Appendix 5A

Original and Revised LADCO Technical Support Document for Regional Haze Modeling

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

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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.

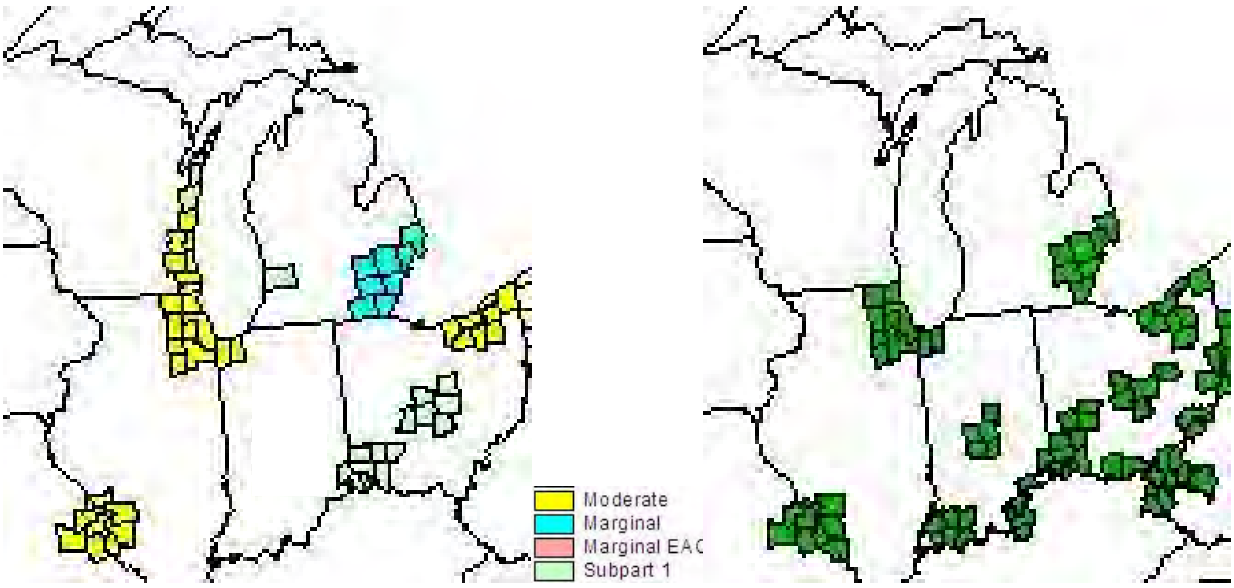


Figure i. Current nonattainment counties for ozone (left) and $PM_{2.5}$ (right)

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).

[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

[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.

[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.

[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.

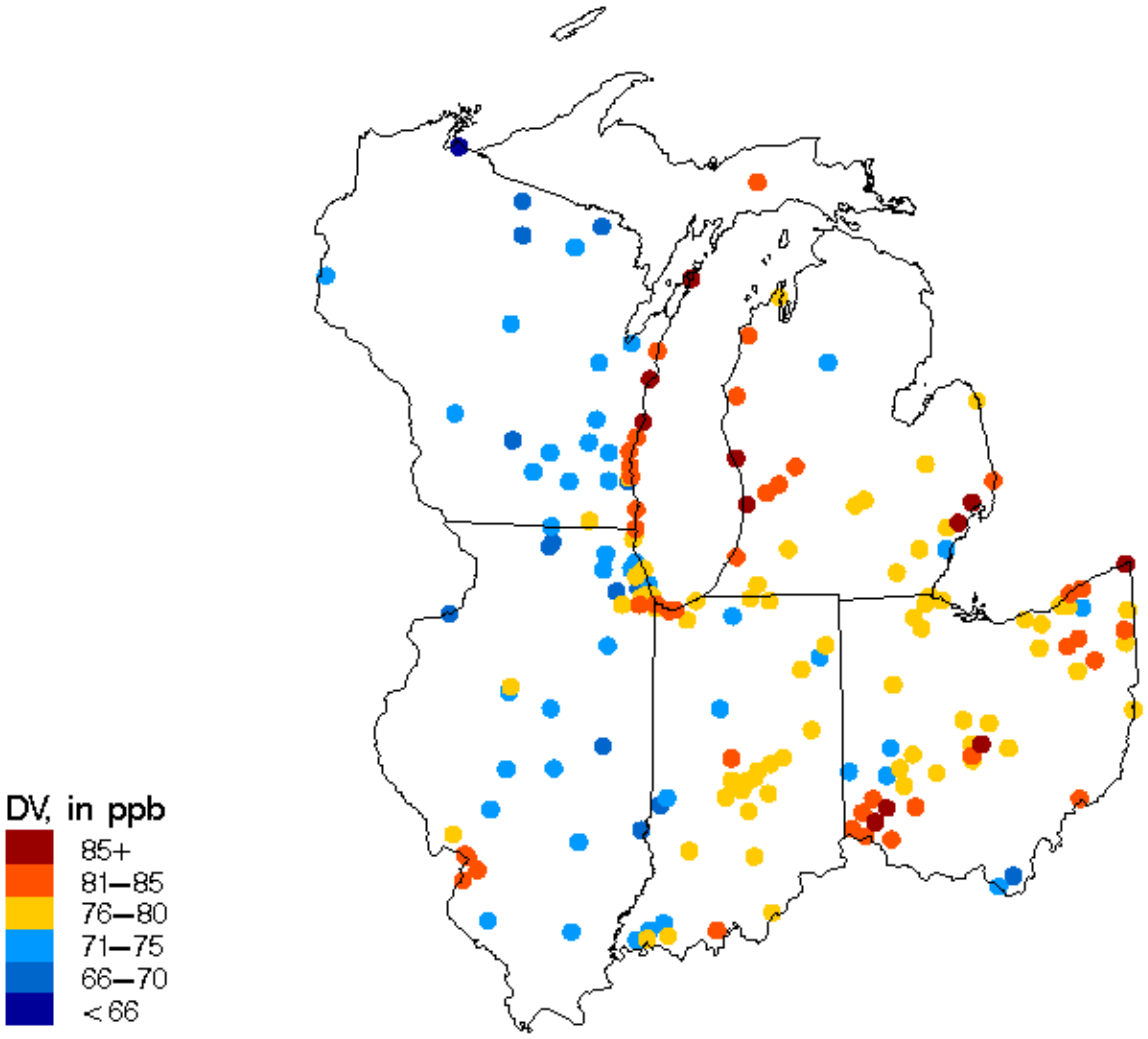


Figure 1. 8-hour ozone design values (2005-2007)

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).

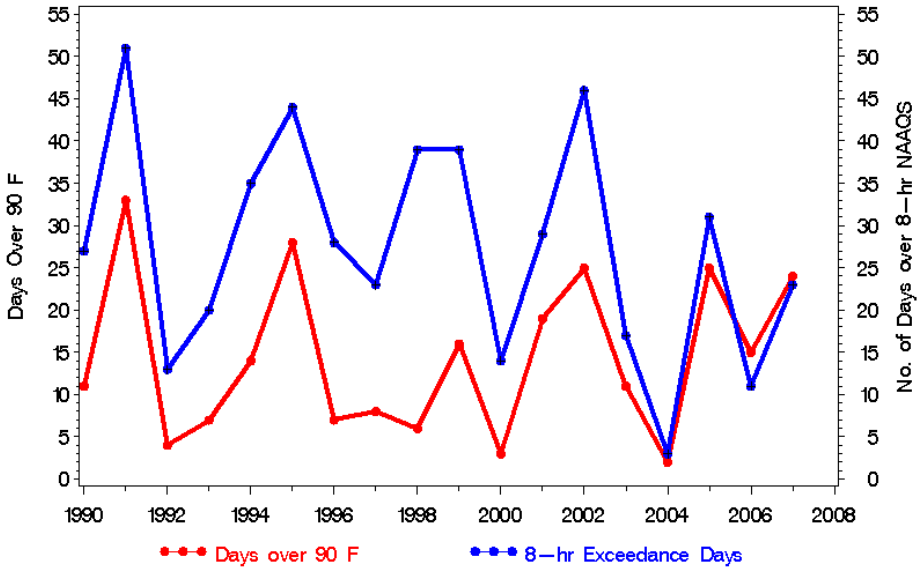


Figure 2. Number of hot days and 8-hour "exceedance" days in 5-state region

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.

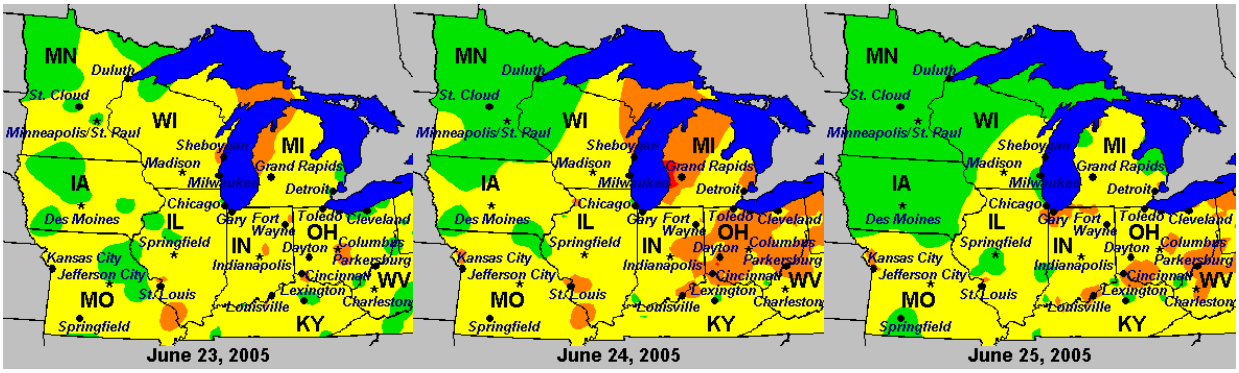


Figure 3. Example of elevated regional ozone concentrations (June 23 – 25, 2005)

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).

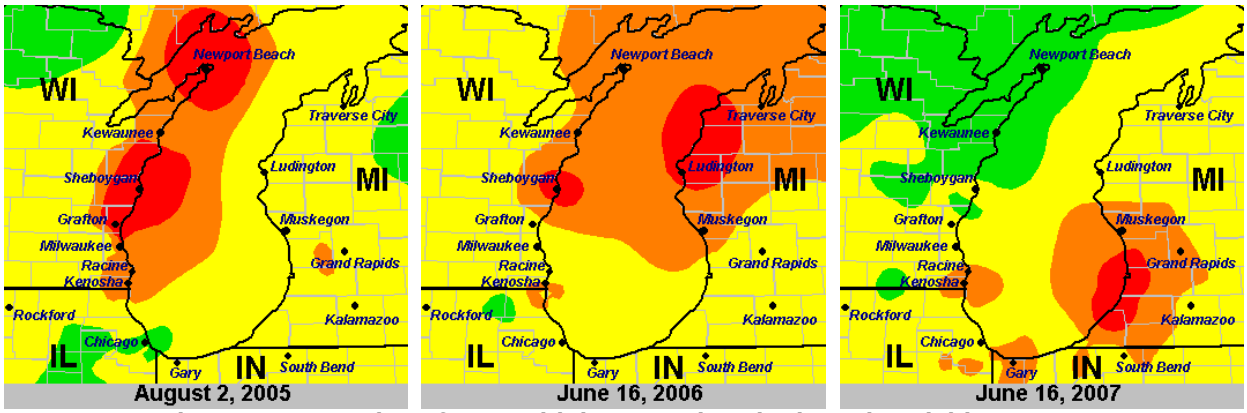


Figure 4. Examples of recent high ozone days in the Lake Michigan area

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).

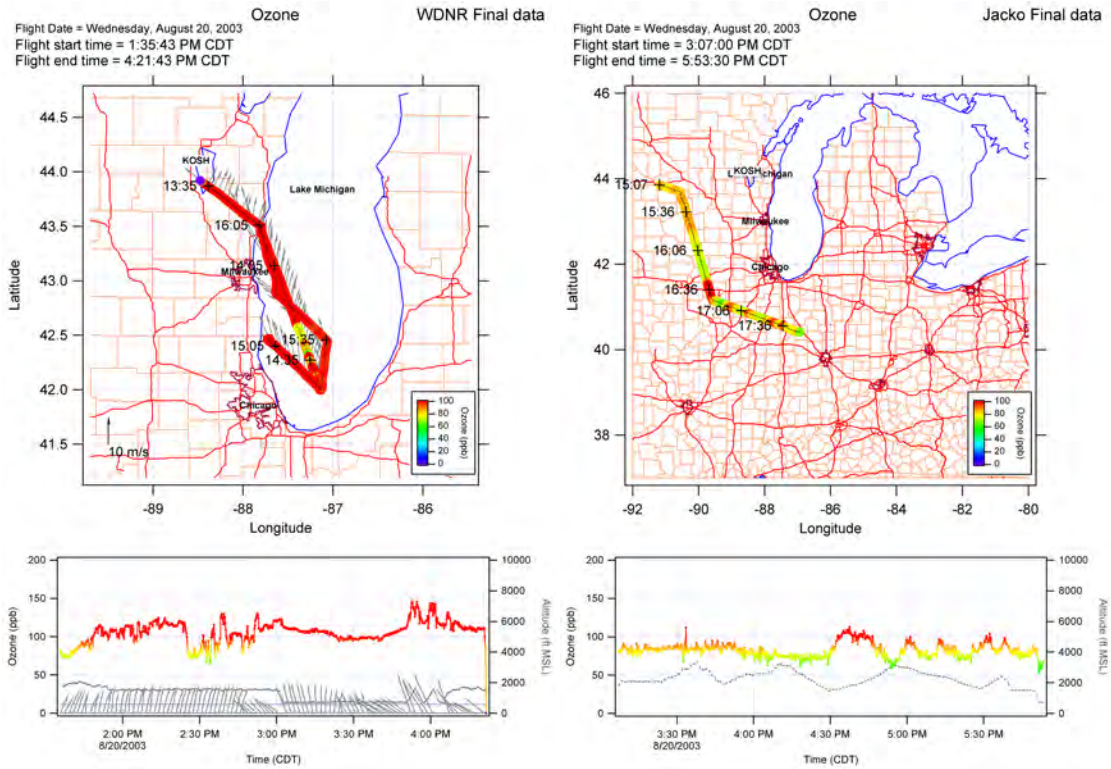


Figure 5. Aircraft ozone measurements over Lake Michigan (left) and along upwind boundary (right) – August 20, 2003 (Note: aircraft measurements reflect instantaneous values)

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.

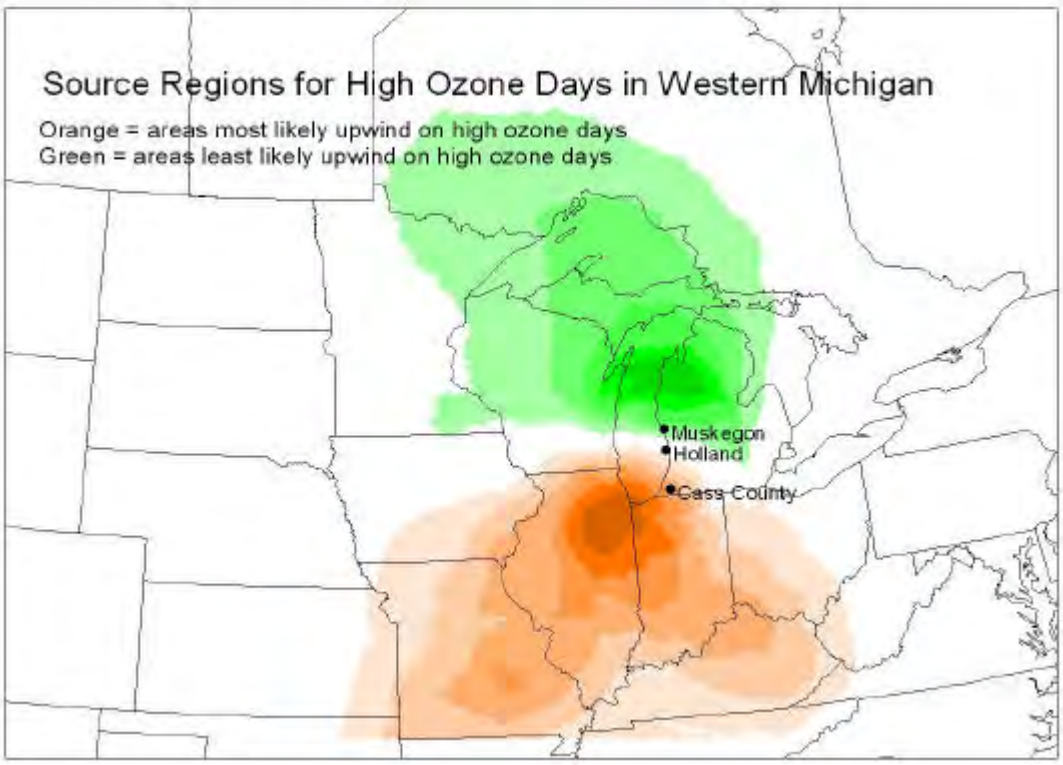


Figure 6 Back trajectory analysis showing upwind areas associated with high ozone concentrations

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.

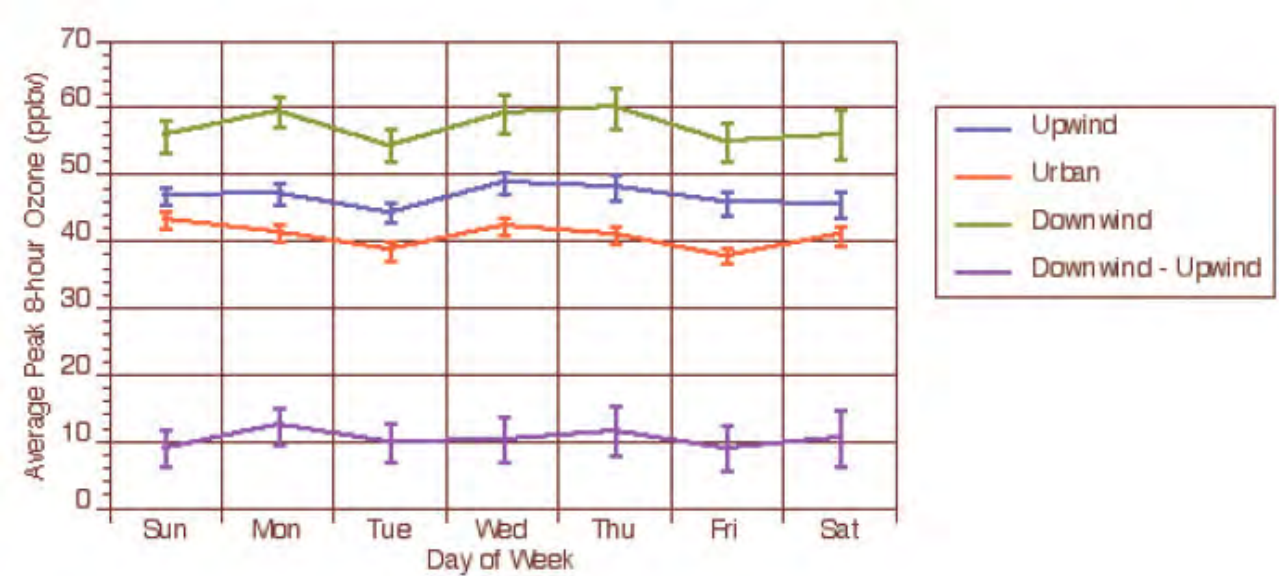


Figure 7. Mean day-of-week peak 8-hour ozone concentrations at sites upwind, within, and downwind of Chicago, 1999 – 2002 (southwesterly wind days)

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.

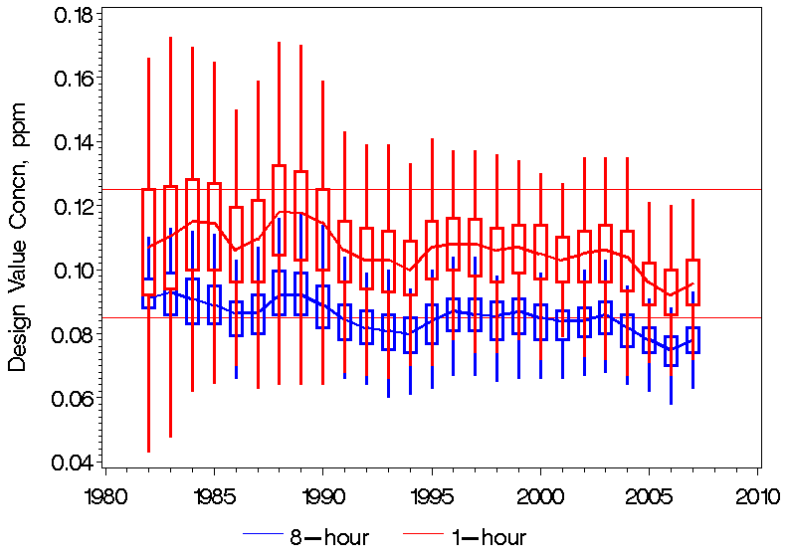


Figure 8 Ozone design value trends in 5-State region

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.

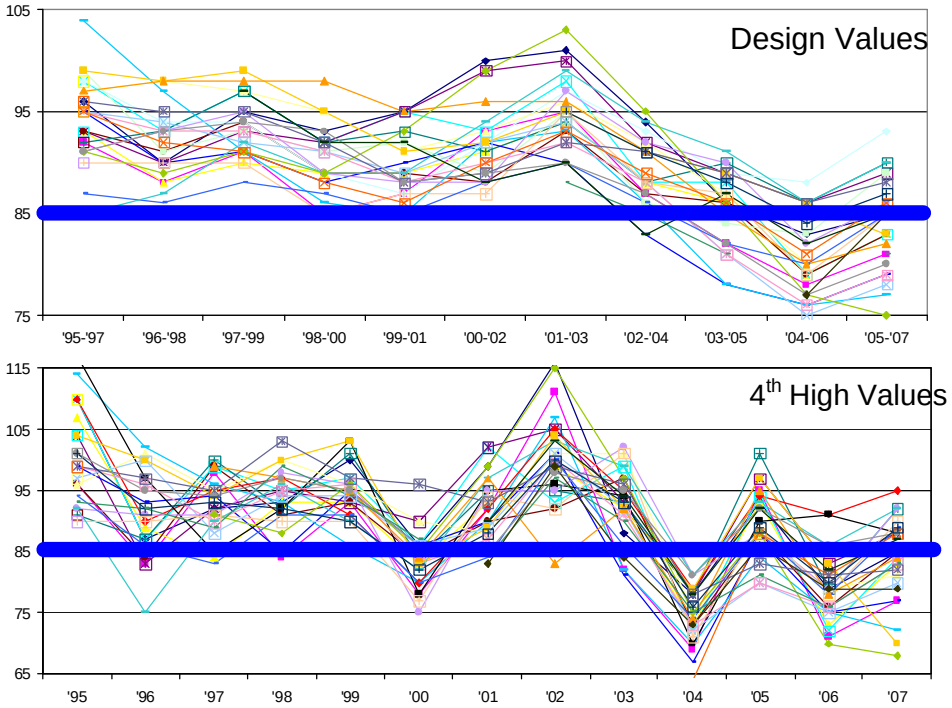


Figure 9. Trend in ozone design values and 4th high values for higher ozone sites in region

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).

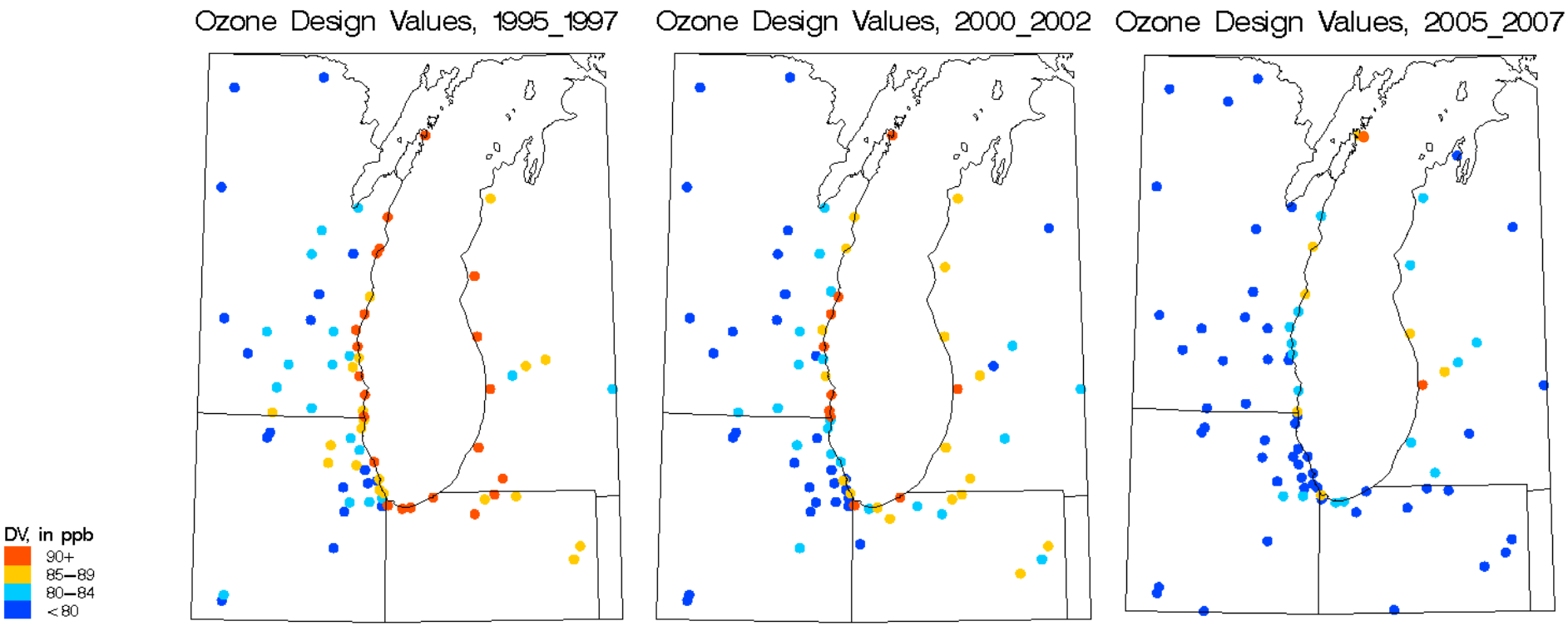


Figure 10. Ozone design value maps for 1995-1997, 2000-2002, and 2005-2007

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.

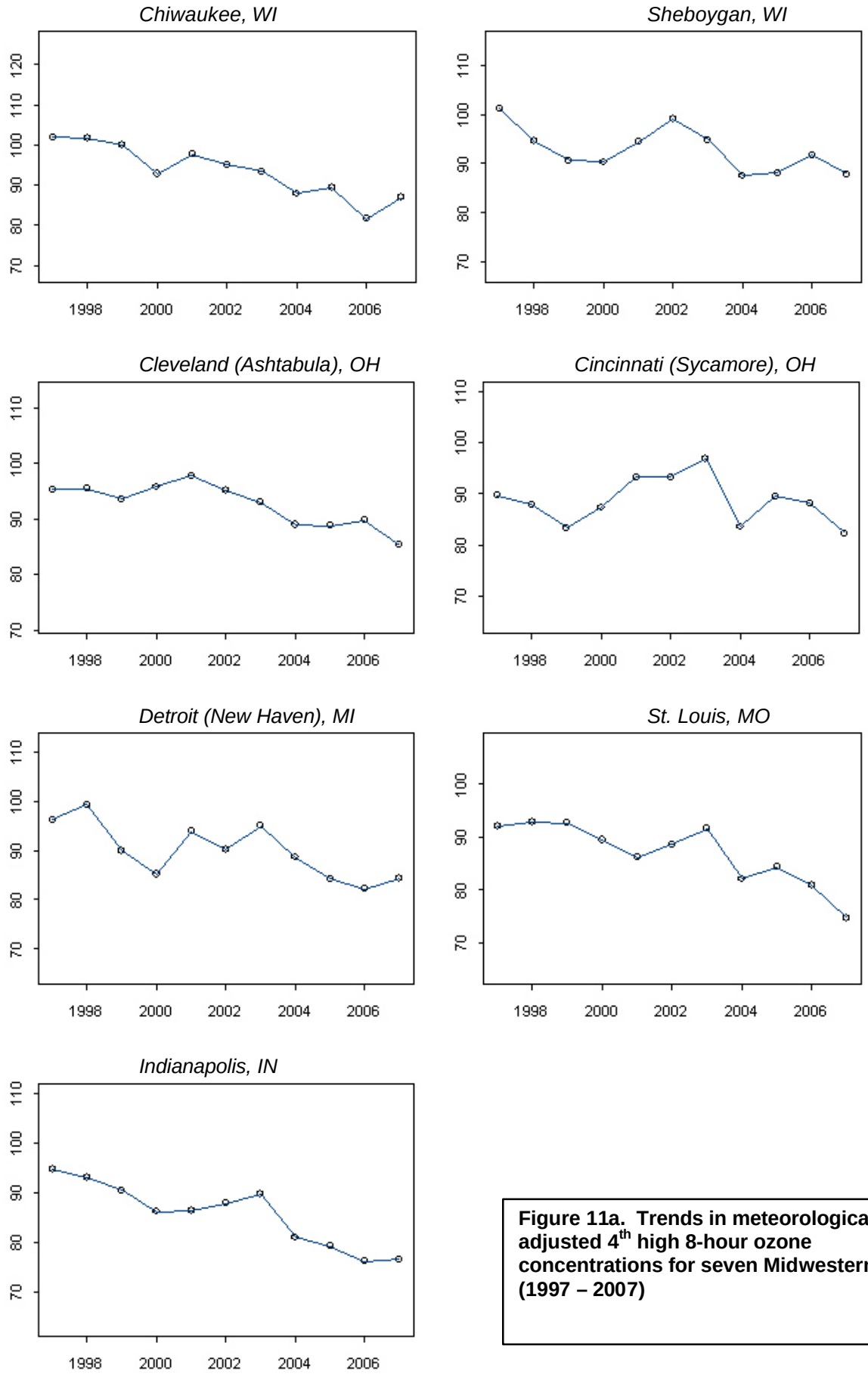


Figure 11a. Trends in meteorologically adjusted 4th high 8-hour ozone concentrations for seven Midwestern sites (1997 – 2007)

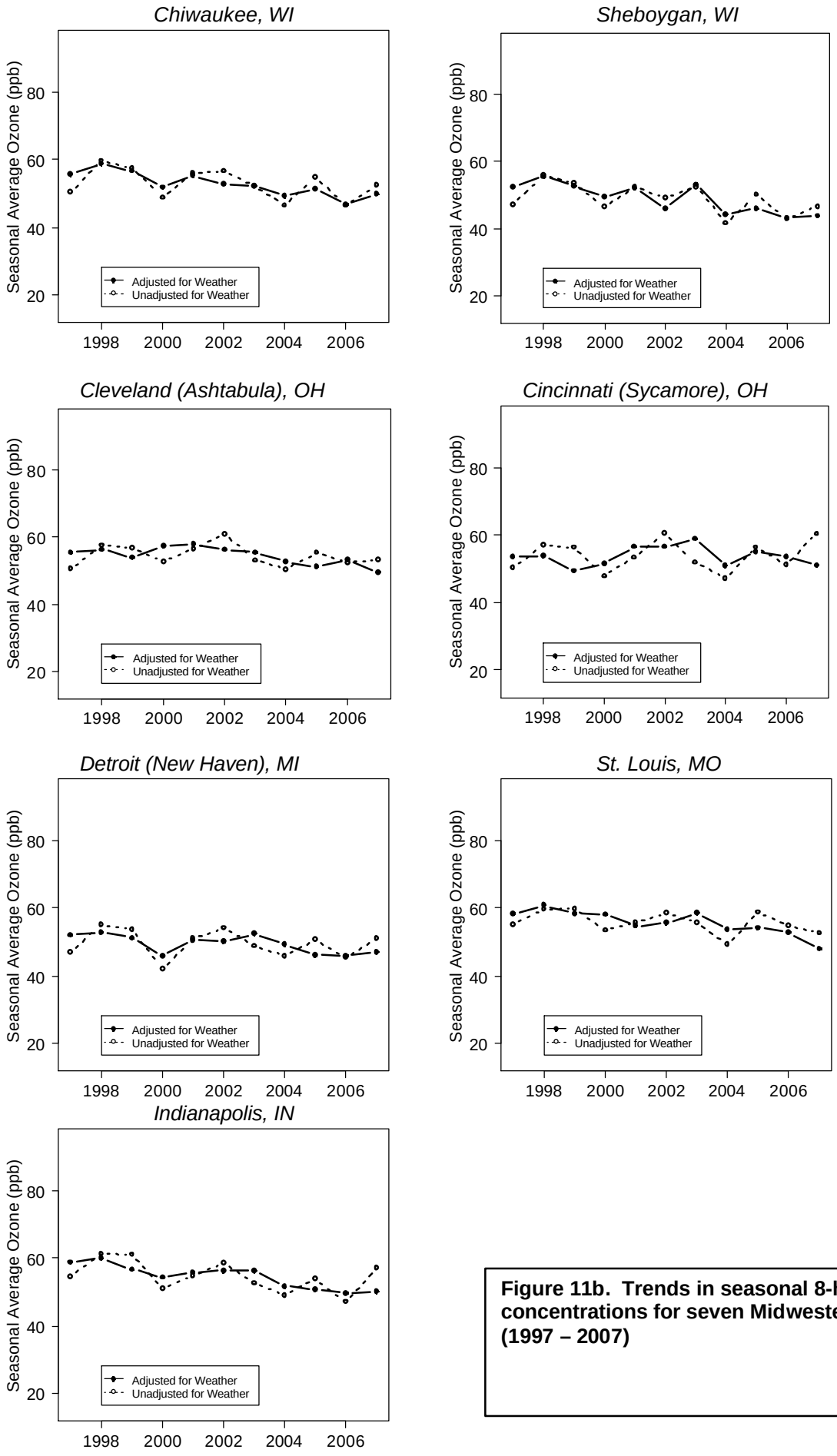


Figure 11b. Trends in seasonal 8-hour ozone concentrations for seven Midwestern sites (1997 – 2007)

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).

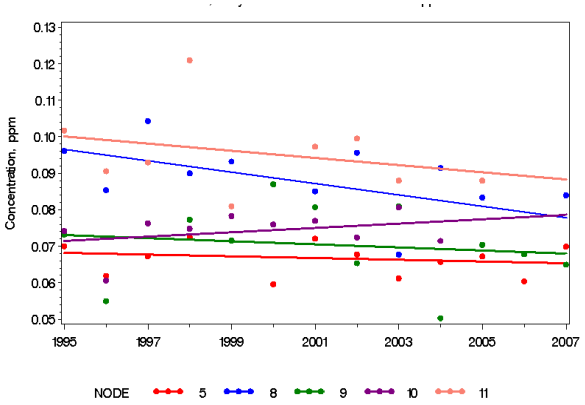
The effect of meteorology was further examined by using an ozone conduciveness index (Kenski, 2008b). This metric reflects the variability from the 13-year average in the number of days in the higher ozone concentration nodes (see Figure 13). Examination of these plots indicates:

- 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).

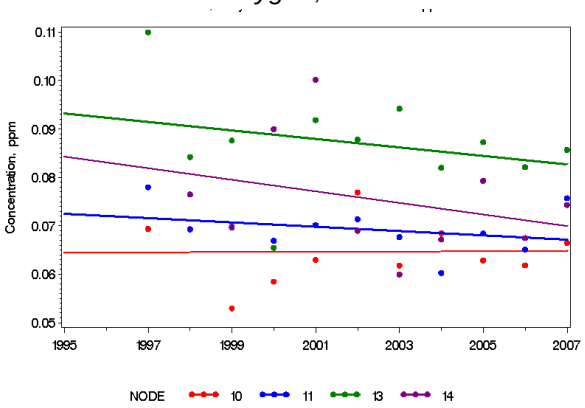
Given the similarity in ozone conduciveness between 2001-2003 and 2005-2007, the improvement in ozone levels noted above is presumed to be due to non-meteorological factors (i.e., emission reductions).

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.

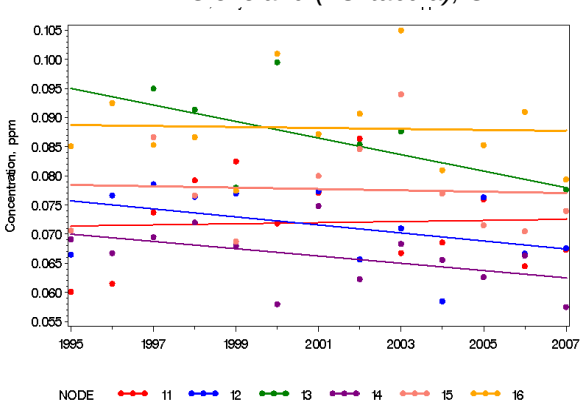
Chiwaukee, WI



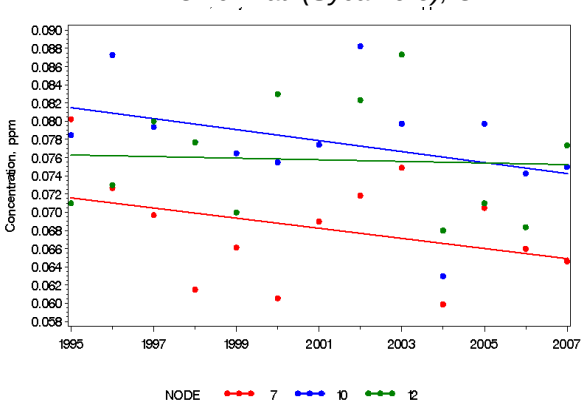
Sheboygan, WI



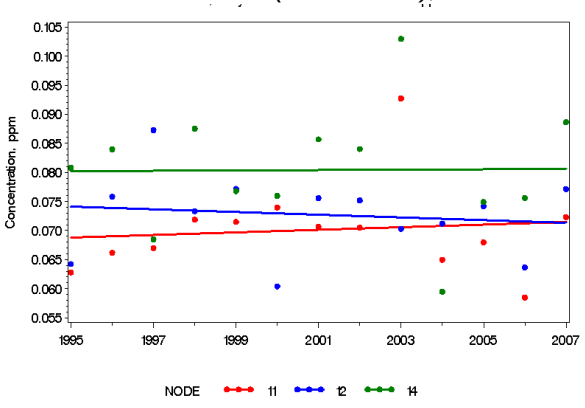
Cleveland (Ashtabula), OH



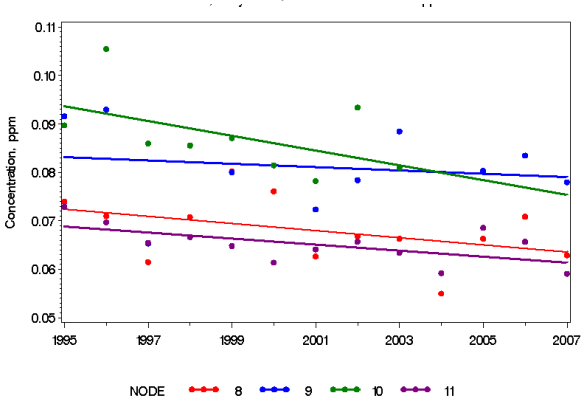
Cincinnati (Sycamore), OH



Detroit (New Haven), MI



St. Louis, MO



Indianapolis, IN

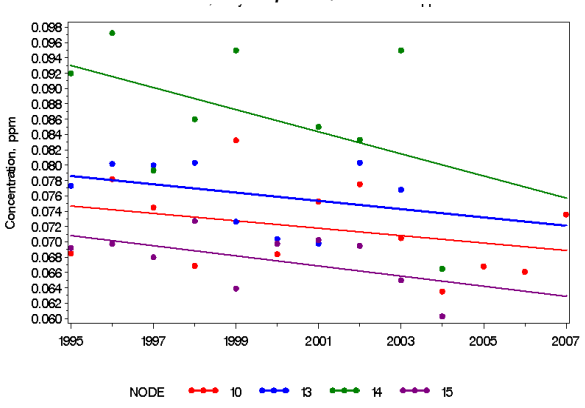


Figure 12. Trends for higher ozone CART groups (average ozone > 65 ppb) for seven Midwestern sites (1995 – 2007)

Note: line represents linear best fit

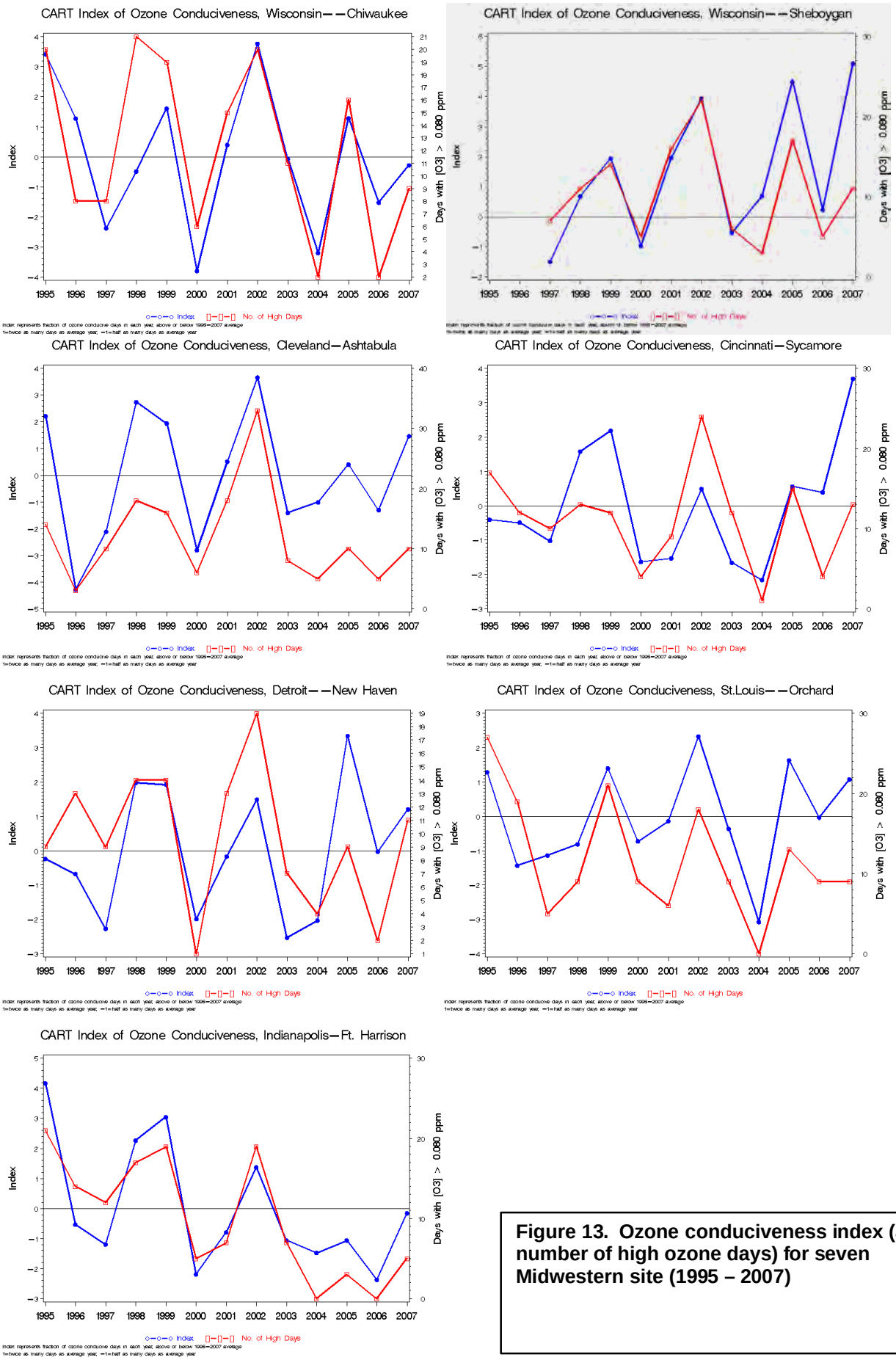


Figure 13. Ozone conduciveness index (and number of high ozone days) for seven Midwestern site (1995 – 2007)

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.

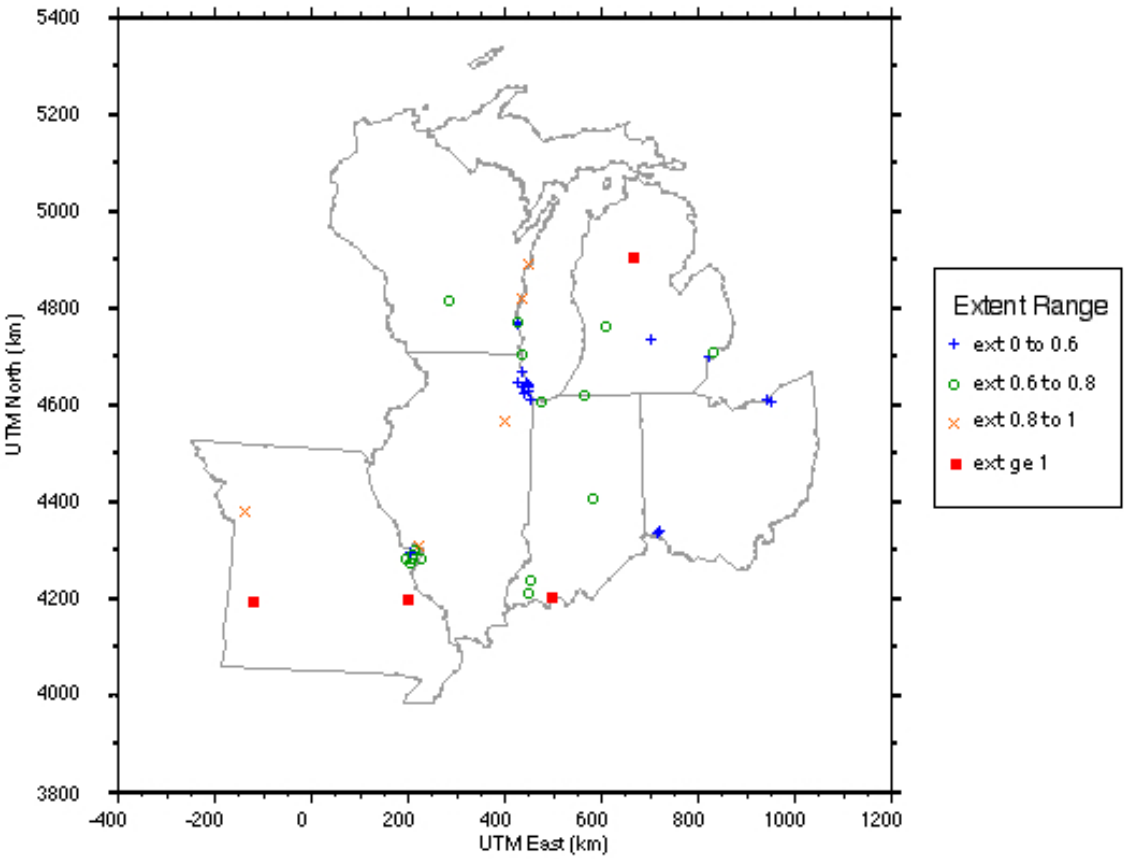


Figure 14. Mean afternoon extent of reaction (1998 – 2002)

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.

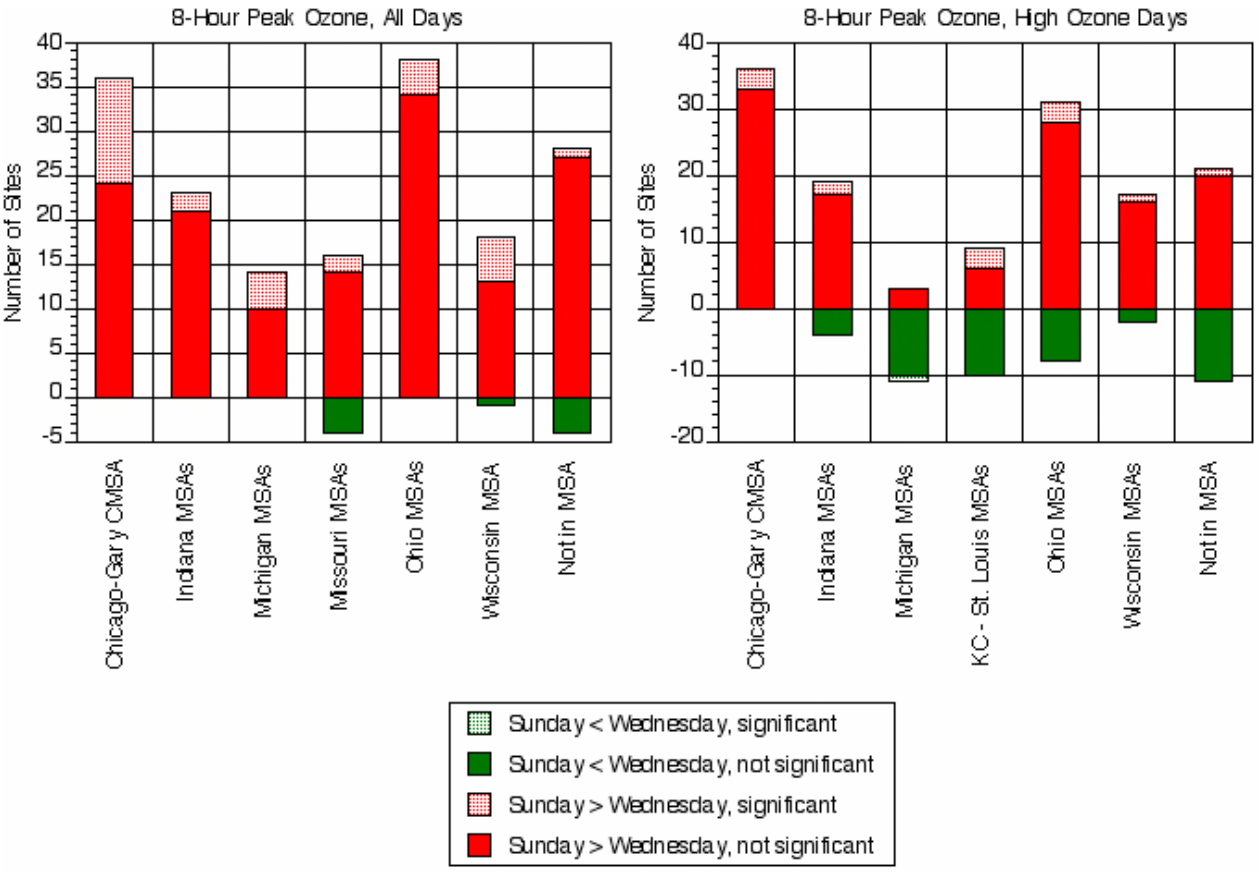


Figure 15. Weekday/weekend differences in 8-hour ozone – number of sites with weekend increase (positive values) v. number of sites with weekend decreases (negative values)

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.

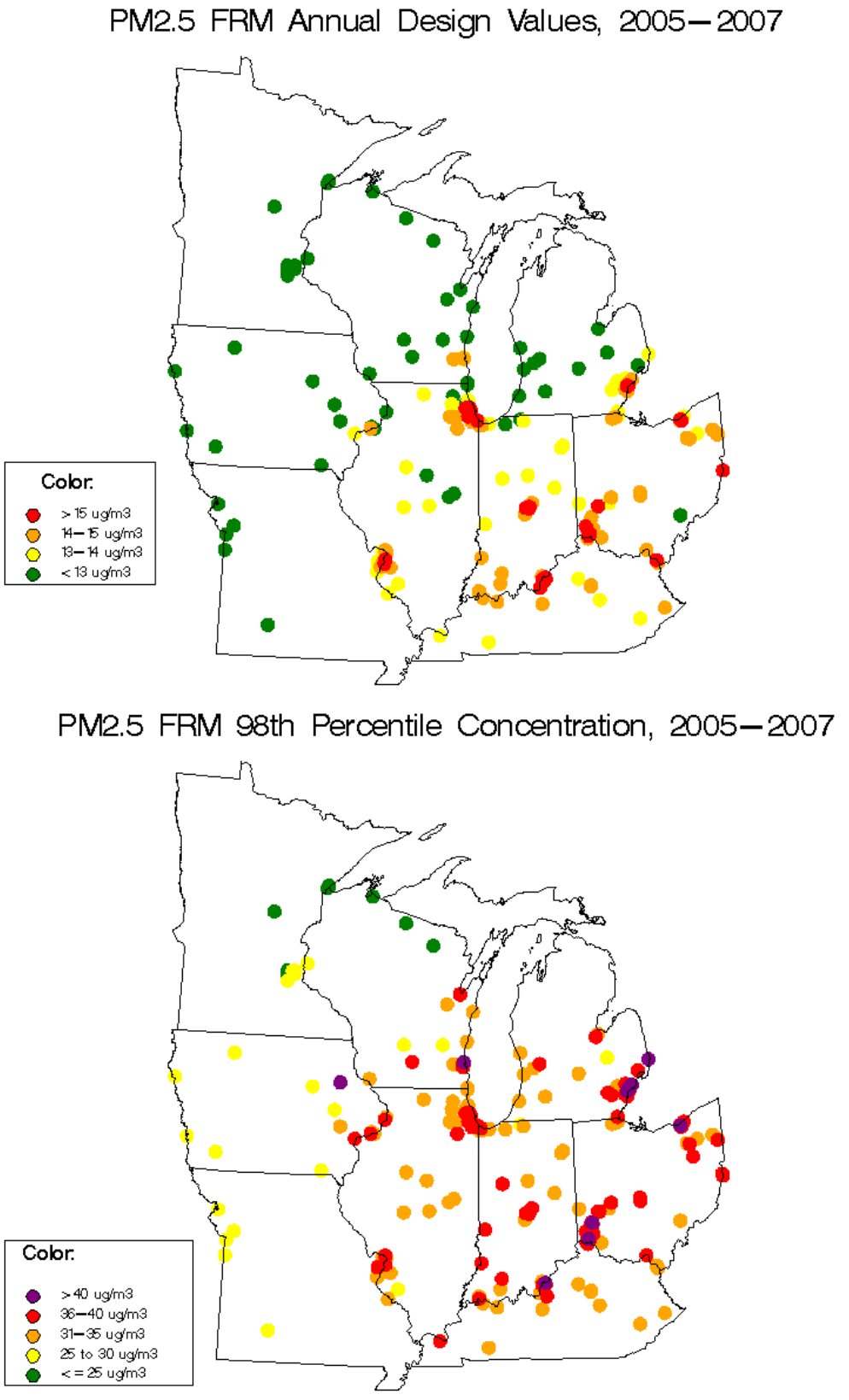


Figure 16. $PM_{2.5}$ design values - annual average (top) and 24-hour average (bottom) (2005-2007)

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.

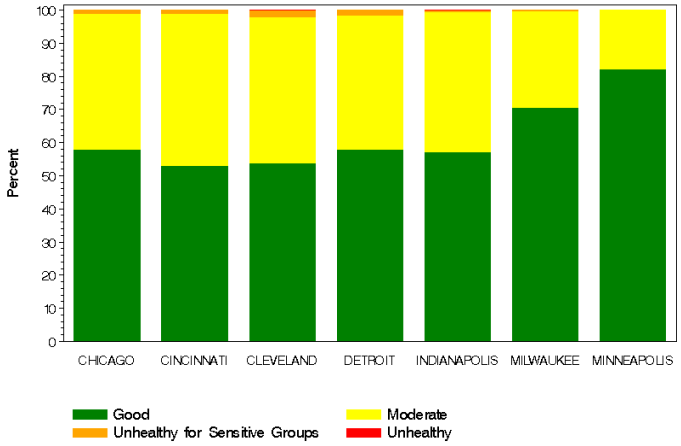


Figure 17. Percent of days in AQI categories for $PM_{2.5}$ (2002-2004)

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).

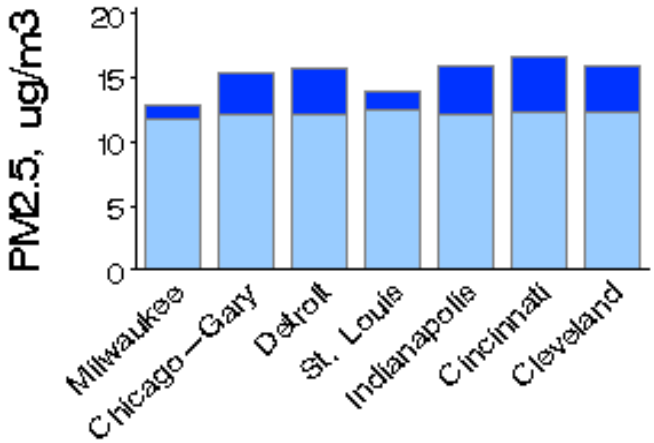


Figure 18. Regional (lighter shading) v. local components (darker shading) of annual average $PM_{2.5}$ concentrations

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].

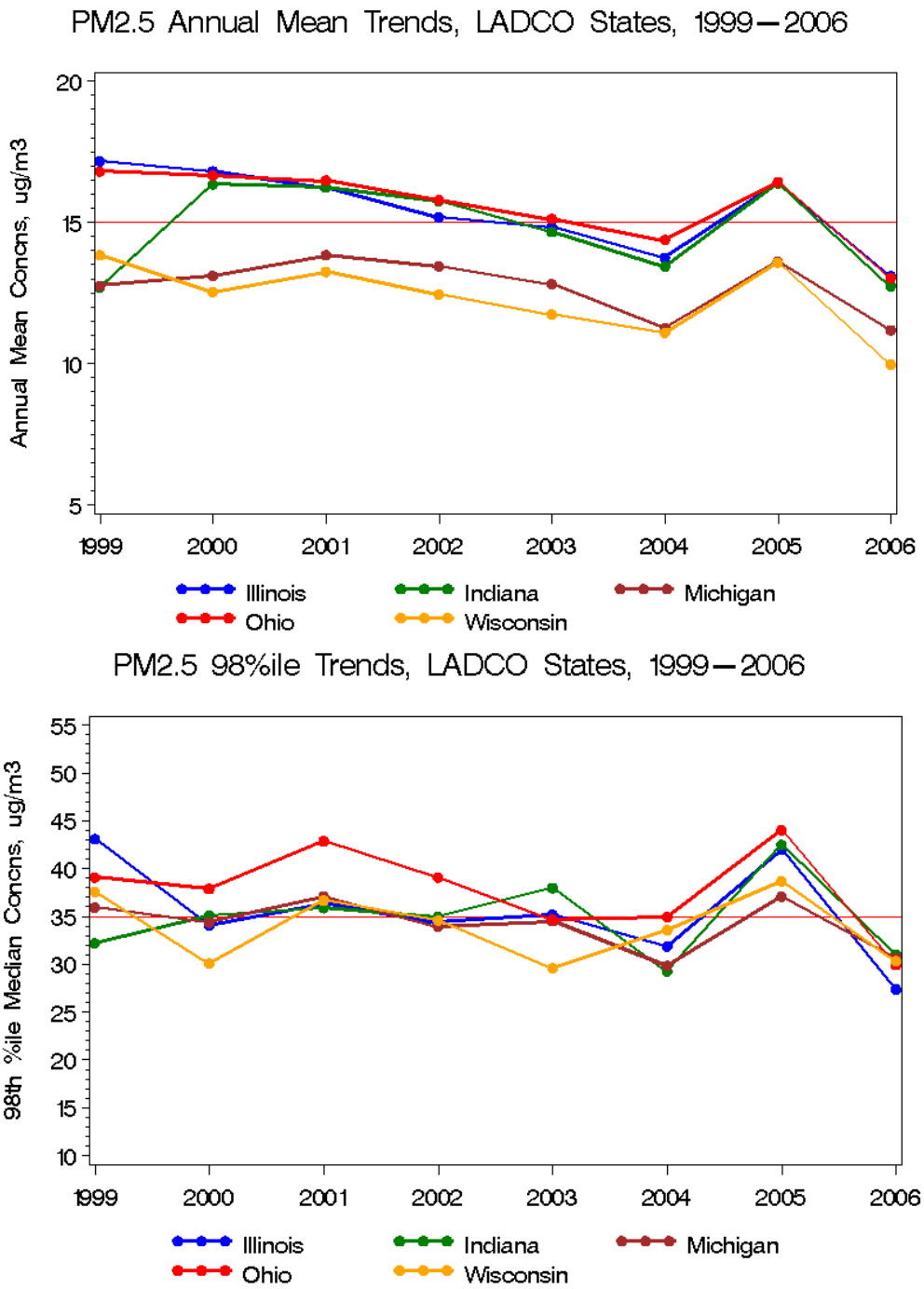


Figure 19. $PM_{2.5}$ trends in annual average (top) and daily concentrations (bottom)

[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.

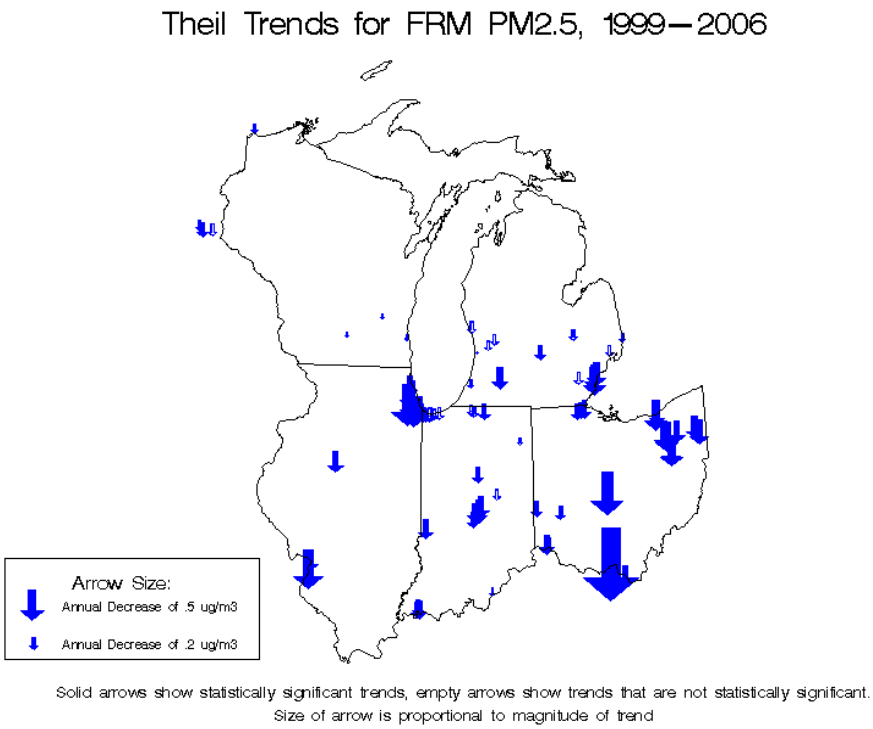


Figure 20. Annual trends in $PM_{2.5}$ mass (1999 – 2006)

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.

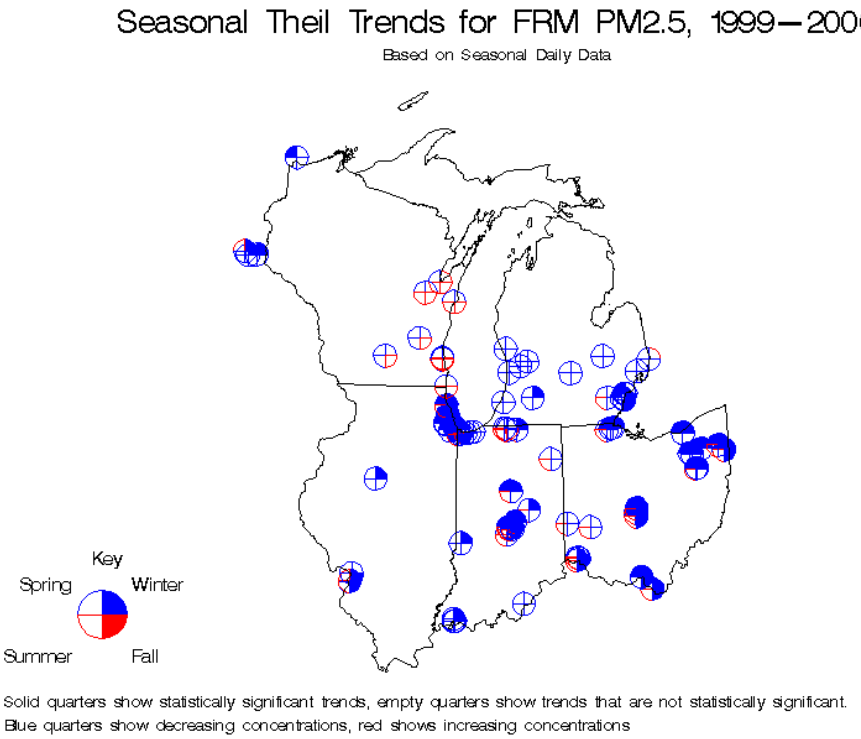


Figure 21. Seasonal trends in $PM_{2.5}$ mass (1999 – 2006)

$PM_{2.5}$ 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.

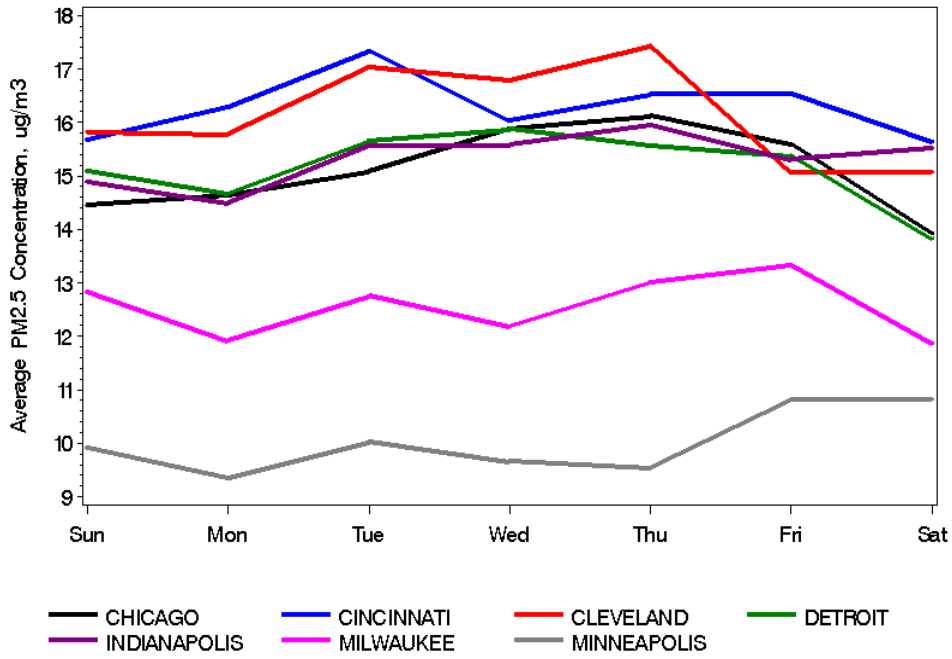


Figure 22 Day-of-week variability in $PM_{2.5}$ (2002-2004)

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.

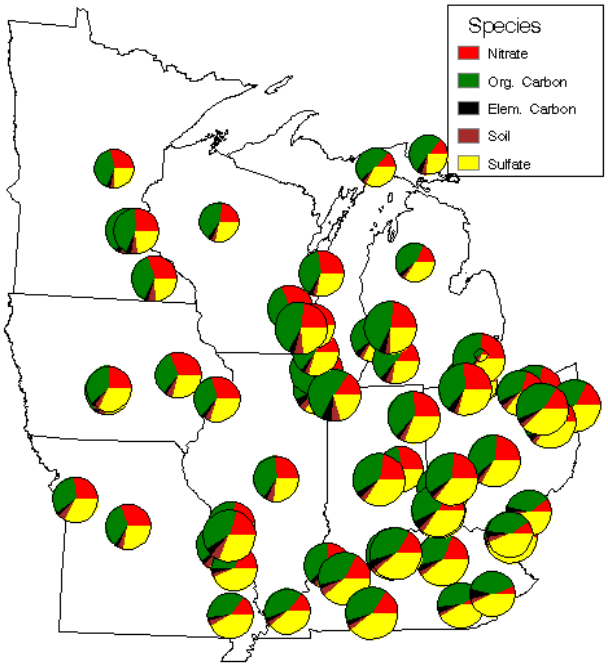


Figure 23. Spatial map of $PM_{2.5}$ chemical composition in the Midwest (2002-2003)

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.

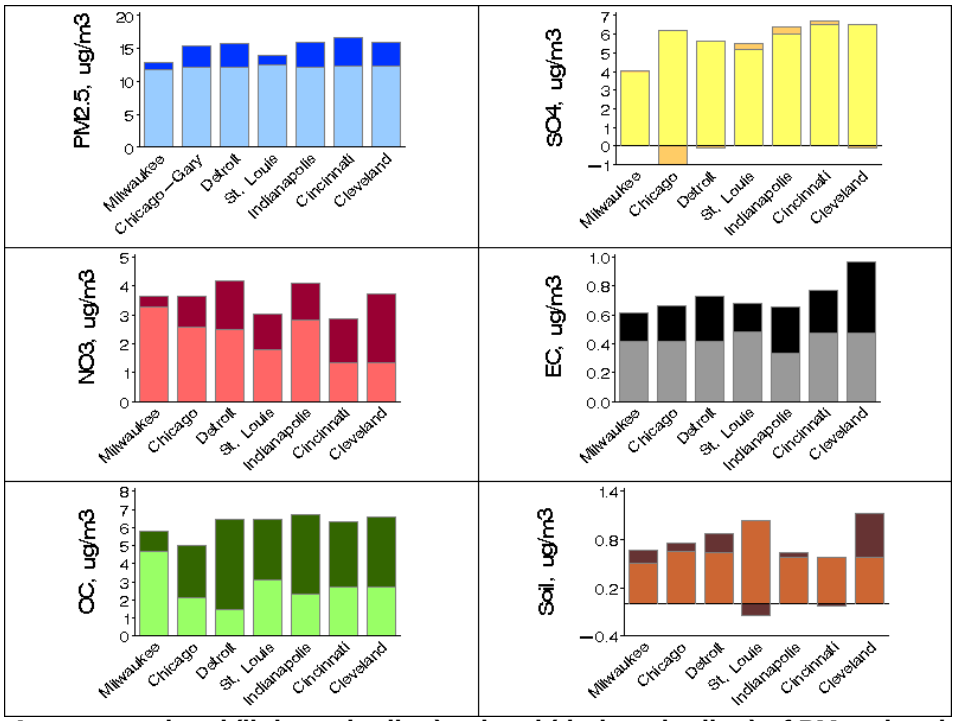


Figure 24. Average regional (lighter shading) v. local (darker shading) of $PM_{2.5}$ chemical species

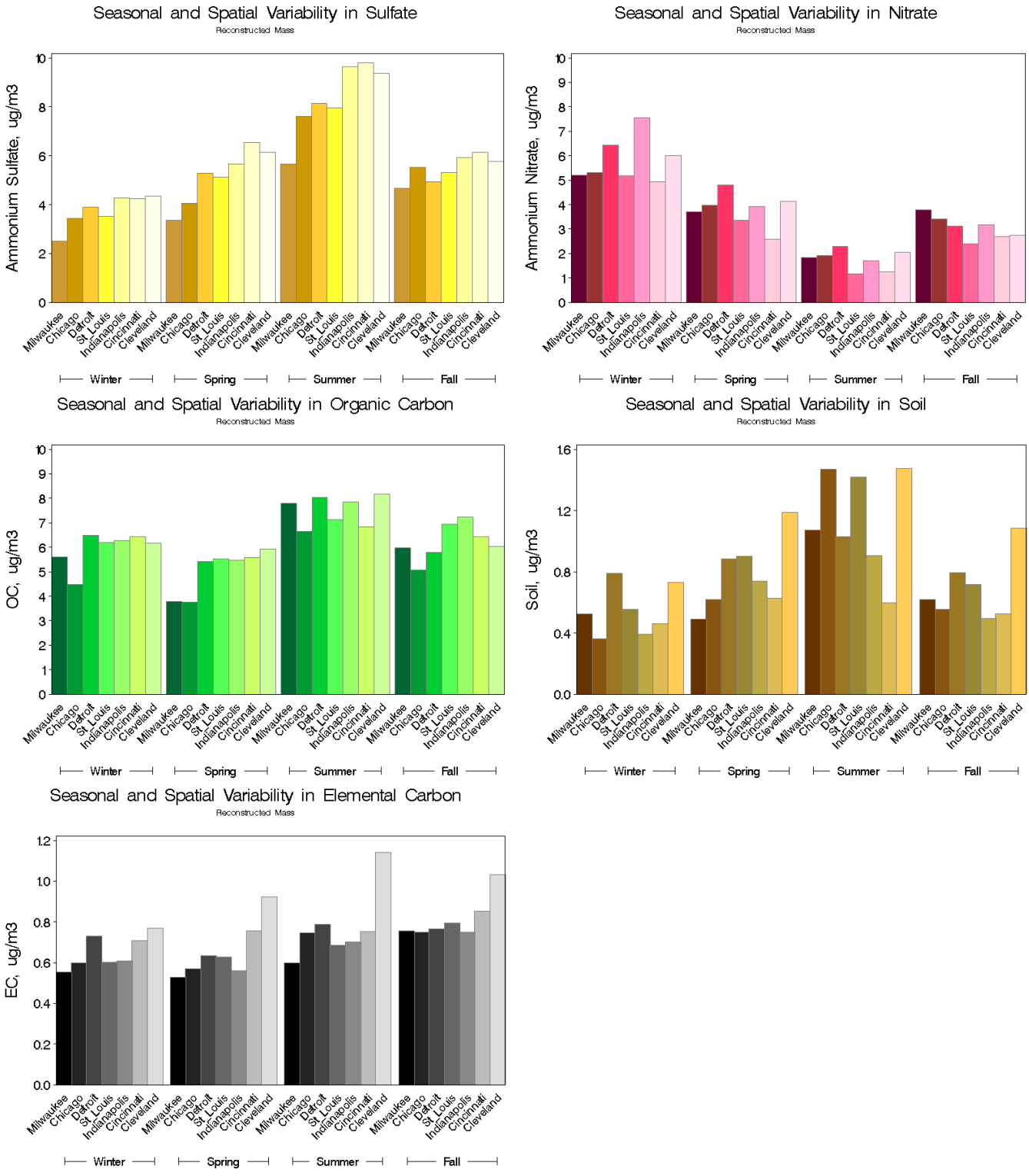


Figure 25 Seasonal and spatial variability in $PM_{2.5}$ components

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).

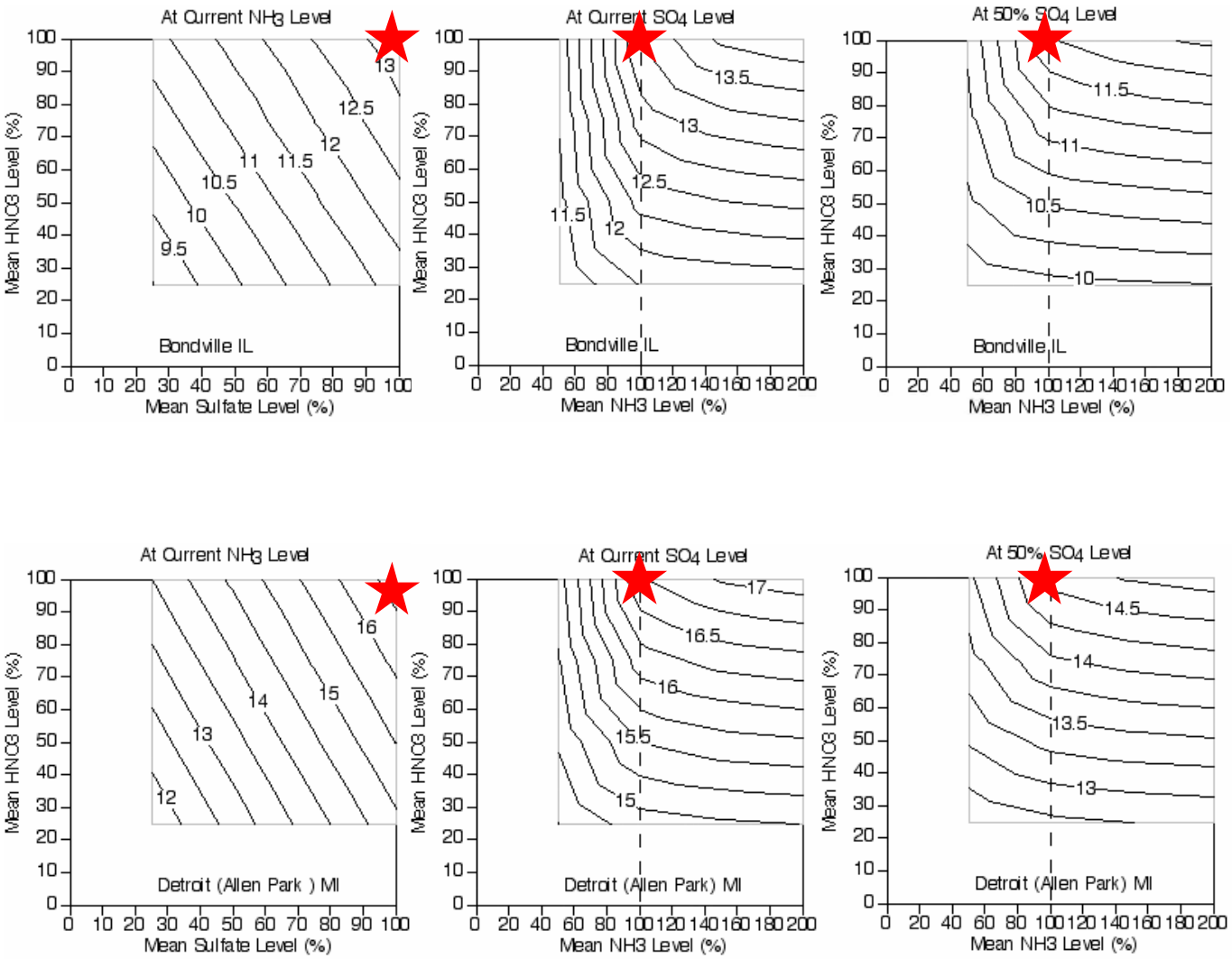


Figure 26. Predicted mean PM fine mass concentrations at Bondville, IL (top) and Detroit (Allen Park), MI (bottom) as functions of changes in sulfate, nitric acid (HNO3), and ammonia (NH3)

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.

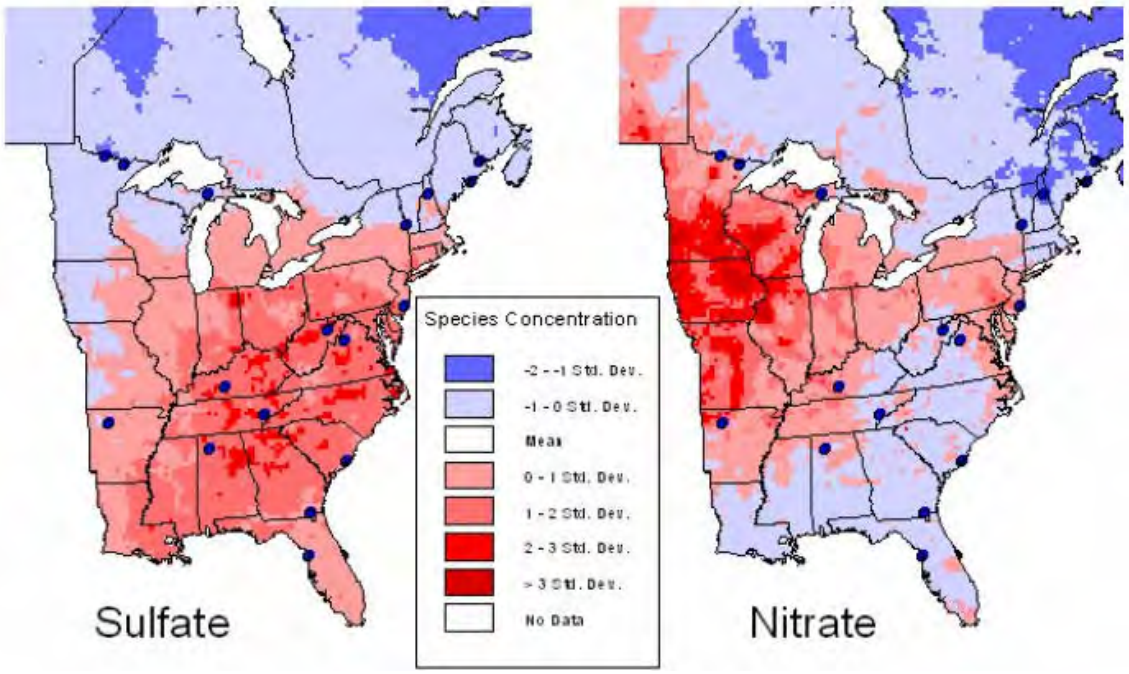


Figure 27. Sulfate and nitrate source regions based on ensemble trajectory analysis

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.

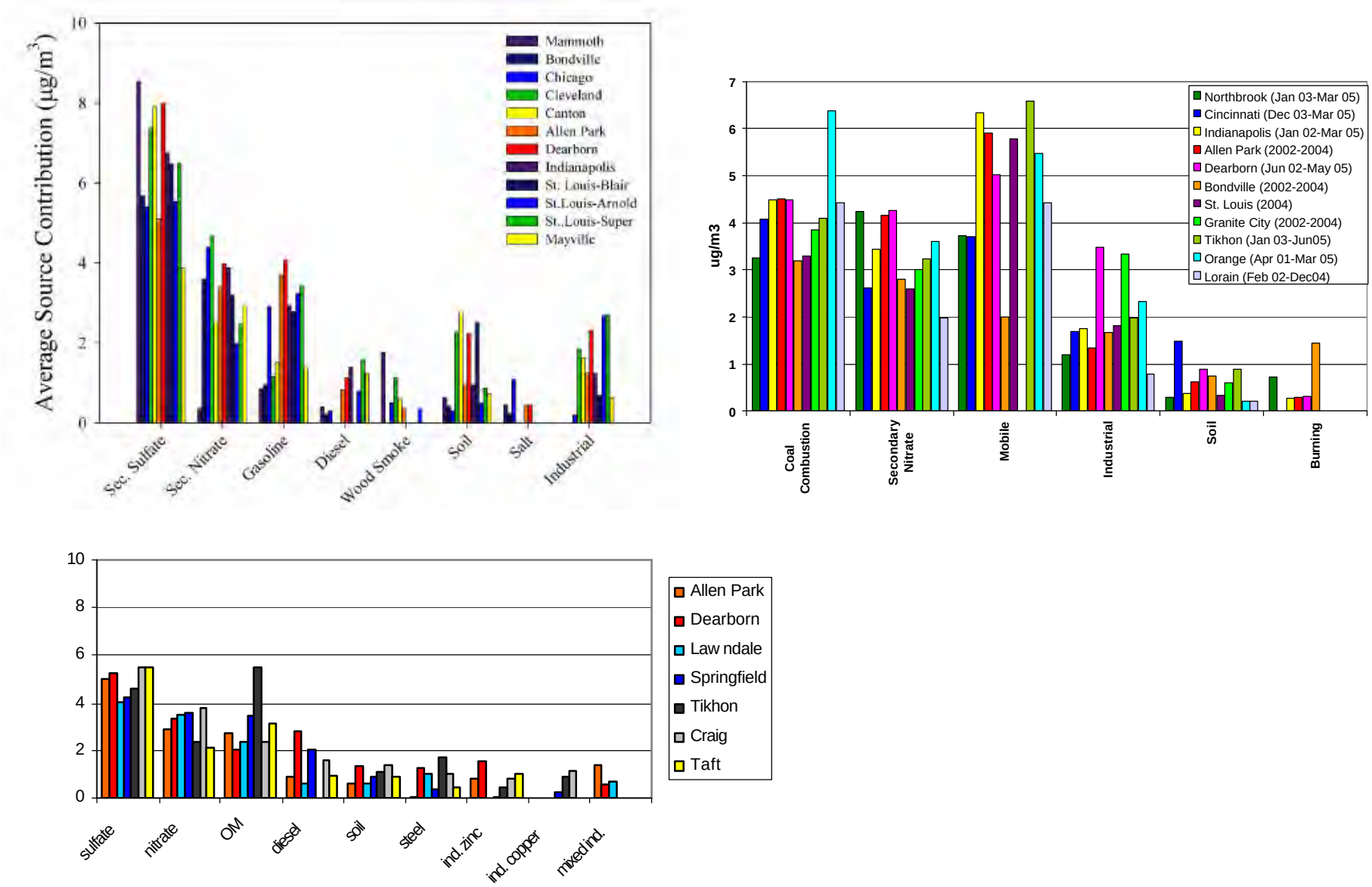


Figure 28. Major Source Contributions in the Midwest based on Hopke, 2005 (upper left), STI, 2006 (upper right), and STI, 2008 (lower left) (Note: the labeling of similar source types varies between studies – e.g., organic carbon/mobile sources are named gasoline and diesel by Hopke, mobile by STI 2006,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

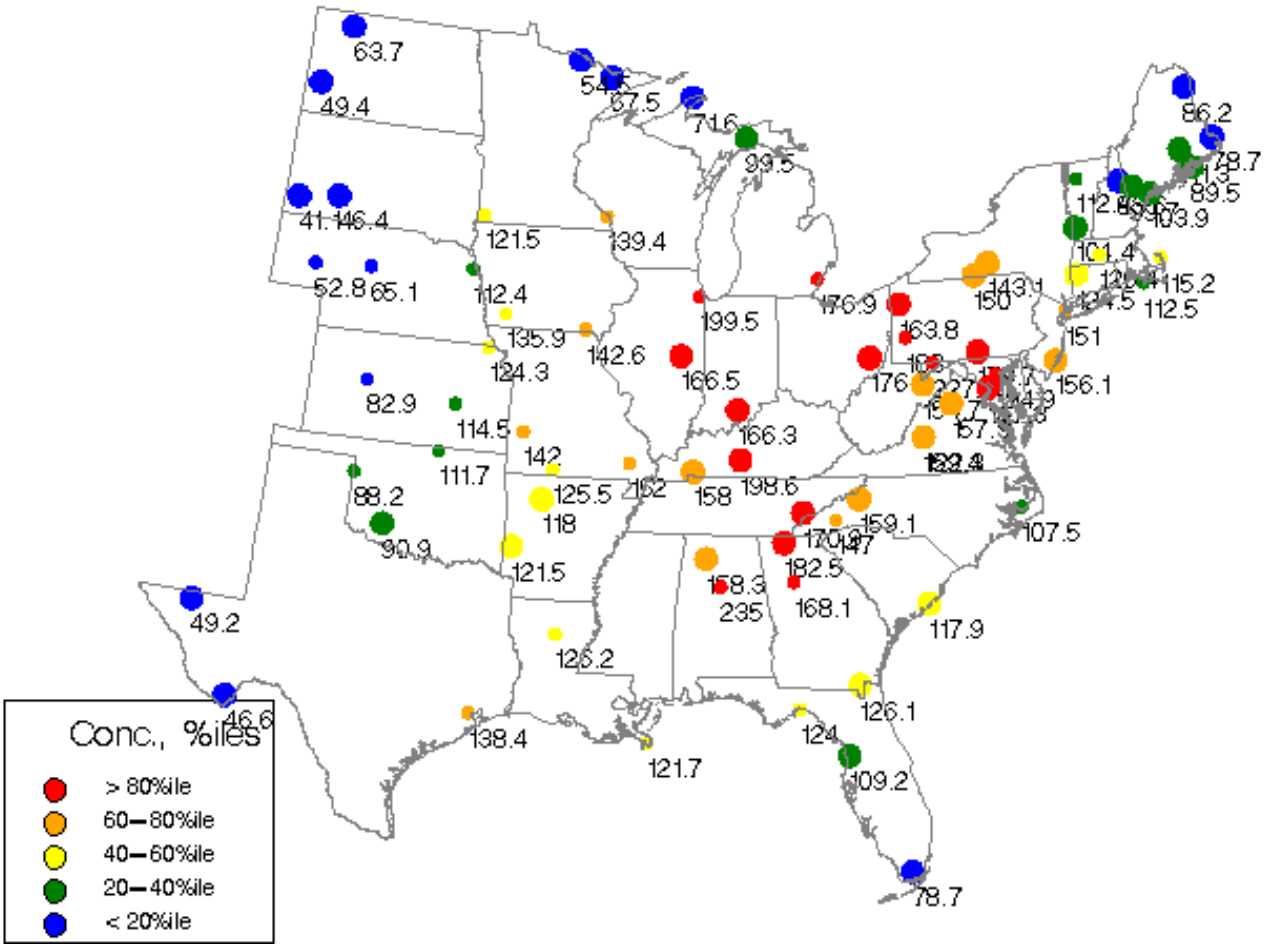


Figure 29. Baseline Visibility Levels for 20% Worst Days (2000 – 2004), units: Mm^{-1}

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.

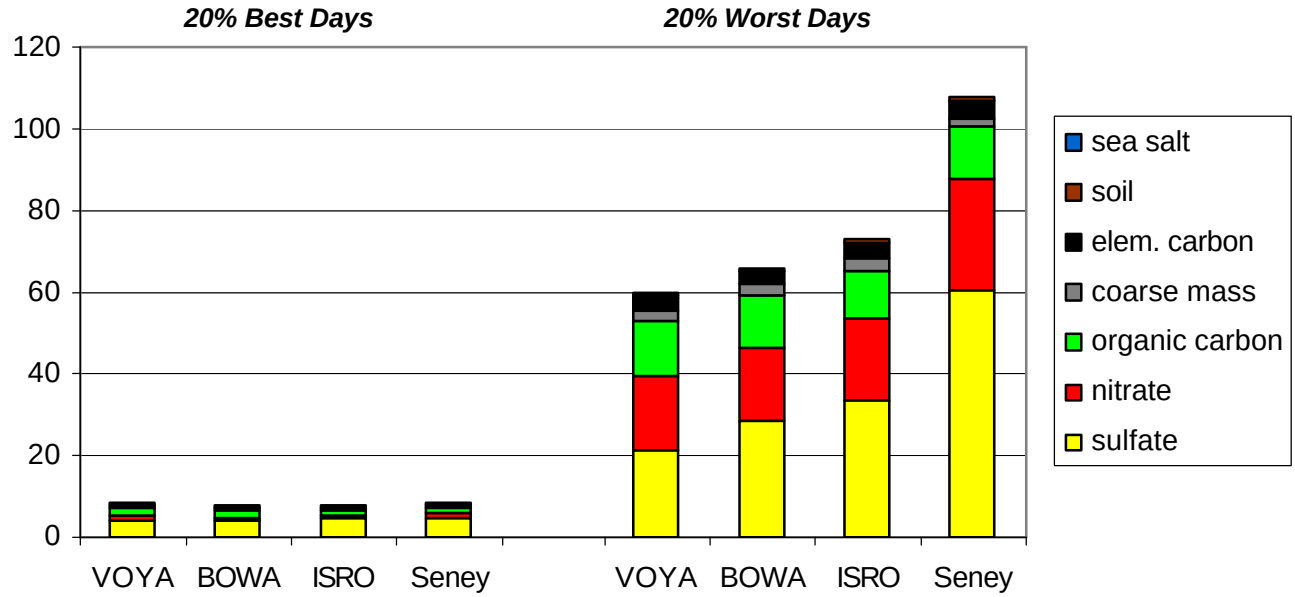


Figure 30. Chemical composition of light extinction for 20% best visibility days (left) and 20% worst visibility days (right) in terms of Mm^{-1}

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).

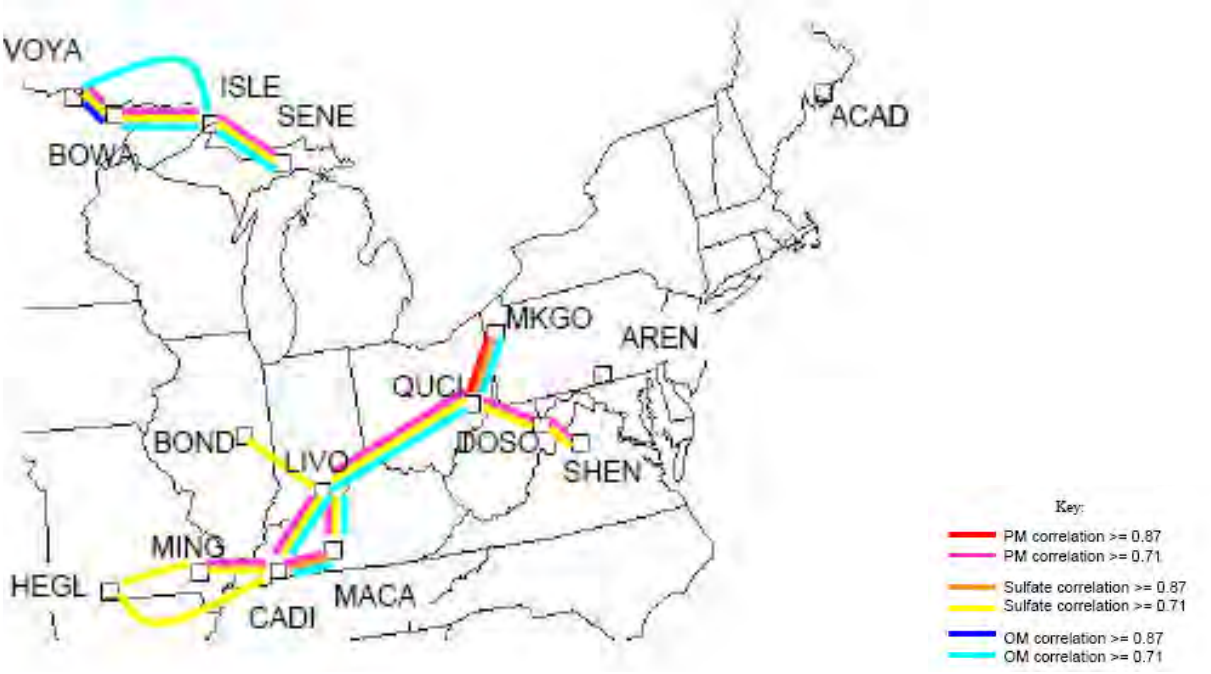


Figure 31. Correlations among IMPROVE (and IMPROVE-protocol) monitoring sites in Eastern U.S.

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.

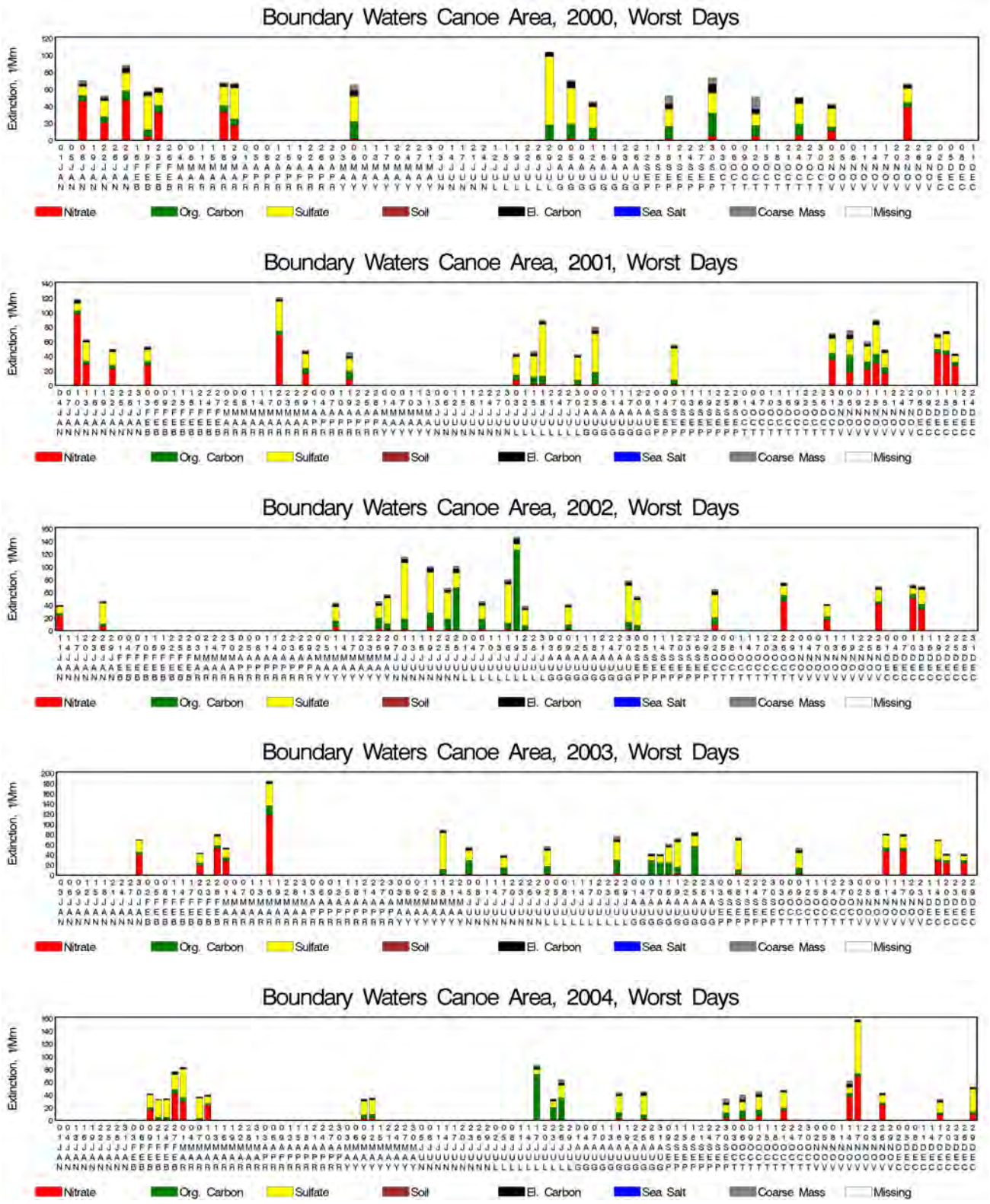


Figure 32. Daily light extinction values for 20% worst days at Boundary Waters (2000 – 2004)

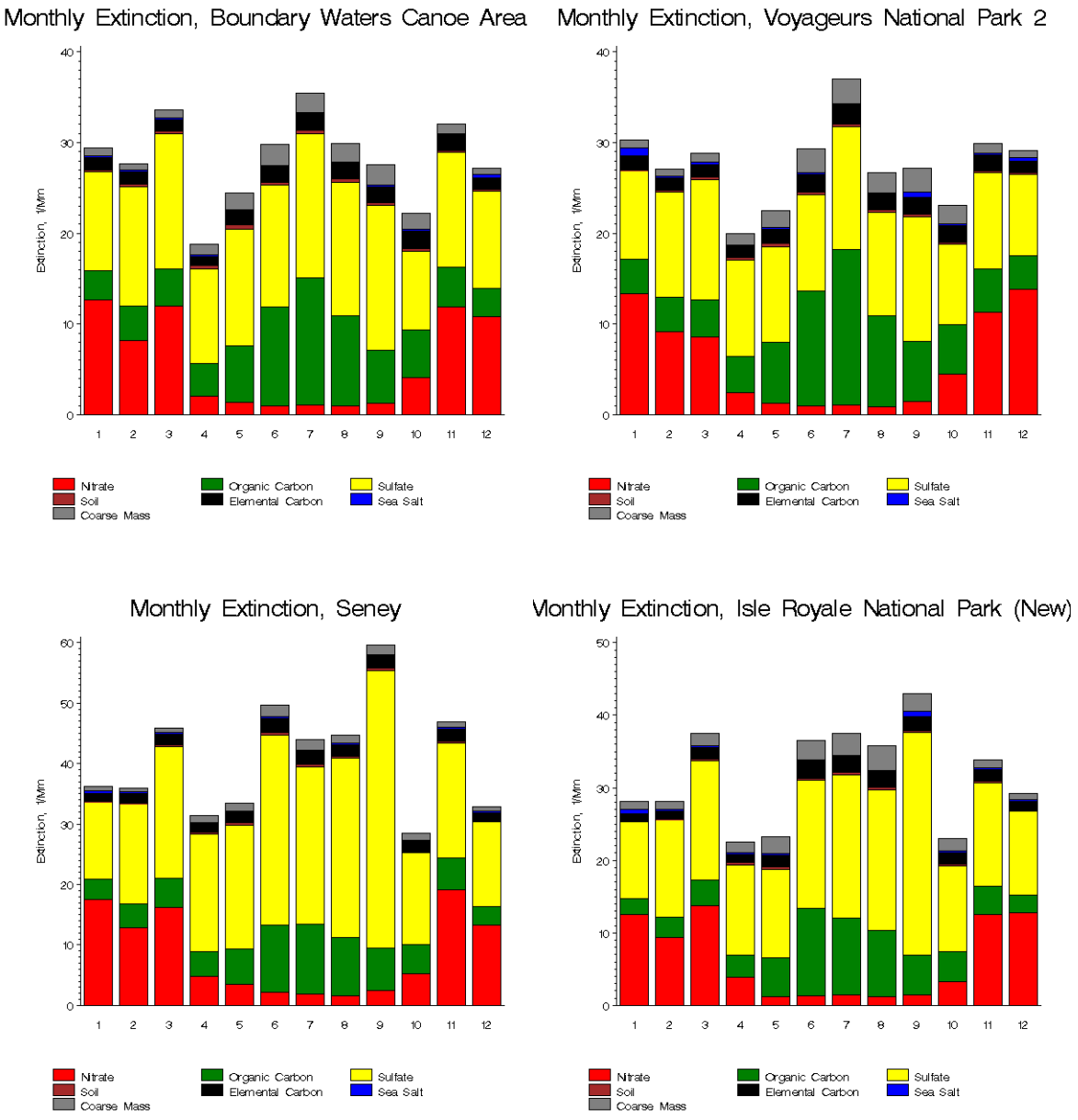


Figure 33. Monthly average light extinction values for northern Class I areas

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.

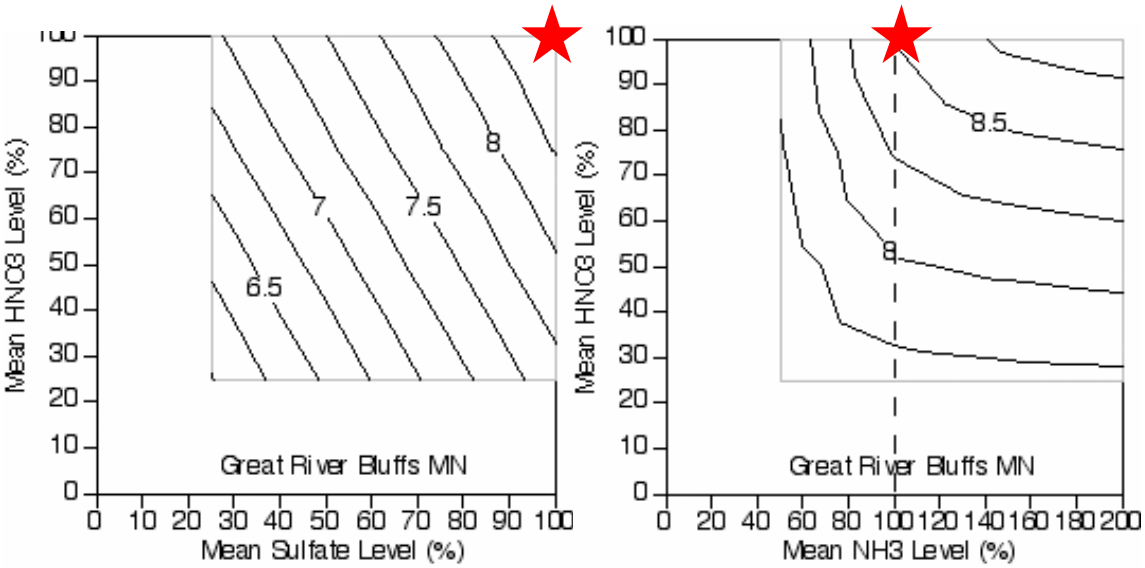


Figure 34. Predicted $PM_{2.5}$ mass concentrations at Great River Bluffs, MN as functions of changes in sulfate, nitric acid, and ammonia

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.

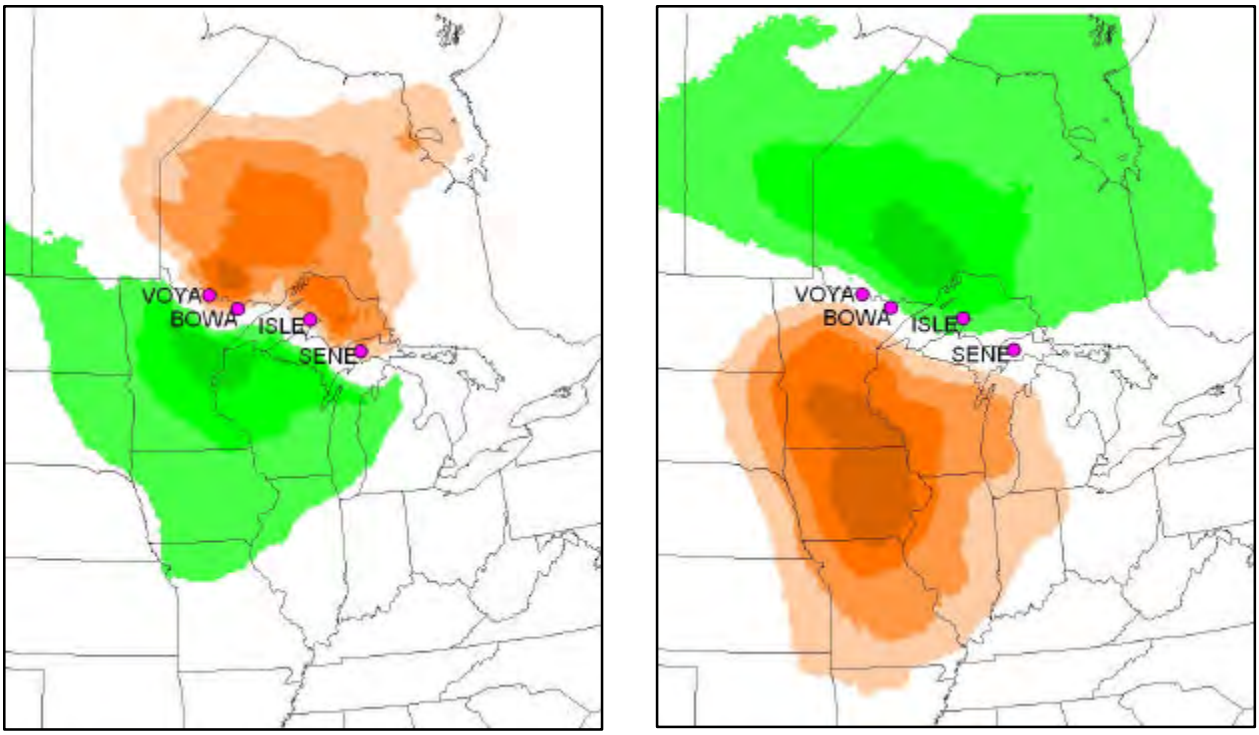


Figure 35. Composite back trajectories for light extinction- 20% best visibility days (left) and 20% worst visibility days (right) (2000 – 2005)

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.

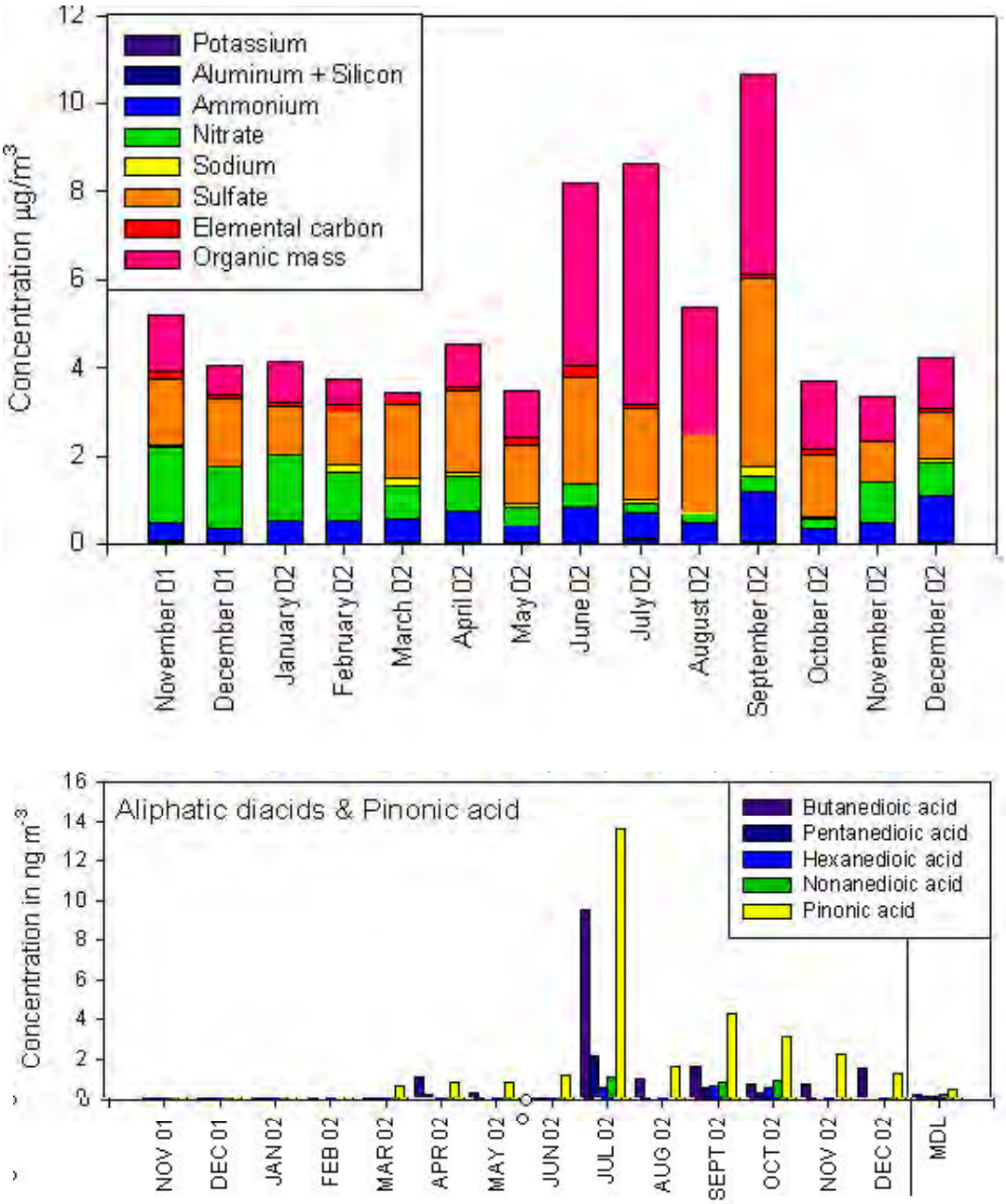


Figure 36. Monthly concentrations of $PM_{2.5}$ species (top), and secondary and biogenic-related organic carbon species in Seney (bottom)

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

[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.

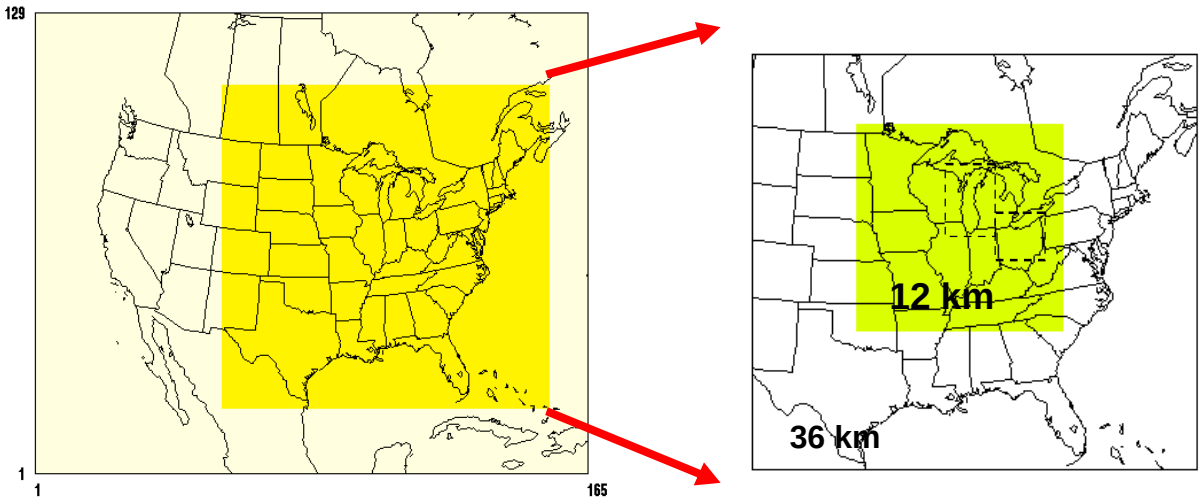


Figure 37. Modeling grids – RPO domain (left) and LADCO modeling domain (right)

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).

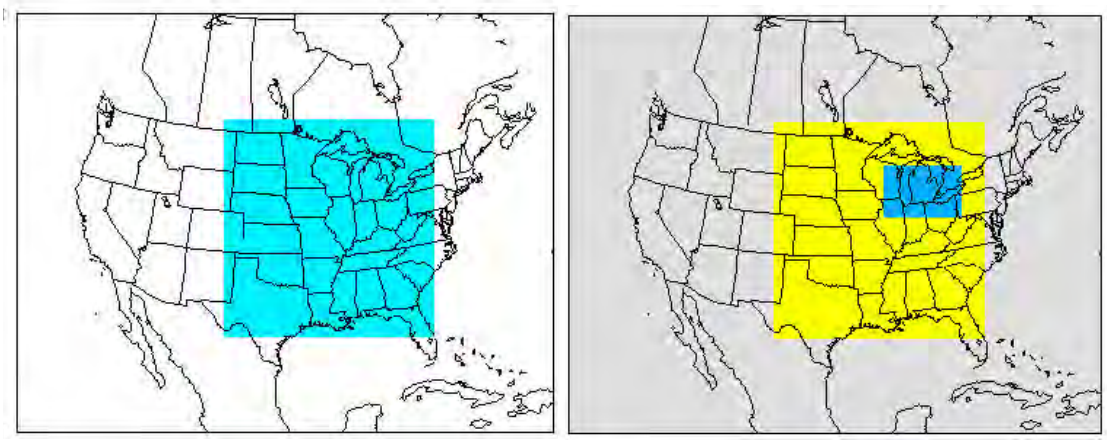


Figure 38. MM5 modeling domain for 2001-2003 (left) and 2005 (right)

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.

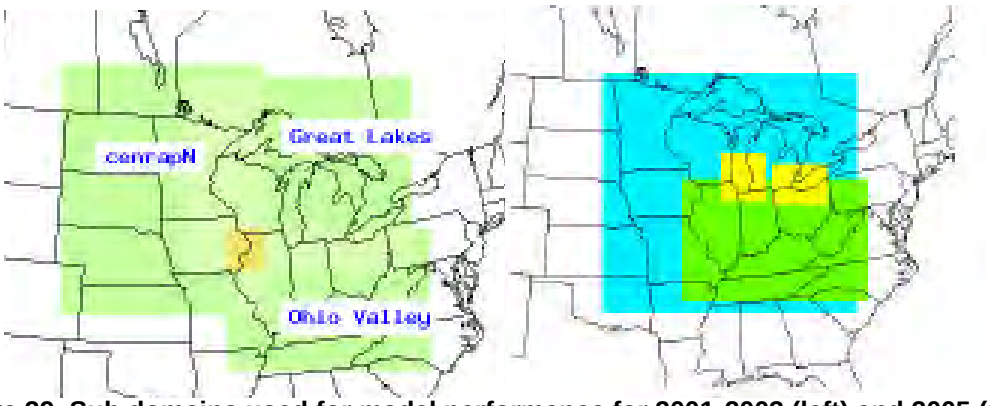


Figure 39. Sub-domains used for model performance for 2001-2003 (left) and 2005 (right)

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.

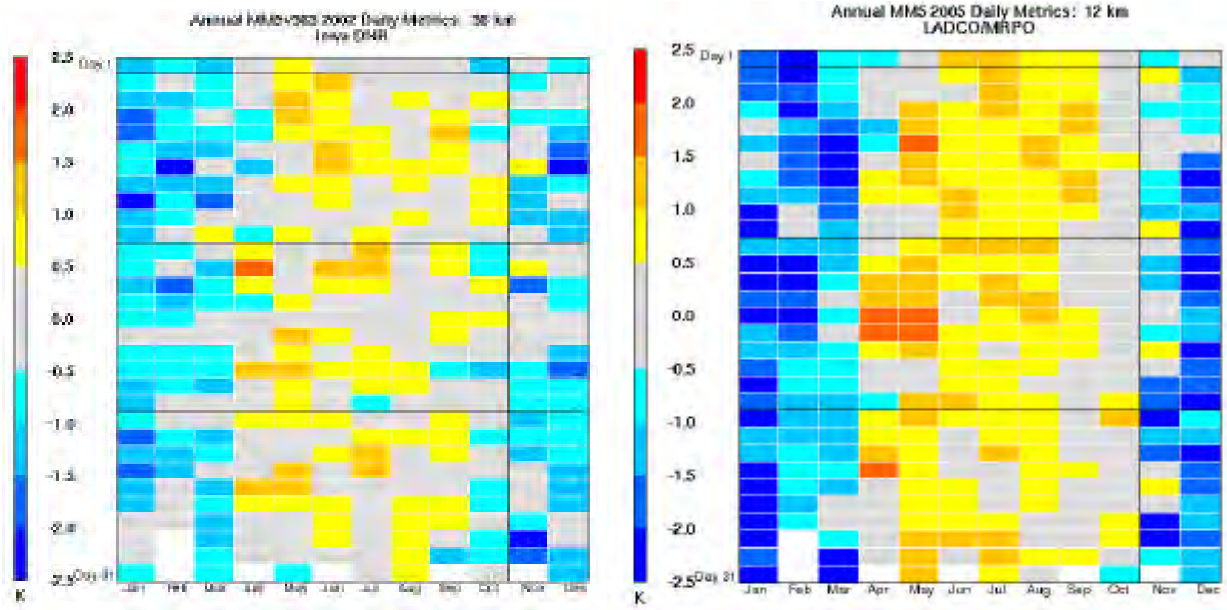


Figure 40. Daily temperature bias for 2002 (left) and 2005 (right) with hotter colors (yellow/orange/red) representing overestimates and cooler colors (blues) representing underestimates

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.

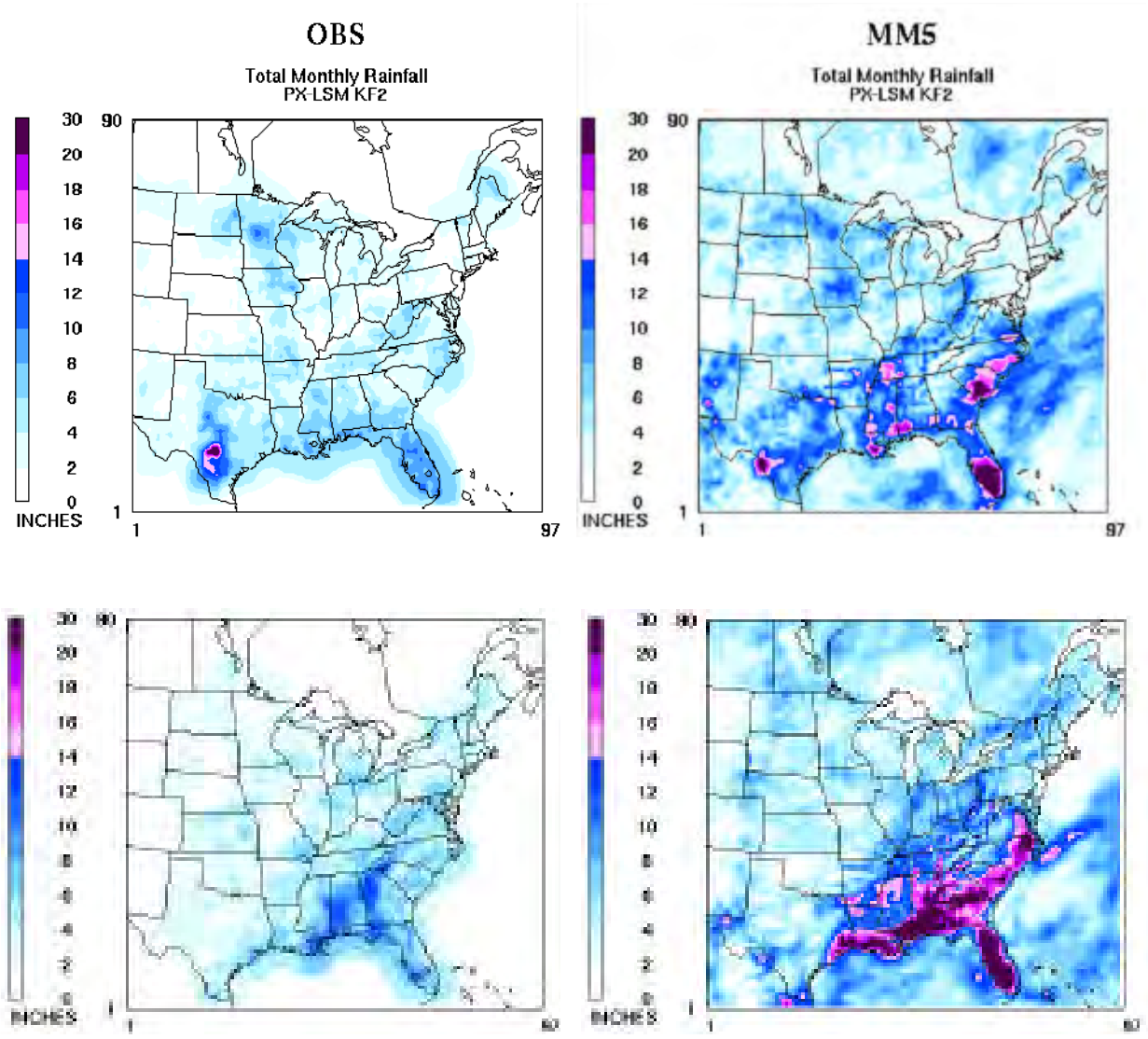


Figure 41. Comparison of observed (left column) and modeled (right column) monthly rainfall for July 2002 (top) and July 2005 (bottom)

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).

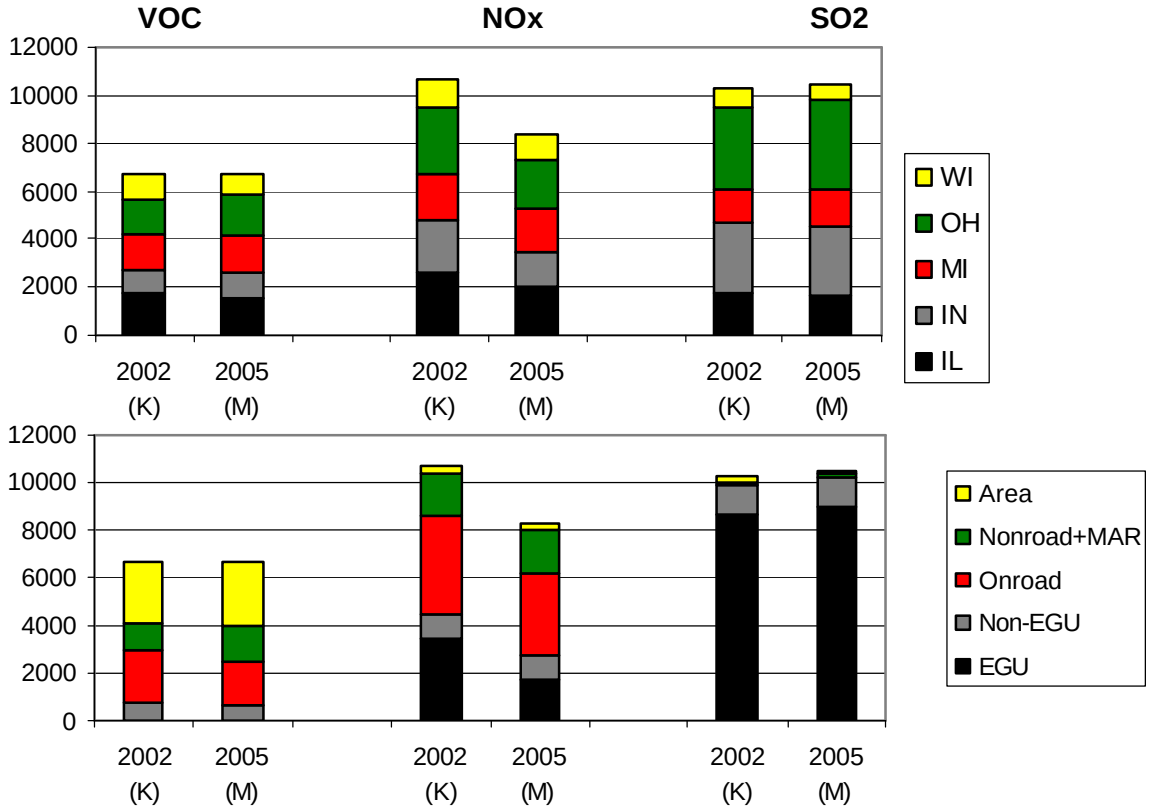


Figure 42. Base K and Base M emissions for 5-state LADCO region by state (top) and source sector (bottom), units: tons per summer weekday

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.

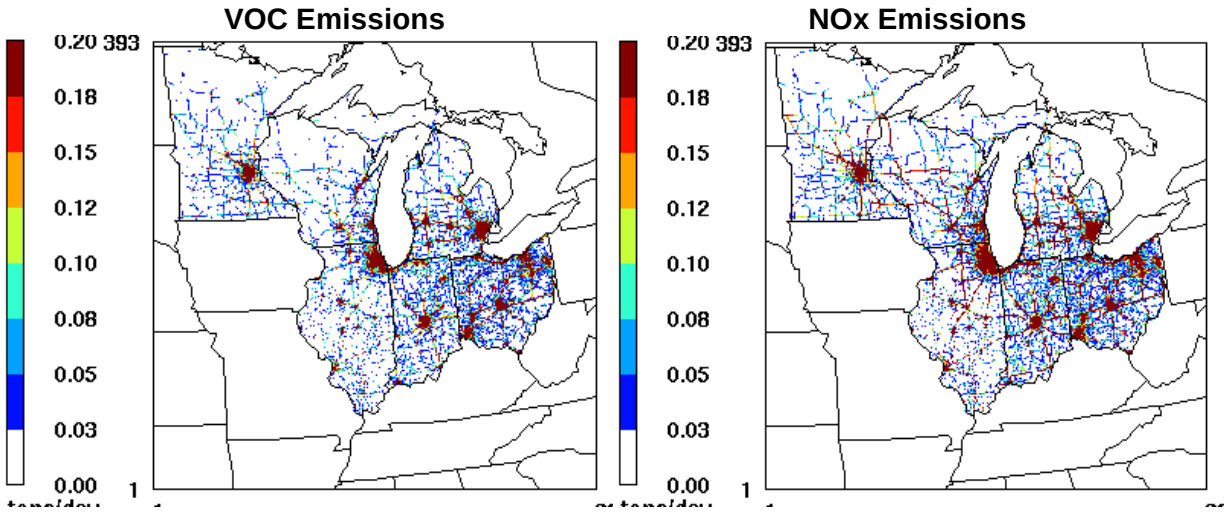


Figure 43. Motor vehicle emissions for VOC (left) and NOx (right) for a July weekday (2005)

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.

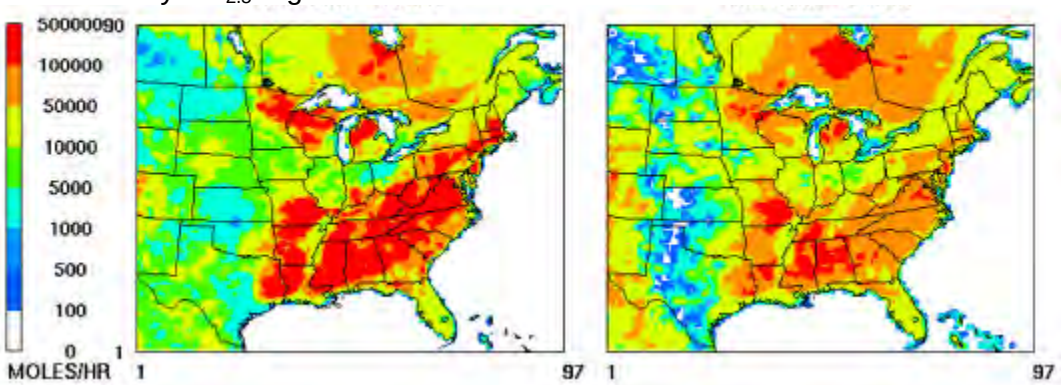


Figure 44. Isoprene emissions for Base M (left) v. Base K (right)

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.

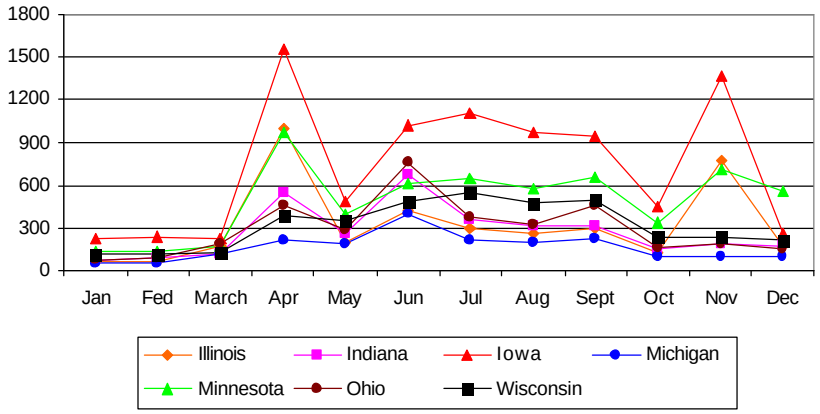


Figure 45. Average daily ammonia emissions for Midwest States by month (2005) - (units: average daily emissions – tons per day)

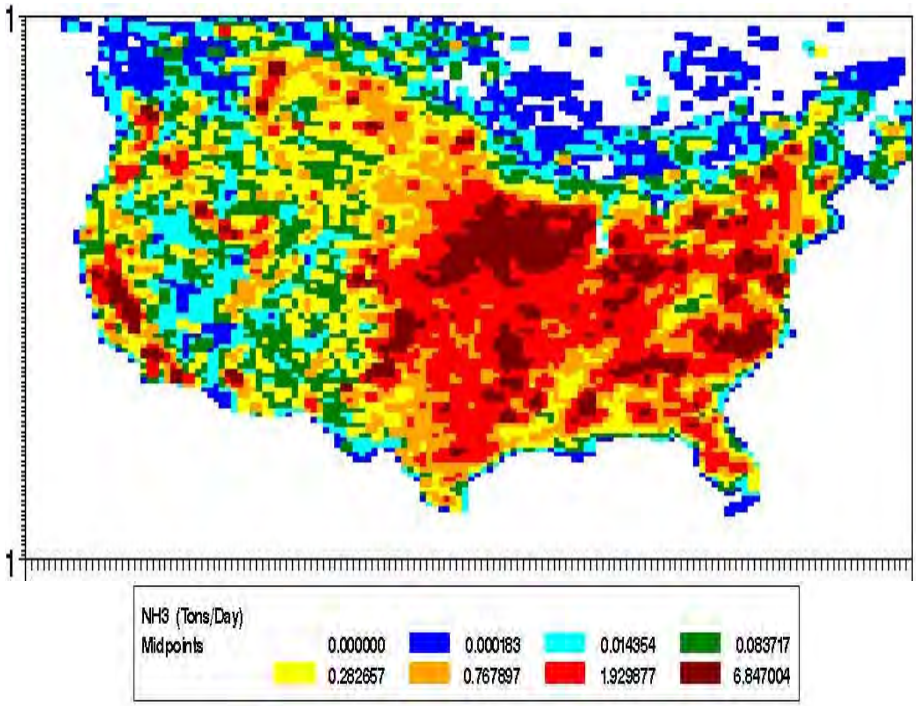


Figure 46. Ammonia emissions for a July weekday (2005) – 12 km modeling domain

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).

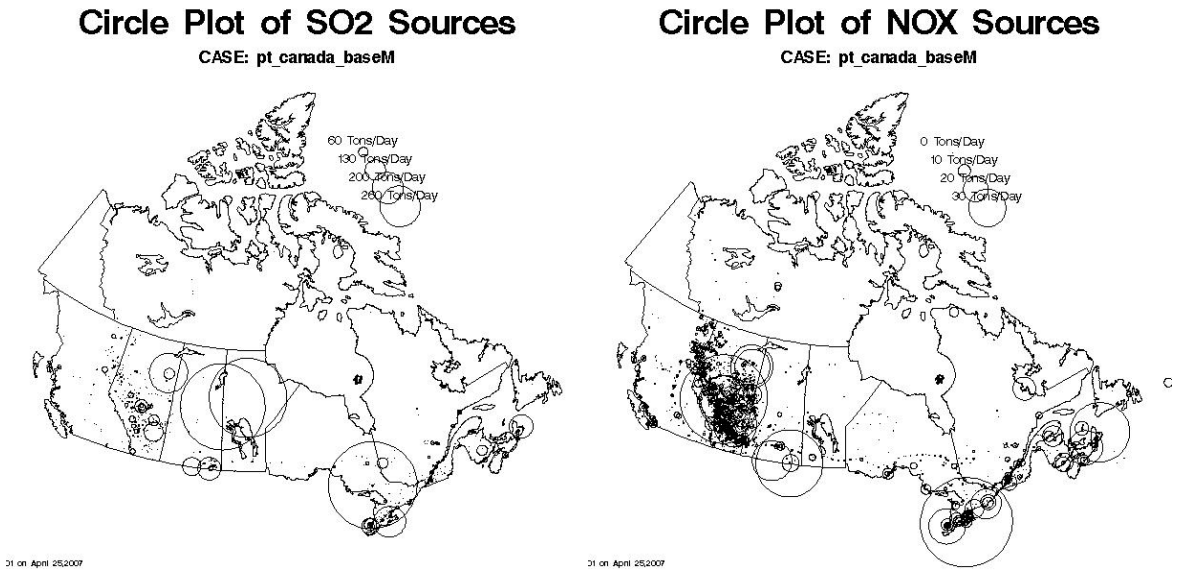


Figure 47. Canadian point source emissions for SO2 (left) and NOx (right)

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.

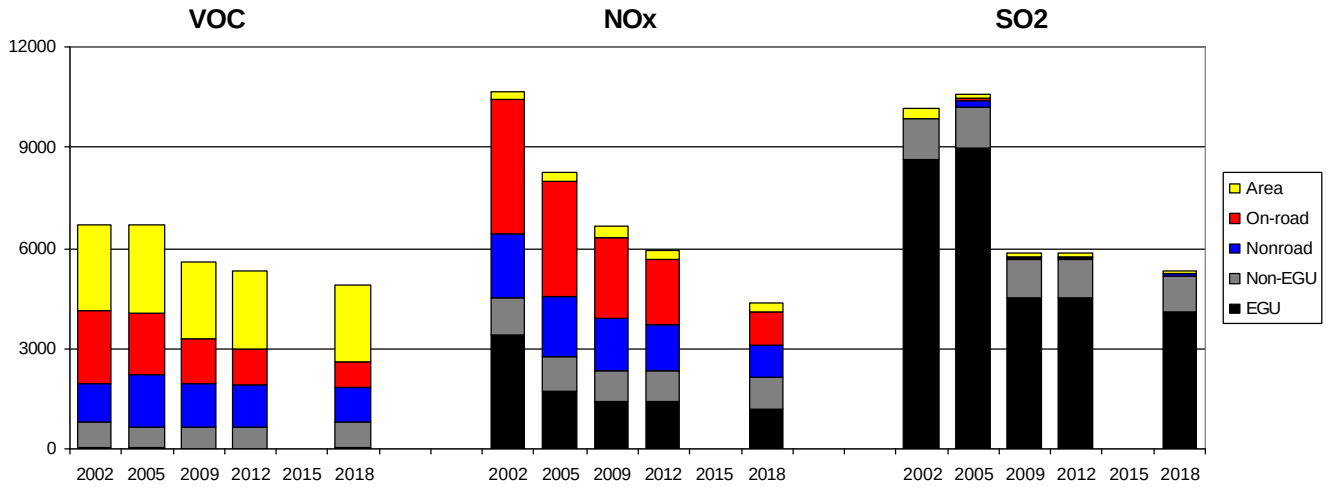


Figure 48. Base year and future year emissions for 5-State LADCO Region (TPD, July weekday)

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.

[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.

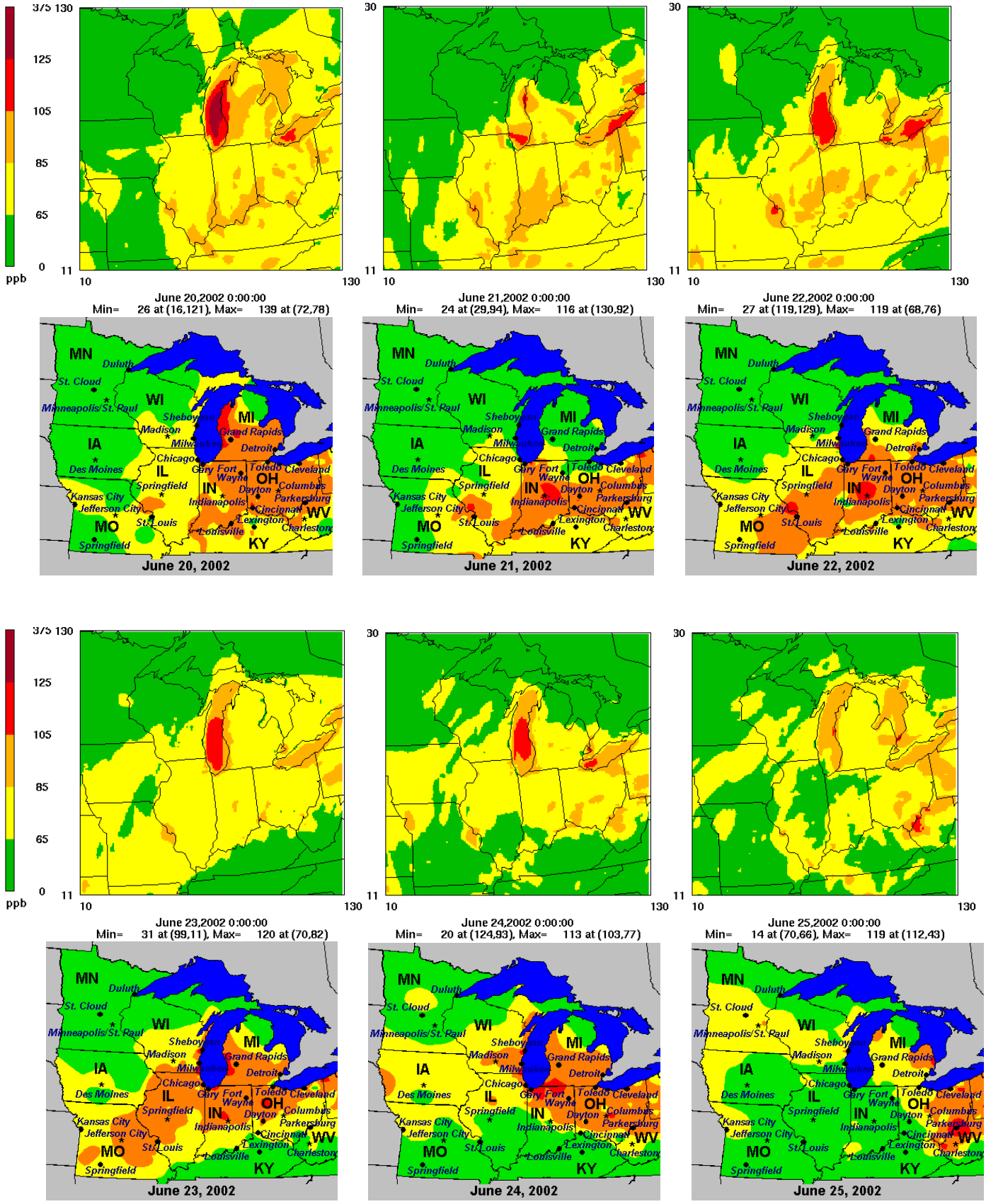


Figure 49a. Modeled (top) v. monitored (bottom) 8-hour ozone concentrations: June 20 – 25, 2002

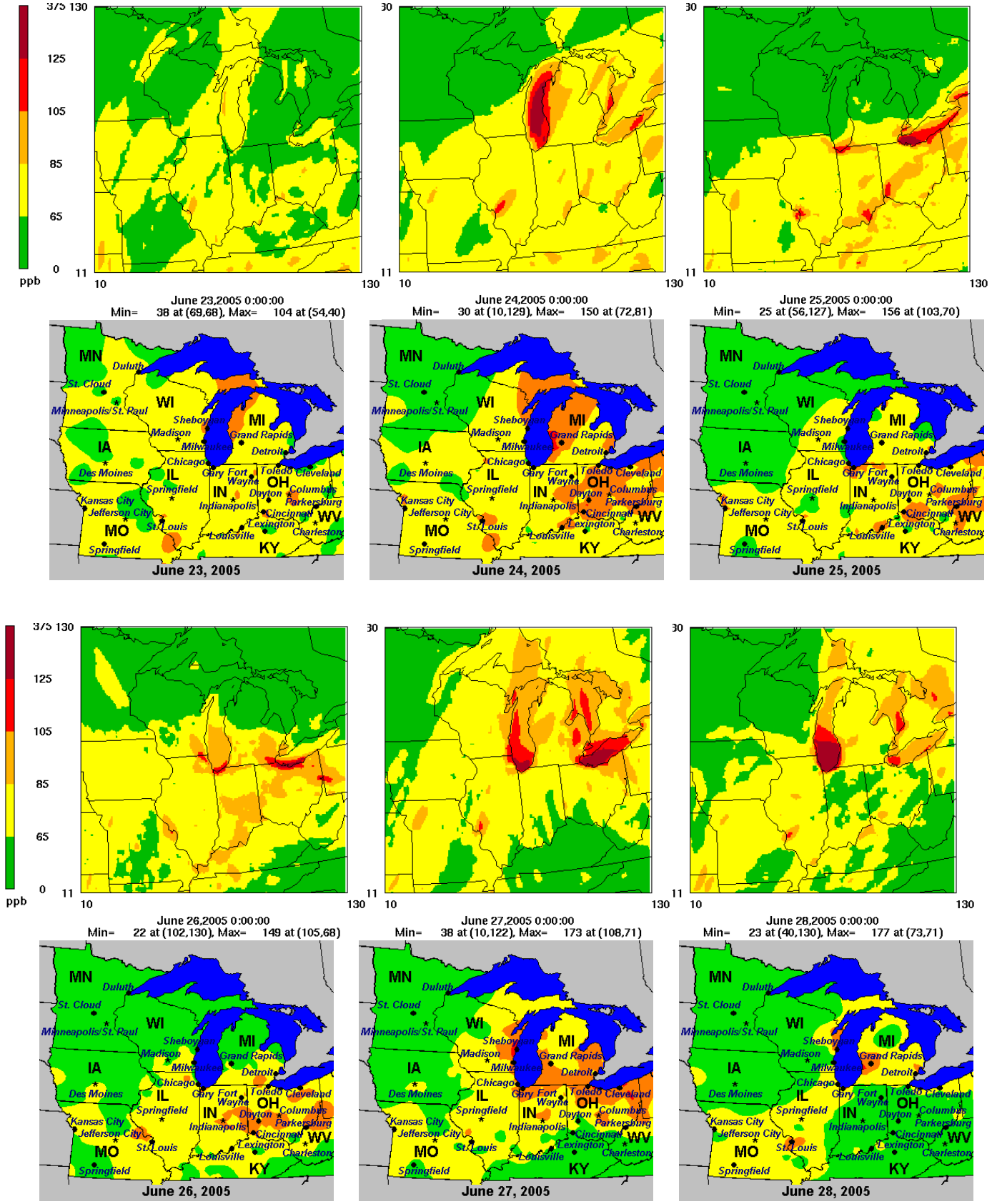


Figure 49b Modeled (top) v. monitored (bottom) 8-hour ozone concentrations: June 23– 28 2005

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).

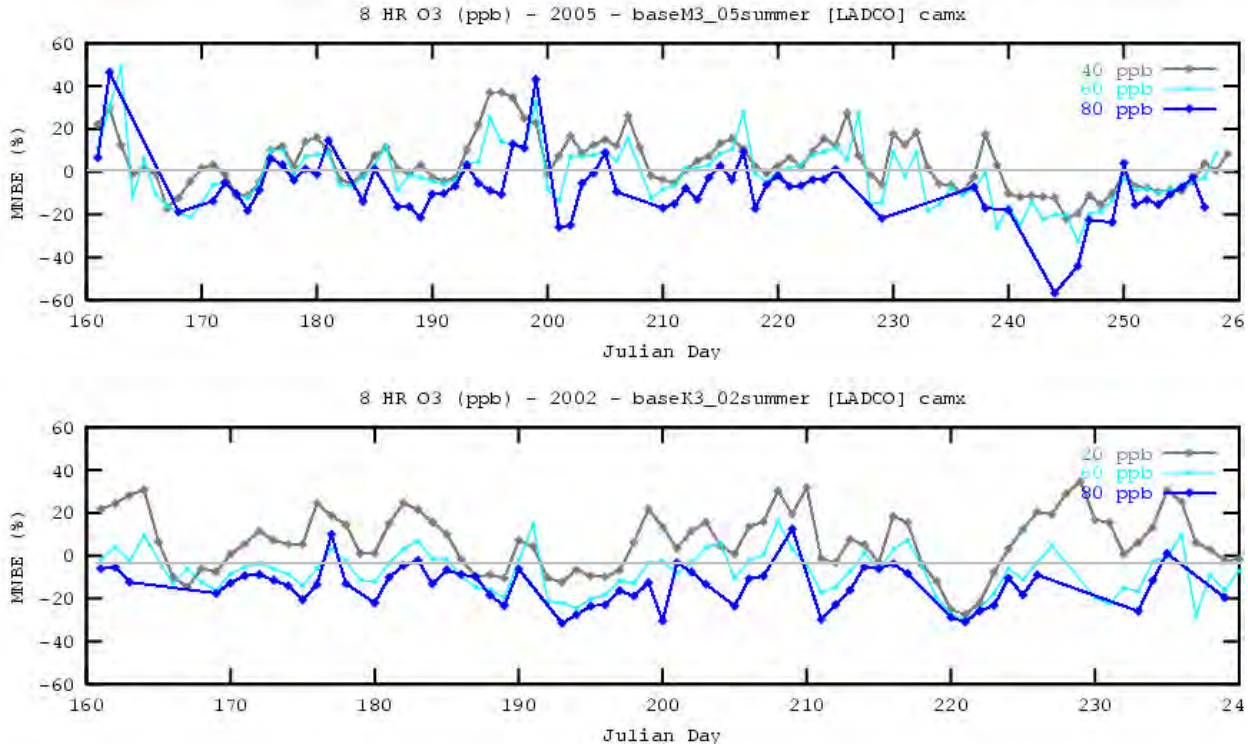


Figure 50. Mean bias for summer 2005 (Base M) and summer 2002 (Base K)

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.

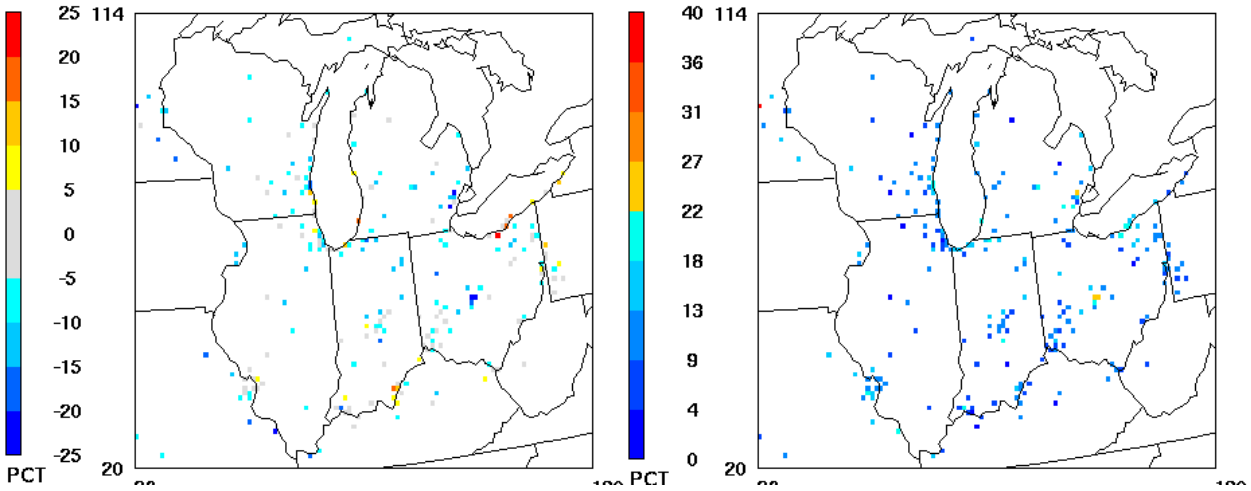


Figure 51. Mean bias (left) and gross error (right) for summer 2005

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.

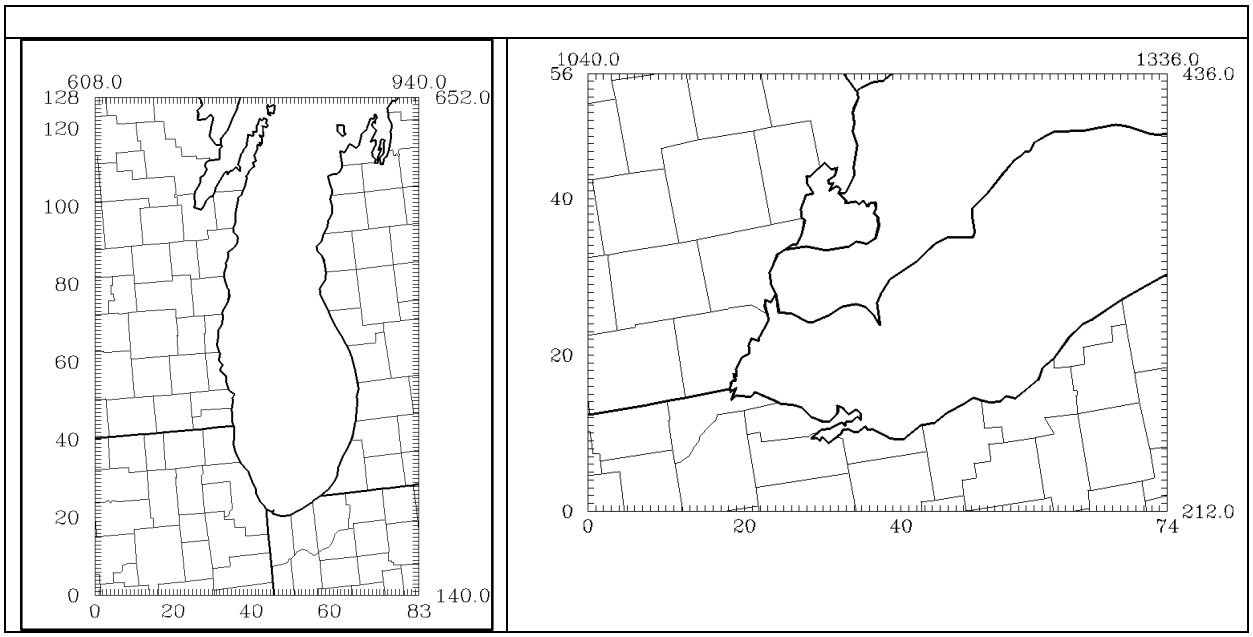


Figure 52. 4 km grids for Lake Michigan region and Detroit-Cleveland region

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.

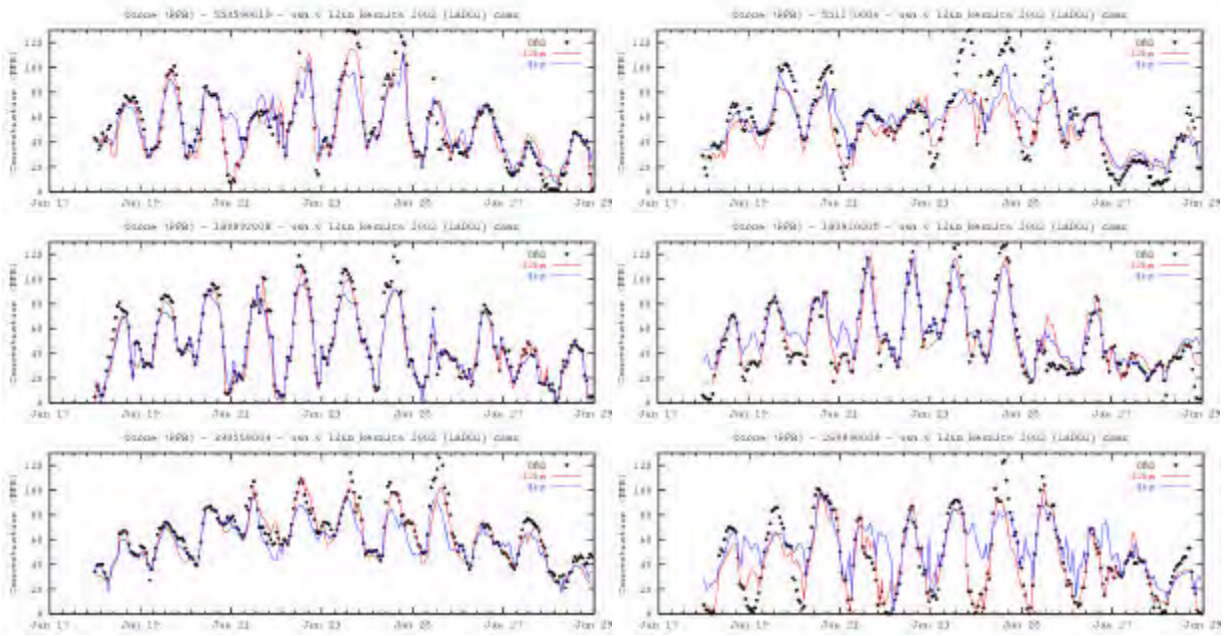


Figure 53. Ozone time series plots for 12 km and 4 km modeling (June 17-29, 2002)

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.

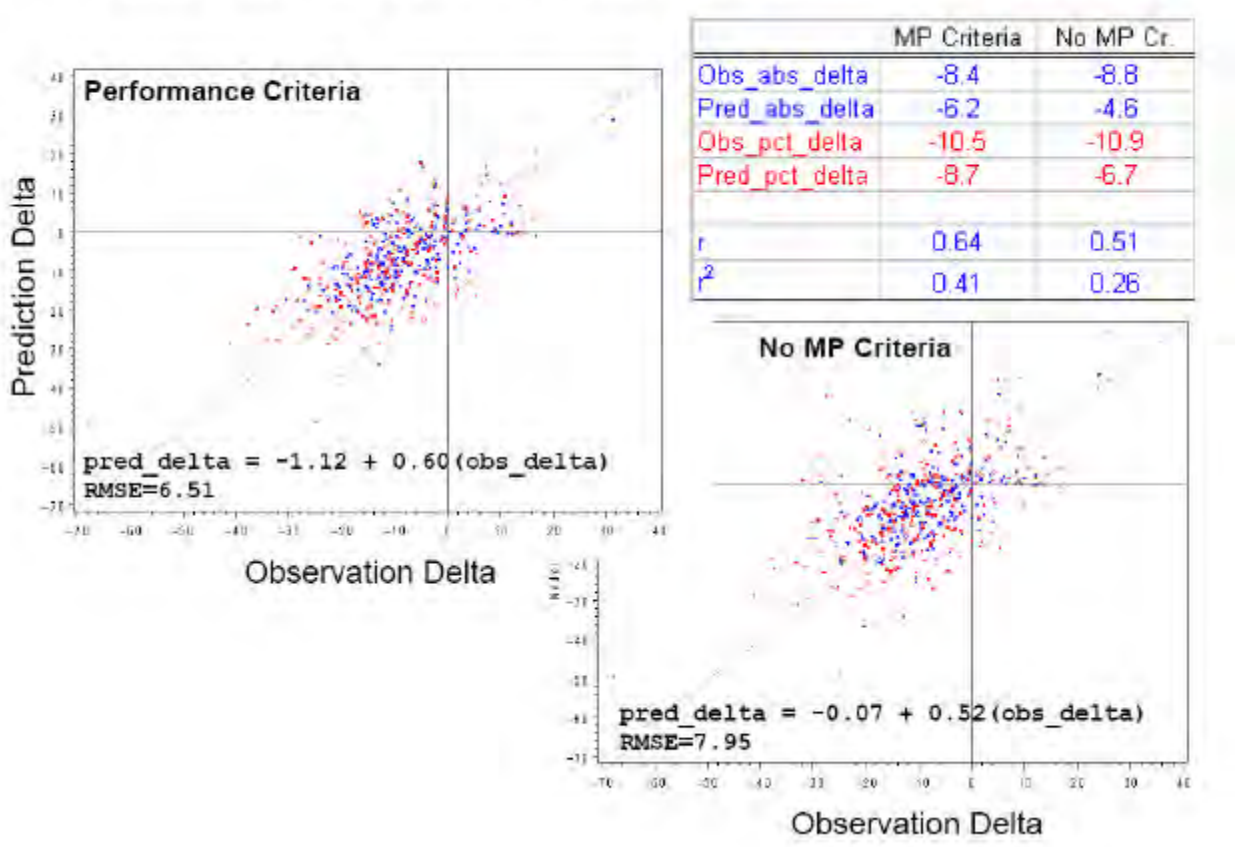


Figure 54. Comparison of change in predicted and observed ozone concentrations (2002 v. 2005)

$PM_{2.5}$: 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).

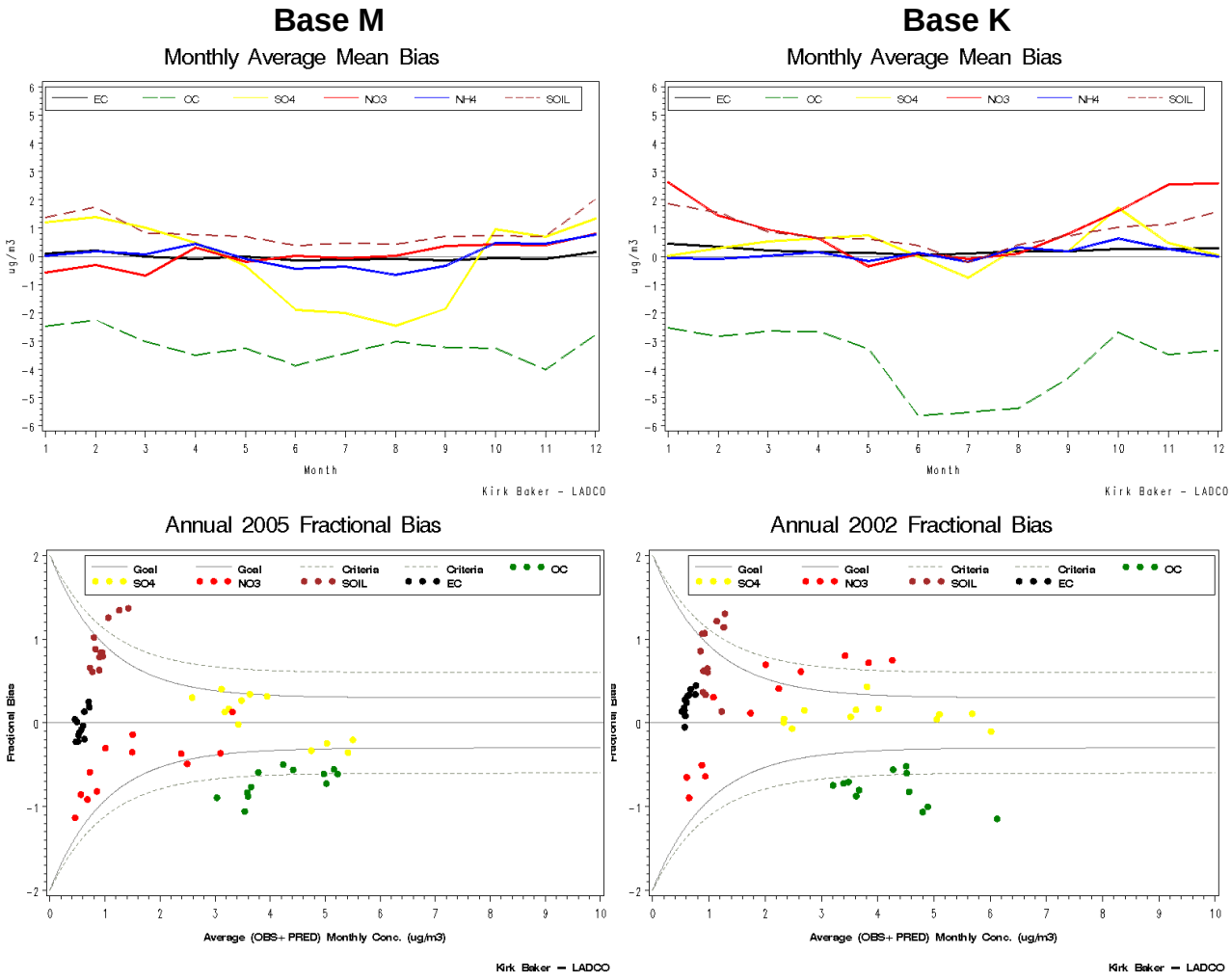


Figure 55. $PM_{2.5}$ Model performance - monthly average mean bias and annual fractional bias for Base M (left column) and Base K (right column)

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.

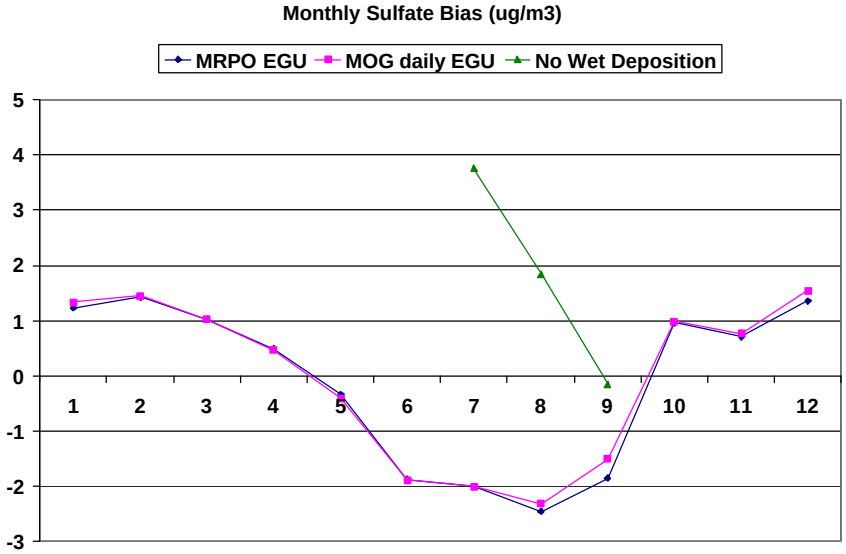


Figure 56. Monthly sulfate bias for Base M (MRPO EGU) v. two sensitivity analyses (Note: positive values indicate over-prediction, negative values indicate under-prediction)

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).

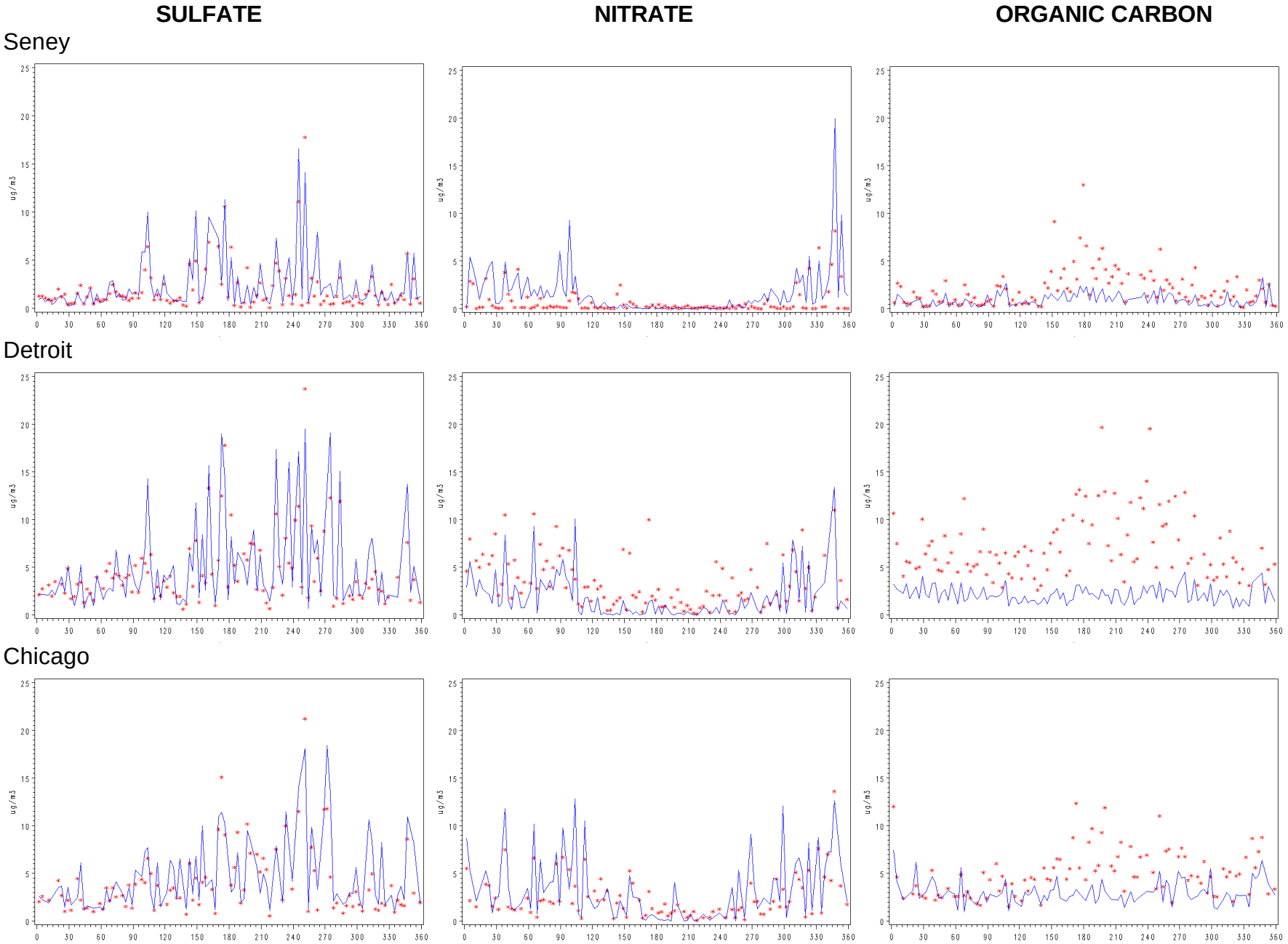
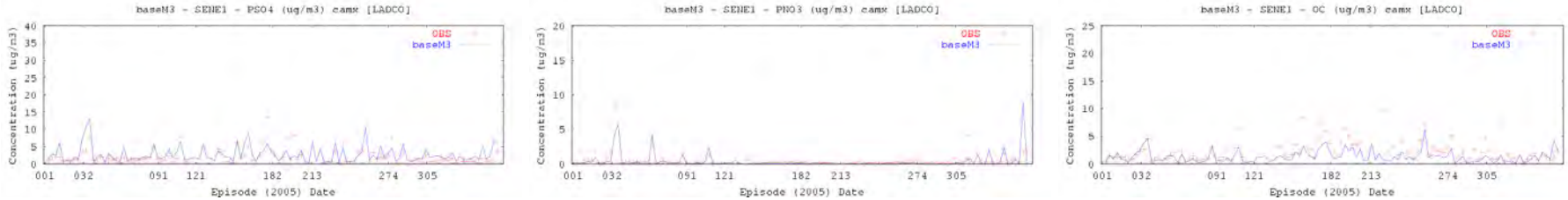


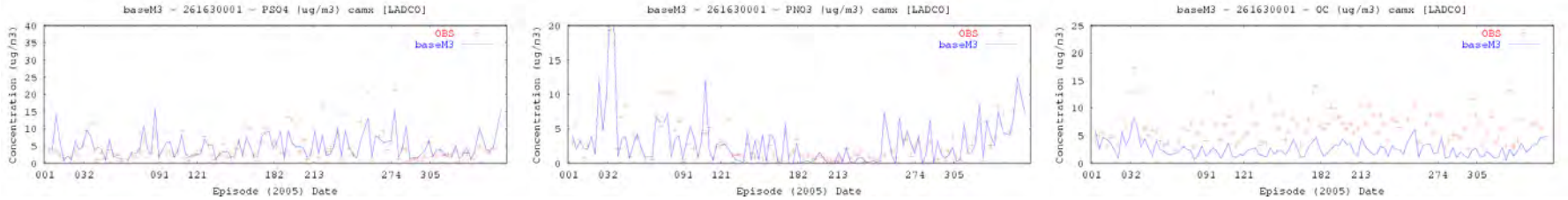
Figure 57. Time series of sulfate, nitrate, and organic carbon at three Midwest sites for 2005

SULFATE	NITRATE	ORGANIC CARBON

Seney



Detroit



Chicago

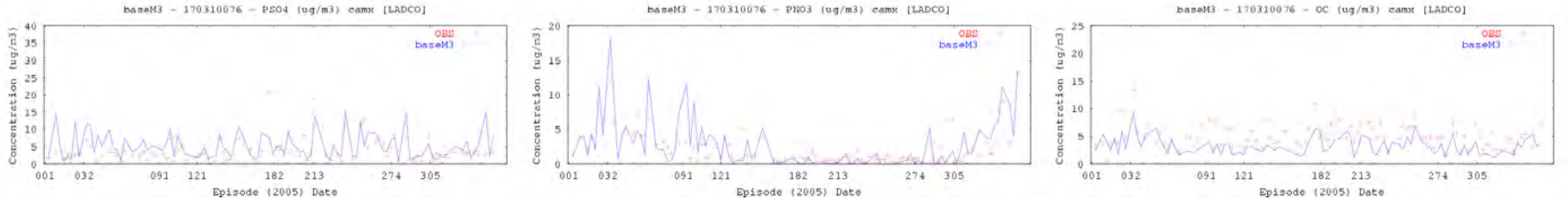


Figure 58. Time series of sulfate, nitrate, and organic carbon at three Midwest sites for 2005

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]

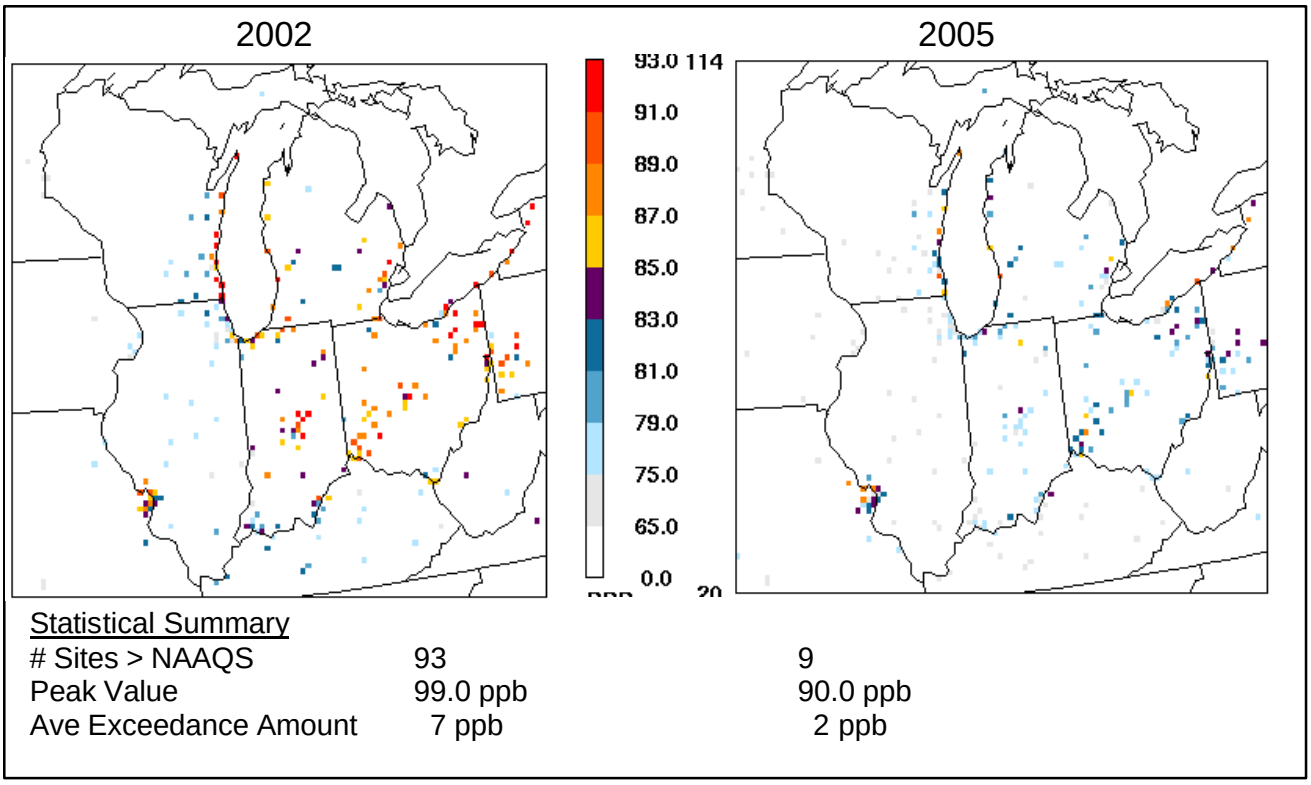
(2) Estimate the expected change in air quality: For each grid cell, a relative reduction factor (RRF) is calculated by taking the ratio of the future year and baseline modeling results.

(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.

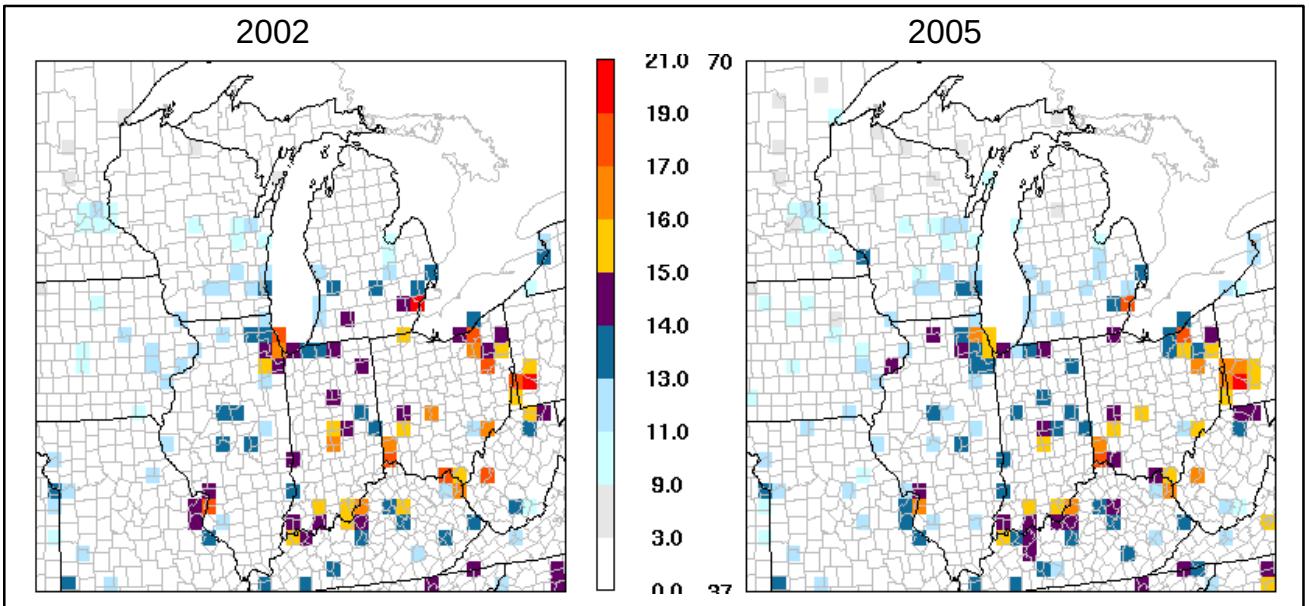
A comparison of the 2002 and 2005 base year design values for ozone and $PM_{2.5}$ is provided in Figure 59. In general, the figure shows that the 2005 base year design values are much lower than the 2002 base year design values, especially for ozone.

[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

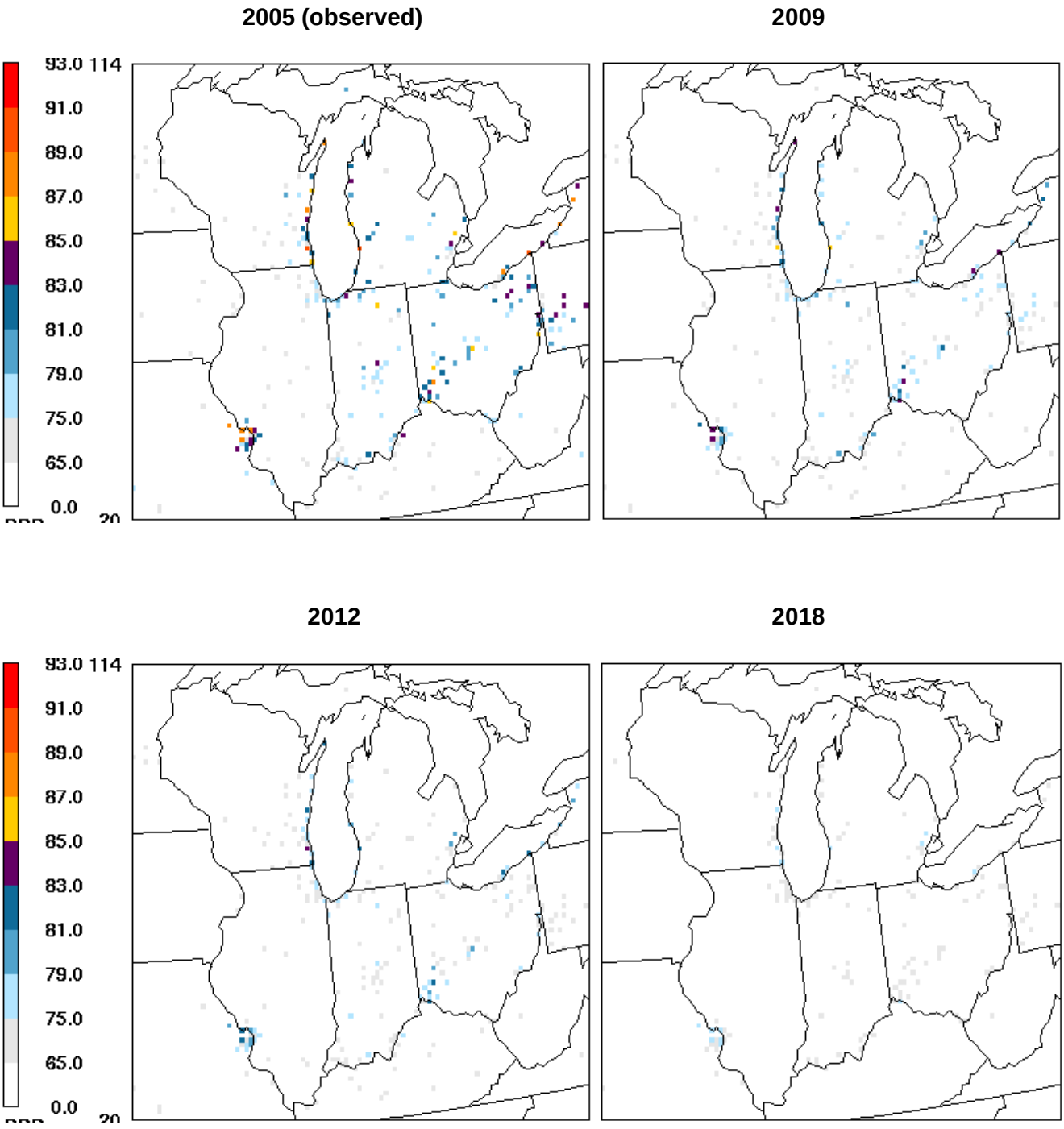


Figure 60. Observed base year and projected future year design values for ozone – Base M

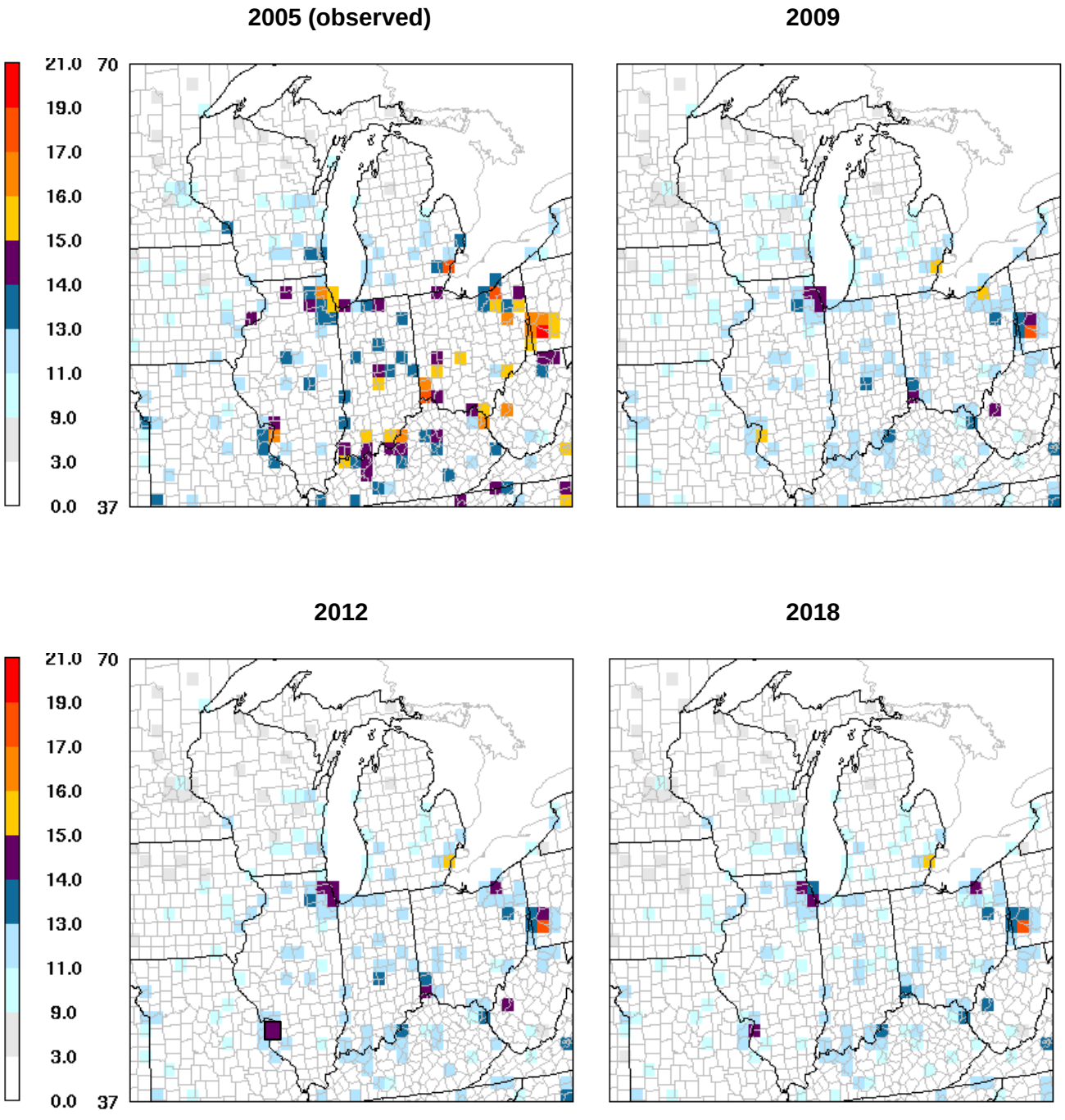


Figure 61. Observed base year and projected future year design values for $PM_{2.5}$ (annual average)–Base M

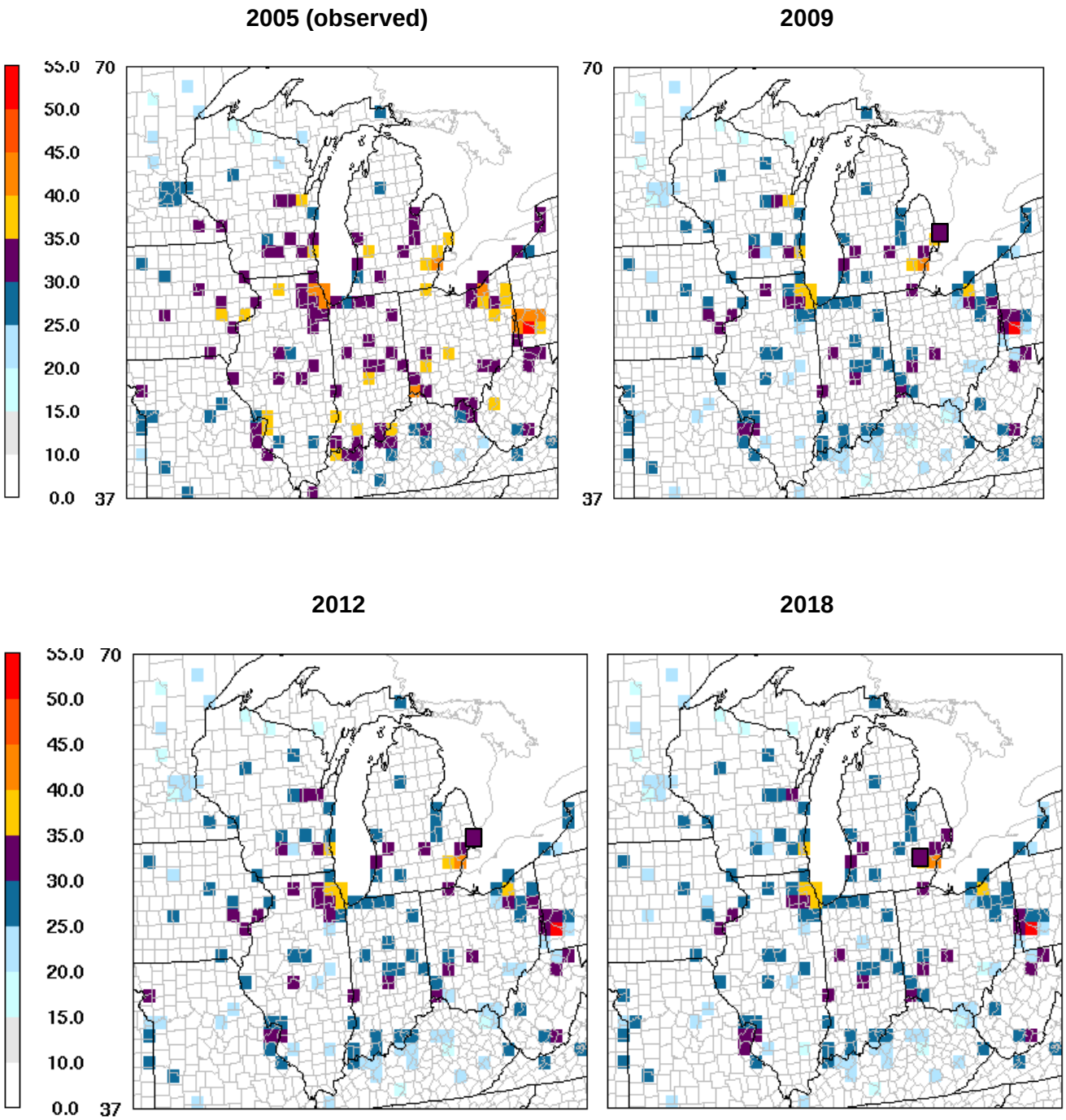


Figure 62. Observed base year and projected future year design values for $PM_{2.5}$ (24-hr average)-Base M

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).

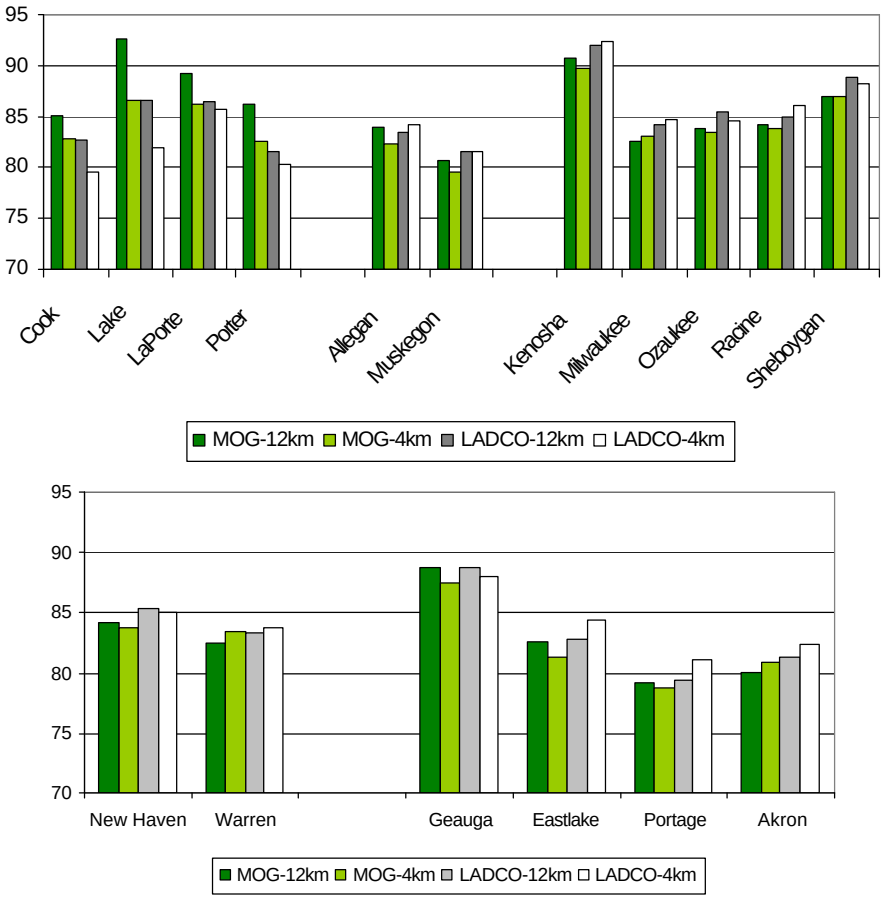


Figure 63. Future year (2009) values for Lake Michigan area (top) and Detroit-Cleveland region (bottom)

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.

[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**

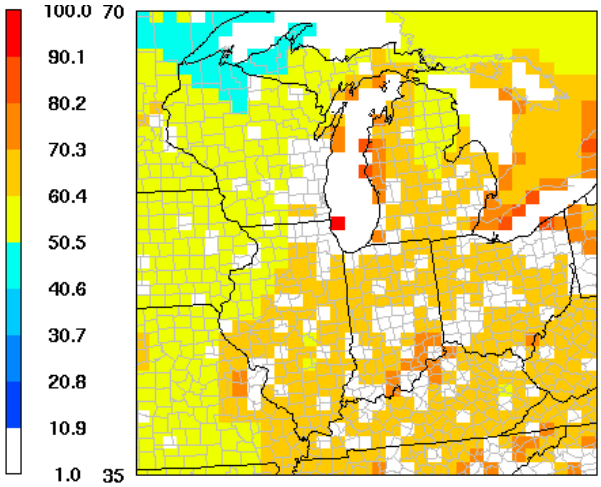


Figure 64. Estimated Future Year Values (unmonitored grid cells)

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).

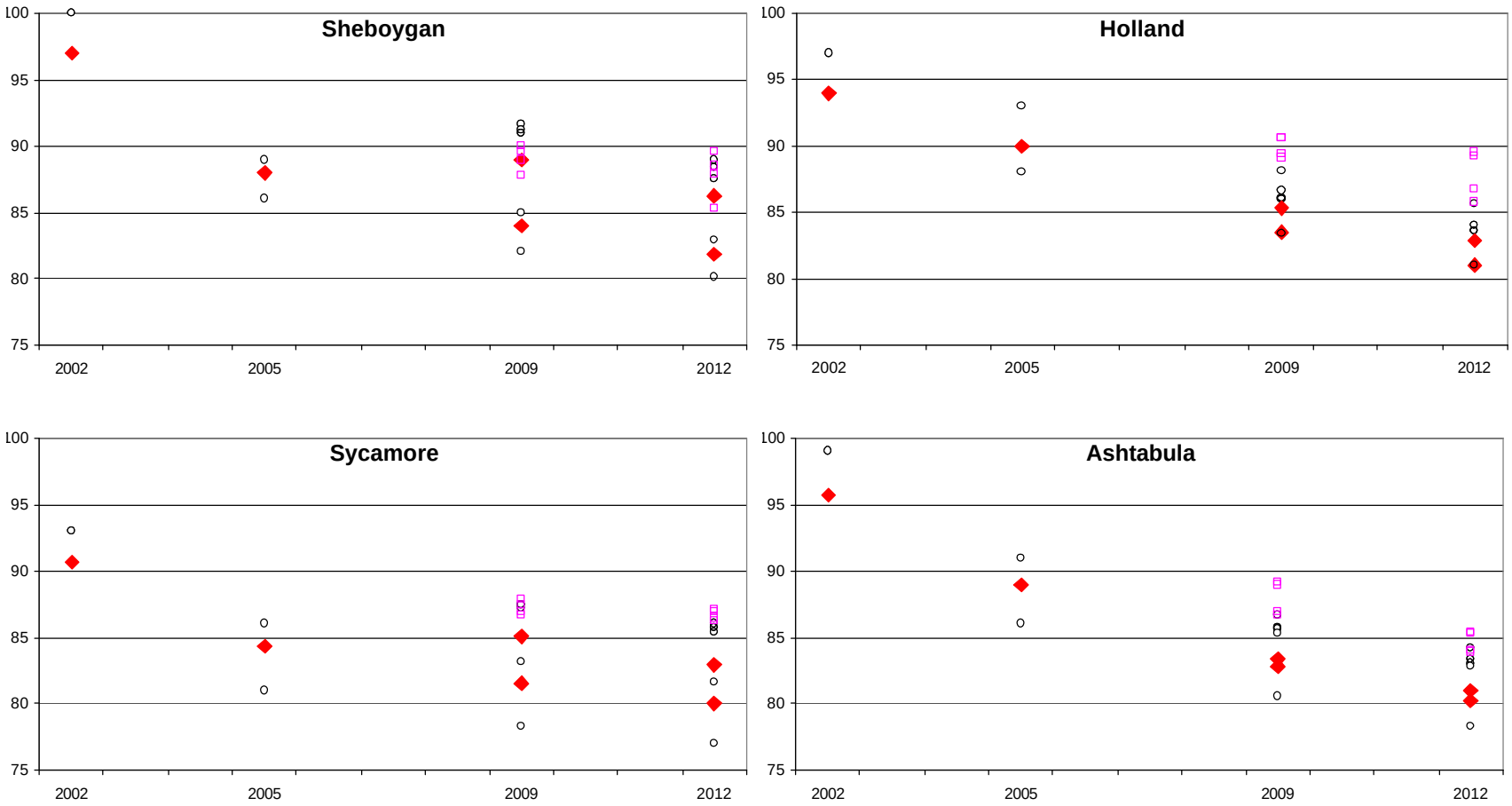


Figure 65. Estimates of Future Year Ozone Concentrations – Lake Michigan Area (Sheboygan and Holland), Cincinnati (Sycamore), and Cleveland (Ashtabula)

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.

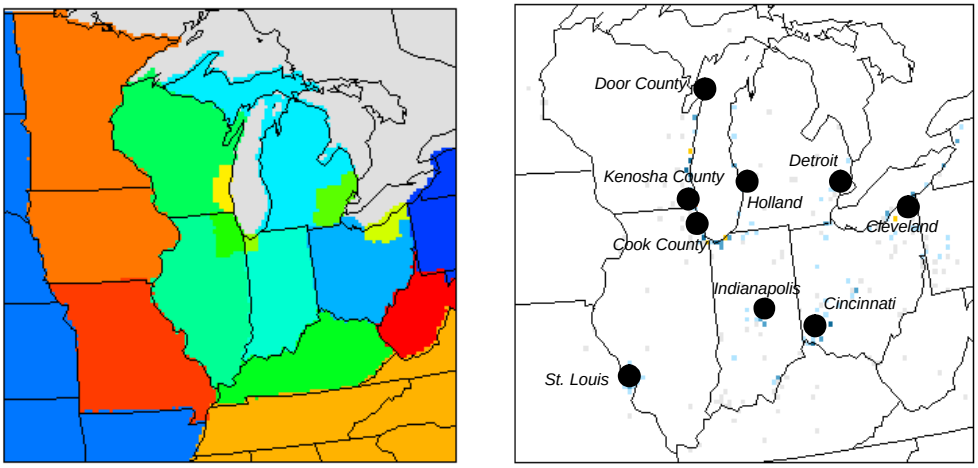


Figure 66. Source regions (left) and key monitoring sites (right) for ozone modeling analysis

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.

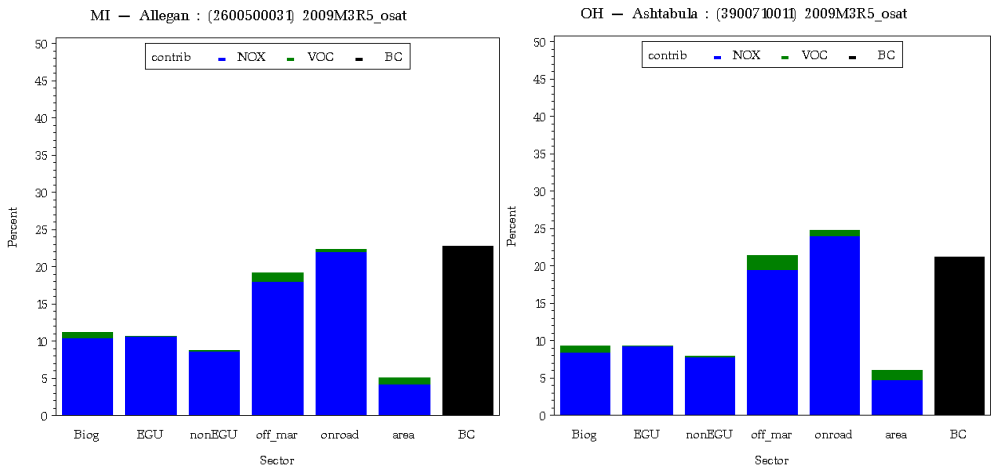


Figure 67. Source-sector results for Holland (left) and Ashtabula (right) monitors – 2009 (Base M)

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).

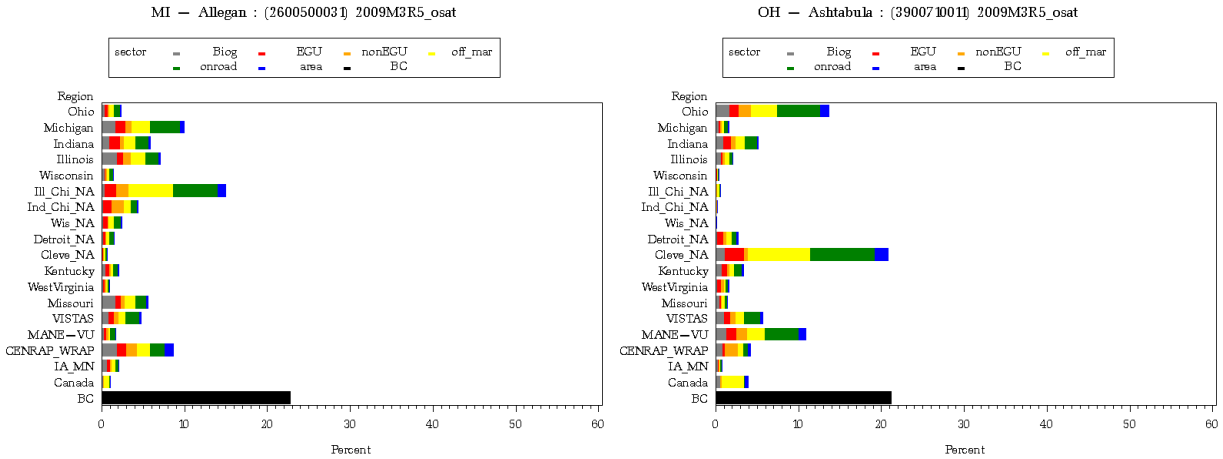


Figure 68. Source-region results for Holland (left) and Ashtabula (right) monitors – 2009 (Base M)

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.

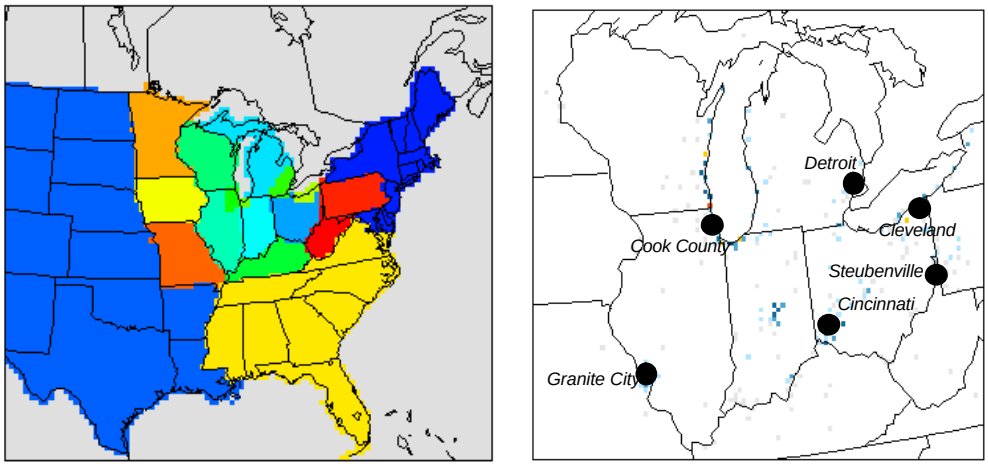


Figure 69. Source regions (left) and key monitoring sites (right) for $PM_{2.5}$ modeling analysis

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.

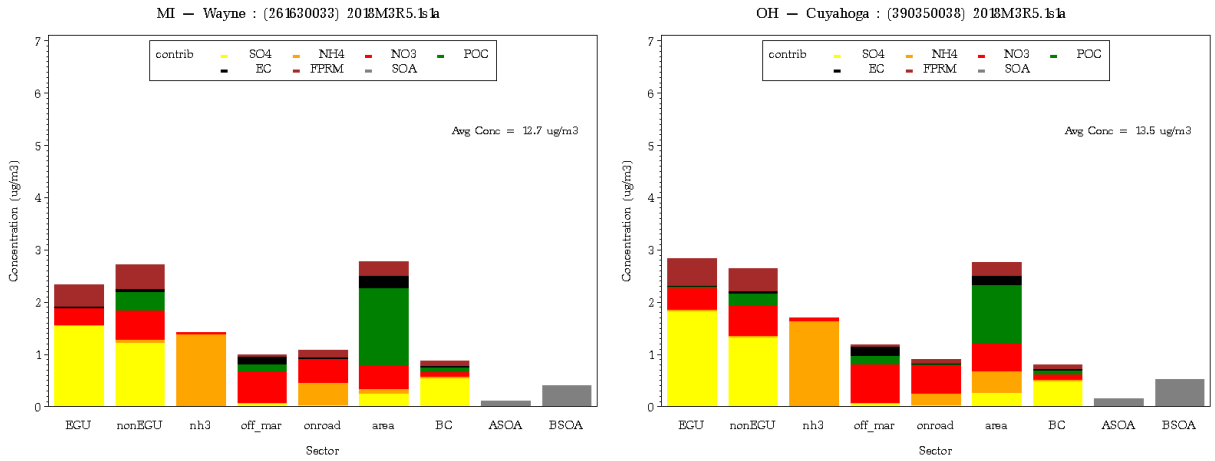


Figure 70. Source-sector results for Detroit (left) and Cleveland (right) monitors – 2018 (Base M)

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).

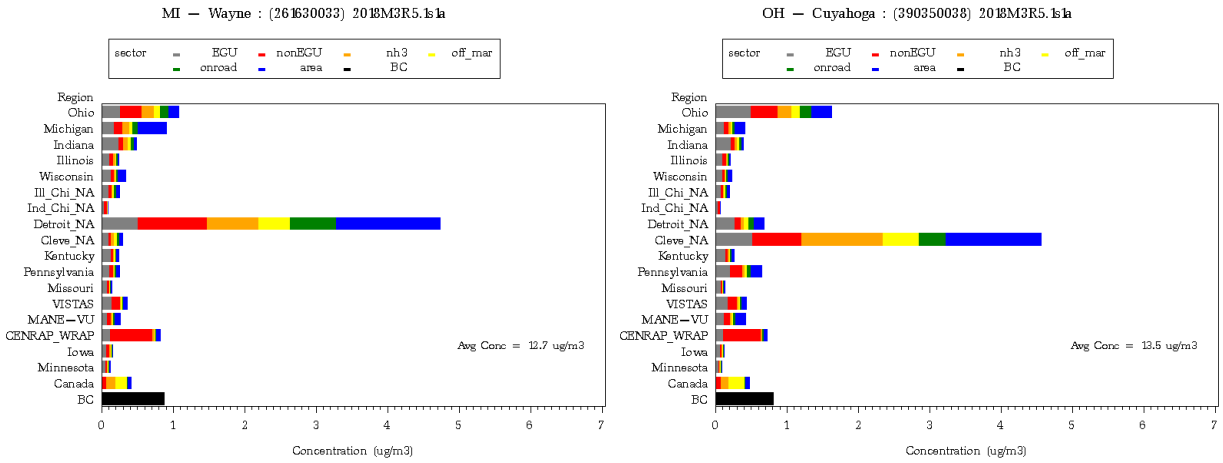


Figure 71. Source-region results for Detroit (left) and Cleveland (right) monitors – 2018 (Base M)

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).

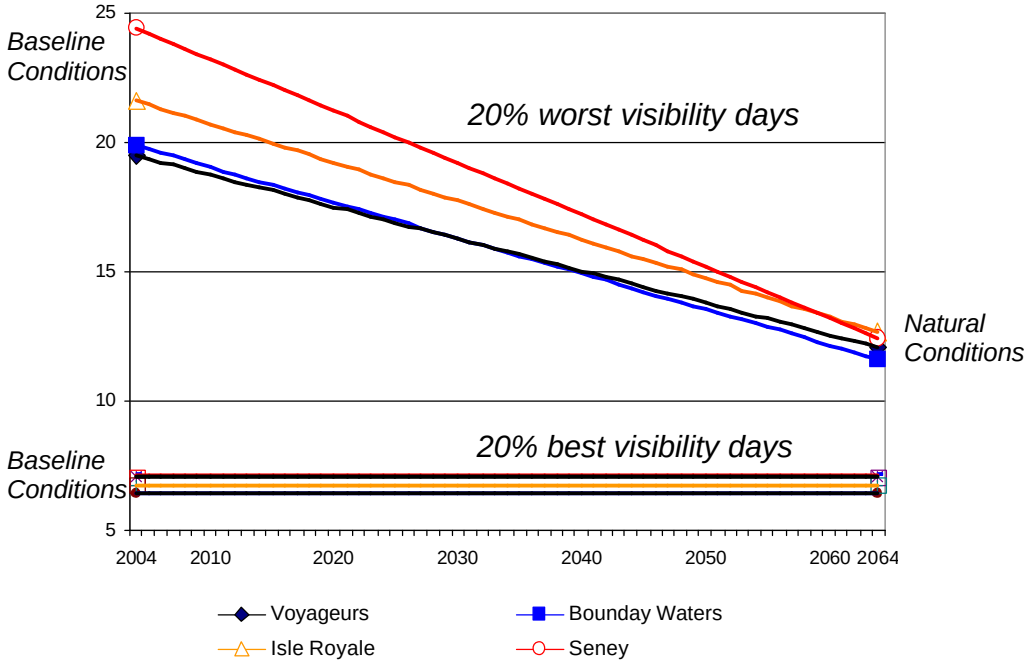


Figure 72. Visibility "glide paths" for northern Class I areas (units: deciviews)

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.

[13] Model results reflect the grid cell where the IMPROVE monitor is located.

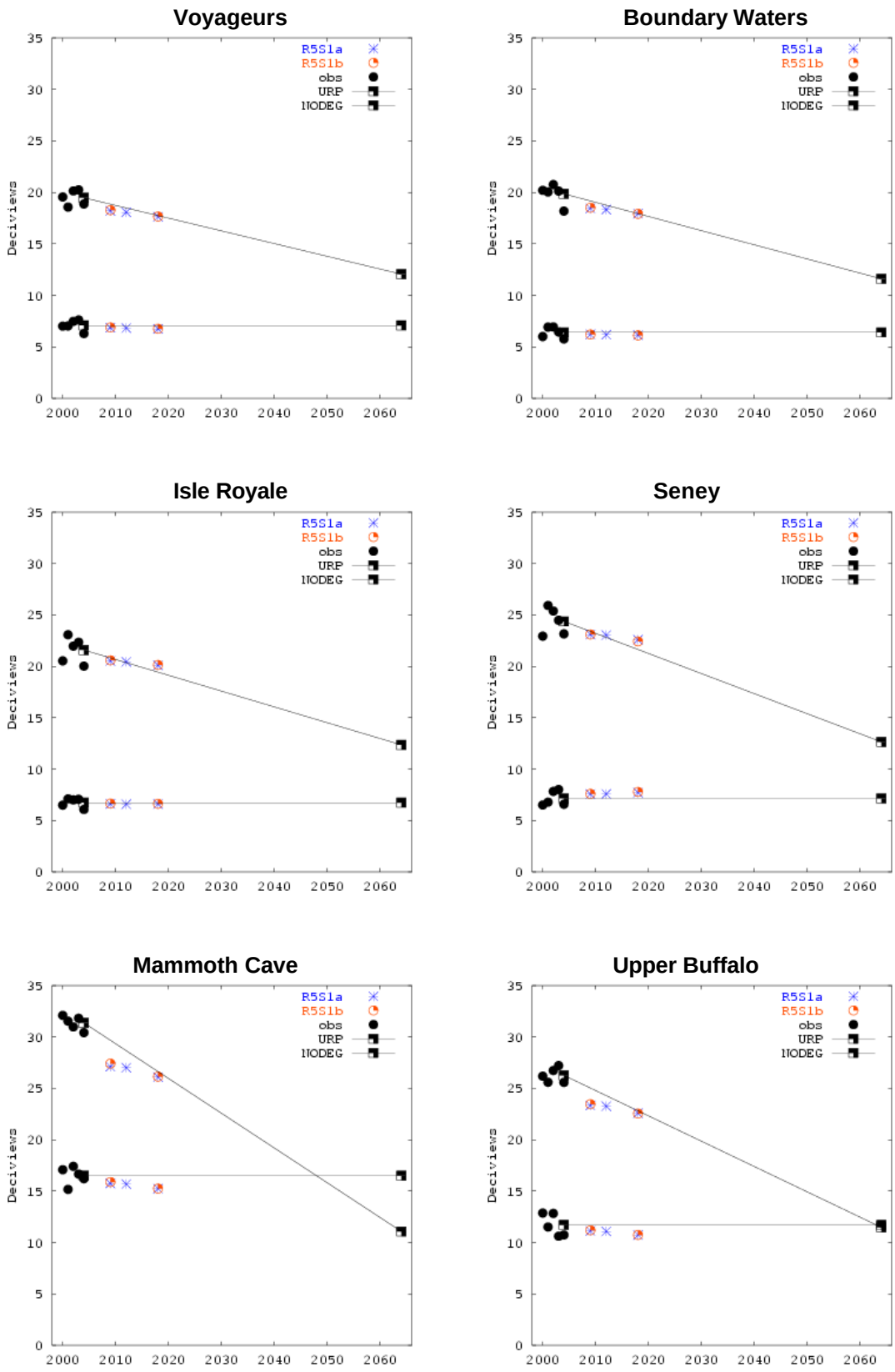


Figure 73. Visibility modeling results for Class I areas in eastern U.S.

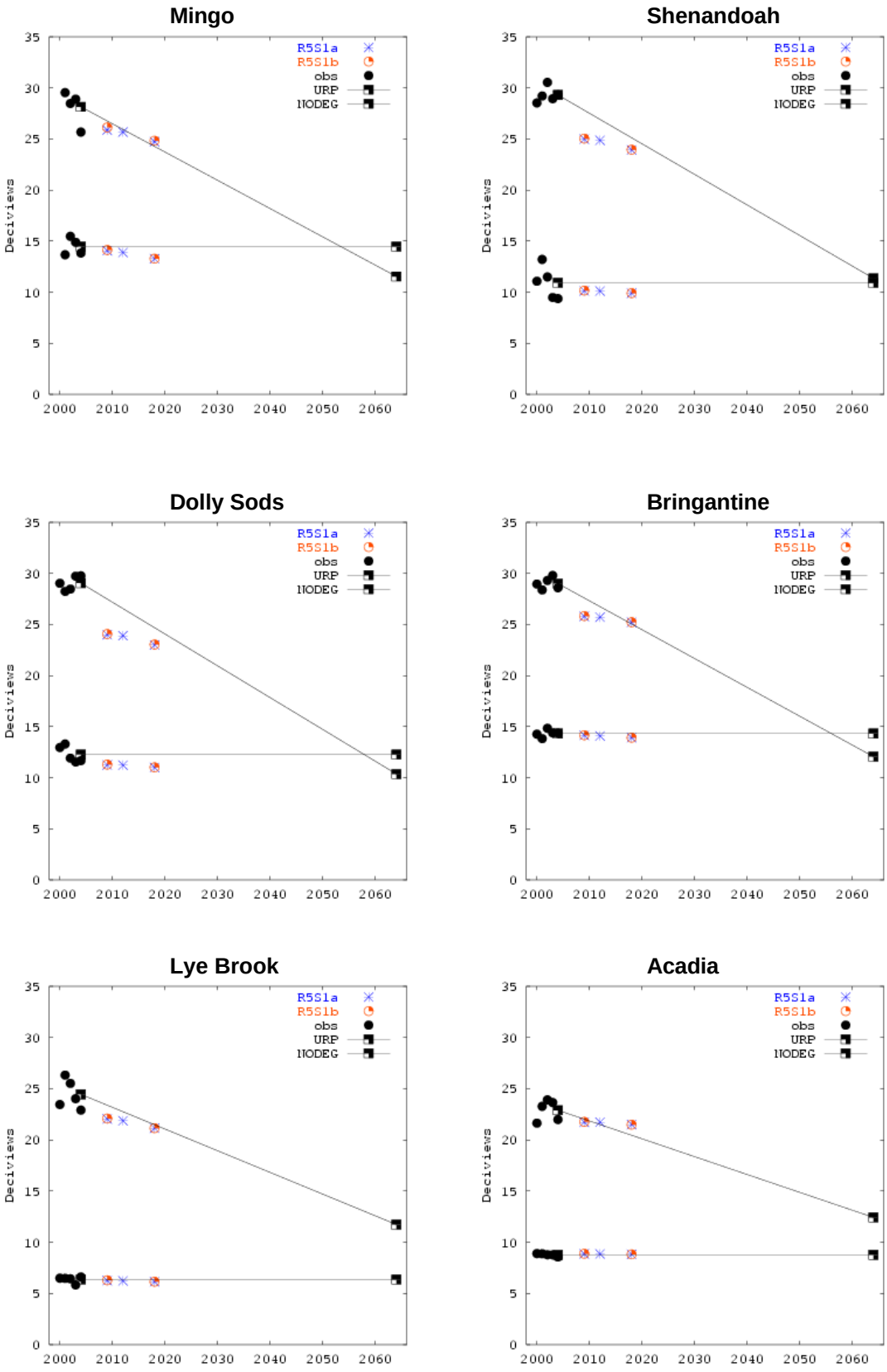


Figure 73 (cont.) Visibility modeling results for Class I areas in eastern U.S.

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

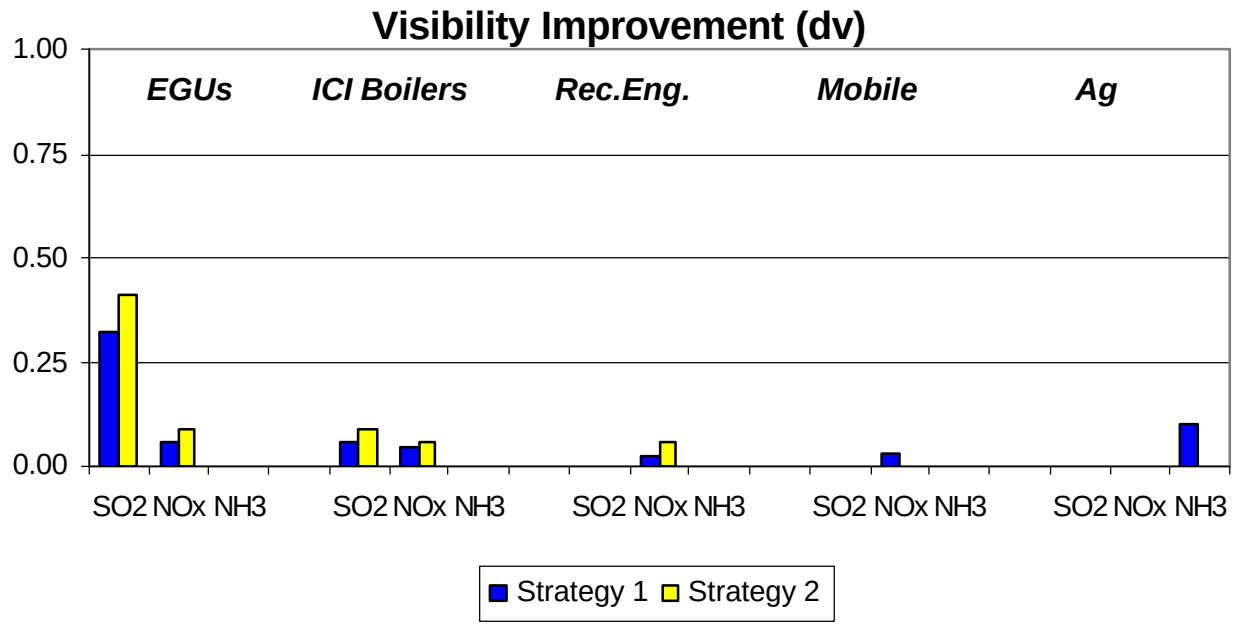
			Average Cost effectiveness ($/ton)		
Emission category	Control strategy	Region	SO2	NOX	NH3
EGU	EGU1	3-State	1,540	2,037	
		9-State	1,743	1,782	
	EGU2	3-State	1,775	3,016	
		9-State	1,952	2,984	
ICI boilers	ICI1	3-State	2,992	2,537	
		9-State	2,275	1,899	
	ICI Workgroup	3-State	2,731	3,814	
		9-State	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.



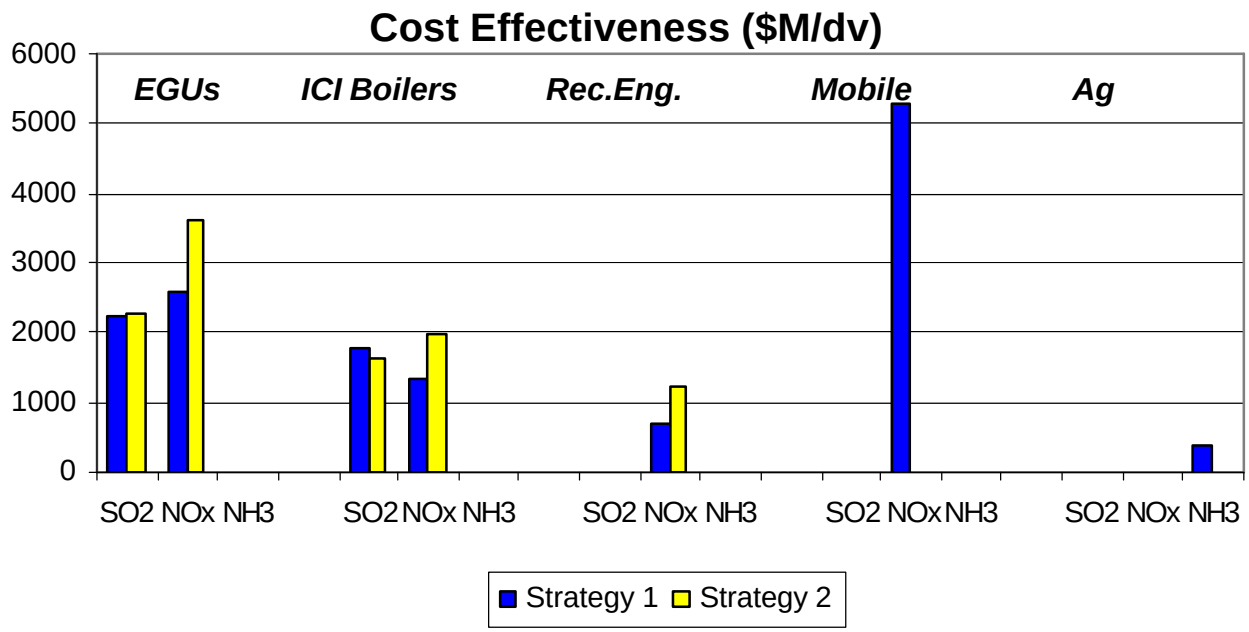


Figure 74. Results of ECR analysis of reasonable progress factors – visibility improvement (Factor 5) is on top, and cost effectiveness (Factor 1) is on bottom

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.

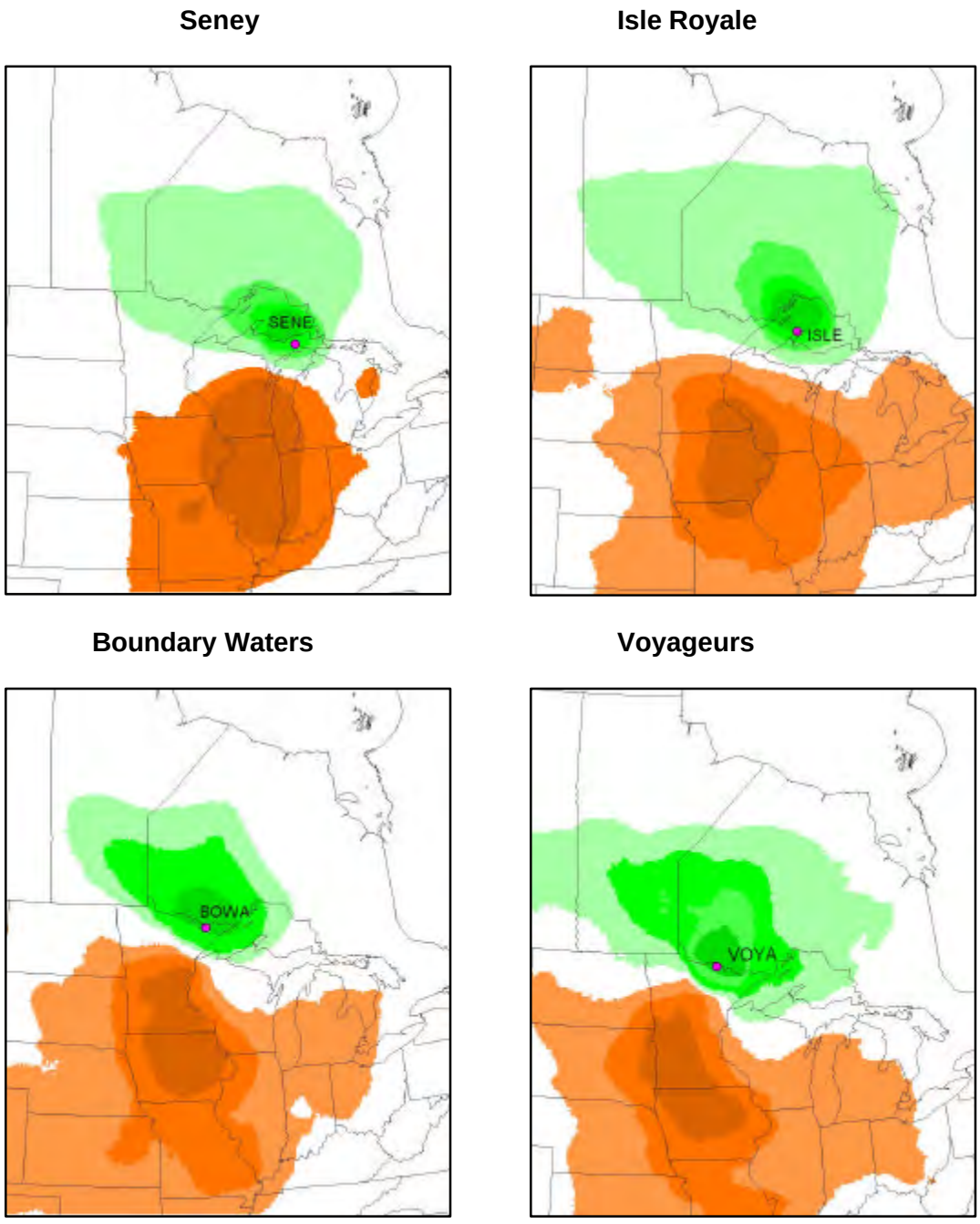


Figure 75. Trajectory analysis results for northern Class I areas on 20% worst visibility days

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 se ctors (EGU point, non-EGU point, on-road, off-road, area, and ammonia sources) at visibility/haze monitoring sites in the eastern U.S.

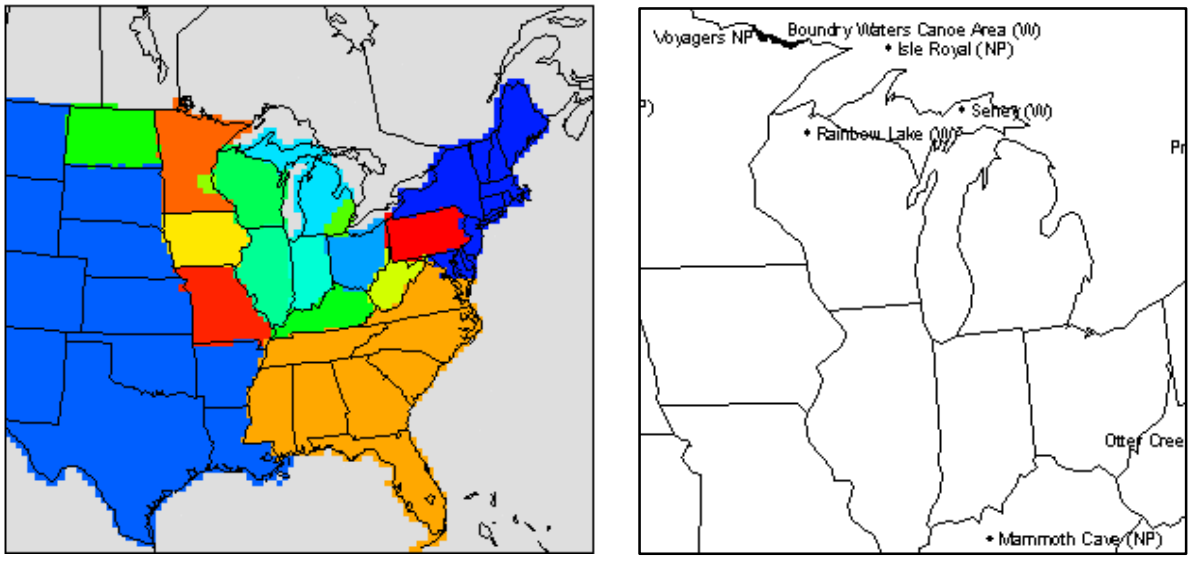


Figure 76. Source regions (left) and key monitoring sites (right) for haze modeling analysis

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.

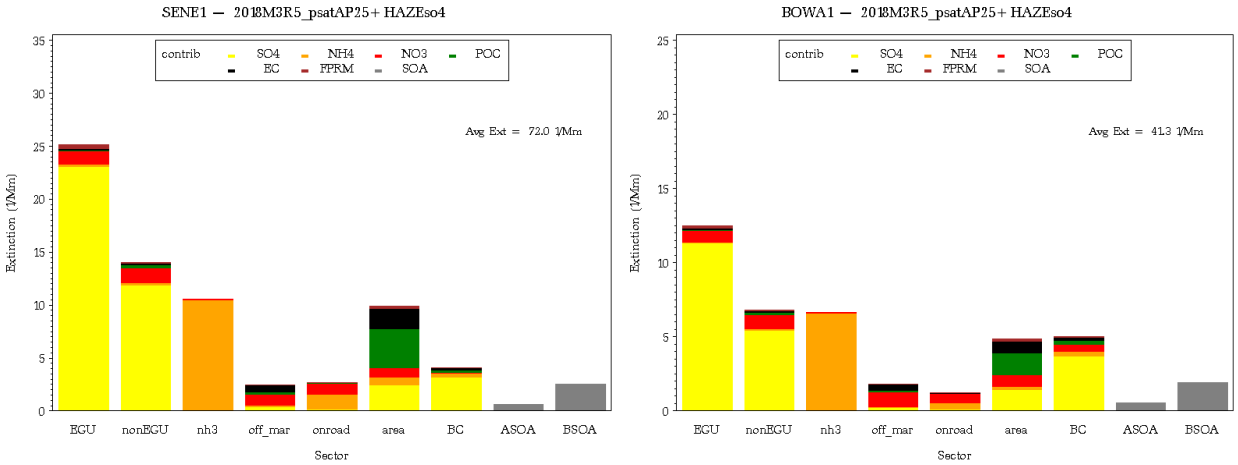


Figure 77. Source-sector results for Seney (left) and Boundary Waters (right) – 2018 (Base M)

The source region results (see, for example, Figure 78) show that emissions from a number of nearby states contribute to regional haze levels.

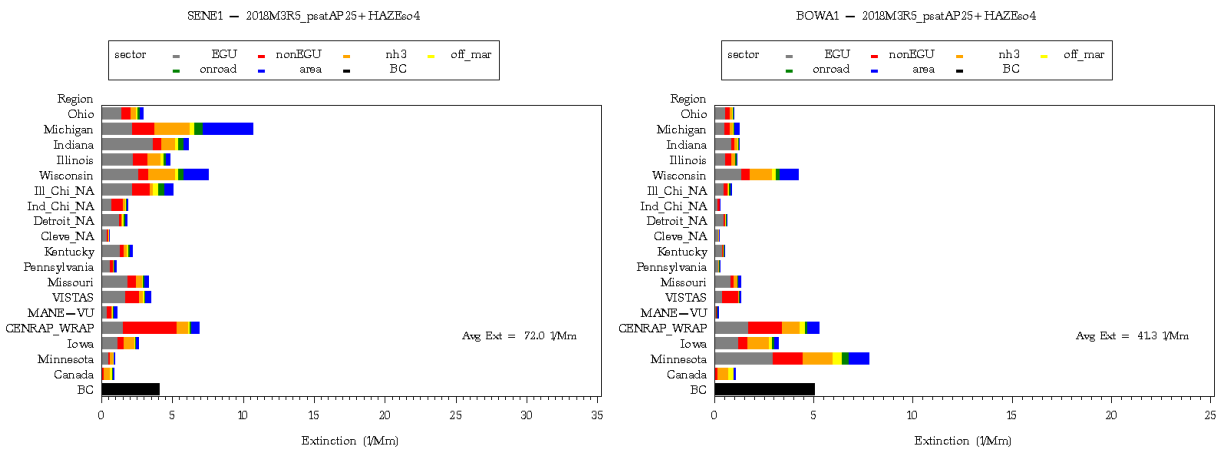


Figure 78. Source-region results for Seney (left) and Boundary Waters (right) – 2018 (Base M)

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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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

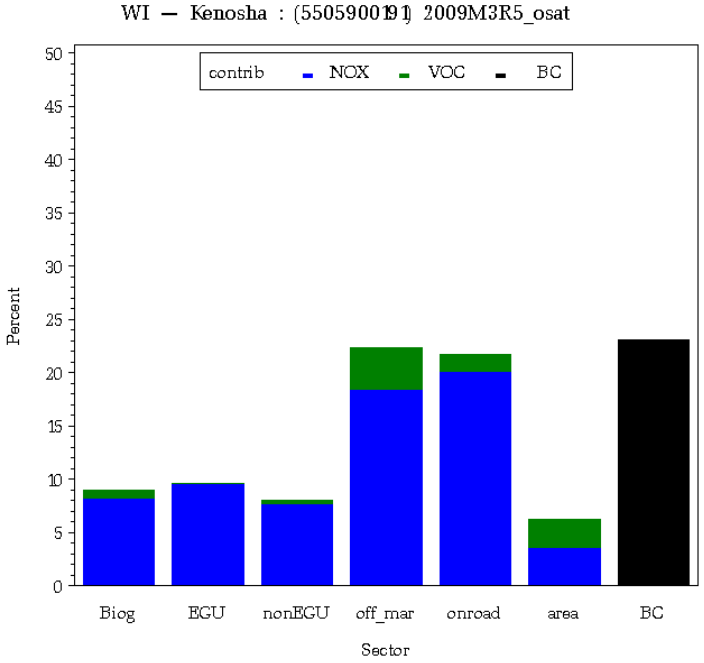
Site ID	State	County	Season	Species	Species Comp. of Ave. FRM (fraction)	Species RRF
3904900241	OH	Franklin	winter	so4	0.2555	0.8622
3904900241	OH	Franklin	winter	no3	0.2373	1.0002
3904900241	OH	Franklin	winter	ocm	0.2082	0.974
3904900241	OH	Franklin	winter	ec	0.0375	0.8537
3904900241	OH	Franklin	winter	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


WI — Kenosha : (550590019) 2009M3R5_osat
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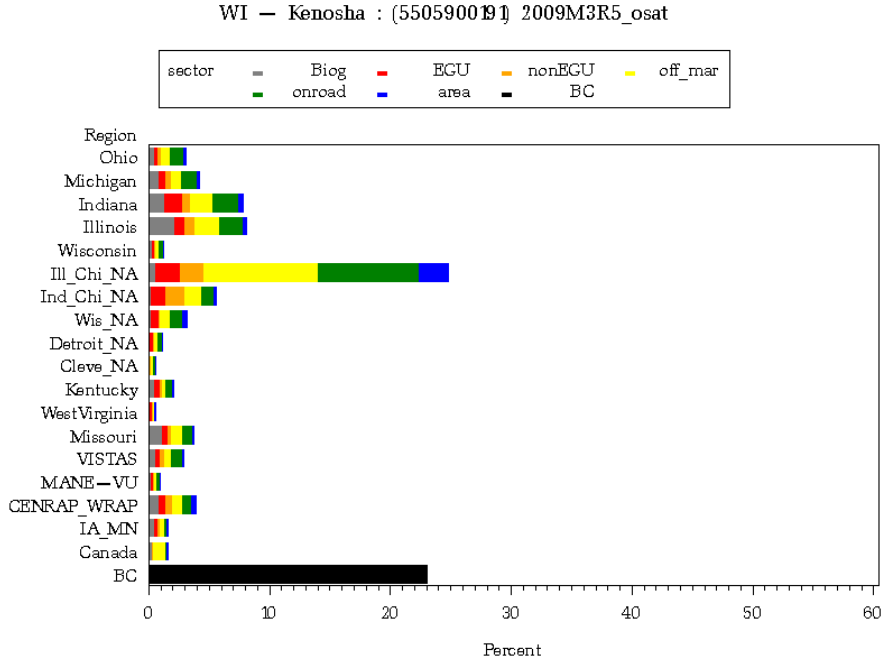
VOC
BC
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


WI — Kenosha : (550590019) 2009M3R5_osat
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Biog
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nonEGU
off_mar
onroad
area
BC
Region
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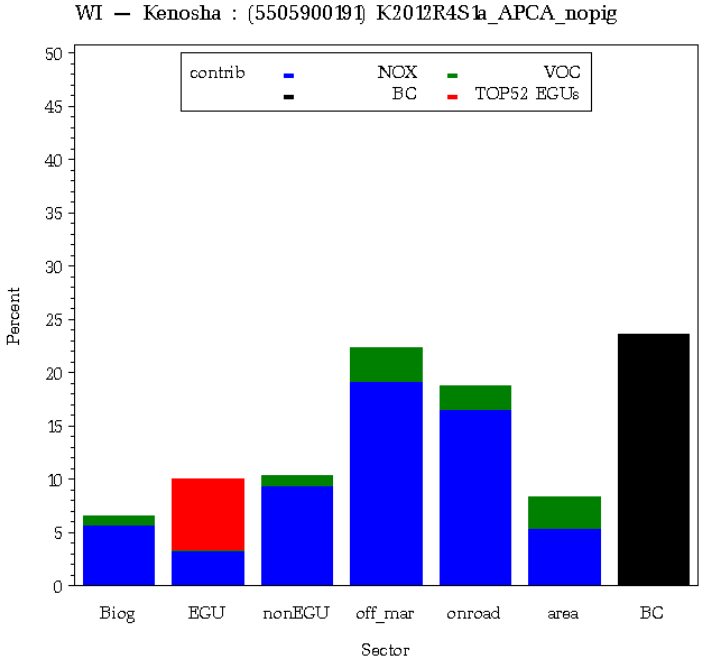
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent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VOC
BC
TOP52 EGUs
Percent
Biog
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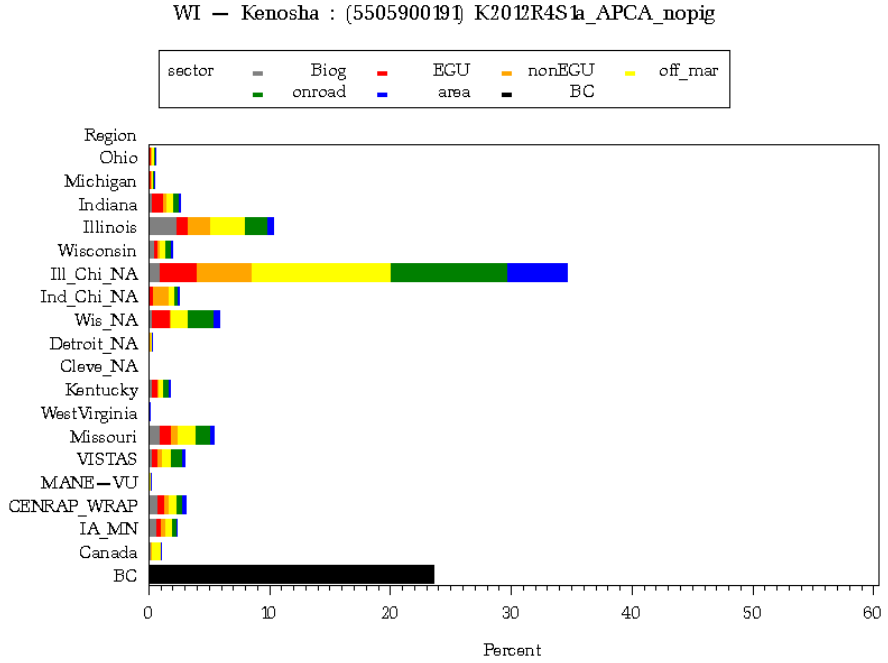
nonEGU
off_mar
onroad
area
BC
Sector


WI — Kenosha : (550590019) K2012R4S1a_APCA_nopig
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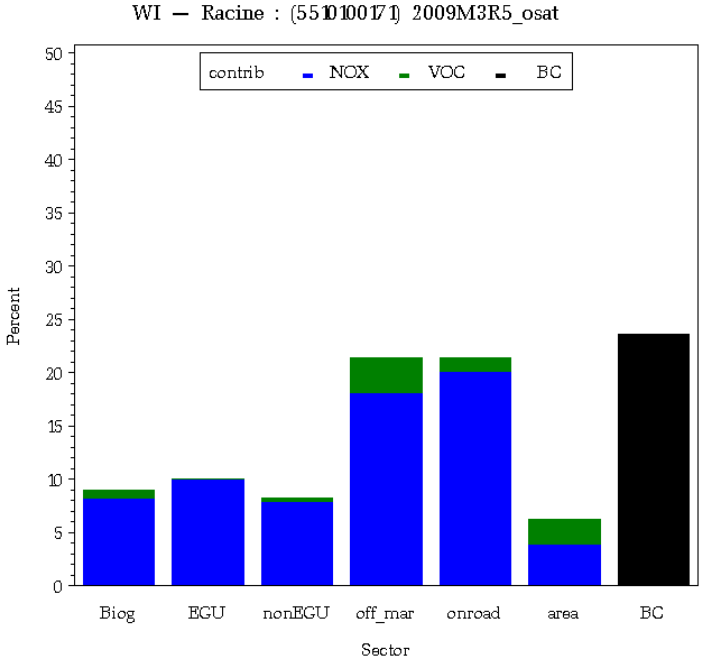
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Racine : (551010017) 2009M3R5_osat
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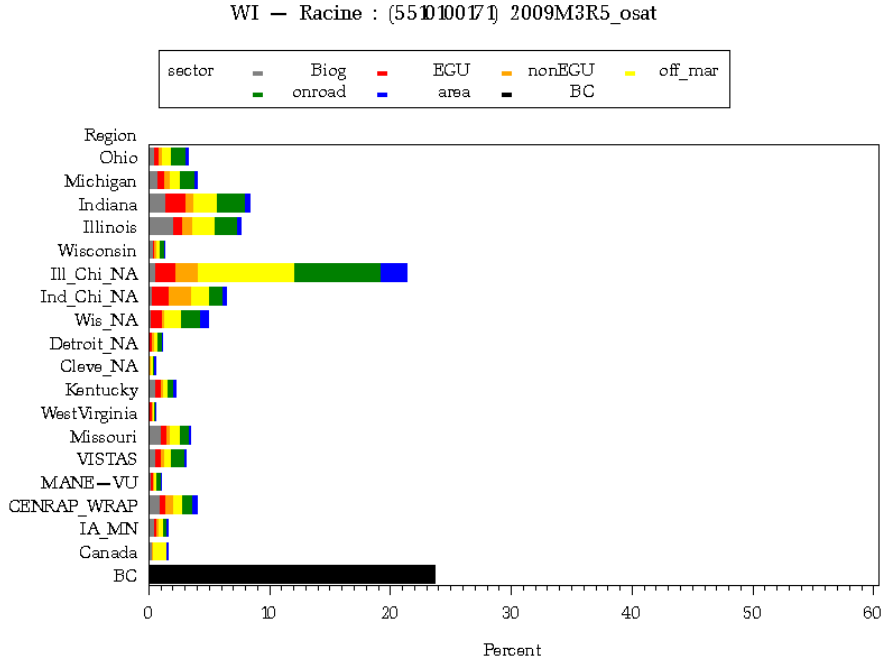
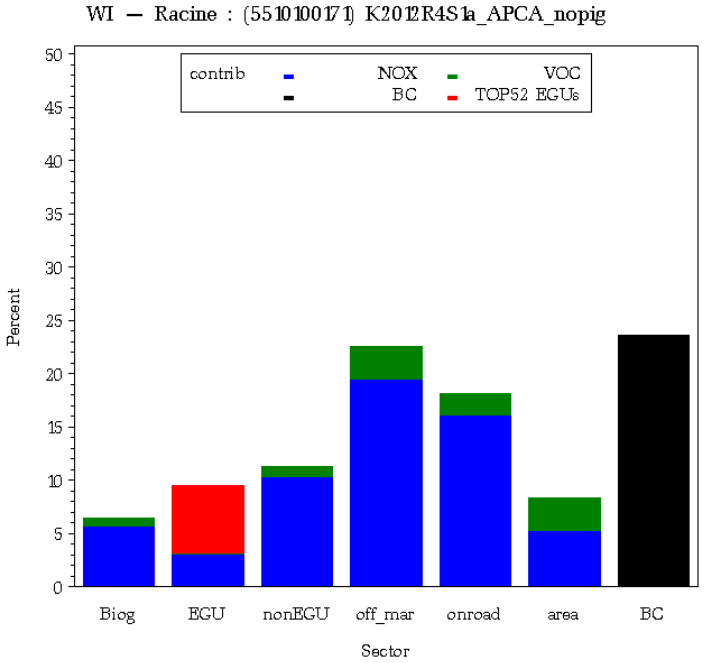
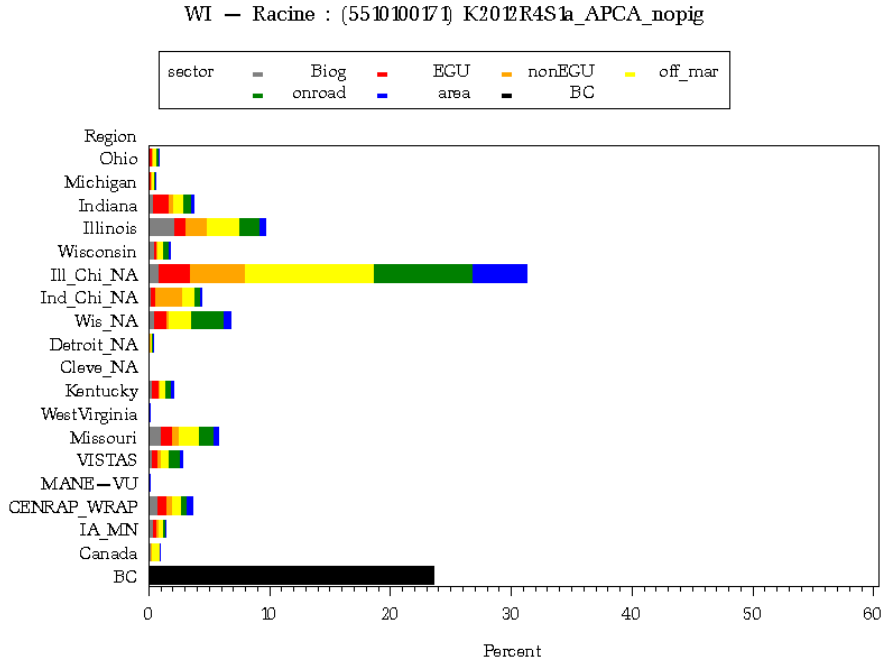
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Racine : (551010017) 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
Percent


WI — Racine : (551010017) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Racine : (551010017) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
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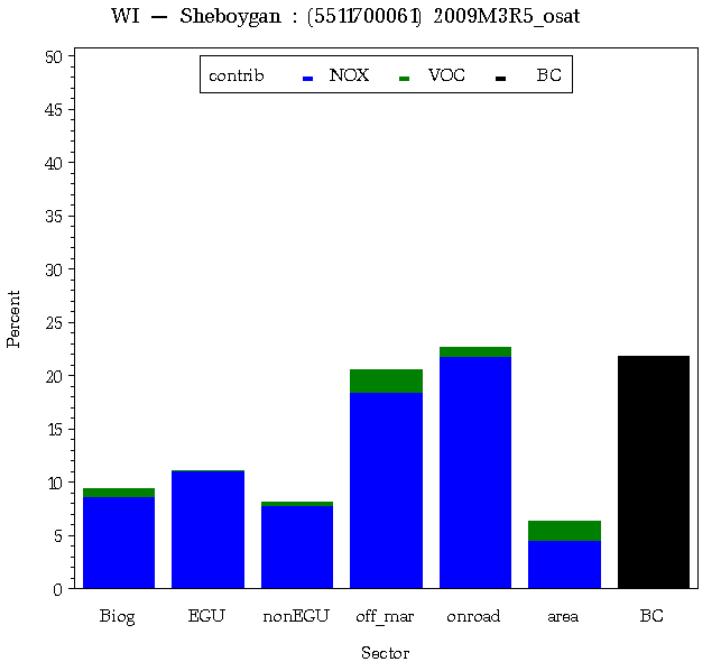
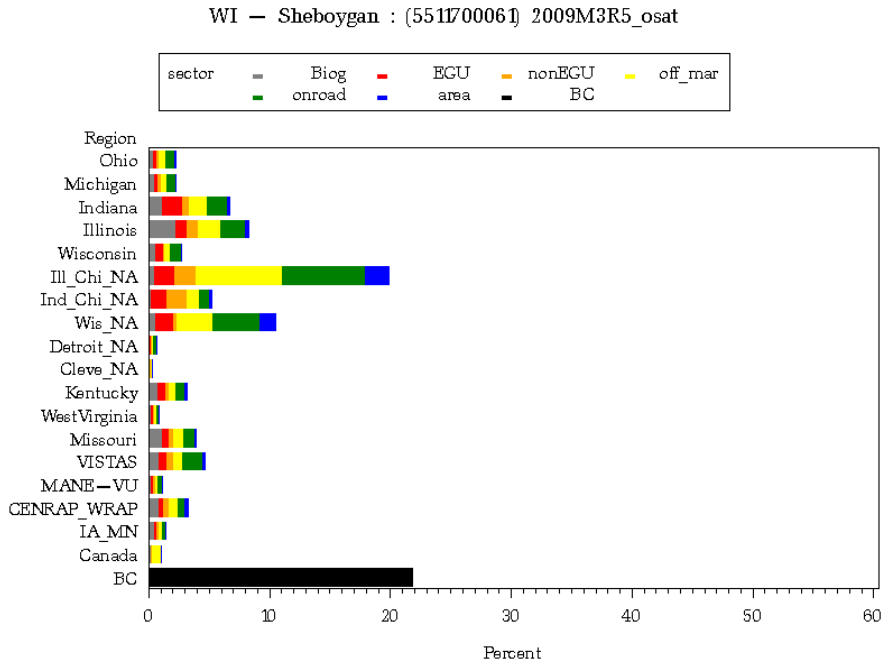
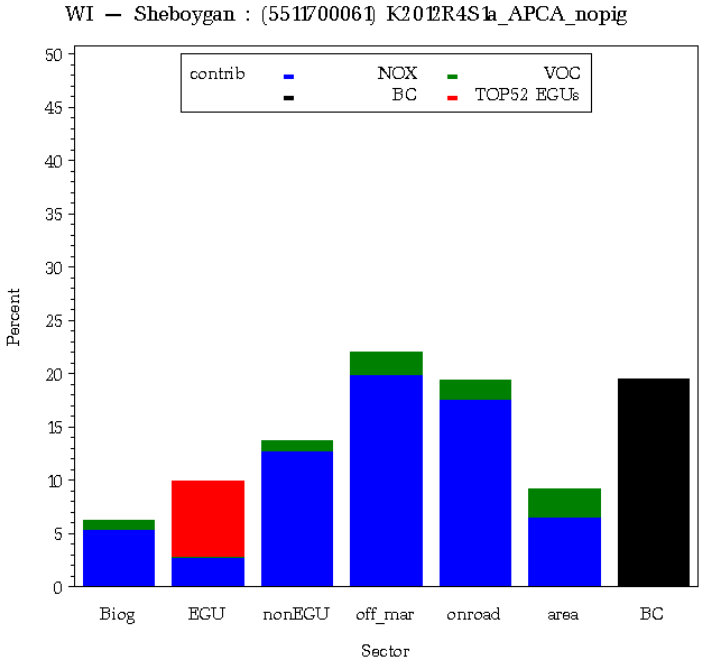
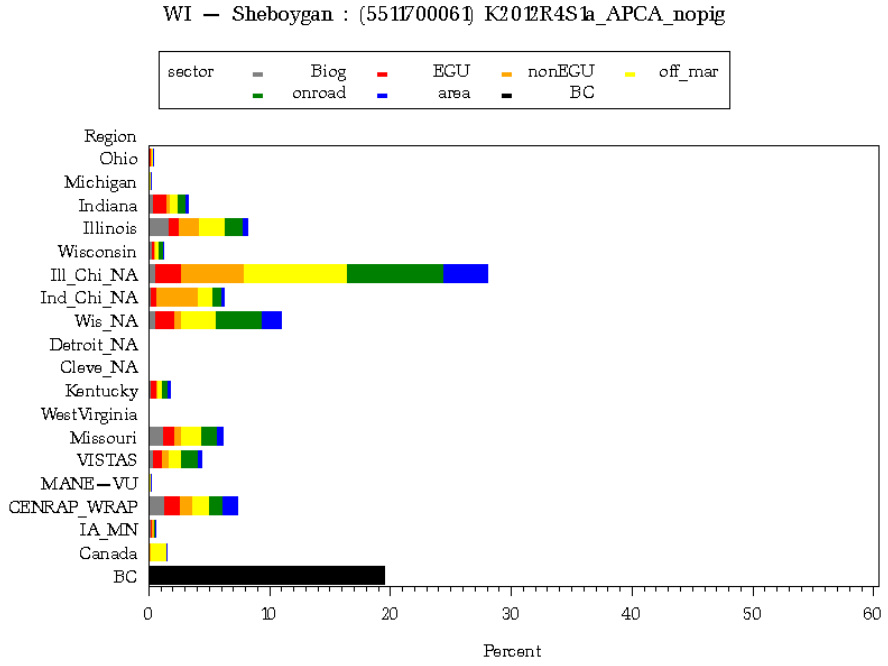
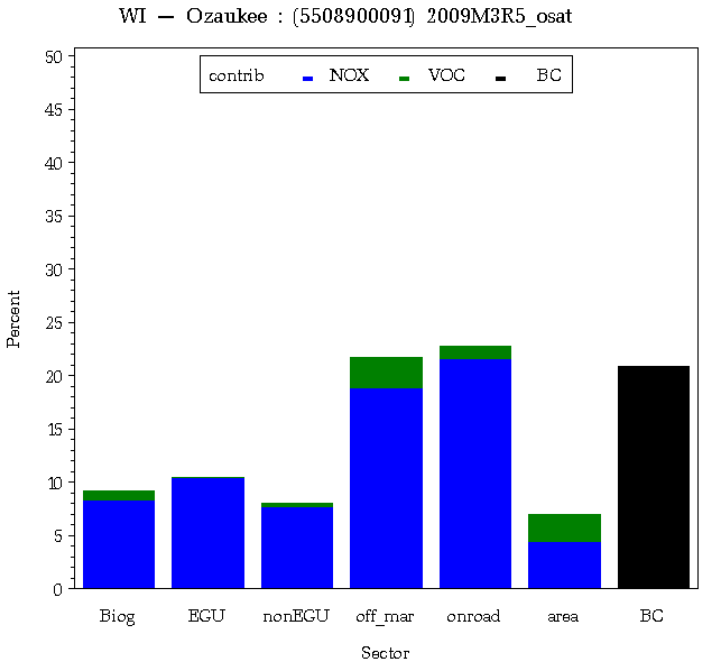
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

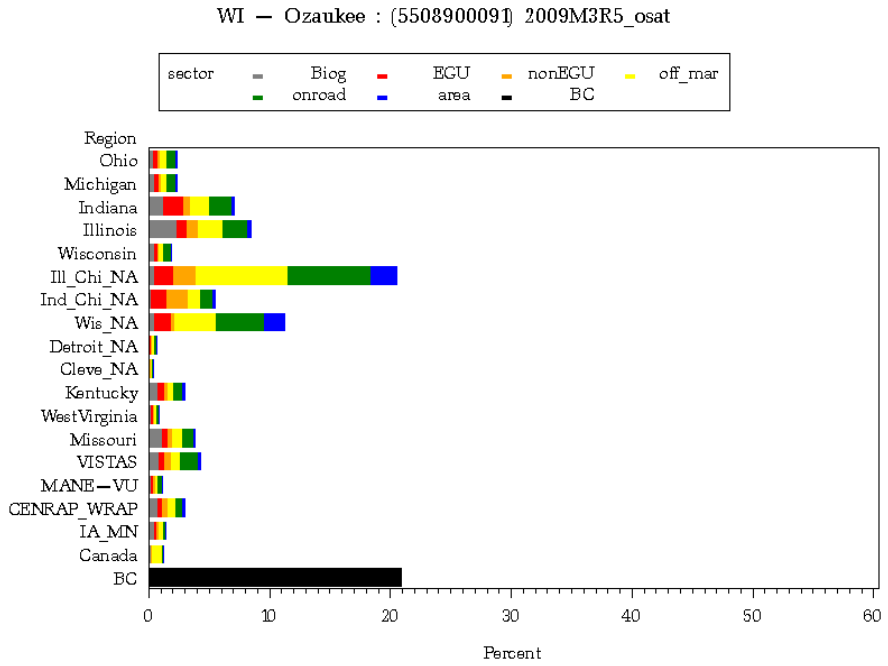

WI — Sheboygan : (551700061) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

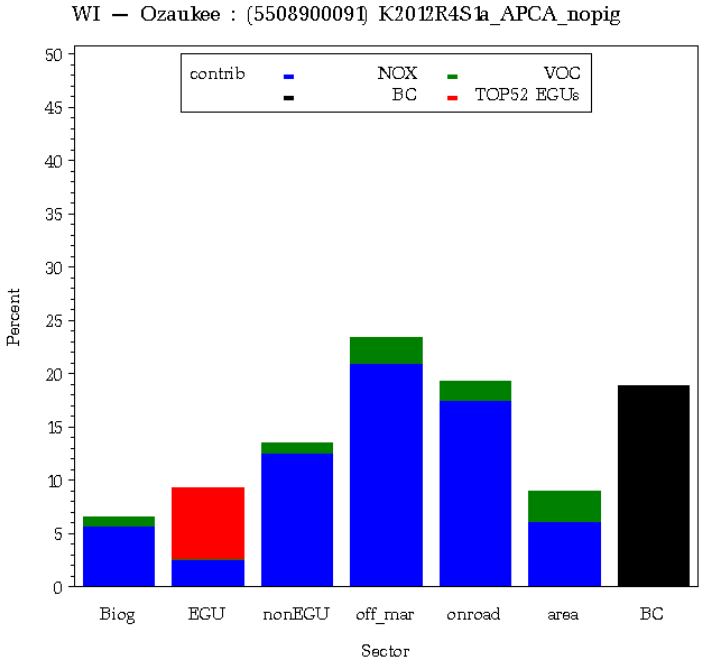

WI — Sheboygan : (551700061) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

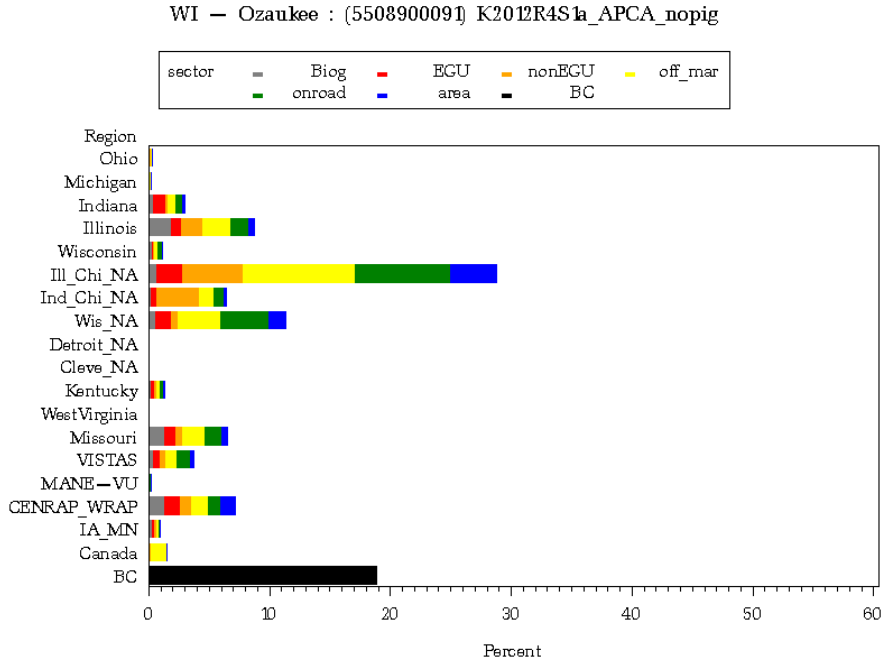

WI — Sheboygan : (551700061) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

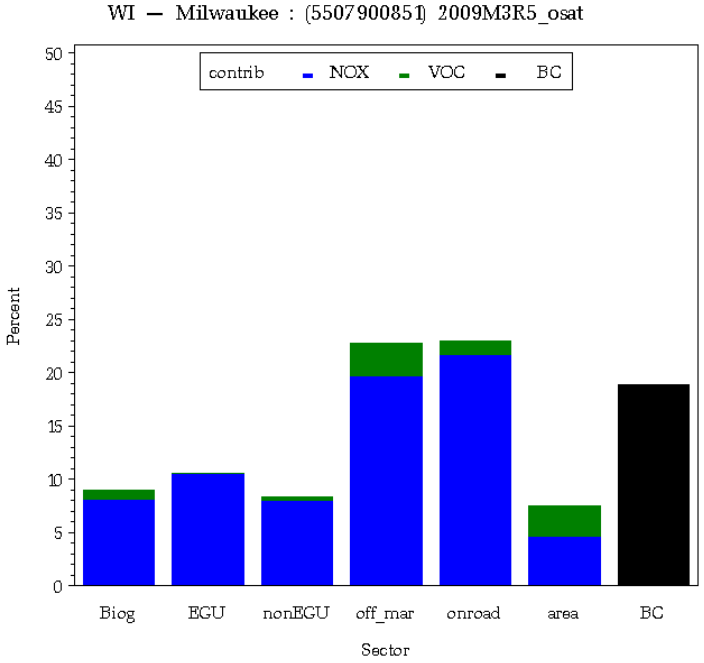

WI — Sheboygan : (551700061) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

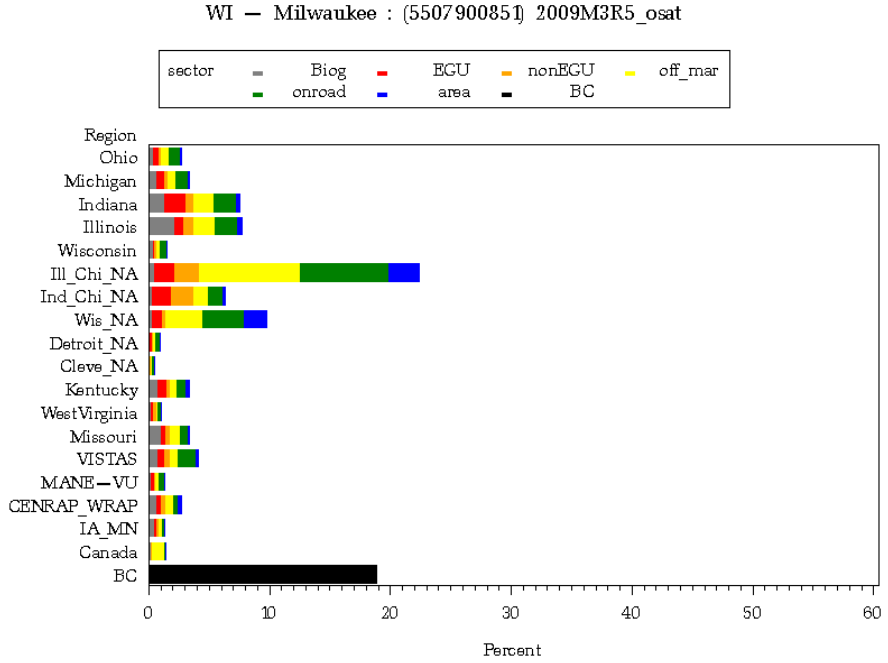

WI — Ozaukee : (5508900091) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Ozaukee : (5508900091) 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
Percent


WI — Ozaukee : (5508900091) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Ozaukee : (5508900091) 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
Percent


WI — Milwaukee : (550790085 1) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Milwaukee : (550790085 1) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
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Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
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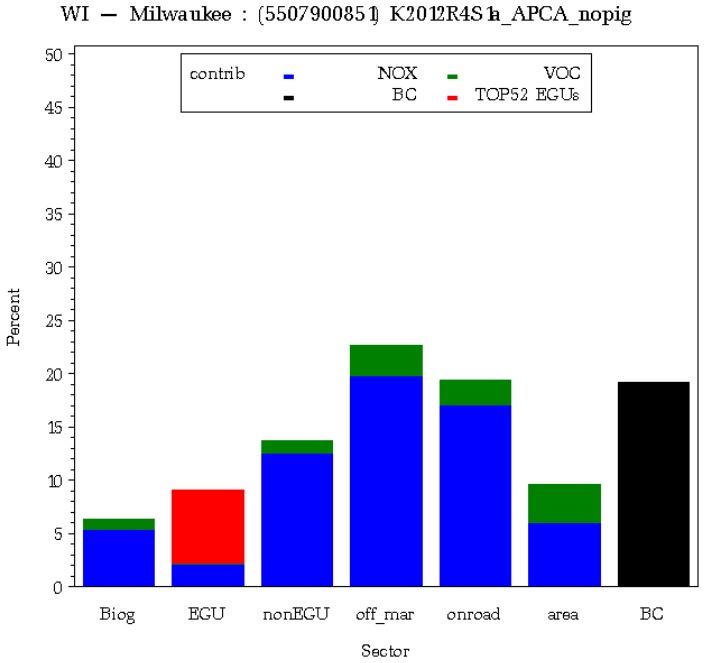
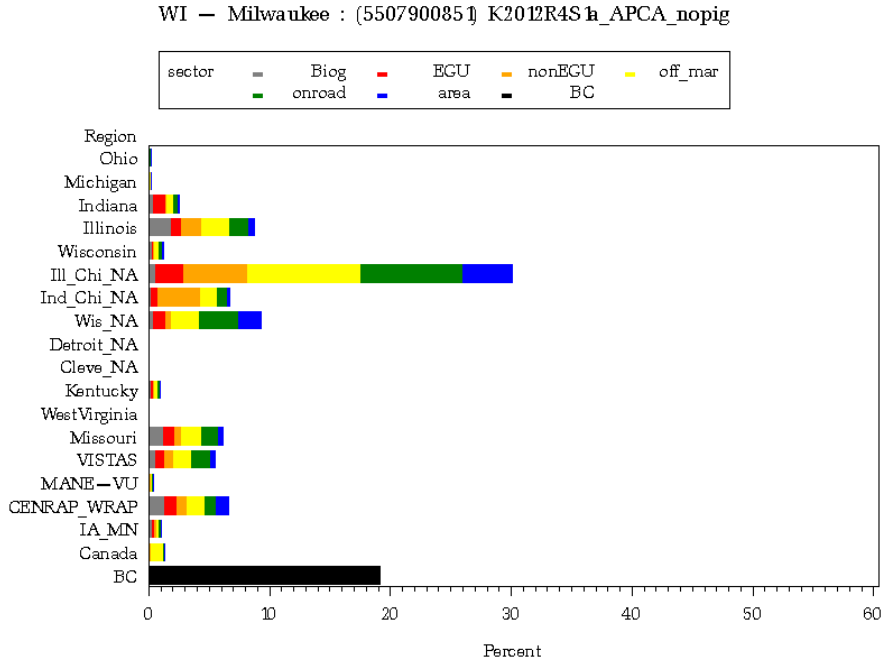
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Milwaukee : (550790085 1) K2012R4S ha_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Milwaukee : (550790085 1) K2012R4S ha_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
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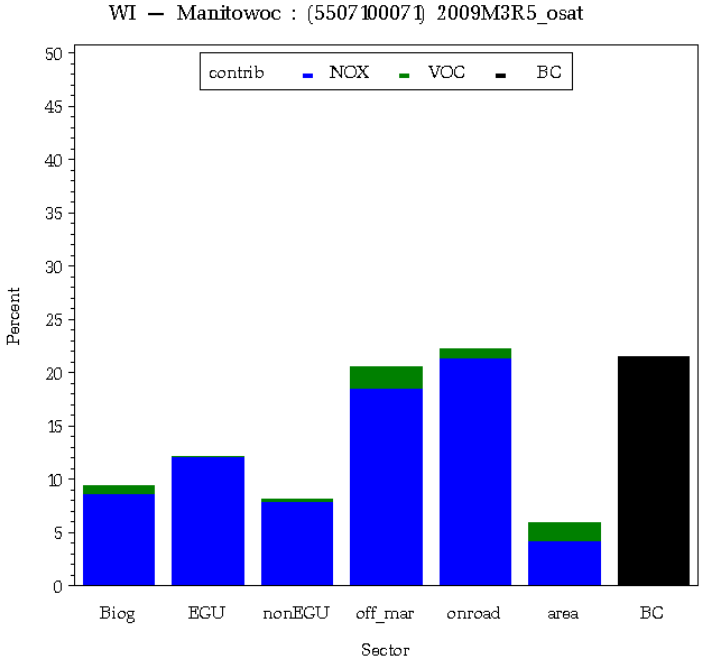
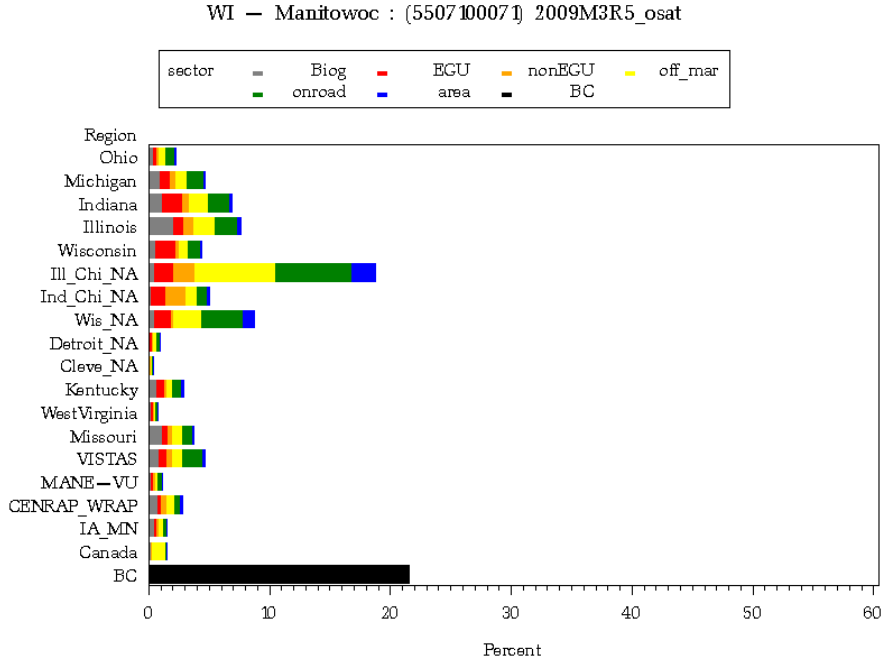
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Manitowoc : (550710071) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Manitowoc : (550710071) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
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Indiana
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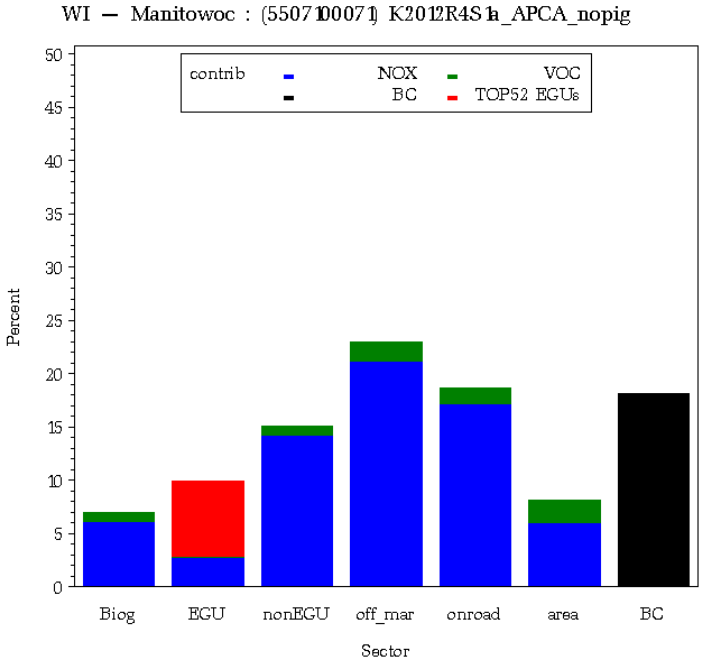
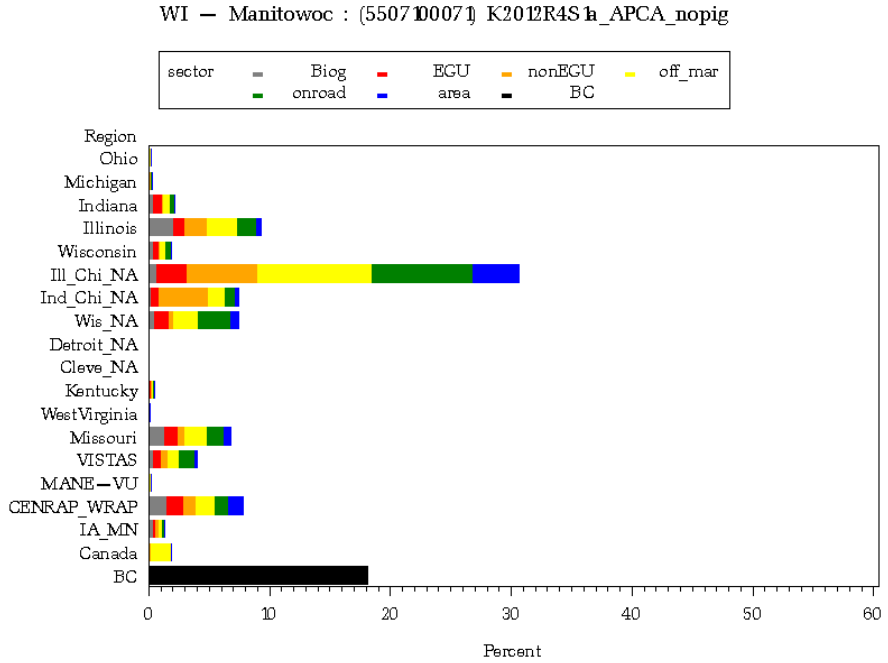
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Manitowoc : (550710071) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


WI — Manitowoc : (550710071) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
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Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
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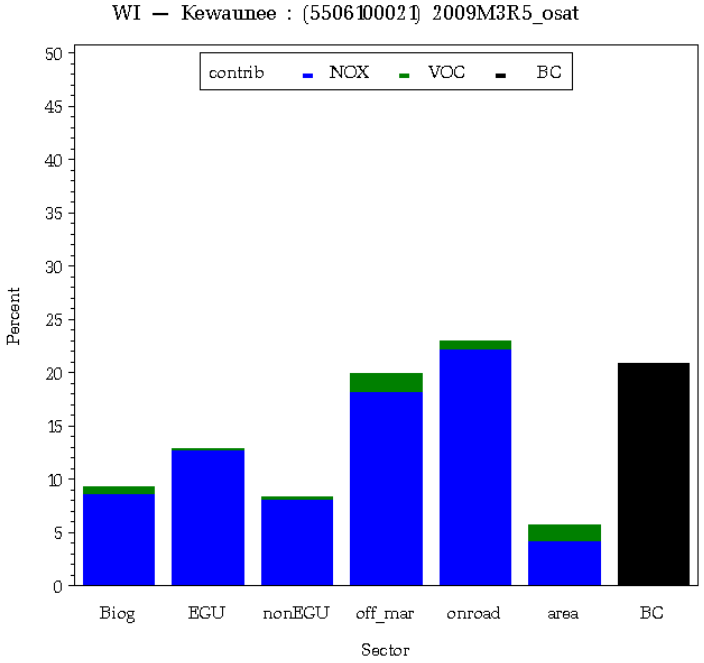
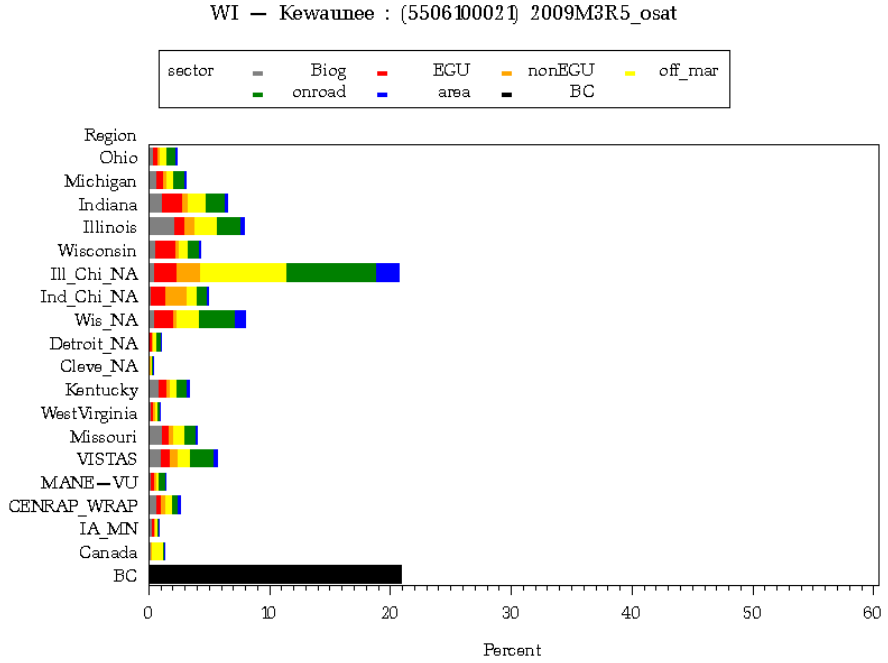
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Kewaunee : (550610002 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


WI — Kewaunee : (550610002 1) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
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Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
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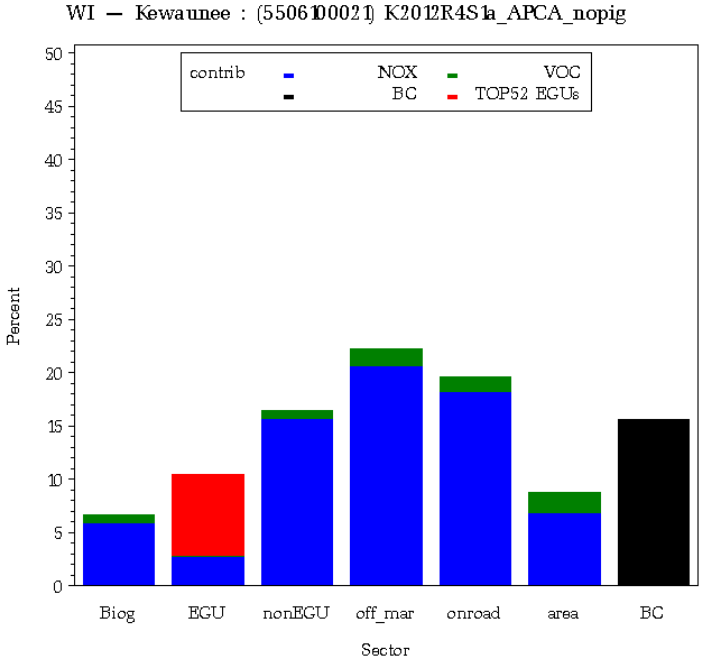
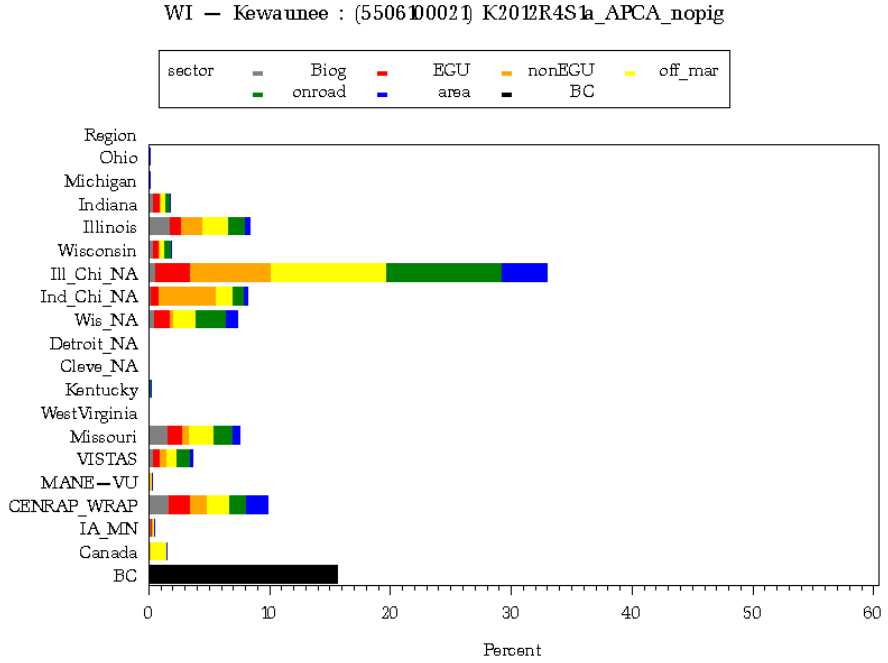
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0 10 20 30 40 50 60
Percent


WI — Kewaunee : (550610002 1) 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


WI — Kewaunee : (550610002 1) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
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Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
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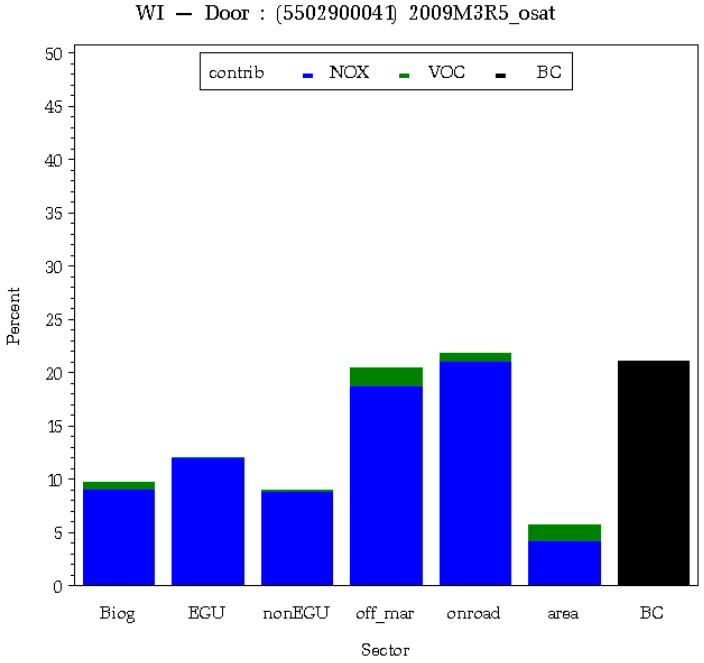
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0 10 20 30 40 50 60
Percent


WI — Door : (550290041) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
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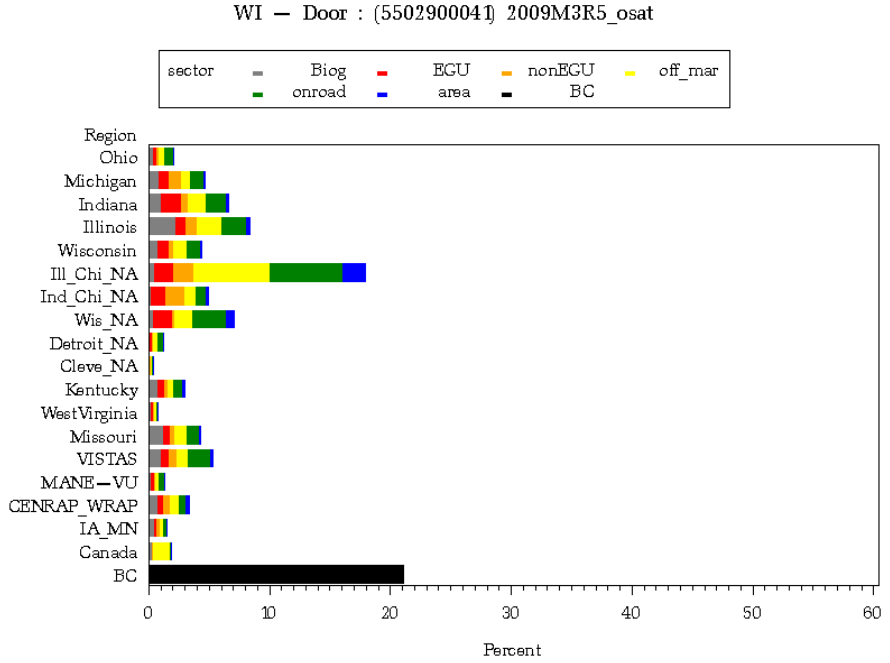
nonEGU
off_mar
onroad
area
BC
Sector


WI — Door : (550290041) 2009M3R5_osat
sector
Biog
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off_mar
onroad
area
BC
Region
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Indiana
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Wisconsin
Ill_Chi_NA
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Wis_NA
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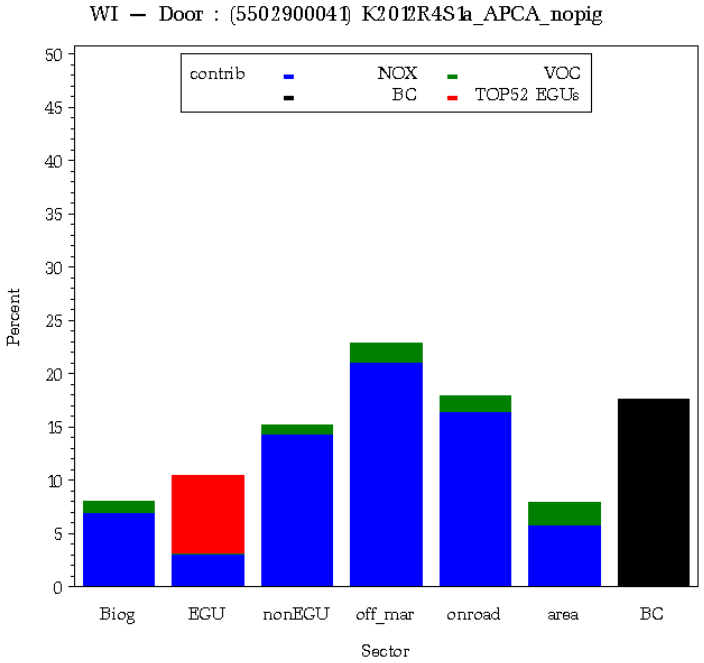
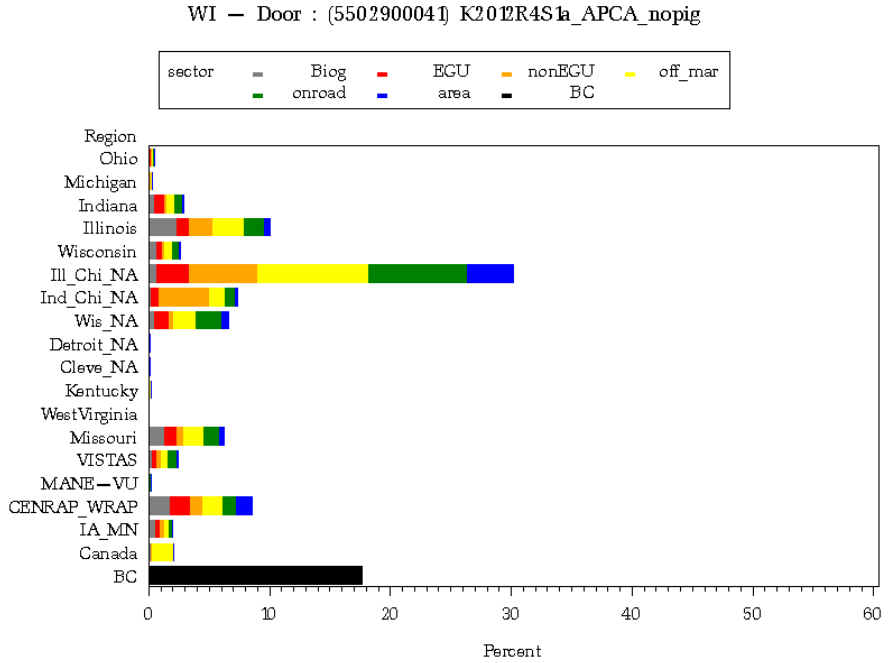
CENRAP_WRAP
IA_MN
Canada
BC
Percent


WI — Door : (550290041) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


WI — Door : (550290041) 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
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MANE—VU
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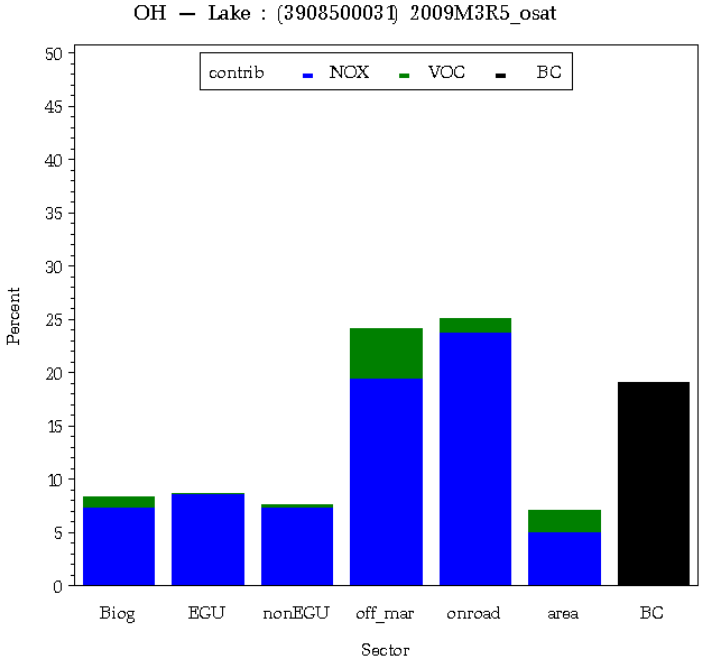
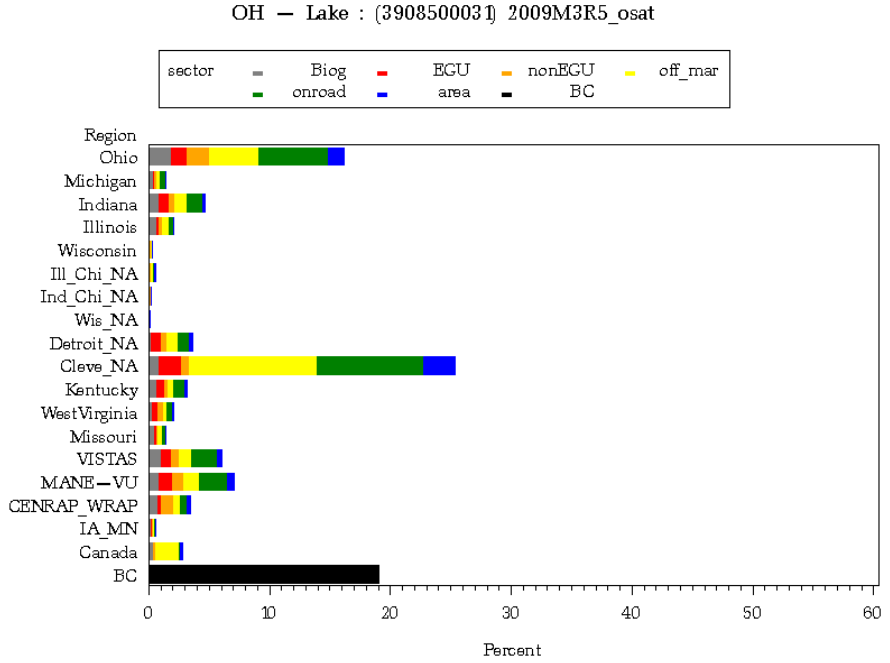
IA_MN
Canada
BC
Percent


OH — Lake : (390850003) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


OH — Lake : (390850003) 2009M3R5_osat
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
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Indiana
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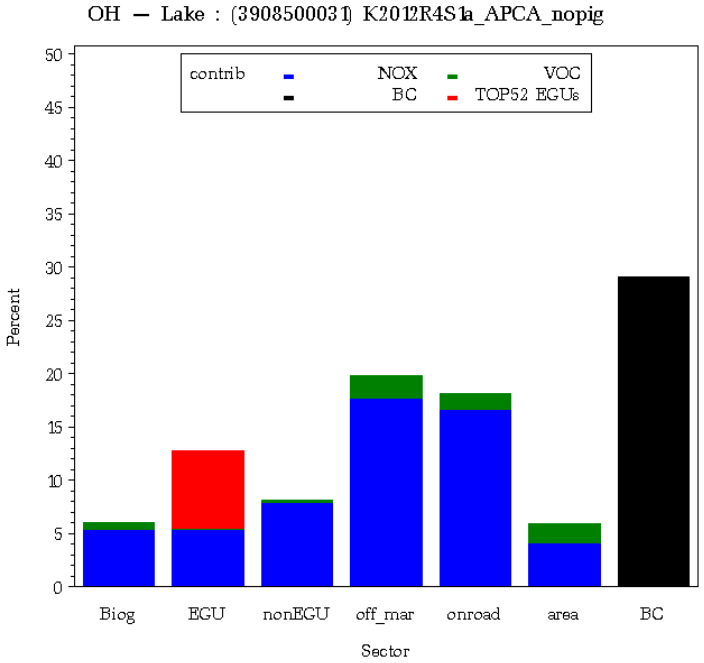
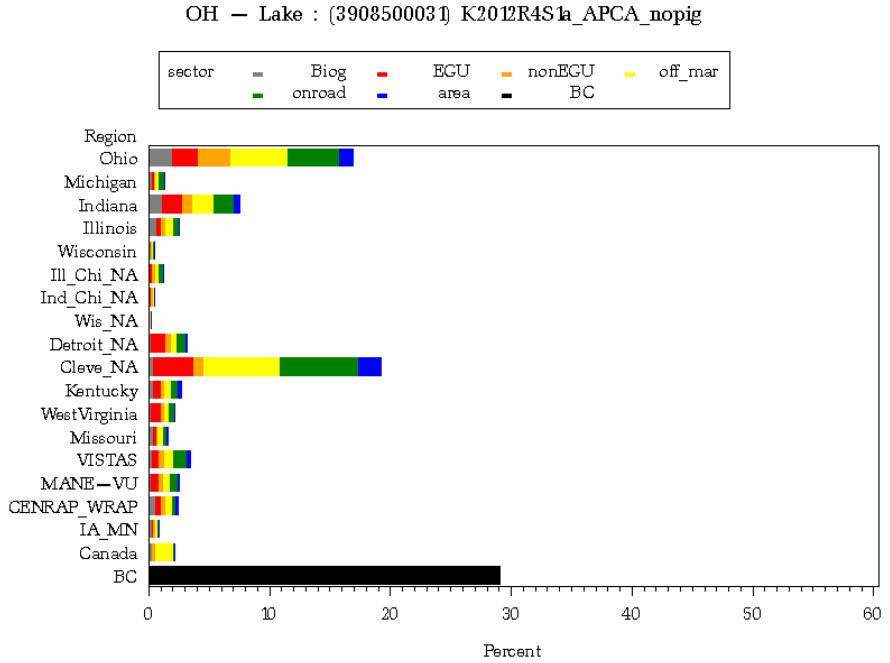
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


OH — Lake : (390850003) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


OH — Lake : (390850003) K2012R4S1a_APCA_nopig
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
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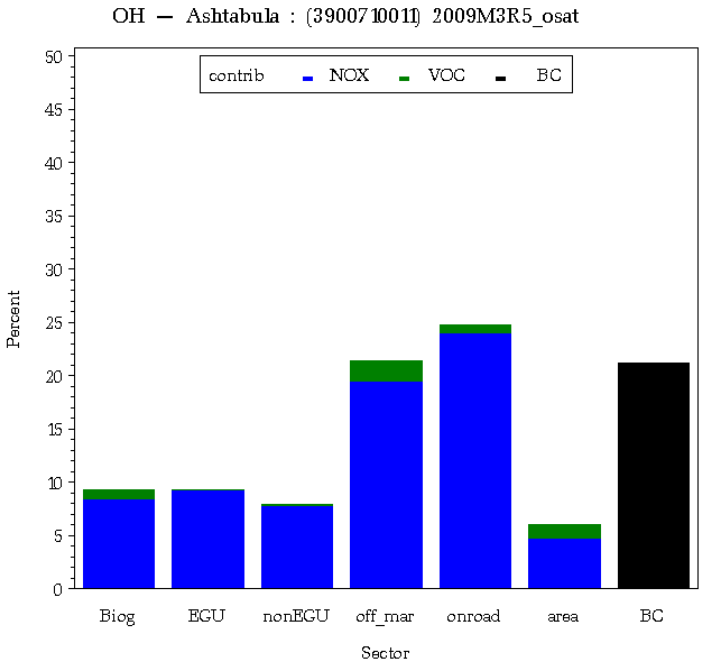
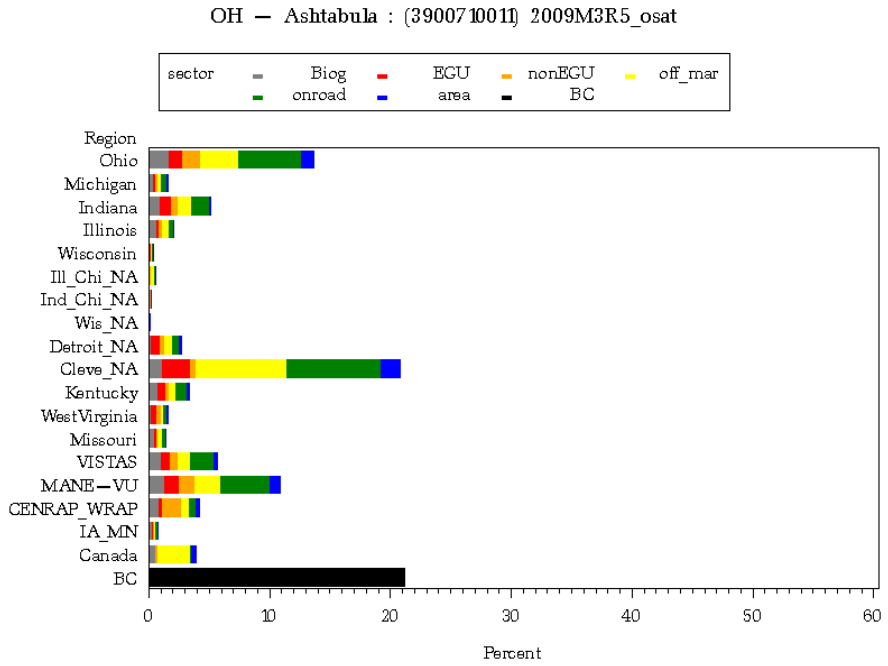
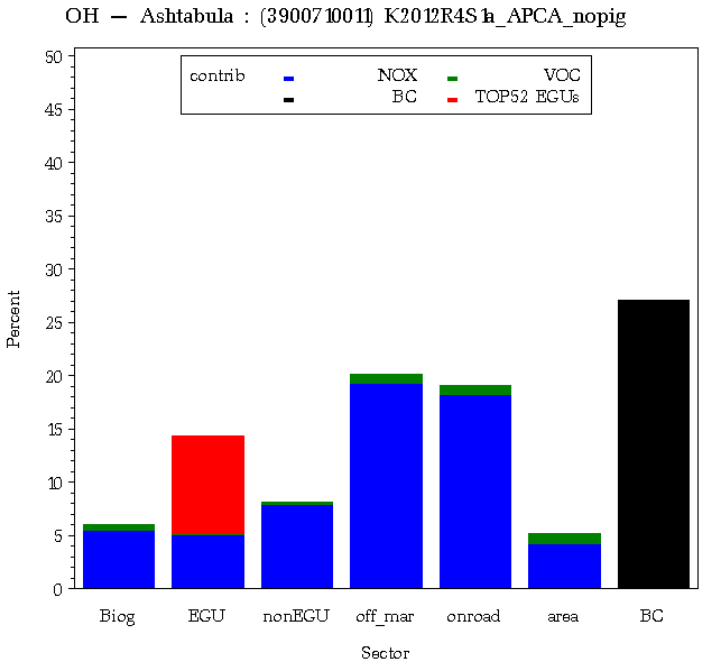
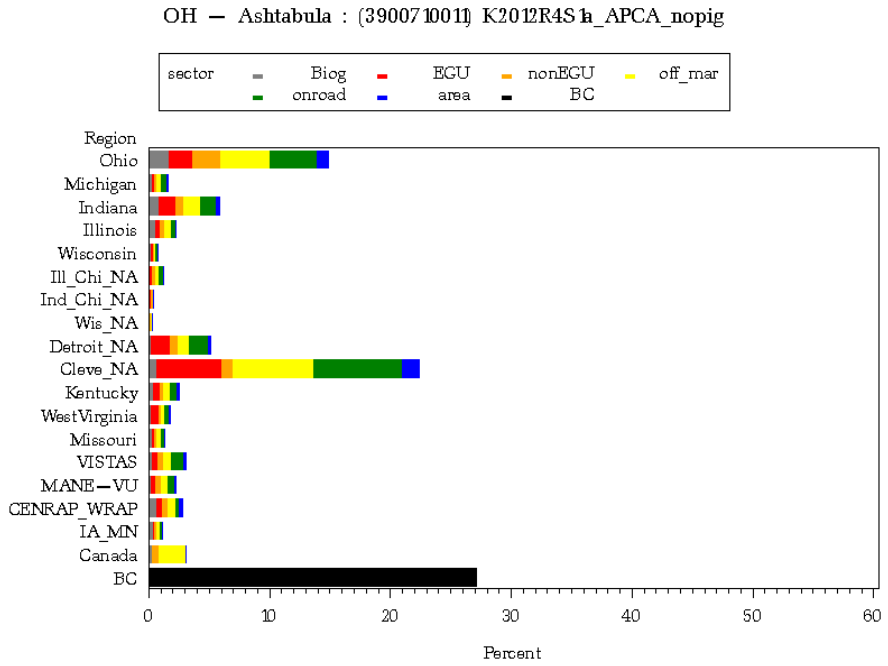
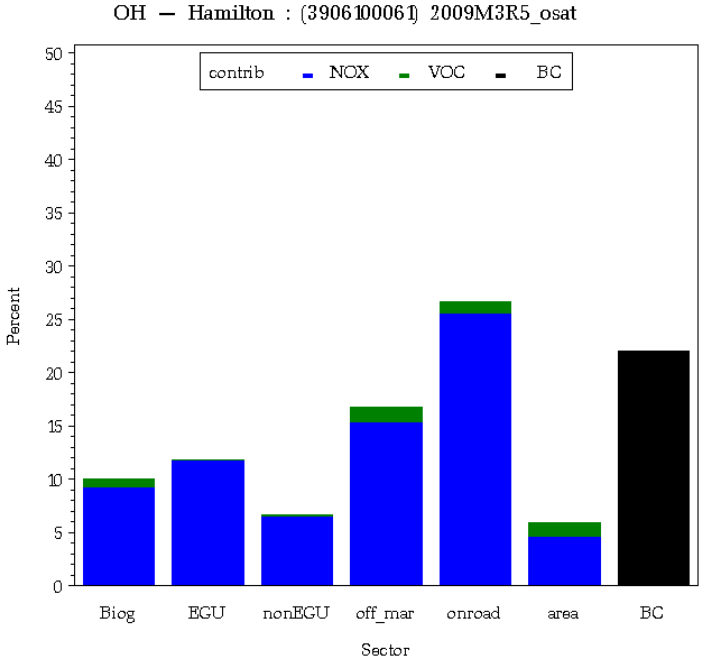
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

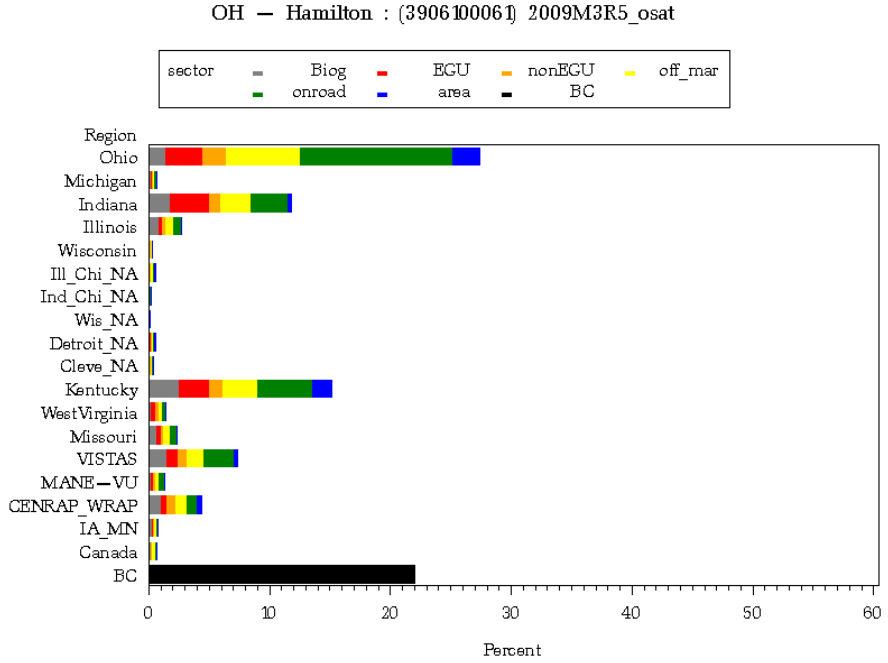

OH — Ashtabula : (390071001) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


OH — Ashtabula : (390071001) 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
Percent


OH — Ashtabula : (390071001) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


OH — Ashtabula : (390071001) 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
Percent


OH — Hamilton : (3906100061) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector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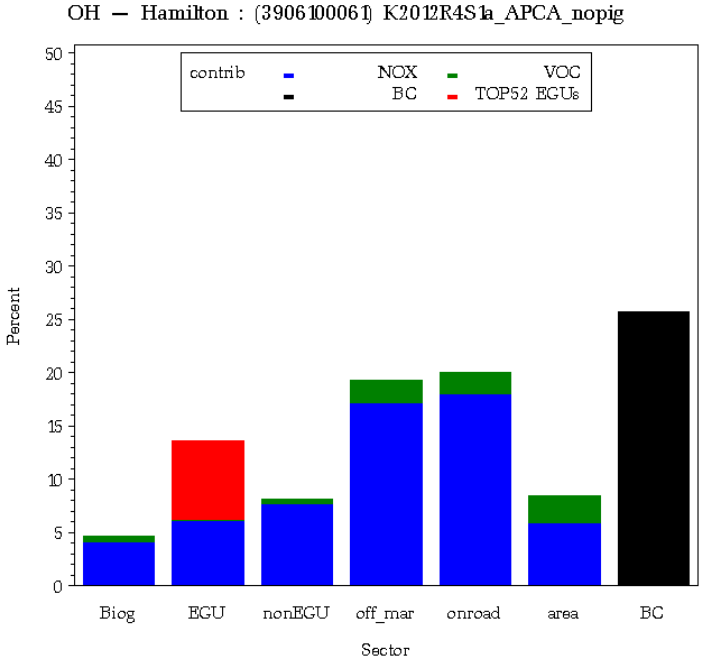
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent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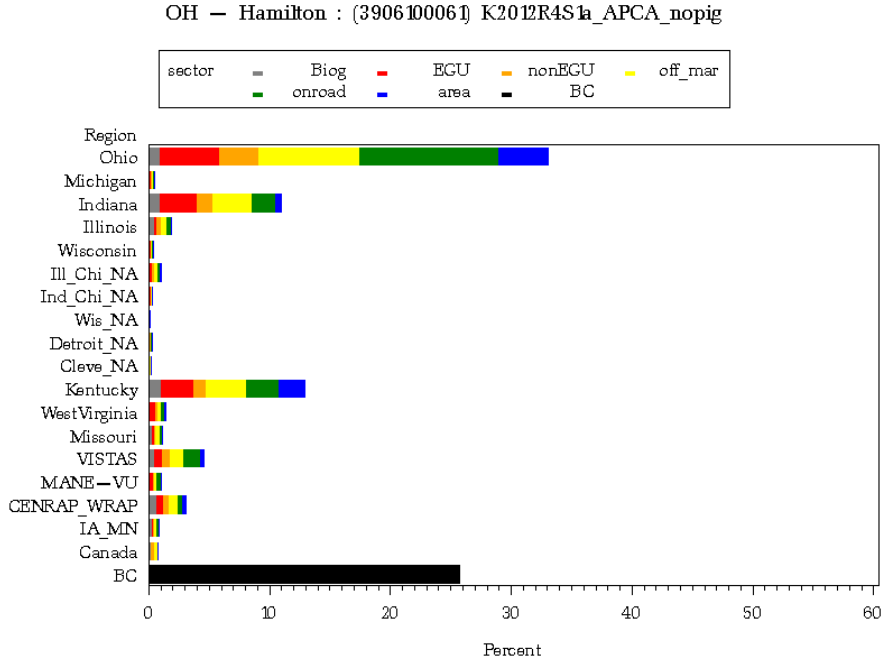
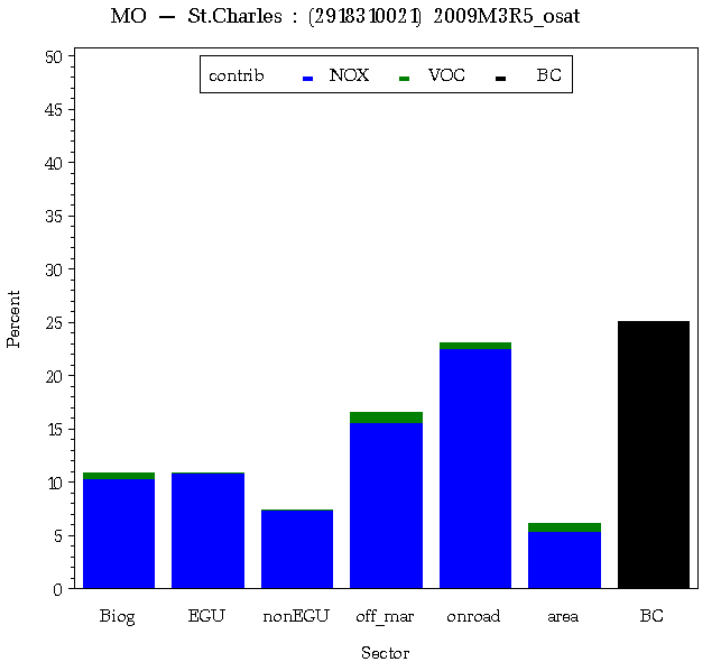
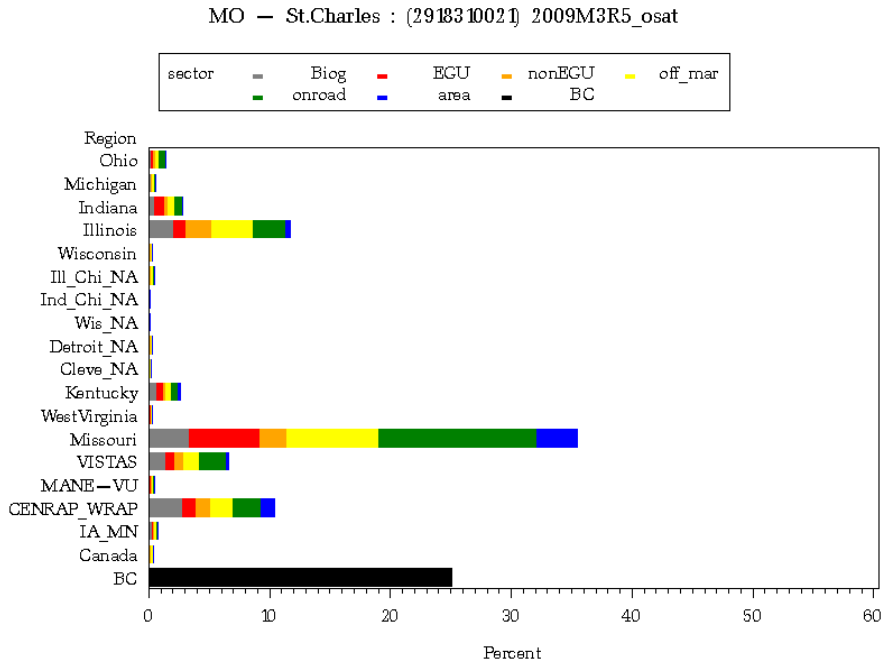
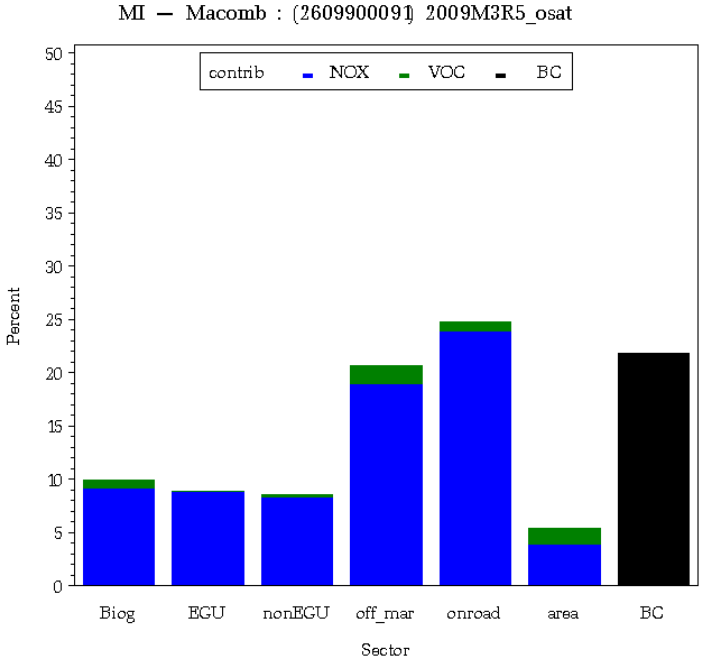
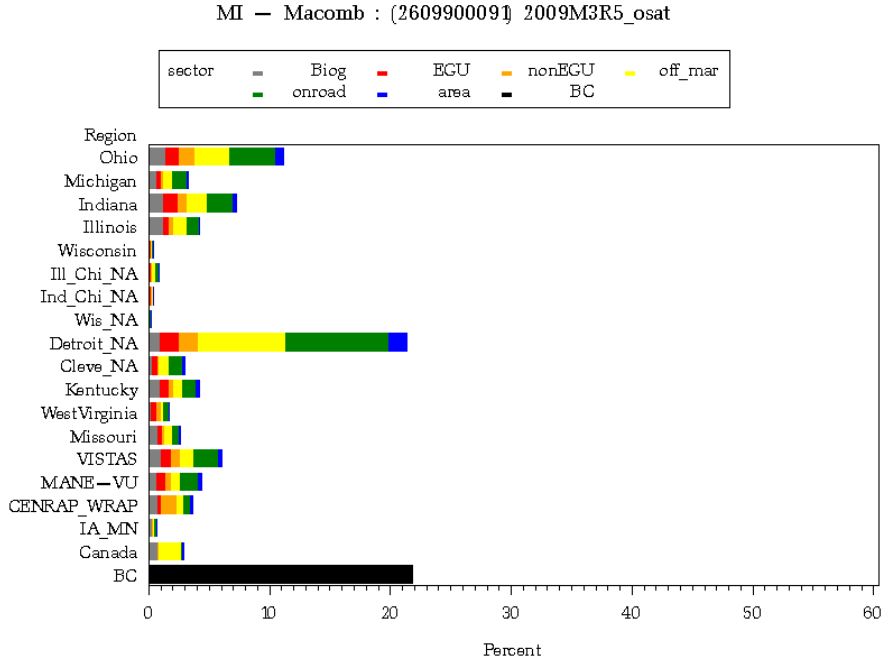
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

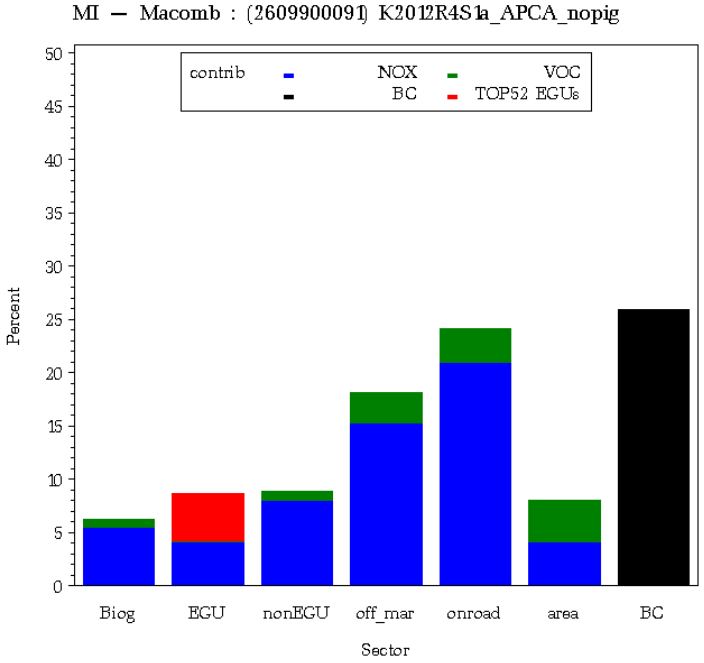

OH — Hamilton : (3906100061) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

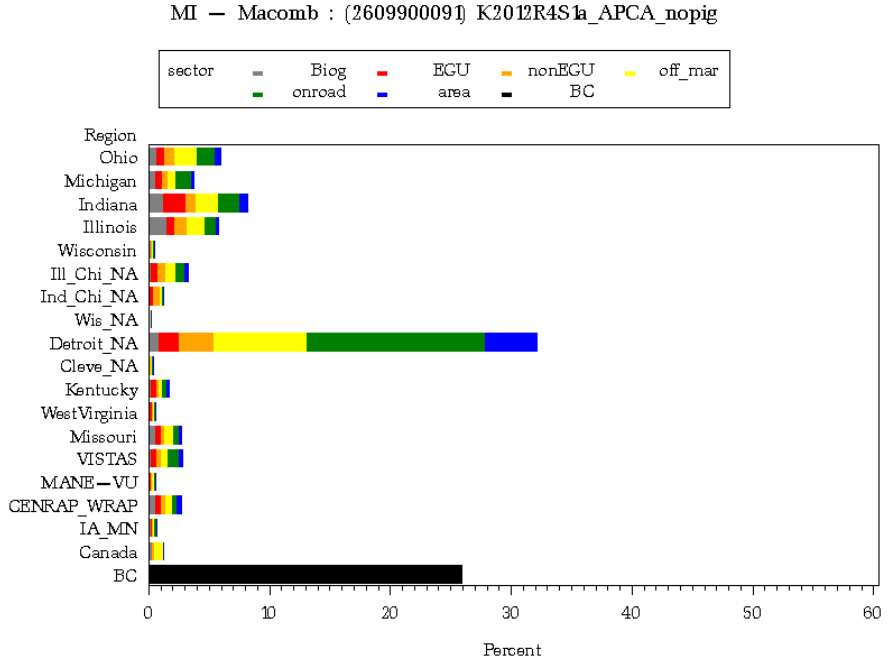

MO — St.Charles : (291831002 1) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
0
5
10
15
20
25
30
35
40
45
50
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector

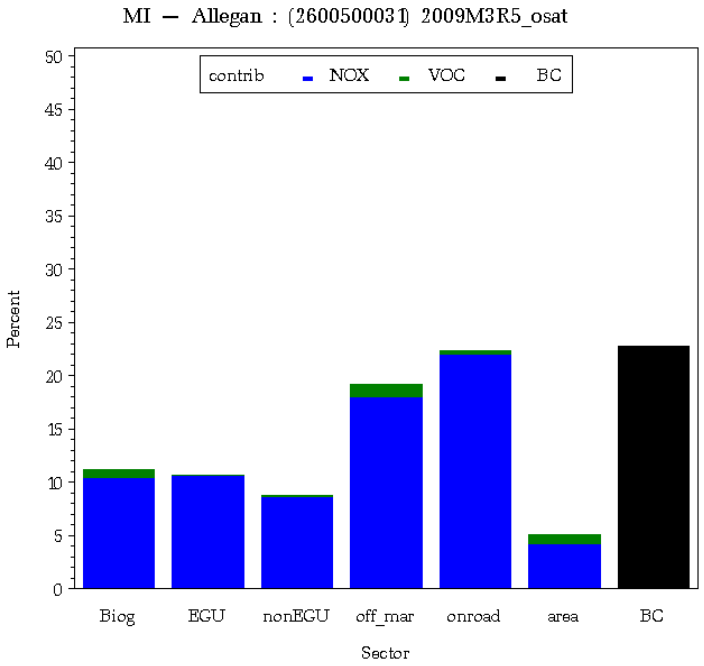

MO — St.Charles : (291831002 1) 2009M3R5_osat
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
0
10
20
30
40
50
60
Percent

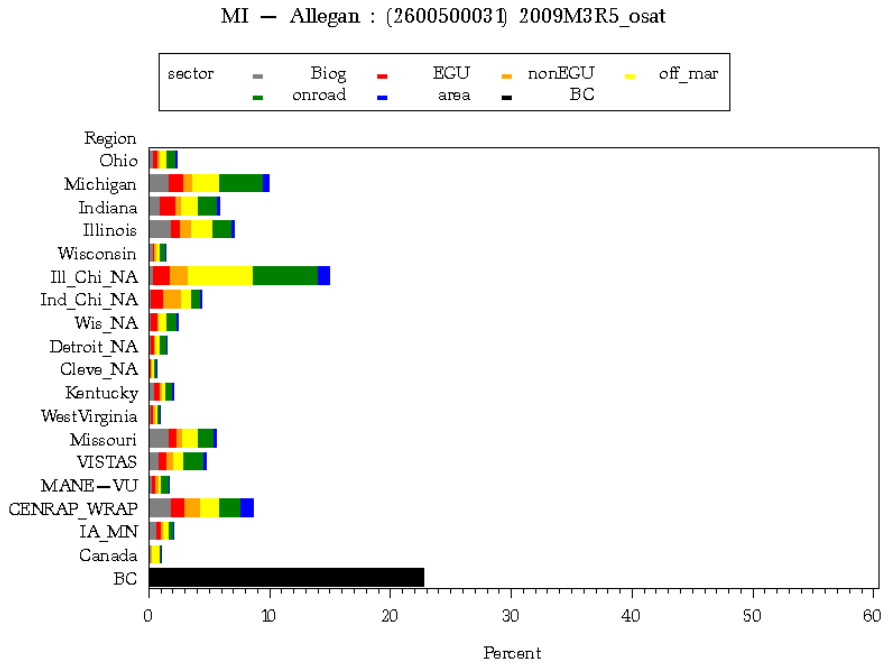

MI — Macomb : (2609900091) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

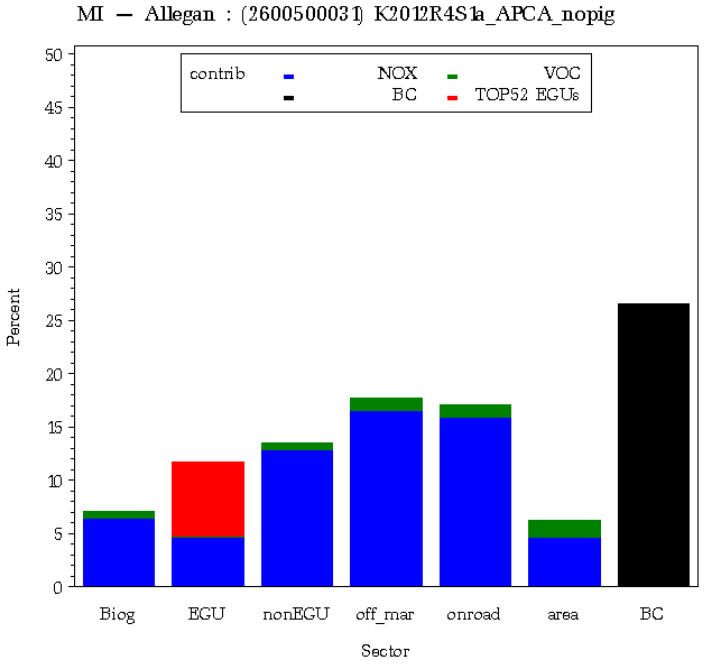

MI — Macomb : (2609900091) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

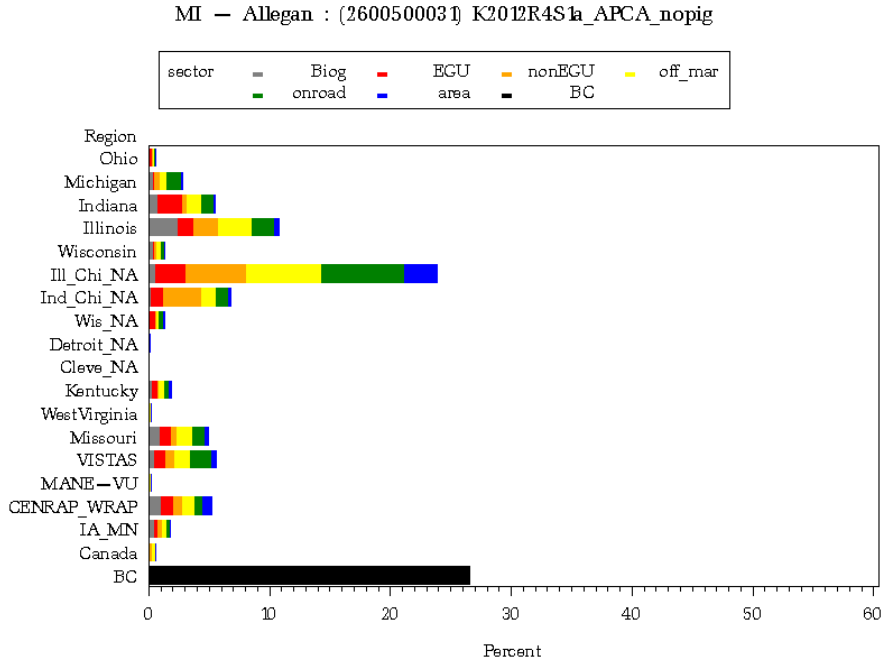

MI — Macomb : (2609900091) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

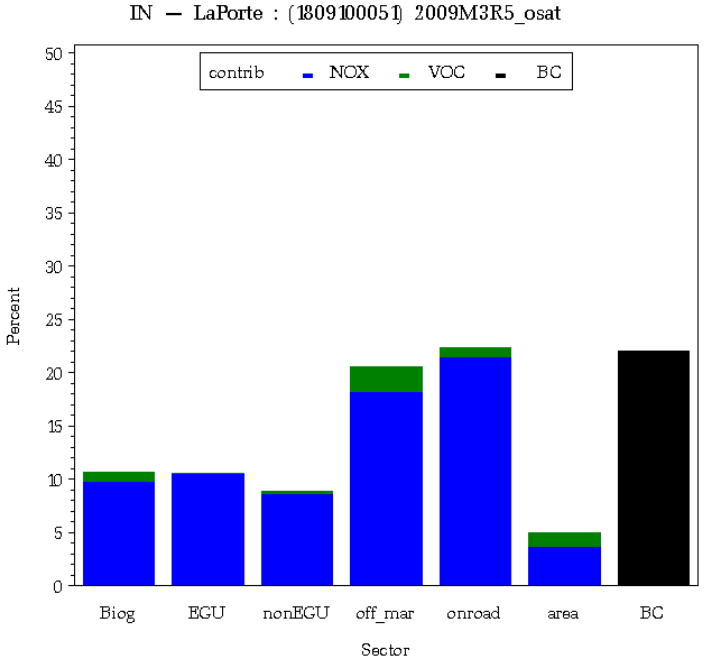

MI — Macomb : (2609900091) K2012R4S1a_APCA_nopig
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

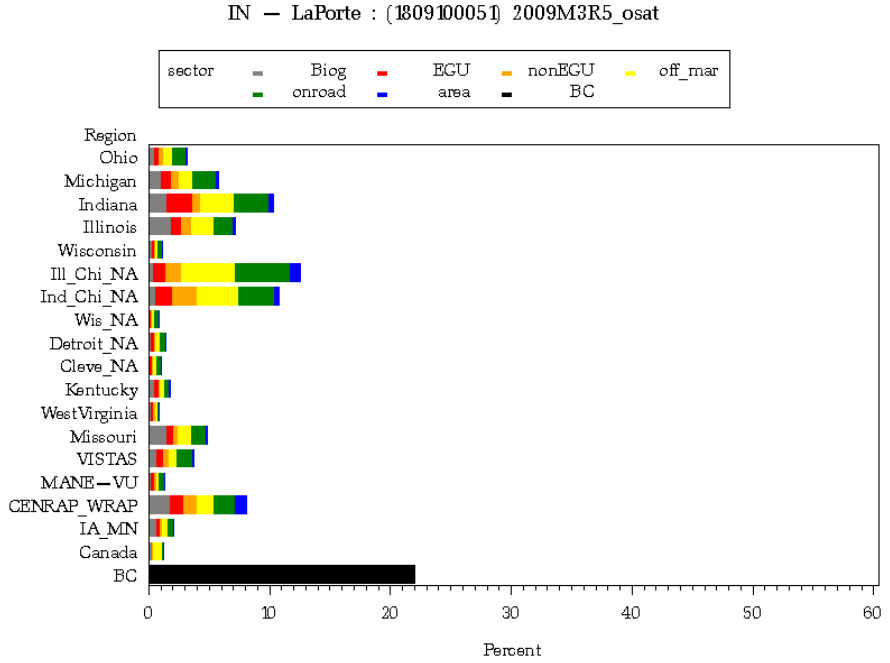

MI — Allegan : (2600500031) 2009M3R5_osat
contrib NOX VOC BC
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector

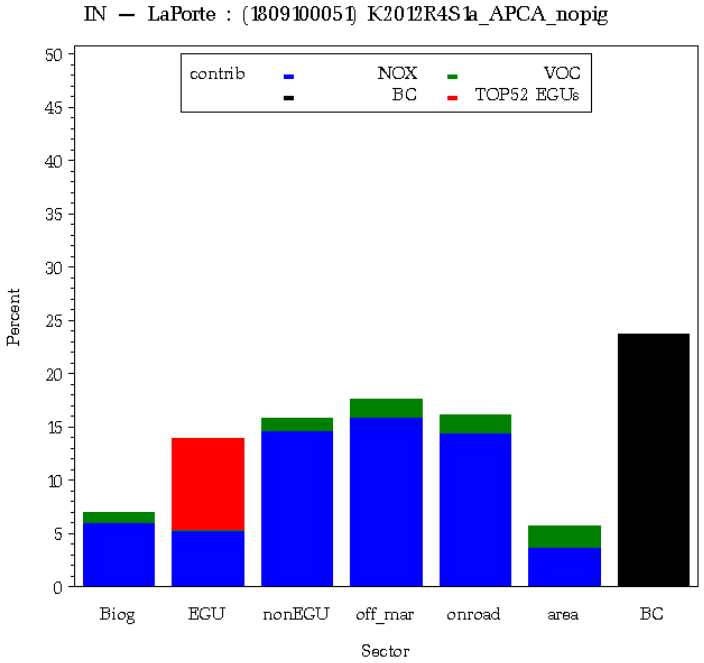

MI — Allegan : (2600500031) 2009M3R5_osat
sector Biog EGU nonEGU off_mar onroad area BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

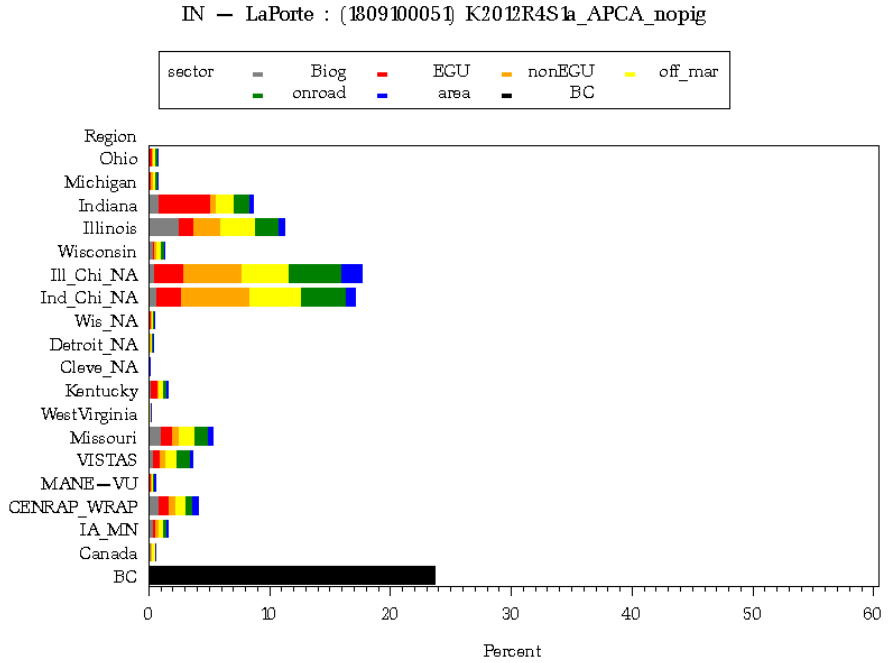

MI — Allegan : (2600500031) K2012R4S1a_APCA_nopig
contrib NOX VOC BC TOP52 EGUs
Percent
Biog EGU nonEGU off_mar onroad area BC
Sector


MI — Allegan : (2600500031) 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
Percent


IN — LaPorte : (180910005 1) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


IN — LaPorte : (180910005 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
Percent


IN — LaPorte : (180910005 1) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


IN — LaPorte : (180910005 1) 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
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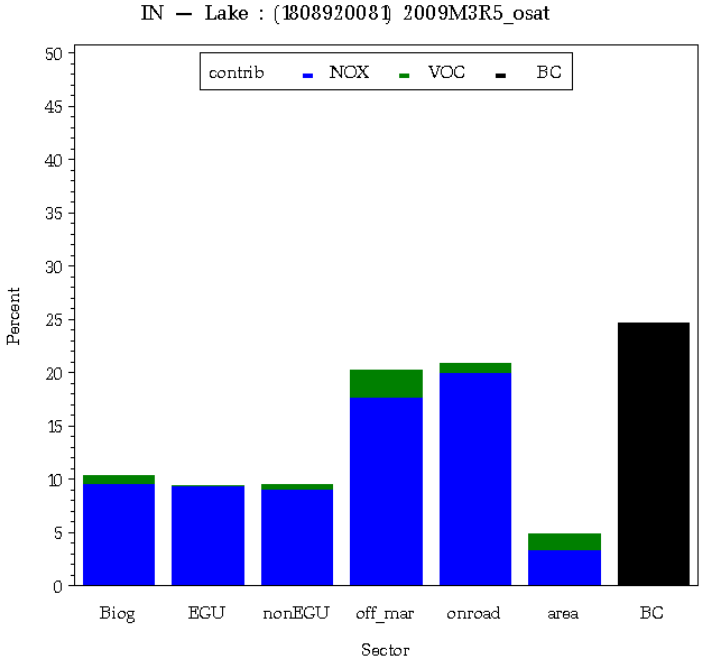
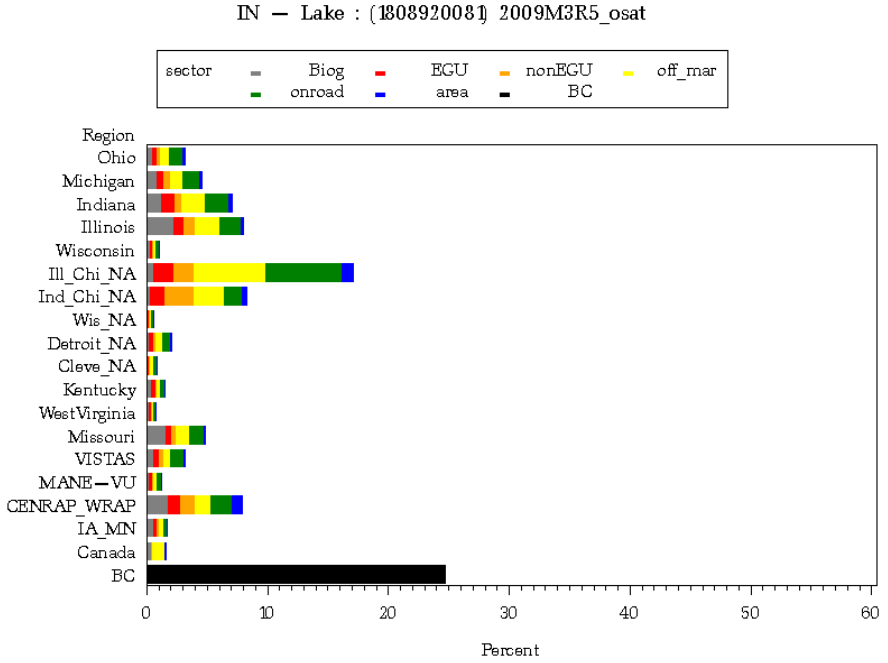
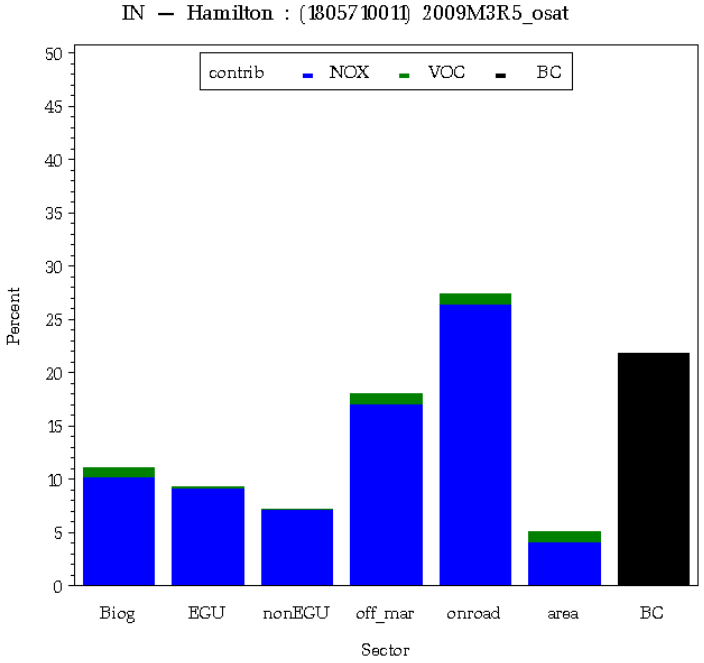
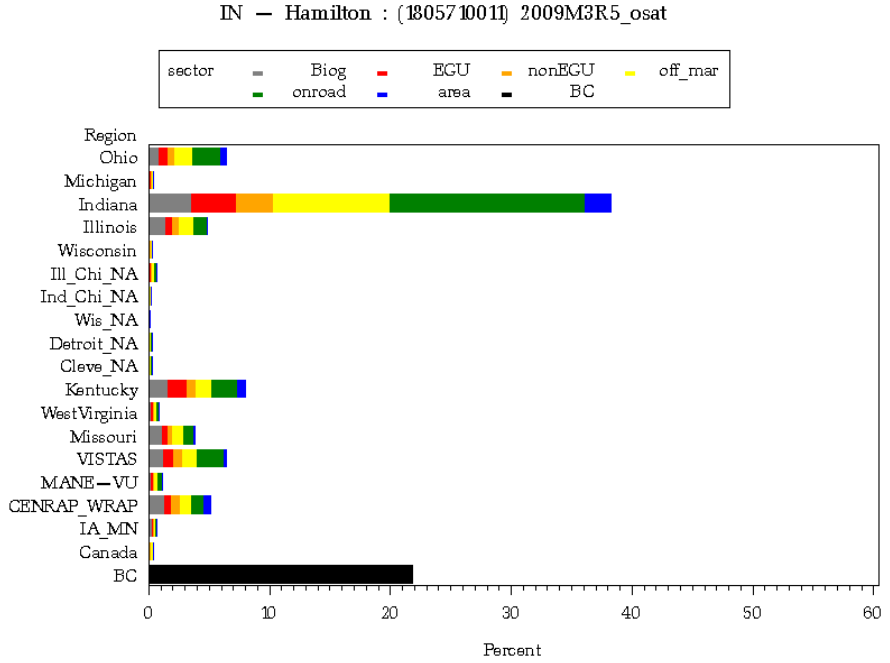
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


IN — Lake : (1808920081) 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 : (1808920081) 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 : (180571011) 2009M3R5_osat
contrib
NOX
VOC
BC
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector


IN — Hamilton : (180571011) 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
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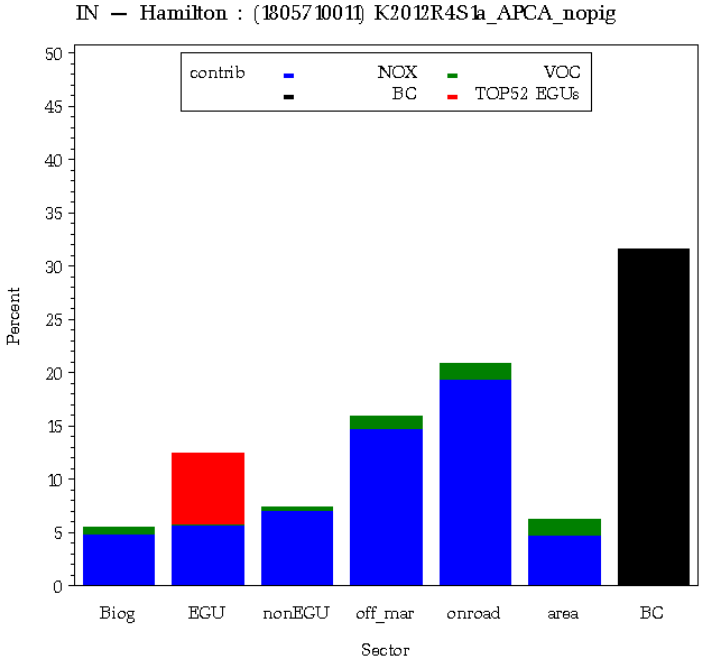
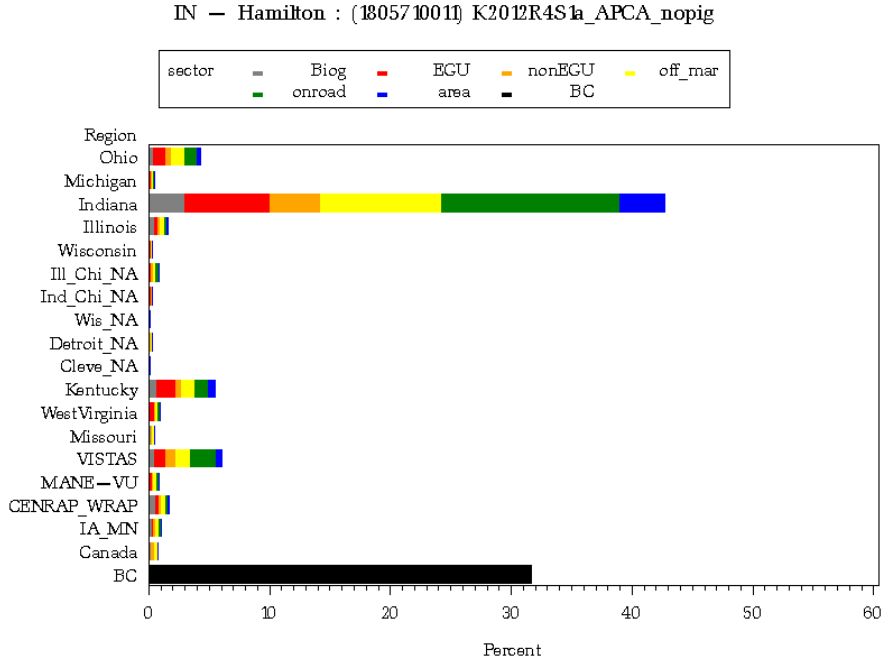
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent


IN — Hamilton : (180571011) K2012R4S1a_APCA_nopig
contrib
NOX
VOC
BC
TOP52 EGUs
Percent
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Sector

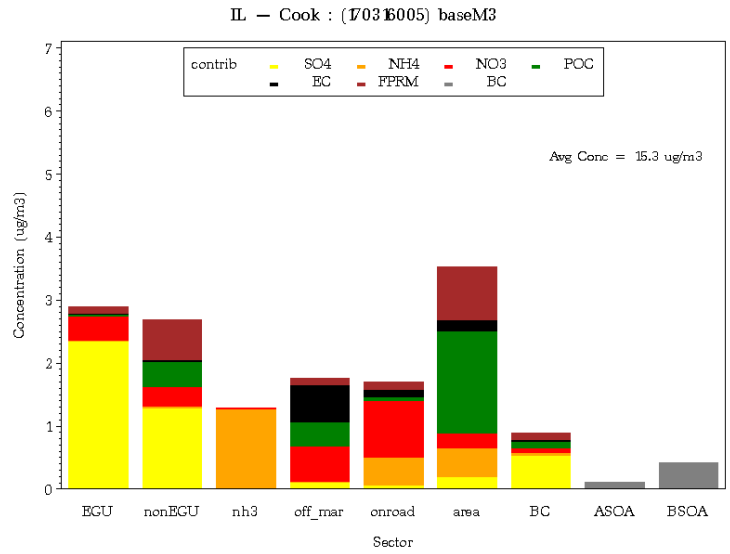

IN — Hamilton : (180571011) K2012R4S1a_APCA_nopig
sector
Biog
EGU
nonEGU
off_mar
onroad
area
BC
Region
Ohio
Michigan
Indiana
Illinois
Wisconsin
Ill_Chi_NA
Ind_Chi_NA
Wis_NA
Detroit_NA
Cleve_NA
Kentucky
WestVirginia
Missouri
VISTAS
MANE—VU
CENRAP_WRAP
IA_MN
Canada
BC
Percent

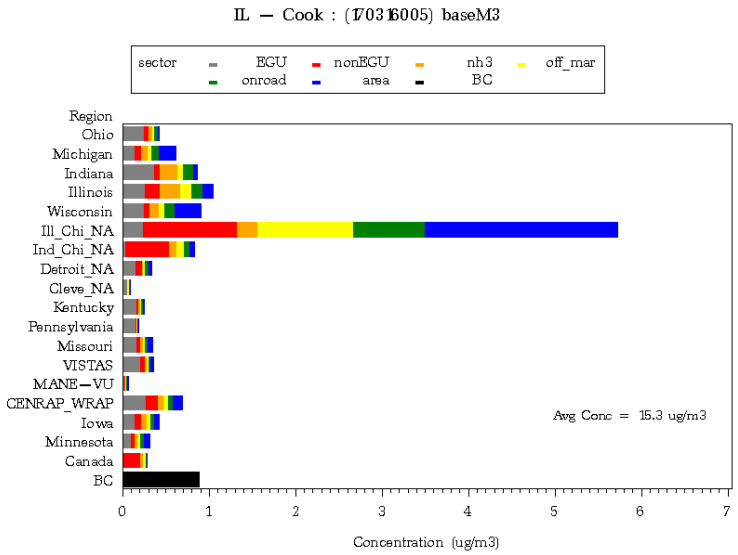
APPENDIX III

$PM_{2.5}$ Source Apportionment Modeling Results

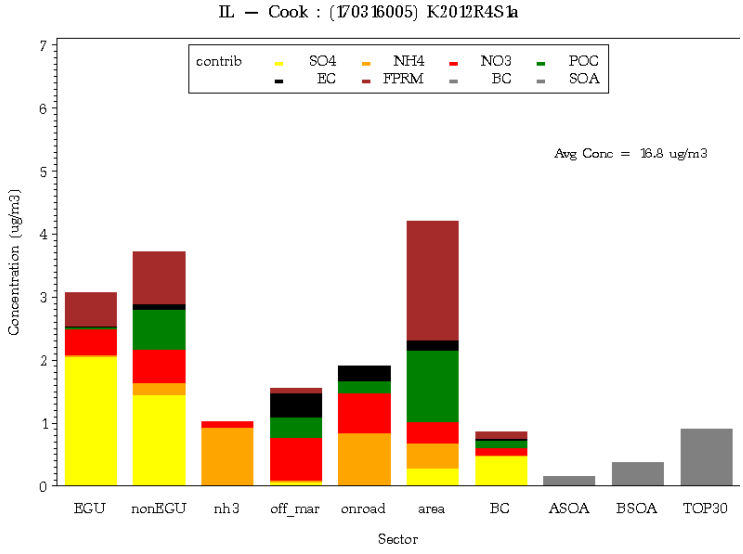
Chicago (Cicero), Illinois

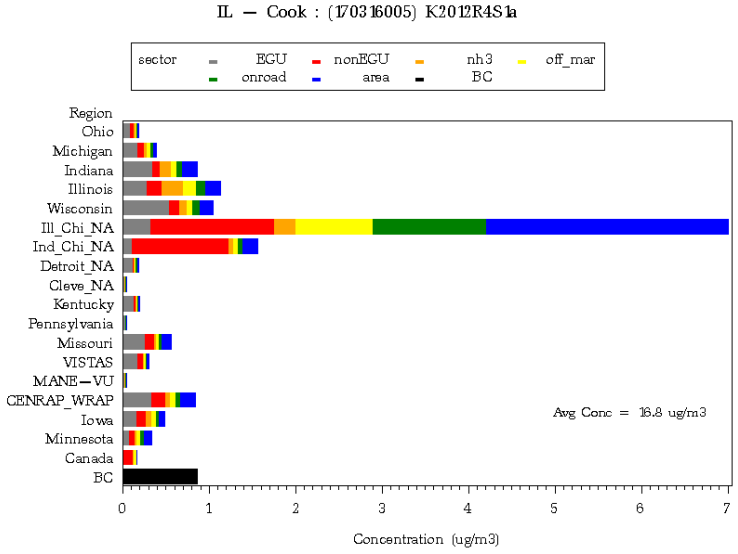
2005 (Round 5)



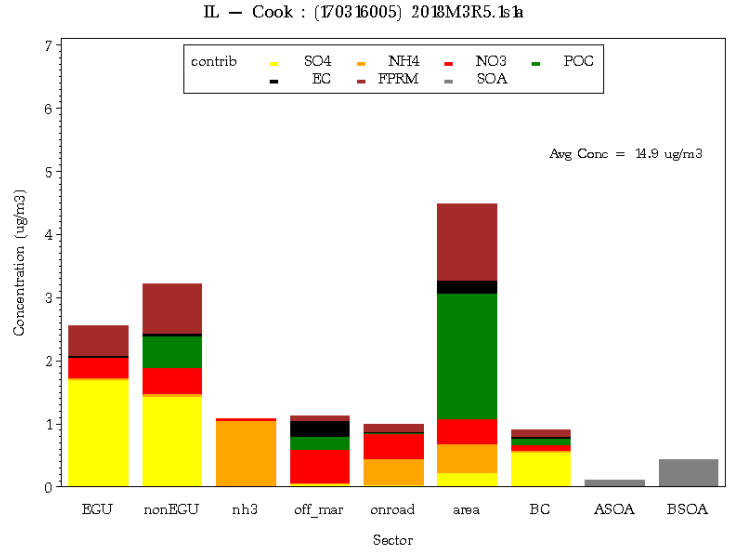


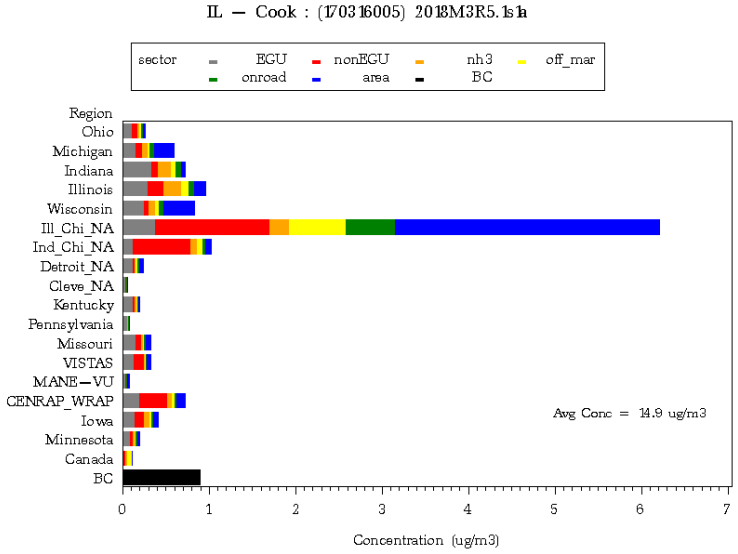
2012 (Round 4)





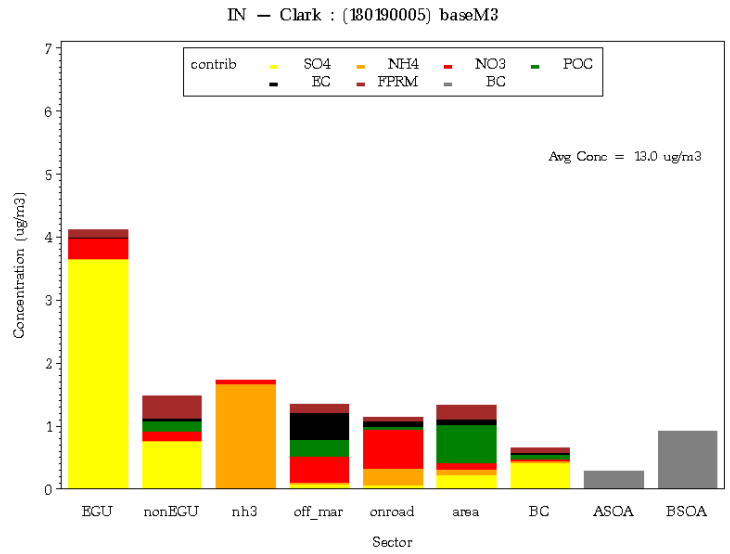
2018 (Round 5)

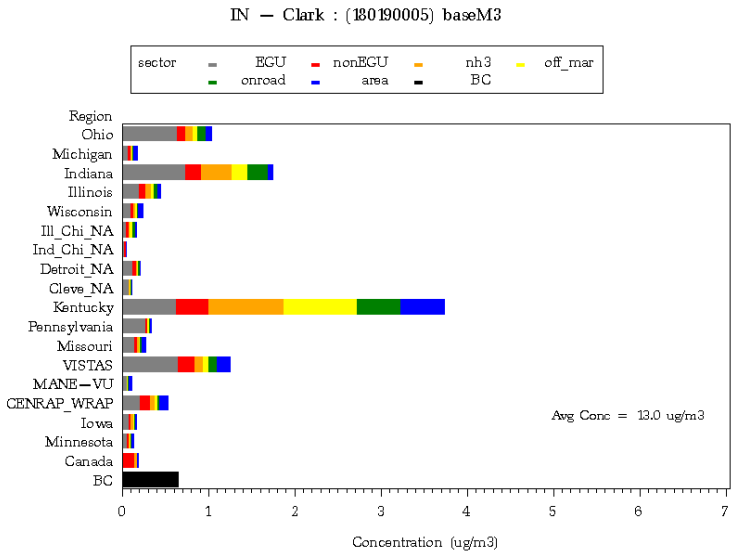




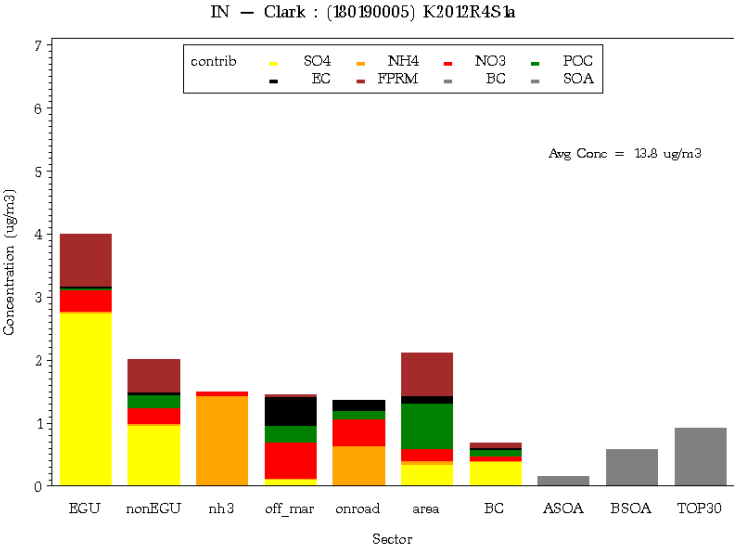
Clark County, Indiana

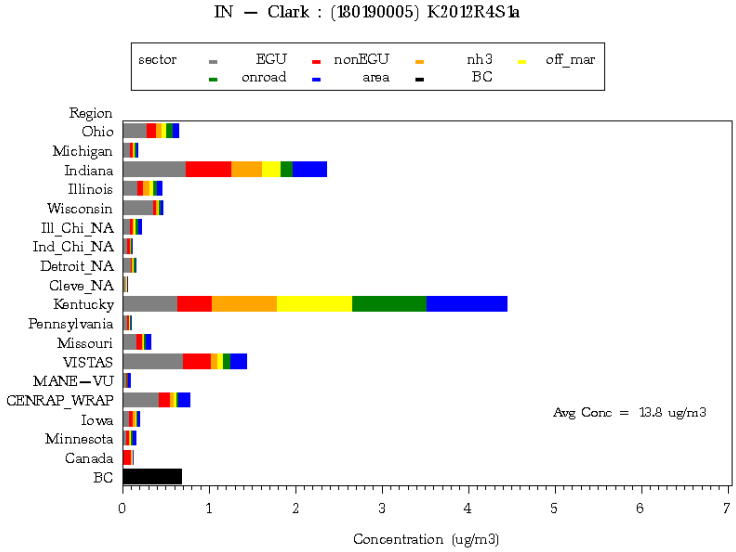
2005 (Round 5)



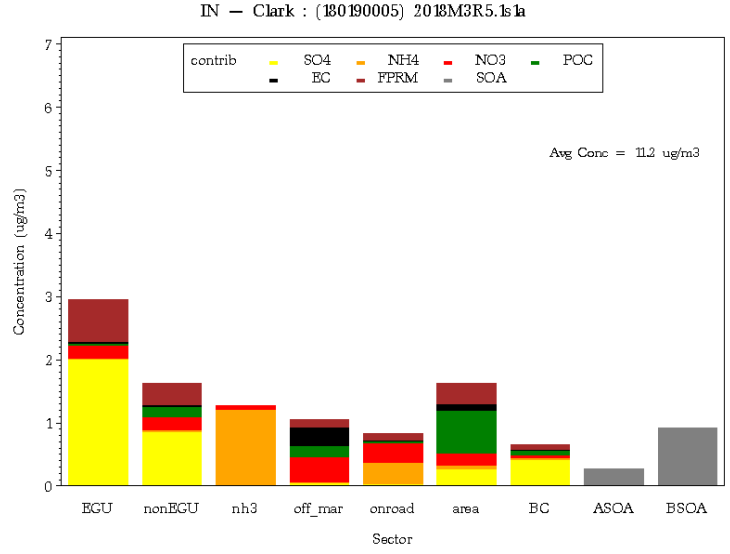


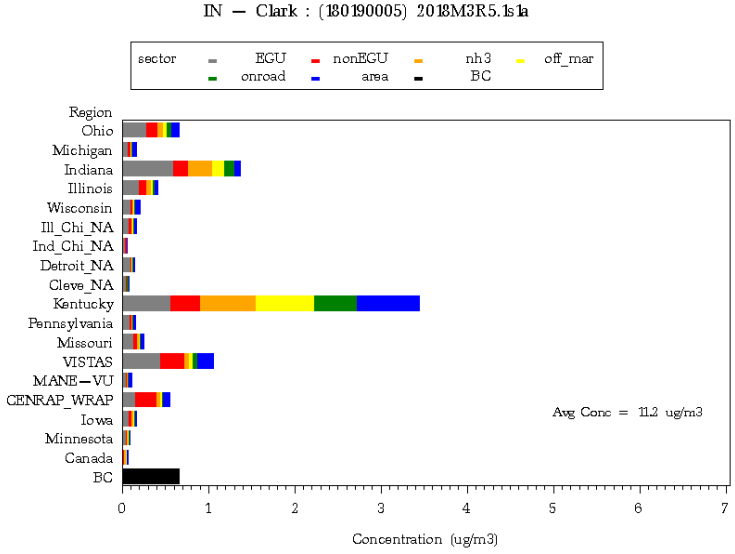
2012 (Round 4)





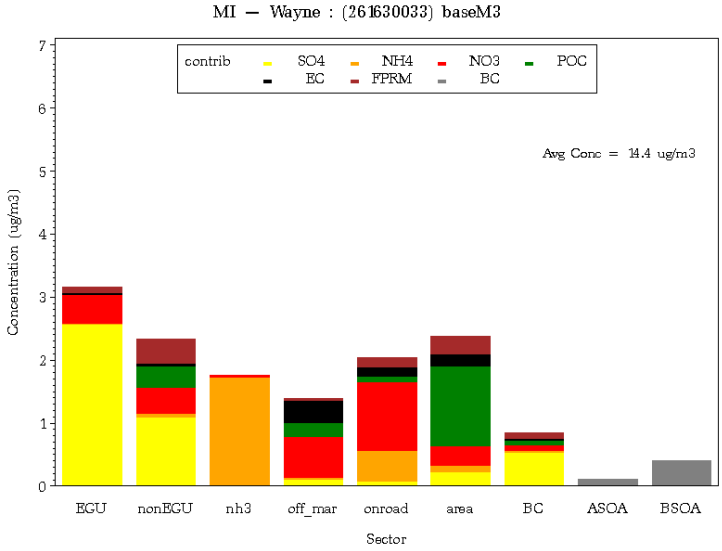
2018 (Round 5)

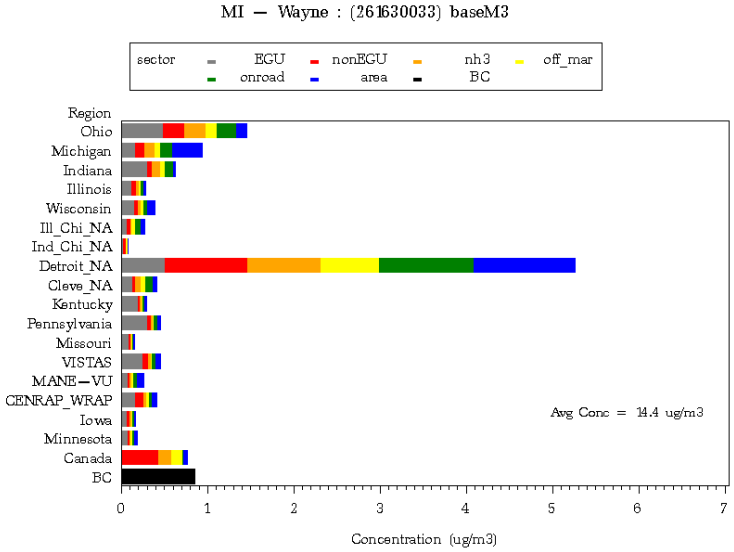




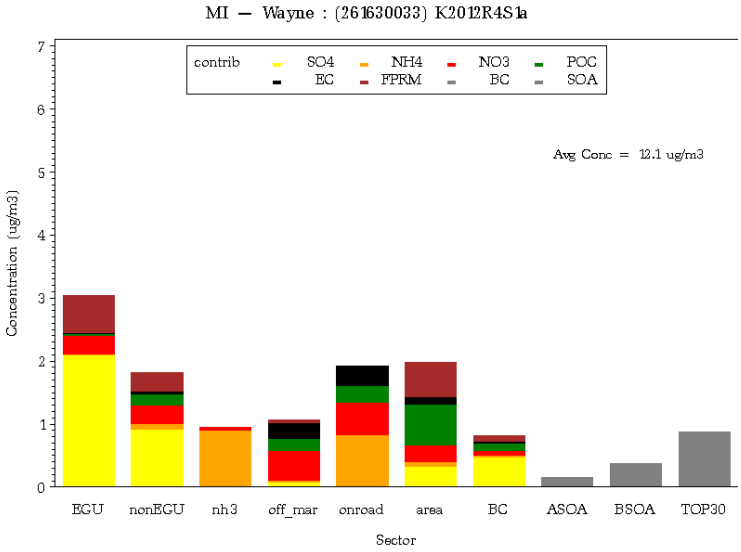
Dearborn, Michigan

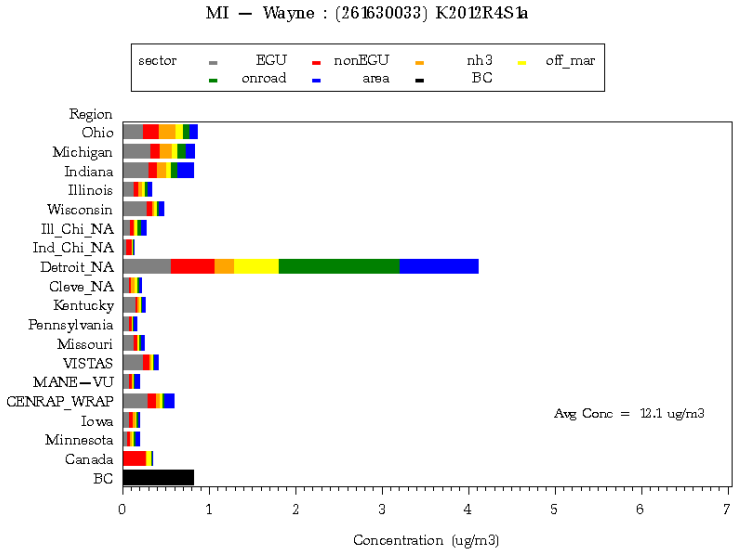
2005 (Round 5)



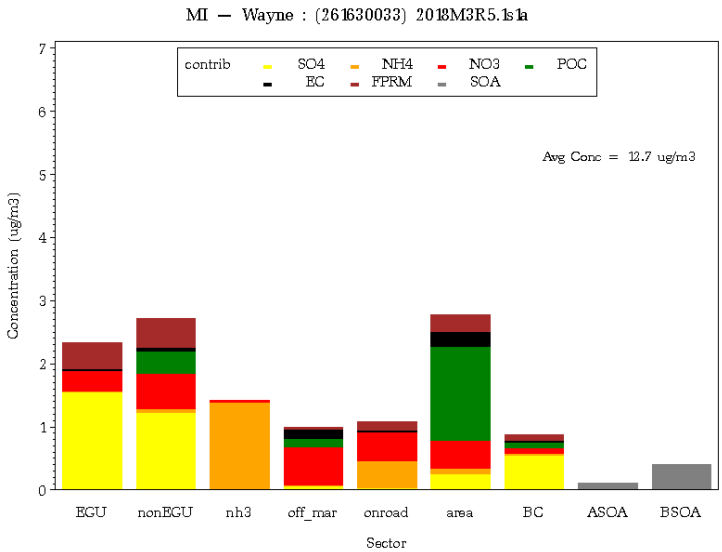


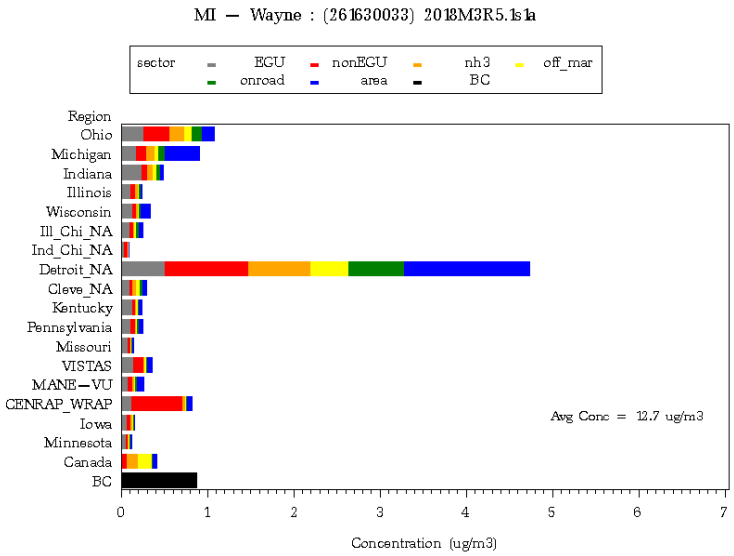
2012 (Round 4)





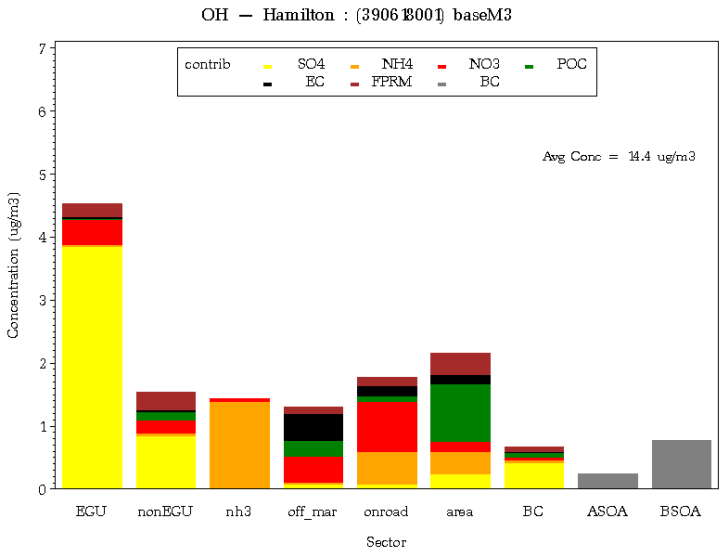
2018 (Round 5)

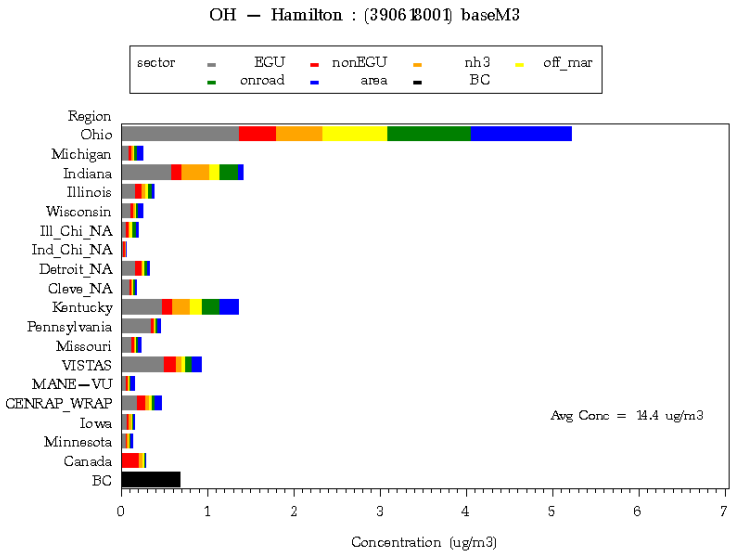




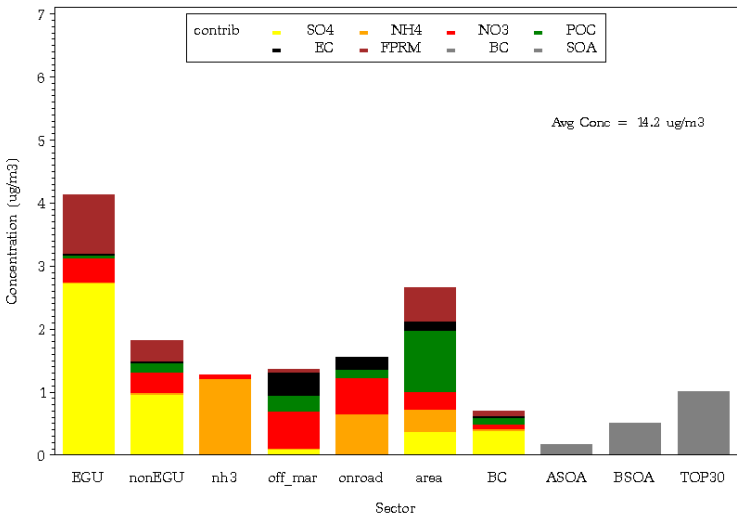
Cincinnati, Ohio

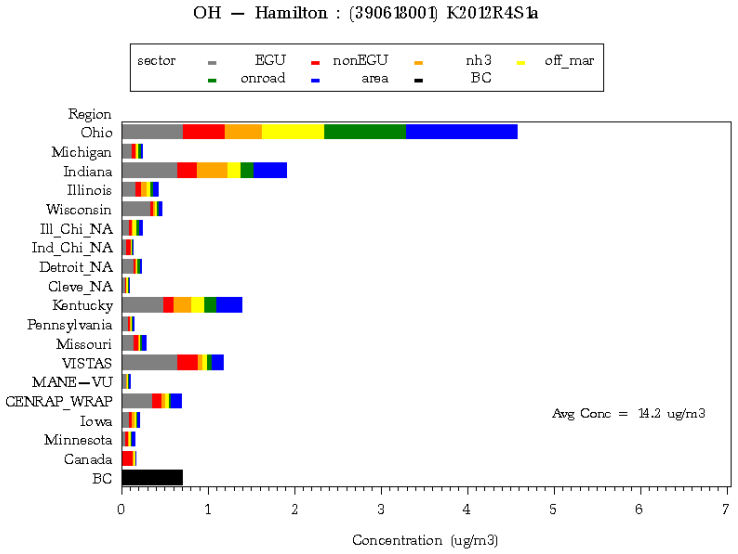
2005 (Round 5)



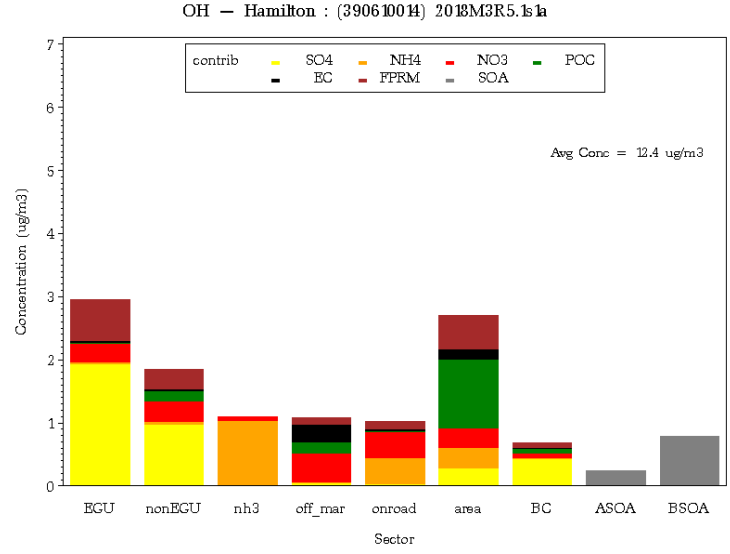


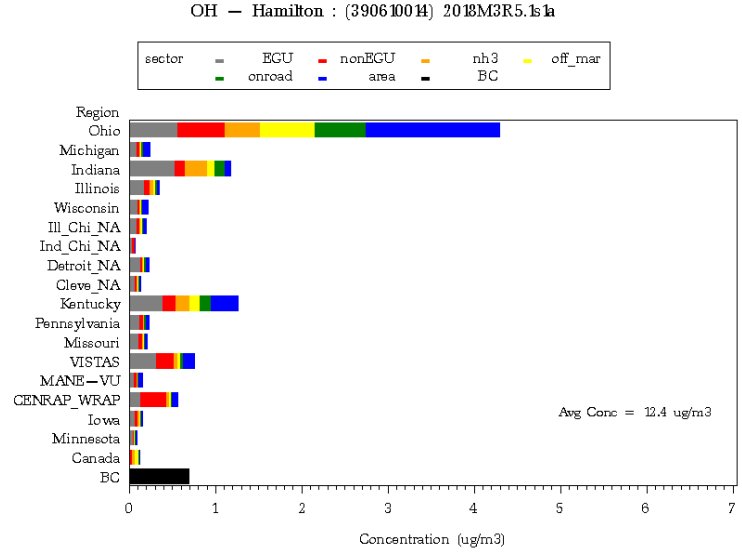
2012 (Round 4)





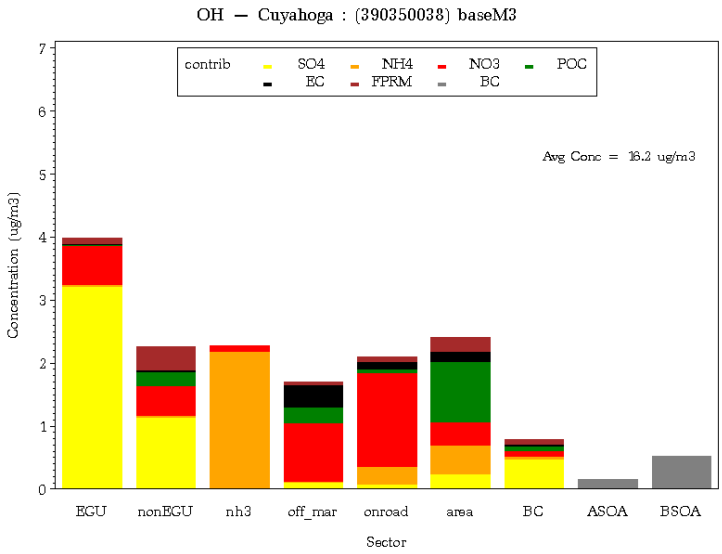
2018 (Round 5)

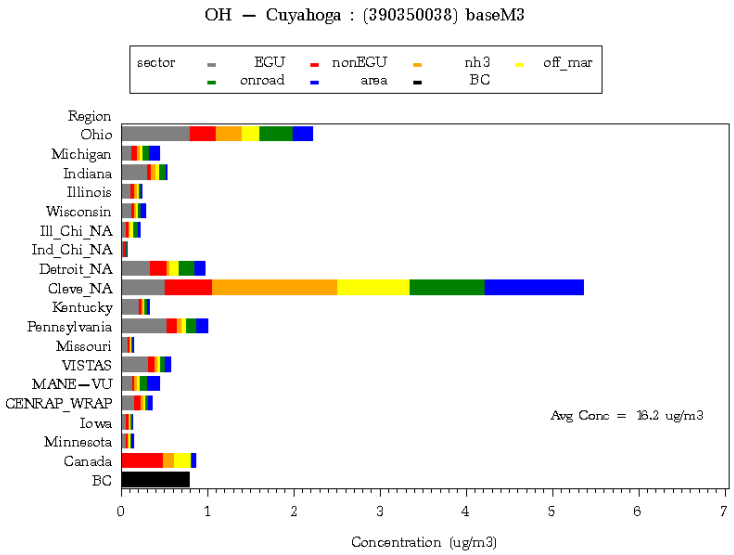




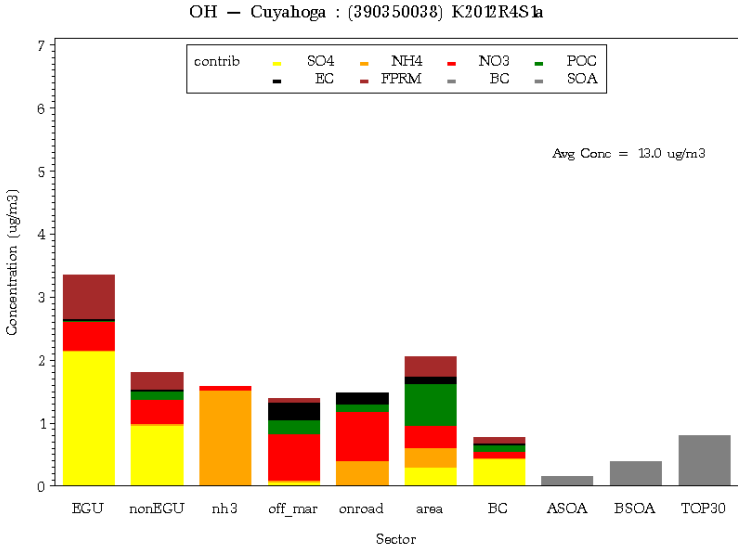
Cleveland, Ohio

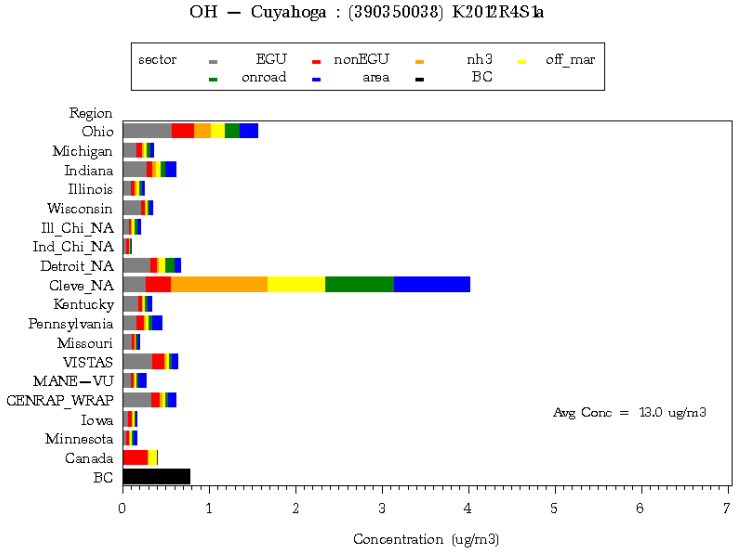
2005 (Round 5)



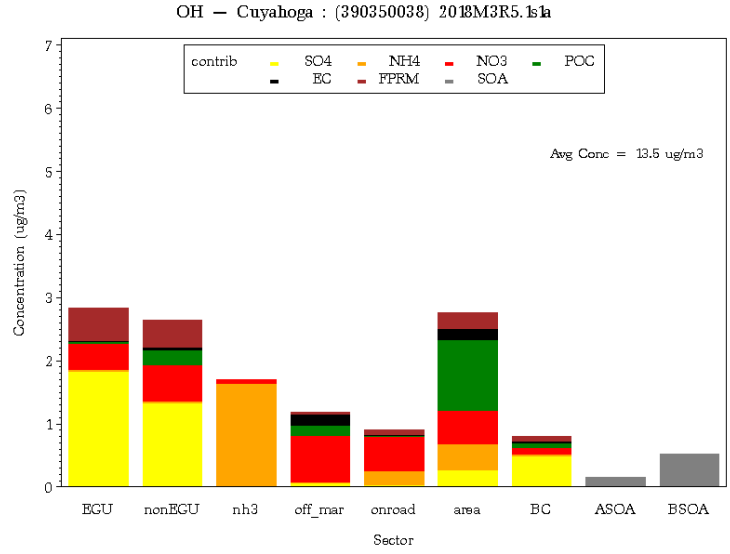


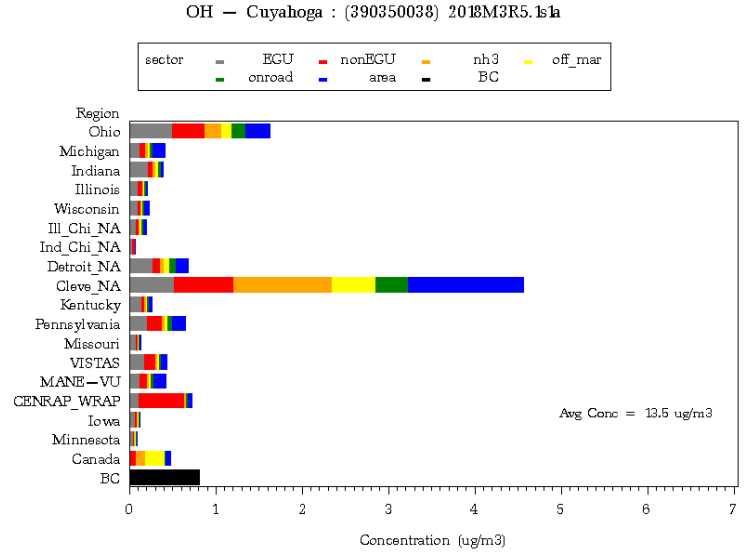
2012 (Round 4)





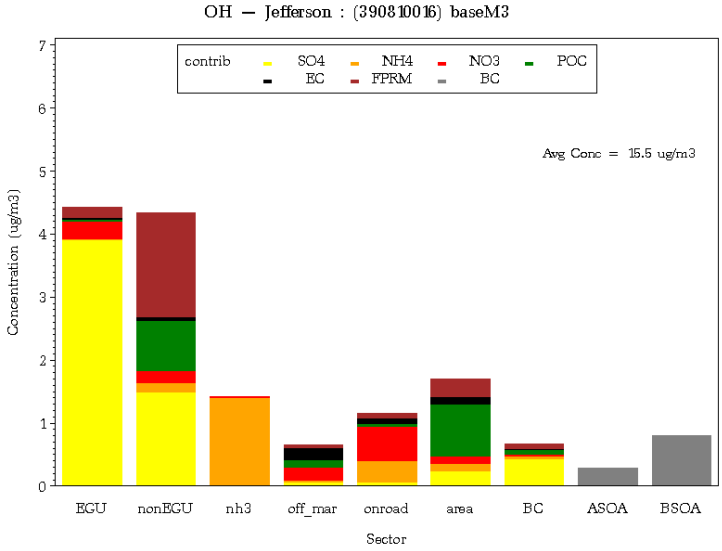
2018 (Round 5)

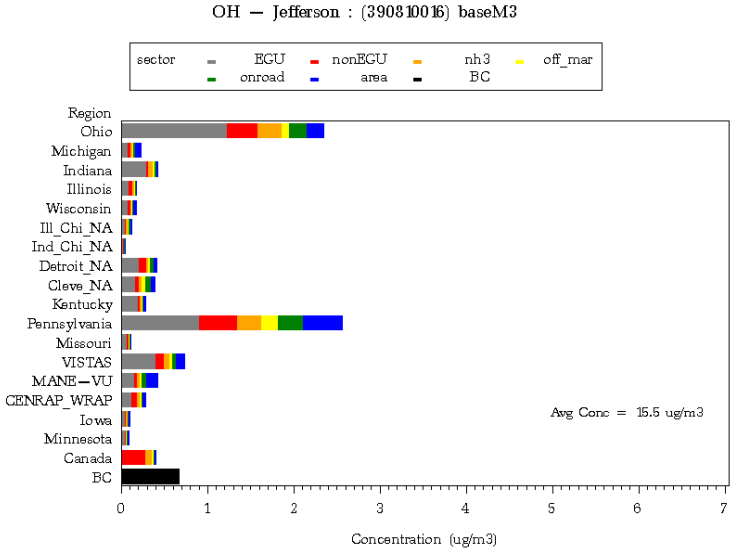




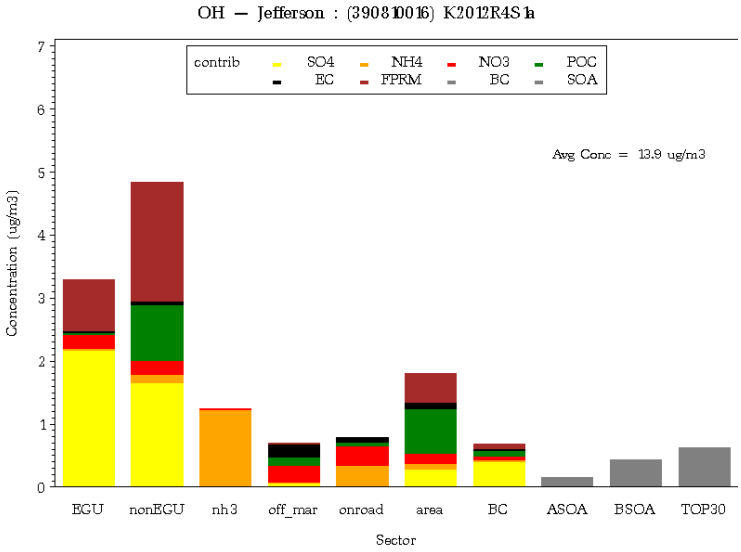
Steubenville, Ohio

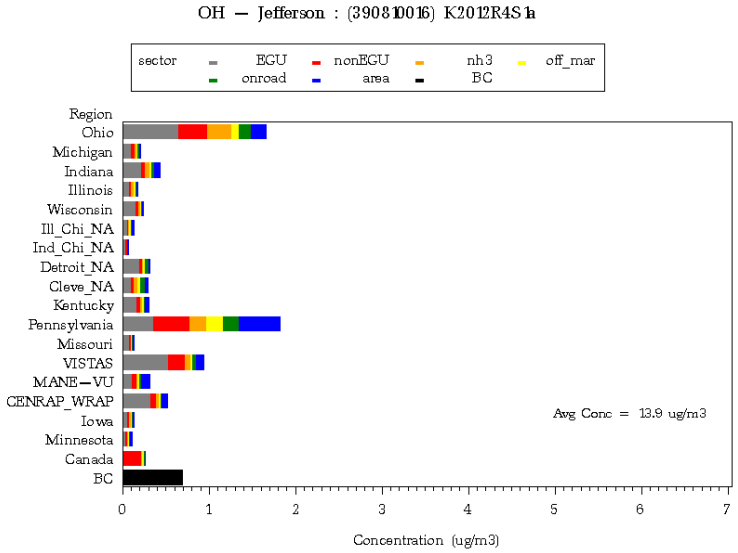
2005 (Round 5)



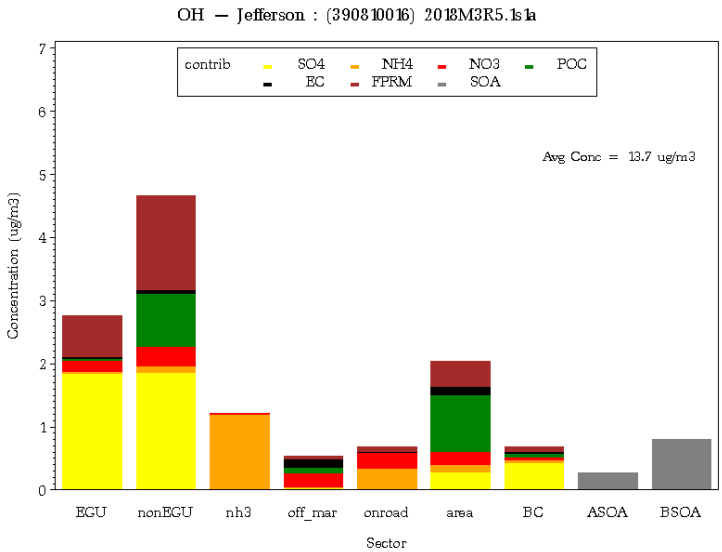


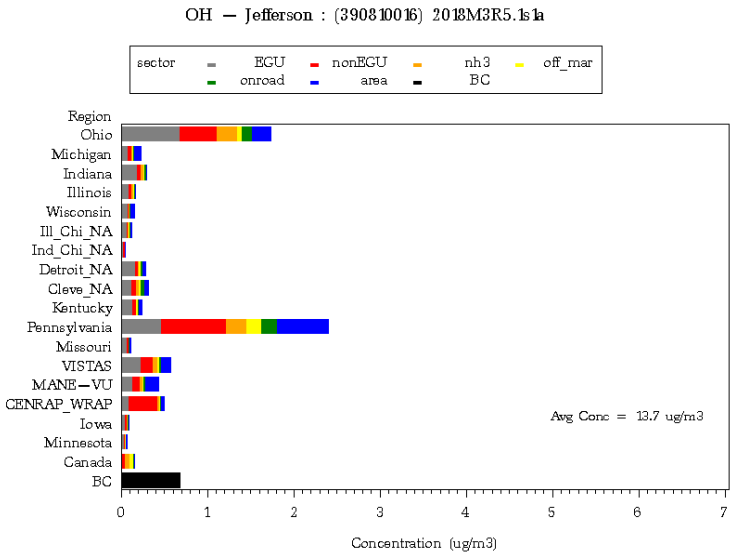
2012 (Round 4)





2018 (Round 5)



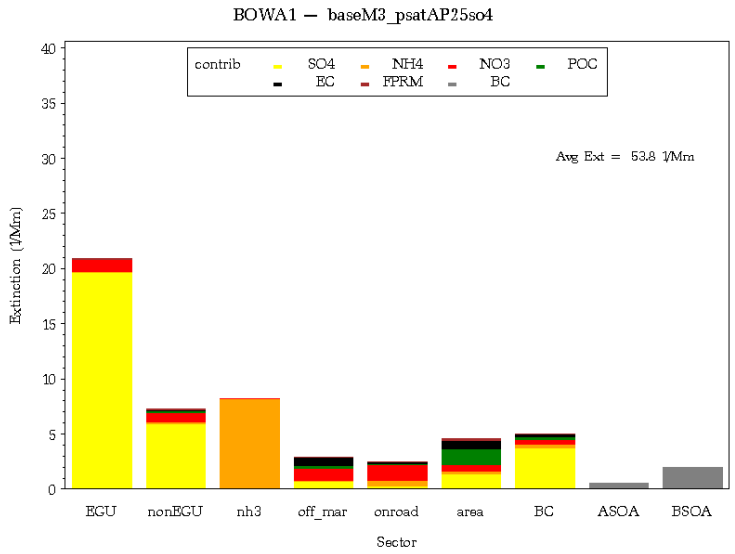


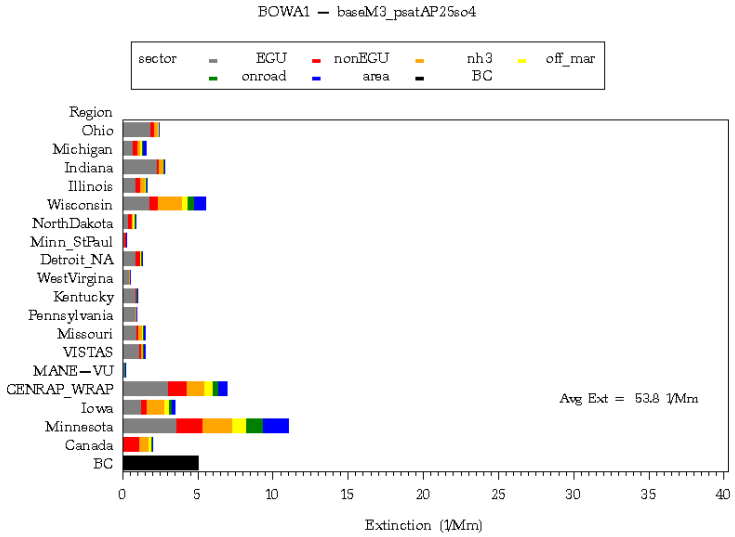
APPENDIX IV

Haze Source Apportionment Modeling Results

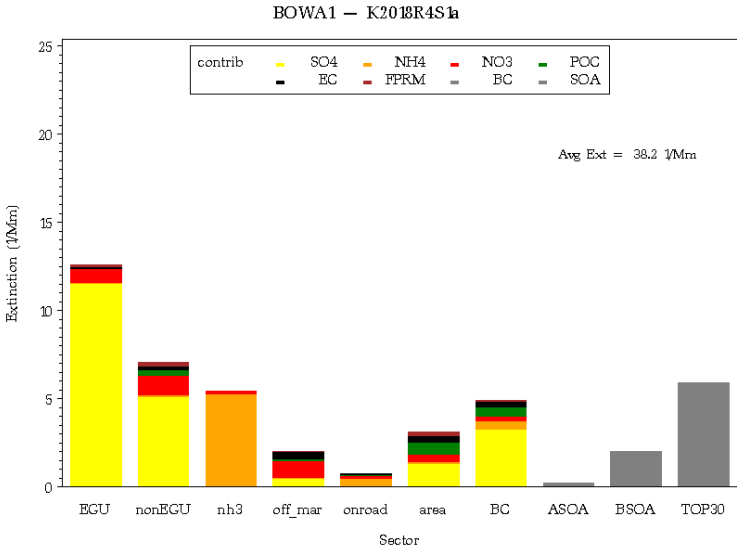
Boundary Waters, Minnesota

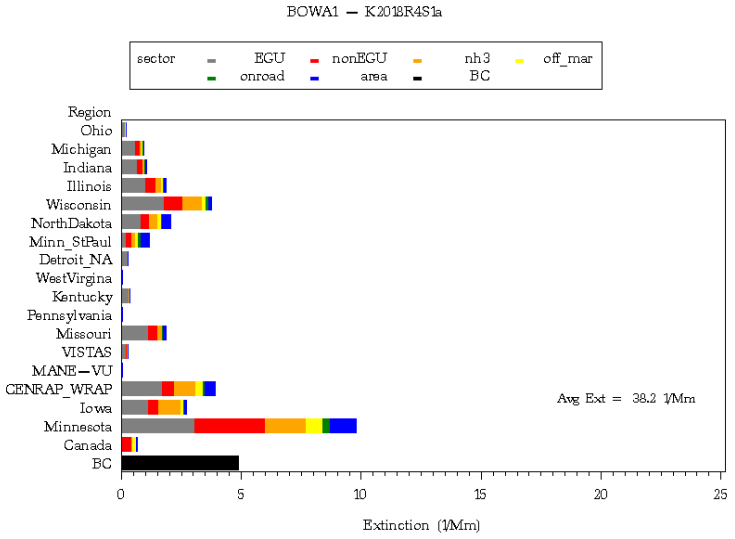
2005 (Round 5)



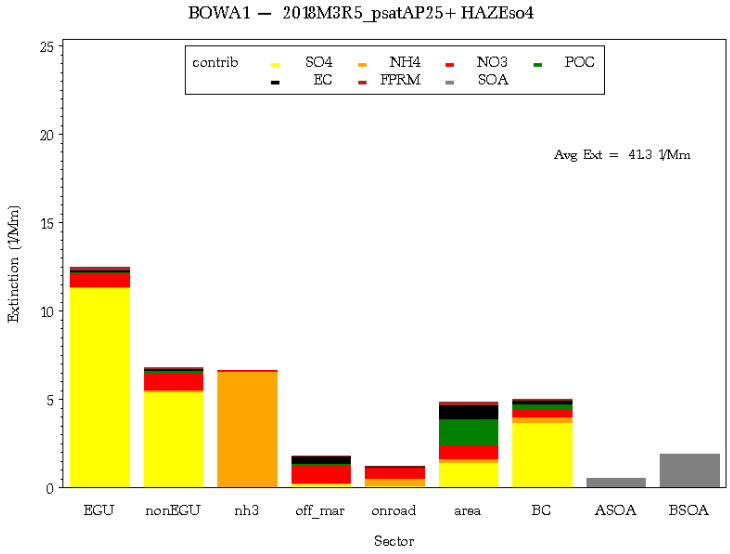


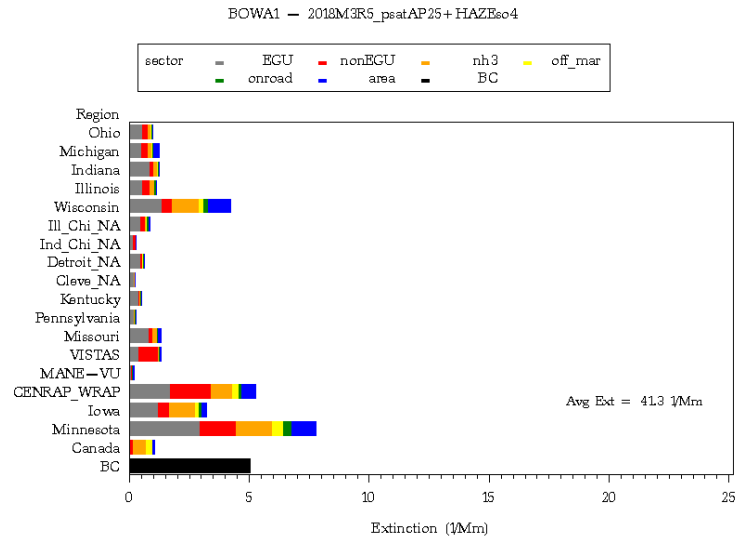
2018 (Round 4)





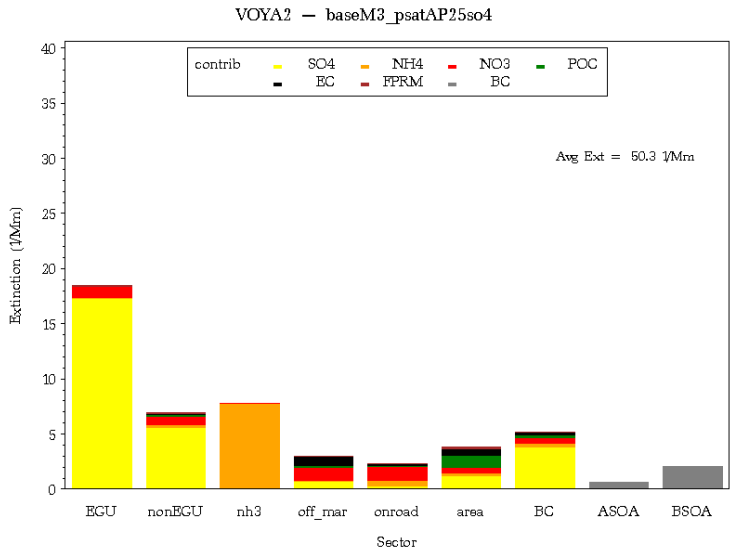
2018 (Round 5)

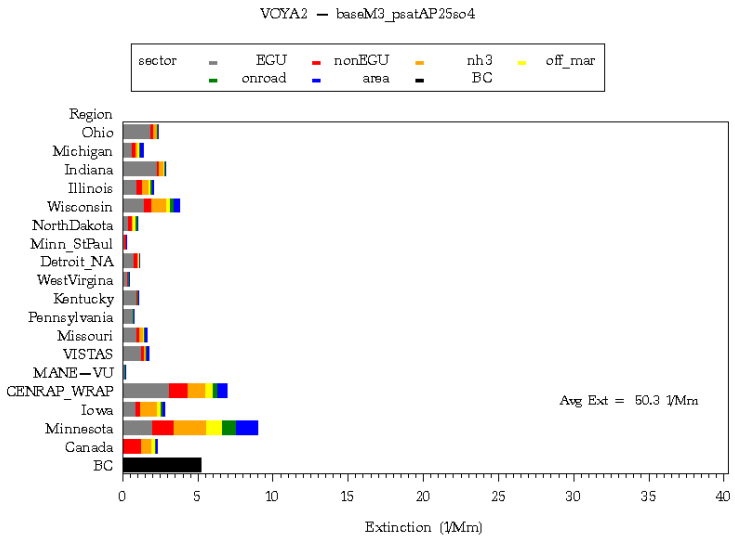




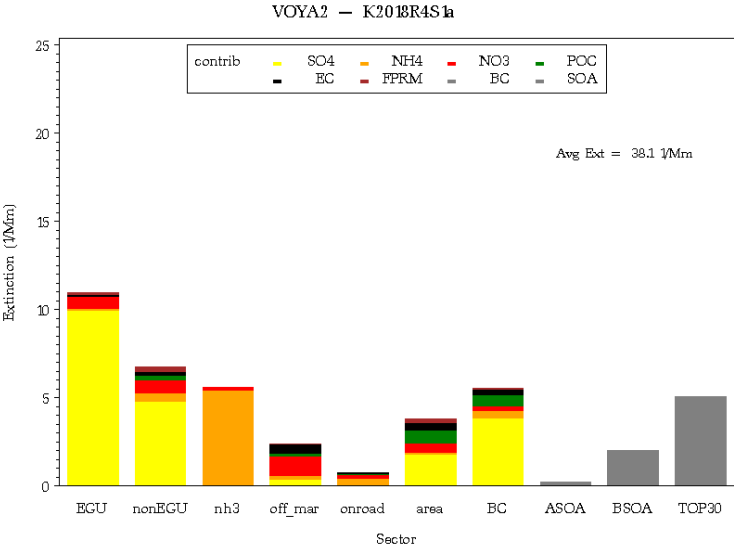
Voyageurs, Minnesota

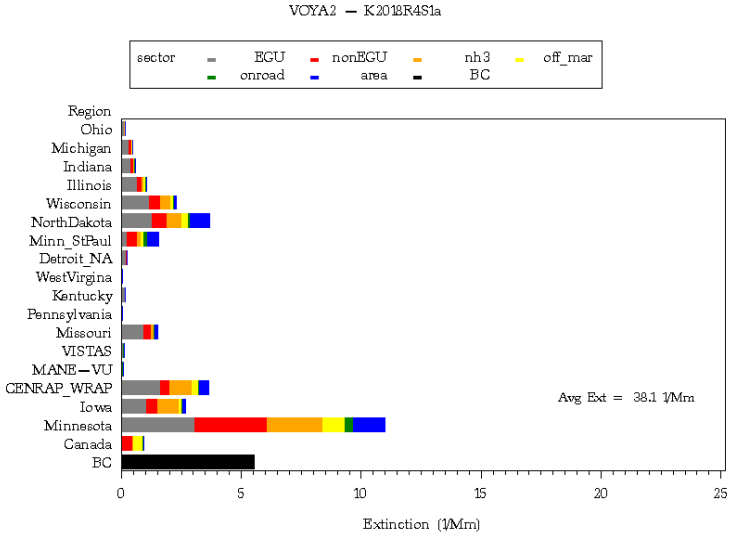
2005 (Round 5)



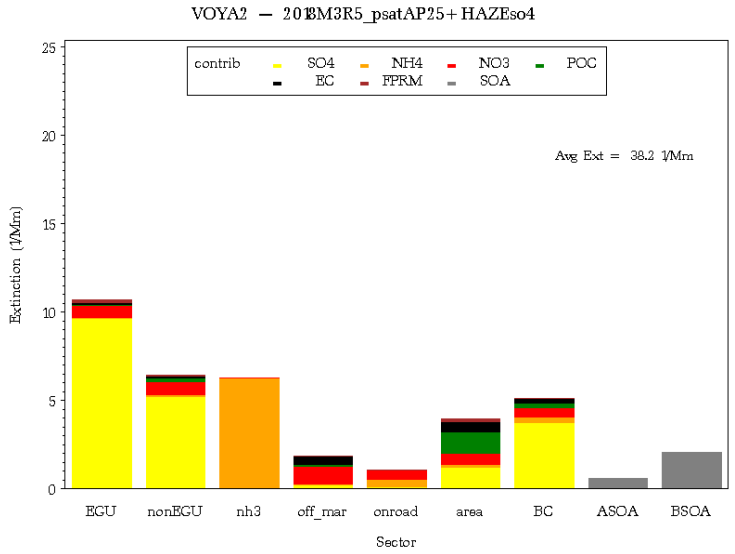


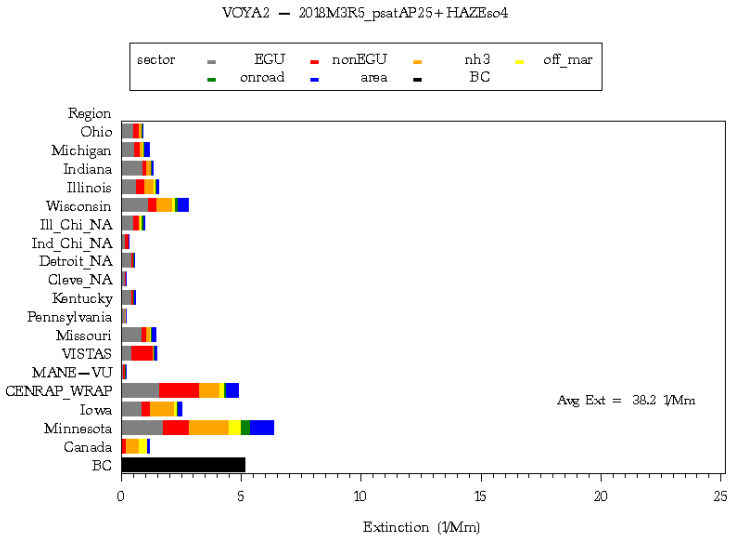
2018 (Round 4)





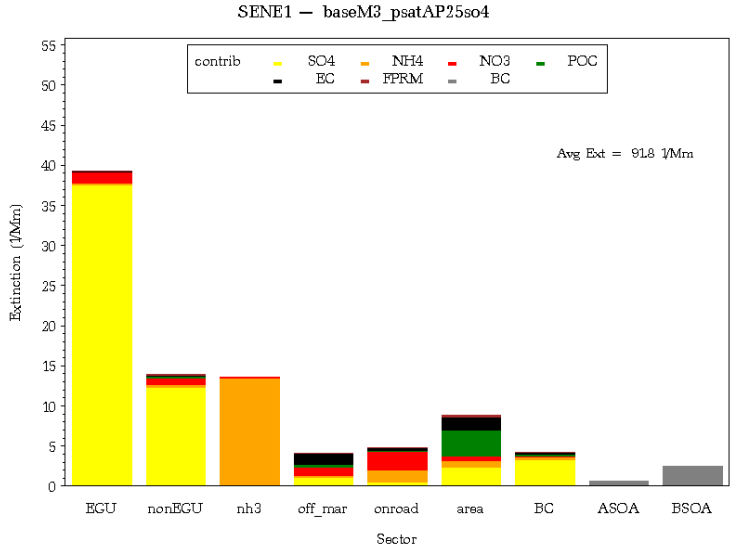
2018 (Round 5)

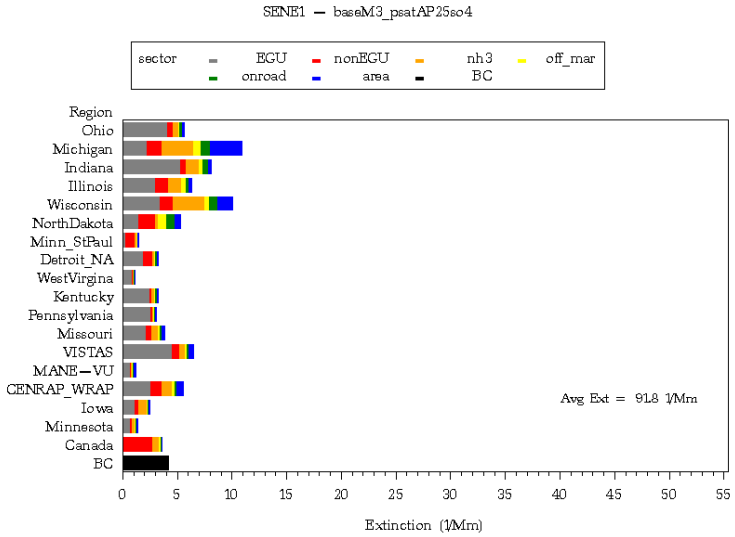




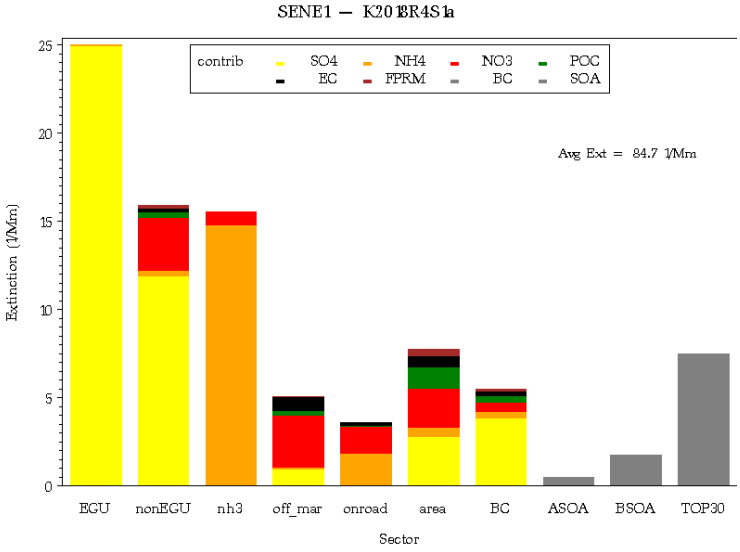
Seney, Michigan

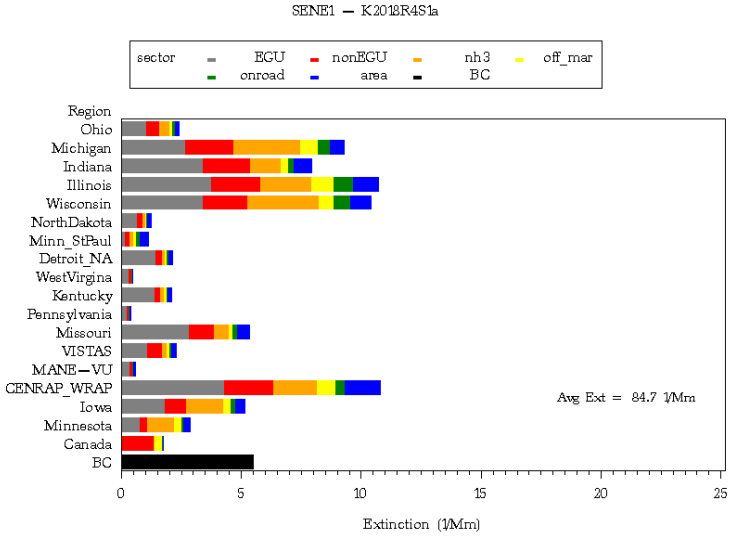
2005 (Round 5)



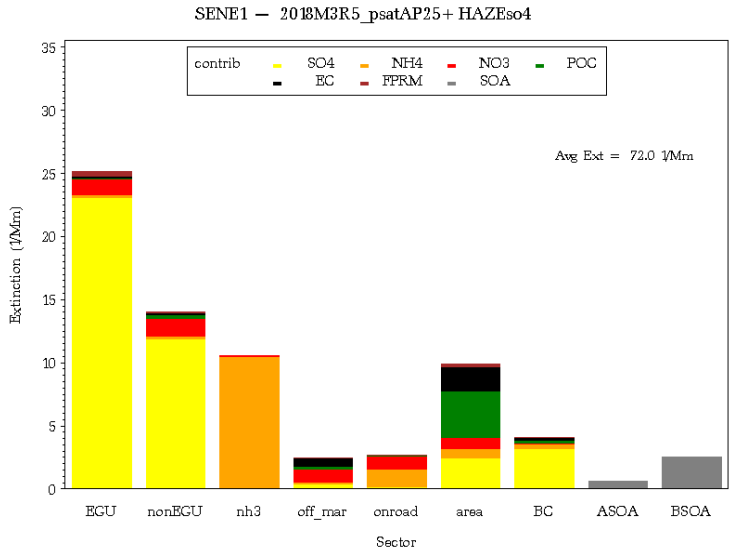


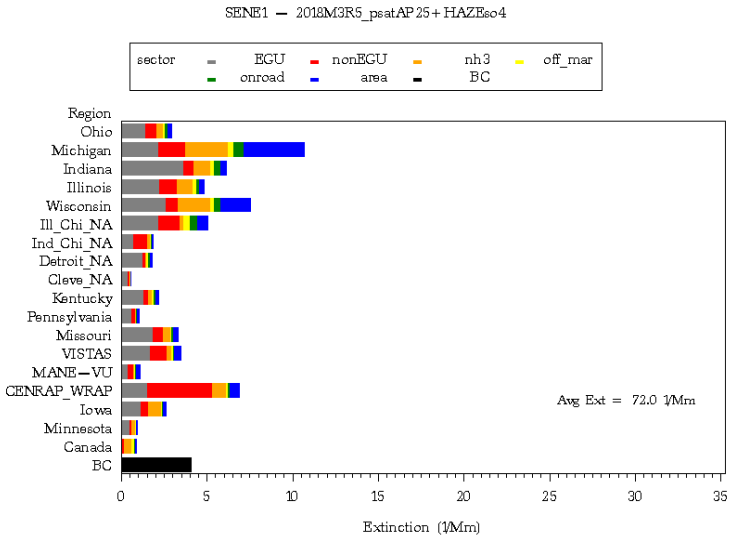
2018 (Round 4)





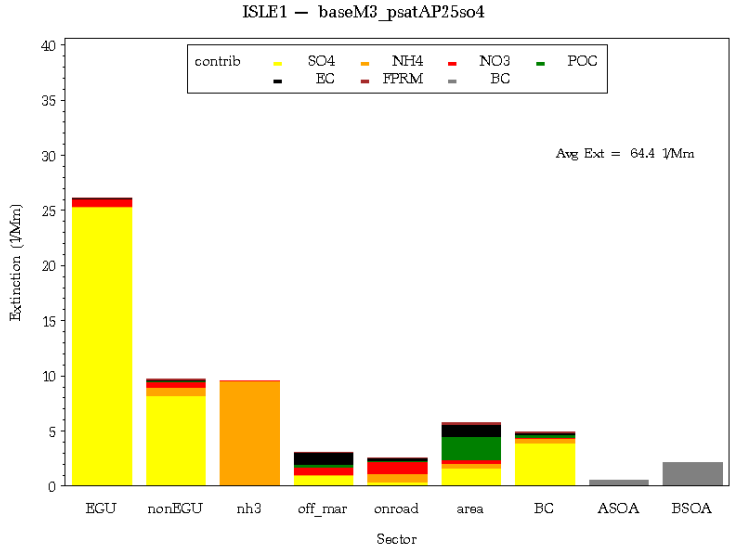
2018 (Round 5)

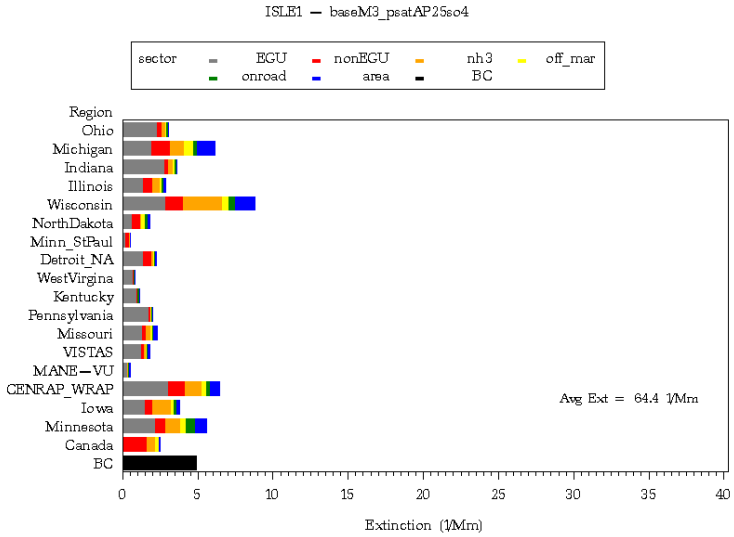




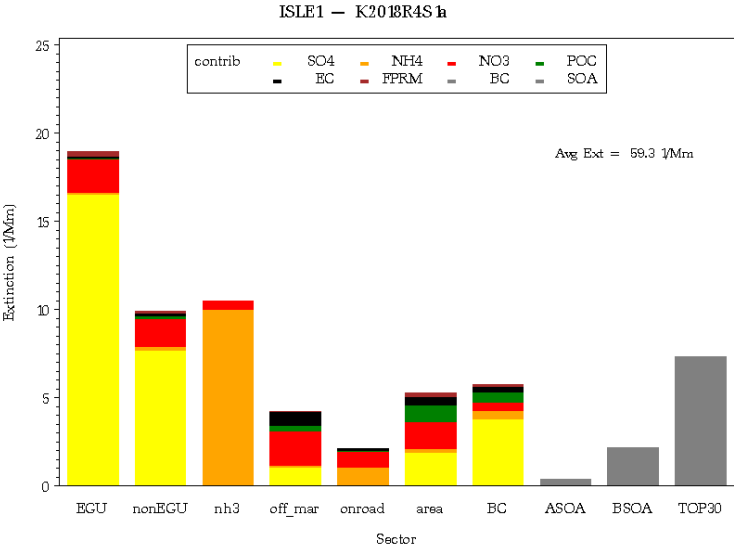
Isle Royale, Michigan

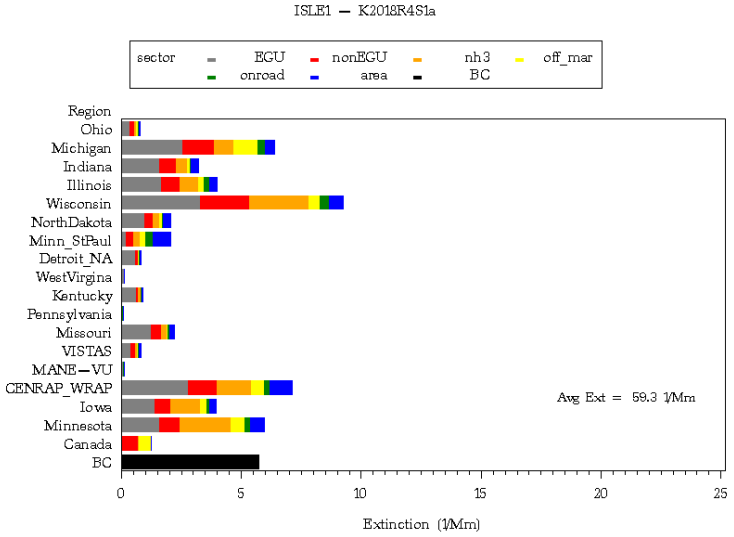
2005 (Round 5)





2018 (Round 4)





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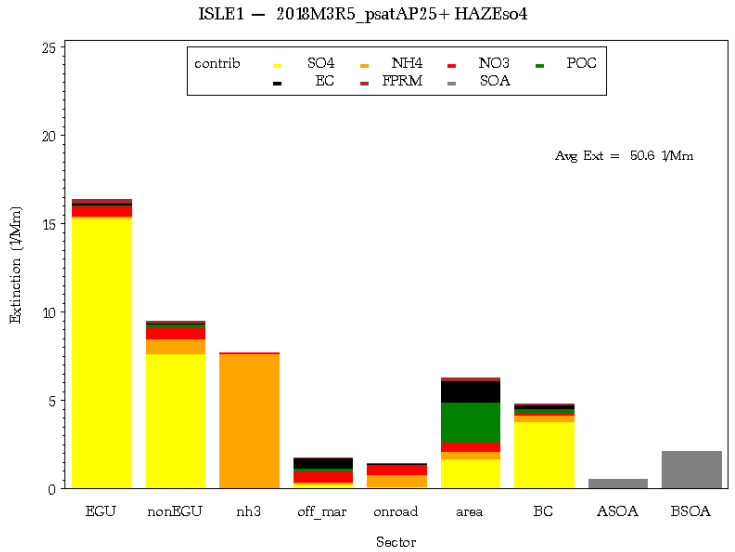
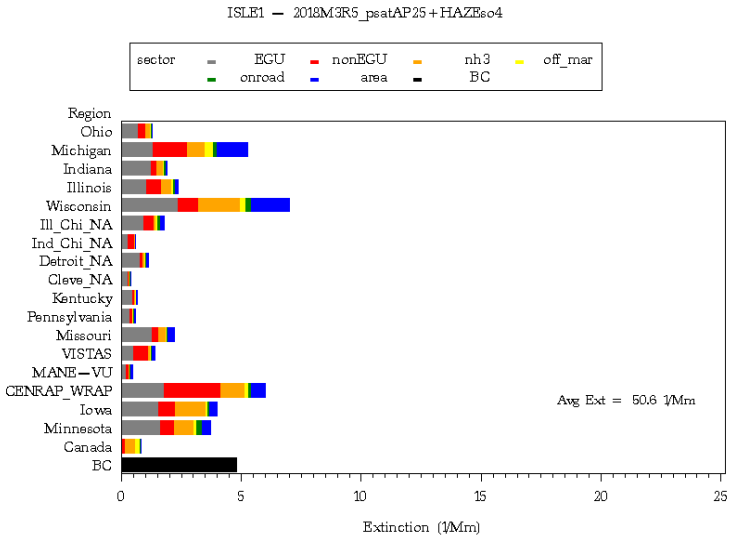
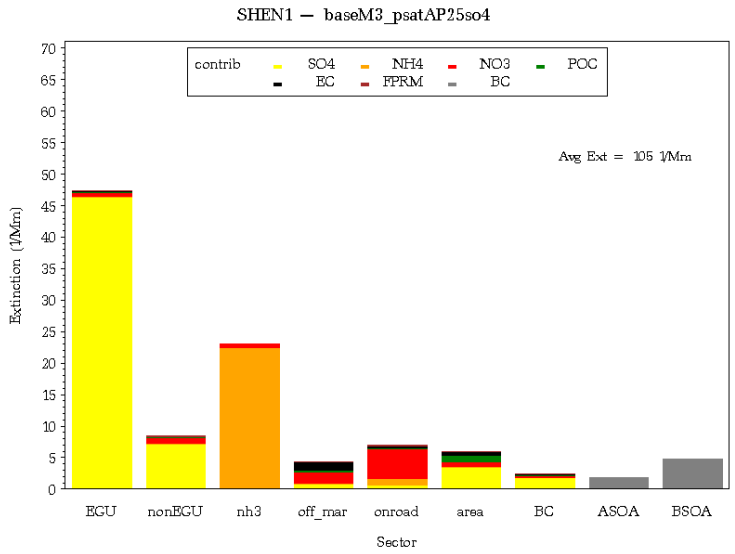
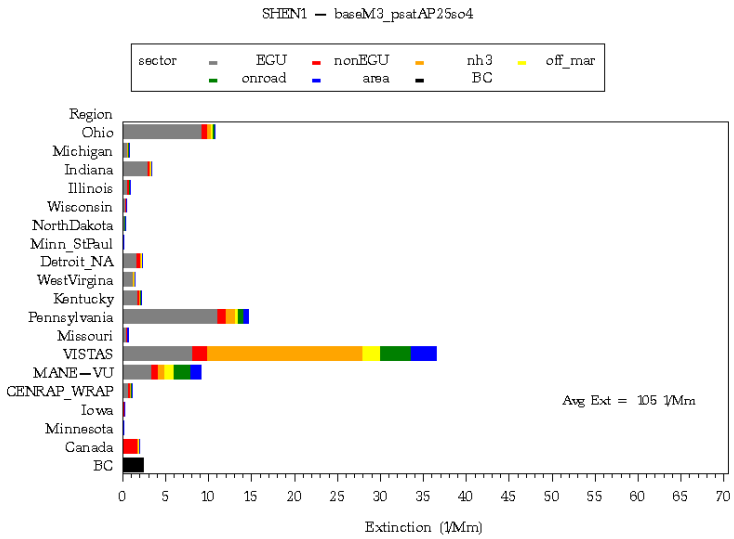




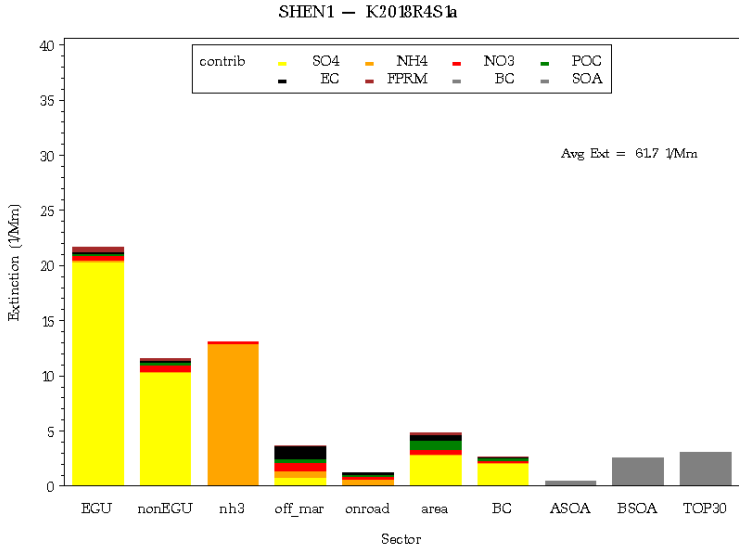
Shenandoah, Virginia

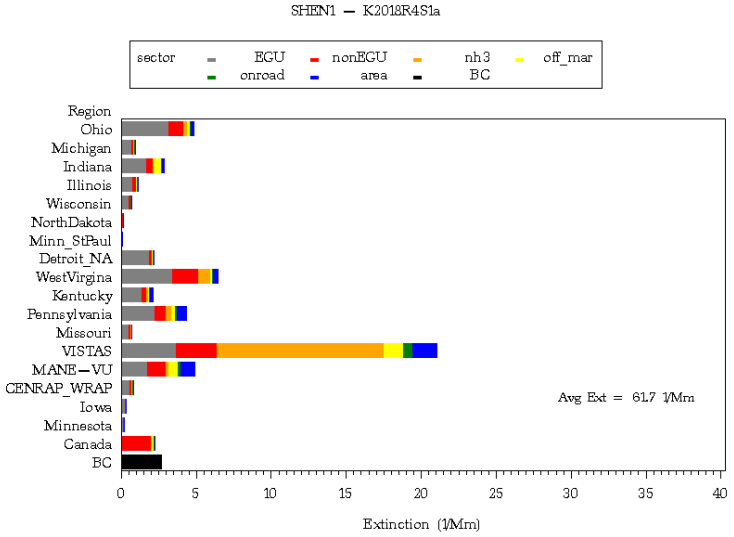
2005 (Round 5)





2018 (Round 4)





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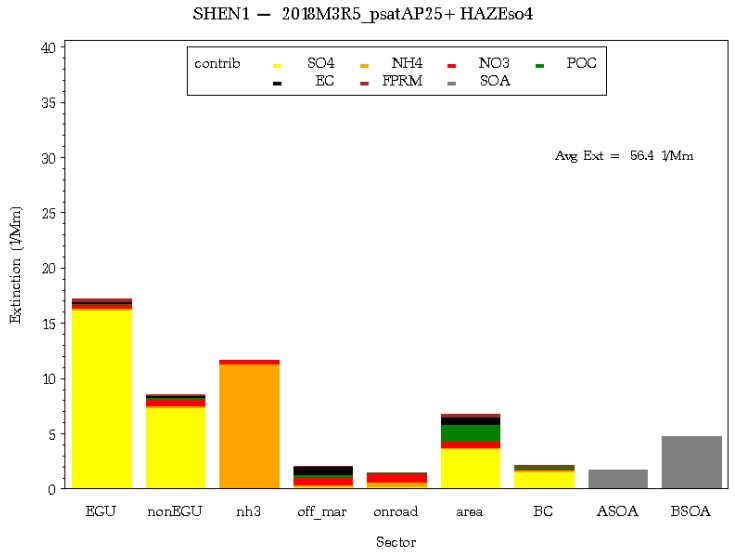
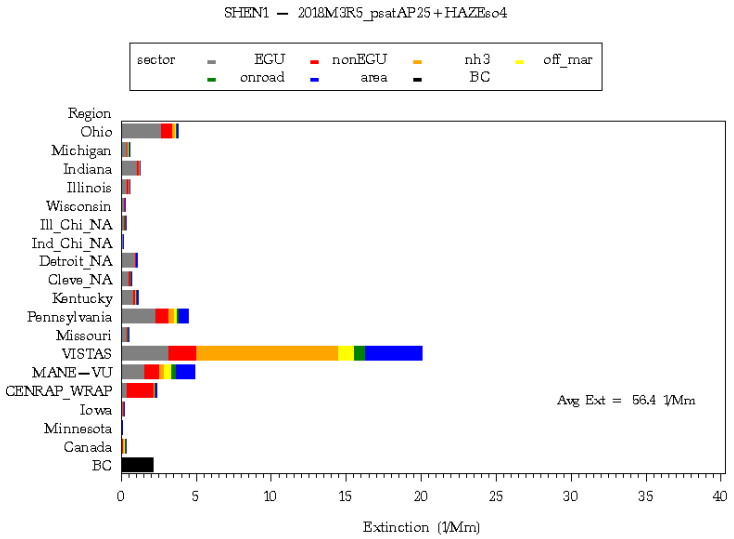
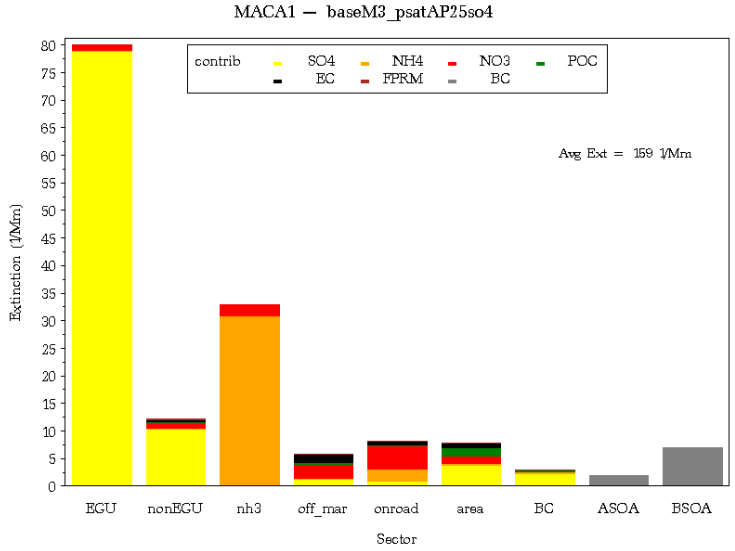
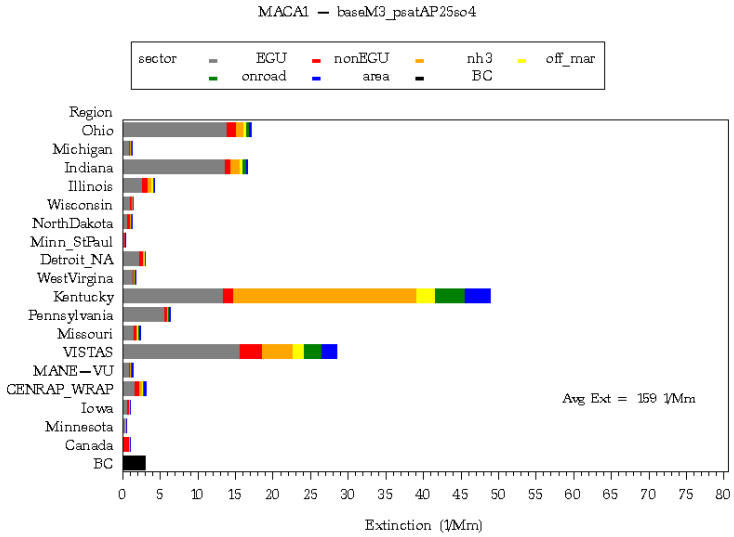




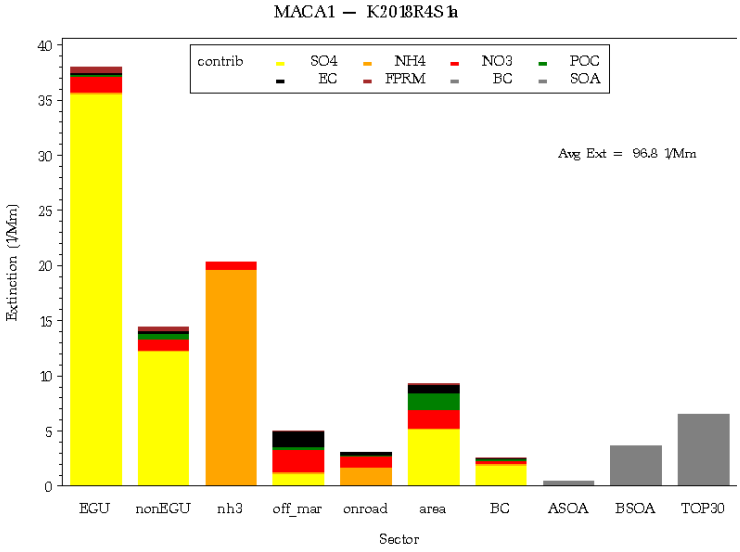
Mammoth Cave, Kentucky

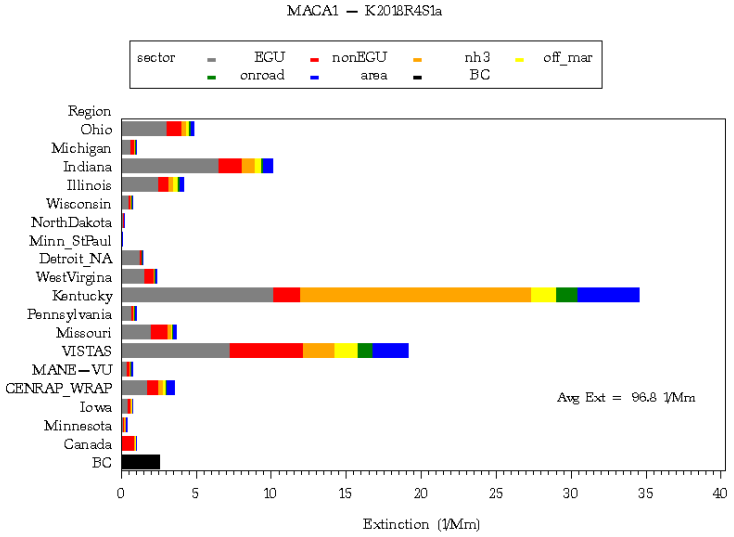
2005 (Round 5)





2018 (Round 4)





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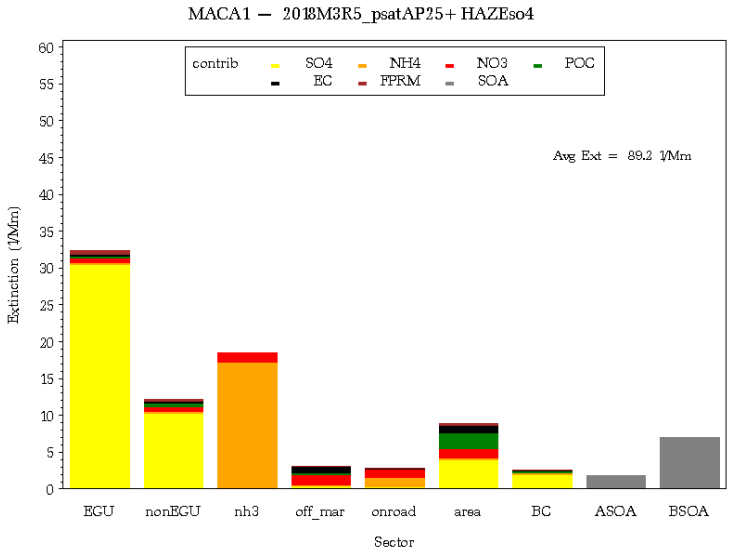
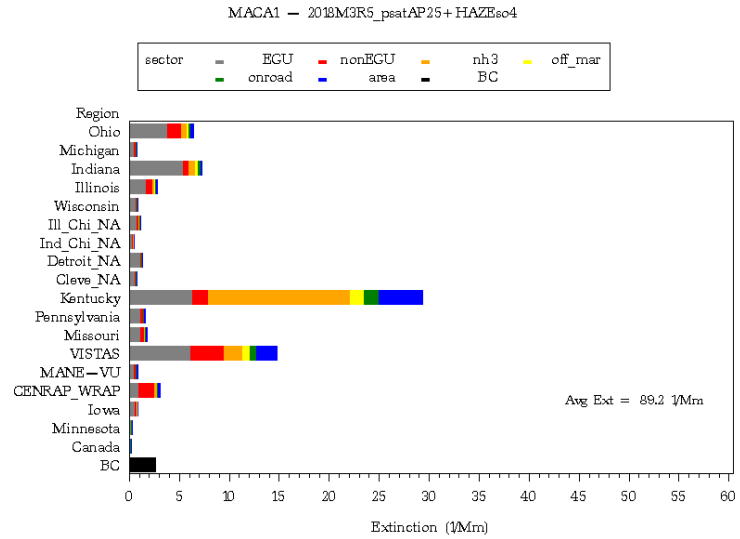
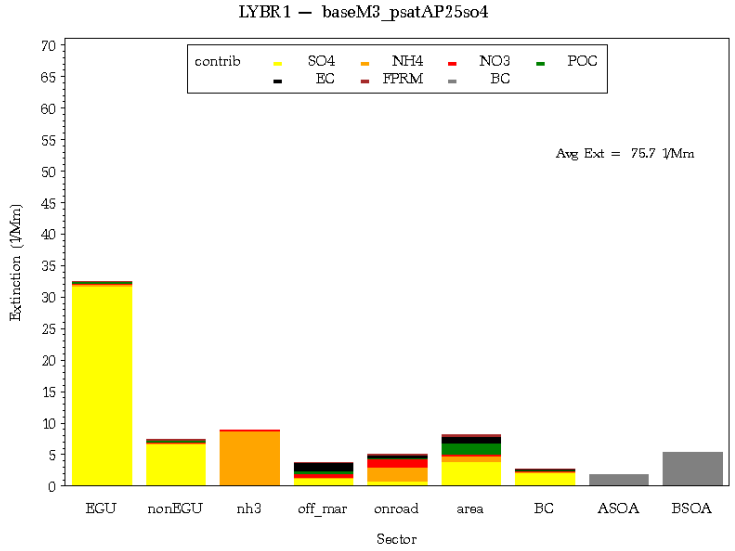
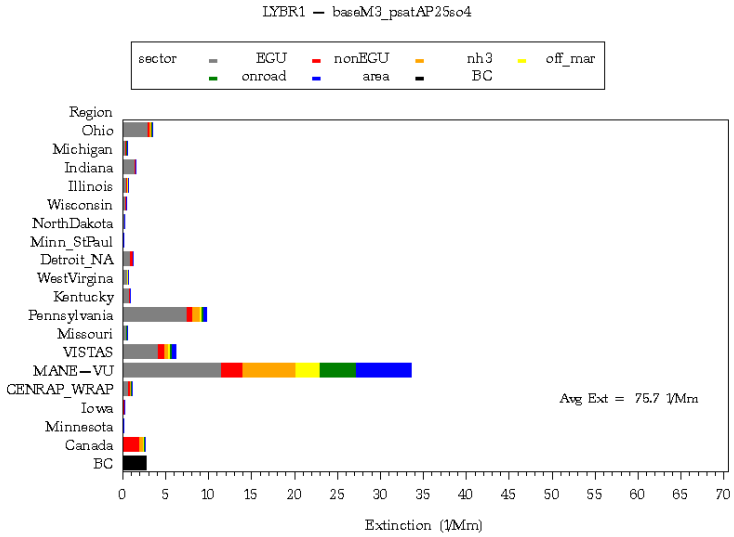




Lye Brook, Vermont

2005 (Round 5)





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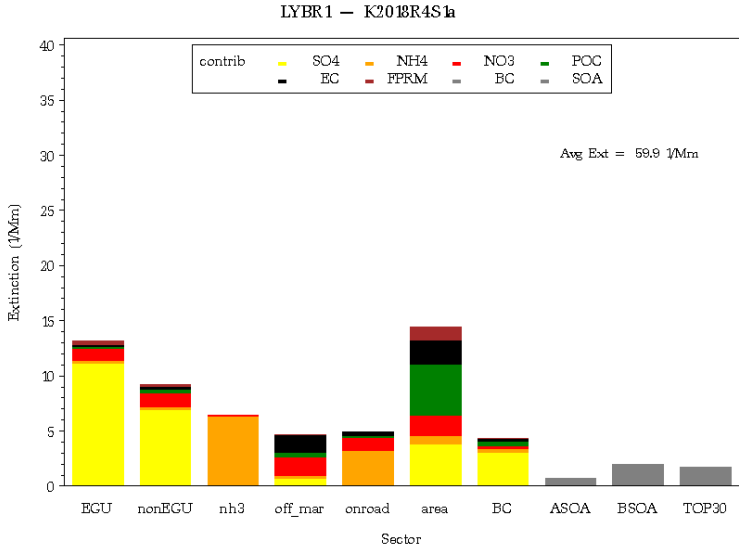
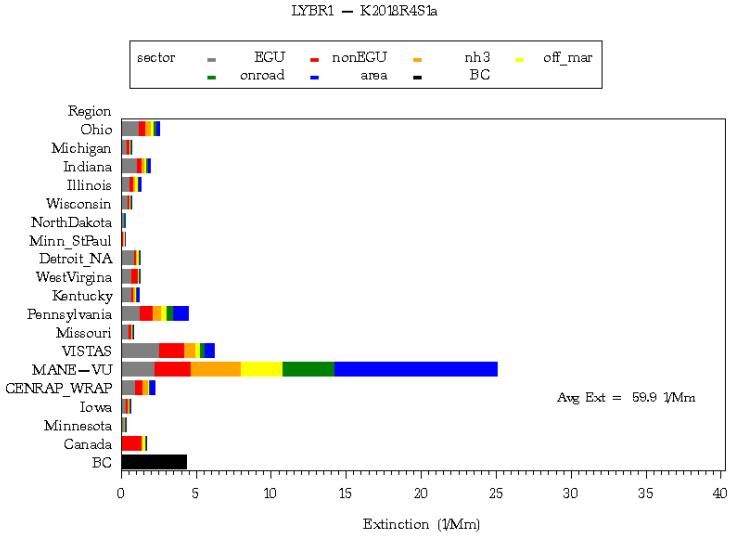
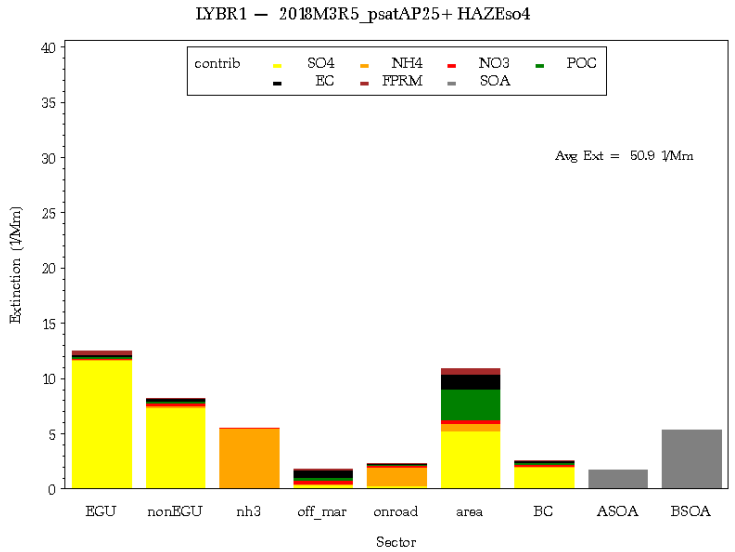
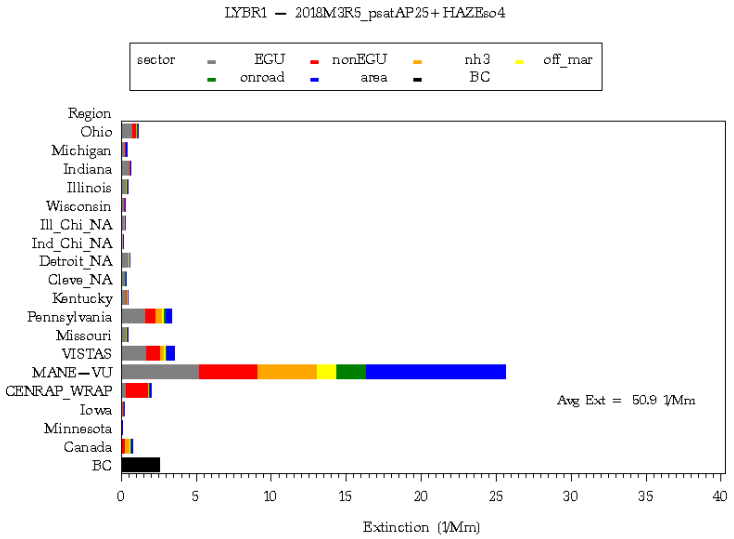




2018 (Round 5)





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). All Scenario B controls were included in Scenario C. A table summarizing the Scenario C controls (CAMD list plus BART) 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; especially, IL, OH, and 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 C.
- 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; especially, IL, OH, and 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 C.
- Assumed BART controls result in a significant emissions decrease (i.e., even lower emissions than the IPM-estimated CAIR emissions).

Figure 1. Regional NOx and SO2 Emissions

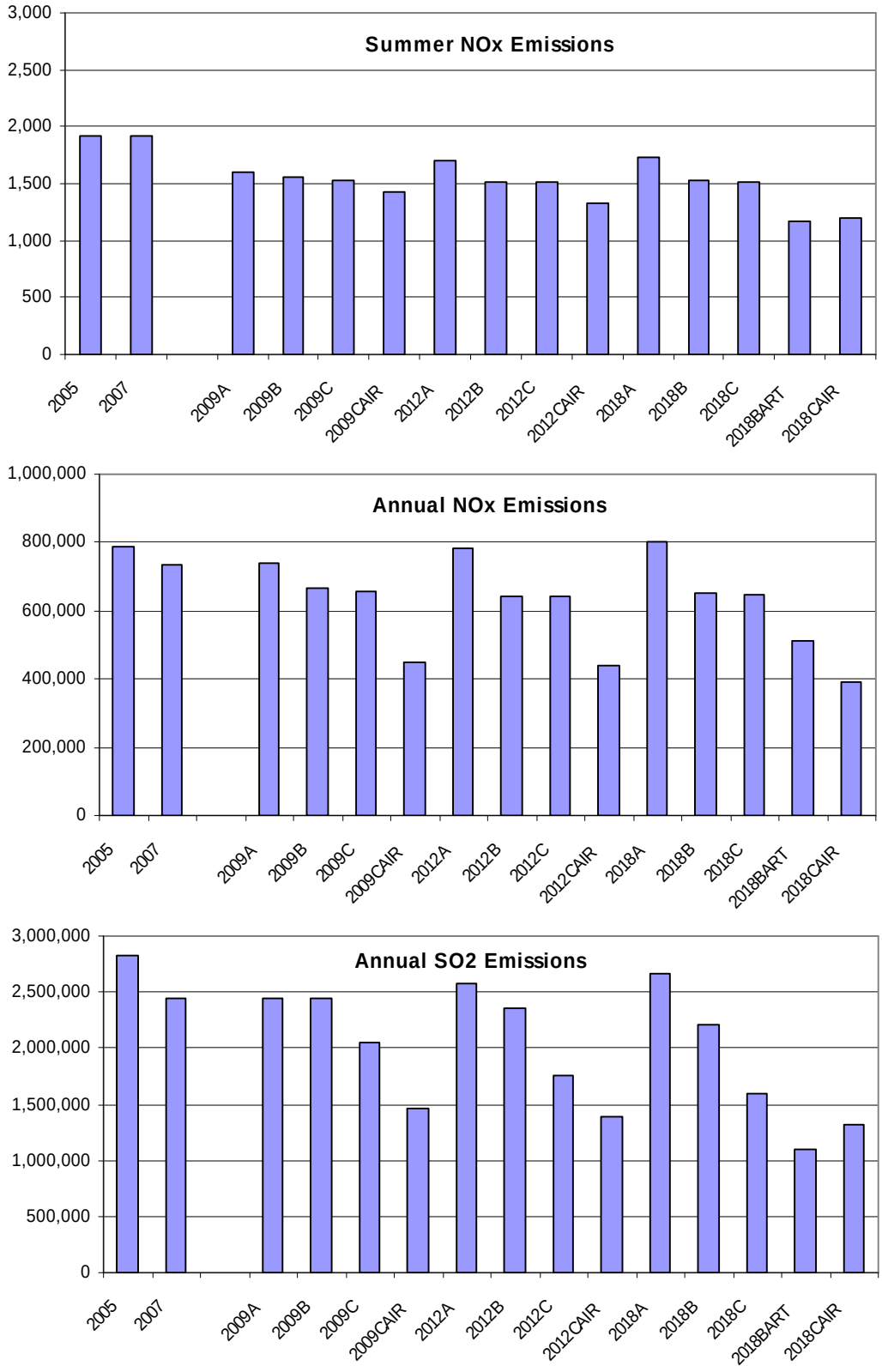


Table 1. Regional NOx and SO2 Emissions

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				
Site	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen.C-BART**	**Round 5**
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				
Site	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen.C-BART**	**Round 5**
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				
Key Site	**County**	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen. C - BART**	**Round 5**
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

Table 2c. $PM_{2.5}$ Modeling Results (Daily)

			2005		2009					2012					2018				
Key Site	**County**	**Site ID**	**Base Year**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Round 5**		**Scen. A**	**Scen. B**	**Scen.C**	**Scen. C - BART**	**Round 5**
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
Cincinnait	Hamilton	390610006	40.6		33	33	30	27		33	32	29	28		34	32	29	28	27
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)						
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	**CAIR**
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)						
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	**CAIR**
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**

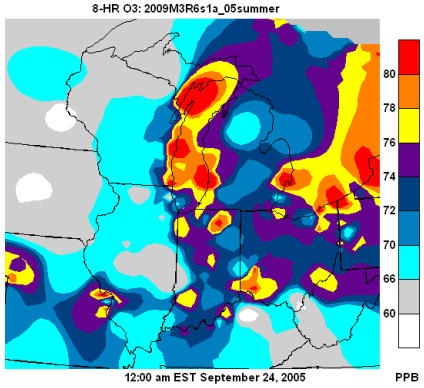
PM2.5 - Annual						
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	**CAIR**
IL	7	4	4	1	----	1
IN	6	2	2	0	----	0
MI	2	2	2	1	----	1
OH	26	13	12	5	----	1
WI	0	0	0	0	----	0
Total	**41**	**21**	**20**	**7**		**3**
2012						
IL	7	3	1	1	----	0
IN	6	1	1	0	----	0
MI	2	2	1	1	----	1
OH	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						
2009	**Baseyear**	**Scen. A**	**Scen. B**	**Scen. C**	**Scen. C-BART**	**CAIR**
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

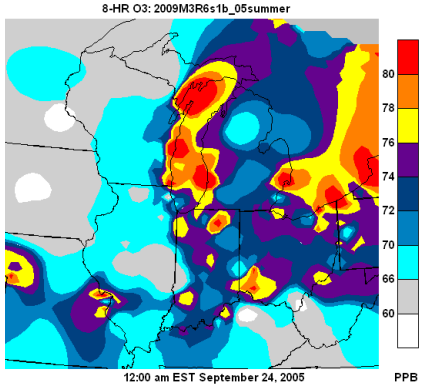
Worst 20%				2018				
Site	Baseline (2000-2004)	2018 URP		Scen. A	Scen. B	Scen. C	Scen. C-BART	CAIR
BOWA1	19.86	17.94		19.09	18.87	18.54	18.02	17.94
VOYA2	19.48	17.75		18.60	18.44	18.17	17.77	17.63
SENE1	24.38	21.64		24.02	23.58	23.03	22.38	22.59
ISLE1	21.59	19.43		21.05	20.86	20.62	20.22	20.09
ISLE9	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**				
Site	Baseline (2000-2004)	2018 Max		Scen. A	Scen. B	Scen. C	Scen. C-BART	CAIR
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

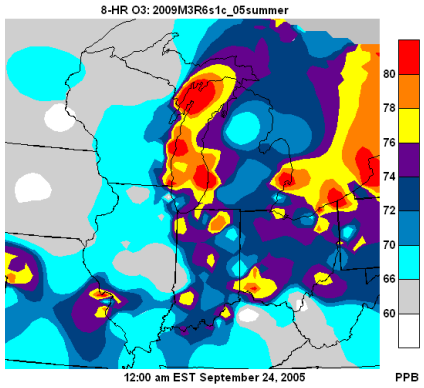
2009 Scenario A



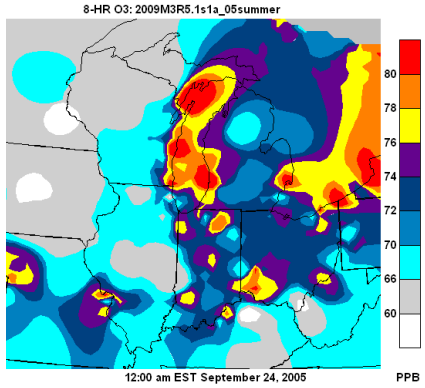
Scenario B



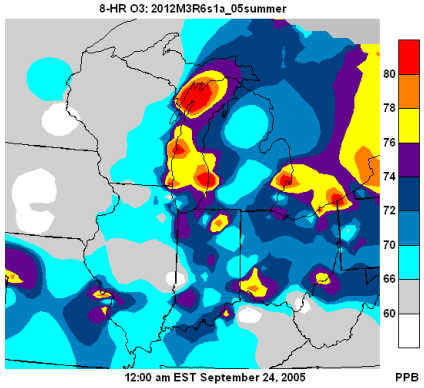
Scenario C



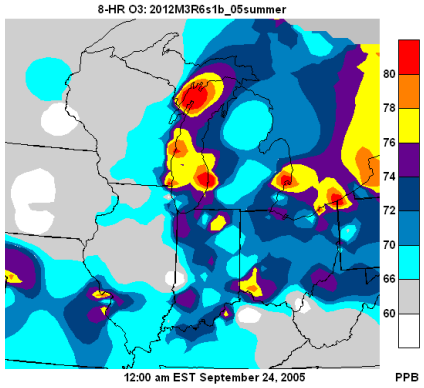
CAIR



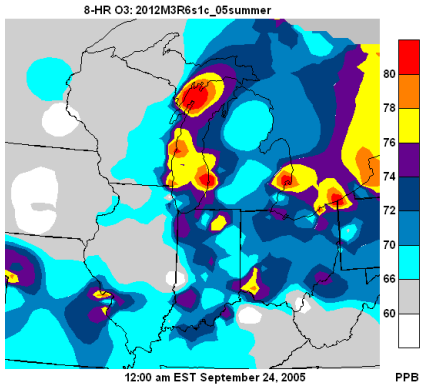
2012 Scenario A



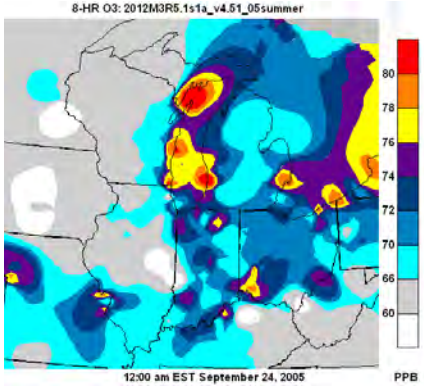
Scenario B



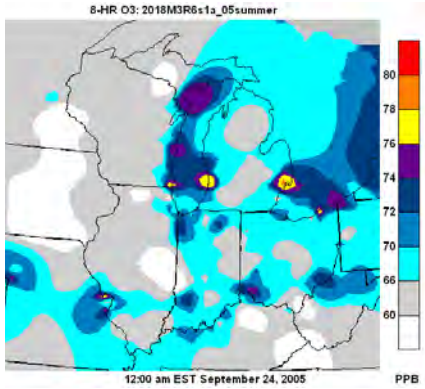
Scenario C



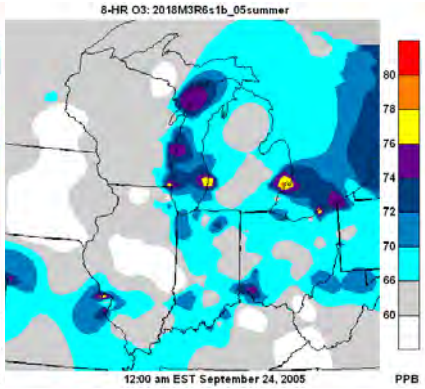
CAIR



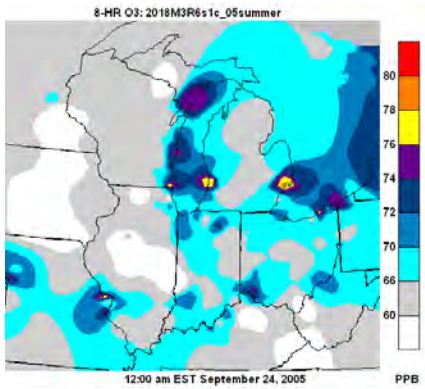
2018 Scenario A



Scenario B



Scenario C



CAIR

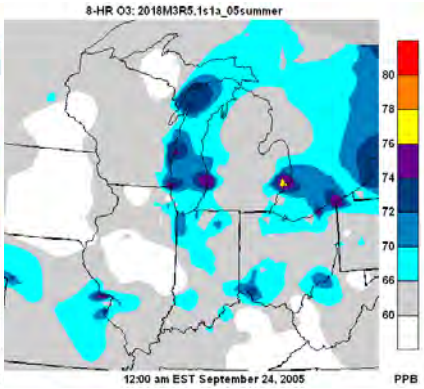


Figure 3. PM2.5 Annual Modeling Results

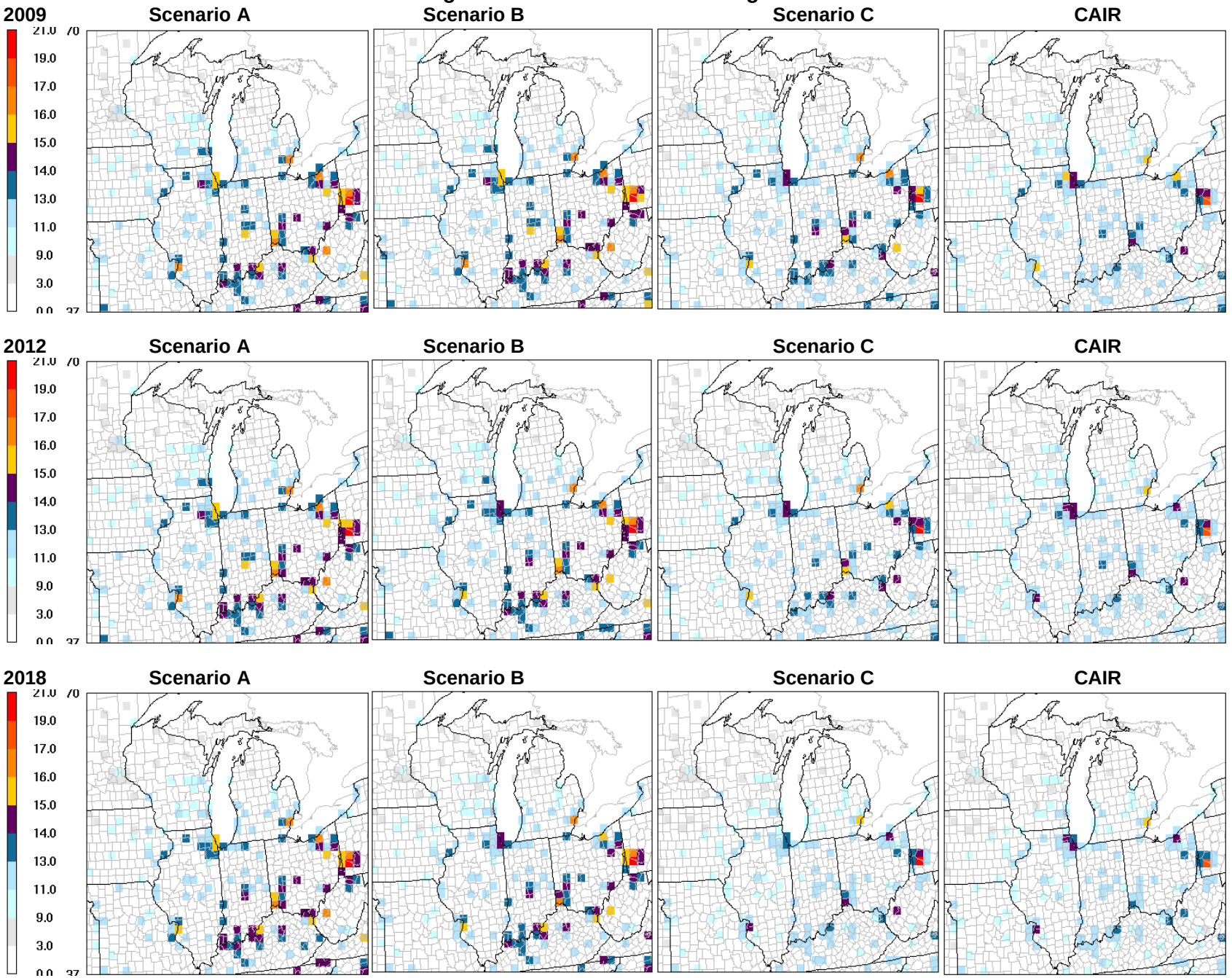
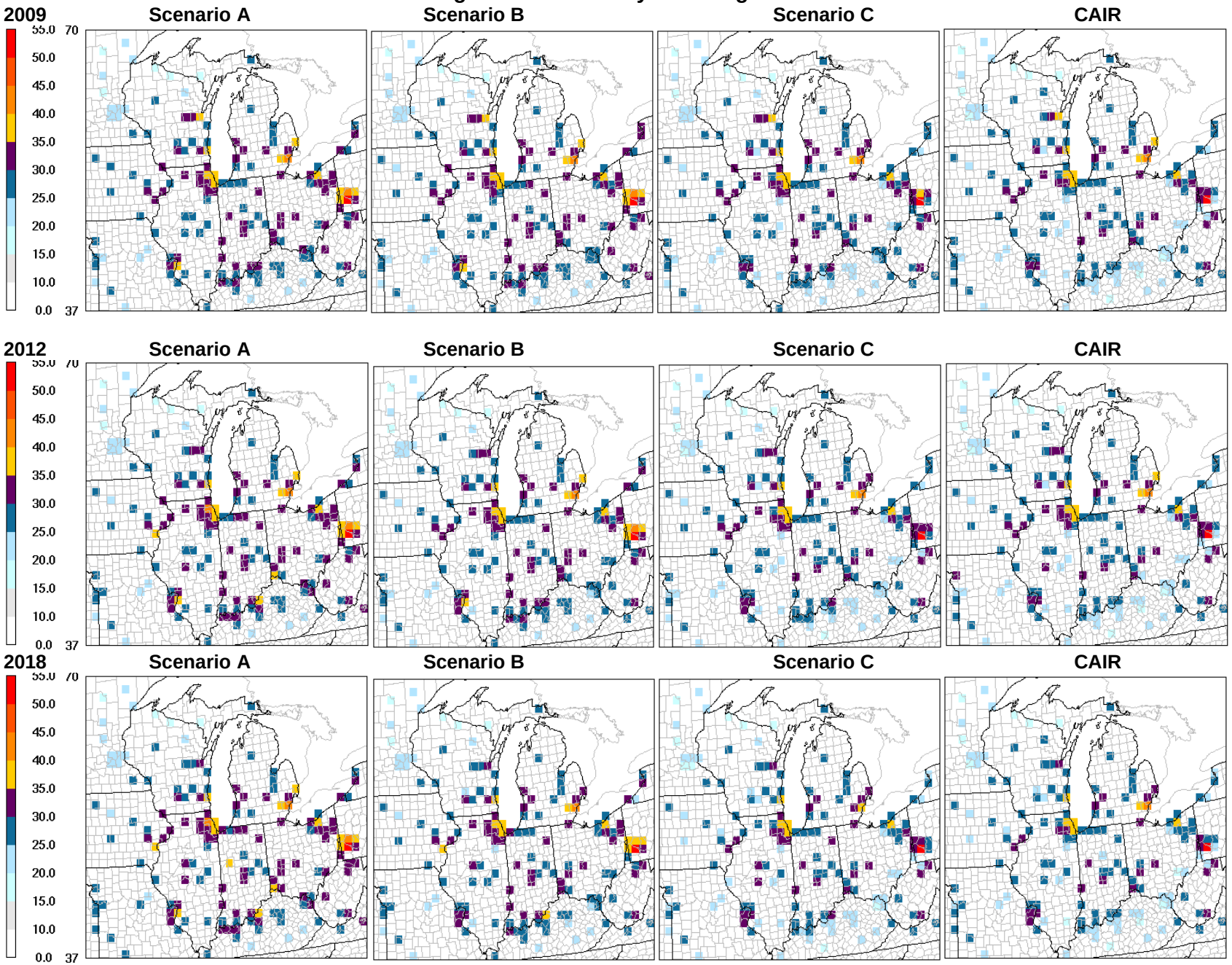


Figure 4. PM2.5 Daily Modeling Results



Appendix I

Scenario B (Legally Enforceable) Controls

NOx – 2009

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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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"

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								3.758	4.284	2.1420				
cyid								3.758	4.284	2.1420				

STID=17 CYID=57 fcid=057801AAA name=AES DUCK CREEK

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								12.671	13.056	13.0561				
cyid								12.671	13.056	13.0561				

STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								9.173	10.458	0.0105				
cyid								9.173	10.458	0.0105				

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								61.422	70.024	3.5012				
cyid								61.422	70.024	3.5012				

STID=17 CYID=197 fcid=197809AAO name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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
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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
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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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								14.749	16.814	11.0757				

STID=55 CYID=79 fcid=241007800 name=WIS ELECTRIC POWER VALLEY STATION

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Grown Tons/Day	Controlled Tons/Day	Base Year Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								3.758	4.266	2.1329				
cyid								3.758	4.266	2.1329				

STID=17 CYID=57 fcid=057801AAA name=AES DUCK CREEK

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								12.671	11.629	11.6291				
cyid								12.671	11.629	11.6291				

STID=17 CYID=97 fcid=097190AAC name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								9.173	10.414	0.0104				
cyid								9.173	10.414	0.0104				

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								61.422	69.726	3.4863				
cyid								61.422	69.726	3.4863				

STID=17 CYID=197 fcid=197809AAO name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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stid								15.739	18.127	4.5830				

STID=39 CYID=1 fcid=0701000007 name="DP&L, J.M. STUART GENERATING STATION"

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								23.481	25.570	8.5232				
cyid								23.481	25.570	8.5232				

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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	291.931	324.149	95.1624

SO2 – 2009

Point Source Grown and Controlled Emissions by facility for SO2 r6s1b_2009

Base Year = 2002

Future Year = 2009

STID=19 CYID=115 fcid=58-07-001 name=MIDAMERICAN ENERGY CO. - LOUISA STATION

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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
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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

Base Year = 2002

Future Year = 2012

STID=17 CYID=31 fcid=031600AMI name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Base Year Tons/Day	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								60.61	69.10	0.069				
cyid								60.61	69.10	0.069				

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								66.91	76.29	7.629				
cyid								66.91	76.29	7.629				

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								64.60	67.46	6.746				
cyid								64.60	67.46	6.746				

STID=39 CYID=31 fcid=0616000000 name=CONESVILLE POWER PLANT

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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stid								380.60	397.46	39.746				

STID=47 CYID=1 fcid=0009 name=TVA BULL RUN FOSSIL PLANT

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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
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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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								43.68	49.80	11.797				
cyid								43.68	49.80	11.797				
stid								43.68	49.80	11.797				
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								1950.90	2075.80	287.480				

SO2 – 2018

Point Source Grown and Controlled Emissions by facility for SO2 r6s1b_2018

Base Year = 2002

Future Year = 2018

STID=17 CYID=31 fcid=031600AIN name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year Control EF	ctrltype	ctrldes
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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								60.61	68.80	0.069				
cyid								60.61	68.80	0.069				

STID=17 CYID=179 fcid=179801AAA name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								66.45	75.44	7.544				

STID=17 CYID=197 fcid=197810AAK name=MIDWEST GENERATION LLC

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year Control EF	ctrltype	ctrldes
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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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
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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
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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
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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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fcid								23.46	25.55	2.555				

STID=54 CYID=51 fcid=0006 name=OHIO POWER - KAMMER PLANT

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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cyid								134.53	146.49	14.649				

STID=54 CYID=79 fcid=0006 name=APPALACHIAN POWER - JOHN E AMOS PLANT

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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

STID	CYID	fcid	stkid	dvid	prid	scc	polid	Base Yr Tons/Day	Grown Tons/Day	Controlled Tons/Day	Base Year Control EF	Future Year 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
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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				

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	Vermillon	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 5B

Updated Glide Path Analysis for Regional Haze

Updated Glide Path Analysis for Regional Haze (DRAFT)

This memo provides updated information on the measured and model-projected visibility levels for the Class I areas in northern Michigan and Minnesota. Specifically, four additional years of measured data (2005-2008) and one recent air quality modeling analysis were considered in preparing new plots of the glide paths for these Class I areas. This memo supplements the LADCO Technical Support Document ("Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Final Technical Support Document", April 25, 2008)[1], which summarized the air quality analyses conducted by LADCO and its contractors to support the development of State Implementation Plans (SIPs) for ozone, PM2.5, and regional haze in the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin.

Monitoring Data: A summary data set of the mean values for the best 20%, middle 20%, and worst 20% visibility days for the period 1988-2008 was obtained from the IMPROVE website: http://vista.cira.colostate.edu/IMPROVE/Data/IMPROVE/summary_data.htm
The values were calculated using the revised (new) IMPROVE algorithm. It should be noted that the baseline values were determined using 2000-2004 data, in accordance with the Regional Haze Rule.

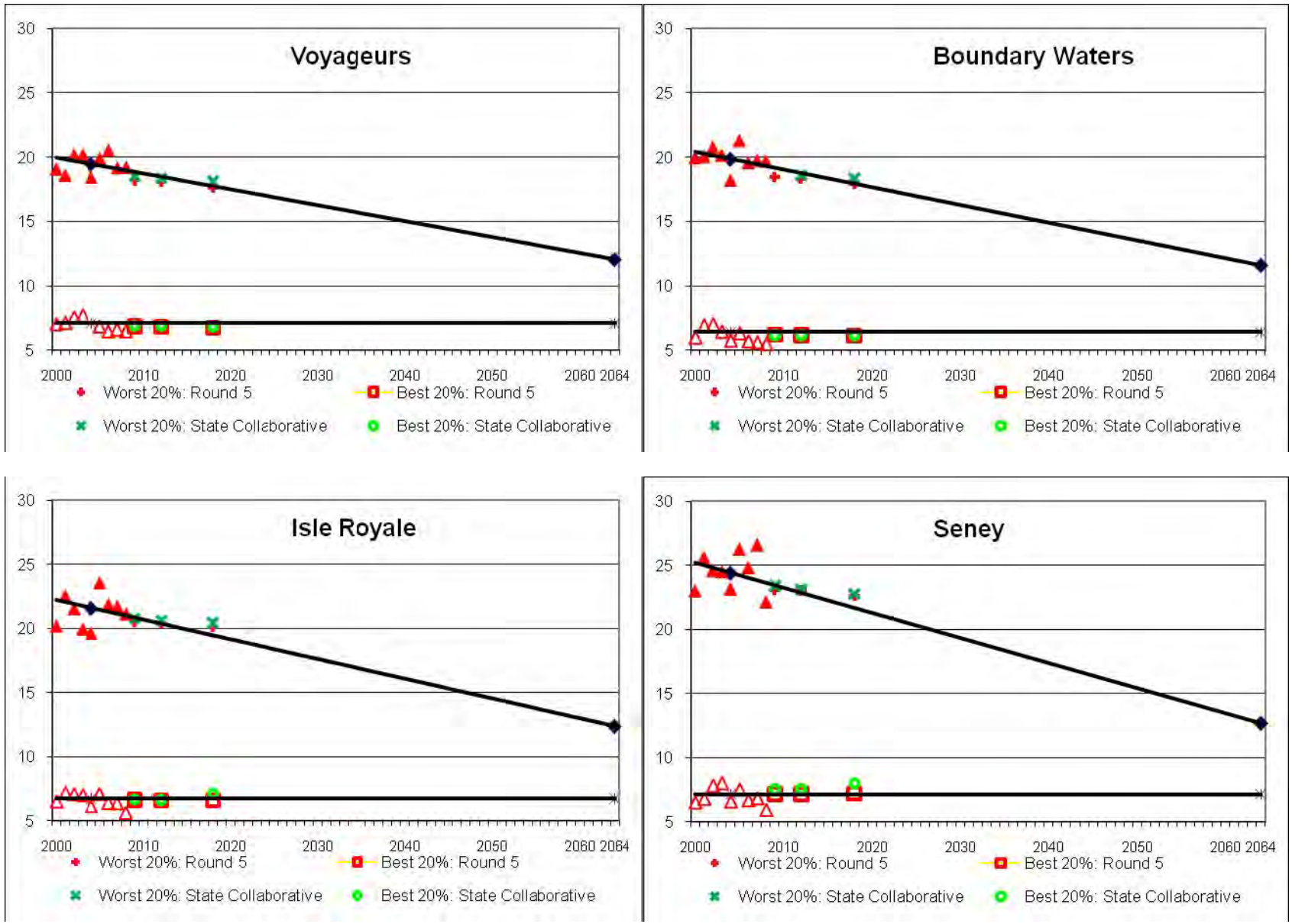
Modeling Data: Two sets of future year model predictions were considered:

(1) Round 5.1 results for 2009, 2012, and 2018 (using EPA's IPM-based projections of EGU growth and the original CAIR rule) – see "Regional Air Regional Air Quality Analyses for Ozone, PM2.5, and Regional Haze: Final Technical Support Document", April 25, 2008
(2) State Collaborative results for 2009, 2012, and 2018 (using an alternate EGU growth methodology and planned/expected EGU controls) – see "Regional Modeling for the Easter U.S.: Technical Support Document", July 9, 2009

A major difference between these modeling analyses is the assumed level of EGU control. LADCO's Round 5.1 modeling reflects full implementation of EPA's Clean Air Interstate Rule (CAIR), and the State Collaborative modeling recognizes the CAIR remand and reflects only planned/expected EGU controls. Not surprisingly, with lesser control, the State Collaborative modeling shows less visibility improvement. In light of the uncertainty due to the CAIR remand, however, the projections, particularly for the farthest out year – 2018, are suspect.

Results: Figure 1 provides updated glide path plots for Voyageurs and Boundary Waters in Minnesota, and Isle Royale and Seney in Michigan. There are insufficient data to establish any clear trends, but it is encouraging that measured visibility levels for the most recent 2 – 3 years have improved in three of the four Class I areas (and, furthermore, are on the glide path). In preparation for the first 5-year progress report (due in December 2012), this analysis will be updated on a periodic basis as more measured data become available (e.g., 2009 – 2011 data), and as more modeling is conducted (e.g., new SIP analyses).

[1] The memo also supplements the summary of technical information of regional haze and visibility impairment in the northern Michigan and Minnesota Class I areas: "Regional Haze in the Upper Midwest: Summary of Technical Information", Version 2.2, February 22, 2008.



The top line in each figure represents visibility values for the 20% worst days and the bottom line for the 20% best days. The black diamonds in the top line are the baseline value (2000-2004 average) and the natural conditions value (2064).

Appendix 6A

Description of Isle Royale National Park and Seney Wilderness Area IMPROVE Sites

Description of Isle Royale National Park and Seney Wilderness Area

Isle Royale National Park

A description of the Isle Royale IMPROVE site is given in the Table 1 below. The monitor for Isle Royale is located off-site of the island on the Keweenaw Peninsula. The monitoring site was formerly located on the island itself, however, due to accessibility problems during the winter, the monitoring site was moved to the main land.

Table 1. Information from VIEWS website for Isle Royale

SiteCode:	**ISLE1**
SiteName:	**Isle Royale NP**
State:	**MI**
StateFIPS:	**26**
CountyFIPS:	**083**
Latitude:	**47.4596**
Longitude:	**-88.1491**
ElevationMSL:	**182**
StartDate:	**11/16/1999**
EPARegion:	**5**
ImproveRegionID:	**3**
AQCRID:	**0**
CMSAID:	**0**
AirBasinID:	**0**
UrbanAreaID:	**0**
AgencyID:	**1648**
LocDesc:	**Near the boat ramp on point opposite town of Eagle Harbor**
ProgramCode:	**IMPROVE**
NativeSiteCode:	**ISLE1**
Sponsor:	**NPS**

Since the monitor is located at a site different than the class I area, the two sites could have different visibility impairment. However, based on the siting criteria in the Visibility Monitoring Guidance[1] (see section 3.2), the monitor location fits the criteria.

LADCO performed some modeling which estimated the deciviews on Isle Royale rather than the monitor location. These results can be seen in Table 2. Visibility impairment is slightly less at the class I area versus the monitor location, thus reaching the RPGs at the

[1] USEPA, 1999, Visibility Monitoring Guidance, June 1999, http://www.epa.gov/ttnamti1/files/ambient/visible/r-99-003.pdf

monitor location should ensure that the Class I site itself will have similar or even greater visibility improvements.

Table 2. 2018 on-the-books modeling results (in dv) for Isle Royale for 20% best and worst days comparing the results for grid cell where the IMPROVE monitor is located (ISLE1) versus where the class I area is located (ISLE9).

	Worst 20%	Best 20%
Monitor (ISLE1)	20.09	6.6
Class I area (ISLE9)	19.84	6.52
Difference	0.25	0.08

Seney Wilderness Area

A description of the Seney IMPROVE site is given in the Table 3 below. The monitor for Seney is located on-site of the Seney Wilderness area.

Table 3. Information from VIEWS website

SiteCode:	**SENE1**
SiteName:	**Seney**
State:	**MI**
StateFIPS:	**26**
CountyFIPS:	**153**
Latitude:	**46.2889**
Longitude:	**-85.9503**
ElevationMSL:	**214.5**
StartDate:	**11/16/1999**
EPARegion:	**5**
ImproveRegionID:	**3**
AQCRID:	**0**
CMSAID:	**0**
AirBasinID:	**0**
UrbanAreaID:	**0**
AgencyID:	**1646**
LocDesc:	**Near Refuge Headquarters**
ProgramCode:	**IMPROVE**
NativeSiteCode:	**SENE1**
Sponsor:	**FWS**

Appendix 8A

EMISSIONS INVENTORY METHODOLOGY SUPPORT DOCUMENTATION FOR THE REGIONAL HAZE SIP

Table of Contents

Page

List of Acronyms

AEO	Annual Energy Output
AMS	Area Mobile Source Codes
AQD	Michigan's Air Quality Division
ATADS	Air Traffic Activity Data System
CAMD	Clean Air Markets Division
CAS	Chemical Abstract Service
CEM	Continuous Emissions Monitoring
CERR	Consolidated Emissions Reporting Rule
CFC	Chlorofluorocarbons
CO	carbon monoxide
CONCEPT	CONsolidated Community Emissions Processing Tool
DLEG	Michigan Department of Labor and Economic Growth
EDMS	Emissions and Dispersion Modeling System
EIA	Energy Information Agency
EIIP	Emission Inventory Improvement Program
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FIRE	Factor Information Retrieval System
GLC	Great Lakes Commission
HAP	Hazardous air pollutants
HDGV	Heavy duty gasoline vehicle
Hg	Mercury
IPM	Integrated Planning Model
kW	Kilowatt
LDGT	Light duty gasoline truck
LPG	liquefied petroleum gas
LTO	Landing-Take Offs
MAERS	Michigan Air Emissions Reporting System
MAR	Marine, air and rail
MEGAN	Model of Emissions of Gases and Aerosols from Nature
mg/Mg	milligrams/megagram
MSW	municipal solid waste
NAICS	North American Industry Classification System
NCD	NMIM County Database
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIF	National Inventory Format
NMIM	National Mobile Inventory Model
NOAA	National Oceanic and Atmospheric Administration
ODBC	Open Database Connectivity
Pb	Lead
Pechan	E.H. Pechan & Associates, Inc.
PERC	perchloroethylene
psia	pounds per square inch absolute
RCRA	Resource Conservation and Recovery Act

RFP	reasonable further progress
ROP	rate of progress
RPS	Renewable Portfolio Standards
RVP	Reid Vapor Pressure
SCC	Source Classification Codes
SEMCOG	Southeast Michigan Counsel of Governments
SIC	Standard Industrial Classification Code
SF 3	Summary File 3
SSD	Source Summary Database
T3	Travel Demand Modeling [TDM] Transformation Tool
TAF	Terminal Area Forecast
TCA	trichloroethane
TDM	Travel Demand Modeling
USDA	U.S. Department of Agriculture
VMT	vehicle miles traveled
WI DNR	Wisconsin Department of Natural Resources

1. Introduction

Emissions inventory documentation support for the Regional Haze SIP is provided in this appendix. An inventory was prepared for all counties in Michigan. Mobile emissions for other counties were prepared by the Midwest Regional Planning Organization's (MRPO) contractor using traffic and vehicle information provided by the Michigan Department of Transportation. The Lake Michigan Air Director's Consortium (LADCO) is the MRPO. The focus of the inventory effort was to produce modeling inventories for the base year (2005) and the future years (2018). The future year projections take into account existing control measures and measures that are known to be on the way (e.g., CAIR measures). This inventory is referred to as the LADCO Base-M inventory. Procedures used to prepare these inventory products can be found in the "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document," prepared by LADCO. LADCO has produced numerous summary reports with State and county total emissions and has posted them on their Internet site at:

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

In a related effort, the 2005 Michigan statewide inventory was submitted to the EPA by the Michigan Department of Environmental Quality (MDEQ) pursuant to 40 CFR Part 51, Subpart A – Emissions Inventory Reporting Requirements.

2. EGU Point Sources

2005 EGU Point Source Methodology

The 2005 EGU point source data originated with annual emissions data provided to Michigan DEQ via the Michigan Air Emissions Reporting System (MAERS). Temporal allocation was performed by emission unit, month, day of week and hour using the procedures described in "Temporally Allocating Emissions with CEM Data for Chemical Transport and SIP Modeling," available at:

http://www.epa.gov/ttn/chief/conference/ei15/session4/edick.pdf

In addition to the heat input-based temporal profiles described in the paper, separate temporal profiles were developed based on Continuous Emissions Monitoring (CEM) reported emissions of NOX and SO_2 and these profiles were used instead of heat input to temporalize annual emissions of the respective pollutants. The CEM data used as the basis of the profiles was that for 2004 through 2006 obtained from the EPA Clean Air Markets Division (CAMD) website:

http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=emissions.wizard

Growing EGU Point Source to 2009

The 2009 data is obtained from Integrated Planning Model (IPM) results obtained by the EPA and converted to a modeling inventory by LADCO. The following is a LADCO Integrated Planning Model discussion, which details the methodologies used to project the EGU emissions to 2009 using results from the IPM model:

Specifically, future year emissions are based on EPA's IPM3.0 modeling. Three CAIR scenarios were addressed:

- Round 5a: EPA's IPM3.0 was assumed as the future year base for EGUs.
- Round 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).
- Round 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).

Inter-RPO IPM Global Parameter Decisions (May 11, 2005):

The following summarizes the decisions made by VISTAS, MRPO, CENRAP, and MANE-VU for global assumptions to be used in EGU forecasting with IPM. These decisions and changes are made to IPM version 2.1.9 assumptions, which can be referenced via EPA's IPM website at:

http://cfpub.epa.gov/crem/knowledge_base/crem_report.cfm?deid=74919

A. Market Assumptions

1. National Electricity and Peak Demand
   Decision: Use unadjusted Energy Information Agency (EIA) Annual Energy Output (AEO) 2005 national electricity and peak demand values.
2. Regional Electricity and Demand Breakout
   Decision: Use the existing IPM region breakdown as conducted in earlier modeling.
3. Natural Gas Supply Curve and Price Forecast
   Decision: Take existing supply curves and scale application to EIA AEO 2005 price point. In this approach, the EPA 2.1.9 gas supply curves will be scaled in such a manner that IPM will solve for AEO 2005 gas prices when the power sector gas demand in IPM is consistent with AEO 2005 power sector gas demand projections. In instances where the power sector gas demand in IPM is lower than that of AEO 2005 projections, IPM will project gas prices that are lower than that in AEO 2005 and vice versa.
4. Oil Price Forecast
   Decision: Use EIA AEO 2005 values.
5. Coal Supply and Price Forecast

Decision: Take existing supply curves and scale application to EIA AEO 2005 price points, coal supply regions, and coal grades. In this approach, the coal supply curves used in EPA 2.1.9 are scaled in such a manner that the average mine mouth coal prices that the IPM is solving in aggregated coal supply regions are comparable to AEO 2005. Due to the fact that the coal grades and supply regions between AEO 2005 and the EPA 2.1.9 are not directly comparable, this is an approximate approach and has to be performed in an iterative fashion. This approach does not involve updating the coal transportation matrix with EIA assumptions due to significant differences between the EPA 2.1.9 and EIA AEO 2005 coal supply and coal demand regions.

B. Technical Assumptions

1. Firmly Planned Capacity Assumptions
   Decision: Use revisions and new data as provided by RPOs and stakeholders.
   Decision: Allow North Carolina Clean Smokestacks 2009 data as provided to define "must run" units.
2. Pollution Control Retrofit Cost and Performance [SO_2, NOx, and Hg] Decision: Retain pollution control retrofit cost and performance values.
3. New Conventional Capacity cost and performance assumptions
   Decision: Use EIA AEO 2005 cost and performance assumptions for new conventional capacity.
   Decision: Retain existing 2.1.9 framework cost and performance for new renewable capacity.
   Decision: Exclude constraint on new capacity type builds (i.e., no new coal).
4. SO_2 Title IV Allowance Bank
   Decision: Use existing SO_2 allowance bank value (4.99 million tons) for 2007.
5. Nuclear Re-licensing and Uprate
   Decision: Use existing IPM configuration with updated EIA AEO 2005 (~$27/kW) incurrence cost for continued operation.

C. Strategy Assumptions

1. Clear Air Mercury Rule (CAMR)
   Decision: Include CAMR in future rounds of IPM modeling.
2. Renewable Portfolio Standards
   Decision: Model Renewable Portfolio Standards (RPS) based on the most recent Regional Greenhouse Gas Initiative documentation using a single RPS region for MA, RI, NY, NJ, MD and CT. The RPS requirements within these states can be met by renewable generation from New England, New York and PJM. EPA 2.1.9

methodology and hardwired EIA AEO 2004 projected renewable builds for the remainder of the country.

D. Other Assumptions

1. Run Years
   Decision: Revise runs years to 2008 [2007-08], 2009 [2009], 2012 [2010-13], 2015 [2014-17], 2018 [2018], 2020 [2019-22], and 2026 [2023-2030].
2. Canadian Sources
   Decision: Utilize existing v.2.1.9 configuration (no Canadian site specific sources).

3. Non-EGU Point Sources

2005 Non-EGU Point Source Methodologies

The 2005 point source data have as their original sources the 2005 Michigan point source emission inventory. This section of the document describes the compilation and processing of point source emission data submitted to comply with the Consolidated Emission Reporting Rule (CERR) for the EPA NEI 2005 inventory.

The data originates with the entry of data by the reporting facilities into the MAERS. The electronic data received from the reporting facilities is reviewed and compiled by the MDEQ, and exported to the fixed-width text version of the National Inventory Format (NIF). After the exported data is loaded into a PostgreSQL database patterned after the MS Access version of the NIF, the following processing steps and checks are performed.

Both emissions estimated by default calculations in MAERS and any emissions reported by facility operators are maintained in MAERS. For evaluation and quality assurance purposes, both types of records are included in the exports. To avoid double-counting, where a specific process/pollutant has emission records both reported directly by the facility operator, and estimated via MAERS calculations, the latter are excluded.

Portable facilities, such as asphalt plants, report total throughput and emissions, plus operating percentages for each county in which the portable facility was located during the year. From this information, records are generated for each county of operation, and throughput and emissions are apportioned based on the operating percentages reported by county and process. As geographic coordinates for all operating sites are not reported, coordinates corresponding to the centers of the counties of operation are assigned.

As attention has shifted from total particulate to PM_{10} and $PM_{2.5}$, total particulate records are excluded from the reporting requirements.

Over 99.8 percent of total criteria emissions are accounted for by emissions reported by operator; therefore, exported criteria emissions estimated via MAERS calculations are excluded.

In the site table, where strFacilityCategory is not set in the export, it is set to “01.”

Mandatory geo-coordinate fields were added to the NIF specifications released in December 2003, well after it would have been possible to collect this information from the reporting facilities for 2002 operations. The following values were deemed most often representative and the exported data are updated accordingly for 2002 data:

“strHorizontalCollectionMethodCode” is set to '027'
“strHorizontalAccuracyMeasure” is set to '2000'
“strHorizontalReferenceDatumCode” is set to '001'
“strReferencePointCode” is set to '106'

For 2005, these geographic data elements were requested of the facilities. The defaults above were applied only where data was not provided by the facility.

MAERS tracks emissions of some pollutants that are of interest to the Great Lakes Commission, but which do not have corresponding pollutant codes in the most recent NIF pollutant code table. Emission records for the following pollutant codes are excluded:

7440508; 8052413; DICDD,TOT; DICDF,TOT; HYDFLUORO; PERFLUORO; TRICDD,TO; TRICDF,TO; CH4; CO2; N20; 117840; 7783064.

Emission records for ammonia are exported with the Chemical Abstract Service (CAS) number 7664417, rather than the pollutant code NH3. These pollutant codes are updated to NH3. Likewise, records exported with pollutant codes PAH and POM are updated to pollutant codes 234 and 246, respectively.

All criteria and HAP emissions are reported at the process level, and the export routines reflect that in the strEmissionDataLevel field of the emission table. This field is set to null for criteria pollutant emission records per EPA guidance.

All emissions are exported as pounds of annual emissions. The EPA guidance suggests that criteria pollutant emission be reported in tons. The field strEmissionUnitNumerator is changed to TON and the filed dblEmissionNumericValue is divided by two000 for criteria pollutant emission records.

Null values in the quarterly throughput fields of process records are set to zero.

Where quarterly throughput fields of process records sum to zero, throughput percentages are set to 25% for each quarter.

MAERS recognizes a control device code of '909' for a “Roll Media Fiberglass Tack Filter (Tacky 1 side),” which is not recognized in the NIF code tables. Where this control device code is exported, the “strPrimaryDeviceTypeCode” field of the control equipment table is updated to a value of 058.

Because of the exclusion of emission records as described above, referential integrity of the exported data can be compromised. At this point, it is re-established by deleting records stepwise, in the following order.

CE records without corresponding EM records
PE records without corresponding EM records
EP records without corresponding EM records
ER records without corresponding EP records
EU records without corresponding EP records
SI records without corresponding EU records

The data are then checked again for referential integrity and mandatory fields and then loaded into the MS Access shell version of the NIF via append queries that connect to the PostgreSQL data tables via ODBC. The Basic Content and Format Checker is run and its output is reviewed. Where corrections are needed, to assure consistency among data sources, the corrections are made in the MAERS and a full iteration of the export and post-processing steps are performed.

The 2005 point source inventory was incorporated into the LADCO Base M inventory and serve as the basis for Michigan’s 2005 CERR submittal.

Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories to 2009

The 2009 emissions are based on work and a follow-up report (E.H. Pechan & Associates, Inc., Development of Growth and Control Factors for Lake Michigan Air Directors Consortium, Final Report, December 14, 2004) done by E.H. Pechan & Associates, Inc. (Pechan). This work supports LADCO’s efforts to forecast anthropogenic emissions for the purpose of assessing progress for air quality goals, including goals related to regional haze and attainment of the ozone NAAQS. The Pechan growth factors were used to estimate the LADCO base M future year emissions posted by LADCO in 2007. The future year emissions represent both emission controls that already exist and those that are known to be on the way (e.g., CAIR control measures).

To assess progress for attaining air quality goals, LADCO requires emission activity growth and control data to forecast emissions from a 2005 base-year inventory to several future years of interest. These future years include 2009, 2012, and 2018 (e.g., 2018 is the first milestone for regional haze reasonable progress demonstrations). Pechan prepared emission control factors to support forecasting for each of these years. Because the incremental level of effort required to develop emission activity

growth factors for each year over the 2003-2018 period was nominal, Pechan prepared non-EGU point and area and non-road source growth factors for each year over this entire period.

The report describes Pechan efforts to develop emission growth and control data to support future year air quality modeling by LADCO. The report is organized into a background chapter and:

Chapter II, which describes the development of the emission activity growth data;
Chapter III, which discusses how the emission control data were compiled;
Chapter IV, which describes the preparation of the growth and control factor files;
Chapter V, which identifies projection issues for future consideration; and
Chapter VI, which presents the references consulted in preparing this report.

The Pechan Growth and Control Factor report is too lengthy to be included in this document, but it can be provided upon request or downloaded at:

http://www.ladco.org/reports/rpo/emissions/ladco_2005_base_yr_growth_and_controls_report_final.pdf

For sectors non-EGU point source, stationary area source and MAR source sectors, the future year emissions for the LADCO States were derived by applying growth and control factors to the base year inventory. As stated above, these factors were developed by a contractor (E.H. Pechan). Growth factors were based initially on EGAS (version 5.0), and were subsequently modified (for select, priority categories) by examining emissions activity data.

Additional information on the procedures used to project emissions can be found in the "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document" prepared by LADCO.

4. Stationary Area Sources

2005 Stationary Area Source Emission Inventory

The following is a description of the various area source categories that were inventoried as part of the year 2005 emissions inventory as required by the EPA under the CERR. It also provides documentation as part of the development of a broader emissions inventory (which encompasses point, area, non-road mobile, on-road mobile, and biogenic sources) that is being developed for (SIP requirements for attainment with the 8-hour ozone and $PM_{2.5}$ NAAQS and the regional haze regulations. For the purpose of developing state SIPs to demonstrate compliance with the ozone NAAQS, $PM_{2.5}$ NAAQS and regional haze rule, states are currently required to submit base-year inventories, 3-year cycle update inventories, rate of progress inventories, and modeling inventories. In a November 18, 2002 memorandum – 2002 Base-year Emission

Inventory for SIP Planning Process, EPA identified year 2002 as the base-year for the SIP planning process. Within 3 years after designations are determined, states will need to submit SIP attainment demonstrations for the 8-hour ozone and $PM_{2.5}$ NAAQS. The 2002 base-year inventory serves several purposes in supporting air quality modeling and control measure selection to determine the types and amount of emission reductions needed to meet reasonable further progress (RFP) and rate of progress (ROP) emission reduction targets and demonstrate attainment. Many of the emission inventory planning requirements can be found in the EPA document entitled: Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. Subsequent to the submission of the 2002 inventory, there was considerable discussion by LADCO staff with states and the EPA as to the appropriateness of 2002 base-year inventory with respect to using a 2005 base-year inventory. At the time of the preparation of the year 2005 emissions inventory, these discussions were still ongoing between LADCO and EPA. EPA designated nonattainment areas for the 8-hour ozone NAAQS with an effective date of June 15, 2004, while nonattainment designations for the $PM_{2.5}$ NAAQS were published in the *Federal Register* later on January 5, 2005, with an effective date of April 5, 2005. For those states participating in regional planning organizations, there are additional SIP inventory requirements for regional haze. The cascading effect of subsequent nonattainment designations as well as subsequent attainment demonstrations, existing emission reductions from NOx SIP calls, and the appropriateness of the base-years 2002 and 2005 were discussed by LADCO, EPA, and the states. The 2005 inventory was developed to fulfill both a base-year inventory and three-year cycle update inventories that are required by the existing CERR.

The following chart shows the specific air pollutants that must be provided by the CERR and base-year inventories for the 8-hour ozone and $PM_{2.5}$ NAAQS and regional haze regulations.

Required Air Pollutants Emissions

	CO	NH3	NOX	Pb	PM_{10}-PRI	PM25-PRI	SOX	VOC
Consolidated Emissions Reporting Rule (CERR)	√	√	√	√	√	√	√	√
Ozone NAAQS	√		√					√
$PM_{2.5}$ NAAQS		√	√		√	√	√	√
Regional haze		√	√		√	√	√	

In producing the 2005 emission inventory, multiple emission estimates must be provided to reflect temporal resolution that is required by the CERR and base-year inventories for the ozone and $PM_{2.5}$ NAAQS. These requirements are summarized as follows:

Temporal Resolution Requirements for Inventories

	Statewide Inventory	Summer Weekday
Consolidated Emissions Reporting Rule (CERR)	**Required**	
Ozone NAAQS	**Required**	**Required**
$PM_{2.5}$ NAAQS	**Required**	**Optional**
Regional haze	**Required**	**Optional**

Consequently, the statewide year 2005 emission estimates that are being provided reflect the annual and summer weekday for the referenced air pollutants. A list of the 30 area source categories appears on the following page. EPA requires specific data elements to be provided via electronic data transfer using the National Emission Inventory NEI-NIFV3.0 format. A description of data structures can be found in the EPA publication NEI Input Format (NIF) Version 3.0 User's Guide Instructions and Conventions of Use, April 2003.

Summary of Area Sources and Respective Air Pollutants Inventoried for 2005 Inventory

Seq #	Area Source Description	SCCs	SIC	CO	NH3	NOX	PM_{10}-PRI	PM25-PRI	SOX	VOC
1	Crude oil production	2310010000	1311							√
2	Natural gas production	2310020000	1311							√
3	Breweries	2302070001	2082							√
4	Cutback asphalts	2461021000	2951							√
5	Distilleries	2302070010	2085							√
6	Emulsified asphalts	2461022000	2951							√
7	Aircraft refueling	2275900000	4581							√
8	Commercial coal	2103002000	9999	√	√	√	√	√	√	√
9	Commercial distillate oil	2103004000	9999	√	√	√	√	√	√	√
10	Commercial kerosene	2103011005	9999	√	√	√	√	√	√	√
11	Commercial natural gas	2103006000	9999	√	√	√	√	√	√	√
12	Commercial residual oil	2103005000	9999	√	√	√	√	√	√	√
13	Gasoline marketing	2505030120, 2501060100, 2501060051, 2501060052, 2501060053, 2501060200	5541							√
14	Industrial coal	2102002000	3999	√	√	√	√	√	√	√
15	Industrial distillate oil	2102004000	3999	√	√	√	√	√	√	√
16	Industrial kerosene	2102011000	3999	√	√	√	√	√	√	√

17	Industrial natural gas	2102006000	3999	√	√	√	√	√	√	√
18	Industrial residual oil	2102005000	3999	√	√	√	√	√	√	√
19	Residential coal	2104001000	8811	√	√	√	√	√	√	√
20	Residential distillate oil	2104004000	8811	√	√	√	√	√	√	√
21	Residential kerosene	2104011000	8811	√	√	√	√	√	√	√
22	Residential natural gas	2104006000	8811	√	√	√	√	√	√	√
23	Residential propane	2199007000	8811	√		√	√	√	√	√
24	Municipal landfills	2620030000	4953	√		√	√	√		√
25	Vessel ballasting	2505020900	4432							√
26	Vessel loading	2505020120, 2505020030,2505020150, 2505020180, 2505020090, 2505020060	4432							√
27	Remedial action	2660000000	9511	√		√	√		√	√
28	Traffic marking paints	2401008000	1611							√
29	Wineries	2302070005	2084							√
30	Aviation stage I	2501080050	5541							√

Oil and Natural Gas Production

The oil and gas production area source category represents those VOC emissions that result from the exploration, drilling, and the field processing of crude oil and natural gas. Fugitive VOC emissions occur from control valves, relief valves, spills, pipe fittings, pump seals and compressor seals in the production and field processing of crude oil and natural gas. Individual county crude oil and natural gas production data was obtained from the MDEQ, Geological and Land Management Division. VOC emission factors were derived from the EPA publication entitled: Revision of Evaporative Hydrocarbon Emission Factors (EPA – 450/3-76-039). The emission factors are 107 pounds of emitted VOC per thousand barrels of produced crude oil and 175 pounds of emitted VOC per million cubic feet of produced natural gas. For crude oil production, emission controls reflecting NESHAP application of a 45% reduction in VOC were considered. This control level was based on EPA determination of an overall 45% reduction in VOC from oil and natural gas production facilities. This control reduction was obtained from a 5/14/99 EPA fact sheet that was published with the Final Air Toxics Rules for Oil and Natural Gas Production Facilities and Natural Gas Transmission and Storage Facilities. Rule effectiveness of 80% was then applied, and point source deductions were performed to estimate the area source contribution. For natural gas, emission controls from Michigan air pollution control rule R336.1629 of 72% and the federal emission control reduction in VOC of 19% associated with NESHAP application to natural gas transmission and storage were applied. The 19% emission reduction was obtained from the 5/14/99 EPA fact sheet that was published with the Final Air Toxics Rules for Oil and Natural Gas Production Facilities and Natural Gas Transmission and Storage Facilities. The federal NESHAP rule became effective June 17, 1999. Area source emissions were then reported using Source Classification Codes (SCC) of 2310010000 for crude petroleum oil production and 2310020000 for natural gas production.

Vessel Loading/Ballasting

Evaporative VOC occur from Great Lakes ships when being loaded with gasoline and petrochemicals. Vapors are also displaced when cargo tanks are loaded with water for ballasting. In order to estimate VOC from vessel loading/ballasting activities, a list of marine terminals at Michigan based ports handling petroleum products was obtained from the MDOT. Because of the need to acquire information on gasoline and petrochemical handling at each Michigan port and the time frames during vessel loading/ballasting occurred, a survey form was again sent to the marine terminals that were previously surveyed in the 2002 inventory. This State survey approach went beyond the EPA's prescribed inventory procedures in Volume III, Chapter 12 of the Emission Inventory Improvement Program January 2001 guidance for Marine Vessel Loading, Ballasting and Transit. The survey form requested information on days of operation, seasonal fuel transfer information on gasoline, distillate fuel oil, jet naphtha, jet kerosene, kerosene, residual fuel oil, and crude petroleum loading into ship and barge cargo tanks as well as ballast operations. The survey data was then summed to derive individual county totals. The results of this survey revealed that there were only

two fuel types (contaminated gasoline, and residual fuel oil) where loading had occurred. VOC emission factors (0.00009 lbs/1000 gallons of residual fuel oil and 3.4 lbs/1000 gallons of gasoline) were then applied to their respective fuel volumes to obtain the estimated emission losses. Although the EPA, on September 19, 1995, issued Federal Standards for Marine Tank Vessel Loading Operations and National Emission Standards for Hazardous Air Pollutants for Marine Vessel Loading Operations, the respective facilities transferring fuel were exempt from control requirements. Consequently, emissions estimates were based on the respective emission factors without the application of control measures. Individual county VOC emission estimates from loading and ballasting operations were reported using the following SCC codes:

Vessel Loading/Ballasting Operations	Reported SCC Code
Vessel loading, distillate fuel oil	2505020090
Vessel loading, gasoline	2505020120
Vessel loading, residual fuel oil	2505020060
Vessel loading, crude oil	2505020030
Vessel loading, naphtha	2505020150
Vessel loading, jet kerosene	2505020180
Vessel loading, kerosene	2505020180
Vessel ballasting, gasoline	2505020900
Vessel ballasting, crude oil	2505020900

Service Station Loading (Stage I)

Gasoline vapor loss occurs at service stations when gasoline is unloaded from delivery tank trucks into underground storage tanks. The extent of vapor loss is dependent upon the method of filling (splash, submerge, or vapor balanced). In computing VOC emissions from service station loading, year 2005 gasoline throughput estimates were obtained from Energy Information Administration's Petroleum Marketing Monthly data. The monthly data was then summed to derive an estimated statewide gasoline total. County gasoline total estimates were then determined by apportioning the statewide gasoline by the percent of state gasoline sales occurring within each county. County gasoline sales data was obtained from the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. State gasoline throughput consumption was apportioned on a county basis using the following mathematical equation:

$Ct = St \times Cs/Ss$

Where:

Ct = Estimated county gasoline consumption for year 2005
St = Statewide gasoline consumption for year 2005
Cs = County gasoline service station retail sales data
Ss = State gasoline service station retail sales data

VOC emission estimates were developed based upon the guidance provided in the EPA prescribed inventory procedures in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) and subsequent September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. Year 2005 and summer weekday emission factors were developed based upon actual temperature, and RVP fuel volatility information for various regions of the State to reflect the applicable RVP control measures. Monthly temperature data was obtained for the year 2005 from the NOAA, National Climatic Center Local Climatological Data that was utilized in determining year and summer day temperatures for the Michigan Upper Peninsula and Michigan Lower Peninsula regions. Reid Vapor Pressure (RVP) data for marketed gasoline during year 2005 was obtained from the Michigan Department of Agriculture, Motor Fuels Quality, Laboratory Division. VOC mission factors were then developed for splash fill, submerge fill, and vapor balanced gasoline dispensing facilities on a county basis which reflected the actual temperature and RVP of marketed gasoline products.

Year 2005 Temperature Summary

Month	Lower Peninsula Month Avg of Day Maximum	Upper Peninsula Month Avg of Day Maximum
December	33.5	24.8
January	28.0	18.9
February	33.8	29.5
March	38.2	33.2
April	59.7	53.8
May	64.8	59.3
June	82.4	77.1
July	83.5	79.4
August	81.8	77.1
September	77.3	72.5
October	62.1	55.7
November	49.4	37.1
Year Avg	57.9	51.5
Ozone Season Avg	74.9	69.9
Summer Weekday Avg	82.6	77.9

Stage I loading emission factors were determined using the methodology specified in September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. The following equation is presented:

L = 12.46xSPM/T

Where:

L = Loading loss (uncontrolled), pounds per 1000 gal of liquid
loaded

S= A saturation factor where S= 0.6 for submerged loading
with no vapor balance, S = 1.00 for submerge loading
with vapor balance, and S = 1.45 = splash

loading no
vapor balance

P = True vapor pressure of liquid loaded, pounds per square inch absolute (psia)

M = Molecular weight of vapors, pounds per pound-mole
T = Temperature of bulk liquid in degrees F + 460

The quantity of county gasoline throughput that is splash filled, submerge filled, and vapor balanced was estimated on basis of past gasoline surveys, and the applicability of state regulations which require the installation of submerge fill or vapor balanced systems. These percentages were obtained from the year 1999 emissions inventory. The same county fractional percentages of splash filled, submerge filled, and vapor balanced were used in the year 2005 inventory for consistency with respect to prior emission inventory.

The respective emission estimates were reported using the following SCC codes:

Michigan Gasoline Marketing Stage I Emission SCC Codes

Stage I Type	SCC
Submerge filled loading	2501060051
Splash filled loading	2501060052
Vapor balanced loading	2501060053

The EPA on December 19, 2003 issued final rule requirements for Stage I gasoline distribution in Standards of Performance for Bulk Gasoline Terminals and National Emission Standards for Gasoline Distribution Facilities (Bulk Gasoline Terminals and Pipeline Breakout Stations. These NESHAP requirements will be applied in point source inventories for bulk terminals.

Calculation of Stage I Emission Factors for Year 2005

Notes: Gasoline stage I temperatures based on available data as of 5/18/06. Reid vapor pressures were derived from Michigan Dept. of Agriculture analytical data which showed higher than expected averages due to the suspension of RVP restrictions during Hurricane Katrina.

Region	Year 2005 Annual Emission Factor lbs/1000 gal	Ozone Season 4/1/05-9/30/05 Emission Factor lbs/1000 gal	Summer Weekday 6/1/05-8/31/05 Emission Factor lbs/1000 gal	Year 2005 Annual Temperature F	Year 2005 Ozone Season 4/1/05-9/30/05 Temperature F	Year 2005 Summer Weekday 6/1/05-8/31/05 Temperature F	Year 2005 Annual RVP	Ozone Season RVP 4/1/05-9/30/05	Summer Weekday RVP 6/1/05-8/31/05	Year 2005 Annual True Vapor Pressure P	Year 2005 Ozone Season 4/1/05-9/30/05 True Vapor Pressure P	Year 2005 Summer Weekday 6/1/05-8/31/05 True Vapor Pressure P	Saturation Factor S	Year 2005 Annual RVP Molecular Weight	Ozone Season 4/1/05-9/30/05 RVP Molecular Weight	Summer Weekday 6/1/02-8/31/02 RVP Molecular Weight
Vapor Balance Gasoline																
Upper Peninsula	0.76	0.91	0.99	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	1	64.4	66.2	66.67
Lower Peninsula	0.86	1.00	1.07	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	1	64.4	66.2	66.67
SE Michigan	0.86	0.96	0.99	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	1	64.4	66.47	67.07
Submerge Fill Gasoline																
Upper Peninsula	4.54	5.44	5.93	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	0.6	64.4	66.2	66.67
Lower Peninsula	5.19	6.01	6.43	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	0.6	64.4	66.2	66.67
SE Michigan	5.19	5.79	5.91	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	0.6	64.4	66.47	67.07
Splash Fill Gasoline																
Upper Peninsula	10.97	13.14	14.33	**51.1**	**69.9**	**77.9**	11.2	9.6	9.0	4.82	5.82	6.4	1.45	64.4	66.2	66.67
Lower Peninsula	12.54	14.53	15.54	**57.9**	**74.9**	**82.6**	11.2	9.6	9.0	5.58	6.5	7	1.45	64.4	66.2	66.67
SE Michigan	12.54	13.99	14.29	**57.9**	**74.9**	**82.6**	11.2	9.3	8.4	5.58	6.23	6.4	1.45	64.4	66.47	67.07

Service Station Unloading/Vehicle Fueling (Stage II)

Motor vehicle fueling at service stations results in evaporative loss of gasoline. VOC emissions are produced during displacement of vaporized hydrocarbons and spillage of gasoline during refueling. EPA guidance in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) recommends the MOBILE model be used to generate refueling (Stage II) emission factors for highway emission inventories. Additional procedures were presented in September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. The MOBILE6 model was used to derive the Stage II emission factor by obtaining monthly emission factors in grams/VOC mile as well as fuel economy as miles per gallon and vehicle miles traveled mix for the different gasoline vehicle types (e.g., LDTV, LDGT, and HDGV). For each vehicle type, the monthly emission factor was multiplied by the fuel economy to obtain an emission factor in unit grams of VOC/gallon.

grams VOC/gallon = Grams/mile x miles/gallon

Stage II grams/gallon refueling emission factor rates were initially prepared by SEMCOG using MOBILE6.2 and then later adjusted for year 2005 state specific RVP and temperature data. The vehicle miles traveled (VMT) mix for each vehicle types was used to calculate a single weighted monthly emission factor. Summer and average annual emission factors were then developed for Southeast Michigan, the rest of the Lower Peninsula, and the Upper Peninsula. SEMCOG's Stage II grams/gallon adjusted emission factors are presented below. It is noted that the Stage II emission rates for year 2005 were greater than year 2002 rates due to the marketing of RVP exempt fuels created by Hurricane Katrina disruption of refinery operations.

Year 2005 Refueling Emission Rates for State of Michigan

Average Type and Geographical Area	**Grams/Gallon**
Summer (Average of monthly refueling emission rates for June, July & August, 2005)	
Southeast Michigan (Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne counties)	2.71
Rest of Lower Peninsula (All counties in Lower Peninsula except the 7 Southeast Michigan counties)	3.04
Upper Peninsula (All counties in the Upper Peninsula)	2.85
Average Annual (Average of monthly refueling emission rates)	
Southeast Michigan (Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne counties)	2.94
Rest of Lower Peninsula (All counties in Lower Peninsula except the 7 Southeast Michigan counties)	3.05
Upper Peninsula (All counties in the Upper Peninsula)	2.94

All rates were initially calculated using MOBILE6.2 model, and then later adjusted for year 2005 RVP and temperature conditions.

The respective SEMCOG grams VOC/gallon were then converted to lbs/1000 gallons.

Lbs VOC/1000 gallons = Grams VOC/gallon x 1 lb/453 grams x 1000 gallons

Year 2005 gasoline throughput estimates were obtained from Energy Information Administration's Petroleum Marketing Monthly data. The monthly data was then summed to derive an estimated statewide gasoline total. County gasoline total estimates were then determined by apportioning the statewide gasoline by the percent of state gasoline sales occurring within each county. County gasoline sales data was obtained from the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. Total county emissions estimates were based on the county gasoline volume by the corresponding refueling emission factor. Emission rates were reported using the SCC code 2501060100.

Service Station Tank Breathing

Pressure changes occur within underground storage tanks as a result of temperature differences that exist between gasoline vapor and the liquid phases. The exchange of vapor within the storage tank to the atmosphere is commonly described as tank breathing.

Underground gasoline storage tank breathing losses were estimated by applying a 1.0 pound per thousand gallon throughput emission factor using procedures presented in EPA's Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) and September 2002 Draft Summary of the Analysis of the Emissions Reported in the 1999 NEI for Stage I and Stage II Operations at Gasoline Service Stations. Year 2005 county gasoline consumption estimates were obtained by apportionment of the statewide gasoline consumption based on the county percentage of state gasoline retail sales. Statewide gasoline consumption data was obtained from Energy Information Administration's Petroleum Marketing Monthly and county retail gasoline sales information was identified in the U.S. Department of Commerce, Bureau of Census, Michigan 1997 Economic Census, Retail Trade, Geographic Area Series. Emission estimates were reported using the SCC of 2501060200.

Gasoline Tank Truck Transit

Breathing losses from gasoline tank trucks occurs as a result of pressure changes within the containment vessel. The pressure change in the containment vessel is caused by temperature differences between the vapor and liquid phases as well as

agitation during transport. Gasoline tank trucks leak VOC vapors and liquids from gaskets, seals, and seams during transport.

Because some gasoline is delivered to bulk plants rather than delivered directly to service stations from terminals, the amount of gasoline transferred in any area may exceed the total gasoline consumption, due to additional trips involved. Therefore, gasoline tank truck transit evaporation emissions were based on the total volume of gasoline transferred rather than county consumption level.

The total gasoline transferred in a given county was obtained by taking the sum of both the service station volume delivery and the bulk plant gasoline transfer. The bulk plant gasoline transfer volume in a county was obtained from point source data. VOC emissions estimates were developed using the gasoline tank truck transit emission factors identified by EPA procedures presented in Volume III, Chapter 11 of the Emission Inventory Improvement Program January 2001 guidance for Gasoline Marketing (Stage I and Stage II) . In this document, VOC loss from gas filled tank truck emission factor was 0.005 lbs/1000 gallons while empty vapor-filled tank trucks were 0.055 lbs/1000 gallons. A single emission factor of 0.06 lbs/1000 gallons was derived by taking the sum of the two respective factors, and then applying this emission factor to the total transported gasoline volume. Further emission adjustments were then made to the respective emission totals to reflect those delivery vessels in those counties that are subject to Michigan Air Pollution Control Rule R 336.1627. A control efficiency of 76% was considered before subsequent application of an 80% rule effectiveness and 100% rule penetration factors for delivery vessels in those counties subject to R336.1627. Emission estimates were reported using the SCC of 2505030120.

Aviation Fuel Stage I Loading

Gasoline vapor loss occurs at airports when gasoline is unloaded from delivery tank trucks into underground storage tanks. Because of the need to temporally adjust aircraft refueling emissions for all respective fuel types within all Michigan counties, it was determined that local aviation fuel sales information could only be acquired by contacting each fuel distributor serving each airport. Because the fleet of the aircraft varies at each airport, the amount of fuel type consumed will likewise be dependent on the types of aircraft being serviced and not just based upon Landing-Take Offs (LTOs) alone.

A list of those Michigan commercial and private airports where fuels are dispensed was obtained from the MDOT publication 2003 Michigan Airport Directory. A survey form was then mail to each airport operations manager. Total fuels sales information by fuel type(s) and season were obtained from either airport staff or assigned fixed base operators. This information was then summed for each Michigan county to provide an estimate of the total volumes of jet kerosene, jet naphtha, and aviation gasoline handled at each airport facility. Stage I loading VOC emission factors for jet kerosene and jet naphtha were determined using the following equation:

L = 12.46xSPM/T

Where:

L = Loading loss (uncontrolled), pounds per 1000 gal of liquid loaded

S= A saturation factor where 1.45 = splash loading

P = True vapor pressure of liquid loaded, pounds per square inch absolute (psia)

M = Molecular weight of vapors, pounds per pound-mole

T = Temperature of bulk liquid in degrees F + 460

For Stage I aviation gasoline VOC emissions, an emission factor was obtained the EPA publication entitled: Documentation for the 2002 Nonpoint Source National Emission Inventory for Criteria and Hazardous Air Pollutants (January 2004 Version). The resultant emission factors were then applied to the total county fuel throughput after considering point source fuel throughput deductions. Because EPA does not have itemized SCC codes by fuel type, VOC emissions were added together and reported using a SCC of 2501080050.

Aircraft Refueling (Stage II)

Aircraft refueling at airports results in the evaporative loss of aviation gasoline, jet kerosene, and jet naphtha. VOC emissions occur when vapor laden air in a partially empty fuel tank is displaced to the atmosphere during refueling. The quantity of the vapor being displaced is dependent upon the fuel temperature, fuel vapor pressure, aircraft fuel tank temperature, and the fuel dispensing rate.

Because of the need to temporally adjust aircraft refueling emissions for each respective fuel type within each Michigan county, it was determined that local aviation fuel sales information could only be acquired by contacting each fuel distributor serving each airport. Because the fleet of the aircraft varies at each airport, the amount of fuel type consumed will likewise be dependent on the types of aircraft being serviced and not just based upon LTOs alone.

A list of those Michigan commercial and private airports where fuels are dispensed was obtained from the MDOT publication 2003 Michigan Airport Directory. A survey form was then mailed to each airport operations manager. Total fuels sales information by fuel type(s) and season were obtained from either airport staff or assigned fixed base operators. This information was then summed for each Michigan county to provide the

total dispensed volumes of jet kerosene, jet naphtha, and aviation gasoline. VOC aviation refueling loss emission factors were obtained from the EPA publication Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) were then applied to the respective county total fuel volumes.

Aviation Fuel Type	Emission Factor as lbs of VOC/1000 gallons fuel
Jet kerosene	0.08
Jet naphtha	5.58
Aviation gasoline	12.20

Because there is no provision currently to allow for the reporting of emissions by individual fuel type, emissions were then summed for all fuel types and reported using the SCC code 2275900000.

Traffic Marking Coatings

Traffic marking coatings are paints that are used to mark pavement, including dividing lines for traffic lanes, parking space markings, crosswalks, and arrows to direct traffic flow. VOC emissions result from the evaporation of organic solvents during the application and curing of the marking paint.

VOC emissions were estimated for each county using the methodology identified in the EPA's Volume III, Chapter 14 of the Emission Inventory Improvement Program May 1997 Final Guidance for Traffic Markings. The preferred method was to conduct surveys to determine the volume of water and solvent based coating consumption, coating formulation (in terms of pounds of VOC content per applied gallon), and months of year 2005 when the coatings were applied. Survey forms were mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. In those situations where a county road commission failed to submit such information, emission estimates were based upon results of those counties that had responded to the survey. An average coating application rate (total gallons of coating applied per road miles in county) was first determined from survey respondents. Road length miles were obtained for the counties that failed to respond to the survey. Total coating gallon consumption estimates were estimated for counties that failed to respond by applying the road length miles to the average coating application rate. Similarly, an average VOC content (as lbs/gallon) was obtained by dividing the total mass of VOC emissions by the total coating volume of survey respondents. The result thereof was then applied to the estimated coating volumes for those counties that did not respond to the survey. This average density was reflective of the proportions of solvent and water based coatings by survey respondents. Seasonal coating application was also based

upon county survey results of the months during which the coatings were applied. It should be recognized that year 2002 was a recession year in which Michigan county and local governments had limited budgets. Consequently, it is likely that projected emissions would be greater during better economic times. Traffic marking paint emissions were reported using a SCC of 2401008000

Cutback Asphalts

Cutback asphalt is a bituminous road coating material that is prepared by blending an asphalt cement tar with a petroleum distillate (such as naphtha, kerosene, or other fuel oils). Cutback asphalt is used as a pavement sealant, tack coat, pothole filler, and a bonding agent between layers of paving material. Evaporative loss of the solvent from bitumen cement occurs as the cutback asphalt cures on the road surface. The rate at which VOC emissions occur is dependent both upon the temperature of the applied road surface, and the type of solvent used in the formulation of the cutback asphalt material. Gasoline or naphtha is used as a diluent in the production of "rapid cure" cutback asphalts. Kerosene and other low volatility fuel oils are also used as diluents in the production of "medium cure" and "slow cure" cutback asphalts.

VOC emissions were estimated for each county using the methodology identified in the EPA's Volume III, Chapter 17 of the Emission Inventory Improvement Program January 2001 Final Guidance for Asphalt Paving. In this document, the preferred method was to conduct surveys to determine locally-specific information on cutback asphalt use on Michigan roads.

In order to estimate VOC emissions from the application of cutback asphalt materials (rapid cure, medium cure, and slow cure), a survey was mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. The survey requested information on:

1. The quantities of rapid cure, medium cure, and slow cure cutback asphalt materials that were applied during year 2005;

2. The type of petroleum distillate and volume that was used as a diluent in the formulation of each cutback paving material; and

3. The months during which cutback asphalt materials were applied.

The EPA has determined that evaporation occurs on about four months with 75 percent by weight of diluent evaporates in the first day for rapid cure materials while it takes about one week for 50 percent by weight of diluent to evaporate from medium cure cutback asphalt materials. Conservative estimates were made by assuming that all the diluent evaporates within the season during which it is applied.

VOC emission estimates were based on the amount of the petroleum based diluent that comprises the cutback asphalt material and then applying their respective solvent density. Emission estimates were reported using a SCC of 2461021000.

Emulsified Asphalts

Emulsified asphalts are a type of liquefied road surfacing material that is used in the same application as cutback asphalts. Instead of blending the asphalt material with a petroleum distillate like their cutback asphalt counterparts, emulsified asphalts use a blend of water with an emulsifier (soap). Emulsified asphalts either rely on water evaporation to cure (anionic-high float emulsions) or ionic bonding of the emulsion and the aggregate surface (cationic emulsions).

In the EPA's Volume III, Chapter 17 of the Emission Inventory Improvement Program January 2001 Final Guidance for Asphalt Paving., the preferred method is conduct a survey of emulsified asphalt application on Michigan roads. Survey forms were mailed to all Michigan county road commissions, major municipality road maintenance departments, and to MDOT. This form requested information on the quantities of asphalt materials (in pounds and barrels) applied to Michigan roadways and the months during which they were applied. Road length miles were also obtained for all Michigan counties. In those situations where a county road commission failed to submit such information, emission estimates were based upon results of those counties that had responded to the survey. An average application rate (total barrels of emulsified asphalts applied per road miles in county) was first determined from survey respondents. Total barrel consumption estimates were estimated for counties that failed to respond by applying the road length miles to the average emulsified asphalt application rate. VOC emissions were obtained by applying an EPA factor of 9.2 lbs VOC/barrel of applied asphalt. It was further assumed that all emissions occur during the season that the asphalt materials were applied and reported using a SCC of 2461022000.

Breweries

Breweries, microbreweries, brewpubs, and contract brewers emit VOC including ethanol, ethyl acetate, myrcene and other higher alcohols from various brewing processes. For the smaller brewers, VOC are lost by the fermentation, in brew kettles, hot wort, mash and lauter tuns, and through spent grain. Microbreweries and brewpubs typically produce beer for patron on-site consumption, although some may have limited keg distribution. These smaller microbreweries and brewpubs typically combine some processes, and canning/bottling operations typically do not exist since the beer is consumed on-site or stored in kegs.

Various trade organization lists were obtained to identify brewers in the State of Michigan along with their beer production. Although there are some regional breweries, the vast majority are brewpubs and microbreweries. These facilities have very small to

insignificant volatile organic compound emissions. Emission estimates were based on a combined emission factor rate obtained from Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) of 3.0465 lbs VOC per 1000 barrels. Consequently, this small emission factor and Michigan beer production rates didn't justify the need for a survey of such establishments. Emissions were estimated by establishment on the basis of trade reported production and applying the respective emission factor. A SCC of 2302070001 was used in reporting brewery emissions.

Distilleries

Distilleries include ethanol production facilities that are used in the production of gasohol motor fuels, grain alcohol for industrial purposes, and distilled spirits for personal consumption. These products are produced from the fermentation of aged mashed grains with distillation for the capture of desired alcohol based products. The fermentation products use yeast to convert grain sugars into ethanol, ethyl acetate, isomyl alcohol, isobutyl alcohol and carbon dioxide. Grains used in the process may include corn, rye, barley, and wheat. A more detailed description of distilleries and their emissions can be found in the EPA publication entitled: Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).

During year 2005, there was only one ethanol production facility in operation. The Michigan Ethanol LLC - Caro, Michigan facility was already being reported as a point source. Consequently, the area source contribution from distilleries using SCC 2302070010 had zero emissions for all Michigan counties. A number of new ethanol plants were under construction, but did not operate in the 2005 inventory year.

Wineries

Wineries produce alcohol beverages from the fermentation of fruit juices. The major processes in vinification include fruit harvesting, crushing, pressing, fermentation, clarification, aging, finishing, and bottling. During this fermentation process of both red and white wines, primarily ethanol and smaller quantities of methyl alcohol, n-propyl alcohol, butyl alcohol, isoamyl alcohol, and acetaldehydes are produced along with carbon dioxide. This process involves the reaction of a yeast with glucose and fructose sugars to produce ethanol and carbon dioxide. The EPA emission factors are reflective of VOC evolved during fermentation in vinification.

County estimates of wine production were based upon wine volume information of Michigan Department of Treasury tax receipt information supplied to the Michigan Grape and Wine Industry Council. A VOC emission factor was obtained from Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).of 4.6263 lbs VOC/ 1000 gallons This emission factor is a sum of ethyl alcohol, methyl alcohol, n-propyl alcohol, n-butyl

alcohol, sec-butyl alcohol, isobutyl alcohol, isoamyl alcohol and acetaldehyde for red wine from AP-42. Emission estimates were reported using a SCC of 230207005

Stationary Source Fossil Fuel Combustion

The combustion of natural gas, propane-LPG, distillate fuel oil, kerosene, and residual fuel oil in small boilers, furnaces, heaters, and stoves are also a source of VOC, NOx, particulates, sulfur dioxide, and ammonia emissions. Because these sources are so numerous to be identified in point source inventories, this area source category attempts to provide a collective estimate of emissions from these smaller energy consumption sources by subtracting all fuel used by point sources from total fuel consumption. Procedures for the estimation of these smaller sources are presented in the EPA's documents entitled:

1. Volume II, Chapter 2 of the Emission Inventory Improvement Program January 2001 Preferred and Alternate Methods for Estimating Air Emissions from Boilers.

2. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion

3. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion

4. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion

5. Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia

6. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: A National Methodology and Emission Inventory for Residential Fuel Combustion

This documentation involves determination of total fuel consumption over an area with subsequent fuel deductions made for point source fuel consumption, and then applying emissions factors to estimate fuel emissions.

Total fuel consumption information was based on data supplied from U.S. Department of Energy, EIA documents. This unaccounted fuel consumption was then apportioned to individual counties using U.S. Census Bureau information for the individual end use sector fuel types based upon LADCO states methodology. Area source fuel emissions were reported for the following residential, commercial/institutional, and industrial end use sectors. Since utility boilers are accounted as point sources, area source emissions are not reported for this end use sector.

Residential Boilers & Furnaces

County emission estimates for the residential end use sector was based upon the consumption of natural gas, propane-LPG, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Since the EIA merely provides statewide fuel consumption totals, county fuel consumption estimates were obtained by apportioning the fuel consumption based upon the number of year 2000 occupied household census counts using the given fuel. Emission estimates were calculated using the following mathematical equation:

$$Cf = Ch/Sh \times Sf$$

Where

Cf = Estimated county residential sector consumption of a given fuel type for year 2005

Ch = Number of year 2000 census occupied households in a given county that utilize a given fuel type

Sh = Total number of year 2000 census occupied households statewide that utilize a given fuel type

Sf = Total statewide residential sector consumption of a given fuel type

Michigan Residential Fuel Consumption Information Sources

Residential Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Propane LPG	Petroleum Marketing Annual, 2005, Table 49: Prime Supplier Sales Volumes of Aviation Fuels, Propane and Residual Fuel Oil by PAD District and State
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 19: Adjusted Sales for Residential Use: Distillate Fuel Oil and Kerosene, 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county residential fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Residential Fuel Emission Factors

Residential Fuel Type	Units	CO	NH_3	NOx	PM_{10}-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	40	0.49	94	7.6	7.6	0.6	5.5
Propane LPG	Lbs/1000 gal	3.2		13	0.68	0.68	0.1	0.5
Distillate fuel oil	Lbs/1000 gal	5.0	0.8	18	2.38	2.13	42.60	0.7
Kerosene	Lbs/1000 gal	4.8	0.8	17.4	2.38	2.13	41.1	0.7
Coal	Lbs/ton	275	0.000565	3.0	18.63	4.86	37.83	10

Sources of Emission Factors:

1. U.S. Environmental Protection Agency Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia

2. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: A National Methodology and Emission Inventory for Residential Fuel Combustion

3. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

The resulting emission estimates were reported by individual fuel type using the following SCC codes.

Michigan Residential Combustion Emission SCC Codes

Residential Fuel Type	SCC
Natural gas	2104006000
Propane LPG	2199007000
Distillate fuel oil	2104004000
Kerosene	2104011000
Coal	2104001000

Commercial/Institutional Boilers and Furnaces

Estimation of fuel combustion by the commercial/institutional sector was performed using an adaptation of a methodology presented in the U.S. Environmental Protection Agency publications:

1. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion

2. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion

3. Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion

County emission estimates for the commercial/institutional end use sector were based upon the consumption of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Fuels were subtracted for point sources, and the net area fuel contribution was apportioned or allocated using procedures instructed by LADCO. This procedure involved statewide commercial/ institutional fuel apportionment to a county level using the commercial/institutional employment data as obtained from U.S. Department of Commerce, Bureau of Census publication entitled: County Business Patterns, Michigan: 2003 (CBP/03-24 issued September, 2005). County fuel estimates of individual fuel types were estimated using the following equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county commercial/institutional sector consumption of a given fuel type
Ce= Total county employment in the commercial/institutional sector
Se= Statewide employment in commercial/institutional sector
Sf= Statewide commercial/institutional sector consumption of a given fuel type

Because the Energy Information data includes diesel fuel totals within the distillate fuel oil total, these motor vehicle fuels were deducted to provide only an estimate of #1, #2, and #4 fuel oils.

Michigan Commercial/Institutional Fuel Consumption Information Sources

Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 20: Adjusted Sales for Commercial Use: Distillate Fuel Oil, Residual Fuel Oil and Kerosene 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county commercial/institutional fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Commercial/Institutional Fuel Emission Factors

Commercial/Institutional Fuel Type	Units	CO	NH_3	NOx	PM_{10}-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	0.49	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1000 gal	5	0.80	55	9.07	3.37	194.05	1.13
Distillate fuel oil	Lbs/1000 gal	5	0.80	20	2.38	2.13	53.96	0.34
Kerosene	Lbs/1000 gal	5	0.80	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.000565	7.5	6.0	2.2	36.86	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for commercial/institutional natural gas combustion

2. U.S. Environmental Protection Agency. FIRES database

3. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42)

4. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

The resulting emission estimates were reported by individual fuel type using the following SCC codes.

Michigan Commercial/Institutional Combustion Emission SCC Codes

Fuel Type	SCC
Natural gas	2103006000
Residual fuel oil	2103005000
Distillate fuel oil	2103004000
Kerosene	2103011005
Coal	2103002000

Industrial Boilers and Furnaces

Estimation of fuel combustion emissions of industrial boilers and furnaces was performed in similar manner as the commercial/institutional sector. Statewide industrial fuel consumption information was obtained from the U.S. Department of Energy, EIA publications. Point source deductions were made for each fuel type to obtain the area contribution which was then apportioned to the county level using LADCO prescribed procedures.

County fuel consumption estimates of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal were based upon the following mathematical equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county industrial sector consumption of a given fuel type
Ce= Total county employment in the industrial sector
Se= Statewide employment in industrial sector
Sf= Statewide industrial sector consumption of a given fuel type

Michigan Industrial Fuel Consumption Information Sources

Industrial Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 21 Adjusted Sales for Industrial Use: Distillate Fuel Oil, Residual Fuel Oil, and Kerosene (#1, #2, and #4 fuel oils– excludes diesel oil)
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, , Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

County employment data was obtained from the U.S. Department of Commerce, Bureau of Census publication entitled: County Business Patterns, Michigan: 2003 (CBP/03-24 issued September, 2005). Upon obtaining county industrial fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were generally based on the LADCO adopted emissions factors.

Michigan Industrial Fuel Emission Factors

Industrial Fuel Type	Units	CO	NH_3	NOx	PM_{10}-PRI	PM25-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	3.2	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1000 gal	5.0	0.8	55	7.17	4.67	157	0.28
Distillate fuel oil	Lbs/1000 gal	5.0	0.8	20	2.3	1.55	53.96	0.2
Kerosene	Lbs/1000 gal	5.0	0.8	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.00057	7.5	6.0	2.2	38	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for industrial natural gas, residual fuel oil, distillate fuel oil, and coal combustion

2. U.S. Environmental Protection Agency. FIRES database
3. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42)

4. U.S. Environmental Protection Agency. Final Report on Development and Selection of Ammonia Emission Factors

Emission estimates were reported using the following SCC codes:

Michigan Industrial Combustion Emission SCC Codes

Industrial Fuel Type	SCC
Natural gas	2102006000
Residual fuel oil	2102005000
Distillate fuel oil	2102004000
Kerosene	2102011000
Coal	2102002000

Remedial Action, Site Clean Up & Leaking Storage Tanks

Evaporative VOC emissions occur during remediation and clean up at those sites of environmental contamination. Such remediation activities may include air stripping or sparging of a VOC from contaminated groundwater or incineration of a spoil material removed from a contaminated site. In some instances carbon adsorption may be required to reduce VOC emitted during air stripping or spraying operations.

Estimation of VOC loss from remedial action activities was determined by summing the allowable emissions from permits to those parties that were engaged in such activities as provided by the MDEQ, Air Quality Division, Permit Section. Although site remediation activities are subject to NESHAPs, these requirements did not apply at the time of the year 2005 emissions inventory. Emissions were reported using a SCC of 2660000000.

Municipal Waste Landfills

A municipal solid waste landfill is defined as any facility that is regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA) which receives primarily household and/or commercial wastes.

VOC are produced from municipal solid waste by: the volatilization of the waste material itself, the microbiological (anaerobic) putrefaction of organic waste materials that result in the formation of organic acids and alcohols that are vaporized, and the chemical reaction of one or more waste materials or chemical decomposition intermediate. The rate at which VOCs are emitted from a landfill is dependent upon the structural design of cells, the waste composition (physical/chemical properties), the moisture content of the waste, the amount of waste disposed, temperature, age of the landfill, the chemical reactivity of the waste, the microbiological toxicity of the waste, and the effectiveness of landfill gas collection systems. Where landfill gas is collected for use in boilers, internal combustion engines (reciprocating and turbines) or flared at the landfill site, there are additional air pollutants such as NOx, particulates ($PM_{2.5}$ and PM_{10}), and carbon monoxide produced from incomplete combustion.

Estimation of VOC emissions from municipal landfills were based on the revised technical procedures presented in the EPA publication entitled: Volume III, Chapter 15 of the Emission Inventory Improvement Program January 2001 Revised Final Guidance for Landfills. In this publication, the preferred method for the estimation of area source emissions is to use the LandGem model or the equations from the Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42) section on landfills. LandGem is a computer based model that uses the same equations as that of AP-42. The emissions calculation for the estimation of landfill gas requires site specific information including: landfill design capacity, accumulated waste totals from operation of the landfill, and existing control requirements from landfill gas collection systems. Landfills may be subject to either

new source performance standards (40 Code of Federal Regulations part 60 Subpart WWW) or emission guidelines (40 Code of Federal Regulations, part 60, Subpart Cc). Landfills are now also subject to NESHAPs which became effective on January 16, 2003. For those landfills that were not being reported in the point source inventory, area emission estimates were reported on the basis on LandGem model simulations using the SCC of 2620030000. These simulations reflected total waste receipts under the prior year 1999 inventory with addition made for waste receipts for years 2000-2005 as obtained from annual reports by the MDEQ, Waste and Hazardous Division Report of Solid Waste Landfilled in Michigan. For those landfills that operated landfill gas collection/combustion systems, emission estimates considered tables 2.4-3 and 2.4-5 of AP-42 with adjustments considered for a landfill gas methane collection efficiency of 75% of LandGem model predicted methane generation at a given landfill site.

Non-Methane Organic Compound Control Efficiencies for Landfill Gas Combustion from AP-42

Combustion Control Device	Typical Control Efficiency (%)
Boilers	98
Flares	99.2
Gas Turbines	94.4
IC Engine	97.2

Emission Rates for Secondary Compounds from Landfill Gas Combustion (Based upon lbs/ Million Cubic Feet of Landfill Gas Combusted)

Combustion Control Device	NOX	$PM_{2.5}$-PRI	PM_{10}-PRI	CO
Flare	40	17	17	750
IC Engine	250	48	48	470
Boiler	33	8.2	8.2	5.7
Gas Turbines	87	22	22	230

Architectural Surface Coating, 2005

Alternative method one was chosen from the guidance document *Emission Inventory Improvement Program (EIIP), Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating*. Data was readily available for the use of per capita emission factors.

MDEQ, Air Quality Division staff determined per capita usage factors by dividing the 2004 national total architectural surface quantities for solvent and water based coatings (U.S. Census Bureau MA325F, Paint and Allied Products) by the U.S. population for 2004 (U.S. Census Bureau, http://www.census.gov).

http://www.census.gov/industry/1/ma325f04.pdf

http://www.census.gov/popest/national/files/NST_EST2005_ALLDATA.csv

Solvent-Based Paint

Solvent-based paints produced and shipped in the U.S. in 2004, the most recent available year, were totaled (includes architectural lacquers and architectural coatings, n.s.k.). The resulting number was divided by the 2005 U.S. population to produce a per capita solvent-based paint usage factor of 0.5265 gallons per person.

The resulting solvent paint use, in gallons per county, was multiplied by a VOC emission factor of 3.87 lb/gal, from Table 5-2 of the EIIP guidance, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating.* This produced total VOC emissions from solvent-based paint. The VOC was then speciated for toxics, utilizing speciation factors from Table 5-4 from the EIIP guidance. Acetone, listed in the methodology prepared by the Great Lakes states, was removed because it is not a toxic.

Water-Based Paint

Water-based paints produced and shipped in the U.S. in 2004 were totaled. The resulting number was divided by the 2005 U.S. population to produce a per capita water-based paint usage factor of 2.2473 gallons per person.

The resulting water-based paint use in gallons per county was multiplied by a VOC emission factor of 0.74 lb/gal, from Table 5-2 from the EIIP guidance, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 3: Architectural Surface Coating.* This produced total VOC emissions from water-based paint. The VOC was speciated for toxics, utilizing speciation factors from Table 5-3 from the EIIP guidance.

No point source deductions were performed, as none were needed for this category.

Autobody Refinishing in Michigan, 2005

Alternate method 3 of the EIIP document, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 13: Auto Body Refinishing* was followed by Michigan. National emissions for the category were allocated to the county level based on census data.

79,429.59 tons of VOC were estimated nationally for this category based on 1997, 1998 and 1999 data, as indicated within the GLC methodology. The estimate of national VOC emissions from autobody refinishing was divided by a 2005 national population estimate of 296,410,404 to produce a VOC emission factor of 0.54 lbs/person.

Area source estimations were adjusted by deducting point source VOC emissions.

A seasonal adjustment factor of 1.0 was made for this category for the ozone season. The category of auto refinishing was considered to be uniform throughout the year, per Table 5.8.1 of the EPA document *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources*. Ozone season daily emissions were calculated per the example on page 5-23 of this document. Ozone season throughput was also calculated. 5 activity days per week were selected, per Table 5.8.1. Annually, 260 days of operation were assumed. NOx and CO emissions were not calculated, as this category is not considered a source of NOx or CO.

References

1. Emission Inventory Improvement Program, Volume 3, Chapter 13, *Auto Body Refinishing, January 2000*.
2. Fire 6.23 database
3. U.S. Census Bureau, Population Division. 2006. Population Estimates Program. Washington, DC 20233.
4. Annual County Business Patterns data are available through U.S. census at: http://www.census.gov/epcd/cbp/view/cbpview.html
5. Section 3.8 of Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I (1991)

Estimating Emissions from Consumer and Commercial Solvent Use

The GLC methodology, a portion of which is included below, was based on the EIIP guidance document, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 5: Consumer and Commercial Solvent Use.* Michigan used the EIIP and GLC guidance for the estimation of criteria and toxic pollutants for this category for 2005. Michigan chose to use the preferred method with per capita emission factors, adjusted for the federal VOC reduction rule as provided in Table 2 of the EIIP guidance.

SCCs

The following SCCs were utilized by Michigan, per LADCO's recommendations:

2460100000	personal care products
2460200000	household Products
2460400000	automotive aftermarket
2460600000	adhesives and sealants
2460800000	FIFRA-regulated products
2460500000	coatings and related products
2460900000	miscellaneous products

From GLC methodology**:**

Overview

All quotes and information contained within are from the source, Emission Inventory Improvement Program, Volume 3, Chapter 5, *Consumer and Commercial Solvent Use, August 1996*. The consumer and commercial solvent source category includes a wide array of products including personal care products, household cleaning products and household pesticides. However, all VOC emitting products used by businesses, institutions and numerous industrial manufacturing operations are also included. A detailed list of products included in this category can be found on page 5.2-3 of the 1996 EIIP document. The majority of VOCs introduced into the atmosphere from this category is a result of evaporation of the solvent contained in the product or from the propellant released during product use.

Dry cleaning Area Source Emissions for Michigan, 2005

Standard Industrial Classification (SIC) 7215 (coin-operated dry cleaning establishments) was not considered for this inventory. The AQD's dry cleaning staff in the Technical Programs Unit indicated that virtually all coin-operated dry cleaning machines in Michigan have been discontinued due to the large cost of keeping them supplied with perchloroethylene (per Elden Dickinson, AQD). SIC 7216 (dry cleaning establishments, excluding coin-operated facilities) was considered instead. Under the North American Industrial Classification System (NAICS), SIC 7216 is known as NAICS 812320.

To calculate 2002 VOC emissions, Michigan utilized alternative method two, per employee emission factor. 2003 county employment data was obtained from the U.S. Census Bureau's document, *2003 Michigan County Business Patterns*. 2005 data was not available, and was not expected for some time.

Dry cleaning has a uniform seasonal adjustment factor (1.0), remaining constant during the ozone season, per EPA's *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources.*

2003 employment data, the latest from the U.S. Census Bureau's County Business Patterns, was obtained for NAICS 812320, for each county where it was available. Where available, employment data for the broader category of NAICS 812 was also obtained.

The next step was to determine a ratio between the number of employees under NAICS 812320, and the number of employees under NAICS 812. For counties that had employment numbers for NAICS 812, this ratio was used to estimate how many of the employees would fall under the code 812320.

The next task was to develop an employment number for those counties where drycleaner employment numbers were not available from the County Business Patterns. Using population numbers for those counties where employment data was available, a per capita number of dry cleaning employees was calculated. As certain counties have no perchloroethylene drycleaners (per lists of perc dry cleaners from Randy Johnson, AQD), values of zero were entered for those counties.

Reports from Michigan's 2005 point source emission inventory (the latest complete inventory) were reviewed to determine if any counties had point source employment for SIC 7216 (NAICS 812320). Berrien, Ingham and Jackson (NAICS 8123) counties did have point sources under SIC 7216, and the number of employees at each source was obtained from the emission inventory. Each source's employment number was subtracted from the appropriate county's employment number.

Once estimates of employment for SIC 7216 were available for each county, an emission factor for VOC of 1,800 lb/yr/employee was obtained from Table 4.5-1 of EIIP Vol. III, Chapter 4.

From EIIP

Subcategory	Reactive VOC (lb/year/employee)	Total Organics (lb/year/employee)
All solvents (total)	1,800	2,300
Halogenated Solvents PERC, TCA and CFC 113 Coin Operated Commercial/Industrial		 980 52 1,200
Mineral Spirits and Other Unspecified Solvents	1,800	1,800

On a per-unit basis: 0.8 tons/facility-year (assumes that average coin-op facility has two dry cleaning units and each emits 0.4 tons of PERC per year).

From AP-42

Commercial: 1.3 lb/year/person (all nonmethane VOC)
Coin Operated: 0.4 lb/year/person (all nonmethane VOC)

A rule for perchloroethylene dry cleaning air emissions became effective late 1996 (58FR49354. National Emission Standards for Hazardous Air Pollutants for Source Categories: Perchloro-ethylene Dry Cleaning Facilities. Final Rule. September 22, 1993.). EPA estimates the rule reduces perchloroethylene emissions from dry cleaning operations by 44%. Depending on the methodology used to estimate air emissions from perchloroethylene dry cleaning operations the effectiveness of this rule may need to be factored into the calculation.

References:

U.S. Census Bureau, *2003 Michigan County Business Patterns*

Emission Inventory Improvement Program Vol. III, *Area Sources: Preferred and Alternative Methods*, Chapter 4, Dry cleaning. May 1996.

Elden Dickinson, Dry Cleaning Unit, Drinking Water and Radiological Protection Division, Michigan DEQ. Personal communication, 5/07/01.

US EPA. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources. May 1991. EPA –450/4-91-016.

Graphic Arts Criteria and Toxics, 2005

The EIIP area source guidance document, dated November 18, 1996, was followed.

The EIIP preferred method was not utilized, as it required a survey of facilities. Alternative Method 1, ink sales emission factor method, was found to be not feasible for Michigan, as (during calculation of the 1999 inventory) point sources used more ink than the state proportion of national ink production was calculated to be.

Per Alternative Method 2, the population of the inventory region was obtained from state data for 2005, and multiplied by the per capita emission factor provided in the EIIP guidance. This produced total uncontrolled emissions from all graphic arts facilities with less than 100 tons per year of VOC emissions, for the entire state. This method used a 1991 EPA emission factor of 0.00065 tons VOC per capita.

Total uncontrolled VOC emissions from area source graphic arts facilities (those with less than 100 tons per year of VOC emissions) was then estimated for each county. This was done by obtaining uncontrolled VOC emissions from point sources with less than 100 tons per year of VOC, from the 2005 EI. SICs 2711, 2721, 2752 and 2754 (NAICS 51111, 511112, 323114, and 323111) were the SIC codes queried. This number was then subtracted from total uncontrolled emissions from graphic arts facilities, on a county by county basis. The remaining number is the area source VOC emissions per year.

Solvent Cleaning 2005 (criteria)

In this category, the use of solvents is broken into two broad classifications. The classifications are solvent cleaning (which is composed of cold cleaning and vapor/in-line cleaning), and solvent cleanup (predominantly wipe cleaning of external surfaces).

EIIP Alternative Method

Solvent Cleaning Equipment (both Cold Cleaners and Vapor/In-line Cleaners):

Emission factors:

EIIP Table 6.5-2 provides per capita and per employee emission factors, as reproduced below.

Recommended Method for Solvent Cleaning Equipment

Michigan chose to use the per employment factors available in Table 6.5-2 from *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume I: General Guidance for Stationary Sources* (EPA, 1991), for the 2005 emissions inventory. Employee data was obtained from the U.S. Bureau

of the Census document, *County Business Patterns, Michigan: 2003*, which was the most recent version at the time the category was estimated. Area source emissions were then determined by subtracting point source emissions from total emissions. When the result was a negative number, area source emissions were set to zero.

The following SCCs, per email from Grant Hetherington, WI DNR on 9/19/05, were utilized for reporting the emissions to be consistent with the other LADCO states:

2415360000 - Auto Repair Services (SIC 75): Cold Cleaning

2415345000 - Miscellaneous Manufacturing (SIC 39): Cold Cleaning

2415245000 - Miscellaneous Manufacturing (SIC 39): Conveyerized Degreasing

241523000 - Electronic and Other Elec. (SIC 36): Conveyerized Degreasing

Table 6.5-2: Per Capita and Per Employee Solvent Cleaning Emission Factors (EPA, 1991)

Subcategory	SIC Codes	Per Capita Factor (lb/yr/person)		Per Employee Factor (lb/yr/person)	
		VOCs	Organics	VOCs	Organics
Solvent cleaning (total)	25, 33-39, 417 423, 551, 552, 554-556, 753	4.3	7.2	87	144
Cold Cleaning					
Automobile Repair	417, 423, 551, 552, 554-556, 753	2.5	2.5	270	270
Manufacturing	25, 33-39	1.1	1.1	24	24
Vapor and In-Line Cleaning					
Electronics and Electrical	36	0.21	1.1	29	150
Other	25, 33-39, 417, 423, 551, 552, 554-556, 753	0.49	25	9.8	49

2005 point source employment data was obtained from MAERS. These values were then deducted from the total emissions estimated by using the per capita emission factor and 2005 Michigan county population data.

References

EPA. *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone: Volume I: General Guidance for Stationary Sources* (May 1991).

EPA. *STAPPA-ALAPCO-EPA Emission Inventory Improvement Program (EIIP).* Volume III - Area Sources Preferred and Alternative Methods. Chapter 6, Solvent Cleaning. September 1997.

US Department of Commerce, Bureau of the Census. *County Business Patterns, Michigan: 2003*. September 2005.

Industrial Surface Coatings, Toxics, 2005

The GLC methodology was followed by Michigan for estimating toxics for 2005. The GLC methodology is based on EIIP, *Volume III, Area Sources Preferred and Alternative Methods, Chapter 8: Industrial Surface Coating*. In most cases alternative method one, default per employee factors, were used, except for SCCs where the per employee-based emission factors yielded unrealistically high values of pollutants. The MDEQ, Air Quality Division staff believe that the point source employee deductions performed for each affected SCC (based on NAICS information from U.S. Census Bureau's *County Business Patterns*, and the Air Quality Division's point source inventory) do not account for all of the point source employees, resulting in the high values.

For the SCCs 2401050000 (miscellaneous finished metal) and 2401070000 (motor vehicles), it was decided that per capita based emission estimates would be utilized instead of the per employment based methods which yielded large values of 486 million lbs VOC (935 tons per summer weekday) and 57 million lbs VOC, respectively. The per capita methods yielded more realistic numbers of 4.6 million and 10.9 million lbs VOC.

For the SCC 2401020000 (furniture and fixtures), the employment based method resulted in an estimate of 31 million lbs (60 tons per summer weekday). The per capita method resulted in an estimate of 20 million lbs. As the estimates for 2401020000 appeared unrealistically large with either method, this category was omitted from the inventory.

Total area source VOC emissions for industrial surface coating for 2005 were approximately 50 million lbs.

From the GLC methodology:

> **Source Identification**
>
> Searching through the Standard Industrial Classification Code List (SIC), the North American Industry Classification System (NAICS), through the Factor Information Retrieval System (FIRE 6.23) and table 8.5-1 of the Volume III Chapter 8 Industrial Surface Coating September 1997 publication of EPA, the following codes were identified for each of the fifteen industrial surface coating category.
>
> **Factory Finished Wood** - **A2401015000**
> **SIC** 2426-2429, 243-245, 2492, 2499
> **NAICS** 321113, 321912, 32192, 321911, 321918, 33711, 321212, 321214, 321213, 321991, 321992, 33999, 333414, 321999, 321211

Wood Furniture - **A2401020000**
SIC 25
NAICS 337122, 337121, 337124, 337214, 33791, 337129, 337125, 337211, 33636, 339942,
337127, 337212, 337215, 33792,

Metal Cans - A2401040000
SIC 3411
NAICS 332431

Misc Finished Metals - **240105000**
SIC 34xx(exclude 341 and 3498)
NAICS 332211, 332212, 332213, 332999, 332722, 332117, 332912, 332611, 332998, 332913, 332439, 33251, 332919, 332312, 322225, 332618, 332321, 332313, 33242, 332612, 332322, 332311, 339911, 333924, 332114, 332721, 332994, 334518, 332111, 332112, 33637, 332115, 332116, 332214, 332813, 339914, 339912, 332812, 332992, 332993, 332995, 332911

Machinery and Equipment - A2401055000
SIC 35
NAICS 333611, 333618, 333111, 332323, 333312, 333112, 33312, 333131, 336311, 333995
333132, 333921, 333922, 333923, 333924, 333513, 332997, 333514, 333511, 333515, 333516, 333992, 333518, 333292, 33321, 333291, 333293, 333294, 33322, 33241, 333295, 333911, 332991, 333912, 333411, 333993, 333612, 333994, 333613, 314999, 334418, 333996, 333997, 33271, 333999, 334119, 334518, 333512, 333991, 333412, 336391, 333415, 333913,

Large Appliances - A240106000
SIC 363
NAICS 335221, 335222, 335224, 335211, 339999, 333414, 335212, 333298, 335228,

Electronic and Other Electrical - 2401065000
SIC 36,123,357
NAICS 334111, 334112, 334113, 33422, 334418, 334613, 333992, 335129, 333311, 333313, 339942, 51222, 335311, 335313, 335312, 335991, 335314, 335999, 33511, 335931, 335932, 335121, 335122, 334613, 336321, 335129, 33431, 334612, 334419, 335911, 335912, 333319,
334411, 334412, 334414, 336322, 334415, 334416, 334417, 333618, 33429, 33421,

Motor Vehicles - 240107000
SIC 3711

NAICS 33611, 336112, 33612, 336211

Other Transportation Coatings - 2401075000
SIC 37(not 3711,373)
NAICS 336213, 336312, 336322, 33633, 33634, 33635, 336399, 336212, 336415, 336411, 336412, 54171, 332912, 336999, 336413, 333911, 333924, 33651, 336991, 336414, 336419, 336214, 336992

Marine Coatings - 240108000
SIC 373
NAICS 48839, 336611, 336612, 81149

Misc. Product Coatings Manufacturing - 240109000
SIC
NAICS 339

Industrial High Performance Maintenance Coatings- 2401100000
SIC
NAICS 811

Other Special Purpose Coatings - 2401200000
SIC
NAICS

VOC factors from Table 8.5-1 of the EIIP guidance were applied to employment estimates based on the U.S. Bureau of the Census document, County Business Patterns: Michigan, 2003, which was the most recent data available at the time the estimates were created.

References

EPA. STAPPA-ALAPCO-EPA Emission Inventory Improvement Program (EIIP). Volume III: Chapter 8 Industrial Surface Coating September 1997.

U. S. Census web site http://www.census.gov/

Open Burning: Municipal Solid Waste, 2005 Criteria Pollutants

For the category of open burning of municipal solid waste (MSW), EPA's methodology from Appendix A of *Documentation for the Final 2002 Nonpoint Sector (Feb 06 Version) National Emission Inventory for Criteria and Hazardous Air Pollutants* was followed. The ratio of urban to rural population was obtained from 2000 U.S. Census data, per the EPA's method, then multiplied by a 2005 U.S. Census Bureau estimate of the county population in Michigan to obtain an estimate of rural population in 2005. Per capita emission factors were used, after first excluding those counties where the population was greater than 80% urban under EPA's presumption that open burning of MSW would not occur there.

Outdoor Wood Boilers, 2005 criteria pollutant estimates

The Wisconsin methodology distributed by Bart Sponseller was followed. Per that methodology, the MARAMA emission factor of 13.82 g/kg wood burned was used.

An estimate of 11.68 cords/yr/unit in Michigan was obtained from Brian Brady, MDEQ Air Quality Division. Brian serves as the MDEQ, Air Quality Division's outdoor wood boiler expert.

Michigan estimated an average weighted density of 1.65 tons/cord of wood, based on information contained within Table 8 of the USDA survey report "Residential Fuelwood Consumption and Production in Michigan, 1992."

Per the Wisconsin methodology, it was assumed that 90% of outdoor wood boilers are used in rural areas and 10% are used in urban areas. To determine which counties were urban and which were rural, staff reviewed the list of counties, which are part of Michigan's Consolidated Statistical Areas (metropolitan areas) and determined that the 22 affected counties should be considered as urban. Ten percent of the 29,568 Michigan outdoor wood boilers were apportioned to the urban counties by population. The remaining 90% of the outdoor wood boilers were apportioned to the 61 rural counties by population.

Residential Wood Burning, 2005

Michigan utilized the EIIP methodology's alternative method for estimating emissions from residential woodburning, by apportioning data from the U.S. Census Bureau and the EIA.

Two options were available to estimate woodburning households per county.

Housing Units with Wood Heat by County was determined by using 1990 U.S. Census Data, Database C90STF3C1, Summary Level State, for House Heating Fuel for Occupied Housing Units (http://factfinder.census.gov/home/saff/main.html?_lang=en).

- Although this data is for the 1990 year, it did provide a value for each county.

- Housing Units with Wood Heat by County was determined by using the U.S. Census Bureau's DP-4, Profile of Selected Housing Characteristics: 2000, Data Set: Census 2000 Summary File 3 (SF 3) for Michigan. This file provided a *total* value of households using wood heating. However, no breakdown was given by county.

The MDEQ, Air Quality Division staff used the 2000 number of total wood burning households in Michigan, and used the 1990 county proportions of the 1990 total to apportion the 2000 value to the county level.

Then, based on county value for number of wood burning households, the value for state wood use in cords was apportioned to each county. The 2003 state wood use in cords data came from the US

MAP States Page, *Table 8, Residential Energy Consumption Estimates, Selected Years 1960-2003, Michigan*, from the U.S. Department of Energy, EIA:

http://www.eia.doe.gov/emeu/states/sep_use/res/use_res_mi.html

Data for 2005 was not yet available.

Once county wood use in cords was produced, the next step was to determine the wood weight in tons for each county. Wood weight was determined by estimating a weighted average wood weight of 1.65 tons per cord, from species and consumption data from Table 8 of the USDA report, "Residential Fuelwood Consumption and Production in Michigan, 1992."

Michigan did not have data available on the number of catalytic and non-catalytic woodstoves in Michigan, but did utilize 1993 survey data which showed the proportions of fireplaces to woodstoves by county in Michigan. This was used to apportion wood weight per county between wood stoves and fireplaces. SCCs and emission factors were selected for fireplaces – cordwood (2104008001), and woodstoves – general (2104008010).

No ozone season activity was estimated, as staff felt it was unlikely that residents would utilize their fireplaces or wood stoves between June 1 and August 31 of each year.

FIRE 6.23 (Factor Information Retrieval System Version 6.23) and Source Summary Database (SSD) list the following Area Mobile Source Codes (AMS):

A2104008000: Total wood stoves and fireplaces
A2104008001: (lb/ton dry wood burned): Fireplaces - general
A2104008010: (mg/Mg dry wood burned): Wood stoves - general
A2104008030: (lb/ton dry wood burned): Catalytic wood stoves - general
A2104008050: (lb/ton dry wood burned): Non-catalytic wood stoves - general
A2104008051: (lb/ton dry wood burned): Non-catalytic wood stoves - conventional
A2104008052: (lb/ton dry wood burned): Non-catalytic wood stoves - low emitting
A2104008053: (lb/ton dry wood burned): Non-catalytic wood stoves - pellet fired

Michigan selected AMS codes A2104008001 and A2104008010. These were the most appropriate codes, as data exists for the proportion of woodstoves to fireplaces per county in Michigan, but data was not available on numbers of catalytic or non-catalytic wood stoves. Emission factors for A2104008010 were converted from mg/Mg to lb/ton by multiplying by the conversion factor of 2.00E-06.

References

1. USEPA, “Factor Information Retrieval System Version 6.23”, U.S. Environmental Protection Agency, 2000.

2. EPA, STAPPA, ALAPCO, Emission Inventory Improvement Program (EIIP), Volume III, July 1997, Chapter 2.

Structure Fires, 2005 Criteria Emissions

The EIIP guidance from EIIP Volume III, Chapter 18: *Structure Fires*, was followed. The preferred method for estimating emissions was used, due to the availability of county level structure fire data for 2002. More recent data was not available; the fire statistics data, which was originally kept by the Michigan State Police Fire Marshall Division, is now kept by the Michigan Department of Labor and Economic Growth. DLEG staff were unable to locate more recent county level data on structure fires. The 2002 data was re-used from the 2002 area source submittal. However, it did not provide any detail on the extent of each structure fire, or indicate if the structure was residential or commercial.

The default fuel loading factor provided in the EIIP guidance (1.15 tons of fuel per structure fire) was used. Emission factors for VOC, CO, and NOx were obtained from Table 18.4-1.

Year 2009 Stationary Area Source Emission Inventory Projections:

See **Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories for the Years 2009** in the **Non-EGU Point Sources** section for reference and methodology for projecting the Stationary Area Source inventory.

5. Non-Road Mobile

Non-Road Emissions Estimation exclusive of Locomotive, Shipping, and Aircraft Emissions

Non-road emission estimates for 2005 and 2009 were obtained from the EPA’s National Mobile Inventory Model (NMIM). The model uses a database to store the information about individual counties, referred to as the NMIM County Database (NCD); the current version is NCD20051207.

Recent updates to the model were made by the EPA and can be found at: www.epa.gov/omswww/models/nonrdmdl/nonrdmdl2005/readme.htm, (NON-ROAD2005 Update Chronology).

One of the updates included in this modeling was a correction in the NON-ROAD.EXE file that includes modifications for permeation. Changes were also made in the external files (15 files) to incorporate recommendations of SEMCOG and LADCO consultants regarding fuel data. Program files for emissions and population data were modified. These changes were made to improve the accuracy of the model estimates and to produce emission values that will be consistent with those that will be used for future ozone and fine particulate SIP demonstrations.

The Non-road emissions estimates were prepared by Wisconsin for all LADCO States, including Michigan. Additional details on the procedures used to prepare these inventory products can be found in the "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document" prepared by LADCO.

2005 Aircraft Emissions Estimation

In order to estimate aircraft emissions, aircraft activity was obtained for Michigan airports. Historically this information was obtained from MDOT. However MDOT was unable to provide updated information for year 2005. In the absence of updated MDOT 2005 aircraft activity data, commercial aircraft and commercial air freight departure information by aircraft model type was obtained from FAA airport records. For determining airport LTO cycles, the Air Traffic Activity Data System (ATADS) air traffic count database of larger towered airports, Terminal Area Forecast (TAF) air traffic operations database of towered and non-towered airports, and G.C.R. & Associates airport activity data were used. Since ATADS provides aircraft operations for a limited number of the States' airports, TAF aircraft operations estimates were considered where ATADS information was unavailable. G.C.R. & Associates, Inc. consultant data was used for the smaller airports of which FAA aircraft operations information was unavailable. The following information from the respective sources 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 need to have aircraft operations information expressed as LTO cycles, the following assumptions were made:

a. 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.

b. For general aircraft annual local and itinerant airport operations, each respective operations total was divided by two 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.

c. For military annual local and itinerant operations, each respective operations total was divided by two 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, FAA EDMS 4.5 Emissions and Dispersion Modeling System. A description of this model can be found in the FAA publication entitled: Emissions and Dispersion Modeling System (EDMS) User Manual (September 2004). Commercial and air freight aircraft emission factors per LTO cycle were determined using EDMS 4.5 for each commercial aircraft type models where possible were used at each towered airport. Default commercial aircraft engine type, and EPA default time in mode values for takeoff, approach, and landing roll times were used in the EDMS 4.5 model simulations.

For those aircraft types that could not be determined using the EDMS 4.5 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 VOC was performed and based upon the EPA guidance.

Aircraft emissions were then obtained by adding emissions contributions from commercial, itinerant general, and local general aircraft, and were reported using the following SCC codes.

Michigan Aircraft Emission SCC Codes

Aircraft Type	SCC
Military	2275001000
Commercial	2275020000
General Aviation	2275050000

2005 Locomotive and Shipping Emissions Estimation

The 2005 non-road shipping and Locomotive emissions were prepared using the same techniques used for the 2002 emissions. These estimates are based on work and a follow-up report (Environ Report for LADCO, April 2004, 2002 Shipping Emissions Sources) completed by Environ to support LADCO's efforts to prepare a 2002 Air Emissions Inventory. The report describes Environ efforts to develop a shipping 2002 air emissions estimates to support air quality modeling. The Environ report is too long to be included in this document, but it can be provided upon request or downloaded at:

http://www.ladco.org/reports/rpo/emissions/nonroad_locomotive_commercial_marine_recreational_marine_final_report_environ.pdf

The estimate of 2005 locomotive and shipping emissions was made by LADCO in the same manner as the 2002 inventory described above. The 2005 estimates are part of LADCO's base M inventory.

Non-Road Mobile Source Emission Inventory Projections to 2009

The non-road source categories exclusive of locomotive, shipping, and aircraft were grown in the EPA Mobile source model NMIM. The locomotive, shipping, and aircraft non-NMIM source categories were grown using growth factors provided in the report (E.H. Pechan & Associates, Inc., Development of Growth and Control Factors for Lake Michigan Air Directors Consortium, Final Report, December 14, 2004) done by E.H. Pechan & Associates, Inc. for LADCO and available upon request.

See **Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories for the Years 2009** in the **Non-EGU Point Sources** section for references and methodology for projecting the Locomotive, Shipping and Aircraft emissions inventory.

6. On-Road Mobile

For the 2005 base year, the emissions model CONCEPT was run by a LADCO contractor (Environ) using transportation data (e.g., VMT and vehicle speeds) supplied by the state (MDOT) and local planning agencies (SEMCOG) 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. CONCEPT was run with meteorological data for a July and January weekday, Saturday, and Sunday (July 15 – 17 and January 16 – 18). The six days were used to derive the weekday, Sat, and Sun values for the other months, and then (for each month) were multiplied by the number of weekdays, Sat, and Sun to get the annual totals.

Similar to the base year modeling, CONCEPT was run using transportation data (e.g., VMT and vehicle speeds) supplied by the state and local planning agencies for 2009 and 2018. CONCEPT was only run with meteorological data for a weekday. The emissions for Saturday and Sunday were derived by using scaling factors based on the 2005 emissions.

Additional details on the procedures used to prepare these inventory products can be found in the Environ report "LADCO On-Road Emissions Inventory Development Using Concept MV" which can be found at

http://www.ladco.org/reports/rpo/emissions/NREL_LADCO_FinalReport09.pdf

and "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document" prepared by LADCO.

7. Area Source Ammonia and Biogenic Emissions

Ammonia Emissions

LADCO estimated area source ammonia emissions for all member states, including Michigan. 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.

Biogenic Emissions

A LADCO contractor (Alpine) provided an updated version of the CONCEPT/MEGAN4 (Model of Emissions of Gases and Aerosols from Nature) biogenics model, which was

used to produce 2005 base year biogenic emission estimates. Model improvements included: (a) reduced model run times, (b) improved ability to run successive days, and (c) enhanced meteorological input processing5.

Compared to the previous (EMS/BIOME) emissions, there is more regional isoprene using MEGAN compared to the BIOME estimates used for Base K. 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.

Additional details on the procedures used to prepare these inventory products can be found in the “Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document” prepared by LADCO.

Appendix 9A

DNRE Best Available Retrofit Technology (BART) Rules

R 336.1970 Best available retrofit technology; adoption by reference.

Rule 970. (1) The provisions of 40 C.F.R., part 51, appendix Y, "Guidelines for BART Determinations Under the Regional Haze Rule," and 40 C.F.R. §51.301, "Definitions," are adopted by reference in R 336.1902.

History: 2008 MR 4, Eff. Sep. 11, 2008.

R 336.1971 Best available retrofit technology or BART program.

Rule 971. (1) The department shall determine applicability of best available retrofit technology based on the provisions referenced in R 336.1970.

(2) The owner or operator of a unit subject to BART shall perform an engineering analysis as described in the provisions referenced in R 336.1970 and shall provide the results of the analysis to the department within 60 days of the effective date of R 336.1970 and R 336.1971.

(3) If an electric generating unit (EGU) subject to BART is subject to the trading programs of the Clean Air Interstate Rule under 40 C.F.R. part 97, the owner or operator of the EGU is not required to conduct a BART analysis for sulfur dioxide and oxides of nitrogen emissions under this rule.

(4) An engineering analysis required by subrule (2) of this rule shall be submitted to the department and shall be subject to review and approval by the department. If the department determines additional information is required, the department shall provide to the owner or operator additional information requests and comments in writing. The owner or operator shall provide the requested information within 60 days from receipt of written requests and comments from the department. The department may determine that more than 60 days will be allowed.

(5) The department shall determine the BART level of control for each unit subject to BART based on the engineering analysis referenced in subrule (2) of this rule, the provisions referenced in R 336.1970, and other information which the department determines to be relevant.

(6) The owner or operator of a unit subject to BART shall enter into a permit to install or consent order with the department to make the BART provisions legally enforceable within 90 days of the department's approval of the engineering analysis, unless the department determines that more than 90 days will be allowed. BART controls shall be in place and operating not later than December 31, 2012.

(7) An owner or operator subject to this rule shall measure oxides of nitrogen and sulfur dioxide emissions with 1 or more of the following:

(a) A continuous emission monitoring system.

(b) An alternate method as described in 40 C.F.R. part 60 or 75, adopted by reference in R 336.1802a, as applicable and acceptable to the department.

(c) A method currently in use or a future method developed for use and acceptable to the department, including methods contained in existing permit conditions.

(8) An owner or operator of an emission unit that measures oxides of nitrogen or sulfur dioxide emissions by a continuous emission monitoring system shall do either of the following:

(a) Use procedures set forth in 40 C.F.R., part 60, subpart A and appendix B, and comply with the quality assurance procedures in appendix F, adopted by reference in R 336.1802a as applicable and acceptable to the department.

(b) Use procedures set forth in 40 C.F.R., part 75, and associated appendices, adopted by reference in R 336.1802a, as applicable and acceptable to the department.

(9) An owner or operator of an emission unit who uses a continuous emission monitoring system to demonstrate compliance with this rule and who has already installed a continuous emission monitoring system for oxides of nitrogen or sulfur dioxide pursuant to other applicable federal, state, or local rules shall meet the installation, testing, operation, quality assurance, and reporting requirements specified by the department.

(10) An owner or operator of an emission unit that is subject to this rule and has a permit or consent order issued under R 336.1971(4) shall submit at a minimum semiannual summary reports, in an acceptable format, to the department by March 15 for the reporting period July 1 to December 31 and September 15 for the reporting period January 1 to June 30 of each calendar year. The reports shall include all of the following information:

(a) The date, time, magnitude of emissions, and emission rates where applicable, of the specified emission unit or utility system.

(b) If emissions or emission rates exceed the emissions or emission rates allowed by the applicable emission limit, the cause, if known, and any corrective action taken.

(c) The total operating time of the emission unit during the time period.

(d) For continuous emission monitoring systems, system performance information shall include the date and time of each period during which the continuous monitoring system was inoperative, except for zero and span checks, and the nature of the system repairs or adjustments. When the continuous monitoring system has not been inoperative, repaired, or adjusted, the information shall be stated in the report.

(11) Quarterly summary reports, if required by the department pursuant to R 336.1213, shall be submitted within 30 days following the end of the calendar quarter and may be used in place of the semi-annual reports required pursuant to subrule (9) of this rule.

History: 2008 MR 4, Eff. Sep. 11, 2008.

Appendix 9B

Determining BART-Eligible and BART-Subject Facilities

Description of BART-eligible and BART-subject Facilities

The DNRE determined that the electric generating units (EGUs) subject to BART are included in the Clean Air Interstate Rule (CAIR) program and therefore do not have to conduct BART control analyses at this time. The remainder of this appendix deals with the Non-EGU sources in Michigan that may be subject to BART requirements, using the federal BART guidelines.

To identify BART-subject sources, DNRE identified 35 non-EGU facilities with a total of 84 emission units within the state that were potentially subject to BART (i.e. BART-eligible) based on dates of installation and commencement of operations. (See Table 1)

Next, using emission inventory data from the years 2002 and 2004, DNRE evaluated the quantity of emissions from each source in relationship to the distance from known Class 1 areas, i.e. Q/d values. It was assumed that facilities with higher Q/d values have more than a 0.5 dV impact on more days over a relatively large area, and that a Q/d value of 10 TPY/km is a reasonable threshold. (i.e., facilities with Q/d values less than 10 TPY/km generally have few days over a relatively small area with more than a 0.5 dV impact). This resulted in six BART-eligible sources to be modeled in the next step of the evaluation. (See Table 2)

The next step involved the individual source attribution approach (dispersion modeling) using the 0.5 deciview threshold value, and using the CALPUFF model on the six facilities that met the Q/d criteria. This final step confirmed the six facilities as being non-EGU BART-subject sources (See Table 3). However, in the process of doing BART reviews, DNRE determined that an Empire mine furnace had shut down and that the Smurfit/Stone Container facility closed, resulting in removal of the two facilities from the BART-subject list.

Table 1: BART-eligible Sources in Michigan

Source Name	Unit Description	SIC
Cargill Salt	Spreader Stroker Boiler	2899
	Pulverized Coal Boiler	2899
Chrysler - Trenton Engine	Boiler #5	3714
Delphi Saginaw Steering	Boiler #5	3714
	Boiler #6	3714
	Boiler #4	3714
Detroit Diesel Corp	B & W	3519
Dow Corning Corp	Boiler # 8, 72 mmbtu/hr	2899
	Boiler # 6, 84 mmbtu/hr	2899
	Boiler #9, 72	2899
Eastern Michigan University	Boiler #1	8221
	Boiler #2	8221
Empire Iron Mining	Unit 1 Boilers (1-3)	1011
	Unit 2 Boilers (4-5)	1011
	Pit Boilers (6-7)	1011
	primary ore processing	1011
	Furnace Unit #1	1011
	Unit #1 scrubbers	1011
	Furnace Unit #2	1011
	Unit #2 scrubbers	1011
	furnace unit #3	1011
	Unit #3 scrubbers	1011
Ford - Livonia Transmission	Boiler #1	3714
	Boiler #3	3714
	Boiler #4	3714
Ford - Rawsonville	Boiler #1	3714
	Boiler #2	3714
	Boiler #5	3714
Ford - Saline	Boiler 166-77	3714
	Boiler 403-74	3714
Ford - Utica Trim	GRD Stor Boiler	3714
Gm - Pontiac Site Ope	Boiler #6	3714
	Boiler #7	3714
	Boiler #8	3714
	Boiler #9	3714
Gm - Powertrain Div	Boiler #6	3714
	Boiler #4	3714
	Boiler #5	3714
	Pouring/casting	33xx
Gm - Saginaw Metal	Boiler # 3-2	3321
	Boiler # 4-2	3321
Gm - Technical Ctr R	202 Boiler	3711
	Boiler #1	3711
Kalsec Inc Mfg Plant	Cleaver-Brooks	2087
Lafarge Midwest Inc.	Kilns 19	3241
	Kilns 20	3241

Source Name	Unit Description	SIC
	Kilns 21	3241
	Kilns 22	3241
	Kilns 23	3241
Louisiana Pacific Corp	Boiler #3	2493
Marathon Ashland Petro	Crude Oil heater	2911
Marblehead Lime Co	Kiln	3274
Merillat Industries Inc	Wood Boiler	2434
Michigan State University	Boiler #2	8221
	Boiler #3	8221
	Boiler #1	8221
Michigan Sugar Co Caro	Pkg. Boiler#3	2063
Michigan Sugar Co Carrollton	Riley Boiler	2063
Michigan Sugar Co Sebewaing	Pkg. boiler	2063
National Steel Corp Gld	Coke ovens & operations	3312
	O2 furnaces & operations	3312
	Boiler #9, 10-100 MMBTU/HR	3312
	Boiler #8, 10-100 MMBTU/HR	3312
New Page Paper Co	Boiler 8	2611
	Boiler 9	2611
Rouge Steel Company	Reheat furnace & heater	3312
	Reheat furnace & heater	3312
	Blast Furnaces & operations	3312
Sappi	Calciner	2621
	Boiler #3	2621
	Rec. Boiler	2621
St. Mary’s Cement	Lime kiln with pre-calciner	3241
Smurfit-Stone Container	Boiler	2611
University Of Michigan	Boiler #3	8221
	Boiler #4	8221
Tilden Mining Co	Boiler #1(Pelletizing line #1)	1011
	primary crusher	1011
	cooler	1011
	dryer	1011
	Kiln	1011
Western Michigan University	Boiler #6	8221
William Beaumont Hospital	Boiler #1	8062
	Boiler #4	8062
	Boiler #5	8062

Table 2: Facilities with a Q/d >10 TPY/km

Facility	County	Sox*	NOx*	Q/d
Empire Iron Mining	Marquette	369	2,708	22
Lafarge Midwest Inc.(All Units)	Alpena	20,623	10,953	127.3
New Page Paper Company	Escanaba	193	1,726.6	22
St. Mary's Cement	Charlevoix	817	4,209	35
Smurfit-Stone Container	Ontonagon	1,949	1,128	23.5
Tilden Mining Co	Marquette	590	5,314	22

* In Tons per Year

Table 3: Final List of BART-subject Sources in Michigan

BART-subject Facility Name	City
Empire Iron Mining*	Marquette
Lafarge Midwest Inc.	Alpena
New Page Paper Company	Escanaba
St. Mary's Cement	Charlevoix
Smurfit-Stone Container *	Ontonagon
Tilden Mining Co	Marquette

*Due to permanent shut downs, a furnace at Empire and the Smurfit facility, the two facilities are no longer BART-subject

Appendix 9C

Lafarge BART Technical Analysis

PROPOSED BEST AVAILABLE RETROFIT TECHNOLOGY (BART) FOR THE LAFARGE FACILITY IN ALPENA, MICHIGAN

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April 2007

LAFARGE

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1.0 EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) published final amendments and guidelines to its 1999 regional haze rule on July 6, 2005 (70 FR 39104). Under this regulation, certain existing stationary sources that emit visibility impairing pollutants must install and operate the Best Available Retrofit Technology (BART). BART is required for sources that fit specific criteria, as discussed below, and that "may reasonably be anticipated to cause or contribute" to visibility impairment in any Class I area. The determination of what constitutes BART is made on a case-by-case basis considering technical feasibility, costs of compliance, energy impacts, and the modeled reduction in visibility impacts.

The BART requirement only applies to sources included in the specific source categories listed in CAA Section 169A(g)(7) that also meet the time frame and emission level thresholds specified in the BART Guidelines found at 40 CFR Part 51, Appendix Y. Once the emission units in the applicable source categories have been identified, the second step is to determine whether the units fall within the 15-year time frame established by the BART Guidelines. Therefore, BART applicability focuses on sources that were "in existence" on August 7, 1977 and not "in operation" before August 7, 1962. The third step of identifying BART-eligible emission sources is determining whether the source meets a 250 ton per year emission threshold. The 250 ton per year threshold is applied facility-wide. To be BART-eligible, the combined potential to emit of the emission units meeting the source category and operational date tests must be in excess of 250 tons per year for any single visibility impairing pollutant. Visibility-impairing pollutants include sulfur dioxide (SO_2), nitrogen oxides (NOx), and particulate matter (PM).

Lafarge owns and operates a portland cement manufacturing facility in Alpena, Michigan. Portland cement manufacturing is one of the specific source categories listed in Section 169A. In addition, Lafarge operates five cement kilns that were constructed and, based upon available information, became operational between August 7, 1962

and August 7, 1977. Since the potential to emit of the five kilns is in excess of 250 tons per year for one or more visibility impairing pollutants, the kilns are considered to be BART-eligible.

Based upon source-specific modeling of the Lafarge facility, the Michigan Department of Environmental Quality (MDEQ) has determined that the five BART-eligible emission units at Lafarge "may reasonably be anticipated to cause or contribute" to a visibility impairment at the Seney Wilderness Class I area. This source-specific modeling indicates that the emissions from Lafarge change the 24-hour background visibility at Seney by more than 0.5 deciviews (the deciview is the accepted metric for expressing visibility and changes in visibility). The five kilns at Lafarge are therefore subject to BART.

Once a source is determined to be subject to BART, a BART review is required for each visibility-impairing pollutant emitted. The BART review must identify the best system of continuous emission reduction considering the following five statutory factors: 1) the cost of compliance, 2) energy and non-air quality environmental impacts, 3) any existing pollution control in use at the source, 4) the remaining useful life of the source, and 5) the degree of visibility improvement reasonably anticipated from implementing BART.

This document presents the procedures and results of the BART review conducted for the five cement kilns at the Lafarge Alpena facility. The BART review focused on emissions of SO_2 and NOx and did not consider emissions of PM_{10} as PM_{10} emissions are subject to the Maximum Achievable Control Technology (MACT) standard for portland cement (40 CFR 63.1340). The states may assume that the level of control required by a MACT standard meets BART (see 70 FR 39164).[1]

[1] PM_{10} emissions were included in the evaluation of visibility impacts. However, PM_{10} control options were not evaluated as the MDEQ has agreed that the Alpena facility's compliance with the MACT standards for particulates satisfies the BART requirements.

The results presented herein demonstrate that wet scrubbers on the two large kilns (K22 and 23) represent BART for control of SO_2 and that selective non-catalytic reduction (SNCR) on all five kilns represent BART for control of NOx. The analysis demonstrates that the addition of SO_2 controls on the three smaller kilns would result in minimal improvement in visibility at a very high cost. Table 1-1 presents the proposed BART for the Lafarge Alpena facility.

Table 1-1. Proposed BART for Lafarge Alpena

Emission Unit	Proposed BART	Pollutant(s) Controlled	Proposed BART Emission Limit	Visibility Improvement on 98th Percentile Day (delta deciview)	Class I Area Impacted
Kiln 19	SNCR	NOx	See note	See note	Seney
Kiln 20	SNCR	NOx	See note	See note	Seney
Kiln 21	SNCR	NOx	See note	See note	Seney
Kiln 22	SNCR, Wet scrubbing	NOx, SO_2	See note	See note	Seney
Kiln 23	SNCR, Wet scrubbing	NOx, SO_2	See note	See note	Seney
Kilns 19-23	See above control for each kiln	NOx, SO_2	29.4 TPD NOx 53.8 TPD SO_2	-0.83[a]	Seney

Note: Lafarge is proposing facility-wide BART limits. The proposed BART limits are listed once, for all five kilns. The facility-wide limits were developed in reliance upon the MDEQ's recognition that Appendix Y, 40 CFR Part 51 provides:

> *You should consider allowing sources to "average" emissions across any set of BART eligible emission units within a fenceline, so long as the emission reductions from each pollutant being controlled for BART would be equal to those reductions that would be obtained by simply controlling each of the BART-eligible units that constitute BART-eligible source.*

TPD = tons per day.
[a]2003 meteorology.

2.0 BACKGROUND INFORMATION

2.1 Facility Location

The Lafarge facility is located on the western shore of Lake Huron in northeastern Michigan in Alpena County. The approximate Lambert Conformal Conic (LCC) coordinates of the facility are 1,066.778 kilometers east and 641.461 kilometers north. Figure 2-1 shows the location of the facility on the Alpena 7.5 minute USGS quadrangle.

2.2 Description of Operations

The plant includes five dry process kilns, a quarry, raw material grinding and storage, finish grinding, and cement loading operations. Kiln Nos. 19-21 are collectively referred to as Kiln Group 5 (KG5) while the larger kilns (Kiln Nos. 22 & 23) are referred to as Kiln Group 6 (KG6). The facility is defined as a major source of air pollution per Rule 336.1211 of the Michigan Administrative Rules for Air Pollution Control and under the Federal Prevention of Significant Deterioration regulation of 40 CFR 52.21. The facility operates under Renewable Operating Permit (ROP) No. MI-ROP-B1477-2006b.

The production of portland cement at Alpena is a long-dry process (i.e., the facility does not have pre-heaters to pre-calcine raw materials before entering the kilns). Limestone is quarried on site. Other primary raw material components (aluminum, silica, and iron) are transported to the facility via barge, truck, and rail. The raw materials are conveyed by belt to one of two dryers prior to being processed in the raw grind operation. Once dried and ground, the raw materials are stored in silos. When needed for production, the raw materials are withdrawn from the blending silos and fed to the kilns.

The Alpena facility uses a combination of coal and petroleum coke to provide heat to the kilns. Natural gas is also used as a “start-up” fuel. The heat from the hot combustion gases is transferred to the raw materials in a countercurrent manner. The materials are slowly moved to the lower end by rotation of the kilns. As they move

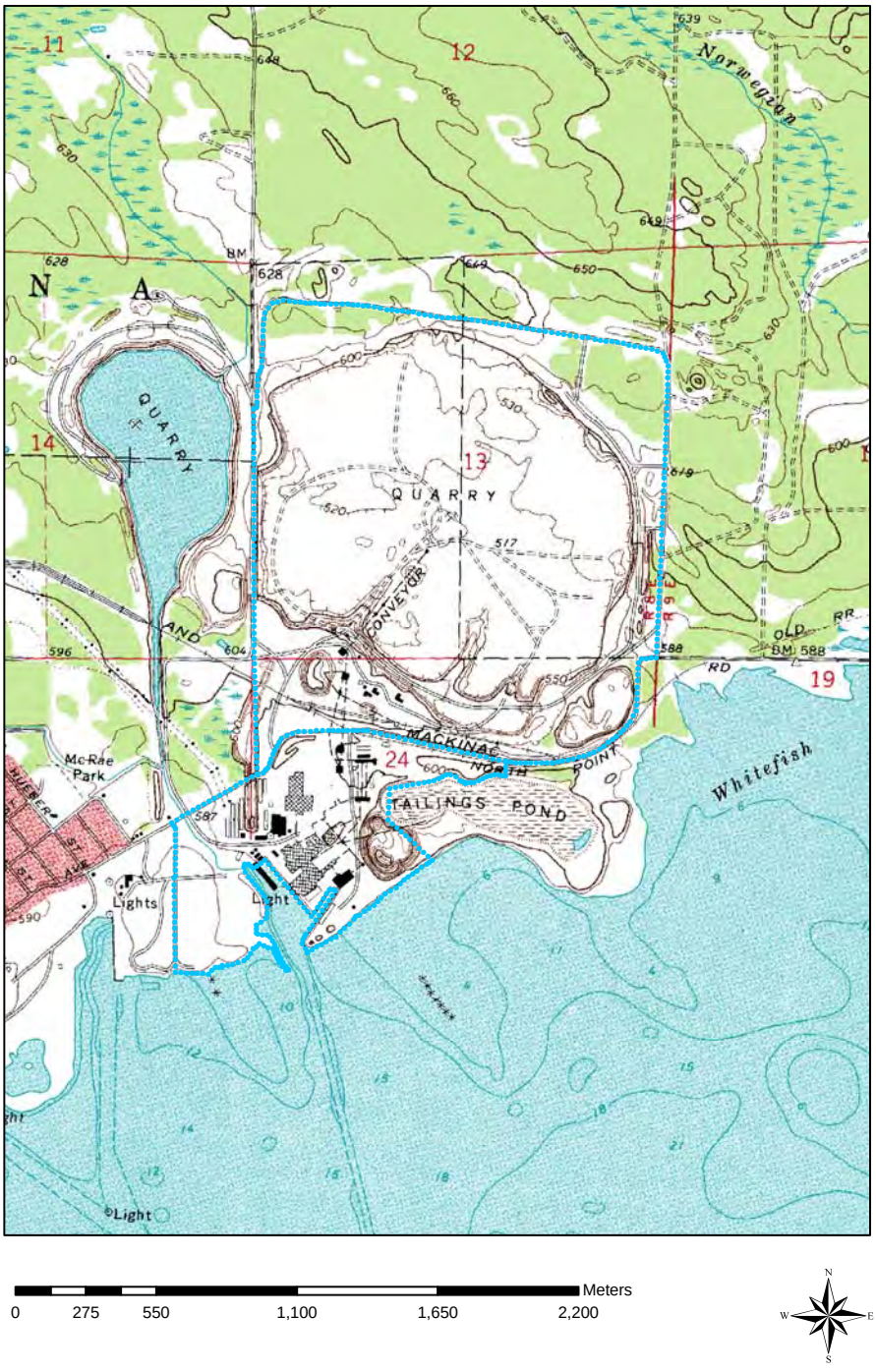

Figure 2-1. Location of the Lafarge Alpena Facility

down the kilns, the materials are changed to cementitious or hydraulic minerals because of the increasing temperature. The exhaust gases exit the kilns at the elevated end. The exhaust gases are controlled with baghouses prior to release to the atmosphere.

Once the cementitious materials (clinker) leave the kilns, the last component of the pyroprocessing system is the clinker cooler. In this step, the clinker is rapidly cooled using air to lock in desirable product qualities by freezing mineralogy. The clinker cooler also enables the material to be cooled for further processing. The final step in the manufacture of portland cement at Alpena involves a sequence of blending and grinding that transform the clinker into finished portland cement. Gypsum and other materials are added as needed to impart specific product properties. These materials and the clinker are mixed and milled in the finish mill. The final product is then stored in either land or marine silos prior to shipment. The cement is shipped off-site via trucks, railcars, and barges.

2.3 Class I Area Evaluated

Class I areas are national parks and wilderness areas in which visibility is more stringently protected under the Clean Air Act than any other areas in the United States. Class I areas that are located within 300 km of a BART-eligible source are typically evaluated for visibility impacts.[2]

There is one Class I area located within 300 km of the Lafarge site that required evaluation: the Seney Wilderness Area. Seney is located 250 km to the northwest of the Lafarge facility. Figure 2-2 shows the location of this Class I area with respect to the Lafarge facility. There is no other Class I area located within 500 km of the Lafarge facility. The next closest Class I area is Isle Royale National Park which is located 520 km northwest of Lafarge Alpena.

[2] Visibility Improvement State and Tribal Association of the Southeast (VISTAS) Regional Planning Organization (RPO), "Protocol for the Appication of the CALPUFF Model for Analysis of Best Available Retrofit Technology (BART), December 22, 2005 (with revisions January 23 and March 9, 2006).

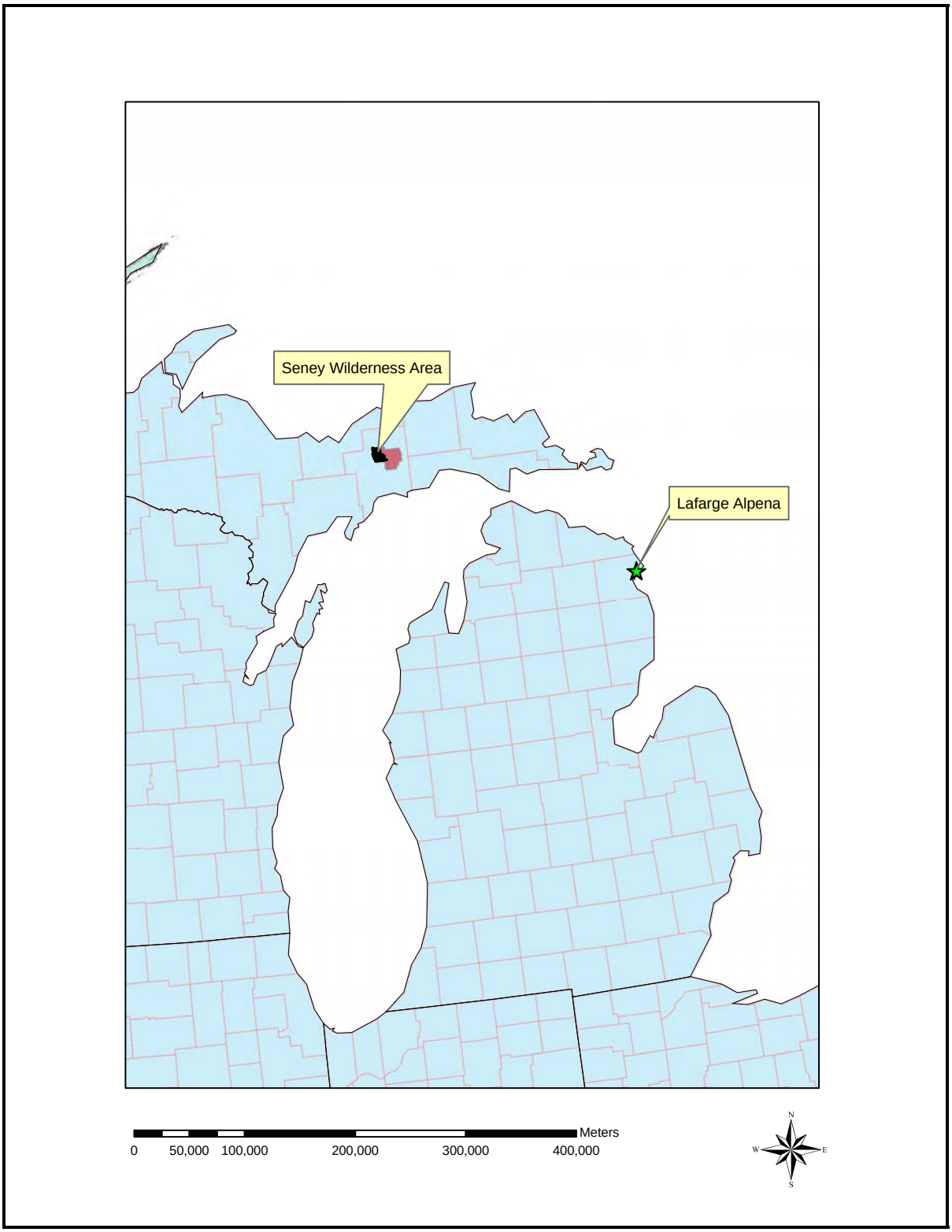

Figure 2-2. Location of the Lafarge Alpena Facility and the Seney Class I Area

3.0 BART SELECTION PROCESS

Five basic steps were taken in selecting BART for the Lafarge Alpena kilns:

- All available retrofit control technologies were identified;
- Technically infeasible options were eliminated;
- The technically feasible options were ranked in order of control effectiveness:
- The energy, environmental, and economic impacts of each control were evaluated; and
- The visibility impact of each control alternative was determined (see 70 FR 39164).

Based on this process, Lafarge has proposed BART limits for the Alpena kilns as shown in Table 1-1 of this report.

As discussed previously, the BART analysis for the Alpena plant focused on SO_2 and NOx controls for the cement kilns. Since the control options for these pollutants are basically unrelated, each pollutant is addressed individually. However, because the impacts of SO_2 and NOx on visibility are similar, the proposed BART limits are based on a combined SO_2 and NOx control strategy (see Section 3.3).[3]

3.1 SO_2 BART Analysis

Step 1 – Identify Potentially Applicable SO_2 Control Options

Lafarge has identified SO_2 control options for retrofit to the Alpena kilns. Based on review of U.S. EPA's RBLC (RACT, BACT, and LAER Clearinghouse) database, industry practice, recently issued permits for cement kilns, and considering the potential for technology transfer, the SO_2 control technologies potentially available[4] for retrofit to the Alpena kilns include:

[3] Model results indicate that SO_2 and NOx emissions contributed equally to visibility reduction at Seney. Lafarge therefore concluded that both SO_2 and NOx control strategies would need to be implemented to yield appreciable modeled visibility improvement. Modeling output data supporting this conclusion are provided in Appendix E.

[4] Available retrofit control options are those air pollution control technologies with a practical potential for application to the emissions unit and the regulated pollutant under evaluation70 FR 39614]. A source owner is not required to purchase or construct a process or control device that has not already been demonstrated in practice. The term "demonstrated in practice" is not specifically defined in the BART rule, but EPA proposed to define this term to

- Duct Sorbent Injection; and
- Flue Gas Desulfurization.

The following subsections describe each of these technologies and their potential applicability to the Alpena kilns.

Duct Sorbent Injection Systems. In general, sorbent injection systems consist of atomizing a reagent slurry or solution into fine droplets into the exhaust gas duct upstream of a particulate control device. In situations where there is limited ability to dry injected reagent, moist reagent powders (typically hydrated lime) are injected. Examples of alkaline reagents used in sorbent injection systems include magnesium hydroxide, hydrated lime, and sodium carbonate. The injected reagent reacts with SO_2 in the gas stream. Once dry, the byproduct of this reaction consists of fine sulfate and sulfite particles along with unreacted reagent. These particles are collected in a downstream particulate control device and either disposed of or reintroduced into the process.

Sorbent injection systems, such as Envirocare International's Micro-Fine Lime system, have been applied on cement kilns in recent years to reduce SO_2 emissions. With respect to the kilns at Alpena, a sorbent injection system could be installed upstream of the existing baghouse on each kiln. However, such systems could only be expected to reduce SO_2 emissions by an estimated 25 percent. This efficiency is a function of the relatively low baghouse inlet temperatures at Alpena coupled with the limited duct residence time available for drying of injected reagent. The Alpena kilns are equipped with waste heat boilers designed to recover energy from the kiln exhaust gas. The resultant low temperature at the waste heat boiler exit affects the effectiveness of sorbent injection technologies as discussed below. Sorbent injection upstream of the

include any technology that meets the following criteria: (1) it has been installed and operating continually for at least 6 months on an emissions unit(s) which has been operating at least at 50 percent of design capacity during that period of time; and (2) its performance has been verified during that 6 month period with a performance test or performance data while operating under a load that coincides with either the operation of the emissions units served by the control technology at their PTE, or 90 percent of the control technology's design specifications [61 FR 38249]. This definition is assumed to be relevant for purposes of this BART analysis.

waste heat boilers is not feasible due to the potential for plugging and erosion of the boilers by injected sorbent.

The effectiveness of sorbent injection is a function of the moisture content and drying time of injected reagent. Because of the gas temperatures downstream of the waste heat boilers and the limited duct residence time, a reagent slurry cannot be injected into these ducts at Alpena. The moisture in a slurry cannot be evaporated quickly enough to prevent either plugging of the baghouses or the formation of significant deposits of injected reagent on the duct walls. With limited ability to dry slurry, the moisture content of any injected reagent must be kept to a minimum. This factor limits the effectiveness of sorbent injection technologies for the Alpena kilns to an estimated 25% SO_2 control efficiency on a short-term basis. Coupled with an on-stream factor of 80%, Lafarge estimates that the overall SO_2 control efficiency is 20% for this technology.

Flue Gas Desulfurization (FGD). A review of technical publications and USEPA guidance shows that one of the most effective add-on control technologies for SO_2 control involves scrubbing with an aqueous alkaline slurry or solution. This type of add-on control technology is commonly referred to as wet flue gas desulfurization.

Another type of widely-used flue gas desulfurization technology is known as dry or semi-dry scrubbing. This is also an effective SO_2 control technology because it uses water to enhance the reactions between SO_2 and the alkaline reagent used. It has the advantage of producing a dry byproduct which is may be easier to manage depending on the application. The following subsections provide additional information on wet and semi-dry FGD systems and their potential applicability to the Lafarge Alpena cement kilns.

Wet Flue Gas Desulfurization. Wet flue gas desulfurization (FGD) systems are characterized by low flue gas outlet temperatures and saturated flue gas conditions, and a wet sludge reaction product which is dewatered before reuse or disposal. Wet FGD systems typically are installed with a particulate matter

control device upstream of the scrubber so that the fly ash and scrubber reaction products are collected separately. The following discussion reviews wet scrubbing technologies that are potentially applicable to the Alpena kilns.

Wet Limestone with Forced Oxidation (LSFO) – Limestone with forced oxidation (LSFO) is the type of wet limestone FGD process that is most commonly used today. A conventional wet limestone FGD system forms a scrubber byproduct composed mostly of calcium sulfite ($CaSO_3$) solids. The LSFO process produces a scrubber byproduct with very little $CaSO_3$ in the byproduct. Instead, the byproduct from an LSFO FGD system has a calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$ or gypsum) content in excess of 90 percent. The high gypsum content of the scrubber byproduct makes the solids easier to dewater, improves the reliability of the scrubbing process, and provides the potential for byproduct reuse. For most applications, these factors result in lower overall costs of control than a conventional, unoxidized limestone scrubbing process.

In the LSFO process, hot flue gas exiting the particulate control device enters an absorber where a slurry of limestone and gypsum is sprayed into the flue gas.[5] The SO_2 in the flue gas is absorbed into the slurry which is alkaline relative to the absorbed SO_2. The flue gas exits the absorption tower through a mist eliminator to remove entrained droplets. The absorbed SO_2 (now mostly dissolved sulfite) contained in the slurry drains into a recirculation tank located at the bottom of the spray tower. The sulfite is subsequently oxidized to sulfate in the recirculation tank, and following the oxidation step, it precipitates as calcium sulfate dihydrate. This process is called “forced oxidation,” and involves bubbling air through the slurry to force the oxidation of sulfite to sulfate. A portion of the slurry

[5] There are a number of variations on the design of a limestone forced oxidation scrubbing system that may differ slightly from the system described here. However the basic principals of SO_2 control and byproduct formation are

in the recirculation tank is pumped back into the spray tower, and a portion is removed. The removed slurry is dewatered, typically using hydrocyclones followed by a horizontal belt filter. The final gypsum product may be used in a number of applications. In the case of Alpena, depending on process chemistry and gypsum quality, it may be possible to reuse the byproduct gypsum by adding it to final cement product.

For this BART analysis, an overall SO_2 removal efficiency of 81% is assumed for the LSFO process. This efficiency represents a short-term 90% SO_2 control efficiency coupled with an estimated system on-stream factor of 90%. The control efficiency is typical of control efficiencies for wet scrubbers applied in this industry. The estimated on-stream factor reflects both limited experience with wet FGD systems in the cement industry along with the expected impacts on reliability of a single-module FGD system. An overall 81% control efficiency is consistent with Lafarge's experience on a cement kiln in Europe that has been retrofitted with an FDG system. Lafarge has not be able to identify reliable published control efficiency data on other retrofitted FGD systems on long dry cement kilns.

Wet Lime FGD Process – In the wet lime FGD process, flue gas leaving the particulate control device enters an absorber tower. The SO_2 is removed from the flue gas when the gas comes into contact with an alkaline slurry of hydrated lime and calcium sulfite. The scrubbed flue gas exits the absorption tower through a mist eliminator to remove entrained droplets prior to gas exiting the system. The reaction products (i.e., scrubber slurry composed primarily of calcium sulfite) are withdrawn from the absorber and then sent for dewatering and further processing. This includes thickening the sulfite sludge and fixating the sludge or filter cake

the same. The differences are principally due to alternative designs that have different features and benefits and the choice of technology is often a function of site-specific considerations and individual company preferences.

with lime and/or fly ash. The blend of fly ash, lime, and filter cake is then conveyed to a truck loading facility for disposal.

A significant disadvantage of the wet lime FGD system as compared to the LSFO system is the higher operating costs, primarily due to the high lime reagent costs and higher byproduct disposal costs. The production of lime for this process also has important secondary environmental impacts as compared to the LSFO process, including the consumption of natural gas or other fuels for calcining raw limestone.

The wet lime FGD process, like the LSFO process, can be designed for short-term SO_2 removal efficiencies of 90%. However, due to the nature of the byproduct produced by this system, it is not considered a good choice for use at Alpena. The production of byproduct gypsum using the LSFO is much better match and it also provides cost advantages. For these reasons, wet lime scrubbing is not considered further in this BART assessment. Because LSFO is the best option from technical and environmental perspective, and because it provides equivalent levels of performance, this is the only wet scrubbing technology that is evaluated in this BART analysis.[6]

Dry or Semi-Dry Flue Gas Desulfurization. Spray dryers (also referred to as "semi-dry" FGD systems) are characterized by flue gas temperatures above the saturation point (i.e., the gas exiting the scrubber is at less than 100% relative humidity). Dry and semi-dry FGD systems typically use a particulate control system downstream of the FGD system to collect both scrubber byproduct and fly ash such that the fly ash and the FGD reaction products are commingled into a single byproduct stream.

[6] This approach is consistent with the BART rule which states:"It is not necessary to list all permutations of available control levels that exist for a given technology - the list is complete if it includes the maximum level of control each technology is capable of achieving." [70 FR 39164]

In the spray drying process, hot flue gases enters a spray dryer vessel. Within the spray dryer, a finely atomized slurry of lime and recycled ash is sprayed into the flue gas stream. The SO_2 in the flue gas reacts with the lime and any alkali present in the fly ash to form sulfur salts (mostly $CaSO_3$). As the SO_2 reacts with the slurry, the water in the droplets evaporates forming solid particles, raising the flue gas moisture content, and lowering the flue gas temperature. A baghouse downstream of the spray dryer removes the dry solid reaction products and fly ash before the scrubbed gas is released to the atmosphere. A portion of the collected reaction products and fly ash solids is recycled to the spray dryer reagent feed system. The remaining solids are removed for reuse or disposal.

Other semi-dry technologies involve the use of separate humidification and reagent injection steps in a fluidized bed reactor. In this reactor, the elevated humidity promotes the reaction between gas-phase SO_2 and the semi-dry alkaline reagent. Possible reagents used in this type of system include lime and soda ash. Soda ash is less desirable because the sodium-sulfur byproducts (i.e., sodium sulfate and sodium sulfite) have a high level of solubility and thus, are more difficult to dispose of in an environmentally sound manner.

Like spray drying, the reaction byproducts from the semi-dry technologies are typically collected in a fabric filter downstream of the reactor vessel. Some of the collected material is recycled to the reactor and a portion is sent to disposal. In the case of the Alpena plant, this reactor would have to be located upstream of the existing baghouse or a new second baghouse would need to be constructed.

Step 2 – Eliminate Technically Infeasible Control Options

Of the SO_2 control options identified in this BART analysis, duct sorbent injection and wet scrubbing are technically feasible for retrofit application to the cement kilns at the Lafarge Alpena plant. The various dry scrubbing options are a poor choice for Alpena

and they are deemed infeasible for several reasons. First, there is insufficient space in the flue gas path for installation of a dry scrubber. While it may be theoretically possible to install dry scrubbers on the Alpena kilns, it is practically infeasible. Construction would involve large, complex duct runs, the need for additional gas fans, and complex duct/control system configurations. The cost of such a system would result in a dry FGD system that costs as much or more as a wet FGD system while providing less effective SO_2 removal.

Second, the presence of the waste heat boilers in the gas path makes dry scrubbing a poor choice for application to the kilns at Alpena. The reduction in gas temperature by the waste heat boilers limits the applicability of dry scrubber systems because less water can be used in the scrubbing process. When less water is used, dry scrubbing tends to be less effective.

Finally, the effect of collecting removed SO_2 in the kiln baghouses on the overall sulfur balance in the kilns presents a problem. Because much of the cement kiln dust (CKD) collected in the baghouses is recycled to the kiln, capturing and returning large amounts of sulfur to the process will result in reduced control effectiveness for these technologies. Alternatively, control efficiencies can be maintained at design levels at the expense of increased rates of CKD disposal to remove sulfur from the kiln system. Wet scrubbing is a better option because the gypsum byproduct can be added to the final product from the plant, thus eliminating the production of additional waste material as a result of installing an SO_2 control system.

Step 3 – Rank Feasible SO_2 Control Options

The most effective, technically feasible SO_2 control option for the Alpena kilns is wet FGD at 81% overall SO_2 control efficiency (90% control and 90% on-stream factor). The least effective option SO_2 control option identified for the Alpena kilns is the use of duct sorbent injection at an overall SO_2 control efficiency of 20% (25% control and 80% on-stream factor).

Step 4 – Evaluate Feasible Control Options

The results of the visibility impact analysis performed for the Lafarge Alpena kilns show that both SO_2 and NOx impacts on visibility are similar when compared on a mass emissions basis (i.e., SO_2 and NOx reductions both result in similar visibility improvements per ton of emissions reduction). For this reason, Lafarge has evaluated the effectiveness, costs, and energy and environmental impacts of the technically feasible SO_2 and NOx control technologies identified in this BART analysis together and used this assessment to select BART based on a combination of SO_2 and NOx controls. The results of this combined SO_2 and NOx assessment are contained in Section 3.4.

3.2 NOx BART Analysis

Step 1 – Identify Potentially Applicable NOx Control Options

Lafarge has identified possible NOx control options for retrofit to the Alpena kilns. Based on review of U.S. EPA's RBLC (RACT, BACT, and LAER Clearinghouse) database, industry practice, recently issued permits for cement kilns, and considering the potential for technology transfer, the available NOx control technologies that are potentially applicable for retrofit to the Alpena kilns include:

- Process Optimization
- Low NOx Burners;
- Selective non-catalytic NOx reduction (SNCR);and
- Selective catalytic NOx reduction (SCR).

The following subsections describe each of these technologies and their potential applicability to the Alpena kilns.

Process Optimization. Any effort that is related to reducing the amount of fuel fired in a cement kiln can be characterized as process optimization since reduced fuel consumption (e.g., improved fuel efficiency) generally results in reduced NOx emissions. The Lafarge kilns have been upgraded over the years to incorporate enhanced process monitoring systems, advanced computer controls, and necessary instrumentation to improve overall kiln operation. The baseline and projected NOx

emission rates from the Alpena kilns reflect the impact that process optimization has had on reducing NOx emissions. Since process optimization is a technically feasible NOx control technique that is currently being used by the facility, it is not considered further in this analysis (i.e., this technology cannot be retrofit to the Alpena kilns and its effects are already included in the baseline NOx emissions from the facility).

Low NOx Burners. Low NOx burner designs limit NOx formation by lowering the burner flame temperature, minimizing residence time at peak temperatures, and reducing the flame aggressiveness within the combustion zone. These burner designs typically introduce fuel in a sub-stoichiometric (lean) air-to-fuel ratio (generally 6 to 10 percent) at the primary burner inlet to reduce the combustion zone temperature and create an air-starved flame. Secondary air inlets introduce more supplemental air beyond the primary flame to complete combustion. The goal of low NOx burner technology is to create an ignition of the fuel in an oxygen deficient environment, thereby creating less NOx.

In many industries using conventional steam boilers, the implementation of low NOx burners has been very successful. However, in cement manufacturing, the success of low NOx burners is limited because much higher burning zone temperatures (as compared to the combustion temperature range found in industrial and utility boilers) are essential to achieve acceptable product quality. Lafarge is currently in the process of installing low-NOx burners on the Alpena kilns. Thus far, two of the five kilns have been fitted with low-NOx burner systems, and the installation of these low-NOx burner systems influence the NOx reductions that are achievable relative to baseline emissions for BART purposes.

Selective Non-Catalytic Reduction (SNCR). SNCR is an add-on control technology that involves injection of aqueous or anhydrous ammonia (NH_3), or urea (urea is composed of two attached ammonia molecules) into the gas stream. The injected ammonia is converted by OH* free radicals to ammonia free radicals (i.e., NH_2*), which react with NOx to form N_2 and H_2O. The optimum temperature range for this reaction is

1,600ºF to 1,900ºF. Above 1,900ºF, the amount of NH_3 that oxidizes to NOx increases, and, in turn, the NOx reduction performance deteriorates. Both laboratory work and field data show NH_3 slip[7] to be a strong function of temperature. At temperatures at or above 1,900ºF, unreacted NH_3 emissions decrease due to the NH_3 oxidation to NOx. At temperatures at or below 1,600ºF, unreacted NH_3 emissions may rapidly increase. At Alpena, NH_3 can be injected into the kiln in a region that operates between 1,600ºF and 1900ºF. This temperature window is appropriate for SNCR application.

The following factors influence the control effectiveness of SNCR:

- Temperature and oxygen availability (i.e., the NH_3 injection location);
- The baseline, or uncontrolled NOx concentration;
- Mixing;
- Reagent Ratio (i.e., the NH_3 to NOx molar ratio at the injection point);
- NH_3 accumulation;
- Excess ammonia emissions; and
- Ammonium salt formation.

Based on the current state of knowledge, these technical differences usually do not result in an SNCR system's "inability to perform" but instead present a "level of performance" question (i.e., generally, the central issue is the exact level of NOx reduction that can be achieved when SNCR is applied).

For SNCR to work effectively, the gas stream being treated must have a relatively high concentration of NOx as opposed to other potential reactants with which NOx would compete with to react with NH_3. The presence of competing reactants in the gas stream may result in less NH_3 to convert NOx to its non-polluting forms. This would reduce the effectiveness of the SNCR process.

Second, the desirable SNCR chemical reactions are most effective in a temperature range between 1,600°F and 1,900°F. Above the high end of the SNCR temperature range, the NOx reduction efficiency degrades dramatically; in fact, at higher

[7] "Slip" is a term used to refer to emissions of unreacted ammonia from SNCR and SCR processes.

temperatures, the injected reagent can oxidize and actually increase NOx emissions. Below the low end of the temperature range, the reaction rates are not rapid enough for the injected reagent to react completely. Therefore, selection of the proper temperature range for ammonia or urea injection is critical to achieving optimum performance of SNCR.

Finally, SNCR requires an oxidizing, or fuel-lean atmosphere to effectively reduce NOx emissions. In a fuel-rich, or reducing environment, partially oxidized fuel (e.g., CO) competes with NH_3 for OH* radicals, thus reducing NOx control effectiveness. In addition, ammonia interferes with the complete oxidation of organic compounds in the fuel, potentially causing a rise in CO emissions. These three conditions must be met for SNCR to be most effective in NOx reduction.

The successful application of SNCR also depends on the accurate injection of the optimum quantity of reagent NH_3. Insufficient reagent will not result in effective control, while excess reagent will result in excessive ammonia slip. Ammonia is typically injected in approximately equal molar quantities relative to the NOx present in the gas stream. While this injection ratio can theoretically result in conversion of 50% or more of the NOx with an ammonia slip of 10 ppm or less, there is a strong potential for the formation of a detached plume resulting from the presence of chlorides and sulfates in the exhaust gas stream. These compounds are present in the raw materials and are released in the kiln system.

In recent years, SNCR has been applied to a number of cement kilns in both the U.S. and internationally. However, nearly all of these applications have been on modern preheater/precalciner kilns and only limited testing has been conducted on long dry kilns similar to those at the Alpena plant. The key reason for this is the location within the kiln system where reagent injection occurs. In a preheater/precalciner kiln, reagent injection occurs at the exit of the kiln in the lower part of the preheater tower. This injection location is readily accessible using conventional injection technology. In a long-dry kiln, injection must occur mid-kiln because this is where the gas temperature is

in the proper range for the NOx reduction reactions to occur. Specialized injection systems are required to allow reagent injection in a mid-kiln location.

Lafarge has completed an engineering assessment and determined that SNCR can be applied to the Alpena kilns. Based on this assessment, Lafarge estimates that SNCR, in combination with the low-NOx burners now being installed on the Alpena kilns, can achieve 35% NOx reductions on Kiln Group 5 and 40% NOx reductions on Kiln Group 6 (relative to current baseline NOx emissions). These reduction efficiencies are consistent with the reduction efficiencies that have been observed on the limited SNCR testing and operation for other long-dry kilns.

Selective Catalytic Reduction (SCR). Like SNCR, SCR systems use NH_3 to chemically convert NOx to molecular N_2 (i.e., the same form of nitrogen that comprises 79% of the air we breathe). However, as the name indicates, SCR uses a catalyst to promote the selective reaction of NOx and ammonia. Ammonia injected into the gas stream reacts with NOx and the SCR catalyst enables these reactions to occur at lower temperatures than are possible with SNCR. While catalysts can operate over a range of temperatures, the optimal temperature range for SCR applications is between 570º to 750ºF, well below the 1,600ºF to 1,900ºF temperature range for SNCR reactions discussed previously.

The SCR catalytic reactions occur on the surface of the catalyst structure. However, the catalyst structures are not composed of simple, flat surfaces. The catalyst is designed to have a series of large openings termed “macropores” and small openings termed “micropores.” These macropores and micropores maximize the surface area of the catalyst available for reaction with NOx and NH_3.

A set of SCR catalyst beds is placed in series in a large vessel located in a part of the process where the gas temperatures are in the appropriate range during routine

operation. The NH_3[8] is injected at a controlled rate upstream of the catalyst using an injection grid designed to ensure relatively even NH_3 distribution, good mixing, and minimum NH_3 slip. The injected NH_3 reacts with NOx compounds (i.e., NO and NO_2) on the surface of the catalyst in equal molar amounts (i.e., one molecule of NH_3 reacts with one molecule of NOx) to form N_2 and water.

There is only one large scale installation of SCR on a cement plant in the world with any significant operating experience.[9] This installation is at the Solnhofen Cement Works in Germany. This is a preheater kiln with the SCR system located at the exit of the preheater tower. In this location, the kiln exhaust gas temperature is in excess of 610ºF which is in the correct range for SCR to function.[10] There is no equivalent location for installing an SCR system in Alpena's long dry kilns. The raw materials used in the Solnhofen plant differ significantly from those at Alpena. The Solnhofen kiln raw materials contain minimal amounts of sulfur and alkali while the Alpena kiln raw materials contain appreciable amounts of both. These compounds are significant because they contribute to SCR problems such as catalyst deactivation and fouling. In addition, the presence of sulfur compounds can lead to downstream problems such as increased particulate emissions and plugging and corrosion of heat exchangers and particulate control equipment.

Lafarge has assessed the publicly available information regarding the Solnhofen SCR application and has determined that the long-term demonstrated performance of the SCR system at Solnhofen shows a demonstrated NOx reduction efficiency that is

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[8] The NH_3 reagent can be in the form of an aqueous solution (typically 25 wt. % NH_3), anhydrous NH_3, or as a product of urea decomposition.

[9] A second commercial-scale SCR system has been installed in Europe on a cement kiln at Cementeria di Monselice. This unit began operation in mid-2006. Very little data are available on this application, but what data are available show that it differs significantly from the Alpena kilns. The Monselice SCR system is installed on a pre-heater, pre-calciner kiln system. There is no equivalent location in the Alpena kilns that would allow installation of such a system.

[10] When it was operational, the SCR system at the Solnhofen Cement Works would be bypassed if the flue gas temperature dropped below 320ºC or about 610ºF.

similar to the reduction efficiencies expected to be achieved using SNCR.[11] These data are consistent with the fact that this system is currently not operational and SNCR is being used to meet the NOx limit for this facility. In other words, over the long-term, the Solnhofen SCR system has not preformed better than the SNCR system and, as of this writing, it has been shutdown.

The Solnhofen SCR system did operate over a period of several years, but as described above, its long-term, demonstrated control effectiveness was not measurably different than the expected control effectiveness of SNCR (on the order of 30 to 40% based on publicly available data). In addition, there are a number of significant differences between the Solnhofen application and the Alpena kilns including:

- Kiln design;
- Flue gas sulfur levels; and
- Particulate mass loadings and compositions.

For the above reasons, the European cement plant experience with SCR systems does not meet the test of being “demonstrated in practice”.

There are a number of issues that must be considered in evaluating the potential application of SCR to the kilns at Alpena. First, as with SNCR, temperature is a critical variable in application of SCR technology to any source. In the case of the Alpena kilns, there is no location in the gas path where SCR could be applied. Second is the long-term viability of SCR technology in cement kiln applications. There are no known applications of SCR to long dry cement kilns like those at Alpena.

It has been theorized that an SCR system could be installed downstream of the dust collection equipment on long dry kilns. Such an application would involve additional fuel combustion to reheat the gas and then the use of heat recovery equipment to limit the additional fuel used. This type of SCR installation has not been tested or demonstrated on a cement kiln (i.e., it has not been “demonstrated in practice”) and it presents a

[11] See for example: “Response to Comments, Permit No. 2000-05-077”; Submitted to Missouri Department

number of potential problems including the issue of fine particulate emissions generated by the SCR system itself, the potential for significant production of sulfuric acid mist in SCR system, and the potential for rapid catalyst deactivation due to the fine particulate in the effluent gas. The only U.S. applications of SCR in a low-dust environment using heat recovery of the SCR effluent to preheat the SCR inlet stream are on very low sulfur applications (i.e., less than 10 ppm SO_2). Any attempt to apply this type of system to the Alpena kilns would be experimental in nature and such experimental technologies are not considered "available" when it comes to determining BART (as this term is described in the BART rule).

Step 2 - Eliminate Technically Infeasible Control Options

Of the NOx control options identified in this BART analysis, low-NOx burners and SNCR are feasible options for application to the Alpena kilns.

The application of SCR to the Alpena kilns represents a technology experiment that would require significant time, resources, and risk. The BART process is intended to apply "available" technologies to existing facilities. Thus, SCR is not considered "available" as its application would require significant development and testing before the suitability for application to the Alpena kilns could even be determined.

Step 3 - Rank Feasible NOx Control Options

The most effective, technically feasible NOx control option for the Alpena kilns is the application of low-NOx burners and SNCR in combination. Lafarge estimates that this combination of technologies can achieve 35% NOx reduction on KG5 and 40% reduction on KG6.

Step 4 – Evaluate Feasible Control Options

The results of the visibility impact analysis performed for the Lafarge Alpena kilns show that both SO_2 and NOx impacts on visibility are similar when compared on a mass

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of Natural Resources by: Holcim (US) Inc.; April 8, 2004.

emissions basis (i.e., SO_2 and NOx reductions both result in similar visibility improvements per ton of emissions reduction). For this reason, Lafarge has evaluated the effectiveness, costs, and energy and environmental impacts of the technically feasible SO_2 and NOx control technologies identified in this BART analysis together and used this assessment to select BART based on a combination of SO_2 and NOx controls.

3.3 SO_2 and NOx Control Cost Comparision

Table 3-1 summarizes the results of Lafarge's evaluation of the costs of SO_2 and NOx control technologies determined to be technically feasible for retrofit to the Alpena kilns. Note that the energy impacts and secondary environmental impacts of these technologies are judged to be modest. Wet FGD will increase demand for electrical energy to operate pumps and fans in the FGD system. The FGD system will generally be closed loop with respect to water, so wastewater production will be minimal. Fresh water demand for this system can be readily met using existing plant water systems. Duct injection may result in a small increase in power demand and a small increase in the amount of CKD that must be disposed of. SNCR will result in an increase in NH_3 emissions which can cause formation of fine particulates through reaction with SO_3 and/or HCl in the exhaust gases from the kiln. None of these impacts are judged to be significant relative to the benefits of the control technologies evaluated.

Table 3-1. Comparison of Costs for Feasible BART Controls

Control Option	Control Costs ($/ton)*	
	KG5	KG6
Wet FGD	$7,952	$1,087
Duct Injection	$3,367	$754
SNCR	$713	$498

* See Appendix B for details of how these costs were estimated.

As shown in Table 3-1, certain of the estimated control costs appear reasonable and certain costs are excessive. In particular, the costs of both duct injection and wet FGD applied to KG5 at approximately $3,400 and $8,000 per ton, are excessive. This determination is made relative to the costs of the other control options listed in Table 3-1, relative to the costs/value of incremental SO_2 control under the acid rain program, and relative to past SO_2 BACT determinations in the Midwest. For example, the current value of SO_2 allowances available for purchase (and potential retirement) under U.S. EPA's acid rain program (i.e., Title IV of the 1990 Clean Air Act amendments) is less than $500/ton.[12] The reason SO_2 control costs for KG5 are excessive is because of the low SO_2 emissions rate from these kilns relative to the volume of exhaust gases produced. KG6 represents a much more cost-effective location to achieve significant SO_2 reductions at the Alpena plant.

In addition, as discussed in Section 5, addition of SO_2 controls on KG5 result in minimal improvement in visibility. The addition of SO_2 controls on KG5 results in only two fewer days in a three year period with a visibility impact at Seney in excess of the 0.5 dv criterion.

Based on this assessment, Lafarge concludes that the BART limit for the Alpena plant should based on the implementation of the SNCR on KG5 and KG6 and the implementation of wet FGD on KG6. Implementation of additional controls results in substantial added costs with only limited visibility improvement (as measured by the total emissions reductions achieved). The specific visibility impacts of the proposed BART controls are evaluated and discussed in Section 5.

3.4 Proposed BART

Lafarge proposes to install SNCR on all kilns (KG5 and KG6) and wet scrubbers on the kilns in KG6. Consistent with this control plan, Lafarge is proposing a facility-wide BART limit on all five kilns of 29.4 tons of NOx per day and 53.1 tons of SO_2 per day.

[12] CantorCO2e Real Time Market Data; Spot SO2 Market Summary; March 13, 2007.

Lafarge proposes that these limits be expressed as a 30-day rolling average. These proposed limits are based on applying the BART technology control efficiencies outlined in Sections 3.1 and 3.2 to the maximum daily emission rates measured during the 2002-2004 period for each kiln. Specifically, the baseline, actual maximum emissions from the two kiln groups were determined to be:

Compound	Baseline Maximum Emissions (tons/day)	
	KG5	KG6
SO_2	38.1	78.7
NOx	18.9	28.5

Table 1-1 summarizes the proposed BART technologies and emission limits in more detail. Lafarge is proposing mass emission limits for NOx and SO_2 that apply to the total emissions from the BART-affected emission units (i.e., Kilns 19-23). Lafarge will employ continuous emission monitors to record mass emissions on a daily basis to insure compliance.

4.0 BART MODEL PROCEDURE

4.1 Modeled Emissions and Stack Parameters

Maximum, 24-hour actual emission rates during normal operation for 2002-2004 were determined and modeled in CALPUFF to calculate baseline visibility impacts at Seney. Baseline NOx and SO_2 emissions from the kilns were obtained from continuous emission monitors (CEMS) during the 2002-2004 period. Particulate emissions were based upon stack test data. All PM_{10} emission were assumed to be filterable and were speciated, using VISTAS provided speciation profiles for dry process cement kilns, into PM_{10} (PMC or PM Coarse), $PM_{2.5}$ (PMF or PM Fine), and elemental carbon (EC). As recommended by VISTAS, the condensable PM_{10} fraction was assumed to be 85.6% of the total PM_{10} emissions rate. The total PM_{10} rate was calculated from the filterable fraction assuming that the filterable fraction is 14.4% of the total. The condensable fraction was then speciated (again using the VISTAS recommended speciation profiles) into sulfates and secondary organic aerosols (SOA). The PM speciation calculations are presented in Appendix A.

Based upon guidance from the Michigan Department of Environmental Quality (MDEQ), Lafarge modeled emissions of PM_{10}, NOx and SO_2 in calculating baseline visibility impacts at Seney. Lafarge did not model emissions of volatile organic compounds (VOCs) or ammonia as these pollutants are not believed to contribute significantly to visibility degradation at Seney. Only emissions of NOx and SO_2 were varied in evaluating the affects of the various control technologies on visibility improvement. Lafarge did not evaluate PM control alternatives because the kilns are subject to a MACT standard which limits emissions of PM and, according to the final BART Guidelines, states may assume that the level of control required by a MACT standard meets BART (see 70 FR 39164). The stack parameters and emission rates that were modeled are provided in Tables 4-1 and 4-2, respectively.

Table 4-1. Modeled Stack Parameter Data

Model Source ID	Source Description	LCC E (km)[a]	LCC N (km)[a]	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Velocity (m/sec)	Temp. (K)	Sigma Y (m)	Sigma Z (m)	Momentum Flux
SV00031	K19 Exhaust	1066.746	641.668	67.06	182.0	3.96	3.91	439.26	0	0	1
SV00032	K20 Exhaust	1066.762	641.671	67.06	182.0	3.96	3.91	439.26	0	0	1
SV00033	K21 Exhaust	1066.780	641.675	67.06	182.0	3.96	6.03	439.26	0	0	1
SV00047	K22-23 Exhaust	1066.867	641.697	89.00	182.0	7.32	6.73	469.82	0	0	1
KILNS	Worst –Case Combined	1066.789	641.678	81.37	182.00	6.15	5.97	459.19	0	0	1

[a]Lambert Conformal Conic (LCC) coordinates are based upon an origin of 40.0N and 97.0W with Standard Parallels of 33.0N and 45.0N (WGS-84 Datum).

Table 4-2. Baseline Modeled Emission Rates (lb/day)

Model Source ID	Source Description	SO_2	SO_4	NOx	HNO_3	NO_3	PMC	PMF	EC	SOA
SV00031	K19 Exhaust	34,760	577	13,116	0	0	51	54	6	79
SV00032	K20 Exhaust	19,656	577	12,712	0	0	51	54	6	79
SV00033	K21 Exhaust	21,796	577	11,942	0	0	51	54	6	79
SV00047	K22-23 Exhaust	157,398	2,768	56,956	0	0	245	257	26	377
KILNS	Worst –Case Combined	233,610	4,498	94,726	0	0	399	417	43	613

Notes: PMFine (PMF) or "soil" = PM < 2.5 um in diameter. PMCoarse (PMC) = PM between 2.5 and 10 um in diameter. SOA = secondary organic aerosols. EC = elemental carbon. Kiln PM speciation based upon VISTAS guidance.

To simplify the modeling analysis, Lafarge modeled a single, worst-case stack. The emissions from each kiln were summed and assumed to be emitted from the worst-case stack. The parameters for the worst-case stack were calculated as a weighed sum with total emissions as the basis for the weighting. Appendix A provides the values used in calculating the worst-case parameters. The worst-case stack parameters were assumed not to be affected by the controls employed. That is, only stack gas emissions were varied in evaluating BART control alternatives. Stack gas exit temperature and flow as well as the physical parameters (i.e., diameter and height) were held constant in the control technology evaluation.

The post-control emission rates for each of the BART control scenarios evaluated were based upon the anticipated reduction from each control device (expressed as a percentage) and the baseline rates. The post-control emission rates for each modeled BART scenario are presented in Table 4-3.

4.2 Modeling Methodology

The modeling followed EPA's Interagency Workgroup on Air Quality Modeling (IWAQM), Phase 2 recommendations, for long-range transport[13] and the Lake Michigan Air Director's Consortium (LADCO) Single Source Modeling Guidance.[14] The IWAQM guidance was developed to address air quality impacts—as assessed through the Prevention of Significant Deterioration permitting program. The LADCO guidance was developed specifically for BART modeling.

[13] Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts, EPA-454/R-98-019, U.S. Environmental Protection Agency, Air Quality Modeling Group, Research Triangle Park, North Carolina. December, 1998.
[14] Single Source Modeling to Support Regional Haze BART Modeling Protocol, Lake Michigan Air Directors Consortium, Des Plaines, IL. March 21, 2006.

Table 4-3. Post-Control Modeled Emission Rates (lb/day)

Source Description	SO_2	SO_4	NOx	HNO_3	NO_3	PMC	PMF	EC	SOA
Control Scenario 1: SNCR KG5 & 6, Wet Scrubbing KG6 (Proposed BART)									
KG5	76,212	1,730	24,551	0	0	153	161	17	236
KG6	31,480	1,384	34,174	0	0	245	257	26	377
Total	107,692	3,114	58,724	0	0	399	417	43	613
Reduction from Baseline (%)	54	31	38	0	0	0	0	0	0
Control Scenario 2: SNCR KG5 & 6, Wet Scrubbing KG6, Duct Injection KG5									
KG5	60,970	1,557	24,551	0	0	153	161	17	236
KG6	31,480	1,384	34,174	0	0	245	257	26	377
Total	92,449	2,941	58,724	0	0	399	417	43	613
Reduction from Baseline (%)	60	35	38	0	0	0	0	0	0
Control Scenario 3: SNCR KG5 & 6, Wet Scrubbing KG5 & 6									
KG5	15,242	865	24,551	0	0	153	161	17	236
KG6	31,480	1,384	34,174	0	0	245	257	26	377
Total	46,722	2,249	58,724	0	0	399	417	43	613
Reduction from Baseline (%)	80	50	38	0	0	0	0	0	0

Note: KG5 = Kiln Group 5 which consists of Kilns 19-21. KG6 = Kiln Group 6 which consists of Kilns 22 & 23.

4.3 CALMET

Meteorological Domain

The Meteorological Domain was set to one hundred kilometers beyond all sources and receptors (see Figure 4-1). This Domain was cast on a Lambert Conformal Conic (LCC) coordinate system. The projection parameters and Meteorological Domain coordinates are as follows:

LCC Projection Parameters	
Projection Origin –	RLAT0 = 40N, RLON0 = 97W
False Easting –	FEAST = 0
False Northing –	FNORTH = 0
Matching Parallels -	XLAT1 =33N, XLAT2 = 45N
Meteorological Domain	
Datum -	WGS-84
Southwest corner (km) -	XORIGKM = 725.1340, YORIGKM = 541.6970
Number of Grid Cells -	NX = 110, NY = 78
Horizontal Grid Spacing (km) -	DGRIDKM = 4
Vertical Grid Spacing (km) – (top of each cell)	20, 40, 80, 160, 320, 1000, 1500, 2200, 3000

Meteorological Data

Prognostic data for 2002, 2003 and 2004 was used for developing the Initial Guess Wind Fields in the CALMET model. The prognostic data was supplied by LADCO. These data cover an area from the eastern seaboard to the Rocky Mountains and from the Gulf of Mexico to well into Canada.

Surface data for 2002, 2003 and 2004 was used as observations in developing the Step 2 Wind Fields in the CALMET model. The surface data were purchased from BEE-Line Software, Asheville, NC. BEE-Line Software obtained these data from the National Climatic Data Center, Asheville, NC. The data includes all stations, with sufficient data for modeling, within or near the meteorological modeling domain. A total of eleven stations were used.

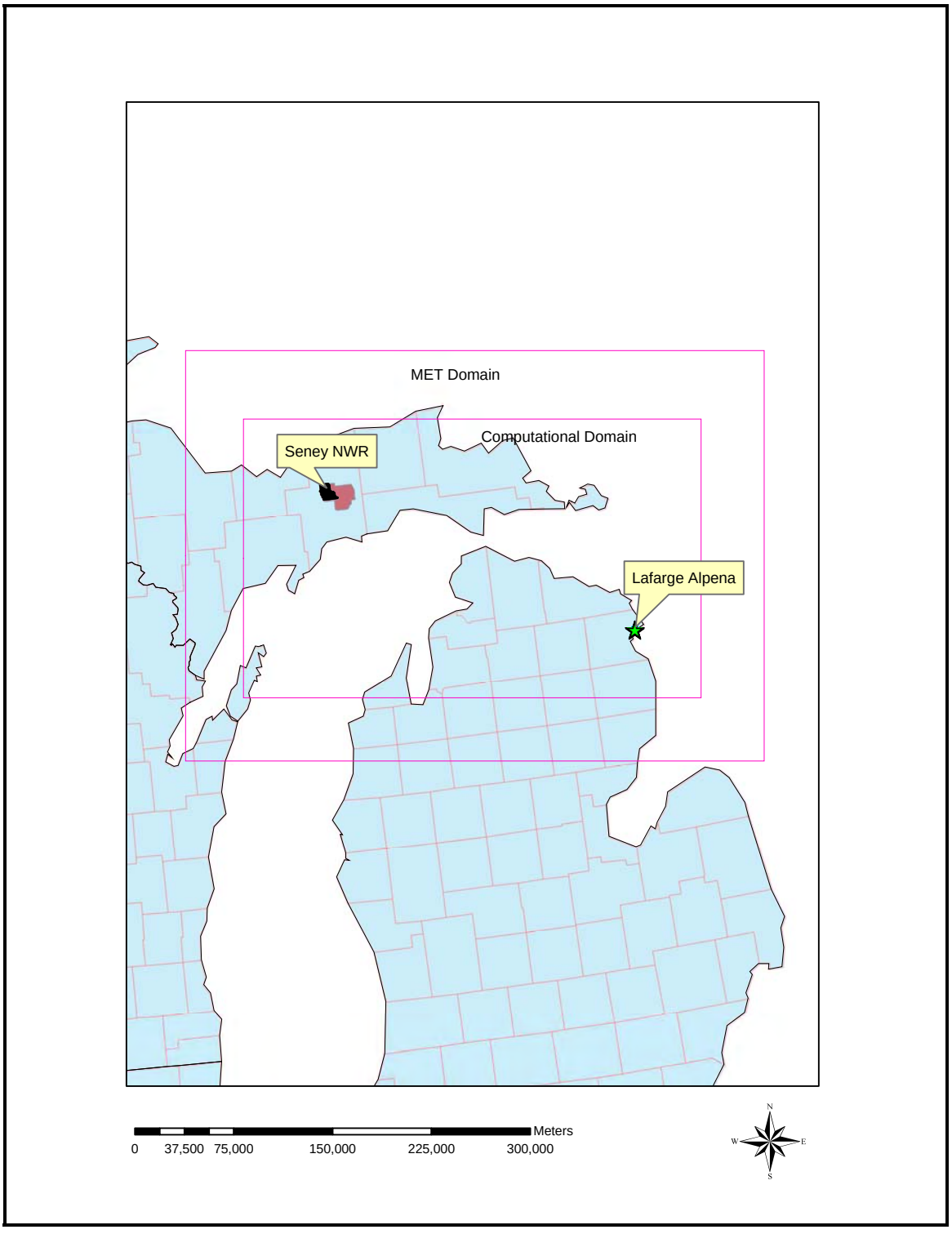

Figure 4-1. Lafarge Meteorological and Computational Domain

Upper air data for 2002, 2003 and 2004 were used as observations in developing the Step 2 Wind Fields in the CALMET model. The upper air data were purchased from BEE-Line Software, Asheville, NC. BEE-Line Software obtained these data from the NOAA Forecast Systems Laboratory web site. Two upper air stations, Gaylord and Green Bay, were found to be located near or in the meteorological modeling domain.

Precipitation data for 2002, 2003 and 2004 were used as observations in developing the Step 2 Wind Fields in the CALMET model. The precipitation data were purchased from BEE-Line Software, Asheville, NC. BEE-Line Software obtained these data from the National Climatic Data Center, Asheville, NC. The dataset includes all stations, with sufficient data for modeling, within or near the meteorological modeling domain. A total of 19 stations were used for 2002 and 21 stations were used for 2003 and 2004.

A list of all the surface, upper air, and precipitation stations that were used in the analysis are presented in Appendix C.

Geophysical Data

Land Use data were used to develop the surface characteristic for input to the CALMET model. For the US portion of the modeling domain, the best large-scale land use data sets are the USGS National Land Cover Dataset (NLCD 92) which have a 30 meter resolution. These data were used for the US portion of the modeling domain. The NLCD data is not available outside of the US. For the Canadian portion of the modeling domain, the USGS EROS Global Land Cover Characterization (GLCC Version 2) were used.

Terrain data is used by the CALMET model to modify the Initial Guess Wind Fields in developing the Step 1 Wind Fields. For the US portion of the modeling domain, USGS 1:250,000 scale Digital Elevation Model (DEM) data were used. For the Canadian portion of the modeling domain, the USGS GTOPO30 data were used.

CALMET Preprocessing

The SMERGE program reads multiple surface data files that may be in several different formats and makes any needed units conversion and writes the combined data to a single file (surf.dat). The surf.dat file is read by CALMET as observations and is used in the modification of the Step 1 Wind Fields in developing the Step 2 Wind Fields.

The READ62 program reads an upper air data file and extracts soundings, makes any needed units conversion and writes the data to a processed data file. READ62 is repeated for each upper air file. Most upper air data files contain missing data and other errors. These missing data are filled and the errors are corrected. These changes are documented in the upper air list (.lst) files. The processed data files are read by CALMET as observations and are used in the modification of the Step 1 Wind Fields in developing the Step 2 Wind Fields.

PXTRACT and PMERGE extract data for specific stations and combine the data into a single processed data file. The processed data file is read by CALMET as observations and are used in the modification of the Step 1 Wind Fields in developing the Step 2 Wind Fields.

CTGPROC reads land use data and calculates weighted land use for each grid cell in the modeling domain and writes a processed data file.

TERREL reads terrain data and calculates the elevation of the center of each grid cell in the modeling domain and writes a processed data file.

MAKEGEO reads the processed data files from CTGPROC and TERREL. MAKEGEO calculates weighted surface characteristics and writes these along with the terrain elevations to a processed data file. The processed data file is used by the CALMET model to modify the Initial Guess Wind Fields in developing the Step 1 Wind Fields.

CALMET Analysis

The CALMET analysis followed guidance of IWAQM[15] and FLAG[16]. Version 6.211 of the CALMET model was used to develop the parameters for the three-dimensional Meteorological Grid. The Meteorological Grid includes meteorological parameters, surface parameters and terrain elevations for each hour. This three-dimensional Meteorological Grid was calculated by CALMET in three steps as follows.

Initial Guess Wind Fields. The 36 km prognostic data for 2002, 2003 and 2004 was used for developing the Initial Guess Wind Fields of the 4 km three-dimensional Meteorological Grid.

Step 1 Wind Fields. The terrain and surface parameters are used to modify the Initial Guess Wind Fields to develop the Step 1 Wind Fields of the 4 km three-dimensional Meteorological Grid. The area that most influences the transport and dispersion of puffs from the source to the Class I Area is the area near a line from the source to the Class I Area. This area is generally gently sloping or overwater. Just to the south of this line in the north-central part of the lower part of Michigan are two higher areas with a shallow valley between. The higher terrain to the south is a little over 400 meters AMS, the valley floor is about 200 meters AMS, and north of the valley the terrain raises to an elevation of about 320 meters AMS. The distance from high terrain to high terrain is about 50 kilometers. Therefore, the radius of influence of terrain features (TERRAD) was set to 25 km to account for this terrain. The slope of the intervening terrain is gentle and the value of TERRAD should have very little influence on the calculated impacts.

Step 2 Wind Fields. Meteorological observations (surface data, upper air data and precipitation data) are used to modify the Step 1 Wind Fields to develop the Step 2

[15] Interagency Workgroup on Air Quality Modeling Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts (EPA-454/R-98-019) (IWAQM)

[16] Federal Land Managers Air Quality Related Values Work Group Phase I report (USFS, NPS, USFWS, 2000) (FLAG)

Wind Fields of the 4 km three-dimensional Meteorological Grid. The terrain is gently rolling in the area that most influences the transport and dispersion of puffs from the source to the Class I Area. Therefore, the radius of influence of the observations should be relatively large. The maximum distances and relative weightings of observations were set as follows.

Maximum Over Land Surface (KM) –	RMAX1 = 100
Maximum Over Land Aloft (KM) -	RMAX2 = 200
Maximum Over Water (KM) -	RMAX3 = 100
Relative Weighting Surface (KM) -	R1 = 30
Relative Weighting Aloft (KM) -	R2 = 60

4.4 CALPUFF

Output from the CALMET model was input to the CALPUFF model, which simulates the effects of the meteorological conditions on the transport and dispersion of pollutants from an individual source. Version 6.112 of CALPUFF was used in the analysis.

Modeling Domain

The CALPUFF modeling domain was designed to include the Lafarge facility and the Seney Class I area (this is the only Class I Area within 500 km of Lafarge). A 50 km buffer zone in each direction was included in establishing the computational modeling domain. The domain dimensions are therefore 440 km east-west by 312 km north-south. The modeling (computational) domain is shown in Figure 3. Ninety eight grid cells were employed in the east-west axis and 65 in the north-south axis.

Class I Area Receptors

Lafarge used the FLM Class I receptors for Seney, with elevations, as obtained from the National Parks Service. The receptor coordinates and elevations are provided in Appendix D.

Control File Settings

In general, Lafarge used the default options in the CALPUFF model.[17] The deviations from the default values are discussed below.

- The MESOPUFF II module was used for chemical transformation (MCHEM=1)
- Number of vertical layers (NZ) was set to 10 and cell face heights (ZFACE) of 0, 20, 40, 80, 160, 320, 1000, 1500, 2200, and 3000 meters were used (to be consistent with CALMET runs).
- The integrated puff sampling methodology was used for puff recognition.
- Building downwash was ignored because the Class Area is located greater than 50 km from the source and downwash should not influence concentration estimates.

Ozone and Ammonia Background Values

CALPUFF uses background ozone (O_3) and ammonia (NH_3) values in its chemistry module. Per LADCO Guidance, Lafarge used the domain seasonal average ozone and ammonia concentration values provided in the LADCO BART Guidance document.

4.5 CALPOST

Calculation Methods for Background Light Extinction

Input required by CALPOST includes an input control file and the hourly concentration output file from CALPUFF. The primary settings for the CALPOST control file are associated with the method for calculation of light extinction. The CALPOST control file was set such that the background light extinction calculation Visibility Method 6 (MVISBK=6) was used. This is the default value as described in LADCO's protocol document. As required by Method 6, The EPA Class I area-specific (centroid) monthly relative humidity values for the Seney Class I area were used. These values were obtained from Table A-3 of the EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule".[18]

[17] As defined by pages B-2 through B-8 of the IWAQM Phase 2 Summary Report.
[18] "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule", EPA-450/B-03-005, September 2003.

In Visibility Method 6, CALPOST also requires monthly background concentrations of ammonium sulfate, ammonium nitrate, coarse particulate mass, organic carbon, soil, and elemental carbon. Annual averages reflective of natural background conditions for these species were obtained from the EPA's "Guidance for Natural Visibility" document.

Light Extinction Efficiencies and Rayleigh Scattering Value

The other values required to execute CALPOST include the light extinction efficiencies for the pollutant species identified above (i.e., ammonium sulfate, ammonium nitrate, etc.) and the extinction due to Rayleigh scattering (BEXTRAY). Dry extinction efficiencies for the pollutant species were set equal to the Table 2-1 values of the EPA Visibility Guidance Document. The value for Rayleigh scattering was set to 10 Mm^{-1}.

5.0 BART MODEL RESULTS

The CALPUFF modeling system was executed with input data and settings as described in Section 4. Delta-deciview results were obtained from the "24HR VISIBILITY (deciview)" table in the CALPOST output files. The regional haze regulation and BART guideline stipulate that the States have flexibility in determining the degree of visibility improvement that should be considered acceptable in assessing appropriate BART controls (see 70 FR 39170). The States may consider the frequency, magnitude, and duration components of visibility impairment. EPA suggests that the States use a comparison threshold, as is done for determining if BART-eligible emission units are subject to BART. Alternatively, States may compare the 98th percent days for the pre- and post-control runs. The MDEQ has requested that Lafarge provide the 98th percentile values as well as the number of days with delta deciview values in excess of the 0.5 BART-eligibility criterion for both the pre- and post-control scenarios. These results are presented in Table 5-1 as well as Appendix E.

As shown in Table 5-1, both the 98th percentile deciview value and the number of days in excess of 0.5 deciviews decrease with each of the control scenarios evaluated. However, the majority of the reduction is realized between the baseline and the control scenario no. 1 (SNCR on all kilns and wet scrubbing on KG6). The next highest level of control (adding duct injection to KG5) results in some degree of visibility improvement. However, the costs of the additional level of control outweighs the small additional improvement in modeled visibility impacts. The addition of duct injection on KG5 would only improve the combined, three year 98% dv value by 0.05 dv (0.746-0.697 dv) at a cost of over $3,300/ton or approximately $2,800,000/dv [$1,702,833/1.301-0.6967 dv]. The next level of control (addition of wet scrubbers to KG5) is even more expensive at $7,952/ton or approximately $21,000,000/dv [$16,287,149/(1.301-.509)].

The CALPUFF and CALPOST input and output files are provided on the enclosed CD.

Table 5-1. Delta Deciview Visibility Impact Rankings (4km CALMET Grid, Annual Average Concentrations as Background)

Scenario	2002		2003		2004		2002-2004 Combined	
	98th Percentile Value	No. Days 98% > 0.5 deciview	98th Percentile Value	No. Days 98% > 0.5 deciview	98th Percentile Value	No. Days 98% > 0.5 deciview	98th Percentile Value	No. Days 98% > 0.5 deciview
Baseline	0.711	3	1.852	15	1.089	7	1.301	25
Control Scenario 1: SNCR KG5&6, Wet Scrubbing KG6 (Proposed BART)	0.371	0	1.022	10	0.641	3	0.746	12
Control Scenario 2: SNCR KG5&6, Wet Scrubbing KG6, Duct Injection KG5	0.340	0	0.908	10	0.614	3	0.697	10
Control Scenario 3: SNCR KG5&6, Wet Scrubbing KG5&6	0.242	0	0.644	6	0.474	0	0.509	1

APPENDIX A

PM_{10} Speciation, Emission Calculations, And Worst Case-Stack Parameter Determination

PM_{10} Emissions from Lafarge Alpena Kilns

Source Equipment Number	New MAERS Activity ID No.	Model Source ID	Source Description	Material	Maximum Feed Rate (ton/hr)	Potential Emission Factor (lb/ton feed)	Emission Factor Reference	PM PTE (lbs/hr)	PM_{10} PTE (lbs/hr)	PM_{10} PTE (ton/yr)
25-253	KILN 19	SV00031	K19 Exhaust	Kilns (CKD)	90	0.06	MAERS, Test	5.40	4.59	20.1
25-265	KILN 20	SV00032	K20 Exhaust	Kilns (CKD)	90	0.06	MAERS, Test	5.40	4.59	20.1
25-266	KILN 21	SV00033	K21 Exhaust	Kilns (CKD)	90	0.06	MAERS, Test	5.40	4.59	20.1
26-256	KILN 22	SV00047	K22-23 Exhaust	Kilns (CKD)	144	0.11	MAERS, Test	15.84	13.46	59.0
26-256	KILN 23	SV00047	K22-23 Exhaust	Kilns (CKD)	144	0.07	MAERS, Test	10.08	8.57	37.5

Maximum hourly feed rates based upon a clinker factor of 1.8 and the following maximum clinker rates: K19-K21:50 ton/hr each, K22-K23-80 ton/hr each.

PM Speciation

	Uncontrolled PM10 Emissions (**Bold** Value is **Input** by user.)																	
Kiln	Total PM10		Filterable	Coarse - PMC	Ext.	Fine	Fine Soil - PMF	Ext.	Fine EC	Ext.		Condensible	CPM IOR -SO4	Particle		CPM OR - SOA	Particle	
Lafarge Kiln	(lb/hr)		(lb/hr)	(lb/hr)	Coef.	(lb/hr)	(lb/hr)	Coef.	(lb/hr)	Coef.		(lb/hr)	(lb/hr)	Type	Ext.Coef.	(lb/hr)	Type	Ext.Coef.
KILN 19	31.9		**4.6**	2.1	0.6	2.5	2.2	1	0.2	10		27.3	24.0	SO4	3	3.3	SOA	4
KILN 20	31.9		**4.6**	2.1	0.6	2.5	2.2	1	0.2	10		27.3	24.0	SO4	3	3.3	SOA	4
KILN 21	31.9		**4.6**	2.1	0.6	2.5	2.2	1	0.2	10		27.3	24.0	SO4	3	3.3	SOA	4
KILN 22	93.6		**13.5**	6.3	0.6	7.2	6.5	1	0.7	10		80.1	70.5	SO4	3	9.6	SOA	4
KILN 22	59.5		**8.6**	4.0	0.6	4.6	4.2	1	0.4	10		51.0	44.9	SO4	3	6.1	SOA	4

Worst-Case Stack Parameter Determination - Weighting Based Upon Emissions

Model Source Description	Model Source ID	Sum of Emissions (lb/hr)	Weighting Factor Based on Emissions	Weighted Stack Height (m)	Weighted Base Elevation (m)	Weighted Stack Diameter (m)	Weighted Exit Velocity (m/sec)	Weighted Temp. (K)
K19 Exhaust	SV00031	2027	0.15	9.76	26.48	0.58	0.57	63.91
K20 Exhaust	SV00032	1381	0.10	6.65	18.04	0.39	0.39	43.54
K21 Exhaust	SV00033	1438	0.10	6.92	18.78	0.41	0.62	45.34
K22-23 Exhaust	SV00047	9085	0.65	58.05	118.70	4.77	4.39	306.41
Combined	KILNS	13929	1	**81.37**	**182.00**	**6.15**	**5.97**	**459.19**

APPENDIX B

Control Costing Calculations and Supporting Documentation

KG5 Wet Scrubber Cost Estimate

Item	Basis	Value	Comments
	Capital Cost Estimate		
Purchased equipment Costs			
Scrubber System Cost (SSC)	Vendor Quote + Plant Estimates	43,200,000	Includes scrubber, reagent prep, piping, tanks, and pumps, air compressors, gypsum handling, fans, and duct work.
Instrumentation	= 0.05*SSC	2,160,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995) - use 1/2 value to account for instrumentation in scrubber price.
Sales taxes	= 0.03*SSC	1,296,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*SSC	2,160,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.13*SSC	48,816,000	= Scrubber System Cost (SSC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in SSC
Handling & erection	Included in PEC	-	Included in SSC
Electrical	Included in PEC	-	Included in SSC
Piping	Included in PEC	-	Included in SSC
Insulation	Included in PEC	-	Included in SSC
Painting	Included in PEC	-	Included in SSC
Direct installation costs	Included in PEC	-	Included in SSC
Site preparation & Buildings (SP + BLD.)	As required	9,000,000	Lafarage Estimate: includes roads, electrical, water, etc.
Total Direct Costs (DC)	= PEC + SP +BLD.	57,816,000	= Site preparation & Buildings (SP + BLD.) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	4,881,600	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	4,881,600	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	4,881,600	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	488,160	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	488,160	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	9,763,200	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	30 days of downtime/kiln	4,320,000	Based on lost production of $40/ton and a capacity of 150 tph.
Total Indirect Costs (IC)	= 0.35*PEC	29,704,320	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	91,840,320	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles limestone/mole SO2 removed)	Estimate.	1.1	1.05 Reagent Ratio & 95% CaCO3 in limestone.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Maintenance Labor Cost ($/hr)	Lafarge Data; unburdened cost.	24.78	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
Limestone Cost ($/ton)	Lafarge Data	1.25	Lafarge Data
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
SO2 to Scrubber (tpy)	Based on 2004/2005 Average Emissions.	2,529	
SO2 Removal Efficiency (%)	Design Estimate.	90%	
FGD On-stream Time (%)	Design Estimate.	90%	
SO2 Removed by Scrubber (tpy)	Calculated from above values.	2,048	= SO2 to Scrubber (tpy) * SO2 Removal Efficiency (%) * FGD On-stream Time (%)
Gypsum MW (lb/lb-mole)	Constant	172	
CaCO3 MW (lb/lb-mole)	Constant	100	
SO2 MW (lb/lb-mole)	Constant	64	
Gypsum Production Rate (tpy -dry basis)	CaSO4*2H2O (dry basis)	5,504	= SO2 Removed by Scrubber (tpy) * Gypsum MW (lb/lb-mole) / SO2 MW (lb/lb-mole)
Gypsum Value ($/ton - dry basis)	Lafarge Data	16	Lafarge Data
Water Evaporation Rate (gpm)	Estimate.	100	
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	3.0 operators per shift	624,938	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	124,488	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	10 wt. % free moisture in Gypsum + evap.	233,790	Based on evaporation, and water lost w/ gypsum.
• Limestone ($/yr)	Based on Reagent Ratio of 1.1.	4,400	Calculated based on Reagent Ratio & SO2 removal rate.
• Wastewater disposal ($/yr)	None (FGD is assumed zero discharge)	0	Zero discharge.
Maintenance			
• Labor ($/yr)	1.0 person per shift	217,073	Estimate of staffing based on scrubber complexity.
• Material ($/yr)	100% of maintenance labor	217,073	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Electricity			
• Fans ($/yr)	400 kW for scrubber fans.	198,677	Design estimate.
• Pumps ($/yr)	120 kW for scrubber pumps.	59,603	Design estimate.
• Air Compressors ($/yr)	20 kW for oxidation air compressor.	9,934	Design estimate.
• Limestone Grinding System ($/yr)	150 kW for limestone grinding circuit.	74,504	Design estimate.
Gypsum Credit ($/yr)	Gypsum value as cement additive.	-88,069	= -Gypsum Production Rate (tpy -dry basis) * Gypsum Value ($/ton - dry basis)
DAC Subtotal	Direct Annual Costs (DAC)	1,676,411	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	853,058	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	1,836,806	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	918,403	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	918,403	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	10,084,067	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	14,610,738	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	16,287,149	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons SO2 Removed	7,952	= Total Annual Cost ($/yr) / SO2 Removed by Scrubber (tpy)

KG6 Wet Scrubber Cost Estimate

Item	*Basis*	*Value*	*Comments*
	Capital Cost Estimate		
Purchased equipment Costs			
Scrubber System Cost (SSC)	Vendor Quote + Plant Estimates	30,000,000	Includes scrubber, reagent prep, piping, tanks, and pumps, air compressors, gypsum handling, fans, and duct work.
Instrumentation	= 0.05*SSC	1,500,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995) - use 1/2 value to account for instrumentation in scrubber price.
Sales taxes	= 0.03*SSC	900,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*SSC	1,500,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.13*SSC	33,900,000	= Scrubber System Cost (SSC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in SSC
Handling & erection	Included in PEC	-	Included in SSC
Electrical	Included in PEC	-	Included in SSC
Piping	Included in PEC	-	Included in SSC
Insulation	Included in PEC	-	Included in SSC
Painting	Included in PEC	-	Included in SSC
Direct installation costs	Included in PEC	-	Included in SSC
Site preparation & Buildings (SP + BLD.)	As required	7,000,000	Lafarage Estimate: includes roads, electrical, water, etc.
Total Direct Costs (DC)	= PEC + SP +BLD.	40,900,000	= Site preparation & Buildings (SP + BLD.) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	3,390,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	3,390,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	3,390,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	339,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	339,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	6,780,000	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	30 days of downtime/kiln	4,608,000	Based on lost production of $40/ton and a capacity of 160 tph.
Total Indirect Costs (IC)	= 0.35*PEC	22,236,000	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	63,136,000	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles limestone/mole SO2 removed)	Estimate.	1.1	1.05 Reagent Ratio & 95% CaCO3 in limestone.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Maintenance Labor Cost ($/hr)	Lafarge Data; unburdened cost.	24.78	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
Limestone Cost ($/ton)	Lafarge Data	1.25	Lafarge Data
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
SO2 to Scrubber (tpy)	Based on 2004/2005 Average Emissions.	13,433	
SO2 Removal Efficiency (%)	Design Estimate.	90%	
FGD On-stream Time (%)	Design Estimate.	90%	
SO2 Removed by Scrubber (tpy)	Calculated from above values.	10,880	= SO2 to Scrubber (tpy) * SO2 Removal Efficiency (%) * FGD On-stream Time (%)
Gypsum MW (lb/lb-mole)	Constant	172	
CaCO3 MW (lb/lb-mole)	Constant	100	
SO2 MW (lb/lb-mole)	Constant	64	
Gypsum Production Rate (tpy -dry basis)	CaSO4*2H2O (dry basis)	29,241	= SO2 Removed by Scrubber (tpy) * Gypsum MW (lb/lb-mole) / SO2 MW (lb/lb-mole)
Gypsum Value ($/ton - dry basis)	Lafarge Data	16	Lafarge Data
Water Evaporation Rate (gpm)	Estimate.	100	
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	3.0 operators per shift	624,938	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	124,488	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	10 wt. % free moisture in Gypsum + evap.	242,417	Based on evaporation, and water lost w/ gypsum.
• Limestone ($/yr)	Based on Reagent Ratio of 1.1.	23,376	Calculated based on Reagent Ratio & SO2 removal rate.
• Wastewater disposal ($/yr)	None (FGD is assumed zero discharge)	0	Zero discharge.
Maintenance			
• Labor ($/yr)	1.0 person per shift	217,073	Estimate of staffing based on scrubber complexity.
• Material ($/yr)	100% of maintenance labor	217,073	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Electricity			
• Fans ($/yr)	500 kW for scrubber fans.	248,346	Design estimate.
• Pumps ($/yr)	300 kW for scrubber pumps.	149,008	Design estimate.
• Air Compressors ($/yr)	50 kW for oxidation air compressor.	24,835	Design estimate.
• Limestone Grinding System ($/yr)	200 kW for limestone grinding circuit.	99,338	Design estimate.
Gypsum Credit ($/yr)	Gypsum value as cement additive.	-467,858	= -Gypsum Production Rate (tpy -dry basis) * Gypsum Value ($/ton - dry basis)
DAC Subtotal	Direct Annual Costs (DAC)	1,503,034	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	869,619	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	1,262,720	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	631,360	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	631,360	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	6,932,333	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	10,327,392	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	11,830,426	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons SO2 Removed	1,087	= Total Annual Cost ($/yr) / SO2 Removed by Scrubber (tpy)

KG5 Duct Injection Cost Estimate

Item	*Basis*	*Value*	*Comments*
	Capital Cost Estimate		
Purchased equipment Costs			
Duct Injection System Cost (DISC)	Vendor Quote + Plant Estimates	1,455,600	Includes injection system, reagent prep, piping, tanks, silos, and pumps and duct work.
Instrumentation	= 0.10*DISC	145,560	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Sales taxes	= 0.03*DISC	43,668	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*DISC	72,780	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.18*DISC	1,717,608	= Duct Injection System Cost (DISC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in DISC
Handling & erection	Included in PEC	-	Included in DISC
Electrical	Included in PEC	-	Included in DISC
Piping	Included in PEC	-	Included in DISC
Insulation	Included in PEC	-	Included in DISC
Painting	Included in PEC	-	Included in DISC
Direct installation costs	Included in PEC	-	Included in DISC
Site preparation & Buildings (SP + BLD.)	As required	500,000	Order of magnitude estimate.
Total Direct Costs (DC)	= PEC + SP +BLD.	2,217,608	= Site preparation & Buildings (SP + BLD.) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	171,761	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	171,761	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	171,761	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	17,176	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	17,176	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	343,522	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	10 days of downtime/kiln	1,440,000	Based on lost production of $40/ton and a capacity of 150 tph.
Total Indirect Costs (IC)	= 0.35*PEC	2,333,156	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	4,550,764	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles limes/mole SO2 removed)	Estimate.	1.0	1.0 reagent ration estiamted to achieve 20% reduction.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Maintenance Labor Cost ($/hr)	Lafarge Data; unburdened cost.	24.78	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
Lime Cost ($/ton)	Lafarge Data	80	Estimate
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
CKD disposal cost ($/ton)	Lafarge Data	3.5	Lafarge Data
SO2 to Scrubber (tpy)	Based on 2004/2005 Average Emissions.	2,529	
SO2 Removal Efficiency (%)	Design Estimate.	25%	
FGD On-stream Time (%)	Design Estimate.	80%	
SO2 Removed by System (tpy)	Calculated from above values.	506	= SO2 to Scrubber (tpy) * SO2 Removal Efficiency (%) * FGD On-stream Time (%)
Ca(OH)2 MW (lb/lb-mole)	Constant	74	
SO2 MW (lb/lb-mole)	Constant	64	
Water Evaporation Rate (gpm)	Estimate.	50	
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	1.0 operators per shift	208,313	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	41,496	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	Based on evaporation rate.	103,018	Based on evaporation.
• Lime ($/yr)	Based on Reagent Ratio of 1.0.	46,778	Calculated based on Reagent Ratio & SO2 removal rate.
• Wastewater disposal ($/yr)	None (FGD is assumed zero discharge)	0	Zero discharge.
• CKD disposal ($/yr)	Assumes 2 tons CKD/ton SO2 removed.	3,540	Need to purge sulfur from system.
Maintenance			
• Labor ($/yr)	0.5 person per shift	108,536	Estimate of staffing based on scrubber complexity.
• Material ($/yr)	100% of maintenance labor	108,536	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Electricity			
• Fans ($/yr)	50 kW for scrubber fans.	22,075	Design estimate.
• Pumps ($/yr)	20 kW for scrubber pumps.	8,830	Design estimate.
DAC Subtotal	Direct Annual Costs (DAC)	651,123	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	370,006	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	91,015	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	45,508	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	45,508	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	499,674	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	1,051,711	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	1,702,833	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons SO2 Removed	3,367	= Total Annual Cost ($/yr) / SO2 Removed by System (tpy)

KG6 Duct Injection Cost Estimate

Item	*Basis*	*Value*	*Comments*
	Capital Cost Estimate		
Purchased equipment Costs			
Duct Injection System Cost (DISC)	Vendor Quote + Plant Estimates	1,344,000	Includes injection system, reagent prep, piping, tanks, silos, and pumps and duct work.
Instrumentation	= 0.10*DISC	134,400	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Sales taxes	= 0.03*DISC	40,320	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*DISC	67,200	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.18*DISC	1,585,920	= Duct Injection System Cost (DISC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in DISC
Handling & erection	Included in PEC	-	Included in DISC
Electrical	Included in PEC	-	Included in DISC
Piping	Included in PEC	-	Included in DISC
Insulation	Included in PEC	-	Included in DISC
Painting	Included in PEC	-	Included in DISC
Direct installation costs	Included in PEC	-	Included in DISC
Site preparation & Buildings (SP + BLD.)	As required	500,000	Order of magnitude estimate.
Total Direct Costs (DC)	= PEC + SP +BLD.	2,085,920	= Site preparation & Buildings (SP + BLD.) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	158,592	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	158,592	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	158,592	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	15,859	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	15,859	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	317,184	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	10 days of downtime/kiln	1,536,000	Based on lost production of $40/ton and a capacity of 160 tph.
Total Indirect Costs (IC)	= 0.35*PEC	2,360,678	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	4,446,598	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles lime/mole SO2 removed)	Estimate.	1.0	1.0 reagent ration estiamted to achieve 20% reduction.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Maintenance Labor Cost ($/hr)	Lafarge Data; unburdened cost.	24.78	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
Lime Cost ($/ton)	Lafarge Data	80	Estimate
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
CKD disposal cost ($/ton)	Lafarge Data	3.5	Lafarge Data
SO2 to Scrubber (tpy)	Based on 2004/2005 Average Emissions.	13,433	
SO2 Removal Efficiency (%)	Design Estimate.	25%	
FGD On-stream Time (%)	Design Estimate.	80%	
SO2 Removed by System (tpy)	Calculated from above values.	2,687	= SO2 to Scrubber (tpy) * SO2 Removal Efficiency (%) * FGD On-stream Time (%)
Ca(OH)2 MW (lb/lb-mole)	Constant	74	
SO2 MW (lb/lb-mole)	Constant	64	
Water Evaporation Rate (gpm)	Estimate.	50	
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	1.0 operators per shift	208,313	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	41,496	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	Based on evaporation rate.	103,018	Based on evaporation.
• Lime ($/yr)	Based on Reagent Ratio of 1.0.	248,504	Calculated based on Reagent Ratio & SO2 removal rate.
• Wastewater disposal ($/yr)	None (FGD is assumed zero discharge)	0	Zero discharge.
• CKD disposal ($/yr)	Assumes 2 tons CKD/ton SO2 removed.	18,806	Need to purge sulfur from system.
Maintenance			
• Labor ($/yr)	0.5 person per shift	108,536	Estimate of staffing based on scrubber complexity.
• Material ($/yr)	100% of maintenance labor	108,536	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Electricity			
• Fans ($/yr)	50 kW for scrubber fans.	22,075	Design estimate.
• Pumps ($/yr)	20 kW for scrubber pumps.	8,830	Design estimate.
DAC Subtotal	Direct Annual Costs (DAC)	868,114	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	491,042	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	88,932	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	44,466	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	44,466	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	488,237	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	1,157,142	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	2,025,256	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons SO2 Removed	754	= Total Annual Cost ($/yr) / SO2 Removed by System (tpy)

KG5 SNCR Cost Estimate

Item	*Basis*	*Value*	*Comments*
	Capital Cost Estimate		
Purchased equipment Costs			
SNCR System Cost (SNCRSC)	Vendor Quote + Plant Estimates	975,000	Includes injection system, reagent prep, piping, tanks, silos, and pumps and duct work.
Instrumentation	= 0.10*SNCRSC	97,500	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Sales taxes	= 0.03*SNCRSC	29,250	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*SNCRSC	48,750	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.18*SNCRSC	1,150,500	= SNCR System Cost (SNCRSC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in SNCRSC
Handling & erection	Included in PEC	-	Included in SNCRSC
Electrical	Included in PEC	-	Included in SNCRSC
Piping	Included in PEC	-	Included in SNCRSC
Insulation	Included in PEC	-	Included in SNCRSC
Painting	Included in PEC	-	Included in SNCRSC
Direct installation costs	Included in PEC	-	Included in SNCRSC
General Facilities (GF)	= 0.05*PEC	57,525	USEPA Control Cost Manual, Sec. 4.2, C1, Table 1.4 (10/2000).
Total Direct Costs (DC)	= PEC + GF	1,208,025	= General Facilities (GF) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	115,050	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	115,050	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	115,050	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	11,505	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	11,505	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	230,100	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	5 days of downtime/kiln	720,000	Based on lost production of $40/ton and a capacity of 150 tph.
Total Indirect Costs (IC)	= 0.35*PEC	1,318,260	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	2,526,285	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles limestone/mole SO2 removed)	Estimate.	1.0	1.0 reagent ration estiamted to achieve 40% reduction.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
NH3 Cost ($/ton)	Lafarge Data	650	Estimate.
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
NOx to SNCR (tpy)	Based on 2004/2005 Average Emissions.	3,547	
NOx Removal Efficiency (%)	Design Estimate.	44%	
SNCR On-stream Time (%)	Design Estimate.	80%	
NOx Removed by System (tpy)	Calculated from above values.	1,242	= NOx to SNCR (tpy) * NOx Removal Efficiency (%) * SNCR On-stream Time (%)
NH3 MW (lb/lb-mole)	Constant	17	
NOx MW (lb/lb-mole)	Constant	46	
Water Injection Rate (gpm)	Based on 20% NH3/80% H2O by weight.	1.05	Calculated value.
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	0.25 operators per shift	41,663	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	8,299	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	Based on evaporation rate.	2,157	Based on water used in injection system.
• NH3 ($/yr)	Based on Reagent Ratio of 1.0.	214,365	Calculated based on Reagent Ratio & SO2 removal rate.
Maintenance			
• Labor & Materials ($/yr)	1.5% of TCI	37,894	USEPA Control Cost Manual, Sec. 4.2, C1, Eqn. 1.21 (10/2000).
Electricity			
• Vaporization System & Pumps ($/yr)	44 kW	19,426	USEPA Control Cost Manual, Sec. 4.2, C1, Eqn. 1.23 (10/2000).
DAC Subtotal	Direct Annual Costs (DAC)	323,804	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	182,626	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	50,526	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	25,263	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	25,263	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	277,386	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	561,064	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	884,867	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons NOx Removed	713	= Total Annual Cost ($/yr) / NOx Removed by System (tpy)

KG6 SNCR Cost Estimate

Item	*Basis*	*Value*	*Comments*
	Capital Cost Estimate		
Purchased equipment Costs			
SNCR System Cost (SNCRSC)	Vendor Quote + Plant Estimates	800,000	Includes injection system, reagent prep, piping, tanks, silos, and pumps and duct work.
Instrumentation	= 0.10*SNCRSC	80,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Sales taxes	= 0.03*SNCRSC	24,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Freight	= 0.05*SNCRSC	40,000	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Purchased equipment cost (PEC)	PEC = 1.18*SNCRSC	944,000	= SNCR System Cost (SNCRSC) + Instrumentation + Sales taxes + Freight
Direct installation costs			
Foundations & supports	Included in PEC	-	Included in SNCRSC
Handling & erection	Included in PEC	-	Included in SNCRSC
Electrical	Included in PEC	-	Included in SNCRSC
Piping	Included in PEC	-	Included in SNCRSC
Insulation	Included in PEC	-	Included in SNCRSC
Painting	Included in PEC	-	Included in SNCRSC
Direct installation costs	Included in PEC	-	Included in SNCRSC
General Facilities (GF)	= 0.05*PEC	47,200	USEPA Control Cost Manual, Sec. 4.2, C1, Table 1.4 (10/2000).
Total Direct Costs (DC)	= PEC + GF	991,200	= General Facilities (GF) + Purchased equipment cost (PEC)
Indirect Costs (installation)			
Engineering	= 0.10*PEC	94,400	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Construction and field expenses	= 0.10*PEC	94,400	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contractor fees	= 0.10*PEC	94,400	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Start-up	= 0.01*PEC	9,440	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Performance test	= 0.01*PEC	9,440	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.3 (12/1995).
Contingencies	= 0.25*PEC	188,800	Conservative estimate of contingency based on level of engineering.
Lost Production During Retrofit	5 days of downtime/kiln	768,000	Based on lost production of $40/ton and a capacity of 160 tph.
Total Indirect Costs (IC)	= 0.35*PEC	1,258,880	= SUM of Indirect Cost Elements
Total Capital Investment $ (TCI)	= IC+ DC	2,250,080	= Total Direct Costs (DC) + Total Indirect Costs (IC)

Annualized Cost Estimate			
Annual Cost Inputs			
Reagent Ratio (moles limestone/mole SO2 removed)	Estimate.	1.0	1.0 reagent ration estiamted to achieve 40% reduction.
Operating Labor Cost ($/hr)	Lafarge Data; unburdened cost.	23.78	Lafarge Data
Supervisory Labor Cost ($/hr)	Lafarge Data; unburdened cost.	31.58	Lafarge Data
Power Cost ($/kW)	Lafarge Data	0.063	Lafarge Data
NH3 Cost ($/ton)	Lafarge Data	650	Estimate.
Water Cost ($/1000 gal)	Lafarge Data	4.9	Lafarge Data
NOx to SNCR (tpy)	Based on 2004/2005 Average Emissions.	5,748	
NOx Removal Efficiency (%)	Design Estimate.	50%	
SNCR On-stream Time (%)	Design Estimate.	80%	
NOx Removed by System (tpy)	Calculated from above values.	2,299	= NOx to SNCR (tpy) * NOx Removal Efficiency (%) * SNCR On-stream Time (%)
NH3 MW (lb/lb-mole)	Constant	17	
NOx MW (lb/lb-mole)	Constant	46	
Water Injection Rate (gpm)	Based on 20% NH3/80% H2O by weight.	1.94	Calculated value.
Direct Annual Costs (DAC)			
Operating labor			
• Operator ($/yr)	0.25 operators per shift	41,663	Estimate of staffing based on scrubber complexity.
• Supervisor ($/yr)	15% of operator labor	8,299	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Operating materials			
• Water ($/yr)	Based on evaporation rate.	3,994	Based on water used in injection system.
• NH3 ($/yr)	Based on Reagent Ratio of 1.0.	396,957	Calculated based on Reagent Ratio & SO2 removal rate.
Maintenance			
• Labor & Materials ($/yr)	1.5% of TCI	33,751	USEPA Control Cost Manual, Sec. 4.2, C1, Eqn. 1.21 (10/2000).
Electricity			
• Vaporization System & Pumps ($/yr)	71 kW	31,347	USEPA Control Cost Manual, Sec. 4.2, C1, Eqn. 1.23 (10/2000).
DAC Subtotal	Direct Annual Costs (DAC)	516,011	= SUM of Direct Annual Cost Items
Indirect Annual Costs (IAC)			
Overhead ($/yr)	60% of total labor and material costs	290,798	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Administrative charges ($/yr)	2% of Total Capital Investment	45,002	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Property tax ($/yr)	1% of Total Capital Investment	22,501	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Insurance ($/yr)	1% of Total Capital Investment	22,501	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
Capital recovery ($/yr)	10.98% x Total Capital Investment	247,059	USEPA Control Cost Manual, Sec. 5.2, C1, Table 1.4 (12/1995).
IAC Subtotal	Indirect Annual Costs (IAC)	627,860	= SUM of Indirect Annual Cost Items
Annualized Costs			
Total Annual Cost ($/yr)	DAC + IAC	1,143,871	= IAC Subtotal + DAC Subtotal
Control Cost Effectiveness ($/ton)	TAC / Tons NOx Removed	498	= Total Annual Cost ($/yr) / NOx Removed by System (tpy)

APPENDIX C

CALMET Meteorological Stations

Surface Stations
2002, 2003 and 2004

WBAN Number	WMO Number	Station Name	State	Geographic Location		Lambert CC		UTM			Time Zone
				Longitude	Latitude	Easterly	Northerly	Easterly	Northerly	Zone	
				(deg)	(deg)	(km)	(km)	(km)	(km)		
4874	726394	Charlevoix - Newberry Luce Co	MI	85.47	46.32	885.399	757.221	155.894	5139.320	17	5
14808	726395	Wurtsmith AFB	MI	83.40	44.45	1074.281	573.444	309.041	4924.657	17	5
14841	727347	Pellston Emmet County AP	MI	84.78	45.57	949.275	681.352	205.051	5053.226	17	5
14847	727340	SAULT STE MARIE/NWSO	MI	84.35	46.47	968.599	784.893	242.800	5151.391	17	5
14850	726387	TRAVERSE CITY/FAA AIRPORT	MI	85.58	44.73	898.900	580.888	137.112	4963.516	17	5
14898	726450	GREEN BAY/AUSTIN STRAUBEL FIE	WI	88.13	44.48	701.564	530.828	-67.248	4950.327	17	6
86399*	726399	Seul Choix Pt AMOS - false WBAN	MI	85.92	45.92	856.439	708.678	118.499	5096.940	17	5
94814	726380	Houghton Lake Roscommon	MI	84.68	44.37	975.025	550.216	206.794	4919.558	17	5
94849	726390	ALPENA/PHELPS COLLINS AP	MI	83.57	45.07	1051.088	639.300	297.917	4993.599	17	5
94853	726480	Escanaba AWOS	MI	87.03	45.75	773.078	679.921	31.008	5083.982	17	5
94896	726487	Menominee AWOS	MI	87.63	45.13	733.824	606.346	-21.357	5018.818	17	5

*Pseudo-WBAN number assigned for unknown WBAN number.

Upper Air Stations
2002, 2003 and 2004

Station Number	Station Name	State	Geographic Location		Lambert CC		UTM			Time Zone
			Longitude	Latitude	Easterly	Northerly	Easterly	Northerly	Zone	
			(deg)	(deg)	(km)	(km)	(km)	(km)		
4837	Gaylord	MI	84.43	44.54	992.082	571.628	227.506	4937.577	17	5
14898	GREEN BAY/AUSTIN STRAUBEL FIE	WI	88.13	44.48	701.564	530.828	-67.248	4950.327	17	6

Precipitation Stations
2002, 2003 and 2004

Station Number	Station Name	State	Geographic Location		Lambert CC		UTM			Time Zone
			Longitude (deg)	Latitude (deg)	Easterly (km)	Northerly (km)	Easterly (km)	Northerly (km)	Zone	
200164*	ALPENA WB AIRPORT	MI	83.57	45.07	1050.806	639.596	297.692	4993.940	17	5
200662	BELLAIRE	MI	85.20	44.98	925.333	611.962	168.860	4989.315	17	5
200766	BIG BAY 8 NW	MI	87.87	46.88	695.537	798.422	-23.381	5214.786	17	5
201486	CHATHAM EXP FARM 2	MI	86.92	46.33	774.419	745.086	44.371	5147.770	17	5
202094	DETOUR VILLAGE	MI	83.90	46.00	1010.299	738.259	275.450	5098.137	17	5
202626	ESCANABA	MI	87.03	45.75	773.078	679.921	31.008	5083.982	17	5
202788	FIFE LAKE 1 NNW	MI	85.35	44.58	919.318	566.356	154.653	4945.506	17	5
203199	GLENNIE ALCONA DAM	MI	83.80	44.57	1040.981	581.974	277.671	4938.999	17	5
203391	GRAYLING	MI	84.70	44.65	969.256	580.820	206.611	4950.733	17	5
203516	GWINN 1 W	MI	87.45	46.28	734.439	735.145	3.134	5145.413	17	5
203936*	HOUGHTON LAKE WSO AIRPORT	MI	84.68	44.37	975.025	550.216	206.794	4919.558	17	5
204090	IRON MTN-KINGSFORD WWTP	MI	88.08	45.78	691.610	674.781	-50.350	5094.035	17	5
205073	MANISTIQUE	MI	86.25	45.95	830.658	708.932	93.133	5101.908	17	5
205816	NEWBERRY STATE HOSPITL	MI	85.50	46.33	882.967	758.035	153.648	5140.562	17	5
206438	PELLSTON REGIONAL AP	MI	84.79	45.56	948.651	680.145	204.218	5052.152	17	5
207366	SAULT STE MARIE WSO	MI	84.35	46.47	968.552	785.224	242.814	5151.724	17	5
208246	TRAVERSE CITY	MI	85.57	44.77	899.402	585.097	138.373	4967.569	17	5
208293	TROUT LAKE	MI	85.02	46.20	921.517	748.429	189.856	5124.128	17	5
208417	VANDERBILT 11 ENE	MI	84.45	45.17	980.874	640.766	228.893	5007.628	17	5
476510	PESHTIGO	WI	87.73	45.03	727.152	594.481	-30.148	5008.362	17	6
478267	STURGEON BAY EXP FARM	WI	87.33	44.87	760.302	580.063	-0.032	4988.036	17	6

*Not used for 2002 (contained invalid characters)

APPENDIX D

Seney Receptor Locations and Elevations

CALPUFF Receptor Locations (LCC)

LCC Origin: 40.0N, 97.0W, Standard Parallels: 33.0N, 45.0N

Receptor No.	LCC East (km)	LCC West (km)	z (m)	Description	Distance to Lafarge (km)
Source	1066.867	641.697		Lafarge	
1	827.834	740.858	225.000	Seney	258.785
2	828.472	740.934	225.000	Seney	258.225
3	829.110	741.010	225.000	Seney	257.666
4	829.748	741.086	226.000	Seney	257.107
5	830.386	741.163	226.000	Seney	256.548
6	831.024	741.239	226.000	Seney	255.989
7	831.662	741.315	226.000	Seney	255.432
8	832.300	741.391	226.000	Seney	254.874
9	832.938	741.468	226.000	Seney	254.317
10	833.576	741.544	225.000	Seney	253.760
11	834.214	741.621	224.000	Seney	253.204
12	834.852	741.697	223.000	Seney	252.649
13	835.490	741.774	223.000	Seney	252.093
14	836.128	741.850	222.000	Seney	251.538
15	836.765	741.927	221.000	Seney	250.984
16	837.403	742.004	220.000	Seney	250.430
17	838.041	742.081	220.000	Seney	249.877
18	827.725	741.781	227.000	Seney	259.241
19	828.362	741.857	226.000	Seney	258.682
20	829.000	741.933	227.000	Seney	258.124
21	829.638	742.009	227.000	Seney	257.566
22	830.276	742.085	227.000	Seney	257.008
23	830.914	742.161	228.000	Seney	256.451
24	831.552	742.237	228.000	Seney	255.894
25	832.190	742.314	228.000	Seney	255.338
26	832.828	742.390	227.000	Seney	254.782
27	833.465	742.466	226.000	Seney	254.226
28	834.103	742.543	224.000	Seney	253.671
29	834.741	742.619	223.000	Seney	253.117
30	835.379	742.696	223.000	Seney	252.562
31	836.017	742.773	221.000	Seney	252.009
32	836.654	742.849	221.000	Seney	251.455
33	826.977	742.627	227.000	Seney	260.258
34	827.615	742.703	229.000	Seney	259.700
35	828.253	742.779	229.000	Seney	259.142
36	828.890	742.855	228.000	Seney	258.585
37	829.528	742.931	228.000	Seney	258.028
38	830.166	743.007	229.000	Seney	257.471
39	830.804	743.083	229.000	Seney	256.915
40	831.442	743.160	229.000	Seney	256.359
41	832.079	743.236	228.000	Seney	255.804
42	832.717	743.312	229.000	Seney	255.249
43	833.355	743.389	228.000	Seney	254.695

CALPUFF Receptor Locations (LCC)

LCC Origin: 40.0N, 97.0W, Standard Parallels: 33.0N, 45.0N

Receptor No.	LCC East (km)	LCC West (km)	z (m)	Description	Distance to Lafarge (km)
44	833.993	743.465	225.000	Seney	254.141
45	834.630	743.542	226.000	Seney	253.587
46	835.268	743.618	226.000	Seney	253.034
47	835.906	743.695	226.000	Seney	252.481
48	826.867	743.550	229.000	Seney	260.718
49	827.505	743.626	231.000	Seney	260.161
50	828.143	743.702	231.000	Seney	259.604
51	828.780	743.778	231.000	Seney	259.048
52	829.418	743.854	231.000	Seney	258.492
53	830.056	743.930	230.000	Seney	257.936
54	830.694	744.006	230.000	Seney	257.381
55	831.331	744.082	230.000	Seney	256.827
56	831.969	744.158	229.000	Seney	256.273
57	832.607	744.235	229.000	Seney	255.719
58	833.244	744.311	229.000	Seney	255.165
59	833.882	744.387	227.000	Seney	254.613
60	834.520	744.464	229.000	Seney	254.060
61	835.157	744.541	229.000	Seney	253.508
62	835.795	744.617	229.000	Seney	252.957
63	826.120	744.397	229.000	Seney	261.738
64	826.758	744.472	236.000	Seney	261.181
65	827.395	744.548	235.000	Seney	260.625
66	828.033	744.624	234.000	Seney	260.069
67	828.671	744.700	234.000	Seney	259.514
68	829.308	744.776	233.000	Seney	258.959
69	829.946	744.852	232.000	Seney	258.404
70	830.583	744.928	232.000	Seney	257.850
71	831.221	745.004	232.000	Seney	257.297
72	831.859	745.081	231.000	Seney	256.744
73	832.496	745.157	230.000	Seney	256.191
74	833.134	745.233	229.000	Seney	255.639
75	833.771	745.310	229.000	Seney	255.087
76	834.409	745.386	229.000	Seney	254.536
77	835.047	745.463	229.000	Seney	253.985
78	835.684	745.539	229.000	Seney	253.434
79	826.010	745.319	229.000	Seney	262.202
80	826.648	745.395	236.000	Seney	261.646
81	827.286	745.471	237.000	Seney	261.091
82	827.923	745.547	237.000	Seney	260.536
83	828.561	745.622	236.000	Seney	259.982
84	829.198	745.698	236.000	Seney	259.428
85	829.836	745.775	234.000	Seney	258.875
86	830.473	745.851	234.000	Seney	258.322
87	831.111	745.927	235.000	Seney	257.769
88	831.748	746.003	234.000	Seney	257.217

CALPUFF Receptor Locations (LCC)

LCC Origin: 40.0N, 97.0W, Standard Parallels: 33.0N, 45.0N

Receptor No.	LCC East (km)	LCC West (km)	z (m)	Description	Distance to Lafarge (km)
89	832.386	746.079	232.000	Seney	256.666
90	833.023	746.156	231.000	Seney	256.115
91	833.661	746.232	230.000	Seney	255.564
92	834.298	746.309	230.000	Seney	255.014
93	834.936	746.385	229.000	Seney	254.464
94	825.901	746.242	238.000	Seney	262.668
95	826.538	746.317	239.000	Seney	262.114
96	827.176	746.393	239.000	Seney	261.560
97	827.813	746.469	238.000	Seney	261.006
98	828.451	746.545	238.000	Seney	260.453
99	829.088	746.621	237.000	Seney	259.900
100	829.726	746.697	236.000	Seney	259.348
101	830.363	746.773	236.000	Seney	258.796
102	831.000	746.849	236.000	Seney	258.244
103	831.638	746.926	236.000	Seney	257.694
104	832.275	747.002	234.000	Seney	257.143
105	832.913	747.078	233.000	Seney	256.593
106	825.154	747.088	238.000	Seney	263.691
107	825.791	747.164	242.000	Seney	263.137
108	826.429	747.240	242.000	Seney	262.584
109	827.066	747.316	242.000	Seney	262.031
110	827.703	747.391	240.000	Seney	261.478
111	828.341	747.467	240.000	Seney	260.926
112	828.978	747.543	240.000	Seney	260.374
113	829.615	747.619	239.000	Seney	259.823
114	830.253	747.696	238.000	Seney	259.272
115	830.890	747.772	238.000	Seney	258.722
116	831.528	747.848	237.000	Seney	258.172
117	832.165	747.924	236.000	Seney	257.623
118	825.682	748.087	244.000	Seney	263.608
119	826.319	748.162	244.000	Seney	263.056
120	826.956	748.238	244.000	Seney	262.504
121	827.594	748.314	243.000	Seney	261.953
122	828.231	748.390	242.000	Seney	261.402
123	828.868	748.466	242.000	Seney	260.851
124	829.505	748.542	241.000	Seney	260.301
125	830.143	748.618	240.000	Seney	259.751
126	830.780	748.694	240.000	Seney	259.202
127	831.417	748.770	238.000	Seney	258.653
128	832.054	748.847	236.000	Seney	258.105
129	825.572	749.009	244.000	Seney	264.082
130	826.209	749.085	244.000	Seney	263.531
131	826.846	749.161	244.000	Seney	262.980
132	827.484	749.237	244.000	Seney	262.430
133	828.121	749.312	244.000	Seney	261.880

CALPUFF Receptor Locations (LCC)

LCC Origin: 40.0N, 97.0W, Standard Parallels: 33.0N, 45.0N

Receptor No.	LCC East (km)	LCC West (km)	z (m)	Description	Distance to Lafarge (km)
134	828.758	749.388	244.000	Seney	261.330
135	829.395	749.464	243.000	Seney	260.781
136	830.032	749.541	243.000	Seney	260.233
137	830.670	749.617	240.000	Seney	259.684
138	831.307	749.693	239.000	Seney	259.137
139	831.944	749.769	238.000	Seney	258.590
140	825.462	749.932	245.000	Seney	264.558
141	826.100	750.007	245.000	Seney	264.008
142	826.737	750.083	245.000	Seney	263.458
143	827.374	750.159	244.000	Seney	262.909
144	828.011	750.235	244.000	Seney	262.360
145	828.648	750.311	244.000	Seney	261.812
146	829.285	750.387	244.000	Seney	261.264
147	829.922	750.463	243.000	Seney	260.716
148	830.559	750.539	241.000	Seney	260.169
149	831.196	750.615	240.000	Seney	259.623
150	831.834	750.692	240.000	Seney	259.077
151	825.353	750.854	247.000	Seney	265.037
152	825.990	750.930	246.000	Seney	264.488
153	826.627	751.006	245.000	Seney	263.939
154	827.264	751.082	245.000	Seney	263.391
155	827.901	751.158	244.000	Seney	262.843
156	828.538	751.233	244.000	Seney	262.296
157	829.175	751.309	244.000	Seney	261.749
158	829.812	751.386	244.000	Seney	261.203
159	830.449	751.462	242.000	Seney	260.657
160	831.086	751.538	241.000	Seney	260.111
161	831.723	751.614	241.000	Seney	259.566
162	825.243	751.777	247.000	Seney	265.518
163	825.880	751.853	246.000	Seney	264.970
164	826.517	751.928	246.000	Seney	264.422
165	827.154	752.004	245.000	Seney	263.875
166	827.791	752.080	245.000	Seney	263.329
167	828.428	752.156	244.000	Seney	262.782
168	829.065	752.232	244.000	Seney	262.237
169	829.702	752.308	244.000	Seney	261.691
170	830.339	752.384	243.000	Seney	261.146
171	830.976	752.460	242.000	Seney	260.602
172	825.134	752.700	247.000	Seney	266.002
173	825.770	752.775	247.000	Seney	265.455

APPENDIX E

Model Summary Results and Example CALPOST Output for Baseline 2002 Model

All other model output and input files provided on enclosed CD

Delta Deciview Ranking (4km CALMET Runs)

		Year of Meteorology											
		2002				2003				2004			
Class I Area	**Delta Deciview Rank**	**Baseline**	**Scenario 1: SNCR KG5&6, Wet Scrub KG6**	**Scenario 2: SNCR KG5&6, Wet Scrub KG6, DAA KG5**	**Scenario 3: SNCR KG5&6, Wet Scrub KG5&6**	**Baseline**	**Scenario 1: SNCR KG5&6, Wet Scrub KG6**	**Scenario 2: SNCR KG5&6, Wet Scrub KG6, DAA KG5**	**Scenario 3: SNCR KG5&6, Wet Scrub KG5&6**	**Baseline**	**Scenario 1: SNCR KG5&6, Wet Scrub KG6**	**Scenario 2: SNCR KG5&6, Wet Scrub KG6, DAA KG5**	**Scenario 3: SNCR KG5&6, Wet Scrub KG5&6**
Seney	1	2.949	1.637	1.498	1.058	3.866	2.098	1.883	1.364	2.178	1.228	1.141	0.869
	2	2.324	1.357	1.281	1.039	3.38	1.932	1.795	1.275	1.777	0.956	0.874	0.678
	3	1.735	0.896	0.798	0.494	2.945	1.61	1.488	1.198	1.616	0.912	0.855	0.619
	4	1.277	0.702	0.642	0.452	2.579	1.555	1.462	0.996	1.315	0.765	0.729	0.613
	5	1.104	0.561	0.496	0.399	2.346	1.221	1.081	0.774	1.305	0.746	0.701	0.557
	6	1.029	0.53	0.477	0.313	2.054	1.058	0.981	0.702	1.3	0.719	0.661	0.526
	7	0.807	0.484	0.464	0.294	1.983	1.047	0.947	0.656	1.285	0.699	0.641	0.509
	8	0.711	0.371	0.34	0.242	1.852	1.022	0.908	0.644	1.089	0.641	0.614	0.474
	9	0.609	0.314	0.29	0.216	1.747	0.974	0.903	0.639	0.96	0.591	0.572	0.461
	10	0.589	0.306	0.274	0.215	1.733	0.957	0.884	0.625	0.935	0.534	0.505	0.414
	11	0.478	0.273	0.26	0.197	1.438	0.82	0.773	0.603	0.777	0.417	0.384	0.283
	12	0.432	0.244	0.233	0.177	1.437	0.778	0.746	0.564	0.653	0.358	0.332	0.252
	13	0.42	0.214	0.191	0.153	1.385	0.772	0.722	0.527	0.608	0.332	0.302	0.206
	14	0.352	0.197	0.186	0.124	1.301	0.769	0.697	0.471	0.529	0.274	0.249	0.194
	15	0.346	0.184	0.169	0.12	1.096	0.597	0.555	0.422	0.435	0.236	0.222	0.173
	16	0.281	0.151	0.141	0.118	1.073	0.586	0.533	0.41	0.428	0.233	0.219	0.171
	17	0.269	0.149	0.14	0.104	1.02	0.566	0.528	0.364	0.414	0.233	0.218	0.171
	18	0.212	0.117	0.11	0.085	0.889	0.481	0.443	0.326	0.389	0.231	0.215	0.165
	19	0.182	0.104	0.097	0.076	0.81	0.423	0.383	0.264	0.338	0.197	0.191	0.161
	20	0.162	0.094	0.09	0.075	0.68	0.362	0.334	0.257	0.324	0.169	0.15	0.119
	21	0.157	0.089	0.083	0.067	0.581	0.335	0.318	0.25	0.262	0.15	0.142	0.104
	22	0.15	0.074	0.066	0.046	0.524	0.264	0.237	0.155	0.249	0.138	0.13	0.096
No. Days > 0.5 dv -->		10	6	4	2	22	17	17	13	14	10	10	7
98% value (8th high) -->		0.711	0.371	0.340	0.242	1.852	1.022	0.908	0.644	1.089	0.641	0.614	0.474
No. Days 8th high > 0.5 dv -->		3	0	0	0	15	10	10	6	7	3	3	0
Largest delta dv -->		2.9	1.6	1.5	1.1	3.9	2.1	1.9	1.4	2.2	1.2	1.1	0.9
3-yrs Combined 98% value ->		1.301	0.746	0.697	0.509								
3-yrs Comb. Days 98% > 0.5 dv ->		25	12	10	1								
Annualized Control Costs		$0	$11,470,682	$12,877,600	$21,949,728	$0	$11,470,682	$12,877,600	$21,949,728	$0	$11,470,682	$12,877,600	$21,949,728
Modeled Rates (lb/hr)		**All Kilns**											
	NOx -->	3947	2447	2447	2447								
	SO_2 -->	9734	4487	3852	1947								
Modeled Rates (ton/day)		**All Kilns**											
	NOx -->	47.4	29.4	29.4	29.4								
	SO_2 -->	116.8	53.8	46.2	23.4								

0.5 dv is critical value, allowed 7 exceedences per year.

Assumptions:
No ammonia limiting method.
CALMET in OBS mode, 12 surface, 2 upper air stations
Average background concentration (not 20% best days)
% Reductions Due to Control:

	KG5	**KG6**
DAA	20	20
Wet Scrubbing	80	80
SNCR	35	40