	Pike	Statewide		
39133	Portage	Akron	Akron Metropolitan Area Transportation Study	Jason Segedy
39135	Preble	Statewide		
39137	Putnam	Statewide		
39139	Richland	Statewide	Richland County Regional Planning Commission	John Adams
39141	Ross	Statewide		
39143	Sandusky	Statewide		
39145	Scioto	Statewide		
39147	Seneca	Statewide		
39149	Shelby	Statewide		
39151	Stark	Canton	Stark County Regional Planning Commission	Dan Slicker
39153	Summit	Akron	Akron Metropolitan Area Transportation Study	Jason Segedy
39155	Trumbull	Youngstown (partial county model coverage)	Eastgate Regional Council of Governments	R.P. Samulka
39157	Tuscarawas	Statewide		
39159	Union	Statewide		
39161	Van Wert	Statewide		
39163	Vinton	Statewide		
39165	Warren	Cincinnat/Dayton	Ohio-Kentucky-Indiana Regional Council of Governments	Andy Reser, OKI +

			+ Miami Valley Regional Planning Commission	Ana Ramirez, MVRPC
39167	Washington	Statewide	Wood-Washington-Wirt Interstate Planning Commission	
39169	Wayne	Statewide		
39171	Williams	Statewide		
39173	Wood	Toledo	Toledo Metropolitan Area Council of Governments	Sujatha Mohanakrishnan
39175	Wyandot	Statewide		

NOTE: Complete MPO information can be found at, www.dot.state.oh.us/urban/mpomap.htm and at www.dot.state.oh.us/urban/mpolist.htm#Cleveland .

SECTION 5

MARINE, AIRCRAFT and RAIL (MAR) SOURCES

MAR sources are non-road sources which are significant enough in terms of emissions to be considered separately from the rest of the non-road sources. The MAR inventory consists of commercial marines, aircraft and locomotive sources. The marine and locomotive inventory is generated by Environ[1] under contract with LADCO and the aircraft inventory is generated by Ohio EPA.

5.1 Marine Vessel Sources

The approach to commercial marine emission estimates needed to be flexible because the activity data was available in many formats. Emission estimates were determined either by multiplying engine power, load factor, hours per year of operation, or on the basis of the number of gallons of fuel consumed.

Emissions were determined for ten subclasses of vessel types: Deep draft vessels (DDV) at port, DDV mid-late, push boats (rivers/lakes), tugs, ferries, other special (excursion) vessels, support vessels, dredges, commercial fishing, and military vessels (Coast Guard). These were linked to various Ohio lakes and rivers.

Because of the large variety of methodologies employed, inventory tables for the ten subcategories are detailed in the complete inventory prepared and published by ENVIRON International Corporation: **LADCO 2005 COMMERCIAL MARINE EMISSIONS**, by Christian E. Lindhjem, March, 2007.

Emission totals produced by ENVIRON were provided to LADCO to submit to EPA for Ohio's State Implementation Plan (SIP).

5.2 Rail Sources

The primary activity unit used to determine emissions is gallons of fuel consumed. Emission rates were derived from EPA documents provided as support documentation for the 1997 locomotive emission standards (EPA, 1997). Gallons of fuel consumed were based on rail activity.

Rail activity was broken down into four Source Category Codes (SCC). Class I, line-haul rail: Large interstate railroad companies like Union Pacific and Norfolk Southern. Class I,II, III, switching rail: Yard operations. Class II, III line haul: Regional and local railroads. And Passenger rail: AMTRAK.

Class I, line-haul represents 84.3% of fuel used and the largest emission's category. The complete emission's inventory was prepared and published by ENVIRON International Corporation: **LADCO 2005 LOCOMOTIVE EMISSIONS**, by Christian E. Lindhjem, February, 2007.

Emission totals produced by ENVIRON were provided to LADCO to submit to EPA for Ohio's State Implementation Plan (SIP).

EPA. 1997: "Locomotive Emission Standards." Regulatory Support Document, United States Environmental Protection Agency, Office of Mobile Sources, April. And EPA 1997, Emission Factors for Locomotives," Environmental Protection Agency, EPA420-F-97-051, December.

5.3 Aircraft Sources

INTRODUCTION:

The aircraft emission's inventory is derived by taking the number of Landings and Take Offs (LTOs) per year and multiplying by an emission factor. In the Ohio inventory when specific aircraft models and engine type emission factors are known they were used. For the rest of the inventory the emission factors came from USEPA's fleet average emissions data. Those results are then compiled as tons per year per pollutant by county. The following describes the components, methodology, and concludes with a description of an Access based aircraft emission calculator.

COMPONENTS:

I. Ohio Airports:

A list of both towered and non-towered airports in Ohio is obtained from the Ohio Department of Transportation. See: www.dot.state.oh.us/aviation/ In conversation with ODOT two individuals stated that the 164 airports listed covered over 90% of the airports in Ohio. See Table 1.

II. Number of Operations/LTOs by Airport/County:

The ODOT list contained the number of operations a year per airport. An operation is either a landing or a take-off. A Landing and Take Off (LTO) is required for FAA EDMS calculations. LTOs were derived simply by dividing the number of operations by two. These were totaled by county.

Table 5-1 Number of operations and LTOs for 2005

County	Airport Name	ID	Total Operations	LTOs/Year
Adams	Alexander Salamon	AMT	**5210**	2605
Allen	Allen County	AOH	**32500**	16250
Ashland	Ashland County	3G4	**49240**	24620
Ashtabula	Ashtabula County	HZY	**16886**	8443
Ashtabula	Germack	7D9	**840**	420
Athens	Ohio University	UNI	**51600**	25800
Auglaize	Neil Armstrong	AXV	**29456**	14728
Belmont	Barnesville-Bradfield	6G5	**10150**	5075
Belmont	Alderman	2P7	**6150**	3075
Brown	Brown County	GEO	**5157**	2578.5
Butler	Butler County Regional	HAO	**61687**	30843.5
Butler	Hook Field Municipal	MWO	**40050**	20025
Butler	Miami University	OXD	**16708**	8354
Carroll	Carroll County -Tolson	TSO	**34950**	17475
Carroll	Parsons	5D6	**2674**	1337
Champaign	Grimes Field	I74	**23480**	11740
Champaign	Weller	38I	**300**	150
Clark	Springfield-Beckley Municipal	SGH	**64033**	32016.5
Clark	Mad River	I54	**15350**	7675
Clermont	Clermont County	I69	**35741**	17870.5
Clinton	Airborne Airpark	ILN	**52000**	26000
Clinton	Clinton Field	I66	**29360**	14680
Clinton	Hollister Field	2B6	**161**	80.5
Columbiana	Columbiana County	02G	**31146**	15573
Columbiana	Koons	8G8	**2546**	1273
Coshocton	Richard Downing	I40	**19550**	9775
Coshocton	Tri-City	80G	**8085**	4042.5
Crawford	Port Bucyrus	17G	**24871**	12435.5
Crawford	Galion Municipal	GQQ	**5216**	2608
Cuyahoga	Burke Lakefront	BKL	**97100**	48550
Cuyahoga	Cleveland-Hopkins International	CLE	**234356**	117178
Cuyahoga	Cuyahoga County	CGF	**79774**	39887
Darke	Darke County	VES	**9238**	4619
Defiance	Defiance Memorial	DFI	**9130**	4565
Delaware	Delaware Municipal	DLZ	**39300**	19650
Delaware	Packer	5E9	**3181**	1590.5
Erie	Hinde	88D	**1350**	675
Erie	Kelleys Island	89D	**25495**	12747.5
Erie	Griffing-Sandusky	SKY	**112100**	56050

Erie	Wakeman	I64	**17324**	8662
Fairfield	Miller's Farm	7B4	**360**	180
Fairfield	Fairfield County	LHQ	**43066**	21533
Fayette	Fayette County	I23	**29405**	14702.5
Franklin	Ohio State University	OSU	**134459**	67229.5
Franklin	Port Columbus International	CMH	**218438**	109219
Franklin	Rickenbacker International	LCK	**96200**	48100
Franklin	Bolton Field	TZR	**69149**	34574.5
Franklin	Columbus Southwest	04I	**11833**	5916.5
Franklin	Darby Dan	6I6	**11260**	5630
Fulton	Fulton County	USE	**21123**	10561.5
Gallia	Gallia-Meigs Regional	GAS	**12200**	6100
Geauga	Gates	7D8	**4200**	2100
Geauga	Geauga County	7G8	**5350**	2675
Greene	Greene County - Lewis A. Jackson	I19	**37400**	18700
Greene	Bloom	14I	**100**	50
Guernsey	Cambridge Municipal	CDI	**6040**	3020
Hamilton	Lunken	LUK	**129430**	64715
Hamilton	Blue Ash	ISZ	**35000**	17500
Hamilton	Cincinnati West	I67	**30197**	15098.5
Hancock	Bluffton	5G7	**71980**	35990
Hancock	Findlay	FDY	**19800**	9900
Hancock	Priebe	7D5	**3850**	1925
Hardin	Ada	0D7	**331**	165.5
Hardin	Hardin County	I95	**6562**	3281
Hardin	Elliott's Landing	O74	**1560**	780
Harrison	Harrison County	8G6	**11900**	5950
Henry	Henry County	7W5	**15637**	7818.5
Highland	Highland County	HOC	**18325**	9162.5
Holmes	Holmes County	10G	**21400**	10700
Huron	Huron County	5A1	**10100**	5050
Huron	Willard	8G1	**2715**	1357.5
Jackson	James A. Rhodes	I43	**6053**	3026.5
Jefferson	Jefferson County Airpark	2G2	**15969**	7984.5
Jefferson	Eddie Dew Memorial	1G8	**3540**	1770
Knox	Knox County	4I3	**20150**	10075
Knox	Wynkoop	6G4	**4691**	2345.5
Lake	Concord Airpark	2G1	**4510**	2255
Lake	Willoughby Lost Nation Municipal	LNN	**45085**	22542.5
Lawrence	Lawrence County Airpark	HTW	**41910**	20955
Licking	Newark-Heath	VTA	**12457**	6228.5
Logan	Bellefontaine Regional	EDJ	**8325**	4162.5
Lorain	Columbia	4G8	**5150**	2575
Lorain	Elyria	1G1	**14300**	7150
Lorain	Lagrange	92D	**1155**	577.5
Lorain	Lorain County Regional	LPR	**62000**	31000
Lorain	Reader-Botsford Airfield	67D	**18700**	9350
Lucas	Toledo Express	TOL	**94600**	47300

Madison	Madison County	UYF	**41410**	20705
Mahoning	Salem Airpark	38D	**16920**	8460
Mahoning	Tri-City	3G6	**10555**	5277.5
Mahoning	Elser Metro	4G4	**49232**	24616
Mahoning	Lansdowne	04G	**750**	375
Marion	Marion Municipal	MNN	**42650**	21325
Medina	Medina Municipal	1G5	**79685**	39842.5
Medina	Wadsworth Municipal	3G3	**41025**	20512.5
Medina	Weltzien Skypark	15G	**79130**	39565
Mercer	Lakefield	CQA	**16212**	8106
Miami	Hartzell Field	I17	**10200**	5100
Miami	Troy Skypark	37I	**4264**	2132
Miami	Waco Field	1WF	**0**	0
Monroe	Monroe County	4G5	**3324**	1662
Montgomery	Brookville Air-Park	I62	**29359**	14679.5
Montgomery	James M. Cox Dayton Intl	DAY	**134524**	67262
Montgomery	Dayton Wright Brothers	MGY	**89045**	44522.5
Montgomery	Moraine Airpark	I73	**12938**	6469
Montgomery	Dahio Trotwood	I44	**1853**	926.5
Montgomery	Phillipsburg	3I7	**68000**	34000
Morgan	Morgan County	I71	**5725**	2862.5
Morrow	Morrow County	4I9	**19108**	9554
Muskingum	Zanesville Municipal	ZZV	**33312**	16656
Muskingum	Parr	42I	**16150**	8075
Noble	Noble County - Mike Brienza Field	I10	**5950**	2975
Ottawa	Middle Bass-East Point	3W9	**1300**	650
Ottawa	Middle Bass Island	3T7	**6500**	3250
Ottawa	North Bass Island	3X5	**1000**	500
Ottawa	Carl R. Keller Field	PCW	**20890**	10445
Ottawa	Put-In-Bay	3W2	**15140**	7570
Paulding	Paulding	2H8	**2100**	1050
Perry	Crooksville	I84	**400**	200
Perry	Perry County	I86	**4550**	2275
Pickaway	Pickaway County	CYO	**35450**	17725
Pickaway	Clarks Dream Strip	03I	**2770**	1385
Pike	Pike County	EOP	**2012**	1006
Portage	Freedom Air Field	7D6	**1623**	811.5
Portage	Farview	86D	**3353**	1676.5
Portage	Mills	7E3	**1050**	525
Portage	Portage County	29G	**9621**	4810.5
Putnam	Ruhe's	R47	**13250**	6625
Putnam	Putnam County	OWX	**11910**	5955
Putnam	Ohio Dusting Co.	6C2	**2995**	1497.5
Richland	Mansfield Lahm Regional	MFD	**57518**	28759
Richland	Shelby Community	12G	**2012**	1006
Ross	Ross County	RZT	**50150**	25075
Sandusky	Fremont	14G	**37450**	18725
Sandusky	Sandusky County Regional	S24	**6148**	3074

Scioto	Greater Portsmouth Regional	PMH	**45830**	22915
Seneca	Bandit Field	5D9	**140**	70
Seneca	Fostoria Metropolitan	FZI	**7900**	3950
Seneca	Weiker	82D	**320**	160
Seneca	Seneca County	16G	**60165**	30082.5
Shelby	Sidney Municipal	I12	**20500**	10250
Stark	Barber	2D1	**13750**	6875
Stark	Miller Airport	4G3	**8000**	4000
Stark	Beach City	2D7	**6112**	3056
Summit	Akron Fulton International	AKR	**26000**	13000
Summit	Akron-Canton Regional	CAK	**120441**	60220.5
Summit	Mayfield	1D4	**450**	225
Summit	Kent State University	1G3	**72500**	36250
Trumbull	Braceville	41N	**425**	212.5
Trumbull	Warren	62D	**14738**	7369
Trumbull	Youngstown-Warren Regional	YNG	**98298**	49149
Tuscarawas	Harry Clever Field	PHD	**54880**	27440
Union	Union County	MRT	**31886**	15943
Van Wert	Van Wert County	VNW	**20516**	10258
Vinton	Vinton County	22I	**5225**	2612.5
Warren	Warren County	I68	**24951**	12475.5
Warren	Red Stewart Airfield	40I	**16800**	8400
Wayne	Wayne County	BJJ	**96520**	48260
Williams	Williams County	0G6	**10010**	5005
Wood	Wood County	1G0	**27405**	13702.5
Wood	Bordner	3D8	**2200**	1100
Wood	Deshler Municipal	6D7	**2000**	1000
Wood	Metcalf	TDZ	**90700**	45350
Wyandot	Wyandot County	56D	**7410**	3705

III. Aircraft Models and Number of LTO/yr:

Specific aircraft models by airport (generally the larger airports) is obtained from “Table 7” provided by the United States Department of Transportation, Office of Airline Information. This provided the number of LTO’s for each aircraft model per year per airport.

Table 2. Sample from “Table 7.” This is the all community total of aircraft models for the Akron/Canton area. “All Service” departures were used as the number of LTOs per year for that model. Listed in the original table are aircraft model by airport and number of services/LTOs.

TOTAL DEPARTURES PERFORMD

Aircraft Model	Scheduled Service	Non-Sched Service	All Service
A-318	1		1
A319	384		384
BOEING 717-200	3850		3850
BOEING 727-100		1	1
BOEING 727-200		5	5
BOEING 737-100/200		74	74
BOEING 737-200C	3	3	6
BOEING 737-300		2	2
BOEING 737-700/LR	212		212
BOEING 737-800		5	5
BOEING 757-200		4	4
BOEING 767-300/ER		4	4
CANADAIR RJ-100/ER	542	3	545
CANADAIR RJ-700	2881		2881
CONVAIR CV-580		3	3
DASSAULT FALCON		7	7
DHC8-100 DASH 8	2		2
DOUGLAS DC-9-15F		13	13
DOUGLAS DC-9-30		6	6
EMBRAER-145	144		144
RJ-200ER/RJ-440	5519		5519
SAAB-FAIRCHD 340/B	1804		1804
ALL TYPES	15342	130	15472

IV. Emission Factors:

Where there was specific aircraft model data the emission factors were derived using the FAA's Emission Dispersion Modeling System (EDMS). EDMS is a combined emissions and dispersion model for assessing air quality at civilian airports and military air bases. The model was developed by the Federal Aviation Administration (FAA) in cooperation with the United States Air Force (USAF). The model is used to produce an inventory of emissions generated by sources on and around the airport or air base, and to calculate pollutant concentrations in these environments.

Table 5-2 EDMS Aircraft Emissions

Emissions provided by Michigan Department of Environmental Quality. (The few aircraft in Ohio not included in the table had emissions derived by EDMS 5.0 in-house.)

EDMS Aircraft Emissions/LTO by Aircraft Type

EDMS 4.5 Emissions Inventory Report of 2005 Aircraft Inventory Emissions Factors

Year 2005	Lbs Emitted Per LTO						
Aircraft Type	CO	NOx	HC	VOC	SO2	PM2.5	PM10
A- 318	19.8	18.7	4.0	4.4	1.5	0.0	0.0
A-300-600/R/CF/RCF	27.1	56.4	2.0	2.2	4.0	0.2	0.2
A-300B/C/F-100/200	30.2	52.5	3.5	3.7	3.3	0.2	0.2
A-310-200C/F	32.6	52.5	7.3	7.9	3.3	0.2	0.2
A-319	19.8	18.7	4.0	4.4	1.5	0.0	0.0
A320-100/200	13.7	19.8	1.3	1.3	1.8	0.2	0.2
A-321	16.8	36.8	3.1	3.3	2.2	0.0	0.0
A-330-200	29.8	61.5	0.4	0.4	4.4	0.2	0.2
AVROLINER RJ85	24.7	9.5	2.9	3.3	1.3	0.2	0.2
BAE-146-300	24.7	9.0	3.1	3.3	1.3	0.2	0.2
BEECH 1900 A/B/C	11.0	1.1	3.3	3.5	0.2	0.0	0.0
BEECH KINGAIR C-90	1.8	0.9	0.2	0.2	0.2	0.0	0.0
717-200	11.7	23.4	0.0	0.0	1.5	0.0	0.0
727-100	21.4	23.1	4.6	5.1	2.9	0.4	0.4
727-100C/QC	44.5	19.8	4.6	5.1	2.4	1.1	1.1
727-200	19.6	27.3	2.9	3.1	3.3	1.1	1.1
737-100/200	14.1	16.1	2.2	2.4	2.0	0.7	0.7
737-200C	13.9	17.4	6.8	7.5	2.0	0.9	0.9
737-300	28.7	15.9	1.8	2.0	1.8	0.0	0.0
737-400	26.5	18.5	1.5	1.5	1.8	0.0	0.0
737-500	24.7	21.2	1.3	1.3	2.0	0.0	0.0
737-700/LR	17.6	20.1	2.0	2.0	1.8	0.4	0.4
737-800	15.7	27.1	1.5	1.8	2.0	0.7	0.7
737-900	15.7	27.1	1.5	1.8	2.0	0.7	0.7
747-100	252.6	108.5	106.7	116.8	7.1	0.4	0.4
747-200/300	60.6	104.7	7.1	7.7	6.8	0.7	0.7
747-400	67.0	105.6	5.7	6.4	7.3	0.7	0.7
757-200	24.7	35.7	2.0	2.2	2.6	0.4	0.4
757-300	27.1	33.1	0.4	0.4	3.1	0.2	0.2
767-200/ER	32.6	52.5	7.3	7.9	3.3	0.2	0.2
767-300/ER	32.0	62.2	2.6	2.9	4.0	0.4	0.4
777	32.8	85.1	5.1	5.7	4.4	0.4	0.4
CANADAIR RJ-100/ER	16.3	4.9	1.5	1.8	0.7	0.0	0.0
CANADAIR RJ-700	12.6	9.3	0.0	0.0	1.1	0.0	0.0
CESSNA 208	1.1	0.4	0.0	0.0	0.0	0.0	0.0
CONVAIR CV-580	36.2	0.9	8.8	9.5	0.7	0.0	0.0
DASSAULT FALCON	13.7	2.6	2.4	2.6	0.2	0.0	0.0
DHC8-100 DASH 8	5.1	3.1	0.0	0.0	0.4	0.0	0.0
DORNIER 328 JET	1.3	6.6	11.9	12.6	0.7	0.0	0.0
DOUGLAS DC-10-10	102.5	76.7	38.6	42.1	4.2	0.0	0.0
DOUGLAS DC-10-30	45.4	78.7	5.3	5.7	5.1	0.4	0.4

DOUGLAS DC-10-40	131.8	81.8	30.2	33.1	6.0	0.7	0.7
DOUGLAS DC-8-63	263.5	25.6	219.1	239.9	4.2	5.1	5.1
DOUGLAS DC-8-71	53.6	34.6	3.1	3.3	3.7	0.0	0.0
DOUGLAS DC-8-73	53.6	34.6	3.1	3.3	3.7	0.0	0.0
DOUGLAS DC-9-10	14.1	14.6	3.7	4.0	1.8	0.2	0.2
DOUGLAS DC-9-15F	14.1	14.6	3.7	4.0	1.8	0.2	0.2
DOUGLAS DC-9-30	14.1	14.6	3.7	4.0	1.8	0.2	0.2
DOUGLAS DC-9-40	39.7	16.5	10.8	11.9	2.0	1.3	1.3
DOUGLAS DC-9-50	12.6	20.1	1.8	1.8	2.2	0.9	0.9
EMBRAER-135	12.8	5.5	1.1	1.3	0.7	0.0	0.0
EMBRAER-140	13.7	6.0	1.3	1.3	0.7	0.0	0.0
EMBRAER-145	6.4	6.8	1.1	1.1	0.7	0.0	0.0
EMBRAER-170	9.0	9.7	0.0	0.0	1.1	0.0	0.0
F28-4000/6000	76.7	10.4	77.2	84.4	1.5	0.0	0.0
JETSTREAM 41	4.6	2.0	0.4	0.7	0.2	0.0	0.0
L-101101/100/200	33.3	112.0	6.2	6.8	5.7	1.3	1.3
LEAR-25	75.2	0.7	7.9	8.4	0.2	0.0	0.0
LOCKHEED L100-30	48.7	9.9	19.6	21.4	1.8	0.0	0.0
MD-11	47.8	93.3	4.0	4.4	6.0	0.7	0.7
MD-80, 1, 2, 3, 7, 8	16.3	20.3	0.0	0.0	2.2	0.2	0.2
MD-90	12.1	23.8	0.2	0.2	2.0	0.2	0.2
RJ-200ER/RJ-440	16.3	4.9	1.5	1.8	0.7	0.0	0.0
SAAB-FAIRCHD 340/B	4.2	1.5	1.5	1.5	0.2	0.0	0.0

NOTE: Where specific aircraft model data was not available fleet emissions were used. EPA default fleet average emission factors were taken from “Documentation for Aircraft, Commercial Marine Vessel, ,Locomotive, and Other Non-road Components of the National Emissions Inventory. 2005, see Appendix A, Aircraft Emission Estimation Methodology.” Specific model LTOs were subtracted from county LTO totals to eliminate double counting those LTOs.

Table 5-3 Fleet Emission Factor Categories

Fleet emission factors were broken down into three categories. Itinerant General, Local General, and Military.

Table 5-3a Fleet Average Emission Factors for Itinerant General Aircraft.

(Taken from : Table A-5)

Pollutant	**Emission Factors (lbs/LTO)**
HC	1.234
NOx	0.158
CO	28.13
SOx	0.015
PM10	0.60333

Note: *Air taxi HC emissions * VOC/HC* (0.9914) *conversion factor = air taxi VOC estimate*

Table 5-3b Fleet Average Emission Factors for Local General Aircraft.

(Taken From: Table A-11)

Pollutant	**Emission Factors (lbs/LTO)**
HC	0.394
NOx	0.065
CO	12.014
SOx	0.01
PM10	0.2367

Note: *GA HC emissions * VOC/HC(*0.9708) *conversion factor = GA VOC estimate*

Table 5-3c Fleet Average Emission Factors for Military Aircraft.

(Taken from: Table A-17)

Pollutant	**Emission Factors (lbs/LTO**
HC	1.234
NOx	0.158
CO	28.13
SOx	0.015
PM10	0.60333

Note: *Military HC emissions * VOC/HC(*1.1046) *conversion factor = Military VOC estimate*

METHODOLOGY

Introduction

The following information was considered in the development of emission estimates:

1. Commercial scheduled and non-scheduled aircraft air carrier activity and commercial air freight activity by aircraft model types,

2. General aviation and air taxi annual local and itinerant operations for year 2005,

3. Military annual local and itinerant operations for year 2005.

Due to the need to have aircraft operations information expressed as landing/take off (LTO) cycles, the following assumptions were made:

1. For commercial aircraft and commercial air freight activity, the number of annual aircraft annual LTO cycles was assumed to be equal to the number of

departures. The daily LTO cycle frequency was then obtained by dividing the yearly LTO cycles by 365.

2. For general aircraft annual local and itinerant airport operations, each respective operations total was divided by 2 to obtain the corresponding year local and itinerant LTO cycles. The expected daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.
3. For military annual local and itinerant operations, each respective operations total was divided by 2 to obtain the corresponding year local and itinerant LTO cycles. The expected military daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.

Airport LTO cycles were further categorized into commercial aircraft by plane and engine type, general aviation itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. This was necessary in order to utilize the U.S. Department of Transportation, Federal Aviation Administration EDMS Emissions and Dispersion Modeling System. Commercial and air freight aircraft emission factors per LTO cycle were determined using EDMS for each commercial aircraft type models where possible were used at each towered airport. Default commercial aircraft engine type, and Environmental Protection Agency (EPA) default time in mode values for takeoff, approach, and landing roll times were used in the EDMS model simulations.

For those aircraft types that could not be determined using the EDMS emissions model, aircraft emission factors based upon EPA alternative fleet average procedures were then used to estimate their emissions. These included general aviation and air taxi itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. Conversion from total hydrocarbons to volatile organic compounds was performed and based upon the EPA guidance.

APPROACH

1. A list of more than 90% of the airports was obtained from the Ohio Department of Transportation. These were classed by airport, county, aircraft flight classification, and the total number of operations per year.

2. The number of operations (a landing <u>or</u> a take off) were then divided by two giving the number of LTOs per year per airport. These airports were combined by county for the total number of LTOs per year, per county.

3. In dialog with ODOT it was determined that the following Ohio flight groups of aircraft be combined to match the three categories used by the USEPA in calculating emissions.

Itinerant (General, air carrier, commuter, air taxi, general aviation itinerant)

Local (General aviation local)

Military (Military)

4. LTOs for specific models of aircraft per airport were taken from the FAA Table 7. See **Table 2** above. These were then combined to give the number of LTOs per aircraft model per county. Specific model LTOs were subtracted from county totals to avoid double counting those LTOs.

5. Emission factors were determined from the FAA's EDMS program for specific aircraft model and engine type. See **IV. Emission factors** above. The aircraft emission table provided by Michigan has the emission factors for most of the aircraft flown in Ohio. . Where specific aircraft model data was not available USEPA average fleet emissions were used.

6. Emission factors times LTOs by county yielded tons per year per county.

Table 5-4 Pollutant by County (Sample)

County	POLLUTANT	ACTIVITY(LTOS/YEAR)	ACTIVITY(LTOS/DAY)	EMISSIONS(TON/YEAR)
ADAMS	CO	2605	7.136986	24.552325
ADAMS	HC	2605	7.136986	0.977285
ADAMS	NOX	2605	7.136986	0.136045
ADAMS	PM10-PRI	2605	7.136986	0.513114825
ADAMS	PM25-PRI	2605	7.136986	0
ADAMS	SOX	2605	7.136986	0.0157875
ADAMS	VOC	2605	7.136986	0.96314234
ALLEN	CO	16250	44.52055	147.945065
ALLEN	HC	16250	44.52055	5.841097
ALLEN	NOX	16250	44.52055	0.827189
ALLEN	PM10-PRI	16250	44.52055	3.081191265
ALLEN	PM25-PRI	16250	44.52055	0
ALLEN	SOX	16250	44.52055	0.0984575
ALLEN	VOC	16250	44.52055	5.769568254
ASHLAND	CO	24620	67.45205	173.67794
ASHLAND	HC	24620	67.45205	6.19414
ASHLAND	NOX	24620	67.45205	0.94895
ASHLAND	PM10-PRI	24620	67.45205	3.532515
ASHLAND	PM25-PRI	24620	67.45205	0
ASHLAND	SOX	24620	67.45205	0.1311
ASHLAND	VOC	24620	67.45205	6.07175247
ASHTABULA	CO	8863	24.28219	78.115087
ASHTABULA	HC	8863	24.28219	3.042551
ASHTABULA	NOX	8863	24.28219	0.431593

ASHTABULA	PM10-PRI	8863	24.28219	1.623493455
ASHTABULA	PM25-PRI	8863	24.28219	0
ASHTABULA	SOX	8863	24.28219	0.0520325
ASHTABULA	VOC	8863	24.28219	2.99420213
ATHENS	CO	25800	70.68493	196.874985
ATHENS	HC	25800	70.68493	7.267183
ATHENS	NOX	25800	70.68493	1.081521
ATHENS	PM10-PRI	25800	70.68493	4.037266335
ATHENS	PM25-PRI	25800	70.68493	0
ATHENS	SOX	25800	70.68493	0.1420925
ATHENS	VOC	25800	70.68493	7.128180006

7. Emissions were then summed by pollutants in each county by SCC aircraft category type so data could be provided to LADCO in the EPA prescribed NEI – NIF format.

DATA ERROR

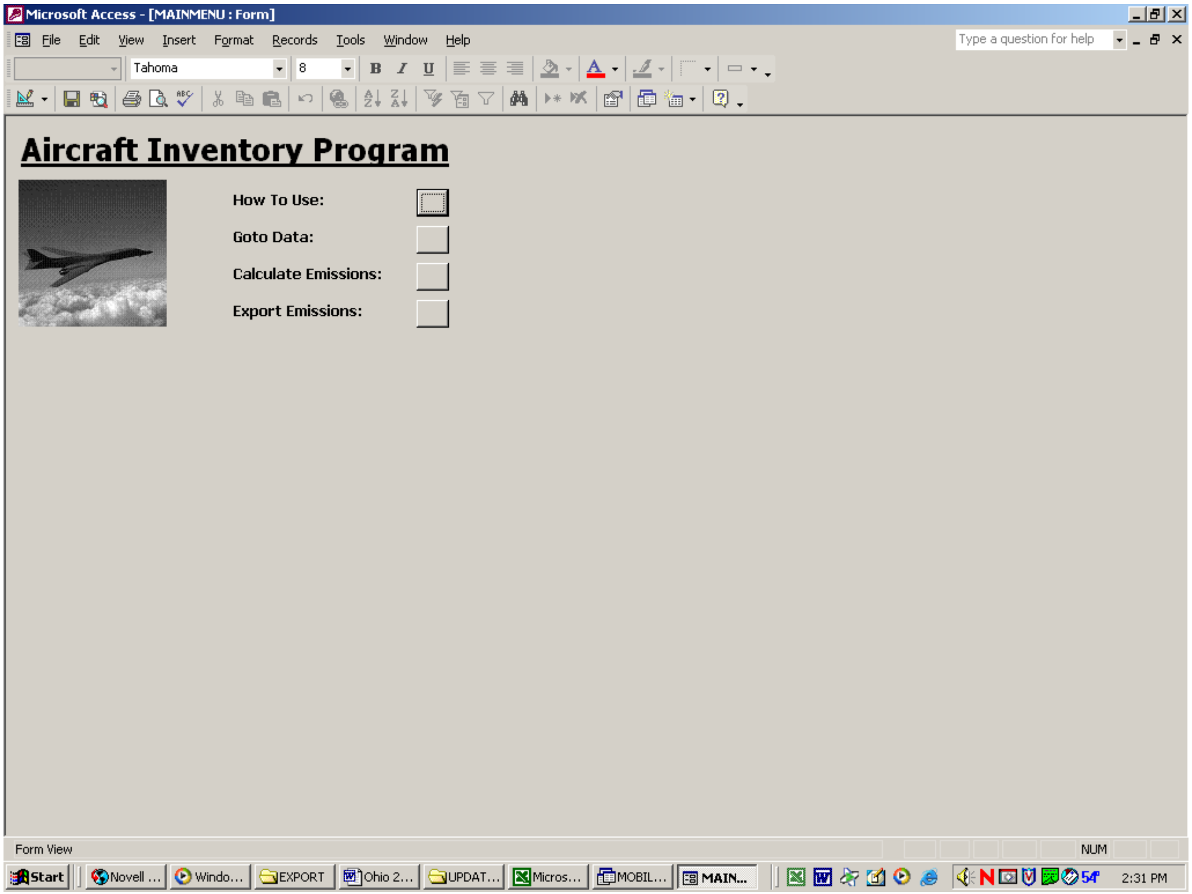
The first aircraft emission inventory submitted to LADCO in April, 2007 contained an error. The inventory submitted in May, 2007 has the error corrected. The error was the result of a carry-over function in Access that picked up the number of operations as instead of LTOs….which made the inventory exactly twice as large as what it really was.

ACCESS CALCULATOR

Introduction:

Our database programmer set up Access application to calculate Ohio's aircraft emission inventory, and export those results to Excel. His utility allows for easy modification of the aircraft data to match future data scenarios. Output to Excel also allows for additional data manipulation and importation.

Interface:



Through this interface the following sets of data can be edited/updated: Airport activity, emission factors, specific airport emissions, state/county FIPS, detailed aircraft information, airport information, and aircraft SCCs. Once the final emissions have been calculated and summed, then the data can be export via the export function on the Main Menu.

Appendix C

Mobile Source Emissions Inventory

Parkersburg-Marietta

$PM_{2.5}$ Nonattainment Area

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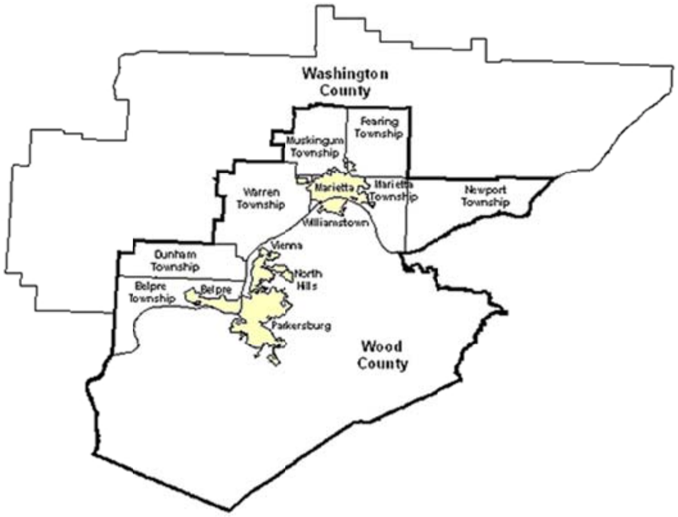
WOOD-WASHINGTON-WIRT INTERSTATE PLANNING COMMISSION
Transportation Air Quality Analysis and Technical Documentation
State Implementation Plan Inventory Mobile Emission Estimates
For the U.S. EPA Daily PM$_{2.5}$ National Ambient Air Quality Standard

Submitted: September 2011



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SELECTED ABBREVIATIONS & ACRONYMS

DOT – Department of Transportation
FHWA – Federal Highway Administration;
LRTP – Long Range Transportation Plan
MOU – Memorandum of Understanding
MVEB – Motor Vehicle Emissions Budget
NOx – Nitrogen Oxides

EPA – Environmental Protection Agency
FTA – Federal Transit Administration;
MOBILE6 – Mobile Source Emission Factor Model
MPO – Metropolitan Planning Organization
NAAQS – National Ambient Air Quality Standard

PM2.5 - Particulate Matter with an aerodynamic diameter less than 2.5 microns (often referred to as Fine Particulate Matter)

PM10 – Particulate Matter with an aerodynamic diameter less than 10 microns

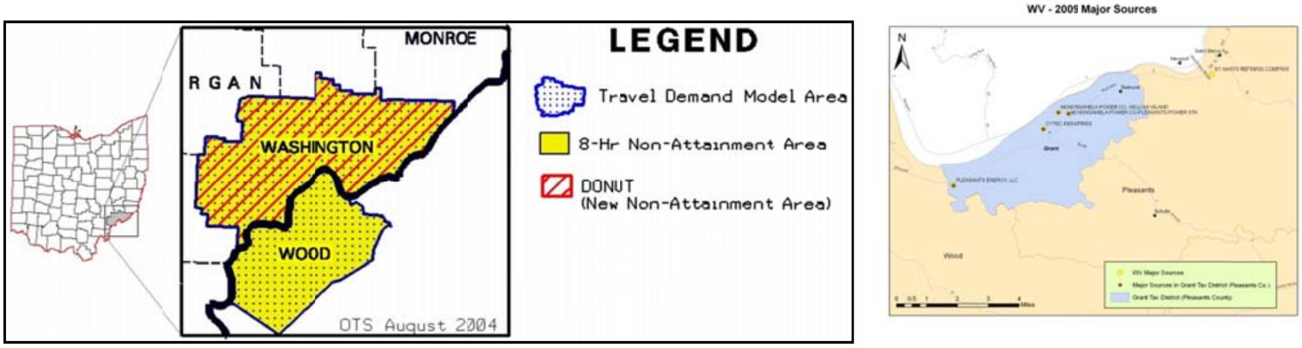
SIP – State Implementation Plan
TAZs – Traffic Analysis Zones
TDM – Travel Demand Model
VMT – Vehicle Miles of Travel

TIP – Transportation Improvement Program
TCM – Transportation Control Measure
TIP – Transportation Improvement Program
VOC – Volatile Organic Compounds

INTRODUCTION

This memorandum documents the air quality analyses and underlying planning assumptions performed by the Ohio Department of Transportation (ODOT), Division of Transportation System Development-Modeling and Forecasting Section and the Wood-Washington-Wirt Interstate Planning Commission (WWW) for the Annual PM2.5 on-road mobile source emission inventories for the Parkersburg-Marietta WV/OH Metropolitan area State Implementation Plan (SIP) in coordination with the Ohio Environmental Protection Agency (OEPA) and West Virginia Department of Environmental Protection (WVDEP). The WWW Region is comprised of Washington county, Ohio, Wood county, West Virginia, and the Grant Tax district of Pleasant county, West Virginia. On January 5, 2005, the USEPA designated these areas as non-attainment for the PM2.5 air quality standard. The designation became effective on April 5, 2005; 90 days after USEPA published action in the *Federal Registry*. Figure 1 displays the geographic extent of the WWW region non-attainment area.

Figure 1
NON-ATTAINMENT AREA BOUNDARY



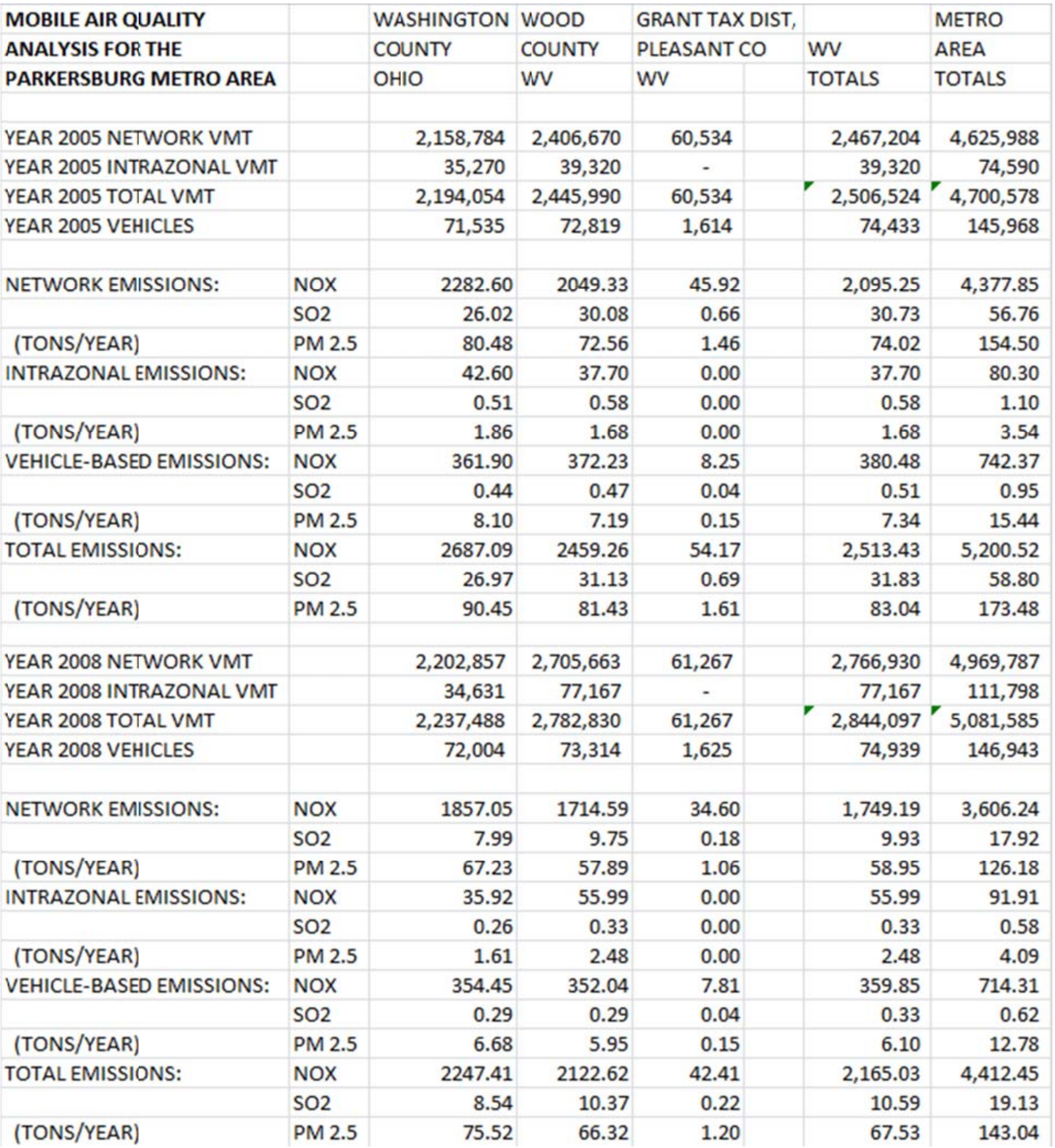
As part of $PM_{2.5}$ analysis, the Grant Tax district in Pleasant county, West Virginia (shown above and adjacent to Wood county) is considered a "doughnut area" for planning purposes. For the most part, roadways within this district are not included in the travel demand model network. The WVDOT provided WWW with the VMT on the roads in this district by federal functional class for the year 2004. Based upon the advice of the WVDAQ, the modeling area's growth factor was used to calculate future year VMT within this Tax district by functional class.

ON ROAD MOBILE EMISSION SUMMARY

Tables 1 and 2 present a summary of the pollutant emissions including Fine Particulate Matter (PM2.5) and Nitrogen Oxides (NOx) modeled for each county and Tax District that makes up the WWW PM 2.5 Non-Attainment Region. The Model Years for the demonstration includes the Base Year 2005, Attainment Year 2008, Interim Year 2015, and Maintenance Year 2022.

Table 1

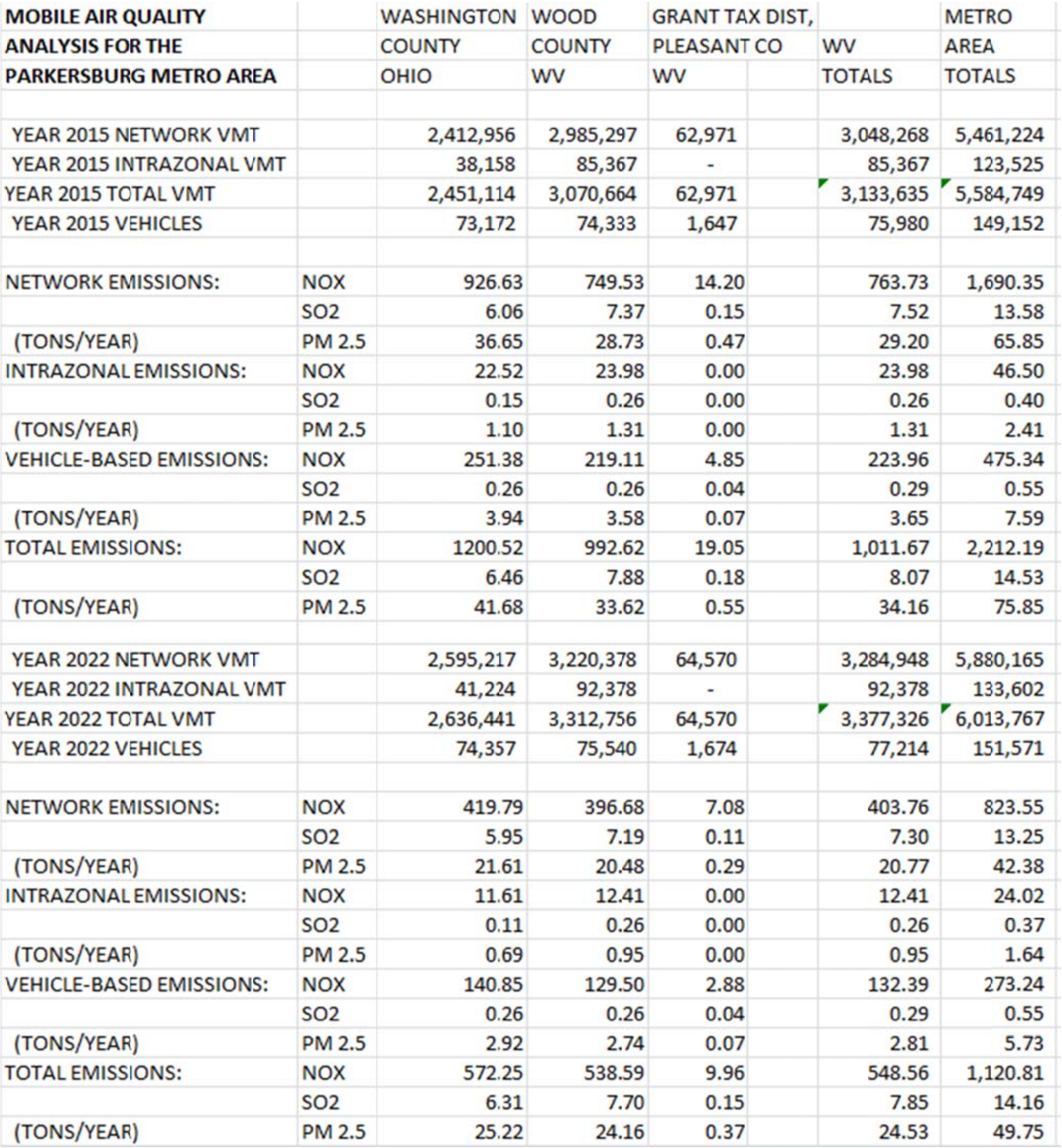
WWW REGION ON-ROAD MOBILE EMISSIONS BY STATE AND COUNTY (2005 & 2008)



MOBILE AIR QUALITY		WASHINGTON	WOOD	GRANT TAX DIST,			METRO
ANALYSIS FOR THE		COUNTY	COUNTY	PLEASANT CO		WV	AREA
PARKERSBURG METRO AREA		OHIO	WV	WV		TOTALS	TOTALS
YEAR 2005 NETWORK VMT		2,158,784	2,406,670	60,534		2,467,204	4,625,988
YEAR 2005 INTRAZONAL VMT		35,270	39,320	-		39,320	74,590
YEAR 2005 TOTAL VMT		2,194,054	2,445,990	60,534		2,506,524	4,700,578
YEAR 2005 VEHICLES		71,535	72,819	1,614		74,433	145,968
NETWORK EMISSIONS:	NOX	2282.60	2049.33	45.92		2,095.25	4,377.85
	SO2	26.02	30.08	0.66		30.73	56.76
(TONS/YEAR)	PM 2.5	80.48	72.56	1.46		74.02	154.50
INTRAZONAL EMISSIONS:	NOX	42.60	37.70	0.00		37.70	80.30
	SO2	0.51	0.58	0.00		0.58	1.10
(TONS/YEAR)	PM 2.5	1.86	1.68	0.00		1.68	3.54
VEHICLE-BASED EMISSIONS:	NOX	361.90	372.23	8.25		380.48	742.37
	SO2	0.44	0.47	0.04		0.51	0.95
(TONS/YEAR)	PM 2.5	8.10	7.19	0.15		7.34	15.44
TOTAL EMISSIONS:	NOX	2687.09	2459.26	54.17		2,513.43	5,200.52
	SO2	26.97	31.13	0.69		31.83	58.80
(TONS/YEAR)	PM 2.5	90.45	81.43	1.61		83.04	173.48
YEAR 2008 NETWORK VMT		2,202,857	2,705,663	61,267		2,766,930	4,969,787
YEAR 2008 INTRAZONAL VMT		34,631	77,167	-		77,167	111,798
YEAR 2008 TOTAL VMT		2,237,488	2,782,830	61,267		2,844,097	5,081,585
YEAR 2008 VEHICLES		72,004	73,314	1,625		74,939	146,943
NETWORK EMISSIONS:	NOX	1857.05	1714.59	34.60		1,749.19	3,606.24
	SO2	7.99	9.75	0.18		9.93	17.92
(TONS/YEAR)	PM 2.5	67.23	57.89	1.06		58.95	126.18
INTRAZONAL EMISSIONS:	NOX	35.92	55.99	0.00		55.99	91.91
	SO2	0.26	0.33	0.00		0.33	0.58
(TONS/YEAR)	PM 2.5	1.61	2.48	0.00		2.48	4.09
VEHICLE-BASED EMISSIONS:	NOX	354.45	352.04	7.81		359.85	714.31
	SO2	0.29	0.29	0.04		0.33	0.62
(TONS/YEAR)	PM 2.5	6.68	5.95	0.15		6.10	12.78
TOTAL EMISSIONS:	NOX	2247.41	2122.62	42.41		2,165.03	4,412.45
	SO2	8.54	10.37	0.22		10.59	19.13
(TONS/YEAR)	PM 2.5	75.52	66.32	1.20		67.53	143.04

Table 2

WWW REGION ON-ROAD MOBILE EMISSIONS BY STATE AND COUNTY (2015 & 2022)



MOBILE AIR QUALITY		WASHINGTON	WOOD	GRANT TAX DIST,		METRO
ANALYSIS FOR THE		COUNTY	COUNTY	PLEASANT CO	WV	AREA
PARKERSBURG METRO AREA		OHIO	WV	WV	TOTALS	TOTALS
YEAR 2015 NETWORK VMT		2,412,956	2,985,297	62,971	3,048,268	5,461,224
YEAR 2015 INTRAZONAL VMT		38,158	85,367	-	85,367	123,525
YEAR 2015 TOTAL VMT		2,451,114	3,070,664	62,971	3,133,635	5,584,749
YEAR 2015 VEHICLES		73,172	74,333	1,647	75,980	149,152
NETWORK EMISSIONS:	NOX	926.63	749.53	14.20	763.73	1,690.35
	SO2	6.06	7.37	0.15	7.52	13.58
(TONS/YEAR)	PM 2.5	36.65	28.73	0.47	29.20	65.85
INTRAZONAL EMISSIONS:	NOX	22.52	23.98	0.00	23.98	46.50
	SO2	0.15	0.26	0.00	0.26	0.40
(TONS/YEAR)	PM 2.5	1.10	1.31	0.00	1.31	2.41
VEHICLE-BASED EMISSIONS:	NOX	251.38	219.11	4.85	223.96	475.34
	SO2	0.26	0.26	0.04	0.29	0.55
(TONS/YEAR)	PM 2.5	3.94	3.58	0.07	3.65	7.59
TOTAL EMISSIONS:	NOX	1200.52	992.62	19.05	1,011.67	2,212.19
	SO2	6.46	7.88	0.18	8.07	14.53
(TONS/YEAR)	PM 2.5	41.68	33.62	0.55	34.16	75.85
YEAR 2022 NETWORK VMT		2,595,217	3,220,378	64,570	3,284,948	5,880,165
YEAR 2022 INTRAZONAL VMT		41,224	92,378	-	92,378	133,602
YEAR 2022 TOTAL VMT		2,636,441	3,312,756	64,570	3,377,326	6,013,767
YEAR 2022 VEHICLES		74,357	75,540	1,674	77,214	151,571
NETWORK EMISSIONS:	NOX	419.79	396.68	7.08	403.76	823.55
	SO2	5.95	7.19	0.11	7.30	13.25
(TONS/YEAR)	PM 2.5	21.61	20.48	0.29	20.77	42.38
INTRAZONAL EMISSIONS:	NOX	11.61	12.41	0.00	12.41	24.02
	SO2	0.11	0.26	0.00	0.26	0.37
(TONS/YEAR)	PM 2.5	0.69	0.95	0.00	0.95	1.64
VEHICLE-BASED EMISSIONS:	NOX	140.85	129.50	2.88	132.39	273.24
	SO2	0.26	0.26	0.04	0.29	0.55
(TONS/YEAR)	PM 2.5	2.92	2.74	0.07	2.81	5.73
TOTAL EMISSIONS:	NOX	572.25	538.59	9.96	548.56	1,120.81
	SO2	6.31	7.70	0.15	7.85	14.16
(TONS/YEAR)	PM 2.5	25.22	24.16	0.37	24.53	49.75

LATEST PLANNING ASSUMPTIONS

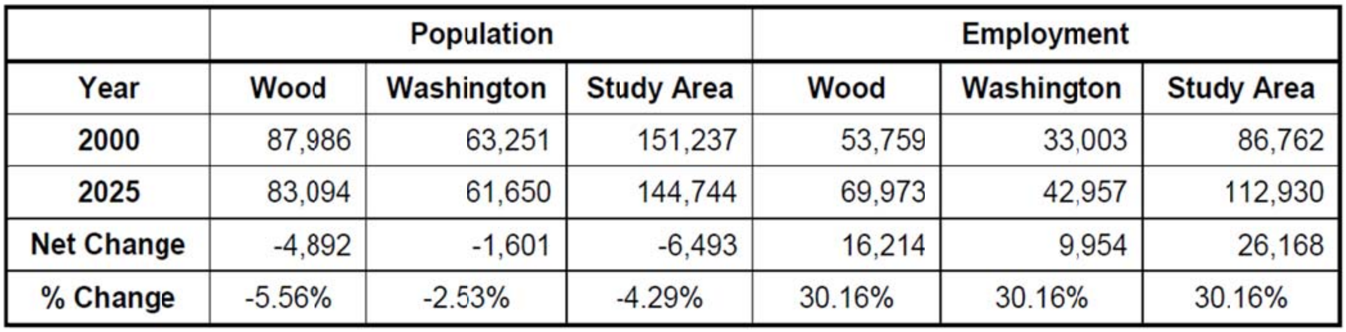
The annual PM2.5 inventory runs meet the latest planning assumption requirement. This report presents the latest population and land use data available that calibrated the modeling process used to calculate the vehicle emissions for the mobile emissions budgets as well as the input values for U.S. EPA’s most recent emissions software (MOVES) for this attainment demonstration. A series of conference calls held during the winter of 2010/2011 by the Interagency Consultancy Group established two parameters. First, that this re-designation effort will require the use of MOVES software for all mobile source emission analyses and second, the annual emission estimates will be based a single-season approach.

LAND USE DATA:

Travel analysis zones (376 in the 2-county area) and external roadway “stations” (34) are the basic geographic units for estimating travel patterns. Socioeconomic data used to forecast these patterns shown in Table 3 include household population, household vehicles, and employment by category and location. Sources for year 2000 data include the 2000 Census and QCEW/ES202 employment data adjusted to Year 2005 county-level control totals. All data sources were geocoded to the zone level. Future year data for each variable were projected through various methods. More detailed explanation of base year and future year data generation for each of the above-mentioned categories of planning data follows. The forecasted distribution of land use by industry and traffic zone was developed in 2003 by WWW staff working in conjunction with WVU’s Regional Research Institute and a consulting firm, as documented in their 2002 Transportation Plan update. Figure 2 displays the zones boundaries in the region.

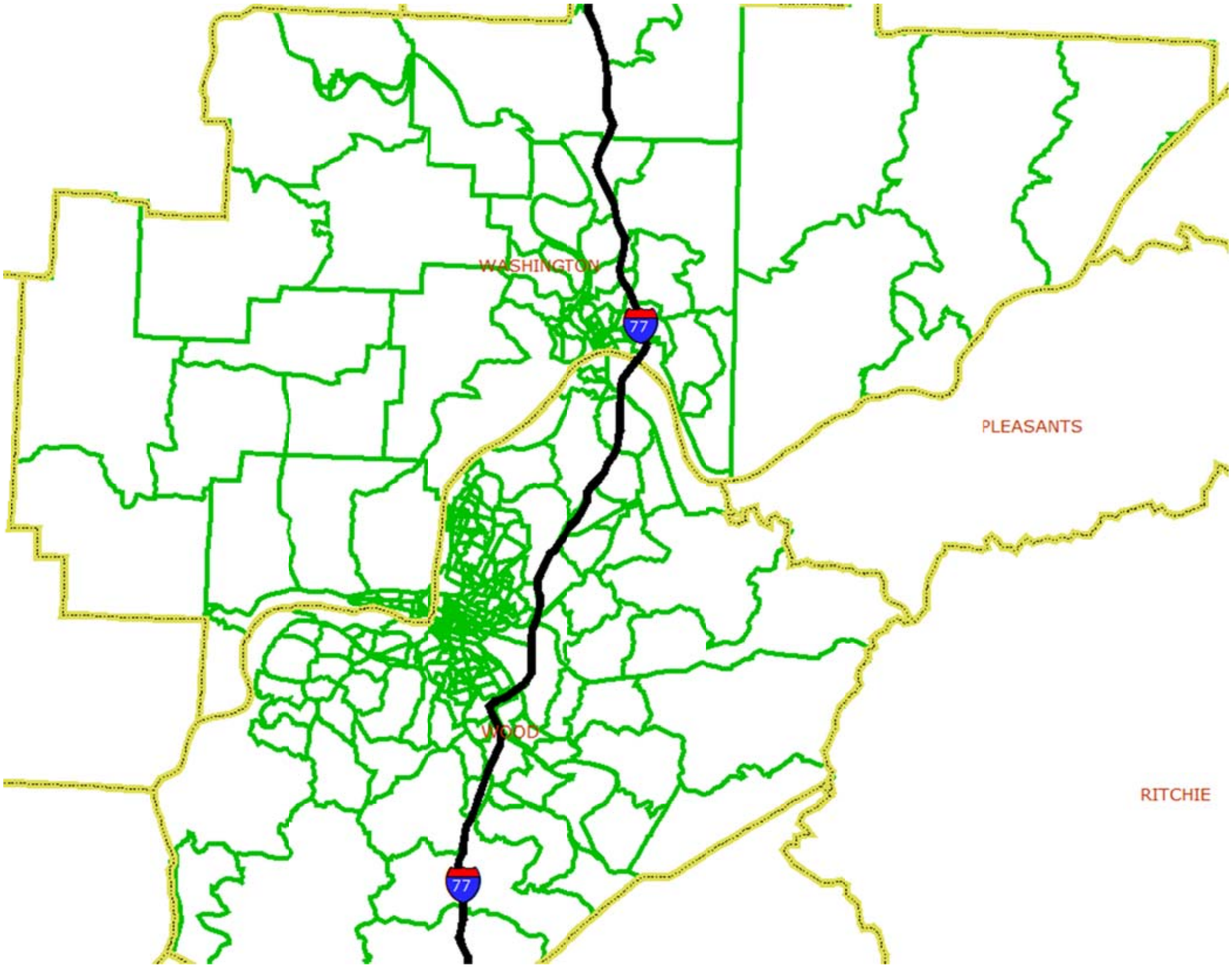
Table 3

WWW REGION LAND USE DATA USED FOR TRAFFIC FORECASTING



	Population			Employment		
Year	**Wood**	**Washington**	**Study Area**	**Wood**	**Washington**	**Study Area**
2000	87,986	63,251	151,237	53,759	33,003	86,762
2025	83,094	61,650	144,744	69,973	42,957	112,930
Net Change	-4,892	-1,601	-6,493	16,214	9,954	26,168
% Change	-5.56%	-2.53%	-4.29%	30.16%	30.16%	30.16%

Figure 2
GEOGRAPHIC AREA COVERED BY TRAVEL MODEL AND TRAFFIC ZONE STRUCTURE



TRAVEL MODELING:
A travel demand model (TDM) is the traditional tool used to examine potential changes in future travel patterns. The road networks within them include all planned federal-aid projects as well as any regionally significant projects found in the TIP and LRTP expected to be open for traffic by the end of each respective analysis year. All projects identified in the LRTP having an impact on travel time and/or vehicle carrying capacity regardless of funding source were included in the air quality analysis. Trip generation figures by zone, are assumed to change linearly with time between the model base year and the Plan Horizon year.

The WWWW region area travel demand model network covers about 1000 miles of streets and highways in the 2-county area including all collector and arterial streets, and has been validated to observed traffic for year 2005. The trip generation model is patterned on the national default structure described in TRB's NCHRP Report 365 and adjusted as needed to match field studies of trip generation. The hourly distribution of trips by trip purpose and direction are constrained to match the hourly distribution of traffic counts. Trip distribution also begins with a trip-length distribution by purpose borrowed from another urban area and adjusted to ensure modeled VMT matched HPMS estimates of VMT within 1% in the model base year of 2005. (Home-based work trips were separately constrained to a target average value based on the 2000 Census.)

The modeling software program utilizes hourly saturation flow rates that are calculated based on road inventory data, roadway type, and the 2000 version of the Highway Capacity Manual (HCM). Coded speeds by street segment are a function of road type and posted speed limits and are based on the Ohio statewide travel time study conducted in 2000 (available on the web at http://www.dot.state.oh.us/urban/data/statewid/report.doc) using the "run time" version of speeds without intersection delays. The model software program internally estimates additional travel times for vehicles that stop for traffic control (stop signs and red lights) based on HCM methods and modeled traffic patterns. The traffic assignment RMS (root mean square) error meets FHWA/ODOT standards for all specified volume groups. Modeled VMT for 2005 was roughly 2% different than HPMS estimated VMT both overall and for freeways. Modeled travel times on arterial streets also match quite closely the results of WWW's travel time field studies.

The interagency consultation process, as previously discussed, established the following model years for Wood county, WV and Washington County, OH that reflected the most recent correspondence from the U.S. EPA:

Analysis Year 2005 – Baseline Emissions
Analysis Year 2015 – Interim Year
Analysis Year 2008 – Attainment Year
Analysis Year 2022 – Maintenance Year

EMISSION FACTOR GENERATION

The MOVES model generated the emission factor files were for base year-2005 and attainment year-2008 representing the transportation improvement programs implemented in the WWW Region. The model also generated emission factors for two future year scenarios 2015 and 2022.

Table 4 summarizes the settings used in the MOVES run specification file and the MOVES County-Data Manager. The subsequent tables provide the specific inputs that are not using the MOVES default values.

Table 4 – MOVES Inputs

RunSpec Parameter Settings	
MOVES Version	2010/08/26
Scale	Custom Domain
MOVES Modeling Technique	Emission Factor Method Rates per Distance, Rates per Vehicle
Time Span	Time Aggregation: Hour 1 Month representing average annual temperatures All hours of day selected 16 speed bins, Weekdays only
Geographic Bounds	Washington OH, Wood WV, Pleasant WV counties
Vehicles/Equipment	All source types, gasoline and diesel
Road Type	All road types including off-network
Pollutants and Processes	NO_x, All $PM_{2.5}$ categories, SO_2, Total Energy Consumption
Strategies	None
General Output	Units = grams, joules and miles
Output Emissions	Time = hour, Location = custom area, on-road emission rates by road type and source use type.

County Data Manager Sources	
Source Type Population	Combination of local and default data Local data (Ohio and West Virginia) from motor vehicle registration Default data used for source types 51, 52, 53, 61, and 62 Future year growth rate based on MPO model Household growth rate.
Vehicle Type VMT	Combination of local and default data HPMSVTypeYear VMT = daily VMT from travel demand model monthVMTFraction = default dayVMTFraction=default hourVMTFraction=local
I/M Program	None
Fuel Formulation	Default
Fuel Supply	Default
Meteorology Data	Local data obtained from NOAA National Climatic Data Center. Data will consist of monthly high and low temperatures and daily relative humidity for 2002.
Ramp Fraction	Using the base year travel demand model for VHT fractions.
Road Type Distribution	Use ODOT and WV Division of Highways county summary VMT categorized by federal functional classes
Age Distribution	Combination of local and default data. Local data (Ohio and West Virginia) from motor vehicle registration Default data used for source types 41, 42, 43, 51, 52, 53, 61, and 62 The same age distribution will be used for all analysis years
Average Speed Distribution	Default
Alternative Fuel Type	Default

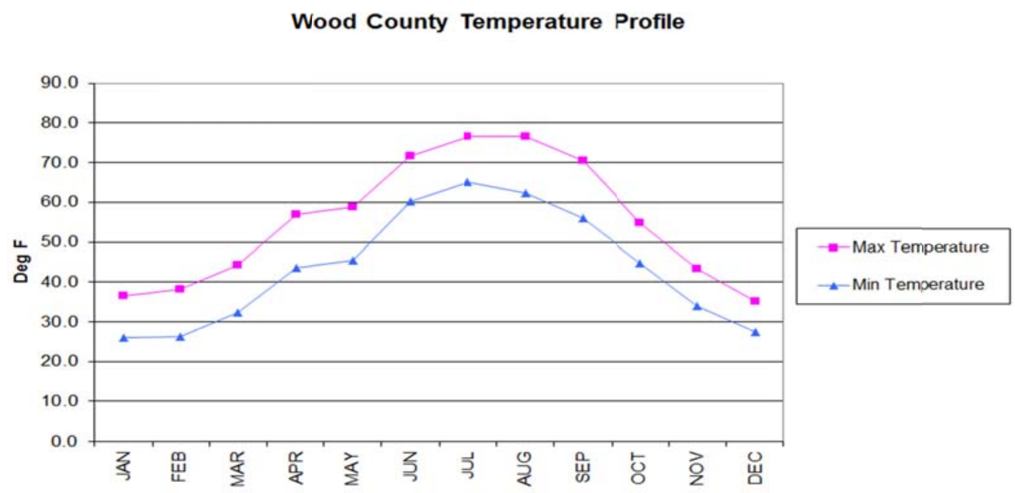
TEMPERATURE AND RELATIVE HUMIDITY

The single season approach for temperature and relative humidity uses weather data collected by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC). The data used in this report, taken from the Parkersburg/Wood County Airport, is representative of 12 months in 2009. Data entered into a spreadsheet provided by U.S. EPA converted the Mobile6 to get the correct data for the MOVES model. Table 5 below contains the average annual hourly temperatures and relative humidity distribution profiles used for the WWW region, while Figure X depicts the typical minimum and maximum temperatures by month of year.

Table 5
AVERAGE TEMPERATURE AND RELATIVE HUMIDITY DATA

Time of Day	Average Temperature	Average Relative Humidity (%)
Midnight	47.2	79.7
1 AM	46.1	67.1
2 AM	45.2	80.7
3 AM	44.6	82.9
4 AM	44.1	83.8
5 AM	43.6	84.1
6 AM	43.1	82.6
7 AM	43.5	79.6
8 AM	45.9	74.8
9 AM	49.6	70.1
10 AM	53.5	65.7
11 AM	56.8	62.0
12 PM	59.7	59.8
1 PM	61.3	58.2
2 PM	61.9	57.4
3 PM	62.0	57.3
4 PM	61.6	58.3
5 PM	60.5	61.2
6 PM	58.6	65.3
7 PM	56.2	69.2
8 PM	53.7	66.1
9 PM	51.6	74.3
10 PM	50.1	75.7
11 PM	48.6	78.1

Figure 3



RAMP FRACTION

The Vehicles Hour of Travel (VHT) fractions from the travel demand model were used to derive the Ramp Fraction values needed for the MOVES model procedures (approximately 16.1% in Washington county Ohio and 12.5% in Wood county West Virginia).

SOURCE TYPE POPULATION

A combination of local and MOVES default data is the Source Type Population for vehicle classifications. The MOVES default values provided the data for vehicle Source Types 51, 52, 53, 61, and 62 while local data from Ohio and West Virginia motor vehicle registrations accounted for all other Source Type Populations needed to run the MOVES model. Table 6 shows the Source Type Population identifications, the corresponding Source Type Name, and the number of vehicles analyzed for Washington County, OH and Wood County, WV. Analysis of the Grant Tax District in Pleasants County WV used the same distribution by source type as Wood County, scaled to Census data of total vehicle ownership within the district.

Table 6

SOURCE TYPE POPULATION FOR YEAR 2005

year	Source Type	Washington Co OH #	Wood Co WV #
2005	11 MotorCycle	4668	2260
2005	21 Passenger Car	42583	31331
2005	31 Passenger Truck	21741	30775
2005	32 Light Commercial Truck	465	4917
2005	41 Intercity Bus	44	33
2005	42 Transit Bus	3	18
2005	43 School Bus	123	137
2005	51 Refuse truck	25	30
2005	52 Single Unit Short-haul Truck	8	1774
2005	53 Single Unit Long-haul Truck	98	202
2005	54 Motor Home	122	129
2005	61 Combination Short-haul Truck	472	575
2005	62 Combination Long-haul Truck	1183	638

VEHICLE AGE DISTRIBUTION

A grouping of data from Ohio and West Virginia sources along with the MOVES model defaults make up the Vehicle Age Distribution. MOVES default values included Vehicle Type ID 41, 42, 51, 52, 53, 61, and 62. Local data from Ohio and West Virginia motor vehicle registrations accounted for all other Vehicle Type ID. Table 7 shows a sample Vehicle Age Distribution By Source Type for Washington County, OH in 2005.

Table 7

VEHICLE AGE DISTRIBUTION BY SOURCE TYPE FOR WASHINGTON COUNTY, OHIO IN 2005

yearid	ageid	11	21	31	32	41	42	43	51	52	53	54	61	62
2005	0	0.0021	0.0048	0.0045	0.0043	0.0000	0.0000	0.0484	0.0000	0.0000	0.0000	0.0060	0.0018	0.0000
2005	1	0.0255	0.0178	0.0189	0.0171	0.0000	0.0000	0.0403	0.2500	0.2500	0.2500	0.0276	0.0093	0.0319
2005	2	0.0577	0.0266	0.0349	0.0321	0.0000	0.0000	0.0565	0.0000	0.0000	0.0000	0.0272	0.0220	0.0361
2005	3	0.0849	0.0336	0.0451	0.0534	0.0667	0.0000	0.0645	0.0000	0.0000	0.0000	0.0388	0.0288	0.0806
2005	4	0.0828	0.0367	0.0528	0.0513	0.0000	0.0000	0.0323	0.0000	0.0000	0.0000	0.0392	0.0319	0.0865
2005	5	0.0862	0.0409	0.0648	0.0363	0.1333	0.0000	0.0806	0.0000	0.0000	0.0000	0.0444	0.0384	0.0949
2005	6	0.0638	0.0391	0.0643	0.0278	0.0667	0.0000	0.0565	0.0000	0.0000	0.0000	0.0568	0.0419	0.0537
2005	7	0.0777	0.0434	0.0620	0.0556	0.2667	0.3333	0.0806	0.0000	0.0000	0.0000	0.0504	0.0420	0.0353
2005	8	0.0594	0.0545	0.0658	0.0235	0.0667	0.0000	0.1129	0.0000	0.0000	0.0000	0.0404	0.0417	0.0428
2005	9	0.0500	0.0543	0.0606	0.0321	0.0000	0.0000	0.0887	0.0000	0.0000	0.0000	0.0352	0.0474	0.0537
2005	10	0.0406	0.0644	0.0651	0.0641	0.0000	0.0000	0.0726	0.1250	0.1250	0.1250	0.0380	0.0570	0.0789
2005	11	0.0336	0.0639	0.0626	0.0406	0.1333	0.6667	0.0161	0.0000	0.0000	0.0000	0.0548	0.0554	0.0621
2005	12	0.0236	0.0590	0.0566	0.0235	0.1333	0.0000	0.0806	0.1250	0.1250	0.1250	0.0348	0.0459	0.0512
2005	13	0.0217	0.0547	0.0498	0.0470	0.0000	0.0000	0.0484	0.0000	0.0000	0.0000	0.0348	0.0504	0.0260
2005	14	0.0206	0.0519	0.0477	0.0449	0.0000	0.0000	0.0081	0.1250	0.1250	0.1250	0.0312	0.0390	0.0411
2005	15	0.0177	0.0568	0.0479	0.0620	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0272	0.0465	0.0386
2005	16	0.0121	0.0456	0.0439	0.0833	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0244	0.0505	0.0311
2005	17	0.0160	0.0426	0.0319	0.0342	0.0000	0.0000	0.0081	0.1250	0.1250	0.1250	0.0224	0.0402	0.0260
2005	18	0.0092	0.0361	0.0235	0.0299	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0236	0.0381	0.0235
2005	19	0.0092	0.0326	0.0194	0.0321	0.0000	0.0000	0.0242	0.0000	0.0000	0.0000	0.0168	0.0337	0.0109
2005	20	0.0094	0.0238	0.0144	0.0406	0.0000	0.0000	0.0161	0.0000	0.0000	0.0000	0.0196	0.0279	0.0067
2005	21	0.0077	0.0213	0.0145	0.0256	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0196	0.0332	0.0168
2005	22	0.0085	0.0150	0.0111	0.0449	0.0000	0.0000	0.0161	0.0000	0.0000	0.0000	0.0272	0.0326	0.0151
2005	23	0.0104	0.0117	0.0104	0.0192	0.0000	0.0000	0.0081	0.0000	0.0000	0.0000	0.0244	0.0237	0.0168
2005	24	0.0213	0.0088	0.0077	0.0214	0.0667	0.0000	0.0081	0.0000	0.0000	0.0000	0.0176	0.0231	0.0042
2005	25	0.0177	0.0068	0.0050	0.0128	0.0000	0.0000	0.0081	0.0000	0.0000	0.0000	0.0216	0.0167	0.0092
2005	26	0.0134	0.0049	0.0030	0.0107	0.0666	0.0000	0.0000	0.0000	0.0000	0.0000	0.0176	0.0125	0.0059
2005	27	0.0168	0.0027	0.0024	0.0085	0.0000	0.0000	0.0081	0.0000	0.0000	0.0000	0.0176	0.0084	0.0008
2005	28	0.0213	0.0017	0.0007	0.0043	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0088	0.0064	0.0034
2005	29	0.0196	0.0020	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0108	0.0054	0.0025
2005	30	0.0595	0.0420	0.0080	0.0169	0.0000	0.0000	0.0160	0.2500	0.2500	0.2500	0.1412	0.0482	0.0137

ROAD TYPE DISTRIBUTION

The ODOT and WV Division of Highway county summary Vehicle Miles Traveled (VMT) data categorized by federal functional class for the three county non-attainment areas is the basis for Road Type Distribution Fraction. Table 8 illustrates Road Type Distribution.

Table 8

ROAD TYPE DISTRIBUTION FOR THE WWW REGION

sourceTypeID	roadTypeID	roadTypeVMTFraction	sourceTypeID	roadTypeID	roadTypeVMTFraction
11	1	0	51	1	0
11	2	0.33	51	2	0.33
11	3	0.34	51	3	0.34
11	4	0.08	51	4	0.08
11	5	0.25	51	5	0.25
21	1	0	52	1	0
21	2	0.33	52	2	0.33
21	3	0.34	52	3	0.34
21	4	0.08	52	4	0.08
21	5	0.25	52	5	0.25
31	1	0	53	1	0
31	2	0.33	53	2	0.33
31	3	0.34	53	3	0.34
31	4	0.08	53	4	0.08
31	5	0.25	53	5	0.25
32	1	0	54	1	0
32	2	0.33	54	2	0.33
32	3	0.34	54	3	0.34
32	4	0.08	54	4	0.08
32	5	0.25	54	5	0.25
41	1	0	61	1	0
41	2	0.33	61	2	0.33
41	3	0.34	61	3	0.34
41	4	0.08	61	4	0.08
41	5	0.25	61	5	0.25
42	1	0	62	1	0
42	2	0.33	62	2	0.33
42	3	0.34	62	3	0.34
42	4	0.08	62	4	0.08
42	5	0.25	62	5	0.25
43	1	0	roadTypeID	roadDesc	
43	2	0.33	2	Rural Restricted Access	
43	3	0.34	3	Rural Unrestricted Access	
43	4	0.08	4	Urban Restricted Access	
43	5	0.25	5	Urban Unrestricted Access	

POST PROCESSING

Several custom programs created by ODOT staff were used to compute the total emissions. The process uses data on daily and directional traffic distributions as well as volume/delay functions from the 2000 Highway Capacity Manual (HCM). This process also uses rewritten code focused on newer CUBE Voyager-based model network formats and MOVES generated emission factors.

The first step in the process involves running postcms.exe to calculate hourly link volumes based on the percentage of the daily volume (travel demand model output) determined by a link's facility and area type. The analysis does not use the link speeds from the travel demand model. Using a link's volume-to- capacity ratio and link group code, a post-process to the model based on HCM methods estimates the link speeds. The second step (mmoves.exe) uses a combination of the MOVES emission factors and the hourly link volumes that are output of the postcms.exe program. The hourly volumes multiplied by the MOVES emission factor for the corresponding hour of day, speed bin, and road type; calculate emissions for every network link for each hour. The final link on road vehicle emissions for the area is the sum of all individual link-hour emissions. The third step, (vehcalm.exe), calculates vehicle-based emissions for each source type for each hour of the day. A combination of local and default data is the source for the vehicle source type. The final vehicle emissions for each county are the sum of all individual hourly emissions for all vehicle types. Since the intrazonal trips are not loaded onto the network, the fourth step in the process requires a separate method to account for those trips that use local roads to travel within a zone. The intracalm.exe program uses intrazonal trips to estimate VMT using the area in square miles and intrazonal trips of each zone. The computer program assumes that the zone is circular and uses the radius of the circle as the average trip length for these intrazonal trips. By combining MOVES generated emissions with estimated intrazonal VMT, the intrazonal emissions are then calculated. The emission rates are the same as those used to calculate link based emissions. The final step is to summarize link, vehicle, and intrazonal emissions for each county, pollutant, and analyzed year.

More details are provided at
http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/cmaqr3.PDF

APPENDIX A

INTERAGENCY CONSULTATION DOCUMENTATION

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Appendix D
LADCO Technical Support Documents

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Appendix D-1

Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Final Technical Support Document

April 25, 2008

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Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze:

Final Technical Support Document

April 25, 2008

States of Illinois, Indiana, Michigan, Ohio, and Wisconsin

Table of Contents

EXECUTIVE SUMMARY

States in the upper Midwest face a number of air quality challenges. More than 50 counties are currently classified as nonattainment for the 8-hour ozone standard and 60 for the fine particle ($PM_{2.5}$) standard (1997 versions). A map of these nonattainment areas is provided in the figure below. In addition, visibility impairment due to regional haze is a problem in the larger national parks and wilderness areas (i.e., Class I areas). There are 156 Class I areas in the U.S., including two in northern Michigan.

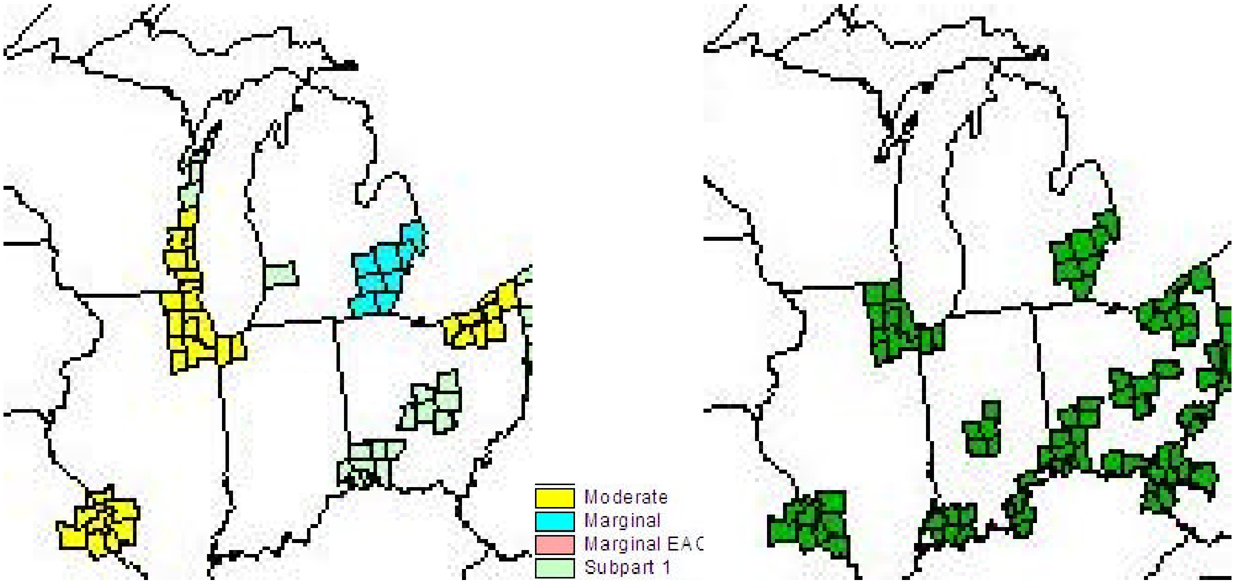

Figure i. Current nonattainment counties for ozone (left) and $PM_{2.5}$ (right)

To support the development of State Implementation Plans (SIPs) for ozone, $PM_{2.5}$, and regional haze in the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin, technical analyses were conducted by the Lake Michigan Air Directors Consortium (LADCO), its member states, and various contractors. The analyses include preparation of regional emissions inventories and meteorological data, evaluation and application of regional chemical transport models, and collection and analysis of ambient monitoring data.

Monitoring data were analyzed to produce a conceptual understanding of the air quality problems. Key findings of the analyses include:

Ozone

- Current monitoring data (2005-2007) show about 20 sites in violation of the 8-hour ozone standard of 85 parts per billion (ppb). Historical ozone data show a steady downward trend over the past 15 years, especially since 2001-2003, due likely to federal and state emission control programs.

- Ozone concentrations are strongly influenced by meteorological conditions, with more high ozone days and higher ozone levels during summers with above normal temperatures.

- Inter- and intra-regional transport of ozone and ozone precursors affects many portions of the five states, and is the principal cause of nonattainment in some areas far from population or industrial centers.

$PM_{2.5}$

- Current monitoring data (2005-2007) show 30 sites in violation of the annual $PM_{2.5}$ standard of 15 ug/m^3. Nonattainment sites are characterized by an elevated regional background (about 12 – 14 ug/m^3) and a significant local (urban) increment (about 2 – 3 ug/m^3). Historical $PM_{2.5}$ data show a slight downward trend since deployment of the $PM_{2.5}$ monitoring network in 1999.

- $PM_{2.5}$ concentrations are also influenced by meteorology, but the relationship is more complex and less well understood compared to ozone.

- On an annual average basis, $PM_{2.5}$ chemical composition consists mostly of sulfate, nitrate, and organic carbon in similar proportions.

Haze

- Current monitoring data (2000-2004) show visibility levels in the Class I areas in northern Michigan are on the order of 22 – 24 deciviews. The goal of EPA's visibility program is to achieve natural conditions, which is about 12 deciviews for these Class I areas, by the year 2064.

- Visibility impairment is dominated by sulfate and nitrate.

Air quality models were applied to support the regional planning efforts. Two base years were used in the modeling analyses: 2002 and 2005. Basecase modeling was conducted to evaluate model performance (i.e., assess the model's ability to reproduce observed concentrations). This exercise was intended to build confidence in the model prior to its use in examining control strategies. Model performance for ozone and $PM_{2.5}$ was found to be generally acceptable.

Future year strategy modeling was conducted to determine whether existing ("on the books") controls would be sufficient to provide for attainment of the standards for ozone and $PM_{2.5}$ and if not, then what additional emission reductions would be necessary for attainment. Based on the modeling and other supplemental analyses, the following general conclusions can be made:

- Existing controls are expected to produce significant improvement in ozone and $PM_{2.5}$ concentrations and visibility levels.

- The choice of the base year affects the future year model projections. A key difference between the base years of 2002 and 2005 is meteorology. 2002 was more ozone conducive than 2005. The choice of which base year to use as the basis for the SIP is a policy decision (i.e., how much safeguard to incorporate).

- Modeling suggests that most sites are expected to meet the current 8-hour ozone standard by the applicable attainment date, except for sites in western Michigan and, possibly, in eastern Wisconsin and northeastern Ohio.

- Modeling suggests that most sites are expected to meet the current $PM_{2.5}$ standard by the applicable attainment date, except for sites in Detroit, Cleveland, and Granite City.

  The regional modeling for $PM_{2.5}$ does not include air quality benefits expected from local controls. States are conducting local-scale analyses and will use these results, in conjunction with the regional-scale modeling, to support their attainment demonstrations for $PM_{2.5}$.

- These findings of residual nonattainment for ozone and $PM_{2.5}$ are supported by current (2005 – 2007) monitoring data which show significant nonattainment in the region (e.g., peak ozone design values on the order of 90 – 93 ppb, and peak $PM_{2.5}$ design values on the order of 16 - 17 ug/m^3). It is unlikely that sufficient emission reductions will occur in the next couple of years to provide for attainment at all sites.

- Attainment at most sites by the applicable attainment date is dependent on actual future year meteorology (e.g., if the weather conditions are consistent with [or less severe than] 2005, then attainment is likely) and actual future year emissions (e.g., if the emission reductions associated with the existing controls are achieved, then attainment is likely). If either of these conditions is not met, then attainment may be less likely.

- Modeling suggests that the new $PM_{2.5}$ 24-hour standard and the new lower ozone standard will not be met at several sites, even by 2018, with existing controls.

- Visibility levels in a few Class I areas in the eastern U.S. are expected to be greater than (less improved than) the uniform rate of visibility improvement values in 2018 based on existing controls, including those in northern Michigan and some in the northeastern U.S. Visibility levels in many other Class I areas in the eastern U.S. are expected to be less than (more improved than) the uniform rate of visibility improvement values in 2018. These results, along with information on the costs of compliance, time necessary for compliance, energy and non air quality environmental impacts of compliance, and remaining useful life of existing sources, should be considered by the states in setting reasonable progress goals for regional haze.

Section 1.0 Introduction

This Technical Support Document summarizes the final air quality analyses conducted by the Lake Michigan Directors Consortium (LADCO)[1] and its contractors to support the development of State Implementation Plans (SIPs) for ozone, fine particles ($PM_{2.5}$), and regional haze in the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin. The analyses include preparation of regional emissions inventories and meteorological modeling data for two base years (2002 and 2005), evaluation and application of regional chemical transport models, and analysis of ambient monitoring data.

Two aspects of the analyses should be emphasized. First, a regional, multi-pollutant approach was taken in addressing ozone, $PM_{2.5}$, and haze for technical reasons (e.g., commonality in precursors, emission sources, atmospheric processes, transport influences, and geographic areas of concern), and practical reasons (e.g., more efficient use of program resources). Furthermore, EPA has consistently encouraged multi-pollutant planning in its rule for the haze program (64 FR 35719), and its implementation guidance for ozone (70 FR 71663) and $PM_{2.5}$ (72 FR 20609). Second, a weight-of-evidence approach was taken in considering the results of the various analyses (i.e., two sets of modeling results -- one for a 2002 base year and one for a 2005 base year -- and ambient data analyses) in order to provide a more robust assessment of expected future year air quality.

The report is organized in the following sections. This Introduction provides an overview of regulatory requirements and background information on regional planning. Section 2 reviews the ambient monitoring data and presents a conceptual model of ozone, $PM_{2.5}$, and haze for the region. Section 3 discusses the air quality modeling analyses, including development of the key model inputs (emissions inventory and meteorological data), and basecase model performance evaluation. A modeled attainment demonstration for ozone and $PM_{2.5}$ is presented in Section 4, along with relevant data analyses considered as part of the weight-of-evidence determination. Section 5 documents the reasonable progress assessment for regional haze, along with relevant data analyses considered as part of the weight-of-evidence determination. Finally, key study findings are reviewed and summarized in Section 6.

1.1 SIP Requirements

For ozone, EPA promulgated designations on April 15, 2004 (69 FR 23858, April 30, 2004). In the 5-state region, more than 100 counties were designated as nonattainment.[2] The designations became effective on June 15, 2004. SIPs for ozone were due no later than three years from the effective date of the nonattainment designations (i.e., by June 2007). The attainment date for ozone varies as a function of nonattainment classification. For the region, the attainment dates are either June 2007 (marginal nonattainment areas), June 2009 (basic nonattainment areas), or June 2010 (moderate nonattainment areas).

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[1] A sub-entity of LADCO, known as the Midwest Regional Planning Organization (MRPO), is responsible for the regional haze activities of the multi-state organization.

[2] Based on more recent air quality data, many counties in Indiana, Michigan, and Ohio were subsequently redesignated as attainment. As of December 31, 2007, there are 53 counties designated as nonattainment in the region.

For $PM_{2.5}$, EPA promulgated designations on December 17, 2004 (70 FR 944, January 5, 2005). In the 5-state region, 70 counties were designated as nonattainment.[3] The designations became effective on April 5, 2005. SIPs for $PM_{2.5}$ are due no later than three years from the effective date of the nonattainment designations (per section 172(b) of the Clean Air Act) (i.e., by April 2008) and for haze no later than three years after the date on which the Administrator promulgated the $PM_{2.5}$ designations (per the Omnibus Appropriations Act of 2004) (i.e., by December 2007). The applicable attainment date for $PM_{2.5}$ nonattainment areas is five years from the date of the nonattainment designation (i.e., by April 2010).

For haze, the Clean Air Act sets "as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas which impairment results from manmade air pollution." There are 156 Class I areas, including two in northern Michigan: Isle Royale National Park and Seney National Wildlife Refuge[4]. EPA's visibility rule (64 FR 35714, July 1, 1999) requires reasonable progress in achieving "natural conditions" by the year 2064. As noted above, the first regional haze SIP was due in December 2007 and must address the initial 10-year implementation period (i.e., reasonable progress by the year 2018). SIP requirements (pursuant to 40 CFR 51.308(d)) include setting reasonable progress goals, determining baseline conditions, determining natural conditions, providing a long-term control strategy, providing a monitoring strategy (air quality and emissions), and establishing BART emissions limitations and associated compliance schedule.

1.2 Organization

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 (LMOS) 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. 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.

MRPO is a similar entity led by the five LADCO States and involves the federally recognized tribes in Michigan and Wisconsin, EPA, and Federal Land Managers (i.e., National Park Service, U.S. Fish & Wildlife Agency, and U.S. Forest Service). In October 2000, the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin signed an MOA that established the MRPO. An operating principles document for MRPO, which describe the roles and responsibilities of states, tribes, federal agencies, and stakeholders, was issued in March 2001. MRPO has a similar purpose as LADCO, but is focused on visibility impairment due to regional haze in the Federal Class I areas located inside the borders of the five states, and the impact of emissions from the five states on visibility impairment due to regional haze in the Federal Class I areas located outside the borders of the five states. MRPO works cooperatively with the Regional Planning Organizations (RPOs) representing other parts of the country. The RPOs sponsored several

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[3] USEPA subsequently adjusted the final designations, which resulted in 63 counties in the region being designated as nonattainment (70 FR 19844, April 15, 2005).

[4] Although Rainbow Lake in northern Wisconsin is also a Class I area, the visibility rule does not apply because the Federal Land Manager determined that visibility is not an air quality related value there.

joint projects and, with assistance by EPA, maintain regular contact on technical and policy matters.

1.3 Technical Work: Overview

To ensure the reliability and effectiveness of its planning process, LADCO has made data collection and analysis a priority. More than $7M in RPO grant funds were used for special purpose monitoring, preparing and improving emissions inventories, and conducting air quality analyses[5]. An overview of the technical work is provided below.

Monitoring: Numerous monitoring projects were conducted to supplement on-going state and local air pollution monitoring. These projects include rural monitoring (e.g., comprehensive sampling in the Seney National Wildlife Refuge and in Bondville, IL); urban monitoring (e.g., continuation of the St. Louis Supersite); aloft (aircraft) measurements; regional ammonia monitoring; and organic speciation sampling in Seney, Bondville, and five urban areas.

Emissions: Baseyear emissions inventories were prepared for 2002 and 2005. States provided point source and area source emissions data, and MOBILE6 input files and mobile source activity data. LADCO and its contractors developed the emissions data for other source categories (e.g., select nonroad sources, ammonia, fires, and biogenics) and processed the data for input into an air quality model. To support control strategy modeling, future year inventories were prepared. The future years of interest include 2008 (planning year to address the 2009 attainment year for basic ozone nonattainment ares), 2009 (planning year to address the 2010 attainment year for $PM_{2.5}$ and moderate ozone nonattainment areas), 2012 (planning to address a 2013 alternative attainment date), and 2018 (first milestone year for regional haze).

Air Quality Analyses: The weight-of-evidence approach relies on data analysis and modeling. Air quality data analyses were used to provide both a conceptual model (i.e., a qualitative description of the ozone, $PM_{2.5}$, and regional haze problems) and supplemental information for the attainment demonstration. Given uncertainties in emissions inventories and modeling, especially for $PM_{2.5}$, these data analyses are a necessary part of the overall technical support.

Modeling includes baseyear analyses for 2002 and 2005 to evaluate model performance and future year strategy analyses to assess candidate control strategies. The analyses were conducted in accordance with EPA's modeling guidelines (EPA, 2007a). The PM/haze modeling covers the full calendar year (2002 and 2005) for an eastern U.S. 36 km domain, while the ozone modeling focuses on the summer period (2002 and 2005) for a Midwest 12 km subdomain. The same model (CAMx) was used for ozone, $PM_{2.5}$, and regional haze.

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[5] Since 1999, MRPO has received almost $10M in RPO grant funds from USEPA.

Section 2.0 Ambient Data Analyses

An extensive network of air quality monitors in the 5-state region provides data for ozone (and its precursors), $PM_{2.5}$ (both total mass and individual chemical species), and visibility. These data are used to determine attainment/nonattainment designations, support SIP development, and provide air quality information to public (see, for example, www.airnow.gov).

Analyses of the data were conducted to produce a conceptual model, which is a qualitative summary of the physical, chemical, and meteorological processes that control the formation and distribution of pollutants in a given region. This section reviews the relevant data analyses and describes our understanding of ozone, $PM_{2.5,}$ and regional haze with respect to current conditions, data variability (spatial, temporal, and chemical), influence of meteorology (including transport patterns), precursor sensitivity, and source culpability.

2.1 Ozone

In 1979, EPA adopted an ozone standard of 0.12 ppm, averaged over a 1-hour period. This standard is attained when the number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1.0, averaged over a 3-year period, which generally reflects a design value (i.e., the 4th highest daily 1-hour value over a 3-year period) less than 0.12 ppm.

In 1997, EPA tightened the ozone standard to 0.08 ppm, averaged over an 8-hour period[6]. The standard is attained if the 3-year average of the 4th-highest daily maximum 8-hour average ozone concentrations (i.e., the design value) measured at each monitor within an area is less than 0.08 ppm (or 85 ppb).

Current Conditions: A map of the 8-hour ozone design values at each monitoring site in the region for the 3-year period 2005-2007 is shown in Figure 1. The “hotter” colors represent higher concentrations, where yellow and orange dots represent sites with design values above the standard. Currently, there are 19 sites in violation of the 8-hour ozone NAAQS in the 5-state region, including sites in the Lake Michigan area, Detroit, Cleveland, Cincinnati, and Columbus.

Table 1 provides the 4th-highest daily 8-hour ozone values and the associated design values since 2001 for several high monitoring sites throughout the region.

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[6] On March 12, 2008, USEPA further tightened the 8-hour ozone standard to increase public health protection and prevent environmental damage from ground-level ozone. USEPA set the primary (health) standard and secondary (welfare) standard at the same level: 0.075 ppm (75 ppb), averaged over an 8-hour period.

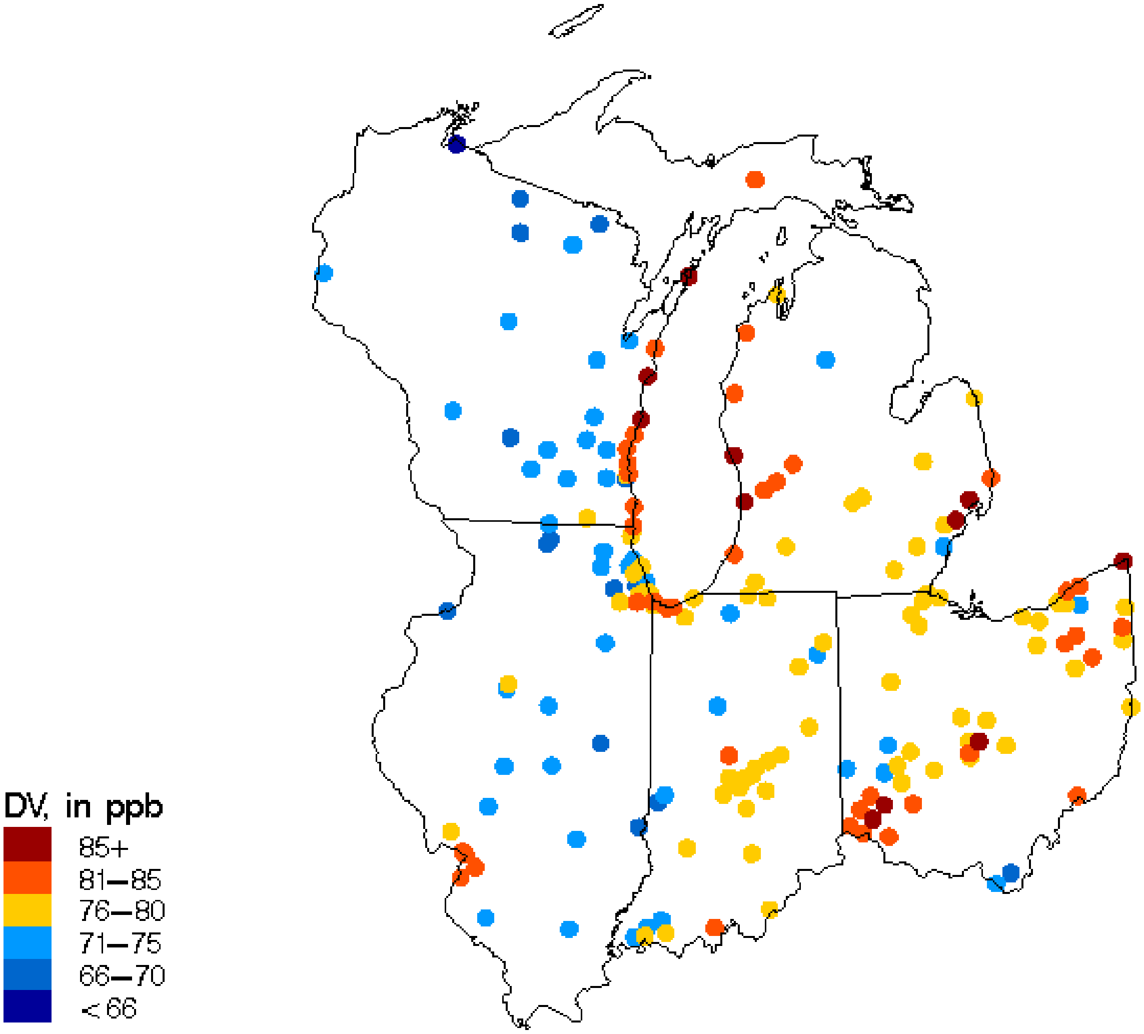


Figure 1. 8-hour ozone design values (2005-2007)

Table 1. Ozone Data for Select Sites in 5-State Region

Key Sites	4th High 8-hour Value								Design Values				
	'01	'02	'03	'04	'05	'06	'07		'01-'03	'02-'04	'03-'05	'04-'06	'05-'07
Lake Michigan Area													
Chiwaukee	99	116	88	78	93	79	85		**101**	**94**	**86**	83	**85**
Racine	92	111	82	69	95	71	77		**95**	**87**	82	78	81
Milwaukee-Bayside	93	99	92	73	93	73	83		**94**	**88**	**86**	79	83
Harrington Beach	102	93	99	72	94	72	84		**98**	**88**	**88**	79	83
Manitowoc	97	83	92	74	95	78	85		**90**	83	**87**	82	**86**
Sheboygan	102	105	93	78	97	83	88		**100**	**92**	**89**	**86**	**89**
Kewaunee	90	92	97	73	88	76	85		**93**	**87**	**86**	*79*	83
Door County	95	95	93	78	101	79	92		**94**	**88**	**90**	**86**	**90**
Hammond	90	101	81	67	87	75	77		**90**	83	78	76	79
Whiting				64	88	81	88					77	**85**
Michigan City	90	107	82	70	84	75	73		**93**	**86**	78	76	77
Ogden Dunes	85	101	77	69	90	70	84		**87**	82	78	76	81
Holland	92	105	96	79	94	91	94		**97**	**93**	**89**	**88**	**93**
Jenison	86	93	91	69	86	83	88		**90**	84	82	79	**85**
Muskegon	95	96	94	70	90	90	86		**95**	**86**	84	83	**88**
Indianapolis Area													
Noblesville	88	101	101	75	87	77	84		**96**	**92**	**87**	79	82
Fortville	89	101	92	72	80	75	81		**94**	**88**	81	75	78
Fort B. Harrison	87	100	91	73	80	76	83		**92**	**88**	81	76	79
Detroit Area													
New Haven	95	95	102	81	88	78	93		**97**	**92**	**90**	82	**86**
Warren	94	92	101	71	89	78	91		**95**	**88**	**87**	79	**86**
Port Huron	84	100	87	74	88	78	89		**90**	**87**	83	80	**85**
Cleveland Area													
Ashtabula (Conneaut)	97	103	99	81	93	86	92		**99**	**94**	**91**	**86**	**90**
Notre Dame (Geauga)	99	115	97	75	88	70	68		**103**	**95**	**86**	77	75
Eastlake (Lake)	89	104	92	79	97	83	74		**95**	**91**	**89**	**86**	84
Akron (Summit)	98	103	89	77	89	77	91		**96**	**89**	**85**	81	**85**
Cincinnati Area													
Wilmington (Clinton)	93	99	96	78	83	81	82		**96**	**91**	**85**	80	82
Sycamore (Hamilton)	88	100	93	76	89	81	90		**93**	**89**	**86**	82	**86**
Hamilton (Butler)	83	100	94	75	86	79	91		**92**	**89**	**85**	80	**85**
Middleton (Butler)	87	98	83	76	88	76	91		**89**	**85**	82	80	**85**
Lebanon (Warren)	85	98	95	81	92	86	88		**92**	**91**	**89**	**86**	**88**
Columbus Area													
London (Madison)	84	97	90	75	81	76	83		**90**	**87**	82	77	80
New Albany (Franklin)	90	103	94	78	92	82	87		**95**	**91**	**88**	84	**87**
Franklin (Franklin)	83	99	84	73	86	79	79		**88**	**85**	81	79	81
Ohio Other Areas													
Marietta (Washington)	85	95	80	77	88	81	86		**86**	84	81	82	**85**
St. Louis Area													
W. Alton (MO)	85	99	91	77	89	91	89		**91**	**89**	**85**	**85**	**89**
Orchard (MO)	88	98	90	76	92	92	83		**92**	**88**	**86**	**86**	**89**
Sunset Hills (MO)	88	98	88	70	89	80	89		**91**	**85**	82	79	**86**
Arnold (MO)	86	93	82	70	92	79	87		**87**	81	81	80	**86**
Margaretta (MO)	80	98	90	72	91	76	91		**89**	**86**	84	79	**86**
Maryland Heights (MO)					88	84	94						**88**

Meteorology and Transport: Most pollutants exhibit some dependence on meteorological factors, especially wind direction, because that governs which sources are upwind and thus most influential on a given sample. Ozone is even more dependent, since its production is driven by high temperatures and sunlight, as well as precursor concentrations (see, for example, Figure 2).

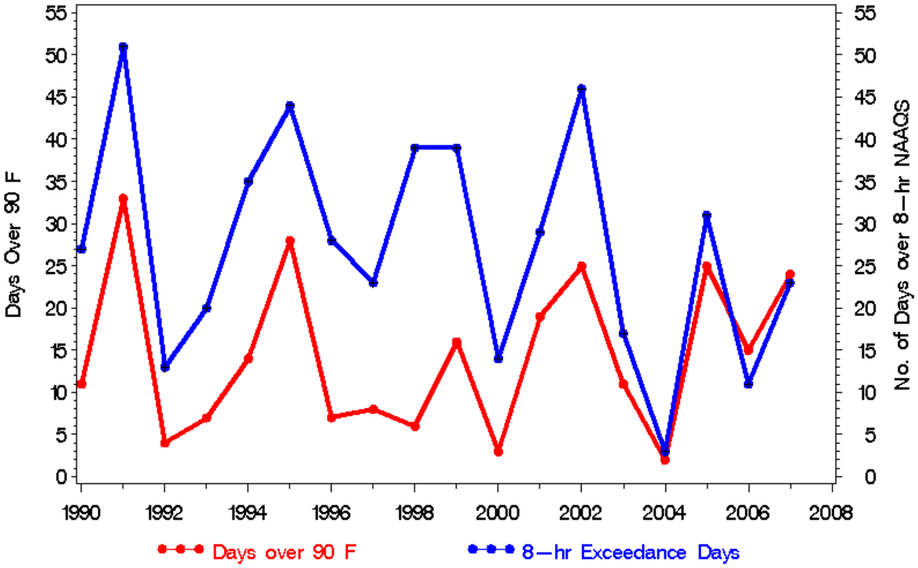
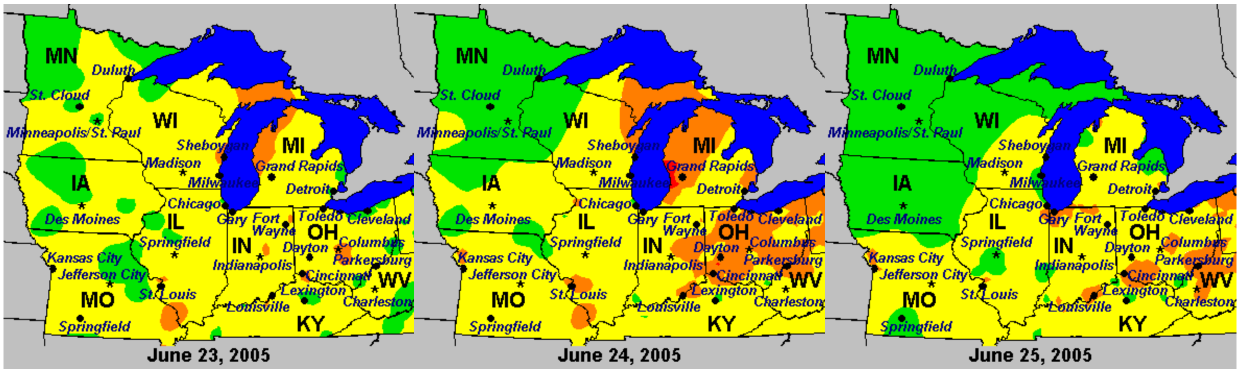


Figure 2. Number of hot days and 8-hour "exceedance" days in 5-state region

Qualitatively, ozone episodes in the region are associated with hot weather, clear skies (sometimes hazy), low wind speeds, high solar radiation, and southerly to southwesterly winds. These conditions are often a result of a slow-moving high pressure system to the east of the region. The relative importance of various meteorological factors is discussed later in this section.

Transport of ozone (and its precursors) is a significant factor and occurs on several spatial scales. Regionally, over a multi-day period, somewhat stagnant summertime conditions can lead to the build-up in ozone and ozone precursor concentrations over a large spatial area. This pollutant air mass can be advected long distances, resulting in elevated ozone levels in locations far downwind. An example of such an episode is shown in Figure 3.



June 23, 2005 June 24, 2005 June 25, 2005

Figure 3. Example of elevated regional ozone concentrations (June 23 – 25, 2005)

Note: hotter colors represent higher concentrations, with orange representing concentrations above the 8-hour standard

Locally, emissions from urban areas add to the regional background leading to ozone concentration hot spots downwind. Depending on the synoptic wind patterns (and local land-lake breezes), different downwind areas are affected (see, for example, Figure 4).

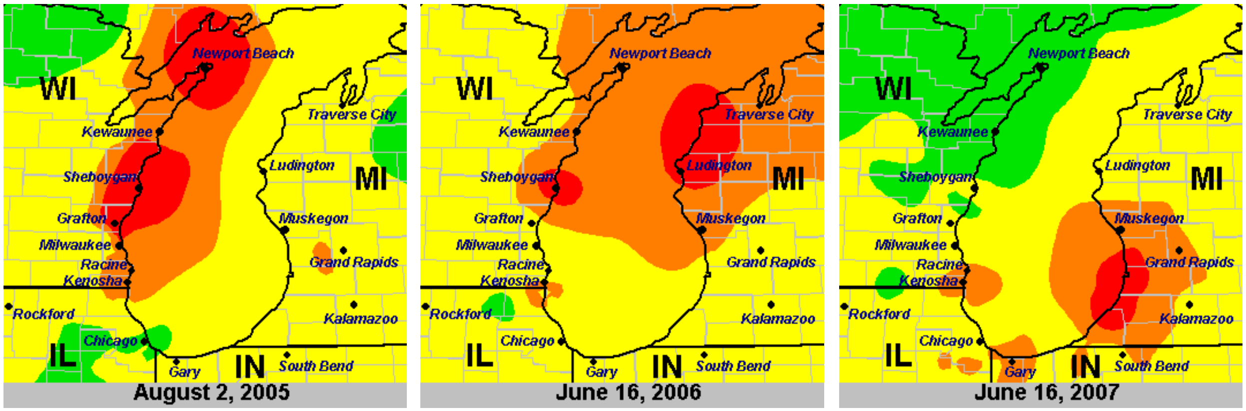


Figure 4. Examples of recent high ozone days in the Lake Michigan area

Note: hotter colors represent higher concentrations, with orange representing concentrations above the 8-hour standard

Aloft (aircraft) measurements in the Lake Michigan area also provide evidence of elevated regional background concentrations and "plumes" from urban areas. For one example summer day (August 20, 2003 – see Figure 5), the incoming background ozone levels were on the order of 80 – 100 ppb and the downwind ozone levels over Lake Michigan were on the order of 100 - 150 ppb (STI, 2004).

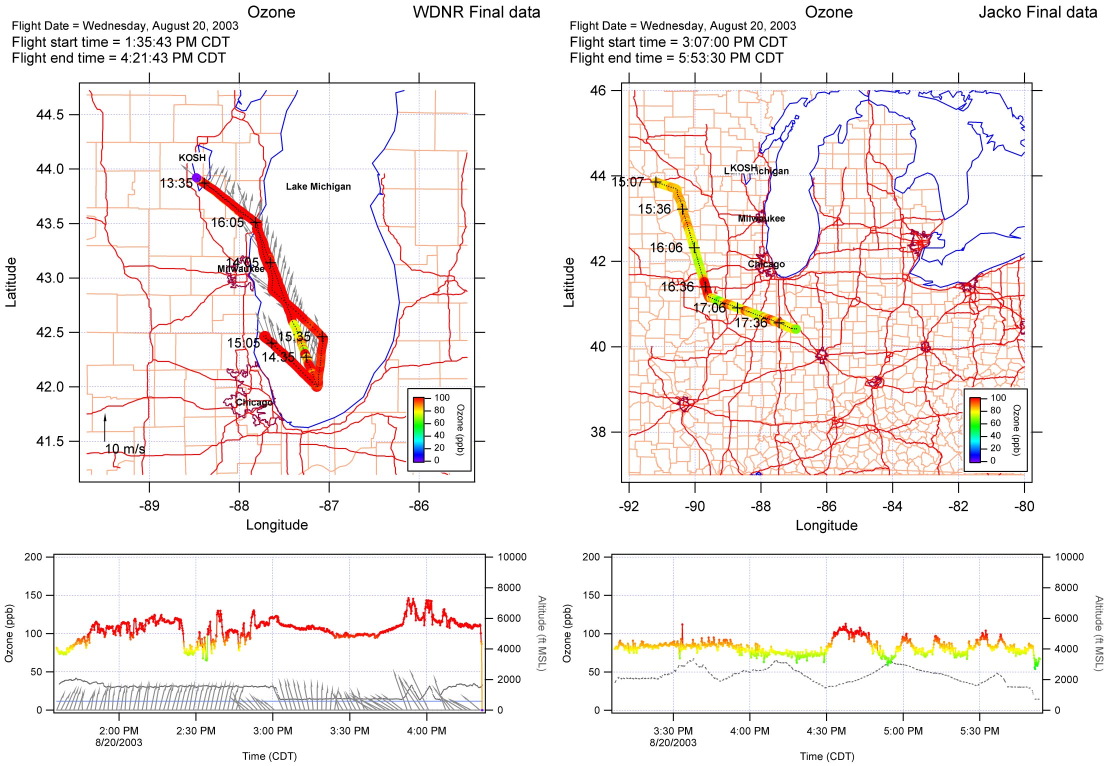


Figure 5. Aircraft ozone measurements over Lake Michigan (left) and along upwind boundary (right) – August 20, 2003 (Note: aircraft measurements reflect instantaneous values)

As discussed in Section 4, residual nonattainment is projected in at least one area in the 5-state region –i.e., western Michigan. To understand the source regions likely impacting high ozone concentrations in western Michigan and estimate the impact of these source regions, two simple transport-related analyses were performed.

First, back trajectories were constructed using the HYSPLIT model for high ozone days (8-hour peak > 80 ppb) during the period 2002-2006 in western Michigan to characterize general transport patterns. Composite trajectory plots for all high ozone days based on data from three sites (Cass County, Holland, and Muskegon) are provided in Figure 6. The plots point back to areas located to the south-southwest (especially, northeastern Illinois and northwestern Indiana) as being upwind on these high ozone days.

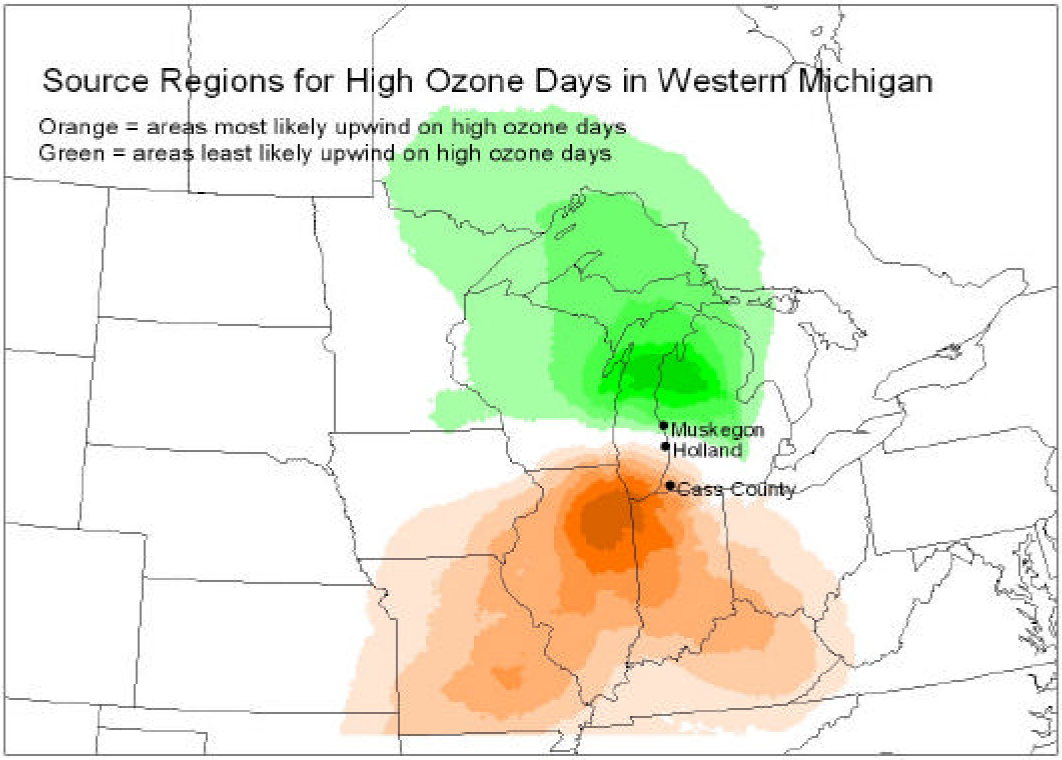


Figure 6 Back trajectory analysis showing upwind areas associated with high ozone concentrations

Second, to assess the impact from Chicago/NW Indiana, Blanchard (2005a) compared ozone concentrations upwind (Braidwood, IL), within Chicago (ten sites in the City), and downwind (Holland and Muskegon) for days in 1999 – 2002 with southwesterly winds - i.e., transport towards western Michigan. Figure 7 shows the distribution of daily peak 8-hour ozone concentrations by day-of-week, with a line connecting the mean values. The difference between day-of-week mean values at downwind and upwind sites indicates that Chicago/NW Indiana contributes about 10-15 ppb to downwind ozone levels.

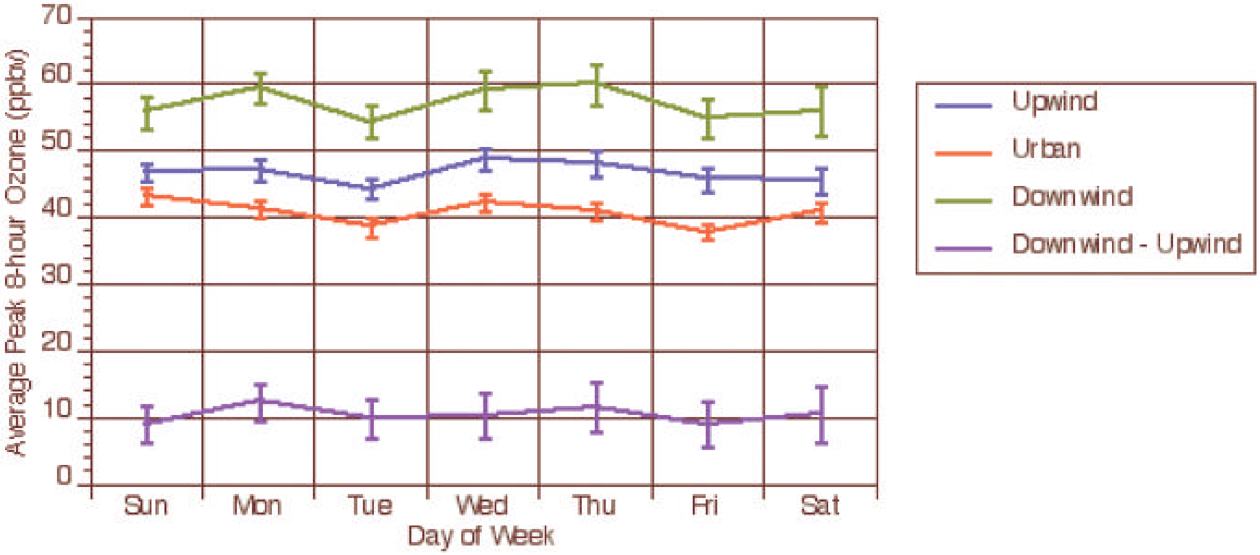


Figure 7. Mean day-of-week peak 8-hour ozone concentrations at sites upwind, within, and downwind of Chicago, 1999 – 2002 (southwesterly wind days)

Based on this information, the following key findings related to transport can be made:

- Ozone transport is a problem affecting many portions of the eastern U.S. The Lake Michigan area (and other areas in the LADCO region) both receive high levels of incoming (transported) ozone and ozone precursors from upwind source areas on many hot summer days, and contribute to the high levels of ozone and ozone precursors affecting downwind receptor areas.

- The presence of a large body of water (i.e., Lake Michigan) influences for the formation and transport of ozone in the Lake Michigan area. Depending on large-scale synoptic winds and local-scale lake breezes, different parts of the area experience high ozone concentrations. For example, under southerly flow, high ozone can occur in eastern Wisconsin, and under southwesterly flow, high ozone can occur in western Michigan.

- Downwind shoreline areas around Lake Michigan are affected by both regional transport of ozone and subregional transport from major cities in the Lake Michigan area. Counties along the western shore of Michigan (from Benton Harbor to Traverse City, and even as far north as the Upper Peninsula) are impacted by high levels of incoming (transported) ozone.

Data Variability: Since 1980, considerable progress has been made to meet the previous 1-hour ozone standard. Figure 8 shows the decline in both the 1-hour and 8-hour design values for the 5-state LADCO region over the last 25 years.

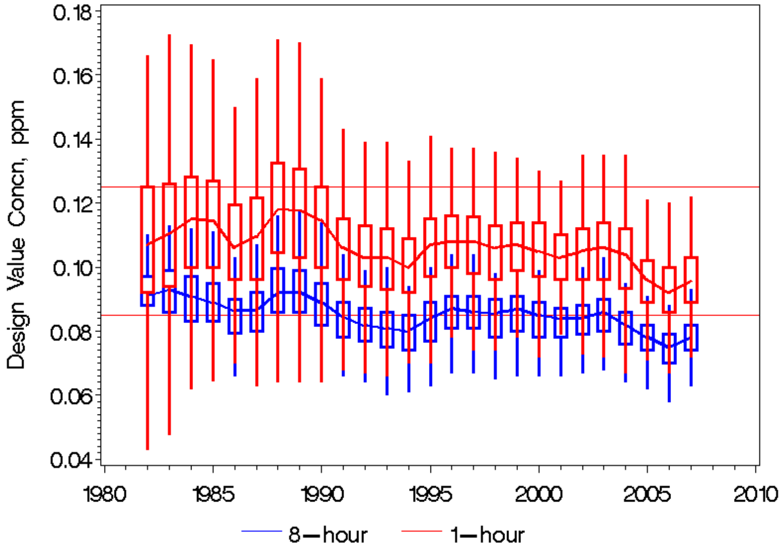


Figure 8 Ozone design value trends in 5-State region

The trend is more dramatic for the higher ozone sites in the 5-state region (see Figure 9). This plot shows a pronounced downward trend in the design value since the 2001-2003 period, due, in part, to the very low 4th high values in 2004.

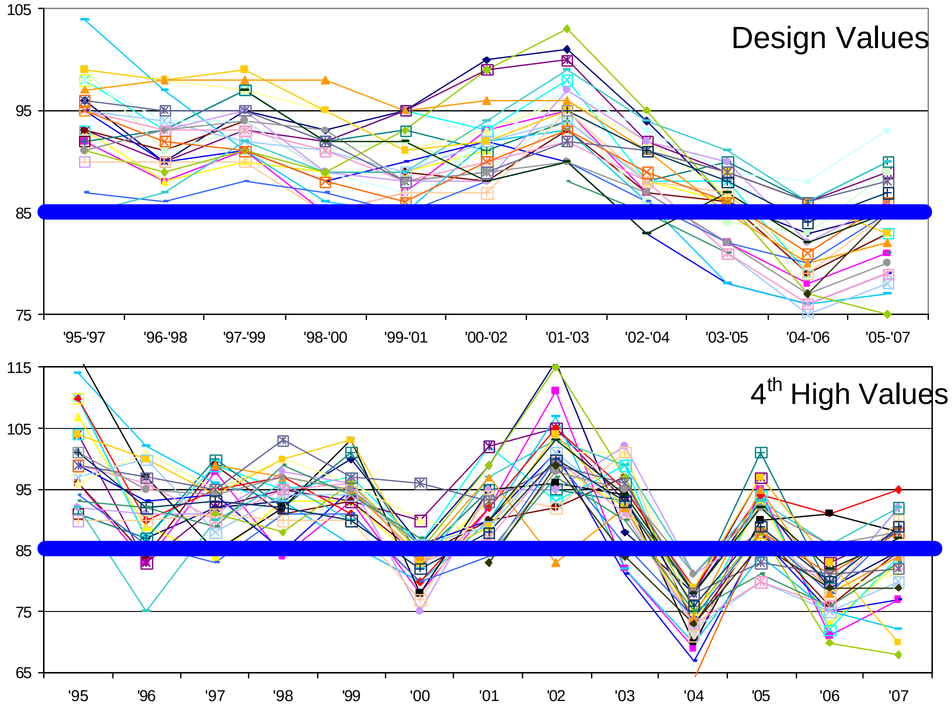


Figure 9. Trend in ozone design values and 4th high values for higher ozone sites in region

The improvement in ozone concentrations is also seen in the decrease in the number of sites measuring nonattainment over the past 15 years in the Lake Michigan area (see Figure 10).

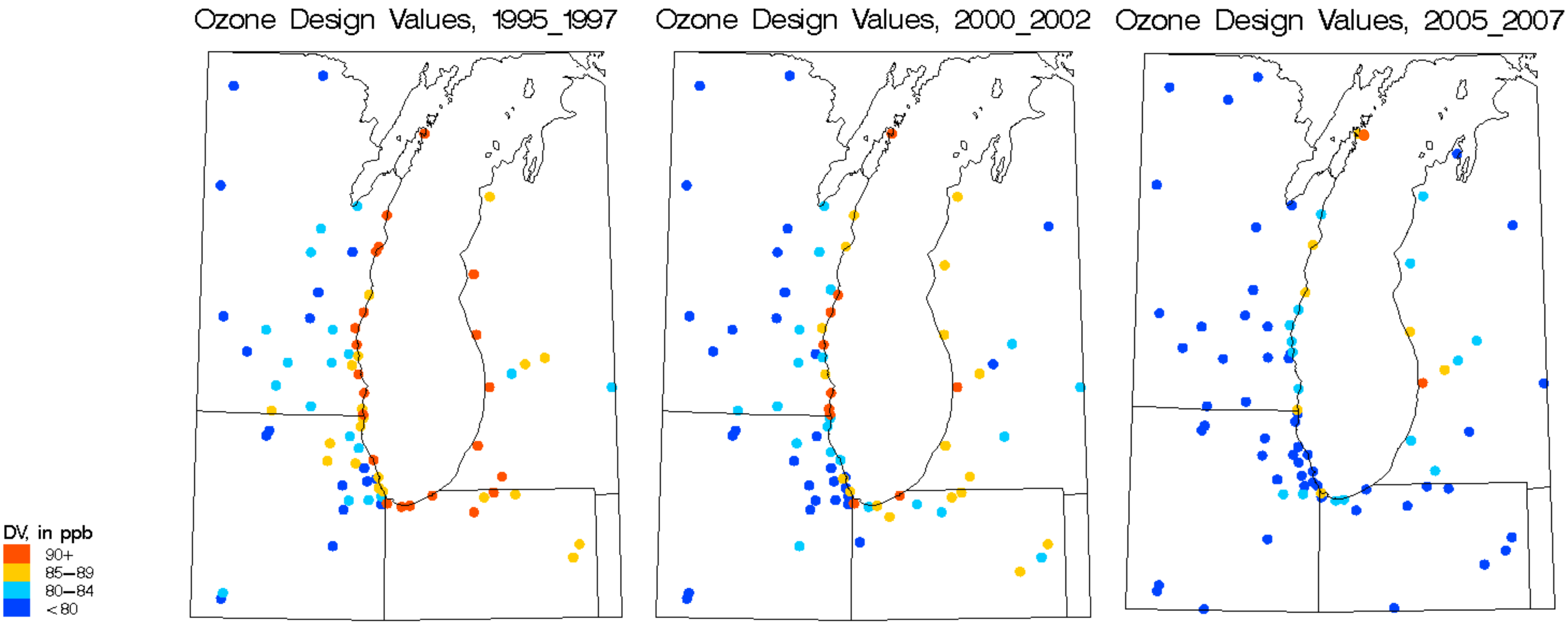


Figure 10. Ozone design value maps for 1995-1997, 2000-2002, and 2005-2007

Given the effect of meteorology on ambient ozone levels, year-to-year variations in meteorology can make it difficult to assess trends in ozone air quality. Two approaches were considered to adjust ozone trends for meteorological influences: an air quality-meteorology statistical model developed by EPA (i.e., Cox method), and statistical grouping of meteorological variables performed by LADCO (i.e., Classification and Regression Trees, or CART).

Cox Method: This method uses a statistical model to 'remove' the annual effect of meteorology on ozone (Cox and Chu, 1993). A regression model was fit to the 1997-2007 data to relate daily peak 8-hour ozone concentrations to six daily meteorological variables plus seasonal and annual factors (Kenski, 2008a). Meteorological variables included were daily maximum temperature, mid-day average relative humidity, morning and afternoon wind speed and wind direction. The model is then used to predict 4th high ozone values. By holding the meteorological effects constant, the long term trend can be examined independently of meteorology. Presumably, any trend reflects changes in emissions of ozone precursors.

Figure 11a shows the meteorologically-adjusted 4th high ozone concentrations for several monitors near major urban areas in the region. The plots indicate a general downward trend since the late 1990s for most cities, indicating that recent emission reductions have had a positive effect in improving ozone air quality.

A similar model was run to examine meteorologically adjusted trends in seasonal average ozone. This model incorporates more meteorological variables, including rain and long-distance transport (direction and distance). Model development was documented in Camalier et al., 2007. The seasonal average trends are shown in Figure 11b. Trends determined by seasonal model for the same set of sites examined above are consistent with those developed by the 4th high model.

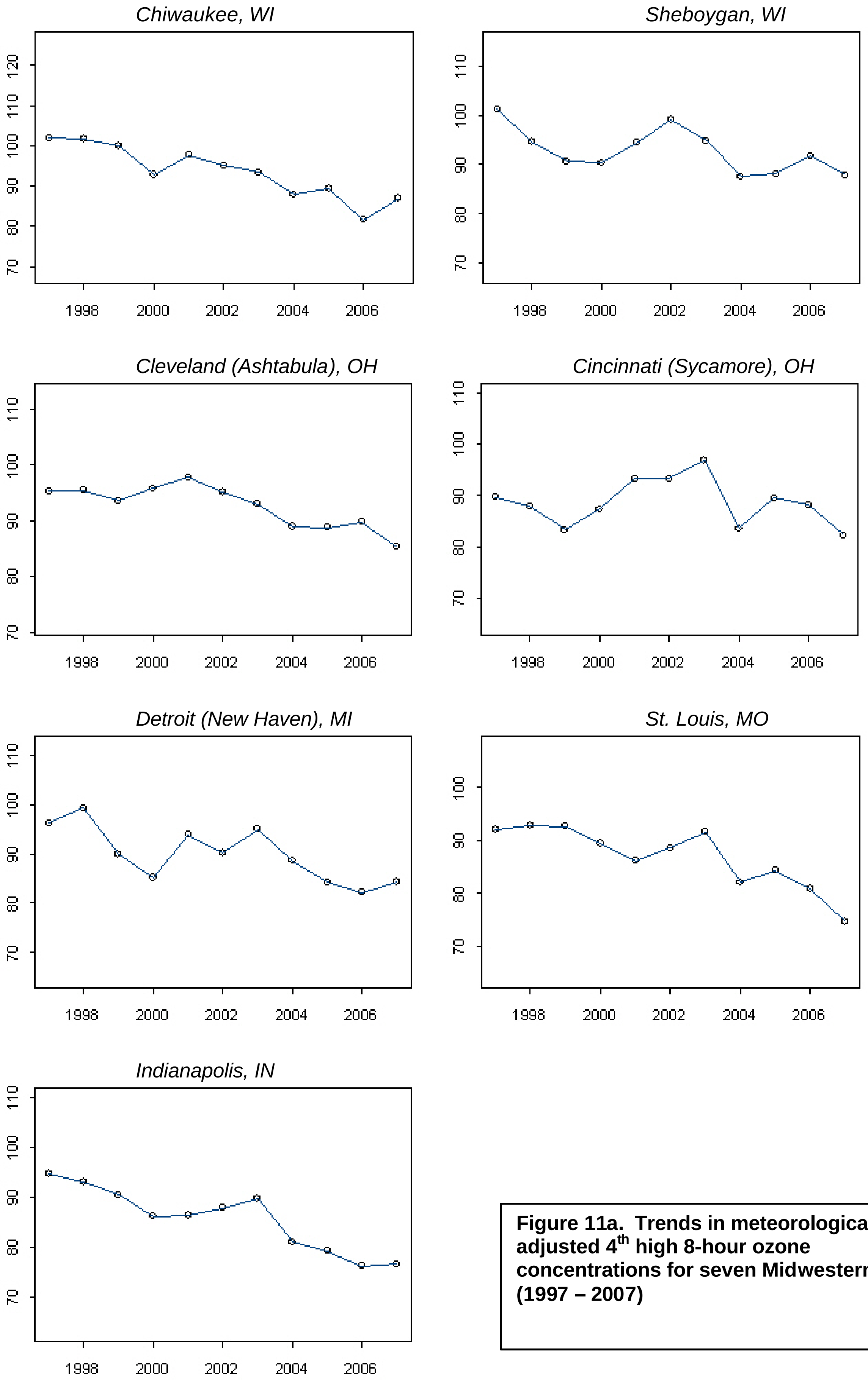


Figure 11a. Trends in meteorologically adjusted 4th high 8-hour ozone concentrations for seven Midwestern sites (1997 – 2007)

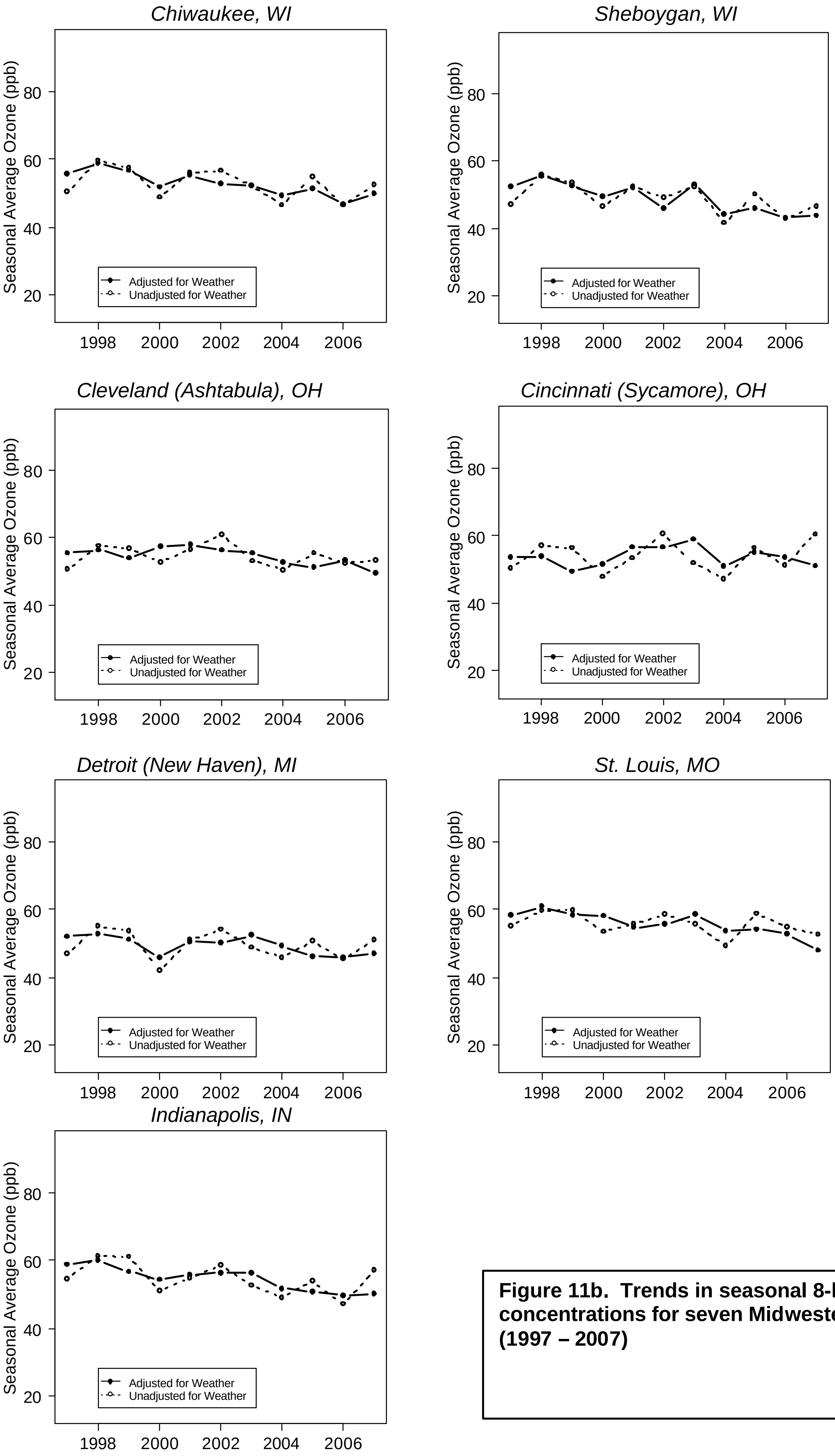


Figure 11b. Trends in seasonal 8-hour ozone concentrations for seven Midwestern sites (1997 – 2007)

CART: Classification and Regression Tree (CART) analysis is another statistical technique which partitions data sets into similar groups (Breiman et al., 1984). CART analysis was performed using data for the period 1995-2007 for 22 selected ozone monitors with current 8-hour design values close to or above the standard (Kenski, 2008b). The CART model searches through 60 meteorological variables to determine which are most efficient in predicting ozone. Although the exact selection of predictive variables changes from site to site, the most common predictors were temperature, wind direction, and relative humidity. Only occasionally were upper air variables, transport time or distance, lake breeze, or other variables significant. (Note, the ozone and meteorological data for the CART analysis are the same as used in the EPA/Cox analysis.)

For each monitor, regression trees were developed that classify each summer day (May-September) by its meteorological conditions. Similar days are assigned to nodes, which are equivalent to branches of the regression tree. Ozone time series for the higher concentration nodes are plotted for select sites in Figure 12. By grouping days with similar meteorology, the influence of meteorological variability on the trend in ozone concentrations is partially removed; the remaining trend is presumed to be due to trends in precursor emissions or other non-meteorological influences. Trends over the 13-year period at most sites were found to be declining, with the exception of Detroit which showed fairly flat trends. Comparison of the average of the high concentration node values for 2001-2003 v. 2005-2007 showed an improvement of about 5 ppb across all sites (even Detroit).

The effect of meteorology was further examined by using an ozone conduciveness index (Kenski, 2008b). This metric reflects the variability from the 13-year average in the number of days in the higher ozone concentration nodes (see Figure 13). Examination of these plots indicates:

- 2002 and 2005 were both above normal, with 2002 tending to be more severe; and
- 2001-2003 and 2005-2007 were both above normal, with no clear pattern in which period was more severe (i.e., ozone conduciveness values were similar at most sites, 2001-2003 values were higher at a few sites, and 2005-2007 values were higher at a few sites).

Given the similarity in ozone conduciveness between 2001-2003 and 2005-2007, the improvement in ozone levels noted above is presumed to be due to non-meteorological factors (i.e., emission reductions).

In conclusion, all three statistical approaches (CART and the two nonlinear regression models) show a similar result; ozone in the urban areas of the LADCO region has declined during the 1997-2007 period, even when meteorological variability is accounted for. The decreases are present whether seasonal average ozone, peak values (annual 4th highs), or a subset of high days with similar meteorology are considered. The consistency in results across models is a good indication that these trends reflect impacts of emission control programs.

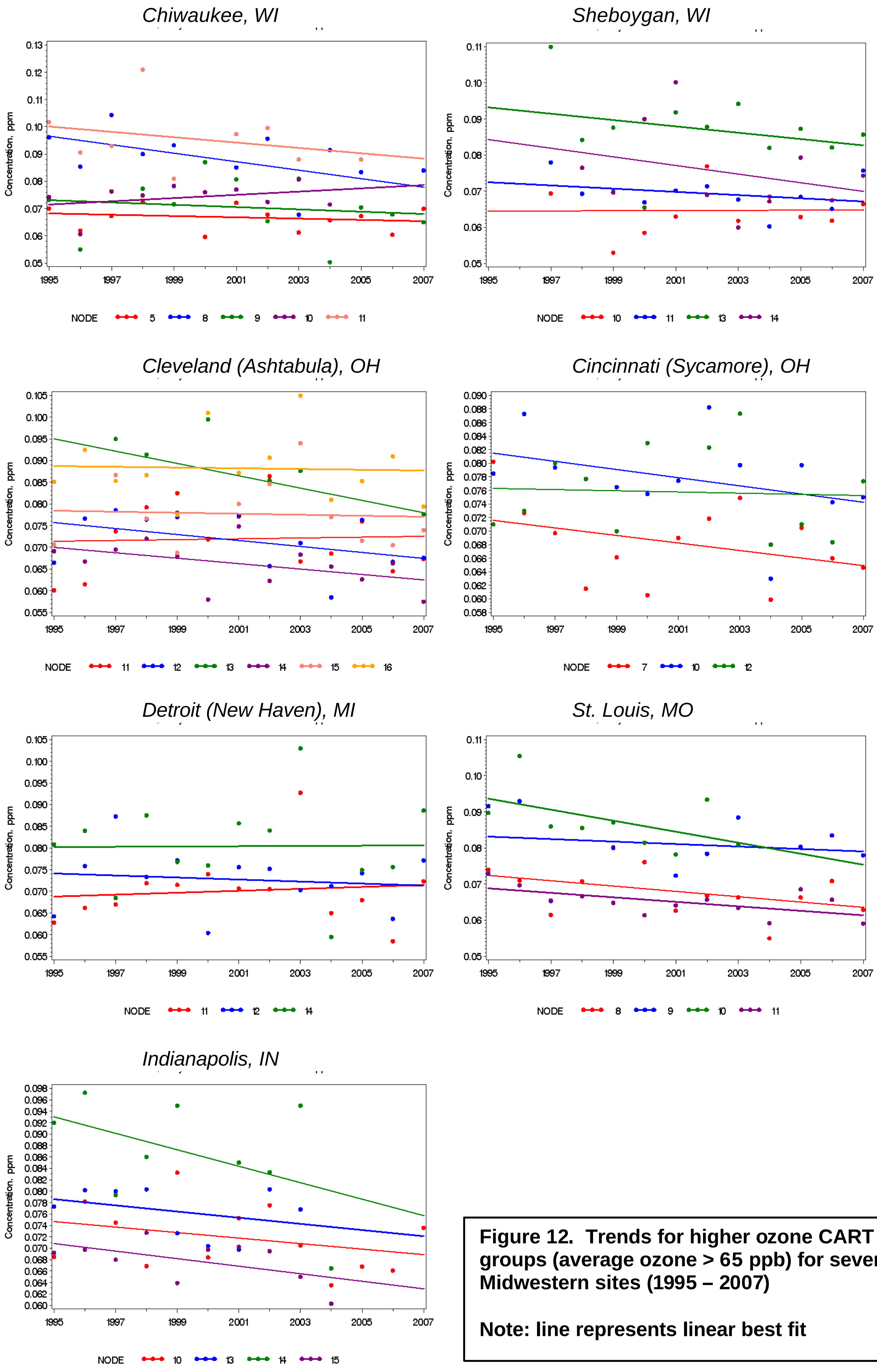
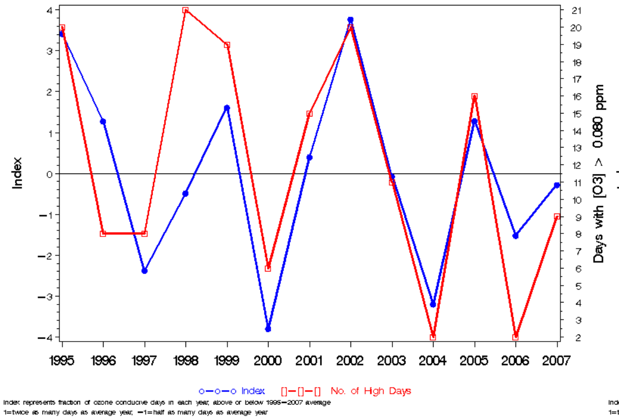


Figure 12. Trends for higher ozone CART groups (average ozone > 65 ppb) for seven Midwestern sites (1995 – 2007)

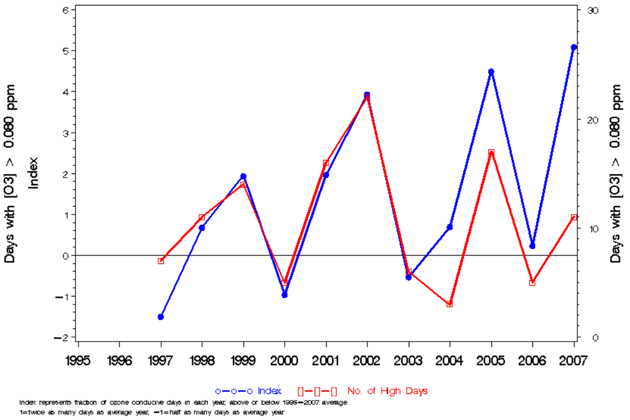
Note: line represents linear best fit

CART Index of Ozone Conduciveness, Wisconsin——Chiwaukee



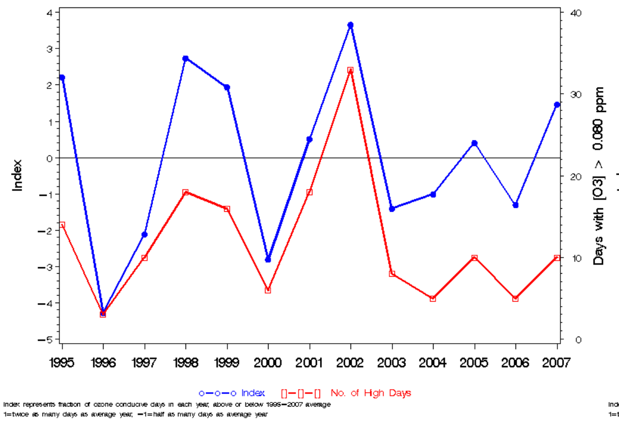
Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, Wisconsin——Sheboygan



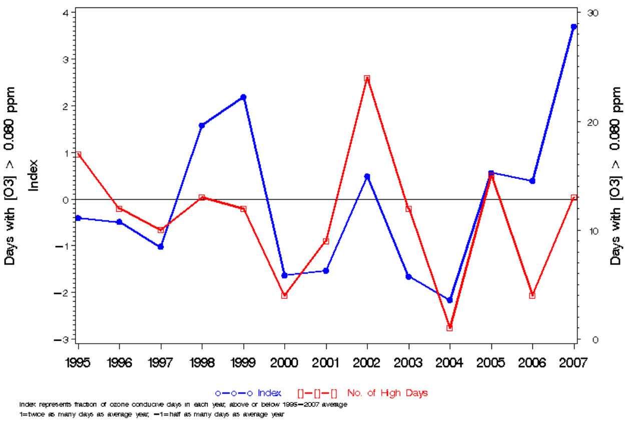
Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, Cleveland—Ashtabula



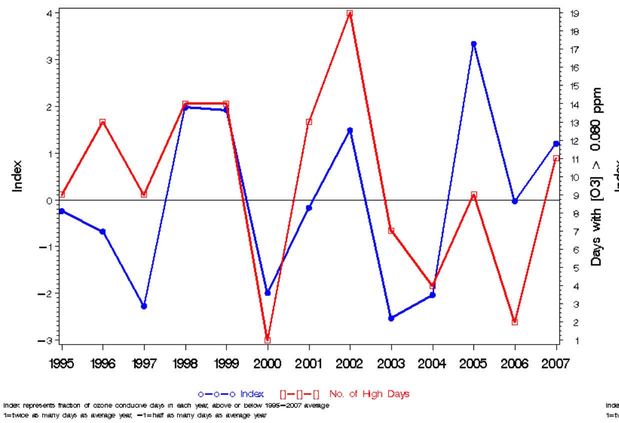
Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, Cincinnati—Sycamore



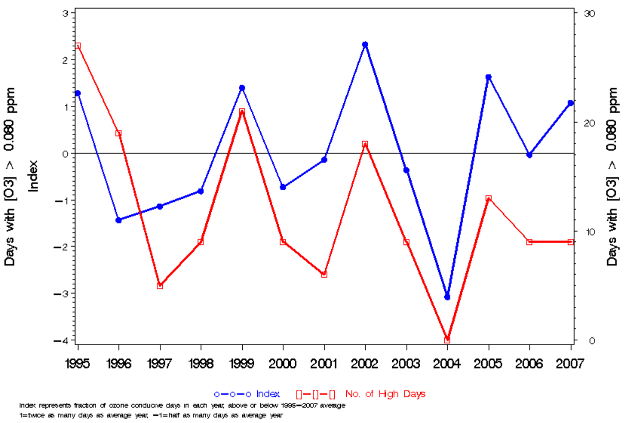
Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, Detroit——New Haven



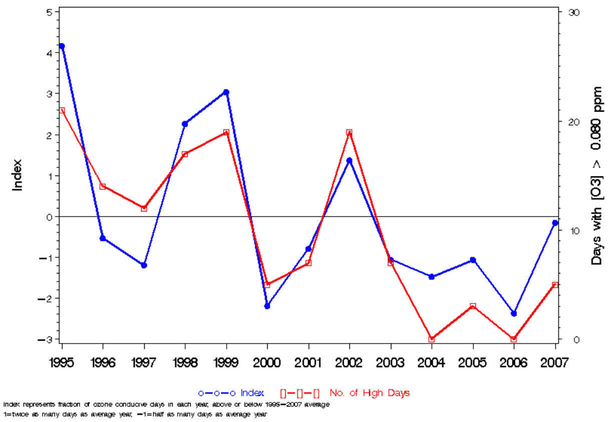
Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, St.Louis——Orchard



Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

CART Index of Ozone Conduciveness, Indianapolis—Ft. Harrison



Index represents fraction of ozone conducive days in each year, above or below 1995–2007 average
1=twice as many days as average year, −1=half as many days as average year

Figure 13. Ozone conduciveness index (and number of high ozone days) for seven Midwestern site (1995 – 2007)

Precursor Sensitivity: Ozone is formed from the reactions of hydrocarbons and nitrogen oxides under meteorological conditions that are conducive to such reactions (i.e., warm temperatures and strong sunlight). In areas with high VOC/NOx ratios, typical of rural environments (with low NOx), ozone tends to be more responsive to reductions in NOx. Conversely, in areas with low VOC/NOx ratios, typical of urban environments (with high NOx), ozone tends to be more responsive to VOC reductions.

An analysis of VOC and NO_x-limitation was conducted with the ozone MAPPER program, which is based on the Smog Production (SP) algorithm (Blanchard, et al., 2003). The “Extent of Reaction” parameter in the SP algorithm provides an indication of VOC and NOx sensitivity:

Extent Range	**Precursor Sensitivity**
< 0.6	VOC-sensitive
0.6 – 0.8	Transitional
> 0.8	NOx-sensitive

A map of the Extent of Reaction values for high ozone days is provided in Figure 14. As can be seen, ozone is usually VOC-limited in cities and NOx-limited in rural areas. (Data from aircraft measurements suggest that ozone is usually NO_x-limited over Lake Michigan and away from urban centers on days when ozone in the urban centers is VOC-limited.) The highest ozone days were found to be NO_x-limited. This analysis suggests that a NOx reduction strategy would be effective in reducing ozone levels. Examination of day-of-week concentrations, however, raises some question about the effectiveness of NOx reductions.

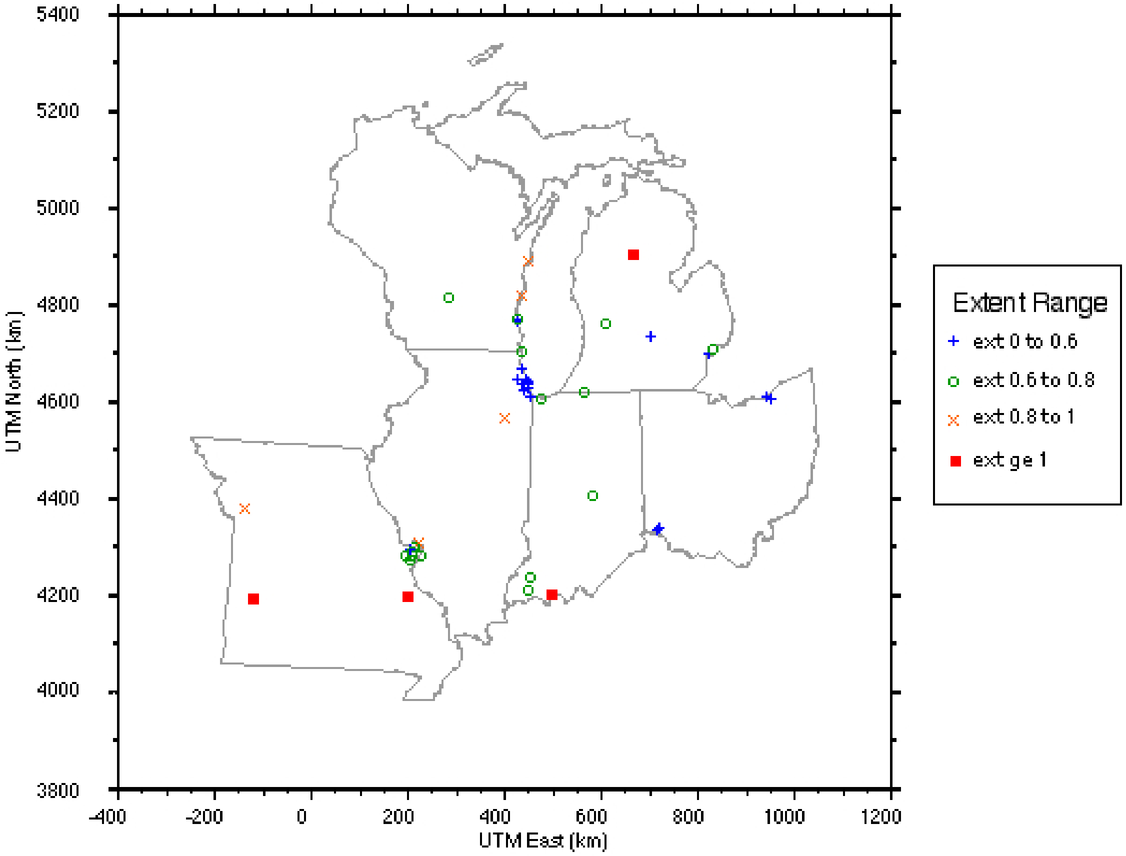


Figure 14. Mean afternoon extent of reaction (1998 – 2002)

Blanchard (2004 and 2005a) examined weekend-weekday differences in ozone and NO_x in the Midwest. All urban areas in these two studies exhibited substantially lower (40-60%) weekend concentrations of NO_x compared to weekday concentrations. Despite lower weekend NO_x concentrations, weekend ozone concentrations were not lower; in fact, most urban sites had higher concentrations of ozone, although the increase was generally not statistically significant (see Figure 15). This small but counterproductive change in **local** ozone concentrations suggests that **local** urban-scale NO_x reductions alone may not be very effective.

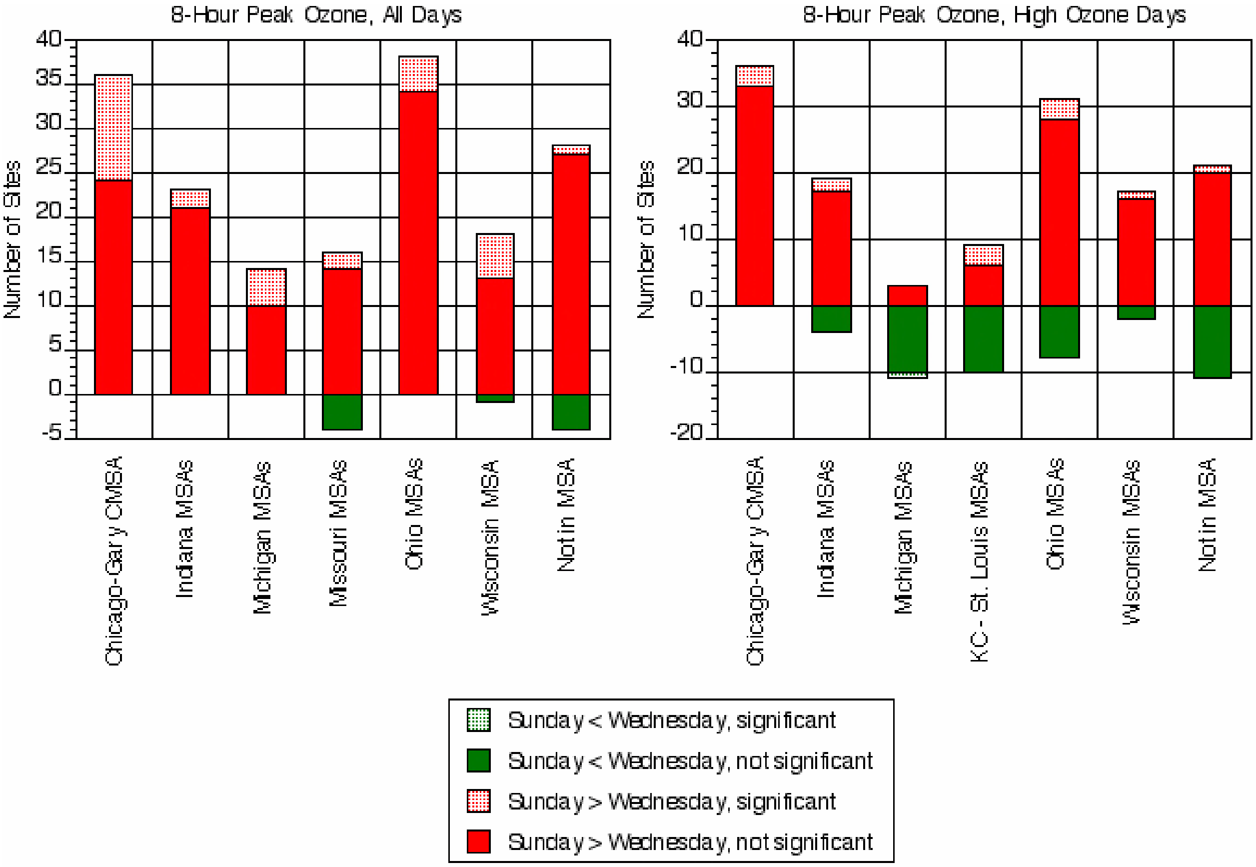


Figure 15. Weekday/weekend differences in 8-hour ozone – number of sites with weekend increase (positive values) v. number of sites with weekend decreases (negative values)

Two additional analyses, however, demonstrate the positive effect of NOx emission reductions on downwind ozone concentrations. First, Blanchard (2005a) looked at the effect of changes in precursor emissions in Chicago on downwind ozone levels in western Michigan. For the transport days of interest (i.e., southwesterly flow during the summers of 1999 – 2002), mean NOx concentrations in Chicago are about 50% lower and mean ozone concentrations at the (downwind) western Michigan sites are about 1.5 – 5.2 ppb (3 – 8 %) lower on Sunday compared to Wednesday. This degree of change in downwind ozone levels suggests a positive, albeit non-linear response to urban area emission reductions.

Second, Environ (2007a) examined the effect of differences in day-of-week emissions in southeastern Michigan on downwind ozone levels. This modeling study found that weekend changes in ozone precursor emissions cause both increases and decreases in Southeast Michigan ozone, depending upon location and time:

- Weekend increases in 8-hour maximum ozone occur in and immediately downwind of the Detroit urban area (i.e., in VOC-sensitive areas).
- Weekend decreases in 8-hour maximum ozone occur outside and downwind of the Detroit urban area (i.e., in NOx-sensitive areas).
- At the location of the peak 8-hour ozone downwind of Detroit, ozone was lower on weekends than weekdays.
- Ozone benefits (reductions) due to weekend emission changes in Southeast Michigan can be transported downwind for hundreds of miles.
- Southeast Michigan benefits from lower ozone transported into the region on Saturday through Monday because of weekend emission changes in upwind areas.

In summary, these analyses suggest that urban VOC reductions and regional (urban and rural) NOx reductions will be effective in lowering ozone concentrations. Local NOx reductions can lead to local ozone increases (i.e., NOx disbenefits), but this effect does not appear to pose a problem with respect to attainment of the standard. It should also be noted that urban VOC and regional NOx reductions are likely to have multi-pollutant benefits (e.g., both lower ozone and $PM_{2.5}$ impacts).

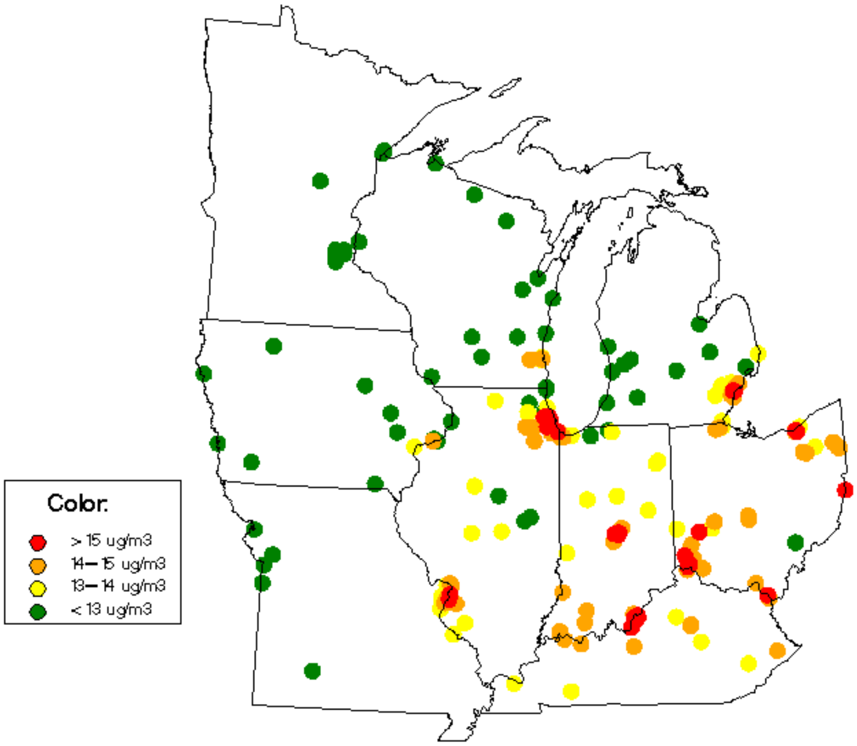
2.2 $PM_{2.5}$

In 1997, EPA adopted the $PM_{2.5}$ standards of 15 ug/m^3 (annual average) and 65 ug/m3 (24-hour average). The annual standard is attained if the 3-year average of the annual average $PM_{2.5}$ concentration is less than or equal to the level of the standard. The daily standard is attained if the 98th percentile of 24-hour $PM_{2.5}$ concentrations in a year, averaged over three years, is less than or equal to the level of the standard.

In 2006, EPA revised the $PM_{2.5}$ standards to 15 ug/m^3 (annual average) and 35 ug/m^3 (24-hour average).

Current Conditions: Maps of annual and 24-hour $PM_{2.5}$ design values for the 3-year period 2005-2007 are shown in Figure 16. The “hotter” colors represent higher concentrations, where red dots represent sites with design values above the annual standard. Currently, there are 30 sites in violation of the annual $PM_{2.5}$ standard.

Table 2 provides the annual $PM_{2.5}$ concentrations and associated design values since 2003 for several high monitoring sites throughout the region.


PM2.5 FRM Annual Design Values, 2005—2007

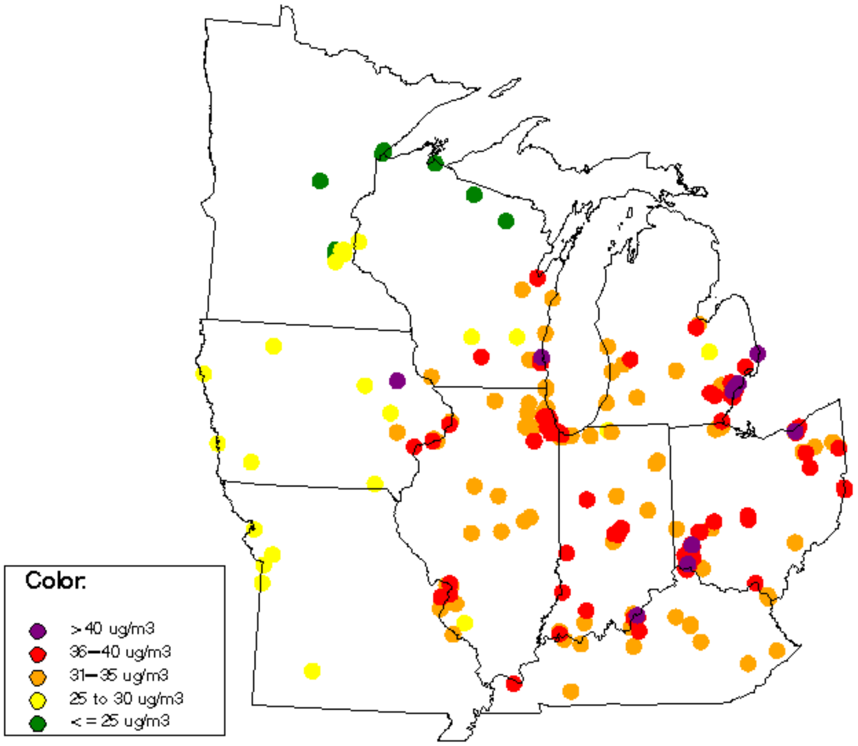

PM2.5 FRM 98th Percentile Concentration, 2005—2007

Figure 16. PM$_{2.5}$ design values - annual average (top) and 24-hour average (bottom) (2005-2007)

Table 2. PM2.5 Data for Select Sites in 5-State Region

			Annual Average Conc.						Design Values				2005 BY	2002 BY
Key Site	County	Site ID	'03	'04	'05	'06	'07		'03 - '05	'04 - '06	'05 - '07		Average w/ 2007	Average
Chicago - Washington HS	Cook	170310022	15.6	14.2	16.9	13.2	15.7		15.6	14.8	15.3		**15.2**	**15.9**
Chicago - Mayfair	Cook	170310052	15.9	15.3	17.0	14.5	15.5		16.1	15.6	15.7		**15.8**	**17.1**
Chicago - Springfield	Cook	170310057	15.6	13.8	16.7	13.5	15.1		15.4	14.7	15.1		**15.0**	**15.6**
Chicago - Lawndale	Cook	170310076	14.8	14.2	16.6	13.5	14.3		15.2	14.8	14.8		14.9	**15.6**
Blue Island	Cook	170312001	14.9	14.1	16.4	13.2	14.3		15.1	14.6	14.6		14.8	**15.6**
Summit	Cook	170313301	15.6	14.2	16.9	13.8	14.8		15.6	15.0	15.2		**15.2**	**16.0**
Cicero	Cook	170316005	16.8	15.2	16.3	14.3	14.8		16.1	15.3	15.1		**15.5**	**16.4**
Granite City	Madison	171191007	17.5	15.4	18.2	16.3	15.1		17.0	16.6	16.5		**16.7**	**17.3**
E. St. Louis	St. Clair	171630010	14.9	14.7	17.1	14.5	15.6		15.6	15.4	15.7		**15.6**	**16.2**
Jeffersonville	Clark	180190005	15.8	15.1	18.5	15.0	16.5		16.5	16.2	16.7		**16.4**	**17.2**
Jasper	Dubois	180372001	15.7	14.4	16.9	13.5	14.4		15.7	14.9	14.9		**15.2**	**15.5**
Gary	Lake	180890031			16.8	13.3	14.5		16.8	15.1	14.9		**15.6**	
Indy - Washington Park	Marion	180970078	15.5	14.3	16.4	14.1	15.8		15.4	14.9	15.4		**15.3**	**16.2**
Indy - W 18th Street	Marion	180970081	16.2	15.0	17.9	14.2	16.1		16.4	15.7	16.1		**16.0**	
Indy - Michigan Street	Marion	180970083	16.3	15.0	17.5	14.1	15.9		16.3	15.5	15.8		**15.9**	**16.6**
Allen Park	Wayne	261630001	15.2	14.2	15.9	13.2	12.8		15.1	14.4	14.0		14.5	**15.8**
Southwest HS	Wayne	261630015	16.6	15.4	17.2	14.7	14.5		16.4	15.8	15.5		**15.9**	**17.3**
Linwood	Wayne	261630016	15.8	13.7	16.0	13.0	13.9		15.2	14.2	14.3		14.6	**15.5**
Dearborn	Wayne	261630033	19.2	16.8	18.6	16.1	16.9		18.2	17.2	17.2		**17.5**	**19.3**
Wyandotte	Wayne	261630036	16.3	13.7	16.4	12.9	13.4		15.5	14.3	14.2		14.7	**16.6**
Middleton	Butler	390170003	17.2	14.1	19.0	14.1	15.4		16.8	15.7	16.2		**16.2**	**16.5**
Fairfield	Butler	390170016	15.8	14.7	17.9	14.0	14.9		16.1	15.5	15.6		**15.8**	**15.9**
Cleveland-28th Street	Cuyahoga	390350027	15.4	15.6	17.3	13.0	14.5		16.1	15.3	14.9		**15.4**	**16.5**
Cleveland-St. Tikhon	Cuyahoga	390350038	17.6	17.5	19.2	14.9	16.2		18.1	17.2	16.8		**17.4**	**18.4**
Cleveland-Broadway	Cuyahoga	390350045	16.4	15.3	19.3	14.0	15.3		17.0	16.2	16.2		**16.5**	**16.7**
Cleveland-E14 & Orange	Cuyahoga	390350060	17.2	16.4	19.4	15.0	15.9		17.7	16.9	16.8		**17.1**	**17.6**
Newburg Hts - Harvard Ave	Cuyahoga	390350065	15.6	15.2	18.6	13.1	15.8		16.5	15.6	15.8		**16.0**	**16.2**
Columbus - Fairgrounds	Franklin	390490024	16.4	15.0	16.4	13.6	14.6		15.9	15.0	14.9		**15.3**	**16.5**
Columbus - Ann Street	Franklin	390490025	15.3	14.6	16.4	13.6	14.7		15.4	14.9	14.9		**15.1**	**16.0**
Columbus - Maple Canyon	Franklin	390490081	14.9	13.6	14.6	12.9	13.1		14.4	13.7	13.5		13.9	**16.0**
Cincinnati - Seymour	Hamilton	390610014	17.0	15.9	19.8	15.5	16.5		17.6	17.1	17.3		**17.3**	**17.7**
Cincinnati - Taft Ave	Hamilton	390610040	15.5	14.6	17.5	13.6	15.1		15.9	15.2	15.4		**15.5**	**15.7**
Cincinnati - 8th Ave	Hamilton	390610042	16.7	16.0	19.1	14.9	15.9		17.3	16.7	16.6		**16.9**	**17.3**
Sharonville	Hamilton	390610043	15.7	14.9	16.9	14.5	14.8		15.8	15.4	15.4		**15.6**	**16.0**
Norwood	Hamilton	390617001	16.0	15.3	18.4	14.4	15.1		16.6	16.0	15.9		**16.2**	**16.3**
St. Bernard	Hamilton	390618001	17.3	16.4	20.0	15.9	16.1		17.9	17.4	17.3		**17.6**	**17.3**
Steubenville	Jefferson	390810016	17.7	15.9	16.4	13.8	16.2		16.7	15.4	15.5		**15.8**	**17.7**
Mingo Junction	Jefferson	390811001	17.3	16.2	18.1	14.6	15.6		17.2	16.3	16.1		**16.5**	**17.5**
Ironton	Lawrence	390870010	14.3	13.7	17.0	14.4	15.0		15.0	15.0	15.4		**15.2**	**15.7**
Dayton	Montgomery	391130032	15.9	14.5	17.4	13.6	15.6		15.9	15.2	15.5		**15.5**	**15.9**
New Boston	Scioto	391450013	14.7	13.0	16.2	14.3	14.0		14.6	14.5	14.8		14.7	**17.1**
Canton - Dueber	Stark	391510017	16.8	15.6	17.8	14.6	15.9		16.7	16.0	16.1		**16.3**	**17.3**
Canton - Market	Stark	391510020	15.0	14.1	16.6	11.9	14.4		15.2	14.2	14.3		14.6	**15.7**
Akron - Brittain	Summit	391530017	15.4	15.0	16.4	13.5	14.4		15.6	15.0	14.8		**15.1**	**16.4**
Akron - W. Exchange	Summit	391530023	14.2	13.9	15.7	12.8	13.7		14.6	14.1	14.1		14.3	**15.6**

When EPA initially set the 24-hour standard at 65 µg/m^3, it also adopted the following concentration ranges for its Air Quality Index (AQI) scale:

Good	< 15 ug/m^3
Moderate	15-40 µg/m^3
Unhealthy for Sensitive Groups (USG)	40-65 µg/m^3
Unhealthy	65-150 µg/m^3

Figure 17 shows the frequency of these AQI categories for major metropolitan areas in the region. Daily average concentrations are often in the moderate range and occasionally in the USG range. Moderate and USG levels can occur any time of the year.

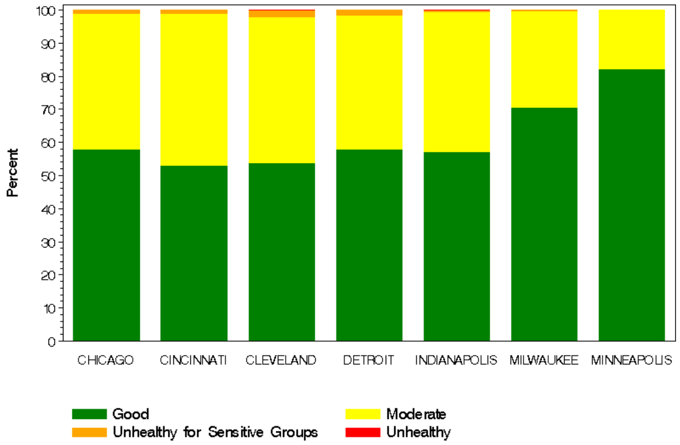


Figure 17. Percent of days in AQI categories for $PM_{2.5}$ (2002-2004)

Data Variability: $PM_{2.5}$ concentrations vary spatially, temporally, and chemically in the region. This variability is discussed further below.

On an annual basis, $PM_{2.5}$ exhibits a distinct and consistent spatial pattern. As seen in Figure 16, across the Midwest, annual concentrations follow a gradient from low values (5-6 µg/m^3) in northern and western areas (Minnesota and northern Wisconsin) to high values (17-18 µg/m^3) in Ohio and along the Ohio River. In addition, concentrations in urban areas are higher than in upwind rural areas, indicating that local urban sources add a significant increment of 2-3 µg/m^3 to the regional background of 12 - 14 µg/m^3 (see Figure 18).

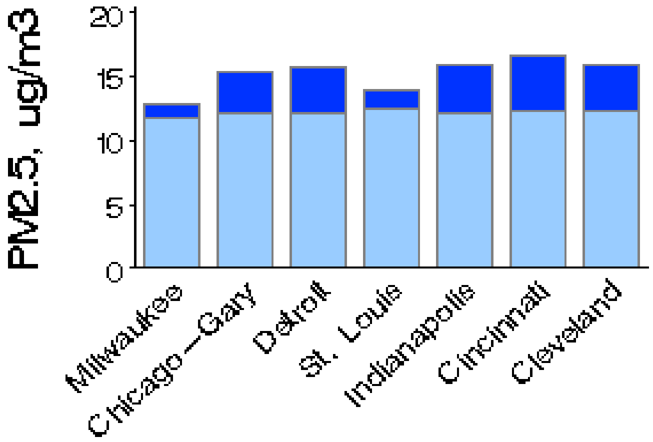


Figure 18. Regional (lighter shading) v. local components (darker shading) of annual average $PM_{2.5}$ concentrations

Because monitoring for $PM_{2.5}$ only began in earnest in 1999, after promulgation of the $PM_{2.5}$ standard, limited data are available to assess trends. Time series based on federal reference method (FRM) $PM_{2.5}$-mass data show a downward trend in each state (see Figure 19)[7].

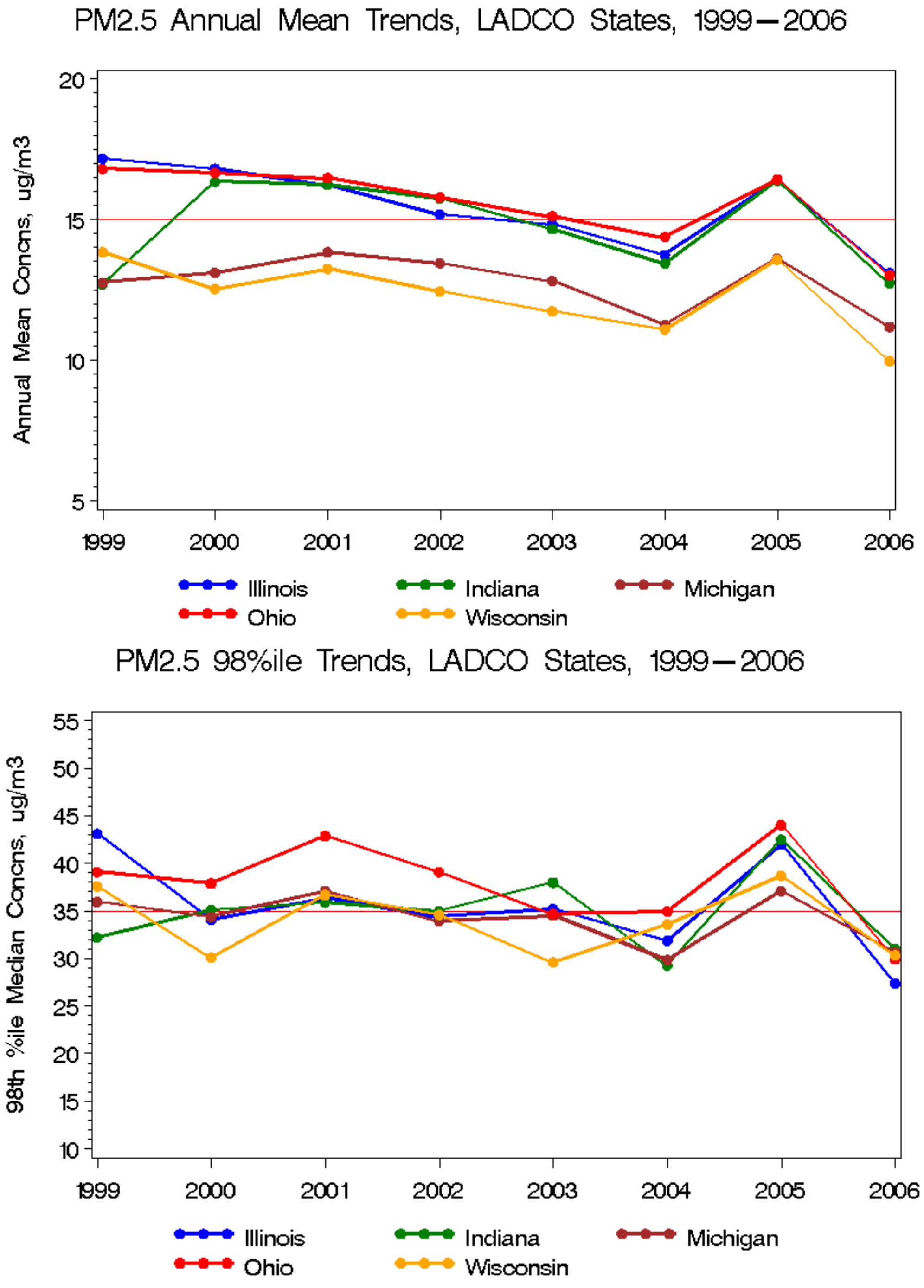


Figure 19. $PM_{2.5}$ trends in annual average (top) and daily concentrations (bottom)

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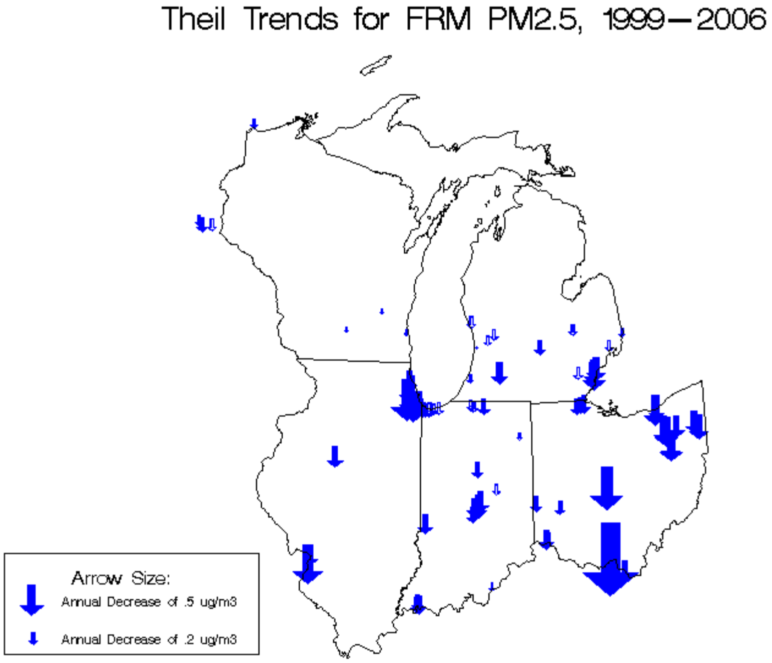
[7] Despite the general downward trend since 1999, all states experienced an increase during 2005. Further analyses are underway to understand this increase (e.g., examination of meteorological and emissions effects).

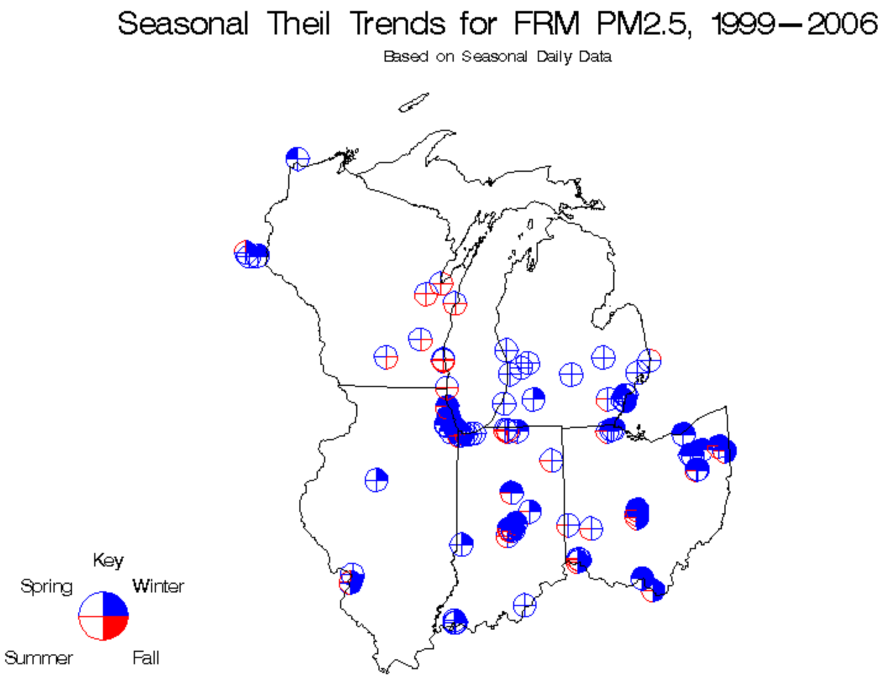
A statistical analysis of $PM_{2.5}$ trends was performed using the nonparametric Theil test for slope (Hollander and Wolfe, 1973). Trends were generally consistent around the region, for both PM mass and for the individual components of mass. Figure 20 shows trends for $PM_{2.5}$ based on FRM data at sites with six or more years of data since 1999. The size and direction of each arrow shows the size and direction of the trend for each site; solid arrows show statistically significant trends and open arrows show trends that are not significant. Region-wide decreases are widespread and consistent; all sites had decreasing concentration trends (13 of the 38 were statistically significant). The average decrease for this set of sites is -0.24 ug/m^3/year.



Solid arrows show statistically significant trends, empty arrows show trends that are not statistically significant.
Size of arrow is proportional to magnitude of trend

Figure 20. Annual trends in $PM_{2.5}$ mass (1999 – 2006)

Seasonal trends show mostly similar patterns (Figure 21). Trends were downward at most sites and seasons, with overall seasonal averages varying between -0.15 to -0.56 ug/m^3/year. The strongest and most significant decreases took place during the winter quarter (January - March). No statistically significant increasing trends were observed.



Solid quarters show statistically significant trends, empty quarters show trends that are not statistically significant.
Blue quarters show decreasing concentrations, red shows increasing concentrations

Figure 21. Seasonal trends in $PM_{2.5}$ mass (1999 – 2006)

$PM_{2.5}$ shows a slight variation from weekday to weekend, as seen in Figure 22. Although most cities have slightly lower concentrations on the weekend, the difference is usually less than 1 µg/m^3. There is a more pronounced weekday/weekend difference at monitoring sites that are strongly source-influenced. Rural monitors tend to show less of a weekday/weekend pattern than urban monitors.

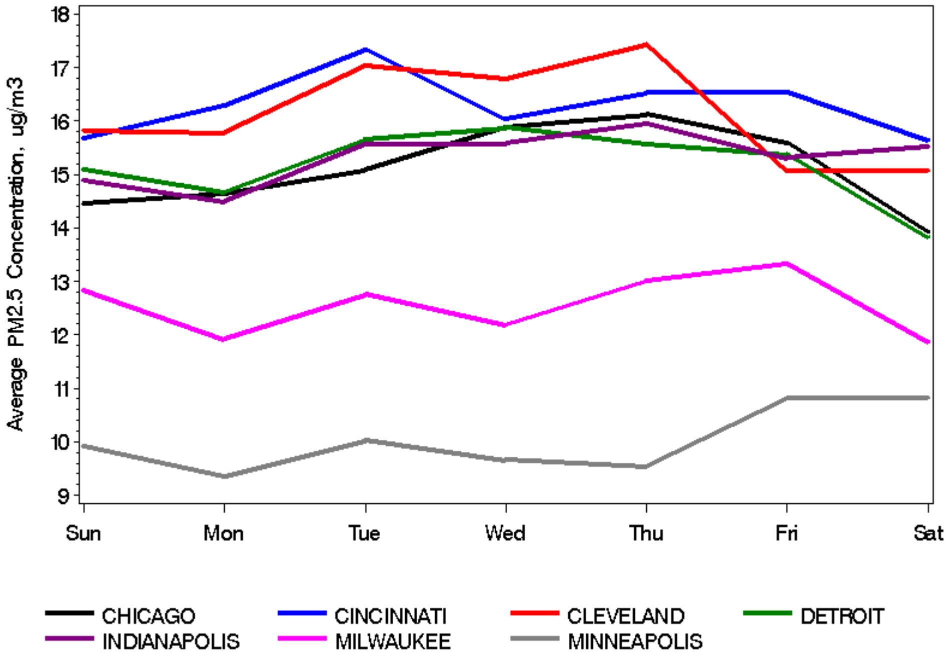


Figure 22 Day-of-week variability in $PM_{2.5}$ (2002-2004)

In the Midwest, $PM_{2.5}$ is made up of mostly ammonium sulfate, ammonium nitrate, and organic carbon in approximately equal proportions on an annual average basis. Elemental carbon and crustal matter (also referred to as soil) contribute less than 5% each.

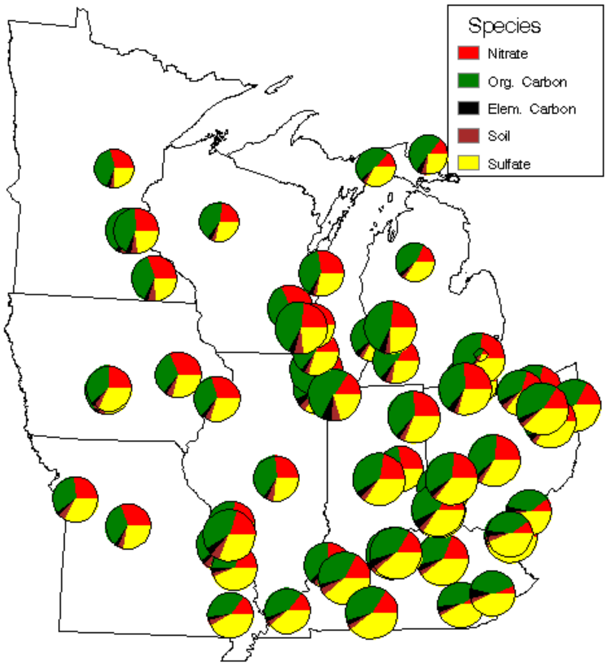


Figure 23. Spatial map of $PM_{2.5}$ chemical composition in the Midwest (2002-2003)

The three major components vary spatially (Figure 23), including notable urban and rural differences (Figure 24). The components also vary seasonally (Figure 25). These patterns account for much of the annual variability in $PM_{2.5}$ mass noted above.

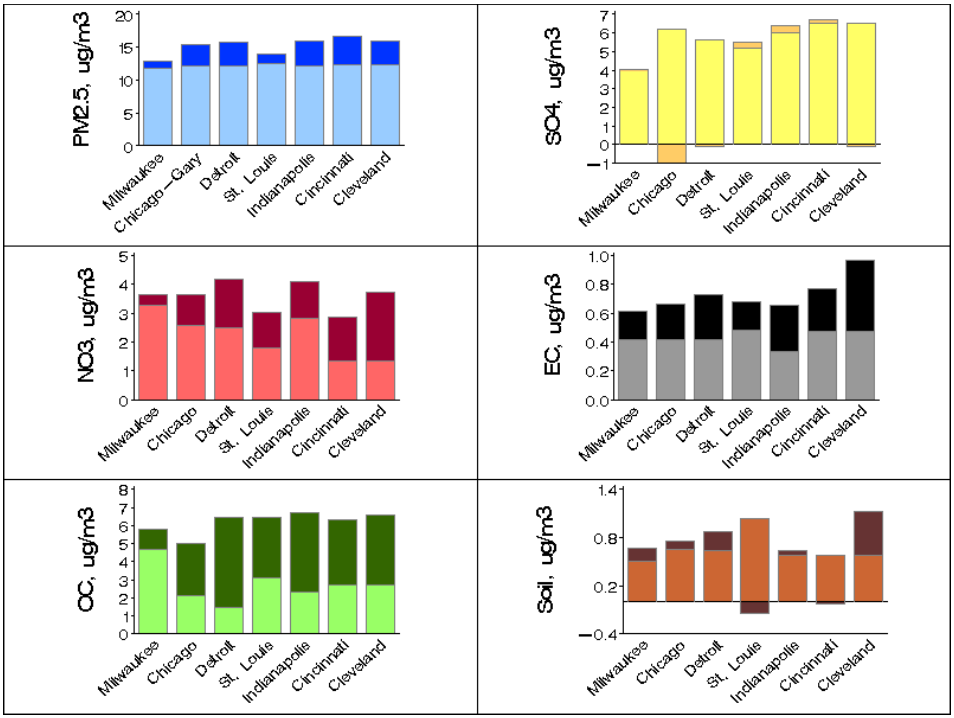


Figure 24. Average regional (lighter shading) v. local (darker shading) of $PM_{2.5}$ chemical species

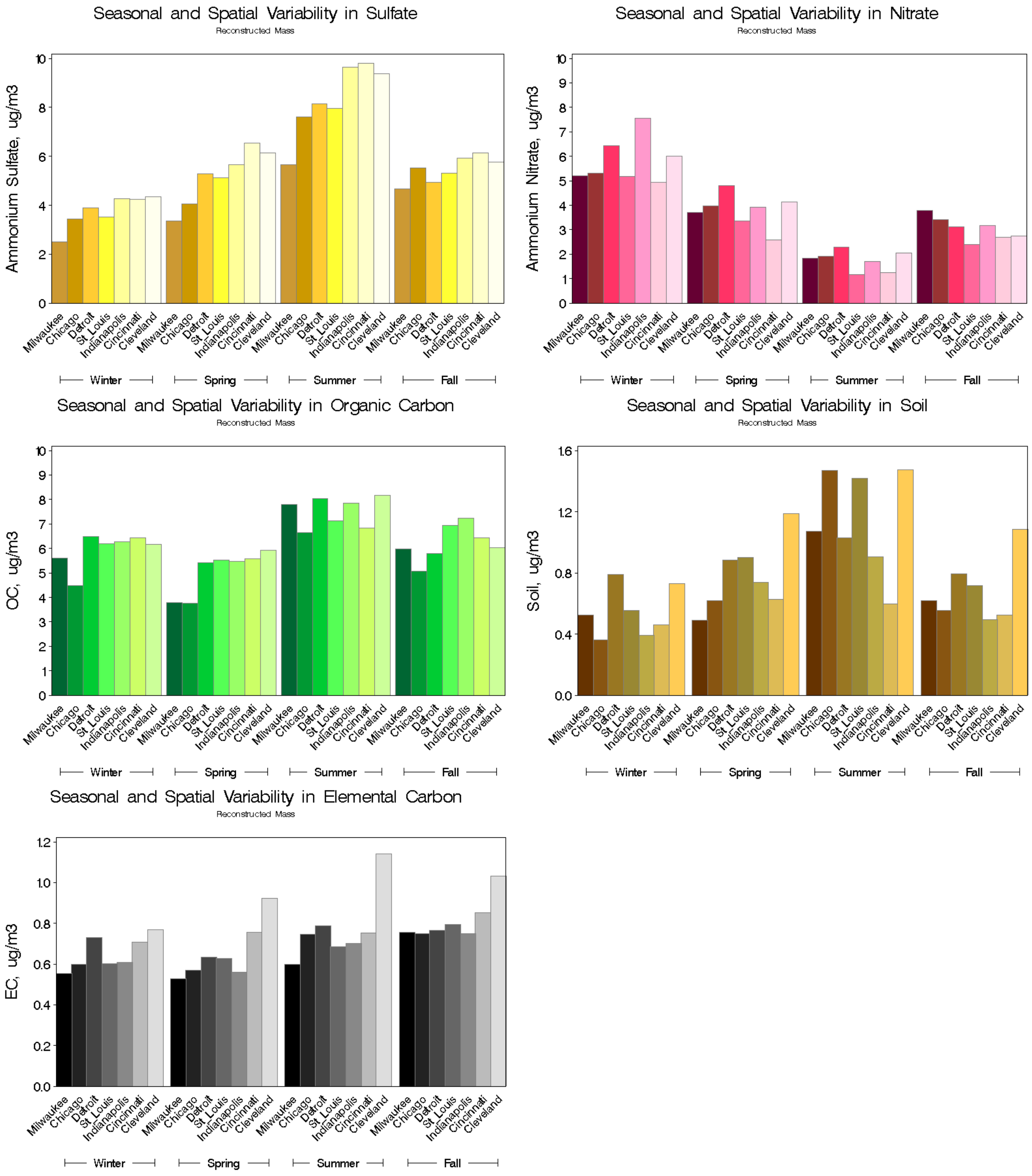


Figure 25 Seasonal and spatial variability in $PM_{2.5}$ components

Ammonium sulfate peaks in the summer and is highest in the southern and eastern parts of the Midwest, closest to the Ohio River Valley. Sulfate is primarily a regional pollutant; concentrations are similar in rural and urban areas and highly correlated over large distances. It is formed when sulfuric acid (an oxidation product of sulfur dioxide) and ammonia react in the atmosphere, especially in cloud droplets. Coal combustion is the primary source of sulfur dioxide; ammonia is emitted primarily from animal husbandry operations and fertilizer use.

Ammonium nitrate has almost the opposite spatial and seasonal pattern, with the highest concentrations occurring in the winter and in the northern parts of the region. Nitrate seems to have both regional and local sources, because urban concentrations are higher than rural upwind concentrations. Ammonium nitrate forms when nitric acid reacts with ammonia, a process that is enhanced when temperatures are low and humidity is high. Nitric acid is a product of the oxidation of nitric oxide, a pollutant that is emitted by combustion processes.

Organic carbon is more consistent from season to season and city to city, although concentrations are generally slightly higher in the summer. Like nitrate, organic carbon has both regional and local components. Particulate organic carbon can be emitted directly from cars and other fuel combustion sources or formed in a secondary process as volatile organic gases react and condense. In rural areas, summer organic carbon has significant contributions from biogenic sources.

Precursor Sensitivity: Data from the Midwest ammonia monitoring network were analyzed with thermodynamic equilibrium models to assess the effect of changes in precursor gas concentrations on $PM_{2.5}$ concentrations (Blanchard, 2005b). These analyses indicate that particle formation responds in varying degrees to reductions in sulfate, nitric acid, and ammonia. Based on Figure 26, which shows $PM_{2.5}$ concentrations as a function of sulfate, nitric acid (HNO3), and ammonia (NH3), several key findings should be noted:

- $PM_{2.5}$ mass is sensitive to reductions in sulfate at all times of the year and all parts of the region. Even though sulfate reductions cause more ammonia to be available to form ammonium nitrate (PM-nitrate increases slightly when sulfate is reduced), this increase is generally offset by the sulfate reductions, such that $PM_{2.5}$ mass decreases.

- $PM_{2.5}$ mass is also sensitive to reductions in nitric acid and ammonia. The greatest $PM_{2.5}$ decrease in response to nitric acid reductions occurs during the winter, when nitrate is a significant fraction of $PM_{2.5}$.

- Under conditions with lower sulfate levels (i.e., proxy of future year conditions), $PM_{2.5}$ is more sensitive to reductions in nitric acid compared to reductions in ammonia.

- Ammonia becomes more limiting as one moves from west to east across the region.

Examination of weekend/weekday difference in PM-nitrate and NOx concentrations in the Midwest demonstrate that reductions in local (urban) NOx lead to reductions, albeit non-proportional reductions, in PM-nitrate (Blanchard, 2004). This result is consistent with analyses of continuous PM-nitrate from several US cities, including St. Louis (Millstein, et al, 2007).

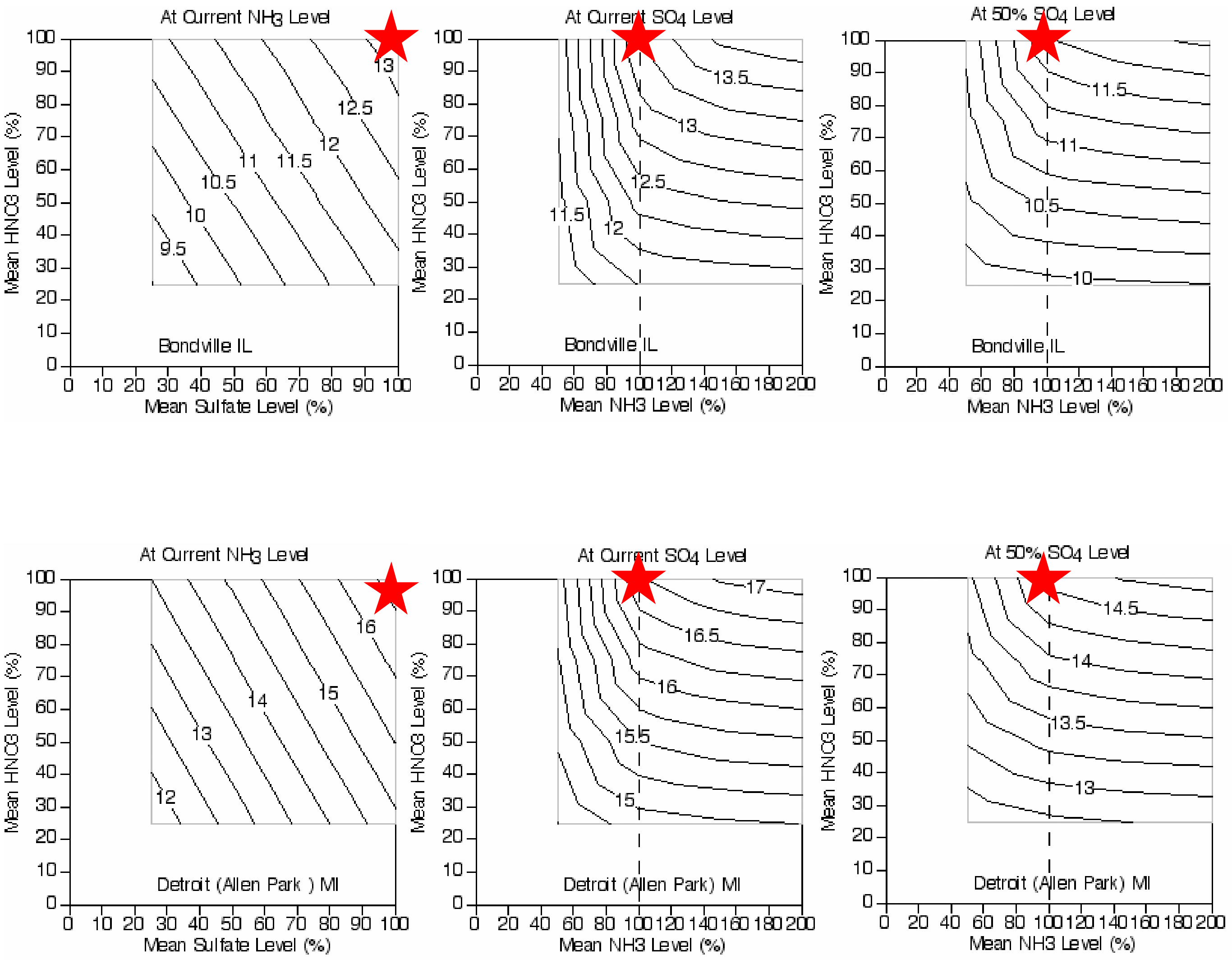


Figure 26. Predicted mean PM fine mass concentrations at Bondville, IL (top) and Detroit (Allen Park), MI (bottom) as functions of changes in sulfate, nitric acid (HNO3), and ammonia (NH3)

Note: starting at the baseline values (represented by the red star), either moving downward (reductions in nitric acid) or moving leftward (reductions in sulfate or ammonia) results in lower $PM_{2.5}$ values

Meteorology: $PM_{2.5}$ concentrations are not as strongly influenced by meteorology as ozone, but the two pollutants share some similar meteorological dependencies. In the summer, conditions that are conducive to ozone (hot temperatures, stagnant air masses, and low wind speeds due to stationary high pressure systems) also frequently give rise to high $PM_{2.5}$. In the case of PM, the reason is two-fold: (1) stagnation and limited mixing under these conditions cause $PM_{2.5}$ to build up, usually over several days, and (2) these conditions generally promote higher conversion of important precursors (SO_2 to SO_4) and higher emissions of some precursors, especially biogenic carbon. Wind direction is another strong determinant of $PM_{2.5}$; air transported from polluted source regions has higher concentrations.

Unlike ozone, $PM_{2.5}$ has occasional winter episodes. Conditions are similar to those for summer episodes, in that stationary high pressure and (seasonally) warm temperatures are usually factors. Winter episodes are also fueled by high humidity and low mixing heights.

$PM_{2.5}$ chemical species show noticeable transport influences. Trajectory analyses have demonstrated that high PM-sulfate is associated with air masses that traveled through the sulfate-rich Ohio River Valley (Poirot, et al, 2002 and Kenski, 2004). Likewise, high PM-nitrate is associated with air masses that traveled through the ammonia-rich Midwest. Figure 27 shows results from an ensemble trajectory analysis of 17 rural eastern IMPROVE sites.

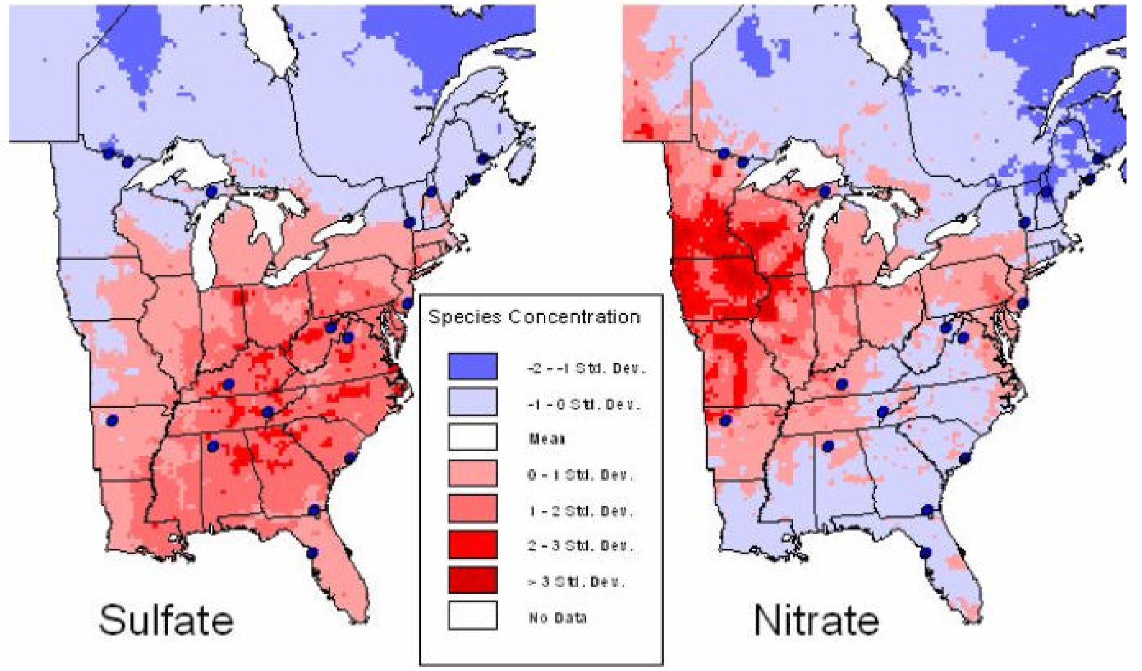


Figure 27. Sulfate and nitrate source regions based on ensemble trajectory analysis

When these results are considered together with analyses of precursor sensitivity (e.g., Figure 26), one possible conclusion is that ammonia control in the Midwest could be effective at reducing nitrate concentrations. The thermodynamic equilibrium modeling shows that ammonia reductions would reduce PM concentrations in the Midwest, but that nitric acid reductions are more effective when the probable reductions in future sulfate levels are considered.

Source Culpability: Three source apportionment studies were performed using speciated $PM_{2.5}$ monitoring data and statistical analysis methods (Hopke, 2005, STI, 2006, and STI, 2008). Figure 28 summarizes the source contributions from these studies. The studies show that a large portion of $PM_{2.5}$ mass consists of secondary, regional impacts, which cannot be attributed to individual facilities or sources (e.g., secondary sulfate, secondary nitrate, and secondary organic aerosols). Nevertheless, wind analyses (e.g., Figure 27) provide information on likely source regions. Regional- or national-scale control programs may be the most effective way to deal with these impacts. EPA's CAIR, for example, will provide for substantial reductions in SO2 emissions over the eastern half of the U.S., which will reduce sulfate (and $PM_{2.5}$) concentrations and improve visibility levels.

The studies also show that a smaller, yet significant portion of $PM_{2.5}$ mass is due to emissions from nearby (local) sources. Local (urban) excesses occur in many urban areas for organic and elemental carbon, crustal matter, and, in some cases, sulfate. The statistical analysis methods help to identify local sources and quantify their impact. This information is valuable to states wishing to develop control programs to address local impacts. A combination of national/regional-scale and local-scale emission reductions may be necessary to provide for attainment.

The carbon sources are not easily identified in complex urban environments. LADCO’s Urban Organics Study (STI, 2006) identified four major sources of organic carbon: mobile sources, burning, industrial sources, and secondary organic aerosols. Additional sampling and analysis is underway in Cleveland and Detroit to provide further information on sources of organic carbon.

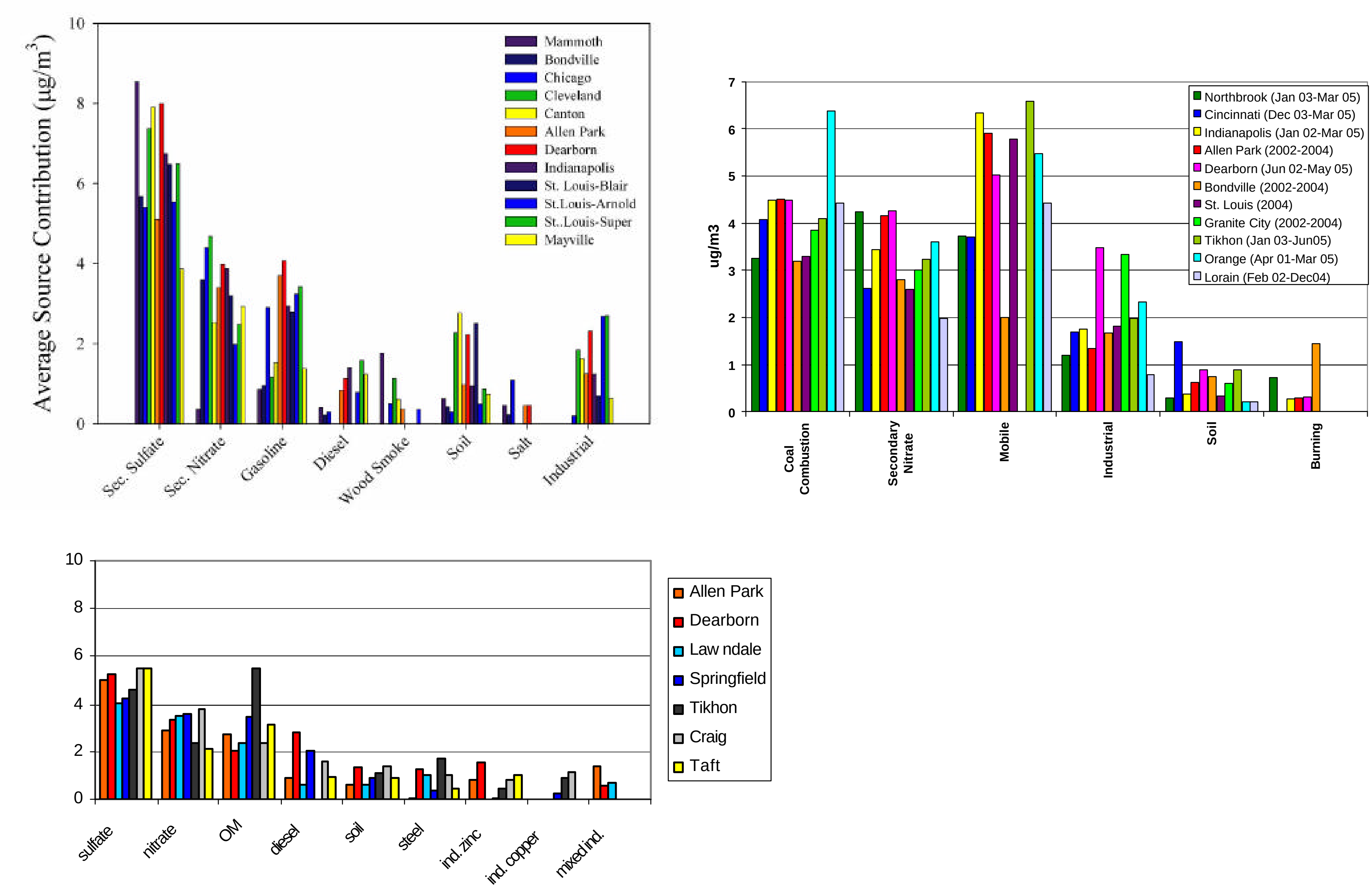


Figure 28. Major Source Contributions in the Midwest based on Hopke, 2005 (upper left), STI, 2006 (upper right), and STI, 2008 (lower left) (Note: the labeling of similar source types varies between studies – e.g., organic carbon/mobile sources are named gasoline and diesel by Hopke, mobile by STI 2006, and OM and diesel by STI 2008)

2.3 Haze

Section 169A of the Clean Air Act sets as a national goal “the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution”. To implement this provision, in 1999, EPA adopted regulations to address regional haze visibility impairment (USEPA, 1999). EPA’s rule requires states to “make reasonable progress toward meeting the national goal”. Specifically, states must establish reasonable progress goals, which provide for improved visibility on the most impaired (20% worst) days sufficient to achieve natural conditions by the year 2064, and for no degradation on the least impaired (20% best) days.

The primary cause of impaired visibility in the Class I areas is pollution by fine particles that scatter light. The degree of impairment, which is expressed in terms of visual range, light extinction (1/Mm), or deciviews (dv), depends not just on the total $PM_{2.5}$ mass concentration, but also on the chemical composition of the particles and meteorological conditions.

Current Conditions: A map of the average light extinction values for the most impaired (20% worst) visibility days for the 5-year baseline period (2000-2004) is shown in Figure 29.

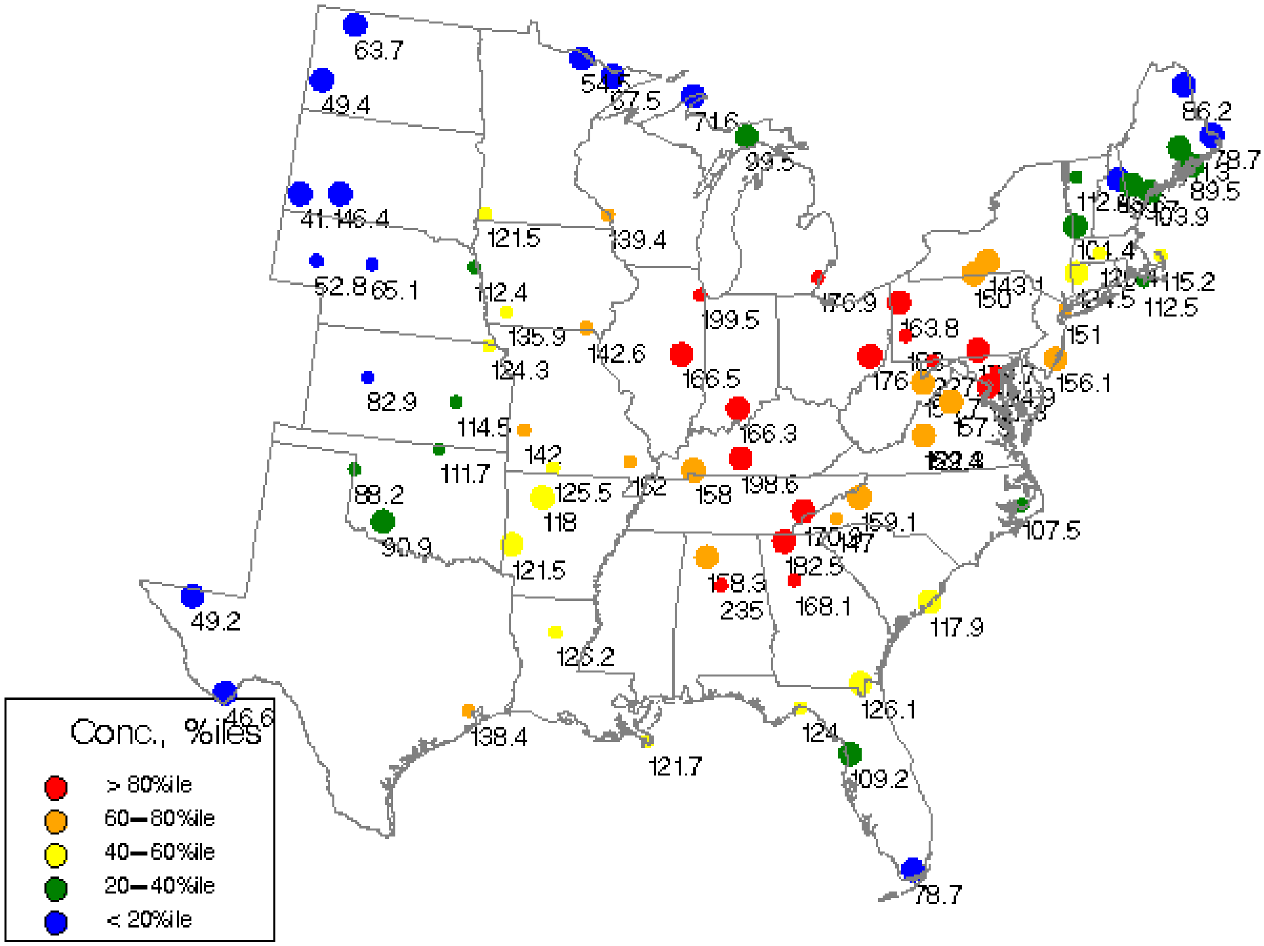


Figure 29. Baseline Visibility Levels for 20% Worst Days (2000 – 2004), units: Mm^{-1}

Initially, the baseline (2000 – 2004) visibility condition values were derived using the average for the 20% worst and 20% best days for each year, as reported on the VIEWS website: http://vista.cira.colostate.edu/views/Web/IMPROVE/SummaryData.aspx . These values were calculated using the original IMPROVE equation for reconstructed light extinction.

Three changes were made to the baseline calculations to produce a new set of values. First, the reconstructed light extinction equation was revised by the IMPROVE Steering Committee in 2005. The new IMPROVE equation was used to calculate updated baseline values.

Second, due to sampler problems, the 2002-2004 data for Boundary Waters were invalid for certain chemical species. (Note, sulfate and nitrate data were valid.) A "substituted" data set was developed by using values from Voyageurs for the invalid species.

Third, LADCO identified a number of days during 2000-2004 where data capture at the Class I monitors was incomplete (Kenski, 2007b). The missing data cause these days to be excluded from the baseline calculations. However, the light extinction due to the remaining measured species is significant (i.e., above the 80th percentile). It makes sense to include these days in the baseline calculations, because they are largely dominated by anthropogenic sources. (Only one of these days is driven by high organic carbon, which might indicate non-anthropogenic aerosol from wildfires.) As seen in Table 3, inclusion of these days in the baseline calculation results in a small, but measurable, effect on the baseline values (i.e., values increase from 0.2 to 0.8 dv).

Table 3. Average of 20% worst days, with and without missing data days

	Average Worst Day DV, per RHR	Average Worst Day DV, with Missing Data Days	Difference
BOWA	19.59	19.86	0.27
ISLE	20.74	21.59	0.85
SENE	24.16	24.38	0.22
VOYA	19.27	19.48	0.21

A summary of the initial and updated baseline values for the Class I areas in northern Michigan and northern Minnesota are presented in Table 4. The updated baseline values reflect the most current, complete understanding of visibility impairing effects and, as such, will be used for SIP planning purposes.

Table 4. Summary of visibility metrics (deciviews) for northern Class I areas

Old IMPROVE Equation (Cite: VIEWS, November 2005)									
		20% Worst Days							
		2000	**2001**	**2002**	**2003**	**2004**	**Baseline Value**	**2018 URI Value**	**Natural Conditions**
Voyageurs		18.50	18.00	19.00	19.20	17.60	18.46	16.74	11.09
BWCA		19.85	19.99	19.68	19.73	17.65	19.38	17.47	11.21
Isle Royale		20.00	22.00	20.80	19.50	19.10	20.28	18.17	11.22
Seney		22.60	24.90	24.00	23.80	22.60	23.58	20.73	11.37
		20% Best Days							
		2000	**2001**	**2002**	**2003**	**2004**	**Baseline Value**		**Natural Conditions**
Voyageurs		6.30	6.20	6.70	7.00	5.40	6.32		3.41
BWCA		5.90	6.52	6.93	6.67	5.61	6.33		3.53
Isle Royale		5.70	6.40	6.40	6.30	5.30	6.02		3.54
Seney		5.80	6.10	7.30	7.50	5.80	6.50		3.69
New IMPROVE Equation (Cite: VIEWS, March 2006)									
		20% Worst Days							
		2000	**2001**	**2002**	**2003**	**2004**	**Baseline Value**	**2018 URI Value**	**Natural Conditions**
Voyageurs		19.55	18.57	20.14	20.25	18.87	19.48	17.74	12.05
BWCA		20.20	20.04	20.76	20.13	18.18	19.86	17.94	11.61
Isle Royale		20.53	23.07	21.97	22.35	20.02	21.59	19.43	12.36
Seney		22.94	25.91	25.38	24.48	23.15	24.37	21.64	12.65
		20% Best Days							
		2000	**2001**	**2002**	**2003**	**2004**	**Baseline Value**		**Natural Conditions**
Voyageurs		7.01	7.12	7.53	7.68	6.37	7.14		4.26
BWCA		6.00	6.92	7.00	6.45	5.77	6.43		3.42
Isle Royale		6.49	7.16	7.07	6.99	6.12	6.77		3.72
Seney		6.50	6.78	7.82	8.01	6.58	7.14		3.73

Notes: (1) BWCA values for 2002 - 2004 reflect "substituted" data.
(2) New IMPROVE equation values include Kenski, 2007 adjustment for missing days

URI = uniform rate of improvement

As noted above, the goal of the visibility program is to achieve natural conditions. Initially, the natural conditions values for each Class I area were taken directly from EPA guidance (EPA, 2003). These values were calculated using the original IMPROVE equation. This equation was revised by the IMPROVE Steering Committee in 2005, and the new IMPROVE equation was used to calculate updated natural conditions values. The updated values are reported on the VIEWS website.

A summary of the initial and updated natural conditions values are presented in Table 4. The updated natural conditions values (based on the new IMPROVE equation) will be used for SIP planning purposes.

Data Variability: For the four northern Class I areas, the most important $PM_{2.5}$ chemical species are ammonium sulfate, ammonium nitrate, and organic carbon. The contribution of these species on the 20% best and 20% worst visibility days (based on 2000 – 2004 data) is provided in Figure 30. For the 20% worst visibility days, the contributions are: sulfate = 35-55%, nitrate = 25-30%, and organic carbon = 12-22%. Although the chemical composition is similar, sulfate increases in importance from west to east and concentrations are highest at Seney (the easternmost site). It should also be noted that sulfate and nitrate contribute more to light extinction than to $PM_{2.5}$ mass because of their hygroscopic properties.

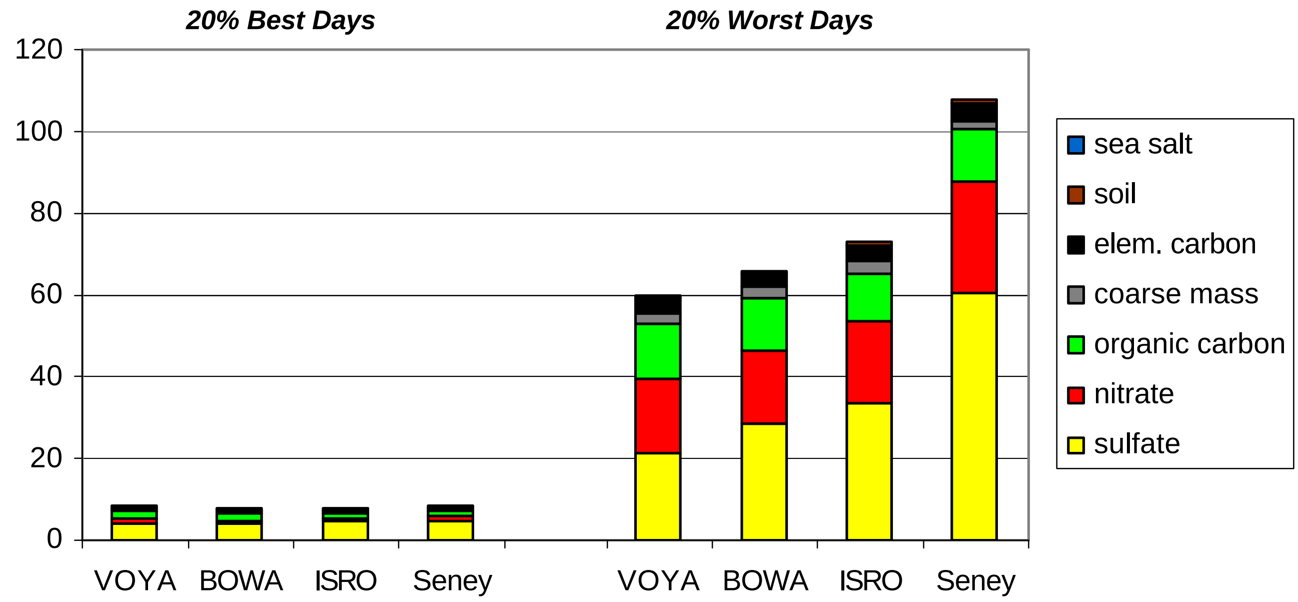


Figure 30. Chemical composition of light extinction for 20% best visibility days (left) and 20% worst visibility days (right) in terms of Mm^{-1}

Analysis of $PM_{2.5}$ mass and chemical species for rural IMPROVE (and IMPROVE-protocol) sites in the eastern U.S. showed a high degree of correlation between $PM_{2.5}$-mass, sulfate, and nitrate levels (see Figure 31). The Class I sites in northern Michigan and northern Minnesota, in particular, are highly correlated for $PM_{2.5}$ mass, sulfates, and organic carbon mass (AER, 2004).

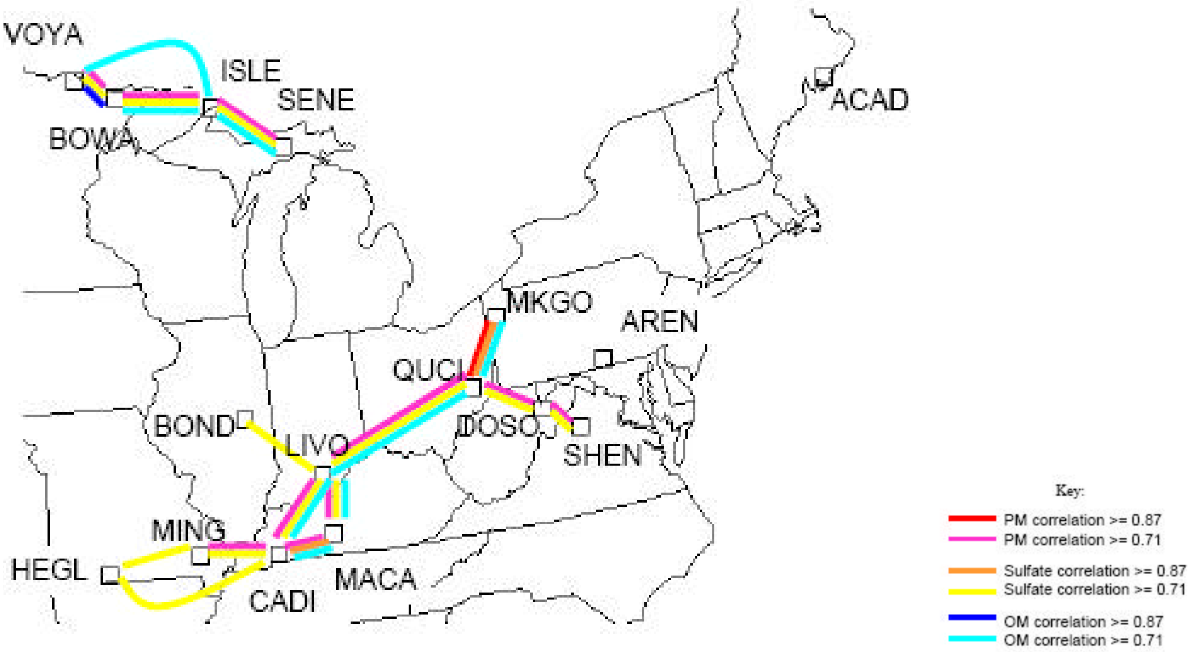


Figure 31. Correlations among IMPROVE (and IMPROVE-protocol) monitoring sites in Eastern U.S.

Long-term trends at Boundary Waters (the only regional site with a sufficient data record) show significant decreases in total $PM_{2.5}$ (-0.005 ug/year) and SO4 (-0.04 ug/year) and an increase in NO3 (+0.01 ug/year). These $PM_{2.5}$ and SO4 trends are generally consistent with long-term trends at other IMPROVE sites in the eastern U.S., which have shown widespread decreases in SO4 and $PM_{2.5}$ (DeBell, et al, 2006). Detecting changes in nitrate has been hampered by uncertainties in the IMPROVE data for particular years and, thus, this estimate should be considered tentative.

Haze in the Midwest Class I areas has no strong seasonal pattern. Poor visibility days occur throughout the year, as indicated in Figure 32. (Note, in contrast, other parts of the country, such as Shenandoah National Park in Virginia, show a strong tendency for the worst air quality days to occur in the summer months.) This figure and Figure 33 (which presents the monthly average light extinction values based on all sampling days) also show that sulfate and organic carbon concentrations are higher in the summer, and nitrate concentrations are higher in the winter, suggesting the importance of different sources and meteorological conditions at different times of the year.

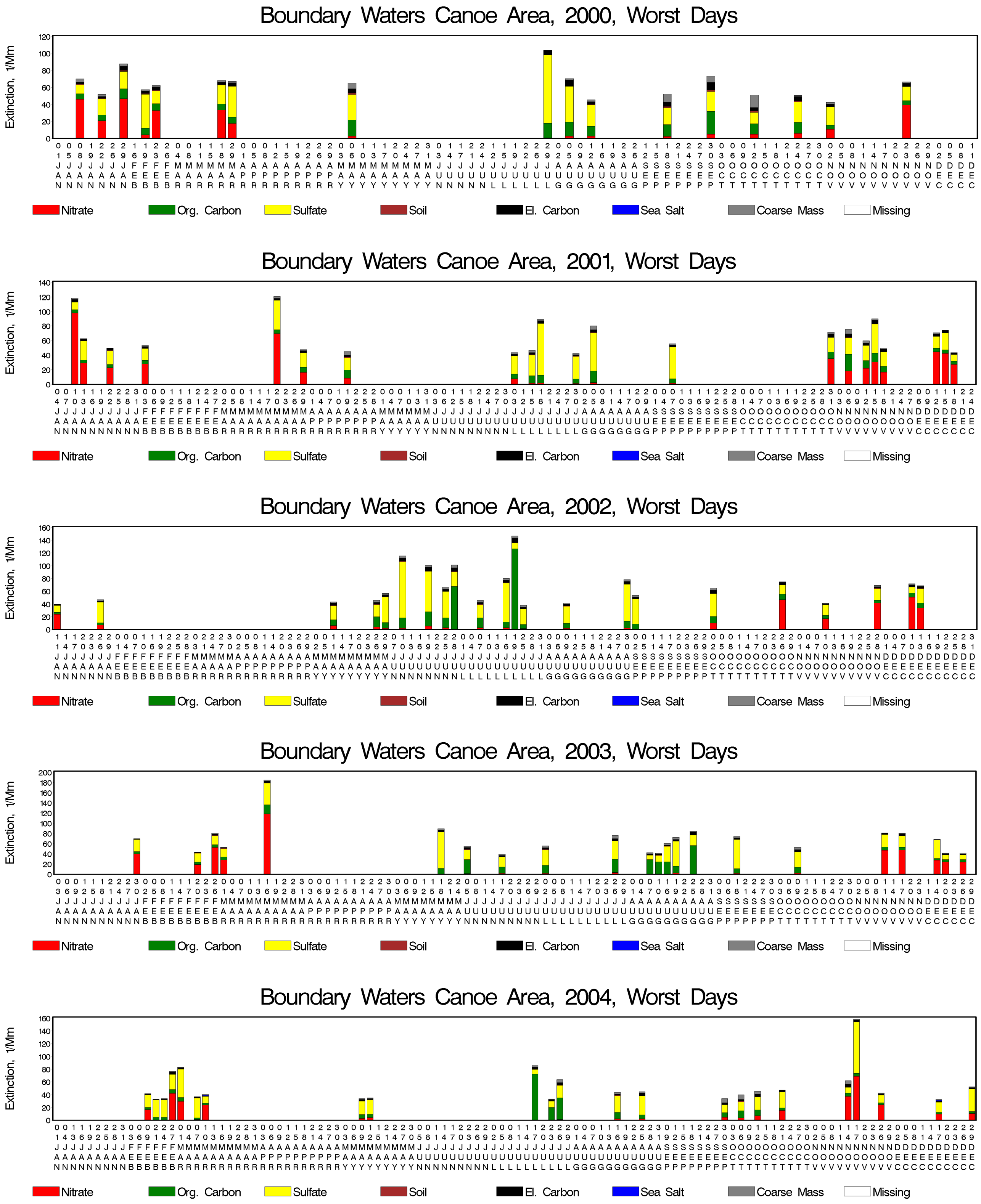
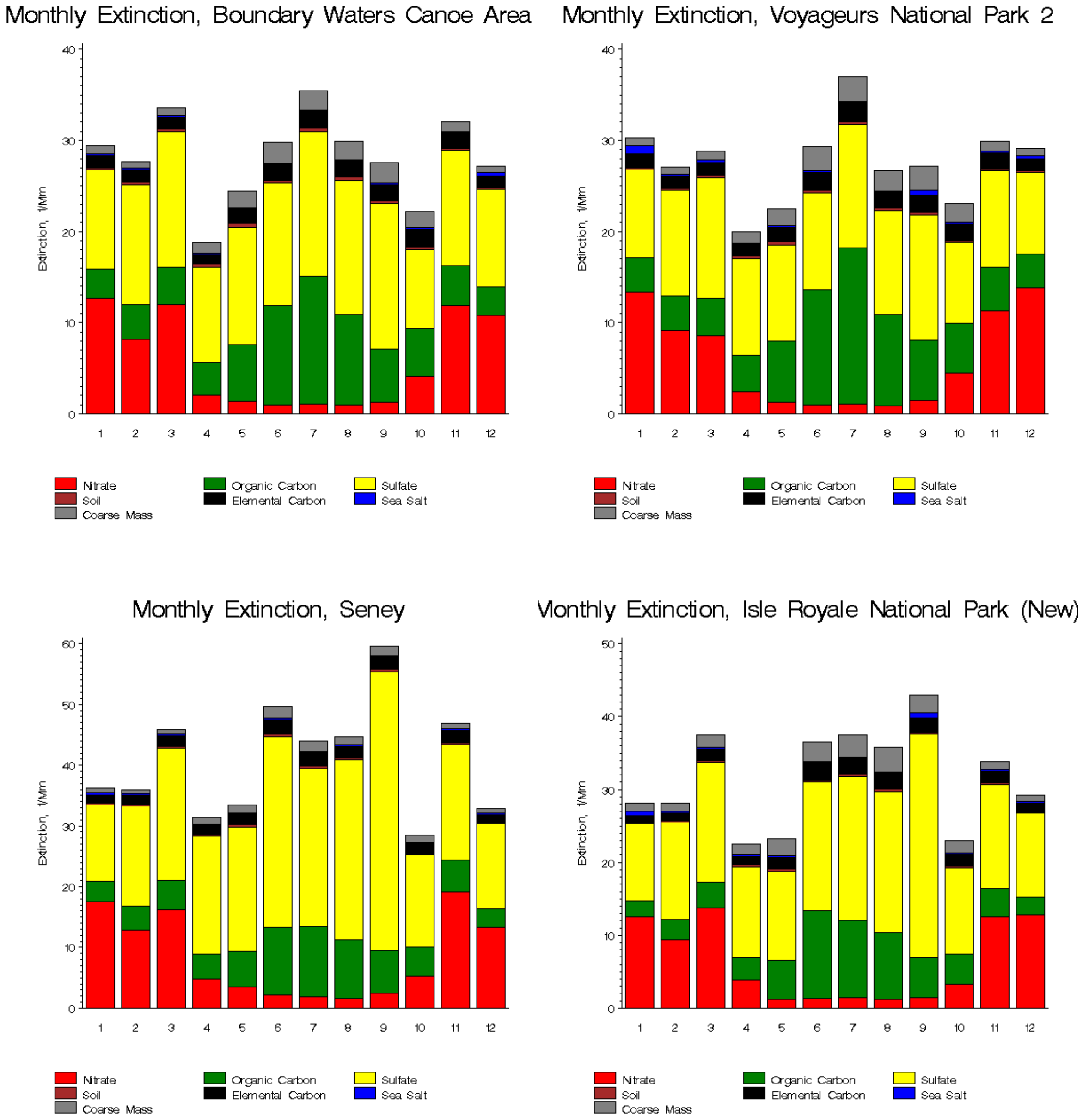


Figure 32. Daily light extinction values for 20% worst days at Boundary Waters (2000 – 2004)


Monthly Extinction, Boundary Waters Canoe Area

Monthly Extinction, Voyageurs National Park 2

Monthly Extinction, Seney

Monthly Extinction, Isle Royale National Park (New)

Figure 33. Monthly average light extinction values for northern Class I areas

Precursor Sensitivity: Results from two analyses using thermodynamic equilibrium models provide information on the effect of changes in precursor concentrations on $PM_{2.5}$ concentrations (and, in turn, visibility levels) in the northern Class I areas. First, a preliminary analysis using data collected at Seney indicated that $PM_{2.5}$ there is most sensitive to reductions in sulfate, but is also sensitive to reductions in nitric acid (Blanchard, 2004).

Second, an analysis was performed using data from the Midwest ammonia monitoring network for a site in Minnesota -- Great River Bluffs, which is the closest ammonia monitoring site to the northern Class I areas (Blanchard, 2005b). Figure 34 shows $PM_{2.5}$ concentrations as a function of sulfate, nitric acid (HNO3), and ammonia (NH3). Reductions in sulfate (i.e., movement to the left of baseline value [represented by the red star]), as well as reductions in nitric acid (i.e., movement downward) and NH3 (i.e., movement to the left), result in lower $PM_{2.5}$ concentrations. Thus, reductions in sulfate, nitric acid, and ammonia will lower $PM_{2.5}$ concentrations and improve visibility in the northern Class I areas.

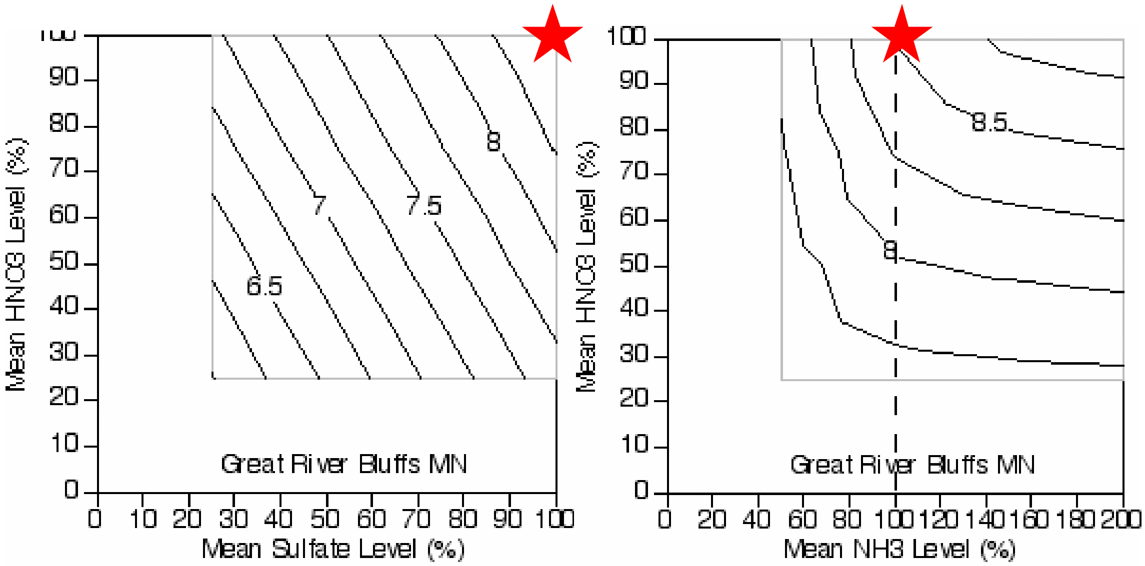


Figure 34. Predicted $PM_{2.5}$ mass concentrations at Great River Bluffs, MN as functions of changes in sulfate, nitric acid, and ammonia

Meteorology and Transport: The role of meteorology in haze is complex. Wind speed and wind direction govern the movement of air masses from polluted areas to the cleaner wilderness areas. As noted above, increasing humidity increases the efficiency with which sulfate and nitrate aerosols scatter light. Temperature and humidity together govern whether ammonium nitrate can form from its precursor gases, nitric acid and ammonia. Temperature and sunlight also play an indirect role in emissions of biogenic organic species that condense to form particulate organic matter; emissions increase in the summer daylight hours.

Trajectory analyses were performed to understand transport patterns for the 20% worst and 20% best visibility days. The composite results for the four northern Class I areas are provided in Figure 35. The orange areas are where the air is most likely to come from, and the green areas are where the air is least likely to come from. As can be seen, bad air days are generally associated with transport from regions located to the south, and good air days with transport from Canada.

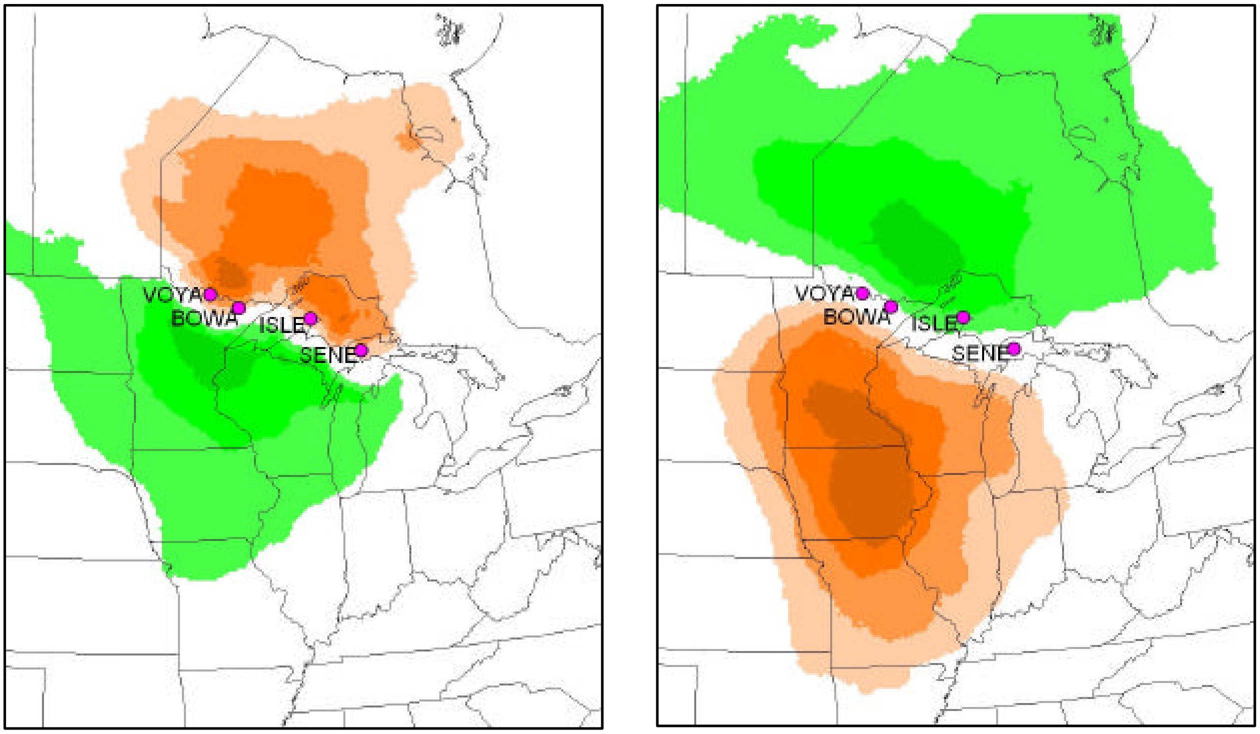
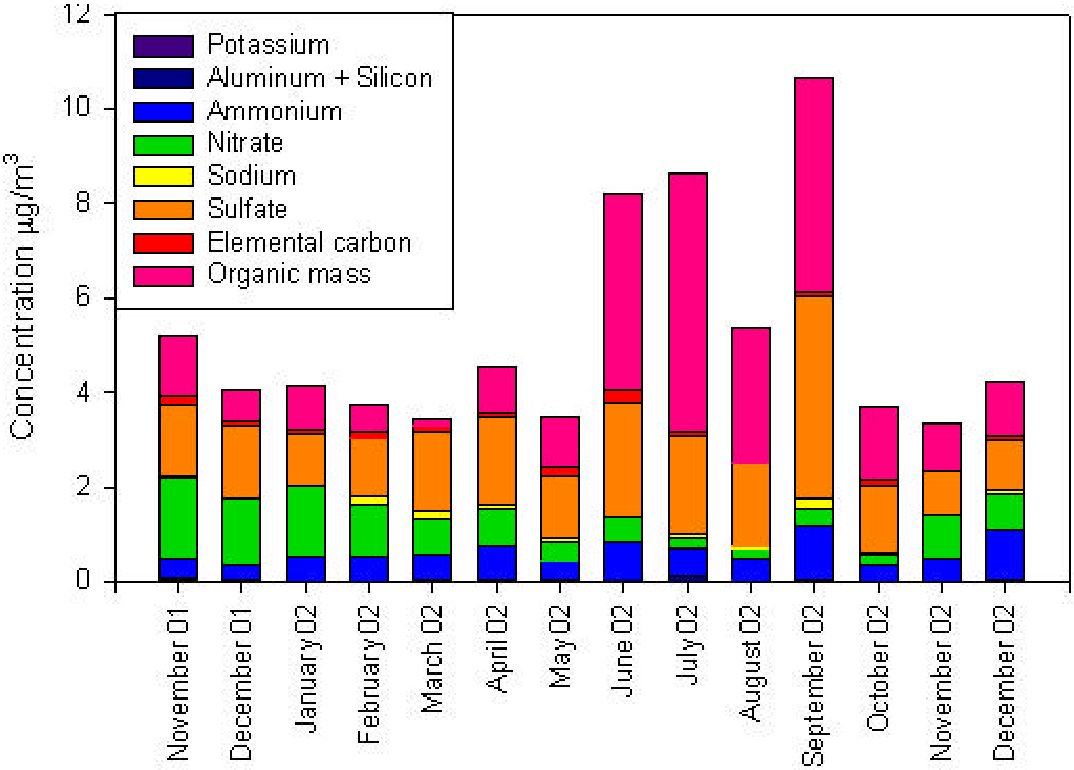


Figure 35. Composite back trajectories for light extinction- 20% best visibility days (left) and 20% worst visibility days (right) (2000 – 2005)

Source Culpability: Air quality data analyses (including the trajectory analyses above) and dispersion modeling were used to provide information on source region and source sector contributions to regional haze in the northern Class I areas (see MRPO, 2008). Based on this information, the most important contributing states are Michigan, Minnesota, and Wisconsin, as well as Missouri, North Dakota, Iowa, Indiana and Illinois (see, for example, Figure 35 above). The most important contributing pollutants and source sectors are SO2 emissions from electrical generating units (EGUs) and certain non-EGUs, which lead to sulfate formation, and NOx emissions from a variety of source types (e.g., motor vehicles), which lead to nitrate formation. Ammonia emissions from livestock waste and fertilizer applications are also important, especially for nitrate formation.

A source apportionment study was performed using monitoring data from Boundary Waters and statistical analysis methods (DRI, 2005). The study shows that a large portion of $PM_{2.5}$ mass consists of secondary, regional impacts, which cannot be attributed to individual facilities or sources (e.g., secondary sulfate, secondary nitrate, and secondary organic aerosols). Industrial sources contribute about 3-4% and mobile sources about 4-7% to $PM_{2.5}$ mass.

A special study was performed in Seney to identify sources of organic carbon (Sheesley, et al, 2004). As seen in Figure 36, the highest $PM_{2.5}$ concentrations occurred during the summer, with organic carbon being the dominant species. The higher summer organic carbon concentrations were attributed mostly to secondary organic aerosols of biogenic origin because of the lack of primary emission markers, and concentrations of know biogenic-related species (e.g., pinonic acid – see Figure 36) were also high during the summer.



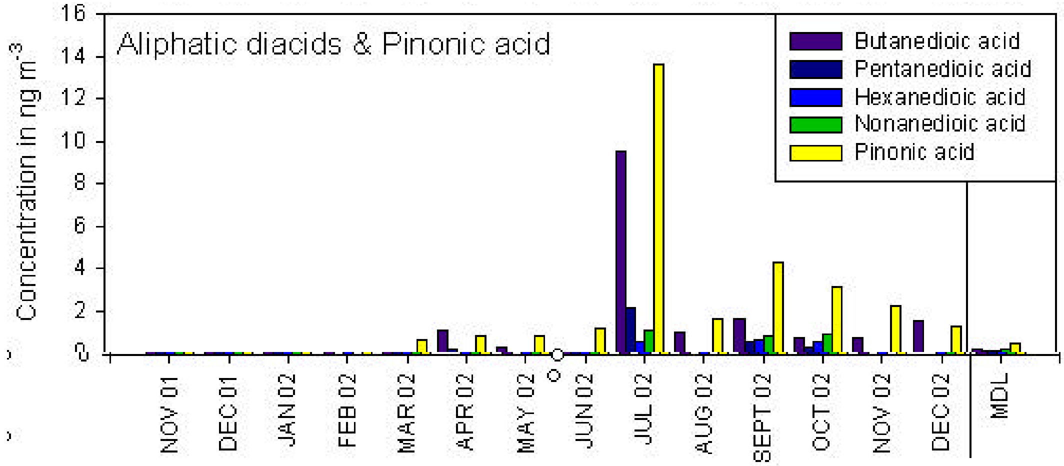


Figure 36. Monthly concentrations of PM$_{2.5}$ species (top), and secondary and biogenic-related organic carbon species in Seney (bottom)

Although the Seney study showed that biomass burning was a relatively small contributor to organic carbon on an annual average basis, episodic impacts are apparent (see, for example, high organic carbon days in Figure 32). To assess further whether burning is a significant contributor to visibility impairment in the northern Class I areas, the $PM_{2.5}$ chemical speciation data were examined for days with high organic carbon and elemental carbon concentrations, which are indicative of biomass burning impacts. Only a handful of such days were identified:

Table 5. Days with high OC and EC concentrations in northern Class I areas

Site	2000	2001	2002	2003	2004
Voyageurs	---	---	Jun 1	Aug 25	Jul 17
			Jun 28		
			Jul 19		
Boundary Waters	---	---	Jun 28	Aug 25	Jul 17
			Jul 19		
Isle Royale	---	---	Jun 1	Aug 25	---
			Jun 28		
Seney	---	---	Jun 28	---	---

Back trajectories on these days point mostly to wildfires in Canada. Elimination of these high organic carbon concentration days has a small effect in lowering the baseline visibility levels in the northern Class I areas (i.e., Minnesota Class I areas change by about 0.3 deciviews and Michigan Class I areas change by less than 0.2 deciviews). This suggests that fire activity, although significant on a few days, is on average a relatively small contributor to visibility impairment in the northern Class I areas.

In summary, these analyses show that organic carbon in the northern Class I is largely uncontrollable.

Section 3.0 Air Quality Modeling

Air quality models are relied on by federal and state regulatory agencies to support their planning efforts. Used properly, models can assist policy makers in deciding which control programs are most effective in improving air quality, and meeting specific goals and objectives. For example, models can be used to conduct “what if” analyses, which provide information for policy makers on the effectiveness of candidate control programs.

The modeling analyses were conducted in accordance with EPA’s modeling guidelines (EPA, 2007a). Further details of the modeling are provided in two protocol documents: LADCO, 2007a and LADCO, 2007b.

This section reviews the development and evaluation of the modeling system used for the multi-pollutant analyses. Application of the modeling system (i.e., attainment demonstration for ozone and $PM_{2.5}$, and reasonable progress assessment for haze) is covered in the following sections.

3.1 Selection of Base Year

Two base years were used in the modeling analyses: 2002 and 2005. EPA’s modeling guidance recommends using 2002 as the baseline inventory year, but also allows for use of an alternative baseline inventory year, especially a more recent year. Initially, LADCO conducted modeling with a 2002 base year (i.e., Base K/Round 4 modeling, which was completed in 2006). A decision was subsequently made to conduct modeling with a 2005 base year (i.e., Base M/Round 5, which was completed in 2007). As discussed in the previous section, 2002 and 2005 both had above normal ozone conducive conditions, although 2002 was more severe compared to 2005. Examination of multiple base years provides for a more complete technical assessment. Both sets of model runs are discussed in this document.

3.2 Future Years of Interest

To address the multiple attainment requirements for ozone and $PM_{2.5}$, and reasonable progress goals for regional haze, several future years are of interest:

2008	Planning year for ozone basic nonattainment areas (attainment date 2009)[8]
2009	Planning year for ozone moderate nonattainment areas and $PM_{2.5}$ nonattainment areas (attainment date 2010)
2012	Planning year for ozone moderate nonattainment areas and $PM_{2.5}$ nonattainment areas, with 3-year extension (attainment date 2013)
2018	First milestone year for regional haze planning

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[8] According to USEPA’s ozone implementation rule (USEPA, 2005), emission reductions needed for attainment must be implemented by the beginning of the ozone season immediately preceding the area’s attainment date. The PM2.5 implementation rule contains similar provisions – i.e., emission reductions should be in place by the beginning of the year preceding the attainment date (USEPA, 2007c). The logic for requiring emissions reductions by the year (or season) immediately preceding the attainment year follows from language in the Clean Air Act, and the ability for an area to receive up to two 1-year extensions. Therefore, emissions in the year preceding the attainment year should be at a level that is consistent with attainment. It also follows that the year preceding the attainment year should be modeled for attainment planning purposes.

Detailed emissions inventories were developed for 2009 and 2018. To support modeling for other future years, less rigorous emissions processing was conducted (e.g., 2012 emissions were estimated for several source sectors by interpolating between 2009 and 2018 emissions).

3.3 Modeling System

The air quality analyses were conducted with the CAMx model, with emissions and meteorology generated using EMS (and CONCEPT) and MM5, respectively. The selection of CAMx as the primary model is based on several factors: performance, operator considerations (e.g., ease of application and resource requirements), technical support and documentation, model extensions (e.g., 2-way nested grids, process analysis, source apportionment, and plume-in-grid), and model science. CAMx model set-up for Base M and Base K is summarized below:

Base M (2005)	**Base K (2002)**
• CAMx v4.50	* CAMx 4.30
• CB05 gas phase chemistry	* CB-IV with updated gas-phase chemistry
• SOA chemistry updates	* No SOA chemistry updates
• AERMOD dry deposition scheme	* Wesley-based dry deposition
• ISORROPIA inorganic chemistry	• ISORROPIA inorganic chemistry
• SOAP organic chemistry	• SOAP organic chemistry
• RADM aqueous phase chemistry	• RADM aqueous phase chemistry
• PPM horizontal transport	• PPM horizontal transport

3.4 Domain/Grid Resolution

The National RPO grid projection was used for this modeling. A subset of the RPO domain was used for the LADCO modeling. For $PM_{2.5}$ and haze, the large eastern U.S. grid at 36 km (see box on right side of Figure 36) was used. A $PM_{2.5}$ sensitivity run was also performed for this domain at 12 km. For ozone, the smaller grid at 12 km (see shaded portion of the box on the right side of Figure 37) was used for most model runs. An ozone sensitivity run was also performed with a 4km sub-grid over the Lake Michigan area and Detroit/Cleveland.

The vertical resolution in the air quality model consists of 16 layers extending up to 15 km, with higher resolution in the boundary layer.

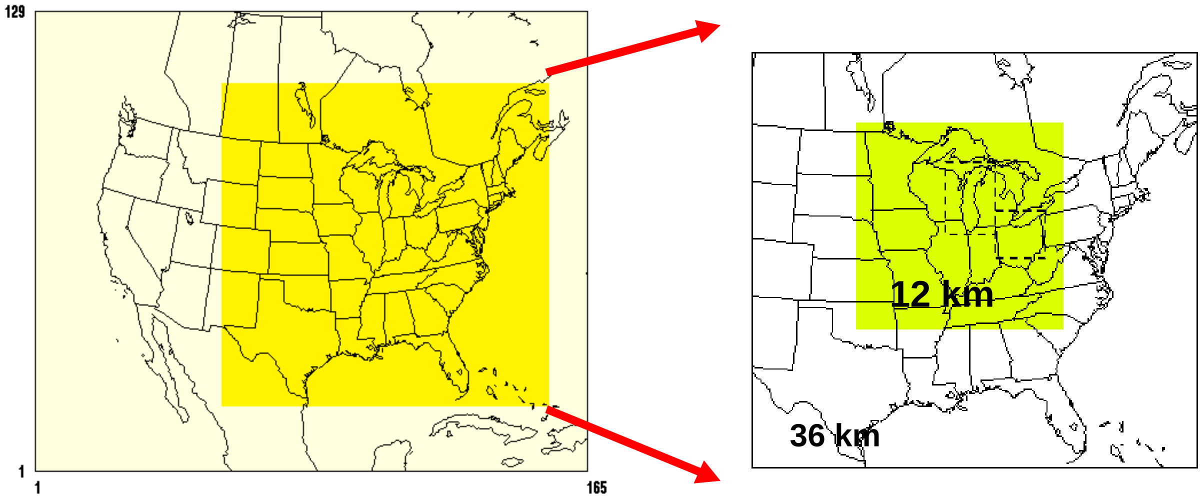

Figure 37. Modeling grids – RPO domain (left) and LADCO modeling domain (right)

3.5 Model Inputs: Meteorology

Meteorological inputs were derived using the Fifth-Generation NCAR/Penn State Meteorological Model (MM5) – version 3.6.3 for the years 2001–2003, and version 3.7 for the year 2005. The MM5 modeling domains are consistent with the National RPO grid projections (see Figure 38).

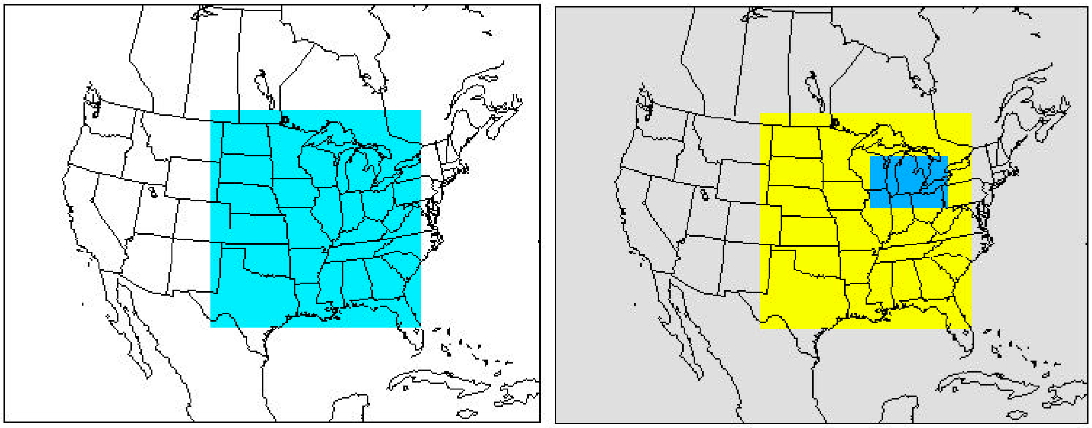

Figure 38. MM5 modeling domain for 2001-2003 (left) and 2005 (right)

The annual 2002 36 km MM5 simulation was completed by Iowa DNR. The 36/12 km 2-way nested simulation for the summers of 2001, 2002, and 2003 were conducted jointly by Illinois EPA and LADCO. The 36 km non-summer portion of the annual 2003 simulation was conducted by Wisconsin DNR. The annual 2005 36/12 km (and summer season 4 km) MM5 modeling was completed by Alpine Geophysics. Wisconsin DNR also completed 36/12 km MM5 runs for the summer season of 2005.

Model performance was assessed quantitatively with the METSTAT tool from Environ. The metrics used to quantify model performance include mean observation, mean prediction, bias, gross error, root mean square error, and index of agreement. Model performance metrics were calculated for several sub-regions of the modeling domain (Figure 39) and represent hourly spatial averages of multiple monitor locations. Additional analysis of rainfall is done on a monthly basis.

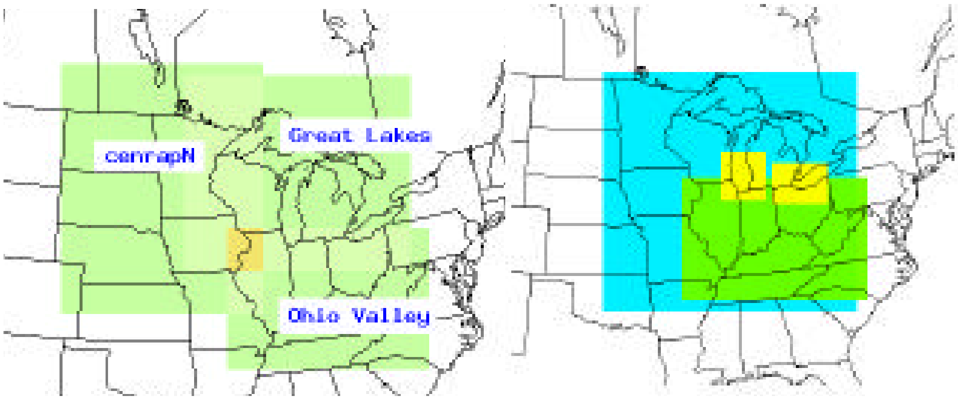

Figure 39. Sub-domains used for model performance for 2001-2003 (left) and 2005 (right)

A summary of the performance evaluation results for the meteorological modeling is provided below. Further details are provided in two summary reports (LADCO, 2005 and LADCO, 2007c).

Temperature: The biggest issue with the performance in the upper Midwest is the existence of a cool diurnal temperature bias in the winter and warm temperature bias over night during the summer (see Figure 40). These features are common to other annual MM5 simulations for the central United States and do not appear to adversely affect model performance.

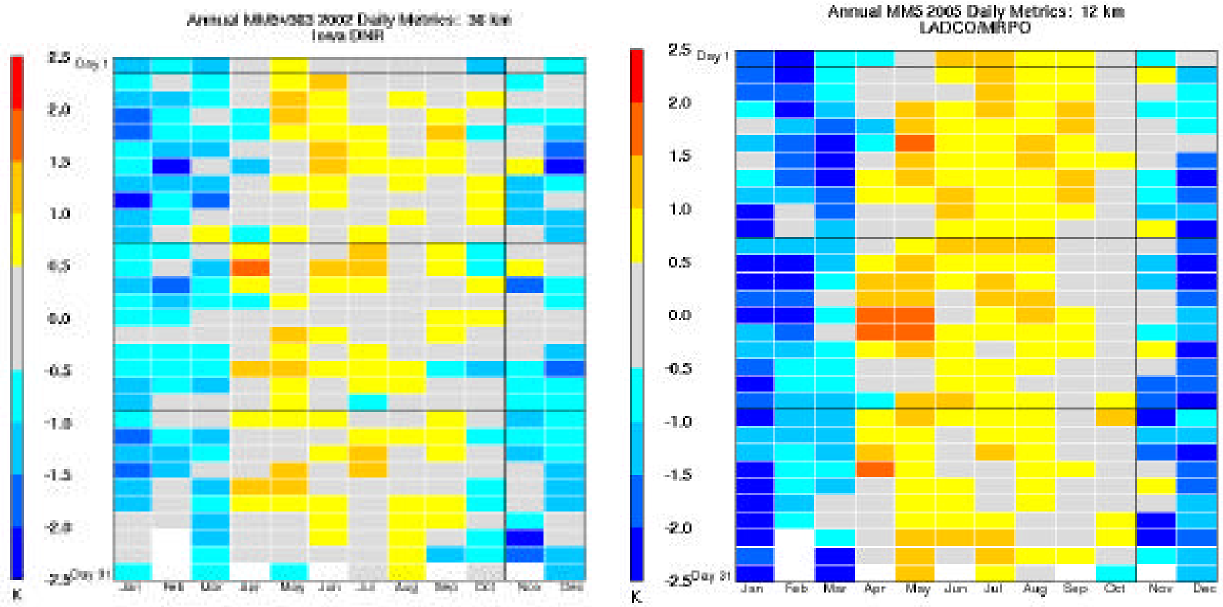

Figure 40. Daily temperature bias for 2002 (left) and 2005 (right) with hotter colors (yellow/orange/red) representing overestimates and cooler colors (blues) representing underestimates

Note: months are represented from left to right (January to December) and days are represented from top to bottom (1 to 30(31) – i.e., upper left hand corner is January 1 and lower right hand corner is December 31

Wind Fields: The wind fields are generally good. Wind speed bias is less than 0.5 m/sec and wind speed error is consistently between 1.0 and 1.5 m/sec. Wind direction error is generally within 15-30 degrees.

Mixing Ratio: The mixing ratio (a measure of humidity) is over-predicted in the late spring and summer months, and mixing ratio error is highest during this period. There is little bias and error during the cooler months when there is less moisture in the air.

Rainfall: The modeled and observed rainfall totals show good agreement spatially and in terms of magnitude in the winter, fall, and early spring months. There are, however, large over-predictions of rainfall in the late spring and summer months (see Figure 41). These over-predictions are seen spatially and in magnitude over the entire domain, particularly in the Southeast United States, and are likely due to excessive convective rainfall being predicted in MM5. This over-prediction of rainfall in MM5 does not necessarily translate into over-prediction of wet deposition in the photochemical model. CAMx does not explicitly use the convective and non-convective rainfall output by MM5, but estimates wet scavenging by hydrometeors using cloud, ice, snow, and rain water mixing ratios output by MM5. Nevertheless, this could have an effect on model performance for $PM_{2.5}$, as discussed in Section 3.7, and may warrant further attention.

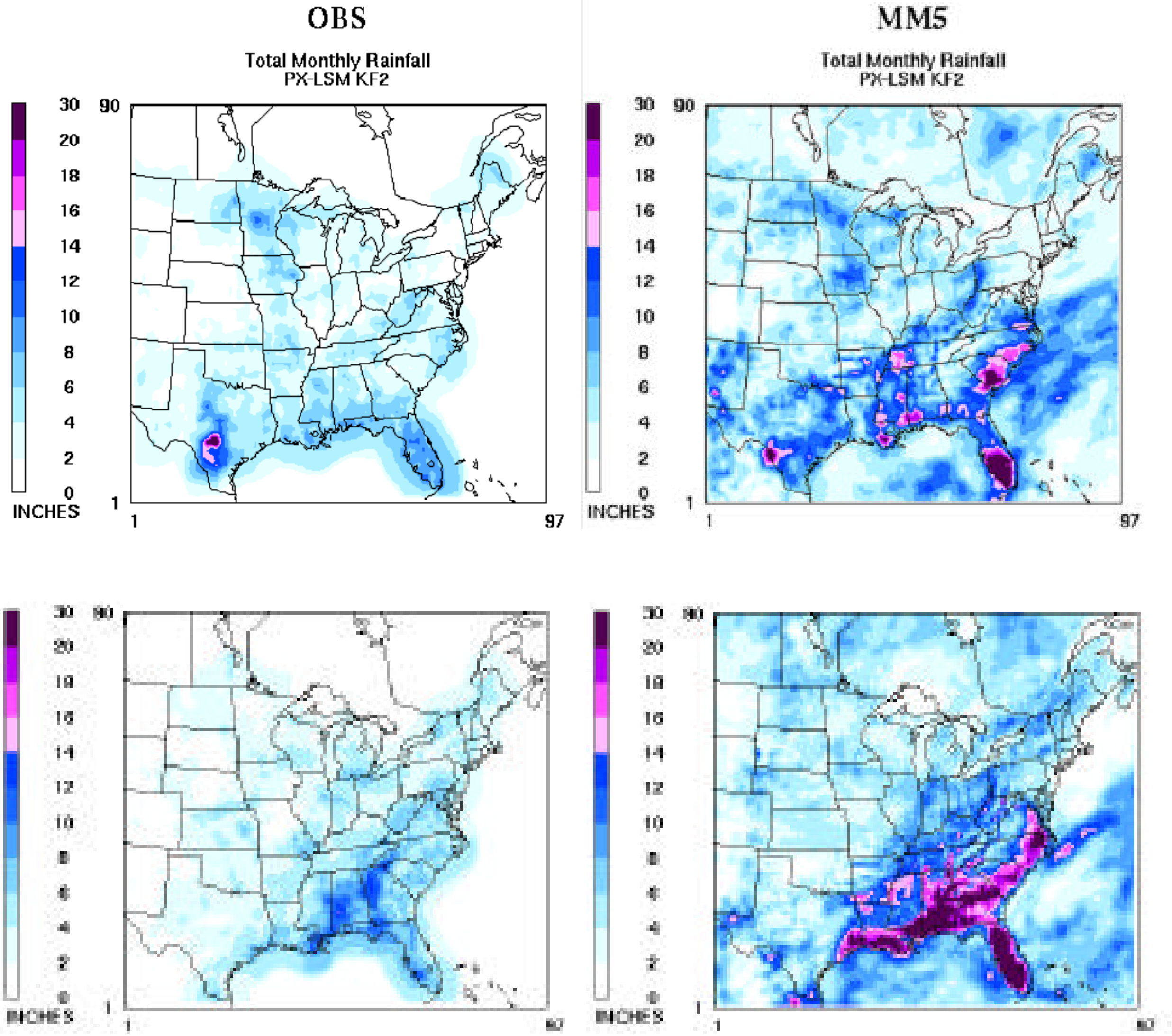

Figure 41. Comparison of observed (left column) and modeled (right column) monthly rainfall for July 2002 (top) and July 2005 (bottom)

3.6 Model Inputs: Emissions

Emission inventories were prepared for two base years: 2002 (Base K) and 2005 (Base M), and several future years: 2008, 2009, 2012, and 2018. Further details of the emission inventories are provided in two summary reports (LADCO, 2006a and LADCO, 2008a) and the following pages of the LADCO web site:

http://www.ladco.org/tech/emis/basek/BaseK_Reports.htm
http://www.ladco.org/tech/emis/r5/round5_reports.htm

For on-road, nonroad, ammonia, and biogenic sources, emissions were estimated by models. For the other sectors (point sources, area sources, and MAR [commercial marine, aircraft, and railroads]), emissions were prepared using data supplied by the LADCO States and other RPOs.

Base Year Emissions: State and source sector emission summaries for 2002 (Base K) and 2005 (Base M) are compared in Figure 42. Additional detail is provided in Tables 6a (all sectors – tons per day) and 6b (EGUs – tons per year).

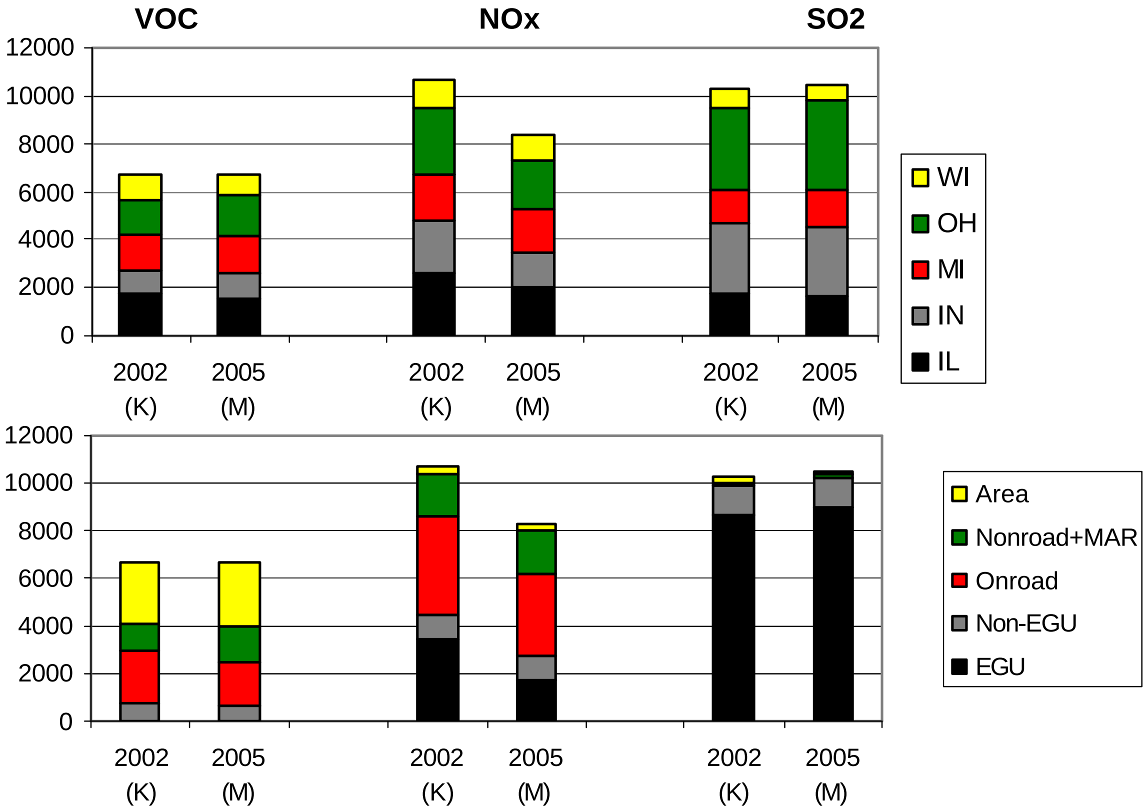

Figure 42. Base K and Base M emissions for 5-state LADCO region by state (top) and source sector (bottom), units: tons per summer weekday

A summary of the base year emissions by sector for the LADCO States is provided below.

	VOC	Base M	BaseK	Base M	BaseK	BaseK	Base M	NOx	Base M	BaseK	Base M	BaseK	BaseK	Base M	SOX	Base M	BaseK	Base M	BaseK	BaseK	Base M	PM2.5	Base M	BaseK	Base M	BaseK	BaseK	Base M
July	2002	2005	2009	2009	2012	2018	2018	2002	2005	2009	2009	2012	2018	2018	2002	2005	2009	2009	2012	2018	2018	2002	2005	2009	2009	2012	2018	2018
Nonroad																												
IL	224	321	164	257	149	130	213	324	333	263	275	224	154	155	31	33	5	5	0.6	0.4	0.4		30		24			14
IN	125	195	94	160	95	95	128	178	191	142	158	141	141	89	17	19	3	3	3	0.3	0.2		17		13			7
MI	348	414	307	350	276	222	271	205	239	159	197	133	93	112	19	22	3	3	0.5	0.3	0.3		22		18			11
OH	222	356	161	294	145	126	238	253	304	195	246	162	109	135	23	29	4	5	0.5	0.3	0.4		27		22			13
WI	214	238	194	203	175	140	157	145	157	114	129	97	69	77	13	15	2	2	0.3	0.2	0.2		14		12			7
5-State Total	1133	1524	920	1264	840	713	1007	1105	1224	873	1005	757	566	568	103	118	17	18	4.9	1.5	1.5		110		89			52
U.S. Total	8463	9815	5442	8448		5244	6581	6041	9060	6057	8120		5832	5100	505	654	117	153		104	13		573		750			475
MAR																												
IL	10	11	10	10	10	10	6	277	246	201	228	195	186	165	0	22	0	19	0	0	17		7		6			4
IN	5	5	5	5	5	5	3	123	93	89	87	87	84	65	0.2	8	0.2	7	0.2	0.2	6		2		2			2
MI	7	7	7	7	7	8	7	114	87	112	82	111	110	65	0.6	21	0.7	14	0.7	0.8	8		3		3			2
OH	8	7	8	7	8	8	5	177	134	128	126	126	122	94	0.4	14	0.3	12	0.3	0.3	10		4		4			2
WI	4	4	4	4	4	4	3	79	58	59	54	59	57	41	12.7	8	9.5	6	9.5	8.7	5		2		2			1
5-State Total	34	34	34	33	34	35	24	770	618	589	577	578	559	430	13.9	73	10.7	58	10.7	10	46		18		17			11
U.S. Total	307	317	321	157	329	346	334	4968	4515	4002	1813	3964	3919	3812	620	512	509	122	509	503	290		147		57			165
OtherArea																												
IL	679	675	688	594	700	738	582	62	48	68	48	70	73	49	11	11	12	16	12	13	16		40		64			69
IN	354	391	365	358	373	398	384	62	56	65	58	67	69	59	158	32	150	32	151	153	32		2		2			2
MI	518	652	516	562	520	541	549	49	49	52	50	53	54	51	71	29	68	29	68	68	28		111		114			120
OH	546	604	550	506	558	593	487	50	93	59	108	60	62	108	22	6	34	15	35	35	14		19		35			34
WI	458	315	467	290	474	506	293	32	37	34	37	34	35	37	9	17	9	13	10	10	13		11		12			12
5-State Total	2555	2637	2586	2310	2625	2776	2295	255	283	278	301	284	293	304	271	95	273	105	276	279	103		183		227			237
U.S. Total	17876	21093	18638	18683		20512	24300	3856	4899	4100	4220		4418	5357	2075	2947	2062	2559		2189	2709		2735		2621			2570
On-Road																												
IL	446	341	314	268	260	197	151	890	748	578	528	474	300	201		9		4			3		13		10			6
IN	405	282	237	235	193	150	138	703	541	425	402	313	187	173		11		3			2		9		7			2
MI	522	351	335	269	303	217	163	926	722	680	501	619	385	204		14		4			3		12		9			3
OH	574	680	365	424	340	238	242	1035	934	609	693	512	270	274		18		4			4		16		12			4
WI	238	175	144	119	117	88	68	481	457	303	322	226	118	138		9		2			2		8		6			2
5-State Total	2185	1829	1395	1315	1213	890	762	4035	3402	2595	2446	2144	1260	990		61		17			14		58		44			17
U.S. Total	14263				7825			23499				13170																
EGU																												
IL	9	7	8	6	8	9	7	712	305	227	275	244	231	224	1310	1158	944	958	789	810	869		13		34			77
IN	6	6	6	6	7	6	6	830	393	406	370	424	283	255	2499	2614	1267	1033	1263	1048	1036		16		73			74
MI	12	6	11	4	11	12	4	448	393	218	242	219	247	243	1103	1251	1022	667	1031	1058	725		15		25			29
OH	5	4	6	5	7	7	6	1139	408	330	280	322	271	285	3131	3405	1463	1326	994	701	983		28		94			80
WI	3	5	3	2	4	4	3	293	213	146	165	139	147	177	602	545	512	460	492	500	435		0		22			25
5-State Total	35	28	34	23	37	38	26	3422	1712	1327	1332	1348	1179	1184	8645	8973	5208	4444	4569	4117	4048		72		248			285
U.S. Total	214	140	195	124	197	215	138	14371	10316	7746	7274	7721	7007	6095	31839	34545	20163	16903	17629	14727	14133		685		1131			1571
Non-EGU																												
IL	313	221	286	218	305	350	258	356	330	334	218	338	343	235	373	423	251	335	257	249	346		16		17			19
IN	150	130	160	137	170	199	167	238	179	212	175	216	225	178	292	218	270	216	274	290	180		35		36			44
MI	123	116	115	119	122	139	140	216	240	208	242	214	229	271	162	158	166	148	171	185	163		20		21			25
OH	77	84	75	87	79	90	104	177	175	157	166	160	167	178	240	289	231	288	210	216	293		27		28			33
WI	88	84	97	87	104	120	106	98	97	91	93	92	94	81	163	156	154	152	155	156	85		0		0.1			0.1
5-State Total	751	635	733	648	780	898	775	1085	1021	1002	894	1020	1058	943	1230	1244	1072	1139	1067	1096	1067		98		102			121
U.S. Total	4087	3877	4409		4700	5378		6446	6730	6129		6435	6952		5759	5630	6093		6340	6970					1444			1777
IL	1681	1576	1470	1353	1432	1434	1217	2621	2010	1671	1572	1545	1287	1029	1725	1656	1212	1337	1059	1072	1251		119		155			189
IN	1045	1009	867	901	843	853	826	2134	1453	1339	1250	1248	989	819	2966	2902	1690	1294	1691	1492	1256		81		133			131
MI	1530	1546	1291	1311	1239	1139	1134	1958	1730	1429	1314	1349	1118	946	1356	1495	1260	865	1271	1312	927		183		190			190
OH	1432	1735	1165	1323	1137	1062	1082	2831	2048	1478	1619	1342	1001	1074	3416	3761	1732	1650	1240	953	1304		121		195			166
WI	1005	821	909	705	878	862	630	1128	1019	747	800	647	520	551	800	750	687	635	667	675	540		35		54			47
5-State Total	6693	6687	5702	5593	5529	5350	4889	10672	8260	6664	6555	6131	4915	4419	10263	10564	6581	5781	5928	5504	5280		539		727			723

Table 6b. EGU Emissions for Midwest States (2018)

	Heat Input (MMBTU/year)	Scenario	SO2 (tons/year)	SO2 (lb/MMBTU)	NOx (tons/year)	NOx (lb/MMBTU)
IL	**980,197,198**	**2001 - 2003 (average)**	**362,417**	**0.74**	**173,296**	**0.35**
		IPM 2.1.9	241,000		73,000	
	1,310,188,544	IPM3.0 (base)	277,337	0.423	70,378	0.107
		IPM3.0 - will do	140,296	0.214	62,990	0.096
		IPM3.0 - may do	140,296	0.214	62,990	0.096
IN	**1,266,957,401**	**2001 - 2003 (average)**	**793,067**	**1.25**	**285,848**	**0.45**
		IPM 2.1.9	377,000		95,000	
	1,509,616,931	IPM3.0 (base)	361,835	0.479	90,913	0.120
		IPM3.0 - will do	417,000	0.552	94,000	0.125
		IPM3.0 - may do	417,000	0.552	94,000	0.125
MI	**756,148,700**	**2001 - 2003 (average)**	**346,959**	**0.92**	**132,995**	**0.35**
		IPM 2.1.9	399,000		100,000	
	1,009,140,047	IPM3.0 (base)	244,151	0.484	79,962	0.158
		IPM3.0 - will do	244,151	0.484	79,962	0.158
		IPM3.0 - may do	244,151	0.484	79,962	0.158
OH	**1,306,296,589**	**2001 - 2003 (average)**	**1,144,484**	**1.75**	**353,255**	**0.54**
		IPM 2.1.9	216,000		84,000	
	1,628,081,545	IPM3.0 (base)	316,883	0.389	96,103	0.118
		IPM3.0 - will do	348,000		101,000	
		IPM3.0 - may do	348,000		101,000	
WI	**495,475,007**	**2001 - 2003 (average)**	**191,137**	**0.77**	**90,703**	**0.36**
		IPM 2.1.9	155,000		46,000	
	675,863,447	IPM3.0 (base)	127,930	0.379	56,526	0.167
		IPM3.0 - will do	150,340	0.445	55,019	0.163
		IPM3.0 - may do	62,439	0.185	46,154	0.137
IA	**390,791,671**	**2001 - 2003 (average)**	**131,080**	**0.67**	**77,935**	**0.40**
		IPM 2.1.9	147,000		51,000	
	534,824,314	IPM3.0 (base)	115,938	0.434	59,994	0.224
		IPM3.0 - will do	115,938	0.434	59,994	0.224
		IPM3.0 - may do	100,762	0.377	58,748	0.220
MN	**401,344,495**	**2001 - 2003 (average)**	**101,605**	**0.50**	**85,955**	**0.42**
		IPM 2.1.9	86,000		42,000	
	447,645,758	IPM3.0 (base)	61,739	0.276	41,550	0.186
		IPM3.0 - will do	54,315	0.243	49,488	0.221
		IPM3.0 - may do	51,290	0.229	39,085	0.175
MO	**759,902,542**	**2001 - 2003 (average)**	**241,375**	**0.63**	**143,116**	**0.37**
		IPM 2.1.9	281,000		78,000	
	893,454,905	IPM3.0 (base)	243,684	0.545	72,950	0.163
		IPM3.0 - will do	237,600	0.532	72,950	0.163
		IPM3.0 - may do	237,600	0.532	72,950	0.163
ND	**339,952,821**	**2001 - 2003 (average)**	**145,096**	**0.85**	**76,788**	**0.45**
		IPM 2.1.9	109,000		72,000	
	342,685,501	IPM3.0 (base)	41,149	0.240	44,164	0.258
		IPM3.0 - will do	56,175	0.328	58,850	0.343
		IPM3.0 - may do	56,175	0.328	58,850	0.343
SD	**39,768,357**	**2001 - 2003 (average)**	**12,545**	**0.63**	**15,852**	**0.80**
		IPM 2.1.9	12,000		15,000	
	44,856,223	IPM3.0 (base)	4,464	0.199	2,548	0.114
		IPM3.0 - will do	4,464	0.199	2,548	0.114
		IPM3.0 - may do	4,464	0.199	2,548	0.114

On-road Sources: For 2002, EMS was run by LADCO using VMT and MOBILE6 inputs supplied by the LADCO States. EMS was run to generate 36 days (weekday, Saturday, Sunday for each month) at 36 km, and 9 days (weekday, Saturday, Sunday for June – August) at 12 km. For 2005, CONCEPT was run by a contractor (Environ) using transportation data (e.g., VMT and vehicle speeds) supplied by the state and local planning agencies in the LADCO States and Minnesota for 24 networks. These data were first processed with T3 (Travel Demand Modeling [TDM] Transformation Tool) to provide input files for CONCEPT to calculate link-specific, hourly emission estimates (Environ, 2008). CONCEPT was run with meteorological data for a July and January weekday, Saturday, and Sunday (July 15 – 17 and January 16 – 18). A spatial plot of emissions is provided in Figure 43.

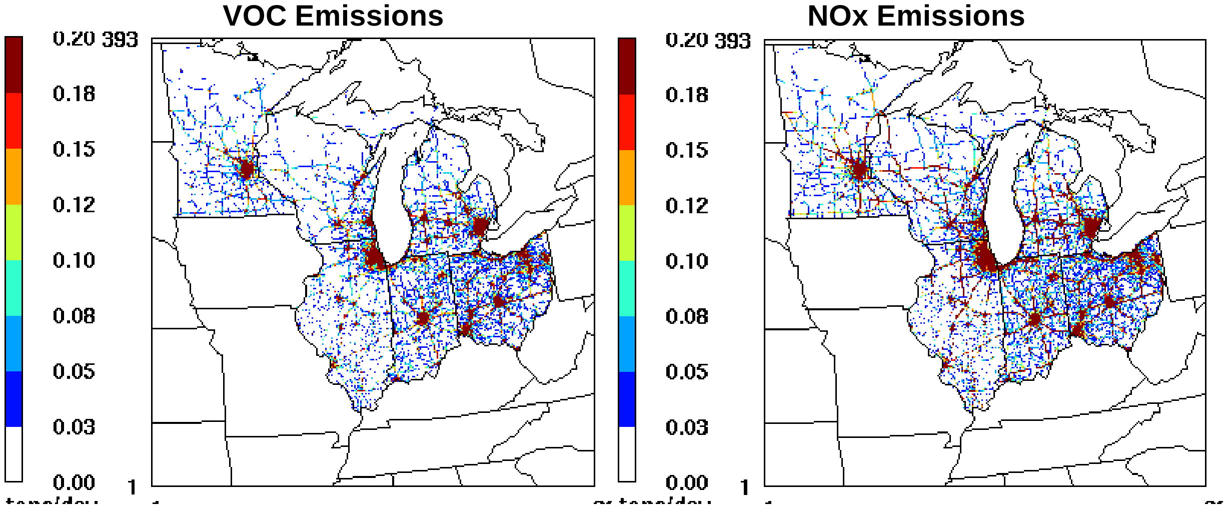

Figure 43. Motor vehicle emissions for VOC (left) and NOx (right) for a July weekday (2005)

Off-road Sources: For 2002 and 2005, NMIM and NMIM2005, respectively, were run by Wisconsin DNR. Additional off-road sectors (i.e., commercial marine, aircraft, and railroads [MAR]) were handled separately. Local data for agricultural equipment, construction equipment, commercial marine, recreational marine, and railroads were prepared by contractors (Environ, 2004, and E.H. Pechan, 2004). For Base M, updated local data for railroads and commercial marine were prepared by a contractor (Environ, 2007b, 2007c). Table 7 compares the Base M 2005 and Base K 2002 emissions. Compared to 2002, the new 2005 emissions reflect substantially lower commercial marine emissions and lower locomotive NOx emissions.

Table 7. Locomotive and commercial marine emissions for the five LADCO States (2002 v. 2005)

	Railroads (TPY)			Commercial Marine (TPY)	
	2002	2005		2002	2005
VOC	7,890	7,625		1,562	828
CO	20,121	20,017		8,823	6,727
NOx	182,226	145,132		64,441	42,336
PM	5,049	4,845		3,113	1,413
SO2	12,274	12,173		25,929	8,637
NH3	86	85		----	----

Area Sources: For 2002 and 2005, EMS was run by LADCO using data supplied by the LADCO States to produce weekday, Saturday, and Sunday emissions for each month. For 2005, special attention was given to two source categories: industrial adhesive and sealant solvents (which were dropped from the inventory to avoid double-counting) and outdoor wood boilers (which were added to the inventory).

Point Sources: For 2002 and 2005, EMS was run by LADCO using data supplied by the LADCO States to produce weekday, Saturday, and Sunday emissions for each month. For EGUs, the annual and summer season emissions were temporalized for modeling purposes using profiles prepared by Scott Edick (Michigan DEQ) based on CEM data.

Biogenics: For Base M, a contractor (Alpine) provided an updated version of the CONCEPT/MEGAN biogenics model. Compared to the previous (EMS/BIOME) emissions, there is more regional isoprene using MEGAN compared to the BIOME estimates used for Base K (see Figure 44). Also, with the secondary organic aerosol updates to the CAMx air quality model, Base M includes emissions for monoterpenes and sesquiterpenes, which are pre-cursors of secondary $PM_{2.5}$ organic carbon mass.

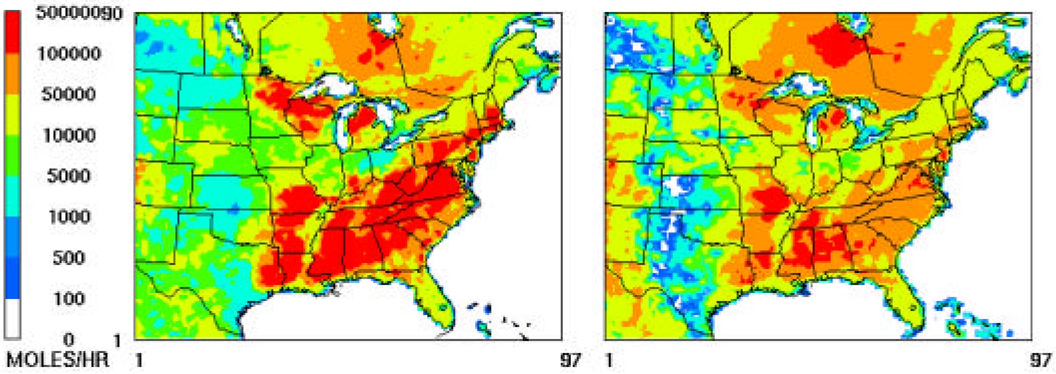

Figure 44. Isoprene emissions for Base M (left) v. Base K (right)

Ammonia: For Base M, the CMU-based 2002 (Base K) ammonia emissions were projected to 2005 using growth factors from the Round 4 emissions modeling. These emissions were then adjusted by applying temporal factors by month based on the process-based ammonia emissions model (Zhang, et al, 2005, and Mansell, et al, 2005). A plot of average daily emissions by state and month is provided in Figure 45. A spatial plot of emissions is provided in Figure 46, which shows high emissions densities in the central U.S.

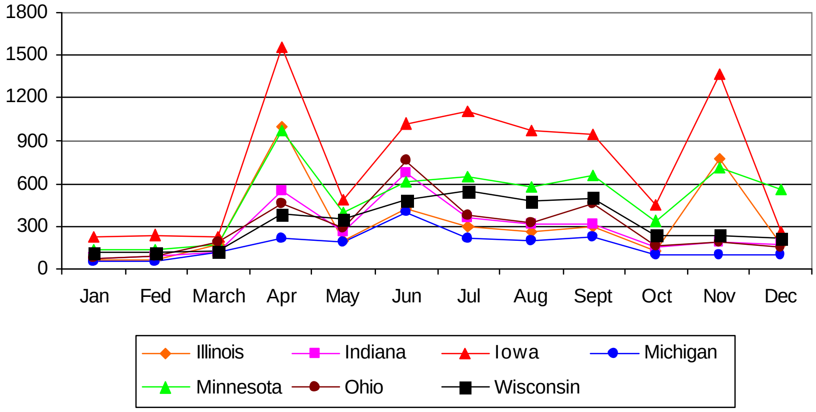

Figure 45. Average daily ammonia emissions for Midwest States by month (2005) - (units: average daily emissions – tons per day)

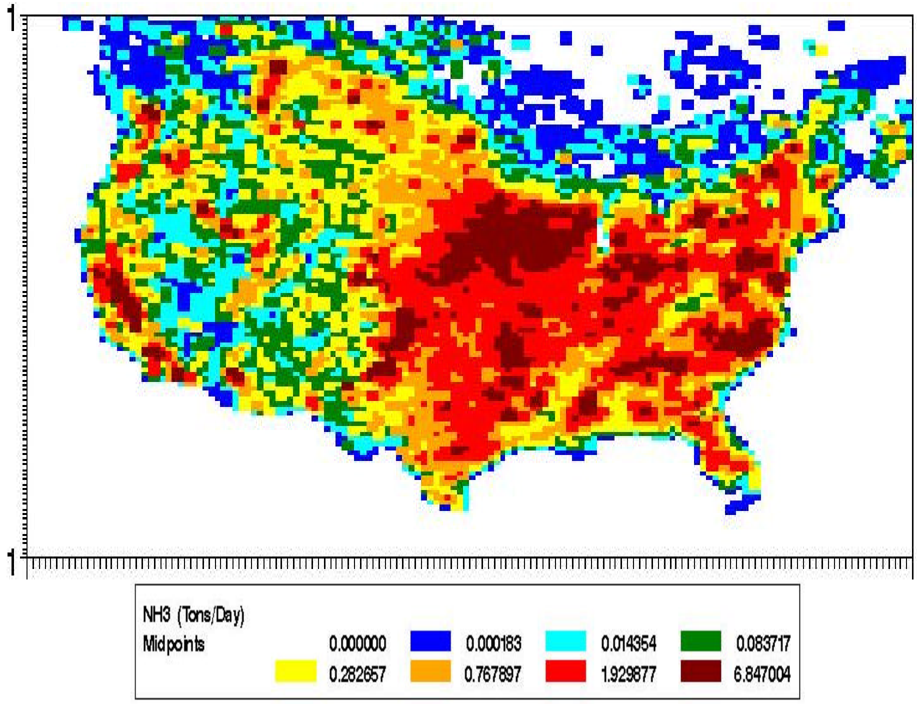

Figure 46. Ammonia emissions for a July weekday (2005) – 12 km modeling domain

Canadian Emissions: For Base M, Scott Edick (Michigan DEQ) processed the 2005 Canadian National Pollutant Release Inventory, Version 1.0 (NPRI). Specifically, a subset of the NPRI data (emissions and stack parameters) relevant to the air quality modeling were reformatted. The resulting emissions represent a significant improvement in the base year emissions.

A spatial plot of point source SO2 and NOx emissions is provided in Figure 47. Additional plots and emission reports are available on the LADCO website (http://www.ladco.org/tech/emis/basem/canada/index.htm).

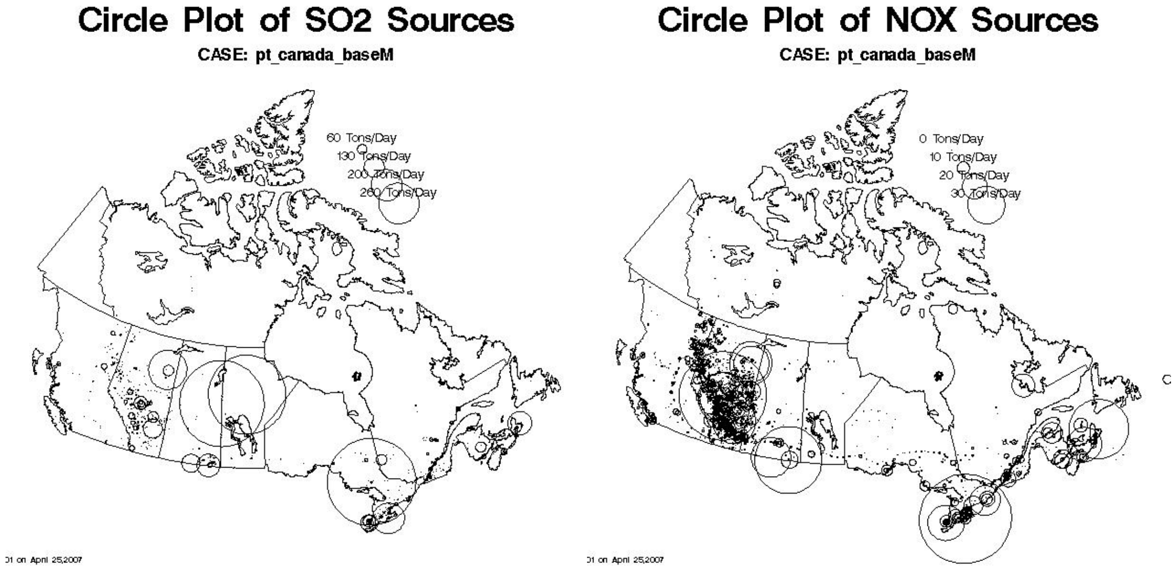

Figure 47. Canadian point source emissions for SO2 (left) and NOx (right)

Fires: For Base K, a contractor (EC/R, 2004) developed a 2001, 2002, and 2003 fire emissions inventory for eight Midwest States (five LADCO states plus Iowa, Minnesota, and Missouri), including emissions from wild fires, prescribed fires, and agricultural burns. Projected emissions were also developed for 2010 and 2018 assuming "no smoke management" and "optimal smoke management" scenarios. An early model sensitivity run showed very little difference in modeled $PM_{2.5}$ concentrations. Consequently, the fire emissions were not included in subsequent modeling runs (i.e., they were not in the Base K or Base M modeling inventories).

Future Year Emissions: Complete emission inventories were developed for several future years: Base K – 2009, 2012, and 2018, and Base M – 2009 and 2018. In addition, 2008 (Base K and Base M) and 2012 (Base M) proxy inventories were estimated based on the 2009 and 2018 data. (Note, the EGU emissions for the Base M 2012 inventory were based on EPA's IPM3.0 modeling.)

Source sector emission summaries for the base years and future years are shown in Figure 48. Additional detail is provided in Tables 6a and 6b.

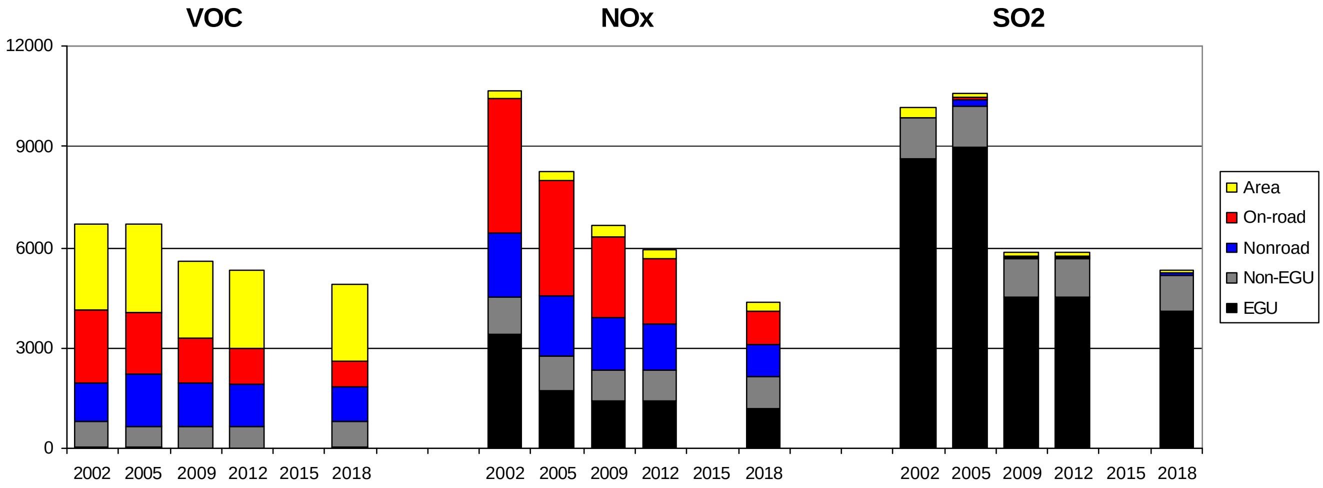

Figure 48. Base year and future year emissions for 5-State LADCO Region (TPD, July weekday)

For on-road, and nonroad, the future year emissions were estimated by models (i.e., EMS/CONCEPT and NMIM, respectively). One adjustment was made to the 2009 and 2018 motor vehicle emission files prepared by Environ with CONCEPT. To reflect newer transportation modeling conducted by CATS for the Chicago area, emissions were increased by 9% in 2009 and 2018. The 2005 base year and adjusted 2009 and 2018 motor vehicle emissions are provided in Table 8.

Table 8. Motor Vehicle Emissions Produced by CONCEPT Modeling (July weekday – tons per day)

Year	State	Sum of CO	Sum of TOG	Sum of NOx	Sum of PM2.5	Sum of SO2	Sum of NH3	Sum of VMT
2005	IL	3,684.3	341.5	748.2	12.9	9.6	35.9	344,087,819.6
	IN	3,384.9	282.0	541.1	8.9	11.1	25.7	245,537,231.9
	MI	4,210.3	351.9	722.0	12.4	13.9	35.3	340,834,025.9
	MN	2,569.1	218.7	380.5	6.3	7.6	17.7	170,024,599.7
	OH	6,113.4	679.8	933.6	16.2	18.8	36.5	360,521,068.6
	WI	2,206.0	175.1	457.5	7.8	9.2	19.7	189,123,964.3
Total		22,168.0	2,049.0	3,782.9	64.5	70.2	170.8	1,650,128,709.9
2009	IL	2,824.4	268.0	527.8	10.1	4.2	38.9	372,132,591.1
	IN	2,839.5	234.9	401.9	6.7	2.8	26.1	249,817,026.3
	MI	3,172.0	269.2	500.9	9.2	4.0	37.1	356,347,010.5
	MN	2,256.8	206.3	307.5	5.1	2.3	21.5	204,443,017.8
	OH	4,619.2	423.7	693.5	11.8	4.7	39.5	387,428,127.2
	WI	1,673.4	119.4	322.1	5.7	2.3	20.6	197,729,964.9
Total		17,385.3	1,521.5	2,753.6	48.7	20.3	183.6	1,767,897,737.8
2018	IL	2,084.7	151.5	200.7	6.3	3.7	43.1	413,887,887.3
	IN	2,217.3	138.4	173.0	4.4	2.6	30.2	288,042,232.1
	MI	2,434.3	163.5	204.1	5.9	3.6	40.5	388,128,431.8
	MN	1,799.6	123.1	137.1	3.6	2.2	24.9	237,022,213.7
	OH	3,361.5	242.5	274.1	6.8	4.0	43.1	421,694,093.4
	WI	1,255.5	68.4	138.5	3.9	2.0	22.2	218,277,167.5
Total		13,152.9	887.5	1,127.5	30.8	18.1	203.9	1,967,052,025.8

For EGUs, future year emissions were based on IPM2.1.9 modeling completed by the RPOs in July 2005 Base K and IPM3.0 completed by EPA in February 2007 for Base M. Several CAIR scenarios were assumed:

Base K
1a: IPM2.1.9, with full trading and banking
1b: IPM2.1.9, with restricted trading (compliance with state-specific emission budgets) and full trading
1d: IPM2.1.9, with restricted trading (compliance with state-specific emission budgets)

Base M
5a: EPA's IPM3.0 was assumed as the future year base for EGUs.
5b: EPA's IPM3.0, with several "will do" adjustments identified by the States. These adjustments should reflect a legally binding commitment (e.g., signed contract, consent decree, or operating permit).
5c: EPA's IPM3.0, with several "may do" adjustments identified by the States. These adjustments reflect less rigorous criteria, but should still be some type of public reality (e.g., BART determination or press announcement).

For other sectors (area, MAR, and non-EGU point sources), the future year emissions for the LADCO States were derived by applying growth and control factors to the base year inventory. These factors were developed by a contractor (E.H. Pechan, 2005 and E.H. Pechan, 2007). For the non-LADCO States, future year emission files were based on data from other RPOs.

Growth factors were based initially on EGAS (version 5.0), and were subsequently modified (for select, priority categories) by examining emissions activity data. Due to a lack of information on future year conditions, the biogenic VOC and NOx emissions, and all Canadian emissions were assumed to remain the constant between the base year and future years.

A "base" control scenario was prepared for each future year based on the following "on the books" controls:

On-Highway Mobile Sources

- Federal Motor Vehicle Emission Control Program, low-sulfur gasoline and ultra-low sulfur diesel fuel
- Inspection - maintenance programs, including IL's vehicle emissions tests (NE IL), IN's vehicle emissions testing program (NW IN), OH's E-check program (NE OH), and WI's vehicle inspection program (SE WI) – note: a special emissions modeling run was done for the Cincinnati/Dayton area to reflect the removal of the state's E-check program and inclusion of low RVP gasoline
- Reformulated gasoline, including in Chicago-Gary,-Lake County, IL,IN; and Milwaukee, Racine, WI

Off-Highway Mobile Sources

- Federal control programs incorporated into NONROAD model (e.g., nonroad diesel rule), plus the evaporative Large Spark Ignition and Recreational Vehicle standards
- Heavy-duty diesel (2007) engine standard/Low sulfur fuel
- Federal railroad/locomotive standards
- Federal commercial marine vessel engine standards

Area Sources (Base M only)

- Consumer solvents
- AIM coatings
- Aerosol coatings
- Portable fuel containers

Power Plants

- Title IV (Phases I and II)
- NOx SIP Call
- Clean Air Interstate Rule

Other Point Sources

- VOC 2-, 4-, 7-, and 10-year MACT standards
- Combustion turbine MACT

Other controls included in the modeling include: consent decrees (refineries, ethanol plants, and ALCOA)[9], NOx RACT in Illinois and Ohio[10], and BART for a few non-EGU sources in Indiana and Wisconsin.

For Base K, several additional control scenarios were considered:

Scenario 2 – "base" controls plus additional controls recommended in LADCO White Papers for stationary and mobile sources

Scenario 3 – Scenario 2 plus additional White Papers for stationary and mobile sources

Scenario 4 – "base" controls plus additional candidate control measures under discussion by State Commissioners

Scenario 5 – "base" controls plus additional candidate control measures identified by the LADCO Project Team

3.7 Basecase Modeling Results

The purpose of the basecase modeling is to evaluate model performance (i.e., assess the model's ability to reproduce the observed concentrations). The model performance evaluation focused on the magnitude, spatial pattern, and temporal of modeled and measured concentrations. This exercise was intended to assess whether, and to what degree, confidence in the model is warranted (and to assess whether model improvements are necessary).

Model performance was assessed by comparing modeled and monitored concentrations. Graphical (e.g., side-by-side spatial plots, time series plots, and scatter plots) and statistical analyses were conducted. No rigid acceptance/rejection criteria were used for this study. Instead, the statistical guidelines recommended by EPA and other modeling studies (e.g., modeling by the other RPOs) were used to assess the reasonableness of the results. The model performance results presented here describe how well the model replicates observed ozone and $PM_{2.5}$ concentrations after a series of iterative improvements to model inputs.

Ozone: Spatial plots are provided for high ozone periods in June 2002 and June 2005 (see Figures 49a and 49b). The plots show that the model is doing a reasonable job of reproducing the magnitude, day-to-day variation, and spatial pattern of ozone concentrations. There is a tendency, however, to underestimate the magnitude of regional ozone levels. This is more apparent with the 2002 modeling; the regional concentrations in the 2005 modeling agree better with observations due to model and inventory improvements.

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[9] E.H. Pechan's original control file included control factors for three sources in Wayne County, MI. These control factors were not applied in the regional-scale modeling to avoid double-counting with the State's local-scale analysis for PM2.5

[10] NOx RACT in Wisconsin is included in the 2005 basecase (and EGU "will do" scenario). NOx RACT in Indiana was not included in the modeling inventory.

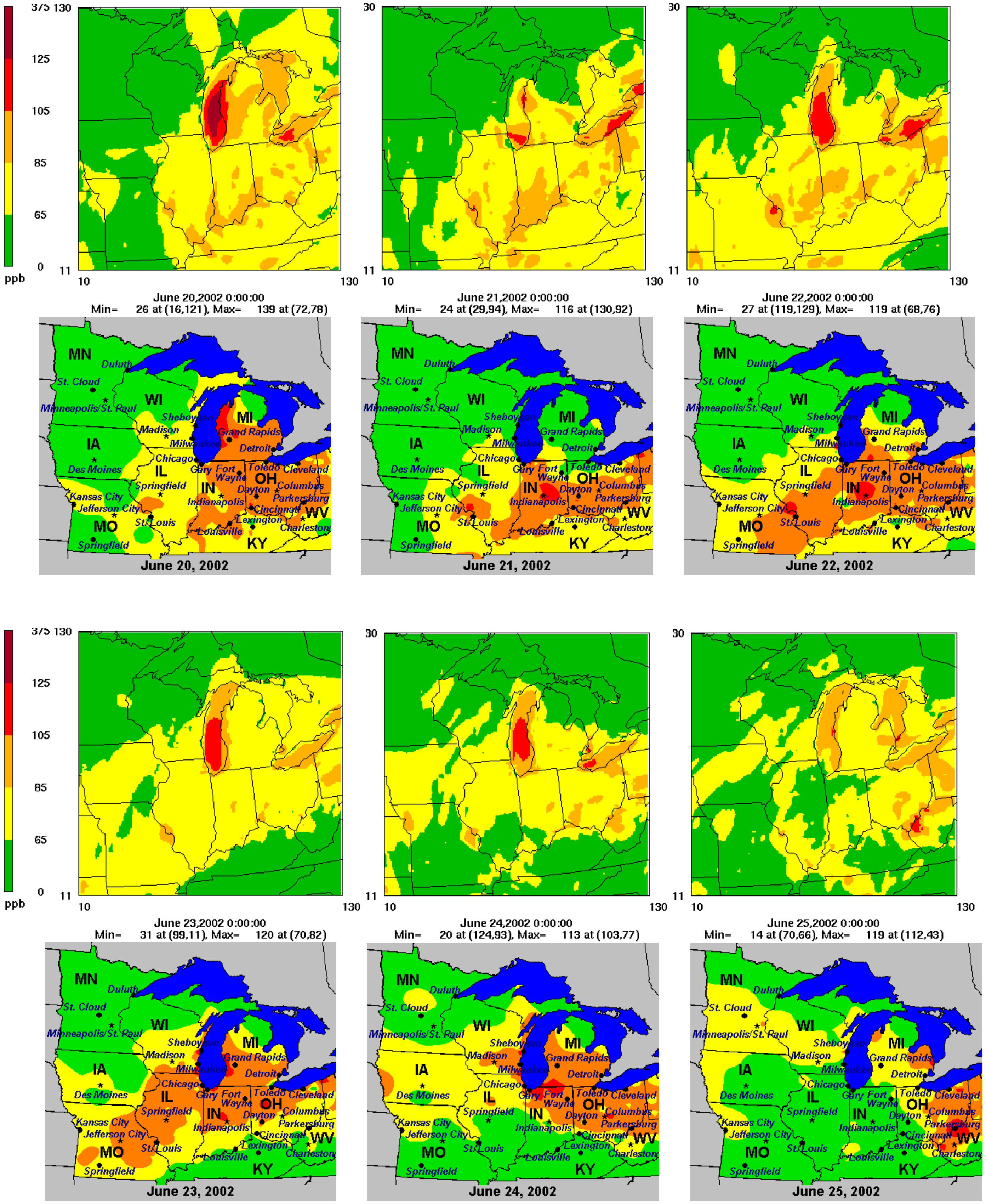


Figure 49a. Modeled (top) v. monitored (bottom) 8-hour ozone concentrations: June 20 – 25, 2002

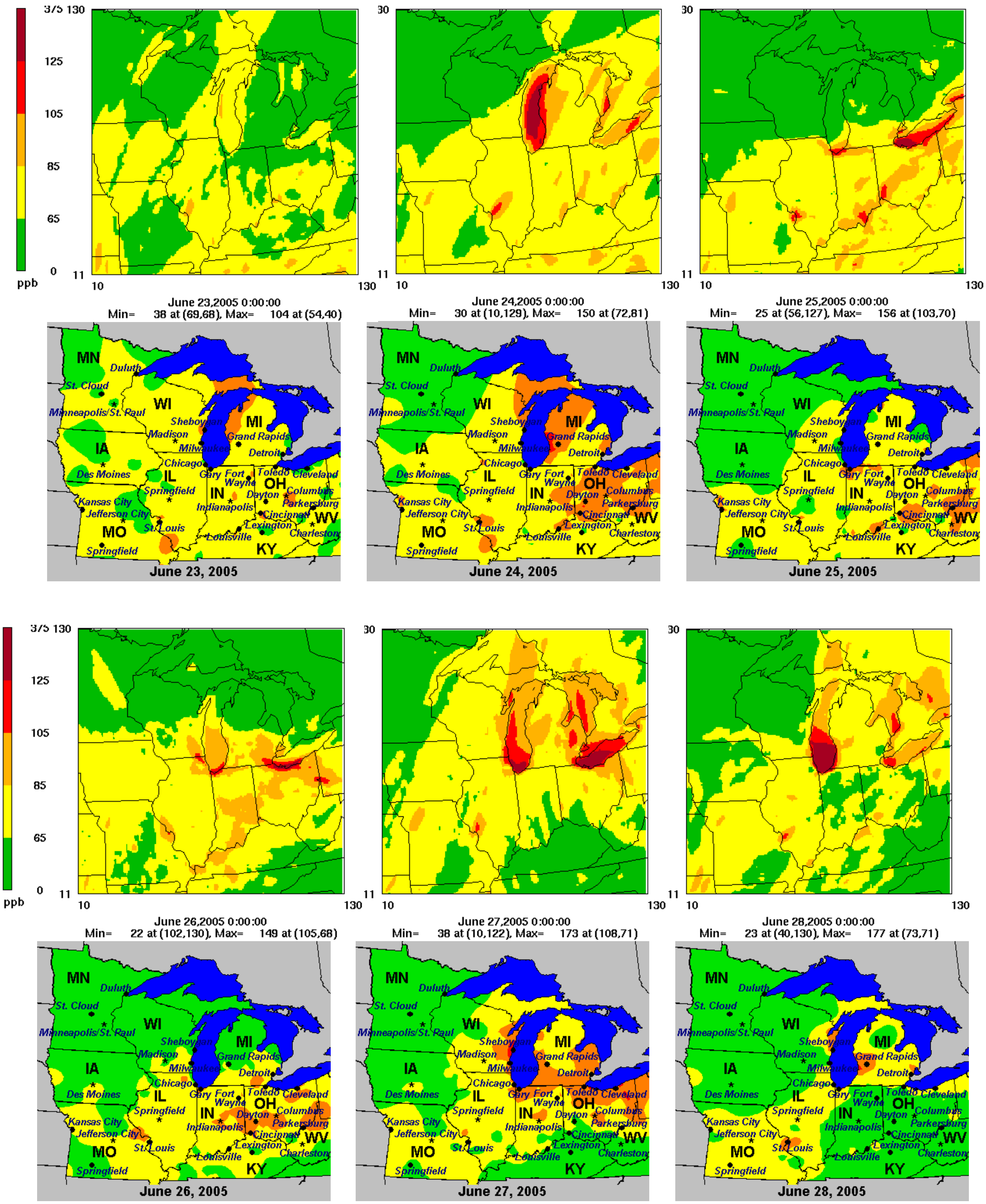


Figure 49b Modeled (top) v. monitored (bottom) 8-hour ozone concentrations: June 23– 28 2005

Standard model performance statistics were generated for the entire 12 km domain, and by day and by monitoring site. The domain-wide mean normalized bias for the 2005 base year is similar to that for the 2002 base year and is generally within 30% (see Figure 50).

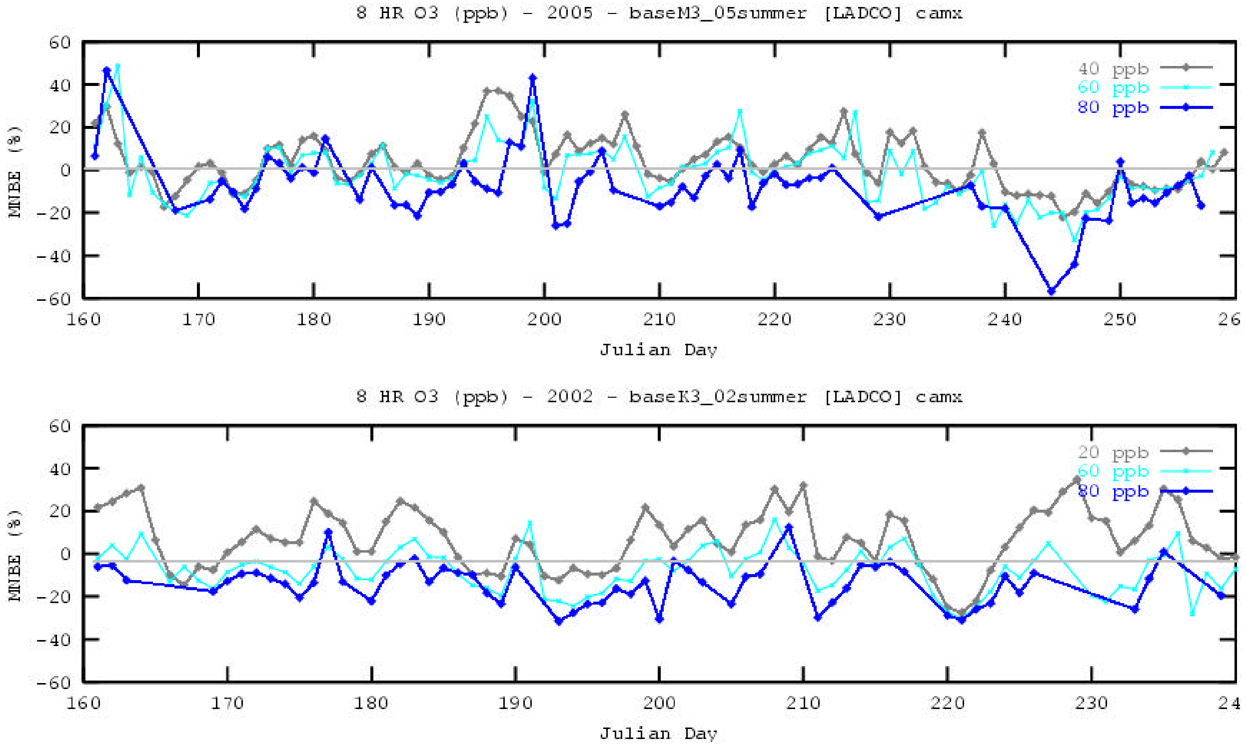


Figure 50. Mean bias for summer 2005 (Base M) and summer 2002 (Base K)

Station-average metrics (over the entire summer) are shown in Figure 51. The bias results further demonstrate the model's tendency to underestimate absolute ozone concentrations.

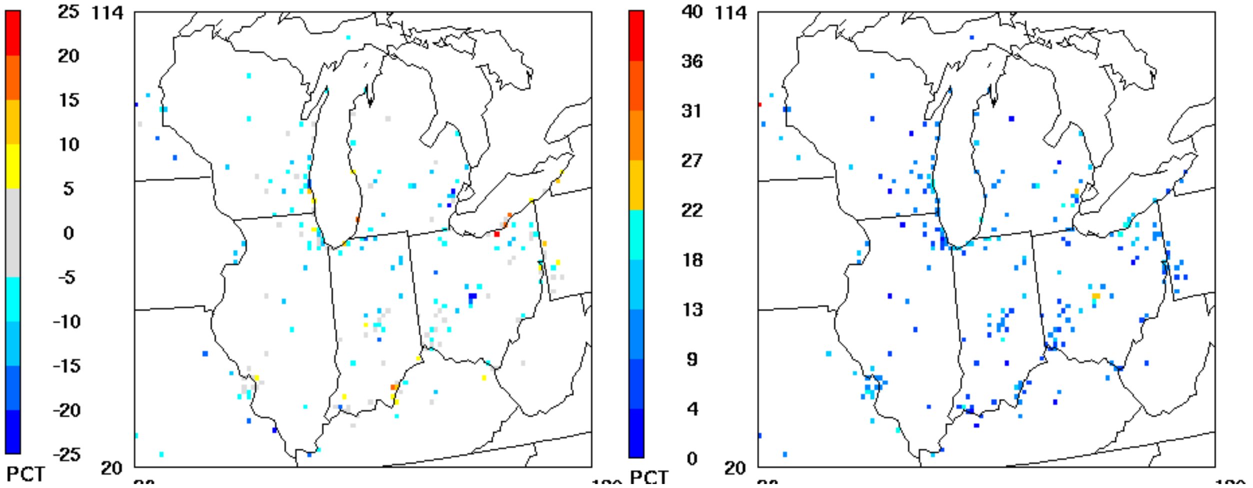


Figure 51. Mean bias (left) and gross error (right) for summer 2005

A limited 4 km ozone analysis was performed by LADCO to address the effect of grid spacing. For this modeling, 4 km grids were placed over Lake Michigan and the Detroit-Cleveland area (see Figure 52). Model inputs included 4 km emissions developed by LADCO (consistent with Base K/Round 4) and the 4 km meteorology developed by Alpine Geophysics.

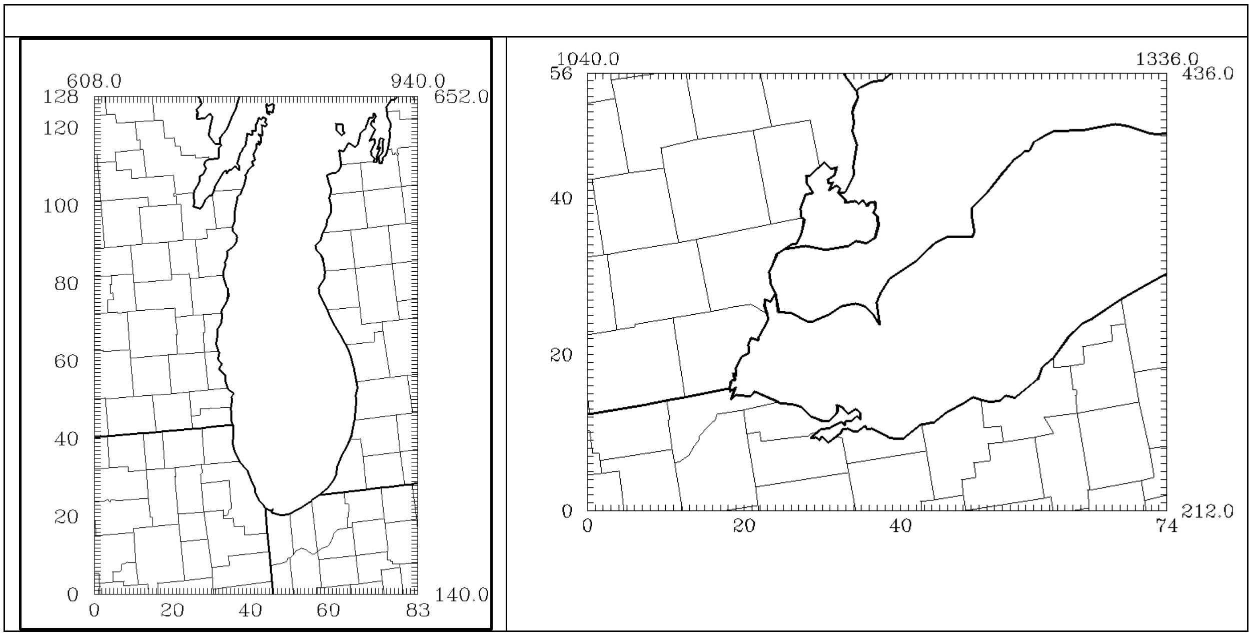


Figure 52. 4 km grids for Lake Michigan region and Detroit-Cleveland region

Hourly time series plots were prepared for several monitors (see Figure 53). The results are similar at 12 km and 4 km, with some site-by-site and day-by-day differences.

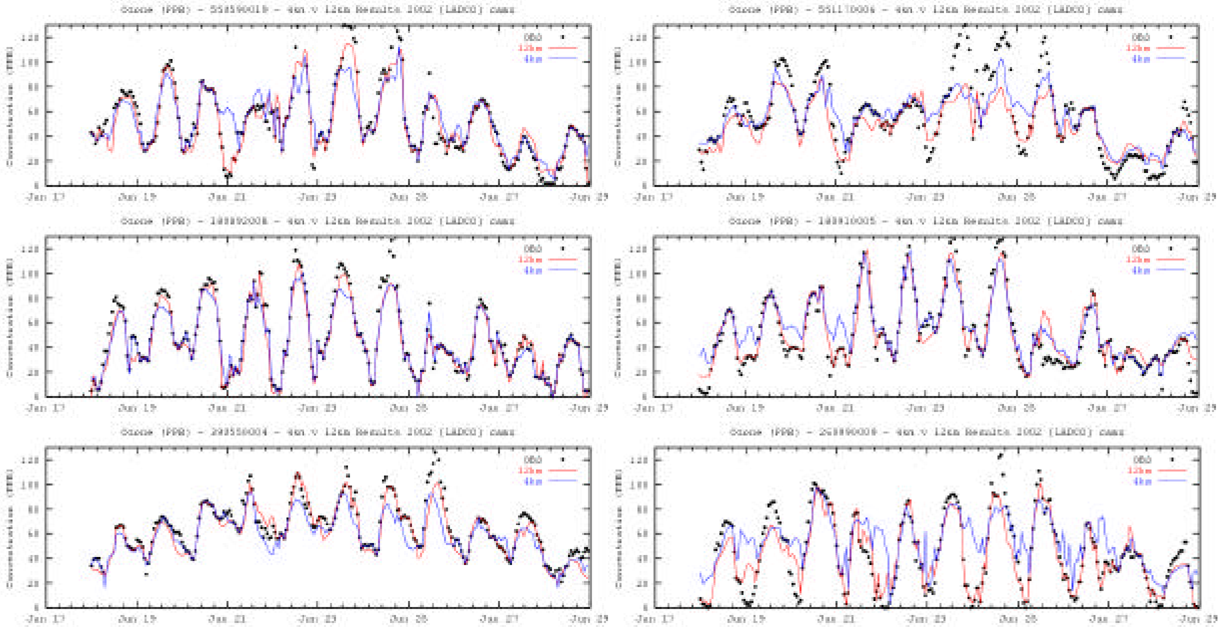
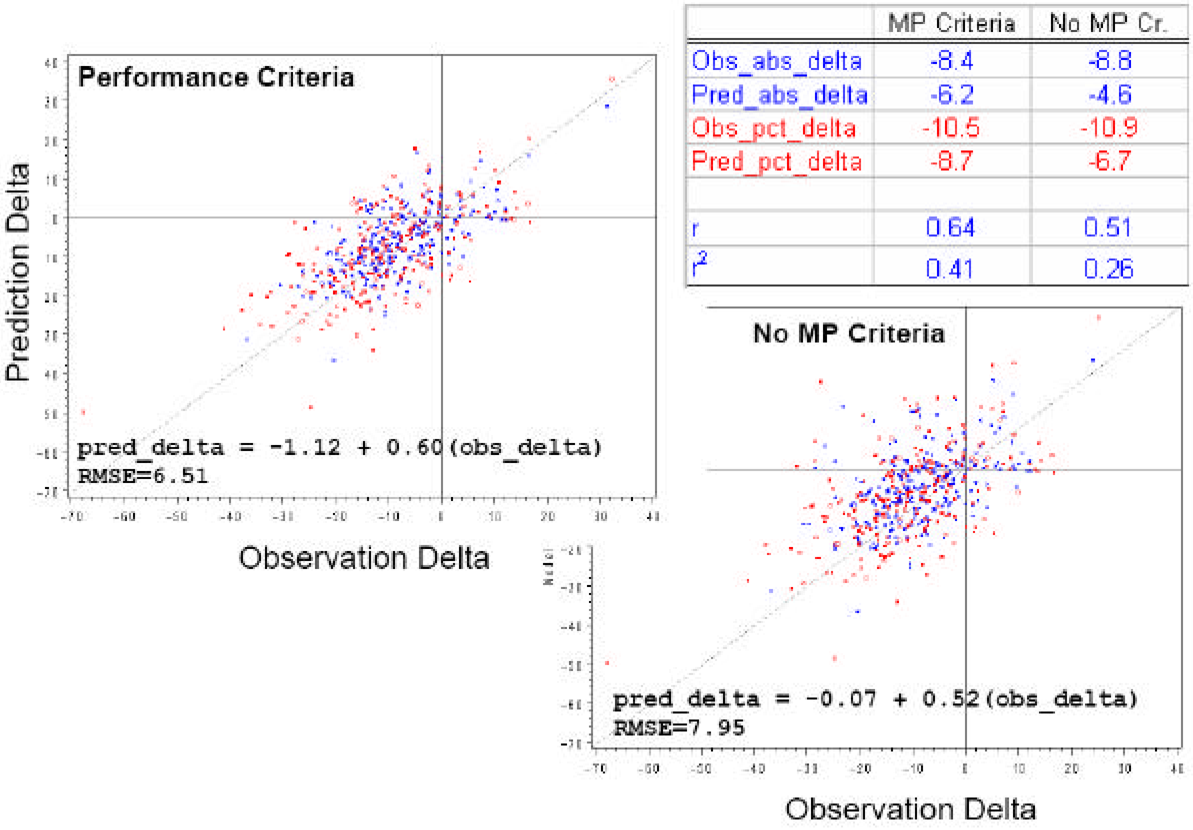


Figure 53. Ozone time series plots for 12 km and 4 km modeling (June 17-29, 2002)

An additional diagnostic analysis was performed to assess the response of the modeling system to changes in emissions (Baker and Kenski, 2007). Specifically, the 2002-to-2005 change in observed ozone concentrations was compared to the change in modeled ozone concentrations based on the 95th percentile(and above) concentration values for each monitor. This analysis was also done with the inclusion of model performance criteria which eliminated poorly performing days (i.e., error > 35%). The results show good agreement in the modeled and monitored ozone concentration changes (e.g., ozone improves by about 9-10 ppb between 2002 and 2005 according to the model and the measurements) – see Figure 54. This provides further support for using the model to develop ozone control strategies.



	MP Criteria	No MP Cr.
Obs_abs_delta	-8.4	-8.8
Pred_abs_delta	-6.2	-4.6
Obs_pct_delta	-10.5	-10.9
Pred_pct_delta	-8.7	-6.7
r	0.64	0.51
r^2	0.41	0.26

Figure 54. Comparison of change in predicted and observed ozone concentrations (2002 v. 2005)

$PM_{2.5}$: Time series plots of the monthly average mean bias and annual fractional bias for Base M and Base K are shown in Figure 55. As can be seen, Base M model performance for most species is fair (i.e., close to “no bias” throughout most of the year), with two main exceptions. First, the Base M and Base K results for organic carbon are poor, suggesting the need for more work on primary organic carbon emissions. Second, the Base M results for sulfate, while acceptable (i.e., bias values are within 35%), are not as good as the Base K results (e.g., noticeable underprediction during the summer months).

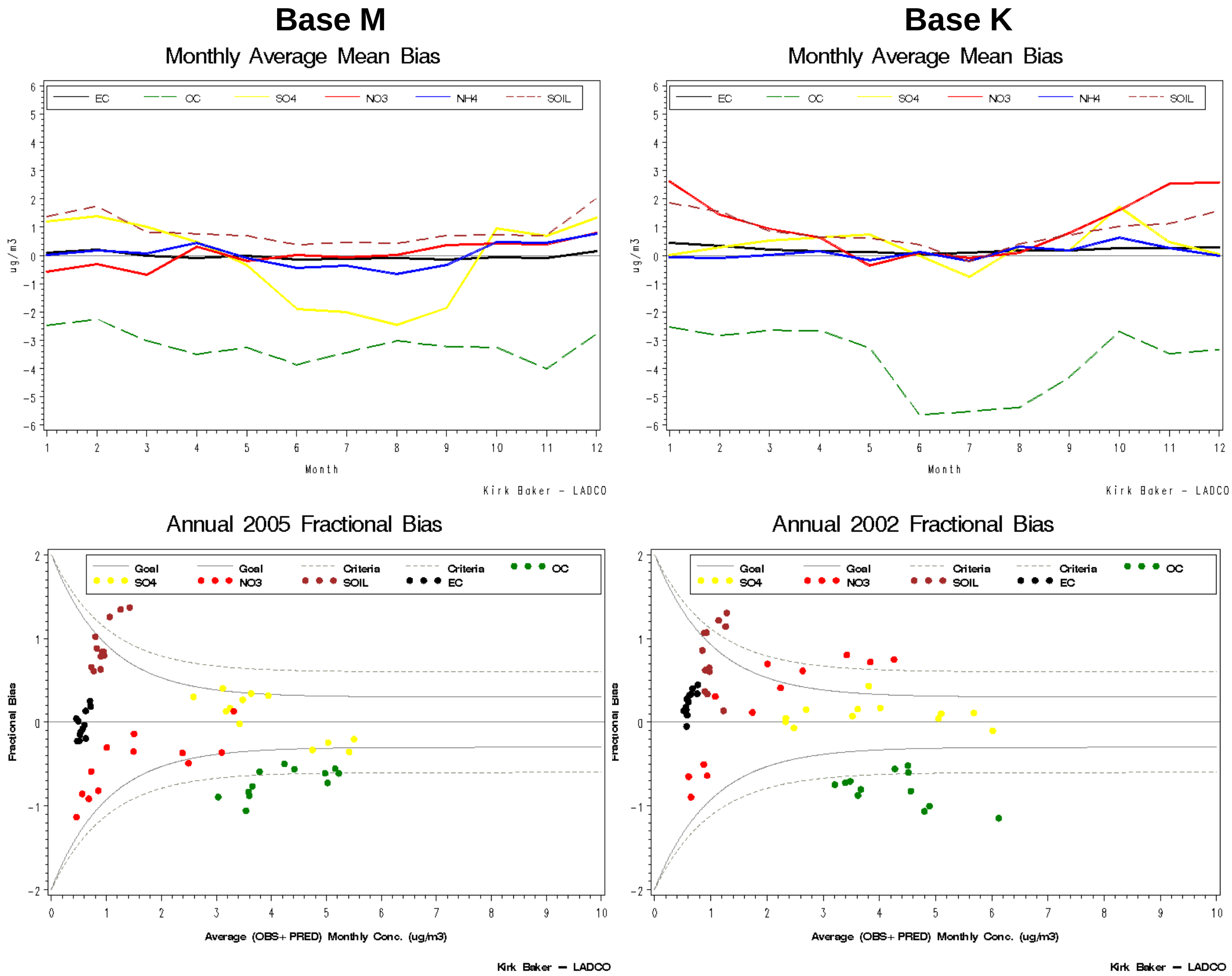


Figure 55. $PM_{2.5}$ Model performance - monthly average mean bias and annual fractional bias for Base M (left column) and Base K (right column)

Two analyses were undertaken to understand sulfate model performance for 2005:

- Assess Meteorological Influences: The MM5 model performance evaluation showed that rainfall is over-predicted by MM5 over most of the domain during the summer months (LADCO, 2007c). Because CAMx does not explicitly use the rainfall output by MM5, this may or may not result in over-prediction sulfate wet deposition (and under-prediction of sulfate concentrations). A sensitivity run was performed with no wet deposition for July, August, and September. The resulting model performance (see green line in Figure 56) showed a noticeable difference from the basecase (i.e., higher sulfate concentrations), and suggests that further evaluation of MM5 precipitation fields may be warranted.

- Assess Emissions Influences: The major contributor to sulfate concentrations in the region is SO2 emitted from EGUs. The basecase modeling inventory for EGUs is based on annual emissions, which were allocated to a typical weekday, Saturday, and Sunday by month using CEM-based temporal profiles. A sensitivity run was performed using day-specific emissions. The resulting model performance (see purple line in Figure 56) showed little difference from the basecase.

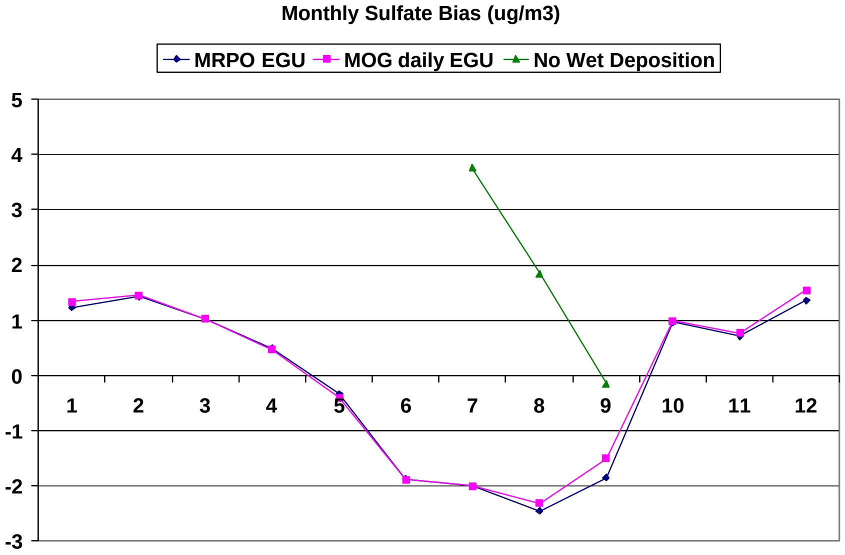


Figure 56. Monthly sulfate bias for Base M (MRPO EGU) v. two sensitivity analyses (Note: positive values indicate over-prediction, negative values indicate under-prediction)

To assess the effect of the wet deposition issue on future year modeled values, another sensitivity run was conducted with no wet deposition in Quarters 2-3 for the base year (2005) and 2018. The resulting future year values were only slightly different from the current base strategy run. In general, the future year values (without wet deposition) were a little higher (+0.15 ug/m^3 or less) in the Ohio Valley and a little lower (-.10 ug/m^3 of less) in the Great Lakes region. This sensitivity run provides a bound for sulfate wet deposition issue in terms of the attainment test, given that having no wet deposition is unrealistic. The results suggest that even with an improved wet deposition treatment, the Base M strategy results are not expected to change very much.

Time series plots of daily sulfate, nitrate, elemental carbon, and organic carbon concentrations for three Midwestern locations are presented in Figures 57 (2002) and 58 (2005). These results are consistent with the model performance statistics (i.e., good agreement for sulfates and nitrates and poor agreement [large underprediction] for organic carbon).

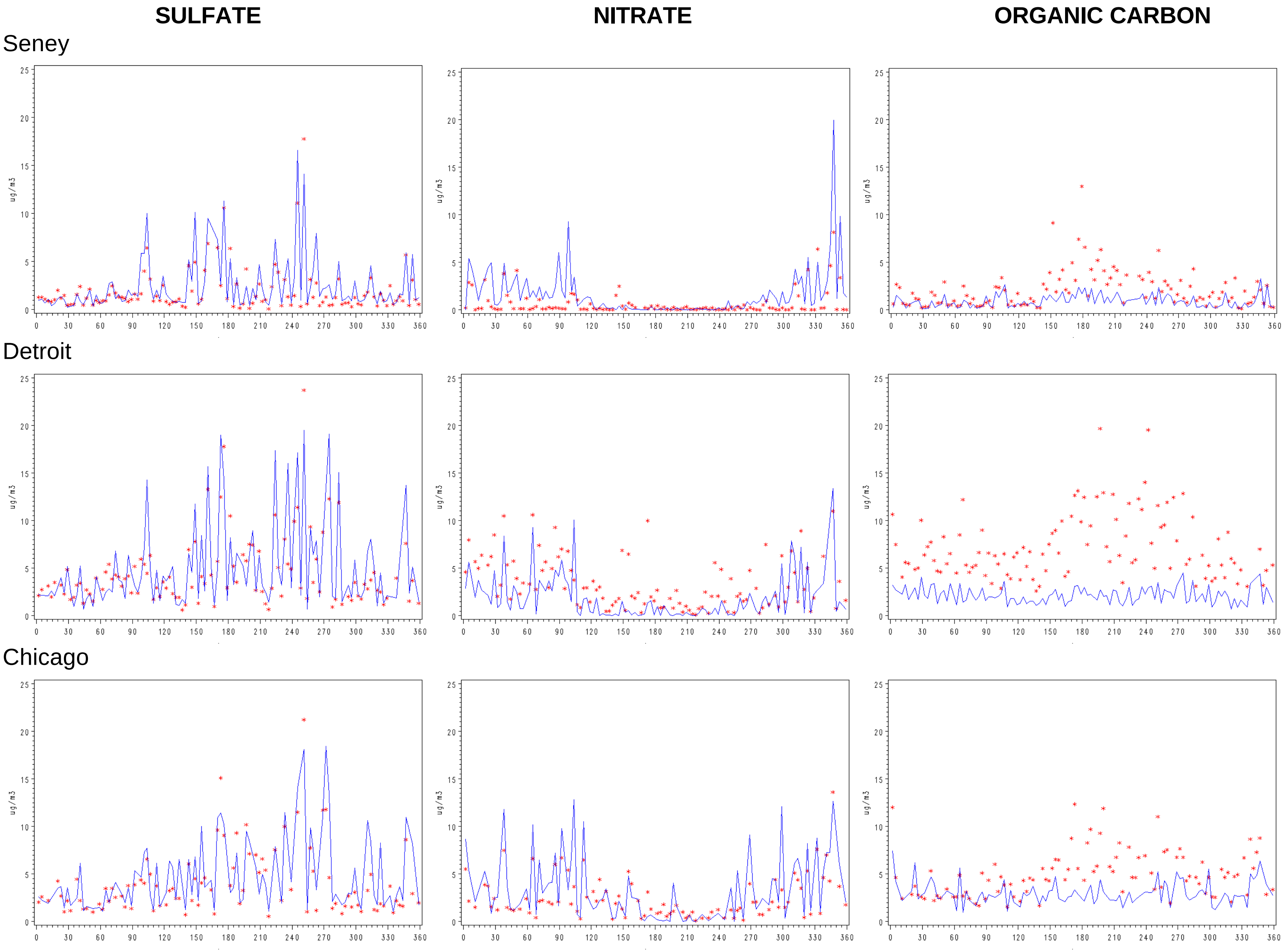
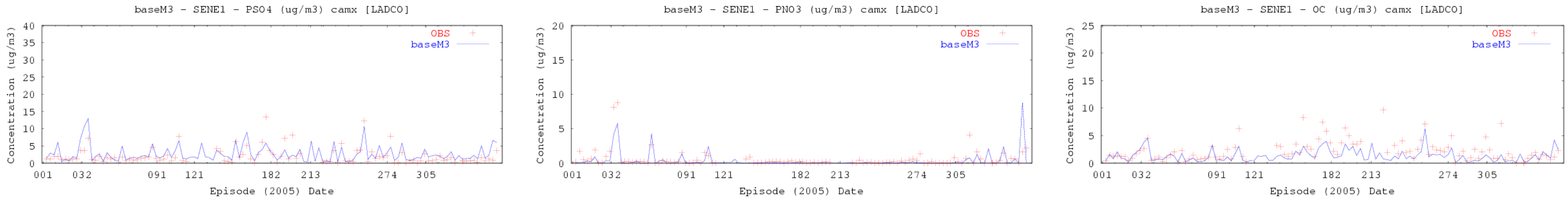


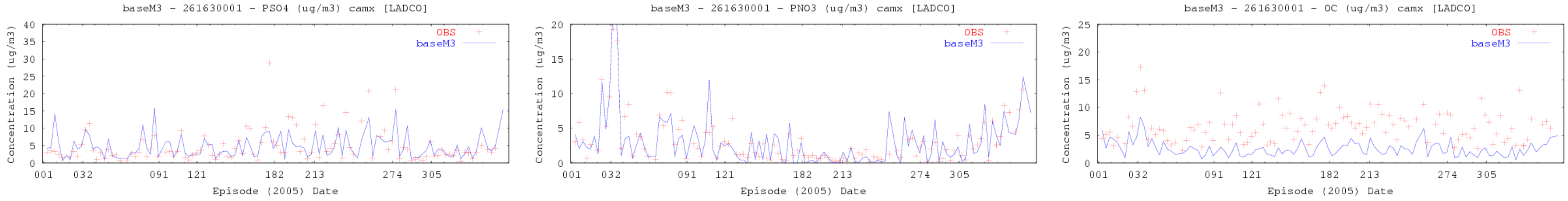
Figure 57. Time series of sulfate, nitrate, and organic carbon at three Midwest sites for 2005

SULFATE NITRATE ORGANIC CARBON

Seney



Detroit



Chicago

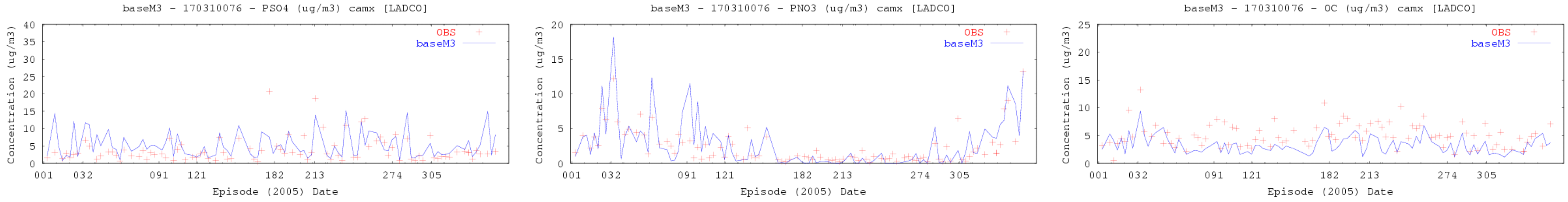


Figure 58. Time series of sulfate, nitrate, and organic carbon at three Midwest sites for 2005

In summary, model performance for ozone and $PM_{2.5}$ is generally acceptable and can be characterized as follows:

Ozone

- Good agreement between modeled and monitored concentration for higher concentration levels (> 60 ppb) – i.e., bias within 30%
- Regional modeled concentrations appear to be underestimated in the 2002 base year, but show better agreement (with monitored data) in the 2005 base year due to model and inventory improvements.
- Day-to-day and hour-to-hour variation in and spatial patterns of modeled concentrations are consistent with monitored data
- Model accurately simulates the change in monitored ozone concentrations due to reductions in precursor emissions.

$PM_{2.5}$

- Good agreement in the magnitude of fine particle mass, but some species are overestimated and some are underestimated (during periods of the year when it is important)
  - Sulfates: good agreement in the 2002 base year, but underestimated in the summer in the 2005 base year due probably to meteorological factors
  - Nitrates: slightly overestimated in the winter in the 2002 base year, but good agreement in the 2005 base year as a result of model and inventory improvements
  - Organic Carbon: grossly underestimated in the 2002 and 2005 base years due likely to missing primary organic carbon emissions and, possibly, other factors (e.g., grid resolution and model chemistry).
- Temporal variation and spatial patterns of modeled concentrations are consistent with monitored data

Several observations should be noted on the implications of these model performance findings on the attainment modeling presented in the following section. First, it has been demonstrated that model performance overall is acceptable and, thus, the model can be used for air quality planning purposes. Second, consistent with EPA guidance, the model is used in a relative sense to project future year values. EPA suggests that this approach “should reduce some of the uncertainty attendant with using absolute model predictions alone” (EPA, 2007a). Furthermore, the attainment modeling is supplemented by additional information to provide a weight of evidence determination.

Section 4.0 Attainment Demonstration for Ozone and $PM_{2./5}$

Air quality modeling and other information were used to determine whether existing ("on the books") controls would be sufficient to provide for attainment of the NAAQS for ozone and $PM_{2.5}$ and if not, then what additional emission reductions would be necessary for attainment. Traditionally, attainment demonstrations involved a "bright line" test in which a single modeled value was compared to the ambient standard. To provide a more robust assessment of expected future year air quality, EPA's modeling guidelines call for consideration of supplemental information. This section summarizes the results of the primary (guideline) modeling analysis and a weight of evidence determination based on the modeling results and other supplemental analyses.

4.1 Future Year Modeling Results

The purpose of the future year modeling is to assess the effectiveness of existing and possible additional control programs. The model was used in a relative sense to project future year values, which are then compared to the standard to determine attainment/nonattainment. Specifically, the modeling test consists of the following steps:

(1) Calculate base year design values: For ozone and $PM_{2.5}$, the base year design values were derived by averaging the three 3-year periods centered on the emissions base year:

2002 base year: 2000-2002, 2001-2003, and 2002-2004
2005 base year: 2003-2005, 2004-2006, and 2005-2007[11]

(2) Estimate the expected change in air quality: For each grid cell, a relative reduction factor (RRF) is calculated by taking the ratio of the future year and baseline modeling results.

(3) Calculate future year values: For each grid cell (with a monitor), the RRFs are multiplied by the base year design values to project the future year values

(4) Assess attainment: Future year values are compared to the NAAQS to assess attainment or nonattainment.

A comparison of the 2002 and 2005 base year design values for ozone and $PM_{2.5}$ is provided in Figure 59. In general, the figure shows that the 2005 base year design values are much lower than the 2002 base year design values, especially for ozone.

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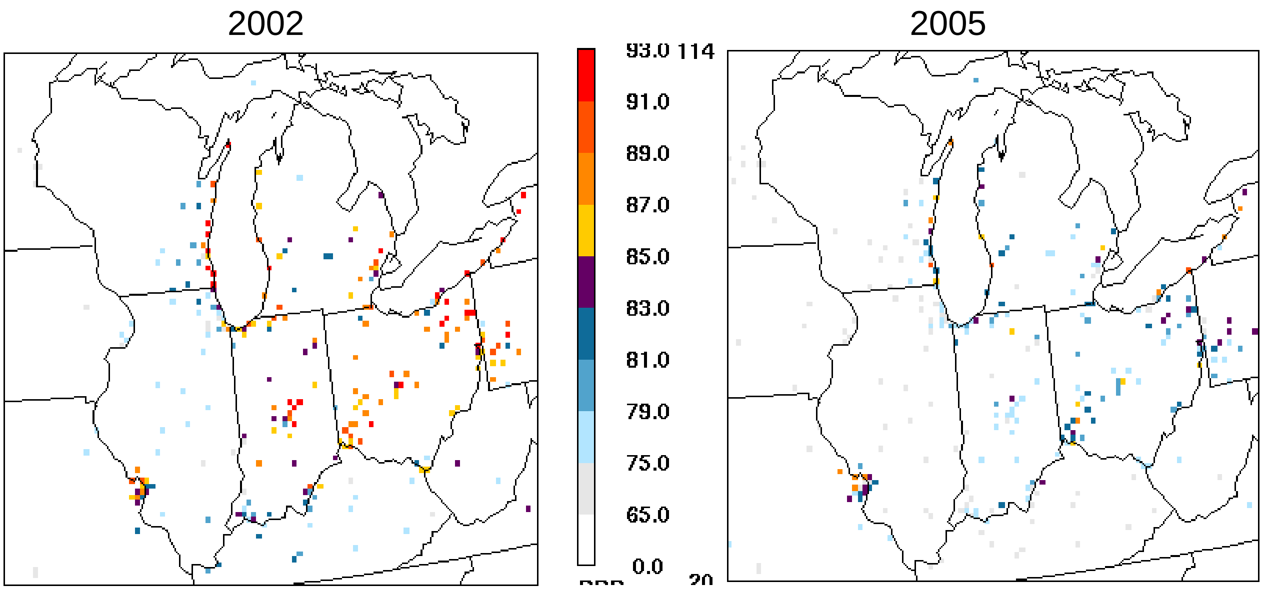
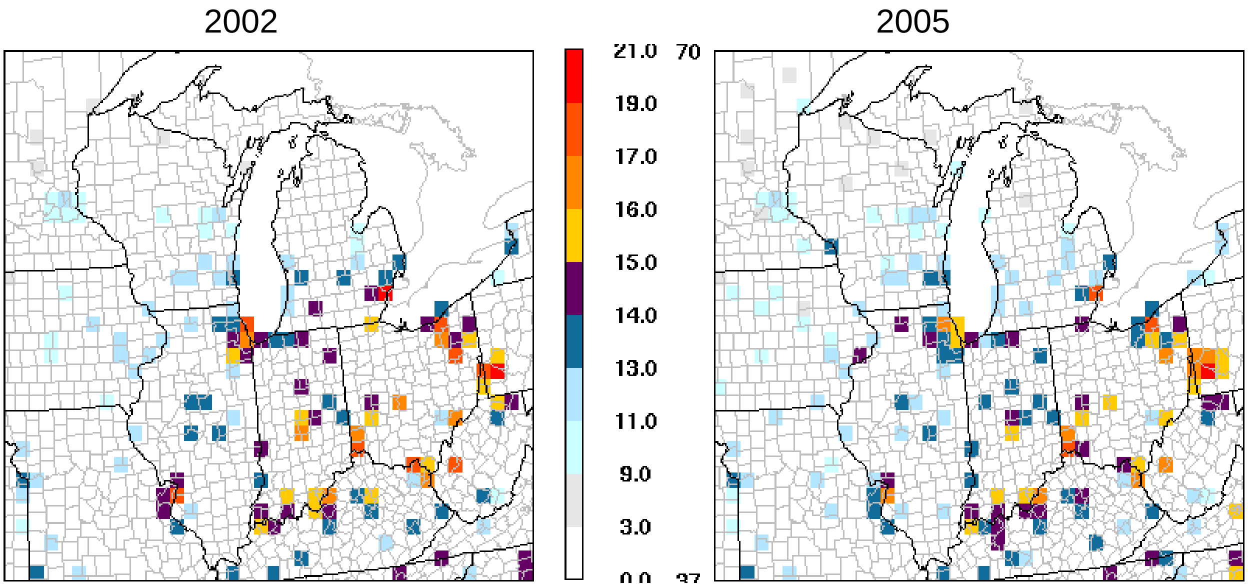
[11] A handful of source-oriented PM2.5 monitors in Illinois and Indiana were excluded from the annual attainment test, because these monitors are not to be used to judging attainment of the annual standard.



Statistical Summary

# Sites > NAAQS	93	9
Peak Value	99.0 ppb	90.0 ppb
Ave Exceedance Amount	7 ppb	2 ppb



Statistical Summary

# Sites > NAAQS	58	41
Peak Value	19.3 ug/m^3	17.7 ug/m^3
Ave Exceedance Amount	1.2 ug/m^3	0.9 ug/m^3

Figure 59. 2002 v. 2005 base year design values for ozone (top) and PM$_{2.5}$ (bottom)

Ozone results are provided for those grid cells with ozone monitors. The RRF calculation considers all nearby grid cells (i.e., 3x3 for 12 km modeling) and a threshold of 85 ppb. (If there were less than 10 days above this value, then the threshold was lowered until either there were 10 days or the threshold reached 70 ppb.) $PM_{2.5}$ results are provided for those grid cells with FRM ($PM_{2.5}$-mass) monitors. Spatial mapping was performed to extrapolate $PM_{2.5}$-speciation data from STN and IMPROVE sites to FRM sites. RRF values for $PM_{2.5}$ were derived as a function of quarter and chemical species.

Additional, hot-spot modeling will be performed by the states for certain $PM_{2.5}$ nonattainment areas (e.g., Detroit, Cleveland, and Granite City) to address primary emissions from local point sources which may not be adequately accounted for by the regional grid modeling. This modeling will consist of Gaussian dispersion modeling (e.g., AERMOD) performed in accordance with EPA's modeling guidance (see Section 5.3 of the April 2007 guidance document). Further analyses will need to be undertaken to determine how to best combine the regional modeling and the hot-spot modeling. This could mean some adjustment to the model results presented in this document to reflect better the regional component.

The ozone and $PM_{2.5}$ modeling results are provided in Appendix I for select monitors (high concentration sites) in the 5-state region for the following future years of interest: 2008 (ozone only), 2009, 2012, and 2018. (Note, RRF values for ozone, and for $PM_{2.5}$ by season and chemical species are also included in Appendix I for key monitoring sites.) A summary of the modeling results is provided in Table 9 (ozone) and Table 10 ($PM_{2.5}$), and spatial maps of the Base M future year concentrations are provided in Figures 60-62.

Table 9. Summary of Ozone Modeling Results

Key Sites		2008			2009			2012			2018
		Round 5	Round 4		Round 5	Round 4		Round 5	Round 4		Round 5
Lake Michigan Area											
Chiwaukee	550590019	82.0	**93.0**		82.3	**92.0**		80.9	**90.3**		76.2
Racine	551010017	77.6	**85.9**		77.5	84.9		76.1	82.9		71.2
Milwaukee-Bayside	550190085	79.6	**85.4**		79.8	84.9		78.0	82.3		72.7
Harrington Beach	550890009	80.0	**86.7**		80.1	**85.4**		78.3	82.9		72.5
Manitowoc	550710007	81.3	80.3		80.8	78.9		78.6	76.3		72.5
Sheboygan	551170006	84.4	**90.0**		84.0	**88.9**		81.8	**86.4**		75.4
Kewaunee	550610002	78.9	82.5		78.1	81.0		75.9	79.1		69.9
Door County	550290004	84.8	83.6		83.9	81.8		81.5	79.3		74.7
Hammond	180892008	75.4	**86.9**		75.4	**86.6**		74.6	**86.3**		71.6
Whiting	180890030	77.0			77.0			76.2			73.1
Michigan City	180910005	74.2	**87.4**		73.9	**86.5**		72.5	**85.4**		68.1
Ogden Dunes	181270020	75.7	82.3		75.6	82.8		74.5	82.0		70.8
Holland	260050003	**85.6**	84.9		**85.3**	83.4		82.8	81.0		76.1
Jenison	261390005	77.9	78.7		77.1	77.6		74.5	75.5		68.7
Muskegon	261210039	80.8	82.7		80.5	81.5		78.0	79.4		71.9
Indianapolis Area											
Noblesville	189571001	78.0	**85.2**		78.1	83.7		75.6	82.0		68.7
Fortville	180590003	73.9	**85.1**		73.9	83.8		71.4	82.1		65.1
Fort B. Harrison	180970050	74.8	84.8		75.1	83.7		73.2	82.4		69.1
Detroit Area											
New Haven	260990009	82.7	**86.3**		81.4	**85.3**		80.2	83.5		76.1
Warren	260991003	82.5	84.3		81.3	83.3		80.7	81.9		77.6
Port Huron	261470005	79.0	80.5		77.5	79.1		75.5	77.0		70.9
Cleveland Area											
Ashtabula	390071001	84.9	84.7		83.4	82.7		81.0	80.2		75.1
Geauga	390550004	75.7	**90.3**		74.7	**88.8**		72.7	**86.2**		67.3
Eastlake	390850003	82.8	84.2		81.9	82.8		80.5	80.6		76.2
Akron	391530020	79.3	83.0		78.1	81.4		75.6	78.5		68.7
Cincinnati Area											
Wilmington	390271002	77.8	84.8		77.5	83.5		74.9	81.1		68.3
Sycamore	390610006	81.7	**85.4**		81.9	84.7		80.3	82.9		74.6
Lebanon	391650007	83.6	80.1		83.0	79.0		80.7	77.0		74.2
Columbus Area											
London	390970007	75.4	79.9		75.0	78.4		72.6	76.5		66.3
New Albany	390490029	82.4	84.1		81.8	82.6		79.6	80.2		73.0
Franklin	290490028	77.0	77.7		75.9	76.5		74.1	74.7		69.0
St. Louis Area											
W. Alton (MO)	291831002	82.4	**86.1**		81.0	**85.2**		78.6	84.0		74.9
Orchard (MO)	291831004	83.3	83.3		82.0	82.2		80.0	80.4		76.2
Sunset Hills (MO)	291890004	79.5	82.8		78.7	81.9		77.1	80.6		73.9
Arnold (MO)	290990012	78.7	78.4		77.2	77.4		75.6	75.8		72.0
Margaretta (MO)	295100086	79.8	84.0		79.3	83.4		77.9	82.5		74.4
Maryland Heights (MO)	291890014	84.5			83.4			81.7			78.1

Table 10. Summary of PM2.5 Modeling Results

			2009		2012		2018	
County	**Site ID**	**Site**	**Round 5**	**Round4**	**Round 5**	**Round4**	**Round 5**	**Round4**
Cook	170310022	Chicago - Washington HS	14.1	14.8	14.0	14.6	13.9	14.4
Cook	170310052	Chicago - Mayfair	14.4	**15.8**	14.2	**15.5**	13.9	**15.0**
Cook	170310057	Chicago - Springfield	13.9	14.5	13.8	14.3	13.7	14.1
Cook	170310076	Chicago - Lawndale	13.8	14.5	13.7	14.3	13.6	14.1
Cook	170312001	Blue Island	13.7	14.5	13.6	14.3	13.4	14.1
Cook	170313301	Summit	14.2	14.8	14.0	14.6	13.9	14.4
Cook	170316005	Cicero	14.4	**15.3**	14.3	**15.1**	14.2	14.9
Madison	171191007	Granite City	**15.1**	**16.0**	14.9	**15.8**	14.3	**15.5**
St. Clair	171630010	E. St. Louis	14.1	14.9	13.9	14.7	13.4	14.5
Clark	180190005	Jeffersonville	13.8	**15.5**	13.7	**15.0**	13.4	14.4
Dubois	180372001	Jasper	12.4	13.8	12.2	13.5	11.8	13.0
Lake	180890031	Gary	13.0		12.8		12.4	
Marion	180970078	Indy-Washington Park	12.8	14.5	12.6	14.2	12.0	13.7
Marion	180970083	Indy- Michigan Street	13.4	14.8	13.1	14.9	12.6	14.0
Wayne	261630001	Allen Park	13.0	14.5	12.8	14.1	12.4	13.3
Wayne	261630015	Southwest HS	14.2	**15.8**	13.9	**15.3**	13.5	14.4
Wayne	261630016	Linwood	13.1	14.1	12.8	13.7	12.5	13.0
Wayne	261630033	Dearborn	**15.8**	**17.7**	**15.5**	**17.1**	**15.1**	**16.1**
Wayne	261630036	Wyandotte	13.1	**15.1**	12.8	14.7	12.5	13.9
Butler	390170003	Middleton	13.5	14.2	13.2	13.7	12.8	13.1
Butler	390170016	Fairfield	13.1	13.5	12.9	12.9	12.5	12.2
Cuyahoga	390350027	Cleveland-28th Street	13.5	14.4	13.2	13.8	12.7	12.9
Cuyahoga	390350038	Cleveland-St. Tikhon	**15.2**	**16.1**	14.8	**15.4**	14.3	14.4
Cuyahoga	390350045	Cleveland-Broadway	14.4	14.6	14.0	14.0	13.5	13.1
Cuyahoga	390350060	Cleveland-GT Craig	15.0	**15.3**	14.6	14.7	14.1	13.7
Cuyahoga	390350065	Newburg Hts - Harvard Ave	14.0	14.1	13.6	13.5	13.1	12.6
Franklin	390490024	Columbus - Fairgrounds	12.9	14.6	12.6	14.0	12.0	13.0
Franklin	390490025	Columbus - Ann Street	12.7	14.1	12.4	13.5	11.9	12.5
Franklin	390490081	Columbus - Maple Canyon	11.7	14.0	11.4	13.4	10.9	12.5
Hamilton	390610014	Cincinnati - Seymour	14.5	**15.5**	14.3	14.8	13.8	14.0
Hamilton	390610040	Cincinnati - Taft Ave	12.8	13.6	12.6	13.0	12.2	12.3
Hamilton	390610042	Cincinnati - 8th Ave	14.0	14.6	13.8	14.0	13.4	13.2
Hamilton	390610043	Sharonville	12.9	13.6	12.7	13.0	12.3	12.2
Hamilton	390617001	Norwood	13.4	14.2	13.2	13.6	12.8	12.8
Hamilton	390618001	St. Bernard	14.7	**15.2**	14.4	14.6	14.0	13.8
Jefferson	390810016	Steubenville	12.8	**16.3**	12.5	**15.9**	12.7	**16.2**
Jefferson	390811001	Mingo Junction	13.5	**15.5**	13.2	**15.0**	13.4	**15.3**
Lawrence	390870010	Ironton	12.8	14.2	12.5	13.7	12.3	13.2
Montgomery	391130032	Dayton	13.2	13.7	12.9	13.2	12.4	12.3
Scioto	391450013	New Boston	12.1	**15.4**	11.9	14.8	11.6	14.2
Stark	391510017	Canton - Dueber	14.0	**15.0**	13.6	14.3	13.3	13.6
Stark	391510020	Canton - Market	12.6	13.6	12.3	13.0	11.9	12.2
Summit	391530017	Akron - Brittain	13.0	14.4	12.7	13.6	12.3	12.9
Summit	391530023	Akron - W. Exchange	12.3	13.6	12.0	13.0	11.5	12.2

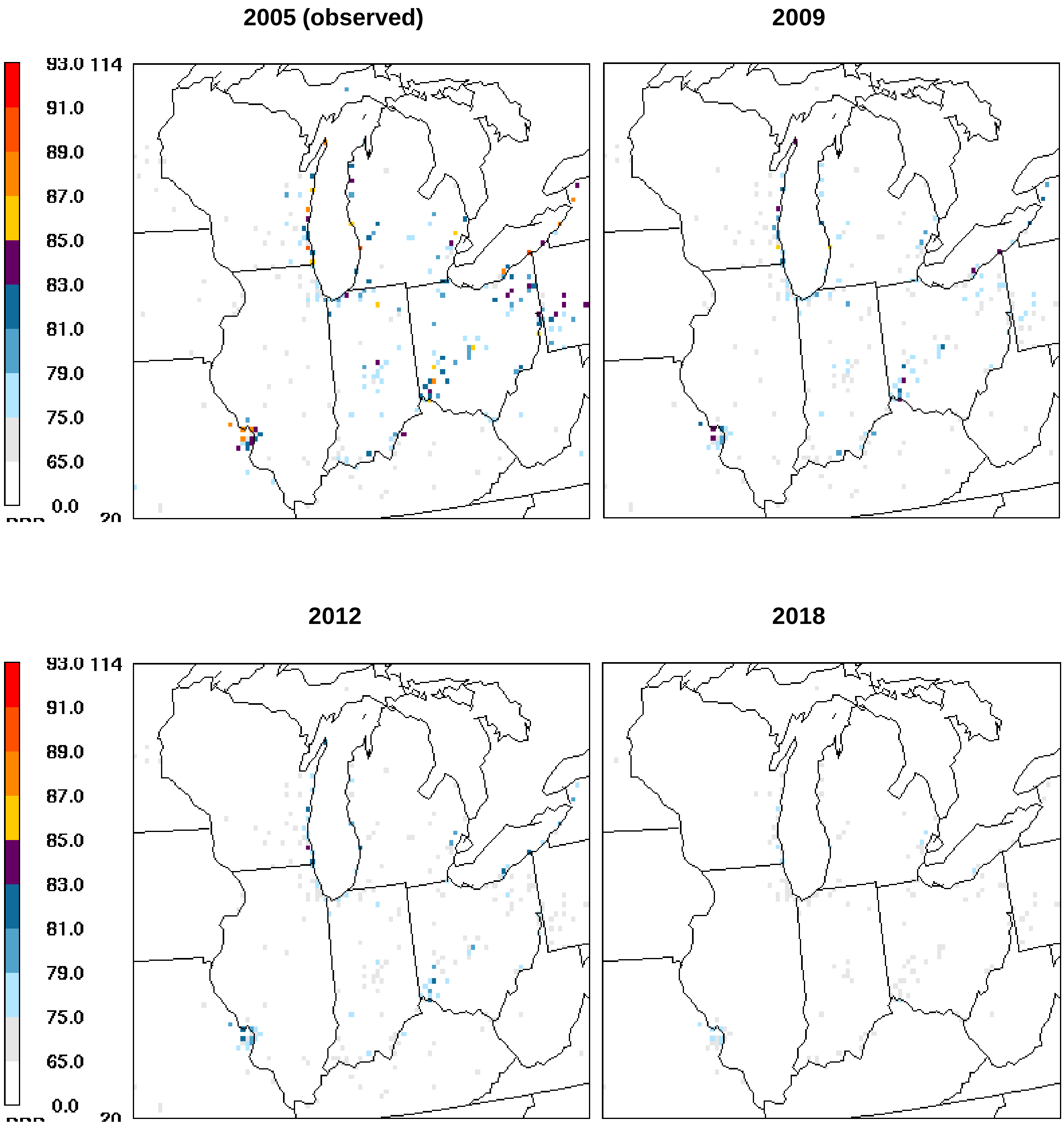


Figure 60. Observed base year and projected future year design values for ozone – Base M

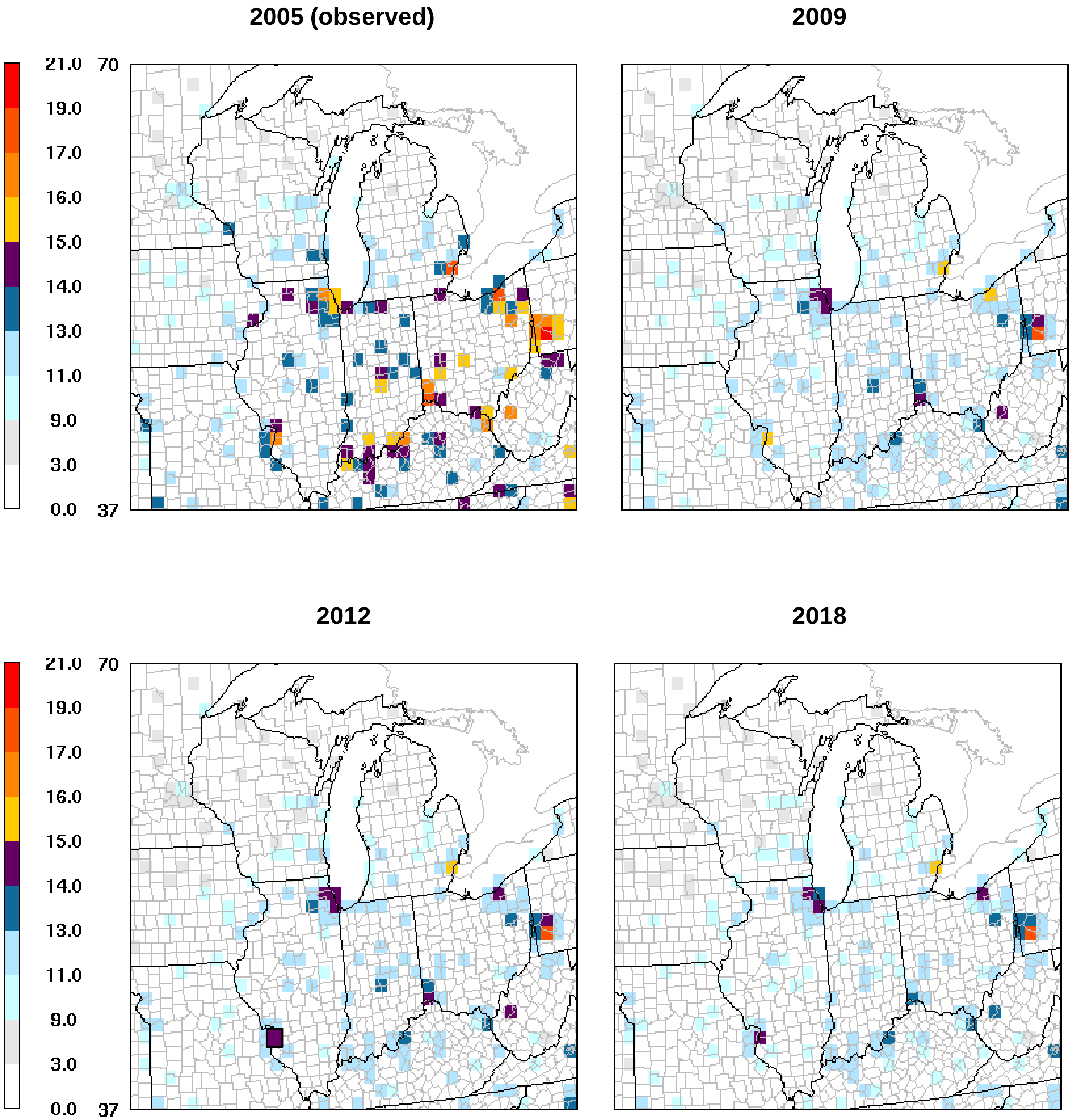


Figure 61. Observed base year and projected future year design values for $PM_{2.5}$ (annual average)–Base M

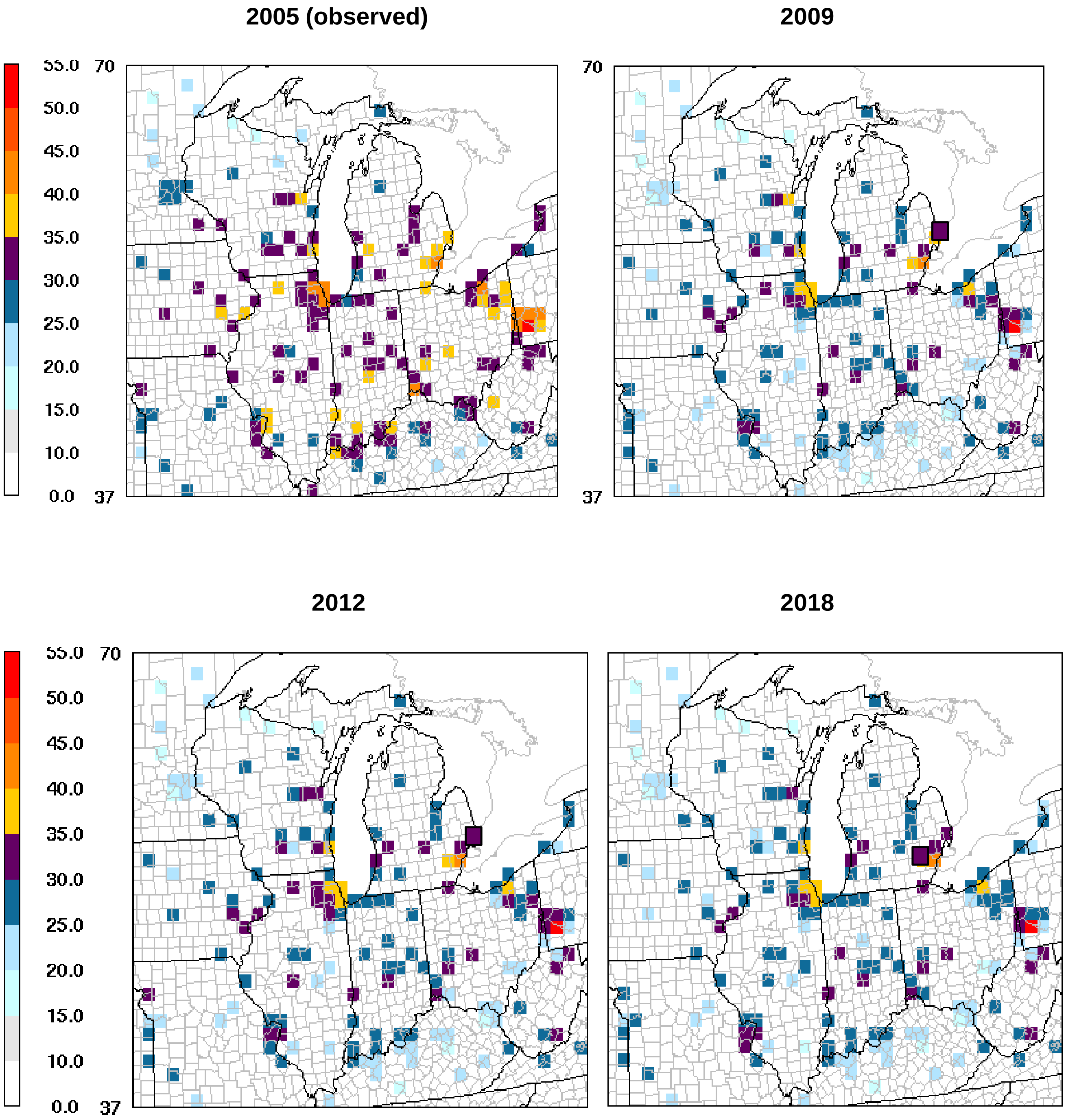


Figure 62. Observed base year and projected future year design values for $PM_{2.5}$ (24-hr average)-Base M

The number of monitors with design values above the standard are as follows:

Table 11. Number of sites above standard

Ozone (8 hour: 85 ppb)											
State	2002	2005		2009			2012			2018	
	BaseK	Base M		BaseK	Base M		BaseK	Base M		BaseK	Base M
IL	3	0		0	0		0	0		0	0
IN	22	0		0	0		0	0		0	0
MI	15	3		1	1		0	0		0	0
OH	40	4		1	0		1	0		0	0
WI	13	2		4	0		3	0		1	0
Total	93	9		6	1		4	0		1	0
PM2.5 (Annual: 15 ug/m^3)											
State	2002	2005		2009			2012			2018	
	BaseK	Base M		BaseK	Base M		BaseK	Base M		BaseK	Base M
IL	11	7		3	1		3	0		2	0
IN	10	6		1	0		1	0		0	0
MI	6	2		3	1		2	1		0	0
OH	31	26		7	1		4	0		1	1
WI	0	0		0	0		0	0		2	0
Total	58	41		14	3		10	1		5	1

The modeling results above reflect the "base" controls identified in Section 3.6, with EGU emissions based on IPM modeling (i.e., Round 4 – IPM2.1.9, and Round 5 – IPM3.0). In addition, two sets of alternative future year EGU emissions were examined in Round 5. First, alternative control assumptions were provided for several facilities by the states (i.e., "will do" and "may do" scenarios). In general, these scenarios produced a small change in future year ozone and $PM_{2.5}$ concentrations (i.e., about 0.1 ug/m^3 for $PM_{2.5}$ and 0.1-0.2 ppb for ozone). Second, EPA suggested adjustments to the 2010 IPM emissions to reflect 2009 conditions. The revised (2009) SO2 emissions represent a 5-6% increase in domainwide SO2 emissions. The increased SO2 emissions result in slightly greater annual average $PM_{2.5}$ concentrations (on the order of 0.1 – 0.2 ug/m^3), but do not produce any new residual nonattainment areas.

The limited 4 km ozone modeling (based on Base K) performed by LADCO included a future year analysis for 2009. The figure below shows the 2009 values with 12 km and 4 km grid spacing for the LADCO modeling and similar modeling conducted by a stakeholder group (Midwest Ozone Group).

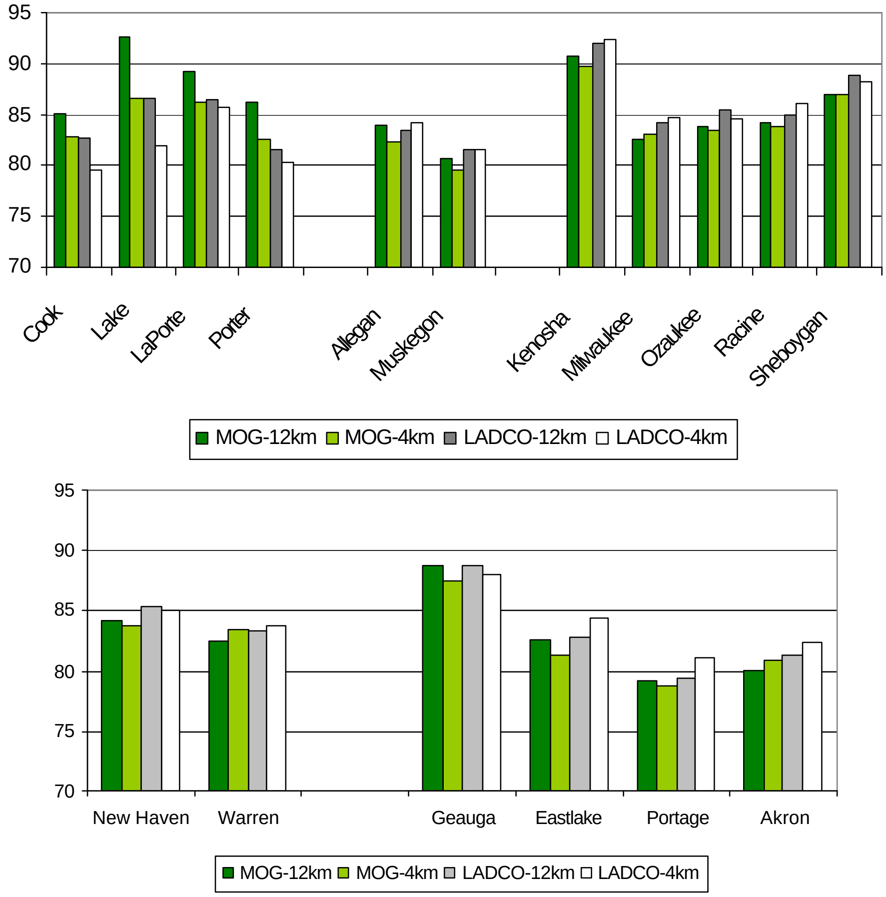


Figure 63. Future year (2009) values for Lake Michigan area (top) and Detroit-Cleveland region (bottom)

These results show that the 12 km and 4 km values are similar, with the most notable changes in northwestern Indiana and northeastern Illinois (e.g., 4 km values are as much as 4 ppb lower than 12 km values). The differences in the southern part of the Lake Michigan area are plausible, given the tight emissions gradient there (i.e., finer grid resolution appears to provide more appropriate representation).

In light of these findings, 12 km grid spacing can continue to be used for ozone modeling, but the Base K/Round 4 results for northwestern Indiana/northeastern Illinois should be viewed with caution (i.e., probably 1 – 4 ppb too high).

In summary, the ozone modeling provides the following information for the nonattainment areas in the region (see Table 12):

Table 12. Ozone Nonattainment Areas in the LADCO Region (as of December 31, 2007)

Area Name	Category	Number of Counties	Attainment Deadline
Detroit-Ann Arbor, MI	Marginal	8	2007
Chicago-Gary-Lake County, IL-IN	Moderate	10	2010
Cleveland-Akron-Lorain, OH	Moderate	8	2010
Milwaukee-Racine, WI	Moderate	6	2010
Sheboygan, WI	Moderate	1	2010
St Louis, MO-IL	Moderate	4	2010
Allegan Co, MI	Subpart 1	1	2009
Cincinnati-Hamilton, OH-KY-IN	Subpart 1	6	2009
Columbus, OH	Subpart 1	6	2009
Door Co, WI	Subpart 1	1	2009
Kewaunee Co, WI	Subpart 1	1	2009
Manitowoc Co, WI	Subpart 1	1	2009
		53	

Marginal Areas (2007 attainment date): No modeling was conducted for the 2006 SIP planning year. Rather, 2005 – 2007 air quality data are available to determine attainment.

Basic (Subpart 1) Areas (2009 attainment date): The modeling results for the 2008 SIP planning year show:

- Base K: all areas in attainment, except Cincinnati and Indianapolis
- Base M: all areas in attainment, except Holland (Allegan County)

Moderate Areas (2010 attainment date): The modeling results for the 2009 SIP planning year show:

- Base K: all areas still in nonattainment
- Base M: all areas in attainment

The $PM_{2.5}$ modeling results show:

- Base K: all areas in attainment, except for Chicago, Cincinnati, Cleveland, Detroit, Granite City (IL), Louisville, Portsmouth (OH), and Steubenville
- Base M: all areas in attainment, except for Cleveland, Detroit, and Granite City (IL)

With respect to the new lower 8-hour ozone standard, the modeling about 30 sites in 2012 and 5 sites in 2018 with design values greater than 75 ppb. With respect to the new lower 24-hour $PM_{2.5}$ standard, the modeling shows 13 sites in 2012 and 10 in 2018 with design values greater than 35 ug/m^3.

4.2 Supplemental Analyses

EPA's modeling guidelines recommend that attainment demonstrations consist of a primary (guideline) modeling analysis and supplemental analyses. Three basic types of supplemental analyses are recommended:

- additional modeling
- analyses of trends in ambient air quality and emissions, and
- observational models and diagnostic analyses

Furthermore, according to EPA's guidelines, if the future year modeled values are "close" to the standard (i.e., 82 – 87 ppb for ozone and 14.5 – 15.5 ug/m^3 for PM$_{2.5}$), then the results of the primary modeling should be reviewed along with the supplemental information in a "weight of evidence" assessment of whether each area is likely to achieve timely attainment.

A WOE determination for ozone and PM$_{2.5}$ is provided in the following sections. Special attention is given to the following areas with future year modeled values that exceed or are "close" to the ambient standard (see Appendix I):

Ozone	**PM2.5**
Lake Michigan area	Chicago, IL
Cleveland, OH	Cleveland, OH
Cincinnati, OH	Cincinnati, OH
	Granite City, IL
	Detroit, MI

4.3 Weight-of-Evidence Determination for Ozone

The WOE determination for ozone consists of the primary modeling and other supplemental analyses (some of which were discussed in Section 2). A summary of this information is provided below.

Primary (Guideline) Modeling: The guideline modeling is presented in Section 4.1. Key findings from this modeling include:

- Base M regional modeling shows attainment by 2008 and 2009 at all sites, except Holland (MI), and attainment at all sites by 2012.

- Base K modeling results reflect generally higher future year values, and show more sites in nonattainment compared to the Base M modeling. The difference in the two modeling analyses is due mostly to lower base year design values in Base M.

- Base K and Base M modeling analyses are considered "SIP quality", so the attainment demonstration for ozone should reflect a weight-of-evidence approach, with consideration of monitoring based information.

- Base M modeling also shows that the proposed lower 8-hour standard will not be met at many sites, even by 2018, with existing controls.

Additional Modeling: Four additional modeling analyses were considered: (1) re-examination of the primary modeling to estimate attainment probabilities, (2) remodeling with different assumptions, (3) an unmonitored area analysis, and (4) EPA's latest regional ozone modeling. Each of these analyses is described below.

First, the primary modeling results (which were initially processed using EPA's attainment test) were re-examined to estimate the probability of attaining the ozone standard (Lopez, 2007, and LADCO, 2008b). Seven estimates of future year ozone concentrations were calculated based on model-based RRFs and appropriate monitor-based concentrations for each year between 2001 and 2007. RRF values for 2001, 2003, 2004, 2006, and 2007 were derived based on the 2002 and 2005 modeling results. Monitor-based concentrations reflect 4th high values, design values, or average of three design values centered on the year in question. The probability of attainment was determined as the percentage of these seven estimates below the standard. The results indicate that sites in the Lake Michigan area (Chiwaukee, Sheboygan, Holland, Muskegon), Cleveland (Ashtabula), and St. Louis (W Alton) have a fairly low probability of attainment by 2009 (i.e., about 50% or less).

Second, the primary modeling analysis was redone with different types of assumptions for calculating base year design values (i.e., using the 3-year period centered on base year, and using the highest 3-year period that includes the base year), and for calculating RRFs (i.e., using all days with base year modeled value > 70 ppb, and using all days with base year modeled value > 85 ppb, with at least 10 days and "acceptable" model performance). The results for several high concentration sites are presented in Tables 13a and 13b for 2009. The different modeling assumptions produce eight estimates of future year ozone concentrations. The highest estimates are associated with base year design values representing the 3-year average for 2001-2003, and the lowest estimates are associated with base year design values representing the 3-year average 2004-2006. The different RRF approaches produce little change in future year ozone concentrations. This suggests that future year concentration estimates are most sensitive to the choice of the base year and the methodology used to derive the base year design values.

Third, EPA's modeling guidelines recommend that an "unmonitored area analysis" be included as a supplemental analysis, particularly in nonattainment areas where the monitoring network just meets or minimally exceeds the size of the network required to report data to EPA's Air Quality System. The purpose of this analysis is to identify areas where future year values are predicted to be greater than the NAAQS.

Based on examination of the spatial plots in Figures 49a and 49b, the most notable areas of high modeled ozone concentrations are over the Great Lakes. Over-water monitoring, however, is not required by EPA[12]. A cursory analysis of unmonitored areas for ozone was performed by LADCO using an earlier version of the 2002 base year modeling (i.e, Base I) (Baker, 2005). Base year and future year "observed" values were derived for unmonitored grid cells using the absolute modeled concentrations (in all grid cells) and the observed values (in monitored grid cells). A spatial map of the estimated 2009 values is provided in Figure 64. As can be seen, there are very few (over land) grid cells where additional monitors may be desirable. This indicates that the current modeling analysis, which focuses on monitored locations, is addressing areas of high ozone throughout the region.

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[12] Air quality measurements over Lake Michigan were collected by LADCO previously to understand ozone transport in the area (see, for example, Figure 5). Due to cut-backs in USEPA funding, however, these measurements were discontinued in 2003.

Table 13a. Primary and Additional Ozone Modeling Results – Lake Michigan and Cleveland Areas (2009)

2009 Modeling Results		Lake Michigan Area								Cleveland Area		
		Chiwaukee	Harr.Beach	Sheboygan	DoorCounty	Holland	Hammond	MichiganCity		Ashtabula	Geauga	Eastlake
		550590019	550890009	551170006	550290004	260050003	180892008	180910005		390071001	390550004	390850003
Attainment Test (based on EPA guidance-2002 baseyear)												
Base Year Design Value (average of three 3-year periods)		*98.3*	*93.0*	*97.0*	*91.0*	*94.0*	*88.3*	*90.3*		*95.7*	*99.0*	*92.7*
RRF (all days > 85 ppb, or at least 10 days)		0.935	0.918	0.916	0.899	0.888	0.980	0.958		0.865	0.897	0.894
Future Year Design Value		**91.9**	**85.4**	**88.9**	**81.8**	83.5	**86.5**	**86.5**		82.8	**88.8**	82.9
Attainment Test (based on EPA guidance-2005 baseyear)												
Base Year Design Value (average of three 3-year periods)		*84.7*	*83.3*	*88.0*	*88.7*	*90.0*	*77.7*	*77.0*		*89.0*	*79.3*	*86.3*
RRF (all days > 85 ppb, or at least 10 days)		0.972	0.961	0.955	0.946	0.948	0.971	0.960		0.937	0.942	0.949
Future Year Design Value		82.3	80.1	84.0	83.9	**85.3**	75.4	73.9		83.4	74.7	81.9
Weight of Evidence (alternative approaches-2002baseyear)												
Alt 1 - Base Year Des. Value (3-year period centered on 2002)		*101.0*	*98.0*	*100.0*	*94.0*	*97.0*	*90.0*	*93.0*		*99.0*	*103.0*	*95.0*
Alt 2 - Base Year Des. Value (Highest 3-year period including 2002)		*101.0*	*98.0*	*100.0*	*94.0*	*97.0*	*92.0*	*93.0*		*99.0*	*103*	*95.0*
RRF (all days > 85 ppb, or at least 10 days)		0.935	0.918	0.916	0.899	0.888	0.980	0.958		0.865	0.897	0.894
Alt 1 - Future Year Projected Value		**94.4**	**90.0**	**91.6**	84.5	**86.1**	**88.2**	**89.1**		**85.6**	**92.4**	84.9
Alt 2 - Future Year Projected Value		**94.4**	**90.0**	**91.6**	84.5	**86.1**	**90.2**	**89.1**		**85.6**	**92.4**	84.9
Alt 1 - RRF (all days > 70 ppb)		0.933	0.918	0.912	0.907	0.893	0.969	0.947		0.876	0.907	0.900
Alt 1 - Future Year Projected Value		**94.2**	**90.0**	**91.2**	**85.3**	**86.6**	**87.2**	**88.1**		**86.7**	**93.4**	**85.5**
Alt 2 - Future Year Projected Value		**94.2**	**90.0**	**91.2**	**85.3**	**86.6**	**89.1**	**88.1**		**86.7**	**93.4**	**85.5**
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)		0.945	0.904	0.910	0.904	0.887	0.976	0.964		0.866	0.896	0.894
Alt 1 - Future Year Projected Value		**95.4**	**88.6**	**91.0**	**85.0**	**86.0**	**87.8**	**89.7**		**85.7**	**92.3**	84.9
Alt 2 - Future Year Projected Value		**95.4**	**88.6**	**91.0**	**85.0**	**86.0**	**89.8**	**89.7**		**85.7**	**92.3**	84.9
Weight of Evidence (alternative approaches-2005baseyear)												
Alt 1 - Base Year Des. Value (3-year period centered on 2005)		*83.0*	*79.0*	*86.0*	*86.0*	*88.0*	*76.0*	*76.0*		*86.0*	*77.0*	*86.0*
Alt 2 - Base Year Des. Value (Highest 3-year period including 2005)		*86.0*	*88.0*	*89.0*	*90.0*	*93.0*	*79.0*	*78.0*		*91.0*	*86.0*	*89.0*
Alt 1 - Future Year Projected Value		80.7	75.9	82.1	81.4	83.4	73.8	73.0		80.6	72.5	81.6
Alt 2 - Future Year Projected Value		83.6	84.6	**85.0**	**85.1**	**88.2**	76.7	74.9		**85.3**	81.0	84.5

Table 13b. Primary and Additional Ozone Modeling Results – Cincinnati, Columbus, St. Louis, Indianapolis, and Detroit (2009)

2009 Modeling Results	Cincinnati Area			Columbus	St. Louis Area		Indianapolis Area		Detroit Area
	Wilmington	Lebanon	Sycamore	NewAlbany	W. Alton	OrchardFarm	Noblesville	Fortville	New Haven
	390271002	39165007	390610006	390490029	291831002	291831004	180571001	18059003	260990009
Attainment Test (based on EPA guidance-2002 baseyear)									
Base Year Design Value (average of three 3-year periods)	*94.3*	*90.7*	*90.7*	*94.0*	*90.0*	*90.0*	*93.7*	*91.3*	*92.3*
RRF (all days > 85 ppb, or at least 10 days)	0.885	0.908	0.938	0.888	0.947	0.914	0.894	0.918	0.924
Future Year Design Value	83.5	82.4	**85.1**	83.5	**85.2**	82.3	83.8	83.8	**85.3**
Attainment Test (based on EPA guidance-2005 baseyear)									
Base Year Design Value (average of three 3-year periods)	*82.3*	*87.7*	*84.3*	*86.3*	*86.3*	*87.0*	*83.3*	*78.7*	*86.0*
RRF (all days > 85 ppb, or at least 10 days)	0.941	0.947	0.967	0.947	0.938	0.942	0.945	0.947	0.947
Future Year Design Value	77.4	83.1	81.5	81.7	80.9	82.0	78.7	74.5	81.4
Weight of Evidence (alternative approaches-2002baseyear)									
Alt 1 - Base Year Des. Value (3-year period centered on 2002)	*96.0*	*92.0*	*93.0*	*95.0*	*91.0*	*92.0*	*96.0*	*94.0*	*97.0*
Alt 2 - Base Year Des. Value (Highest 3-year period including 2002)	*96.0*	*92.0*	*93.0*	*96.0*	*91.0*	*92.0*	*96.0*	*94.0*	*97.0*
RRF (all days > 85 ppb, or at least 10 days)	0.885	0.908	0.938	0.888	0.947	0.914	0.894	0.918	0.924
Alt 1 - Future Year Projected Value	**85.0**	83.5	**87.2**	84.4	**86.2**	84.1	**85.8**	**86.3**	**89.6**
Alt 2 - Future Year Projected Value	**85.0**	83.5	**87.2**	**85.2**	**86.2**	84.1	**85.8**	**86.3**	**89.6**
Alt 1 - RRF (all days > 70 ppb)	0.885	0.914	0.940	0.901	0.945	0.911	0.912	0.907	0.918
Alt 1 - Future Year Projected Value	**85.0**	84.1	**87.4**	**85.6**	**86.0**	83.8	**87.6**	**85.3**	**89.0**
Alt 2 - Future Year Projected Value	**85.0**	84.1	**87.4**	**86.5**	**86.0**	83.8	**87.6**	**85.3**	**89.0**
Alt 2 - RRF (all days > 85 ppb, or at least 10 days; with acceptable model performance)	0.880	0.911	0.940	0.886	0.951	0.913	0.894	0.916	0.935
Alt 1 - Future Year Projected Value	84.5	83.8	**87.4**	84.2	**86.5**	84.0	**85.8**	**86.1**	**90.7**
Alt 2 - Future Year Projected Value	84.5	83.8	**87.4**	**85.1**	**86.5**	84.0	**85.8**	**86.1**	**90.7**
Weight of Evidence (alternative approaches-2005baseyear)									
Alt 1 - Base Year Des. Value (3-year period centered on 2005)	*80.0*	*86.0*	*81.0*	*84.0*	*85.0*	*86.0*	*80.0*	*76.0*	*82.0*
Alt 2 - Base Year Des. Value (Highest 3-year period including 2005)	*85.0*	*89.0*	*86.0*	*88.0*	*89.0*	*89.0*	*87.0*	*81.0*	*90.0*
Alt 1 - Future Year Projected Value	75.3	81.4	78.3	79.5	79.7	81.0	75.6	72.0	77.7
Alt 2 - Future Year Projected Value	80.0	84.3	83.2	83.3	83.5	83.8	82.2	76.7	**85.2**

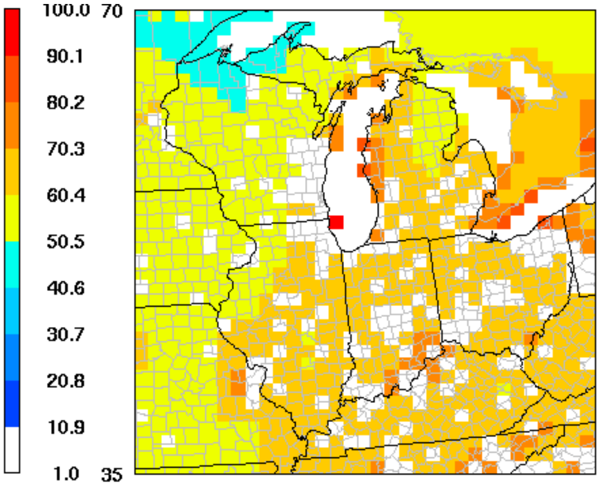

Figure 64. Estimated Future Year Values (unmonitored grid cells)

Finally, EPA's latest regional ozone modeling was considered as corroborative information. This modeling was performed as part of the June 2007 proposal to revise the ozone standard (EPA, 2007b). EPA applied the CMAQ model with 2001 meteorology to first estimate ozone levels in 2020 based on the current standard and national rules in effect or proposed (i.e., the baseline), and then to evaluate strategies for attaining a more stringent (70 ppb) primary standard. Baseline (2020) ozone levels were predicted to be below the current standard in 481 of the 491 counties with ozone monitors. Of the 10 counties predicted to be above the standard, there is one county in the LADCO region (i.e., Kenosha County, WI at 86 ppb). This result is consistent with LADCO's Base K modeling for 2018 (i.e., Kenosha County, WI at 86.7 ppb), which is not surprising given that EPA's modeling and LADCO's Base K modeling have a similar base year (2001 v. 2002).

Analysis of Trends: EPA's modeling guidelines note that while air quality models are generally the most appropriate tools for assessing the expected impacts of a change in emissions, it may also be possible to extrapolate future trends based on measured historical trends of air quality and emissions. To do so, USEPA's guidance suggests that ambient trends should first be normalized to account for year-to-year variations in meteorological conditions (EPA, 2002). Meterologically-adjusted 4th high 8-hour ozone concentrations were derived using the air quality – meteorological regression model developed by EPA (i.e., Cox method – see Section 2.1).

The historical trend in these met-adjusted ozone concentrations were extrapolated to estimate future year ozone concentrations based on historical and projected trends in precursor emissions. Both VOC and NOx emissions affect ozone concentrations. Given that observation-based methods show that urban areas in the region are generally VOC-limited and rural areas in the region are NOx-limited (see Section 2.1), urban VOC emissions and regional NOx emissions are considered important. The trends in urban VOC and regional NOx emissions were calculated to produce appropriate weighting factors.

The resulting 2009 and 2012 ozone values are provided in Figure 65, along with the primary and alternative modeling ozone values for key sites in the Lake Michigan, Cleveland, and Cincinnati areas. The results reflect a fairly wide scatter, but, on balance, the supplemental information is supportive of the primary modeling results (i.e., sites in the Lake Michigan area and Cleveland are expected to be close to the standard).

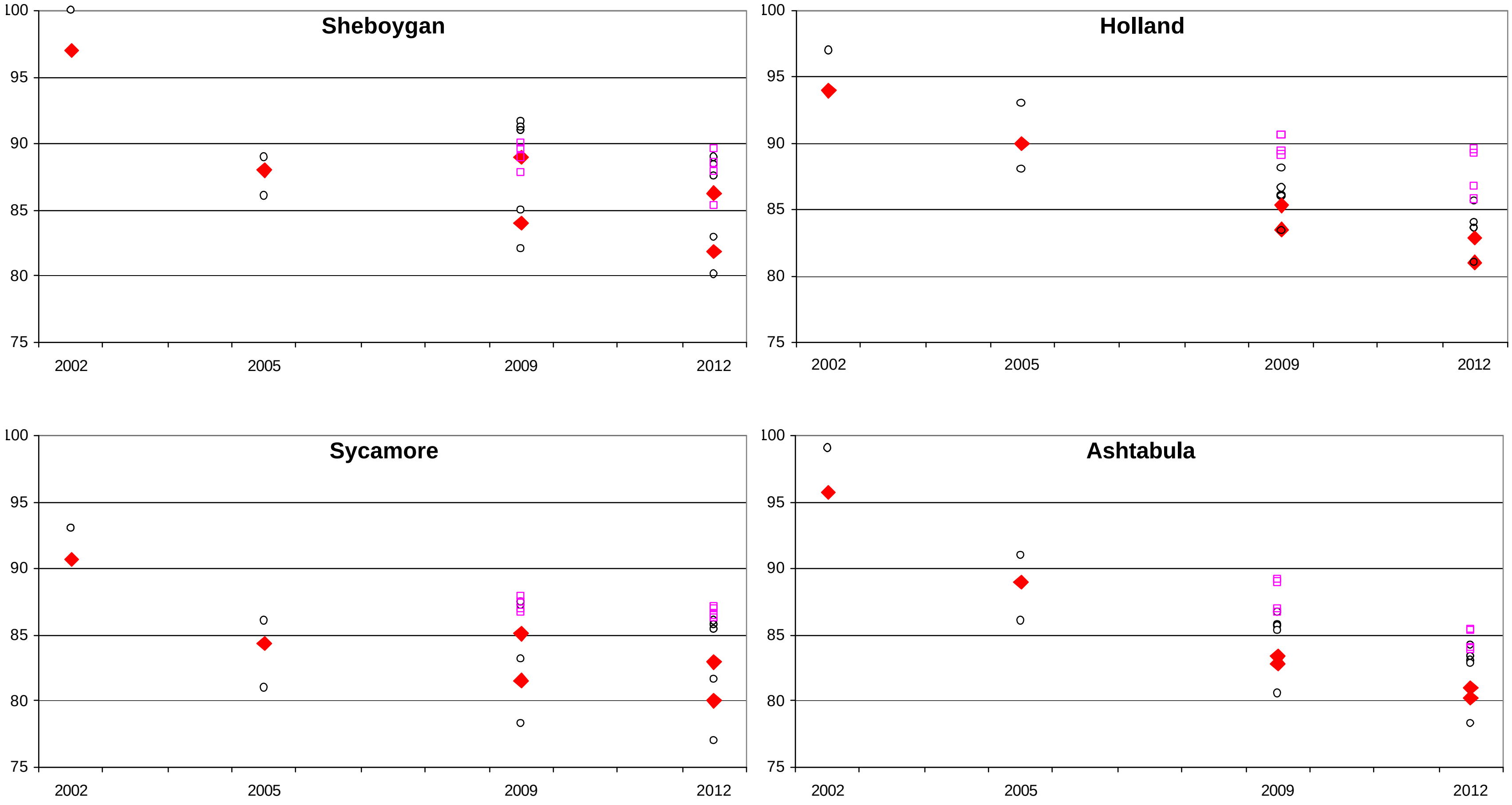

Figure 65. Estimates of Future Year Ozone Concentrations – Lake Michigan Area (Sheboygan and Holland), Cincinnati (Sycamore), and Cleveland (Ashtabula)

Note: Primary (guideline) modeling values (Base K and Base M results) are represented by large red diamonds, additional modeling values by small black circles, and trends-based values by small pink squares

Observational Models and Diagnostic Analyses: The observation-based modeling (i.e., MAPPER) is presented in Section 3. The key findings from this modeling are that most urban areas are VOC-limited and rural areas are NOx-limited.

The primary diagnostic analysis is source apportionment modeling with CAMx to provide more quantitative information on source region (and source sector) impacts (Baker, 2007a). Specifically, the model estimated the impact of 18 geographic source regions (which are identified in Figure 66) and 6 source sectors (EGU point, non-EGU point, on-road, off-road, area, and biogenic sources) at ozone monitoring sites in the region.

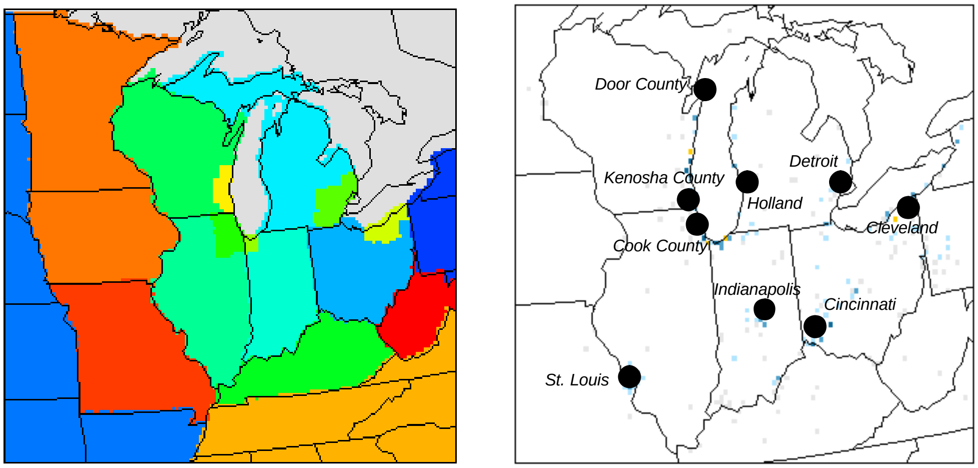

Figure 66. Source regions (left) and key monitoring sites (right) for ozone modeling analysis

Modeling results for 2009 (Base M) and 2012 (Base K) are provided in Appendix II for several key monitoring sites. For each monitoring site, there are two graphs: one showing sector-level contributions, and one showing source region and sector-level contributions in terms of percentages. (Note, in the sector-level graph, the contributions from NOx emissions are shown in blue, and from VOC emissions in green.)

The sector-level results (see, for example, Figure 67) show that on-road and nonroad NOx emissions generally have the largest contributions at the key monitor locations (> 15% each). EGU and non-EGU NOx emissions are also important contributors (> 10% each). The source group contributions vary by receptor location due to emissions inventory differences.

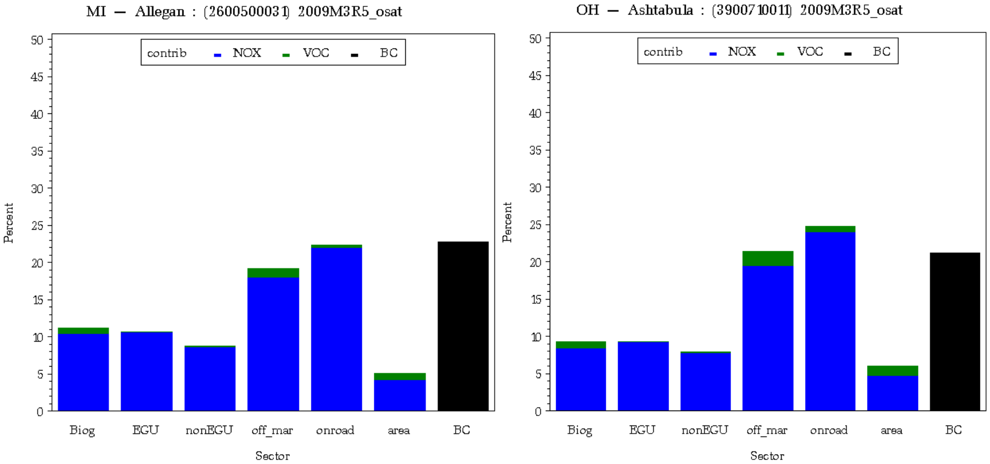

Figure 67. Source-sector results for Holland (left) and Ashtabula (right) monitors – 2009 (Base M)

The source region results (see, for example, Figure 68) show that while nearby areas generally have the highest impacts (e.g., the northeastern IL/northwestern IN/southeastern WI nonattainment area contributes 25-35% to high sites in the Lake Michigan area, and Cleveland nonattainment counties contribute 20-25% to high sites in northeastern Ohio), there is an even larger regional impact (i.e., contribution from other states).

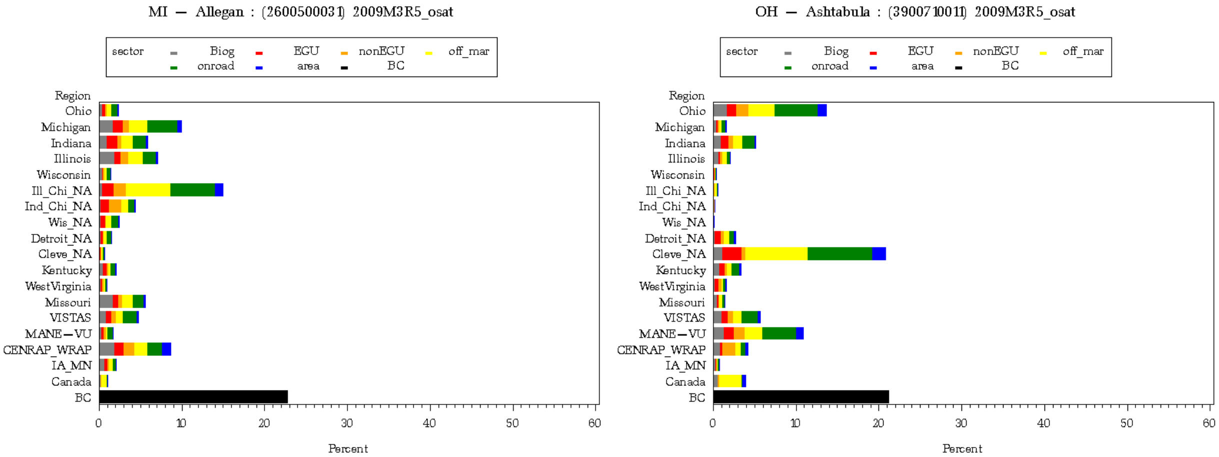

Figure 68. Source-region results for Holland (left) and Ashtabula (right) monitors – 2009 (Base M)

Summary: Air quality modeling and other supplemental analyses were performed to estimate future year ozone concentrations. Based on this information, the following general conclusions can be made:

- Existing ("on the books") controls are expected to produce significant improvement in ozone air quality.
- The choice of the base year affects the future year model projections. A key difference between the base years of 2002 and 2005 is meteorology. As noted above, 2002 was more ozone conducive than 2005. The choice of which base year to use as the basis for the SIP is a policy decision (i.e., how much safeguard to incorporate).
- Most sites are expected to meet the current 8-hour standard by the applicable attainment date, except, for sites in western Michigan and, possibly, in eastern Wisconsin and northeastern Ohio.
- Current monitoring data show significant nonattainment in these areas (e.g., peak design values on the order of 90 – 93 ppb). It is not clear whether sufficient emission reductions will occur in the next couple of years to provide for attainment.
- Attainment by the applicable attainment date is dependent on actual future year meteorology (e.g., if the weather conditions are consistent with [or less severe than] 2005, then attainment is likely) and actual future year emissions (e.g., if the emission reductions associated with the existing controls are achieved, then attainment is likely). On the other hand, if either of these conditions is not met, then attainment may be less likely.

4.3 Weight-of-Evidence Determination for $PM_{2.5}$

The WOE determination for $PM_{2.5}$ consists of the primary modeling and other supplemental analyses. A summary of this information is provided below.

Primary (Guideline) Modeling: The results of the guideline modeling are presented in Section 4.1. Key findings from this modeling include:

- Base M regional modeling shows attainment by 2009 at all sites, except Detroit, Cleveland, and Granite City, and attainment at all sites by 2012, except for Detroit and Granite City.

  The regional modeling for $PM_{2.5}$ does not reflect any air quality benefit expected from local controls. States are conducting local-scale analyses and will use these results, in conjunction with the regional-scale modeling, to support their attainment demonstrations for $PM_{2.5}$

- Base K modeling results reflect generally higher future year values, and show more sites in nonattainment in 2009 and 2012 compared to the Base M modeling. The difference in the two modeling analyses is due mostly to lower base year design values in Base M.

- Base K and Base M modeling analyses are considered "SIP quality", so the attainment demonstration for $PM_{2.5}$ should reflect a weight-of-evidence approach, with consideration of monitoring based information.

- Base M modeling also shows that the new $PM_{2.5}$ 24-hour standard will not be met at many sites, even by 2018, with existing controls.

Additional Modeling: EPA's latest regional $PM_{2.5}$ modeling was considered as corroborative information. This modeling was performed as part of the September 2006 revision to the $PM_{2.5}$ standard (USEPA, 2006). EPA applied the CMAQ model with 2001 meteorology to estimate $PM_{2.5}$ levels in 2015 and 2020 first with national rules in effect or proposed, and then with additional controls to attain the current standard (15 ug/m^3 annual/65 ug/m^3 daily). Additional analyses were performed to evaluate strategies for attaining more stringent standards in 2020 (15/35, and 14/35). Baseline (2015) $PM_{2.5}$ levels were predicted to be above the current standard in four counties in the LADCO region: Madison County, IL at 15.2 ug/m^3, Wayne County, MI at 17.4, Cuyahoga County, OH at 15.4, and Scioto County, OH at 15.6. These results are consistent with LADCO's Base K modeling for 2012/2018, which is not surprising given that EPA's modeling and LADCO's Base K modeling have a similar base year (2001 v. 2002).

Observational Models and Diagnostic Analyses: The observation-based modeling (i.e., application of thermodynamic equilibrium models) is presented in Section 3. The key findings from this modeling are that $PM_{2.5}$ mass is sensitive to reductions in sulfate, nitric acid, and ammonia concentrations. Even though sulfate reductions cause more ammonia to be available to form ammonium nitrate (PM-nitrate increases slightly when sulfate is reduced), this increase is generally offset by the sulfate reductions, such that $PM_{2.5}$ mass decreases. Under conditions with lower sulfate levels (i.e., proxy of future year conditions), $PM_{2.5}$ is more sensitive to reductions in nitric acid compared to reductions in ammonia.

The primary diagnostic analysis is source apportionment modeling with CAMx to provide more quantitative information on source region (and source sector) impacts (Baker, 2007b). Specifically, the model estimated the impact of 18 geographic source regions (which are identified in Figure 69) and 6 source sectors (EGU point, non-EGU point, on-road, off-road, area, and biogenic sources) at $PM_{2.5}$ monitoring sites in the region.

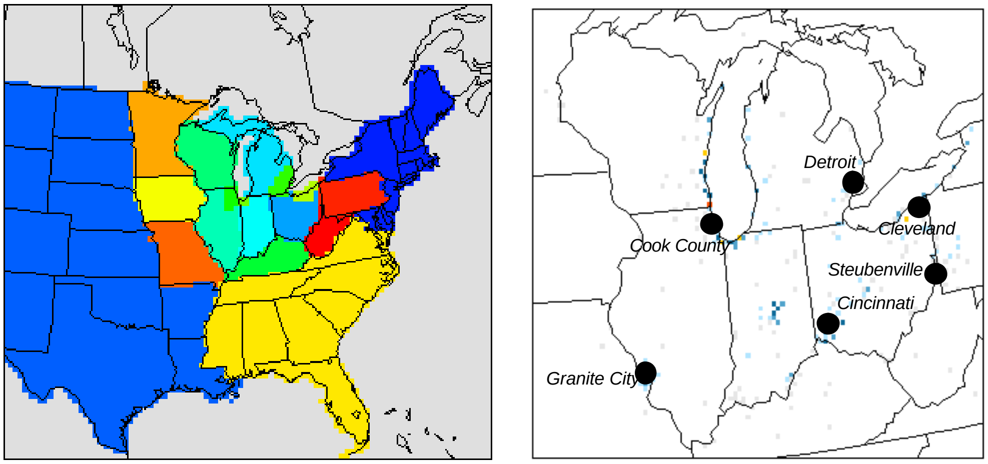

Figure 69. Source regions (left) and key monitoring sites (right) for $PM_{2.5}$ modeling analysis

Modeling results for 2012 (Base K) and 2018 (Base M) are provided in Appendix III for several key monitoring sites. For each monitoring site, there are two graphs: one showing sector-level contributions, and one showing source region and sector-level contributions in terms of absolute modeled values.

The sector-level results (see, for example, Figure 70) show that EGU sulfate, non-EGU-sulfate, and area organic carbon emissions generally have the largest contributions at the key monitor locations (> 15% each). Ammonia emissions are also important contributors (> 10%). The source group contributions vary by receptor location due to emissions inventory differences.

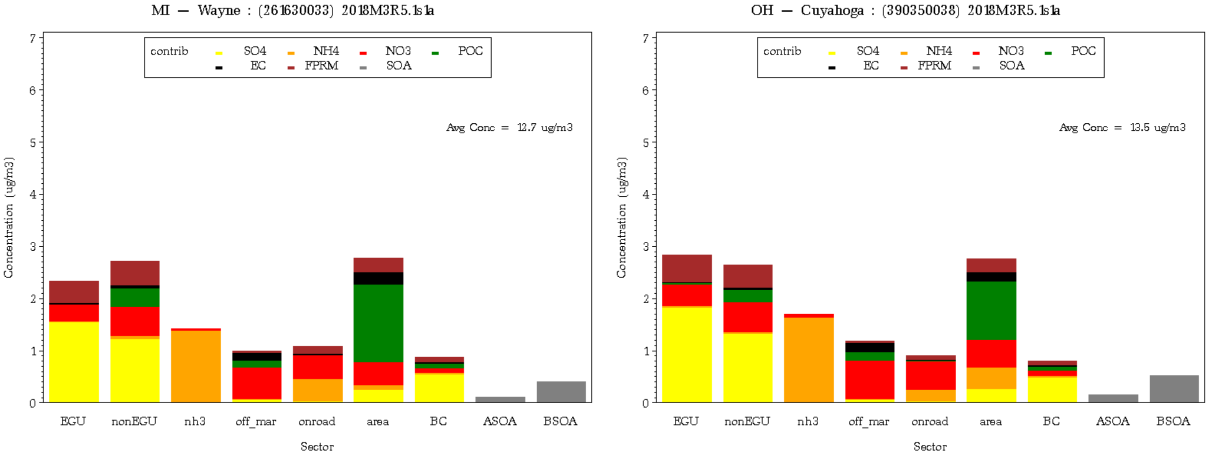

Figure 70. Source-sector results for Detroit (left) and Cleveland (right) monitors – 2018 (Base M)

The source region results (see, for example, Figure 71) show that while nearby areas generally have the highest impacts (e.g., Detroit nonattainment counties contribute 40% to high sites in southeastern Michigan, and Cleveland nonattainment counties contribute 35% to high sites in northeastern Ohio), there is an even larger regional impact (i.e., contribution from other states).

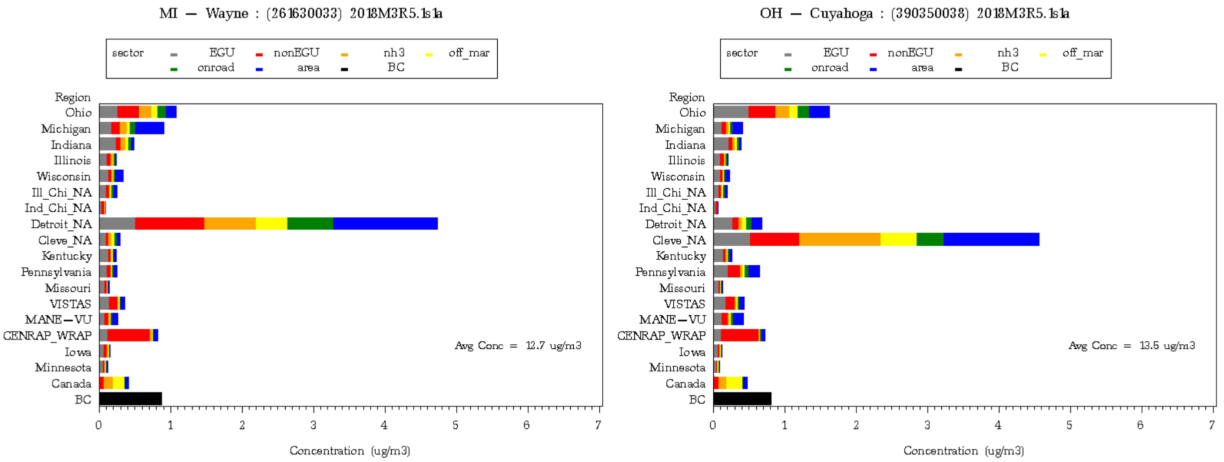

Figure 71. Source-region results for Detroit (left) and Cleveland (right) monitors – 2018 (Base M)

Summary: Air quality modeling and other supplemental analyses were performed to estimate future year $PM_{2.5}$ concentrations. Based on this information, the following general conclusions can be made:

- Existing ("on the books") controls are expected to produce significant improvement in $PM_{2.5}$ air quality.

- The choice of the base year affects the future year model projections. It is not clear how much of this is attributable to differences in meteorology, because, as noted in Section 3, $PM_{2.5}$ concentrations are not as strongly influenced by meteorology as ozone.

- Most sites are expected to meet the current $PM_{2.5}$ standard by the applicable attainment date, except for sites in Detroit, Cleveland, and Granite City.

- Current monitoring data show significant nonattainment in these areas (e.g., peak design values on the order of 16 – 17 ug/m^3). It is not clear whether sufficient emission reductions will occur in the next couple of years to provide for attainment. States are conducting local-scale analyses for Detroit, Cleveland, and Granite City, in particular, to identify appropriate additional local controls.

- Attainment by the applicable attainment date is dependent (possibly) on actual future year meteorology and (more likely) on actual future year emissions (e.g., if the emission reductions associated with the "on the books" controls are achieved, then attainment is likely). On the other hand, if either of these conditions is not met (especially, with respect to emissions), then attainment may be less likely.

Section 5. Reasonable Progress Assessment for Regional Haze

Air quality modeling and other information were used to assess the improvement in visibility that would be provided by existing ("on the books") controls and possible additional control programs. In determining reasonable progress for regional haze, Section 169A of the Clean Air Act and EPA's visibility rule requires states to consider five factors:

- costs of compliance
- time necessary for compliance
- energy and non-air quality environmental impacts of compliance
- remaining useful life of any existing source subject to such requirements
- uniform rate of visibility improvement needed to attain natural visibility conditions by 2064

The uniform rate of visibility improvement requirement can be depicted graphically in the form of a "glide path" (see Figure 72).

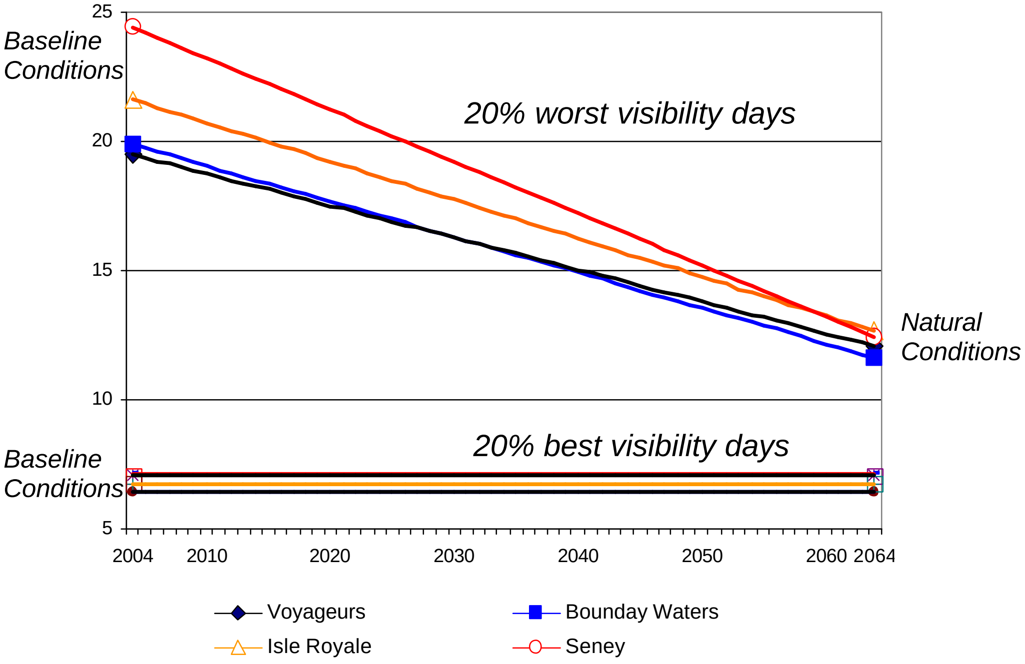

Figure 72. Visibility "glide paths" for northern Class I areas (units: deciviews)

5.1 Class I Areas Impacted

EPA's visibility rule requires a state to "address regional haze in each mandatory Class I Federal area located within the State and in each mandatory Class I Federal area located outside the State which may be affected by emissions from within the State." (40 CFR Part 51.308(d)) To meet this requirement, technical analyses conducted by the RPOs were consulted to obtain information on areas of influence and culpability for Class I areas in the eastern U.S. (MRPO, 2007). A summary of this information is provided in Table 1 (MRPO, 2007). The table shows that every LADCO State impacts multiple Class I areas in the eastern U.S.

Table 14. Draft List of Class I Areas Impacted by LADCO States

AREA NAME	IL	IN	MI	OH	WI
81.401 Alabama.					
Sipsey Wilderness Area	(1)	(1)			
81.404 Arkansas.					
Caney Creek Wilderness Area	(2), (4)	(2), (4)		(2), (4)	
Upper Buffalo Wilderness Area	(1),(2),(4),(5)	(2), (4)		(2), (4)	(2)
81.408 Georgia.					
Cohotta Wilderness Area					
Okefenokee Wilderness Area					
Wolf Island Wilderness Area					
81.411 Kentucky.					
Mammoth Cave NP	(1), (2), (5)	(1), (2), (5)	(1), (2)	(1), (2), (5)	
81.412 Louisiana.					
Breton Wilderness Area					
81.413 Maine.					
Acadia National Park	(3)	(3)	(3)	(3)	
Moosehorn Wilderness Area.	(3)	(3)	(3)	(3)	
81.414 Michigan.					
Isle Royale NP.	(1), (2)	(1), (2)	(1), (2)		(1), (2)
Seney Wilderness Area	(1), (2)	(1), (2)	(1), (2)	(1), (2)	(1), (2)
81.415 Minnesota.					
Boundary Waters Canoe Area Wilderness	(2)	(2)	(2)		(1), (2)
Voyageurs NP	(2)	(2)			(1), (2)
81.416 Missouri.					
Hercules-Glades Wilderness Area	(2), (4), (5)	(2), (4), (5)		(2), (4)	(2)
Mingo Wilderness Area	(2), (4), (5)	(2), (4), (5)	(2)	(2), (4)	(2)
81.419 New Hampshire.					
Great Gulf Wilderness Area	(3)	(3)	(3)	(1), (3)	
Pres. Range-Dry River Wilderness Area.					
81.42 New Jersey.					
Brigantine Wilderness Area	(3)	(3)	(1), (3)	(1), (3)	

81.422 North Carolina.					
Great Smoky Mountains NP{1}	(1)	(1)		(1)	
Joyce Kilmer-Slickrock Wilderness Area{2}					
Linville Gorge Wilderness Area.					
Shining Rock Wilderness Area.					
Swanquarter Wilderness Area					
81.426 South Carolina.					
Cape Romain Wilderness					
81.428 Tennessee.					
Great Smoky Mountains NP{1}.	(1)	(1)		(1)	
Joyce Kilmer-Slickrock Wilderness{2}					
81.431 Vermont.					
Lye Brook Wilderness	(2), (3)	(2), (3)	(2), (3)	(1), (2), (3)	
81.433 Virginia.					
James River Face Wilderness.	(2)	(2)	(2)	(2), (5)	
Shenandoah NP	(2), (3)	(1), (2), (3)	(2), (3)	(1),(2),(3),(5)	
81.435 West Virginia.					
Dolly Sods/Otter Creek Wilderness.	(2), (3)	(1), (2), (3)	(1), (2), (3)	(1),(2),(3),(5)	

Key

(1) MRPO Back Trajectory Analyses
(2) MRPO PSAT Modeling
(3) MANE-VU Contribution Assessment
(4) Missouri-Arkansas Contribution Assessment
(5) VISTAS Areas of Influence

5.2 Future Year Modeling Results

For regional haze, the calculation of future year conditions assumed:

- baseline concentrations based on 2000-2004 IMPROVE data, with updated (subsitituted) data for Mingo, Boundary Waters, Voyageurs, Isle Royale, and Seney (see Section 2.3);
- use of the new IMPROVE light extinction equation; and
- use of EPA default values for natural conditions, based on the new IMPROVE light extinction equation.

The uniform rate of visibility improvement values for the 2018 planning year were derived (for the 20% worst visibility days) based on a straight line between baseline concentration value (plotted in the year 2004 -- end year of the 5-year baseline period) and natural condition value (plotted in the year 2064 -- date for achieving natural conditions). Plots of these “glide paths” with the Base M modeling results are presented in Figure 73 for Class I areas in the eastern U.S. A tabular summary of measured baseline and modeled future year deciview values for these Class I areas are provided in Table 15 (2002 base year) and Table 16 (2005 base year)[13].

The haze results show that several Class I areas in the eastern U.S. are expected to be greater than (less improved than) the uniform rate of visibility improvement values (in 2018), including those in northern Michigan and several in the northeastern U.S. Many other Class I areas in the eastern U.S. are expected to be less than (more improved than) the uniform rate of visibility improvement values (in 2018). As noted above, states should consider these results, along with information on the other four factors, in setting reasonable progress goals.

An assessment of the five factors was performed for LADCO and the State of Minnesota by a contractor (EC/R, 2007). Specifically, ECR examined reductions in SO2 and NOx emissions from EGUs and industrial, commercial and institutional (ICI) boilers; NOx emissions from mobile sources and reciprocating engines and turbines; and ammonia emissions from agricultural operations. The impacts of “on the books” controls were also examined to provide a frame of reference for assessing the impacts of the additional control measures.

The results of ECR’s analysis of the five factors are summarized below:

> Factor 1 (Cost of Compliance): The average cost effectiveness values (in terms of $M per ton) are provided in Table 16. For comparison, cost-effectiveness estimates previously provided for “on the books” controls include:
>
> | | |
> |---|---|
> | CAIR | SO2: $700 - $1,200, NOx: $1,400 – $2.600 ($/T) |
> | BART | SO2: $300 - $963, NOx: $248 - $1,770 |
> | MACT | SO2: $1,500, NOx: $7,600 |
>
> Most of the cost-effectiveness values for the additional controls are within the range of cost-effectiveness values for “on the books” controls.

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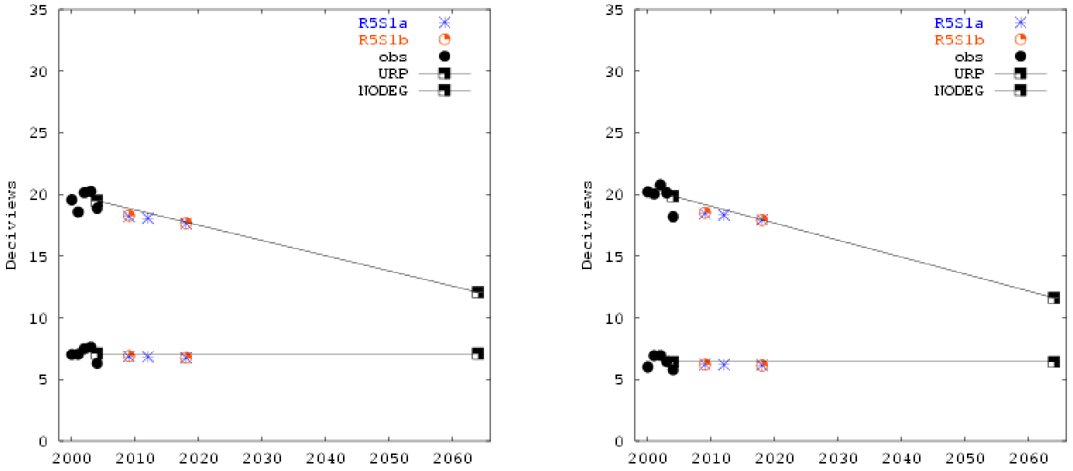
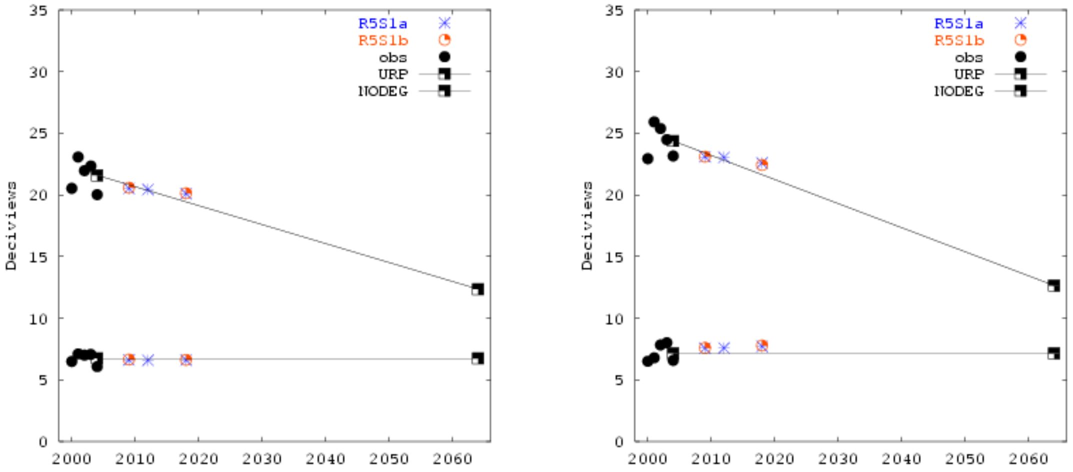
[13] Model results reflect the grid cell where the IMPROVE monitor is located.

Voyageurs Boundary Waters



Isle Royale Seney



Mammoth Cave Upper Buffalo

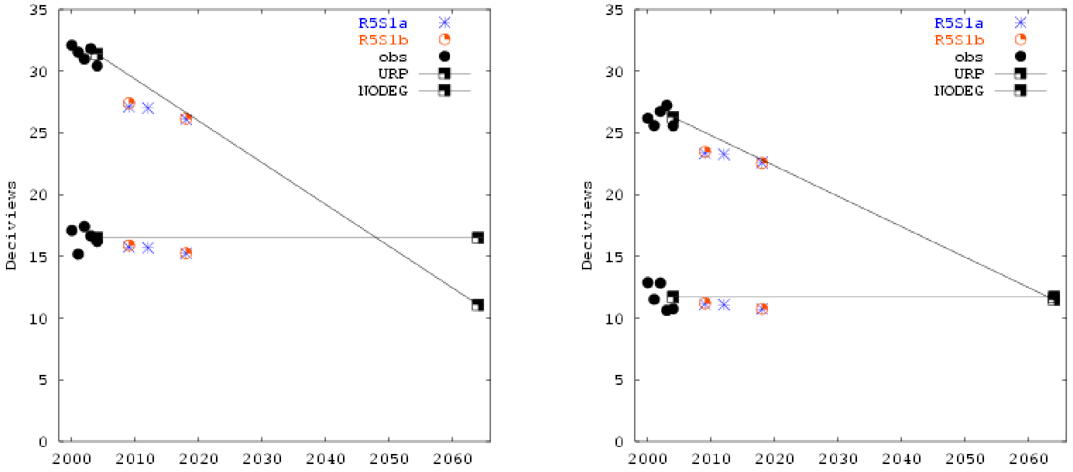


Figure 73. Visibility modeling results for Class I areas in eastern U.S.

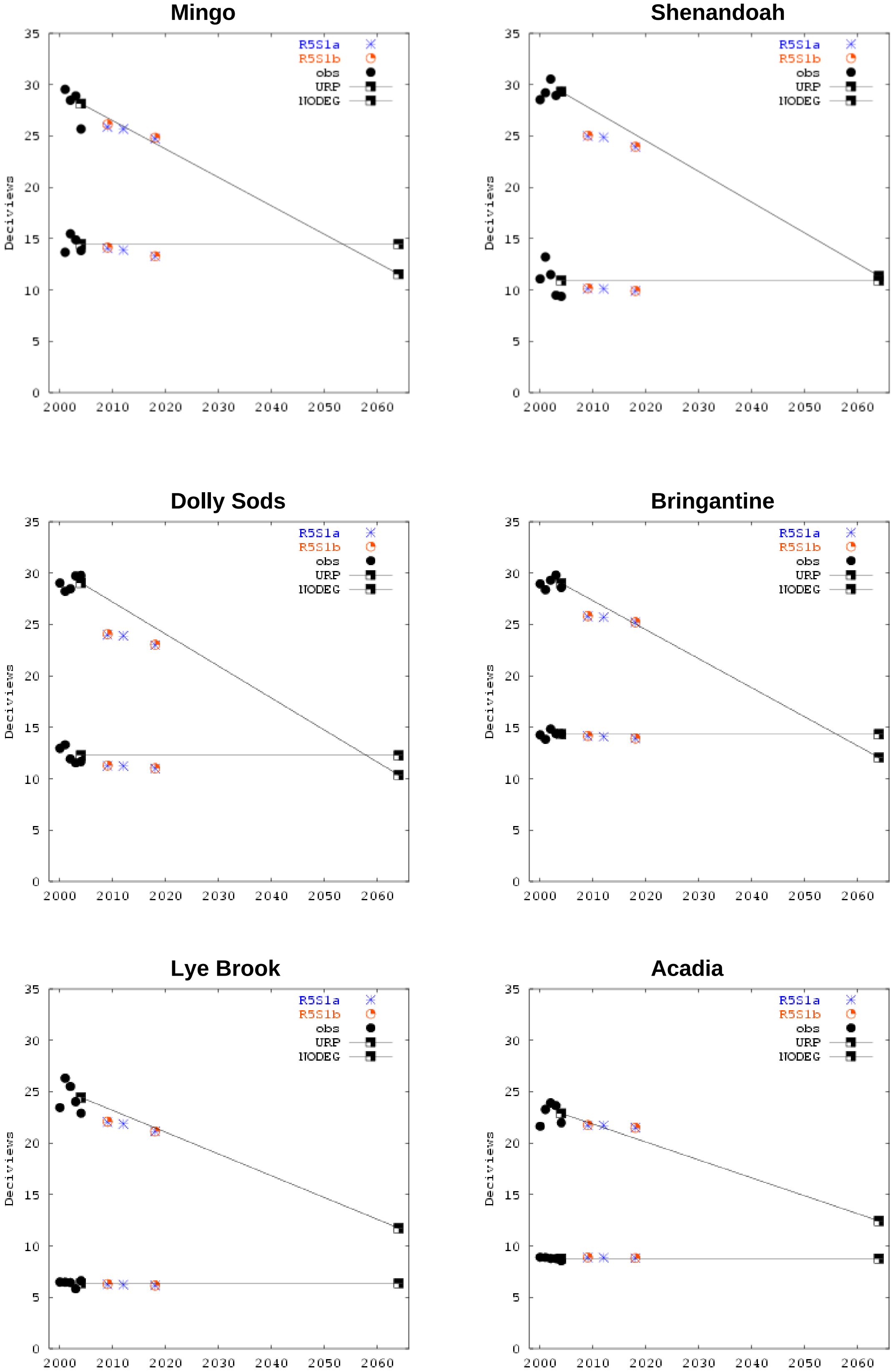


Figure 73 (cont.) Visibility modeling results for Class I areas in eastern U.S.

Table 15. Haze Results - Round 4 (Based on 2000-2004)

Worst 20%		**2018**	**2009**	**2012**	**2018**	**2018**	**2018**
Site	**Baseline**	**URP**	**OTB**	**OTB**	**OTB**	**EGU2 (5-state region)**	**EGU2 (12-state region)**
BOWA1	19.86	17.70	19.05	19.01	**18.94**	**18.40**	17.72
VOYA2	19.48	17.56	19.14	19.19	**19.18**	**18.94**	**18.38**
SENE1	24.38	21.35	22.98	22.71	**22.38**	21.26	20.63
ISLE1	21.59	19.21	20.46	20.28	**20.04**	19.09	18.64
HEGL1	26.75	22.76	24.73	24.34	**23.85**	**23.01**	22.04
MING1	28.15	24.08	25.18	24.67	24.01	22.53	21.45
CACR1	26.36	22.55	24.01	23.55	**22.99**	22.43	21.57
UPBU1	26.27	22.47	24.02	23.58	**23.06**	22.31	21.38
MACA1	31.37	26.14	28.06	27.03	25.52	24.27	22.57
DOSO1	29.04	24.23	24.86	23.59	22.42	21.60	20.15
SHEN1	29.31	24.67	24.06	22.79	21.57	20.43	19.42
JARI1	29.12	24.48	24.81	23.79	22.42	21.59	20.88
BRIG1	29.01	24.68	25.87	25.25	24.39	23.91	23.45
LYBR1	24.45	21.16	21.80	21.32	20.69	20.18	19.79
Best 20%		**2018**	**2009**	**2012**	**2018**	**2018**	**2018**
Site	**Baseline**	**URP**	**OTB**	**OTB**	**OTB**	**EGU2 (5-state region)**	**EGU2 (12-state region)**
BOWA1	6.42	6.42	6.71	6.73	6.87	6.83	6.81
VOYA2	7.09	7.09	7.21	7.25	7.34	7.31	7.26
SENE1	7.14	7.14	7.19	7.19	7.23	7.06	6.91
ISLE1	6.75	6.75	6.57	6.51	6.47	6.20	6.06
HEGL1	12.84	12.84	12.61	12.62	12.61	12.43	12.02
MING1	14.46	14.46	13.96	13.93	13.94	13.74	13.33
CACR1	11.24	11.24	10.91	10.92	10.90	10.75	10.42
UPBU1	11.71	11.71	11.47	11.46	11.42	11.28	11.01
MACA1	16.51	16.51	16.06	15.91	15.54	15.18	14.75
DOSO1	12.28	12.28	11.72	11.45	11.19	10.93	10.67
SHEN1	10.93	10.93	9.73	9.53	9.17	9.05	8.90
JARI1	14.21	14.21	13.56	13.33	12.97	12.65	12.46
BRIG1	14.33	14.33	13.74	13.69	13.47	13.32	13.21
LYBR1	6.36	6.36	6.12	6.05	5.96	5.88	5.82

Table 16. Haze Results - Round 5.1 (Based on 2000-2004)

Worst 20%		**2018**	**2009**	**2012**	**2018**	**2018**
Site	**Baseline**	**URP**	**OTB**	**OTB**	**OTB**	**OTB+Will DO**
BOWA1	19.86	17.94	18.45	18.33	17.94	17.92
VOYA2	19.48	17.75	18.20	18.07	17.63	17.66
SENE1	24.38	21.64	23.10	23.04	**22.59**	**22.42**
ISLE1	21.59	19.43	20.52	20.43	**20.09**	**20.13**
ISLE9	21.59	19.43	20.33	20.22	**19.84**	**19.82**
HEGL1	26.75	23.13	24.72	24.69	**24.22**	**24.17**
MING1	28.15	24.27	25.88	25.68	**24.74**	**24.83**
CACR1	26.36	22.91	23.39	23.29	22.44	22.40
UPBU1	26.27	22.82	23.34	23.27	22.59	22.55
MACA1	31.37	26.64	27.11	27.01	26.10	26.15
DOSO1	29.05	24.69	24.00	23.90	23.00	23.04
SHEN1	29.31	25.12	24.99	24.87	23.92	23.95
JARI1	29.12	24.91	25.17	25.01	24.06	24.12
BRIG1	29.01	25.05	25.79	25.72	**25.21**	**25.22**
LYBR1	24.45	21.48	22.04	21.86	21.14	21.14
ACAD1	22.89	20.45	21.72	21.72	**21.49**	**21.49**
Best 20%		**2018**	**2009**	**2012**	**2018**	**2018**
Site	**Baseline**	**Max**	**OTB**	**OTB**	**OTB**	**OTB+Will DO**
BOWA1	6.42	6.42	6.21	6.19	6.14	6.12
VOYA2	7.09	7.09	6.86	6.83	6.75	6.76
SENE1	7.14	7.14	7.57	7.58	7.71	7.78
ISLE1	6.75	6.75	6.62	6.59	6.60	6.62
ISLE9	6.75	6.75	6.56	6.55	6.52	6.50
HEGL1	12.84	12.84	12.51	12.32	11.66	11.64
MING1	14.46	14.46	14.07	13.89	13.28	13.29
CACR1	11.24	11.24	10.88	10.85	10.52	10.52
UPBU1	11.71	11.71	11.13	11.08	10.73	10.74
MACA1	16.51	16.51	15.76	15.69	15.25	15.25
DOSO1	12.28	12.28	11.25	11.23	11.00	11.01
SHEN1	10.93	10.93	10.13	10.11	9.91	9.91
JARI1	14.21	14.21	13.38	13.38	13.14	13.14
BRIG1	14.33	14.33	14.15	14.08	13.92	13.92
LYBR1	6.37	6.37	6.25	6.23	6.14	6.15
ACAD1	8.78	8.78	8.86	8.86	8.82	8.82

Table 17. Estimated Cost Effectiveness for Potential Control Measures

			Average Cost effectiveness ($/ton)		
Emission category	Control strategy	Region	SO2	NOX	NH3
EGU	EGU1	3-State	1,540	2,037	
		9-State	1,743	1,782	
	EGU2	3-State	1,775	3,016	
		9-State	1,952	2,984	
ICI boilers	ICI1	3-State	2,992	2,537	
		9-State	2,275	1,899	
	ICI Workgroup	3-State	2,731	3,814	
		9-State	2,743	2,311	
Reciprocating engines and turbines	Reciprocating engines emitting 100 tons/year or more	3-State		538	
		9-State		506	
	Turbines emitting 100 tons/year or more	3-State		754	
		9-State		754	
	Reciprocating engines emitting 10 tons/year or more	3-State		1,286	
		9-State		1,023	
	Turbines emitting 10 tons/year or more	3-State		800	
		9-State		819	
Agricultural sources	10% reduction	3-State			31 - 2,700
		9-State			31 - 2,700
	15% reduction	3-State			31 - 2,700
		9-State			31 - 2,700
Mobile sources	Low-NOX Reflash	3-State		241	
		9-State		241	
	MCDI	3-State		10,697	
		9-State		2,408	
	Anti-Idling	3-State		(430) - 1,700	
		9-State		(430) - 1,700	
	Cetane Additive Program	3-State		4,119	
		9-State		4,119	
Cement Plants	Process Modification	Michigan		-	
	Conversion to dry kiln	Michigan		9,848	
	LoTox™	Michigan		1,399	
Glass Manufacturing	LNB	Wisconsin		1,041	
	Oxy-firing	Wisconsin		2,833	
	Electric boost	Wisconsin		3,426	
	SCR	Wisconsin		1,054	
	SNCR	Wisconsin		1,094	
Lime Manufacturing	Mid-kiln firing	Wisconsin		688	
	LNB	Wisconsin		837	
	SNCR	Wisconsin		1,210	
	SCR	Wisconsin		5,037	
	FGD	Wisconsin		128 - 4,828	
Oil Refinery	LNB	Wisconsin		3,288	
	SNCR	Wisconsin		4,260	
	SCR	Wisconsin		17,997	
	LNB+FGR	Wisconsin		4,768	
	ULNB	Wisconsin		2,242	
	FGD	Wisconsin		1,078	

Factor 2 (Time Necessary for Compliance): All of the control measures can be implemented by 2018. Thus, this factor can be easily addressed.

Factor 3 (Energy and Non-Air Quality Environmental Impacts): The energy and other environmental impacts are believed to be manageable. For example, the increased energy demand from add-on control equipment is less than 1% of the total electricity and steam production in the region, and solid waste disposal and wastewater treatment costs are less than 5% of the total operating costs of the pollution control equipment. It should also be noted that the SO2 and NOx controls would have beneficial environmental impacts (e.g., reduced acid deposition and nitrogen deposition).

Factor 4 (Remaining Useful Life): The additional control measures are intended to be market-based strategies applied over a broad geographic region. It is not expected that the control requirements will be applied to units that will be retired prior to the amortization period for the control equipment. Thus, this factor can be easily addressed.

Factor 5 (Visibility Impacts): The estimated incremental improvement in 2018 visibility levels for the additional measures is shown in Figure 74, along with the cost-effectiveness expressed in $M per deciview improvement). These results show that although EGU and ICI boiler controls have higher cost-per-deciview values (compared to some of the other measures), their visibility impacts are larger.

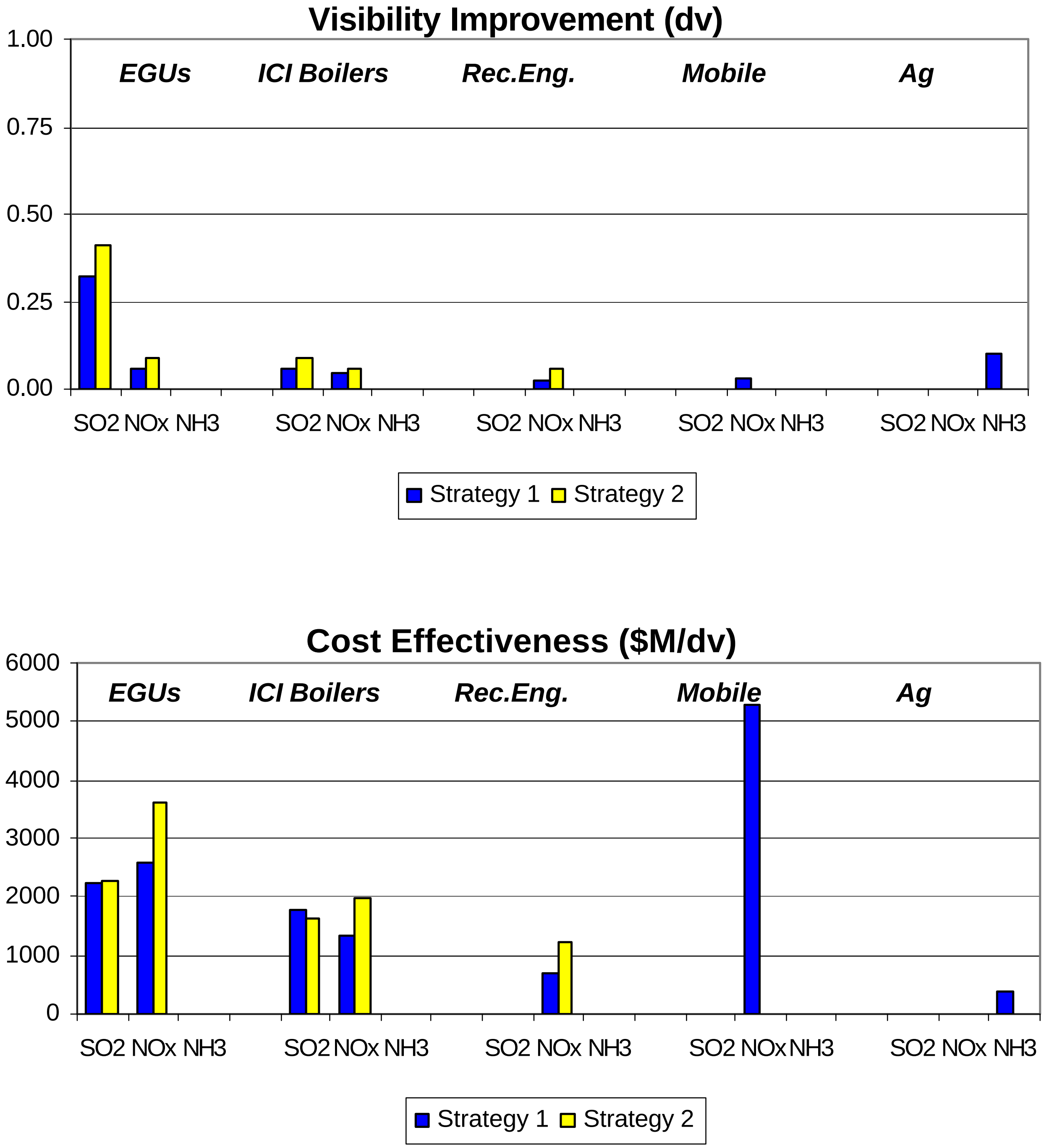


Figure 74. Results of ECR analysis of reasonable progress factors – visibility improvement (Factor 5) is on top, and cost effectiveness (Factor 1) is on bottom

5.3 Weight-of-Evidence Determination for Haze

The WOE determination for haze consists of the primary modeling and other supplemental analyses. A summary of this information is provided below.

Primary (Guideline) Modeling: The results of the guideline modeling are presented in Section 4.1. Key findings from this modeling include:

- Base M modeling results show that the northern Minnesota Class I areas are close to the glide path, whereas the northern Michigan Class I areas are above the glide path in 2018. Other sites in the eastern U.S. are close to (or below) the glide path, except for Mingo (MO), Brigantine (NJ), and Acadia (ME).

- Base K modeling results show that the northern Minnesota and northern Michigan Class I areas are above the glide path in 2018. Other sites in the eastern U.S. are close to (or below) the glide path.

- The difference in the two modeling analyses is due mostly to differences in future year emission projections, especially for EGUs (e.g., use of IPM2.1.9 v. IPM3.0).

- Base K and Base M modeling analyses are considered “SIP quality”, so the attainment demonstration for haze should reflect a weight-of-evidence approach, with consideration of monitoring based information.

Additional Modeling: Two additional modeling analyses were considered: (1) the primary modeling redone with different baseline values, and (2) modeling by the State of Minnesota which looked at different receptor locations in the northern Class I areas (MPCA, 2008). Each of these analyses is described below.

First, the primary modeling analysis (Base M) was revised using an alternative baseline value. Specifically, the data for the period 2000-2005 were used to calculate the baseline, given that the Base M modeling reflects a 2005 base year. The results of this alternative analysis (see Table 18) are generally consistent with the primary modeling (see Table 16).

Second, Minnesota’s modeling reflects a 2002 base year and much of the data developed by LADCO for its modeling. (Note, Minnesota conducted modeling for LADCO’s domain at 36 km, and for a statewide domain at 12 km.) The purpose of the 12 km modeling was to address local scale impacts on the northern Class I areas at several locations, not just the location of the IMPROVE monitor. Results for the Boundary Waters on the 20% worst days range from 18.3 – 19.0 dv, with an average value of 18.7 dv, which is consistent with Minnesota’s 36 km modeling results at the IMPROVE monitor. This variability in visibility levels should be kept in mind when reviewing the values presented in Tables 15, 16, and 18, which reflect results at the IMPROVE monitor locations.

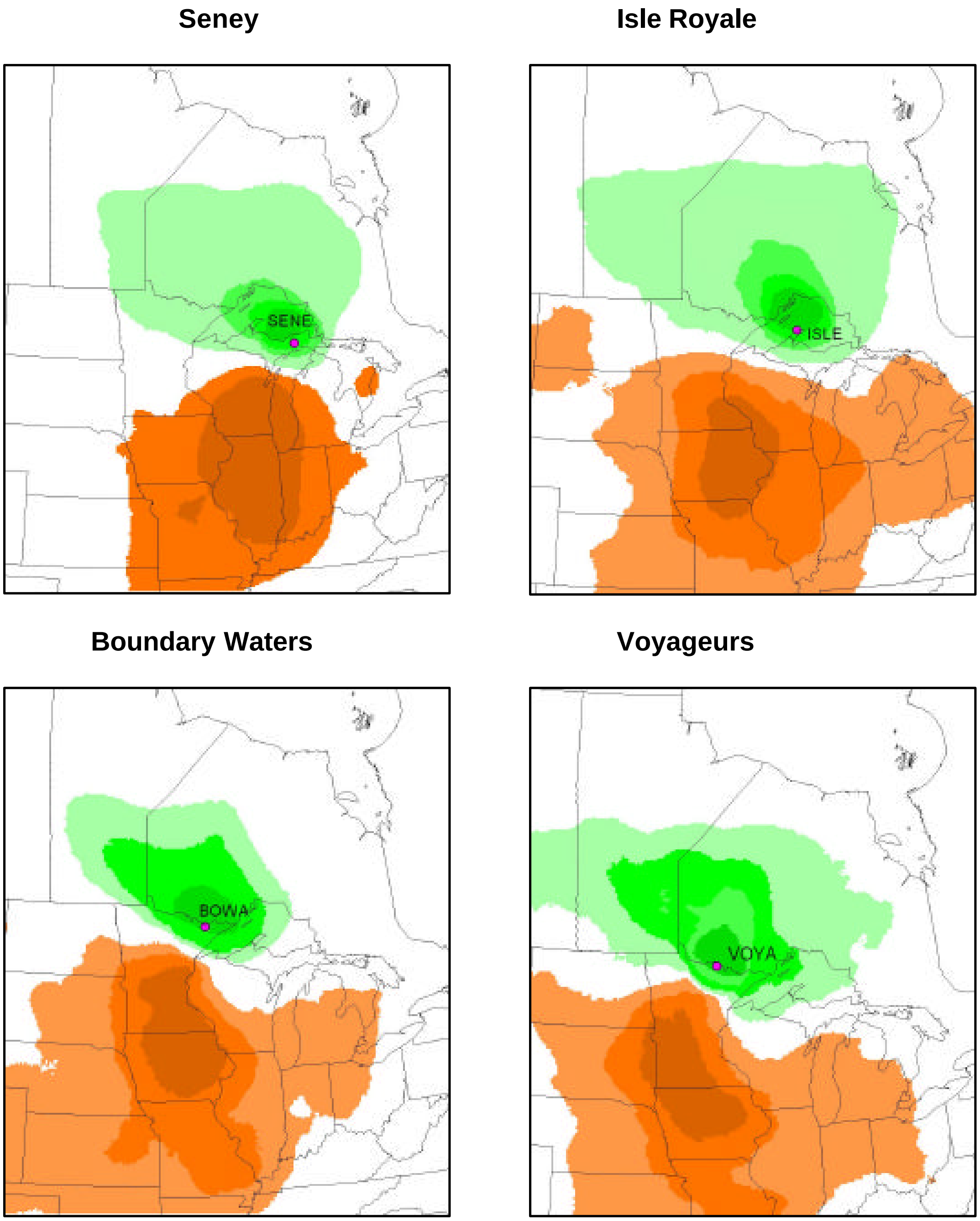
Table 18. Haze Results - Round 5.1 (Based on 2000-2005)

Worst 20%			**2009**	**2012**	**2018**	**2018**
Site	**Baseline**	**URP**	**OTB**	**OTB**	**OTB**	**OTB+Will DO**
BOWA1	20.10	18.12	18.63	18.51	18.12	18.09
VOYA2	19.62	17.86	18.27	18.15	17.70	17.72
SENE1	24.77	21.94	23.44	23.39	**22.94**	**22.77**
ISLE1	21.95	19.71	20.84	20.76	**20.41**	**20.44**
ISLE9	21.95	19.71	20.65	20.55	**20.15**	**20.13**
HEGL1	27.45	23.67	25.30	25.27	**24.79**	**24.73**
MING1	28.92	24.86	25.88	25.68	24.74	24.83
CACR1	27.05	23.44	23.88	23.78	22.92	22.86
UPBU1	26.97	23.36	23.92	23.85	23.14	23.09
MACA1	31.76	26.93	27.42	27.32	26.39	26.44
DOSO1	29.36	24.92	24.20	24.11	23.19	23.23
SHEN1	29.45	25.23	25.06	24.94	23.98	24.01
JARI1	29.40	25.13	25.32	25.17	24.22	24.28
BRIG1	29.12	25.14	25.84	25.77	**25.26**	**25.26**
LYBR1	24.71	21.69	22.22	22.06	21.36	21.36
ACAD1	22.91	20.47	21.72	21.72	**21.49**	**21.49**
Best 20%			**2009**	**2012**	**2018**	**2018**
Site	**Baseline**	**URP**	**OTB**	**OTB**	**OTB**	**OTB+Will DO**
BOWA1	6.40	6.40	6.20	6.17	6.13	6.10
VOYA2	7.05	7.05	6.82	6.78	6.71	6.71
SENE1	7.20	7.20	7.60	7.61	7.73	7.80
ISLE1	6.80	6.80	6.67	6.64	6.65	6.66
ISLE9	6.80	6.80	6.62	6.61	6.57	6.55
HEGL1	13.04	13.04	12.71	12.51	11.85	11.82
MING1	14.68	14.68	14.07	13.89	13.28	13.29
CACR1	11.62	11.62	11.24	11.20	10.86	10.86
UPBU1	11.99	11.99	11.41	11.36	11.01	11.02
MACA1	16.64	16.64	15.88	15.82	15.37	15.38
DOSO1	12.24	12.24	11.21	11.19	10.96	10.97
SHEN1	10.85	10.85	10.04	10.02	9.82	9.83
JARI1	14.35	14.35	13.51	13.51	13.27	13.27
BRIG1	14.36	14.36	14.17	14.10	13.94	13.94
LYBR1	6.21	6.21	6.11	6.09	6.01	6.01
ACAD1	8.57	8.57	8.67	8.66	8.62	8.62

Observational Models and Diagnostic Analyses: The observation-based modeling (i.e., application of thermodynamic equilibrium models) is presented in Section 3. The key findings from this modeling are that $PM_{2.5}$ mass is sensitive to reductions in sulfate, nitric acid, and ammonia concentrations. Even though sulfate reductions cause more ammonia to be available to form ammonium nitrate (PM-nitrate increases slightly when sulfate is reduced), this increase is generally offset by the sulfate reductions, such that $PM_{2.5}$ mass decreases and visibility improves. Under conditions with lower sulfate levels (i.e., proxy of future year conditions), $PM_{2.5}$ is more sensitive to reductions in nitric acid compared to reductions in ammonia.

As discussed in Section 2, thermodynamic equilibrium modeling based on data collected at Seney indicates that $PM_{2.5}$ there is most sensitive to reductions in sulfate, but also responsive to reductions in nitric acid (Blanchard, 2004). An analysis using data from the Midwest ammonia monitoring network for a site in Minnesota (i.e., Great River Bluffs, which is the closest ammonia monitoring site to the northern Class I areas) suggested that reductions in sulfate, nitric acid, and ammonia concentrations will lower $PM_{2.5}$ concentrations and improve visibility levels in the northern Class I areas.

Trajectory analyses for the 20% worst visibility days for the four northern Class I areas are provided in Figure 75. (Note, this figure is similar to Figure 34, but the trajectory results for each Class I area are displayed separately here.) The orange areas are where the air is most likely to come from, and the green areas are where the air is least likely to come from. Darker shading represents higher frequency. As can be seen, bad air days are generally associated with transport from regions located to the south, and good air days with transport from Canada.


Seney

Isle Royale

Boundary Waters

Voyageurs

Figure 75. Trajectory analysis results for northern Class I areas on 20% worst visibility days

The primary diagnostic analysis is source apportionment modeling with CAMx to provide more quantitative information on source region (and source sector) impacts (Baker, 2007b). Specifically, the CAMx model was applied to provide source contribution information. Specifically, the model estimated the impact of 18 geographic source regions (which are identified in Figure 76) and 6 source sectors (EGU point, non-EGU point, on-road, off-road, area, and ammonia sources) at visibility/haze monitoring sites in the eastern U.S.

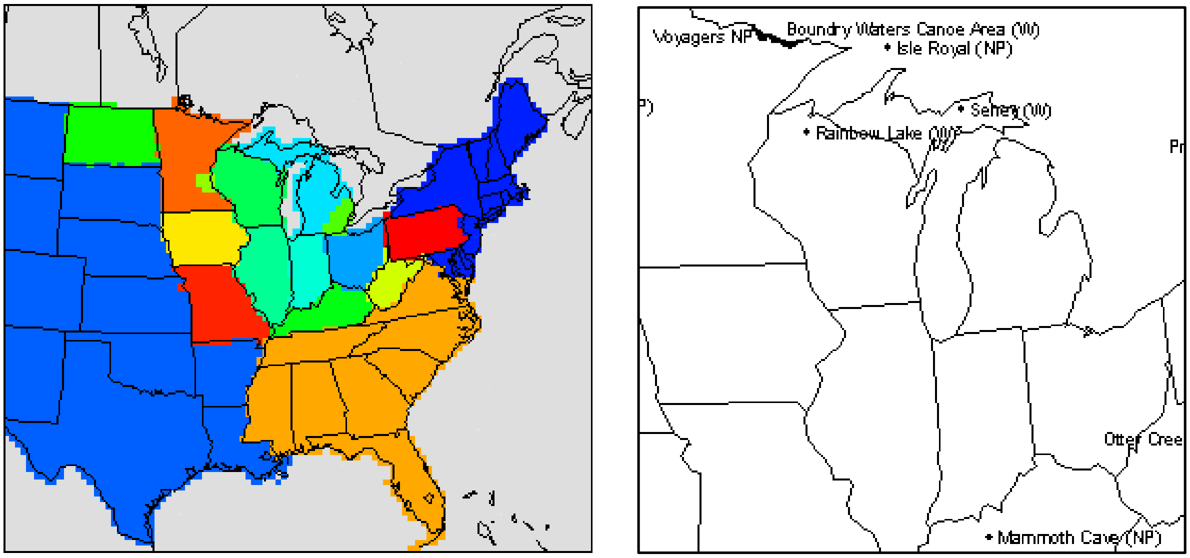


Figure 76. Source regions (left) and key monitoring sites (right) for haze modeling analysis

Modeling results for 2018 (Base K and Base M) are provided in Appendix IV for several key monitoring sites (Class I areas). For each monitoring site, there are two graphs: one showing sector-level contributions, and one showing source region and sector-level contributions in terms of absolute modeled values.

The sector-level results (see, for example, Figure 77) show that EGU sulfate, non-EGU-sulfate, and ammonia emissions generally have the largest contributions at the key monitor locations. The source group contributions vary by receptor location due to emissions inventory differences.

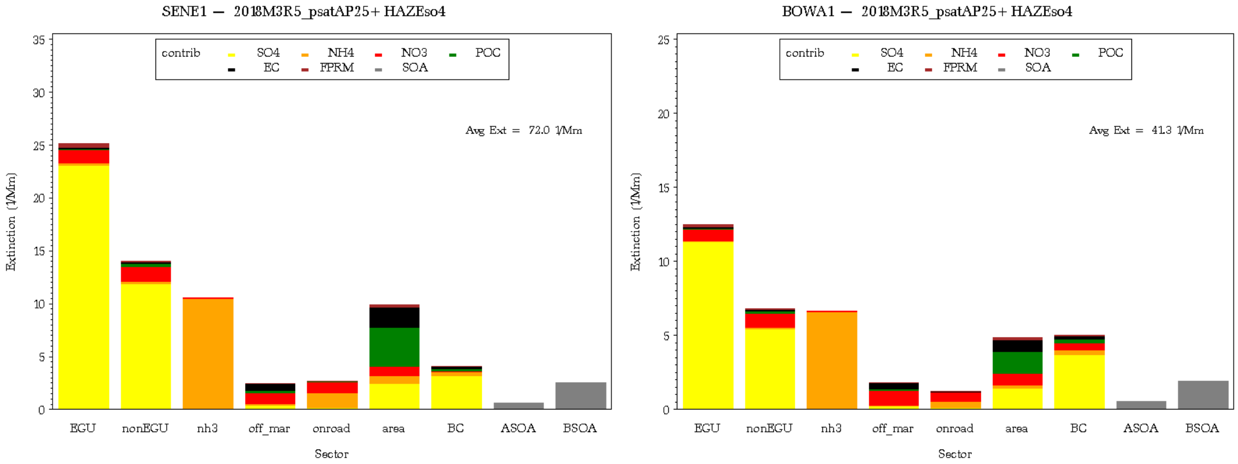


Figure 77. Source-sector results for Seney (left) and Boundary Waters (right) – 2018 (Base M)

The source region results (see, for example, Figure 78) show that emissions from a number of nearby states contribute to regional haze levels.

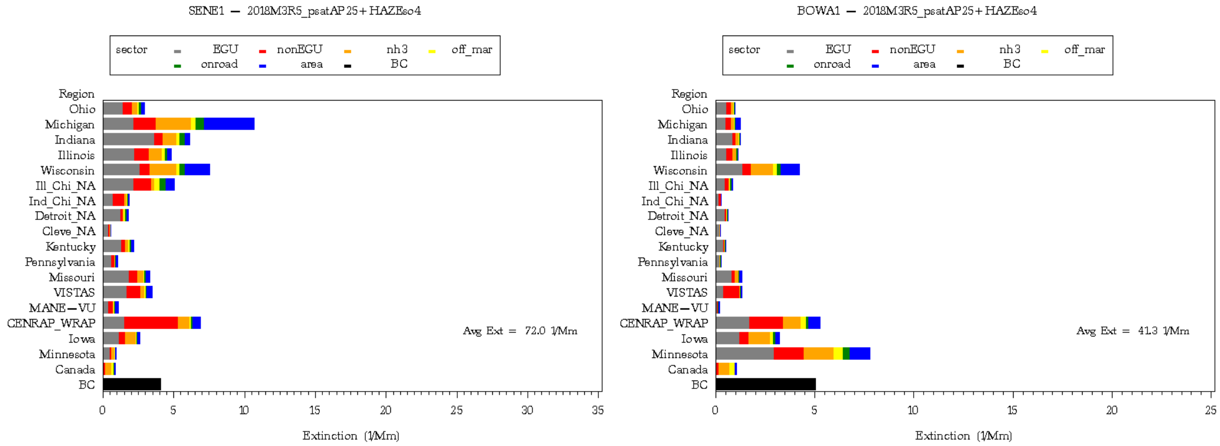


Figure 78. Source-region results for Seney (left) and Boundary Waters (right) – 2018 (Base M)

Table 19 provides a summary of the estimated state-level culpabilities based on the LADCO back trajectory analyses and the PSAT analyses for 2018.

Summary: Air quality modeling and other supplemental analyses were performed to estimate future year visibility levels. Based on this information, the following general conclusions can be made:

- Existing ("on the books") controls are expected to improve visibility levels in the northern Class I areas.
- Visibility levels in a few Class I areas in the eastern U.S. are expected to be greater than (less improved than) the uniform rate of visibility improvement values in 2018, including those in northern Michigan and some in the northeastern U.S.
- Visibility levels in many other Class I areas in the eastern U.S. are expected to be less than (more improved than) the uniform rate of visibility improvement values in 2018.

Table 19. State Culpabilities Based on PSAT Modeling and Trajectory Analyses

	Boundary Waters						Seney			
	LADCO - Round 4 PSAT	**LADCO - Round 5 PSAT**	**MPCA-PSAT**	**CENRAP - PSAT**	**LADCO - Traj. Analysis**		**LADCO - Round 4 PSAT**	**LADCO - Round 5 PSAT**	**CENRAP - PSAT**	**LADCO - Traj. Analysis**
Michigan	3.4%	4.8%	3.0%	1.9%	0.7%		13.8%	18.1%		14.7%
Minnesota	30.5%	23.5%	28.0%	30.6%	37.6%		4.8%	1.6%		3.8%
Wisconsin	10.4%	10.9%	10.0%	6.4%	10.6%		12.6%	10.9%		8.4%
Illinois	5.2%	5.1%	6.0%	3.5%	2.7%		13.0%	14.3%		7.4%
Indiana	2.9%	3.9%	3.0%	1.8%	1.2%		9.6%	11.6%		2.2%
Iowa	7.6%	8.3%	8.0%	2.5%	7.4%		6.2%	3.8%		5.7%
Missouri	5.2%	3.4%	6.0%	2.1%	3.3%		6.5%	4.8%		3.2%
N. Dakota	5.7%	1.1%	6.0%	4.6%	5.9%		1.5%	0.1%		0.6%
Canada	1.9%	2.7%	3.0%	12.5%	15.1%		2.1%	1.2%		11.1%
CENRAP-WRAP	10.9%	13.5%		4.2%	10.1%		13.1%	10.0%		7.0%
	83.6%	**77.2%**	**73.0%**	**70.2%**	**94.6%**		**83.3%**	**76.4%**		**64.1%**
	Voyageurs						**Isle Royale**			
	LADCO - Round 4 PSAT	**LADCO - Round 5 PSAT**	**MPCA-PSAT**	**CENRAP - PSAT**	**LADCO - Traj. Analysis**		**LADCO - Round 4 PSAT**	**LADCO - Round 5 PSAT**	**CENRAP - PSAT**	**LADCO - Traj. Analysis**
Michigan	2.0%	4.9%	2.0%	1.0%	1.6%		12.7%	13.4%		
Minnesota	35.0%	20.2%	31.0%	31.5%	36.9%		14.1%	9.5%		
Wisconsin	6.3%	7.9%	6.0%	3.7%	9.7%		16.3%	14.7%		
Illinois	3.0%	7.1%	3.0%	1.8%	1.2%		7.0%	8.7%		
Indiana	1.6%	4.6%	2.0%	0.8%			5.6%	5.2%		
Iowa	7.4%	7.1%	7.0%	2.4%	10.2%		6.9%	8.3%		
Missouri	4.3%	4.0%	4.0%	1.6%	0.3%		3.9%	4.6%		
N. Dakota	10.3%	1.7%	13.0%	6.1%	7.1%		3.6%	0.3%		
Canada	2.7%	3.3%	5.0%	17.2%	13.3%		2.2%	1.7%		
CENRAP-WRAP	10.2%	13.7%		6.1%	16.5%		12.5%	12.6%		
	82.7%	**74.5%**	**73.0%**	**72.2%**	**96.8%**		**84.9%**	**79.0%**		

Section 6. Summary

To support the development of SIPs for ozone, $PM_{2.5}$, and regional haze in the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin, technical analyses were conducted by LADCO, its member states, and various contractors. The analyses include preparation of regional emissions inventories and meteorological modeling data for two base years, evaluation and application of regional chemical transport models, and review of ambient monitoring data.

Analyses of monitoring data were conducted to produce a conceptual model, which is a qualitative summary of the physical, chemical, and meteorological processes that control the formation and distribution of pollutants in a given region. Key findings of the analyses include:

Ozone

- Current monitoring data show about 20 sites in violation of the 8-hour ozone standard of 85 ppb. Historical ozone data show a steady downward trend over the past 15 years, especially since 2001-2003, due likely to federal and state emission control programs.

- Ozone concentrations are strongly influenced by meteorological conditions, with more high ozone days and higher ozone levels during summers with above normal temperatures.

- Inter- and intra-regional transport of ozone and ozone precursors affects many portions of the five states, and is the principal cause of nonattainment in some areas far from population or industrial centers

$PM_{2.5}$

- Current monitoring data show 30 sites in violation of the annual $PM_{2.5}$ standard of 15 ug/m^3. Nonattainment sites are characterized by an elevated regional background (about 12 – 14 ug/m^3) and a significant local (urban) increment (about 2 – 3 ug/m^3). Historical $PM_{2.5}$ data show a slight downward trend since deployment of the $PM_{2.5}$ monitoring network in 1999.

- $PM_{2.5}$ concentrations are also influenced by meteorology, but the relationship is more complex and less well understood compared to ozone.

- On an annual average basis, $PM_{2.5}$ chemical composition consists of mostly sulfate, nitrate, and organic carbon in similar proportions.

Haze

- Current monitoring data show visibility levels in the Class I areas in northern Michigan are on the order of 22 – 24 deciviews. The goal of EPA's visibility program is to achieve natural conditions, which is on the order of 12 deciviews for these Class I areas, by the year 2064.

- Visibility impairment is dominated by sulfate and nitrate.

Air quality models were applied to support the regional planning efforts. Two base years were used in the modeling analyses: 2002 and 2005. EPA's modeling guidance recommends using

2002 as the baseline inventory year, but also allows for use of an alternative baseline inventory year, especially a more recent year. Initially, LADCO conducted modeling with a 2002 base year (i.e., Base K modeling, which was completed in 2006). A decision was subsequently made to conduct modeling with a 2005 base year (i.e., Base M, which was completed in 2007). Statistical analyses showed that 2002 and 2005 both had above normal ozone-conducive conditions, although 2002 was more severe compared to 2005. Examination of multiple base years provides for a more complete technical assessment. Both sets of model runs are discussed in this document.

Basecase modeling was conducted to evaluate model performance (i.e., assess the model's ability to reproduce the observed concentrations). This exercise was intended to assess whether, and to degree, confidence in the model is warranted (and to assess whether model improvements are necessary). Model performance for ozone and $PM_{2.5}$ was generally acceptable and can be characterized as follows:

Ozone

- Good agreement between modeled and monitored concentration for higher concentration levels (> 60 ppb) – i.e., bias within 30%
- Regional modeled concentrations appear to be underestimated in the 2002 base year, but show better agreement (with monitored data) in the 2005 base year due to model and inventory improvements.
- Day-to-day and hour-to-hour variation in and spatial patterns of modeled concentrations are consistent with monitored data
- Model accurately simulates the change in monitored ozone concentrations due to reductions in precursor emissions.

$PM_{2.5}$

- Good agreement in the magnitude of fine particle mass, but some species are overestimated and some are underestimated
  - Sulfates: good agreement in the 2002 base year, but underestimated in the summer in the 2005 base year due probably to meteorological factors
  - Nitrates: slightly overestimated in the winter in the 2002 base year, but good agreement in the 2005 base year as a result of model and inventory improvements
  - Organic Carbon: grossly underestimated in the 2002 and 2005 base years due likely to missing primary organic carbon emissions
- Temporal variation and spatial patterns of modeled concentrations are consistent with monitored data

Future year strategy modeling was conducted to determine whether existing (“on the books”) controls would be sufficient to provide for attainment of the standards for ozone and $PM_{2.5}$ and if not, then what additional emission reductions would be necessary for attainment. Traditionally, attainment demonstrations involved a “bright line” test in which a single modeled value (based on EPA guidance) was compared to the ambient standard. To provide a more robust assessment of expected future year air quality, other information was considered. Furthermore, according to EPA’s modeling guidance, if the future year modeled values are “close” to the standard (i.e., 82 – 87 ppb for ozone and 14.5 – 15.5 ug/m^3 for $PM_{2.5}$), then the results of the primary modeling should be reviewed along with the supplemental information in a "weight of evidence" (WOE) assessment of whether each area is likely to achieve timely attainment. Key findings of the WOE determination include:

- Existing controls are expected to produce significant improvement in ozone and $PM_{2.5}$ concentrations and visibility levels.

- The choice of the base year affects the future year model projections. A key difference between the base years of 2002 and 2005 is meteorology. 2002 was more ozone conducive than 2005. The choice of which base year to use as the basis for the SIP is a policy decision (i.e., how much safeguard to incorporate).

- Most sites are expected to meet the current 8-hour standard by the applicable attainment date, except for sites in western Michigan and, possibly, in eastern Wisconsin and northeastern Ohio.

- Most sites are expected to meet the current $PM_{2.5}$ standard by the applicable attainment date, except for sites in Detroit, Cleveland, and Granite City.

  The regional modeling for $PM_{2.5}$ does not reflect air quality benefits expected from local controls. States are conducting local-scale analyses and will use these results, in conjunction with the regional-scale modeling, to support their attainment demonstrations for $PM_{2.5}$.

- These findings of residual nonattainment for ozone and $PM_{2.5}$ are supported by current (2005 – 2007) monitoring data which show significant nonattainment in the region (e.g., peak ozone design values on the order of 90 – 93 ppb, and peak $PM_{2.5}$ design values on the order of 16 - 17 ug/m^3). It is unlikely that sufficient emission reductions will occur in the next few of years to provide for attainment at all sites.

- Attainment at most sites by the applicable attainment date is dependent on actual future year meteorology (e.g., if the weather conditions are consistent with [or less severe than] 2005, then attainment is likely) and actual future year emissions (e.g., if the emission reductions associated with the existing controls are achieved, then attainment is likely). If either of these conditions is not met, then attainment may be less likely.

- The new $PM_{2.5}$ 24-hour standard and the new lower ozone standard will not be met at several sites, even by 2018, with existing controls.

- Visibility levels in a few Class I areas in the eastern U.S. are expected to be greater than (less improved than) the uniform rate of visibility improvement values in 2018 based on existing controls, including those in northern Michigan and some in the northeastern U.S. Visibility levels in many other Class I areas in the eastern U.S. are expected to be less than (more improved than) the uniform rate of visibility improvement values in 2018.

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http://vista.cira.colostate.edu/views/

APPENDIX I

Ozone and PM$_{2.5}$ Modeling Results

Key Sites		4th High 8-hour Value					Des. Values (truncated)			2005 BY	2002 BY	2008 - OTB		
		'03	'04	'05	'06	'07	'03-'05	'04-'06	'05-'07	Average	Average	RRF	Round 5	
Lake Michigan Area														***Lake Michigan Area***
Chiwaukee	550590019	88	78	93	79	85	**86**	83	**85**	84.7	**98.3**	0.968	**82.0**	Chiwaukee
Racine	551010017	82	69	95	71	77	82	78	81	80.3	**91.7**	0.966	77.6	Racine
Milwaukee-Bayside	550190085	92	73	93	73	83	**86**	79	83	82.7	**91.0**	0.963	79.6	Milwaukee-Bayside
Harrington Beach	550890009	99	72	94	72	84	**88**	79	83	83.3	**93.0**	0.960	80.0	Harrington Beach
Manitowoc	550710007	92	74	95	78	85	**87**	82	**86**	85.0	**87.0**	0.957	81.3	Manitowoc
Sheboygan	551170006	93	78	97	83	88	**89**	**86**	**89**	**88.0**	**97.0**	0.959	**84.4**	Sheboygan
Kewaunee	550610002	97	73	88	76	85	**86**	79	83	82.7	**89.3**	0.954	78.9	Kewaunee
Door County	550290004	93	78	101	79	92	**90**	**86**	**90**	**88.7**	**91.0**	0.956	**84.8**	Door County
Hammond	180892008	81	67	87	75	77	78	76	79	77.7	**88.3**	0.971	75.4	Hammond
Whiting	180890030		64	88	81	88	76	77	**85**	79.3		0.971	77.0	Whiting
Michigan City	180910005	82	70	84	75	73	78	76	77	77.0	**90.3**	0.964	74.2	Michigan City
Ogden Dunes	181270020	77	69	90	70	84	78	76	81	78.3	**86.3**	0.967	75.7	Ogden Dunes
Holland	260050003	96	79	94	91	94	**89**	**88**	**93**	**90.0**	**94.0**	0.951	**85.6**	Holland
Jenison	261390005	91	69	86	83	88	82	79	**85**	82.0	**86.0**	0.950	77.9	Jenison
Muskegon	261210039	94	70	90	90	86	84	83	**88**	**85.0**	**90.0**	0.951	80.8	Muskegon
Indianapolis Area														***Indianapolis Area***
Noblesville	189571001	101	75	87	77	84	**87**	79	82	82.7	**93.7**	0.944	78.0	Noblesville
Fortville	180590003	92	72	80	75	81	81	75	78	78.0	**91.3**	0.948	73.9	Fortville
Fort B. Harrison	180970050	91	73	80	76	83	81	76	79	78.7	**90.0**	0.951	74.8	Fort B. Harrison
Detroit Area														***Detroit Area***
New Haven	260990009	102	81	88	78	93	**90**	82	**86**	**86.0**	**92.3**	0.962	**82.7**	New Haven
Warren	260991003	101	71	89	78	91	**87**	79	**86**	84.0	**90.0**	0.982	**82.5**	Warren
Port Huron	261470005	87	74	88	78	89	83	80	**85**	82.7	**88.0**	0.956	79.0	Port Huron
Cleveland Area														***Cleveland Area***
Ashtabula	390071001	99	81	93	86	92	**91**	**86**	**90**	**89.0**	**95.7**	0.954	**84.9**	Ashtabula
Geauga	390550004	97	75	88	70	68	**86**	77	75	79.3	**99.0**	0.954	75.7	Geauga
Eastlake	390850003	92	79	97	83	74	**89**	**86**	84	**86.3**	**92.7**	0.959	**82.8**	Eastlake
Akron	391530020	89	77	89	77	91	**85**	81	**85**	83.7	**93.3**	0.948	79.3	
Cincinnati Area														***Cincinnati Area***
Wilmington	390271002	96	78	83	81	82	**85**	80	82	82.3	**94.3**	0.945	77.8	Wilmington
Sycamore	390610006	93	76	89	81	90	**86**	82	**86**	84.7	**90.3**	0.965	81.7	Sycamore
Lebanon	391650007	95	81	92	86	88	**89**	**86**	**88**	**87.7**	**87.0**	0.954	**83.6**	Lebanon
Columbus Area														***Columbus Area***
London	390970007	90	75	81	76	83	82	77	80	79.7	**88.7**	0.946	75.4	London
New Albany	390490029	94	78	92	82	87	**88**	84	**87**	**86.3**	**93.0**	0.954	**82.4**	New Albany
Franklin	290490028	84	73	86	79	79	81	79	81	80.3	**86.0**	0.958	77.0	Franklin
St. Louis Area														***St. Louis Area***
W. Alton (MO)	291831002	91	77	89	91	89	**85**	**85**	**89**	**86.3**	**90.0**	0.954	**82.4**	W. Alton (MO)
Orchard (MO)	291831004	90	76	92	92	83	**86**	**86**	**89**	**87.0**	**90.0**	0.958	**83.3**	Orchard (MO)
Sunset Hills (MO)	291890004	88	70	89	80	89	82	79	**86**	82.3	**88.3**	0.966	79.5	Sunset Hills (MO)
Arnold (MO)	290990012	82	70	92	79	87	81	80	**86**	82.3	84.7	0.956	78.7	Arnold (MO)
Margaretta (MO)	295100086	90	72	91	76	91	84	79	**86**	83.0	**87.7**	0.962	79.8	Margaretta (MO)
Maryland Heights (MO)	291890014			88	84	94	**88**	**86**	**88**	**87.3**		0.967	**84.5**	Maryland Heights (MO)

Key Sites		**4th High 8-hour Value**					**Des. Values (truncated)**			**2005 BY**	**2002 BY**	**2009 - OTB**			**2009 - Will Do**		
		'03	**'04**	**'05**	**'06**	**'07**	**'03-'05**	**'04-'06**	**'05-'07**	**Average**	**Average**	**RRF**	**Round 5**	**Round 4**	**RRF**	**Round 5**	
Lake Michigan Area																	***Lake Michigan Area***
Chiwaukee	550590019	88	78	93	79	85	86	83	85	84.7	98.3	0.972	82.3	92.0	0.971	82.2	Chiwaukee
Racine	551010017	82	69	95	71	77	82	78	81	80.3	91.7	0.965	77.5	84.9	0.964	77.4	Racine
Milwaukee-Bayside	550190085	92	73	93	73	83	86	79	83	82.7	91.0	0.965	79.8	84.9	0.964	79.7	Milwaukee-Bayside
Harrington Beach	550890009	99	72	94	72	84	88	79	83	83.3	93.0	0.961	80.1	85.4	0.960	80.0	Harrington Beach
Manitowoc	550710007	92	74	95	78	85	87	82	86	85.0	87.0	0.951	80.8	78.9	0.949	80.7	Manitowoc
Sheboygan	551170006	93	78	97	83	88	89	86	89	88.0	97.0	0.955	84.0	88.9	0.953	83.9	Sheboygan
Kewaunee	550610002	97	73	88	76	85	86	79	83	82.7	89.3	0.945	78.1	81.0	0.943	78.0	Kewaunee
Door County	550290004	93	78	101	79	92	90	86	90	88.7	91.0	0.946	83.9	81.8	0.945	83.8	Door County
Hammond	180892008	81	67	87	75	77	78	76	79	77.7	88.3	0.971	75.4	86.6	0.970	75.3	Hammond
Whiting	180890030		64	88	81	88	76	77	85	79.3		0.971	77.0		0.970	77.0	Whiting
Michigan City	180910005	82	70	84	75	73	78	76	77	77.0	90.3	0.960	73.9	86.5	0.959	73.8	Michigan City
Ogden Dunes	181270020	77	69	90	70	84	78	76	81	78.3	86.3	0.965	75.6	82.8	0.964	75.5	Ogden Dunes
Holland	260050003	96	79	94	91	94	89	88	93	90.0	94.0	0.948	85.3	83.4	0.947	85.2	Holland
Jenison	261390005	91	69	86	83	88	82	79	85	82.0	86.0	0.940	77.1	77.6	0.939	77.0	Jenison
Muskegon	261210039	94	70	90	90	86	84	83	88	85.0	90.0	0.947	80.5	81.5	0.945	80.3	Muskegon
Indianapolis Area																	***Indianapolis Area***
Noblesville	189571001	101	75	87	77	84	87	79	82	82.7	93.7	0.945	78.1	83.7	0.946	78.2	Noblesville
Fortville	180590003	92	72	80	75	81	81	75	78	78.0	91.3	0.947	73.9	83.8	0.948	73.9	Fortville
Fort B. Harrison	180970050	91	73	80	76	83	81	76	79	78.7	90.0	0.955	75.1	83.7	0.956	75.2	Fort B. Harrison
Detroit Area																	***Detroit Area***
New Haven	260990009	102	81	88	78	93	90	82	86	86.0	92.3	0.947	81.4	85.3	0.947	81.4	New Haven
Warren	260991003	101	71	89	78	91	87	79	86	84.0	90.0	0.968	81.3	83.3	0.969	81.4	Warren
Port Huron	261470005	87	74	88	78	89	83	80	85	82.7	88.0	0.937	77.5	79.1	0.938	77.5	Port Huron
Cleveland Area																	***Cleveland Area***
Ashtabula	390071001	99	81	93	86	92	91	86	90	89.0	95.7	0.937	83.4	82.7	0.941	83.7	Ashtabula
Geauga	390550004	97	75	88	70	68	86	77	75	79.3	99.0	0.942	74.7	88.8	0.945	75.0	Geauga
Eastlake	390850003	92	79	97	83	74	89	86	84	86.3	92.7	0.949	81.9	82.8	0.954	82.4	Eastlake
Akron	391530020	89	77	89	77	91	85	81	85	83.7	93.3	0.934	78.1	81.4	0.935	78.2	
Cincinnati Area																	***Cincinnati Area***
Wilmington	390271002	96	78	83	81	82	85	80	82	82.3	94.3	0.941	77.5	83.5	0.942	77.6	Wilmington
Sycamore	390610006	93	76	89	81	90	86	82	86	84.7	90.3	0.967	81.9	84.7	0.968	82.0	Sycamore
Lebanon	391650007	95	81	92	86	88	89	86	88	87.7	87.0	0.947	83.0	79.0	0.948	83.1	Lebanon
Columbus Area																	***Columbus Area***
London	390970007	90	75	81	76	83	82	77	80	79.7	88.7	0.941	75.0	78.4	0.942	75.0	London
New Albany	390490029	94	78	92	82	87	88	84	87	86.3	93.0	0.947	81.8	82.6	0.948	81.8	New Albany
Franklin	290490028	84	73	86	79	79	81	79	81	80.3	86.0	0.945	75.9	76.5	0.948	76.2	Franklin
St. Louis Area																	***St. Louis Area***
W. Alton (MO)	291831002	91	77	89	91	89	85	85	89	86.3	90.0	0.938	81.0	85.2	0.932	80.5	W. Alton (MO)
Orchard (MO)	291831004	90	76	92	92	83	86	86	89	87.0	90.0	0.942	82.0	82.2	0.939	81.7	Orchard (MO)
Sunset Hills (MO)	291890004	88	70	89	80	89	82	79	86	82.3	88.3	0.956	78.7	81.9	0.954	78.5	Sunset Hills (MO)
Arnold (MO)	290990012	82	70	92	79	87	81	80	86	82.3	84.7	0.938	77.2	77.4	0.937	77.1	Arnold (MO)
Margaretta (MO)	295100086	90	72	91	76	91	84	79	86	83.0	87.7	0.955	79.3	83.4	0.955	79.3	Margaretta (MO)
Maryland Heights (MO)	291890014			88	84	94	88	86	88	87.3		0.955	83.4		0.954	83.3	Maryland Heights (MO)

Key Sites		4th High 8-hour Value					Des. Values (truncated)			2005 BY	2002 BY	2012 - OTB			2018 - OTB		
		'03	'04	'05	'06	'07	'03-'05	'04-'06	'05-'07	Average	Average	RRF	Round 5	Round 4	RRF	Round 5	
Lake Michigan Area																	***Lake Michigan Area***
Chiwaukee	550590019	88	78	93	79	85	**86**	83	**85**	84.7	**98.3**	0.956	80.9	**90.3**	0.900	76.2	Chiwaukee
Racine	551010017	82	69	95	71	77	82	78	81	80.3	**91.7**	0.947	76.1	**82.9**	0.886	71.2	Racine
Milwaukee-Bayside	550190085	92	73	93	73	83	**86**	79	83	82.7	**91.0**	0.944	78.0	**82.3**	0.880	72.7	Milwaukee-Bayside
Harrington Beach	550890009	99	72	94	72	84	**88**	79	83	83.3	**93.0**	0.939	78.3	**82.9**	0.870	72.5	Harrington Beach
Manitowoc	550710007	92	74	95	78	85	**87**	82	**86**	85.0	**87.0**	0.925	78.6	76.3	0.853	72.5	Manitowoc
Sheboygan	551170006	93	78	97	83	88	**89**	**86**	**89**	**88.0**	**97.0**	0.930	81.8	**86.4**	0.857	75.4	Sheboygan
Kewaunee	550610002	97	73	88	76	85	**86**	79	83	82.7	**89.3**	0.918	75.9	79.1	0.845	69.9	Kewaunee
Door County	550290004	93	78	101	79	92	**90**	**86**	**90**	**88.7**	**91.0**	0.919	81.5	79.3	0.843	74.7	Door County
Hammond	180892008	81	67	87	75	77	78	76	79	77.7	**88.3**	0.960	74.6	**86.3**	0.922	71.6	Hammond
Whiting	180890030		64	88	81	88	76	77	**85**	79.3		0.960	76.2		0.922	73.1	Whiting
Michigan City	180910005	82	70	84	75	73	78	76	77	77.0	**90.3**	0.942	72.5	**85.4**	0.884	68.1	Michigan City
Ogden Dunes	181270020	77	69	90	70	84	78	76	81	78.3	**86.3**	0.951	74.5	**82.0**	0.904	70.8	Ogden Dunes
Holland	260050003	96	79	94	91	94	**89**	**88**	**93**	**90.0**	**94.0**	0.920	**82.8**	81.0	0.846	76.1	Holland
Jenison	261390005	91	69	86	83	88	82	79	**85**	82.0	**86.0**	0.909	74.5	75.5	0.838	68.7	Jenison
Muskegon	261210039	94	70	90	90	86	84	83	**88**	**85.0**	**90.0**	0.918	78.0	79.4	0.846	71.9	Muskegon
Indianapolis Area																	***Indianapolis Area***
Noblesville	189571001	101	75	87	77	84	**87**	79	82	82.7	**93.7**	0.914	75.6	**82.0**	0.831	68.7	Noblesville
Fortville	180590003	92	72	80	75	81	81	75	78	78.0	**91.3**	0.916	71.4	**82.1**	0.835	65.1	Fortville
Fort B. Harrison	180970050	91	73	80	76	83	81	76	79	78.7	**90.0**	0.931	73.2	**82.4**	0.879	69.1	Fort B. Harrison
Detroit Area																	***Detroit Area***
New Haven	260990009	102	81	88	78	93	**90**	82	**86**	**86.0**	**92.3**	0.932	80.2	**83.5**	0.885	76.1	New Haven
Warren	260991003	101	71	89	78	91	**87**	79	**86**	84.0	**90.0**	0.961	80.7	81.9	0.924	77.6	Warren
Port Huron	261470005	87	74	88	78	89	83	80	**85**	82.7	**88.0**	0.913	75.5	77.0	0.858	70.9	Port Huron
Cleveland Area																	***Cleveland Area***
Ashtabula	390071001	99	81	93	86	92	**91**	**86**	**90**	**89.0**	**95.7**	0.910	81.0	80.2	0.844	75.1	Ashtabula
Geauga	390550004	97	75	88	70	68	**86**	77	75	79.3	**99.0**	0.916	72.7	**86.2**	0.848	67.3	Geauga
Eastlake	390850003	92	79	97	83	74	**89**	**86**	84	**86.3**	**92.7**	0.932	80.5	80.6	0.883	76.2	Eastlake
Akron	391530020	89	77	89	77	91	**85**	81	**85**	83.7	**93.3**	0.903	75.6	78.5	0.821	68.7	Akron
Cincinnati Area																	***Cincinnati Area***
Wilmington	390271002	96	78	83	81	82	**85**	80	82	82.3	**94.3**	0.910	74.9	81.1	0.830	68.3	Wilmington
Sycamore	390610006	93	76	89	81	90	**86**	82	**86**	84.7	**90.3**	0.948	80.3	**82.9**	0.881	74.6	Sycamore
Lebanon	391650007	95	81	92	86	88	**89**	**86**	**88**	**87.7**	**87.0**	0.921	80.7	77.0	0.846	74.2	Lebanon
Columbus Area																	***Columbus Area***
London	390970007	90	75	81	76	83	82	77	80	79.7	**88.7**	0.911	72.6	76.5	0.832	66.3	London
New Albany	390490029	94	78	92	82	87	**88**	84	**87**	**86.3**	**93.0**	0.922	79.6	80.2	0.845	73.0	New Albany
Franklin	290490028	84	73	86	79	79	81	79	81	80.3	**86.0**	0.923	74.1	74.7	0.859	69.0	Franklin
St. Louis Area																	***St. Louis Area***
W. Alton (MO)	291831002	91	77	89	91	89	**85**	**85**	**89**	**86.3**	**90.0**	0.911	78.6	**84.0**	0.868	74.9	W. Alton (MO)
Orchard (MO)	291831004	90	76	92	92	83	**86**	**86**	**89**	**87.0**	**90.0**	0.919	80.0	80.4	0.876	76.2	Orchard (MO)
Sunset Hills (MO)	291890004	88	70	89	80	89	82	79	**86**	82.3	**88.3**	0.937	77.1	80.6	0.897	73.9	Sunset Hills (MO)
Arnold (MO)	290990012	82	70	92	79	87	81	80	**86**	82.3	84.7	0.918	75.6	75.8	0.874	72.0	Arnold (MO)
Margaretta (MO)	295100086	90	72	91	76	91	84	79	**86**	83.0	**87.7**	0.939	77.9	**82.5**	0.896	74.4	Margaretta (MO)
Maryland Heights (MO)	291890014			88	84	94	**88**	**86**	**88**	**87.3**		0.936	81.7		0.894	78.1	Maryland Heights (MO)

			Annual Average Conc.					Design Values			2005 BY	2002 BY	2009 Modeling Results		
Key Site	County	Site ID	'03	'04	'05	'06	'07	'03 - '05	'04 - '06	'05 - '07	Average w/ 2007	Average	Round 5	Round4	Key Site
Chicago - Washington HS	Cook	170310022	15.6	14.2	16.9	13.2	15.7	15.6	14.8	15.3	**15.2**	**15.9**	**14.1**	**14.8**	Chicago - Washington HS
Chicago - Mayfair	Cook	170310052	15.9	15.3	17.0	14.5	15.5	16.1	15.6	15.7	**15.8**	**17.1**	**14.4**	**15.8**	Chicago - Mayfair
Chicago - Springfield	Cook	170310057	15.6	13.8	16.7	13.5	15.1	15.4	14.7	15.1	15.0	**15.6**	13.9	**14.5**	Chicago - Springfield
Chicago - Lawndale	Cook	170310076	14.8	14.2	16.6	13.5	14.3	15.2	14.8	14.8	14.9	**15.6**	13.8	**14.5**	Chicago - Lawndale
Blue Island	Cook	170312001	14.9	14.1	16.4	13.2	14.3	15.1	14.6	14.6	14.8	**15.6**	13.7	**14.5**	Blue Island
Summit	Cook	170313301	15.6	14.2	16.9	13.8	14.8	15.6	15.0	15.2	**15.2**	**16.0**	**14.2**	**14.8**	Summit
Cicero	Cook	170316005	16.8	15.2	16.3	14.3	14.8	16.1	15.3	15.1	**15.5**	**16.4**	**14.4**	**15.3**	Cicero
Granite City	Madison	171191007	17.5	15.4	18.2	16.3	15.1	17.0	16.6	16.5	**16.7**	**17.3**	**15.1**	**16.0**	Granite City
E. St. Louis	St. Clair	171630010	14.9	14.7	17.1	14.5	15.6	15.6	15.4	15.7	**15.6**	**16.2**	**14.1**	**14.9**	E. St. Louis
Jeffersonville	Clark	180190005	15.8	15.1	18.5	15.0	16.5	16.5	16.2	16.7	**16.4**	**17.2**	13.8	**15.5**	Jeffersonville
Jasper	Dubois	180372001	15.7	14.4	16.9	13.5	14.4	15.7	14.9	14.9	**15.2**	**15.5**	12.4	13.8	Jasper
Gary	Lake	180890031			16.8	13.3	14.5	16.8	15.1	14.9	**15.6**		13.0		Gary
Indy-Washington Park	Marion	180970078	15.5	14.3	16.4	14.1	15.8	15.4	14.9	15.4	**15.3**	**16.2**	12.8	**14.5**	Indy-Washington Park
Indy-W 18th Street	Marion	180970081	16.2	15.0	17.9	14.2	16.1	16.4	15.7	16.1	**16.0**		13.4		Indy-W 18th Street
Indy- Michigan Street	Marion	180970083	16.3	15.0	17.5	14.1	15.9	16.3	15.5	15.8	**15.9**	**16.6**	13.4	**14.8**	Indy- Michigan Street
Allen Park	Wayne	261630001	15.2	14.2	15.9	13.2	12.8	15.1	14.4	14.0	14.5	**15.8**	13.0	**14.5**	Allen Park
Southwest HS	Wayne	261630015	16.6	15.4	17.2	14.7	14.5	16.4	15.8	15.5	**15.9**	**17.3**	**14.2**	**15.8**	Southwest HS
Linwood	Wayne	261630016	15.8	13.7	16.0	13.0	13.9	15.2	14.2	14.3	14.6	**15.5**	13.1	**14.1**	Linwood
Dearborn	Wayne	261630033	19.2	16.8	18.6	16.1	16.9	18.2	17.2	17.2	**17.5**	**19.3**	**15.8**	**17.7**	Dearborn
Wyandotte	Wayne	261630036	16.3	13.7	16.4	12.9	13.4	15.5	14.3	14.2	14.7	**16.6**	13.1	**15.1**	Wyandotte
Middleton	Butler	390170003	17.2	14.1	19.0	14.1	15.4	16.8	15.7	16.2	**16.2**	**16.5**	13.5	**14.2**	Middleton
Fairfield	Butler	390170016	15.8	14.7	17.9	14.0	14.9	16.1	15.5	15.6	**15.8**	**15.9**	13.1	13.5	Fairfield
Cleveland-28th Street	Cuyahoga	390350027	15.4	15.6	17.3	13.0	14.5	16.1	15.3	14.9	**15.4**	**16.5**	13.5	**14.4**	Cleveland-28th Street
Cleveland-St. Tikhon	Cuyahoga	390350038	17.6	17.5	19.2	14.9	16.2	18.1	17.2	16.8	**17.4**	**18.4**	**15.2**	**16.1**	Cleveland-St. Tikhon
Cleveland-Broadway	Cuyahoga	390350045	16.4	15.3	19.3	14.1	15.3	17.0	16.2	16.2	**16.5**	**16.7**	**14.4**	**14.6**	Cleveland-Broadway
Cleveland-E14 & Orange	Cuyahoga	390350060	17.2	16.4	19.4	15.0	15.9	17.7	16.9	16.8	**17.1**	**17.6**	**15.0**	**15.3**	Cleveland-E14 & Orange
Newburg Hts - Harvard Ave	Cuyahoga	390350065	15.6	15.2	18.6	13.1	15.8	16.5	15.6	15.8	**16.0**	**16.2**	**14.0**	**14.1**	Newburg Hts - Harvard Ave
Columbus - Fairgrounds	Franklin	390490024	16.4	15.0	16.4	13.6	14.6	15.9	15.0	14.9	**15.3**	**16.5**	12.9	**14.6**	Columbus - Fairgrounds
Columbus - Ann Street	Franklin	390490025	15.3	14.6	16.5	13.8	14.7	15.5	15.0	15.0	**15.1**	**16.0**	12.7	**14.1**	Columbus - Ann Street
Columbus - Maple Canyon	Franklin	390490081	14.9	13.6	14.6	12.9	13.1	14.4	13.7	13.5	13.9	**16.0**	11.7	**14.0**	Columbus - Maple Canyon
Cincinnati - Seymour	Hamilton	390610014	17.0	15.9	19.8	15.5	16.5	17.6	17.1	17.3	**17.3**	**17.7**	**14.5**	**15.5**	Cincinnati - Seymour
Cincinnati - Taft Ave	Hamilton	390610040	15.5	14.6	17.5	13.6	15.1	15.9	15.2	15.4	**15.5**	**15.7**	12.8	13.6	Cincinnati - Taft Ave
Cincinnati - 8th Ave	Hamilton	390610042	16.7	16.0	19.1	14.9	15.9	17.3	16.7	16.6	**16.9**	**17.3**	**14.0**	**14.6**	Cincinnati - 8th Ave
Sharonville	Hamilton	390610043	15.7	14.9	16.9	14.5	14.8	15.8	15.4	15.4	**15.6**	**16.0**	12.9	13.6	Sharonville
Norwood	Hamilton	390617001	16.0	15.3	18.4	14.4	15.1	16.6	16.0	16.0	**16.2**	**16.3**	13.4	**14.2**	Norwood
St. Bernard	Hamilton	390618001	17.3	16.4	20.0	15.9	16.1	17.9	17.4	17.3	**17.6**	**17.3**	**14.7**	**15.2**	St. Bernard
Steubenville	Jefferson	390810016	17.7	15.9	16.4	13.8	16.2	16.7	15.4	15.5	**15.8**	**17.7**	12.8	**16.3**	Steubenville
Mingo Junction	Jefferson	390811001	17.3	16.2	18.1	14.6	15.6	17.2	16.3	16.1	**16.5**	**17.5**	13.5	**15.5**	Mingo Junction
Ironton	Lawrence	390870010	14.3	13.7	17.0	14.4	15.0	15.0	15.0	15.5	**15.2**	**15.7**	12.8	**14.2**	Ironton
Dayton	Montgomery	391130032	15.9	14.5	17.4	13.6	15.6	15.9	15.2	15.5	**15.5**	**15.9**	13.2	13.7	Dayton
New Boston	Scioto	391450013	14.7	13.0	16.2	14.3	14.0	14.6	14.5	14.8	14.7	**17.1**	12.1	**15.4**	New Boston
Canton - Dueber	Stark	391510017	16.8	15.6	17.8	14.6	15.9	16.7	16.0	16.1	**16.3**	**17.3**	**14.0**	**15.0**	Canton - Dueber
Canton - Market	Stark	391510020	15.0	14.1	16.6	11.9	14.4	15.2	14.2	14.3	14.6	**15.7**	12.6	13.6	Canton - Market
Akron - Brittain	Summit	391530017	15.4	15.0	16.4	13.5	14.4	15.6	15.0	14.8	**15.1**	**16.4**	13.0	**14.4**	Akron - Brittain
Akron - W. Exchange	Summit	391530023	14.2	13.9	15.7	12.8	13.7	14.6	14.1	14.1	14.3	**15.6**	12.3	13.6	Akron - W. Exchange

			Annual Average Conc.					Design Values			2005 BY	2002 BY	2012 Modeling Results		
Key Site	County	Site ID	'03	'04	'05	'06	'07	'03 - '05	'04 - '06	'05 - '07	Average w/ 2007	Average	Round 5	Round4	Key Site
Chicago - Washington HS	Cook	170310022	15.6	14.2	16.9	13.2	15.7	15.6	14.8	15.3	**15.2**	**15.9**	**14.0**	**14.6**	Chicago - Washington HS
Chicago - Mayfair	Cook	170310052	15.9	15.3	17.0	14.5	15.5	16.1	15.6	15.7	**15.8**	**17.1**	**14.2**	**15.5**	Chicago - Mayfair
Chicago - Springfield	Cook	170310057	15.6	13.8	16.7	13.5	15.1	15.4	14.7	15.1	15.0	**15.6**	13.8	**14.3**	Chicago - Springfield
Chicago - Lawndale	Cook	170310076	14.8	14.2	16.6	13.5	14.3	15.2	14.8	14.8	14.9	**15.6**	13.7	**14.3**	Chicago - Lawndale
Blue Island	Cook	170312001	14.9	14.1	16.4	13.2	14.3	15.1	14.6	14.6	14.8	**15.6**	13.6	**14.3**	Blue Island
Summit	Cook	170313301	15.6	14.2	16.9	13.8	14.8	15.6	15.0	15.2	**15.2**	**16.0**	**14.0**	**14.6**	Summit
Cicero	Cook	170316005	16.8	15.2	16.3	14.3	14.8	16.1	15.3	15.1	**15.5**	**16.4**	**14.3**	**15.1**	Cicero
Granite City	Madison	171191007	17.5	15.4	18.2	16.3	15.1	17.0	16.6	16.5	**16.7**	**17.3**	**14.9**	**15.8**	Granite City
E. St. Louis	St. Clair	171630010	14.9	14.7	17.1	14.5	15.6	15.6	15.4	15.7	**15.6**	**16.2**	13.9	**14.7**	E. St. Louis
Jeffersonville	Clark	180190005	15.8	15.1	18.5	15.0	16.5	16.5	16.2	16.7	**16.4**	**17.2**	13.7	**15.0**	Jeffersonville
Jasper	Dubois	180372001	15.7	14.4	16.9	13.5	14.4	15.7	14.9	14.9	**15.2**	**15.5**	12.2	13.5	Jasper
Gary	Lake	180890031			16.8	13.3	14.5	16.8	15.1	14.9	**15.6**		12.8		Gary
Indy-Washington Park	Marion	180970078	15.5	14.3	16.4	14.1	15.8	15.4	14.9	15.4	**15.3**	**16.2**	12.6	**14.2**	Indy-Washington Park
Indy-W 18th Street	Marion	180970081	16.2	15.0	17.9	14.2	16.1	16.4	15.7	16.1	**16.0**		13.2		Indy-W 18th Street
Indy- Michigan Street	Marion	180970083	16.3	15.0	17.5	14.1	15.9	16.3	15.5	15.8	**15.9**	**16.6**	13.1	**14.9**	Indy- Michigan Street
Allen Park	Wayne	261630001	15.2	14.2	15.9	13.2	12.8	15.1	14.4	14.0	14.5	**15.8**	12.8	**14.1**	Allen Park
Southwest HS	Wayne	261630015	16.6	15.4	17.2	14.7	14.5	16.4	15.8	15.5	**15.9**	**17.3**	13.9	**15.3**	Southwest HS
Linwood	Wayne	261630016	15.8	13.7	16.0	13.0	13.9	15.2	14.2	14.3	14.6	**15.5**	12.8	13.7	Linwood
Dearborn	Wayne	261630033	19.2	16.8	18.6	16.1	16.9	18.2	17.2	17.2	**17.5**	**19.3**	**15.5**	**17.1**	Dearborn
Wyandotte	Wayne	261630036	16.3	13.7	16.4	12.9	13.4	15.5	14.3	14.2	14.7	**16.6**	12.8	**14.7**	Wyandotte
Middleton	Butler	390170003	17.2	14.1	19.0	14.1	15.4	16.8	15.7	16.2	**16.2**	**16.5**	13.2	13.7	Middleton
Fairfield	Butler	390170016	15.8	14.7	17.9	14.0	14.9	16.1	15.5	15.6	**15.8**	**15.9**	12.9	12.9	Fairfield
Cleveland-28th Street	Cuyahoga	390350027	15.4	15.6	17.3	13.0	14.5	16.1	15.3	14.9	**15.4**	**16.5**	13.2	13.8	Cleveland-28th Street
Cleveland-St. Tikhon	Cuyahoga	390350038	17.6	17.5	19.2	14.9	16.2	18.1	17.2	16.8	**17.4**	**18.4**	**14.8**	**15.4**	Cleveland-St. Tikhon
Cleveland-Broadway	Cuyahoga	390350045	16.4	15.3	19.3	14.1	15.3	17.0	16.2	16.2	**16.5**	**16.7**	**14.0**	**14.0**	Cleveland-Broadway
Cleveland-E14 & Orange	Cuyahoga	390350060	17.2	16.4	19.4	15.0	15.9	17.7	16.9	16.8	**17.1**	**17.6**	**14.6**	**14.7**	Cleveland-E14 & Orange
Newburg Hts - Harvard Ave	Cuyahoga	390350065	15.6	15.2	18.6	13.1	15.8	16.5	15.6	15.8	**16.0**	**16.2**	13.6	13.5	Newburg Hts - Harvard Ave
Columbus - Fairgrounds	Franklin	390490024	16.4	15.0	16.4	13.6	14.6	15.9	15.0	14.9	**15.3**	**16.5**	12.6	**14.0**	Columbus - Fairgrounds
Columbus - Ann Street	Franklin	390490025	15.3	14.6	16.5	13.8	14.7	15.5	15.0	15.0	**15.1**	**16.0**	12.4	13.5	Columbus - Ann Street
Columbus - Maple Canyon	Franklin	390490081	14.9	13.6	14.6	12.9	13.1	14.4	13.7	13.5	13.9	**16.0**	11.4	13.4	Columbus - Maple Canyon
Cincinnati - Seymour	Hamilton	390610014	17.0	15.9	19.8	15.5	16.5	17.6	17.1	17.3	**17.3**	**17.7**	**14.3**	**14.8**	Cincinnati - Seymour
Cincinnati - Taft Ave	Hamilton	390610040	15.5	14.6	17.5	13.6	15.1	15.9	15.2	15.4	**15.5**	**15.7**	12.6	13.0	Cincinnati - Taft Ave
Cincinnati - 8th Ave	Hamilton	390610042	16.7	16.0	19.1	14.9	15.9	17.3	16.7	16.6	**16.9**	**17.3**	13.8	**14.0**	Cincinnati - 8th Ave
Sharonville	Hamilton	390610043	15.7	14.9	16.9	14.5	14.8	15.8	15.4	15.4	**15.6**	**16.0**	12.7	13.0	Sharonville
Norwood	Hamilton	390617001	16.0	15.3	18.4	14.4	15.1	16.6	16.0	16.0	**16.2**	**16.3**	13.2	13.6	Norwood
St. Bernard	Hamilton	390618001	17.3	16.4	20.0	15.9	16.1	17.9	17.4	17.3	**17.6**	**17.3**	**14.4**	**14.6**	St. Bernard
Steubenville	Jefferson	390810016	17.7	15.9	16.4	13.8	16.2	16.7	15.4	15.5	**15.8**	**17.7**	12.5	**15.9**	Steubenville
Mingo Junction	Jefferson	390811001	17.3	16.2	18.1	14.6	15.6	17.2	16.3	16.1	**16.5**	**17.5**	13.2	**15.0**	Mingo Junction
Ironton	Lawrence	390870010	14.3	13.7	17.0	14.4	15.0	15.0	15.0	15.5	**15.2**	**15.7**	12.5	13.7	Ironton
Dayton	Montgomery	391130032	15.9	14.5	17.4	13.6	15.6	15.9	15.2	15.5	**15.5**	**15.9**	12.9	13.2	Dayton
New Boston	Scioto	391450013	14.7	13.0	16.2	14.3	14.0	14.6	14.5	14.8	14.7	**17.1**	11.9	**14.8**	New Boston
Canton - Dueber	Stark	391510017	16.8	15.6	17.8	14.6	15.9	16.7	16.0	16.1	**16.3**	**17.3**	13.6	**14.3**	Canton - Dueber
Canton - Market	Stark	391510020	15.0	14.1	16.6	11.9	14.4	15.2	14.2	14.3	14.6	**15.7**	12.3	13.0	Canton - Market
Akron - Brittain	Summit	391530017	15.4	15.0	16.4	13.5	14.4	15.6	15.0	14.8	**15.1**	**16.4**	12.7	13.6	Akron - Brittain
Akron - W. Exchange	Summit	391530023	14.2	13.9	15.7	12.8	13.7	14.6	14.1	14.1	14.3	**15.6**	12.0	13.0	Akron - W. Exchange

			Annual Average Conc.					Design Values			2005 BY	2002 BY	2018 Modeling Results			
Key Site	**County**	**Site ID**	**'03**	**'04**	**'05**	**'06**	**'07**	**'03 - '05**	**'04 - '06**	**'05 - '07**	**Average w/ 2007**	**Average**	**Round 5 OTB**	**Round 5 Will Do**	**Round4**	**Key Site**
Chicago - Washington HS	Cook	170310022	15.6	14.2	16.9	13.2	15.7	15.6	14.8	15.3	**15.2**	**15.9**	13.9	13.8	**14.4**	Chicago - Washington HS
Chicago - Mayfair	Cook	170310052	15.9	15.3	17.0	14.5	15.5	16.1	15.6	15.7	**15.8**	**17.1**	13.9	13.8	**15.0**	Chicago - Mayfair
Chicago - Springfield	Cook	170310057	15.6	13.8	16.7	13.5	15.1	15.4	14.7	15.1	15.0	**15.6**	13.7	13.5	**14.1**	Chicago - Springfield
Chicago - Lawndale	Cook	170310076	14.8	14.2	16.6	13.5	14.3	15.2	14.8	14.8	14.9	**15.6**	13.6	13.4	**14.1**	Chicago - Lawndale
Blue Island	Cook	170312001	14.9	14.1	16.4	13.2	14.3	15.1	14.6	14.6	14.8	**15.6**	13.4	13.3	**14.1**	Blue Island
Summit	Cook	170313301	15.6	14.2	16.9	13.8	14.8	15.6	15.0	15.2	**15.2**	**16.0**	13.9	13.8	**14.4**	Summit
Cicero	Cook	170316005	16.8	15.2	16.3	14.3	14.8	16.1	15.3	15.1	**15.5**	**16.4**	**14.2**	**14.0**	**14.9**	Cicero
Granite City	Madison	171191007	17.5	15.4	18.2	16.3	15.1	17.0	16.6	16.5	**16.7**	**17.3**	**14.3**	**14.2**	**15.5**	Granite City
E. St. Louis	St. Clair	171630010	14.9	14.7	17.1	14.5	15.6	15.6	15.4	15.7	**15.6**	**16.2**	13.4	13.3	**14.5**	E. St. Louis
Jeffersonville	Clark	180190005	15.8	15.1	18.5	15.0	16.5	16.5	16.2	16.7	**16.4**	**17.2**	13.4	13.4	**14.4**	Jeffersonville
Jasper	Dubois	180372001	15.7	14.4	16.9	13.5	14.4	15.7	14.9	14.9	**15.2**	**15.5**	11.8	11.9	13.0	Jasper
Gary	Lake	180890031			16.8	13.3	14.5	16.8	15.1	14.9	**15.6**		12.4	12.4		Gary
Indy-Washington Park	Marion	180970078	15.5	14.3	16.4	14.1	15.8	15.4	14.9	15.4	**15.3**	**16.2**	12.0	12.1	13.7	Indy-Washington Park
Indy-W 18th Street	Marion	180970081	16.2	15.0	17.9	14.2	16.1	16.4	15.7	16.1	**16.0**		12.6	12.7		Indy-W 18th Street
Indy- Michigan Street	Marion	180970083	16.3	15.0	17.5	14.1	15.9	16.3	15.5	15.8	**15.9**	**16.6**	12.6	12.6	**14.0**	Indy- Michigan Street
Allen Park	Wayne	261630001	15.2	14.2	15.9	13.2	12.8	15.1	14.4	14.0	14.5	**15.8**	12.4	12.4	13.3	Allen Park
Southwest HS	Wayne	261630015	16.6	15.4	17.2	14.7	14.5	16.4	15.8	15.5	**15.9**	**17.3**	13.5	13.5	**14.4**	Southwest HS
Linwood	Wayne	261630016	15.8	13.7	16.0	13.0	13.9	15.2	14.2	14.3	14.6	**15.5**	12.5	12.5	13.0	Linwood
Dearborn	Wayne	261630033	19.2	16.8	18.6	16.1	16.9	18.2	17.2	17.2	**17.5**	**19.3**	**15.1**	**15.1**	**16.1**	Dearborn
Wyandotte	Wayne	261630036	16.3	13.7	16.4	12.9	13.4	15.5	14.3	14.2	14.7	**16.6**	12.5	12.5	13.9	Wyandotte
Middleton	Butler	390170003	17.2	14.1	19.0	14.1	15.4	16.8	15.7	16.2	**16.2**	**16.5**	12.8	12.8	13.1	Middleton
Fairfield	Butler	390170016	15.8	14.7	17.9	14.0	14.9	16.1	15.5	15.6	**15.8**	**15.9**	12.5	12.6	12.2	Fairfield
Cleveland-28th Street	Cuyahoga	390350027	15.4	15.6	17.3	13.0	14.5	16.1	15.3	14.9	**15.4**	**16.5**	12.7	12.9	12.9	Cleveland-28th Street
Cleveland-St. Tikhon	Cuyahoga	390350038	17.6	17.5	19.2	14.9	16.2	18.1	17.2	16.8	**17.4**	**18.4**	**14.3**	**14.5**	**14.4**	Cleveland-St. Tikhon
Cleveland-Broadway	Cuyahoga	390350045	16.4	15.3	19.3	14.1	15.3	17.0	16.2	16.2	**16.5**	**16.7**	13.5	13.7	13.1	Cleveland-Broadway
Cleveland-E14 & Orange	Cuyahoga	390350060	17.2	16.4	19.4	15.0	15.9	17.7	16.9	16.8	**17.1**	**17.6**	**14.1**	**14.2**	13.7	Cleveland-E14 & Orange
Newburg Hts - Harvard Ave	Cuyahoga	390350065	15.6	15.2	18.6	13.1	15.8	16.5	15.6	15.8	**16.0**	**16.2**	13.1	13.3	12.6	Newburg Hts - Harvard Ave
Columbus - Fairgrounds	Franklin	390490024	16.4	15.0	16.4	13.6	14.6	15.9	15.0	14.9	**15.3**	**16.5**	12.0	12.1	13.0	Columbus - Fairgrounds
Columbus - Ann Street	Franklin	390490025	15.3	14.6	16.5	13.8	14.7	15.5	15.0	15.0	**15.1**	**16.0**	11.9	11.9	12.5	Columbus - Ann Street
Columbus - Maple Canyon	Franklin	390490081	14.9	13.6	14.6	12.9	13.1	14.4	13.7	13.5	13.9	**16.0**	10.9	11.0	12.5	Columbus - Maple Canyon
Cincinnati - Seymour	Hamilton	390610014	17.0	15.9	19.8	15.5	16.5	17.6	17.1	17.3	**17.3**	**17.7**	13.8	13.9	**14.0**	Cincinnati - Seymour
Cincinnati - Taft Ave	Hamilton	390610040	15.5	14.6	17.5	13.6	15.1	15.9	15.2	15.4	**15.5**	**15.7**	12.2	12.3	12.3	Cincinnati - Taft Ave
Cincinnati - 8th Ave	Hamilton	390610042	16.7	16.0	19.1	14.9	15.9	17.3	16.7	16.6	**16.9**	**17.3**	13.4	13.4	13.2	Cincinnati - 8th Ave
Sharonville	Hamilton	390610043	15.7	14.9	16.9	14.5	14.8	15.8	15.4	15.4	**15.6**	**16.0**	12.3	12.4	12.2	Sharonville
Norwood	Hamilton	390617001	16.0	15.3	18.4	14.4	15.1	16.6	16.0	16.0	**16.2**	**16.3**	12.8	12.8	12.8	Norwood
St. Bernard	Hamilton	390618001	17.3	16.4	20.0	15.9	16.1	17.9	17.4	17.3	**17.6**	**17.3**	**14.0**	**14.1**	13.8	St. Bernard
Steubenville	Jefferson	390810016	17.7	15.9	16.4	13.8	16.2	16.7	15.4	15.5	**15.8**	**17.7**	12.7	12.7	**16.2**	Steubenville
Mingo Junction	Jefferson	390811001	17.3	16.2	18.1	14.6	15.6	17.2	16.3	16.1	**16.5**	**17.5**	13.4	13.4	**15.3**	Mingo Junction
Ironton	Lawrence	390870010	14.3	13.7	17.0	14.4	15.0	15.0	15.0	15.5	**15.2**	**15.7**	12.3	12.3	13.2	Ironton
Dayton	Montgomery	391130032	15.9	14.5	17.4	13.6	15.6	15.9	15.2	15.5	**15.5**	**15.9**	12.4	12.5	12.3	Dayton
New Boston	Scioto	391450013	14.7	13.0	16.2	14.3	14.0	14.6	14.5	14.8	14.7	**17.1**	11.6	11.6	**14.2**	New Boston
Canton - Dueber	Stark	391510017	16.8	15.6	17.8	14.6	15.9	16.7	16.0	16.1	**16.3**	**17.3**	13.3	13.3	13.6	Canton - Dueber
Canton - Market	Stark	391510020	15.0	14.1	16.6	11.9	14.4	15.2	14.2	14.3	14.6	**15.7**	11.9	12.0	12.2	Canton - Market
Akron - Brittain	Summit	391530017	15.4	15.0	16.4	13.5	14.4	15.6	15.0	14.8	**15.1**	**16.4**	12.3	12.3	12.9	Akron - Brittain
Akron - W. Exchange	Summit	391530023	14.2	13.9	15.7	12.8	13.7	14.6	14.1	14.1	14.3	**15.6**	11.5	11.6	12.2	Akron - W. Exchange

24-Hour PM$_{2.5}$			**98th Percentile (24-hour)**					**Design Values**			**Base Year**	**Round 5 Modeling Results**			
Key Site	**County**	**Site ID**	**'03**	**'04**	**'05**	**'06**	**'07**	**'03-'05**	**'04-'06**	**'05-'07**	**Average w/ 2007**	**2009**	**2012**	**2018**	**Key Site**
Chicago - Washington HS	Cook	170310022	37.7	32.5	45.7	27.0	35.7	38.6	35.1	36.1	36.6	36	36	35	Chicago - Washington HS
Chicago - Mayfair	Cook	170310052	37.3	38.8	48.3	31.6	39.4	41.5	39.6	39.8	40.3	36	36	36	Chicago - Mayfair
Chicago - Springfield	Cook	170310057	36.4	33.1	46.5	27.7	38.9	38.7	35.8	37.7	37.4	32	32	31	Chicago - Springfield
Chicago - Lawndale	Cook	170310076	32.6	39.7	45.1	29.0	37.2	39.1	37.9	37.1	38.1	35	35	34	Chicago - Lawndale
McCook	Cook	170311016									43.0	39	39	38	McCook
Blue Island	Cook	170312001	39.6	38.5	43.8	28.1	35.1	40.6	36.8	35.7	37.7	34	34	33	Blue Island
Schiller Park	Cook	170313103		40.7	50.3	30.0	36.6	45.5	40.3	39.0	41.6	39	39	39	Schiller Park
Summit	Cook	170313301	38.4	42.4	49.1	27.4	36.7	43.3	39.6	37.7	40.2	38	38	37	Summit
Maywood	Cook	170316005	38.5	42.5	44.6	29.2	36.9	41.9	38.8	36.9	39.2	38	38	37	Maywood
Granite City	Madison	171191007	40.8	35.4	44.1	36.3	36.0	40.1	38.6	38.8	39.2	33	33	32	Granite City
E. St. Louis	St. Clair	171630010	32.6	30.2	39.6	29.2	33.1	34.1	33.0	34.0	33.7	28	28	28	E. St. Louis
Jeffersonville	Clark	180190005		28.4	45.5	35.9	43.3	37.0	36.6	41.6	38.4	29	31	31	Jeffersonville
Jasper	Dubois	180372001	39.5	30.0	41.2	31.6	39.5	36.9	34.3	37.4	36.2	28	29	28	Jasper
Gary - IITRI	Lake	180890022									39.0	34	34	35	Gary - IITRI
Gary - Burr School	Lake	180890026									39.0	33	34	32	Gary - Burr School
Gary	Lake	180890031			38.7	27.1	36.2	38.7	32.9	34.0	35.2	24	24	27	Gary
Indy-West Street	Marion	180970043									38.0	33	33	33	Indy-West Street
Indy-English Avenue	Marion	180970066									38.0	32	32	32	Indy-English Avenue
Indy-Washington Park	Marion	180970078	39.3	31.0	42.5	31.7	37.6	37.6	35.1	37.3	36.6	31	31	32	Indy-Washington Park
Indy-W 18th Street	Marion	180970081	36.2	31.9	45.7	34.8	38.4	37.9	37.5	39.6	38.3	31	31	31	Indy-W 18th Street
Indy- Michigan Street	Marion	180970083	36.7	31.3	40.3	33.5	37.2	36.1	35.0	37.0	36.0	28	28	29	Indy- Michigan Street
Luna Pier	Monroe	261150005	34.7	35.0	49.3	32.6	32.2	39.7	39.0	38.0	38.9	32	32	31	Luna Pier
Oak Park	Oakland	261250001	36.6	32.5	52.2	33.0	35.3	40.4	39.2	40.2	39.9	36	36	35	Oak Park
Port Huron	St. Clair	261470005	37.2	32.2	47.6	37.9	36.3	39.0	39.2	40.6	39.6	34	34	33	Port Huron
Ypsilanti	Washtenaw	261610008	38.8	31.5	52.1	31.3	34.5	40.8	38.3	39.3	39.5	35	35	34	Ypsilanti
Allen Park	Wayne	261630001	40.5	36.9	43.0	34.1	35.9	40.1	38.0	37.7	38.6	35	34	33	Allen Park
Southwest HS	Wayne	261630015	33.6	36.0	49.7	36.2	34.0	39.8	40.6	40.0	40.1	35	35	33	Southwest HS
Linwood	Wayne	261630016	46.2	38.3	51.8	36.9	34.8	45.4	42.3	41.2	43.0	39	39	38	Linwood
E 7 Mile	Wayne	261630019	37.1	35.0	52.3	36.2	33.0	41.5	41.2	40.5	41.0	38	38	37	E 7 Mile
Dearborn	Wayne	261630033	42.8	39.4	50.2	43.1	36.6	44.1	44.2	43.3	43.9	40	40	39	Dearborn
Wyandotte	Wayne	261630036	34.8	32.3	46.7	33.2	28.6	37.9	37.4	36.2	37.2	35	35	34	Wyandotte
Newberry	Wayne	261630038		36.8	57.5	28.6	33.4		39.1	39.8	42.7	38	37	36	Newberry
FIA	Wayne	261630039			43.9	32.4	34.8			37.0	39.7	33	33	31	FIA
Middleton	Butler	390170003	38.6	37.2	47.6	30.2	37.1	41.1	38.3	38.3	39.3	28	28	27	Middleton
Fairfield	Butler	390170016	34.8	32.2	43.4	35.2	34.5	36.8	36.9	37.7	37.1	27	28	27	Fairfield
	Butler	390170017	34.6	34.3	44.9			37.9	39.6		40.8	29	29	28	
Cleveland-28th Street	Cuyahoga	390350027	41.3	40.9	35.7	31.5	39.0	39.3	36.0	35.4	36.9	32	32	31	Cleveland-28th Street
Cleveland-St. Tikhon	Cuyahoga	390350038	47.3	42.5	51.2	36.1	39.7	44.9	47.0	42.3	44.2	36	35	34	Cleveland-St. Tikhon
Cleveland-Broadway	Cuyahoga	390350045	42.2	36.1	46.2	29.5	37.0	41.5	37.3	37.6	38.8	31	30	29	Cleveland-Broadway
Cleveland-GT Craig	Cuyahoga	390350060	45.5	42.2	49.5	31.0	38.7	45.7	40.9	39.7	42.1	37	37	35	Cleveland-GT Craig
Newburg Hts - Harvard Ave	Cuyahoga	390350065	39.1	36.1	47.9	27.8	39.1	41.0	37.3	38.3	38.9	31	30	30	Newburg Hts - Harvard Ave
Columbus - Fairgrounds	Franklin	390490024	39.2	35.1	45.0	34.0	34.2	39.8	38.0	37.7	38.5	33	32	31	Columbus - Fairgrounds
Columbus - Ann Street	Franklin	390490025	37.0	35.5	44.9	34.0	35.5	39.1	38.1	38.1	38.5	31	31	30	Columbus - Ann Street
Cincinnait	Hamilton	390610006			45.0	33.3	34.7			37.7	40.6	27	28	27	Cincinnait
Cincinnati - Seymour	Hamilton	390610014	37.8	42.0	38.5	35.2	38.1	39.4	38.6	37.3	38.4	26	25	24	Cincinnati - Seymour
Cincinnati - Taft Ave	Hamilton	390610040	31.9	30.5	45.8	32.8	34.7	36.1	36.4	37.8	36.7	24	24	23	Cincinnati - Taft Ave
Cincinnati - 8th Ave	Hamilton	390610042	33.8	31.9	44.4	34.5	35.9	36.7	36.9	38.3	37.3	28	28	27	Cincinnati - 8th Ave
Sharonville	Hamilton	390610043	37.3	31.4	39.9	34.9	34.0	36.2	35.4	36.3	36.0	28	28	27	Sharonville
Norwood	Hamilton	390617001	37.1	34.6	47.1	34.0	33.7	39.6	38.6	38.3	38.8	30	30	29	Norwood
St. Bernard	Hamilton	390618001	35.8	33.9	51.4	36.1	35.4	40.4	40.5	41.0	40.6	30	30	29	St. Bernard
Steubenville	Jefferson	390810016	39.6	43.8	43.8	32.1	43.5	42.4	39.9	39.8	40.7	29	28	28	Steubenville
Mingo Junction	Jefferson	390811001	40.9	51.5	44.2	32.9	35.4	45.5	42.9	37.5	42.0	30	30	30	Mingo Junction
Dayton	Montgomery	391130032	42.7	32.5	45.0	30.3	36.9	40.1	35.9	37.4	37.8	30	30	30	Dayton
Canton - Dueber	Stark	391510017	34.2	36.3	47.6	32.2	33.4	39.4	38.7	37.7	38.6	28	28	27	Canton - Dueber
Akron - Brittain	Summit	391530017	36.9	36.9	45.2	31.5	33.3	39.7	37.9	36.7	38.1	30	30	29	Akron - Brittain
Green Bay - Est High	Brown	550090005	33.5	32.3	41.5	36.9	37.1	35.8	36.9	38.5	37.1	35	34	32	Green Bay - Est High
Madison	Dane	550250047	32.0	31.9	40.1	33.4	44.3	34.7	35.1	39.3	36.4	32	31	29	Madison
Milwaukee-Health Center	Milwaukee	550790010	33.2	38.4	38.7	40.7	40.6	36.8	39.3	40.0	38.7	35	34	33	Milwaukee-Health Center
Milwaukee-SER Hdqs	Milwaukee	550790026	29.6	28.7	41.5	42.6	39.8	33.3	37.6	41.3	37.4	34	34	33	Milwaukee-SER Hdqs
Milwaukee-Virginia FS	Milwaukee	550790043	39.2	41.4	37.1	44.0	38	39.2	40.8	39.7	39.9	36	36	36	Milwaukee-Virginia FS
Milwaukee- Fire Dept Hdqs	Milwaukee	550790099	33.7	38.9	37.1	38.3	40.7	36.6	38.1	38.7	37.8	33	32	32	Milwaukee- Fire Dept Hdqs
Waukesha	Waukesha	551330027	29.1	38.4	41.1	28.2	33.8	36.2	35.9	34.4	35.5	31	31	29	Waukesha

PM2.5 RRFs by Species and Season (2009)

Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
1703100521	IL	Cook	winter	so4	0.1772	0.9342
1703100521	IL	Cook	winter	no3	0.3099	1.0128
1703100521	IL	Cook	winter	ocm	0.2147	0.9942
1703100521	IL	Cook	winter	ec	0.0372	0.888
1703100521	IL	Cook	winter	soil	0.0242	1.1674
1703100521	IL	Cook	winter	nh4	0.1421	0.97
1703100521	IL	Cook	winter	pbw	0.0947	0.9678
1703100521	IL	Cook	spring	so4	0.32	0.8018
1703100521	IL	Cook	spring	no3	0.0609	0.9385
1703100521	IL	Cook	spring	ocm	0.2742	1.0629
1703100521	IL	Cook	spring	ec	0.0501	0.8712
1703100521	IL	Cook	spring	soil	0.0505	1.1796
1703100521	IL	Cook	spring	nh4	0.1203	0.8619
1703100521	IL	Cook	spring	pbw	0.0984	0.8492
1703100521	IL	Cook	summer	so4	0.3089	0.725
1703100521	IL	Cook	summer	no3	0	1.0124
1703100521	IL	Cook	summer	ocm	0.1599	1.069
1703100521	IL	Cook	summer	ec	0.0351	0.8683
1703100521	IL	Cook	summer	soil	0.0318	1.204
1703100521	IL	Cook	summer	nh4	0.0932	0.7354
1703100521	IL	Cook	summer	pbw	0.094	0.7217
1703100521	IL	Cook	fall	so4	0.1872	0.9151
1703100521	IL	Cook	fall	no3	0.1628	0.9408
1703100521	IL	Cook	fall	ocm	0.2389	1.0091
1703100521	IL	Cook	fall	ec	0.0403	0.8623
1703100521	IL	Cook	fall	soil	0.0284	1.1443
1703100521	IL	Cook	fall	nh4	0.1062	0.9247
1703100521	IL	Cook	fall	pbw	0.0614	0.9233
1711910071	IL	Madison	winter	so4	0.213	0.9195
1711910071	IL	Madison	winter	no3	0.2705	1.0306
1711910071	IL	Madison	winter	ocm	0.2093	0.9289
1711910071	IL	Madison	winter	ec	0.0434	0.9083
1711910071	IL	Madison	winter	soil	0.0306	1.1782
1711910071	IL	Madison	winter	nh4	0.1528	0.9513
1711910071	IL	Madison	winter	pbw	0.0804	0.9243
1711910071	IL	Madison	spring	so4	0.3194	0.7717
1711910071	IL	Madison	spring	no3	0.0189	0.8611
1711910071	IL	Madison	spring	ocm	0.2455	1.1103
1711910071	IL	Madison	spring	ec	0.0564	1.0046
1711910071	IL	Madison	spring	soil	0.0459	1.2252
1711910071	IL	Madison	spring	nh4	0.1121	0.7894
1711910071	IL	Madison	spring	pbw	0.1085	0.7783
1711910071	IL	Madison	summer	so4	0.313	0.705
1711910071	IL	Madison	summer	no3	0	0.884
1711910071	IL	Madison	summer	ocm	0.153	1.1546
1711910071	IL	Madison	summer	ec	0.0345	1.0513
1711910071	IL	Madison	summer	soil	0.0302	1.2532
1711910071	IL	Madison	summer	nh4	0.102	0.7409
1711910071	IL	Madison	summer	pbw	0.1096	0.7133
1711910071	IL	Madison	fall	so4	0.2058	0.9037
1711910071	IL	Madison	fall	no3	0.1308	0.9426
1711910071	IL	Madison	fall	ocm	0.259	1.0233
1711910071	IL	Madison	fall	ec	0.0563	0.9248
1711910071	IL	Madison	fall	soil	0.0549	1.1412
1711910071	IL	Madison	fall	nh4	0.1073	0.9185
1711910071	IL	Madison	fall	pbw	0.0655	0.918

Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
1803720011	IN	Dubois	winter	so4	0.2669	0.8833
1803720011	IN	Dubois	winter	no3	0.2548	0.9526
1803720011	IN	Dubois	winter	ocm	0.1747	0.9374
1803720011	IN	Dubois	winter	ec	0.0313	0.9319
1803720011	IN	Dubois	winter	soil	0.0192	1.1349
1803720011	IN	Dubois	winter	nh4	0.1646	0.9069
1803720011	IN	Dubois	winter	pbw	0.0885	0.9006
1803720011	IN	Dubois	spring	so4	0.4141	0.6808
1803720011	IN	Dubois	spring	no3	0.0022	0.8106
1803720011	IN	Dubois	spring	ocm	0.178	0.9997
1803720011	IN	Dubois	spring	ec	0.0324	0.9083
1803720011	IN	Dubois	spring	soil	0.0218	1.1284
1803720011	IN	Dubois	spring	nh4	0.1432	0.7075
1803720011	IN	Dubois	spring	pbw	0.1556	0.6916
1803720011	IN	Dubois	summer	so4	0.3687	0.644
1803720011	IN	Dubois	summer	no3	0	0.8029
1803720011	IN	Dubois	summer	ocm	0.1174	1.0136
1803720011	IN	Dubois	summer	ec	0.0207	0.913
1803720011	IN	Dubois	summer	soil	0.0213	1.1988
1803720011	IN	Dubois	summer	nh4	0.1168	0.6789
1803720011	IN	Dubois	summer	pbw	0.1246	0.6613
1803720011	IN	Dubois	fall	so4	0.2964	0.8232
1803720011	IN	Dubois	fall	no3	0.138	0.8797
1803720011	IN	Dubois	fall	ocm	0.2116	0.9861
1803720011	IN	Dubois	fall	ec	0.0437	0.9019
1803720011	IN	Dubois	fall	soil	0.03	1.1387
1803720011	IN	Dubois	fall	nh4	0.1449	0.8444
1803720011	IN	Dubois	fall	pbw	0.0941	0.8558
1809700811	IN	Marion	winter	so4	0.2358	0.9192
1809700811	IN	Marion	winter	no3	0.2729	0.9769
1809700811	IN	Marion	winter	ocm	0.1851	0.9546
1809700811	IN	Marion	winter	ec	0.0385	0.8647
1809700811	IN	Marion	winter	soil	0.0239	1.0835
1809700811	IN	Marion	winter	nh4	0.1561	0.9446
1809700811	IN	Marion	winter	pbw	0.0877	0.944
1809700811	IN	Marion	spring	so4	0.3745	0.6868
1809700811	IN	Marion	spring	no3	0.0167	0.8082
1809700811	IN	Marion	spring	ocm	0.2034	0.9881
1809700811	IN	Marion	spring	ec	0.0447	0.8547
1809700811	IN	Marion	spring	soil	0.0376	1.0625
1809700811	IN	Marion	spring	nh4	0.1313	0.7182
1809700811	IN	Marion	spring	pbw	0.1309	0.7056
1809700811	IN	Marion	summer	so4	0.3582	0.6529
1809700811	IN	Marion	summer	no3	0	0.8099
1809700811	IN	Marion	summer	ocm	0.1231	1.0043
1809700811	IN	Marion	summer	ec	0.03	0.8444
1809700811	IN	Marion	summer	soil	0.0253	1.0918
1809700811	IN	Marion	summer	nh4	0.1114	0.6854
1809700811	IN	Marion	summer	pbw	0.1163	0.6674
1809700811	IN	Marion	fall	so4	0.2751	0.8538
1809700811	IN	Marion	fall	no3	0.149	0.9452
1809700811	IN	Marion	fall	ocm	0.223	0.9648
1809700811	IN	Marion	fall	ec	0.0525	0.8412
1809700811	IN	Marion	fall	soil	0.0358	1.089
1809700811	IN	Marion	fall	nh4	0.1378	0.8905
1809700811	IN	Marion	fall	pbw	0.0865	0.8888

Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
2616300331	MI	Wayne	winter	so4	0.1587	0.9206
2616300331	MI	Wayne	winter	no3	0.2394	0.9813
2616300331	MI	Wayne	winter	ocm	0.3193	1.0781
2616300331	MI	Wayne	winter	ec	0.0383	0.9279
2616300331	MI	Wayne	winter	soil	0.0541	1.0206
2616300331	MI	Wayne	winter	nh4	0.1188	0.9518
2616300331	MI	Wayne	winter	pbw	0.0714	0.9566
2616300331	MI	Wayne	spring	so4	0.3383	0.7398
2616300331	MI	Wayne	spring	no3	0.0259	0.8787
2616300331	MI	Wayne	spring	ocm	0.3543	1.0234
2616300331	MI	Wayne	spring	ec	0.0504	0.8671
2616300331	MI	Wayne	spring	soil	0.0915	1.0153
2616300331	MI	Wayne	spring	nh4	0.1191	0.7818
2616300331	MI	Wayne	spring	pbw	0.1126	0.7619
2616300331	MI	Wayne	summer	so4	0.3311	0.6681
2616300331	MI	Wayne	summer	no3	0	0.8431
2616300331	MI	Wayne	summer	ocm	0.2297	1.0029
2616300331	MI	Wayne	summer	ec	0.0362	0.8332
2616300331	MI	Wayne	summer	soil	0.061	1.0177
2616300331	MI	Wayne	summer	nh4	0.1027	0.6974
2616300331	MI	Wayne	summer	pbw	0.1073	0.6754
2616300331	MI	Wayne	fall	so4	0.1898	0.854
2616300331	MI	Wayne	fall	no3	0.1075	0.9367
2616300331	MI	Wayne	fall	ocm	0.3689	1.0607
2616300331	MI	Wayne	fall	ec	0.0546	0.8862
2616300331	MI	Wayne	fall	soil	0.1676	1.0317
2616300331	MI	Wayne	fall	nh4	0.0866	0.8919
2616300331	MI	Wayne	fall	pbw	0.0553	0.8821
3903500381	OH	Cuyahoga	winter	so4	0.2117	0.8993
3903500381	OH	Cuyahoga	winter	no3	0.2665	0.9856
3903500381	OH	Cuyahoga	winter	ocm	0.2048	0.9716
3903500381	OH	Cuyahoga	winter	ec	0.0413	0.8903
3903500381	OH	Cuyahoga	winter	soil	0.0465	1.0959
3903500381	OH	Cuyahoga	winter	nh4	0.1459	0.9416
3903500381	OH	Cuyahoga	winter	pbw	0.0832	0.9541
3903500381	OH	Cuyahoga	spring	so4	0.3334	0.7145
3903500381	OH	Cuyahoga	spring	no3	0.0374	0.8393
3903500381	OH	Cuyahoga	spring	ocm	0.2068	1.0899
3903500381	OH	Cuyahoga	spring	ec	0.052	0.9362
3903500381	OH	Cuyahoga	spring	soil	0.0697	1.0601
3903500381	OH	Cuyahoga	spring	nh4	0.1256	0.7666
3903500381	OH	Cuyahoga	spring	pbw	0.115	0.7761
3903500381	OH	Cuyahoga	summer	so4	0.3241	0.6303
3903500381	OH	Cuyahoga	summer	no3	0	0.89
3903500381	OH	Cuyahoga	summer	ocm	0.1306	1.0998
3903500381	OH	Cuyahoga	summer	ec	0.0419	0.9354
3903500381	OH	Cuyahoga	summer	soil	0.0583	1.0906
3903500381	OH	Cuyahoga	summer	nh4	0.1074	0.7038
3903500381	OH	Cuyahoga	summer	pbw	0.1183	0.6674
3903500381	OH	Cuyahoga	fall	so4	0.2055	0.8193
3903500381	OH	Cuyahoga	fall	no3	0.1275	0.9189
3903500381	OH	Cuyahoga	fall	ocm	0.2234	1.0245
3903500381	OH	Cuyahoga	fall	ec	0.0499	0.8913
3903500381	OH	Cuyahoga	fall	soil	0.0675	1.0927
3903500381	OH	Cuyahoga	fall	nh4	0.1034	0.8615
3903500381	OH	Cuyahoga	fall	pbw	0.0637	0.8564

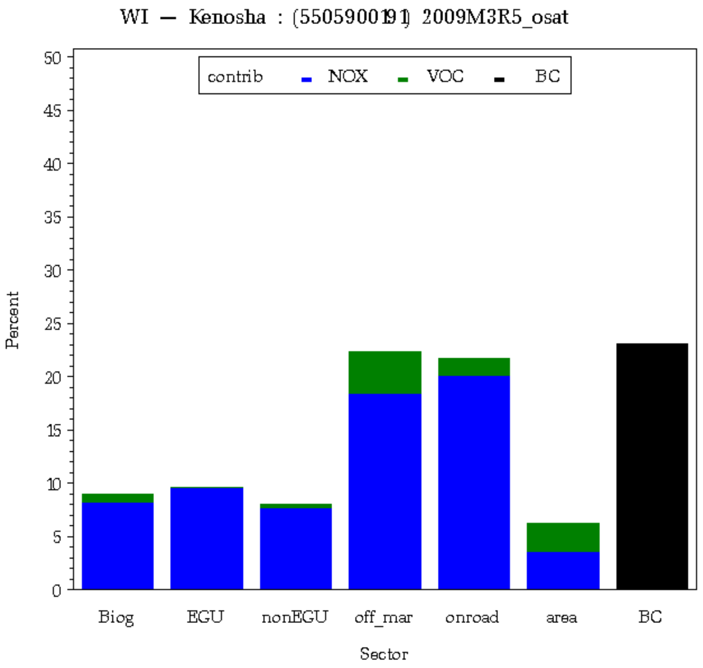
Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
3904900241	OH	Franklin	winter	so4	0.2555	0.8622
3904900241	OH	Franklin	winter	no3	0.2373	1.0002
3904900241	OH	Franklin	winter	ocm	0.2082	0.974
3904900241	OH	Franklin	winter	ec	0.0375	0.8537
3904900241	OH	Franklin	winter	soil	0.0259	1.0844
3904900241	OH	Franklin	winter	nh4	0.1495	0.9261
3904900241	OH	Franklin	winter	pbw	0.0861	0.9274
3904900241	OH	Franklin	spring	so4	0.3754	0.6615
3904900241	OH	Franklin	spring	no3	0.0176	0.8436
3904900241	OH	Franklin	spring	ocm	0.2069	1.062
3904900241	OH	Franklin	spring	ec	0.0405	0.8678
3904900241	OH	Franklin	spring	soil	0.0371	1.0551
3904900241	OH	Franklin	spring	nh4	0.1296	0.7212
3904900241	OH	Franklin	spring	pbw	0.128	0.6992
3904900241	OH	Franklin	summer	so4	0.3703	0.622
3904900241	OH	Franklin	summer	no3	0	0.9056
3904900241	OH	Franklin	summer	ocm	0.1343	1.0654
3904900241	OH	Franklin	summer	ec	0.0311	0.8565
3904900241	OH	Franklin	summer	soil	0.0267	1.0667
3904900241	OH	Franklin	summer	nh4	0.1142	0.7021
3904900241	OH	Franklin	summer	pbw	0.1186	0.6614
3904900241	OH	Franklin	fall	so4	0.2692	0.8119
3904900241	OH	Franklin	fall	no3	0.1186	0.9099
3904900241	OH	Franklin	fall	ocm	0.2489	1.019
3904900241	OH	Franklin	fall	ec	0.0533	0.8371
3904900241	OH	Franklin	fall	soil	0.0423	1.0924
3904900241	OH	Franklin	fall	nh4	0.1217	0.8539
3904900241	OH	Franklin	fall	pbw	0.0821	0.8519
3906100141	OH	Hamilton	winter	so4	0.2685	0.8104
3906100141	OH	Hamilton	winter	no3	0.2378	1.0886
3906100141	OH	Hamilton	winter	ocm	0.19	0.961
3906100141	OH	Hamilton	winter	ec	0.035	0.8969
3906100141	OH	Hamilton	winter	soil	0.0229	1.4146
3906100141	OH	Hamilton	winter	nh4	0.1583	0.9077
3906100141	OH	Hamilton	winter	pbw	0.0874	0.8687
3906100141	OH	Hamilton	spring	so4	0.3583	0.6331
3906100141	OH	Hamilton	spring	no3	0.0025	1.0155
3906100141	OH	Hamilton	spring	ocm	0.1986	1.0798
3906100141	OH	Hamilton	spring	ec	0.0466	0.9228
3906100141	OH	Hamilton	spring	soil	0.0289	1.3785
3906100141	OH	Hamilton	spring	nh4	0.1215	0.6968
3906100141	OH	Hamilton	spring	pbw	0.128	0.6307
3906100141	OH	Hamilton	summer	so4	0.3722	0.577
3906100141	OH	Hamilton	summer	no3	0	1.0923
3906100141	OH	Hamilton	summer	ocm	0.121	1.082
3906100141	OH	Hamilton	summer	ec	0.0309	0.9099
3906100141	OH	Hamilton	summer	soil	0.0199	1.537
3906100141	OH	Hamilton	summer	nh4	0.1178	0.6441
3906100141	OH	Hamilton	summer	pbw	0.1261	0.5734
3906100141	OH	Hamilton	fall	so4	0.2608	0.7754
3906100141	OH	Hamilton	fall	no3	0.1184	0.9857
3906100141	OH	Hamilton	fall	ocm	0.213	1.0235
3906100141	OH	Hamilton	fall	ec	0.0512	0.8876
3906100141	OH	Hamilton	fall	soil	0.0328	1.4007
3906100141	OH	Hamilton	fall	nh4	0.1254	0.846
3906100141	OH	Hamilton	fall	pbw	0.0828	0.8172

Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
3908110011	OH	Jefferson	winter	so4	0.2367	0.8217
3908110011	OH	Jefferson	winter	no3	0.1709	1.0522
3908110011	OH	Jefferson	winter	ocm	0.3288	0.8819
3908110011	OH	Jefferson	winter	ec	0.0435	0.9091
3908110011	OH	Jefferson	winter	soil	0.0272	0.4368
3908110011	OH	Jefferson	winter	nh4	0.1199	0.8904
3908110011	OH	Jefferson	winter	pbw	0.073	0.8583
3908110011	OH	Jefferson	spring	so4	0.3508	0.6666
3908110011	OH	Jefferson	spring	no3	0.0154	0.9156
3908110011	OH	Jefferson	spring	ocm	0.3078	0.9995
3908110011	OH	Jefferson	spring	ec	0.0395	0.9853
3908110011	OH	Jefferson	spring	soil	0.0407	0.4844
3908110011	OH	Jefferson	spring	nh4	0.114	0.7054
3908110011	OH	Jefferson	spring	pbw	0.1095	0.6713
3908110011	OH	Jefferson	summer	so4	0.3779	0.6156
3908110011	OH	Jefferson	summer	no3	0	1.0837
3908110011	OH	Jefferson	summer	ocm	0.2098	1.0145
3908110011	OH	Jefferson	summer	ec	0.0308	0.9689
3908110011	OH	Jefferson	summer	soil	0.0323	0.3632
3908110011	OH	Jefferson	summer	nh4	0.1065	0.6428
3908110011	OH	Jefferson	summer	pbw	0.1007	0.625
3908110011	OH	Jefferson	fall	so4	0.2315	0.7694
3908110011	OH	Jefferson	fall	no3	0.0702	1.0302
3908110011	OH	Jefferson	fall	ocm	0.372	0.9312
3908110011	OH	Jefferson	fall	ec	0.051	0.9086
3908110011	OH	Jefferson	fall	soil	0.0344	0.4555
3908110011	OH	Jefferson	fall	nh4	0.0859	0.8284
3908110011	OH	Jefferson	fall	pbw	0.0629	0.7951
3911300321	OH	Montgomer	winter	so4	0.2613	0.8598
3911300321	OH	Montgomer	winter	no3	0.2407	1.029
3911300321	OH	Montgomer	winter	ocm	0.1954	0.9442
3911300321	OH	Montgomer	winter	ec	0.036	0.8746
3911300321	OH	Montgomer	winter	soil	0.0259	1.1295
3911300321	OH	Montgomer	winter	nh4	0.1531	0.9304
3911300321	OH	Montgomer	winter	pbw	0.0876	0.9205
3911300321	OH	Montgomer	spring	so4	0.3659	0.6606
3911300321	OH	Montgomer	spring	no3	0.0163	0.8639
3911300321	OH	Montgomer	spring	ocm	0.1895	1.0976
3911300321	OH	Montgomer	spring	ec	0.0442	0.9417
3911300321	OH	Montgomer	spring	soil	0.0253	1.0873
3911300321	OH	Montgomer	spring	nh4	0.1313	0.7149
3911300321	OH	Montgomer	spring	pbw	0.1326	0.6839
3911300321	OH	Montgomer	summer	so4	0.375	0.6234
3911300321	OH	Montgomer	summer	no3	0	0.9474
3911300321	OH	Montgomer	summer	ocm	0.128	1.1047
3911300321	OH	Montgomer	summer	ec	0.029	0.9496
3911300321	OH	Montgomer	summer	soil	0.0205	1.1299
3911300321	OH	Montgomer	summer	nh4	0.1114	0.6931
3911300321	OH	Montgomer	summer	pbw	0.1114	0.6482
3911300321	OH	Montgomer	fall	so4	0.3062	0.8033
3911300321	OH	Montgomer	fall	no3	0.1012	0.9634
3911300321	OH	Montgomer	fall	ocm	0.2221	1.0158
3911300321	OH	Montgomer	fall	ec	0.0514	0.877
3911300321	OH	Montgomer	fall	soil	0.028	1.1391
3911300321	OH	Montgomer	fall	nh4	0.1352	0.8625
3911300321	OH	Montgomer	fall	pbw	0.0982	0.8475

Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
3915100171	OH	Stark	winter	so4	0.2362	0.8558
3915100171	OH	Stark	winter	no3	0.2234	1.0222
3915100171	OH	Stark	winter	ocm	0.2478	0.9255
3915100171	OH	Stark	winter	ec	0.0414	0.8866
3915100171	OH	Stark	winter	soil	0.0334	1.099
3915100171	OH	Stark	winter	nh4	0.1376	0.925
3915100171	OH	Stark	winter	pbw	0.0802	0.9155
3915100171	OH	Stark	spring	so4	0.3581	0.6834
3915100171	OH	Stark	spring	no3	0.0236	0.855
3915100171	OH	Stark	spring	ocm	0.221	1.0892
3915100171	OH	Stark	spring	ec	0.0501	1.0017
3915100171	OH	Stark	spring	soil	0.058	1.0528
3915100171	OH	Stark	spring	nh4	0.1288	0.7264
3915100171	OH	Stark	spring	pbw	0.1256	0.7009
3915100171	OH	Stark	summer	so4	0.3621	0.6277
3915100171	OH	Stark	summer	no3	0	0.8203
3915100171	OH	Stark	summer	ocm	0.1483	1.0984
3915100171	OH	Stark	summer	ec	0.0403	1.016
3915100171	OH	Stark	summer	soil	0.037	1.0781
3915100171	OH	Stark	summer	nh4	0.1157	0.6739
3915100171	OH	Stark	summer	pbw	0.124	0.651
3915100171	OH	Stark	fall	so4	0.2293	0.8041
3915100171	OH	Stark	fall	no3	0.1262	0.9363
3915100171	OH	Stark	fall	ocm	0.2722	1.0226
3915100171	OH	Stark	fall	ec	0.0545	0.9202
3915100171	OH	Stark	fall	soil	0.0461	1.0959
3915100171	OH	Stark	fall	nh4	0.1105	0.8549
3915100171	OH	Stark	fall	pbw	0.0706	0.8428
3915300171	OH	Summit	winter	so4	0.2511	0.8771
3915300171	OH	Summit	winter	no3	0.2376	1.0052
3915300171	OH	Summit	winter	ocm	0.2185	0.9429
3915300171	OH	Summit	winter	ec	0.0334	0.8677
3915300171	OH	Summit	winter	soil	0.0255	1.0835
3915300171	OH	Summit	winter	nh4	0.1489	0.9374
3915300171	OH	Summit	winter	pbw	0.0851	0.945
3915300171	OH	Summit	spring	so4	0.387	0.7046
3915300171	OH	Summit	spring	no3	0.0072	0.8466
3915300171	OH	Summit	spring	ocm	0.1901	1.0967
3915300171	OH	Summit	spring	ec	0.035	0.9482
3915300171	OH	Summit	spring	soil	0.0304	1.0524
3915300171	OH	Summit	spring	nh4	0.1294	0.7521
3915300171	OH	Summit	spring	pbw	0.1342	0.7384
3915300171	OH	Summit	summer	so4	0.3694	0.6378
3915300171	OH	Summit	summer	no3	0	0.8587
3915300171	OH	Summit	summer	ocm	0.1417	1.1077
3915300171	OH	Summit	summer	ec	0.0332	0.9506
3915300171	OH	Summit	summer	soil	0.0198	1.0744
3915300171	OH	Summit	summer	nh4	0.1121	0.6961
3915300171	OH	Summit	summer	pbw	0.1146	0.6691
3915300171	OH	Summit	fall	so4	0.2443	0.8074
3915300171	OH	Summit	fall	no3	0.1175	0.9392
3915300171	OH	Summit	fall	ocm	0.2636	1.0252
3915300171	OH	Summit	fall	ec	0.0623	0.8883
3915300171	OH	Summit	fall	soil	0.0494	1.086
3915300171	OH	Summit	fall	nh4	0.109	0.8622
3915300171	OH	Summit	fall	pbw	0.0723	0.8506

APPENDIX II

Ozone Source Apportionment Modeling Results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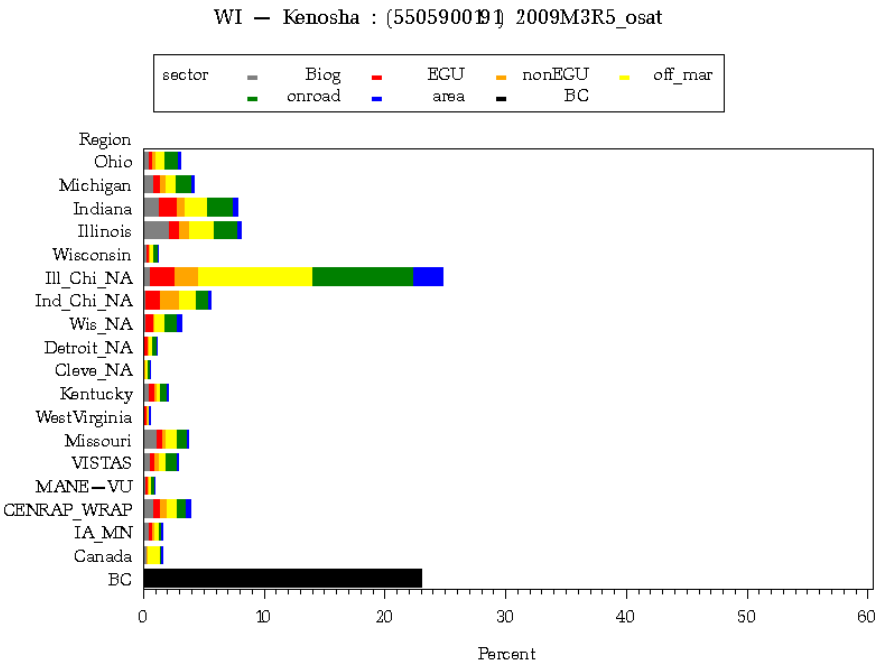
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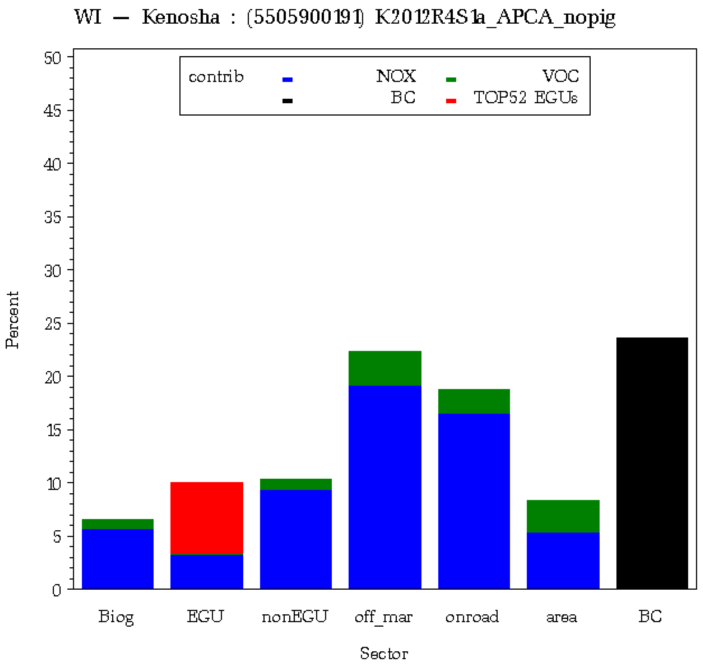
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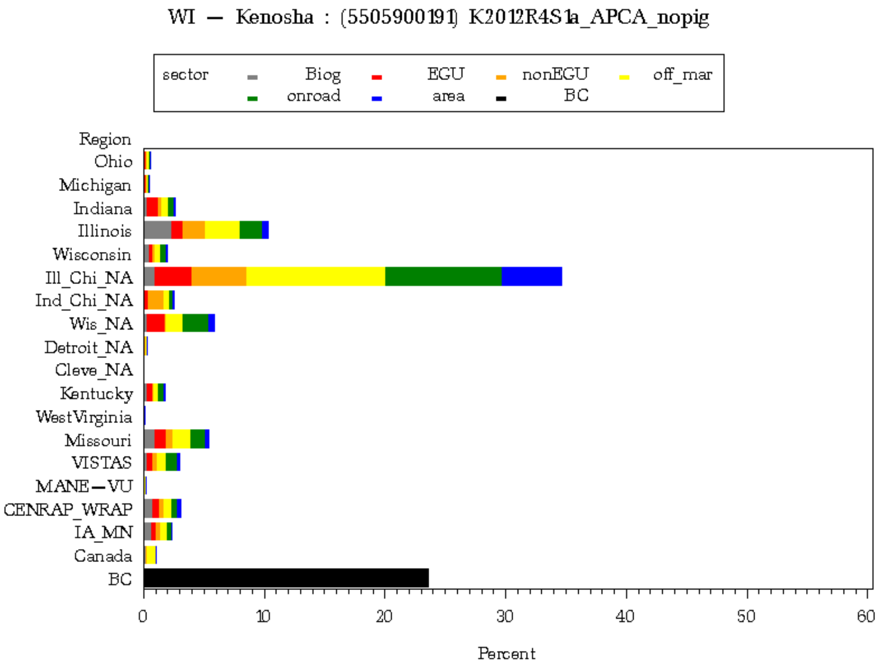
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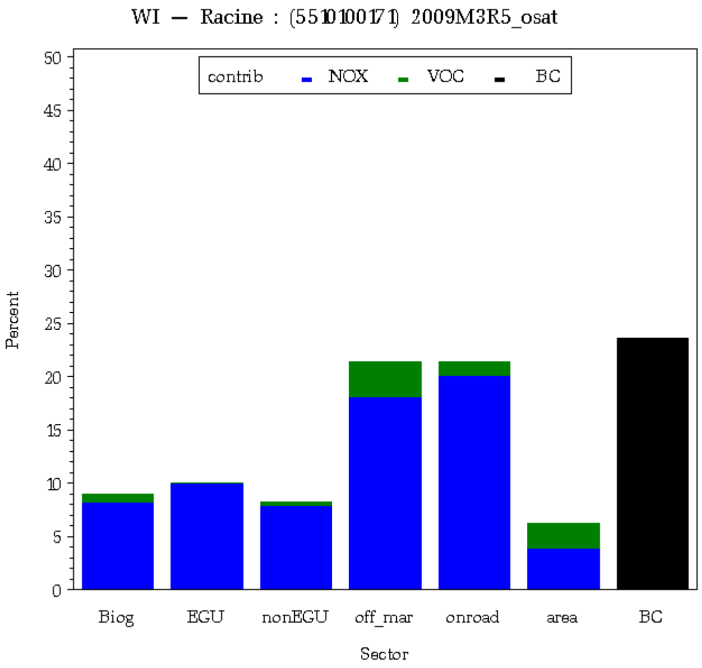
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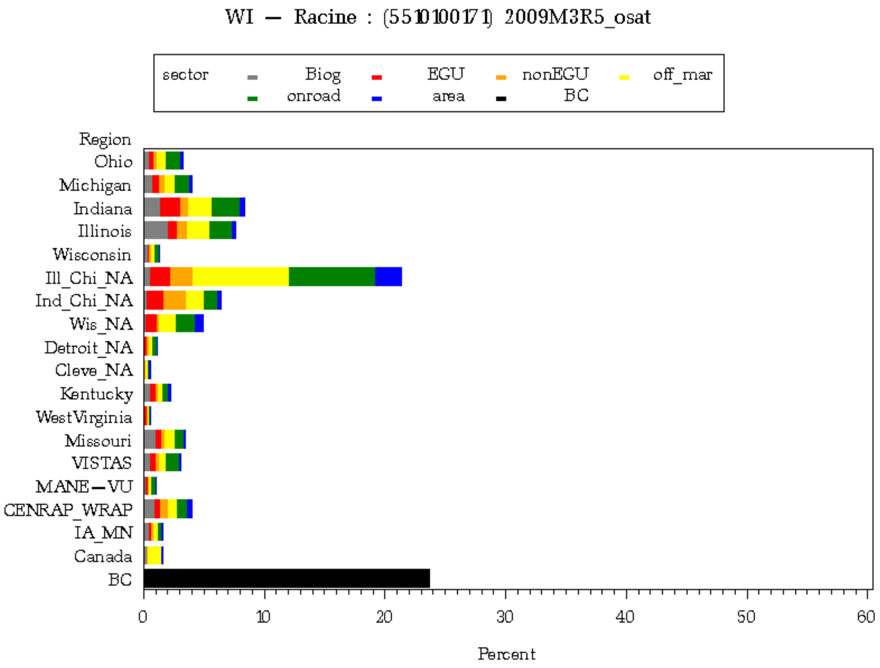
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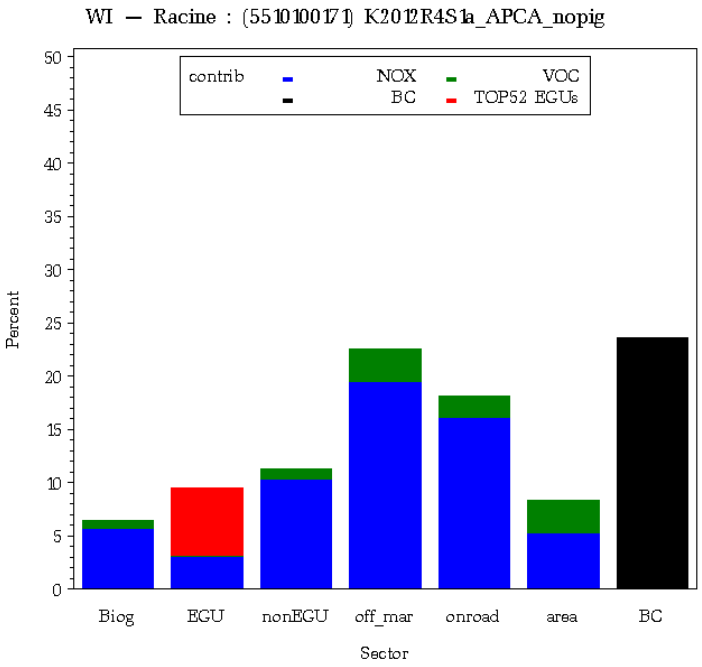
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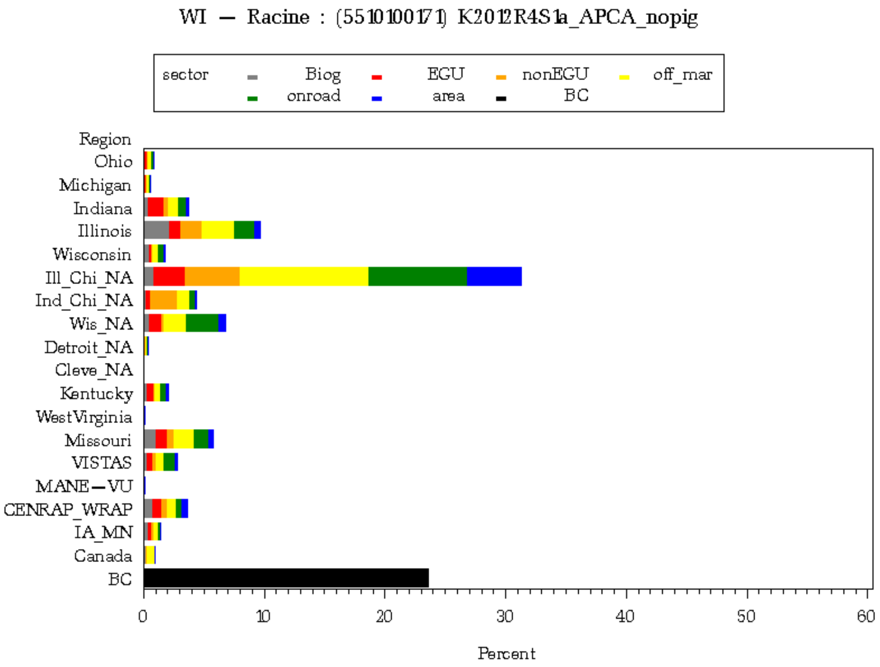
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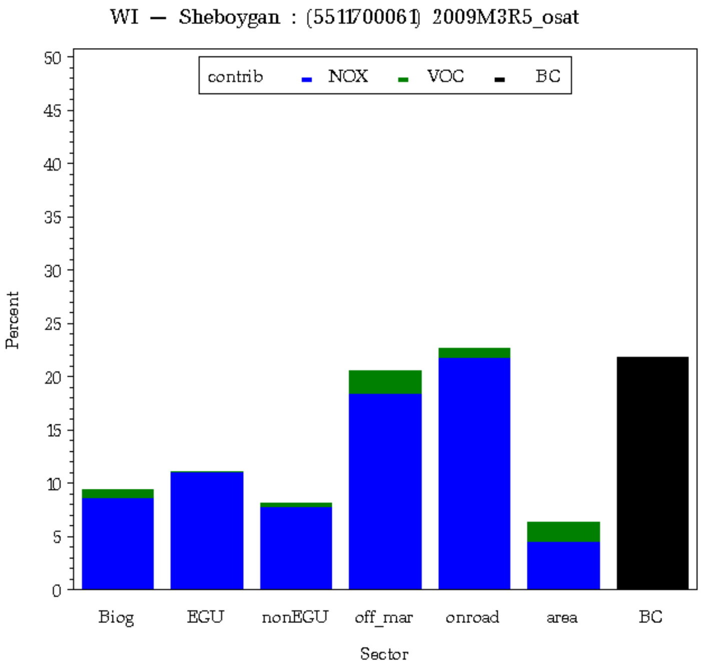
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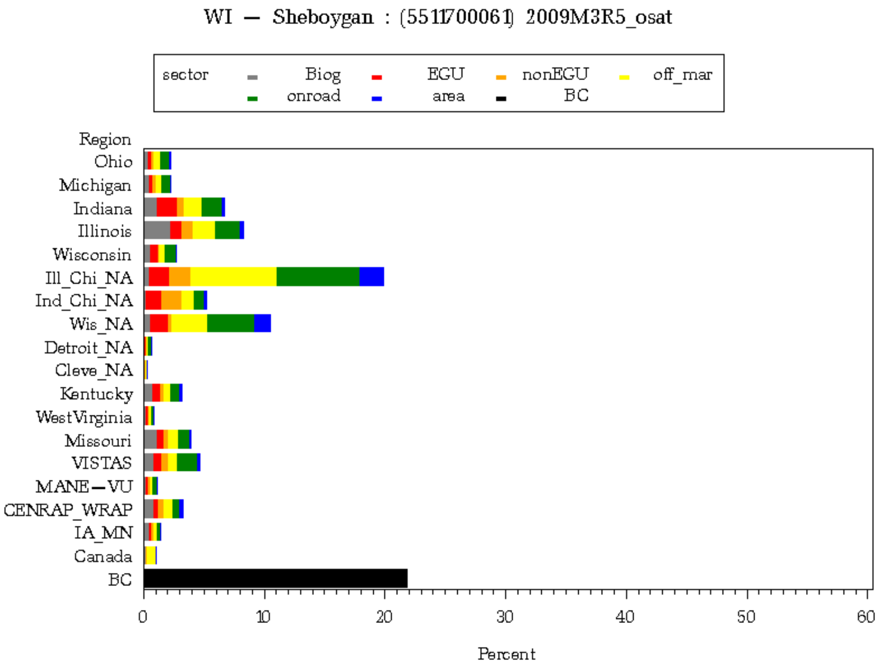
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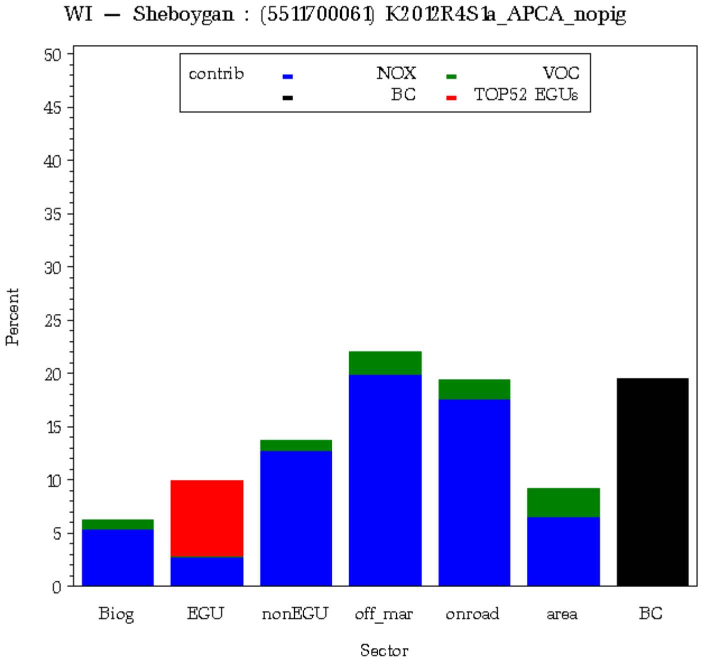
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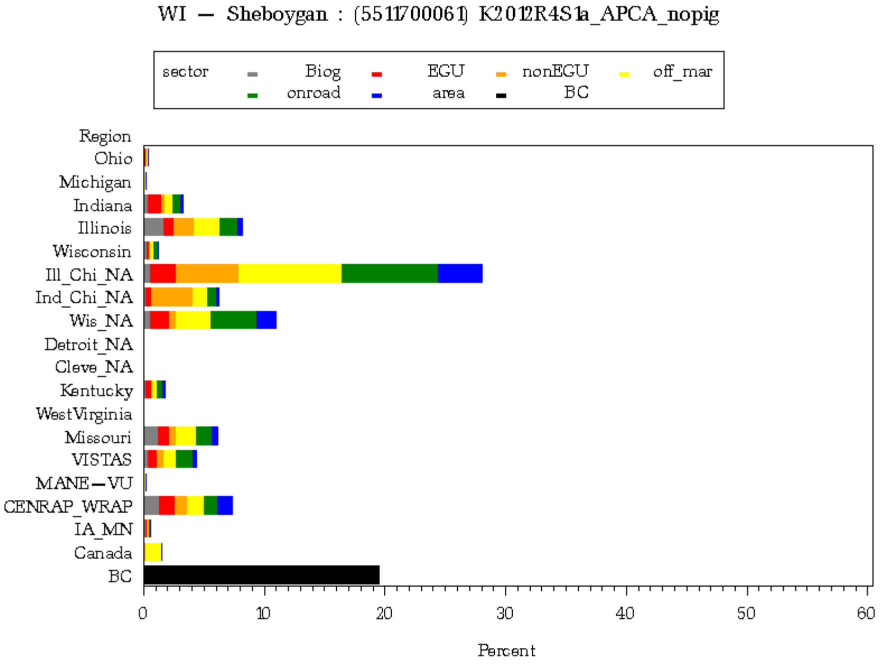
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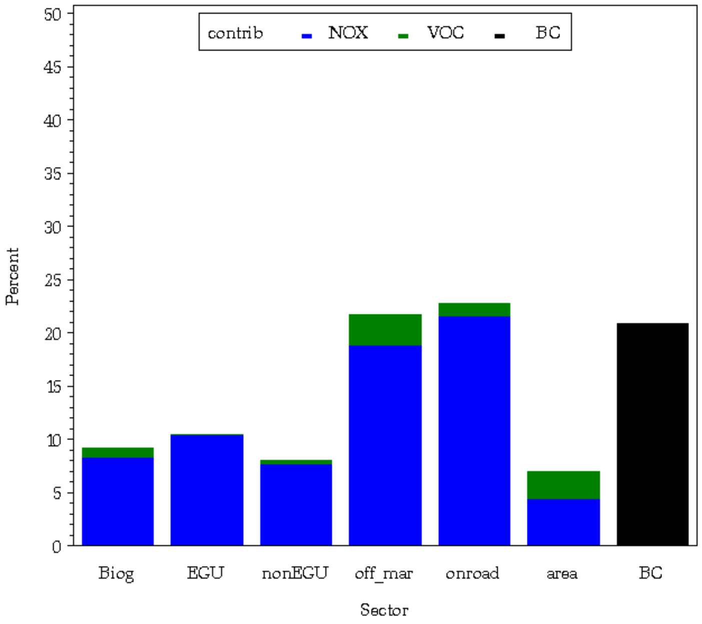
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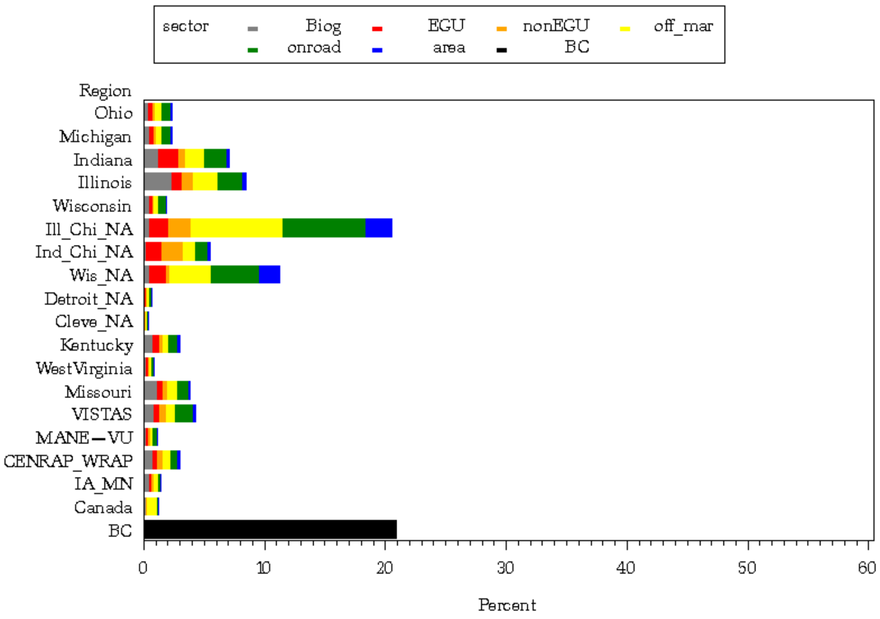
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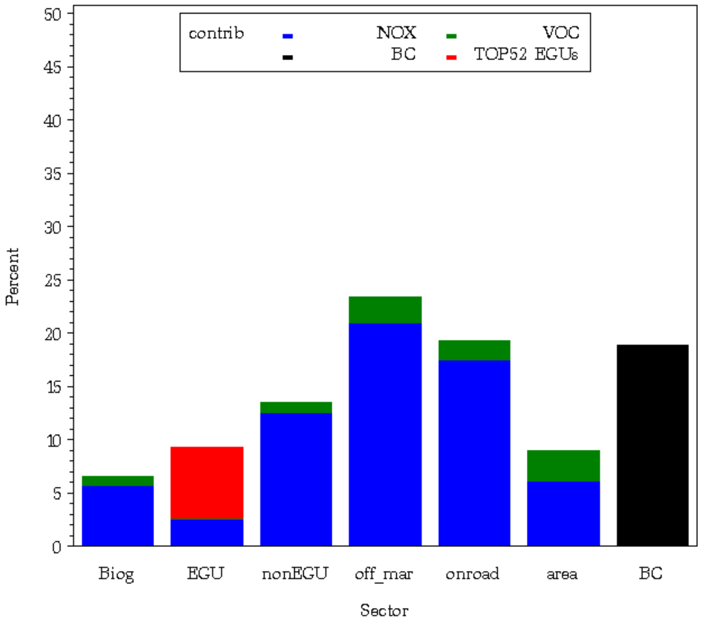
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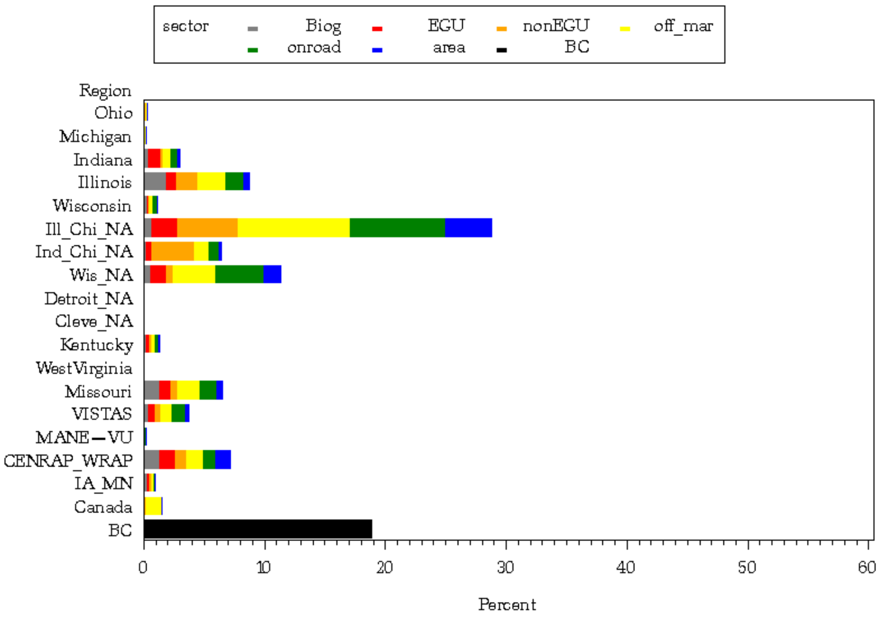
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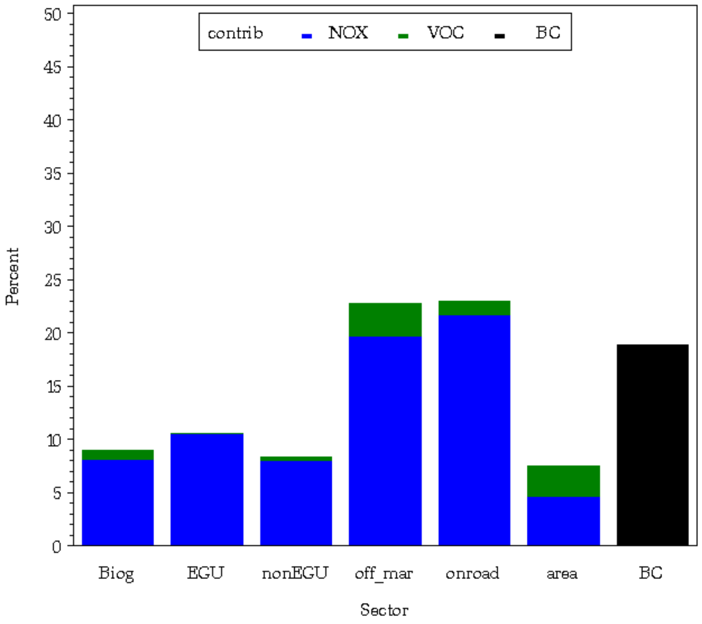
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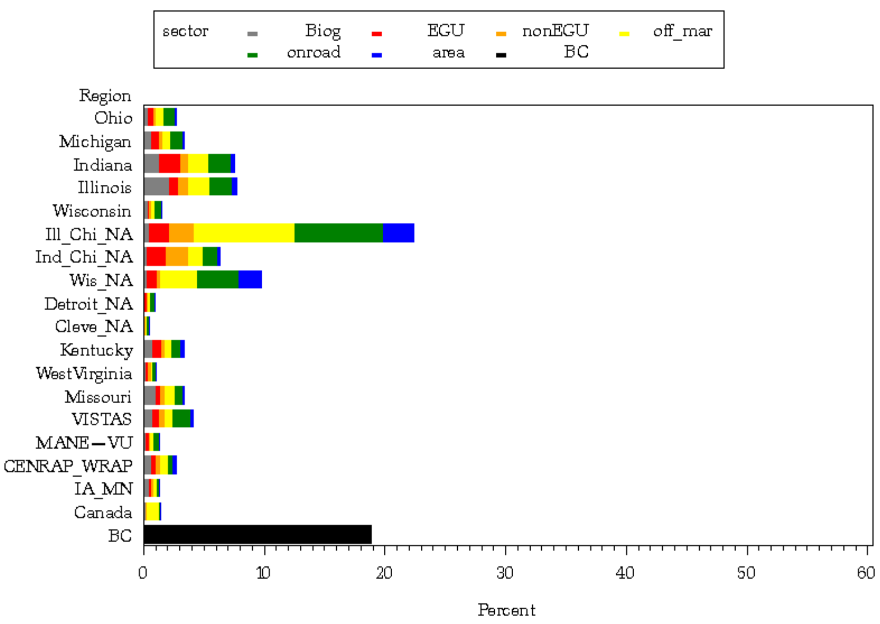
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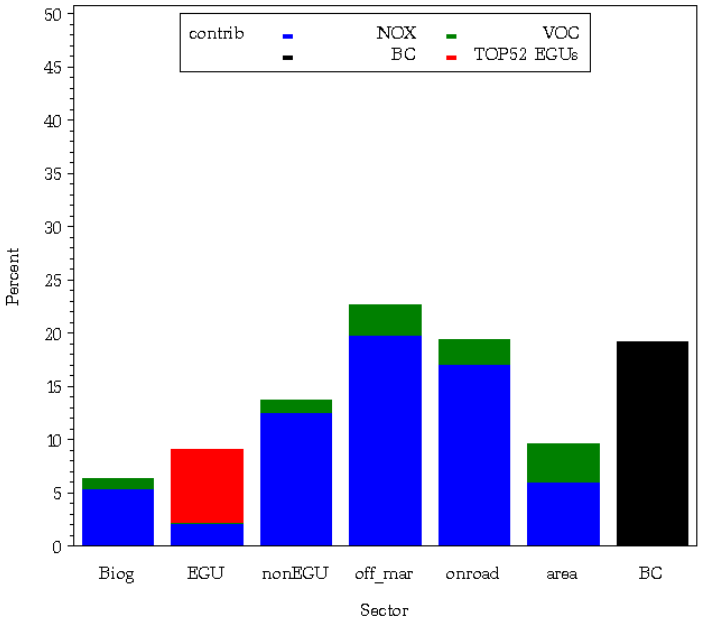
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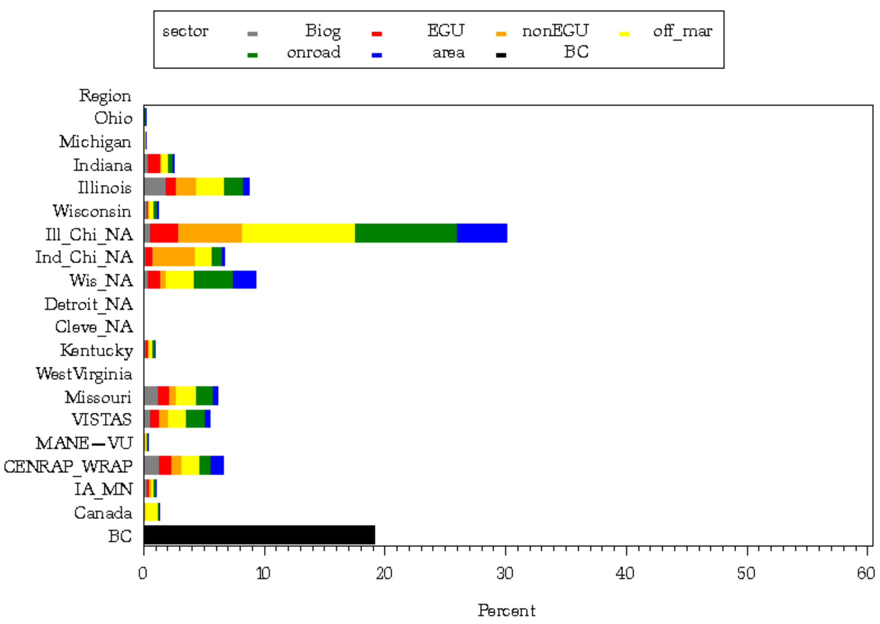
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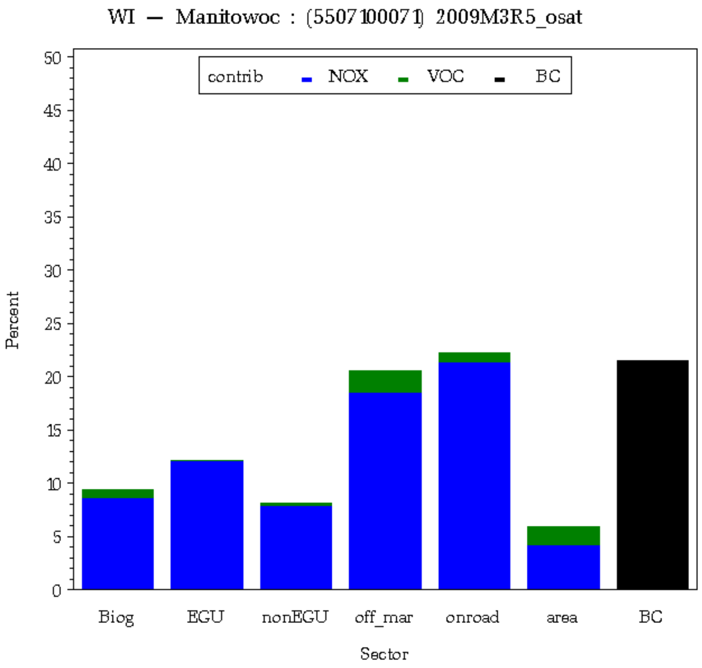
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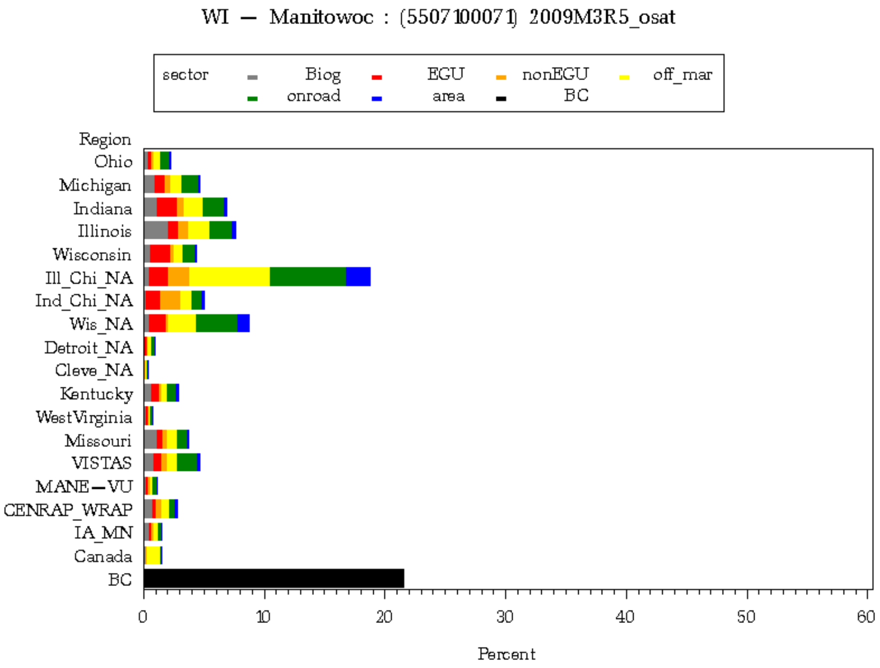
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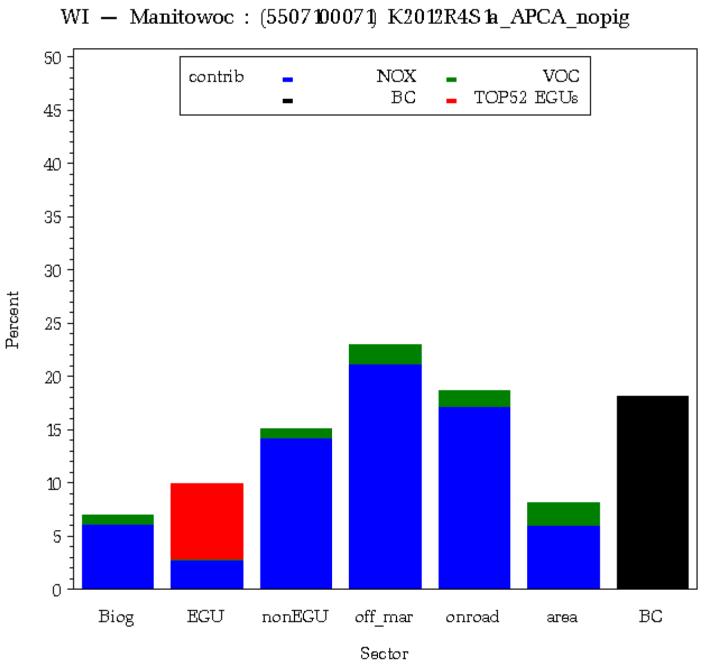
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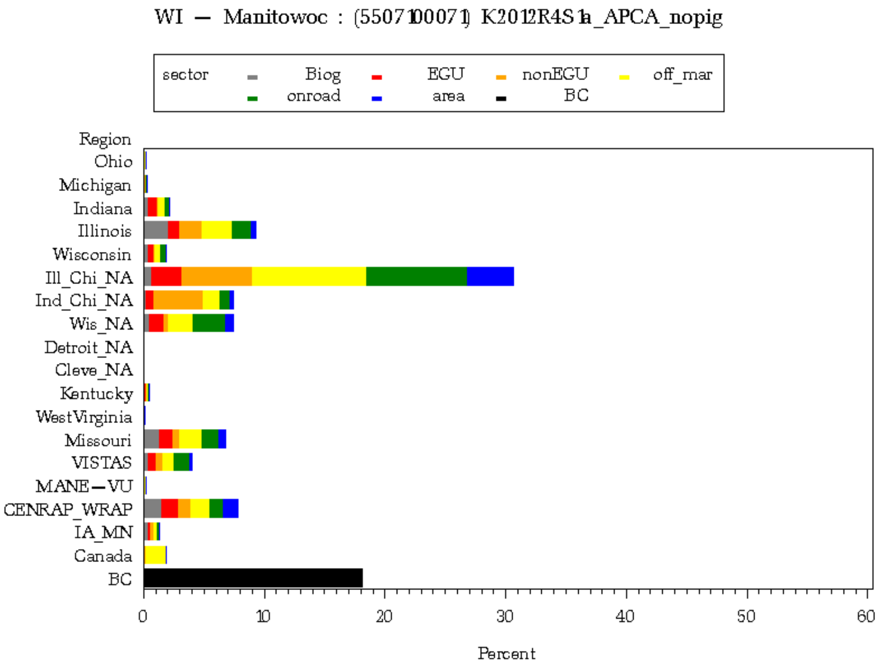
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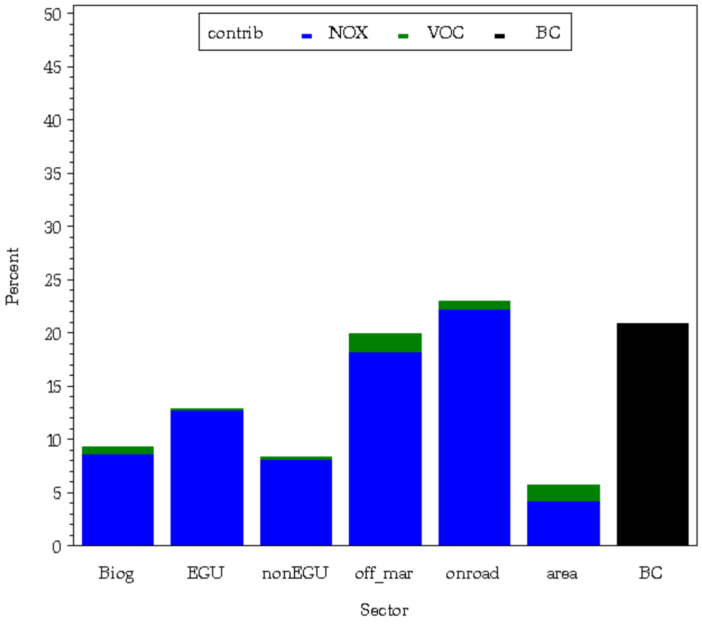
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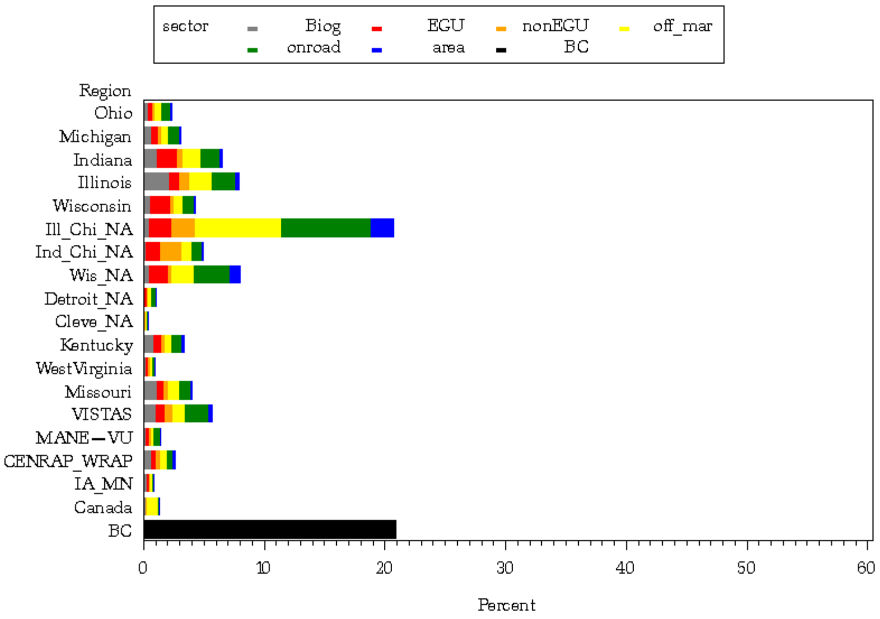
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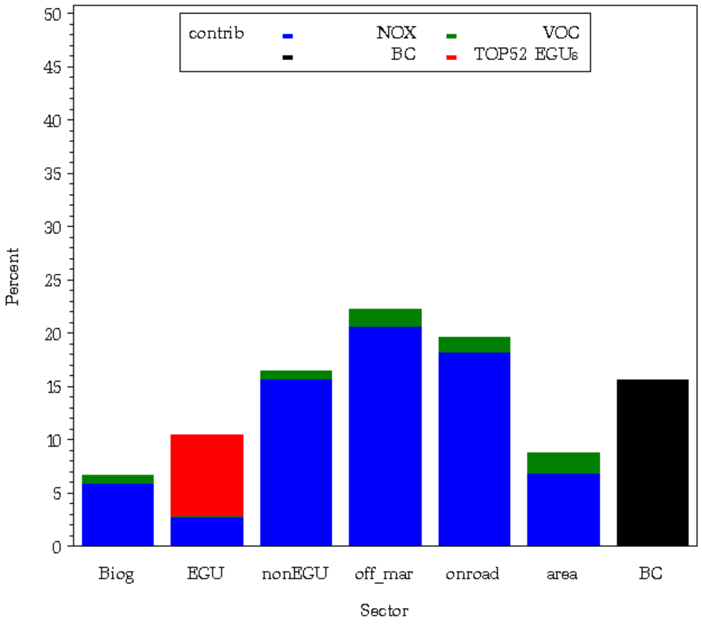
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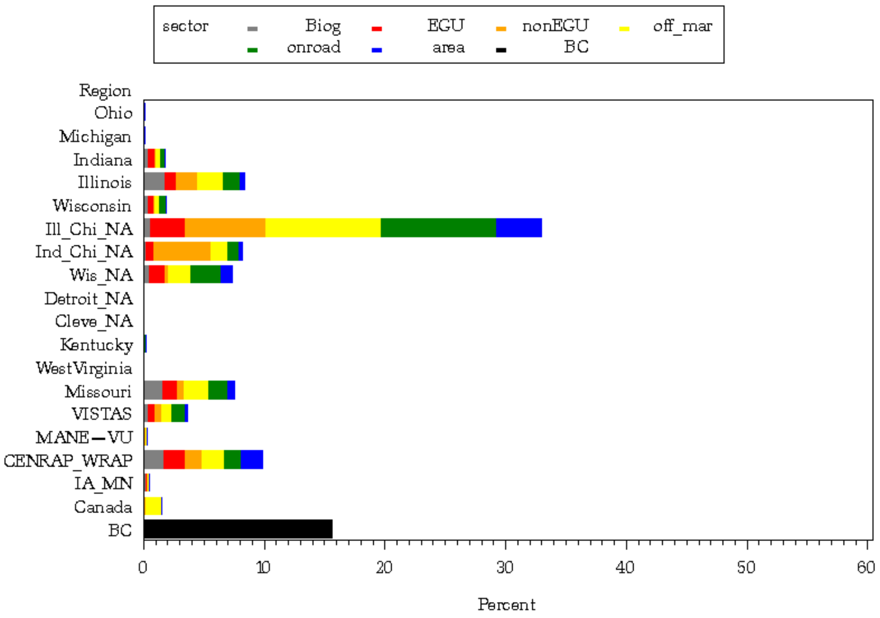
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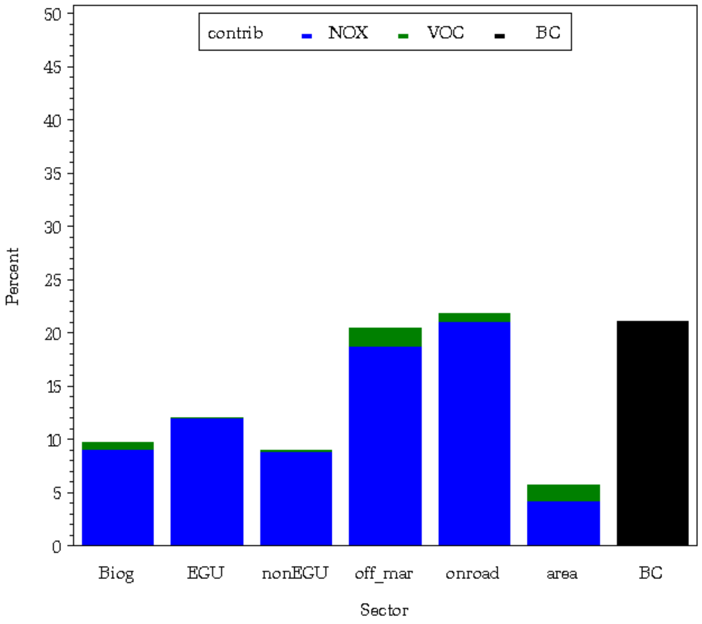
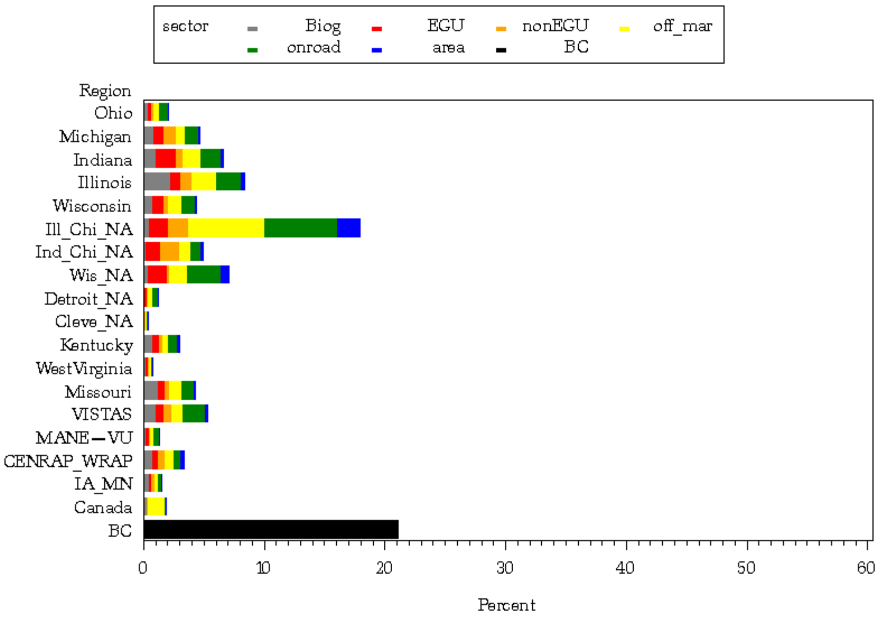
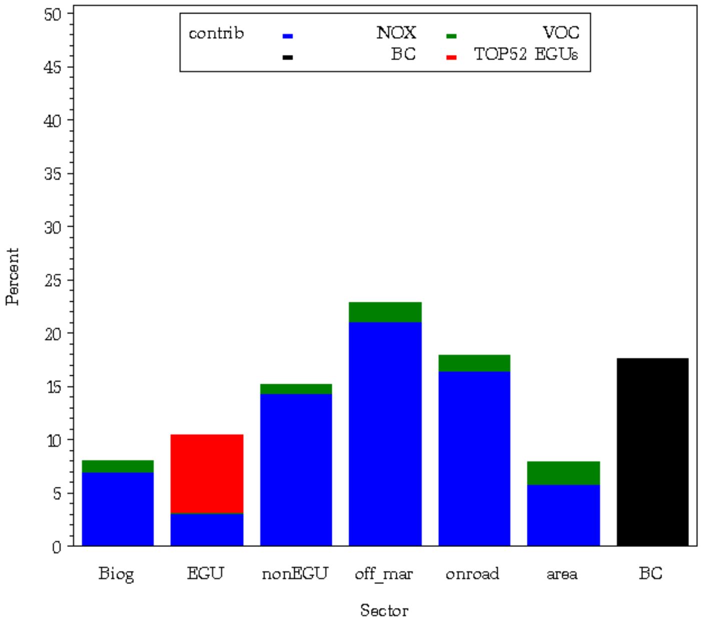


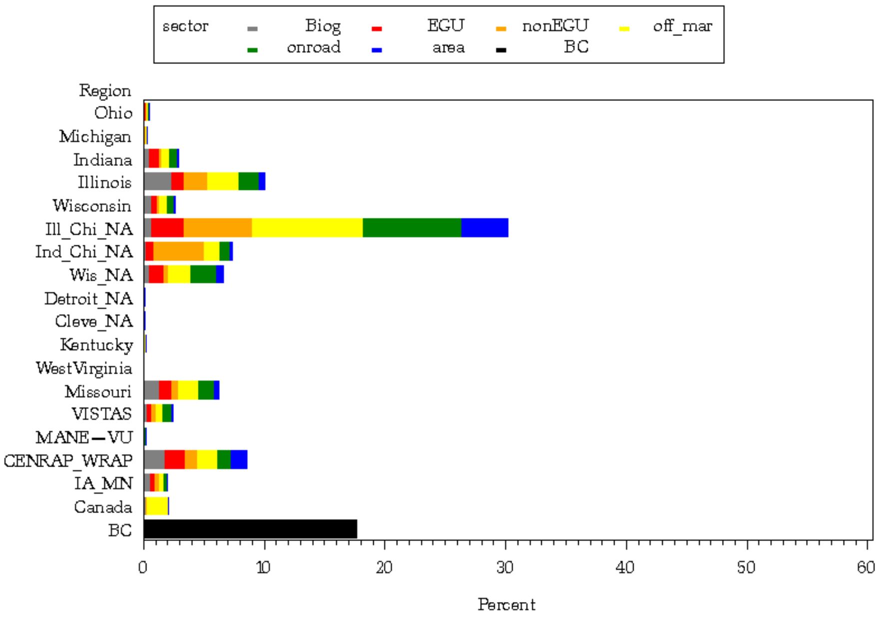
WI — Door : (550290004I) 2009M3R5_osat



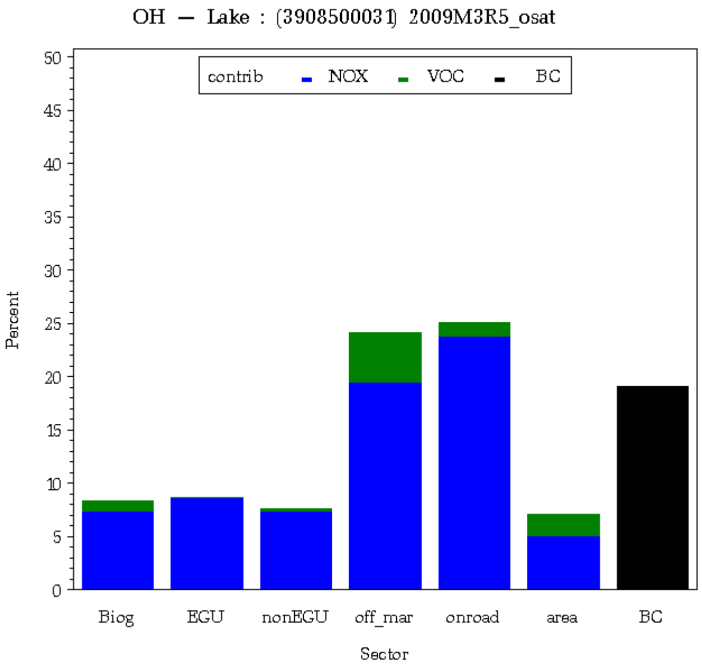
WI — Door : (550290004I) 2009M3R5_osat



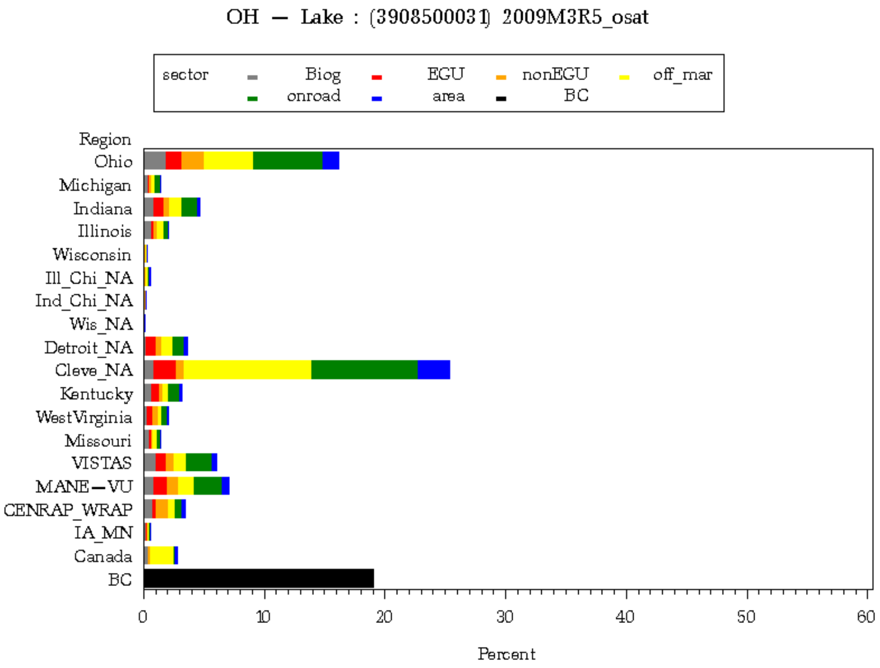
WI — Door : (550290004I) K2012R4S1a_APCA_nopig



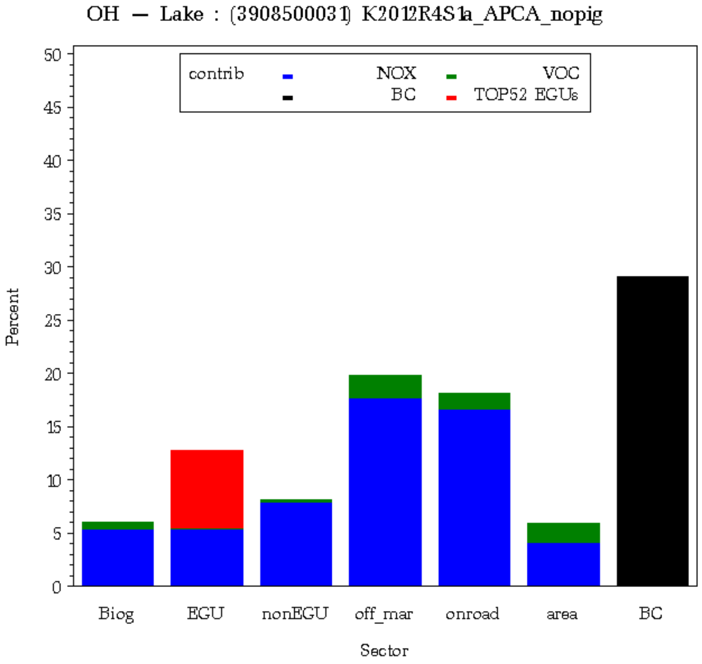
WI — Door : (550290004I) K2012R4S1a_APCA_nopig



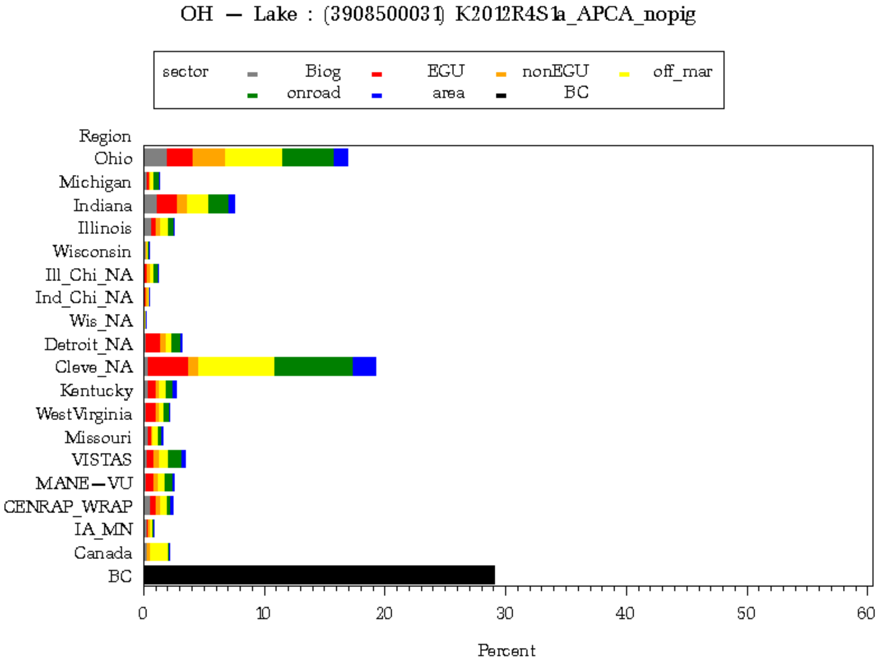
OH — Lake : (390850003 1) 2009M3R5_osat



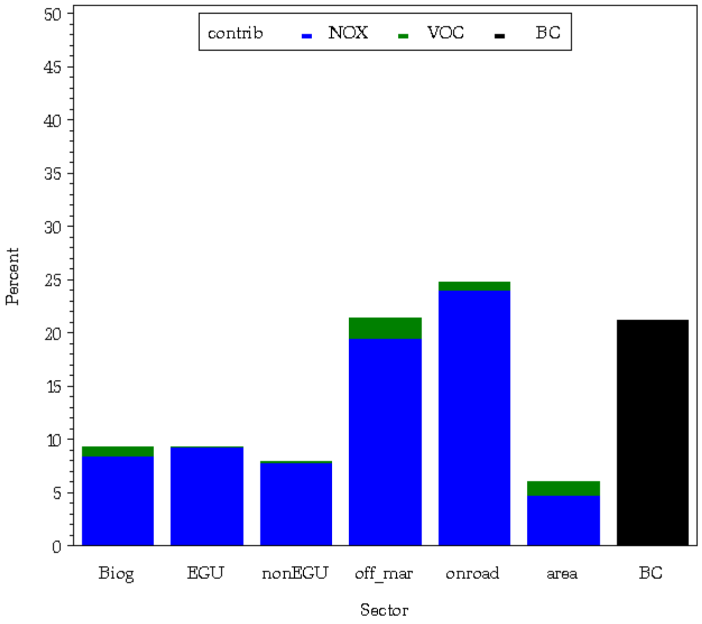
OH — Lake : (390850003 1) 2009M3R5_osat



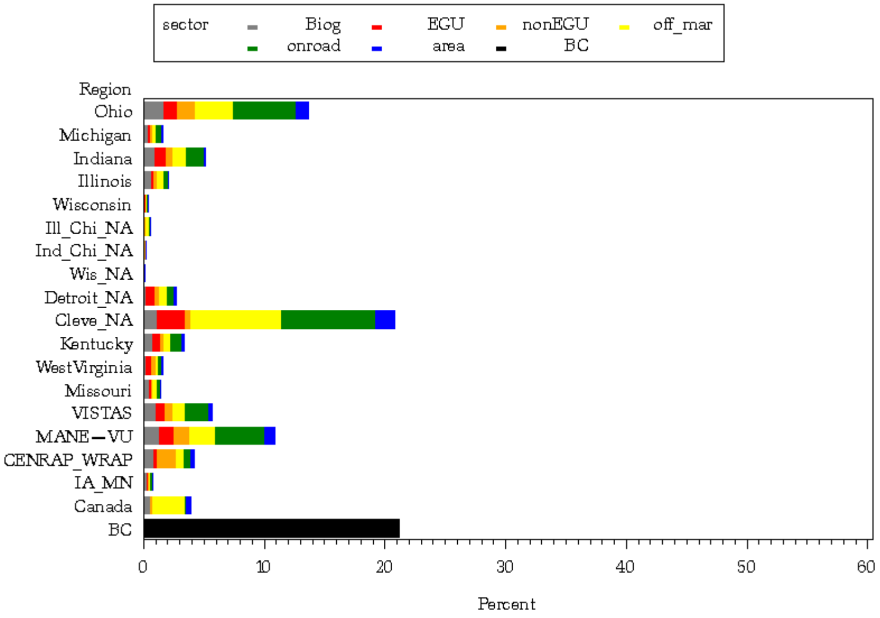
OH — Lake : (390850003 1) K2012R4S1a_APCA_nopig



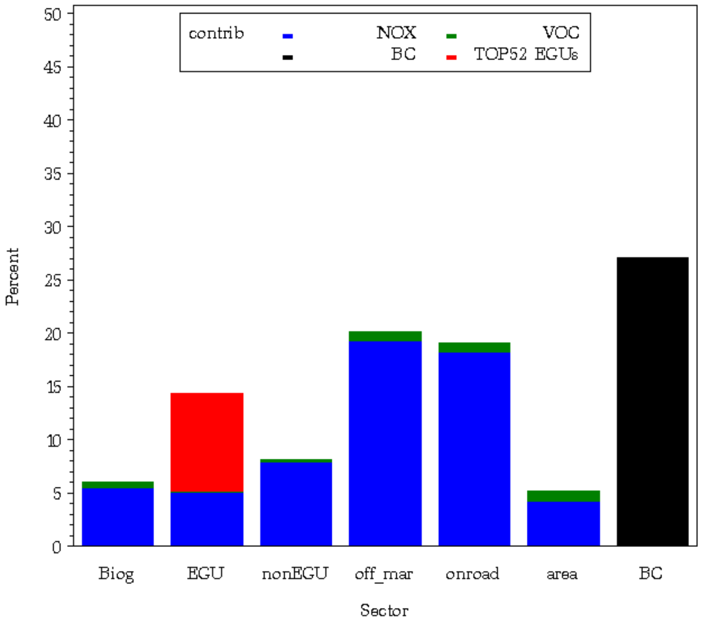
OH — Lake : (390850003 1) K2012R4S1a_APCA_nopig



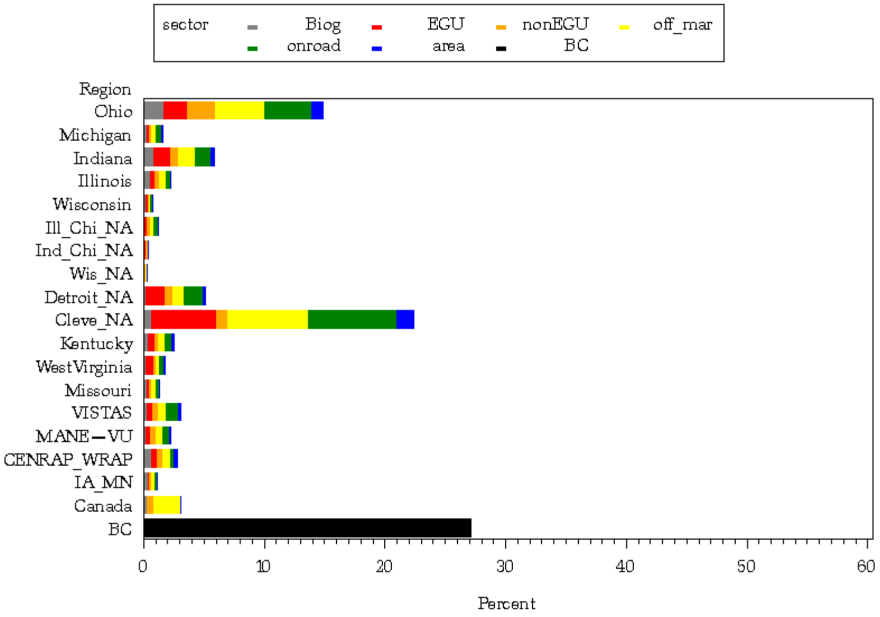
OH — Ashtabula : (390071001) 2009M3R5_osat



OH — Ashtabula : (390071001) 2009M3R5_osat

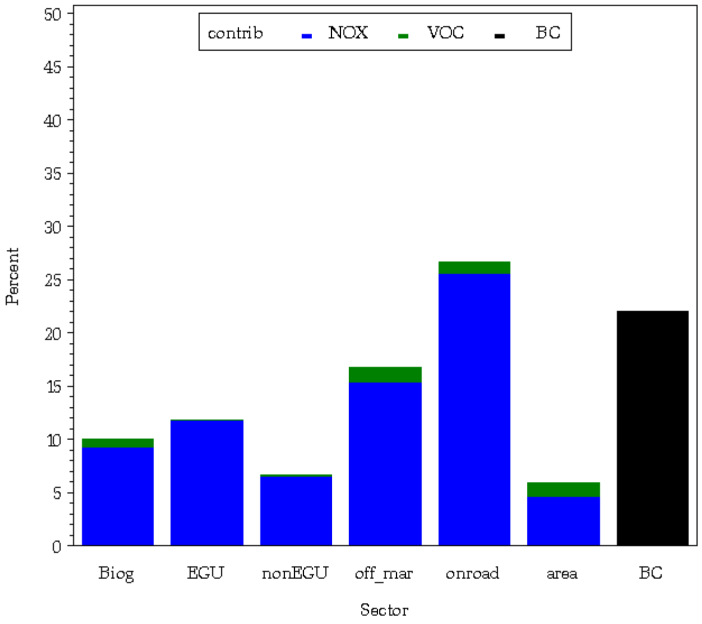


OH — Ashtabula : (390071001) K2012R4S1a_APCA_nopig

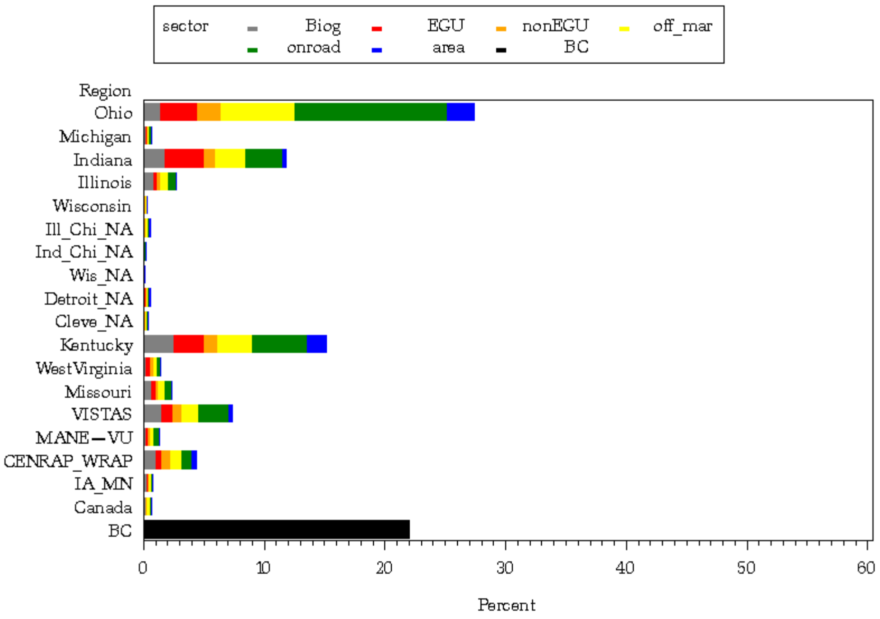


OH — Ashtabula : (390071001) K2012R4S1a_APCA_nopig

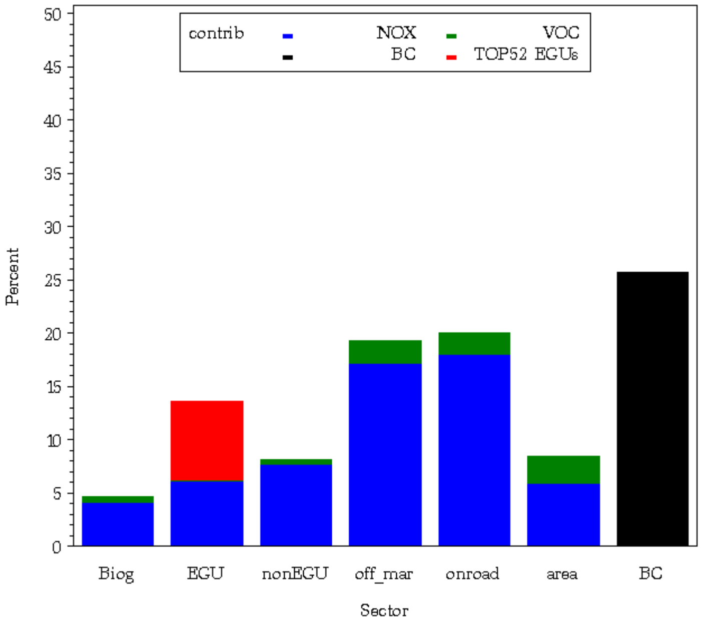
OH — Hamilton : (390610006 1) 2009M3R5_osat



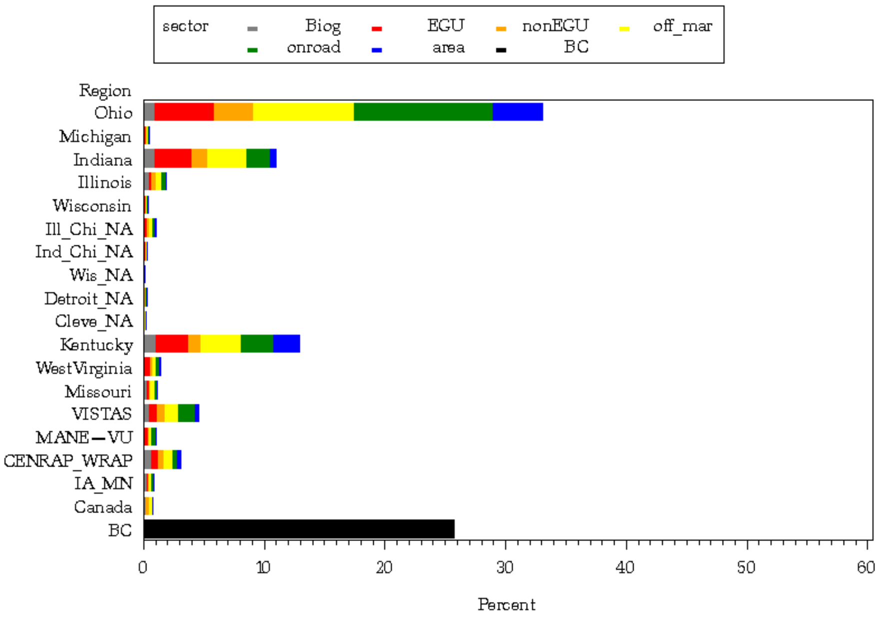
OH — Hamilton : (390610006 1) 2009M3R5_osat

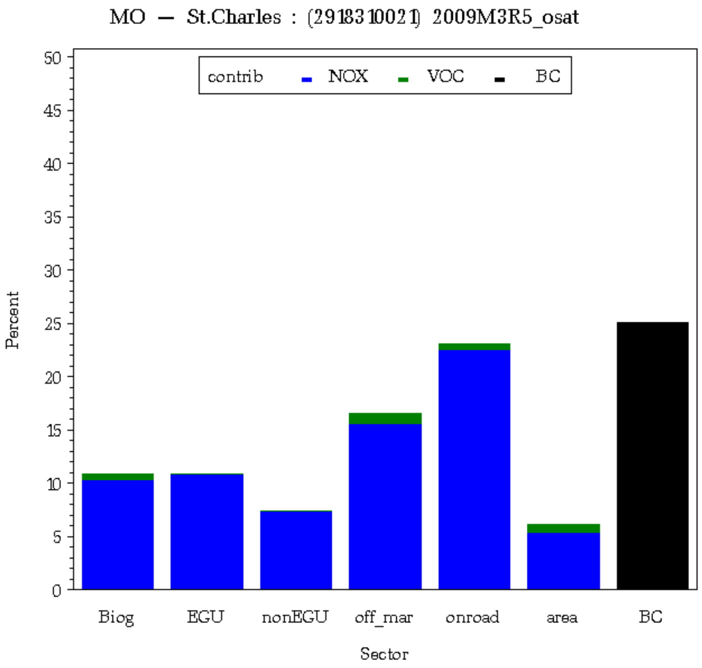


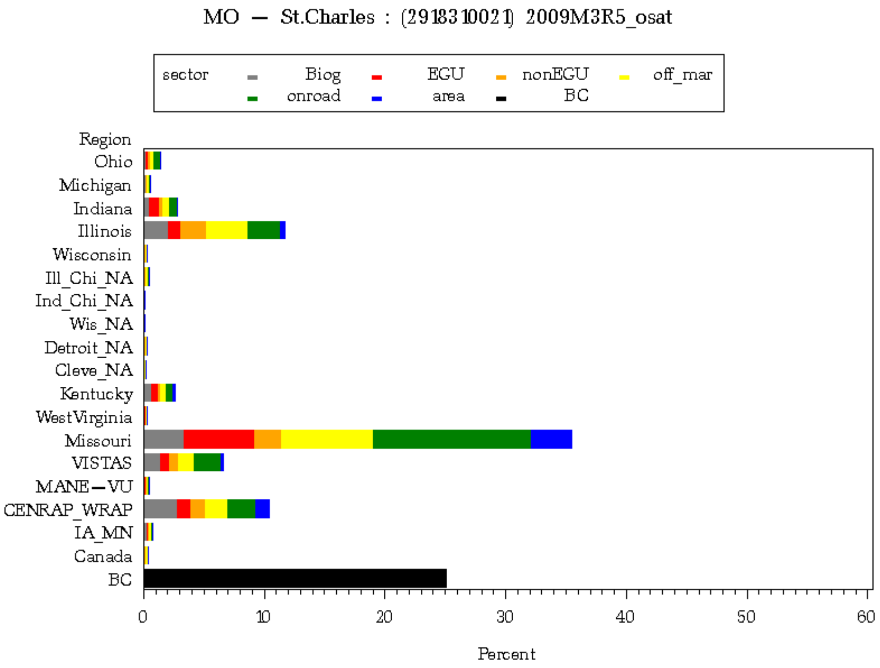
OH — Hamilton : (390610006 1) K2012R4S1a_APCA_nopig



OH — Hamilton : (390610006 1) K2012R4S1a_APCA_nopig




MO — St.Charles : (291831002 1) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


MO — St.Charles : (291831002 1) 2009M3R5_osat
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE-VU
CENRAP_WRAP
IA_MN
Canada
BC
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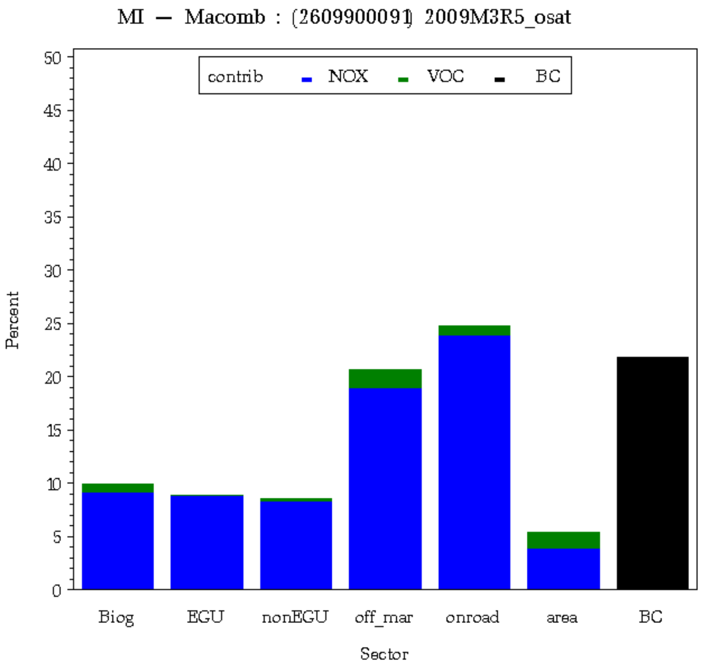
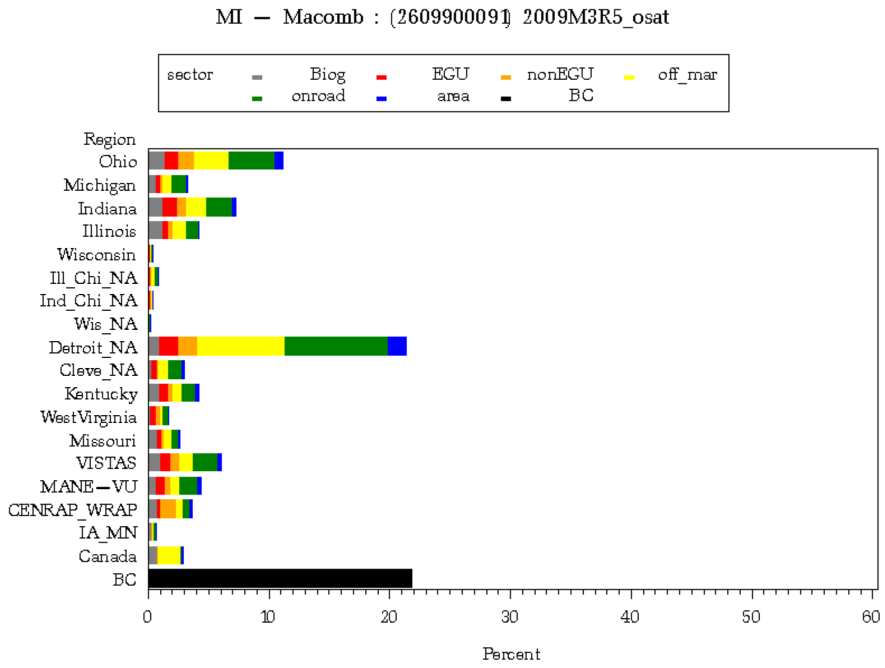
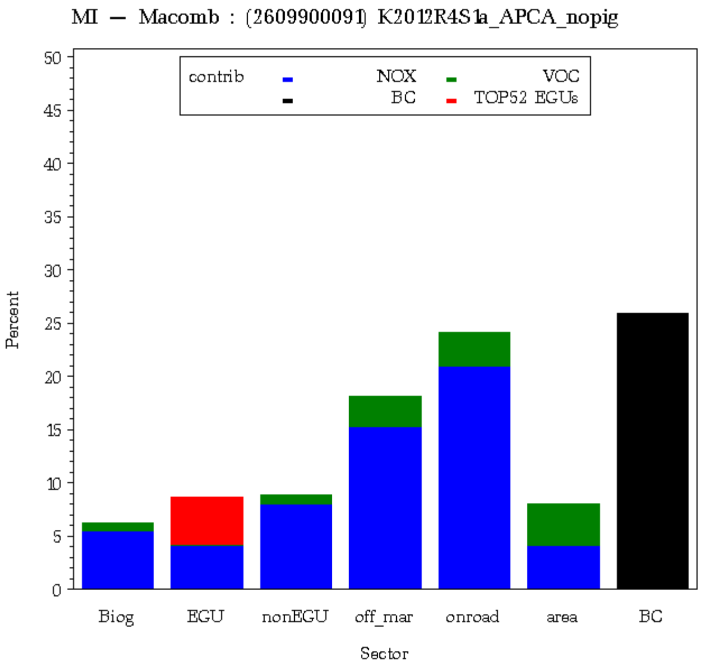
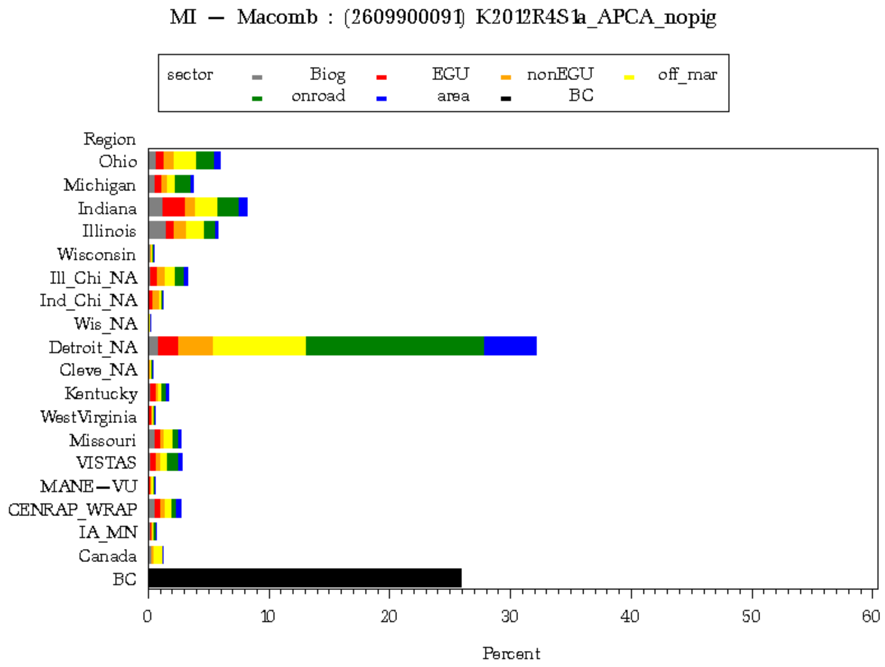
10
20
30
40
50
60
Percent

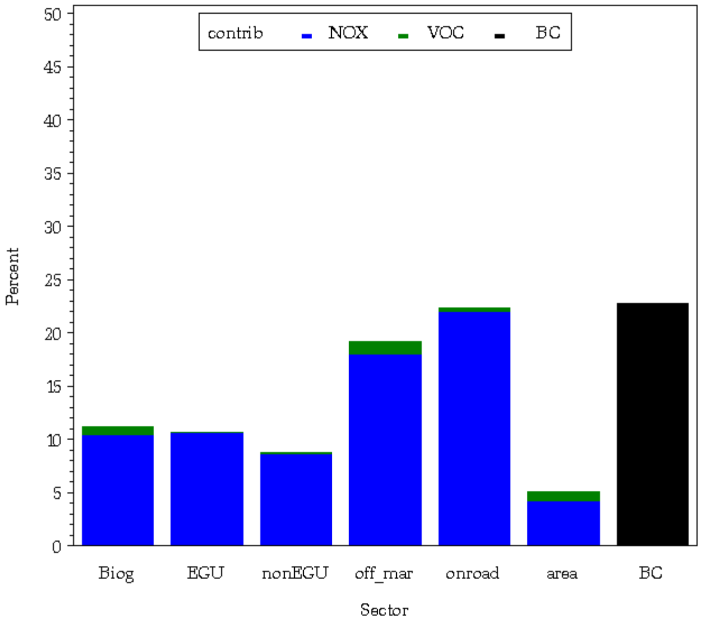

MI — Macomb : (260990009) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


MI — Macomb : (260990009) 2009M3R5_osat
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent

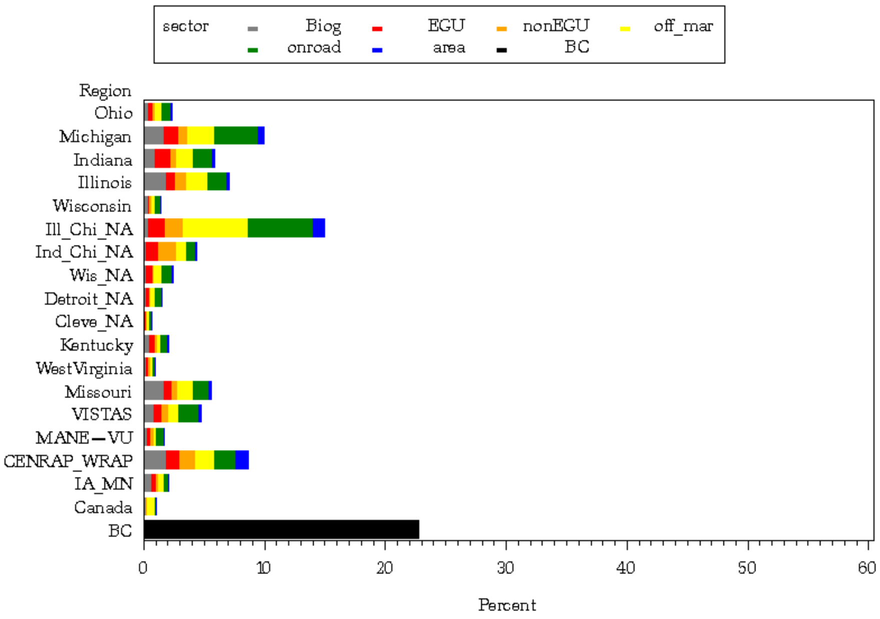

MI — Macomb : (260990009) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


MI — Macomb : (260990009) K2012R4S1a_APCA_nopig
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent

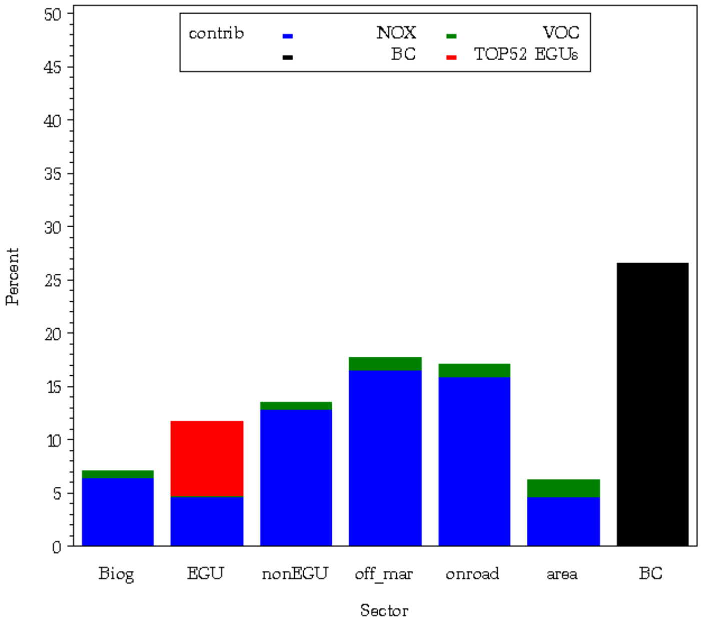
MI — Allegan : (260050031) 2009M3R5_osat



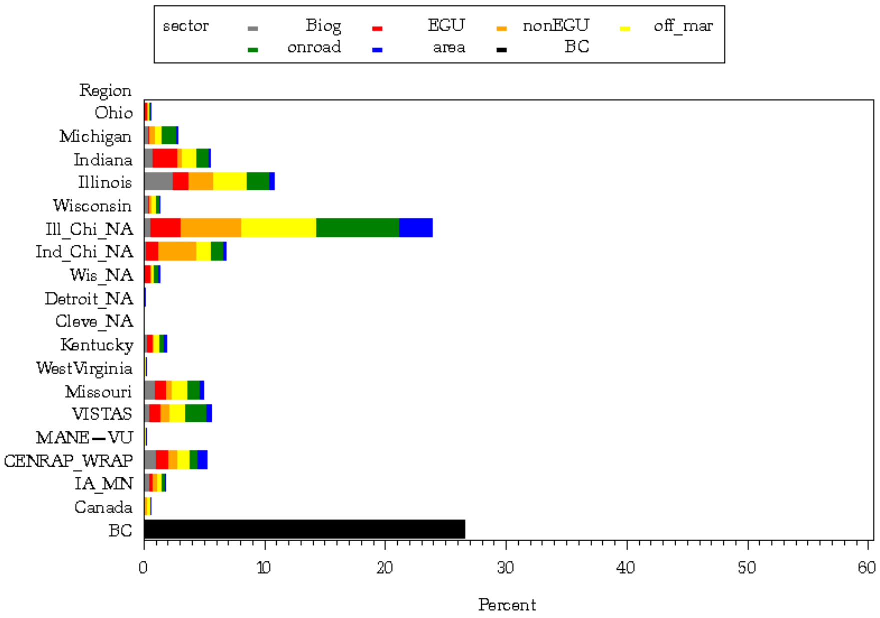
MI — Allegan : (260050031) 2009M3R5_osat



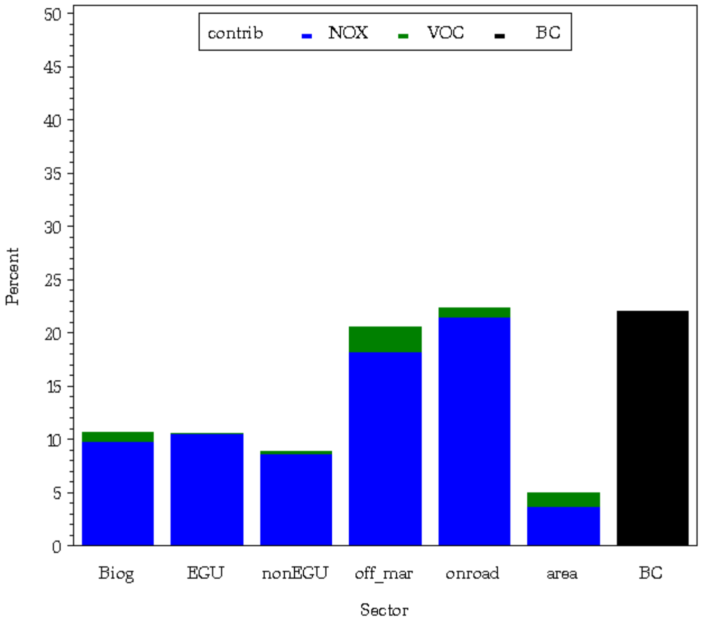
MI — Allegan : (260050031) K2012R4S1a_APCA_nopig



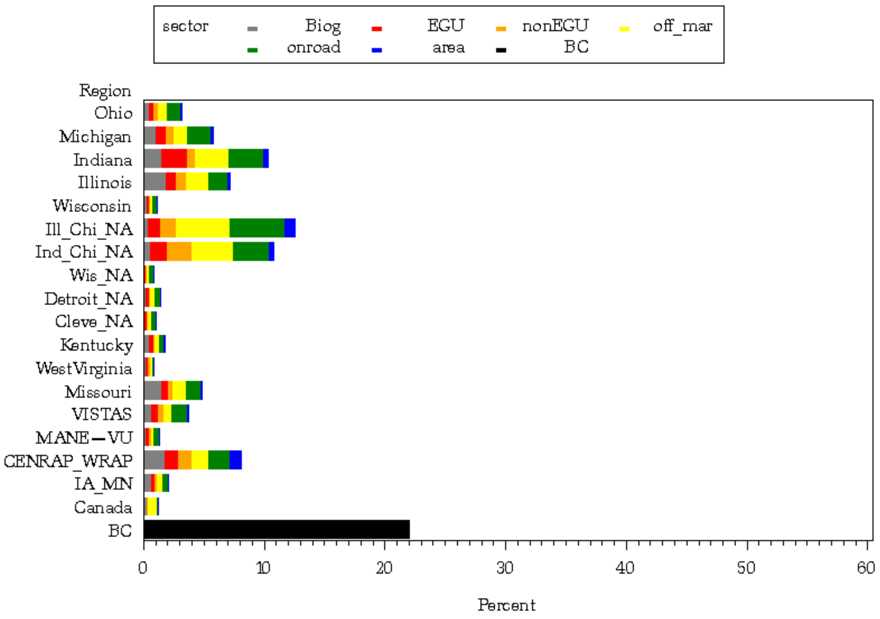
MI — Allegan : (260050031) K2012R4S1a_APCA_nopig



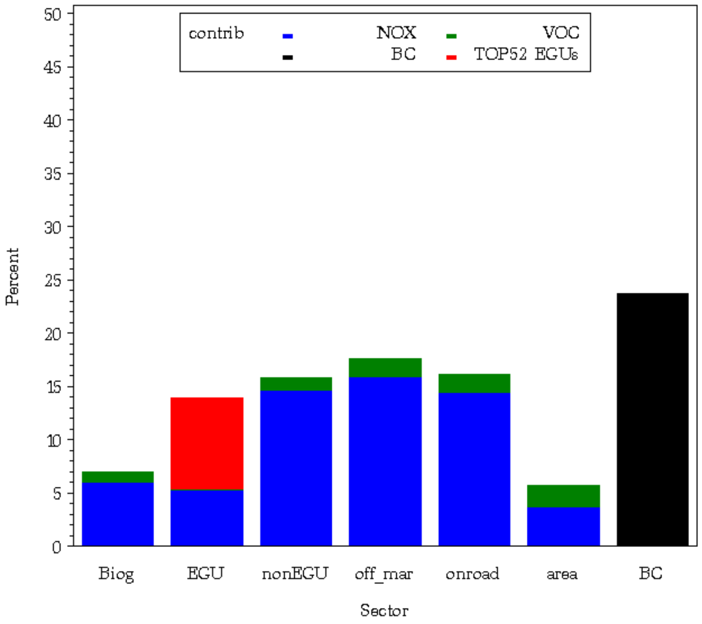
IN — LaPorte : (180910005 1) 2009M3R5_osat



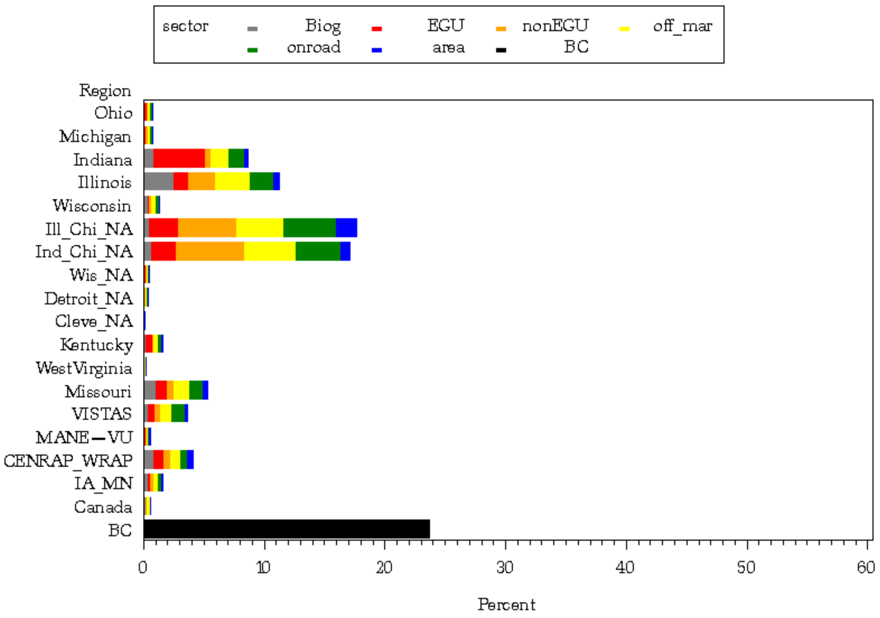
IN — LaPorte : (180910005 1) 2009M3R5_osat

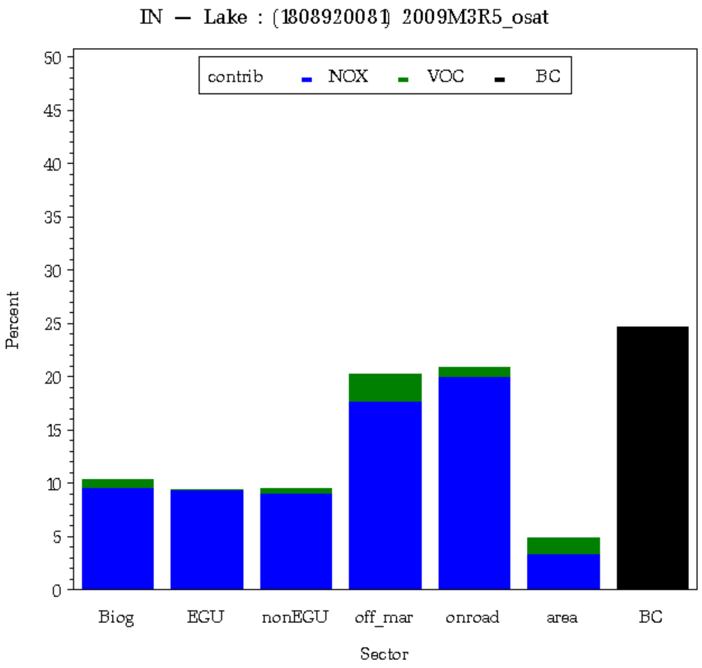


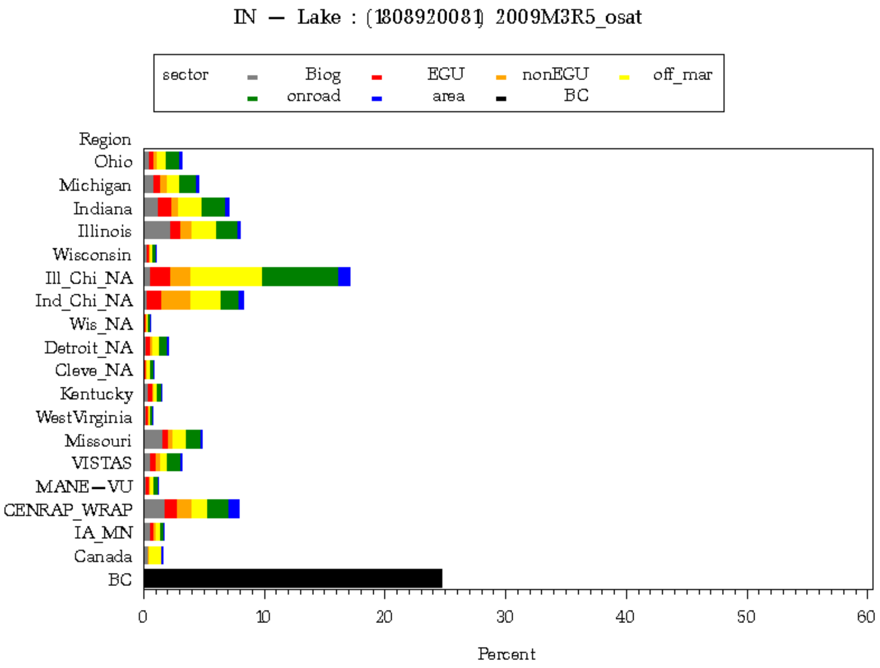
IN — LaPorte : (180910005 1) K2012R4S1a_APCA_nopig

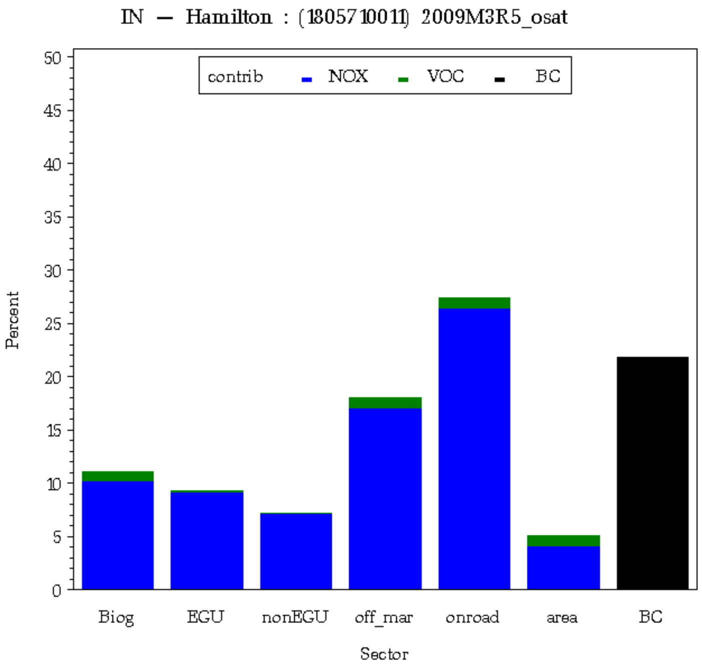


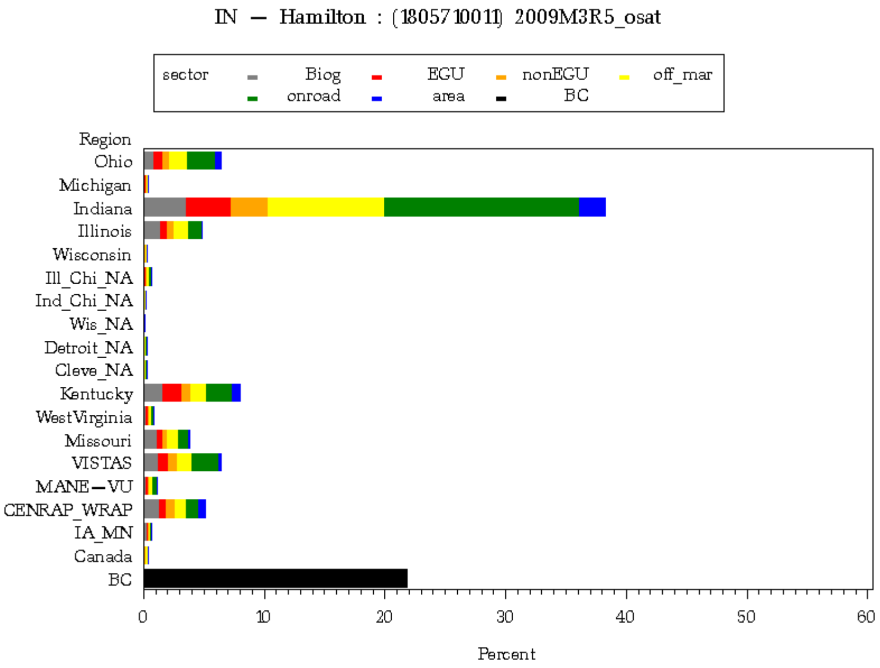
IN — LaPorte : (180910005 1) K2012R4S1a_APCA_nopig

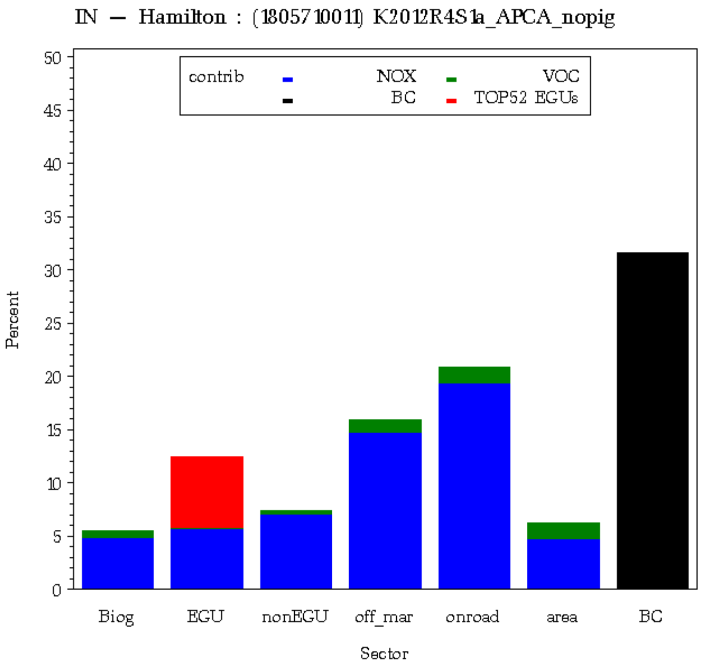


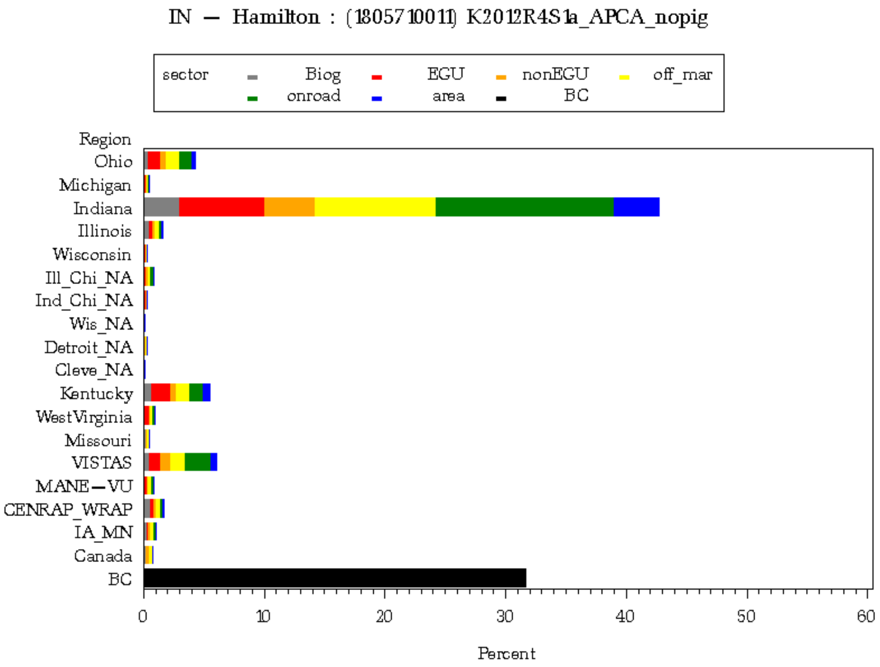

IN — Lake : (180892008l) 2009M3R5_osat
contrib NOX VOC BC
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


IN — Lake : (180892008l) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent


IN — Hamilton : (180571001l) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


IN — Hamilton : (180571001l) 2009M3R5_osat
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent


IN — Hamilton : (180571001l) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector

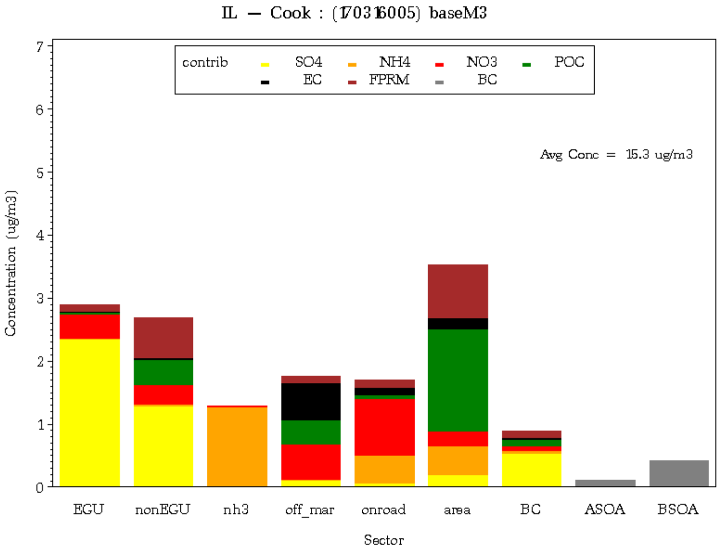

IN — Hamilton : (180571001l) K2012R4S1a_APCA_nopig
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent

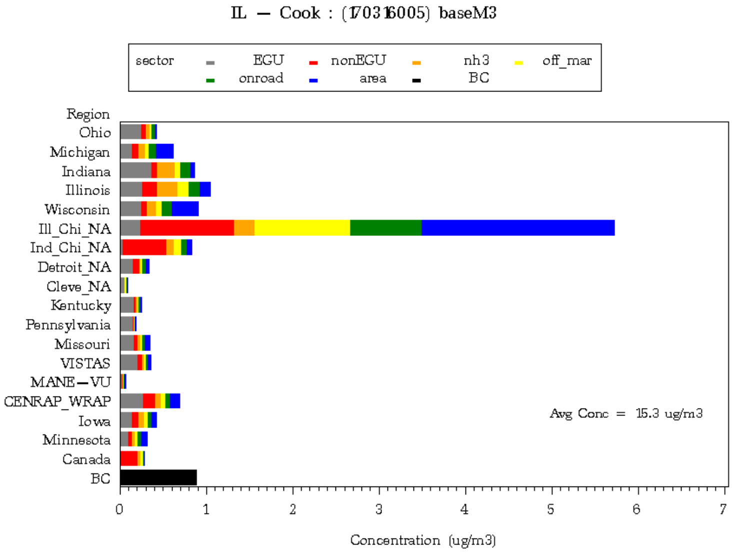
APPENDIX III

$PM_{2.5}$ Source Apportionment Modeling Results

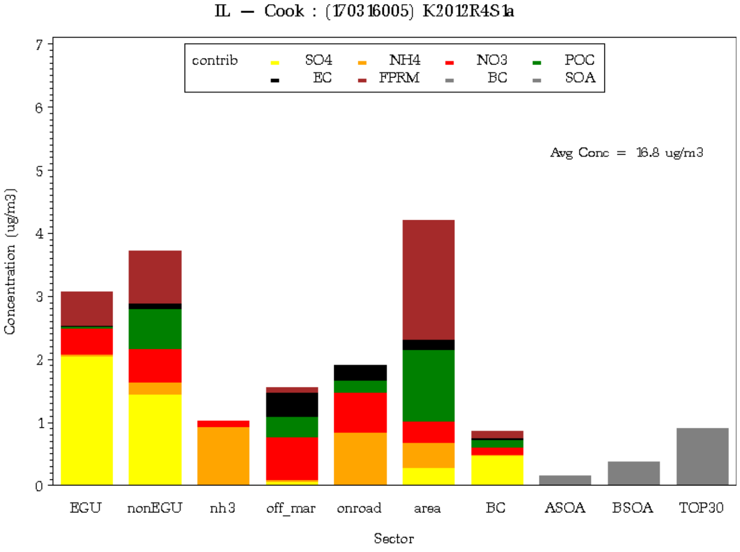
Chicago (Cicero), Illinois

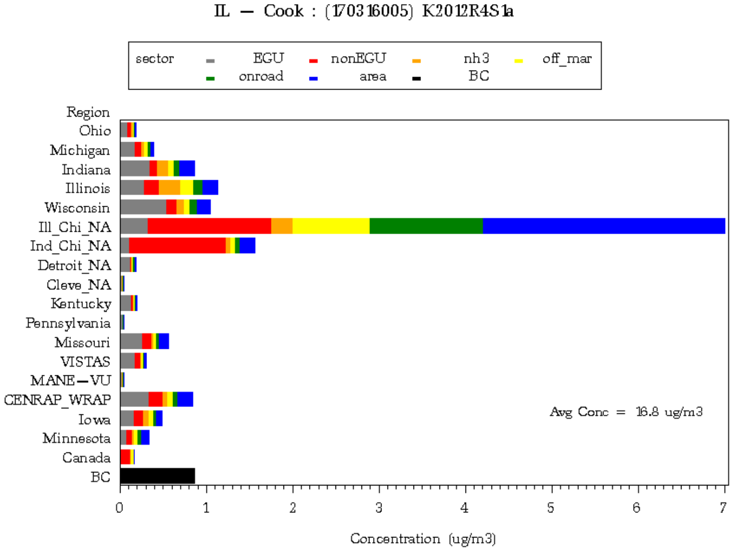
2005 (Round 5)



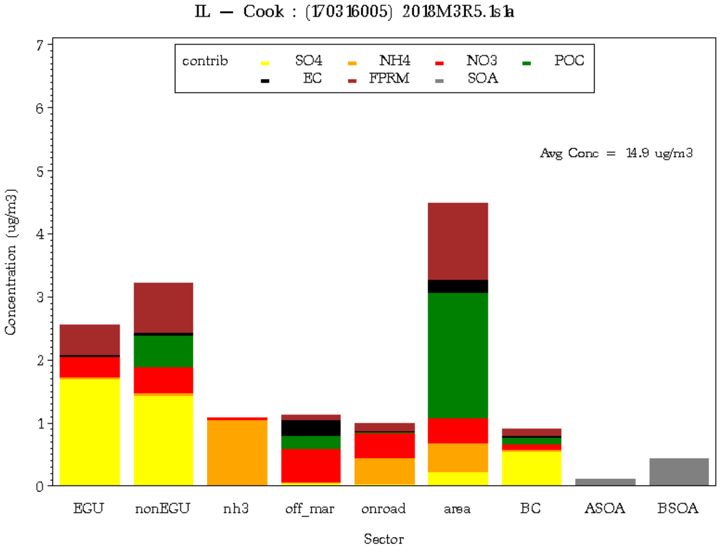


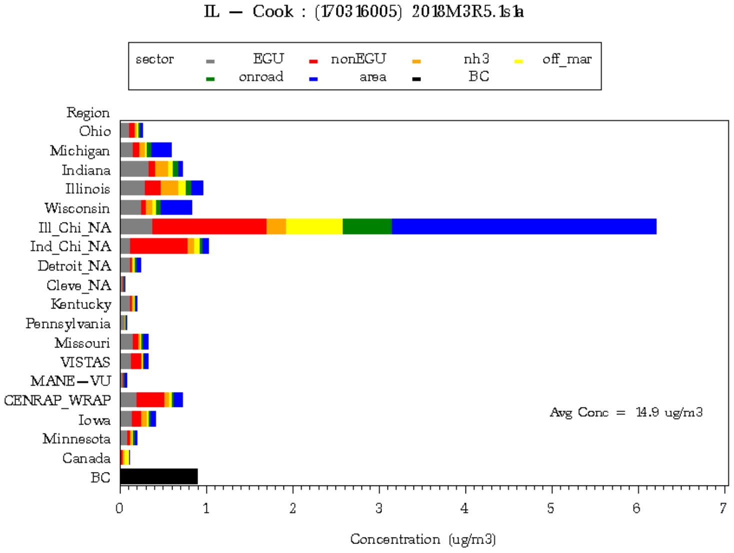
2012 (Round 4)





2018 (Round 5)

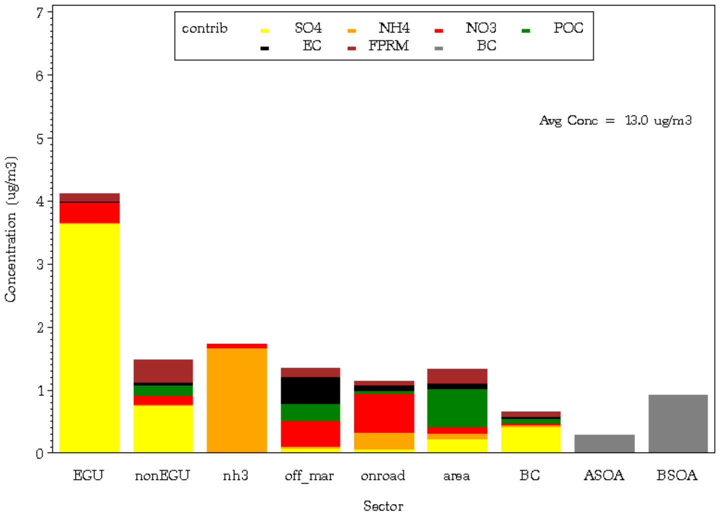




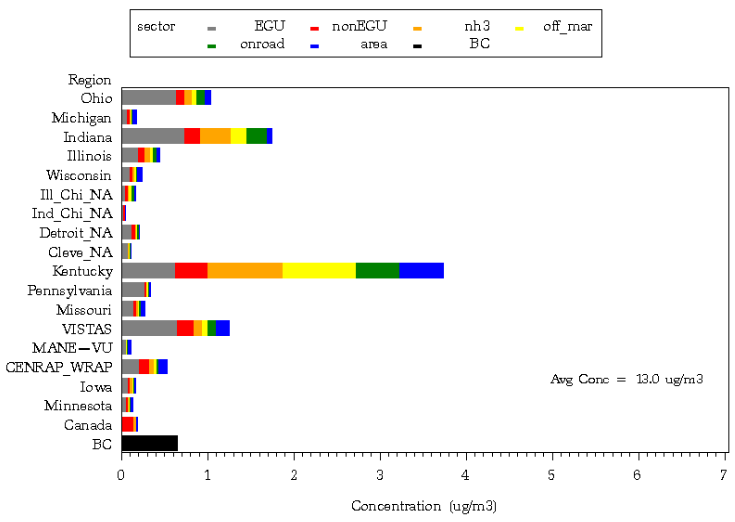
Clark County, Indiana

2005 (Round 5)

IN — Clark : (180190005) baseM3

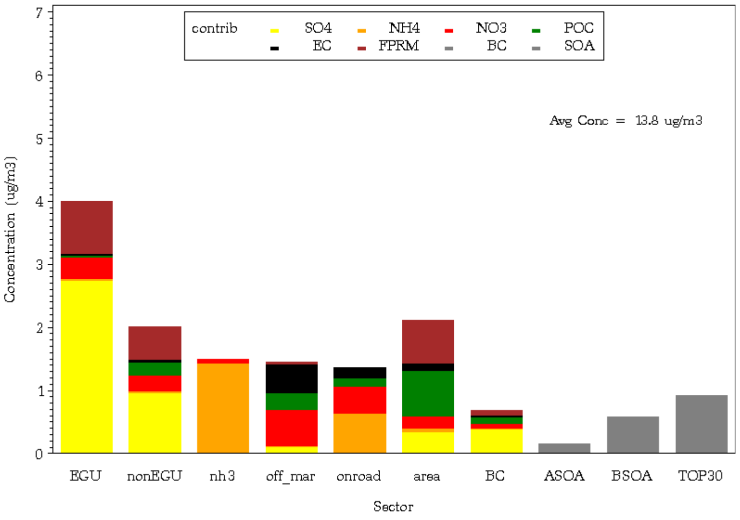


IN — Clark : (180190005) baseM3

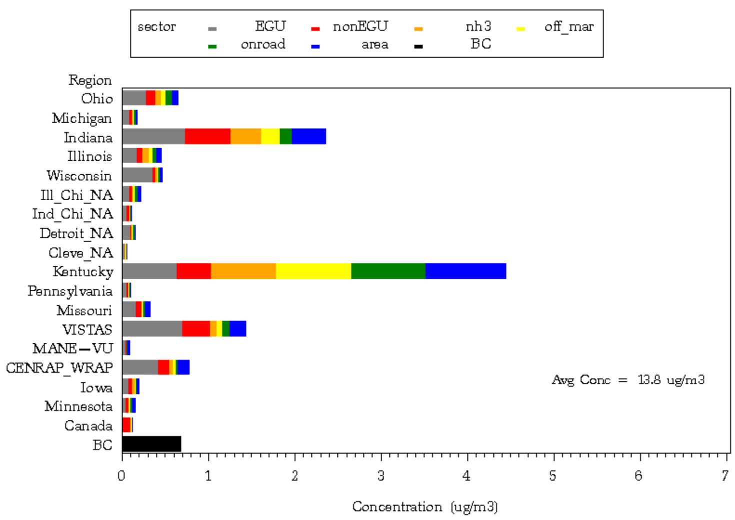


2012 (Round 4)

IN — Clark : (180190005) K2012R4S1a

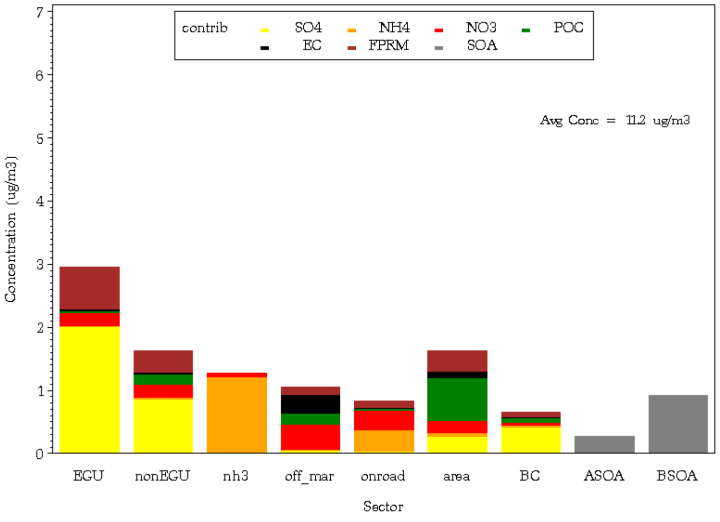


IN — Clark : (180190005) K2012R4S1a

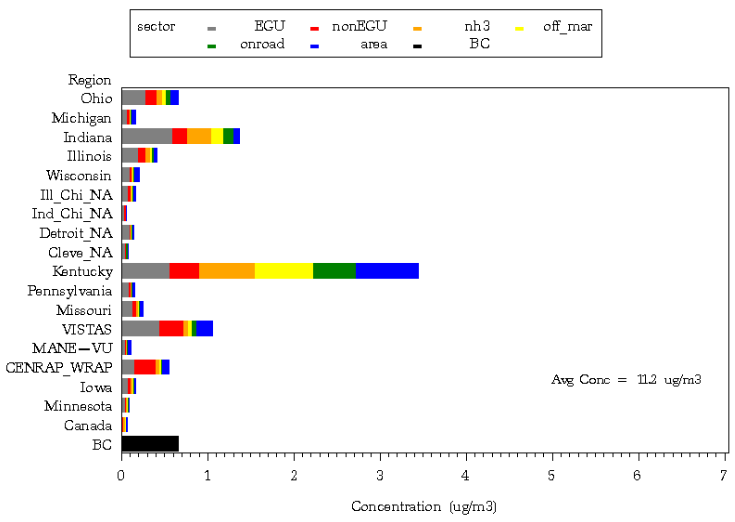


2018 (Round 5)

IN — Clark : (180190005) 2018M3R5.1s1a

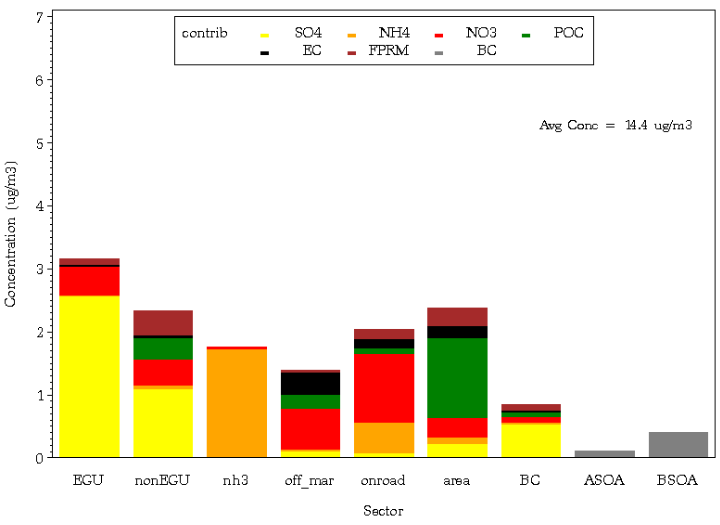


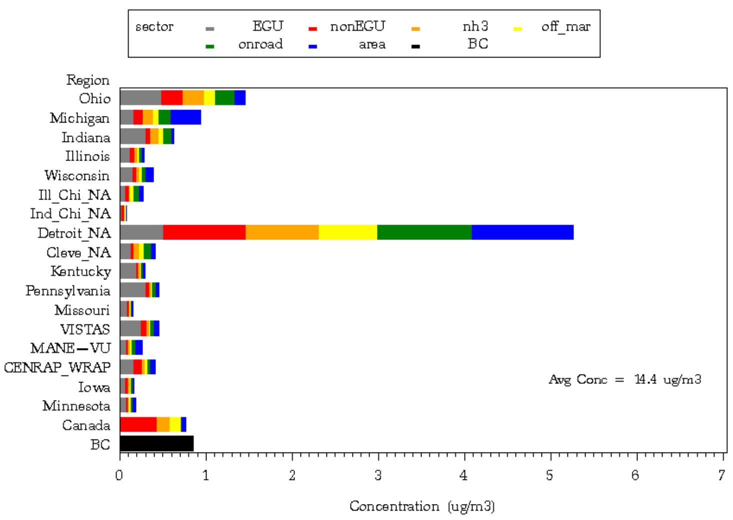
IN — Clark : (180190005) 2018M3R5.1s1a



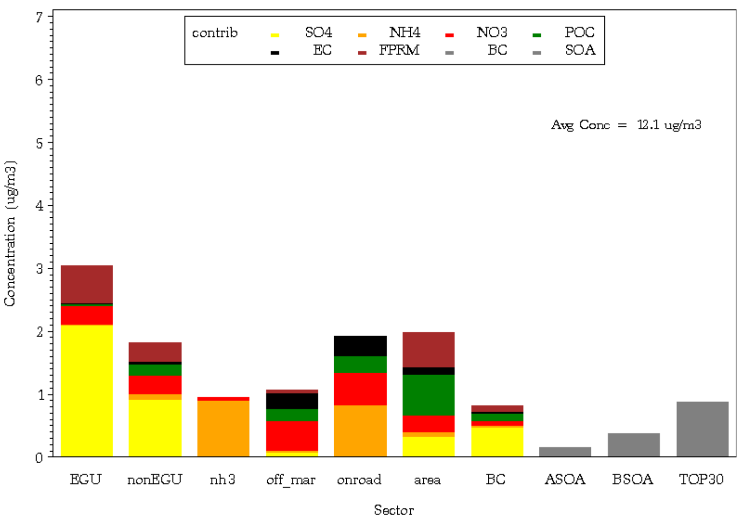
Dearborn, Michigan

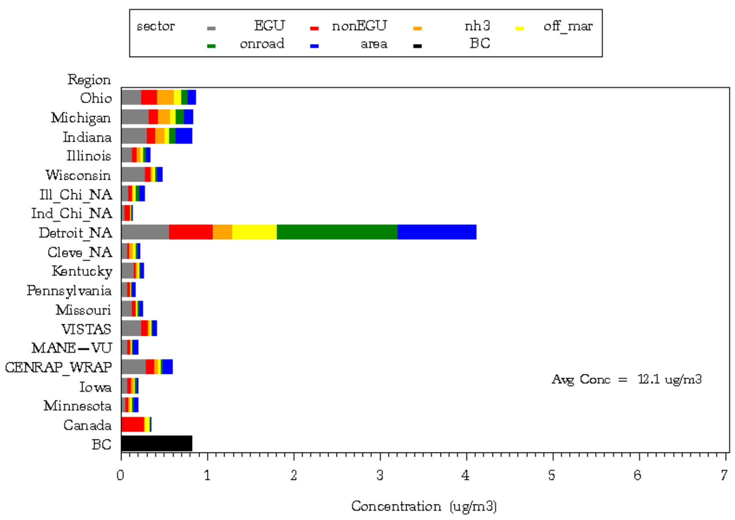
2005 (Round 5)


MI — Wayne : (261630033) baseM3


MI — Wayne : (261630033) baseM3

2012 (Round 4)


MI — Wayne : (261630033) K2012R4S1a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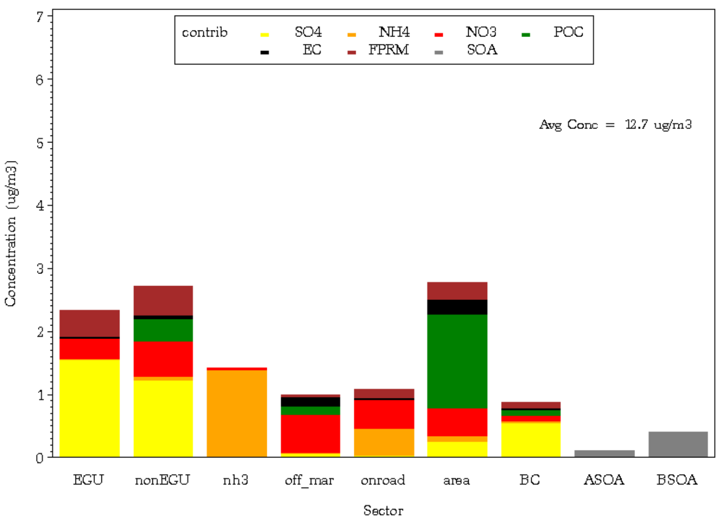
2018 (Round 5)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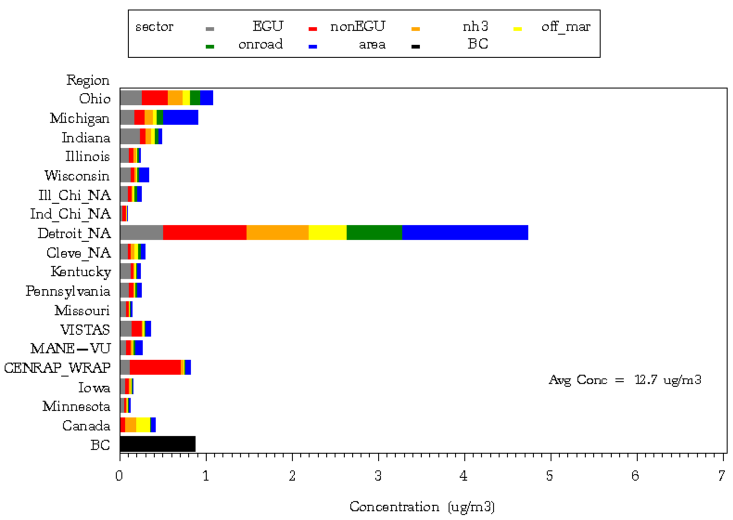
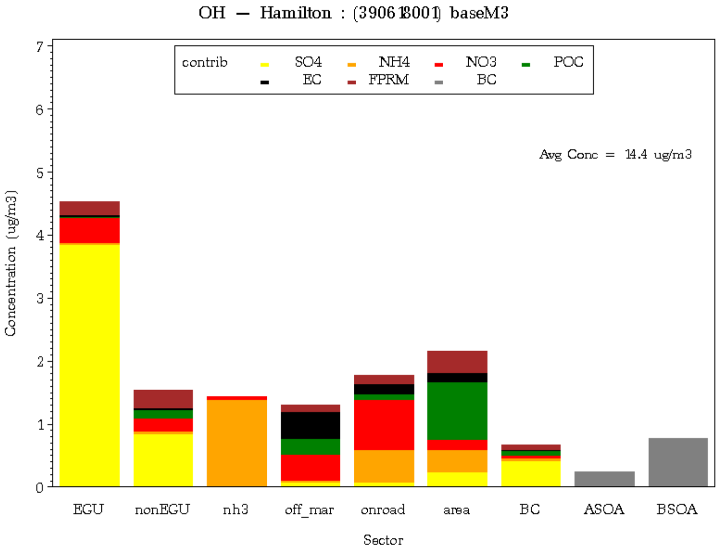
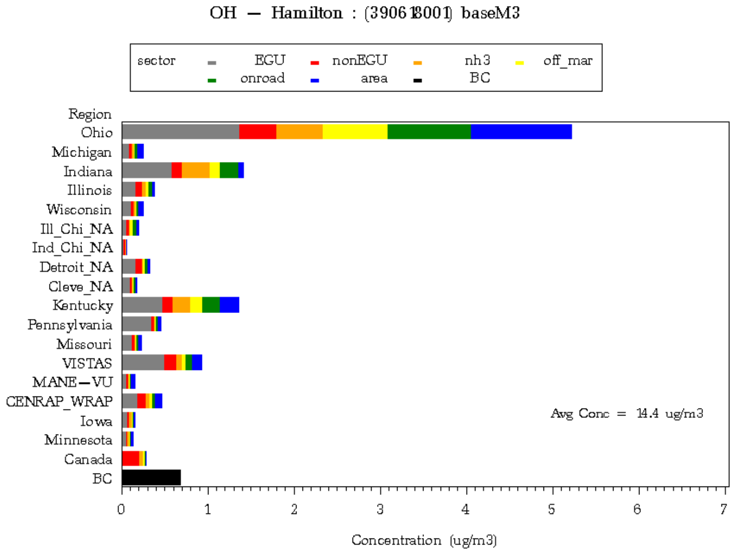

MI — Wayne : (261630033) 2018M3R5.1s1a

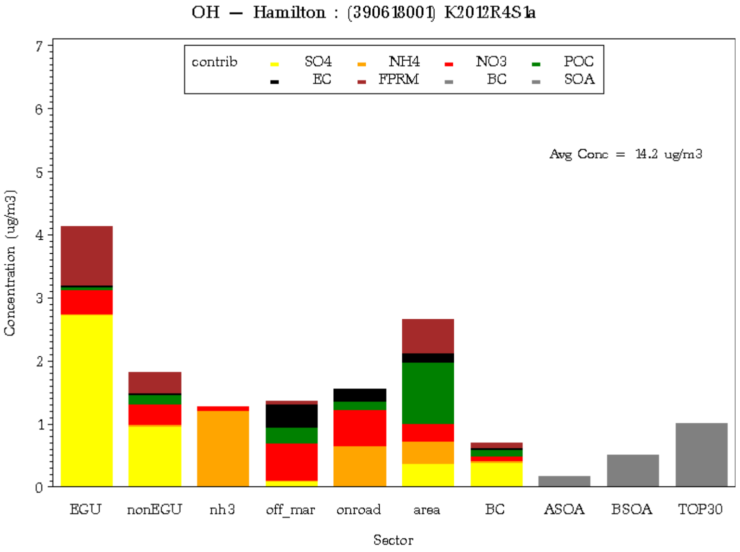
Cincinnati, Ohio

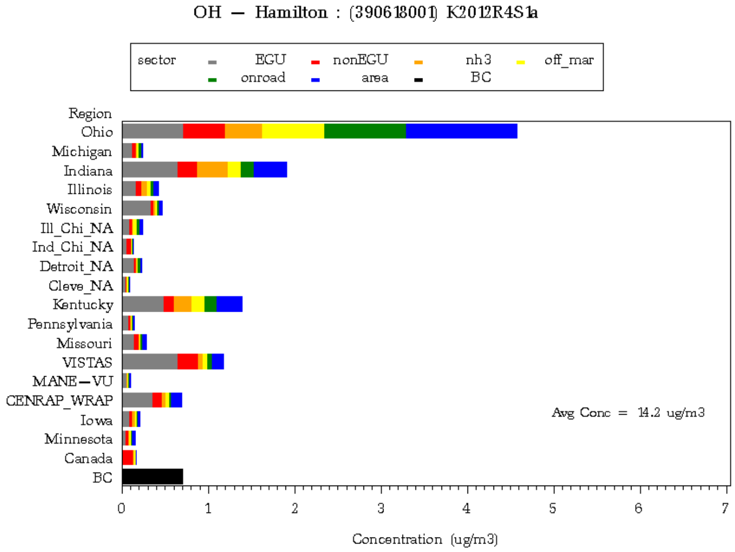
2005 (Round 5)





2012 (Round 4)





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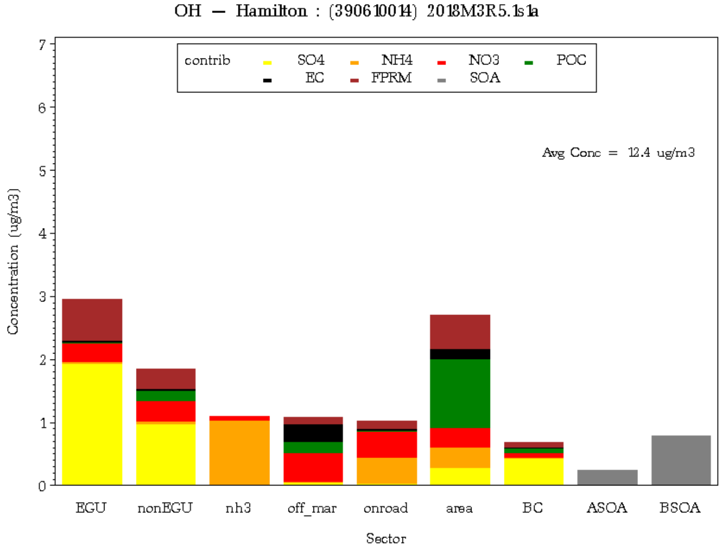
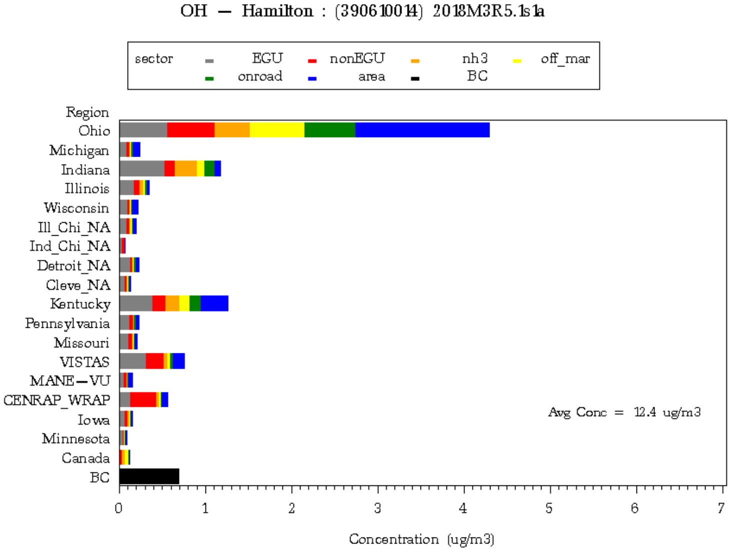
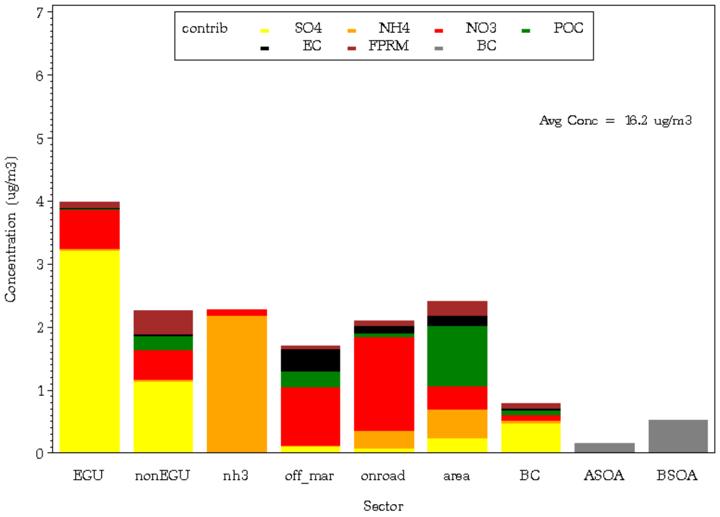




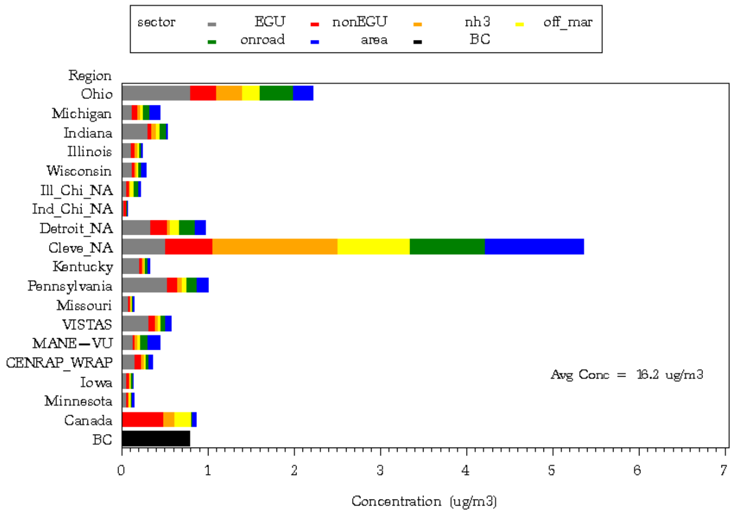
Cleveland, Ohio

2005 (Round 5)

OH — Cuyahoga : (390350038) baseM3

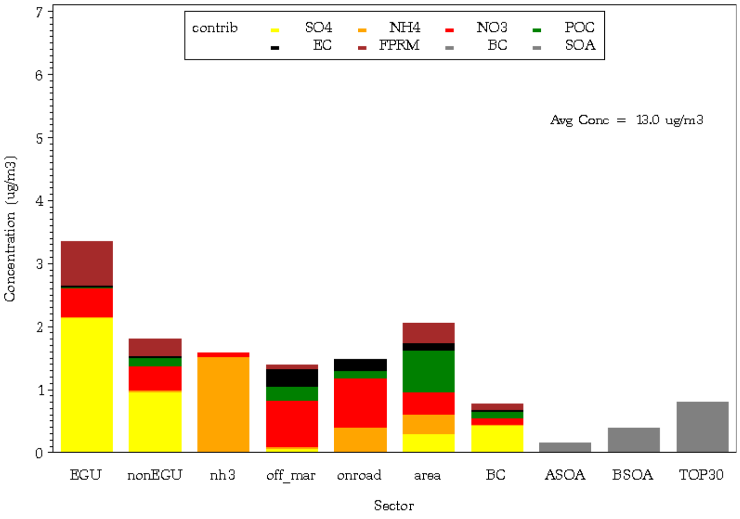


OH — Cuyahoga : (390350038) baseM3



2012 (Round 4)

OH — Cuyahoga : (390350038) K2012R4S1a



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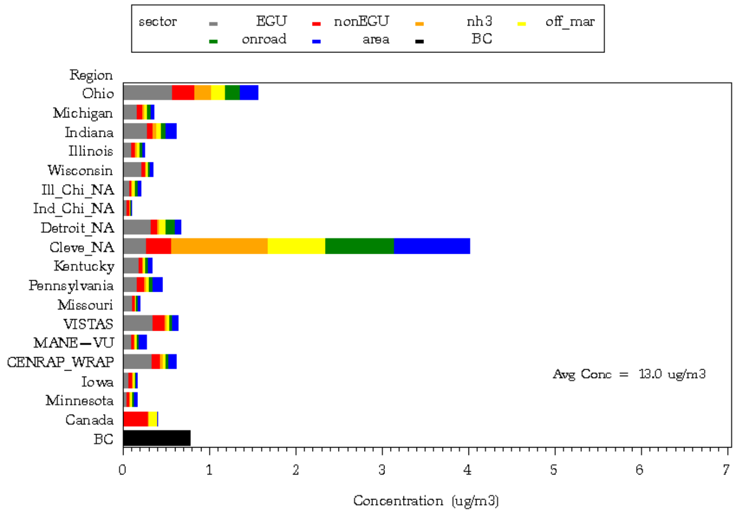
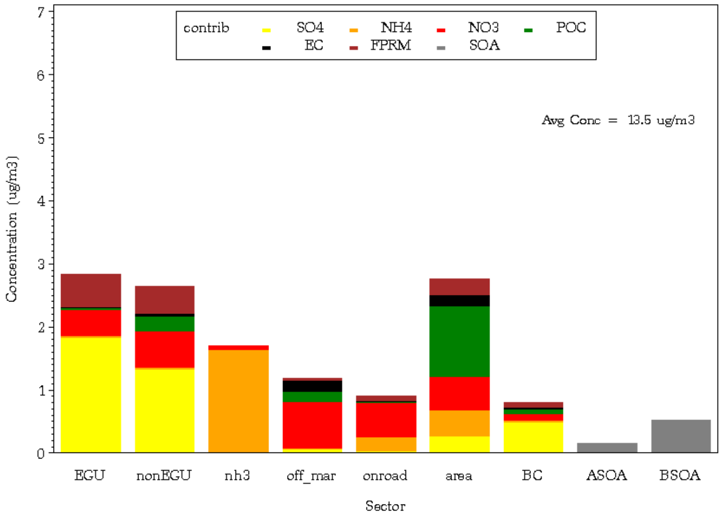


2018 (Round 5)

OH — Cuyahoga : (390350038) 2018M3R5.1s1a



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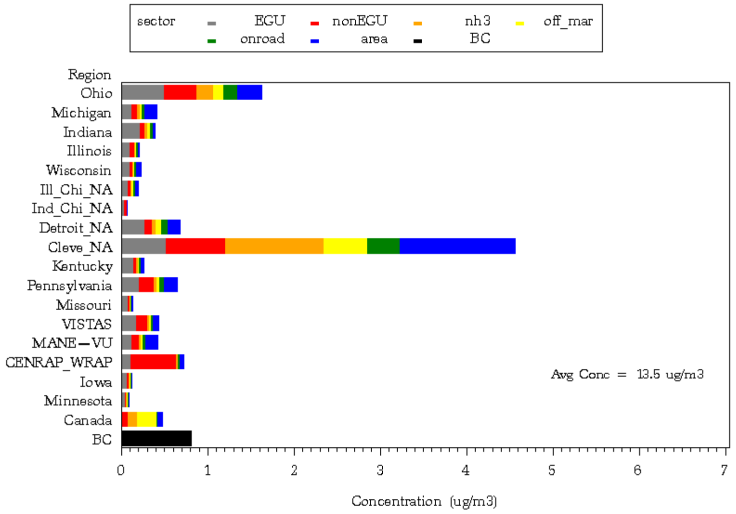
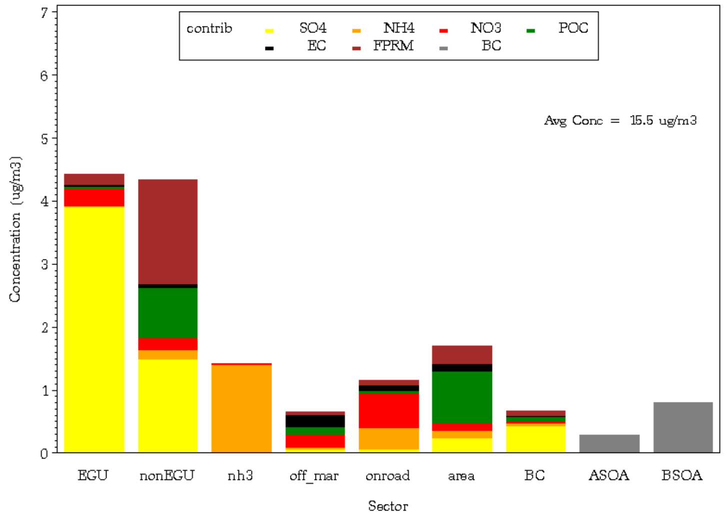
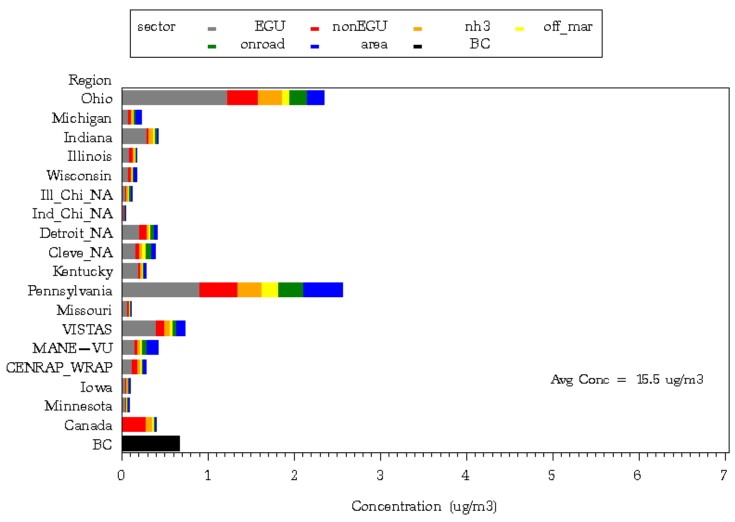


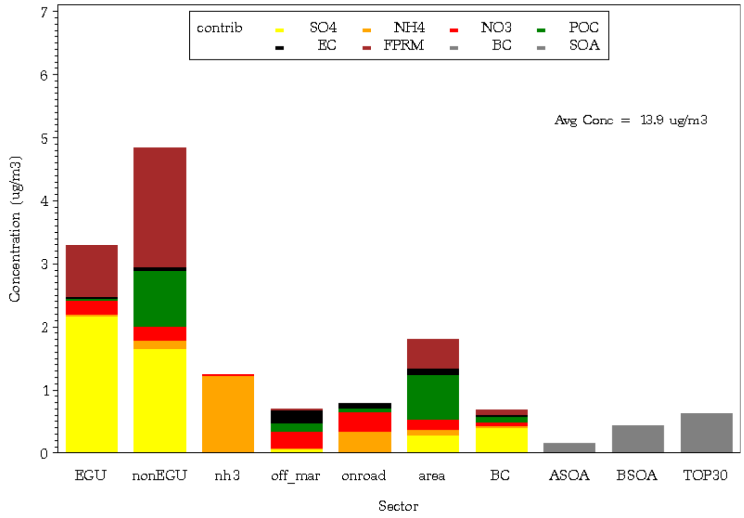
Steubenville, Ohio

2005 (Round 5)


OH — Jefferson : (390810016) baseM3


OH — Jefferson : (390810016) baseM3

2012 (Round 4)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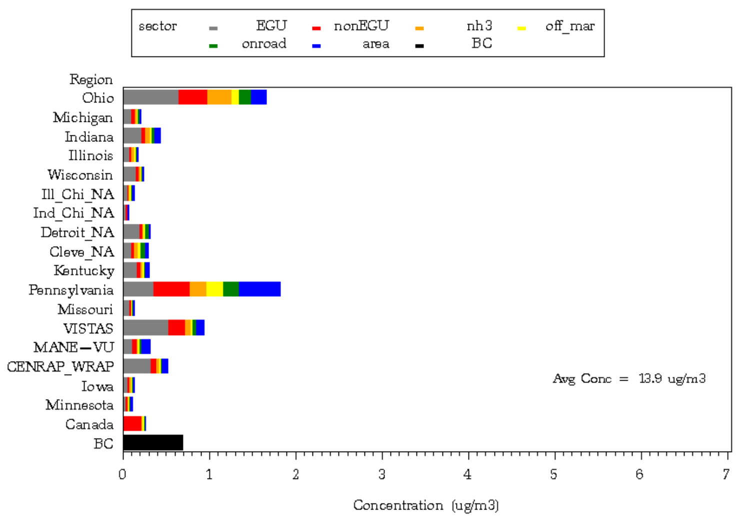
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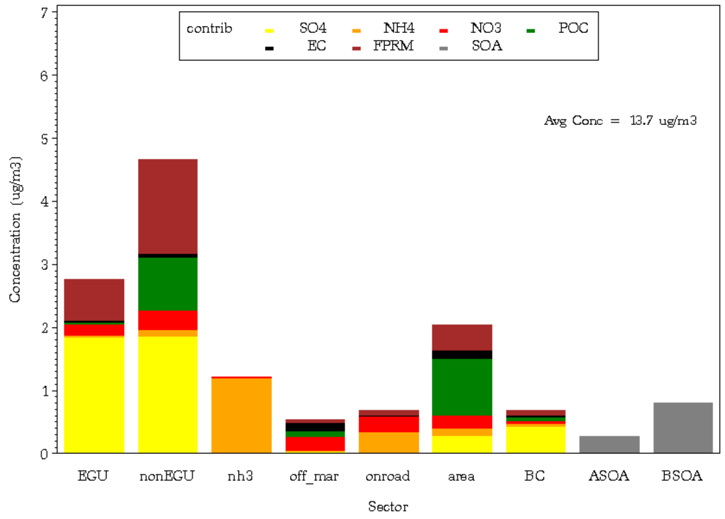
2018 (Round 5)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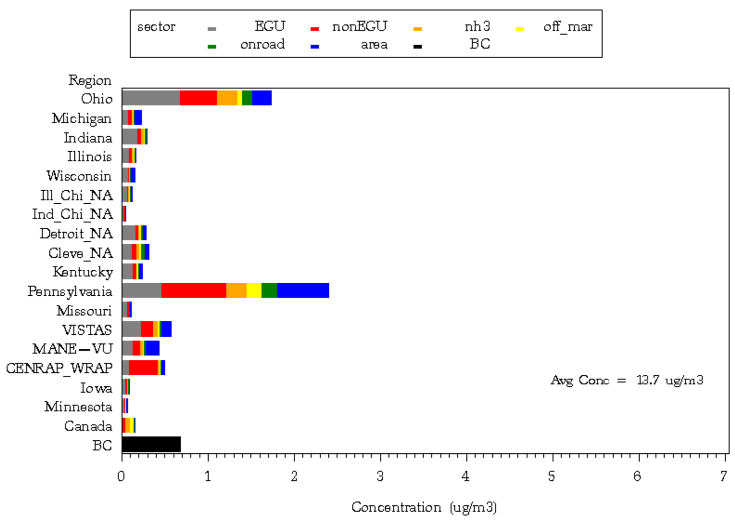
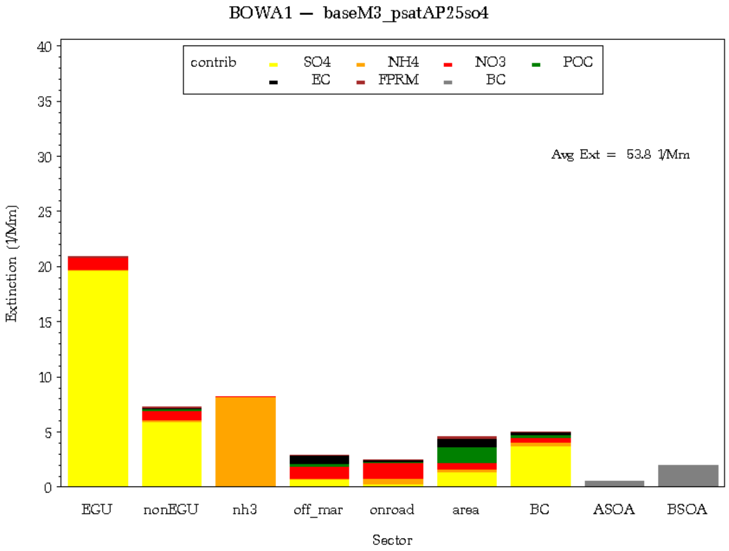

OH — Jefferson : (390810016) 2018M3R5.1s1a

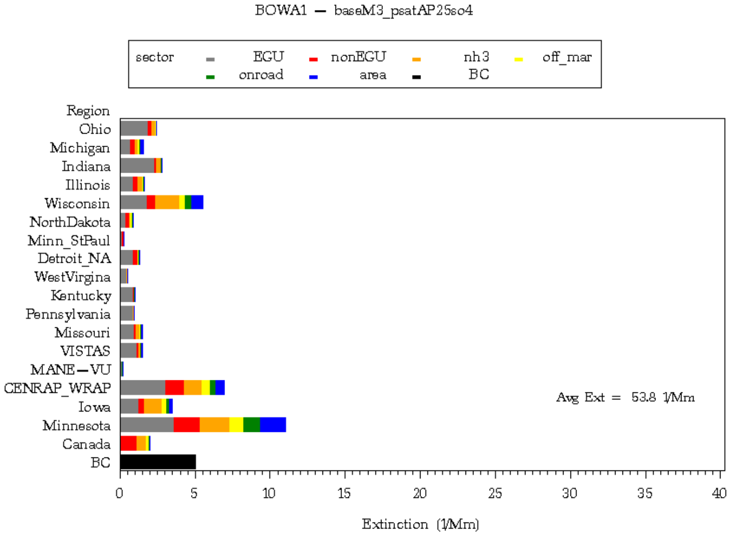
APPENDIX IV

Haze Source Apportionment Modeling Results

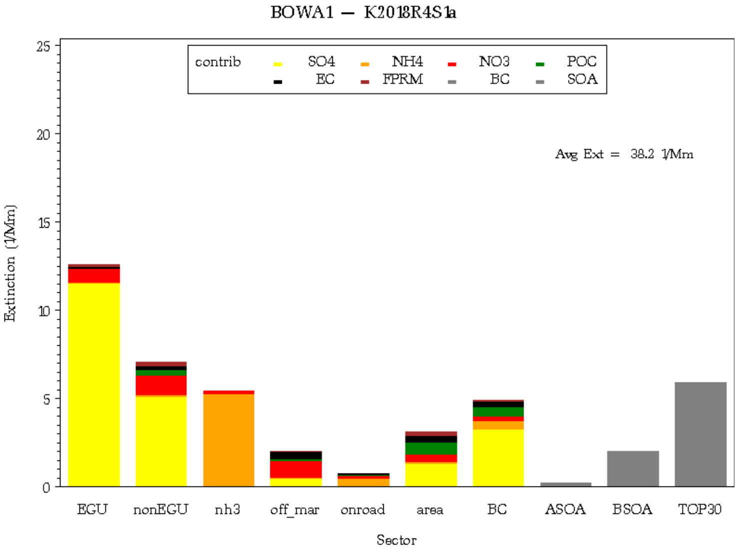
Boundary Waters, Minnesota

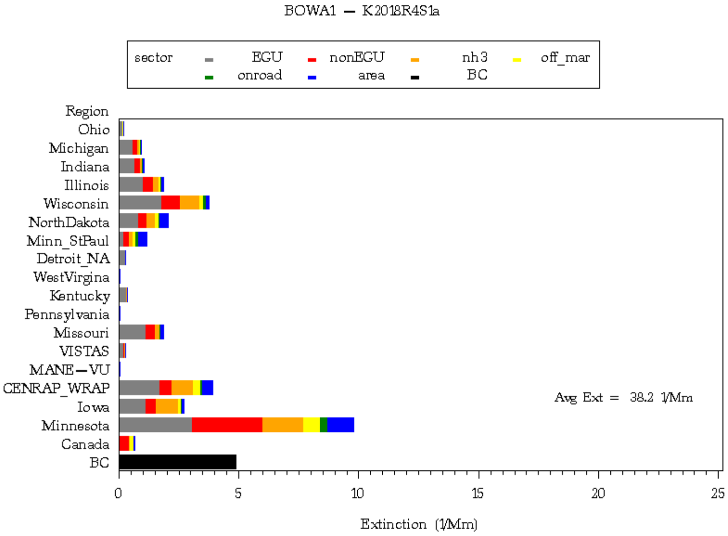
2005 (Round 5)



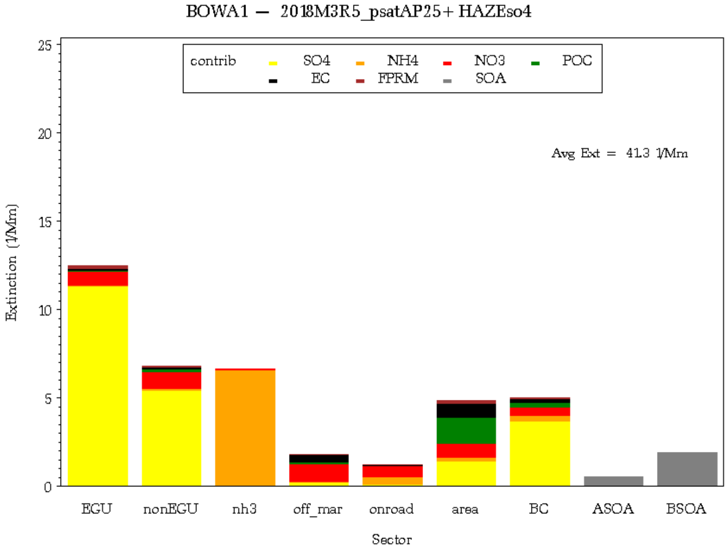


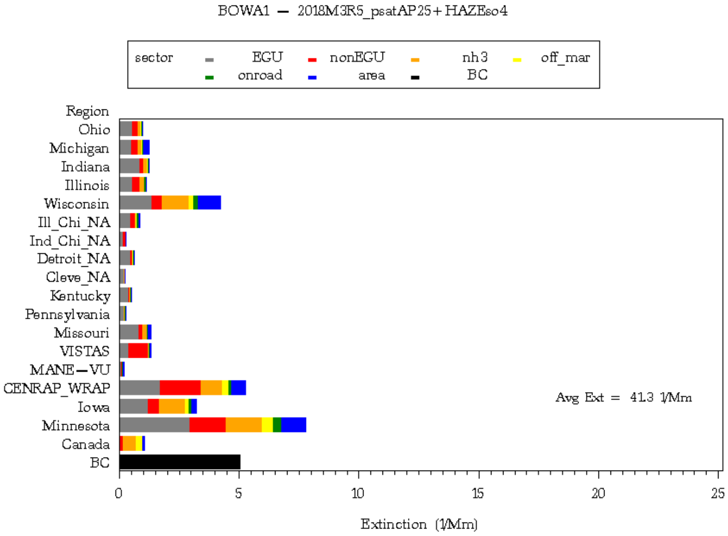
2018 (Round 4)





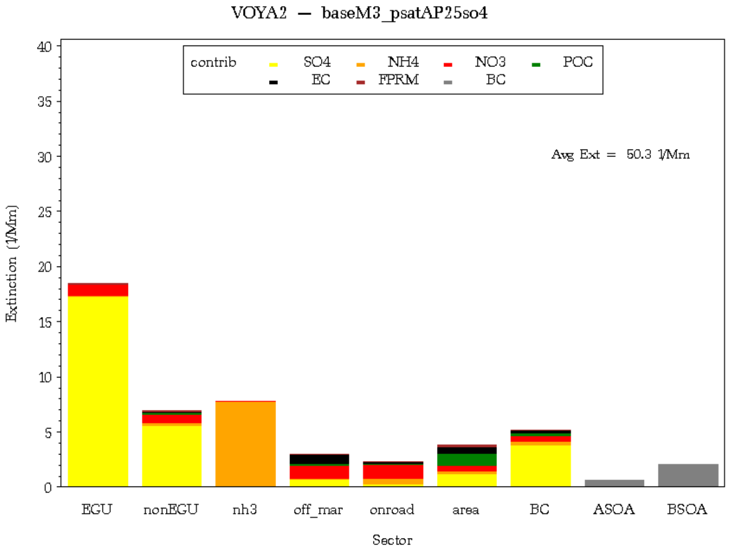
2018 (Round 5)

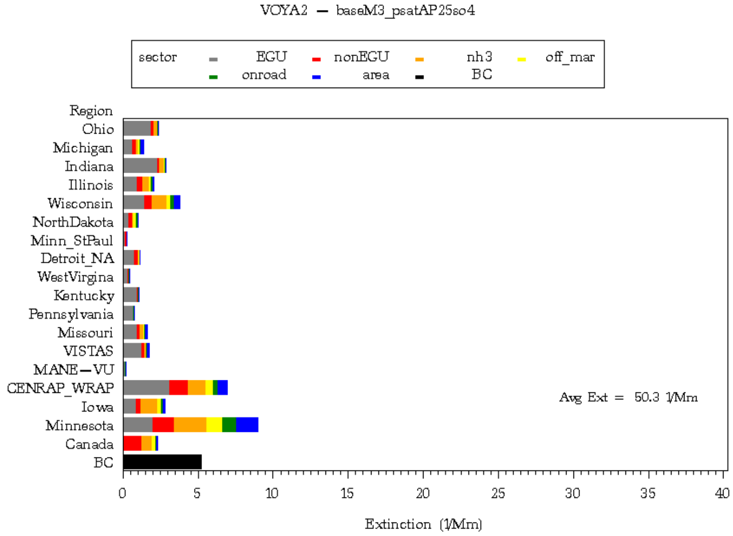




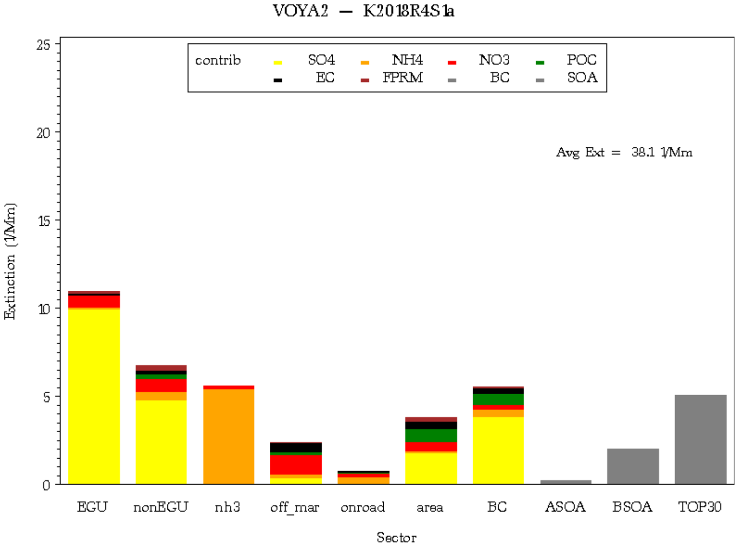
Voyageurs, Minnesota

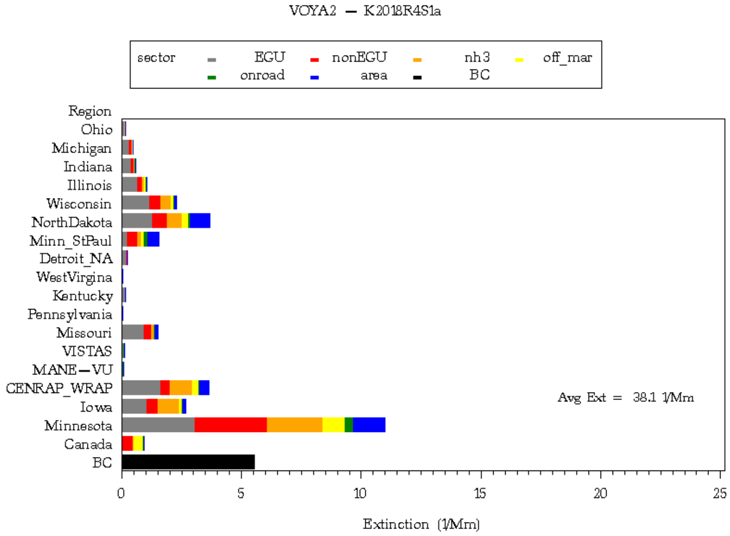
2005 (Round 5)



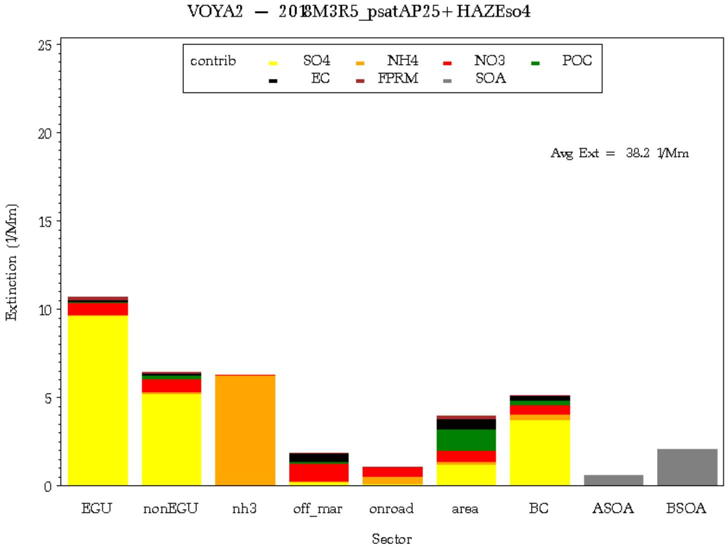


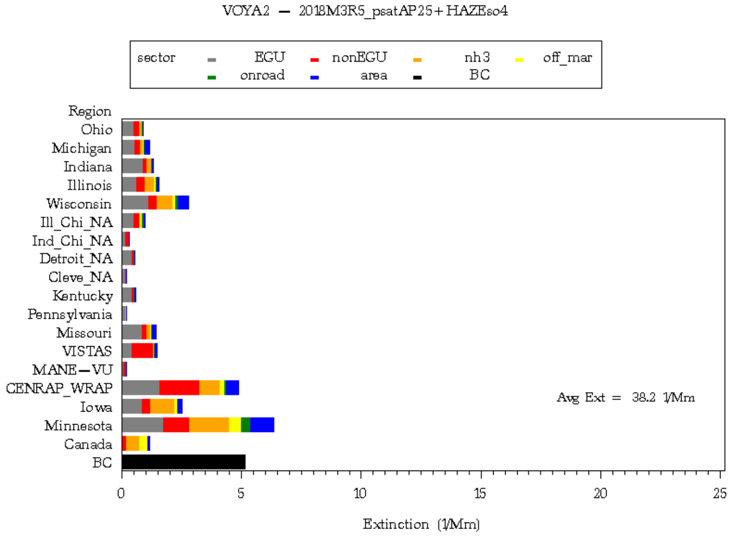
2018 (Round 4)





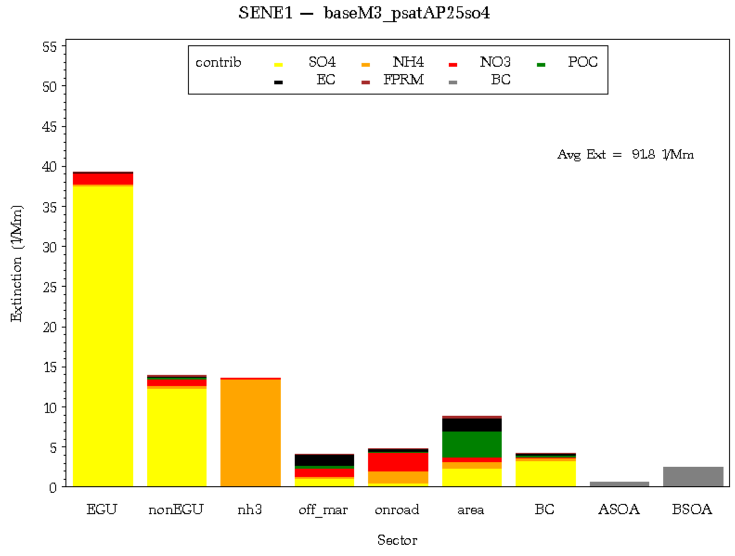
2018 (Round 5)

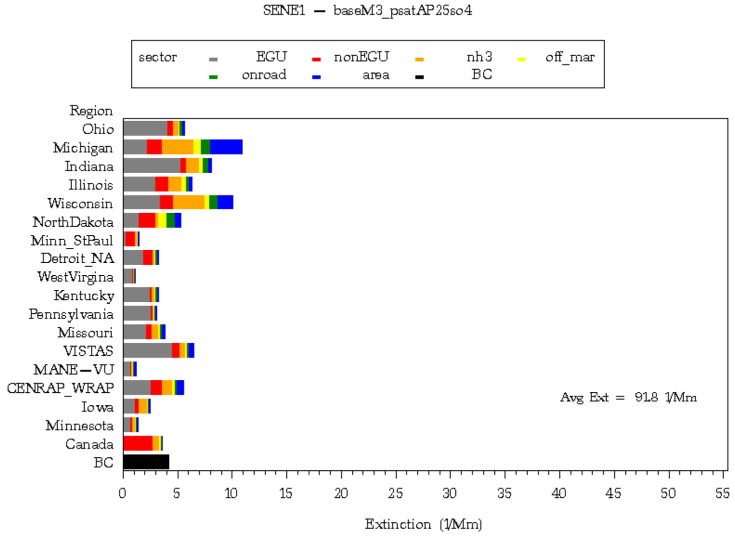




Seney, Michigan

2005 (Round 5)





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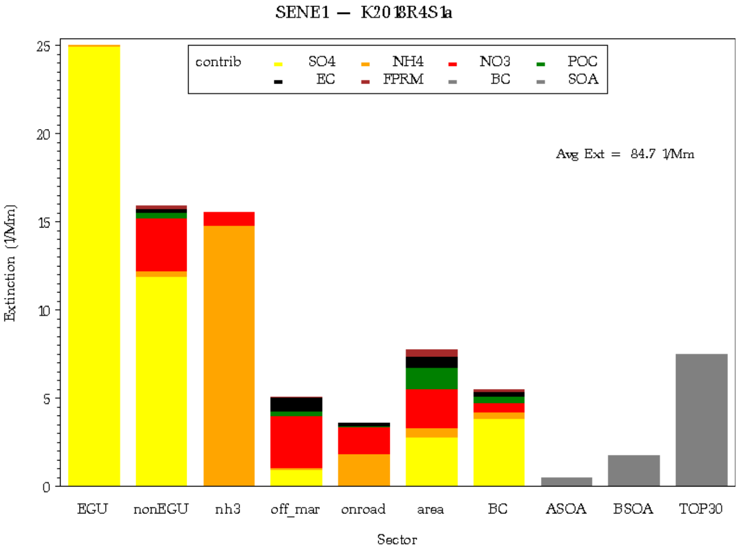

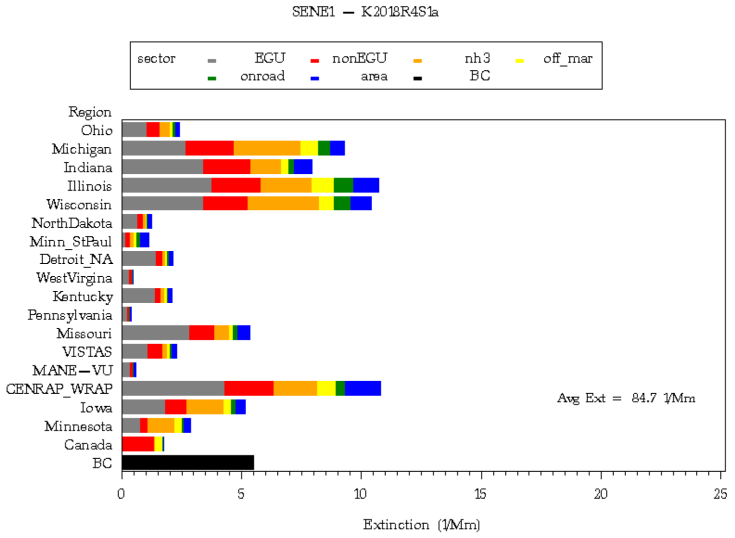

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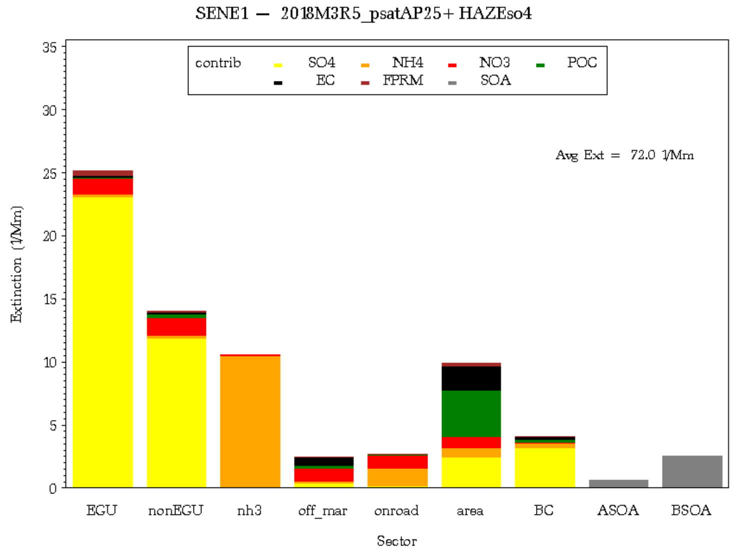
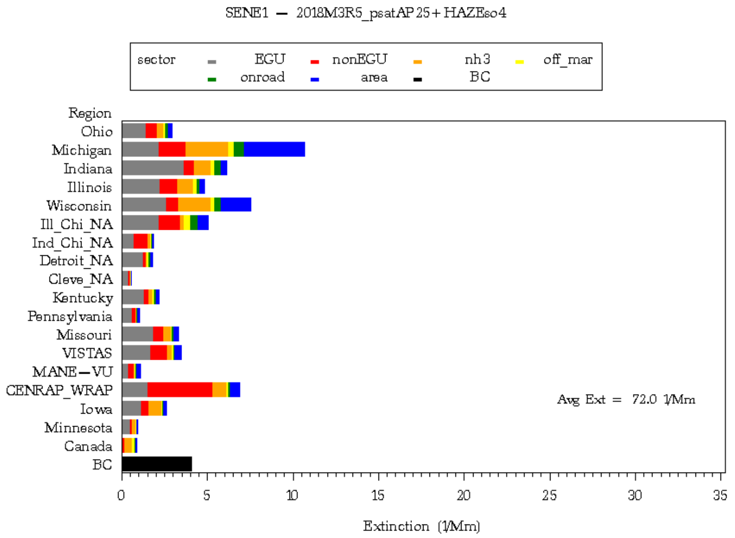
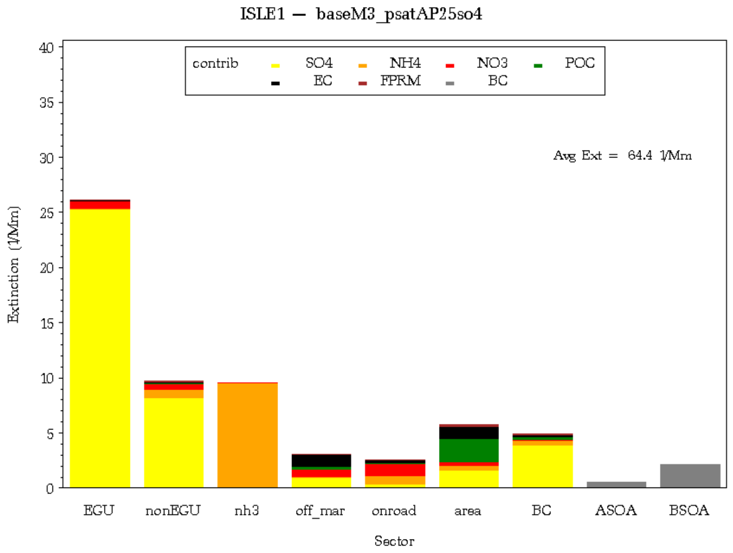
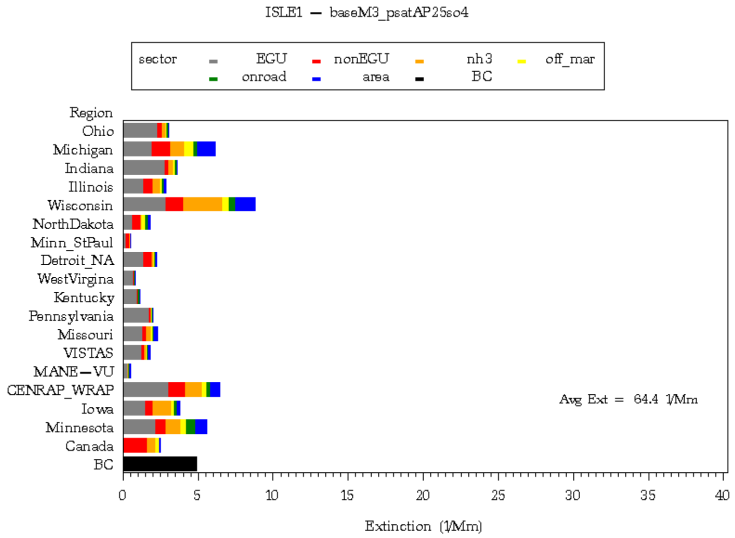




Isle Royale, Michigan

2005 (Round 5)





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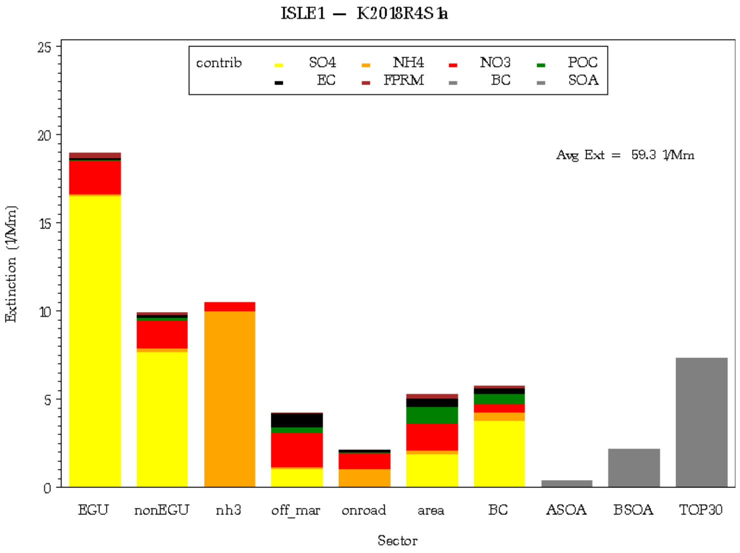

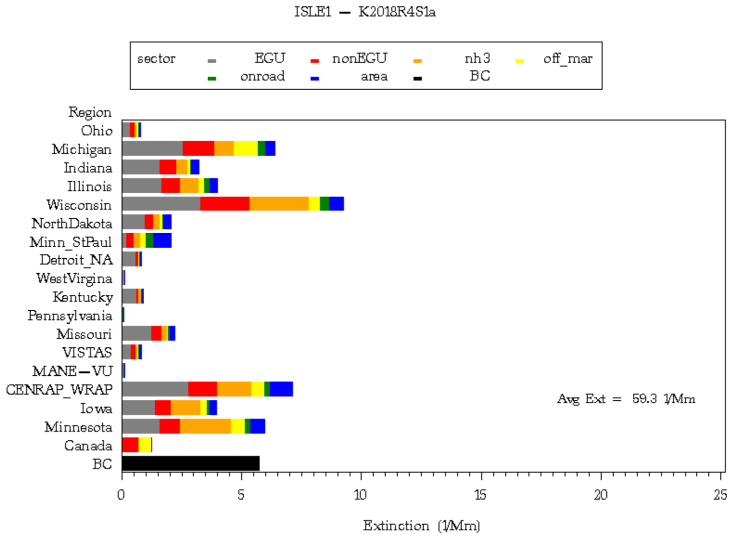

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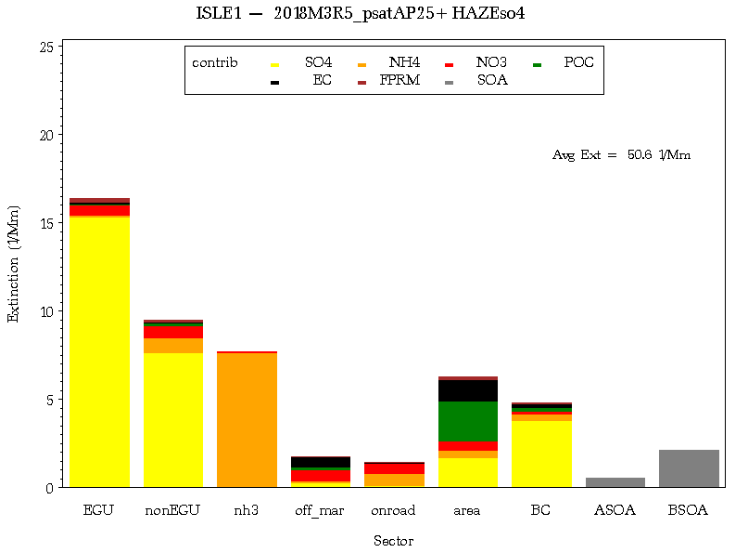
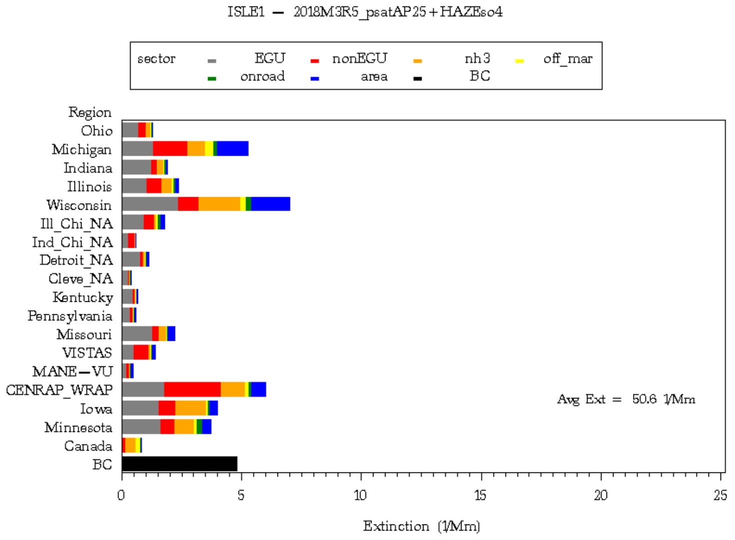
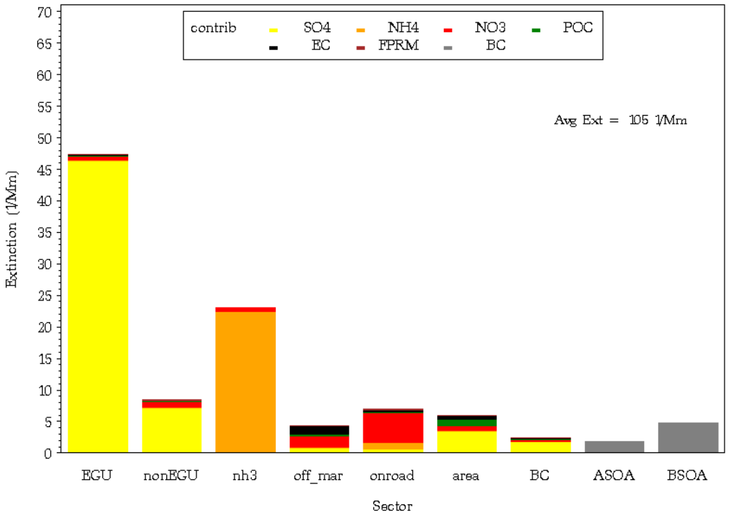




Shenandoah, Virginia

2005 (Round 5)

SHEN1 — baseM3_psatAP25so4



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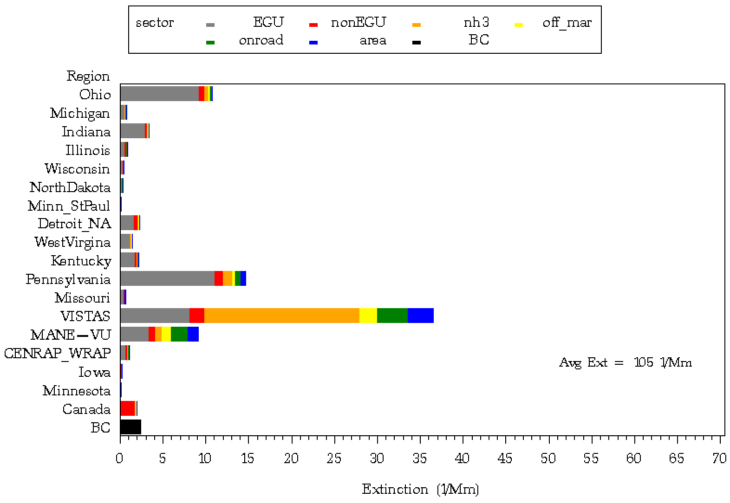
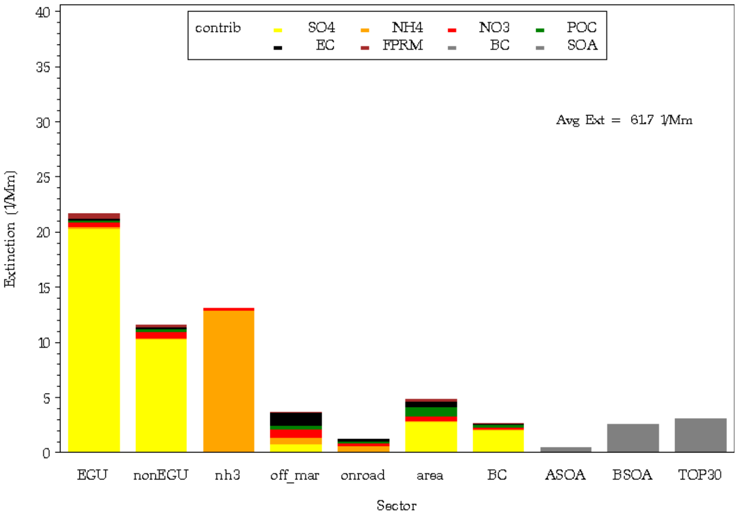
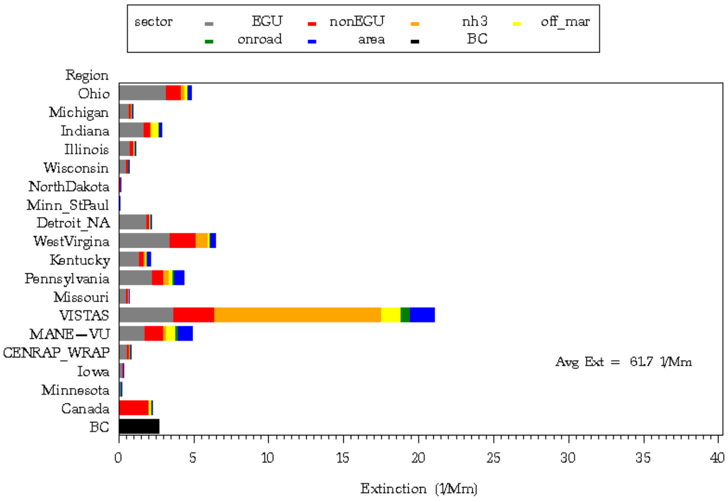


2018 (Round 4)

SHEN1 — K2018R4S1a

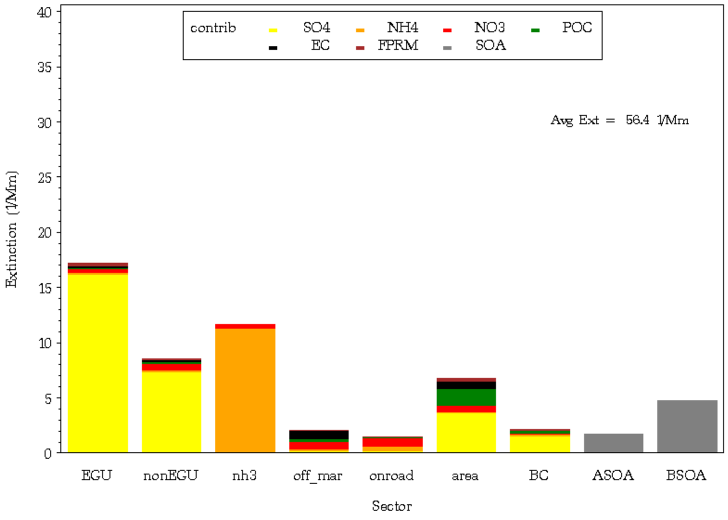


SHEN1 — K2018R4S1a

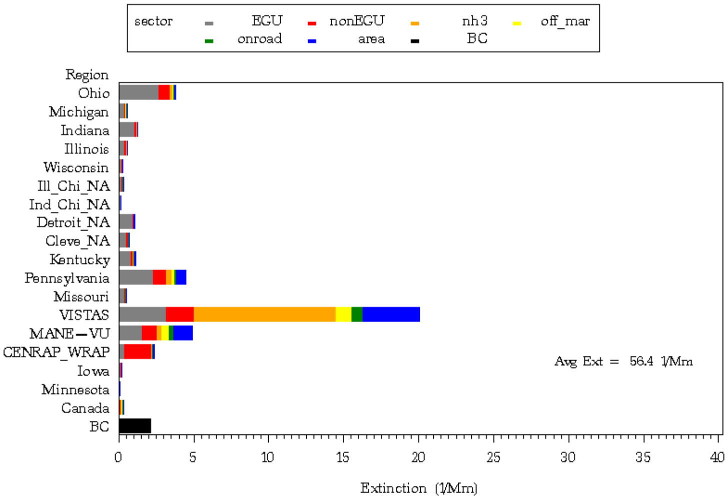


2018 (Round 5)

SHEN1 — 2018M3R5_psatAP25+HAZEso4

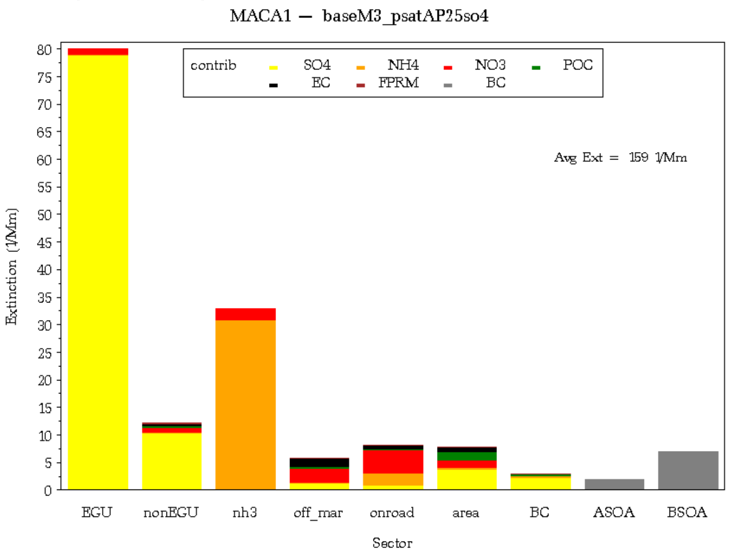


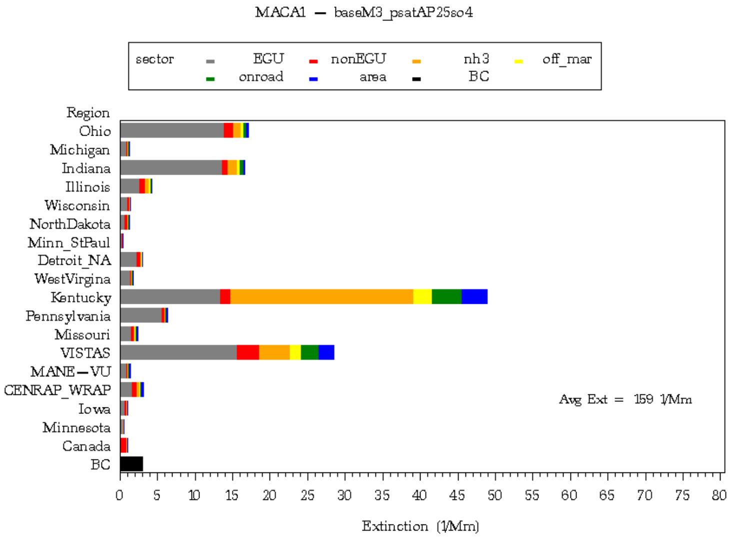
SHEN1 — 2018M3R5_psatAP25+HAZEso4



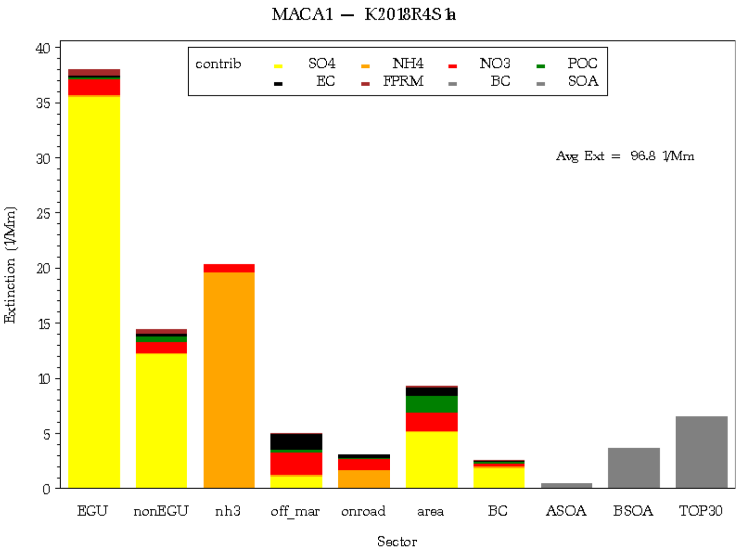
Mammoth Cave, Kentucky

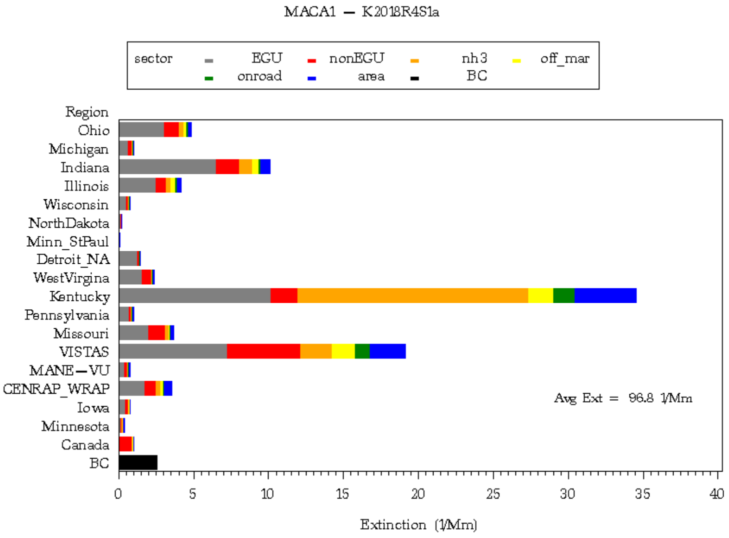
2005 (Round 5)



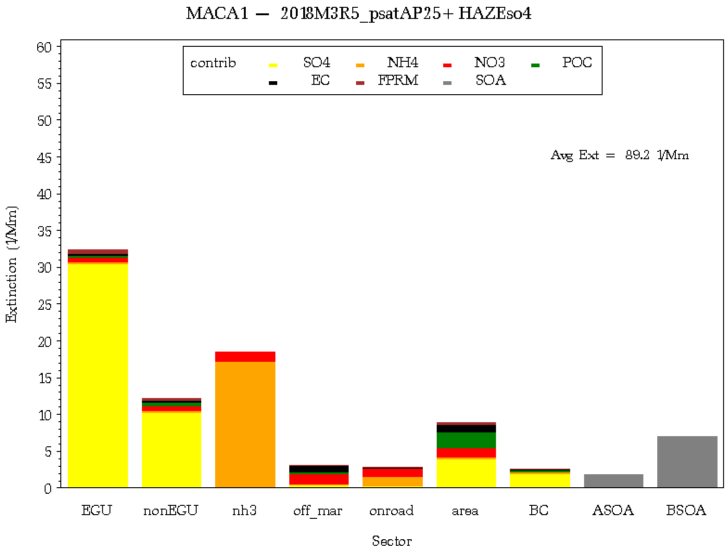


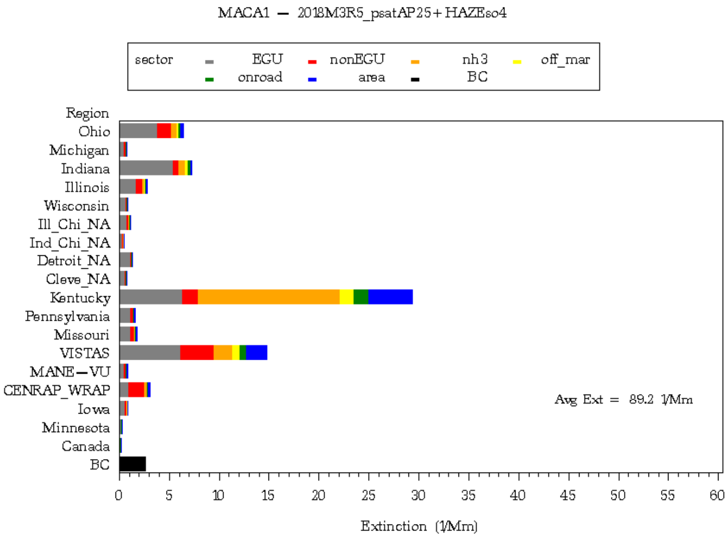
2018 (Round 4)





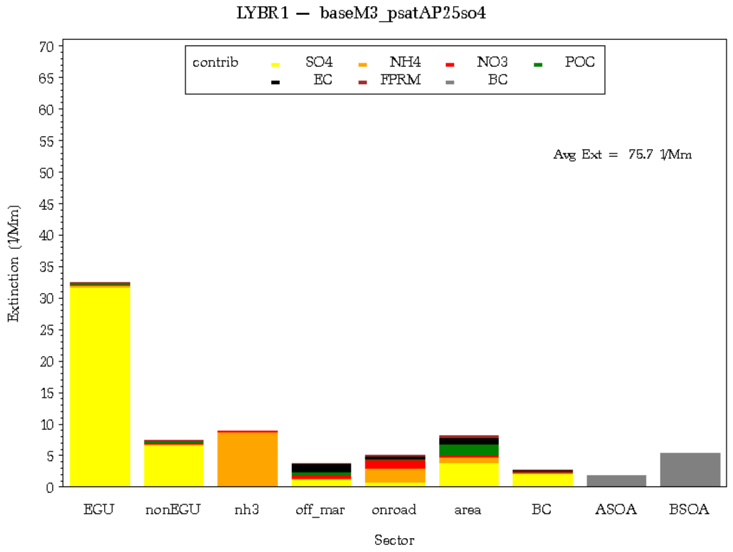
2018 (Round 5)

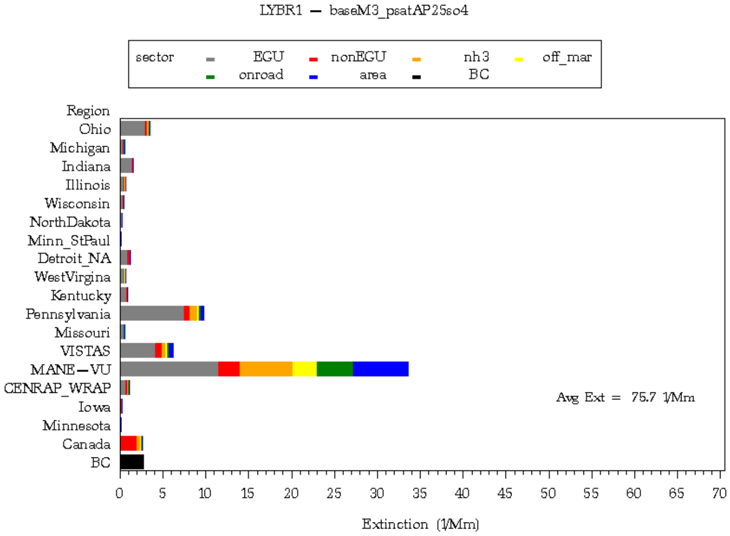




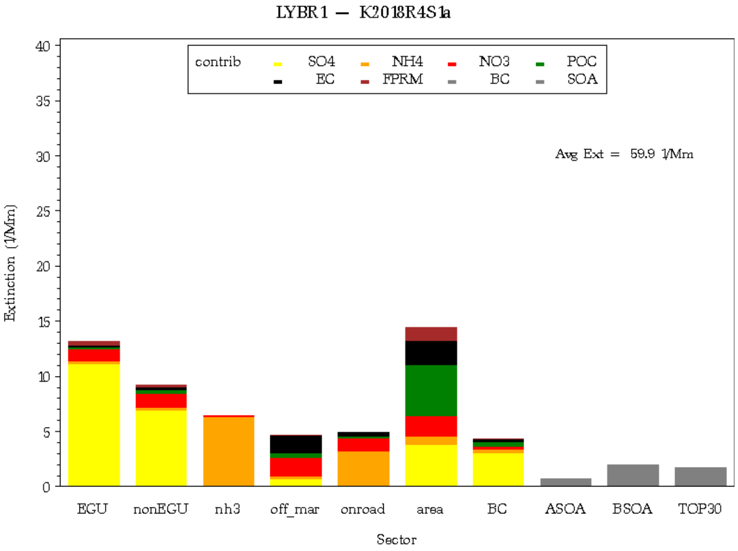
Lye Brook, Vermont

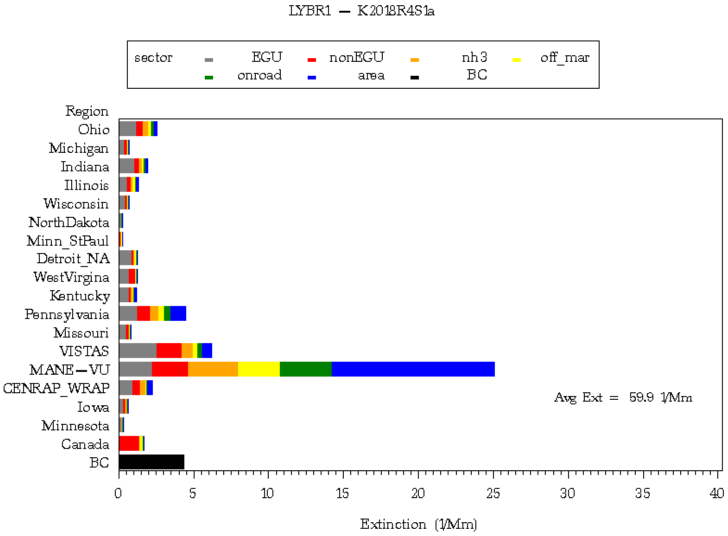
2005 (Round 5)



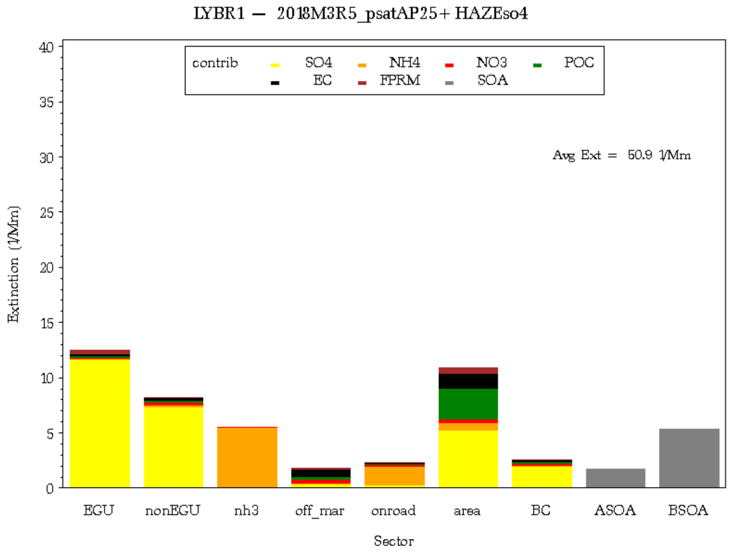


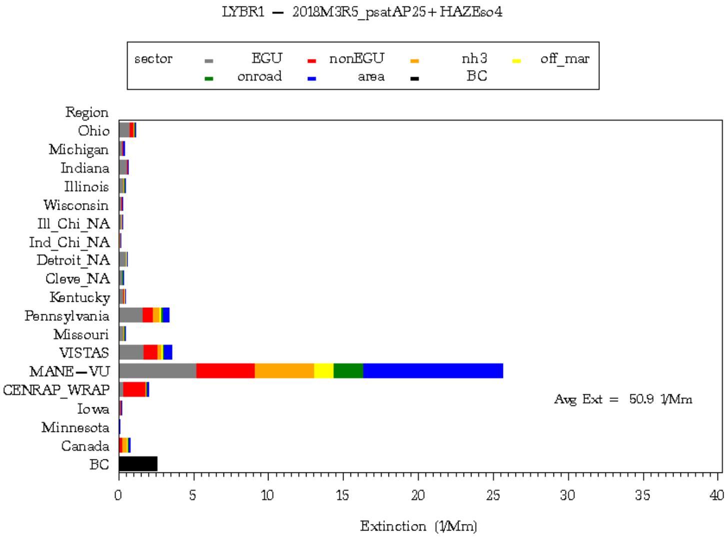
2018 (Round 4)





2018 (Round 5)





Appendix D-2

Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Final Technical Support Document (Supplement)

September 12, 2008

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Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Final Technical Support Document (Supplement), September 12, 2008

The purpose of this paper is to summarize a new modeling analysis performed by the Lake Michigan Air Directors Consortium (LADCO) to address the effect of the recent court decision vacating EPA's Clean Air Interstate Rule (CAIR). This new modeling is intended to supplement the LADCO Technical Support Document ("Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Final Technical Support Document", April 25, 2008), which summarizes the air quality analyses conducted by LADCO and its contractors to support the development of State Implementation Plans for ozone, PM2.5, and regional haze in the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin.

Compared to the previous LADCO modeling (Round 5.1), the new modeling shows similar results for ozone, but much more nonattainment for PM2.5 and higher visibility levels for regional haze. Specifically, the new modeling shows:

> **Ozone:** Attainment of the 0.08 ppm standard by 2009 everywhere in the region, except Holland, MI, and nonattainment of the 0.075 ppm standard through at least 2018.
>
> **PM2.5**: Widespread nonattainment of annual (15 ug/m^3) and daily (35 ug/m^3) standards.
>
> **Haze:** Higher visibility levels on the 20% worst visibility days in 2018 in Class I areas in the eastern U.S., resulting in most areas being above the glide path.

Background: On July 11, 2008, the U.S. Court of Appeals for D.C. Circuit vacated EPA's CAIR rule (cite). The reductions in NOx and SO2 emissions associated with this rule were a key part of the LADCO States' attainment demonstrations for ozone and PM2.5 and the reasonable progress determinations for regional haze. LADCO's previous modeling (Round 5.1) relied on EGU emission projections from EPA's IPM3.0 analysis, which assumed implementation of Phases I and II of CAIR. For this new modeling, alternative EGU emission projections were developed, which did not rely on CAIR (or IPM).

Model Set-Up: The new modeling was performed consistent with LADCO's previous modeling (Round 5.1):

Model Version: CAMx v4.50beta_deposition
Future Years: 2009, 2012, 2018
Runs: (a) Ozone: Summer 2005 meteorology with 12 km grids
(b) PM2.5 and haze: Full year 2005 meteorology with 36 km grids

Emission Scenarios: The new modeling assumed the same set of "on the books" controls as in LADCO's previous modeling (Round 5.1) for all sectors, except EGUs. In light of the CAIR decision, three new EGU scenarios were prepared:

> Scenario A: 2007 CEM-based emissions were projected for all states in the modeling domain based on EIA growth rates by state (NERC region) and fuel type. The assumed growth rates for the Midwest States were: MAIN (IL, IA, MO, WI): 8.8% (2007-2018); ECAR (IN, KY, MI, OH): 13.5% (2007-2018); and MAPP (MN): 15.1% (2007-2018). No control was applied. The annual emissions were temporalized based on profiles derived from 2004-2006 CEM data. (Note, these are the same temporal profiles used in Round 5.1.)
>
> Scenario B. Scenario A emissions for the LADCO States and select neighboring states (e.g., MN, IA, MO, KY, TN, and WV) were adjusted by applying legally enforceable controls (i.e., emission reductions required by a Consent Decree, state rule, or permit). Only those legally enforceable controls identified (and justified) by the States were applied. The States also supplied the appropriate control factors. A table summarizing the Scenario B controls is provided in Appendix I.
>
> Scenario C. For the years 2009 and 2012, Scenario A emissions for all states were adjusted by applying all planned SO2 and NOx controls based on the July 10 CAMD list (i.e., 90% reduction for scrubbers, 95% reduction for SCRs). Because the July 10 CAMD list only includes controls generally out to 2011, additional SO2 and NOx controls for the year 2018 were assumed for all BART-eligible EGUs in the five LADCO State plus MN, IA, MO, KY, TN, and MO list (i.e., 90% reduction for scrubbers, 95% reduction for SCRs).[1] All Scenario B controls were included in Scenario C. A table summarizing the Scenario C controls is provided in Appendix II.

Table 1 and Figure 1 provide a summary of the 5-state regional NOx and SO2 emissions for each scenario and future year. (Note, the CAIR emissions included here are based on EPA's IPM3.0 modeling.) Several comments on the emissions should be noted:

Summer NOx

- There is llittle difference between the three alternative scenarios and CAIR. This suggests that summer ozone concentrations for the alternative scenarios are likely to be similar to those predicted with CAIR (i.e., Round 5.1).

Annual NOx:

- There is a significant change in emissions between scenarios, mostly during the non-summer months.
- Scenario B reflects application of NOx controls in several states (e.g., IL,OH,WI).
- Because there are relatively few SCRs (in the LADCO States) on the CAMD list, Scenario C results in only a small emissions decrease compared to Scenario B.
- Assumed BART controls result in a significant emissions decrease.

Annual SO2

- There is a significant change in emissions between scenarios.
- Scenario B reflects application of SO2 controls in several states (e.g., IL,OH,WI).
- Because there are several FGDs (in the LADCO States) on the CAMD list, Scenario C results in a large emissions decrease compared to Scenario B.
- Assumed BART controls result in a significant emissions decrease (i.e., even lower emissions than the IPM-estimated CAIR emissions).

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[1] A subsequent analysis was conducted with the following inventory changes: (a) 95% reduction for scrubbers, 90% redcuction for SCRs (consistent with EPA's default assumptions for IPM), and (b) revisions provided for a few plants in Indiana and Minnesota. The changes resulted in a relatively small difference in the regioinal NOx and SO2 emissions (e.g., about a 2% NOx increase and about a 1-2% decrease in SO2). To assess the impact of the changes, PM2.5 modleing was conducted with the new Scenario B and Scenario C emissions for 2012. The modeling showed little change in the predicted PM2.5 concentrations.

Figure 1. Regional NOx and SO2 Emissions

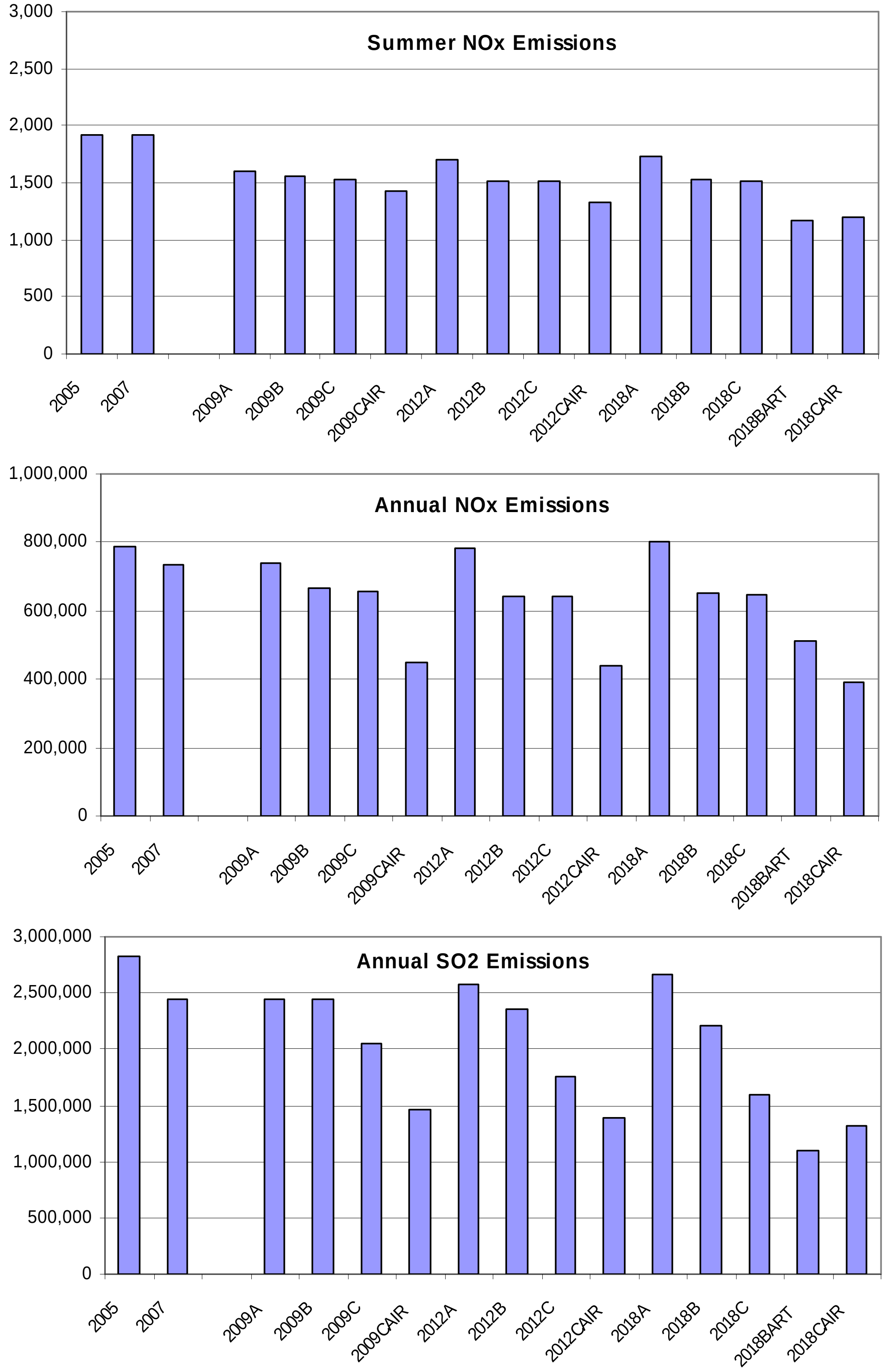


Table 1. Regional NOx and SO2 Emissions

Summer NOx Emissions (TPD)

	2005	2007		2009 A	2009 B	2009 C	2010 CAIR	2012 A	2012 B	2012 C	2012 CAIR	2018 A	2018 B	2018 C	2018 C-BART	2018 CAIR
IL	305	305		311	311	311	275	340	236	236	266	333	227	227	219	224
IN	393	393		376	376	374	384	393	393	390	368	410	386	383	292	264
MI	393	393		350	350	350	242	366	366	366	229	377	377	377	260	243
OH	408	408		395	355	335	285	423	351	351	290	431	366	366	230	290
WI	413	413		167	160	160	238	184	170	170	177	183	168	168	168	177
	1,912	**1,912**		**1,599**	**1,552**	**1,530**	**1,424**	**1,706**	**1,516**	**1,513**	**1,330**	**1,734**	**1,524**	**1,521**	**1,169**	**1,198**

Annual NOx Emissions (TPY)

	2005	2007		2009 A	2009 B	2009 C	2010 CAIR	2012 A	2012 B	2012 C	2012 CAIR	2018 A	2018 B	2018 C	2018 C-BART	2018 CAIR
IL	126,786	121,006		124,917	124,917	124,917	83,224	137,438	81,989	81,989	82,248	135,983	79,771	79,771	63,590	69,958
IN	214,727	203,493		203,776	203,776	201,947	133,188	212,790	212,790	210,877	125,541	221,950	212,805	210,810	177,027	90,415
MI	120,332	112,484		112,478	112,478	112,478	83,117	117,621	117,621	117,621	77,897	122,447	122,447	122,447	89,444	79,543
OH	255,554	240,351		240,016	173,071	164,911	94,346	251,065	172,514	172,514	97,679	261,644	179,737	179,737	125,762	95,678
WI	71,414	54,582		56,540	54,065	54,065	53,032	62,266	57,759	57,759	56,480	61,812	56,952	56,952	56,952	56,158
	788,812	**731,917**		**737,727**	**668,307**	**658,317**	**446,908**	**781,179**	**642,673**	**640,760**	**439,845**	**803,837**	**651,712**	**649,717**	**512,774**	**391,752**

Annual SO2 Emissions (TPY)

	2005	2007		2009 A	2009 B	2009 C	2010 CAIR	2012 A	2012 B	2012 C	2012 CAIR	2018 A	2018 B	2018 C	2018 C-BART	2018 CAIR
IL	326,598	273,467		281,028	281,028	281,028	295,516	309,209	196,238	194,746	267,110	305,364	106,638	105,152	82,351	275,716
IN	866,964	722,301		721,252	721,252	619,486	374,335	754,323	754,323	558,567	379,144	786,551	764,065	559,945	426,695	359,915
MI	350,694	343,487		343,140	343,140	315,326	227,296	358,879	358,879	301,062	233,204	373,964	373,964	313,677	178,680	242,853
OH	1,100,510	960,820		959,466	959,466	693,438	427,145	1,003,633	897,099	572,807	370,532	1,045,945	819,770	481,623	333,740	315,560
WI	181,426	137,562		142,007	142,007	133,738	139,181	156,659	144,818	133,592	139,203	155,818	144,027	132,849	77,214	127,073
	2,826,192	**2,437,638**		**2,446,892**	**2,446,892**	**2,043,017**	**1,463,473**	**2,582,703**	**2,351,356**	**1,760,775**	**1,389,192**	**2,667,641**	**2,208,463**	**1,593,245**	**1,098,679**	**1,321,116**

Modeling Results: Several tables summarizing the modeling results are provided:

Table 2 - future year ozone and PM2.5 concentrations for key monitors in the LADCO region

Table 3 - number of monitoring sites greater than the National Ambient Air Quality Standards (NNAQS)

Table 4 – visibility levels for Class I areas in the eastern U.S.

Note, given that Scenario B and BART controls were only applied in an 11-state Midwest region, the validity of the results for other Class I areas in the eastern U.S. may be questionable. The Scenario C controls, on the other hand, cover all states and are, thus, likely valid in other Class I areas.

Spatial plots of the future year ozone and PM2.5 concentrations are provided in Figures 2 – 4.

Based on these results, the following key findings should be noted:

Ozone

- There is little change from the previous LADCO modeling (Round 5.1 with CAIR)
- The modeling shows attainment of the 0.08 ppm (85 ppb) standard by 2009, except Holland. (Note, Holland does meet this standard by 2012.)
- The modeling shows nonattainment of the 0.075 ppm (75 ppb) standard through 2018.

PM2.5 - Annual

- There is a significant change from the previous LADCO modeling (Round 5.1 with CAIR)
- The modeling shows extensive nonattainment of the annual standard.

PM2.5 - Daily

- There is a significant change from the previous LADCO modeling (Round 5.1 with CAIR)
- The modeling shows extensive nonattainment of the daily standard.

Haze

- There is a significant change from the previous LADCO modeling (Round 5.1 with CAIR)
- The modeling shows higher visibility levels in 2018 for the 20% worst visibility days (average about 0.5 deciviews for the northern Class I areas). The resulting visibility levels in the northern Class I areas (except Voyageurs) are above the glide path.

Table 2a. Ozone Modeling Results

		2005		2009					2012					2018				
				Round 5 without CAIR			Round 5 with CAIR		Round 5 without CAIR			Round 5 with CAIR		Round 5 without CAIR				Round 5 with CAIR
Site	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**			**Scen. A**	**Scen. B**	**Scen.C**			**Scen. A**	**Scen. B**	**Scen.C**	**Scen.C-BART**	
Lake Michigan Area																		
Chiwaukee	550590019	84.7		82.2	82.2	82.0	82.3		81.1	80.8	80.6	80.9		77.2	77.2	77.0	76.0	76.2
Racine	551010017	80.3		77.8	77.8	77.5	77.5		76.6	76.2	76.1	76.1		72.9	72.3	72.1	71.1	71.2
Milwaukee-Bayside	550890085	82.7		79.9	79.9	79.7	79.8		78.5	78.0	78.0	78.0		74.3	73.6	73.4	72.4	72.7
Harrington Beach	550890009	83.3		80.1	80.1	79.9	80.1		78.6	78.1	78.0	78.3		73.9	73.2	73.1	72.2	72.5
Manitowoc	550710007	**85.0**		80.8	80.8	80.7	80.8		79.0	78.5	78.4	78.6		73.9	73.2	73.1	72.0	72.5
Sheboygan	551170006	**88.0**		84.1	84.0	83.9	84.0		82.2	81.7	81.5	81.8		76.9	76.0	75.9	74.8	75.4
Kewaunee	550610002	82.7		78.2	78.2	78.0	78.1		76.4	75.9	75.7	75.9		71.3	70.7	70.5	69.4	69.9
Door County	550290004	**88.7**		84.1	84.1	83.9	83.9		82.0	81.4	81.3	81.5		76.5	75.6	75.5	74.2	74.7
Hammond	180892008	77.7		76.2	76.2	76.0	75.4		75.6	75.3	75.2	74.6		73.2	72.7	72.6	71.7	71.6
Whiting	180890030	79.3		77.8	77.8	77.7	77.0		77.2	76.9	76.8	76.2		74.8	74.3	74.2	73.2	73.1
Michigan City	180910005	77.0		74.5	74.5	74.3	73.9		73.3	72.9	72.8	72.5		69.7	69.2	69.1	68.1	68.1
Ogden Dunes	181270020	78.3		76.3	76.3	76.2	75.6		75.5	75.1	75.0	74.5		72.9	72.3	72.1	71.2	70.8
Holland	260050003	**90.0**		**85.7**	**85.7**	**85.5**	**85.3**		83.5	83.1	82.9	82.8		78.2	77.5	77.3	76.0	76.1
Jenison	261390005	82.0		76.8	76.8	76.7	76.0		75.1	74.6	74.5	74.5		70.2	69.6	69.5	67.9	68.7
Muskegon	261210039	**85.0**		80.6	80.6	80.5	80.5		78.6	78.2	78.1	78.0		73.5	72.8	72.8	71.5	71.9
Indianapolis Area																		
Noblesville	189571001	82.7		78.3	78.3	78.1	78.1		76.1	75.9	75.7	75.6		70.2	69.9	69.8	68.9	68.7
Fortville	180590003	78.0		74.1	74.1	73.9	73.9		71.9	71.8	71.7	71.4		66.7	66.5	66.3	65.4	65.1
Fort B. Harrison	180970050	78.7		75.4	75.3	75.2	75.1		73.8	73.6	73.6	73.2		70.6	70.3	70.2	69.3	69.1
Detroit Area																		
New Haven	260990009	86.0		82.4	82.3	82.1	81.4		81.4	81.2	81.1	80.2		78.1	77.8	77.7	76.5	76.1
Warren	260991003	84.0		82.4	82.3	82.2	81.3		82.1	81.8	81.7	80.7		79.7	79.4	79.3	78.0	77.6
Port Huron	261470005	82.7		78.2	78.2	78.1	77.5		76.5	76.3	76.2	75.5		72.6	72.5	72.3	70.9	70.9
Cleveland Area																		
Ashtabula	390071001	**89.0**		84.2	84.1	83.9	83.4		82.0	81.8	81.6	81.0		76.8	76.5	76.4	74.8	75.1
Geauga	390550004	79.3		75.8	75.8	75.6	74.7		74.0	73.8	73.7	72.7		69.5	69.2	69.1	67.6	67.3
Eastlake	390850003	**86.3**		83.1	83.1	82.9	81.9		81.8	81.6	81.5	80.5		78.2	78.0	77.8	76.5	76.2
Akron	391530020	83.7		79.1	79.1	79.0	78.1		76.9	76.7	76.6	75.6		70.9	70.6	70.4	68.7	68.7
Cincinnati Area																		
Wilmington	390271002	82.3		77.3	77.4	77.1	77.5		75.3	75.2	74.8	74.9		70.1	69.9	69.5	67.1	68.3
Sycamore	390610006	84.7		81.5	81.4	81.1	81.9		80.4	80.2	79.8	80.3		76.4	76.0	75.7	73.5	74.6
Lebanon	391650007	**87.7**		82.8	82.8	82.4	83.0		80.8	80.7	80.3	80.7		75.4	75.1	74.8	72.6	74.2
Columbus Area																		
London	390970007	79.7		75.0	75.0	74.8	75.0		73.0	72.8	72.7	72.6		68.1	67.8	67.6	65.9	66.3
New Albany	390490029	**86.3**		82.1	82.1	81.9	81.8		80.2	80.0	79.9	79.6		74.7	74.3	74.2	73.3	73.0
Franklin	290490028	80.3		76.7	76.6	76.5	75.9		75.1	74.9	74.8	74.1		70.5	70.2	70.1	70.2	69.0
St. Louis Area																		
W. Alton (MO)	291831002	**86.3**		81.1	81.2	81.1	81.0		80.0	79.9	79.9	78.6		76.9	76.8	76.7	74.2	74.9
Orchard (MO)	291831004	**87.0**		82.1	82.1	82.0	82.0		80.9	80.8	80.7	80.0		77.7	77.6	77.4	75.2	76.2
Sunset Hills (MO)	291890004	82.3		79.2	79.2	79.1	78.7		78.3	78.1	78.1	77.1		75.3	75.2	75.1	73.0	73.9
Arnold (MO)	290990012	82.3		77.8	77.8	77.7	77.2		76.7	76.6	76.5	75.6		73.6	73.4	73.4	71.3	72.0
Margaretta (MO)	295100086	83.0		79.8	79.8	79.7	79.3		78.8	78.7	78.6	77.9		75.7	75.6	75.5	73.7	74.4
Maryland Heights (MO)	291890014	**87.3**		**85.4**	**85.4**	**85.3**	84.0		84.3	84.1	84.0	81.7		81.1	80.9	80.8	78.4	78.1

Table 2b. PM$_{2.5}$ Modeling Results (Annual)

		2005	2009				2012				2018				
			Round 5 without CAIR			Round 5 with CAIR	Round 5 without CAIR			Round 5 with CAIR	Round 5 without CAIR				Round 5 with CAIR
Site	**Site ID**	**Base Year**	**Scen. A**	**Scen. B**	**Scen.C**		**Scen. A**	**Scen. B**	**Scen.C**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen.C-BART**	
Illinois															
Chicago - Washington HS	170310022	**15.2**	14.9	14.8	14.5	14.1	14.8	14.7	14.2	14.0	15.0	14.6	14.2	13.7	13.9
Chicago - Mayfair	170310052	**15.8**	**15.1**	**15.1**	14.8	14.4	**15.1**	14.9	14.5	14.2	**15.1**	14.7	14.3	13.7	13.9
Chicago - Springfield	170310057	**15.0**	14.6	14.6	14.3	13.9	14.6	14.4	14.0	13.8	14.8	14.4	14.0	13.4	13.7
Chicago - Lawndale	170310076	14.9	14.5	14.5	14.2	13.8	14.5	14.3	13.9	13.7	14.7	14.3	13.9	13.3	13.6
Blue Island	170312001	14.8	14.4	14.4	14.0	13.7	14.4	14.2	13.8	13.6	14.5	14.1	13.7	13.2	13.4
Summit	170313301	**15.2**	14.9	14.9	14.6	14.2	14.9	14.7	14.3	14.0	15.0	14.6	14.3	13.7	13.9
Cicero	170316005	**15.5**	**15.1**	**15.1**	14.8	14.4	**15.1**	14.9	14.5	14.3	**15.2**	14.9	14.4	13.9	14.2
Granite City	171191007	**16.7**	**16.3**	**16.2**	**15.9**	**15.1**	**16.1**	**16.0**	**15.3**	14.9	**15.9**	**15.6**	14.9	14.2	14.3
E. St. Louis	171630010	**15.6**	**15.2**	**15.2**	14.8	14.1	15.0	14.9	14.3	13.9	14.9	14.6	14.0	13.3	13.4
Indiana															
Jeffersonville	180190005	**16.4**	**15.8**	**15.7**	14.8	13.8	**15.8**	**15.6**	14.5	13.7	**16.0**	**15.5**	14.3	13.7	13.4
Jasper	180372001	**15.2**	14.3	14.2	13.4	12.4	14.2	14.0	13.0	12.2	14.3	13.9	12.8	12.1	11.8
Gary	180890031	**15.6**	13.9	13.9	13.5	13.0	13.8	13.6	13.1	12.8	13.7	13.4	12.9	12.3	12.4
Indy-Washington Park	180970078	**15.3**	14.4	14.4	13.6	12.8	14.3	14.2	13.2	12.6	14.3	13.9	12.9	12.2	12.0
Indy-W 18th Street	180970081	**16.0**	**15.1**	**15.1**	14.3		15.0	14.9	13.9		15.0	14.6	13.5	12.8	
Indy- Michigan Street	180970083	**15.9**	15.0	15.0	14.2	13.4	14.9	14.8	13.8	13.1	14.9	14.5	13.5	12.8	12.6
Michigan															
Allen Park	261630001	14.5	11.0	14.0	13.5	13.0	14.0	13.8	13.2	12.8	13.9	13.6	13.0	12.4	12.4
Southwest HS	261630015	**15.9**	**15.3**	**15.3**	14.8	14.2	**15.2**	15.0	14.4	13.9	**15.1**	14.8	14.1	13.5	13.5
Linwood	261630016	14.6	14.1	14.1	13.6	13.1	14.0	13.9	13.3	12.8	13.9	13.6	13.0	12.5	12.5
Dearborn	261630033	**17.5**	**17.0**	**17.0**	**16.4**	**15.8**	**16.9**	**16.7**	**16.0**	**15.5**	**16.8**	**16.4**	**15.7**	**15.1**	**15.1**
Wyandotte	261630036	**14.7**	14.2	14.1	13.6	13.1	14.1	13.9	13.3	12.8	14.0	13.7	13.0	12.4	12.5
Ohio															
Middletown - Bonita	390170003	**16.2**	**15.3**	**15.2**	14.3	13.5	**15.2**	15.0	13.9	13.2	**15.2**	14.8	13.7	13.0	12.8
Fairfield	390170016	**15.8**	**15.1**	15.0	14.1	13.1	**15.1**	14.9	13.7	12.9	**15.2**	14.7	13.5	12.8	12.5
Cleveland-28th Street	390350027	**15.4**	14.9	14.9	14.3	13.5	14.7	14.5	13.9	13.2	14.6	14.2	13.5	12.8	12.7
Cleveland-St. Tikhon	390350038	**17.4**	**16.7**	**16.7**	**16.0**	**15.2**	**16.5**	**16.3**	**15.6**	14.8	**16.3**	**16.0**	**15.2**	14.4	14.3
Cleveland-Broadway	390350045	**16.5**	**15.9**	**15.8**	**15.2**	14.4	**15.6**	**15.5**	14.8	14.0	**15.5**	**15.1**	14.4	13.6	13.5
Cleveland-GT Craig	390350060	**17.1**	**16.5**	**16.4**	**15.8**	15.0	**16.3**	**16.1**	**15.4**	14.6	**16.1**	**15.7**	15.0	14.2	14.1
Newburg Hts - Harvard Ave	390350065	**16.0**	**15.4**	**15.3**	14.7	14.0	**15.2**	15.0	14.3	13.6	**15.1**	14.7	14.0	13.2	13.1
Columbus - Fairgrounds	390490024	**15.3**	14.6	14.5	13.7	12.9	14.4	14.1	13.2	12.6	14.2	13.8	12.8	12.2	12.0
Columbus - Ann Street	390490025	**15.1**	14.4	14.3	13.5	12.7	14.2	13.9	13.1	12.4	14.1	13.6	12.6	12.0	11.9
Cincinnati - Seymour	390610014	**17.3**	**16.6**	**16.5**	**15.5**	14.5	**16.5**	**16.3**	**15.1**	14.3	**16.6**	**16.2**	14.9	14.2	13.8
Cincinnati - Taft Ave	390610040	**15.5**	14.8	14.7	13.8	12.8	14.8	14.6	13.4	12.6	14.9	14.5	13.2	12.5	12.2
Cincinnati - 8th Ave	390610042	**16.9**	**12.0**	**16.1**	15.0	14.0	**16.1**	**15.9**	14.7	13.8	**16.2**	**15.7**	14.4	13.7	13.4
Sharonville	390610043	**15.6**	14.9	14.8	13.9	12.9	14.9	14.7	13.5	12.7	14.9	14.5	13.3	12.6	12.3
Norwood	390617001	**16.2**	**15.5**	**15.4**	14.4	13.4	**15.4**	**15.2**	14.0	13.2	**15.5**	**15.1**	13.8	13.1	12.8
St. Bernard	390618001	**17.6**	**16.8**	**16.7**	**15.7**	14.7	**16.7**	**16.5**	**15.3**	14.4	**16.8**	**16.4**	**15.1**	14.3	14.0
Steubenville	390810016	**15.8**	14.5	14.4	13.5	12.8	14.3	14.2	13.1	12.5	14.8	14.5	13.3	12.9	12.7
Mingo Junction	390811001	**16.5**	**15.2**	**15.2**	14.3	13.5	15.0	14.9	13.8	13.2	**15.6**	**15.2**	14.0	13.6	13.4
Ironton	390870010	**15.2**	14.8	14.6	13.6	12.8	14.6	14.4	13.2	12.5	14.8	14.1	12.8	12.4	12.3
Dayton	391130032	**15.5**	14.9	14.8	14.0	13.2	14.8	14.6	13.6	12.9	14.8	14.3	13.3	12.6	12.4
New Boston	391450013	14.7	12.0	14.0	13.0	12.1	14.1	13.8	12.5	11.9	14.2	13.6	12.2	11.7	11.6
Canton - Dueber	391510017	**16.3**	**15.7**	**15.6**	14.8	14.0	**15.5**	**15.3**	14.4	13.6	**15.4**	14.9	14.0	13.3	13.3
Canton - Market	391510020	**14.6**	11.0	14.1	13.3	12.6	13.9	13.7	12.9	12.3	13.9	13.5	12.6	12.0	11.9
Akron - Brittain	391530017	**15.1**	14.6	14.5	13.8	13.0	14.4	14.2	13.4	12.7	14.3	13.8	13.0	12.3	12.3
Akron - W. Exchange	391530023	14.3	13.7	13.7	13.0	12.3	13.6	13.3	12.6	12.0	13.4	13.0	12.2	11.6	11.5

Table 2c. $PM_{2.5}$ Modeling Results (Daily)

			2005	2009				2012				2018				
				Round 5 without CAIR			Round 5 with CAIR	Round 5 without CAIR			Round 5 with CAIR	Round 5 without CAIR				Round 5 with CAIR
Key Site	**County**	**Site ID**	**Base Year**	**Scen. A**	**Scen. B**	**Scen.C**		**Scen. A**	**Scen. B**	**Scen.C**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen. C - BART**	
Illinois																
Chicago - Washington HS	Cook	170310022	36.6	**36**	**36**	**36**	**36**	**36**	**36**	**37**	**36**	**37**	**36**	**37**	**37**	35
Chicago - Mayfair	Cook	170310052	40.3	**37**	**37**	**37**	**36**	**37**	**36**	**37**	**36**	**38**	**37**	**37**	**37**	**36**
Chicago - Springfield	Cook	170310057	37.4	34	34	33	32	35	34	33	32	**36**	34	33	33	31
Chicago - Lawndale	Cook	170310076	38.1	35	35	35	35	36	35	36	35	**36**	35	**36**	**36**	34
McCook	Cook	170311016	43.0	**39**	**39**	**39**	**39**	**40**	**39**	**40**	**39**	**40**	**40**	**41**	**40**	**38**
Blue Island	Cook	170312001	37.7	35	35	35	34	36	35	36	34	**36**	35	**36**	**36**	33
Schiller Park	Cook	170313103	41.6	**40**	**40**	**40**	**39**	**40**	**40**	**40**	**39**	**41**	**40**	**40**	**39**	**39**
Summit	Cook	170313301	40.2	**38**	**38**	**39**	**38**	**39**	**38**	**39**	**38**	**39**	**38**	**39**	**39**	**37**
Maywood	Cook	170316005	39.2	**38**	**38**	**38**	**38**	**38**	**38**	**39**	**38**	**39**	**38**	**39**	**39**	**37**
Granite City	Madison	171191007	39.2	**36**	**36**	35	33	**36**	35	34	33	**36**	35	35	33	32
E. St. Louis	St. Clair	171630010	33.7	31	31	30	28	31	30	29	28	31	30	30	29	28
Indiana																
Jeffersonville	Clark	180190005	38.4	35	33	31	29	35	34	32	31	**37**	35	34	33	31
Jasper	Dubois	180372001	36.2	32	32	30	28	32	32	30	29	33	31	31	30	28
Gary - IITRI	Lake	180890022	39.0	35	35	35	34	35	34	35	34	**36**	**36**	**36**	35	35
Gary - Burr School	Lake	180890026	39.0	34	34	34	33	34	34	35	34	34	34	34	34	32
Gary	Lake	180890031	35.2	29	28	26	24	28	28	24	24	29	28	27	27	27
Indy-West Street	Marion	180970043	38.0	34	34	33	33	35	35	34	33	**36**	35	34	34	33
Indy-English Avenue	Marion	180970066	38.0	34	34	32	32	35	34	33	32	35	34	33	33	32
Indy-Washington Park	Marion	180970078	36.6	33	33	32	31	33	33	32	31	34	33	32	32	32
Indy-W 18th Street	Marion	180970081	38.3	33	33	31	31	33	33	32	31	34	33	32	32	31
Indy- Michigan Street	Marion	180970083	36.0	32	32	29	28	32	31	29	28	32	31	29	29	29
Michigan																
Luna Pier	Monroe	261150005	38.9	34	34	32	32	34	34	32	32	34	33	32	31	31
Oak Park	Oakland	261250001	39.9	**38**	**38**	**37**	**36**	**38**	**37**	**37**	**36**	**38**	**37**	**37**	**36**	35
Port Huron	St. Clair	261470005	39.6	**36**	35	35	34	35	35	35	34	35	35	34	33	33
Ypsilanti	Washtenaw	261610008	39.5	**37**	**37**	**36**	35	**37**	**36**	**36**	35	**37**	**36**	**36**	35	34
Allen Park	Wayne	261630001	38.6	**36**	**36**	**36**	35	**36**	35	35	34	**36**	35	35	34	33
Southwest HS	Wayne	261630015	40.1	**36**	**36**	**36**	35	**36**	35	35	35	**36**	35	35	34	33
Linwood	Wayne	261630016	43.0	**40**	**40**	**40**	**39**	**40**	**40**	**40**	**39**	**40**	**39**	**39**	**39**	**38**
E 7 Mile	Wayne	261630019	41.0	**39**	**39**	**39**	**38**	**39**	**39**	**39**	**38**	**39**	**38**	**38**	**38**	**37**
Dearborn	Wayne	261630033	43.9	**41**	**41**	**41**	**40**	**41**	**41**	**41**	**40**	**41**	**40**	**40**	**40**	**39**
Wyandotte	Wayne	261630036	37.2	**36**	**36**	**36**	35	35	35	35	35	35	35	35	35	34
Newberry	Wayne	261630038	42.7	**39**	**39**	**39**	**38**	**39**	**38**	**38**	**37**	**39**	**38**	**38**	**37**	**36**
FIA	Wayne	261630039	39.7	35	34	34	33	35	34	34	33	35	34	33	33	31
Ohio																
Middleton	Butler	390170003	39.3	33	32	29	28	33	33	29	28	34	32	29	28	27
Fairfield	Butler	390170016	37.1	32	31	29	27	31	30	28	28	32	30	29	28	27
	Butler	390170017	40.8	33	32	30	29	33	33	30	29	33	32	30	29	28
Cleveland-28th Street	Cuyahoga	390350027	36.9	34	34	33	32	34	33	33	32	34	33	33	31	31
Cleveland-St. Tikhon	Cuyahoga	390350038	44.2	**40**	**40**	**37**	**36**	**40**	**39**	**36**	35	**40**	**38**	**36**	35	34
Cleveland-Broadway	Cuyahoga	390350045	38.8	35	35	33	31	35	34	32	30	35	34	31	29	29
Cleveland-GT Craig	Cuyahoga	390350060	42.1	**39**	**39**	**38**	**37**	**39**	**38**	**38**	**37**	**39**	**38**	**37**	**36**	35
Newburg Hts - Harvard Ave	Cuyahoga	390350065	38.9	35	35	33	31	35	34	32	30	**36**	35	32	31	30
Columbus - Fairgrounds	Franklin	390490024	38.5	34	34	33	33	34	33	32	32	34	34	33	32	31
Columbus - Ann Street	Franklin	390490025	38.5	34	33	31	31	33	33	31	31	34	33	31	31	30
Cincinnati	Hamilton	390610006	40.6	33	33	30	27	33	32	29	28	34	32	29	28	27

Table 2c. $PM_{2.5}$ Modeling Results (Daily)

			2005		2009					2012					2018				
					Round 5 without CAIR			Round 5 with CAIR		Round 5 without CAIR			Round 5 with CAIR		Round 5 without CAIR				Round 5 with CAIR
Key Site	**County**	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**			**Scen. A**	**Scen. B**	**Scen.C**			**Scen. A**	**Scen. B**	**Scen.C**	**Scen. C - BART**	
Cincinnati - Seymour	Hamilton	390610014	38.4		33	33	28	26		33	32	27	25		33	31	29	25	24
Cincinnati - Taft Ave	Hamilton	390610040	36.7		31	30	26	24		31	30	26	24		32	29	26	24	23
Cincinnati - 8th Ave	Hamilton	390610042	37.3		32	32	30	28		32	31	29	28		33	31	29	28	27
Sharonville	Hamilton	390610043	36.0		32	31	30	28		32	31	29	28		32	31	29	28	27
Norwood	Hamilton	390617001	38.8		34	33	32	30		33	33	31	30		34	33	31	30	29
St. Bernard	Hamilton	390618001	40.6		35	35	32	30		35	34	31	30		35	33	32	31	29
Steubenville	Jefferson	390810016	40.7		**36**	35	32	29		35	34	30	28		**37**	35	31	29	28
Mingo Junction	Jefferson	390811001	42.0		**37**	**37**	33	30		**37**	**36**	32	30		**38**	**36**	32	30	30
Dayton	Montgomery	391130032	37.8		34	33	31	30		33	33	31	30		34	33	31	31	30
Canton - Dueber	Stark	391510017	38.6		33	32	30	28		33	31	30	28		33	30	29	28	27
Akron - Brittain	Summit	391530017	38.1		33	33	31	30		33	32	31	30		33	32	30	29	29
Wisconsin																			
Green Bay - Est High	Brown	550090005	37.1		35	34	35	35		34	35	35	34		33	33	33	32	32
Madison	Dane	550250047	36.4		33	33	32	32		33	32	32	31		32	31	30	29	29
Milwaukee-Health Center	Milwaukee	550790010	38.7		35	35	35	35		35	35	35	34		35	34	34	34	33
Milwaukee-SER Hdqs	Milwaukee	550790026	37.4		34	34	34	34		34	34	34	34		34	34	34	34	33
Milwaukee-Virginia FS	Milwaukee	550790043	39.9		**37**	**37**	**37**	**36**		**37**	**36**	**37**	**36**		**36**	**36**	**37**	**36**	**36**
Milwaukee- Fire Dept Hdqs	Milwaukee	550790099	37.8		34	34	33	33		34	33	33	32		34	33	33	33	32
Waukesha	Waukesha	551330027	35.5		32	32	32	31		32	32	32	31		32	31	31	30	29

Table 3. Modeling Results: Number of Sites > NAAQS

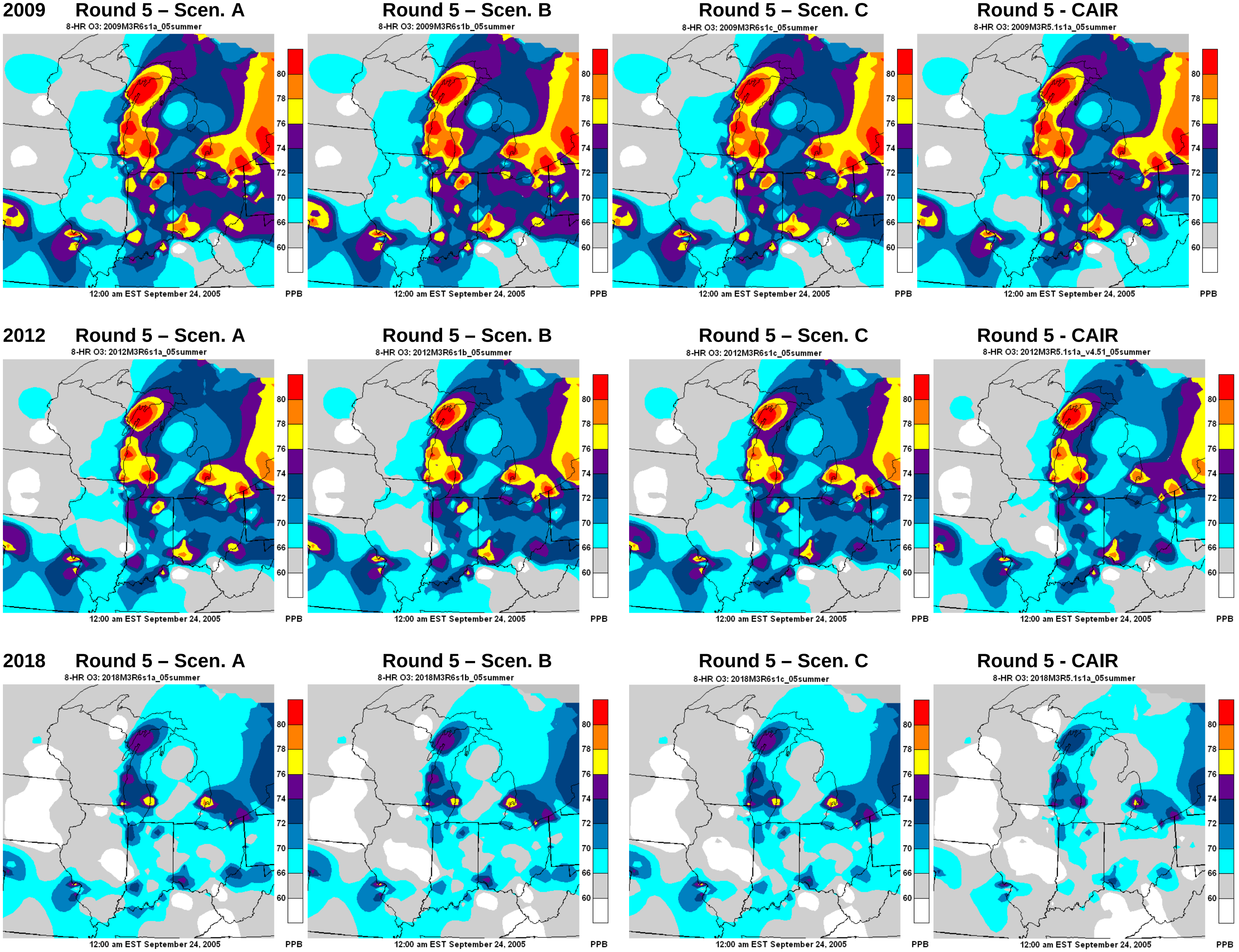
Ozone (85 ppb)		**Round 5 without CAIR**				**Round 5 w/ CAIR**
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
IL	0	0	0	0	----	0
IN	0	0	0	0	----	0
MI	3	1	1	1	----	1
OH	4	0	0	0	----	0
WI	2	0	0	0	----	0
Total	**9**	**1**	**1**	**1**		**1**
2012						
IL	0	0	0	0	----	0
IN	0	0	0	0	----	0
MI	3	0	0	0	----	0
OH	4	0	0	0	----	0
WI	2	0	0	0	----	0
Total	**9**	**0**	**0**	**0**		**0**
2018						
IL	0	0	0	0	0	0
IN	0	0	0	0	0	0
MI	3	0	0	0	0	0
OH	4	0	0	0	0	0
WI	2	0	0	0	0	0
Total	**9**	**0**	**0**	**0**	**0**	**0**
Ozone (75 ppb)		**Round 5 without CAIR**				**Round5 w/ CAIR**
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
IL	12	6	6	6	----	4
IN	26	10	9	8	----	5
MI	21	12	12	12	----	12
OH	45	27	25	24	----	21
WI	12	10	10	10	----	10
Total	**116**	**65**	**62**	**60**	**----**	**52**
2012						
IL	12	3	3	3	----	1
IN	26	5	4	4	----	3
MI	21	9	8	8	----	6
OH	45	18	14	12	----	11
WI	12	10	9	9	----	9
Total	**116**	**45**	**38**	**36**		**30**
2018						
IL	12	0	0	0	0	0
IN	26	0	0	0	0	0
MI	21	3	3	3	3	3
OH	45	3	3	2	1	1
WI	12	3	2	1	1	1
Total	**116**	**9**	**8**	**6**	**5**	**5**

PM2.5 - Annual		**Round 5 without CAIR**				**Round 5 w/ CAIR**
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
IL	7	4	4	1	----	1
IN	6	2	2	0	----	0
MI	2	2	2	1	----	1
OH	26	13	12	5	----	1
WI	0	0	0	0	----	0
Total	**41**	**21**	**20**	**7**		**3**
2012						
IL	7	3	1	1	----	0
IN	6	1	1	0	----	0
MI	2	2	1	1	----	1
OH	26	12	9	4	----	0
WI	0	0	0	0	----	0
Total	**41**	**18**	**12**	**6**		**1**
2018						
IL	7	3	1	0	0	0
IN	6	1	1	0	0	0
MI	2	2	1	1	1	1
OH	26	13	8	2	0	0
WI	0	0	0	0	0	0
Total	**41**	**19**	**11**	**3**	**1**	**1**
PM2.5 - Daily						
		Round 5 without CAIR				**Round 5 w/ CAIR**
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
IL	16	7	7	6	----	6
IN	13	0	0	0	----	0
MI	14	10	9	9	----	5
OH	31	4	3	2	----	2
WI	8	1	1	1	----	1
Total	**82**	**22**	**20**	**18**	**----**	**14**
2012						
IL	16	9	6	8	----	6
IN	13	0	0	0	----	0
MI	14	8	6	6	----	5
OH	31	3	3	2	----	1
WI	8	1	1	1	----	1
Total	**82**	**21**	**16**	**17**		**13**
2018						
IL	16	10	6	8	8	5
IN	13	4	1	1	0	0
MI	14	8	6	6	5	4
OH	31	5	3	2	1	0
WI	8	1	1	1	1	1
Total	**82**	**28**	**17**	**18**	**15**	**10**

Table 4. Modeling Results: Future Year Visibility Levels

Worst 20%				**2018**				
				Round 5 without CAIR				**Round 5 w/ CAIR**
Site	**Baseline (2000-2004)**	**2018 URP**		**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
BOWA1	19.86	17.94		19.09	18.87	18.54	18.02	17.94
VOYA2	19.48	17.75		18.60	18.44	18.17	17.77	17.63
SENE1	24.38	21.64		24.02	23.58	23.03	22.38	22.59
ISLE1	21.59	19.43		21.05	20.86	20.62	20.22	20.09
ISLE9	21.59	19.43		20.83	20.58	20.38	19.84	19.84
HEGL1	26.75	23.13		26.24	25.83	24.87	24.23	24.22
MING1	28.15	24.27		27.51	26.98	25.81	24.93	24.74
CACR1	26.36	22.91		25.32	24.80	23.57	22.97	22.44
UPBU1	26.27	22.82		25.31	24.79	23.50	22.79	22.59
MACA1	31.37	26.64		30.11	29.08	27.06	26.24	26.10
DOSO1	29.05	24.69		27.88	26.96	24.36	23.74	23.00
SHEN1	29.31	25.12		28.38	27.65	25.24	24.69	23.92
JARI1	29.12	24.91		28.06	27.21	25.00	24.48	24.06
BRIG1	29.01	25.05		28.10	28.07	26.57	26.25	25.21
LYBR1	24.45	21.48		24.06	23.86	22.58	22.30	21.14
ACAD1	22.89	20.45		22.88	22.76	22.31	22.16	21.49
Best 20%				**2018**				
				Round 5 without CAIR				**Round 5 w/ CAIR**
Site	**Baseline (2000-2004)**	**2018 Max**		**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	
BOWA1	6.42	6.42		6.20	6.17	6.16	6.12	6.14
VOYA2	7.09	7.09		6.87	6.83	6.81	6.78	6.75
SENE1	7.14	7.14		7.80	7.78	7.81	7.77	7.71
ISLE1	6.75	6.75		6.77	6.76	6.72	6.67	6.60
ISLE9	6.75	6.75		6.63	6.61	6.58	6.53	6.52
HEGL1	12.84	12.84		12.17	12.20	12.07	11.63	11.66
MING1	14.46	14.46		13.78	13.77	13.70	13.37	13.28
CACR1	11.24	11.24		10.94	10.99	10.97	10.78	10.52
UPBU1	11.71	11.71		11.18	11.23	11.18	10.96	10.73
MACA1	16.51	16.51		16.32	16.21	15.76	15.34	15.25
DOSO1	12.28	12.28		12.02	11.84	11.27	11.03	11.00
SHEN1	10.93	10.93		10.98	10.91	10.25	10.16	9.91
JARI1	14.21	14.21		14.19	13.98	13.42	13.21	13.14
BRIG1	14.33	14.33		14.32	14.46	14.22	14.17	13.92
LYBR1	6.37	6.37		6.39	6.38	6.31	6.28	6.14
ACAD1	8.78	8.78		8.97	8.96	8.90	8.89	8.82

Figure 2. Ozone Modeling Results



2009 Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

2012 Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

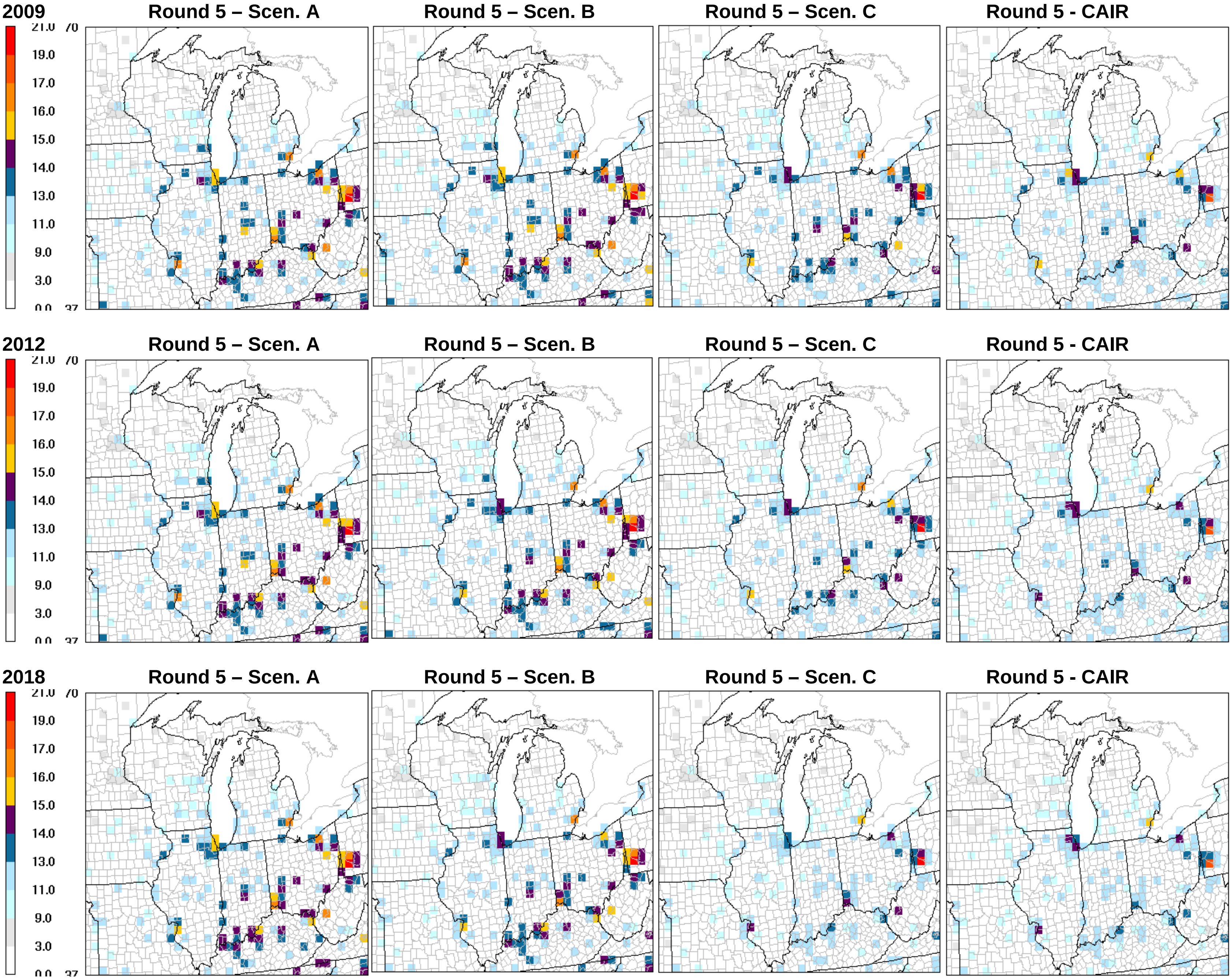
2018 Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

Figure 3. PM2.5 Annual Modeling Results


2009

Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

2012

Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

2018

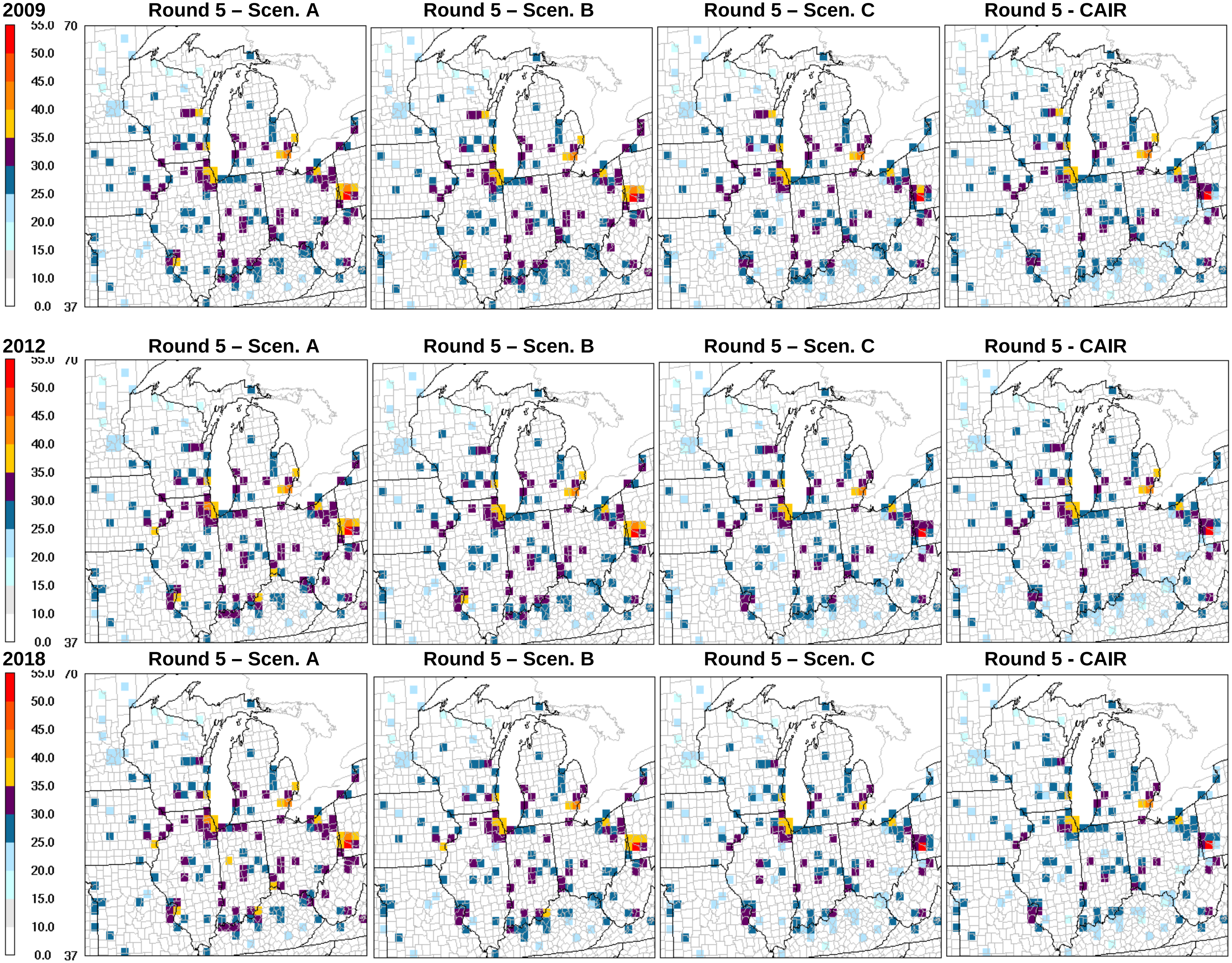
Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

Figure 4. PM2.5 Daily Modeling Results



2009

Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

2012

Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

2018

Round 5 – Scen. A

Round 5 – Scen. B

Round 5 – Scen. C

Round 5 - CAIR

Appendix I

Scenario B (Legally Enforceable) Controls

NOx – 2009

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Point Source Grown and Controlled Emissions by facility for NOX r6s1b_2009                                              Base Year = 2002
Future Year = 2009

STID=17 CYID=57 fcid=057801AAA name=AES DUCK CREEK
                                                    Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID     fcid      stkid   dvid   prid         scc     polid   Tons/Day   Tons/Day   Tons/Day   Control EF   Control EF   ctrltype       ctrldes

 17    57    057801AAA    0001    0001   01      10100202    NOX      0.8147    0.8416     0.8416      0.00        0.00       SCR      SCR added by LADCO

STID=17 CYID=143 fcid=143805AAG name=AES ED EDWARDS STATION
                                                    Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID     fcid      stkid   dvid   prid         scc     polid   Tons/Day   Tons/Day   Tons/Day   Control EF   Control EF   ctrltype       ctrldes

 17   143    143805AAG    0001    0001   01      10100202    NOX      3.0515    3.1522     3.1522      0.00        0.00       lnb      LNB added by LADCO
 17   143    143805AAG    0001    0003   01      10100202    NOX      6.9419    7.1708     7.1708      0.00        0.00       lnb      LNB added by LADCO
 17   143    143805AAG    0002    0004   01      10100202    NOX      2.1310    2.2013     2.2013      0.00        0.00       lnb      LNB added by LADCO
----                                                 --------   --------   ----------
fcid                                                  12.1244    12.5243    12.5243
cyid                                                  12.1244    12.5243    12.5243
stid                                                  12.9392    13.3659    13.3659

STID=39 CYID=1 fcid=0701000007 name="DP&L, J.M. STUART GENERATING STATION"
                                                    Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID     fcid      stkid   dvid   prid         scc     polid   Tons/Day   Tons/Day   Tons/Day   Control EF   Control EF   ctrltype       ctrldes

 39    1    0701000007    R1     B001   B001P1   10100202    NOX      6.9860    6.9756     2.3252      0.85        0.95       SCR      SCR added by LADCO
 39    1    0701000007    R2     B002   B002P1   10100202    NOX      3.6327    3.6273     1.2091      0.85        0.95       SCR      SCR added by LADCO
 39    1    0701000007    R3     B003   B003P1   10100202    NOX      5.0133    5.0058     1.6686      0.85        0.95       SCR      SCR added by LADCO
 39    1    0701000007    R4     B004   B004P1   10100202    NOX      7.8493    7.8376     2.6125      0.85        0.95       SCR      SCR added by LADCO
----                                                 --------   --------   ----------
fcid                                                  23.4814    23.4464     7.8155
cyid                                                  23.4814    23.4464     7.8155

STID=39 CYID=167 fcid=0684000000 name=MUSKINGUM RIVER POWER PLANT
                                                    Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID     fcid      stkid   dvid   prid         scc     polid   Tons/Day   Tons/Day   Tons/Day   Control EF   Control EF   ctrltype       ctrldes

 39   167   0684000000    R1     B001   B001P1   10200501    NOX      0.0017    0.0017     0.0001      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R2     B002   B002P1   10100201    NOX      5.8167    5.8080     0.2904      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R2     B002   B002P2   10100501    NOX      0.0000    0.0000     0.0000      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R3     B003   B003P1   10100201    NOX      7.9017    7.8899     0.3945      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R3     B003   B003P2   10100501    NOX      0.0000    0.0000     0.0000      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R4     B004   B004P1   10100203    NOX      7.8775    7.8657     0.3933      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R4     B004   B004P2   10100501    NOX      0.0000    0.0000     0.0000      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R6     B006   B006P1   10100202    NOX      3.8586    3.8528     0.1926      0.00        0.95       SCR      SCR added by LADCO
 39   167   0684000000    R6     B006   B006P2   10100501    NOX      0.0000    0.0000     0.0000      0.00        0.95       SCR      SCR added by LADCO
----                                                 --------   --------   ----------
fcid                                                  25.4561    25.4182     1.2709
cyid                                                  25.4561    25.4182     1.2709
stid                                                  48.9375    48.8646     9.0864

STID=55 CYID=79 fcid=241007800 name=WIS ELECTRIC POWER VALLEY STATION
                                                    Base Yr    Grown    Controlled    Base Year   Future Year
```

```
STID  CYID     fcid     stkid  dvid  prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 55    79   241007800   S11    B21   01    10100202   NOX     2.7972    2.8895     1.6470     0.00         0.43       SCR      SCR added by LADCO
 55    79   241007800   S11    B22   01    10100202   NOX     2.9073    3.0032     1.7118     0.00         0.43       SCR      SCR added by LADCO
 55    79   241007800   S12    B23   01    10100202   NOX     2.3270    2.4038     1.2740     0.00         0.47       SCR      SCR added by LADCO
 55    79   241007800   S12    B24   01    10100202   NOX     2.3427    2.4199     1.2826     0.00         0.47       SCR      Scrubber added by LADCO
----                                       --------  --------  ----------
fcid                                         10.3742   10.7164     5.9154
cyid                                         10.3742   10.7164     5.9154

STID=55 CYID=117 fcid=460033090 name=WP & L Alliant Energy - Edgewater Gen Station
                                           Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID     fcid     stkid  dvid  prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 55   117   460033090   S11    B23   01    10100203   NOX     1.6197    1.6731     1.0038     0.00         0.40       SCR      SCR added by LADCO
 55   117   460033090   S11    B24   01    10100203   NOX     4.1072    4.2426     3.4789     0.00         0.18       SCR      SCR added by LADCO
 55   117   460033090   S12    B25   01    10100221   NOX     5.6804    5.8677     4.9876     0.00         0.15       SCR      SCR added by LADCO
----                                       --------  --------  ----------
fcid                                         11.4072   11.7834     9.4703
cyid                                         11.4072   11.7834     9.4703
stid                                         21.7814   22.4997    15.3857
                                          ========  ========  ==========
                                           83.6581   84.7302    37.8380
```

NOx - 2012

```
Point Source Grown and Controlled Emissions by facility for NOX r6s1b_2012                                                      Base Year = 2002
Future Year = 2012

STID=17 CYID=33 fcid=033801AAA name=AMEREN ENERGY GENERATING CO
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17    33    033801AAA    0005    0005    01      10100202    NOX      1.642      1.871      0.9357      0.00        0.500      SCR        SCR added by LADCO
  17    33    033801AAA    0006    0006    01      10100202    NOX      2.116      2.413      1.2063      0.00        0.500      SCR        SCR added by LADCO
----                                                   --------   --------   ----------
fcid                                                     3.758      4.284      2.1420
cyid                                                     3.758      4.284      2.1420

STID=17 CYID=57 fcid=057801AAA name=AES DUCK CREEK
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17    57    057801AAA    0001    0001    01      10100202    NOX      0.815      0.929      0.9288      0.00        0.000      SCR        SCR added by LADCO

STID=17 CYID=79 fcid=079808AAA name=AMEREN ENERGY GENERATING CO
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17    79    079808AAA    0003    0003    01      10100202    NOX      6.735      7.678      7.6780      0.00        0.000      SCR        SCR added by LADCO
  17    79    079808AAA    0012    0013    01      10100501    NOX      5.936      5.378      5.3781      0.00        0.000      SCR        SCR added by LADCO
----                                                   --------   --------   ----------
fcid                                                    12.671     13.056     13.0561
cyid                                                    12.671     13.056     13.0561

STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17    97    097190AAC    0016    0031    02      10100401    NOX      0.000      0.000      0.0000      0.00        0.999      SHUTDOWN   SCR added by LADCO

STID=17 CYID=137 fcid=137805AAA name=AMEREN ENERGY GENERATING CO
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17   137    137805AAA    0003    0003    01      10100202    NOX      5.356      6.106      6.1058      0.00        0.000      LNB        LNB added by LADCO


STID=17 CYID=143 fcid=143805AAG name=AES ED EDWARDS STATION
                                                     Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID     fcid     stkid   dvid   prid     scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

  17   143    143805AAG    0001    0001    01      10100202    NOX      3.052      3.479      3.4789      0.00        0.000      lnb        LNB added by LADCO
  17   143    143805AAG    0001    0003    01      10100202    NOX      6.942      7.914      7.9141      0.00        0.000      lnb        LNB added by LADCO
  17   143    143805AAG    0002    0004    01      10100202    NOX      2.131      2.429      2.4294      0.00        0.000      lnb        LNB added by LADCO
----                                                   --------   --------   ----------
fcid                                                    12.124     13.822     13.8224
cyid                                                    12.124     13.822     13.8224
```

```
STID=17 CYID=167 fcid=167120AAO name=CITY WATER LIGHT & POWER
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes

 17   167   167120AAO   0010  0012   01   10100203  NOX    6.527     7.441    0.0074     0.00      0.999    SHUTDOWN  SHUTDOWN added by LADCO
 17   167   167120AAO   0010  0013   01   10100203  NOX    2.646     3.017    0.0030     0.00      0.999    SHUTDOWN  SHUTDOWN added by LADCO
----                                              --------  --------  ----------
fcid                                                9.173    10.458    0.0105
cyid                                                9.173    10.458    0.0105

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes

 17   179   179801AAA   0018  0029   01   10100203  NOX   22.429    25.570    1.2785     0.00      0.950    SCR      SCR added by LADCO
 17   179   179801AAA   0018  0031   01   10100203  NOX   38.993    44.454    2.2227     0.00      0.950    SCR      SCR added by LADCO
-----                                             --------  --------  ----------
fcid                                               61.422    70.024    3.5012
cyid                                               61.422    70.024    3.5012

STID=17 CYID=197 fcid=197809AAO name=MIDWEST GENERATION LLC
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes

 17   197   197809AAO   0032  0033   02   10100604  NOX    0.000     0.000    0.0000     0.00      0.800    SCR      SCR added by LADCO

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes

 17   197   197810AAK   0011  0016   02   10100222  NOX    5.731     6.534    3.9203     0.00      0.400    SCR      SCR added by LADCO
 17   197   197810AAK   0011  0016   03   10100501  NOX    0.000     0.000    0.0000     0.00      0.400    SCR      SCR added by LADCO
 17   197   197810AAK   0013  0010   02   10100223  NOX    8.598     9.802    0.0098     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17   197   197810AAK   0013  0010   03   10100501  NOX    0.000     0.000    0.0000     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17   197   197810AAK   0007  0012   02   10100223  NOX   10.974    12.511    0.0125     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17   197   197810AAK   0007  0012   03   10100501  NOX    0.000     0.000    0.0000     0.00      0.999    SHUTDOWN  SCR added by LADCO
----                                              --------  --------  ----------
fcid                                               25.303    28.847    3.9426
cyid                                               25.303    28.847    3.9426
stid                                              130.622   147.527   43.5096

STID=27 CYID=61 fcid=2706100004 name=Minnesota Power Inc - Boswell Energy Ctr
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes

 27    61  2706100004  SV003  EU003  001  10100226  NOX   13.661    14.142    2.8284     0.00      0.800    SCR      SCR added by LADCO
 27    61  2706100004  SV003  EU003  002  10100501  NOX    0.000     0.000    0.0000     0.00      0.800    SCR      SCR added by LADCO
----                                              --------  --------  ----------
fcid                                               13.661    14.142    2.8284
cyid                                               13.661    14.142    2.8284

STID=27 CYID=109 fcid=2710900011 name=Rochester Public Utilities - Silver Lake
                                                  Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID    fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day  Control EF  Control EF  ctrltype      ctrldes
```

```
  27   109    2710900011    SV003    EU004    001      10100202     NOX       2.079       2.152       1.2911       0.00         0.400      SNCR       SCR added by LADCO
----                                                   --------    --------    ----------
stid                                                       15.739      16.294      4.1195

STID=39 CYID=1 fcid=0701000007 name="DP&L, J.M. STUART GENERATING STATION"
                                                    Base Yr     Grown     Controlled     Base Year    Future Year
STID    CYID       fcid       stkid    dvid     prid       scc       polid    Tons/Day    Tons/Day      Tons/Day     Control EF     Control EF    ctrltype          ctrldes

  39      1     0701000007    R1       B001     B001P1    10100202     NOX       6.986       7.296       2.4319       0.85         0.950      SCR        SCR added by LADCO
  39      1     0701000007    R2       B002     B002P1    10100202     NOX       3.633       3.794       1.2646       0.85         0.950      SCR        SCR added by LADCO
  39      1     0701000007    R3       B003     B003P1    10100202     NOX       5.013       5.235       1.7452       0.85         0.950      SCR        SCR added by LADCO
  39      1     0701000007    R4       B004     B004P1    10100202     NOX       7.849       8.197       2.7324       0.85         0.950      SCR        SCR added by LADCO
----                                                   --------    --------    ----------
fcid                                                       23.481      24.522      8.1740
cyid                                                       23.481      24.522      8.1740

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT
                                                    Base Yr     Grown     Controlled     Base Year    Future Year
STID    CYID       fcid       stkid    dvid     prid       scc       polid    Tons/Day    Tons/Day      Tons/Day     Control EF     Control EF    ctrltype          ctrldes

  39     31     0616000000     R4      B004     B004P1    10100212     NOX      20.852      21.776       1.0888       0.00         0.950      SCR        SCR added by LADCO


STID=39 CYID=167 fcid=0684000000 name=MUSKINGUM RIVER POWER PLANT
                                                    Base Yr     Grown     Controlled     Base Year    Future Year
STID    CYID       fcid       stkid    dvid     prid       scc       polid    Tons/Day    Tons/Day      Tons/Day     Control EF     Control EF    ctrltype          ctrldes

  39    167     0684000000     R1      B001     B001P1    10200501     NOX       0.002       0.002       0.0001       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R2      B002     B002P1    10100201     NOX       5.817       6.074       0.3037       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R2      B002     B002P2    10100501     NOX       0.000       0.000       0.0000       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R3      B003     B003P1    10100201     NOX       7.902       8.252       0.4126       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R3      B003     B003P2    10100501     NOX       0.000       0.000       0.0000       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R4      B004     B004P1    10100203     NOX       7.877       8.227       0.4113       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R4      B004     B004P2    10100501     NOX       0.000       0.000       0.0000       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R6      B006     B006P1    10100202     NOX       3.859       4.030       0.2015       0.00         0.950      SCR        SCR added by LADCO
  39    167     0684000000     R6      B006     B006P2    10100501     NOX       0.000       0.000       0.0000       0.00         0.950      SCR        SCR added by LADCO
----                                                   --------    --------    ----------
fcid                                                       25.456      26.584      1.3292
cyid                                                       25.456      26.584      1.3292
stid                                                       69.789      72.882     10.5920

STID=55 CYID=79 fcid=241007690 name=WIS ELECTRIC POWER OAK CREEK STATION
                                                    Base Yr     Grown     Controlled     Base Year    Future Year
STID    CYID       fcid       stkid    dvid     prid       scc       polid    Tons/Day    Tons/Day      Tons/Day     Control EF     Control EF    ctrltype          ctrldes

  55     79     241007690     S13     B25      01       10100202     NOX       4.755       5.421       3.0898       0.00         0.430      SCR        SCR added by LADCO
  55     79     241007690     S13     B26      01       10100202     NOX       3.277       3.736       2.2045       0.00         0.410      SCR        SCR added by LADCO
  55     79     241007690     S14     B27      01       10100212     NOX       3.333       3.800       2.8499       0.00         0.250      SCR        SCR added by LADCO
  55     79     241007690     S14     B28      01       10100212     NOX       3.384       3.857       2.9316       0.00         0.240      SCR        SCR added by LADCO
----                                                   --------    --------    ----------
fcid                                                       14.749      16.814     11.0757

STID=55 CYID=79 fcid=241007800 name=WIS ELECTRIC POWER VALLEY STATION
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                                                         Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID      fcid      stkid   dvid    prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

  55    79    241007800    S11     B21     01     10100202    NOX      2.797      3.189     1.8177      0.00        0.430       SCR       SCR added by LADCO
  55    79    241007800    S11     B22     01     10100202    NOX      2.907      3.314     1.8893      0.00        0.430       SCR       SCR added by LADCO
  55    79    241007800    S12     B23     01     10100202    NOX      2.327      2.653     1.4061      0.00        0.470       SCR       SCR added by LADCO
  55    79    241007800    S12     B24     01     10100202    NOX      2.343      2.671     1.4155      0.00        0.470       SCR       Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                10.374     11.827     6.5285
cyid                                                 25.123     28.641     17.6042



STID=55 CYID=117 fcid=460033090 name=WP & L Alliant Energy - Edgewater Gen Station
                                                         Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID      fcid      stkid   dvid    prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

  55   117    460033090    S11     B23     01     10100203    NOX      1.620      1.846     1.1079      0.00        0.400       SCR       SCR added by LADCO
  55   117    460033090    S11     B24     01     10100203    NOX      4.107      4.682     3.8395      0.00        0.180       SCR       SCR added by LADCO
  55   117    460033090    S12     B25     01     10100221    NOX      5.680      6.476     5.5045      0.00        0.150       SCR       SCR added by LADCO
----                                              --------   --------   ----------
fcid                                                11.407     13.005     10.4519
cyid                                                 11.407     13.005     10.4519
stid                                                36.530     41.646     28.0562
                                                 ========   ========   ==========
                                                 252.681    278.349     86.2773
```

NOx 2018

```
Point Source Grown and Controlled Emissions by facility for NOX r6s1b_2018                                          Base Year = 2002
Future Year = 2018

STID=17 CYID=31 fcid=031600AIN name=MIDWEST GENERATION LLC
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17   31   031600AIN   0010   0013   01   10100226   NOX    2.283    2.592   1.5550    0.00    0.400    SCR     SCR added by LADCO
 17   31   031600AIN   0010   0013   02   10100601   NOX    0.000    0.000   0.0000    0.00    0.400    SCR     SCR added by LADCO
 17   31   031600AIN   0012   0016   01   10100226   NOX    3.991    4.531   2.7184    0.00    0.400    SCR     SCR added by LADCO
 17   31   031600AIN   0012   0016   02   10100601   NOX    0.000    0.000   0.0000    0.00    0.400    SCR     SCR added by LADCO
----                                            --------  --------  ----------
fcid                                              6.274    7.122    4.2734
cyid                                              6.274    7.122    4.2734

STID=17 CYID=33 fcid=033801AAA name=AMEREN ENERGY GENERATING CO
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17   33   033801AAA   0005   0005   01   10100202   NOX    1.642    1.863   0.9317    0.00    0.500    SCR     SCR added by LADCO
 17   33   033801AAA   0006   0006   01   10100202   NOX    2.116    2.402   1.2012    0.00    0.500    SCR     SCR added by LADCO
----                                            --------  --------  ----------
fcid                                              3.758    4.266    2.1329
cyid                                              3.758    4.266    2.1329

STID=17 CYID=57 fcid=057801AAA name=AES DUCK CREEK
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17   57   057801AAA   0001   0001   01   10100202   NOX    0.815    0.925   0.9249    0.00    0.000    SCR     SCR added by LADCO

STID=17 CYID=79 fcid=079808AAA name=AMEREN ENERGY GENERATING CO
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17   79   079808AAA   0003   0003   01   10100202   NOX    6.735    7.645   7.6453    0.00    0.000    SCR     SCR added by LADCO
 17   79   079808AAA   0012   0013   01   10100501   NOX    5.936    3.984   3.9838    0.00    0.000    SCR     SCR added by LADCO
----                                            --------  --------  ----------
fcid                                             12.671   11.629   11.6291
cyid                                             12.671   11.629   11.6291


STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17   97   097190AAC   0016   0031   02   10100401   NOX    0.000    0.000   0.0000    0.00    0.999    SHUTDOWN   SCR added by LADCO

STID=17 CYID=137 fcid=137805AAA name=AMEREN ENERGY GENERATING CO
                                               Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype     ctrldes

 17  137   137805AAA   0003   0003   01   10100202   NOX    5.356    6.080   6.0798    0.00    0.000    LNB     LNB added by LADCO
```

```
STID=17 CYID=143 fcid=143805AAG name=AES ED EDWARDS STATION
                                                 Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid   scc       polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17  143   143805AAG   0001   0001   01    10100202   NOX     3.052     3.464    3.4641     0.00      0.000    lnb       LNB added by LADCO
 17  143   143805AAG   0001   0003   01    10100202   NOX     6.942     7.880    7.8804     0.00      0.000    lnb       LNB added by LADCO
 17  143   143805AAG   0002   0004   01    10100202   NOX     2.131     2.419    2.4191     0.00      0.000    lnb       LNB added by LADCO
----                                             --------  --------  ----------
fcid                                               12.124    13.764    13.7636
cyid                                               12.124    13.764    13.7636

STID=17 CYID=167 fcid=167120AAO name=CITY WATER LIGHT & POWER
                                                 Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid   scc       polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17  167   167120AAO   0010   0012   01    10100203   NOX     6.527     7.410    0.0074     0.00      0.999    SHUTDOWN   SHUTDOWN added by LADCO
 17  167   167120AAO   0010   0013   01    10100203   NOX     2.646     3.004    0.0030     0.00      0.999    SHUTDOWN   SHUTDOWN added by LADCO
----                                             --------  --------  ----------
fcid                                                9.173    10.414     0.0104
cyid                                                9.173    10.414     0.0104

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC
                                                 Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid   scc       polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17  179   179801AAA   0018   0029   01    10100203   NOX    22.429    25.462    1.2731     0.00      0.950    SCR       SCR added by LADCO
 17  179   179801AAA   0018   0031   01    10100203   NOX    38.993    44.265    2.2132     0.00      0.950    SCR       SCR added by LADCO
----                                             --------  --------  ----------
fcid                                               61.422    69.726     3.4863
cyid                                               61.422    69.726     3.4863


STID=17 CYID=197 fcid=197809AAO name=MIDWEST GENERATION LLC
                                                 Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid   scc       polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17  197   197809AAO   0032   0033   02    10100604   NOX     0.000     0.000    0.0000     0.00      0.800    SCR       SCR added by LADCO

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC
                                                 Base Yr   Grown   Controlled   Base Year   Future Year
STID  CYID  fcid       stkid  dvid  prid   scc       polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17  197   197810AAK   0011   0016   02    10100222   NOX     5.731     6.506    3.9036     0.00      0.400    SCR       SCR added by LADCO
 17  197   197810AAK   0011   0016   03    10100501   NOX     0.000     0.000    0.0000     0.00      0.400    SCR       SCR added by LADCO
 17  197   197810AAK   0013   0010   02    10100223   NOX     8.598     9.760    0.0098     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17  197   197810AAK   0013   0010   03    10100501   NOX     0.000     0.000    0.0000     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17  197   197810AAK   0007   0012   02    10100223   NOX    10.974    12.458    0.0125     0.00      0.999    SHUTDOWN  SCR added by LADCO
 17  197   197810AAK   0007   0012   03    10100501   NOX     0.000     0.000    0.0000     0.00      0.999    SHUTDOWN  SCR added by LADCO
----                                             --------  --------  ----------
fcid                                               25.303    28.724     3.9258
cyid                                               25.303    28.724     3.9258
stid                                              136.896   152.649    46.2263
```

```
STID=18 CYID=147 fcid=00020 name=INDIANA MICHIGAN POWER-ROCKPORT
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 18   147    00020       1       001     01      10100222    NOX      23.226     25.291     1.2646      0.00        0.950      SCR       SCR added by LADCO
 18   147    00020       1       001     02      10100501    NOX       0.000      0.000     0.0000      0.00        0.950      SCR       SCR added by LADCO
----                                              --------   --------   ----------
fcid                                                23.226     25.291      1.2646
cyid                                                23.226     25.291      1.2646
stid                                                23.226     25.291      1.2646

STID=27 CYID=61 fcid=2706100004 name=Minnesota Power Inc - Boswell Energy Ctr
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 27    61    2706100004   SV003   EU003   001     10100226    NOX      13.661     15.733     3.1466      0.00        0.800      SCR       SCR added by LADCO
 27    61    2706100004   SV003   EU003   002     10100501    NOX       0.000      0.000     0.0000      0.00        0.800      SCR       SCR added by LADCO
----                                              --------   --------   ----------
fcid                                                13.661     15.733      3.1466
cyid                                                13.661     15.733      3.1466


STID=27 CYID=109 fcid=2710900011 name=Rochester Public Utilities - Silver Lake
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 27   109    2710900011   SV003   EU004   001     10100202    NOX       2.079      2.394     1.4363      0.00        0.400      SNCR      SCR added by LADCO
----                                              --------   --------   ----------
stid                                                15.739     18.127      4.5830

STID=39 CYID=1 fcid=0701000007 name="DP&L, J.M. STUART GENERATING STATION"
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 39     1    0701000007   R1     B001   B001P1   10100202    NOX       6.986      7.607     2.5358      0.85        0.950      SCR       SCR added by LADCO
 39     1    0701000007   R2     B002   B002P1   10100202    NOX       3.633      3.956     1.3186      0.85        0.950      SCR       SCR added by LADCO
 39     1    0701000007   R3     B003   B003P1   10100202    NOX       5.013      5.459     1.8197      0.85        0.950      SCR       SCR added by LADCO
 39     1    0701000007   R4     B004   B004P1   10100202    NOX       7.849      8.547     2.8491      0.85        0.950      SCR       SCR added by LADCO
----                                              --------   --------   ----------
fcid                                                23.481     25.570      8.5232
cyid                                                23.481     25.570      8.5232

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 39    31    0616000000   R4     B004   B004P1   10100212    NOX      20.852     22.706     1.1353      0.00        0.950      SCR       SCR added by LADCO

STID=39 CYID=167 fcid=0684000000 name=MUSKINGUM RIVER POWER PLANT
                                                   Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid      scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype         ctrldes

 39   167    0684000000   R1     B001   B001P1   10200501    NOX       0.002      0.002     0.0001      0.00        0.950      SCR       SCR added by LADCO
```

```
 39  167  0684000000  R2   B002  B002P1  10100201  NOX    5.817   6.334   0.3167   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R2   B002  B002P2  10100501  NOX    0.000   0.000   0.0000   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R3   B003  B003P1  10100201  NOX    7.902   8.604   0.4302   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R3   B003  B003P2  10100501  NOX    0.000   0.000   0.0000   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R4   B004  B004P1  10100203  NOX    7.877   8.578   0.4289   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R4   B004  B004P2  10100501  NOX    0.000   0.000   0.0000   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R6   B006  B006P1  10100202  NOX    3.859   4.202   0.2101   0.00    0.950   SCR    SCR added by LADCO
 39  167  0684000000  R6   B006  B006P2  10100501  NOX    0.000   0.000   0.0000   0.00    0.950   SCR    SCR added by LADCO
----                                         --------  --------  ----------
fcid                                           25.456    27.720     1.3860
cyid                                           25.456    27.720     1.3860
stid                                           69.789    75.996    11.0445


STID=54 CYID=39 fcid=0006 name=APPALACHIAN POWER - KANAWHA RIVER PLANT
                                        Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid      stkid   dvid   prid    scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype     ctrldes

 54   39   0006     012   001   99    10100202   NOX    4.829    5.258    2.6291    0.00     0.500    SCR     Scrubber added by LADCO
 54   39   0006     012   002   99    10100202   NOX    4.921    5.359    2.6794    0.00     0.500    SCR     Scrubber added by LADCO
----                                         --------  --------  ----------
fcid                                            9.750    10.617     5.3085
cyid                                            9.750    10.617     5.3085
stid                                            9.750    10.617     5.3085


STID=55 CYID=79 fcid=241007690 name=WIS ELECTRIC POWER OAK CREEK STATION
                                        Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid      stkid   dvid   prid    scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype     ctrldes

 55   79   241007690   S13   B25   01    10100202   NOX    4.755    5.398    3.0766    0.00     0.430    SCR     SCR added by LADCO
 55   79   241007690   S13   B26   01    10100202   NOX    3.277    3.720    2.1951    0.00     0.410    SCR     SCR added by LADCO
 55   79   241007690   S14   B27   01    10100212   NOX    3.333    3.784    2.8378    0.00     0.250    SCR     SCR added by LADCO
 55   79   241007690   S14   B28   01    10100212   NOX    3.384    3.841    2.9191    0.00     0.240    SCR     SCR added by LADCO
----                                         --------  --------  ----------
fcid                                           14.749    16.743    11.0285

STID=55 CYID=79 fcid=241007800 name=WIS ELECTRIC POWER VALLEY STATION
                                        Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid      stkid   dvid   prid    scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype     ctrldes

 55   79   241007800   S11   B21   01    10100202   NOX    2.797    3.175    1.4289    0.00     0.550    SCR     SCR added by LADCO
 55   79   241007800   S11   B22   01    10100202   NOX    2.907    3.300    1.4852    0.00     0.550    SCR     SCR added by LADCO
 55   79   241007800   S12   B23   01    10100202   NOX    2.327    2.642    1.1887    0.00     0.550    SCR     SCR added by LADCO
 55   79   241007800   S12   B24   01    10100202   NOX    2.343    2.659    1.1967    0.00     0.550    SCR     SCR added by LADCO
----                                         --------  --------  ----------
fcid                                           10.374    11.777     5.2995
cyid                                           25.123    28.519    16.3281

STID=55 CYID=117 fcid=460033090 name=WP & L Alliant Energy - Edgewater Gen Station
                                        Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid      stkid   dvid   prid    scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype     ctrldes

 55   117   460033090   S11   B23   01    10100203   NOX    1.620    1.839    1.1032    0.00     0.400    SCR     SCR added by LADCO
```

```
 55  117   460033090   S11   B24   01    10100203   NOX    4.107   4.662   3.8232   0.00   0.180   SCR   SCR added by LADCO
 55  117   460033090   S12   B25   01    10100221   NOX    5.680   6.448   5.4811   0.00   0.150   SCR   SCR added by LADCO
----                                    --------  --------  ----------
fcid                                      11.407    12.949    10.4074
cyid                                      11.407    12.949    10.4074
stid                                      36.530    41.469    26.7355
                                       ========  ========  ==========
                                        291.931   324.149    95.1624
```

SO2 – 2009

```
Point Source Grown and Controlled Emissions by facility for SO2 r6s1b_2009                                    1
Base Year = 2002
Future Year = 2009

STID=19 CYID=115 fcid=58-07-001 name=MIDAMERICAN ENERGY CO. - LOUISA STATION
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 19   115    58-07-001    117487   147281   99    10100222    SO2      33.664     34.774      3.4774       0.0         0.90     SCRUBBER    Scrubber added by LADCO

STID=21 CYID=161 fcid=2116100009 name=EAST KY POWER COOP
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 21   161    2116100009   1      001     99    10100202    SO2      42.166     42.103      4.2103       0.0         0.90     SCRUBBER    Scrubber added by LADCO
 21   161    2116100009   2      002     99    10100212    SO2      55.385     55.303      5.5303       0.0         0.90     SCRUBBER    Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            97.551     97.406      9.7406
cyid                                             97.551     97.406      9.7406
stid                                            97.551     97.406      9.7406

STID=27 CYID=141 fcid=2714100004 name=NSP - Sherburne Generating Plant
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 27   141    2714100004   SV001    EU001    001    10100222    SO2      16.765     16.987      3.6401       0.3         0.85     SCRUBBER    Scrubber added by LADCO
 27   141    2714100004   SV001    EU002    001    10100222    SO2      22.549     22.848      4.8959       0.3         0.85     SCRUBBER    Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            39.314     39.834      8.5360
cyid                                             39.314     39.834      8.5360
stid                                            39.314     39.834      8.5360

STID=54 CYID=51 fcid=0005 name=OHIO POWER - MITCHELL PLANT
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 54   51   0005       012     001     99    10100202    SO2      17.775     17.748      1.7748       0.0         0.90     SCRUBBER    Scrubber added by LADCO
 54   51   0005       012     002     99    10100202    SO2       5.689      5.680     0.5680       0.0         0.90     SCRUBBER    Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            23.463     23.428      2.3428
cyid                                             23.463     23.428      2.3428


STID=54 CYID=53 fcid=0009 name=APPALACHIAN POWER - MOUNTAINEER PLANT
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 54   53   0009       001     001     99    10100202    SO2      11.196     11.179      1.1179       0.0         0.90     SCRUBBER    Scrubber added by LADCO


STID=54 CYID=79 fcid=0006 name=APPALACHIAN POWER - JOHN E AMOS PLANT
                                              Base Yr    Grown    Controlled    Base Year    Future Year
STID   CYID   fcid       stkid   dvid    prid    scc     polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes
```

```
  54   79   0006      012     001     99    10100202    SO2      79.635     79.516     7.9516       0.0        0.90    SCRUBBER   Scrubber added by LADCO
  54   79   0006      003     003     99    10100202    SO2     139.377    139.169    13.9169       0.0        0.90    SCRUBBER   Scrubber added by LADCO
----                                                  --------  --------  ----------
fcid                                                   219.012   218.685     21.8685
cyid                                                   219.012   218.685     21.8685
stid                                                   253.671   253.293     25.3293
                                                     ========  ========  ==========
                                                      424.200   425.307     47.0832
```

SO2 – 2012

```
Point Source Grown and Controlled Emissions by facility for SO2 r6s1b_2012                                                 1
Base Year = 2002
Future Year = 2012

STID=17 CYID=31 fcid=031600AMI name=MIDWEST GENERATION LLC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid    scc     polid  Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17    31    031600AMI    0007    0010    01     10100226   SO2      16.13      18.39      1.839       0.0        0.900      SCRUBBER   Scrubber added by LADCO

STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid    scc     polid  Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17    97    097190AAC    0018    0033    01     10100226   SO2      24.14      27.52      2.752       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    97    097190AAC    0021    0036    01     10100226   SO2      19.23      21.92      2.192       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    97    097190AAC    0016    0031    01     10100203   SO2       4.59       5.24      0.005      0.0        0.999     SHUTDOWN   Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                               47.96      54.68      4.950
cyid                                               47.96      54.68      4.950

STID=17 CYID=125 fcid=125804AAB name=DYNEGY MIDWEST GENERATION INC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid    scc     polid  Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17   125    125804AAB    0019    0023    01     10100202   SO2      22.34      25.47      3.821       0.0        0.850      SCRUBBER   Scrubber added by LADCO

STID=17 CYID=127 fcid=127855AAC name=ELECTRIC ENERGY INC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid    scc     polid  Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17   127    127855AAC    0001    0001    01     10100222   SO2      11.83      13.48      13.482      0.0        0.000      LNB        LNB added by LADCO
 17   127    127855AAC    0001    0002    01     10100222   SO2      11.48      13.09      13.085      0.0        0.000      LNB        LNB added by LADCO
 17   127    127855AAC    0002    0003    01     10100222   SO2      10.25      11.68      11.680      0.0        0.000      LNB        LNB added by LADCO
 17   127    127855AAC    0002    0004    01     10100222   SO2      12.04      13.73      13.731      0.0        0.000      LNB        LNB added by LADCO
 17   127    127855AAC    0003    0006    01     10100222   SO2      12.68      14.46      14.456      0.0        0.000      LNB        LNB added by LADCO
----                                              --------   --------   ----------
fcid                                               58.27      66.43      66.435
cyid                                               58.27      66.43      66.435



STID=17 CYID=135 fcid=135803AAA name=AMEREN ENERGY GENERATING CO
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid       stkid   dvid   prid    scc     polid  Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17   135    135803AAA    0001    0001    01     10100203   SO2      32.99      37.61      3.761       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17   135    135803AAA    0001    0003    01     10100203   SO2      72.92      83.13      8.313       0.0        0.900      SCRUBBER   Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                              105.91     120.74      12.074
cyid                                              105.91     120.74      12.074
```

```
STID=17 CYID=157 fcid=157851AAA name=DYNEGY MIDWEST GENERATION INC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes

  17   157    157851AAA    0001    0001    01     10100203   SO2     25.14     28.66      4.299       0.0        0.850      SCRUBBER    Scrubber added by LADCO
  17   157    157851AAA    0002    0002    01     10100203   SO2     25.79     29.41      4.411       0.0        0.850      SCRUBBER    Scrubber added by LADCO
  17   157    157851AAA    0013    0013    01     10100202   SO2     27.79     31.68      4.752       0.0        0.850      SCRUBBER    Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                 78.72     89.75     13.462
cyid                                                 78.72     89.75     13.462

STID=17 CYID=167 fcid=167120AAO name=CITY WATER LIGHT & POWER
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes

  17   167    167120AAO    0010    0012    01     10100203   SO2     44.20     50.39      0.050       0.0        0.999      SHUTDOWN    Scrubber added by LADCO
  17   167    167120AAO    0010    0013    01     10100203   SO2     16.40     18.70      0.019       0.0        0.999      SHUTDOWN    Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                 60.61     69.10      0.069
cyid                                                 60.61     69.10      0.069

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes

  17   179    179801AAA    0018    0029    01     10100203   SO2     25.35     28.90      2.890       0.0        0.900      SCRUBBER    Scrubber added by LADCO
  17   179    179801AAA    0018    0031    01     10100203   SO2     41.57     47.39      4.739       0.0        0.900      SCRUBBER    Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                 66.91     76.29      7.629
cyid                                                 66.91     76.29      7.629

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes

  17   197    197810AAK    0013    0010    03     10100501   SO2      0.00      0.00      0.000       0.0        0.999      SHUTDOWN    Scrubber added by LADCO
  17   197    197810AAK    0007    0012    02     10100223   SO2     15.33     17.48      0.017       0.0        0.999      SHUTDOWN    Scrubber added by LADCO
  17   197    197810AAK    0007    0012    03     10100501   SO2      0.00      0.00      0.000       0.0        0.999      SHUTDOWN    Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                 15.33     17.48      0.017
cyid                                                 15.33     17.48      0.017
stid                                                472.19    538.32    110.295


STID=19 CYID=115 fcid=58-07-001 name=MIDAMERICAN ENERGY CO. - LOUISA STATION
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes

  19   115    58-07-001   117487  147281   99     10100222   SO2     33.66     38.38      3.838       0.0        0.900      SCRUBBER    Scrubber added by LADCO


STID=21 CYID=161 fcid=2116100009 name=EAST KY POWER COOP
                                                  Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid    scc       polid  Tons/Day   Tons/Day    Tons/Day    Control EF   Control EF   ctrltype       ctrldes
```

```
 21  161   2116100009  1      001    99     10100202   SO2     42.17    44.03     4.403      0.0      0.900    SCRUBBER   Scrubber added by LADCO
 21  161   2116100009  2      002    99     10100212   SO2     55.39    57.84     5.784      0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                        --------  --------  ----------
fcid                                          97.55    101.87    10.187
cyid                                          97.55    101.87    10.187
stid                                          97.55    101.87    10.187


STID=27 CYID=61 fcid=2706100004 name=Minnesota Power Inc - Boswell Energy Ctr
                                            Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 27    61   2706100004  SV003   EU003   001     10100226   SO2     33.99    35.19    15.081      0.3      0.700    SCRUBBER   Scrubber added by LADCO
 27    61   2706100004  SV003   EU003   002     10100501   SO2      0.00     0.00     0.000      0.3      0.700    SCRUBBER   Scrubber added by LADCO
----                                        --------  --------  ----------
fcid                                          33.99     35.19    15.081
cyid                                          33.99     35.19    15.081

STID=27 CYID=109 fcid=2710900011 name=Rochester Public Utilities - Silver Lake
                                            Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 27   109   2710900011  SV003   EU004   001     10100202   SO2      7.86     8.13     1.220      0.0      0.850    SCRUBBER   Scrubber added by LADCO
STID=27 CYID=141 fcid=2714100004 name=NSP - Sherburne Generating Plant
                                            Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 27   141   2714100004  SV001   EU001   001     10100222   SO2     16.76    17.36     3.719      0.3      0.850    SCRUBBER   Scrubber added by LADCO
 27   141   2714100004  SV001   EU002   001     10100222   SO2     22.55    23.34     5.002      0.3      0.850    SCRUBBER   Scrubber added by LADCO
----                                        --------  --------  ----------
fcid                                          39.31     40.70     8.721
cyid                                          39.31     40.70     8.721
stid                                          81.16     84.02    25.023

STID=39 CYID=13 fcid=0607130015 name=R. E. BURGER PLANT
                                            Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 39    13   0607130015  R6      B011    B011P1  10100202   SO2     29.83    31.15     3.115      0.0      0.900    SCRUBBER   Scrubber added by LADCO
 39    13   0607130015  R7      B012    B012P1  10100202   SO2     34.77    36.31     3.631      0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                        --------  --------  ----------
fcid                                          64.60     67.46     6.746
cyid                                          64.60     67.46     6.746

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT
                                            Base Yr    Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 39    31   0616000000  R4      B004    B004P1  10100212   SO2    316.00   330.00    33.000      0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                        --------  --------  ----------
stid                                         380.60    397.46    39.746

STID=47 CYID=1 fcid=0009 name=TVA BULL RUN FOSSIL PLANT
```

```
                                                   Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID  fcid      stkid  dvid   prid      scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 47    1   0009     S-1    001    99    10100212   SO2    130.81    133.01    13.301      0.0        0.900     SCRUBBER   Scrubber added by LADCO

STID=47 CYID=73 fcid=0007 name=TVA JOHN SEVIER FOSSIL PLANT
                                                   Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID  fcid      stkid  dvid   prid      scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 47   73   0007     S-1A   001    99    10100212   SO2     20.15     20.49     2.049      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47   73   0007     S-1B   002    99    10100212   SO2     20.25     20.59     2.059      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47   73   0007     S-2A   003    99    10100212   SO2     19.62     19.95     1.995      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47   73   0007     S-2B   004    99    10100212   SO2     18.93     19.25     1.925      0.0        0.900     SCRUBBER   Scrubber added by LADCO
----                                               --------   --------   ----------
fcid                                                78.95     80.28      8.028
cyid                                                 78.95     80.28      8.028

STID=47 CYID=85 fcid=0011 name=TVA JOHNSONVILLE FOSSIL PLANT
                                                   Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID  fcid      stkid  dvid   prid      scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 47   85   0011     S1-01  001    99    10100212   SO2     17.06     17.35     1.735      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47   85   0011     S1-04  004    99    10100212   SO2     19.85     20.18     2.018      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47   85   0011     S1-05  005    99    10100212   SO2     24.11     24.52     2.452      0.0        0.900     SCRUBBER   Scrubber added by LADCO
----                                               --------   --------   ----------
fcid                                                61.02     62.04      6.204
cyid                                                 61.02     62.04      6.204

STID=47 CYID=145 fcid=0013 name=TVA KINGSTON FOSSIL PLANT
                                                   Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID  fcid      stkid  dvid   prid      scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 47  145   0013     S-1    001    99    10100202   SO2     12.68     12.89     1.289      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    002    99    10100202   SO2     14.00     14.24     1.424      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    003    99    10100202   SO2     13.80     14.04     1.404      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    004    99    10100202   SO2     12.24     12.44     1.244      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    005    99    10100202   SO2     19.57     19.90     1.990      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    006    99    10100202   SO2     18.92     19.24     1.924      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    007    99    10100202   SO2     21.30     21.66     2.166      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    008    99    10100202   SO2     18.54     18.85     1.885      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    009    99    10100202   SO2     20.72     21.07     2.107      0.0        0.900     SCRUBBER   Scrubber added by LADCO
----                                               --------   --------   ----------
fcid                                               151.77    154.33     15.433
cyid                                                151.77    154.33     15.433

STID=47 CYID=165 fcid=0025 name=TVA GALLATIN FOSSIL PLANT
                                                   Base Yr    Grown    Controlled   Base Year   Future Year
STID  CYID  fcid      stkid  dvid   prid      scc      polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF   ctrltype        ctrldes

 47  165   0025     S-01   001    99    10100212   SO2     13.91     14.14     1.414      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-01   002    99    10100212   SO2     14.87     15.12     1.512      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-02   003    99    10100212   SO2     16.33     16.60     1.660      0.0        0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-02   004    99    10100212   SO2     20.39     20.73     2.073      0.0        0.900     SCRUBBER   Scrubber added by LADCO
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fcid                                                  65.49     66.59     6.659
cyid                                                  65.49     66.59     6.659
stid                                                 488.04    496.25    49.625

STID=54 CYID=51 fcid=0005 name=OHIO POWER - MITCHELL PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype      ctrldes

  54   51   0005      012    001   99   10100202   SO2     17.77     18.56     1.856      0.0        0.900    SCRUBBER   Scrubber added by LADCO
  54   51   0005      012    002   99   10100202   SO2      5.69      5.94     0.594      0.0        0.900    SCRUBBER   Scrubber added by LADCO
----                                               --------  --------  ----------
fcid                                                  23.46     24.50     2.450
cyid                                                  23.46     24.50     2.450

STID=54 CYID=53 fcid=0009 name=APPALACHIAN POWER - MOUNTAINEER PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype      ctrldes

  54   53   0009      001    001   99   10100202   SO2     11.20     11.69     1.169      0.0        0.900    SCRUBBER   Scrubber added by LADCO

STID=54 CYID=79 fcid=0006 name=APPALACHIAN POWER - JOHN E AMOS PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype      ctrldes

  54   79   0006      012    001   99   10100202   SO2     79.63     83.16     8.316      0.0        0.900    SCRUBBER   Scrubber added by LADCO
  54   79   0006      012    002   99   10100202   SO2    100.33    104.78    10.478      0.0        0.900    SCRUBBER   Scrubber added by LADCO
  54   79   0006      003    003   99   10100202   SO2    139.38    145.55    14.555      0.0        0.900    SCRUBBER   Scrubber added by LADCO
----                                               --------  --------  ----------
fcid                                                 319.35    333.50    33.350
cyid                                                 319.35    333.50    33.350
stid                                                 354.00    369.69    36.969

STID=55 CYID=79 fcid=241007690 name=WIS ELECTRIC POWER OAK CREEK STATION
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc      polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype      ctrldes

  55   79   241007690  S13   B25   01   10100202   SO2     12.75     14.54     3.490      0.0        0.760    SCRUBBER   Scrubber added by LADCO
  55   79   241007690  S13   B26   01   10100202   SO2      8.68      9.89     2.473      0.0        0.750    SCRUBBER   Scrubber added by LADCO
  55   79   241007690  S14   B27   01   10100212   SO2     10.97     12.51     2.876      0.0        0.770    SCRUBBER   Scrubber added by LADCO
  55   79   241007690  S14   B28   01   10100212   SO2     11.28     12.86     2.958      0.0        0.770    SCRUBBER   Scrubber added by LADCO
----                                               --------  --------  ----------
fcid                                                  43.68     49.80    11.797
cyid                                                  43.68     49.80    11.797
stid                                                  43.68     49.80    11.797
                                                   ========  ========  ==========
                                                    1950.90   2075.80   287.480
```

SO2 – 2018

```
Point Source Grown and Controlled Emissions by facility for SO2 r6s1b_2018                                              1
Base Year = 2002
Future Year = 2018

STID=17 CYID=31 fcid=031600AIN name=MIDWEST GENERATION LLC
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 17    31    031600AIN    0010    0013    01      10100226    SO2      10.92      12.39      1.239       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    31    031600AIN    0012    0016    01      10100226    SO2      17.69      20.08      2.008       0.0        0.900      SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
fcid                                                 28.61     32.48     3.248

STID=17 CYID=31 fcid=031600AMI name=MIDWEST GENERATION LLC
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 17    31    031600AMI    0007    0010    01      10100226    SO2      16.13      18.31      1.831       0.0        0.900      SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
cyid                                                  44.74     50.79     5.079

STID=17 CYID=79 fcid=079808AAA name=AMEREN ENERGY GENERATING CO
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 17    79    079808AAA    0003    0003    01      10100202    SO2      36.35      41.27      4.127       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    79    079808AAA    0012    0013    01      10100501    SO2      28.99      19.46      1.946       0.0        0.900      SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
fcid                                                 65.34     60.72     6.072
cyid                                                  65.34     60.72     6.072

STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 17    97    097190AAC    0018    0033    01      10100226    SO2      24.14      27.40      2.740       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    97    097190AAC    0021    0036    01      10100226    SO2      19.23      21.83      2.183       0.0        0.900      SCRUBBER   Scrubber added by LADCO
 17    97    097190AAC    0016    0031    01      10100203    SO2       4.59       5.22      0.005       0.0        0.999      SHUTDOWN   Scrubber added by LADCO
----                                                --------  --------  ----------
fcid                                                 47.96     54.45     4.928
cyid                                                  47.96     54.45     4.928


STID=17 CYID=125 fcid=125804AAB name=DYNEGY MIDWEST GENERATION INC
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 17   125    125804AAB    0019    0023    01      10100202    SO2      22.34      25.36      3.805       0.0        0.850      SCRUBBER   Scrubber added by LADCO

STID=17 CYID=127 fcid=127855AAC name=ELECTRIC ENERGY INC
                                                     Base Yr   Grown    Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid    prid      scc       polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes
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```
 17  127   127855AAC   0002   0003   01    10100222   SO2    10.25    11.63    11.630     0.0      0.000    LNB      LNB added by LADCO
 17  127   127855AAC   0002   0004   01    10100222   SO2    12.04    13.67    13.673     0.0      0.000    LNB      LNB added by LADCO
 17  127   127855AAC   0001   0001   01    10100222   SO2    11.83    13.42     1.342     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 17  127   127855AAC   0001   0002   01    10100222   SO2    11.48    13.03     1.303     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 17  127   127855AAC   0003   0005   01    10100222   SO2    11.72    13.31     1.331     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 17  127   127855AAC   0003   0006   01    10100222   SO2    12.68    14.39     1.439     0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            70.00     79.46     30.719
cyid                                            70.00     79.46     30.719

STID=17 CYID=135 fcid=135803AAA name=AMEREN ENERGY GENERATING CO
                                          Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17  135   135803AAA   0001   0001   01    10100203   SO2    32.99    37.45     3.745     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 17  135   135803AAA   0001   0003   01    10100203   SO2    72.92    82.77     8.277     0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                          ---------   --------   ----------
fcid                                           105.91    120.22     12.022
cyid                                           105.91    120.22     12.022

STID=17 CYID=143 fcid=143805AAG name=AES ED EDWARDS STATION
                                          Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17  143   143805AAG   0002   0004   01    10100202   SO2    15.28    17.34     1.734     0.0      0.900    SCRUBBER   Scrubber added by LADCO

STID=17 CYID=157 fcid=157851AAA name=DYNEGY MIDWEST GENERATION INC
                                          Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17  157   157851AAA   0001   0001   01    10100203   SO2    25.14    28.54     4.281     0.0      0.850    SCRUBBER   Scrubber added by LADCO
 17  157   157851AAA   0002   0002   01    10100203   SO2    25.79    29.28     4.392     0.0      0.850    SCRUBBER   Scrubber added by LADCO
 17  157   157851AAA   0013   0013   01    10100202   SO2    27.79    31.54     4.732     0.0      0.850    SCRUBBER   Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            78.72     89.36     13.404
cyid                                            78.72     89.36     13.404

STID=17 CYID=167 fcid=167120AAO name=CITY WATER LIGHT & POWER
                                          Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17  167   167120AAO   0010   0012   01    10100203   SO2    44.20    50.18     0.050     0.0      0.999    SHUTDOWN   Scrubber added by LADCO
 17  167   167120AAO   0010   0013   01    10100203   SO2    16.40    18.62     0.019     0.0      0.999    SHUTDOWN   Scrubber added by LADCO
----                                          --------   --------   ----------
fcid                                            60.61     68.80      0.069
cyid                                            60.61     68.80      0.069

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC
                                          Base Yr    Grown    Controlled    Base Year   Future Year
STID   CYID   fcid       stkid   dvid    prid     scc      polid  Tons/Day  Tons/Day    Tons/Day    Control EF    Control EF   ctrltype        ctrldes

 17  179   179801AAA   0018   0029   01    10100203   SO2    25.35    28.77     2.877     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 17  179   179801AAA   0018   0031   01    10100203   SO2    41.57    47.19     4.719     0.0      0.900    SCRUBBER   Scrubber added by LADCO
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fcid                                              66.91    75.96     7.596
cyid                                              66.91    75.96     7.596

STID=17 CYID=197 fcid=197809AAO name=MIDWEST GENERATION LLC
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17   197   197809AAO   0006   0009   01     10100203   SO2     15.89    18.04     1.804     0.0       0.900     SCRUBBER   Scrubber added by LADCO
 17   197   197809AAO   0016   0031   01     10100202   SO2     27.43    31.13     3.113     0.0       0.900     SCRUBBER   Scrubber added by LADCO
 17   197   197809AAO   0017   0033   01     10100202   SO2     23.13    26.26     2.626     0.0       0.900     SCRUBBER   Scrubber added by LADCO
----                                             --------  --------  ----------
fcid                                              66.45    75.44     7.544

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 17   197   197810AAK   0009   0014   02     10100222   SO2     11.64    13.21     1.321     0.0       0.900     SCRUBBER   Scrubber added by LADCO
 17   197   197810AAK   0011   0016   02     10100222   SO2     25.67    29.14     2.914     0.0       0.900     SCRUBBER   Scrubber added by LADCO
 17   197   197810AAK   0013   0010   03     10100501   SO2      0.00     0.00     0.000     0.0       0.999    SHUTDOWN   Scrubber added by LADCO
 17   197   197810AAK   0007   0012   02     10100223   SO2     15.33    17.40     0.017     0.0       0.999     SHUTDOWN   Scrubber added by LADCO
 17   197   197810AAK   0007   0012   03     10100501   SO2      0.00     0.00     0.000     0.0       0.999    SHUTDOWN   Scrubber added by LADCO
----                                             --------  --------  ----------
fcid                                              52.64    59.75     4.252
cyid                                             119.09   135.19    11.796
stid                                             696.90   777.66    97.225

STID=18 CYID=147 fcid=00020 name=INDIANA MICHIGAN POWER-ROCKPORT
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 18   147   00020      1     001    01    10100222   SO2    66.42    72.32     7.232     0.0      0.900    SCRUBBER   Scrubber added by LADCO
 18   147   00020      1     001    02    10100501   SO2     0.00     0.00     0.000     0.0      0.900    SCRUBBER   Scrubber added by LADCO
----                                             --------  --------  ----------
fcid                                              66.42    72.32     7.232
cyid                                              66.42    72.32     7.232
stid                                              66.42    72.32     7.232

STID=19 CYID=115 fcid=58-07-001 name=MIDAMERICAN ENERGY CO. - LOUISA STATION
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 19   115   58-07-001   117487   147281   99     10100222   SO2     33.66    38.22     3.822     0.0       0.900     SCRUBBER   Scrubber added by LADCO

STID=21 CYID=127 fcid=2112700003 name=KENTUCKY POWER CO
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes

 21   127   2112700003   2     002    99     10100202   SO2    104.52   113.82    11.382     0.0      0.900     SCRUBBER   Scrubber added by LADCO

STID=21 CYID=161 fcid=2116100009 name=EAST KY POWER COOP
                                                 Base Yr    Grown   Controlled   Base Year   Future Year
STID   CYID   fcid        stkid   dvid   prid     scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF   Control EF  ctrltype       ctrldes
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  21   161    2116100009   1       001      99      10100202    SO2      42.17      45.92      4.592       0.0        0.900     SCRUBBER    Scrubber added by LADCO
  21   161    2116100009   2       002      99      10100212    SO2      55.39      60.31      6.031       0.0        0.900     SCRUBBER    Scrubber added by LADCO
----                                                 --------   --------   ----------
fcid                                                  97.55      106.23      10.623
cyid                                                   97.55     106.23      10.623
stid                                                 202.07     220.04      22.004

STID=27 CYID=61 fcid=2706100004 name=Minnesota Power Inc - Boswell Energy Ctr
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes

  27    61    2706100004   SV003     EU003    001      10100226    SO2      33.99      39.15      16.778       0.3        0.700     SCRUBBER    Scrubber added by LADCO
  27    61    2706100004   SV003     EU003    002      10100501    SO2       0.00       0.00      0.000       0.3        0.700     SCRUBBER    Scrubber added by LADCO
----                                                 --------   --------   ----------
fcid                                                  33.99      39.15      16.778
cyid                                                   33.99      39.15      16.778

STID=27 CYID=109 fcid=2710900011 name=Rochester Public Utilities - Silver Lake
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes

  27    109    2710900011   SV003     EU004    001      10100202    SO2       7.86       9.05      1.357       0.0        0.850     SCRUBBER    Scrubber added by LADCO

STID=27 CYID=141 fcid=2714100004 name=NSP - Sherburne Generating Plant
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes

  27    141    2714100004   SV001     EU001    001      10100222    SO2      16.76      19.31      4.138       0.3        0.850     SCRUBBER    Scrubber added by LADCO
  27    141    2714100004   SV001     EU002    001      10100222    SO2      22.55      25.97      5.565       0.3        0.850     SCRUBBER    Scrubber added by LADCO
----                                                 --------   --------   ----------
fcid                                                  39.31      45.28       9.703
cyid                                                   39.31      45.28       9.703
stid                                                  81.16      93.48      27.838

STID=39 CYID=13 fcid=0607130015 name=R. E. BURGER PLANT
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes

  39    13    0607130015   R6      B011     B011P1   10100202    SO2      29.83      32.48      3.248       0.0        0.900     SCRUBBER    Scrubber added by LADCO
  39    13    0607130015   R7      B012     B012P1   10100202    SO2      34.77      37.86      3.786       0.0        0.900     SCRUBBER    Scrubber added by LADCO
----                                                 --------   --------   ----------
fcid                                                  64.60      70.34       7.034
cyid                                                   64.60      70.34       7.034

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes

  39    31    0616000000   R4      B004     B004P1   10100212    SO2     316.00     344.11      34.411       0.0        0.900     SCRUBBER    Scrubber added by LADCO

STID=39 CYID=167 fcid=0684000000 name=MUSKINGUM RIVER POWER PLANT
                                                     Base Yr     Grown    Controlled    Base Year    Future Year
STID    CYID    fcid        stkid    dvid      prid      scc      polid   Tons/Day    Tons/Day     Tons/Day     Control EF     Control EF   ctrltype          ctrldes
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 39  167  0684000000  R2   B002  B002P1  10100201  SO2   65.07   70.85   7.085   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R2   B002  B002P2  10100501  SO2    0.00    0.00   0.000   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R3   B003  B003P1  10100201  SO2   94.58  103.00  10.300   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R3   B003  B003P2  10100501  SO2    0.00    0.00   0.000   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R4   B004  B004P1  10100203  SO2   81.64   88.90   8.890   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R4   B004  B004P2  10100501  SO2    0.00    0.00   0.000   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R5   B005  B005P1  10100203  SO2   97.22  105.87  10.587   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R5   B005  B005P2  10100501  SO2    0.00    0.00   0.000   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R6   B006  B006P1  10100202  SO2  113.96  124.10  12.410   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 39  167  0684000000  R6   B006  B006P2  10100501  SO2    0.00    0.00   0.000   0.0   0.900  SCRUBBER  Scrubber added by LADCO
----                                                 --------  --------  ----------
fcid                                                  452.48   492.72   49.272
cyid                                                  452.48   492.72   49.272
stid                                                  833.08   907.16   90.716


STID=47 CYID=1 fcid=0009 name=TVA BULL RUN FOSSIL PLANT
                                                Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID  fcid   stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype   ctrldes

 47   1   0009    S-1   001   99   10100212  SO2   130.81   136.82   13.682   0.0   0.900  SCRUBBER  Scrubber added by LADCO

STID=47 CYID=73 fcid=0007 name=TVA JOHN SEVIER FOSSIL PLANT
                                                Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID  fcid   stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype   ctrldes

 47   73   0007   S-1A   001   99   10100212  SO2   20.15   21.07   2.107   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47   73   0007   S-1B   002   99   10100212  SO2   20.25   21.18   2.118   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47   73   0007   S-2A   003   99   10100212  SO2   19.62   20.52   2.052   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47   73   0007   S-2B   004   99   10100212  SO2   18.93   19.80   1.980   0.0   0.900  SCRUBBER  Scrubber added by LADCO
----                                                 --------  --------  ----------
fcid                                                   78.95    82.57    8.257
cyid                                                   78.95    82.57    8.257

STID=47 CYID=85 fcid=0011 name=TVA JOHNSONVILLE FOSSIL PLANT
                                                Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID  fcid   stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype   ctrldes

 47   85   0011   S1-01  001   99   10100212  SO2   17.06   17.84   1.784   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47   85   0011   S1-04  004   99   10100212  SO2   19.85   20.76   2.076   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47   85   0011   S1-05  005   99   10100212  SO2   24.11   25.22   2.522   0.0   0.900  SCRUBBER  Scrubber added by LADCO
----                                                 --------  --------  ----------
fcid                                                   61.02    63.82    6.382
cyid                                                   61.02    63.82    6.382



STID=47 CYID=145 fcid=0013 name=TVA KINGSTON FOSSIL PLANT
                                                Base Yr   Grown   Controlled  Base Year  Future Year
STID  CYID  fcid   stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day  Tons/Day  Control EF  Control EF  ctrltype   ctrldes

 47  145   0013   S-1   001   99   10100202  SO2   12.68   13.26   1.326   0.0   0.900  SCRUBBER  Scrubber added by LADCO
 47  145   0013   S-1   002   99   10100202  SO2   14.00   14.65   1.465   0.0   0.900  SCRUBBER  Scrubber added by LADCO
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 47  145   0013     S-1    003    99     10100202   SO2     13.80    14.44     1.444     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    004    99     10100202   SO2     12.24    12.80     1.280     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-1    005    99     10100202   SO2     19.57    20.47     2.047     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    006    99     10100202   SO2     18.92    19.79     1.979     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    007    99     10100202   SO2     21.30    22.28     2.228     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    008    99     10100202   SO2     18.54    19.39     1.939     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  145   0013     S-2    009    99     10100202   SO2     20.72    21.68     2.168     0.0      0.900     SCRUBBER   Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                               151.77     158.75     15.875
cyid                                               151.77     158.75     15.875

STID=47 CYID=165 fcid=0025 name=TVA GALLATIN FOSSIL PLANT
                                                  Base Yr     Grown    Controlled    Base Year   Future Year
STID   CYID   fcid      stkid   dvid    prid       scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 47  165   0025     S-01    001    99     10100212   SO2     13.91    14.54     1.454     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-01    002    99     10100212   SO2     14.87    15.56     1.556     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-02    003    99     10100212   SO2     16.33    17.08     1.708     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 47  165   0025     S-02    004    99     10100212   SO2     20.39    21.32     2.132     0.0      0.900     SCRUBBER   Scrubber added by LADCO
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fcid                                                65.49      68.50      6.850
cyid                                                65.49      68.50      6.850
stid                                               488.04     510.46     51.046


STID=54 CYID=39 fcid=0006 name=APPALACHIAN POWER - KANAWHA RIVER PLANT
                                                  Base Yr     Grown    Controlled    Base Year   Future Year
STID   CYID   fcid      stkid   dvid    prid       scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 54   39   0006      012    001    99    10100202   SO2     19.45    21.18    10.591     0.0      0.500     SCRUBBER   Scrubber added by LADCO
 54   39   0006      012    002    99    10100202   SO2     20.94    22.80    11.399     0.0      0.500     SCRUBBER   Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                40.39      43.98     21.990
cyid                                                40.39      43.98     21.990



STID=54 CYID=51 fcid=0005 name=OHIO POWER - MITCHELL PLANT
                                                  Base Yr     Grown    Controlled    Base Year   Future Year
STID   CYID   fcid      stkid   dvid    prid       scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 54   51   0005      012    001    99    10100202   SO2     17.77    19.36     1.936     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 54   51   0005      012    002    99    10100202   SO2      5.69     6.19     0.619     0.0      0.900     SCRUBBER   Scrubber added by LADCO
----                                              --------   --------   ----------
fcid                                                23.46      25.55      2.555

STID=54 CYID=51 fcid=0006 name=OHIO POWER - KAMMER PLANT
                                                  Base Yr     Grown    Controlled    Base Year   Future Year
STID   CYID   fcid      stkid   dvid    prid       scc      polid   Tons/Day   Tons/Day    Tons/Day    Control EF    Control EF   ctrltype       ctrldes

 54   51   0006      013    001    99    10100203   SO2     47.06    51.25     5.125     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 54   51   0006      013    002    99    10100203   SO2     47.66    51.90     5.190     0.0      0.900     SCRUBBER   Scrubber added by LADCO
 54   51   0006      013    003    99    10100203   SO2     41.94    45.67     4.567     0.0      0.900     SCRUBBER   Scrubber added by LADCO
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fcid                                                 136.67    148.82     14.882
cyid                                                 160.13    174.37     17.437

STID=54 CYID=53 fcid=0001 name=APPALACHIAN POWER CO.-PHILIP SPORN PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF  Control EF  ctrltype    ctrldes

 54   53   0001      014    001    99   10100202  SO2     18.65     20.31     2.031      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   53   0001      014    002    99   10100202  SO2     15.87     17.28     1.728      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   53   0001      014    003    99   10100202  SO2     21.46     23.36     2.336      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   53   0001      014    004    99   10100202  SO2     20.53     22.36     2.236      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   53   0001      005    005    99   10100202  SO2     46.82     50.98     5.098      0.0       0.900    SCRUBBER   Scrubber added by LADCO
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fcid                                                 123.33    134.30     13.430

STID=54 CYID=53 fcid=0009 name=APPALACHIAN POWER - MOUNTAINEER PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF  Control EF  ctrltype    ctrldes

 54   53   0009      001    001    99   10100202  SO2     11.20     12.19     1.219      0.0       0.900    SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
cyid                                                 134.53    146.49     14.649

STID=54 CYID=79 fcid=0006 name=APPALACHIAN POWER - JOHN E AMOS PLANT
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF  Control EF  ctrltype    ctrldes

 54   79   0006      012    001    99   10100202  SO2     79.63     86.72     8.672      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   79   0006      012    002    99   10100202  SO2    100.33    109.26    10.926      0.0       0.900    SCRUBBER   Scrubber added by LADCO
 54   79   0006      003    003    99   10100202  SO2    139.38    151.77    15.177      0.0       0.900    SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
fcid                                                 319.35    347.75     34.775
cyid                                                 319.35    347.75     34.775
stid                                                 654.39    712.59     88.851


STID=55 CYID=79 fcid=241007690 name=WIS ELECTRIC POWER OAK CREEK STATION
                                                   Base Yr    Grown   Controlled  Base Year  Future Year
STID  CYID  fcid     stkid  dvid  prid    scc     polid  Tons/Day  Tons/Day   Tons/Day   Control EF  Control EF  ctrltype    ctrldes

 55   79   241007690  S13   B25    01   10100202  SO2     12.75     14.48     3.475      0.0       0.760    SCRUBBER   Scrubber added by LADCO
 55   79   241007690  S13   B26    01   10100202  SO2      8.68      9.85     2.462      0.0       0.750    SCRUBBER   Scrubber added by LADCO
 55   79   241007690  S14   B27    01   10100212  SO2     10.97     12.45     2.864      0.0       0.770    SCRUBBER   Scrubber added by LADCO
 55   79   241007690  S14   B28    01   10100212  SO2     11.28     12.81     2.945      0.0       0.770    SCRUBBER   Scrubber added by LADCO
----                                                --------  --------  ----------
fcid                                                  43.68     49.59     11.746
cyid                                                  43.68     49.59     11.746
stid                                                  43.68     49.59     11.746
                                                   ========  ========  ==========
                                                    3099.41   3381.52    400.481
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Appendix II

Scenario C Controls (CAMD List)

NOx Controls (SCRs, 2007 – 2013))

Plant Name	UniqueID_Final	State Name	County	Capacity MW	On Line Year	SCR Online Year
Chesterfield	3797_B_4	Virginia	Chesterfield	166	1960	2013
Chesterfield	3797_B_5	Virginia	Chesterfield	310	1964	2012
Scherer	6257_B_3	Georgia	Monroe	875	1987	2011
Chesterfield	3797_B_6	Virginia	Chesterfield	658	1969	2011
Sandow No 4	6648_B_4	Texas	Milam	545	1981	2011
Beech Hollow Power Project	82704_B_1	Pennsylvania	Washington	272	2011	2011
Longview Power	82702_B_1	West Virginia	Monongalia	695	2011	2011
Cliffside	2721_B_6	North Carolina	Cleveland	800	2011	2011
AES Westover	2526_B_11	New York	Broome	22	1943	2010
AES Westover	2526_B_12	New York	Broome	22	1943	2010
AES Westover	2526_B_13	New York	Broome	84	1951	2010
Iatan 2	6065_B_2	Missouri	Platte	850	2010	2010
Southwest	6195_B_2	Missouri	Greene	300	2010	2010
Trimble Station (LGE)	6071_B_2	Kentucky	Trimble	732	2010	2010
Elm Road Generating Station	56068_B_2	Wisconsin	Milwaukee	615	2010	2010
Clay Boswell	1893_B_3	Minnesota	Itasca	350	1973	2009
Asheville	2706_B_2	North Carolina	Buncombe	184	1971	2009
Conesville	2840_B_4	Ohio	Coshocton	780	1973	2009
Marshall	2727_B_3	North Carolina	Catawba	657	1969	2009
St Johns River Power Park	207_B_1	Florida	Duval	626	1987	2009
Ghent	1356_B_2	Kentucky	Carroll	469	1977	2009
Chalk Point LLC	1571_B_1	Maryland	Prince George's	341	1964	2009
Chalk Point LLC	1571_B_2	Maryland	Prince George's	342	1965	2009
San Juan	2451_B_2	New Mexico	San Juan	320	1973	2009
Big Bend	645_B_BB01	Florida	Hillsborough	411	1970	2009
Big Bend	645_B_BB02	Florida	Hillsborough	391	1973	2009
Big Bend	645_B_BB03	Florida	Hillsborough	414	1976	2009
Nebraska City Unit 2	6096_B_2	Nebraska	Otoe	663	2009	2009
Cross	130_B_4	South Carolina	Berkeley	652	2009	2009
Springerville	8223_B_4	Arizona	Apache	400	2009	2009
Sandow 5	82010_B_5	Texas	Milam	600	2009	2009
Oak Grove	82011_B_1	Texas	Robertson	800	2009	2009
Oak Grove	82011_B_2	Texas	Robertson	800	2009	2009
TS Power Plant	82013_B_1	Nevada	Eureka	200	2009	2009
Plum Point Energy	82014_B_1	Arkansas	Mississippi	665	2009	2009
Comanche	470_B_3	Colorado	Pueblo	750	2009	2009
Elm Road Generating Station	56068_B_1	Wisconsin	Milwaukee	615	2009	2009
Two Elk Generating Station	55360_B_1	Wyoming	Campbell	300	2009	2009
J K Spruce	7097_B_BLR2	Texas	Bexar	750	2009	2009
Dallman	963_B_34	Illinois	Sangamon	200	2009	2009
AES Greenidge LLC	2527_B_4	New York	Yates	27	1950	2008
AES Greenidge LLC	2527_B_5	New York	Yates	27	1950	2008
AES Greenidge LLC	2527_B_6	New York	Yates	106	1953	2008
Charles R Lowman	56_B_2	Alabama	Washington	238	1979	2008
Charles R Lowman	56_B_3	Alabama	Washington	238	1980	2008
Barry	3_B_5	Alabama	Mobile	750	1971	2008
St Johns River Power Park	207_B_2	Florida	Duval	626	1988	2008
Morgantown Generating Plant	1573_B_2	Maryland	Charles	620	1971	2008

Bailly	995_B_7	Indiana	Porter	160	1962	2008
San Juan	2451_B_1	New Mexico	San Juan	322	1976	2008
San Juan	2451_B_3	New Mexico	San Juan	495	1979	2008
Weston	4078_B_4	Wisconsin	Marathon	519	2008	2008
AES Deepwater	10670_B_AAB001	Texas	Harris	140	1986	2007
La Cygne	1241_B_1	Kansas	Linn	724	1973	2007
Morgantown Generating Plant	1573_B_1	Maryland	Charles	624	1970	2007
PSEG Hudson Generating Station	2403_B_2	New Jersey	Hudson	583	1967	2007
San Juan	2451_B_4	New Mexico	San Juan	506	1982	2007
Big Bend	645_B_BB04	Florida	Hillsborough	457	1985	2007
Cross	130_B_3	South Carolina	Berkeley	620	2007	2007
Wygen II	55479_B_4	Wyoming	Campbell	90	2007	2007
Council Bluffs	1082_B_4	Iowa	Pottawattamie	790	2007	2007

SO2 Controls (FGDs, 2007 – 2012)

Plant Name	UniqueID_Final	State Name	County	Capacity MW	On Line Year	Scrubber Online Year
James H Miller Jr	6002_B_1	Alabama	Jefferson	684	1978	2011
James H Miller Jr	6002_B_2	Alabama	Jefferson	687	1985	2011
James H Miller Jr	6002_B_3	Alabama	Jefferson	687	1989	2011
James H Miller Jr	6002_B_4	Alabama	Jefferson	688	1991	2011
Cape Fear	2708_B_5	North Carolina	Chatham	143	1956	2011
Baldwin Energy Complex	889_B_1	Illinois	Randolph	624	1970	2011
Baldwin Energy Complex	889_B_2	Illinois	Randolph	629	1973	2011
Baldwin Energy Complex	889_B_3	Illinois	Randolph	629	1975	2011
Scherer	6257_B_3	Georgia	Monroe	875	1987	2011
Milton R Young	2823_B_B1	North Dakota	Oliver	250	1970	2011
W H Sammis	2866_B_6	Ohio	Jefferson	630	1969	2011
W H Sammis	2866_B_7	Ohio	Jefferson	630	1971	2011
PSEG Hudson Generating Station	2403_B_2	New Jersey	Hudson	583	1967	2011
John Sevier	3405_B_1	Tennessee	Hawkins	176	1955	2011
John Sevier	3405_B_2	Tennessee	Hawkins	176	1955	2011
John Sevier	3405_B_3	Tennessee	Hawkins	176	1956	2011
John Sevier	3405_B_4	Tennessee	Hawkins	176	1957	2011
Beech Hollow Power Project	82704_B_1	Pennsylvania	Washington	272	2011	2011
Longview Power	82702_B_1	West Virginia	Monongalia	695	2011	2011
Cliffside	2721_B_6	North Carolina	Cleveland	800	2011	2011
AES Greenidge LLC	2527_B_4	New York	Yates	27	1950	2010
AES Greenidge LLC	2527_B_5	New York	Yates	27	1950	2010
Barry	3_B_5	Alabama	Mobile	750	1971	2010
E C Gaston	26_B_5	Alabama	Shelby	861	1974	2010
Warrick	6705_B_4	Indiana	Warrick	300	1970	2010
Coffeen	861_B_01	Illinois	Montgomery	340	1965	2010
Coffeen	861_B_02	Illinois	Montgomery	560	1972	2010
Cardinal	2828_B_3	Ohio	Jefferson	630	1977	2010
Brandon Shores	602_B_1	Maryland	Anne Arundel	643	1984	2010
Brandon Shores	602_B_2	Maryland	Anne Arundel	643	1991	2010
Monroe	1733_B_4	Michigan	Monroe	775	1974	2010
Cliffside	2721_B_5	North Carolina	Cleveland	550	1972	2010
Crystal River	628_B_4	Florida	Citrus	720	1982	2010
Bowen	703_B_1BLR	Georgia	Bartow	713	1971	2010

Crist	641_B_6	Florida	Escambia	302	1970	2010
Crist	641_B_7	Florida	Escambia	477	1973	2010
Clifty Creek	983_B_1	Indiana	Jefferson	217	1955	2010
Clifty Creek	983_B_2	Indiana	Jefferson	217	1955	2010
Clifty Creek	983_B_3	Indiana	Jefferson	217	1955	2010
Clifty Creek	983_B_4	Indiana	Jefferson	217	1955	2010
Clifty Creek	983_B_5	Indiana	Jefferson	217	1955	2010
Clifty Creek	983_B_6	Indiana	Jefferson	217	1956	2010
Chalk Point LLC	1571_B_1	Maryland	Prince George's	341	1964	2010
Chalk Point LLC	1571_B_2	Maryland	Prince George's	342	1965	2010
Dickerson	1572_B_1	Maryland	Montgomery	182	1959	2010
Dickerson	1572_B_2	Maryland	Montgomery	182	1960	2010
Dickerson	1572_B_3	Maryland	Montgomery	182	1962	2010
R E Burger	2864_B_7	Ohio	Belmont	156	1955	2010
R E Burger	2864_B_8	Ohio	Belmont	156	1955	2010
Kyger Creek	2876_B_1	Ohio	Gallia	217	1955	2010
Kyger Creek	2876_B_2	Ohio	Gallia	217	1955	2010
Kyger Creek	2876_B_3	Ohio	Gallia	217	1955	2010
Kyger Creek	2876_B_4	Ohio	Gallia	217	1955	2010
Kyger Creek	2876_B_5	Ohio	Gallia	217	1955	2010
Cheswick	8226_B_1	Pennsylvania	Allegheny	580	1970	2010
PSEG Mercer Generating Station	2408_B_1	New Jersey	Mercer	315	1960	2010
PSEG Mercer Generating Station	2408_B_2	New Jersey	Mercer	310	1961	2010
Silver Lake	2008_B_4	Minnesota	Olmsted	61	1969	2010
Kingston	3407_B_1	Tennessee	Roane	135	1954	2010
Kingston	3407_B_2	Tennessee	Roane	135	1954	2010
Kingston	3407_B_3	Tennessee	Roane	135	1954	2010
Kingston	3407_B_4	Tennessee	Roane	135	1954	2010
Kingston	3407_B_5	Tennessee	Roane	177	1955	2010
Kingston	3407_B_6	Tennessee	Roane	177	1955	2010
Kingston	3407_B_7	Tennessee	Roane	177	1955	2010
Kingston	3407_B_8	Tennessee	Roane	177	1955	2010
Kingston	3407_B_9	Tennessee	Roane	178	1955	2010
Sioux	2107_B_1	Missouri	St. Charles	497	1967	2010
Sioux	2107_B_2	Missouri	St. Charles	497	1968	2010
Chesterfield	3797_B_5	Virginia	Chesterfield	310	1964	2010
Yorktown	3809_B_1	Virginia	York	159	1957	2010
AES Westover	2526_B_11	New York	Broome	22	1943	2010
AES Westover	2526_B_12	New York	Broome	22	1943	2010
AES Westover	2526_B_13	New York	Broome	84	1951	2010
Iatan 2	6065_B_2	Missouri	Platte	850	2010	2010
Southwest	6195_B_2	Missouri	Greene	300	2010	2010
Trimble Station (LGE)	6071_B_2	Kentucky	Trimble	732	2010	2010
Elm Road Generating Station	56068_B_2	Wisconsin	Milwaukee	615	2010	2010
Cholla	113_B_3	Arizona	Navajo	271	1980	2009
Mayo	6250_B_1A	North Carolina	Person	362	1983	2009
Mayo	6250_B_1B	North Carolina	Person	362	1983	2009
Conesville	2840_B_4	Ohio	Coshocton	780	1973	2009
G G Allen	2718_B_1	North Carolina	Gaston	162	1957	2009
G G Allen	2718_B_2	North Carolina	Gaston	162	1957	2009
G G Allen	2718_B_3	North Carolina	Gaston	260	1959	2009

G G Allen	2718_B_4	North Carolina	Gaston	275	1960	2009
G G Allen	2718_B_5	North Carolina	Gaston	265	1961	2009
H L Spurlock	6041_B_1	Kentucky	Mason	315	1977	2009
Crystal River	628_B_5	Florida	Citrus	717	1984	2009
Deerhaven Generating Station	663_B_B2	Florida	Alachua	228	1981	2009
Bowen	703_B_2BLR	Georgia	Bartow	718	1972	2009
Wansley	6052_B_2	Georgia	Heard	892	1978	2009
E W Brown	1355_B_1	Kentucky	Mercer	94	1957	2009
E W Brown	1355_B_2	Kentucky	Mercer	160	1963	2009
E W Brown	1355_B_3	Kentucky	Mercer	422	1971	2009
Ghent	1356_B_2	Kentucky	Carroll	469	1977	2009
Fayette Power Project	6179_B_1	Texas	Fayette	598	1979	2009
Fayette Power Project	6179_B_2	Texas	Fayette	598	1980	2009
Morgantown Generating Plant	1573_B_1	Maryland	Charles	624	1970	2009
Morgantown Generating Plant	1573_B_2	Maryland	Charles	620	1971	2009
PPL Brunner Island	3140_B_1	Pennsylvania	York	321	1961	2009
PPL Brunner Island	3140_B_2	Pennsylvania	York	378	1965	2009
Keystone	3136_B_1	Pennsylvania	Armstrong	850	1967	2009
Keystone	3136_B_2	Pennsylvania	Armstrong	850	1968	2009
Bull Run	3396_B_1	Tennessee	Anderson	881	1967	2009
Bay Shore	2878_B_4	Ohio	Lucas	215	1968	2009
Hatfields Ferry Power Station	3179_B_1	Pennsylvania	Greene	530	1969	2009
Hatfields Ferry Power Station	3179_B_2	Pennsylvania	Greene	530	1970	2009
Hatfields Ferry Power Station	3179_B_3	Pennsylvania	Greene	530	1971	2009
Nebraska City Unit 2	6096_B_2	Nebraska	Otoe	663	2009	2009
Cross	130_B_4	South Carolina	Berkeley	652	2009	2009
Springerville	8223_B_4	Arizona	Apache	400	2009	2009
Sandow 5	82010_B_5	Texas	Milam	600	2009	2009
Oak Grove	82011_B_1	Texas	Robertson	800	2009	2009
Oak Grove	82011_B_2	Texas	Robertson	800	2009	2009
TS Power Plant	82013_B_1	Nevada	Eureka	200	2009	2009
Plum Point Energy	82014_B_1	Arkansas	Mississippi	665	2009	2009
Comanche	470_B_3	Colorado	Pueblo	750	2009	2009
Elm Road Generating Station	56068_B_1	Wisconsin	Milwaukee	615	2009	2009
Two Elk Generating Station	55360_B_1	Wyoming	Campbell	300	2009	2009
J K Spruce	7097_B_BLR2	Texas	Bexar	750	2009	2009
Dallman	963_B_34	Illinois	Sangamon	200	2009	2009
Charles R Lowman	56_B_1	Alabama	Washington	86	1969	2008
John E Amos	3935_B_1	West Virginia	Putnam	800	1971	2008
John E Amos	3935_B_2	West Virginia	Putnam	800	1972	2008
Cholla	113_B_4	Arizona	Navajo	380	1981	2008
Roxboro	2712_B_1	North Carolina	Person	369	1966	2008
Roxboro	2712_B_3A	North Carolina	Person	341	1973	2008
Roxboro	2712_B_3B	North Carolina	Person	341	1973	2008
Miami Fort	2832_B_7	Ohio	Hamilton	500	1975	2008
Miami Fort	2832_B_8	Ohio	Hamilton	500	1978	2008
Cogentrix Virginia Leasing Corp	10071_B_2A	Virginia	Portsmouth	19	1988	2008
Cogentrix Virginia Leasing Corp	10071_B_2B	Virginia	Portsmouth	19	1988	2008
Cogentrix Virginia Leasing Corp	10071_B_2C	Virginia	Portsmouth	19	1988	2008
J M Stuart	2850_B_1	Ohio	Adams	585	1971	2008
J M Stuart	2850_B_2	Ohio	Adams	597	1970	2008

J M Stuart	2850_B_3	Ohio	Adams	597	1972	2008
J M Stuart	2850_B_4	Ohio	Adams	597	1974	2008
Monroe	1733_B_3	Michigan	Monroe	795	1973	2008
Belews Creek	8042_B_1	North Carolina	Stokes	1,115	1974	2008
Belews Creek	8042_B_2	North Carolina	Stokes	1,115	1975	2008
Bowen	703_B_3BLR	Georgia	Bartow	902	1974	2008
Bowen	703_B_4BLR	Georgia	Bartow	929	1975	2008
Hammond	708_B_1	Georgia	Floyd	112	1954	2008
Hammond	708_B_2	Georgia	Floyd	112	1954	2008
Hammond	708_B_3	Georgia	Floyd	112	1955	2008
Hammond	708_B_4	Georgia	Floyd	510	1970	2008
Wansley	6052_B_1	Georgia	Heard	891	1976	2008
Harding Street	990_B_70	Indiana	Marion	435	1973	2008
Cogentrix Hopewell	10377_B_1A	Virginia	Hopewell (city)	18	1987	2008
Cogentrix Hopewell	10377_B_1B	Virginia	Hopewell (city)	18	1987	2008
Cogentrix Hopewell	10377_B_1C	Virginia	Hopewell (city)	18	1987	2008
Ghent	1356_B_4	Kentucky	Carroll	478	1984	2008
Council Bluffs	1082_B_3	Iowa	Pottawattamie	690	1978	2008
PPL Brunner Island	3140_B_3	Pennsylvania	York	749	1969	2008
PPL Montour	3149_B_1	Pennsylvania	Montour	774	1972	2008
PPL Montour	3149_B_2	Pennsylvania	Montour	766	1973	2008
Comanche	470_B_1	Colorado	Pueblo	366	1973	2008
Comanche	470_B_2	Colorado	Pueblo	370	1975	2008
Cayuga	1001_B_2	Indiana	VermilIon	473	1972	2008
Winyah	6249_B_1	South Carolina	Georgetown	295	1975	2008
Winyah	6249_B_2	South Carolina	Georgetown	295	1977	2008
Winyah	6249_B_3	South Carolina	Georgetown	295	1980	2008
Chesterfield	3797_B_6	Virginia	Chesterfield	658	1969	2008
Brayton Point	1619_B_1	Massachusetts	Bristo	243	1963	2008
Brayton Point	1619_B_2	Massachusetts	Bristo	244	1964	2008
Weston	4078_B_4	Wisconsin	Marathon	519	2008	2008
Gorgas	8_B_10	Alabama	Walker	690	1972	2007
Gorgas	8_B_8	Alabama	Walker	165	1956	2007
Gorgas	8_B_9	Alabama	Walker	175	1958	2007
John E Amos	3935_B_3	West Virginia	Putnam	1,300	1973	2007
Mountaineer	6264_B_1	West Virginia	Mason	1,300	1980	2007
Cardinal	2828_B_1	Ohio	Jefferson	600	1967	2007
Cardinal	2828_B_2	Ohio	Jefferson	600	1967	2007
Roxboro	2712_B_2	North Carolina	Person	639	1968	2007
Roxboro	2712_B_4A	North Carolina	Person	343	1980	2007
Roxboro	2712_B_4B	North Carolina	Person	343	1980	2007
Cogentrix Virginia Leasing Corp	10071_B_1A	Virginia	Portsmouth	19	1988	2007
Cogentrix Virginia Leasing Corp	10071_B_1B	Virginia	Portsmouth	19	1988	2007
Cogentrix Virginia Leasing Corp	10071_B_1C	Virginia	Portsmouth	19	1988	2007
Killen Station	6031_B_2	Ohio	Adams	615	1982	2007
Marshall	2727_B_2	North Carolina	Catawba	378	1966	2007
Marshall	2727_B_3	North Carolina	Catawba	657	1969	2007
Cogentrix Hopewell	10377_B_2A	Virginia	Hopewell (city)	18	1987	2007
Cogentrix Hopewell	10377_B_2B	Virginia	Hopewell (city)	18	1987	2007
Cogentrix Hopewell	10377_B_2C	Virginia	Hopewell (city)	18	1987	2007
Ghent	1356_B_3	Kentucky	Carroll	478	1981	2007

Louisa	6664_B_101	Iowa	Louisa	700	1983	2007
Allen S King	1915_B_1	Minnesota	Washington	571	1968	2007
Mitchell	3948_B_1	West Virginia	Marshall	800	1971	2007
Gibson	6113_B_1	Indiana	Gibson	630	1975	2007
Gibson	6113_B_2	Indiana	Gibson	628	1975	2007
Winyah	6249_B_4	South Carolina	Georgetown	270	1981	2007
Pleasant Prairie	6170_B_2	Wisconsin	Kenosha	617	1985	2007
Cross	130_B_3	South Carolina	Berkeley	620	2007	2007
Wygen II	55479_B_4	Wyoming	Campbell	90	2007	2007
Council Bluffs	1082_B_4	Iowa	Pottawattamie	790	2007	2007

Assumed BART Facilities and Units

State	County	Fac ID	Facility Name	Unit ID
MI	Bay	B2840	CE - KARN/WEADOCK	EU00036
MI	Bay	B2840	CE - KARN/WEADOCK	EU00037
MI	Eaton	B4001	LAN. BW&L ERICKSON	EU00007
MI	Houghton	B6553	UP POWER CO / PORTAGE	EU00008
MI	Huron	B2815	DTE - HARBOR BEACH	EU00009
MI	Ingham	B2647	LAN. BW&L Eckert	RG00023
MI	Ingham	B2647	LAN. BW&L Eckert	RG00023
MI	Ingham	B2647	LAN. BW&L Eckert	RG00023
MI	Ingham	B2647	LAN. BW&L Moores Park	RG00021
MI	Marquette	B4261	WE-ENERGIES	EU00029
MI	Marquette	B4261	WE-ENERGIES	EU00030
MI	Marquette	B4261	WE-ENERGIES	EU00031
MI	Marquette	B4261	WE-ENERGIES	EU00032
MI	Marquette	B4261	WE-ENERGIES	EU00033
MI	Monroe	B2816	DTE - MONROE	EU00062
MI	Monroe	B2816	DTE - MONROE	EU00068
MI	Monroe	B2816	DTE - MONROE	EU00063
MI	Monroe	B2816	DTE - MONROE	EU00064
MI	Ottawa	B2835	CE – CAMPBELL	EU00062
MI	Ottawa	B2835	CE – CAMPBELL	EU00061
MI	Saint Clair	B2796	DTE - ST. CLAIR / BELLE RIVER	EU00111
MI	Saint Clair	B6145	DTE – GREENWOOD	EU00009
MI	Wayne	B2132	WYANDOTTE	EU00036
MI	Wayne	B2185	DETROIT PLD, MISTERSKY	EU00014
MI	Wayne	B2811	DTE – TRENTON	EU00035
OH	Lake	0243160009	CEI., EASTLAKE PLANT	B005
OH		0247030013	Orion Power Midwest	B012
OH		0285010188	Dept of Public Utilities, City of Orrville	B001
OH		0285010188	Dept of Public Utilities, City of Orrville	B004
OH		0448020006	Toledo Edison Co., Bay Shore	B003
OH		0448020006	Toledo Edison Co., Bay Shore	B004
OH		0616000000	Conesville Power Plant	B003
OH		0616000000	Conesville Power Plant	B004
OH		0616000000	Conesville Power Plant	B007
OH		0641050002	Cardinal Power Plant	B001
OH		0641050002	Cardinal Power Plant	B002

OH		0641050002	Cardinal Power Plant	B003
OH		0641050002	Cardinal Power Plant	B004
OH		0641050002	Cardinal Power Plant	B008
OH		0641050002	Cardinal Power Plant	B009
OH		0641050002	Cardinal Power Plant	B009
OH	Jefferson	0641160017	W. H. SAMMIS PLANT	B011
OH	Jefferson	0641160017	W. H. SAMMIS PLANT	B012
OH	Jefferson	0641160017	W. H. SAMMIS PLANT	B013
OH		0684000000	Muskingum River Power Plant	B006
OH	Adams	0701000007	DP&L, J.M. Stuart Generating Station	B001
OH	Adams	0701000007	DP&L, J.M. Stuart Generating Station	B002
OH	Adams	0701000007	DP&L, J.M. Stuart Generating Station	B003
OH	Adams	0701000007	DP&L, J.M. Stuart Generating Station	B004
OH		0701000060	DP&L, Killen Station	B001
OH		1409040243	City of Hamilton Dept of Public Utilities	B002
OH		1409040243	City of Hamilton Dept of Public Utilities	B008
OH		1409040243	City of Hamilton Dept of Public Utilities	B009
OH		1413100008	CG&E W. C. BECKJORD	B005
OH		1413100008	CG&E W. C. BECKJORD	B006
OH		1431350093	CG&E MIAMI FORT STATION	B015
IL	Peoria	856	Ameren – Edwards	2
IL	Sangamon	963	CWLP – Dallman	31
IL	Sangamon	963	CWLP – Dallman	32
IL	Christian	876	Dominion – Kincaid	1
IL	Christian	876	Dominion – Kincaid	2
WI	COLUMBIA	111003090	Alliant Energy-Columbia Generating	B20
WI	COLUMBIA	111003090	Alliant Energy-Columbia Generating	B21
WI	COLUMBIA	111003090	Alliant Energy-Columbia Generating	B22
WI	GRANT	122014530	Alliant Energy, Nelson Dewey	B22 (unit 2)
WI	MILWAUKEE	241007690	We Energies-Oak Creek Station	B26 (Unit 6)
WI	MILWAUKEE	241007690	We Energies-Oak Creek Station	B27 (Unit 7)
WI	MILWAUKEE	241007690	We Energies-Oak Creek Station	B28
WI	MILWAUKEE	241007800	We Energies-Valley Station	B21
WI	MILWAUKEE	241007800	We Energies-Valley Station	B23
WI	MILWAUKEE	241007800	We Energies-Valley Station	B24
WI	BROWN	405031990	WI Public Service Corp - JP Pulliam	B27 (unit 8)
WI	SHEBOYGAN	460033090	WP & L Alliant Energy – Edgewater	B24
WI	BUFFALO	606034110	Dairyland Power Coop Alma Station (J.P. Madgett boilers)	B25 (+B26)
WI	BUFFALO	606034110	Dairyland Power Coop Alma Station	B27
WI	VERNON	663020930	Dairyland Power Coop Genoa Station	B20
WI	VERNON	663020930	Dairyland Power Coop Genoa Station	B25
IN	Porter	995	Bailly	7
IN	Porter	995	Bailly	8
IN	Vermillion	1001	Cayuga	1
IN	Vermillion	1001	Cayuga	2
IN	Montgomery	1024	Crawfordsville	6
IN	Warrick	1012	Culley	2

IN	Warrick	1012	Culley	3
IN	Gibson	6113	Gibson	1
IN	Gibson	6113	Gibson	2
IN	Cass	1032	Logansport	6
IN	Sullivan	6213	Merom	1
IN	Sullivan	6213	Merom	2
IN	LaPorte	997	Michigan City	12
IN	Lake	996	Mitchell	11
IN	Pike	994	Petersburg	1
IN	Pike	994	Petersburg	2
IN	Pike	994	Petersburg	3
IN	Pike	1043	Ratts	1
IN	Pike	1043	Ratts	2
IN	Wayne	7335	RPL	2
IN	Jasper	6085	Schahfer	14
IN	Jasper	6085	Schahfer	15
IN	Lake	981	Stateline	4
IN	Marion	990	Stout	70
IN	Dearborn	988	Tanners Creek	4
IN	Vigo	1010	Wabash River	6
IN	Warrick	6705	Warrick	4
IA		07-02-005	Cedar Falls Utilities	Unit #7 (EU10.1A)
IA		88-01-004	Central Iowa Power Cooperative (CIPCO) – Summit Lake Station	CombTurbines (EU 1/1G, EU2/2G)
IA		70-08-003	Central Iowa Power Cooperative (CIPCO) – Fair Station	Unit # 2 (EU 2 & EU 2G)
IA		85-01-006	City of Ames - Steam Electric Plant	Boiler #7 (EU 2)
IA		29-01-013	Interstate Power & Light - Burlington	Main Plant Boiler.
IA		03-03-001	Interstate Power & Light - Lansing	Boiler #4. Sixteen units in total.
IA		23-01-014	Interstate Power & Light - ML Kapp	Boiler #2. Six units in total.
IA		57-01-042	Interstate Power & Light - Prairie Creek	Boiler #4. Fourteen units in total.
IA		78-01-026	MidAmerican Energy Co - Council Bluffs	Boiler #3 (EU003)
IA		97-04-010	MidAmerican Energy Co - Neal North	Boilers #1-3 (EU001 - EU003)
IA		97-04-011	MidAmerican Energy Co - Neal South	Boiler #4 (EU003)
IA		70-01-011	Muscatine Power and Water	Boiler #8
IA		63-02-005	Pella Municipal Power Plant	Boilers #6-8
MN		2709900001	Austin Utilities NE Power Station	EU001
MN		2713700027	Hibbing Public Utilities	EU003
MN		2703100001	MN Power, Taconite Harbor	EU003
MN		2706100004	MN Power, Boswell Energy Center	EU003
MN		2701500010	New Ulm Public Utilities	EU003 - Boiler 4
MN		2711100002	Otter Tail Power Hoot Lake	EU003
MN		2710900011	Rochester Public Utilities, Silver Lake	EU003
MN		2710900011	Rochester Public Utilities, Silver Lake	EU004
MN		2713700028	Virginia Public Utilities	EU003 - Boiler 9
MN		2714100004	Xcel Energy, Sherco	EU001, EU002
MN		2716300005	Xcel Energy, Allen S King	EU001 - Boiler 1

MN		2705300015	Xcel Energy, Riverside	EU003 - Boiler 8
MO		290710003	Ameren -Labadie	B1, B2, B3, B4
MO		291830001	Ameren - Sioux	B1, B2
MO		290990016	Ameren - Rush Island	B1, B2
MO		290950031	Auila - Sibley	B3 - 5C
MO		291430004	Assoc. Electric - New Madrid	B1(EP-01), B2 (EP-02)
MO		290770039	City Utilities Springfield - Southwest	B1 (E09)
MO		290770005	City Utilities Springfield - James River	EO7, EO8
MO		290970001	Empire Distric Electric - Asbury	B7
MO		290830001	KC Power and Light - Montrose	EP08
MO		290210004	Aqula - Lake Road	EP06
MO		291750001	Assoc. Electric - Thomas Hill	EP01, EP02
MO		290950021	Trigen - Kansas City	B1A
MO		290190002	City of Columbia Municipal Power Plant	EP02
MO		291950010	Marshall Munipal Utilities	EP05
MO		290950050	Independence Power & Light-Blue Valley	B3 (EP05)
WV		3943	Fort Martin	
WV		6004	Pleasants	
WV		3948	Mitchell	
WV		3935	Amos	
WV		6264	Mountaineer	
WV		3944	Harrison	
TN		3396	TVA Bull Run	
TN		3399	TVA Cumberland	
KY		1363	Cane Run	
KY		1364	Mill Creek	
KY		6041	Spurlock	
KY		1384	John Sherman Cooper	
KY		1353	Big Sandy	
KY		1356	Ghent	
KY		1355	Brown	
KY		1374	Owensboro Municipal	
KY		1372	Henderson Municipal	
KY		1378	Paradise	
KY		1361	Coleman	
KY		1382	Reid/Henderson 2	
KY		6639	Green	

Appendix E-1

Analysis of Insignificance of Mobile Emissions

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Analysis of Insignificance of Mobile Emissions

In Ohio's July 16, 2008 $PM_{2.5}$ Attainment Demonstration SIP[1], Ohio found that the regional highway emissions of $PM_{2.5}$, NO_x, and SO_2 were insignificant contributors to the nonattainment problems and, therefore, none of the three pollutants necessitated emissions inventory analysis or required the establishment of mobile emission budgets. As documented in Ohio EPA's attainment demonstration SIP, Ohio EPA in consultation with U.S. EPA determined that the Parkersburg-Marietta nonattainment area is not significantly impacted by on-road mobile emissions as compared to other source emissions; in addition, mobile source emissions in the area were expected to decrease. Based on the results of mobile source emission projections prepared as a part of this redesignation and maintenance plan, Ohio EPA is again making a finding that the regional highway emissions of $PM_{2.5}$, NO_x, and SO_2 continue to be insignificant contributors to the nonattainment problems in this area, as discussed below.

U.S. EPA's redesignation guidance requires the submittal of a comprehensive inventory of $PM_{2.5}$ precursor emissions (primary particles (organic carbon, crustal matter, and elemental carbon), SO_2 and NO_x[2]) representative of the year when the area achieves attainment of the annual $PM_{2.5}$ air quality standard. Ohio also must demonstrate that the improvement in air quality between the year that violations occurred and the year that attainment was achieved is based on permanent and enforceable emission reductions. Other emission inventory related requirements include a projection of the emission inventory to a year at least 10 years following redesignation; a demonstration that the projected level of emissions is sufficient to maintain the annual $PM_{2.5}$ standard; and a commitment to provide future updates of the inventory to enable tracking of emission levels during the 10-year maintenance period.

The emissions inventory development process addresses emissions from several types of sources or sectors: point (EGU or non-EGU); non-point or area; marine, air, rail (MAR); non-road, and on-road or mobile. The inventories, with the exception of the mobile (on-road), used in this submittal are developed by the Lake Michigan Area Directors Consortium (LADCO) as discussed in greater detail elsewhere in the documents associated with this submittal. All emission inventories utilized in the redesignation and maintenance plan for the Parkersburg-Marietta annual $PM_{2.5}$ nonattainment area were prepared for county level emissions.

Mobile emissions inventories and projections for all counties were prepared by the Ohio Department of Transportation (ODOT) and the Wood-Washington-Wirt Interstate Planning Commission (WWW), with data provided by the ODOT, Ohio EPA, West Virginia Department of Transportation (WVDOT), and West Virginia Department of Environmental Protection (WVDEP). The mobile emission inventories are only generated for the annual $PM_{2.5}$ nonattainment areas, meaning that if an area was designated partial nonattainment, that was the only area that was modeled for inventory

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[1] http://www.epa.ohio.gov/portals/27/SIP/Attain/PM2_5/PM25Doc.pdf
[2] VOC and NH_3 are not addressed.

development (as opposed to the entire county that the partial nonattainment area is included within).

Since the mobile emissions inventories only address nonattainment areas (county level or only partial areas determined as nonattainment) and the remainder of the source sector inventories (non-electric generating unit (EGU), EGU, area, non-road, and MAR) address complete counties (which are not necessarily entirely classified as nonattainment), Ohio EPA and U.S. EPA agreed that an apportioning analysis approach would most accurately provide for a determination of mobile emissions insignificance. The analysis incorporates apportioning non-EGU, non-road, MAR, and area emission sources from the entire county level inventory to the partial nonattainment portion of the county based on the percentages of population in the county versus the partial area (based on the 2000 Census). However, for all partial nonattainment counties within this nonattainment area all EGU emissions within the county level inventory reside solely within the partial area. As such, Ohio EPA has apportioned all EGU emissions into the partial area.

Table 1 shows the total population in each county that contains one or more partial nonattainment areas, the total population in each partial nonattainment area, and the population percentage in each partial nonattainment area relative to the county population. This data is based on the 2000 Census data. The population percentages will be used to apportion all existing county level emissions (except mobile and EGU emissions) to the partial nonattainment area.

Table 1. Total County Population, Partial Nonattainment Area Population, and Percentage of County Population within the Partial Nonattainment Area.

	Population	
	Total	**% of County**
Pleasants County, WV	7,514	
Grant Tax District	1,675	22.29%

Sources:
http://censtats.census.gov/pub/Profiles.shtml
http://www.epa.gov/oaqps001/greenbk/qnay.html

The designation of a partial area as nonattainment for the annual PM2.5 standard is primarily attributed to the existence of EGUs (power plants) within the area encompassing the partial nonattainment area. As mentioned previously, all EGU emissions within each partial area presented in this redesignation and maintenance plan, reside only within the partial nonattainment area. Hence, all county level EGU emission sources are apportioned to the partial area since these emissions are only present in the partial area. EGU sources include those sources that are identified by <u>point</u> locations, typically because they are regulated and their locations are available in regulatory reports.

Table 2 to Table 4[3] show partial nonattainment areas apportioning results and entire county level emissions. The emission reductions from the apportioning approach compared to the entire county level emissions, show further reductions across all emission sources (except EGUs and mobile sources since they are already only representing partial nonattainment areas). Please note the Table 2 to Table 4 below only reflects emissions as a part of the apportioning analysis for the partial nonattainment areas. The remaining emissions for full nonattainment counties included in the determination of insignificance can be found in redesignation and maintenance document from Table 13, Table 17, and Table 21.

$PM_{2.5}$

Table 2 - Pleasants County, West Virginia $PM_{2.5}$ Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2015 Partial Only	2022 Maintenance	2022 Partial Only	Safety Margin
EGU Point	1,360.23	1,287.83	1,330.92	**1,330.92**	1,286.59	**1,286.59**	1.24
Non-EGU	198.72	159.57	143.78	**32.05**	141.49	**31.54**	18.08
Non-road	8.32	8.19	5.96	**1.33**	3.73	**0.83**	4.46
Area	143.43	121.73	116.47	**25.96**	113.48	**25.30**	8.25
MAR	28.83	12.30	12.38	**2.76**	12.45	**2.78**	-0.15
On-road	1.61	1.20	0.55	**0.55**	0.37	**0.37**	0.83
TOTAL	1,741.14	1,590.82	1,610.06	**1,393.57**	1,558.11	**1,347.41**	32.71

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[3] Tables 2 to Table 4 are similar to Table 13, Table 17, and Table 21 of the Redesignation and Maintenance document.

NO_X

Table 3 - Pleasants County, West Virginia NO_X Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2015 Partial Only	2022 Maintenance	2022 Partial Only	Safety Margin
EGU Point	12,318.14	8,251.74	3,733.99	**3,733.99**	3,798.80	**3,798.80**	4,452.94
Non-EGU	639.94	156.90	22.73	**5.07**	21.64	**4.82**	135.26
Non-road	38.49	37.72	31.31	**6.98**	26.65	**5.94**	11.07
Area	174.42	43.54	42.80	**9.54**	42.07	**9.38**	1.47
MAR	799.88	362.14	364.42	**81.24**	366.7	**81.74**	-4.56
On-road	54.17	42.41	19.05	**19.05**	9.96	**9.96**	32.45
TOTAL	14,025.04	8,894.45	4,214.30	**3,855.87**	4,265.82	**3,910.64**	4,628.63

SO_2

Table 4 - Pleasants County, West Virginia SO_2 Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CSAPR

Sector	2005 Base	2008 Attainment	2015 Interim	2015 Partial Only	2022 Maintenance	2022 Partial Only	Safety Margin
EGU Point	52,295.78	15,803.98	6,090.44	**6,090.44**	7,687.48	**7,687.48**	8,116.50
Non-EGU	5,623.32	1,175.69	1.11	**0.25**	1.08	**0.24**	1,174.61
Non-road	2.42	0.47	0.12	**0.03**	0.13	**0.03**	0.34
Area	97.76	55.40	52.50	**11.70**	49.60	**11.06**	5.80
MAR	38.47	19.29	19.41	**4.33**	19.53	**4.35**	-0.24
On-road	0.69	0.22	0.18	**0.18**	0.15	**0.15**	0.07
TOTAL	58,058.44	17,055.05	6,163.76	**6,106.93**	7,757.97	**7,703.31**	9,297.08

Table 5 to Table 7 show a summary comparison between entire counties (without apportionment, see columns D and F) and only nonattainment areas (with apportionment, see columns E and G). The comparison shows the apportionment results in a decrease of at least 5.77% for all 2015 PM2.5 emissions and 5.76% for all 2022 PM2.5 emissions, 1.90% for all 2015 NO_X emissions and 2.67% for all 2022 NO_X emissions, and 0.07% for all 2015 SO_2 emissions and 0.11% for all 2022 SO_2 emissions. Recall, as mentioned above, detailed emissions by each sector for full counties included in the determination of insignificance and identified below can be found in the full document.

Table 5 - **Parkersburg-Marietta Area PM2.5 Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – Without CAIR (Ohio) and With CSAPR (West Virginia)**

A	B	C	D	E	F	G
PM$_{2.5}$	**2005 Base**	**2008 Attainment**	**2015 Interim**	**2015 Interim with Apportionment**	**2022 Maintenance**	**2022 Interim with Apportionment**
Pleasants, WV	1,741.14	1,590.82	1,610.06	**1,393.57**	1,558.11	**1,347.40**
Wood, WV	1,262.25	1,002.42	944.57	944.57	918.15	918.15
Washington, OH	1,143.35	1,203.35	1,198.61	1,198.61	1,181.01	1,181.01
COMBINED PM$_{2.5}$ TOTAL	4,146.74	3,796.59	3,753.24	**3,536.75**	3,657.27	**3,446.56**

Table 6 - **Parkersburg-Marietta Area NO$_x$ Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR (Ohio) and With CSAPR (West Virginia)**

A	B	C	D	E	F	G
NOx	**2005 Base**	**2008 Attainment**	**2015 Interim**	**2015 Interim with Apportionment**	**2022 Maintenance**	**2022 Interim with Apportionment**
Pleasants, WV	14,025.04	8,894.45	4,214.30	**3,855.87**	4,265.82	**3,910.64**
Wood, WV	5,760.06	4,495.90	3,195.98	3,195.98	2,640.34	2,640.34
Washington, OH	21,668.23	22,365.96	11,439.41	11,439.41	6,417.53	6,417.53
COMBINED NOx TOTAL	41,453.33	35,756.31	18,849.69	**18,491.26**	13,323.69	**12,968.52**

Table 7 - **Parkersburg-Marietta Area SO2 Partial Nonattainment Areas Apportioning Results and Entire County Level Emissions: Emission Inventory Totals for Base Year 2005, Estimated 2008, and Projected 2015 and 2022 (tpy) – With CAIR (Ohio) and With CSAPR (West Virginia)**

A	B	C	D	E	F	G
SO$_2$	**2005 Base**	**2008 Attainment**	**2015 Interim**	**2015 Interim with Apportionment**	**2022 Maintenance**	**2022 Interim with Apportionment**
Pleasants, WV	58,058.44	17,055.05	6,163.76	**6,106.93**	7,757.97	**7,703.31**
Wood, WV	6,068.44	3,751.88	3,560.54	3,560.54	3,384.15	3,384.15
Washington, OH	146,280.18	138,786.24	67,625.84	67,625.84	37,351.17	37,351.17
COMBINED SO$_2$ TOTAL	210,407.06	159,593.17	77,350.14	**77,293.31**	48,493.29	**48,438.63**

The following table shows the percentage of the mobile portion of all emissions, for each pollutant in the entire nonattainment area, apportioned per the above, for 2015 and 2022.

Table 8 – Percent of Mobile Emissions for the Parkersburg-Marietta Area in 2015 and 2022 – With Apportionment Analysis for partial nonattainment areas

		NOx		SO2		PM2.5	
		2015	**2022**	**2015**	**2022**	**2015**	**2022**
Parkersburg-Marietta Area	**Total (tpy)**	18,491.26	12,968.52	77,293.31	48,438.63	3,536.75	3,446.56
	Mobile (tpy)	2,212.19	1,120.80	14.52	14.16	75.85	49.75
	% Mobile	11.96%	8.64%	0.02%	0.03%	2.14%	1.44%
Ohio Portion	**Total (tpy)**	11,439.41	6,417.53	67,625.84	37,351.17	1,198.61	1,181.01
	Mobile (tpy)	1,200.52	572.25	6.46	6.31	41.68	25.22
	% Mobile	10.49%	8.92%	0.01%	0.02%	3.48%	2.14%

NO_x on-road emissions are just under twelve percent (11.96%) of the area's total NO_x emissions in the 2015 horizon year and just over eight percent (8.64%) in the 2022 horizon year. $PM_{2.5}$ on-road emissions constitute just over two percent (2.14%) of the area's total $PM_{2.5}$ emissions in the 2015 and just over one percent (1.44%) in the 2022 horizon years. SO_2 on-road emissions constitute less than one percent (0.02% for 2015 and 0.03% for 2022) of the area's total SO_2 emissions in both the 2015 and 2022 horizon years.

Based on the results from Table 8 the Ohio EPA is herein making a finding that the area's highway emissions for $PM_{2.5}$, NO_x, and SO_2 continue to be insignificant contributors to the nonattainment problem of the Parkersburg-Marietta area, as agreed upon as a part of the interagency consultation process. Because of this finding it is not necessary to establish mobile emission budgets for this area in the 2015 and 2022 horizon years.

Moreover, the nonattainment area meets the 40 CFR 93.109(m) criteria for PM2.5, NO_x, and SO_2. As shown, throughout the "Redesignation Request and Maintenance Plan for the Ohio Portion of the Parkersburg-Marietta, OH-WV Annual $PM_{2.5}$ Nonattainment Area" document, it would be unreasonable to expect that the Parkersburg-Marietta area would experience enough motor vehicle emissions growth in PM2.5, NO_x, and SO_2 for a $PM_{2.5}$ NAAQS violation to occur. Ohio EPA demonstrates that the percentage of motor vehicle emissions in the context of the total SIP inventory, the current state of air quality as determined by monitoring data, the absence of SIP motor vehicle control measures, and historical trends and future projections of the growth of motor vehicle emissions, are evidence enough to consider mobile source PM2.5, NO_x, and SO_2 insignificant contributors to fine particles.

Appendix F

Public Participation Documentation

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Public Notice
Ohio Environmental Protection Agency
Redesignation and Maintenance Plan for the Ohio Portion of the Parkersburg-Marietta, WV-OH Annual $PM_{2.5}$ Nonattainment Area

Washington County

Notice is hereby given that the Director of the Ohio Environmental Protection Agency (Ohio EPA) is requesting that the United States Environmental Protection Agency (U.S. EPA) revise the current air quality designation for the Ohio portion of the Parkersburg-Marietta, WV-OH area, including Washington County, to attainment with respect to the 1997 annual $PM_{2.5}$ national ambient air quality standard (NAAQS). Air quality monitoring data collected between 2008 and 2010 in the region demonstrate attainment of the NAAQS and there is evidence that the improved air quality is due to permanent, enforceable emission reductions. In addition, existing requirements are sufficient to maintain the 1997 annual $PM_{2.5}$ standard in this area at least ten years into the future.

Computer models show that existing state and federal emission reduction requirements are sufficient to attain and maintain the NAAQS in the Parkersburg-Marietta area. Therefore, Ohio EPA proposes to utilize existing emission inventory information and projections of future emissions as the demonstration of the ability to maintain the NAAQS in the Parkersburg-Marietta area in the future.

The Parkersburg-Marietta area is currently designated as nonattainment for the 1997 annual $PM_{2.5}$ standard. As part of an acceptable maintenance plan, Ohio EPA is required to develop a contingency plan to provide for additional emission reductions if a violation of the NAAQS is monitored after the area has been redesignated. The plan which Ohio EPA is proposing to USEPA as part of this redesignation contains reductions which will help alleviate any ambient problem until a revised SIP can be developed.

The State of Ohio proposes to:

1. Request the U.S. EPA redesignate the Ohio portion of the Parkersburg-Marietta, WV-OH area to attainment with respect to the 1997 annual $PM_{2.5}$ NAAQS and revise the maintenance plan. This request will document that existing enforceable control measures are responsible for the observed improvement in air quality.

2. Designate existing controls as sufficient to maintain the NAAQS into the future.

3. Commit to the proposed contingency plan.

These actions must be noticed to allow public comment and to satisfy USEPA requirements for public involvement in SIP-related activities. This notice addresses Ohio

EPA's reliance on the emission projections as evidence of attainment and maintenance and the commitment to institute contingency measures if ambient exceedances or violations trigger the contingency plan requirements. Written comments will be received on or before February 16, 2012 at the following address:

E-mail: jennifer.dines@epa.state.oh.us

Mailing address: Jennifer Dines
Ohio Environmental Protection Agency, DAPC
Lazarus Government Center
P.O. Box 1049
Columbus, Ohio 43216-1049
Phone: (614) 644-3696

Pursuant to Part D of Title I of the Clean Air Act, Ohio EPA is also required to hold a public hearing on this SIP revision. A public hearing on this SIP revision will be conducted as follows: **February 16, 2012 at 3:00 PM at the Marietta Library, 615 5th Street, Marietta, Ohio 45750**.

All interested persons are entitled to attend or be represented at the hearing and give written or oral comments on these changes. All oral comments presented at the hearing, and all written statements submitted at the hearing or to the above address by the close of business on February 16, 2012 will be considered by Ohio EPA prior to final action on this redesignation. Written statements submitted after February 16, 2012 may be considered as time and circumstances permit, but will not be part of the official record of the hearing.

This redesignation and maintenance request is available on Ohio EPA, DAPC's web page for electronic downloading at: http://www.epa.ohio.gov/dapc/SIP/annual.aspx. Questions regarding accessing the web site should be directed to Arunee Niamlarb at 614-728-1342; other questions or comments about this document should be directed to Jennifer Dines at (614) 644-3696, Jennifer.dines@epa.state.oh.us or mailed to Jennifer Dines at the above address.