

# USE OF RPO MODELING TO MEET REGIONAL HAZE AND NAAQS REQUIREMENTS

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## 1. INTRODUCTION

In order to help meet the objectives of the Regional Haze Rule, EPA created five Regional Planning Organizations (VISTAS, WRAP, CENRAP, MRPO, and MANE-VU) to initiate and coordinate activities associated with the management of regional haze at 156 federally mandated Class I areas (Figure 1). Class I areas are defined as national parks greater than 6000 acres and wilderness areas greater than 5000 acres. These RPOs (Figure 2) are using various air quality models (CMAQ, CAMx, REMSAD) to demonstrate “reasonable progress” towards natural conditions for their Regional Haze State Implementation Plans (SIPs). This paper will summarize the modeling efforts that are currently underway at each of these RPOs and describe how their member states plan to use this modeling for PM<sub>2.5</sub> and ozone SIPs in addition to their Regional Haze SIPs.

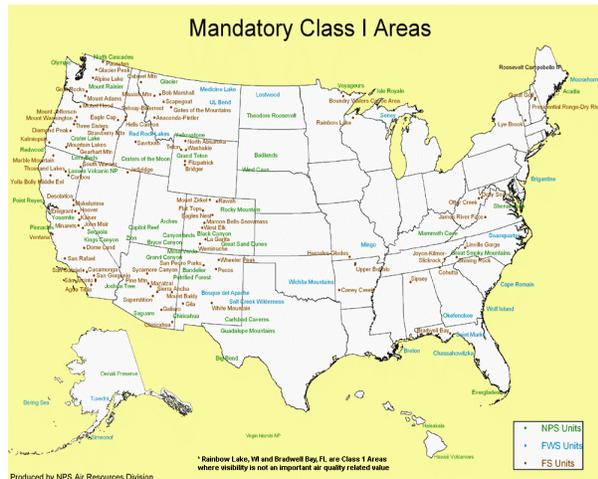


Figure 1: Federally mandated Class I areas from [http://www.epa.gov/ttn/oarpg/t1/fr\\_notices/classimp.gif](http://www.epa.gov/ttn/oarpg/t1/fr_notices/classimp.gif)

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Figure 2: Geographic breakdown of the five RPOs from <http://www.epa.gov/oar/visibility/regional.html>.

## 2. REGIONAL HAZE AND VISIBILITY

Regional haze is the impairment of visibility caused by the presence of particulate matter in the atmosphere that scatter and absorb light. Visibility (Malm, 1999) is a measure of the clearness of the atmosphere and is typically expressed in terms of light extinction ( $b_{ext}$ ) or deciviews ( $dV$ ).

$$b_{ext} (Mm^{-1}) = 3 * f(RH) * [SO_4^{2-}] + 3 * f(RH) * [NO_3] + 4 * [ORG] + 10 * [EC] + 1 * [Soils] + 0.6 * [PMC] + b_{rayleigh} \quad (1)$$

$$dV = 10 * \ln(b_{ext}/b_{rayleigh}) \quad (2)$$

where,  $[SO_4^{2-}]$  is the mass associated with fine sulfate PM ( $\mu g/m^3$ ),  $[NO_3]$  is the mass associated with fine nitrate PM ( $\mu g/m^3$ ),  $[OC]$  is the fine total organic PM mass ( $\mu g/m^3$ ),  $[EC]$  is the fine elemental carbon PM mass ( $\mu g/m^3$ ),  $[Soils]$  is the fine soil (or crustal) PM mass ( $\mu g/m^3$ ),  $[CM]$  is the coarse PM mass ( $\mu g/m^3$ ),  $b_{rayleigh}$  is Rayleigh scattering ( $10 Mm^{-1}$ ), and  $f(rh)$  is the climatological relative humidity adjustment factor (unitless). Equation 1 (Malm *et al.*, 2000) assumes that the sulfate and nitrate are fully neutralized with ammonium and adds this assumed ammonium mass to the sulfate and nitrate mass, respectively.

### 3. THE REGIONAL HAZE RULE

The objectives of the Regional Haze Rule (EPA, 1999) are (1) achieve natural (no man-made impairment) visibility conditions at federal mandated Class I areas by 2064 for the worst 20% visibility days and (2) prevent any worsening in visibility at Class I areas for best 20% visibility days (Figure 3).

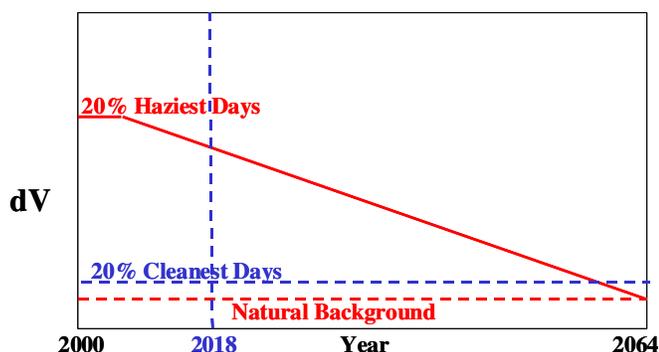


Figure 3: Reasonable progress glide slope.

Reasonable progress must be demonstrated every 10 years. The first regional haze SIPs are due December 15, 2007 demonstrating reasonable progress toward natural conditions between 2000-2004 and 2014-2018.

### 4. VISTAS

Visibility Improvement State and Tribal Association of the Southeast (VISTAS) is the RPO responsible for managing regional haze in the southeastern U.S. (AL, GA, MS, FL, SC, NC, TN, KY, VA, WV). VISTAS is performing annual simulations for 2002, 2009 and 2018 on a 36 km grid (entire continental U.S.) and a 12 km grid (Figure 4) using MM5, SMOKE, and CMAQ as their primary modeling tools. Corroborative modeling has been performed using CAMx. The modeling contractors involved with this effort include: Baron Advanced Meteorological Systems (MM5), Environ (CMAQ, CAMx), Alpine Geophysics (SMOKE, CMAQ, CAMx), and University of California - Riverside (CMAQ). In addition, Georgia Tech is performing episodic emission sensitivities with CMAQ on the VISTAS 12 km grid.

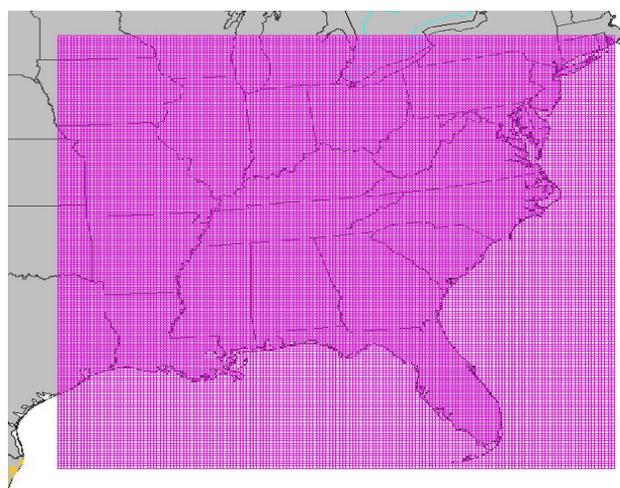


Figure 4: VISTAS 12 km modeling domain

All states that have PM<sub>2.5</sub> non-attainment areas (AL, GA, KY, NC, TN, VA, WV) and most states that have 8-hour ozone non-attainment areas (AL, GA, KY, NC, SC, TN, VA, WV) will utilize the VISTAS annual 36 and 12 km modeling for SIP attainment demonstrations. Some states will do additional modeling beyond VISTAS. This additional modeling will include annual simulations on smaller 36/12 km domains, modeling on 4 km grids, improvement to specific emission categories (e.g., updated mobile source emissions), and pollutant and source specific emission sensitivities. Additional information on VISTAS modeling can be found at the following web sites:

<http://www.vistas-sesarm.org/tech/>  
<http://www.baronams.com/projects/VISTAS/>  
<http://pah.cert.ucr.edu/vistas/vistas2/>  
<http://www.ce.gatech.edu/research/vistas>

In addition, the newly formed Association for Southeastern Integrated Planning (ASIP) will be performing seasonal 36 and 12 km modeling for 2008 to aid with 8-hour ozone “basic” non-attainment areas.

### 5. MRPO

The Midwest Regional Planning Organization (MRPO) is affiliated with the Lake Michigan Air Directors Consortium (LADCO) and is responsible for managing regional haze in Illinois, Indiana, Michigan, Ohio, and Wisconsin. MRPO is performing annual simulations for 2001, 2002,

2003, 2009, and 2018 on a 36 km grid (Figure 5) using MM5, EMS-2004, and CAMx to model regional haze and PM2.5. Corroborative modeling has been performed using CMAQ. Since all five MRPO states have non-attainment areas for PM2.5 and ozone, additional modeling is being performed for 2008 and 2012 on a 12 km grid (Figure 5) for ozone. In addition, MRPO is using OSAT and PSAT to perform ozone and PM2.5 source apportionment.



Figure 5: MRPO 36 km grid (regional haze and PM2.5) and nested 12 km grid (ozone).

Most of the modeling applications are performed in-house at LADCO while most model development work is contracted out. In addition, each state has in-house modeling capability allowing them the opportunity to perform local scale assessments to help determine local/regional culpability. MRPO provides States with technical support for modeling projects and assists States with system administration and computer hardware needs. Additional information on MRPO modeling can be found at the following web site: <http://www.ladco.org/>.

## 6. WRAP

The Western Regional Air Partnership (WRAP) is a collaborative effort of tribal governments, state governments (AK, AZ, CA, CO, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY) and various federal agencies to implement the Grand Canyon Visibility Transport Commission's recommendations and to develop the technical and policy tools needed by western states and tribes to comply with the U.S. EPA's regional haze regulations. Other common

air quality issues raised by WRAP members may also be addressed. WRAP is performing annual simulations for 2002 and 2018 on a 36 km grid (entire continental U.S.) and a 12 km grid (Figure 6) using MM5, SMOKE, and both CMAQ and CAMx. The modeling contractors involved with this effort include: Carolina Environmental Program (SMOKE), Environ (MM5, CMAQ, CAMx), and University of California - Riverside (CMAQ). In addition, WRAP has used CMAQ with TSSA and plans to use CAMx with PSAT for PM source apportionment.

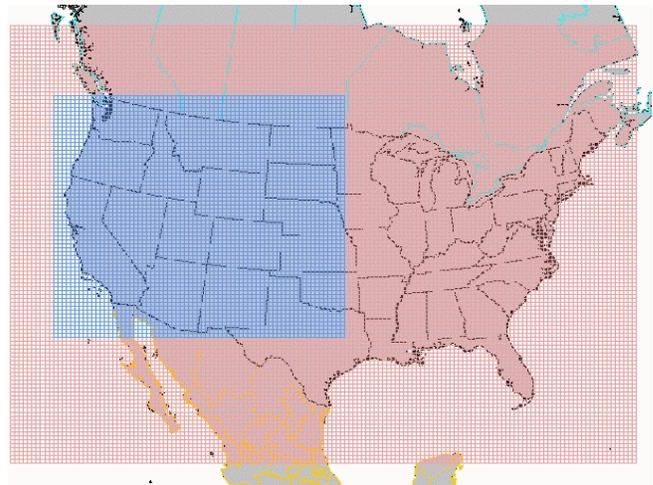


Figure 6: WRAP 36 and 12 km modeling domains.

All of WRAP's PM2.5 non-attainment areas are located in California (except Libby, MT); therefore, California ARB is taking the lead on PM2.5 and ozone NAAQS SIP modeling in California. WRAP does not plan to perform any 2008 or 2009 modeling. However, some non-attainment and EAC areas outside California have used 2002 MM5 and SMOKE files (36 and 12 km) generated by WRAP. Additional information on WRAP modeling can be found at the following web sites: <http://www.wrapair.org/> and <http://pah.cert.ucr.edu/aqm/308/>.

## 7. CENRAP

Central Regional Air Planning Association (CENRAP) is affiliated with the Central States Air Resource Agencies (CENSARA) and is responsible for managing regional haze in Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana. CENRAP is performing annual simulations for 2002 and 2018 on a 36 km grid (entire continental U.S.) using MM5, SMOKE, and both CMAQ and

CAMx. The modeling contractors involved with this effort include: Environ (CMAQ, CAMx) and University of California - Riverside (SMOKE, CMAQ). MM5 simulations were performed by Iowa DNR. In addition, CENRAP is performing episodic modeling on a 12 km grid (Figure 7).

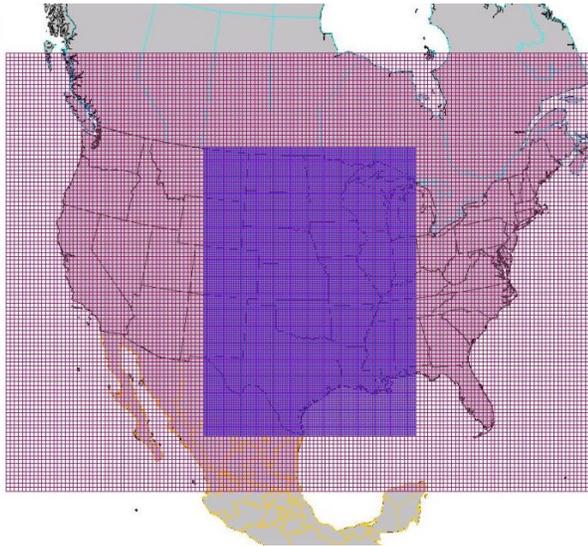


Figure 7: CENRAP 36 and 12 km modeling domains.

CENRAP states with 8-Hour ozone non-attainment areas include Texas, Louisiana, Arkansas, and Missouri. The only PM2.5 non-attainment area in CENRAP is St. Louis, MO. CENRAP does not plan to perform any 2008 or 2009 modeling. However, some states will use CENRAP's model input files and information on model and science options in their PM2.5 and 8-hour ozone modeling. Additional information on CENRAP modeling can be found at the following web sites: <http://cenrap.org/> and <http://pah.cert.ucr.edu/aqm/cenrap/>.

## 8. MANE-VU

Mid-Atlantic/Northeast Visibility Union (MANE-VU) is working on regional haze issues in the northeastern U.S. (CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT) and is a partnership between the Northeast States for Coordinated Air Use Management (NESCAUM), Mid-Atlantic Regional Air Management Association (MARAMA), and the Ozone Transport Commission (OTC). MANE-VU is performing annual simulations for 2002, 2009, and 2018 on a 12 km grid (Figure 8) using MM5,

SMOKE, and both CMAQ and REMSAD. Modeling is being performed by NESCAUM (CMAQ and REMSAD), MARAMA (SMOKE), New York DEC (CMAQ), and University of Maryland (MM5). In addition, MANE-VU is running REMSAD with tagged sulfur species to help perform source apportionment.

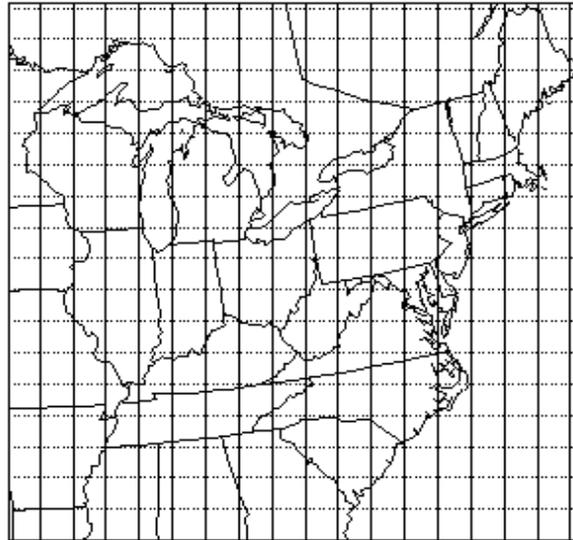


Figure 8: MANE-VU 12 km modeling domain.

MANE-VU states with PM2.5 non-attainment areas include NY, NJ, CT, PA, DC, MD, and DE. These states will use MANE-VU modeling as starting point for their PM2.5 modeling attainment demonstrations. States with 8-Hour ozone non-attainment areas include NY, NJ, CT, PA, DC, MD, DE, MA, RI, CT, NH, ME. The OTC modeling committee is coordinating 8-hour ozone modeling as a regional activity. Additional information on MANE-VU activities can be found at <http://www.manevu.org/>.

## 9. REFERENCES

- EPA, 1999: Regional Haze Regulations; Final Rule. *Federal Register*, 64, 35713-35774.
- Malm, W.C., 1999: *Introduction to Visibility*, CA2350-97-001: T097-04, T098-06; Cooperative Institute for Research in the Atmosphere; Colorado State University: Fort Collins, CO (<http://vista.cira.colostate.edu/improve/Education/IntroToVisinstr.htm>).
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## **10. ACKNOWLEDGEMENTS**

The author would like to acknowledge the contributions to this paper from the following people: Pat Brewer (VISTAS), Kirk Baker (LADCO), Tom Moore (WRAP), Lee Warden (Oklahoma DEQ), Calvin Ku (Missouri DNR), and Gary Kleiman (NESCAUM).