Proposed Regional Haze

State Implementation Plan

For

South Carolina Class I Federal Areas

Prepared by
South Carolina Department of Health and Environmental Control
Bureau of Air Quality

November 26, 2021

Executive Summary

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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 South Carolina Department of Health and Environmental Control (Department), has developed a proposed State Implementation Plan (SIP) revision to address regional haze. The 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 in South Carolina's designated Class I area (Cape Romain). To develop this proposed SIP revision, the state has relied heavily on the work of the Southeast regional planning group VISTAS (Visibility Improvement States 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 requirements 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. These data and analyses produced by VISTAS form the technical basis for South Carolina'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 (or their representatives) from the National Park Service, the Fish and Wildlife Service, and the Forest Service, industry representatives, and third-party groups.

South Carolina'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, "Regional Haze State Implementation Plan for South Carolina Class I Federal Areas" and 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 South Carolina-specific and which are VISTAS-wide).

The primary elements of the South Carolina regional haze SIP include:

1. Baseline, Current, and Natural Visibility Conditions – South Carolina calculated the baseline visibility conditions (2000-2004), current visibility conditions (2014-2018), and natural visibility conditions for the 20% most impaired and 20% clearest days in each Class I area in deciviews (dv):

Class I Areas	Baseline Clearest 20%	Baseline Most Impaired 20%	Current Clearest 20%	Current Most Impaired 20%	Natural Clearest 20%	Natural Most Impaired 20%
Cape Romain Wilderness Area	14.29 dv	25.25 dv	11.80 dv	17.67 dv	5.93 dv	9.79 dv

South Carolina 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:

Class I Areas	Current minus Baseline - Clearest 20%	Current minus Baseline - Most Impaired 20%	Natural minus Current - Clearest 20%	Natural minus Current - Most Impaired 20%
Cape Romain Wilderness Area	-2.49	-7.58	-5.87	-7.88

2. 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 a VISTAS analysis, the Department has focused its response to reasonable progress on sulfur dioxide (SO_2) emissions from large EGU and non-EGU point sources. Based on criteria to identify, from among these sources, those that are most affecting visibility in Class I areas, four facilities in South Carolina and four facilities outside South Carolina (two in Georgia, one in Ohio, and one in Pennsylvania) were selected for review.

The four selected facilities in South Carolina demonstrated that the applicable units are effectively controlled. Therefore, there is a low likelihood that cost-effective technological advancements exist that could provide further reasonable emission reductions for these sources.

3. Long-Term Strategy for Regional Haze – South Carolina has developed a long-term strategy 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; South Carolina'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.

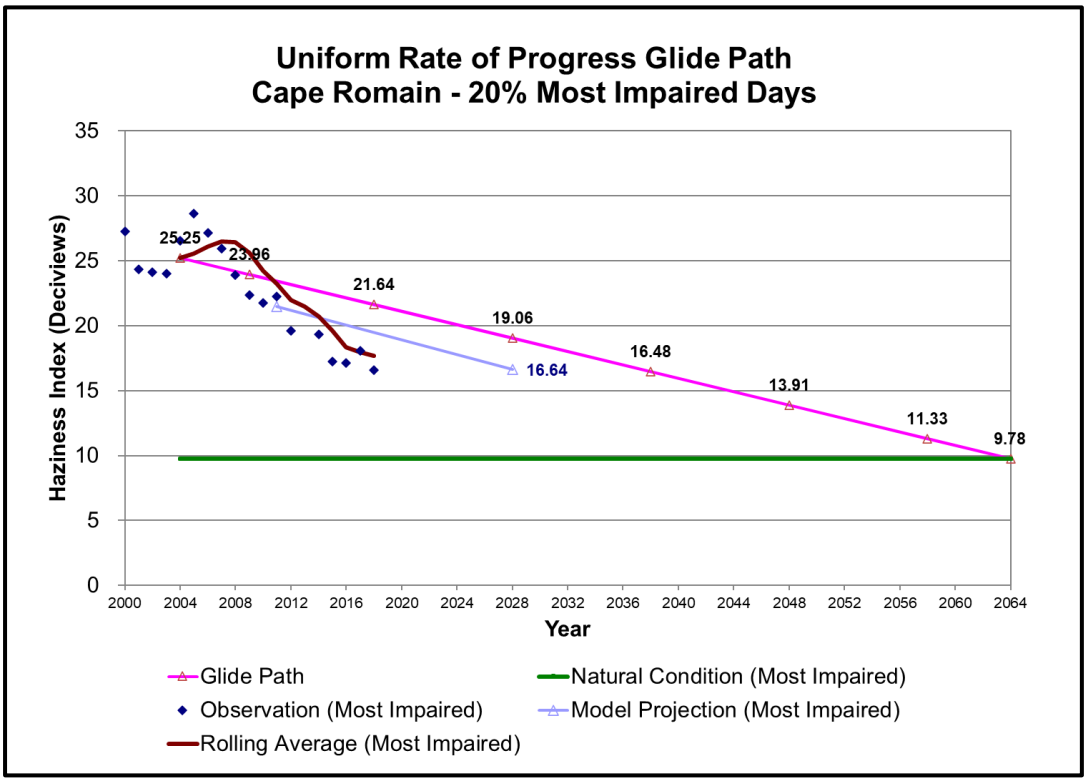
4. Reasonable Progress Goals – The state is required to set reasonable progress goals (RPGs) in units of deciviews applicable for 2028. These goals represent the progress (visibility improvement) expected as a result of implementation of the long-range plan presented in this regional haze SIP. Two goals are set for Cape Romain, one for the 20% most impaired days and one for the 20% clearest days (all numbers in deciviews):

Class I Areas	Baseline Clearest 20%	Baseline Most Impaired 20%	Natural Clearest 20%	Natural Most Impaired 20%	2028 RPG Clearest 20%	2028 RPG Most Impaired 20%
Cape Romain Wilderness Area	14.29 dv	25.25 dv	5.93 dv	9.79 dv	11.42	16.64

These goals are based upon predicted visibility response 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 air quality 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 vs. predicted visibility improvement for the 20% most impaired days for Cape Romain, and compares these to the Uniform Rate of Progress, the line which connects baseline visibility conditions in 2000-2004 to natural visibility conditions in 2064.



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

5. Progress Report – So that this plan revision will also serve as a progress report, South Carolina has also addressed the progress report requirements of 40 CFR 51.308(g)(1) through (5), covering the period since the most recent progress report.

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

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E-6	Future Year Model Projections Task 9a September 23, 2020 VISTAS Task 9 GLIDESLOPE_20200923v2.pdf APP_A_ag_v6_40.2028elv5.vistas_12_SESARM (4 Sept 2020).xlsx APP_B_StackedBarCharts.xlsx APP_C_SESARM_2028elv5_URP_20200903.xlsx (Spreadsheets only available in electronic format and upon request.)
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List of 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
CEM	continuous emissions monitoring
CenSARA	Central State Air Resource Agencies
CFR	Code of Federal Regulations
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
CWT	concentration weighted trajectory
d	distance (kilometers)
DHEC	South Carolina Department of Health and Environmental Control
DSI	dry sorbent injection
dv	deciview
EC	elemental carbon
EGU	Electric Utility 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
FDDA	four dimensional data assimilation
FGD	flue gas desulfurization

Acronym/Abbreviation	Meaning
FIA	Forest Inventory and Analysis
FLM	federal land manager
FR	Federal Register
FS	Forest Service
FSL	Forecast Systems Laboratory
FWS	Fish and Wildlife Service
g/bhp-hr	grams per brake horsepower-hour
HAP	hazardous air pollutant
HC	hydrocarbons
H_2SO_4	hydrogen sulfate
HMS	Hazard Mapping System
HNH_4SO_4	ammonium bisulfate
HYSPLIT	Hybrid Single Particle Lagrangian Integration Trajectory Model
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
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
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

Acronym/Abbreviation	Meaning
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
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
PSAT	Particulate Matter Source Apportionment Technology
PTE	potential to emit
Q	in Q/d, the emissions in tons per year
RACT	reasonably available control technology
RBLC	EPA's RACT/BACT/LAER Clearinghouse
RFG	reformulated gasoline
RPG	reasonable progress goal
RPO	regional planning organization
RRF	relative reduction factor
RT	residence time
SCC	source category code
SCR	selective catalytic reduction
SDA	spray dryer absorber system
SIP	state implementation plan
SMAT-CE	EPA Software for Model Attainment Test – Community Edition
SMOKE	Sparse Matrix Operator Kernel Emissions model
SO_2	sulfur dioxide
SO_4^{-2}	sulfate ion
SOAP	secondary organic aerosol partitioning
TAF	Terminal Area Forecast System
TDF	Tire-derived fuel

Acronym/Abbreviation	Meaning
TECO	Tampa Electric Company
tpy	tons per year
TRS	Total Reduced Sulfur
ULSD	Ultra-Low Sulfur Diesel
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
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 of what is seen. 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 of our 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 manmade sources. Fine particles 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 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) ($PM_{2.5}$). 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, onroad, and non-road engine emissions; stationary non-combustion emissions (area sources); wildfires and prescribed burning emission; 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, the 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 the 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 the 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, the 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 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 the visibility issue. These five RPOs are illustrated in Figure 1-1.[2] The Southeastern States Air Resource Managers, Inc. (SESARM) has been designated by the EPA as the entity responsible for coordinating regional haze evaluations for the 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 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 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(d) requires all states to submit a SIP for regional haze. Paragraph 51.308(f) of the regional haze rule requires each state to periodically revise and submit revisions to its regional haze SIP. 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 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 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 20% clearest days is to ensure that no degradation from the baseline (2000-2004) occurs. For 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 (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. The long-term strategy 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 long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures as necessary to make reasonable progress. Section 169B 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 long-term strategy upon which it bases the RPGs for each Class I area. States are also required to consider the following additional factors in developing their long-term strategies: 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 long-term strategy (40 CFR 51.308(f)(2)).

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

States must include a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment data that is representative of all mandatory federal Class I 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 long-term strategies for visibility improvement to the end of the second planning period (2028). States are required to evaluate progress toward meeting RPGs every five years to assure that emissions controls are on track with emissions reduction forecasts in each SIP. On January 10, 2017, the 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 the EPA by January 31, 2025. If emissions controls are not on track to ensure reasonable progress, then states would need to take action to assure emissions controls by 2028 will be consistent with the SIP or to revise the SIP to be consistent with the revised emissions forecast (40 CFR 51.308(f) and 40 CFR 51.308(g)).

The 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)

1.4. Mandatory Federal Class I Area in South Carolina

South Carolina has one Class I Federal area within its borders: Cape Romain Wilderness Area (Cape Romain), also may be referenced as Cape Romain National Wildlife Refuge. The South Carolina Department of Health and Environmental Control (Department) Bureau of Air Quality is responsible for developing South Carolina's Regional Haze SIP. This SIP establishes reasonable progress goals for visibility improvement at each of these mandatory federal Class I areas and a long-term strategy that will achieve those reasonable progress goals within the second regional haze planning period. The Class I Area for South Carolina is described at 40 CFR 81.426 and South Carolina's Class I impact area is shown in Figure 1-2.

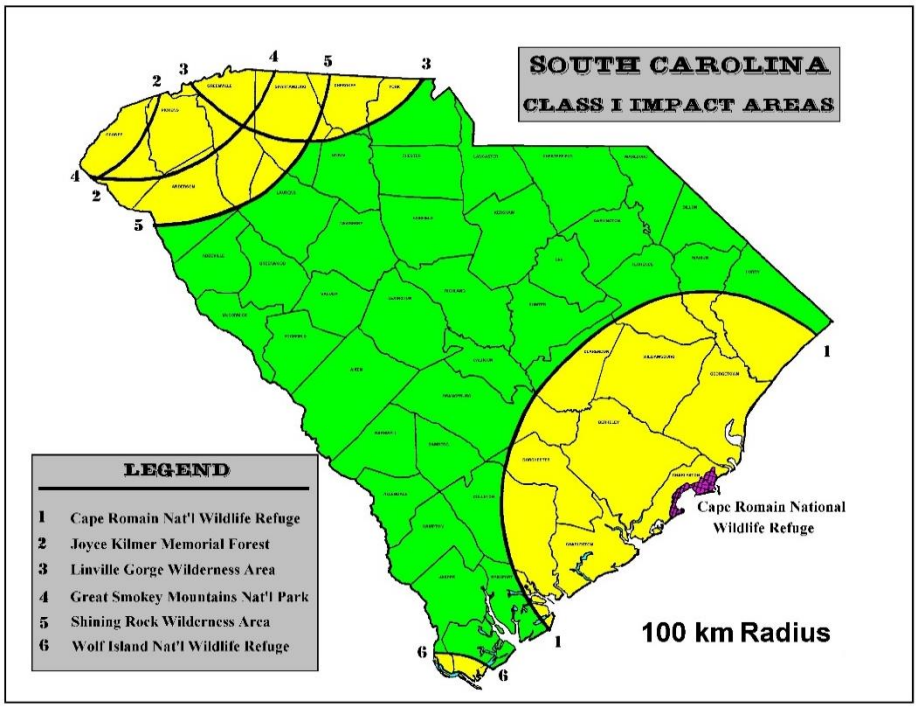

Figure 1-2: South Carolina Class I Impact Area

As required by the regional haze rule, The Department has also considered the impacts of emission sources outside of South Carolina that may affect visibility at this South Carolina Class I area and emission sources within South Carolina 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 this in South Carolina and those affected by emissions from South Carolina. This technical work is discussed further in Sections 5, 6, 7, and 7 below. Consultations to date between South Carolina and other states are summarized in Section 10; these consultations are ongoing.

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). South Carolina 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 progress analysis;
- 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 long-term strategy 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 another region.

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 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 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 are the United States Department of Interior (USDI) Fish and Wildlife Service (FWS), the National Park Service (NPS), and the United States Department of Agriculture (USDA) Forest Service (FS).

Coordination with the FLMs of South Carolina's continuing obligations to periodically revise its regional haze SIP is also discussed in Section 11. The Department formally commits to follow the FLM consultation procedures as prescribed in 40 CFR 51.308(i) in making these future implementation plan reviews and revisions.

The FLMs were involved in the preparation of this regional haze SIP. Documentation of the formal comments made by the FLMs and the Department's response appears in Appendix H – Public Hearing Comment Summary and Agency Responses.

1.7. Cross-Reference to Regional Haze Regulatory Requirements

Table 1-2 identifies each section of the SIP that addresses 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) and (i)

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)	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 for regional haze
(f)(2)(i)	7	Emission reduction measures that are necessary to make reasonable progress
(f)(2)(ii)	10	Consult with those states that have emissions that are reasonably anticipated to contribute to visibility impairment in 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

Rule Section	Chapter/Section in SIP	Description
(f)(2)(ii)(B)	10	Consider the emission reduction measures identified by other states for their 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, 7.7, 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 long-term strategy
(f)(3)(i)	8	Reasonable progress goals – The state must establish reasonable progress goals (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.
(f)(3)(ii)(A)	not applicable	If a state in which a mandatory federal Class I area is located establishes a reasonable progress goal 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 long-term strategy
(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 long-term strategy. 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 long-term strategy.
(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.

Rule Section	Chapter/Section in SIP	Description
(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 with the implementation plan a monitoring strategy 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 network.
(f)(6)(i)	not applicable	The establishment of any additional monitoring sites or equipment needed to assess whether 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)	9	For a state with no mandatory Class I federal 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.
(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: (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 the State.
(g)(2)	13.5	(2) A summary of the emissions reductions achieved throughout the state through implementation of the measures described in paragraph (g)(1) of this section.
(i)	10.4	State and federal land manager 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 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* means 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* means the average of individual values of daily natural visibility unique to each Class I area for either the most impaired days or the 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 index, as required by 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.

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 Section 5, Section 6, and Section 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 delineated

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

in the SIP. The five-year period comprising current conditions in this SIP is 2014-2018, inclusive.

2.1. IMPROVE Algorithm

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

The IMPROVE 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. 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 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 separate estimates. The current IMPROVE equation includes contributions from sea salt and an increase in the multiplier for contributions from 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.

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

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

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. Such 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 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 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 the 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 the 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, however, the new calculation of natural background allows Rayleigh scattering to vary with elevation. Secondly, 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

The 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 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 visibility impairment portfolio that

[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

comprised the 20% 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, the EPA notes that visibility conditions have never been measured without any anthropogenic impairment whatsoever, and 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 said 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 (p. 15) notes that these new natural background visibility values are "consistently" lower than the prior natural values for 20% haziest days. The natural background conditions computed and utilized by VISTAS for the 20% most impaired days at Class I sites follow the 2018 EPA guidance without exception.

2.3.3. Summary of Natural Background Conditions for 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 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.[10]

2.4. Baseline Conditions

Baseline visibility conditions at the South Carolina Class I area are estimated using sampling data collected at IMPROVE monitoring site at Cape Romain. A five-year average (2000 to 2004) was calculated for the 20% clearest days as well as the 20% most impaired days at each Class I site 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 Cape Romain for the period 2000 to 2004 meet the EPA requirements for data completeness (75% for the year and 50% for each quarter).[11]

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 VISTAS Class I areas. 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 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."[12]

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 Refuge	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

[10] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf
[11] URL: http://vista.cira.colostate.edu/DataWarehouse/IMPROVE/Data/SummaryData/RHR_2018/Updated/Changes%20to%20IMPROVE%20RHR%20Metric%20Data%20Processing%20since%2010_2019%20v5_20.pptx
[12] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

Class I Areas	Average for 20% Most Impaired Days	Average for 20% Clearest Days
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 Cape Romain 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 Cape Romain. 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. At Cape Romain and other coastal sites, the 20% most impaired and clearest visibility days are distributed throughout the year.

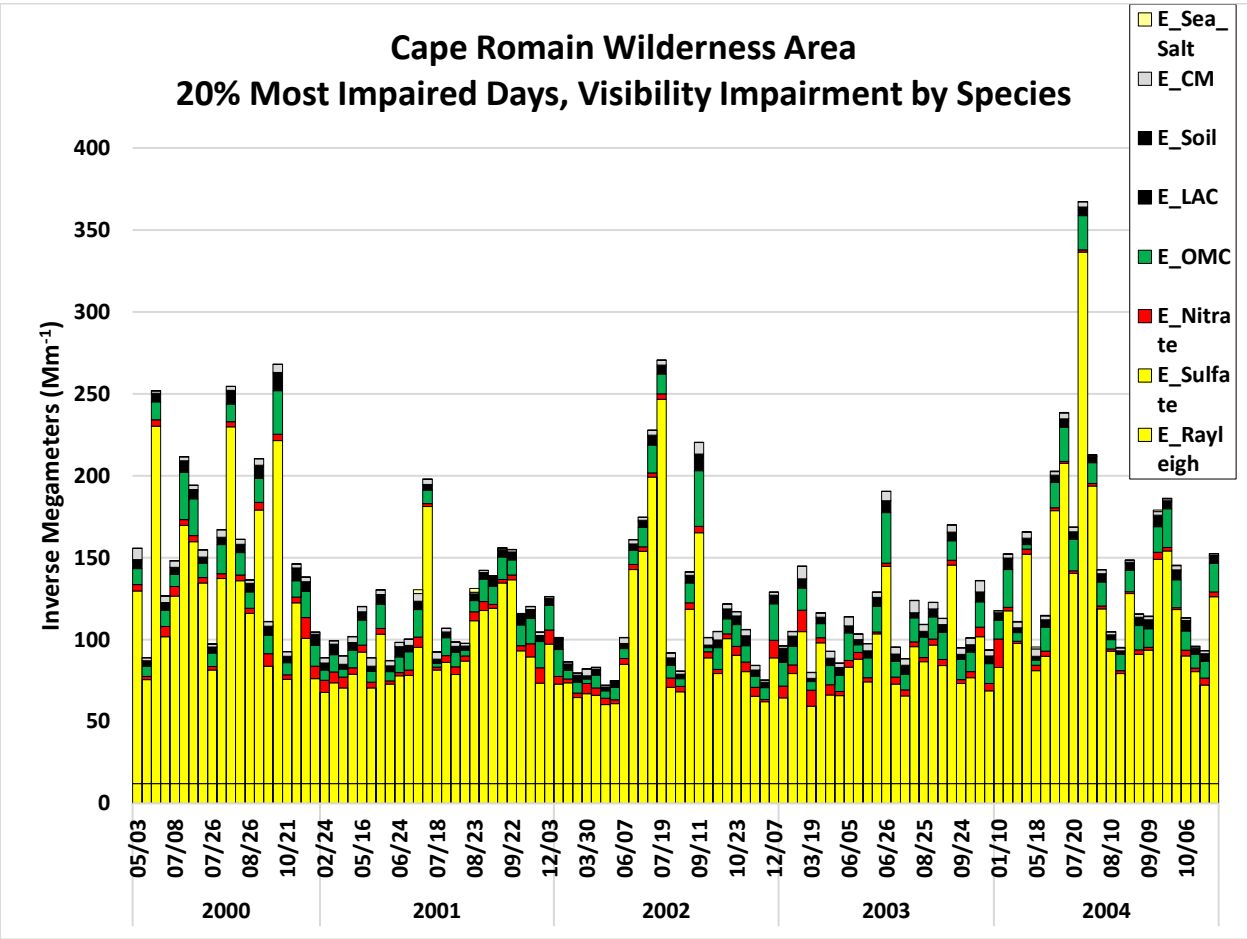

Figure 2-1: 2000-2004 Reconstructed Extinction for the 20% Most Impaired Days at Cape Romain Wilderness Area

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.

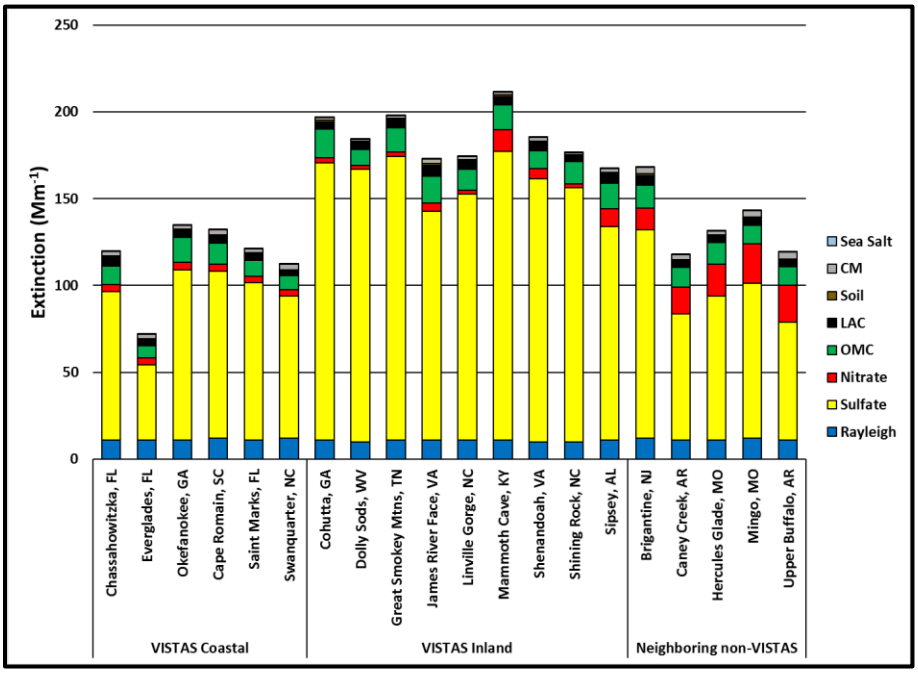

Figure 2-2: Average Light Extinction, 20% Most Impaired Days, 2000-2004, VISTAS and Neighboring Class I Areas

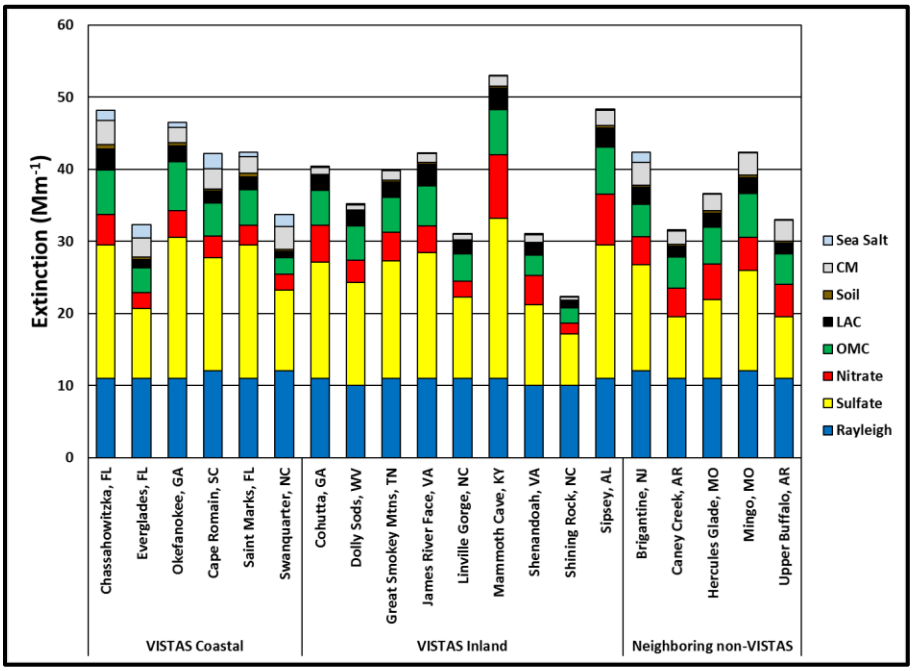

Figure 2-3: Average Light Extinction, 20% Clearest Days, 2000-2004, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-1, Figure 2-2, and Figure 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 the 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."[13] 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.

Ammonium sulfate, $(NH_4)_2SO_4$, is the most important contributor to visibility impairment and fine particle mass on the 20% most impaired and 20% clearest visibility days at Cape Romain during the baseline period. During this period, sulfate levels on the 20% most impaired days accounted for 75% to 90% 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 shown as organic matter carbon (OMC) in the 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 Cape Romain 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. Significant fire impacts are infrequent at Cape Romain. 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

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

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 this section's 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 higher at urban monitors than at the Class I areas and suggest controls of primary 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 Everglades, Florida, 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 modeling 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 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 used as the modeling basis for this SIP revision's projection analysis described in Sections 5, 6, and 7. The baseline light extinction and dv index values for the 20% most impaired and 20% clearest days at the Class I areas are based on data and calculations included in Appendix E-6 of this SIP (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 Cape Romain. 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 became more prevalent. On nearly all days, sulfate continues

to be the dominant visibility impairing pollutant. Nitrate impacts become more significant on some 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 400 Mm^{-1}, maximum values in Figure 2-4 are in the 180 Mm^{-1} range, highlighting the impact of the many control programs implemented during the intervening period.

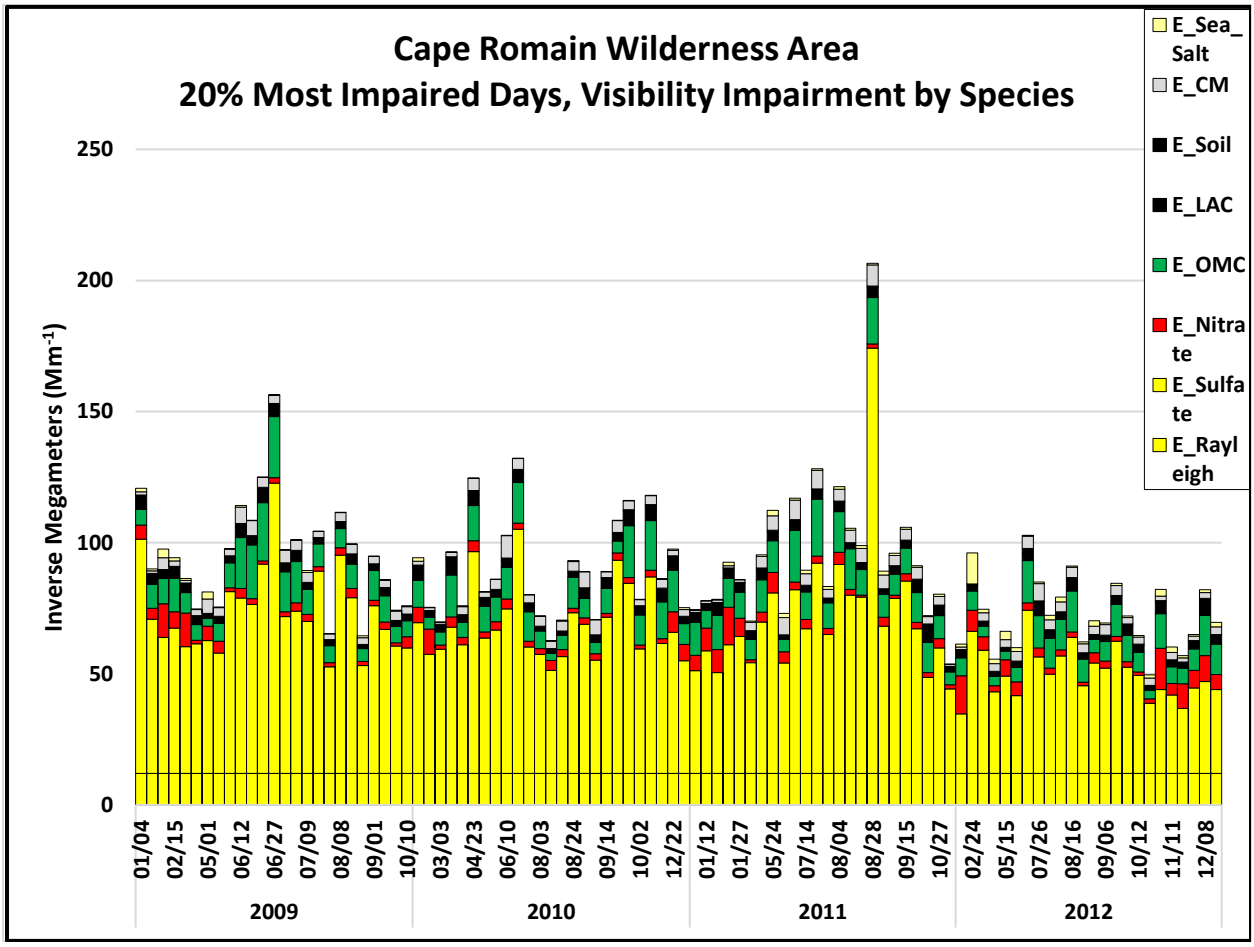

Figure 2-4: 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at Cape Romain Wilderness Area

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 20% worst visibility 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.

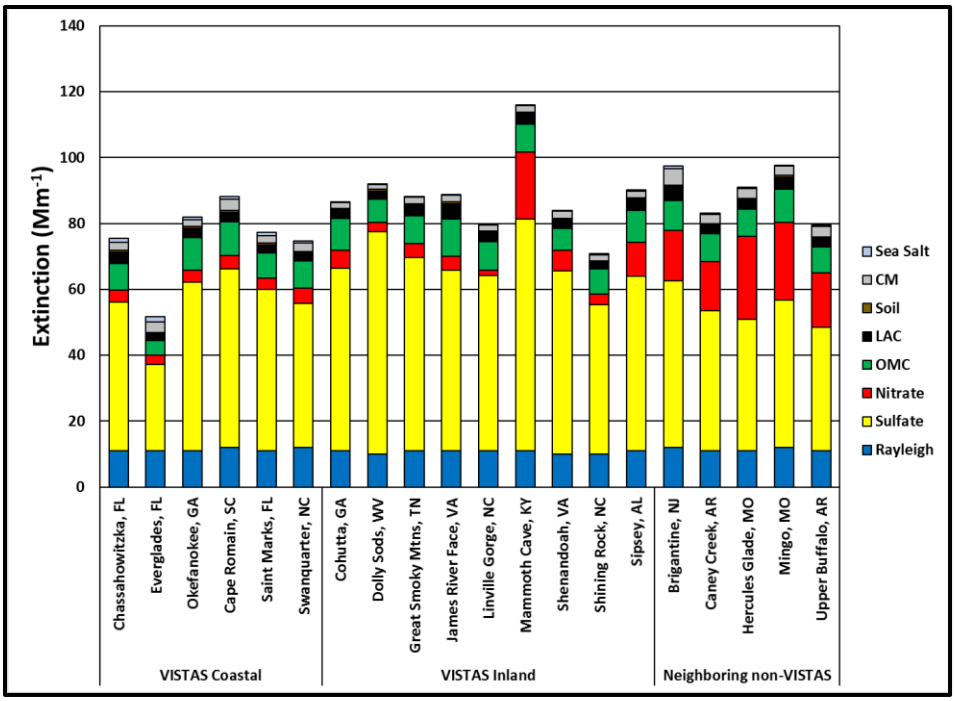

Figure 2-5: Average Light Extinction, 20% Most Impaired Days, 2009-2013, VISTAS and Neighboring Class I Areas

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.

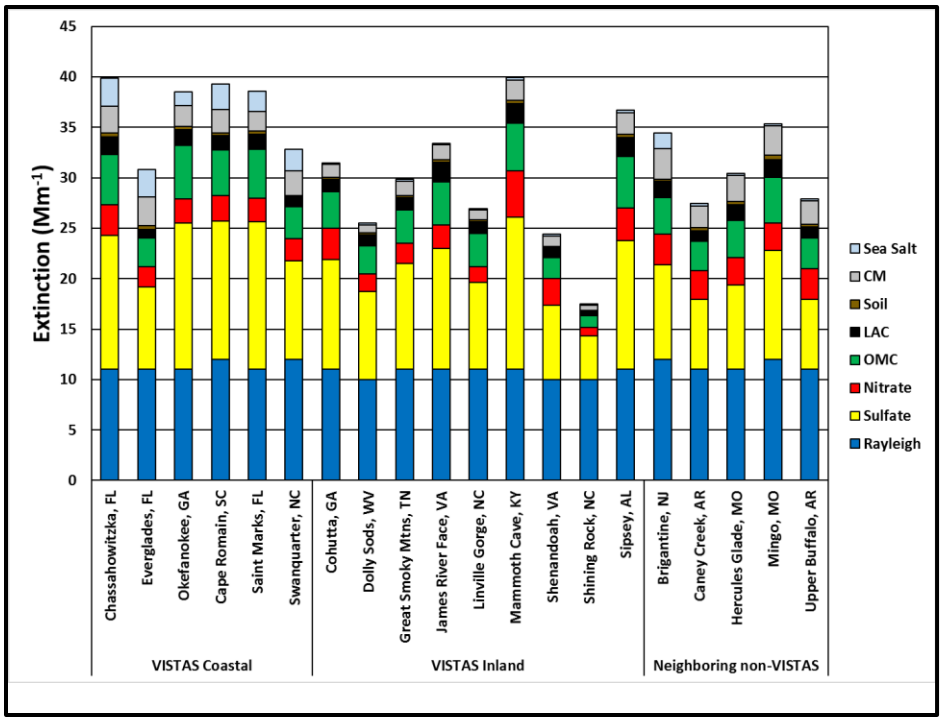

Figure 2-6: Average Light Extinction, 20% Clearest Days, 2009-2013, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-4, Figure 2-5, Figure 2-6) 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 the 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 VISTAS Class I areas. These data reflect values included in Table 1 on 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."[14]

[14] 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	10.76 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 displays the 2014 – 2018 reconstructed extinction for the 20% most impaired days for Cape Romain. 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 Figure 2-9 show light extinction averaged from 2014-2018 IMPROVE data for the 20% most impaired and clearest days, respectively. These bar charts (Figure 2-7, Figure 2-8, and Figure 2-9) are based on the IMPROVE data file called sia_impairment_daily_budgets_10_18.zip for data through 2017. For 2018 data, the IMRPOVE data file called sia_impairment_daily_budgets_4_20_2.zip was used. Therefore, the data through 2017 have not been updated with the patching and substitution algorithms described in the 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 these reductions are resulting in better visibility.

Figure 2-8 presents average data for 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, which is daily monitoring values, shows that occasionally nitrate is the predominant visibility impairing pollutant on certain days, generally in winter months.

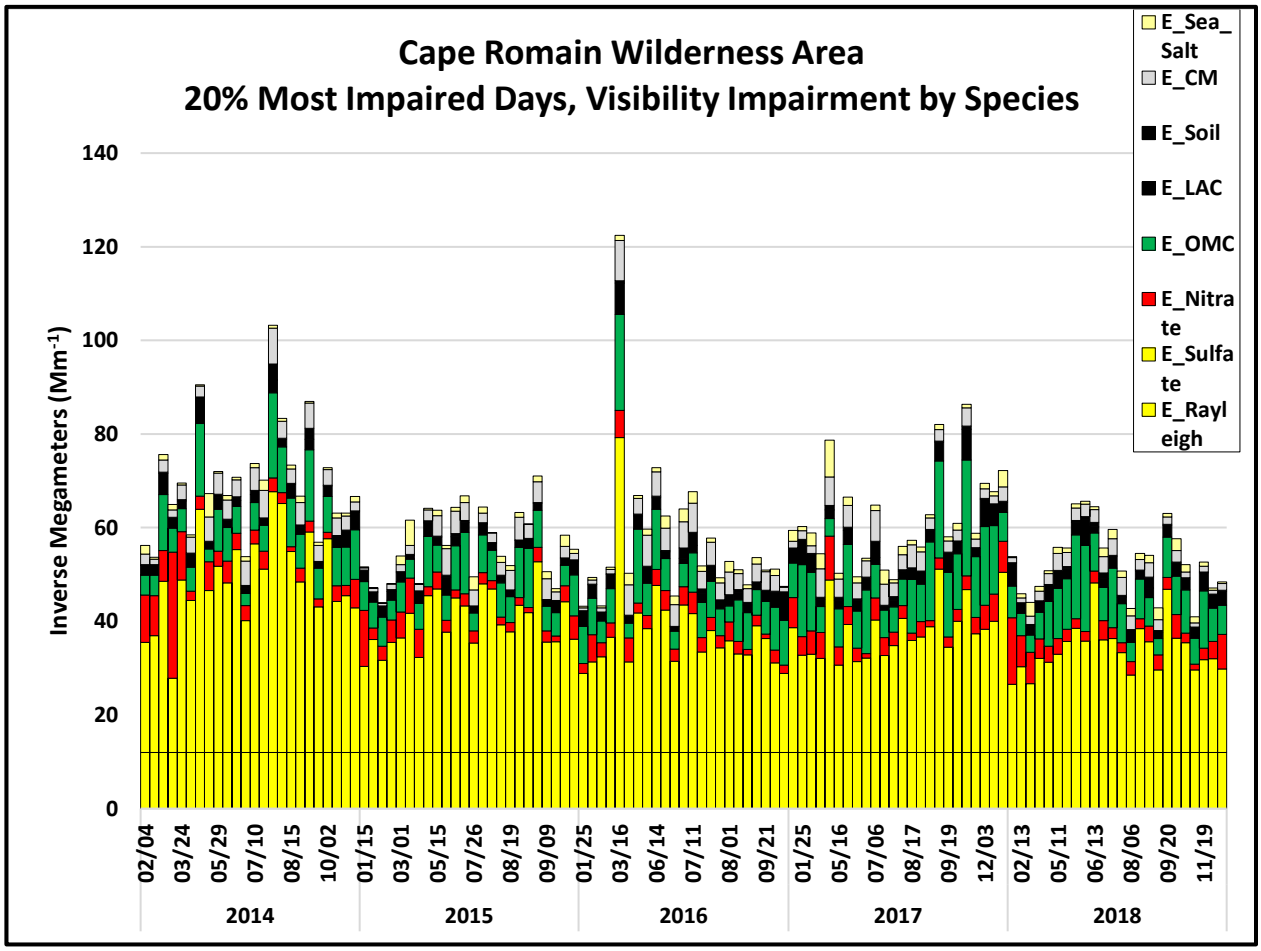

Figure 2-7: 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at Cape Romain Wilderness Area

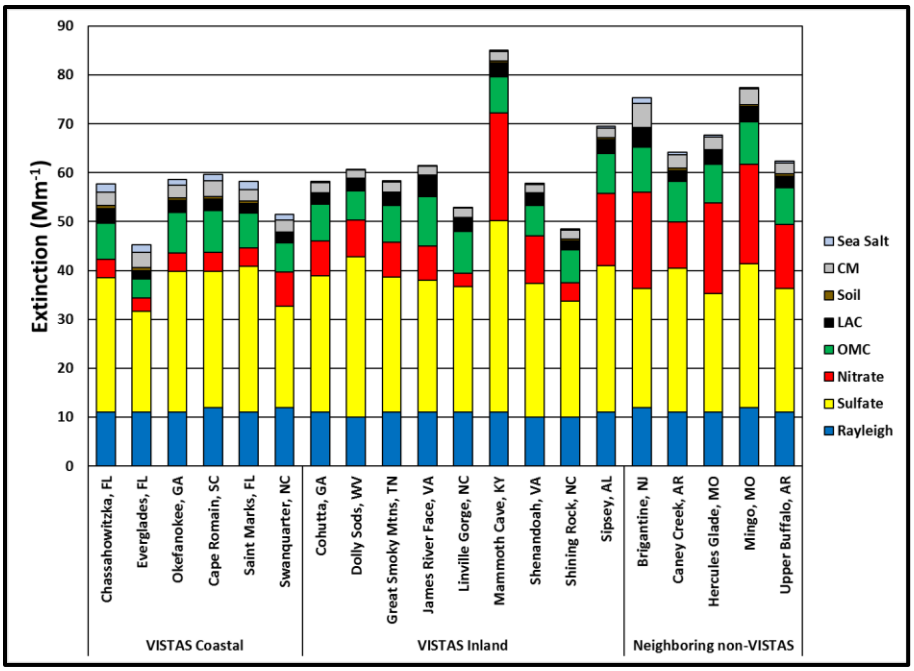

Figure 2-8: Average Light Extinction, 20% Most Impaired Days, 2014-2018, VISTAS and Neighboring Class I Areas

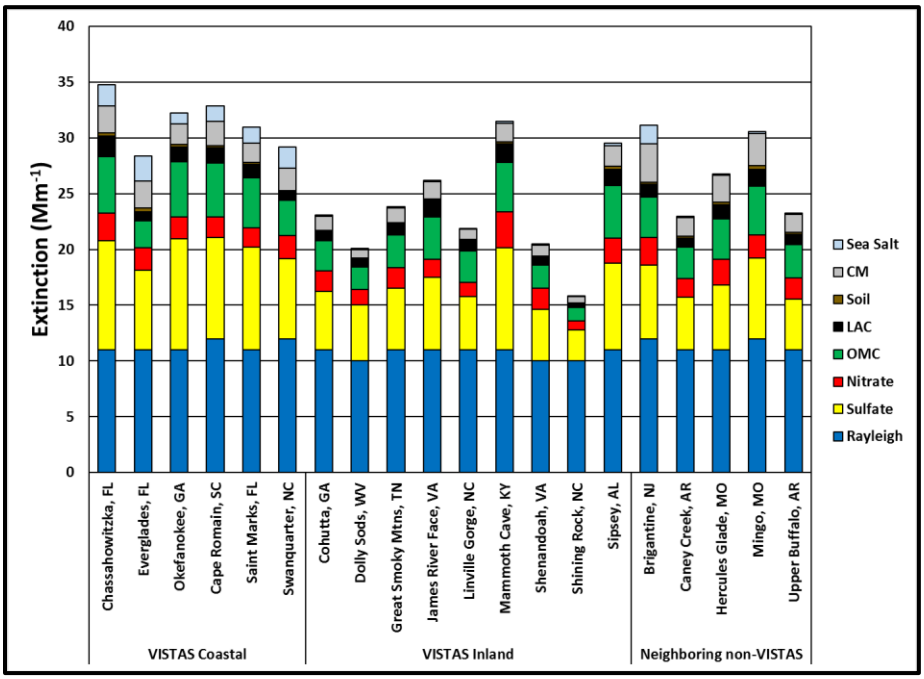

Figure 2-9: Average Light Extinction, 20% Clearest Days, 2014-2018, VISTAS and Neighboring Class I Areas

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 enumerate 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 20% most impaired days, data for current conditions show 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 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	10.76 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. States must analyze and determine the consistent rate of progress over time. Starting with the baseline period of 2000-2004, states must analyze and determine the consistent rate of progress over time. States must compare the baseline visibility conditions (2000-2004) for the most impaired days to the natural visibility condition for the most impaired days to determine the uniform rate of visibility improvements 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 the EPA's guidance for tracking progress[15] 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.

Figure 3-1 shows the glide path for the 20% most impaired days for Cape Romain assuming a uniform rate of progress toward natural conditions. Natural background visibility for the most impaired days at Cape Romain is calculated to be 9.78dv.

The data in Figure 3-1 is derived from 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."[16]

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

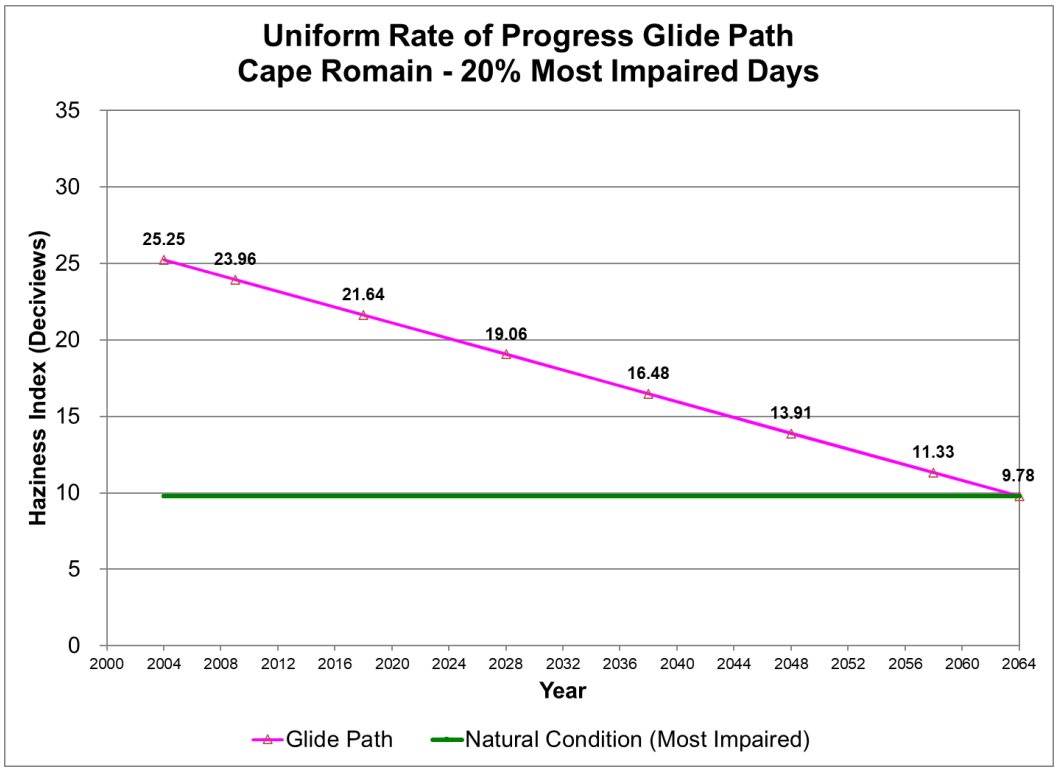

Figure 3-1: Uniform Rate of Progress Glide Path for 20% Most Impaired Days at Cape Romain Wilderness Area

4. Emissions Inventories Used For Visibility Analyses

4.1. Overview

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 Class I area. The inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions. South Carolina complies with the Air Emission Reporting Requirements (AERR) by submitting the required triennial (and annual) inventories to the 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 regional haze rule provision also requires states to commit to update the inventory periodically, which South Carolina 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 include carbon monoxide[17] (CO), volatile organic compounds (VOCs), NO_X, $PM_{2.5}$, 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 the EPA's TSD entitled "Documentation for the EPA's Preliminary 2028 Regional Haze Modeling."[18] The EPA has projected the 2011 base year emissions[19] to a 2028 future year base case scenario. These data were the foundation of the revised emissions used for this analysis as described elsewhere. 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 the 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 the EPA in the final Cross-State Air Pollution Rule (CSAPR) Update[20] and the subsequent notice of data availability (NODA)[21] 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,

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

biogenic sources, and point fires which are reported as events in the National Emissions Inventory.[22] The following sections define each emission inventory source sector and the emissions estimation methods applied to estimate emissions for each sector.

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 and provided at the facility level. Large sources emitting at least 100 tons per year (tpy) of a criteria pollutant are inventoried every three years. The largest sources have been 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 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 matched to CEMS is 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 the EPA has taken to implement the Regional Haze Rule, the Cooling Water Intakes

[22] Note that prescribed fires and wildfires are designated events in the National Emissions Inventory.

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 replaced by natural gas-fired EGUs. Thus, the EPA 2028el projected emissions for EGU emissions are not 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, the EPA 2028el EGU emissions were replaced with the 2028 ERTAC 2.7 EGU emissions. South Carolina 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 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 itinerate operations are defined as aircraft take-offs or aircraft landings. The 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 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 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, are 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. The emissions from these sources are estimated at the county level. 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 then 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. SMARTFIRE 2 estimates were used directly for all states except Georgia and Florida. For Georgia, the satellite-derived emissions were removed from the fire inventory and replaced with a separate state-supplied fire inventory. Adjustments were also made to Florida to rescale their emissions to match the total acres burned that Florida reported in the NEI. The 2011 fire emissions are used for the 2028 future year without any changes

4.1.7. Summary 2011 Baseline Emissions Inventory for South Carolina

Table 4-1 is a summary of the 2011 baseline emission inventory for South Carolina. 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 4-1: 2011 Emissions Inventory Summary for South Carolina (tpy)

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
EGU	17,424	268	26,476	10,519	8,365	68,307	750
Non-EGU Point	88,270	1,835	25,513	7,365	5,187	26,593	23,927
Nonpoint	84,986	30,215	22,008	280,076	49,289	5,878	74,281
Onroad	475,876	2,104	109,374	6,618	3,766	504	51,164
Non-Road	233,460	31	23,155	2,343	2,228	65	34,267
Point-Fires	200,969	3,323	4,017	21,583	18,290	1,900	47,771
Total	**1,100,985**	**37,776**	**210,543**	**328,503**	**87,125**	**103,247**	**232,160**

4.1.8. Emissions Inventory Improvements Prior to Remodeling 2028 Future Year

The VISTAS initial emission inventory was completed in June 2018. The VISTAS initial modeling for the future year 2028 was completed in October 2019. VISTAS compared the VISTAS' emission inventory information to EPA's modeling inventory, which was released in

September 2019. The 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 the 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 emissions, with the EPA's 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[23] emissions used by the EPA (projected from 2016). The emissions in Table 4-2 are extracted from the VISTAS12 modeling domain, which covers the eastern US. As shown in Table 4-2, the EPA's SO_2 emissions are 45.61% lower than VISTAS' estimates, and the EPA's NO_X emissions are 20.19% lower than VISTAS' estimates.

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%

[23] 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).

The Regional Haze rule and guidance indicate that future year projections should be as accurate as possible. Thus, after consulting with the EPA, VISTAS decided to model the future year 2028 again 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 Cape Romain, and reduction of SO_2 emissions would be the most effective means of reducing ammonium sulfate. As illustrated in Figure 4-1, 91.2% of 2011 SO_2 emissions in the VISTAS states are attributable to electric generating facilities and industrial point sources. Similarly, in South Carolina the stationary point sources, consisting mostly of electric generating facilities and industrial point sources, contribute 91.9% of SO_2 emissions in the state (see Table 4-5).

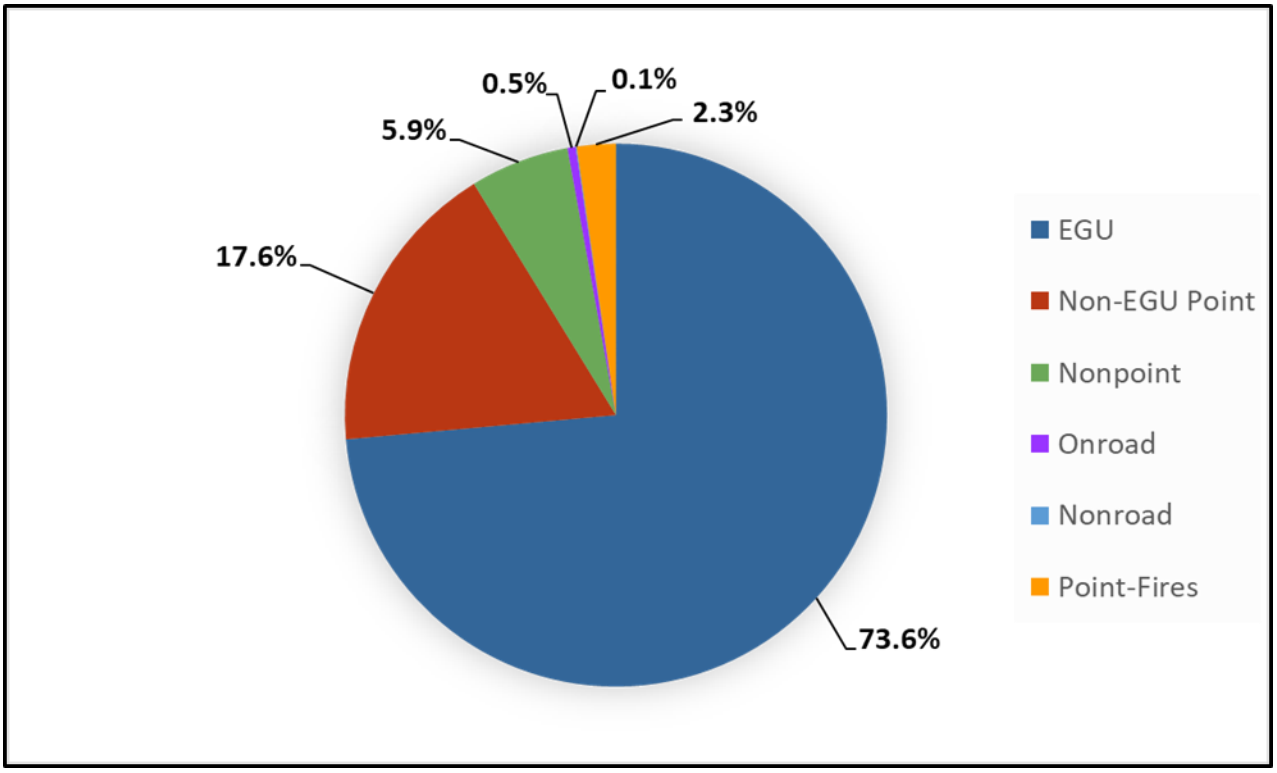


Figure 4-1: 2011 SO_2 Emissions in the VISTAS States

Table 4-5: 2011 SO2 Emissions for South Carolina, tpy

Sector	SO_2, tpy	Percentage
Point	94,900	91.9%
Nonpoint	5,878	5.7%
Onroad	504	0.5%
Non-Road	65	0.1%
Point-Fires	1,900	1.8%
Total	103,247	100.0%

Since the largest source of SO_2 emissions comes from the stationary point sources, the focus of potential controls and the impacts for those controls was on this source sector. In South Carolina, the types of sources emitting SO_2, and thus contributing to the visibility impairment of the Class I area, were predominately coal-fired utilities and industrial boilers.

5. Regional Haze Modeling Methods and Inputs

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

5.1. Analysis Method

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system. For the most part, the modeling analysis approach for regional haze 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). The EPA projected the 2011 base year emissions to a 2028 future year base case scenario. The EPA's work is the foundation of the emissions used in the VISTAS analysis, with significant revisions as described in Appendix B. As noted in the 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 the EPA in the final CSAPR Update[24] and the subsequent NODA[25] to support ozone transport mandates for the 2015 ozone NAAQS. VISTAS decided to use 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 study. It features multiple dynamical 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[26] was used 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. 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 the EPA with

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

SMOKE-MOVES to generate onroad mobile source emissions with EPA generated vehicle activity data provided in the 2028 regional haze analysis.

- 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 of 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 in 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 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 execution and verification at no or low 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 a regional haze SIP, a state needs to show that it meets the same general criteria as a model for a NAAQS attainment demonstration. The 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[27] 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. The 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

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

grid modeling is to be 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:

- Non-hydrostatic formulation;
- Reasonably current, peer reviewed formulation;
- Simulates cloud physics;
- Publicly available at no or low 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 WRF[28] 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 ARW version of WRF was used in this regional haze analysis study 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 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).

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

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;
- 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;
- No or low cost for acquisition and maintenance; and
- Expandable to support other species and mechanisms.

5.2.3.2. Overview of SMOKE

The SMOKE[29] 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 the 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 the 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[30] was developed through a collaborative effort to improve

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

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 the 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 E.

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.

The 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 the EPA's modeling guidance episode selection discussion and is consistent with the base year modeling platform. Specifically, the 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. The 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.

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 the 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) 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.

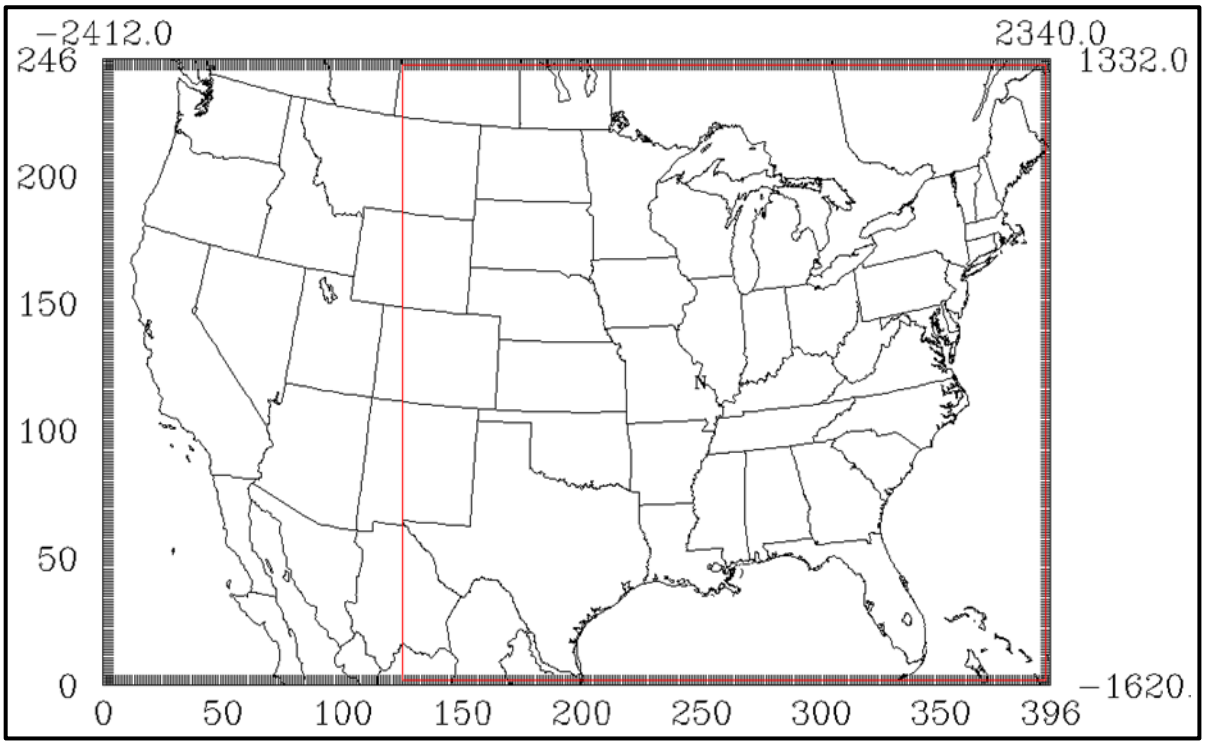


Figure 5-1: Map of 12-km CAMx Modeling Domains; VISTAS_12 Domain Represented as Inner Red Domain

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). The EPA ran WRF using 35 vertical layers. A layer

averaging scheme is adopted for CAMx simulations whereby multiple WRF layers are 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 the EPA's draft 2028 regional haze modeling.[31]

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

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

6. Model Performance Evaluation

The VISTAS 2011 modeling platform (VISTAS2011) used meteorological modeling files developed by the EPA. The evaluation of the meteorological modeling can be found in the EPA's document titled, "Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation."[32] 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, and Clean Air Status and Trends Network (CASTNet) monitoring networks. Modeled weekly speciated wet and dry deposition species were compared to observations from the National Acid Deposition Program (NADP) and CASTNet.

6.1. Ozone Model Performance Evaluation

As indicated by the statistics in Table 6-1, 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

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

Figure 6-1 through Figure 6-4 show the spatial variability in bias and error at monitor locations. Mean bias, as seen from Figure 6-1, 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 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 6-2 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 over predict at most sites in the eastern region of the VISTAS12 domain and generally under predict at sites in and around the western and northwestern borders of the domain.

The ME, as seen from 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 6-4 indicates that the 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.

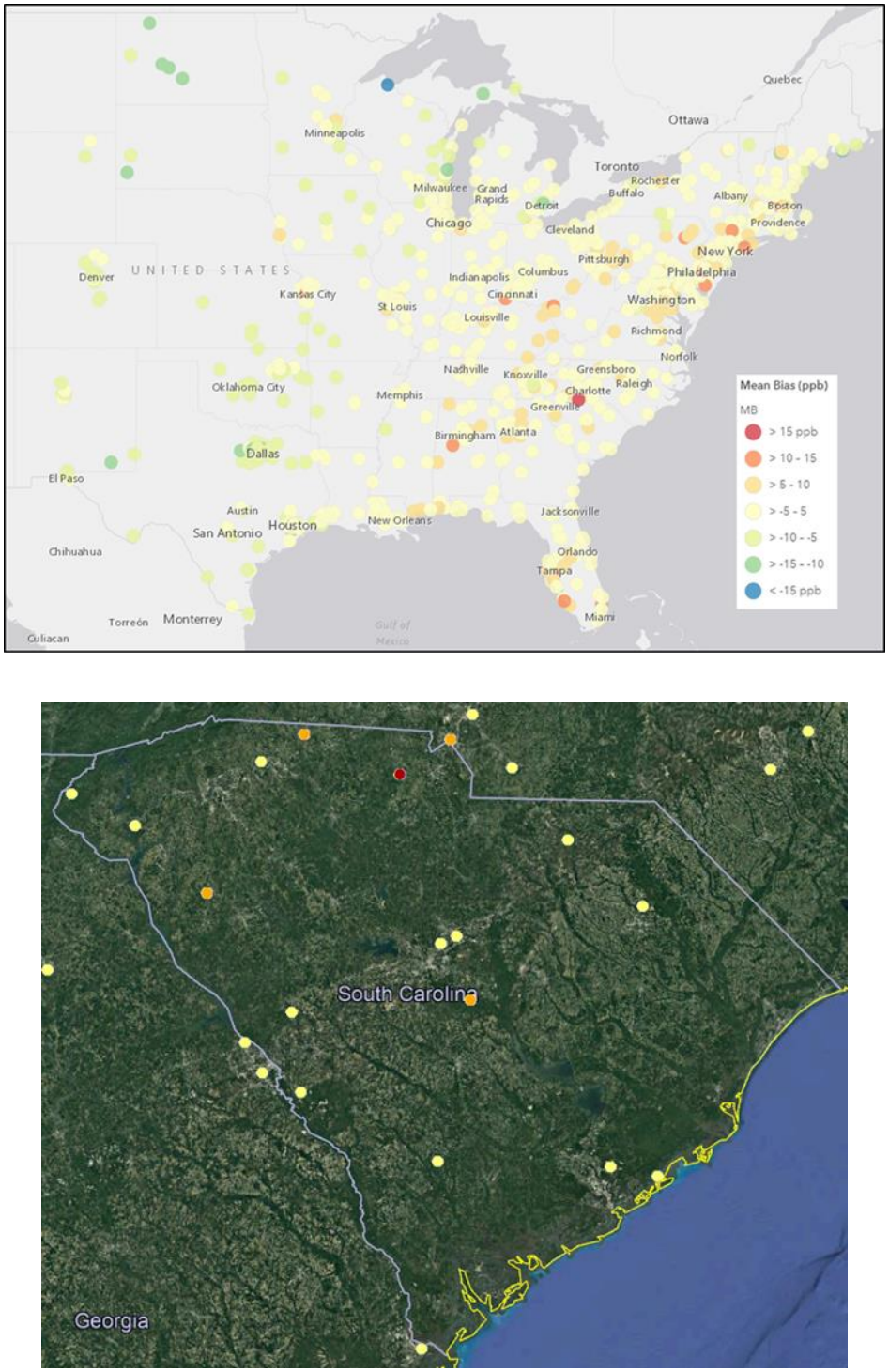


Figure 6-1: Mean Bias (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in South Carolina (bottom).

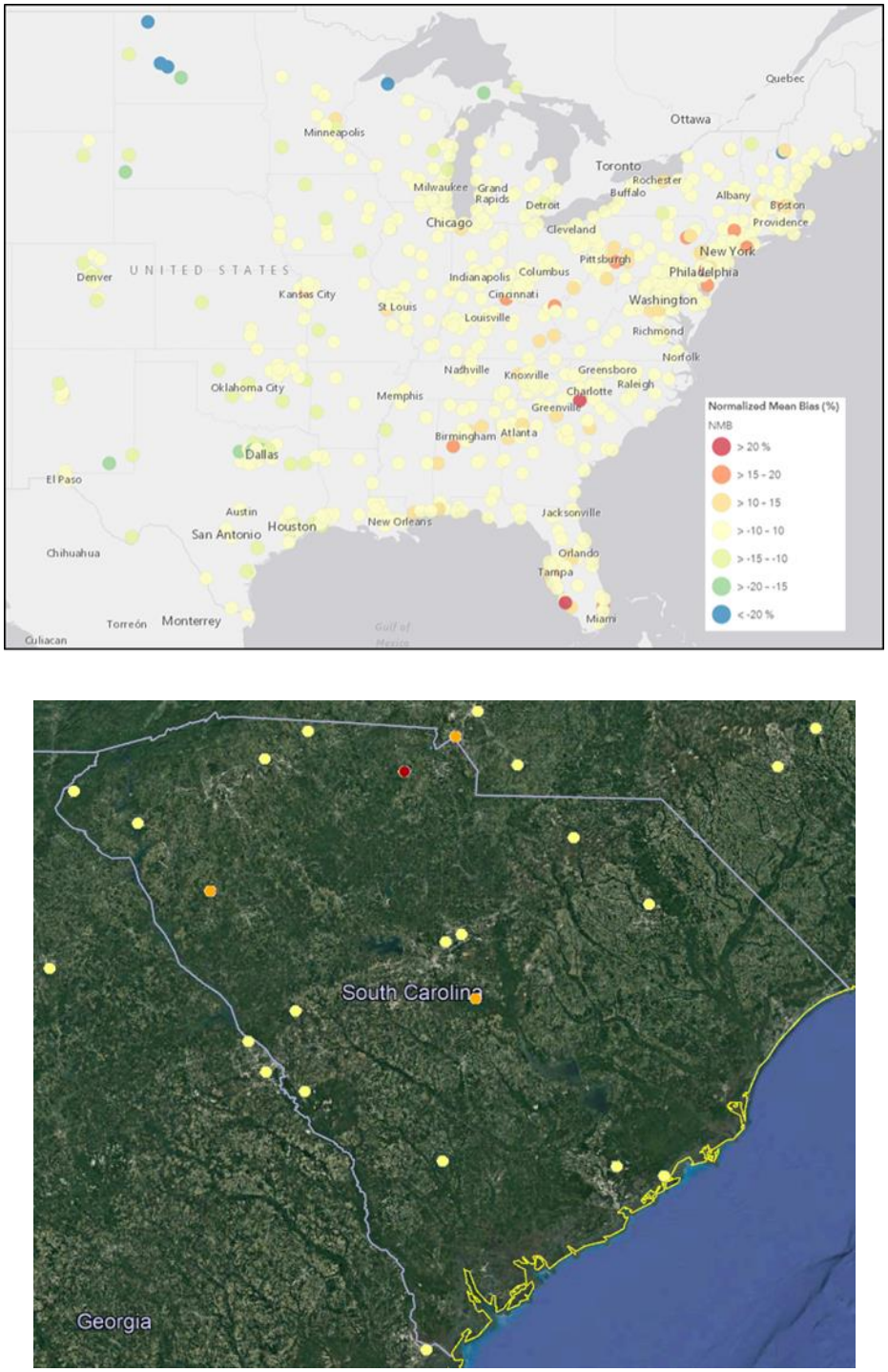


Figure 6-2: Normalized Mean Bias (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in South Carolina (bottom).

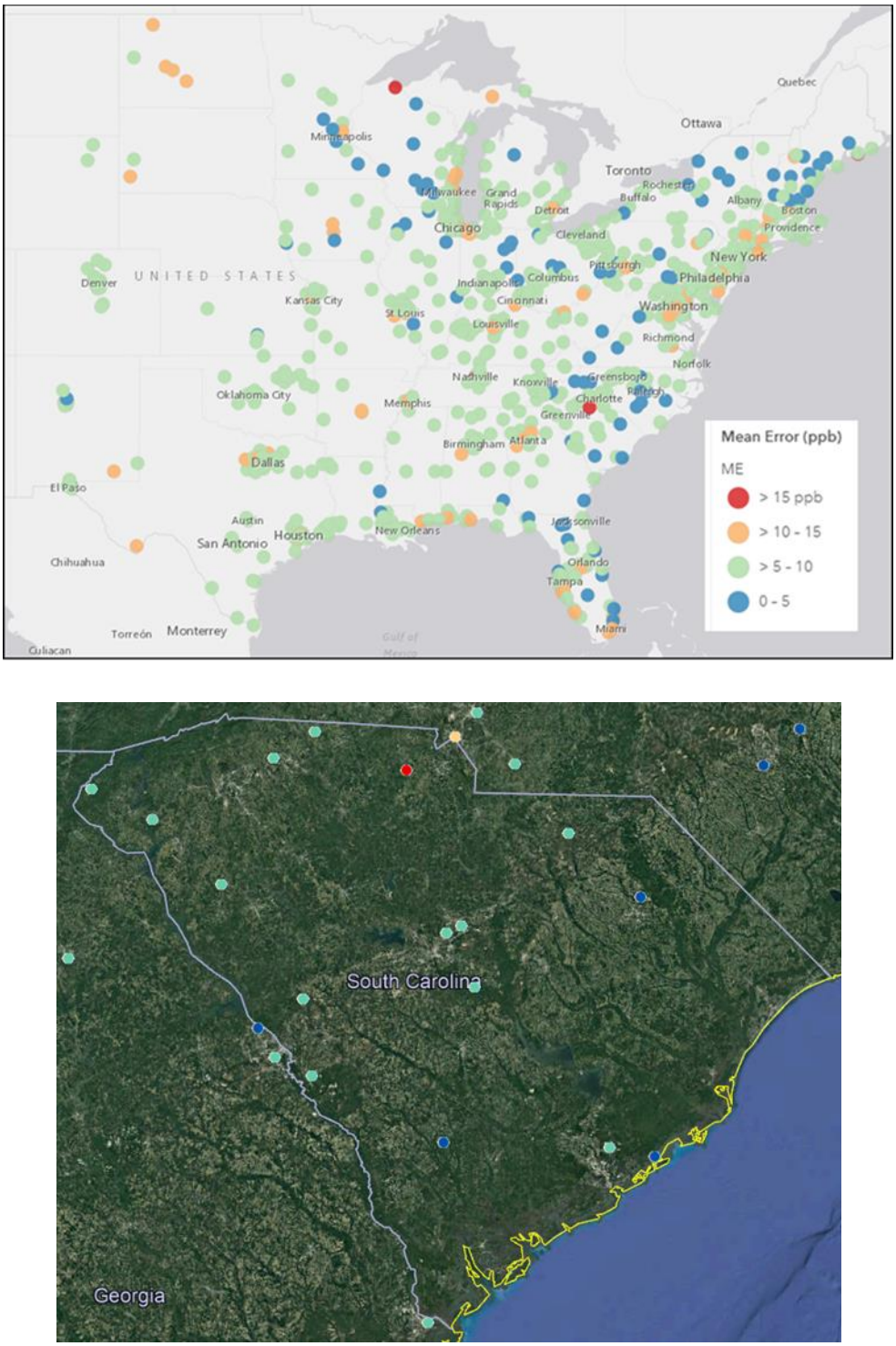


Figure 6-3: ME (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in South Carolina (bottom).

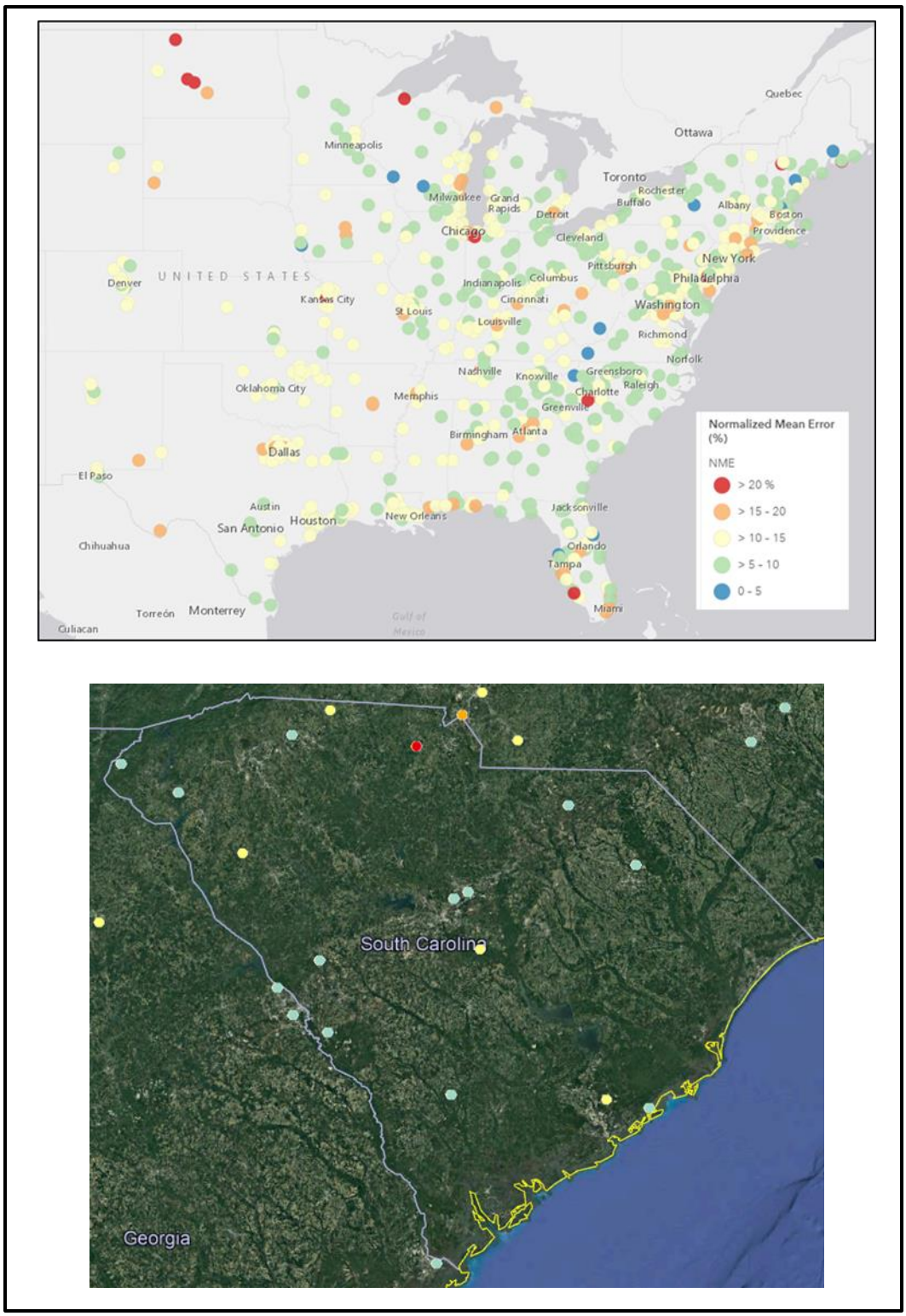


Figure 6-4: NME (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in South Carolina (bottom).

6.2. Acid Deposition Model Performance Evaluation

The primary source for deposition data is the National Atmospheric Deposition Program (NADP).[33] 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).

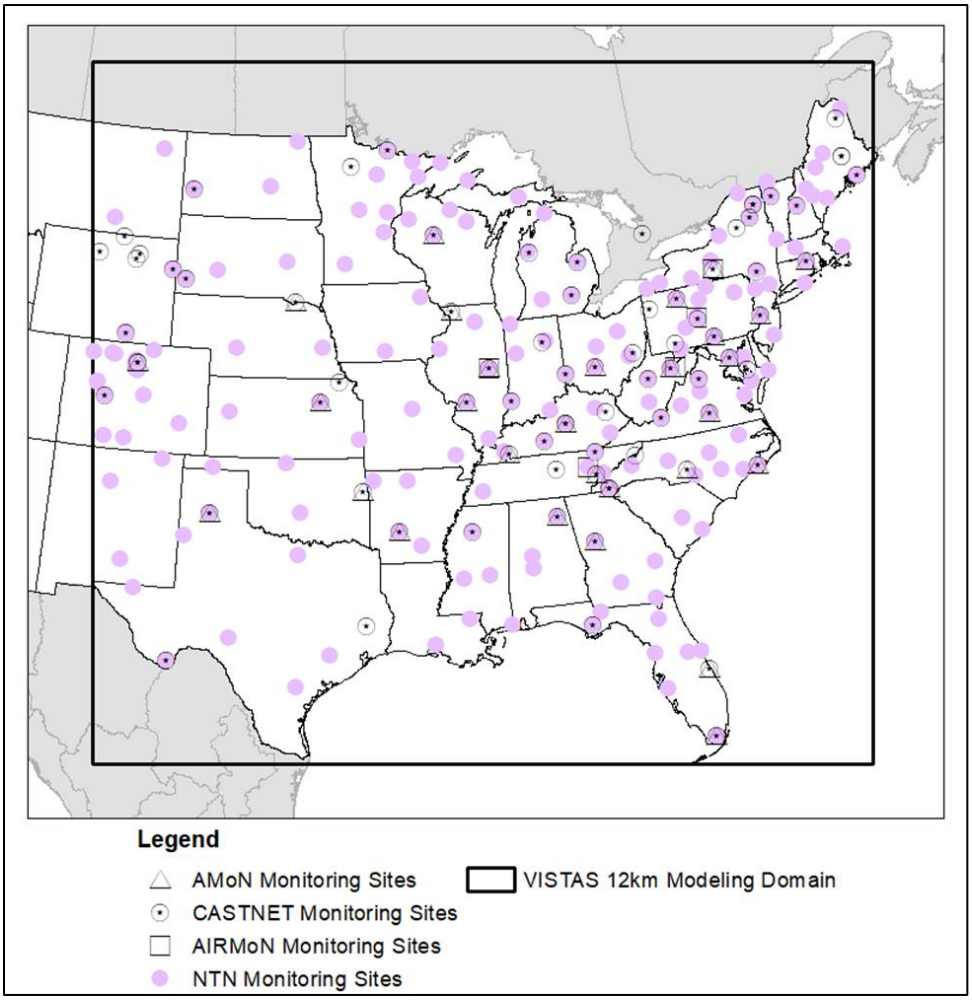


Figure 6-5: Deposition Monitors Included in the VISTAS 12 Domain

[33] 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%7	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 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 MB and 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. SO_2 and HNO_3 have the worst under prediction of all the pollutants, followed by Cl^-.

Table 6-5: Accumulated Annual Wet Deposition MPE Metrics for 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 Model Performance Goals and Criteria

Because $PM_{2.5}$ is a mixture, the current EPA PM modeling guidance[34] 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 the 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 and Table 6-7 below were used for this modeling. Based on the EPA's guidance and the referenced publication, 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 1,000 Km. This

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

indicates that model performance should be evaluated based on the entire domain and not based on a comparison of modeled to observed values for and individual Class 1 area.

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

Species	NMB, Goal	NMB, Criteria	NME, Goal	NME, Criteria
24-hr $PM_{2.5}$ and sulfate	<± 10%	<± 30%	< 35%	< 50%
24-hr nitrate	<± 10%	<± 65%	< 65%	< 115%
24-hr OC	<± 15%	<± 50%	< 45%	< 65%
24-hr EC	<± 20%	<± 40%	< 50%	< 75%

Table 6-7: Fine Particulate Matter Performance Goals and Criteria

Species	FB, Goal	FB, Criteria	FE, Goal	FE, Criteria
24-hr $PM_{2.5}$ and sulfate	<± 30%	<± 60%	< 50%	< 75%
24-hr nitrate	<± 30%	<± 60%	< 50%	< 75%
24-hr OC	<± 30%	<± 60%	< 50%	< 75%
24-hr EC	<± 30%	<± 60%	< 50%	< 75%

The mapping of the CAMx species into the observed species are presented in Table 6-8.

Table 6-8: 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 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 6-9) in the VISTAS12 modeling domain and model output data from the VISTAS2011 annual air quality modeling.

Table 6-9: 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.

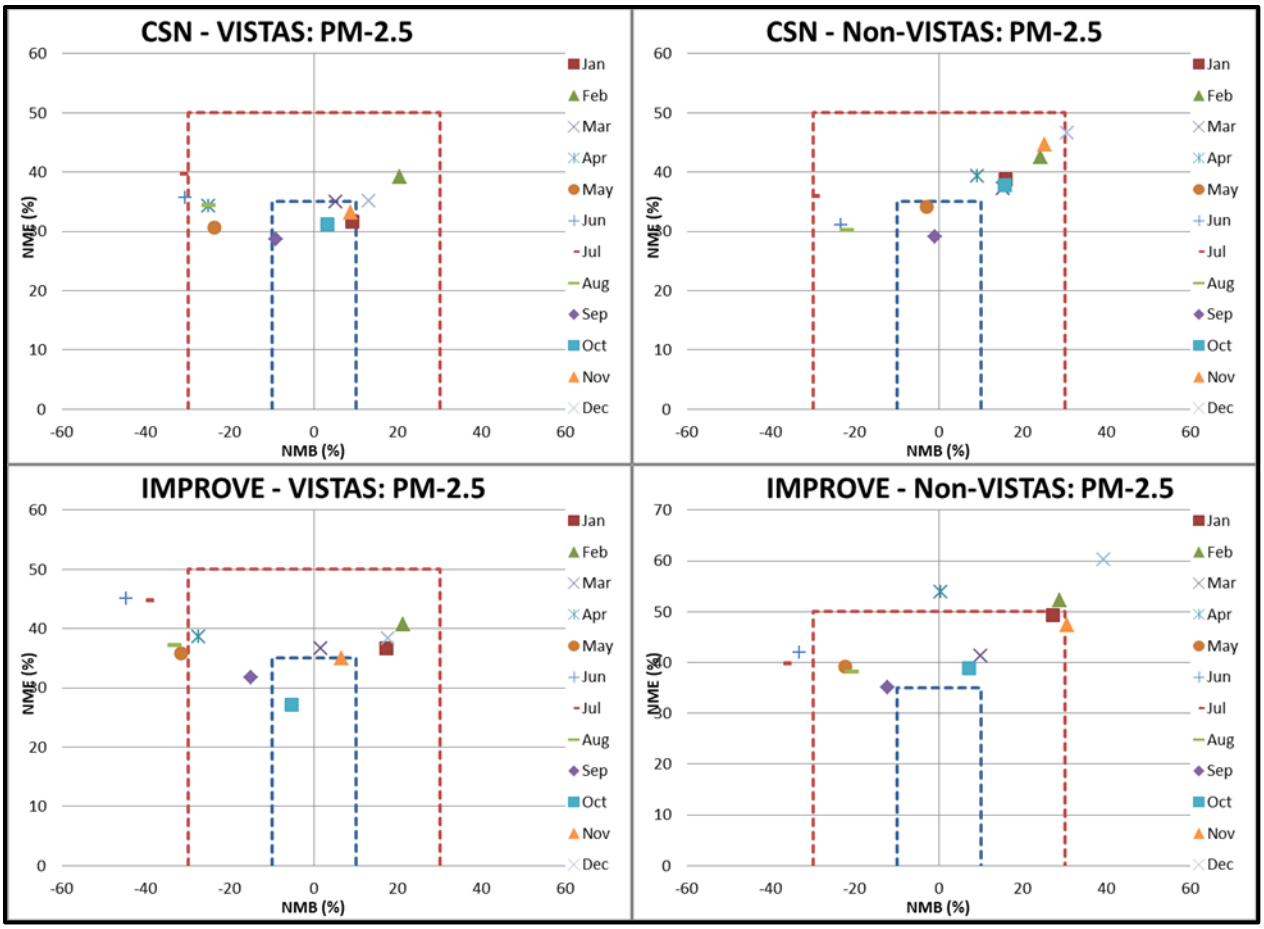


Figure 6-6: Soccer Plots of Total $PM_{2.5}$ by Network and Month for VISTAS and Non-VISTAS Sites

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.

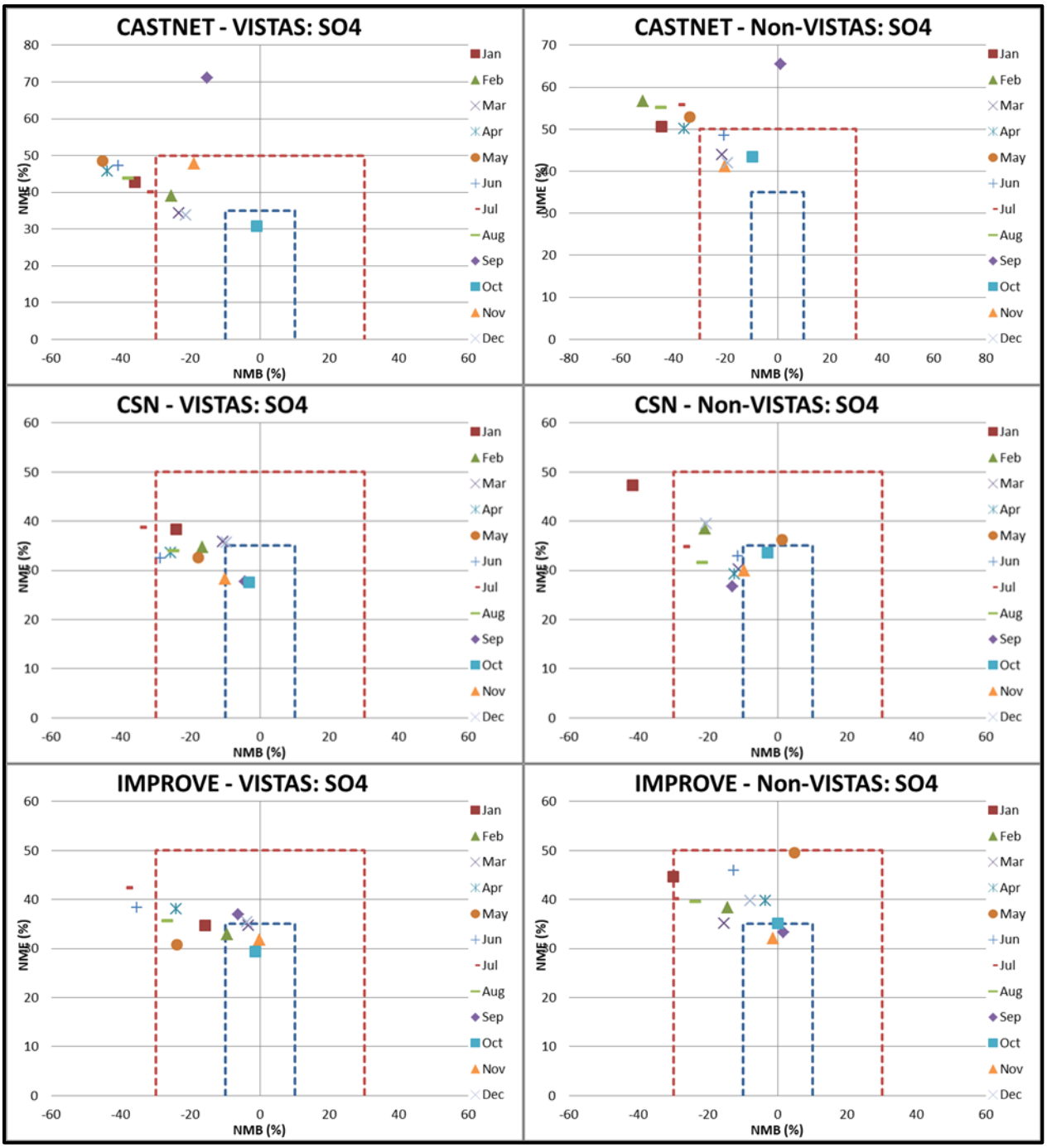


Figure 6-7: Soccer Plots by Network and Month for VISTAS and Non-VISTAS Sites

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.

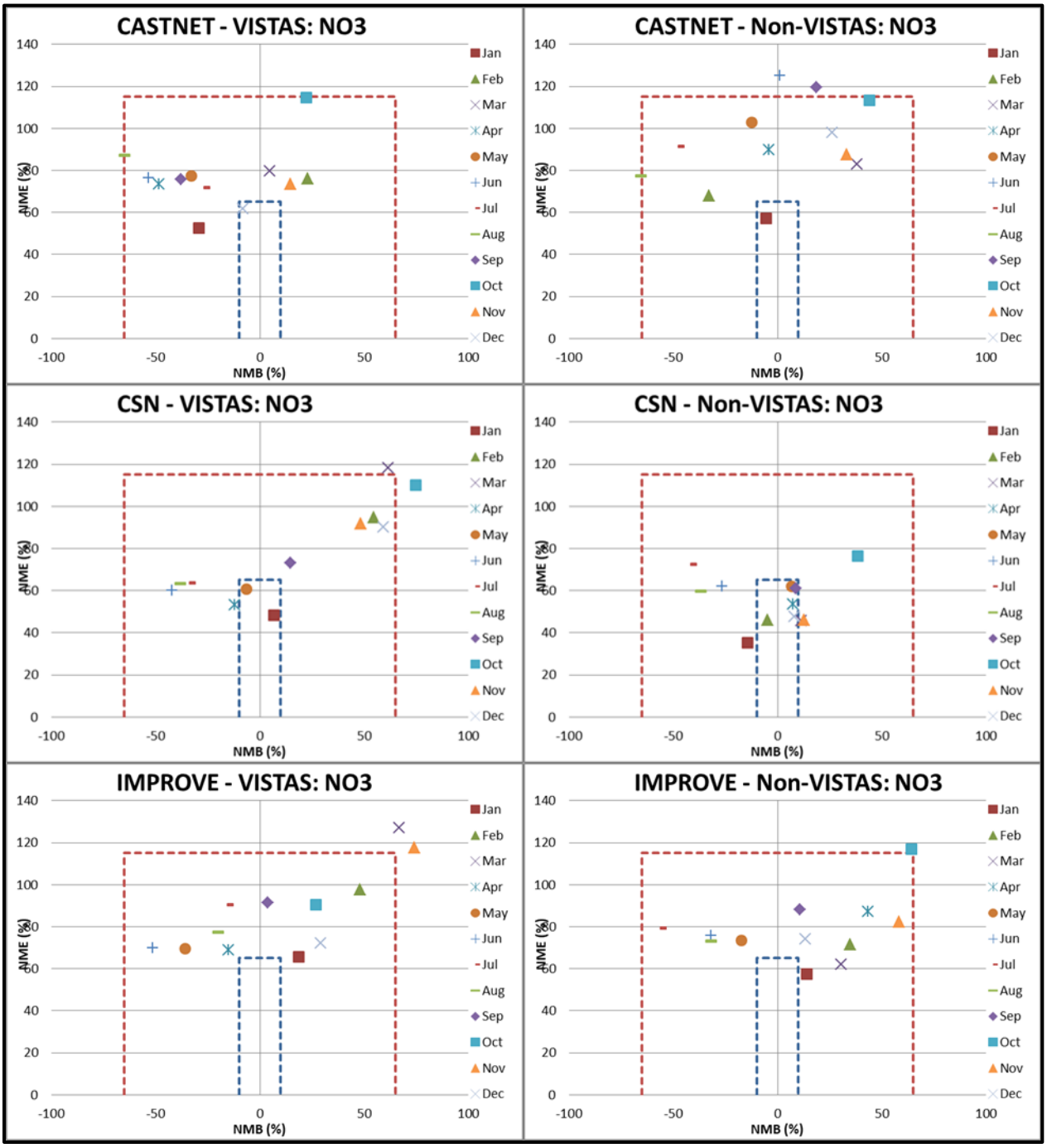


Figure 6-8: Soccer Plots of Nitrate by Network and Month for VISTAS and Non-VISTAS Sites

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.

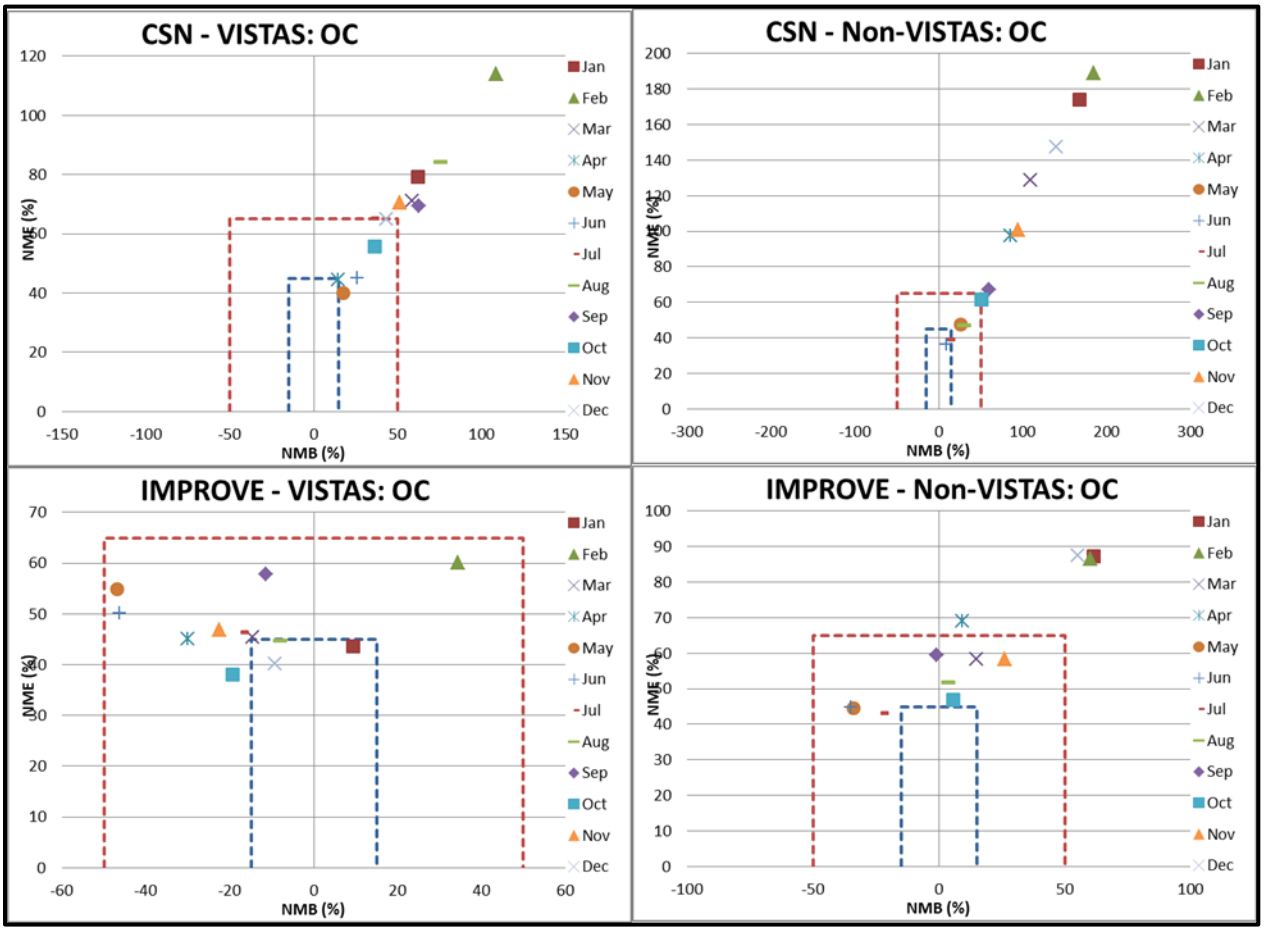


Figure 6-9: Soccer Plots of OC by Network and Month for VISTAS and Non-VISTAS Sites

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.

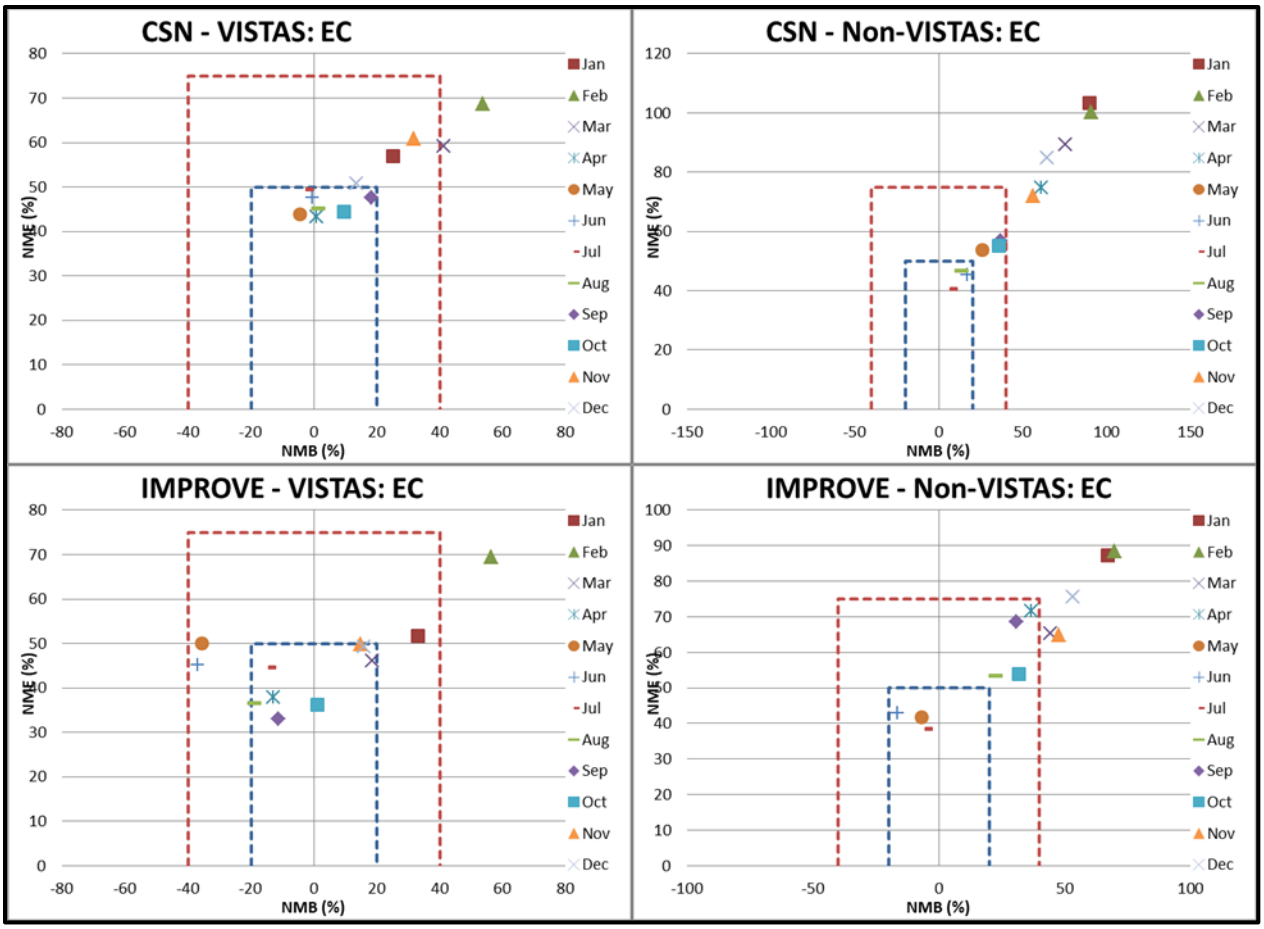


Figure 6-10: Soccer Plots of EC by Network and Month for VISTAS and Non-VISTAS Sites

Spatial plots summarizing IMPROVE observations and model NMB on the 20% most-impaired days are shown in Figure 6-11 through Figure 6-16. In each figure the top graphic presents the observed concentration 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 the rest of the VISTAS12 modeling domain.

In conclusion, performance assessed at the "one atmosphere" level was deemed acceptable for ozone, wet/dry deposition, and particulate matter at various monitoring sites. Overall, the VISTAS2011 modeling platform was found to be representative and acceptable for use in regulatory modeling applications for ozone, particulate matter, and regional haze.

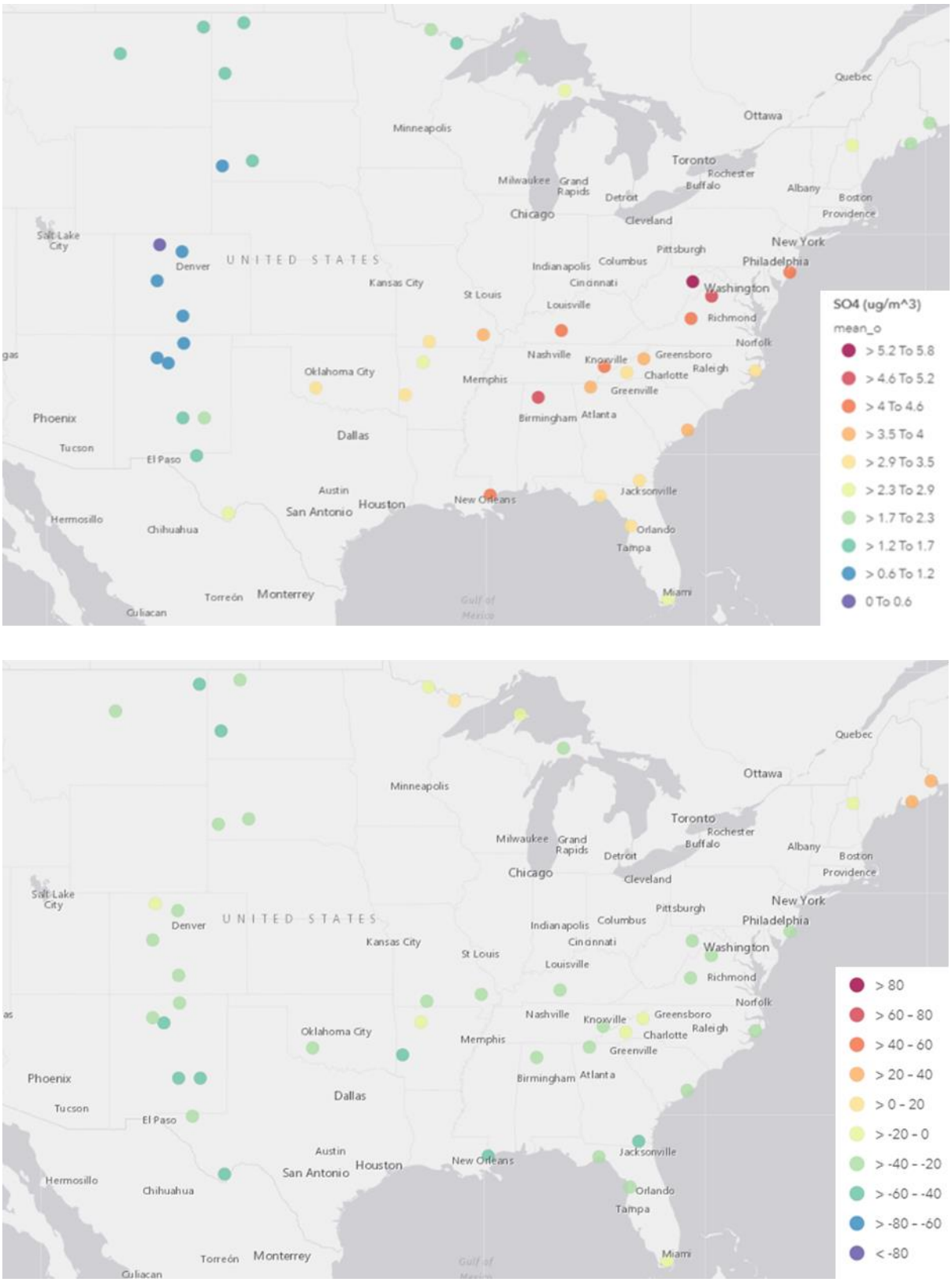


Figure 6-11: Observed Sulfate (Top) and Modeled NMB (Bottom) for Sulfate on the 20% Most-Impaired Days at IMPROVE Monitor Locations

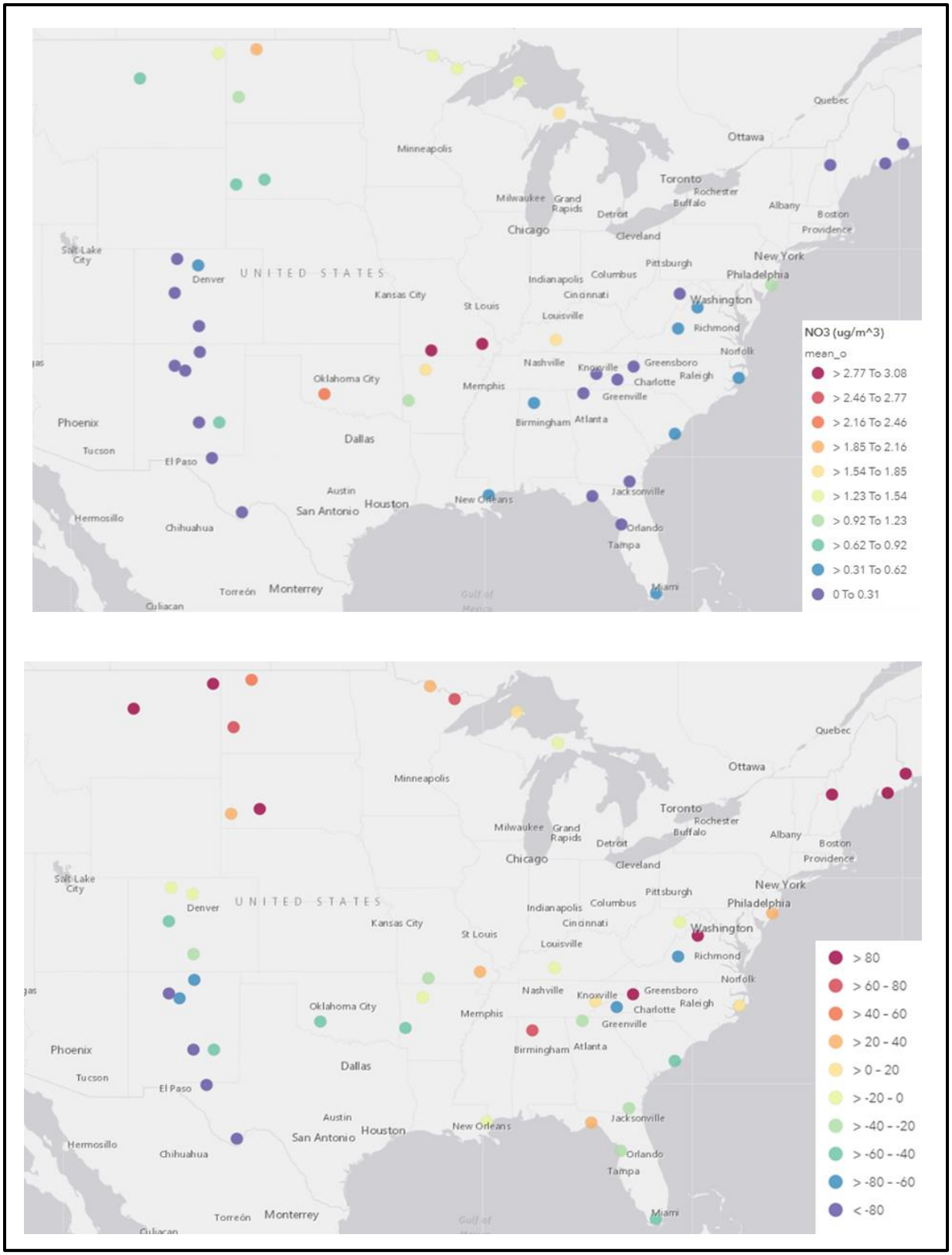


Figure 6-12: Observed Nitrate (Top) and Modeled NMB (Bottom) for Nitrate on the 20% Most Impaired Days at IMPROVE Monitor Locations

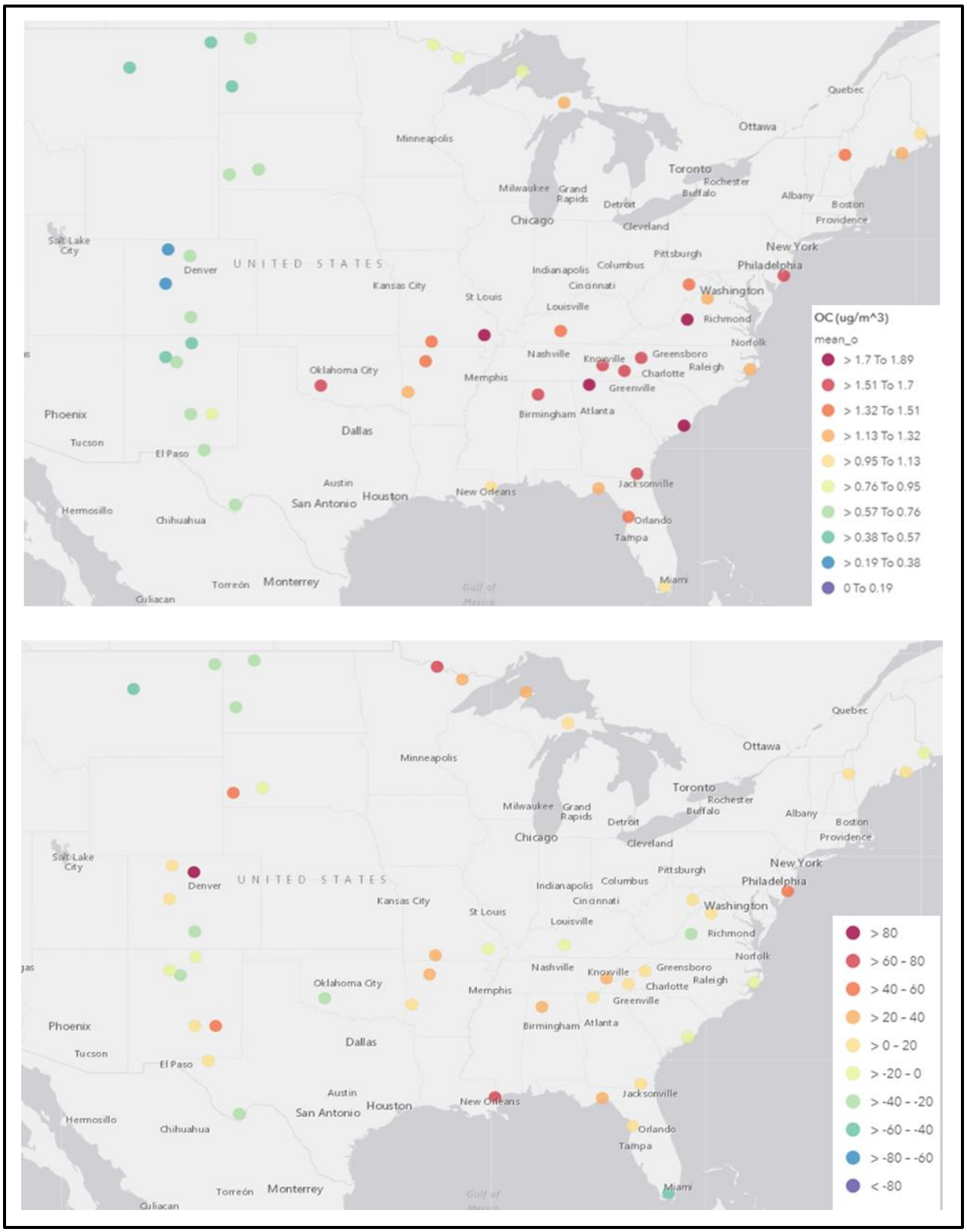


Figure 6-13: Observed OC (Top) and Modeled NMB (Bottom) for OC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

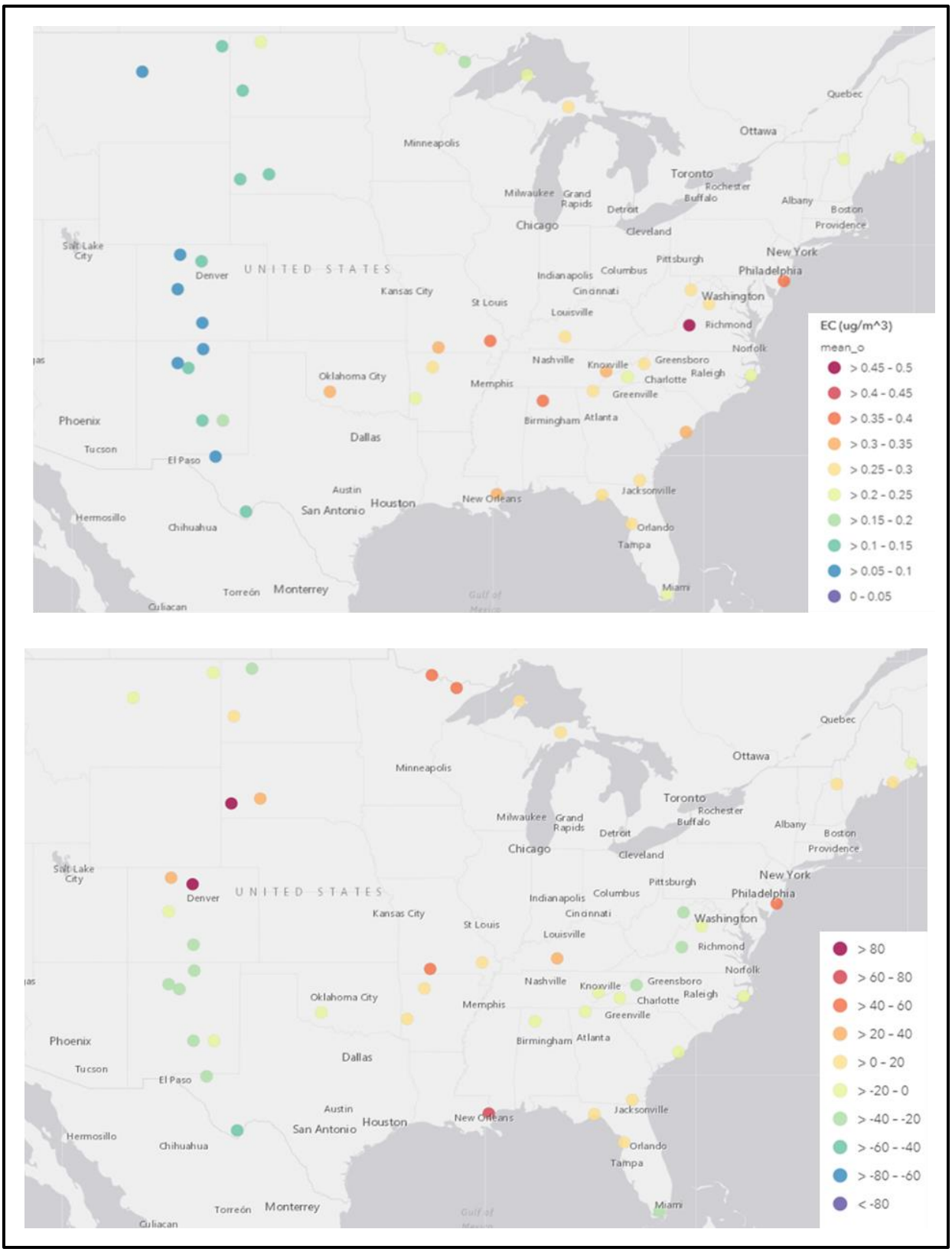


Figure 6-14: Observed EC (Top) and Modeled NMB (Bottom) for EC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

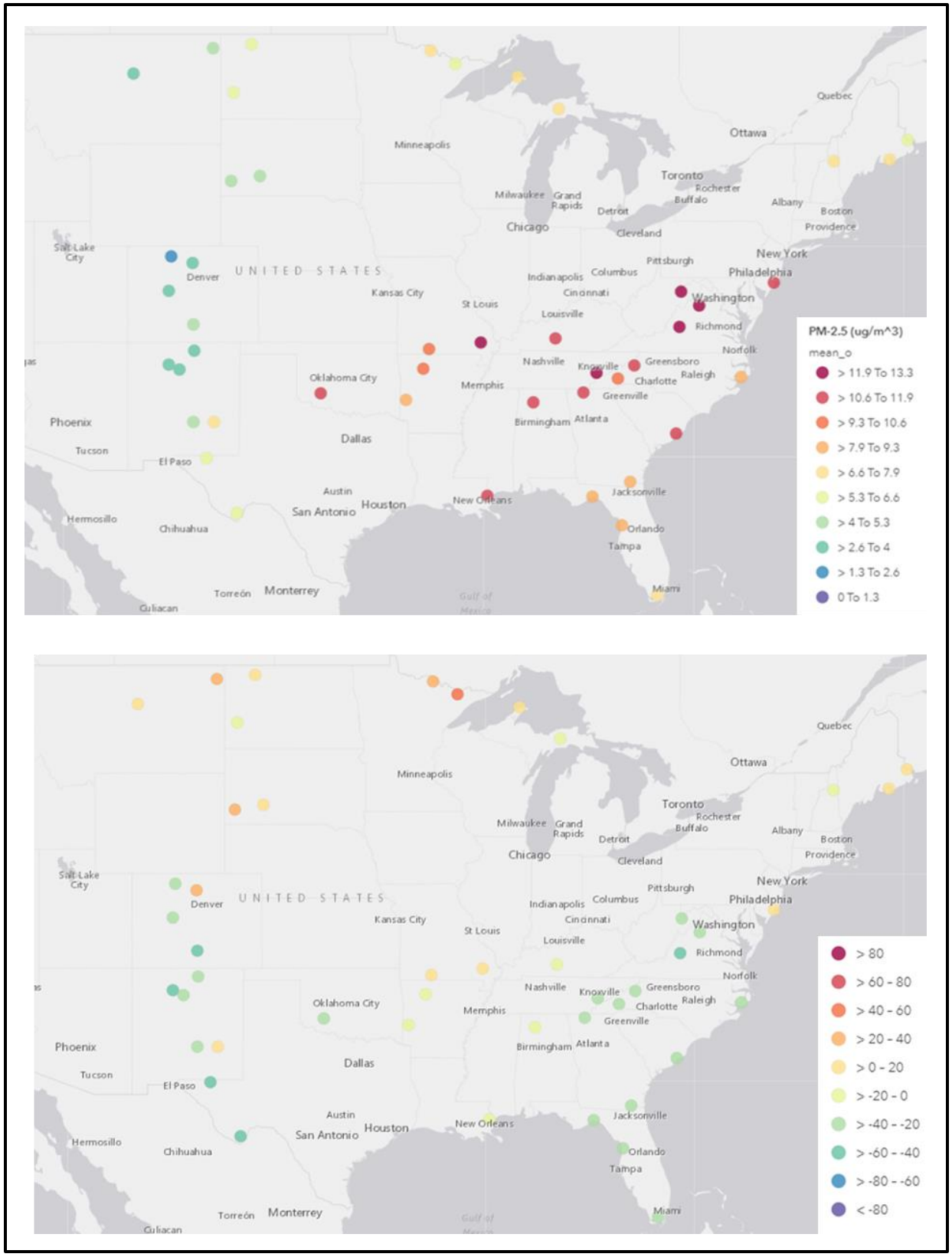


Figure 6-15: Observed Total $PM_{2.5}$ (Top) and Modeled NMB (Bottom) for Total $PM_{2.5}$ on the 20% Most-Impaired Days at IMPROVE Monitor Locations

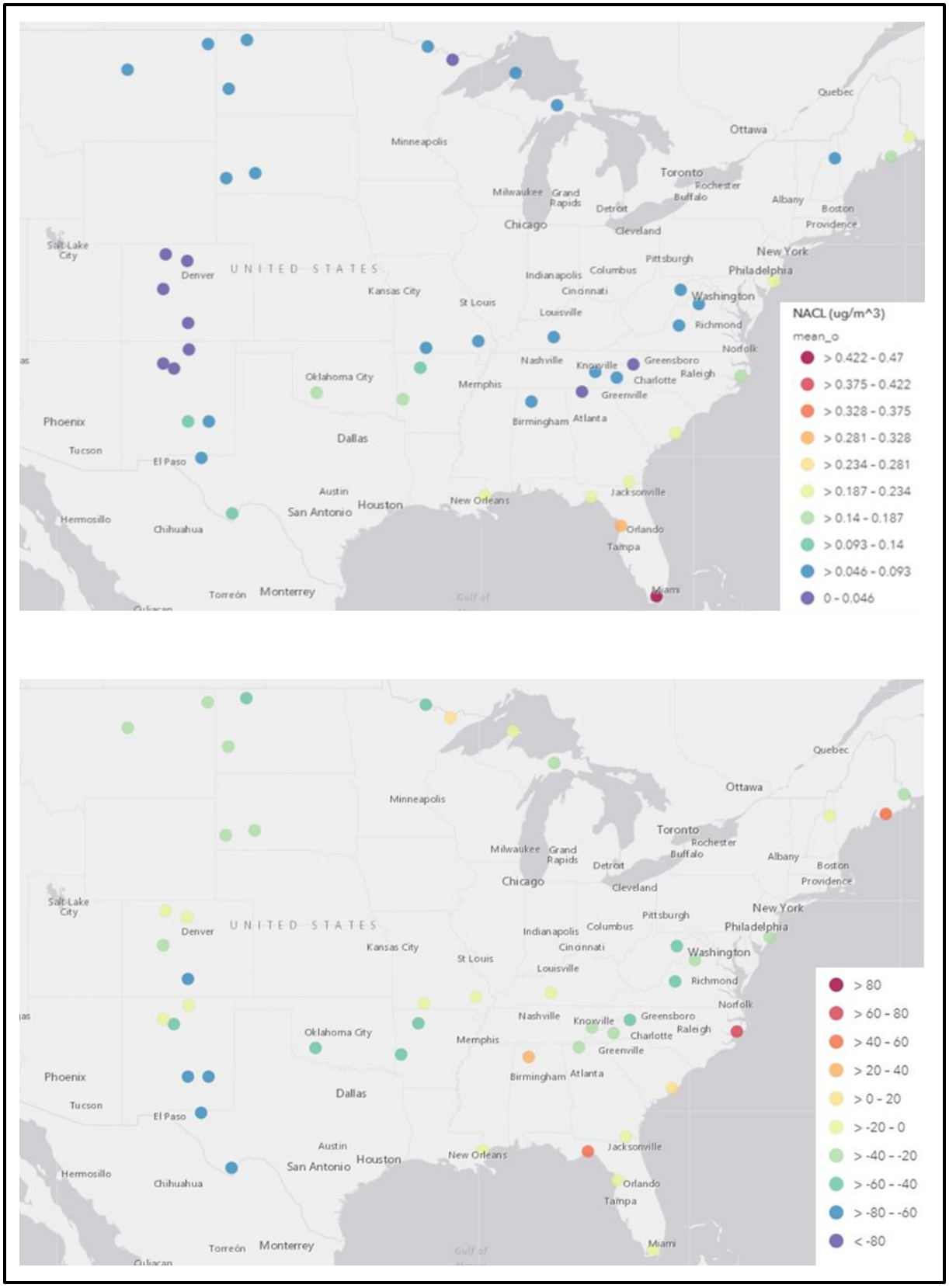


Figure 6-16: Observed Sea Salt (Top) and Modeled NMB (Bottom) for Sea Salt on the 20% Most-Impaired Days at IMPROVE Monitor Locations

6.5. PM Model Performance Evaluation for the Class I Area in South Carolina

The following section provides a detailed model performance evaluation for Cape Romain. 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 through Figure 6-20 contain the average stacked bar charts for Cape Romain. 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
- Brown = mass concentrations of or light extinction due to soil
- Blue = mass concentrations of or light extinction due to sea salt
- Gray = mass concentrations of or light extinction due to coarse mass

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

Figure 6-21 through Figure 6-24 and Figure 6-25 through Figure 6-28 contain the day-by-day stacked bar charts for Cape Romain. These charts allow a side-by-side comparison of observed and modeled speciated PM concentrations and speciated light extinctions on each 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 through Figure 6-22, sulfates and organic carbon are the largest contributors to light extinction in the South Carolina Class I area on both the 20% most-impaired days and the 20% clearest days. The stacked bar charts also suggest that nitrates can be important on the 20% clearest days. Model performance discussion for individual species were further examined with scatter plots.

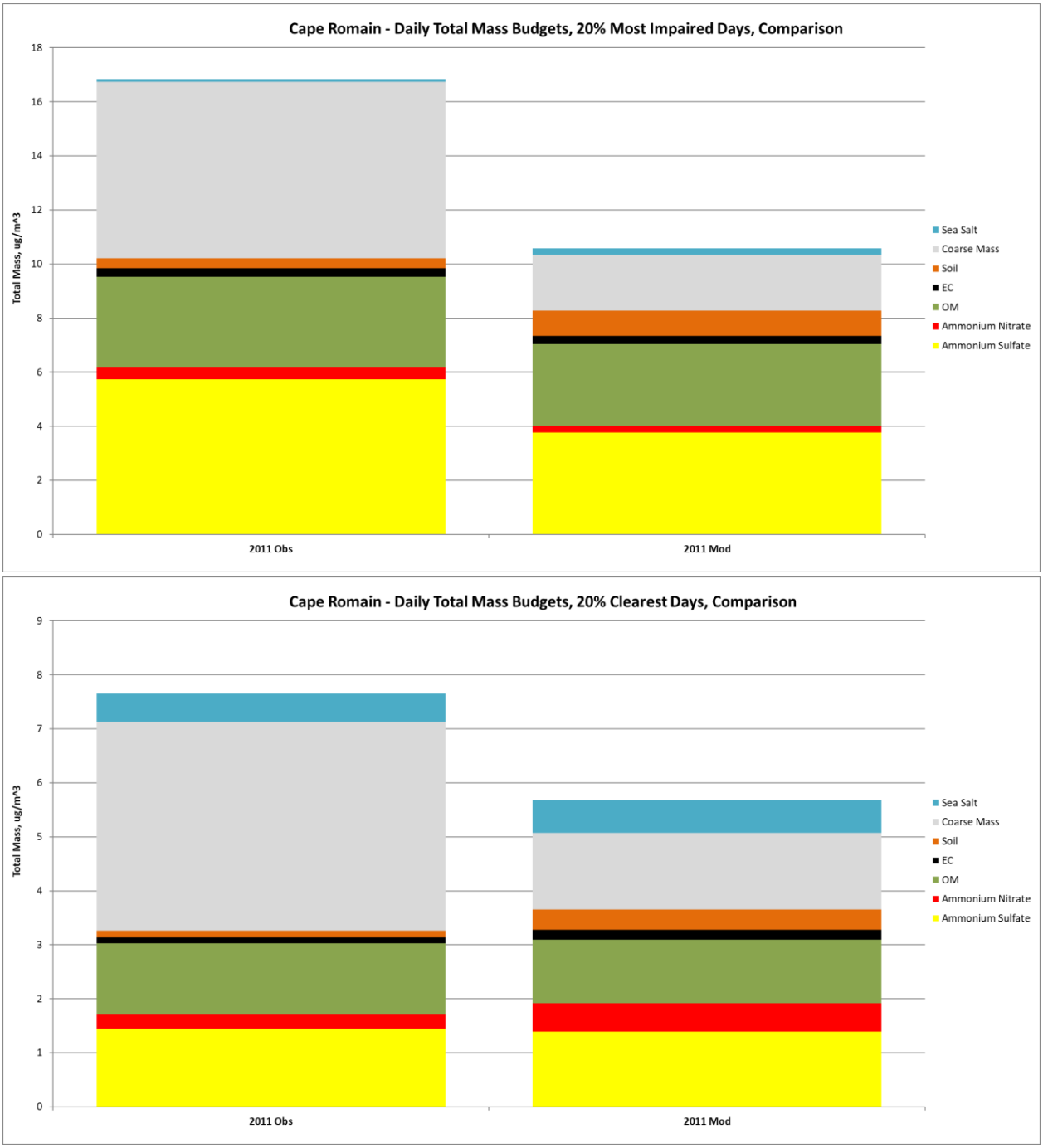


Figure 6-17: Stacked Bar Charts for Average $PM_{2.5}$ Concentrations on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Cape Romain.

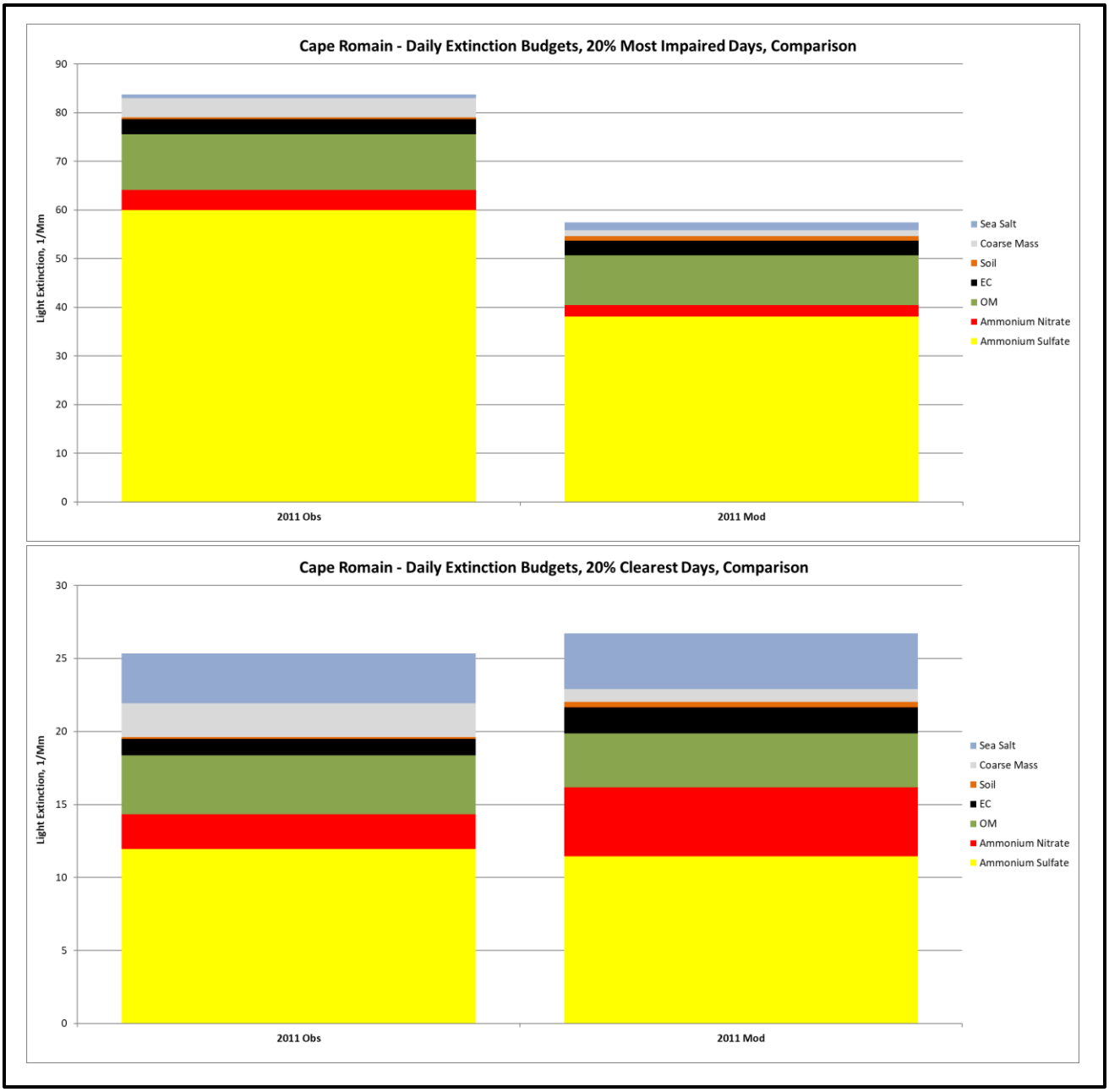


Figure 6-18: Stacked Bar Charts for Average Light Extinction on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Cape Romain.

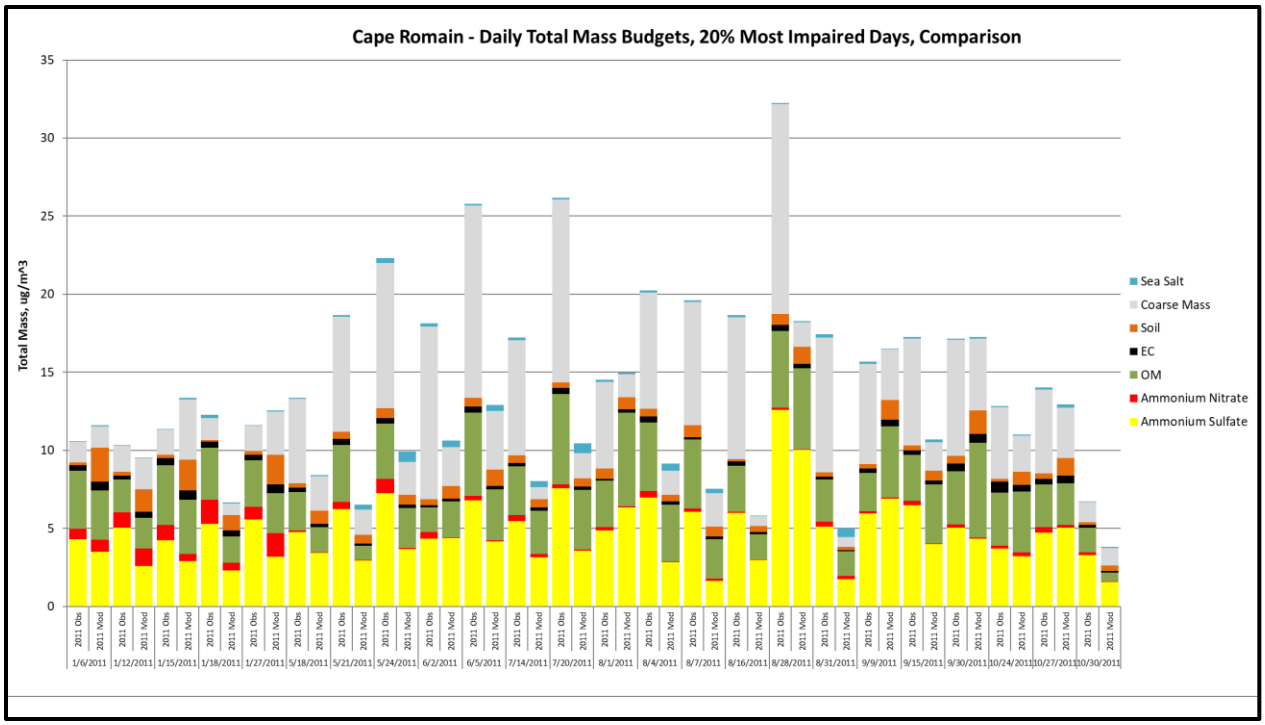


Figure 6-19: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Cape Romain on the 20% Most Impaired Days: Observation (left) and Modeled (Right)

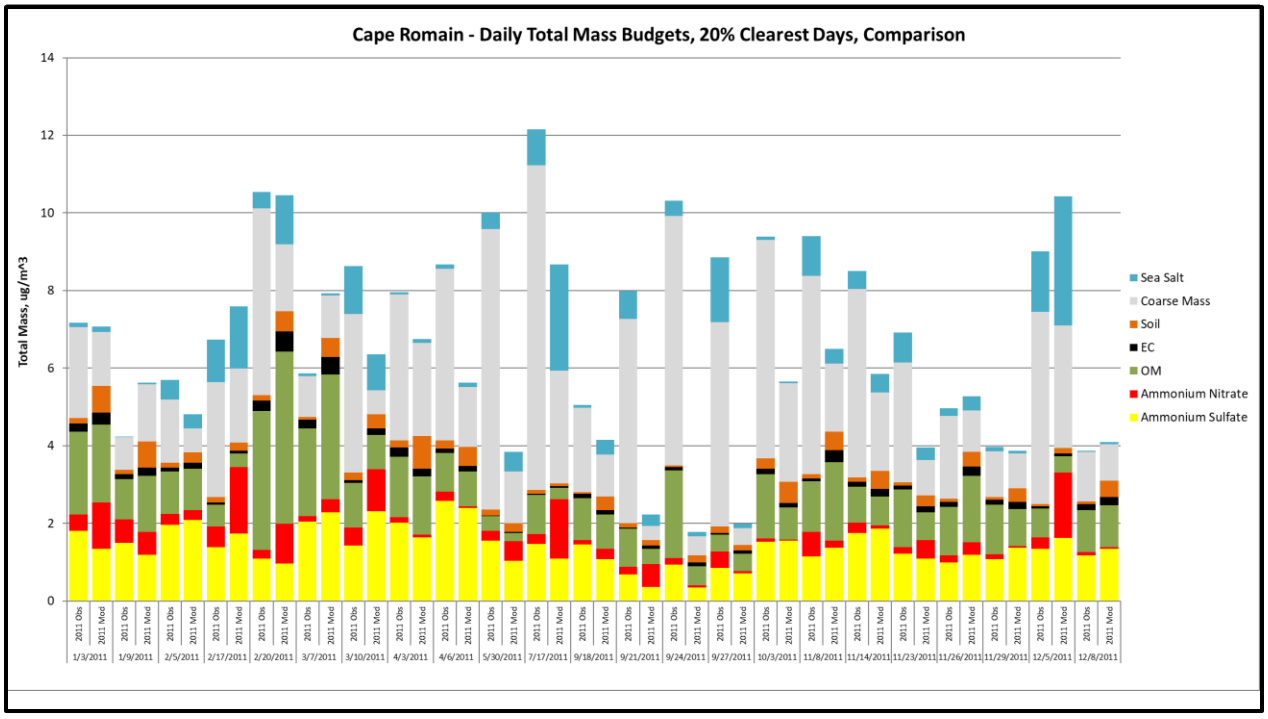


Figure 6-20: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Cape Romain on the 20% Clearest Days: Observation (left) and Modeled (Right)

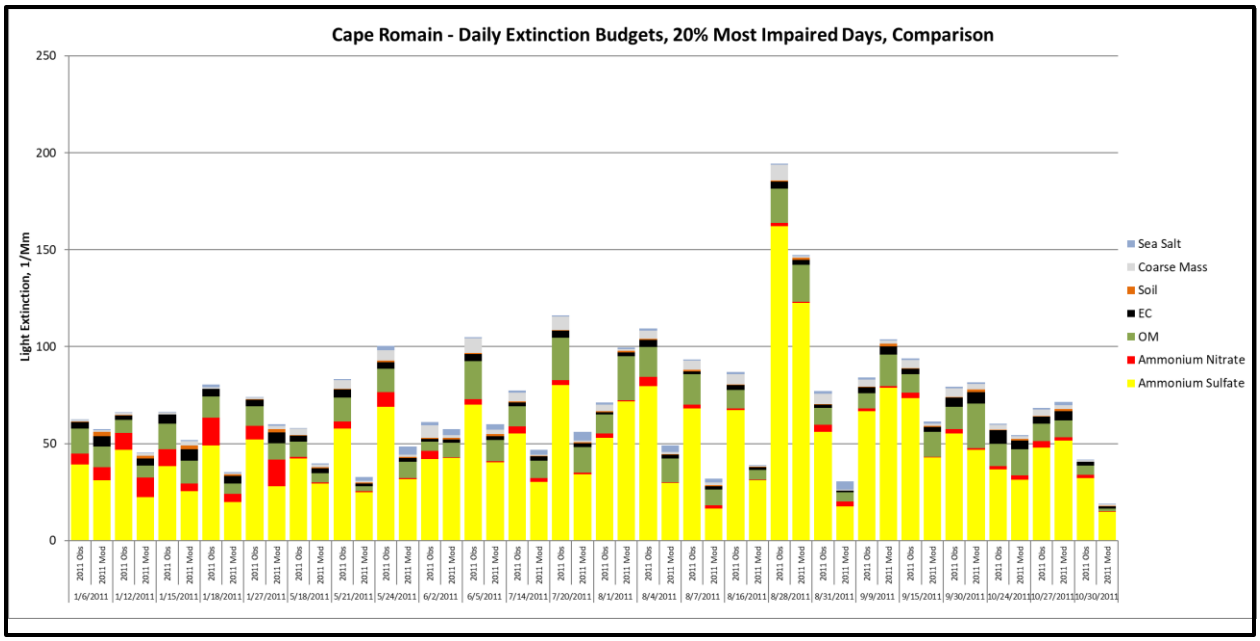


Figure 6-21: Stacked Bar Charts for Light Extinction at Cape Romain the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

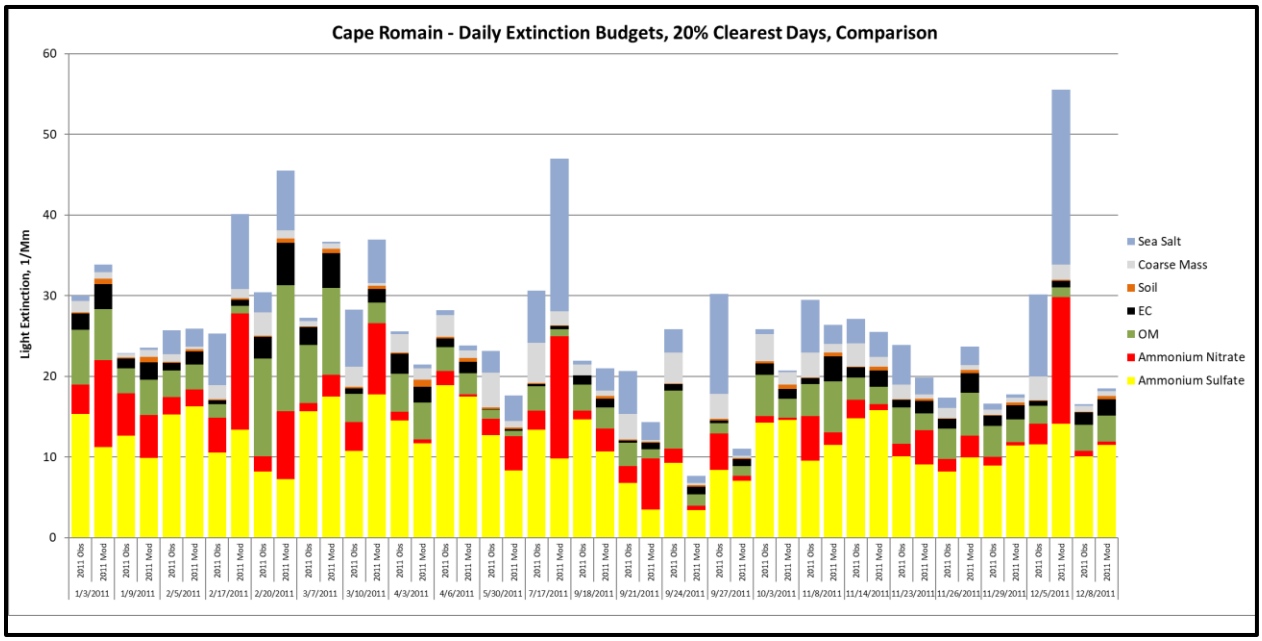


Figure 6-22: Stacked Bar Charts for Light Extinction at Cape Romain on the 20% Clearest Days: Observation (left) and Modeled (Right)

Figure 6-23 and Figure 6-24 contain 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 Cape Romain on the 20% most-impaired days. $PM_{2.5}$, sulfate, nitrate, and coarse mass (labeled as PMC) were generally under predicted while crustal was generally over predicted. Organic carbon, elemental carbon, and sea salt show both over predictions and under predictions.

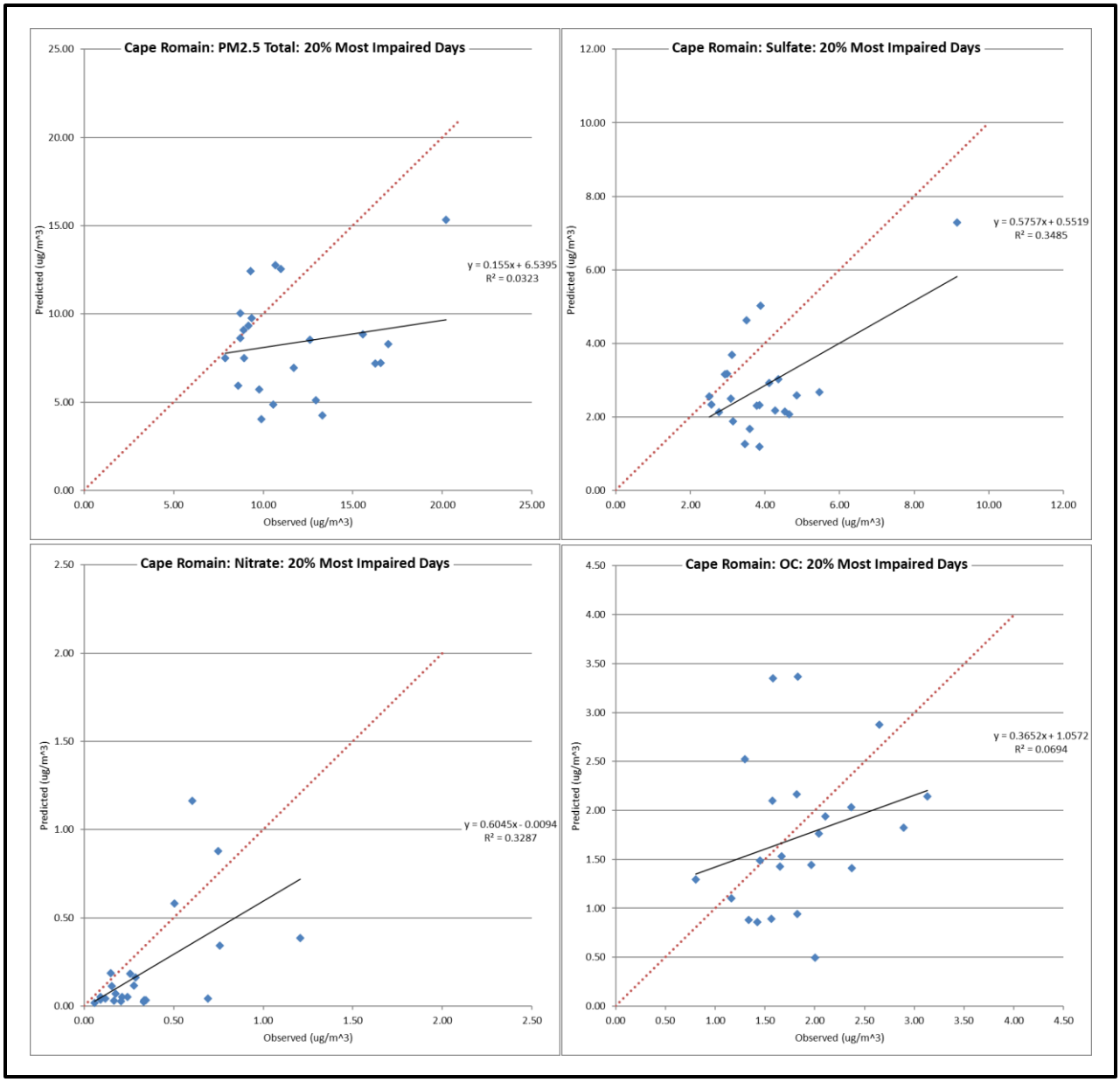


Figure 6-23: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Cape Romain on the 20% Most Impaired Days

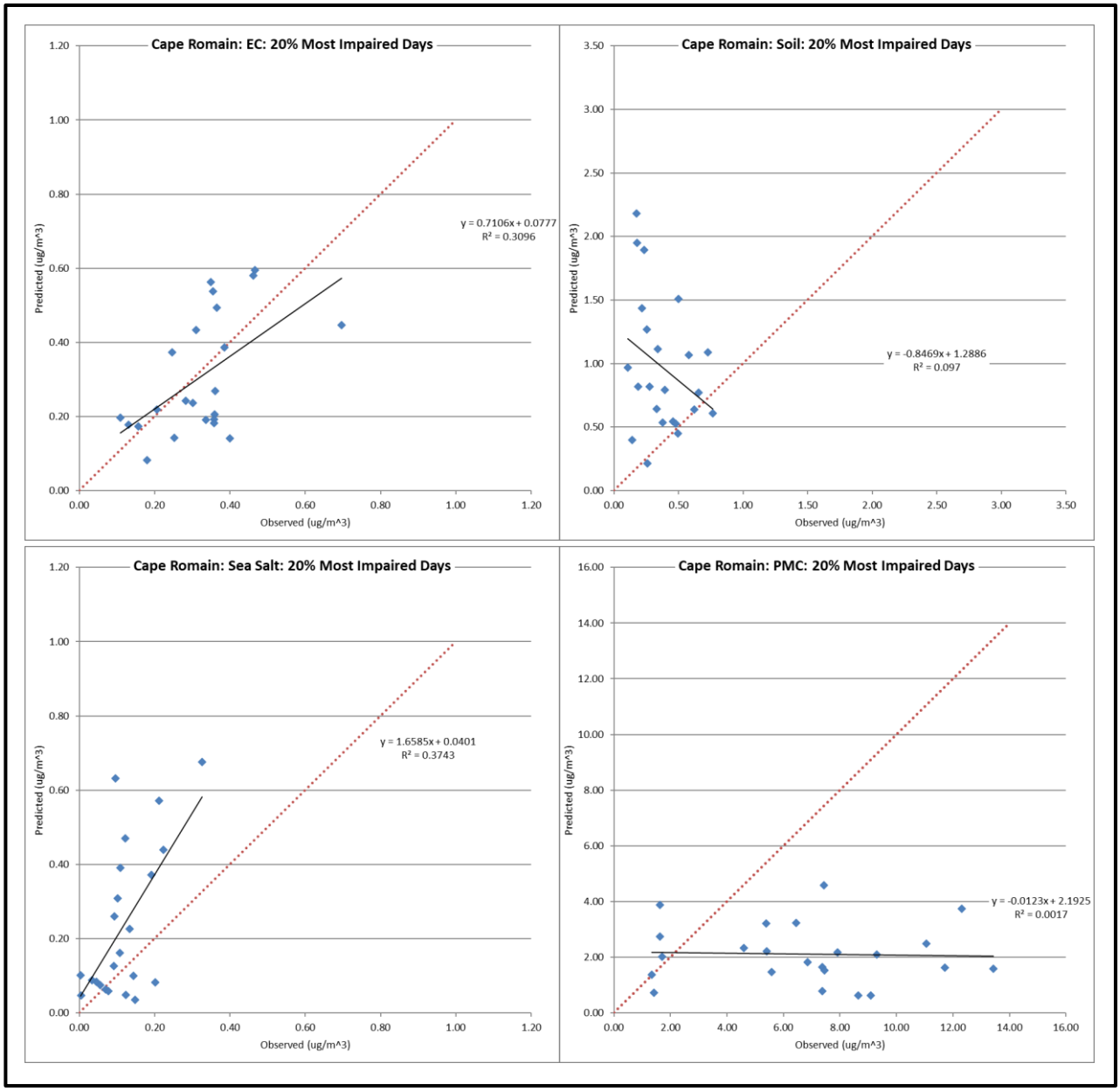


Figure 6-24: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Cape Romain on the 20% Most Impaired Days

Figure 6-25 and Figure 6-26 contain 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 Cape Romain 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.

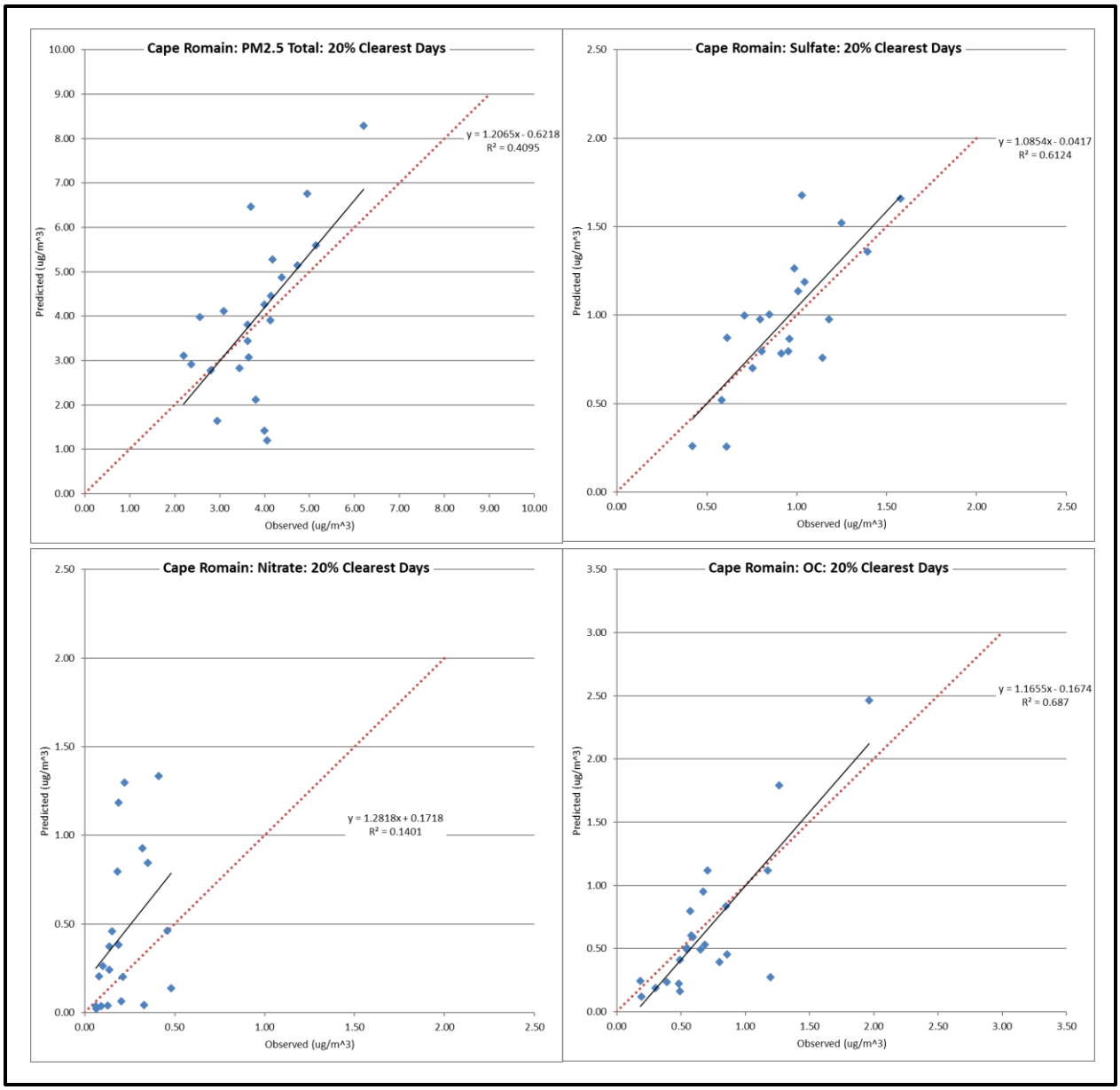


Figure 6-25: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Cape Romain on the 20% Clearest Days.

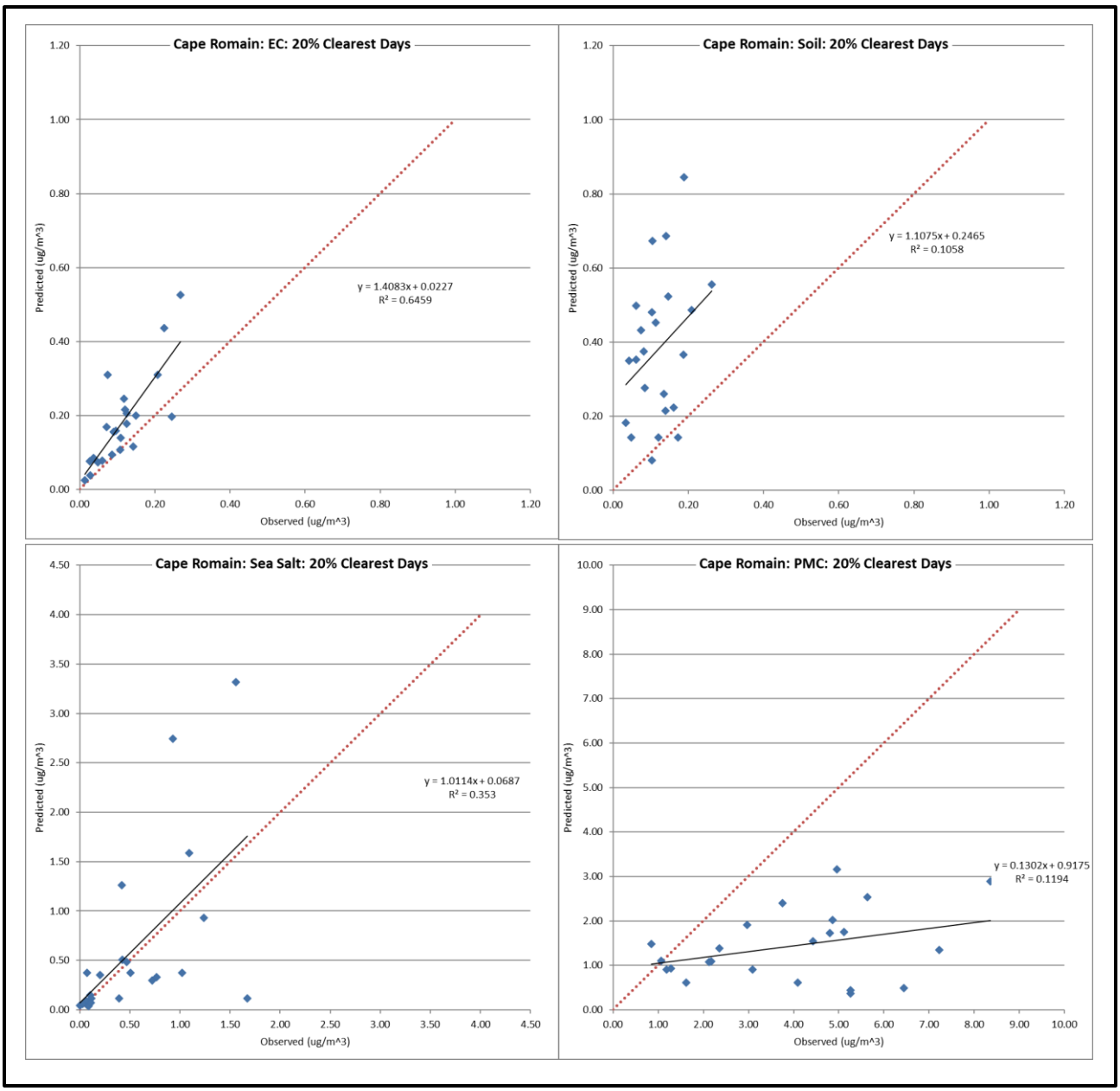


Figure 6-26: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Cape Romain on the 20% Clearest Days

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

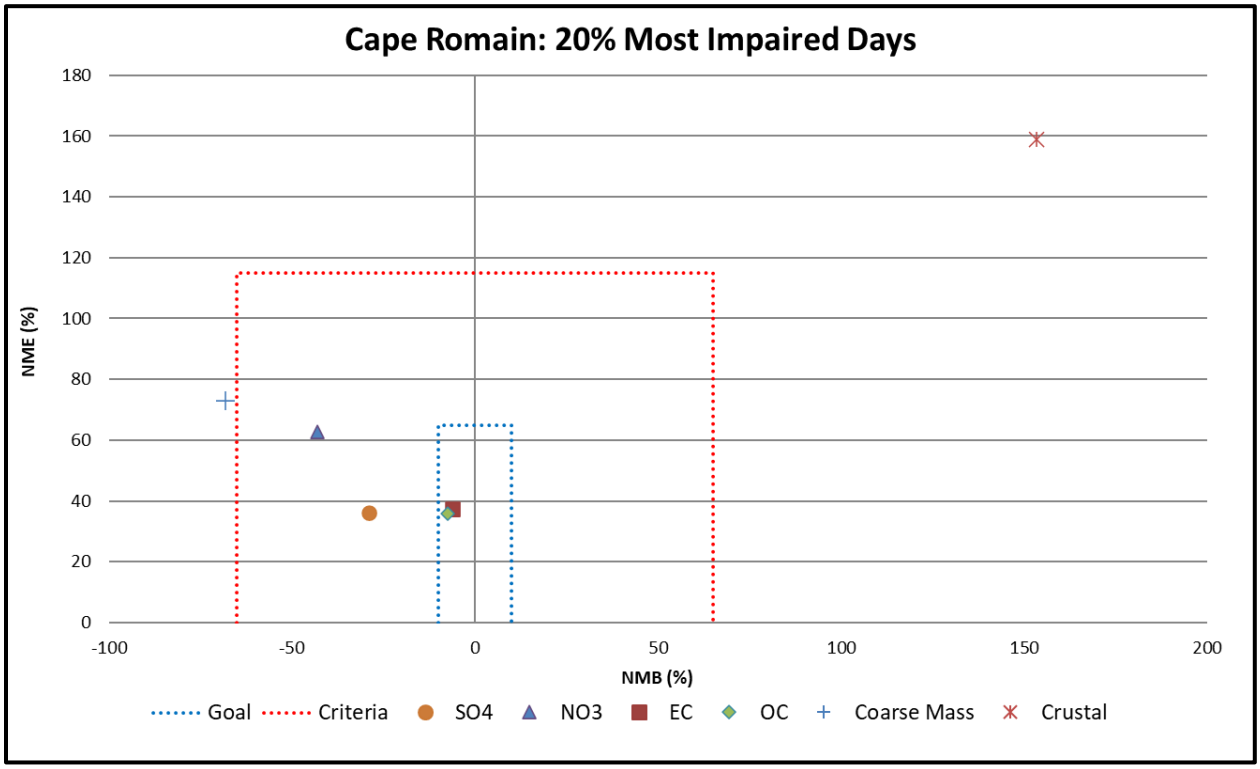


Figure 6-27: Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Cape Romain

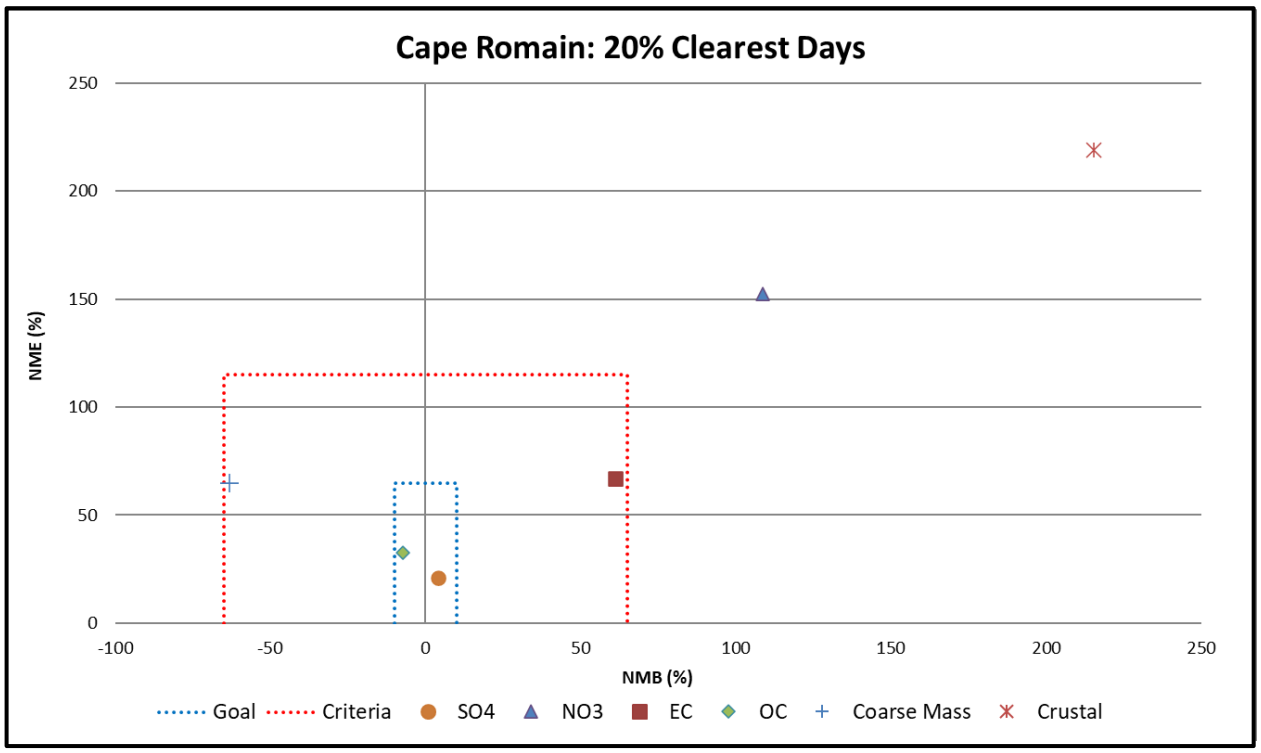


Figure 6-28: Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Cape Romain

Figure 6-29 and Figure 6-30 are bugle plots showing MFB and MFE for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Cape Romain on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days and the 20% clearest days, all species (except course mass) meet the MFB and MFE criteria (red line). On the 20% most impaired days and the 20% clearest days, all species (except sulfate and course mass MFB on 20% most impaired days) meet the MFB and MFE goal (green line).

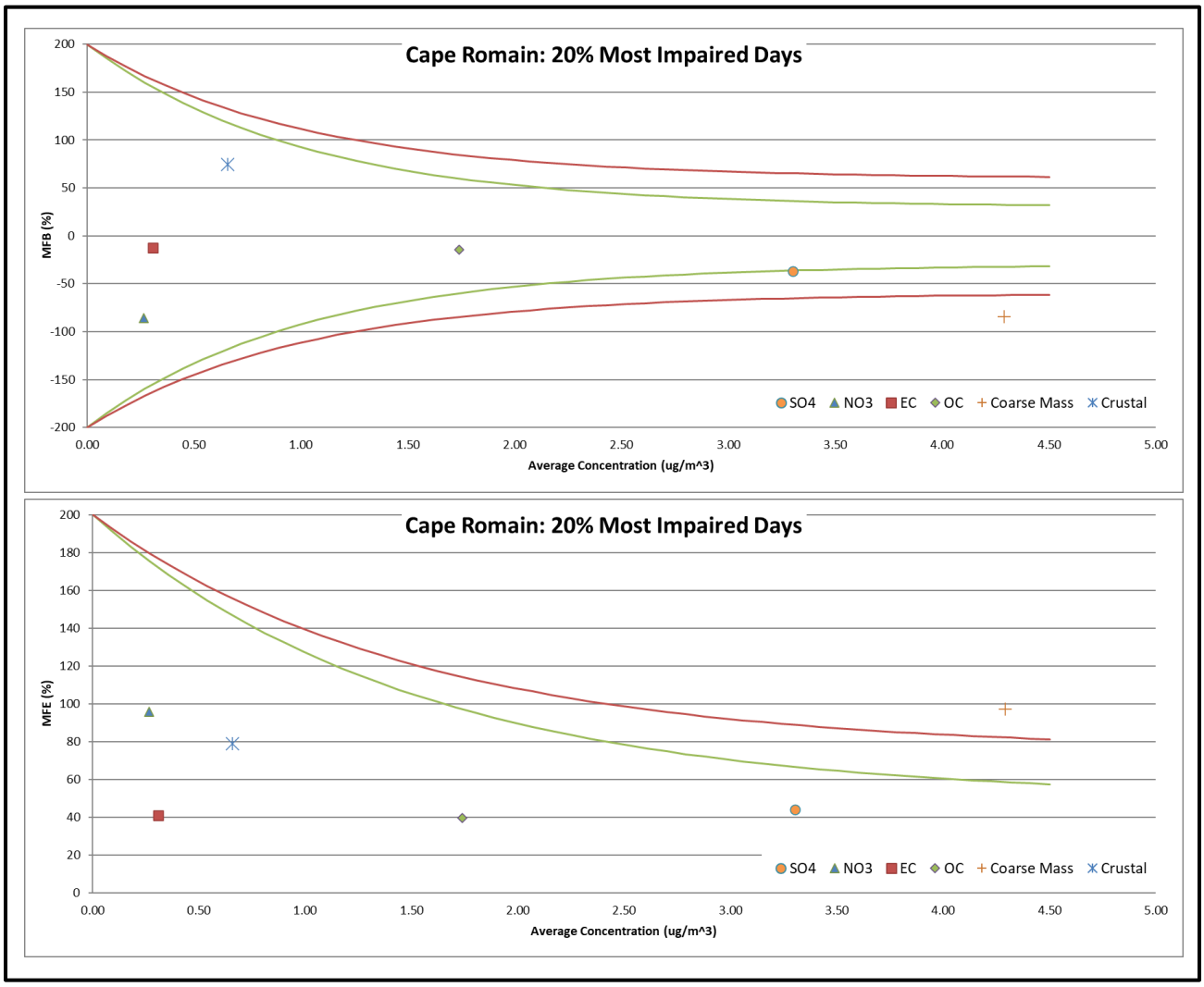


Figure 6-29: Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Cape Romain

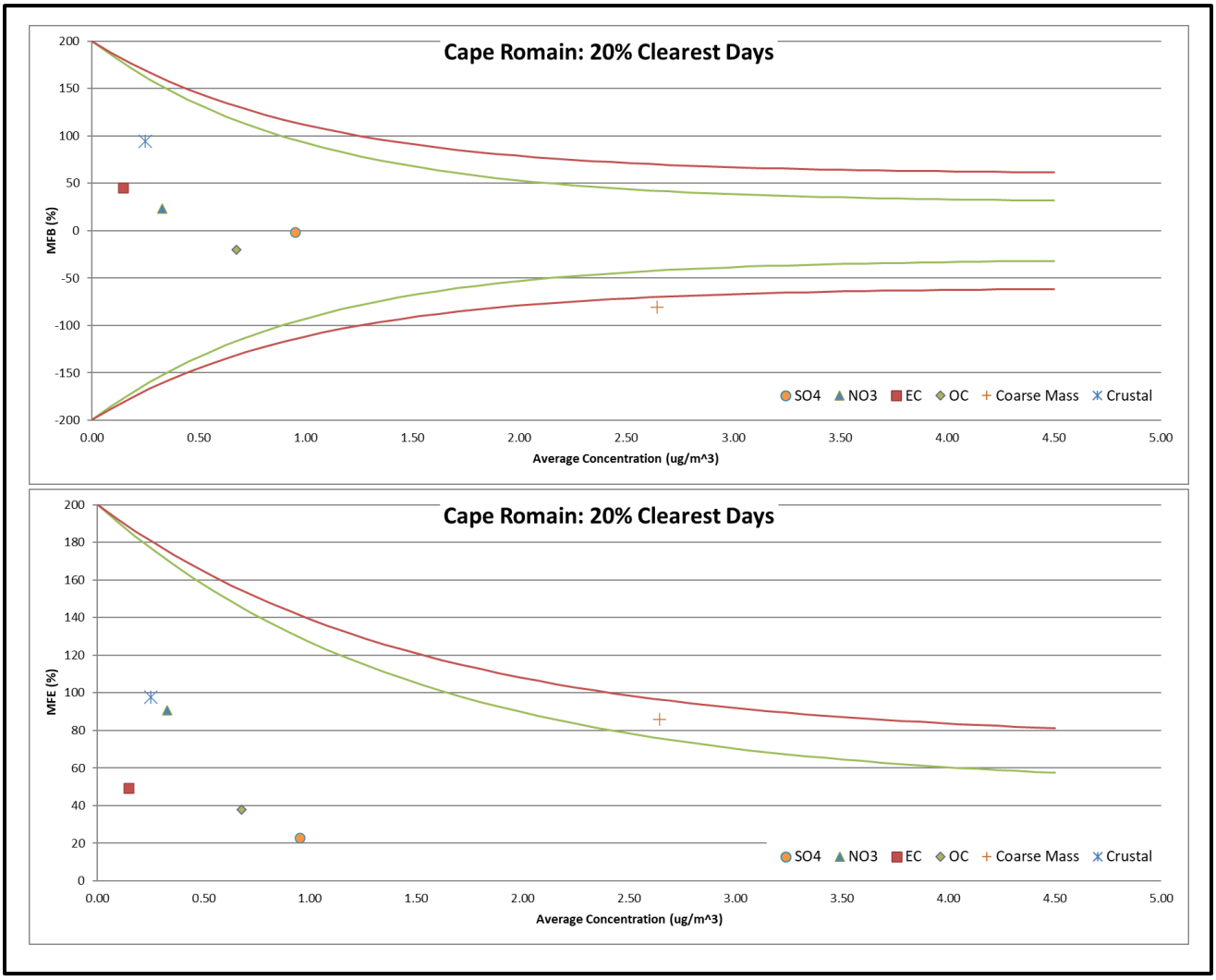


Figure 6-30: Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Cape Romain

Overall, South Carolina found model performance to fall within acceptable limits. South Carolina further asserts 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 South Carolina's Regional Haze SIP.

7. Long-Term Strategy

The regional haze regulation under 40 CFR 51.308(f)(2) requires states to submit a long-term strategy 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 long-term strategy must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress. The regional haze regulation also requires under 40 CFR 51.308(f)(3) that states containing mandatory federal Class I areas must establish 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 long-term strategy 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 long-term strategy through the year 2028. This section discusses development of South Carolina's long-term strategy.

7.1. Overview of the Long-Term Strategy Development Process

The monitor data and the 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 20% most impaired days during the baseline period for Cape Romain. Sulfate accounted for the vast majority of the pollutant impairing species on these days. 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 Cape Romain, 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 Cape Romain. 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 Cape Romain 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. Keeping this conclusion in mind, this section addresses the following questions:

- Assuming implementation of existing federal and state air regulatory requirements in South Carolina and the VISTAS region, how much visibility improvement, compared to the glide path, is expected at Cape Romain by 2028?
- Which mandatory federal Class I areas located outside of South Carolina are significantly impacted by visibility impairing pollutants originating from within South Carolina?
- 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 the South Carolina Class I Area Under Existing and Planned Emissions Controls

Several significant control programs reduce emissions of visibility impairing pollutants between the base year 2011 and the future year 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, Section 110(a)(2)(D)(i)(I), is called the "Good Neighbor" provision. The EPA has implemented a number of rules enforcing the Good Neighbor provision for a variety of NAAQS.

The 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 the ozone season program. Phase 2 began January 2017 for the annual programs and May 2017 for the ozone season program. 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

The 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 the EPA to address the court's holding that the rule unlawfully allows significant contributions to continue beyond downwind attainment deadlines. Therefore, the reductions required by the CSAPR Update rule remain in effect.

7.2.1.2. MATS Rule

On February 16, 2012 (77 FR 9304), the 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. As a direct result of compliance with MATS, there was reduction of 47,382 tons per year of SO_2 emissions from the 2011 baseline modeling. The following facilities either retired the units or switched the units from coal-fired to natural gas-fired: Santee Cooper Grainger, Santee Cooper Jefferies, Progress Energy Robinson, Duke Energy W.S. Lee Steam Station, SCE&G Canadys, SCE&G (now Dominion) McMeekin, and SCE&G (now Dominion) Urquhart.

7.2.1.3. 2010 SO_2 NAAQS

On June 22, 2010 (75 FR 35520), the 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, the 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. The EPA simultaneously revised ambient air monitoring requirements for SO_2, requiring fewer monitors due to the use of a hybrid approach 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 and further reductions may be necessary at certain point sources.

7.2.1.4. Onroad and Non-Road Programs

The CAA authorizes the EPA to establish emission standards for motor vehicles under Section 202 and the authority to establish fuel controls under Section 211. The CAA generally prohibits states other than California from enacting emission standards for motor vehicles under Section 209(a) and for non-road engines under Section 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.

- **2007 Heavy-Duty Highway Rule**

In Subpart P of 40 CFR Part 86, the 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.

- **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 in

this rule are 80% less than the existing fleet average. The heavy-duty tailpipe standards are 60% less than the existing fleet average.

- **Non-Road Diesel Emissions Programs**

The 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 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.

- **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,[35] 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:

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

- Lehigh Cement Company/Lehigh White Cement Company (US District Court, Eastern District of Pennsylvania): the 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 serval 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 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.

7.2.2.1. Cross-State Air Pollution Rule Applicability for South Carolina

The EPA promulgated the CSAPR to replace the Clean Air Interstate Rule (CAIR) and address the good neighbor provisions for the 1997 ozone National Ambient Air Quality Standard (NAAQS), the 1997 $PM_{2.5}$ NAAQS, and the 2006 $PM_{2.5}$ NAAQS. (76 FR 48208; August 8, 2011). CSAPR requires large electric generating units (EGUs) in eastern states, including South Carolina, to meet annual and ozone season NO_X emission budgets and annual SO_2 emission budgets implemented through new trading programs. In a subsequent rulemaking, the EPA determined that in affected Class I areas, CSAPR achieves greater reasonable progress towards the national goal of achieving natural visibility conditions than source-specific BART; and participation by EGUs in CSAPR meets the requirements of an alternative program as prescribed in the Regional Haze Rule at 40 CFR 51.308(e)(2) and (3).

In the CSAPR Update, the EPA relieved EGUs in South Carolina from the obligation to participate in the original CSAPR NO_X ozone season trading program for purposes of addressing the good neighbor requirements for the 1997 ozone NAAQS, and did not require the EGUs to participate in the new CSAPR Update trading program for purposes of addressing the 2008 ozone NAAQS. (40 CFR 52.38(b)(2)(ii)–(iii)).

EGUs in South Carolina remained subject to CSAPR obligations for annual NO_X and SO_2 emissions, for purposes of addressing interstate transport requirements for the 1997 Annual Fine Particulate Matter ($PM_{2.5}$) NAAQS. The Department addressed the CSAPR obligations by

adding state trading program rules codified in South Carolina Regulation 61-62.97 "Cross-State Air Pollution Trading Program" that were adopted into the State's SIP. (82 FR 47936). Regulation 61-62.97 requires EGUs to participate in the South Carolina CSAPR state trading programs for annual NO_X and SO_2 emissions. South Carolina retained the EPA's default allowance allocation methodology, with the trading budgets for NO_X annual and SO_2 Group 2, and the EPA remains the implementing authority for administration of the trading program. The EPA approved these portions of the SIP revision on October 13, 2017 (82 FR 47936), satisfying South Carolina's good neighbor obligation for the 1997 Annual $PM_{2.5}$ NAAQS.

7.2.2.2. NO_X SIP Call

In developing the CSAPR Update rule, the EPA's air quality modeling projected that South Carolina would not contribute significantly to nonattainment or interfere with maintenance in downwind areas for either the 1997 ozone NAAQS or the 2008 ozone NAAQS as of 2017. The EPA determined that the EGUs in the state therefore are no longer subject to a NO_X ozone season trading program under either CSAPR or the CSAPR Update.

On March 8, 2019, the EPA revised the original NO_X SIP Call regulations to give states greater flexibility in the NO_X emissions monitoring requirements that the states must include in their SIPs for certain emissions sources. The revision made part 75 monitoring, recordkeeping, and reporting optional, and allowed states to establish alternative monitoring requirements for NO_X SIP Call budget units that meet the general requirements of 40 CFR 51.121(f)(1) and (i)(1).

Because South Carolina's EGUs and non-EGUs no longer participate in any CSAPR or CSAPR Update trading program for ozone season NO_X emissions, the Department addressed the NO_X SIP Call requirements, and anti-backsliding provisions at 40 CFR 51.905(f) and 40 CFR 51.1105(e), by reinstating applicable NO_X SIP Call requirements at Regulation 61-62.96, ''Nitrogen Oxides (NO_X) Budget Program''. These regulations became state effective upon publication in the SC *State Register* on January 25, 2019. On July 11, 2019, the Department submitted a SIP revision to remove CAIR and incorporate NO_X SIP Call requirements for EGUs and large non-EGUs. South Carolina's NO_X SIP Call state budget for EGUs is 16,199 tons, and the non-EGU budget is 3,479 tons. The SIP submission, which was approved by the EPA on July 29, 2020 (85 FR 45541), included a demonstration under CAA section 110(l) demonstrating that the SIP revision does not interfere with any applicable CAA requirements. and as shown by the technical analysis of potential to emit and historical emissions, NO_X ozone season emissions from South Carolina's covered EGUs and large non-EGUs have remained well below budgeted levels.

The monitoring requirements for each source are specified as NO_X SIP Call permit conditions in federally enforceable Title V operating permits. The Department requires facilities with large

non-EGUs requesting the alternative monitoring to calculate the NO_X mass emissions (tons) for each ozone season and report the total to the Department following each ozone season, annually. In addition, the Department conducts an annual review of its emission inventory data for both EGUs and large non-EGUs, including any new applicable unit emissions, to ensure that the total emissions remain below the NO_X budgets. Should the total emissions from covered EGUs and large non-EGUs for the control period exceed their respective NO_X budgets, the Department will, within one year of determining the exceedance of the NO_X budget, submit a revised state implementation plan to the EPA which compensates for the exceedance and ensures the NO_X budget is met in future years.

7.2.2.3. SC Regulation 61-62.5, Standard No. 5.2 – Control of Oxides of Nitrogen (NO_X)

On June 25, 2004, the Department added new R.61-62.5, Standard No. 5.2, *Control of Oxides of Nitrogen (NO_X)* as part of the EAC process to require reasonable NO_X controls on new stationary sources that emit NO_X. The regulation also requires existing sources that replace their burner assemblies to replace them with low NO_X burners capable of achieving a 30% reduction from uncontrolled levels. The Department received SIP approval for this regulation on August 26, 2005 (70 FR 50195).

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. Projected VISTAS 2028 Emissions Inventory

The VISTAS emissions inventory for 2028 account for post-2011 emission reductions from promulgated federal, state, local, and site-specific control programs, many of which are described 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.[36] 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

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

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 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. In particular, NC developed their own 2028 non-EGU point source emissions inventory based on application of growth and control factors to their most recent year (2016) non-EGU point source inventory. Georgia used 2016 emissions (or 2014 emissions if 2016 was not available) to represent 2028 emissions for the 33 non-EGU facilities with over 100 tpy of SO_2 in 2011, exclusive of Hartsfield-Jackson Atlanta International Airport.

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

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

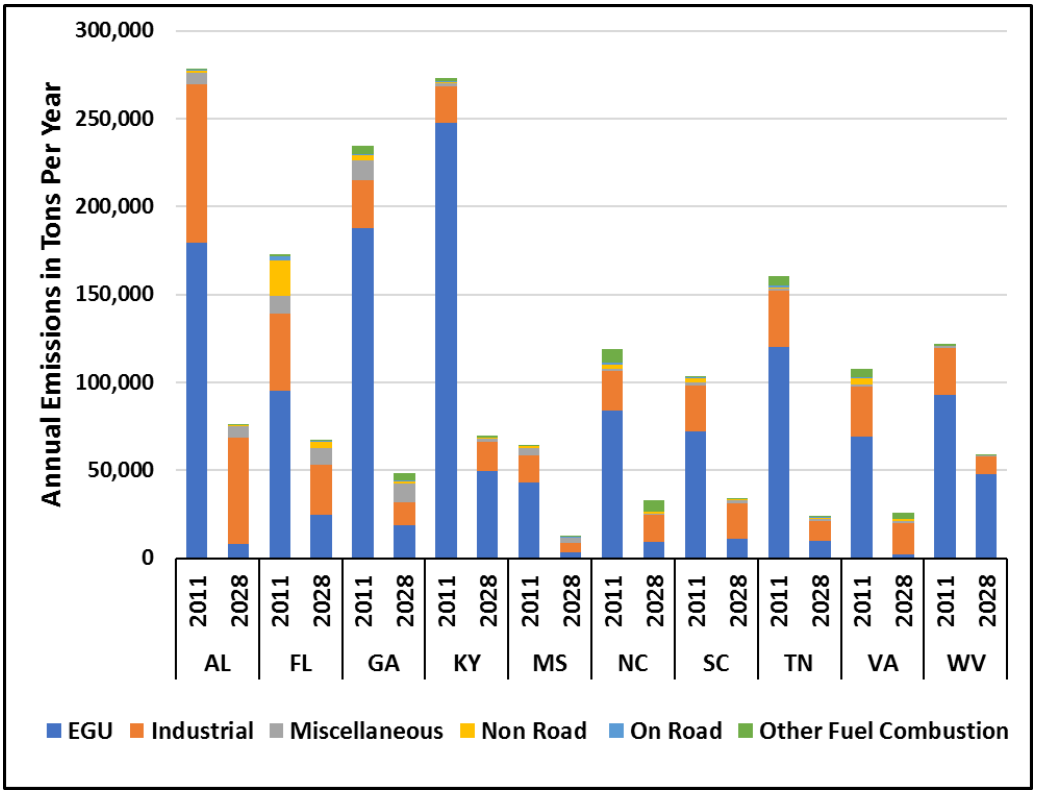


Figure 7-1: SO_2 Emissions for 2011 and 2028 for VISTAS States

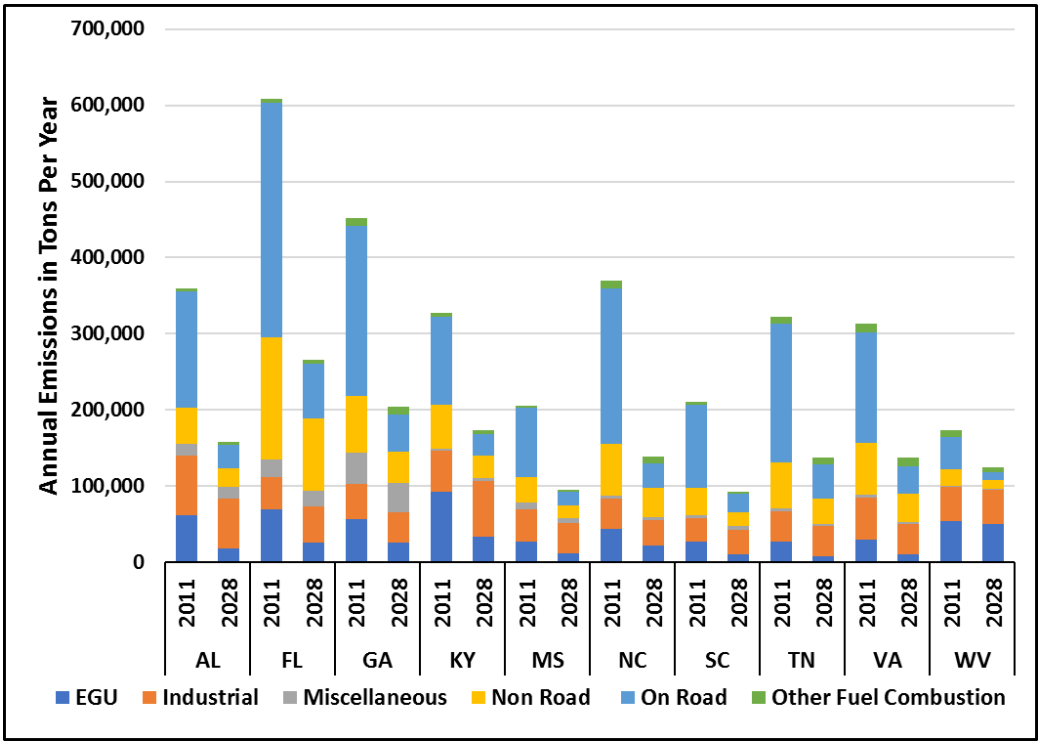


Figure 7-2: NO_X Emissions for 2011 and 2028 for VISTAS States

For SO_2 emissions in particular, which are the largest contributors to haze, 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 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. The 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 inventories from prior the planning period. The expected SO_2 and NO_X emission reductions 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.

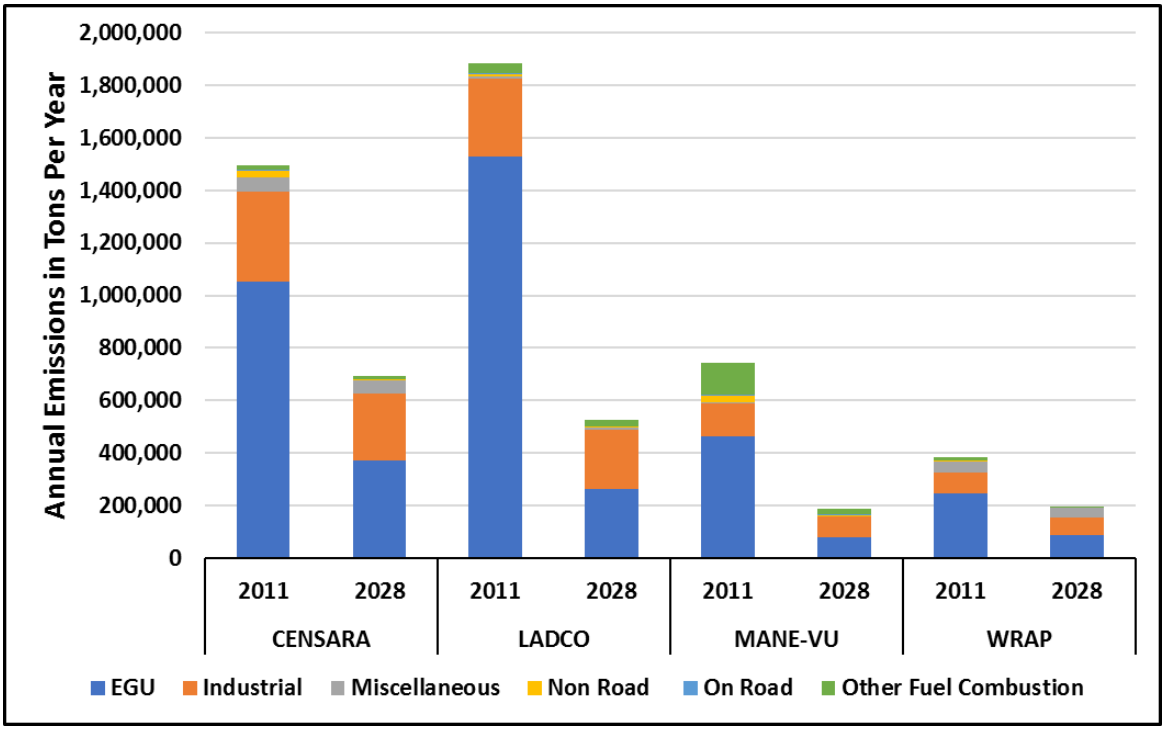


Figure 7-3: SO_2 Emissions for 2011 and 2028 for Other RPOs

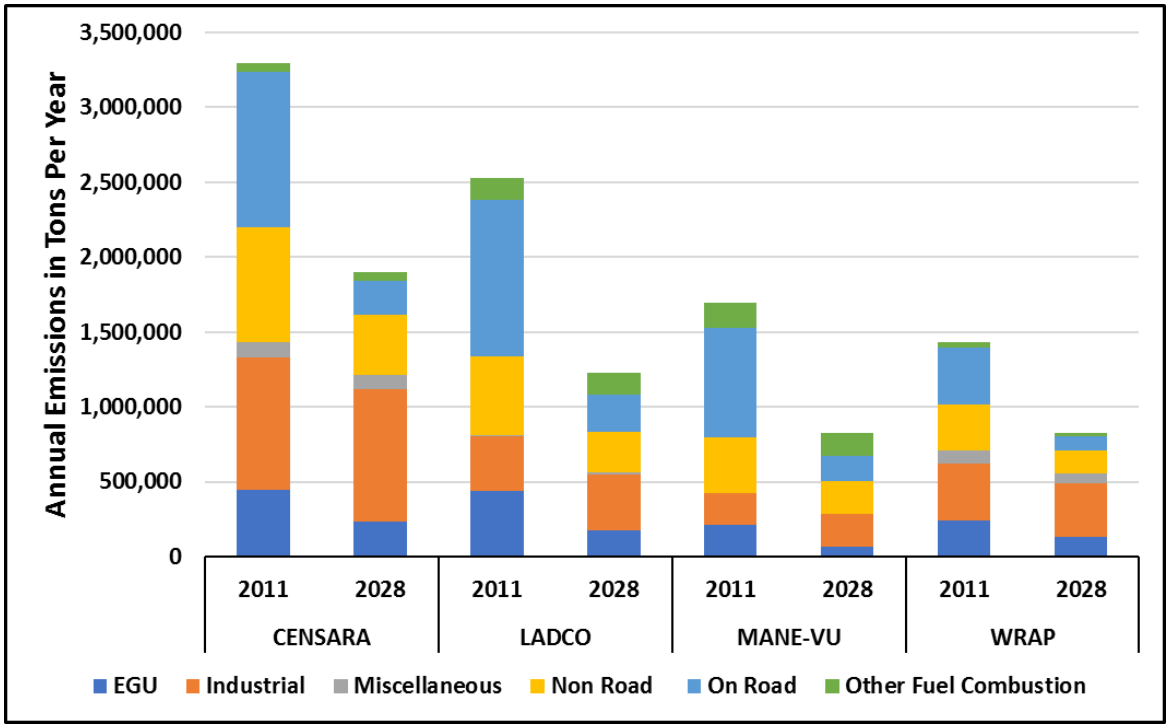


Figure 7-4: NO_X Emissions for 2011 and 2028 for Other RPOs

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

The 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 the 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.[37] The 2023 and 2028 projections from 2016 relied upon IPM for estimates of EGU activity and emissions. The EPA has provided emission summaries of this information at state and SCC levels for both the 2016 base year and the EPA's previous 2014 base year. The 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 the 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.

The EPA has also prepared and published the 2017 NEI[38] based on point source and EGU sector data that originated with state EIS submissions or unit level reporting to CAMD. The 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 The 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. The EPA's 2023 and 2028 data forecast continued 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.

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

[37] URL: https://www.epa.gov/air-emissions-modeling/2016v1-platform
[38] URL: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

years 2023 and 2028, projected from the base year 2016 data by the EPA; and the 2011 and 2028 VISTAS inventories used in the RPG modeling. The 2011, 2014, and 2016 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. The EPA's 2023 and 2028 projections forecast continued 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 the 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, the 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 does 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.

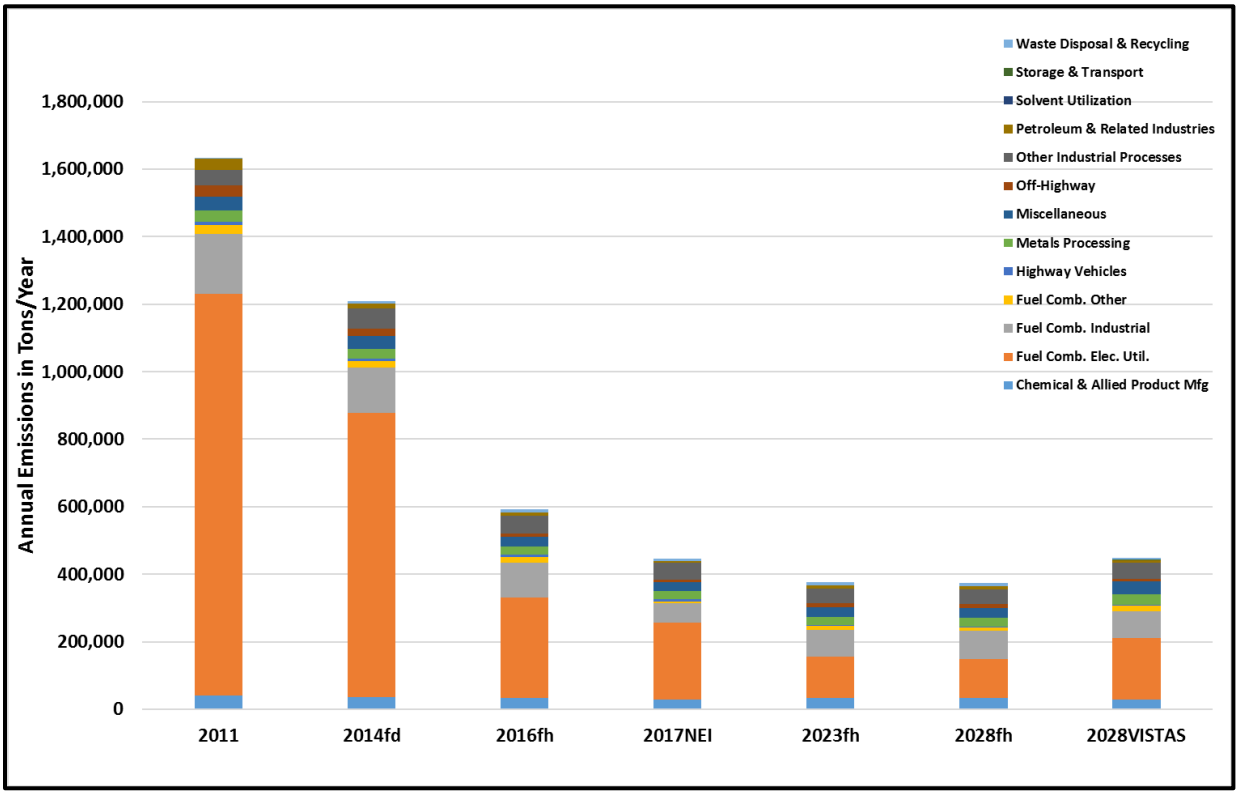


Figure 7-5: SO_2 Emissions from VISTAS States

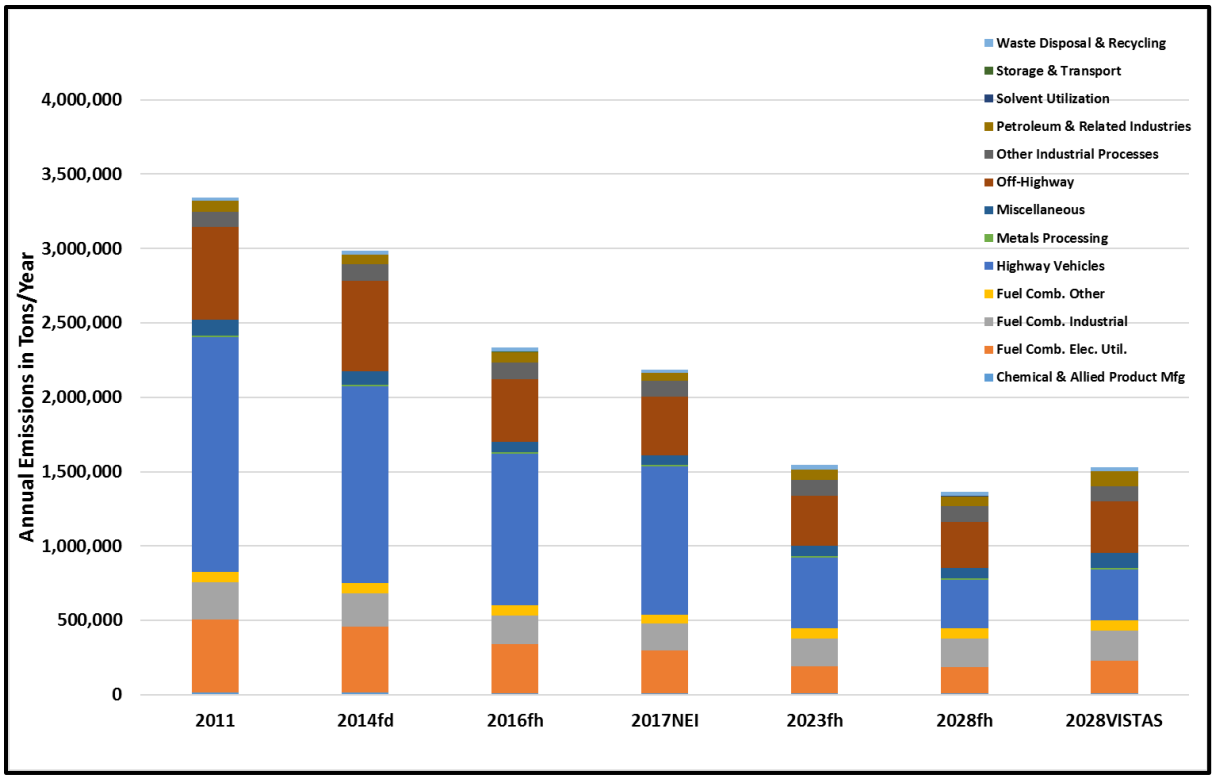


Figure 7-6: NO_X Emissions from VISTAS States

The data for South Carolina in the EPA inventories also forecast significant declines in both SO_2 and NO_X emissions. Figure 7-7 provides the EPA's estimates of South Carolina's actual SO_2 emissions from 2011, 2014, 2016, and 2017 as well as the EPA's projected values for 2023 and 2028 and the VISTAS projected value for 2028. The EPA estimated just over 103,000 tons of SO_2 emissions from South Carolina in 2011. The EPA expects that SO_2 emissions in South Carolina will drop to just over 26,000 tons by 2028, a 75% reduction. The VISTAS projection for South Carolina shows that emissions of SO_2 should drop to just under 34,000 tons by 2028, a 67% reduction.

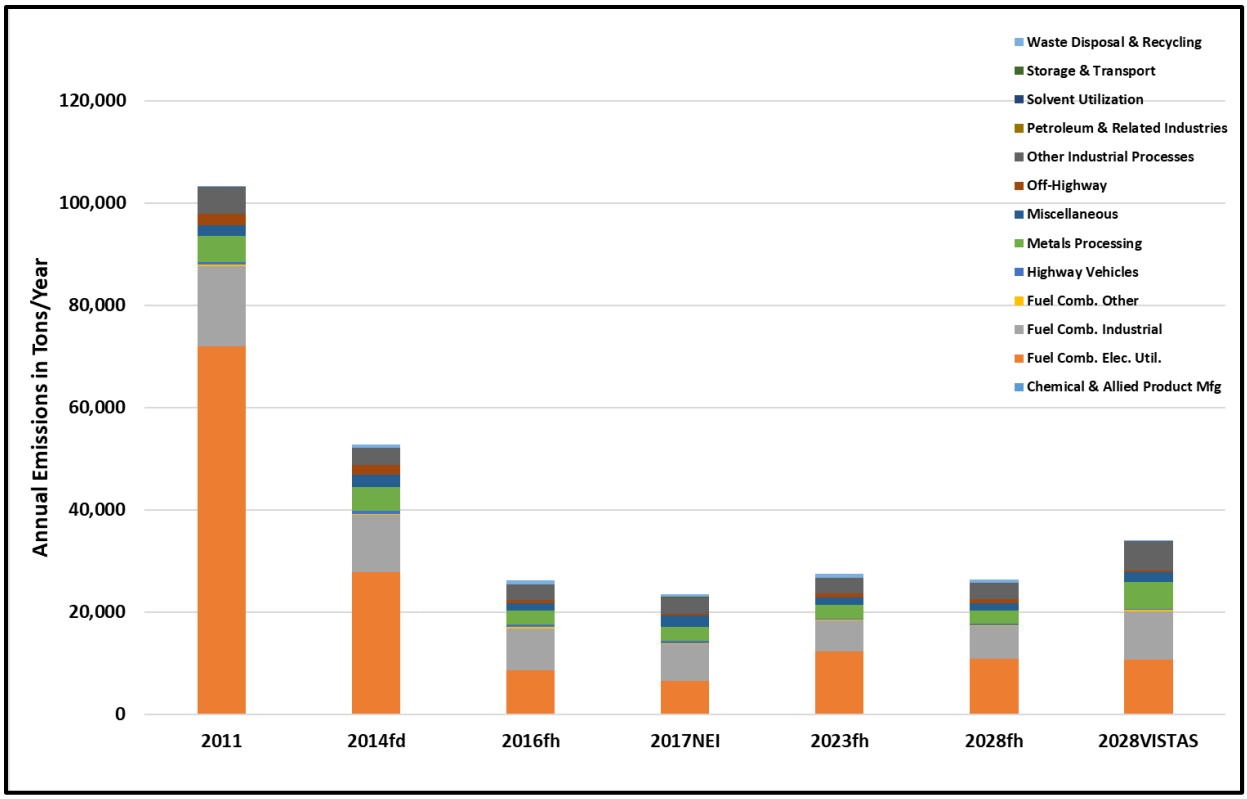


Figure 7-7: South Carolina SO_2 Emissions

Figure 7-8 provides the EPA's estimates of actual NO_X emissions in South Carolina from 2011, 2014, 2016, and 2017. The figure also shows the EPA's projected values for 2023 and 2028, using 2016 as the base year, and the VISTAS projections for 2028. The EPA estimated about 210,500 tons of NO_X emissions from South Carolina in 2011. The EPA expects that NO_X emissions in South Carolina will drop to just over 97,000 tons by 2028, a 54% reduction. The VISTAS projections estimate that South Carolina NO_X emissions will drop to under 93,000 tons by 2028, a 56% reduction.

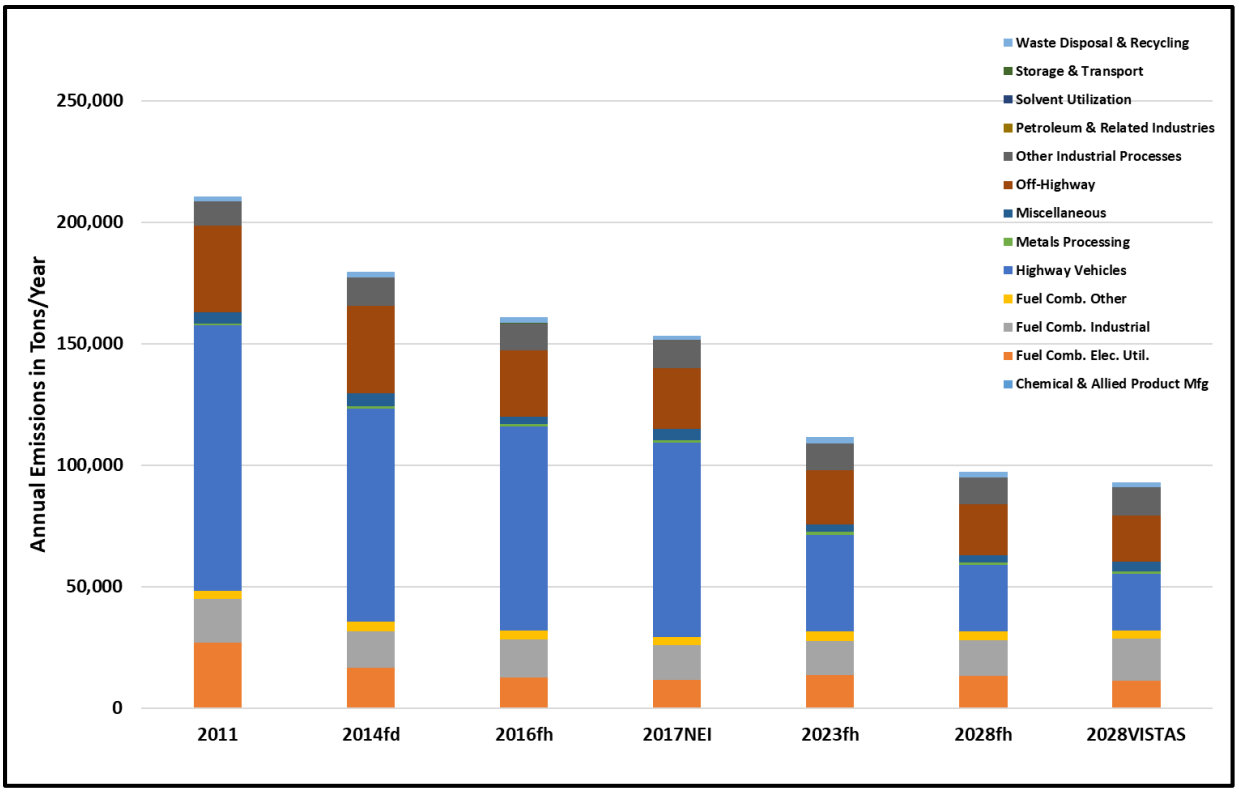


Figure 7-8: South Carolina NO_X Emissions

The VISTAS 2028 projections do not include reductions from programs noted in Section 8.2 so that the estimates are likely conservative and actual 2028 emissions of SO_2 and NO_X should be lower than those noted.

7.2.6. VISTAS 2028 Model Projections

VISTAS states used emissions modeling, as described in Section 5 and Section 6, to project visibility in 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[39] is an EPA software tool that implements the procedures in the "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze," (SIP modeling guidance)[40] 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.

[39] URL: https://www.epa.gov/scram/photochemical-modeling-tools
[40] URL: https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

7.2.6.1. Calculation of 2028 Visibility Estimates

The visibility projections follow the procedures in Section 5 of the SIP modeling guidance. Based on recommendations in the SIP 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. 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 detailed description 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.[41] 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 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,

[41] 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

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 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	11.42	33.87	16.64	53.81
Chassahowitzka Wilderness Area	CHAS1	FL	12.54	35.28	16.79	54.50

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})
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 Areae	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 Paths for the South Carolina Class I 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 base line 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 URP glide paths for Cape Romain. The pink lines represent the URP at the Class I area. 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 the Class I area. 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 long-term strategy associated with this round of planning. Blue diamonds on these figures represent IMPROVE monitoring data on the 20% most impaired days at the Class I area, and the brown lines denote the five-year rolling average of each set of IMPROVE monitoring data.

At Cape Romain, visibility improvements on the 20% most impaired days are expected to be significantly better than the uniform rate of progress glide path by 2028.

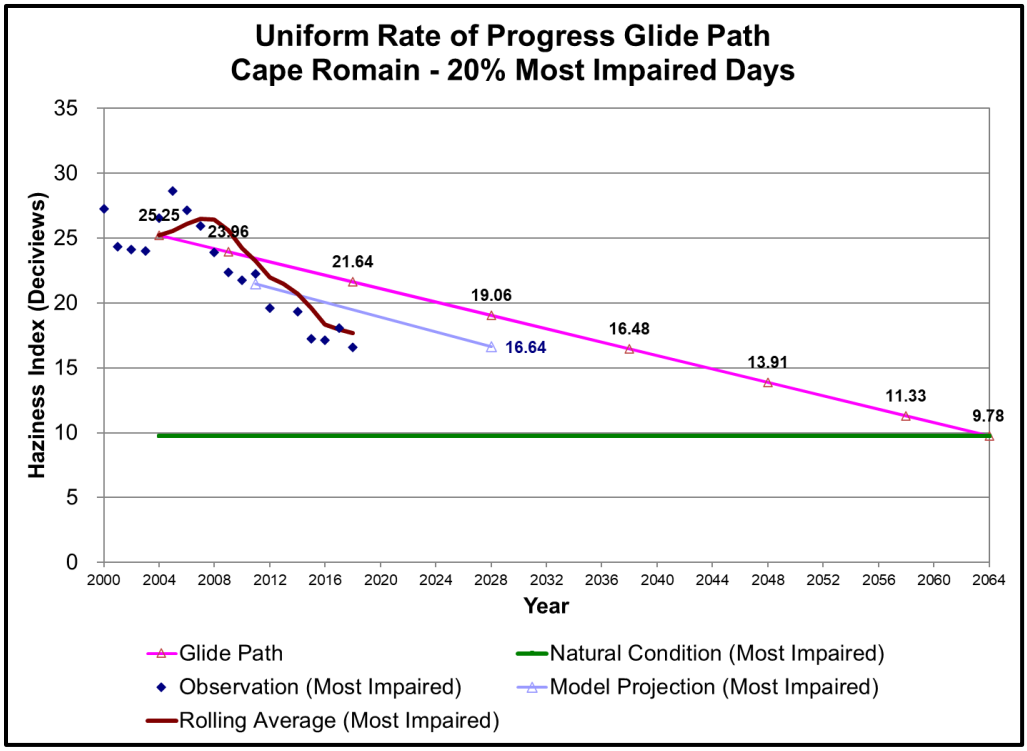


Figure 7-9: Cape Romain Wilderness Area URP on the 20% Most Impaired Days

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 uniform rate of progress. In Figure 7-11, 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, haze in Cape Romain is projected to be 12% lower than the expected visibility for 2028 on the URP. For Cape Romain, visibility improvements are ahead of the timeline noted on the URP.

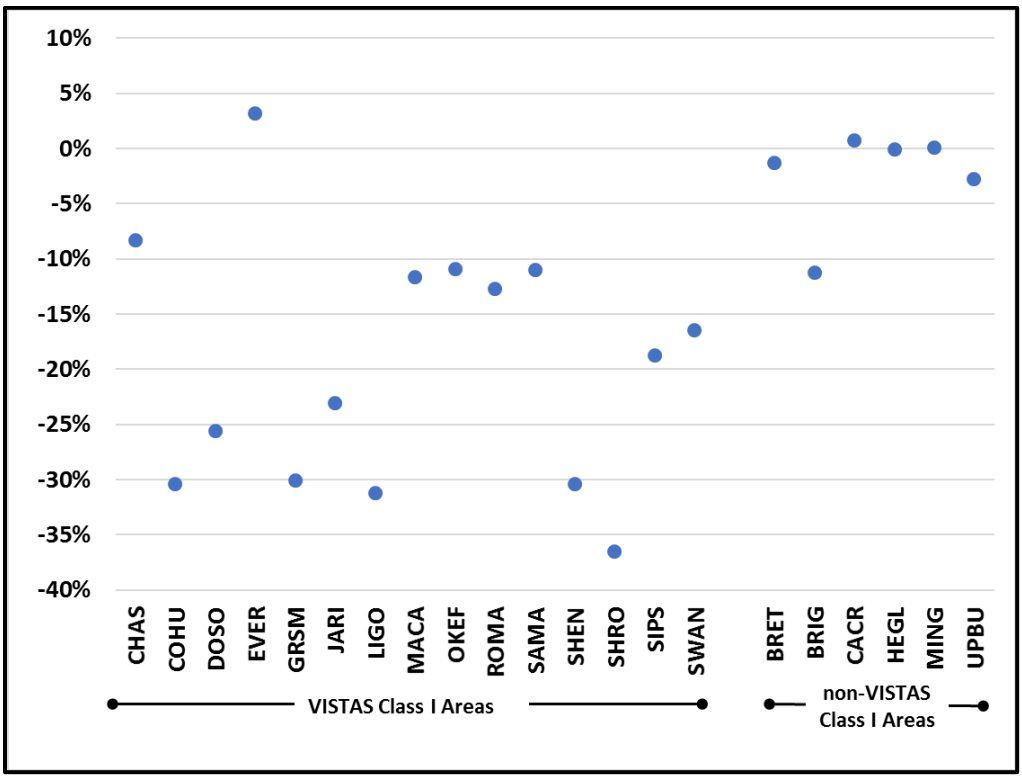


Figure 7-10: Percent of URP in 2028

Figure 7-11 illustrate the visibility improvement in 20% most impaired days. These figures show scenery at Cape Romain 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.

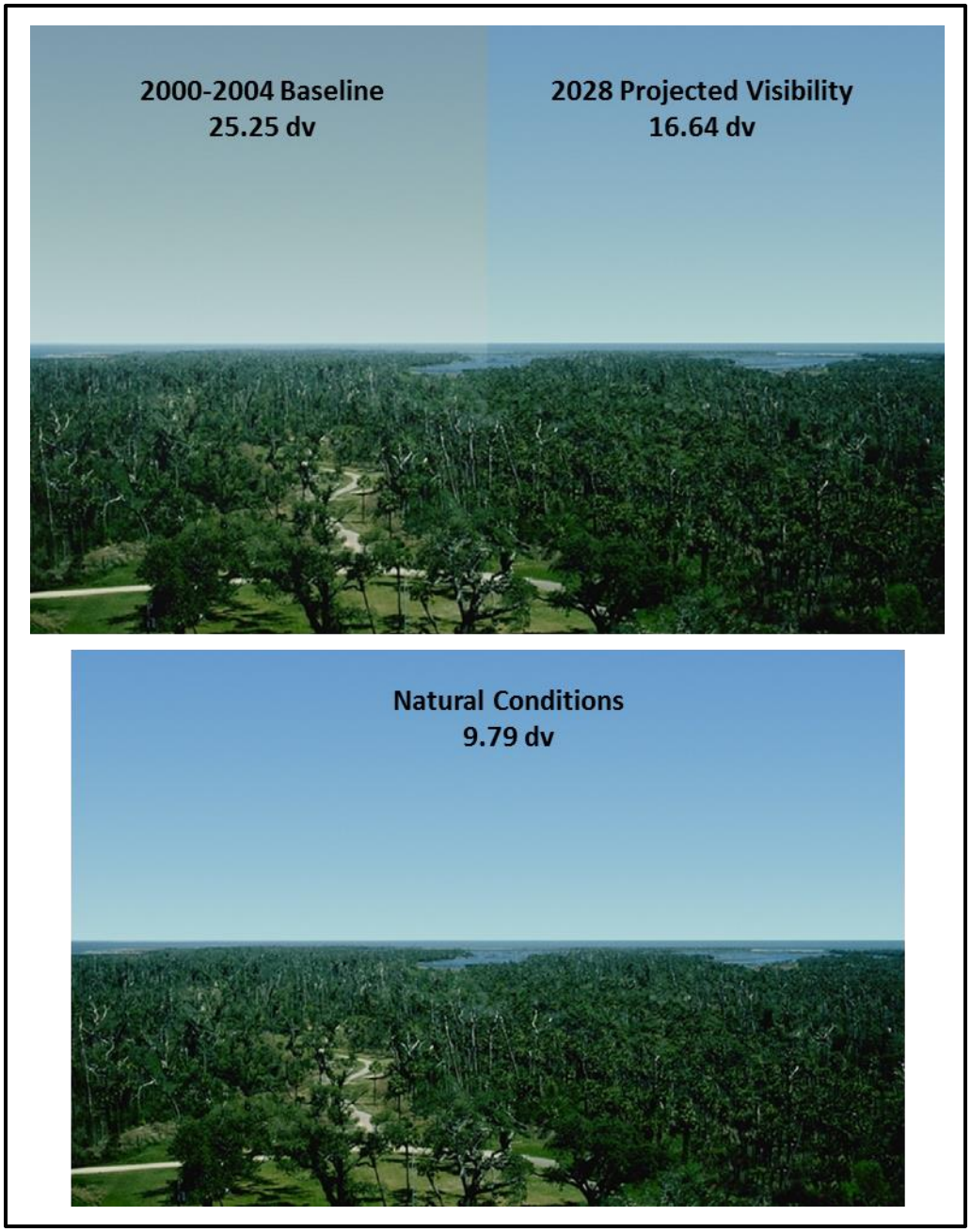


Figure 7-11:Cape Romain 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions

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 the Class I areas to ensure no degradation of visibility on these clearest days occurs. Figure 7-12 shows the improvements expected on the 20% clearest visibility days 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 long-term strategy associated with this round of planning. Blue diamonds depict IMPROVE monitoring data values, and the gray lines denote 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 Cape Romain.

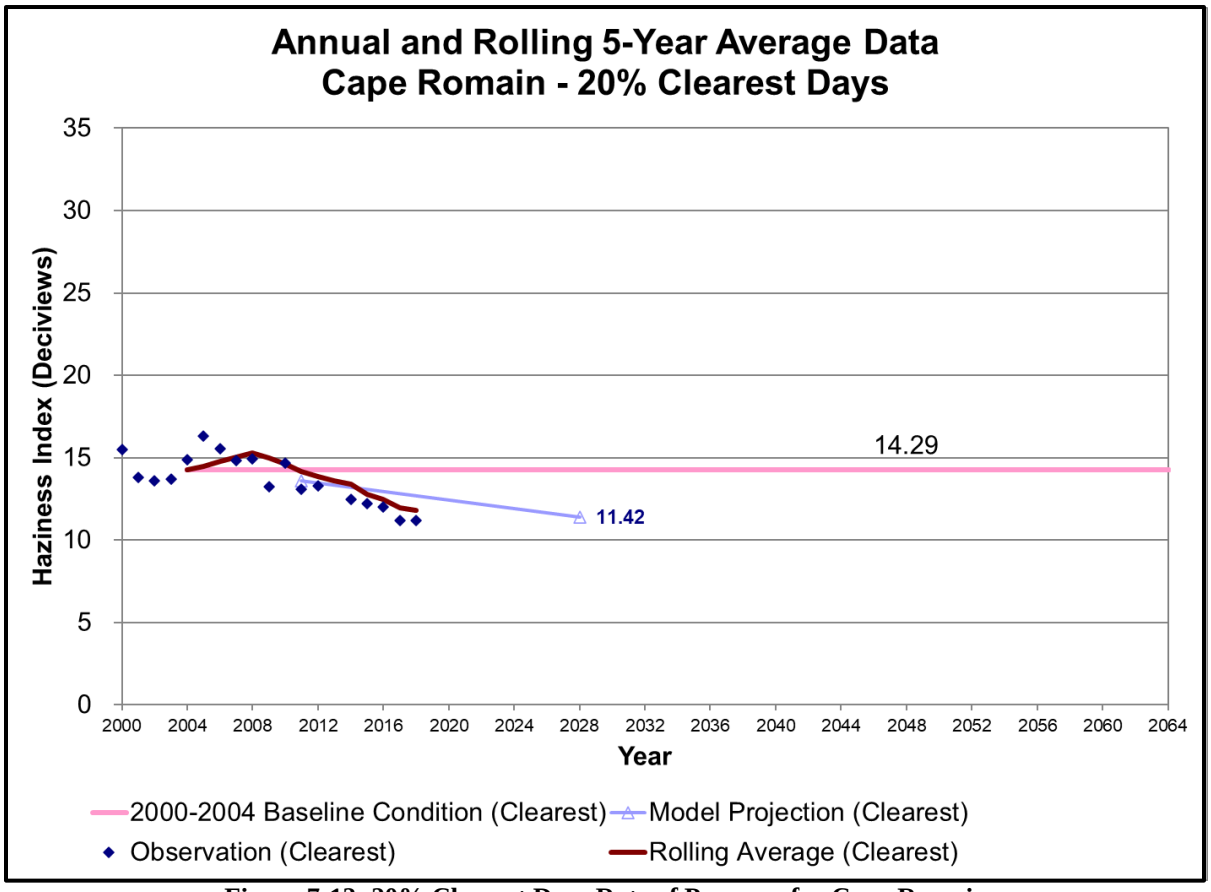


Figure 7-12: 20% Clearest Days Rate of Progress for Cape Romain

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 20% clearest days is projected to be -15.3 % for Cape Romain.

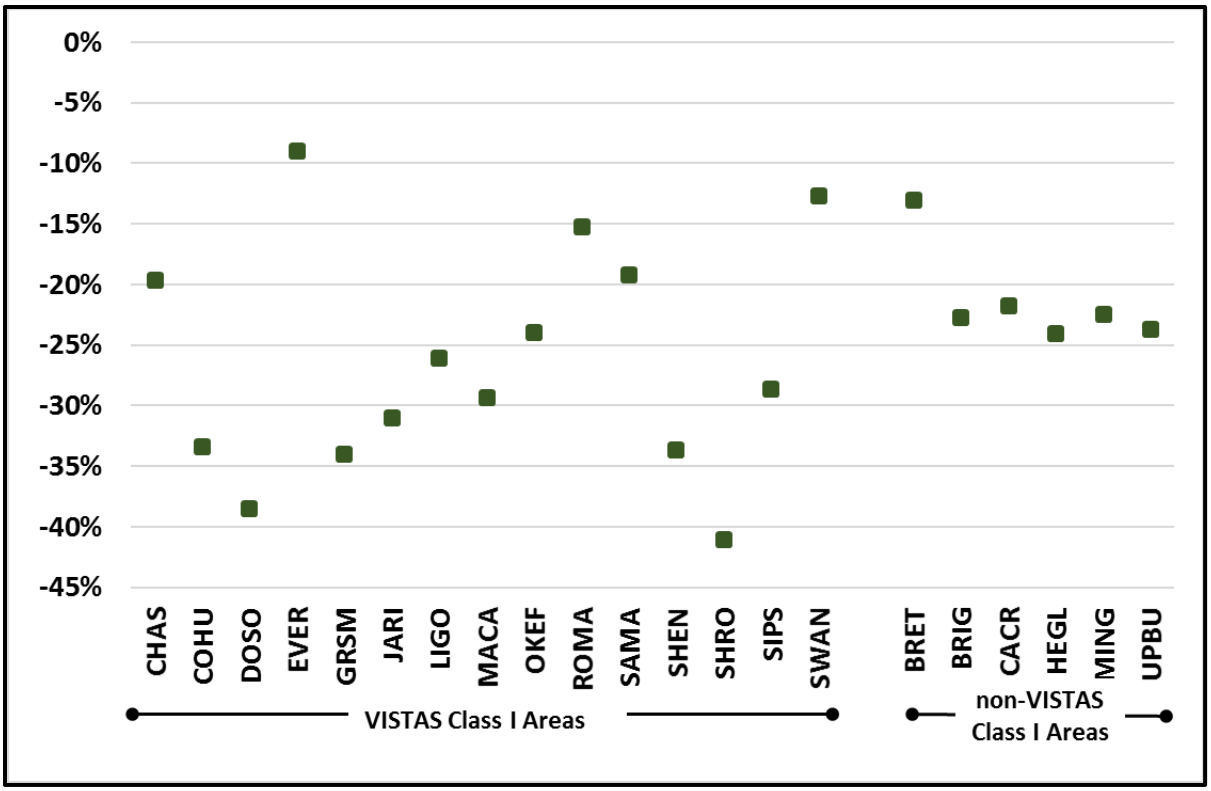


Figure 7-13: Percent Visibility Improvement on 20% Clearest Days

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 regional haze rule at 40 CFR 51.308(f)(1)(vi)(B) allows states to optionally propose an adjustment of the 2064 uniform rate of progress endpoint to account for international anthropogenic impacts, if the adjustment has been developed using scientifically valid data and methods. On September 19, 2019, The EPA released Technical Support Document for EPA's Updated 2028 Regional Haze Modeling.[42] This document provides the results of the EPA's updated 2028 visibility modeling analyses and includes projections of both domestic and international source contributions. The EPA used 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. The EPA used these estimated contributions to derive adjusted glide path endpoints for each federal Class I area.

In this study, the EPA used the CAMx PSAT tool to tag certain sectors. The EPA processed each sector through the SMOKE model and tracked each sector in PSAT as an individual source tag. The EPA tracked sulfate, nitrate, ammonium, secondary organic aerosols, and primary PM in

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

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 □, and international anthropogenic boundary conditions.

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 area from the 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

South Carolina's Class I area is expected to be beneath the 2028 uniform rate of progress goal based on VISTAS modeling, which includes current and forthcoming control programs. The estimated international emissions impact for Cape Romain is 6.23 Mm^{-1}. Adjustments to the

2028 uniform rate of progress 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 those on the uniform rate of progress. Therefore, in this round of regional haze planning, South Carolina is not updating the 2028 uniform rate of progress goals based on the 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 CenSARA, 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 CenSARA, 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 CenSARA, 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, and Swanquarter Wilderness Area. All of the mandatory federal Class I areas in VISTAS show total contributions to nitrate impairment from the CenSARA, 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 Everglades National Park and Okefenokee Wilderness Area.

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 CenSARA, LADCO, and MANE-VU sources (dark

grey, medium grey, and light grey, respectively) that are larger than home state contributions, with the exception of Everglades National Park.

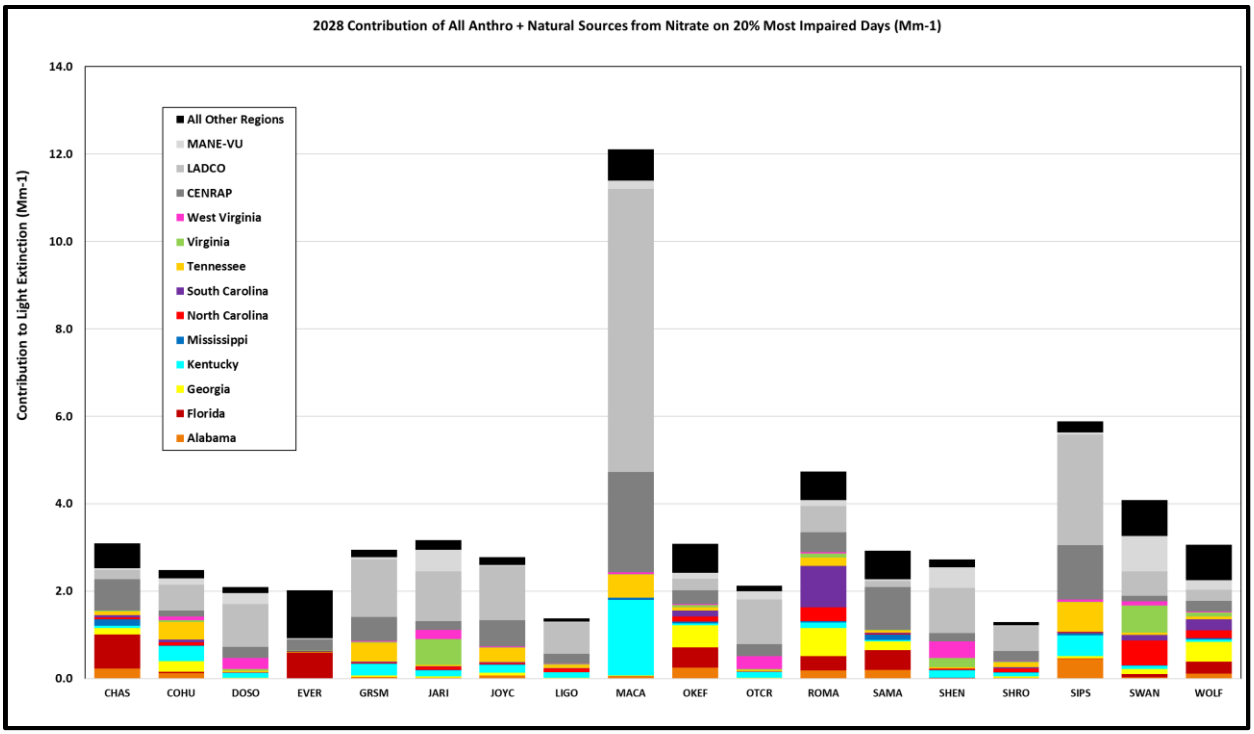


Figure 7-14: 2028 Nitrate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

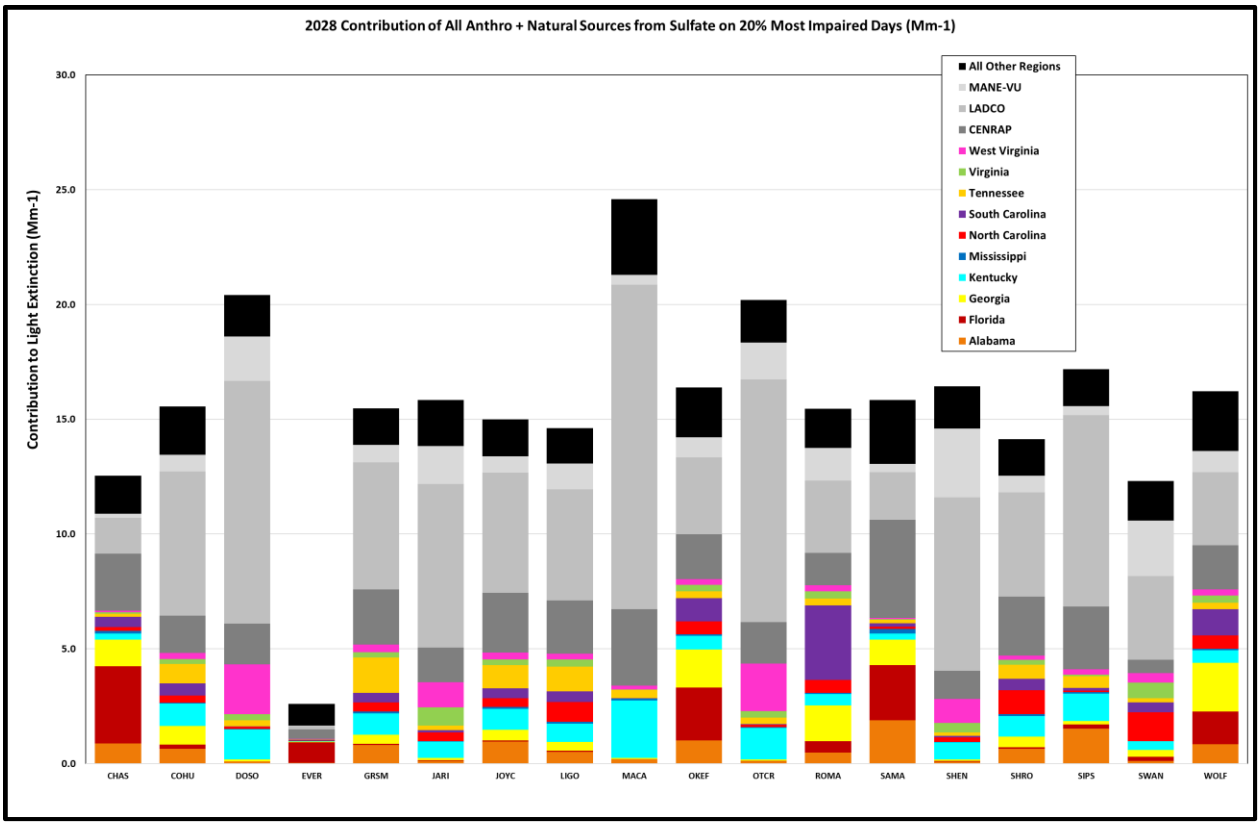


Figure 7-15: 2028 Sulfate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

These figures indicate that sulfate continues to be the primary driver of visibility impairment in most mandatory federal VISTAS Class I areas. 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 mandatory federal VISTAS Class I areas.

Figure 7-16 and Figure 7-17 provide comparisons of projected light extinction from sulfate and nitrate in 2028 at mandatory federal Class I areas in VISTAS. These figures show the light extinction associated with all emissions within the pollutant inventory, 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 these 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 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, St. Marks Wilderness Area, and Wolf Island Wilderness Area. In the case of

Everglades National Park, total sulfate impairment in 2028 is expected to be less than 5 Mm^{-1}, and EGU and non-EGU sulfate contributions are minimal. Projections for Okefenokee, Cape Romain, St. Marks, and Wolf Island show that EGU and non-EGU sulfate contributions are the majority of sulfate impairment but that the relative impacts from each sector are similar.

Figure 7-17 provides nitrate light extinction data in 2028 for 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, 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 Figure 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. Results in Figure 7-17 also show that the majority of nitrate light extinction is not caused by NO_X emissions from EGU and non-EGU point sources.

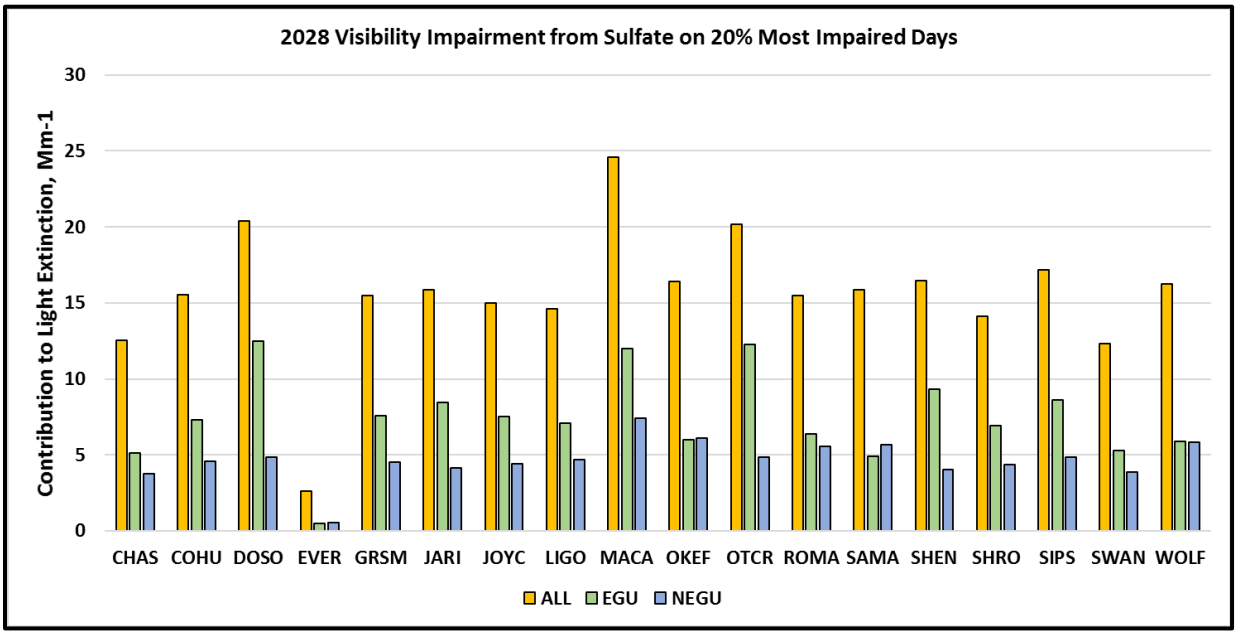


Figure 7-16: 2028 Visibility Impairment from Sulfate on 20% Most Impaired Days, VISTAS Class I Areas

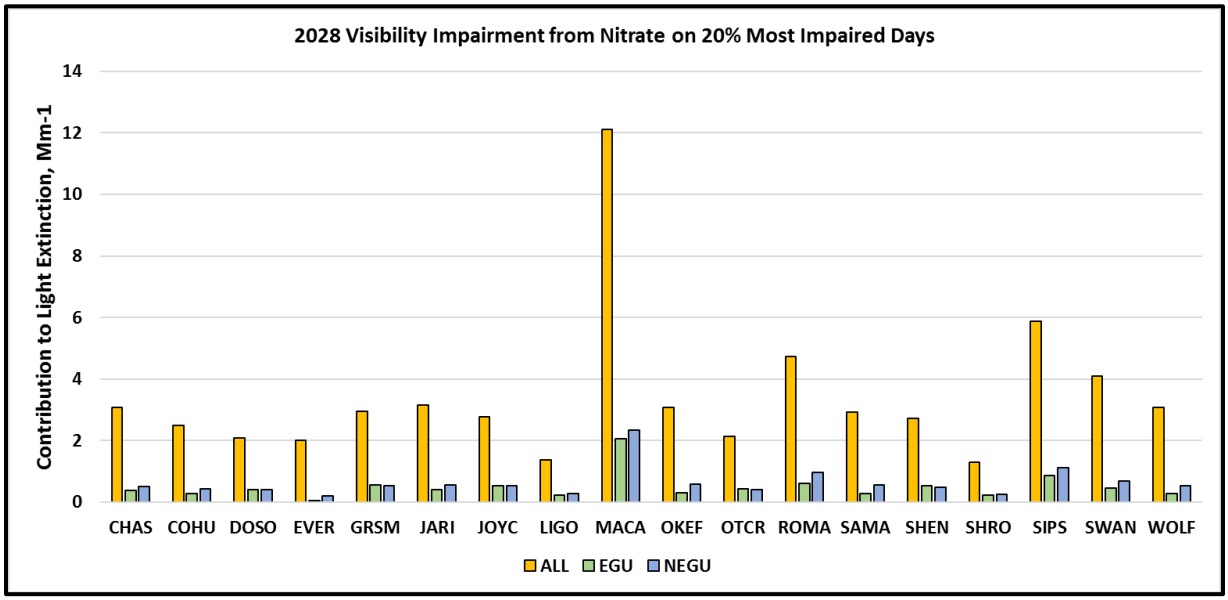


Figure 7-17: 2028 Visibility Impairment from Nitrate on 20% Most Impaired Days, VISTAS Class I Areas

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 to visibility impairment in 2028 at VISTAS mandatory federal Class I areas than nitrates.

- Emissions from other regional planning organizations (MANE-VU, LADCO, and CenSARA) 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 Class I areas in VISTAS.

Figure 7-18 provides more detailed comparisons for Cape Romain. This figure shows that projected light extinction in 2028 from total sulfate is significantly larger than light extinction from total nitrate. At Cape Romain, projected total sulfate extinction is greater than 19 Mm^{-1} while total projected nitrate extinction is about 5 Mm^{-1}. This figure also shows that sulfate from EGUs and non-EGUs account for the majority of the total sulfate impact at the mandatory federal Class I area in South Carolina. At Cape Romain, the 2028 sulfate extinction from EGUs and non-EGU point sources is 11.9 Mm^{-1} while the total sulfate extinction is 19.5 Mm^{-1}. Therefore, EGU and non-EGU point sources account for 61% of the total sulfate impact at Cape Romain. Lastly, this figure shows that sulfates originating in the LADCO region contribute

substantially to the estimated 2028 sulfate impairment at this mandatory federal Class I area in South Carolina. At Cape Romain, sulfates originating within LADCO contribute 3.1 Mm^{-1} to visibility impairment in 2028, or 16% of the total sulfate impact.

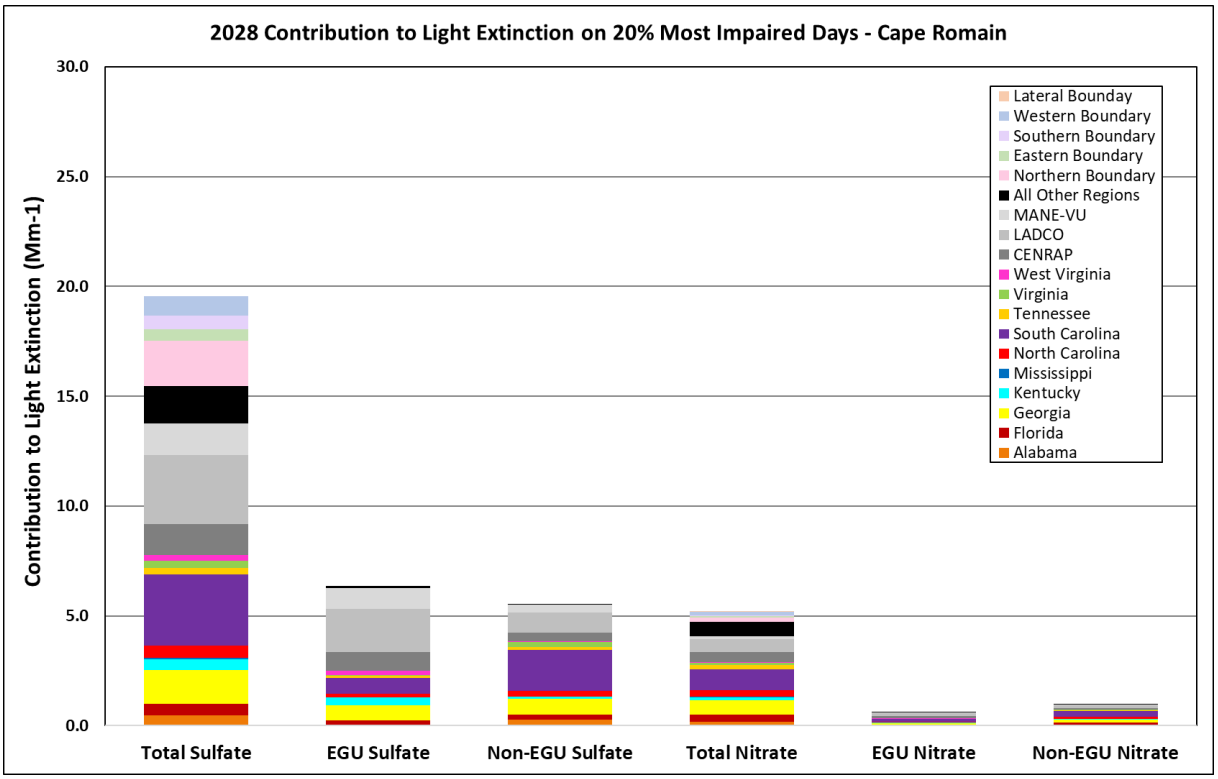


Figure 7-18: 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Cape Romain

The EPA released an updated 2028 visibility air quality modeling study in September 2019.[43] The goal of this effort was to project 2028 visibility conditions for each mandatory federal Class I area. This effort used the EPA's 2016 modeling platform as the basis for the 2028 projections. The EPA provided VISTAS an output file from the SMAT-CE tool showing visibility impairment at each Class I area by visibility impairing species. Figure 7-23 provides these outputs graphically for the VISTAS mandatory federal Class I area with an IMPROVE monitoring site. This figure, based on the 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 2-8. Figure 7-23 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

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

haze planning. Appendix E-8 provides the data supplied by the EPA from their 2019 modeling study.

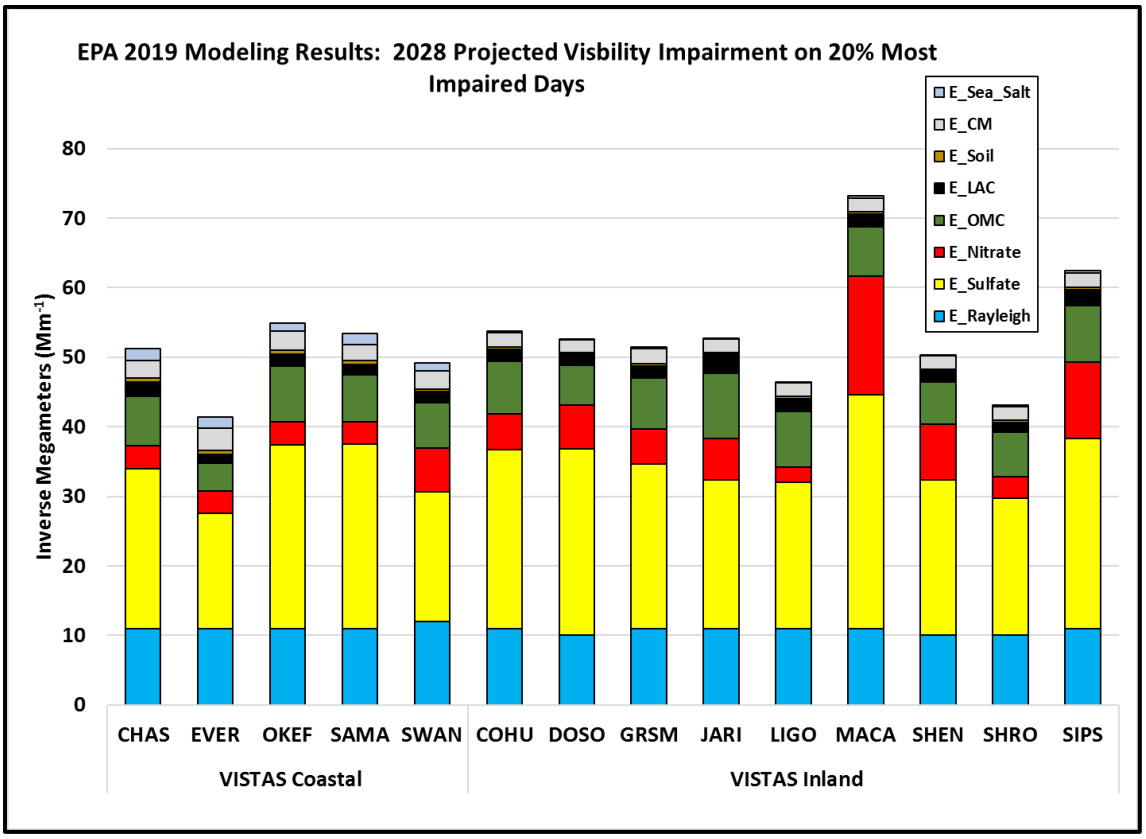


Figure 7-19: 2028 Projected Visibility Impairment by Pollutant Species, EPA 2019 Modeling Results

7.5. Area of Influence Analyses for the South Carolina Class I 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 and NO_X area of influence (AoI) analyses were performed for each Class I area to determine the relative visibility impact from each facility. Then, these facilities were ranked by their sulfate and nitrate 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 are the greatest contributors to visibility impairment at VISTAS Class I areas. 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)[44] back trajectories for IMPROVE monitoring sites in South Carolina 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 Cape Romain. Figure 7-21 contains the 100-meter back trajectories by season for the 20% most impaired visibility days (2011-2016) at Cape Romain. Figure 7-22 contains the 100-meter, 500-meter, 1000-meter, and 1500-meter back trajectories for the 20% most impaired visibility days (2011-2016) at Cape Romain. These back trajectories for the 20% most impaired days were then used to develop residence time (RT) plots.

[44] 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

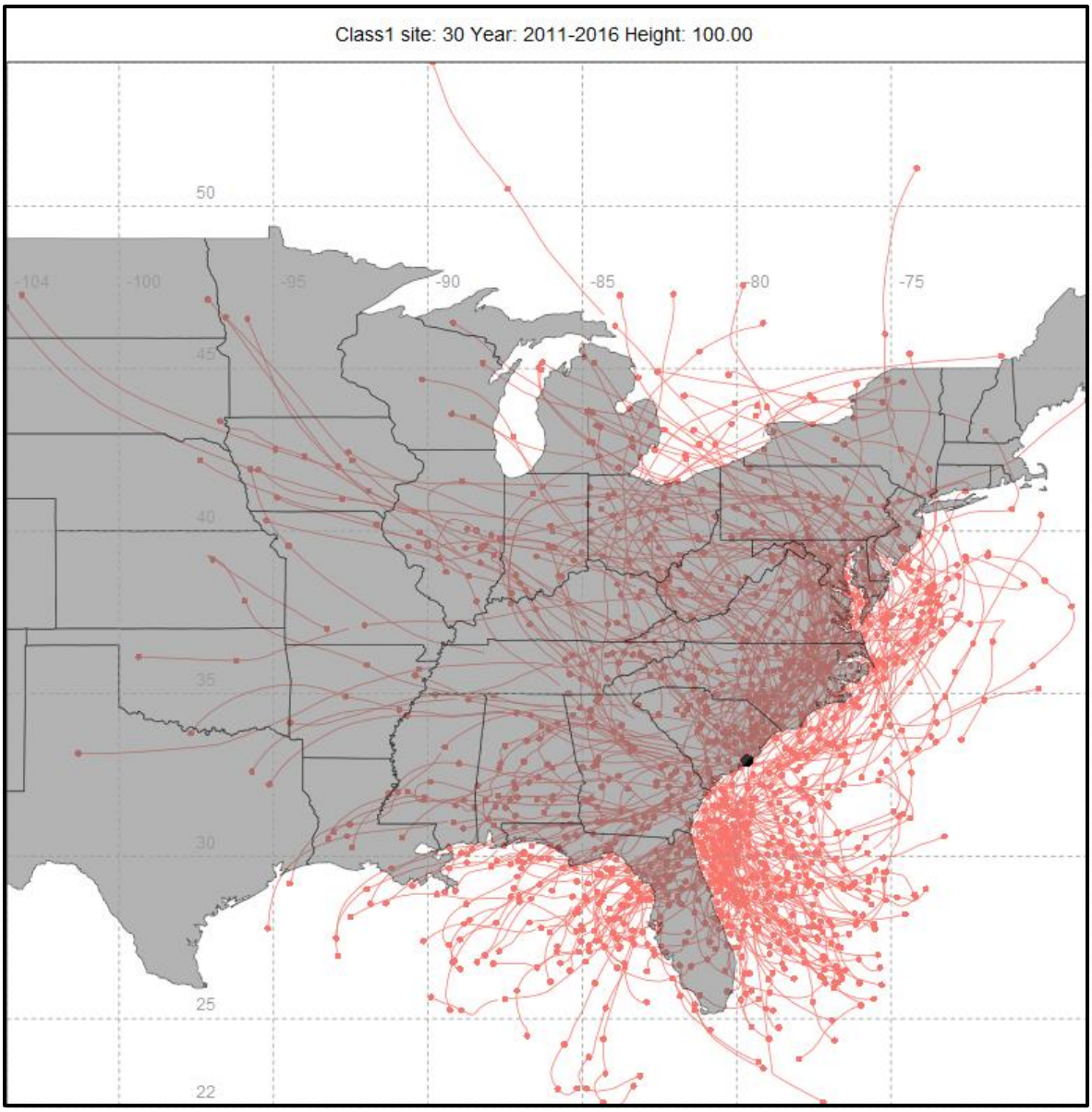


Figure 7-20: 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016), from Cape Romain Wilderness Area

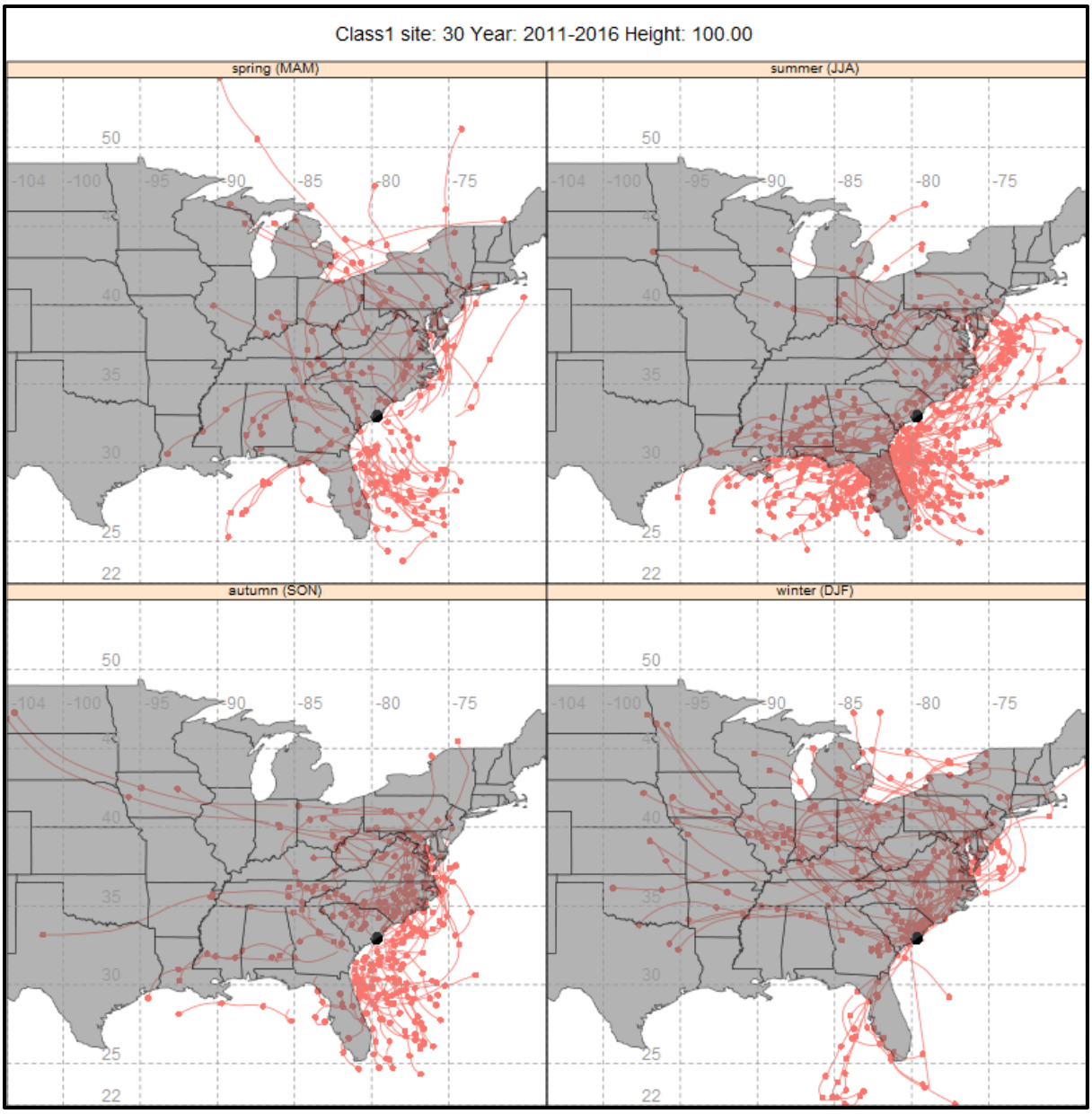


Figure 7-21: 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Cape Romain Wilderness Area

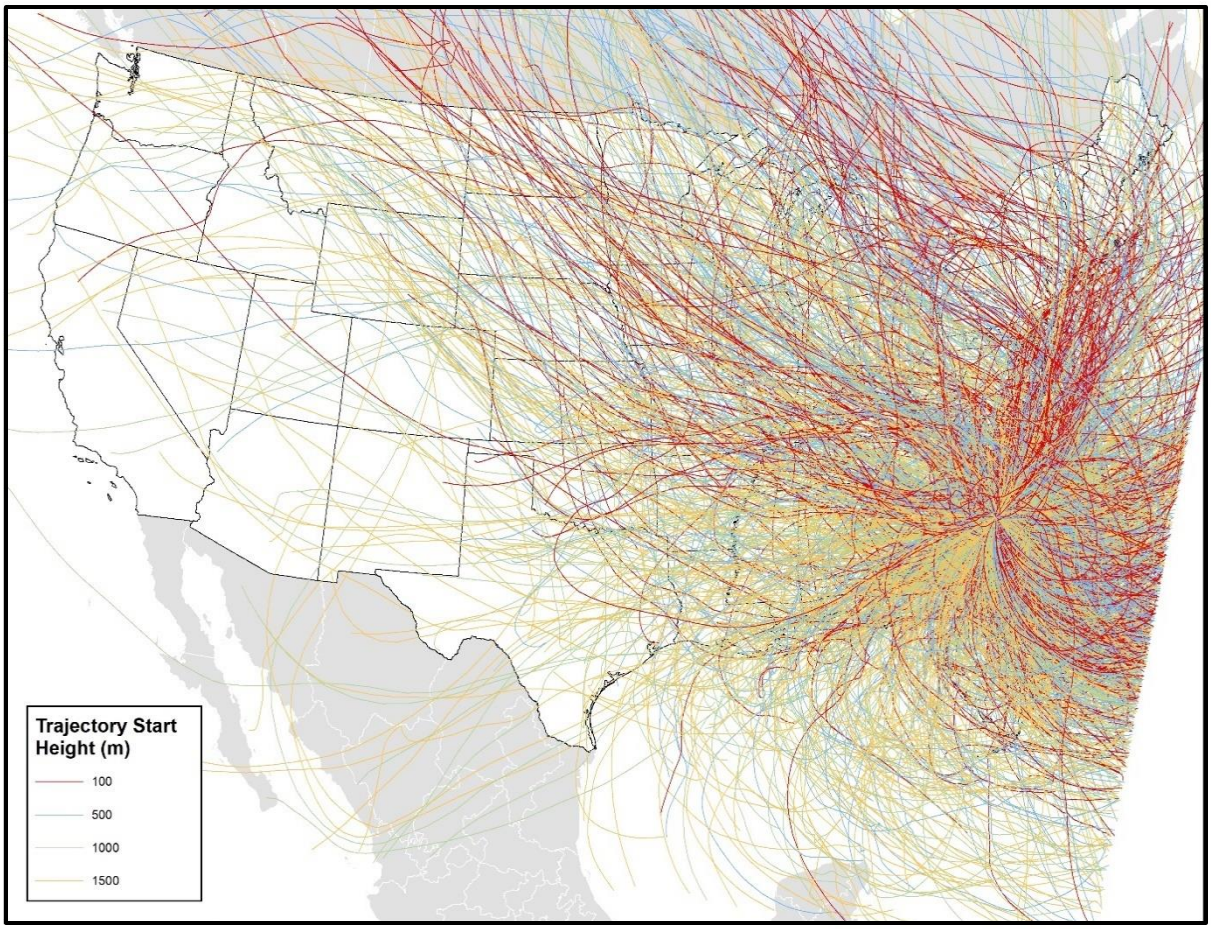


Figure 7-22: 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Cape Romain Wilderness Area

7.5.2. Residence Time Plots

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

Figure 7-23 contains the RT (counts per 12-km modeling grid cell) for Cape Romain. Figure 7-24 contains the residence time (percent of total counts per 12-km modeling grid cell) for Cape Romain. As illustrated in these figures, winds influencing Cape Romain 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.

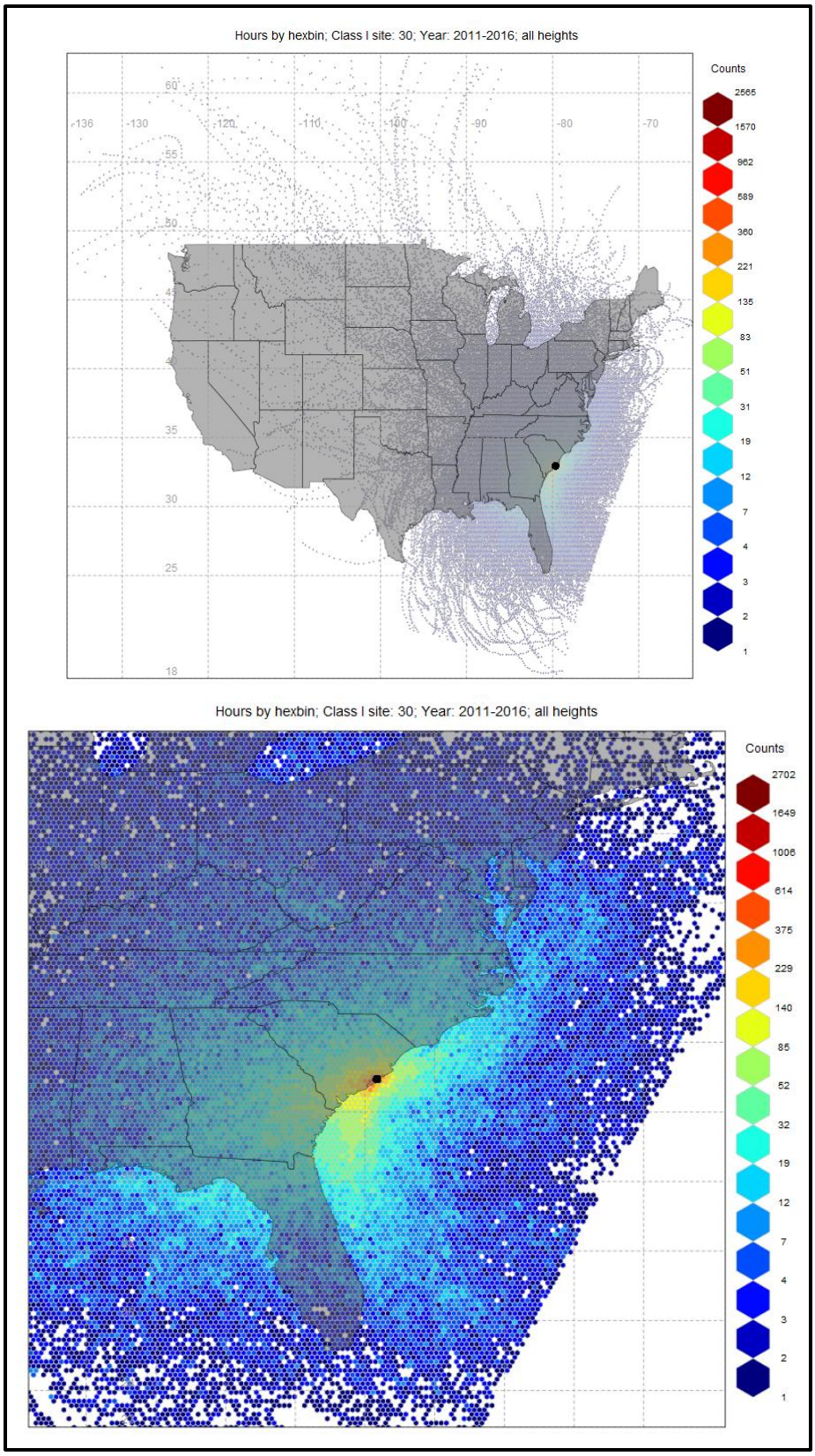


Figure 7-23: Residence Time (Counts per 12km Modeling Grid Cell) for Cape Romain Wilderness Area – Full View (top) and Class I Zoom (bottom)

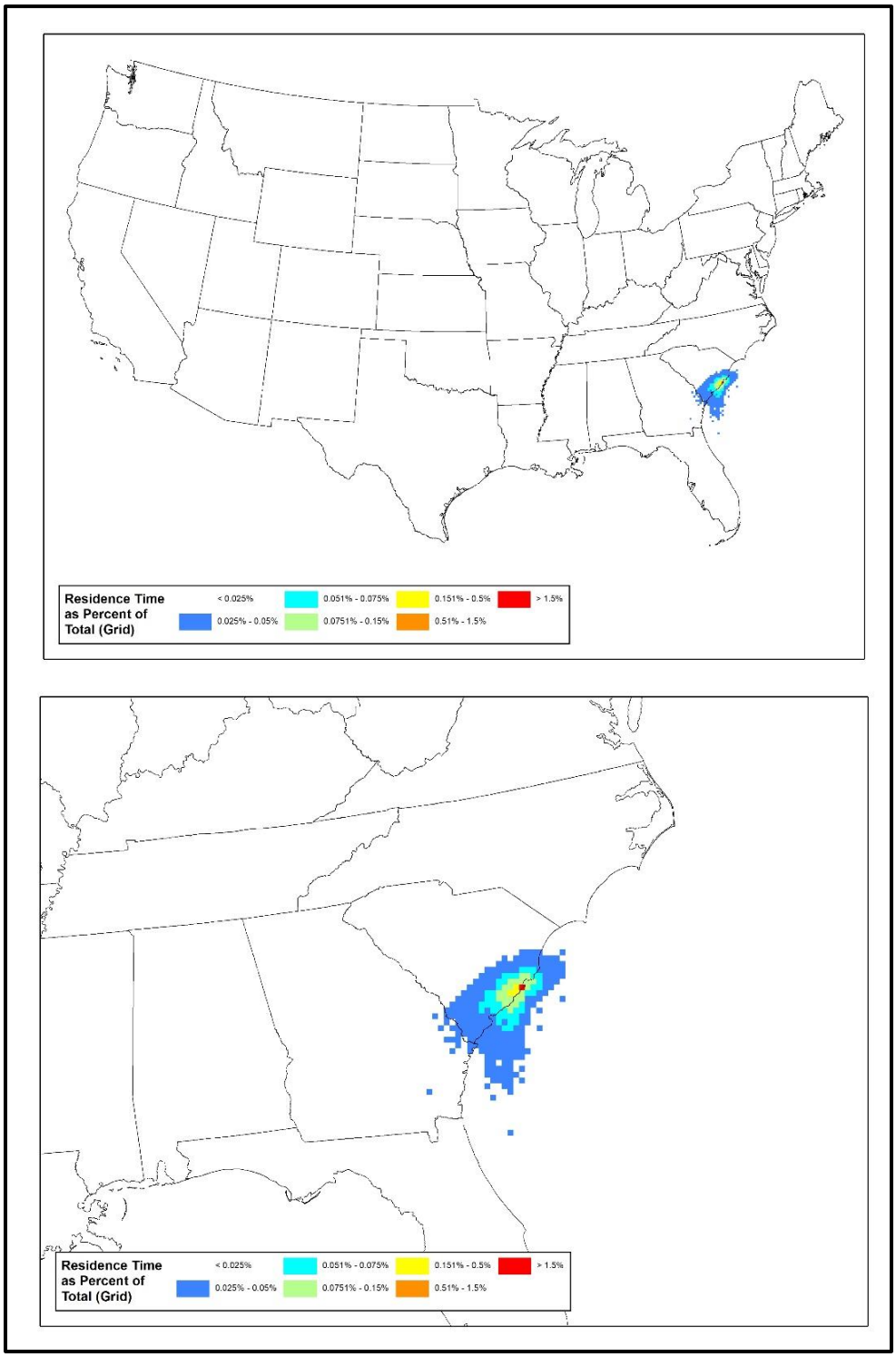


Figure 7-24: Residence Time (% of Total Counts per 12km Modeling Grid Cell for Cape Romain Wilderness Area – Full View (top) and Class I Zoom (bottom)

7.5.3. Extinction-Weighted Residence Time Plots

The next step was to develop sulfate and nitrate extinction-weighted residence time (EWRT) plots. Each back trajectory was weighted by ammonium sulfate and ammonium nitrate extinction for that day and used to produce separate sulfate and nitrate EWRT plots. This allows separate analyses for sulfate and nitrate.

The concentration weighted trajectory (CWT)[45] 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
- τ_{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 cell (*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 sources are more discernible than those passing over moderate sources.

Figure 7-25 contains the sulfate extinction weighted residence time (sulfate EWRT per 12-km modeling grid cell) for Cape Romain for the 20% most impaired days from 2011 to 2016. Figure 7-26 contains the nitrate extinction weighted residence time (nitrate EWRT per 12-km modeling grid cell) for Cape Romain for the 20% most impaired days from 2011 to 2016. It should be noted that the sulfate extinction weighted residence times are significantly higher than the nitrate extinction weighted residence times, demonstrating the importance of focusing on SO_2 emission reductions.

[45] 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

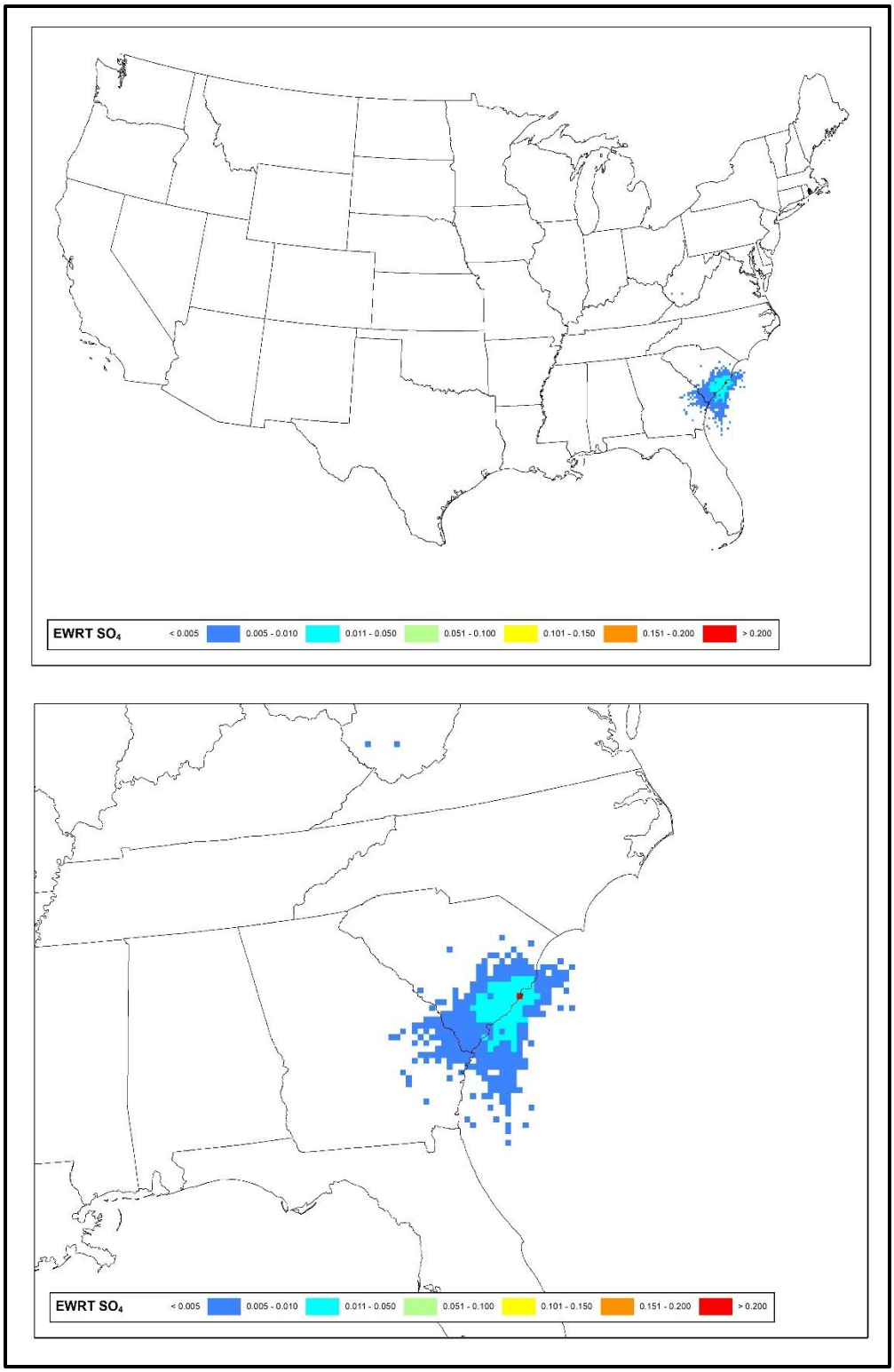


Figure 7-25: Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12km Modeling Grid Cell) for Cape Romain Wilderness Area - Full View (top) and Class I Zoom (bottom)

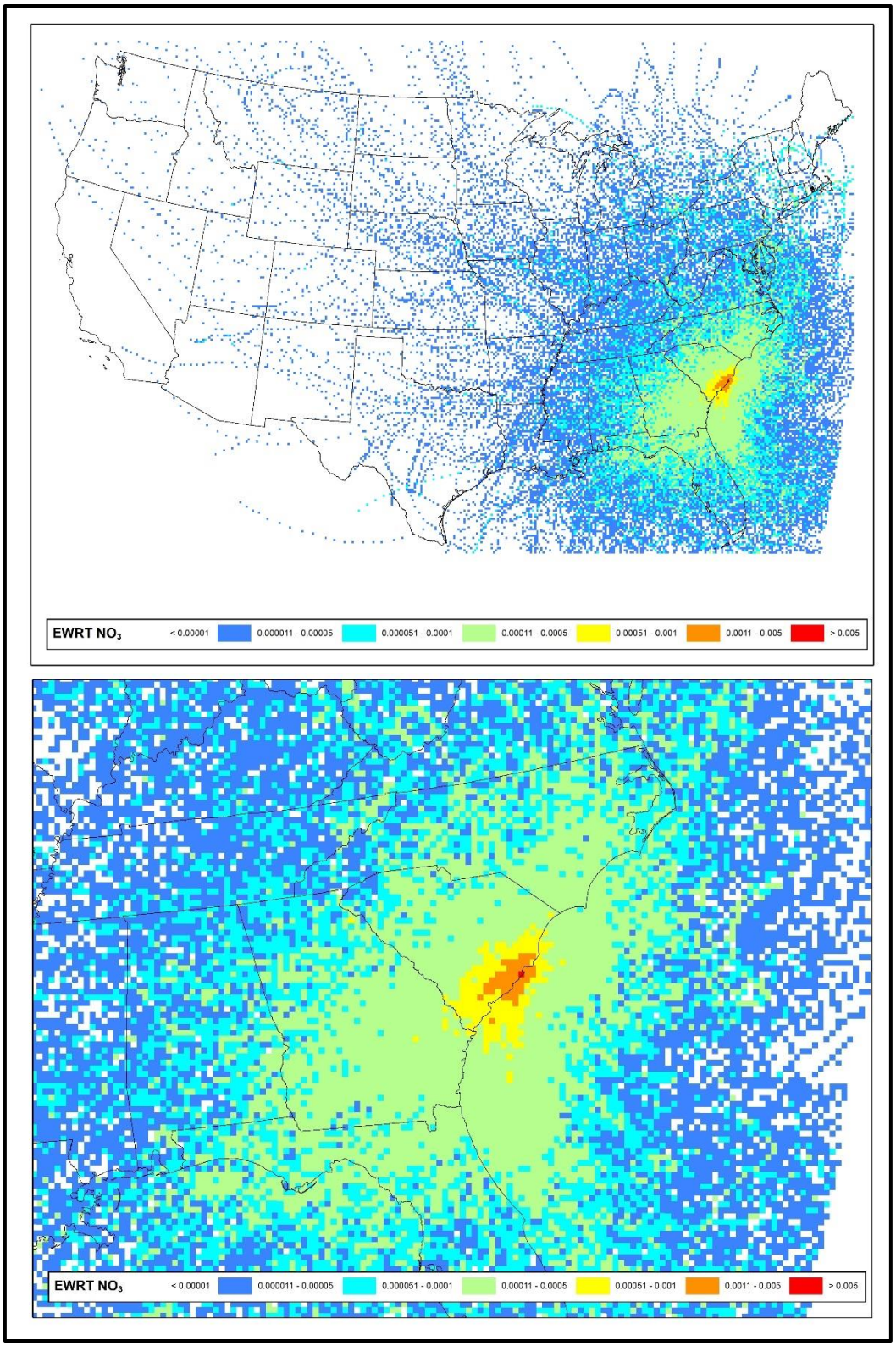


Figure 7-26: Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-km Modeling Grid Cell) for Cape Romain Wilderness Area - Full View (top) and Class I Zoom (bottom)

7.5.4. Emissions/Distance Extinction Weighted Residence Time Plots

Extinction weighted residence times were then combined with 12-km gridded SO_2 and NO_X 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 or NO_X 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 or nitrate EWRT grid values (i.e., EWRT*(Q/d)) on a grid cell by grid cell basis. Next, the sulfate and nitrate 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 and/or nitrate 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 7-27 contains the sulfate emissions/distance extinction weighted residence time (percent of total Q/d*EWRT per 12-km modeling grid cell) for Cape Romain. Figure 7-28 contains the nitrate emissions/distance extinction weighted residence time (percent of total Q/d*EWRT per 12-km modeling grid cell) for Cape Romain. These maps help visualize where the sources of the largest visibility impacts are located. Figure 7-27 and Figure 7-28 illustrate the relative importance of South Carolina sources of SO_2 and NO_X, respectively, compared to sources in neighboring states.

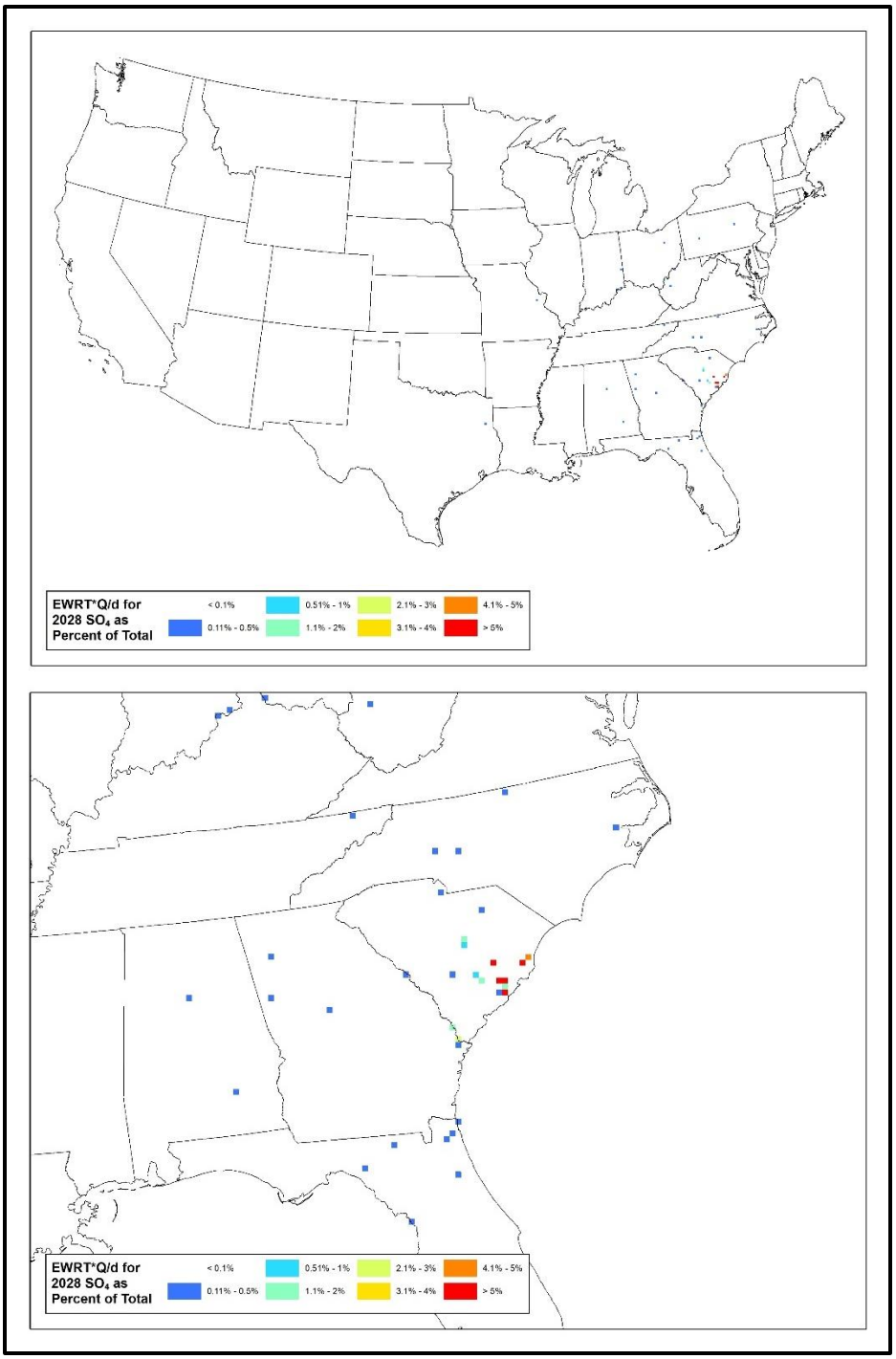


Figure 7-27: Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12km Modeling Grid Cell) for Cape Romain Wilderness Area – Full View (top) and Class I Zoom (bottom)

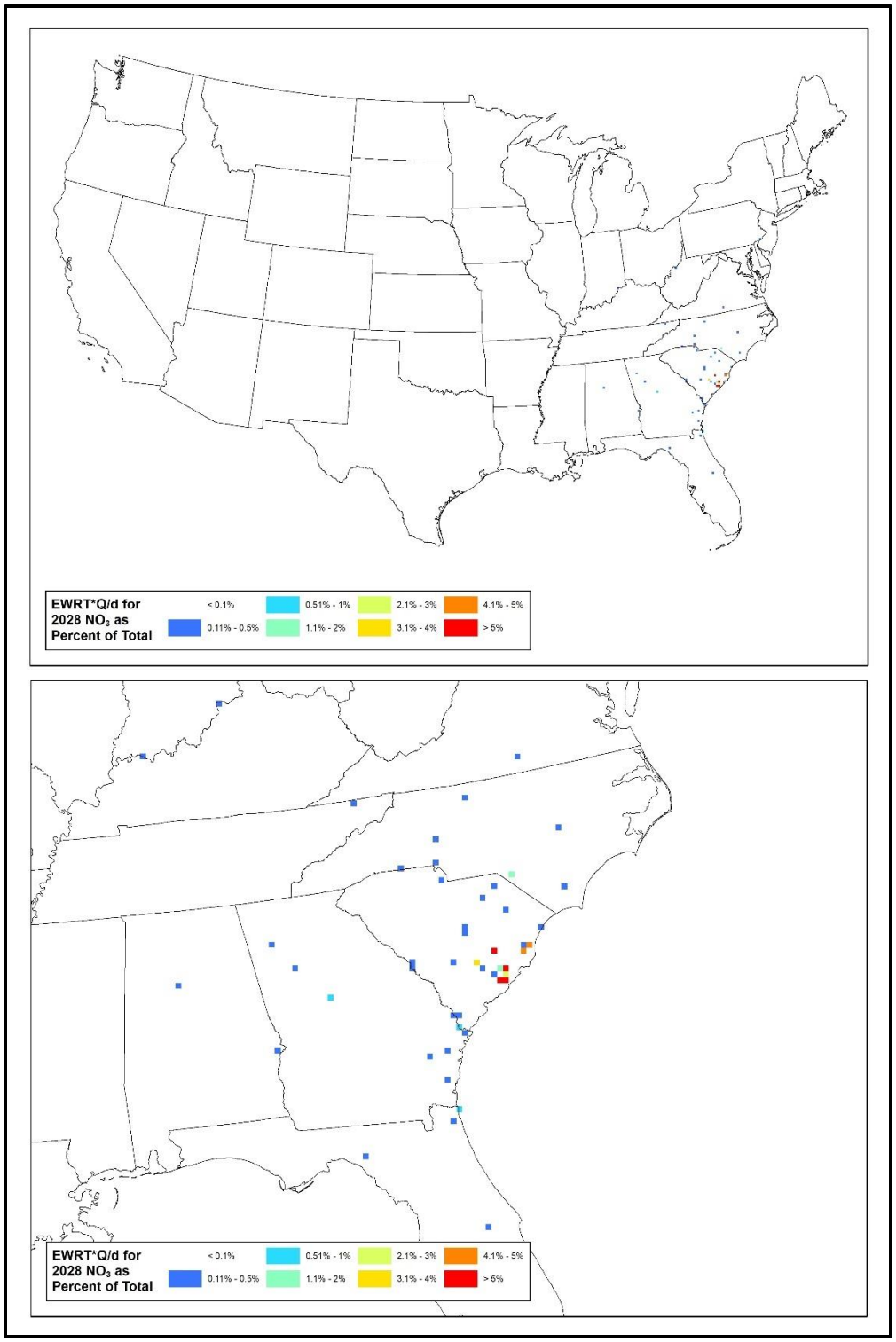


Figure 7-28: Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12km Modeling Grid Cell) for Cape Romain Wilderness Area – Full View (top) and Class I Zoom (bottom)

7.5.5. Ranking of Sources for South Carolina Class I 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 description. 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 and/or nitrate 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 can be attributable to the onroad and nonpoint sectors. As such, a similar analysis for county level data was conducted, that included county total point source contributions. This allows the point source contribution to be directly compared to the other source categories.

Similar analyses were conducted to rank SO_2 and NO_X emissions contributions for the county-level sources (nonpoint, onroad, non-road, fires, and total point source sectors). 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 join was made between the county-level EWRT, emissions, and source information for each sector.

Table 7-4 contains the NO_X and SO_2 source contributions to visibility impairment on the 20% most impaired days at Cape Romain. Based on these contributions, it is clear that SO_2 from point sources is the dominant source category at Cape Romain (84.98%).

Table 7-4: NO_X and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Cape Romain Wilderness Area

Category	NO_X	SO_2	Total
NONPOINT	1.12%	1.76%	2.88%
NONROAD_MAR	2.39%	1.67%	4.07%
NONROAD_OTHER	1.86%	0.09%	1.96%
ONROAD	2.86%	0.34%	3.21%
POINT	5.91%	79.08%	84.98%
PT_FIRES_PRESCRIBED	0.43%	2.47%	2.91%
Total	14.57%	85.43%	100.00%

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 any other source information. The database was then used to generate individual spreadsheets for each Class I area.

Table 7-5 contains the AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at Cape Romain. This table only shows the facilities contributing more than 1.00% sulfate + nitrate. The full list of all facilities can be found in Appendix D. The lists of individual facilities identified by the AoI analysis for each Class I area were used to determine which facilities were tagged in the PSAT source contribution analysis.

Table 7-5: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Cape Romain Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC	29.2	2,355.8	1,863.6	2.74%	30.18%	32.92%
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA	39.1	108.1	3751.6	0.03%	17.07%	17.10%
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	63.7	3,273.4	4,281.1	0.45%	6.57%	7.02%
SC	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION	51.4	1,772.5	2,246.8	0.38%	4.60%	4.98%
SC	45015-8306711	SCE&G WILLIAMS	26.7	992.7	392.4	0.79%	4.01%	4.80%
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL	57.4	2,031.2	2,767.5	0.35%	4.31%	4.66%
SC	45015-4953011	NUCOR STEEL BERKELEY	22.1	440.0	148.2	0.42%	1.83%	2.25%
GA	13051-3679811	International Paper - Savannah	166.1	1,560.7	3,945.3	0.04%	1.76%	1.80%
SC	45035-4797811	SHOWA DENKO CARBON INC	66.1	264.5	971.1	0.03%	1.71%	1.74%
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	159.9	351.5	1,860.1	0.02%	1.15%	1.17%
SC	45079-4801411	INTERNATIONAL PAPER EASTOVER	139	1,780.3	3,212.8	0.04%	1.06%	1.09%
SC	45015-15655111	COOPER RIVER PARTNERS LLC	25.9	58.4	58.1	0.07%	0.94%	1.02%

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).

VISTAS states used the NO_X and SO_2 facility contributions from the AoI analysis to help select sources to be tagged with PSAT. Each state used the AoI results to develop its initial list of facilities for tagging. The VISTAS states then compared their lists and collaborated on developing the final list of facilities in both the VISTAS and non-VISTAS states for which AoI impacts were significant enough to warrant further evaluation. 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. Some of the 87 facilities were selected by more than one state. In addition, PSAT tags previously discussed in Section 7.4 include total sulfate and nitrate 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 and nitrate contributions from EGU + non-EGU point sources) to be determined for each facility at each Class I area. If the sulfate contribution was greater than or equal to 1.00%, then the facility was considered for an SO_2 reasonable progress analysis. If the nitrate contribution was greater than or equal to 1.00%, then the facility was considered for a NO_X 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.

Based on the sources selected by South Carolina and the other VISTAS states, VISTAS selected 87 facilities for SO_2 and NO_X PSAT tagging. Some of the 87 facilities were selected by multiple states. Table 7-6 lists PSAT tags selected for facilities in AL and FL. Table 7-7 lists PSAT tags selected for facilities in GA, KY, MS, NC, SC, and TN. Table 7-8 lists PSAT tags selected for facilities in VA and WV. Table 7-9 lists 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 Class I areas is contained in Appendix E-7a and Appendix E-7b.

Table 7-6: PSAT Tags Selected for Facilities in AL and FL

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (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 7-7: PSAT Tags Selected for Facilities in GA, KY, MS, NC, SC, and TN

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (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
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 7-8: PSAT Tags Selected for Facilities in VA and WV

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (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 7-9: PSAT Tags Selected for Facilities in AR, MO, PA, IL, IN, and OH

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (TPY)
AR	CENSARA	05063-1083411	ENTERGY ARKANSAS INC-INDEPENDENCE PLANT	32,050.48	14,133.10
MO	CENSARA	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	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

7.6.1. Selection of Sources for PSAT Tagging

Since SO_2 and NO_X emissions from point sources were estimated to have the largest AoI contribution to visibility impairment at the Class I area in South Carolina (see Table 7-4 and Table 7-5), South Carolina used the fraction of total sulfate plus nitrate 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. Due to the continuing predominance of SO_2, as discussed in Section 7.4, South Carolina selected an AoI screening threshold that would include a reasonable number of large SO_2 sources in proximity to Class I areas in and around South Carolina. South Carolina requested that all South Carolina facilities with an AoI contribution of nitrate of 3% or more or sulfate of 2% or more in be tagged with PSAT. South Carolina also requested that all facilities outside South Carolina with an AoI contribution of 4% or more be tagged with PSAT, which resulted in no additional tags with PSAT. South Carolina felt that this would capture the most important nearby sources as well as any large sources outside South Carolina.

Based on these criteria, South Carolina selected the sources listed in Table 7-10 for PSAT tagging. Section 7.6.4 of this SIP provides information on why additional facilities were not selected for PSAT modeling. In addition, the Department also considered the fact that emissions are continuing to decline early in the second planning period and are expected to maintain a rate that is parallel with the URP for Cape Romain based on the federal and state control programs and actions discuss in Section 7.2 of this SIP. Given these considerations, and the fact that the regional haze planning is an iterative process that requires the state to evaluate and adjust the LTS as needed during future planning periods, the Department believes that the facilities selected by South Carolina and other VISTAS states for PSAT modeling is a reasonable number of facilities for which to evaluate further for reasonable progress analyses. The detailed PSAT selection process for each VISTAS state is provided in their individual regional haze SIPs.

Table 7-10: Facilities Selected by South Carolina for PSAT Tagging

State	Facility ID	Facility Name
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION
SC	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION
SC	45015-8306711	SCE&G WILLIAMS
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL

7.6.2. PSAT Contributions at the South Carolina Class I Area

The original PSAT results were determined based on the initial 2028 SO_2 and NO_X 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 and nitrate 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 adjusted PSAT results for Cape Romain. Ten (10) facilities where sulfate contributions are above 1.00% are included in the table and address more than 23% of the entire sulfate plus nitrate point source visibility impact in 2028. Table 7-12 and Table 7-13 contain the adjusted PSAT results for South Carolina facilities significantly impacting (sulfate contributions of at least 1.00%) Wolf Island Wilderness Area (GA) and Okefenokee Wilderness Area (GA), respectively. The full list of tagged facilities and their contributions to each Class I area can be found in Appendix E-7b.

Table 7-11: PSAT Results for Cape Romain 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, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC	29.3	0.523	13.483	3.88%	0.046	13.483	0.341%
GA	13015-2813011	Ga Power Company - Plant Bowen	506.2	0.495	13.483	3.67%	0.019	13.483	0.141%
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA	39.1	0.327	13.483	2.42%	0.003	13.483	0.022%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	857.1	0.320	13.483	2.37%	0.002	13.483	0.012%
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	63.8	0.316	13.483	2.34%	0.038	13.483	0.282%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	701.0	0.305	13.483	2.26%	0.005	13.483	0.036%
MD	24001-7763811	Luke paper	726.7	0.267	13.483	1.98%	0.001	13.483	0.007%
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL	57.4	0.230	13.483	1.70%	0.021	13.483	0.156%
SC	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION	51.4	0.187	13.483	1.38%	0.024	13.483	0.178%
GA	13051-3679811	International Paper - Savannah	166.1	0.180	13.483	1.33%	0.009	13.483	0.067%
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	159.9	0.069	13.483	0.51%	0.002	13.483	0.015%

Table 7-12: PSAT Results for South Carolina Facilities Significantly Impacting Wolf Island Wilderness Area (GA)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	223.0	0.168	12.508	1.343%	0.011	12.508	0.088%
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA	250.9	0.168	12.508	1.295%	0.001	12.508	0.008%

Table 7-13: PSAT Results for South Carolina Facilities Significantly Impacting Okefenokee Wilderness Area (GA)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	348.1	0.158	12.954	1.219%	0.006	12.954	0.046%

7.6.3. AoI versus PSAT Contributions

After the PSAT modeling was completed, a comparison was made of PSAT results to AoI results. The PSAT results used in this comparison did not incorporate any PSAT adjustments discussed in Appendix E-7b (Roadmap for PSAT Scaled Adjustments) 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 7-29 shows three plots of the ratio of AoI/PSAT contributions for sulfate, nitrate, and sulfate + nitrate, respectively, as a function of distance from the facility to the Class I area. Figure 7-30 shows three plots of the fractional bias (FB) for sulfate, nitrate, and sulfate + nitrate, respectively, as a function of distance from the facility to the Class I area. The FB is equal to 2*(AoI – PSAT)/(AoI + PSAT). The FB 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 7-29 and **Error! Reference source not found.**Figure 7-30, AoI tends to overestimate impacts for facilities near the Class I area. This appears to be the case for both sulfates and nitrates. In fact, if the facility is <100 Km from the Class I area, the AoI results are generally (with a few exceptions for nitrates) three times or more higher than the PSAT results. Even in those exceptions, those AoI-computed nitrate impacts for facilities close to a Class I area were always higher than PSAT-computed nitrate impacts.

As a result, some sources near a Class I area were tagged for PSAT but were found to not have a significant 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 AoI may underestimate the impact of some far away sources, the visibility impairment of those sources was 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.

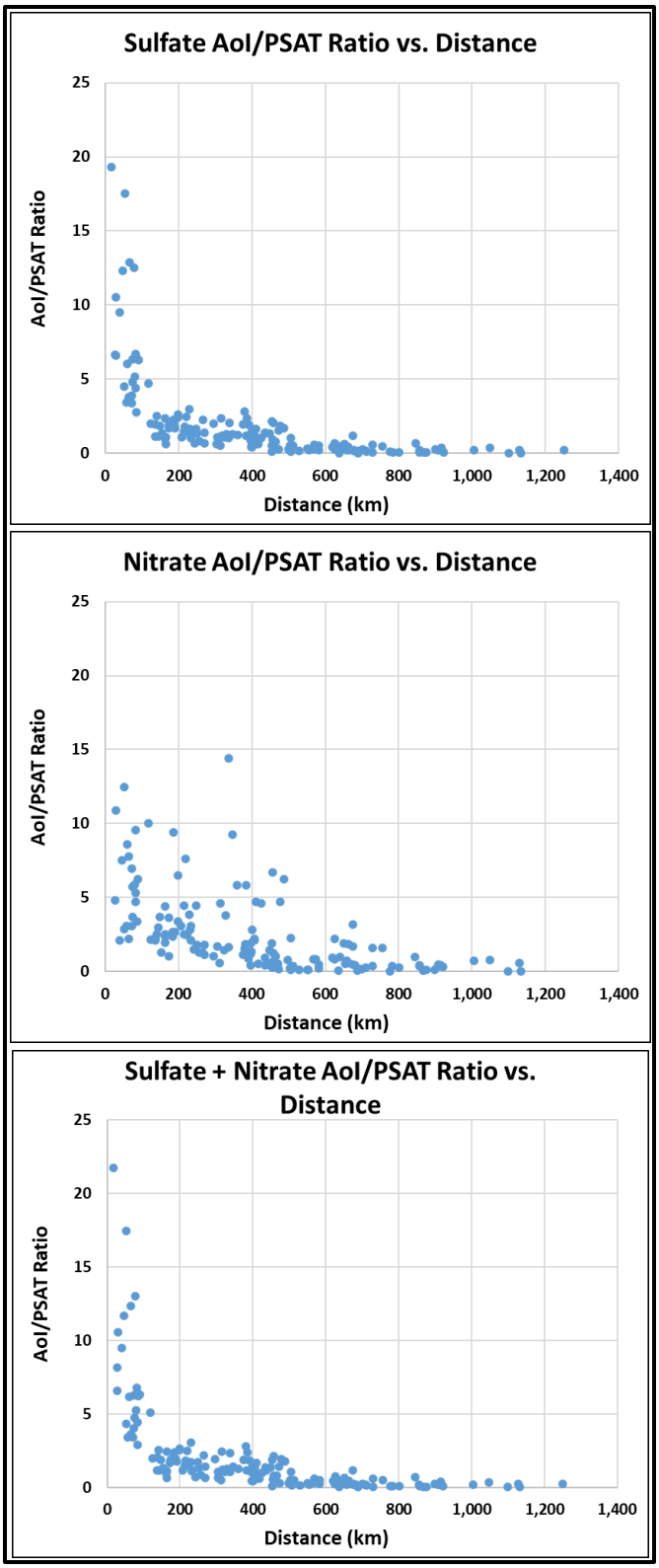


Figure 7-29: Ratio of AoI/PSAT % Contributions for Sulfate and Nitrate as a Function of Distance from the Facility to the Class I Area

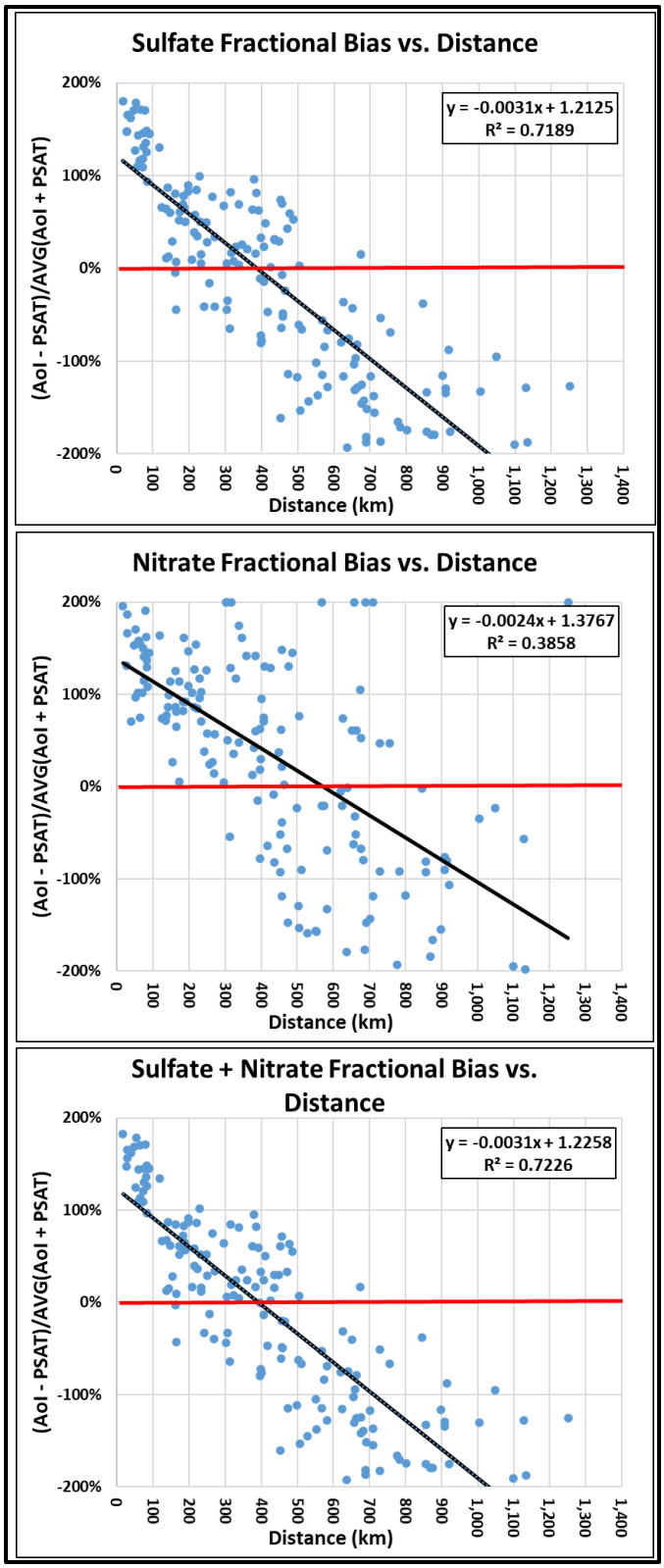


Figure 7-30: Fractional Bias for Sulfate and Nitrate as a Function of Distance from the Facility to the Class I Area

Although many facilities were tagged with PSAT, there are some facilities identified by AoI with a sulfate + nitrate contribution over 1% that were not tagged.

Table 7-14 shows AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at Cape Romain. There are four facilities in the table that were not tagged with PSAT. GA Power Company – Plant Bowen is included to show how its numbers for AoI and PSAT differ. Plant Bowen did not meet the criteria during the AoI stage and was not chosen by the Department for PSAT, it was picked by another state. Georgia-Pacific Consumer Products LP (Savannah River Mill) did meet the criteria during the AoI stage and was chosen for PSAT, but this analysis showed the facility did not have the impact that the AoI showed.

Table 7-14: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Cape Romain Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC	29.2	2,355.8	1,863.6	2.74%	30.18%	32.92%
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA	39.1	108.1	3751.6	0.03%	17.07%	17.10%
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	63.7	3,273.4	4,281.1	0.45%	6.57%	7.02%
SC	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION	51.4	1,772.5	2,246.8	0.38%	4.60%	4.98%
SC	45015-8306711	SCE&G WILLIAMS	26.7	992.7	392.4	0.79%	4.01%	4.80%
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL	57.4	2,031.2	2,767.5	0.35%	4.31%	4.66%
SC	45015-4953011	NUCOR STEEL BERKELEY [(1)]	22.1	440.0	148.2	0.42%	1.83%	2.25%
GA	13051-3679811	International Paper - Savannah	166.1	1,560.7	3,945.3	0.04%	1.76%	1.80%
SC	45035-4797811	SHOWA DENKO CARBON INC [(1)]	66.1	264.5	971.1	0.03%	1.71%	1.74%
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill) [(2)]	159.9	351.5	1,860.1	0.02%	1.15%	1.17%
SC	45079-4801411	INTERNATIONAL PAPER EASTOVER [(1)]	139	1,780.3	3,212.8	0.04%	1.06%	1.09%
SC	45015-15655111	COOPER RIVER PARTNERS LLC [(1)]	25.9	58.4	58.1	0.07%	0.94%	1.02%
GA	13015-2813011	Ga Power Company - Plant Bowen	506.2	6,643.3	10,453.4	0.01%	0.36%	0.37%

[(1)]These facilities were not tagged in the PSAT analysis.

[(2)]This facility was tagged by Georgia, but not South Carolina.

7.6.4. Selection of Sources for Reasonable Progress Evaluation

The EPA has made clear that each state has the authority to select the sources to evaluate for reasonable progress analysis 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 the 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, the 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] the 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 EPA guidance goes on to discuss which pollutants to consider. The guidance discusses methods for estimating baseline visibility impacts for selected sources, including residence time analysis and photochemical modeling, both of which were used by South Carolina and 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 also discussed using estimates of visibility impacts to select sources including the use of a visibility impact threshold level for selecting sources. South Carolina, 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 NO_X and 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. 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, greatest opportunity for reasonable progress improvement, at Class I areas. This process also resulted in selecting a number of sources that South Carolina, and states that contribute to South Carolina Class I areas, could analyze with the limited resources available to the state. Sources selected for analysis by South Carolina include sources that contribute to visibility impairment in both South Carolina and non-South Carolina Class I areas. Thresholds selected by South Carolina for each of the steps are discussed in this document. 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. The 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 emission unit. In this second round of planning for regional haze SIPs, all VISTAS states used the AoI/PSAT approach and a ≥ 1.00% PSAT threshold by facility for screening sources for reasonable progress evaluation. Using a facility basis for emission estimates pulled in more facilities as compared to an emission unit-by-unit basis for emission estimates. 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.

As discussed in Section 7.6.1, SO_2 emissions from point sources were estimated to have the largest contribution to visibility impairment at Cape Romain (see Table 7-4 and Table 7-5), and South Carolina 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 South Carolina determined that a 2% AoI threshold would capture a sufficient number of sources that would reflect a significant impact on Cape Romain but not strain the limited resources that would be needed for reviewing reasonable progress analyses. Since the regional haze rules 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, South Carolina determined which South Carolina sources would be selected and which non-South Carolina sources impacted Cape Romain. That information is shown in Table 7-15. Table 7-15 shows that the 2% AoI threshold resulted in eight facilities, six in South Carolina and two in Georgia, being selected for PSAT tagging by VISTAS states. Note that for selected South Carolina sources, the

table displays the percent sulfate contribution to Cape Romain regardless of their AoI percentage. Percentages above 2% are shown in bold.

Table 7-15: Sources Selected by South Carolina for PSAT Tagging and Percentage of Point Source Sulfate Impairment at each Class I Area

State	Facility ID	Facility Name	ROMA Sulfate (%)	JOYC Sulfate (%)	GRSM Sulfate (%)	LIGO Sulfate (%)	SHRO Sulfate (%)	OKEF Sulfate (%)	WOLF Sulfate (%)
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC	**30.17%**	0.02%	0.05%	0.06%	0.02%	0.71%	0.89%
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA	**17.06%**	0.14%	0.03%	0.03%	0.05%	1.06%	1.84%
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	**6.57%**	0.17%	0.03%	0.03%	0.11%	0.92%	1.59%
SC	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION	**4.59%**	0.07%	0.02%	0.07%	0.008%	0.61%	0.82%
SC	45015-8306711	SCE&G WILLIAMS	**4.01%**	0.004%	0.007%	0.001%	0.02%	0.09%	0.21%
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL	**4.31%**	0.12%	0.09%	0.13%	0.02%	0.55%	0.77%
GA	13051-3679811	International Paper - Savannah	1.76%	0.13%	0.03%	0.08%	0.04%	**3.05%**	**7.53**
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	1.15%	0.06%	0.04%	0.01%	0.03%	1.14%	**2.65**

South Carolina conducted a similar analysis using sulfate plus nitrate visibility impairment since NO_X emissions from point sources are also a contributor to visibility impairment at Cape Romain. This analysis indicated that the inclusion of NO_X in the AoI selection analysis would not have resulted in any additional facilities tagged for PSAT analysis. South Carolina will continue to monitor nitrate contribution from point sources to visibility impairment at Cape Romain, and if it becomes an important contributor, South Carolina will address nitrate contribution from point sources in the third implementation period.

Based on the PSAT results presented in Table 7-11, Table 7-12, and Table 7-13, the VISTAS states agreed that all facilities with a ≥ 1.00% PSAT threshold for sulfate or nitrate would be examined for reasonable progress. A total of eight facilities exceeded the ≥ 1.00% PSAT threshold and were identified to evaluate additional controls for reasonable progress for Cape Romain. Table 7-16 contains a list of facilities in South Carolina selected for reasonable progress analysis. Table 7-17 contains a list of facilities in VISTAS states (not including South Carolina) selected for reasonable progress analysis. Table 7-18 contains a list of facilities in non-VISTAS states selected for reasonable progress analysis. Six of the eight sources listed above in Table 7-15 were selected for reasonable progress analysis, and this captured an estimated 64.46% of the point source sulfate visibility impairment for Cape Romain. This also resulted in a manageable number of sources to be reviewed by state staff. In addition, South Carolina did not identify any uncontrolled or lightly controlled facilities that were large contributors to anthropogenic light extinction at Cape Romain. Thus, South Carolina concludes that the 1% PSAT threshold captured a reasonable number of facilities for reasonable progress analysis for their potential impacts on Cape Romain.

Table 7-16: Facilities in South Carolina Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
SC	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC
SC	45015-4834911	ALUMAX OF SOUTH CAROLINA
SC	45015-4120411	SANTEE COOPER CROSS GENERATING STATION
SC	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL

Table 7-17: Facilities in VISTAS states (not including SC) Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
GA	13015-2813011	Ga Power Company - Plant Bowen
GA	13051-3679811	International Paper - Savannah

Table 7-18: Facilities Located Outside of VISTAS States Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA

Santee Cooper Cross Generating Station was contacted on November 25, 2020, and the other three South Carolina facilities listed in Table 7-16 were contacted on June 2, 2020, and asked to perform a reasonable progress analysis. The state of Georgia was contacted on November 5, 2020, and asked to perform a reasonable progress analysis for the facilities listed in Table 7-17. A copy of these letters and their respective responses can be found in Appendix G. The states of Ohio and Pennsylvania were contacted on June 22, 2020, and asked to perform a reasonable progress analysis for the facilities listed in Table 7-18.[46] A copy of these letters and their respective responses can be found in Appendix F.

South Carolina facilities listed in Table 7-5 that were not tagged with PSAT are discussed below. It should be noted that SCE&G Williams was tagged for PSAT, but the contribution was below the 1% threshold and is included in the below discussion.

- **Dominion Energy A.M. Williams Station**

  Dominion Energy operates one EGU at A.M. Williams Station (Williams), formerly SCE&G Williams, located in Goose Creek, South Carolina. The EGU is permitted to burn coal and is controlled by an ESP for PM emissions, wet FGD for SO_2 emissions, and selective catalytic reduction (SCR) for NO_X emissions.

  In addition to being below the 1% threshold, the Department did not select Williams for several other reasons. The EGU is subject to and in compliance with 40 CFR 63,

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

Subpart UUUUU, National Emission Standards for Hazardous Air Pollutants for Electric Generating Units, also known as the Mercury and Air Toxics Standards (MATS). Dominion Energy measures emissions and assures compliance with the SO_2 emission limits using a SO_2 continuous emissions monitoring system (CEMS) certified under 40 CFR Part 75. Wet FGD provides the greatest control of SO_2 emissions from EGUs, meaning there is not a more feasible control technology to consider.

- **Nucor Steel Berkeley**
  This facility is 22 km from Cape Romain and the AoI sulfate contribution is 1.83%. According to Section 7.6.3, if a facility is less than 100 km from the Class I area, the AoI results are always at least three times higher than the PSAT results. Reducing the AoI sulfate contribution by a conservative factor of three results in a revised AoI sulfate contribution of 0.61%; this facility will be screened out due to insignificant visibility impacts at Cape Romain. In addition, the facility submitted a facility-wide PSD permit application in 2015 (updated in 2017), which included a visibility analysis and BACT analysis where appropriate. The Department issued the permit in November 2020 following appropriate permitting procedures, such as public notice and opportunity to comment from the EPA and FWS.

- **Showa Denko Carbon, Inc.**
  Showa Denko Carbon, Inc. (Showa Denko), located in Ridgeville, South Carolina, manufactures graphite electrodes for use in the steel manufacturing industry. Showa Denko is 66 km from Cape Romain and the AoI sulfate contribution is 1.71%. According to Section 7.6.3, if a facility is less than 100 km from the Class I area, the AoI results are always at least three times higher than the PSAT results. Reducing the AoI sulfate contribution by a conservative factor of three results in a revised AoI sulfate contribution of 0.57%; this facility will be screened out due to insignificant visibility impacts at Cape Romain.

- **Cooper River Partners, LLC**
  Cooper River Partners, LLC (CRP) owns the Bushy Park Industrial Complex, located in Goose Creek, South Carolina. CRP is 25 km from Cape Romain and the AoI sulfate contribution is 0.94%. According to Section 7.6.3, if a facility is less than 100 km from the Class I area, the AoI results are always at least three times higher than the PSAT results. Reducing the AoI sulfate contribution by a conservative factor of three results in a revised AoI sulfate contribution of 0.31%; this facility will be screened out due to insignificant visibility impacts at Cape Romain.

- **IP Eastover**
  This facility is 139 km from Cape Romain and the AoI sulfate contribution is 1.06%. SO_2 emissions used in the AoI analysis was 3212.8 tpy. In 2016, IP Eastover discontinued

burning coal in one of the main power boilers to comply with 40 CFR Part 63, Subpart DDDDD, National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters. The SO_2 emission for the past 4 years were, 2020.35 tpy (2017), 2167.93 tpy (2018), 2108.21 tpy (2019), and 2190.11 tpy (2020) and the average over this period was 2121.62 tpy. Scaling the AoI sulfate contribution of 1.06% by the ratio of current to 2028 SO_2 emissions (2121.62/3212.8) results in a revised AoI sulfate contribution of 0.66%; therefore, this facility will be screened out due to insignificant visibility impacts on Cape Romain.

7.6.5. Evaluation of Recent Emissions 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.

South Carolina examined the 2017, 2018, and 2019 emission information that has been reported to the EPA and compared these emissions to the 2028 emissions that were used in the modeling. Table 7-19 shows all the facilities with SO_2 emissions greater than 100 tpy in 2017. In addition to 2017 emissions, the tables have 2018 and 2019 emissions, if available. Projected emissions for 2028 are also shown. One column has the 2028 original value that was used in the first run on the model, and another column has the 2028 remodel value that was used in the second run of the model. The last three column show the difference between the 2028 remodel value and 2017, 2018, and 2019 values, respectively.

South Carolina relied primarily on evaluation of 2028 emissions for screening sources for reasonable progress analysis and developing a long-term strategy. There are some facilities where the most recent 2017, 2018, and/or 2019 emissions are significantly lower than the 2028 emissions used in the modeling and for the selection of sources for reasonable progress analysis. Likewise, there are some facilities where the most recent 2017, 2018, and/or 2019 emissions are significantly higher than the 2028 emissions used in the modeling and for the selection of sources for reasonable progress analysis. These differences, either way, can be contributed to conservatively high modeled emissions for 2028, recent or projected unit retirements, operational or process changes, or the installation of air pollution controls that were taken into consideration when estimating 2028 emissions. In summary, review of the 2017, 2018, and 2019 emissions data does not change South Carolina's conclusions regarding reasonable progress or the long-term strategy.

Table 7-19: SO_2 Emissions Comparison Between 2017, 2018, 2019, and 2028

EIS Facility ID	Facility	SO_2 2017 (tpy)	SO_2 2018 (tpy)	SO_2 2019 (tpy)	SO_2 2028 Original (tpy)	SO_2 2028 Remodel (tpy)	SO_2 2028 Remodel minus 2017 (tpy)	SO_2 2028 Remodel minus 2018 (tpy)	SO_2 2028 Remodel minus 2019 (tpy)
3909611	MILLIKEN PENDLETON	145	145	145	6	6	-139	-139	-139
8306711	A M WILLIAMS STATION	460	593	546	392	392	-68	-201	-154
4834911	CENTURY ALUMINUM OF SOUTH CAROLINA INC	2046	1890	1758	3752	3752	1706	1862	1994
4120411	SANTEE COOPER CROSS GENERATING STATION	2799	3560	3538	4281	4281	1482	721	743
4953011	NUCOR STEEL BERKELEY	132	157	160	148	148	16	-9	-12
4952811	DAK AMERICAS LLC COOPER RIVER PLANT	115	83	104	14	14	-101	-69	-90
4973611	WESTROCK CHARLESTON KRAFT LLC	913	1113	1145	1864	1864	951	751	719
3762811	MILLIKEN & CO MAGNOLIA PLT	697	757	528	28	28	-669	-729	-500
4779511	GUARDIAN INDUSTRIES	103	106	111	98	98	-5	-8	-13
5684811	GIANT CEMENT CO	376	344	331	309	309	-67	-35	-22
4797811	SHOWA DENKO CARBON INC	241	239	62	971	971	730	732	909
4758811	WESTROCK CP LLC	1480	1309	537	64	64	-1416	-1245	-473
5698611	INTERNATIONAL PAPER GEORGETOWN MILL	919	1093	1079	2768	2768	1849	1675	1689
6652811	SANTEE COOPER WINYAH GENERATING STATION	542	539	348	2247	2247	1705	1708	1899
5720711	HOLCIM (US) HOLLY HILL	128	144	141	123	123	-5	-21	-18
7870811	COPE STATION	1166	888	581	962	962	-204	74	381
7126411	WATEREE STATION	1066	1017	673	2377	2377	1311	1360	1704
4801411	INTERNATIONAL PAPER EASTOVER	2020	2171	1198	3213	3213	1193	1042	2015
4962511	CARLISLE FINISHING LLC	181	175	172	4	4	-177	-171	-168
4054911	NEW-INDY CATAWBA LLC	2211	2288	2117	2521	2521	310	233	404

*2017, 2018, & 2019 Inventory data pulled from EIS (2019 NEI data was not yet 'final' so used the 'scdhec' data source)

*Original and Revised 2028 VISTAS inventory data was confirmed with "TASK_11_3_COMPARISONS_20191218"

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 RPG 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, the EPA issued a memorandum entitled "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, 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 energy and non-air environmental impacts (statutory factor 3), charactering 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 facilities in South Carolina selected for reasonable progress analysis as identified in Table 7-16. The results of these analyses are found in Section 7.8.

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

The following summarizes the process for determining reasonable progress for South Carolina sources and whether to implement reasonable progress controls or measures. Four-factor analyses were completed for units at four facilities, consistent with the EPA's Control Cost Manual and the 2019 Regional Haze Guidance. The Department used these analyses to determine whether a given control measure is cost-effective. Below is a summary for units at five facilities, one of which did not do a four-factor analysis (Winyah): Santee Cooper Winyah Generating Station, Century Aluminum of South Carolina, International Paper Georgetown, Kapstone Charleston Kraft, and Santee Cooper Cross Station. Appendix G provides the correspondence between the Department and each facility and each facility's reasonable progress assessment and four factor analysis. One facility, Santee Cooper Winyah Generating Station, was not selected for a reasonable progress evaluation by South Carolina or by another state during state-to-state consultation. The facility is considered an effectively controlled source with a wet FGD complying with the 0.2 lb/MMBtu SO_2 limit in 40 CFR 63, Subpart UUUUU, National Emission Standards for Hazardous Air Pollutants for Electric Generating Units, also known as the Mercury and Air Toxics Standards (MATS) rule. For each of the five facilities, the permit conditions to be adopted into the regulatory portion of the SIP are listed in Section 7.9.

7.8.1. Century Aluminum of South Carolina (formerly ALUMAX of South Carolina)

Century Aluminum of South Carolina, Inc. (Century), formerly known as ALUMAX of South Carolina, operates an aluminum smelter facility in Goose Creek, South Carolina.

Description of SO_2 Emission Units

The aluminum manufacturing process at Century consists of three basic steps: 1) The manufacture of carbon anodes from coke and pitch; 2) The reduction of alumina to produce molten aluminum; and 3) The processing of molten aluminum for end users. For purposes of the facility's air permitting submittals, these three steps have been divided into the following seven processes that emit regulated pollutants: 1) Green Carbon Plant; 2) Baked Carbon Plant; 3) Anode Rodding; 4) Potlines; 5) Pot Repair; 6) Cast House; and 7) General Facility. Table 7-20 displays the sources of non-combustion sulfur compound emissions at Century.

Table 7-20: Century Sources of Non-Combustion Sulfur Compound Emissions

Source	Proportion of Facility SO_2 Emissions (Percent)
85 – Anode Forming Equipment (Green Carbon Plant)	0.05
01 – Bake Oven (Baked Carbon Plant)	7.35
02, 03, 04, 05 – Potline Potrooms (Potlines)	92.60 (23.15 each)

Based on the information in Table 7-20, the four-factor analysis is focused on the Bake Oven and the Potline Potrooms as these sources constitute 99.95 percent of Century's SO_2 emissions. In the Bake Oven, green anodes are baked in ring furnaces. The green anodes are stacked in rows, covered with a layer of insulating material to reduce heat loss, and fired. After the completion of the firing cycle, the anodes are uncovered and removed from the ring furnaces. The Bake Oven is equipped with a dry scrubbing system that uses alumina as the scrubbing media to control fluoride emissions. A baghouse downstream of the dry scrubber is used to control particulate and fluoride emissions. Spent scrubbing media is used as feedstock on the Potlines. SO_2 emissions from the anode Bake Oven are generated from natural gas combustion and sulfur compounds released from the coke and pitch in the green anodes during the baking process. Any add-on SO_2 control equipment would need to be installed downstream of the existing controls, which are required by the National Emission Standards for Hazardous Air Pollutants for Primary Aluminum Reduction Plants (Primary Aluminum MACT) and NSPS regulations. The Potlines consist of reduction pots that produce aluminum using the Hall-Heroult electrolytic process. Baked carbon anodes from the Bake Oven are inserted into each pot. The lining of the pot includes a carbon cathode. Alumina, electrolytic bath, and additives are maintained in each pot.

Voltage is applied across the pot initiating the reduction process. During the reduction process, molten aluminum forms in the pot, is removed from the pot into crucibles, and is then transported to the Cast House. Most of the anode is consumed during the reduction process. There are two Potlines at Century, each containing two Potrooms. There are two operating scenarios that have existing construction permits: 1) One Potline with the two associated Potrooms or 2) Two Potlines with the four associated Potrooms (two per Potline). Each of the four Potrooms is equipped with a dry scrubbing system that uses fresh alumina as the scrubbing media to control fluoride emissions, followed by a baghouse used to control particulate emissions. SO_2 emissions from the Potrooms are generated from consumption of the anodes in the pots and subsequent oxidation of sulfur containing compounds found in the anodes to form SO_2. SO_2 emissions are released from the Potroom roof vents and alumina dry scrubber stacks. Any add-on SO_2 control equipment would need to be installed downstream of the existing controls, which are required by the Primary Aluminum MACT and NSPS regulations.

Control Technology Evaluation

Century identified wet scrubbers and dry sorbent injection scrubbers as potential SO_2 control technologies. Wet scrubbers are deemed technically feasible for the Bake Oven and the Potline Potrooms. Dry injection systems involve the injection of a dry sorbent (normally lime or limestone) into the flue gas in the ductwork following the process. Sulfur oxides react directly with the dry sorbent, which are collected in a downstream particulate control device. In the application to Century Bake Oven and Potroom dry aluminum scrubber stacks, dry sorbent injection would require the installation of a new downstream particulate collector because the sorbent cannot be injected upstream of the current alumina dry scrubbers. The reacted alumina represents a raw material for the Potlines and adding any type of sorbent would disrupt the associated molten aluminum production from the reacted alumina. Because a separate scrubber vessel is not needed, capital costs are sometimes reduced. Reduced capital costs are offset by lower reagent utilization, which result in higher operating costs for equivalent SO_2 removal rates. Dry injection systems are generally applied when lower removal efficiencies are required. Typical inlet gas temperatures for dry sorbent injection systems are 300 °F to 350 °F. The inlet gas temperatures to dry scrubber applications for Century Mt. Holly are approximately 180 °F for the Bake Oven and the Potrooms. Therefore, inlet gas preheating would be required to implement this dry scrubbing option. Dry sorbent injection scrubbers are also deemed technically feasible for the Bake Oven and Potline Potrooms.

The cost analysis assumes that wet scrubbers would reduce SO_2 emissions by 93 percent based on the EPA's RACT/BACT/LAER Clearinghouse (RBLC) database research that indicates a smelter in Kentucky operates a scrubber with a design control efficiency of 93 percent. In recent years, Century's environmental consultant worked on a project in South Carolina at a similar industry (electrode production). Existing sources at that facility were retrofitted with wet SO_2

scrubbers. Based on the final as-installed design for those wet scrubbers, the SO_2 control efficiency in that similar retrofit application was targeted at 93 percent. For the dry sorbent injection scrubber solution, the cost analysis assumes 90 percent SO_2 reduction. Information provided by the vendor stated that the typical efficiency of their dry sorbent injection system in this retrofit application is 90 percent.

To calculate the emission reductions, Century used estimated annual SO_2 emissions in 2028 for the Bake Oven and four Potrooms. Table 7-21 shows the emissions for the units for the base year, current inventory, and future projected. This was compared to the maximum emission rate of the source post-control to obtain an emission reduction (tons per year (tpy)) value. The annual cost was then divided by the emission reduction to arrive at the cost effectiveness ($/ton) amount.

Table 7-21: Century, Baseline and Future Projected Emissions (tpy)

Unit	2011	2028
Potline 02	864	864
Potline 03	864	864
Potline 04	864	864
Potline 05	864	864
Bake Oven 01	294	294
Total	3750	3750

Cost of Compliance

The initial analysis was calculated using 5.5 percent interest rate and a useful life of 20 years. The Department requested Century to justify the interest rate and use a useful life of 30 years. Century used the Control Cost Manual (CCM), Section 5, Chapter 1 (Tables 1.7 and 1.8), dated July 2020 and an interest rate of 5 percent to calculate the revised costs. The use of an interest rate higher than prime is based on a footnote in Table 1.8, which states that this capital recovery factor is based on a useful life of 30 years and an interest rate of 5 percent. The change from a 20-year useful life to the 30- year useful life dictated by the most recent CCM guidance had no meaningful impact on the cost analysis. South Carolina accepts this justification of an interest rate other than prime.

For the wet scrubber control option, the initial Century cost analysis at an assumed 93 percent control efficiency with a 5.5 percent interest rate and 20-year scrubber life determined the cost effectiveness calculated to be $8,305 per ton of SO_2. The revised cost analysis at an assumed 93 percent control efficiency for wet scrubbers with a 5 percent interest rate and 30-year scrubber life determined the cost effectiveness calculated to be $7,968 per ton of SO_2. The Department requested that Century perform a cost analysis assuming at least 98 percent control efficiency.

The revised cost analysis at an assumed 99 percent control efficiency for wet scrubbers with a 5 percent interest rate and 30-year life determined the cost effectiveness calculated to be $7,485 per ton of SO_2 reduction. These revised calculations assumed a total cost of $96,012,124 and an annual cost of $28,994,086.

For the dry scrubber control option, the initial Century cost analysis at an assumed 90 percent control efficiency with a 5.5 percent interest rate and 20-year scrubber life determined the cost effectiveness calculated to be $10,323 per ton of SO_2. These calculations assumed a total cost of $109,760,060 and an annual cost of $34,878,587. The Department accepts the cost analysis and did not request a revision.

Remaining Useful Life

The assessment of this factor involves estimating how long the sources analyzed will remain in operation and the operating life of potential control measures, accounting for equipment and site-specific limitations. Situated outdoors in South Carolina's climate, with proper maintenance the typical operating life of wet or dry scrubbers is 20 years and this was used in Century's original cost analysis. At the request of the Department based on a footnote in Table 1.8 of the CCM, the cost analysis was revised by Century using a capital recovery factor assuming a useful life of 30 years of the wet scrubber. Therefore, compliance costs for a wet scrubber have been annualized based on the useful life of the control equipment (30 years for a wet scrubber). The change from a 20-year useful life to the 30-year useful life for a wet scrubber dictated by the most recent CCM guidance had no meaningful impact on the cost analysis.

Energy and Non-Air Quality Impacts of Compliance

Operating SO_2 emission controls would impact energy use and the environment in forms other than air quality. Both wet and dry scrubbers require significant amounts of electricity and consumables to operate. The amount and cost of electricity and consumable reagents required are detailed in the tables included in Appendix II and are based on the EPA Air Pollution Control Cost Manual. Non-air impacts include solid, liquid, and hazardous waste generation resulting from the transfer of captured atmospheric pollutants to non-air land and water environmental media. Wet SO_2 scrubbers generate significant wastewater and sludge that increase a facility's wastewater treatment and solid waste management requirements and costs. Primary aluminum wastewaters are subject to the EPA categorical discharge standards. An extensive wastewater system would need to be constructed at Century to collect, convey, and treat wet scrubber blowdown wastewaters prior to discharge to the local publicly owned treatment works (POTW). Dry scrubbers generate solids that are collected by particulate control devices and will need to be properly disposed at a landfill.

Time Necessary for Compliance

Century included this discussion for time necessary for compliance:

> Sources are generally given between two and five years to implement changes for compliance with new regulations. MACT standards typically allow three years for compliance. Under the NOx SIP Call for Phases I and II, the EPA allowed for three and a half and two years, respectively, after the SIP submittal date for compliance. Affected sources would require time to design, purchase, and install selected control options in addition to the time needed to obtain an air construction permit for the control equipment. Allowing for these variables, five years is an accurate estimate of the time necessary for compliance. This timeframe is consistent with the compliance timeframes allowed for in the majority of first planning period SIPs. For example, in Oklahoma, each source subject to Best Available Retrofit Technology (BART) was required to install and operate (BART) as expeditiously as practicable, but in no event later than 5 years after approval of the SIP revision. Assuming an EPA approval date for the DHEC's regional haze second planning period SIP of December 31, 2022, anticipated implementation date would be January 1, 2028. Century believes that a compliance timeframe of four to five years is accurate. This includes a year to obtain environmental construction permits (both air and wastewater construction permits would be required) and three to four years to contract, design, fabricate, deliver, construct, and make operational the control equipment and ancillary wastewater treatment plant.

Summary of Findings

Century identified no cost-effective control measures to further reduce SO_2 emissions for the potlines and the bake oven. The Department concludes that the units at Century are well controlled for SO_2, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at Cape Romain. For the purpose of preventing any future anthropogenic visibility impairment at Cape Romain, the Department is proposing that existing measures in Department-issued permits be adopted into the SIP as required by Section 169A(b)(2) of the CAA.

Additional Information

In Section 9.1 of the four-factor analysis, Century stated that an air dispersion modeling compliance demonstration was conducted as part of retroactive PSD permitting documentation. The Department is including their discussion for informational purposes. The decision to require additional controls or use existing controls was based on the cost analysis. The PSD visibility evaluation included CALPUFF modeling to determine predicted visibility impacts at Cape Romain from Century's emissions of NO_X, SO_2, and particulate matter. The CALPUFF model is

based on a Lagrangian (receptor or puff-based dispersion model) approach containing simplistic chemistry and physics options to simulate visibility as described in Section 9.1 and consistent with FLAG 2010 guidance and procedures.[47] The Table 7-22 below provides the predicted change in light extinction (Δb_{ext}) for each year of meteorological data processed and shows the maximum and 98th percentile (8th highest) values for each year of analysis.

Table 7-22: PSD Class I Area Visibility Impairment (Δb_{ext}) Analysis at Cape Romain NWR Using Method 8 (with IMPROVE tools)

Year	Δb_{ext} (%)		Number of Days	
	Maximum	98th Percentile	Δb_{ext} >5%	Δb_{ext} >10%
2001	2.41	1.15	0	0
2002	2.07	1.06	0	0
2003	2.08	1.11	0	0

As shown, CALPUFF predicted that the facility will not cause visibility impacts exceeding the thresholds of concern related to PSD Class I area visibility assessments since the maximum Δb_{ext} is less than the 5% threshold as discussed in the FLAG 2010 guidance and procedures. The FLM also reviewed and approved the CALPUFF modeling analysis provided for this project.

For regional haze, the existing emissions from Century Aluminum were also evaluated using the VISTAS CAMx photochemical modeling platform to determine whether a Four Factor Analysis would be required. Photochemical models are 3-dimensional Eulerian (gridded) models that incorporate state-of-the-science sulfate and nitrate chemistry. The model also uses diffusion and transport processes to move chemical species to other grid cells. Thus, photochemical models provide a spatially and temporally dynamic realistic chemical and physical environment for plume growth and chemical transformation.

Although there are significant technical differences between CALPUFF and CAMx, both models are acceptable methods for simulating light extinction/visibility degradation at Class I areas. The CAMx model is the more refined model for evaluating cumulative impacts from multiple sources over a regional area. Source apportionment techniques in CAMx can also evaluate single-source contributions (as applied to existing Century Aluminum emissions). However, CAMx is computationally more expensive than CALPUFF and requires much more time and resources to conduct the complex simulations that are a part of CAMx. Although CALPUFF is based more on empirical parameters (rather than state-of-the-science chemistry), it has been shown to produce light extinction coefficients that are reasonable for screening a single source. Furthermore, FLMs have stated that CALPUFF will remain the preferred single source model for Class I Air Quality Related Values (AQRV) analyses (including visibility).

[47] Federal Land Managers' Air Quality Related Values Work Group (FLAG): https://irma.nps.gov/DataStore/DownloadFile/568936

7.8.2. International Paper Georgetown Mill

International Paper Georgetown Mill (IP Georgetown) owns and operates a pulp and paper mill in Georgetown, South Carolina. The primary source of SO_2 emissions at IP Georgetown are Nos. 1 and 2 Power Boilers, Nos. 1 and 2 Recovery Boilers, Nos. 1 and 2 Smelt Dissolving Tanks, and Nos. 1 and 2 Lime Kilns. Miscellaneous sources not analyzed include temporary natural-gas fired boilers and seven diesel-fired reciprocating compression ignition internal combustion engines. IP Georgetown stated the facility has seen a significant decrease in actual emissions of SO_2 since the first implementation period for Regional Haze; this is discussed in more detail below. South Carolina concurs with the following analysis as provided by IP Georgetown.

Description of SO_2 Emission Units

The Power Boilers, installed in 1982, are controlled by multi-cyclone/electrostatic precipitators (ESP) and are permitted to burn bark, coal/synfuel, waste/recovered paper, wood waste, containerboard clippings/pellets, No. 6 fuel oil, natural gas, tire-derived fuel (TDF), sludge, and propane. The Power Boilers were modified in 2016 to replace some of the coal burners with natural gas burners to comply with 40 CFR Part 63, Subpart DDDDD, National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers (Boiler MACT).

No. 1 Recovery Boiler, installed in 1963, is controlled by an ESP, and is permitted to burn black liquor solids, and No. 6 fuel oil and natural gas as auxiliary. Emissions testing in December 2015 and 2018 for No. 1 Recovery Boiler determined that the emission factor was significantly lower than the published emission factor of 2.30 lb/tons of black liquor solids (TBLS).

No. 2 Recovery Boiler, installed in 1966 (modified in 1989), is controlled by an ESP followed by a wet scrubber to control PM emissions, and is permitted to burn black liquor solids, and No. 6 fuel oil and natural gas when no black liquor is available. IP Georgetown stated the scrubber on the No. 2 Recovery Boiler is intended for control of particulate emissions and is not designed or intended to be an SO_2 control device; however, there may be a very small collateral benefit of SO_2 control, but the scrubber's purpose is control of particulates. The scrubber unit is required to operate year-round when the No. 2 Recovery Boiler is operational. IP Georgetown noted that there are no recovery furnaces in the United States that have installed an add-on SO_2 control device and therefore, while this technology may be technically feasible, it may not perform at an optimal control efficiency given that the current actual stack emissions of SO_2 from the recovery boilers are very low at less than 5 ppm. One of the main purposes of the recovery furnace is to recover the sulfur in the spent liquor and regenerate/re-use it in the chemical pulping process. The sodium salt fumes in the upper furnace act as an inherent scrubbing medium to limit SO_2 emissions in the stack. No additional analysis was conducted on No. 2 Recovery Boiler given it is already effectively controlled.

Table 7-23 shows emissions from the 2011 baseline and 2028 future predicted emissions used in the modeling analysis and the 2019 actual emissions provided by IP Georgetown. The 2028 projected emissions are from the EPA's 2028 future projected inventory, which does not account for the changes made at the facility since 2011. IP Georgetown attributed the decrease in actual SO_2 emissions to several factors: 1) Compliance with the Boiler MACT for the power boilers; 2) increased use of natural gas rather than fuel oil; and 3) emissions testing on No. 1 Recovery Boiler showing a significantly lower emission rate.

Table 7-23: IP Georgetown Modeled Baseline, Facility Current, and Modeled Future Projected Emissions (tpy)

Source	2011	2019	2028
PB01	921.01	480.54	951.42
PB02	947.01	479.09	1137.32
RB01	680.05	76.56	637.96[1]
RB02	68.26	65.98	32.50

[1]This value is no longer applicable because the facility has requested federally enforceable operating limitations to limit its potential to emit to less than 330.0 tons per year for SO_2 emissions from RB01. See Section 7.9.2.

No. 1 and No. 2 Smelt Dissolving Tanks, installed in 1964 and 1967, respectively, control PM and TRS emissions with scrubbers. IP Georgetown did not further analyze the smelt dissolving tanks due to low SO_2 emissions (less than 4 tons per year) and add-on control technologies would not be cost-effective. The SO_2 emissions from the smelt dissolving tanks fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the sources would not be permitted for only SO_2 emissions.

The PM and SO_2 emissions from the Lime Kilns are controlled by wet scrubbers and are permitted to burn No. 6 fuel oil, propane, natural gas, and digester chip bin low volume, high concentration noncondensable gases. IP Georgetown did not further analyze the lime kilns for several reasons: inherent control of SO_2 emission via absorption by the lime, significant reduction in burning No. 6 fuel oil (both kilns have burned only natural gas since 2014), annual emissions of SO_2 are below 3 tons per year, and both are controlled by wet scrubbers. In addition, the SO_2 emissions from the lime kilns fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the sources would not be permitted for only SO_2 emissions.

Control Technology Evaluation

Power Boilers

IP Georgetown included this discussion regarding the power boilers, which do not have any existing SO_2 emissions controls. However, certain operational practices serve to limit SO_2 emissions from these boilers due to exclusion from SC Regulation 61-62.96, *Nitrogen Oxides (NO_X) Budget Program*, by maintaining fossil fuel use in the boilers to less than 50 percent on an annual heat input basis. Additionally, wood/bark being the primary fuel in the power boilers also helps control SO_2 emissions because wood's sulfur content is low and the alkaline wood ash acts as an in-situ scrubbing medium for the SO_2 generated by other fuels. Lastly, due to changes in the regulatory landscape as well as the increased availability and more attractive pricing on natural gas, a large quantity of coal has been replaced with natural gas in recent years. Specifically, in 2011, the power boilers combined burned approximately 28,000 tons of coal whereas in 2019, the two units burned only 1,760 tons of coal. Wood/bark and TDF continue to provide about 85 percent of the heat input to the power boilers. The balance is provided by the primary wastewater treatment dewatered sludge and fossil fuels. Among the fossil fuels, the majority of the heat input in recent years has been provided by natural gas firing. IP Georgetown has not purchased coal since 2016 and per current projections, they expect natural gas to dominate the fossil fuel mix used in the power boilers (subject to availability).

IP Georgetown identified potential control technologies to include wet Flue Gas Desulfurization (wet FGD), dry FGD (such as spray dryer absorber system (SDA)), and dry sorbent injection (DSI).

Fuel switching of high sulfur content fuels with low sulfur fuels was not considered for the Power Boilers. The combustion of TDF reduces the need to rely on the combustion of fossil fuels and the TDF is burned for energy recovery, which reduces tires having to be landfilled.

Recovery Boilers

IP Georgetown identified that, while not installed for SO_2 control, wet scrubbers are technically feasible for No. 1 Recovery Boiler. DSI was not initially evaluated because it has never been applied to a recovery boiler in the United States and was deemed technically infeasible. The Department requested IP Georgetown address DSI as a feasible control. IP Georgetown responded with the following discussion:

> Dry sorbent injection has never been applied to a recovery boiler in the United States and is deemed to be technically infeasible for the following reasons. In general, black liquor dry solids may contain 20% sodium, 2% potassium, and 5% sulfur. Ideally, all the sulfur and sodium would be retained in the smelt on the furnace bottom as Na_2S and Na_2CO_3, respectively. However, some sodium compounds are volatilized and some sulfur is released as SO_2. In the recovery boiler flue gas, some SO_2 tends to react with sodium and to a lesser extent with potassium. The effect of injecting additional sodium as Trona is unknown but is

expected to be minimal. Because DSI has never been applied to a recovery boiler and the control efficiency of a DSI on a recovery boiler is unknown, DSI is not a reasonable control option to take forward in this analysis. Based on the same argument as those presented above for the DSI, the technical feasibility of an SDA is also unknown. Moreover, there are no recovery boilers in the United States that employ this technology for SO_2 control. Therefore, both SDA and DSI were deemed technically infeasible for controlling SO_2 emissions from recovery boilers.

Cost of Compliance

Table 7-24 below shows the cost effectiveness for each of the options. The cost analysis was conducted using an interest rate of 5.5 percent and a useful life of 20 years. The Department requested IP Georgetown to explain why prime interest rate of 3.25 percent was not used. Their response was:

> For cost analyses which evaluate equipment costs for future installations, it is crucial to factor in the interest rates for long term loans. The Control Cost Manual notes that the bank prime rate can be used as an indicator of interest rate when a firm-specific interest rate is not available. However, EPA cautions that the bank prime rates do not adequately account for project-specific risks including the length of the project and the credit risks of the borrowers. Therefore, the bank prime rate should be considered the low end of the range for estimating capital cost recovery. Lastly, the Office of Management and Budget (OMB) uses an interest rate of 7%. OMB Circular A-4 states the following: "As a default position, OMB Circular A-94 states that a real discount rate of 7 percent should be used as a base-case for regulatory analysis. The 7 percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector." International Paper's cost of capital is significantly higher than the bank prime rate and is closer to 7%. However, in response to EPA's comment, we have conducted a cost-effectiveness analysis using an interest rate of 3.25%.

South Carolina accepts this justification of an interest rate other than prime.

Power Boilers

The cost analysis of installing a wet scrubber was based on 98 percent control efficiency. For the 2011 calculations, the total cost was estimated to be $166,000,000 and the annual cost was estimated to be $14,100,000. For the 2019 calculations, the total cost was estimated to be $162,000,000 and the annual cost was estimated to be $13,600,000. The annual costs are based

on a capital recovery assuming 5.5% interest rate and 30-amortization period. The addition of a wet scrubber would increase usage of water and electricity and increase generation of wastewater.

The cost analysis of installing a dry FGD was based on 98 percent control efficiency. For the 2011 calculations, the total cost was estimated to be $155,000,000 and the annual cost was estimated to be $13,500,000. For the 2019 calculations, the total cost was estimated to be $152,000,000 and the annual cost was estimated to be $13,000,000. The annual costs are based on a capital recovery assuming 5.5% interest rate and 30-amortization period. The addition of a dry FGD would require a PM control device and generation of solid waste.

DSI was not initially evaluated because using trona is expensive and provides relatively little control for SO_2 emissions and was deemed technically infeasible. The Department requested IP Georgetown address DSI as a feasible control. IP Georgetown did evaluate the cost, but responded with the following discussion:

> Because of the presence of sodium in the wood ash (which is an inherent scrubbing medium for SO_2), and because bark is the primary fuel fired in the power boilers (> 60% on a BTU basis), it is unknown if DSI and SDA will be able to offer the same level of control to the Mill's Power Boiler SO_2 emissions as they would to a coal-fired utility boiler. Therefore, even a removal target of 90% for SDA and 50% for DSI is an overestimate. The SO_2 control options are most effective for coal-fired utility sized units.

Recovery Boilers

Emissions testing in December 2015 and 2018 for No. 1 Recovery Boiler determined that the emission factor was significantly lower than the published emission factor of 2.30 lb/TBLS; therefore, the cost effectiveness calculation was also evaluated based on 2019 emissions. IP Georgetown did submit cost analyses at prime interest rate of 3.25% using 2011 baseline SO_2 emissions; however, the Department accepted the justification to use a higher interest rate as described above. IP Georgetown is accepting an annual SO_2 limit for No. 1 Recovery Boiler that is lower than the 2011 baseline and the 2028 future projected emissions. IP Georgetown identified that, while not installed for SO_2 control, wet scrubbers are technically feasible for No. 1 Recovery Boiler. The cost analysis of installing a wet scrubber was based on 90 percent control efficiency. The total cost was estimated to be $8,878,000 and the annual cost, based on a capital recovery assuming 5.5% interest rate and 30-year amortization period, was estimated to be $1,533,000. The addition of a wet scrubber would increase usage of water and electricity and increase generation of wastewater.

Table 7-24 shows the cost effectiveness for each option analyzed by IP Georgetown for the No. 1 and No. 2 Power Boilers and No. 1 Recovery Boiler. The 2011 and 2019 cost analyses demonstrate that additional controls are not cost effective regardless of the emission levels. IP Georgetown is accepting an annual SO_2 limit for No. 1 Recovery Boiler that is lower than the 2011 baseline and the 2028 future projected emissions; therefore, the 2011 cost effectiveness is for informational purposes only.

Table 7-24: IP Georgetown Cost Effectiveness Comparison of Baseline and Current Emissions

Emission Unit	Control Technology	Cost Effectiveness ($/ton) at 2011 Emission Levels (5.5% interest rate)	Cost Effectiveness ($/ton) at 2019 Emission Levels (5.5% interest rate)
No. 1 Power Boiler/No. 2 Power Boiler	Wet FGD	$7,700	$14,400
No. 1 Power Boiler/No. 2 Power Boiler	Dry FGD (SDA)	$7,400	$13,800
No. 1 Power Boiler/No. 2 Power Boiler	Dry FGD (DSI)	$5,200	$7,900
No. 1 Recovery Boiler	Wet FGD	$3,100[1]	$19,200

[1]This value is no longer applicable because the facility has requested federally enforceable operating limitations to limit its potential to emit to less than 330.0 tons per year for SO_2 emissions from RB01. See Section 7.9.2.

Remaining Useful Life

The power boilers were both commissioned in 1982. Although the units are approaching 40 years, no specific retirement date has been set for either of them. Therefore, the remaining useful life of the emission units may be assumed to be 30 years and as such, a 30-year amortization period has been assumed for capital recovery calculations. No. 1 Recovery Boiler was installed in 1963. Although the unit is over 50 years old, no specific retirement date has been set. Therefore, the remaining useful life of the emission unit may be assumed to be 30 years and as such, a 30-year amortization period has been assumed for capital recovery calculations.

Energy and Non-Air Quality Impacts of Compliance

For the power boilers, additional electricity would be needed to run the wet scrubber since a new fan would be needed to overcome the additional back pressure. Another source of electricity consumption would be the pump required to recirculate the scrubbing liquid. Other environmental and energy impacts include freshwater usage and disposal of the wastewater. The SDA system needs installation of a dry PM control device downstream to collect the dry waste. Once collected, disposal of the spent lime is also an environmental impact. Lastly, the dry sorbent needs to be stored in very low-moisture environment to maintain their flowability.

For the No. 1 Recovery Boiler, additional electricity would be needed to run the wet scrubber since a new fan would be needed to overcome the additional back pressure and the recirculation pump would also require electricity. Other environmental and energy impacts include freshwater usage and disposal of the wastewater.

Time Necessary for Compliance

IP Georgetown stated that after SIP approval, time will be needed for design, permitting, procurement, installation, and startup of the control system. If a wet/dry FGD system is required, IP Georgetown expects that at least 5 years would be required to complete installation of an FGD system after the SIP is fully approved by the EPA. Implementing an emissions reduction project requires a series of critical activities typical of any large Engineering, Procurement, and Construction (EPC) project. The ability to execute these activities in the least amount of time is greatly impacted by the number and scope of anticipated retrofit issues. More retrofit issues translate to more unknowns leading to the need to revisit previously executed project execution steps resulting in a longer implementation timeline. If minimal retrofit issues are encountered, an FGD system could be installed by 2028.

Summary of Findings

IP Georgetown identified no cost-effective control measures to further reduce SO_2 emissions for the power boilers and recovery boilers. The Department concludes that No. 1 and No. 2 Power Boilers and No. 1 and No. 2 Recovery Boilers are well controlled, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at Cape Romain. For the purpose of preventing any future anthropogenic visibility impairment at Cape Romain, the Department is proposing that existing measures for No. 1 and No. 2 Power Boilers and No. 2 Recovery Boiler, and an additional SO_2 limit for No. 1 Recovery Boiler be adopted into the SIP as required by Section 169A(b)(2) of the CAA.

7.8.3. WestRock Charleston Kraft (formerly Kapstone Charleston Kraft LLC)

WestRock Charleston Kraft, LLC (WestRock), formerly Kapstone Charleston Kraft LLC, operates a pulp and paper mill in North Charleston, South Carolina. WestRock's primary source of SO_2 emissions are the Main Boiler and two Recovery Furnaces. WestRock identified other sources of SO_2 at the facility that are low emitting, including auxiliary boilers, smelt dissolving tanks, lime kilns, and reciprocating internal combustion engines (RICE).

Emissions Units Not Evaluated in the Four-Factor Analysis

The auxiliary boilers burn low-sulfur fuels (primarily natural gas, with ultra-low sulfur diesel (ULSD) as backup if natural gas is curtailed or not available). The projected total 2028 actual

emissions for all of these units are less than 1 ton per year SO_2. The SO_2 emissions from the auxiliary boilers fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the source would not be permitted for only SO_2 emissions.

No. 1 Smelt Dissolving Tank and No. 9 East and West Smelt Dissolving Tanks were installed in 1984 and 1966, respectively. Emissions of SO_2 from WestRock's three smelt dissolving tanks are based on National Council of Air and Stream Improvement, Inc. (NCASI) emissions factor data that ranges from non-detect to low, and these emissions are likely a result of either carryover from the recovery furnace or smelt/water interactions. The projected 2028 actual emissions for each smelt dissolving tank are less than 1 ton per year SO_2. Each smelt dissolving tank is already controlled with a wet scrubber. With emissions of less than 1 ton per year SO_2, a full four-factor analysis would not likely identify any feasible, cost-effective or reasonable SO_2 reduction measures for the smelt dissolving tanks. The SO_2 emissions from the smelt dissolving tanks fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the source would not be permitted for only SO_2 emissions.

The No. 4 Lime Kiln and No. 5 Lime Kiln, installed in 1972 and 1990, respectively, at WestRock are fired with No. 6 fuel oil. The lime kilns are used to calcine lime mud ($CaCO_3$) to produce lime product (CaO) for use in the process of recovering and reusing the pulp cooking chemicals. The lime kilns at WestRock are also used as control devices for pulp mill Non-condensable gases (NCGs) and Stripper off-gases (SOGs). The lime kilns provide inherent control of SO_2 that might be generated from combustion of fuel and pulp mill NCGs and SOGs through absorption of sulfur by the calcium in the kiln. The mill also utilizes pre-scrubbers to remove sulfur compounds from NCGs and SOGs prior to firing them in the kilns and reduce the potential for SO_2 formation from combustion of these gases. No. 4 Lime Kiln is primarily used as a backup unit for NCG and SOG combustion and is equipped with a wet scrubber. The wet scrubber, which was installed primarily for control of PM and TRS emissions, provides SO_2 control during startup on No. 6 Fuel Oil. No. 5 Lime Kiln is equipped with an ESP for PM emissions control and starts up on natural gas, resulting in negligible SO_2 emissions during startup. The projected 2028 actual emissions of SO_2 from each kiln are less than 1 ton per year. The No. 4 Lime Kiln is currently utilized only as a backup unit for NCG and SOG combustion and will be retired after WestRock re-routes the NCGs and SOGs to the No. 1 Recovery Furnace (prior to 2028). With emissions of less than 1 ton per year SO_2, a full four-factor analysis would not likely identify any feasible, cost-effective, or reasonable SO_2 reduction measures for the lime kilns. In addition, the SO_2 emissions from the lime kilns fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the source would not be permitted for only SO_2 emissions.

Emissions of SO_2 from reciprocating internal combustion engines are dependent on the sulfur content of the fuel fired. The Mill's seven emergency engines fire propane or ULSD, which contain very little sulfur, and are classified as insignificant activities. Total SO_2 emissions from the engines are less than 1 ton per year, and as such, a full four-factor analysis would not likely identify any feasible, cost-effective, or reasonable SO_2 reduction measures for the engines. In addition, the SO_2 emissions from the engines fall below the permitting exemption level of uncontrolled potential to emit of less than five tons per year as set in SC Regulation 61-62.1; therefore, the source would not be permitted for only SO_2 emissions.

Description of SO_2 Emission Units

The Main Boiler was installed in 1998 and is controlled by a hydrated lime spray dryer and a fabric filter. The Main Boiler is permitted to burn ULSD, biomass, coal, used oil, and wastewater treatment plant residuals.
No. 1 Recovery Furnace was installed in 1984 and is permitted to burn No. 6 fuel oil and used oil and is controlled by an ESP.
No. 9 Recovery Furnace was installed in 1966 and is permitted to burn No. 6 fuel oil and used oil. The facility took an emission limit on No. 9 Recovery Furnace for BART avoidance in the first implementation period of Regional Haze.

Table 7-25 shows emissions from the baseline and future predicted emissions used in the modeling analysis. WestRock calculated the cost effectiveness based on expected actual emissions in 2028, which are unchanged from the 2011 modeled baseline emissions and 2028 modeled future projected emissions.

Table 7-25: WestRock Baseline and Future Predicted Emissions (tpy)

Source	2011	2028
Main Boiler	803	803
No. 1 Recovery Furnace	387	387
No. 9 Recovery Furnace	579	579

Control Technology Evaluation and Cost of Compliance

WestRock stated in the initial submittal that the four-factor analysis was conducted using available site-specific data, capital costs of controls from vendor estimates, and operating cost estimates in the EPA Control Cost Manual. A site-specific engineering analysis was not conducted at the time due to time constraints to submit the analysis. The Department requested additional information to account for site-specific requirements rather than estimates, inconsistencies with the EPA Control Cost Manual, and to provide additional justifications. The cost effectiveness described below is based on revised calculations submitted to the Department.

An interest rate of 4.75 percent and the typical values for equipment life shown in the EPA Control Cost Manual examples were used to calculate the capital recovery factor. A 4.75 percent interest rate represents the prime rate just prior to the COVID-19 pandemic and is representative because the prime rate has varied over the past two years from the current low of 3.25 percent to a high of 5.5 percent in December 2018. Labor, fuel, and utility costs are based on mill-specific values.

Main Boiler

WestRock identified potential control technologies for the Main Boiler to include significant upgrades to the existing SDA to achieve 95 percent control efficiency, switching fuel from coal to natural gas or ULSD, or replacing the existing SDA with a wet scrubber at 98 percent control efficiency.

One of the options evaluated for the Main Boiler was upgrading the existing SDA to achieve a higher removal efficiency. The Main Boiler is a multi-fuel boiler that uses an SDA with hydrated lime addition. The SDA consistently removes SO_2 from fossil fuel combustion in excess of 90 percent as required by NSPS Subpart Db. However, for the typical fuel mix of biomass (including WWTP residuals) and coal (generally between 40/60 to 60/40 heat input ratio of biomass to coal), the SDA provides an average SO_2 control efficiency around 80 percent. Limited data show that removal efficiencies of 85 to 90 percent have been attained for short periods of time when the coal firing ratio is increased, which is consistent with the anticipated control efficiency for this type of control device. The original manufacturer of the control device indicates that it is designed to fully saturate and treat 100 percent of the gas stream, and the system currently operates near the maximum sorbent injection capacity. Based on information provided by Babcock and Wilcox (B&W), 95 percent control could be achieved by replacing a significant portion of the existing SDA system. As such, this option is considered technically feasible.

The initial cost estimate (October 2020) contained a section specifically identifying a number of excluded items, which the vendor has since determined a subset to be necessary in order to rebuild the equipment so that it can meet the necessary control efficiency and a life expectancy of 20 years. Revised calculations (June 2021) incorporated specific upgrades that were not in the original submittal, including an ID fan upgrade, replacement of the existing slurry make down system, and upgrades/replacement of the fabric filter bags. The necessary additions to the scope of work bring the estimated equipment cost to $38,000,000 and an annual cost of $4,124,918. The cost effectiveness of significant upgrades to the existing SDA was calculated to be $6,849 per ton of SO_2.

Replacement of coal with a lower sulfur fuel such as virgin biomass, natural gas and/or ULSD was identified as an available SO_2 control option for the Main Boiler. Replacement of coal with additional biomass is not feasible because the grate is not designed to combust that much solid fuel (the coal burned in the boiler is pulverized, not fired on the grate). Replacing coal with natural gas and/or ULSD would be technically feasible and would require the addition of a new burner system that would combust both natural gas and ULSD. Firm natural gas is not currently available at the Charleston Mill, so replacement of coal with natural gas and use of ULSD during gas curtailments has been selected as the available technically feasible low sulfur fuel option. It would result in an approximately 70 percent reduction in SO_2 emissions. The capital cost of replacing coal as a fuel is estimated to be $18,100,000 and the annual costs are estimated to be $13,010,761. The cost effectiveness of replacing coal as a fuel was calculated to be $18,380 per ton of SO_2 reduction.

It would be technically feasible to replace the existing SDA system on the Main Boiler with a wet scrubber designed for a minimum of 98 percent SO_2 removal. In the October 2020 submittal, WestRock cited time constraints to conduct engineering studies and did not include site-specific factors for determining the cost effectiveness of replacing the existing SDA with a wet scrubber. At the time, WestRock did not determine if a new Main Boiler Stack would be required if a wet scrubber was deemed feasible and only used scaled factors. In subsequent communication, the Department requested that WestRock provide a site-specific cost analysis for installing a wet scrubber. WestRock determined through additional engineering studies that the existing concrete stack is not appropriate for a wet scrubber and the Main Boiler Stack would need to be replaced. The total capital cost is estimated to be $54,137,160 and the annual costs are estimated to be $5,089,672. The cost effectiveness of replacing the SDA with a wet scrubber was calculated to be $7,043 per ton of SO_2.

Recovery Furnaces

Cost analyses were developed for the technically feasible control alternatives. Budgetary estimates of capital and operating costs were determined and used to estimate the annualized costs for each control technology considering existing equipment design and exhaust characteristics. A capital cost for each control measure evaluated was based on company-specific data, vendor estimates, previously developed company project costs, and/or EPA costing methodologies. The cost effectiveness for each technically feasible control technology was calculated using the annualized capital and operating costs and the amount of pollutant expected to be removed based on the procedures presented in the latest version of the EPA Control Cost Manual. Actual 2017 emissions were used as the basis for emissions reductions. With the possible exception of the No. 9 Recovery Furnace which has not operated since January 2020, the actual 2019 emissions are a reasonable estimate of 2028 actual emissions.

Air pollution control technologies or techniques (including lower-emitting processes and practices) that have the potential for practical application to the emissions unit and pollutant under evaluation were evaluated. The scope of possible control options for recovery furnaces was determined based on a review of the RBLC database and knowledge of typical controls used on recovery furnaces in the pulp and paper industry. RBLC entries that are not representative of the type of emissions unit or fuel being fired were excluded from further consideration. WestRock identified potential control technologies for the Recovery Furnaces to include good operating practices, low-sulfur fuel during startup (natural gas or ULSD), and a wet scrubber at 98 percent control efficiency.

The No. 1 and No. 9 Recovery Furnaces are not equipped with add-on SO_2 control technology. WestRock stated that good combustion practices are utilized to minimize SO_2 emissions. Thus, the control alternative is considered technically feasible, but was not analyzed further because it is already in use.

Although SO_2 emissions from recovery furnaces can be inherently low, addition of a wet scrubber to further reduce SO_2 emissions is considered technically feasible. Addition of a scrubber designed for 98 percent control efficiency was analyzed. For No. 1 Recovery Furnace, the total capital cost was estimated to be $34,685,528 and the annual costs are estimated to be $7,162,226. For No. 9 Recovery Furnace, the total capital cost was estimated to be $22,821,321 and the annual costs are estimated to be $5,761,292. The cost effectiveness of the addition of a wet scrubber was calculated to be $160,624 per ton of SO_2 reduction for No. 1 Recovery Furnace and $54,434 per ton of SO_2 reduction for No. 9 Recovery Furnace.

It is technically feasible to modify the recovery furnaces to start up on ULSD instead of No. 6 fuel oil. This project has been conducted at other mills to reduce SO_2 emissions during startup. Class 1 natural gas igniters for ULSD would have to be installed for safety reasons. Class 1 igniters are required to operate at all times when ULSD is being fired but can be operated independently when fuel oil firing is not in service. The igniters could be used to provide initial heat during a prolonged cold startup, but the oil burners would be required to provide the heat necessary to complete startup and transition to stable black liquor firing operations. The cost effectiveness of using low-sulfur fuel during startup was calculated to be $53,629 per ton of SO_2 for No. 1 Recovery Furnace and $28,123 per ton of SO_2 for No. 9 Recovery Furnace. Fuel switching during startup would have no additional energy impacts, but could have an increase in waste from cleaning residual No. 6 fuel oil out of the storage and delivery system before switching fuels.

Remaining Useful Life

The Main Boiler is assumed to have a remaining useful life of twenty years or more. The No. 1 Recovery Furnace is assumed to have a remaining useful life of twenty years or more. The No. 9 Recovery Furnace is currently shut down and WestRock stated it will likely be retired prior to 2028; the Department.

Energy and Non-Air Quality Impacts of Compliance

Main Boiler

Installation of a wet scrubber to replace the SDA system would be expected to increase water usage. Modifying the existing control system is not likely to result in a significant energy or non-air impact, based on preliminary information from B&W. When converting a coal-fired boiler to a gas-fired boiler, an energy efficiency drop of around 3 percent is expected, based on the differences in fuel heat transfer characteristics, moisture content of natural gas, and burner/boiler design. However, discontinuing coal firing would reduce the amount of solid waste generated by the boiler.

Recovery Furnaces

Additional electricity would be needed to run a wet scrubber and additional fan power would be required to overcome the additional pressure drop through a new wet scrubber. Other environmental impacts associated with operating a wet scrubber include water usage and generation and disposal of solid waste and wastewater. There are no energy impacts anticipated with switching from No. 6 fuel oil to ULSD. The conversion from No. 6 fuel oil to ULSD could generate waste from cleaning the residual No. 6 fuel oil out of the storage and delivery system prior to startup on ULSD.

Time Necessary for Compliance

Although WestRock believes their four-factor analysis shows there are no additional controls that would be reasonable, if controls are ultimately required to meet RHR requirements, the Mill would need a minimum of four years to implement them after final EPA approval of the RHR SIP. At least four years would be required because the process to undertake a retrofitting project is complex, involving design, engineering, permitting, procurement, and installation to name only some of the necessary work streams.

Summary of Findings

WestRock identified no cost-effective control measures to further reduce SO_2 emissions for the Main Boiler and Recovery Furnaces. The Department concludes that the Main Boiler and No. 1

and No. 9 Recovery Furnaces are well controlled, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at Cape Romain. For the purpose of preventing any future anthropogenic visibility impairment at Cape Romain, the Department is proposing that existing measures for Main Boiler and No. 1 and No. 9 Recovery Furnaces be adopted into the SIP as required by Section 169A(b)(2) of the CAA.

7.8.4. Santee Cooper Cross Generating Station

Santee Cooper operates four electric generating units (EGUs) at Cross Generating Station (Cross) located in Berkeley County, South Carolina. All four EGUs are subject to and in compliance with the MATS rule. Santee Cooper measures emissions and assures compliance with the SO_2 emission limits using a SO_2 continuous emissions monitoring system (CEMS) certified under 40 CFR Part 75. South Carolina concurs with the following analysis as provided by Santee Cooper.

Description of SO_2 Emission Units

1. Cross Unit 01, 5,200 MMBtu/hr: This unit began commercial operation in 1995 and is permitted to burn coal. The unit is equipped with two separate ESPs arranged in parallel (ESP1A and 1B), one SCR system (SCR1), and one wet FGD scrubber (Scrubber 1).
2. Cross Unit 02, 5,200 MMBtu/hr: This unit began commercial operation in 1983 and is permitted to burn coal. The unit is equipped with two separate ESPs arranged in parallel (ESP2A and 2B), one SCR system (SCR2), and one wet FGD scrubber (Scrubber 2).
3. Cross Unit 03, 5,400 MMBtu/hr: This unit began commercial operation in 2007 and is permitted to burn coal. The unit is equipped with one dedicated ESP (ESP3), one SCR system (SCR3), and one wet FGD scrubber (Scrubber 3).
4. Cross Unit 04, 5,400 MMBtu/hr: This unit began commercial operation in 2008 and is permitted to burn coal. The unit is equipped with one dedicated ESP (ESP4), one SCR system (SCR4), and one wet FGD scrubber (Scrubber 4).

Control Technology Evaluation

Santee Cooper identified fuel sulfur control as the only potential control technology and evaluated this control option using the four factors as summarized below. They identified other potential SO_2 control options, including wet and dry FGD and fuel switches, which were not considered further using the four factors for the following reasons:

SO_2 emissions from all four units at Cross are currently controlled by wet limestone flue gas desulfurization (Wet FGD) scrubbers. The control efficiencies of the Wet FGD systems on Units 1, 3, and 4 are at least 95% and the Wet FGD system on Unit 2 is designed to achieve a 91%

removal efficiency and is required to maintain at least an 87% removal efficiency. Wet FGD provides the greatest control of SO_2 emissions from EGUs, and the four Cross EGUs are at over 90 percent control efficiency. The EPA stated in the Guidance "[t]he two limits in the rule (0.2 lb/MMBtu for coal-fired EGUs or 0.3 lb/MMBtu for EGUs fired with oil-derived solid fuel) are low enough that it is unlikely that an analysis of control measures for a source already equipped with a scrubber and meeting one of these limits would conclude that even more stringent control of SO_2 is necessary to make reasonable progress." Cross is meeting the MATS 0.2 lb/MMBtu emission limit. Santee Cooper did not consider a different add-on control technology.

Regarding the fuel switching control option, Santee Cooper stated that any fuel switch option must be considered independently of the other options. Switching any one of the EGUs at CGS from coal to natural gas would be a significant and fundamental change to the plant. Switching the units to burn natural gas would involve significant modifications to the units, powerhouse ventilation systems, electrical upgrades to meet National Fire Protection Association's (NFPA) electrical requirements, and gas detector additions for a powerhouse with units that were originally designed to only burn coal for electrical generation. Such a conversion would result in gas units that are less efficient than units that were originally designed to burn coal. Such a conversion would impact the heat rate of the units and could reduce their maximum generating capacity. Either of these changes would impact the manner and frequency with which the units are dispatched. Any such recategorization would fundamentally redefine the source (i.e., the CGS facility) and would be beyond the scope of what would have been contemplated by Congress to be emission control measures implemented at a source to achieve visibility goals. Moreover, a switch to natural gas at CGS could not be achieved without building a new gas supply pipeline. A sufficiently sized natural gas pipeline currently does not serve the site. Constructing a new pipeline to bring adequate natural gas capacity to the CGS site could negatively impact streams and wetlands along the pipeline route, as well as require significant efforts to determine an appropriate route and mitigation measures. The change in source design, and the other considerations (e.g., the environmental impacts of building a pipeline) taken together render the fuel switch option profoundly infeasible. Accordingly, it is not considered further in this report.

Cost of Compliance

The cost effectiveness of reducing the sulfur content from 2.65 percent (current coal sulfur content at the time of the Cross analysis) to 1 percent was estimated to be 62 percent at a cost of $31,451 per ton of SO_2 reduction based on the calculation:

Cost effectiveness ($/ton) = Total Annual Cost ($/year) / Annual Emissions Reduction (tons/year). The cost analysis was conducted using the annual-average monthly emissions from 2018-2019. In addition, the lower sulfur content would produce lower amounts of gypsum and

Santee Cooper would be required to purchase external gypsum to fulfill supply contracts to outside suppliers; this would increase annual operating costs.

Remaining Useful Life

Cross anticipates operating Units 1-4 through at least 2039. EPA's 2019 Guidance on page 33 states that, "Generally, states can consider this factor by considering the useful life of the control system rather than the source." For a switch to lower sulfur fuel, the "equipment life" is the same as the source life.

In addition, Cross noted that the 2019 Guidance (page 34) states that, "If a control measure involves only operational changes, there typically will be only small capital costs, if any, and the useful life of the source or control equipment will not materially affect the annualized cost of the measure." Utilizing coal with a lower sulfur content involves operating costs only, and the calculated annual cost of this control option does not depend on the equipment useful life.

Energy and Non-Air Quality Impacts of Compliance

Santee Cooper stated that the use of low sulfur coal adds minimal power demand and similar environmental impacts to the coal that is currently used.

Time Necessary for Compliance

Santee Cooper stated two (2) years, starting from the effective date of an approved determination, would be required to utilize fuel sulfur control as an SO2 emissions reduction option. Santee Cooper has coal contracts in place and would be required to honor the specified duration of these contracts. Assuming an EPA approval date for the DHEC's regional haze SIP of January 31, 2023 and adding the times necessary for implementation to this date, the assumed implementation date would be February 1, 2025.

Summary of Findings

Cross identified no cost-effective control measures to further reduce SO_2 emissions for the four EGUs and is already complying with the MATS limit. The Department concludes that Cross Units 1-4 are well controlled, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at Cape Romain. For the purpose of preventing any future anthropogenic visibility impairment at Cape Romain, the Department is proposing that existing SO_2 control measures for Cross based on the MATS rule be adopted into the regulatory portion of the SIP as required by Section 169A(b)(2) of the CAA.

7.8.5. Santee Cooper Winyah Generating Station

Santee Cooper operates four electric generating units (EGUs) at Winyah Generating Station (Winyah) located in Georgetown, South Carolina. The Department did not select Winyah to conduct a four-factor analysis because even though the facility exceeded the 1% PSAT threshold, South Carolina is relying on a demonstration that this source is effectively controlled for SO_2 (see pp. 22-26 of the 2019 Guidance). All four EGUs are subject to and in compliance with 40 CFR 63, Subpart UUUUU, National Emission Standards for Hazardous Air Pollutants for Electric Generating Units, also known as the Mercury and Air Toxics Standards (MATS). Santee Cooper measures emissions and assures compliance with the SO_2 emission limits using a SO_2 continuous emissions monitoring system (CEMS) certified under 40 CFR Part 75. Wet FGD provides the greatest control of SO_2 emissions from EGUs, and the Wet FGD at the four Winyah EGUs, which operate year-round, are at over 90 percent control efficiency. The EPA stated in the 2019 Guidance "[t]he two limits in the rule (0.2 lb/MMBtu for coal-fired EGUs or 0.3 lb/MMBtu for EGUs fired with oil-derived solid fuel) are low enough that it is unlikely that an analysis of control measures for a source already equipped with a scrubber and meeting one of these limits would conclude that even more stringent control of SO_2 is necessary to make reasonable progress." Winyah is meeting the MATS 0.2 lb/MMBtu emission limit.

Description of SO_2 Emission Units

1. Winyah Unit 01, 2,660 MMBtu/hr: This unit began commercial operation in 1971 and is permitted to burn coal. The unit is equipped with an ESP (ESP1), an SCR system (SCR1), and a wet FGD scrubber (Scrubber 1).
2. Winyah Unit 02, 2,660 MMBtu/hr: This unit began commercial operation in 1974 and is permitted to burn coal. The unit is equipped with an ESP (ESP2), an SCR system (SCR2), and a wet FGD scrubber (Scrubber 2).

The exhaust streams from the FGD scrubber for Winyah Units 01 and 02 are routed through a single stack with separate flues.

3. Winyah Unit 01, 2,660 MMBtu/hr: This unit began commercial operation in 1978 and is permitted to burn coal. The unit is equipped with an ESP (ESP3), an SCR system (SCR3), and a wet FGD scrubber (Scrubber 3).
4. Winyah Unit 04, 2,660 MMBtu/hr: This unit began commercial operation in 1978 and is permitted to burn coal. The unit is equipped with an ESP (ESP4), an SCR system (SCR4), and a wet FGD scrubber (Scrubber 4).

The exhaust streams from the FGD scrubber for Winyah Units 03 and 04 are routed through dedicated stacks.

Table 7-20 shows the emissions for the four units for the base year, current inventory, and future projected.

Table 7-26: Winyah Unit Emission, Current and Future Projected (tpy)

Unit	2011	2018	2019	2028
Winyah Unit 1	274.9	125.9	65.0	173.4
Winyah Unit 2	348.2	228.8	163.9	222.7
Winyah Unit 3	1895.4	150.2	79.0	1207.6
Winyah Unit 4	991.6	145.1	40.1	642.9
Total	3510.1	650.0	348.0	2246.6

The Department concludes that Winyah Units 1-4 are effectively controlled because, as noted earlier, Units 1-4 are complying with the MATS SO_2 limit of 0.2 lb of SO_2/MMBtu and the scrubbers on these units are achieving greater than a 90 percent control efficiency, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at Cape Romain. For the purpose of preventing any future anthropogenic visibility impairment at Cape Romain, the Department is proposing that existing SO_2 control measures for Winyah based on the MATS rule be adopted into the regulatory portion of the SIP as required by Section 169A(b)(2) of the CAA.

7.9. Materials Proposed for Adoption into the Regulatory Portion of the South Carolina SIP

This section identifies the materials the Department requests the EPA include in the regulatory portion of the South Carolina SIP. The Department request the EPA incorporate the following permit conditions for each affected source to include the SO_2 emission rate limitations and associated monitoring, recordkeeping, and reporting requirements. Existing permits for Century Aluminum are included in Appendix G-3. Permits conditions not currently in an existing construction permit are proposed below for IP Georgetown, WestRock Charleston Kraft, Santee Cooper Cross Generating Station, and Santee Cooper Winyah Generating Station. The permits will be submitted as a supplement to the EPA following issuance.

7.9.1. Century Aluminum (formerly ALUMAX of South Carolina)

Emission limit: The following emission sources and emission limitations of SO_2 when operating two Potlines:

A. Permit TV-0420-0015 Condition C.25 (page 33): Emissions of SO_2 from Potlines 02, 03, 04, and 05 shall not exceed 212.24 lb/hr (each), 848.96 lb/hr (total), 3718.44 tpy (total)
B. Permit TV-0420-0015 Condition C.17 (page 29-30): Emissions of SO_2 from Bake Oven 01 shall not exceed 82.92 lb/hr
C. Permit TV-0420-0015, Condition C.15 (page 29): the monthly average sulfur content limit for coke shall not exceed 2.22 percent by weight

D. Permit TV-0420-0015, Condition C.15 (page 29): the monthly average sulfur content limit for pitch shall not exceed 0.85 percent by weight

Monitoring, Reporting, and Recordkeeping: To ensure the SO_2 emission limitations in the above conditions will not be exceeded, Century shall be subject to the following requirements for the Potlines and Bake Oven when operating two Potlines:

A. Permit TV-0420-0015, Condition C.25 (page 33)
B. Permit TV-0420-0015, Condition C.17 (page 29-30)
C. Permit TV-0420-0015, Condition C.15 (page 29)

Emission limit: The following emission sources and emission limitations of SO_2 when operating one Potline (Potlines 02 and 03):

A. Permit 0420-0015-CW, Condition C.7 (page 4) and Condition C.8 (page 4): Emissions of SO_2 from Potlines 02 and 03 shall not exceed 279.9 lb/hr (each), 559.8 lb/hr (total), 2451.92 tpy (total) and Potlines 04 and 05 shall not exceed 0.0 lb/hr (each)
B. Permit 0420-0015-CW, Condition C.6 (page 4): Emissions of SO_2 from Bake Oven 01 shall not exceed 54.72 lb/hr
C. Permit 0420-0015-CW, Condition C.4 (page 3): the monthly average sulfur content limit for coke shall not exceed 3.00 percent by weight
D. Permit TV-0420-0015, Condition C.15 (page 29): the monthly average sulfur content limit for pitch shall not exceed 0.85 percent by weight

Monitoring, Reporting, and Recordkeeping: To ensure the SO_2 emission limitations in the above conditions will not be exceeded, Century shall be subject to the following requirements for the Potlines and Bake Oven when operating one Potline:

A. Permit 0420-0015-CW, Condition C.7 (page 4)
B. Permit 0420-0015-CW, Condition C.8 (page 4)
C. Permit 0420-0015-CW, Condition C.6 (page 4)
D. Permit 0420-0015-CW, Condition C.4(page 3)
E. Permit TV-0420-0015, Condition C.15 (page 29)

7.9.2. International Paper Georgetown Mill

The following conditions for SO_2 emission limits and respective monitoring, reporting, and recordkeeping requirements for each of the Power Boilers and Recovery Boilers (listed as Recovery Furnaces in the permit).

<u>Power Boilers Nos. 1 & 2</u>
Emission Unit ID: 01
Equipment ID: PB01, PB02

Control Device ID: PB1Cyclone, PB1ESP, PB2Cyclone, PB2ESP

Each of these sources must demonstrate simultaneous compliance with requirements and associated record keeping as detailed below:

- (S.C. Regulation 61-62.5, Standard No. 1, Section III) The maximum allowable discharge of sulfur dioxide (SO_2) resulting from each source is 2.3 pounds per million British thermal units (MMBtu) input.

(S.C. Regulation 61-62.5, Standard No. 1, Section VI) An owner or operator shall demonstrate compliance with the SO_2 emissions standard by source testing, continuous monitoring, or fuel analysis as required by permit conditions. Compliance shall be demonstrated per 40 CFR 60, Subpart D.

- (40 CFR 60.43(a)) Except as provided under paragraph (d) of this section, on and after the date on which the performance test required to be conducted by §60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere from any affected facility any gases that contain SO_2 in excess of:

(1) 340 ng/J heat input (0.80 lb/MMBtu) derived from liquid fossil fuel or liquid fossil fuel and wood residue.
(2) 520 ng/J heat input (1.2 lb/MMBtu) derived from solid fossil fuel or solid fossil fuel and wood residue, except as provided in paragraph (e) of this section.

(b) Except as provided under paragraph (d) of this section, when different fossil fuels are burned simultaneously in any combination, the applicable standard (in ng/J) shall be determined by proration using the following formula:

$$PS_{SO_2} = \frac{y\ (340) + z\ (520)}{(y + z)}$$

Where:

PS_{SO2} = Prorated standard for SO_2 when burning different fuels simultaneously, in ng/J heat input derived from all fossil fuels or from all fossil fuels and wood residue fired;

y = Percentage of total heat input derived from liquid fossil fuel; and

z = Percentage of total heat input derived from solid fossil fuel.

(c) Compliance shall be based on the total heat input from all fossil fuels burned, including gaseous fuels.

(d) – (e) …

Compliance, monitoring, recordkeeping, and reporting shall be in accordance with per 40 CFR 60, Subpart D, as applicable.

Recovery Furnaces Nos. 1 &2

Emission Unit ID: 01
Equipment ID: RB02
Control Device ID: RB2ESP, RB2 Scrubber

(S.C. Regulation 61-62.1, Section II(E)) This facility established federally enforceable operating limitations to limit the potential to emit from this source to avoid a PSD Significant Increase to less than:

Pollutant	Limit	Averaging Time
SO_2	< 130 ppm @ 8% O_2 (volume, dry)	annual average
SO_2	< 1132 tons per year	12-month rolling sum

Note: For streamlining purposes the monitoring for S.C. Regulation 61-62.5, Section II (E) uses Part 63 monitoring methods; however, this is not a Part 63 (MACT) condition.

The owner/operator shall continue to operate, and maintain total scrubber liquid flow, scrubber inlet duct spray flow, and scrubber pressure differential. The continuous monitoring of the parameters, associated recordkeeping, and reporting requirements, per 40 CFR 63, Subpart MM shall be followed.

The scrubber shall be in place and operational whenever processes controlled by it are running, except during periods of scrubber malfunction or mechanical failure.

The owner or operator must record the actual monthly production rates for the affected sources and maintain these records on-site for a period of at least five (5) years from the date generated. These production rates shall be used, along with Bureau approved emission factors and/or control efficiencies or site-specific factors to calculate a 12-month rolling sum for SO_2 emissions. These records shall be made available to Department personnel upon request.

Reports of the monthly calculated values and the twelve-month rolling sum SO_2 emissions, calculated for each month in the reporting period, shall be submitted semiannually.

An algorithm, including example calculations and emission factors, explaining the method used to determine the SO_2 emission rates shall only be included in the initial report. Subsequent submittals of the algorithm are required within 30 days of the change, if the algorithm or basis for emissions is modified or the Department requests additional information.

Emission Unit ID: 01
Equipment ID: RB01
Control Device ID: RB1ESP

(S.C. Regulation 61-62.1, Section II.E) The facility has requested federally enforceable operating limitations to limit its potential to emit to less than 330.0 tons per year for sulfur dioxide (SO_2) emissions from RB01.

The owner/operator shall maintain black liquor solids throughput, fuel oil usage, fuel oil sulfur content, natural gas usage and any other records necessary to determine SO_2 emissions from RB01. SO_2 emissions shall be calculated on a monthly basis, and a twelve-month rolling sum shall be calculated for total SO_2 emissions. Emissions from malfunctions are required to be quantified and included in the calculations. The twelve-month rolling sum shall be less than 330.0 tons. Reports of the calculated values and the twelve-month rolling sum, calculated for each month in the reporting period, shall be submitted semiannually.

An algorithm, including example calculations and emission factors, explaining the method used to determine emission rates shall only be included in the initial report. Subsequent submittals of the algorithm are required within 30 days of the change if the algorithm or basis for emissions is modified or the Department requests additional information.

7.9.3. WestRock Charleston Kraft LLC (formerly Kapstone Charleston Kraft)

The following conditions for SO_2 emission limits and respective monitoring, reporting, and recordkeeping requirements for each of the Main Boiler, No. 1 Recovery Furnace, and No. 2 Recovery Furnace.

<u>Main Boiler (1998)</u>

Emission Unit ID: 17
Equipment ID: B001
Control Device ID: SD01, BH01

This source must demonstrate simultaneous compliance with requirements and associated record keeping as detailed below:

- (S.C. Regulation 61-62.5, Standard No. 1, Section III) The maximum allowable discharge of sulfur dioxide (SO_2) resulting from each source is 2.3 pounds per million BTU input.

(S.C. Regulation 61-62.5, Standard No. 1, Section VI) An owner or operator shall demonstrate compliance with SO_2 emissions by source testing, continuous monitoring, or fuel analysis as required by permit conditions. Compliance shall be demonstrated per 40 CFR 60, Subpart Db.

- (S.C. Regulation 61-62.1, Section II(E)) The Main Boiler established federally enforceable operating limitations to limit the potential to emit from this source to avoid PSD as follows:

(1) less than or equal to 0.3 pounds per million Btu heat input (30-day rolling average),
(2) less than 1757 tons per year of Sulfur Dioxide (SO_2) (12-month rolling sum), and
(3) greater than or equal to 90 percent SO_2 removal efficiency (30-day rolling average).

Compliance shall be demonstrated for limit (1) and (3) per 40 CFR 60, Subpart Db. For limit (2), the owner or operator must record the actual monthly fuel input rates for each fuel burned during the period. These fuel input rates will be used to calculate heat input rates and used, along with Bureau approved emission factors, site specific data, source test data, laboratory data, control efficiencies and/or CEMS data to calculate a 12-monthly rolling sum for SO_2 emissions. The emission factors may be updated following submittal to the Air Permitting Division Director, Bureau of Air Quality. Records shall be kept of the monthly data and calculations, any exceedances of the 1757 tons per year limit as well as any corrective actions taken for each exceedance with supporting data and information for each incident.

Semiannual reports including any exceedances of the standard limits and any corrective action taken during the reporting period shall be submitted. If there are no excess emissions during the reporting period, the report shall indicate such.

- (40 CFR 60.42b(a)) Except as provided in paragraphs (b), (c), (d), or (j) of this section, on and after the date on which the performance test is completed or required to be completed under §60.8, whichever comes first, no owner or operator of an affected facility that commenced construction, reconstruction, or modification on or before February 28, 2005, that combusts coal or oil shall cause to be discharged into the atmosphere any gases that contain SO_2 in excess of 87 ng/J (0.20 lb/MMBtu) or 10 percent (0.10) of the potential SO_2 emission rate (90 percent reduction) and the emission limit determined according to the following formula:

$$E_s = \frac{(K_a H_a + K_b H_b)}{(H_a + H_b)}$$

Where:
E_s = SO_2 emission limit, in ng/J or lb/MMBtu heat input;
K_a = 520 ng/J (or 1.2 lb/MMBtu);
K_b = 340 ng/J (or 0.80 lb/MMBtu);
H_a = Heat input from the combustion of coal, in J (MMBtu); and
H_b = Heat input from the combustion of oil, in J (MMBtu).

For facilities complying with the percent reduction standard, only the heat input supplied to the affected facility from the combustion of coal and oil is counted in this paragraph. No credit is provided for the heat input to the affected facility from the combustion of natural gas, wood, municipal-type solid waste, or other fuels or heat derived from exhaust gases from other sources, such as gas turbines, internal combustion engines, kilns, etc.
(b) – (d) …
(e) Except as provided in paragraph (f) of this section, compliance with the emission limits, fuel oil sulfur limits, and/or percent reduction requirements under this section are determined on a 30-day rolling average basis.
(f) …
(g) Except as provided in paragraph (i) of this section and §60.45b(a), the SO_2 emission limits and percent reduction requirements under this section apply at all times, including periods of startup, shutdown, and malfunction.
(h) …
(i) An affected facility subject to paragraph (a), (b), or (c) of this section may combust very low sulfur oil or natural gas when the SO_2 control system is not being operated because of malfunction or maintenance of the SO_2 control system.
(j) – (k) …
Compliance, monitoring, recordkeeping, and reporting shall be in accordance with 40 CFR 60, Subpart Db, as applicable.

<u>No. 1 Recovery Furnace</u>

Emission Unit ID: 06
Equipment ID: REC004
Control Device ID: RECCD2

(S.C. Regulation 61-62.1, Standard No. 7) The No. 1 Recovery Furnace has an established PSD limit of less than or equal to 250 ppmv (dry basis) of Sulfur Dioxide (SO_2) averaged over 24 hours. The *PSD BACT* limit does not apply during startup and shutdown periods when the unit is

fired on No.6 fuel oil. During startup and shutdown (when the unit is fired on No. 6 fuel oil), the facility shall use good operating practices to minimize SO_2 emissions.

In order to assure reasonable continuing compliance with the *PSD BACT* limit for SO_2, the amount of No. 6 fuel oil burned each day shall be limited and monitored by the owner or operator. The daily allowable maximum amount of No. 6 fuel oil is based on the amount of 100 % fuel oil (fuel oil burned without black liquor), the amount of black liquor fired without fuel oil, and the amount of black liquor and fuel oil that are co-fired (burned at the same time). The equation below was developed based on test data to monitor the amount of fuel oil that may be burned in a 24-hour day.

$T_O = (0.83 \times T_{BL}) + (0.3 \times T_{C\text{-}F})$

Where:
T_O = Daily time allowed for burning 100% No. 6 fuel oil (fuel oil without black liquor), hours
T_{BL} = Daily time 100% black liquor is burned (black liquor without fuel oil), hours
$T_{C\text{-}F}$ = Daily time that black liquor and No. 6 fuel oil are co-fired (fired at the same time), hours

When co-firing black liquor and No. 6 fuel oil, the ratio of black liquor/fuel oil must be maintained above 3.1 gpm of black liquor per one gallon of oil. The facility must count any use of specification used oil as No. 6 fuel oil in the calculation above.

During each 24-hour day, the owner or operator must continuously monitor the use of No. 6 fuel oil and black liquor burned in No. 1 Recovery Furnace. The data will be used to calculate the daily amount of fuel oil allowed as well as the ratio of black liquor to oil when black liquor and fuel oil is co-fired. Based on equation above, the daily time on fuel oil (burned alone without black liquor) must be maintained below the calculated limitation, and the ratio of black liquor/fuel oil must be maintained at or above 3.1 when black liquor and fuel oil are co-fired. When very low sulfur No. 6 fuel oil or specification used oil (less than or equal to 0.5 percent by weight) is used there is no limitation on the amount of fuel oil used during a 24-hour day. Records of the monitoring data and the results of the calculations must be kept on site.

Semiannual reports including any deviations from the fuel oil use limitations, sulfur content limitations, and any corrective actions taken during the reporting period shall be submitted. If there are no exceedances of the fuel oil use limitations or sulfur content limitations, the report shall indicate such.

<u>No. 9 Recovery Furnace</u>

Emission Unit ID: 06

Equipment ID: REC007
Control Device ID: RECCD5

(40 CFR §51.803(e); *77 FR 38509, June 28, 2012 {SC Regional Haze State Implementation Plan, December 21, 2007}*) The No. 9 Recovery Furnace has an established Best Available Retrofit Technology (BART) avoidance limitation of less than 534 pounds per hour of Sulfur Dioxide (SO_2) averaged over 24 hours. This SO_2 BART Federally enforceable avoidance limitation was established by approved modeling for BART applicability analysis. (Modeling analysis summary and requested limitation based on letter from Ms. Amy Artmeier, Kapstone Charleston Kraft, LLC to Mr. John P. Glass, SC DHEC, Bureau of Air Quality-May 29, 2008.)

During each 24-hour day, daily average fuel usage shall be recorded and maintained on site for the No. 9 Recovery Furnace. The daily fuel use data shall be used along with Department approved SO_2 emissions factors for each fuel to calculate 24-average SO_2 emissions each day. Source testing may be done to establish emission factors, provided the testing is done per a Source Test Plan approved by the Department. Records of the fuel use and SO_2 emissions along with supporting data and information along with any corrective actions taken shall be kept on site and made available to the Department on request.

Semiannual summary reports of any exceedances of the 24-hour SO_2 *BART* avoidance limit and any corrective actions taken during the reporting period shall be submitted. If there are no exceedances during the reporting period, the report shall indicate such.

7.9.4. Santee Cooper Cross Generating Station

The following is required when Santee Cooper Cross owns or operates coal-fired EGUs as defined by 40 CFR 63.10042 of the Mercury and Air Toxic Standards Rule (40 CFR 63 Subpart UUUUU, 77 FR 9304, February 16, 2012):

Emission limit: Each of the four (4) coal-fired boilers (B01, B02, B03, B04) are subject to a SO_2 emission rate limitation of 0.20 lbs/MMBtu averaged over 30 boiler operating days. Compliance with the SO_2 limit may be achieved on a unit-by-unit basis or based on emissions averaging, using the Part 75 certified SO_2 CEMS associated with each of the four units (B01, B02, B03, B04) operating at the facility. If compliance is determined based on emissions averaging, Equation 2a in 40 CFR 63.10009 of the Mercury and Air Toxic Standards Rule (40 CFR 63 Subpart UUUUU, 77 FR 9304, February 16, 2012) will be used to determine the overall SO_2 emissions average for the facility. The SO_2 emissions average for the facility will be based on all the operating hours from each of the four (4) coal-fired units over the previous 30-group boiler operating days. A group boiler operating day is defined as day in which one or more units has

operated, excluding periods of start-up or shutdown. The following equation, based on Equation 2a, will be used to calculate the 30-day SO_2 emissions average for the facility.

$$WAER_{CGS} = \frac{(\sum_{i=1}^{n} ER1_i * HI1_i) + (\sum_{i=1}^{n} ER2_i * HI2_i) + (\sum_{i=1}^{n} ER3_i * HI3_i) + (\sum_{i=1}^{n} ER4_i * HI4_i)}{\sum_{i=1}^{n} HI1_i + \sum_{i=1}^{n} HI2_i + \sum_{i=1}^{n} HI3_i + \sum_{i=1}^{n} HI4_i}$$

Where: $WAER_{CGS}$ = Qualifying weighted average emission rate (lb/MMBtu)

$ER1_i$ = Hourly SO_2 emission rate for B01 (lb/MMBtu)
$HI1_i$ = Hourly heat input for B01 (MMBtu/hr)
$ER2_i$ = Hourly SO_2 emission rate for B02 (lb/MMBtu)
$HI2_i$ = Hourly heat input for B02 (MMBtu/hr)
$ER3_i$ = Hourly SO_2 emission rate for B03 (lb/MMBtu)
$HI3_i$ = Hourly heat input for B03 (MMBtu/hr)
$ER4_i$ = Hourly SO_2 emission rate for B04 (lb/MMBtu)
$HI4_i$ = Hourly heat input for B04 (MMBtu/hr)

The maximum number of operating hours per unit during a 30-group boiler operating day period (n) will be 720 hours. The minimum number of operating hours for any one unit during a 30-group boiler operating day period may be zero hours.

Monitoring, Reporting, and Recordkeeping: The SO_2 CEMS shall be calibrated, maintained, and operated in accordance with 40 CFR 75 – Continuous Emission Monitoring, including Subpart A – General, Subpart B – Monitoring Provisions, Subpart C – Operation and Maintenance Requirements, Subpart D – Missing Data Substitution Procedures, Subpart F – Recordkeeping Requirements, and Subpart G – Reporting Requirements.

Reports of the thirty (30) day rolling SO_2 averages, calculated for each thirty (30) day rolling average in the reporting period, shall be submitted semiannually.

7.9.5. Santee Cooper Winyah Generating Station

The following is required when Santee Cooper Winyah owns or operates coal-fired EGUs as defined by 40 CFR 63.10042 of the Mercury and Air Toxic Standards Rule (40 CFR 63 Subpart UUUUU, 77 FR 9304, February 16, 2012):

Emission limit: Each of the four (4) coal-fired boilers (B01, B02, B03, B04) are subject to a SO_2 emission rate limitation of 0.20 lbs/MMBtu averaged over 30 boiler operating days. Compliance with the SO_2 limit may be achieved on a unit-by-unit basis or based on emissions averaging, using the Part 75 certified SO_2 CEMS associated with each of the four units (B01, B02, B03, B04) operating at the facility. If compliance is determined based on emissions averaging,

Equation 2a in 40 CFR 63.10009 of the Mercury and Air Toxic Standards Rule (40 CFR 63 Subpart UUUUU, 77 FR 9304, February 16, 2012) will be used to determine the overall SO_2 emissions average for the facility. The SO_2 emissions average for the facility will be based on all the operating hours from each of the four (4) coal-fired units over the previous 30-group boiler operating days. A group boiler operating day is defined as day in which one or more units has operated, excluding periods of start-up or shutdown. The following equation, based on Equation 2a, will be used to calculate the 30-day SO_2 emissions average for the facility.

$$WAER_{WGS} = \frac{(\sum_{i=1}^{n} ER1_i * HI1_i) + (\sum_{i=1}^{n} ER2_i * HI2_i) + (\sum_{i=1}^{n} ER3_i * HI3_i) + (\sum_{i=1}^{n} ER4_i * HI4_i)}{\sum_{i=1}^{n} HI1_i + \sum_{i=1}^{n} HI2_i + \sum_{i=1}^{n} HI3_i + \sum_{i=1}^{n} HI4_i}$$

Where: $WAER_{WGS}$ = Qualifying weighted average emission rate (lb/MMBtu)

$ER1_i$ = Hourly SO_2 emission rate for B01 (lb/MMBtu)
$HI1_i$ = Hourly heat input for B01 (MMBtu/hr)
$ER2_i$ = Hourly SO_2 emission rate for B02 (lb/MMBtu)
$HI2_i$ = Hourly heat input for B02 (MMBtu/hr)
$ER3_i$ = Hourly SO_2 emission rate for B03 (lb/MMBtu)
$HI3_i$ = Hourly heat input for B03 (MMBtu/hr)
$ER4_i$ = Hourly SO_2 emission rate for B04 (lb/MMBtu)
$HI4_i$ = Hourly heat input for B04 (MMBtu/hr)

The maximum number of operating hours per unit during a 30-group boiler operating day period (n) will be 720 hours. The minimum number of operating hours for any one unit during a 30-group boiler operating day period may be zero hours.

Monitoring, Reporting, and Recordkeeping: The SO_2 CEMS shall be calibrated, maintained, and operated in accordance with 40 CFR 75 – Continuous Emission Monitoring, including Subpart A – General, Subpart B – Monitoring Provisions, Subpart C – Operation and Maintenance Requirements, Subpart D – Missing Data Substitution Procedures, Subpart F – Recordkeeping Requirements, and Subpart G – Reporting Requirements.

Reports of the thirty (30) day rolling SO_2 averages, calculated for each thirty (30) day rolling average in the reporting period, shall be submitted semiannually.

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. 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 7.10.1 and Section 7.10.2, 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 long-term strategy is reflected in the reasonable progress goals discussion located in Section 8.

7.10.1. Smoke Management

Section 51.308(d)(3)(v) of the RHR requires that each state consider and address the effects of smoke on visibility. The SC Forestry Commission ("SCFC") has developed (and revised as of August 2006) the Smoke Management Guideline for Vegetative Debris Burning Operations, which serves to regulate vegetative debris burning for forestry, agriculture, and wildlife purposes in the State of SC. The Department's Bureau of Air Quality has developed a state air pollution control regulation (R. 61-62.2, Prohibition of Open Burning, SIP approval on May 31, 1972 (37 FR 10842)) that prohibits: open burning of any/all household garbage, open burning for the purpose of land clearing or right of way maintenance in areas other than predominantly residential, and open burning of residential construction waste from building and construction operations unless specific conditions are met.

When weighed together, these documents address all sources of fire used for land management purposes within South Carolina and effectively minimize visibility impacts while recognizing the important ecological role that fires can and do play. Appendix G-4 includes the SCFC plan and a memorandum of understanding between the SCFC and the Department and represents the State's collective commitment to develop a comprehensive approach to establish and maintain a smoke management plan. Appendix G-4 is included for reference only and should not be adopted as part of the SIP.

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 Cape Romain 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 Cape Romain 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.

8. Reasonable Progress Goals

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 that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period (2028), as a result of those enforceable emissions limitations, compliance schedules, and other measures required that can be fully implemented by the end of the applicable implementation period (2028), as well as the implementation of other requirements of the CAA. The long-term strategy 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 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 long-term strategy. (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 long-term strategy. (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 Class I Area within South Carolina

Therefore, in accordance with the requirements of 40 CFR 51.308(f)(3), this regional haze SIP establishes RPGs for Cape Romain. To calculate the rate of progress represented by each goal, South Carolina compared baseline visibility conditions (2000 to 2004) to natural visibility conditions in 2064 at Cape Romain 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, South Carolina estimated the expected visibility improvements by 2028 in Cape Romain resulting from existing federal

and state regulations expected to be implemented and facility closures expected to occur by 2028 in South Carolina 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 Cape Romain 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 long-term strategy. The results of this modeling are shown in Section 7.2.6.

As detailed in Section 7.6, eight facilities were identified for reasonable progress analysis based on PSAT modeling. Four facilities are located in South Carolina, two facilities are located in Georgia, one facility is located in Ohio, and one facility is located in Pennsylvania. These analyses did not result in any further emission reductions beyond that quantified in the baseline 2028 modeling. South Carolina is not adjusting the RPGs; therefore, the RPGs are a conservative estimate of 2028 visibility projections.

Table 8-1 provides the RPGs for Cape Romain, baseline visibility, the URPs for 2028, and natural visibility conditions. The numbers in brackets contain the projected improvement from the baseline, the amount of improvement form 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. 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. South Carolina is adopting the 2028 RPG for the clearest days at Cape Romain Wilderness Area of 11.42 deciviews identified in the EPA 2028 regional haze modeling because this value is based on 2016 emission data which is more recent than the 2011 data that VISTAS used to identify 2028 clearest days RPG of 12.11 deciviews. See "Future Year (2028) 20% Clearest Days (dv)" in Table 3-2 on page 22 of the *Technical Support Document for EPA's Updated 2028 Regional Haze Modeling* available at: https://www.epa.gov/sites/default/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf.

Table 8-1: South Carolina RPGs – 20% Most Impaired Days

Class I Area	**2000-2004 Baseline Visibility (dv)[(1)]**	**2028 Reasonable Progress Goals (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]
Cape Romain	25.25 dv	16.64 [8.61]	19.06 [6.19]	9.78 [6.86]

[(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: South Carolina Class I Area 20% Clearest Day Comparisons

Class I Area	2000-2004 Baseline Visibility (dv)[(1)]	2028 Reasonable Progress Goal (dv) [2004 – 2028 improvement goal]
Cape Romain	14.29	11.42 [2.87]

[(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."[49]

South Carolina has determined that the RPGs will be at least as stringent as the expected glide path prediction for Cape Romain. In addition, there are no sources in South Carolina 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.

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 the Cape Romain will meet these projected RPGs and that additional visibility improvement is likely.

8.2.1. Out of State Reasonable Progress Evaluation Reductions

Table 7-17 and Table 7-18 provide the listing of facilities that were estimated to impact Cape Romain that are located outside of South Carolina and outside of VISTAS. As required by the RHR, South Carolina notified these states of the findings of significant contribution and asked those states for information regarding the results of the reasonable progress evaluations performed at those facilities. Section 10.1 provide a description of each response. These reductions were not included in the VISTAS 2028 RPG modeling and thus will help ensure that the RPGs provided in Table 8-1 are met for 20% most impaired days and that no visibility degradation on the 20% clearest days occurs.

8.2.2. Other Control Programs

South Carolina's emissions inventory is rapidly changing due to economic pressures, aging equipment, 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

[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

of the inventory development or were not well documented and supported. These forthcoming emission reductions should continue to improve visibility in Class I areas as well as improve air quality across South Carolina.

9. Monitoring Strategy

The 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 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 to address regional haze for all mandatory Class I Federal 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 Class I Federal 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 Class I Federal 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 Class I Federal 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 Class I Federal 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 RRFs for using those models.

The primary monitoring network for regional haze, both nationwide and in South Carolina, 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, IMPROVE. The IMPROVE measurements provide the only long-term record available for tracking visibility improvement or degradation, and, therefore, South Carolina intends to rely on the IMPROVE network for complying with the regional haze monitoring requirement in the rule.

As shown in Table 9-1, there is currently one IMPROVE site in the state, in Cape Romain. Figure 9-1 shows the IMRPOVE monitoring network for the VISTAS Region.

Table 9-1: South Carolina Class I Areas and Representative IMPROVE Monitors

Class I Area	IMPROVE Site Designation
Cape Romain Wilderness Area	ROMA1 (SC)

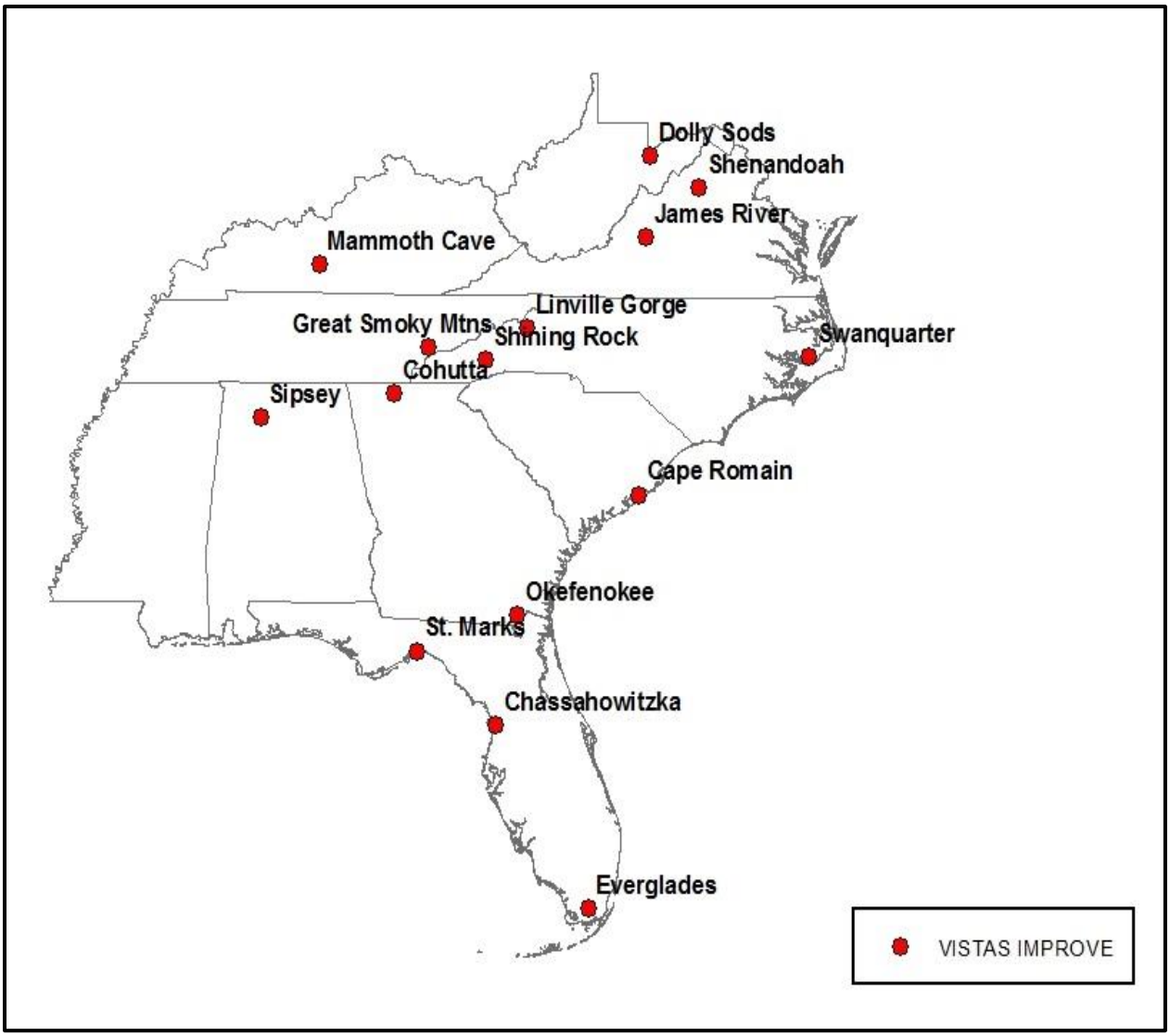


Figure 9-1: VISTAS States IMPROVE Monitoring Network

The IMPROVE measurements are central to South Carolina's regional haze monitoring strategy because the IMPROVE monitor in South Carolina represents unique air sheds, and it is difficult to visualize how the objectives listed above could be met without the monitoring provided by IMPROVE. Any reduction in the scope of the IMPROVE network in South Carolina and neighboring Class I areas would jeopardize the state's ability to demonstrate reasonable progress toward visibility improvement in its Class I areas and plan for appropriate future programs. In particular, South Carolina's regional haze strategy relies on emission reductions that will result from federal and state programs in South Carolina 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 air sheds during the second implementation period to document reasonable progress.

Because the current IMPROVE monitor in South Carolina represents a unique airshed and a significant component of the contributions are regional, any reduction of the IMPROVE network by shutting down these monitoring sites impedes tracking progress or planning improvements at the affected Class I areas. If any of these IMPROVE monitors are shut down, South Carolina, in consultation with the EPA and FLMs, will develop an alternative approach for meeting the tracking goal, 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, FLMs, and 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). South Carolina 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): South Carolina believes the existing IMPROVE monitors for the state's Class I areas are adequate and does not believe any additional monitoring sites or equipment are needed to assess whether RPGs for all mandatory Class I Federal areas within the state are 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 Class I Federal areas does not apply to South Carolina.

- 51.308(f)(6)(iv): South Carolina believes the existing IMPROVE monitor for the State's 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). South Carolina 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. (Source: 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 NPS/NPS contractors before submission to EPA's Air Quality System (AQS), https://www.epa.gov/aqs). The network also posts raw (http://views.cira.colostate.edu/fed/) and summary data (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 the SIP. South Carolina 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 South Carolina Class I area or Class I areas outside the state that are affected by sources in South Carolina.

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 for each Class I area. VISTAS initially used an AoI analysis to identify the areas and source sectors most likely contributing to poor visibility in Class I areas. 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 were SO_2 and NO_X 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 due to individual sources. PSAT results showed that in 2028 the majority of visibility impairment at VISTAS Class I areas will continue to be from point source SO_2 and NO_X emissions. Using the PSAT data, VISTAS states identified, for the reasonable progress analyses, sources shown to have a sulfate or nitrate impact on one or more Class I areas greater than or equal to 1.00% of the total sulfate plus nitrate point source visibility impairment on the 20% most impaired days for each Class I area. The states collectively accept the conclusions of these analyses for use in evaluating reasonable progress.

10.1. Interstate Consultation

This section addresses paragraph 40 CFR 51.308(f)(2) of the RHR that requires each state to addresses in its LTS visibility impairment for each 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, as determined pursuant to paragraphs 40 CFR 51.308(f)(2)(i) through (iv). The subsections below document South Carolina's consultation with other states with emission sources with impact on Cape Romain in South Carolina, and South Carolina impacts on Class I areas outside of the state.

In evaluating controls needed to assess reasonable progress, VISTAS states with a Class I area initiated a consultation process with other VISTAS states with one or more facilities identified as having greater than or equal to 1.00% of the total sulfate plus nitrate point source visibility impairment on the 20% most impaired days. The letter requested that the VISTAS state provide a response indicating its plans for conducting a reasonable progress analysis for each facility.

In addition, VISTAS 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 plus nitrate point source visibility impairment on the 20% most impaired days in one or more VISTAS Class I areas. The letter requested that the non-VISTAS state verify if the 2028 SO_2 and NO_X emissions modeled for each facility identified in the letter were correct. If the emissions have decreased since the modeling was initiated, the non-VISTAS state was asked to provide updated emissions so that the facility contribution could be adjusted using the PSAT results to determine if additional analysis of controls would be necessary. If a non-VISTAS state did not decrease the 2028 emissions modeled, the non-VISTAS state was asked to provide a response indicating its plans for conducting a reasonable progress analysis for each facility.

10.1.1. Emission Sources in Other States with Impacts on Cape Romain

There are several sources for which PSAT modeling indicated a contribution to visibility impairment of ≥1.00% for sulfate at Cape Romain. The Department sent a letter to Georgia requesting reasonable progress assessments for the facilities. For sources outside of the VISTAS states, a similar letter was sent by VISTAS to obtain the analyses.

Table 10-1 provides a summary of the VISTAS and non-VISTAS states to which a letter was sent and identifies the total number of facilities impacting Cape Romain. Table 10-2 identifies each facility and its PSAT contribution to Cape Romain. Appendix F-1 provides the consultation letter from the Department to Georgia and the response to the letter. Appendix F-2 provides the consultation letters from VISTAS to each non-VISTAS state and the responses to the letters.

Table 10-1: Number of Out-of-State Facilities with ≥ 1.00% Sulfate Contribution to Cape Romain in 2028

Class I Area	Region	States
Cape Romain		
	VISTAS	GA
	Non-VISTAS	PA, OH
	Total States	3
	Total Facilities	4

Table 10-2: Out-of-State Facilities with ≥1.00% Sulfate Contributions in 2028 at Cape Romain

Facility	State	Class 1 Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
Georgia Power Company – Plant Bowen	GA	Cape Romain	3.67%	SC, November 5, 2020	
International Paper - Savannah	GA	Cape Romain	1.70%	SC, November 5, 2020	
Genon NE Mgmt Co/Keystone Station	PA	Cape Romain	2.37%	VISTAS, June 22, 2020	July 8, 2020

Facility	State	Class 1 Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
General James M. Gavin Power Plant	OH	Cape Romain	2.26%	VISTAS, June 22, 2020	October 29, 2020

The following summarizes the response received for each facility.

- Georgia Power Company – Plant Bowen, GA: No summary was available at the time of public noticing.

- International Paper – Savannah, GA: No summary was available at the time of public noticing.

- Genon NE Mgmt Co/Keystone Station, PA: A reasonable progress analysis provided by the state of Pennsylvania asserts that Units 1 and 2 at this facility are considered to be effectively controlled. Keystone indicated that the units are currently controlled by BACT-level controls for SO_2 and NO_X. In addition, the units made process improvements to comply with the MATS Rule and the 2010 1-hour SO_2 NAAQS. Keystone Generating Station stated in the four-factor analysis that since 2008, annual SO_2 emissions have been reduced by 89%. Keystone did not identify any technically feasible controls for SO_2, because the units are already controlled by wet FGD (at least 90% effectiveness) and dry sorbent injection. For NO_X control, Keystone did evaluate potential tuning and upgrading of the low NO_X burners installed the units. The cost effectiveness of this upgrade was estimated to be $16,322/ton NO_X removed. Keystone did not identify any reasonable control measures for NO_X or SO_2 as a result of the four-factor analysis.

- General James M. Gavin Power Plant, OH: A reasonable progress analysis provided by the state of Ohio asserts that due to the presence of an FGD and SCR system of at least 90% effectiveness, this facility is considered to be effectively controlled. Boilers B003 and B004 have federally enforceable SO_2 emissions limits of 7.41 lb/MMBtu. Both boilers are required to be continuously controlled by FGD systems with an effective control efficiency of 95%. Ohio has requested a four-factor analysis from the facility. Ohio has requested a four-factor analysis from the facility.

10.1.2. South Carolina Emission Source Impacts on Class I Areas in Other States

In accordance with 40 CFR 51.308(f)(2), the Department used the results of the PSAT analysis to determine how South Carolina's state-wide emissions may affect Class I areas outside of South Carolina. 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 NO_X emissions, particularly from point sources, are projected to have the largest impact on visibility impairment in 2028.

Figure 10-1 below shows the relative contribution of South Carolina's SO_2 and NO_X emissions to sulfate and nitrate visibility impairment at 57 Class I areas, compared to the relative contribution from other states and RPOs. Table 10-3 shows the top 10 Class I areas outside of South Carolina impacted by South Carolina emissions, ranked by absolute impact in inverse megameters (the table includes South Carolina's estimated impact on Cape Romain for comparison). All Class I areas listed are VISTAS Class I areas. South Carolina consulted with all the VISTAS states throughout the SIP development process. Georgia also consulted with South Carolina regarding specific South Carolina facilities impacting its Class I areas. The state of Georgia contacted the Department on November 24, 2020, and asked South Carolina to perform a reasonable progress analysis for two facilities, Santee Cooper Cross Generating Station and WestRock Charleston Kraft LLC, that potentially impact Wolf Island Wilderness Area and Okefenokee Wilderness Area. A copy of this letter and our response can be found in Appendix F.

Table 10-3: Top 10 Class I areas outside South Carolina impacted by South Carolina emissions

Class I Area	State	Percent impact	Absolute impact (Mm^{-1})
ROMA	*SC*	20.8%	4.20
WOLF	**GA**	7.2%	1.38
OKEF	**GA**	5.9%	1.15
COHU	**GA**	3.3%	0.59
SWAN	**NC**	3.4%	0.56
SHRO	**NC**	3.4%	0.53
CHAS	**FL**	3.1%	0.48
LIGO	**NC**	3.0%	0.47
JOYC	**NC**	2.6%	0.46
GRSM	**NC, TN**	2.3%	0.43
SAMA	**FL**	0.9%	0.17

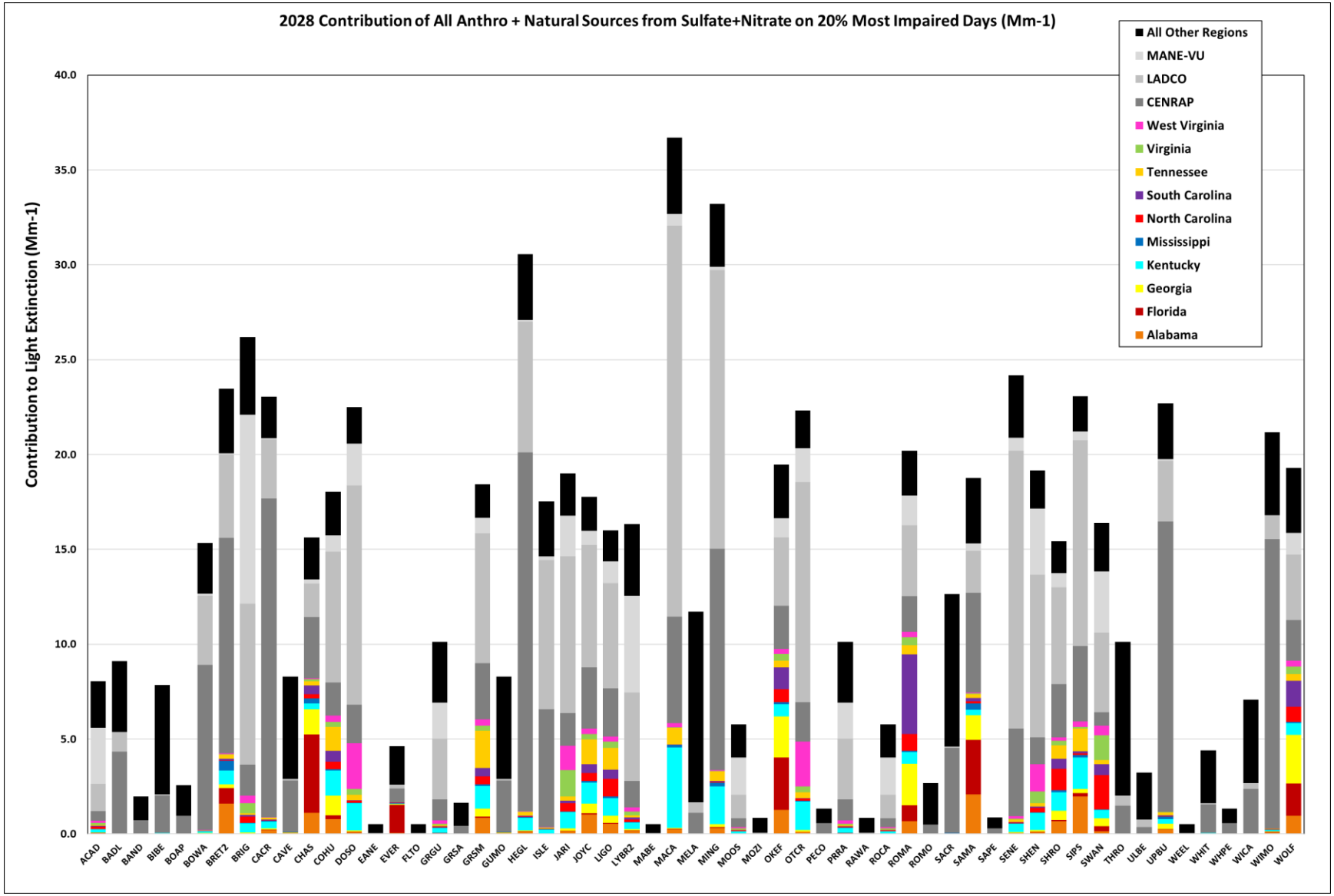


Figure 10-1: Relative contribution to sulfate and nitrate visibility impairment from SO_2 and NO_X emissions from all anthropogenic and natural sources

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 their comments along the way. The chronology of these meetings and conferences is presented in Table 10-3.

Table 10-4: 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
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 the 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 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. 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 while most Class I areas are projected to have greater improvements than the uniform rate of progress.

Subsequent calls were held with the 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 listing sources and their plans for further interstate consultation. Documentation of these calls can be found in Appendix F-3.

Additionally, South Carolina 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. South Carolina was part of a southeastern state breakout session with the FLMs and the EPA discussing the modeling and future expectations from all parties. South Carolina also regularly participated in CenSARA calls.

10.3. Consultation with MANE-VU

The following information documents South Carolina's participation in Mid-Atlantic/Northeast Visibility Union (MANE-VU) consultation. 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] A previous version of this report was released on May 4, 2017, which originally listed South Carolina as potentially impacting Class I Areas in the MANE-VU states. South Carolina responded to the report on June 26, 2017, with comments regarding the inventory for the screening modeling for selecting sources and the back trajectory analyses. South Carolina did not receive any further communication from MANE-VU and South Carolina was not included in the final report as a contributing state; therefore, no further consultation was necessary. Appendix F-4 provides documentation of South Carolina's consultation with MANE-VU including the report dated May 4, 2017, and South Carolina's comments on the MANE-VU screening modeling.

[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

10.4. State and Federal Land Manager Consultation

The Department provided a draft of this regional haze SIP to the FLMs for the formal 60-day consultation process from July 27 to September 27, 2021. The U.S. Forest Service (USFS) and National Park Service (NPS) provided written comments on September 24, 2021; neither requested a formal consultation. The U.S. Fish & Wildlife Service (FWS) provided written comments on October 1, 2021. The following provides a summary of comments provided by the NPS, USFS, FWS, and the Department's responses to the comments. Appendix H to this SIP includes the full set of comments provided by the NPS, USFS, and FWS. In addition, the Department provided written responses to each of the NPS, USFS, and FWS.

10.4.1. Source Selection

FWS Comment

Screening methods for four-factor analysis were developed by the VISTAS planning organization. It utilized a multi-tiered approach starting with a weighted "area-of-influence" screen followed by an evaluation of facilities with a photo-chemical model. The result was a very targeted list of major sources that directly impact visibility at Cape Romain and other out-of-state Class I areas. Though well thought out, the approach combined a relatively high contribution threshold that narrowed the four-factor source list similar to that of the first round.

The photo-chemical model used during screened incorporated emissions that already accounted for emission reductions for the year 2028. Though EPA regional haze guidance discussed using a future year, screening with these emissions does not represent current impacts and may not focus the state on sources that need four-factor review. Did the state consider if there was more visibility benefit in reviewing a broader spectrum of impairing sources or source categories? Did the state verify that unenforced controls were not biasing the 2028 based CAMx screening process, giving the impression that controls were sufficient when in fact they needed more review?

NPS Comment

Our primary concern is that the individual facility percent contribution approach to source selection used by VISTAS and South Carolina offers less protection for the more-impacted Class I areas. In our May 17th communication, we identified three South Carolina facilities for four-factor analyses as a result of contribution to 80% of visual impact at NPS Class I areas. Those facilities were: Resolute FP US INC; Dominion Energy Wateree (formerly SCE&G); and Alumax of South Carolina. Of these, only the Alumax facility was selected by South Carolina for four-factor analysis.

USFS Comment

Section 7.6 of SC's draft RH SIP discusses the methodology that was used to determine which sources to analyze for additional controls. Sources both within and out of SC were included in the screening (i.e., in the 'denominator' of the contribution evaluation), and a source was selected for reasonable progress evaluation / four-factor analysis if the facility was estimated to have a ≥ 1.00% sulfate contribution to visibility impairment in 2028 at Cape Romain Class I Area. This process resulted in four SC facilities being selected for further evaluation. USDA Forest Service understands and recognizes that EPA has afforded states the flexibility to screen facilities for additional analysis if that screening is based on reasonable methods. However, we request that SC consider only in-state facilities in the denominator of the contribution equation when screening for sulfate and nitrate visibility contributions at a Class I Area, as outlined in the July 2021 EPA Regional Haze Clarification Memorandum (https://www.epa.gov/visibility/clarifications-regarding-regional-haze-state-implementation-plans-second-implementation). This methodology would result in a more robust reasonable progress evaluation by focusing on sources permitted by SC DHEC. To illustrate this, a review of the SC Source Selection data indicates that the SC sources selected for further analysis only capture 24% of the emissions from SC sources that impact Linville Gorge, 12% of the emissions from SC sources that impact Shining Rock, 47% of the emissions from SC sources that impact Joyce Kilmer-Slickrock, and 38% of the emissions from SC sources that impact Cohutta. As a further example, NEW-INDY CATAWBA LLC (formerly known as RESOLUTE FP US INC) is the largest SC source contributing to visibility impairment at each of the Forest Service Class I Areas listed above. NEW-INDY CATAWBA LLC contributes over 38% of the SC emissions that impact Linville Gorge Wilderness Area, greater than 26% of the SC emissions that impact Shining Rock Wilderness Area, over 19% of the SC emissions that impact Cohutta Wilderness, and nearly 13% of the SC emissions that impact Joyce Kilmer-Slickrock Wilderness. The USDA Forest Service requests additional analysis of the NEW-INDY CATAWBA LLC facility and its contribution to our nearby Class I Areas.

Department Response

The Department reviewed the NPS analysis and, although it is informative, has taken a different approach to source selection. This approach does recognize the significant progress South Carolina has and is expected to achieve in the future toward improving visibility in its Class I areas which is consistent with the EPA's August 20, 2019 guidance. Regarding the selection of sources for analysis (Step 3), the EPA states:

> Page 5, Table 1: *Select the emission sources for which an analysis of emission control measures will be completed in the second implementation period and explain the bases for these selections. For the purpose of this source selection step, a state may consider*

estimated visibility impacts (or surrogate metrics for visibility impacts), the four statutory factors, the five required factors listed in section 51.308(f)(2)(iv), and other factors that are reasonable to consider.

Page 9: "*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. Instead, a state may reasonably select a set of sources for an analysis of control measures. The guidance that an analysis of control measures is not required for every source in each implementation period is based on CAA section 169A(b)(2), which requires each SIP to contain emission limits, schedules of compliance, and other measures as may be necessary to make reasonable progress, but …does not provide direction regarding the particular sources or source categories to which such emission limits, etc., must apply. Selecting a set of sources for analysis of control measures in each implementation period is also consistent with the Regional Haze Rule, which sets up an iterative planning process and anticipates that a state may not need to analyze control measures for all its sources in a given SIP revision. Specifically, section 51.308(f)(2)(i) of the Regional Haze Rule requires a SIP to include a description of the criteria the state has used to determine the sources or groups of sources it evaluated for potential controls. Accordingly, it is reasonable and permissible for a state to distribute its own analytical work, and the compliance expenditures of source owners, over time by addressing some sources in the second implementation period and other sources in later periods. For the sources that are not selected for an analysis of control measures for purposes of the second implementation period, it may be appropriate for a state to consider whether measures for such sources are necessary to make reasonable progress in later implementation periods.*"

Consistent with the RHR, South Carolina followed a process (documented in Sections 7.7 and 7.8) for narrowing the list of sources to consider for selecting for a four-factor analysis. In so doing, the Department relied on the latest available tools (i.e., PSAT) to understand source impacts on visibility impairment in each Class I area. From the comparison of AoI to PSAT modeling of stationary sources, it became apparent that the AoI methodology overstates impacts close to Class I areas (i.e., <100 Km) and understates impacts associated with stationary sources located further away (i.e., >100 Km) from Class I areas.

The Department selected facilities for a reasonable progress/four-factor analysis if the facility's PSAT contribution was ≥1.00% for sulfate or nitrate. This threshold identified four out-of-state facilities in three states and four South Carolina facilities for reasonable progress/four-factor analysis. Given that this is a "regional" program, the Department determined that selection of a total of eight facilities impacting Cape Romain is reasonable. In the same regards, North Carolina selected facilities for a reasonable progress/four-factor analysis if the facility's PSAT contribution was ≥1.00% for sulfate or nitrate. North Carolina did not identify any facilities in

South Carolina that was above that threshold. In addition, the AoI contribution of New Indy to any Class I area in North Carolina, Georgia, Tennessee, and South Carolina was below the respective thresholds to be selected for PSAT tagging for sulfate, nitrate, or combined sulfate/nitrate. Specifically, the AoI contribution of New Indy to Linville Gorge Wilderness Area is 0.769%; Shining Rock Wilderness Area is 0.459%; Cohutta Wilderness is 0.348%; and Joyce Kilmer-Slickrock Wilderness is 0.193%.

10.4.2. Exclusion of NO_X from Four-Factor Analysis

NPS Comment

Secondly, we note that South Carolina excluded NO_X from reasonable progress four-factor analyses and did not include NO_X emissions in screening used for source selection. Light extinction from ammonium nitrate is an increasingly important component of haze on most-impaired days in recent years in Class I areas across the region. For this reason, we encourage South Carolina to evaluate NO_X emission control opportunities in this planning period. Please refer to our May 17th, 2021 communication for additional details and discussion.

USFS Comment

USDA Forest Service appreciates the discussion within the draft RH SIP regarding nitrate formation in the VISTAS region, while also recognizing that sulfates have historically been the main contributor to visibility impairment at Class I Areas within the southern US. The nitrate contribution to visibility impairment is increasing as sulfur dioxide emissions decrease, and there are still significant NO_X sources within the point sector in SC. EPA's 2019 Regional Haze Guidance states that "because regional haze results from a multitude of sources over a broad geographic area, a measure may be necessary for reasonable progress even if that measure in isolation does not result in perceptible visibility improvement." Widespread emissions controls, particularly for SO_2 and NO_X, are essential for making reasonable progress at Class I areas both near to, and more distant from, emissions sources. Further, small visibility improvements, even those that may be imperceptible by themselves, are essential as we continue to make progress towards the national goal of restoring natural conditions at Class I areas by 2064. While we appreciate that SC DHEC has committed to monitor nitrate contribution to visibility impairment and perhaps address it in the third implementation period, we request that SC DHEC consider decoupling NO_X sources from SO_2 sources and evaluating them, along with SO_2 sources, for reasonable progress during this planning period.

Department Response

For Cape Romain, Figure 10-1 show particle contributions to light extinction from 2010 through 2018 for the 20% most impaired days. Ammonium nitrate has remained mostly stable in its

contribution to light extinction from 2010 to 2018. The Department will continue to monitor ammonium nitrate, but ammonium sulfate is the largest contributor to light extinction currently.

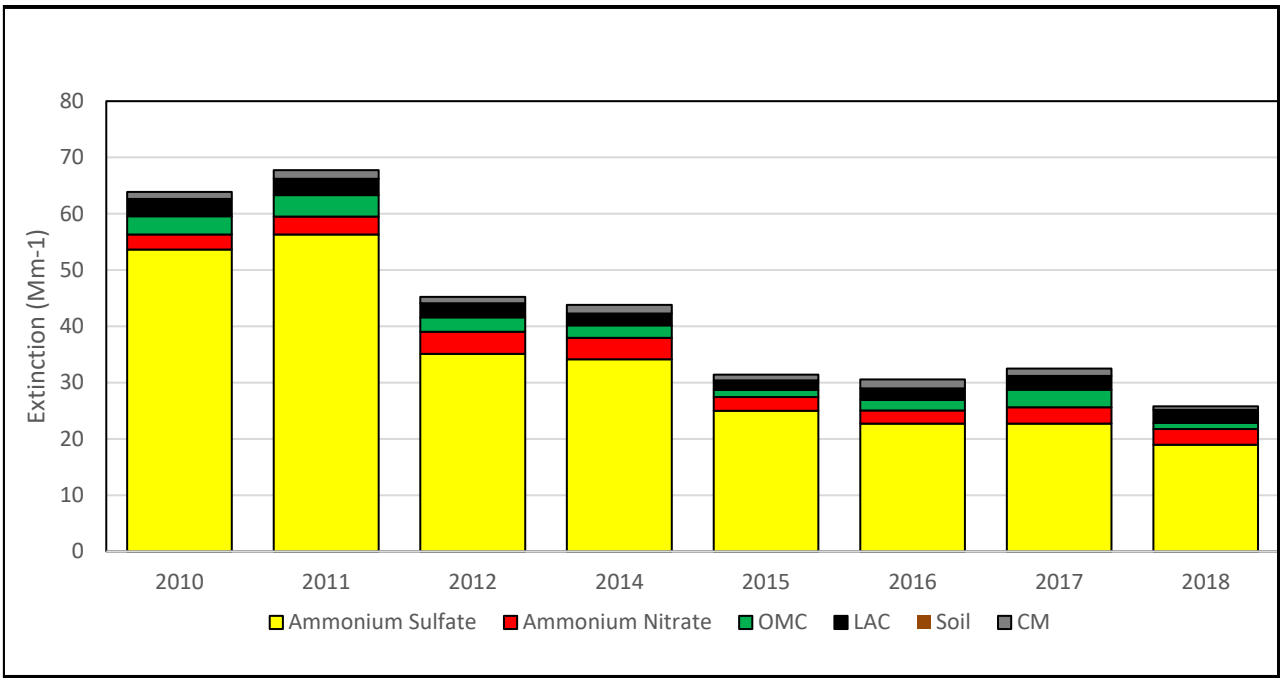


Figure 10-2 Particle Contributions to Light Extinction for 20% Most Impaired Days at Cape Romain for 2010- 2019:

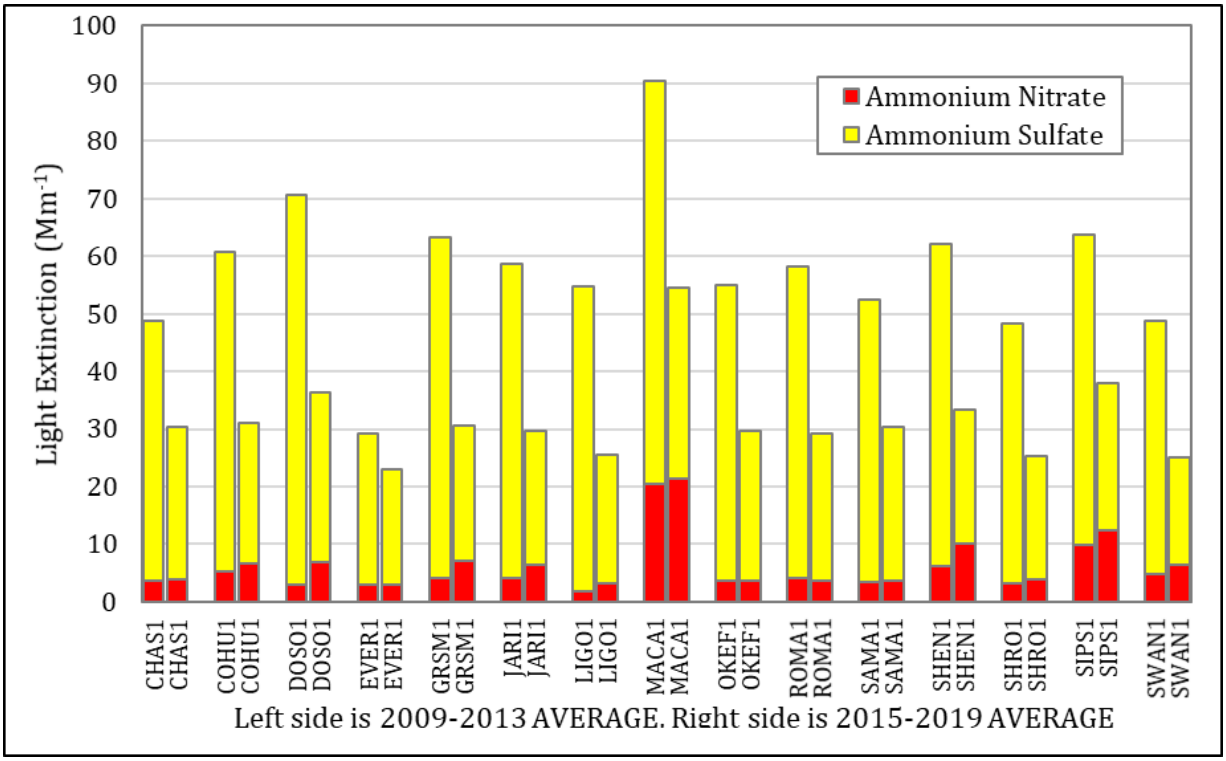


Figure 10-3: Comparison of Ammonium Sulfate and Ammonium Nitrate Five-Year Average (2009 – 2013 vs. 2015 – 2019) Contributions to Visibility Impairment for 20% Most Impaired Days at VISTAS Class 1 Areas

Figure 10-2 compares the five-year average of 2009 – 2013 and 2015 – 2019 for ammonium sulfate and ammonium nitrate contributions to visibility impairment for all Class I areas in the VISTAS region. These data clearly show that although ammonium nitrate contributions have increased slightly for some Class I areas, ammonium sulfate remains as the dominant visibility impairment species through 2019.

10.4.3. Long Term Strategy

FWS Comment

Though the Long-Term Strategy section discusses the many programs contributing to emission reductions, it does not summarize well how/where emissions will reach the 2028 levels described. Could the state enhance the discussion in the Long-Term Strategy to more specially detail how the programs listed will obtain the emission reductions for the 2028 projection?

Department Response

The Department appreciates the concern expressed by FWS of future projected emissions. The Department relies on future emissions predicted by the EPA and ERTAC, and the Department reviewed the emissions inventory as part of the VISTAS modeling process. The Department did not identify any issues of concern for future predicted emissions. Any future emissions at South Carolina facilities will continue to be subject to federal and state regulations, such as NSPS and NESHAPs, which the state has legal authority to implement and enforce.

10.4.4. Prescribed Fire Emissions

USFS Comment

Fire plays an important role in shaping the vegetation and landscape in SC. Recurring fire has been a part of the landscape for thousands of years. Aggressive fire suppression, coupled with an array of other disturbances (e.g., logging and chestnut blight), has changed the historic composition and structure of the forests. Periodic prescribed burning and other vegetation management can recreate the ecological role of fire in a controlled manner. Fire and fuels management supports a variety of desired conditions and objectives across the Forests (e.g., community protection, hazardous fuels reduction, native ecosystems restoration, historic fire regimes restoration, wildlife openings, and open woodland creation, etc.). The 2017 Regional Haze Rule includes a provision to allow states to adjust the glidepath to account for prescribed fire. The draft SC RH SIP states that prescribed fire emissions were taken from the 2011 National Emissions Inventory (NEI) and were carried forward into the 2028 future year emissions without any changes. Recent data on prescribed fire activity, especially within the USDA Forest Service, show that the number of acres burned in prescribed fires during 2011

were lower than all other recent years. For example, within the southern region of the Forest Service a total of 749,080 acres were treated with prescribed fire in 2011, while the average number of acres treated annually from the years 2007-2019 was 980,422. The 2021 target for treatment by prescribed fire within the USDA Forest Service southern region is well over 1 million acres. Furthermore, the Land Management Plans for each of the southern Forests call for a cumulative total of up to 2.1 million acres per year to be treated with prescribed fire in the future. Therefore, keeping prescribed fire emissions steady from to 2028 undercounts emissions in the VISTAS states by up to fifty percent. At this point in the draft RH SIP review process, a quantitative analysis to adjust the glidepaths for actual prescribed fire projections is not practical. While prescribed fire is currently a minor contributor to visibility impairment on the 20% most impaired days, the USDA Forest Service would like assurances that TDEC-APC will continue to recognize the important ecological role of prescribed fire and in the future adjust the glidepath to account for prescribed fire emissions accordingly.

Department Response

The Department has been a long-time supporter of the use of prescribed fire as a landscape management tool throughout South Carolina. As discussed in Section 7.9.1 (Smoke Management) of this SIP, The Department works closely with other state and federal agencies to share information and resources and provide consistent messaging in support of prescribed burning and will continue to do so. The Department's Bureau of Air Quality has developed a state air pollution control regulation (R. 61-62.2, Prohibition of Open Burning, SIP approval on May 31, 1972 (37 FR 10842)) that prohibits: open burning of any/all household garbage, open burning for the purpose of land clearing or right of way maintenance in areas other than predominantly residential, and open burning of residential construction waste from building and construction operations unless specific conditions are met. Using this approach, the Department has been effective with managing air quality during periods of prescribed fire activity in South Carolina.

The EPA's revised method for selecting the 20% most impaired days to a large extent eliminates days where light extinction is primarily associated with fire activity. This methodology helps to minimize impacts associated with fire activity in the 20% most impaired days evaluated during the development of this SIP. For future planning periods, should the 20% most impaired days show a significant increase in organic carbon that can be attributed to prescribed burning activity, the Department will consult with the USFS and other federal and South Carolina state agencies, as well as with neighboring states to determine if an adjustment to the glidepath in 2064 is necessary for Cape Romain. It is very difficult to project emissions associated with prescribed burning and wildfires because the amount of activity is highly variable depending on weather conditions and other factors. In addition, projections of increased activity relative to a base year would require creating new fires with assigned location coordinates, fuel type, and the

size of each burn which is impractical. Thus, it is standard practice to carry the base year emissions forward to the projection year.

10.4.5. Four-Factor Analysis

NPS Comment

Also, in the South Carolina draft SIP, we note that two sources are excluded from selection for four-factor analysis because they are meeting the MATS emission limits. Facilities that are meeting these limits may still have opportunities for control optimization that should be considered. The need to consider potential upgrades to existing controls was recently highlighted in the EPA Memorandum, Clarifications Regarding Regional Haze State Implementation Plans for the Second Implementation Period, released July 8th, 2021 in Sections 2.3 and 3.2:

> *"The underlying rationale for the "effective controls" flexibility is that if a source's emissions are already well controlled, it is unlikely that further cost-effective reductions are available. A state relying on an "effective control" to avoid performing a four-factor analysis for a source should demonstrate why, for that source specifically, a four-factor analysis would not result in new controls and would, therefore, be a futile exercise. States should first assess whether the source in question already operates an "effective control" as described in the August 2019 Guidance. They should further consider information specific to the source, including recent actual and projected emission rates, to determine if the source could reasonably attain a lower rate." (Section 2.3)*
>
> *"Similarly, in some cases, states may be able to achieve greater control efficiencies, and, therefore, lower emission rates, using their existing measures. Considering efficiency improvements for an existing control (e.g., using additional reagent to increase the efficiency of an existing scrubber) as a potential measure is generally reasonable since in many cases such improvements may only involve additional operation and maintenance costs. States should generally include efficiency improvements for sources' existing measures as control options in their four-factor analyses in addition to other types of emission reduction measures." (Section 3.2)*

Further, we observe that South Carolina did not establish a cost effectiveness threshold for new controls and is not requiring any source-specific emission reductions at sources that conducted four factor analyses as part of the draft SIP. We encourage South Carolina to ensure that cost-effectiveness calculations are in keeping with standards from the EPA Control Cost Manual and to set a reasonable cost effectiveness threshold to use in control determinations.

Finally, although several sources point to minimal visibility benefit as factor for consideration, the Clean Air Act does not include an additional "off-ramp" for visibility improvement when evaluating emission controls for specific emission units.

42 U.S. Code § 7491. Visibility protection for Federal class I areas

(g)DEFINITIONS For the purpose of this section (CAA Section 169a)—

(1) in determining reasonable progress there shall be taken into consideration the costs of compliance, the time necessary for compliance, and the energy and nonair quality environmental impacts of compliance, and the remaining useful life of any existing source subject to such requirements;

While the EPA 2019 Regional Haze Guidance does allow states to consider visibility when determining their long-term strategy, the guidance did not intend for visibility improvement to be used as a fifth factor to reject controls that would otherwise be determined reasonable. In order to achieve reasonable progress in this round of SIP development we recommend that South Carolina require all technically feasible and cost-effective controls identified through four-factor analysis.

FWS Comment

The summary of the Alumax (Century Aluminum) four-factor analysis focused on whether the source completed a CALPUFF based evaluation based on FLAG thresholds. This discussion is similar to BART screening used in the first round and does not fulfill four-factor review.

- Did the state conduct a four-factor review of Alumax similar to others presented in the draft SIP?
- Did the state set a value ($/ton, etc..) that was determined as reasonable?

Department Response

As appropriately stated above in the NPS comment, the EPA identified that if an EGU is meeting the MATS requirements using add-on controls (FGD wet scrubber), it is unlikely that additional add-on controls are feasible or available. The Department reviewed one utility (Santee Cooper Cross Generating Station) and determined the facility is meeting the MATS SO_2 limit of 0.2 lb/MMBtu and utilizes a FGD wet scrubber for compliance. The Department applied this information to determine that a four-factor analysis was unnecessary for Santee Cooper Winyah Generating Station, which is also complying with MATS using FGD wet scrubber. Dominion Energy Williams PSAT calculation was below the 1% threshold and was not included in the four-factor analysis requests. Both Santee Cooper Cross and Santee Cooper Winyah will have permit limits, and associated requirements, identified in the SIP.

The Department did not rely on the modeling information provided by Century Aluminum (formerly Alumax) in their four-factor analysis submittal. The discussion was included for additional information only. The Department did not set a specific cost per ton threshold, but rather analyzed each facility to determine whether a given control measure is cost-effective based on the EPA's Control Cost Manual and the 2019 Regional Haze Guidance.

11. Comprehensive Periodic Implementation Plan Revision

40 CFR Section 51.308(f) requires South Carolina to revise its regional haze SIP and submit a plan revision to the 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 RHR, South Carolina commits to revising and submitting this regional haze SIP by July 31, 2028, and every ten years thereafter.

In addition, Section 51.308(g) requires periodic reports evaluating progress towards the RPGs established for each mandatory Class I area. The periodic reports are due by January 31, 2025, July 31, 2033, and every ten years thereafter. South Carolina commits to meeting all of the requirements for 40 CFR 51.308(g), including revising and submitting a regional haze progress report by January 31, 2025, July 31, 2033, and every ten years thereafter.

The progress report will evaluate the progress made towards the RPG for each of the mandatory federal Class I areas located within South Carolina and in each mandatory federal Class I area located outside South Carolina that may be affected by emissions from South Carolina sources. All requirements listed in Section 51.308(g) shall be addressed in the periodic 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 Class I Federal areas both within and outside 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 Class I Federal area within the state, the state must assess the following visibility conditions and changes, with values for 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.

    (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 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.

(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 Class I Federal areas affected by emissions from the state, to meet all established reasonable progress goals 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 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 emission management measures implemented. Therefore this Progress Report will provide for a comparison of emission inventories, ultimately expressing the change in visibility for the most impaired and least impaired days over the past five years.

Moreover, due to the uncertainty of some measures, this 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 South Carolina is required to submit any progress reports to the EPA, depending on the findings of the five-year progress report, South Carolina 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 South Carolina determines that the existing SIP requires no further substantive revision in order to achieve established goals, it will provide to the EPA a declaration that further revision of the SIP is not needed.

(2) If South Carolina 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 the EPA and collaborate with the states that participated in regional planning to address the SIP's deficiencies.

(3) If South Carolina 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 the EPA.

(4) If South Carolina 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 such notification to the EPA.

13. Progress Report

13.1. Background

On December 21, 2007, South Carolina submitted for approval its SIP for regional haze to the EPA Region 4. South Carolina's regional haze plan documents South Carolina's long-term plan for improving visibility in the state's federal Class I area as well as assisting with improvement of visibility in Class I areas located outside of the state. The SIP includes specific RPGs for visibility improvement at milestones that start in 2018. The ultimate goal is to reach background visibility levels in the Class I areas. South Carolina's Class I area regulated for visibility is the Cape Romain Wilderness Area.

Subparagraph 40 CFR 51.308(g) of the regional haze rule requires that states report on the success of the long-term strategy at specific intervals. On December 28, 2012, South Carolina submitted the first regional haze progress report to the EPA, which demonstrated that South Carolina was on track to meet the RPGs set in the regional haze SIP.

This progress report, in accordance with the EPA's requirements, contains the following elements:

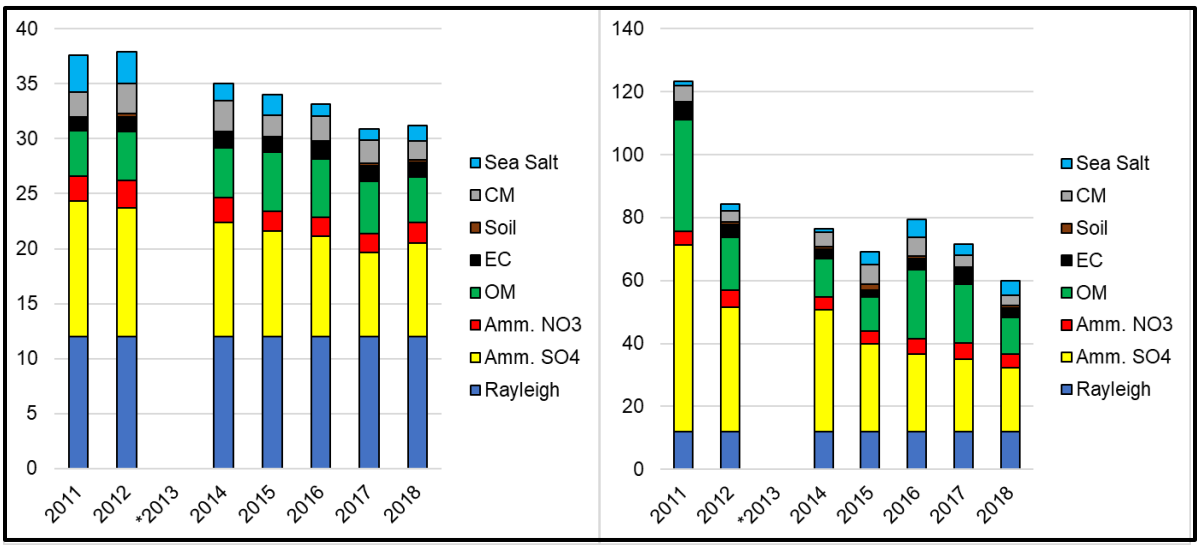
- Status of implementation of the control measures included in the original SIP;
- Summary of the emissions reductions achieved through the above-referenced control measures;
- Assessment of visibility conditions and changes for each Class I area located within the state;
- Analysis tracking the change over the past five years in emissions of pollutants contributing to visibility impairment from all sources and activities within South Carolina;
- 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;

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. South Carolina's Long-term Strategy for Visibility Improvement

In Section 7.4 of South Carolina's Regional Haze Plan, atmospheric ammonium sulfate was identified as the largest contributor to visibility impairment in Class I areas throughout the southeastern United States 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 EGUs and, with an important but smaller impact, to reduce SO_2 emissions from non-utility industrial point sources. SO_2 reductions from point sources were therefore identified as the focus of South Carolina's long-term strategy for visibility improvement.

The bar charts in Figure 13-1 show the speciated average light extinction for South Carolina's Class I area 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.



***incomplete data for 2013**

Figure 13-1: Annual Average Light Extinction for the 20% Worst Visibility Days (left) and the 20% Clearest Visibility Days (right) at Cape Romain

13.1.2. 2018 Reasonable Progress Goals for South Carolina's Class I Area

Table 13-1 and Table 13-2 show the 2018 RPGs for South Carolina's Class I area on the 20% worst and 20% best visibility days, respectively. As seen in these tables, Cape Romain has met the 2018 RPGs.

Table 13-1: 2018 RPGs for Visibility Impairment in South Carolina's Class I Area, 20% Worst Days

Class I Area	Baseline Average (2000-2004)	2018 Average (2014-2018)	2018 Goal	Natural Background
Cape Romain	26.48	19.39	22.7	12.13

Table 13-2: 2018 RPGs for Visibility Impairment in South Carolina's Class I Area, 20% Clearest Days

Class I Area	Baseline Average dv (2000-2004	2018 Average dv (2014-2018)	2018 Goal (dv)	Natural Background (dv)
Cape Romain	14.29	11.80	<14.29	5.93

*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 the EPA every five years evaluating the progress towards the reasonable progress goal 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.

The 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. South Carolina's previous progress report included data through the year 2013. Therefore, this progress report covers years since 2013. 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), South Carolina has estimated the SO_2 emissions reductions achieved through 2019 from measures implemented by the state.

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 each Class I area meet the RPG set in the regional haze SIP for 2018.

13.3.1. Emissions Reduction Measures Included in the Regional Haze SIP

South Carolina's regional haze SIP included the following types of measures for achieving reasonable progress goals:

- Federal programs and
- 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.

- **Clean Air Interstate Rule**

On May 12, 2005, the 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 the 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 the 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.

- **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.

- **Consent Agreements (TECO, VEPCO) and Gulf Power Crist 7 Voluntary Agreement**

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 SO_2 and NO_X emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.

Under a 2002 voluntary agreement, Gulf Power upgraded its operation to significantly cut NO_X emissions at its Crist generating plant.

- **One-hour Ozone SIPs (Atlanta/Birmingham/Northern Kentucky)**

The regional haze SIP also included emissions reductions from one-hour ozone SIPs submitted to the 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.

- **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.

- **2007 Heavy-Duty Highway Rule (40 CFR Part 86, Subpart P)**

In this regulation, the 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. The EPA required a 97% reduction in the sulfur content of highway diesel fuel, from levels of 500 ppm (low sulfur diesel) to 15 ppm (ULSD). These requirements were successfully implemented on the timeline in the regulation. This program applies to all areas of the country, including South Carolina, thus, more directly affecting Cape Romain.

- **Tier 2 Vehicle and Gasoline Sulfur Program (40 CFR Part 80 Subpart H; Part 85; Part 86)**

The 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 South Carolina, and, thus, has a more direct impact on Cape Romain.

- **Large Spark Ignition and Recreational Vehicle Rule**

The 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 South Carolina.

- **Non-Road Mobile Diesel Emissions Program (40 CFR Part 89)**

The 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 South Carolina sources.

- **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

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 the 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.

The EPA finalized the revised ICI Boiler MACT on March 21, 2011. The 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 January 31, 2016, with the option to request an additional year. The 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, the 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 ICI Boiler MACT has brought about more SO_2 reductions in South Carolina than were modeled in South Carolina's Regional Haze Plan.

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.

- **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. 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.

- **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. South Carolina Reasonable Progress and BART Control Measures

South Carolina completed source-specific reasonable progress and BART determinations for all applicable sources in the first-round regional haze SIP. In total, South Carolina had 21 BART-eligible sources and identified 7 units at 6 facilities as reasonable progress sources. Nineteen of the 21 BART-eligible sources were able to demonstrate that they did not cause or contribute to visibility impairment in any Class I area within 300 km of the sources. Exemptions included VOC only exemption, EGUs that were subject to CAIR, and the IMPROVE equation to demonstrate exemption. Two BART-eligible sources completed a BART demonstration (equivalent to a reasonable progress determination).

Table 13-4 lists the six facilities that had units for which a reasonable progress determination was made and the current status. 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. Since the last progress report, one reasonable progress unit has been decommissioned and replaced with a natural gas-fired boiler, with 5 reasonable progress units still in operation. At of the end of the first implementation period (2018), actual emissions from all existing facilities (tpy from six facilities) are significantly lower than the emissions that were modeled in the SIP for 2018 (tpy from six facilities), including those facilities that made no changes due to no reasonable progress controls being identified.

Table 13-5 lists the two sources for which a BART review was made. Sources that were exempt from BART analysis are not listed. It was determined that no BART controls were required in the first implementation round. South Carolina determined that implementation of CAIR was equivalent to BART for SO_2 and NO_X; this has now been replaced with CSAPR for SO_2 and NO_X SIP Call for NO_X. The BART analyses for Dominion Energy Williams and Dominion Energy Wateree (both were formerly SCE&G) focused on PM_{10}. Both analyses determined that the cost effectiveness for additional PM_{10} controls were excessive. 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 Reasonable Progress Sources from the First Implementation Period

Plant Name	Unit ID	Current Status of Controls/Reductions	BART-Eligible ?	Modeled 2018 SO_2 Emissions	Actual 2018 SO_2 Emissions	Actual 2019 SO_2 Emissions
Kapstone (formerly MeadWestvaco)	006		Y	2,706	224	154
INTERNATIONAL PAPER: GEORGETOWN	001 (Power Boilers)	Some coal burners replaced with NG burners to comply with Boiler MACT	Y	3,655*	749	960
INTERNATIONAL PAPER: GEORGETOWN	001 (Recovery Boilers)	Wet scrubber	Y	*	168	108
GIANT CEMENT CO	005	Fabric filters		3,893	344	331
HOLCIM: HOLLY HILL	004 (formerly 001 and 002)	ESP, fabric filters		5915	139	127
DAK AMERICAS	002	Coal-fired boiler decommissioned and replaced with NG boiler	Y	492	83	103

*Modeled 2018 SO_2 emissions were totaled for both power boilers and both recovery boilers

Table 13-5: Current Status of BART Sources

Plant Name	Unit ID	Current Status of Controls/Reductions	2002 SO_2	Est. SO_2 Reduction 2018 (2002 Base Year – Modeled 2018)	Actual 2018 SO_2	Actual 2019 SO_2	2002 NO_X	Est NO_X Reduction 2018	Actual 2018 NO_X	Actual 2019 NO_X	2002 PM_{10}	Est. PM_{10} Reduction 2018	Actual 2018 PM_{10}	Actual 2019 PM_{10}
SCE&G Williams	1	FGD, SCR, ESP	22,698	21,418	593	546	10,214	0	2,061	2,189		0	20	28
SCE&G Wateree	1	FGD, SCR, fabric filter	18,803	17,301	475	358	4,811	0	934	871		0	18	15
SCE&G Wateree	2	FGD, SCR, fabric filter	18,207	17,332	542	300	4,568	0	1,065	731		0	20	13

*Note: Emissions are in tons per year. PM_{10} emissions represent PM_{10} filterable + condensable.

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 South Carolina's original SIP submittal. These measures provided additional emission reductions to allow VISTAS Class I areas to meet their reasonable progress goals.

- 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.
- The 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.

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 Table 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% clearest days, respectively. The baseline conditions are for 2000 through 2004 and the current conditions are for 2014 through 2018. Because the 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. Table 2-6 shows the current visibility conditions and the difference between the current visibility and the baseline condition for the 20% most impaired days.

The data shows that all Class I areas saw an improvement in visibility on the 20% worst days, the 20% most impaired days, and on the 20% clearest days. The current observed 5-year average values for all three areas on the 20% worst days are below the 2018 goal. On the 20% clearest days, the current observed 5-year average values for all three areas are below the 2018 goal of no degradation.

Table 13-6: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Worst Days

Class I Area	Baseline Average (2000-2004)	Current Average (2014-2018)	Change, current – baseline	2018 Goal	Difference, current – goal
Cape Romain	26.48	19.39	-7.09	22.7	-3.3

Table 13-7: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Clearest Days

Class I Area	Baseline Average (2000-2004)	Current Average (2014-2018)	Change, current – baseline	2018 Goal	Difference, current – goal
Cape Romain	14.29	11.80	-2.49	<14.29	-2.5

The previous progress report covered visibility through 2013. Table 13-8 and Table 13-9 display the change in visibility impairment for the 20% worst and 20% clearest days since 2013 through 2018. The data shows that all three Class I areas saw an improvement in visibility on the 20% worst and 20% clearest days.

Table 13-8: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Worst Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Cape Romain	22.45	21.34	20.18	19.77	19.39

Table 13-9: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Most Impaired Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Cape Romain	19.69 dv	19.99 dv	19.07 dv	18.28 dv	17.67 dv

Table 13-10: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Clearest Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Cape Romain	13.41	12.78	12.48	11.95	11.80

Figure 13-2 and Figure 13-3 display the data listed in Table 13-6 through Table 13-9, 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. Figure 7-9 show 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 in Cape Romain, 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.

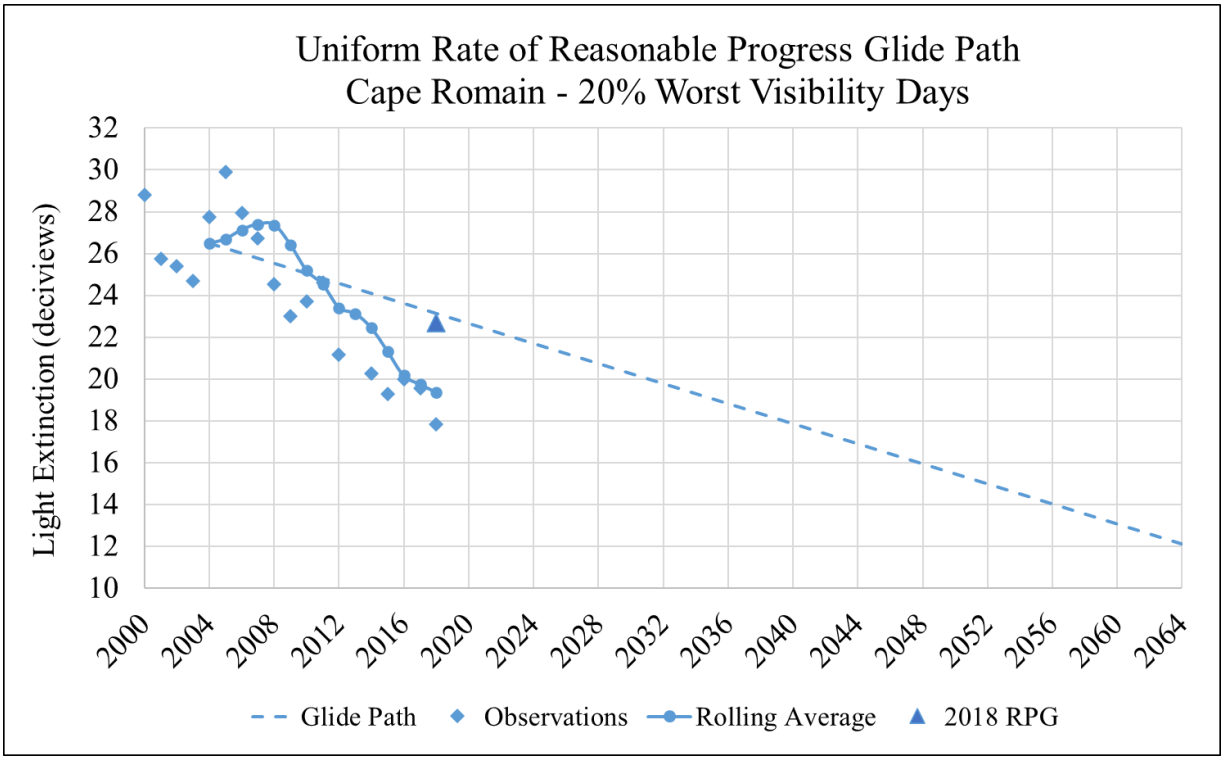


Figure 13-2: Cape Romain Visibility Impairment on the 20% Worst Visibility Days, Glide Path, and 2018 RPG

Figure 13-3 shows the observed five-year average impairment values for the 20% clearest days in Cape Romain, as well as the predicted impairment from the regional haze SIP. The observed five-year average impairment for the 20% clearest days of 2018 is below both the baseline and the predicted impairment.

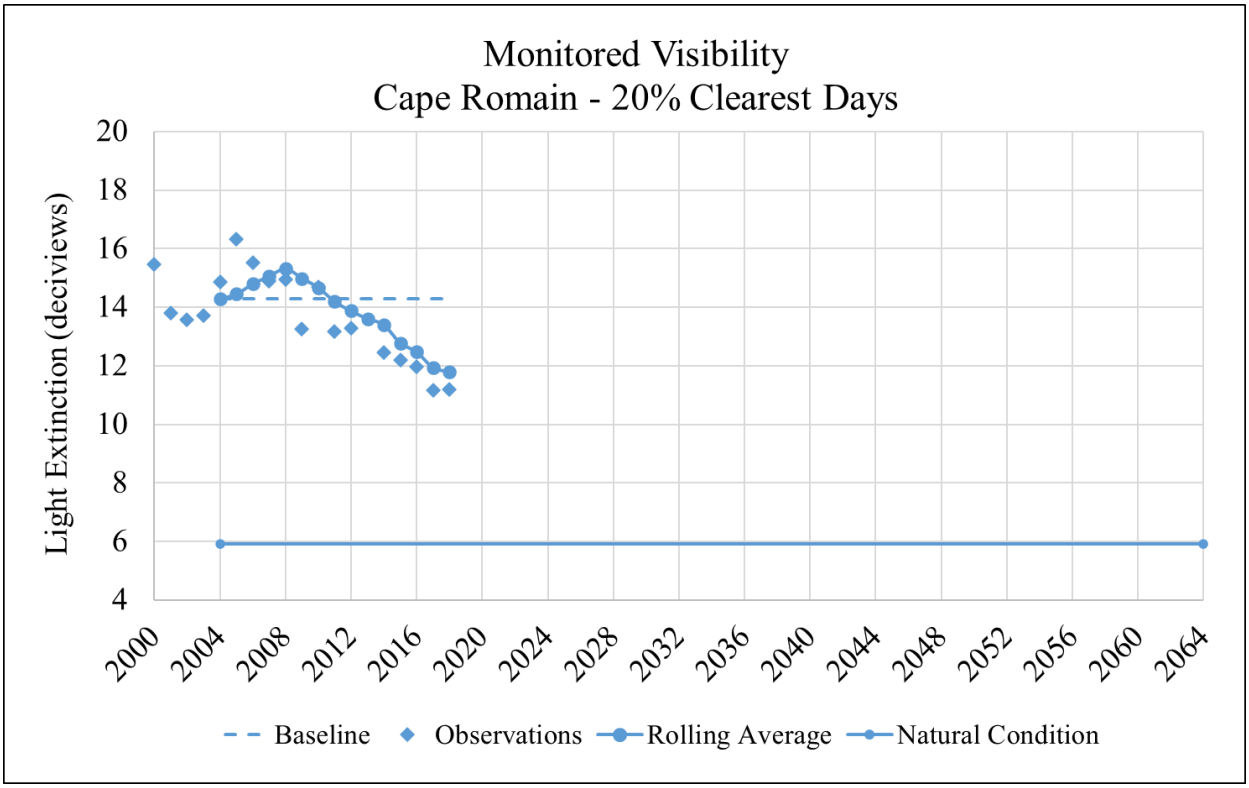


Figure 13-3: Cape Romain Visibility Impairment on the 20% Clearest Days and Natural Conditions

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, SO_2, 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, South Carolina 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 and area source categories. However, the overall $PM_{2.5}$ emissions across all categories in the 2017 NEI are 20% lower than what VISTAS projected for 2018.

Table 13-11: PM2.5 Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

$PM_{2.5}$ Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	8,061	8,048	34,493
Area	35,970	34,894	44,319
Onroad	2,539	2,297	1,087
Non Road	1,900	1,319	2,474
Fires	22,180	22,008	25,955
Total	**70,649**	**68,566**	**108,328**

For NO_X emissions (Table 13-12), there have been significant decreases in each source category. The 2017 NEI emissions for area and onroad categories are higher than the 2018 projected emissions. However, the overall NO_X emissions from all categories for 2017 are approximately 12% lower than the 2018 projections.

Table 13-12: NOX Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

NO_X Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	43,104	37,874	95,082
Area	23,031	16,947	20,592
Onroad	87,847	80,125	43,490
Non Road	19,247	13,987	31,758
Fires	4,856	4,380	5,899
Total	**178,086**	**153,314**	**196,821**

For SO_2 emissions (Table 13-13), point sources show the most significant decrease since 2014, and actual emissions from point sources are already 75% lower than the projected 2018 emissions. This is largely due to a significant reduction in oil use and 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 75% below the 2018 projections.

Table 13-13: SO2 Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

NO_X Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	46,913	19,400	147,787
Area	2,987	1,276	13,457
Onroad	546	568	643
Non Road	48	32	1,198
Fires	2,300	2,163	1,359
Total	**52,794**	**23,440**	**164,444**

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 South Carolina. 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 shows the CAMD emissions from 2014 to 2019.

Table 13-14: South Carolina EGU SO2 Emissions for CAMD (2014-2019)

SO_2 Emissions	2014 (tpy)	2015 (tpy)	2016 (tpy)	2017 (tpy)	2018 (tpy)	2019 (tpy)
CAMD	26,122.19	10,338.27	7,983.20	6,108.47	6,842.34	5,731.06

Figure 13-4 below depicts the trends for units that report annual emissions to CAMD and are located in South Carolina. Since 2014, heat input has remained fairly steady with a decrease of about 5% over this period.

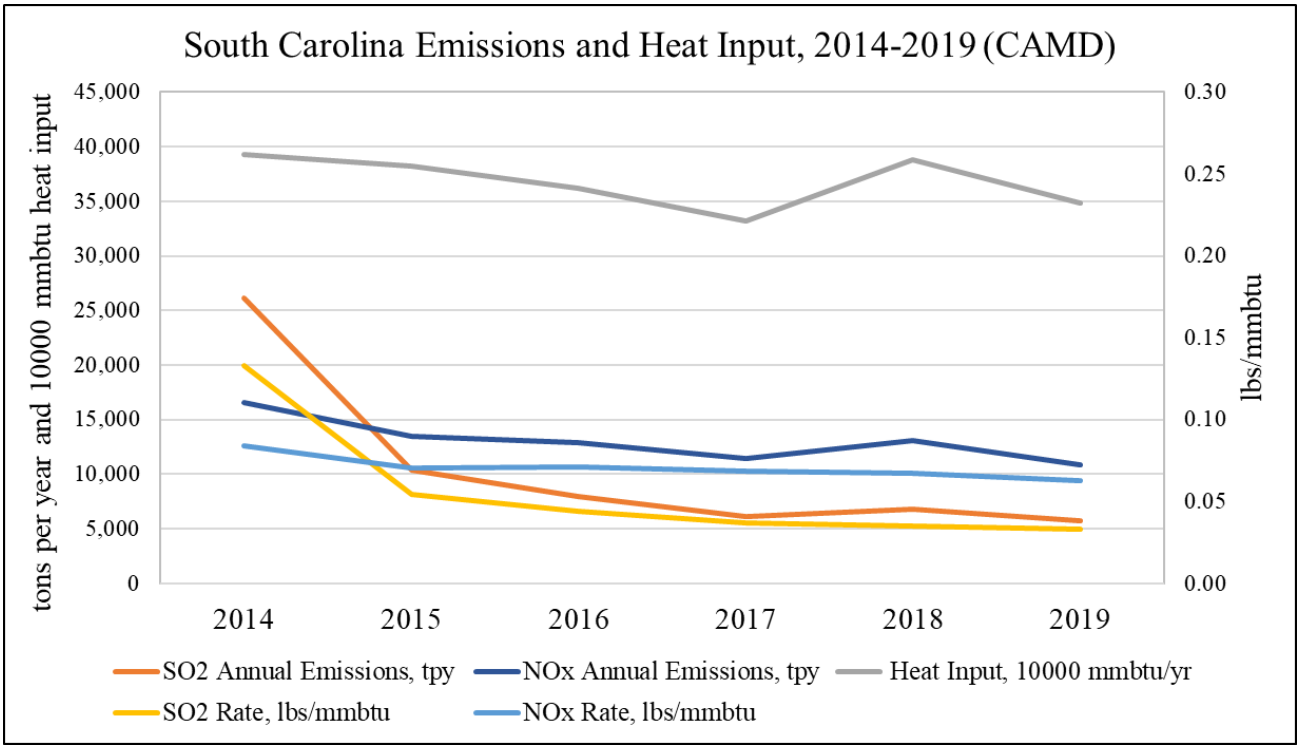


Figure 13-4: South Carolina CAMD Emissions and Heat Input Data ***(Source: EPA CAMD Database)***

The SO_2 emissions from these units decreased from 26,122 tons annually in 2014 to 5,731 tons annually in 2019, a decrease of 78%. The average SO_2 emission rate from these units decreased from 0.133 lbs/mmbtu in 2014 to 0.033 lbs/mmbtu in 2019, a decrease of 75%. 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 16,567 tpy to 10,909 tpy, a drop of 34%.

Figure 13-5 shows the trends for units reporting to CAMD across all VISTAS states.

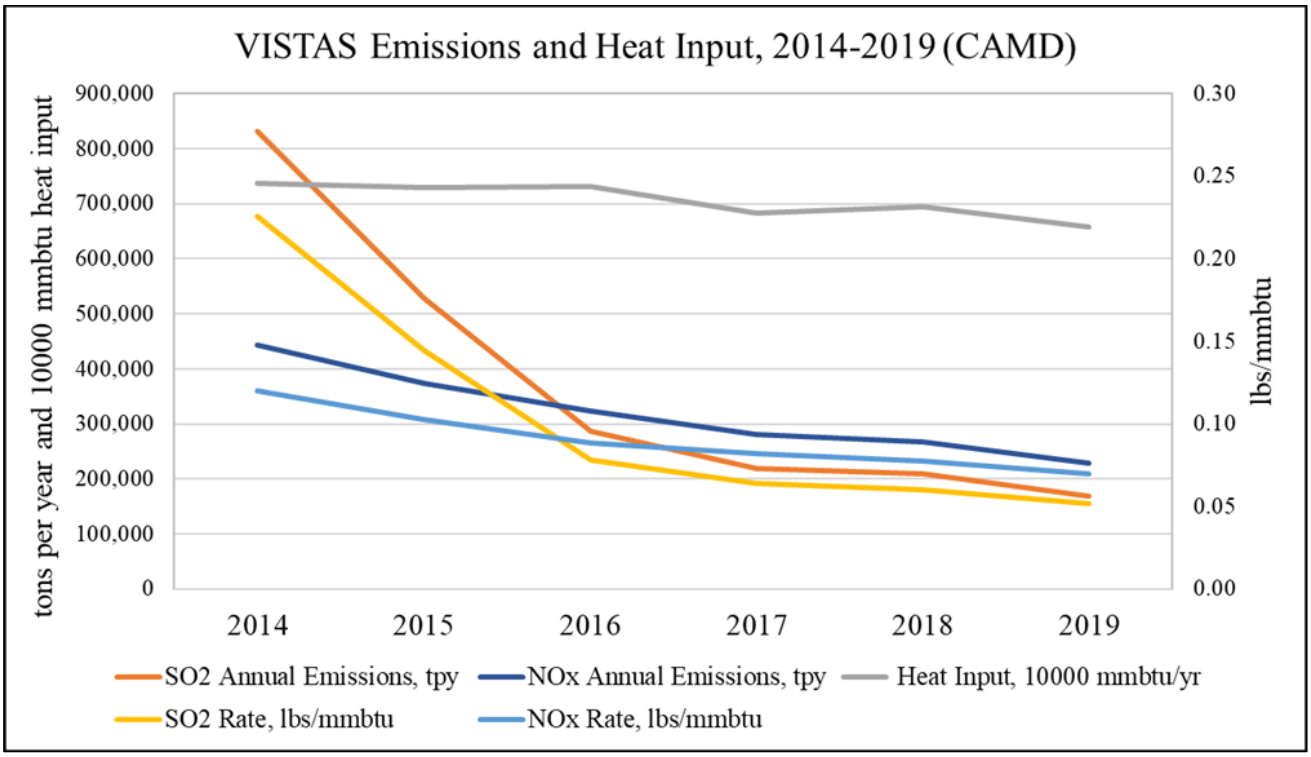


Figure 13-5: VISTAS CAMD Emissions and Heat Input Data *(source: EPA CAMD Database)*

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

Paragraph 40 CFR 51.308(g)(4) of the RHR specifies that a state assess if a*ny 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.

To address this paragraph, the Department reviewed anthropogenic SO_2 and NO_x emissions trends for the VISTAS states and each of the Regional Planning Organizations (RPOs) based on emissions included in the 2011, 2014, and 2017 NEI. The emissions trends are shown in Table 13-15, and the data in this table are presented in bar charts in Figure 13-6 and Figure 13-7 for SO_2 and NO_x emissions, respectively. These data show a significant decline in both SO_2 and NO_x emissions during the 2011 through 2018 period covered by this progress report both within South Carolina, each VISTAS state, and non-VISTAS states included in the RPOs covering the rest of the U.S.

Table 13-15: Annual Anthropogenic SO_2 and NO_x Emissions Trends by RPO and VISTAS States (2011, 2014, and 2017)

	SO_2 Emissions (TPY)			**NO_x Emissions (TPY)**		
RPO/State	**2011**	**2014**	**2017**	**2011**	**2014**	**2017**
CENSARA	1,552,522	1,215,472	966,258	3,668,137	3,197,228	2,614,611
LADCO	1,899,157	1,250,232	486,481	2,664,749	2,259,264	1,608,532
WESTAR/WRAP	595,077	450,132	445,217	3,015,273	2,610,400	2,197,499
MANE-VU	739,180	503,720	169,617	1,661,320	1,468,719	1,067,962
VISTAS	1,634,354	1,210,228	446,961	3,343,166	2,984,899	2,184,753
VISTAS States						
AL	278,365	201,422	59,519	359,823	339,558	221,815
FL	172,700	164,434	78,173	608,366	583,991	414,369
GA	234,701	102,155	38,188	452,318	349,908	290,072
KY	272,921	224,782	71,804	327,755	299,784	198,435
MS	63,940	108,445	12,724	205,897	179,687	138,059
NC	118,721	71,282	42,073	369,496	310,480	231,679
SC	103,248	52,795	23,440	210,544	179,663	153,314
TN	160,323	94,202	46,738	322,567	272,996	200,581
VA	107,818	77,210	27,188	313,456	278,652	208,371
WV	121,617	113,500	47,117	172,944	190,181	128,059

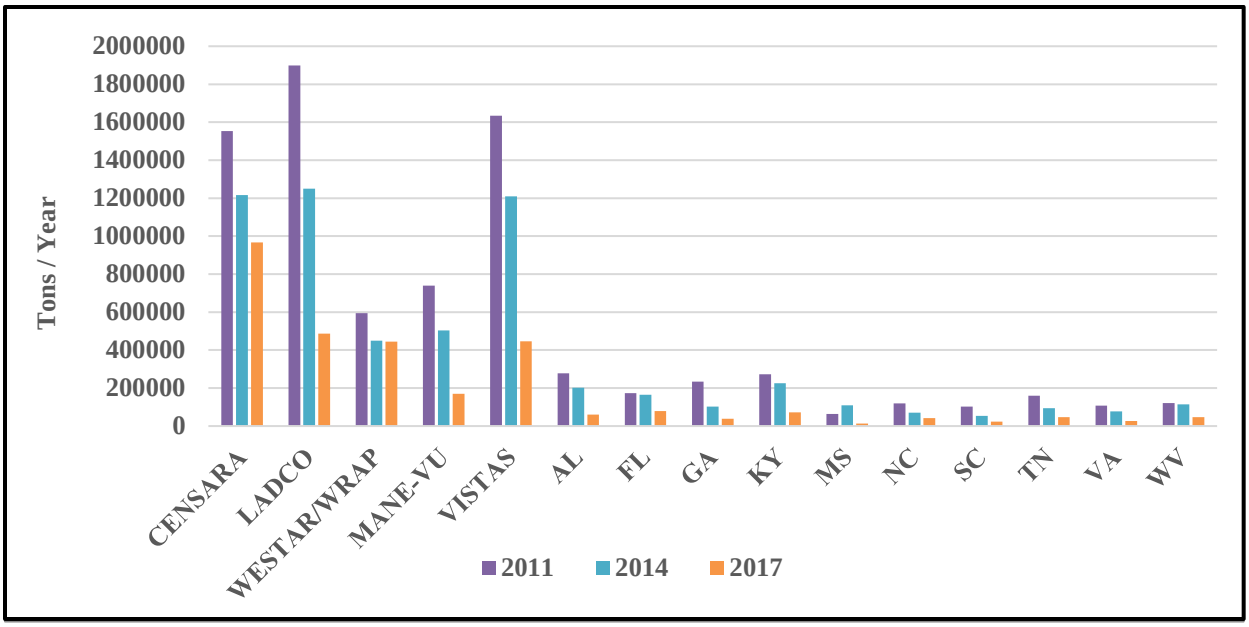


Figure 13-6: Annual Anthropogenic SO_2 Emissions Trends by RPO and VISTAS States

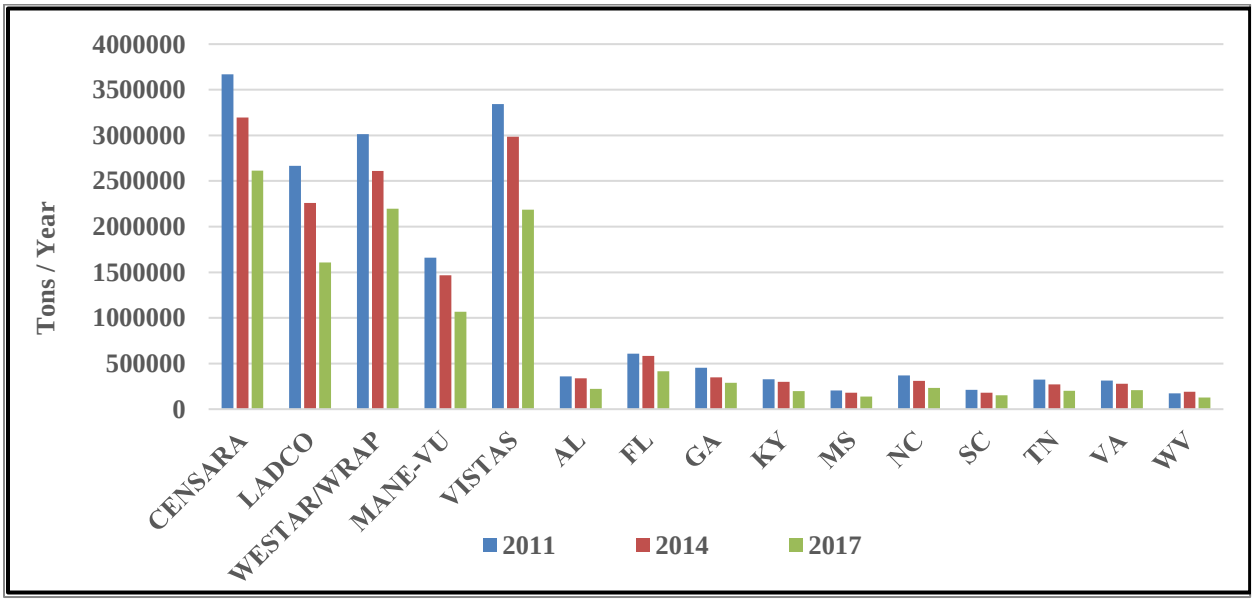


Figure 13-7: Annual Anthropogenic NO_x Emissions Trends by RPO and VISTAS States

Figure 13-8 shows the average light extinction for the 20% worst days over the 5-year period 2011 through 2018 for all Class I areas in the Southeast. Figure 13-9 shows the average light extinction for the 20% most impaired days over the 5-year period 2011 through 2018 for all Class I areas in the Southeast. These figures demonstrate that on the 20% worst days and 20% most impaired days at Cape Romain, sulfates (SO_4) continue to be the major concern during the first planning period, which is formed from the SO_2 emissions from stationary point sources. As shown in Figure 13-8 and Figure 13-9, the significant reduction in SO_2 and NO_x emissions at Cape Romain as well as neighboring states has resulted in significant improvements in visible

range at Cape Romain as well as Class I areas in nearby states. Based on these data, there does not appear to be any anthropogenic emissions within South Carolina that would have limited or impeded progress in reducing pollutant emissions or improving visibility.

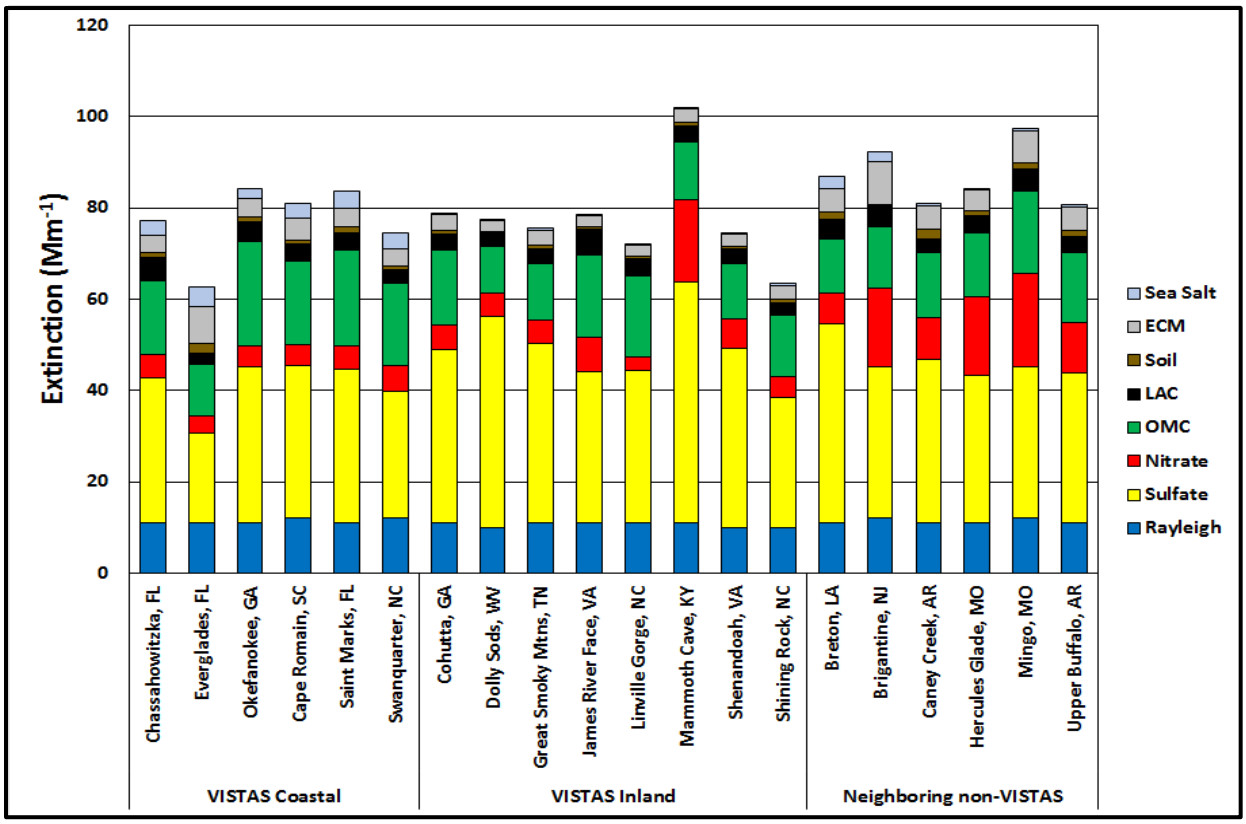


Figure 13-8: Average light extinction for the 20% Worst Days in 2011-2018 at Southeast and Neighboring Class I Areas

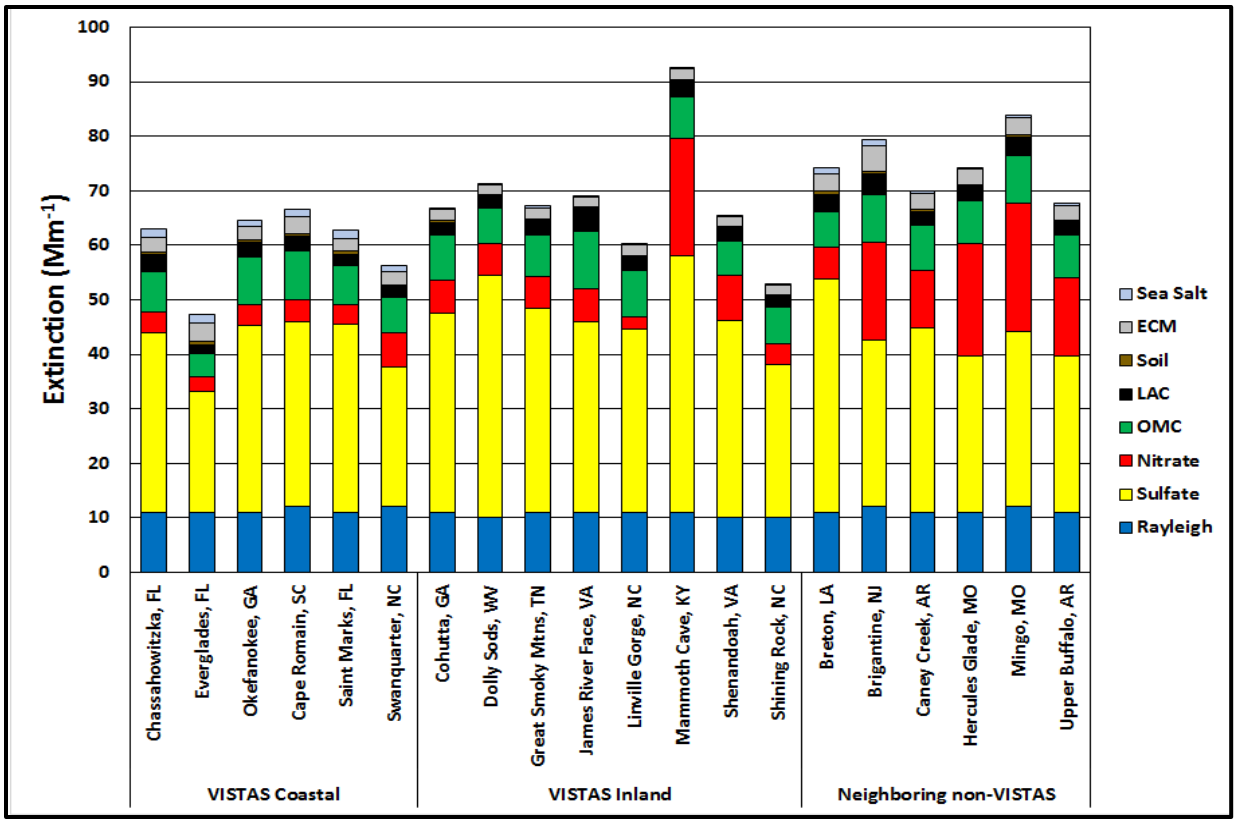


Figure 13-9: Average light extinction for the 20% Most Impaired Days in 2011-2018 at Southeast and Neighboring Class I Areas

13.6. Conclusion

This progress report documents that all control measures outlined in South Carolina's regional haze SIP have been implemented and that South Carolina has met all RPGs projected for 2018. Reductions in SO_2 emissions have been significant and greater than VISTAS projected. In spite of significant reduction 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 begin to have a larger relative impact on regional haze. The next regional haze progress report is due by January 31, 2025, and will cover progress in the second implementation period.