# Alabama's Regional Haze State Implementation Plan (SIP) for the Second Planning Period

**Prepared by**

**The Alabama Department of Environmental Management**

**Air Division**

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## Executive Summary

Pursuant to the Clean Air Act (CAA) requirements contained in Sections 169A and 169B, and the subsequent implementing regulations contained in 40 CFR 51.308, the State of Alabama Department of Environmental Management (ADEM), has developed a proposed State Implementation Plan (SIP) revision to address regional haze. This SIP revision represents commitments and actions taken by the state to address the requirements of these regulations during the second implementation period, which includes the years 2019 to 2028, towards the goal of attaining natural visibility conditions at Alabama's designated Federal Class I area. Alabama has one Class I area within its borders, the Sipsey Wilderness Area (Sipsey), located within the Bankhead National Forest, as designated in 40 CFR § 81.401 with visibility designated as an important value. To develop this proposed SIP revision, the state has relied heavily on the work of the Southeast regional planning group VISTAS (Visibility Improvement State and Tribal Association of the Southeast). VISTAS is directed by the State Air Directors of ten southeastern states, including the eight U.S. Environmental Protection Agency (EPA) Region 4 states, plus Virginia and West Virginia.

The data and analyses necessary to meet the requirements of the Federal Regional Haze Regulations are considerable. The ten states, through VISTAS, completed most of the technical analyses using contracted resources. To help coordinate and direct the technical work, VISTAS created the Coordinating Committee, the Technical Analysis Workgroup, the Data Analysis Workgroup, and the SIP Template Workgroup. Each state had at least one representative participating in each group. These workgroups discussed and reviewed the work completed by the contractors used by VISTAS, and these data and analyses form the technical basis for Alabama's proposed SIP revision. Throughout the technical work and SIP development process, VISTAS and the individual states provided updates to EPA Regions 3 and 4, the Federal Land Managers (FLMs) or their representatives, from the National Park Service, the Fish and Wildlife Service, and the Forest Service, as well as industry representatives and third-party groups.

Alabama's proposed Regional Haze SIP consists of a set of commitments, permit conditions, and plans addressing the requirements of the federal regulations, as well as supporting administrative and technical documentation. The required elements for the prehearing submittal for the second implementation period are contained in this document, and in Appendices A through H. The full table of appendices includes descriptions and file names for each appendix and sub-appendix (and indicates which appendices are Alabama-specific and which are VISTAS-wide).

The primary elements of the Alabama Regional Haze SIP include:

- Baseline, Current, and Natural Visibility Conditions – Alabama calculated the baseline visibility conditions (2000-2004), the current visibility conditions (2014-2018), and the natural visibility conditions for the 20% most impaired and 20% clearest days for Sipsey in deciviews (dv):

| Alabama's Class I Area | Baseline 20% Clearest Days | Baseline 20% Most Impaired Days | Current 20% Clearest Days | Current 20% Most Impaired Days | Natural 20% Clearest Days | Natural 20% Most Impaired Days |
|---|---|---|---|---|---|---|
| Sipsey WA | 15.57 dv | 27.69 dv | 10.76 dv | 19.03 dv | 5.03 dv | 9.62 dv |

Alabama also calculated the actual progress made towards natural visibility conditions, to date, since the baseline period (current minus baseline), and the additional progress needed to reach natural visibility conditions from current conditions (natural minus current), in deciviews (dv):

| Alabama's Class I Area | Current minus Baseline – 20% Clearest Days | Current minus Baseline – 20% Most Impaired Days | Natural minus Current – 20% Clearest Days | Natural minus Current – 20% Most Impaired Days |
|---|---|---|---|---|
| Sipsey WA | -4.81 dv | -8.66 dv | -5.73 dv | -9.41 dv |

- Reasonable Progress Requirements – The state is required to consider four-factors (cost, time to comply, energy and non-air impacts, and remaining useful life) in determining whether further reductions in visibility-impairing pollutants would be reasonable for any sources in the state. To limit the scope of this requirement, and based on VISTAS analyses, Alabama has focused its response to reasonable progress on sulfur dioxide ($SO_2$) emissions from large EGU and non-EGU point sources. Based on specific criteria, Alabama identified, from among these sources, facilities that are expected to significantly affect visibility at Sipsey. One facility in Alabama and eight facilities outside Alabama (three in Indiana, two in Kentucky, one in Tennessee, one in Ohio, and one in Missouri) were selected for review.

  The selected facility in Alabama, Lhoist- Montevallo (Lhoist) identified, through a four-factor analysis, that additional $SO_2$ controls resulting in a 1,200-ton reduction demonstrated reasonable progress. Additionally, Alabama consulted with those states with sources that were identified as having a significant contribution at Sipsey. Documentation on the consultation can be found in Appendix F.

- Long Term Strategy (LTS) for Regional Haze – Alabama has developed a LTS that relied on the technical analyses developed by VISTAS and EPA, and considered the effect of emission reductions due to ongoing pollution control programs; measures to mitigate the impacts of construction activities; Alabama's smoke management plan; the effect of source retirements and replacement schedules; and the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions expected through 2028.

- Reasonable Progress Goals (RPGs)– The state is required to set RPGs in units of deciviews applicable for 2028. In accordance with 40 CFR 51.308(f), these goals represent the progress (visibility improvement) expected as a result of implementation of the LTS presented in this

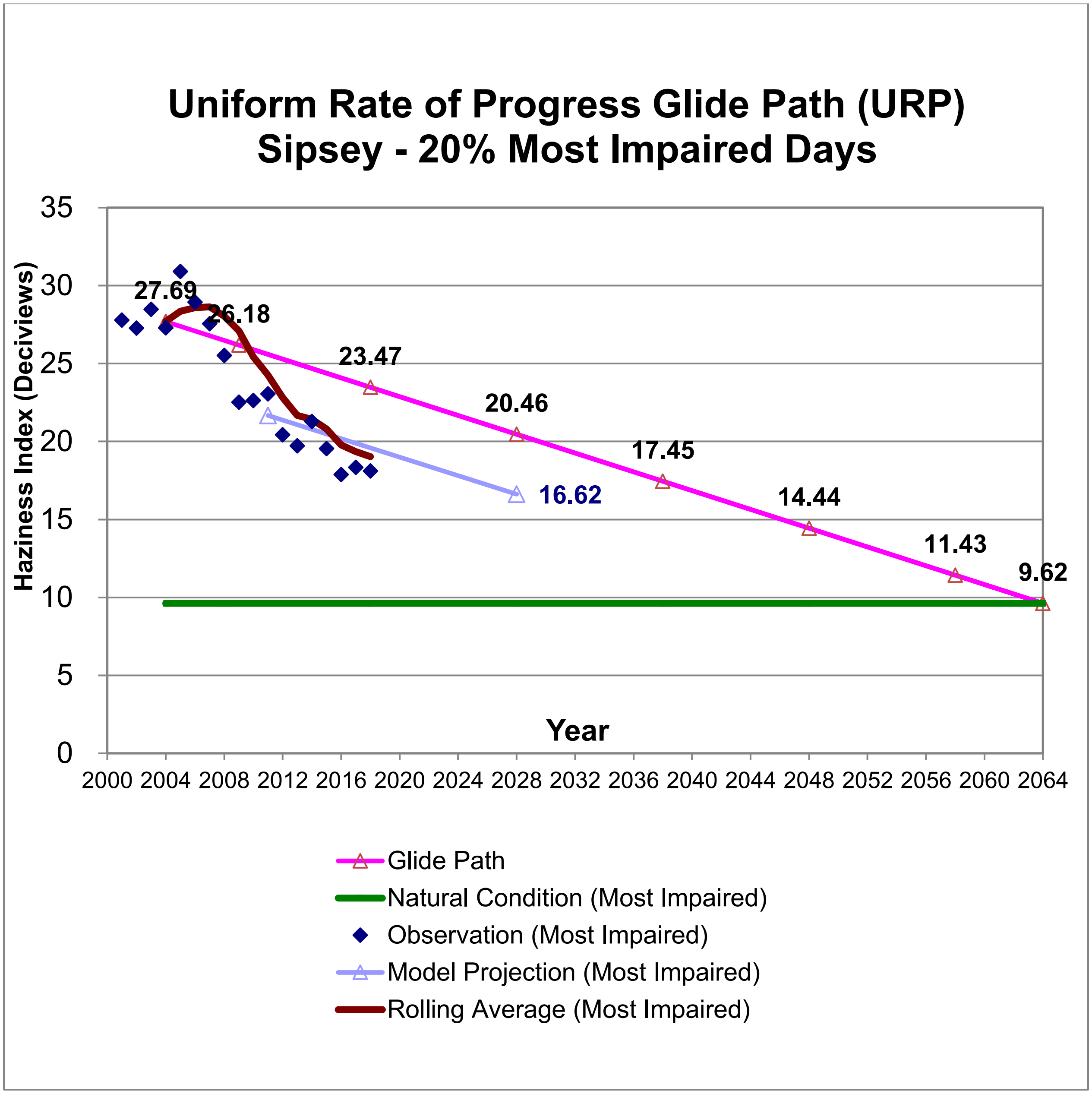
Regional Haze SIP. Two goals are set for Sipsey, one for the 20% most impaired days and one for the 20% clearest days (all numbers in deciviews (dv)):

| Class I Area | Baseline 20% Clearest Days | Baseline 20% Most Impaired Days | Natural 20% Clearest Days | Natural 20% Most Impaired Days | 2028 RPG 20% Clearest Days | 2028 RPG 20% Most Impaired Days |
|---|---|---|---|---|---|---|
| Sipsey WA | 15.57 dv | 27.69 dv | 5.03 dv | 9.62 dv | 11.11 dv | 16.62 dv |

These goals are based on predicted visibility responses to the expected emissions reductions of visibility-impairing pollutants using air quality models and represent the state's best estimate at this time.

Through VISTAS, state-of-the-art photochemical modeling was completed to analyze the regional, national, and global contributions to visibility in each Class I area. Emissions of visibility impairing pollutants were included from all known source sectors and locations, including boundary conditions derived from a global model. Current visibility conditions were evaluated using data from public and private monitoring networks, and these and other associated data were used to validate model performance. Projected emissions were developed for 2028, considering growth and known or estimated emissions changes due to existing regulations. Substantial analysis was completed to determine visibility sensitivity to specific pollutant reductions, and to parse out the source-sector contributions.

The following chart shows the observed versus predicted visibility improvement for the 20% most impaired days for Sipsey, compared to the Uniform Rate of Progress, also referred to as the Glidepath, the line which connects baseline visibility conditions in 2000-2004 to natural visibility conditions in 2064.




Alabama has determined that the 2028 RPGs will be significantly below the URP glide path for the 20% most impaired days at the Sipsey Wilderness Area. Also, the 2028 RPGs will be significantly below the 2000-2004 baseline visibility conditions for the 20% clearest days at Sipsey.

The conclusion of this analysis is that Alabama can rely on recent emission reductions as well as existing and proposed new regulations to provide reasonable progress toward the goal of attaining natural visibility conditions during the second implementation period ending in 2028 for the Sipsey Wilderness Area.

- Progress Report – This plan revision is intended to also serve as a progress report. As such, Alabama has addressed the progress report requirements of 40 CFR 51.308(g)(1) through (5), covering the period since the most recent progress report.

- Commitments – Alabama commits to completing mid-point reviews of the Regional Haze SIP as required in the Regional Haze Rule (40 CFR 51.308(f)). The next mid-point review is due by January 31, 2025. Alabama will review the progress of the projected emissions changes to judge the necessity of making any revisions to the plan. Alabama also commits to completing comprehensive periodic revisions of the SIP. The next revision is due by July 31, 2028, and every ten years thereafter.

Finally, Alabama would like to acknowledge the immeasurable efforts of John Hornback and Greg DeAngelo throughout the first and second planning periods. Through their leadership and dedication as SESARM's Directors, the VISTAS states developed the invaluable work products that formed the basis of this Regional Haze SIP.

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Contents

# Table of Appendices

| Appendix ID | Description and File Names |
|---|---|
| Appendix A | Project Reports |
| A-1 | Revised Quality Assurance Project Plan Southeastern VISTAS II Regional Haze Analysis Project April 3, 2018 |
| A-2 | Work Plan Southeastern VISTAS II Regional Haze Analysis Project April 18, 2018 |
| A-3 | VISTAS II Regional Haze Air Quality Report (Final) – February 10, 2021 |
| Appendix B | Emissions Preparation and Processing |
| B-1a | VISTAS II Task 2A- Emission Inventory Updates Report (AoI and PSAT) September 22, 2020 |
| B-1b | VISTAS II Task 3A – Conversion of the Task 2A 2028 Point Source Files for Emissions Processing with SMOKE |
| B-2a | VISTAS II Task 2B – Emission Inventory Updates Report (2028 Visibility Estimates) |
| B-2b | VISTAS II Task 3B- Conversion of the Task 2B 2028 Point Source Remodeling Files for Emissions Processing with SMOKE |
| Appendix C | Monitoring, Meteorological, and Other Data Acquisition and Preparation |
| C-1 | Southeastern VISTAS II Regional Haze Analysis Project: Task 4 Report October 17, 2018 |
| C-2a | 2000-2018 VISTAS ClearMI |
| C-2b | Annual 2000-2018 Charts |
| C-2c | Annual 2000-2018 Pictures |
| C-2d | 2019 VISTAS Stacked Bar Charts – Excel Spreadsheet |
| C-2e | COHU Daily Stacked Bar Chart – Excel Spreadsheet |
| C-2f | OKEF Daily Stacked Bar Charts – Excel Spreadsheet |
| C-2g | VISTAS Daily Pictures |
| Appendix D | Area of Influence Analyses |
| D-1 | Area of Influence Analysis Southeastern VISTAS II Regional Haze Analysis Project – Revised Final – December 2, 2020 |
| D-2 | AoI and HYSPLIT Graphics for VISTAS and Nearby Class I areas<br>Electronic files for these graphics are only available upon request. |
| Appendix E | Visibility and Source Apportionment Projections |
| E-1a | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project – Final Modeling Protocol June 27, 2018 |
| E-1b | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project Final Modeling Protocol Update and Addendum August 31, 2020 |
| E-2a | Regional Haze Modeling for Southwestern VISTAS II Regional Haze Analysis Project 2011el and 2028el CAMx Benchmarking Report Benchmark Report #1 and #2 August 17, 2020 |
| E-2b | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2011el CAMx Version 6.32 and 6.40 Comparison Report Benchmark Run #3 August 17, 2020 |

# Table of Appendices

| Appendix ID | Description and File Names |
|---|---|
| E-2c | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2011el CAMx Version 6.40 12km VISTAS and EPA 12km Continental Grid Comparison Report Benchmark Run #5 August 17, 2020 |
| E-2d | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2028 CAMx Version 6.32 and 6.40 Comparison Report Benchmark Run #4 August 17, 2020 |
| E-2e | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2028elv3 CAMx Version 6.40 12km VISTAS and EPA 12km Continental Grid Comparison Report Benchmark Run #6 August 17, 2020 |
| E-2f | Regional Haze Modeling for Southeastern VISTAS II Regional Haze Analysis Project 2028 Emissions Version V3 and V5 Comparison Report Benchmark Run #7 September 22, 2020 |
| E-3 | Model Performance Evaluation for Particulate Matter and Regional Haze of the CAMx 6.40 Modeling System and the VISTAS II 2011 Updated Modeling Platform October 29, 2020<br>Spreadsheets only available in electronic format and upon request. |
| E-4 | Deposition Model Performance Evaluation Southeastern VISTAS II Regional Haze Analysis Project Revised Final January 22,2021 |
| E-5 | Model Performance Evaluation for Ozone of the CAMx 6.40 Modeling System and the VISTAS II 2011 Updated Modeling Platform August 17, 2020<br>Spreadsheet only available in electronic format and upon request. |
| E-6 | Future Year Model Projections<br>Spreadsheets only available in electronic format and upon request. |
| E-7a | Particulate Source Apportionment Technology Modeling Results<br>Spreadsheets only available in electronic format and upon request. |
| E-7b | Roadmap for PSAT Scaled Adjustments<br>Spreadsheets only available in electronic format and upon request. |
| E-8 | SMAT 2028 Model Projections of Visibility Impairing Species at VISTAS Class I Areas for 20% Most Impaired Days |
| Appendix F | Consultation |
| F-1 | VISTAS state to VISTAS state Consultation |
| F-2 | VISTAS state to Non-VISTAS State Consultation |
| F-2a | VISTAS Consultation with IN Office of Air Quality |
| F-2b | VISTAS Consultation with MO Air Pollution Control Program |
| F-2c | VISTAS Consultation with OH Division of Air Pollution Control |
| F-3 | EPA/FLM/Stakeholder Outreach and Presentations |
| F-3a | Consultation Record |
| F-3b | National Regional Haze Meeting, Denver, CO December 5-7, 2017 |
| F-3c | Presentation to FLMs, EPA Region 4, CC/TAWG on January 31, 2018 |
| F-3d | VISTAS Call with FLMs August 1, 2018 |
| F-3e | VISTAS Presentation to other RPOs September 5, 2018 |
| F-3f | VISTAS Regional Haze Project Update June 3, 2019 |
| F-3g | VISTAS Regional Haze Meeting, St Louis, MO October 28-30, 2019 |

# Table of Appendices

# List of Figures

# List of Figures

# List of Figures

# List of Tables

# List of Tables

# List of Tables

# Acronyms and Abbreviations

| Acronym/Abbreviation | Meaning |
|---|---|
| AERR | Air Emission Reporting Rule |
| AFWA | Air Force Weather Agency |
| AIRMon | Atmospheric Integrated Research Monitoring Network (AIRMon) |
| AMoN | Ammonia Monitoring Network |
| AoI | Area of Influence |
| AQS | Air Quality System network |
| ARW | Advanced Research WRF model |
| BART | best available retrofit technology |
| BEIS | Biogenic Emission Inventory System |
| BELD | Biogenic Emissions Land Use Database |
| $b_{ext}$ | visibility impairment as extinction, $Mm^{-1}$ |
| CAA | Clean Air Act |
| CAIR | Clean Air Interstate Rule |
| CAMD | Clean Air Markets Division |
| CAMx | Comprehensive Air Quality Model with Extensions |
| CASTNet | Clean Air Status and Trends Network |
| CEDS | Comprehensive Environmental Data System |
| CENRAP | Central Regional Air Planning Association |
| CEM | continuous emissions monitoring |
| CFI | Covanta Fairfax Inc |
| CM | course particle mass |
| CO | carbon monoxide |
| CONUS | continental U.S. |
| CoST | Control Strategy Tool |
| CPP | Clean Power Plan |
| CSA | North Carolina Clean Smokestacks Act |
| CSAPR | Cross State Air Pollution Rule |
| CTG | control technique guideline |
| CWT | concentration weighted trajectory |
| d | distance (kilometers) |
| ADEM | Alabama Department of Environmental Management |
| dv | Deciview |
| E_CM | extinction from coarse matter |
| EC | elemental carbon |
| EGU | Electric generating unit |
| EIA | Energy Information Administration |
| EIS | Emissions Inventory System |
| EPA | United States Environmental Protection Agency |
| ERTAC | Eastern Regional Technical Advisory Committee |
| EWRT | extinction-weighted residence time |
| FAA | Federal Aviation Administration |
| FCCS | Fuel Characteristic Classification System |

# Acronyms and Abbreviations

| Acronym/Abbreviation | Meaning |
|---|---|
| FDDA | four-dimensional data assimilation |
| FGD | flue gas desulfurization |
| FIA | Forest Inventory and Analysis |
| FLM | Federal Land Manager |
| FS | Forest Service |
| FSL | Forecast Systems Laboratory |
| FWS | Fish and Wildlife Service |
| g/bhp-hr | grams per brake horsepower-hour |
| GVWR | gross vehicle weight rating |
| HAP | hazardous air pollutant |
| HC | hydrocarbons |
| $H_2SO_4$ | hydrogen sulfate |
| HMP | Hazard Mapping System |
| $HNH_4SO_4$ | ammonium bisulfate |
| HYSPLIT | Hybrid Single Particle Lagrangian Integration Trajectory Model |
| I/M | inspection and maintenance |
| ICI | industrial/commercial/institutional |
| IMPROVE | Interagency Monitoring of Protected Visual Environments |
| I/O API | Input/Output Applications Programming Interface |
| IPM | Integrated Planning Model |
| km | kilometer |
| kW | kilowatts |
| LAC | light absorbing carbon |
| LADCO | Lake Michigan Air Directors Consortium |
| lbs/mmbtu | pounds per million British thermal units |
| LEV | California Low Emission Vehicle Standards |
| LN | low $NO_X$ combustion technology |
| m | meters |
| $m^2g^{-1}$ | meter squared per gram |
| MACT | maximum achievable control technology |
| MANE-VU | Mid-Atlantic/Northeast Visibility Union |
| MATS | Mercury and Air Toxics Standard |
| MB | mean bias |
| MDA8 | maximum daily 8-hour average |
| mb | millibar |
| MJO | multi-jurisdictional organizations |
| $Mm^{-1}$ | Inverse Megameters |
| mmbtu/hr | million British thermal units per hour |
| MOVES | Motor Vehicle Emission Simulator |
| MW | megawatt |
| NAAQS | National Ambient Air Quality Standards |
| NaCl | sodium chloride, sea salt |

# Acronyms and Abbreviations

| Acronym/Abbreviation | Meaning |
|---|---|
| NADP | National Acid Deposition Program |
| NAICS | North American Industry Classification System |
| NCAR | National Center for Atmospheric Research |
| NCEP | National Centers for Environmental Prediction |
| NEI | National Emissions Inventory |
| NEEDS | National Electric Energy Database Systems |
| $NH_3$ | Ammonia |
| $NH_4^+$ | ammonium ion |
| $NH_4NO_3$ | ammonium nitrate |
| $(NH_4)_2SO_4$ | ammonium sulfate |
| NLCD | National Land Cover Database |
| NMB | normalized mean bias |
| NME | normalized mean error |
| NMHC | non-methane hydrocarbons |
| NMIM | National Mobile Inventory Model |
| NTN | National Trends Network |
| NO | nitric oxide |
| $NO_3^-$ | nitrate ion |
| NOAA | National Oceanic and Atmospheric Administration |
| NODA | notice of data availability |
| $NO_X$ | nitrogen oxides |
| NPS | National Park Service |
| NSPS | New Source Performance Standards |
| ORE | On-Road Emissions Program |
| OTR | Ozone Transport Region |
| PM | particulate matter |
| $PM_{10}$ | coarse particulate matter |
| $PM_{2.5}$ | fine particles with a diameter smaller than 2.5 µg |
| POM | particulate organic matter |
| ppb | parts per billion |
| ppm | parts per million |
| ppmvd | parts per million volume dry |
| PSAT | Particulate Matter Source Apportionment Technology |
| PTE | potential to emit |
| Q | emissions, tons per year |
| RACT | reasonably available control technology |
| RFG | reformulated gasoline |
| RPG | reasonable progress goal |
| RPO | regional planning organization |
| RRF | relative reduction factor |
| RT | residence time |
| SAP | sulfuric acid plant |
| SOAP | secondary organic aerosol partitioning |

# Acronyms and Abbreviations

| Acronym/Abbreviation | Meaning |
|---|---|
| SCC | source category code |
| SCR | selective catalytic reduction |
| SIP | state implementation plan |
| SMAT-CE | EPA Software for Model Attainment Test – Community Edition |
| SMOKE | Sparse Matrix Operator Kernel Emissions model |
| SNCR | selective noncatalytic reduction |
| $SO_2$ | sulfur dioxide |
| $SO_4^{-2}$ | sulfate ion |
| TAF | Terminal Area Forecast System |
| tpOS | tons per ozone season |
| tpy | tons per year |
| URP | uniform rate of progress |
| USDA | United States Department of Agriculture |
| USDI | United States Department of the Interior |
| USFS | United States Forest Service |
| VEPCO | Virginia Electric and Power Company |
| VISTAS | Visibility Improvement State and Tribal Association of the Southeast |
| VMT | vehicle miles traveled |
| VOC | volatile organic compound |
| WRF | Weather Research and Forecasting Model |
| µm | micrometer |
| $\mu g/m^3$ | microgram per cubic meter |

# 1. INTRODUCTION

## 1.1. What Is Regional Haze?

Regional Haze is defined as visibility impairment that is caused by atmosphere-entrained air pollutants emitted from numerous anthropogenic and natural sources located over a wide geographic area. These emissions are often transported long distances. Haze is caused when sunlight is absorbed or scattered by airborne particles which, in turn, reduce the clarity, contrast, color, and viewing distance. Regional Haze refers to haze that impairs visibility in all directions uniformly.

Pollution from particulate matter (PM) is the major cause of reduced visibility (haze) in the United States, including many national parks, forests, and wilderness areas (including 156 mandatory Federal Class I areas as defined in 40 CFR Part 81.400). PM affects visibility through the scattering and absorption of light, and fine particles – particles similar in size to the wavelength of light – are most efficient, per unit of mass, at reducing visibility. Fine particles are produced by a variety of natural and anthropogenic sources and may either be emitted directly or formed from emissions of precursors, the most significant of which are sulfur oxides such as sulfur dioxide ($SO_2$), and nitrogen oxides ($NO_X$). Reducing fine particles in the atmosphere is generally considered to be an effective method of reducing regional haze and, thus, improving visibility. Fine particles also adversely impact human health, especially the respiratory and cardiovascular systems. The United States Environmental Protection Agency (EPA) has set national ambient air quality standards (NAAQS) for daily and annual levels of fine particles with a diameter less than or equal to 2.5 micrometers (µm), known as $PM_{2.5}$. In the southeast, the most important sources of $PM_{2.5}$ and its precursors are coal-fired power plants, industrial boilers, process heaters, and other stationary combustion sources. Other significant contributors to $PM_{2.5}$ and visibility impairment include the following source categories: mobile, on road, and non-road engine emissions; stationary non-combustion emissions (area sources); wildfires and prescribed burning emissions; and wind-blown dust.

## 1.2. What Are the Requirements Under the Clean Air Act for Addressing Regional Haze?

In Section 169A of the 1977 Amendments to the Clean Air Act (CAA), Congress set forth a program for protecting visibility in Class I areas that calls for the "prevention of any future, and the remedying of any existing impairment of visibility caused by anthropogenic (manmade) air pollution." On December 2, 1980, EPA promulgated regulations to address visibility impairment (45 FR 80084) that is "reasonably attributable" to a single source or small groups of sources. These regulations represented the first phase in addressing visibility impairment and deferred action on regional haze that emanates from a variety of sources until monitoring, modeling, and scientific knowledge about the relationships between pollutants and visibility impairment improved.

In the 1990 Amendments to the CAA, Congress added Section 169B and called on EPA to issue regional haze rules. The Regional Haze Rule that EPA promulgated on July 1, 1999, (64 FR 35713) revised the existing visibility regulations to integrate provisions addressing regional haze impairment and established a comprehensive visibility protection program for mandatory Federal Class I areas.[1] Each state was required to submit a State Implementation Plan (SIP) to EPA by December 17, 2007, which set out that state's plan for complying with the Regional Haze Rule for the first planning period from 2007 to 2018. Each state was required to consult and coordinate with other states and with Federal Land Managers (FLMs) in developing its SIP. Paragraph 40 CFR 51.308(f) of the 1999 Rule required states to submit periodic comprehensive revisions of their regional haze plans by July 31, 2018, and every ten years thereafter. However, on January 10, 2017, EPA revised, among other things, paragraph 40 CFR 51.308(f) of the Regional Haze Rule to change the deadlines for submitting revisions and updates to regional haze plans to July 31, 2021, July 31, 2028, and every 10 years thereafter. This SIP was prepared for the second planning period, which includes the years 2021 to 2028.

The Regional Haze Rule addressed the combined visibility effects of various pollution sources over a wide geographic region. This wide-reaching pollution net meant that many states – even those without mandatory Federal Class I areas – would be required to participate in haze reduction efforts. Five regional planning organizations (RPOs) were formed to assist with the coordination and cooperation needed to address regional haze. These five RPOs are illustrated in Figure 1-1.[2] The Southeastern States Air Resource Managers, Inc. (SESARM) has been designated by EPA as the entity responsible for coordinating regional haze evaluations for ten Southeastern states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia), local air pollution control agencies, and tribal authorities. These parties collaborated through the organization known as the Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) to prepare the technical analyses and planning activities associated with visibility and related regional air quality issues supporting the development of Regional Haze SIPs for the first and second planning periods. For the second planning period, local air pollution control agencies were represented by the Knox County, Tennessee local air pollution control agency, and tribal authorities were represented by the Eastern Band of Cherokee Indians.

[1] The regional haze regulations were amended on July 6, 2005 (70 FR 39104), October 13, 2006 (71 FR 60612), June 7, 2012 (77 FR 33642), and January 10, 2017 (82 FR 3078).

[2] URL: https://www.epa.gov/visibility/visibility-regional-planning-organizations


**Figure 1-1: Geographical Areas of Regional Planning Organizations**

## 1.3. General Overview of Regional Haze SIP Requirements

The Regional Haze Rule at 40 CFR 51.308 requires all states to submit a SIP for regional haze. The Rule requires each state to periodically revise and submit revisions to its Regional Haze SIP, for this planning period by July 31, 2021, July 31, 2028, and every 10 years thereafter. All Regional Haze SIPs must include the following:

- Reasonable progress goals (RPGs) for each mandatory Federal Class I area located within the state;
- Natural, baseline, and current visibility conditions for each mandatory Federal Class I area within the state;
- A long-term strategy (LTS) to address visibility for each mandatory Federal Class I area within the state, and for each mandatory Federal Class I area located outside the state that may be affected by emissions from the state;
- A monitoring strategy for measuring, characterizing, and reporting data that is representative of all mandatory Federal Class I areas within the state; and
- Other requirements and analyses

The Regional Haze Rule requires states to establish RPGs, expressed in deciviews (dv), for the end of each implementation period (approximately ten years), that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of enforceable measures required by the Regional Haze Rule and other requirements of the CAA (40 CFR 51.308(f)(3)). The goals must provide for reasonable progress towards achieving natural visibility conditions by providing for improvement in visibility for the most impaired days and ensuring no degradation in visibility for the clearest days over each ten-year period.

The Regional Haze Rule requires states to compute natural visibility conditions for both the 20% most impaired days and the 20% clearest days (40 CFR 51.308(f)(1)). For the 20% most impaired days, the Regional Haze Rule directs each state with a Class I area to determine the Uniform Rate of Progress (URP or "glide path") that would need to be maintained during each implementation period to attain natural visibility conditions for the Class I area by 2064. Data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are used to establish baseline and natural visibility metrics.[3] States are to establish baseline visibility conditions using a five-year average of monitoring data for 2000-2004 and natural visibility conditions for 2064. A line is then drawn between the two data points to determine the URP for the most impaired days. Days with the lowest 20% annual values of the daily haze index are used to represent the clearest days. The requirement of the Regional Haze Rule for the 20% clearest days is to ensure that no degradation from the baseline (2000-2004) occurs. For the 20% clearest days, the regulatory requirements do not rely on a comparison to the estimated 2064 natural background conditions.

For this second planning period, Regional Haze SIPs must include the current visibility conditions for the most impaired and clearest days, the actual progress made towards natural visibility since the baseline period, and the actual progress made during the previous implementation period. The period for calculating current visibility conditions is the most recent five-year period for which data are available. For this SIP, the current visibility conditions include data from years 2014 to 2018. The period for evaluating actual progress made is from the baseline period (2000 to 2004) up to and including the five-year period for calculating current visibility conditions 2014-2018 (40 CFR 51.308(f)(1)(iii)-(iv)).

The 2028 RPGs for each Class I area must be met through measures contained in the state's Long-Term Strategy (LTS). The LTS must address regional haze visibility impairment for each mandatory Federal Class I area within the state, and for each mandatory Federal Class I area located outside the state that may be affected by emissions from the state. The LTS must include enforceable emissions limitations, compliance schedules, and other measures necessary to make reasonable progress. Section 169A of the CAA requires a state to consider the four statutory factors (cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life) when developing the LTS upon which it bases the RPGs for each Class I area. States are also required to consider the following additional factors in developing their LTS: ongoing air pollution control programs; measures to mitigate the impact of construction activities; source retirement and replacement schedules; smoke management programs for agriculture and forestry; and the anticipated net effect of visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the LTS (40 CFR 51.308(f)(2)(iv)).

States must also include a monitoring strategy for the measuring, characterizing, and reporting of regional haze visibility impairment data that is representative of all mandatory Federal Class I

[3] URL: http://vista.cira.colostate.edu/Improve/

areas within the state. The Regional Haze Rule states that compliance with this requirement may be met through participation in the IMPROVE network (40 CFR 51.308(f)(6)).

The SIPs for this second planning period cover the LTS for visibility improvement to the end of the second planning period (2028). States are required to evaluate progress toward meeting their RPGs every five years to ensure that emissions controls are on track with emissions reduction forecasts in each SIP. On January 10, 2017, EPA amended 40 CFR 51.308(f) so that the plan revision for the second planning period will also serve as a progress report and thus address the periodic report requirement specified in 40 CFR 51.308(g)(1) through (5). The next progress report will be due to EPA by January 31, 2025. If emissions controls are not on track to ensure reasonable progress, then states would need to take action to ensure emissions controls by 2028 will be consistent with the SIP or revise the SIP to be consistent with the revised emissions forecast (40 CFR 51.308(f) and 40 CFR 51.308(g)).

EPA provided several guidance documents listed below to assist the states in implementation of the Regional Haze Rule requirements, including documents that specifically address the second implementation period. All VISTAS states followed these guidance documents in developing the technical analyses reported in this plan.

- Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule (EPA-454/B-03-005, September 2003)
- General Principles for 5-year Regional Haze Progress Reports for the Initial Regional Haze State Implementation Plans (Intended to Assist States and EPA Regional Offices in Development and Review of the Progress Reports) (EPA, April 2013)
- Technical Guidance for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program (EPA, December 20, 2018)
- Guidance on Regional Haze State Implementation Plans for the Second Implementation Period (EPA, August 20, 2019)
- Technical Support Document for EPA's 2028 Regional Haze Modeling (EPA, September 19, 2019)
- Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program (EPA, June 3, 2020)
- Memorandum Titled Clarification Regarding Regional Haze State Implementation Plans for the Second Implementation Period (EPA, July 8, 2021)

### 1.4. Mandatory Federal Class I Area in Alabama

Alabama has one mandatory Federal Class I area within its borders: the Sipsey Wilderness Area (Sipsey) within the Bankhead National Forest in Northwest Alabama. The Alabama Department of Environmental Management (ADEM) is responsible for developing the Regional Haze SIP for

Alabama and submitting it to EPA for approval. This SIP establishes Reasonable Progress Goals (RPGs) for visibility improvement at Sipsey and a Long-Term Strategy (LTS) that will achieve those RPGs within the second regional haze planning period. The Sipsey Wilderness Area is described at 40 CFR § 81.401 and is shown below in Figure 1-2.

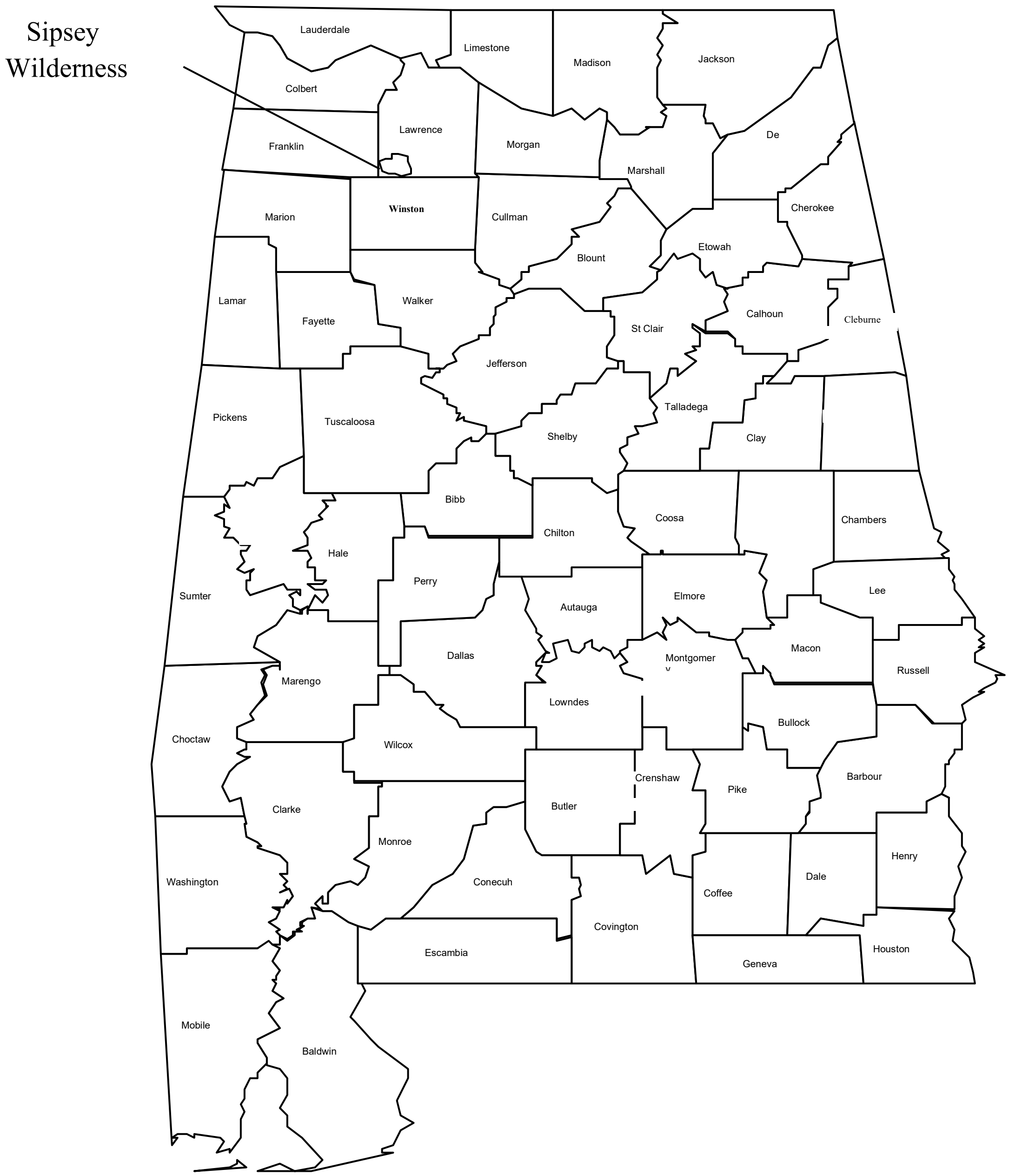



**Figure 1-2: Alabama's Mandatory Federal Class I Area (the Sipsey Wilderness Area)**

As required by the Regional Haze Rule, Alabama has also considered the impacts of emission sources outside of Alabama that may affect visibility at Sipsey, and emission sources within Alabama that may affect visibility at Class I areas in neighboring states. Through VISTAS, the southeastern states worked together to assess state-by-state contributions to visibility impairment in specific Class I areas, including Sipsey, and those affected by emissions from Alabama. This technical work is discussed further in Sections 5, 6, and 7 below. Consultations to date between Alabama and other states are summarized in Section 10 of this document.

## 1.5. Regional Planning and Coordination

Successful implementation of a regional haze program involves long-term regional coordination among states. SESARM formed VISTAS in 2001 to coordinate technical work and long-range planning for addressing visibility impairment in each of the eighteen mandatory Federal Class I areas in the VISTAS region (see Figure 1-3 and Table 1-1 below). Alabama participated as a member state in VISTAS during the first and second planning periods. The objectives of VISTAS are as follows:

- To coordinate and document natural, baseline, and current conditions for each Class I area in the Southeast;
- To develop base year and future year emission inventories to support air quality modeling;
- To develop methodologies for screening sources and groups of sources for reasonable further progress (RPG) analyses;
- To conduct photochemical grid modeling to support development of RPGs for each Class I area; and
- To share information to support each state in developing the LTS for its SIP.

In addition, VISTAS states also coordinated with other RPOs to share information and undertake consultation, as needed, to address visibility impairment associated with sources affecting Class I areas in the VISTAS region and sources in the VISTAS region potentially affecting visibility impairment in other regions.


**Figure 1-3: Mandatory Federal Class I Areas in the VISTAS Region**

**Table 1-1: Mandatory Federal Class I Areas in the VISTAS Region**

| State | Area Name | Acreage | Federal Land Manager |
|---|---|---|---|
| Alabama | Sipsey Wilderness Area | 12,646 | USDA-FS |
| Florida | Chassahowitzka Wilderness Area | 23,360 | USDI-FWS |
| Florida | Everglades National Park | 1,397,429 | USDI-NPS |
| Florida | St. Marks Wilderness Area | 17,745 | USDI-FWS |
| Georgia | Cohutta Wilderness Area | 33,776 | USDA-FS |
| Georgia | Okefenokee Wilderness Area | 343,850 | USDI-FWS |
| Georgia | Wolf Island Wilderness Area | 5,126 | USDI-FWS |
| Kentucky | Mammoth Cave National Park | 51,303 | USDI-NPS |
| North Carolina | Great Smoky Mountains National Park | 273,551 | USDI-NPS |
| North Carolina | Joyce Kilmer-Slickrock Wilderness Area | 10,201 | USDA-FS |
| North Carolina | Linville Gorge Wilderness Area | 7,575 | USDA-FS |
| North Carolina | Shining Rock Wilderness Area | 13,350 | USDA-FS |
| North Carolina | Swanquarter Wilderness Area | 9,000 | USDI-FWS |
| South Carolina | Cape Romain Wilderness Area | 28,000 | USDI-FWS |
| Tennessee | Great Smoky Mountains National Park | 241,207 | USDI-NPS |
| Tennessee | Joyce Kilmer-Slickrock Wilderness Area | 3,832 | USDA-FS |
| Virginia | James River Face Wilderness Area | 8,703 | USDA-FS |
| Virginia | Shenandoah National Park | 190,535 | USDI-NPS |
| West Virginia | Dolly Sods Wilderness Area | 10,215 | USDA-FS |
| West Virginia | Otter Creek Wilderness Area | 20,000 | USDA-FS |

## 1.6. State and Federal Land Manager (FLM) Coordination

As required by 40 CFR 51.308(i), the Regional Haze SIP must include procedures for continuing consultation between the states and FLMs on the implementation of the visibility protection program. Continuing consultation should encompass the development and review of periodic implementation plan revisions and five-year progress reports, as well as the implementation of other programs having the potential to contribute to impairment of visibility in any Class I area within the state. The three FLMs include the United States Department of Interior (USDI) Fish and Wildlife Service (FWS) and National Park Service (NPS), and the United States Department of Agriculture (USDA) Forest Service (FS).

Coordination with the FLMs including Alabama's continuing obligations to periodically revise its regional haze SIP is also discussed in Section 11. Alabama formally commits to follow the FLM consultation procedures as prescribed in 40 CFR 51.308(i) for this and future planning periods.

The FLMs, in particular the USFS, were involved in the preparation of this Regional Haze SIP. Documentation of the formal comments made by the FLMs and Alabama's responses appear in Appendix H – Public Hearing Comment Summary and Agency Responses. More information on FLM consultation can be found in Section 10.3 and in Appendix F-3

## 1.7. Cross-Reference to Regional Haze Regulatory Requirements

Table 1-2 identifies each section of the SIP that addresses the Regional Haze Rule requirements specified in 40 CFR 51.308(f), (g), and (i) for this second planning period.

**Table 1-2: Cross-Reference of Sections in the SIP to Regional Haze Rule Requirements Specified in 40 CFR 51.308(f) and (g)**

| Rule Section | Chapter/Section in SIP | Description |
|---|---|---|
| (f) | 11 | Requirements for periodic comprehensive revisions of implementation plans for regional haze |
| (f)(1) | 2.1, 2.2, 2.3, 2.4, 2.6, 3 | Calculations of baseline, current, and natural visibility conditions; progress to date; and the Uniform Rate of Progress |
| (f)(1)(i) | 2.4 | Baseline visibility conditions for the most impaired and clearest days |
| (f)(1)(ii) | 2.3 | Natural visibility conditions for the most impaired and clearest days |
| (f)(1)(iii) | Exec Summary, 2.6 | Current visibility conditions for the most impaired and clearest days |
| (f)(1)(iv) | 2.7 | Progress to date for the most impaired and clearest days |
| (f)(1)(v) | 2.7 | Differences between current visibility condition and natural visibility condition |
| (f)(1)(vi)(A) | 3 | Uniform Rate of Progress |
| (f)(1)(vi)(B) | Not Applicable | Any adjustments to rate of progress |
| (f)(2) | 7 | Long-Term Strategy (LTS) for Regional Haze |
| (f)(2)(i) | 7 | Emission reduction measures that are necessary to make reasonable progress |
| (f)(2)(ii) | 10 | Consultation with states that have emissions that are reasonably anticipated to contribute to visibility impairment at the mandatory Federal Class I area |
| (f)(2)(ii)(A) | 10 | Demonstrate that it has included in its implementation plan all measures agreed to during state-to-state consultations |
| (f)(2)(ii)(B) | 10 | Consider the emission reduction measures identified by other states for sources |
| (f)(2)(ii)(C) | 10 | In any situation in which a state cannot agree with another state on the emission reduction measures necessary to make reasonable progress in a mandatory Federal Class I area, the state must describe the actions taken to resolve the disagreement |
| (f)(2)(iii) | 2, 4, 5, 6, 7.2, 7.8, 9, 10 | Document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, on which the state is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory Federal Class I area |
| (f)(2)(vi)(A) | 7.2 | Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment |
| (f)(2)(vi)(B) | 7.10.2 | Measures to mitigate the impacts of construction activities |
| (f)(2)(vi)(C) | 7.2.2 | Source retirement and replacement schedules |
| (f)(2)(vi)(D) | 7.2.3, 7.10.1 | Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs |
| (f)(2)(vi)(E) | 8 | The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the LTS |
| (f)(3)(i) | 8 | Reasonable Progress Goals (RPGs)– The state must establish RPGs (expressed in dv) that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of those enforceable emissions limitations, compliance schedules, and other measures |

| Rule Section | Chapter/Section in SIP | Description |
|---|---|---|
| (f)(3)(ii)(A) | not applicable | If a state in which a mandatory Federal Class I area is located establishes a RPG for the most impaired days that provides for a slower rate of improvement in visibility than the uniform rate of progress calculated under paragraph (f)(1)(vi) of this section, the state must demonstrate, based on the analysis required by paragraph (f)(2)(i) of this section, that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in the LTS |
| (f)(3)(ii)(B) | 7 | If a state contains sources which are reasonably anticipated to contribute to visibility impairment in a mandatory Federal Class I area in another state for which a demonstration by the other state is required under (f)(3)(ii)(A), the state must demonstrate that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in its own LTS. The state must provide a robust demonstration, including documenting the criteria used to determine which sources or groups or sources were evaluated and how the four factors required by paragraph (f)(2)(i) were taken into consideration in selecting the measures for inclusion in its LTS |
| (f)(4) | Not Applicable | If the Administrator, Regional Administrator, or the affected Federal Land Manager has advised a state of a need for additional monitoring to assess reasonably attributable visibility impairment at the mandatory Federal Class I area, in addition to the monitoring currently being conducted, the state must include in the plan revision an appropriate strategy for evaluating reasonably attributable visibility impairment in the mandatory Federal Class I area by visual observation or other appropriate monitoring techniques |
| (f)(5) | 13.5 | An assessment of any significant changes in anthropogenic emissions within or outside of the state that have occurred since the period addressed in the most recent plan required under paragraph (f) of this section including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility |
| (f)(6) | 9 | Monitoring strategy and other implementation plan requirements – States must submit a monitoring strategy with the SIP for measuring, characterizing, and reporting of regional haze visibility impairment that is representative of all mandatory Federal Class I areas within the state. Compliance with this requirement may be met through participation in the Interagency Monitoring of Protected Visual Environments (IMPROVE) network |
| (f)(6)(i) | Not Applicable | The establishment of any additional monitoring sites or equipment needed to assess Reasonable Progress Goals |
| (f)(6)(ii) | 9 | Procedures by which monitoring data and other information are used in determining the contribution of emissions from within the state |
| (f)(6)(iii) | Not Appliable | For a state with no mandatory Federal Class I areas, procedures by which monitoring data and other information are used to in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I federal areas in other states |

| Rule Section | Chapter/Section in SIP | Description |
|---|---|---|
| (f)(6)(iv) | 9 | The implementation plan must provide for the reporting of all visibility monitoring data to the Administrator at least annually for each mandatory Federal Class I area in the state |
| (f)(6)(v) | 4, 7.2.4 | A statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Federal Class I area |
| (f)(6)(vi) | 9 | Other elements, including reporting, recordkeeping, and other measures, necessary to assess and report on visibility |
| (g)(1) | 13.3 | Periodic progress reports must contain at a minimum the following elements:<br>(1) A description of the status of implementation of all measures included in the implementation plan for achieving the RPGs for mandatory Federal Class I areas both within and outside the state |
| (g)(2) | 13.4 | (2) A summary of the emissions reductions achieved throughout the state through implementation of the measures described in paragraph (g)(1) of this section |
| g(3) | 13.4 | For each mandatory Federal Class I area within the State, the State must assess the following visibility conditions and changes, with values for the most impaired, least impaired and/or clearest days as applicable expressed in terms of 5-year averages of these annual values. The period for calculating current visibility conditions is the most recent 5-year period preceding the required date of the progress report for which data are available as of a date 6-months preceding the required date of the progress report. |
| g(3)(i)(a) | 13.4 | Progress reports due before January 31, 2025. The current visibility conditions for the most impaired and least impaired days. |
| (g)(3)(i)(B) | not applicable | Progress reports due on and after January 31, 2025. The current visibility conditions for the most impaired and clearest days |
| (g)(3)(ii)(A) | 13.4 | Progress reports due before January 31, 2025. The difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions. |
| (g)(3)(ii)(B) | not applicable | Progress reports due on and after January 31, 2025. The difference between current visibility conditions for the most impaired and clearest days and baseline visibility conditions. |
| (g)(3)(iii)(A) | 13.4 | Progress reports due before January 31, 2025. The change in visibility impairment for the most impaired and least impaired days over the period since the period addressed in the most recent plan required under paragraph (f) of this section. |
| (g)(3)(iii)(B) | not applicable | Progress reports due on and after January 31, 2025. The change in visibility impairment for the most impaired and clearest days over the period since the period addressed in the most recent plan required under paragraph (f) of this section. |

| Rule Section | Chapter/Section in SIP | Description |
|---|---|---|
| g(4) | 13.5 | An analysis tracking the change over the period since the period addressed in the most recent plan required under paragraph (f) of this section in emissions of pollutants contributing to visibility impairment from all sources and activities within the State. Emissions changes should be identified by type of source or activity. With respect to all sources and activities, the analysis must extend at least through the most recent year for which the state has submitted emission inventory information to the Administrator in compliance with the triennial reporting requirements of subpart A of this part as of a date 6 months preceding the required date of the progress report. With respect to sources that report directly to a centralized emissions data system operated by the Administrator, the analysis must extend through the most recent year for which the Administrator has provided a State-level summary of such reported data or an internet-based tool by which the State may obtain such a summary as of a date 6 months preceding the required date of the progress report. The State is not required to backcast previously reported emissions to be consistent with more recent emissions estimation procedures and may draw attention to actual or possible inconsistencies created by changes in estimation procedures. |
| g(5) | 13.5 | An assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred since the period addressed in the most recent plan required under paragraph (f) of this section including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility. |
| (i) | 10.4 | State and FLM coordination |

## 2. Natural Background Conditions and Assessment of Baseline, Modeling Base Period, and Current Conditions

The goal of the Regional Haze Rule is to restore natural visibility conditions to the 156 Class I areas identified in the 1977 Clean Air Act Amendments (40 CFR 51.301), and contains the following definitions:

> *Natural conditions* reflect naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration, and may refer to the conditions on a single day or set of days. These phenomena include, but are not limited to: humidity, fire events, dust storms, volcanic activity, and biogenic emissions from soils and trees. These phenomena may be near or far from a Class I area and may be outside the United States.
>
> *Natural visibility* is defined as visibility (contrast, coloration, and texture) on a day or days that would have existed under natural conditions. Natural visibility varies with time and location, is estimated or inferred rather than directly measured, and may have long-term trends due to long-term trends in natural conditions.
>
> *Natural visibility condition* is the average of individual values of daily natural visibility unique to each Class I area for either the most impaired or clearest days.

The Regional Haze SIPs must contain measures that make "reasonable progress" toward achieving natural visibility conditions by reducing anthropogenic, i.e., manmade emissions that cause haze.

An easily understood measure of visibility to most people is visual range. Visual range is the greatest distance, in kilometers or miles, at which a dark object can be viewed against the sky. For evaluating the relative contributions of pollutants to visibility impairment, however, the most useful measure of visibility impairment is light extinction, which affects the clarity and color of objects being viewed.

The measure used by the Regional Haze Rule is the deciview (dv) index, as provided at 40 CFR 51.301. Deciviews are calculated directly from light extinction using the following logarithmic equation:

$$dv = 10 * \ln \left(\frac{b_{ext}}{10 * Mm^{-1}}\right)$$

In this equation, the atmospheric light extinction coefficient, $b_{ext}$, is expressed in units of inverse megameters ($Mm^{-1}$).[4] The dv units are useful for tracking progress in improving visibility because each dv change is an equal incremental change in visibility perceived by the human eye. Most people can detect a change in visibility at one dv.

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[4] Colorado State University, "The IMPROVE Algorithm." URL: http://vista.cira.colostate.edu/Improve/haze-metrics-converter/

For each Class I area, there are three metrics of visibility that are part of the determination of reasonable progress:

- natural conditions,
- baseline conditions, and
- current conditions

Each of the three metrics includes the concentration data of the visibility-impairing pollutants as different terms in the IMPROVE light extinction algorithm, with respective extinction coefficients and relative humidity factors. Total light extinction when converted to dv is calculated for the average of the 20% clearest and 20% most impaired days. The terminology for these two sets of days changed for the second round of regional haze planning owing to a focus on anthropogenically-induced visibility impairment.[5]

"Natural" visibility is determined by estimating the natural concentrations of visibility pollutants and then calculating total light extinction. "Baseline" visibility is the starting point for the improvement of visibility conditions. Baseline visibility is calculated from the average of the IMPROVE monitoring data for 2000 through 2004. The comparison of initial baseline conditions from 2000-2004 to natural visibility conditions indicates the amount of improvement necessary to attain natural visibility by 2064. Each state must estimate natural visibility levels for Class I areas within its borders in consultation with FLMs and other states as required by 40 CFR 51.308(f)(1).

Another important set of visibility monitoring data is the base period used for air quality modeling projections, in this case monitoring data from years 2009 through 2013. These monitoring data are used in conjunction with inventory and meteorological data to project expected visibility parameters for each Class I area, as described in Sections 5, 6, and 7.2.6.2.

"Current conditions" are assessed every five years as part of the regional haze planning process where actual progress in reducing visibility impairment is compared to the reductions identified in the SIP. The five-year period comprising current conditions for this planning period is 2014-2018, inclusive.

## 2.1. IMPROVE Algorithm

The IMPROVE algorithm for estimating light extinction was adopted by EPA as the basis for the regional haze metric used to track progress in reducing haze levels and estimate light extinction, which is then converted to the dv haze index.

The equation accounts for the effect of particle size distribution on light extinction efficiency of sulfate, nitrate, and organic carbon; the equation also accounts for light extinction by sea salt and light absorption by gaseous nitrogen dioxide. Additionally, site-specific values are used for Rayleigh scattering to account for the site-specific effects of elevation and temperature. Separate relative humidity enhancement factors are used for small and large size distributions of ammonium

[5] EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

sulfate and ammonium nitrate and for sea salt. A complete description of the terms in the IMPROVE equation is given on the IMPROVE website.[6]

The algorithm has been revised over the years to produce consistent estimates of light extinction for all remote area IMPROVE aerosol monitoring sites. It permits the individual particle component contributions to light extinction to be calculated separately. The current IMPROVE equation includes contributions from sea salt and an increase in the multiplier for contributions from particulate organic matter (POM) as compared to the previous IMPROVE algorithm.

In the IMPROVE algorithm, as described in the equation below, light extinction ($b_{ext}$) and Rayleigh scattering are described in units of $Mm^{-1}$. Dry mass extinction efficiency terms are in units of meter squared per gram ($m^2g^{-1}$). Water growth terms, *f(RH)*, are unitless. The total sulfate, nitrate, and organic compound concentrations are each split into two fractions, representing small and large size distributions of those components. For masses less than 20 $\mu g/m^3$, the fraction in the large mode is estimated by dividing the total concentration of the component by 20 $\mu g/m^3$. If the total concentration of a component exceeds 20 $\mu g/m^3$, all is assumed to be in the large mode. The small and large modes of sulfate and nitrate have relative humidity correction factors, $f_S(RH)$ and $f_L(RH)$, applied since these species are hygroscopic (i.e. absorb water), and their extinction efficiencies change with relative humidity.

**IMPROVE Equation**

$$b_{ext} \approx 2.2 \times f_S(RH) \times [Small\ Ammonium\ Sulfate] + 4.8 \times f_L(RH) \times [Large\ Ammonium\ Sulfate] + 2.4 \times f_S(RH) \times [Small\ Ammonium\ Nitrate] + 5.1 \times f_L(RH) \times [Large\ Ammonium\ Nitrate] + 2.8 \times [Small\ Organic\ Mass] + 6.1 \times [Large\ Organic\ Mass] + 10 \times [Elemental\ Carbon] + 1 \times [Fine\ Soil] + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] + 0.6 \times [Coarse\ Mass] + Rayleigh\ Scattering(Site\ Specific) + 0.33 \times [NO_2(ppb)]$$

More information on the IMPROVE algorithm may be found in Appendix E-1a and Appendix E-1b.

## 2.2. IMPROVE Monitoring Sites

Table 2-1 provides the VISTAS Class I areas and their associated monitoring site identification numbers. In certain instances, a Class I area may not have a monitoring site located within its boundaries. These sites rely on data from nearby monitoring sites to act as surrogates within the analyses described in this SIP revision. For Class I areas in the Southeastern U.S., Joyce Kilmer-Slickrock Wilderness Area relies upon data from the Great Smoky Mountains National Park IMPROVE monitoring site (GRSM1), Otter Creek Wilderness Area relies on data from the Dolly Sods Wilderness Area IMPROVE monitoring site (DOSO1), and Wolf Island Wilderness Area relies on data from the Okefenokee Wilderness Area IMPROVE monitoring site (OKEF1). For the analyses described within this document, site-specific data such as elevation and location are used

[6] Colorado State University, "The IMPROVE Algorithm", URL: http://vista.cira.colostate.edu/Improve/the-improve-algorithm/.

for these areas in combination with the monitoring data from the surrogate IMPROVE site. Table 2-1 provides the IMPROVE site identification number for the surrogate monitor in these situations.

**Table 2-1: VISTAS Class I Areas and IMPROVE Site Identification Numbers**

| Class I Area | IMPROVE Site Identification Number |
|---|---|
| Cape Romain Wilderness Area | ROMA1 |
| Chassahowitzka Wilderness Area | CHAS1 |
| Cohutta Wilderness Area | COHU1 |
| Dolly Sods Wilderness Area | DOSO1 |
| Everglades National Park | EVER1 |
| Great Smoky Mountains National Park | GRSM1 |
| James River Face Wilderness Area | JARI1 |
| Joyce Kilmer-Slickrock Wilderness Area | GRSM1 |
| Linville Gorge Wilderness Area | LIGO1 |
| Mammoth Cave National Park | MACA1 |
| Okefenokee Wilderness Area | OKEF1 |
| Otter Creek Wilderness Area | DOSO1 |
| Shenandoah National Park | SHEN1 |
| Shining Rock Wilderness Area | SHRO1 |
| Sipsey Wilderness Area | SIPS1 |
| St. Marks Wilderness Area | SAMA1 |
| Swanquarter Wilderness Area | SWAN1 |
| Wolf Island Wilderness Area | OKEF1 |

## 2.3. Estimating Natural Conditions for VISTAS Class I Areas

Natural background visibility, as defined in the document Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program, EPA-454/B-03-005, September 2003,[7] is based on annual average concentrations of fine particle components. There are two separate methodologies to compute natural conditions: one methodology for the 20% clearest days and one for the 20% most impaired days. In the first round of regional haze planning as well as the first mid-course review, these days were referred to as the 20% best and 20% worst days, respectively. These terms were updated to "clearest" and "most impaired" as part of two recent actions by EPA: a Rule amending requirements for state plans finalized in January 2017,[8] and EPA guidance that updates recommended methodologies for tracking visibility impairment, issued in December 2018.[9] Also, as part of EPA's 2018 guidance, the recommended methodology for computing natural conditions for the 20% most impaired days changed, while no change was made for the 20% clearest days.

Natural background conditions using the current IMPROVE equation are calculated separately for each Class I area, and the methodology for calculating background conditions for the 20% most impaired days and the 20% clearest days are discussed in the preceding sections. Broadly speaking,

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7 URL: https://www3.epa.gov/ttnamti1/files/ambient/visible/tracking.pdf

8 Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.

9 EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

however, the new calculation of natural background allows Rayleigh scattering to vary with elevation. Also, natural conditions are adjusted (as with the 20% most impaired days) to reflect impacts of natural events, heretofore, unrecognized in the computation of visibility under natural background conditions.

### 2.3.1. Natural Background Conditions on 20% Clearest Days

EPA's 2018 guidance memo notes that days with the lowest 20% annual values of the daily haze index are used to represent the clearest days and are not selected based on the lowest anthropogenic impairment. The requirements of the Regional Haze Rule for the 20% clearest days is to ensure that no degradation from the baseline (2000-2004) occurs and do not rely on a comparison to the estimated natural background conditions on the 20% clearest days.

### 2.3.2. Natural Background Conditions on 20% Most Impaired Days

The methodology for computing natural background values for the 20% most impaired days separates observed visibility impairment into natural and anthropogenic contributions. The days with the highest anthropogenic visibility impairment contribution are what now comprise the 20% most impaired days, as opposed to the entirety of the subset of days that comprised the 20% worst (haziest) days previously. The reason for this change was to separate visibility impairment associated with significant natural events such as wildfires and dust storms, over which states have no control, from visibility impairment associated with anthropogenic emissions sources, which states may control. Further, EPA notes that visibility conditions have never been measured without any anthropogenic impairment whatsoever, so such conditions must be estimated.

Within these 20% most impaired days at a given Class I site, the natural visibility impairment for each day measured at each Class I site from 2000 to 2014, inclusive, are aggregated. That average value then becomes the natural background endpoint for the 20% most impaired days at the given Class I site. The 2018 EPA guidance “Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program” (p.15) notes that these new natural background visibility values are "consistently" lower than the prior natural values for the 20% haziest days. The natural background conditions computed and utilized by VISTAS for the 20% most impaired days at Class I sites followed the 2018 EPA guidance without exception.

### 2.3.3 Summary of Natural Background Conditions for the VISTAS Class I areas

Table 2-2 provides a summary of the natural background conditions for VISTAS Class I areas.

**Table 2-2: Average Natural Background Conditions for VISTAS Class I Areas**

| Class I Areas | Average for 20% Most Impaired Days* | Average for 20% Clearest Days* |
|---|---|---|
| Cape Romain Wilderness Area | 9.79 dv | 5.93 dv |
| Chassahowitzka Wilderness Area | 9.03 dv | 6.00 dv |
| Cohutta Wilderness Area | 9.88 dv | 4.42 dv |
| Dolly Sods Wilderness Area | 8.92 dv | 3.64 dv |
| Everglades National Park | 8.33 dv | 5.22 dv |
| Great Smoky Mountains National Park | 10.05 dv | 4.62 dv |
| James River Face Wilderness Area | 9.47 dv | 4.39 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 10.05 dv | 4.62 dv |
| Linville Gorge Wilderness Area | 9.70 dv | 4.07 dv |
| Mammoth Cave National Park | 9.80 dv | 5.00 dv |
| Okefenokee Wilderness Area | 9.45 dv | 5.43 dv |
| Otter Creek Wilderness Area | 8.92 dv | 3.64 dv |
| Shenandoah National Park | 9.52 dv | 3.15 dv |
| Shining Rock Wilderness Area | 10.25 dv | 2.49 dv |
| Sipsey Wilderness Area | 9.62 dv | 5.03 dv |
| St. Marks Wilderness Area | 9.13 dv | 5.37 dv |
| Swanquarter Wilderness Area | 10.01 dv | 5.71 dv |
| Wolf Island Wilderness Area | 9.45 dv | 5.43 dv |

* Data taken from Table 1 in the EPA memorandum titled: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[10]

## 2.4. Baseline Conditions

Baseline visibility conditions at the Sipsey Class I area are estimated using sampling data collected at the IMPROVE monitoring site. A five-year average (2000 to 2004) was calculated for the 20% clearest days as well as the 20% most impaired days at Sipsey in accordance with 40 CFR 51.308(f)(1); Guidance for Tracking Progress Under the Regional Haze Rule, EPA-454-03-004, September 2003; and the 2018 EPA guidance. IMPROVE data records for Sipsey for the period 2000 to 2004 meet the EPA requirements for data completeness (75% for the year and 50% for each quarter).

### 2.4.1. Baseline Conditions for 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-3 provides a summary of the baseline conditions (2000-2004) for the 20% clearest and 20% most impaired days at each VISTAS Class I area. The baseline dv index values for the 20% most impaired and 20% clearest days at these Class I areas are based on data included in Table 1 in the EPA memorandum (dated June 3, 2020): "Recommendation for the use of Patched and

[10] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[11]

**Table 2-3: Baseline Visibility Conditions for VISTAS Class I Areas (2000-2004)**

| Class I Areas | Average for 20% Most Impaired Days | Average for 20% Clearest Days |
|---|---|---|
| Cape Romain Wilderness Area | 25.25 dv | 14.29 dv |
| Chassahowitzka Wilderness Area | 24.52 dv | 15.60 dv |
| Cohutta Wilderness Area | 29.12 dv | 13.73 dv |
| Dolly Sods Wilderness Area | 28.29 dv | 12.28 dv |
| Everglades National Park | 19.52 dv | 11.69 dv |
| Great Smoky Mountains National Park | 29.11 dv | 13.58 dv |
| James River Face Wilderness Area | 28.08 dv | 14.21 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 29.11 dv | 13.58 dv |
| Linville Gorge Wilderness Area | 28.05 dv | 11.11 dv |
| Mammoth Cave National Park | 29.83 dv | 16.51 dv |
| Okefenokee Wilderness Area | 25.34 dv | 15.23 dv |
| Otter Creek Wilderness Area | 28.29 dv | 12.28 dv |
| Shenandoah National Park | 28.32 dv | 10.93 dv |
| Shining Rock Wilderness Area | 28.13 dv | 7.70 dv |
| Sipsey Wilderness Area | 27.69 dv | 15.57 dv |
| St. Marks Wilderness Area | 24.68 dv | 14.34 dv |
| Swanquarter Wilderness Area | 23.79 dv | 12.34 dv |
| Wolf Island Wilderness Area | 25.34 dv | 15.23 dv |

### 2.4.2. Pollutant Contributions to Visibility Impairment (2000-2004 Baseline Data)

The 20% most impaired visibility days at Sipsey during the baseline period generally occurred in the period April to September, with sulfate being the largest component. To illustrate this, Figure 2-1 displays the 2000 – 2004 reconstructed extinction for the 20% most impaired days for the Sipsey Wilderness Area. Similar plots for the other VISTAS Class I areas can be found in Appendix C. During the baseline period, the peak visibility impairment days occur in the summer under stagnant weather conditions with high relative humidity, high temperatures, and low wind speeds. The 20% clearest days at Sipsey can occur at any time of year.

[11] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

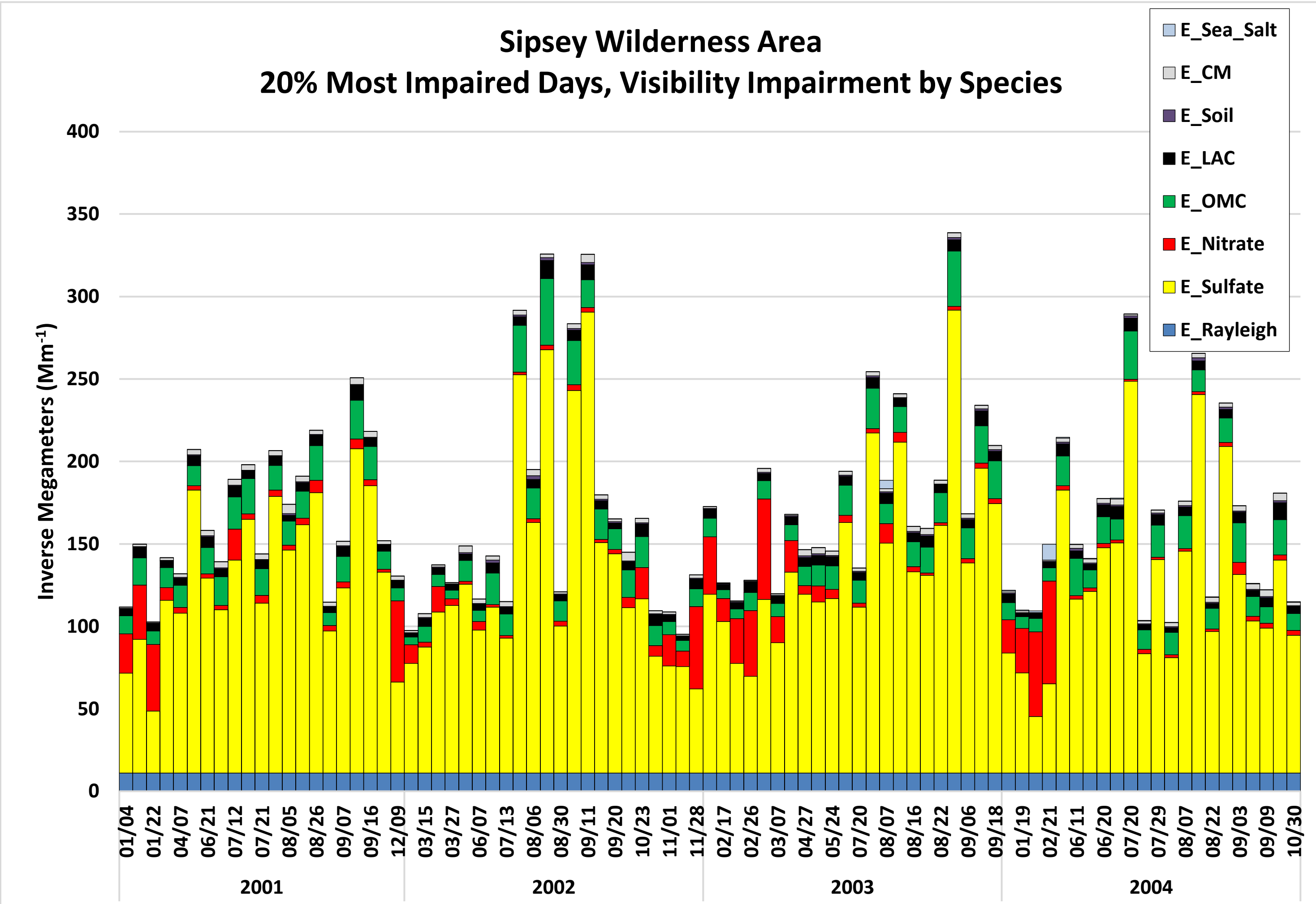



**Figure 2-1: 2000-2004 Reconstructed Extinction for the 20% Most Impaired Days at the Sipsey Wilderness Area**

Figure 2-2 displays the average light extinction for the 20% most impaired days during the baseline period (2000-2004) for each VISTAS Class I area and for nearby Class I areas. Figure 2-3 displays the average light extinction for the 20% clearest during the baseline period (2000-2004) for each VISTAS Class I area and for nearby Class I areas.

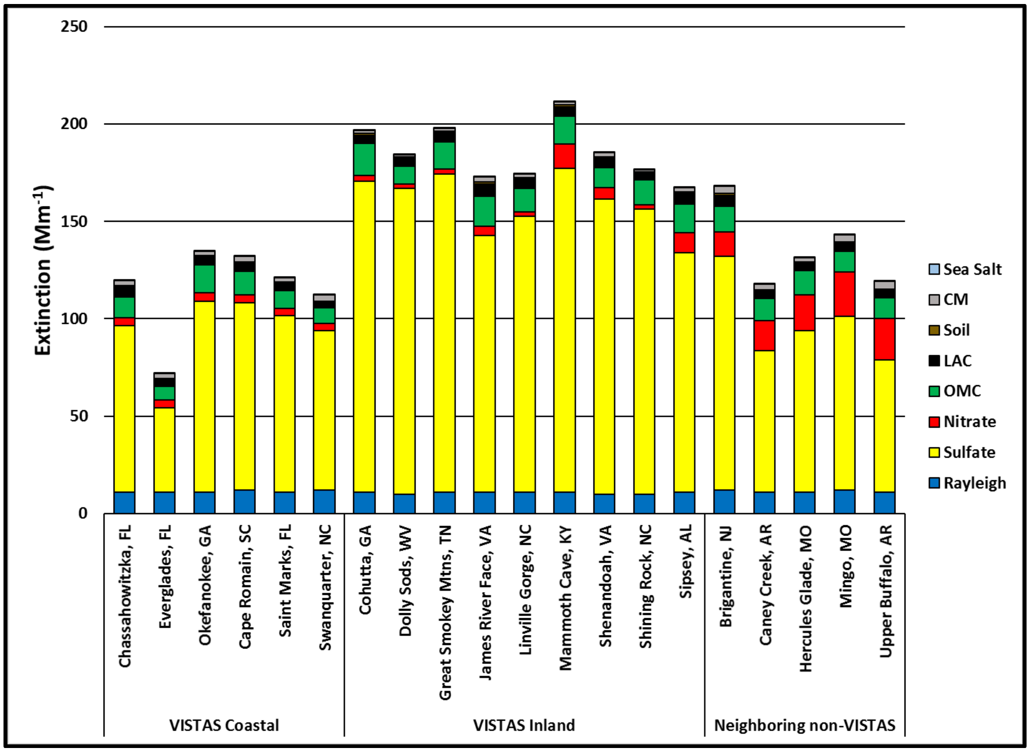



**Figure 2-2: Average Light Extinction, 20% Most Impaired Days, 2000-2004, VISTAS and Neighboring Class I Areas**

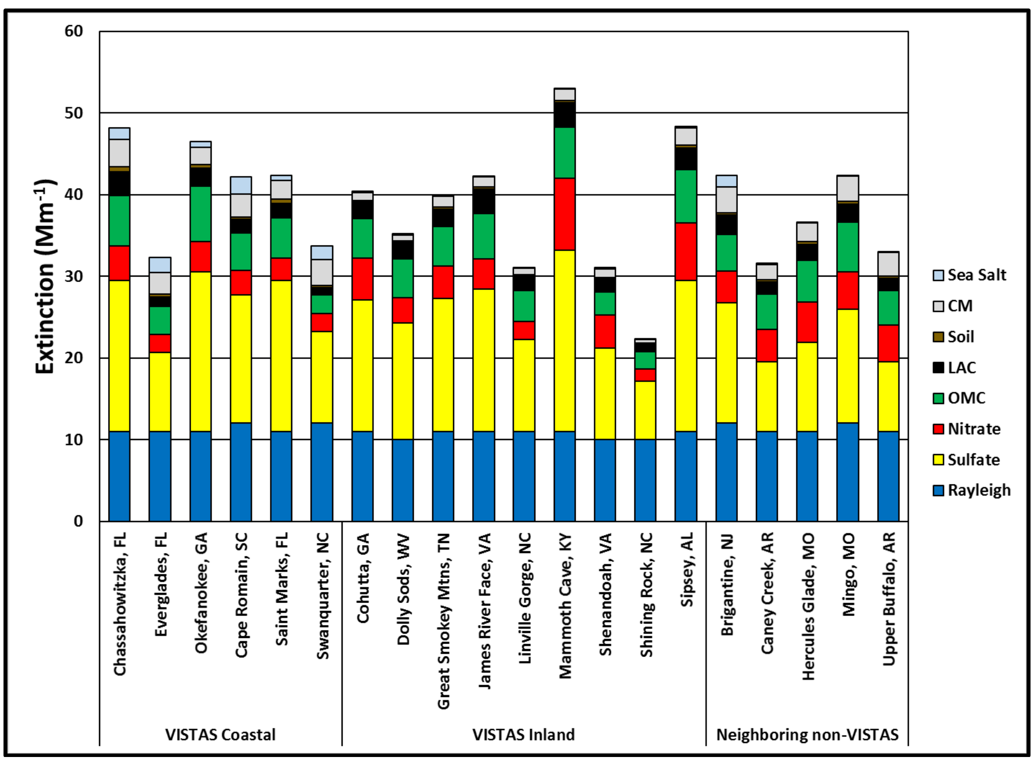



**Figure 2-3: Average Light Extinction, 20% Clearest Days, 2000-2004, VISTAS and Neighboring Class I Areas**

The above bar charts (Figures 2-1 through 2-3) are based on the IMPROVE data file called sia_impairment_daily_budgets_10_18.zip and, therefore, have not been updated with the patching and substitution algorithms described in EPA's June 3, 2020, guidance memorandum entitled, "Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[12] Changes to the daily data from the application of these routines is expected to be slight and will not change the conclusions of this SIP.

Sulfates are the most important contributor to visibility impairment and fine particle mass on the 20% most impaired and 20% clearest visibility days at the Sipsey Wilderness Area during the baseline period. During this period, sulfate levels on the 20% most impaired days accounted for, generally, the vast majority of anthropogenically-driven visibility impairment. Sulfate particles are formed in the atmosphere from $SO_2$ emissions. Sulfate particles occur as hydrogen sulfate, $H_2SO_4$; ammonium bisulfate, $HNH_4SO_4$; and ammonium sulfate, $(NH_4)_2SO_4$, depending on the availability of ammonia, $NH_3$, in the atmosphere.

Across the VISTAS region, sulfate levels are higher at the Southern Appalachian sites than at the coastal sites (Figure 2-2). On the 20% clearest days, sulfate levels are more uniform across the region (Figure 2-3).

Particulate Organic Matter (POM) is represented as organic matter carbon (OMC) in the previous figures. POM is the second most important contributor to fine particle mass and light extinction on the 20% most impaired and the 20% clearest days at Sipsey during the baseline period. Days for which visibility impairment is associated with elevated levels of POM and elemental carbon are associated with natural events such as wildland fires and are largely removed from the 20% most impaired days because they are regarded as natural sources. In the fall, winter, and spring, more of the carbon is attributable to wood burning while in the summer months more of the carbon mass is attributable to biogenic emissions from vegetation.

Ammonium nitrate ($NH_4NO_3$) is formed in the atmosphere by reaction of ammonia ($NH_3$) and $NO_X$. In the VISTAS region, nitrate formation is limited by availability of ammonia and by temperature. Ammonia preferentially reacts with $SO_2$ and sulfate before reacting with $NO_X$. Particle nitrate is formed at lower temperatures; at elevated temperatures nitric acid remains in gaseous form. For this reason, particle nitrate levels are very low in the summer and a minor contributor to visibility impairment during the baseline period of 2000-2004. Particle nitrate concentrations are higher on winter days and are more important for the coastal sites where the 20% most impaired days occur during the winter months.

Elemental Carbon (EC) is shown as light absorbing carbon (LAC) in the figures. EC is a comparatively minor contributor to visibility impairment in the baseline period. Sources include agriculture, prescribed, wildland, and wildfires, and incomplete combustion of fossil fuels. EC levels are often higher at urban monitors than at the Class I areas and suggest controls of primary

[12] URL: https://www.epa.gov/visibility/memo-and-technical-addendum-ambient-data-usage-and-completeness-regional-haze-program

PM at fossil fuel combustion sources would be more effective to reduce $PM_{2.5}$ in urban areas than to improve visibility in Class I areas.

Soil fine particles are minor contributors to visibility impairment at most southeastern sites on most days in the baseline period. Occasional episodes of elevated fine soil can be attributed to Saharan dust episodes, particularly at the Everglades, Florida Class I area, but rarely are seen in other VISTAS Class I areas; these contributions are now largely teased out as natural routine events. Due to its small contribution to anthropogenic visibility impairment in southeastern Class I areas, fine soil control strategies to improve visibility would not be effective.

Sea salt (NaCl) is observed at the coastal sites. During the baseline period, sea salt contributions to visibility impairment are most important on the 20% clearest days when sulfate and POM levels are low. Sea salt levels do not contribute significantly to visibility on the 20% most impaired visibility days. The new IMPROVE equation uses chloride ion, $Cl^-$, from routine IMPROVE measurements to calculate sea salt levels. VISTAS used $Cl^-$ to calculate sea salt contributions to visibility following IMPROVE guidance.

Coarse mass (CM) are particles with diameters between 2.5 and 10 microns. This component has a relatively small contribution to visibility impairment because the light extinction efficiency of coarse mass is very low compared to the extinction efficiency for sulfate, nitrate, and carbon.

Rayleigh scattering is the scattering of sunlight off the molecules of the atmosphere and varies with the elevation of the monitoring site. For VISTAS monitoring sites, this value varies from 10 to 12 $Mm^{-1}$.

## 2.5. Modeling Base Period (2009-2013)

Visibility projections discussed in Sections 5, 6, and 7.2.6.2 use IMPROVE data from 2009-2013 to estimate future year visibility at Class I areas. For each Class I area, estimated anthropogenic impairment observations from each IMPROVE site for the five-year period surrounding the 2011 modeling base year comprise the data representing the modeling base period. The year 2011 was selected as the model base year because the VISTAS 2028 emissions inventory is based on the 2011 Version 6 EPA modeling platform, which at the commencement of the VISTAS second round of planning for regional haze was the most current, complete modeling platform available. For the analyses in this SIP, this period consists of those years surrounding 2011 (i.e., 2009-2013). While not required by the regional haze regulation, examination of these data provides insight into the future year visibility projections for the VISTAS Class I areas.

### 2.5.1. Modeling Base Period (2009-2013) for the 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-4 provides a summary of the conditions for the 20% clearest and 20% most impaired days at VISTAS Class I areas during 2009-2013, the period which was used as the modeling basis for this SIP revision's projection analysis is described in Sections 5, 6, and 7. The baseline light extinction and deciview (dv) index values for the 20% most impaired and 20% clearest days at the

Class I areas are based on data and calculations, and can be found in Appendix E-6. (Task 9a, APP_C_SESARM_2028elv5_URP_20200903.xlsx).

**Table 2-4: Modeling Base Period (2009-2013) Conditions for VISTAS Class I Areas**

| Class I Areas | Average for 20% Most Impaired Days | Average for 20% Clearest Days |
|---|---|---|
| Cape Romain Wilderness Area | 21.48 dv | 13.59 dv |
| Chassahowitzka Wilderness Area | 19.96 dv | 13.76 dv |
| Cohutta Wilderness Area | 21.19 dv | 10.94 dv |
| Dolly Sods Wilderness Area | 21.59 dv | 9.03 dv |
| Everglades National Park | 16.30 dv | 11.23 dv |
| Great Smoky Mountains National Park | 21.39 dv | 10.63 dv |
| James River Face Wilderness Area | 21.37 dv | 11.79 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 21.39 dv | 10.63 dv |
| Linville Gorge Wilderness Area | 20.39 dv | 9.70 dv |
| Mammoth Cave National Park | 24.04 dv | 13.69 dv |
| Okefenokee Wilderness Area | 20.70 dv | 13.34 dv |
| Otter Creek Wilderness Area | 21.59 dv | 9.03 dv |
| Shenandoah National Park | 20.72 dv | 8.60 dv |
| Shining Rock Wilderness Area* | 20.39 dv | 9.70 dv |
| Sipsey Wilderness Area | 21.67 dv | 12.84 dv |
| St. Marks Wilderness Area | 20.11 dv | 13.34 dv |
| Swanquarter Wilderness Area | 19.76 dv | 11.76 dv |
| Wolf Island Wilderness Area | 20.70 dv | 13.34 dv |

* The IMPROVE monitoring data at Shining Rock Wilderness Area is missing complete data for 2010 and 2011. After consultation with North Carolina, a three-year average of 2009, 2012, and 2013 IMPROVE data was used to calculate the visibility (dv) for both the 20% clearest and 20% most impaired days at Shining Rock.

### 2.5.2. Pollutant Contributions to Visibility Impairment (2009-2013 Modeling Base Period Data)

Figure 2-4 shows the 2009 – 2013 reconstructed extinction for the 20% most impaired days for the Sipsey Wilderness Area. Similar plots for the other VISTAS Class I areas can be found in Appendix C. During the modeling base period the peak visibility impairment days continue to occur in the summer, although winter episodes are occurring. On nearly all days, sulfate continues to be the dominant visibility impairing pollutant. Nitrate impacts become more significant on a few of the 20% most impaired days. The figure also shows the improvement in visibility impairment when compared to Figure 2-1. While maximum values in Figure 2-1 are in the range of 300 - 350 $Mm^{-1}$, maximum values in Figure 2-4 are less than 200 $Mm^{-1}$, highlighting the impact of the many control programs implemented during the intervening period.

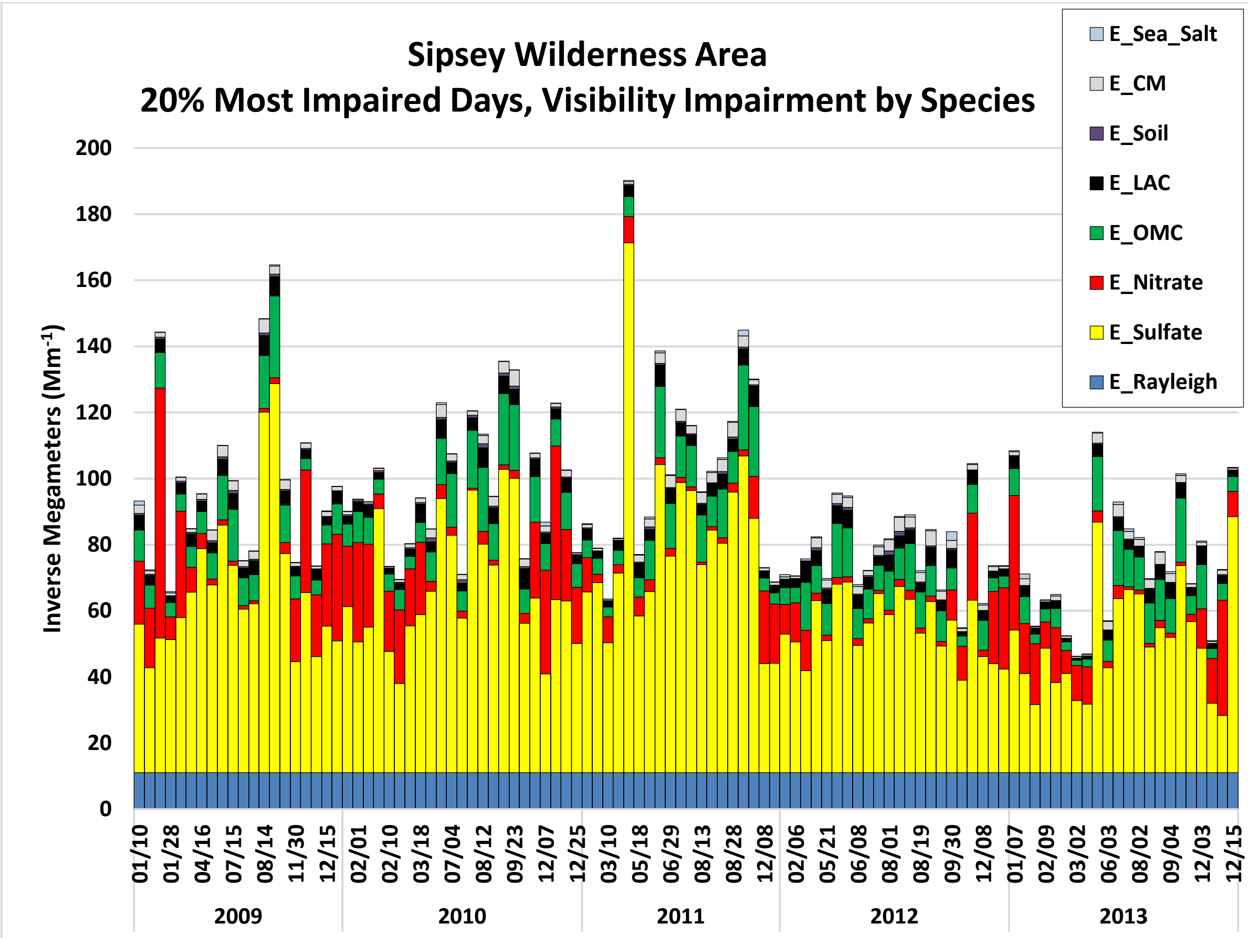



**Figure 2-4: 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at Sipsey**

Figure 2-5 displays the average light extinction for the 20% most impaired days during the modeling base period (2009-2013) for each VISTAS Class I area and for nearby Class I areas. Figure 2-5 shows that for the VISTAS Class I areas, sulfate continues to be the driver for the 20% most impaired days. In all VISTAS Class I areas except Mammoth Cave, organic matter is the second leading cause of visibility impairment on average during 20% most impaired days. In neighboring Class I areas and at Mammoth Cave, nitrate is the second leading cause of visibility impairment on average 20% most impaired days.

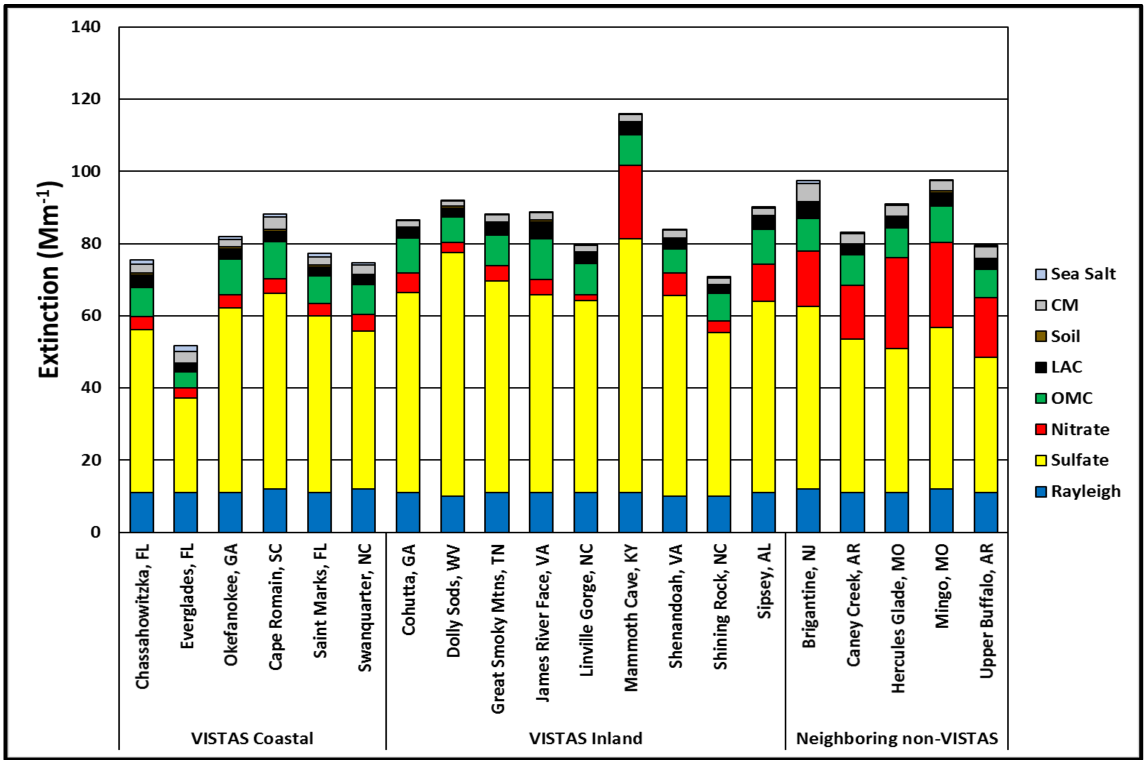



**Figure 2-5: Average Light Extinction, 20% Most Impaired Days, 2009-2013, VISTAS and Neighboring Class I Areas**

Figure 2-6 displays the average light extinction for the 20% clearest days during the modeling base period (2009-2013) for each VISTAS Class I area and for nearby Class I areas. On the 20% clearest days, sulfate continues to be the main component of visibility impairing pollution for VISTAS and nearby Class I areas. Comparison to Figure 2-3 shows that no degradation of visibility occurs between the 2000-2004 and 2009-2013 data sets, and in most cases improvement on 20% clearest days occurs.

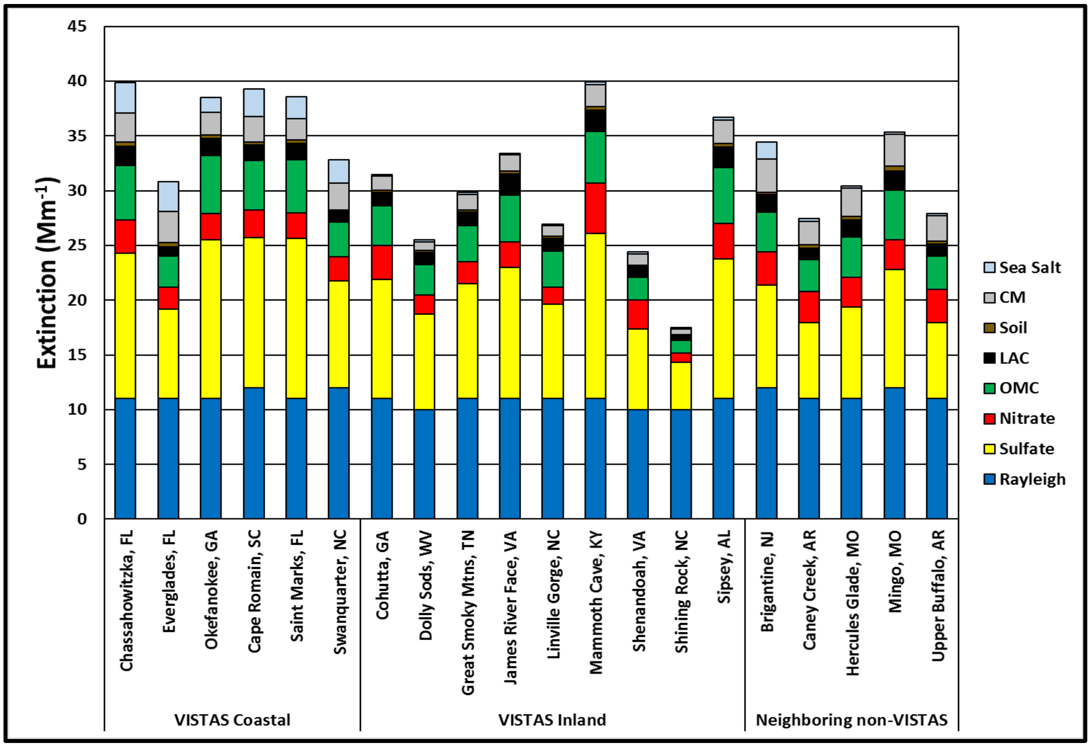



**Figure 2-6: Average Light Extinction, 20% Clearest Days, 2009-2013, VISTAS and Neighboring Class I Areas**

These bar charts (Figure 2-4 through 2-6) are based on the IMPROVE data file sia_impairment_daily_budgets_10_18.zip and therefore have not been updated with the patching and substitution algorithms described in EPA's 2020 guidance memo. Changes to the daily data from the application of these routines is expected to be slight and will not change the conclusions of this SIP.

## 2.6. Current Conditions

The current visibility estimates are comprised of measurements from the five-year period between 2014 and 2018, inclusive.

### 2.6.1. Current Conditions (2014-2018) for 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-5 provides a summary of the current conditions (2014-2018) for the 20% clearest and 20% most impaired days at the VISTAS Class I areas. These data reflect values included in Table 1 on the EPA memorandum titled: Technical addendum including updated visibility data through 2018 for the memo, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[13]

[13] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

**Table 2-5: Current Conditions (2014-2018) for VISTAS Class I Areas**

| Class I Areas | Average for 20% Most Impaired Days | Average for 20% Clearest Days |
|---|---|---|
| Cape Romain Wilderness Area | 17.67 dv | 11.80 dv |
| Chassahowitzka Wilderness Area | 17.41 dv | 12.41 dv |
| Cohutta Wilderness Area | 17.37 dv | 8.10 dv |
| Dolly Sods Wilderness Area | 17.65 dv | 6.68 dv |
| Everglades National Park | 14.90 dv | 10.37 dv |
| Great Smoky Mountains National Park | 17.21 dv | 8.35 dv |
| James River Face Wilderness Area | 17.89 dv | 9.47 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 17.21 dv | 8.35 dv |
| Linville Gorge Wilderness Area | 16.42 dv | 7.61 dv |
| Mammoth Cave National Park | 21.02 dv | 11.31 dv |
| Okefenokee Wilderness Area | 17.39 dv | 11.57 dv |
| Otter Creek Wilderness Area | 17.65 dv | 6.68 dv |
| Shenandoah National Park | 17.07 dv | 6.85 dv |
| Shining Rock Wilderness Area* | 15.49 dv | 4.40 dv |
| Sipsey Wilderness Area | 19.03 dv | 10.75 dv |
| St. Marks Wilderness Area | 17.39 dv | 11.15 dv |
| Swanquarter Wilderness Area | 16.30 dv | 10.61 dv |
| Wolf Island Wilderness Area | 17.39 dv | 11.57 dv |

### 2.6.2. Pollutant Contributions to Visibility Impairment (2014-2018 Current Data)

Figure 2-7 below displays the 2014-2018 reconstructed extinction for the 20% most impaired days for the Sipsey Wilderness Area. Similar plots for the other VISTAS Class I areas can be found in Appendix C. For the VISTAS region and neighboring Class I areas, Figure 2-8 and 2-9 show light extinction averaged from 2014-2018 IMPROVE data for the 20% most impaired and clearest days, respectively. The bar charts (Figure 2-7 through Figure 2-9) are based on the IMPROVE data file "sia_impairment_daily_budgets_10_18.zip" for data through 2017. For the 2018 data, the IMPROVE data file "sia_impairment_daily_budgets_4_20_2.zip" was used. The data through 2017 have not been updated with the patching and substitution algorithms described in EPA's 2020 guidance memo. Changes to the daily data from the application of these routines are expected to be slight and will not change the conclusions of this SIP.

These figures continue to demonstrate improved visibility when compared to the 2009-2013 data or the 2000-2004 data. Emissions of $SO_2$ and other visibility impairing pollutants are reducing, as discussed in Section 7 and, as a result, these reductions are resulting in better visibility.

Figure 2-8 presents the average data for the 20% most impaired days and shows that, on average, sulfate continues to be the predominant visibility impairing pollutant. However, the data in Figure 2-7 shows that nitrate can play a larger role, generally, during the winter months.

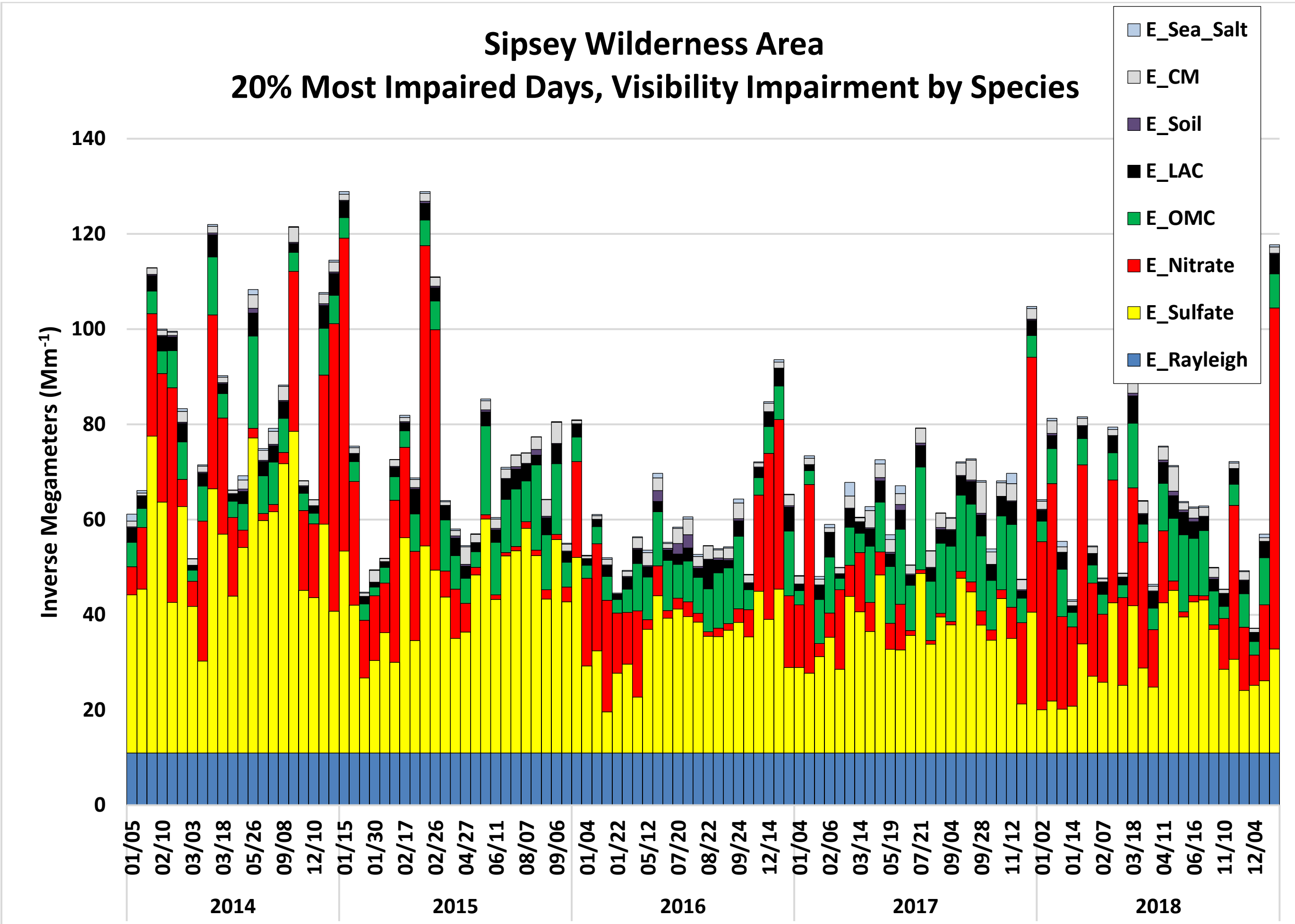



**Figure 2-7: 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at Sipsey**

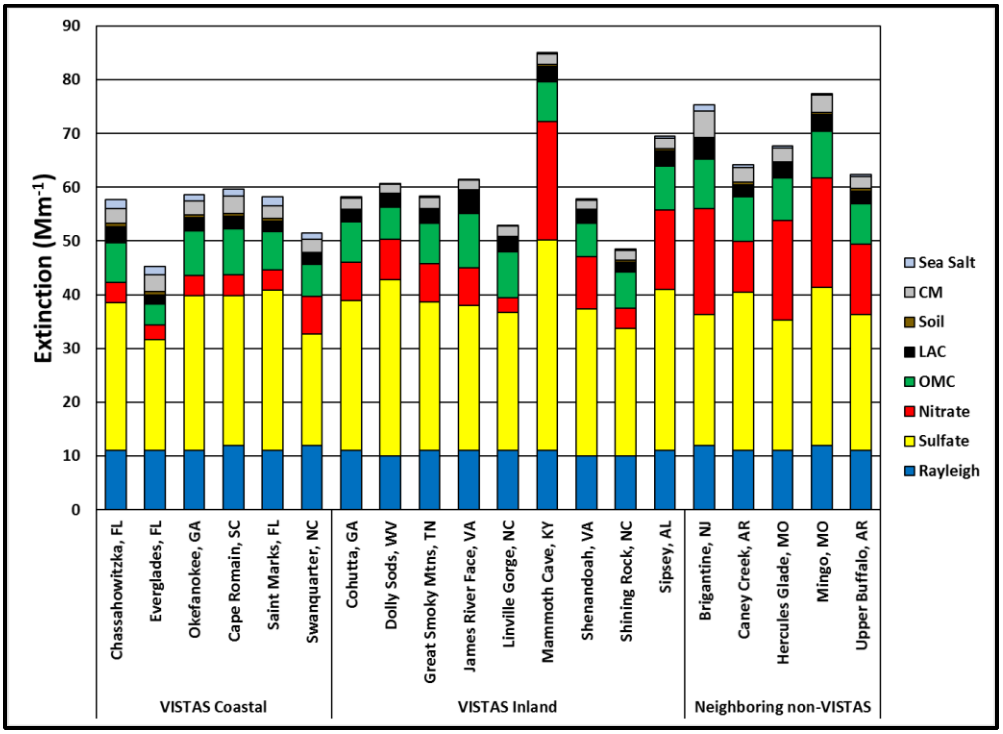



**Figure 2-8: Average Light Extinction, 20% Most Impaired Days, 2014-2018, VISTAS and Neighboring Class I Areas**

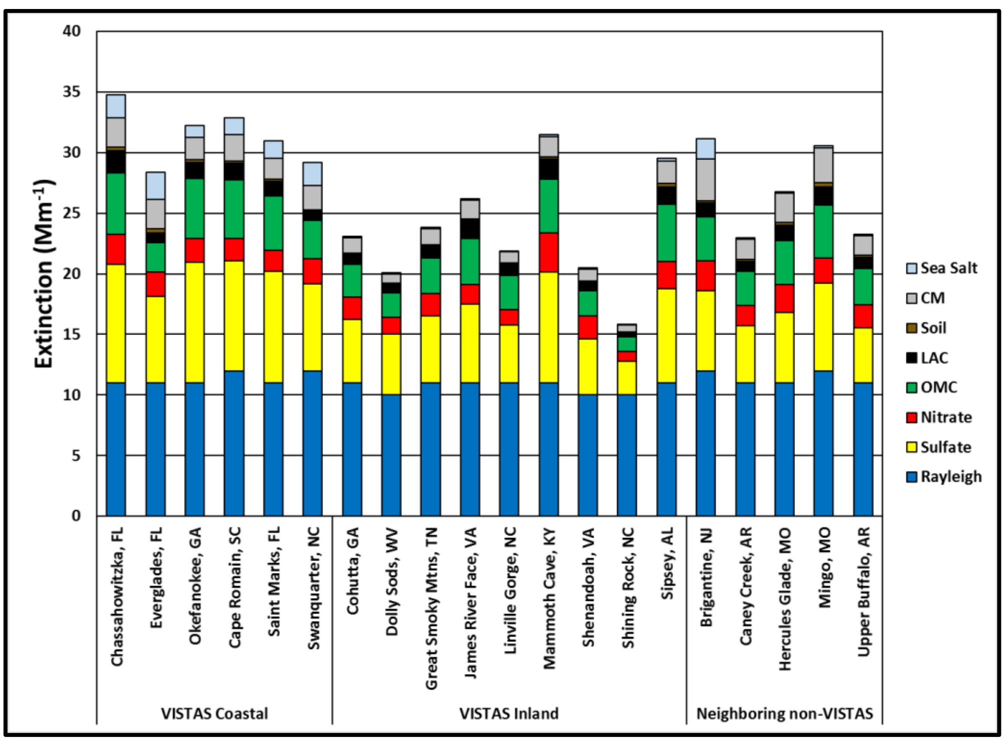



**Figure 2-9: Average Light Extinction, 20% Clearest Days, 2014-2018, VISTAS and Neighboring Class I Areas**

## 2.7. Comparisons of Baseline, Current, and Natural Background Visibility

The Regional Haze Rule requires that SIPs include an evaluation of progress made since the baseline period toward improving visibility on the 20% most impaired days and 20% clearest days for each state's Class I areas (40 CFR 51.308(f)(1)(iv)). The Rule also requires that the SIP identify the deciview value by which the current visibility condition exceeds the natural visibility condition, for each state's Class I areas, on the 20% most impaired days and the 20% clearest days (40 CFR 51.308(f)(1)(v)). Table 2-6 summarizes this data for each Class I area located in VISTAS for the 20% most impaired days. On the 20% most impaired days, data for current conditions shows that significant progress has been made as compared to baseline conditions. In many cases the improvement in visibility from baseline conditions demonstrated by the 2014-2018 visibility data is more than half of the improvement needed to achieve natural conditions.

**Table 2-6: Comparison of Baseline, Current, and Natural Conditions for 20% Most Impaired Days**

| Class I Areas | 2000-2004 Baseline Conditions | 2014-2018 Current Conditions | Change in Visibility, Baseline to Current | Natural Background Conditions | Difference Between Current Conditions and Natural Background |
|---|---|---|---|---|---|
| Cape Romain Wilderness Area | 25.25 dv | 17.67 dv | 7.58 dv | 9.79 dv | 7.88 dv |
| Chassahowitzka Wilderness Area | 24.52 dv | 17.41 dv | 7.11 dv | 9.03 dv | 8.38 dv |
| Cohutta Wilderness Area | 29.12 dv | 17.37 dv | 11.75 dv | 9.88 dv | 7.49 dv |
| Dolly Sods Wilderness Area | 28.29 dv | 17.65 dv | 10.64 dv | 8.92 dv | 8.73 dv |
| Everglades National Park | 19.52 dv | 14.90 dv | 4.62 dv | 8.33 dv | 6.57 dv |
| Great Smoky Mountains National Park | 29.11 dv | 17.21 dv | 11.90 dv | 10.05 dv | 7.16 dv |
| James River Face Wilderness Area | 28.08 dv | 17.89 dv | 10.19 dv | 9.47 dv | 8.42 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 29.11 dv | 17.21 dv | 11.90 dv | 10.05 dv | 7.16 dv |
| Linville Gorge Wilderness Area | 28.05 dv | 16.42 dv | 11.63 dv | 9.70 dv | 6.72 dv |
| Mammoth Cave National Park | 29.83 dv | 21.02 dv | 8.81 dv | 9.80 dv | 11.22 dv |
| Okefenokee Wilderness Area | 25.34 dv | 17.39 dv | 7.95 dv | 9.45 dv | 7.94 dv |
| Otter Creek Wilderness Area | 28.29 dv | 17.65 dv | 10.64 dv | 8.92 dv | 8.73 dv |
| Shenandoah National Park | 28.32 dv | 17.07 dv | 11.25 dv | 9.52 dv | 7.55 dv |
| Shining Rock Wilderness Area | 28.13 dv | 15.49 dv | 12.64 dv | 10.25 dv | 5.24 dv |
| Sipsey Wilderness Area | 27.69 dv | 19.03 dv | 8.66 dv | 9.62 dv | 9.41 dv |
| St. Marks Wilderness Area | 24.68 dv | 17.39 dv | 7.29 dv | 9.13 dv | 8.26 dv |
| Swanquarter Wilderness Area | 23.79 dv | 16.30 dv | 7.49 dv | 10.01 dv | 6.29 dv |
| Wolf Island Wilderness Area | 25.34 dv | 17.39 dv | 7.95 dv | 9.45 dv | 7.94 dv |

Table 2-7 summarizes this data for each Class I area located in VISTAS for the 20% clearest days. On the 20% clearest days, data for current conditions show that visibility on these days has improved from the baseline conditions for all VISTAS Class I areas.

**Table 2-7: Comparison of Baseline, Current, and Natural Conditions for 20% Clearest Days**

| Class I Areas | 2000-2004 Baseline Conditions | 2014-2018 Current Conditions | Change in Visibility, Baseline to Current | Natural Background Conditions | Difference Between Current Conditions and Natural Background |
|---|---|---|---|---|---|
| Cape Romain Wilderness Area | 14.29 dv | 11.801 dv | 2.49 dv | 5.93 dv | 5.87 dv |
| Chassahowitzka Wilderness Area | 15.60 dv | 12.41 dv | 3.19 dv | 6.00 dv | 6.41 dv |
| Cohutta Wilderness Area | 13.73 dv | 8.10 dv | 5.63 dv | 4.42 dv | 3.68 dv |
| Dolly Sods Wilderness Area | 12.28 dv | 6.68 dv | 5.60 dv | 3.64 dv | 3.04 dv |
| Everglades National Park | 11.69 dv | 10.37 dv | 1.32 dv | 5.22 dv | 5.15 dv |
| Great Smoky Mountains National Park | 13.58 dv | 8.35 dv | 5.23 dv | 4.62 dv | 3.73 dv |
| James River Face Wilderness Area | 14.21 dv | 9.47 dv | 4.74 dv | 4.39 dv | 5.08 dv |
| Joyce Kilmer-Slickrock Wilderness Area | 13.58 dv | 8.35 dv | 5.23 dv | 4.62 dv | 3.73 dv |
| Linville Gorge Wilderness Area | 11.11 dv | 7.61 dv | 3.50 dv | 4.07 dv | 3.54 dv |
| Mammoth Cave National Park | 16.51 dv | 11.31 dv | 5.20 dv | 5.00 dv | 6.31 dv |
| Okefenokee Wilderness Area | 15.23 dv | 11.57 dv | 3.66 dv | 5.43 dv | 6.14 dv |
| Otter Creek Wilderness Area | 12.28 dv | 6.68 dv | 5.60 dv | 3.64 dv | 3.04 dv |
| Shenandoah National Park | 10.96 dv | 6.85 dv | 4.11 dv | 3.15 dv | 3.70 dv |
| Shining Rock Wilderness Area | 7.70 dv | 4.40 dv | 3.30 dv | 2.49 dv | 1.91 dv |
| Sipsey Wilderness Area | 15.57 dv | 10.75 dv | 4.81 dv | 5.03 dv | 5.73 dv |
| St. Marks Wilderness Area | 14.34 dv | 11.15 dv | 3.19 dv | 5.37 dv | 5.78 dv |
| Swanquarter Wilderness Area | 12.34 dv | 10.61 dv | 1.73 dv | 5.71 dv | 4.90 dv |
| Wolf Island Wilderness Area | 15.23 dv | 11.57 dv | 3.66 dv | 5.43 dv | 6.14 dv |

# 3. Glide Paths to Natural Conditions in 2064

In accordance with 40 CFR 51.308(f)(1)(vi)(A), each state must calculate a uniform rate of progress (URP), also known as a "glide path," for each mandatory Federal Class I area located within that state. Starting with the baseline period of 2000-2004, states must analyze and determine the consistent rate of progress over time. States must also compare the baseline visibility conditions (2000-2004) for the most impaired days to the natural visibility conditions for the most impaired days to determine the uniform rate of visibility improvement needed to attain the natural visibility conditions by the end of 2064.

Glide paths were developed for each mandatory Federal Class I area in the VISTAS region. The glide paths were developed in accordance with EPA's guidance for tracking progress[14] and used data collected from the IMPROVE monitoring sites as described in Section 2 of this document. Glide paths are one of the indicators used in setting Reasonable Progress Goals (RPGs).

Figure 3-1 shows the glide path for the 20% most impaired days for Sipsey Wilderness Area assuming a uniform rate of progress toward natural conditions. Natural background visibility for the most impaired days at Sipsey is calculated to be 9.62 dv.

The data in Figure 3-1 is derived from Table 1 in EPA memorandum titled: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[15]

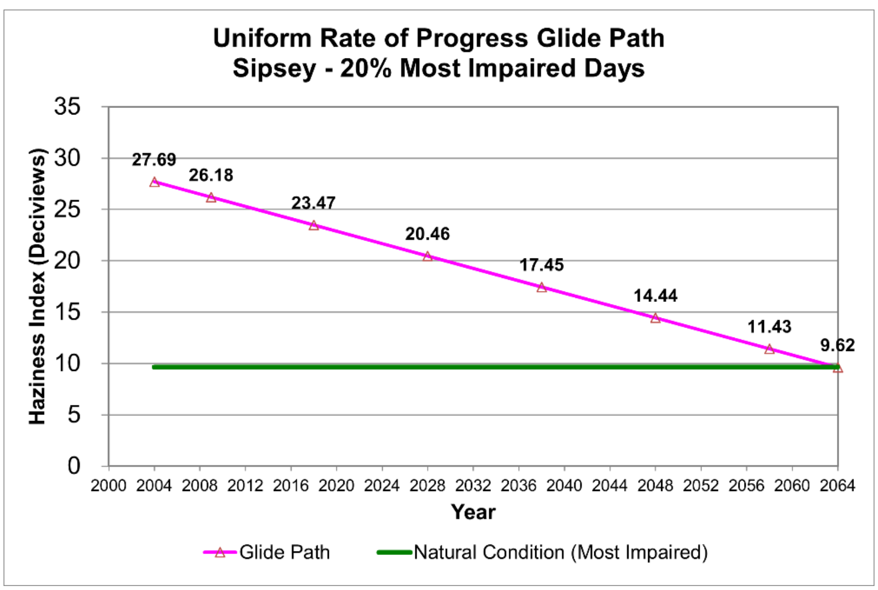



**Figure 3-1: Uniform Rate of Progress Glide Path for 20% Most Impaired Days at Sipsey Wilderness Area**

[14] URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf
[15] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

# 4. Types of Emissions Impacting Visibility Impairment at Sipsey

## 4.1. Baseline Emissions Inventory

The Regional Haze Rule at 51.308(f)(6)(v) requires a statewide emissions inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Federal Class I area. The inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions. Alabama complies with the Air Emission Reporting Requirements (AERR) to submit triannual (and some annual data) inventories to EPA. Section 13.5.1 shows National Emission Inventory (NEI) data for 2014 and 2017 and Clean Air Markets Division (CAMD) data for 2018 and 2019. The same Rule provision also requires states to commit to update the inventory periodically, which Alabama commits to do. This section describes how the projected emissions inventory for 2028 was developed, and Section 7.2.4 shows the 2028 projected emissions data. For the inventory, VISTAS used a baseline year of 2011 and projected future year of 2028. The emission inventories included carbon monoxide[16] (CO), volatile organic compounds (VOCs), NOx, $PM_{2.5}$, coarse particulate matter ($PM_{10}$), $NH_3$, and $SO_2$.

VISTAS contracted with ERG to perform emission inventory work as part of the air quality modeling analysis. ERG was directed by VISTAS to use EPA's 2011el-based air quality modeling platform, which includes emissions, meteorology, and other inputs for 2011, as the base year for the modeling described in EPA's TSD entitled "Documentation for the EPA's Preliminary 2028 Regional Haze Modeling."[17] EPA has projected the 2011 base year emissions[18] to a 2028 future year base case scenario. These data were the foundation of the revised emissions used for this analysis. The 2011 modeling platform and projected 2028 emissions were used to drive the 2011 base year and 2028 base case air quality model simulations. As noted in EPA's TSD, the 2011 base year emissions and methods for projecting these emissions to 2028 are in large part similar to the data and methods used by EPA in the final Cross-State Air Pollution Rule (CSAPR) Update[19] and the subsequent notice of data availability (NODA)[20] to support ozone transport for the 2015 ozone NAAQS. Appendix B-1a and Appendix B-2a contain complete reports from ERG detailing the emission inventory work.

There are six different emission inventory source classifications: stationary point sources, nonpoint (formerly called "stationary area") sources, non-road and onroad mobile sources, biogenic sources, and point fires.[21] Stationary point sources are those sources that emit greater than a specified tonnage per year, with data provided at the facility level. Electric generating utilities and industrial sources are the major categories for stationary point sources. Nonpoint sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source category could be significant (e.g., dry cleaners, service

[16] CO is not a visibility impairing pollutant, and thus, CO data was not evaluated for this regional haze plan.
[17] EPA OAQPS, *Documentation for the EPA's Preliminary 2028 Regional Haze Modeling,* October 2017.
[18] URL: https://www.epa.gov/air-emissions-modeling/2011-version-63-technical-support-document
[19] URL: https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update
[20] URL: https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone
[21] Note that prescribed fires and wildfires are designated events in the National Emissions Inventory.

stations, combustion of fuels for heating, and agricultural sources). These types of emissions are estimated on a countywide level. Non-road mobile sources are equipment that can move but do not use the roadways (e.g., lawn mowers, construction equipment, and railroad locomotives). The emissions from these sources, like nonpoint sources, are estimated on a countywide level. Onroad mobile sources include passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses that are normally operated on public roadways. The emissions from these sources are estimated by vehicle type and road type and are summed to the countywide level. Biogenic sources are the natural sources of emissions like trees, crops, grasses, and natural decay of plants. The emissions from these sources are estimated on a countywide level. The point fire sector includes both prescribed fires and wildfires.

### 4.1.1. Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate, and their emissions are inventoried on a regular schedule. Large sources emitting at least 100 tons per year (tpy) of a criteria pollutant are inventoried every three years. The largest sources are inventoried annually. Some state and local agencies conduct emission inventories more frequently, use lower thresholds, and include HAPs. Smaller sources have been inventoried less frequently. The point source emissions data can be grouped as electricity generating unit (EGU) sources and other industrial point sources, also called non-EGUs. Airport-related sources, including aircraft, airport ground support equipment, and jet refueling, are also part of the point source sector. In previous modeling platforms, airport-related sources were included in the non-road sector.

#### 4.1.1.1. Electricity Generating Units

The electricity generation unit (EGU) sector contains emissions from EGUs in the 2011 NEI v2 point inventory that could be matched to units found in the National Electric Energy Database System (NEEDS) v5.15. In most cases, the base year 2011 inventory for the EGU sources used 2011 continuous emissions monitoring (CEM) data reported to the EPA's Clean Air Markets Division (CAMD). These data provide hourly emissions profiles for $SO_2$ and $NO_X$ that can be used in air quality modeling. Emissions profiles are used to estimate emissions of other pollutants (VOCs, CO, $NH_3$, $PM_{2.5}$) based on measured emissions of $SO_2$ and $NO_X$. The NEEDS database of units includes many smaller emitting EGUs that are not included in the CAMD hourly CEMS programs. Thus, there are more units in the NEEDS database than have CEMS data. Emissions from EGUs vary daily and seasonally as a function of variability in energy demand, utilization, and outage schedules. The temporalization of EGU units is matched to CEMS data based on the base year CEMS data for those units, whereas regional profiles are used for the remaining units.

For projected year 2028 EGU point sources, the VISTAS states considered the EPA 2028el, the EPA 2023en, or 2028 emissions from the Eastern Regional Technical Advisory Committee (ERTAC) EGU projection tool from the most recent CONUS 2.7 run. The EPA 2028el emissions inventory for EGUs were created by the Integrated Planning Model (IPM) version 5.16. This scenario represents the implementation of the Cross-State Air Pollution Rule (CSAPR) Update, CSAPR, Mercury and Air Toxics Standards (MATS), Clean Power Plan (CPP) and the final actions EPA has taken to implement the Regional Haze Rule, the Cooling Water Intakes Rule, and

Combustion Residuals from Electric Utilities (CCR). The CPP was later vacated. Impacts of the CPP assumed that coal-fired EGUs would be shut down and be replaced by natural gas-fired EGUs. Thus, EPA 2028el projected emissions for EGU emissions may not be reflective of probable emissions for 2028. The ERTAC EGU emissions did not consider the impacts of the CPP. After evaluating the different projection options, each VISTAS state determined the estimated emissions for each EGU for the projected year 2028. Appendix B contains a summary of the action items provided by each VISTAS state in preparing the 2028 EGU emissions inventory. For non-VISTAS states, EPA 2028el EGU emissions were replaced with the 2028 ERTAC 2.7 EGU emissions. Alabama used a combination of ERTAC, 2011el, 2023en, and 2028el data for projected 2028 EGU emissions.

#### 4.1.1.2. Other Industrial Point Sources and Airport-Related Sources

The non-EGU sector uses annual emissions contained in the 2011 NEIv2. These emissions are temporally allocated to month, day, and hour using source category code (SCC)-based allocation factors. The Control Strategy Tool (CoST) was used to apply most non-EGU projection/growth factors, controls, and facility/unit/stack-level closures to the 2011 NEI-based emissions modeling inventories to create a future year inventory for 2028. Similar to the EGU sector, each state was able to make adjustments to the 2028 non-EGU inventory based on their knowledge of each facility. Airport-related source emissions for the base year 2011 were developed from the 2011 NEIv2. Aircraft emissions for 2011 are projected to future year 2028 by applying activity growth using data on itinerant operations at airports. The itinerant operations are defined as aircraft take-offs or aircraft landings. EPA used projected itinerate information available from the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System.

### 4.1.2. Nonpoint Sources

Nonpoint sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source category could be significant (e.g., dry cleaners, service stations, combustion of fuels for heating, and agricultural sources). Emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel usage, number of households, or population. Nonpoint source emissions are estimated at the countywide level. The base year 2011 nonpoint source inventory was developed from the 2011NEIv2. The control strategy tool (CoST) was used to apply most nonpoint projection/growth factors, controls and facility/unit/stack-level closures to the 2011 NEI-based emissions modeling inventories to create a future year inventory for 2028.

### 4.1.3. Non-Road Mobile Sources

Non-road mobile sources are equipment that can move but do not use the roadways, such as construction equipment, railroad locomotives, commercial marine vessels, and lawn equipment. The emissions from these sources, like nonpoint sources, were estimated at the county level. For the majority of the non-road mobile sources, the emissions for 2011 were estimated using the EPA's National Mobile Inventory Model (NMIM, 2005). For the two source categories not included in the NMIM, i.e., railroad locomotives and commercial marine, more traditional methods of estimating the emissions were used.

For the source categories estimated using the EPA's NMIM model, the model growth assumptions were used to create the 2028 future year inventory. The NMIM model takes into consideration regulations affecting emissions from these source categories. The 2028 future-year commercial marine vessels and railroad locomotives emissions account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections for freight and emissions reductions resulting from emissions standards from the Final Locomotive-Marine rule.

#### 4.1.4. Onroad Mobile Sources

Onroad mobile sources include passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses that are normally operated on public roadways. For onroad vehicles, the Motor Vehicle Emissions Simulator (MOVES) model (MOVES2014a) was used to develop base year 2011 emissions. Key inputs for MOVES include information on the age of vehicles on the roads, vehicle miles traveled, the average speeds on the roads, the mix of vehicles on the roads, any programs in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. The MOVES model takes into consideration regulations that affect emissions from this source sector. The MOVES model was run for 2028 inventory using input data reflective of that year.

#### 4.1.5. Biogenic Sources

Biogenic sources are natural sources of emissions like trees, crops, grasses, and natural decay of plants. The emissions from these sources are estimated at the county level. Biogenic emissions for 2011 were developed using the Biogenic Emission Inventory System version 3.61 (BEIS3.61) within the Sparse Matrix Operator Kernel Emissions (SMOKE). BEIS3.61 creates gridded, hourly, model-species emissions from vegetation and soil. BEIS3.61 includes the incorporation of version 4.1 of the Biogenic Emissions Land use Database (BELD4) and the incorporation of a canopy model to estimate leaf-level temperatures. BELD version 4.1 is based on an updated version of the USDA-United States Forest Service (USFS) Forest Inventory and Analysis (FIA) vegetation speciation-based data from 2001 to 2014 in the FIA version 5.1. Canopy coverage is based on the Landsat satellite National Land Cover Database (NLCD) product from 2011. The 2011 biogenic emissions are used for the 2028 future year without any changes.

#### 4.1.6. Point Fires

The point fires sector includes emissions from both prescribed fires and wildfires. The point fire sector excludes agricultural burning and other open burning sources that are included in the nonpoint sector. Fire emissions are specified at geographic coordinates (point locations) and have daily emissions values. Emissions are day-specific and include satellite-derived latitude/longitude of the fire's origin and other parameters associated with the emissions such as acres burned and fuel load, which allow estimation of plume rise.

Fire emissions for the base year 2011 were taken from the 2011NEIv2. The point source day-specific emission estimates for 2011 fires rely on SMARTFIRE 2, which uses the National Oceanic and Atmospheric Administration's (NOAA's) Hazard Mapping System (HMS) fire location information as input. Additional inputs include the CONSUMEv3.0 software application and the

Fuel Characteristic Classification System (FCCS) fuel-loading database to estimate fire emissions from wildfires and prescribed burns on a daily basis. SMARTFIRE2 estimates were used directly for all states except Georgia and Florida.

#### 4.1.7. Summary 2011 Baseline Emissions Inventory for Alabama

Table 4-1 contains a summary of the 2011 baseline emission inventory for Alabama. The complete inventory and discussion of the methodology is contained in Appendix B. It should be noted that the emissions in Table 4-1 may be different than those in the 2011 National Emissions Inventory version 2 (NEIv2) because the "afdust" sector emissions for air quality modeling are adjusted downward to account for the effects of precipitation and the emissions that are transported by physical forces (e.g., wind, vehicle traffic). The emissions summaries for other VISTAS states can also be found in Appendix B.

**Table 4-1: 2011 Emissions Inventory Summary for Alabama (tpy)**

| Sector | CO | $NH_3$ | $NO_X$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
|---|---|---|---|---|---|---|---|
| EGU | 12,888 | 556 | 64,008 | 8,026 | 5,591 | 186,219 | 1,163 |
| Non-EGU Point | 68,197 | 1,937 | 59,791 | 19,981 | 16,418 | 59,672 | 25,594 |
| Nonpoint* | 127,779 | 61,118 | 45,871 | 433,089 | 88,576 | 25,048 | 90,646 |
| Onroad | 701,397 | 2,724 | 152,732 | 8,001 | 4,611 | 683 | 75,523 |
| Non-Road | 245,942 | 32 | 22,869 | 2,464 | 2,336 | 65 | 41,818 |
| Point-Fires | 666,279 | 11,041 | 14,551 | 72,656 | 61,573 | 6,677 | 158,720 |
| **Total** | **1,822,482** | **77,408** | **359,822** | **544,217** | **179,105** | **278,364** | **393,464** |

***Biogenic emissions were not included in the nonpoint category**

#### 4.1.8. Emissions Inventory Improvements Prior to Remodeling 2028 Future Year

The VISTAS initial emission inventory was completed in June 2018, and the VISTAS initial modeling for the future year 2028 was completed in October 2019. VISTAS compared the VISTAS emission inventory information to EPA's most recent modeling inventory, which was released in September 2019. EPA used a base year of 2016 and a future year of 2028. One main difference between the VISTAS and EPA modeling is that VISTAS used a base year of 2011 while EPA used a base year of 2016. This is an important difference since the future year 2028 emissions are generally projected from the base year. VISTAS noted large differences in $SO_2$ and $NO_X$ between the 2028 runs, with EPA emissions being much lower. One reason for this difference was that VISTAS initial modeling used an older version of ERTAC, which did not account for many coal-fired EGU retirements and fuel switches. Table 4-2 below compares the 2028 point emissions used by VISTAS versus the latest 2028fh[22] emissions used by EPA (projected from 2016). The emissions in Table 4-2 are extracted from the VISTAS12 modeling domain, which covers the eastern U.S. As shown in Table 4-2, EPA's $SO_2$ emissions are 45.61% lower than VISTAS' estimates, and EPA's NOx emissions are 20.19% lower than VISTAS' estimates.

[22] The "f" represents the base year emissions modeling platform iteration, which shows that it is 2014 NEI based (whereas for 2011 NEI-based platforms, this letter was "e"); and the "h" stands for the eighth configuration of emissions modeling for a 2014-NEI based modeling platform).

Table 4-2: VISTAS 2028 versus New EPA 2028

| Pollutant | VISTAS 2028 (tpy) | New EPA 2028 (tpy) | Difference (tpy) | Difference (%) |
|---|---|---|---|---|
| $NO_X$ | 2,641,463.83 | 2,108,115.50 | 533,348.33 | 20.19% |
| $SO_2$ | 2,574,542.02 | 1,400,287.10 | 1,174,254.92 | 45.61% |

The two tables below compare the $SO_2$ and $NO_X$ emissions for the older version of ERTAC (2.7opt) and the newer version of ERTAC (16.0), with the newer version of ERTAC having much lower emissions. The older version of ERTAC was used in the VISTAS modeling in the non-VISTAS states. As explained in Section 4.1.1 above, each VISTAS state determined the estimated emissions for each EGU in their state for the projected year 2028.

Table 4-3: $SO_2$ Old ERTAC (2.7opt) versus $SO_2$ New ERTAC (16.0)

| RPO | 16.0 2028 (tpy) | 2.7opt 2028 (tpy) | Difference (tpy) | Difference (%) |
|---|---|---|---|---|
| CENSARA | 367,683.7 | 760,828.2 | -393,144.5 | -51.67% |
| LADCO | 266,047.0 | 379,577.5 | -113,530.5 | -29.91% |
| MANE-VU | 78,657.0 | 196,672.6 | -118,015.6 | -60.01% |
| VISTAS | 161,502.5 | 273,582.1 | -112,079.6 | -40.97% |
| **Total** | **976,471.2** | **1,783,376.5** | **-806,905.3** | **-45.25%** |

Table 4-4: $NO_X$ Old ERTAC (2.7opt) versus $NO_X$ New ERTAC (16.0)

| RPO | 16.0 2028 (tpy) | 2.7opt 2028 (tpy) | Difference (tpy) | Difference (%) |
|---|---|---|---|---|
| CENSARA | 244,499.3 | 354,795.1 | -110,295.8 | -31.09% |
| LADCO | 166,429.4 | 198,966.9 | -32,537.4 | -16.35% |
| MANE-VU | 56,315.3 | 83,432.5 | -27,117.2 | -32.50% |
| VISTAS | 200,791.1 | 270,615.7 | -69,824.6 | -25.80% |
| **Total** | 840,973.6 | 1,166,663.1 | -325,689.5 | -27.92% |

The Regional Haze Rule and associated guidance indicate that future year projections should be as accurate as possible. Thus, after consulting with EPA, VISTAS decided to remodel the future year 2028 in order to have more accurate visibility projections. VISTAS made several improvements to the 2028 emissions inventory before remodeling the 2028 future year. These inventory improvements are detailed in the VISTAS emissions inventory report in Appendix B-2a. Each VISTAS state was given the opportunity to adjust any point source emissions in the 2028 inventory. For EGUs in the non-VISTAS states, ERTAC 2.7 emissions were replaced with the ERTAC 16.0 emissions, except for the LADCO states where ERTAC 2.7 emissions were replaced with ERTAC 16.1 emissions.

## 4.2. Summary of the 2028 Emissions Inventory and Assessment of Relative Contributions from Specific Pollutants and Source Categories

As noted in Section 2.4 for the years 2000-2004 and Section 2.6 for years 2014-2018, ammonium sulfate is the largest contributor to visibility impairment at Sipsey, and reduction of $SO_2$ emissions would be the most effective means of reducing ammonium sulfate for this planning period. As illustrated in Figure 4-1 below, 91.2% of 2011 $SO_2$ emissions in the VISTAS states are attributable to electric generating facilities and industrial point sources. Similarly, in Alabama the stationary point sources, consisting mostly of electric generating facilities and industrial point sources, contribute 88.3% of $SO_2$ emissions in the state (see Table 4-5 below).

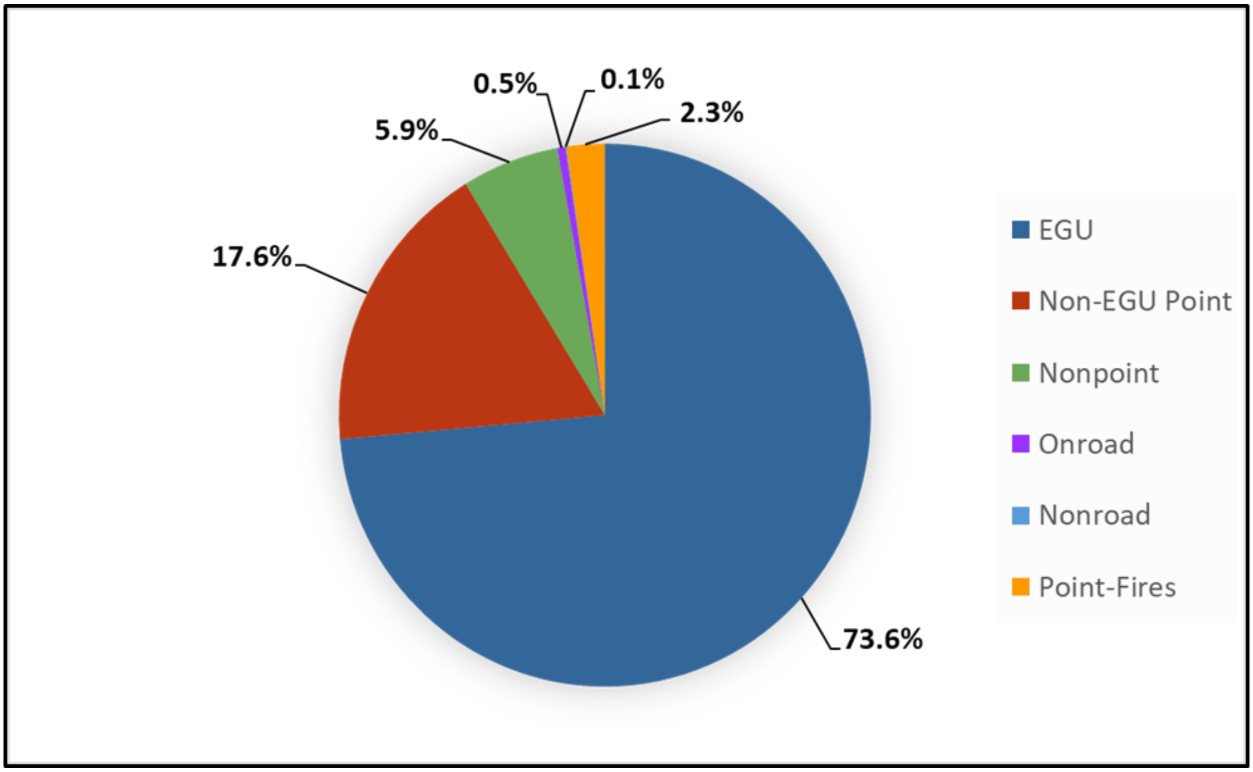


**Figure 4-1: 2011 $SO_2$ Emissions in the VISTAS States**

**Table 4-5: 2011 $SO_2$ Emissions for Alabama**

| Sector | $SO_2$, tpy | Percentage |
|---|---|---|
| Point | 245,891 | 88.3% |
| Nonpoint | 25,048 | 9.0% |
| Onroad | 683 | 0.2% |
| Non-Road | 65 | 0.0% |
| Point-Fires | 6,677 | 2.4% |
| Total | 278,364 | 100.0% |

Since the largest source of $SO_2$ emissions comes from stationary point sources, the focus of potential controls and the impacts for those controls was on this source sector for this planning period. In Alabama, the types of sources emitting $SO_2$, and thus contributing to the visibility impairment at Sipsey, were predominately coal fired utilities and industrial boilers.

Table 4-6 contains a summary of the 2028 baseline emission inventory for Alabama. The complete inventory and discussion of the methodology is contained in Appendix B. The emissions summaries for other VISTAS states can also be found in Appendix B.

**Table 4-6: 2028 Emissions Inventory Summary for Alabama (tpy)**

| Sector | CO | $NH_3$ | $NO_X$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
|---|---|---|---|---|---|---|---|
| EGU | 10,747 | 685 | 20,008 | 2,742 | 2,063 | 8,366 | 1,787 |
| Non-EGU Point | 61,719 | 1,622 | 50,817 | 17,065 | 14,057 | 50,691 | 23,747 |
| Nonpoint* | 124,390 | 67,011 | 31,534 | 483,650 | 98,737 | 9,799 | 76,396 |
| Onroad | 182,602 | 1,703 | 30,113 | 4,984 | 1,322 | 262 | 15,013 |
| Non-Road | 236,571 | 40 | 11,092 | 1,175 | 1,100 | 39 | 21,639 |
| Point-Fires | 666,279 | 11,041 | 14,551 | 72,656 | 61,573 | 6,677 | 158,720 |
| **Total** | **1,282,308** | **82,102** | **158,115** | **582,272** | **178,852** | **75,834** | **297,302** |

***Biogenic emissions were not included in the nonpoint category**

# 5. Regional Haze Modeling Methods and Inputs

Modeling for regional haze was performed by VISTAS for the ten southeastern states, including Alabama. The following sections outline the methods and inputs employed by VISTAS in the regional scale modeling. Additional details are provided in Appendix E.

## 5.1. Analysis Method

The modeling analysis is a complex technical evaluation that begins by selecting the modeling system. The modeling analysis approach for regional haze closely followed EPA's 2011el-based air quality modeling platform, which includes emissions, meteorology, and other inputs for 2011 as the base year for the modeling described in their Regional Haze TSD (EPA, 2017). EPA projected the 2011 base year emissions to a 2028 future year base case scenario. EPA's work is the foundation of the emissions used in the VISTAS analysis, except that VISTAS provided significant revisions to the 2028 EGU and non-EGU point sources as described in Appendix B. As noted in EPA's documentation, the 2011 base year emissions and methods for projecting these emissions to 2028 are in large part similar to the data and methods used by EPA in the final CSAPR Update[23] and the subsequent NODA[24] to support ozone transport mandates for the 2015 ozone NAAQS. VISTAS used the following modeling systems:

- Meteorological Model: The Weather Research and Forecasting (WRF) model is a mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs (Skamarock, 2004; 2006; Skamarock et al., 2005). The Advanced Research WRF (ARW) version of WRF was used in this regional haze analysis. It features multiple dynamic cores, a three-dimensional variational (3DVAR) data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers.

- Emissions Model: Emissions processing was completed using the SMOKE model for most source categories. The exceptions include EGUs for certain areas, as well as the biogenic and mobile sectors. For certain areas in the modeling domain, the ERTAC EGU Forecasting Tool[25] was used to grow base year hourly EGU emissions inventories to future projection years. The tool uses base year hourly EPA CAMD data, fuel specific growth rates, and other information to estimate future emissions. The BEIS model was used for biogenic emissions. Special processors were used for fires, windblown dust, lightning, and sea salt emissions. The 2014 MOVES onroad mobile source emissions model was used by EPA with SMOKE-MOVES to generate onroad mobile source emissions with EPA

[23] URL: https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update
[24] URL: https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone
[25] URL: https://marama.org/technical-center/ertac-egu-projection-tool/

generated vehicle activity data provided in the 2028 regional haze analysis. Special processors were used for fires, windblown dust, lightning, and sea salt emissions.

- Air Quality Model: The Comprehensive Air Quality Model with Extensions (CAMx) Version 6.40 was used in this study, with the secondary organic aerosol partitioning (SOAP) algorithm module as the default. The CAMx photochemical grid model, which supports two-way grid nesting was used. The setup is based on the same WRF/SMOKE/CAMx modeling system used in the EPA 2011/2028el platform modeling. The Particulate Source Apportionment Technology (PSAT) tool in CAMx was selected to develop source contribution and significant contribution calculations.

Episode selection is an important component of any modeling analysis. EPA guidance recommends choosing time periods that reflect the variety of meteorological conditions representing visibility impairment on the 20% clearest and 20% most impaired days in the Class I areas being modeled. This is best accomplished by modeling a full year. For this analysis, VISTAS performed modeling for the full 2011 calendar year with 10 days of model spin-up from 2010.

Once base year model performance was deemed adequate, the future year emissions were processed. The air quality modeling results were used to determine a relative reduction in future visibility impairment, which was used to determine future visibility conditions and Reasonable Progress Goals.

The complete modeling protocol used for this analysis can be found in Appendix E-1b.

## 5.2. Model Selection

To ensure that a modeling study is defensible, care must be taken in the selection and use of the models to be used. The models selected must be scientifically appropriate for the intended application and be freely accessible to all stakeholders. "Scientifically appropriate" means that the models address important physical and chemical phenomena in sufficient detail, using peer-reviewed methods. "Freely accessible" means that model formulations and coding are freely available for review and that the models are available to stakeholders, and their consultants, for little to no cost.

The following sections outline the criteria for selecting a modeling system that is both defensible and capable of meeting the study's goals. These criteria were used in selecting the modeling system for this modeling demonstration.

### 5.2.1. Selection of Photochemical Grid Model

#### 5.2.1.1. Criteria

For a photochemical grid model to qualify as a candidate for use in regional scale modeling, a state needs to demonstrate that it meets the same general criteria as a model for a NAAQS attainment demonstration. EPA's current modeling guidelines lists the following criteria for model selection (EPA, 2018):

- It should not be proprietary;
- It should have received a scientific peer review;
- It should be appropriate for the specific application on a theoretical basis;
- It should be used with databases that are available and adequate to support its application;
- It should be shown to have performed well in past modeling applications;
- It should be applied consistently with an established protocol on methods and procedures;
- It should have a User's Guide and technical description;
- The availability of advanced features (e.g., probing tools or science algorithms) is desirable; and
- When other criteria are satisfied, resource considerations may be important and are a legitimate concern.

#### 5.2.1.2. Overview of CAMx

The CAMx model[26] is a state-of-science "One-Atmosphere" photochemical grid model capable of addressing ozone, PM, visibility, and acid deposition at a regional scale for periods up to one year (Ramboll Environ, 2016). CAMx is a publicly available open-source computer modeling system for the integrated assessment of gaseous and particulate air pollution and meets all the photochemical grid model criteria above. Built on today's understanding that air quality issues are complex, interrelated, and reach beyond the urban scale, CAMx is designed to: (a) simulate air quality over many geographic scales; (b) treat a wide variety of inert and chemically active pollutants including ozone, inorganic and organic $PM_{2.5}$ and $PM_{10}$, mercury, and toxics; (c) provide source-receptor, sensitivity, and process analyses; and (d) be computationally efficient and easy to use. EPA has approved the use of CAMx for numerous ozone, PM, and Regional Haze SIPs throughout the U.S. and has used this model to evaluate regional mitigation strategies including those for most recent regional-scale rules such as CSAPR.

### 5.2.2. Selection of Meteorological Model

#### 5.2.2.1. Criteria

Meteorological models, either through objective, diagnostic, or prognostic analysis, extend available information about the state of the atmosphere to the grid upon which photochemical grid modeling is carried out. The criteria for selecting a meteorological model are based on both the model's ability to accurately replicate important meteorological phenomena in the region of study and the model's ability to interface with the rest of the modeling systems, particularly the photochemical grid model. With these issues in mind, the following criteria were established for the meteorological model to be used in this study:

[26] URL: http://www.camx.com

- Non-hydrostatic formulation;
- Reasonably current, peer reviewed formulation;
- Simulates cloud physics;
- Publicly available at little or no cost;
- Output available in Input/Output Applications Programming Interface (I/O API) format;
- Supports four-dimensional data assimilation (FDDA); and
- Enhanced treatment of planetary boundary layer heights for air quality modeling.

#### 5.2.2.2. Overview of WRF

The Weather Research and Forecasting (WRF[27]) model is a mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs (Skamarock, 2004; 2006; Skamarock et al., 2005). The Advanced Research WRF (ARW) version of WRF was used in this regional haze analysis and meets all the meteorological model criteria above. It features multiple dynamical cores, a three-dimensional variational data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers. The effort to develop WRF has been a collaborative partnership, principally among the National Center for Atmospheric Research (NCAR), NOAA, the National Centers for Environmental Prediction (NCEP) and the Forecast Systems Laboratory (FSL), the Air Force Weather Agency (AFWA), the Naval Research Laboratory, the University of Oklahoma, and the Federal Aviation Administration (FAA). WRF allows researchers the ability to conduct simulations reflecting either real data or idealized configurations. WRF is a model that provides operational weather forecasting. It is flexible and computationally efficient while offering the advances in physics, numerics, and data assimilation contributed by the research community.

The configuration used for this modeling demonstration, as well as a more detailed description of the WRF model, can be found in the EPA's meteorological modeling report (EPA, 2014d).

### 5.2.3. Selection of Emissions Processing System

#### 5.2.3.1. Criteria

The principal criterion for an emissions processing system is that it accurately prepares emissions files in a format suitable for the photochemical grid model being used. The following list includes clarification of this criterion and additional desirable criteria for effective use of the system.

- File system compatibility with the I/O API;
- File portability;
- Ability to grid emissions on a Lambert conformal projection;
- Report capability;
- Graphical analysis capability;

[27] URL: http://www.wrf-model.org/index.php

- MOVES mobile source emissions;
- BEIS version 3;
- Ability to process emissions for the proposed domain in a reasonable amount of time;
- Ability to process control strategies;
- Little to no cost for acquisition and maintenance; and
- Expandable to support other species and mechanisms.

#### 5.2.3.2. Overview of the Sparse Matrix Operator Kernel Emissions Model (SMOKE)

The SMOKE[28] modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, non-road, nonpoint area, point, fire and biogenic emission sources for photochemical grid models (Coats, 1995; Houyoux et al., 1999) and meets all the emissions processing system criteria above. As with most "emissions models," SMOKE is principally an emissions processing system; its purpose is to provide an efficient modern tool for converting existing base emissions inventory data into the hourly gridded speciated formatted emission files required by a photochemical grid model. For biogenic, mobile, and EGU sources, external emission models/processors were used to prepare SMOKE inputs. MOVES2014 is EPA's latest onroad mobile source emissions model and was first released in July 2014 (EPA, 2014a; 2014b; 2014c). MOVES2014 includes the latest onroad mobile source emissions factor information. Emission factors developed by EPA were used in this analysis. SMOKE-MOVES uses an emissions factor look-up table from MOVES, county-level gridded vehicle miles travelled (VMT) and other activity data, and hourly gridded meteorological data (typically from WRF) to generate hourly gridded speciated onroad mobile source emissions inputs. The ERTAC EGU Forecasting Tool[29] was developed through a collaborative effort to improve emission inventories among the Northeastern, Mid-Atlantic, Southeastern, and Lake Michigan area states; other member states; industry representatives; and multi-jurisdictional organization (MJO) representatives. The tool was used for some states to grow base year hourly EGU emissions inventories into future projection years. The tool uses base year hourly EPA CAMD data, fuel specific growth rates, and other information to estimate future emissions. Biogenic emissions were modeled by EPA using version 3.61 of BEIS. First developed in 1988, BEIS estimates VOC emissions from vegetation and nitric oxide (NO) emissions from soils. Because of resource limitations, recent BEIS development has been restricted to versions that are built within the SMOKE system. Additional information about the SMOKE model is contained in Appendix B.

## 5.3. Selection of the Modeling Year

A crucial step to SIP modeling is the selection of the period of time to model so that air quality conditions may be well represented and so that changes in air quality in response to changes in emissions may be projected.

[28] URL: http://www.smoke-model.org/index.cfm
[29] URL: https://marama.org/technical-center/ertac-egu-projection-tool/

EPA's most recent regional haze modeling guidance (EPA, 2018) contains recommended procedures for selecting modeling episodes. The VISTAS regional haze modeling used the annual calendar year 2011 modeling period. Calendar year 2011 satisfies the criteria in EPA's modeling guidance episode selection discussion and is consistent with the base year modeling platform. Specifically, EPA's guidance recommends choosing a time period which reflects the variety of meteorological conditions that represent visibility impairment on the 20% clearest and 20% most impaired days in the Class I areas being modeled (high and low concentrations necessary). This is best accomplished by modeling a full calendar year.

In addition, the 2011/2028 modeling platform was the most recent available platform when VISTAS started their modeling work. EPA's 2016-based platform became available at a later date after VISTAS had already invested a considerable amount of time and money into the modeling analysis. Using the 2016-based platform was not feasible from a monetary perspective, nor could such work be done in a timely manner to meet the goals of this planning period.

## 5.4. Modeling Domains

### 5.4.1. Horizontal Modeling Domain

The VISTAS modeling used a 12-kilometer (km) continental U.S. (CONUS_12 or 12US2) domain. The 12-km nested grid modeling domain (Figure 5-1) represents the CAMx 12-km air quality and SMOKE/BEIS emissions modeling domain. As shown in EPA's meteorological model performance evaluation document, the WRF meteorological modeling was run on a larger 12-km modeling domain than the 12-km domain that was used for CAMx (EPA, 2014d). The WRF meteorological modeling domains are defined larger than the air quality modeling domains because meteorological models can sometimes produce artifacts in the meteorological variables near the boundaries as the prescribed boundary conditions come into dynamic balance with the coupled equations and numerical methods in the meteorological model.

An additional VISTAS_12 domain was prepared that is a subset of the CONUS_12 domain. Development of the VISTAS_12 domain (also presented in Figure 5-1 in red) requires the EPA CONUS_12 simulation to be run using CAMx Version 6.40 modeling saving 3-dimensional concentration fields for extraction using the CAMx BNDEXTR program. Dimensions for both VISTAS_12 and CONUS_12 domains are provided in Table 5-1.

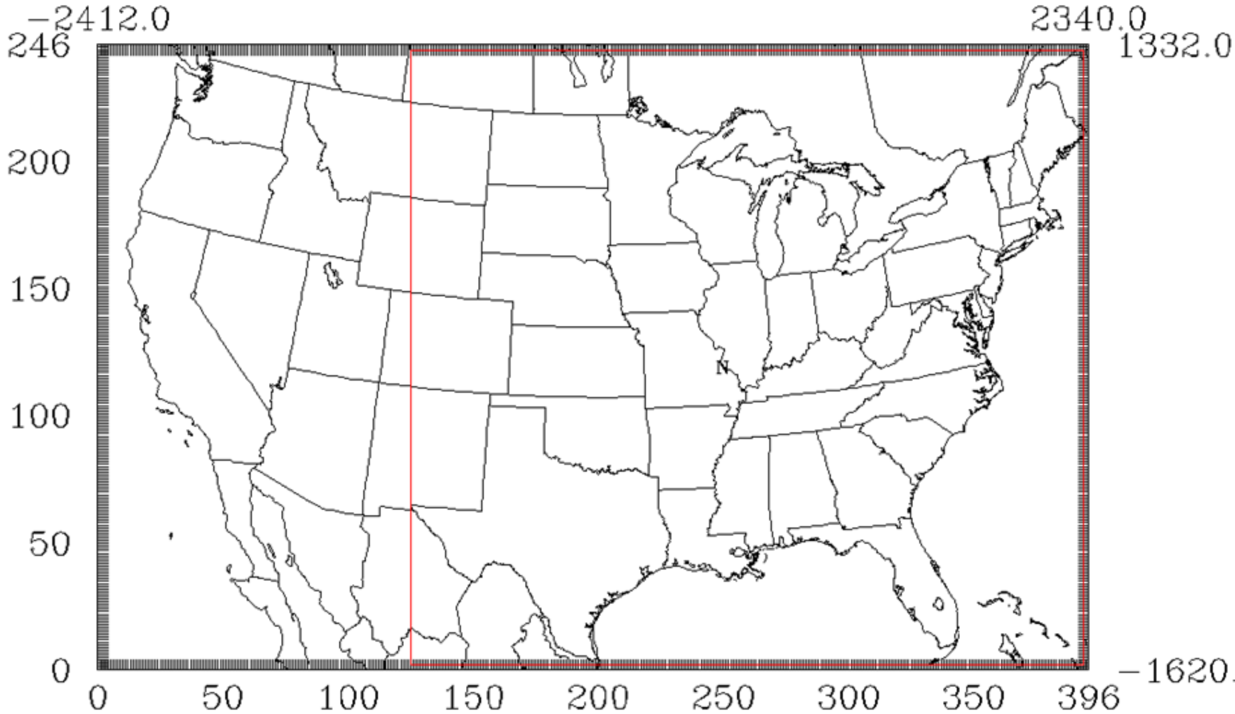


**Figure 5-1: Map of 12-km CAMx Modeling Domains; VISTAS_12 Domain Represented as Inner Red Domain**

**Table 5-1: VISTAS II Modeling Domain Specifications**

| Domain | Columns | Rows | Vertical Layers | X Origin (km) | Y Origin (km) |
|---|---|---|---|---|---|
| CONUS_12 | 396 | 246 | 25 | -2,412 | -1,620 |
| VISTAS_12 | 269 | 242 | 25 | -912 | -1,596 |

### 5.4.2. Vertical Modeling Domain

The CAMx vertical structure is primarily defined by the vertical layers used in the WRF meteorological modeling. The WRF model employs a terrain following coordinate system defined by pressure, using multiple layer interfaces that extend from the surface to 50 millibar (mb) (approximately 19 km above sea level). EPA ran WRF using 35 vertical layers. A layer averaging scheme was adopted for CAMx simulations whereby multiple WRF layers were combined into one CAMx layer to reduce the air quality model computational time. Table 5-2 displays the approach for collapsing the 35 vertical layers in WRF to 25 vertical layers in CAMx. This approach is consistent with EPA's draft 2028 regional haze modeling.[30]

[30] Table 2-2, EPA, 2017.

**Table 5-2: WRF and CAMx Layers and Their Approximate Height Above Ground Level**

| CAMx Layer | WRF Layers | Sigma P | Pressure (mb) | Approximate Height (meters above ground level) |
|---|---|---|---|---|
| 25 | 35 | 0.00 | 50.00 | 17,556 |
| 25 | 34 | 0.05 | 97.50 | 14,780 |
| 24 | 33 | 0.10 | 145.00 | 12,822 |
| 24 | 32 | 0.15 | 192.50 | 11,282 |
| 23 | 31 | 0.20 | 240.00 | 10,002 |
| 23 | 30 | 0.25 | 382.50 | 7,064 |
| 22 | 29 | 0.30 | 335.00 | 7,932 |
| 22 | 28 | 0.35 | 382,50 | 7,064 |
| 21 | 27 | 0.40 | 430.00 | 6,275 |
| 21 | 26 | 0.45 | 477.50 | 5,553 |
| 20 | 25 | 0.50 | 525.00 | 4,885 |
| 20 | 24 | 0.55 | 572.50 | 4,264 |
| 19 | 23 | 0.60 | 620.00 | 3,683 |
| 18 | 22 | 0.65 | 667.50 | 3,136 |
| 17 | 21 | 0.70 | 715.00 | 2,619 |
| 16 | 20 | 0.74 | 753.00 | 2,226 |
| 15 | 19 | 0.77 | 781.50 | 1,941 |
| 14 | 18 | 0.80 | 810.00 | 1,665 |
| 13 | 17 | 0.82 | 829.00 | 1,485 |
| 12 | 16 | 0.84 | 848.00 | 1,308 |
| 11 | 15 | 0.86 | 867.00 | 1,134 |
| 10 | 14 | 0.88 | 886.00 | 964 |
| 9 | 13 | 0.90 | 905.00 | 797 |
| 9 | 12 | 0.91 | 914.50 | 714 |
| 8 | 11 | 0.92 | 924.00 | 632 |
| 8 | 10 | 0.93 | 933.50 | 551 |
| 7 | 9 | 0.94 | 943.00 | 470 |
| 7 | 8 | 0.95 | 952.50 | 390 |
| 6 | 7 | 0.96 | 962.00 | 311 |
| 5 | 6 | 0.97 | 971.50 | 232 |
| 4 | 5 | 0.98 | 981.00 | 154 |
| 4 | 4 | 0.99 | 985.75 | 115 |
| 3 | 3 | 0.99 | 985.75 | 115 |
| 2 | 2 | 1.00 | 995.25 | 38 |
| 1 | 1 | 1.00 | 997.63 | 19 |

# 6. Model Performance Evaluation (MPE)

The VISTAS 2011 modeling platform (VISTAS2011) used meteorological modeling files developed by EPA. The evaluation of the meteorological modeling can be found in the EPA document titled, "Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation."[31] Overall, the meteorological modeling was deemed acceptable for regulatory applications.

In keeping with the one-atmosphere objective of the CAMx modeling platform, model performance was evaluated for ozone, fine particles, and acid deposition. For the model performance analysis, model predictions were paired in space and time with observational data from various monitoring networks. Modeled 8-hour ozone concentrations were compared to observations from the EPA's Air Quality System (AQS) network. Modeled 24-hour speciated PM concentrations were compared to observations from IMPROVE, CSN, CASTNET monitoring networks. Modeled weekly speciated wet and dry deposition species were compared to observations from NADP and CASTNET.

## 6.1. Ozone Model Performance Evaluation

As indicated by the statistics in Table 6-1 below, bias and error for maximum daily 8-hour average (MDA8) ozone are relatively low in the region. Mean bias (MB) for MDA8 ozone ≥ 60 parts per billion (ppb) during each month (May through September) was within ±5 ppb at AQS sites in the VISTAS states, ranging from -0.13 ppb (September) to 3.79 ppb (July). The mean error (ME) is less than 10 ppb in all months. Normalized mean bias (NMB) is within ±5% for AQS sites in all months except July (5.63%). The mean bias and normalized mean bias statistics indicate a tendency for the model to over predict MDA8 ozone concentrations in the months of May through August and slightly under predict MDA8 ozone concentrations in September for AQS sites. The normalized mean error (NME) is less than 15% in the region across all months.

**Table 6-1: Performance Statistics for MDA8 Ozone ≥ 60 ppb by Month for VISTAS States Based on Data at AQS Network Sites**

| Region | Month | # of Obs | MB (ppb) | ME (ppb) | NMB (%) | NME (%) |
|---|---|---|---|---|---|---|
| VISTAS | May | 838 | 2.48 | 6.11 | 3.79 | 9.34 |
| VISTAS | Jun | 2028 | 1.73 | 7.11 | 2.57 | 10.55 |
| VISTAS | Jul | 1233 | 3.79 | 8.88 | 5.63 | 13.21 |
| VISTAS | Aug | 1531 | 2.38 | 6.94 | 3.59 | 10.48 |
| VISTAS | Sep | 681 | -0.13 | 6.09 | -0.19 | 9.08 |

Figures 6-1 through 6-4 show the spatial variability in bias and error at monitor locations. Mean bias, as seen from the table above, is within ±5 ppb at most sites across the VISTAS12 domain, with a maximum under-prediction of 23.44 ppb at one site (AQS monitor 550030010) in Ashland County, Wisconsin and a maximum over-prediction of 17.95 ppb in York County, South Carolina (AQS monitor 450910006); both with small sample sizes (n=1 and n=7, respectively). A positive mean bias is generally seen in the range of 5 to 10 ppb with regions of 10 to 15 ppb over-prediction

[31] URL: https://www.epa.gov/sites/production/files/2020-10/documents/met_tsd_2011_final_11-26-14.pdf

seen scattered throughout the domain. The model has a tendency to underestimate in the western portion of the domain and overestimate in the eastern portion of the domain.

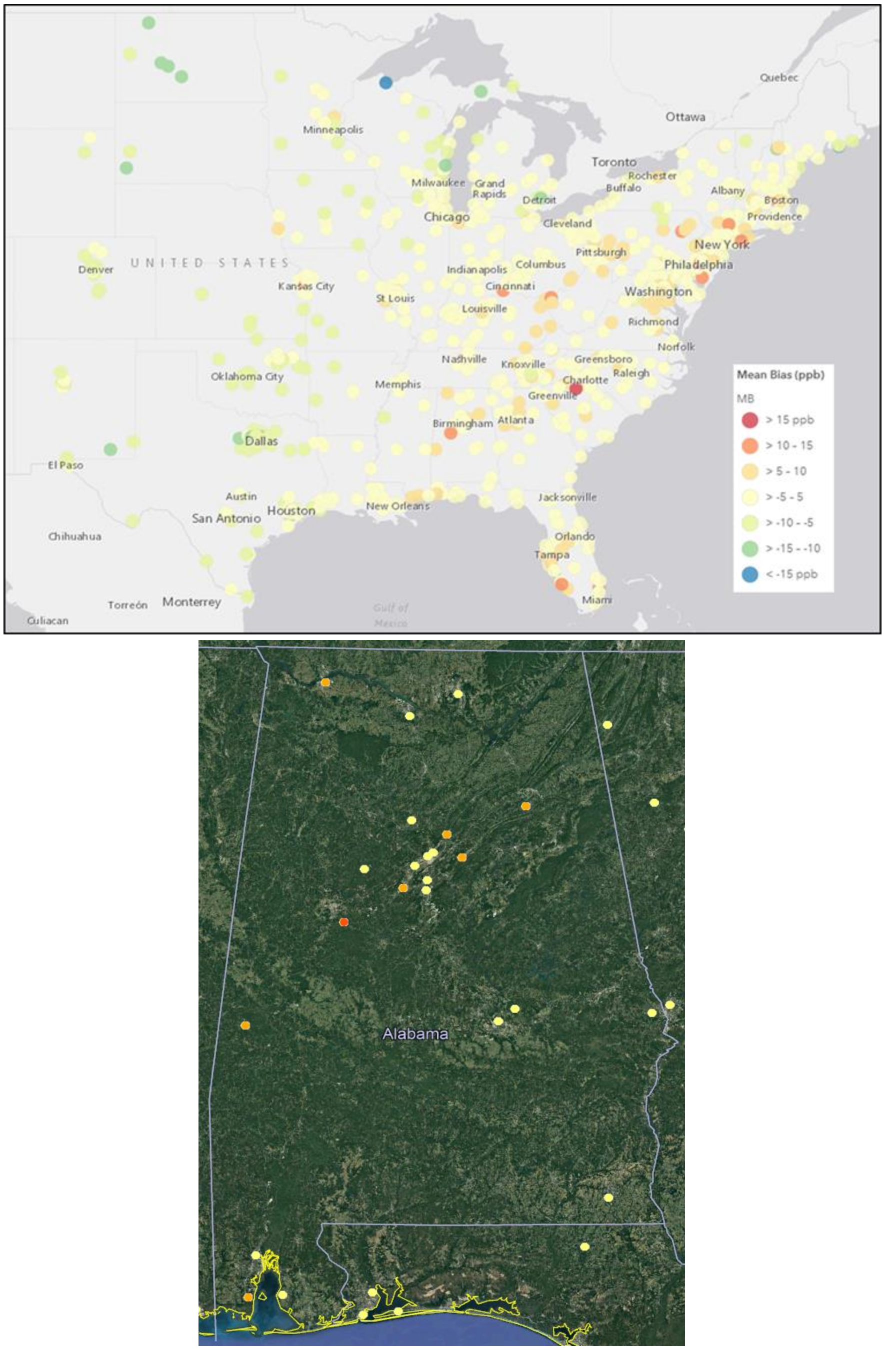



**Figure 6-1: Mean Bias (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in Alabama (bottom).**

Figure 6-2 indicates that the normalized mean bias for days with observed MDA8 ozone ≥ 60 ppb is within ± 10% at the vast majority of monitoring sites across the VISTAS12 modeling domain. Monitors in Ashland County, Wisconsin and York County, South Carolina again bookend the NMB range with 38.03% and 27.44%, respectively. There are regional differences in model performance, as the model tends to overpredict at most sites in the eastern region of the VISTAS domain and generally underpredict at sites in and around the western and northwestern borders of the domain.

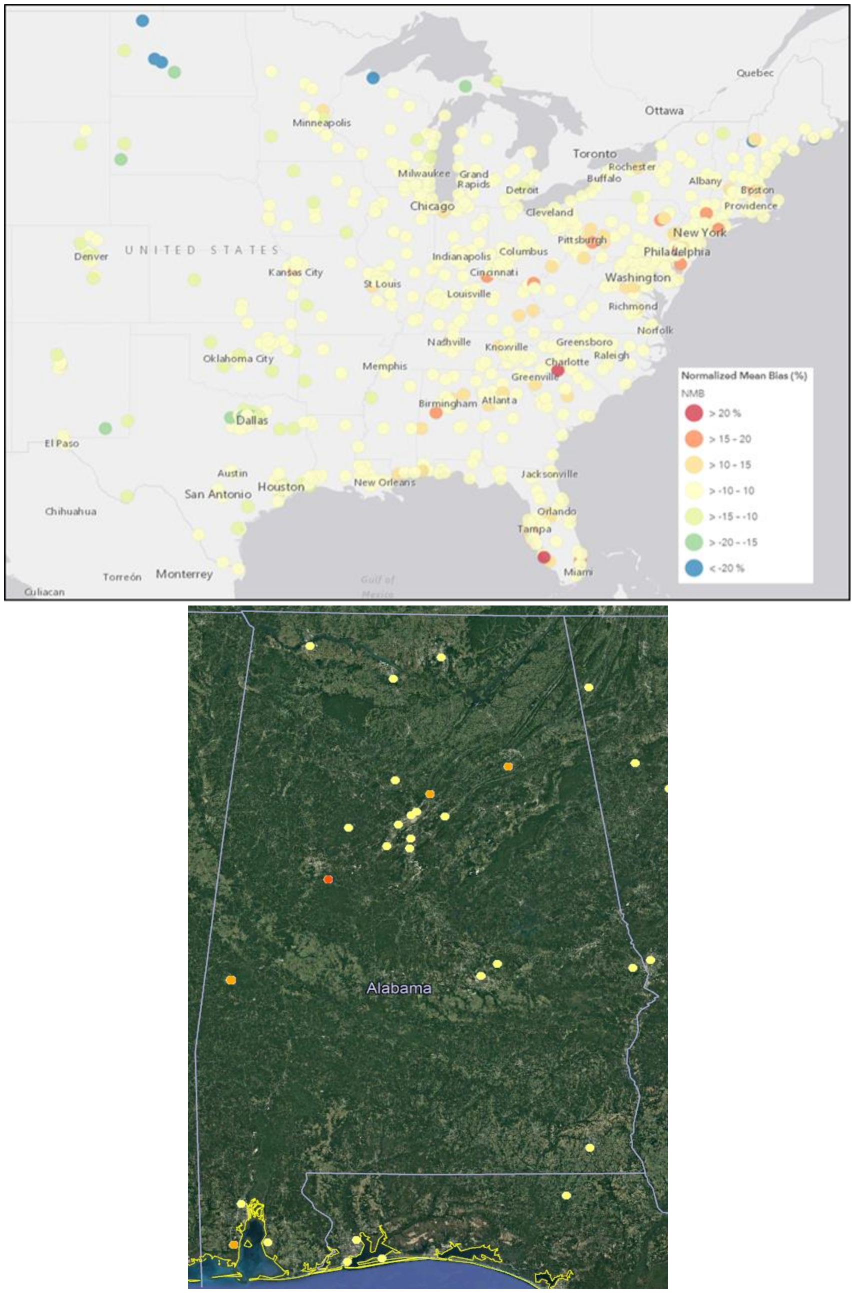



**Figure 6-2: Normalized Mean Bias (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in Alabama (bottom).**

The mean error (ME), as seen below (Figure 6-3), is generally 10 ppb or less at most of the sites across the VISTAS12 modeling domain, although the Ashland, Wisconsin and York County, South Carolina monitors show much higher ME of 23.44 and 17.95 ppb, respectively. VISTAS states show less than 10% of their monitors above 10 ppb model error, with the majority of those within this value.

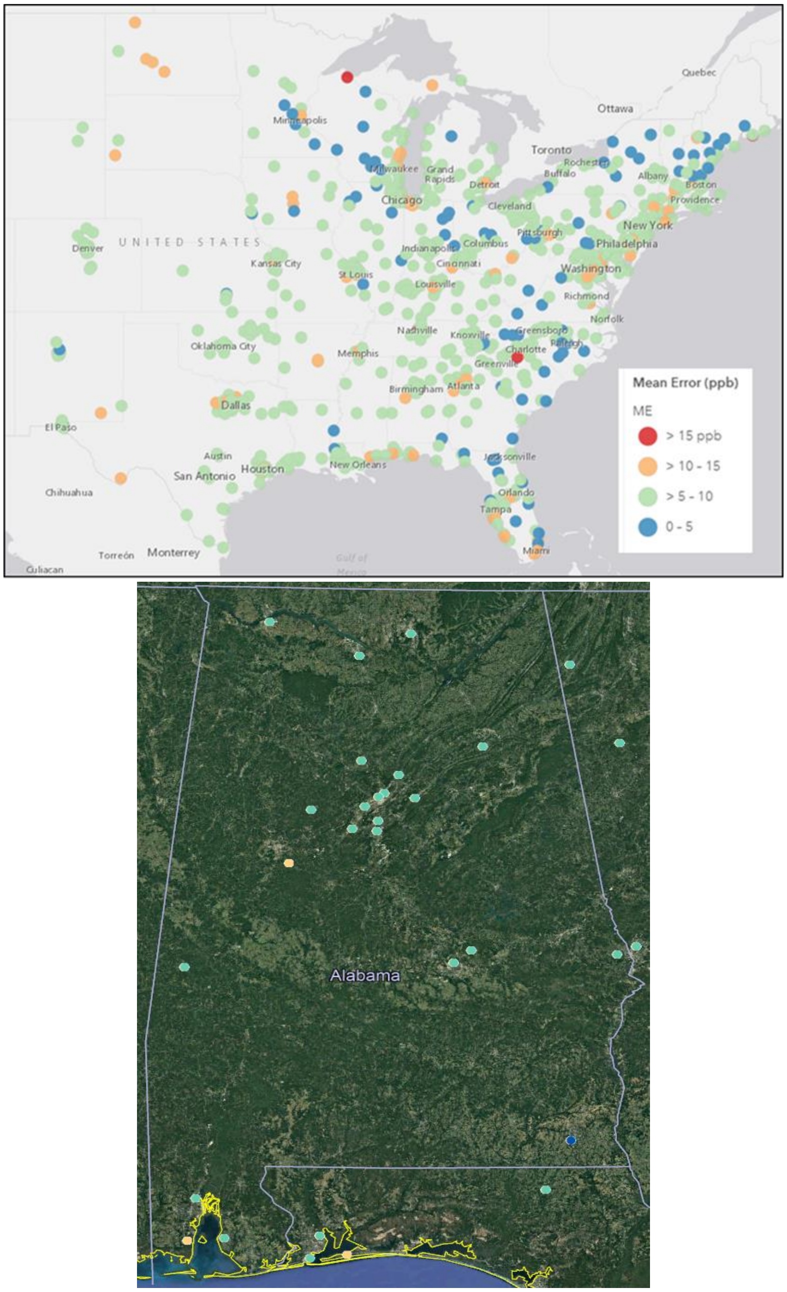



**Figure 6-3: ME (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in Alabama (bottom).**

Figure 6-4 indicates that the normalized mean error (NME) for days with observed MDA8 ozone ≥ 60 ppb is less than 15% at the vast majority of monitoring sites across the VISTAS12 modeling domain. Noted exceptions seen are monitors 450910006 (York County, South Carolina), 470370011 (Davidson County, Tennessee), and 120713002 (Lee County, Florida) with NMEs of 27.44%, 25.4%, and 23.07%, respectively. Somewhat elevated NMEs (>15%) are seen in and around many of the VISTAS state metro areas.

Additional details on the ozone model performance evaluation can be found in Appendix E-5.

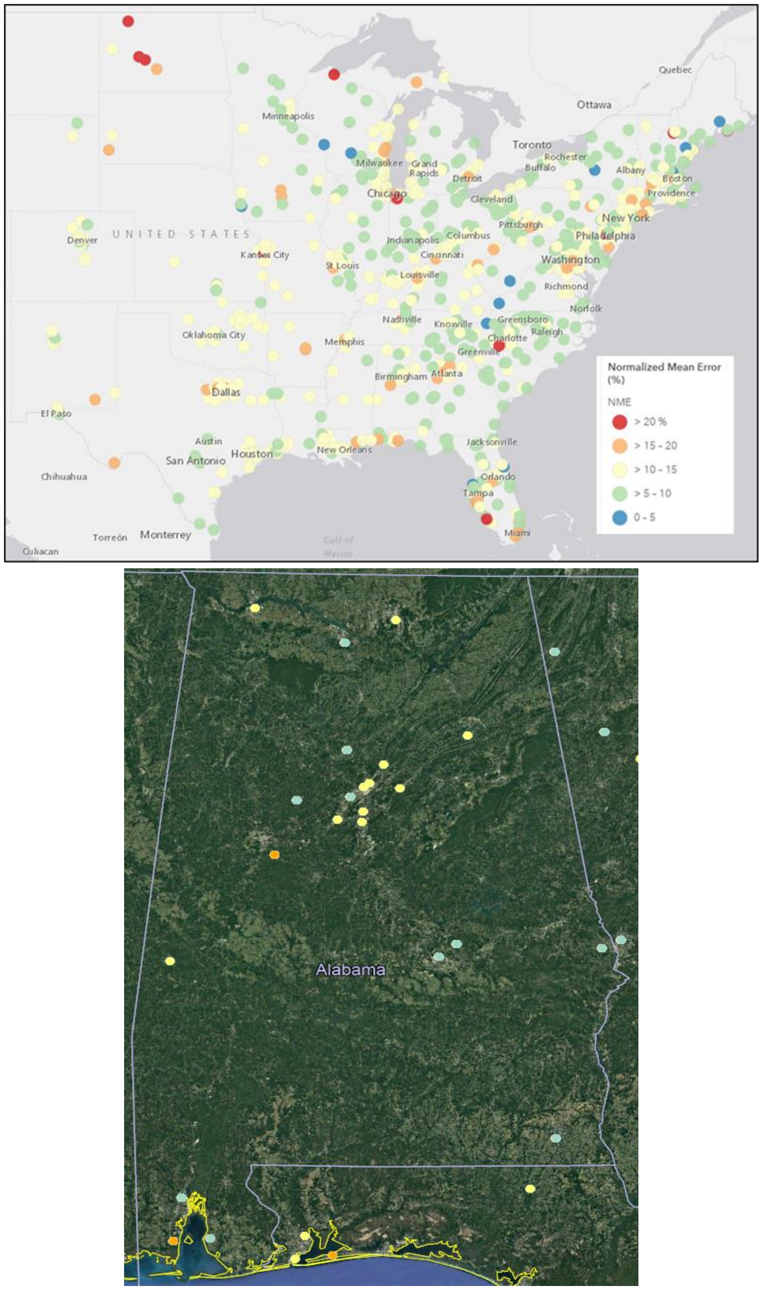



**Figure 6-4: NME (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in Alabama (bottom).**

### 6.2. Acid Deposition Model Performance Evaluation (MPE)

The primary source for deposition data is the National Atmospheric Deposition Program (NADP).[32] The NADP monitoring networks used in this evaluation include:

- National Trends Network (NTN)
- Atmospheric Integrated Research Monitoring Network (AIRMon)
- Ammonia Monitoring Network (AMoN)

Dry deposition information is also available from CASTNET. The data from NTN and AIRMon were used in the wet deposition MPE, and the data from CASTNET and AMoN were used for dry deposition MPE. The MPE focused on the monitors from these networks within the VISTAS 12-km modeling domain (Figure 6-5).

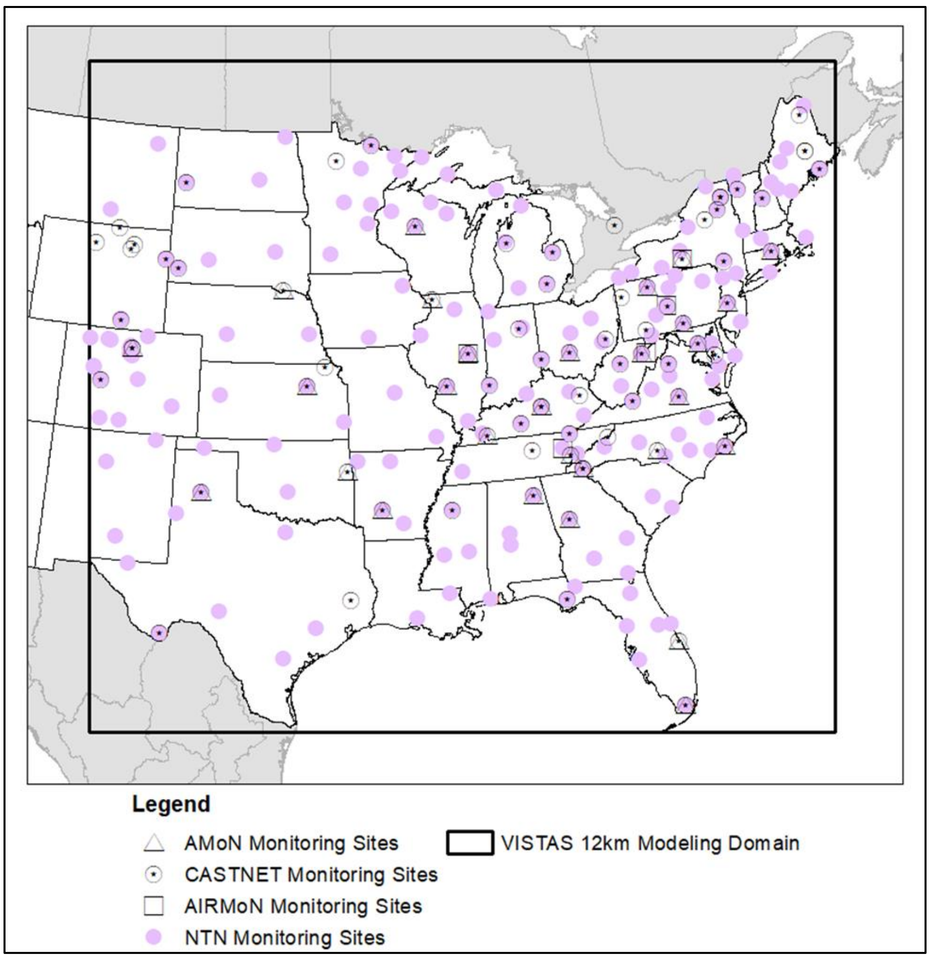



**Figure 6-5: Deposition Monitors Included in the VISTAS12 Domain**

[32] National Atmospheric Deposition Program (NRSP-3). 2018. NADP Program Office, Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53706. URL: http://nadp.slh.wisc.edu/

Table 6-2 summarizes the aggregated weekly MPE metrics for wet deposition in the VISTAS 12-km domain. The model demonstrates a negative mean bias for the ammonium ion ($NH_4^+$) and the sulfate ion ($SO_4^{-2}$) and a positive mean bias for the nitrate ion ($NO_3^-$) compared to the weekly NTN observations. The AIRMon sites have a larger positive mean bias for all pollutants.

**Table 6-2: Weekly Wet Deposition MPE Metrics for NADP Sites in the VISTAS 12-km Domain**

| Network | Pollutant | n | MB (kg/ha) | ME (kg/ha) | NMB (%) | NME (%) | r (unitless) | MFB (%) | MFE (%) | RMSE (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| NTN | $NH_4^+$ | 3,404 | -0.025 | 0.045 | -32% | 58% | 0.629 | -19% | 34% | 0.092 |
| NTN | $NO_3^-$ | 3,404 | 0.024 | 0.123 | 12% | 62% | 0.642 | 6% | 29% | 0.242 |
| NTN | $SO_4^{-2}$ | 3,404 | -0.001 | 0.118 | 0% | 57% | 0.681 | 0% | 29% | 0.245 |
| AIRMon | $NH_4^+$ | 158 | -0.003 | 0.020 | -31% | 76% | 0.534 | -7% | 41% | 0.041 |
| AIRMon | $NO_3^-$ | 158 | 0.051 | 0.097 | 67% | 127% | 0.398 | 25% | 47% | 0.192 |
| AIRMon | $SO_4^{-2}$ | 158 | 0.018 | 0.091 | 20% | 100% | 0.352 | 9% | 46% | 0.197 |

When considering the total accumulated wet deposition for the calendar year, there is still an under prediction of $NH_4^+$ and $SO_4^{2-}$, and a slight over prediction of $NO_3^-$. However, continued improvement is seen from the seasonal accumulated performance with respect to the NME and r values, as presented in Table 6-3.

**Table 6-3: Accumulated Annual Wet Deposition MPE Metrics for NADP Sites in the VISTAS 12-km Domain**

| Pollutant | n | MB (kg/ha) | MGE (kg/ha) | NMB (%) | NME (%) | r (unitless) | MFB (%) | MFE (%) | RMSE (unitless) |
|---|---|---|---|---|---|---|---|---|---|
| $NH_4^+$ | 99 | -1.245 | 1.246 | -38% | 38% | 0.861 | -23% | 23% | 1.536 |
| $NO_3^-$ | 99 | 0.134 | 1.453 | 2% | 17% | 0.901 | 1% | 8% | 1.933 |
| $SO_4^{2-}$ | 99 | -0.585 | 1.604 | -7% | 18% | 0.916 | -3% | 9% | 2.142 |

The weekly dry deposition mean bias (MB) and mean error (ME) presented in Table 6-4 would seem to suggest relatively good model performance for the CASTNET sites. The higher normalized mean and mean fractional bias and error values are due to small values in the denominator.

**Table 6-4: Weekly Dry Deposition MPE Metrics for CASTNet Sites in the VISTAS 12-km Domain**

| Network | Pollutant | n | MB (kg/ha) | ME (kg/ha) | NMB (%) | NME (%) | r (unitless) | MFB (%) | MFE (%) | RMSE (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|
| CASTNet | $Cl^-$ | 965 | -0.001 | 0.001 | -87% | 89% | 0.796 | -77% | 79% | 0.004 |
| CASTNet | $NH_4^+$ | 965 | 0.001 | 0.003 | 13% | 51% | 0.603 | 6% | 24% | 0.004 |
| CASTNet | $SO_4^{2-}$ | 965 | 0.0004 | 0.007 | 3% | 43% | 0.650 | 1% | 21% | 0.009 |
| CASTNet | $SO_2$ | 965 | -0.031 | 0.031 | -96% | 96% | 0.656 | -93% | 93% | 0.052 |
| CASTNet | $NO_3^-$ | 965 | 0.001 | 0.004 | 12% | 80% | 0.601 | 6% | 37% | 0.006 |
| CASTNet | $HNO_3$ | 965 | -0.062 | 0.062 | -95% | 95% | 0.612 | -90% | 90% | 0.077 |
| AMoN | $NH_3$ | 355 | -0.007 | 0.007 | -95% | 95% | 0.463 | %91 | 91% | 0.013 |

As presented in Table 6-5, most pollutants, except for $NO_3$, are under predicted, based on the total accumulated dry deposition. Of all pollutants, $SO_2$ and $HNO_3$ under predict the worst, followed by $Cl^-$.

**Table 6-5: Accumulated Annual Wet Deposition MPE Metrics at CASTNet Sites in the VISTAS 12-km Domain**

| Pollutant | n | MB (kg/ha) | MGE (kg/ha) | NMB (%) | NME (%) | r (unitless) | MFB (%) | MFE (%) | RMSE (unitless) |
|---|---|---|---|---|---|---|---|---|---|
| $Cl^-$ | 19 | -0.054 | 0.054 | -88% | 88% | 0.981 | -78% | 78% | 0.156 |
| $NH_4^+$ | 19 | -0.002 | 0.077 | -1% | 27% | 0.688 | 0% | 14% | 0.090 |
| $SO_4^{2-}$ | 19 | -0.067 | 0.219 | -8% | 27% | 0.537 | -4% | 14% | 0.268 |
| $SO_2$ | 19 | -1.616 | 1.616 | -97% | 97% | 0.869 | -94% | 94% | 2.221 |
| $NO_3^-$ | 19 | 0.001 | 0.113 | 1% | 46% | 0.572 | 0% | 23% | 0.154 |
| $HNO_3$ | 19 | -3.272 | 3.272 | -95%.4 | 95% | 0.607 | -91% | 91% | 3.688 |

Additional details on the wet and dry acid deposition model performance evaluation can be found in Appendix E-4.

## 6.3. PM Component Model Performance Goals and Criteria

Because $PM_{2.5}$ is a mixture, the current EPA PM modeling guidance[33] recommends that a meaningful performance evaluation should include an assessment of how well the model is able to predict individual chemical components that constitute $PM_{2.5}$. Consistent with EPA's performance evaluation of the regional haze 2028 analysis, in addition to total $PM_{2.5}$, the following components of $PM_{2.5}$ were also examined.

- Sulfate ion ($SO_4^{2-}$)
- Nitrate ion ($NO_3^-$)
- Ammonium ion ($NH_4^+$)
- Elemental Carbon (EC)
- Organic Carbon (OC) and/or Organic Carbon Mass (OCM)
- Crustal (weighted average of the most abundant trace elements in ambient air)
- Sea salt constituents ($Na^+$ and $Cl^-$)

Recommended benchmarks for photochemical model performance statistics (Boylan, 2006; Emery, 2017) were used to assess the applicability of the VISTAS modeling platform for Regional Haze SIP purposes. The goal and criteria values noted in Table 6-6 below were used for this modeling. The original publication notes that the temporal scales for the 24-hour total and speciated PM should not exceed 3 months (or 1 season) and the spatial scales should range from urban to less than or equal to 1000 kilometers. This indicates that model performance should be evaluated based on the entire domain

**Table 6-6: Fine Particulate Matter Performance Goals and Criteria**

| Species | NMB, Goal | NMB, Criteria | NME, Goal | NME, Criteria | FB, Goal | FB, Criteria | FE, Goal | FE, Criteria | r, Goal | r, Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| 24-hr $PM_{2.5}$ and sulfate | <± 10% | <± 30% | < 35% | < 50% | <± 30% | <± 60% | < 50% | < 75% | > 0.75 | > 0.50 |

[33] URL: https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

| Species | NMB, Goal | NMB, Criteria | NME, Goal | NME, Criteria | FB, Goal | FB, Criteria | FE, Goal | FE, Criteria | r, Goal | r, Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| 24-hr nitrate | <± 10% | <± 65% | < 65% | < 115% | <± 30% | <± 60% | < 50% | < 75% | > 0.75 | > 0.40 |
| 24-hr OC | <± 15% | <± 50% | < 45% | < 65% | <± 30% | <± 60% | < 50% | < 75% | None | None |
| 24-hr EC | <± 20% | <± 40% | < 50% | < 75% | <± 30% | <± 60% | < 50% | < 75% | None | None |

The mapping of the CAMx species into the observed species are presented in Table 6-7.

**Table 6-7: Species Mapping from CAMx into Observation Network**

| Network | Observed Species | CAMx Species |
|---|---|---|
| IMPROVE | $NO_3$ | PNO3 |
| IMPROVE | $SO_4$ | PSO4 |
| IMPROVE | $NH_4$ | PNH4 |
| IMPROVE | OM = 1.8*OC | SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA |
| IMPROVE | EC | PEC |
| IMPROVE | SOIL | FPRM+FCRS |
| IMPROVE | $PM_{2.5}$ | PSO4+PNO3+PNH4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL |
| CSN | $PM_{2.5}$ | PSO4+PNO3+PNH4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL |
| CSN | $NO_3$ | PNO3 |
| CSN | $SO_4$ | PSO4 |
| CSN | $NH_4$ | PNH4 |
| CSN | OM = 1.4*OC | SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA |
| CSN | EC | PEC |

Several graphic displays of model performance were prepared, including:

- Performance goal plots ("soccer plots") that summarize model performance by species, region, and season.
- Concentration performance plots ("bugle plots") that display fractional bias or error as a function of concentration by species, region, monitoring network, and month.
- Scatter plots of predicted and observed concentrations by species, monitoring network, and month.
- Time series plots of predicted and observed concentrations by species, monitoring site, and month.
- Spatially averaged time series plots.
- Time series plots of monthly fractional bias and error by species, region, and monitoring network.

Both soccer plots and bugle plots offer a convenient way to examine model performance with respect to set goals and criteria. The bugle plots have the added benefit of adjusting the goals and criteria to consider the concentration of the species. Analysis of bugle plots generally suggests that greater emphasis should be placed on performance of those components with the greatest contribution to PM mass and visibility impairment (e.g., sulfate and organic carbon) and that greater bias and error could be accepted for components with smaller contributions to total PM mass (e.g., elemental carbon, nitrate, and soil).

## 6.4. PM Model Performance Evaluation for the VISTAS Modeling Domain

Further discussion of model performance in this document will focus on the comparison of observational data from the CASTNET, CSN, and IMPROVE monitors (Table 6-8) in the VISTAS12 modeling domain and model output data from the VISTAS 2011 annual air quality modeling.

**Table 6-8: Overview of Utilized Ambient Data Monitoring Networks**

| Monitoring Network | Chemical Species Measured | Sampling Period |
|---|---|---|
| IMPROVE | Speciated $PM_{2.5}$ and $PM_{10}$; light extinction data | 1 in 3 days; 24-hour average |
| CASTNET | Speciated $PM_{2.5}$, and $O_3$ | 1-week average |
| CSN | Speciated $PM_{2.5}$ | 24-hour average |

The evaluation primarily focused on the air quality model's performance with respect to individual components of fine particulate matter, as good model performance of the component species will dictate good model performance of total or reconstituted fine particulate matter. Model performance of the total fine particulate matter and the resulting total light extinction was also examined as a means to discuss the overall model performance. A full list of model performance statistics is found in Appendix E-3.

The soccer plots for all VISTAS and non-VISTAS monitors are included here for summary purposes. Plots have been developed for the monthly average performance statistics for the most significant light scattering component species (i.e. sulfate, nitrate, organic carbon, and elemental carbon).

The soccer plots of monthly concentrations show values for $PM_{2.5}$ (Figure 6-6) at CSN, IMPROVE monitors and sulfate (Figure 6-7), nitrate (Figure 6-8), organic carbon (Figure 6-9), and elemental carbon (Figure 6-10) at CSN, IMPROVE, CASTNET monitors in VISTAS and non-VISTAS states in the modeling domain. $PM_{2.5}$ is mostly inside the NMB and NME criteria for CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS. Sulfate is mostly inside the NMB and NME criteria for CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for CASTNet/VISTAS and CASTNet/non-VISTAS. Nitrate is mostly inside the NMB and NME criteria for CASTNet/VISTAS, CASTNet/non-VISTAS, CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS. Organic carbon is mostly inside the NMB and NME criteria for IMPROVE/VISTAS and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for CSN/VISTAS and CSN/non-VISTAS. Elemental carbon is mostly inside the NMB and NME criteria for CSN/VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for and CSN/non-VISTAS.

Figure 6-6 contains soccer plots of NMB and NME for total $PM_{2.5}$ at CSN and IMPROVE monitors. Most CSN values are within the NMB and NME criteria. For IMPROVE, four months are outside the NMB and NME criteria for the VISTAS states and six months are outside the NMB and NME criteria for the non-VISTAS states.

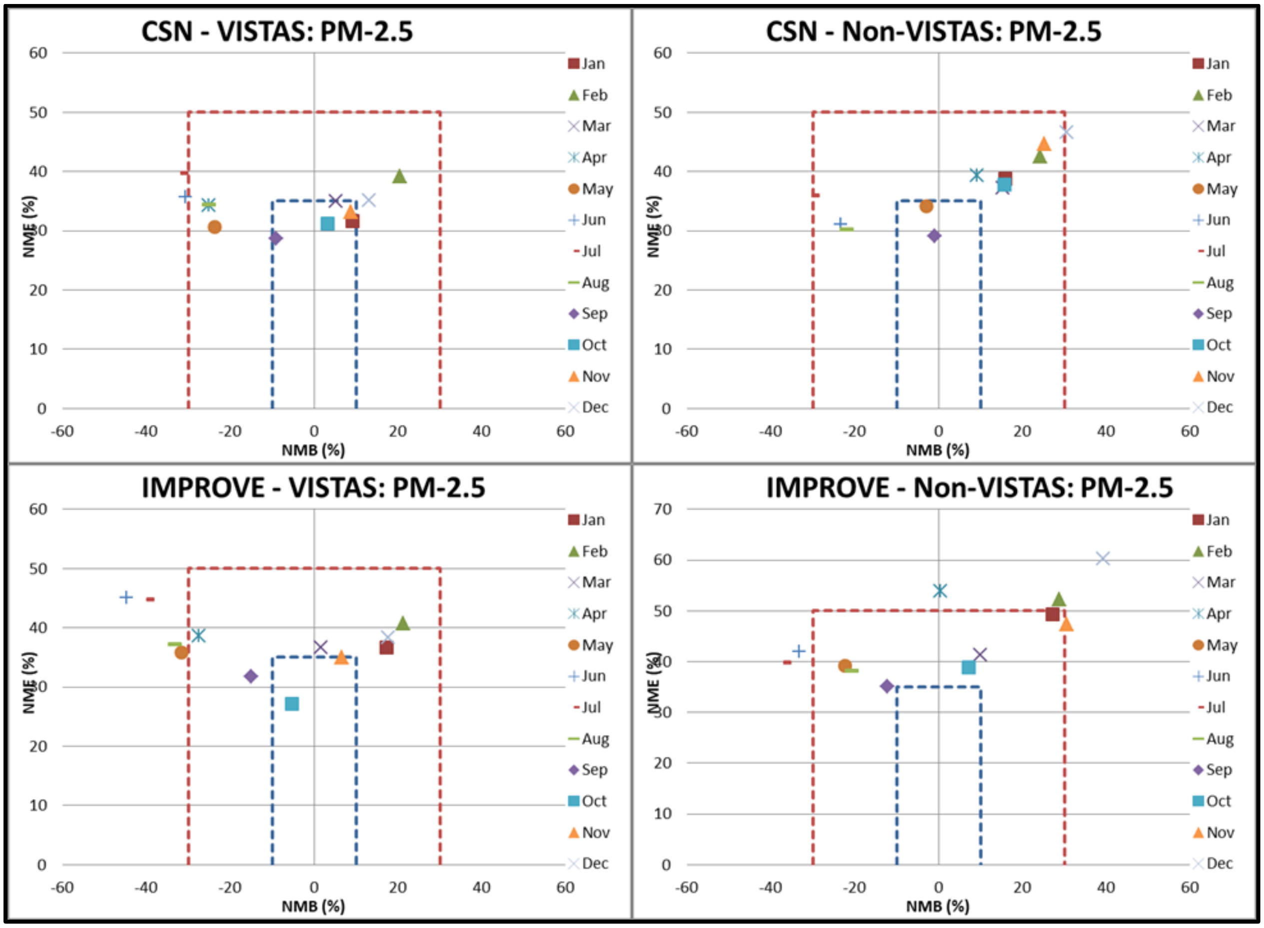



**Figure 6-6: Soccer Plots of Total $PM_{2.5}$ by Network and Month for VISTAS and Non-VISTAS Sites**

Figure 6-7 contains soccer plots of NMB and NME for sulfate at CASTNET, CSN, and IMPROVE monitors. For CASTNET, seven months are outside the NMB and NME criteria for the VISTAS states and seven months are outside the NMB and NME criteria for the non-VISTAS states. Most CSN values are within the NMB and NME criteria. For IMPROVE, two months are outside the NMB and NME criteria for the VISTAS states and no months are outside the NMB and NME criteria for the non-VISTAS states.

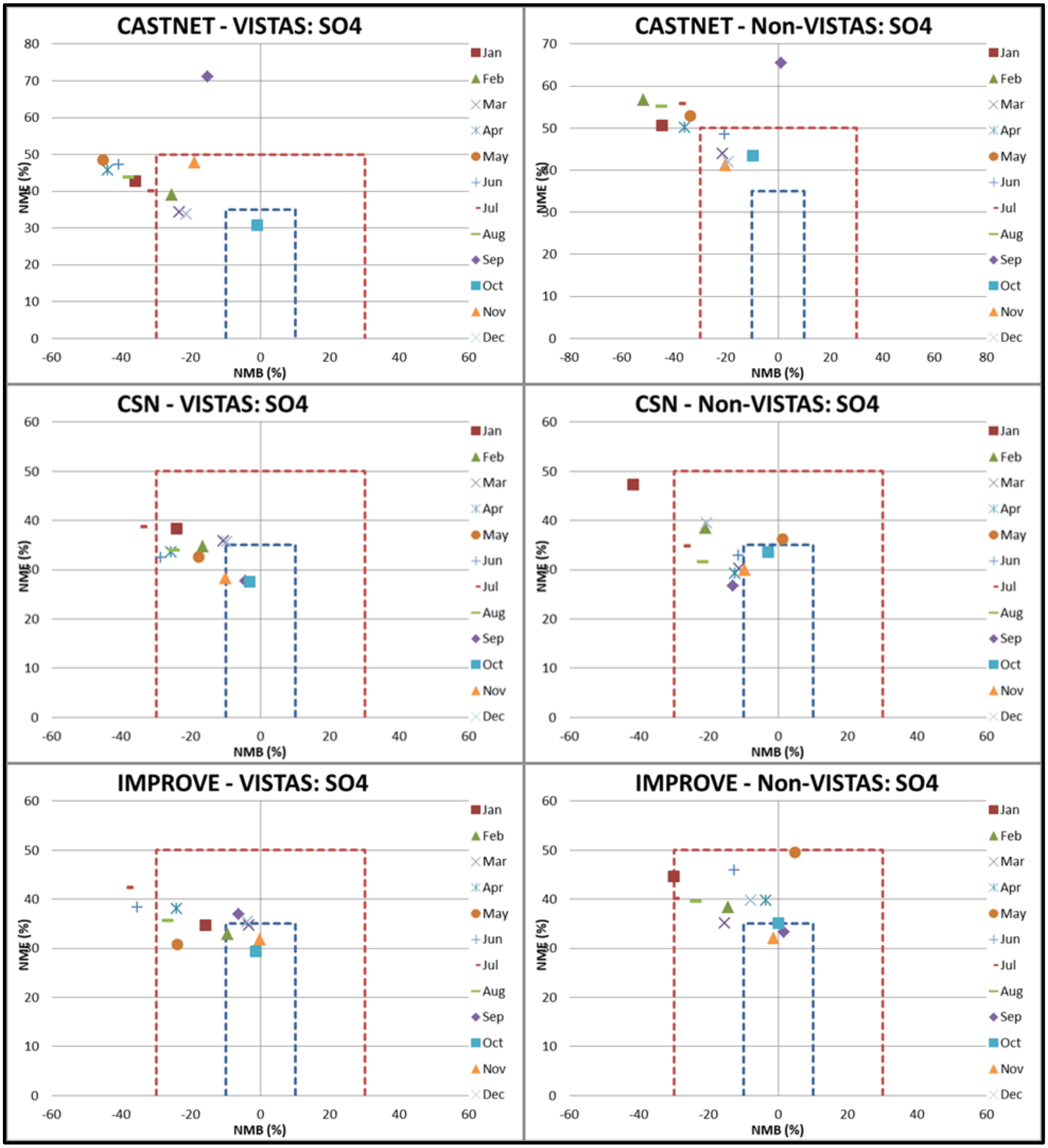



**Figure 6-7: Soccer Plots of Sulfate by Network and Month for VISTAS and Non-VISTAS Sites**

Figure 6-8 contains soccer plots of NMB and NME for nitrate at CASTNET, CSN, and IMPROVE monitors. Most CASTNET and CSN values are within the NMB and NME criteria. For IMPROVE, two months are outside the NMB and NME criteria for the VISTAS states and one month is outside the NMB and NME criteria for the non-VISTAS states.

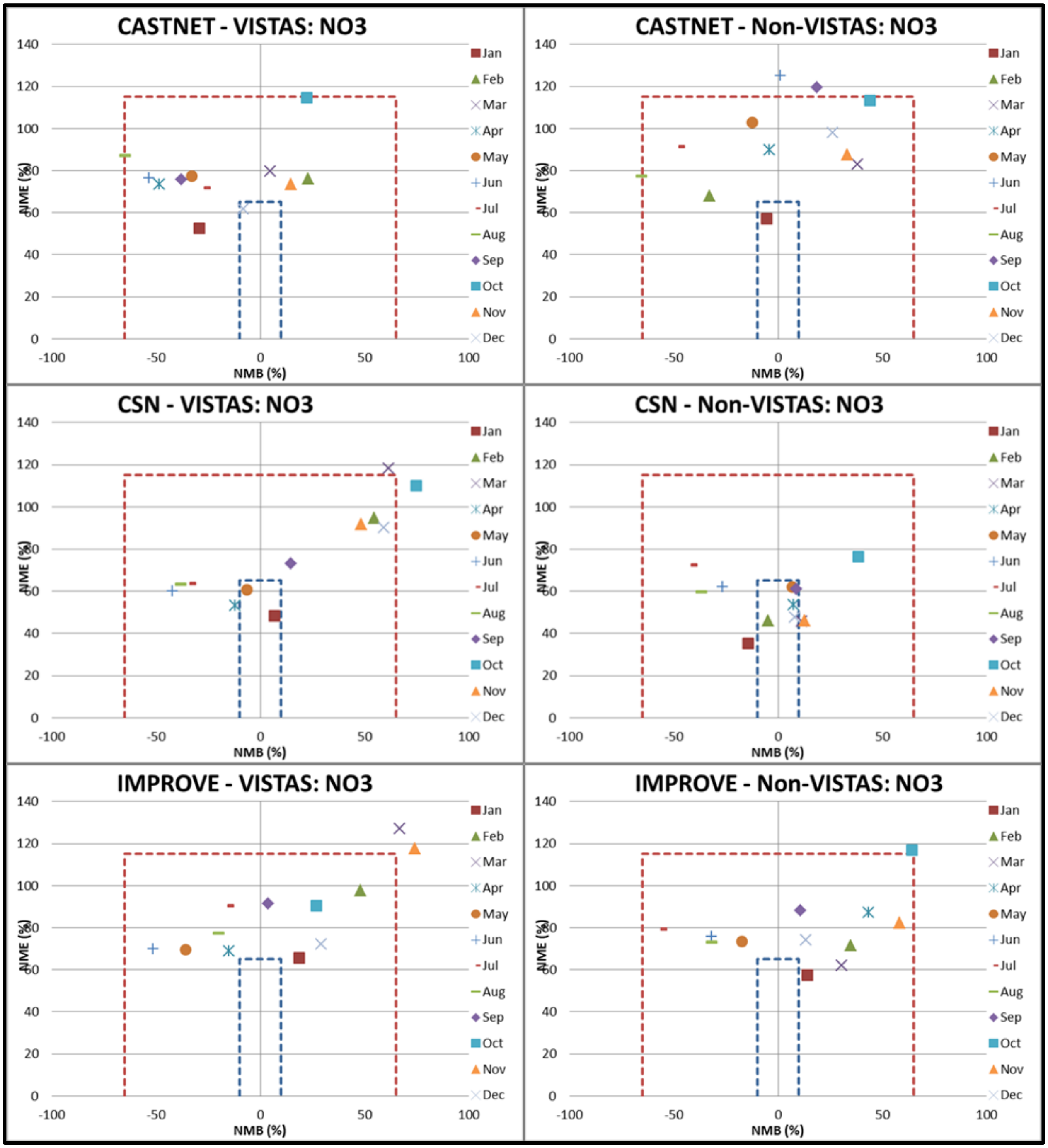



**Figure 6-8: Soccer Plots of Nitrate by Network and Month for VISTAS and Non-VISTAS Sites**

Figure 6-9 contains soccer plots of NMB and NME for organic carbon at CASTNET, CSN, and IMPROVE monitors. Most CSN values are outside the NMB and NME criteria. For IMPROVE, no months are outside the NMB and NME criteria for the VISTAS states and four months are outside the NMB and NME criteria for the non-VISTAS states.

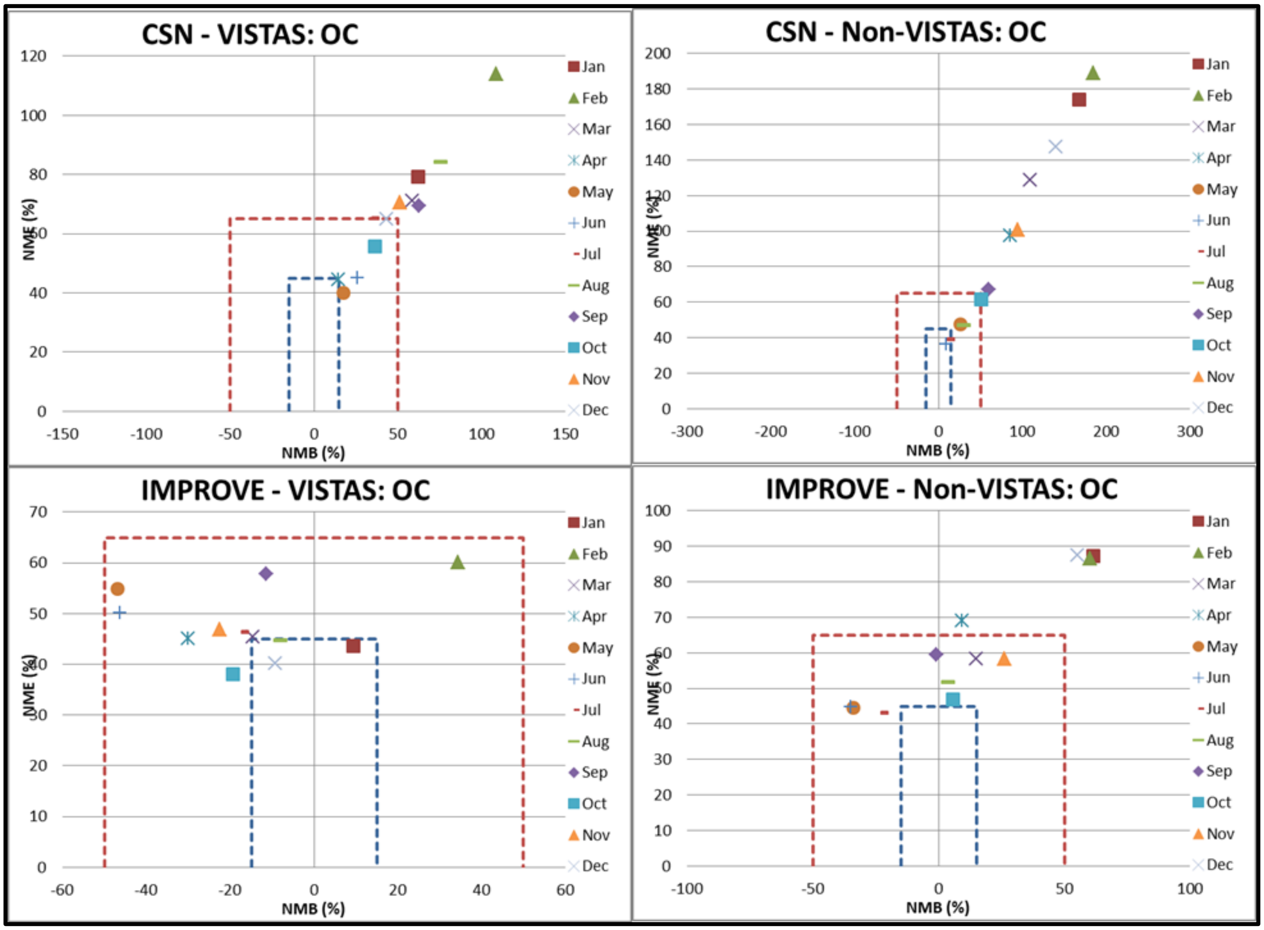



**Figure 6-9: Soccer Plots of OC by Network and Month for VISTAS and Non-VISTAS Sites**

Figure 6-10 contains soccer plots of NMB and NME for elemental carbon at CASTNET, CSN, and IMPROVE monitors. For CSN, two months are outside the NMB and NME criteria for the VISTAS states and six months are outside the NMB and NME criteria for the non-VISTAS states. For IMPROVE, one month is outside the NMB and NME criteria for the VISTAS states and five months are outside the NMB and NME criteria for the non-VISTAS states.

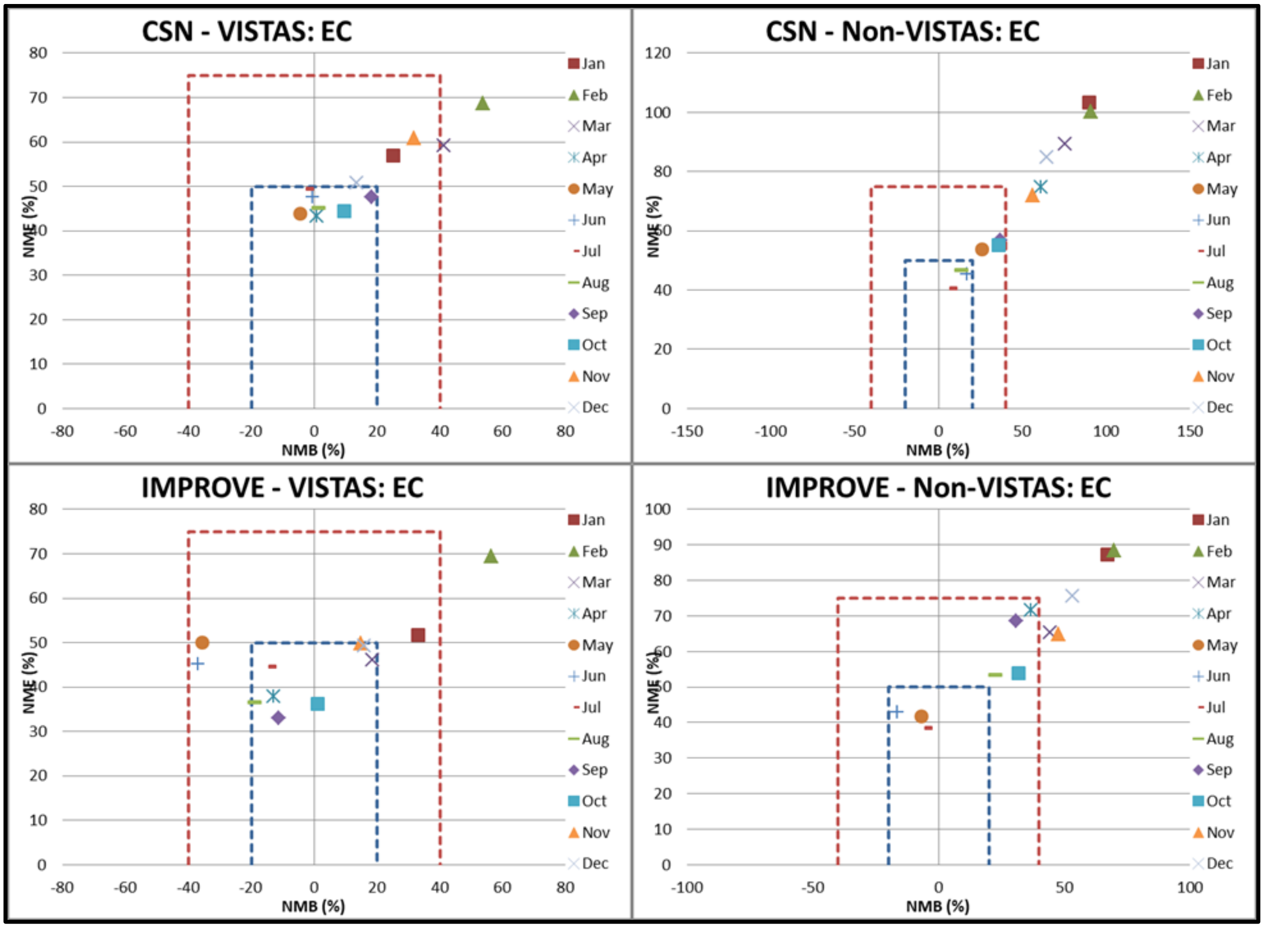



**Figure 6-10: Soccer Plots of EC by Network and Month for VISTAS and Non-VISTAS Sites**

Spatial plots summarizing IMPROVE observations and model NMB on the 20% most-impaired days are shown in Figure 6-11 through 6-16. In each figure, the top graphic presents the observed concentrations, and the bottom graphic presents the NMB.

For sulfate (Figure 6-11), predictions on the 20% most-impaired days are biased low across all regions, with the most significant percentage under predictions occurring in the southwest quarter of the VISTAS12 modeling domain. Some isolated over predictions are observed in a few Class I areas near the outer domain boundaries and in the northeast.

Predictions of nitrate (Figure 6-12) on the 20% most-impaired days in the VISTAS12 modeling domain are mixed with a high positive bias in the north and a mix of negative and positive bias in the southeast.

A general positive bias of OC (Figure 6-13) is observed across the region on the 20% most-impaired days. In the SESARM states, the OC has approximately the same NMB at monitors with high observed concentrations as monitors with lower observed concentrations. For EC (Figure 6-14) the model shows a slight under prediction at monitors in the northern portion of the SESARM states and a positive bias at monitors in the southern SESARM region.

On the 20% most-impaired days, model performance for total $PM_{2.5}$ (Figure 6-15) is overall biased low across most quadrants of the VISTAS12 modeling domain (corresponding closely to the sulfate performance). A slight over prediction of $PM_{2.5}$ on those days is observed in the Northern Plains and Upper Midwest, primarily along the Canadian border (corresponding closely to high nitrate concentrations and performance).

Sea salt (Figure 6-16) is generally over predicted along boundaries with ocean water bodies (Atlantic Ocean and Gulf of Mexico) and is expectedly under predicted across most of the rest of the VISTAS12 modeling domain.

Table 6-9 shows model performance statistics for the Class I Areas in VISTAS and closely surrounding VISTAS. The criteria for each statistic is listed in the first row. These criteria are listed in Table 6-6. The values in red text in Table 6-9 indicate that the criteria was not met. As stated previously, the model performance statistics should be looked for all of the VISTAS Class I Areas collectively. As such, the averages of the statistics were calculated. The second to last row of Table 6-9 shows the average of all the Class I Areas in the table and the last row shows the average of all the VISTAS Class I Areas. Of the five statistics listed in the table, only one (NMB) average did not meet the criteria, and it was only slightly above the criteria. The other four statistics meet the criteria.

The EPA guidance states that it is not appropriate to assign "bright line" criteria that distinguish between adequate and inadequate model performance with a single model performance test[34]. The EPA guidance recommends that a "weight of evidence" approach be used to determine whether a particular modeling application is acceptable for use in regulatory demonstrations. The EPA recommends that air agencies conduct a variety of performance tests and weigh them qualitatively to assess model performance.

For the most part, modeled and observed $PM_{2.5}$ concentrations and light extinctions at each Class I area match reasonably well on both 20% most-impaired days and clearest days. Although model performance for sulfate at each Class I area is biased low on the 20% most-impaired days, the model performance statistics for sulfate are reasonable for regulatory modeling. Additionally, the future year sulfate concentrations are not based on the absolute modeled values, but instead the model is applied in a relative sense through calculation of relative response factors (RRFs). The RRF is the relative change in sulfates between the base year modeled value and future year modeled value. The future year sulfate concentrations are then estimated by multiplying the base year actual monitored value by the RRF. Factors causing bias in the base case will also affect the future case; therefore, using the modeling in a relative sense resolves any problems posed by the underprediction of sulfates, and will not lead to an under-estimation of source contributions.

Overall, based on the weight of evidence approach recommended by EPA's guidance document, Alabama found model performance to fall within acceptable limits. In conclusion, performance assessed at the "one atmosphere" level was deemed acceptable for ozone, wet/dry deposition, and particulate matter at various monitoring sites. Alabama also asserts the one atmosphere modeling

[34] EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze, November 2018

performed by the VISTAS contractors is representative of conditions in the southeastern states and is acceptable for use in regulatory modeling applications for ozone, particulate matter, and regional haze.

**Table 6-9: Sulfate Model Performance Criteria for 20% Most Impaired Days in 2011**

| Class I Area | # Obs. | NMB (<±30%) | MFB (<±60%) | NME (<50%) | MFE (<75%) | r (>0.4) |
|---|---|---|---|---|---|---|
| Breton | 22 | -41.83 | -60.47 | 47.93 | 65.77 | 0.27 |
| Brigantine | 23 | -32.93 | -39.18 | 32.93 | 39.18 | 0.79 |
| Caney Creek | 11 | -46.01 | -70.2 | 52.63 | 75.57 | 0.49 |
| Cape Romain | 24 | -28.85 | -36.98 | 36.03 | 44.17 | 0.62 |
| Chassahowitzka | 24 | -39.37 | -48.96 | 44.06 | 54.49 | -0.06 |
| Cohutta | 18 | -28.18 | -32.67 | 33.06 | 38.07 | 0.14 |
| Dolly Sods | 24 | -27.18 | -30.24 | 34.55 | 37.86 | 0.63 |
| Everglades | 14 | -12.14 | -19.56 | 38.62 | 43.1 | 0.2 |
| Great Smokey Mountains | 23 | -36.92 | -46.25 | 41.47 | 51.74 | 0.22 |
| Hercules – Glade | 20 | -31.75 | -41.93 | 37.76 | 47.55 | 0.7 |
| James River Face | 24 | -36.62 | -44.57 | 36.89 | 44.88 | 0.52 |
| Linville Gorge | 23 | -16.32 | -19.66 | 30.87 | 35.2 | 0.49 |
| Mammoth Cave | 23 | -38.26 | -48.89 | 38.27 | 48.91 | 0.8 |
| Mingo | 19 | -31.4 | -38.96 | 31.88 | 39.67 | 0.64 |
| Okefenokee | 22 | -41.42 | -58.55 | 43.98 | 61.54 | 0.52 |
| Saint Marks | 22 | -40.16 | -56.91 | 48.3 | 65.37 | 0.37 |
| Shenandoah | 24 | -24.34 | -30.57 | 29.31 | 35.53 | 0.74 |
| Shining Rock[35] | 0 | -- | -- | -- | -- | -- |
| Sipsey | 19 | -35.37 | -43.37 | 35.37 | 43.37 | 0.75 |
| Swanquarter | 22 | -25.28 | -32.13 | 31.56 | 37.56 | 0.6 |
| Upper Buffalo | 23 | -17 | -27.18 | 30.66 | 37.22 | 0.71 |
| **AVERAGE – ALL** | **424** | **-31.82** | **-40.97** | **37.27** | **46.7** | **0.62** |
| **AVERAGE - VISTAS** | **306** | **-31.33** | **-39.76** | **36.93** | **45.95** | **0.63** |

[35] Shining Rock did not have valid monitoring data for 2011

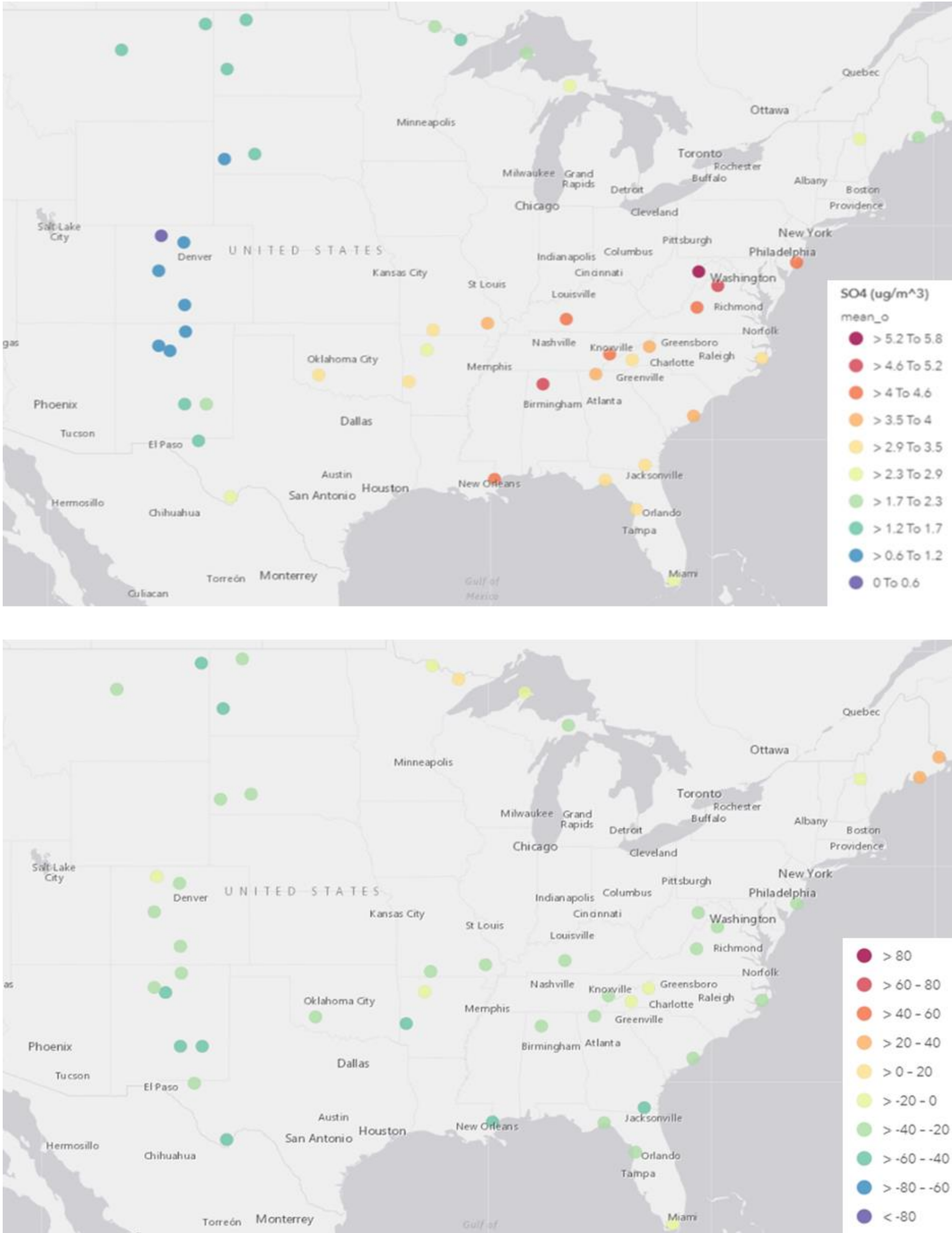



**Figure 6-11: Observed Sulfate (Top) and Modeled NMB (Bottom) for Sulfate on the 20% Most-Impaired Days at IMPROVE Monitor Locations**

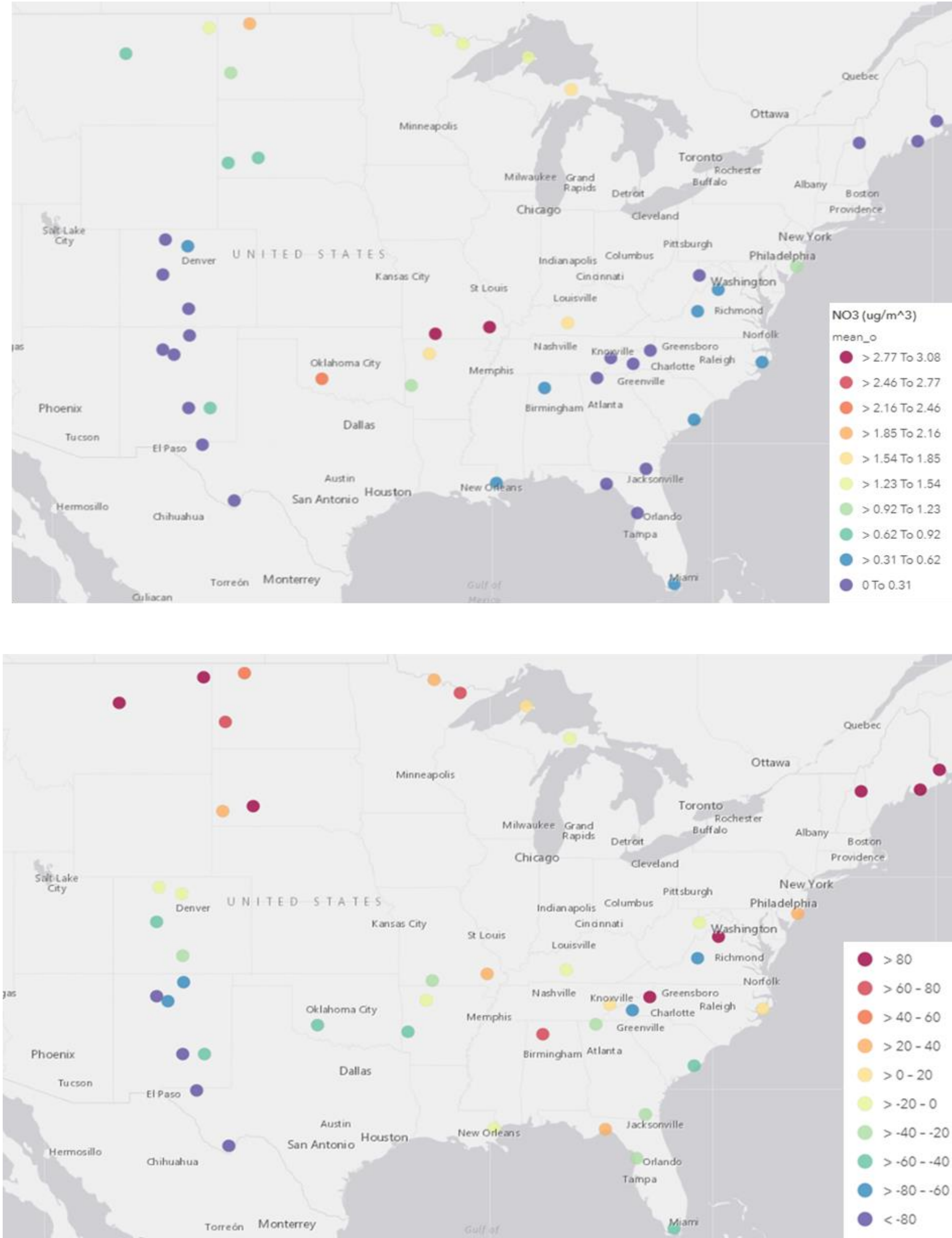



**Figure 6-12: Observed Nitrate (Top) and Modeled NMB (Bottom) for Nitrate on the 20% Most Impaired Days at Improve Monitor Locations**

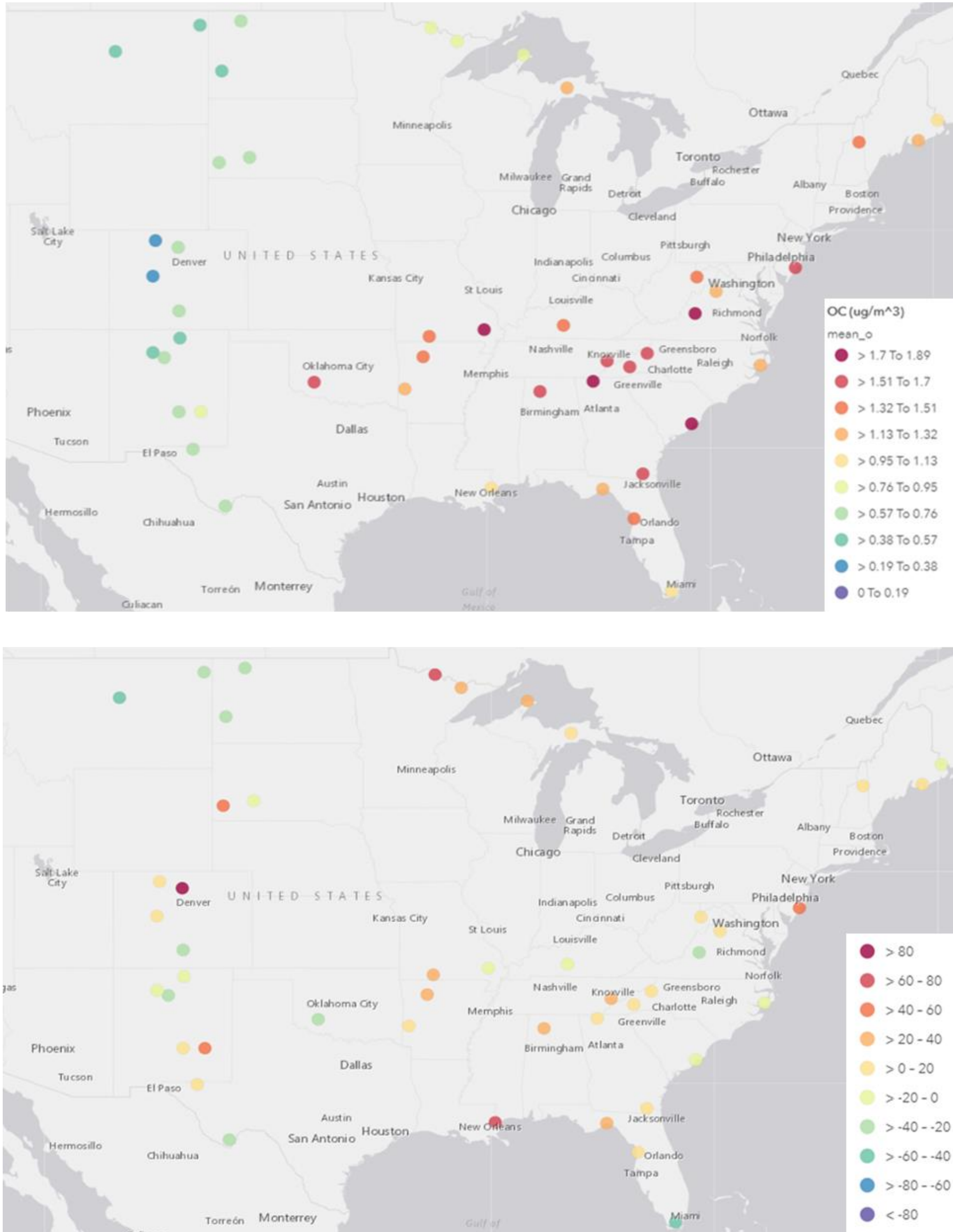



**Figure 6-13: Observed OC (Top) and Modeled NMB (Bottom) for OC on the 20% Most-Impaired Days at IMPROVE Monitor Locations**

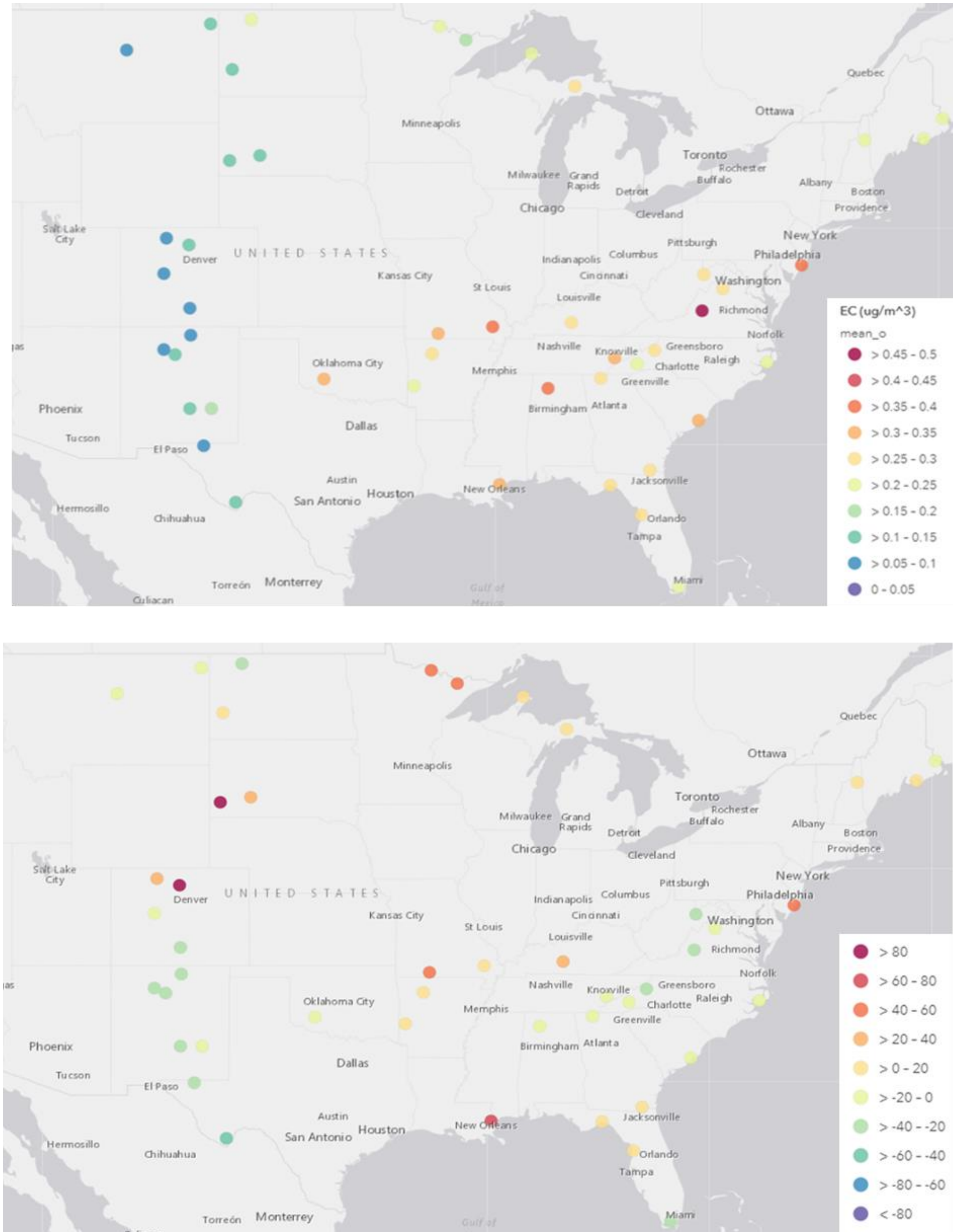



**Figure 6-14: Observed EC (Top) and Modeled NMB (Bottom) for EC on the 20% Most-Impaired Days at IMPROVE Monitor Locations**

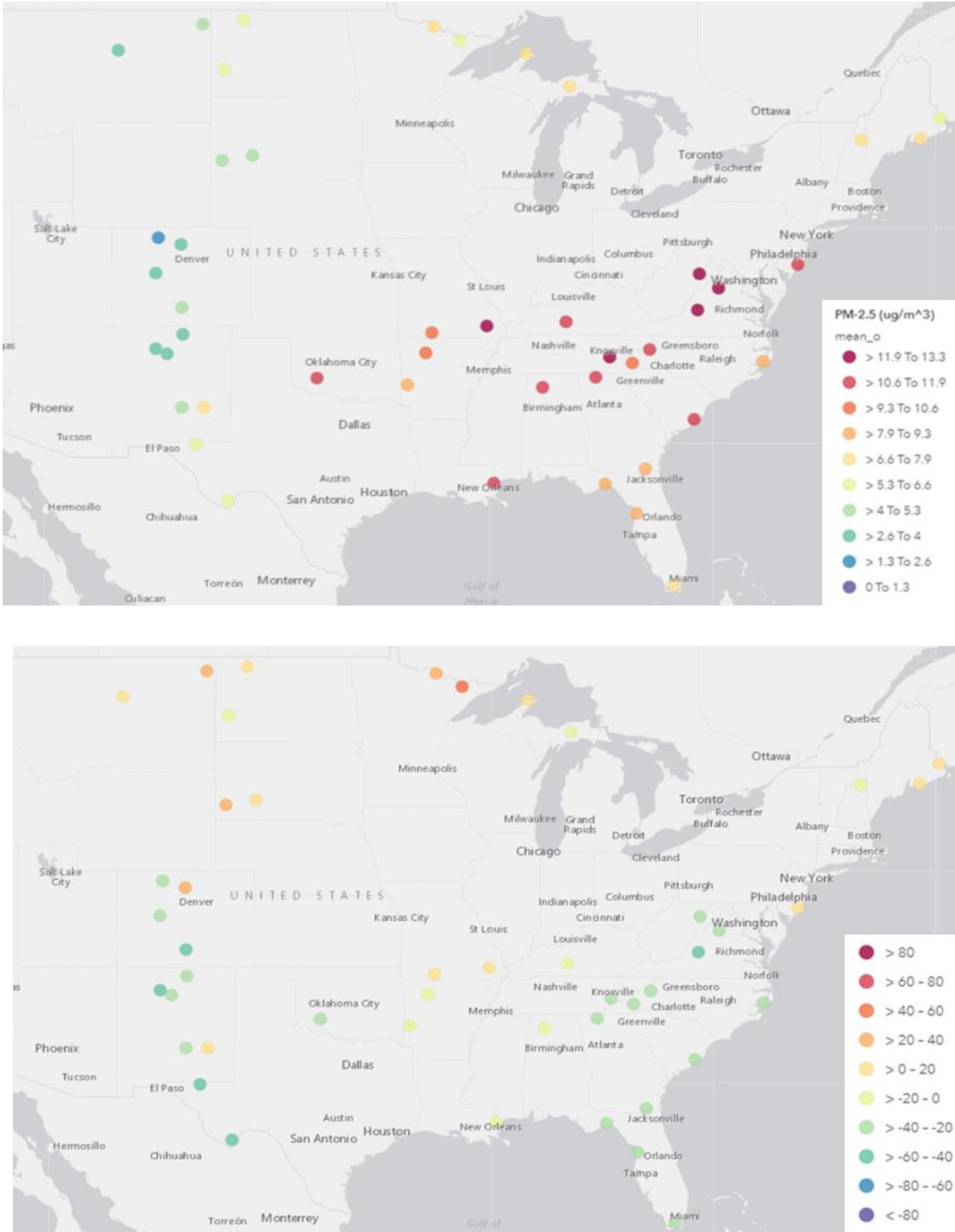



**Figure 6-15: Observed Total $PM_{2.5}$ (Top) and Modeled NMB (Bottom) for Total $PM_{2.5}$ on the 20% Most-Impaired Days at IMPROVE Monitor Locations**

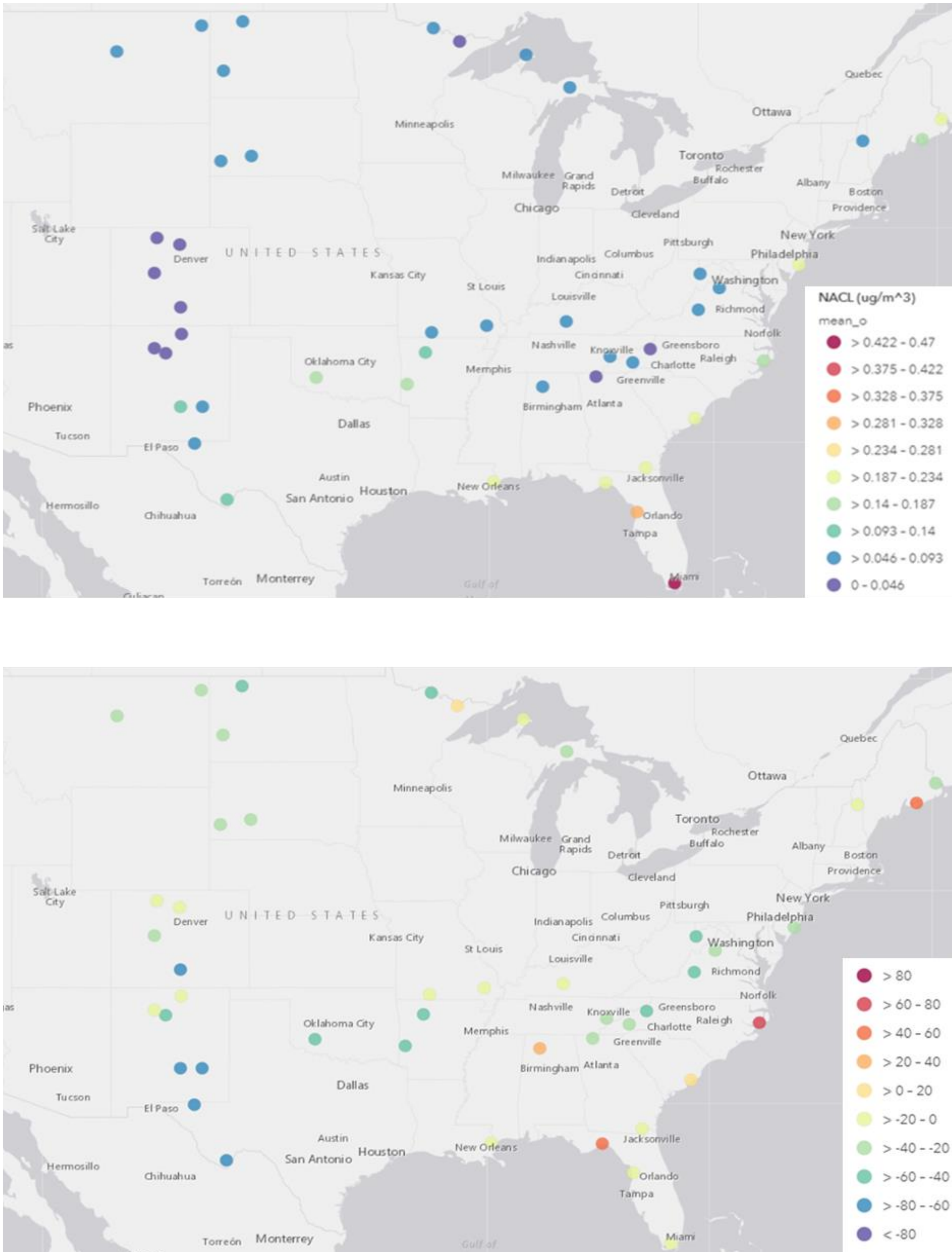



**Figure 6-16: Observed Sea Salt (Top) and Modeled NMB (Bottom) for Sea Salt on the 20% Most-Impaired Days at IMPROVE Monitor Locations**

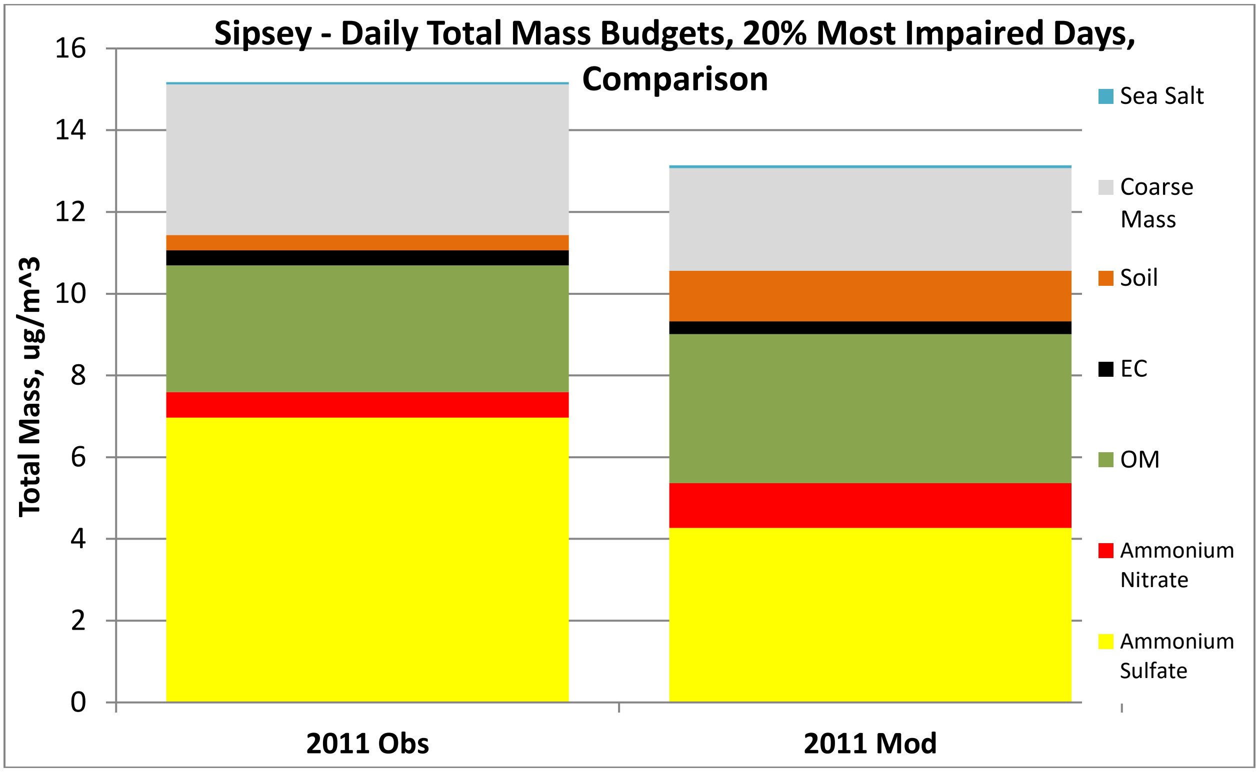
## 6.5. PM Model Performance Evaluation for the Sipsey Wilderness Area in Alabama

The following section provides a detailed model performance evaluation for the Sipsey Wilderness Area. This evaluation includes average stacked bar charts, day-by-day stacked bar charts, scatter plots, soccer plots, and bugle plots for the 20% most-impaired days and 20% clearest days.

Figure 6-17 and Figure 6-18 contain the average stacked bar charts for Sipsey. These figures include (1) observed and modeled mass concentrations of particulate matter constituents and (2) observed and modeled light extinctions constituents on the 20% most-impaired days and the 20% clearest days. The color codes for the stacked bars are:

- Yellow = mass concentrations of or light extinction due to sulfates
- Red = mass concentrations of or light extinction due to nitrates
- Green = mass concentrations of or light extinction due to organic carbon
- Black = mass concentrations of or light extinction due to elemental carbon
- Orange = mass concentrations of or light extinction due to soil
- Gray = mass concentrations of or light extinction due to coarse mass
- Blue = mass concentrations of or light extinction due to sea salt

Overall, modeled and observed $PM_{2.5}$ concentrations and light extinctions at Sipsey match reasonably well on both 20% most-impaired days and clearest days. Model performance for sulfate at Sipsey is biased low on 20% most-impaired days and slightly biased high on the 20% clearest days.



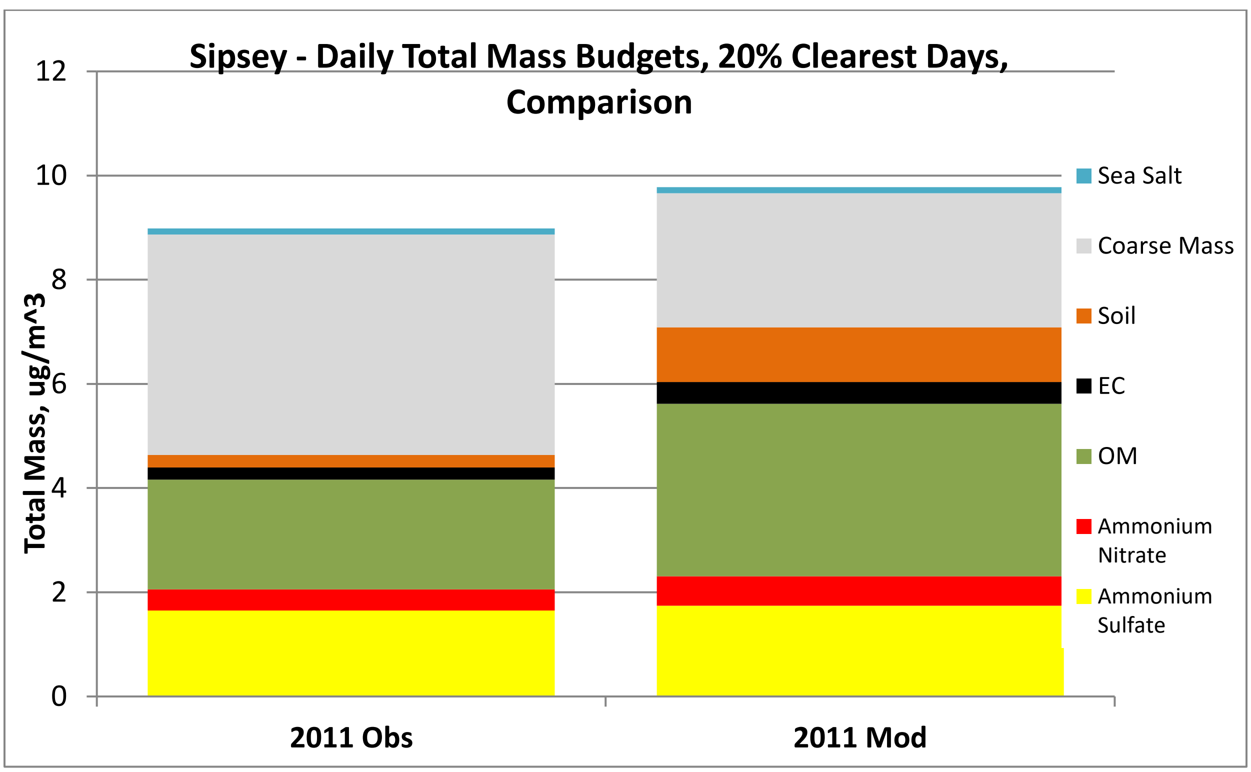
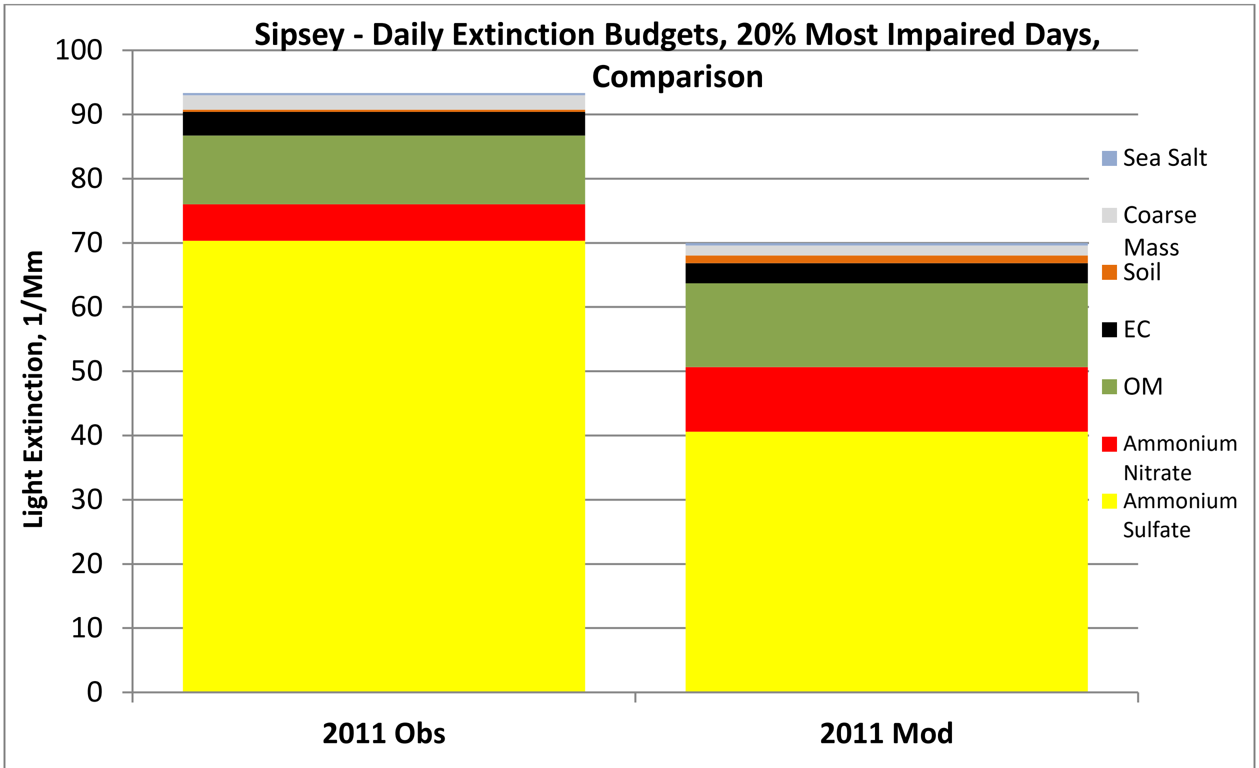




**Figure 6-17: Stacked Bar Charts for Average $PM_{2.5}$ Concentrations on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Sipsey**



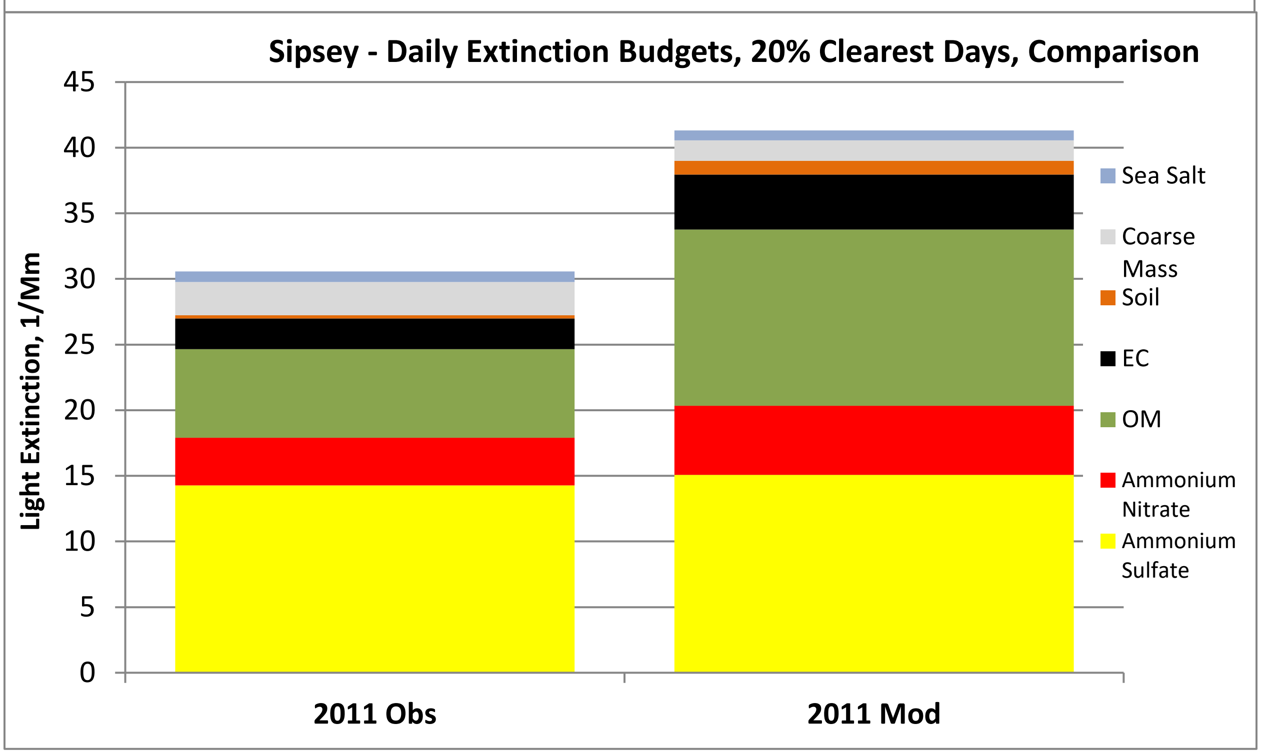




**Figure 6-18: Stacked Bar Charts for Average Light Extinction on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Sipsey**

Figure 6-22 through 6-22 contain the day-by-day stacked bar charts for the Sipsey Wilderness Area for the 20% most impaired and 20% clearest days. These charts allow a side-by-side comparison of observed and modeled speciated PM concentrations and speciated light extinctions on each of the 20% most impaired and 20% clearest days. The speciated components are presented in the same order for both the observations (left bar) and modeled data (right bar) to help identify specific days when the predicted mass concentrations or light extinction for the components differ from the observed values. The total height of the bar provides the total particulate matter mass concentrations or the total reconstructed light extinction values. It should be noted that values used for these stacked bar charts are from the grid cell where each IMPROVE monitor is located.

According to Figure 6-17 and 6-18 above, sulfates and organic carbon are the largest contributors to light extinction at Sipsey on both the 20% most impaired days and the 20% clearest days. Model performance discussion for individual species were further examined with scatter plots.

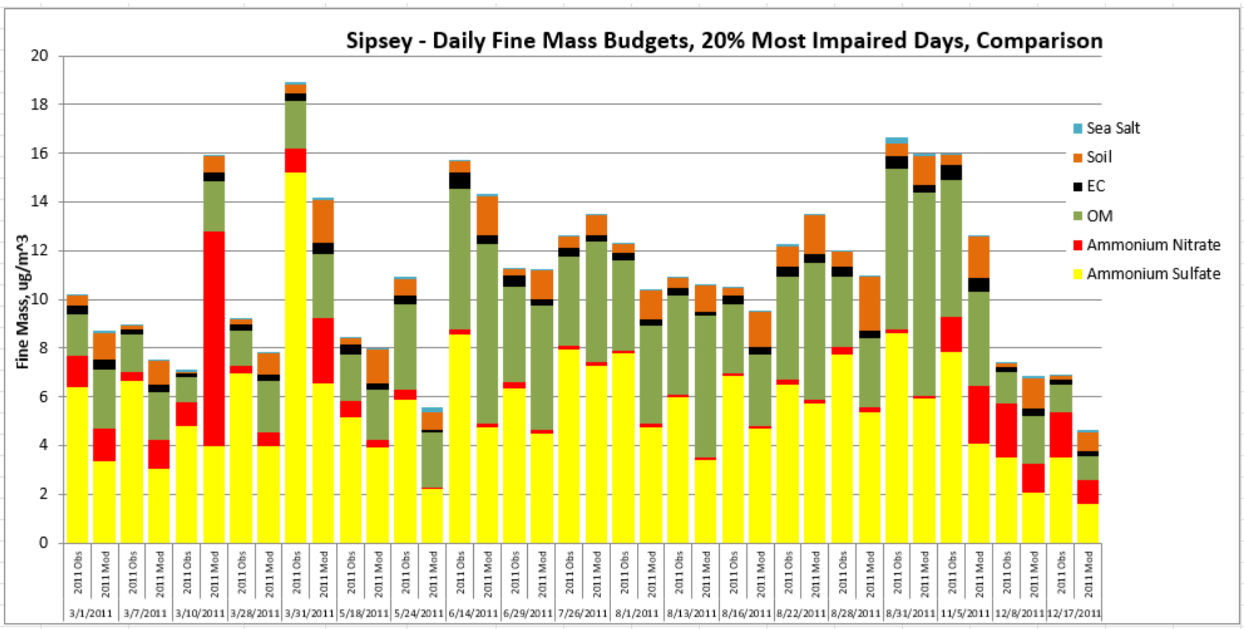



**Figure 6-19: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Sipsey on the 20% Most Impaired Days: Observation (left) and Modeled (Right)**

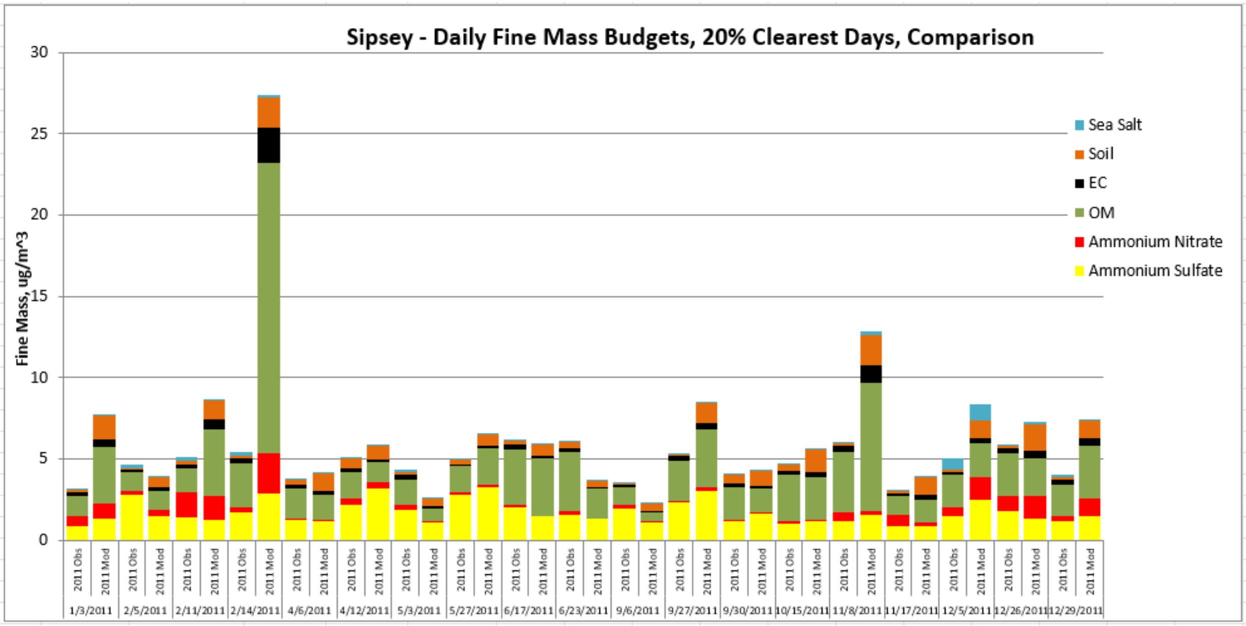



**Figure 6-20: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Sipsey on the 20% Clearest Days: Observation (left) and Modeled (Right)**

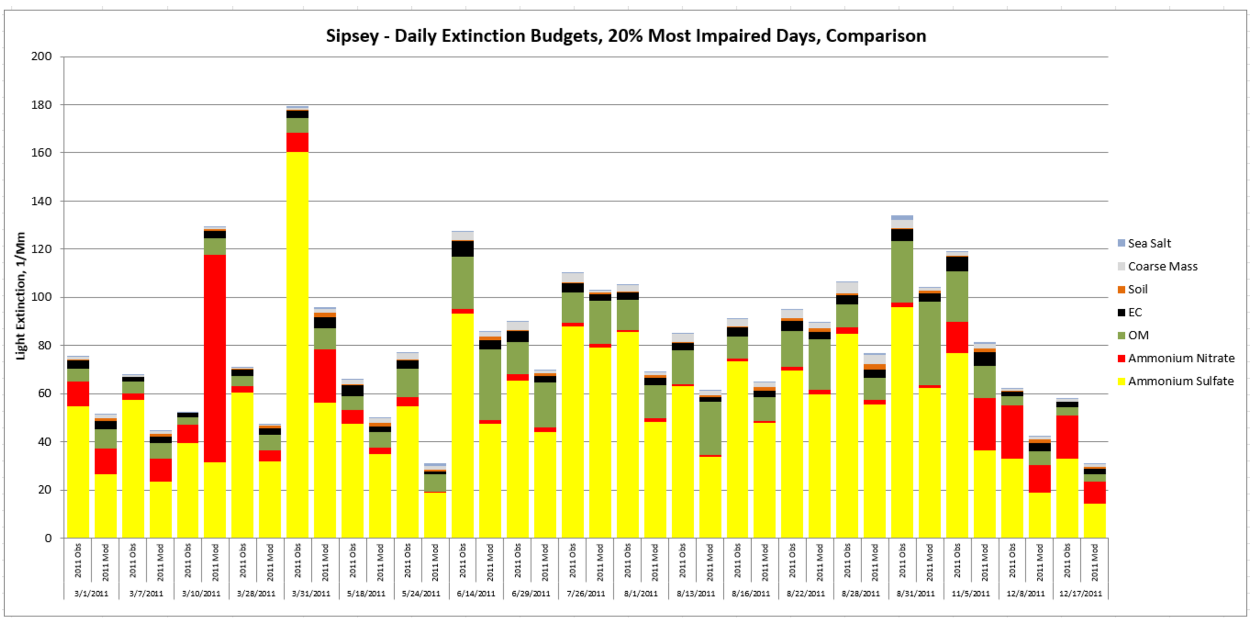



**Figure 6-21: Stacked Bar Charts for Light Extinction at Sipsey on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)**

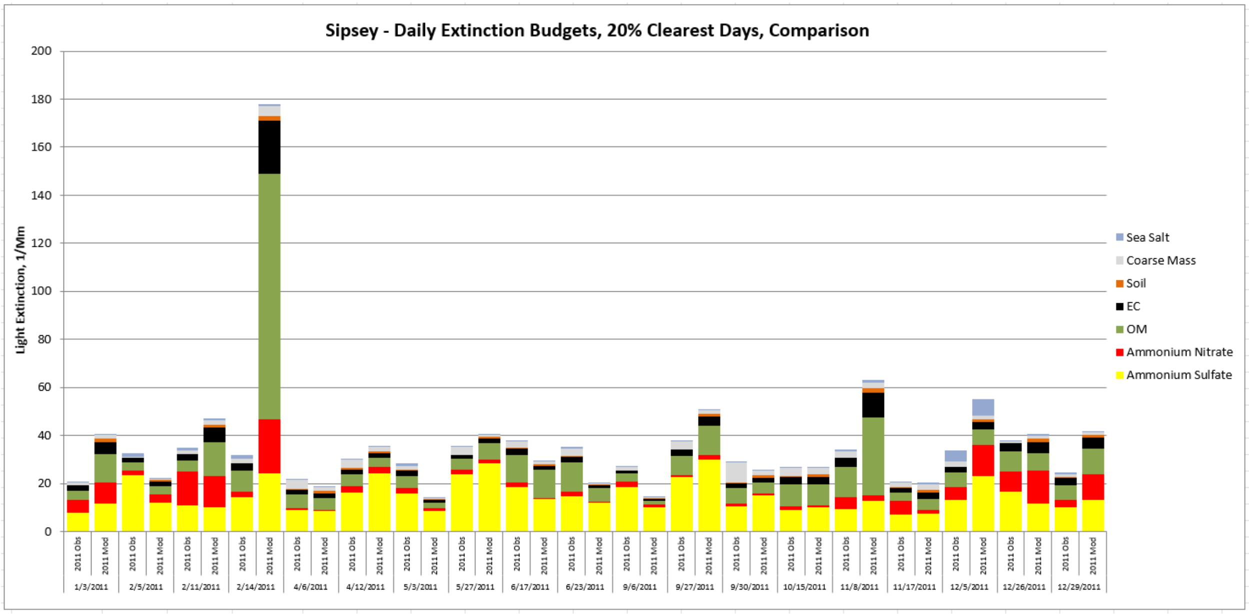



**Figure 6-22: Stacked Bar Charts for Light Extinction at Sipsey on the 20% Clearest Days: Observation (left) and Modeled (Right)**

Figure 6-24 and 6-24 contain the scatter plots of daily observations vs. modeled concentration for $PM_{2.5}$, sulfate, nitrate, organic carbon, elemental carbon, crustal (labeled as soil), sea salt, and coarse mass for Sipsey on the 20% most impaired days. $PM_{2.5}$, sulfate, EC, and coarse mass (labeled as PMC) were generally under predicted while crustal and OC were generally over predicted.  Nitrate and sea salt show both over predictions and under predictions.

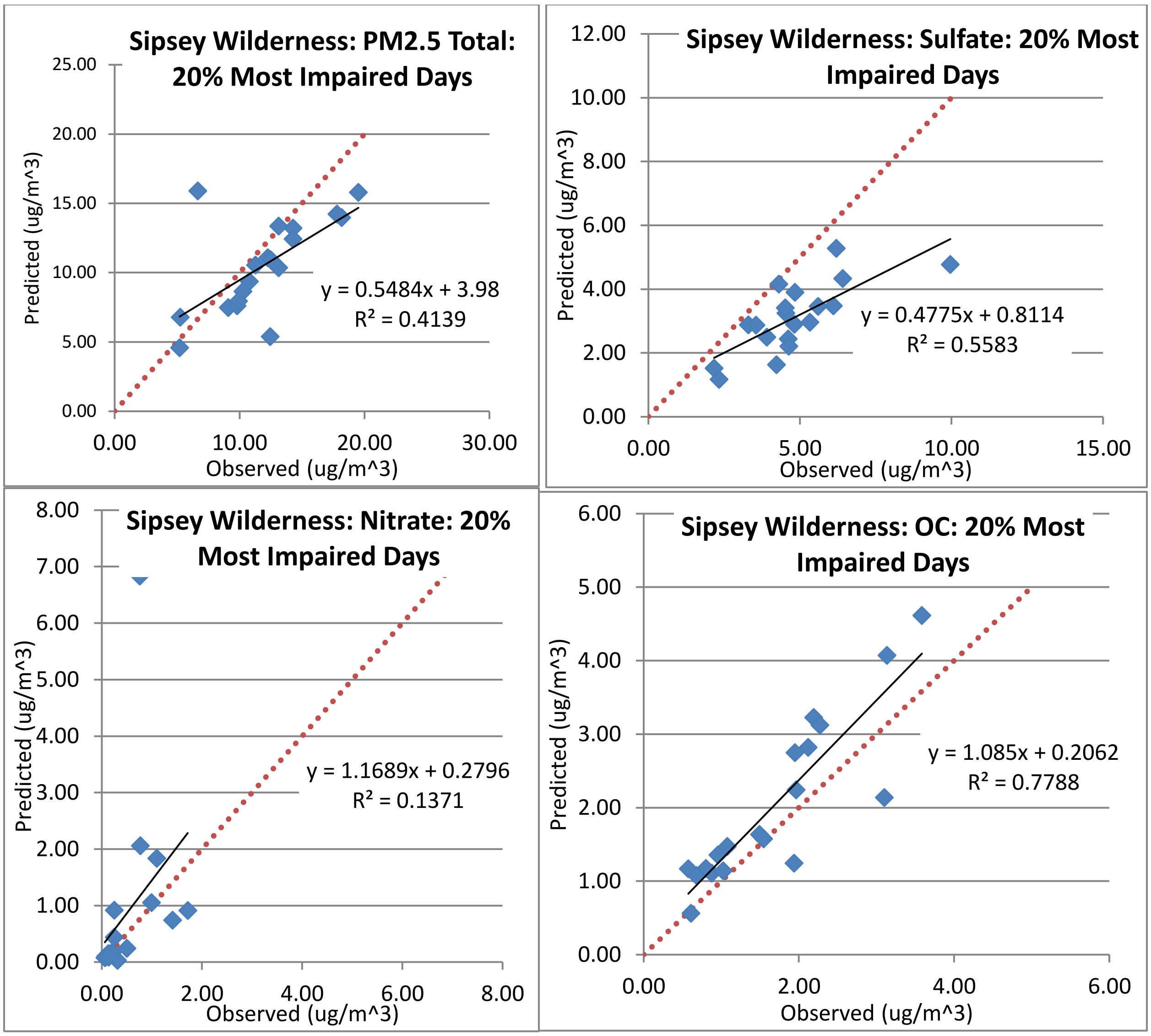



**Figure 6-23: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Sipsey on the 20% Most Impaired Days**

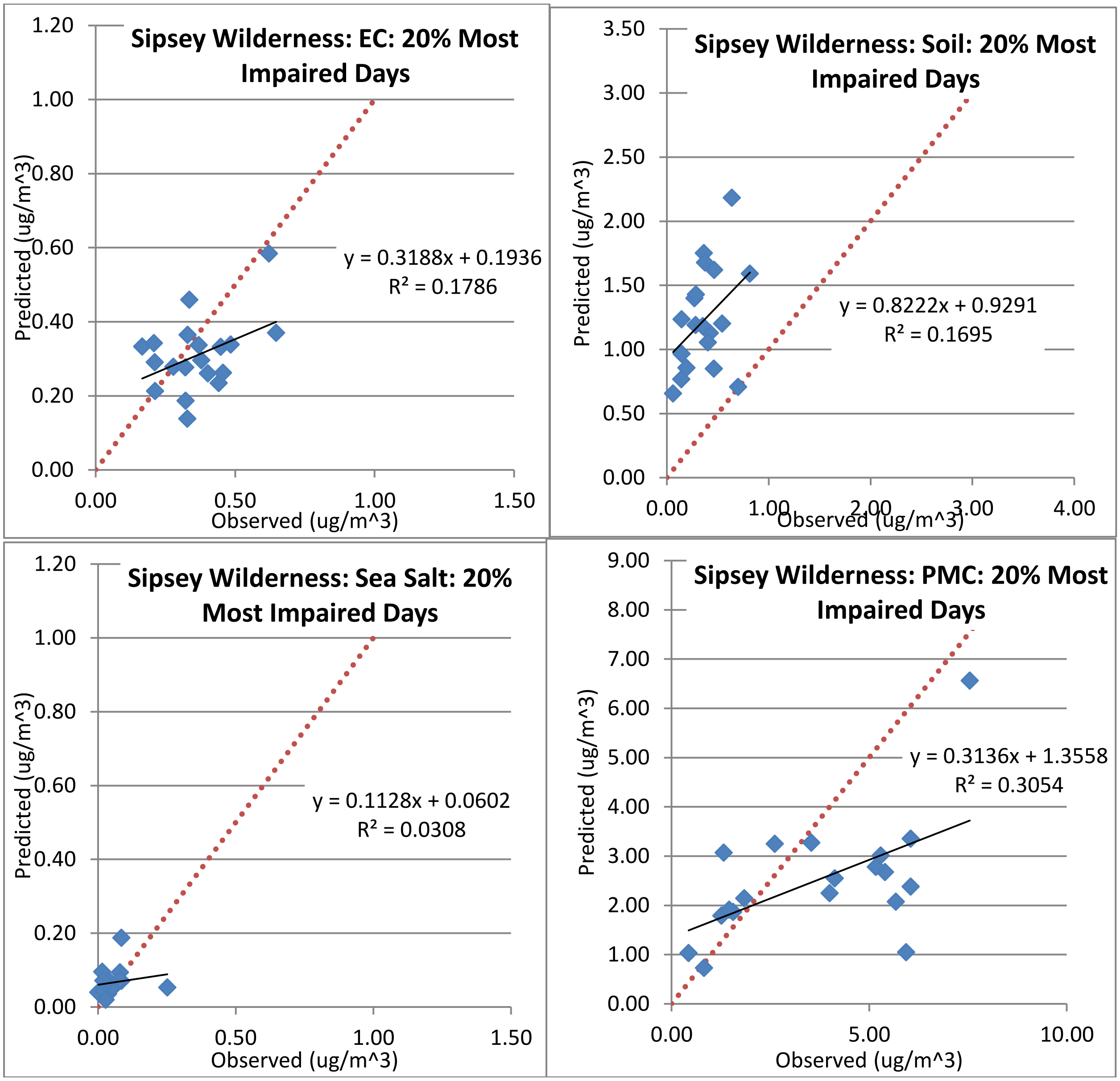



**Figure 6-24: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Sipsey on the 20% Most Impaired Days**

Figure 6-25 and 6-26 contain the scatter plots of daily observations vs. modeled concentration for $PM_{2.5}$, sulfate, nitrate, organic carbon, elemental carbon, crustal (labeled as soil), sea salt, and coarse mass (labeled as PMC) for Sipsey on the 20% clearest days. $PM_{2.5}$, sulfate, elemental carbon, and crustal were generally over predicted. Nitrate, organic carbon, sea salt, and coarse mass show both over predictions and under predictions.

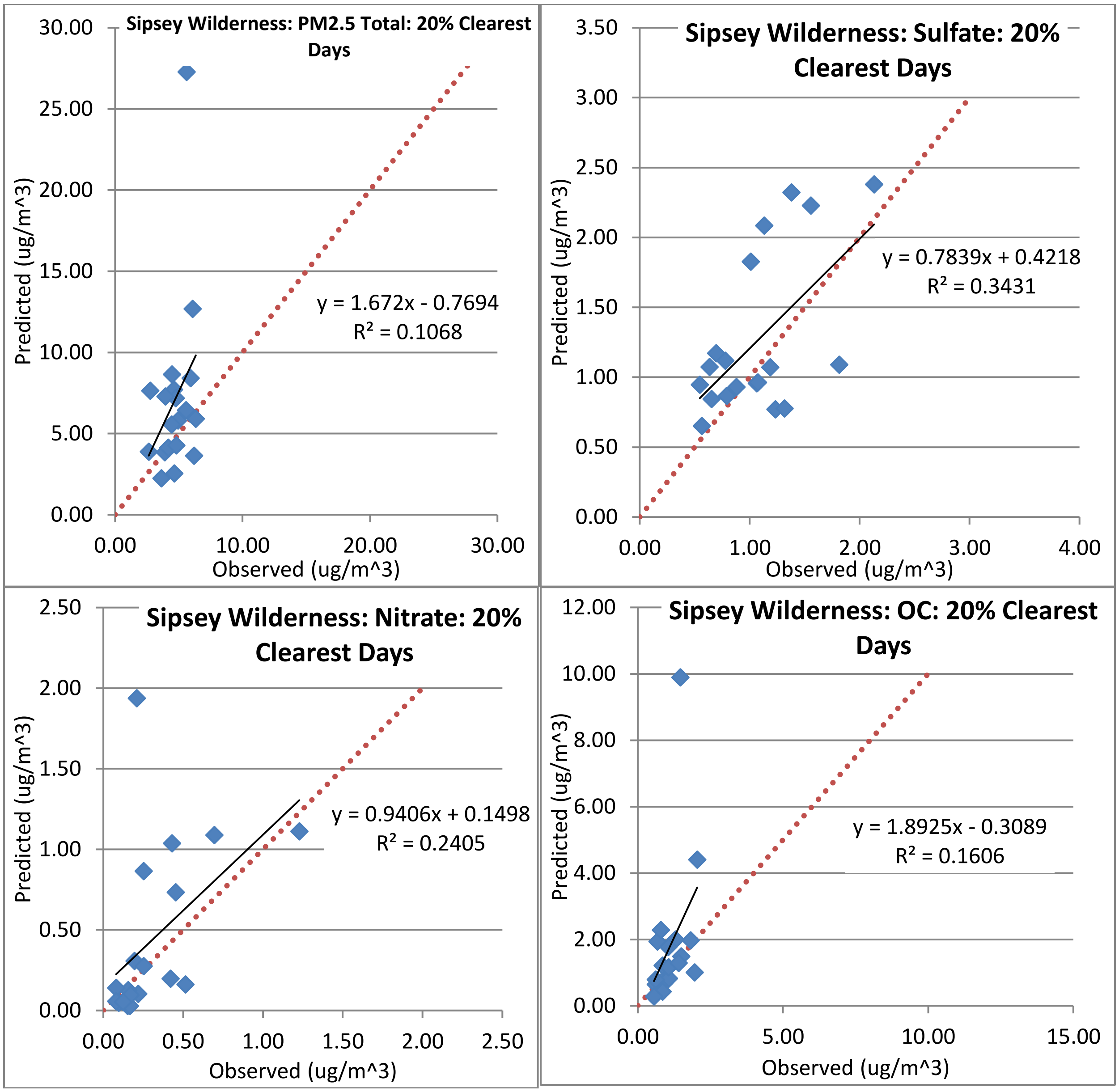



**Figure 6-25: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Sipsey on the 20% Clearest Days.**

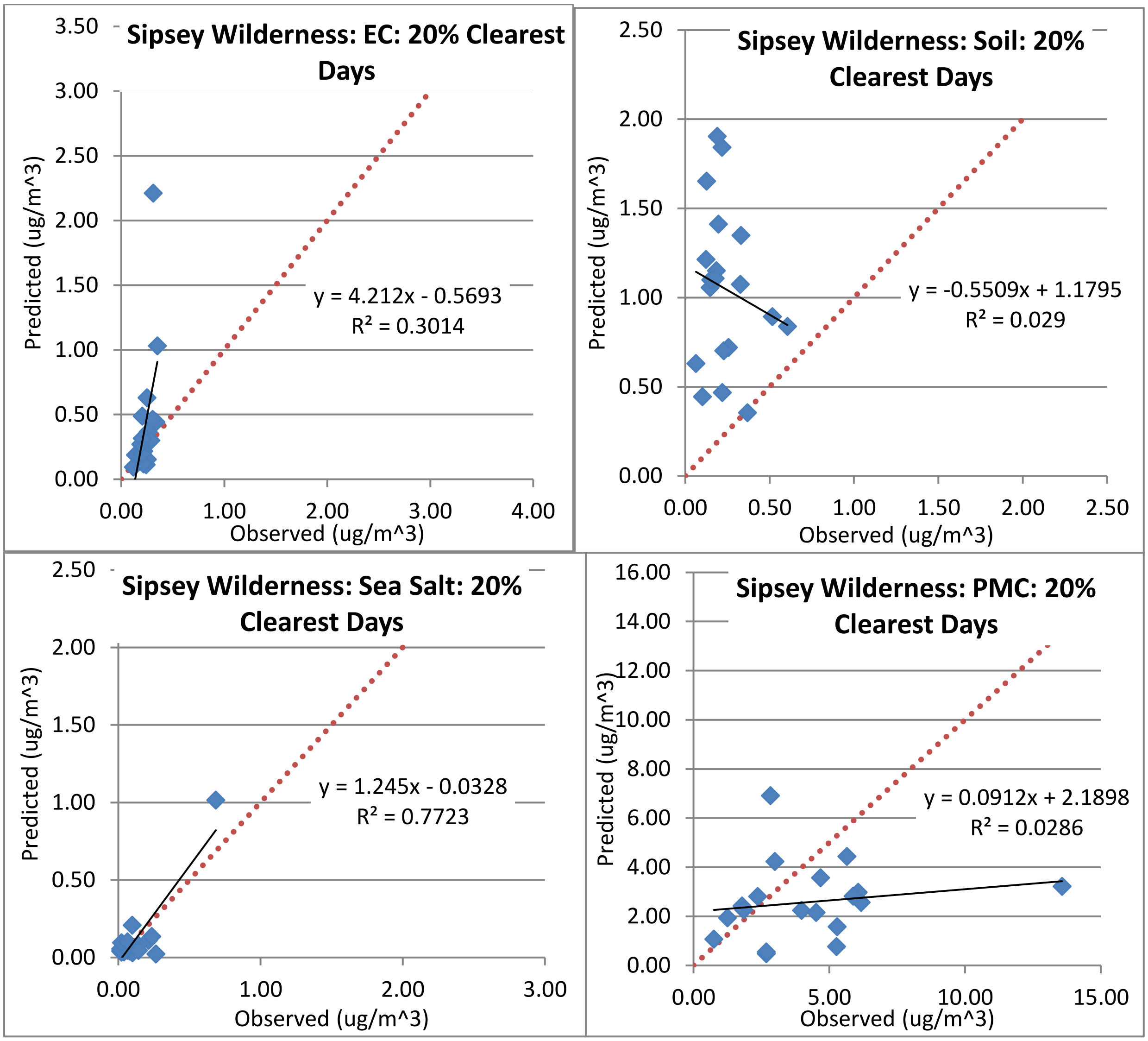



**Figure 6-26: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Sipsey on the 20% Clearest Days**

Figures 6-27 and 6-28 contain soccer plots showing NMB and NME for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Sipsey on the 20% most impaired days and the 20% clearest days. For Sipsey on the 20% most impaired days, sulfate, organic carbon, elemental carbon, and coarse mass meet the NMB and NME criteria while crustal and nitrate do not.  For Sipsey on the 20% clearest days, sulfate, organic carbon, nitrate, and coarse mass meet the NMB and NME criteria while elemental carbon, and crustal do not.

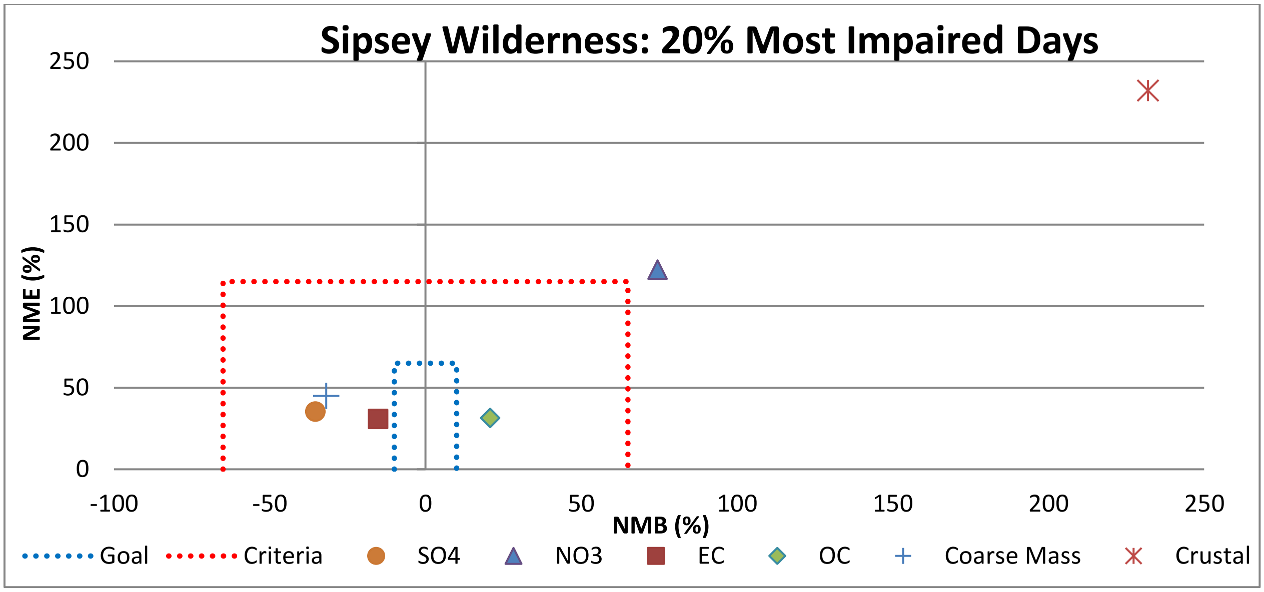



**Figure 6-27: Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Sipsey**

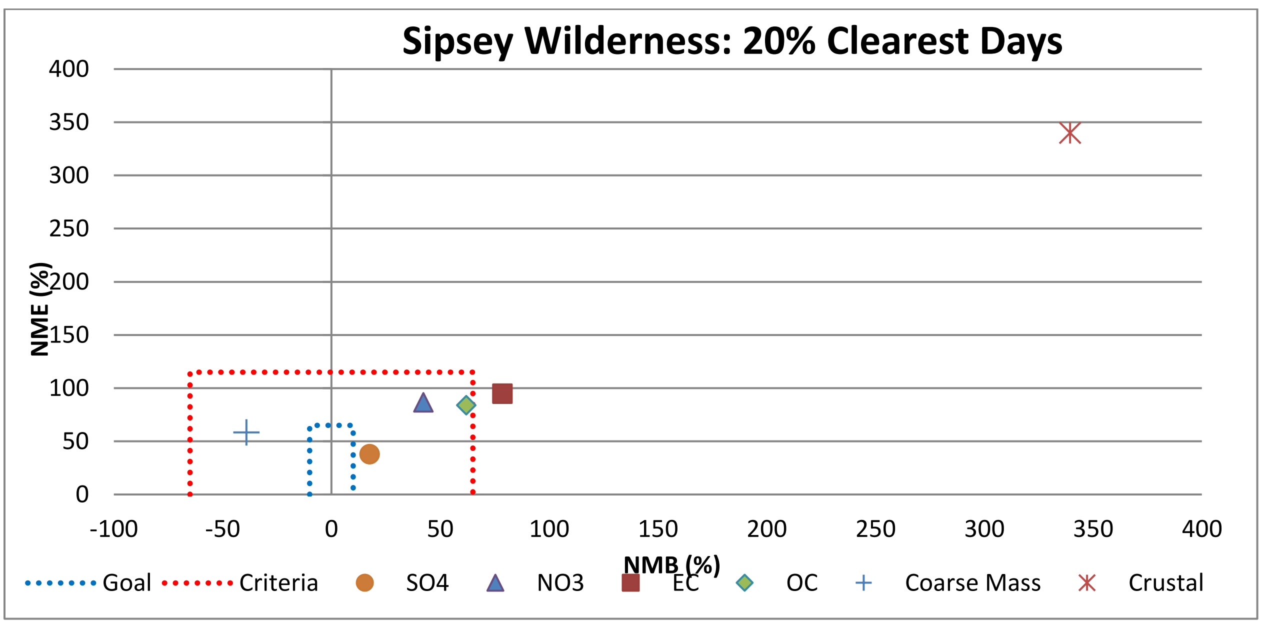



**Figure 6-28:  Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Sipsey**

Figures 6-29 and 6-30 contain bugle plots showing the Mean Fractional Bias (MFB) and the Mean Fractional Error (MFE) for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Sipsey on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days and the 20% clearest days, all species meet the MFB and MFE criteria (red line). On the 20% most impaired days and the 20% clearest days, all species (except crustal and sulfate MFB on 20% most impaired days and coarse mass MFB and MFE on the 20% clearest days) meet the MFB and MFE goal (green line).

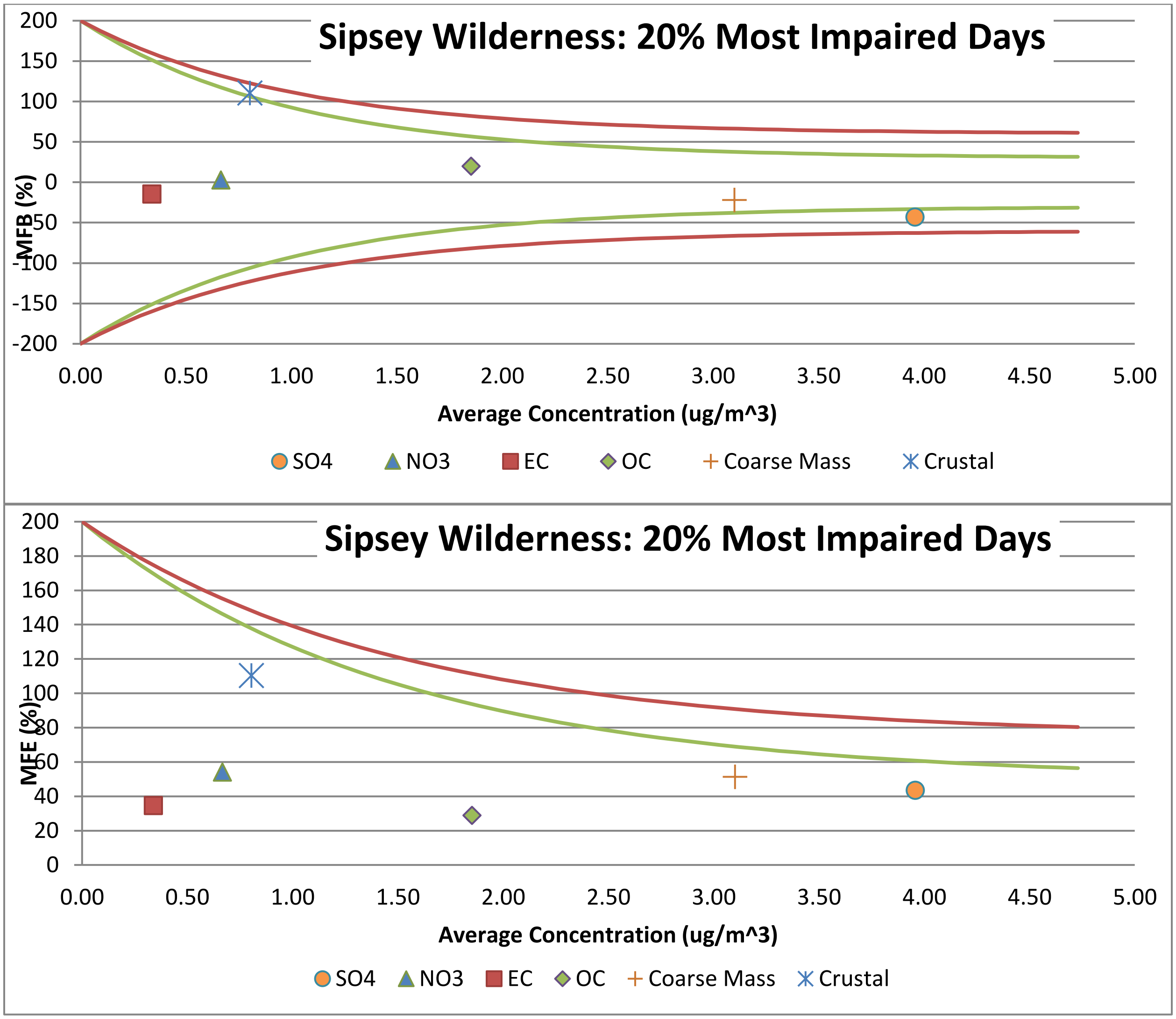



**Figure 6-29: Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Sipsey**

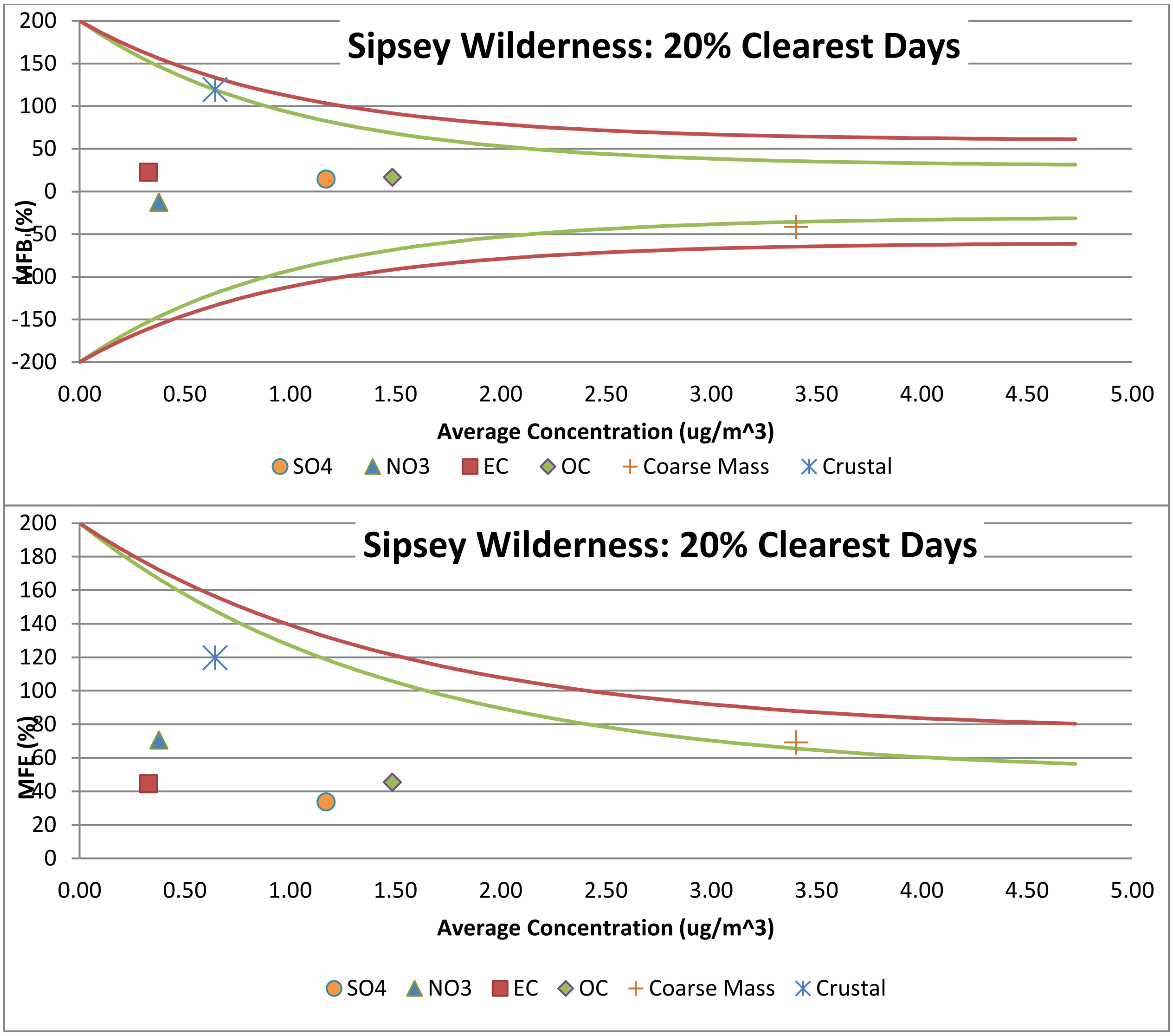



**Figure 6-30: Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Sipsey**

Overall, model performance at Sipsey fell within acceptable limits. Therefore, the one atmosphere modeling performed by the VISTAS contractors is representative of conditions in the southeastern states and is acceptable for use in regulatory demonstrations to support Alabama's Regional Haze SIP.

# 7. Long-Term Strategy (LTS)

The Regional Haze Rule at 40 CFR 51.308(f)(2) requires states to submit a Long-Term Strategy (LTS) addressing regional haze visibility impairment for each mandatory Federal Class I area within the state and for each mandatory Federal Class I area located outside the state that may be affected by emissions from the state. The LTS must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress. The Rule at 40 CFR 51.308(f)(3) requires that states containing mandatory Federal Class I areas must establish reasonable progress goals (RPGs) expressed in dv. These RPGs must reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of those enforceable emission limitations, compliance schedules, and other measures established as part of the LTS, as well as the implementation of other CAA requirements. The RPGs, while not directly federally enforceable, must be met through measures contained in the state's LTS through the year 2028. This section discusses the development of Alabama's LTS. Section 7.8 specifies measures in the LTS that Alabama deems necessary for reasonable progress and proposes that these measures be incorporated into the regulatory portion of the SIP. Alabama proposes that all other measures in the LTS not be incorporated into the regulatory portion of the SIP.

## 7.1. Overview of the LTS Development Process

The monitoring data and modeling analyses included with the first Regional Haze SIP established that, for the VISTAS region, the key contributors to regional haze in the 2000-2004 baseline timeframe were large stationary sources of $SO_2$ emissions. Figure 2-1 shows the daily visibility data for the 20% most impaired days during the baseline period for the Sipsey Wilderness Area. Sulfate accounted for the vast majority of the pollutant impairing species on these days, and the visibility data for the baseline period for most VISTAS Class I areas showed this same trend.

More current speciation data for years 2014 through 2018 show significant visibility improvement on the 20% most impaired days. As shown in Figure 2-7 for Sipsey, sulfate continues to be the predominant visibility impairing species. Unlike the data for the baseline period of 2000 to 2004, where nearly all days with poor visibility were heavily dominated by sulfate impairment, the 2014 to 2018 data show some 20% most impaired days having large organic matter or nitrate impacts at Sipsey. The organic matter components on poor visibility days are associated with episodic events while the nitrate components are associated with anthropogenic emissions. However, the visibility during the majority of 20% most impaired days at Sipsey during the period 2014 to 2018 continue to be impacted most heavily by sulfate. The 2014 to 2018 IMPROVE data for other VISTAS Class I areas, provided in Appendix C, show similar trends. Therefore, reducing $SO_2$ emissions continues to be important for generating further visibility improvements for this planning period. Keeping this conclusion in mind, this section addresses the following questions:

- Assuming implementation of existing federal and state air regulatory requirements in Alabama and the VISTAS region, how much visibility improvement, compared to the glide path, is expected at Sipsey by 2028?

- Which mandatory Federal Class I areas located outside of Alabama are significantly impacted by visibility impairing pollutants originating from within Alabama?

- If additional emission reductions were needed, from what pollutants and source categories would the greatest visibility benefits be realized by 2028?

- Where are these pollutants and source categories located?

- Which specific individual sources in those geographic locations have the greatest visibility impacts at a given mandatory Federal Class I area?

- What additional emission controls represent reasonable progress for those specific sources?

## 7.2. Expected Visibility in 2028 for Sipsey Under Existing and Planned Emissions Controls

Several significant control programs are expected to reduce emissions of visibility impairing pollutants between the base year 2011 and the future projection year of 2028. These programs are described in more detail below.

### 7.2.1. Federal Control Programs Included in the 2028 Projection Year

Federal control programs impacting onroad and off-road engines, as well as industrial and EGU facilities, have reduced, and will continue to reduce emissions of $SO_2$ and $NO_X$. The reductions from these programs, as described below, are included in the 2028 future year estimates upon which visibility projections are based.

#### 7.2.1.1. Federal EGU and Industrial Unit Trading Programs

The CAA requires each upwind state to ensure that it does not interfere with either the attainment of a NAAQS or continued compliance with a NAAQS at any downwind monitor. This section of the CAA, § 110(a)(2)(D)(i)(I), is called the "Good Neighbor" provision. EPA has implemented a number of rules enforcing the Good Neighbor provision for a variety of NAAQS.

EPA finalized CSAPR on August 8, 2011 (76 FR 48208). This rule required 28 states to reduce $SO_2$, annual $NO_X$, and ozone season $NO_X$ from fossil fuel-fired EGUs in support of the 1997 and 2006 $PM_{2.5}$ NAAQS and the 1997 ozone NAAQS. CSAPR relied on a trading program to achieve these reductions and became effective January 1, 2015, as set forth in an October 23, 2014, decision by the U.S. Court of Appeals for the D.C. Circuit. Phase 1 of the program began January 2015 for annual programs and May 2015 for ozone season programs. Phase 2 began January 2017 for the annual programs and May 2017 for ozone season programs. Total emissions allowed in each compliance period under CSAPR equals the sum of the affected state emission budgets in the program. The 2017 budgets for these programs, exclusive of new unit set asides and tribal budgets, are:

- $SO_2$ Group 1 – 1.37 million tons,
- $SO_2$ Group 2 – 892,000 tons,
- Annual $NO_X$ – 1.21 million tons, and
- Ozone Season $NO_X$ – 586,000 tons

EPA published revised CSAPR ozone season $NO_X$ budgets to address the 2008 ozone NAAQS on October 26, 2016 (81 FR 74504). This Rule, called the CSAPR Update, reduced state budgets for $NO_X$ during the ozone season to 325,645 tons in 2017 and 330,526 tons in 2018 and later years, exclusive of new unit set asides and tribal budgets. This rule applies to all VISTAS states except North Carolina, South Carolina, Georgia, and Florida and continues to encourage $NO_X$ emissions reductions from fossil fuel-fired EGUs. The U.S. Court of Appeals for the D.C. Circuit remanded, but did not vacate, the CSAPR Update to EPA to address the court's holding that the rule unlawfully allows significant contributions to continue beyond downwind attainment deadlines. The amended CSAPR Update Rule was published in the Federal Register on April 30, 2021. EPA will issue new or amended FIPs for 12 states to replace their existing CSAPR NOx Ozone Season Group 2 emissions budgets for EGUs with revised budgets under a new CSAPR NOx Ozone Season Group 3 Trading Program. Implementation of the revised emission budgets is required beginning with the 2021 ozone season. The final Rule includes state by-state adjusted ozone season emission budgets for 2021 through 2024. Emission reductions are required at power plants in the 12 states based on optimization of existing, already-installed selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) controls beginning in the 2021 ozone season, and installation or upgrade of state-of-the-art NOx combustion controls beginning in the 2022 ozone season. EPA estimates the Revised CSAPR Update will reduce summertime NOx emissions from power plants in the 12 linked upwind states by 17,000 tons in 2021 compared to projections without the Rule.

#### 7.2.1.2. The Mercury and Air Toxics (MATS) Rule

On February 16, 2012 (77 FR 9304), EPA promulgated the National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units. This rule is often called the Mercury and Air Toxics Standard (MATS). The standard applies to EGUs burning fossil fuel and sets standards for certain HAP emissions, many of which are acid gases. Control of these acid gases often have the co-benefit of reducing $SO_2$ emissions. Sources had until April 16, 2015, to comply with the rule unless granted a one-year extension for control installation or an additional extension for reliability reasons.

#### 7.2.1.3. 2010 $SO_2$ NAAQS

On June 22, 2010 (75 FR 35520), EPA finalized a new primary NAAQS for $SO_2$. This regulation significantly strengthened the short-term requirements by lowering the standard to 75 ppb on a one-hour basis. Using inventory and other technical data as support, EPA determined that anthropogenic $SO_2$ emissions originate chiefly from point sources, with fossil fuel combustion at electric utilities accounting for 66% and fossil fuel combustion at other industrial facilities accounting for 29% of total anthropogenic $SO_2$ emissions. EPA simultaneously revised the ambient air monitoring requirements for $SO_2$, combining air quality modeling and monitoring to determine compliance with the new standard. Much of this work focuses on the evaluation of point source emissions. To ensure compliance with the 2010 $SO_2$ NAAQS, reductions in $SO_2$ emissions have occurred.

#### 7.2.1.4. Onroad and Non-Road Programs

The CAA authorizes the EPA to establish emission standards for motor vehicles under § 202 and the authority to establish fuel controls under § 211. The CAA generally prohibits states other than California from enacting emission standards for motor vehicles under § 209(a) and for non-road engines under § 209(e). States may choose to adopt California requirements or meet federal requirements. Federal programs to reduce emissions from onroad and non-road engines are therefore critical to improving both visibility and air quality.

Several of the programs discussed below address $SO_2$ emissions by reducing allowable sulfur contents in various fuels. As well as reducing $SO_2$ emissions, reduced sulfur content improves the efficiency of $NO_X$ controls on existing engines and facilitates the use of state-of-the-art $NO_X$ controls on new engines.

##### 7.2.1.4.1. 2007 Heavy-Duty Highway Rule

In Subpart P of 40 CFR Part 86, EPA set limitations for heavy-duty engines, which became effective between 2007 and 2010. This rule limited $NO_X$ to 0.20 grams per brake horsepower-hour (g/bhp-hr) and limited non-methane hydrocarbons to 0.14 g/bhp-hr. The rule also required that the sulfur content of diesel fuel not exceed 0.0015% by weight to facilitate the use of modern pollution control technology on these engines. These standards continue to provide benefit as older vehicles are replaced with newer models.

##### 7.2.1.4.2. Tier 3 Motor Vehicle Emissions and Fuel Standards

The Federal Tier 3 program under Subpart H of 40 CFR Part 80, 40 CFR Part 85, and 40 CFR Part 86 reduces tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and some heavy-duty vehicles. The tailpipe standards include different phase-in schedules that vary by vehicle class and begin to apply between model years 2017 and 2025. The Tier 3 gasoline sulfur standard, which reduced the allowable sulfur content to 10 parts per million (ppm) in 2017, allows manufacturers to comply across the fleet with the more stringent Tier 3 emission standards. Reduced sulfur content in gasoline will also enable the control devices on vehicles already in use to operate more effectively. Compared to older standards, the non-methane organic gases and $NO_X$ tailpipe standards for light duty vehicles resulted in a 80% reduction based on the fleet average, and the heavy-duty tailpipe standards are 60% less than the existing fleet average.

##### 7.2.1.4.3. Non-Road Diesel Emissions Programs

EPA promulgated a series of control programs in 40 CFR Part 89, Part 90, Part 91, Part 92, and Part 94 that implemented limitations by 2012 on compression ignition engines, spark-ignition non-road engines, marine engines, and locomotive engines. Environmental benefits will continue into the future as consumers replace older engines with newer engines that have improved fuel economy and more stringent emissions standards. These regulations also required the use of cleaner fuels.

#### 7.2.1.4.4. Emission Control Area Designation and Commercial Marine Vessels

On April 4, 2014, new standards for ocean-going vessels became effective and applied to ships constructed after 2015. These standards are found in MARPOL Annex VI,[36] the international convention for the prevention of pollution from ocean-going ships. These requirements also mandate the use of significantly cleaner fuels by all large ocean-going vessels when operated near the coastlines. The cleaner fuels lower $SO_2$ emission rates as well as emissions of other criteria pollutants since the engines operate more efficiently on the cleaner fuel. These requirements apply to vessels operating in waters of the United States as well as ships operating within 200 nautical miles of the coast of North America, also known as the North American Emission Control Area.

### 7.2.2. State Control Programs Included in the 2028 Projection Year

Under the North Carolina Clean Smokestacks Act, coal-fired power plants in North Carolina were required to achieve a 77% cut in $NO_X$ emissions by 2009 and a 73% cut in $SO_2$ emissions by 2013.

Georgia Rule 391-3-1-.02(2)(sss) "Multi-Pollutant Control for Electric Utility Generating Units" established a schedule for the installation and operation of $NO_X$ and $SO_2$ pollution control systems on many of the coal-fired power plants in Georgia. This rule, adopted in 2007, required controls for all affected units to be in place before June 1, 2015. The rule reduced $SO_2$ emissions by approximately 90%, $NO_X$ emissions by approximately 85%, and mercury emissions by approximately 79%.

A number of consent agreements also impose specific controls that were included in this inventory development process:

- Lehigh Cement Company/Lehigh White Cement Company (US District Court, Eastern District of Pennsylvania): EPA reached a settlement with these companies on December 3, 2019, to settle alleged violations of the CAA. The settlement will reduce emissions of $NO_X$ and $SO_2$ and applied to facilities located in several states, including Alabama.

- VEPCO (US District Court, Eastern District of Virginia): Virginia Electric and Power Company (also known as Virginia-Dominion Power) agreed to spend $1.2 billion by 2013 to eliminate 237,000 tons of $SO_2$ and $NO_X$ emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.

- Anchor Glass Container (US District Court for the Middle District of Florida): On August 3, 2018, Anchor agreed to convert six of its furnaces to oxyfuel furnaces and will meet $NO_X$ emission limits at these furnaces that are consistent or better

[36] URL: https://www.epa.gov/sites/production/files/2016-09/documents/resolution-mepc-251-66-4-4-2014.pdf

than best available control technology. On remaining furnaces, Anchor agreed to install oxygen enriched air staging and meet more stringent emission limits. To control $SO_2$, Anchor agreed to install dry or semi-dry scrubber systems on two furnaces. Remaining furnaces must achieve batch optimization and meet enforceable emissions limits. Anchor also agreed to install $NO_X$ and $SO_2$ continuous emissions monitoring systems at all furnaces. The expected emission reductions from the agreement are 2,000 tpy of $NO_X$ and 700 tpy of $SO_2$ at facilities located in Florida, Georgia, Indiana, Minnesota, New York and Oklahoma.

### 7.2.3. Construction Activities, Agricultural and Forestry Smoke Management

In addition to accounting for specific emission reductions due to ongoing air pollution programs as required under the regional haze regulation Section 40 CFR 51.308(d)(3)(v)(A), states are also required to consider the air quality benefits of measures to mitigate the impacts of construction activities (40 CFR 51.308(d)(3)(v)(B)) and agricultural and forestry smoke management (40 CFR 51.308(d)(3)(v)(E)). Section 7.10.1 and Section 7.10.2 provide more information on these activities.

### 7.2.4 Measures Included in the First Planning Period SIP

Pursuant to 40 CFR 51.308(g)(1), the following information provides a description of measures that were included in the First Planning Period SIP:

#### 7.2.4.1 Expected Visibility Results in 2018 for the Sipsey Wilderness Area under Existing and Planned Emissions Controls

There were significant control programs being implemented both nationally as well as across the southeast between the baseline period and 2018. These programs are described in more detail below. The impact of programs such as the Clean Air Interstate Rule (CAIR) and the NOx SIP Call were expected be realized regionally. The implementation of these programs in Alabama were expected to significantly reduce emissions of sources not only within the state that these reductions were to occur, but these reductions were expected to also improve visibility at surrounding Class I areas outside Alabama.

#### 7.2.4.2 Federal and State Control Requirements

CAIR. CAIR was to permanently cap emissions of $SO_2$ and NOx from EGUs in the eastern United States by 2015. When fully implemented, CAIR was expected to reduce $SO_2$ emissions from EGUs in these states by more than 70%, and NOx emissions by more than 60%, from 2003 levels.

NOx SIP Call. Phase I of the NOx SIP call applied to certain EGUs and large non-EGUs, including large industrial boilers and turbines, and cement kilns. Those states affected by the NOx SIP call in the VISTAS region, including Alabama, developed rules for the control of NOx emissions that were approved by EPA. The NOx SIP Call resulted in a 68% reduction in NOx emissions from large stationary combustion sources in Alabama. For the analysis in the First Planning Period, emissions were capped for NOx SIP call-affected sources at 2007 levels and carried forward for the 2009 and 2018 future year inventories.

North Carolina CSA. Under the Act, enacted in 2002, coal-fired power plants in North Carolina were to achieve a 77% cut in NOx emissions by 2009 and a 73% cut in $SO_2$ emissions by 2013. This legislation established annual caps on both $SO_2$ and NOx emissions for the two primary utility companies in North Carolina: Duke Energy and Progress Energy. These reductions must have been made in North Carolina, and allowances were not saleable.

Consent Agreements (TECO, VEPCO, Gulf Power Crist 7, Santee Cooper, EKPC and APCO Plant Miller).

- Under a settlement agreement, by 2008, Tampa Electric Company will install permanent emissions-control equipment to meet stringent pollution limits; implement a series of interim pollution reduction measures to reduce emissions while the permanent controls are designed and installed; and retire pollution emission allowances that Tampa Electric or others could use, or sell to others, to emit additional NOx, $SO_2$, and PM.
- Virginia Electric and Power Co. (VEPCO) agreed to spend $1.2 billion by 2013 to eliminate 237,000 tons of $SO_2$ and NOx emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia. VEPCO installed the following controls/fuel switches already.
    - Chesterfield Power Station:
        - Unit #4-SCR by 01/01/13;
        - Unit #5-SCR by 01/01/12;
        - Unit #6 SCR by 01/01/11 & FGD by 01/01/10
    - Chesapeake Power Station:
        - Unit #3-SCR by 01/01/13;
        - Unit #4-SCR by 01/01/13
    - Clover Power Station:
        - Unit #1 and Unit #2: Upgrade of the existing FGD to meet 95% removal.
    - Possum Point Power Station:
        - Unit #3 and Unit #4: Conversion of these coal fired units to natural gas. Coal fired operations must cease by 5/1/13.
- A 2002 voluntary agreement called for Gulf Power to upgrade its operation to cut NOx emission rates by 61% at its Crist generating plant by 2007, with major reductions beginning in early 2005. The Crist plant was a significant source of NOx emissions in the Pensacola, Florida area.
- A 2004 consent agreement called for Santee Cooper to install and commence operation of continuous emissions control equipment for PM/$SO_2$/NOx emissions; comply with system-wide annual PM/SO2/NOx emissions limits; agree not to buy, sell or trade PM/SO2/NOx allowances allocated to Santee Cooper System as a result of said agreement; and to comply with emission unit limits of said agreement. Specific plants/units were not identified in the consent agreement.
- A July 2, 2007, consent agreement between the U.S. EPA and East Kentucky Power Cooperative (EKPC) requires the utility to reduce its emissions by 62,000 tpy (including

54,000 tons of $SO_2$ and 8,000 tons of NOx) by installing/operating selective catalytic reduction (SCR) technology; low-NOx burners, and PM and Mercury Continuous Emissions Monitoring at the utility's Spurlock, Dale and Cooper Plants. According to EPA, the plant's total emissions will drop from between 50 – 75% from 2005 levels. As with all Federal Consent Decrees, EKPC is precluded from using reductions required under other programs, such as the Clean Air Interstate Rule (CAIR). EKPC is expected to spend over $600 million on pollution controls.
    - FGD controls for EKPC Spurlock Units 1 and 2
    - EKPC Cooper Unit 2
- Alabama Power Company – Plant Miller (Jefferson County) On April 25, 2006, the U.S. EPA and the Department of Justice announced a settlement with Alabama Power Company (APC) to reduce emissions of sulfur dioxide ($SO_2$) and nitrogen oxides (NOx) from Boiler Units 3 and 4 at its Plant Miller in Quinton, Alabama. The plant was required to reduce $SO_2$ by installing flue gas desulfurization (FGD) and was required to reduce NOx by installing selective catalytic reduction (SCR) equipment. The Consent Decree required APC to commence continuous year-round operation of SCR equipment for control of NOx emissions by May 1, 2008. APC was also required to begin year-round operation of the FGD equipment for control of $SO_2$ emissions by December 31, 2011. The installation and operation of the controls were expected to result in the reduction of 4,953 tons per year of NOx and 22,788 tons per year of $SO_2$. APC was also required to install and operate by December 31, 2008, a mercury continuous emission monitoring system. APC was precluded from using the emissions reductions required under other programs, such as the Clean Air Interstate Rule (CAIR). In addition, the Consent Decree required APC to purchase and permanently retire $4.9 million worth of 2007 $SO_2$ emissions allowances.

Cargill, Inc. Consent Decree

On March 3, 2006, the Federal District Court in Minnesota entered a Consent Decree between Cargill, Incorporated, U.S. EPA, the Iowa Department of Natural Resources and other participating agencies. Under this agreement, Cargill was to implement a program of enforceable emissions reductions of $SO_2$, CO, NOx, and VOCs from its corn processing and oilseed processing plants of at least 40,000 tons per year. That included a reduction of $SO_2$ of 15,000 tons per year, CO of 16,000 tons per year, NOx of 2,500 tons per year, and VOCs of 6,500-11,500 tons per year. The Consent Decree required permit applications to be submitted within three years from entry of the Consent Decree (March 3, 2009) containing annual limits for boilers and facilities in Appendix B of the Consent Decree, which included Cargill Sweeteners, to less than 15,355 tons per year on a 12-month rolling sum. That represented a reduction of 15,067 tons of $SO_2$ per year from the current allowable emissions from these sources. Also, Cargill was required to submit a permit application within three years from entry of the Consent Decree that would include individual emission limits for boilers at various facilities, including the Cargill Sweeteners Stoker Coal-fired boiler, (which was evaluated for reasonable progress (RP)) that in aggregate would not exceed a capacity weighted average $SO_2$ emission rate of 1.2 lb/MMBtu. The Cargill Sweeteners Decatur Facility was required by 3/3/09 to control and comply with $SO_2$ emissions limitations for its coil fired boilers.

One-hour Ozone SIPs (Atlanta / Birmingham / Northern Kentucky). SIPs were submitted to EPA to demonstrate attainment of the one-hour ozone National Ambient Air Quality Standard (NAAQS). Those SIPs required NOx reductions from specific coal fired power plants and that transportation plans in those cities were addressed.

Heavy Duty Diesel (2007) Engine Standard (for onroad trucks and buses). EPA set a PM emissions standard for new heavy-duty engines of 0.01 grams per brake-horsepower-hour (g/bhp-hr), to take full effect for diesel engines in the 2007 model year. That rule also included standards for NOx and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. Those NOx and NMHC standards were to be phased in together between 2007 and 2010, for diesel engines. Sulfur in diesel fuel had to be lowered to enable modern pollution-control technology to be effective on those trucks and buses. EPA required a 97% reduction in the sulfur content of highway diesel fuel from its current level of 500 parts per million (low sulfur diesel, or LSD) to 15 parts per million (ultra-low sulfur diesel, or ULSD).

Tier 2 Tailpipe (Onroad vehicles). EPA Mobile rules included the Tier 2 fleet averaging program, modeled after the California LEV II standards. Manufacturers could produce vehicles with emissions ranging from relatively dirty to zero, but the mix of vehicles a manufacturer sells each year must had to average NOx emissions below a specified value. Tier 2 standards became effective in the 2005 model year.

Large Spark Ignition and Recreational Vehicle Rule. EPA adopted new standards for emissions of oxides of nitrogen (NOx), hydrocarbons (HC), and carbon monoxide (CO) from several groups of previously unregulated nonroad engines. Included in those were large industrial spark-ignition engines and recreational vehicles. Nonroad spark-ignition engines were those powered by gasoline, liquid propane gas, or compressed natural gas rated over 19 kilowatts (kW) (25 horsepower). Those engines were used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Nonroad recreational vehicles include snowmobiles, off highway motorcycles, and all terrain-vehicles. Those rules were initially effective in 2004 and were to be fully phased in by 2012.

Non-road Diesel Rule. This rule set standards that were to reduce emissions by more than 90% from nonroad diesel equipment and reduce sulfur levels by 99% from current levels in nonroad diesel fuel starting in 2007. This rule applied to most nonroad diesel fuel in 2010 and to fuel used in locomotives and marine vessels in 2012.

Combustion Turbine MACT. The projection inventories did not include the NOx co-benefit effects of the MACT regulations for Gas Turbines or stationary Reciprocating Internal Combustion Engines, which EPA estimated to be small compared to the overall inventory.

VOC 2-, 4-, 7-, and 10-year MACT Standards. Various point source MACTs and associated emission reductions were implemented. Reductions occurring before 2002 were not considered.

### 7.2.4. Projected VISTAS 2028 Emissions Inventory

The VISTAS emissions inventory for 2028 accounts for post-2011 emission reductions from promulgated federal, state, local, and site-specific control programs, many of which are described previously in Section 7.2.1 and Section 7.2.2. The VISTAS 2028 emissions inventory is based on EPA's 2028el emissions inventory data sets.[37] Onroad and non-road mobile source emissions were created for 2028 using the MOVES model. Nonpoint area source emissions were prepared using growth and control factors simulating changes in economic conditions and environmental regulations anticipated to be fully implemented by calendar year 2028. For EGU sources in projected year 2028, VISTAS states considered the EPA 2028el, the EPA 2023en, or 2028 emissions from the ERTAC EGU projection tool CONUS2.7 run and CONUS16.0 run. The EPA 2028el emissions inventory for EGUs considered the impacts of the Clean Power Plan (CPP), which was later vacated. Additionally, the EPA 2028el EGU emissions inventory used results from IPM. IPM assumes units may retire or sit idle in future years based solely on economic decisions determined within the tool. Impacts of the CPP, IPM economic retirements, and IPM economic idling resulted in many coal-fired EGUs being shut down. Thus, the EPA 2028el projected emissions for EGUs are not reflective of probable emissions for 2028. The ERTAC EGU tool outputs do not consider the impacts of the CPP. For states outside of VISTAS, EGU estimates were derived from CONUS16.0 and CONUS16.1 outputs. For non-EGU point source projections to year 2028, VISTAS states considered the EPA 2023en and EPA 2028el emissions and, in some cases, supplied their own emissions data.

The updates for 2028 are documented in the ERG emissions inventory reports included in Appendix B-2a.

Figure 7-1 and Figure 7-2 provide the expected decrease in emissions of $SO_2$ and $NO_X$, respectively, across the VISTAS states from 2011 to 2028.

[37] URL: https://www.epa.gov/air-emissions-modeling/updates-2011-and-2028-emissions-version-63-technical-support-document

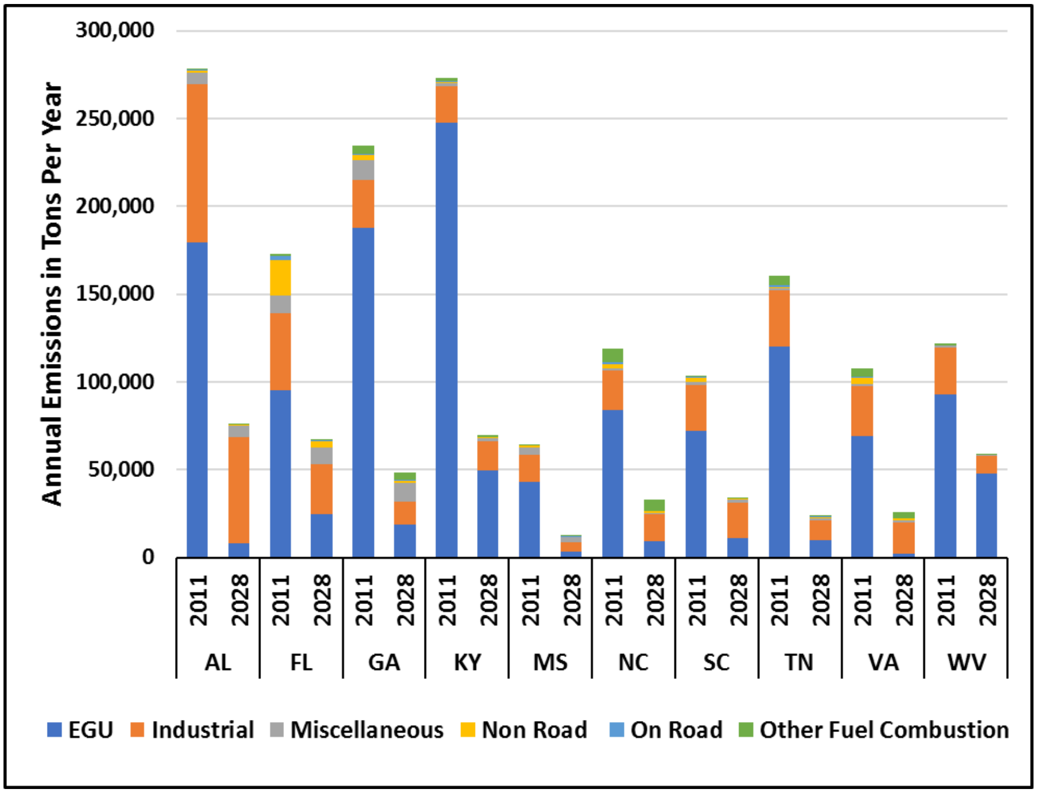



**Figure 7-1: VISTAS $SO_2$ Emissions for 2011 and 2028**

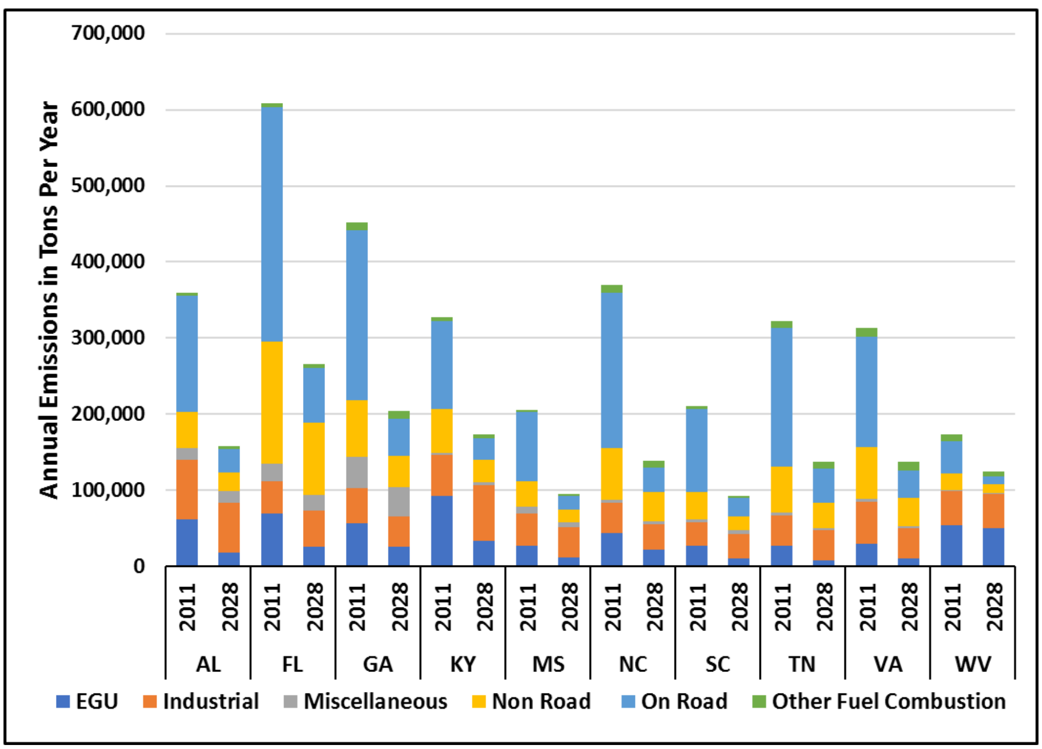



**Figure 7-2: VISTAS $NO_X$ Emissions for 2011 and 2028**

For $SO_2$ emissions in particular, which are the largest contributors to haze during this planning period, emissions across VISTAS are expected to decrease from 1,633,000 tons in 2011 to 448,000 tons in 2028, a 73% decrease. The EGU sector accounts for most of the reductions, although in some states industrial $SO_2$ emissions are also expected to decrease significantly. Emissions of $NO_X$ in VISTAS are similarly projected to drop from 3,343,000 tons in 2011 to 1,528,000 tons in 2028, a 54% reduction. The majority of these reductions come from the onroad sector, and such reductions are heavily dependent on federal control programs due to the CAA prohibition regarding state regulation of engine controls. $NO_X$ reductions from the EGU sector are also expected to continue, although $NO_X$ from EGUs now make up a much smaller portion of the overall anthropogenic $NO_X$ inventory as compared to prior inventories. The expected $SO_2$ and $NO_X$ emission reductions at EGUs are due to state and federal control programs, the construction and operation of renewable energy sources and very efficient combined cycle generating units, the use of cleaner burning fuels, and other factors.

Figure 7-3 and Figure 7-4 show the 2011 and 2028 emissions for $SO_2$ and $NO_X$, respectively, in other areas of the country. These data show significant drops in both pollutants from all other RPOs. For Class I areas that are disproportionately impacted by emissions from states in RPOs other than VISTAS, these reductions will help improve visibility impairment by 2028.

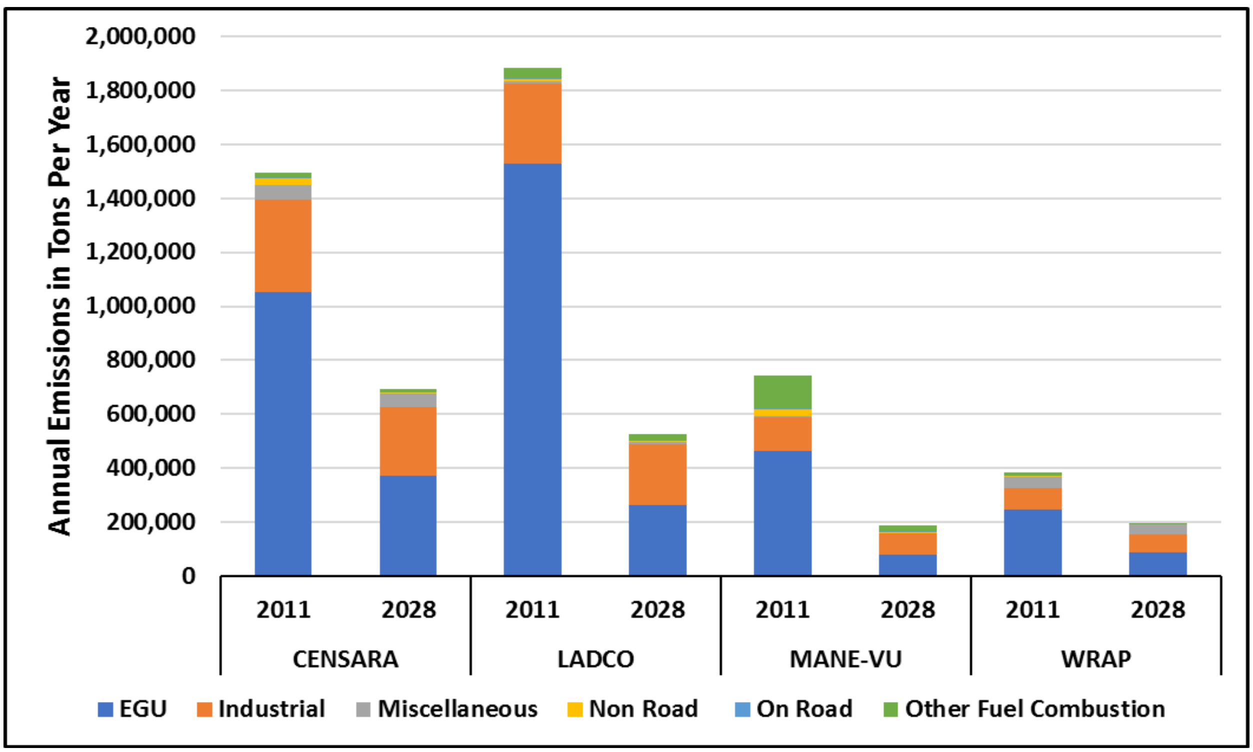



**Figure 7-3: $SO_2$ Emissions for 2011 and 2028 for Other RPOs**

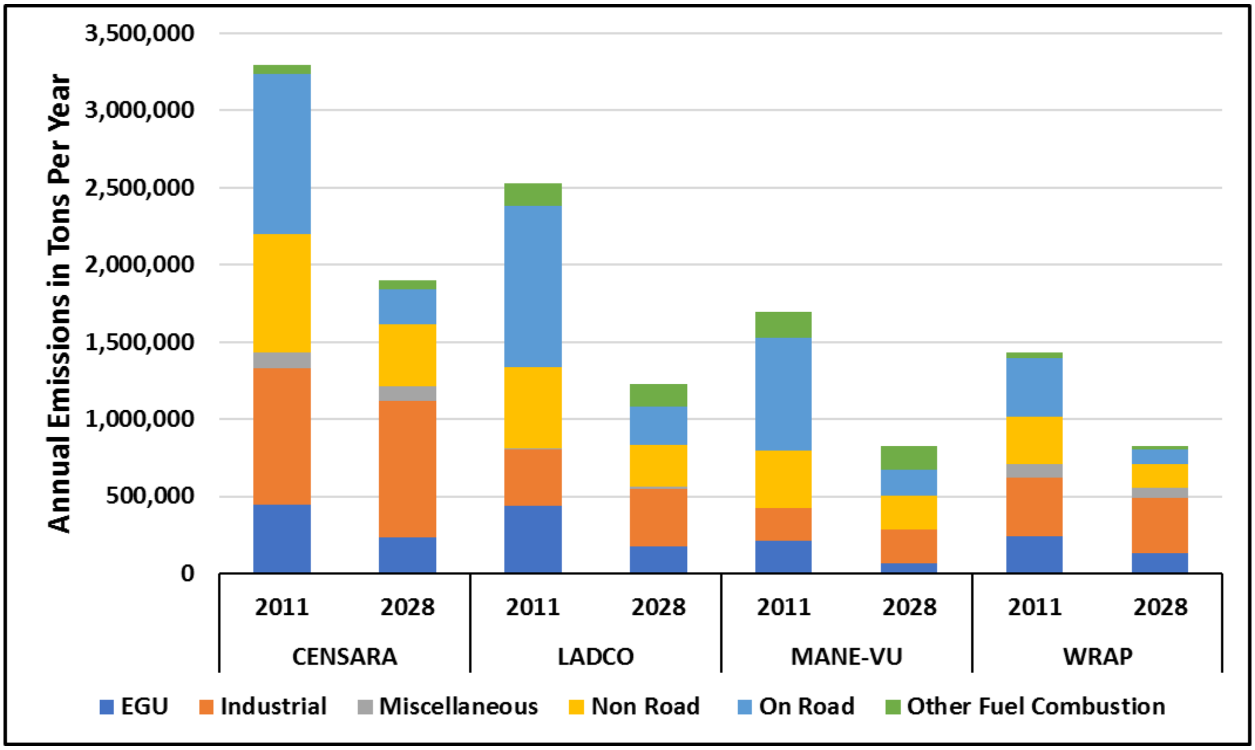



**Figure 7-4: NOx Emissions for 2011 and 2028 for Other RPOs**

Table 7-1 summarizes criteria pollutant emissions by state and Tier 1 NEI source sector from the 2011 and 2028 emissions inventories. The complete inventories and discussion of the methodology are contained in Appendix B-2a.

## Table 7-1: 2011 and 2028 Criteria Pollutant Emissions, VISTAS States

| State | Tier 1 Sector | 2011 CO (tpy) | 2028 CO (tpy) | 2011 $NO_X$ (tpy) | 2028 $NO_X$ (tpy) | 2011 $PM_{10}$ (tpy) | 2028 $PM_{10}$ (tpy) | 2011 $PM_{2.5}$ (tpy) | 2028 $PM_{2.5}$ (tpy) | 2011 $SO_2$ (tpy) | 2028 $SO_2$ (tpy) | 2011 VOC (tpy) | 2028 VOC (tpy) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | Chemical & Allied Product Mfg | 3,123 | 3,122 | 2,411 | 2,409 | 704 | 704 | 650 | 650 | 6,559 | 6,583 | 1,629 | 1,576 |
| AL | Fuel Comb. Elec. Util. | 9,958 | 6,748 | 61,687 | 18,098 | 7,323 | 1,714 | 4,866 | 1,190 | 179,323 | 7,965 | 1,152 | 910 |
| AL | Fuel Comb. Industrial | 71,865 | 73,890 | 35,447 | 27,842 | 46,274 | 47,304 | 34,664 | 39,088 | 41,322 | 18,806 | 3,283 | 3,413 |
| AL | Fuel Comb. Other | 12,104 | 11,352 | 4,229 | 4,100 | 1,689 | 1,584 | 1,654 | 1,549 | 417 | 193 | 2,038 | 1,796 |
| AL | Highway Vehicles | 701,397 | 182,602 | 152,732 | 30,113 | 8,001 | 4,984 | 4,611 | 1,322 | 683 | 262 | 75,523 | 15,013 |
| AL | Metals Processing | 10,991 | 10,759 | 5,947 | 5,434 | 5,359 | 4,326 | 4,647 | 3,844 | 13,298 | 13,072 | 1,843 | 1,550 |
| AL | Miscellaneous | 670,765 | 666,279 | 14,735 | 14,567 | 445,039 | 494,515 | 108,297 | 113,981 | 6,746 | 6,679 | 159,034 | 158,720 |
| AL | Off-Highway | 261,788 | 253,400 | 47,801 | 25,355 | 3,584 | 1,781 | 3,369 | 1,653 | 1,074 | 193 | 43,396 | 22,709 |
| AL | Other Industrial Processes | 19,708 | 18,908 | 21,546 | 20,732 | 17,032 | 16,269 | 8,749 | 8,095 | 9,569 | 15,773 | 14,327 | 13,927 |
| AL | Petroleum & Related Industries | 14,882 | 9,353 | 11,226 | 7,416 | 373 | 310 | 354 | 292 | 19,196 | 3,365 | 22,103 | 15,109 |
| AL | Solvent Utilization | 124 | 119 | 135 | 120 | 83 | 74 | 61 | 54 | 1 | 1 | 46,790 | 46,658 |
| AL | Storage & Transport | 65 | 65 | 51 | 51 | 870 | 823 | 653 | 604 | 2 | 2,767 | 18,726 | 12,302 |
| AL | Waste Disposal & Recycling | 45,712 | 45,712 | 1,876 | 1,876 | 7,885 | 7,885 | 6,531 | 6,531 | 175 | 175 | 3,620 | 3,620 |
| **AL** | **Subtotals:** | **1,822,482** | **1,282,309** | **359,823** | **158,113** | **544,216** | **582,273** | **179,106** | **178,853** | **278,365** | **75,834** | **393,464** | **297,303** |
| FL | Chemical & Allied Product Mfg | 117 | 117 | 1,393 | 1,279 | 415 | 337 | 348 | 295 | 21,948 | 14,260 | 1,231 | 1,230 |
| FL | Fuel Comb. Elec. Util. | 36,344 | 25,254 | 69,049 | 26,425 | 11,621 | 8,680 | 9,607 | 7,973 | 95,087 | 24,565 | 1,931 | 1,497 |
| FL | Fuel Comb. Industrial | 72,200 | 78,811 | 31,291 | 29,867 | 33,061 | 38,121 | 28,979 | 33,504 | 15,715 | 8,477 | 4,576 | 3,617 |
| FL | Fuel Comb. Other | 25,015 | 23,851 | 4,601 | 4,590 | 3,498 | 3,278 | 3,448 | 3,248 | 1,183 | 303 | 4,330 | 3,860 |
| FL | Highway Vehicles | 1,784,678 | 679,511 | 308,752 | 72,019 | 21,329 | 19,834 | 9,377 | 4,412 | 2,104 | 823 | 183,609 | 51,019 |
| FL | Metals Processing | 742 | 480 | 80 | 80 | 199 | 192 | 165 | 159 | 337 | 31 | 62 | 49 |
| FL | Miscellaneous | 992,515 | 960,190 | 22,844 | 21,346 | 384,091 | 466,941 | 129,258 | 138,297 | 10,473 | 9,727 | 231,259 | 228,825 |
| FL | Off-Highway | 1,120,490 | 1,125,776 | 159,796 | 94,782 | 14,009 | 6,737 | 13,181 | 6,231 | 20,051 | 2,973 | 166,582 | 88,560 |
| FL | Other Industrial Processes | 13,065 | 13,065 | 8,885 | 12,313 | 28,504 | 28,693 | 11,836 | 12,042 | 4,338 | 4,315 | 14,485 | 14,315 |
| FL | Petroleum & Related Industries | 802 | 828 | 279 | 293 | 92 | 93 | 63 | 64 | 211 | 211 | 2,847 | 2,252 |
| FL | Solvent Utilization | 3 | 3 | 2 | 2 | 34 | 33 | 30 | 30 | <0.5 | <0.5 | 151,477 | 151,367 |
| FL | Storage & Transport | 104 | 104 | 154 | 154 | 1,177 | 971 | 592 | 528 | 29 | 29 | 101,966 | 68,391 |
| FL | Waste Disposal & Recycling | 27,944 | 28,108 | 1,240 | 2,301 | 4,151 | 4,199 | 3,492 | 3,534 | 1,224 | 1,265 | 2,707 | 2,734 |
| **FL** | **Subtotal:** | **4,074,019** | **2,936,098** | **608,366** | **265,451** | **502,181** | **578,109** | **210,376** | **210,317** | **172,700** | **66,979** | **867,062** | **617,716** |

| State | Tier 1 Sector | 2011 CO (tpy) | 2028 CO (tpy) | 2011 $NO_X$ (tpy) | 2028 $NO_X$ (tpy) | 2011 $PM_{10}$ (tpy) | 2028 $PM_{10}$ (tpy) | 2011 $PM_{2.5}$ (tpy) | 2028 $PM_{2.5}$ (tpy) | 2011 $SO_2$ (tpy) | 2028 $SO_2$ (tpy) | 2011 VOC (tpy) | 2028 VOC (tpy) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA | Chemical & Allied Product Mfg | 502 | 476 | 959 | 931 | 476 | 406 | 408 | 353 | 1,580 | 1,054 | 2,571 | 2,399 |
| GA | Fuel Comb. Elec. Util. | 13,543 | 10,611 | 56,037 | 25,481 | 9,061 | 5,150 | 6,298 | 4,242 | 188,009 | 18,411 | 1,195 | 1,016 |
| GA | Fuel Comb. Industrial | 21,837 | 19,771 | 22,274 | 17,788 | 3,198 | 2,672 | 2,752 | 2,311 | 21,358 | 9,769 | 1,737 | 1,618 |
| GA | Fuel Comb. Other | 20,021 | 19,536 | 11,233 | 10,857 | 2,204 | 1,998 | 2,152 | 1,950 | 4,660 | 4,187 | 3,056 | 2,730 |
| GA | Highway Vehicles | 1,018,645 | 305,264 | 223,223 | 48,973 | 12,518 | 8,914 | 6,829 | 2,289 | 1,088 | 443 | 109,005 | 25,629 |
| GA | Metals Processing | 344 | 344 | 149 | 149 | 156 | 156 | 82 | 82 | 92 | 92 | 57 | 57 |
| GA | Miscellaneous | 1,022,524 | 984,133 | 40,646 | 39,003 | 858,861 | 998,804 | 220,258 | 232,719 | 11,424 | 10,688 | 78,048 | 75,220 |
| GA | Off-Highway | 471,960 | 477,533 | 74,217 | 40,838 | 5,923 | 2,974 | 5,594 | 2,769 | 2,562 | 967 | 60,843 | 36,837 |
| GA | Other Industrial Processes | 24,548 | 17,280 | 15,893 | 13,130 | 47,506 | 45,021 | 17,925 | 15,808 | 3,705 | 2,268 | 22,763 | 20,583 |
| GA | Petroleum & Related Industries | 6 | 6 | none reported | none reported | 23 | 22 | 11 | 13 | none reported | none reported | 132 | 131 |
| GA | Solvent Utilization | 25 | 24 | 30 | 28 | 31 | 31 | 30 | 30 | <0.5 | <0.5 | 84,352 | 83,997 |
| GA | Storage & Transport | 49 | 49 | 21 | 21 | 1,015 | 1,014 | 511 | 502 | none reported | none reported | 33,985 | 23,439 |
| GA | Waste Disposal & Recycling | 227,703 | 227,696 | 7,636 | 7,628 | 26,852 | 26,851 | 26,222 | 26,221 | 223 | 222 | 17,363 | 17,361 |
| **GA** | **Subtotals:** | **2,821,707** | **2,062,723** | **452,318** | **204,827** | **967,824** | **1,094,013** | **289,072** | **289,289** | **234,701** | **48,101** | **415,107** | **291,017** |
| KY | Chemical & Allied Product Mfg | 62 | 62 | 241 | 241 | 817 | 816 | 708 | 708 | 1,663 | 393 | 2,202 | 2,189 |
| KY | Fuel Comb. Elec. Util. | 15,547 | 12,253 | 92,756 | 33,258 | 13,874 | 7,409 | 9,495 | 5,781 | 247,556 | 49,728 | 1,749 | 1,067 |
| KY | Fuel Comb. Industrial | 10,848 | 10,870 | 20,009 | 17,876 | 2,247 | 2,505 | 1,981 | 2,214 | 5,774 | 4,819 | 1,422 | 1,031 |
| KY | Fuel Comb. Other | 48,175 | 43,582 | 5,765 | 5,477 | 6,891 | 6,158 | 6,781 | 6,072 | 1,868 | 1,166 | 8,390 | 7,183 |
| KY | Highway Vehicles | 498,702 | 157,636 | 115,685 | 27,819 | 5,480 | 3,448 | 3,345 | 1,015 | 502 | 209 | 50,326 | 12,938 |
| KY | Metals Processing | 61,446 | 61,446 | 1,611 | 1,611 | 4,151 | 4,111 | 3,402 | 3,383 | 6,021 | 3,200 | 2,081 | 2,081 |
| KY | Miscellaneous | 190,510 | 180,432 | 3,486 | 3,034 | 204,775 | 230,661 | 44,517 | 47,310 | 1,742 | 1,528 | 43,514 | 42,725 |
| KY | Off-Highway | 201,625 | 193,150 | 56,646 | 29,793 | 3,573 | 1,557 | 3,392 | 1,464 | 641 | 402 | 31,999 | 17,094 |
| KY | Other Industrial Processes | 4,985 | 4,992 | 5,682 | 5,662 | 26,177 | 25,483 | 9,042 | 8,737 | 6,468 | 6,465 | 31,759 | 31,489 |
| KY | Petroleum & Related Industries | 31,312 | 67,128 | 24,707 | 47,426 | 683 | 2,795 | 633 | 2,745 | 522 | 1,561 | 31,085 | 44,846 |
| KY | Solvent Utilization | 3 | 3 | 5 | 5 | 83 | 81 | 73 | 72 | <0.5 | <0.5 | 44,118 | 44,031 |
| KY | Storage & Transport | 23 | 23 | 6 | 6 | 2,005 | 1,804 | 484 | 427 | 3 | 3 | 22,606 | 16,169 |
| KY | Waste Disposal & Recycling | 25,288 | 25,288 | 1,156 | 1,156 | 5,335 | 5,330 | 4,532 | 4,527 | 161 | 161 | 2,352 | 2,352 |
| **KY** | **Subtotals:** | **1,088,526** | **756,865** | **327,755** | **173,364** | **276,091** | **292,158** | **88,385** | **84,455** | **272,921** | **69,635** | **273,603** | **225,195** |

| State | Tier 1 Sector | 2011 CO (tpy) | 2028 CO (tpy) | 2011 $NO_X$ (tpy) | 2028 $NO_X$ (tpy) | 2011 $PM_{10}$ (tpy) | 2028 $PM_{10}$ (tpy) | 2011 $PM_{2.5}$ (tpy) | 2028 $PM_{2.5}$ (tpy) | 2011 $SO_2$ (tpy) | 2028 $SO_2$ (tpy) | 2011 VOC (tpy) | 2028 VOC (tpy) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MS | Chemical & Allied Product Mfg | 7,477 | 7,454 | 1,864 | 1,841 | 487 | 481 | 430 | 428 | 1,377 | 49 | 1,317 | 1,316 |
| MS | Fuel Comb. Elec. Util. | 6,154 | 4,172 | 26,602 | 12,229 | 2,084 | 1,457 | 1,627 | 1,120 | 43,259 | 3,237 | 487 | 416 |
| MS | Fuel Comb. Industrial | 14,794 | 16,135 | 32,381 | 27,363 | 3,448 | 3,458 | 2,935 | 2,820 | 6,397 | 1,631 | 3,428 | 3,253 |
| MS | Fuel Comb. Other | 7,450 | 7,009 | 2,885 | 2,848 | 1,029 | 967 | 997 | 935 | 50 | 50 | 1,200 | 1,056 |
| MS | Highway Vehicles | 433,332 | 117,589 | 91,026 | 17,788 | 4,491 | 3,100 | 2,538 | 814 | 405 | 165 | 46,084 | 9,317 |
| MS | Metals Processing | 1,313 | 2,021 | 381 | 1,446 | 549 | 371 | 546 | 364 | 124 | 1,366 | 127 | 156 |
| MS | Miscellaneous | 372,960 | 325,044 | 9,080 | 6,803 | 996,316 | 1,211,587 | 142,022 | 160,523 | 4,248 | 3,165 | 81,272 | 77,346 |
| MS | Off-Highway | 153,473 | 143,429 | 33,132 | 16,707 | 2,493 | 1,074 | 2,353 | 999 | 1,029 | 143 | 29,662 | 14,770 |
| MS | Other Industrial Processes | 5,127 | 5,046 | 3,204 | 2,591 | 8,129 | 7,605 | 5,372 | 4,901 | 678 | 652 | 10,915 | 10,632 |
| MS | Petroleum & Related Industries | 4,592 | 5,412 | 3,641 | 4,105 | 257 | 322 | 200 | 270 | 6,240 | 1,407 | 28,840 | 24,313 |
| MS | Solvent Utilization | 31 | 30 | 39 | 37 | 115 | 113 | 105 | 104 | <0.5 | <0.5 | 38,358 | 37,486 |
| MS | Storage & Transport | 368 | 368 | 71 | 71 | 109 | 103 | 70 | 66 | 42 | 42 | 29,068 | 20,947 |
| MS | Waste Disposal & Recycling | 42,760 | 42,760 | 1,591 | 1,591 | 6,657 | 6,657 | 5,392 | 5,392 | 91 | 91 | 3,780 | 3,843 |
| **MS** | **Subtotals:** | **1,049,831** | **676,469** | **205,897** | **95,420** | **1,026,164** | **1,237,295** | **164,587** | **178,736** | **63,940** | **11,998** | **274,538** | **204,851** |
| NC | Chemical & Allied Product Mfg | 7,188 | 693 | 1,286 | 879 | 738 | 1,184 | 472 | 462 | 5,507 | 5,056 | 2,756 | 3,712 |
| NC | Fuel Comb. Elec. Util. | 32,828 | 10,563 | 43,911 | 21,401 | 8,790 | 3,190 | 6,921 | 2,867 | 83,925 | 8,976 | 934 | 1,095 |
| NC | Fuel Comb. Industrial | 16,197 | 14,319 | 24,394 | 16,775 | 3,828 | 2,910 | 2,899 | 2,430 | 12,354 | 5,139 | 1,500 | 1,172 |
| NC | Fuel Comb. Other | 29,163 | 28,846 | 9,652 | 9,791 | 4,724 | 4,604 | 4,323 | 4,246 | 7,757 | 5,970 | 4,611 | 4,302 |
| NC | Highway Vehicles | 1,145,623 | 252,167 | 204,008 | 30,968 | 10,447 | 6,512 | 5,510 | 1,646 | 1,082 | 311 | 112,173 | 21,709 |
| NC | Metals Processing | 2,675 | 2,122 | 324 | 454 | 355 | 547 | 308 | 471 | 556 | 433 | 1,493 | 1,005 |
| NC | Miscellaneous | 101,890 | 86,087 | 4,047 | 3,500 | 195,376 | 221,483 | 45,672 | 49,500 | 1,068 | 956 | 7,851 | 6,672 |
| NC | Off-Highway | 479,335 | 471,127 | 68,433 | 39,379 | 5,742 | 2,994 | 5,435 | 2,798 | 2,472 | 1,055 | 63,283 | 37,520 |
| NC | Other Industrial Processes | 5,731 | 11,412 | 10,261 | 12,529 | 14,515 | 18,192 | 6,970 | 8,780 | 3,279 | 4,105 | 15,218 | 20,374 |
| NC | Petroleum & Related Industries | 773 | 1,007 | 263 | 305 | 249 | 295 | 160 | 263 | 432 | 412 | 306 | 354 |
| NC | Solvent Utilization | 53 | 79 | 72 | 103 | 145 | 177 | 121 | 165 | 31 | 8 | 95,419 | 110,199 |
| NC | Storage & Transport | 2,174 | 278 | 125 | 128 | 590 | 654 | 306 | 412 | 7 | 11 | 24,731 | 15,117 |
| NC | Waste Disposal & Recycling | 66,928 | 67,028 | 2,720 | 2,772 | 11,151 | 11,153 | 9,386 | 9,420 | 251 | 213 | 5,613 | 5,800 |
| **NC** | **Subtotals:** | **1,890,558** | **945,728** | **369,496** | **138,984** | **256,650** | **273,895** | **88,483** | **83,460** | **118,721** | **32,645** | **335,888** | **229,031** |

| State | Tier 1 Sector | 2011 CO (tpy) | 2028 CO (tpy) | 2011 $NO_X$ (tpy) | 2028 $NO_X$ (tpy) | 2011 $PM_{10}$ (tpy) | 2028 $PM_{10}$ (tpy) | 2011 $PM_{2.5}$ (tpy) | 2028 $PM_{2.5}$ (tpy) | 2011 $SO_2$ (tpy) | 2028 $SO_2$ (tpy) | 2011 VOC (tpy) | 2028 VOC (tpy) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC | Chemical & Allied Product Mfg | 1,217 | 1,217 | 165 | 165 | 132 | 131 | 77 | 76 | 9 | 4 | 2,110 | 1,843 |
| SC | Fuel Comb. Elec. Util. | 16,809 | 13,527 | 26,752 | 10,993 | 10,851 | 3,290 | 8,604 | 2,672 | 71,899 | 10,762 | 607 | 573 |
| SC | Fuel Comb. Industrial | 19,560 | 21,191 | 17,924 | 17,505 | 10,314 | 11,286 | 8,273 | 9,498 | 15,748 | 9,386 | 1,103 | 1,117 |
| SC | Fuel Comb. Other | 12,508 | 11,800 | 3,283 | 3,351 | 1,701 | 1,580 | 1,660 | 1,546 | 339 | 309 | 2,128 | 1,867 |
| SC | Highway Vehicles | 475,876 | 155,913 | 109,374 | 23,263 | 6,618 | 4,504 | 3,766 | 1,152 | 504 | 215 | 51,164 | 12,546 |
| SC | Metals Processing | 53,733 | 53,811 | 780 | 861 | 572 | 581 | 480 | 489 | 5,139 | 5,182 | 457 | 457 |
| SC | Miscellaneous | 214,147 | 200,969 | 4,602 | 4,033 | 280,281 | 341,123 | 51,363 | 56,686 | 1,978 | 1,902 | 48,908 | 47,771 |
| SC | Off-Highway | 240,507 | 233,340 | 35,569 | 19,154 | 3,036 | 1,477 | 2,856 | 1,369 | 2,268 | 360 | 35,104 | 19,097 |
| SC | Other Industrial Processes | 17,912 | 17,827 | 10,251 | 11,697 | 7,581 | 7,311 | 4,149 | 3,897 | 5,223 | 5,724 | 15,036 | 14,754 |
| SC | Petroleum & Related Industries | none reported | none reported | none reported | none reported | none reported | none reported | none reported | none reported | none reported | none reported | 31 | 29 |
| SC | Solvent Utilization | 7 | 7 | 1 | 1 | 14 | 14 | 13 | 12 | <0.5 | <0.5 | 41,039 | 39,341 |
| SC | Storage & Transport | 39 | 39 | 26 | 26 | 346 | 282 | 139 | 119 | 1 | 1 | 30,397 | 21,258 |
| SC | Waste Disposal & Recycling | 48,668 | 48,667 | 1,817 | 1,806 | 7,055 | 7,042 | 5,746 | 5,735 | 140 | 139 | 4,073 | 4,059 |
| **SC** | **Subtotals:** | **1,100,983** | **758,308** | **210,544** | **92,855** | **328,501** | **378,621** | **87,126** | **83,251** | **103,248** | **33,984** | **232,157** | **164,712** |
| TN | Chemical & Allied Product Mfg | 14,866 | 14,862 | 811 | 804 | 755 | 755 | 426 | 426 | 492 | 489 | 4,412 | 4,397 |
| TN | Fuel Comb. Elec. Util. | 5,529 | 3,771 | 27,156 | 8,006 | 5,191 | 2,618 | 4,172 | 2,444 | 120,170 | 10,059 | 769 | 585 |
| TN | Fuel Comb. Industrial | 18,910 | 22,671 | 27,988 | 25,234 | 10,632 | 12,293 | 9,018 | 10,691 | 27,778 | 8,076 | 1,129 | 1,239 |
| TN | Fuel Comb. Other | 25,945 | 23,479 | 9,207 | 8,441 | 3,470 | 3,044 | 3,182 | 2,928 | 5,441 | 779 | 5,168 | 4,906 |
| TN | Highway Vehicles | 739,041 | 233,423 | 182,796 | 44,927 | 9,927 | 6,734 | 5,778 | 1,811 | 769 | 338 | 80,463 | 20,483 |
| TN | Metals Processing | 5,066 | 5,066 | 611 | 611 | 1,492 | 1,492 | 1,251 | 1,251 | 572 | 681 | 2,923 | 2,923 |
| TN | Miscellaneous | 133,301 | 124,792 | 2,840 | 2,450 | 150,164 | 165,066 | 36,986 | 39,404 | 1,347 | 1,162 | 31,052 | 30,344 |
| TN | Off-Highway | 309,062 | 298,569 | 60,384 | 33,596 | 4,242 | 2,032 | 4,010 | 1,898 | 767 | 625 | 46,292 | 25,501 |
| TN | Other Industrial Processes | 5,668 | 6,244 | 7,449 | 8,189 | 11,527 | 11,224 | 6,034 | 5,779 | 2,550 | 1,468 | 15,672 | 14,828 |
| TN | Petroleum & Related Industries | 2,706 | 4,956 | 1,812 | 3,193 | 189 | 307 | 160 | 278 | 243 | 149 | 3,559 | 3,517 |
| TN | Solvent Utilization | 72 | 72 | 84 | 84 | 328 | 328 | 288 | 288 | 15 | 15 | 67,091 | 67,091 |
| TN | Storage & Transport | 56 | 56 | 37 | 29 | 520 | 393 | 238 | 184 | 5 | 4 | 29,921 | 19,812 |
| TN | Waste Disposal & Recycling | 26,959 | 26,959 | 1,392 | 1,392 | 5,710 | 5,710 | 4,813 | 4,813 | 174 | 137 | 2,549 | 2,839 |
| **TN** | **Subtotals:** | **1,287,181** | **764,920** | **322,567** | **136,956** | **204,147** | **211,996** | **76,356** | **72,195** | **160,323** | **23,982** | **291,000** | **198,465** |

| State | Tier 1 Sector | 2011 CO (tpy) | 2028 CO (tpy) | 2011 $NO_X$ (tpy) | 2028 $NO_X$ (tpy) | 2011 $PM_{10}$ (tpy) | 2028 $PM_{10}$ (tpy) | 2011 $PM_{2.5}$ (tpy) | 2028 $PM_{2.5}$ (tpy) | 2011 $SO_2$ (tpy) | 2028 $SO_2$ (tpy) | 2011 VOC (tpy) | 2028 VOC (tpy) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VA | Chemical & Allied Product Mfg | 83 | 83 | 7,707 | 1,734 | 169 | 169 | 73 | 73 | 203 | 203 | 486 | 485 |
| VA | Fuel Comb. Elec. Util. | 4,984 | 6,232 | 30,213 | 10,677 | 5,794 | 3,858 | 1,157 | 1,456 | 69,077 | 1,903 | 742 | 448 |
| VA | Fuel Comb. Industrial | 13,713 | 11,294 | 22,048 | 13,962 | 5,883 | 5,071 | 4,817 | 4,376 | 14,349 | 5,776 | 950 | 871 |
| VA | Fuel Comb. Other | 77,919 | 74,900 | 11,470 | 11,034 | 11,302 | 10,748 | 11,002 | 10,507 | 4,884 | 3,264 | 12,940 | 11,877 |
| VA | Highway Vehicles | 566,315 | 232,611 | 145,507 | 35,427 | 7,106 | 4,302 | 4,368 | 1,309 | 711 | 279 | 63,152 | 18,550 |
| VA | Metals Processing | 3,016 | 3,016 | 812 | 812 | 859 | 858 | 724 | 723 | 5,196 | 5,196 | 270 | 270 |
| VA | Miscellaneous | 167,730 | 164,877 | 3,186 | 3,077 | 141,777 | 156,214 | 33,384 | 36,128 | 1,487 | 1,439 | 39,308 | 39,107 |
| VA | Off-Highway | 383,506 | 391,290 | 67,844 | 37,836 | 5,029 | 2,576 | 4,747 | 2,398 | 3,355 | 892 | 48,417 | 30,266 |
| VA | Other Industrial Processes | 5,644 | 7,256 | 12,766 | 10,337 | 12,394 | 12,839 | 5,001 | 5,400 | 7,028 | 5,294 | 6,937 | 7,107 |
| VA | Petroleum & Related Industries | 12,445 | 12,993 | 9,618 | 9,748 | 406 | 541 | 284 | 424 | 59 | 65 | 8,525 | 12,152 |
| VA | Solvent Utilization | <0.5 | 0 | <0.5 | 0 | 66 | 68 | 61 | 63 | <0.5 | <0.5 | 85,760 | 93,969 |
| VA | Storage & Transport | 5 | 6 | 2 | 2 | 351 | 353 | 286 | 301 | <0.5 | <0.5 | 23,556 | 16,224 |
| VA | Waste Disposal & Recycling | 33,103 | 33,192 | 2,283 | 2,305 | 5,745 | 5,758 | 4,925 | 4,932 | 1,469 | 1,483 | 4,317 | 4,380 |
| **VA** | **Subtotals:** | **1,268,463** | **937,750** | **313,456** | **136,951** | **196,881** | **203,355** | **70,829** | **68,090** | **107,818** | **25,794** | **295,360** | **235,706** |
| WV | Chemical & Allied Product Mfg | 247 | 249 | 402 | 278 | 330 | 296 | 246 | 229 | 145 | 106 | 2,000 | 1,036 |
| WV | Fuel Comb. Elec. Util. | 10,106 | 8,663 | 54,289 | 49,885 | 11,066 | 6,822 | 9,100 | 5,462 | 93,080 | 47,746 | 1,011 | 1,162 |
| WV | Fuel Comb. Industrial | 4,424 | 3,896 | 16,592 | 10,820 | 1,977 | 1,291 | 1,086 | 492 | 16,306 | 6,241 | 540 | 581 |
| WV | Fuel Comb. Other | 19,471 | 18,115 | 8,661 | 6,695 | 2,893 | 2,751 | 2,803 | 2,671 | 760 | 677 | 4,059 | 3,472 |
| WV | Highway Vehicles | 185,437 | 55,258 | 41,840 | 10,124 | 2,101 | 1,273 | 1,269 | 375 | 179 | 72 | 20,493 | 5,208 |
| WV | Metals Processing | 24,179 | 24,088 | 1,806 | 1,839 | 1,468 | 1,362 | 1,046 | 973 | 2,069 | 1,956 | 520 | 499 |
| WV | Miscellaneous | 86,791 | 86,171 | 1,296 | 1,277 | 76,122 | 76,051 | 15,876 | 15,810 | 684 | 677 | 20,396 | 20,356 |
| WV | Off-Highway | 89,194 | 89,372 | 22,397 | 11,934 | 1,428 | 696 | 1,341 | 649 | 204 | 35 | 15,934 | 8,932 |
| WV | Other Industrial Processes | 2,726 | 2,616 | 2,464 | 1,941 | 21,016 | 20,439 | 3,655 | 3,664 | 1,983 | 1,350 | 1,283 | 1,443 |
| WV | Petroleum & Related Industries | 27,645 | 42,008 | 22,041 | 29,242 | 692 | 1,514 | 594 | 1,511 | 6,144 | 191 | 47,734 | 130,121 |
| WV | Solvent Utilization | <0.5 | <0.5 | <0.5 | none reported | 13 | 2 | 13 | 2 | <0.5 | none reported | 14,315 | 13,610 |
| WV | Storage & Transport | 2 | 2 | 4 | 21 | 465 | 220 | 182 | 74 | <0.5 | <0.5 | 8,621 | 5,687 |
| WV | Waste Disposal & Recycling | 31,785 | 31,786 | 1,152 | 1,152 | 4,840 | 4,840 | 3,981 | 3,981 | 63 | 63 | 2,622 | 2,606 |
| **WV** | **Subtotals:** | **482,007** | **362,224** | **172,944** | **125,208** | **124,411** | **117,557** | **41,192** | **35,893** | **121,617** | **59,114** | **139,528** | **194,713** |
| **VISTAS** | **Totals:** | **16,885,757** | **11,483,394** | **3,343,166** | **1,528,129** | **4,427,066** | **4,969,272** | **1,295,512** | **1,284,539** | **1,634,354** | **448,066** | **3,517,707** | **2,658,709** |

### 7.2.5. EPA Inventories

EPA created a 2016 base year emissions inventory for modeling purposes in a collaborative effort with states and RPOs. The 2016 emissions inventory data for the point source and EGU sectors originated with state submissions to the EIS and, for those units subject to 40 CFR Part 75 monitoring requirements, unit level reporting to CAMD. Other source sector data were estimated by EPA, through emissions inventory tools, or estimates based upon state supplied input. This data set includes a full suite of 2016 base year inventories and projection year data for 2023 and 2028.[38] The 2023 and 2028 projections from 2016 relied upon IPM for estimates of EGU activity and emissions. EPA has provided emission summaries of this information at state and SCC levels for both the 2016 base year and EPA's previous 2014 base year. EPA used the 2014 NEI data to create the 2014 base year data set. Point source and EGU sector information for the 2014 NEI originated with state submissions or from unit level reporting to CAMD. Other sectors in the 2014 NEI were created by EPA based on tool inputs supplied by state staff, contractor estimates, and additional sources. Evaluation of these data sets show trends that are similar to those in the VISTAS emissions inventory.

EPA has also prepared and published the 2017 NEI[39] based on point source and EGU sector data that originated with state EIS submissions or unit level reporting to CAMD. EPA developed other emissions sectors of the 2017 NEI using state-supplied input files for emission estimation tools, contractor estimates, and additional sources of data. These data represent the January 2021 version of this database, which includes all sectors and pollutants for emissions across the United States.

Figure 7-5 provides the estimated actual $SO_2$ emissions within the EPA inventories for 2014, 2016, and 2017 by Tier 1 category within the ten VISTAS states; the emissions inventories for years 2023 and 2028, projected from the base year 2016 data by EPA; and the 2011 and 2028 VISTAS inventories used in the RPG modeling. The 2011 and 2014 data show that $SO_2$ emissions were predominantly emitted from electric utility fuel combustion and industrial fuel combustion within the VISTAS region. Significant $SO_2$ reductions occurred by 2016, and additional reductions occurred in 2017. These $SO_2$ reductions are most pronounced in the electric utility fuel combustion category. EPA's 2023 and 2028 data forecast continues to show declines in $SO_2$ emissions from this category. The VISTAS 2028 data also project additional $SO_2$ emission reductions across the VISTAS states, although these projections are higher than the EPA 2028 projections.

[38] URL: https://www.epa.gov/air-emissions-modeling/2016v1-platform

[39] URL: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

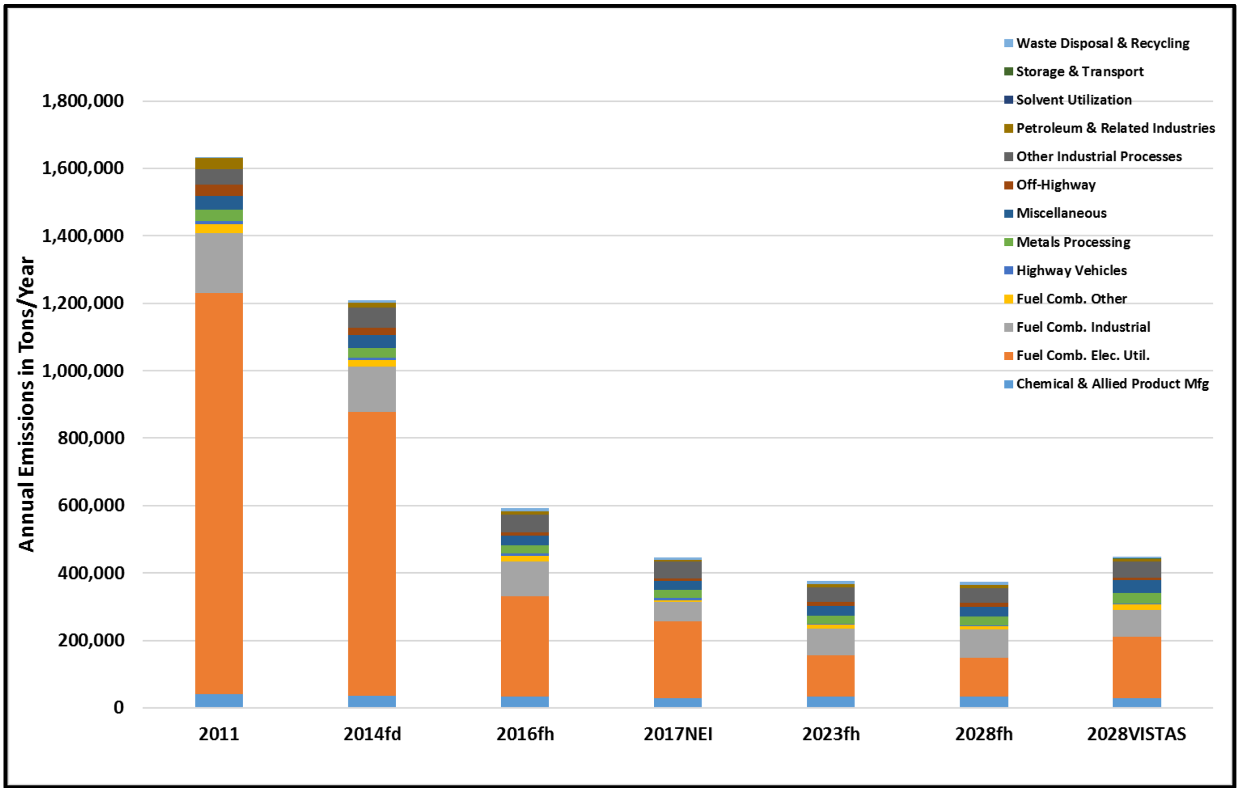



**Figure 7-5: $SO_2$ Emissions from VISTAS States**

Figure 7-6 provides the estimated actual $NO_X$ emissions within the EPA inventories for 2014, 2016, and 2017 by Tier 1 category within the ten VISTAS states; the emissions inventories for years 2023 and 2028, projected from the base year 2016 data by EPA; and the 2011 and 2028 VISTAS inventories used in the RPG modeling. The 2011, 2014, 2016 and 2017 data show that $NO_X$ emissions were predominantly emitted from onroad and off-highway source sectors. Significant reductions in $NO_X$ occurred by 2016 as compared to 2011. During this time period reductions in emissions from onroad and off-highway source sectors as well as the electrical utility fuel combustion sector contributed to this drop. EPA's 2023 and 2028 projections demonstrate further declines in $NO_X$ emissions, most notably from the onroad and off-highway source sectors. The VISTAS 2028 data also project additional $NO_X$ emission reductions across the VISTAS states although the estimated reductions are not as great as those from EPA.

The VISTAS 2028 data is higher than the EPA 2028 projections largely due to differences in projection methodologies for EGUs and some non-EGUs. For example, EPA relied upon IPM results that generally have lower $SO_2$ and $NO_X$ emissions than ERTAC results. The IPM tool may retire or idle coal fired EGUs and certain coal fired industrial boilers that occasionally provide electricity to the grid due to economic assumptions within the model. ERTAC projections do not use economic decisions to forecast retirements or idling of units in future years. Rather, states provide estimated retirement dates based on information provided by the facility owners, consent decrees, permits, or other types of documentation. The ERTAC projections, therefore, tend to be more conservative.

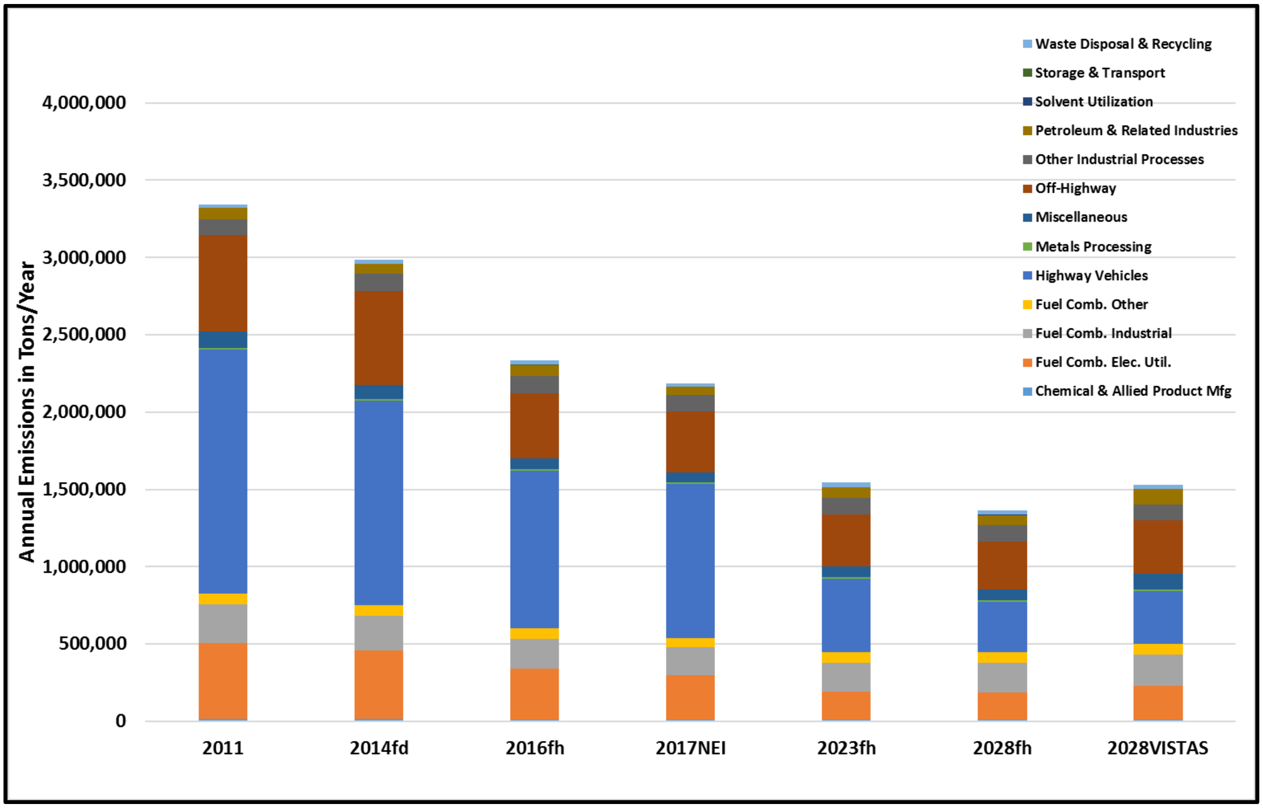



**Figure 7-6: $NO_X$ Emissions from VISTAS States**

The data for Alabama in the EPA inventories also forecast significant declines in both $SO_2$ and $NO_X$ emissions. Figure 7-7 provides EPA's estimates of Alabama's actual $SO_2$ emissions from 2011, 2014, 2016, and 2017 as well as EPA's projected values for 2023 and 2028 and the VISTAS projected value for 2028. EPA estimated 278,365 tons of $SO_2$ emissions from Alabama in 2011. EPA expects that $SO_2$ emissions in Alabama will drop to 77,857 tons by 2028, a 72% reduction. The VISTAS projection for Alabama shows that emissions of $SO_2$ should drop to 75,834 tons by 2028, a 73% reduction.

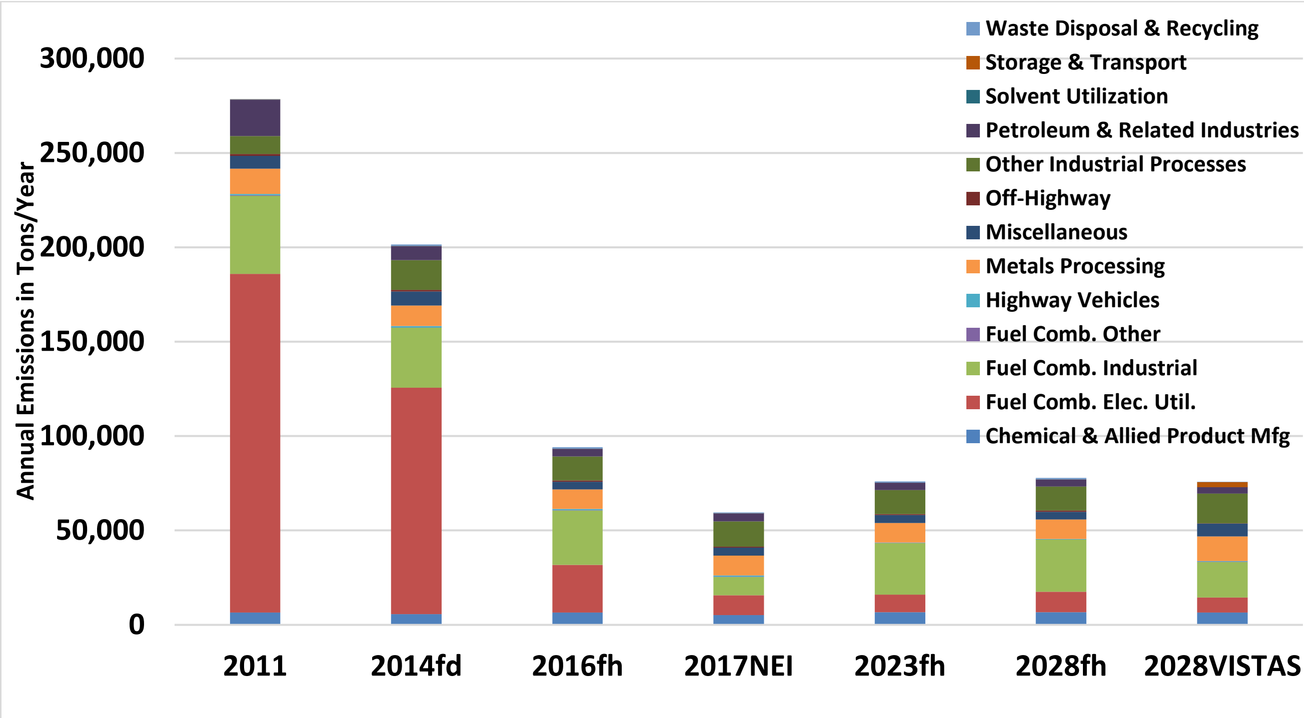



**Figure 7-7: Alabama $SO_2$ Emissions**

Figure 7-8 provides EPA's estimates of actual $NO_X$ emissions in Alabama from 2011, 2014, 2016, and 2017. The figure also shows EPA's projected values for 2023 and 2028, using 2016 as the base year, and the VISTAS projections for 2028. EPA estimated 359,822 tons of $NO_X$ emissions from Alabama in 2011. EPA expects that $NO_X$ emissions in Alabama will drop to 148,697 tons by 2028, a 59% reduction. The VISTAS projections estimate that Alabama $NO_X$ emissions will drop to 158,113 tons by 2028, a 56% reduction.

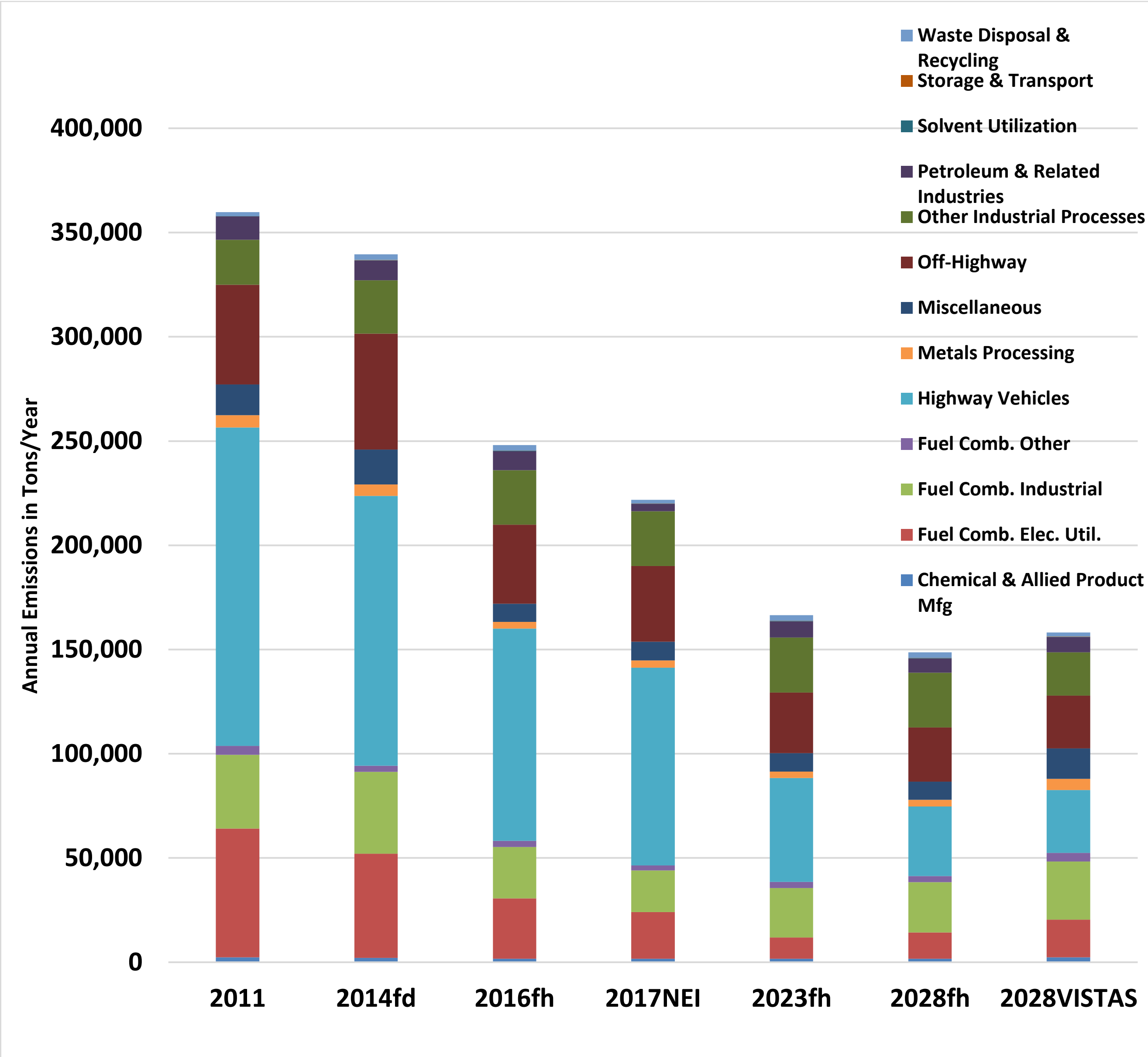



**Figure 7-8: Alabama $NO_X$ Emissions**

The VISTAS 2028 projections do not include reductions from programs noted in Section 8.2, therefore, the estimates are likely conservative and actual 2028 emissions of $SO_2$ and $NO_X$ are expected to be lower than those noted.

### 7.2.6. VISTAS 2028 Model Projections

VISTAS states used emissions modeling to project visibility to 2028 using a 2028 emissions inventory, as described in Section 4. The EPA Software for Model Attainment Test – Community Edition (SMAT-CE) tool was used to calculate 2028 deciview values on the 20% most impaired and 20% clearest days at each Class I area IMPROVE monitoring site. SMAT-CE[40] is an EPA software tool that implements the procedures found in the "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze," (SIP modeling guidance)[41] to project visibility in the future year. The SMAT-CE tool outputs individual year and five-year average base year and future year deciview values on the 20% most impaired days and the 20% clearest days.

#### 7.2.6.1. Calculation of 2028 Visibility Estimates

The visibility projections follow the procedures in EPA's SIP modeling guidance (Section 5) referenced previously in this document. Based on recommendations in the modeling guidance, the observed base period visibility data is linked to the modeling base period. In this case, for a base modeling year of 2011, the 2009-2013 IMPROVE data for the 20% most impaired days and 20% clearest days were used as the basis for the 2028 projections. Section 2.5 discusses the IMPROVE monitoring data during the modeling base period of 2009-2013.

The visibility calculations use the IMPROVE equation discussed in Section 2.1 above. As noted in Section 2.1, the IMPROVE algorithm uses PM species concentrations and relative humidity data to calculate visibility impairment as extinction ($b_{ext}$) in units of inverse megameters.

The 2028 future year visibility on the 20% most impaired days and the 20% clearest days at each Class I area is estimated by using the observed IMPROVE data from years 2009-2013 and the relative percent modeled change in PM species between 2011 and 2028. The following steps describe the process. The SIP modeling guidance contains more details and examples.

- Step 1 -For each Class I area (i.e., IMPROVE site), estimate anthropogenic impairment ($Mm^{-1}$) on each day using observed speciated $PM_{2.5}$ data plus $PM_{10}$ data (and other information) for each of the five years comprising the modeling base period (2009-2013) and rank the days on this indicator.[42] This ranking will determine the 20% most impaired days. For each Class I area, also rank observed visibility (in deciviews) on each day using observed speciated $PM_{2.5}$ data plus $PM_{10}$ data for each of the five years comprising the modeling base period. This ranking will determine the 20% clearest days.

- Step 2 -For each of the five years comprising the base period, calculate the mean deciviews for the 20% most impaired days and the 20% clearest days. For each Class I area, calculate

[40] URL: https://www.epa.gov/scram/photochemical-modeling-tools
[41] URL: https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf
[42] EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

the five-year mean deciviews for the 20% most impaired and the 20% clearest days from the five year-specific values.

- Step 3 - Use an air quality model to simulate air quality with base period (2011) emissions and future year (2028) emissions. Use the resulting information to develop monitor site-specific relative response factors (RRFs) for each component of PM identified in the "revised" IMPROVE equation. The RRFs are an average percent change in species concentrations based on the measured 20% most impaired days and 20% clearest days from 2011 to 2028. The calendar days from 2011 identified from the IMPROVE data above are matched by day to the modeled days. RRFs are calculated separately for sulfate, nitrate, organic carbon mass, elemental carbon, fine soil mass, and coarse mass. The observed sea salt is primarily from natural sources that are not expected to be year-sensitive, and the modeled sea salt is uncertain. Therefore, the sea salt RRF for all monitor sites is assumed to be 1.0.

- Step 4 – For each monitor site, multiply the species-specific RRFs by the measured daily species concentration data during the 2009-2013 base period for each day in the measured 20% most impaired day data set and each day in the 20% clearest day data set. This results in daily future year 2028 PM species concentration data.

- Step 5 - Using the results in Step 4 and the IMPROVE algorithm described in Section 2.1, calculate the future daily extinction coefficients for the previously identified 20% most impaired days and 20% clearest days in each of the five base years.

- Step 6 - Calculate daily deciview values (from total daily extinction) and then compute the future year (2028) average mean deciviews for the 20% most impaired days and 20% clearest days for each year. Average the five years together to get the final future mean deciview values for the 20% most impaired days and 20% clearest days.

In cases where an IMPROVE monitor is located within a Class I area, the five-year average modeling base period visibility is used with modeled concentrations from the grid cell containing the IMPROVE monitor to calculate future year RRFs and visibility results. In cases within VISTAS states where an IMPROVE monitor is not located within a Class I Area, surrogate IMPROVE monitors are assigned to establish modeling base period visibility values. See Section 2.2 for a description and listing of these sites. When using a surrogate IMPROVE monitor site, the five-year average modeling base period visibility from the surrogate location is used with modeled concentrations from the actual modeled grid cell at the centroid of the Class I area to calculate future year RRFs and visibility results. In Class I areas outside of the VISTAS states, surrogate monitor modeling base period data and RRFs are used to project future year visibility.

#### 7.2.6.2. 2028 Visibility Projection Results

Table 7-2 provides the 2028 visibility projections for the VISTAS Class I areas and nearby Class I areas. More information on these projections may be found in Appendix E-6.

**Table 7-2: 2028 Visibility Projections for VISTAS and Nearby Class I Areas**

| Class I Area | Site ID | State | 2028 20% Clearest Days dv) | 2028 20% Clearest Days ($Mm^{-1}$) | 2028 20% Most Impaired Days (dv) | 2028 20% Most Impaired Days ($Mm^{-1}$) |
|---|---|---|---|---|---|---|
| Cape Romain Wilderness Area | ROMA1 | SC | 12.11 | 33.87 | 16.64 | 53.81 |
| Chassahowitzka Wilderness Area | CHAS1 | FL | 12.54 | 35.28 | 16.79 | 54.50 |
| Cohutta Wilderness Area | COHU1 | GA | 9.15 | 25.51 | 14.90 | 45.63 |
| Dolly Sods Wilderness Area | DOSO1 | WV | 7.55 | 21.79 | 15.29 | 47.82 |
| Everglades National Park | EVER1 | FL | 10.64 | 29.13 | 15.52 | 47.87 |
| Great Smoky Mountains National Park | GRSM1 | TN | 8.96 | 25.02 | 15.03 | 46.08 |
| James River Face Wilderness Area | JARI1 | VA | 9.80 | 27.13 | 15.87 | 50.46 |
| Joyce Kilmer-Slickrock Wilderness Area | GRSM1 | TN | 8.97 | 25.02 | 14.88 | 45.36 |
| Linville Gorge Wilderness Area | LIGO1 | NC | 8.21 | 23.06 | 14.25 | 42.61 |
| Mammoth Cave National Park | MACA1 | KY | 11.66 | 32.50 | 19.27 | 70.87 |
| Okefenokee Wilderness Area | OKEF1 | GA | 11.58 | 32.14 | 16.90 | 55.59 |
| Otter Creek Wilderness Area | DOSO1 | WV | 7.55 | 21.80 | 15.26 | 47.66 |
| Shenandoah National Park | SHEN1 | VA | 7.27 | 21.20 | 14.47 | 44.02 |
| Shining Rock Wilderness Area | SHRO1 | NC | 4.54 | 15.74 | 13.31 | 37.86 |
| Sipsey Wilderness Area | SIPS1 | AL | 11.11 | 30.75 | 16.62 | 54.13 |
| St. Marks Wilderness Area | SAMA1 | FL | 11.59 | 32.18 | 16.43 | 53.05 |
| Swanquarter Wilderness Area | SWAN1 | NC | 10.77 | 29.61 | 15.27 | 47.42 |
| Wolf Island Wilderness Area | OKEF1 | GA | 11.55 | 32.05 | 16.75 | 54.71 |
| Breton Wilderness | BRIS1 | LA | 12.13 | 34.21 | 18.39 | 65.06 |
| Brigantine Wilderness Area | BRIG1 | NJ | 11.07 | 30.54 | 18.40 | 65.20 |
| Caney Creek Wilderness Area | CACR1 | AR | 8.79 | 24.75 | 18.32 | 64.25 |
| Hercules Glade Wilderness Area | HEGL1 | MO | 9.75 | 26.88 | 18.80 | 67.92 |
| Mingo Wilderness Area | MING1 | MO | 11.14 | 30.87 | 19.69 | 74.03 |
| Upper Buffalo Wilderness Area | UPBU1 | AR | 8.93 | 25.07 | 17.82 | 60.73 |

### 7.2.7. Model Results for the VISTAS 2028 Inventory Compared to the URP Glide Path for the Sipsey Wilderness Area

Using 2000 through 2004 IMPROVE monitoring data, the dv values for the 20% clearest days in each year were averaged together, producing a single average dv value for the clearest days during that time period. Similarly, the dv values for the 20% most impaired days in each year were averaged together, producing a single average dv value for the days with the most anthropogenic visibility impairment during that time period. These values form the baseline for visibility at each Class I area and are used to gauge improvements. In this second round of visibility planning, 2011 represents the base year for air quality modeling projections. To develop an average 2011 impairment suitable for use in air quality projections, 2009 through 2013 IMPROVE monitoring data were used. The dv values for the 20% clearest days in each year are averaged together to produce a single average dv value for the clearest days. The 20% most impaired days were also averaged from this timeframe to produce a single value for the 20% most impaired days.

Figure 7-9 illustrates the predicted visibility improvement on the 20% most impaired days by 2028, compared to the Uniform Rate of Progress (URP) for the Sipsey Wilderness Area. The pink line represents the URP for Sipsey. The URP starts at the 2000-2004 average of the 20% most impaired days and ends in 2064 at the estimated natural condition value for Sipsey. This line shows a uniform, linear progression between the 2000-2004 baseline and the target natural condition in 2064. The model projections shown in blue triangles start at 2011 (the observed 2009-2013 average of the visibility on the 20% most impaired days) and end at the 2028 projected visibility values for the 20% most impaired days based on existing and planned emissions controls during the period of the LTS associated with this round of planning. The blue diamonds on the figure represent the IMPROVE monitoring data on the 20% most impaired days at Sipsey, and the brown line denotes the five-year rolling average of each set of IMPROVE monitoring data.

As can be seen in both the model projection as well as the monitoring data, at Sipsey visibility improvements on the 20% most impaired days are expected to be significantly better than the URP Glide Path by 2028.

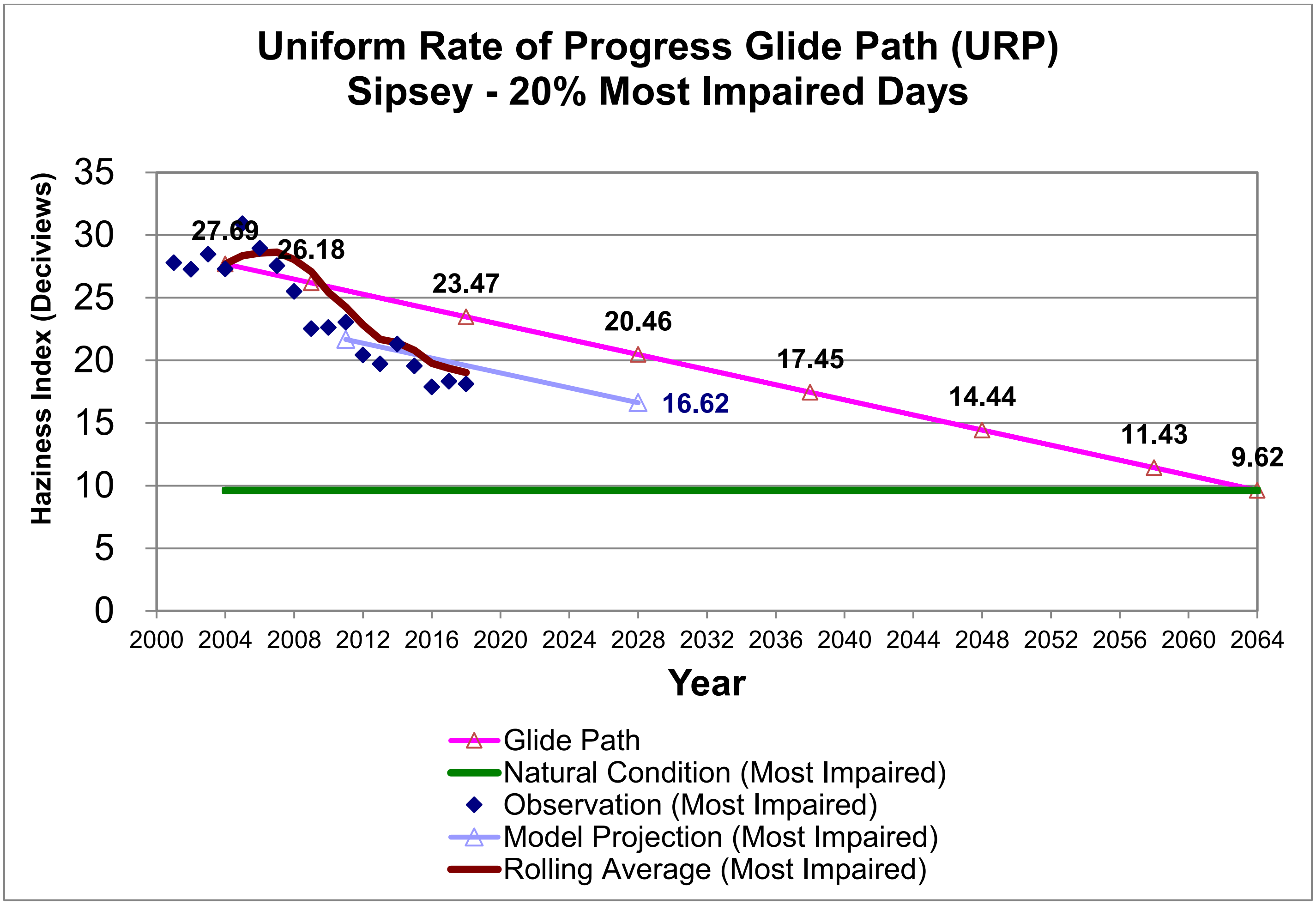



**Figure 7-9: Sipsey URP on the 20% Most Impaired Days**

As illustrated in Figure 7-10, visibility improvements at all the VISTAS Class I areas except the Everglades are projected to be better than the URP. In Figure 7-10, the percentage displayed represents the difference between the 2028 projected visibility value from the VISTAS modeling analyses and the expected visibility improvement by 2028 on the URP. Because this calculation is based on the level of haze in dv, negative percentages indicate that the 2028 projected visibility value is better than the expected visibility by 2028 on the URP while positive percentages indicate that the 2028 projected visibility value is worse than the expected visibility by 2028 on the URP. For example, regional haze in the Sipsey Wilderness Area is projected to be 19% lower than the expected visibility for 2028 on the URP, well ahead of the timeline noted on the URP.

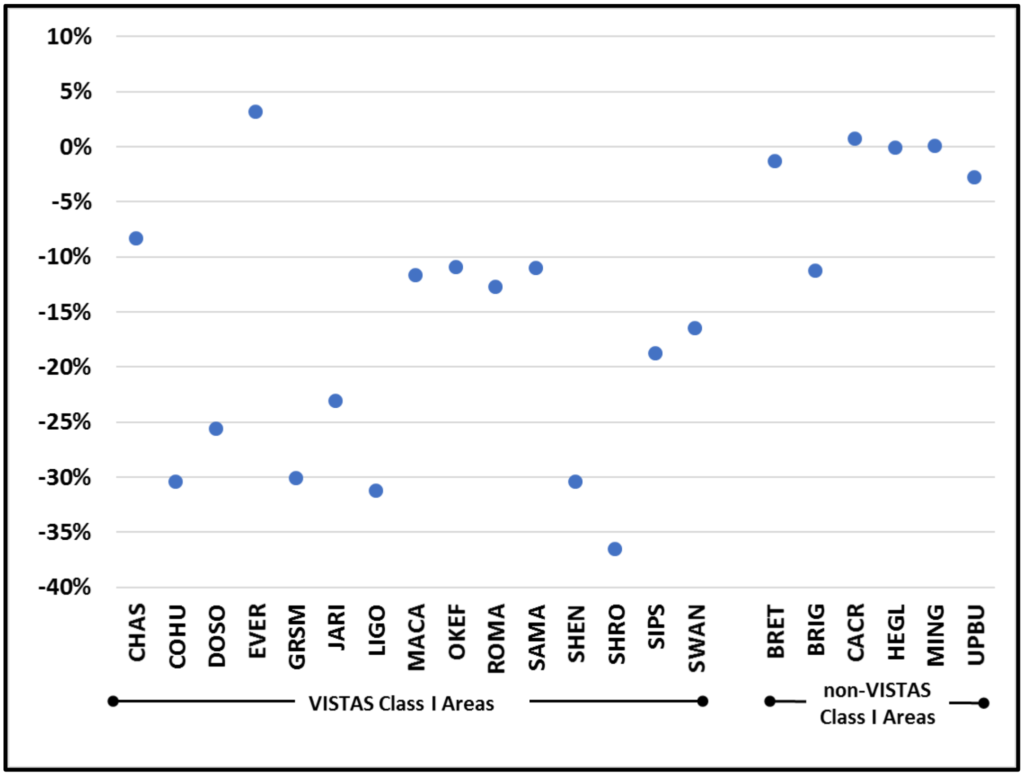



**Figure 7-10: Percent of URP in 2028**

Figure 7-11 illustrates the visibility improvement in 20% most impaired days. This figure shows the scenery at the Sipsey Wilderness Area impacted at levels equivalent to the 2000-2004 baseline conditions on the 20% most impaired days, the 2028 projections based on the VISTAS inventory, and natural conditions.

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**Figure 7-11: Sipsey 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions**

In addition to improving visibility on the 20% most impaired visibility days, states are also required to protect visibility on the 20% clearest days at Class I areas to ensure no degradation of visibility on these clearest days occurs. Figure 7-12 shows the improvement expected on the 20% clearest visibility days at Sipsey using the VISTAS emissions inventory and associated reductions. The pink line represents the 2000-2004 average baseline conditions for the 20% clearest days. The model projections shown in blue triangles start at 2011 (the observed 2009-2013 average of the visibility on the 20% clearest days) and end at the 2028 projected visibility values for the 20% clearest days based on existing and planned emissions controls during the period of the LTS associated with this round of planning. Blue diamonds depict IMPROVE monitoring data values, and the brown line denotes IMPROVE monitoring data five-year averages. As noted in these figures, visibility conditions in 2028 on the 20% clearest visibility days are expected to continue to improve at Sipsey.

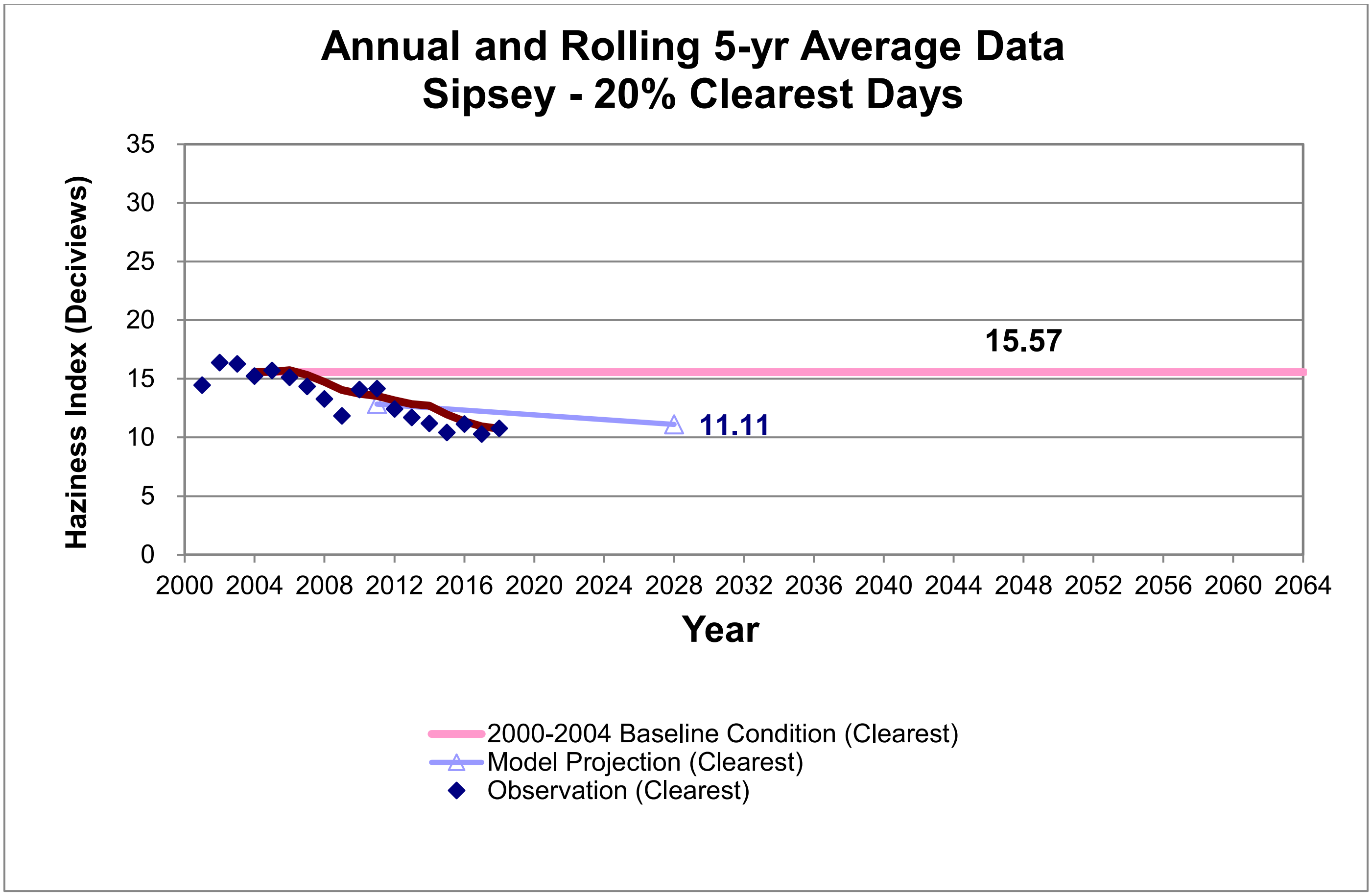



**Figure 7-12: 20% Clearest Days Rate of Progress for Sipsey**

As illustrated in Figure 7-13, visibility on the 20% clearest days is projected to improve in 2028 at all VISTAS and non-VISTAS Class I areas as a result of the emission control programs included in the VISTAS 2028 emissions inventory. In this figure, a zero percent change indicates no change in visibility. A negative percentage indicates improvement in projected visibility while a positive change indicates visibility degradation. The percent improvement on the 20% clearest days is projected to be 29% lower than the baseline conditions for Sipsey.

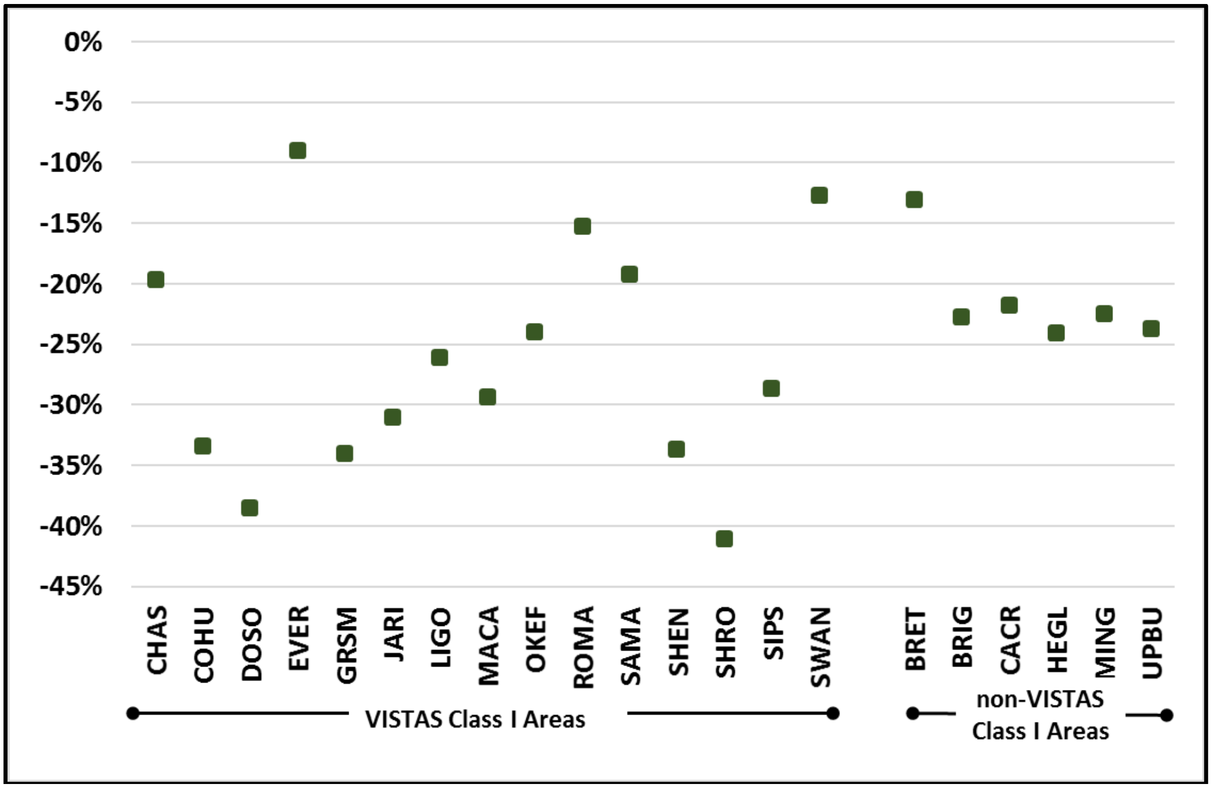



**Figure 7-13: Percent Visibility Improvement on 20% Clearest Days**

## 7.3. Relative Contribution from International Emissions to Visibility Impairment in 2028 at VISTAS Class I Areas

International anthropogenic emissions are beyond the control of states preparing Regional Haze SIPs. Therefore, the Rule at 40 CFR 51.308(f)(1)(vi)(B) allows states to optionally propose an adjustment of the 2064 URP endpoint to account for international anthropogenic impacts, if the adjustment has been developed using scientifically valid data and methods. On September 19, 2019, EPA released the Technical Support Document for EPA's Updated 2028 Regional Haze Modeling.[43] This document provides the results of EPA's updated 2028 visibility modeling analyses and includes projections of both domestic and international source contributions. EPA used these source apportionment results to calculate the estimated source contribution of international anthropogenic emissions to visibility impairment at Class I areas on the 20% most impaired days. EPA then used estimated contributions to derive adjusted glide path endpoints for each Federal Class I area.

In this study, EPA used the CAMx PSAT tool to tag certain sectors. EPA processed each sector through the SMOKE model and tracked each sector in PSAT as an individual source tag. EPA tracked sulfate, nitrate, ammonium, secondary organic aerosols, and primary PM in this manner. International anthropogenic emissions within this study include anthropogenic emissions from Canada and Mexico, C3 commercial marine emissions outside of the emissions control area as described in Section 7.2.1.4.4, and international anthropogenic boundary conditions.

[43] https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

Results from this study show that international anthropogenic boundary conditions account for a sizable fraction of sulfate concentrations in the west in certain months, and to a lesser extent nitrate. Estimated international anthropogenic visibility impairment ranges from 3.0 $Mm^{-1}$ to 19.7 $Mm^{-1}$. For Class I areas located in VISTAS, total international anthropogenic emissions impacts range from 4.10 $Mm^{-1}$ to 8.80 $Mm^{-1}$. Table 7-3 provides the estimated international anthropogenic visibility impacts to VISTAS Class I areas from EPA's study.

**Table 7-3: VISTAS Class I Area International Anthropogenic Emissions 2028 Impairment, $Mm^{-1}$**

| Class I Area Name | State | Site ID | Non-US C3 Marine | Canada | Mexico | Boundary International | Total International Anthropogenic |
|---|---|---|---|---|---|---|---|
| Cape Romain Wilderness Area | SC | ROMA | 0.50 | 0.81 | 1.24 | 3.68 | 6.23 |
| Chassahowitzka Wilderness Area | FL | CHAS | 1.30 | 0.62 | 1.01 | 3.81 | 6.75 |
| Cohutta Wilderness Area | GA | COHU | 0.10 | 1.31 | 0.68 | 3.20 | 5.29 |
| Dolly Sods Wilderness Area | WV | DOSO | 0.05 | 2.11 | 0.53 | 2.31 | 4.99 |
| Everglades National Park | FL | EVER | 2.28 | 0.48 | 0.36 | 4.65 | 7.77 |
| Great Smoky Mountains National Park | NC/TN | GRSM | 0.09 | 1.38 | 0.54 | 2.83 | 4.48 |
| James River Face Wilderness Area | VA | JARI | 0.04 | 2.01 | 0.38 | 2.56 | 4.99 |
| Joyce Kilmer-Slickrock Wilderness Area | NC/TN | JOYC | 0.09 | 1.38 | 0.54 | 2.83 | 4.84 |
| Linville Gorge Wilderness Area | NC | LIGO | 0.04 | 1.42 | 0.39 | 2.26 | 4.10 |
| Mammoth Cave National Park | KY | MACA | 0.02 | 3.34 | 0.30 | 3.28 | 6.94 |
| Okefenokee Wilderness Area | GA | OKEF | 0.99 | 0.98 | 2.23 | 4.60 | 8.80 |
| Otter Creek Wilderness Area | WV | OTCR | 0.05 | 2.11 | 0.53 | 2.31 | 4.99 |
| Shenandoah National Park | VA | SHEN | 0.02 | 1.98 | 0.30 | 2.42 | 4.72 |
| Shining Rock Wilderness Area | NC | SHRO | 0.09 | 1.01 | 1.00 | 2.61 | 4.70 |
| Sipsey Wilderness Area | AL | SIPS | 0.09 | 1.45 | 0.74 | 2.83 | 5.12 |
| St. Marks Wilderness Area | FL | SAMA | 0.59 | 0.76 | 1.43 | 3.78 | 6.57 |
| Swanquarter Wilderness Area | NC | SWAN | 0.16 | 1.91 | 0.65 | 2.42 | 5.13 |
| Wolf Island Wilderness Area | GA | WOLF | 0.99 | 0.98 | 2.23 | 4.60 | 8.80 |

The Sipsey Wilderness Area is expected to be well below the 2028 URP goal based on VISTAS modeling, which includes current and forthcoming control programs. The estimated international emissions impact for Sipsey is 5.12 $Mm^{-1}$. Adjustments to the 2028 URP goal based on these estimated visibility impairment contributions of international anthropogenic emissions would not change the conclusion that these areas will experience visibility improvements that are significantly better than the URP. Therefore, in this round of regional haze planning, Alabama is not updating the 2028 URP goals based on EPA's contribution study of international anthropogenic emissions.

## 7.4. Relative Contributions to Visibility Impairment: Pollutants, Source Categories, and Geographic Areas

To determine what areas and emissions source sectors impact VISTAS mandatory Federal Class I areas, VISTAS relied on PSAT results examining the impacts of sulfate and nitrate from the following geographic areas and emissions sectors:

- Total $SO_2$ and $NO_X$ emissions from each VISTAS state;

- Total $SO_2$ and $NO_X$ emissions from the CENRAP, MANE-VU, and LADCO regional planning organizations;
- Total $SO_2$ and $NO_X$ emissions from EGUs from each VISTAS state;
- Total $SO_2$ and $NO_X$ emissions from EGUs from the CENRAP, MANE-VU, and LADCO regional planning organizations;
- Total $SO_2$ and $NO_X$ emissions from non-EGU point sources from each VISTAS state; and
- Total $SO_2$ and $NO_X$ emissions from non-EGU point sources from the CENRAP, MANE-VU, and LADCO regional planning organizations.

Visibility impacts in 2028 estimated by PSAT for each region (10 individual VISTAS states plus three RPOs), emission sector (total, EGU, and non-EGU), and pollutant ($SO_2$ and $NO_X$) at each mandatory Federal Class I area are available for comparison.

Figure 7-14 shows the 2028 nitrate impairment from each region at mandatory Federal Class I areas within VISTAS. Most mandatory Federal Class I areas in VISTAS show contributions of less than 4 $Mm^{-1}$ from nitrate in 2028, with the exceptions being Mammoth Cave National Park, Sipsey Wilderness Area, Cape Romain Wilderness Area, and Swanquarter Wilderness Area. All of the mandatory Federal Class I areas in VISTAS show total contributions to nitrate impairment from the CENRAP, LADCO, and the MANE-VU sources (dark grey, medium grey, and light grey, respectively) that are larger than home state contributions, with the exception of the Everglades National Park and the Okefenokee Wilderness Area.

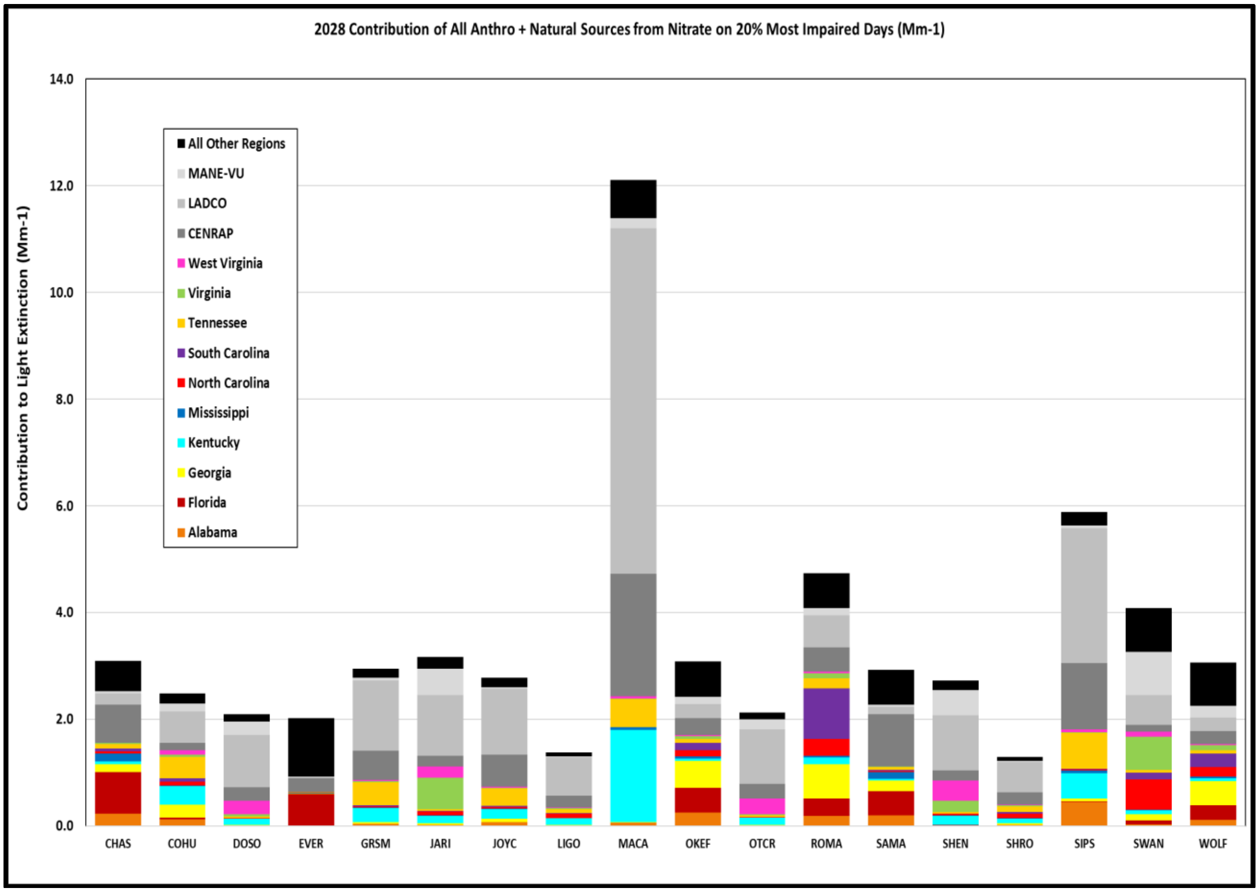



**Figure 7-14: 2028 Nitrate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas**

Figure 7-15 shows the 2028 sulfate impairment from each region at mandatory Federal Class I areas within VISTAS. All areas, with the exception of Everglades National Park, show sulfate impacts of at least 10 $Mm^{-1}$. All of the mandatory Federal Class I areas in VISTAS show contributions to sulfate impairment from CENRAP, LADCO, and MANE-VU sources (dark grey, medium grey, and light grey, respectively) that are larger than home state contributions, with the exception of the Everglades National Park.

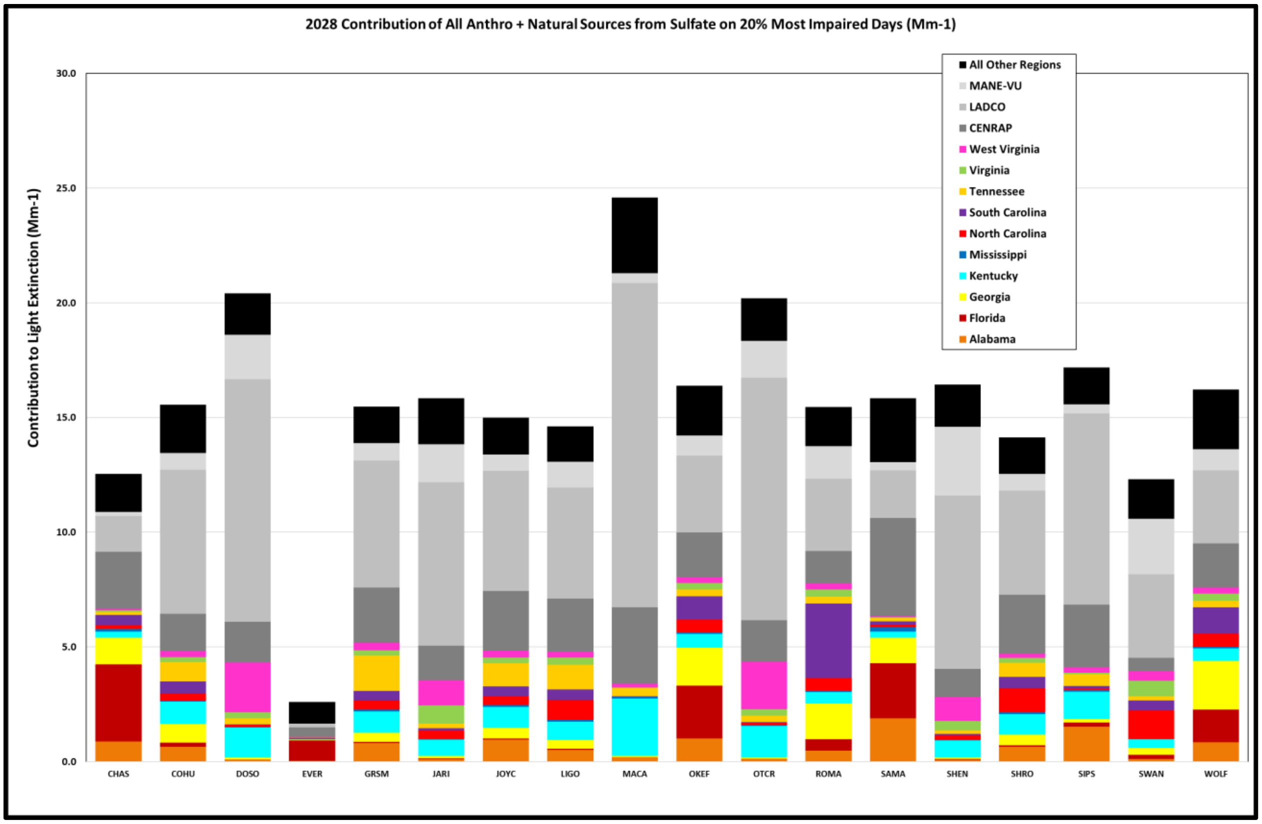



**Figure 7-15: 2028 Sulfate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas**

These figures indicate that sulfate continues to be the primary driver of visibility impairment in most VISTAS Class I areas, including the Sipsey Wilderness Area. These figures also show that emissions from sources located outside of the home state and outside of VISTAS have a significant impact on visibility in VISTAS mandatory Federal Class I areas.

Figure 7-16 and 7-17 provide comparisons of projected light extinction from sulfate and nitrate in 2028 at the mandatory Federal Class I areas in VISTAS. These figures show the light extinction associated with all emissions within the pollutant inventory (absent contributions from boundary conditions), the light extinction caused by emissions from the EGU sector, and light extinction caused by emissions from the non-EGU point source sector.

Figure 7-16 shows this data for sulfate visibility impairment. Comparison of bar heights in this figure demonstrates that sulfate visibility impairment from the EGU and non-EGU point source sectors comprise the majority of the total sulfate visibility impairment at all mandatory Federal Class I areas within VISTAS except the Everglades National Park. Figure 7-16 also shows that for some VISTAS mandatory Federal Class I areas, visibility impairment due to sulfate from the EGU sector is significantly higher than visibility impairment due to sulfate from the non-EGU sector. Exceptions to this observation are Everglades National Park, Okefenokee Wilderness Area, Cape Romain Wilderness Area, St. Marks Wilderness Area, and Wolf Island Wilderness Area.

Figure 7-17 provides nitrate light extinction data in 2028 for the mandatory Federal Class I areas in VISTAS. In all but four cases, the total nitrate light extinction estimated for 2028 is well beneath

4 $Mm^{-1}$. In the case of Mammoth Cave National Park, Cape Romain Wilderness Area, Sipsey Wilderness Area, and Swanquarter Wilderness Area, total nitrate impairment is more than 4 $Mm^{-1}$, but the contributions from the EGU and non-EGU point source sectors are well under half of the total nitrate contribution.

Figure 7-16 and 7-17 show that sulfates generally contribute more to light extinction in 2028 at VISTAS mandatory Federal Class I areas than nitrates, and that sulfates from EGU and non-EGU point source sectors contribute the majority of the sulfate light extinction at most of these areas. Figure 7-17 also shows that the majority of nitrate light extinction is not caused by $NO_X$ emissions from EGU and non-EGU point sources.

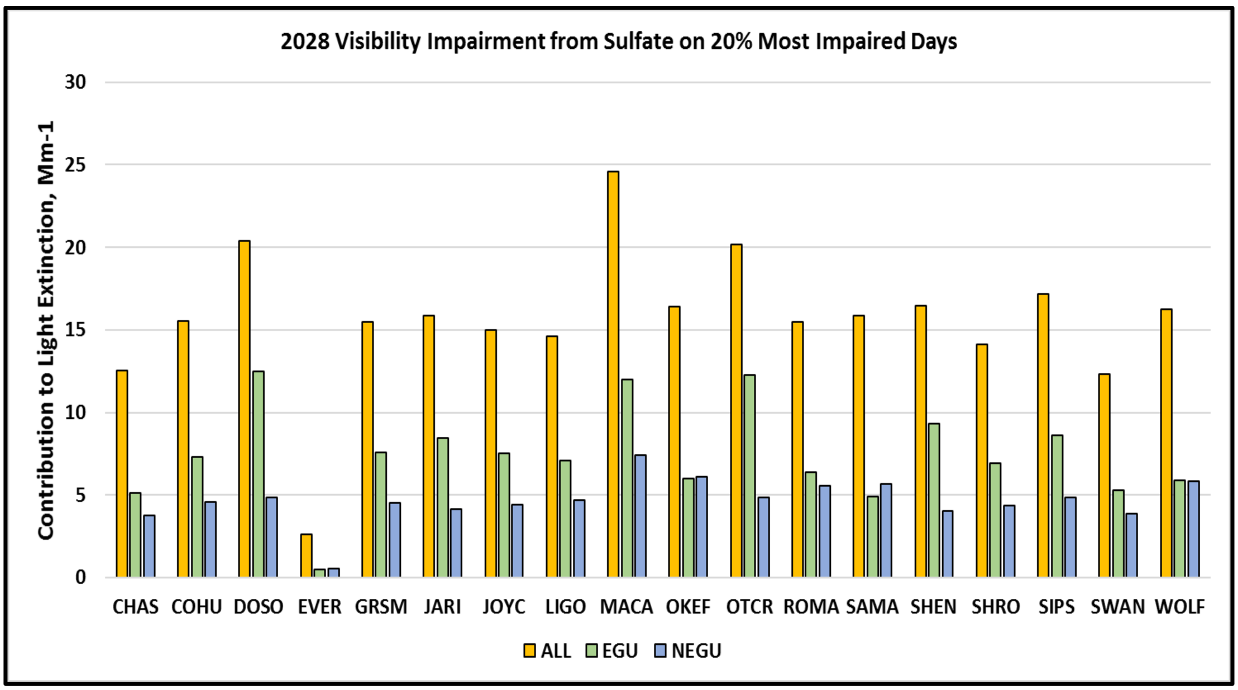



**Figure 7-16: 2028 Visibility Impairment from Sulfate on 20% Most Impaired Days, VISTAS Class I Areas**

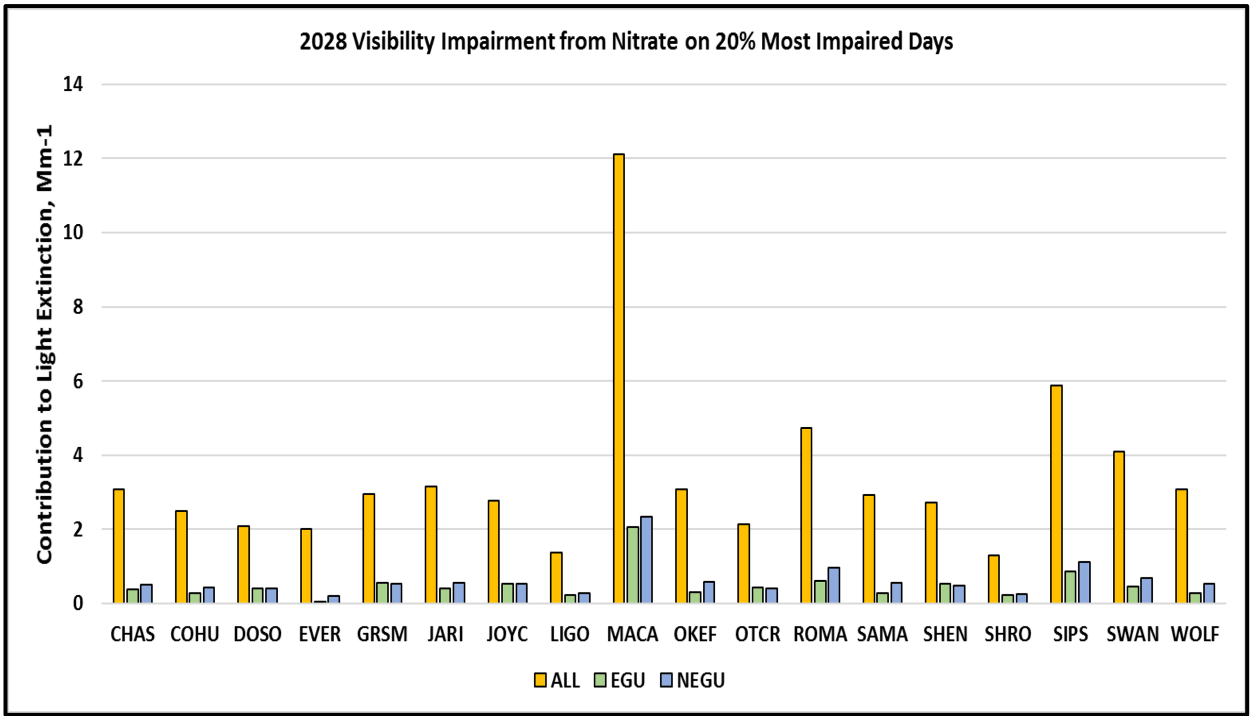



**Figure 7-17: 2028 Visibility Impairment from Nitrate on 20% Most Impaired Days, VISTAS Class I Areas**

These PSAT analyses support the following conclusions concerning the visibility impairing emissions, the source categories responsible for these emissions, and the locations of the pollutant emitting activities:

- Sulfate will generally be a much larger contributor than nitrates to visibility impairment in 2028 at VISTAS mandatory Federal Class I areas.
- Emissions from other regional planning organizations (MANE-VU, LADCO, and CENRAP) generally have higher contributions to 2028 visibility impairment at mandatory Federal Class I areas in VISTAS than the emissions from the home state.
- Emissions from EGUs and non-EGU point sources contribute the majority of the total sulfate contributions to visibility impairment in 2028 at mandatory Federal Class I areas in VISTAS.

Figure 7-18 provides a more detailed comparison for the Sipsey Wilderness Area. This figure shows that projected light extinction in 2028 from total sulfate is significantly larger than light extinction from total nitrate. At Sipsey, projected total sulfate extinction is approximately 22 $Mm^{-1}$ while total projected nitrate extinction is less than 7 $Mm^{-1}$. These figures also show that sulfate from EGUs and non-EGUs account for the majority of the total sulfate impact at Sipsey. For 2028, sulfate extinction from EGUs and non-EGU point sources at Sipsey is 13.5 $Mm^{-1}$ while the total sulfate extinction is 22 $Mm^{-1}$. Therefore, EGU and non-EGU point sources account for 61% of the total sulfate impact at Sipsey. Lastly, this figure shows that sulfates originating in the LADCO region contribute substantially to the estimated 2028 sulfate impairment at Sipsey. At Sipsey, sulfates originating within LADCO contribute approximately 8 $Mm^{-1}$ to visibility impairment in 2028, or roughly 36% of the total sulfate impact.

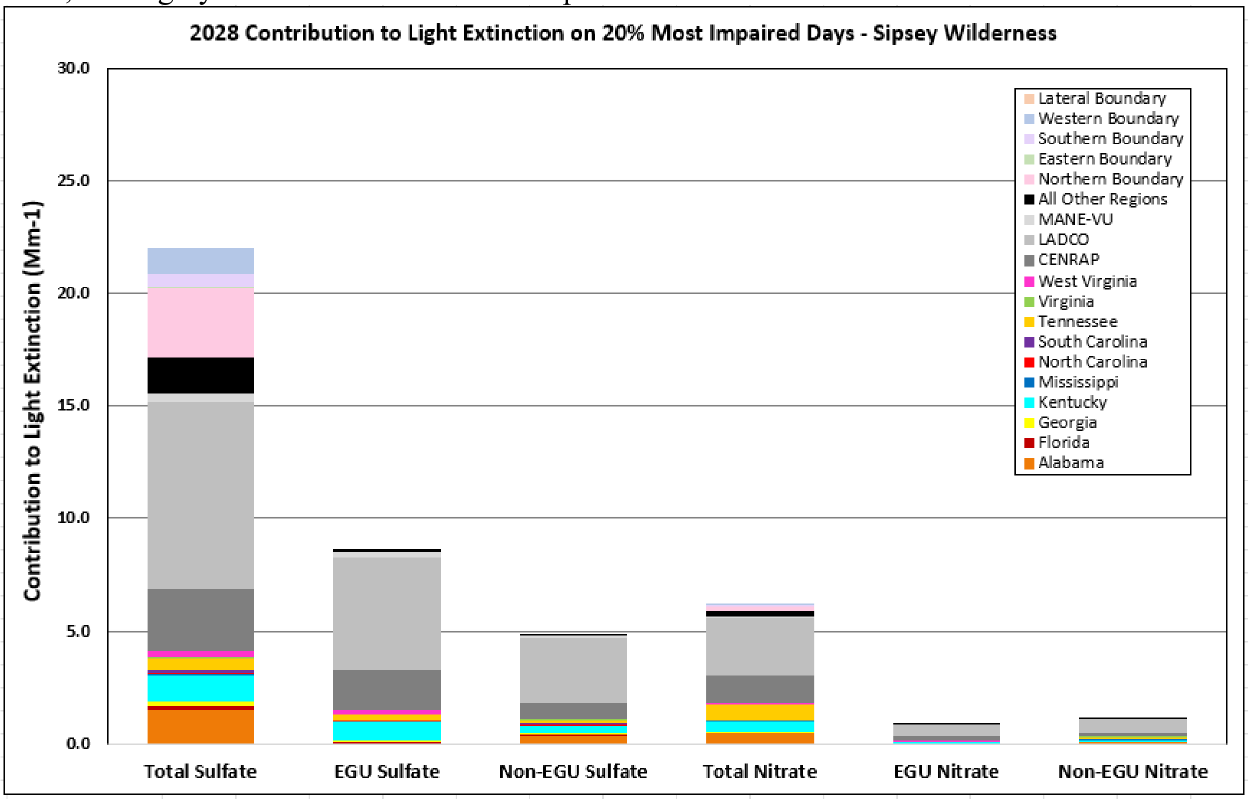



**Figure 7-18: 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Sipsey**

EPA released an updated 2028 visibility air quality modeling study in September 2019.[44] The goal of this effort was to project 2028 visibility conditions for each mandatory Federal Class I area. This effort used EPA's 2016 modeling platform as the basis for the 2028 projections. EPA provided VISTAS with an output file from the SMAT-CE tool showing visibility impairment at each Class I area by visibility impairing species. Figure 7-19 provides these outputs graphically for the VISTAS mandatory Federal Class I areas with an IMPROVE monitoring site. This figure, based on EPA's September 2019 modeling study, also shows that sulfates will continue to be the prevailing visibility impairing species in 2028 at VISTAS Class I areas and is consistent with a similar analysis of baseline conditions shown in Figure 2-2, and of current conditions shown in Figure 7-19 shows that sulfates, depicted by the yellow bars, have more than double the impact at each VISTAS Class I area as compared to nitrates, the next most prevalent species and depicted by the red bars, in all cases except Mammoth Cave National Park. At Mammoth Cave National Park, the projected 2028 sulfate to nitrate ratio is just under 2.0. These results corroborate the findings of the VISTAS study and indicate that focusing resources on the control of $SO_2$ is appropriate for this round of regional haze planning. Appendix E-8 provides the data supplied by EPA from their 2019 modeling study.

[44] URL: https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

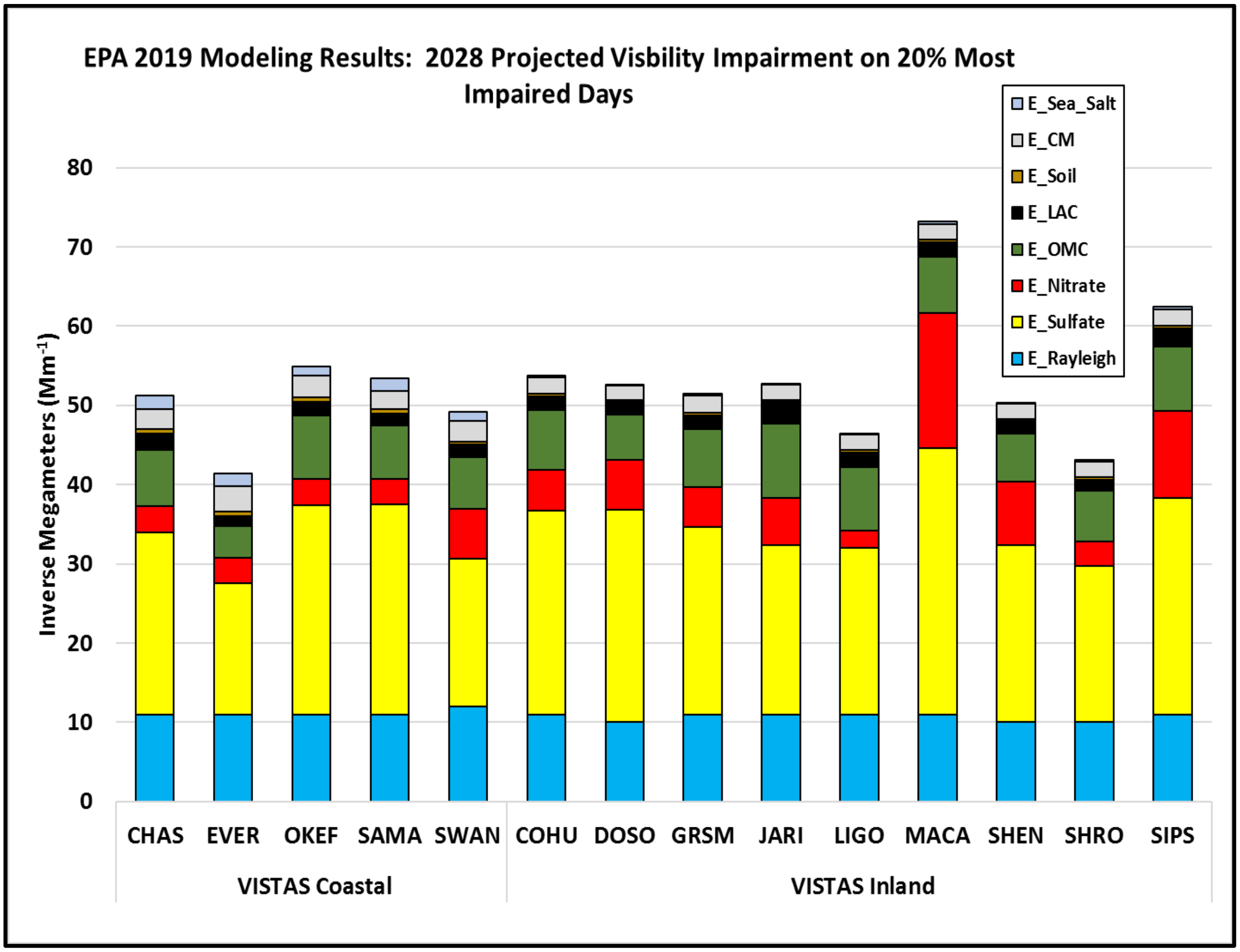



**Figure 7-19: 2028 Projected Visibility Impairment by Pollutant Species, EPA 2019 Modeling Results**

In accordance with 40 CFR 51.308(f)(2), Alabama used the results of the PSAT analysis to determine how Alabama's state-wide emissions may affect Class I areas outside of Alabama. In the PSAT analysis, VISTAS tagged statewide emissions of $SO_2$ and $NO_x$. Although PM is another pollutant that can contribute to visibility impairment, VISTAS did not tag PM emissions in the PSAT analysis after concluding that $SO_2$ and NOx emissions, particularly from point sources, are projected to have the largest impact on visibility impairment in 2028.

Table 7- presents the results of PSAT modeling VISTAS conducted to estimate the impact of statewide SO2 and NOx emissions in 2028 on total light extinction for the 20% most impaired days in all Class I areas in the VISTAS modeling domain (see Section 5.4 of this SIP). The results show total impairment for each Class I area and the state and RPO in which the Class I area is located. The statewide contribution to total impairment is provided in the fifth column in the table followed by the combined contribution from the nine remaining VISTAS states and the states located in CENRAP, LADCO, and MANE-VU. The last column in the table represents the contribution from the portion of the WRAP region that falls within the VISTAS modeling domain (see Figure 5-1). Contributions to visibility impairment that come from outside of the VISTAS modeling domain, including the remainder of the WRAP region, are accounted for via the boundary contributions which are provided in Appendix E-7a. Alabama determined that emissions

occurring in Alabama are reasonably anticipated to contribute to visibility impairment in the following Class I Federal areas: Sipsey Wilderness Area (AL), Chassahowitzka Wilderness Area (FL), and St. Marks Wilderness Area (FL). Alabama consulted with all the VISTAS states throughout the SIP development process. As discussed in Section 10.1.1.2, Alabama consulted with Florida about the Sanders Lead facility in Troy, Alabama. As detailed in Section 10.2, the VISTAS states participated in national conferences and consultation meetings with other states, RPOs, FLMs, and EPA throughout the SIP development process to share this information.

Table 7-4: Alabama Statewide Contributions of 2028 SO2 and NOx Emissions for all Source Sectors to Visibility Impairment for the 20% Most Impaired Days for Class I Areas in the VISTAS Modeling Domain (Mm-1)

| **Class I area** | **Alabama** | **All other VISTAS states** | **CENRAP** | **LADCO** | **MANE-VU** | **All Other Regions** | **Grand Total** |
|---|---|---|---|---|---|---|---|
| ACAD | 0.03 | 0.66 | 0.51 | 1.45 | 2.96 | 2.44 | 8.04 |
| BIBE | 0.02 | 0.03 | 1.96 | 0.07 | 0.00 | 5.77 | 7.85 |
| BOWA | 0.03 | 0.16 | 8.72 | 3.65 | 0.11 | 2.66 | 15.33 |
| BRET2 | 1.59 | 2.67 | 11.34 | 4.40 | 0.08 | 3.40 | 23.46 |
| BRIG | 0.02 | 1.99 | 1.63 | 8.48 | 9.96 | 4.08 | 26.18 |
| CACR | 0.20 | 0.69 | 16.80 | 3.10 | 0.06 | 2.20 | 23.06 |
| CAVE | 0.05 | 0.05 | 2.71 | 0.09 | 0.00 | 5.38 | 8.28 |
| CHAS | 1.12 | 7.09 | 3.21 | 1.76 | 0.22 | 2.22 | 15.63 |
| COHU | 0.78 | 5.45 | 1.76 | 6.88 | 0.87 | 2.30 | 18.04 |
| DOSO | 0.10 | 4.68 | 2.03 | 11.56 | 2.20 | 1.92 | 22.50 |
| EVER | 0.04 | 1.67 | 0.68 | 0.17 | 0.03 | 2.05 | 4.63 |
| GRGU | 0.03 | 0.67 | 1.13 | 3.18 | 1.91 | 3.20 | 10.12 |
| GRSM | 0.85 | 5.20 | 2.96 | 6.84 | 0.82 | 1.76 | 18.42 |
| GUMO | 0.05 | 0.05 | 2.71 | 0.09 | 0.00 | 5.38 | 8.28 |
| HEGL | 0.12 | 1.07 | 18.92 | 6.89 | 0.09 | 3.46 | 30.55 |
| ISLE | 0.02 | 0.34 | 6.19 | 7.88 | 0.20 | 2.89 | 17.53 |
| JARI | 0.13 | 4.52 | 1.70 | 8.26 | 2.15 | 2.24 | 19.01 |
| JOYC | 1.02 | 4.54 | 3.21 | 6.46 | 0.76 | 1.78 | 17.76 |
| LIGO | 0.53 | 4.60 | 2.55 | 5.54 | 1.15 | 1.62 | 15.99 |
| LYBR2 | 0.15 | 1.25 | 1.39 | 4.67 | 5.10 | 3.77 | 16.32 |
| MACA | 0.25 | 5.58 | 5.61 | 20.62 | 0.63 | 4.01 | 36.70 |
| MING | 0.31 | 3.05 | 11.67 | 14.70 | 0.18 | 3.31 | 33.20 |
| MOOS | 0.01 | 0.36 | 0.45 | 1.24 | 1.96 | 1.75 | 5.78 |
| OKEF | 1.26 | 8.48 | 2.27 | 3.60 | 1.01 | 2.84 | 19.47 |
| PRRA | 0.03 | 0.67 | 1.13 | 3.18 | 1.91 | 3.20 | 10.12 |
| ROCA | 0.01 | 0.36 | 0.45 | 1.24 | 1.96 | 1.75 | 5.78 |
| ROMA | 0.66 | 9.99 | 1.87 | 3.74 | 1.57 | 2.36 | 20.20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SAMA | 2.09 | 5.37 | 5.26 | 2.21 | 0.39 | 3.44 | 18.76 |
| SENE | 0.06 | 0.88 | 4.63 | 14.63 | 0.70 | 3.29 | 24.18 |
| SHEN | 0.10 | 3.56 | 1.43 | 8.57 | 3.48 | 2.02 | 19.16 |
| SHRO | 0.66 | 4.43 | 2.80 | 5.11 | 0.75 | 1.67 | 15.43 |
| SIPS | 1.98 | 3.95 | 3.98 | 10.86 | 0.46 | 1.86 | 23.07 |
| SWAN | 0.15 | 5.55 | 0.72 | 4.19 | 3.23 | 2.56 | 16.40 |
| UPBU | 0.22 | 0.95 | 15.29 | 3.22 | 0.09 | 2.94 | 22.70 |
| WIMO | 0.10 | 0.17 | 15.27 | 1.24 | 0.01 | 4.38 | 21.17 |
| WOLF | 0.96 | 8.17 | 2.15 | 3.44 | 1.15 | 3.41 | 19.29 |
| Grand Total | 15.73 | | 167.08 | 193.20 | 48.17 | 105.28 | 638.38 |

## 7.5. Area of Influence Analyses for the Sipsey Wilderness Area

Once the key pollutants and source categories contributing to visibility impairment at each Class I area have been identified, it is necessary to focus on the greatest contributing sources. Facility-level $SO_2$ area of influence (AoI) analyses were performed for the Sipsey Wilderness Area to determine the relative visibility impact from each facility. Then, these facilities were ranked by their sulfate visibility contribution at each Class I area. In addition, county-level AoI analyses were performed to confirm that $SO_2$ emissions from EGU and non-EGU point sources were the greatest contributors to visibility impairment at Sipsey. The following sections contain a broad overview of the steps in the AoI analyses. See Appendix D for a more detailed discussion of these analyses and plots for additional Class I areas.

### 7.5.1. Back Trajectory Analyses

The first step was to generate Hybrid Single Particle Lagrangian Integration Trajectory (HYSPLIT)[45] back trajectories for the Sipsey IMPROVE monitoring sites and neighboring Class I areas for 2011-2016 on the 20% most impaired days. Back trajectory analyses use interpolated measured or modeled meteorological fields to estimate the most likely central path of air masses that arrive at a receptor at a given time. The method essentially follows a parcel of air backward in hourly steps for a specified length of time.

The HYSPLIT runs included starting heights of 100 meters (m), 500 m, 1,000 m, and 1,500 m. Trajectories were run 72 hours backwards in time for each height at each location. Trajectories were run with start times of 12:00 a.m. (midnight of the start of the day), 6:00 a.m., 12:00 p.m., 6:00 p.m., and 12:00 a.m. (midnight at the end of the day) local time.

Figure 7-20 contains the 100-meter back trajectories for the 20% most impaired visibility days (2011-2016) at the Sipsey Wilderness Area. Figure 7-21 contains the 100-meter back trajectories by season for the 20% most impaired visibility days (2011-2016) at Sipsey. Figure 7-22 contains

[45] Stein, A. F., Draxler, R. R., Rolph, G. D., Stunder, B. J. B., Cohen, M. D., and Ngan, F., (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., 96, 2059-2077, http://dx.doi.org/10.1175/BAMS-D-14-00110.1

the 100-meter, 500-meter, 1000-meter, and 1500-meter back trajectories for the 20% most impaired visibility days (2011-2016) at Sipsey. These back trajectories for the 20% most impaired days were then used to develop residence time (RT) plots.

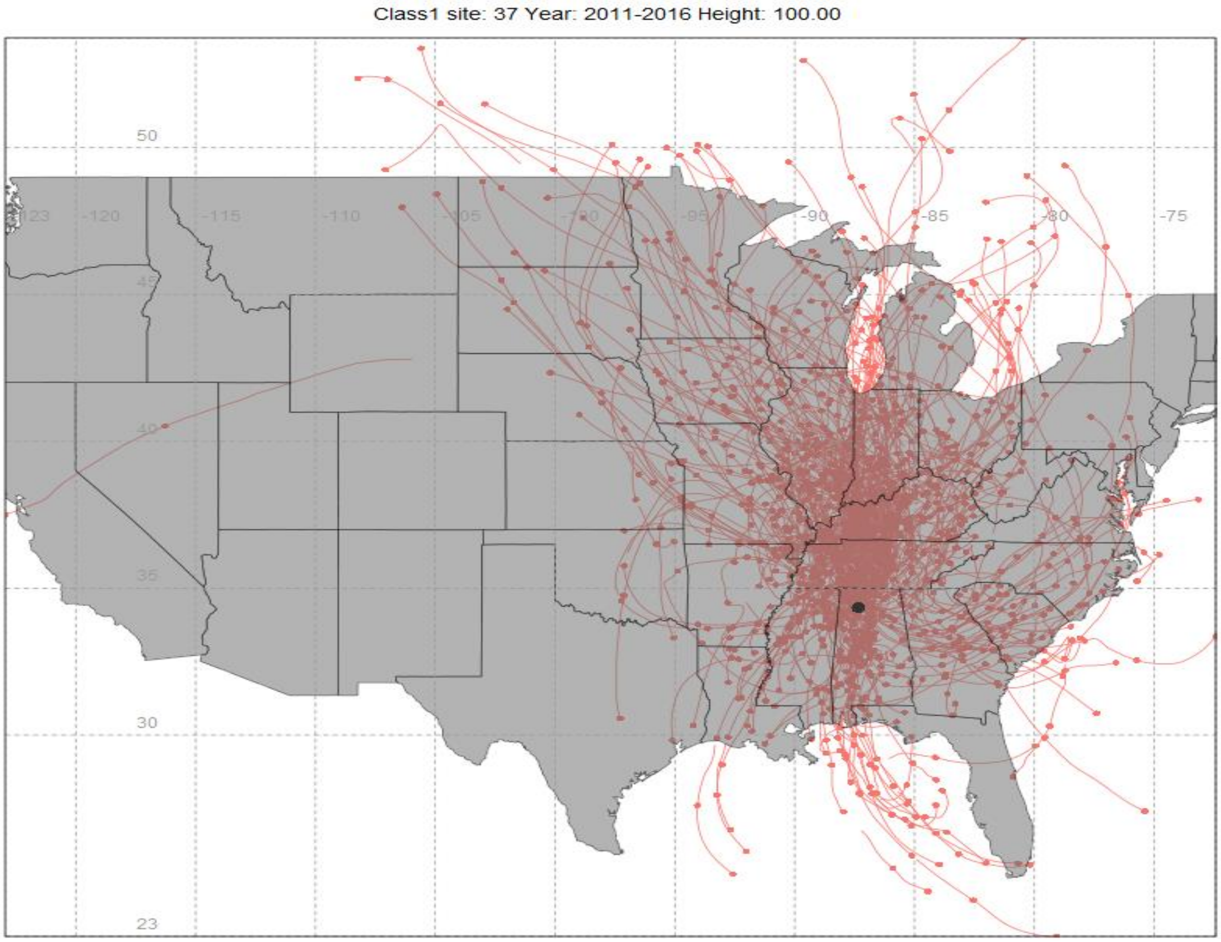



**Figure 7-20: 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016), from the Sipsey Wilderness Area**

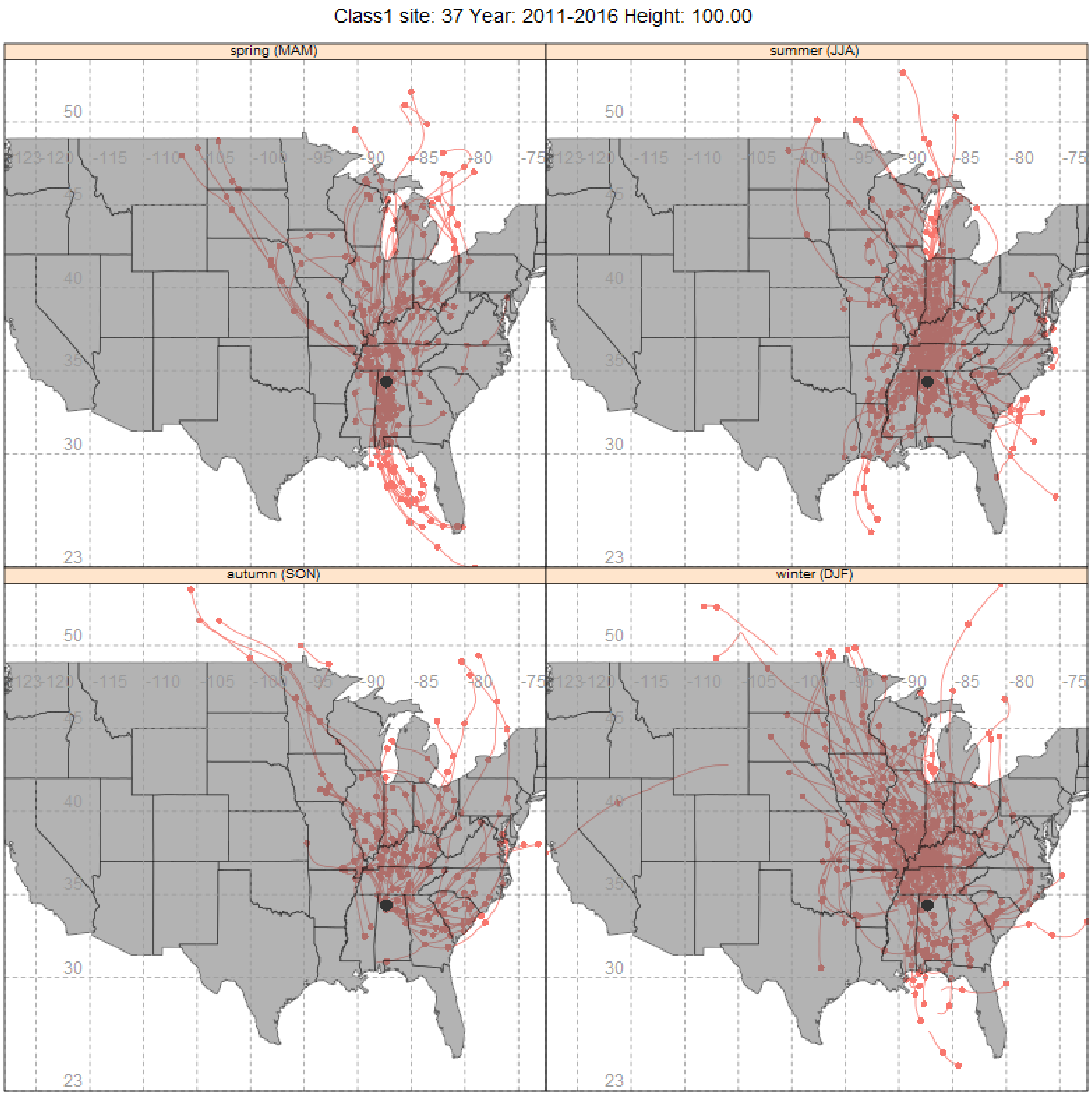



**Figure 7-21: 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from the Sipsey Wilderness Area**

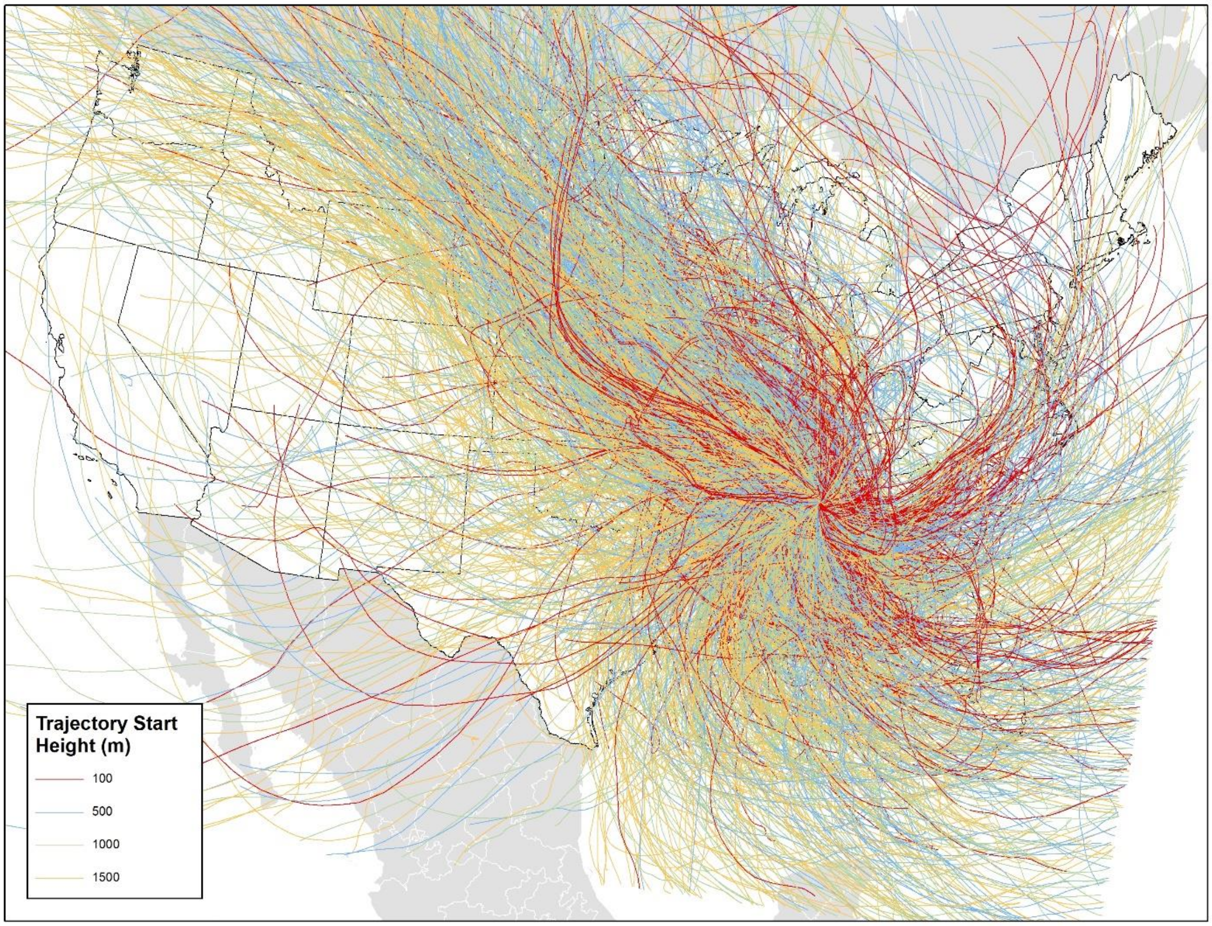



**Figure 7-22: 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from the Sipsey Wilderness Area**

### 7.5.2. Residence Time (RT) Plots

The next step was to plot Residence Time (RT) for each Class I area using six years of back trajectories for the 20% most impaired visibility days in 2011-2016. RT is the frequency that winds pass over a specific geographic area (model grid cell or county) on the path to a Class I area. RT plots include all trajectories for each Class I area.

Figure 7-23 contains the RT plots (counts per 12-km modeling grid cell) for the Sipsey Wilderness Area. Figure 7-24 contains the residence time (percent of total counts per 12-km modeling grid cell) for Sipsey. As illustrated in these figures, winds influencing Sipsey on the 20% most impaired days come from all directions, and there is no single predominant wind direction influencing the 20% most impaired visibility days.

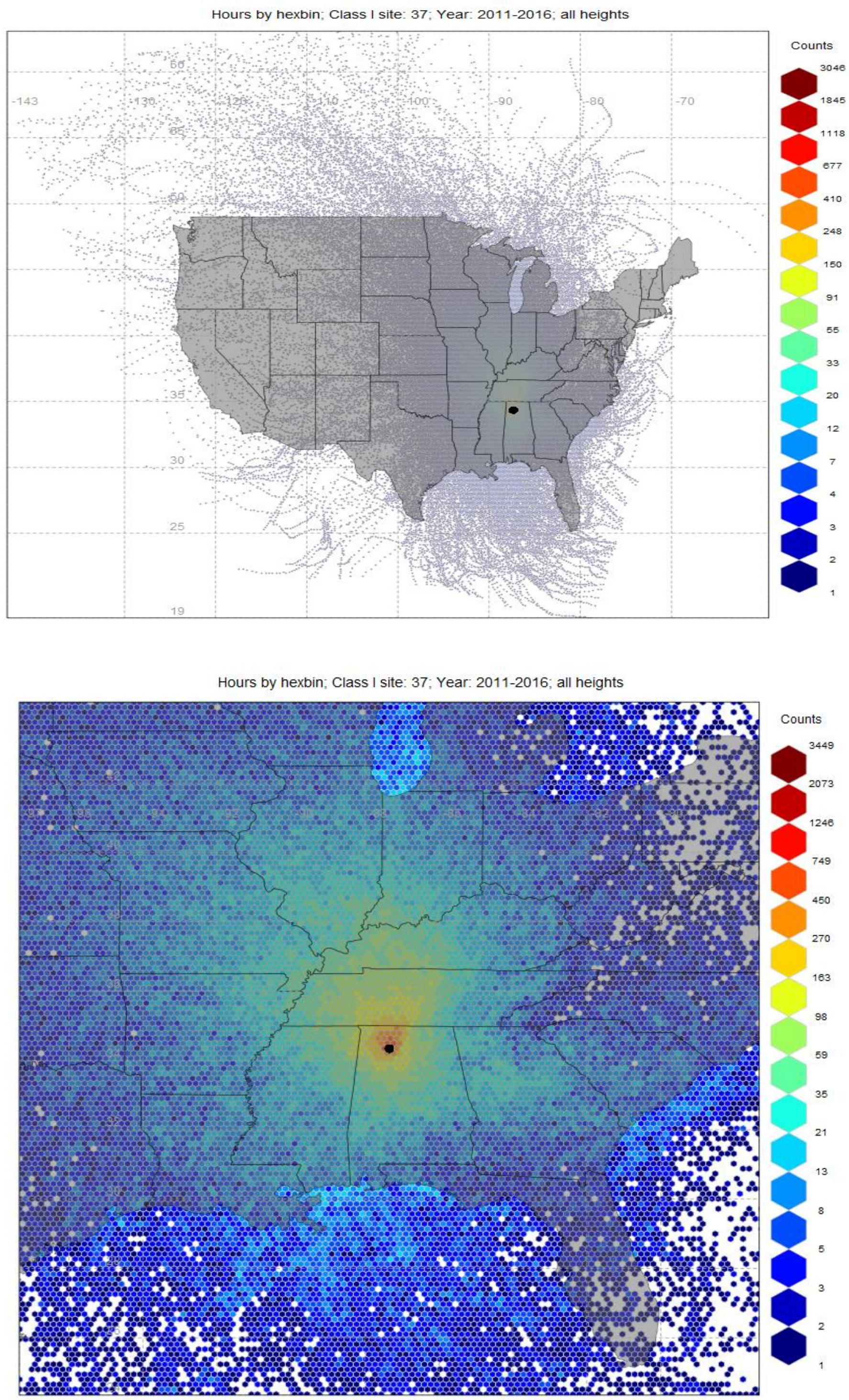
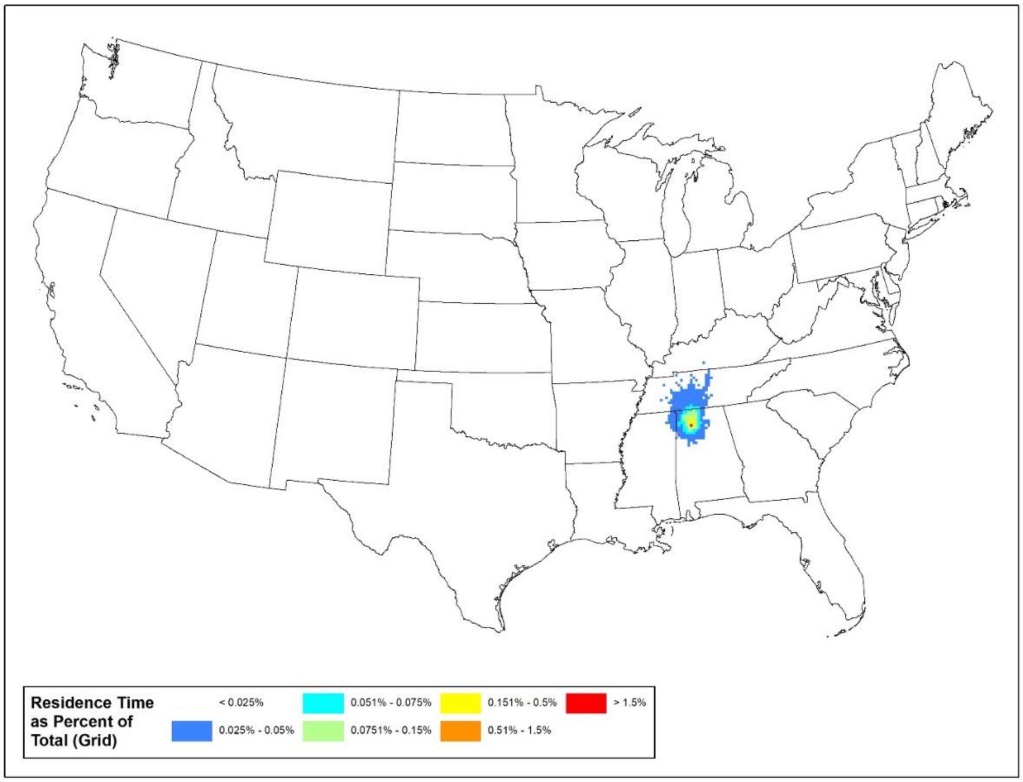



**Figure 7-23: Residence Time (Counts per 12km Modeling Grid Cell) for the Sipsey Wilderness Area- Full View (top) and zoomed in (bottom)**



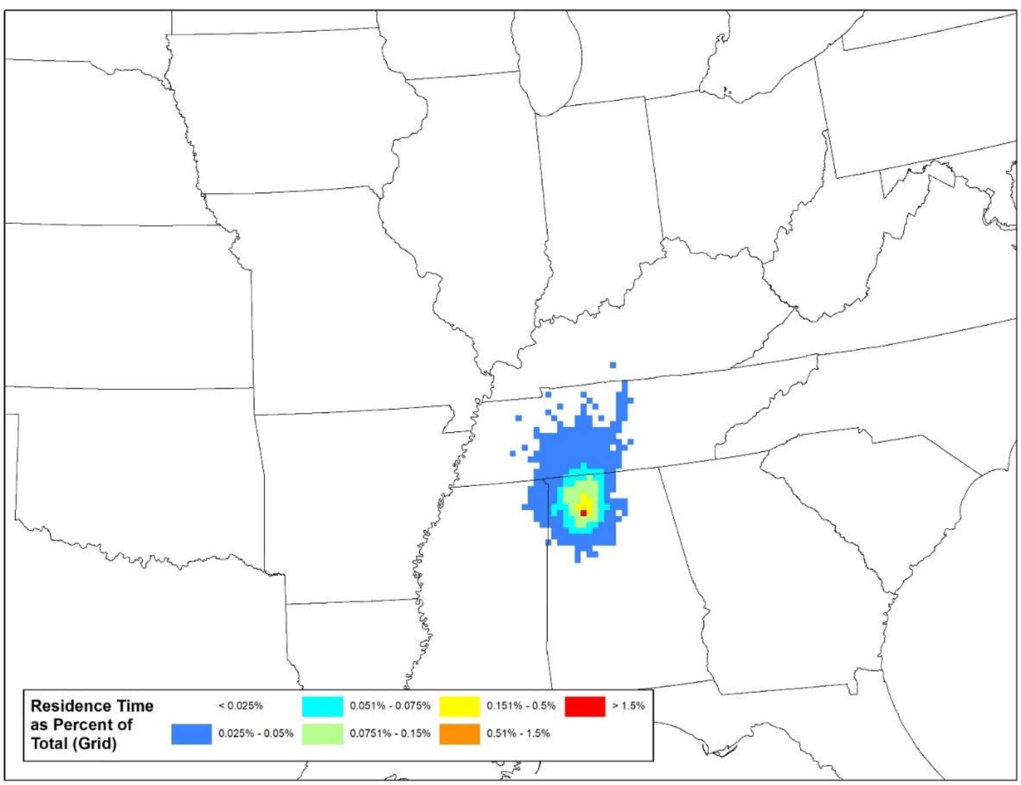




**Figure 7-24: Residence Time (% of Total Counts per 12km Modeling Grid Cell for the Sipsey Wilderness Area – Full View (top) and zoomed in (bottom)**

### 7.5.3. Extinction-Weighted Residence Time Plots (EWRT)

The next step was to develop extinction-weighted residence time (EWRT) plots for each VISTAS Class I area. Each back trajectory was weighted by ammonium sulfate extinction for that day and used to produce sulfate EWRT plots.

The concentration weighted trajectory (CWT)[46] approach was used to develop the EWRT, substituting the extinction values for the concentration. The extinction attributable to each pollutant is paired with the trajectory for that day. The mean weighted extinction of the pollutant species for each grid cell is calculated according to the following formula:

$$\overline{E}ij = EWRT = \frac{1}{\sum_{k=1}^{N} \tau_{ijk}} \sum_{k=1}^{N} (bext_k)\tau_{ijk}$$

Where:

- $i$ and $j$ are the indices of the grid;
- $k$ is the index of the trajectory;
- $N$ is the total number of trajectories used in the analysis;
- $b_{ext}$ is the 24-hour extinction attributed to the pollutant measured upon arrival of trajectory $k$; and
- $\tau_{ijk}$ is the number of trajectory hours that pass through each grid cell ($i, j$), where $i$ is the row and $j$ is the column.

The higher the value of the EWRT ($\overline{E}_{ij}$), the more likely that the air parcels passing over the cells (i, j) would cause higher extinction at the receptor site for that light extinction species. Since this method uses the extinction value for weighting, trajectories passing over large sized sources are more discernible than those passing over moderate sized sources.

Figure 7-25 contains the sulfate extinction weighted residence time (sulfate EWRT per 12-km modeling grid cell) for Sipsey for the 20% most impaired days from 2011 to 2016.

[46] Hsu, Y.-K., T. M. Holsen and P. K. Hopke (2003). "Comparison of hybrid receptor models to locate PCB sources in Chicago". In: Atmospheric Environment 37.4, pp. 545–562. DOI: 10.1016/S1352-2310(02)00886-5

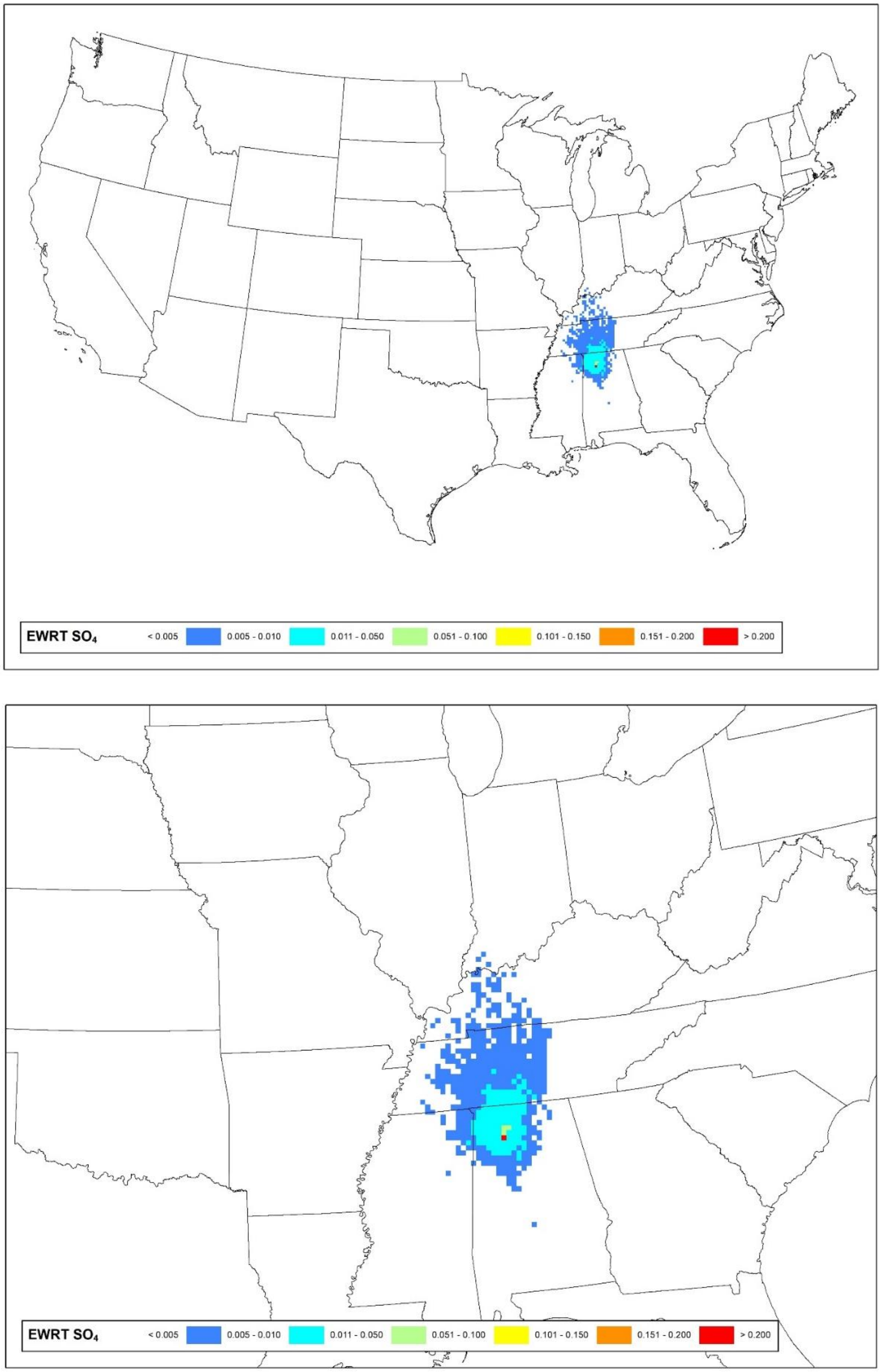


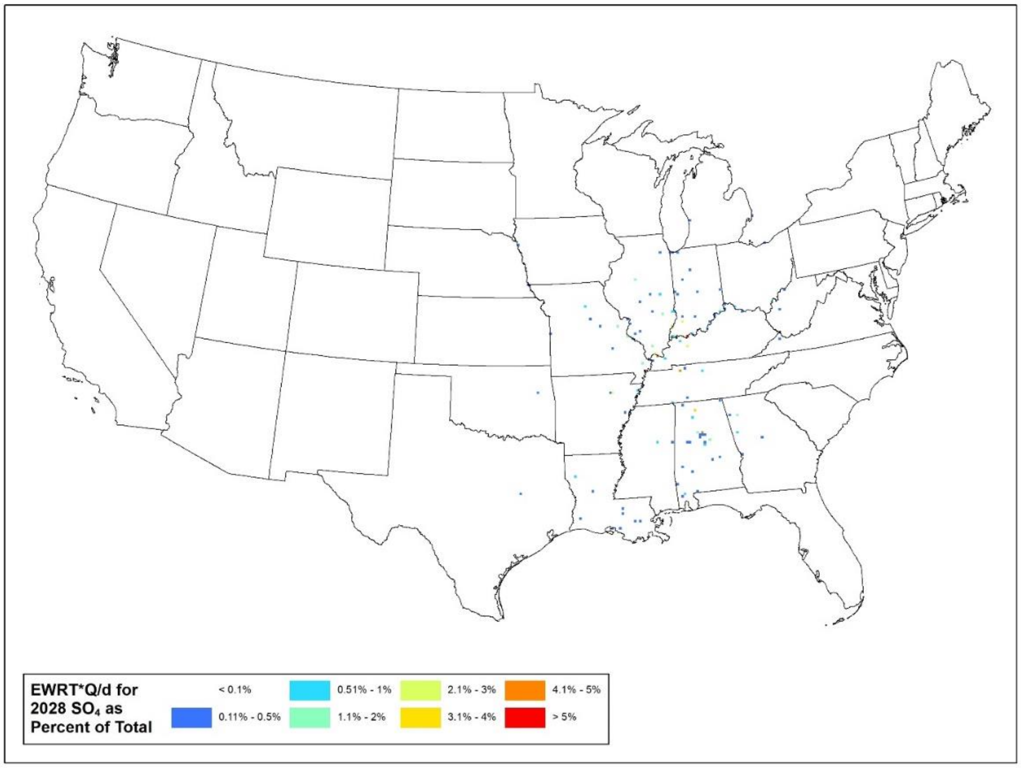

**Figure 7-25: Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12km Modeling Grid Cell) for the Sipsey Wilderness Area - Full View (top) and zoomed in (bottom)**

### 7.5.4. Emissions/Distance Extinction Weighted Residence Time Plots

Extinction weighted residence times were then combined with 12-km gridded $SO_2$ emissions from the 2028 emissions inventory. As a way of incorporating the effects of transport, deposition, and chemical transformation of point source emissions along the path of the trajectories, these data were weighted by 1/d, where d was calculated as the distance, in kilometers, between the center of the grid cell in which a source is located and the center of the grid cell in which the IMPROVE monitor is located. For Class I areas without an IMPROVE monitor (WOLF, JOYC, and OTCR), the grid cell for the centroid of the Class I area was used.

The grid cell total point $SO_2$ emissions (Q, in tons per year) were divided by the distance (d, in kilometers) to the trajectory origin; for a final value (Q/d). This value was then multiplied by the sulfate EWRT grid values (i.e., EWRT*(Q/d)) on a grid cell by grid cell basis. Next, the sulfate EWRT *(Q/d) values were normalized by the domain-wide total and displayed as a percentage. This information allows the individual facilities to be ranked from highest to lowest based on sulfate contributions. It should be noted that if non-normalized EWRT*(Q/d) values had been used to rank facilities from highest to lowest, the order would have been identical to the ranking from the normalized EWRT*(Q/d) values.

Figure 7-26 contains the sulfate emissions/distance extinction weighted residence time (percent of total Q/d*EWRT per 12-km modeling grid cell) for Sipsey. These maps help visualize where the sources of the largest visibility impacts are located. The figure illustrates the relative importance of Alabama sources of $SO_2$ compared to sources in neighboring states.



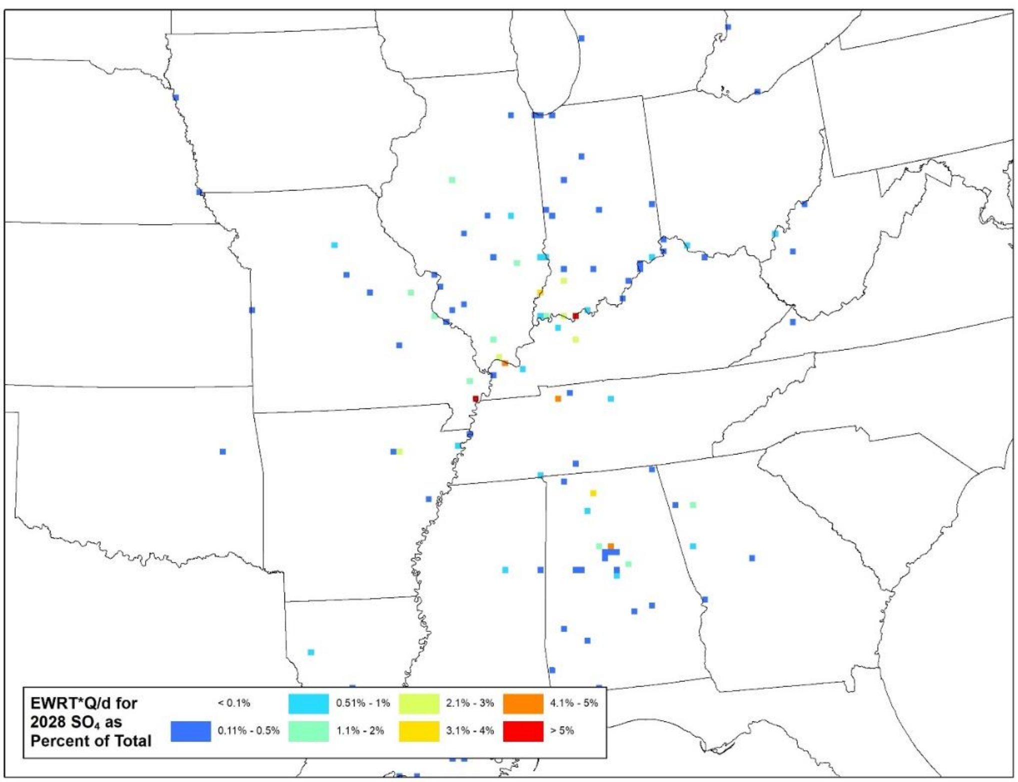




**Figure 7-26: Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12km Modeling Grid Cell) for the Sipsey Wilderness Area (top) and zoomed in (bottom)**

### 7.5.5. Ranking of Sources for the Sipsey Wilderness Area

The Q/d*EWRT data was further paired with additional point source metadata that defined the facility. Such data included facility identification numbers, facility names, state and county of location, Federal Information Processing Standard (FIPS) codes, North American Industry Classification System (NAICS) codes, and industry descriptions. Spreadsheets for individual Class I areas were then exported from the database for further analysis by the states. This information allows the individual facilities to be ranked from highest to lowest based on sulfate contributions.

It should be noted that while point sources account for most of the sulfate extinction, these sources only account for a portion of the nitrate extinction. Much of the nitrate extinction is attributable to the onroad and nonpoint sectors. Additionally, there is a continuous downward trend in NOx emissions being realized. This further bolsters the justification for evaluating only $SO_2$ for reasonable further progress for this planning period.

Similar analyses were conducted to rank $SO_2$ emissions contributions for the county-level sources (nonpoint, onroad, non-road, fires, and total point source sectors) (Please refer to Appendix D). The process was similar to the process for point sources previously described, except calculations of RT and EWRT were completed at the county-level as opposed to grid cells. The calculation of "d" was from the centroid of the county to the trajectory origin, in km. Similar to point sources, the final spatial pairing was made between the county-level EWRT, emissions, and source information for each sector.

In order to compare the contributions from counties on a relative basis, an additional analysis was conducted by adding new columns to normalize the EWRT*(Q/d) by the area of each county to develop a metric to compare the contributions from counties on a relative basis. The previous calculation (prior to being normalized by area) had a propensity to attribute higher contributions to larger counties simply because they typically contained more emission sources and more hourly trajectory end points. Normalizing the contribution by the area of the county (i.e., EWRT*(Q/d) per square kilometer) provides a sense of the source emission density within the county. This allows county contributions to be directly compared, without large counties being weighted more heavily by simply having more emission sources and more hourly trajectory end points. County contributions (normalized or non-normalized by area) can be found in Appendix D.

All county and emissions source identifying information were joined in an Access database with calculations of Q/d, EWRT, EWRT*(Q/d), fraction and sum contributions, and other source information. The database was then used to generate individual spreadsheets for each Class I area.

Table 7-5 contains the AoI $SO_2$ facility contributions to visibility impairment on the 20% most impaired days at the Sipsey Wilderness Area. The table only shows the eleven facilities contributing more than 2.00% sulfate, the percentage threshold chosen by Alabama as significant for carrying through to PSAT tagging. The full list of all facilities can be found in Appendix D. The lists of individual facilities identified by the AoI analysis for Sipsey were used to determine which facilities were tagged in the PSAT source contribution analysis. It should be noted that during the 2028 emissions inventory update completed in Spring 2020, an additional source, Lhoist North America- Montevallo (Lhoist) was identified when comparing the revised EPA 2028 emissions inventory to the 2028 VISTAS inventory. Alabama evaluated all emissions changes greater than 50 tons between the two inventories and determined that the difference in the emissions inventories for Lhoist warranted a reasonable progress analysis.

| STATE | Facility ID | FACILITY_NAME | DISTANCE (km) | 2028 SO2 (tpy) | Sulfate (%) |
|---|---|---|---|---|---|
| IN | 18147-8017211 | INDIANA MICHIGAN POWER DBA AEP ROCKPORT | 398.4450 | 30536.328 | 7.521 |
| KY | 21145-6037011 | Tennessee Valley Authority (TVA) - Shawnee Fossil Plant | 337.6610 | 19504.746 | 4.354 |
| AR | 05063-1083411 | ENTERGY ARKANSAS INC-INDEPENDENCE PLANT | 399.7234 | 32050.492 | 2.213 |
| IL | 17127-7808911 | Joppa Steam | 346.4890 | 20509.277 | 2.555 |
| IN | 18125-7362411 | INDIANAPOLIS POWER & LIGHT PETERSBURG | 464.3724 | 18141.881 | 2.268 |
| MO | 29143-5363811 | NEW MADRID POWER PLANT-MARSTON | 314.5284 | 16783.712 | 4.577 |
| IN | 18051-7363111 | Duke Energy Indiana- Gibson | 448.6590 | 23117.234 | 3.748 |
| TN | 47161-4979311 | TVA CUMBERLAND FOSSIL PLANT | 228.9452 | 8427.325 | 4.187 |
| KY | 21183-5561611 | Big Rivers Electric Corp - Wilson Station | 345.4659 | 6934.157 | 2.622 |
| AL | 01073-1018711 | DRUMMOND COMPANY, INC. | 98.72557 | 2562.167 | 2.231 |
| AL | 01103-1000011 | Nucor Steel Decatur LLC | 40.01976 | 170.233 | 2.242 |
| AL | 01117-949311 | Lhoist North America of Alabama, LLC* | 143.808 | 9,489.71 | 2.705 |

**Table 7-5: AoI $SO_2$ Facility Contributions on the 20% Most Impaired Days at Sipsey**

*During the 2028 emissions inventory update completed in Spring 2020, an additional source, Lhoist North America- Montevallo (Lhoist) was identified when comparing the revised EPA 2028 emissions inventory to the 2028 VISTAS inventory. Alabama evaluated all emissions changes greater than 50 tons between the two inventories and determined that the difference in the emissions inventories for Lhoist warranted a reasonable progress analysis, which was done.

## 7.6. Screening of Sources for Reasonable Progress Analysis

In order to gain a better understanding of the source contributions to modeled visibility, VISTAS used CAMx PSAT modeling. PSAT uses multiple tracer families to track the fate of both primary and secondary PM. PSAT allows emissions to be tracked (tagged) for individual facilities as well as various combinations of sectors and geographic areas (e.g., by state).

Alabama used the $SO_2$ facility contributions from the AoI analysis to help select sources for tagging with PSAT. Each VISTAS state submitted their list of facilities to be tagged, and, in the end, $SO_2$ and $NO_X$ emissions for 87 individual facilities were tagged and the visibility contributions ($Mm^{-1}$) for the 20% most impaired days were determined at all Class I areas in the VISTAS_12 domain. It should be noted, again, that Alabama chose for this planning period to only evaluate $SO_2$ sources. As such, PSAT tags previously discussed in Section 7.4 include total sulfate contributions from EGU + non-EGU point sources at each Class I area. This allows a percent contribution (individual facility contribution divided by the total sulfate from EGU non-EGU point sources) to be determined for each facility at each Class I area. If the sulfate contribution from the PSAT analysis was greater than or equal to 1.00%, then the facility was considered for an $SO_2$ reasonable progress analysis. Details of the PSAT modeling can be found in Appendix E-7a and details of the percent contribution calculations can be found in Appendix E-7b.

### 7.6.1. Selection of Sources for PSAT Tagging

Alabama used the $SO_2$ facility contributions from the AoI analysis to help select sources to be tagged with PSAT. Alabama requested any facility both inside or outside of Alabama with an AoI contribution of 2% or more be tagged with PSAT. This threshold was chosen to capture the most important nearby sources within Alabama, as well as any large sources outside Alabama. Based on these criteria, Alabama selected the sources listed in Table 7-6 for PSAT tagging. It should be noted that during the 2028 emissions inventory update completed in Spring 2020, an additional source, Lhoist North America- Montevallo (Lhoist) was identified when comparing the revised EPA 2028 emissions inventory to the 2028 VISTAS inventory. Alabama evaluated all emissions changes greater than 50 tons between the two inventories and determined that the difference in the emissions inventories for Lhoist warranted a reasonable progress analysis.

| Facility State | Facility ID | Facility Name |
|---|---|---|
| AL | 1000011 | Nucor Steel Decatur |
| AL | 1018711 | Drummond Company |
| AL | 1061611 | Union Oil of CA |
| AL | 949811 | Akzo Nobel |
| AL | 1056111 | Alabama Power Co, Barry |
| AL | 7440211 | Escambia Operating Co |
| AL | 985111 | Escambia Operating Co |
| AL | 985711 | Sanders Lead |
| AL | 1028711 | American Midstream Chatom, LLC |
| AR | 1083411 | Entergy Arkansas, Inc-Independence Plant |
| IL | 7808911 | Joppa Steam |
| IN | 8017211 | Rockport |
| IN | 7363111 | Gibson |
| IN | 7362411 | Petersburg |
| KY | 6037011 | Shawnee |
| KY | 5561611 | Big Rivers- Wilson |
| MO | 5363811 | Marston |
| TN | 4979311 | Cumberland |

**Table 7-6: Facilities Selected by Alabama for PSAT Tagging (>2% AoI contribution at a VISTAS Class I Area)**

In addition, other VISTAS states selected sources for PSAT tagging. The detailed PSAT selection process for each VISTAS state is provided in their individual regional haze SIPs.

Based on the sources selected by Alabama and the other VISTAS states, VISTAS selected 87 facilities in total for $SO_2$ and $NO_X$ PSAT tagging. Some of the 87 facilities were selected by multiple states. Table 7-7 lists the PSAT tags selected for facilities in AL and FL. Table 7-8 lists the PSAT tags selected for facilities in GA, KY, MS, NC, SC, and TN. Table 7-9 lists the PSAT tags selected for facilities in VA and WV. Table 7-10 lists the PSAT tags selected for facilities in AR, MO, PA, IL, IN, and OH. The contributions from all 87 PSAT tags were evaluated at all Class I areas in the VISTAS_12 domain.

A detailed description of the PSAT modeling and post-processing for creating PSAT contributions for each Class I area is contained in Appendix E-7a and Appendix E-7b.

**Table 7-7: PSAT Tags Selected for Facilities in AL and FL**

| State | RPO | Facility ID | Facility Name | $SO_2$ (TPY) | NOx (TPY) |
|---|---|---|---|---|---|
| AL | VISTAS | 01097-949811 | Akzo Nobel Chemicals Inc | 3,335.72 | 20.71 |
| AL | VISTAS | 01097-1056111 | Ala Power - Barry | 6,033.17 | 2,275.76 |
| AL | VISTAS | 01129-1028711 | American Midstream Chatom, LLC | 3,106.38 | 425.87 |
| AL | VISTAS | 01073-1018711 | DRUMMOND COMPANY, INC. | 2,562.17 | 1,228.55 |
| AL | VISTAS | 01053-7440211 | Escambia Operating Company LLC | 18,974.39 | 349.32 |
| AL | VISTAS | 01053-985111 | Escambia Operating Company LLC | 8,589.60 | 149.64 |
| AL | VISTAS | 01103-1000011 | Nucor Steel Decatur LLC | 170.23 | 331.24 |
| AL | VISTAS | 01109-985711 | Sanders Lead Co | 7,951.06 | 121.71 |
| AL | VISTAS | 01097-1061611 | Union Oil of California - Chunchula Gas Plant | 2,573.15 | 349.23 |
| FL | VISTAS | 12123-752411 | BUCKEYE FLORIDA, LIMITED PARTNERSHIP | 1,520.42 | 1,830.71 |
| FL | VISTAS | 12086-900111 | CEMEX CONSTRUCTION MATERIALS FL. LLC. | 29.51 | 910.36 |
| FL | VISTAS | 12017-640611 | DUKE ENERGY FLORIDA, INC. (DEF) | 5,306.41 | 2,489.85 |
| FL | VISTAS | 12086-900011 | FLORIDA POWER & LIGHT (PTF) | 13.05 | 170.61 |
| FL | VISTAS | 12033-752711 | GULF POWER - Crist | 2,615.65 | 2,998.39 |
| FL | VISTAS | 12086-3532711 | HOMESTEAD CITY UTILITIES | 0.00 | 97.09 |
| FL | VISTAS | 12031-640211 | JEA | 2,094.48 | 651.79 |
| FL | VISTAS | 12105-717711 | MOSAIC FERTILIZER LLC | 7,900.67 | 310.42 |
| FL | VISTAS | 12057-716411 | MOSAIC FERTILIZER, LLC | 3,034.06 | 159.71 |
| FL | VISTAS | 12105-919811 | MOSAIC FERTILIZER, LLC | 4,425.56 | 141.02 |
| FL | VISTAS | 12089-845811 | RAYONIER PERFORMANCE FIBERS LLC | 561.97 | 2,327.10 |
| FL | VISTAS | 12089-753711 | ROCK TENN CP, LLC | 2,606.72 | 2,316.77 |
| FL | VISTAS | 12005-535411 | ROCKTENN CP LLC | 2,590.88 | 1,404.89 |
| FL | VISTAS | 12129-2731711 | TALLAHASSEE CITY PURDOM GENERATING STA. | 2.86 | 121.46 |
| FL | VISTAS | 12057-538611 | TAMPA ELECTRIC COMPANY (TEC) | 6,084.90 | 2,665.03 |
| FL | VISTAS | 12086-899911 | TARMAC AMERICA LLC | 9.38 | 879.70 |
| FL | VISTAS | 12047-769711 | WHITE SPRINGS AGRICULTURAL CHEMICALS, INC | 3,197.77 | 112.41 |

**Table 7-8: PSAT Tags Selected for Facilities in GA, KY, MS, NC, SC, and TN**

| State | RPO | Facility ID | Facility Name | $SO_2$ (TPY) | NOx (TPY) |
|---|---|---|---|---|---|
| GA | VISTAS | 13127-3721011 | Brunswick Cellulose Inc | 294.20 | 1,554.51 |
| GA | VISTAS | 13015-2813011 | Ga Power Company - Plant Bowen | 10,453.41 | 6,643.32 |
| GA | VISTAS | 13103-536311 | Georgia-Pacific Consumer Products LP (Savannah River Mill) | 1,860.18 | 351.52 |
| GA | VISTAS | 13051-3679811 | International Paper – Savannah | 3,945.38 | 1,560.73 |
| GA | VISTAS | 13115-539311 | TEMPLE INLAND | 1,791.00 | 1,773.35 |
| KY | VISTAS | 21183-5561611 | Big Rivers Electric Corp - Wilson Station | 6,934.16 | 1,151.95 |
| KY | VISTAS | 21091-7352411 | Century Aluminum of KY LLC | 5,044.16 | 197.66 |
| KY | VISTAS | 21177-5196711 | Tennessee Valley Authority - Paradise Fossil Plant | 3,011.01 | 3,114.52 |
| KY | VISTAS | 21145-6037011 | Tennessee Valley Authority (TVA) - Shawnee Fossil Plant | 19,504.75 | 7,007.34 |
| MS | VISTAS | 28059-8384311 | Chevron Products Company, Pascagoula Refinery | 741.60 | 1,534.12 |
| MS | VISTAS | 28059-6251011 | Mississippi Power Company, Plant Victor J Daniel | 231.92 | 3,829.72 |
| NC | VISTAS | 37087-7920511 | Blue Ridge Paper Products - Canton Mill | 1,127.07 | 2,992.37 |
| NC | VISTAS | 37117-8049311 | Domtar Paper Company, LLC | 687.45 | 1,796.49 |
| NC | VISTAS | 37035-8370411 | Duke Energy Carolinas, LLC - Marshall Steam Station | 4,139.21 | 7,511.31 |
| NC | VISTAS | 37013-8479311 | PCS Phosphate Company, Inc. - Aurora | 4,845.90 | 495.58 |
| NC | VISTAS | 37023-8513011 | SGL Carbon LLC | 261.64 | 21.69 |
| SC | VISTAS | 45015-4834911 | ALUMAX OF SOUTH CAROLINA | 3,751.69 | 108.08 |
| SC | VISTAS | 45043-5698611 | INTERNATIONAL PAPER GEORGETOWN MILL | 2,767.52 | 2,031.26 |
| SC | VISTAS | 45019-4973611 | KAPSTONE CHARLESTON KRAFT LLC | 1,863.65 | 2,355.82 |
| SC | VISTAS | 45015-4120411 | SANTEE COOPER CROSS GENERATING STATION | 4,281.17 | 3,273.47 |
| SC | VISTAS | 45043-6652811 | SANTEE COOPER WINYAH GENERATING STATION | 2,246.86 | 1,772.53 |
| SC | VISTAS | 45015-8306711 | SCE&G WILLIAMS | 392.48 | 992.73 |
| TN | VISTAS | 47093-4979911 | Cemex - Knoxville Plant | 121.47 | 711.50 |
| TN | VISTAS | 47163-3982311 | EASTMAN CHEMICAL COMPANY | 6,420.16 | 6,900.33 |
| TN | VISTAS | 47105-4129211 | TATE & LYLE, Loudon | 472.76 | 883.25 |
| TN | VISTAS | 47001-6196011 | TVA BULL RUN FOSSIL PLANT | 622.54 | 964.16 |

| State | RPO | Facility ID | Facility Name | $SO_2$ (TPY) | NOx (TPY) |
|---|---|---|---|---|---|
| TN | VISTAS | 47161-4979311 | TVA CUMBERLAND FOSSIL PLANT | 8,427.33 | 4,916.52 |
| TN | VISTAS | 47145-4979111 | TVA KINGSTON FOSSIL PLANT | 1,886.09 | 1,687.38 |

**Table 7-9: PSAT Tags Selected for Facilities in VA and WV**

| State | RPO | Facility ID | Facility Name | $SO_2$ (TPY) | NOx (TPY) |
|---|---|---|---|---|---|
| VA | VISTAS | 51027-4034811 | Jewell Coke Company LLP | 5,090.95 | 520.17 |
| VA | VISTAS | 51580-5798711 | Meadwestvaco Packaging Resource Group | 2,115.31 | 1,985.69 |
| VA | VISTAS | 51023-5039811 | Roanoke Cement Company | 2,290.17 | 1,972.97 |
| WV | VISTAS | 54033-6271711 | ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON | 10,082.94 | 11,830.88 |
| WV | VISTAS | 54049-4864511 | AMERICAN BITUMINOUS POWER-GRANT TOWN PLT | 2,210.25 | 1,245.10 |
| WV | VISTAS | 54079-6789111 | APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT | 10,984.24 | 4,878.10 |
| WV | VISTAS | 54023-6257011 | Dominion Resources, Inc. - MOUNT STORM POWER STATION | 2,123.64 | 1,984.14 |
| WV | VISTAS | 54041-6900311 | EQUITRANS - COPLEY RUN CS 70 | 0.10 | 511.06 |
| WV | VISTAS | 54083-6790711 | FILES CREEK 6C4340 | 0.15 | 643.35 |
| WV | VISTAS | 54083-6790511 | GLADY 6C4350 | 0.11 | 343.29 |
| WV | VISTAS | 54093-6327811 | KINGSFORD MANUFACTURING COMPANY | 16.96 | 140.88 |
| WV | VISTAS | 54061-16320111 | LONGVIEW POWER | 2,313.73 | 1,556.57 |
| WV | VISTAS | 54051-6902311 | MITCHELL PLANT | 5,372.40 | 2,719.62 |
| WV | VISTAS | 54061-6773611 | MONONGAHELA POWER CO.- FORT MARTIN POWER | 4,881.87 | 13,743.32 |
| WV | VISTAS | 54073-4782811 | MONONGAHELA POWER CO-PLEASANTS POWER STA | 16,817.43 | 5,497.37 |
| WV | VISTAS | 54061-6773811 | MORGANTOWN ENERGY ASSOCIATES | 828.64 | 655.58 |

**Table 7-10: PSAT Tags Selected for Facilities in AR, MO, PA, IL, IN, and OH**

| State | RPO | Facility ID | Facility Name | $SO_2$ (TPY) | NOx (TPY) |
|---|---|---|---|---|---|
| AR | CENRAP | 05063-1083411 | ENTERGY ARKANSAS INC-INDEPENDENCE PLANT | 32,050.48 | 14,133.10 |
| MO | CENRAP | 29143-5363811 | NEW MADRID POWER PLANT-MARSTON | 16,783.71 | 4,394.10 |
| MD | MANE-VU | 24001-7763811 | Luke Paper Company | 22,659.84 | 3,607.00 |
| PA | MANE-VU | 42005-3866111 | GENON NE MGMT CO/KEYSTONE STA | 56,939.25 | 6,578.47 |
| PA | MANE-VU | 42063-3005211 | HOMER CITY GEN LP/ CENTER TWP | 11,865.70 | 5,215.96 |
| PA | MANE-VU | 42063-3005111 | NRG WHOLESALE GEN/SEWARD GEN STA | 8,880.26 | 2,254.64 |
| IL | LADCO | 17127-7808911 | Joppa Steam | 20,509.28 | 4,706.35 |
| IN | LADCO | 18173-8183111 | Alcoa Warrick Power Plt Agc Div of AL | 5,071.28 | 11,158.55 |
| IN | LADCO | 18051-7363111 | Duke Power- Gibson | 23,117.23 | 12,280.34 |
| IN | LADCO | 18147-8017211 | INDIANA MICHIGAN POWER DBA AEP ROCKPORT | 30,536.33 | 8,806.77 |
| IN | LADCO | 18125-7362411 | INDIANAPOLIS POWER & LIGHT PETERSBURG | 18,141.88 | 10,665.27 |
| IN | LADCO | 18129-8166111 | Sigeco AB Brown South Indiana Gas & Ele | 7,644.70 | 1,578.59 |
| OH | LADCO | 39081-8115711 | Cardinal Power Plant (Cardinal Operating Company) (0641050002) | 7,460.79 | 2,467.31 |
| OH | LADCO | 39031-8010811 | Conesville Power Plant (0616000000) | 6,356.23 | 9,957.87 |
| OH | LADCO | 39025-8294311 | Duke Energy Ohio, Wm. H. Zimmer Station (1413090154) | 22,133.90 | 7,149.97 |
| OH | LADCO | 39053-8148511 | General James M. Gavin Power Plant (0627010056) | 41,595.81 | 8,122.51 |
| OH | LADCO | 39053-7983011 | Ohio Valley Electric Corp., Kyger Creek Station (0627000003) | 3,400.14 | 9,143.84 |

### 7.6.2. PSAT Contributions at VISTAS Class I areas

The original PSAT results were determined based on the initial 2028 $SO_2$ point emissions, which may be found in Appendix B-1a and Appendix B-1b. As described in Section 4.1.8 and Section 7.2.4, the 2028 EGU and non-EGU point emissions were updated for a new 2028 model run (Task 2B and Task 3B reports), but the original PSAT runs were not redone. Details of the updated emissions may be found in Appendix B-2a and Appendix B-2b. Instead, the original PSAT results were linearly scaled to reflect the updated 2028 emissions. The details of the PSAT adjustments can be found in Appendix E-7b.

The adjusted PSAT results were used to calculate the percent contribution of each tagged facility to the total sulfate point source (EGU + non-EGU) contribution at each Class I area. Then, the facilities were sorted from highest impact to lowest impact.

Table 7-11 contains the eight (8) facilities that PSAT identified as having a significant contribution (sulfate contributions at or greater than 1.00%) at the Sipsey Wilderness Area. Tables 7-12 and 7-13 contain the PSAT results for the Alabama facility significantly impacting (sulfate contributions of at or greater than 1.00%) at the Chassahowitzka Wilderness Area (FL) and the St Marks Wilderness Area (FL).

The full list of tagged facilities and their contributions to each Class I area can be found in Appendix E-7b.

| State | Facility ID | Facility Name | Distance (km) | Final Revised Sulfate PSAT ($Mm^{-1}$) | Final Revised EGU+NEG ($Mm^{-1}$) | Final Revised Sulfate PSAT, % |
|---|---|---|---|---|---|---|
| KY | 21145-6037011 | Tennessee Valley Authority (TVA) - Shawnee Fossil Plant | 337.66102 | 0.364 | 15.470152 | 2.35% |
| OH | 39053-8148511 | General James M. Gavin Power Plant (0627010056) | 690.91188 | 0.3265621 | 15.470152 | 2.11% |
| IN | 18147-8017211 | INDIANA MICHIGAN POWER DBA AEP ROCKPORT | 398.44508 | 0.3265155 | 15.470152 | 2.11% |
| IN | 18051-7363111 | Duke Power- Gibson | 448.65906 | 0.2699204 | 15.470152 | 1.74% |
| IN | 18125-7362411 | INDIANAPOLIS POWER & LIGHT PETERSBURG | 464.37249 | 0.2576016 | 15.470152 | 1.67% |
| TN | 47161-4979311 | TVA Cumberland Fossil Plant | 228.9453 | 0.242 | 15.470152 | 1.56% |
| MO | 29143-5363811 | NEW MADRID POWER PLANT-MARSTON | 314.52846 | 0.220059 | 15.470152 | 1.42% |
| KY | 21183-5561611 | Big Rivers Electric Corp - Wilson Station | 345.46598 | 0.211 | 15.470152 | 1.36% |

**Table 7-11: PSAT Results for Facilities Significantly Impacting the Sipsey Wilderness Area**

| State | Facility ID | Facility Name | Distance (km) | Final Revised Sulfate PSAT ($Mm^{-1}$) | Final Revised EGU+NEG ($Mm^{-1}$) | Final Revised Sulfate PSAT, % |
|---|---|---|---|---|---|---|
| AL | 01109-985711 | Sanders Lead Co | 471.1935 | 0.101 | 9.759868 | 1.03% |

**Table 7-12: PSAT Results for Alabama Facilities Significantly Impacting the Chassahowitzka Wilderness Area (FL)**

| State | Facility ID | Facility Name | Distance (km) | Final Revised Sulfate PSAT ($Mm^{-1}$) | Final Revised EGU+NEG ($Mm^{-1}$) | Final Revised Sulfate PSAT, % |
|---|---|---|---|---|---|---|
| AL | 01109-985711 | Sanders Lead Co | 255.9018 | 0.131 | 11.390131 | 1.15% |

**Table 7-13: PSAT Results for Alabama Facilities Significantly Impacting the St. Marks Wilderness Area (FL)**

### 7.6.3. AoI versus PSAT Contributions

After the PSAT modeling was completed, a comparison was made of PSAT results to the AoI results. The PSAT results used in this comparison did not incorporate any of the PSAT adjustments discussed in Appendix E-7b to better match the emissions used in the AoI analysis. Only PSAT contributions greater than or equal to 1.00% were included in the analysis. Figure 7-27 shows the ratio of AoI/PSAT contributions for sulfate as a function of distance from the facility to the Class I area. Figure 7-28 shows the fractional bias for sulfate as a function of distance from the facility to the Class I area. Fractional bias (FB) is equal to 2*(AoI – PSAT)/(AoI + PSAT). Fractional bias gives equal weight to over predictions and under predictions. If FB equals 100%, then the AoI contribution is three times higher than the PSAT contribution.

Based on Figure 7-27 and 7-28, the AoI analysis tends to overestimate impacts for facilities near a Class I area. In fact, if the facility is less than 100 km from the Class I area, the AoI results are almost always approximately three times higher than the PSAT results. As a result, some sources near a Class I area were tagged for PSAT but were found to have an insignificant contribution to visibility impairment. PSAT is the most reliable modeling tool for tracking facility contributions to visibility impairment at Class I areas. Therefore, AoI impacts for nearby sources can be adjusted downward to remove the systematic bias in the contributions. Also, AoI tends to underestimate impacts for facilities in other states that are far away from the Class I area. Although the AoI analysis may underestimate the impact of some far away sources, the visibility impairment of those sources were likely included in the PSAT analysis and found to be significantly contributing to visibility impairment in the Class I area because they were tagged for PSAT analysis by states with Class I areas that are closer to those sources.

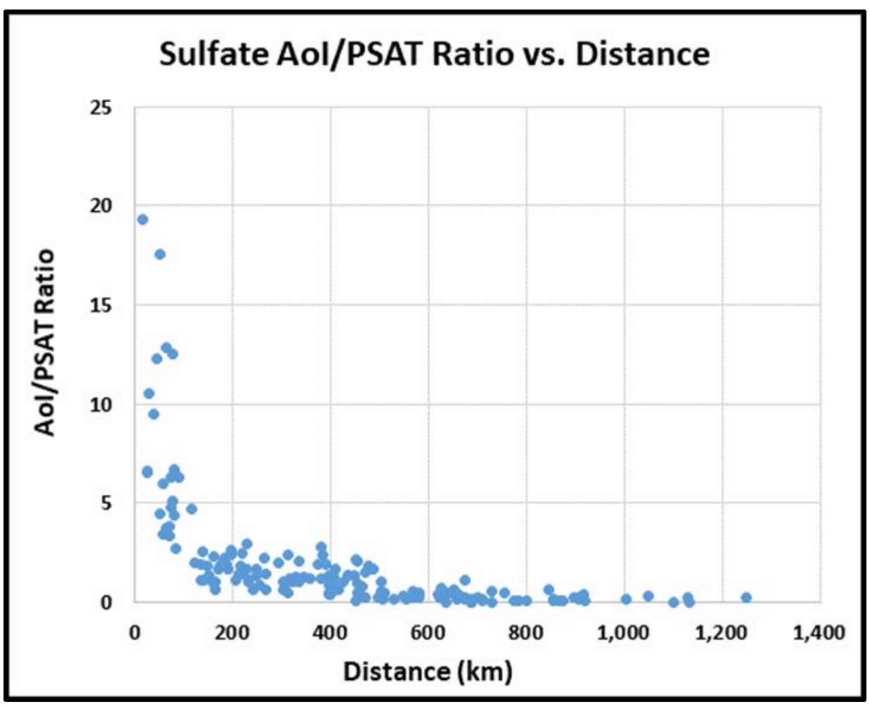



**Figure 7-27: Ratio of AoI/PSAT % Contributions for Sulfate as a Function of Distance from the Facility to the Class I Area**

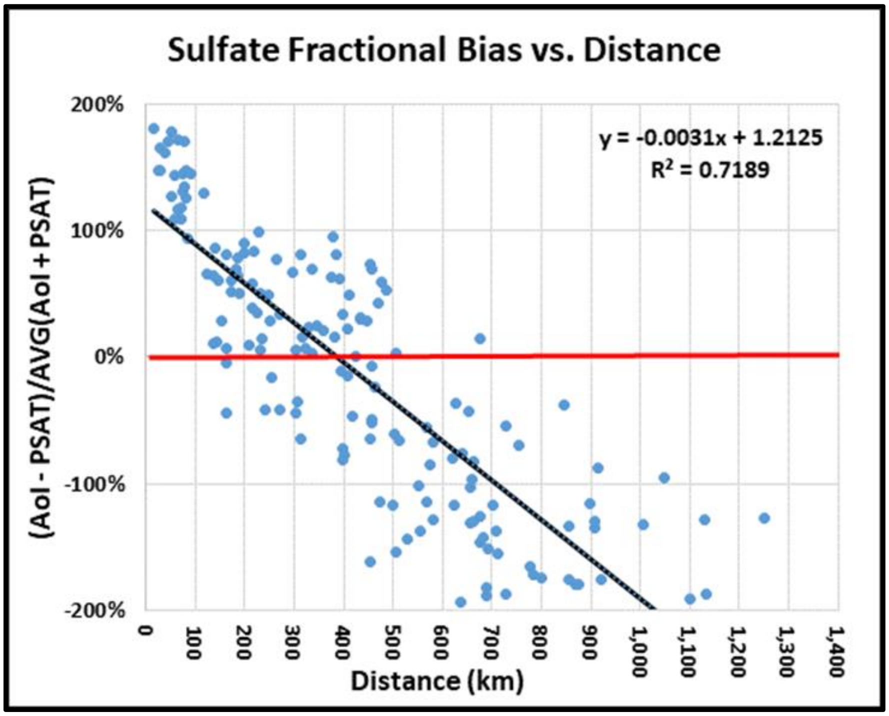



**Figure 7-28: Fractional Bias for Sulfate as a Function of Distance from the Facility to the Class I Area**

Although many facilities were tagged with PSAT, there are some facilities identified by the AoI analysis with a sulfate contribution over 1% that were not tagged. Table 7-5 shows the AoI $SO_2$ facility contributions greater than 2% to visibility impairment on the 20% most impaired days at the Sipsey Wilderness Area. There were 12 facilities that were not tagged with PSAT.

### 7.6.4. Selection of Sources for Reasonable Progress Evaluation

EPA has made clear that each state has the authority to select the sources to evaluate for reasonable progress analyses and to determine the factors used in making such selection, as long as the factors used in the process are explained and justified in the state's plan. Subsection 169A(b) requires EPA to "provide guidelines to the **States**" [emphasis added] and "require **each applicable implementation plan for a State**" [emphasis added] to address reasonable progress including the requirement for long-term strategies. In promulgating its Regional Haze Rules, EPA stated that "**The State must include in its implementation plan a description of the criteria it used to determine which sources or groups of sources** it evaluated and how the four factors were taken into consideration in selecting the measures for inclusion in its long-term strategy." [emphasis added] EPA's August 20, 2019, guidance on Regional Haze SIPs for the second implementation period, goes on to clearly state that the selection of emission sources for analysis is the responsibility of the state. The EPA guidance states the following:

> The Regional Haze Rule does not explicitly list factors that a state must or may not consider when selecting the sources for which it will determine what control measures are necessary to make reasonable progress. A state opting to select a set of its sources to analyze must reasonably choose factors and apply them in a reasonable way given the statutory requirement to make reasonable progress towards natural visibility. Factors could include, but are not limited to, baseline source emissions, baseline source visibility impacts (or a surrogate metric for the impacts), the in-place emission control measures and by implication the emission reductions that are possible to achieve at the source through additional measures, the four statutory factors (to the extent they have been characterized at this point in SIP development), potential visibility benefits (also to the extent they have been characterized at this point in SIP development), and the five additional required factors listed in 40 CFR 51.308(f)(2)(iv).

The 2019 guidance also discusses which pollutants to consider as well as the methods for estimating baseline visibility impacts for selected sources, including residence time analysis and photochemical modeling, both of which were used by Alabama and the other VISTAS states. The selection of pollutants to consider and the residence time analysis are discussed in Section 7.4 and Section 7.5 of this SIP. The use of photochemical modeling to better understand source contribution to modeled visibility and further refine the sources selected is discussed in Section 7.6.

The EPA guidance discussed using estimates of visibility impacts to select sources including the use of a visibility impact threshold level for selecting sources. Alabama, as well as the other VISTAS states, have used a two-step process for selecting sources. The first step was a screening analysis using the $SO_2$ source category and facility contributions from the AoI analysis described in Section 7.5. The second step was CAMx PSAT modeling of the sources selected in Step 1. The results of the PSAT model informed which sources were then selected for reasonable progress analysis. This two-step process was used to select sources that have the largest contribution to visibility impairment, and thus, the greatest opportunity for reasonable progress improvement, at the Class I areas. This process also resulted in selecting sources to analyze that significantly contribute to visibility at Sipsey with the limited resources available to the state. Sources selected for analysis by Alabama include sources that contribute to visibility impairment at Sipsey as well as other Class I areas. The thresholds selected by Alabama for each of the steps are discussed below. As explained in Section 7.6.3, PSAT modeling resulted in significantly different results than the AoI analysis. Therefore, it is appropriate to have different percentage thresholds for these two steps in the selection process. EPA's guidance states, "Whatever threshold is used, the state must justify why the use of that threshold is a reasonable approach…". The justification for the thresholds used in both steps of the selection process are described in this plan.

In the regional haze SIPs developed for the first round of planning, many VISTAS states used the AoI approach and a 1% threshold by unit. In this second round of planning for regional haze SIPs, all VISTAS states are using the AOI/PSAT approach and a $\geq$ 1.00% PSAT threshold by facility for screening sources for reasonable progress evaluation. Using a facility basis for emission estimates will pull in more facilities as compared to a unit basis for emission estimates. In the regional haze SIPs developed in the first round of planning, 2018 emissions were used as the starting point and 2018 Class I visibility impacts were used in the denominator of the percent contribution calculations. In this second round of planning for regional haze, VISTAS states are using 2028 $SO_2$ emissions in the denominator of the percent contribution calculations. As a result, more facilities with smaller visibility impacts (in Mm-1) were examined as compared to the first round of regional haze planning. Overall, the VISTAS screening approach results in a reasonable number of sources that can be evaluated with limited state resources and focuses on the sources and pollutants with the largest impacts.

Since $SO_2$ emissions from point sources were estimated to have the largest contribution to visibility impairment at Sipsey (Figure 7-16, Figure 7-18, and Figure 19), Alabama used the fraction of total sulfate visibility impairment (projected to 2028) from individual point source facilities as the metric for which an AoI threshold would be chosen to select sources for PSAT tagging. Several thresholds were considered, and Alabama determined that a 2% AoI threshold would capture a sufficient number of sources that would reflect a significant impact on Sipsey. Since the Regional Haze Rule requires states to address visibility impairment for each Class I area within the state and for each Class I area located outside the state that may be affected by emissions from the state, Alabama determined which Alabama sources and which non-Alabama sources significantly impacted each Class I Area.

Table 7-6 shows that the selection of a 2% AoI threshold results in 18 facilities, 9 within Alabama, for PSAT tagging. This captured an estimated 38.52% of the point source sulfate visibility impairment for Sipsey (tagged sources and their contribution to Sipsey). This list resulted in a manageable number of sources that would potentially need to be reviewed by state staff.

These 18 sources were added to the VISTAS list of PSAT Tags as listed in Table 7-7 through Table 7-10. Following receipt of the PSAT modeling, Alabama evaluated sources with sulfate greater than or equal to 1.00% of the total sulfate contribution from point sources. Tables 7-11 through 7-13 identified 9 sources for reasonable progress analysis consideration, with an additional source identified outside of the AoI/PSAT analysis. The additional source is discussed in more detail below. In total, 10 sources, two in Alabama (Table 7-14) and eight sources outside of Alabama (Table 7-11) were evaluated for reasonable progress.

During the 2028 emissions inventory update completed in Spring 2020, an additional source, Lhoist North America- Montevallo (Lhoist) was identified when comparing the revised EPA 2028 emissions inventory to the 2028 VISTAS inventory. Alabama evaluated all emissions changes greater than 50 tons between the two inventories and determined that the difference in the emissions inventories for Lhoist warranted a reasonable progress analysis, which was done.

| State | Facility ID | Facility Name |
|---|---|---|
| AL | 01117-949311 | Lhoist North America of Alabama, LLC |
| AL | 01109-985711 | Sanders Lead Co |

**Table 7-14: Facilities in Alabama Selected for Reasonable Progress Analysis**

For those sources identified outside of Alabama potentially impacting Sipsey, the agencies in Indiana, Kentucky, Tennessee, Missouri, and Ohio were contacted through VISTAS and notified that the VISTAS analyses had identified their sources as potential contributors to visibility impairment at the Sipsey Wilderness Area.[47] Documentation of this correspondence can be found in Appendix F.

### 7.6.5. Evaluation of Recent Emission Inventory Information

The Regional Haze Rule at 40 CFR 51.308(f)(2)(iii) requires the state to document the emissions information on which the state is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory Federal Class I area it affects. The emissions information must include, but need not be limited to, information on emissions in a year at least as recent as the most recent year for which the state has submitted emission inventory information to the EPA Administrator in compliance with the triennial reporting requirements. Alabama primarily relied on the evaluation of 2028 emissions of $SO_2$ for screening sources for reasonable progress analysis and developing a long-term strategy. In late 2019, revised EPA modeling for 2028 was released. This modeling showed a significant difference, VISTAS wide, between the two modeled $SO_2$ inventories. In an effort to determine the bases for these differences, Alabama examined the 2018 $SO_2$ Title V fees (most recent year) and compared these emissions to the 2028 $SO_2$ emissions that were used in the both the VISTAS and EPA modeling. Table 7-15 below shows all the facilities with a $SO_2$ emissions difference greater than 50 tpy between the original VISTAS 2028 $SO_2$ emissions and the 2019 EPA modeling for 2028. Revised projected emissions of $SO_2$ for 2028 are shown in the last column. These revisions were used in the final modeling for these facilities.

[47] VISTAS sent letters to IN, MO, and OH. URL: https://www.metro4-sesarm.org/content/consultation-non-vistas-states

**Table 7-15: Alabama 2028 Emissions Evaluation- Tons per Year**

| EIS_FAC_ID | FACILITY_NAME | VISTAS 2028 | EPA 2028 | ERTAC 2028 | 2018 Title V | Revised Emission Rate |
|---|---|---|---|---|---|---|
| 1000211 | WestRock Coated Board-Mahrt Mill | 349.94 | 176.69 | [redacted] | 230.44 | **253.9** |
| 1002811 | WestRock Mill Co, LLC | 37.82 | 223.13 | [redacted] | 257.55 | **307.82** |
| 1019211 | GP/Alabama River Cellulose LLC | 998.68 | 175.86 | [redacted] | 69.96 | **1109.08** |
| 1020111 | SABIC Innovative Plastics US LLC | 25.59 | 143.34 | [redacted] | 107.35 | **128.91** |
| 10633711 | International Paper | 835.34 | 1018.35 | [redacted] | 1076.61 | **1150.00** |
| 7212311 | International Paper Company | 2286.33 | 1792.63 | [redacted] | 708.87 | **708.87** |
| 7440111 | Georgia-Pacific Brewton LLC | 967.46 | 597.87 | [redacted] | 27.88 | **997.46** |
| 7442111 | Georgia Pacific | 2393.68 | 1440.39 | [redacted] | 1656.96 | **2965.81** |
| 985511 | Ascend Performance Materials | 53.46 | 2163.41 | [redacted] | 1436.5 | **83.15** |
| 1003511 | Globe Metallurgical Inc | 515.97 | 62.07 | [redacted] | 436.86 | **587.3** |
| 1028611 | PowerSouth Energy Coop-Lowman | 3805.20 | 0.00 | 900.56 | 808 | **0.00** |
| 1028711 | American Midstream Chatom | 3106.38 | 826.74 | [redacted] | ceased | **0.00** |
| 1056111 | Alabama Power Barry** | 6033.17 | 3148.82 | 3961.24 | 5258.13 | **3007.57** |
| 1060811 | Mobile Energy Services Co | 213.77 | 0.00 | [redacted] | ceased 4/19 | **0.00** |
| 1061511 | Four Star Oil & Gas Co | 269.86 | 147.73 | [redacted] | 84.81 | **120.75** |
| 1061611 | Union Oil of CA-Chunchula | 2573.15 | 105.01 | [redacted] | ceased | **0.00** |
| 1061711 | ExxonMobil Production Co | 325.33 | 110.73 | [redacted] | 143.89 | **137.62** |
| 12787611 | Ventex Operating Co | 376.53 | 52.41 | [redacted] | 28.5 | **60.16** |
| 7440211 | Escambia Operating Co* | 18974.39 | 3253.53 | [redacted] | 2990.03 | **3782.18** |
| 7440711 | Lhoist North America of AL | 173.70 | 141.67 | [redacted] | 153.3 | **138.64** |
| 7440811 | Unimin Lime Corp | 153.16 | 38.52 | [redacted] | 37.72 | **38.47** |
| 7441411 | Hunt Refining Co | 439.68 | 54.93 | [redacted] | 51.14 | **52.82** |
| 7917311 | Alabama Power - Gorgas | 1410.80 | 0.00 | 1085.30 | 1695.22 | **0.00** |
| 867511 | Dow Corning Alabama, Inc. | 682.69 | 579.24 | [redacted] | 619.63 | **682.69** |
| 949211 | Alabama Power E.C. Gaston** | 2286.91 | 5654.68 | 1370.10 | 3273.25 | **4000.00** |
| 949311 | Lhoist North America of AL | 2456.35 | 8134.42 | [redacted] | 11644.49 | **9489.71** |
| 949411 | Lhoist North America of AL | 760.00 | 826.04 | [redacted] | 1484.17 | **958.40** |
| 949611 | National Cement Co of Alabama*** | 90.80 | 380.79 | [redacted] | 410.65 | **3149.04** |
| 964311 | Pruet Production Co | 298.66 | 93.43 | [redacted] | 69.3 | **0.00** |
| 985111 | Escambia Operating Co | 8589.60 | 87.32 | [redacted] | 2.07 | **88.01** |
| 985311 | Cobra Oil & Gas Corp | 184.95 | 88.11 | [redacted] | 56.03 | **88.35** |
| 985911 | SSAB Alabama Inc | 413.29 | 354.63 | [redacted] | 417.04 | **378.04** |
| 1003111 | ALABAMA POWER MILLER** | 1490.45 | 2079.64 | 563.10 | 858.31 | **1000.00** |
| 1018711 | DRUMMOND CO, INC.**** | 2562.17 | 1417.90 | [redacted] | 1482.63 | **2562.17** |
| 1057611 | US STEEL FAIRFIELD WORKS***** | 705.96 | 6.78 | [redacted] | 0.92 | **0.00** |
| 948811 | ERP Compliant Coke/Utilities/WW****** | 2229.19 | 1533.12 | [redacted] | 1306.13 | **2229.19** |

*** When calculating the contribution threshold for Escambia Operating Co., the last 2 years' data are over the 1% threshold. However, the facility was not under normal operating conditions in 2023-2024. The previous owner was in bankruptcy, and the trustee appointed to manage its assets was responsible for operating the plant. Therefore, there are reasons to believe those two years were an outlier, and as of the date of this submittal, the facility is not operating nor has it operated this year. The new owner has indicated that it will undertake improvements at the facility, and the Department does not know when the facility will resume operation. The average $SO_2$ emissions from this plant, in the 10 years preceding 2023, were under 3600 tons per year, which lends credence to the 2023-2024 being an anomaly.**

**The future emissions for this facility are thus uncertain, given the new ownership, market demands for natural gas, and the effect (if any) on emissions due to maintenance/repair/upgrade activities at the plant and its associated well heads. In addition, the Big Escambia Creek Field, which this plant services, is declining in production potential. Given these uncertainties, the Department plans to monitor this facility closely for potential inclusion in the third implementation period plan.**

****APC Gaston is in the process of converting to natural gas. While APC Barry maintains the capability to operate on coal, coal usage is typically a seasonal fuel source used during periods of high demand. Actual $SO_2$ emissions are expected to be lower than the projections listed in Table 7-15. The emissions numbers for APC Miller appear to not capture controls. APC Miller has not been close to 1000 tpy since $S0_2$ controls went online.**

*****The 90.80 tpy was likely a typo and should have been 390.80 tpy. 380.79 tpy was the actual emissions reported in 2016. They averaged 390 tpy from 2016 through 2018. Regarding the revised 2028 emission rate of 3,149 tpy, at the time the RH plan was originally being drafted, National Cement had gone through PSD for a new Kiln that was still under construction. The allowable for the new kiln plus the 390 is 3,149 tpy. The new kiln went through PSD and BACT analysis for SO2; therefore, it was decided that a 4-factor analysis was not necessary.**

******For Drummond Co., the market for coke is difficult to project, because it does not follow any typical demand models due to complexity in the market and the influence of imports (based on current and past production trends in a 10-year window).**

*******USS Fairfield works shut down the Blast Furnace (source of $SO_2$ in 2015) and the facility is no longer permitted.**

********ERP Coke is currently shutdown and not expected to reopen.**

## 7.7. Evaluating the Four Statutory Factors for Specific Emissions Sources

Section 169A(g)(1) of the CAA and the Regional Haze Rule at 40 CFR 51.308(f)(2)(i) require a state to evaluate the following four "statutory" factors when establishing the RPGs for any Class I area within a state: (1) cost of compliance, (2) time necessary for compliance, (3) energy and non-air quality environmental impacts of compliance, and (4) remaining useful life of any existing source subject to such requirements.

On August 20, 2019, EPA issued the memorandum "Guidance on Regional Haze State Implementation Plan for the Second Implementation Period." This memorandum included guidance for characterizing the four statutory factors, including which emission control measures to consider, the selection of emission information for characterizing emissions-related factors, characterizing the cost of compliance (statutory factor 1), characterizing the time necessary for compliance (statutory factor 2), characterizing the energy and non-air environmental impacts (statutory factor 3), characterizing the remaining useful life of the source (statutory factor 4), characterizing visibility benefits, and reliance on previous analysis and previously approved approaches. The memorandum also contains guidance on decisions on what control measures are necessary to make reasonable progress. This guidance was used in evaluating the four statutory factors for the Lhoist Montevallo facility in Alabama selected for a reasonable progress analysis for the Sipsey Wilderness Area.

## 7.8. Control Measures Representing Reasonable Progress for Individual Sources to be Included in the Long-Term Strategy for the Sipsey Wilderness Area

The following summarizes the process for determining reasonable progress for the Lhoist Montevallo facility. For a detailed discussion of the reasonable progress assessment for Sipsey, please see Appendix G.

### 7.8.1 Lhoist – Montevallo Plant Four-Factor Analysis

The Lhoist–Montevallo Plant (Lhoist) is a lime manufacturing facility located in Calera, Alabama. Lhoist submitted a four-factor analysis to the Department on February 5, 2021. At the request of the Department, additional information was submitted on March 30, May 18, and June 23, 2021, to complete the analysis. The main $SO_2$ emissions sources at the facility are four rotary lime kilns (Kilns 1-4). The facility also operates a fifth kiln, Kiln 5; however, Kiln 5 was constructed as an exclusively natural gas-fired unit, so it was excluded from the four-factor analysis. By comparison, Kilns 1 through 4 are fueled through a combination of coal, petroleum coke, and natural gas. Potential $SO_2$ emissions from Unit 5 are less than 5 tpy. Kilns 1 and 2 utilize venturi scrubber systems to control for particulate matter (PM) and sulfur dioxide ($SO_2$) emissions. Kilns 3 and 4 share a common stack and utilize baghouses to control for PM emissions. Table 7-16 summarizes the installation date, daily production capacity in tons of lime per day (TPD), and the control devices for these sources.

**Table 7-16: Description of Sources Kilns 1-4**

| Source | Installation Date | Nominal Production Capacity (TPD) | Existing Control Device |
|---|---|---|---|
| Kiln 1 (CA-01) | 1968 | 425 | Wet Scrubber |
| Kiln 2 (CA-02) | 1955 | 375 | Wet Scrubber |
| Kiln 3 (CA-03) | 1973 | 750 | Baghouse |
| Kiln 4 (CA-03) | 1977 | 750 | Baghouse |

Table 7-17 shows Kilns 1 through 4 baseline emissions used in the four-factor analysis. Baseline emissions are based on Lhoist estimates of kiln fuel efficiency and the fuel mix combusted in the kilns from 2018-2019, heating values and sulfur content of fuel based on AP-42 Section 1.4 and fuel sampling data, and an assumption that 75 percent of input sulfur is removed by the venturi scrubbers from Kilns 1 and 2.

**Table 7-17: Baseline $SO_2$ Emissions (TPY) from Kilns 1-4**

| Source | $SO_2$ Emissions (TPY) |
|---|---|
| Kiln 1 | 373 |
| Kiln 2 | 347 |
| Kiln 3 | 2,854 |
| Kiln 4 | 3,008 |

#### 7.8.1.1. Lhoist – Montevallo Plant Kilns 1-4 (CA-01, CA-02, CA-03)

Rotary lime Kilns 1 through 4 combust a combination of coal, petroleum coke, and natural gas to calcine limestone into quicklime. The primary source of sulfur dioxide ($SO_2$) emissions is fuel combustion. In addition, the limestone used as raw material in the kilns contains sulfur that can contribute to the total $SO_2$ emissions from the calcining process. $SO_2$ emissions can be reduced by either removing $SO_2$ from the flue gas stream or reducing the sulfur input to the kilns in the fuel or raw material. Potential retrofit control technologies considered for reducing $SO_2$ emissions included dry sorbent injection (DSI), wet flue gas desulfurization (FGD) scrubbing, semi-wet/dry FGD scrubbing, and alternative fuel scenarios using different mixes of low-sulfur and standard coal, pet coke, and natural gas.

Dry sorbent injection (DSI) involves injecting a sorbent (e.g., hydrated lime) into the kiln flue gas to absorb $SO_2$, creating a dry waste product which is removed downstream by a baghouse. Control efficiency for DSI is assumed to be 50 percent for $SO_2$ removal. Lhoist stated that replacing the existing wet scrubbers (assumed control efficiency of 75 percent) with DSI for Kilns 1 and 2 would increase $SO_2$ emissions; therefore, this option was only considered for Kilns 3 and 4. This scenario includes removing the existing baghouses from Kilns 3 and 4 and replacing them with new baghouses that could handle the additional load from hydrated lime injection. Due to the costs and secondary factors, including kiln downtime for construction and increased solid waste generation, the facility stated this option was infeasible.

A wet flue gas desulfurization (FGD) scrubber consists of a reactor vessel in which an alkaline reagent is sprayed into the entering flue gas stream. The alkaline reagent (such as calcium) reacts with $SO_2$ in the flue gas to form sulfites and sulfates that are removed and disposed of with the scrubber sludge. Control efficiency for wet FGD scrubbing was assumed to be 98 percent for $SO_2$ removal. Wet FGD scrubbing also controls particulate matter emissions, though this was not assessed in this analysis. This scenario includes removing the existing wet scrubbers (estimated $SO_2$ control efficiency of 75 percent) from Kilns 1 and 2 and the existing baghouses from Kilns 3 and 4 and replacing them with wet FGD scrubbers. Due to the costs and secondary factors, including kiln downtime for construction and increased solid waste and wastewater generation, the facility stated this option was infeasible.

A semi-wet/dry flue gas desulfurization (FGD) scrubber uses a scrubber tower to spray atomized hydrated lime slurry into the flue gas stream. The lime slurry adsorbs the $SO_2$ and produces a powdered calcium/sulfur compound. The solid is removed from the flue gas stream by a baghouse. The facility stated that semi-wet/dry FGD scrubbing would be similar to wet FGD scrubbing but more costly and less effective at reducing emissions. Therefore, the facility stated this option would not be considered over wet FGD scrubbing, and no further analysis was provided.

The kilns combust a blend of standard coal, petroleum coke, and natural gas based on operating conditions and product specifications. The facility assessed lowering pet coke usage and increasing standard coal, natural gas, or low-sulfur coal usage to reduce $SO_2$ emissions from fuel combustion, since these fuels tend to contain less sulfur that pet coke.

The facility stated that the supply of natural gas to the plant was limited by the capacity of the natural gas supplier (Spire Inc.). Lhoist provided a letter from Spire Inc. stating the current total connective load to the plant was 330 MMBtu/hr on an interruptible basis, and any increase above that would require additional infrastructure outside of Lhoist's control. Lhoist estimated that the existing supply, minus the natural gas needed for other equipment at the plant, would allow the four kilns to run on approximately 20 percent natural gas, and a total supply of approximately 1,000 MMBtu/hr would be required to run all four kilns on 100 percent natural gas.

The baseline mix of fuels for each kiln, based on 2019 data, is listed in Table 7-18. The estimated fuel efficiency for each kiln, based on estimates for 2018 through 2019, is listed in Table 7-19. The annual heat input for each kiln, based on data from 2015 through 2019, is listed in Table 7-20.

**Table 7-18: Baseline Fuel Ratios for Kilns 1-4**

| Source | Natural Gas (%) | Standard Coal (%) | Petroleum Coke (%) |
|---|---|---|---|
| Kiln 1 (CA-01) | 9.0 | 36.4 | 54.6 |
| Kiln 2 (CA-02) | 11.0 | 35.6 | 53.4 |
| Kiln 3 (CA-03) | 4.0 | 38.4 | 57.6 |
| Kiln 4 (CA-03) | 4.0 | 38.4 | 57.6 |

**Table 7-19: Estimated Fuel Efficiencies for Kilns 1-4**

| Source | Fuel Efficiency (MMBtu/ton production) |
|---|---|
| Kiln 1 (CA-01) | 10.6 |
| Kiln 2 (CA-02) | 12.0 |
| Kiln 3 (CA-03) | 7.2 |
| Kiln 4 (CA-03) | 7.6 |

**Table 7-20: Annual Heat Input for Kilns 1-4**

| Source | Heat Input (MMBtu/yr) |
|---|---|
| Kiln 1 (CA-01) | 956,700 |
| Kiln 2 (CA-02) | 910,100 |
| Kiln 3 (CA-03) | 1,440,000 |
| Kiln 4 (CA-03) | 1,518,000 |

#### 7.8.1.1.1. Estimated Costs of Compliance

Lhoist prepared a cost analysis for each kiln for dry sorbent injection (DSI), wet flue gas desulfurization (FGD) scrubbing, and various alternative fuel scenarios including the emissions reductions for each technology compared to baseline emissions. Lhoist also assessed semi-wet/dry FGD scrubbing but determined it would be less effective and more expensive than wet FGD scrubbing, so no further analysis was conducted for that option. The Department requested additional alternative fuel scenarios to assess the cost effectiveness of different blends of fuels.

Lhoist stated that the costs from adding DSI systems to the kilns would be due to the construction, operation, and maintenance of the DSI equipment, purchasing a supply of hydrated lime, solid waste disposal, and the cost of additional electricity. The capital and annual costs for sorbent injection systems are from April 2017 Final Report, *Dry Sorbent Injection for $SO_2$/HCl Control Cost Development Methodology*, by Sargent and Lundy, LLC. The capital and annual costs for sorbent injection baghouses are based on the Air Pollution Control Technology Fact Sheet for Pulse-Jet Cleaned Type Fabric Filters (2003). A capital recovery factor of 0.09, assuming a 7 percent interest rate and a 20-year lifespan, was calculated from a formula in the EPA Control Cost Manual and used to calculate the annualized capital cost. Indirect costs such as overhead, administrative charges, property taxes, and insurance based on the EPA Control Cost Manual, Section 5.2, Chapter 1, Table 1.4, were also included in the analysis. The fuel cost for this option was equivalent to the baseline fuel cost and not included in the total annualized cost.

Lhoist stated that the costs from adding wet FGD scrubbing systems would be due to the construction, operation, and maintenance of the wet FGD scrubbing equipment, purchasing a supply of reagent, and waste disposal. The capital and annual costs, as well as a $SO_2$ removal efficiency of 98 percent, for wet FGD scrubbers are based on the Air Pollution Control Technology Fact Sheet for Flue Gas Desulfurization (2003). Lhoist estimated the costs for expanding an on-site pond to supply scrubber water. A capital recovery factor of 0.09, assuming a 7 percent interest rate and a 20-year lifespan, was calculated from a formula in the EPA Control Cost Manual and used to calculate the annualized capital cost. The reagent and waste disposal costs were assumed to be similar to that of hydrated lime found in April 2017 Final Report, *Dry Sorbent Injection for $SO_2$/HCl Control Cost Development Methodology*, by Sargent and Lundy, LLC. Indirect costs such as overhead, administrative charges, property taxes, and insurance based on the EPA Control Cost Manual, Section 5.2, Chapter 1, Table 1.4, were also included. Lhoist estimated that this option would lead to increased kiln downtime due to maintenance on the FGD scrubber system, and the potential revenue loss and additional kiln startup costs were included in this analysis. The fuel cost for this option was equivalent to the baseline fuel cost and not included in the total annualized cost.

The cost of each alternative fuel scenario reflects the difference between the annual cost of the baseline fuel blend and the alternative fuel blend. The cost of each fuel was based on quoted fuel costs. Lhoist estimated that increasing coal usage would lead to increased kiln downtime due to additional ash and plugging issues, and the potential revenue loss and additional kiln startup costs were included in this analysis.

The total baseline emissions reduction and cost of each option for all four kilns, listed from least effective to most effective, are summarized in Table 7-21. The emissions reduction and cost of each option for each kiln are summarized in Tables 7-22 through 7-25. The numbers in parentheses next to each alternative fuel scenario describe the percentage of heat input (MMBtu/yr) to the kilns from standard coal, petroleum coke, and natural gas, respectively. For low-sulfur coal scenarios, the numbers in parentheses describe the percentage of heat input (MMBtu/yr) from standard coal, low-sulfur coal, petroleum coke, and natural gas, respectively.

**Table 7-21: Kilns 1-4 Cost Effectiveness Analysis for $SO_2$ Reduction Options**

| Control Option | Emissions Reduction, tons | Cost Effectiveness, $/ton |
|---|---|---|
| Semi-wet/Dry FGD Scrubbing[1] | N/A | N/A |
| Natural Gas (28/52/20) | 791 | $979 |
| Standard Coal (45/46/9) | 871 | $7,903 |
| Low-S Coal (25/20/46/9) | 1,112 | $6,730 |
| Low-S Coal (0/45/46/9) | 1,413 | $5,611 |
| Standard Coal (60/31/9) | 1,870 | $4,114 |
| Low-S Coal (40/20/31/9) | 2,111 | $3,929 |
| Low-S Coal (20/40/31/9) | 2,353 | $3,725 |
| Natural Gas (25/35/40) | 2,505 | $1,164 |
| Standard Coal (72.8/18.2/9 & 76/19/5) | 2,574 | $3,212 |
| Low-S Coal (0/60/31/9) | 2,594 | $3,506 |
| Standard Coal (75/16/9) | 2,870 | $2,965 |
| DSI | 2,931 | $4,419 |
| Low-S Coal (55/20/16/9) | 3,111 | $2,928 |
| Low-S Coal (35/40/16/9) | 3,352 | $2,857 |
| Low-S Coal (15/60/16/9) | 3,593 | $2,795 |
| Low-S Coal (0/75/16/9) | 3,774 | $2,717 |
| Standard Coal (91/0/9 & 95/0/5) | 3,834 | $2,421 |
| Natural Gas (20/20/60) | 4,086 | $1,108 |
| Max Low-S Coal | 4,973 | $2,304 |
| Natural Gas (10/10/80) | 5,334 | $1,099 |
| Wet FGD Scrubbing | 6,386 | $3,568 |
| Natural Gas (0/0/100) | 6,582 | $1,094 |

[1] Semi-wet/dry FGD scrubbing was deemed less effective and more costly than wet FGD scrubbing and was not assessed further.

**Table 7-22: Kiln 1 Cost Effectiveness Analysis for $SO_2$ Reduction Options**

| Control Option | Emissions Reduction, tons | Cost Effectiveness, $/ton |
|---|---|---|
| Semi-wet/Dry FGD Scrubbing[1] | N/A | N/A |
| DSI[2] | N/A | N/A |
| Natural Gas (28/52/20) | 29 | $3,924 |
| Standard Coal (45/46/9) | 34 | $33,901 |

| | | |
|---|---|---|
| Low-S Coal (25/20/46/9) | 48 | $26,479 |
| Low-S Coal (0/45/46/9) | 66 | $20,558 |
| Standard Coal (60/31/9) | 93 | $14,083 |
| Low-S Coal (40/20/31/9) | 108 | $13,384 |
| Low-S Coal (20/40/31/9) | 122 | $12,572 |
| Natural Gas (25/35/40) | 131 | $4,118 |
| Low-S Coal (0/60/31/9) | 136 | $11,681 |
| Standard Coal (72.8/18.2/9 & 76/19/5) | 144 | $10,087 |
| Standard Coal (75/16/9) | 153 | $9,667 |
| Low-S Coal (55/20/16/9) | 167 | $9,595 |
| Low-S Coal (35/40/16/9) | 181 | $9,348 |
| Low-S Coal (15/60/16/9) | 196 | $9,136 |
| Low-S Coal (0/75/16/9) | 206 | $8,832 |
| Standard Coal (91/0/9 & 95/0/5) | 216 | $7,632 |
| Natural Gas (20/20/60) | 225 | $3,820 |
| Max Low-S Coal | 281 | $7,359 |
| Natural Gas (10/10/80) | 299 | $3,761 |
| Wet FGD Scrubbing | 332 | $15,056 |
| Natural Gas (0/0/100) | 373 | $3,726 |

[1] Semi-wet/dry FGD scrubbing was deemed less effective and more costly than wet FGD scrubbing and was not assessed further.

[2] DSI resulted in greater $SO_2$ emissions than the existing venturi scrubber and was not considered as an option for this kiln.

**Table 7-23: Kiln 2 Cost Effectiveness Analysis for $SO_2$ Reduction Options**

| Control Option | Emissions Reduction, tons | Cost Effectiveness, $/ton |
|---|---|---|
| Semi-wet/Dry FGD Scrubbing[1] | N/A | N/A |
| DSI[2] | N/A | N/A |
| Natural Gas (28/52/20) | 20 | $4,088 |
| Standard Coal (45/46/9) | 25 | $40,324 |
| Low-S Coal (25/20/46/9) | 38 | $29,139 |
| Low-S Coal (0/45/46/9) | 55 | $21,532 |
| Standard Coal (60/31/9) | 81 | $14,123 |
| Low-S Coal (40/20/31/9) | 95 | $13,379 |
| Low-S Coal (20/40/31/9) | 108 | $12,508 |
| Natural Gas (25/35/40) | 117 | $4,148 |
| Low-S Coal (0/60/31/9) | 122 | $11,553 |
| Standard Coal (72.8/18.2/9 & 76/19/5) | 129 | $9,871 |
| Standard Coal (75/16/9) | 137 | $9,440 |
| Low-S Coal (55/20/16/9) | 151 | $9,396 |
| Low-S Coal (35/40/16/9) | 165 | $9,153 |
| Low-S Coal (15/60/16/9) | 178 | $8,947 |

| | | |
|---|---|---|
| Low-S Coal (0/75/16/9) | 189 | $8,632 |
| Standard Coal (91/0/9 & 95/0/5) | 198 | $7,393 |
| Natural Gas (20/20/60) | 206 | $3,825 |
| Max Low-S Coal | 260 | $7,170 |
| Natural Gas (10/10/80) | 277 | $3,764 |
| Wet FGD Scrubbing | 309 | $15,702 |
| Natural Gas (0/0/100) | 347 | $3,728 |

[1] Semi-wet/dry FGD scrubbing was deemed less effective and more costly than wet FGD scrubbing and was not assessed further.

[2] DSI resulted in greater $SO_2$ emissions than the existing venturi scrubber and was not considered as an option for this kiln.

**Table 7-24: Kiln 3 Cost Effectiveness Analysis for $SO_2$ Reduction Options**

| Control Option | Emissions Reduction, tons | Cost Effectiveness, $/ton |
|---|---|---|
| Semi-wet/Dry FGD Scrubbing[1] | N/A | N/A |
| Natural Gas (28/52/20) | 361 | $778 |
| Standard Coal (45/46/9) | 395 | $6,036 |
| Low-S Coal (25/20/46/9) | 499 | $5,128 |
| Low-S Coal (0/45/46/9) | 629 | $4,293 |
| Standard Coal (60/31/9) | 826 | $3,184 |
| Low-S Coal (40/20/31/9) | 929 | $3,015 |
| Low-S Coal (20/40/31/9) | 1,033 | $2,847 |
| Natural Gas (25/35/40) | 1,099 | $842 |
| Standard Coal (72.8/18.2/9 & 76/19/5) | 1,120 | $2,479 |
| Low-S Coal (0/60/31/9) | 1,137 | $2,679 |
| Standard Coal (75/16/9) | 1,256 | $2,287 |
| Low-S Coal (55/20/16/9) | 1,360 | $2,240 |
| DSI | 1,427 | $4,560 |
| Low-S Coal (35/40/16/9) | 1,464 | $2,176 |
| Low-S Coal (15/60/16/9) | 1,567 | $2,120 |
| Low-S Coal (0/75/16/9) | 1,645 | $2,063 |
| Standard Coal (91/0/9 & 95/0/5) | 1,665 | $1,852 |
| Natural Gas (20/20/60) | 1,779 | $790 |
| Max Low-S Coal | 2,158 | $1,735 |
| Natural Gas (10/10/80) | 2,316 | $779 |
| Wet FGD Scrubbing | 2,797 | $2,315 |
| Natural Gas (0/0/100) | 2,854 | $773 |

[1] Semi-wet/dry FGD scrubbing was deemed less effective and more costly than wet FGD scrubbing and was not assessed further.

**Table 7-25: Kiln 4 Cost Effectiveness Analysis for $SO_2$ Reduction Options**

| Control Option | Emissions Reduction, tons | Cost Effectiveness, $/ton |
|---|---|---|
| Semi-wet/Dry FGD Scrubbing[1] | N/A | N/A |
| Natural Gas (28/52/20) | 380 | $778 |
| Standard Coal (45/46/9) | 417 | $5,640 |
| Low-S Coal (25/20/46/9) | 526 | $4,811 |
| Low-S Coal (0/45/46/9) | 663 | $4,044 |
| Standard Coal (60/31/9) | 870 | $2,995 |
| Low-S Coal (40/20/31/9) | 980 | $2,845 |
| Low-S Coal (20/40/31/9) | 1,089 | $2,694 |
| Natural Gas (25/35/40) | 1,158 | $834 |
| Standard Coal (72.8/18.2/9 & 76/19/5) | 1,181 | $2,339 |
| Low-S Coal (0/60/31/9) | 1,198 | $2,542 |
| Standard Coal (75/16/9) | 1,324 | $2,162 |
| Low-S Coal (55/20/16/9) | 1,433 | $2,123 |
| DSI | 1,504 | $4,286 |
| Low-S Coal (35/40/16/9) | 1,543 | $2,068 |
| Low-S Coal (15/60/16/9) | 1,652 | $2,019 |
| Low-S Coal (0/75/16/9) | 1,734 | $1,968 |
| Standard Coal (91/0/9 & 95/0/5) | 1,755 | $1,758 |
| Natural Gas (20/20/60) | 1,876 | $785 |
| Max Low-S Coal | 2,275 | $1,663 |
| Natural Gas (10/10/80) | 2,442 | $776 |
| Wet FGD Scrubbing | 2,948 | $2,195 |
| Natural Gas (0/0/100) | 3,008 | $770 |

[1] Semi-wet/dry FGD scrubbing was deemed less effective and more costly than wet FGD scrubbing and was not assessed further.

#### 7.8.1.1.2. Time Necessary for Compliance

Lhoist stated that the time to implement the DSI option would include demolishing the existing baghouses and combined stack for Kilns 3 and 4 as well as constructing the DSI system with new baghouses.

The time to implement the wet FGD scrubbing option would include demolishing the existing scrubbers for Kilns 1 and 2 and the existing baghouses and combined stack for Kilns 3 and 4 and constructing the new wet FGD scrubbing systems.

The time required for increased standard coal combustion would be minimal since the kilns were already equipped to burn coal and a supplier was in place.

The time required for increased low-sulfur coal combustion would include procuring a long-term supplier for low-sulfur coal (i.e. Appalachian coal). Lhoist expressed concerns about the long-term availability and reliable supply of this type of coal for this facility.

The time required for increased natural gas combustion would be minimal for increases up to approximately 20 percent natural gas for all four kilns, since that could be met by the facility's existing supply of natural gas. Any increase in natural gas combustion above 20 percent for all four kilns would require an unknown amount of time to reach an agreement with the facility's natural gas supplier and for the supplier to construct the infrastructure to increase supply to the plant.

#### 7.8.1.1.3. Energy and Non-Air Quality Impacts of Compliance

Lhoist stated the DSI option would increase electricity consumption from control equipment and generate solid waste in the form of spent hydrated lime.

Wet FGD scrubbing would increase electricity consumption from control equipment, increase water consumption, and generate wastewater as well as solid waste in the form of scrubber sludge. The facility would also have to manage an increase in the sulfate content of wastewater in the facility's water treatment system to continue meeting their sulfate and total dissolved solids water discharge limits.

Lhoist stated that standard coal and low-sulfur coal contain, on average, more of certain trace metals than petroleum coke. Examples of such trace metals include arsenic, cadmium, lead, manganese, and mercury. Burning more coal while decreasing pet coke and natural gas usage could result in an increase in emissions of these trace metals. Emissions of other metals, such as beryllium and nickel, could be decreased by burning less petroleum coke. Lhoist also stated that, based on fuel sampling data, standard coal and low-sulfur coal have a higher ash and moisture content and lower heating value than pet coke. This could cause an increase in operational issues like plugging, which would lead to increased kiln downtime for cleaning and maintenance. This could also lead to an increase in particulate matter and $NO_x$ emissions, which also impair visibility.

Lhoist stated that no energy or non-air quality impacts would be expected from the increased use of natural gas while decreasing pet coke and/or coal usage.

#### 7.8.1.1.4. Remaining Useful Life

Lhoist followed the guidance from the EPA OAQPS Control Cost Manual that was available at the time of the analysis regarding the useful life of the controls being evaluated (e.g., calculated the CRF assuming a 20-year lifespan). Accordingly, the remaining useful life of the kilns was not a factor in this cost effectiveness analysis.

#### 7.8.1.1.5. Summary of Findings for Lhoist – Montevallo Plant Kilns 1-4

The Department primarily considered cost effectiveness and feasibility to determine whether a control or measure was necessary for reasonable progress. The Department then further considered the other three factors (time necessary for compliance, energy and non-air quality impacts, and remaining useful life).

For Kilns 1-4, the Department did not consider installing wet FGD scrubbing or DSI systems or increasing standard or low-sulfur coal usage necessary for reasonable progress. Since Kilns 1 and 2 have existing venturi scrubbers that reduce $SO_2$ emissions, increasing natural gas usage would result in minimal $SO_2$ reduction for those units. The Department determined that increasing natural gas usage for Kilns 3 and 4 was a cost-effective control available to these units. Given that Lhoist could implement a fuel switch in a timely manner with no energy or non-air environmental impacts, the Department determined that increasing natural gas usage to maximize the existing available supply for Kilns 3 and 4 was necessary for reasonable progress. This measure was expected to result in a reduction of 1,205 tons of $SO_2$ per year, which represents an 18.3 percent reduction from baseline annual emissions from the kilns.

The Department required the following conditions through Air Permit No. 411-0008-X053 issued on September 21, 2021, which are submitted for inclusion into the SIP:

- "Emission Standards":
  - Proviso 4: Natural gas shall make up at least 22% of total fuel usage, on a MMBtu basis, in Kiln Nos. 3 and 4 in any 12-month rolling period.
  - Proviso 5: Sulfur Dioxide ($SO_2$) emissions from Kiln Nos. 3 and 4 combined shall not exceed 4,657 TPY in any 12-month rolling period as determined by a CEMS.
- "Compliance and Performance Test Methods and Procedures:
  - Proviso 11: By May 1, 2022, the permittee shall install, operate, maintain, and calibrate a continuous emissions monitoring system (CEMS) with a flow meter at a location approved by the Director in order to determine compliance with the applicable sulfur dioxide ($SO_2$) emissions standard. The CEMS and flow meter shall comply with the applicable specifications and procedures outlined in 40 CFR Part 75, Appendices A, B and C.
- "Emission Monitoring":
  - Proviso 3: By May 1, 2022, a certified continuous emissions monitoring system (CEMS) with a flow meter shall be used in the determination of sulfur dioxide (SO2) emissions from the kilns.
- "Recordkeeping and Reporting Requirements":
  - Proviso 2: All original data charts, performance evaluations, calibration checks, adjustments, and maintenance records for the CEMS and flow meter shall be kept in a permanent form suitable for inspection. These records shall be maintained for a period of at least five (5) years from the date of generation and shall be made available to the permitting authority upon request.
  - Proviso 3: The permittee shall record the monthly fuel usage of each kiln in terms of MMBtu of each fuel type. The percentage of natural gas usage based on MMBtu during the previous 12-month period shall be calculated for each month within 10 days of the end of the month.
  - Proviso 4: Quarterly excess emissions reports (EER) shall be submitted to the Department for each calendar quarter within the month following the end of the quarter. The reports shall include the following information:
    a) The rolling 12-month natural gas usage (percentage of total fuel based on MMBtu) for Kiln Nos. 3 and 4 for each calendar month in the quarter;

b) The magnitude of $SO_2$ emissions for Kiln Nos. 3 and 4 in excess of the applicable emissions standard, as determined by the CEMS;
c) The date, time, and duration of each period of excess emissions;
d) The nature and cause of each period of excess emissions, if known;
e) Description of any corrective 187action or preventative measures implemented in response to excess emissions;
f) Data recorded during periods associated with monitor breakdowns, repairs, calibrations, and zero and span adjustments shall not be included in data averages;
g) The date and time of each period in which the CEMS was inoperative, excluding periods of zero and span checks, and the nature of any system repairs or adjustments performed;
h) During periods in which no excess emissions have occurred, the CEMS has not been inoperative, and/or repairs and adjustments were not necessary, such information shall be stated in the report;
i) The total source operating time (all times and periods in the appropriate averaging units, such as hours, days, minutes, etc.);
j) The total time the CEMS was available to record source performance. Information identifying each period during which the monitoring system was inoperative, excluding zero and span checks, and the nature of any system repairs or adjustments shall also be included;
k) Monitor availability expressed as percent (%) of source operating time, calculated as follows:

$$\frac{\text{Total monitor availability time}}{\text{Total source operating time}} * 100\%$$

l) Overall performance, expressed as percent (%), calculated as follows:

$$\frac{[(\text{Total monitor availability time}) - (\text{Total time of excess emissions})]}{(\text{Total monitor availability time})} * 100\%$$

m) Statement of certification of truth, accuracy, and completeness; and
n) Signature of the responsible official.

Air Permit No. 411-0008-X053, in its entirety, is included **For Informational Purposes Only** in Appendix G.

The Department further intends to include these provisos in the next Title V operating permit, referencing the Regional Haze SIP as the applicable authority.

## 7.9. Control Measures Representing Reasonable Progress for the Sanders Lead Facility identified in the PSAT modeling for the Chassahowitzka and St. Marks Wilderness Areas in Florida

The AoI/PSAT analyses identified the Sanders Lead facility (Sanders), located in Troy, Alabama, as having a significant impact (sulfate contributions at or greater than 1.00%) at the Chassahowitzka and St. Marks Wilderness Areas in Florida. The PSAT impacts are provided in Tables 7-12 and 7-13, above. In 2020, Sanders installed a scrubber on the blast furnace stacks, resulting in a 90%+ reduction in actual $SO_2$ emissions. As a result of the installation of the scrubber, the PSAT contribution, if scaled, would fall to well below the significance threshold (sulfate contributions at or greater than 1.00%) at both Class I areas. In a letter from Ron Gore, ADEM Air Director, to Hastings Read, FDEP Air Resource Management Division on December 7, 2020, the control of the blast furnaces and resulting impact at Chassahowitzka and St. Marks was discussed. As a result of this consultation with Florida, no additional review of reasonable progress is warranted for Sanders. A copy of this correspondence can be found in Appendix G.

## 7.10. Consideration of Five Additional Factors

Section 51.308(f)(2(iv) of the Regional Haze Rule requires that states must consider five additional factors when developing a long-term strategy (LTS). These five additional factors are:

A. Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment;
B. Measures to mitigate the impacts of construction activities;
C. Source retirement and replacement schedules;
D. Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs; and
E. The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy.

Factors B and D are addressed below in Section 7.10.2 and Section 7.10.1, respectively.

Factor A and Factor C are addressed in other sections of this document. For Factor A, the emission reductions from ongoing air pollution control programs, including, where applicable, measures to address reasonably attributable visibility impairment, are included in the baseline and 2028 emission inventories discussed in Section 4. For Factor C, specific existing and planned emission controls are explained in Section 7.2.

For Factor E, the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the LTS7 is reflected in the reasonable progress goals discussion located in Section 8.

### 7.10.1. Smoke Management

As demonstrated in Figure 2-1, elemental carbon (sources include agriculture, prescribed wildland fires, and wildfires) is a relatively minor contributor to visibility impairment at the Sipsey Class I areas. Smoke Management techniques for agricultural and forestry management purposes include plans as they currently exist within the state for these purposes. The Alabama Forestry Commission ("AFC") has developed The State of Alabama Smoke Management Program, which serves to regulate vegetative debris burning for forestry, agriculture, and wildlife purposes in the State of Alabama. ADEM's Air Division has developed a state air pollution control regulation (ADEM Admin. Code 335-3-3-.01, Open Burning) that lists the specific circumstances in which open burning is permissible. ADEM has an approved smoke management program that addresses the issues laid out in EPA's 1998 draft guidance "Interim Air Quality Policy on Wildland and Prescribed Fires" for smoke management plans. The voluntary prescribed fire smoke management techniques practiced include Class I areas as a sensitive receptor, and ADEM contends that the current smoke management plan is sufficient to satisfy the directive in Section 308(d)(3)(v)(E).

### 7.10.2. Dust and Fine Soil from Construction Activities

As discussed in Section 2.4.2 and demonstrated in Figure 2-1, fine soils were a relatively minor contributor to visibility impairment at Sipsey during the baseline period of 2000-2004. Figure 2-2 and Figure 2-3 show that no VISTAS Class I areas experienced significant visibility impairment from soils during this timeframe. Figure 2-7 shows that fine soils continue to be only a minor contributor to visibility at Sipsey during the most current period of monitoring data (2014-2018). Figure 2-8 and Figure 2-9 show that no VISTAS Class I areas experienced significant visibility impairment from soils during the 2014-2018 timeframe.

### 7.10.3. Consideration of NOx and Nitrate in Source Selection

As stated in EPA's August 2019 regional haze guidance, "When selecting sources for analysis of control measures, a state may focus on the PM species that dominate visibility impairment at the Class I areas affected by emissions from the state and then select only sources with emissions of those dominant pollutants and their precursors." Based on data presented in Figure 2-4, $SO_2$ was the dominant PM species at Sipsey, followed by organic carbon, based on the most recent IMPROVE data at the time the AoI analyses and PSAT modeling were being performed. As a result, Alabama elected to only evaluate $SO_2$ emission sources for the LTS. States are required to establish RPGs for each mandatory Class I Federal area located within the state. The LTS and RPGs must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period.

Figure 2-7 shows the visibility impairment by species at the Sipsey Wilderness Area for 2014-2018. Although sulfate has decreased dramatically over this period, it is still the dominant species over the period. As such, Alabama has concluded that ammonium sulfate is the dominant pollutant impacting visibility at the Sipsey for this planning period. States are required to establish RPGs for each mandatory Class I Federal area located within the state. The LTS and RPGs must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period. Alabama believes that targeting $SO_2$ emissions is the best way to accomplish this for this planning period. Alabama also believes that, based on more recent data, both $SO_2$ and $NO_2$ emissions may need to be evaluated for future planning periods.

## 7.11 Environmental Justice

Environmental Justice Environmental justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. This goal will be achieved when everyone enjoys the same degree of protection from environmental and health hazards, and equal access to the decision-making process to have a healthy environment in which to live, learn, and work. The purpose of the Regional Haze Rule is to improve visibility in the Federal Class I Areas. Alabama has not identified any EJ communities living in the Sipsey Wilderness Area whose visibility would be disproportionately impacted by Alabama's selection of reasonable progress controls.

# 8. Reasonable Progress Goals (RPGs)

The Rule at 40 CFR 51.308(f)(3) requires states to establish RPGs in units of dv for each Class I area within the state to reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period (2028). This is accomplished by implementing enforceable limitations, compliance schedules, and other requirements by the end of the applicable implementation period (2028), as well as the implementation of other requirements of the Clean Air Act (CAA). The Long-Term Strategy (LTS) and the RPGs must provide for an improvement in visibility for the most impaired days since the baseline period and ensure no degradation in visibility for the clearest days since the baseline period.

If a state in which a mandatory Federal Class I area is located establishes an RPG for the most impaired days that provides for a slower rate of improvement in visibility than the Uniform Rate of Progress (URP), the state must demonstrate, based on the analysis required by 40 CFR 51.308(f)(2)(i), that there are no additional emission reduction measures for anthropogenic sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in the LTS. (See 40 CFR 51.308(f)(3)(ii)(A) for additional requirements.)

Further, if a state contains sources that are reasonably anticipated to contribute to visibility impairment in a mandatory Federal Class I area in another state for which that state has established an RPG that provides for slower rate of improvement in visibility than the URP, the state must demonstrate that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in its own LTS. (See 40 CFR 51.308(f)(3)(ii)(B).)

It is notable that the RPGs established in this SIP are not directly enforceable, but the RPGs can be used to evaluate whether the SIP is adequately providing reasonable progress towards achieving natural visibility. (See 40 CFR 51.308(f)(3)(iii).)

## 8.1. RPGs for the Sipsey Wilderness Area

Therefore, in accordance with the requirements of 40 CFR 51.308(f)(3), this Regional Haze SIP establishes RPGs for the Sipsey Wilderness Area. To calculate the rate of progress represented by each goal, Alabama compared baseline visibility conditions (2000 to 2004) to natural visibility conditions in 2064 at Sipsey and determined the uniform rate of visibility improvement (in dv) that would need to be maintained during each implementation period in order to attain natural visibility conditions by 2064.

Through the VISTAS modeling, expected visibility improvements by 2028 were estimated at Sipsey resulting from existing federal and state regulations expected to be implemented and facility closures expected to occur by 2028 in Alabama and neighboring states. The VISTAS baseline modeling demonstrated that the 2028 base case control scenario provides for an improvement in visibility below the URP for Sipsey for the 20% most impaired days and ensures no degradation in visibility for the 20% clearest days over the 2000 to 2004 baseline period. These controls and facility closures, to the extent known and quantifiable, were modeled as part of the LTS. The results of this modeling are provided in Section 7.2.7.

As detailed in Section 7.6.2 above, ten (10) facilities were identified for reasonable progress analysis for Sipsey, including two (2) facilities located in Alabama, and eight (8) facilities located in the States of Indiana, Kentucky, Missouri, Ohio and Tennessee.

Table 8-1 and 8-2 provide the Reasonable Progress Goals (RPGs) for the Sipsey Wilderness Area. The table lists the 2028 RPGs, the URP for 2028, and natural visibility conditions. The numbers in brackets contain the projected improvement from the baseline, the amount of improvement from the baseline needed to meet the 2028 uniform rate of progress, and the additional improvement needed to achieve natural conditions, respectively. Table 8-2 provides the expected visibility in 2028 on 20% clearest days as compared to the 2000-2004 baseline 20% clearest day values at the Sipsey Wilderness Area. This table shows that projected visibility on the 20% clearest days will not degrade but rather will improve significantly by 2028. The number in the brackets indicates the projected improvement from baseline conditions.

**Table 8-1: Sipsey Wilderness Area RPG – 20% Most Impaired Days**

| **Class I Area** | **2000-2004 Baseline Visibility (dv)[(1)]** | **2028 Reasonable Progress Goal (dv)** [2004 – 2028 decrease, (dv)] | **2028 Uniform Rate of Progress (dv)** [2004 – 2028 decrease to meet uniform progress, (dv)] | **Natural Visibility (dv)** [2028 – 2064 decrease needed from 2028 goal] |
|---|---|---|---|---|
| Sipsey WA | 27.69 | 16.62<br>[11.07] | 20.46<br>[7.23] | 9.62<br>[7.00] |

(1) The 2000-2004 baseline visibility data reflect values included in Table 1 in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[48]

**Table 8-2: Sipsey Wilderness Area RPG - 20% Clearest Days**

| **Class I Area** | **2000-2004 Baseline Visibility (dv)[(1)]** | **2028 Reasonable Progress Goal (dv)** [2004 – 2028 improvement goal] |
|---|---|---|
| Sipsey WA | 15.57 | 11.11<br>[4.46] |

(1) The 2000-2004 baseline visibility data reflect values included in Table 1 in the EPA memorandum titled: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[49]

Alabama has determined that the RPGs will be at least as stringent as the expected glide path prediction for Sipsey. In addition, there are no sources in Alabama that are reasonably anticipated to contribute to visibility impairment in a Class I area in another state for which an RPG has been established that is slower than the URP.

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48 URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf
49 URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

## 8.2. Reductions Not Included in the 2028 RPG Analysis

Additional reductions in visibility impairing pollutants have occurred since VISTAS conducted the modeling analyses for the 2028 RPGs. These reductions, described below, will help to ensure that Sipsey and other VISTAS Class I areas will meet the projected RPGs and that additional visibility improvement is likely.

### 8.2.1. Out of State Reasonable Progress Evaluation Reductions

Table 7-10 in Section 7.6.2 provides the listing of facilities that were estimated to impact Sipsey that are located outside of Alabama but within VISTAS and other non-VISTAS states. As required by the Rule, Alabama notified these states, through VISTAS, of the findings of significant contribution and consulted with those states regarding the evaluations performed. Section 10.1 provides each response. These reductions were not included in the VISTAS 2028 RPG modeling and thus will help ensure that the RPGs provided in Tables 8-1 and 8-2 are met for the 20% most impaired days and that no visibility degradation on the 20% clearest days occurs.

#### 8.2.1.1 CSAPR Update Rule Reductions

As stated in Section 7.2.1.1, the amended CSAPR Update Rule was published in the Federal Register on April 30, 2021. The final Rule includes state-by-state adjusted ozone season emission budgets for 2021 through 2024. Emission reductions are required at power plants in the 12 states based on optimization of existing, already-installed selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) controls beginning in the 2021 ozone season, and installation or upgrade of state-of-the-art NOx combustion controls beginning in the 2022 ozone season. EPA estimates the Revised CSAPR Update will reduce summertime NOx emissions from power plants in the 12 linked upwind states by 17,000 tons in 2021 compared to projections without the Rule.

### 8.2.2. Other Control Programs

Alabama's emissions inventory is rapidly changing due to economic pressures, aging equipment, new policy and legislation, and other factors. These changes generally decrease emissions. A number of such changes were not included in the elv5 modeling inventory since they were not known at the time of the inventory development or were not well documented and supported. These forthcoming emission reductions should further improve visibility in Sipsey. Please see Section 10 for more information on these sources and potential controls.

# 9. Monitoring Strategy

The Regional Haze SIP is to be accompanied by a strategy for monitoring regional haze visibility impairment. Specifically, the Rule states at 40 CFR 51.308(f)(6):

> (6) The State must submit with the implementation plan a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment that is representative of all mandatory Class I Federal areas within the State. Compliance with this requirement may be met through participation in the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. The implementation plan must also provide for the following:
>
>> (i) The establishment of any additional monitoring sites or equipment needed to assess whether reasonable progress goals (RPGs) to address regional haze for all mandatory Federal Class I areas within the State are being achieved.
>>
>> (ii) Procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I Federal areas both within and outside the State.
>>
>> (iii) For a State with no mandatory Federal Class I areas, procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Federal Class I areas in other States.
>>
>> (iv) The implementation plan must provide for the reporting of all visibility monitoring data to the Administrator at least annually for each mandatory Federal Class I area in the State. To the extent possible, the State should report visibility monitoring data electronically.
>>
>> (v) A statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Federal Class I area. The inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions. The State must also include a commitment to update the inventory periodically.
>>
>> (vi) Other elements, including reporting, recordkeeping, and other measures, necessary to assess and report on visibility.

Such monitoring is intended to provide the data needed to satisfy four objectives:

- Track the expected visibility improvements resulting from emissions reductions identified in this SIP.
- Better understand the atmospheric processes of importance to haze.
- Identify chemical species in ambient particulate matter and relate them to emissions from sources.
- Evaluate regional air quality models for haze and construct relative reduction factors using those models.

The primary monitoring network for regional haze, both nationwide and in Alabama, is the IMPROVE network. Given that IMPROVE monitoring data from 2000-2004 serves as the baseline for the regional haze program, the future regional haze monitoring strategy must necessarily be based on, or directly comparable to, the IMPROVE network. The IMPROVE network measurements provide the only long-term record available for tracking visibility improvement or degradation, and, therefore, Alabama is relying on the IMPROVE network for complying with the regional haze monitoring requirement in the Rule.

As shown in Figure 9-1, there is currently one IMPROVE site in the state, the Sipsey Wilderness Area within the Bankhead National Forest in Northwest Alabama.

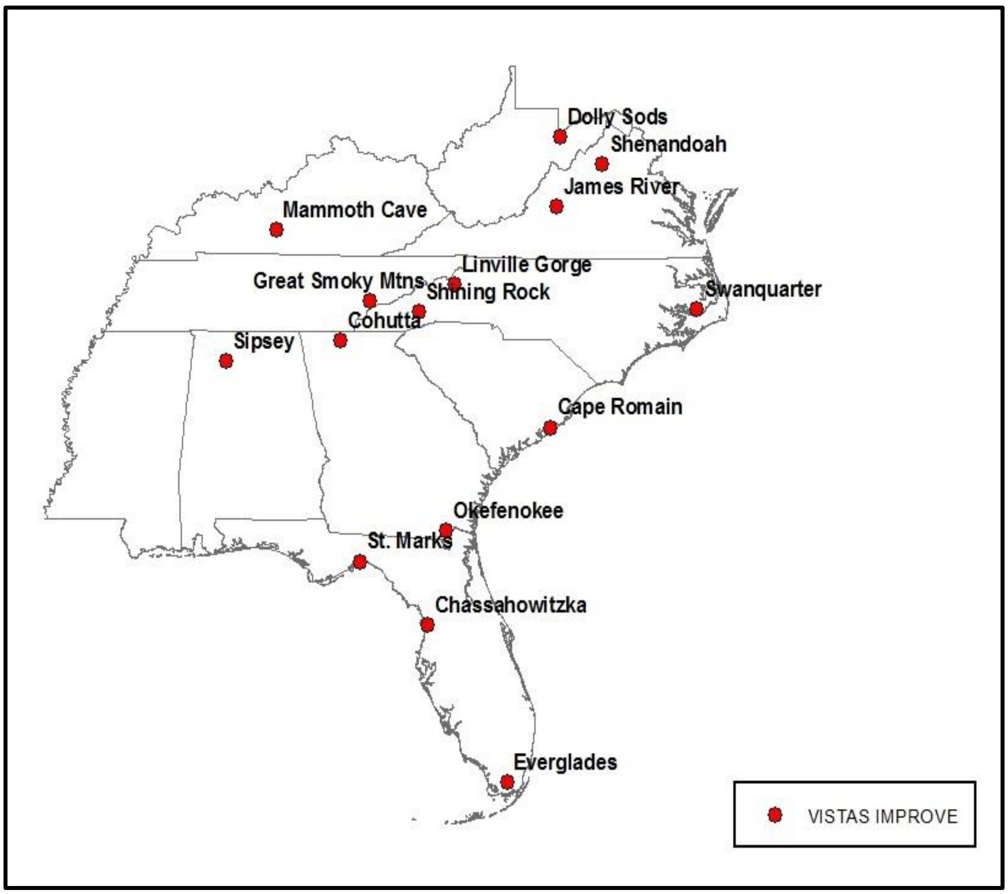



**Figure 9-1: VISTAS States IMPROVE Monitoring Network**

The IMPROVE measurements are central to Alabama's regional haze monitoring strategy because the IMPROVE monitor in Alabama represents a unique airshed, and it is difficult to visualize how the objectives listed above could be met without the monitoring provided by the IMPROVE network. Any reduction in the scope of the IMPROVE network in Alabama and neighboring Class I areas would jeopardize the state's ability to demonstrate reasonable progress toward visibility improvement at Sipsey and plans for appropriate future programs. Alabama's regional haze strategy relies on emission reductions that will result from federal and state programs in Alabama and in neighboring states, which occur on different time scales and will most likely not be spatially uniform. Monitoring at Class I areas is important to document the different air quality responses to the emissions reductions that occur in those unique airsheds during the second implementation period to document reasonable progress.

Because the current IMPROVE monitor in Alabama represents a unique airshed, it accurately demonstrates regional influences. Any reduction of the IMPROVE network by shutting down these monitoring sites will impede tracking progress or planning improvements at the affected Class I areas. If any of these IMPROVE monitors are shut down, Alabama, in consultation with EPA and the FLMs, will develop an alternative approach for meeting the tracking goals, perhaps by seeking contingency funding to carry out limited monitoring or by relying on data from nearby urban monitoring sites to demonstrate trends in speciated $PM_{2.5}$ mass.

Data produced by the IMPROVE monitoring network will be used for preparing the five-year progress reports and the 10-year comprehensive SIP revisions, each of which relies on analysis of the preceding five years of data. Consequently, the monitoring data from the IMPROVE sites needs to be readily available and up to date. Presumably, the IMPROVE network will continue to process information from its own measurements at about the same pace and with the same attention to quality as it has shown to date. A website has been maintained by Colorado State University, the FLMs, and the RPOs to provide ready access to the IMPROVE data and data analysis tools. These databases provide a valuable resource for states and the funding and necessary upkeep of the repository is crucial.

The remainder of this section addresses the requirements of 40 CFR 51.308(f)(6). Alabama relies on the IMPROVE monitoring network to fulfill the requirements in paragraphs 40 CFR 51.308(f)(6)(i) through (iv) and paragraph (vi).

- 51.803(f)(6)(i): Alabama believes the existing IMPROVE monitor for the state's Class I area is adequate and does not believe any additional monitoring sites or equipment are needed to assess whether RPGs for the Sipsey Wilderness Class I Area within the state is being achieved.

- 51.308(f)(6)(ii): Data produced by the IMPROVE monitoring network will be used for preparing the five-year progress reports and the 10-year comprehensive SIP revisions, each of which rely on analysis of the preceding five years of IMPROVE monitor data.

- 51.308(f)(6)(iii): This provision for states with no mandatory Federal Class I areas does not apply to Alabama.

- 51.308(f)(6)(iv): Alabama contends that the existing IMPROVE monitor for the Sipsey Wilderness Class I area is sufficient for the purposes of this SIP revision. IMPROVE is a cooperative measurement effort managed by a Steering Committee that consists of representatives from various organizations (EPA, NPS, USFS, FWS, BLM, NOAA, four organizations representing state air quality organizations (NACAA, WESTAR, NESCAUM, and MARAMA), and three Associate Members: AZ DEQ, Env. Canada, and the South Korea Ministry of Environment). Alabama believes that participation of the state organizations in the IMPROVE Steering Committee adequately represents the needs of the state. The IMPROVE program establishes current visibility and aerosol conditions in mandatory Class I areas; identifies chemical species and emission sources responsible for existing man-made visibility impairment; documents long-term trends in visibility; and provides regional haze monitoring at mandatory Federal Class I areas. (http://vista.cira.colostate.edu/Improve/improve-program/) The National Park Service (NPS) manages and oversees the IMPROVE monitoring network. The IMPROVE monitoring network samples particulate matter from which the chemical composition of the sampled particles is determined. The measured chemical composition is then used to calculate visibility. Samples are collected and data are reviewed, validated, and verified by contractors before submission to EPA's Air Quality System (AQS), (https://www.epa.gov/aqs). The network also posts raw and summary data (http://views.cira.colostate.edu/fed/)(http://vista.cira.colostate.edu/Improve/rhr-summary-data/) to assist states and local air agencies and multijurisdictional organizations. Details about the IMPROVE monitoring network and procedures are available at http://vista.cira.colostate.edu/Improve/.

- 51.308(f)(6)(v): The requirements of 40 CFR 51.308(f)(6)(v) are addressed in Section 4, Section 7.2.4, and Section 13.1 of this SIP. Alabama will continue to participate in SESARM/VISTAS efforts for projecting future emissions and continue to comply with the requirements of the AERR to periodically update emissions inventories.

- 51.308(f)(6)(vi): There are no elements, including reporting, recordkeeping, or other measures, necessary to address and report on visibility for the Sipsey Wilderness Class I area or any Class I areas outside the state that are affected by sources in Alabama.

# 10. Consultation Process

The VISTAS states have jointly developed the technical analyses that define the amount of visibility improvement that can be achieved by 2028 as compared to the Uniform Rate of Progress (URP) for each Class I area. VISTAS initially used an Area of Influence (AoI) analysis to identify the areas and source sectors most likely contributing to poor visibility in Class I areas within the southeast. This AoI analysis involved running the HYSPLIT model to determine the origin of the air parcels affecting visibility within each Class I area. This information was then spatially combined with emissions data to determine the pollutants, sectors, and individual sources that are most likely contributing to the visibility impairment at each Class I area. This information indicated that the pollutants and sector with the largest impact on visibility impairment in 2028 at Sipsey was $SO_2$ from point sources. Next, VISTAS states used the results of the AoI analysis to identify sources to "tag" for PSAT modeling. PSAT modeling uses "reactive tracers" to apportion particulate matter among different sources, source categories, and regions. PSAT was implemented with the CAMx photochemical model to determine visibility impairment from individual sources. PSAT results showed that in 2028 the majority of visibility impairment at Sipsey will continue to be from point source $SO_2$ emissions. Using the PSAT data, Alabama identified, for the reasonable progress analyses, sources shown to have a sulfate impact at Sipsey greater than or equal to (≥) 1.00% of the total sulfate from point sources on the 20% most impaired days, as determined by the PSAT modeling. Further, Alabama accepts the conclusions of these analyses for use in evaluating reasonable further progress.

## 10.1. Interstate Consultation

This section addresses paragraph 40 CFR 51.308(f)(2) of the Regional Haze Rule that requires each state to address in its Long-Term Strategy (LTS) visibility impairment for each mandatory Class I Federal area located outside the State that may be affected by emissions from the State. The LTS must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress, as determined pursuant to paragraphs 40 CFR 51.308(f)(2)(i) through (iv). Section 10.1.1 documents Alabama's consultation with other states with emission sources that impact the Sipsey Wilderness Areas in Alabama, and Section 10.1.2 addresses Alabama impacts on Class I areas outside of the state. Alabama accepts the decisions made by other state agencies concerning the emission sources listed in Section 10.1.1. Additionally, Alabama consulted with Florida regarding the reasonable progress assessment for Sanders Lead in Troy, Alabama as discussed in Section 10.1.1.2

#### 10.1.1.1 Emission Sources in Other States with Impacts on the Sipsey Wilderness Area

In evaluating controls needed to assess reasonable progress within the VISTAS states, Alabama initiated a consultation process with Kentucky and Tennessee to address sources with greater than or equal to 1.00% of the sulfate point source visibility impairment on the 20% most impaired days at the Sipsey Wilderness Area. This consultation was done through phone calls and emails. The documentation can be found in Appendix F1.

Alabama, through VISTAS, also sent a letter to each non-VISTAS state with one or more facilities identified as having greater than or equal to 1.00% of the total sulfate point source visibility impairment on the 20% most impaired days at one or more VISTAS Class I areas. The letter requested that the non-VISTAS state verify if the 2028 $SO_2$ emissions modeled for each facility identified in the letter were correct. The state was asked to provide a formal response including the plans for the facility, if the state was requiring controls.

Table 10-1 provides a summary of the VISTAS and non-VISTAS states, for which consultation was completed, affecting the Sipsey Wilderness Area. The table identifies each facility and its PSAT contribution at Sipsey. Appendix F-1 provides documentation from Alabama to Kentucky and Tennessee. Appendix F-2 provides the consultation letters from VISTAS to each non-VISTAS state and the responses to the letters.

| Facility | State | Impairment Impact |
|---|---|---|
| Tennessee Valley Authority – Shawnee Fossil Plant | KY | 2.35% |
| Indiana Michigan Power | IN | 2.11% |
| General James M. Gavin Power Plant | OH | 2.11% |
| Duke Power- Gibson | IN | 1.74% |
| Indianapolis Power and Light Petersburg | IN | 1.67% |
| TVA Cumberland Fossil Plant | TN | 1.56% |
| New Madrid Power Plant-Marston | MO | 1.42% |
| Big Rivers Electric Corp-Wilson Station | KY | 1.36% |

**Table 10-1: Out-of-State Facilities with ≥ 1.00% Sulfate Contributions in 2028 at Sipsey**

The following identifies where to find the response or summarizes the response received for each facility.

<u>Tennessee Valley Authority (TVA) - Shawnee Fossil Plant – KY</u>

- Kentucky requested that this facility perform a reasonable progress analysis. Kentucky provided the facility's reasonable progress analysis, dated February 19, 2021, which is included in Appendix F-1. TVA proposed to accept a facility-wide emission limitation of no more than 8,719 tons of SO2 per 12-month rolling total starting on December 31, 2034. This represents a 7,028 ton per year reduction in SO2 emissions when compared to projected 2028 emissions.

<u>Indiana Michigan Power– IN</u>

- The Indiana Department of Environmental Management (IDEM) did not require a 4-factor analyses from its EGUs, including Michigan Power, Gibson or Petersburg. In their letter, IDEM states that "IDEM is intently evaluating other emission sectors for this second implementation period to determine their visibility impacts on Class I areas. IDEM will conduct a review of all its emission sources, with focus on the EGU sector, for its January 31, 2025, progress report; pursuant to 40 CFR 51.308(g). IDEM will evaluate EGUs for the third implementation period of the RH rule, as necessary, to be submitted in 2028." Additionally, IDEM cites the EPA's 2019 Guidance that states a "key flexibility of the regional haze program is that a state is not required to evaluate all sources of emissions in each implementation period." IDEM submitted their final Regional Haze SIP to EPA on December 30, 2021.

General James M. Gavin Power Plant – OH

- Ohio EPA's Regional Haze SIP for the Second Implementation Period, dated July 2021, contains a four-factor analysis for the General James M. Gavin Power Plant. Ohio EPA concluded that no technically feasible control measures were identified for SO2 control at Gavin Power Plant beyond existing wet FGD systems.

Duke Power- Gibson – IN

- The Indiana Department of Environmental Management (IDEM) is not requiring 4-factor analyses from its EGU's. See above information for Michigan Power.

Indiana Power and Light- Petersburg – IN

- The Indiana Department of Environmental Management (IDEM) is not requiring 4-factor analyses from its EGU's. See above information for Michigan Power.

TVA Cumberland Fossil Plant – TN

- TVA submitted a reasonable progress analysis for Units 1 and 2 at TVA's Cumberland Fossil Plant for the second planning period. All control options identified for TVA Cumberland were deferred to a future review period based on review of the four statutory factors. However, in June 2023, after submission of the Round 2 Regional Haze SIP, TVA Cumberland was issued a permit to construct two natural gas-fired combined-cycle electric generating units and permanently shut down the two coal-fired electric generating units. TDEC-APC is working on a SIP revision that would adopt into the SIP the permit condition that the two coal-fired electric generating units permanently shut down by December 31, 2028. The permanent shutdown of the two coal-fired electric generating units at TVA Cumberland is projected to result in a reduction of 8,427 tons per year of sulfur dioxide.

New Madrid Power Plant- Marston – MO

- Based on a review of possible and feasible options to reduce $SO_2$ emissions, Missouri determined that there are no cost-effective methods of $SO_2$ reductions for this facility needed to make reasonable progress, other than continued use of sub-bituminous coal with the inherently lower sulfur content, as stipulated in the consent agreement. However, Missouri and the New Madrid Power Plant have entered into a consent agreement to help set and maintain RPGs for both Class I areas in Missouri. This consent agreement requires that all of New Madrid Power Plant's future coal purchases shall be western sub-bituminous coal. This is the type of coal currently utilized at the facility and has inherently lower sulfur content than other types of coal such as lignite or bituminous.

Big Rivers Electric Corp- Wilson Station- KY

- Kentucky identified Unit 1, a pulverized coal-fired boiler for a 4-factor analysis. The boiler, Unit 1, has an input capacity of 4,585 MMBtu/hr. Unit 1 is equipped with an electrostatic precipitator (ESP), wet flue gas desulfurization (WFGD), selective catalytic reduction (SCR), hydrated lime injection, and low nitrogen oxide burners. Kentucky focused on Unit 1 since it was the only unit contributing to significant $SO_2$ emissions. The controls installed on Unit 1, along with the implementation of these programs, has resulted in a steady decline in $SO_2$ emissions throughout the years. Additionally, in November 2021, Kentucky finalized a minor revision application to replace the current WFGD on Unit 1 with an advanced WFGD control device. The $SO_2$ emissions removal efficiency increased to 97% resulting in a source-wide SO2 PTE of 3,733 tpy, which is 3,201 tpy less than the projected 2028 $SO_2$ emissions (6,934 tpy). Given that Big Rivers recently made a significant expenditure to install the advanced WFGD device at Wilson Station resulting in an increase of $SO_2$ emissions removal efficiency to 97%, it is determined that Wilson Station is effectively controlled and thus not be required to perform a four-factor analysis.

#### 10.1.1.2 Alabama Emission Source Impacts on Class I Areas in Other States

The AoI/PSAT analyses identified the Sanders Lead facility (Sanders), located in Troy, Alabama, as having a significant impact (sulfate contributions at or greater than 1.00%) at the Chassahowitzka and St. Marks Wilderness Areas in Florida. In 2020, Sanders installed a scrubber on the blast furnace stacks, resulting in a 90%+ reduction in actual $SO_2$ emissions. As a result of the installation of the scrubber, the PSAT contribution, if scaled, would fall to well below the significance threshold (sulfate contributions at or greater than 1.00%) at both Class I areas. In a letter from Ron Gore, ADEM Air Director, to Hastings Read, FDEP Air Resource Management Division on December 7, 2020, the control of the blast furnaces and resulting impact at Chassahowitzka and St. Marks was discussed. As a result of this consultation with Florida, no additional review of reasonable progress is warranted for Sanders. A copy of this correspondence can be found in Appendix G.

## 10.2. Outreach

The VISTAS states participated in national conferences and consultation meetings with other states, RPOs, FLMs, and EPA throughout the SIP development process to share information. VISTAS held calls and webinars with FLMs, EPA, RPOs and their member states, and other stakeholders (industry and non-governmental organizations) to explain the overall analytical approach, methodologies, tools, and assumptions used during the SIP development process and considered comments provided along the way. The chronology of these meetings and conferences is presented in Table 10-2.

**Table 10-2: Summary of VISTAS Consultation Meetings and Calls**

| Date | Meetings and Calls | Participants |
|---|---|---|
| December 5-7, 2017 | Denver, CO, National Regional Haze Meeting – VISTAS States gave several presentations | FLMs; EPA OAQPS[1], Region 3, Region 4; RPOs; various VISTAS agency attendees |
| January 31, 2018 | Teleconference and VISTAS Presentation | FLMs, EPA Region 4 |
| August 1, 2018 | Teleconference and VISTAS Presentation | FLMs, EPA OAQPS, Region 3, Region 4 |

| Date | Meetings and Calls | Participants |
|---|---|---|
| September 5, 2018 | Teleconference and VISTAS Presentation | RPOs, CC[2]/TAWG[3] |
| June 3, 2019 | Teleconference and VISTAS Presentation | FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG |
| October 28-30, 2019 | St Louis, MO, National Regional Haze Meeting – VISTAS States gave presentations | FLMs; EPA OAQPS, Region 3, Region 4; RPOs; various VISTAS agency attendees |
| April 2, 2020 | Teleconference and VISTAS Presentation | FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG |
| April 21, 2020 | Webinar and VISTAS Presentation | RPOs, CC/TAWG |
| May 11, 2020 | Webinar and VISTAS Presentation | FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG |
| May 20, 2020 | Webinar and VISTAS Presentation | Stakeholders; FLMs; EPA OAQPS, Region 3, Region 4; RPOs; and member states, STAD, CC/TAWG |
| August 4, 2020 | Webinar and VISTAS Presentation | FLMs; EPA OAQPS, Region 3, Region 4; RPOs and Member States; CC/TAWG |
| October 26, 2020 | Fall 2020 EPA Region 4 and State Air Director's Call - Webinar and VISTAS Presentation | EPA Region 3, EPA Region 4 |

**[1]Office of Air Quality Planning and Standards (OAQPS)**
**[2]VISTAS Coordinating Committee (CC)**
**[3]VISTAS Technical Advisory Work Group (TAWG)**

Beginning in January 2018, VISTAS held the first of several formal consultation calls with EPA and the FLMs to review the methodologies used to evaluate source lists for four-factor analyses. The development of AoIs for each Class I area with the HYSPLIT model was presented to identify source regions for which additional controls might be considered and that are likely to have the greatest impact on each Class I area. Additionally, information was shared on how states identified specific facilities within the AoIs to be tagged by the CAMx (PSAT) photochemical model to further identify impacts associated with those facilities on each Class I area. Based on the results of these two analyses, each state agreed to evaluate reasonable control measures for sources that met or exceeded individual state thresholds for four-factor analyses. Each state would consider sources within their state and would identify sources in neighboring states for consideration. VISTAS states acknowledged that the review process would differ among states since some Class I areas are projected to see visibility improvements near the Uniform Rate of Progress (URP) while most Class I areas are projected to have greater improvements than the URP.

Subsequent calls were held with EPA, FLMs, and stakeholders to share revised analyses of sources in their state and neighboring states for each Class I area, as well as their criteria for selecting sources and their plans for further interstate consultation. Documentation of these calls can be found in Appendix F-3.

Additionally, Alabama attended a National Regional Haze Conference in St. Louis, Missouri in October 2019 to discuss national and regional modeling to date and to plan next steps for submitting 2028 Regional Haze SIPs. Alabama was part of a southeastern state breakout session with FLMs and EPA discussing the modeling and future expectations from all parties. Alabama also regularly participated in CENRAP calls, which discussed issues specific to the Breton Wilderness Area located on the Chandeleur Island chain off the coast of Louisiana.

## 10.3. Consultation with MANE-VU

The following information documents the VISTAS states' participation in Mid-Atlantic/Northeast Visibility Union (MANE-VU) consultation meetings. Table 10-3 provides the correspondence and meetings that occurred during the consultation process. MANE-VU prepared the *MANE-VU Regional Haze Consultation Report*, which contains a record of the consultation meetings, comments received, and responses to comments.[50] Appendix F-4 provides documentation of consultation with MANE-VU including VISTAS' comments on the MANE-VU Ask.

On October 16, 2016, MANE-VU notified Alabama, Florida, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia that its analysis of upwind emissions from these states may contribute to visibility impairment at one or more MANE-VU Class I areas located in Maine, New Hampshire, New Jersey, and Vermont. MANE-VU invited each aforementioned VISTAS state to participate in its consultation process involving five conference calls from October 20, 2017, to March 23, 2018, to explain their methodologies, data sources, and assumptions used in its contribution analyses. MANE-VU's technical analyses were based on actual 2015 emissions for EGUs and 2011 emissions for other emission sources. MANE-VU's criteria for identifying upwind states for consultation included:

- Point Source Emissions Analysis: Kentucky, North Carolina, Virginia, and West Virginia were identified as having at least one facility estimated to contribute ≥3 $Mm^{-1}$ to light extinction in at least one MANE-VU Class I area based on CALPUFF modeling of the facility's $SO_2$ and $NO_x$ emissions.

- Statewide Emissions Analysis for all Sectors: Alabama, Florida, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia were estimated to contribute ≥2% of the visibility impairment at one or more MANE-VU Class I areas and/or an average mass impact of over 1% (0.01μg/$m^3$). This methodology involved a weight-of-evidence approach based on emissions (tons per year) divided by distance (kilometers) (Q/d) calculations, CALPUFF modeling, and the use of HYSPLIT back trajectories as a quality check.

All seven VISTAS states participated in MANE-VU's five consultation calls and reviewed the technical information supporting MANE-VU's conclusions. On January 27, 2018, VISTAS submitted a letter to MANE-VU documenting its appreciation for the opportunity to participate in the consultation process and identified the following concerns and recommendations:

- Timing: At the time the consultation calls were held, the MANE-VU states indicated that they planned to submit their Regional Haze SIPs to EPA by the original July 2018 deadline. VISTAS noted that its states planned to complete their regional haze technical analysis in 2019 with the intention of submitting Regional Haze SIPs by July 31, 2021. The differing

[50] "MANE-VU Regional Haze Consultation Report," July 27, 2018, MANE-VU Technical Support Committee, URL: _https://otcair.org/MANEVU/Upload/Publication/Correspondence/MANE-VU_RH_ConsultationReport_Appendices_ThankYouLetters_08302018.pdf

schedules resulted in the seven VISTAS states included in MANE-VU's Ask being requested to assess the MANE-VU analysis without the benefit of the forthcoming VISTAS technical work. Subsequently, schedules were delayed, and VISTAS shared the results of its emissions inventory and modeling analyses with the MANE-VU states during consultation calls in 2020 (see Table 10-3 below). VISTAS's technical analyses, which are based on more recent emissions inventory data and robust modeling tools, indicate that VISTAS state contributions to MANE-VU Class I areas are below the thresholds established by MANE-VU.

- Technical Analysis – Inventories, Modeling, and Evaluation: The MANE-VU states' analysis used emission inventories that are inconsistent with the recent EPA regional haze modeling platform. These inventories do not fully reflect emission reductions expected from southeastern EGUs by 2028 and other sources as well. Modeling results derived from use of the outdated emissions inventories may not allow conclusive determinations of impacts, if any, from VISTAS states on Class I areas in the MANE-VU region.

  In many cases, the sources of the alleged contributions to downwind receptors are located thousands of miles away from the MANE-VU Class I areas. The MANE-VU states used the CALPUFF model and the Q/d screening approach to identify contributions that they allege are significant. CALPUFF should not be used for transport distances greater than 300 km since there are serious conceptual concerns with the use of puff dispersion models for very long-range transport which can result in overestimations of surface concentrations in the range of 3 to 4 times. The use of CALPUFF predictions is questionable [51]

  The preamble to the recent Revisions to the Guideline on Air Quality Models that modified Appendix W of 40 CFR Part 51 states, in part, "the EPA has fully documented the past and current concerns related to the regulatory use of the CALPUFF modeling system and believes that these concerns, including the well documented scientific and technical issues with the modeling system, support the EPA's decision to remove it as a preferred model in Appendix A of the Guidelines"[52]. The model is subject to an alternative model demonstration

  The reliability of the Q/d screening approach diminishes over distance and especially beyond 300 km. If the MANE-VU states wish to evaluate emission impacts more than 300 km downwind from sources, a scientifically reliable approach is essential and necessary, such as the CAMX model with the PSAT source apportionment method.

  In response to VISTAS concerns about inaccuracies in the MANE-VU analysis that were shared during the December 18, 2018 technical call, the MANE-VU states suggested that the seven VISTAS states could reassess contributions using their own information to correct the MANE-VU analysis. The VISTAS states affirmed their commitment to conduct a thorough technical review of emission impacts during their forthcoming analysis. However, it was incumbent on the MANE-VU states to correct the errors inherent in their

[51] *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts* (December 1998).
[52] *Federal Register,* Vol. 82, No. 10, Tuesday, January 17, 2017, Page 5195.

own analysis and reassess the states with which consultation would be necessary.

The MANE-VU Ask included year-round use of effective control technologies on EGUs; a four-factor analysis on sources with potential for visibility impacts of ≥ 3.0 $Mm^{-1}$ at any MANE-VU Class I area; establishment of an ultra-low sulfur fuel oil standard; updated permits, enforceable agreements, and/or rules to lock in lower emission rates for EGUs and other large emission sources that had recently reduced emissions or were scheduled to do so; and efforts to decrease energy demand through use of energy efficiency and increased use of combined heat and power and other clean distributed generation technologies. The MANE-VU Ask failed to recognize fully the improved controls, fuel switches, retirements, and energy demand reductions that had already been achieved in the Southeast. Further, the MANE-VU states suggested that the Southeast adopt control measures that would produce little if any visibility improvement at MANE-VU Class I areas. VISTAS recommended that the MANE-VU states refine their analyses and establish a sound basis for any actions requested of the seven VISTAS states and incorporate such expectations in MANE-VU SIPs.

- Permanent and Enforceable: Regional Haze SIPs (including the reasonable progress goals that are set for each Class I area) should only include emission reductions that are permanent, quantifiable, and enforceable. Therefore, the MANE-VU states should only include in their Regional Haze SIPs emission control presumptions for the seven VISTAS states that are clearly necessary and effective and have been made permanent and enforceable via state rulemaking or permit revisions. For MANE-VU states to include within their Regional Haze SIPs emission controls in other states that are not permanent and enforceable, and which the state in question has no intention of adopting, would be inconsistent with the CAA and RHR and could result in adverse comments from the seven VISTAS states during the MANE-VU Regional Haze SIP public comment period.

As a result of their active participation in the MANE-VU consultation process, the VISTAS states fulfilled the consultation requirements specified in the Rule (51.308(f)(2)(ii)).

**Table 10-3: MANE-VU Consultation with VISTAS States - Correspondence and Meetings**

| Date | Description |
|---|---|
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Director Lance LeFleur, Alabama Department of Environmental Management. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Noah Valenstein, Florida Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Commissioner Aaron Keatley, Kentucky Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Michael Regan, North Carolina Department of Environmental Quality (NCDEQ) (formerly Department of Environment and Natural Resources). Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Commissioner Bob Martineau, Tennessee Department of Environment and Conservation. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |

| Date | Description |
|---|---|
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Director David Paylor, Virginia Department of Environmental Quality. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 16, 2017 | Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Austin Caperton, West Virginia Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017. |
| October 20, 2017 | MANE-VU Conference Call. Inter-RPO Consultation #1, Introduction and Overview of MANE-VU Analyses and Ask. |
| December 1, 2017 | MANE-VU Conference Call. Inter-Regional Consultation #2, Discussion of the Ask and listening to upwind states and FLM questions. |
| December 18, 2017 | MANE-VU Conference Call. Inter-Regional Consultation #3, Overview of technical analyses behind the Ask, source contributions, 4-factor analysis, and available technical products. |
| December 29, 2017 | Letter from Laura Mae Crowder, WV Division of Air Quality, Deputy Director/Assistant Director of Planning, to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Provide technical information on emission sources. |
| December 22, 2017 | Email from Mark A. Reynolds, Environmental Consultant, Tennessee Department of Environment and Conservation to Joseph Jakuta, MANE-VU/OTC. Purpose: Provided additional information on EGU emissions and Cargill Corn Milling facility. |
| January 12, 2018 | MANE-VU Conference Call. Inter-Regional Consultation #4, Reasonable Progress Overview. |
| January 18, 2018 | Email from Doris McLeod, Air Quality Planner, Virginia Department of Environmental Quality to Joseph Jakuta, MANE-VU/OTC. Purpose: Information on closure of coal fired boilers at Radford Army Ammunition Plant. |
| January 19, 2018 | Letter from Jeffery F. Koerner, Director, Division of Air Resource Management, Florida Department of Environmental Protection. Purpose: Comments on MANE-VU Inter-RPO Ask regarding flaws in analysis for North Carolina emissions sources. |
| January 27, 2018 | Letter from John E. Hornback, Executive Director, Metro 4/SESARM/VISTAS, to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Comments on timing; technical analysis – inventories, modeling, and evaluation; and permanence and enforceability of control measures not adopted by VISTAS states. |
| January 30, 2018 | Email from Randy Strait, Supervisor of Attainment Planning Branch, Division of Air Quality, NCDEQ to Joseph Jakuta, Program Manager, MANE-VU/OTC, and David Healy, Air Quality Analyst/Modeler, New Hampshire Dept. of Environmental Services. Purpose: Documentation of errors with CALPUFF for KapStone Kraft Paper and documentation showing that 2016 $SO_2$ emissions were 95% lower and 2016 $NO_x$ emissions were 18% lower than in the 2011 emissions used in MANE-VU's modeling. Email reply from Dave Healy on January 31, 2018, confirmed that there was an error in the Ask and that KapStone Kraft Paper's contribution is $<3Mm^{-1}$. |
| February 16, 2018 | Letter from Michael Abraczinskas, Director, Division of Air Quality, NCDEQ to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Comments on MANE-VU Inter-RPO Ask regarding flaws in analysis for North Carolina emissions sources. |
| March 23, 2018 | MANE-VU Conference Call. Inter-RPO Consultation #5. Executive Summaries, SIP submittal plans, and perspectives from upwind states. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Director Lance LeFleur, Alabama Department of Environmental Management. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Commissioner Aaron Keatley, Kentucky Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |

| Date | Description |
|---|---|
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Secretary Noah Valenstein, Florida Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Secretary Michael Regan, North Carolina NCDEQ. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Commissioner Bob Martineau, Tennessee Department of Environment and Conservation. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Director David Paylor, Virginia Department of Environmental Quality. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| May 8, 2018 | Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Cabinet Secretary Austin Caperton, West Virginia Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask. |
| October 22, 2019 | Letter from Director, Lance LeFleur Alabama Department of Environmental Management to Franceis Steitz, Air Quality Division Director, New Jersey Department of Environmental Protection. Purpose: Alabama comments regarding the New Jersey 2018-2028 Regional Haze SIP. |

## 10.4. Federal Land Manager Consultation

As required by 40 CFR §51.308(i), the regional haze SIP must include procedures for continuing consultation between the States and Federal Land Managers (FLMs) pertaining to visibility protection. The FLM responsible for the Sipsey Wilderness Area in Alabama is:

- U.S. Forest Service (FS) under the U.S. Department of Agriculture

The requirements for ongoing State and FLMs consultation and how Alabama will comply with the requirements are described in the following paragraphs.

40 CFR 51.308(i)(2) requires the State to provide the FLMs with an opportunity for consultation, in person and at least 60 days prior to holding a public hearing on a SIP revision. The consultation must include the opportunity for the FLMs to discuss the:

- Assessment of visibility impairment in the Class I area; and
- Recommendations on the development of the reasonable progress goal and on the development and implementation of strategies to address visibility impairment.

ADEM sent a copy of the draft plan to the National Park Service, the U.S. Forest Service, and the U.S. Fish & Wildlife Service on January 23, 2025. No comments were received from the FLMs regarding the plan. Records of Alabama's consultations with the FLMs on this Regional Haze SIP are included in Appendix F.

40 CFR 51.308(i)(3) requires the State to incorporate into any SIP or SIP revision a description of how it addressed comments provided by the FLMs. The comments on the SIP and the description of how they were addressed will be included in Appendix H.

40 CFR 51.308(i)(4) requires the plan (or plan revision) to include procedures for continuing consultation between the State and Federal Land Managers on the implementation of the visibility protection program, including development and review of implementation plan revisions and 5-year progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in mandatory Class I Federal areas. Alabama will offer the Federal Land Managers an opportunity for consultation on a yearly basis, including the opportunity to discuss the implementation process and the most recent IMPROVE monitoring data and VIEWS data. Records of annual consultations and progress report consultations will be maintained in Alabama's Regional Haze files.

# 11. Comprehensive Periodic Implementation Plan Revisions

40 CFR Section 51.308(f) requires Alabama to revise its Regional Haze SIP and submit a plan revision to EPA by July 31, 2021, July 31, 2028, and every ten years thereafter. This plan is submitted in order to meet the July 31, 2021, requirement. In accordance with the requirements listed in Section 51.308(f) of the Rule, Alabama commits to revising and submitting Regional Haze SIPs accordingly.

In addition, Section 51.308(g) requires periodic reports evaluating progress towards the Reasonable Progress Goals (RPGs) established for each mandatory Federal Class I area. These periodic reports are due by January 31, 2025, July 31, 2033, and every ten years thereafter. Alabama commits to meeting all of the requirements for 40 CFR 51.308(g), including revising and submitting a Regional Haze Progress Report (Report), accordingly.

The progress report will evaluate the progress made towards the RPGs for the Sipsey Wilderness Area, located within Alabama, and in each mandatory Federal Class I area located outside Alabama that may be affected by emissions from Alabama sources. All requirements listed in Section 51.308(g) shall be addressed in the progress report.

The requirements listed in 51.308(g) include the following:

(1) A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory Federal Class I areas both within and outside of the state.

(2) A summary of the emissions reductions achieved throughout the state through implementation of the measures described in paragraph 51.308(g)(1).

(3) For each mandatory Federal Class I area within the state, the state must assess the following visibility conditions and changes, with values for the most impaired, least impaired and/or clearest days as applicable expressed in terms of 5-year averages of the annual values. The period for calculating current visibility conditions is the most recent 5-year period preceding the required date of the progress report for which data are available as of a date 6 months preceding the required date of the progress report.

  (i) The current visibility conditions for the most impaired and clearest days;

  (ii) The difference between current visibility conditions for the most impaired and clearest days and baseline visibility conditions;

  (iii) The change in visibility impairment for the most impaired and clearest days over the period since the period addressed in the most recent plan required under paragraph 51.308(f).

(4) An analysis tracking the change over the period since the period addressed in the most recent plan required under paragraph 51.308(f) in emissions of pollutants contributing to visibility impairment from all sources and activities within the state. Emissions changes

should be identified by type of source or activity. With respect to all sources and activities, the analysis must extend at least through the most recent year for which the state has submitted emission inventory information to the Administrator in compliance with the triennial reporting requirements of subpart A of 40 CFR 51 as of a date six months preceding the required date of the progress report. With respect to sources that report directly to a centralized emissions data system operated by the Administrator, the analysis must extend through the most recent year for which the Administrator has provided a state-level summary of such reported data or an internet-based tool by which the state may obtain such a summary as of a date six months preceding the required date of the Report. The state is not required to backcast previously reported emissions to be consistent with more recent emissions estimation procedures and may draw attention to actual or possible inconsistencies created by changes in estimation procedures.

(5) An assessment of any significant changes in anthropogenic emissions within or outside the state that have occurred since the period addressed in the most recent plan required under 40 CFR 51.308(f), including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility.

(6) An assessment of whether the current implementation plan elements and strategies are sufficient to enable the state, or other states with mandatory Federal Class I areas affected by emissions from the state, to meet all established Reasonable Progress Goals (RPGs) for the period covered by the most recent plan required under 40 CFR 51.308(f).

(7) For progress reports for the first implementation period only, a review of the state's visibility monitoring strategy and any modifications to the strategy as necessary.

(8) For a state with a Long-Term Strategy (LTS) that includes a smoke management program for prescribed fires on wildland that conducts a periodic program assessment, a summary of the most recent periodic assessment of the smoke management program including conclusions, if any, that were reached in the assessment as to whether the program is meeting its goals regarding improving ecosystem health and reducing the damaging effects of catastrophic wildfires.

More specifically, the five-year progress report (due by January 31, 2025, July 31, 2033, and every 10 years thereafter) will examine the effect of emission reductions, as well as seek to evaluate the effectiveness of emissions management measures implemented. Therefore, the progress report will provide for a comparison of emission inventories, ultimately expressing the change in visibility for the most impaired and clearest days over the past five years.

Moreover, due to the uncertainty of some measures, the progress report will also provide the opportunity to evaluate the overall effectiveness of proposed measures to reduce visibility impairment to include the effect of state and federal measures.

In keeping with the EPA's requirements and recommendations related to consultation, each five-year review will also enlist the support of appropriate state, local, and tribal air pollution control agencies, as well as the corresponding FLMs.

## 12. Determination of the Adequacy of the Existing Plan

At the same time that Alabama is required to submit any progress reports to EPA, depending on the findings of the five-year progress report, Alabama commits to taking one of the actions listed in 40 CFR Section 51.308(h). The findings of the five-year progress report will determine which action is appropriate and necessary.

List of Possible Actions - 40 CFR Section 51.308(h)

(1) If Alabama determines that the existing SIP requires no further substantive revision in order to achieve established goals, it will provide to EPA a declaration that further revision of the SIP is not needed.

(2) If Alabama determines that the existing SIP may be inadequate to ensure reasonable progress due to emissions from other states that participated in the regional planning process, it will provide notification to EPA and collaborate with the states that participated in regional planning to address the SIP deficiencies.

(3) If Alabama determines that the current SIP may be inadequate to ensure reasonable progress due to emissions from another country, it will provide notification of such, along with available information making such a demonstration, to EPA.

(4) If Alabama determines that the existing SIP is inadequate to ensure reasonable progress due to emissions within the state, it will revise its SIP to address the plan's deficiencies within one year after submitting notification to EPA.

# 13. Regional Haze Progress Report

## 13.1. Background

In July 2008, Alabama submitted its Regional Haze Progress Report for approval to EPA Region 4. The SIP documents Alabama's long-term plan for improving visibility at Sipsey, as well as assisting with improvement of visibility in Class I areas located outside of the state. The SIP also includes specific Reasonable Progress Goals (RPGs) for visibility improvement at milestones that start in 2018. The ultimate goal is to reach background visibility levels at Sipsey by 2064.

Subparagraph 40 CFR 51.308(g) of the Regional Haze Rule requires that states report on the success of the Long-Term Strategy (LTS) at specific intervals. In June 2018, Alabama submitted the first Regional Haze Progress Report to EPA, which demonstrated that Alabama was on track to meet the RPGs set in the Regional Haze SIP.

This progress report, in accordance with EPA's requirements, contains the following elements:

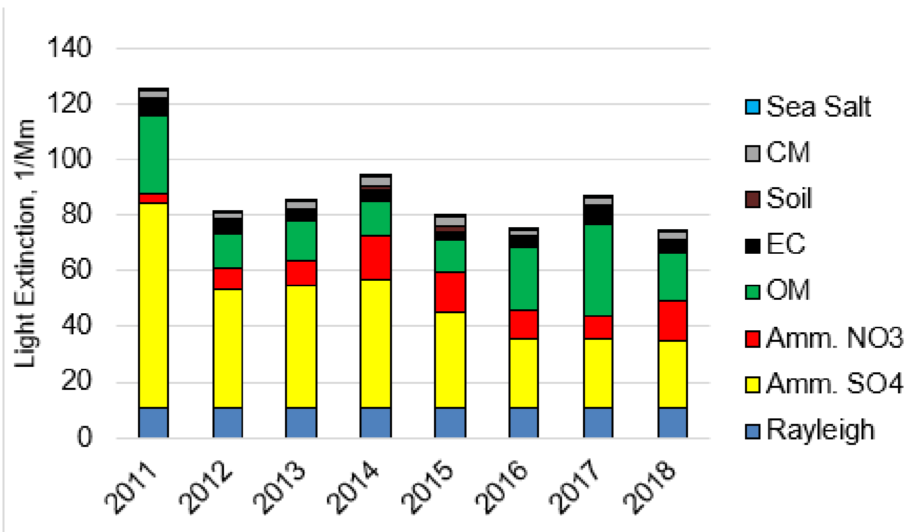
- Status of implementation of the control measures included in the original SIP;
- Summary of the emissions reductions achieved through the above-referenced control measures;
- Assessment of visibility conditions and changes for the Sipsey Wilderness Area;
- Analysis tracking the change over the past five years in emissions of pollutants contributing to visibility impairment from all sources and activities within Alabama;
- Assessment of any significant changes in anthropogenic emissions within the past five years that have limited or impeded progress in reducing pollutant emissions and improving visibility;
- An assessment of whether the current implementation plan elements and strategies are sufficient to enable the state, or other states with mandatory Federal Class I areas affected by emissions from the state, to meet all established RPGs; and
- A review of the state's visibility monitoring strategy and any modifications to the strategy as necessary.

Although future planning periods will focus on the most anthropogenically impaired ("most impaired") visibility days, the work completed in the first planning period and the development of the 2018 RPGs focused on the worst visibility days. In order to properly compare current conditions to the 2018 RPGs, this progress report includes visibility data for the 20% worst visibility days, in addition to visibility data for the 20% most impaired days as required by the Regional Haze Rule.

### 13.1.1. Alabama's Long-Term Strategy (LTS) for Visibility Improvement

In Sections 2.4 and 7.4 of Alabama's Regional Haze SIP, atmospheric ammonium sulfate was identified as the largest contributor to visibility impairment at Sipsey during the baseline period. Emissions sensitivity modeling performed for VISTAS determined that the most effective ways to reduce ammonium sulfate were to reduce $SO_2$ emissions from point sources. $SO_2$ reductions from point sources were therefore identified as the focus of Alabama's LTS for visibility improvement.

Figure 13-1 shows the speciated average light extinction at Sipsey and demonstrate that sulfates have continued to be a significant contributor to light extinction since submittal of the last progress report, although the relative contribution from sulfates is decreasing over time.



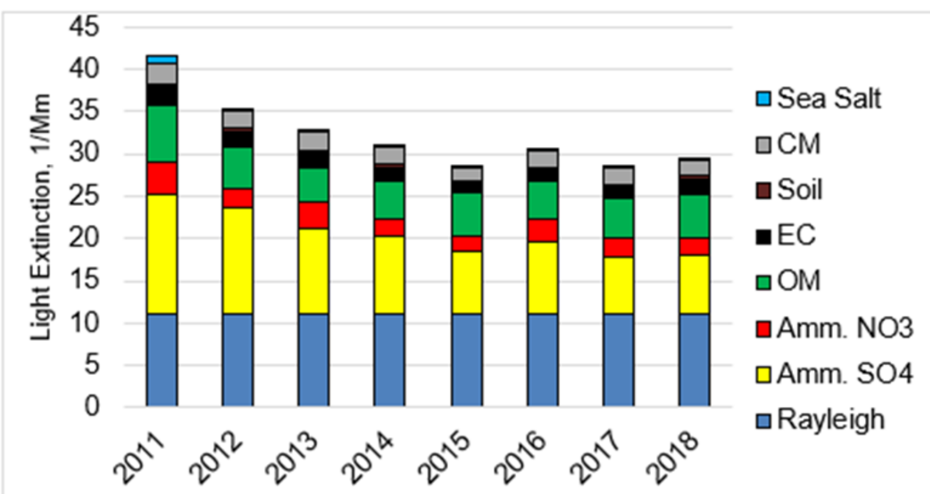




**Figure 13-1: Annual Average Light Extinction for the 20% Worst Visibility Days (top) and the 20% Clearest Visibility Days (bottom) at the Sipsey Wilderness Area**

#### 13.1.2. 2018 Reasonable Progress Goals (RPGs) for the Sipsey Wilderness Area

Table 13-1 and Table 13-2 show the 2018 RPGs for Sipsey on the 20% worst and 20% best visibility days, respectively. As seen in these tables, Sipsey has met the 2018 RPGs.

**Table 13-1: 2018 RPGs for Visibility Impairment at Sipsey on the 20% Worst Days**

| Class I Area | Baseline Average dv (2000-2004) | 2018 Average dv (2014-2018) | 2018 Goal (dv) | Natural Background (dv) |
|---|---|---|---|---|
| Sipsey W. A. | 28.99 | 20.66 | 23.53 | 10.99 |

**Table 13-2: 2018 RPGs for Visibility Impairment at Sipsey on the 20% Clearest Days***

| Class I Area | Baseline Average dv (2000-2004) | 2018 Average dv (2014-2018) | 2018 Goal (dv) | Natural Background (dv) |
|---|---|---|---|---|
| Sipsey W. A. | 15.57 | 10.75 | <15.57 | 5.03 |

*The regional haze requirement for the 20% clearest days is to maintain the visibility impairment at or below the baseline impairment.

### 13.2. Requirements for the Periodic Progress Report

The requirements for periodic reports are outlined in 40 CFR 51.308(g). Each state must submit a report to EPA every five years evaluating the progress towards the Reasonable Progress Goals (RPGs) for each Class I area located within the state and in each Class I area located outside the state which may be affected by emissions from within the state.

EPA's revised Regional Haze Rule no longer requires the progress report to be a formal SIP submittal. At a minimum, the progress report must cover the first year not covered by the previously submitted progress report through the most recent year of data available prior to submission. Alabama's previous progress report included data through the year 2010. Therefore, this Progress Report covers the period since 2010. For the purposes of this periodic review (included as part of this Regional Haze Plan revision), the most recent data available are used to highlight the progress made. This review includes NEI data through 2017, visibility data through 2018, and stationary source data through 2019. Section 51.308(f)(5) of the Regional Haze Rule requires that this regional haze plan revision address the progress report requirements of paragraphs 51.308(g)(1) through (5):

(1) A description of the status of implementation of all measures included in the SIP for achieving reasonable progress goals for Class I areas both within and outside the State.

(2) A summary of the emission reductions achieved throughout the State through implementation of the measures described in (1) above.

(3) For each Class I area within the State, the State must assess the following visibility conditions and changes, with values for most impaired and least impaired days expressed in terms of five-year averages of these annual values:

(i) The current visibility conditions for the most impaired and least impaired days;

(ii) The difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions;

(iii) The change in visibility impairment for the most impaired and least impaired days over the past five years;

(4) An analysis tracking the change over the past five years in emissions of pollutants contributing to visibility impairment from all sources and activities within the state. Emissions changes should be identified by type of source or activity. The analysis must be based on the most recently updated emissions inventory, with estimates projected forward as necessary and appropriate to account for emissions changes during the applicable five-year period.

(5) An assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred over the past five years that have limited or impeded progress in reducing pollutant emissions and improving visibility.

### 13.3. Status of Implementation of Control Measures

This section provides the status of implementation of the emission reduction measures that were included in the original Regional Haze SIP starting in the year 2014 to 2019, as required by 40 CFR 51.308(g)(1). These measures include federal programs, state requirements for EGUs, and State requirements for non-EGU point sources. As required by 40 CFR 51.308(g)(2), Alabama has estimated the $SO_2$ emissions reductions achieved through 2019 from measures implemented by the state. Where quantitative assessments of emission reductions are not available, a qualitative assessment is given.

This section also describes other strategies that were not included in the Regional Haze SIP. At the time of the best and final inventory development process, these measures were not fully documented or had not yet been published in final form, and therefore the benefits of these measures were not included in the 2018 inventory. Emission reductions from these measures have helped the Class I area meet the RPGs set in the Regional Haze SIP for 2018.

#### 13.3.1. Emissions Reduction Measures Included in the Regional Haze SIP

Alabama's Regional Haze SIP included the following types of measures for achieving reasonable progress goals:

- Federal programs

- State reasonable progress and BART control measures

These emissions reduction strategies were included as inputs to the VISTAS modeling. The current status of the implementation of these measures is summarized in the following paragraphs and an estimate of the $SO_2$ emissions reductions achieved is presented.

#### 13.3.1.1. Federal and Other State Programs

The emissions reductions associated with the Federal and other state programs that are described in the following paragraphs were included in the VISTAS future year emissions estimates for the first planning period. Descriptions contain qualitative assessments of emissions reductions associated with each program, and where possible, quantitative assessments. In cases where delays or modification have altered emissions reduction estimates such that the original estimates of emissions are no longer accurate, information is also provided on the effects of these alterations.

##### 13.3.1.1.1. Clean Air Interstate Rule

On May 12, 2005, EPA promulgated CAIR, which required reductions in emissions of $NO_X$ and $SO_2$ from large EGUs fired by fossil fuels. Due to court rulings, CAIR was remanded to EPA to revise elements that were deemed unacceptable and was ultimately replaced by CSAPR. This was later updated through the CSAPR Update rule.

However, at the time that the states were developing their regional haze plans, challenges to CSAPR had left CAIR in place until residual issues were decided by the D.C. Circuit and EPA had resolved implementation issues. Therefore, states included CAIR in the Regional Haze SIP. The 2018 projected emissions used in the regional haze analysis reflect a modified IPM solution based on the state’s best estimate of that year.

Although different than the CAIR solution projected in the regional haze analysis, CSAPR and the CSAPR Update have continued reductions from large EGUs.

##### 13.3.1.1.2. $NO_X$ SIP Call

Phase I of the $NO_X$ SIP Call was included in the Regional Haze SIP. This applies to certain EGUs and large non-EGUs, including large industrial boilers and turbines, and cement kilns. Those states affected by the $NO_X$ SIP call in the VISTAS region have developed rules for the control of $NO_X$ emissions that have been approved by the EPA. The $NO_X$ SIP Call has resulted in a significant reduction in $NO_X$ emissions from large stationary combustion sources. For the first Regional Haze SIP, the emissions for $NO_X$ SIP Call-affected sources were capped at 2007 levels and carried forward to the 2009 and 2018 inventories.

##### 13.3.1.1.3. Consent Agreements (TECO, VEPCO) and Gulf Power Crist 7 Voluntary Agreement

In April of 2011, the USEPA announced a settlement with the Tennessee Valley Authority (TVA) to resolve alleged Clean Air Act violations at 11 of its coal-fired plants in Alabama, Kentucky, and Tennessee. The settlement requires TVA to invest $3 billion to $5 billion on new and upgraded state-of-the-art pollution controls. Once fully implemented, the pollution controls and other required actions will address 92 percent of TVA's coal-fired power plant capacity, reducing emissions of NOX by 69 percent and SO2 by 67 percent from TVA's 2008 emissions levels.

Under a settlement agreement, Tampa Electric Company (TECO) converted units at the TECO Gannon Station Power Plant (now TECO Bayside Power Station) from coal to natural gas and installed permanent emissions-control equipment to meet stringent pollution limits.

Under a settlement agreement, Virginia Electric and Power Company (VEPCO) agreed to spend $1.2 billion by 2013 to eliminate 237,000 tons of SO2 and NOX emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia. In October 2007, American Electric Power (AEP) agreed to spend $4.6 billion dollars to eliminate 72,000 tons of $NO_x$ emissions each year by 2016 and 174,000 tons of SO2 emissions each year by 2018 from sixteen coal-fired power plants located in Indiana, Kentucky, Ohio, Virginia, and West Virginia.

Under a 2002 voluntary agreement, Gulf Power upgraded its operation to significantly cut NOX emissions at its Crist generating plant.

The consent agreements related to Tampa Electric Company, Virginia Electric and Power Company, Gulf Power, and American Electric Power were discussed on page v of the 2010 regional haze SIP.

#### 13.3.1.1.4. One-hour Ozone SIPs (Atlanta/Birmingham/Northern Kentucky)

The Regional Haze SIP also included emissions reductions from one-hour ozone SIPs submitted to EPA to demonstrate attainment of the one-hour ozone NAAQS. These SIPs require $NO_X$ reductions from specific coal-fired power plants and address transportation plans in these cities. These reductions further improve regional visibility.

#### 13.3.1.1.5. $NO_X$ RACT in 8-hour Nonattainment Area SIPs

The NCDAQ's SIP for the Charlotte / Rock Hill / Gastonia nonattainment area includes RACT for $NO_X$ for two facilities located in the nonattainment area: Philip Morris USA and Norandal USA. These controls were also modeled for 2018. Additional RACT controls may be realized as other companies subject to RACT complete the determination, but RACT-level controls were assumed for just these two sources. These controls further improve regional visibility.

#### 13.3.1.1.6. 2007 Heavy-Duty Highway Rule (40 CFR Part 86, Subpart P)

In this regulation, EPA set a PM emissions standard for new heavy-duty engines of 0.01 g/bhp-hr, which took full effect for diesel engines in the 2007 model year. This Rule also included standards for $NO_X$ and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These diesel engine $NO_X$ and NMHC standards were successfully phased in together between 2007 and 2010. The rule also required that sulfur in diesel fuel be reduced to facilitate the use of modern pollution-control technology on these trucks and buses. EPA required a 97%

reduction in the sulfur content of highway diesel fuel, from levels of 500 ppm (low sulfur diesel) to 15 ppm (ultra-low sulfur diesel). These requirements were successfully implemented on the timeline in the regulation. This program applies to all areas of the country, including Alabama, thus, more directly affecting the Alabama Class I area.

#### 13.3.1.1.7. Tier 2 Vehicle and Gasoline Sulfur Program (40 CFR Part 80 Subpart H; Part 85; Part 86)

EPA's Tier 2 fleet averaging program for onroad vehicles, modeled after the California Low Emission Vehicle (LEV) II standards, became effective in the 2005 model year. The Tier 2 program allows manufacturers to produce vehicles with emissions ranging from relatively dirty to very clean, but the mix of vehicles a manufacturer sells each year must have average $NO_X$ emissions below a specified value. Mobile emissions continue to be reduced by this program as motorists replace older, more polluting vehicles with cleaner vehicles. The Tier 2 program applies nationwide, including Alabama, and thus, has a more direct impact on Sipsey.

#### 13.3.1.1.8. Large Spark Ignition and Recreational Vehicle Rule

EPA has adopted new standards for emissions of $NO_X$, hydrocarbons (HC), and CO from several groups of previously unregulated non-road engines. Included in these are large industrial spark-ignition engines and recreational vehicles. Non-road spark-ignition engines are those powered by gasoline, liquid propane gas, or compressed natural gas rated over 19 kW (25 horsepower). These engines are used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Non-road recreational vehicles include snowmobiles, off-highway motorcycles, and all-terrain-vehicles. These rules were initially effective in 2004 and were fully phased in by 2012. These rules apply nationwide, including Alabama.

#### 13.3.1.1.9. Non-Road Mobile Diesel Emissions Program (40 CFR Part 89)

EPA adopted standards for emissions of $NO_X$, HC, and CO from several groups of non-road engines, including industrial spark-ignition engines and recreational non-road vehicles. Industrial spark-ignition engines power commercial and industrial applications and include forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Non-road recreational vehicles include snowmobiles, off-highway motorcycles, and all-terrain vehicles. These Rules were initially effective in 2004 and were fully phased in by 2012. Non-road mobile emissions continue to benefit from this program as motorists replace older, more polluting non-road vehicles with cleaner vehicles.

The non-road diesel rule set standards that reduced emissions by more than 90% from non-road diesel equipment and, beginning in 2007, the Rule reduced fuel sulfur levels by 99% from previous levels. The reduction in fuel sulfur levels applied to most non-road diesel fuel in 2010 and applied to fuel used in locomotives and marine vessels in 2012. This is a nationwide program and impacts Alabama sources.

#### 13.3.1.1.10. Maximum Achievable Control Technology Programs (40 CFR Part 63)

VISTAS applied controls to future year emissions estimates from various MACT regulations for VOC, $SO_2$, $NO_X$, and PM for source categories where controls were installed on or after 2002.

Table 13-3 describes the MACTs used as control strategies for the non-EGU point source emissions in the Regional Haze SIP. The table notes the pollutants for which controls were applied as well as the promulgation dates and the compliance dates for existing sources.

**Table 13-3: MACT Source Categories**

| MACT Source Category | 40CFR63 Subpart | Original Promulgation Date | Compliance Date (Existing Sources) | Pollutants Affected |
|---|---|---|---|---|
| Hazardous Waste Combustion (Phase I) | 63(EEE), 261 and 270 | 9/30/99 | 9/30/03 | PM |
| Portland Cement Manufacturing | LLL | 6/14/99 | 6/10/02 | PM |
| Secondary Aluminum Production | RRR | 3/23/00 | 3/24/03 | PM |
| Lime Manufacturing | AAAAA | 1/5/04 | 1/5/07 | PM, $SO_2$ |
| Taconite Iron Ore Processing | RRRRR | 10/30/03 | 10/30/06 | PM, $SO_2$ |
| Industrial Boilers, Institutional/Commercial Boilers and Process Heaters | DDDDD | 9/13/04 | 9/13/07 | PM, $SO_2$ |
| Reciprocating Internal Combustion Engines | ZZZZ | 6/15/04 | 6/15/07 | $NO_X$, VOC |
| Stationary Combustion Turbines | YYYY | 3/5/04 | 3/5/04 (oil-fired) 3/9/22 (gas-fired) | CO, VOC |

The Industrial/Commercial/Institutional (ICI) boiler MACT standard (40 CFR 63 Subpart DDDDD) was vacated by the U.S. Court of Appeals and remanded the regulation to EPA on June 8, 2007. VISTAS chose, however, to leave the emissions reductions associated with this regulation in place as the CAA required use of alternative control methodologies under Section 112(j) for uncontrolled source categories. The applied MACT control efficiencies were 4% for $SO_2$ and 40% for $PM_{10}$ and $PM_{2.5}$ to account for the co-benefit from installation of acid gas scrubbers and other control equipment to reduce HAPs.

EPA finalized the revised ICI Boiler MACT on March 21, 2011. EPA subsequently reconsidered certain aspects of the rule and proposed changes on December 2, 2011. The rules were re-promulgated on January 31, 2013. The final compliance date for ICI boilers at major sources was 2016, with the option to request an additional year. EPA's estimate of nationwide $SO_2$ emissions reductions from this rule is over 500,000 tons/year, as compared to an estimate of 113,000 tons/year in the analysis for the 2004 rule (78 FR 7138 and 69 FR 55218). On November 5, 2015, EPA finalized additional revisions to the Boiler MACT and projected that these updates would not significantly change the emissions reductions expected from the rule. It is, therefore, reasonable to conclude that the 2012 Rule has brought about more $SO_2$ reductions in Alabama than were modeled in Alabama's Regional Haze SIP.

#### 13.3.1.2. State EGU Control Measures

Emissions from EGUs have been regulated through state measures in North Carolina and Georgia, which were included in the regional haze SIP modeling. Reductions associated with these measures were used to estimate the 2018 visibility improvements at the VISTAS Class I areas.

##### 13.3.1.2.1. North Carolina Clean Smokestacks Act

In June of 2002, the North Carolina General Assembly enacted the Clean Smokestacks Act (CSA), which required significant actual emissions reductions from coal-fired power plants in North Carolina. Thes CSA was discussed on page v of the 2010 Regional Haze SIP. These reductions were included as part of the VISTAS 2018 Best and Final modeling effort. Under the CSA, power plants were required to reduce their $NO_X$ emissions by 77% in 2009 and their $SO_2$ emission by 73% in 2013. Actions taken to date by facilities subject to these requirements comply with the provisions of the CSA, and compliance plans and schedules will allow these entities to achieve the emissions limitations set out by the Act. This program has been highly successful. In 2009, regulated entities emitted less than the 2013 system annual cap of 250,000 tons of $SO_2$ and less than the 2009 system annual cap of 56,000 tons of $NO_X$. In 2002, the sources subject to CSA emitted 459,643 tons of $SO_2$ and 142,770 tons of $NO_X$. In 2011, these sources emitted only 73,454 tons of $SO_2$ and 39,284 tons of $NO_X$, well below the Act's system caps.

This legislation established annual caps on both $SO_2$ and $NO_X$ emissions for the two primary utility companies in North Carolina, Duke Energy and Progress Energy. Duke Energy and Progress Energy have produced emissions reductions beyond what was required which further improved regional visibility.

##### 13.3.1.2.2. Georgia Multi-Pollutant Control for Electric Utility Steam Generating Units

Georgia rule 391-3-1.02(2)(sss), enacted in 2007, requires flue-gas desulphurization (FGD) and SCR controls on large coal-fired EGUs in Georgia. Reductions from this regulation were included as part of the VISTAS 2018 Best and Final modeling effort. These controls reduced $SO_2$ emissions from the affected emissions units by at least 95% and reduced $NO_X$ emissions by approximately 85%. Control implementation dates vary by EGU, starting with December 31, 2008, and ending with December 31, 2015.

#### 13.3.1.3. Alabama Reasonable Progress and BART Control Measures

Alabama completed source-specific reasonable progress and BART determinations for all applicable sources during the first planning period. In total, Alabama identified 44 BART-eligible sources. Of those sources, 3 were given exemption status for VOCs, 4 sources took limits to be exempt from BART, 35 met the modeling exemption criteria and 2 performed BART determinations. Both facilities identified controls and/or limits for the subject to BART units, and those controls and/or limits were subsequently incorporated into the SIP for the first planning period. Since that time, one of the facilities, the International Paper- Courtland Mill has ceased operation, and several units at the other facility, Solutia, Inc- Decatur have similarly shut down. For reasonable further progress, 6 units at 3 facilities were identified for review based on VISTAS' analyses. Of the 3 facilities, two were also BART sources that completed a BART demonstration (equivalent to a reasonable progress determination), and the other facility's 4-factor analysis yielded no additional control.

Table 13-4 lists the three facilities that had units for which a reasonable progress determination was completed made and the current status. All facilities that were required to implement reasonable progress controls or measures have met their compliance dates. The table compares the modeled 2018 $SO_2$ emissions to the actual 2018 emissions for these sources. The 2019 emissions are also available and have been included in the table.

Table 13-5 lists the two sources for which a BART review was completed. Sources that were exempt from BART analysis, via modeling, emissions limitation or VOC exclusion, are not listed in the table. Again, the actual 2018 emissions for these sources are compared to the emission reductions estimated in the previous progress report.

**Table 13-4: Current Status of Alabama's Reasonable Progress Sources from the First Implementation Period**

| Plant Name | Unit ID | Current Status of Controls/Reductions | Met Compliance Date? | BART-Eligible? | Modeled 2018 $SO_2$ Emissions* (tpy) | Actual 2018 $SO_2$ Emissions (tpy) | Actual 2019 $SO_2$ Emissions** (tpy) |
|---|---|---|---|---|---|---|---|
| International Paper-Courtland Mill | 006 | Facility ceased operation (2017) | N | Y | 1238 | 0 | 0 |
| | | | | | | | |
| Solutia-Decatur Plant** | 009 | Coker Boilers 1 & 2 | Y | Y | 2244 | 1300 | 901 |
| | 013 | Boiler 5 | Y | Y | 1673 | 0 | 0 |
| | 014 | Boiler 6 | Y | Y | 1610 | 134 | 116 |
| | 015 | Boiler 7 | Y | Y | 1849 | 2 | 2 |
| | | | | | | | |
| Cargill | 020 | No controls identified | N/A | N | 1101 | 0.2 | 0.19 |

***Base G emissions**
**** Boilers 5, 6 & the Cokers (009) have all ceased operation as of 2022. Boiler 7 is natural gas fired only.**

**Table 13-5: Current Status of Alabama's BART Sources from the First Implementation Period**

| Plant Name | Unit ID | Current Status of Controls/Reductions | Met Compliance Date? | Modeled 2018 $SO_2$ Emissions* (tpy) | Actual 2018 $SO_2$ Emissions (tpy) | Actual 2019 $SO_2$ Emissions** (tpy) |
|---|---|---|---|---|---|---|
| International Paper- Courtland Mill | 006 | Facility ceased operation (2017) | N | 1238 | 0 | 0 |
| | | | | | | |
| Solutia- Decatur Plant | 009 | Coker Boilers 1 & 2 | Y | 2244 | 1300 | 901 |
| | 013 | Boiler 5 | Y | 1673 | 0 | 0 |
| | 014 | Boiler 6 | Y | 1610 | 134 | 116 |
| | 015 | Boiler 7 | Y | 1849 | 2 | 2 |

***Base G emissions**
**** Boilers 5, 6 & the Cokers (009) have all ceased operation as of 2022. Boiler 7 is natural gas fired only.**

### 13.3.2. Emission Reduction Measures Not Included in the Regional Haze SIP

A number of regulations and requirements have been promulgated that were not included in Alabama's original SIP submittal. These measures provided additional emission reductions to allow VISTAS Class I areas to meet their reasonable progress goals.

- The International Maritime Organization has strengthened the standards for sulfur in marine fuel (discussed in Section 7.2.1.4.4).
- New source performance standards (NSPS) for stationary compression ignition internal combustion engines and stationary spark ignition internal combustion engines, contained in 40 CFR Part 60 Subpart IIII and Subpart JJJJ, respectively, have generated a significant decrease in $NO_X$ emissions from these sources.
- EPA's Mercury and Air Toxics Standards (discussed in Section 7.2.1.2) and the 2010 $SO_2$ NAAQS (discussed in Section 7.2.1.3) have further reduced emissions from EGUs.
- A 2007 agreement called for the Dupont James River plant, located in Virginia, to install dual absorption pollution control equipment by September 1, 2009, resulting in emission reductions of approximately 1,000 tons of SO2 annually.
- A 2004 agreement called for Stone Container, located in West Point, Virginia, to control SO2 emissions from the #8 Power Boiler with a wet scrubber. This device was installed and operational in October of 2007, resulting in emission reduction of approximately 3,000 tons of SO2 annually.
- The Maryland Healthy Air Act (HAA) regulations became effective on July 16, 2007, and required reductions in NOX, SO2, and mercury emissions from large coal burning power plants in Maryland. Emission reductions from the HAA come in two phases. The first phase required reductions in the 2009/2010 timeframe, and compared to a 2002 emission baseline, reduced NOx emissions by almost 70 percent and SO2 emission by 80 percent. The second phase of emissions controls occurs in the 2012/2013 time frame. At full implementation, the HAA will reduce NOX emissions by approximately 75 percent from 2002 levels and SO2 emissions by approximately 85 percent from 2002 levels. Maryland is not a VISTAS participant. However, Maryland borders two VISTAS states, and Maryland facilities have calculated sulfate visibility impairment contributions to several VISTAS Class I areas. Reductions associated with this program were included as part of the VISTAS 2018 Round 1 Best and Final modeling effort

## 13.4. Visibility Conditions

40 CFR 51.308(g)(3) requires the state to assess the visibility conditions for the most impaired and least impaired days expressed in terms of five-year averages. The visibility conditions that must be reviewed include: (1) the current visibility conditions; (2) the difference between current visibility conditions compared to the baseline; and (3) the change in visibility impairment for the most and least impaired days over the past five years.

Table 13-6 and 13-7 show the current visibility conditions and the difference between the current visibility and the baseline condition expressed in terms of five-year averages of observed visibility impairment for the 20% worst days and the 20% best days, respectively. The baseline conditions are for 2000 through 2004 and the current conditions are for 2014 through 2018. Because the reasonable progress goals (RPGs) in the first planning period were calculated for the 20% worst days, the table includes a comparison of the baseline average and current average for the 20% worst days.

The data shows that the Sipsey Wilderness Class I area saw an improvement in visibility on the 20% worst days, the 20% most impaired days, and on the 20% best days. The current observed 5-year average values for Sipsey on the 20% worst days are below the 2018 goal. On the 20% best days, the current observed 5-year average values for Sipsey are below the 2018 goal of no degradation.

| Class I Area | Baseline Average dv (2000-2004) | Current Average, dv (2014-2018) | Change, current – baseline, (dv) | 2018 Goal (dv) | Difference, current – goal, (dv) |
|---|---|---|---|---|---|
| Sipsey W.A. | 28.99 | 20.66 | -8.83 | 23.53 | -2.87 |

**Table 13-6: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Worst Days at the Sipsey Wilderness Area**

| Class I Area | Baseline Average dv (2000-2004) | Current Average, dv (2014-2018) | Change, current – baseline, (dv) | 2018 Goal (dv) | Difference, current – goal, (dv) |
|---|---|---|---|---|---|
| Sipsey W.A. | 15.57 | 10.76 | -4.81 | <15.57 | -4.81 |

**Table 13-7: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Best Days at the Sipsey Wilderness Area**

The previous progress report covered visibility through 2013. Table 13-8 through 13-10 display the change in visibility impairment for the 20% worst, 20% most impaired days, and 20% clearest days since 2014 through 2018. The data shows that Sipsey saw an improvement in visibility on the 20% worst and 20% clearest days during the period.

| Class I Area | 2010-2014 | 2011-2015 | 2012-2016 | 2013-2017 | 2014-2018 |
|---|---|---|---|---|---|
| Sipsey W.A. | 22.67 | 22.07 | 20.95 | 20.94 | 20.66 |

**Table 13-8: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Worst Days at the Sipsey Wilderness Area**

| Class I Area | 2010-2014 | 2011-2015 | 2012-2016 | 2013-2017 | 2014-2018 |
|---|---|---|---|---|---|
| Sipsey W.A. | 21.48 dv | 20.81 dv | 19.77 dv | 19.35 dv | 19.03 dv |

**Table 13-9: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Most Impaired Days at the Sipsey Wilderness Area**

| Class I Area | 2010-2014 | 2011-2015 | 2012-2016 | 2013-2017 | 2014-2018 |
|---|---|---|---|---|---|
| Sipsey W.A. | 12.71 | 11.97 | 11.37 | 10.94 | 10.75 |

**Table 13-10: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Clearest Days at the Sipsey Wilderness Area**

Figure 13-2 and 13-3 display the data listed in Table 13-6 and Table 13-10 for the 20% worst days, 20% most impaired and the 20% best days, as well as the URP towards natural background for the 20% worst days. The URP and 2018 RPGs in the first implementation period were based on the

20% worst days; therefore, the figures below continue to look at the 20% worst days. Figures 7-9, in Section 7 of this report shows the URP and observed visibility impairment for the 20% most impaired days.

Figure 13-2 shows the observed five-year average impairment values for the 20% worst days at Sipsey, as well as the associated glide slope and the predicted impairment from the Regional Haze SIP. The 2018 RPG is included in the graph. The observed five-year average impairment for 2018 is below both the glide path and the predicted impairment.

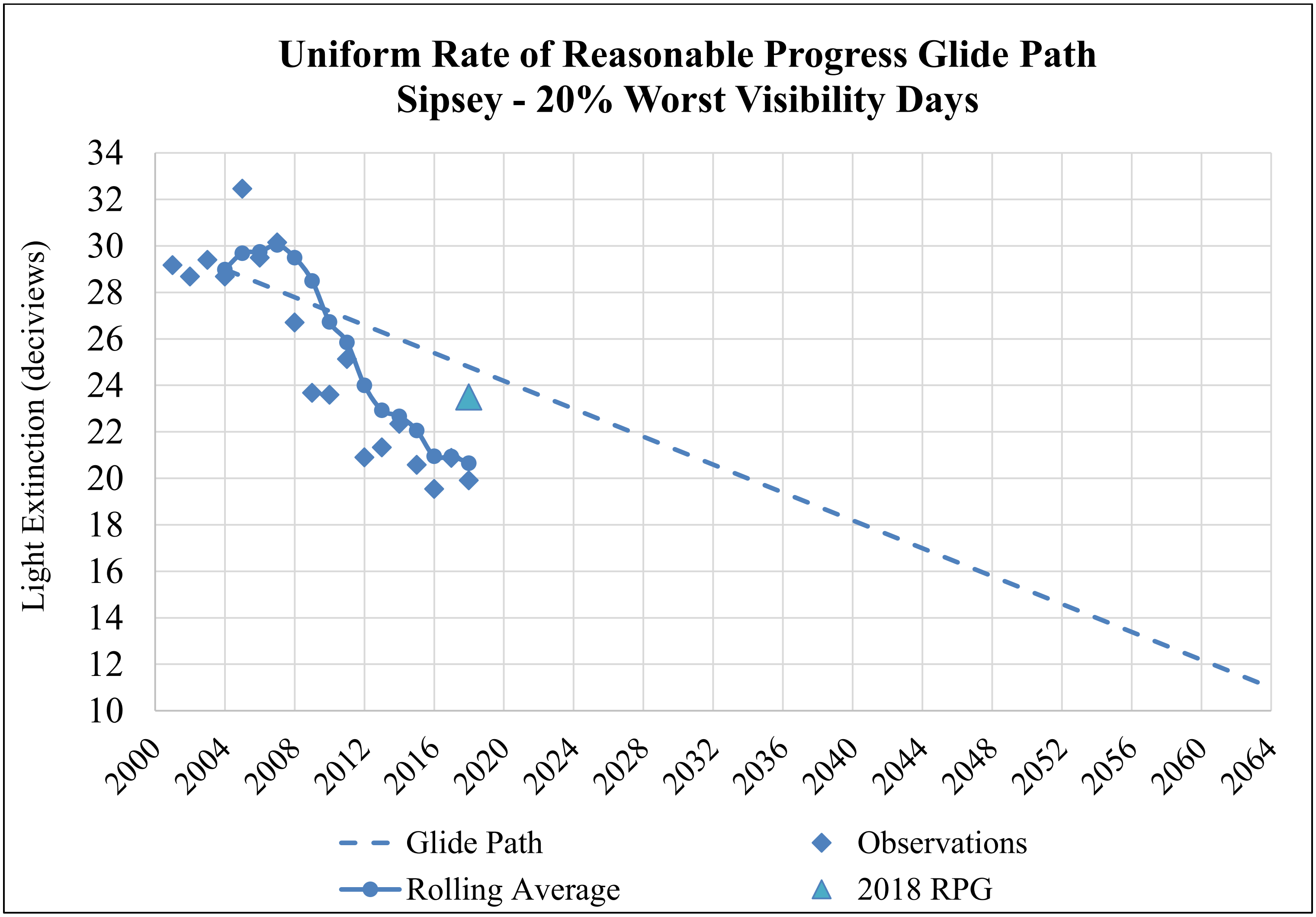



**Figure 13-2: Sipsey Visibility Impairment on the 20% Worst Visibility Days, Glide Path, and 2018 RPG**

Figure 13-3 shows the observed five-year average impairment values for the 20% clearest days at Sipsey, as well as the predicted impairment from the Regional Haze SIP. The observed five-year average impairment for the 20% best days of 2018 is below both the baseline and the predicted impairment.

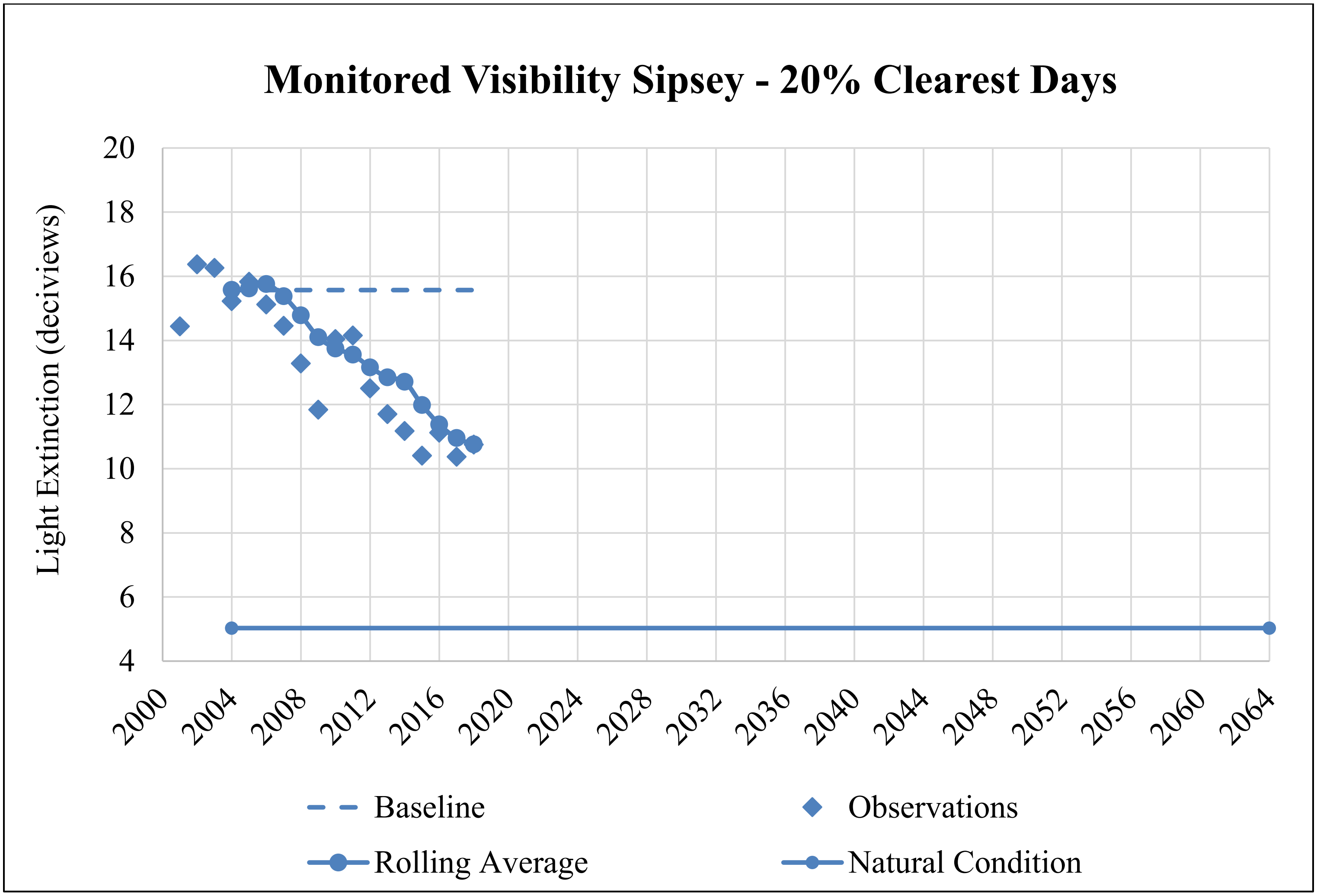



**Figure 13-3: Sipsey Visibility Impairment on the 20% Clearest Days and Natural Conditions**

## 13.5. Emissions Analysis

This section includes an analysis tracking the change since 2013 in emissions of pollutants contributing to visibility impairment from all sources and activities within the state, as required by 40 CFR 51.308(g)(4). Because $SO_2$ was the significant pollutant contributing to visibility impairment during the first implementation period, the emissions analysis will focus mostly on $SO_2$ emissions. This section also includes an assessment of changes in anthropogenic emissions since 2013, as required by 40 CFR 51.308(g)(5).

### 13.5.1. Change in $PM_{2.5}$, $NO_X$, and $SO_{2\text{-}160}$ Emissions from All Source Categories

There are six emissions inventory source categories: stationary point, area (non-point), non-road mobile, onroad mobile, fires, and biogenic sources.

- Stationary point sources are those sources that emit greater than a specified tonnage per year, with data provided at the facility level. Electricity generating utilities and industrial sources are the major categories for stationary point sources.

- Stationary area sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source category could be significant. These types of emissions are estimated on a countywide level.

- Non-road mobile sources are equipment that can move, but do not use the roadways (i.e., lawn mowers, construction equipment, marine vessels, railroad locomotives, aircraft). The emissions from these sources, like stationary area sources, are estimated on a countywide level.

- Onroad mobile sources are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type and are summed to the countywide level.

- Fire emissions include prescribed fire and wildfire emissions and can be summed to a countywide level or reported as a point source.

- Biogenic sources are natural sources like trees, crops, grasses and natural decay of plants. The biogenic emissions are not included in this review since they were held constant as part of the original regional haze SIP modeling and are not controllable emissions.

For the purpose of evaluating recent emissions changes and progress, Alabama used the 2014 NEI, the 2017 NEI, and the state Annual Operating Report point source data collected each year. When available, data after 2017 is also used. For comparison purposes, the tables below include the 2018 emissions projected by VISTAS in the first Regional Haze SIP.

Table 13-11 shows how $PM_{2.5}$ emissions for each source category have changed. The table also includes the VISTAS 2018 emissions projections developed in the first planning period for comparison. Compared to the VISTAS 2018 emissions projections, $PM_{2.5}$ emissions were higher in the 2017 NEI for the onroad category. However, the overall $PM_{2.5}$ emissions across all categories in the 2017 NEI are 27% lower than what VISTAS projected for 2018.

| $PM_{2.5}$ Sector | NEI 2014 (tpy) | NEI 2017 (tpy) | VISTAS 2018G4 (tpy) |
|---|---|---|---|
| Point | 18,970 | 14,388 | 27,352 |
| Area | 92,398 | 44,247 | 62,323 |
| Onroad | 3,919 | 2,652 | 1,192 |
| Non-Road | 1,985 | 1,535 | 2,835 |
| Fires | 69,117 | 39,427 | 46,608 |
| **Total** | **186,389** | **102,250** | **140,310** |

**Table 13-11: $PM_{2.5}$ Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories**

$NO_X$ emissions, as can be seen in Table 13-12 below, have significantly decreased in each source category except for the onroad category. The 2017 NEI emissions for the onroad category is higher than the 2018 projected emissions. However, the overall $NO_X$ emissions from all categories for 2017 are approximately 18% lower than the 2018 projections.

| $NO_X$ Sector | NEI 2014 (tpy) | NEI 2017 (tpy) | VISTAS 2018G4 (tpy) |
|---|---|---|---|
| Point | 113,510 | 79,678 | 142,318 |
| Area | 52,100 | 22,074 | 25,028 |
| Onroad | 129,445 | 94,853 | 47,298 |
| Non-Road | 19,132 | 16,332 | 43,799 |
| Fires | 16,472 | 8,878 | 11,918 |
| **Total** | **330,659** | **221,815** | **270,361** |

**Table 13-12: $NO_X$ Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories**

For $SO_2$ emissions, as seen in Table 13-13, point sources show the most significant decrease since 2014, and actual emissions from point sources are already 78% lower than the projected 2018 emissions. This is largely due to a significant reduction in oil use and a shift to natural gas, as well as installation of control measures from EPA rules such as MATS and the Data Requirements Rule. Overall, $SO_2$ emissions across all categories for 2017 are 80% below the 2018 projections.

| $SO_2$ Sector | NEI 2014 (tpy) | NEI 2017 (tpy) | VISTAS 2018G4 (tpy) |
|---|---|---|---|
| Point | 173,640 | 53,788 | 239,154 |
| Area | 19,473 | 816 | 50,264 |
| Onroad | 724 | 725 | 720 |
| Non-Road | 48 | 34 | 2,818 |
| Fires | 7,532 | 4,156 | 2,686 |
| **Total** | **201,418** | **59,519** | **295,642** |

**Table 13-13: Alabama $SO_2$ Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories**

Actual emissions reductions from the EGU sector have continued to decrease significantly due to installation of scrubbers and other controls on some of the larger power generation sources in Alabama. Repowering or shifting to natural gas, as well as some reduced utilization of coal EGUs and increased utilization of natural gas EGUs and renewable energy has also significantly reduced emissions of $SO_2$. Table 13-14 provides the CAMD emissions from 2014 to 2019.

| $SO_2$ Emissions | 2014 (tpy) | 2015 (tpy) | 2016 (tpy) | 2017 (tpy) | 2018 (tpy) | 2019 (tpy) |
|---|---|---|---|---|---|---|
| CAMD | 119,897.65 | 97,765.21 | 25,034.17 | 10,477.68 | 12,023.16 | 6,419.58 |

**Table 13-14: Alabama EGU $SO_2$ Emissions from CAMD (2014-2019)**

Figure 13-4 below depicts the trends for units that report annual emissions to CAMD, and which are located in Alabama. Since 2014, heat input has remained fairly steady with a decrease of about 5% over this period.

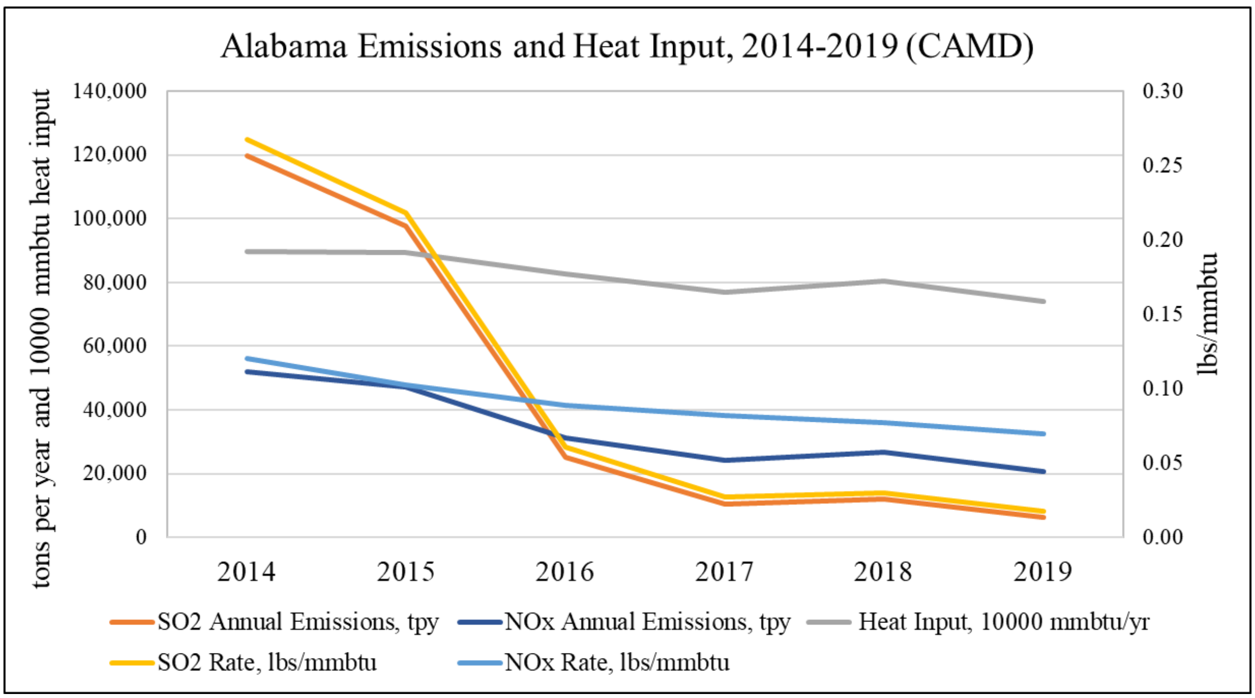



**Figure 13-4: Alabama CAMD Emissions and Heat Input Data *(Source: EPA CAMD Database)***

The $SO_2$ emissions from these units decreased from 119,897.65 tons annually in 2014 to 6,419.58 tons annually in 2019, a decrease of 95%. The average $SO_2$ emission rate from these units decreased from 0.120 lbs/mmbtu in 2014 to 0.022 lbs/mmbtu in 2019, a decrease of 82%. The reductions in emissions are not attributable to reduced demand for power. Instead, the significant emission reductions are attributable to the overall emissions rate decrease that is due to the installation of controls and the use of cleaner burning fuels. Over the same period, $NO_X$ emissions decreased from 51,850 tpy to 20,571 tpy, a drop of 60%.

Figure 13-5 shows the trends for units reporting to CAMD across all VISTAS states.

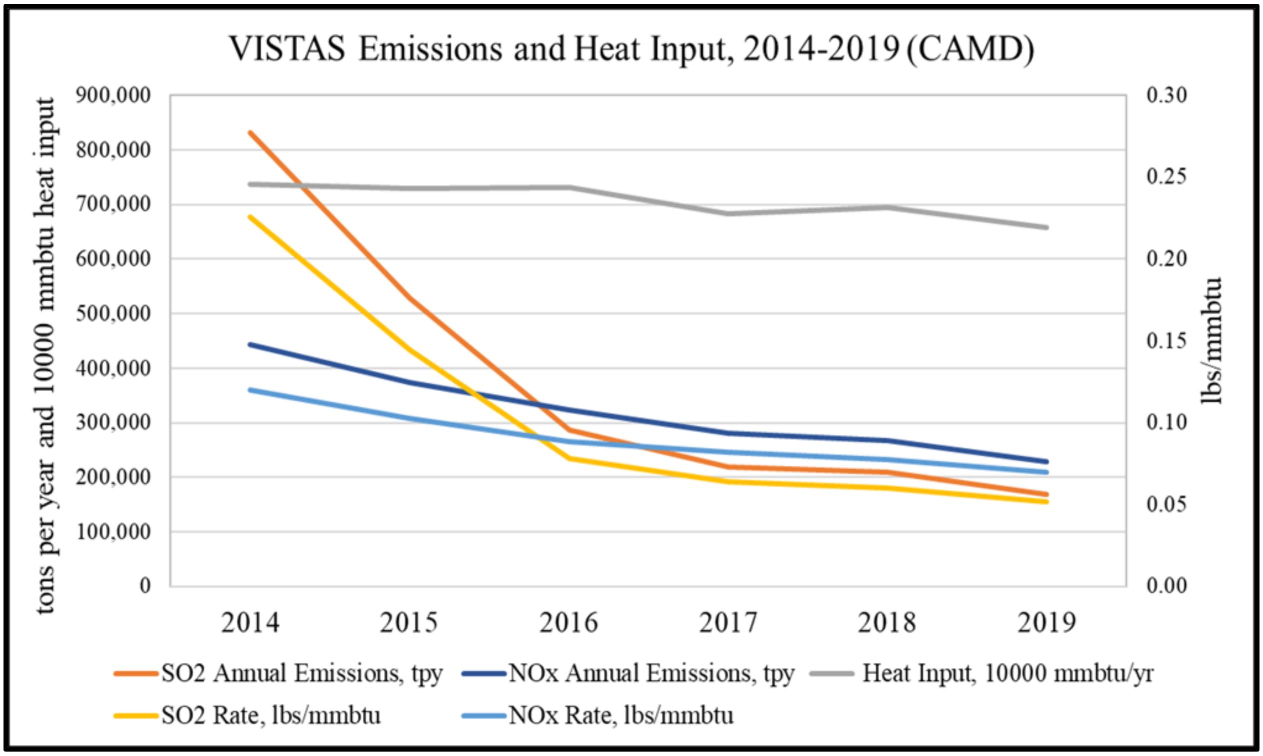



**Figure 13-5: VISTAS CAMD Emissions and Heat Input Data** ***(source: EPA CAMD Database)***

Between 2014 and 2019, heat input to these units decreased approximately 11%. However, emissions from these units and the emission rates decreased significantly more than this. $SO_2$ emissions decreased from 831,079 to 169,013 tons annually, a decrease of 80%. The average $SO_2$ emission rate from these units decreased from 0.225 lb/mmbtu in 2014 to 0.051 lb/mmbtu in 2019, a decrease of 77%. Additional controls installed on certain units to meet the stringent requirements of MATS has further reduced the emission rates of those units. Over the same period, $NO_X$ emissions decreased from 442,412 tpy to 228,673 tpy, a drop of 48%.

The figures above reflect the fact that the reductions in $SO_2$ and $NO_X$ are generally a result of permanent changes at EGUs through the use of control technology and fuel switching, not reductions in heat input. Thus, visibility improvements from reduced sulfate and nitrate contribution should continue into the future even if demand for power and heat input to these units may have moderate increases. In addition, market forces on coal EGUs have shifted these units from baseload operations to load following operations with increased usage of natural gas and renewable energy sources for electricity production.

### 13.5.2. Assessments of Changes in Anthropogenic Emissions

Pursuant to 40 CFR 51.308(g)(5), there does not appear to be any significant change in anthropogenic emissions within Alabama or outside the State that have occurred since the period addressed in the most recent plan that would limit or impede progress in reducing pollutant emissions or improving visibility. These changes in anthropogenic emission were anticipated in that most recent plan. In particular, $SO_2$ emissions from point sources have significantly decreased since 2014. There have also been decreases in emissions of NOx and $PM_{2.5}$ since 2014. As stated in Section 2.6, the IMPROVE monitoring data for 2014-2018 for the 20% most impaired days shows that sulfate continues to be the predominant visibility impairing pollutant

## 13.6. Conclusion

This progress report documents that all control measures outlined in Alabama's Regional Haze SIP have been implemented and Alabama has met all RPGs projected for 2018. Reductions in $SO_2$ emissions have been significant and greater than VISTAS projected. In spite of significant reductions in $SO_2$, sulfates continue to play a significant role in visibility impairment, especially for the most anthropogenically impaired days. As $SO_2$ emissions continue to drop in future planning periods, nitrates may have a larger relative impact on regional haze.  This is expected to be addressed in the 2038 SIP.