Draft List of Class I Areas Located Within (or Impacted by) Midwest RPO States

The purpose of this paper is to provide a draft list of Class I areas located within or impacted by a Midwest Regional Planning Organization (MRPO) State. A variety of technical analyses were considered in developing the draft list, including base year (2002) and future year (2018) modeling, back trajectories, and other data analyses. This information shows that every MRPO State impacts multiple Class I areas in the eastern U.S.

Regulatory Requirements

EPA's regional haze rule requires a state to "address regional haze I 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)) EPA has interpreted this provision as requiring a table identifying each mandatory Class I Federal area located within the State and each mandatory Class I Federal area located outside the State affected by emissions from within the State (see Draft EPA Checklist for Regional Haze SIPs Submitted Under 40 CFR 51.308 - *7/13/06 Staff Draft*).

Discussion

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.[1] A summary of this information is provided below and in Table 1.

For the MRPO analyses, a state was assumed to affect visibility impairment in a Class I area if it contributes 2% (or more) to total light extinction. This criterion was selected based on a review of the back trajectory and modeling results which showed that states contributing 2% (or more) make-up about 90-95% of total light extinction, whereas states contributing 5% (or more) make-up only about 75-80% of total light extinction. For the other RPO analyses, deference was given to the criteria established by each group to identify contributing states.

(1) MRPO Back Trajectory Analyses

An initial trajectory analysis was conducted using data for 1997-2001 (all sampling days), a start height of 200 m, and a 72-hour (3-day) trajectory period (Cite: "Quantifying Transboundary Transport of PM2.5: A GIS Analysis", May 2003, LADCO). By combining trajectory frequencies with concentration information, the average contribution to $PM_{2.5}$ mass and individual $PM_{2.5}$ species was estimated (which, in turn, was used to estimate the average contribution to light extinction). The results for 17 Class I areas in eastern U.S. were examined to identify those Class I areas where an MRPO state had at least a 2% contribution to total light extinction (based on all days).

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[1] Back trajectories and modeling conducted by the WRAP indicate that the Midwest RPO States are not important contributors to visibility impairment due to sulfates and nitrates in western Class I areas (Cite: "Attribution of Haze Phase I Report, Geographic Attribution for the Implementation of the Regional Haze Rule", March 14, 2005). The analyses show only five groups of western Class I areas with at least 5% contribution from states outside the WRAP. The outside-WRAP contribution is generally small (on the order of 0-15%), and is likely due mostly to nearby CENRAP states.

A second trajectory analysis was conducted using data for 2000-2003 (20% highest and lowest days), a start height of 200m, and a 120-hour (5-day) trajectory period (Cite: “Sensitivity Analysis of Various Trajectory Parameters”, June 2005, LADCO). Back trajectory plots were prepared for each of the four northern Class I areas in Michigan and Minnesota for the high extinction days (see Figure 1 – note: areas in orange are mostly likely upwind and the areas in green are least likely upwind on poor visibility days). Although somewhat qualitative, these results provide additional information in identifying states impacting the northern Class I areas.

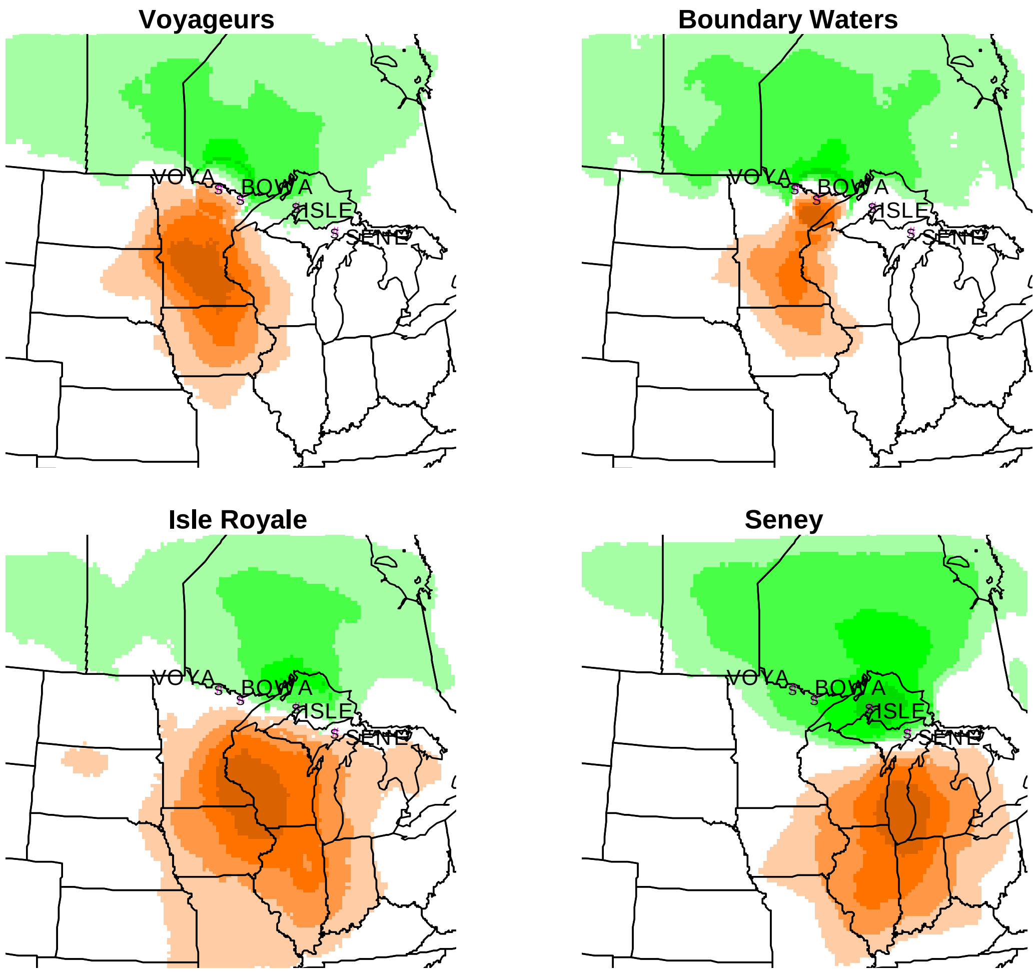

Figure 1. Contoured trajectory plots for poor visibility days for Class I areas in northern Minnesota and Michigan

(2) MRPO PSAT Modeling

A photochemical grid model (CAMx) was applied to provide source contribution information for 2018 conditions. Specifically, the model estimated the impact of 18 geographic source regions and 6 source sectors (EGU point, non-EGU point, on-road, off-road, area, and ammonia sources) at Class I areas in the eastern U.S. Example results for four Class I areas (Seney, Mammoth Cave, Mingo, and Shenandoah) are presented in Figure 2. The results for 13 Class I areas in eastern U.S. were examined to identify those Class I areas where an MRPO state had at least a 2% contribution to total light extinction.

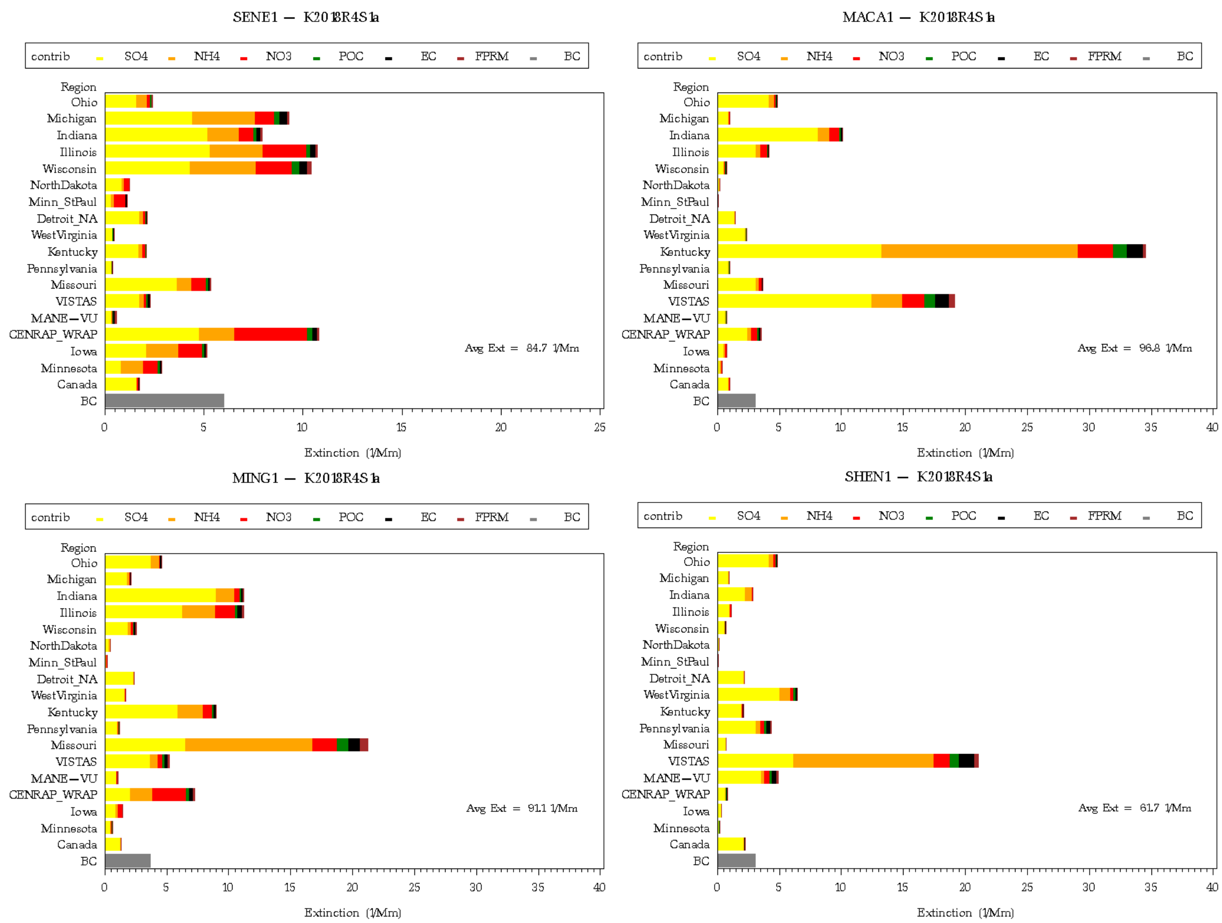

Figure 2. Source region contributions to light extinction based on MRPO PSAT modeling for select Class I areas: Seney, Mammoth Cave, Mingo, and Shenandoah

(3) MANE-VU Contribution Assessment

A weight-of-evidence report was prepared by NESCAUM (on behalf of MANE-VU) to understand the causes of sulfate-driven visibility impairment at Class I areas in the northeastern and mid-Atlantic portions of the U.S. (cite: “Contributions to Regional Haze in the Northeast and Mid-Atlantic United States”, August 2006) The report provides information on the relative contribution of various emissions sources and geographic source regions. The analytical and assessment tools considered include Eulerian and Lagangian air quality models, and data analysis techniques, such as source apportionment analyses, back trajectories, and examination of emissions and monitoring data. Sulfate impacts were quantified using five analytical techniques based on 2002 conditions: REMSAD, Q/d, CALPUFF (w/ NWS data), CALPUFF (w/ MM5 data), and percent time upwind (based on trajectory analyses). Figure 3 summarizes the five sets of results for three MANE-VU Class I areas. Although no specific criteria were identified in the report to determine a significant contribution, the States of Vermont, New Hampshire, Maine, and New Jersey assumed a 2% sulfate impact in recent letters to other states inviting them to consult on reasonable progress goals. The MRPO States identified as contributing to a MANE-VU Class I area were Illinois, Indiana, Michigan, and Ohio

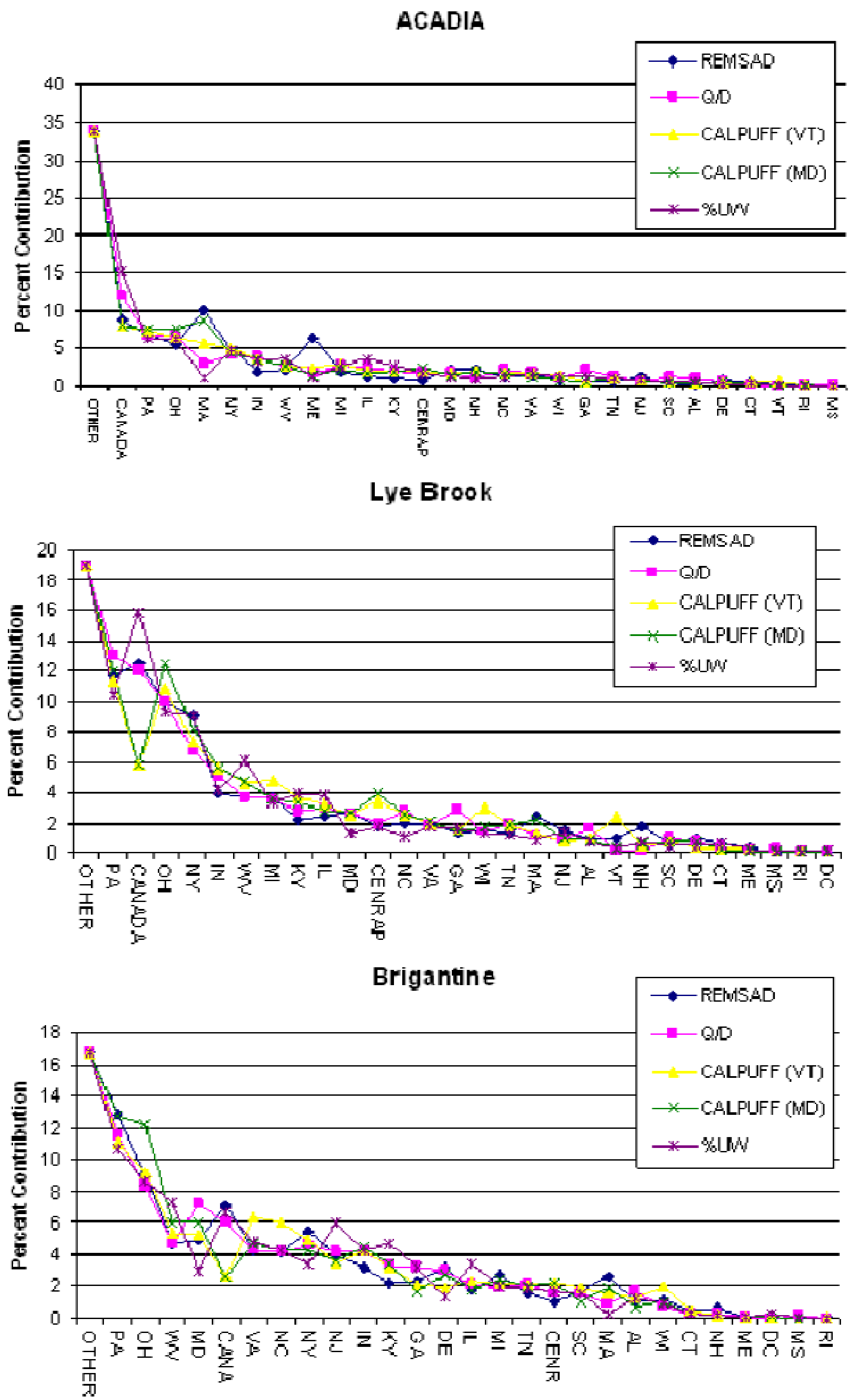

Figure 3. Percent contribution results using different techniques for ranking state contributions to sulfate levels at MANE-VU Class areas (cite: "Contributions to Regional Haze in the Northeastern and Mid-Atlantic Portions of the U.S.", August 2006)

(4) Missouri-Arkansas Contribution Assessment
The draft Consultation Plan for the two Missouri and two Arkansas Class I areas provides information on source regions affecting these Class I areas (i.e., areas of influence) using a variety of data and analyses. (cite: "Central Class I Areas Consultation Plan", States of Missouri and Arkansas, February 2007) A decision on whether a given state is a contributor to visibility impairment in these Class I areas was based on the combined results of three approaches: areas of influence (see Figure 4), PSAT modeling (based on 2018 conditions), and monitoring data analyses (PMF and back trajectories). According to the draft plan, if a state was a major contributor for at least two of the three approaches (for either sulfate or nitrate), then it was determined to be a significant contributor. The MRPO States identified as contributing to a central CENRAP Class I area were Illinois, Indiana, and Ohio.

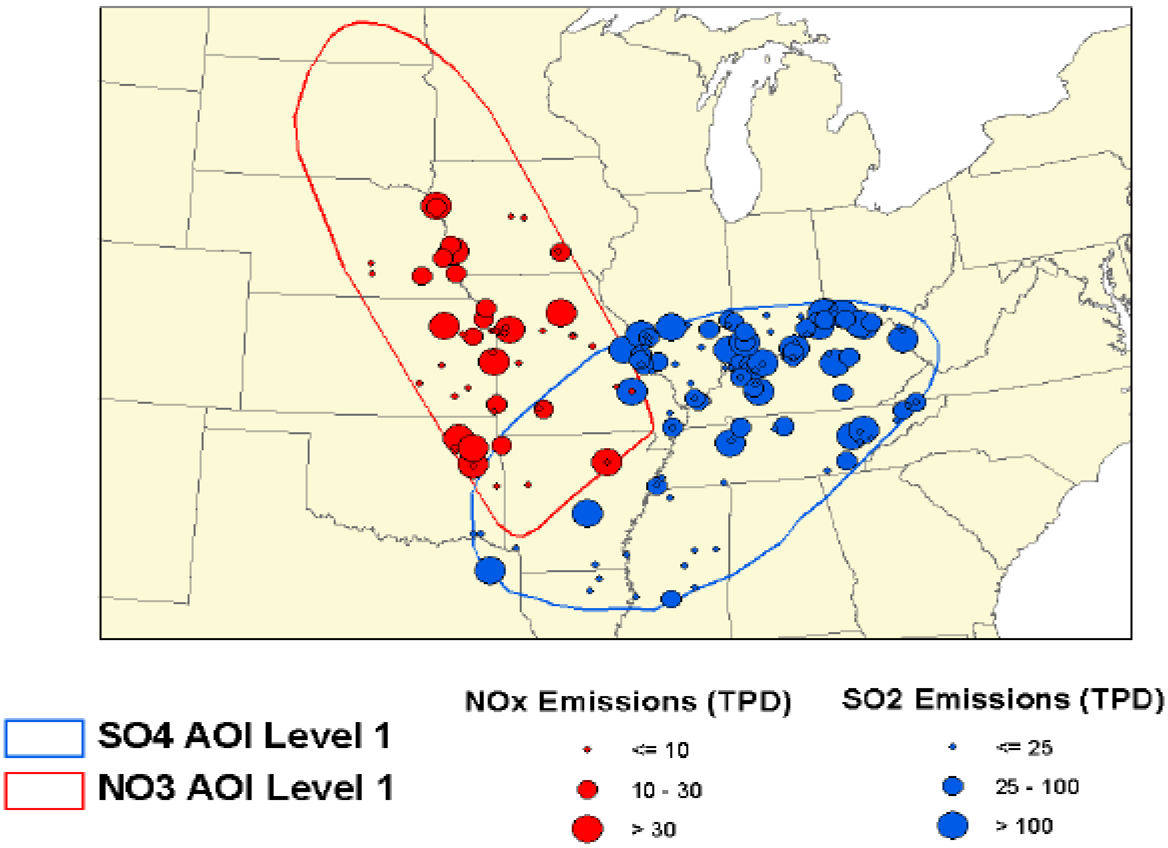

Figure 4. Areas of Influence for Central CENRAP Class I Areas (cite: "Central Class I Areas Consultation Plan", States of Missouri and Arkansas, February 2007)

(5) VISTAS Area of Influence Analysis
Areas of influence (AOI) were identified for Class I areas in the southeastern U.S. using residence time plots based on wind trajectory direction and frequency, and weighted by visibility impact (light extinction by ammonium sulfate, ammonium nitrate, or elemental carbon). (Cite: "VISTAS Areas of Influence Analysis", Draft, February 28, 2007). These extinction-weighted residence time analyses were overlayed on gridded emissions (for both 2002 and 2018) to define emission sources in the areas of greatest influence for each Class I area. Figure 5 shows the plots for two VISTAS Class I areas. AOIs were defined on the basis of residence times greater than 10%. The MRPO States identified as contributing to a VISTAS Class I area were Illinois, Indiana, and Ohio.

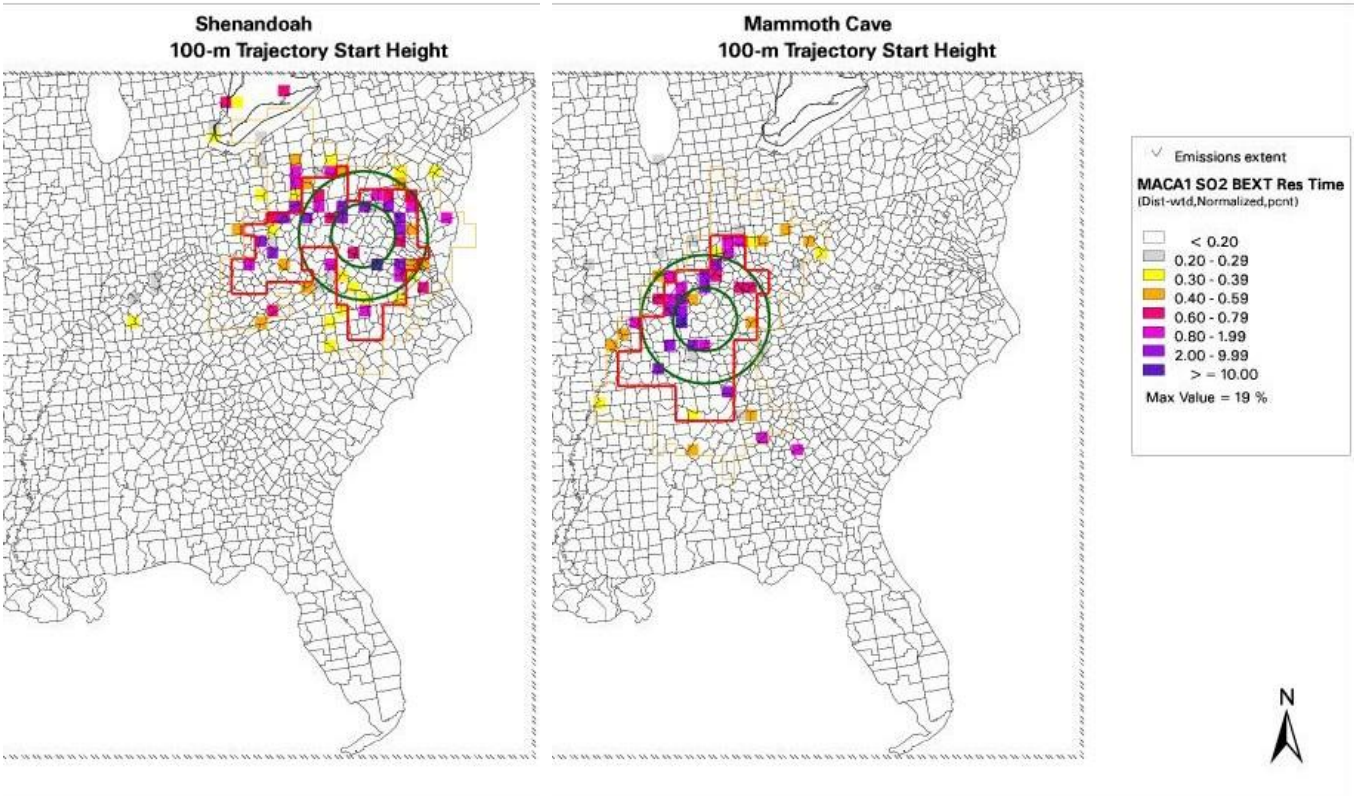

Figure 5. Areas of Influence for Shenandoah (left) and Mammoth Cave (right) for 2018 conditions (cite: "VISTAS Area of Influence Analyses" PowerPoint presentation, November 28, 2006)

Note: green circles indicate 100- and 200-km radii from Class I area, red line perimeter indicate AOI with residence time $\geq$ 10%, and orange line perimeter indicate AOI with residence time $\geq$ 5%

Table 1. Draft List of Class I Areas Impacted by MRPO States - References

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