Midwest Regional Planning Organization

MODELING PROTOCOL

*This document was updated on October 21, 2005
Major changes include technical details relating to landuse data, boundary condition data, and modeling episodes.

More technical details on the photochemical modeling are available in the technical addendum on the website:
http://www.ladco.org/tech/photo/photochemical.html
Midwest Regional Planning Organization

MODELING PROTOCOL

This document describes the plans of the Midwest Regional Planning Organization (MRPO) to conduct an air quality assessment to support the development of state implementation plans for ozone (O₃), fine particles (PM₂.₅), and regional haze for the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin. Consistent with USEPA’s policy to encourage integration of control strategies to reduce regional haze with those designed to meet the National Ambient Air Quality Standards (NAAQS) for O₃ and PM₂.₅ (64 FR 35719) and to optimize available resources, a multi-pollutant planning approach will be pursued.

The MRPO has made considerable progress over the past couple of years in evaluating and applying air quality models for O₃, PM₂.₅, and haze. The “lessons learned” from this preliminary modeling helped shape this document. As new information becomes available, this document will be updated.

Overview

Purpose: The air quality assessment will address what it will take to provide for attainment of the NAAQS for O₃ and PM₂.₅ and meet the reasonable progress goals for haze. The assessment includes the following tasks:

- prepare appropriate photochemical model inputs (e.g., emissions inventories and meteorological data);
- perform basecase photochemical modeling, and evaluate model results;
- perform sensitivity tests to assess the effect of changes in emissions on ambient concentrations;
- perform strategy modeling to assess regional and local control programs, and support; and
- conduct supplemental air quality data analyses as part of a “weight-of-evidence” approach.

All analyses will be conducted in accordance with USEPA guidance, including “Draft Guidelines on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS”, EPA-454/R-99-004, May 1999, and “Guidance for Demonstrating Attainment of Air Quality Goals for PM₂.₅ and Regional Haze”, draft 2.1, January 2, 2001. As these guidelines change, this document will be updated.

The air quality assessment will also help to answer several policy-relevant questions (see Table 1). These questions were identified by the Project Team as being critical to the development of effective control programs for O₃, PM₂.₅, and regional haze.
Table 1. Critical Questions

EMISSIONS
1. What are the uncertainties in emissions estimates for PM, ozone and haze precursors?
2. What are the critical sources that need additional improvement in emission estimates and can we make these changes within one year?

CONTROL PROGRAMS
General
1. How close to attainment will we be with “on-the-books” federal and state controls? with EPA’s proposed Clean Air Interstate Rule?
2. What can we say about the effectiveness of certain control programs (I/M, RFG, etc)?
3. Do we need a regional agreement and if so, then what form does it take?

Ozone
1. What ozone precursor reduction strategy (in terms of pollutants and geographic coverage) will be most effective in lowering elevated 8-hour ozone concentrations in the upper Midwest (and eastern U.S.)?
2. How do control strategies for 8-hour ozone differ (if at all) from those control strategies we employed for 1-hour ozone?
3. Should we consider a waiver from the NOx requirements of the Clean Air Act?

PM
1. What are the limiting reagents to reduce PM and what are their sources?
2. How important are organics in comparison to other constituents?
   a. Can we describe the composition of the organic fraction of the aerosol?
   b. What fraction of the organic aerosol is natural vs anthropogenic and for each of those categories how much is secondary aerosol?
   c. What are the sources of the high levels of organics in cities?
3. How important are ammonia emissions in developing control strategies?

MONITORING AND DATA ANALYSIS
1. What is our conceptual model of 8-hour ozone, PM$_{2.5}$, and regional haze in the Midwest?
2. What have we learned from our special monitoring data?
3. Should we add special monitoring projects at this time? If we do, when will the data become available for analysis and will it be useful (or relevant) to development of PM$_{2.5}$, ozone and haze control programs?

MODELING
1. What are the major uncertainties in modeling analyses?
2. Are there additional model improvements that we should pursue at this time?
3. To what extent do we employ the single atmosphere concept in modeling? If PM modeling is not ready for prime-time, do we cut and run with ozone only?

TRANSPORT
1. What are regional levels of pollutants, how are they transported, and what is their influence on urban and downwind regional levels of ozone and PM?
2. What is the influence of transport of PM from outside the US (Asian and African dust, major forest fires in Canada and S. America) on PM levels in the Midwest? Can we distinguish natural or exceptional events (e.g., locally generated wind blown dust from construction, large wild fires from other combustion, Asian or Saharan dust storms from other sources of crustal related material) from typical air pollution events?
3. Do natural events effect attainment of the 24-hr PM$_{2.5}$ standards or annual standards in the Great Lakes States?
Regulatory Requirements: For PM\textsubscript{2.5}, USEPA must promulgate designations by December 31, 2004, in accordance with the Omnibus Appropriations Act of 2004. (Note, it is our understanding that USEPA will actually promulgate these designations by November 17, 2004.) SIPs for PM\textsubscript{2.5} are due no later than three years from the date of the nonattainment designation (per section 172(b) of the Clean Air Act) and for haze no later than three years after the date on which the Administrator promulgates the PM\textsubscript{2.5} designations (per the Appropriations Act). For the purposes of this document, it is assumed that the SIP submittal date for PM\textsubscript{2.5} and haze will be January 2008. The applicable attainment date for PM\textsubscript{2.5} nonattainment areas is expected to be five years from the date of the nonattainment designation (i.e., by January 2010).

For \textit{O}_3, USEPA promulgated designations for the 8-hour ozone NAAQS on April 15, 2004 (69 FR 23858, April 30, 2004). The designations became effective on June 15, 2004. SIPs for ozone are due no later than three years from the date of the nonattainment designation, per section 172(b) of the Clean Air Act (i.e., by June 2007). On April 15, 2004, USEPA also issued the first phase of its implementation rule for 8-hour ozone (69 FR 23951, April 30, 2004)\textsuperscript{1}. This phase addressed classifications for the 8-hour NAAQS, revocation of the 1-hour NAAQS, attainment dates, and timing of emissions reductions needed for attainment. According to this rule, the applicable attainment date for \textit{O}_3 varies as a function of nonattainment classification. For the region, the attainment dates are either June 2009 (basic nonattainment areas) and June 2010 (moderate nonattainment areas)\textsuperscript{2}.

For haze, the SIP requirements (pursuant to 40 CFR 51.308(d)) include establishing 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. To assist states in meeting these requirements, USEPA issued two guidance documents (“Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program”, EPA-454/B-03-005, September 2003, and “Guidance for Tracking Progress Under the Regional Haze Program”, EPA-454/B-03-004, September 2003), and recently proposed “Guidelines for Best Available Retrofit Technology (BART) Determinations” (69 FR 25184, May 5, 2004).

Schedule: The following milestones are proposed for the air quality assessment:

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
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<tbody>
<tr>
<td>2004</td>
<td>Deliver initial base year (2002) emissions inventory</td>
</tr>
<tr>
<td></td>
<td>Begin model basecase runs</td>
</tr>
<tr>
<td>September</td>
<td>Deliver updated base year emissions inventory</td>
</tr>
<tr>
<td></td>
<td>Update model basecase runs</td>
</tr>
</tbody>
</table>

\textsuperscript{1} The second phase of the rule, which is expected to be published later this year, will address mandatory control measures, interstate transport, attainment demonstrations, reasonable further progress, conformity, reasonably available control measures, and new source review. USEPA is also planning to publish an implementation rule for PM\textsubscript{2.5} soon, which will address these same issues. This document assumes that an attainment demonstration will be required for \textit{O}_3 and PM\textsubscript{2.5} for many nonattainment areas in the region.

\textsuperscript{2} Several counties are considering requesting that they be reclassified from moderate to marginal nonattainment. The attainment date for marginal nonattainment areas is June 2007.
November: Project Team meeting to review model performance, data analyses, and plans for control strategy modeling

December: Deliver initial future year control strategies
Begin control strategy modeling

2005
February: Deliver “final” base year inventory and additional future year control strategies
Finalize basecase modeling
Continue control strategy modeling

April: Deliver additional future year control strategies
Continue control strategy modeling

June: Project Team meeting to discuss strategy modeling, establish haze goals, and identify “draft” regional strategies for O₃, PM₂.₅, and regional haze

July – Oct: Conduct further modeling and data analyses, based on direction from Project Team

December: Project Team meeting to discuss regional/local strategies for O₃, PM₂.₅, and regional haze

Responsibilities: The primary responsibility for this work will be with the LADCO staff. Additional assistance and involvement by the states will also be necessary, especially by the Project Team and various workgroups (Emissions, Modeling, Data Analysis, and Strategy Workgroups).

Modeling System
The major elements of the modeling system are summarized below.

Periods: The modeling will focus on calendar year 2002, which is referred to as the base year. In addition, to provide a more complete evaluation of model performance, several additional periods will be considered: calendar years 2001 and 2003. Reasons for selecting these periods include:

Several periods of high O₃ and PM₂.₅ concentrations occurred during 2002, and the other periods (e.g., June 25-30 and July 31-August 9, 2001)

Current design values for O₃ and PM₂.₅ include 2002 data (i.e., 2001 – 2003 data)

The Midwest RPO sponsored several supplemental sampling programs in 2002 (e.g., aircraft measurements in summer 2002 and fall/winter 2002/2003; increased sampling frequency at rural speciation sites; nephelometers operated at several rural sites; continuation of St. Louis Supersite; and pilot DRUM and organics studies); and additional sampling at several Supersite locations occurred during the Eastern U.S. Supersites program.

A full year of modeled days (2002) are available to use in the modeled attainment test.
Preliminary modeling has already been done with 2002 (and the other periods).

To assess the representativeness of 2002, the following analyses were conducted:

For ozone, a Classification and Regression Tree (CART) analysis was performed with data from 1990 – 2002 for the following cities: Chicago, Cincinnati, Cleveland, Detroit, Indianapolis, Milwaukee, Minneapolis, and St. Louis (“CART Analysis of Historic Ozone Episodes”, January 2004, D. Kenski, Lake Michigan Air Directors Consortium). A representativeness index was calculated based on the variability from “average” conditions for this 12-year period. Lower values indicate years that are most similar to average conditions, and higher values indicate years that deviate more strongly from the average conditions. The table below shows the representativeness index for high ozone days. As can be seen, for most cities, 2002 is very close to “average”. (Note, the higher index (>10) in Indianapolis for 2002 (and 1998) is driven by two very high ozone days during each summer. These very high ozone days occurred only six times in the 12-year period. If these two days are excluded from the analysis, then 2002 is close to average for Indianapolis, too.)

<table>
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<td>0.1</td>
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<td>1.1</td>
<td>0.3</td>
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<td>0.6</td>
<td>1.7</td>
<td>0.8</td>
<td>1.1</td>
<td>0.7</td>
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<td>0.0</td>
<td>3.5</td>
<td>0.8</td>
<td>0.2</td>
<td>0.1</td>
<td>6</td>
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<tr>
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<td>4.5</td>
<td>2.3</td>
<td>2.8</td>
<td>0.7</td>
<td>6.2</td>
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<tr>
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<td>0.3</td>
<td>3.2</td>
<td>0.7</td>
<td>2.8</td>
<td>0.0</td>
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<td>0.6</td>
<td>0.2</td>
<td>1.9</td>
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<tr>
<td>1998</td>
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<td>2000</td>
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<td>0.5</td>
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<tr>
<td>2001</td>
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<td>0.5</td>
<td>3.8</td>
<td>3</td>
</tr>
<tr>
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<td>1.1</td>
<td>1.4</td>
<td>1.3</td>
<td>10.5</td>
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<td>5.1</td>
<td>0.7</td>
<td>11</td>
</tr>
</tbody>
</table>

For PM$_{2.5}$, a similar CART analysis was performed with data from 1999-2002 for each of the eight cities. The results for Chicago presented below show that the number of days in each node is consistent with the other years and seasons. This suggests that 2002 is similar to other recent years.
Models: CAMx4 will be the primary model applied for these analyses. CMAQ and REMSAD may also be used for confirmatory purposes. The selection of CAMx4 as the primary model for this project is based on the following 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), science in the model, and no reliance on third party software.

Domain/Grid: The National RPO grid projection will be used for this modeling. The National RPO grid will be run once and used to feed a smaller 36km domain (97 X 90 cells) shown in the figure to the right. A 12 km sub-grid over the Midwest (see shaded green box) will be used for ozone modeling (summer periods). The air quality model will contain 16 vertical layers, with higher resolution in the boundary layer.

Model Inputs: Model inputs in this protocol are described for CAMx. Where other photochemical models are applied, they will be applied as consistently as possible with CAMx.

Meteorological inputs will be derived using MM5. Based on a series of sensitivity runs, the following model physics configuration is proposed:

- Pleim-Xu land-surface module
- RRTM radiation scheme
• Simple ice moisture
• Kain-Fritsch cumulus
• ETA 3-hourly initialization
• FDDA on above PBL

The MM5 modeling domains extend at least nine grid cells (in each direction) beyond the edge of the air quality modeling domains identified above. The meteorological model will contain 34 vertical layers, with higher resolution in the boundary layer.

Performance of the meteorological model will be evaluated qualitatively with 12-hour surface weather maps, 12-hour satellite images, and vertical sounding plots for select monitor stations. Quantitative performance will be evaluated with daily and hourly statistics: bias, gross error, index of agreement, and mean values. An evaluation will be performed for both the MM5 output files and the meteorological input files for the air quality model.

Emissions inputs will be prepared using the Emissions Modeling System (EMS). A new emissions model (CONCEPT) is currently under development and is expected to be essentially complete in early/mid 2005. Over the course of this SIP modeling, an effort will be made to transition from EMS to CONCEPT.

For basecase modeling, a base year (2002) inventory will be prepared. The emissions data will reflect a combination of state 2002 data (which was prepared in compliance with USEPA’s Consolidated Emissions Reporting Rule), numerous LADCO-sponsored special inventory projects (e.g., ammonia, nonroad sources, and fires), and USEPA’s National Emissions Inventory (NEI) for 2002 (version 1).

For strategy modeling, a baseline inventory and various future year strategy inventories will be prepared. The baseline inventory reflects a typical year and provides the reference modeled air quality conditions against which future year model runs will be compared to derive a relative reduction factor (see Strategy Modeling below). The future year inventories will be prepared by adjusting the baseline inventory using growth and control factors provided by the states or LADCO contractors, or available methods, such as MOBILE6.2 or the NONROAD model.

For point, anthropogenic area, and on-road sources, a weekday, Saturday, and Sunday inventory will be prepared for each month. In addition, day-specific (accounting for ambient temperature) inventories will be prepared for on-road sources for select ozone episodes. Day-specific biogenic emissions will be estimated using BIOME3 (biogenics model in EMS, which is equivalent to BEIS3), with modeled (MM5) temperatures and observed (satellite-based) PAR values.

CAMx uses the TUV model to calculate photolysis rates based on solar zenith angle, height above ground, ultraviolet albedo of the ground, atmospheric turbidity, and total ozone column density. The TUV generates rates for each day as a function of 11 heights, 10 solar zenith angles, 5 ozone column values, 5 albedo values, and 3 turbidity values. The ozone column data is derived from daily TOMS satellite observations. The albedo data varies by month and is based on over 10 years of TOMS reflectivity observations.

The initial and boundary conditions will vary in the horizontal and vertical direction and are based on monthly averaged GEOS-CHEM global model output. GEOS-CHEM was applied to the calendar year of 2002 and that data is used to supply monthly averaged initial and boundary
concentrations to the CAMx model. Where an initial or boundary concentration is not specified for a pollutant, the model will default to a near-zero concentration.
CAMx uses 11 land use categories to describe the surface. The land use data are based on BELD3 1 km data, which is aggregated to the appropriate grid resolution for photochemical modeling.

Quality Assurance: The following quality assurance activities are planned:

**Emissions**
- Review model inputs and outputs – each emissions modeler will review the model input files, and the graphical and tabular model outputs for reasonableness and consistency
- Benchmark modeling – each modeling group will duplicate a set of standard modeling results
- Duplicative modeling – a few runs will be modeled by more than one group
- Reports - a standard set of graphical and tabular model outputs will be identified
- Documentation – appropriate written reports will be prepared which summarize the modeling analyses

**Modeling**
- Establish consistent file naming convention
- Review model inputs – each modeling group will review the air quality model emission (and, if appropriate, meteorological) input files (e.g., compare emission totals with EMS reports, and examine spatial maps of emissions)
- Benchmark modeling – each modeling group will duplicate a set of standard modeling results
- Duplicative modeling – a few runs will be modeled by more than one group
- Reports - a standard set of graphical and tabular model outputs will be identified
- Documentation – appropriate written reports will be prepared which summarize the modeling analyses

**Basecase Modeling**
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 will focus on the magnitude, spatial pattern, and temporal of modeled and measured concentrations. This exercise is intended to build confidence in the model prior to its use in examining candidate control strategies. Increased confidence in the model will increase the role of the modeling results in the design and establishment of any eventual control strategies.

Model performance will be evaluated by comparing modeled and monitored concentrations. For O₃, species of interest include O₃, total VOC, NO2, NOX, and NOY. The relevant averaging times for these species are 1-hour and 8-hour. For PM and haze, species of interest include PM₂.₅-mass (gravimetric and RCFM), SO4, NO3, NH4, EC, OC, soil, b_{scat}, coarse mass, as well as several gaseous precursors, such as NH3, HNO3, and SO2. Aloft data comparisons for O₃, NOx, and b_{scat}, using aircraft data will be also performed. The relevant averaging times for these species are 1-hour and 24-hour. The following evaluations are planned:
Operational Evaluation

- Statistical: unpaired peak, average accuracy of peak, normalized bias, normalized gross error

- Graphical: scatter plots, side-by-side spatial plots, time series plots (ozone hourly concentration time series plots and PM$_{2.5}$ species daily stacked bar charts for select monitoring sites [or groups of monitoring sites])

Diagnostic Evaluation

- Use of process analysis

Mechanistic Evaluation

- Assess relative model results (i.e., change in modeled concentration due to change in emissions)
  
  This evaluation will focus on the change in ambient ozone and sulfate concentrations between summer 2002 and summer 1991.$^3$ (Note, ozone and sulfate concentrations are generally highest during the summer in the eastern half of the U.S.)

No rigid acceptance/rejection criteria will be used for this study. Instead, the statistical guidelines recommended by USEPA and other modeling studies (e.g., modeling by the other RPOs) will be used to assess the reasonableness of the results here.

Note that there may be differences in the definition of certain chemical species from the measurement networks and the modeling output. To ensure consistent matching of measured and modeled species, the conventions identified in Table 2 will be followed.

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$^3$ Meteorological conditions can strongly influence air quality concentrations. The difference in concentrations from one year to the next can be due to changes in emissions, changes in meteorology, or both. In order to assess the effect of emission changes, it is necessary to remove (or minimize) the effect of meteorological changes. This can be done by comparing two periods with similar meteorological conditions. To determine which previous summer was meteorologically similar, several metrics were considered. First, average summer temperature and precipitation for the upper Midwest indicate that 2002 is comparable to 1991. Examining each month shows that June from each year has the best agreement. Second, CART statistics for the major cities in the upper Midwest shows that there are a comparable number of days in the higher ozone nodes for June 1991 and June 2002. Thus, the June 1991 and June 2002 measured and modeled ozone and sulfate concentrations should provide a reasonable initial basis for assessing relative model performance.
Table 2. Species Definitions
Sensitivity Modeling
Application of the modeling system to assess the need for (and, if so, the types of) national, regional, and local control strategies will consist of two types of analyses. First, several sensitivity tests will be performed. These tests are discussed in this section. Second, candidate control strategies (i.e., sets of control measures) will be modeled. These strategy runs are discussed in the following section.

Sensitivity tests can provide useful general information to help guide the development of control strategies. A desirable feature of these tests is that the model inputs can usually be prepared quickly and easily; thereby, allowing many model simulations to be performed.

The sensitivity tests will focus on the effect of changes in the amount, type, and location of primary and precursor emissions. Possible sensitivity tests include:

1. General control path analyses, such as “matrix” runs, which examine the effect of reductions by species, source categories, and geographic area.

2. Focused attainment analyses, which attempt to estimate the type and amount of emission reductions needed to meet the ambient standards using USEPA’s attainment tests. For example, a series of runs could be performed based on the future year base strategy to estimate how much additional control is needed to provide for attainment.

3. NOx “disbenefit” runs, which examine the effect of NOx reductions for elevated v. low-level sources and in urban v. rural areas. Note, these runs should consider both local and regional changes in ozone concentrations associated with NOx reductions, and how these concentration changes may effect attainment of the ozone standard (i.e., do any concentration increases occur when and where high absolute ozone concentrations are predicted?).

The Project Team will identify the specific sensitivity tests.

The modeling results will be presented in graphs, such as scatter plots, concentration difference plots, threshold difference plots, time series plots, and stacked bar charts.

Strategy Modeling
The initial strategies to be modeled include a future year base strategy, which reflects “on-the-books” federal and state controls, and a Clean Air Interstate Rule (or Clear Skies Act) strategy, which reflects the additional SOx and NOx reductions from USEPA’s proposed national rule. A contractor has been hired to provide the necessary growth and control factors for these strategies, plus another strategy (to be determined) later this year.

The Project Team will identify additional control strategies to be modeled.

USEPA’s attainment tests will be applied to the results of the strategy modeling to determine whether a given strategy is sufficient to provide for attainment of the NAAQS for O₃ and PM₂.₅ and meet the reasonable progress goals for haze. USEPA guidelines recommend using the model in a relative sense to project future year design values. This is done through the use of a relative reduction factor (RRF), which is defined as the ratio of the future year and baseline modeling results. The RRFs are multiplied by the base year design values to project the future
year design values, which are then compared to the NAAQS to assess attainment. For O₃ and PM₂.₅, the base year design values will be based on 2001-2003 data, which represents the 3-year period used to establish the nonattainment designations and is consistent with the base year (2002) emissions inventory. For haze, the baseline visibility levels will be based on 2000-2004 data, in accordance with 40 CFR 51.308(d)(2)(i).

O₃ results will be presented for those grid cells/counties with O₃ monitors. PM₂.₅ results will be presented for those grid cells/counties with FRM (PM₂.₅-mass) monitors. Spatial mapping will be performed to extrapolate PM₂.₅-speciation data from STN and IMPROVE sites to FRM sites. (No other mapping of O₃ or PM₂.₅ data will be performed.)

The future years of interest in the attainment demonstration are 2006, 2008, 2009, and 2018. Phase I of USEPA’s implementation rule for ozone states that emission reductions needed for attainment must be implemented by the beginning of the ozone season immediately preceding the area’s attainment date. For example, for areas with an attainment date in May 2010, the emission reductions need to be implemented by the beginning of the 2009 ozone season. As noted above, the applicable ozone attainment dates in the region are June 2007 (marginal nonattainment areas), June 2009 (basic nonattainment areas), and June 2010 (moderate nonattainment areas). Thus, the strategy modeling for ozone must address 2006, 2008, and 2009. Although USEPA has yet to issue its implementation rule for PM₂.₅, a similar approach is assumed for PM₂.₅ (i.e., emission reductions must be implemented by the beginning of calendar year 2009). Thus, the strategy modeling for PM₂.₅ must address 2009. For haze, the RPOs have all agreed to use 2018 as the official year to model for the first regional haze milestone (see May 25, 2004, letter from Chris Recchia, MANE-VU to USEPA).

Weight-of-Evidence
A weight-of-evidence approach will be used to support SIP development with extensive data analysis and modeling. Because USEPA has yet to finalize its implementation guidance on attainment demonstrations for 8-hour of O₃ (and has yet to proposed such guidance for PM₂.₅), it is unclear what is required to demonstrate attainment for these pollutants. For the purposes of this document, it is assumed that a demonstration based on photochemical modeling, supplemented with analyses of air quality data will be sufficient.⁴

Air quality data analyses should be used to provide both a conceptual model (i.e., a qualitative description of the regional haze and nonattainment problem) and information on the effectiveness of emission reductions. Given uncertainties in the emissions inventories and models for haze (and PM₂.₅), these data analyses are a necessary part of the overall technical support.

The conceptual model will draw upon AER’s 2001 “Scoping Study for Regional Haze in the Upper Midwest” and their forthcoming analysis of recent regional haze data, as well as two LADCO reports (“PM₂.₅ in the Upper Midwest”, June 2003; “PM₂.₅ in Urban Areas in the Upper Midwest”, February 2004).

The effect of reducing emissions by pollutant, geographic area, and source category can be assessed through the following:

⁴ It should be noted that several recent Court have upheld the use of a weight-of-evidence approach for 1-hour ozone SIPs, including BCCA Appeal Group v. EPA, 335 F. 3d 817 (5th Cir. 2003), and Environmental Defense v. EPA, ??? (2nd Cir. 2004).

• trends (e.g., how have significant SO2 emission reductions in the eastern U.S. over the past decade affected sulfate and nitrate concentrations?).

• trajectory analyses (e.g., what can we say about the contribution from individual states on Class I areas – see “Quantifying Transboundary Transport of PM$_{2.5}$: A GIS Analysis”, 2003).

• source apportionment analyses (e.g., what can we say about the contribution of individual source categories on Class I areas - see “Source Apportionment Analysis of Air Quality Monitoring Data: Phase I – Final Report”, May 2002; “Source Apportionment Analysis of Air Quality Monitoring Data: Phase II”, Draft, April 2004; and Clarkson University’s forthcoming analyses of Midwest PM-related measurements).