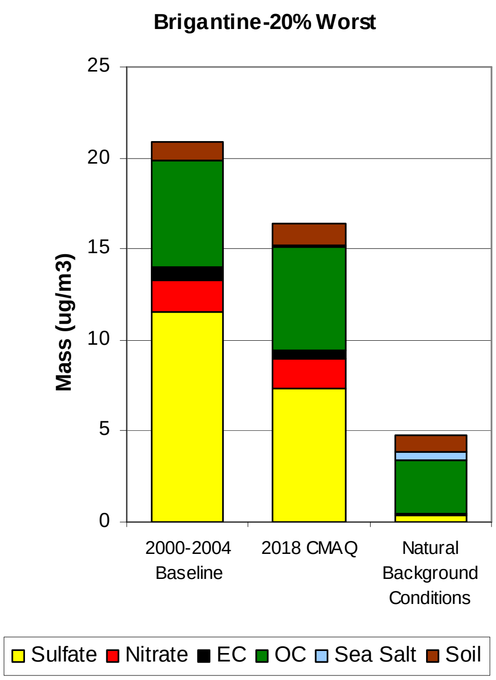
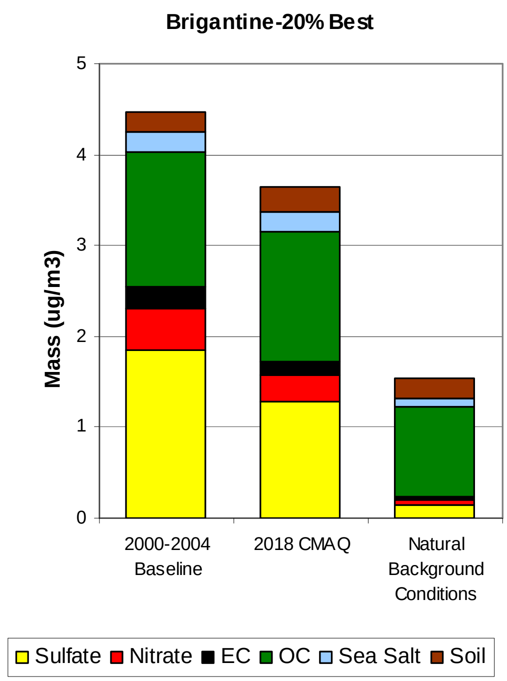
ATTACHMENT Q

MANE-VU 2018 Visibility Projections

2018 VISIBILITY PROJECTIONS





Prepared by
NESCAUM
For the
Mid-Atlantic/Northeast Visibility Union Regional Planning Organization

May 13, 2008

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Executive Summary

This report represents the most detailed effort to date to quantify the visibility impacts of those measures that are being actively considered by the Mid-Atlantic/Northeast Visibility Union (MANE-VU) states as a result of the regional haze consultation process. The visibility projections presented here will be useful to the MANE-VU states as they establish reasonable progress goals and develop their long-term emissions management strategies for Class I areas under the federal Regional Haze Rule.

Over the past several years, NESCAUM – as a partner in the MANE-VU regional planning organization – has coordinated and conducted regional air quality modeling to better understand the visibility implications of a range of potential compliance options with the Haze Rule. NESCAUM has utilized in-house air quality modeling capabilities that include emission processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 and several future periods. This work has been documented in several prior reports that were intended to inform and encourage the decision making process leading up to this point in the SIP submission process.

Results from prior analyses have shown that sulfate aerosol – the dominant contributor to visibility impairment in the Northeast's Class I areas on the 20 percent worst visibility days – has significant contributions from states throughout the eastern U.S. These are projected to continue in future years from all three of the eastern regional planning organizations (RPOs). This assessment of potential control measures that would address these future contributions includes a number of specific strategies and would yield significant visibility benefits at or beyond the uniform rate of progress. Perhaps more importantly, they reflect future visibility benefits corresponding to measures that the MANE-VU states are evaluating as being reasonable to implement.

INTRODUCTION

1.1. Background

This report presents information intended to assist states in establishing reasonable progress goals and fulfilling their long-term emissions management strategies under the 1999 U.S. Environmental Protection Agency (USEPA) "Regional Haze Rule" [64 Fed. Reg. 35714 (July 1, 1999)] for MANE-VU Class I areas.[1] NESCAUM has used in-house air quality modeling capabilities that include emission processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 (representative of the baseline period from 2000 to 2004) and for the end of the first compliance period, 2018.

In reviewing the results here, the reader should refer to prior reports prepared by NESCAUM that provide the foundation upon which these results are built. For example, dating back to the earliest overview of regional haze and visibility impairment in the Northeast and Mid-Atlantic U.S. (NESCAUM, 2001), NESCAUM presented a review of the available models along with their uses and limitations. This served to inform the choice of models and tools used to build the weight of evidence modeling approach taken by MANE-VU in conducting a contribution assessment and pollution apportionment (NESCAUM 2004, 2006). NESCAUM presented a review of the base year 2002 from a meteorological and chemical perspective in its report *2002, A Year in Review* (NESCAUM, 2004). NESCAUM has also separately published a performance evaluation of the MM5 meteorological model, the U.S. EPA Community Multi-scale Air Quality (CMAQ) chemical transport model, as well as a more complete description of the modeling platform used for prior control strategy analyses (NESCAUM, 2008).

In this report, we do not repeat this information, but rather rely upon the prior documentation. The following sections describe the control scenario being considered and present the resulting visibility projections in the context of the uniform rate of progress determined by baseline conditions and estimated natural visibility conditions for each Class I area.

1.2. Meteorology

MANE-VU has adopted the Inter-RPO domain description for its modeling runs.[2] This 36-km grid cell domain covers the continental United States, southern Canada, and northern Mexico. The dimensions of this domain are 145 and 102 cells in the east-west and north-south directions, respectively. A 12-km grid cell inner domain was selected to better characterize air quality in MANE-VU and surrounding RPO regions. This domain covers the eastern region, which includes the northeastern, central, and southeastern U.S.,

[1] There are seven designated Class I areas in the Northeast and Mid-Atlantic States. They include Acadia National Park and Moosehorn Wilderness Area in Maine; Roosevelt Campobello International Park in New Brunswick and Maine; the Lye Brook Wilderness Area in Vermont; the Great Gulf and Presidential Range-Dry River Wilderness Areas in New Hampshire; and the Brigantine Wilderness Area in New Jersey.

[2] The modeling system for the 2002/2018 annual simulation is applied with a Lambert Conformal Conic projection with parallels at 33°N and 45°N. A spherical earth radius of 6,370 km is used for all elements of the system (MM5/SMOKE/CMAQ).

as well as southeastern Canada. It extends from 66°W~94°W in longitude and 29°N~50°N in latitude with 172 × 172 grid cells (Figure 2-1).

Figure 2-1. Modeling domains used with CMAQ for MANE-VU studies.

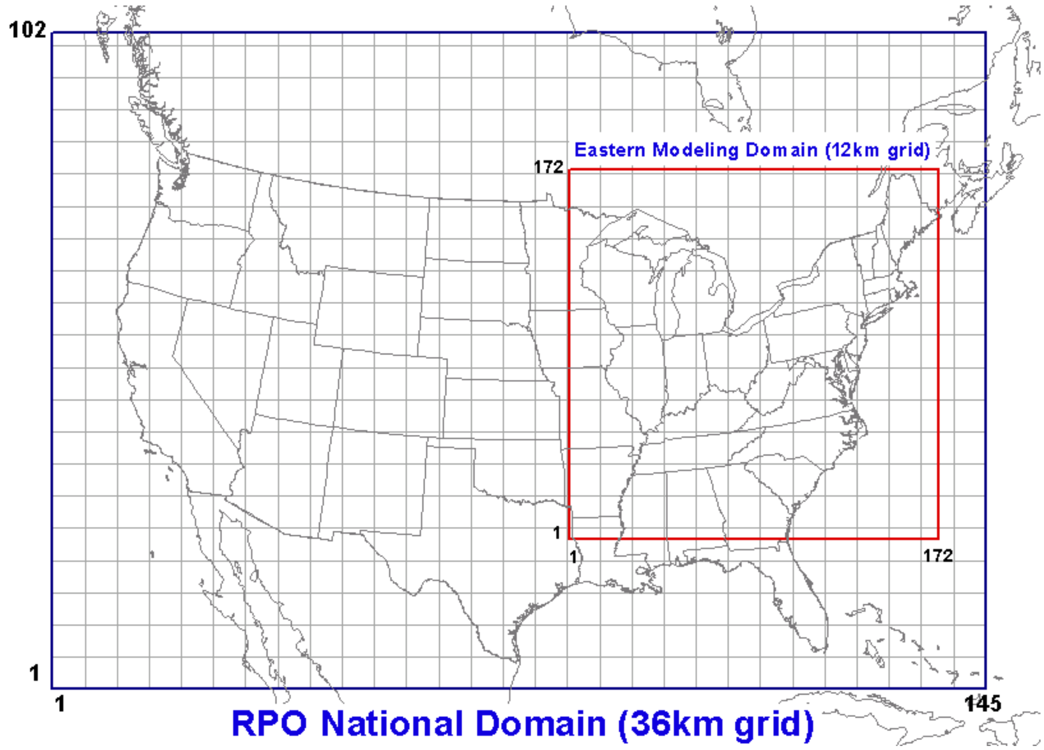


Figure note: Outer (blue) domain is a 36 km grid and inner (red) domain is a 12 km grid. The gridlines are shown at 180 km intervals (5 × 5 36 km cells/15 × 15 12 km cells).

Meteorological inputs for CMAQ, provided by Dalin Zhang's group at the University of Maryland (UMD), are derived from the Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5).[3] The UMD MM5 model runs are made on these two nested domains with the inner (12 km) domain using finer resolution terrain data. Initially, we conducted a set of test runs for the period of August 6–16, 2002. A detailed description of the meteorological inputs can be found in the report *MANE-VU Modeling for Reasonable Progress Goals* (NESCAUM 2008).

1.3. Emissions Preparations

NESCAUM simulated emission scenarios using the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System, an emissions processing system designed to create gridded, speciated, hourly emissions for input into a variety of air quality models such as CMAQ. SMOKE supports area, biogenic, mobile (onroad and nonroad),

[3] http://www.mmm.ucar.edu/mm5/

and point source emissions processing for criteria, particulate, and toxic pollutants. The *MANE-VU Modeling for Reasonable Progress Goals* report describes the SMOKE emissions processing methods in detail (NESCAUM 2008).

2. 2018 EMISSIONS INVENTORY

Descriptions of the 2002, 2018 On the Books/On the Way (OTB/OTW), and 2018 Beyond on the Way (BOTW) inventories are included in the report on reasonable progress modeling (NESCAUM 2008). Based on this previous modeling, contribution assessments, and analyses of the four statutorily required factors, MANE-VU selected a number of control measures on which to base the modeling that would be used to develop proposed reasonable progress goals. These measures include additional SO_2 emissions reductions at electric generating units (EGUs), the use of low-sulfur fuels in MANE-VU, and reductions in non-EGU SO_2 emissions outside of MANE-VU. Revisions due to implementation of BART and anticipated changes in Canadian emissions are also included in the projected 2018 emissions inventory used for this modeling.

MANE-VU received comments from several stakeholders and another RPO related to the fact that the modeling described in this report included control measures and emission reductions that went beyond currently existing regulations. Commenters suggested that since the CAIR program and other "on the books" or "on the way" measures are projected to achieve uniform rates of progress as previously modeled, additional reductions to both EGU and non-EGU sectors were unnecessary. As described below, there are two reasons why MANE-VU has chosen to include these measures in this modeling analysis.

First, while the results of the modeling described in this report suggest individual MANE-VU Class I areas will be able to meet or exceed uniform rates of progress by 2018, our current analysis also suggests that this would be difficult without including additional measures beyond implementation of CAIR. This result is due, in part, to our assumptions about the effectiveness of CAIR. We believe that it is appropriate for MANE-VU to take a conservative approach to estimating the potential for emissions reductions under the CAIR program. Therefore MANE-VU added EGU emissions to estimate the impact of banking and trading under CAIR. Additional EGU reductions would be feasible with additional federal action to control EGU emissions (e.g., a third phase of CAIR), but MANE-VU does not believe that these reductions are likely to occur absent additional regulation.

Second, EPA's Regional Haze Rule requires that states must identify and consider all potential measures that could improve visibility and the preamble contains language indicating that states should adopt the amount of progress required to achieve the uniform rate as its target "unless it determines that additional progress beyond this amount is also reasonable. If the State determines that additional progress is reasonable based on the statutory factors, the State should adopt that amount of progress as its goal for the first long-term strategy." [40 CFR part 51, July 1, 1999, pg. 35,732].

MANE-VU Class I states have concluded based on review of four factor analyses that the control assumptions described below for all three RPOs represent reasonable ways to achieve the goals MANE-VU set forth in consultations. MANE-VU understands that states will document in their Regional Haze SIPs any difference of opinion as to whether reasonable measures exist beyond CAIR for EGUs and as to what measures are reasonable in the non-EGU sector.

The following sections describe the adjustments made to the BOTW inventory to develop the visibility projections documented in this report. These results are available for the MANE-VU states with Class I areas to consider in proposing reasonable progress goals.

2.1. Implementation of Top 167 EGU SO_2 Control Scenario

The Vermont Department of Environmental Conservation (DEC) and Environmental Resources Management, on behalf of the Maryland Department of the Environment/Maryland Department of Natural Resources (MDE/MDNR), simulated sulfate at MANE-VU Class I areas using CALPUFF to identify the major contributors to ambient pollution. The effort identified 167 EGU emission sources as contributing a substantial visibility degradation at northeast Class I sites. As part of the MANE-VU strategy to meet its reasonable progress goals, MANE-VU asked for a 90 percent reduction relative to 2002 emission levels from these stacks. This request did, however, provide flexibility to pursue equivalent reductions by region in lieu of reductions at these specific facilities. The resulting emission levels from the EGU sector for this version of the 2018 MANE-VU inventory reflect the SO_2 control request on the top 167 EGUs over three RPOs: MANE-VU, VISTAS, and MWRPO; while maintaining the SO_2 emission level under the CAIR cap for all states subject to the CAIR cap-and-trade program. A more complete description of the EGU emissions inventory preparation is provided elsewhere (Alpine Geophysics, March 2008).

First, NESCAUM determined the desired emissions levels for the 167 stacks based on continuous emissions monitoring data from 2002 (representing a 90 percent reduction). Table 2-1 displays the target levels summarized by RPO. For the same stacks, states provided their best estimate of emissions in 2018, with IPM results as a starting point and specific knowledge of anticipated activity for each stack (e.g., installation of controls). These future emissions are summed by RPO and shown in the second row of Table 2-1. A comparison of these emissions levels shows that no RPO achieves the desired reductions at these 167 stacks. Therefore, reductions at other stacks at the same facilities as the 167 stacks or from other EGUs are required to meet the target emissions level.

Table 2-1. SO_2 Emissions Summary (TPY) for 167 Top EGU stacks

	MANE-VU	MRPO	VISTAS
10% of 2002 CEMS	117,217	170,454,	169,816
Projected 2018	193,026	436,138	299,090
Shortfall	75,809	265,683	129,275

NESCAUM next reviewed anticipated 2018 emissions by RPO at all stacks other than the 167. For MANE-VU, an emissions reduction exactly matching the shortfall (75,809 tons) was recorded at one hypothetical stack in the region.[4] The VISTAS G2

[4] This hypothetical reduction was not assigned to any specific source since the subsequent "add back" of emissions reductions not backed up by enforceable regulations led to no net reduction.

inventory with some Virginia adjustments estimated reductions relative to IPM 2.1.9[5] of over 180,000 tons for the EGUs not included in the 167 stacks. These reductions exceed the shortfall from the 167 stacks and no further adjustments were required. For MRPO, IPM 3.0 results (based on RPO communication) were used to guide the location of reductions to meet the shortfall. Emissions from 65 units where IPM 3.0 predicted emissions lower than IPM 2.1.9 were adjusted downward to be 10 percent of 2002 emissions, resulting in 290,551 tons per year of additional reductions.

Once EGU SO_2 emissions levels were lowered to meet the desired reductions, NESCAUM compared the adjusted emissions (including adjustments to IPM 2.1.9 made by states directly and those from changes made by NESCAUM to meet the 167 stack reduction targets) with IPM 2.1.9 emissions by each of the three RPOs. The analyses looked at three groupings of EGU stacks: the 167 stacks, other units at the same facilities as the 167 stacks, and all other EGUs. Table 2-2 gives these differences by category. Since the total IPM 2.1.9 EGU emissions sums to the CAIR cap, the sum of the differences in the table represents reductions beyond the CAIR level. Because MANE-VU Class I states made the decision to maintain the CAIR level of emissions in this 2018 modeling, the 516,350 tons of emissions were added back.

Table 2-2. Emissions difference between IPM 2.1.9 and adjusted emissions based on state-specific comments and MANE-VU effort to meet 167 stack reduction levels.

	MANE-VU	MRPO	VISTAS
167 stacks	39,465	-37,913	-14,673
Other stacks at 167 facilities	21,433	24,098	-2,244
Other EGUs	-75,809	-290,551	-180,155
Sum	-14,912	-304,367	-197,071

Note: negative values indicate emissions below IPM 2.1.9

Next, NESCAUM increased the emissions from states subject to the CAIR cap-and-trade program. For MANE-VU, 75,809 tons were added back to the hypothetical facility controlled to meet the “167 stack” reduction request. The remaining 440,188 tons were allocated to VISTAS and MRPO at EGUs that were not among the “167 Stack” facilities based on the fraction of their contribution to the total SO_2 emission. The additional emissions correspond to an increase of 20.5 percent at each of these facilities, with a total of 216,685 tons added to MRPO and 223,504 tons added to VISTAS.

[5] To predict future emissions from EGUs, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) and other Regional Planning Organizations have followed the example of the US Environmental Protection Agency (EPA) in using the Integrated Planning Model® (IPM), an integrated economic and emissions model. IPM projects electricity supply based on various assumptions and develops a least-cost solution to generating needed electricity within specified emissions targets. IPM runs are defined by numerous economic and engineering assumptions. EPA developed Base Case v.2.1.9 using IPM to evaluate the impacts of CAIR and the Clean Air Mercury Rule (CAMR). Recently, EPA updated their input data and developed Base Case v.3.0. All of the IPM results used in MANE-VU modeling were based on EPA Base Case v.2.1.9 with some updates and corrections.

The intent of the EGU emissions adjustments was to retain the same overall level of emissions as predicted by the VISTAS/Inter-RPO run of IPM 2.1.9 overall. The locations of the emissions, however, were modified to better reflect the states' estimates of where emissions would be reduced and to implement the MANE-VU "ask" to achieve reductions at the 167 stacks identified as contributors to visibility reduction at MANE-VU Class I areas.

2.2. Implementation of Low Sulfur Fuel Strategy in MANE-VU

This strategy reduces SO_2 emissions by 2018 from all MANE-VU (non-EGU) sources combusting #1, #2, #4, #5, and #6 oil. Reductions were achieved by lowering sulfur content in fuel from their original levels to 0.0015 percent (equivalent to fuel sulfur content of 15 ppm by volume) for #1 and #2 oil; to 0.25 percent for #4 oil; and to 0.5 percent for #5 and #6 oil. Emissions were reduced from 2002 levels by 168,222 for light distillates (#1 and #2) and 42,875 tons per year for the other fuels. These reductions – when applied within MANE-VU – result in a 35% reduction of our projected 2018 non-EGU SO2 inventory.

2.3. Implementation of BART Strategy in MANE-VU

SO_2 emissions at BART-eligible sources that were not controlled for any other reason (e.g., NOx RACT, CAIR, multi-P state regulations, etc.) have been set to levels as determined by the states.

2.4. Implementation of Gas-Turbine EGU in Canada

SO_2 emissions were removed entirely from six coal-burning EGUs in Ontario, Canada (6500 MW of total capacity) that are scheduled to be shut down (Ontario Power Authority 2006) and replaced with nine natural gas turbine units with Selective Catalytic Reduction (SCR). Emission rates for modeled pollutants from the 'new' gas facilities were based on a combination of factors: recommendation from NH DES (Andy Bodnarik, personal communication), a NYSERDA study (Wien et al. 2003) and AP42 ratios among pollutants. Ontario EGU emissions were reduced by more than 144,000 tons per year as a result of this measure.

2.5. Implementation of 28 percent non-EGU SO_2 emission reduction

Given MANE-VU's low sulfur fuel strategy, MANE-VU requested a comparable reduction in SO_2 emissions from MRPO and VISTAS. The 28 percent value derives from a preliminary estimate of emissions reductions reasonably achievable from non-EGUs sources in MANE-VU. Based on 2002 emissions, this level reduction would amount to 131,600 TPY in MRPO and 308,000 TPY in VISTAS. A number of emission reductions were made to reach these levels, including: reducing emissions from coal-fired ICI boilers by 60 percent, reducing emissions from oil-fired ICI boilers by 75 percent, and reducing emissions from ICI Boilers lacking fuel specification by 50 percent. An additional control was required in VISTAS that reduced emissions from other area oil-combustion sources by 75 percent. These sources were identified by SCCs, matching the source types identified in the list of oil combustion SCCs developed by Alpine Geophysics for the sensitivity runs described previously (NESCAUM, 2008).

3. 2018 MODELING PROJECTIONS

The modeling results based on adjustments to the 2018 emissions inventory detailed in the previous section are given here. All results were developed using the CMAQ modeling platform described previously (NESCAUM, 2008). Table 3-1 provides species-specific relative reduction factors (RRFs) at each Class I area for the 20 percent worst and 20 percent best days. The factors are developed from the 2002 baseline modeling and 2018 modeling results. Ambient measurements identify which days to use in the calculations. The model concentrations for these days are averaged to create the RRF, which is the ratio of the future year to base year average concentration.

Based on the tabulated data, modeled sulfate is reduced by about one-third on worst days, and range from a 6 percent to 31 percent reduction on best days. Nitrate and elemental carbon also show substantial reductions across all sites for both best and worst days. Reductions in organic carbon levels are generally small, while increases are predicted for the fine soil component. The increase may be due to differences in the fire inventory used in VISTAS, as the base year relied on an earlier version of fire emissions than did the 2018 inventory. No changes occur for sea salt since the model does not track that component.

To determine visibility levels in 2018, the measured baseline average concentrations are multiplied by their corresponding RRF for each worst and best day. The projected concentrations are then used to derive daily visibility in deciviews and are averaged across all best and worst days to create the projected future visibility. The results of this procedure are plotted along with the uniform progress glide slope in Figure 3-1 through Figure 3-7. In addition, annual observed 20 percent best and 20 percent worst visibility are plotted as well as a line representing no degradation from current baseline best 20 percent visibility.

All MANE-VU sites are projected to meet or exceed the uniform rate of progress goal for 2018 on the 20 percent worst days. In addition, no site anticipates increases in 20 percent best day visibility impairment relative to the baseline. The nearby sites of Shenandoah and Dolly Sods also show improvement relative to baseline conditions on the 20 percent best days. At Dolly Sods, however, projected visibility impairment on the 20 percent worst days in 2018 exceeds the level determined by the uniform rate. Apparently, the net result of adding back SO_2 emissions across the domain in order to maintain the CAIR cap and reducing emissions in the MidWest RPO and VISTAS in order to comply with the MANE-VU non-EGU ask has been to increase the anticipated visibility impairment relative to previous modeled scenarios. This result is most evident at southern and western sites where more emissions (on an absolute basis) were added back to EGUs.

Table 3-1. 2018 20% best and worst days relative reduction factors at seven sites.

20% Worst Days Relative Reduction Factors

	Acadia	Lye Brook	Brigantine	Moosehorn	Dolly Sods	Shenandoah	Great Gulf
SO4	0.65	0.65	0.63	0.69	0.77	0.65	0.63
NO3	0.79	0.91	0.93	0.73	0.55	0.47	0.85
EC	0.75	0.67	0.62	0.77	0.73	0.58	0.74
OC	0.95	0.93	0.98	0.95	0.93	0.88	0.86
Sea Salt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Soil	1.10	1.13	1.26	1.09	1.21	1.16	1.15

20% Best Days Relative Reduction Factors

	Acadia	Lye Brook	Brigantine	Moosehorn	Dolly Sods	Shenandoah	Great Gulf
SO4	0.90	0.81	0.69	0.95	0.94	0.91	0.94
NO3	0.75	0.67	0.62	0.77	0.73	0.58	0.74
EC	0.74	0.75	0.64	0.78	0.71	0.52	0.83
OC	0.94	0.93	0.97	0.92	0.91	0.72	0.99
Sea Salt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Soil	1.06	1.04	1.17	1.03	1.14	1.08	1.08

* RRFs for Sea Salt are not calculated from CMAQ. We assume no changes in observed values between 2002 and future time periods.

Figure 3-1. Projected improvement in visibility at Acadia National Park based on 2018 Best and Final Projections

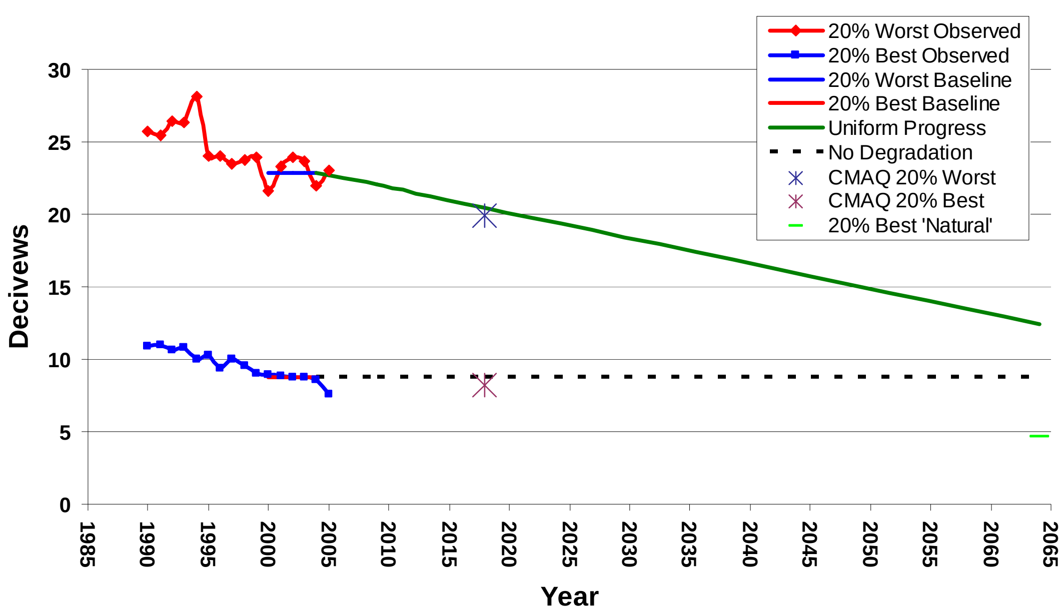


Figure 3-2. Projected improvement in visibility at Brigantine National Wildlife Refuge based on 2018 Best and Final Projections

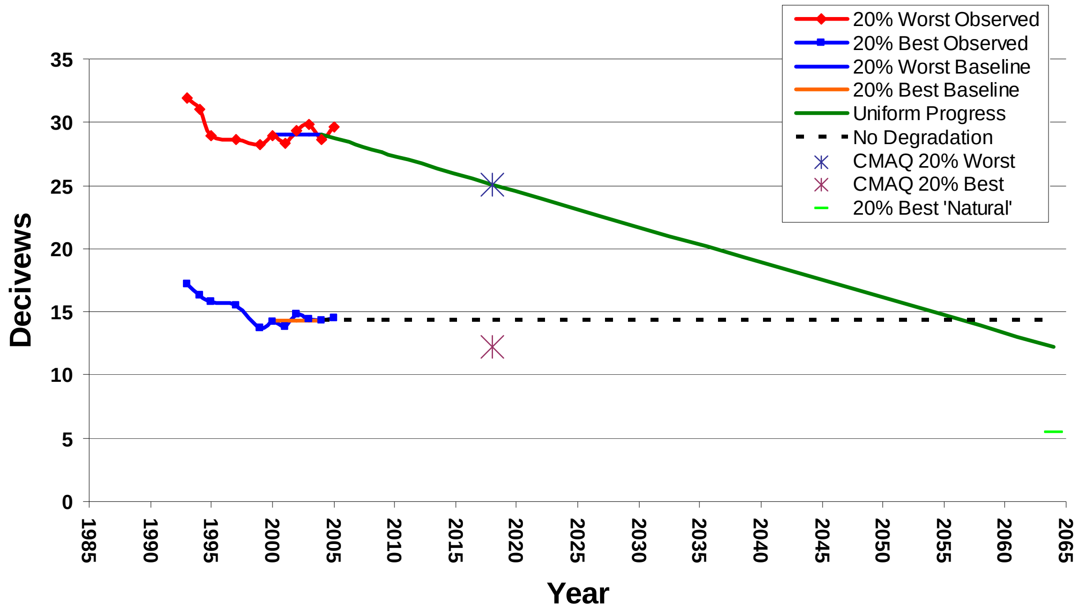


Figure 3-3. Projected improvement in visibility at Great Gulf Wilderness based on 2018 Best and Final Projections

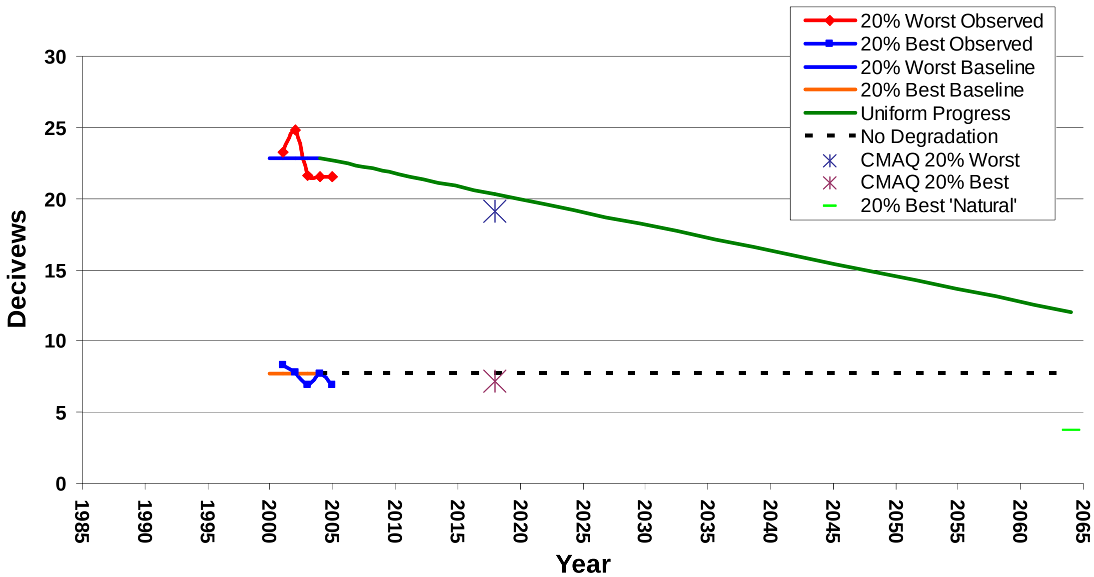


Figure 3-4. Projected improvement in visibility at Lye Brook Wilderness based on 2018 Best and Final Projections

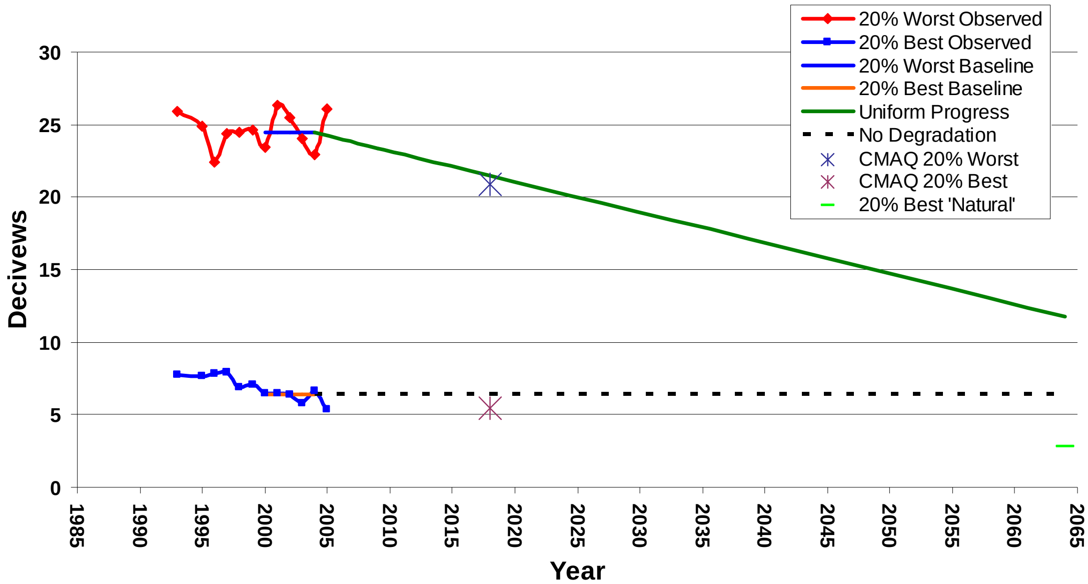


Figure 3-5. Projected improvement in visibility at Moosehorn National Wildlife Refuge based on 2018 Best and Final Projections

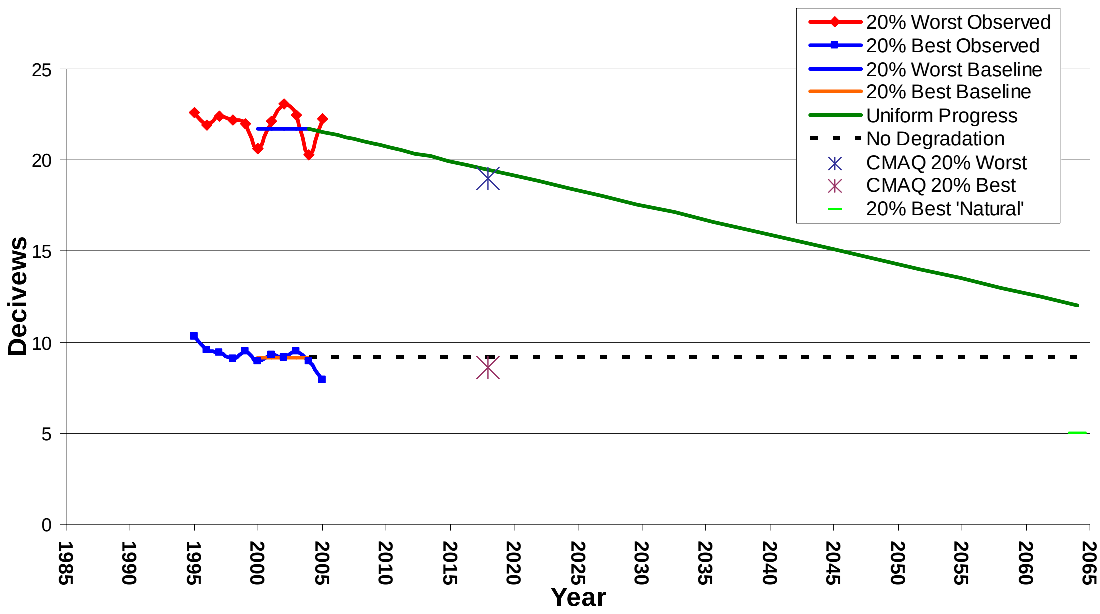


Figure 3-6. Projected improvement in visibility at Dolly Sods Wilderness based on 2018 Best and Final Projections

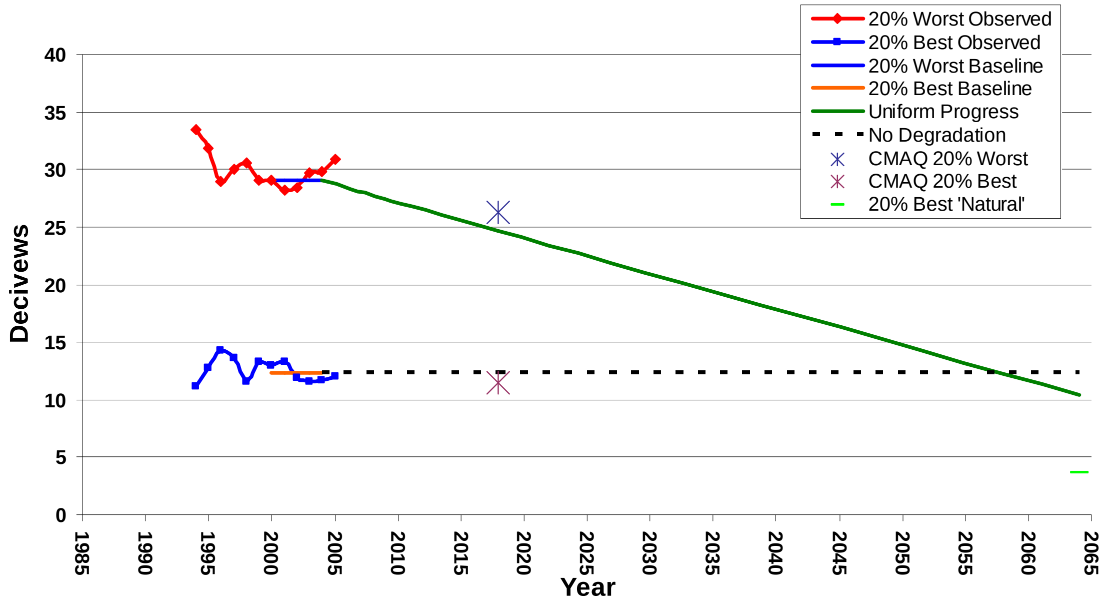
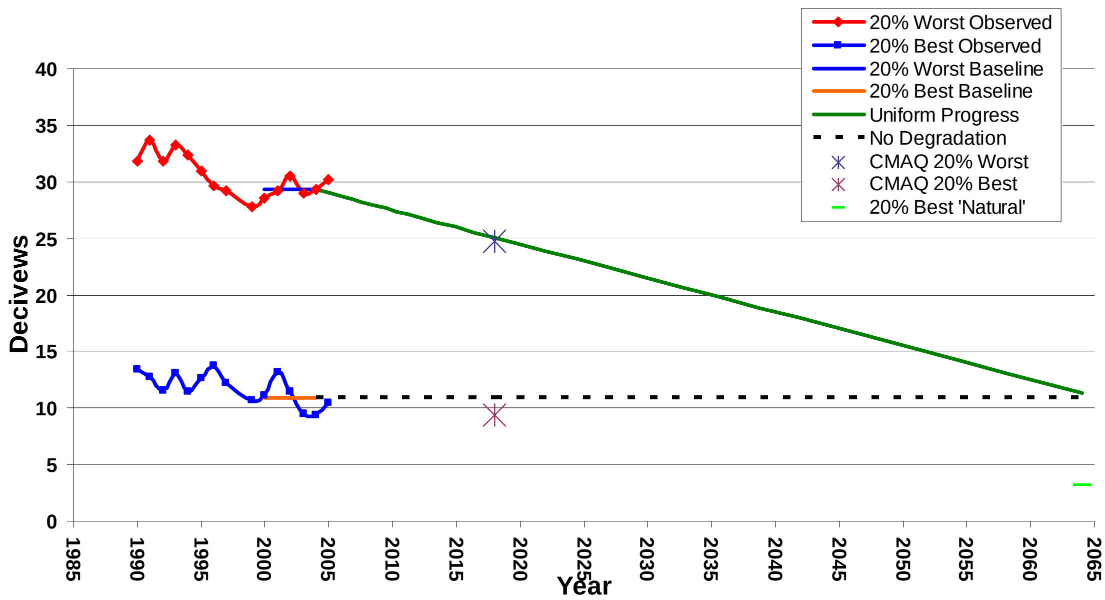


Figure 3-7. Projected improvement in visibility at Shenandoah National Park based on 2018 Best and Final Projections



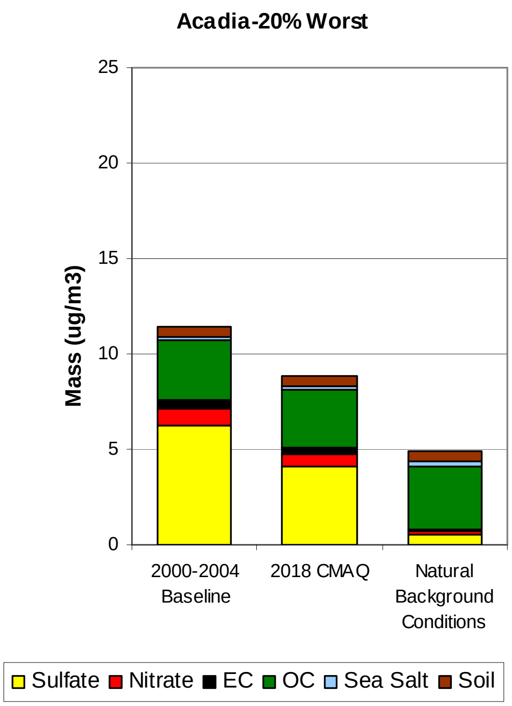
4. 2018 VISIBILITY RESULTS

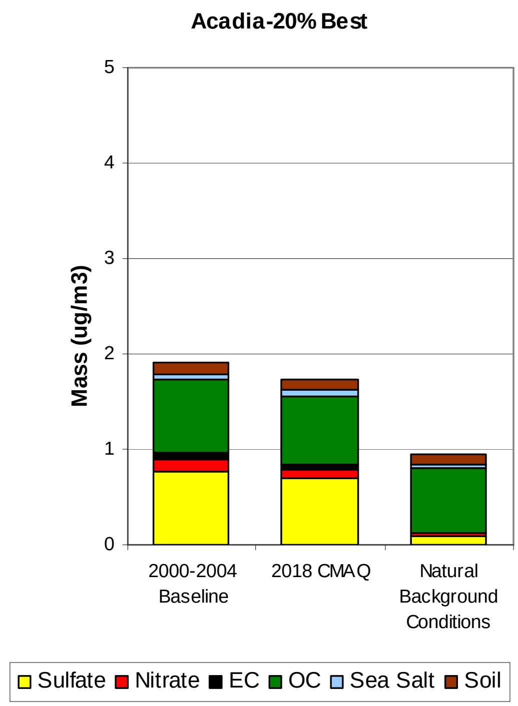
Figure 4-1A through G show the absolute magnitude of measured and projected sulfate, nitrate, elemental carbon (EC), organic carbon (OC), sea salt, and soil at each MANE-VU Class I monitor and two nearby Class 1 sites, Shenandoah and Dolly Sods. Current and projected vibility conditions are shown for both the twenty percent best visibility days (right) and the twenty percent worst visibility days (left; note that the range of the y-axes are five times greater than for the best days!) These figures show that despite large reductions in sulfate relative to the baseline, substantially greater reductions are required to reach natural background conditions. Reductions in nitrate will also be needed. Similarly, the carbonaceous species warrant attention moving forward, although a substantial fraction of the organic carbon will remain as natural background.

Sea salt shows interesting behavior. At coastal sites, the worst day sea salt mass is shown to increase when going from baseline and 2018 time periods to natural background conditions. Presumably this observation is a result of the EPA/IMPROVE program choice to base future estimates of worst day visibility conditions on the current distribution of worst day visibility. We note that for sea salt, this may not be the best method to estimate future worst day conditions as the greatest concentration of sea salt is observed in the Northeast U.S. on the best visibility days, not the worst visibility days.

Figure 4-1A-G. Observed Baseline, CMAQ-projected*, and Estimated Natural Speciated $PM_{2.5}$ Mass Values for MANE-VU Class I Sites.

A. Acadia National Park



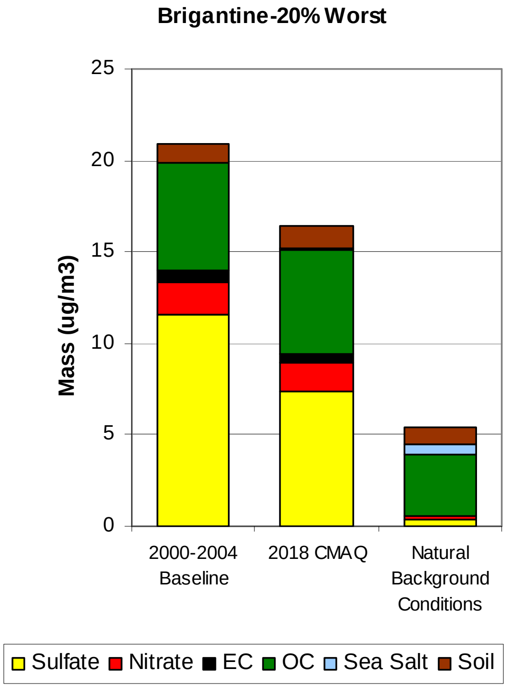


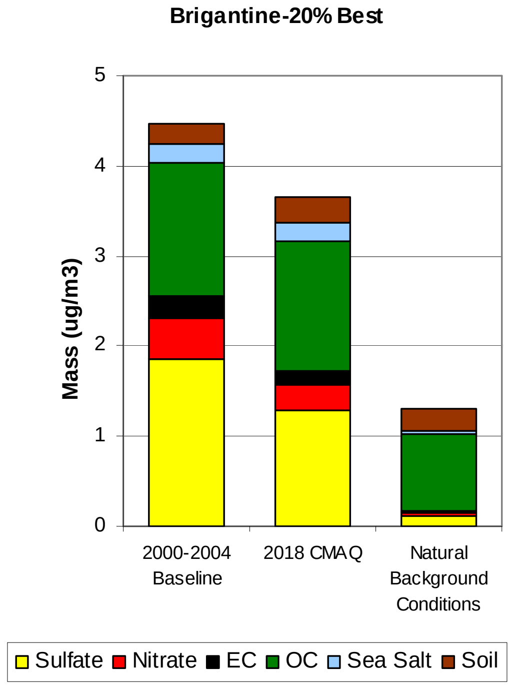
		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	6.29	4.11	0.53
	Nitrate	0.82	0.65	0.21
	EC	0.43	0.33	0.04
	OC	3.17	3.00	3.32
	Sea Salt	0.19	0.19	0.32
	Soil	0.52	0.58	0.52
Visibility	dv	22.9	19.4	12.4

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	0.77	0.69	0.09
	Nitrate	0.11	0.09	0.03
	EC	0.09	0.06	0.01
	OC	0.76	0.71	0.68
	Sea Salt	0.06	0.06	0.03
	Soil	0.11	0.12	0.10
Visibility	dv	8.8	8.3	4.7

* CMAQ projected values are calculated by applying CMAQ-based RRFs by the observed baseline values.

B. Brigantine National Wildlife Refuge

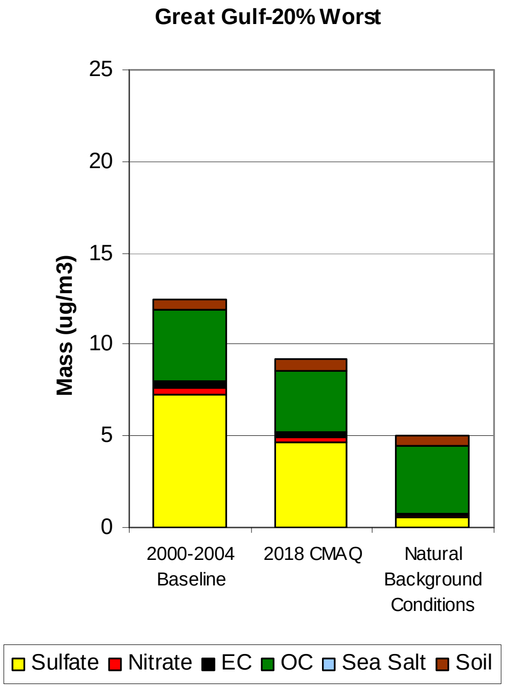


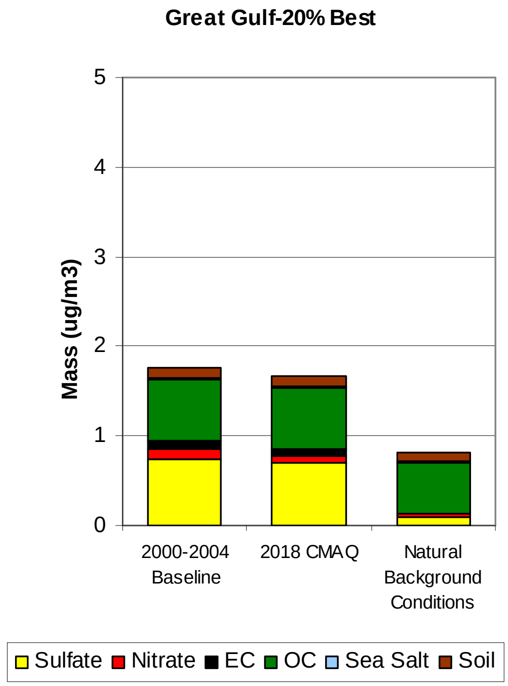


		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	11.58	7.35	0.39
	Nitrate	1.73	1.60	0.13
	EC	0.70	0.43	0.03
	OC	5.83	5.72	3.40
	Sea Salt	0.06	0.06	0.57
	Soil	0.97	1.23	0.85
Visibility	dv	29.0	25.1	12.2

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	1.85	1.28	0.12
	Nitrate	0.46	0.29	0.04
	EC	0.24	0.15	0.01
	OC	1.47	1.43	0.86
	Sea Salt	0.22	0.22	0.04
	Soil	0.23	0.28	0.24
Visibility	dv	14.3	12.2	5.5

C. Great Gulf Wilderness Area

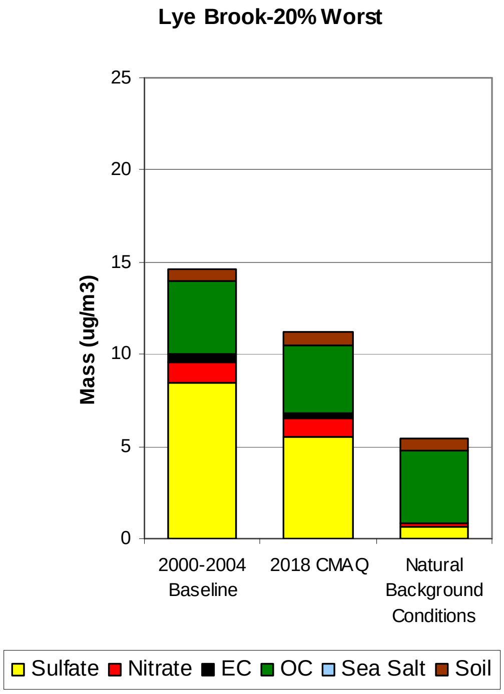


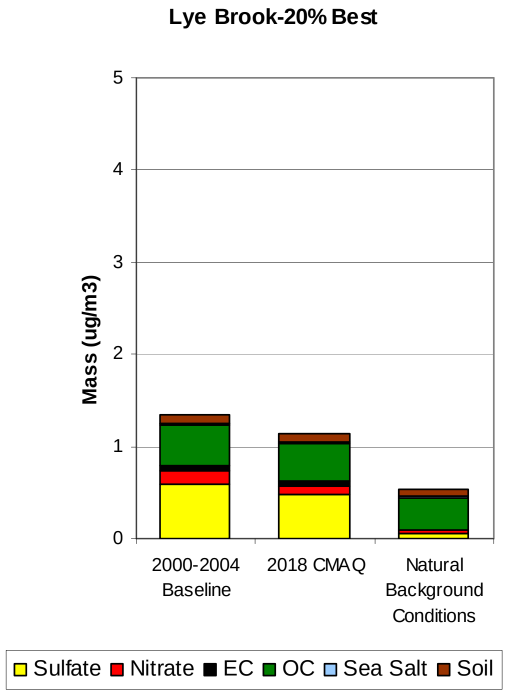


		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	7.28	4.61	0.54
	Nitrate	0.36	0.30	0.13
	EC	0.39	0.29	0.04
	OC	3.84	3.31	3.76
	Sea Salt	0.02	0.02	0.02
	Soil	0.57	0.66	0.53
Visibility	dv	22.8	19.1	12.0

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	0.74	0.70	0.09
	Nitrate	0.12	0.09	0.04
	EC	0.08	0.07	0.01
	OC	0.68	0.67	0.56
	Sea Salt	0.03	0.03	0.02
	Soil	0.10	0.11	0.10
Visibility	dv	7.7	7.2	3.7

D. Lye Brook Wilderness Area

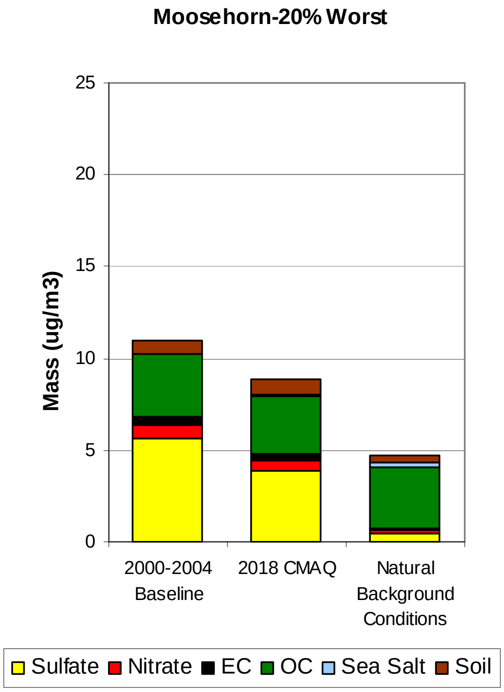


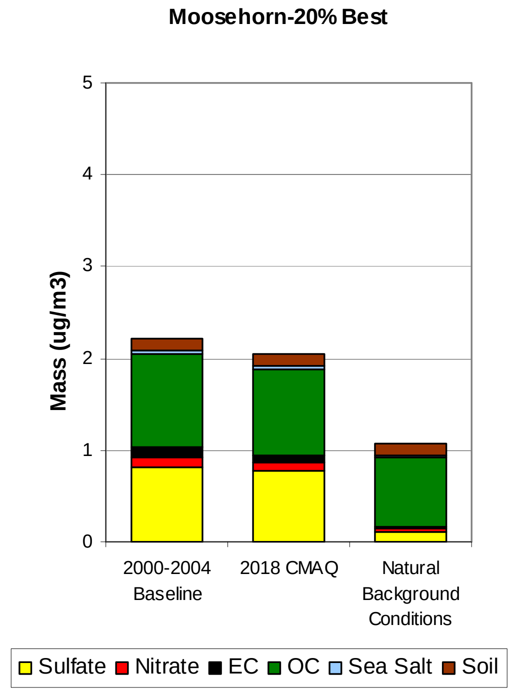


		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	8.46	5.52	0.61
	Nitrate	1.07	0.98	0.18
	EC	0.48	0.32	0.04
	OC	3.94	3.67	3.91
	Sea Salt	0.01	0.01	0.01
	Soil	0.64	0.73	0.66
Visibility	dv	24.4	20.9	11.7

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	0.59	0.48	0.05
	Nitrate	0.14	0.10	0.03
	EC	0.06	0.04	0.01
	OC	0.44	0.41	0.36
	Sea Salt	0.01	0.01	0.01
	Soil	0.09	0.10	0.09
Visibility	dv	6.4	5.5	2.8

E. Moosehorn National Wildlife Refuge

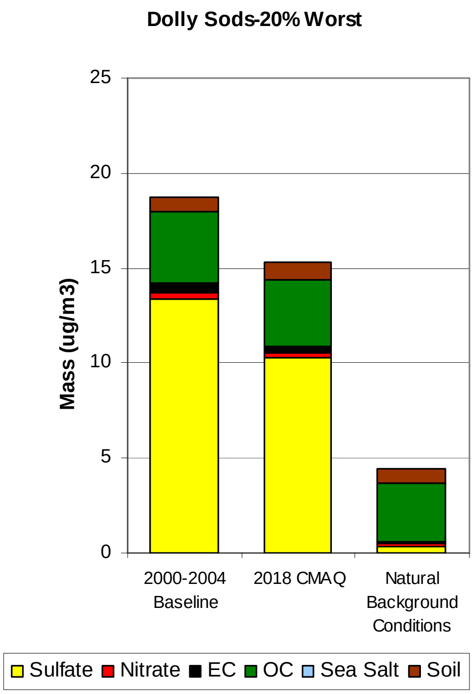


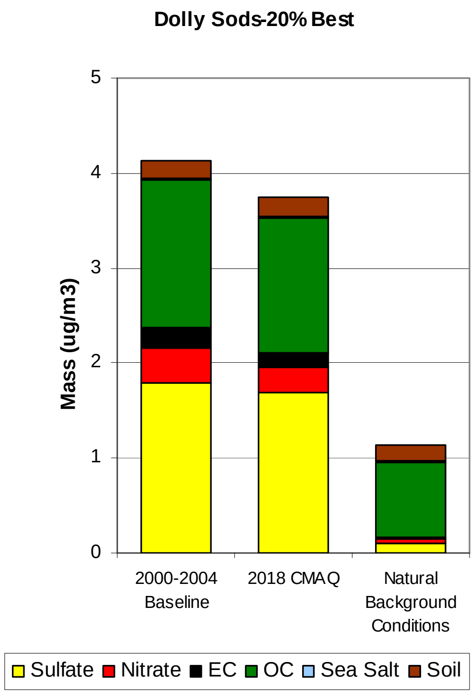


		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	5.67	3.90	0.48
	Nitrate	0.71	0.52	0.20
	EC	0.44	0.34	0.04
	OC	3.38	3.20	3.34
	Sea Salt	0.03	0.03	0.24
	Soil	0.76	0.83	0.40
Visibility	dv	21.7	19.0	12.0

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	0.80	0.77	0.11
	Nitrate	0.12	0.09	0.04
	EC	0.10	0.08	0.01
	OC	1.02	0.94	0.76
	Sea Salt	0.04	0.04	0.02
	Soil	0.11	0.12	0.12
Visibility	dv	9.2	8.6	5.0

F. Dolly Sods Wilderness Area

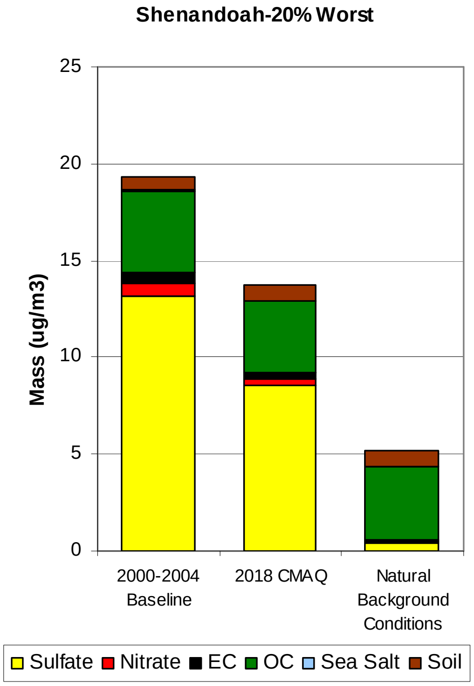


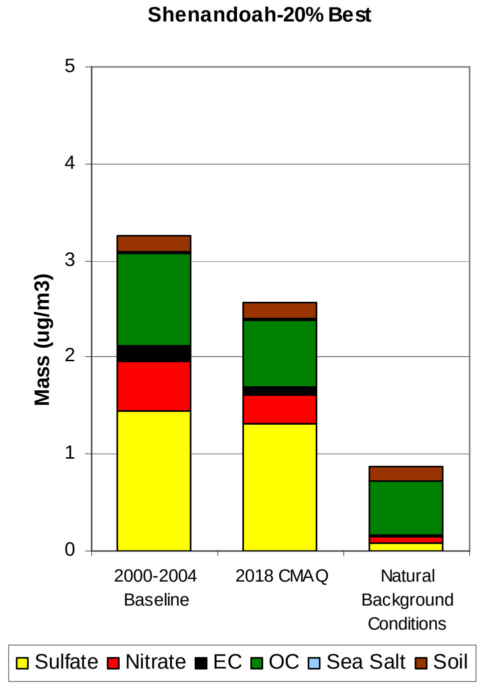


		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass ($\mu g/m^3$)	Sulfate	13.35	10.30	0.38
	Nitrate	0.37	0.20	0.14
	EC	0.47	0.34	0.03
	OC	3.75	3.51	3.11
	Sea Salt	0.02	0.02	0.05
	Soil	0.77	0.94	0.75
Visibility	dv	29.0	26.3	10.4

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass ($\mu g/m^3$)	Sulfate	1.79	1.69	0.10
	Nitrate	0.38	0.27	0.05
	EC	0.21	0.15	0.01
	OC	1.56	1.41	0.80
	Sea Salt	0.02	0.02	0.01
	Soil	0.18	0.20	0.17
Visibility	dv	12.3	11.4	3.6

G. Shenandoah National Park





		20% Worst Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	13.19	8.54	0.43
	Nitrate	0.65	0.31	0.07
	EC	0.57	0.33	0.03
	OC	4.21	3.69	3.78
	Sea Salt	0.01	0.01	0.03
	Soil	0.72	0.84	0.83
Visibility	dv	29.3	24.7	11.4

		20% Best Days		
	Species	2000-2004 Baseline	2018 CMAQ	Natural Background Conditions
Mass (µg/m^3)	Sulfate	1.45	1.31	0.08
	Nitrate	0.52	0.30	0.07
	EC	0.16	0.08	0.01
	OC	0.95	0.69	0.56
	Sea Salt	0.02	0.02	0.01
	Soil	0.16	0.17	0.14
Visibility	dv	10.9	9.4	3.1

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