APPENDIX D

MANE-VU Updated Q/d*C Contribution Assessment

MANE-VU Technical Support Committee

4/6/2016

Contents

Figures

Tables

Background and Introduction

The following analysis is a simplified method for estimating sulfate contributions to a receptor, known as the emissions over distance (Q/d) method. Q/d is largely accepted as a screening tool and continues to be as in the conclusion of a July 2015 report by an interagency air quality modeling work group.[1] NESCAUM previously employed this method in the *Contribution to Regional Haze in the Northeast and Mid-Atlantic United States*[2] and the *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update Through 2007*[3].

This assessment primarily uses the methodology as in these previous two studies, any variances from the method are noted in the methods section below. MANE-VU states discussed various options for determining the largest contributors for opening discussions and employing further analysis; including, but not limited to, further CALPUFF modeling. A review of contribution analyses conducted by MANE-VU, including the previous two NESCAUM Q/d studies (CALPUFF analyses and REMSTAD analysis[2,3]) found similar results regardless of the method. It was decided the most cost effective tool for the first iteration of contribution analysis was the Q/d approach as the resource investment was less than the others and each method previously run provided similar ranking results.

Methods

The 2015 analysis was done using the ARC MAP ® software with some custom visual basic scripts; scripts are noted in Appendix B. The intent of this approach was to provide a simple exercise that could be repeated with little effort as the project evolved; to better test new methods and investigate new sources of haze; all while providing the data and illustrative graphics in a single effort.

The empirical formula that relates emission source strength and estimated impact is expressed through the following equation:

$$I = C_i \left(Q / d \right)$$

In this equation, the strength of an emission source, Q, is linearly related to the impact, I, that it will have on a receptor located a distance, d, away. As in the previous analysis, distances were computed using the Haversine function, using an earth radius of 6371 km[2]. The effect of meteorological prevailing winds can be factored into this approach by establishing the constant, C_i, as a function of the "wind direction sectors" relative to the receptor site.

By establishing a different constant for each wind direction sector, based on prior modeling results—in this case, CALPUFF results—are in effect "scaling" Q/d results by CALPUFF-calculated source impacts. The absolute impacts produced are then dependent on the CALPUFF results. The relative contributions, however, of each

[1] EPA, 2015. *Interagency Work Group on Air Quality Modeling Phase 3 Summary Report: Near-Field Single Source Secondary Impacts.* http://www3.epa.gov/ttn/scram/11thmodconf/IWAQM3_NFI_Report-07152015.pdf

[2] NESCAUM, 2006. *Contribution to Regional Haze in the Northeast and Mid-Atlantic United States.* http://www.nescaum.org/topics/regional-haze/regional-haze-documents

[3] NESCAUM, 2012. *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update through 2007*. http://www.nescaum.org/topics/regional-haze/regional-haze-documents

source within a wind direction sector is established completely independent of the CALPUFF calculation, yielding a quasi-independent method of apportionment to add to the weight-of-evidence approach.

Discussion occurred as to whether the wind direction sectors changed to such an extent that updating the data with more recent data was necessary. A consensus of MANE-VU states determined that on average the directions of prevailing winds had not changed and thereby it was still acceptable to utilize the CALPUFF derived constants in the NESCAUM, 2002 analysis. These constants can be noted in Appendix A. As was done in the NESCAUM 2012 analysis state total emissions were evaluated from a source location of a population weight state centroid. Again little change was expected between the locations of the 2012 and 2015 estimated population densities thus the analysis was repeated with the locations of the centroids used in the NESCAUM 2012 study, also noted in detail in Appendix A.

The MANE-VU Class I areas with Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors; Acadia, Brigantine, Great Gulf, Lye Brook & Moosehorn and several near-by Class I areas with IMPROVE monitors; Dolly Sods, James River Face and Shenandoah were used as receptors. The only new receptor in this analysis was the James River Face Wilderness area as it is in close enough in proximity to MANE-VU states it may be important receptor to MANE-VU states emissions (assumptions made to incorporate this receptor using the previous constants are explained in detail in Appendix B). See Figure 1 for locations of receptors analyzed in the 2015 analysis.

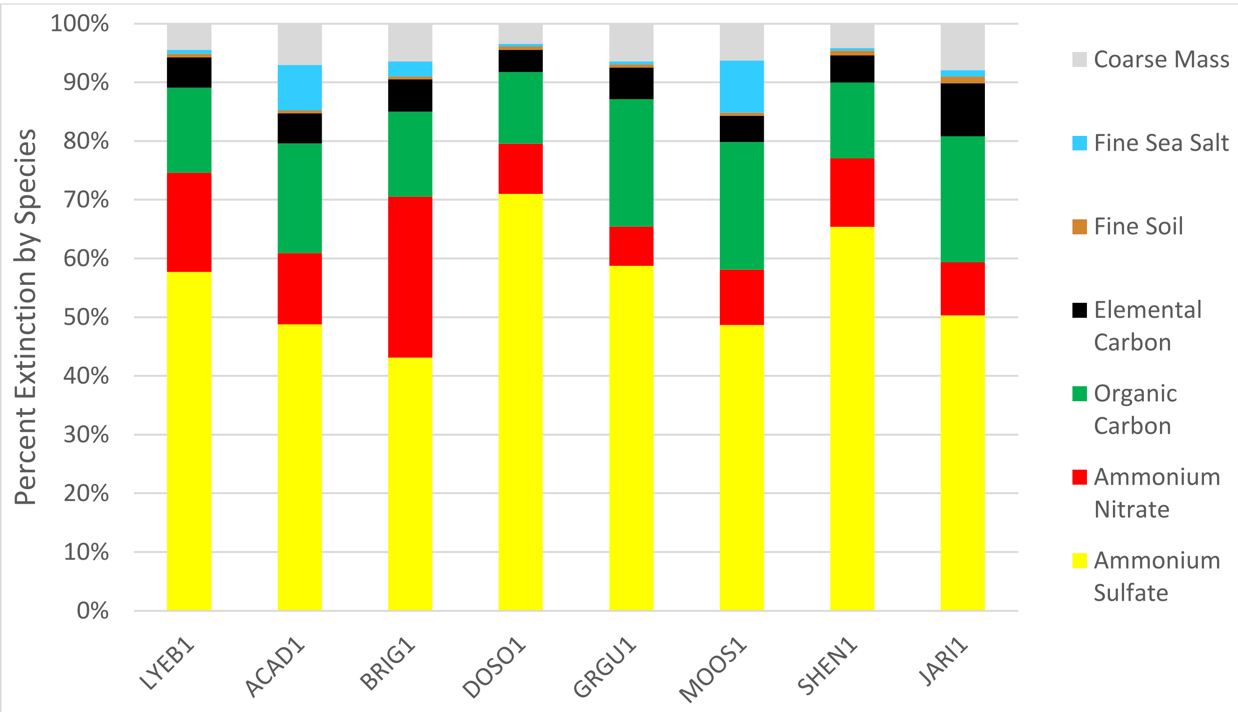
The geographic domain varied from the previous studies in that Canadian emissions were excluded this time. The remainder of the domain was the same and consistent with the regions modeling domain for other pollutant planning efforts.

Figure 1. Receptors for the 2015 $C_i(Q/d)$ Analysis

Sulfur dioxide (SO_2) emissions from 2011 NEI version 2 were summed for each state across all sectors with the exception of biogenic. This is consistent with the NESCAUM 2012 analysis. However, in the 2015 analysis additional experimental runs were done with volatile organic carbons (VOC), direct fine particulates ($PM_{2.5}$) and nitrogen oxides (NO_X). With the exception of $PM_{2.5}$ the same methodology was employed ($PM_{2.5}$ emissions were instead divided by distance squared, as Gaussian dispersion equation indicates is appropriate). A “step by step” documentation of this process can be found in Appendix B.

It was determined that the C_i's, originally derived for the SO_2 emissions, were not appropriate substitutions for these other pollutants; this was most evident in the resulting over estimation of the impact of NO_X at the Class I areas with this methodology. This, in addition with the visibility assessment which also showed the relative importance of sulfates compared to other pollutants in regards to light extinction at the IMPROVE sites analyzed (see Figure 2), led us to conclude that SO_2 was the most accurate and most relevant estimation for determining the impact of states' emissions to the visibility impairment of the MANE-VU Class I areas.

Figure 2. 2013-2014 Monitored Extinction on 20 Haziest Days, Expressed as Percentage of Extinction



In addition to exploring the other haze causing pollutants, the 2015 analysis also reviewed the point only portion of the 2011 NEI v2 emissions. The methodology for this is also outlined in appendix B and followed the same general principles. The $C_i(Q/d)$ for the individual sources were summed for each state. The intent behind this analysis was to evaluate a possibly more accurate method, as Q/d is generally accepted for a screening tool for individual sources. In addition, this provided an understanding of the relative importance of a state's point only contribution to the total contribution of a state. Furthermore, the data from the point source analysis, prior to summation, is useful for later source specific control analyses.

The point analysis was run only with respect to SO_2 emissions. It was determined that it is also of value to run an additional analysis of the 2018 projected emissions for the point sources. The MARAMA α2 2018 was the base for the projected point inventory analysis. The 2018 analysis did not include the area and mobile sectors as the four-factor emissions inventory analysis determined that point sources were the overwhelming source of SO_2 emissions.[4]

[4] MANE-VU, 2015. *Recommendation on Sectors to Review as Part of the Four-Factor Analysis Based on an Emission Inventory Analysis of SO2 & NOX. Appendix B.,*

Results

State Population Weighted Centroid Analysis (State Totals & Comparison to 2012 Analysis)

For all of the analyses historical and current, Ohio was determined to be one of the top two contributors for all of the eight Class I areas reviewed. Pennsylvania also continues to be one of the top three for seven of the eight receptors. The majority of the top five contributors were very similar to the previous analysis, however significant reshuffling of the top five is apparent indicating the emissions reductions achieved were not equally applied among the neighboring states, see Table 1.

Table 1. Top Five Contributing U.S. States for Total State SO_2 Emissions over the Three Analyses

Class I Area (Receptor)	Rank	2002 Analysis (2002 emissions)	2012 Analysis (2007* emissions)	2015 Analysis (2011 emissions)
Acadia	1	Pennsylvania/Ohio	Pennsylvania	Ohio
	2		Ohio	Pennsylvania
	3	New York	Indiana	Indiana
	4	Indiana	Michigan	Michigan
	5	West Virginia/ Massachusetts	Georgia	Illinois
Brigantine	1	Pennsylvania	Pennsylvania	Pennsylvania
	2	Ohio	Maryland	Ohio
	3	Maryland	Ohio	Maryland
	4	West Virginia	Indiana	Indiana
	5	New York	West Virginia	Kentucky
Dolly Sods	1	New to 2007 analysis, no 2002 data	Pennsylvania	Ohio
	2		Ohio	West Virginia
	3		West Virginia	Pennsylvania
	4		Indiana	Indiana
	5		North Carolina	Kentucky
Great Gulf	1	Analysis not done	Pennsylvania	Ohio
	2		Ohio	Pennsylvania
	3		Indiana	Indiana
	4		Michigan	Michigan
	5		New York	Illinois
James River Face	1	New to analysis not available for earlier years		Ohio
	2			Pennsylvania
	3			Indiana
	4			Kentucky
	5			West Virginia
Lye Brook	1	Pennsylvania	Pennsylvania	Pennsylvania
	2	Ohio	Ohio	Ohio
	3	New York	New York	Indiana
	4	Indiana	Indiana	New York
	5	West Virginia	Michigan/West Virginia	Michigan
Moosehorn	1	Pennsylvania/ Ohio	Pennsylvania	Ohio
	2		Ohio	Indiana
	3	Indianan/New York	Indiana	Illinois
	4		Michigan	Michigan
	5	Michigan	Texas/Missouri/Illinois/West Virginia/New York	Texas
Shenandoah	1	Ohio	Pennsylvania	Ohio
	2	Pennsylvania	Ohio	Pennsylvania
	3	West Virginia	West Virginia	Indiana
	4	North Carolina	Maryland	West Virginia
	5	Maryland	Indiana	Virginia

Note: Cells with more than one source state/territory indicate equal values.
* The 2012 analysis uses 2008 NEI emissions, 2007 NPRI point source emissions and 2009 NPRI area and mobile source emissions. (See table 2-1 of the report NESCAUM, 2012)

Table 2, displays the quantitative contributions to the MANE-VU and neighboring Class I areas between the 2012 analysis (2007 emissions) and the 2015 (2011 emissions). Table 2. Comparison of State Emissions Contributions from 2007 Emissions and 2011 Emissions.

	Acadia National Park		*Brigantine Wilderness Area*		*Dolly Sods Wilderness Area*		*Great Gulf Wilderness Area*		*James River Face*		*Lye Brook Wilderness Area*		*Moosehorn Wilderness Area*		*Shenandoah National Park*	
	2007*	2011	2007*	2011	2007*	2011	2007*	2011	2007*	2011	2007*	2011	2007*	2011	2007*	2011
Alabama	0.03	0.02	0.05	0.03	0.06	0.04	0.02	0.02	N/A	0.04	0.04	0.02	0.02	0.02	0.06	0.04
Arkansas	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	N/A	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Connecticut	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	N/A	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Delaware	0.01	0.00	0.08	0.03	0.01	0.00	0.01	0.00	N/A	0.00	0.01	0.00	0.01	0.00	0.02	0.00
DC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Florida	0.03	0.01	0.04	0.01	0.03	0.01	0.01	0.00	N/A	0.02	0.02	0.01	0.01	0.00	0.04	0.02
Georgia	0.06	0.03	0.09	0.04	0.10	0.04	0.04	0.01	N/A	0.05	0.06	0.02	0.04	0.02	0.10	0.04
Illinois	0.04	0.04	0.05	0.03	0.06	0.05	0.04	0.03	N/A	0.04	0.04	0.03	0.04	0.04	0.05	0.04
Indiana	0.08	0.06	0.11	0.05	0.15	0.10	0.07	0.05	N/A	0.09	0.08	0.05	0.08	0.06	0.12	0.08
Iowa	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	N/A	0.01	0.01	0.01	0.02	0.01	0.02	0.01
Kansas	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	N/A	0.01	0.01	0.00	0.01	0.01	0.01	0.01
Kentucky	0.04	0.03	0.07	0.05	0.10	0.07	0.03	0.02	N/A	0.07	0.05	0.03	0.04	0.03	0.09	0.06
Louisiana	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	N/A	0.02	0.02	0.02	0.01	0.01	0.02	0.02
Maine	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.02	0.01	0.00	0.00
Maryland	0.05	0.02	0.20	0.06	0.12	0.03	0.03	0.01	N/A	0.02	0.05	0.01	0.03	0.01	0.15	0.04
Massachusetts	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	N/A	0.01	0.01	0.01	0.02	0.02	0.01	0.01
Michigan	0.07	0.04	0.06	0.03	0.09	0.04	0.06	0.04	N/A	0.04	0.07	0.04	0.07	0.03	0.08	0.04
Minnesota	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	N/A	0.01	0.01	0.01	0.01	0.00	0.01	0.01
Mississippi	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	N/A	0.01	0.01	0.01	0.00	0.00	0.01	0.01
Missouri	0.04	0.03	0.05	0.02	0.05	0.03	0.03	0.02	N/A	0.03	0.04	0.02	0.04	0.03	0.05	0.03
Nebraska	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	N/A	0.01	0.01	0.01	0.01	0.00	0.01	0.01
New Hampshire	0.03	0.02	0.01	0.01	0.00	0.00	0.01	0.01	N/A	0.00	0.01	0.01	0.02	0.01	0.01	0.00
New Jersey	0.01	0.01	0.07	0.01	0.01	0.00	0.01	0.00	N/A	0.00	0.01	0.00	0.01	0.00	0.01	0.00
New York	0.05	0.03	0.06	0.04	0.03	0.02	0.05	0.03	N/A	0.02	0.09	0.05	0.04	0.03	0.04	0.02
North Carolina	0.04	0.02	0.07	0.03	0.06	0.02	0.02	0.01	N/A	0.07	0.03	0.01	0.03	0.01	0.10	0.04
Ohio	0.13	0.11	0.19	0.12	0.43	0.29	0.12	0.10	N/A	0.15	0.16	0.12	0.11	0.08	0.32	0.21
Oklahoma	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	N/A	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Pennsylvania	0.18	0.08	0.40	0.14	0.50	0.13	0.15	0.06	N/A	0.10	0.29	0.13	0.16	0.02	0.42	0.15
Rhode Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Carolina	0.02	0.01	0.04	0.02	0.03	0.01	0.01	0.01	N/A	0.03	0.02	0.01	0.02	0.01	0.04	0.02
Tennessee	0.03	0.01	0.05	0.02	0.07	0.03	0.02	0.01	N/A	0.03	0.04	0.02	0.03	0.01	0.06	0.03
Texas	0.04	0.03	0.05	0.04	0.05	0.04	0.03	0.02	N/A	0.04	0.04	0.03	0.03	0.03	0.05	0.04
Vermont	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Virginia	0.03	0.02	0.09	0.05	0.07	0.03	0.02	0.01	N/A	0.07	0.03	0.02	0.02	0.01	0.11	0.07
West Virginia	0.05	0.02	0.10	0.04	0.32	0.14	0.04	0.01	N/A	0.07	0.07	0.02	0.04	0.01	0.20	0.08
Wisconsin	0.02	0.02	0.02	0.01	0.03	0.02	0.02	0.02	N/A	0.02	0.02	0.02	0.02	0.01	0.02	0.02

2011 Point Source Analysis

The analysis was completed for the 2011 NEI v2 point inventory. Table 3, displays the top five ranks states with but the 2011 population weighted centroid SO_2 emissions and the point only SO_2 emissions in the C_i (Q/d) method. Highlighted cells indicate states that varied in their ranks between the analyses. Two of the eight Class I areas saw a significant difference in the rankings; Brigantine and Moosehorn. The relative quantities displayed in Table 3 also indicate that the point sources are still a significant portion of each state's contributions with respect to SO_2 emissions. Figure 3 and Figure 4 below clarify how the evaluation of the contributions by individual source or state total with population centroid approach can alter the results, using Brigantine as an example. The analysis when done by on an individual source places each source with in different vector constants, theoretically more accurate approach especially with the intent to consider individual source contributions in further analyses.

Table 3. Top Five Ranking Contributing States of Point Only and Population Weighted Centroid Methodology

2011 Point Top 5 Contributions			2011 Centroid Top 5 Contributions		
Receptor	State	Contribution	Receptor	State	Contribution
Acadia	OH	0.091941355	Acadia	Ohio	0.110722
	PA	0.065000429		Pennsylvania	0.076393
	IN	0.050261661		Indiana	0.056531
	MI	0.042254566		Michigan	0.043586
	IL	0.031767801		Illinois	0.035447
Brigantine	OH	0.143782214	Brigantine	Pennsylvania	0.144185
	PA	0.127168402		Ohio	0.122695
	IN	0.060995943		Maryland	0.062602
	KY	0.048691472		Indiana	0.054433
	TX	0.03855251		Kentucky	0.051057
Dolly Sods	OH	0.304332742	Dolly Sods	Ohio	0.285194
	PA	0.156460896		West Virginia	0.140909
	WV	0.121920177		Pennsylvania	0.13217
	IN	0.091857237		Indiana	0.096535
	KY	0.069838976		Kentucky	0.070214
Great Gulf	OH	0.073746721	Great Gulf	Ohio	0.097926
	PA	0.052415185		Pennsylvania	0.062172
	IN	0.045361066		Indiana	0.048236
	MI	0.035254865		Michigan	0.038705
	IL	0.027097205		Illinois	0.029948
James Face	OH	0.220751954	James Face	Ohio	0.148042
	PA	0.093719295		Pennsylvania	0.095895
	IN	0.084795405		Indiana	0.085382
	KY	0.06977157		Kentucky	0.070312
	VA	0.055890047		West Virginia	0.067112
Lye Brook	OH	0.114401027	Lye Brook	Pennsylvania	0.132424
	PA	0.098398004		Ohio	0.116413
	IN	0.051105607		Indiana	0.05447
	MI	0.044568087		New York	0.053722
	NY	0.032786194		Michigan	0.044304
Moosehorn	OH	0.08457113	Moosehorn	Ohio	0.079613
	PA	0.053933613		Indiana	0.057955
	IN	0.047024234		Illinois	0.036654
	MI	0.038105112		Michigan	0.030354
	IL	0.031793931		Texas	0.029351
Shenandoah	OH	0.223136587	Shenandoah	Ohio	0.205847
	PA	0.129388586		Pennsylvania	0.14796
	IN	0.07666613		Indiana	0.079393
	WV	0.063798543		West Virginia	0.079183
	KY	0.057891393		Virginia	0.068504

Figure 3. Wind Sector Constants and the State Total Emissions and the Locations

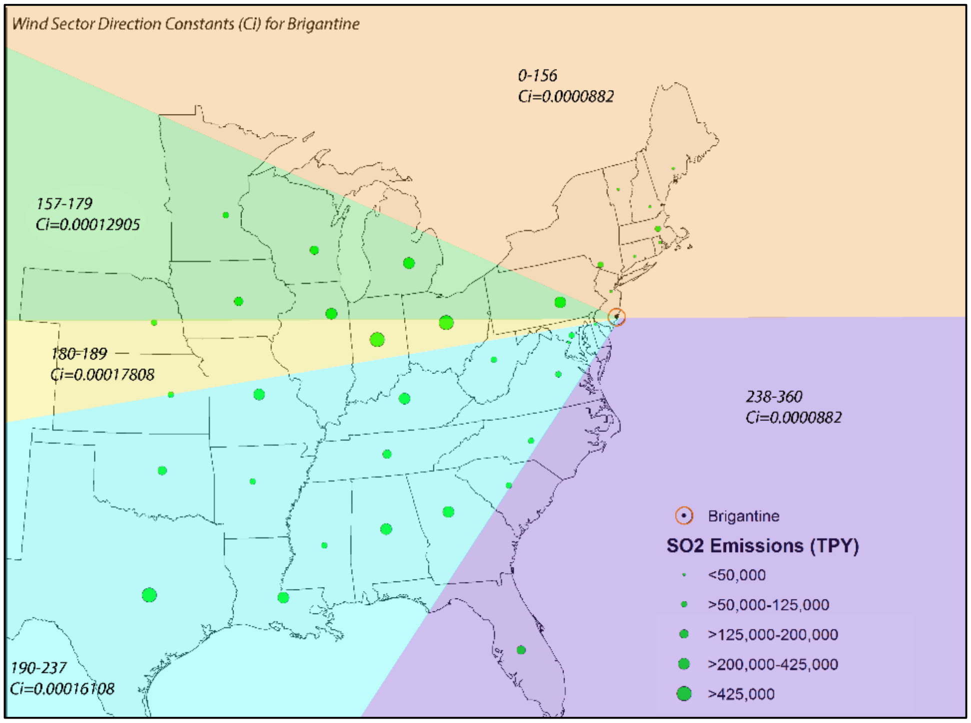
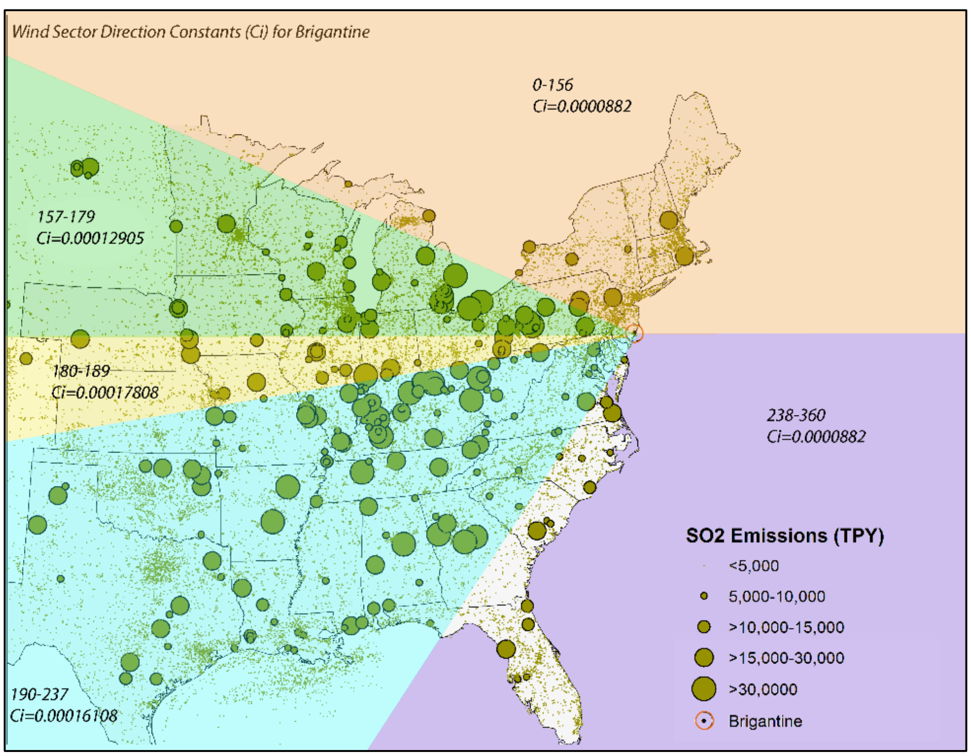


Figure 4. Wind Vectors Point Source Emissions and Their Locations (2011 Emissions)



Projected 2018 Point Source Analysis

The point contribution analysis was repeated for the point sector of the MARAMA α2 2018 inventory. The purpose of this analysis is to calculate a best estimate of with our most current understanding of the “start” year for the next regional haze SIP. Thereby reducing the efforts to further analyzed sources, which are known to significantly reduce emissions or no longer exist by 2018. The summation of the individual contributions by state resulted in an overall decrease in the total contributions by 2018 and the relative rankings did reshuffle for 2018, see Table 4 below.

Table 4. States with the Five Greatest Point Contributions in 2011 and Projected for 2018

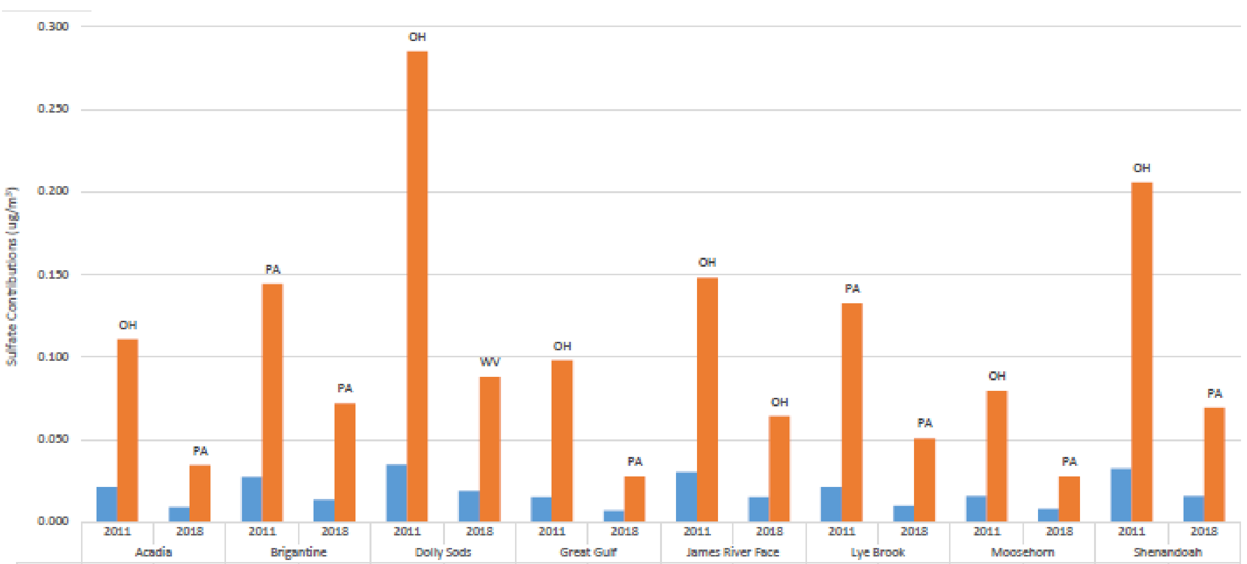
		2011*		**2018***	
Receptor	**Rank**	**State**	**Contribution**	State	Contribution
Acadia	**1**	OH	0.091941355	PA	0.03442676
	2	PA	0.065000429	OH	0.030218026
	3	IN	0.050261661	TX	0.027290416
	4	MI	0.042254566	MO	0.022326675
	5	IL	0.031767801	IN	0.022200948
Brigantine	**1**	OH	0.143782214	PA	0.066174833
	2	PA	0.127168402	OH	0.043255256
	3	IN	0.060995943	TX	0.033915703
	4	KY	0.048691472	MD	0.033394815
	5	TX	0.03855251	IN	0.02723641
Dolly Sods	**1**	OH	0.304332742	WV	0.080326515
	2	PA	0.156460896	PA	0.079466227
	3	WV	0.121920177	OH	0.07326551
	4	IN	0.091857237	TX	0.034729442
	5	KY	0.069838976	KY	0.034046795
Great Gulf	**1**	OH	0.073746721	PA	0.028538138
	2	PA	0.052415185	OH	0.025792798
	3	IN	0.045361066	TX	0.02124918
	4	MI	0.035254865	IN	0.021009177
	5	IL	0.027097205	MO	0.01919794
James Face	**1**	OH	0.21967166	OH	0.059720444
	2	IN	0.088060923	PA	0.04587869
	3	PA	0.086371599	TX	0.03592808
	4	KY	0.072636643	KY	0.034641141
	5	VA	0.057416645	IN	0.033171851
Lye Brook	**1**	OH	0.114401027	PA	0.049709278
	2	PA	0.098398004	OH	0.035424463
	3	IN	0.051105607	TX	0.027899648
	4	MI	0.044568087	IN	0.022562486
	5	NY	0.032786194	MO	0.020612201
Moosehorn	**1**	OH	0.08457113	PA	0.028814579
	2	PA	0.053933613	OH	0.028212134
	3	IN	0.047024234	TX	0.026652076
	4	MI	0.038105112	MO	0.022926812
	5	IL	0.031793931	IN	0.020562191
Shenandoah	**1**	OH	0.223136587	PA	0.066894227
	2	PA	0.129388586	OH	0.058558198
	3	IN	0.07666613	WV	0.038467176
	4	WV	0.063798543	TX	0.032531606
	5	KY	0.057891393	IN	0.02970615

The Q/d contribution analysis showed a promising downward trend at all of the class I areas with IMPROVE monitors in MANE-VU, which is consistent with the ambient air quality measurements. Contributions decreased at all of the class I areas from 2011 to 2018, both the maximum and average state point source contributions were reviewed, See Figure 5. The contributions of the states with the largest point contributions remain fairly consistently in the top 5 through New York and Virginia do drop considerably in ranking when they were in the top 5 for 2011, See Figure 6.

Electric Generating Units (EGUs) that report emissions to the Clean Air Markets Division (CAMD) as a whole still account for the majority of the sulfate contributions to all of the Class I Areas examined (approximately 70% in all cases). Other point sources and non-reporting EGUs (small EGUs) produce the bulk of the remaining contribution. Emissions from oil and gas, refueling, and ethanol point sources have negligible impacts on the monitored Class I areas. Details as to the magnitude and relative importance of 2018 projected emissions from each point source sector can be observed in

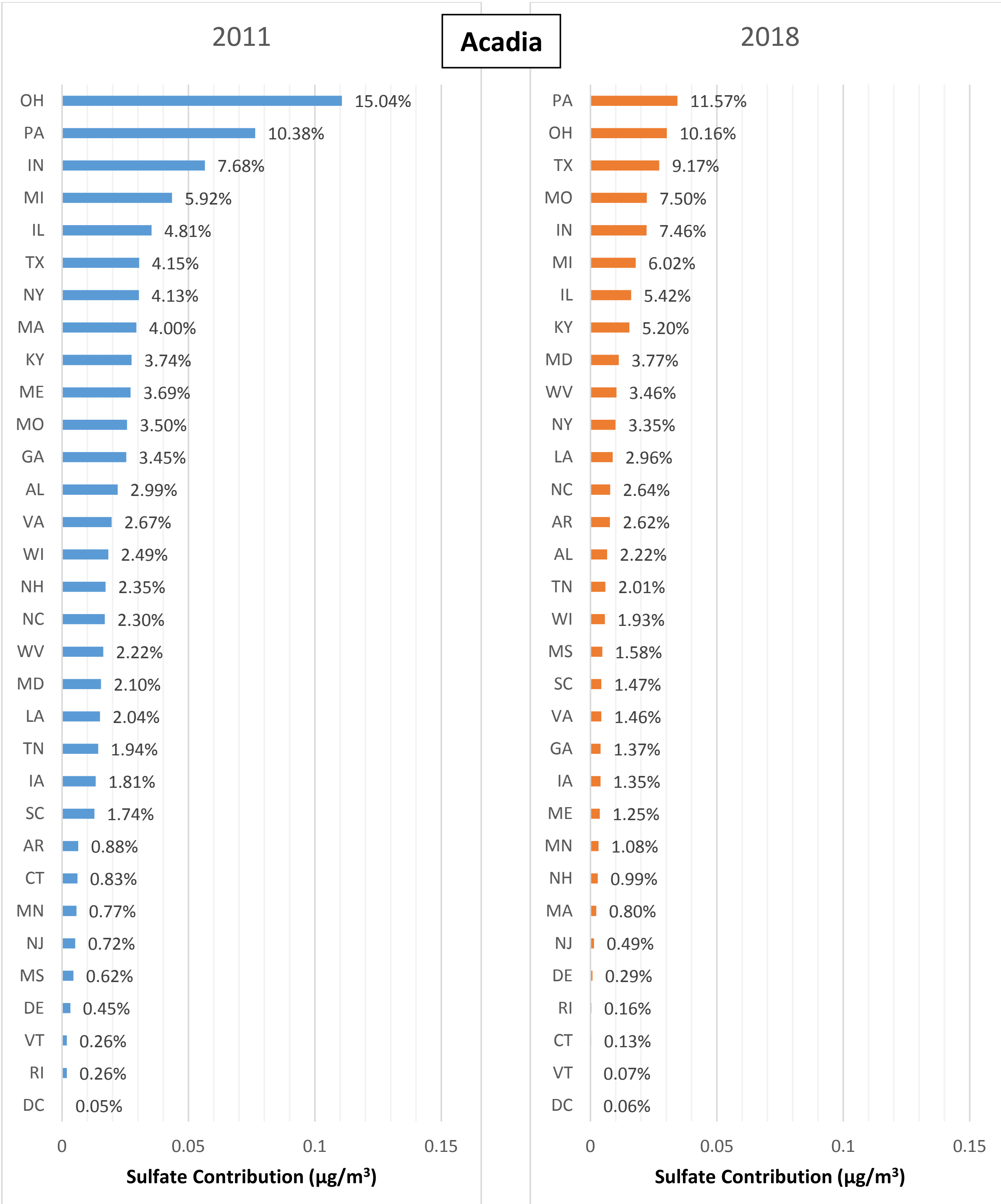
Figure 7 and Figure 8, respectively. Figure 9 emphasizes the outsized role of coal EGUs on impact, since nine of the top ten EGU SCCs in terms of projected 2018 impact are from coal powered EGUs (the other SCC in the top ten is associated with oil powered EGUs).

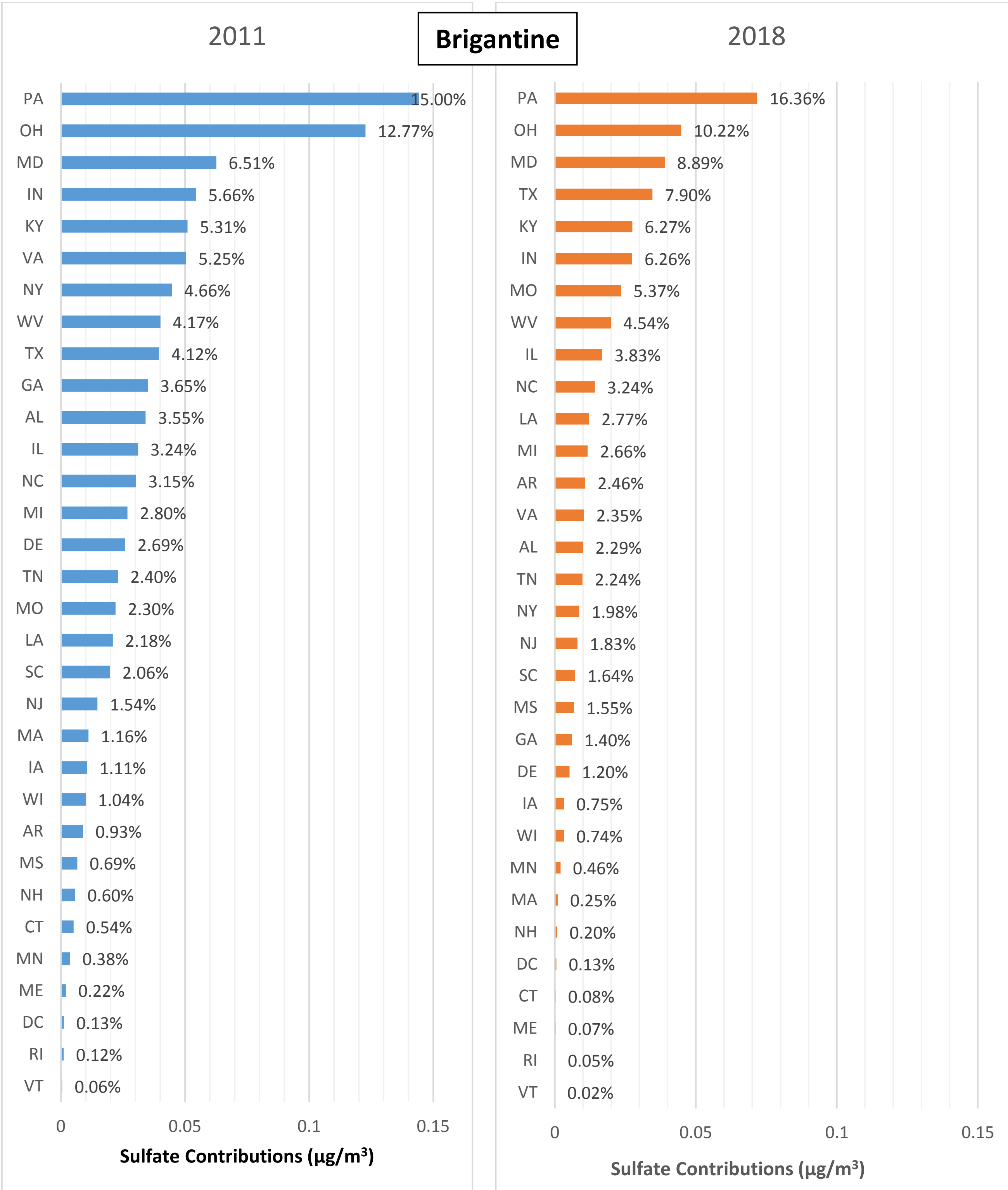
Figure 5: Average and maximum state point source contribution to monitored class I areas for 2011 and 2018

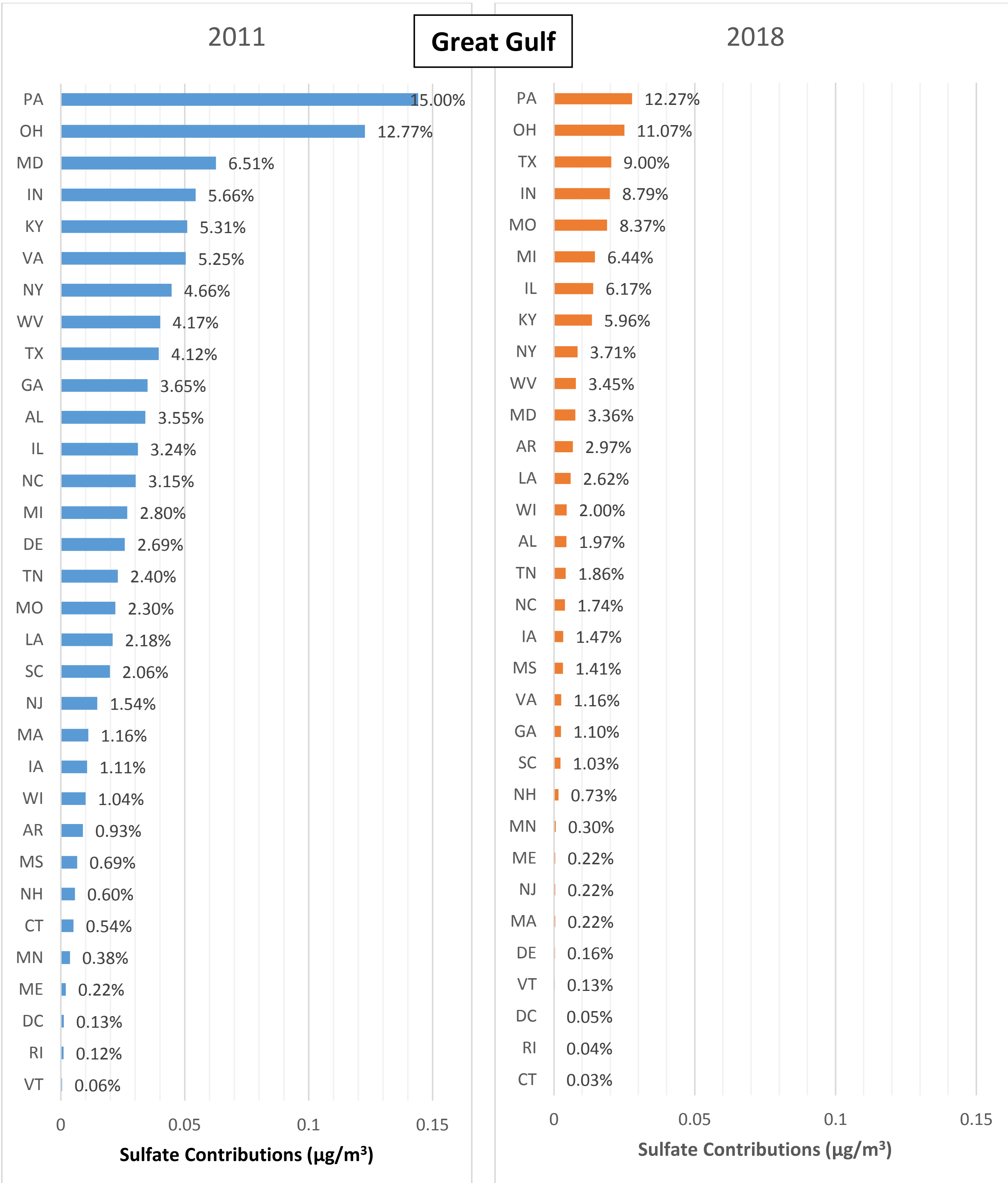


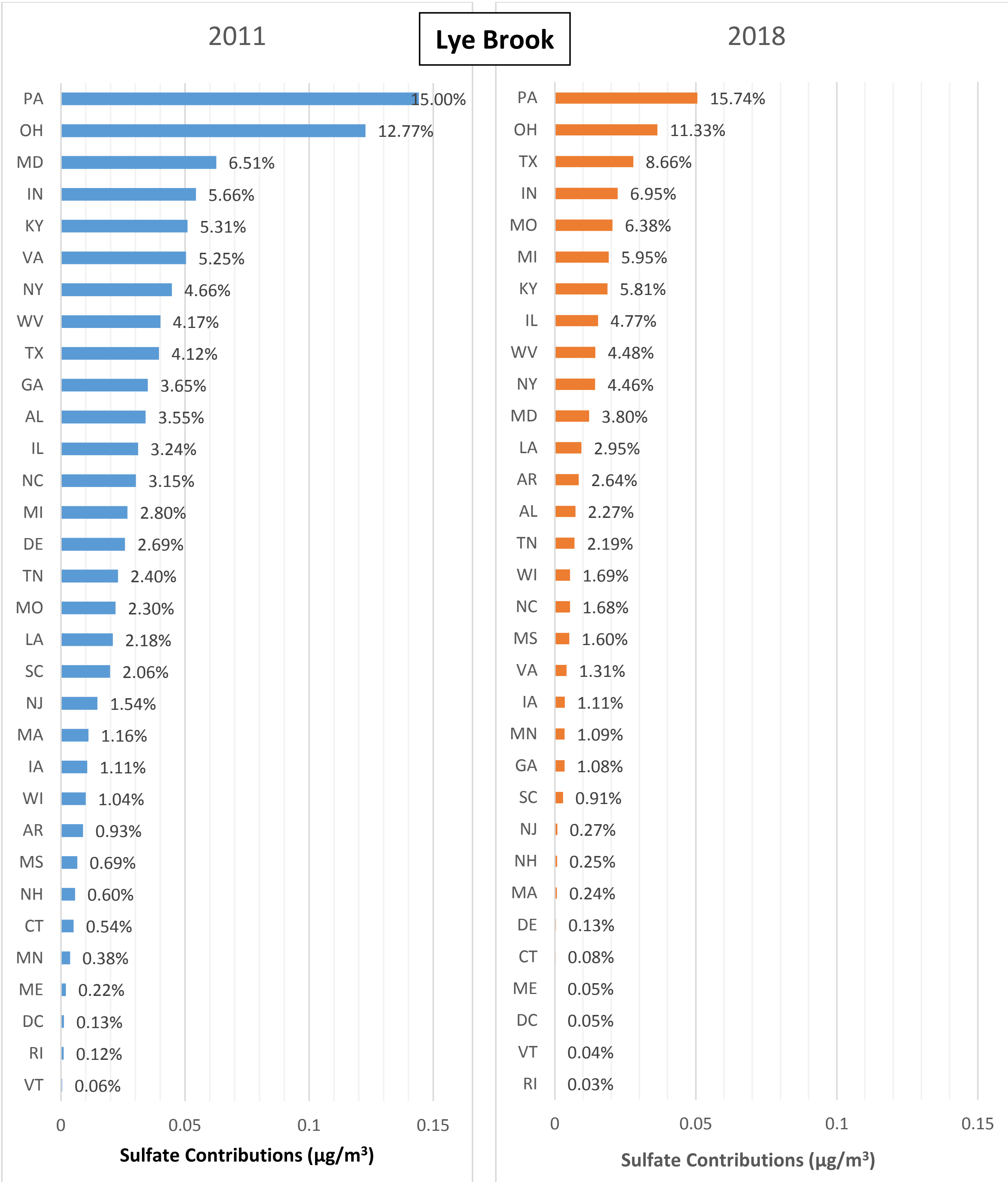
	Acadia 2011	Acadia 2018	Brigantine 2011	Brigantine 2018	Dolly Sods 2011	Dolly Sods 2018	Great Gulf 2011	Great Gulf 2018	James River Face 2011	James River Face 2018	Lye Brook 2011	Lye Brook 2018	Moosehorn 2011	Moosehorn 2018	Shenandoah 2011	Shenandoah 2018
Average	0.0214235	0.0092969	0.0275686	0.0137088	0.0346418	0.0187993	0.0151724	0.0070634	0.0302113	0.0151743	0.0212774	0.0100431	0.0157828	0.0079349	0.0322890	0.0157888
Max	0.1107220	0.0344268	0.1441850	0.0717839	0.2851940	0.0879930	0.0979260	0.0277355	0.1480420	0.0640868	0.1324240	0.0505901	0.0796130	0.0277739	0.2058470	0.0692504

Figure 6. Total point contributions (and percent of total contribution in labels) for 2011 actual and 2018 projections for state in OTC modeling domain.


Acadia
2011
OH 15.04%
PA 10.38%
IN 7.68%
MI 5.92%
IL 4.81%
TX 4.15%
NY 4.13%
MA 4.00%
KY 3.74%
ME 3.69%
MO 3.50%
GA 3.45%
AL 2.99%
VA 2.67%
WI 2.49%
NH 2.35%
NC 2.30%
WV 2.22%
MD 2.10%
LA 2.04%
TN 1.94%
IA 1.81%
SC 1.74%
AR 0.88%
CT 0.83%
MN 0.77%
NJ 0.72%
MS 0.62%
DE 0.45%
VT 0.26%
RI 0.26%
DC 0.05%
0 0.05 0.1 0.15
Sulfate Contribution (µg/m³)
2018
PA 11.57%
OH 10.16%
TX 9.17%
MO 7.50%
IN 7.46%
MI 6.02%
IL 5.42%
KY 5.20%
MD 3.77%
WV 3.46%
NY 3.35%
LA 2.96%
NC 2.64%
AR 2.62%
AL 2.22%
TN 2.01%
WI 1.93%
MS 1.58%
SC 1.47%
VA 1.46%
GA 1.37%
IA 1.35%
ME 1.25%
MN 1.08%
NH 0.99%
MA 0.80%
NJ 0.49%
DE 0.29%
RI 0.16%
CT 0.13%
VT 0.07%
DC 0.06%
0 0.05 0.1 0.15
Sulfate Contribution (µg/m³)


Brigantine
2011
PA 15.00%
OH 12.77%
MD 6.51%
IN 5.66%
KY 5.31%
VA 5.25%
NY 4.66%
WV 4.17%
TX 4.12%
GA 3.65%
AL 3.55%
IL 3.24%
NC 3.15%
MI 2.80%
DE 2.69%
TN 2.40%
MO 2.30%
LA 2.18%
SC 2.06%
NJ 1.54%
MA 1.16%
IA 1.11%
WI 1.04%
AR 0.93%
MS 0.69%
NH 0.60%
CT 0.54%
MN 0.38%
ME 0.22%
DC 0.13%
RI 0.12%
VT 0.06%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)
2018
PA 16.36%
OH 10.22%
MD 8.89%
TX 7.90%
KY 6.27%
IN 6.26%
MO 5.37%
WV 4.54%
IL 3.83%
NC 3.24%
LA 2.77%
MI 2.66%
AR 2.46%
VA 2.35%
AL 2.29%
TN 2.24%
NY 1.98%
NJ 1.83%
SC 1.64%
MS 1.55%
GA 1.40%
DE 1.20%
IA 0.75%
WI 0.74%
MN 0.46%
MA 0.25%
NH 0.20%
DC 0.13%
CT 0.08%
ME 0.07%
RI 0.05%
VT 0.02%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)


Great Gulf
2011
PA 15.00%
OH 12.77%
MD 6.51%
IN 5.66%
KY 5.31%
VA 5.25%
NY 4.66%
WV 4.17%
TX 4.12%
GA 3.65%
AL 3.55%
IL 3.24%
NC 3.15%
MI 2.80%
DE 2.69%
TN 2.40%
MO 2.30%
LA 2.18%
SC 2.06%
NJ 1.54%
MA 1.16%
IA 1.11%
WI 1.04%
AR 0.93%
MS 0.69%
NH 0.60%
CT 0.54%
MN 0.38%
ME 0.22%
DC 0.13%
RI 0.12%
VT 0.06%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)
2018
PA 12.27%
OH 11.07%
TX 9.00%
IN 8.79%
MO 8.37%
MI 6.44%
IL 6.17%
KY 5.96%
NY 3.71%
WV 3.45%
MD 3.36%
AR 2.97%
LA 2.62%
WI 2.00%
AL 1.97%
TN 1.86%
NC 1.74%
IA 1.47%
MS 1.41%
VA 1.16%
GA 1.10%
SC 1.03%
NH 0.73%
MN 0.30%
ME 0.22%
NJ 0.22%
MA 0.22%
DE 0.16%
VT 0.13%
DC 0.05%
RI 0.04%
CT 0.03%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)



Lye Brook
2011
PA 15.00%
OH 12.77%
MD 6.51%
IN 5.66%
KY 5.31%
VA 5.25%
NY 4.66%
WV 4.17%
TX 4.12%
GA 3.65%
AL 3.55%
IL 3.24%
NC 3.15%
MI 2.80%
DE 2.69%
TN 2.40%
MO 2.30%
LA 2.18%
SC 2.06%
NJ 1.54%
MA 1.16%
IA 1.11%
WI 1.04%
AR 0.93%
MS 0.69%
NH 0.60%
CT 0.54%
MN 0.38%
ME 0.22%
DC 0.13%
RI 0.12%
VT 0.06%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)
2018
PA 15.74%
OH 11.33%
TX 8.66%
IN 6.95%
MO 6.38%
MI 5.95%
KY 5.81%
IL 4.77%
WV 4.48%
NY 4.46%
MD 3.80%
LA 2.95%
AR 2.64%
AL 2.27%
TN 2.19%
WI 1.69%
NC 1.68%
MS 1.60%
VA 1.31%
IA 1.11%
MN 1.09%
GA 1.08%
SC 0.91%
NJ 0.27%
NH 0.25%
MA 0.24%
DE 0.13%
CT 0.08%
ME 0.05%
DC 0.05%
VT 0.04%
RI 0.03%
0
0.05
0.1
0.15
Sulfate Contributions (μg/m³)

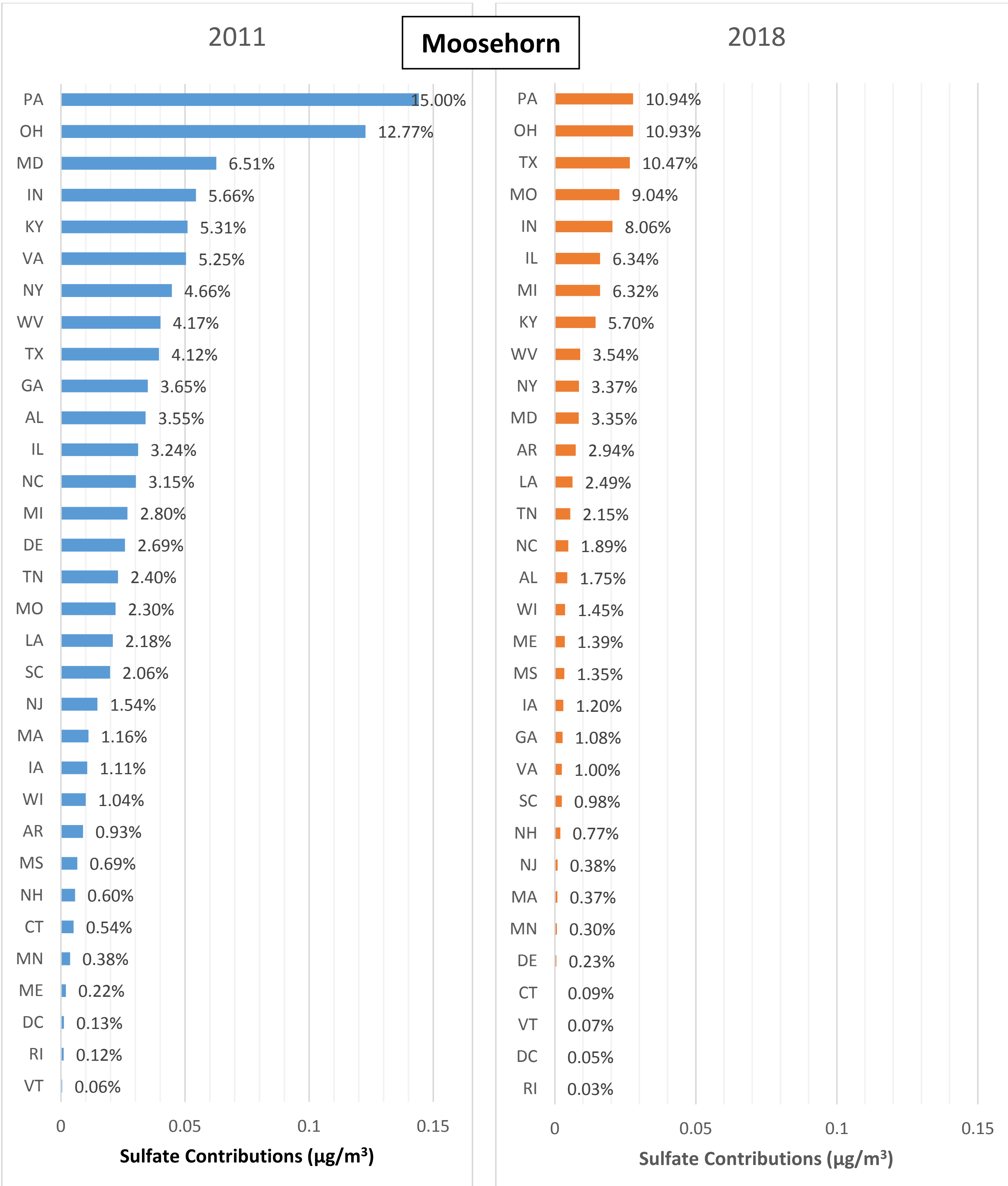

Moosehorn
2011
PA 15.00%
OH 12.77%
MD 6.51%
IN 5.66%
KY 5.31%
VA 5.25%
NY 4.66%
WV 4.17%
TX 4.12%
GA 3.65%
AL 3.55%
IL 3.24%
NC 3.15%
MI 2.80%
DE 2.69%
TN 2.40%
MO 2.30%
LA 2.18%
SC 2.06%
NJ 1.54%
MA 1.16%
IA 1.11%
WI 1.04%
AR 0.93%
MS 0.69%
NH 0.60%
CT 0.54%
MN 0.38%
ME 0.22%
DC 0.13%
RI 0.12%
VT 0.06%
0
0.05
0.1
0.15
Sulfate Contributions (µg/m³)
2018
PA 10.94%
OH 10.93%
TX 10.47%
MO 9.04%
IN 8.06%
IL 6.34%
MI 6.32%
KY 5.70%
WV 3.54%
NY 3.37%
MD 3.35%
AR 2.94%
LA 2.49%
TN 2.15%
NC 1.89%
AL 1.75%
WI 1.45%
ME 1.39%
MS 1.35%
IA 1.20%
GA 1.08%
VA 1.00%
SC 0.98%
NH 0.77%
NJ 0.38%
MA 0.37%
MN 0.30%
DE 0.23%
CT 0.09%
VT 0.07%
DC 0.05%
RI 0.03%
0
0.05
0.1
0.15
Sulfate Contributions (µg/m³)

Figure 7: Impact on Class 1 Areas by Point Sectors

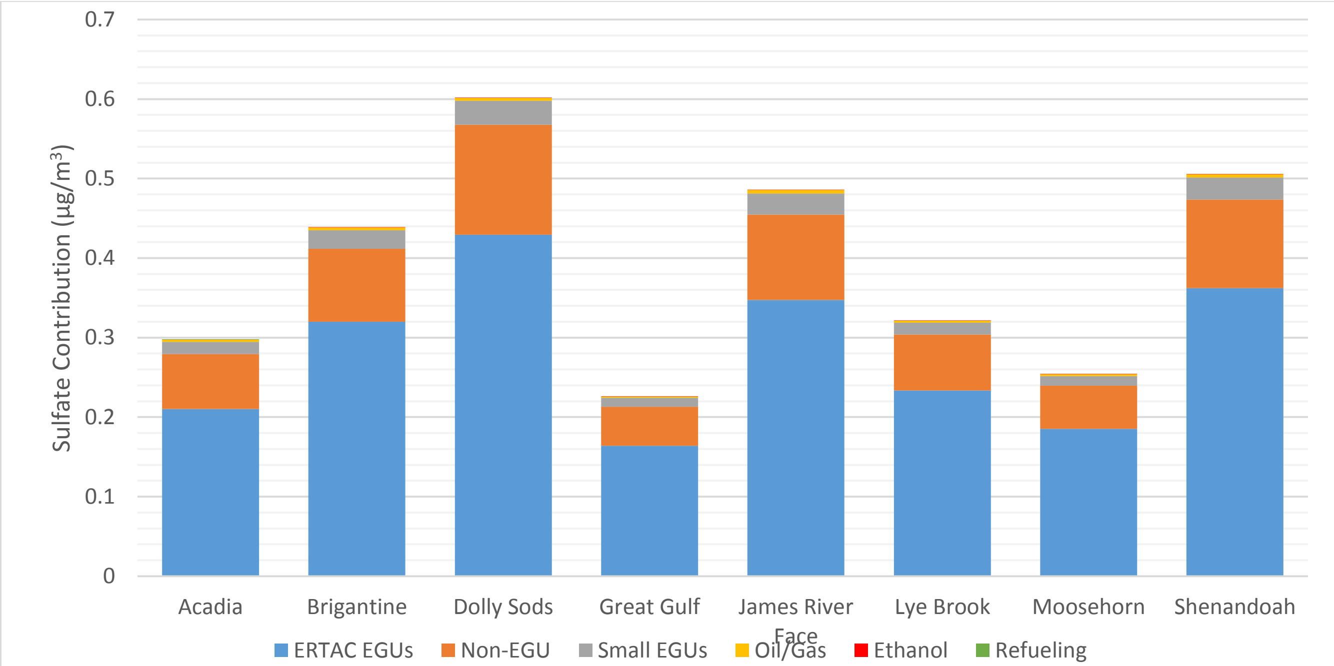


Figure 8: Relative Impact on Class 1 Areas by Point Sectors

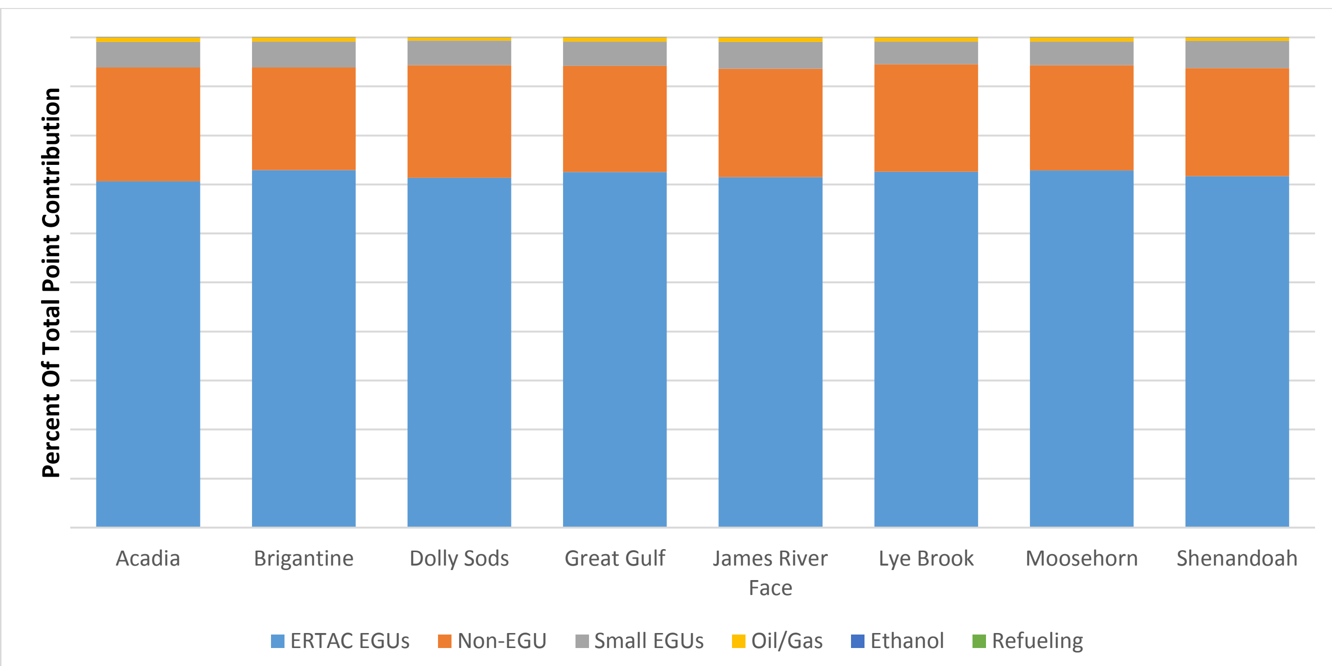
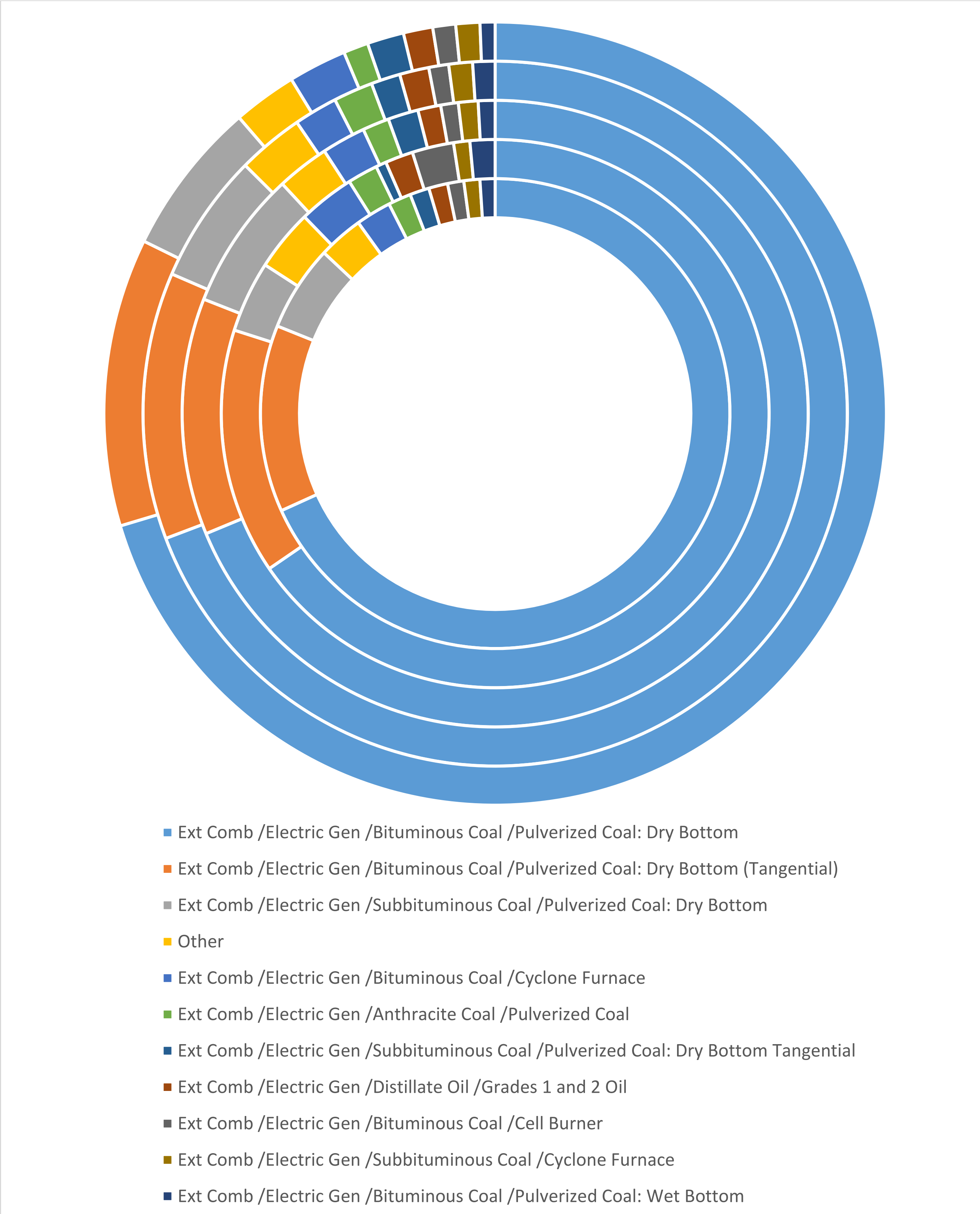


Figure 9: Relative Impact of EGU Point Source SCCs on Acadia, Brigantine, Great Gulf, Lye Brook, and Moosehorn (inner to outer)

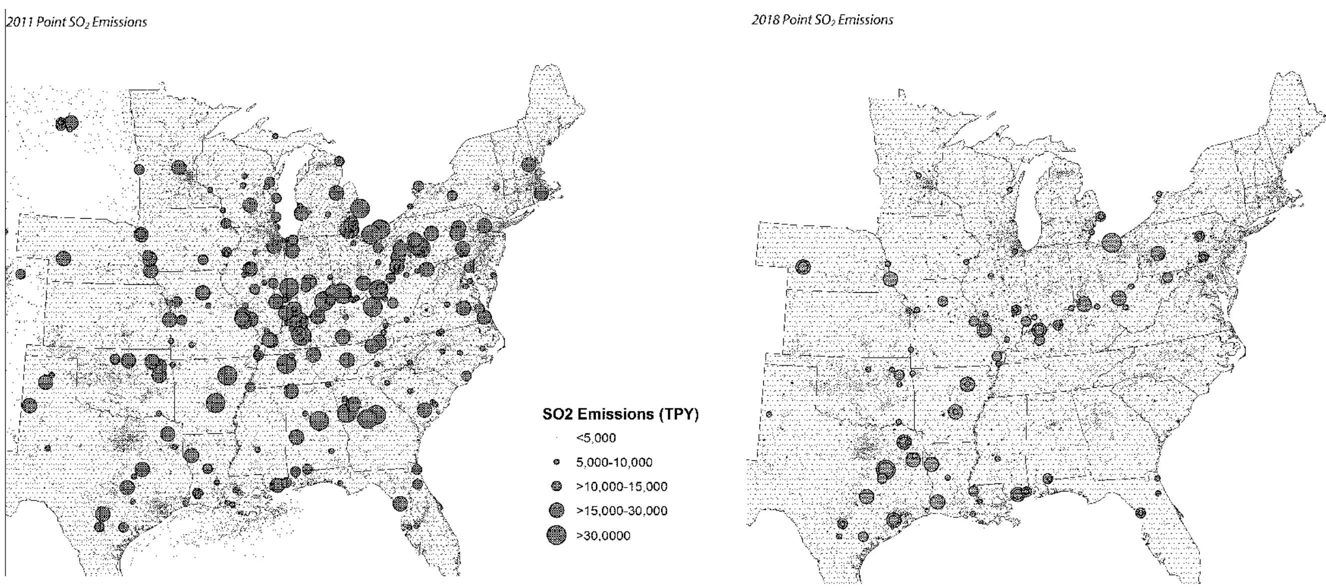

Ext Comb /Electric Gen /Bituminous Coal /Pulverized Coal: Dry Bottom
Ext Comb /Electric Gen /Bituminous Coal /Pulverized Coal: Dry Bottom (Tangential)
Ext Comb /Electric Gen /Subbituminous Coal /Pulverized Coal: Dry Bottom
Other
Ext Comb /Electric Gen /Bituminous Coal /Cyclone Furnace
Ext Comb /Electric Gen /Anthracite Coal /Pulverized Coal
Ext Comb /Electric Gen /Subbituminous Coal /Pulverized Coal: Dry Bottom Tangential
Ext Comb /Electric Gen /Distillate Oil /Grades 1 and 2 Oil
Ext Comb /Electric Gen /Bituminous Coal /Cell Burner
Ext Comb /Electric Gen /Subbituminous Coal /Cyclone Furnace
Ext Comb /Electric Gen /Bituminous Coal /Pulverized Coal: Wet Bottom

Conclusions

The 2015 analyses; 2011 state total emissions, 2011 point emissions and the 2018 point emissions, each provide a unique insight to the contribution of each state and source sector the MANE-VU and neighboring class I areas. This report is the summary and is a starting point for the states in the region to assess their contributions to each neighboring class I area and for the class I areas state to further address the appropriate next steps in tandem with the other analyses available.

The summary of the results presented above illuminated two approaches a geographic approach and source sector approach. Geographically, all three of the 2015 analyses resulted in two top contributors, Ohio and Pennsylvania. The remaining state rankings varied by class I area and by analysis type (total emissions vs. point only emissions). The source sector approach, determined that EGUS (more specifically coal EGUs) still dominated the contributions. While emissions have and are projected to decrease in 2018, see Figure 10 , further work is needed to accomplish to visibility goals for 2064 and the resulting near term goals for the next ten-year planning cycle.

Figure 10. 2011 and 2018 Point Emissions



Appendix A - Inputs to the emissions over distance approach

Table A-1. Geographic coordinates used for "center of state" locations

State	Latitude	Longitude		State	Latitude	Longitude
Alabama	33.008097	-86.756826		Mississippi	32.590954	-89.579514
Arkansas	35.14258	-92.655243		Missouri	38.423798	-92.198469
Connecticut	41.497001	-72.870342		Nebraska	41.1743	-97.315578
Delaware	39.358946	-75.556835		New Hampshire	43.154858	-71.461974
District of Columbia	38.91027	-77.014468		New Jersey	40.43181	-74.432208
Florida	27.822726	-81.634654		New York	41.501299	-74.620909
Georgia	33.376825	-83.882712		North Carolina	35.543075	-79.658232
Illinois	41.286759	-88.390334		Ohio	40.455191	-82.773339
Indiana	40.149246	-86.259514		Oklahoma	35.598464	-96.836786
Iowa	41.946066	-93.036629		Pennsylvania	40.456756	-77.00968
Kansas	38.464949	-96.462812		Rhode Island	41.753609	-71.450869
Kentucky	37.824499	-85.248467		South Carolina	34.025176	-81.011022
Louisiana	30.722814	-91.508833		Tennessee	35.80809	-86.359136
Maine	44.29995	-69.736482		Texas	30.905244	-97.365594
Maryland	39.140769	-76.797763		Vermont	44.094874	-72.816417
Massachusetts	42.272291	-71.36337		Virginia	37.810313	-77.81116
Michigan	42.873187	-84.203434		West Virginia	38.795594	-80.731308
Minnesota	45.203555	-93.571903		Wisconsin	43.721933	-89.018997

Table A-2. Geographic coordinates used for Class I area locations

Class I Area	Area Abbreviation	Latitude	Longitude
Acadia National Park	ACAD	44.3771	-68.2612
Moosehorn Wilderness Area	MOOS	45.1259	-67.2661
Great Gulf Wilderness Area	GRGU	44.3082	-71.2177
Brigantine Wilderness Area	BRIG	39.465	-74.4492
Lye Brook Wilderness Area	LYBR	43.1481	-73.1267
Shenandoah National Park	SHEN	38.5228	-78.4347
Dolly Sods Wilderness Area	DOSO	39.1069	-79.4262

Table A-3. Wind direction sector constants

Class I Area Abbreviation	Minimum Angle	Maximum Angle	Constant (*Ci*)
ACAD	0	171	0.00016071
ACAD	172	197	0.00020593
ACAD	198	216	0.00016071
ACAD	217	226	0.00019667
ACAD	227	360	0.00016071
DOSO	0	140	0.00008446
DOSO	141	254	0.00013503
DOSO	255	355	0.00006458
DOSO	356	360	0.00006458
BRIG	0	33	0.0000882
BRIG	34	156	0.0000882
BRIG	157	179	0.00012905
BRIG	180	189	0.00017808
BRIG	190	237	0.00016108
BRIG	238	360	0.0000882

Class I Area Abbreviation	Minimum Angle	Maximum Angle	Constant (*Ci*)
GRGU	0	170	0.00002371
GRGU	171	203	0.00014956
GRGU	204	236	0.00009968
GRGU	237	289	0.00002371
GRGU	290	360	0.00002371
LYBR	0	143	0.00002303
LYBR	144	225	0.00014575
LYBR	226	240	0.00010289
LYBR	241	299	0.00005815
LYBR	300	360	0.00002303
MOOS	0	173	0.00003842
MOOS	174	184	0.00015274
MOOS	185	196	0.00022409
MOOS	197	209	0.00015967
MOOS	210	211	0.00003842
MOOS	212	212	0.00016344
MOOS	213	215	0.00012298
MOOS	216	225	0.00015147
MOOS	225	360	0.00003842
SHEN	0	133	0.00009164
SHEN	134	280	0.00012969
SHEN	281	311	0.00006097
SHEN	312	360	0.00006097

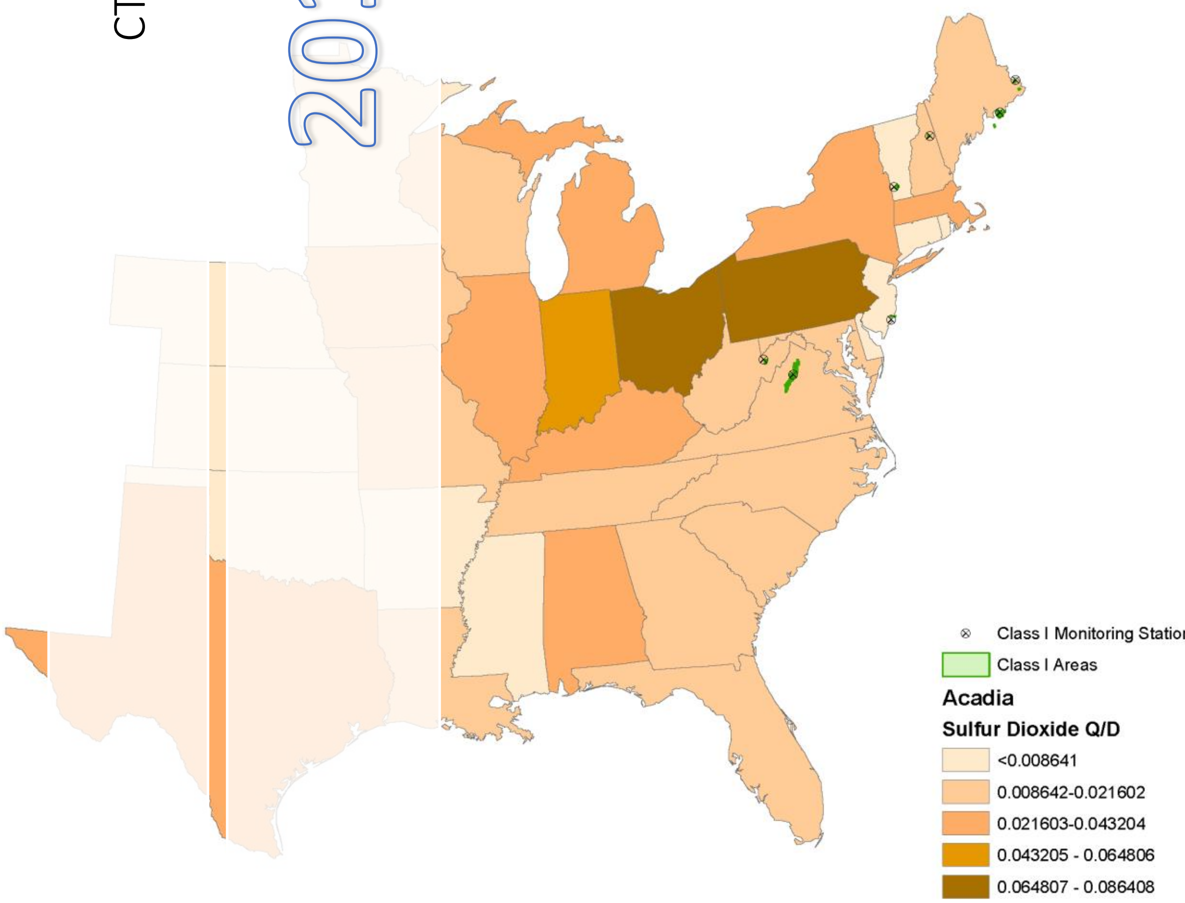
Note: Above angles are measured in degrees counterclockwise, with east equal to zero degrees.

Appendix B - Q/d in ARC Map Step by Step Instructions

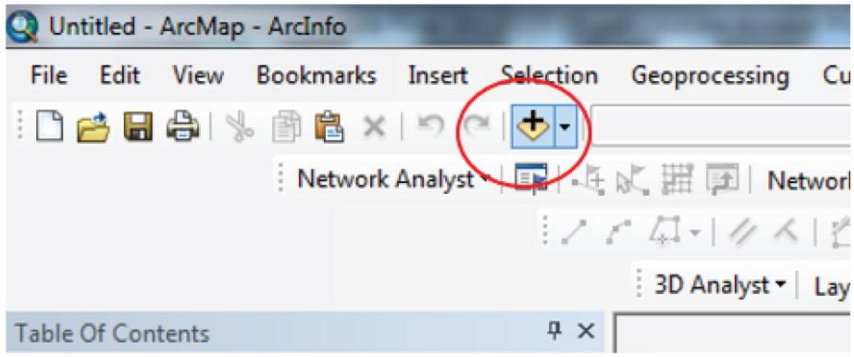
Q/d in ARC Map Step by Step Instructions

CT DEEP

2016

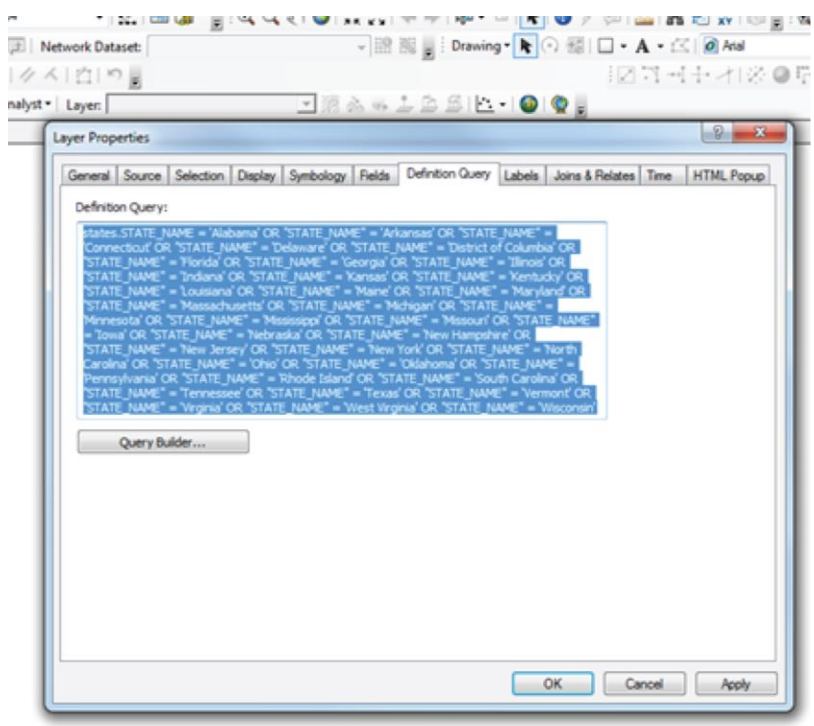


1. In new map import state out line shape file. The most up to date shape file can be downloaded at https://www.census.gov/geo/maps-data/data/tiger-line.html
    a. To import select the add data button circled below.

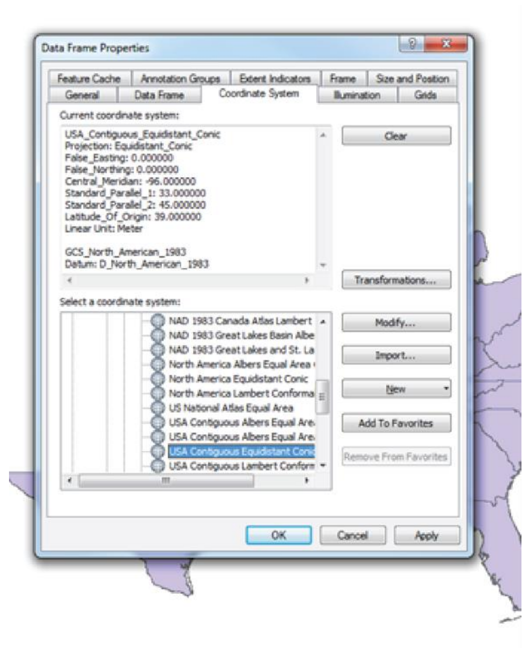


    b. Set definition query to limit view to the states you wish to anlayze. For the 2015 Q/D up date this list of states was used. – Doing this step will save you from memory limits and speed up the calculation steps later on.

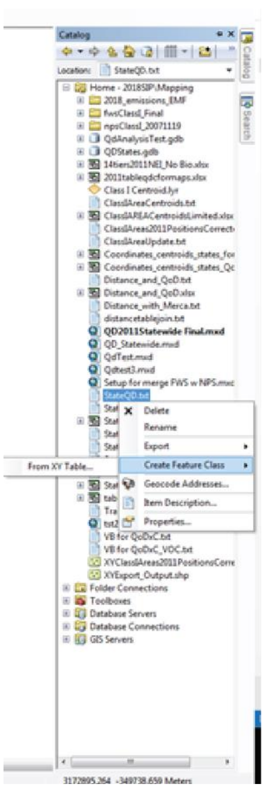
Alabama
Arkansas
Connecticut
Delaware
District of Columbia
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Nebraska
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oklahoma
Pennsylvania
Rhode Island
South Carolina
Tennessee
Texas
Vermont
Virginia
West Virginia
Wisconsin



2. Set the projection for the map
    a. Right click in the map and select Data Frame Properties.
    b. Select the Coordinate System Tab
    c. Select a projection in the projected folder. Depending on your area there may be a different projection that is best suited to your area, but make sure to use one that represents distances correctly, if you do not your distance calculation could be signifigantly skewed. For the purposes of the 2015 Q/d the region USA contigious Equidistant conical. This best represented the states selected and preserved the quality of the distances.



3. Select the add data button again and import the population weighted state centroids.

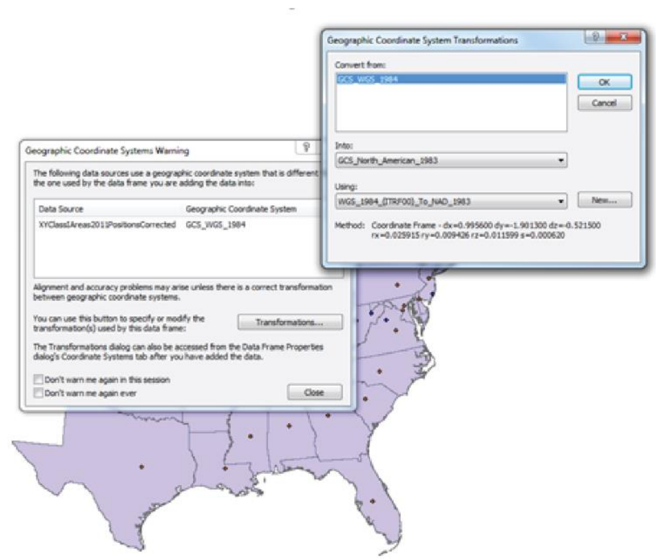


a. You can calculate geographic centroids through the calculate geometry when adding a field in the polygons of interests table. For the 2015 update this was not done and centroids were used from Appendix A of the Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update Through 2007, this table was pasted into excel file with state total NH3, SO2, NOX, PM2.5 primary and VOC emissions totals[5] for each state (minus biogenic/natural totals) and a shape file was made from this appendix.

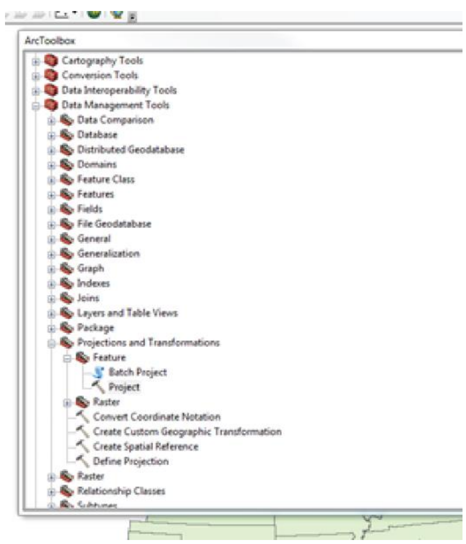
b. To create shapefile from csv or excel:
    i. Right click on file in the catalog list select create feature class then select from xy table
    ii. Identify the coodinate system- the coordinates in appendix A are WGS 84.

[5] NEI 2011 version 2 (April, 2015 download)

c. Import new shapefile into the map and check the transformation is correct WGS 1984 into North american 1983 is what was used.- Repeat with Class I area monitors coordinates.

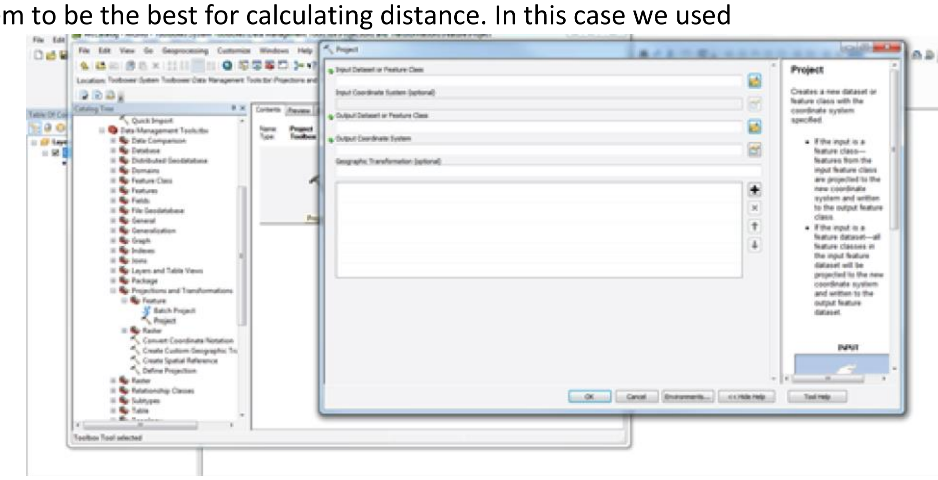


4. This takes the shape file which is in WGS84 and places it in the correct NAD 83 position; now you must convert your shapfiles to the NAD83 datum so that the distance will result in meters and not the angle from the center of the earth (degrees).



5. To convert each shapefile to the projection needed open Data Management Tools>Projections and Transformations>Feature>Project (see image at left)

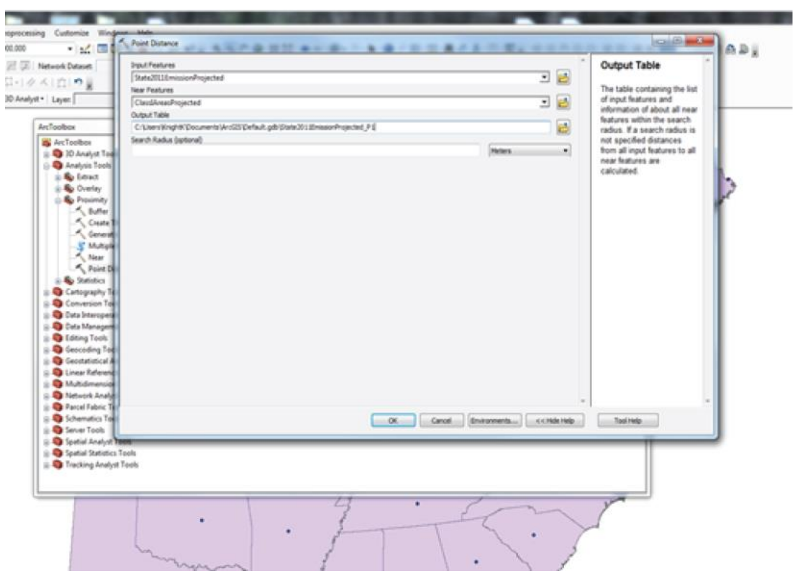
6. Select one of your features (State Centroids with Emissions or the Park Monitors) as the Input Data Set. Select output coordinate system to be the best for calculating distance. In this case we used USA Contiguous Equidistant Conic.prj. (If including Canada in furture I would suggest selecting North America Equidistant Conic) Repeat for the other feature.



7. To ensure your transformation took check the units in the lower right , if you are in NAD 83 projected they should be in meters not DD. If it did not take go into data management tools and projections and retry the projection. Use this tool to project the geometric layer into a projected.

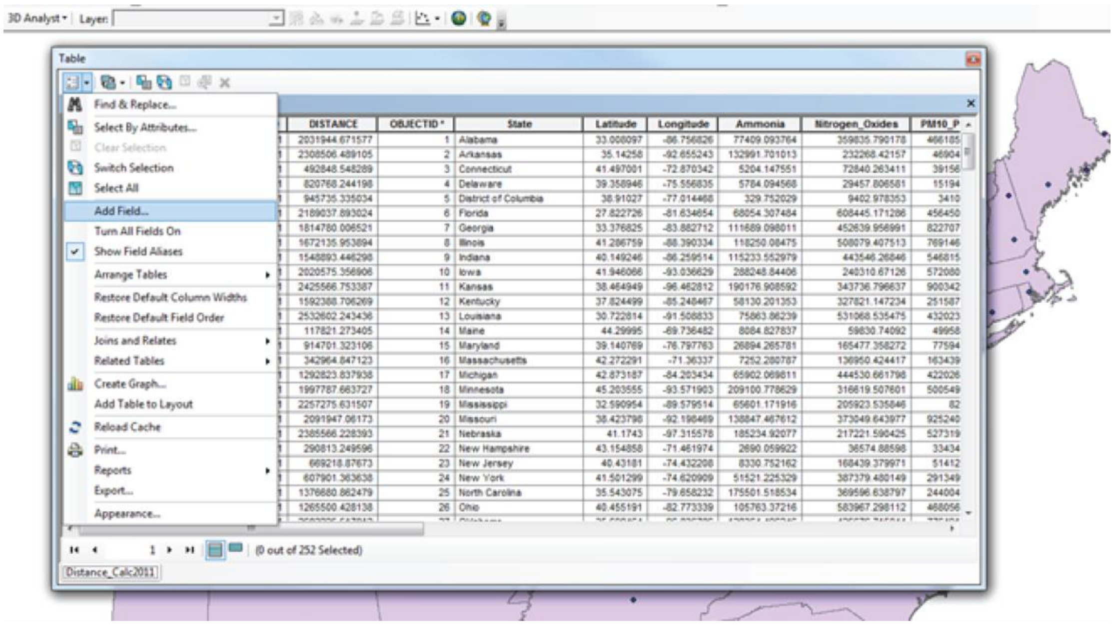
8. Calculate distance
    a. Open Arc tool box and select analysis tools and proxmity tool set. The input feature was state centroids. Make sure to use the newly create shape file that is projected into the flat projection not your WGS 84 file.

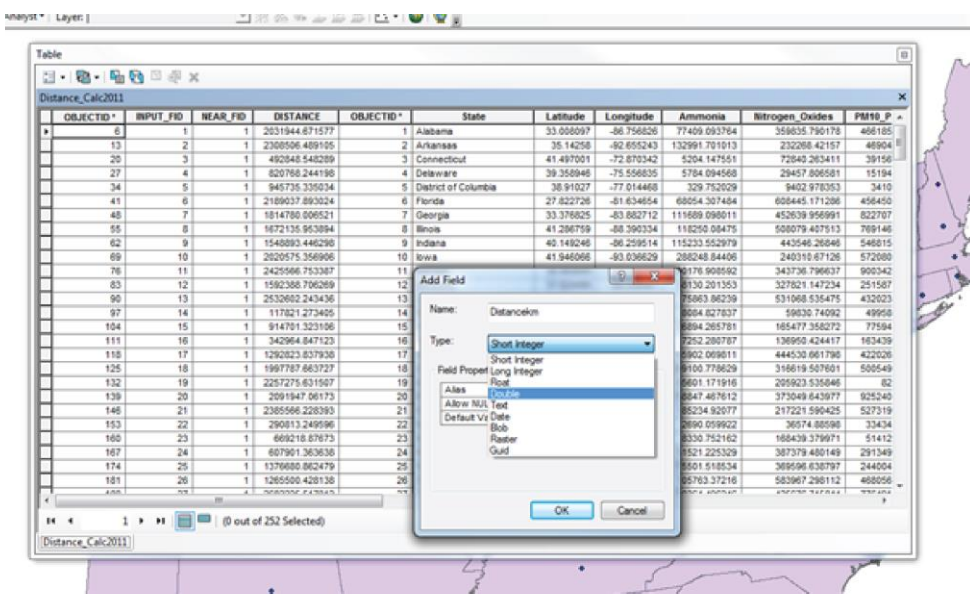
9. Do a quick does this make sense check- by joining the features and new output table to get the context. Right click on your newly created distance table select Joins and Relates and then Join. Your input feature was your states. First Select the States feature for box 2. Box 1 is choices of columns from your new distance table input_FID is the state tables object ID select this column and Object Id should auto populate for selection three if it doesn't select it. Then select validate join. Then select ok. It will tell you the number of joins created this will enable you to notice an error immediately. Too many , too little? Often this is result of formating error. You will need to edit the layer to match the format of one of those columns to match the other. Which you choose to edit doesn't matter as long as they are the same and retain all their digits.
10. Repeat the join for the parks but this time use Near FID column to match the object ID in the parks shapefile.

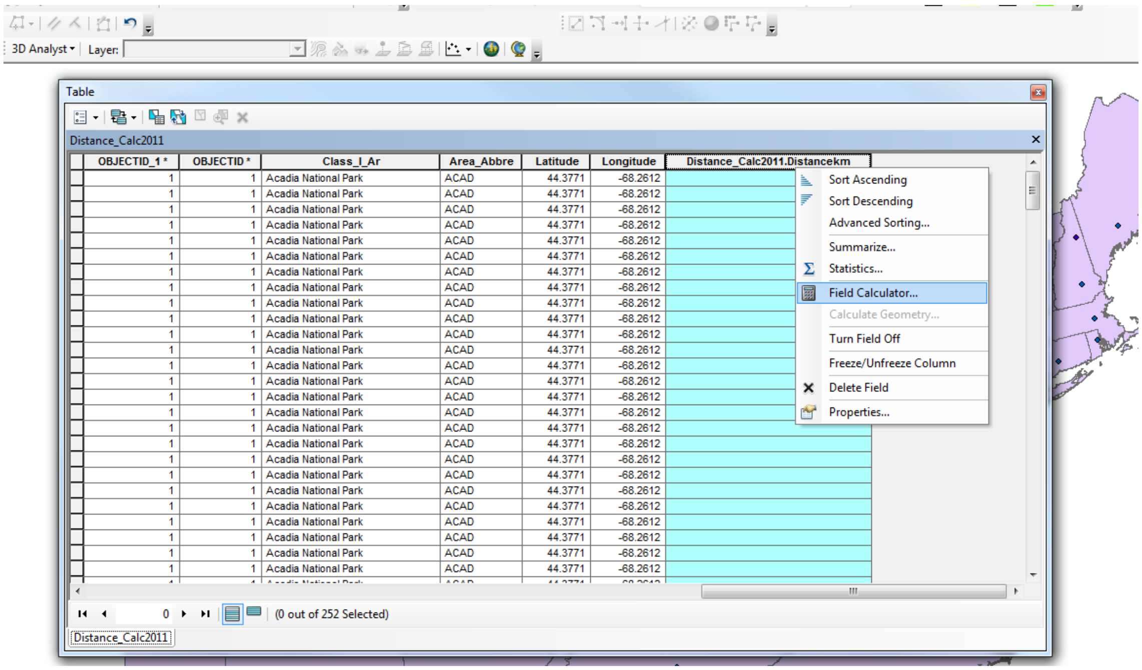


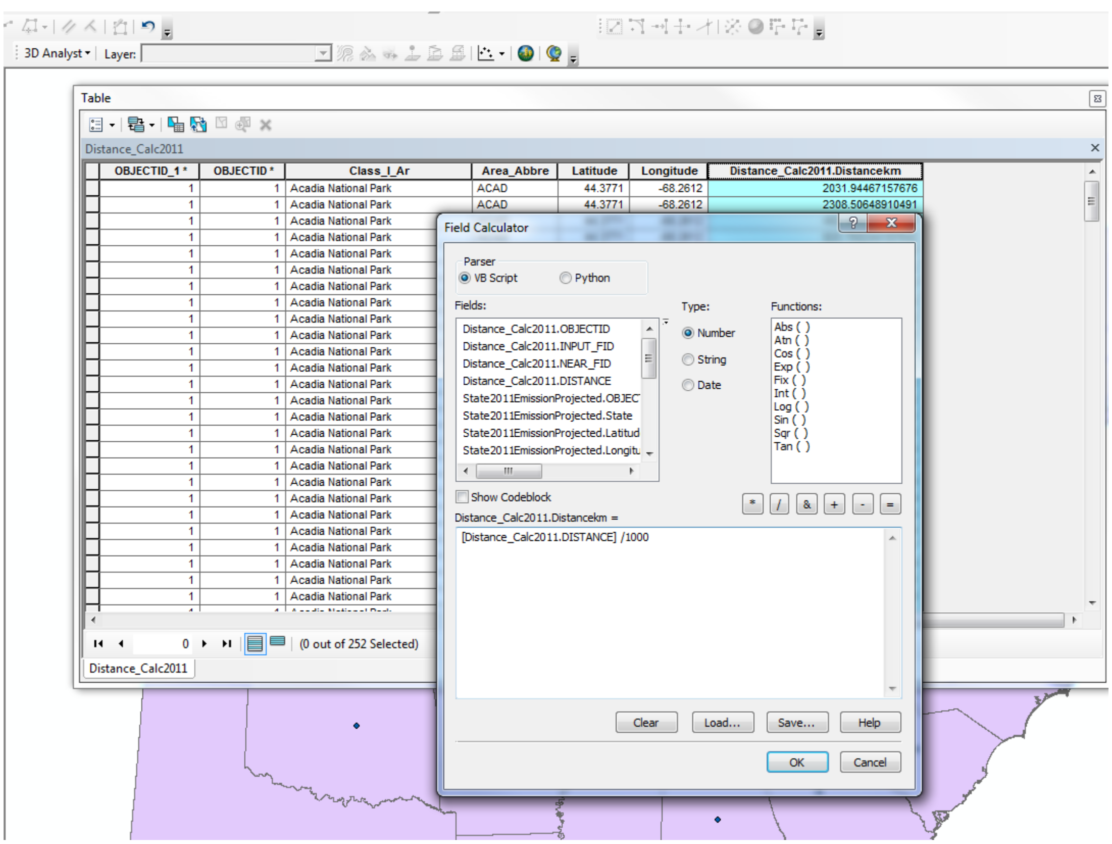
11. Distance is output in m recalculate in km
    a. Add new field to newly created distance table.
    b. Title it and field type should be double

c. Right click new column and select field calculator and insert equation [distance]/1000









12. Calculate the wind vector that the state falls in for each Class I monitor

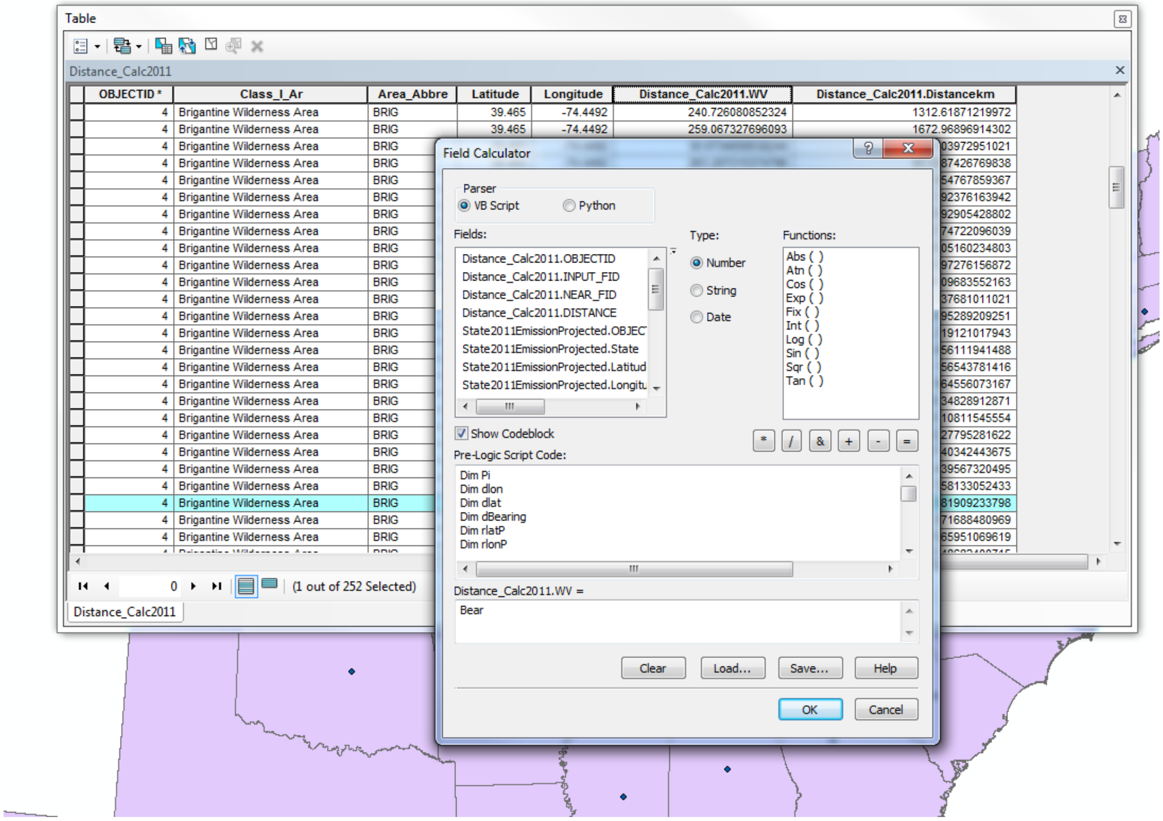
a. Create new field in state table (type=double)

13. Load or select code book and write an equation for calculating bearing from Class I area to state. For the 2015 update this code was written. Should your column titles be different than Longitude, Latitude, Latitude_1, and longitude_1 it is easiest to open the script file in note pad first and do a find and replace to rename each appropriately as your columns are named in your files. Because the Ci from appendix A of the "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update Through 2007" Uses the due east coordinate as 0 degrees and in a counter clockwise direction your bearing will need to be slide 90 degrees and rotated should you want to QA with respect to a north heading. The Ci were developed with this counter clockwise (radian quadrants), see image below for the Acadia example. The equation below puts these in that quadrant system and this result will be the one you apply your Ci value to.

```
Dim Pi
Dim SlatR
Dim SlonR
Dim PlatR
Dim PlonR
Dim dlon
Dim X
Dim Y
Dim Dx
Dim Dy
Dim Bear
Dim Bearing
Pi=4*Atn(1)
SlatR= [FaciProjecEastSO2.latitude_m]*(Pi/180)
SlonR= [FaciProjecEastSO2.longitude_]*(Pi/180)
PlatR= [ClassIProjected.Latitude]*(Pi/180)
PlonR= [ClassIProjected.Longitude]*(Pi/180)
dlon=SlonR-PlonR
X=Sin(dlon)*Cos(SlatR)
Y=Cos(PlatR)*Sin(SlatR)-Sin(PlatR)*Cos(SlatR)*Cos(dlon)
If X>0 AND Y>0 then
Bear=Atn(Y/X)
ElseIf X<0 AND Y>0 then
Bear=Pi+Atn(Y/X)
ElseIf X<0 ANd Y<0 then
Bear=Pi+Atn(Y/X)
ElseIf X>0 AND Y<0 then
Bear=2*PI+Atn(Y/X)
Else
Bear=9999
End If

Bearing=Bear*(180/Pi)
```

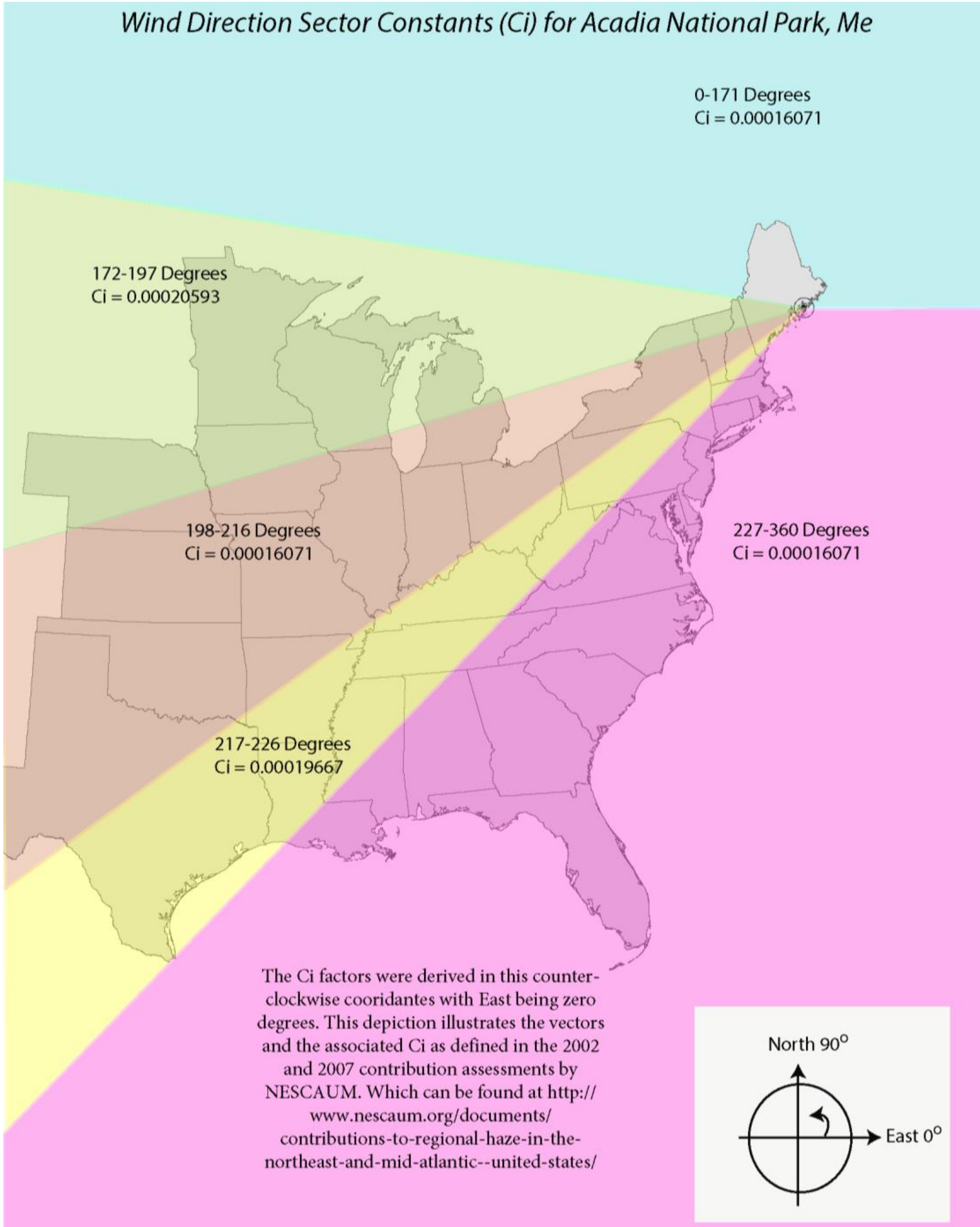
14. Then add new field (again type is double). Q/d Right click and select field calculator and divide emissions by distance in km repeat until each desired Q/d is done. Note – with primary pollutants like PM2.5 use d^2



15. Optional Step for QA Check: Add another field (type=double) dim WVE

```
If [Distance_Calc2011.WV] < 90 then
WVE=90 - [Distance_Calc2011.WV]
Else
WVE=360 - [Distance_Calc2011.WV]- 90
End If
```

This column will have comparable angles to what you think of as a heading w North being zero, easier to quickly eye ball errors.



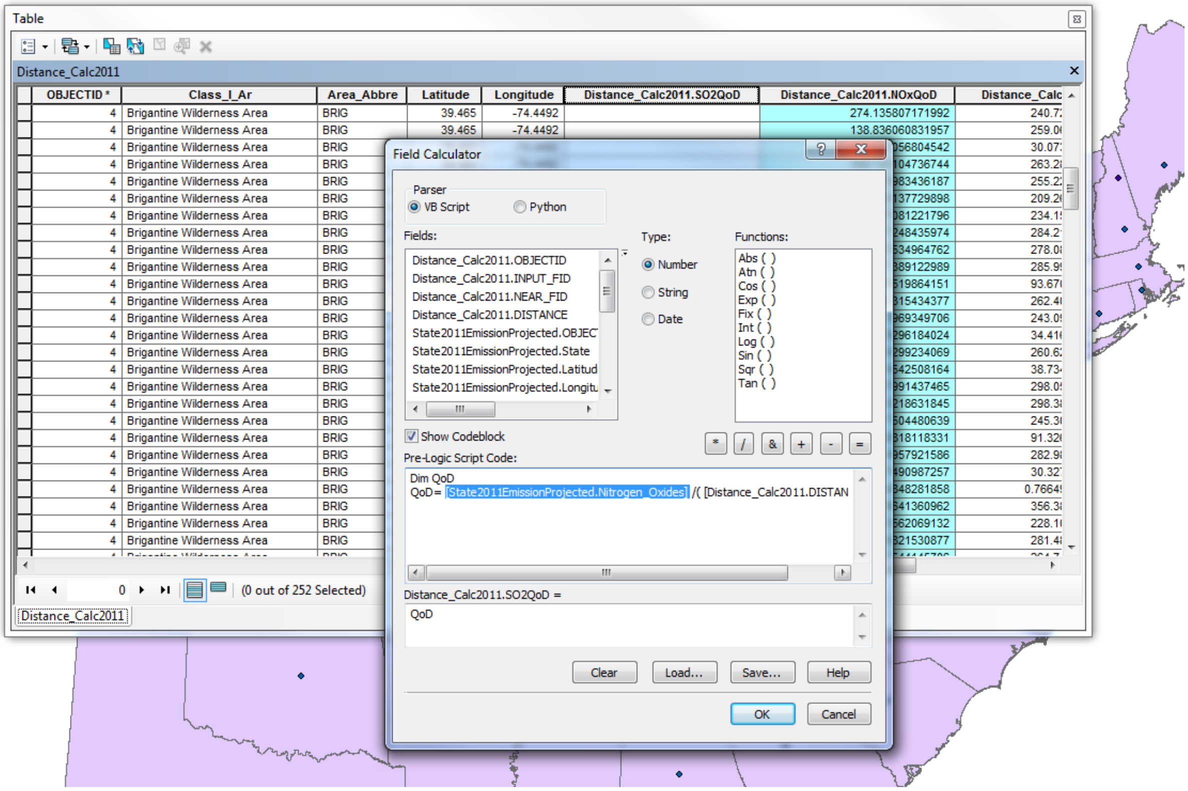
16. Add another field (type=double) and calculate Q/d*C depending on vector calculated earlier. The below scipt was used for 2015 update. Repeated for other pollutants if desired, this study experimented with the other precursors of PM2.5 but in the end found these results to be unreliable and not a priority and were therefore removed. Again easiest way to replace column titles is to open the scrip in Note pad first and find and replace all of that name with the appropriate column names. Remember to use the azimuth created in step 13.
    a. Adding recptors- For the 2015 study the James River Face Wilderness Area was added. This was done to be thorough in considering where MANE-VU states may contribute to. To do so the constants were needed and Dolly Sods and Shenandoah were substituted

to see what made the most sense. Therefore the script below was run twice, once as JARI with SHEN's if then statements and once with JARI with the DOLLY if then statements. Code below illustrates the Shenadoah (SHEN) run.

```
Dim QDC
If [Area_Abbreviation] ="ACAD" then
If [Azimuth] >=171.5 AND [Azimuth] <197.45 then
QDC=[VOCQoD] *0.00020593
ElseIf [Azimuth] >=216.5 AND [Azimuth] <226.5 then
QDC= [VOCQoD] *0.00019667
Else
QDC= [VOCQoD] *0.00016071
End If
Else
If [Area_Abbreviation] = "DOSO" then
If [Azimuth] <140.5 then
QDC= [VOCQoD] *0.00008446
ElseIf  [Azimuth] >=140.5 AND [Azimuth] <254.5 then
QDC= [VOCQoD] *0.00013503
Else
QDC= [VOCQoD] *0.00006458
End If
Else
If [Area_Abbreviation] = "BRIG" then
If [Azimuth] <156.5 then
QDC= [VOCQoD] *0.0000882
ElseIf  [Azimuth] >=156.5 AND [Azimuth] <179.5 then
QDC= [VOCQoD] *0.00012905
ElseIf  [Azimuth] >=179.5 AND [Azimuth] <189.5 then
QDC= [VOCQoD] *0.00017808
ElseIf  [Azimuth] >=189.5 AND [Azimuth] <237.5 then
QDC= [VOCQoD] *0.00016108
Else
QDC= [VOCQoD] *0.0000882
End If
Else
If [Area_Abbreviation] = "GRGU" then
If [Azimuth] <171 then
QDC= [VOCQoD] *0.00002371
ElseIf  [Azimuth] >=170.5 AND [Azimuth] <203.5 then
QDC= [VOCQoD] *0.00014956
ElseIf  [Azimuth] >=203.5 AND [Azimuth] <236.5 then
QDC= [VOCQoD] *0.00009968
Else
QDC= [VOCQoD] *0.00002371
End If
Else
If [Area_Abbreviation] = "LYBR" then
If [Azimuth] <143.5 then
QDC= [VOCQoD] *0.00002303
ElseIf  [Azimuth] >=143.5 AND [Azimuth] <225.5 then
QDC= [VOCQoD] *0.00014575
ElseIf  [Azimuth] >=225.5 AND [Azimuth] <240.5 then
QDC= [VOCQoD] *0.00010289
ElseIf  [Azimuth] >=240.5 AND [Azimuth] <299.5 then
QDC= [VOCQoD] *0.00005815
Else
QDC= [VOCQoD] *0.00002303
End If
```

```
Else
If [Area_Abbreviation] = "MOOS" then
If [Azimuth] <173.5 then
QDC= [VOCQoD] *0.00003842
ElseIf  [Azimuth] >=173.5 AND [Azimuth] <184.5  then
QDC= [VOCQoD] *0.00015274
ElseIf  [Azimuth] >=184.5 AND [Azimuth] <196.5 then
QDC= [VOCQoD] *0.00022409
ElseIf  [Azimuth] >=196.5 AND [Azimuth] <209.5 then
QDC= [VOCQoD] *0.00015967
ElseIf  [Azimuth] >=209.5 AND [Azimuth] <211.5 then
QDC= [VOCQoD] *0.00003842
ElseIf   [Azimuth] >=211.5 AND [Azimuth] <212.5 then
QDC= [VOCQoD] *0.00016344
ElseIf  [Azimuth] >=212.5 AND [Azimuth] <215.5 then
QDC= [VOCQoD] *0.00012298
ElseIf  [Azimuth] >=215.5 AND [Azimuth] <225.5 then
QDC= [VOCQoD] *0.00015147
Else
QDC= [VOCQoD] *0.00003842
End If
Else
If [Area_Abbreviation] = "SHEN" then
If [Azimuth] <133.5 then
QDC= [VOCQoD] *0.00009164
ElseIf  [Azimuth] >=133.5 AND [Azimuth] <280.5  then
QDC= [VOCQoD] *0.00012969
Else
QDC= [VOCQoD] *0.00006097
End If
Else
If [Area_Abbreviation] = "JARI" then
If [Azimuth] <133.5 then
QDC= [VOCQoD] *0.00009164
ElseIf  [Azimuth] >=133.5 AND [Azimuth] <280.5  then
QDC= [VOCQoD] *0.00012969
Else
QDC= [VOCQoD] *0.00006097
End If
Else

QDC=0
End If
End If
End If
End If
End If
End If
End If
```



17. Final step export table to CSV for charts (can do in ARC map as well but more workable format for large group in excel)
18. If these steps are applied to individual sources; then summation for each point by state can be done easily in excel via the pivot table function. This was the case for the 2015 q/d point analysis.

APPENDIX E

Selection of States for MANE-VU Regional Haze Consultation (2018)

MANE-VU Technical Support Committee
9/5/2017

Introduction

Under the Regional Haze Rule[1], States with Class I areas are to consult with states contributing to visibility degradation regarding reasonable measures that can be pursued to improve visibility. The purpose of this paper is to review the process used to determine the selection of states for MANE-VU Class I Area state consultation. Consultation does not mean that selected states have not addressed their visibility impairing emissions, but rather technical analysis suggests that their location, historical emissions and prevailing weather patterns create enough possibility for visibility impact on MANE-VU's Class I areas that they should be included in the discussion of "reasonable" measures to include in the Regional Haze SIP's.

In order to determine which states should be consulted an analysis must be conducted to define what states, sources, or sectors reasonably contribute to visibility impairment. EPA's draft guidance document calls for a process for determining which sources or source sectors should be considered.[2] It begins with analyzing monitored emissions data on the 20% most impaired days to determine what pollution is leading to anthropogenic visibility impacts. This is followed by screening for sources or source sectors that are leading to a majority of that impact. The results of this analysis will lead to what source or sectors need a four-factor analysis and which states should be consulted with.

Firstly, MANE-VU concluded, after developing a conceptual model, that the sulfates from SO_2 emissions were still the primary driver behind visibility impairment in the region, though nitrates from NO_X emission sources do play a more significant role than they had in the first planning period.[3] Because of this, MANE-VU chose an approach for contribution assessments that focused on sulfates and included nitrates when they could be included in a technically sound fashion.

Secondly, MANE-VU examined annual inventories of emissions to find sectors that should be considered for further analysis.[4] EGUs emitting SO_2 and NO_X and industrial point sources emitting SO_2 were found to be point source sectors of high emissions that warranted further scrutiny. Mobile sources were also found to be important an important sector in terms of NO_X emissions.

After this initial work, MANE-VU initiated a process of screening states and sectors for contribution using two tools, Q/d and CALPUFF. Support for these tools for screening purposes follows in the next section. Results of this contribution analysis was then compared to air mass trajectories for 20% most impaired days at the MANE-VU Class I Areas.

---

[1] US EPA, "Protection of Visibility: Amendments to Requirements for State Plans."
[2] US EPA, "Draft Guidance on Progress Tracking Metrics, Long-Term Strategies, Reasonable Progress Goals and Other Requirements for Regional Haze State Implementation Plans for the Second Implementation Period."
[3] Downs et al., *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description*.
[4] Mid-Atlantic Northeast Visibility Union, "Contribution Assessment Preliminary Inventory Analysis."

MANE-VU limited this work to only these two screening analyses to determine which upwind states should be consulted with because of reduced resources within the MANE-VU States. These techniques are conservative, and, more importantly, visibility impacts are not one of the four factors for determining if a future air pollution control is "reasonable" for a state to undertake. The four factors are:

1. Costs of compliance;
2. Time necessary for compliance;
3. Energy and non-air quality environmental impacts; and
4. Remaining useful life of affected sources (40 CFR 51.308(d)(1)(i))

If visibility impacts were specifically determined, this information would not be useful in determining if a control is "reasonable" and would not advance the Clean Air Act mandate of the eventual elimination of all manmade visibility impacts on Class I areas. As a result, the screening work only goes as far as to develop weighted concentration data for use in determining which states have a high likelihood of affecting visibility in MANE-VU's Class I areas.

Support for Use of Q/d and CALPUFF for Screening

Q/d is largely accepted as a screening tool and continues to be as was the conclusion of a July 2015 report by an interagency air quality modeling work group.[5] This conclusion was supported by EPA due to Q/d being a highly conservative screening tool as found in a report by NACAA when assuming 100% conversion of SO_2 gas to the particulate form (NH_3SO_4) that affects visibility[6] EPA has also found that Q/d is well suited for determining the relative impacts for comparison purposes.[7] This means that Q/d lends itself well to determining which states, sectors, or sources have a larger relative impact and warrant further scrutiny.

The FLMs, through the FLAG process, suggest that using the Q/d test is an appropriate initial test when evaluating emissions from new sources "greater than 50 km from a Class I area to determine whether or not any further visibility analysis is necessary".[8] Since many of the sources being examined are well over 50 km from any of the MANE-VU Class I areas, the use of Q/d would appear to be supported.

A review of contribution analyses conducted by MANE-VU, including the previous two NESCAUM Q/d studies (CALPUFF analyses and REMSAD analysis) found similar results regardless of the method.[9] This is demonstrated in the correlation matrix in Table 1 where the ideal result would be that all of the tools produced the exact same results resulting in a correlation coefficient of 100%.

---

[5] US EPA, *Interagency Work Group on Air Quality Modeling Phase 3 Summary Report: Near-Field Single Source Secondary Impacts*.
[6] National Association of Clean Air Agencies, *PM2.5 Modeling Implementation for Projects Subject to National Ambient Air Quality Demonstration Requirements Pursuant to New Source Review*.
[7] Baker and Foley, "A Nonlinear Regression Model Estimating Single Source Concentrations of Primary and Secondarily Formed PM2.5."
[8] US Forest Service, *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report--Revised*.
[9] NESCAUM, *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States*.

Table 1: Correlation coefficients obtained from comparing sulfate concentration results from four techniques10

	Q/D	REMSAD	CALPUFF (NWS)	CALPUFF (MM5)
Q/D	100%	93.01%	92.83%	91.86%
REMSAD		100%	95.12%	94.16%
CALPUFF (NWS)			100%	97.82%
CALPUFF (MM5)				100%

In the FLAG report, the FLM's stated that "CALPUFF is still the preferred first-level air quality model for calculating pollutant concentrations," with the first-level analysis being able to determine a relative change in light extinction.[11] In particular, the FLAG report recommends running 3 years of meteorology as was done as part of this work. As demonstrated in Table 1 CALPUFF produces similar results to REMSAD and Q/d as well. Additionally, some inaccuracies caused by CALPUFF's conservative results should be reduced by considering CALPUFF and Q/d on equal footing.

Although these methods are intended as screening tools, the previous analyses provide a precedent for using them to assess which states should be consulted with as part of the Regional Haze process.

Modeling Analysis

MANE-VU conducted two contribution analyses including a state modified Q/d analysis[12] and a CALPUFF dispersion modeling analysis.[13] Each is summarized in detail in separate reports. An overview as to how the information was incorporated in this analysis is in Table 2.

Table 2: Data Sources Used and Created

Data Sources Used:					
CALPUFF	2015	EGU	NO_X & SO_2	95th daily %tile	Used for relative impact and to provide NO_3/SO_4 chemistry ratio estimates for Q/d
	2011	EGU	NO_X & SO_2	95th daily %tile	Used to insert into 2015 for EGUs only modeled using 2011 emissions
	2011	ICI	NO_X & SO_2	typical day	Used for impact and to provide NO_3/SO_4 chemistry ratio estimates for Q/d
Q/d	2011	EGU	SO_4	annual	Used to validate Q/d State-wide data for SO_4
	2011	State-wide	SO_4	annual	Used to estimate 2015 statewide Q/d SO_4
Data Sources Created:					
Q/d	2015	State-wide	SO_4	annual	Used for relative impact
	2015	State-wide	NO_3	annual	Used for relative impact

The CALPUFF analyses considered 500 EGU and 121 ICI units throughout the eastern United States. For EGUs, the ninety-fifth percentile of daily NO_X and SO_2 emissions for 2011 and 2015 were modeled with three different years of meteorology (2002, 2011, and 2015) and the maximum value from three years of meteorology was used to assess contribution. The 2015 results were used directly in determining relative impact. However some EGUs were only modeled using 2011 emissions, and in these cases the 2011 emissions were scaled at the unit level to represent 2015 emissions at those particular EGUs and then were used to determine impact. Although several EGUs were modeled in Texas in the CALPUFF

[10] Ibid.
[11] US Forest Service, *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report--Revised*.
[12] Mid-Atlantic Northeast Visibility Union, *MANE-VU Updated Q/d*C Contribution Assessment*.
[13] Mid-Atlantic Northeast Visibility Union, *2016 MANE-VU Source Contribution Modeling Report*.

analysis, their locations were adjusted in that analysis to bring them within the modeling domain, which means that those results could not be used for relative contribution and thus the CALPUFF results from Texas were excluded from the analysis.

For ICI units, typical day NO_X and SO_2 emissions for 2011 were modeled with three different years of meteorology (2002, 2011, and 2015) and the maximum value from three years of meteorology was used to assess contribution. ICI units could not be scaled to 2015 since 2015 emissions were not available for those sources. The ICI results were used directly to determine relative impact.

No point sources were modeled with CALPUFF for the District of Columbia, Florida, Louisiana, Mississippi, Rhode Island, and Vermont due to either a lack of major point sources or that their geography was just beyond the modeling domain. As mentioned before with Texas, CALPUFF modeling was excluded in the contribution analysis.

The CALPUFF 2015 EGU and 2011 ICI relative contribution results for NO_3 and SO_4 were summed by state and are provided in Table 3.

Table 3: Summary of state level impacts from 2015 SO_4 and NO_3 from large point sources modeled using CALPUFF

Contrib.	*CALPUFF SO_4 ($\mu g/m^3$)*					*CALPUFF NO_3 ($\mu g/m^3$)*				
State	**Acadia**	**Brigantine**	**Great Gulf**	**Lye Brook**	**Moosehorn**	**Acadia**	**Brigantine**	**Great Gulf**	**Lye Brook**	**Moosehorn**
AL	0.437	0.634	0.226	0.284	0.310	0.060	0.189	0.059	0.079	0.053
AR	0.144	0.113	0.117	0.156	0.136	0.066	0.061	0.059	0.073	0.062
CT	0.144	0.109	0.068	0.140	0.127	0.072	0.151	0.103	0.127	0.112
DE	0.054	0.055	0.042	0.052	0.060	0.004	0.007	0.003	0.003	0.006
GA	0.323	0.521	0.352	0.272	0.203	0.089	0.109	0.092	0.073	0.060
IA	0.144	0.123	0.175	0.133	0.136	0.085	0.078	0.100	0.084	0.081
IL	0.194	0.315	0.329	0.217	0.243	0.068	0.080	0.097	0.069	0.059
IN	1.468	1.711	1.668	1.772	1.368	0.373	0.655	0.546	0.728	0.338
KS	0.039	0.047	0.040	0.060	0.041	0.001	0.001	0.001	0.002	0.001
KY	0.662	1.221	0.682	0.954	0.734	0.194	0.572	0.277	0.352	0.209
MA	0.687	0.347	0.246	0.269	0.425	0.302	0.191	0.232	0.115	0.223
MD	0.399	0.969	0.290	0.404	0.410	0.149	0.460	0.106	0.159	0.117
ME	0.458	0.268	0.349	0.304	0.521	0.262	0.066	0.303	0.246	0.156
MI	1.026	1.550	0.895	0.784	0.882	0.301	0.568	0.378	0.307	0.308
MN	0.044	0.073	0.061	0.058	0.032	0.051	0.069	0.071	0.066	0.047
MO	0.238	0.488	0.482	0.427	0.316	0.091	0.106	0.109	0.144	0.088
NE	0.040	0.054	0.086	0.049	0.038	0.012	0.018	0.030	0.016	0.011
NC	0.750	0.681	0.371	0.504	0.426	0.158	0.673	0.197	0.313	0.150
NH	0.319	0.145	0.266	0.150	0.406	0.410	0.284	0.750	0.193	0.265
NJ	0.063	0.108	0.042	0.051	0.058	0.035	0.155	0.046	0.067	0.029
NY	0.553	0.596	0.452	0.875	0.401	0.285	0.389	0.479	0.544	0.175
OH	2.388	2.810	1.997	3.218	1.970	0.513	1.102	0.827	0.940	0.565
OK	0.122	0.322	0.322	0.408	0.180	0.011	0.029	0.008	0.035	0.010
PA	2.449	4.991	4.077	4.669	2.215	0.767	3.215	0.940	1.685	0.919
SC	0.095	0.118	0.059	0.049	0.087	0.033	0.063	0.019	0.040	0.030
TN	0.292	0.491	0.150	0.210	0.220	0.049	0.184	0.057	0.076	0.052
VA	0.563	1.558	0.406	0.714	0.495	0.075	0.229	0.103	0.134	0.057
WI	0.050	0.080	0.128	0.116	0.059	0.051	0.072	0.122	0.088	0.043
WV	0.561	1.170	0.651	1.070	0.467	0.359	1.188	0.621	0.644	0.470
Total (excl. est. states)	**14.705**	**21.668**	**15.026**	**18.372**	**12.970**	**4.927**	**10.963**	**6.737**	**7.401**	**4.698**

The Q/d analysis considered several approaches to determining impact. Some of these used specific point source locations and some used state centroids. Some looked at both NO_X and SO_2 emissions and some only SO_2 emissions. Some looked at 2011 emissions and some looked at 2018. The Q/d study used dispersion factors developed during a similar analysis conducted by MANE-VU for the 2008 regional haze SIP process. The specific Q/d analyses taken forward in this study are the state-wide 2011 SO_2 emissions emanating from the state centroid. The state-wide results were chosen as the focus since they included emissions from mobile and area sources. This analysis was cross-checked with the analysis of point source specific 2011 SO_2 emissions emanating from the location of the point source for quality assurance purposes. The 2011 state-wide SO_2 emissions were then scaled to 2015 levels for use in the impact analysis. This was done by taking the ratio of 2015 SO_2 emissions to 2011 SO_2 emissions for the state and applying that to the 2011 Q/d contribution result. The resulting 2015 SO_4 Q/d results are presented in Table 4.

Table 4: Summary of state level impacts from 2011 and processed 2015 SO_4 state-wide emissions using Q/d

Contrib.	***SO_2 (annual tons)***		***2011 State Level Impacts***					***2015 State Level Impacts***				
State	**2011**	**2015**	**Acadia**	**Brigantine**	**Great Gulf**	**Lye Brook**	**Moosehorn**	**Acadia**	**Brigantine**	**Great Gulf**	**Lye Brook**	**Moosehorn**
AL	278,364	182,712	0.022	0.034	0.015	0.025	0.021	0.014	0.022	0.010	0.016	0.014
AR	93,232	76,057	0.006	0.009	0.007	0.007	0.006	0.005	0.007	0.005	0.006	0.005
CT	15,339	11,955	0.006	0.005	0.001	0.005	0.004	0.005	0.004	0.001	0.004	0.003
DC	1,829	236	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DE	13,891	2,700	0.003	0.026	0.002	0.002	0.002	0.001	0.005	0.000	0.000	0.000
FL	172,796	121,963	0.013	0.010	0.002	0.005	0.003	0.009	0.007	0.001	0.004	0.002
GA	234,683	67,691	0.025	0.035	0.014	0.017	0.018	0.007	0.010	0.004	0.005	0.005
IA	130,830	67,527	0.013	0.011	0.011	0.012	0.010	0.007	0.006	0.006	0.006	0.005
IL	287,830	149,995	0.035	0.031	0.030	0.033	0.037	0.018	0.016	0.016	0.017	0.019
IN	425,202	218,945	0.057	0.054	0.048	0.054	0.058	0.029	0.028	0.025	0.028	0.030
KS	60,379	25,469	0.005	0.004	0.004	0.004	0.005	0.002	0.002	0.002	0.002	0.002
KY	272,958	151,644	0.028	0.051	0.020	0.034	0.026	0.015	0.028	0.011	0.019	0.014
LA	236,912	148,015	0.015	0.021	0.010	0.016	0.014	0.009	0.013	0.006	0.010	0.009
MA	51,372	15,584	0.029	0.011	0.005	0.007	0.017	0.009	0.003	0.002	0.002	0.005
MD	71,945	44,540	0.015	0.063	0.010	0.014	0.011	0.010	0.039	0.006	0.008	0.007
ME	15,557	11,849	0.027	0.002	0.003	0.001	0.011	0.021	0.002	0.002	0.001	0.009
MI	273,632	162,175	0.044	0.027	0.039	0.044	0.030	0.026	0.016	0.023	0.026	0.018
MN	70,880	38,240	0.006	0.004	0.001	0.006	0.001	0.003	0.002	0.001	0.003	0.001
MO	261,903	152,685	0.026	0.022	0.021	0.023	0.027	0.015	0.013	0.012	0.013	0.016
MS	63,940	43,427	0.005	0.007	0.003	0.005	0.004	0.003	0.004	0.002	0.003	0.003
NC	118,723	52,997	0.017	0.030	0.010	0.012	0.012	0.008	0.014	0.004	0.005	0.005
NE	76,213	68,418	0.007	0.005	0.005	0.006	0.005	0.006	0.005	0.005	0.005	0.004
NH	31,261	6,918	0.017	0.006	0.006	0.005	0.013	0.004	0.001	0.001	0.001	0.003
NJ	18,008	8,895	0.005	0.015	0.001	0.003	0.003	0.003	0.007	0.000	0.002	0.002
NY	115,001	64,517	0.030	0.045	0.027	0.054	0.026	0.017	0.025	0.015	0.030	0.015
OH	680,421	249,640	0.111	0.123	0.098	0.116	0.080	0.041	0.045	0.036	0.043	0.029
OK	133,249	94,614	0.011	0.012	0.008	0.009	0.011	0.007	0.008	0.006	0.006	0.008
PA	398,659	252,340	0.076	0.144	0.062	0.132	0.016	0.048	0.091	0.039	0.084	0.010
RI	4,696	3,710	0.002	0.001	0.000	0.001	0.000	0.002	0.001	0.000	0.000	0.000
SC	103,244	34,465	0.013	0.020	0.007	0.009	0.009	0.004	0.007	0.002	0.003	0.003
TN	160,323	98,949	0.014	0.023	0.010	0.017	0.013	0.009	0.014	0.006	0.010	0.008
TX	559,803	383,717	0.031	0.040	0.021	0.032	0.029	0.021	0.027	0.014	0.022	0.020
VA	107,821	58,336	0.020	0.050	0.012	0.016	0.014	0.011	0.027	0.006	0.008	0.007
VT	3,450	1,478	0.002	0.001	0.004	0.001	0.002	0.001	0.000	0.002	0.000	0.001
WI	147,401	73,814	0.018	0.010	0.015	0.017	0.013	0.009	0.005	0.008	0.008	0.007
WV	122,785	76,580	0.016	0.040	0.012	0.022	0.015	0.010	0.025	0.008	0.014	0.009
Total	***5,544,346***	***3,072,403***	***0.737***	***0.942***	***0.518***	***0.727***	***0.540***	***0.390***	***0.501***	***0.274***	***0.395***	***0.283***

Nitrate impacts were not originally estimated using Q/d. At the time of the Q/d analysis, the recommendation of MANE-VU was to only estimate sulfates, however it has since been realized that an approximation of mobile and area source NO_X emissions was necessary to demonstrate the impact of those sectors on visbility impairment. In order to develop this estimate, the ratio of NO_3/SO_4 was calculated based on 2015 CALPUFF statewide averages and applied to the estimated 2015 SO_4 Q/d results. This ratio was chosen to approximate the differing chemsitry between NO_3 and SO_4 formation which is captured in the CALPUFF results and was accounted for on a ton-by-ton basis of each pollutant. Several states did not have CALPUFF NO_3/SO_4 ratio results so a surrogate was chosen as shown in Table 5. The full set of state level Q/d NO_3 calculations is in Table 6.

Table 5: Surrogate States for NO_3/SO_4 CALPUFF Ratio Calculations

STATE W/O CALPUFF RESULTS	DC	FL	LA	MS	RI	TX	VT
SURROGATE	MD	GA	AR	AL	CT	AR	NH

Table 6: Summary of state level impacts from processed 2015 NO_3 state-wide emissions using Q/d

Contrib. State	*NO_X (Annual Tons)*	*Acadia*	*Brigantine*	*Great Gulf*	*Lye Brook*	*Moosehorn*
AL	304,148	0.015	0.023	0.010	0.017	0.015
AR	193,075	0.014	0.019	0.014	0.015	0.013
CT	55,306	0.019	0.016	0.003	0.015	0.012
DC	7,263	0.002	0.006	0.001	0.002	0.001
DE	25,239	0.002	0.015	0.001	0.001	0.001
FL	497,837	0.026	0.021	0.004	0.011	0.006
GA	335,264	0.026	0.036	0.015	0.017	0.019
IA	186,490	0.019	0.016	0.016	0.017	0.014
IL	414,852	0.052	0.046	0.044	0.049	0.054
IN	344,858	0.036	0.035	0.031	0.035	0.037
KS	261,025	0.030	0.024	0.024	0.026	0.032
KY	256,751	0.020	0.037	0.014	0.024	0.019
LA	375,883	0.024	0.034	0.016	0.026	0.023
MA	111,784	0.060	0.023	0.011	0.014	0.035
MD	126,608	0.033	0.135	0.021	0.030	0.023
ME	49,090	0.256	0.019	0.029	0.011	0.108
MI	350,062	0.058	0.036	0.052	0.059	0.040
MN	239,171	0.019	0.012	0.003	0.021	0.004
MO	303,948	0.032	0.027	0.026	0.028	0.033
MS	144,231	0.006	0.009	0.004	0.007	0.006
NC	260,575	0.009	0.017	0.005	0.007	0.007
NE	175,037	0.013	0.010	0.011	0.011	0.009
NH	32,346	0.030	0.010	0.010	0.009	0.022
NJ	147,801	0.028	0.077	0.004	0.017	0.018
NY	306,614	0.124	0.183	0.112	0.219	0.107
OH	394,956	0.048	0.054	0.043	0.051	0.035
OK	328,105	0.027	0.030	0.021	0.022	0.028
PA	459,406	0.073	0.138	0.060	0.127	0.016
RI	23,814	0.009	0.005	0.002	0.002	0.002
SC	162,401	0.008	0.013	0.005	0.006	0.006
TN	245,434	0.012	0.020	0.009	0.014	0.011
TX	1,097,981	0.055	0.071	0.037	0.058	0.053
VA	259,624	0.025	0.065	0.015	0.020	0.018
VT	13,943	0.013	0.004	0.027	0.005	0.012
WI	211,154	0.046	0.025	0.039	0.042	0.033
WV	210,048	0.025	0.062	0.019	0.035	0.023
Total	***8,490,922***	***1.226***	***1.287***	***0.701***	***0.993***	***0.837***

Both techniques (Q/d and CALPUFF) provided estimates for potential visibility impacting masses. Rather than relying solely on one technique for identifying contributing states, both techniques were included by means of an average of each relative contribution calculation for NO_3 and SO_4. Since nitrates and sulfates have similar visibility impairment for similar ambient air concentrations, they weighted equally in the impact calculations and Q/D and CALPUFF results were also equally weighed when both were available. 2015 CALPUFF results were not available for the District of Columbia, Florida, Louisiana, Mississippi, Rhode Island, Texas, and Vermont so only Q/d results were considered for those states.

Table 7 provides average relative percent contributions for each analyzed state to five MANE-VU Class I Areas. The scores for the 36 states total 100 (or 100%). States listed towards the top of the table (in orange shading) are each estimated to contribute 3 percent or greater of the 36 state total contributions. States in the pink shade contribute 2 to 3 percent and states listed in green contribute less than 2 percent in this ranking. In addition, the table provides the maximum percentage that a state contributes any Class I area in MANE-VU and the average mass estimated by the four methods. The column furthest to the right provides a relative mass factor of NO_3 and SO_4 combined which was used as a filter to ensure the major NO_3 and SO_4 mass contributing states are identified and also to determine if a state contributing a relatively low amount of mass was identified as a contributing state at one or more of the MANE-VU Class I Areas. Figure 1 through Figure 5 provide maps of these results for five MANE-VU Class I Areas.

Table 7: Percent Mass-Weighted Sulfate and Nitrate Contribution for top 36 Eastern States to all MANE-VU Class I areas consolidated (maximum to any Class I area), individual MANE-VU Class I areas, and average contributed mass (mass factor)

Rank	Maximum		Acadia		Brigantine		Great Gulf		Lye Brook		Moosehorn		Mass Factor	
1	PA	20.0	PA	12.4	PA	19.9	PA	15.6	PA	20.0	PA	10.5	PA	2.11
2	OH	11.3	OH	10.1	OH	8.8	OH	10.9	OH	11.3	OH	10.2	OH	1.06
3	NY	10.0	ME	8.3	MD	6.5	IN	8.0	NY	10.0	IN	8.0	IN	0.64
4	ME	8.3	IN	6.9	WV	6.4	NY	7.6	IN	7.4	TX	6.3	WV	0.61
5	IN	8.0	MI	6.0	NY	6.1	MI	6.6	TX	5.4	MI	6.0	MI	0.54
6	MI	6.6	NY	5.8	IN	5.4	TX	4.9	WV	5.3	NY	5.9	VA	0.47
7	MD	6.5	TX	4.7	TX	5.1	WV	4.7	MI	5.1	ME	5.6	KY	0.47
8	WV	6.4	MA	4.4	VA	4.8	IL	3.7	KY	4.2	WV	4.8	TX	0.44
9	TX	6.3	WV	3.9	KY	4.7	NH	3.7	IL	2.7	KY	4.2	NY	0.42
10	VA	4.8	NH	3.4	MI	4.5	KY	3.6	MO	2.5	IL	3.9	MD	0.40
11	KY	4.7	KY	3.4	NC	2.7	MO	3.1	LA	2.4	MA	3.4	NC	0.34
12	MA	4.4	IL	2.8	AL	2.6	ME	2.9	VA	2.4	MO	3.3	MA	0.27
13	IL	3.9	NC	2.7	LA	2.5	WI	2.6	NC	2.3	NH	3.1	NH	0.26
14	NH	3.7	MD	2.7	NJ	2.2	LA	2.2	MD	2.3	LA)	2.8	ME	0.25
15	MO	3.3	VA	2.5	IL	2.1	VA	2.1	AL	2.03	MD	2.6	AL	0.22
16	LA	2.8	MO	2.4	TN	2.01	NC	2.1	WI	1.9	AL	2.5	LA	0.21
17	NC	2.7	AL	2.2	GA	1.97	MD	2.1	OK	1.6	VA	2.4	TN	0.18
18	AL	2.6	FL	2.1	MO	1.9	VT	2.1	ME	1.6	NC	2.2	GA	0.17
19	WI	2.6	LA	2.1	FL	1.5	AL	1.8	TN	1.5	OK	1.8	MO	0.16
20	NJ	2.2	GA	1.9	MA	1.4	OK	1.8	GA	1.3	WI	1.8	FL	0.13
21	FL	2.1	WI	1.8	OK	1.4	MA	1.8	IA	1.2	TN	1.7	IL	0.12
22	VT	2.1	TN	1.5	NH	1.1	GA	1.8	MA	1.2	GA	1.7	OK	0.12
23	TN	2.01	IA	1.5	NE	1.0	IA	1.7	CT	1.2	IA	1.5	VT	0.09
24	GA	1.97	CT	1.3	AR	1.0	AR	1.3	AR	1.2	CT	1.4	NJ	0.09
25	OK	1.8	OK	1.2	CT	1.0	TN	1.3	NH	1.1	AR	1.4	IA	0.07
26	IA	1.7	AR	1.2	WI	0.9	KS	1.0	MN	1.0	KS	1.2	WI	0.07
27	CT	1.4	NJ	1.0	ME	0.9	NE	0.8	FL	1.0	NJ	0.9	CT	0.07
28	AR	1.4	MN	0.9	IA	0.9	CT	0.7	KS	0.8	MS	0.8	MS	0.07
29	KS	1.2	KS	0.8	SC	0.8	MS	0.7	NJ	0.8	NE	0.8	AR	0.06
30	NE	1.0	NE	0.8	MS	0.8	SC	0.5	MS	0.7	VT	0.8	SC	0.05
31	MN	1.0	SC	0.8	DE	0.6	MN	0.5	NE	0.6	SC	0.8	MN	0.04
32	MS	0.8	MS	0.6	KS	0.6	FL	0.5	SC	0.5	FL	0.7	NE	0.03
33	SC	0.8	VT	0.6	MN	0.6	NJ	0.4	VT	0.3	MN	0.5	RI	0.02
34	DE	0.6	RI	0.5	RI	0.3	RI	0.2	RI	0.2	DE	0.2	KS	0.02
35	RI	0.5	DE	0.2	DC	0.2	DE	0.2	DE	0.1	RI	0.1	DE	0.02
36	DC	0.2	DC	0.1	VT	0.2	DC	0.1	DC	0.1	DC	0.1	DC	0.016

Figure 1: States Contributing to 2011 Visibility Impairment at Acadia Based on Mass Weighting Analysis

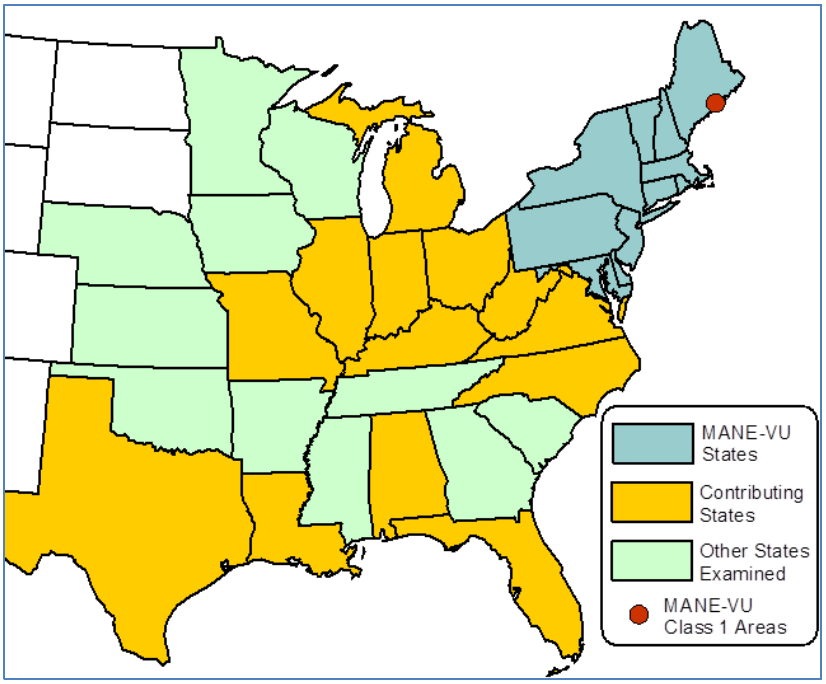


Figure 2: States Contributing to 2011 Visibility Impairment at Brigantine Based on Mass Weighting Analysis

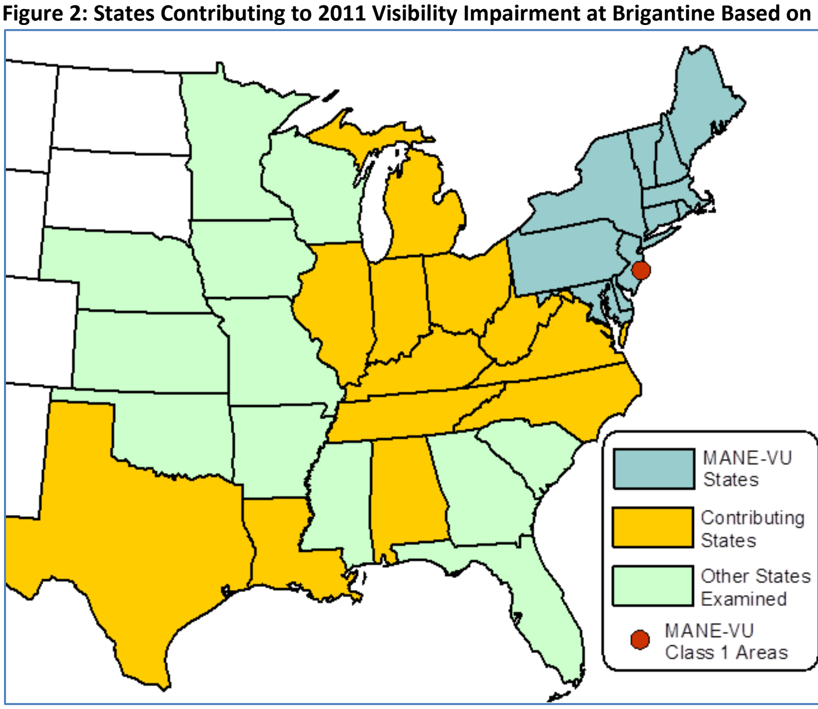


Figure 3: States Contributing to 2011 Visibility Impairment at Great Gulf Based on Mass Weighting Analysis

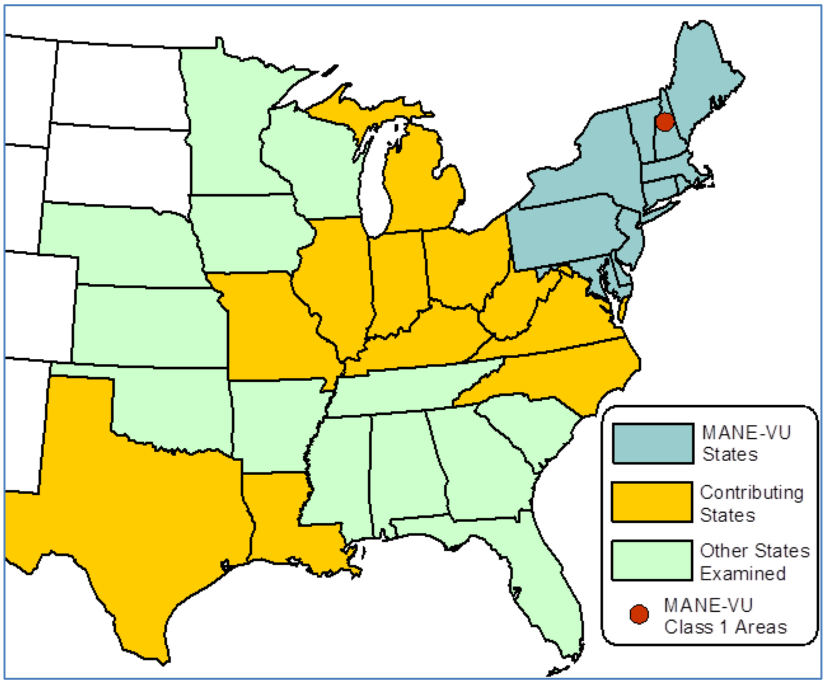


Figure 4: States Contributing to 2011 Visibility Impairment at Lye Brook Based on Mass Weighting Analysis

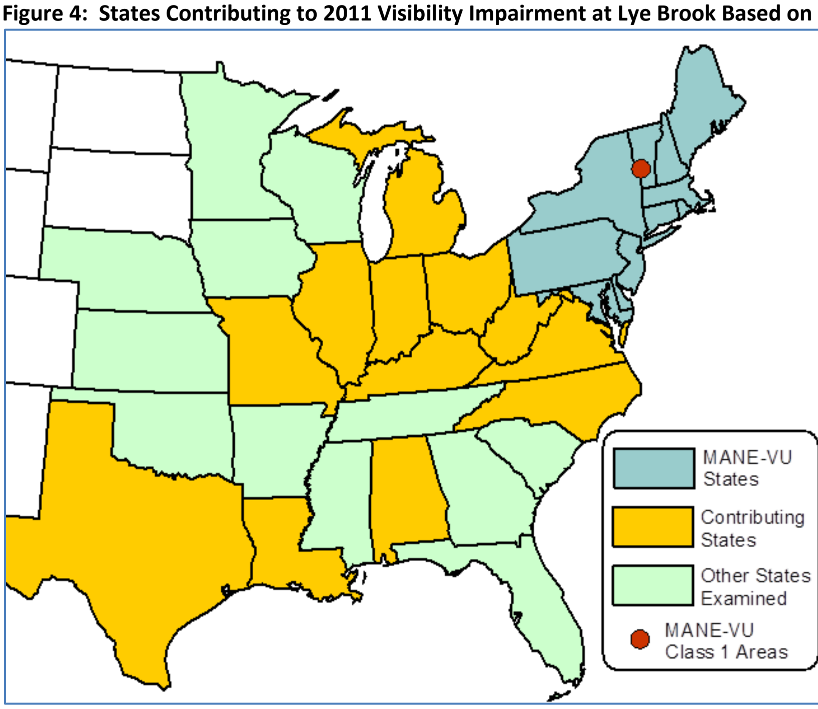


Figure 5: States Contributing to 2011 Visibility Impairment at Moosehorn Based on Mass Weighting Analysis

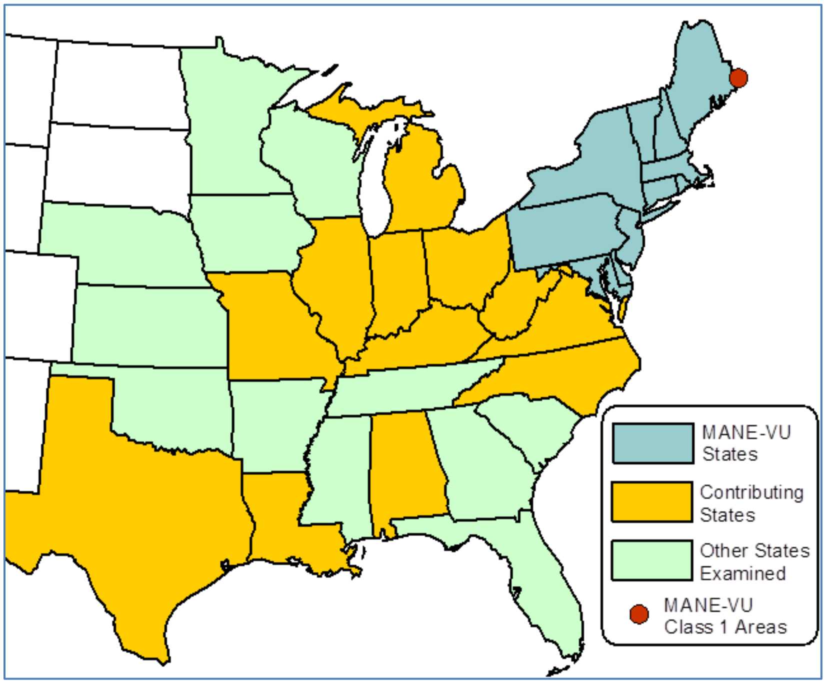
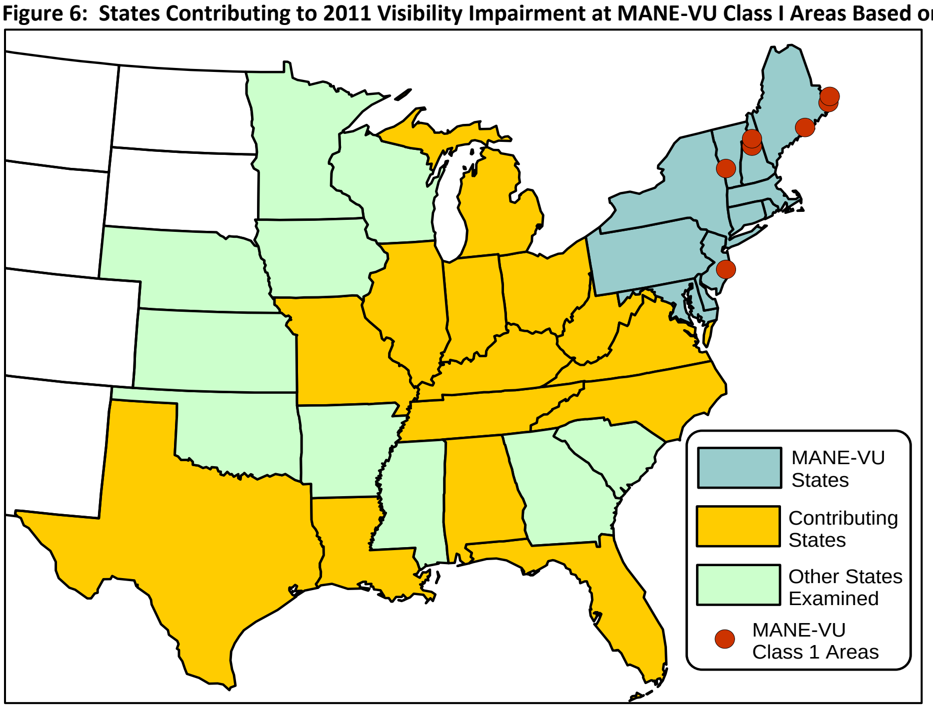


Figure 6 provides a consolidated map for the five MANE-VU Class I Areas (Acadia, Brigantine, Great Gulf, Lye Brook, and Moosehorn). If a state was estimated to contribute two percent or more at any of the five Class I Areas it was considered to be a contributing state. In addition, states were removed from consideration if their mass factor was below 1% (0.01 μg/m^3).

Figure 6: States Contributing to 2011 Visibility Impairment at MANE-VU Class I Areas Based on Mass Weighting Analysis



Trajectory Analysis
A trajectory analysis was also conducted by MANE-VU to better understand the source areas of the country where wind patterns transported emissions during the 20% most impaired visibility days in a MANE-VU Class I area. The analysis considered the 20% most impaired visibility days during 2002, 2011 and 2015 at each of the MANE-VU Class I Areas, excepting Lye Brook in 2015 where 20% most impaired days were not available so the 20% worst visibility days were used. Details of this analysis are contained in a separate report.[14] Having this analysis provides a qualitative opportunity to cross check the reasonability for including states highlighted in Figure 6 in the MANE-VU 2018 SIP consultation process.

The 500m trajectories were modeled by NOAA's HYSPLIT model, which was consistent with analyses conducted in the previous planning period.[15] 72-hour back trajectories were created 4 times per day at 3AM & PM and 9AM & PM. 2002 trajectories used EDAS 89 km MET and 2011 and 2015 used 40 km. Grid cells are 25 x 25 miles. Examples of the back trajectories for Acadia and Brigantine are Figure 7 and Figure 8. In order to determine how potential contributing states align with 72-hour back trajectories on 20% most impaired visibility days, percentages of trajectories per state were calculated.

Figure 7: Trajectory analyses of Acadia National Park most impaired days during 2015

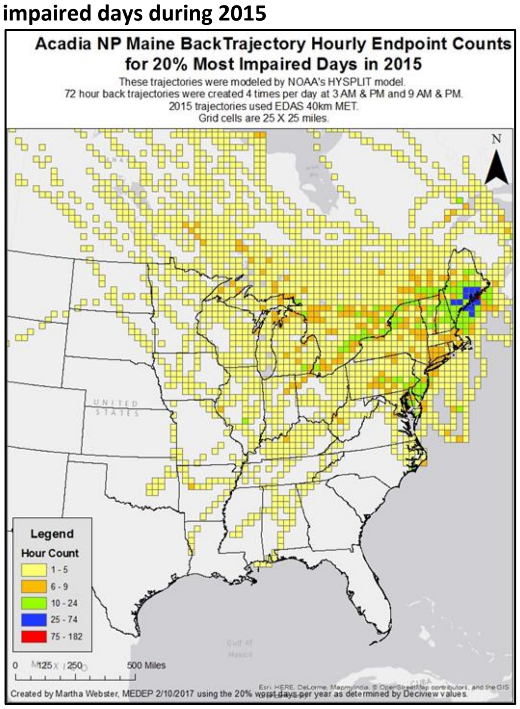
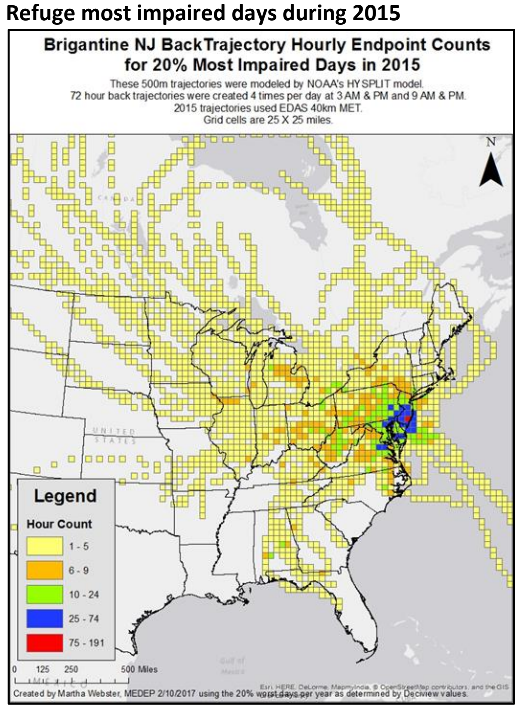


Figure 8: Trajectory analyses of Brigantine National Wildlife Refuge most impaired days during 2015



[14] Mid-Atlantic Northeast Visibility Union, *Regional Haze Metrics Trends and HYSPLIT Trajectory Analyses*.
[15] NESCAUM, *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States*.

In general, the trajectories support the results from the consolidated identification of contributing states. There is strong support for consultation with states located to the west and immediate south of the MANE-VU area. States of Indiana, Illinois, Kentucky, Maryland, Michigan, Missouri, New York, Ohio, Pennsylvania, Virginia and West Virginia were strongly tied to trajectories on 20% most impaired visibility days at each of the five MANE-VU Class I Areas assessed. Trajectory analyses further suggest that Wisconsin and Iowa are frequently upwind on many 20% most impaired visibility days. Modeling suggests that Wisconsin had enough emissions to qualify as a 2% regional haze contributor in 2011, but Iowa did not produce enough emissions to reach the 2% contribution threshold.

20% most impaired visibility day trajectories to the MANE-VU Class I Areas passed over the southern states less frequently than they did with states to the west and immediate south of the OTR. However in virtually all cases, at least one trajectory passed over other states that were identified by modeling as being 2 and 3 percent contributing states. This enables enough total emission contribution to cause a 20% most impaired visibility day.

It appears that the 20% most impaired visibility days at MANE-VU Class I areas are dominated by the clustering of large contributing states which offer a larger total mass of emissions than states along other trajectories. This includes most of the states identified by modeling as contributing states to MANE-VU Class I area visibility impairment. Beyond these states, modeling identified Alabama, Florida, Louisiana and Texas as 2% contributing states, which suggests they have the potential with their actual emissions to cause notable visibility impairment. In each case, trajectory analyses identified weaker connections on 20% most impaired visibility days in the MANE-VU region. These states are relatively isolated from other states identified by modeling as being larger visibility impacting states, and thus lack a cumulative impact and frequency that a clustering of higher emitting states have in order to create 20% most impaired visibility days. When a 20% most impaired visibility day trajectory does pass over Alabama, Florida, Louisiana or Texas, it also passes over at least one of the other 2% contribution states, which likely adds enough additional pollutant mass to create a 20% most impaired visibility day.

Modeling and trajectory analyses appear to support Alabama, North Carolina and Tennessee as being 2% contribution states. Each has sufficient emissions to cause some degree of visibility impact in the MANE-VU area and the trajectories suggest a connection on 20% most impaired visibility days, even if they are not as frequent as other states.

In summary, trajectory analysis supports the list of states identified in Table 7 by the consolidated modeling effort for the purpose of initiating the regional haze consultation process.

Table 8: Percentage of Trajectories per State on 20% most impaired visibility days

State	Acadia			Brigantine			Great Gulf			Lye Brook			Moosehorn		
	2002	2011	2015	2002	2011	2015	2002	2011	2015	2002	2011	2015	2002	2011	2015
AL	0.27%	0.45%	0.65%	0.61%	0.00%	1.44%	0.07%	0.00%	0.67%	0.71%	0.42%	0.04%	0.40%	0.31%	0.48%
AR	0.25%	0.25%	0.50%	0.83%	0.52%	0.28%	0.38%	0.52%	0.00%	0.44%	0.00%	0.34%	0.64%	0.17%	0.25%
CT	0.78%	0.61%	0.79%	0.63%	0.24%	0.25%	0.81%	1.78%	0.61%	1.55%	1.60%	2.33%	0.71%	0.57%	0.28%
DC	0.00%	0.00%	0.00%	0.03%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%
DE	0.16%	0.10%	0.29%	1.10%	1.27%	1.58%	0.06%	0.11%	0.02%	0.38%	0.29%	0.31%	0.20%	0.06%	0.29%
FL	0.37%	0.38%	0.01%	0.47%	0.00%	0.48%	0.00%	0.00%	0.00%	0.24%	0.13%	0.00%	0.25%	0.17%	0.09%
GA	0.28%	0.33%	0.07%	0.36%	0.06%	0.78%	0.33%	0.00%	0.15%	0.29%	0.41%	0.27%	0.58%	0.38%	0.06%
IA	0.59%	0.65%	0.65%	1.40%	1.57%	1.19%	0.58%	0.77%	1.05%	1.57%	0.00%	0.57%	0.52%	0.60%	0.63%
IL	1.14%	1.11%	1.66%	1.93%	3.46%	2.48%	1.72%	1.65%	1.37%	2.94%	0.44%	2.82%	1.31%	0.73%	1.35%
IN	0.82%	1.44%	1.01%	1.78%	3.63%	2.19%	1.23%	1.48%	1.15%	3.79%	0.83%	2.12%	1.07%	1.15%	1.02%
KS	0.58%	0.17%	0.07%	0.47%	0.30%	0.25%	0.13%	0.21%	0.00%	0.26%	0.00%	0.18%	0.22%	0.58%	0.52%
KY	1.01%	0.72%	1.15%	1.60%	1.36%	1.54%	1.63%	1.01%	1.53%	1.54%	1.39%	2.03%	0.89%	0.83%	0.81%
LA	0.00%	0.32%	0.06%	0.17%	0.06%	0.00%	0.01%	0.00%	0.10%	0.02%	0.11%	0.30%	0.09%	0.35%	0.00%
MA	2.27%	1.36%	0.82%	0.27%	0.37%	0.16%	1.30%	2.48%	1.56%	1.25%	2.87%	2.07%	1.69%	1.42%	0.64%
MD	0.70%	0.23%	0.84%	3.10%	2.55%	3.78%	0.32%	0.98%	0.44%	1.34%	1.94%	1.70%	0.35%	0.15%	0.95%
ME	9.23%	9.22%	9.63%	0.27%	0.03%	0.39%	1.89%	2.95%	3.05%	0.17%	0.67%	0.46%	15.72%	12.95%	11.52%
MI	2.06%	2.31%	3.96%	3.43%	5.32%	3.32%	2.24%	2.35%	3.36%	5.28%	2.09%	2.67%	1.37%	1.26%	3.38%
MN	1.17%	0.64%	1.25%	1.67%	1.02%	1.80%	1.10%	0.38%	1.88%	1.72%	0.47%	0.72%	0.35%	0.92%	0.64%
MO	1.51%	0.20%	0.28%	1.75%	0.96%	1.03%	1.14%	0.86%	0.49%	0.95%	0.00%	1.76%	0.55%	0.28%	0.65%
MS	0.38%	0.56%	0.15%	1.05%	0.34%	0.00%	0.14%	0.36%	0.21%	0.59%	0.29%	0.24%	0.45%	0.29%	0.22%
NC	0.73%	0.95%	0.55%	3.11%	1.54%	2.00%	0.77%	0.47%	0.00%	1.21%	1.08%	1.84%	0.38%	1.00%	1.22%
NE	0.00%	0.06%	0.00%	0.52%	0.43%	0.20%	0.46%	0.11%	0.31%	0.21%	0.00%	0.18%	0.03%	0.47%	0.25%
NH	2.57%	3.12%	1.92%	0.11%	0.51%	0.19%	6.97%	8.92%	8.05%	0.17%	0.42%	0.70%	2.22%	2.17%	1.09%
NJ	0.56%	0.91%	1.07%	7.19%	6.47%	8.02%	1.00%	0.73%	0.36%	2.73%	1.37%	1.87%	1.08%	0.42%	0.55%
NY	6.77%	6.82%	5.08%	3.02%	4.29%	3.51%	14.83%	14.09%	11.57%	17.45%	22.11%	19.80%	8.70%	4.20%	4.25%
OH	1.97%	2.04%	1.37%	3.90%	5.42%	4.25%	4.42%	1.97%	2.45%	3.50%	2.51%	2.79%	1.86%	1.53%	1.25%
OK	0.92%	0.26%	0.22%	0.33%	0.19%	0.09%	0.00%	1.19%	0.00%	0.26%	0.00%	0.09%	0.06%	0.36%	0.36%
PA	3.83%	3.58%	4.21%	7.25%	13.58%	9.87%	6.52%	5.38%	3.84%	11.64%	9.65%	7.07%	2.67%	2.65%	2.30%
RI	0.11%	0.14%	0.10%	0.06%	0.04%	0.06%	0.14%	0.03%	0.16%	0.17%	0.13%	0.07%	0.10%	0.07%	0.04%
SC	0.27%	0.26%	0.00%	0.57%	0.00%	0.09%	1.14%	0.00%	0.00%	0.85%	0.31%	0.60%	0.33%	0.19%	0.06%
TN	0.47%	0.25%	0.37%	0.98%	0.46%	0.70%	0.46%	1.03%	0.99%	0.47%	0.91%	0.70%	0.74%	0.32%	0.48%
TX	0.23%	0.74%	0.03%	0.00%	0.07%	0.03%	0.00%	0.05%	0.00%	0.03%	0.00%	0.00%	0.25%	0.20%	0.38%
VA	0.82%	0.68%	0.51%	5.22%	4.05%	5.51%	0.98%	1.11%	1.15%	1.34%	3.57%	2.84%	1.04%	0.25%	1.95%
VT	2.07%	2.08%	1.63%	0.13%	0.30%	0.12%	4.86%	7.60%	5.04%	2.66%	3.93%	3.94%	1.40%	0.90%	1.16%
WI	2.07%	0.61%	1.65%	4.09%	4.98%	2.06%	1.24%	0.83%	1.93%	2.75%	0.62%	0.88%	1.33%	0.60%	1.99%
WV	0.73%	0.36%	0.59%	2.47%	1.95%	3.64%	1.24%	0.62%	1.02%	0.81%	2.61%	1.45%	0.49%	0.32%	0.63%

Summary

MANE-VU considered the results of a weight-of-evidence approach that looked at Q/d calculations, CALPUFF modeling, and HYSPLIT back trajectories in assessing which upwind states contributed to visibility impairment at a level that it would be reasonable to consult with. In conducting this assessment MANE-VU considered emissions from EGUs and ICI units predominately, but also included state-wide emissions to account for the impact of area and mobile sources. Since impairment from winter nitrates have increased percentage wise in several MANE-VU Class I areas, SO_2 and NO_X emissions were both considered. 2015 emissions were either directly considered or estimated so that recent changes in the make-up of the emissions inventory were considered. When these factors were considered, states that contributed 2% or more of the visibility impairment and had an average mass impact of over 1% (0.01 $\mu g/m^3$) were considered to be necessary to consult with as part of the Regional Haze SIP process. This lead to the 14 upwind states in 3 upwind RPOs in Table 9 being considered necessary to consult with.

Table 9: States in each upwind RPO that are considered contributing to a MANE-VU Class I area

LADCO	Illinois	Indiana	Ohio	Michigan			
SESARM	Alabama	Florida	Kentucky	N. Carolina	Tennessee	Virginia	W. Virginia
CENSARA	Louisiana	Missouri	Texas				

APPENDIX F

Inter-RPO State/Tribal and FLM Consultation Framework

I. Introduction

In the preamble for the Regional Haze Regulations ("Rule"), published in the Federal Register on July 1, 1999, the U.S. Environmental Protection Agency ("EPA") strongly encourages States and Tribes to participate in the regional planning process. (See, 64 FR 35714). The preamble also describes the role of regional planning organizations indicating that, "[t]he EPA expects that much of the consultation, apportionment demonstrations, and technical documentation will be facilitated and developed by regional planning organizations." (See, 64 FR 35735). The goals of instituting consultation procedures are mainly:

1. To help develop a common technical basis and apportionment for long-term strategies that could be approved by individual state participants and translated into regional haze SIPs for submission to EPA,
2. To demonstrate that states are working together to develop acceptable approaches for addressing regional visibility problems to which they jointly contribute, and
3. To provide information on areas of agreement and disagreement among States that the Administrator will take into account in the review of a State's implementation plan to determine whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions.

For the purposes of this Inter-Regional Planning Organization ("RPO") Consultation Framework, the term "consultation" refers solely to the consultation requirements, of the Regional Haze Rule, and is not intended to refer to or address theTribal government/Federal government consultation process.

II. Goal of Inter-RPO Consultation Framework

The primary goal of this Inter-RPO Consultation Framework is to delineate, by consensus, the basic consultation requirements for states, tribes, RPOs, and Federal Land Managers ("FLMs") required under 40 CFR Part 51, during the regional haze State Implementation Plan (SIP) development process. The consultation process is a documented process that must be included in the "core requirements" of the Regional Haze SIP submittal. In fact, the preamble of the Regional Haze Rule states that "[t]he EPA is requiring States to document their analyses, including **any** consultations with other States in support of their conclusions…." (64 FR 35721). (emphasis added). Formal consultation, as required by the Regional Haze Rules in 40 CFR Part 51, Subpart P, may be built upon prior, documented informal consultations.

The consultation process explicitly applies to the development of the first regional haze implementation plans due to EPA in 2008 as well as comprehensive periodic revisions every 10 years thereafter. The Consultation Framework may also be useful as states develop their required periodic reports describing progress towards the reasonable progress goals which are due every 5 years.

One of the key purposes of the consultation framework is to better define the consultation process within the context of regional haze planning, and to create greater certainty and understanding among RPOs. The process should be consistent across RPOs, and be well documented such that it positively contributes to improving visibility in mandatory Class 1 areas.

III. Consultation Requirements Specified in 40 CFR Part 51, Subpart P (relating to protection of visibility)

A. Development of the Reasonable Progress Goal:

Section 51.308(d) of the Regional Haze Rule specifies that "–[I]n developing each reasonable progress goal, the State must consult with those States which may reasonably be anticipated to cause or contribute to visibility impairment in the mandatory Class I Federal area. In any situation in which the State cannot agree with another such State or group of States that a goal provides for reasonable progress, the State must describe in its submittal the actions taken to resolve the disagreement. In reviewing the State's implementation plan submittal, the [EPA] Administrator will take this information into account in determining whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions." [40 CFR §51.308(d)(1)(iv)].

B. Development of Long-term Strategy:

The Regional Haze Rule provides that – "[w]here the State has emissions that are reasonably anticipated to contribute to visibility impairment in any mandatory Class I Federal area located in another State or States, the State must consult with the other State(s) in order to develop coordinated emission management strategies. The State must consult with any other State having emissions that are reasonably anticipated to contribute to visibility impairment in any mandatory Class I Federal area within the State." [40 CFR § 51.308(d)(3)(i)].

C. State and Federal Land Manager Coordination:

–According to Section 51.308(i)(2) of the Regional Haze Rule, " "[t]he State must provide the Federal Land Manager [FLM] with an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on an implementation plan (or plan revision) for regional haze required by this [Subpart P]". The purpose of the consultation in person is to allow the affected FLM to discuss: (1) The FLM's "assessment of impairment of visibility in any mandatory Class I Federal area;" and (2) "Recommendations on the development of the reasonable progress goal and on the development and implementation of strategies to address visibility impairment." [40 CFR §51.308(i)(2)].

The Rule also provides that – "[t]he plan (or plan revision) must provide procedures for continuing consultation between the State and Federal Land Manager on the implementation of the visibility protection program required by[Subpart P], including development and review of implementation plan revisions and 5-year progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in mandatory Class I Federal areas." [40 CFR §51.308(i)(4)].

IV. Types of Consultations

A.) State/Tribal-to-State/Tribal Inter-RPO Consultations.
B.) State/Tribal-to-Federal Land Manager (FLM) Consultations.

V. Suggested Discussion Topics during consultation process

A. State-to-State and State-Tribal regional haze consultations are required for the development of the reasonable progress goal and long-term strategies. Suggested discussion topics include the following:

1) Reasonable Progress Goal:

a. Natural background
b. Baseline conditions
c. Uniform Rate of Visibility Improvement
d. Contribution determination
e. Other factors (regarding reasonable progress goals)

2) Long-term Strategies:

a. Emissions inventory/smoke management plans
b. Model performance
c. Control measures
d. Monitoring strategy

B. Thepreliminary listing of discussion topics is subject to change based on the recommendations of States/Tribes, RPOs and federal participants including EPA and the FMLs.

VI. Consultation Principles

1) All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.
2) Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.
3) States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination and cooperation among jurisdictions but does not establish binding obligation on the part of participating agencies.
4) There are two areas which require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.

5) During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.
6) Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.
7) The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus between the State with a Class I area and other States affecting that area. In instances where the State with the Class I area can not agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR §51.308(d)(1)(iv).
8) All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area, must provide the Federal Land Manager ("FLM") agency for that Class I area with an opportunity for consultation, in person, on their regional haze implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLM's comments on the reasonable progress goals and related implementation plans. As required under 40 CFR §51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.
9) States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR §51.308(i) and other consultation procedures developed by consensus..
10) The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.
11) The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPO's/States'/Tribes' requests for comments.

VII. Consultation Processes

A) Formal State/Tribal-to-State/Tribal Inter-RPO Consultations*:

1) Any State or group of States initiating a consultation with another State/States on visibility-related concerns needs to designate a contact person to handle expeditiously the administrative aspects of the consultation, including scheduling and notifying participants, and providing documentation.
2) The State initiating the consultation is responsible for coordination of all aspects of the consultation.
3) This process is designed chiefly to apply to consultations involving States consulting across RPO lines, whether the consultation is initiated by one or more Class I States or by a State or group of States without a Class I area. States consulting with other States within the same RPO are encouraged to follow this process to maintain consistency and achieve good documentation of outcomes.

4) It is assumed that most consultations will be initiated by States with Class I areas. All States (or their RPOs on their behalf) are responsible for initiating the required consultation with affected FLMs according to the procedures in 40 CFR §51.308(i) and this document. At the request of the State or group of States initiating the consultation, the RPO for the region in which the Class I area is located may serve as facilitator to help the Class I States consult with other states and participating tribes. The RPO will assist with all administrative, logistical and documentation aspects of the consultation process for the State or States that have requested facilitation by their RPO.
5) Consultations are a government-to-government transaction. Stakeholders are not participants in these consultations.
6) The consultation process will occur as part of the regional haze SIP development cycle. It may also be initiated as a part of a mid-course adjustment in the middle of a SIP cycle. This Framework does not apply to individual regulatory, enforcement or permitting activities and should not be understood to be of any relevance to those activities.
7) The consultation process as a whole may involve several types of meetings, conference calls, and information sharing. An initial consultation will usually occur in the form of a conference call among all parties, unless the parties agree to an alternative format.
8) The timing of consultations will be coordinated with the production of component work products and the process of offering opportunities for comments on those products. All parties will be sensitive to the time line of the Class I area State or Tribe.
9) For consultations on the regional haze reasonable progress goal and the long-term strategy, and on their component topics, the Class I States may request that an initial consultation be conducted via conference call. When feasible, web meeting tools or videoconferencing technology may be used to enable parties to share information more easily.
10) Preparation and notification:
    a. The State designates a contact (which may be the RPP Director/staff) that will have responsibility for scheduling and notifying all parties about the consultation, and making sure all necessary materials are promptly provided to the participants.
    b. Who gets notified: Those parties associated with what is indicated in the rule as "reasonably anticipated to contribute to a Class I area" – more specifically, the appropriate State Commissioners, State Air Directors, and RPO designated contacts. Affected FLM representative(s) and EPA representative(s) will also be invited to participate in such consultations. If appropriate, the State Commissioner or the State Air Director may wish to notify appropriate state or local government staff regarding any and all consultations.
    c. How scheduled: the State contact or RPO designee sends out an e-mail to the other State or States to arrange for available dates/times. Once arrangements are settled, the initiating State or its RPO designee then sends out formal notification via certified mail with an agenda, list of participants and call for additional materials. Thirty (30) calendar days will be allowed for all parties

to review the technical materials prior to the date of a formal consultation unless otherwise all parties mutually agree, in writing, to adhere to a longer or shorter time frame.

11) During consultation, the participants should:
    a. Explain the issue/proposal and supporting technical information
    b. Provide answers to clarifying questions
    c. Request that any issues that are not addressed or resolved be submitted in writing to the State contact and RPO designee.
    d. The State contact or RPO designee will takes notes and prepares a summary of the consultation.
12) Post-consultation and follow up:
    a. The summary will be distributed for review and comment, along with the consultation notification e-mail and letter, agenda, and list of participants. The finalized documentation will be provided to all participants and other interested stakeholders upon request. The summary notes for any consultation should indicate areas/items of agreement and disagreement.
    b. The State contact or RPO designee is responsible for compiling an ongoing record of the consultation, including any additional meetings/calls that occur on outstanding concerns. The State contact or RPO designee will distribute documentation on additional meetings/calls to all relevant parties.
    c. Issues that cannot be further discussed or resolved without additional information can be taken through pertinent committees involving stakeholders to get feedback.
13) Each RPO will develop a consultation page on their website where the documentation will be posted. Each RPO will post all documentation on behalf of the initiating State.

*Note: No specifics on Tribal consultations are referred to in this section at this time.

VIII. Formal State/Tribal-to-FLM Consultation Process:

A. As required under 40 CFR §51.308(i)(2), the state must provide the FLM with an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on any regional haze implementation plan (or plan revision).
B. As previously described in VII(A) above, a State or group of States initiating a consultation with the FLM may request that their RPO serves as a facilitator for such consultations.
C. As noted in the process described in VII(A) above, the affected FLMs will be invited to participate in the formal State/Tribal to State/Tribal consultations that occur on reasonable progress goals and the long-term strategy. I
D. Unless required pursuant to applicable statute or regulation, nothing herein should be interpreted to require consultation with FLM with respect to any regulatory, enforcement or permitting actions.
E. FLM will be urged to respond in an efficient and timely fashion to the opportunity to consult on a regional haze plan and on the specifics of the plan.

APPENDIX G

MANE - VU
Mid-Atlantic/Northeast Visibility Union

MANE-VU Regional Haze Consultation Report

July 27, 2018

MANE-VU Technical Support Committee

Contents

Background

The Regional Haze Rule and the Clean Air Act (CAA) require consultation between the states, tribal nations and Federal Land Managers (FLMs) responsible for managing Class I areas. Class I area states must consult with contributing states to coordinate emission management strategies to achieve reasonable progress during each planning period[1]. Since regional haze often results from pollution emitted across broad regions, this multi-state approach to air quality planning was designed to aid in developing cost-effective controls for regional haze. The Mid-Atlantic & Northeast Visibility Union (MANE-VU) was established to facilitate regional haze planning in the region extending from the District of Columbia through Maine. For the current state implementation plan (SIP) planning cycle, MANE-VU assisted and facilitated the consultation process among its members and with contributing upwind states.

Consultation between the states is part of the process to determine reasonable progress goals. Both upwind and downwind Class I area receptor states must participate in consultation if the state is reasonably anticipated to contribute to visibility impairment in a federally designated Class I area. The consultation process is needed to ensure that reasonable emission reductions are pursued for sources/sectors that impact visibility in the seven Class I areas in the MANE-VU region. This consultation process may also consider visibility impairment contribution of emission sources within MANE-VU states to Class I areas located outside of the region (namely, Dolly Sods, Otter Creek, James River Face, and Shenandoah).

MANE-VU facilitated the consultation process in two phases:

1. Intra-RPO Consultation among MANE-VU members (states and tribal nations);
2. Inter-RPO Consultation between MANE-VU members and non-MANE-VU states identified as contributing to visibility impairment.[2]

EPA and the FLMs were invited to participate in both consultation phases.

Both phases of consultation primarily took place through webinars, however in-person meetings were included during the Intra-RPO consultation when regular OTC/MANE-VU meetings were conveniently scheduled. For a specific timeline of consultation webinars and meetings, please see the Consultation Schedule section of this document. A formal "Ask" to guide the inter-RPO consultation phase was developed during the intra-RPO consultation phase and adopted during the August 25, 2017 consultation. The consultation timeline was based on MANE-VU targeting a regional haze SIP submittal date of July 2018.

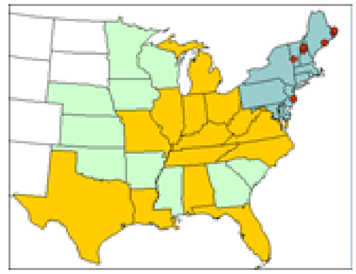
Consultation began in February 2017 and continued through March 2018. Inter-RPO consultation took place after Intra-RPO consultation was complete and consisted of webinar meetings. Inter-RPO consultation was conducted with states identified through the contribution assessment process[2] as contributing significantly to visibility impairment at MANE-VU Class I areas. Contributing states were invited to consult with MANE-VU beginning in October 2017. All MANE-VU states were invited for

[1] Requirement found in 40 C.F.R. §51.308(d)(3)(i) and 40 C.F.R. §51.308(d)(1)(iv)

[2] See the MANE-VU Technical Support Committee document titled, "Selection of States for MANE-VU Regional Haze Consultation (2018)."

consultation regardless of contribution levels. States outside of MANE-VU identified for consultation include:

Alabama	Missouri
Florida	North Carolina
Illinois	Ohio
Indiana	Tennessee
Kentucky	Texas
Louisiana	Virginia
Michigan	West Virginia



Contributing states were identified through the use of several screening tools including, but not limited to, CALPUFF modeling, Q/d analysis, and back-trajectory analysis. The objective of this technical work was to identify states and sources from which MANE-VU will pursue further analysis. This screening was intended to identify which states to invite to consultation, not a definitive list of which states are contributing. The MANE-VU Technical Support Committee refined and recommended selection criteria based on the technical work developed as part of the contribution assessment in order to finalize the inter-RPO consultation state list.

MANE-VU "Ask" for the Second Planning Period of Regional Haze SIPs

MANE-VU Class I area monitoring as of 2016 indicates that all MANE-VU Class I areas are ahead of the uniform rate of progress for visibility improvements by 2028. However, the regional haze rule requires developing a reasonable progress goal based on additional emissions reduction measures that are deemed reasonable for the next planning period, regardless of the uniform rate of progress. Furthermore, many of the visibility improvements observed to date are attributed to unenforceable changes in emissions, for example market conditions favoring natural gas over coal, and the potential remains for sources to revert back to fuels such as coal or oil with greater emissions of visibility-impairing pollutants. The 2017 MANE-VU Ask presents measures that MANE-VU considers reasonable for the 2018-2028 planning period.

Additional technical analyses for the reasonableness of controls included in the 2017MANE-VU Ask were performed. The MANE-VU Technical Support Committee (TSC) facilitated four-factor analysis of select sectors. Four-factor analysis is intended to identify control measures that are necessary to make reasonable progress toward natural visibility conditions at Class I areas based on, 1) cost of compliance, 2) time necessary for compliance, 3) energy and non-air quality environmental impacts of compliance, and 4) the remaining useful life of any potentially affected major or minor stationary source or group of sources.

A briefing document describing sources MANE-VU considers significant and asking to demonstrate reasonable control was provided to the states prior to the final intra- and inter-RPO consultation webinars to review the technical and policy progress to date.

Consultation with Federal Land Managers

The regional haze rule requires consultation to occur with FLMs early enough to allow the state time for full consideration of FLM input, recommended as 120 days, but no fewer than 60 days prior to a public hearing or comment period, and to include discussion of the FLM assessment of the visibility impairment and the recommendations on development of reasonable progress goals (RPGs).[3]

While each state is expected to conduct independent consultation with the FLMs later in the planning process, MANE-VU conducted webinars specifically for additional FLM consultation early in the SIP planning process concurrent with state-to-state consultation to address their input, beginning in February 2017, well before public hearings or other public comment opportunities. A briefing document was provided to the FLMs prior to the last webinar reviewing the technical and policy progress to date. This recommendation is in addition to consultation that includes the FLMs during intra-PRO consultation. The FLMs were invited to attend the intra- and inter-RPO consultations among states and were documented to have attended seven intra-RPO meetings and all inter-RPO meetings.

In addition, a consultation webinar with the FLMs was held prior to the in-person consultation at the May 2017 OTC/MANE-VU Air Directors meeting on April 21, 2017.

MANE-VU expects that all states and tribes included in the MANE-VU consultation process will provide a technical analysis in response to the MANE-VU Ask in their SIPs. Formal minutes of these meetings is provided in the section titled: Consultation session minutes and summaries, below.

Consultation with EPA

Consultation with EPA began early in the first Intra-RPO meeting with the MANE-VU Technical Support Committee on February 28, 2017, where Regions 1, 2, and 3 were represented. EPA continued to be invited to comment on MANE-VU analyses and compliance with the Regional Haze Rule throughout intra- and inter-RPO consultation phases. States will also have the opportunity to consider EPA input during the formal public comment period for their regional haze SIPs.

Development and consultation summary of the MANE-VU Ask

MANE-VU developed a conceptual model that illustrates that sulfates from sulfur dioxide (SO_2) emissions remain the primary driver behind visibility impairment in the region, while nitrates from oxides of nitrogen (NO_x) emissions play a more significant role than they had in the first planning period. MANE-VU chose to assess the contribution to visibility impairment by focusing on sulfates and including nitrates when feasible in a technically sound fashion.

Secondly, MANE-VU examined annual emission inventories to find emission sectors that should be considered for further analysis. Electric Generating Units (EGUs) emitting SO_2 and NO_X and industrial point sources emitting SO_2 were found to be sectors with high emissions that warranted further scrutiny. Mobile sources were not considered in this analysis because any ask concerning mobile sources would be made to EPA and not during the intra-RPO and inter-RPO consultation process among the states and tribes. MANE-VU member states agreed to a course of action that includes pursuing the adoption and implementation of the following emission management strategies. Each element of the "Ask" described below is followed by a brief discussion of situations and outcomes that led to consensus among MANE-VU states.

[3] 40 C.F.R. § 51.308(i)

Explanation of asks

1. "Electric Generating Units (EGUs) with a nameplate capacity larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - ensure the most effective use of control technologies on a year-round basis to consistently minimize emissions of haze precursors, or obtain equivalent alternative emission reductions."

The aim of the first Ask is to reduce year-round emissions by simply expanding the use of already-installed controls for which requirements are lacking that would otherwise ensure their year-round operation. This would help to mitigate visibility impairment due to winter-time NO_X emissions that have been shown to account for a greater proportion of visibility impairment on the 20% most impaired days. This Ask is a reasonable control strategy due to the use of existing equipment. During the consultation process, MANE-VU states worked collaboratively to define the EGU capacity threshold and honed the language that characterizes the desired operation of controls year-round. MANE-VU states ultimately came to consensus with the addition of an option to find alternative, equivalent emissions reductions.

2. "Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses (see attached listing) - perform a four-factor analysis for reasonable installation or upgrade to emission controls."

This Ask targets stationary sources that have the greatest contribution to visibility impairment at MANE-VU Class I areas, as modeled by MANE-VU. While this Ask does not suggest specific controls, it is considered reasonable to have the greatest contributors to visibility impairment conduct a four-factor analysis that would determine whether emission control measures should be pursued and what would be reasonable for each source. The MANE-VU states set a visibility-impairment threshold of 3 Mm^{-1} at any MANE-VU Class I area.

By requesting a four-factor analysis of these sources, a planned shutdown, or other factors, may be taken into account when determining what installation or upgrade of controls would be reasonable.

3. "Each MANE-VU State that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows: a. distillate oil to 0.0015% sulfur by weight (15 ppm), b. #4 residual oil within a range of 0.25 to 0.5% sulfur by weight, c. #6 residual oil within a range of 0.3 to 0.5% sulfur by weight."

This Ask is an extension of the original MANE-VU Ask on ultra-low sulfur fuel oil, specifically the second phase of more stringent sulfur content standards that have been implemented in many MANE-VU states. It was considered reasonable to request that all contributing states that have not already implemented these standards to pursue them as expeditiously as practicable. In the second, current iteration of the MANE-VU Ask, contributing states upwind of MANE-VU are also being requested to pursue this standard.

4. "EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels – pursue updating permits, enforceable agreements, and/or rules to lock-in lower emission rates for SO_2, NO_X and PM. The permit, enforcement agreement, and/or rule can allow for suspension of the lower emission rate during natural gas curtailment."

This ask was developed in an attempt to maintain the significant improvements in visibility during the first phase of the regional haze program achieved by natural gas taking the place of much of the fuel use previously coming from coal, but that has the potential to be lost should market conditions swing back to favor coal. The Federal Land Management agencies recommended that MANE-VU pursue control strategies to enforce these visibility gains.

The threshold of 250 MMBTU per hour heat input was based on prior BART analysis.

Concerns were raised about locking EGUs during periods of natural gas curtailment and an exception for this situation was added.

5. "Where emission rules have not been adopted, control NO_X emissions for peaking combustion turbines that have the potential to operate on high electric demand days by: a. Striving to meet NO_X emissions standard of no greater than 25 ppm at 15% O_2 for natural gas and 42 ppm at 15% O_2 for fuel oil but at a minimum meet NO_X emissions standard of no greater than 42 ppm at 15% O_2 for natural gas and 96 ppm at 15% O_2 for fuel oil, or b. Performing a four-factor analysis for reasonable installation or upgrade to emission controls, or c. Obtaining equivalent alternative emission reductions on high electric demand days.

High electric demand days are days when higher than usual electrical demands bring additional generation units online, many of which are infrequently operated and may have significantly higher emission rates than the rest of the generation fleet. Peaking combustion turbine is defined for the purposes of this "Ask" as a turbine capable of generating 15 megawatts or more, that commenced operation prior to May 1, 2007, is used to generate electricity all or part of which is delivered to the electric power distribution grid for commercial sale and that operated less than or equal to an average of 1752 hours (or 20%) per year during 2014 to 2016;"

This ask is only directed to the MANE-VU states and is not included in the Ask directed to upwind, potentially contributing states. This ask targets relatively small electric generating units that operate during a small proportion of the year on high electric demand days, but that tend to have higher emission rates per unit of energy produced. Targeting these units is considered reasonable due to MANE-VU analyses that show correlation between high electric demand days and the 20% most impaired days.

6. "Each State should consider and report in their SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar."

The purpose of this ask is to reduce emissions from energy generation by lowering overall usage through energy efficiency and promoting cleaner technologies. During the consultation process, the broadness and specificity of the language used was adjusted.

Consultation schedule

Date	Participant group	Description and consultation type (Intra- or Inter-RPO)
February 7, 2017	Air Directors Call	Introduction to Process & Planning
February 28, 2017	TSC Call	MANE-VU Intra-RPO Consultation #1
March 7, 2017	Air Directors Call	Update
March 28, 2017	TSC Call	MANE-VU Intra-RPO Consultation #2
April 11, 2017	TSC Meeting	MANE-VU Intra-RPO Consultation #3
April 21, 2017	FLM Call	MANE-VU Intra-RPO Consultation #4
April 25, 2017	TSC Call	MANE-VU Intra-RPO Consultation #5
May 9-11, 2017	Air Directors Meeting	MANE-VU Intra-RPO Consultation #6
May 30, 2017	TSC Call	MANE-VU Intra-RPO Consultation #6b
June 5, 2017	Annual Meeting Caucus	MANE-VU Intra-RPO Consultation #7
June 16, 2017	Air Directors Call	MANE-VU Intra-RPO Consultation #8
June 29, 2017	Commissioners Call	Briefing
July 24, 2017	Commissioners Call	MANE-VU Intra-RPO Consultation #9
August 4, 2017	Air Directors Call	MANE-VU Intra-RPO Consultation #10
August 9, 2017	Air Directors Call	MANE-VU Intra-RPO Consultation #11
August 25, 2017		MANE-VU Ask Signed
August 29, 2017	TSC Call	Update on signed Ask, not a consultation session.
September 7, 2017	TSC Meeting	Update
October 20, 2017	Technical staff and/or air directors	Inter-RPO Consultation #1, Introduction and Overview of MANE-VU analyses and Ask
December 1, 2017	Technical staff and/or air directors	Inter-Regional Consultation #2, Discussion of the Ask and listening to upwind states and FLM questions
December 18, 2017	Technical staff and/or air directors	Inter-Regional Consultation #3, overview of technical analyses behind the Ask
January 12, 2018	Technical staff and/or air directors	Inter-Regional Consultation #4, Reasonable Progress Overview
March 23, 2018	Commissioners	Consultation Wrap-up, Inter-RPO Consultation #5

Consultation session minutes and summaries

Please note that after Consultation #11 on August 9, 2017, an ask was removed from the Draft 2018 MANE-VU Ask resulting in subsequent asks being renumbered (see notes under Consultation #11).

MANE-VU Intra-RPO Consultation #1

Technical Support Committee Call
February 28, 2017

MANE-VU Intra-RPO Consultation #1 was held during the monthly MANE-VU Technical Support Committee call on February 28, 2017. The primary purpose of this consultation was to discuss the consultation schedule and the draft MANE-VU "Ask". Contribution assessment, back trajectories, CALPUFF, and synthesis analysis updates were also provided. The agencies that participated in MANE-VU Intra-RPO Consultation #1 are shown in the table below, and the bullet points that follow highlight the items that were discussed.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN[4]	OTC	EPA	FLM
X		X	X	X	X	X	X	X	X	X	X		X	1,2,3	X

- New Hampshire drafted a consultation schedule and reviewed it.
- The three upcoming meetings became part of the official consultation following the March TSC call.
- Consultation with outside RPOs intended to begin following the June Annual Meeting.
- The map was to be revised based on the analysis in "Selection of States for MANE-VU Regional Haze Consultation (2018)"
- The draft "Ask" looked at optimized NO_x and SO_2 annually, a four-factor analysis for top 10 EGUs or ICIs, expansion of the low sulfur distillate limit to 15 ppm, and achievement of a 90% reduction at the remaining sources from the 167 stacks.
- Maryland asked about improving $PM_{2.5}$ standards as part of the "Ask."
- Reports on ICI boilers and CHP that were completed might be useful as part of the "Ask."
- The Regional Haze Regulations state that the four-factor analysis is required by each state's own sources.
- The question was raised as to whether the top 10 sources are for each state or each Class I area.
- The four-factor workgroup will convene to review the old projects.
- The Ask needs to be clarified to make sure the wording is correct for the 15 ppm ask.

Preliminary 2018 MANE-VU "Ask." contents may include:

- EGUs with already installed NO_X and/or SO_2 controls, optimize their full operation
- Sources (top 10 - EGUs and ICIs) perform a four-factor analysis for reasonable installation or upgrade to BART-like emission controls
- Expand low sulfur distillate fuel oil program (all contributing states - MANE-VU and others) – down to 15 ppm (either phase-in by 2028 or meet a date)
- Achieve a 90% SO_2 reduction from 2002 levels at all remaining uncontrolled sources from the 2008 MANE-VU 167 stack Ask.

[4] TrN = Tribal Nations

Overview: There was some discussion of the technical contribution modeling, the Regional Haze Rule requirements for consultation, and preliminary points for developing the MANE-VU Ask.

MANE-VU Intra-RPO Consultation #2

Technical Support Committee Call
March 28, 2017

MANE-VU Intra-RPO Consultation #2 was held during the monthly MANE-VU Technical Support Committee call on March 28, 2017. The purpose of this consultation was to continue discussion of the consultation schedule and the items included in the MANE-VU "Ask". A specific call for FLM consultation was created at the request of the FLMs.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X		X		X	1,2	X

- More time was requested at the Committee Meeting for the consultation
- The FLMs requested adding in a specific call with FLM consultation to the schedule.
- The schedule was also expanded to reflect the Inter-RPO consultation process.
- Concerning the "Ask":
    - Item #1
        - Pennsylvania was concerned about the definition of optimization.
    - Item #2
        - Pennsylvania was also concerned about clarifying that 2011 emissions would be used for ICI boilers since more recent data was available for EGUs.
        - Maine suggested using Mm^{-1} instead for the cutoff rather than top 10 since some Class I areas are impacted less than others and Vermont will compile a new list.
        - New Jersey recommend removing BART-like from the statement and change the wording so that it is industrial sources rather than specifically ICI boilers.
        - It was also suggested that removing the parenthetical from Item #2 might be a solution to the variety of issues presented.
    - Item #3
        - We need to work on the wording on Item #3 for states to satisfy the low-sulfur fuel request so that it better matches the previous Ask.
        - Pennsylvania has already achieved lower levels and would need a rulemaking and doesn't think it is prudent to pursue that.
        - New York has had the rule since 2011 and doesn't think that is reasonable not to pursue rulemaking.
        - New Hampshire asked about equivalent alternative measures, but New Jersey didn't think that those were available.
    - Item #4
        - New Jersey would like to specifically list the four units and does not see the need for the alternative measures.
        - Connecticut requested addition of language on alternatives, but is fine with taking that out if the four units are listed.
    - Item #5

        - New York would like it removed unless there is specificity in the request as would others.
    - Item #6
        - New Jersey has a goal for CHP expansion in their long-term plan.
        - New Jersey stated ICI boilers can be removed from Item #6 since they are dealt with specifically in #2.
        - New Jersey has language that is roughly to "Initiate programs to reduce energy and increase CHP, fuel cells, etc."
        - New York would like the language to be broad, but likes the thought.
        - Massachusetts is concerned if the language is too broad and would fall into the same problem as Item #5.

Preliminary 2018 MANE-VU "Ask" contents may include:

- EGUs with already installed NO_X and/or SO_2 controls, optimize their full operation
- Sources (top 10 - EGUs and ICIs) perform a four-factor analysis for reasonable installation or upgrade to BART-like emission controls
- Expand low sulfur distillate fuel oil program (all contributing states - MANE-VU and others) – down to 15 ppm (either phase-in by 2028 or meet a date)
- Achieve a 90% SO_2 reduction from 2002 levels at all remaining uncontrolled sources from the 2008 MANE-VU 167 stack Ask.

MANE-VU Intra-RPO Consultation #3

Technical Support Committee Meeting

April 11, 2017

MANE-VU Intra-RPO Consultation #3 was held on April 11, 2017. During this consultation, the specifics of proposed Ask items was discussed, as well as thresholds to identify contributing states. It was determined that in consideration of reasonable progress goals, the inclusion of an item in the Ask does not commit an upwind state which can choose to disagree with the Ask.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X				X	1	X

- It was determined that a discussion needed to be completed concerning which states should be consulted: 2%, 3% or 4% contributors in addition to the MANE-VU states
- The Class I states recommended the following in the "Ask":
    - Optimizing Selective Catalytic Reduction (SCR) and scrubbers all year including during winter; there is chemistry switch during the winter so that nitrates have a high impact during the season:
        - Connecticut wanted to discuss the size threshold for units that will need to be addressed.
        - To be consistent with other EGU regulations the suggestion was to make 25 MW the cutoff.
        - EGUs with already installed NO_x and/or SO_2 controls, optimize their operation to best and most efficient rates on a year-round basis.

    - The question was raised as to whether any <25 MW have controls? New EGUs have MACT/BAER type of controls; emissions will go down as older units get retired and bigger units restricted to lower emissions levels.
  - Updating permits to reflect achievable rates for SO_2, NO_X, and $PM_{2.5}$:
    - New York is concerned that they cannot put anything in the permit that's not in a rule especially for natural gas switches.
    - New Hampshire stated that the switch to natural gas was the basis for much of the visibility improvement since 2002 and locking in these changes is an FLM recommendation.
    - MARAMA points out that many large EGUs are reserving the right to burn coal even if they now burn gas, and permit changes would prevent that.
    - Pennsylvania wanted to know what regulation would require Pennsylvania to lock in natural gas, but that is something that states would determine on their own.
    - New Hampshire said that the request may be only for those units that have not retained ability to burn coal.
  - Conduct four-factor analysis for most important sources for reasonable installation or upgrade to emission controls; using top 10 sources or extinction cut-off approach (e.g. it extinguishes 2 or 3 Mm^{-1}):
    - The recommendation is against using a cutoff as high as 10 because only 1-2 units would be included.
    - We do need a good reason for picking a number.
    - For an extinction cut-off of 3.0 Mm^{-1} facilities range from top 7 to top 26 depending impacting visibility on Class I area.
    - Extinction >2 - 3 Mm^{-1} visibility impacts at any MANE-VU Class I area identified by contribution analyses using the most recent emissions.
    - 3 Mm^{-1} is a good number to begin our discussions with though this is just a preliminary list to get a general idea on what we need to look at.
    - Pennsylvania would prefer a 5 Mm^{-1} cutoff.
    - New Hampshire noted that the "Ask" only refers to doing a four-factor analysis and does not ask for adding specific controls.
    - To determine the sources, CALPUFF modeling was used with a 2011 inventory for industrial/non EGUs, and 2015 inventory for EGUs.
  - Low sulfur distillate fuel rule at the 15 ppm standard to be adopted as expeditiously as possible in all of MANE-VU, and other RPOs by 2028:
    - First phase was adopted everywhere, but second phase was not adopted in Maryland and Pennsylvania.
    - The question was raised if we want this to be a universal Ask since some states might not rely on fuel oil to the same degree and residential oil use does not transport as far (for instance should Missouri, a 3% contributor, be required to adopt 15 ppm oil).
    - It was suggested that states with $PM_{2.5}$ nonattainment issues might be able take credit for $PM_{2.5}$ SIP if creditable reductions are needed.
  - Achieve a 90% reduction in 2002 SO_2 emission levels at the four remaining uncontrolled sources that were included in the "167 stacks" identified during the first RH SIP process as impairing visibility in a MANE-VU Class I area.
  - Perform a four-factor analysis for peaking EGU units that operate on high electric demand days (HEDD) to address and control NO_x and SO_2 emissions:

    - Definition of peaking units is not applicable to all states.
    - NJ has language on HEDD in their rule even that could be helpful.
    - There is a question as to how many peaking units are there? New York expects there are approximate 150 in New York with 200 MW generation.
    - Another question concerned the correlation between HEDD and impaired visibility days.
    - A final question concerned what are "peaking units" (e.g., those operating on that day or 3-4 days before an event)?
  - Ask States to initiate measures to increase energy efficiency and implement CHP or other DG/renewable technologies such as fuel cells, wind, biomass, and solar.
  - Should there be an Ask of EPA (e.g., NO_x reductions from mobile sources (e.g., federal heavy-duty engine standards)?
- MARAMA pointed out that we will need to update inventories, rerun the photochemical model if you go beyond on the books measures, but New York believes that states should be able to take an approach that does not require rerunning the photochemical modeling.
- Concerning reasonable progress goals (RPGs), Class I states need to determine what to factor in even if states don't commit – should modeling include everything in Ask whether states agree to or not?
  - In the past EPA held states accountable for what is in their RH SIP.
  - States that were never consulted with had their SIPs approved without any problem.
  - New York stated that if you put something in the Ask, the upwind states need not commit; Authority does not lie with the Class I state. If during consultation process states do not agree on the Asks, you need to show how the differences were resolved; states may agree to the Ask or not, then asking states may not submit it in SIPs.

Preliminary 2018 MANE-VU "Ask" contents may include but is not limited to the following:

1. EGUs with already installed NO_X and/or SO_2 controls, optimize their operation to best and most efficient rates on a year-round basis;
2. Update permits to lock-in lower emission rates for SO_2, NO_X and PM at EGUs and other large emission sources that have switched operations to lower emitting fuels;
3. Top ten sources with the largest modeled visibility impacts at each MANE-VU Class I area as identified by MANE-VU contribution analyses perform a four-factor analysis for reasonable installation or upgrade to emission controls;
    a. Alternative: Sources with 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area as identified by MANE-VU contribution analyses, using the most recent emissions, perform a four-factor analysis for reasonable installation or upgrade to emission controls;
4. Each MANE-VU State that has not adopted a standard for distillate fuel oil sulfur content of 15 parts per million (ppm) should adopt this standard as expeditiously as possible and all other states that contribute to visibility impairment in a MANE-VU Class I state should adopt this 15 ppm standard by 2028;
5. A 90% reduction from the 2002 SO_2 emission levels should be achieved at the four remaining uncontrolled sources from the MANE-VU list of 167 stacks (Trenton Channel, Unit 9A and Saint Clair, Unit 7 in Michigan, Herbert Wagner, Unit 3 in Maryland and Yorktown, Unit 3 in Virginia) that were identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area;

6. Perform a four-factor analysis for peaking EGU units that operate on high electric demand days to address and control NO_X and SO_2 emissions; and
7. Each State should initiate measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, biomass, and solar.

MANE-VU Intra-RPO Consultation #4

TSC/FLM Call
April 21, 2017

MANE-VU Intra-RPO Consultation #4 was held on April 21, 2017. This was a FLM-specific call as requested by FLMs in Intra-RPO Call #2. This consultation responded to nine questions submitted by the FLMs related to EPA guidance, MANE-VU modeling, reasonable progress goals, long term strategies, and future consultation with FLMs. Modeling topics included the emphasis of 20% impaired days over 20% worst days to avoid confusion, the decision to use MANE-VU modeling with 2011 platform and only indirectly using EPA's 2028 modeling, and for the 2028 control case modeling, the decision to model controls as a package rather than individually to see overall effect. Future consultation with FLMs was also planned, both as a region and as individual states as required, after states had begun their four-factor analysis to demonstrate RPG.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X		X		X		X

1. Metric:
    - Joseph Jakuta (OTC/MANE-VU) will update the slides with the 20% most impaired days in future slide sets to avoid confusion as to what MANE-VU is relying on for a metric once a full data set is available for Lye Brook.
    - 20% most impaired days will be relied on for future work, but we will keep data around for 20% worst days just in case something happens with the rules.
    - We will look at the 20% best days as well, but focusing mostly on 20% most impaired days.

2. 2011 and 2028 base case modeling:
    - The plan for photochemical modeling involves using the 2011 platform because that is what we have available and has been quality assured.
    - There is a need to add the 2028 base case results to the modeling platform Technical Support Document (TSD) following completion of control case runs.
    - We are relying on MANE-VU modeling and we are not planning on using EPA's 2028 work directly.
    - Performance evaluation was completed for ozone, $PM_{2.5}$, and haze constituents and is in the modeling platform TSD.
    - The committee believed that the TSD received 21 day review but Joseph Jakuta (OTC/MANE-VU) will follow up and confirm and resend the documents.

3. 2028 control case modeling:

- Control scenario would come out of the "Ask."
- Still talking about what goes into the "Ask."
- FLMs recommend taking a look at the guidance for modeling.
- FLMS had the question of will you model controls individually? How many of control scenarios get run depends on modeling resources.
- One issue with modeling controls individually is that sometimes if you break it out each component becomes insignificant, which is why we prefer to do everything as a package.

4. RPGs:
   - There is a need to provide the four-factor analysis with details on a source or sector level to demonstrate the RPG.
   - All of the Class I states are still working on their approach, which will likely be addressed after the "Ask" is adopted.

5. Four-Factor Analysis:
   - Cost and control data for the analyses have been provided so that each state can individually develop their analyses.
   - More discussion will occur later in the year with the FLMs after states complete their analyses.

6. FLM Consultation:
   - There will have to be an FLM consultation with individual states since that is the requirement.
   - MANE-VU will have another regional consultation with FLMs prior to control runs and following the inter-RPO consultation.
   - We will schedule that call for August or early September at a later date and time.
   - Pat Brewer is the National Park Service (NPS) lead, Bret Anderson is the Forest Service (FS) lead, and Tim Allen is the Fish and Wildlife Service (FWS) lead.

7. Contribution Assessment:
   - Weight of evidence is supposed to point you in the right direction.
   - FLMs are concerned when the contribution assessment is described as "conclusions," that language might be too strong.
   - FLMs will provide assistance with the tools they have developed for assessing control strategies and Joseph Jakuta (OTC/MANE-VU) will work to set up a call.
     No substantive discussion of revisions to the draft Ask.

MANE-VU Intra-RPO Consultation #5

TSC Call

April 25, 2017

MANE-VU Intra-RPO Consultation #5 took place on April 25, 2017. States went over the seven proposed Ask items and made corrections in the Ask Draft; modifications were made for consistency, greater clarity, and both stronger or weaker language. There was also emphasis on locking in benefits from the previous planning period and discussion on who should sign the Ask because there was no current MANE-VU chair.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM

X	X	X	X	X	X	X	X	X	X		X		X	1	X

- Vermont reviewed the draft Ask.
- During the conversation New Jersey reiterated that the Ask is a set of "reasonable" requests and that though everyone is below the glide path at this point future planning periods could be harder to plan for and it is important to lock in benefits that were achieved during the first planning period if they were not driven by enforceable actions.
- The "Ask" last time was signed by the MANE-VU chair, but there is no current chair and will likely not be one at the meeting. The two options are for the Class I states to sign the document or for all the MANE-VU states to sign the document individually. The recollection is that last time everyone voted in favor of the "Ask," except Pennsylvania which abstained.
- Item #1
    - Connecticut requested that "or equal to" be added to maintain consistency with unit sizes in other programs.
    - Pennsylvania was concerned about the use of the word "best" in regard to control optimization.
    - FLMs asked if we should elaborate on "most efficient" and clarify that it meant "least polluting."
- Item #2
    - At this point a threshold for visibility has not yet been agreed upon although 3 Mm^{-1} is listed in the document.
    - Massachusetts requested a minor change to clarify the language in the first sentence.
    - Pennsylvania asked what happened to the language about the top 10 sources. Vermont thought that the top 10 language was turning out to be confusing and Maine was concerned that the 10^{th} source for a particular Class I area might be impacting the site far less than the 10^{th} source at a different Class I area.
    - Pennsylvania would like to see a list of sources at particular thresholds.
    - Though it needs to be confirmed, Maine believes that 3 Mm^{-1} will result in a similar number of sources needing four-factor analysis as a top 10 list of sources would.
- Item #3
    - The concentrations for sulfur in fuel oil should be the same as those requested in the second stage of the "Ask" in the first planning period.
    - A digit was missing from the distillate oil percentage, it should read 0.0015%.
    - Vermont will work with Joseph Jakuta (OTC/MANE-VU) to clean up the large amount of "to"s in the section since they get confusing to read.
    - OTC will distribute the low sulfur fuel oil adoption matrix to ensure we know which states have adopted the model rule.
- Item #4
    - The units should be listed in a bullet point form.
    - New Jersey would like the "infeasible…" language removed and there were no objections.
- Item #5
    - The question was raised as to whether a unit would need a new permit to operate using a higher emitting fuel source if they had reconfigured their unit to only use natural gas.
    - Another question was whether this should be done at the facility level.

    - Massachusetts believes it would make sense to remove the language, "and no longer have the ability to operate with higher emitting fuels." Pennsylvania objects to that change.
    - New Hampshire suggested adding the language to "consider" to this request may help soften some of the concerns.
- Item #6
    - New Jersey had updated language that was in the draft consultation plan document that had not gotten included, but was updated during the call which elaborated on the definitions needed for the request.
    - Connecticut was concerned about including units down to 5 MW and thought it should be 15 only, New Jersey believes that is what their on-the-books rule says.
    - Pennsylvania wanted to know how many units would fall into this Ask.
    - New Hampshire suggested adding the language to "consider" to this request may help soften some of the concerns.
- Item #7
    - New Hampshire suggested adding the language to "consider" to this request may help soften some of the concerns.

Draft 2018 MANE-VU "Ask" contents as of April 25, 2017:

1. Electric Generating Units (EGUs) larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - *optimize operation to best and most efficient rates on a year-round basis*;
2. Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area (as identified by MANE-VU contribution analyses using actual 2015 emissions for EGUs and 2011 for other emission sources) - *perform a four-factor analysis for reasonable installation or upgrade to emission controls*;
3. Each MANE-VU State that has not yet fully adopted a low sulfur fuel oil standard as requested by MANE-VU in 2007 - *pursue this standard as expeditiously as possible and all other states identified for consultation by MANE-VU should adopt this standard by 2028 depending on supply availability*;
    a. distillate oil to 0.0015% sulfur by weight (15 ppm);
    b. #4 residual oil;
        i. to 0.25% sulfur by weight (Delaware, New Jersey, New York, and Pennsylvania, or portions thereof)
        ii. to 0.25 to 0.5% sulfur by weight (Remainder of MANE-VU region)
        iii. to 0.5% sulfur by weight or equivalent reduction in sulfur emissions from fuel oil combustion (Beyond MANE-VU region)
    c. #6 residual oil;
        i. to 0.3 to 0.5% sulfur by weight (Delaware, New Jersey, New York, and Pennsylvania, or portions thereof)
        ii. to 0.5% sulfur by weight (Remainder of MANE-VU region)
        iii. to 0.5% sulfur by weight or equivalent reduction in sulfur emissions from fuel oil combustion (Beyond MANE-VU region)
4. Four remaining uncontrolled sources from the MANE-VU list of 167 stacks:
    - Trenton Channel, Unit 9A in Michigan,
    - Saint Clair, Unit 7 in Michigan,
    - Herbert Wagner, Unit 3 in Maryland, and

- Yorktown, Unit 3 in Virginia.

These sources were identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area – *reduce SO_2 emissions by 90% from the 2002 SO_2 emission levels. If it is infeasible to achieve that level of reduction from a unit, equivalent alternative measures should be pursued*;

5. EGUs and other large emission sources that have switched operations to lower emitting fuels and no longer have the ability to operate with higher emitting fuels – consider *update permits and/or rules to lock-in lower emission rates for SO_2, NO_X and PM*;
6. [Should consider performing | Perform] a four-factor analysis for peaking combustion turbines that operate on high electric demand days to address and control NO_X and SO_2 emissions, where:
    a. "High Electric Demand Day or "HEDD" is defined as the day following a day in which the next day forecast load is estimated to reach its peak value, as defined by the state's specific ISO or regional transmission organization; and,
    b. "Peaking combustion turbine" is defined as capable of generating [5 - 15] megawatts or more, that commenced operation prior to [May 1, 2007], is used to generate electricity, all or part of which is delivered to the electric power distribution grid for commercial sale, and that operated less than or equal to an average of [50] percent of the time during the ozone seasons of 2011 through 2013;
7. Each State should [consider initiating | initiate] measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, biomass, and solar.

MANE-VU Intra-RPO Consultation #6

Air Directors Meeting
May 9-10, 2017

MANE-VU Intra-RPO Consultation #6 was an Air Directors meeting that took place on May 9-10, 2017. The purpose of the call was to discuss proposed Ask items and reach consensus on the final Asks. Although it was agreed unanimity of agreement was not necessary, Class I states wanted all MANE-VU states to vote and sought consensus. Consensus was not met and additional meetings were scheduled.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X		X		X		

- <u>Ask #1 – Operation and optimization of controls year-round:</u>
    - MARAMA brought up the question of what was being optimized – emissions or cost? This was to be corrected through a language change to clarify it is emissions.
    - Maryland stated that they are the only state in MANE-VU that requires optimization of NO_X during the ozone season (24 hour averaging with limits of 0.07 lb/mmBTU for SCR operations) and that their sources are required to look at optimization every single day of operation and create a report that Maryland staff looks at every day; it is a huge, resource-intensive effort which works very well. There is no single limit for all units, but each unit optimizes based on its own historic data.

- New Hampshire stated that Maryland's approach if expanded to include SO_2 and cover the annual period will meet the "Ask."
- Maryland noted that scrubbers are run consistently – there is no variability as seen with SCR. Year-round NO_X control would be great but they don't have technical justification for the need for daily limits for non-ozone season.
- NESCAUM suggested that the language could say to run controls all year regardless of optimization.
- New Jersey pointed out that SCR will not work well at all temperatures because of temperature variation and it is not possible to run year-round and NESCAUM agreed.
- New Jersey also pointed out that the "Ask" should reflect that during startup, when the unit and SCR catalyst is cold, NH_3 injection will slip right through and go out of the stack. In New Jersey their rule doesn't require controls unless you are putting power on the grid and Pennsylvania has provisions that address operating temperatures.
- Optimization could be defined as maximizing emissions reductions.
- Maryland pointed out that their 126 petition included this language, which came from EPA, and was built from federal consent orders that requires controls to be run every day, which can be copied for use here.
- Pennsylvania stated that the "Ask" on operating controls all year is going to happen in Pennsylvania because of their new RACT regulations obligations.
- The "Ask" on this needs to be as soft as possible; keep the "operate controls (SCR) all year" but do not say maximum achievable goals; do not pin down the optimization to specific rates
- Pennsylvania will have RACT 3 for a 2015 ozone standard and the industry is changing rapidly as are the nature of baseload operations.
- New Jersey brought up the question of how one addresses the situation where power plants are using part of the SCR for mercury control and other part for NO_X control. In this case they are optimizing for something other than what the controls were originally installed for.
- Pennsylvania pointed out that units are not monolithic; for some units NH_3 reductant runs counter to mercury controls and that units have temporal and spatial variations. That's why they do not want to pin down on optimization.
- New Hampshire brought up the issue that has been seen over the last couple of summers where SCR is technically running but practically no NH_3 injection is occurring. Suboptimal operation of controls is not sufficient, the language has to be stronger than to just run controls.
- Pennsylvania would prefer not to include specific rates in the "Ask."
- Maine and New York suggested that the word "optimal" could be problematic.
- Maryland asked if optimal could mean to run the technologies to manufacturer's specifications.
- Language will be worked on this evening to clarify the optimization issue.

- Ask #2 – Conduct a four-factor analysis for sources modeled to produce visibility impacts of 3 Mm^{-1}:
  - Vermont asked how we choose the 3 Mm^{-1} cut off. New Hampshire stated that the "Ask" began by looking at the top 10 at each Class I area but this created a non-uniform threshold of some small sources with little impact at some sites while leaving off large ones with

substantial impact at other sites so the extinction threshold approximates the top 10 while capturing only those sources that would do most good for all if controlled.
  - OTC staff reminded that EPA's draft guidance expected states to look at 80% of sources and what is being asked is far less than that.
  - In Maryland the units in question are at Wagner and Luke and there are other major changes happening not related to Regional Haze like SO_2, Mercury and Air Toxics Standards (MATS), evolution of coal, etc., expected by 2028.
  - New Jersey pointed out that if we are identifying the really large SO_2 sources, then the 1 hr SO_2 MATS will capture a high percentage of these sources so it makes an easier "Ask."
  - Maryland was concerned the Class I states are asking big things and wanted to confirm that all the Class I state commissioners are on board.
  - New Jersey followed up by stating that there is nothing in this "Ask" that hasn't been discussed before, except of the "Ask" of EPA.
- Ask #3 – Adopting the low sulfur fuel oil model rule:
  - This language is the same "Ask" we saw ten years ago for low sulfur fuels and is included for states that have not fully adopted it to do so quickly.
  - Delaware brought up again why they are included in the "Ask."
  - NESCAUM brought up that the Regional Haze program has the goal of meeting natural visibility conditions sometime in the distant future and Delaware has an impact on visibility above natural levels even if they contribute less than 2%.
  - New York pointed out that many states or cities have met this Ask or something more stringent such as phasing out types of fuel oil completely.
- Ask #4 – Remaining stacks from the original 167 stack Ask:
  - These are the four stacks are stacks that were not controlled or retired from the previous 167 stack "Ask."
  - Maryland pointed out that the "unless infeasible" language is no longer in the "Ask," which could be problematic at Wagner 3 due to footprint issues.
  - New Jersey pointed out that a plant in their state had footprint issues and built platform and a baghouse and that their commissioner will not be satisfied with softening the "Ask."
  - MARAMA reminded that if Class I states ask and the upwind state don't agree, both states need to document how they have tried to resolve the disagreement and include it in the SIP.
- Ask #5 – Permit updates:
  - The point of this item is that if units have switched to natural gas why not lock-in emissions reductions, especially from EGUs and other large emissions sources that have switched.
  - Connecticut wanted to know how large are the sources they would need to update permits for.
  - Also, there is a concern from Connecticut that there are EGUs that typically burn gas, but have the ability as peaking plants to burn oil in gas-outage times and those cannot be locked in to run natural gas during curtailment.
  - New Jersey thought it was acceptable to add an exception for gas curtailment.
  - Pennsylvania noted that fuel augmentation could be used and states could use separate standards for different fuels and update permits to fuel-specific standards. Natural gas has lower impact on visibility and if a natural gas unit has RACT already in place, alternative

operating scenario will not be an option for Pennsylvania. Pennsylvania needs technical rationale for public comment for rulemaking, otherwise it is unacceptable.
    - New Jersey suggested adding a statement about whether a fuel contributes to Regional Haze, but New Hampshire did not like that approach.
    - New Jersey noted that many of the problems being discussed have been resolved in their permitting process including multi-fuel options, curtailment, emergencies, outages, fuel switching, etc.
    - Pennsylvania noted that MATS rule requires scrubber to operate so enough rules exist and to ask for more from companies to give up on specific fuels is not viable.
    - Pennsylvania would like the wording "as necessary and appropriate" added.
    - New York stated that a four-factor analysis needs to be done on all fuels.
    - New Jersey stated that if switching fuels has a Regional Haze impact, limits should be enforceable.
- <u>Ask 6 HEDD Sources:</u>
    - The Class I states had been considering a threshold of 15 MW or 25 MW and the 15 MW cutoff was considered to be acceptable.
    - Pennsylvania was concerned as to what the technical rationale was for the four-factor analysis to apply on a unit that is not operating constantly since they will need rationale to take a rulemaking to the public.
    - New York stated that there are data for units 25 MW or greater but most of their units are 15-25 MW and all the daily data stopped being collected in 2015.
        - Pennsylvania-New Jersey-Maryland Interconnection (PJM) data show correlation between bad air days and HEDD.
- <u>Ask 7:</u>
    - Biomass should not be included and will be removed.
- <u>Federal Partner Ask:</u>
    - There are many mobile source asks that can be made of EPA (e.g., ZEVs, federal heavy-duty engine standards, aftermarket catalysts, etc.), but EPA is not required to do any of these and if the list is too long they will likely ignore everything, which is why the ask is focused on heavy-duty engine standards solely.
    - New Jersey was concerned with some of the suggestions and brought up the VW mitigation funds, but that can solely be used for NO_x mitigation.

Process Discussion

- In the past, MANE-VU had three Asks – one for MANE-VU states, another for non-MANE-VU impact states and a third for federal partners.
- The question was raised as to whether we will have all MANE-VU states or only Class I states to vote on the "Ask."
- The Class I states would prefer all of MANE-VU to vote, which is why they are seeking consensus.
- Another question was raised as to whether we should take the "Ask" to public comment in OTC spring meeting.
- Pennsylvania will need to go to public comment before putting in committal SIP and since there is a lot in here that the commissioners had not been briefed on, they will need briefing packages. At a minimum several weeks are needed so there is not enough time to vote on these before June.

- This was countered that there is nothing new in the "Ask" that has not been discussed in previous consultation discussions but there are a lot of new commissioners that need to be brought up to speed.
- Agreement in MANE-VU that it is not necessarily a full RPO "Ask" and that unanimity to agreement is not a requirement.
- Pennsylvania will need the option for alternate measures to be included to support.
- New York stated that this is a conceptual document based on our analysis today. We still need to do CMAQ modeling, develop our SIPs, even if we agree with this we may end up in a different place. The "Ask" is not binding and while we may agree to the "Ask" we may not do exactly what was written and voted on.
- It was recommended that units with new controls should be exempted from repeating the four-factor analysis.
- Pennsylvania was concerned since they can only go through rulemaking with a technical rationale.
- On the other hand, the upwind states are concerned that if you don't lock reductions at a plant like Brunner Island then they can backslide by 2028.
- MANE-VU needs to begin the engagement internally and externally, otherwise we don't have much time.
- After consultation, states should develop their own analysis for their own SIP and the SIP doesn't have to match "Ask" but the state is bound to complete an analysis to say why it is or is not doing it.
- Consultation is a two-way process. After consultation, states should be able to change and take into consideration what they have heard.
- There is no obligation on MANE-VU as an entity to endorse or reject "Ask."
- If all of the Commissioners are going to sign the "Ask" and we cannot complete it at the June meeting we need to look up MANE-VU's operating principles to determine how a vote can occur, for instance can we have a vote by phone.
- Have an education at the meeting and Class I areas can continue their meeting beyond that; no need to involve stakeholders during the development of the "Ask."
- The Class I states pointed out that there is room for commissioners' responses even if they don't vote on the "Ask." We will put the "Ask" out as a draft to commissioners, although we don't know if we will get a consensus at the June meeting.
- June meeting will be another step in consultation process and we don't have to explain to private sector until states are in the process of putting together their individual SIPs.
- A question was raised about participation from tribal nations and they have been invited to every call and the Penobscot Nation had commented that we are doing a good job.

Draft 2018 MANE-VU "Ask" as of May 10, 2017:

1. Electric Generating Units (EGUs) larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - optimize operation of controls on a year-round basis;
2. Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area (as identified by MANE-VU contribution analyses using actual 2015 emissions for EGUs and 2011 for other emission sources) - perform a four-factor analysis for reasonable installation or upgrade to emission controls;
3. Each MANE-VU State that has not yet fully adopted a low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and all other states

identified for consultation by MANE-VU should adopt this standard by 2028 depending on supply availability of;

a. distillate oil to 0.0015% sulfur by weight (15 ppm);
b. #4 residual oil to;
    i. 0.25% sulfur by weight (Delaware, New Jersey, New York, and Pennsylvania, or portions thereof)
    ii. 0.25 to 0.5% sulfur by weight (Remainder of MANE-VU region)
    iii. 0.5% sulfur by weight or equivalent reduction in sulfur emissions from fuel oil combustion (Beyond MANE-VU region)
c. #6 residual oil to;
    i. 0.3 to 0.5% sulfur by weight (Delaware, New Jersey, New York, and Pennsylvania, or portions thereof)
    ii. 0.5% sulfur by weight (Remainder of MANE-VU region)
    iii. 0.5% sulfur by weight or equivalent reduction in sulfur emissions from fuel oil combustion (Beyond MANE-VU region)

4. Four remaining uncontrolled sources from the MANE-VU list of 167 stacks were identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area:
    - Trenton Channel, Unit 9A in Michigan,
    - Saint Clair, Unit 7 in Michigan,
    - Herbert Wagner, Unit 3 in Maryland, and
    - Yorktown, Unit 3 in Virginia.

   Reduce SO_2 emissions at these sources by 90% from the 2002 SO_2 emission levels;
5. EGUs and other large emission sources that have switched operations to lower emitting fuels – pursue updating permits and/or rules to lock-in lower emission rates for SO_2, NO_X and PM;
6. Where rules have not been adopted, perform] a four-factor analysis for peaking combustion turbines that operate on high electric demand days to address and control NO_X and SO_2 emissions, where:
    a. "High Electric Demand Day or "HEDD" is defined as the day following a day in which the next day forecast load is estimated to reach its peak value, as defined by the state's specific ISO or regional transmission organization; and,
    b. "Peaking combustion turbine" is defined as capable of generating 15-25 megawatts or more, that commenced operation prior to [May 1, 2007], is used to generate electricity, all or part of which is delivered to the electric power distribution grid for commercial sale, and that operated less than or equal to an average of [50] percent of the time during the ozone seasons of 2011 through 2013;
7. Each State should consider measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, biomass, and solar.

MANE-VU Intra-RPO Consultation #6b

TSC Call

May 30, 2017

MANE-VU Intra-RPO Consultation #6b took place on May 30, 2017 and was an additional Technical Support Committee call intended to address issues unresolved from the Air Directors call (#6). There is further discussion on whether unanimity to agreement is necessary and the timing of Commissioners signing; MANE-VU moves to begin engagement both internally and externally.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X	X	1,2	X

- This call was added to the schedule following the Air Directors Meeting to address issues unresolved from that meeting.
- A briefing document is available for edits and will be provided to the Air Directors on Thursday, comments are needed prior to Thursday, June 1, at noon.
- There are now three Asks, one for the FLMs/EPA, one for the MANE-VU states and one for the upwind contributing states.
- New drafts will be sent out immediately after the call and any final edits are needed by Thursday, June 1, at noon.
- FLM/EPA "Ask":
    - Ask involves heavy-duty onroad NO_X standards and ensuring the "Ask" is met from EPA and notifications of prescribed burns from the FLMs.
    - The order of the "Ask" was changed so that the EPA items were next to each other.
- Intra-RPO "Ask":
    - Pennsylvania’s most recent changes were received but not yet incorporated.
    - The language in #3 was changed to read "within a range of" to increase clarity.
    - The threshold in #5 should be 250 MMBTU consistent with prior BART analysis.
    - The use of "excepting" versus "except" was discussed, but no changes were made.
    - The language in #6 "to address and control NO_X and SO_2 emissions" was moved for clarity.
    - Since the document will not be signed at the meeting, but at a later date, Paul Mercer will sign on behalf of Maine.
- Inter-RPO "Ask":
    - The changes discussed for the Intra-RPO "Ask" were carried over and no other changes were made.

Draft 2018 MANE-VU "Ask" contents as of May 30, 2017:

1. Electric Generating Units (EGUs) larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - *optimize the use of control technologies to minimize emissions of haze precursors on a year-round basis*;

2. Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses (see attached listing) - perform a four-factor analysis for reasonable installation or upgrade to emission controls;

3. Each MANE-VU State that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows:
    a. distillate oil to 0.0015% sulfur by weight (15 ppm);

b. within a range of 0.25 to 0.5% sulfur by weight
c. within a range of 0.3 to 0.5% sulfur by weight
0.5% sulfur by weight (

4. Four sources from the list of 167 stacks identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area continue to operate without control. One of these units is located within the MANE-VU region:
   - Herbert Wagner, Unit 3 in Maryland.

   While the original Ask allowed for alternative measures to achieve the reductions, this Ask is requiring the 90% reduction of SO_2 emissions at these specific units from the 2002 SO_2 emission levels;

5. EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels – pursue *updating permits and/or rules to lock-in lower emission rates for SO_2, NO_X and PM, excepting during natural gas curtailment if demonstrated through a four-factor analysis to be reasonable*;

6. Where emission rules have not been adopted, *perform a four-factor analysis* to address and control NO_X and SO_2 emissions for peaking combustion turbines that have the potential to operate on high electric demand days. High electric demand days are days when higher than usual electrical demands bring additional generation units online, many of which are infrequently operated and may have significantly higher emission rates than the rest of the generation fleet. Peaking combustion turbine is defined for the purposes of this "Ask" as a turbine capable of generating 15 megawatts or more, that commenced operation prior to May 1, 2007, is used to generate electricity all or part of which is delivered to the electric power distribution grid for commercial sale and that operated less than or equal to an average of 1752 hours (or 20%) per year during 2014 to 2016;

7. Each State should consider and report in their SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar.

MANE-VU Intra-RPO Consultation #7

June Annual Meeting Caucus
June 5, 2017

MANE-VU Intra-RPO Consultation #7 took place during the June Annual Meeting Caucus on June 5, 2017. Discussion continued about whether the MANE-VU states needed or ought to reach consensus about all Ask items and how to go about reaching consensus. Ask Items continued to be refined for language and clarity.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X		X		

- The second item on the "Ask" came up through Air Director discussions and States were in consensus with this and all comments were considered and there is a table at the end of the "Ask" which lists the facilities that were modeled to contribute at 3 Mm^{-1} or more to a Class I Area.
- The last time, the MANE-VU "Ask" was endorsed by all states; because of the language, etc. it likely is different this time. The documentation of differences is a possibility under the Regional Haze Rule.
- The "Ask" will be in Regional Haze SIPs which they will be measured against. They need to get a response from contributing states on the "Asks" since they will put them in SIPs only after they have a response from states about the reasonableness of the "Ask" of each state and document their agreement/disagreement.
- New Jersey stated that we have had a lot of consultation within MANE-VU trying to reach consensus on some of the items which were deal breakers but which New Jersey thought were reasonable, but a lack of consensus doesn't preclude it from being asked, disagreement just needs to be documented.
- Maryland preferred to reach consensus since MANE-VU is the first one among RPOs which is much ahead in the process and progress compared to others.
- New Jersey: to come to consensus we need to identify the points that keep us from getting consensus and there seem to be two sticking points.
- The question was brought up regarding if we need to go public with "Asks" at this point since they have been discussed in commissioner and at AD level? It is a formal Ask of Class I states and they need to document our responses
- Pennsylvania is concerned about the HEDD Ask since without knowing the impact of HEDD units they cannot go through rulemaking and go public. They believe a cost-benefit analysis of these HEDD units and a formal document the response and concerns and that simple inclusion in the "Ask" is not good enough. Pennsylvania asked if there was at a minimum an inventory of HEDD units available before they would do a four-factor analysis.
- New Hampshire stated that the modeling was rigorous and we went through a lot of discussions to get to the "Ask."
- New Jersey stated that the "Ask" is reasonable and they are already undertaking these items. Language was changed to help identify the HEDD units in each state. Units in 15-25 MW identified by SAS committee are harder to get information on and there are not data on these from federal databases.
- Pennsylvania asked if it is really necessary to control all these HEDD units when the Class I areas are already on the glide path and though they may be good to control to reduce ozone we don't know if they affect regional haze.
- New York stated that for the states outside MANE-VU the impact is expected to be minimal which is why it is not included in the upwind states "Ask" and that identifying what a state will do and will not do will be based on their four-factor analysis. The obligation is on states to do four-factor analysis based on "Ask."
- New York had a process question. In the agenda at the public session is some action being sought from entire MANE-VU? If so we need to take a vote and hopefully arrive at consensus.
- Since the "Ask" of EPA has different language from other "Asks" and sounds like an Ask from entirety of MANE-VU, MANE-VU could approve the EPA "Ask" as a group and leave the other "Asks" to the Class I states.

- The group decided to delay any action on the three "Asks" until another call was held after the meeting.

Draft 2018 MANE-VU "Ask" contents June 5, 2017:

Therefore, the course of action for pursuing the adoption and implementation of measures necessary to meet the 2028 reasonable progress goal for regional haze include the following "emission management" strategies:

1. Electric Generating Units (EGUs) larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - *optimize the use of control technologies to minimize emissions of haze precursors on a year-round basis*;

2. Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses (see attached listing) - perform a four-factor analysis for reasonable installation or upgrade to emission controls;

3. Each MANE-VU State that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows:
   a. distillate oil to 0.0015% sulfur by weight (15 ppm);
   b. #4 residual oil within a range of 0.25 to 0.5% sulfur by weight
   c. #6 residual oil within a range of 0.3 to 0.5% sulfur by weight

4. Four sources from the list of 167 stacks identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area continue to operate without control. One of these units is located within the MANE-VU region:
   - Herbert Wagner, Unit 3 in Maryland.

   While the original Ask allowed for alternative measures to achieve the reductions, this Ask is requiring the 90% reduction of SO_2 emissions at these specific units from the 2002 SO_2 emission levels;

5. EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels – pursue *updating permits and/or rules to lock-in lower emission rates for SO_2, NO_X and PM, excepting during natural gas curtailment if demonstrated through a four-factor analysis to be reasonable*;

6. Where emission rules have not been adopted, perform a four-factor analysis to address and control NO_X and SO_2 emissions for peaking combustion turbines that have the potential to operate on high electric demand days. High electric demand days are days when higher than usual electrical demands bring additional generation units online, many of which are infrequently operated and may have significantly higher emission rates than the rest of the generation fleet. Peaking combustion turbine is defined for the purposes of this "Ask" as a turbine capable of generating 15 megawatts or more, that commenced operation prior to May

1, 2007, is used to generate electricity all or part of which is delivered to the electric power distribution grid for commercial sale and that operated less than or equal to an average of 1752 hours (or 20%) per year during 2014 to 2016;

7. Each State should consider and report in their SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar.

MANE-VU Intra-RPO Consultation #8

Air Directors Call
June 16, 2017

MANE-VU Intra-RPO Consultation #8 was the second Air Directors call and took place on June 16, 2017, and was held due to lack of consensus during the June Annual Meeting. Discussion continued on the matter of consensus, addressed by adding flexibility (alternative emissions reductions) to the Ask, as well as the necessity of taking public comment on the Asks. Suggestions were made including approving the EPA Ask and leaving the other two Asks to the Class I states to approve. Another call was scheduled to continue discussion.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X		X		X		

- This call, and all subsequent calls were added to the schedule following the lack of consensus at the June Spring Meeting.
- Class I states wanted to come closer to consensus.
- The main feedback that the Class I states received was to allow the use of alternative emission reductions in some parts of the "Ask" and the Class I states tried to provide that flexibility.
- Since the Spring Meeting, the Class I states added alternative measures to year-round control optimization (Item #1) and High Electricity Demand Day (HEDD) unit four-factor analysis (Item #6) (the latter only on HEDDs).
- The Class I states' logic concerning items addressed in the 2008 "Ask" is that if there are Asks that came out 10 years ago and nearly every state implemented them, it seems reasonable to require them at this point since it was proven to be a reasonable measure.
- Luke Paper was cited as an example of a high impact unit, but Maryland stated it is likely not a problem due to SO_2 nonattainment requirements.
- Maryland stated that the last "Ask" provided the alternative measures and they implemented an alternative measure for Herbert Wagner 3 so this is a different Ask. New Jersey stated that the Herbert Wagner 3 stacks are still impacting the Class I area and should be addressed. Maryland brought up the glide path and Brigantine being lower than it. New Jersey stated that the question is about whether the controls are reasonable regardless of the where you are in relation to the glidepath.
- Maryland stated that by agreeing to the "Ask," they would be pushing the unit to shutdown rather than continue operating since the footprint cannot fit a scrubber and the plant doesn't

have the capability to switch to gas, and that the commissioners need to talk about this. Maryland is concerned the other Class I state commissioners beyond New Jersey have not been briefed on Maryland's concerns.

- An idea from New Jersey suggested that maybe the "Ask" should be written so that a state could do either 2 or 4 if a unit falls under both categories. Maryland is fine with that. Maine is fine with that. Vermont and New Hampshire are discussing and this could be agreeable.
- Connecticut had concerns with #5 because they don't require fuel switches to get a permit update so language was added to include consent decrees that could be applicable. The other issue is that the language in the end of #5 concerning the curtailment and a four-factor analysis and changes were made to reflect the concern. The Class I states are still looking at the new language and are likely on board.
- Pennsylvania is also still concerned with #5 since a unit would be locking in one fuel even though multiple fuels are allowed now. New Jersey is concerned about fuel switches at units that don't have SCR or scrubber returning to an "unreasonable" emission rate. Brunner Island, which is a unit of concern, will also get addressed under item #2. Pennsylvania is concerned that they need to show the visibility impacts to justify requiring natural gas only.
- Maryland needs to have some sort of stakeholder process in order to accept the "Ask." New Jersey's stakeholders have already largely addressed the requirements of the "Ask." New Hampshire said the last time there wasn't really a public process as part of the "Ask," but the public process needs to happen during the SIP development process. The public process is not a problem with Maryland if only the Class I states sign it. New York is concerned that taking this to public process will further delay this by a year, and we would have to do it again when we would go out for the SIP, making two drawn out public processes rather than just one. Connecticut thinks it is important that this is the Class I states "Ask." New Hampshire wants to make sure they can go to upwind states with support from MANE-VU. Maryland and Connecticut brought up the question of why this wasn't on the table for the RGGI program review.
- We need a deliberative process mapped out for the inter-RPO consultation as we did for the intra-RPO consultation.

Draft 2018 MANE-VU "Ask" contents as of June 16, 2017:

Therefore, the course of action for pursuing the adoption and implementation of measures necessary to meet the 2028 reasonable progress goal for regional haze include the following "emission management" strategies:

1. Electric Generating Units (EGUs) with a nameplate capacity larger than or equal to 25 MW with already installed NO_X and/or SO_2 controls - *optimize the use of control technologies to minimize emissions of haze precursors on a year-round basis or obtain equivalent alternative emission reductions*;

2. Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses (see attached listing) - perform a four-factor analysis for reasonable installation or upgrade to emission controls;

3. Each MANE-VU State that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows:
    a. distillate oil to 0.0015% sulfur by weight (15 ppm);
    b. #4 residual oil within a range of 0.25 to 0.5% sulfur by weight
    c. #6 residual oil within a range of 0.3 to 0.5% sulfur by weight

4. Four sources from the list of 167 stacks identified by MANE-VU during the first Regional Haze SIP process as adversely affecting visibility in a MANE-VU Class I area continue to operate without control. For sources on this list that are also included under item #2 meeting the Ask put forward in item #2 would be sufficient as well. One of these units is located within the MANE-VU region:

    - Herbert Wagner, Unit 3 in Maryland.

   While the original Ask allowed for alternative measures to achieve the reductions, this Ask is requiring the 90% reduction of SO_2 emissions at these specific units from the 2002 SO_2 emission levels;

5. EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels – pursue *updating permits, enforceable agreements, and/or rules to lock-in lower emission rates for SO_2, NO_X and PM. The permit, enforcement agreement, and/or rule can allow for suspension of the lower emission rate during natural gas curtailment*;

6. Where emission rules have not been adopted, perform a four-factor analysis to address and control NO_X and SO_2 emissions for peaking combustion turbines that have the potential to operate on high electric demand days or obtain equivalent alternative emission reductions on high electric demand days. High electric demand days are days when higher than usual electrical demands bring additional generation units online, many of which are infrequently operated and may have significantly higher emission rates than the rest of the generation fleet. Peaking combustion turbine is defined for the purposes of this "Ask" as a turbine capable of generating 15 megawatts or more, that commenced operation prior to May 1, 2007, is used to generate electricity all or part of which is delivered to the electric power distribution grid for commercial sale and that operated less than or equal to an average of 1752 hours (or 20%) per year during 2014 to 2016;

7. Each State should consider and report in their SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar.

MANE-VU Intra-RPO Consultation #9

Commissioners Call
July 24, 2017

MANE-VU Intra-RPO Consultation #9 took place on July 24, 2017. The emphasis of this call remained on seeking consensus among the MANE-VU states. There was also discussion on the timing of stakeholder input, concluding stakeholder input was important to include further in the process. It was suggested more time was needed for air directors to reach consensus, so the timeframe for reaching consensus was set for August 11, 2017.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X		X		

1. Overview of Call
   - Concerns had been raised from some parties both to the contents of the "Ask" and the process.
   - The Class I states wanted to stop and get a final draft to everyone and find a way to address any final concerns.

2. Report on Selection of States
   - Joseph Jakuta (OTC/MANE-VU) reviewed the slides.
   - Maryland asked how we sat since the data appeared to show everyone was on track to be under the glide path, but it was reminded that that the goals should be set based on what reductions are reasonable not whether an area is above or below the uniform rate of progress.
   - Maryland asked if the reasoning behind EPA delaying the deadline to 2021 was to accommodate other programs such as RGGI and SO_2 standards.

3. HEDD Analysis
   - Maryland asked why the consensus based approach from MANE-VU disappeared.
   - Maryland also asked if there was a willingness to extend the deadline to get to consensus.
   - Vermont and New Hampshire were concerned about dragging it out too long, but would like to reach a consensus.
   - New Hampshire responded to Maryland's question and noted that there was not a lack of desire for consensus, but as the consultation went on, information was not being distributed and the Air Directors were not ready to reach consensus as a result. There was opportunity at the annual meeting for consensus, but this again was not fruitful.
   - Delaware was much closer to accepting the current draft.
   - September is more of a crucial date for MANE-VU states that will submit SIPs in July 2018 rather than for upwind states.
   - Maryland asked about the stakeholder engagement in this process.
   - OTC stated that the stakeholder process was important to have between individual states and their units.
   - New Hampshire looked at the principals adopted by the MANE-VU Board and it focused on the process to be a government to government process.
   - New Hampshire pointed out that the goal was to follow the existing framework.
   - It could be important to point out to stakeholders that such outreach will occur later in the process.
   - Connecticut had no concerns with the current draft, nor did the District of Columbia, Massachusetts, and New York. All supported the need for consensus.
   - Pennsylvania is concerned with Item #6 and would like to see an impact threshold incorporated.

- Discussion occurred as to the time frame for reaching consensus and it was settled on August 11.
- Maryland proposed having OTC staff put together a plan to accomplish this goal.

MANE-VU Intra-RPO Consultation #10

Air Directors Call
August 4, 2017

MANE-VU Intra RPO Consultation #10 was an Air Directors call that took place on August 4, 2017. Ask Items discussed were Item 4 and Item 6. For Item 4, there was discussion about the integration of RGGI with the Asks, and language to indicate RGGI only applies to RGGI States. There was also discussion of retaining demonstrable equivalency of reductions by having Item 4 (four-factor analysis instead of 90% reduction) removed and covered by Item 2. For Item 6, a rewording was suggested for the inclusion of a threshold for four-factor analysis on combustion turbines.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X		X		

- Item #4:
  - Maryland stated that RGGI is important to the RGGI states. It's absolutely critical to Maryland to integrate RGGI and other Federal programs into the "Ask" and that it is a deal breaker to not include it. Maryland doesn't see the harm in listing it. New Hampshire will talk to the commissioner about the issue and Connecticut is willing to talk to their assistant commissioner as well. As another example, Maryland will be putting in an SO_2 SIP in place for the Wagner area and this has to be harmonized with the "Ask."
  - Maryland wanted to know who feels the need to shine the spotlight on Wagner and that RGGI is one of Maryland's most important haze precursor programs. Why take it away? Maryland would be open to drafting some language to the effect that RGGI only applies to RGGI States since some MANE-VU States are not RGGI States.
  - The question was raised as to how a state would demonstrate equivalency of the equivalent reductions? A solution may be to take out Item #4 altogether and let Wagner be covered by Item #2 (i.e. do a 4-factor analysis instead of the 90% reduction). Maine and Vermont would be fine with this approach. The Inter-RPO Ask would have to be consistent with this approach.
- Item #6:
  - Pennsylvania was concerned that there has to be a threshold for combustion turbines to do a four-factor analysis and would like it to be 42 and 96 ppm for gas-fired and oil-fired, respectively. New York already meets those thresholds. New Jersey's RACT limit is currently 25 ppmvd and 42 ppmvd for gas-fired and oil-fired units, respectively. For the Ask, this will need to be a RACT performance level, not RACT applicability.
  - Pennsylvania asked if the "Ask" could be narrowed to a specific geographic region since units further away will have a negligible impact and that modeling could be used to see which impacts units have. The concern is that this process would take too long.
  - A suggestion for rewording Item 6a was:

- "For regional haze precursor reduction purposes, meeting NO_X emissions standard of no greater than 42 ppm at 15% O_2 for natural gas and 96 ppm at 15% O_2 for fuel oil (note: additional limits may be warranted for ground-level ozone reduction purposes), or"

MANE-VU Intra-RPO Consultation #11

Air Directors Call

August 9, 2017

MANE-VU Intra-RPO Consultation #11 was an Air Directors call that took place on August 9, 2017. There was an overview of the timeline, future steps, and States' comfort with the Ask contents. Ask Item 4 was removed and consolidated under Item 2 as previously discussed, and all items were renumbered and reorganized. Minor changes were suggested. The final Ask was signed on August 25, 2017.

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X		X		

- Jeff Underhill (New Hampshire) stated that the goal of the call was intended to:
  - Give an overview of the timeline;
  - Give an overview of the compromise MANE-VU "Ask," Upwind "Ask," and EPA/FLMs "Ask";
  - Hear if states are comfortable with the "Ask";
  - Review next steps, including approval of the "Ask."
- Given the delays in finalizing the "Ask," the goal will be to begin the consultation with the upwind states in early October.
- The language in Ask 1 was changed from "optimization" to "the most effective use of control technologies" to avoid implications of the legal definition of "optimization."
- Ask 4 involving the listing of particular units that had been included in the 167 stack portion of the 2008 MANE-VU Ask was removed.
- Ask 6 (now Ask 5) had SO_2 struck from it given that it is handled under another item.
- The language in Ask 2, Ask 3, Ask 5 (now Ask 4), and Ask 7 (now Ask 6) remain unchanged.
- Instead of being signed by the MANE-VU Class I states, the Ask will now be signed by MANE-VU's Executive Director, Dave Foerter (OTC/MANE-VU).
- The upwind state Ask will say that implementation is to occur by 2028. States from MANE-VU contribution work are listed. Ask 1 was modified and Ask 4 removed similar to the MANE-VU Ask.
- A vote was taken and all states agreed that they were comfortable with the language in the "Ask."
- Agreement was reached that there was no need for another Commissioner level call to resolve any remaining differences in the current version, though a briefing document would be helpful. A concurrence with the current version should be sent via email to Dave Foerter.
- An invitation letter to the upwind states should be drafted as well, with the intention of sending it out in early September.
- Although a vote was taken, Maryland suggested one final set of minor edits to the "Ask" and these changes were also accepted.

- The final "Ask" was signed on August 25, 2017.

MANE-VU Inter-RPO Consultation #1

Technical Staff/Air Directors Call

October 20, 2017

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X	X	X	X	X	X	X	X	X		X	X	FWS, FS, NPS

AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
X	X		X		X	X	X	X	X	X	X	X	X

LADCO	SESARM	CENSARA	WESTAR
X	X	X	X

Introductory Statements

- Jeff Underhill, New Hampshire, welcomed everyone on behalf of Assistant Commissioner Clark Freise, MANE-VU Chair.
- This call was intended as an opportunity for open discussion on completed Regional Haze SIP work from MANE-VU, with this call mainly being a listening session.
- There will be follow-up calls to present information and have a more detailed discussion.
- MANE-VU recognized development of our documents in preparation for the 2nd round Regional Haze SIPs are early to meet our 2018 submittal goal, which means the Inter-RPO Consultation process must be conducted now.
- MANE-VU hoped that this process will give mid-western and southern states an opportunity to prepare better for SIP submittals in 2021.
- The expectation also stated that we would close out the process with a webinar that includes Commissioners from each state in the consultation.
- Several documents are available for review on the MANE-VU website including the Contribution Assessment document and all of the supporting technical analysis and the three MANE-VU Asks (Intra-RPO, Inter-RPO, and Federal), the latter of which were sent out to the upwind Air Directors and Commissioners.
- Another expectation for these calls is to provide information to be used in our SIPs for submittal in 2018.

Presentation

- Heidi Hales – Air Director at VT DEC, Frank Steitz – Air Director at NJ DEP, Joseph Jakuta – OTC Staff, Tom Downs – Chief Meteorologist at ME DEP, Jeff Underhill – Chief Scientist at NH DES, and Rob Sliwinski – Assistant Air Director at NYSDEC and MANE-VU TSC Chair gave the presentation.

Discussion

- SESARM noted that in slides and narrative it looks like the glide-slopes in the northeast are similar to the south. Also, he noted that, though not officially confirmed by EPA, EPA will allow the use of 2011 as a base year for 2021 SIPs. Finally, it was noted that several of targeted EGUs are no longer operating.
- New Hampshire pointed out that part of the consultation is to share information and that we are aware that some units have shut down since 2015 and in those cases are seeking additional documentation that the shutdown is enforceable.
- Alabama asked if a state is contributing greater than 2% but does not have a unit with an impact great that 3 Mm^{-1} has to do anything with the Ask.
- New Hampshire noted that a state can have impact greater than 2% without a large source since we looked at total state emissions as well, and such a state would have to address the other portions of the Ask.
- Texas asked if statewide emissions for SO_2 and NO_x, including mobile sources, were analyzed for both 2011 and 2015 and it was pointed out that they were in the Q/d analysis only.

Closing Remarks

- MANE-VU reiterated the importance of the upwind states to continue to work with us and was glad to see that all of the states in MANE-VU were represented as were nearly all of the states identified as contributing.
- The next call will be scheduled after the MANE-VU Commissioners Meeting (November 15, 2017) and will be open floor. If anyone wants topic discussed, please work with your regional group to let MANE-VU know.

MANE-VU Inter-RPO Consultation #2

Technical Staff/Air Directors Call

December 1, 2017

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X		X	X	X	X	X	X	X			X		X	1	FWS, FS, NPS

AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV	GA	AR
X	X	X	X			X	X	X	X	X	X		X	X	

LADCO	SESARM	CENSARA	WESTAR	MARAMA
X	X	X	X	X

Introductory Statements

- Dave Foerter (OTC/MANE-VU) thanked everyone for attending on short notice so this next consultation could occur before the end of year. The next call will be scheduled for either January 5th or 12th at 3 PM and states should let RPO leads or Dave Foerter know if dates work or not.
- The goal of this call was to set the groundwork for the Ask inside the MANE-VU area and to look at these Asks for those contributory states outside of MANE-VU. This call, and the subsequent one to be scheduled in January, are intended to elicit feedback on the Asks presented.

SESARM Feedback

- SESARM thanked MANE-VU for this effort. He noted that SESARM has not had any calls to discuss any questions. There are some of his member states that are interested in making some adjustments (e.g. KY EGUs) to our data sets.
- North Carolina stated that it was unclear about process and was concerned that Ask 2 cited a North Carolina facility that was contributing based on data from 2011. He wanted to know if North Carolina should provide updated info for that facility and whether MANE-VU would incorporate updated information.
- MANE-VU pointed out that there are no plans to remodel it specifically but we will look at updated information. MANE-VU is particularly interested in updated permit info or something else that is enforceable. MANE-VU wants to have the best information possible and realizes that things have changed since 2011, though needs to ensure any changes modeled are enforceable.
- All information on particular facilities must be in by the end of the year.
- North Carolina stated that his modelers are having a difficult time understanding MANE-VU's modeling. It would be helpful to have some clarity on analytical approach to states that contribute to Class I areas.
- MANE-VU pointed out that the analysis was predominantly based on Q/d with meteorological analysis, and the point source analysis also relied on CALPUFF modeling.
- 2011 and 2015 CAMD data were used in CALPUFF modeling for EGUs and 2011 NEI data only were used for industrial sources. Other sectors were only evaluated using Q/d, which was based on 2011, but adjusted to reflect 2015 data.
- SESARM noted that some of the information about what is enforceable is still developing and there is still some fluidity in the final mix of emissions by 2028 but in some cases permits haven not been updated making the action permanent.
- MANE-VU noted that ERTAC EGU projections get a lot of feedback from states which do not have same threshold as permits denoting enforceability but is acceptable for SIPs though MANE-VU does think it is necessary to have permit requirements for units impacting visibility by 3 Mm^{-1} so MANE-VU can have some level of certainty.
- Tennessee noted that recent US EPA modeling shows monitoring below glidepath in 2028 and current monitoring below glidepath. Additionally, Tennessee does not have any facilities listed in Ask 2 and Tennessee Valley Authority (TVA) owns all of their EGUs, the latter being important since TVA also had a court settlement based on PSD review that required shutdown, controls and fuel switching, which is still ongoing and will result in 55% reduction in NO_X and SO_2. Also,

several units have closed. Tennessee would like to look at data to ensure data is updated and representative.

- New Jersey commended Tennessee for these reductions and noted that inventory is always a moving target and at some point we will need to stop adjusting to move on.

LADCO Feedback

- LADCO noted that their states are just beginning the regional haze planning process and LADCO has no specific comments on the MANE-VU Ask.
- Ohio was still looking through data and stated that they would provide more detailed information.
- A few EGUs on the list in Michigan are in the process of negotiating SIP reductions including Trenton Channel for SO_2 SIP and there may be some emission reductions to provide.
- Indiana was interested to see the data modeled and will wait until then before commenting.
- Illinois had no specific comments at the time.

CENSARA Feedback

- CENSARA stated that it has reached out to its member states and that more information would be helpful since they are still assessing.
- Texas was interested in whether a separate technical call can occur to walk through the analyses and ask more detailed questions. They also noted that two of the three largest EGUs in Texas will shut down in the beginning of 2018 which should lower SO_2 emissions by 100,000 tons and there are some other efforts that will result in significant reductions in SO_2 that they would like to bring to the table. A consent decree involving black carbon will bring down emissions from industrial sources.
- MANE-VU said we appreciated the suggestion of technical consultation and could perhaps schedule another webinar to provide the technical analysis details.
- SESARM stated that a call/webinar would be more conducive than ad-hoc discussions that could occur at the upcoming regional haze meeting in Denver.
- The RPO leads will poll their states and get back to MANE-VU within a week concerning the desire to schedule a technically focused call.

There were no additional comments from EPA or the FLMS.

Action Items

1) MANE-VU will distribute/provide link to the more detailed analysis information.
2) RPOs leads will poll their states (by a week from today) about a webinar.
3) Upwind states will provide updated technical information to MANE-VU by the end of the year.

MANE-VU Inter-RPO Consultation #3

Air Directors/Commissioner Call

December 18, 2017

CT	DC	DE	MA	MD	ME	NH	NJ		NY	PA	RI	VT	TrN	OTC	EPA	FLM*
X			X	X	X	X	X	X	X			X		X	1	FWS, FS, NPS

AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV	GA	AR	SC
X	X	X	X			X	X	X	X	X	X	X	X	X	X	X

LADCO	SESARM	CENSARA	WESTAR	MARAMA
X	X		X	X

Agenda

1. Welcome and Roll Call: OTC
2. Technical briefings (aim for 10 minutes or less – except CALPUFF which may be 15)
    a. Q/d
    b. CALPUFF
    c. Trajectory
    d. Consolidation
    e. 4-Factor Overview – (Delayed to next call)
3. Review of available technical products – (OTC)
4. Next Consultation – (OTC)
5. Wrap up

Introduction

- The purpose of this meeting was to further review technical work in the Asks developed by MANE-VU.

Q/d*C Analysis (Kate Knight, Connecticut)

- This analysis was a tool used as part of the assessment for identifying those states that significantly contribute to visibility impairment at Class I areas within MANE-VU.
- Emissions from 2015 were based on EPA trends site but were scaled to ensure updated values were included. Analysis used the centroid method for anthropogenic emissions with some individual point source locations.
- Conclusion was that sulfates are still the main component of visibility impairment but that NO_X is becoming more prevalent.
- SESARM stated that Q/d does not work well with long distances and asked how this fact was handled in this analysis with CALPUFF.
- New Hampshire noted that the Federal Land Managers also raised this issue but we needed to move forward so we used the tools available to us at the time. MANE-VU was concerned that CAMx is not yet ready to assess individual sources. MANE-VU understands that these results may not be conclusive but they are reasonable.
- SESARM reiterated his concern with using an imperfect tool.

CALPUFF Screening (Jessica Dunbar, New Hampshire)

- This analysis was used to quantify and rank large stationary sources of SO_2 and NO_X. This was a screening exercise and does not provide absolute values. The analysis looked at the top five EGUs and other sources of similar size, taking into account the distance of the sources from the Class I areas.
- EGU emissions were obtained from CAMD for 2011 and 2015 and were based on the 95th hourly rate for SO_2 and NO_X.
- Virginia was strongly concerned with using 2011 & 2015 for the analysis rather than 2018, which was of concern because Yorktown will retire in 2018 and Chesterfield is retired.
- New York noted that the analysis reflects the information available at that time. States can use updated information in their SIP as a response to the Ask using enforceable commitments and that states would perform a 4-factor analysis on any particular unit and document in the SIP.

Trajectory Analysis (Tom Downs, Maine)

- Presented metrics analyses for 2000-2015 and 2015 trajectory modeling analyses for the "most impaired" visibility days.
- A comparison of the metrics showed similar results between 20% Worst Days and 20% Most Impaired Days.
- New Hampshire noted that contributing states were determined based on the Q/d analysis, CALPUFF modeling while using a 2% (sulfate and nitrate) contribution threshold at a Class I area, while the back trajectory was used as a quality check.

Discussion

- Florida asked if MANE-VU performed a synthesis analysis linking the Q/d and trajectory.
- New Hampshire responded that we did not because there are no numerical values associated with the back-trajectory analysis.
- North Carolina asked if we sum up emissions and use the centroid method or were emissions assigned to the county level.
- New Hampshire responded that for some sectors statewide emissions were summed using the centroid position and for some individual point sources locations included.
- LADCO asked about the comment period for technical questions or any questions regarding the process and it was noted that the feedback was due December 31, 2017.
- Virginia asked when states provided updated information, if it will be used in modeling or emissions trends for 2015.
- New Hampshire noted that it may be used for photochemical modeling and also goes towards states satisfying the Asks.
- A question was asked about the Low Sulfur Fuel Oil ask but, due to time, was tabled for the next consultation.

MANE-VU Inter-RPO Consultation #4

Air Directors/Commissioner Call

January 12, 2018

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X	X	X	X		X	X	X	X		X	X		X	1, HQ	FS, NPS

AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV	GA
X	X	X	X	X		X	X	X	X	X	X	X	X	X

LADCO	SESARM	CENSARA	WESTAR	MARAMA
X	X	X		X

Agenda

1. Commissioner Call Scheduling
2. Reasonable Measure Overview - New Jersey
3. Upwind States Feedback
    a. Comments Received During December – Joseph Jakuta (OTC/MANE-VU)
    b. SESARM
    c. LADCO
    d. CENSARA
4. Next Steps

Introductory Statements

- Dave Foerter (OTC/MANE-VU) welcomed everyone and noted that the purpose of this consultation event is to facilitate dialogue between the MANE-VU states and particularly the upwind states that have been identified in the Asks.

Commissioner Call Scheduling (Dave Foerter)

- MANE-VU would like to conclude consultation process with a call among state Commissioners in late February or early March.

Regional Measure Overview (Ray Papalski, New Jersey)

- Presentation discussed four factor analysis, how sources were identified, resources used, and which data were analyzed.
- MANE-VU reassessed Asks from first phase of regional haze planning and made updates.
- The determination was made that the second planning period should include sources that emit NO_X in addition to SO_2.
- Assessed data for several sectors including emissions, cost and control information for specific sources/sectors.
- MANE-VU did not conduct 4-factor analyses on any specific sources but is relying on states to do that for sources located within their state.
- Since many facilities complied during the first planning period new sources were captured.
- Increases in nitrate levels in MANE-VU Class I areas considered in assessing EGUs.
- MANE-VU is not asking contributory states to look at peaking units.

Upwind States Feedback

- North Carolina asked if the top 50 sources for each Class I area in MANE-VU are inside and/or outside of MANE-VU?
- New Jersey noted that sources are both inside and outside of MANE-VU and that contribution analysis is available on MANE-VU website in contributory analysis and in CALPUFF modeling analysis.
- Texas asked if we could you provide a copy of regulations of states' rules, which MANE-VU said could be provided.
- Virginia asked if the Dec 31st, deadline for technical information can be extended.
- MANE-VU noted that we are moving into our modeling phase so if information is sent it may be too late to incorporate into modeling.
- New Jersey noted that states can still document if a unit closed in SIPs even if it is not including in modeling since it could show that you are meeting the Ask.

Upwind States Feedback

- MANE-VU received data or comments WV, TN, OH, LADCO, and SESARM.

Upwind States Feedback (SESARM)

- SESARM noted that some individual member states may submit their own comments.
- He also voiced concern with the schedule given that EPA is allowing until 2021 to submit SIPs. There is a lack of time to consider translating emissions, or how much they might change in your analysis. SESARM thought they would have an opportunity to make corrections.
- SESARM was also concerned that some of the analysis techniques (e.g. CALPUFF and Q/d) have uncertainty, especially at long distances, and it could be unlikely that distant states actually impact northeast Class I areas like the analysis result show.
- SESARM requested that MANE-VU delay their SIP process until SESARM can do their own analysis.
- SESARM noted that EPA said in Denver they will accept SIPs using 2011 base year for a 2021 submittal.
- SESARM also noted that SE emissions have been dramatically reduced (~95% in one state) and after further analysis some of these states may not be contributing and it would be unfair to keep them in the process.
- SESARM does not believe the Asks will produce any change in visibility because of other programs. Concerning low sulfur fuel oil, 2016 residential fuel oil component is only 6% of the total sales in the northeast and southeast.
- SESARM finds the energy efficiency goal interesting, but some EE measures have plateaued at this point for several reasons.
- SESARM will follow up with more formal correspondence, possibly in the coming weeks.
- MANE-VU asked if EPA could clarify the use of 2011 platform with a 2021 RH SIP submittal.
- EPA noted that the Regional Haze rule has no requirement for air quality modeling and it does not dictate what the base year for a modeling platform is, but it has to be reasonable. EPA is not prepared to say if 2011 is reasonable and that is up to the modeling group led by Chet Wayland (EPA OAQPS).
- SESARM argued that it reasonable because it is what states can get together for SIP preparation. To legally meet a 2021 deadline, we need to use 2011.
- New Hampshire noted that in Denver, EPA never gave us anything in writing for us to have any confidence with using 2011 for a 2021 submittal.

Upwind States Feedback (LADCO)

- LADCO noted that a letter was sent to OTC/MANE-VU in December expressing their concerns with the technical analysis. The 2011 modeling platform has had many iterations and MANE-VU's screening used an old version. There is newer data in the current platform that would strengthen and lead to different conclusions of the source contributions. The same problem exists for CAMD data from 2015. There are data quality issues with the CAMD data, e.g. gap-filled data can create artificial spikes. That data needs to be scrubbed or normalized before modeling is performed and before any source contribution analyses.
- LADCO went on to note that there is a better data set in 2011 'en' platform, which can be used in conjunction with ERTAC data that removes the gap filling spikes, etc.
- LADCO and the rest of the country are planning on submitting SIPs in 2021 and new data will be available, as well as new tools and techniques and possibly new rules.
- New Hampshire noted that MANE-VU is in the process of working on updating emission inventory for a control strategy case to be used in CMAQ modeling and is looking at the recent data updates from states to incorporate.
- MANE-VU noted that modeling of RPGs can be upgraded to 2011 'el', but not 'en' because 2028 was not projected for 'en'.
- LADCO noted that they might build a 2028 'el'-'en' hybrid 2028 scenario inventory and expect preliminary results in February with CMAQ and CAM-x ready files that will capture some of the NODA comments and would be happy to share the results.

Upwind States Feedback (CenSARA)

- None

Next Steps

- The next step is to move towards a conversation to the Commissioner level.
- Clark Freise (NH, MANE-VU Chair) will lead that conversation when this occurs.
- Clark Freise (NH, MANE-VU Chair) Thanked to everyone for providing thoughts, concerns and comments on the process.

MANE-VU Inter-RPO Consultation #5

March 23, 2018

CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT	TrN	OTC	EPA	FLM
X		X	X	X	X	X	X	X	X		X		X	1,2, HQ	FS, NPS

AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV	GA	SC
	X		X	X			X	X	X	X	X	X	X	X	X

LADCO	SESARM	CENSARA	WESTAR	MARAMA

X	X	X		X

Agenda

1. Roll Call (5 min.)
2. Welcome and Purpose of this Meeting – Clark Freise, New Hampshire Commissioner and MANE-VU Chair (5 min.)
3. Executive Summaries - MANE-VU States and Staff (10 min.)
    a. The timing and substance of MANE-VU Asks
    b. What was learned from Contribution Analysis
    c. How Consultations informed the process
4. Updates by MANE-VU States on Submitting Regional Haze / Visibility Impairment SIPs (10 min.)
5. Updates and Perspectives by States outside of MANE-VU region, Tribal Nations, Federal Land Managers and EPA (25 min.)
6. Next Steps and Adjourn Meeting

Introduction

- Clark Freise (NH, MANE-VU Chair) thanked the upwind states for input and comments.

Executive Summary Presentation

- Jeff Underhill and Frank Steitz (NJ) reviewed the slides which included:
    - Consultation Plan
        - Northeast has a handful of Class I areas. MANE-VU also looked at nearby areas in Virginia and West Virginia. The first part of the consultation process was with states within MANE-VU, then progressed to consultation with contributing states. Phase 1 was completed in August 2017; Phase 2 reaches completion with this session. FLMs have been involved and consultation will be ongoing.
    - Technical work:
        - MANE-VU provided a great deal of technical work within the MANE-VU region that involved coordination between the MANE-VU states and several MJOs. A lot of work was invested in the process to meet the original 2018 submittal date. We know not all states in consultation have the same submittal goal and other states may be on different timelines and sharing our process–technical and consultation–may help them.
    - Development of the Ask
        - We developed 3 Asks. The first was only being asked of MANE-VU states; there was a separate Ask of contributing states; and a third Ask of the EPA.
        - Current Inter-RPO Ask, paraphrased:
            1. EGU >25 MW with installed control will run controls year-round; as an alternative – obtain equivalent reduction;
            2. If a modeled source >3 Mm^{-1} evaluate controls;
            3. States pursue Ultra Low Sulfur Fuel Oil Standards no later than 2028;
            4. EGUs and other large sources that use lower emitting fuels have enforceable conditions to ensure status quo and allow for emergencies;
            5. Consider and report energy efficiency programs and increasing combined heat and power and renewable energy.

    - Consultation will continue as needed or requested.
    - For any outstanding questions and reports first visit the MANE-VU webpage and then any address questions to MANE-VU.

Discussion

- Virginia asked if there are analyses that show visibility improvements from implementing the low-sulfur fuel item from states.
    - New Hampshire pointed out that NESCAUM analyzed this question 10 years ago. This was a region-wide analysis, but it probably didn't break out individual states, though it determined that a regional measure was well above threshold for human eye to detect.
- Georgia reiterated that many states outside of MANE-VU will not be able to commit to MANE-VU Ask items until they do their SIPs and wanted to know how MANE-VU will account for any changes that occur after their SIPs are submitted but before upwind states SIPS are submitted.
    - New York responded that MANE-VU's 2028 modeling analysis will assume the items in the Inter-RPO Ask have been implemented. It's a little fuzzier as to whether modeled measures in a Region Haze SIP have to be permanent & enforceable than in a criteria pollutant SIP. The SIPs themselves, though, have to include enforceable measures. We're not in a position where we have to show we are meeting Uniform Rate of Progress because all of our Class I areas are at or below the 2028 URP levels. MANE-VU is striving for what's reasonable beyond simply meeting URP.
- MANE-VU is still working on getting the response to comments onto the website and will notify when it is available.
- National Park Service and North Carolina sought clarification of enforceability of measures included in modeling.
    - New York noted that we model what we determine to be reasonable and it is up to the states and their analysis to show why it is not reasonable for them. He also noted that Reasonable Progress Goals in themselves are note enforceable which leads us to our approach.
    - New Jersey stated that in 2008, MANE-VU had the "167 Stack" Ask. Once that ask was made, individual states did an analysis whether the controls were reasonable. For most stacks it was reasonable, but for some stacks it wasn't. Similarly, states should include their justification in their SIPs with the reasonableness of this Ask.

Next Steps

- MANE-VU is willing to share modeling results with states outside of MANE-VU.
- Non-MANE-VU states can consult with the TSC as they move forward with their SIPs.
- This concludes MANE-VU’s scheduled consultation sessions, but MANE-VU will be keeping the lines open and entertain questions as they arise from the upwind states.

Overview of MANE-VU Response to Consultation Comments

In addition to the verbal consultations documented in the previous section, MANE-VU received written comments from eight states and two regional planning organizations (RPOs). MANE-VU appreciated the time and effort each participant put into the consultation process. MANE-VU reviewed and documented detailed responses to each of the comments submitted. These detailed responses are in the following section. The comments consisted of three overarching concerns: the uncertainties of the Q/d*C and CALPUFF tools, the choice of the base year for said tools, and the timing of the 2018 schedule for SIP submittals.

States expressed concern regarding the analyses utilized for the selection of states for the consultation process. Specifically, the Q/d*C and CALPUFF analyses. MANE-VU agreed that these tools, as all models, have their limitations. However, MANE-VU has taken a weight of evidence approach through the use of several analyses. This approach combined with altering traditional methods to account for known uncertainties had resulted in a consistent selection of top contributors. The level of repetition in the analysis results, combined with results of the HYSPLIT quality assurance analysis led MANE-VU states to retain confidence in the selection of states. Additionally, the first planning period incorporated more resource intensive modeling; while this is more reliable tool, the results did not vary from the other methods used. Regarding the setting of the reasonable progress goals for 2028, MANE-VU is building a modeling platform that includes the technical correction supplied by each of the commenters. This documentation will be available on the MANE-VU website upon completion.

Additionally, there were several comments regarding the choice of base year. MANE-VU agreed that the choice of base year is critical to the outcome of the study. MANE-VU acknowledged that there are now newer versions and would use the best available inventory for each analysis. However, MANE-VU disagreed that the choice of these inventories was not appropriate for the Q/d*C and the CALPUFF analysis. Again, several inventories were used, with several meteorological years and the resulting top contributors were similar.

States and regional planning organizations also suggested that MANE-VU states adopt the 2021 timeline. MANE-VU agreed with the reasons the comments provided, such as collaboration with data and planning efforts. However, MANE-VU disagreed that the 2018 timeline would prohibit collaboration. In fact, MANE-VU pointed out that the proactive effort by the MANE-VU states would benefit current and future collaborations. As an eastern set of states, MANE-VU is a region prone to transported air pollution. The early analyses, inventory collection, and strategy collaboration can only make the SIP process more efficient and streamlined for upwind states' planning processes.

Overall, MANE-VU was satisfied with the outcome of the consultation with upwind states. Many reoccurring themes indicated a lot of common ground between the upwind states and the MANE-VU states. Information received during the consultation process provided improved data for modeling and future planning exercises. The 2018-2028 planning period is well grounded with this consultation process.

MANE-VU Response to Consultation Comments

In accordance with 40 CFR 51.308(f)(2)(ii) consultations were held among the 14 states that were identified as potentially contributing to MANE-VU Class I areas, the representing Regional Planning Organizations (RPO), the Environmental Protection Agency (EPA), and the Federal Land Managers (FLM). This section details the responses to the comments received during the consultation process.

Written comments were received from eight states and two regional planning organizations. Each of these comments was carefully considered. Detailed below are MANE-VU's responses to the key concepts for each of the comments received.

Additional comments were received from the Lake Michigan Air Directors Consortium (LADCO) and the National Park Service. Those comment letters and MANE-VU responses are included in Appendix A.

Limitations of Q/d*C and CALPUFF tools

Florida DEP, North Carolina, Texas, Ohio, the Lake Michigan Air Directors Consortium (LADCO), and the Southeastern States Air Resource Managers (SESARM) raised concern regarding the use of the Q/d*C and CALPUFF methodologies. More specifically, concerns regarding the limitations of these tools:

- regarding the use of statewide emissions,
- distances greater than 300 km,
- inherit tendency to overestimate contributions,
- residence times,
- wind directions, and
- secondary particle formation.

One study referenced in the comments was the "Interagency Workgroup on Air Quality Models Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts". MANE-VU agrees that the tools have limitations and appreciates the concern. MANE-VU concurs that this study noted uncertainties associated with long-range CALPUFF transport simulations. We note that the study also determines that uncertainty is driven by the characterization or mixing depth and the transport winds. These conclusions were derived with CALPUFF and CALMET version 5.0.

Therefore, to best account for the noted uncertainty MANE-VU's selection of states for the consultation was derived through the use of several methods, several meteorological years, the utilization of the more recent version of CALPUFF, 7.2.1, to include model refinements[5] and based upon a relative ranking of these quantitative results.

Several Q/d runs were utilized to evaluate the ranking of contributing states. MANE-VU states reviewed Q/d runs whereby state total emissions were analyzed from the states centroid and the individual point sources were run from their unique locations and subsequently summed.[6] The relative rankings for each method were analyzed and compared. Table A1 shows the top five contributing states for each Q/d*C method. Note despite the varying methodologies, there was little difference in the states identified as the top five contributors. Therefore, MANE-VUs inclusion of statewide emissions did not alter the

[5] Details on version updates can be found here: http://www.src.com/

[6] Additional methods were also tested. However, these are the two included for decision making process.

resulting conclusion in the selection of states, but rather added an additional tool to evaluate in a weight of evidence manner.

*Table 1A- Top Five Contributing States Identified in Q/d*C Portion of Analyses*

Class I Area	Rank	Total 2011 Emissions	2011 Point Emissions Individual Locations Summed
Acadia	1	OH	OH
	2	PA	PA
	3	IN	IN
	4	MI	MI
	5	IL	IL
Brigantine	1	PA	OH
	2	OH	PA
	3	MD	IN
	4	IN	KY
	5	KY	TX
Great Gulf	1	OH	OH
	2	PA	PA
	3	IN	IN
	4	MI	MI
	5	IL	IL
Lye Brook	1	PA	OH
	2	OH	PA
	3	IN	IN
	4	NY	MI
	5	MI	NY
Moosehorn	1	OH	OH
	2	IN	PA
	3	IL	IN
	4	MI	MI
	5	TX	IL

Additionally, each method had a "C" factor applied.[7] This C factor was derived for specific wind vectors unique to each Class I area receptor. [8] The C factor accounts for the conversion of sulfur dioxide to the sulfate portion of the fine particulates and is unique to each wind vector for each Class I area, therefore, accounts for some of the uncertainty with resident times, wind vectors and secondary particle formation.

As mentioned, MANE-VU also included additional meteorological analyses. The CALPUFF simulations were done with three sets of meteorology: 2002, 2011 and 2015. The inclusion of these extra

[7] Documentation associated with the Ci development is noted in Section 4 and Appendix D of Contributions to Regional Haze in the Northeast and Mid-Atlantic United States

[8] With the exceptions of James River Face - analyses were run utilizing both Shenandoah and Dolly Sods constants as substitutes in the absence of specific constants for James River Face.

meteorological sets provided MANE-VU with the unique ability to establish a relative ranking with less uncertainty.

Furthermore, to recognize the fact that each of these methods bore their own uncertainties, MANE-VU did not utilize the results for the absolute value of contribution but rather the relative ranking between states, to determine the top contributing states for consultation. Therefore, the concern regarding an over estimation of contribution values is not relevant to the application of these results.

It is also important to note that during the first round of SIP regional haze planning we included several other methods to identify contributing states; all of the methods concurred that the top contributing states would appear in the same relative order of ranking. The first-round of regional haze planning showed that the more resource intensive photochemical modeling would not necessarily change the relative ranking within the top contributing states. Therefore, as this second round of regional haze planning period is more resource restricted than the previous one, MANE-VU moved forward as resources allowed and was careful to recognize the flaws of each tool utilized. MANE-VU also notes that regardless of the model chosen uncertainties will exist, it is up to the interpreter to note those uncertainties and implement due diligence to implement methods that might clarify or reduce those uncertainties. Through the inclusion of the varied methodologies and the treatment of the results for qualitative rankings, MANE-VU feels that these uncertainties were adequately addressed for the resources and objectives at hand.

Scaling Q/d*C Analysis

LADCO, North Carolina, and Texas disagreed with the use of the 2015 CAMD, Mobile and Area emissions for the scaled Q/d*C analysis. As noted above LADCO suggested the use of ERTAC 2.7. This version of ERTAC was not available at the time of the study and therefore was not an option. During the consultation with the Federal Land Managers[9], it was noted that known reductions had occurred since the 2011 base year and decided it was important to estimate that impact on the relative contributions. MANE-VU agreed and went forward with an additional scaling analysis to account for known reductions.

North Carolina noted a lack of documentation in the steps between the emissions and the scaled contributions. MANE-VU's documentation has been updated to include the detail of the methods, these files are located on MANE-VU's webpage.[10] North Carolina also noted that the use of Q/d is not traditionally used for all sources of emissions. MANE-VU opted to continue to track total emissions as one part of the Q/d*C process as these emissions are important piece of the whole. MANE-VU did also do the point sources and grouped them after the unique locations were considered. As noted, above the top contributing states were not altered by including a statewide total emissions analysis.

Texas also commented that mobile sources should be considered uncontrollable. While, MANE-VU agrees the control of mobile emissions falls primarily beyond the scope of a state's authority, it should be noted that the MANE-VU Ask for upwind states did not address mobile sources. But rather the inclusion of mobile sources was incorporated in an Ask of EPA. MANE-VU's visibility analysis noted that nitrates role in visibility impairment is becoming more important for this next planning period. As such,

[9] Verbal feedback received at the Fall 2015 Joint Meeting
[10] https://otcair.org/manevu/document.asp?Fview=Reports

it was MANE-VU's belief it would be inappropriate to neglect the largest source of NOx, the precursor to nitrate.

While, MANE-VU agrees, scaling will also have uncertainties, it was another weight of evidence study whereby known reductions could be fairly evaluated.

Inventories- 2011 Base Year and 2018 Projected Year

LADCO and Texas commented regarding the use of the 2011 and projected 2018 base years for the Q/d*C exercise. Commenters noted there is a more recent rendition of 2011 available and the current state of knowledge would improve the 2018 projections. More specifically, it was suggested that MANE-VU use the EPA 2011 en platform, projections for 2018 has been improved since the Q/d*C study, ERTAC 2.7 should be use instead of Clean Air Markets Division Data (CAMD) and the 2011 base year did not resemble typical meteorology in Texas.

MANE-VU agrees that the choice of base year is important and the technical updates provided are the result of this consultation. These corrections have been included in the emissions platform for the photochemical modeling to determine the 2028 base and control. MANE-VU also requests that each state with specific facilities in the Ask review the use of the 2011 and 2015 emissions and clarify why the use of these emissions are no longer appropriate, so that we may properly incorporate the changes if appropriate. MANE-VU interprets appropriate changes to be those that are permanent and enforceable. We expect as states prepare their SIPs, the appropriate updates, such as additional controls or shut downs of specific units or plants, would be included, especially with regards to units identified as significant sources. MANE-VU is not asking for a significant amount of work on the part of States for those units, as a brief explanation in their SIP describing the specific situation would likely suffice in most cases.

However, with respect to the use of these inventories for the Q/d*C and CALPUFF analyses, MANE-VU is satisfied. These were the most recent years available at the time of the study and when the report was opened for public comment, data was incorporated into the next analyses as appropriate when noted by stakeholders, a process that was open to the states later identified as contributing states. While we appreciate that, there is now more recent data; none of the suggested inventories were available at the timing of the Q/d*C analysis and the CALPUFF analysis. To initiate consultation process it was critical to move forward with those analyses at that time. We are appreciative of the technical corrections that were communicated at each level of the process. MANE-VU intends to continue to implement the more recent data where and when available for the future analyses.

Utilize 2021 Deadline Extension

LADCO, North Carolina, Missouri, and SESARM all indicated that they, or the states they represent, intend to utilize the deadline extension and submitted their respective SIPS in 2021. Commenters the asked that MANE-VU reconsider the timeline currently adopted. Commenters advised MANE-VU to consider the 2021 deadline, in part to collaborate through the SIP process with the upwind states. MANE-VU does not feel that the 2018 timeline prohibits such a collaboration. In fact, MANE-VU sees the earlier timing as mutually beneficial, because the predominant meteorology across the United States creates a west to east wind flow, and therefore, having the eastern portion of a collaborative commit and implement an earlier planning process can only benefit the western planning agencies. MANE-VU committed to this admittedly challenging timeline to address the issue of regional haze in the most efficient manner for all states involved. Additionally, MANE-VU have invested resources into this good faith effort a delay to 2021 not only delays any potential air quality benefit it risks a significant amount of wasted resources. We have no confidence that the USEPA will accept SIPs submitted in 2021 with the 2011 platform. The Regional Haze Rule requires the use of the latest available inventory 2021 will have several renditions of the national emissions inventories, not yet finalized or prepared, that will inevitably need to be analyzed. We recognize the complex and lengthy process of air quality control and are encouraged to find an opportunity to best utilize our resources and provide ample time for our western collaborators to adequately address their own SIP planning process. MANE-VU members intend to submit their respective SIPs in accordance with the original deadline, July 31, 2018.

Use of Back Trajectory Analysis

Florida, North Carolina, and Texas commented regarding the qualitative use the HYSPLIT analysis used for quality assurance of the selection of states. Specifically, concern was noted when states had low percentage of HYSPLIT tracks on impaired days and the choice of EDAS 40 km over NAM 12 km.

MANE-VU utilized the HYSPLIT trajectories as a quality assurance check to the weight of evidence analysis. The purpose of this analysis was to determine if the trajectories on impaired days had the potential to impact the Class I areas of concern. Therefore, the percentage of periods where the state intersected these trajectories was not a threshold for consideration. Doing so would require a much more thorough analysis and considering previous analyses identification of top contributing states, MANE-VU did not feel the additional analysis was an appropriate next step.

The choice of the meteorological data for this analysis was based on the quality of data archived. EDAS 40 km had the best data recovery rate while retaining the methodology to be compared to 2002 analysis.

MANE-VU appreciates the concern voiced and agrees additional analyses would always be better. However, for the objective of the study at hand MANE-VU is confident that this analysis is more than adequate.

Threshold for the Selection of Contributing States for Consultation

Florida, Texas, and North Carolina submitted comments regarding the choice of the threshold whereby a state was included in the consultation. Each of these comments is different in nature and is addressed individually below.

Florida raised concern that that they were only 2.1% of the contribution to Acadia alone when the threshold was 2% to any Class I area. MANE-VU appreciates the concern, however, disagrees that this should negate the invitation for consultation. As the goal for regional haze is natural visibility it is imperative that the top contributors identified are consulted with in each round. MANE-VU also notes Florida’s comments include a summary of emissions reductions. We anticipate Florida’s SIP will document these reductions further and these reductions will in fact reduce their contribution.

Texas included photochemical modeling results that indicated the maximum impact to a MANE-VU Class I area was just below 1%. Without further documentation, MANE-VU cannot respond to these new modeling results. However, MANE-VU appreciates the information and will review these results when Texas makes them available.

North Carolina noted that decision for the 2% threshold had not been documented and requests further documentation to better understand and address their contribution. MANE-VU chose the 2% threshold because it doubles that of the EPA 1% threshold for NAAQS. The one percent threshold was thought to be too stringent given the uncertainties associated with the analyses performed.

It is MANE-VU's contention that given the wind patterns over the United States, all State's to the west and south contribute to some degree to air pollution in the northeastern United States. Thereby, a thorough and complete analysis must include all states in the modeling domain. We believe our analyses have adequately addressed the uncertainties to the extent our resources allow and have identified the states for consultation based on the best data available at the time of the analyses. Where contributing states identify significant emissions reductions in the planning period, we would encourage states to quantify and document said reductions in their federally enforceable SIPs.

Technical Corrections

Florida, Ohio, Texas, Tennessee, Virginia, West Virginia, and North Carolina provided technical updates through the consultation process. Where appropriate, these revisions have been included in the 2028 base and control modeling. SESARM noted that revisions included must be quantifiable, permanent and enforceable. Where technical revisions were submitted if documentation was not accompanied it was requested. When documentations supported the quantification, permanent and enforceability of those revisions, they were incorporated into the 2028 platform. In addition, it is MANE-VU's contention that the recommendation for inclusion into the ERTAC tool is the acknowledgement of the state that the changes are "SIP quality". Thereby, those changes are treated as permanent and enforceable.

Upon completion, the 2028 photochemical modeling, the resulting reasonable progress goals and the associated documentation will be publicly noticed and available on the MANE-VU website.

Summary

Overall, the feedback MANE-VU received is consistent with MANE-VU's perspective. However, it is MANE-VU's hope that these responses clarify the rationale behind the decision-making process. Additionally, MANE-VU is hopeful that its early effort for the 2018 submission increases opportunities for planning and results in improved air quality.

Appendix A: LADCO Comment Letter

LAKE MICHIGAN AIR DIRECTORS CONSORTIUM
9501 W. Devon Ave., Suite 701 Rosemont, IL 60018
Phone: 847-720-7880 Fax: 847-720-7891

May 23, 2018

David Foerter
Ozone Transport Commission and MANE-VU
444 N. Capital St. NW
Washington DC 20001

Subject: MANE-VU Regional Haze Consultative Process

Dear Mr. Foerter,

I would like to reiterate my appreciation for MANE-VU's communication with LADCO and the LADCO states through your regional haze consultative process. LADCO and its states have provided feedback and data to MANE-VU during this process. The meeting minutes circulated by Mr. Jakuta on April 24, 2018 accurately reflect the comments that we made during the MANE-VU conference calls.

In these comments, in a December 20, 2017, letter that LADCO submitted to MANE-VU, and in similar letters submitted by some of the LADCO states to MANE-VU, we expressed concerns about the technical approaches being used by MANE-VU to quantify the contributions of emissions from upwind states to visibility in downwind Class I areas. Briefly, LADCO disagrees with MANE-VU's selection of the base year inventory and future year inventory projections used in your Q/d and Q/d*C contribution assessments, respectively. In the LADCO letter, I provided recommendations to MANE-VU on alternative emissions data that more accurately reflect current and projected future emissions conditions in the LADCO states.

On behalf of LADCO and its states, I also want to restate that we strongly encourage MANE-VU to consider taking advantage of the extension to the current regional haze planning period. New data, modeling tools, and contribution analysis approaches will produce better technical assessments and benefit the overall regional haze planning process. The additional three years will also allow for more opportunities to collaborate on strategies for improving visibility in our Class I areas.

LADCO appreciates the opportunity to provide feedback on your consultative process and we welcome further discussion with MANE-VU on our comments and recommendations.

Sincerely,

Zachariah Adelman
LADCO Executive Director

Appendix B: MANE-VU Response to LADCO Comment Letter

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

July 27, 2018

Mr. Zachariah Adelman
Executive Director
Lake Michigan Air Directors Consortium (LADCO)
9501 W. Devon Ave., Suite 701
Rosemont, IL 60018

Dear Mr. Adelman:

MANE-VU received your May 23, 2018 letter in response to MANE-VU's April 24, 2018 Regional Haze Consultation Report documenting the content of the consultation on-line meetings and calls. Within the next few weeks, MANE-VU will post on its website a report documenting the consultative process for the second regional haze planning period, feedback received from states and regional planning organizations, MANE-VU's responses, and the minutes from each of the consultation sessions.

Thank you for providing your feedback on the minutes from the "Inter-RPO" phase of MANE-VU's consultation. We appreciate that you found the documentation of the meetings to accurately reflect the comments made during the conference calls and webinars.

For the four-factor analyses for the second planning period, MANE-VU encourages LADCO member states to update the inventories as you suggest for actual and projected emissions that they find best fit their situation.

We look forward to further discussion and consultation as the regional haze planning process proceeds.

Sincerely,

David C. Foerter
MANE-VU Executive Director

800 Maine Avenue SW - Suite 200 - Washington, DC 20024
202.318.0190 p

Appendix C: National Park Service Comment Letter

United States Department of the Interior

NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225-0287

N3615 (2350)

TRANSMITTED VIA ELECTRONIC MAIL - NO HARDCOPY TO FOLLOW

April 12, 2018

Joseph Jakuta
Ozone Transport Commission/Mid-Atlantic/Northeast Visibility Union
444 North Capitol Street NW #322
Washington, DC 20001

Dear Mr. Jakuta:

Thank you for the opportunity to comment on the Mid-Atlantic/Northeast Visibility Union (MANE-VU)'s draft Statement of its planned course of action for assuring reasonable progress for the second regional haze implementation period (2018-2028).

Over the past 18 months, MANE-VU has completed a contribution assessment, developed a request for its member states to consider specific control measures as part of the second regional haze state implementation plans (MANE-VU Ask), and consulted with Federal Land Managers and neighboring states concerning the MANE-VU Ask. Our understanding is that individual MANE-VU states are still developing their processes to define which sources will be evaluated for continued visibility improvement in the Class I areas in MANE-VU states.

Because we could not determine which specific sources that the MANE-VU states will be evaluating, we compiled the attached list of sources that may impact Acadia, Mammoth Cave, or Shenandoah National Parks using a simple screening metric. We ask that the states review and consider these sources for inclusion in their long term strategies.

In addition to these major sources, we urge the states with oil and gas point or area source emissions to evaluate oil and gas emission trends and potential for emissions reductions as part of their long term strategy for 2028.

We would like to discuss this further with the MANE-VU Technical Support Committee and the states in the near future. We also would like to learn more about how the screening process in the MANE-VU Ask corresponds with EPA's 2016 Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for Regional

Haze State Implementation Plans for the Second Implementation Period (see especially guidance on page 72, in Section 6.3 of that document).

We look forward to working with MANE-VU on this important program for reducing regional haze affecting Class I national parks and wilderness areas. Pat Brewer (303-969-2153 or patricia_f_brewer@nps.gov) of my staff will be following up with you to set up a call.

Sincerely,

Carol McCoy
Chief, Air Resources Division

cc:
Rob Sliwinski, New York Department of Environmental Conservation and MANE VU Technical Support Committee Chair

ATTACHMENT

Screening Metric

EPA's draft guidance allows use of emissions divided by distance (Q/d) as a surrogate for a modeling analysis to estimate impact. We first summed 2014 NEI NOx + PM_{10} + SO_2 + SO_4 at a given facility and divided by distance to a specified NPS Class I area. Airports and rail yards were deleted because these mobile sources are not regulated by states. For EGUs with significant Q/d values, we used 2017 CAM data to adjust for changes in emissions since 2014. We also deleted facilities that either had shut down since 2014 or had committed to shut down during the next planning period. To estimate the impact of MANE-VU facilities, we summed the Q/d values across all MANE-VU states relative to ACAD, MACA, and SHEN, ranked the Q/d values relative to each Class I area, created a running total, and identified those facilities contributing to 80% of the total impact at each NPS Class I area. We applied a similar process to facilities in ME relative to ACAD. We merged the resulting lists of facilities and sorted them by their states. Although the numbers of facilities identified for most states were not excessive, we observed that the totals for NY and PA could be considered burdensome. To address this problem, we suggest that a state consider those facilities comprising 80% of the Q/d total, not to exceed the 25 top-ranked facilities.

Connecticut

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
754311	PSEG PWR CT LLC/BPT HARBOR STA	1,530	487	3.1	ACAD
754411	WHEELABRATOR BRIDGEPORT LP	1,409	489	2.9	ACAD
715611	C R R A / MID-CONNECTICUT	821	412	2.0	ACAD
715711	MIDDLETOWN POWER LLC	547	421	1.3	ACAD
643411	PSEG FOSSIL LLC/ POWER CT LLC	486	461	1.1	ACAD
754611	COVANTA SOUTHEASTERN CT CO	417	397	1.1	ACAD
8501611	WHEELABRATOR LISBON INC (WM)	327	386	0.8	ACAD
2706711	ALGONQUIN GAS TRANSMISSION (Cromwell)	317	421	0.8	ACAD
588711	COVANTA BRISTOL, INC	300	436	0.7	ACAD

District of Columbia

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
2701211	U.S. GSA Central Heating and Refrigeration Plant	258	101	2.5	SHEN

Delaware

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
588311	Delaware City Refinery	2,730	233	11.7	SHEN
640911	INDIAN RIVER GENERATING STATION	709	260	2.7	SHEN

Massachusetts

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
8127611	SEMASS PARTNERSHIP	1,616	301	5.4	ACAD
7869811	WHEELABRATOR MILLBURY INC	1,257	322	3.9	ACAD
7947211	WHEELABRATOR NORTH ANDOVER INCORPORATED	865	245	3.5	ACAD
8167211	WHEELABRATOR SAUGUS INC	709	256	2.8	ACAD
7236411	SOLUTIA INC	984	376	2.6	ACAD
6622811	MM TAUNTON ENERGY LLC	674	305	2.2	ACAD
7259211	ARDAGH GLASS INC	383	313	1.2	ACAD
7887011	MEDICAL AREA TOTAL ENERGY PLANT	325	273	1.2	ACAD
5979211	STONY BROOK ENERGY CENTER	298	372	0.8	ACAD
7764911	GENERAL ELECTRIC AIRCRAFT ENGINES	191	256	0.7	ACAD

Maryland

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
7763811	Luke Paper Company	20,159	160	126.3	SHEN
6084311	Raven Power Fort Smallwood LLC	16,848	147	114.8	SHEN
8200011	Lehigh Cement Company - Union Bridge	3,026	114	26.6	SHEN
7931411	Holcim (US), Inc.	2,028	93	21.8	SHEN
7717711	AES Warrior Run	1,844	89	20.8	SHEN
6011511	NRG Morgantown Generating Station	2,517	123	20.4	SHEN
5155011	C.P. Crane LLC	3,248	258	12.6	SHEN
6011911	NRG Chalk Point, LLC	1,732	138	12.6	SHEN
5998011	NRG Dickerson Generating Station	724	71	10.2	SHEN
5857411	Wheelabrator Baltimore, LP	1,413	141	10.0	SHEN
7719011	Montgomery County RRF	551	71	7.7	SHEN
6117011	Naval Support Facility, Indian Head	387	96	4.0	SHEN

Maine

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
8200111	SAPPI - SOMERSET	3,476	107	32.5	ACAD
8028411	DRAGON PRODUCTS CO - THOMASTON	1,157	41	28.3	ACAD
8026411	CATALYST PAPER OPERATIONS INC. - RUMFORD	2,829	161	17.6	ACAD
5974211	WOODLAND PULP LLC	1,482	102	14.6	ACAD
7764711	VERSO PAPER - ANDROSCOGGIN MILL	1,803	136	13.2	ACAD
5760811	PENOBSCOT ENERGY RECOVERY CO	481	53	9.1	ACAD
7946611	S D WARREN CO - WESTBROOK	901	141	6.4	ACAD
5823511	FPL ENERGY WYMAN LLC	567	124	4.6	ACAD
5222111	MID MAINE WASTE ACTION CORP	302	129	2.3	ACAD
5223011	REENERGY LIVERMORE FALLS LLC	209	129	1.6	ACAD
7719211	MAINE INDEPENDENCE STATION	130	90	1.4	ACAD
5974111	COVANTA - JONESBORO	126	115	1.1	ACAD
7718411	COVANTA WEST ENFIELD	126	138	0.9	ACAD
8240811	LINCOLN PAPER AND TISSUE, LLC	134	151	0.9	ACAD
5676911	REENERGY STRATTON LLC	164	188	0.9	ACAD
8028611	WESTBROOK ENERGY CENTER	105	144	0.7	ACAD

New Hampshire

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
7287811	PSNH - SCHILLER STATION	389	200	2.0	ACAD
7301111	WHEELABRATOR CONCORD COMPANY LP	411	249	1.7	ACAD
7758711	MONADNOCK PAPER MILLS INC	206	287	0.7	ACAD
17167211	BURGESS BIOPOWER	146	207	0.7	ACAD
7513011	APC PAPER COMPANY INC	209	305	0.7	ACAD

New Jersey

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
7989011	CARNEYS POINT GENERATING PLANT	1,968	249	7.9	SHEN
8093811	Logan Generating Plant	1,224	259	4.7	SHEN
7201311	Paulsboro Refining Company LLC	975	273	3.6	SHEN
7903711	Phillips 66 Bayway Refinery	1,215	390	3.1	SHEN
8177011	Covanta Essex Company	887	402	2.2	SHEN
7392311	PSEG Bergen Generating Station	665	564	1.2	ACAD
7906111	Union County Resource Recovery Facility	649	597	1.1	ACAD
7990011	Cogen Technologies Linden Venture, L.P.	499	592	0.8	ACAD
6719711	NORTH JERSEY ENERGY ASSOC A LP	470	614	0.8	ACAD
7474911	PSEG FOSSIL LLC MERCER GENERATING STATION	480	658	0.7	ACAD

Rhode Island

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
5486911	DOMINION ENERGY MANCHESTER STREET, INC.	231	331	0.7	ACAD

New York

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
17052711	Red-Rochester LLC At Eastman Business Park	12,708	478	26.6	SHEN
8105211	LAFARGE BUILDING MATERIALS INC	6,874	543	12.7	SHEN
8121711	NORTHPORT POWER STATION	3,009	515	5.8	ACAD
7991711	INTERNATIONAL PAPER TICONDEROGA MILL	2,097	380	5.5	ACAD
8325211	FINCH PAPER LLC	2,055	408	5.0	ACAD
7968211	ALCOA MASSENA OPERATIONS (WEST PLANT)	2,883	724	4.0	SHEN
7814711	MORTON SALT DIV	1,590	416	3.8	SHEN
7822211	ANCHOR GLASS CONTAINER CORP	1,298	374	3.5	SHEN
7805611	DUNKIRK STEAM GENERATING STATION	1,282	409	3.1	SHEN
7210211	GUARDIAN GENEVA FLOAT GLASS FACILITY	1,251	453	2.8	SHEN
7994011	CON ED-EAST RIVER GENERATING STATION	1,106	413	2.7	SHEN
8175411	BOWLINE POINT GENERATING STATION	1,322	535	2.5	ACAD
7417811	AES SOMERSET LLC	1,209	494	2.4	SHEN
8123611	WHEELABRATOR WESTCHESTER LP	1,071	447	2.4	SHEN
7417011	COVANTA NIAGARA LP	1,092	468	2.3	SHEN
7993311	HEMPSTEAD RESOURCE RECOVERY FACILITY	1,014	442	2.3	SHEN
8325311	LEHIGH NORTHEAST CEMENT COMPANY	919	407	2.3	ACAD
8309011	RAVENSWOOD GENERATING STATION	940	417	2.3	SHEN
8542611	AES CAYUGA	955	430	2.2	SHEN
7221611	EF BARRETT POWER STATION	1,090	558	2.0	ACAD
8427811	ROSETON GENERATING STATION	948	512	1.9	ACAD
7982311	ASTORIA GENERATING STATION	811	561	1.4	ACAD
7981511	PORT JEFFERSON POWER STATION	581	497	1.2	ACAD
7416911	GLOBE METALLURGICAL INC	978	842	1.2	ACAD
8104811	BLACK RIVER GENERATION LLC	583	569	1.0	ACAD
7844111	ARTHUR KILL GENERATING STATION	593	594	1.0	ACAD
8035411	TGP COMPRESSOR STATION 245	535	541	1.0	ACAD
8322311	NORTHEAST SOLITE CORPORATION	446	484	0.9	ACAD
7209911	GENERAL CHEMICAL LLC	536	617	0.9	ACAD
7982011	ONONDAGA CO RESOURCE RECOVERY FACILITY	510	612	0.8	ACAD
7804411	OWENS-BROCKWAY GLASS CONTAINER INC	505	648	0.8	ACAD
7995311	CON ED-74TH STREET STA	418	565	0.7	ACAD
7986111	CON ED-59TH ST STA	408	567	0.7	ACAD
8123211	HUNTINGTON RESOURCE RECOVERY FACILITY	371	515	0.7	ACAD
8107511	REVERE SMELTING & REFINING CORP	385	545	0.7	ACAD
8539211	INDEPENDENCE STATION	444	629	0.7	ACAD
7800811	OWENS-CORNING INSULATING SYSTEMS- FEURA BUSH	313	451	0.7	ACAD
7980511	OSWEGO HARBOR POWER	432	636	0.7	ACAD
7801111	SELKIRK COGENERATION PROJECT	304	451	0.7	ACAD

Pennsylvania

EIS ID	Facility Name	Q	Distance to NPS Class I Area	Q/d	NPS Class I Area
3866111	GENON NE MGMT CO/KEYSTONE STA	31,020	217	143.2	SHEN
3005211	HOMER CITY GEN LP/ CENTER TWP	13,925	196	70.9	SHEN
2905911	GENON NE MGMT CO/CONEMAUGH PLT	12,422	179	69.5	SHEN
3005111	NRG WHOLESALE GEN/SEWARD GEN STA	8,946	180	49.7	SHEN
8204511	USS/CLAIRTON WORKS	6,269	211	29.8	SHEN
4952111	MAGNESITA REFRACTORIES/YORK	4,568	164	27.8	SHEN
3881111	MONTOUR LLC/MONTOUR SES	7,557	272	27.7	SHEN
6594511	CAMBRIA COGEN CO/EBENSBURG	4,377	178	24.6	SHEN
6463511	PPG IND INC/WORKS NO 6	3,230	161	20.1	SHEN
9248211	TEAM TEN/TYRONE PAPER MILL	3,216	196	16.4	SHEN
8404811	NRG MIDWEST LP/CHESWICK	3,410	226	15.1	SHEN
7872711	APPVION INC/SPRING MILL	1,527	159	9.6	SHEN
3881611	HERCULES CEMENT CO LP/STOCKERTOWN	3,085	322	9.6	SHEN
6652211	PHILA ENERGY SOL REF/ PES	2,675	280	9.5	SHEN
7409311	USS CORP/EDGAR THOMSON WORKS	1,969	217	9.1	SHEN
8406511	SCHUYLKILL ENERGY RES/ST NICHOLAS COGEN	2,360	273	8.6	SHEN
6594311	EBENSBURG POWER CO/EBENSBURG COGENERATION PLT	1,500	177	8.5	SHEN
6651211	ESSROC/NAZARETH LOWER CEMENT PLT I II III	2,535	319	7.9	SHEN
6603511	PITTSBURGH GLASS WORKS/MEADVILLE WORKS 8	2,639	337	7.8	SHEN
6597611	LEHIGH CEMENT CO LLC/EVANSVILLE CEMENT PLT & QUARRY	1,997	262	7.6	SHEN
7409411	US STEEL CORP/IRVIN PLT	1,529	214	7.1	SHEN
6582211	KEYSTONE PORTLAND CEMENT/EAST ALLEN	2,212	312	7.1	SHEN
4737311	SUNBURY GENERATION LP/SUNBURY SES	1,640	243	6.7	SHEN
8219711	COVANTA DELAWARE VALLEY LP/DELAWARE VALLEY RES REC	1,676	261	6.4	SHEN
3186811	PA STATE UNIV/UNIV PARK CAMPUS	1,293	210	6.1	SHEN
4760211	SCRUBGRASS GENERATING CO LP/KENNERDELL PLT	1,621	295	5.5	SHEN
6595211	KIMBERLY CLARK PA LLC/CHESTER OPR	1,409	265	5.3	SHEN
7889111	GRAYMONT PA INC/PLEASANT GAP, CON-LIME & BELLEFONTE PLTS	1,179	223	5.3	SHEN
6582111	INTL WAXES INC/FARMERS VALLEY	1,637	328	5.0	SHEN
4105111	GILBERTON POWER CO/JOHN B RICH MEM POWER STA	1,210	269	4.5	SHEN
6559611	DOMTAR PAPER CO/JOHNSONBURG MILL	1,269	289	4.4	SHEN
4966711	UNITED REFINING CO/WARREN PLT	1,376	333	4.1	SHEN
8330811	ARCELORMITTAL MONESSEN LLC/MONESSEN COKE PLT	795	200	4.0	SHEN
3881711	MARTINS CREEK LLC/MARTINS CREEK	1,255	337	3.7	SHEN
6580811	ARMSTRONG CEMENT & SUPPLY/WINFIELD	900	245	3.7	SHEN
7889011	PANTHER CREEK POWER OPR LLC/NESQUEHONING	1,066	293	3.6	SHEN
7874511	MONROE ENERGY LLC/TRAINER	947	261	3.6	SHEN
8331411	WHEELABRATOR FRACKVILLE/MOREA PLT	953	270	3.5	SHEN
6581211	LANCASTER CNTY RRF/ LANCASTER	616	185	3.3	SHEN
3762011	MT CARMEL COGEN/CULM FIRED COGEN PLT	827	258	3.2	SHEN
2989611	GUARDIAN IND CORP/JEFFERSON HILLS	667	209	3.2	SHEN
7407611	SHENANGO INC/SHENANGO COKE PLT	747	238	3.1	SHEN
8220011	WHEELABRATOR FALLS INC/FALLS TWP	946	325	2.9	SHEN
4843611	COVANTA PLYMOUTH RENEWABLE ENERGY/ PLYMOUTH	812	280	2.9	SHEN
7991611	ALLEGHENY LUDLUM LLC/BRACKENRIDGE	643	229	2.8	SHEN
6532511	AMER REF GROUP/BRADFORD	951	341	2.8	SHEN

4120011	YORK CNTY SOLID WASTE/YORK CNTY RESOURCE RECOVERY	451	175	2.6	SHEN
6621911	LAFARGE CORP/WHITEHALL PLT	759	303	2.5	SHEN
8141411	JEWEL ACQUISITION/MIDLAND FAC	668	271	2.5	SHEN
4952011	PROCTER & GAMBLE PAPER PROD CO/MEHOOPANY	832	347	2.4	SHEN
3020711	OWENS-BROCKWAY GLASS CONTAINER INC/CRENSHAW PLT 19	592	263	2.2	SHEN
8141311	AES BEAVER VALLEY LLC/BEAVER VALLEY LLC	586	267	2.2	SHEN
2990311	ALLEGHENY ENERGY SUPPLY/SPRINGDALE	491	225	2.2	SHEN
3884311	CARMEUSE LIME INC/MILLARD LIME PLT	454	211	2.2	SHEN
3892811	AK STEEL CORP/BUTLER WORKS	554	259	2.1	SHEN
6558911	NORTHAMPTON GEN CO/NORTHAMPTON	769	671	1.1	ACAD
4735811	WESTWOOD GEN LLC/GEN STA	644	743	0.9	ACAD

Appendix D: MANE-VU Response to National Park Service Comment Letter – July 27, 2018

Mid-Atlantic/Northeast Visibility Union

MANE-VU

Reducing Regional Haze for Improved Visibility and Health

Ms. Carol McCoy
Chief, Air Resources Division
United States Department of the Interior
P.O. Box 25287
Denver, CO 80225-0287

Dear Ms. McCoy,

The members of Mid-Atlantic/Northeast Visibility Union (MANE-VU) Regional Planning Organization (RPO) appreciate the feedback submitted by the National Park Service on the MANE-VU Ask for the second regional haze implementation period (2018-2028). This letter intends to better explain the status of the MANE-VU States' efforts in fulfilling the requirements of the Regional Haze program, including the participation of the federal land managers (FLMs) in the State Implementation Plan (SIP) development process.

The MANE-VU Ask was finalized and signed on August 25, 2017, after approximately six months of consultations and discussions between the states with Class I Areas in MANE-VU and the other MANE-VU states. Separate Asks were developed for MANE-VU states[1], upwind states that contributed at least two percent of the visibility impairment to the MANE-VU Class I Areas[2], and for the EPA and Federal Land Managers[3]. The two percent threshold was chosen because it encompassed about 85% of the visibility impairment due to sulfate and nitrate to the Class I Areas in MANE-VU, while keeping the mass factor above one percent (more details can be found in MANE-VU's August 5, 2017 Selection of States document[4]).

The Inter-RPO consultation process included five webinars that took place from October 2017 through March 2018. The Inter-RPO Consultation led to MANE-VU receiving written comments from eight states and two regional planning organizations. MANE-VU responded to these comments in the Consultation Summary document. The FLMs, including the National Park Service, were welcome and valued participants in the consultation process.

[1] https://otcair.org/MANEVU/Upload/Publication/Formal%20Actions/MANE-VU%20Intra-Regional%20Ask%20Final%208-25-2017.pdf
[2] https://otcair.org/MANEVU/Upload/Publication/Formal%20Actions/MANE-VU%20Inter-Regional%20Ask%20Final%208-25-2017.pdf
[3] https://otcair.org/MANEVU/Upload/Publication/Formal%20Actions/MANE-VU%20FLM%20Final%20Ask%208-25-2017.pdf
[4] https://otcair.org/MANEVU/Upload/Publication/Reports/MANE-VU%20Contributing%20State%20Analysis%20Final.pdf

Although the Ask and consultation process are completed, there is still work to do to assist MANE-VU States in preparing Regional Haze SIPs. MANE-VU's Technical Support Committee is currently conducting air quality modeling of 2028 base and control cases to determine the 2028 Reasonable Progress Goals (RPGs) – which, it should be noted, are unenforceable goals, unlike typical SIP planning such as for ozone or particulate matter. After this modeling is completed and RPGs are developed, MANE-VU's tasks will essentially be completed and states will have everything they need to prepare their SIPs.

Each state, whether or not it has a Class I area and whether or not it is a MANE-VU State, must include an analysis of the Ask and the RPGs in their SIP for the second planning period. States must also perform a four-factor analysis, as defined in the December 2016 amendments to the Regional Haze Rule[5], to determine the feasibility of the measures necessary to comply with the Ask and meet the RPGs. The MANE-VU States welcome the input of the FLMs at this critical time. Addressing the questions and concerns of our federal partners can only improve our mutual understanding and result in a better product. States will still provide the FLMs the required 60 to 120 days to review their SIPs before they are released for formal public comment.

It should be noted that your source-specific comments regarding impacts on Class I areas should be made to individual states in the cooperative process described above to be included in their SIPs.

Thank you again for your comments. Please contact me at (202) 318-0192 should you have any additional questions.

Sincerely,

David C. Foerter
Executive Director

[5] https://www.epa.gov/visibility/final-rulemaking-amendments-regulatory-requirements-state-regional-haze-plans

MANE-VU Thank you letters

Mid-Atlantic/Northeast Visibility Union

MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Lance Le Fleur
Alabama Dept. of Environmental Management
1400 Colesium Boulevard
Montgomery, AL 36110

Dear Director Le Fleur;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Bob Martineau
Tennessee Dept. of the Environment and Conservation
312 Rosa L. Parks Avenue
Nashville, TN 37243

Dear Commissioner Martineau;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union

MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Bryan Shaw
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg. F
Austin, TX 78753

Dear Chairman Shaw;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Members
Connecticut
Delaware
District of Columbia
Maine Maryland
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania
Penobscot Indian Nation
Rhode Island
St. Regis Mohawk Tribe
Vermont

Nonvoting Members
U.S. Environmental Protection Agency
National Park Service
U.S. Fish and Wildlife Service
U.S. Forest Service

MANE-VU Class I Areas

ACADIA NATIONAL PARK ME

BRIGANTINE WILDERNESS NJ

GREAT GULF WILDERNESS NH

LYE BROOK WILDERNESS VT

MOOSEHORN WILDERNESS ME

PRESIDENTIAL RANGE DRY RIVER WILDERNESS NH

ROOSEVELT CAMPOBELLO INTERNATIONAL PARK ME/NB, CANADA

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

David Paylor
Virginia Department on Environmental Quality
P.O. Box 10009
Richmond, VA 23240

Dear Director Paylor;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Austin Caperton
West Virginia Department of Environmental Protection
601 57th Street SE
Charleston, WV 25304

Dear Cabinet Secretary Caperton;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Members
Connecticut
Delaware
District of Columbia
Maine Maryland
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania
Penobscot Indian Nation
Rhode Island
St. Regis Mohawk Tribe
Vermont

Nonvoting Members
U.S. Environmental Protection Agency
National Park Service
U.S. Fish and Wildlife Service
U.S. Forest Service

MANE-VU Class I Areas

ACADIA NATIONAL PARK ME

BRIGANTINE WILDERNESS NJ

GREAT GULF WILDERNESS NH

LYE BROOK WILDERNESS VT

MOOSEHORN WILDERNESS ME

PRESIDENTIAL RANGE DRY RIVER WILDERNESS NH

ROOSEVELT CAMPOBELLO INTERNATIONAL PARK ME/NB, CANADA

Mid-Atlantic/Northeast Visibility Union

MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Noah Valenstein
Florida Department of Environmental Protection
3900 Commonwealth Boulevard
Mail Station 30
Tallahassee, FL 32399

Dear Secretary Valenstein;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

May 8, 2018

Alec Messina
Illinois Dept. of Environmental Protection
1021 N. Grand Ave, East
P.O. Box 19276
Springfield, IL 62794

Dear Director Messina;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

May 8, 2018

Bruno Pigott
Indiana Dept. of Environmental Management
100 North Senate Avenue
Indianapolis, IN 46204

Dear Commissioner Pigott;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Aaron Keatley
Kentucky Dept. of Environmental Protection
300 Sower Boulevard
Frankfort, KY 40601

Dear Commissioner Keatley;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Chuck Carr Brown
Louisiana Dept. of Environmental Quality
P.O. Box 4301
Baton Rouge, LA 70821

Dear Secretary Brown;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Carol Comer
Missouri Dept. of Natural Resources
1101 Riverside Drive
Jefferson City, MO 65102

Dear Director Comer;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Michael Regan
North Capitol Dept. of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699

Dear Secretary Regan;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

May 8, 2018

Craig Butler
Ohio Dept. of Environment Protection
50 West Town Street, Suite 700
Columbus, OH 43216

Dear Director Butler;

The MANE-VU members appreciate the feedback, time and effort the participants dedicated for the consultation process. The collaborative effort is not only a Clean Air Act (CAA) requirement but also essential to the success of the program.

Written comments were received from eight states and two regional planning organizations. Each of the comments received were carefully considered. MANE-VU has prepared a report documenting the consultation process, the feedback, and the responses. This report will be publicly available on the MANE-VU website, with finalization expected in early May.

The MANE-VU members were encouraged to find significant common ground and look forward to continuing this collaboration in the next planning cycle. We are appreciative of the general comments and technical updates that states and regional planning organizations provided. Early communication is key in any collaborative effort. This collaboration has yielded improved data, including emissions reductions, to be accounted for in state implementation plans. While the success of this cycle of regional haze planning and implementation is hopeful and rewarding, we all agree the final goal set forth in the Section 169A of the CAA is far from complete. Therefore, continued visibility improvement in this planning period is essential to the final goal. MANE-VU is hopeful this consultation will result in real visibility improvements and thereby continued success.

We look forward to consulting with you during your regional haze state implementation planning process.

Sincerely,

Clark Freise, MANE-VU Chair (NH DES)

David Foerter, MANE-VU Executive Director

APPENDIX H

October 10, 2016
From: MANE-VU Technical Support Committee
To: MANE-VU Air Directors

Re: Contribution Assessment Preliminary Inventory Analysis

Overview

The Clean Air Act and the Regional Haze Rule requires that the following four factors be analyzed in order to determine what controls are feasible for inclusion in a Regional Haze SIP:

1. Costs of compliance;
2. Time necessary for compliance;
3. Energy and non-air quality environmental impacts; and
4. Remaining useful life of affected sources (40 CFR 51.308(d)(1)(i))

However, the resources needed to conduct such an analysis for every source sector would be overwhelming, and therefore the workgroup is recommending that scrutiny only be given to the larger sectors.

Emissions reductions between 2002 and 2011 in and around MANE-VU have resulted in significant improvements in visibility in MANE-VU Class I areas. In order to assist states in continuing to improve visibility, this document analyzes the emissions inventory to determine where the greatest potential for further emissions reductions exists.

A workgroup of the Technical Support Committee looked at the inventory sectors that produce the largest amounts of sulfur dioxide (SO_2) which is a precursor for sulfates, and oxides of nitrogen (NO_X) which impacts formation of nitrates and carbonaceous aerosols. These pollutants are also considered to be reasonably accurate and able to be regulated.

The inventory analyses will be based on the 2011 inventory, while also examining a 2018 inventory, since that is the first year of the second regional haze planning period. This inventory was developed for the purpose of multi-pollutant planning for OTC and MANE-VU members. Several versions of the inventory have been developed and the Alpha 2 inventory was used for this analysis because it is the inventory that was used to project or “grow” emissions to develop a 2028 inventory that will be used for modeling the 2028 Reasonable Progress Goals.[1] All sources from the inventory were included excepting fires and biogenic emissions. More information on the specific files used can be found in Appendix B of the Modeling TSD.[2]

[1] McDill, McCusker, and Sabo, “Technical Support Document: Emission Inventory Development for 2011, 2018, and 2028 for the Northeastern U.S. Alpha 2 Version.”
[2] Ozone Transport Commission, *Technical Support Document for the 2011 Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union Modeling Platform*.

The analysis looked solely at annual emissions. We chose to look at annual emissions given that, with the exception of EGUs, a greater number of assumptions are needed to create daily emissions inventories, so any finer look will likely be increase inaccuracies.

Finally, this review is intended to provide a qualitative analysis of the relative importance of each sector.

Annual Emissions

Methodology

Database Setup

The pre-SMOKE processed Alpha 2 inventory is stored in the EMF system hosted by MARAMA (http://marama.org/training-center/74-general/453-emf-and-cost). The files, stored in the ff10 file format, were downloaded over the course of the week of July 25, 2016 and were imported in the Microsoft Access. All files were imported in full, except nonroad which had unanalyzed pollutants removed prior to exporting from EMF, and non-EGU point sources which were aggregated on FIPS and SCC in a separate Access database due to size limitations. Entries for states that were in WESTAR and any extra pollutants that were not being analyzed were deleted due to space constraints. Tables of SCCs were also imported from those exported from EMF.

Data Import Quality Assurance

After importing the files that had been exported from EMF to Access, SO_2 and NO_X totals were compared to SMOKE reports using the categorization found in Appendix B of the Modeling TSD. For the 2011 base year, the inventories were found to be within 2% and 1% of each other for SO_2 and NO_X, respectively, with most sectors being less than 1% apart. The 2018 future year inventory was found to be within 4% and 3% of each other for SO_2 and NO_X, respectively, with most sectors being less than 1% apart.

SCCs

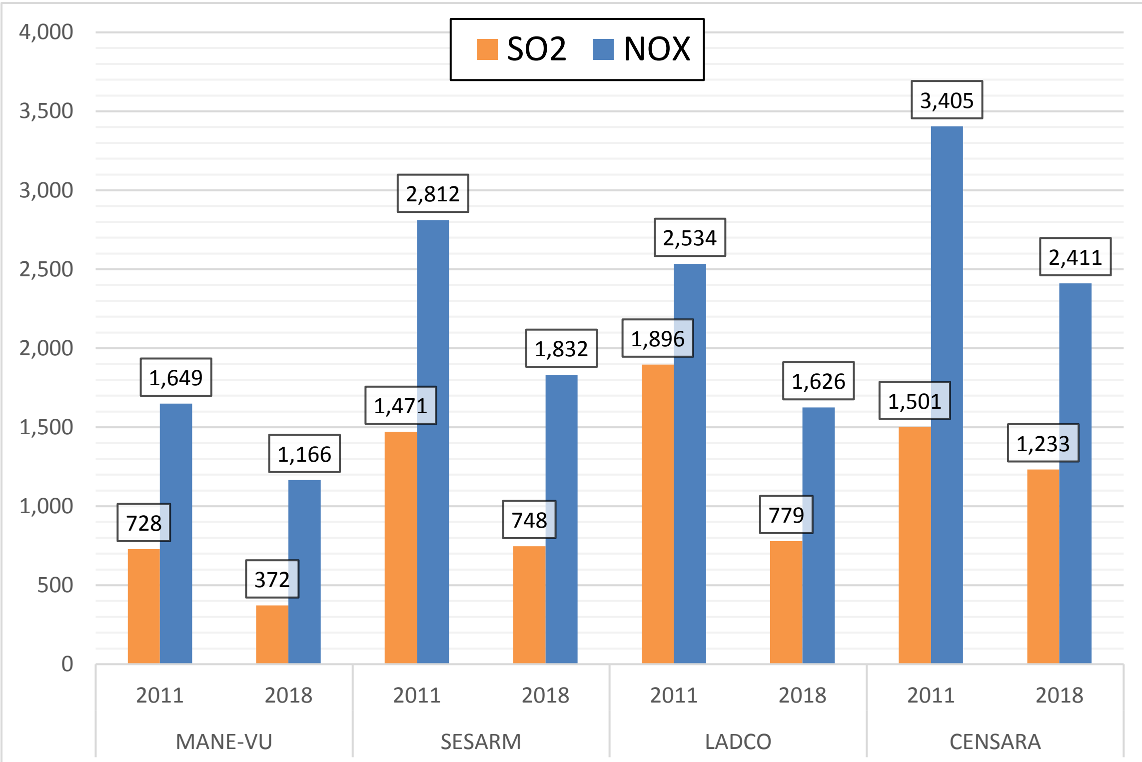
Inventory sectors were aggregated based on second and third level SCCs. Aggregations were based on similarities of the source categories' processes, expected control technologies, and relative magnitudes of emissions. A translation between the SCCs of sources with SO_2 or NO_X emissions in one of the four RPOs and the categorization used in this analysis is available in Table 1.

Table 1: SCC Categorization Methodology for Analysis Inventory Analysis

Sector	Subsector	SCC beginning with	Sector	Subsector	SCC beginning with	Sector	Subsector	SCC beginning with
Ag.	**Other**	2801500	**Industrial Processes**	**Cement Production**	305006	**Onroad**	**Diesel/Buses**	22024
		302			305007		**Diesel/HDV**	220252
Area Comm./Inst.	**Coal**	2103001		**Chemicals**	301			220253
		2103002		**Glass Production**	305014			22026
	Dist. Oil	2103005		**Metal Production**	303		**Diesel/LDT1**	220231
	Kerosene	2103011			304		**Diesel/LDT2**	220232
	LPG	2103007		**Oil & Gas Production**	2310		**Diesel/LDV**	22022
	Natural Gas	2103006			310		**Diesel/MDT**	220251
	Resid. Oil	2103004		**Other Mineral Products**	305001			220254
	Wood	2103008			305002		**E-85 Fueled**	2205
Area Industrial	**Coal**	2102002			305003		**Gas/HDV**	22014
	Dist. Oil	2102004			305004			22015
	Kerosene	2102011			305005			22016
	LPG	2102007			305008		**Gas/LDT1**	220131
	Natural Gas	2102006			305009		**Gas/LDT2**	220132
	Oil	2102012			305010		**Gas/LDV**	22012
	Resid. Oil	2102005			305011		**Gas/Motorcycle**	22011
	Wood	2102008			305012		**Other**	22034
Area Residential	**Coal**	2104001			305013	**Stationary Comm./Inst.**	**Coal**	103001
		2104002			305015			103002
	Kerosene	2104011			305016		**Dist. Oil**	103005
	LPG	2104007			305017		**Natural Gas**	103006
	Natural Gas	2104006			305018			103007
	Resid. Oil	2104004			30502		**Resid Oil**	103004
	RWC	2104008			30503		**Wood**	103009
		2104009			30504		**Other**	103008
EGUS	**Coal**	101001			30505			10301
		101002			30509	**Stationary Industrial**	**Coal**	102001
	Natural Gas	101006			30510			102002
		101007			30515			102003
	Oil	101004			30588		**Dist. Oil**	102005
		101005			30590		**Natural Gas**	102006
		101021			30599			102007
	Other	101008		**Pulp & Paper**	307		**Pet. Coke**	102008
		101009		**Refining**	306		**Resid. Oil**	102004
		10101		**Other**	2301		**Wood**	102009
ICE	**Aircraft Engine Tests**	204001			2306		**Other**	10201
	Diesel	201001			2399	**Waste Disposal**	**Incineration**	2601
		202001			308			501001
		203001			309			501005

Sector	Subsector	SCC beginning with	Sector	Subsector	SCC beginning with	Sector	Subsector	SCC beginning with
	Landfill Gas	201008			312			502001
		203008			313			502005
	Large Bore Engines	202004			314			503001
	Natural Gas	201002			315			503005
		202002			316		**Open Burning**	2610
		203002			330		**Other**	2620
	Other	201003			360			501002
		201007			385			501004
		201009			390			501006
		20101			399			501007
		201900	**Nonroad**	**Aircraft**	22750			501900
		202003		**Marine Vessels**	22800			502002
		202005		**Nonroad Equip - Diesel**	22700			502006
		202007		**Nonroad Equip - Gas**	22600			502900
		202009			22650			503002
		20201		**Nonroad Equip - Other**	22670			503006
		202800			22680			503007
		203003		**Pleasure Craft**	22820			503008
		203007		**Railroad Equipment**	22850			503825
		203009			285002			503900
		20301		**Other**	270003			504
		204002			273003	**Other**		2461023
		204003	**Space Heaters**	**Other**	105			288888
		204004						4 or 6

Figure 1: Annual 2011/2018 SO2 and NOX emissions (thousands tons) by RPO



SO_2 Analysis

SO_2 reductions are projected to occur in all four of the RPOs examined (Figure 1). Annually, SO_2 is projected to decrease by 51% in MANE-VU, 51% in SESARM, 61% in LADCO, and 18% in CENSARA. These are substantial reductions, but they are not enough to return the Class I areas to natural visibility conditions yet.

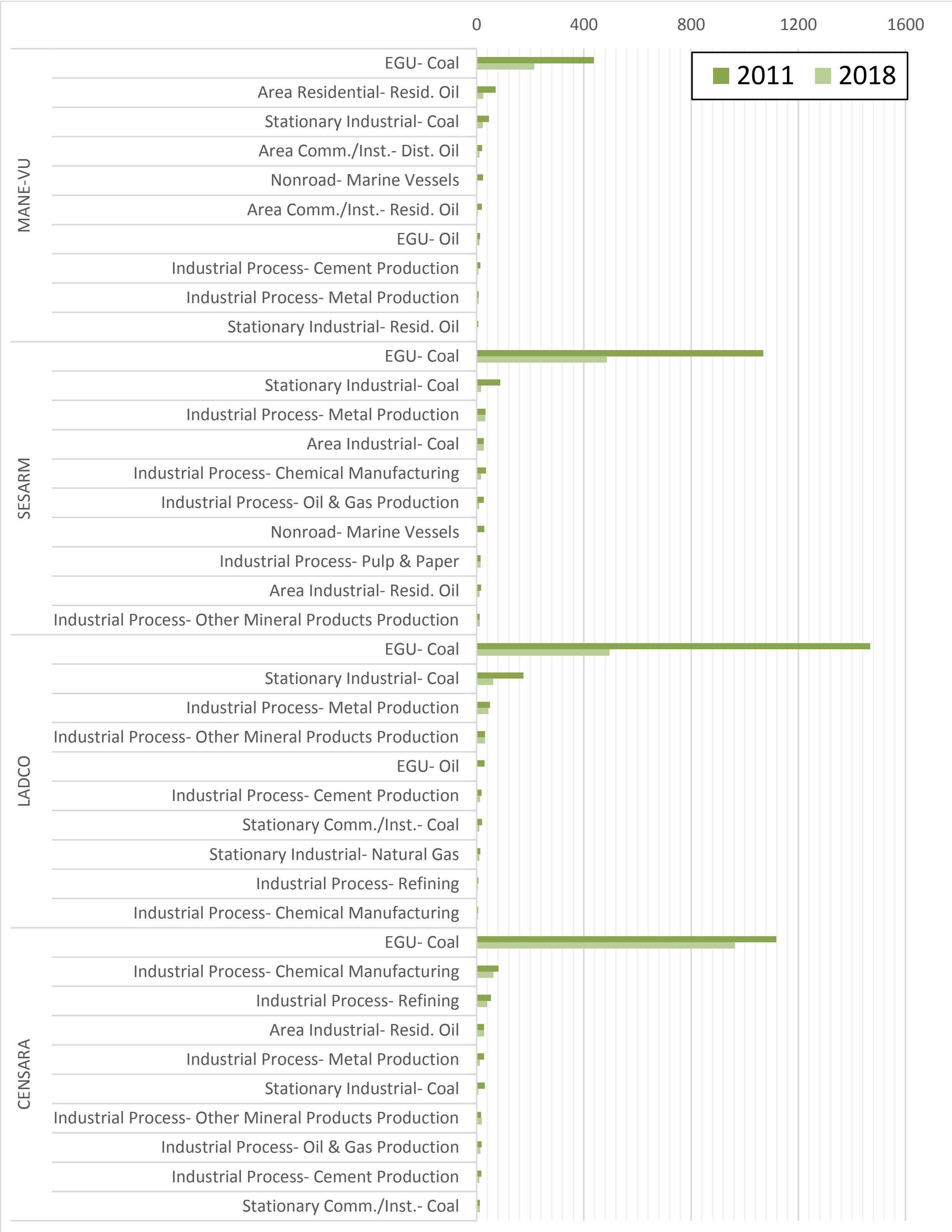
Table 2: Annual SO2 emissions by upper level category and RPO in 2011 and 2018

	MANE-VU		SESARM		LADCO		CENSARA	
	2011	2018	2011	2018	2011	2018	2011	2018
Agriculture	232.33	171.09	4,024.16	3,217.08	2,794.34	2,278.85	7,343.12	7,343.12
Area Comm./Inst.	41,883.65	16,120.21	7,997.42	6,394.31	3,769.14	3,672.57	367.89	367.88
Area Industrial	14,779.10	8,715.45	51,012.03	43,529.67	5,418.87	5,333.68	34,283.65	33,956.16
Area Residential	77,939.54	30,579.93	7,365.06	6,689.54	13,764.88	14,259.29	3,032.51	3,071.90
EGU	451,574.98	225,871.85	1,083,115.43	506,739.65	1,510,168.48	501,901.33	1,119,575.96	965,319.37
ICE	2,873.30	2,708.71	1,306.93	2,896.20	2,364.32	1,939.88	2,900.14	2,185.38
Industrial Process	37,386.68	31,785.80	110,879.32	90,803.45	115,918.66	101,723.86	150,157.26	111,363.89
Nonroad	27,525.51	6,110.23	33,239.93	4,707.97	8,435.52	3,142.67	25,288.54	4,811.39
Onroad	5,069.48	1,948.30	6,040.19	2,546.71	5,474.86	2,271.97	5,594.50	2,450.87
Space Heaters	91.23	83.25	78.50	77.97	7.62	6.19	6.39	6.09
Stationary Comm./Inst.	5,785.57	1,827.03	11,689.73	4,465.13	20,381.36	10,713.74	12,058.22	11,986.26
Stationary Industrial	57,749.62	27,527.16	115,421.65	26,318.99	196,868.92	75,131.49	56,458.54	24,194.37
Waste Disposal	5,020.48	4,896.39	2,797.33	2,718.22	5,223.60	5,006.14	865.56	874.77
Other	29.29	30.44	108.44	67.41	246.68	239.23	1,544.01	1,716.91
SO2 Total	**727,940.76**	**358,375.85**	**1,435,076.13**	**701,172.32**	**1,890,837.24**	**727,620.88**	**1,419,476.29**	**1,169,648.37**

Annually, across all four RPOs, EGU's made up the vast majority of the anthropogenic SO_2 inventory in the 2011 base year Table 2. Even in the 2018 future projected inventories, despite substantial reductions through a variety of Federal programs, EGU's are still the largest emitters of SO_2 in the nation. Area sources, nonroad, and other stationary sources produce SO_2 emissions at levels that warrant further scrutiny as well.

We then summarized emissions further and looked at the top 10 categories at the sector resolution (Figure 2). Coal-fired EGU's are the biggest emitter of SO_2 by far. Several other point source categories emit at a smaller magnitude, but are of noteworthy levels. Industrial boilers that run on coal or oil can produce high levels of emissions as can oil fired EGU's. Oil fired area sources, whether residential, commercial, or industrial as a category make up a significant emitter in some regions. Depending on the region, one or two industrial processes (e.g., cement manufacturing, glass manufacturing, chemicals manufacturing, oil and gas production) are high emitting sectors. The only mobile category to emit high levels of SO_2 is marine vessels.

Figure 2: Annual 2011/2018 SO2 emissions (thousands tons) by RPO and category, top 10 categories for 2011



NO_X Analysis

NO_X reductions are projected to occur in all four of the RPOs examined (**Error! Reference source not found.**). Annually, NO_X is projected to decrease by 30% in MANE-VU, 36% in SESARM, 37% in LADCO, and 29% in CENSARA. Though less percentage wise than SO_2 reductions over the same period, these are still substantial reductions.

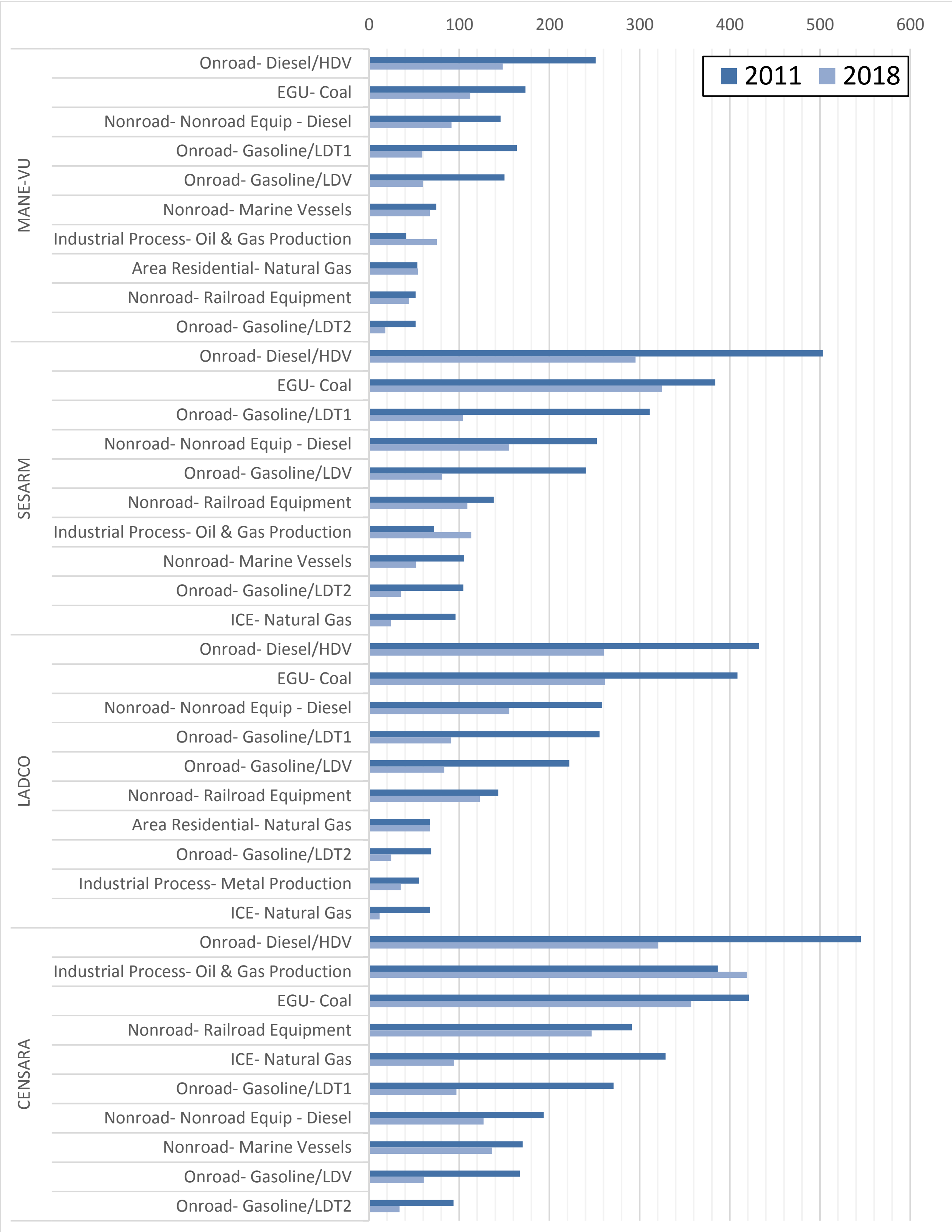
Annually in the four RPOs, onroad vehicles, nonroad vehicles, and EGUs play the largest role in the NO_X emissions inventory for both 2011 and 2018 Table 3. Onroad emissions are decreasing at a much higher rate than the other sectors, which puts nonroad and industrial processes on equal footing with onroad emissions in CENSARA in 2018.

Table 3: Annual NOX emissions by upper level category and RPO in 2011 and 2018

	MANE-VU		SESARM		LADCO		CENSARA	
	2011	2018	2011	2018	2011	2018	2011	2018
Agriculture	591.93	568.80	8,697.65	7,220.71	3,348.21	3,322.08	19,367.63	19,362.48
Area Comm./Inst.	68,116.28	67,369.67	19,598.15	17,271.55	48,720.57	48,386.55	18,696.73	18,519.33
Area Industrial	16,082.96	17,732.96	43,981.63	30,063.88	31,692.06	31,457.95	61,005.47	60,763.91
Area Residential	104,301.04	103,002.78	37,371.64	35,392.05	91,699.84	92,486.19	40,264.60	40,452.39
EGU	187,633.05	120,756.45	409,221.01	351,634.74	423,802.46	268,811.61	432,393.59	368,074.94
ICE	34,870.25	22,913.36	102,505.62	29,597.66	80,208.59	23,615.12	335,286.01	99,992.81
Industrial Process	99,925.45	130,154.05	181,807.80	223,460.16	156,713.49	131,340.72	512,196.12	541,454.54
Nonroad	368,092.20	282,103.43	614,266.09	412,904.89	521,911.17	373,721.73	707,065.55	554,820.28
Onroad	699,944.19	345,810.72	1,245,114.31	577,072.41	1,064,831.89	527,639.35	1,150,395.05	574,792.29
Space Heaters	418.88	441.94	511.70	504.18	920.89	917.63	290.42	275.30
Stationary Comm./Inst.	7,388.05	6,421.80	6,600.86	6,545.29	11,141.03	9,053.09	6,366.74	6,392.39
Stationary Industrial	31,282.47	25,172.63	95,701.85	82,414.42	76,172.49	63,844.03	66,616.20	67,096.80
Waste Disposal	28,698.95	27,753.08	22,538.13	21,601.65	16,576.93	14,827.24	8,710.97	8,265.79
Other	362.04	373.48	1,066.97	1,006.57	912.09	911.95	891.71	973.28
NOX Total	**1,647,707.75**	**1,150,575.17**	**2,788,983.43**	**1,796,690.16**	**2,528,651.70**	**1,590,335.22**	**3,359,546.81**	**2,361,236.54**

We then summarized emissions further and looked at the top 10 categories at the sector resolution (Figure 3). Heavy-duty diesel trucks are the highest emitting NOX sector in all of the RPOs. When different types of mobile sources are separated out, coal-fired EGUs become a more dominate category, in all RPOs, but the CENSARA region is the highest emitter of NOx. Onroad light duty gasoline-powered cars and trucks, nonroad diesel equipment, rail and marine vessels are sectors that appear in the top 10 for most if not all of the RPOs. Oil & gas production is also found throughout the RPOs as a high NOX emitter, as is residential natural gas heating. Oil & gas production is the only sector expected to increase in emissions from 2011 to 2018.

Figure 3: Annual 2011/2018 NOX emissions (thousands tons) by RPO and category, top 10 categories for 2011



Conclusions

Based on the quantity of emissions, this analysis indicates that the highest priority for analysis is SO_2 controls from coal fired power plants. This should be taken up in the four-factor analysis as well as in a review of the controls installed on the 167 stacks that were analyzed during the last planning period.

The second priority should be given to controls for

1. Residential combustion area sources (SO_2),
2. Industrial point combustion sources (SO_2),
3. Oil fired power plants (SO_2),
4. Marine engines (SO_2),
5. Coal fired power plants (NO_X),
6. Heavy duty diesel vehicles(NO_X), and
7. Nonroad diesel equipment (NO_X).

A third priority should be given to controls for

1. Oil & gas sector (SO_2 & NO_X),
2. Commercial ICI boilers (SO_2 & NO_X),
3. Residential wood combustion (SO_2),
4. Aircraft (NO_X), and
5. Locomotives (NO_X).

The workgroup recommends that these categories, in order by tier, should be the foci for obtaining updated cost information and conducting the four-factor analysis, as resources permit. Additionally, the workgroup recommends, as resources permit, compiling a list of available cost data sources in order to provide a contractor with some of the upfront research needed to update the EMF Cost tool, which would be beneficial to both save resources and allow greater consistency with other OTC and MANE-VU efforts.

APPENDIX I

BASELINE AND NATURAL BACKGROUND VISIBILITY CONDITIONS

CONSIDERATIONS AND PROPOSED APPROACH TO THE CALCULATION OF BASELINE AND NATURAL BACKGROUND VISIBILITY CONDITIONS AT MANE-VU CLASS I AREAS

Prepared by NESCAUM

December, 2006

Members of NESCAUM

BASELINE AND NATURAL BACKGROUND VISIBILITY CONDITIONS

CONSIDERATIONS AND PROPOSED APPROACH TO THE CALCULATION OF BASELINE AND NATURAL BACKGROUND VISIBILITY CONDITIONS AT MANE-VU CLASS I AREAS

Prepared by NESCAUM

December, 2006

BASELINE AND NATURAL BACKGROUND VISIBILITY CONDITIONS

Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas

Project Manager
Gary Kleiman, NESCAUM

Principal Contributors
Gary Kleiman, John Graham, NESCAUM

Acknowledgements

NESCAUM acknowledges the funding support for this work through U.S. EPA agreement number XA-97318101-0 to the Ozone Transport Commission in support of the MANE-VU Regional Planning Organization.

Printed: January, 2007

TABLE OF CONTENTS

1. INTRODUCTION

The long-term visibility conditions that would exist in absence of human-caused impairment are referred to as *natural background* visibility conditions. Accurate assessment of these conditions is important due to their role in determining the uniform rate of progress that states must consider when setting reasonable progress goals for each mandatory Federal Class I area subject to the Regional Haze Rule. Baseline visibility conditions – based on monitored visibility during the five year baseline period (2000-2004) – and estimated natural background visibility conditions will determine the uniform rate of progress states will consider when setting reasonable progress goals for any Class I site.

In September 2001, the U.S. Environmental Protection Agency (EPA) issued draft methodological guidelines for the calculation of natural background and baseline visibility conditions as well as methods for tracking progress relative to the derived uniform rate of progress. EPA subsequently finalized this draft guidance in September 2003. The final guidance recommends a default method and allows for certain refinements that states may wish to pursue in order to make these estimates more representative of a specific Class I area if it is poorly represented by the default method.

In the spring of 2006, the IMPROVE Steering Committee adopted an alternative formulation of the reconstructed extinction equation to address certain aspects of the default calculation method. These aspects were well understood from a scientific perspective and were felt to improve the performance of the equation at reproducing observed visibility at Class I sites. This alternative formulation of the reconstructed extinction equation was not adopted as a replacement to the default method, but as an alternative to the default method for states and RPOs to consider as they proceed with the regional haze planning process. It seems likely that most, if not all, RPOs are considering this alternative formulation as the means by which they will calculate baseline conditions, natural background conditions, and track progress toward the national visibility goals under the Regional Haze Rule.

In this report, MANE-VU reviews the default and alternative approaches to the calculation of baseline and natural background conditions and presents a discussion of the principle differences between the methods. In addition, the default and alternative methods are applied to each Class I area in or near the MANE-VU region in order to establish *differences* in baseline conditions, natural background conditions, and 2018 uniform progress goals under each approach.

The prior MANE-VU position on natural background conditions was issued in June, 2004 and stated that, "Refinements to other aspects of the default method (e.g., refinements to the assumed distribution or treatment of Rayleigh extinction, inclusion of sea salt, and improved assumptions about the chemical composition of the organic fraction) may be warranted prior to submissions of SIPs depending on the degree to which scientific consensus is formed around a specific approach…" Based upon the subsequent reviews conducted by the IMPROVE Steering Committee, as well as internal Technical Steering Committee deliberations, MANE-VU is now ready to adopt the alternative reconstructed extinction algorithm for the reasons described in this report.

2. THE DEFAULT METHOD

The default method is explained in detail in *Estimating Natural Background Visibility Conditions* (U.S.EPA, 2003a) and *Guidance for Tracking Progress under the Regional Haze Rule* (U.S. EPA, 2003b). Summary information is provided here but the reader should consult the original guidance documents for any question on how to apply this method.

Estimates of natural visibility impairment due to fine and coarse particles were derived using the 1990 National Acid Precipitation Assessment Program reported average ambient concentrations of naturally present particles (Trijonis, 1990). Separate concentration values were given for the eastern and western United States; no finer spatial resolution is available. Average natural background light extinction due to particles was then calculated using the IMPROVE methodology and site specific ANNUAL f(RH) values. Worst visibility levels are derived using the work of Ames and Malm (2001), who estimated the standard deviation of visibility in deciviews in the eastern U.S. as 3 dv. By assuming a roughly normal distribution of data, the default method adds (subtracts) 1.28*(3 dv) to the average estimated natural background to calculate the 90^{th} (10^{th}) percentile level, which is taken by EPA to be representative of the mean of the 20 percent worst (best) conditions.

In the East, the default method for calculating best and worst natural background visibility conditions (in dv) for any area in the eastern U.S. uses the following formulae:

$$P90 = HI + 1.28\ sd$$

$$P10 = HI - 1.28\ sd$$

P90 and P10 represent the 90^{th} and 10^{th} percentile, respectively, the Haze Index (HI) represents annual average visibility in units of deciview, and sd is the standard deviation of daily average visibility values throughout a year, defined by the guidance as 3.0 for the eastern U.S. The Haze Index is calculated as shown:

$$HI = 10 \ln (bext/10)$$

The atmospheric extinction, bext, is given by the familiar IMPROVE equation (IMPROVE, 2000) in inverse megameters:

$$bext = (3)f(RH)[sulfate] + (3)f(RH)[nitrate] + (4)[OMC] + (10)[LAC] + (1)[SOIL] + (0.6)[CM] + 10$$

Table 2-1 below provides the default values to be applied at all eastern U.S. Class I areas. The result of using these default values in the above equation with an assumed annual average f(RH) value of 3.17 in the northeastern U.S. (the average of 11 northeastern U.S. sites) is approximately 3.6 dv on the 20 percent best days and 11.3 dv on the 20 percent worst days.

The methods for calculating baseline conditions on the 20 percent best or worst days start by repeating the calculation of the Haze Index (HI) as shown above with the individual species mass concentrations replaced by the actual monitored values for each day during the baseline period. These values should be sorted from highest to lowest for each year in the baseline period. Averages (in dv) for each year can be calculated for HI values associated with the 20 percent most impaired and 20 percent least impaired days. The average HI values for the 20 percent most impaired and 20 percent least impaired days in each year should then be averaged for the five consecutive years 2000-2004 to define baseline conditions. One important distinction between the natural conditions and baseline HI calculations is that the f(RH) values shown in Table 2-2 for natural conditions estimates are annual averages. EPA has also estimated site-specific

Table 2-1. Default parameters used in calculating natural background visibility for sites in the eastern U.S.

Parameter	**Value**	**Fractional Uncertainty**	**Reference/Comments**
[SULFATE]	0.23 $\mu g/m^3$	200%	Trijonis, 1990
[NITRATE]	0.10 $\mu g/m^3$	200%	Trijonis, 1990
[OC]	1.0 $\mu g/m^3$	200%	Trijonis, 1990
[LAC]	0.02 $\mu g/m^3$	250%	Trijonis, 1990
[SOIL]	0.50 $\mu g/m^3$	200%	Trijonis, 1990
[CM]	3.0 $\mu g/m^3$	200%	Trijonis, 1990
f(RH)	~3.2	15%	Varies by site (see Table 2-2)
Organic multiplier	1.4	50%	[OMC]=1.4*[OC]
$\sigma_{S/N}$	3.0 m^2/g	33%	Hegg, 1997; IMPROVE, 2000; Malm, 2000
σ_{OC}	4.0 m^2/g	30%	Hegg 1997; Trijonis 1990
σ_{EC}	10.0 m^2/g	40%	Malm, 1996
σ_{soil}	1.0 m^2/g	25%	Trijonis, 1990
σ_{coarse}	0.6 m^2/g	33%	IMPROVE, 2000
Rayleigh	10 Mm^{-1}	20 %	Varies with altitude/season
sd (standard deviation of daily visibility)	3.0 dv	16%	Ames and Malm, 2001
10^{th}, 90^{th} percentile adjustment	1.28	15%	Regulation calls for mean of top twenty percent, not 90^{th} percentile
Parameters used in potential refinements			
[NaCl]	~0.5	50%	Varies by site, IMPROVE
σ_{NaCl}	2.5 m^2/s	16%	Haywood, 1999
$f(RH)_{NaCl}$	~3.2	33%	Assumed same as S, N

Note: The mass estimates presented above are based on estimates of fine particulate concentrations that would exist in absence of any manmade pollution (including Mexican and Canadian emissions) consistent with planning requirements of the Regional Haze Rule. MANE-VU accepts this as an appropriate planning goal and intends to consider the contribution of international transport in deciding what controls are “reasonable” under the regional haze program.

climatological mean monthly average values of f(RH) that are provided in an appendix to its guidance (EPA, 2003b) and used for the individual HI calculations for baseline conditions.

2.1. Application of the Default Methods

The Class I areas in the MANE-VU region that are subject to the requirements of the Regional Haze Rule are: Acadia National Park, Maine; Brigantine Wilderness (within the Edwin B. Forsythe National Wildlife Refuge), New Jersey; Great Gulf Wilderness, New Hampshire; Lye Brook Wilderness, Vermont; Moosehorn Wilderness (within the Moosehorn National Wildlife Refuge), Maine; Presidential Range – Dry River Wilderness, New Hampshire; and Roosevelt Campobello International Park, New Brunswick. In addition to these Class I areas, we consider several nearby Class I areas where MANE-VU states may be contributing to visibility impairment. These Class I areas include: Dolly Sods Wilderness and the Otter Creek Wilderness in West Virginia as well as Shenandoah National Park and the James River Face Wilderness in Virginia. MANE-VU understands that it is the responsibility of the appropriate VISTAS states to establish estimates of natural visibility conditions and reasonable progress goals for these areas. It is anticipated, however, that subsequent consultations will occur with those MANE-VU states that may be affecting visibility in these areas. MANE-VU has therefore calculated estimates of natural background visibility conditions at the nearby sites using MANE-VU approved methods in order to facilitate future consultations.

The only factor in the default method that varies by site is the climatological annual mean relative humidity adjustment factor. Table 2-2 lists this value for the Class I sites of interest and the resulting best 20 percent and worst 20 percent estimates of natural visibility conditions. The variation among sites using the default method is purely a function of differences in climatological annual mean relative humidity, with southern and coastal sites being more humid than inland or elevated sites.

Table 2-2. Site-specific relative humidity adjustment factors, best and worst (default) estimates of natural background visibility conditions.

MANE-VU Mandatory Federal Class I Area	f(RH)	Best Visibility (dv)	Worst Visibility (dv)
Maine			
Acadia National Park	3.34	3.77	11.45
Moosehorn Wilderness	3.15	3.68	11.36
Roosevelt Campobello International Park, New Brunswick	3.16	3.68	11.37
New Hampshire			
Great Gulf Wilderness	3.01	3.63	11.30
Presidential Range – Dry River Wilderness	3.02	3.65	11.30
New Jersey			
Brigantine Wilderness	2.97	3.60	11.28
Vermont			
Lye Brook Wilderness	2.91	3.57	11.25
Nearby Mandatory Federal Class I Area			
Virginia			
James River Face Wilderness	2.93	3.56	11.26
Shenandoah National Park	2.95	3.57	11.27
West Virginia			
Dolly Sods Wilderness	3.06	3.64	11.32
Otter Creek Wilderness	3.06	3.65	11.32

Table 2-3. Site-specific best and worst (default) estimates of baseline visibility conditions (2000-2004).

MANE-VU Mandatory Federal Class I Area	Best Visibility (dv)	Worst Visibility (dv)
Maine		
Acadia National Park	8.06	22.34
Moosehorn Wilderness	8.48	21.18
Roosevelt Campobello International Park, New Brunswick	8.48	21.18
New Hampshire		
Great Gulf Wilderness	7.50	22.25
Presidential Range – Dry River Wilderness	7.50	22.25
New Jersey		
Brigantine Wilderness	13.72	27.60
Vermont		
Lye Brook Wilderness	6.20	23.70
Nearby Mandatory Federal Class I Area		
Virginia		
James River Face Wilderness	14.35	27.72
Shenandoah National Park	11.34	27.88
West Virginia		
Dolly Sods Wilderness	12.70	27.64
Otter Creek Wilderness	12.70	27.64

3. THE ALTERNATIVE METHOD

According to EPA guidance, "[T]he default approach to estimating natural visibility conditions presented in this document is adequate for the development of progress goals for the first implementation period under the regional haze rule" (U.S. EPA, 2003a). However, the guidance does leave the door open for individual states or RPOs to adopt their own methods for calculating natural background (or baseline conditions) if they can demonstrate that the change from the default represents a significant refinement that better characterizes natural visibility (or baseline) conditions at a specific Class I site.

In response to a number of concerns raised with respect to the use of the default methods for Regional Haze Rule compliance (Lowenthal and Kumar, 2003; Ryan et al., 2005), the IMPROVE Steering Committee established a subcommittee to review the default approach and recommend refinements to address criticisms and improve the performance for tracking progress under the Haze Rule. The details presented below come from that subcommittee's summary report and a review of potential refinements by Hand and Malm (2005).

The recommended revised algorithm is shown in the equation below with revised terms in bold font. The total sulfate, nitrate, and organic carbon compound concentrations are each split into two fractions, representing small and large size distributions of those components. Although not explicitly shown in the equation, the organic mass concentration used in this new algorithm is 1.8 times the organic carbon mass concentration, which is changed from 1.4 times the carbon mass concentration as used for input in the current IMPROVE algorithm. New terms have been added for sea salt (important for coastal locations) and for absorption by NO_2 (only used where NO_2 data are available). Site-specific Rayleigh scattering is calculated for the elevation and annual average temperature of each of the IMPROVE monitoring sites.

Bext ≈ 2.2 x f_S(RH) x [Small Sulfate] + 4.8 x f_L(RH) x [Large Sulfate] +
2.4 x f_S(RH) x [Small Nitrate] + 5.1 x f_L(RH) x [Large Nitrate] +
2.8 x [Small Organic Mass] + 6.1 x [Large Organic Mass] +
10 x [Elemental Carbon Mass] + 1 x [Fine Soil Mass] +
1.7 x f_{SS}(RH) x [Sea Salt Mass] + 0.6 x [Coarse Mass] +
Rayleigh Scattering (site specific) + 0.33 x [NO_2 (ppb)]

The apportionment of the total concentration of sulfate compounds into the concentrations of the small and large size fractions is accomplished using the following equations.

$$[Large\ Sulfate] = \frac{[Total\ Sulfate]}{20\mu g/m^3} \times [Total\ Sulfate],\quad for\ [Total\ Sulfate] < 20\mu g/m^3$$

$$[Large\ Sultate] = [Total\ Sulfate]\quad for\ [Total\ Sulfate] \geq 20\ \mu g/m^3$$

$$[Small\ Sulfate] = [Total\ Sulfate] - [Large\ Sulfate]$$

The same equations are used to apportion total nitrate and total organic mass concentrations into the small and large size fractions.

Sea salt is calculated as 1.8 x [*Chloride*], or 1.8 x [*Chlorine*] if the chloride measurement is below detection limits, missing, or invalid. The algorithm uses three water growth adjustment terms as shown in Figure 3-1 and Table 3-1. They are for use with the small size distribution and the large size distribution sulfate and nitrate compounds and for sea salt ($f_S(RH)$, $f_L(RH)$, and $f_{SS}(RH)$, respectively).

Figure 3-1. Water growth curves for small and large size distribution sulfate and nitrate, sea salt, and the original IMPROVE algorithm sulfate and nitrate.

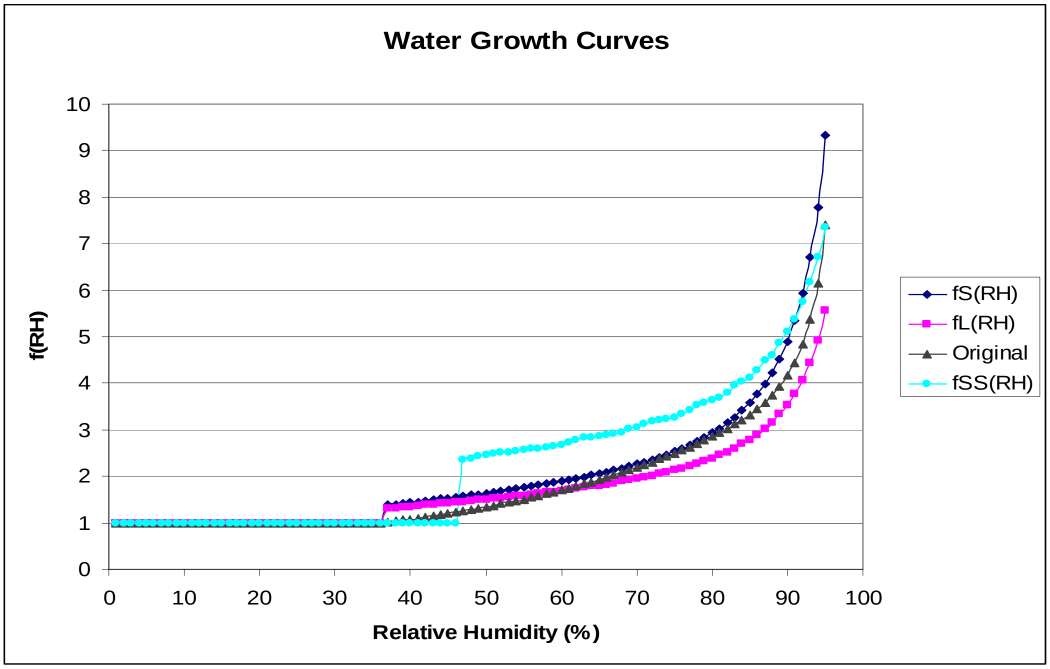


Table 3-1. f(RH) for small and large size distribution sulfate and nitrate, and sea salt.

RH (%)	f_S(RH)	f_L(RH)	f_{SS}(RH)	RH (%)	f_S(RH)	f_L(RH)	f_{SS}(RH)	RH (%)	f_S(RH)	f_L(RH)	f_{SS}(RH)
0 to 36	1.00	1.00	1.00	**56**	1.78	1.61	2.58	**76**	2.60	2.18	3.35
37	1.38	1.31	1.00	**57**	1.81	1.63	2.59	**77**	2.67	2.22	3.42
38	1.40	1.32	1.00	**58**	1.83	1.65	2.62	**78**	2.75	2.27	3.52
39	1.42	1.34	1.00	**59**	1.86	1.67	2.66	**79**	2.84	2.33	3.57
40	1.44	1.35	1.00	**60**	1.89	1.69	2.69	**80**	2.93	2.39	3.63
41	1.46	1.36	1.00	**61**	1.92	1.71	2.73	**81**	3.03	2.45	3.69
42	1.48	1.38	1.00	**62**	1.95	1.73	2.78	**82**	3.15	2.52	3.81
43	1.49	1.39	1.00	**63**	1.99	1.75	2.83	**83**	3.27	2.60	3.95
44	1.51	1.41	1.00	**64**	2.02	1.78	2.83	**84**	3.42	2.69	4.04
45	1.53	1.42	1.00	**65**	2.06	1.80	2.86	**85**	3.58	2.79	4.11
46	1.55	1.44	1.00	**66**	2.09	1.83	2.89	**86**	3.76	2.90	4.28
47	1.57	1.45	2.36	**67**	2.13	1.86	2.91	**87**	3.98	3.02	4.49
48	1.59	1.47	2.38	**68**	2.17	1.89	2.95	**88**	4.23	3.16	4.61
49	1.62	1.49	2.42	**69**	2.22	1.92	3.01	**89**	4.53	3.33	4.86
50	1.64	1.50	2.45	**70**	2.26	1.95	3.05	**90**	4.90	3.53	5.12
51	1.66	1.52	2.48	**71**	2.31	1.98	3.13	**91**	5.35	3.77	5.38
52	1.68	1.54	2.50	**72**	2.36	2.01	3.17	**92**	5.93	4.06	5.75
53	1.71	1.55	2.51	**73**	2.41	2.05	3.21	**93**	6.71	4.43	6.17
54	1.73	1.57	2.53	**74**	2.47	2.09	3.25	**94**	7.78	4.92	6.72
55	1.76	1.59	2.56	**75**	2.54	2.13	3.27	**95**	9.34	5.57	7.35

The proposed new algorithm for estimating haze reduces the biases compared to measurements at the high and low extremes. This is most apparent for the hazier eastern sites. The composition of days selected as best and worst by the current and the new algorithm are very similar, and similar to days selected by measurements. Most of the reduction of bias associated with the new algorithm is attributed to the use of the split component extinction efficiency method for sulfate, nitrate, and organic components that permitted variable extinction efficiency depending on the component mass concentration. Although not subject to explicit performance testing, the proposed new algorithm also contains specific changes from the current algorithm that reflect a better understanding of the atmosphere as reflected in the more recent scientific literature (e.g., change to 1.8 from 1.4 for organic compound mass to carbon mass ratio) and a more complete accounting for contributors to haze (e.g., sea salt and NO_2 terms), and use of site specific Rayleigh scattering terms to reduce elevation-related bias.

Unlike the default approach, which directly uses the Trijonis natural species concentration estimates to calculate natural haze levels, the Alternative Approach uses the baseline data (current species concentrations) with a multiplier applied to each species measurement in order to give the Trijonis estimate for that species. The ratio of the Trijonis estimates for each species divided by the annual mean values for the species is used to transform the entire data set to what is then assumed to be the natural species concentration levels for that site and year. This process is applied to each of the complete years of data (as defined by the EPA *tracking progress* guidance) in the baseline period (2000 through 2004). Sites with three complete years of data are treated as having sufficient data for this assessment. If any of the current annual means for any species is less than the Trijonis estimate for that species, the unadjusted species data are used. Trijonis estimates did not include sea salt, which is only significant at a few coastal sites. Estimates of current sea salt concentrations determined from Cl^- ion data (described as part of the new IMPROVE algorithm) are taken to be natural contributors to haze.

3.1. Application of the Alternative Method

Here we present a comparison of the background and natural visibility conditions calculated using the default and the alternative methods (see Table 3-2 and Table 3-3). Corresponding visibility improvement targets for 2018 using each approach are also presented (see Table 3-3). Results suggest that the alternative approach leads to very similar uniform rates of progress in New England with slightly greater visibility improvement required in the Mid-Atlantic region relative to the default approach.

Table 3-2. Comparison of default and alternative approaches for estimating the 20 percent worst natural background visibility conditions at MANE-VU and nearby sites (2000-2004).

MANE-VU Mandatory Federal Class I Area	Default Baseline dv	Alternative Baseline dv	Default Natural dv	Alternative Natural dv
Maine				
Acadia National Park	22.34	22.89	11.45	12.43
Moosehorn Wilderness	21.18	21.72	11.36	12.01
Roosevelt Campobello International Park, New Brunswick	21.18	21.72	11.37	12.01
New Hampshire				
Great Gulf Wilderness	22.25	22.82	11.30	11.99
Presidential Range – Dry River Wilderness	22.25	22.82	11.30	11.99
New Jersey				
Brigantine Wilderness	27.60	29.01	11.28	12.24
Vermont				
Lye Brook Wilderness	23.70	24.45	11.25	11.73
Nearby Mandatory Federal Class I Areas				
Virginia				
James River Face Wilderness	27.72	29.12	11.26	11.13
Shenandoah National Park	27.88	29.31	11.27	11.35
West Virginia				
Dolly Sods Wilderness	27.64	29.04	11.32	10.39
Otter Creek Wilderness	27.64	29.04	11.32	10.39

Table 3-3. Estimated uniform rates of progress (ROP) (to be considered for worst 20 percent days) and Best Day Baseline Conditions (not to be degraded on best 20 percent days) for first implementation period.

MANE-VU Mandatory Federal Class I Area	**Default ROP** Worst day (dv/14 yrs)	**Alternative ROP** Worst day (dv/14 yrs)	**Default Baseline Visibility** Best Day (dv)	**Alternative Baseline Visibility** Best Day (dv)
Maine				
Acadia National Park	2.54	2.44	8.06	8.77
Moosehorn Wilderness	2.29	2.27	8.48	9.15
Roosevelt Campobello International Park, New Brunswick	2.29	2.27	8.48	9.15
New Hampshire				
Great Gulf Wilderness†	2.56	2.53	7.50	7.66
Presidential Range – Dry River Wilderness†	2.56	2.53	7.50	7.66
New Jersey				
Brigantine Wilderness‡	3.81	3.91	13.72	14.33
Vermont				
Lye Brook Wilderness	2.91	2.97	6.20	6.36
Nearby Mandatory Federal Class I Area				
Virginia				
James River Face Wilderness[¤]	3.84	4.20	14.35	14.21
Shenandoah National Park‡	3.88	4.19	11.34	10.93
West Virginia				
Dolly Sods Wilderness	3.81	4.35	12.70	12.28
Otter Creek Wilderness	3.81	4.35	12.70	12.28

Note: The values are presented for the default and alternative approaches at MANE-VU and nearby sites (2000-2004).

The default estimates provide a sound, nationally consistent framework on which to base the regulatory structure of the Haze Rule that is justified by the current state of scientific understanding of these issues. However, an alternative approach for the calculation of reconstructed extinction under the Regional Haze Rule has been developed that provides all of the same advantages. EPA recommendations on potential refinements to the default approach (Pitchford, personal communication, 2004) suggest that, if used, any refinements should be broadly accepted by the scientific community, substantial, practical to implement, and not create arbitrary inconsistencies. The alternative approach endorsed by the IMPROVE Steering Committee for baseline and natural background conditions meet these requirements.

4. RECOMMENDATIONS

This document reviews EPA guidelines and an IMPROVE Steering Committee-endorsed alternative for calculating baseline and natural background visibility conditions under the Regional Haze Rule. It also explores how adoption of the alternative approach would affect calculated rates of progress and other regulatory drivers under the Haze Rule.

The alternative approach attempts to incorporate better science for several components of the equation to calculate reconstructed extinction that reflects the latest scientific research. MANE-VU recognizes the time and effort that has been invested in the development of this alternative. We also recognize the high likelihood that other RPOs will adopt and use the alternative approach and consider it desirable to use a similar approach to other RPOs with which MANE-VU will consult on visibility goals. Given the large uncertainties that remain in our ability to estimate the concentrations of organic carbon and other species that would be present in the absence of anthropogenic influences, we are not certain that the alternative approach significantly improves the overall accuracy of the estimated natural background conditions, but it certainly does not diminish the accuracy and is likely to improve our estimates of baseline conditions.

Finally, MANE-VU has considered the fact that the uniform rate of progress that results from these calculations is a relatively arbitrary baseline against which progress is measured. This Haze Rule requires states to consider this uniform rate, but control decisions are to be based on a four-factor analysis that is independent of the uniform rate of progress. The relatively small differences in the uniform rate that are introduced as a result of using the alternative approach further diminish the significance of this decision. Based on all of the considerations above, MANE-VU recommends adoption of the alternative approach for use in 2008 MANE-VU SIP submittals, active participation in further research efforts on this topic, and future reconsideration of natural background visibility conditions as evolving scientific understanding warrants.

References

Ames, R. B., and Malm, W. C., Recommendations for Natural Condition Deciview Variability: An Examination of IMPROVE Data Frequency Distributions. *Proceedings (CDROM) of A&WMA/AGU Specialty Conference on Regional Haze and Global Radiation Balance -- Aerosol Measurements and Models: Closure, Reconciliation and Evaluation*, Bend, Oregon, 2-5 October, 2001.

Hand, J.L. and W.C. Malm, *Review of the IMPROVE Equation for Estimating Ambient Light Extinction Coefficients*, on the IMPROVE web site at http://vista.cira.colostate.edu/improve/Publications/GrayLit/gray_literature.htm, 2005.

Haywood, Ramaswamy, and Soden, Tropospheric aerosol climate forcing in Clear-Sky Satellite Observations over the oceans, *Science*, V**283**, pg. 1299-1303, 26 February, 1999.

Hegg, Livingston, Hobbs, Novakov and Russell, Chemical Apportionment of aerosol column optical depth off the Mid-Atlantic coast of the United States, *Journal of Geophysical Research*, vol. **102,** No. D21, pg. 25,293-25,303, 1997.

IMPROVE, Malm, W. C., Principal Author, *Spatial and Seasonal Patterns and Temporal Variability of Haze and Its Constituents in the United States: Report III*, Cooperative Institute for Research in the Atmosphere, Colorado State University, Ft. Collins, CO, May, 2000.

Kumar, N. Recommendations for Natural Background Conditions and Potential Refinements, *Proceedings (CDROM) of MANE-VU/MARAMA Science Meeting on Regional Haze – Organic Aerosols and Natural Background Conditions*, MARAMA Baltimore, MD, 27-29 January, 2004.

Lowenthal, D. H., and Kumar, N. PM2.5 Mass and Light Extinction Reconstruction in IMPROVE. *Journal of the Air and Waste Management Association*, Vol. 53, pp. 1109-1120, 2003.

Malm, Molenar, Eldred and Sisler, Examining the relationship among atmospheric aerosols and light scattering and extinction in the Grand Canyon area, *Journal of Geophysical Research*, vol. **101**, No. D14, pg. 19,251-19,265, 1996.

Malm, Day, Kreidenweis, Light Scattering Characteristics of Aerosols as a function of Relative Humidity: Part 1- A comparison of Measured Scattering and Aerosol Concentrations Using the Theoretical Models, *Journal of the Air and Waste Management Association*, Vol. **50**, pg. 686-700, May 2000.

U.S. EPA, *Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule*, EPA-454/B-03-005, September, 2003a.

U.S. EPA, *Guidance for Tracking Progress under the Regional Haze Rule*, EPA-454/B-03-004, September, 2003b.

Ryan, P.A., Lowenthal, D., and Kumar, N., Improved light extinction reconstruction in Interagency Monitoring of Protected Visual Environments, *J. Air & Waste Manage. Assoc.* **55**, 1751-1759, 2005.

Trijonis, J. C., Characterization of Natural Background Aerosol Concentrations, Appendix A in *Acidic Deposition: State of Science and Technology. Report 24. Visibility: Existing and Historical Conditions* -- *Causes and Effects*, J. C. Trijonis, lead author, National Acid Precipitation Assessment Program, Washington, DC, 1990.

APPENDIX J

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

DEC 2 0 2018

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

FROM: Richard A. Wayland, Division Director
Air Quality Assessment Division

TO: Regional Air Division Directors, Regions 1 – 10

Through this memorandum, the U.S. Environmental Protection Agency (EPA) is communicating the availability of its technical guidance on tracking visibility progress for the second implementation period of the regional haze program. This guidance document includes EPA's final recommendations on 1) methods for selecting the 20 percent most impaired days to track visibility and determining natural visibility conditions; and 2) methods for accounting for total international impacts to adjust the uniform rate of progress (i.e., the URP glidepath) for the second implementation period. EPA committed to releasing this guidance document in the September 11, 2018, Regional Haze Reform Roadmap.[1]

The purpose of this guidance document is to support states with some of the technical aspects of developing regional haze state implementation plans (SIPs) to protect visibility in mandatory Class I Federal areas, in particular the SIPs that are due to be submitted to EPA by July 31, 2021, for the second implementation period.

This guidance describes EPA's recommended methods on two technical aspects of regional haze SIP development: 1) the visibility tracking metrics and 2) estimating international anthropogenic impacts and optional adjustment to the URP glidepath. EPA's recommended visibility tracking metrics and methodology will help states determine baseline, current, and natural visibility conditions. EPA's recommended methods for estimating international anthropogenic impacts will serve as a useful guide to states that choose to propose an adjustment to the URP glidepath endpoint to account for international anthropogenic source contributions.

This document is not a substitute for provisions or requirements of the Clean Air Act (CAA), nor is it a regulation itself. As the term "guidance" suggests, it provides recommendations on how to

[1] *See* https://www.epa.gov/sites/production/files/2018-09/documents/regional_haze_reform_roadmap_memo_09-11-2018.pdf

implement regional haze rule visibility tracking metrics. Thus, it does not impose binding, enforceable requirements on any party, nor does it assure that EPA will approve all instances of its application, as the guidance may not apply to a particular situation based upon the circumstances. Final decisions by EPA regarding a particular SIP demonstration will only be made based on the statute and applicable regulations and will only be made following a final submission by air agencies and after notice and opportunity for public review and comment.

Visibility Tracking Metrics

The 2017 Regional Haze Rule revisions[2] require a revised approach to tracking visibility improvements over time within the URP glidepath framework.[3] Under these rule revisions, in the second and future implementation periods, states must select the "20 percent most impaired days" each year at each Class I area based on daily anthropogenic impairment.[4] This guidance document describes a recommended methodology to develop the required 20 percent most impaired and 20 percent clearest days metrics. In June 2016, EPA sought public comment on this approach which was included in the 2016 draft regional haze SIP development guidance document.[5] After considering public comments received on that draft and more recent discussions with states about the draft recommended method, EPA is now finalizing the portion of that guidance specific to the recommended visibility tracking metrics for the second implementation period. Note that while the rule requires states to track visibility progress for the 20 percent (most anthropogenically) impaired days, it does not require states to follow EPA's recommended methodology for how to select the set of days. We recommend states work closely with their Regional Offices if they intend to pursue an alternative methodology for selecting the most impaired days for one or more Class I areas.

Estimating International Anthropogenic Impacts and Optional Adjustment to the URP/Glidepath

The 2017 Regional Haze Rule includes a provision that allows states to propose an optional adjustment to the URP glidepath to account for impacts from anthropogenic sources outside the United States, if the adjustment has been developed through scientifically valid data and methods. This guidance document describes recommended tools and methods to develop optional adjustments to the URP glidepath endpoint to account for international anthropogenic emissions impacts. Note that this guidance does not provide numerical estimates of international anthropogenic source impacts.

---

[2] Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.
[3] The URP glidepath framework refers to the interrelated Regional Haze Rule requirements regarding the quantification of historical and projected visibility conditions using specific metrics, the quantification of natural conditions, the quantification of the uniform progress that would achieve natural visibility conditions for the 20 percent most anthropogenically impaired days in 2064, the URP glidepath, the setting of RPGs for the end of the implementation period, and the comparison of the RPG for the 20 percent most anthropogenically impaired days to the URP glidepath.
[4] Previously, states and EPA tracked visibility progress on the 20% *worst* visibility days.
[5] Draft Guidance on Progress Tracking Metrics, Long-term Strategies, Reasonable Progress Goals and Other Requirements for the Regional Haze State Implementation Plans for the Second Implementation Period, June 30, 2016.

Next Steps

EPA is continuing to develop the other implementation tools outlined in the September 2018 roadmap, including producing and documenting updated 2028 visibility modeling results and estimating U.S. and international source contributions for individual Class I areas. These results, specifically the numerical estimates of international anthropogenic source contributions, may be useful for states that wish to propose an adjustment to the URP glidepath to account for international anthropogenic visibility impacts. This updated modeling is expected to be released in Spring/Summer 2019. In the roadmap, EPA also committed to providing updated natural visibility conditions estimates, if necessary. This effort will be done in parallel with the visibility modeling and will be released in Spring 2019.

EPA understands the unique and valuable role that states and multi-jurisdictional organizations can provide to enhance the quality of the modeling inputs and results. EPA's regional haze modeling will use emissions inventory inputs developed from the ongoing inventory collaborative partnership[6] between EPA, state emissions inventory staff, multi-jurisdictional organizations, and federal land managers. In addition, EPA will seek further cooperation with states on model inputs and methods as we further refine the 2028 visibility modeling over the next several months. We also encourage states to continue to work closely with their Regional offices as they develop their regional haze SIPs.

EPA is also continuing to develop updated guidance on regional haze SIP development for the second implementation period. This guidance will be a final version of the remaining portions of the 2016 draft guidance. This guidance will focus on issues raised by states as needed for work on second planning period SIPs and will be consistent with the Administration's key principles for implementing the regional haze program moving forward as laid out in the roadmap.

For convenience, this technical guidance document is available electronically on EPA's visibility website, https://www.epa.gov/visibility/visibility-guidance-documents. Questions or comments should be electronically submitted to Brett Gantt (gantt.brett@epa.gov) or Brian Timin (timin.brian@epa.gov) of EPA's Air Quality Assessment Division.

[6] See the inventory collaborative partnership wiki at: http://views.cira.colostate.edu/wiki/wiki/9169.

United States Environmental Protection Agency

Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

EPA-454/R-18-010
December 2018

Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Air Quality Assessment Division
Research Triangle Park, North Carolina

Table of Contents

1.0 Purpose of this guidance

The purpose of this guidance document is to support states in the development of regional haze state implementation plans (SIPs) to protect visibility in certain national parks and wilderness areas, known as mandatory Class I Federal areas,[1] in particular the SIPs that are due to be submitted to the Environmental Protection Agency (EPA) by July 31, 2021, for the second implementation period. The required content of these SIPs is specified in 40 CFR 51.308(f), which was revised in 2017.[2] As called for in the agency's "Regional Haze Reform Roadmap" (September 11, 2018), this guidance document describes EPA's recommended methods on two aspects of the regional haze program:

1) **Visibility Tracking Metrics:** The 2017 Regional Haze Rule revisions require a revised approach to tracking visibility improvements over time within the Uniform Rate of Progress (URP) framework.[3] Under these 2017 Regional Haze Rule revisions, in the second and future implementation periods, states must select the "20 percent most impaired days" each year at each Class I area based on daily anthropogenic impairment.[4] This guidance document describes a recommended methodology to develop the baseline and current visibility conditions, and natural conditions on the most impaired and clearest days.

2) **International Emissions:** The 2017 Regional Haze Rule includes a provision that allows states to propose an adjustment to the URP to account for impacts from anthropogenic sources outside the United States, if the adjustment has been developed through scientifically valid data and methods. This guidance document describes recommended tools and methods to develop optional adjustments to the URP endpoint to account for international anthropogenic emissions impacts.

This document provides recommendations on these two aspects of SIP development under the Regional Haze Rule and is for use by states in developing SIP submissions and for EPA Regional offices in acting on them. This document does not substitute for provisions or requirements of the Clean Air Act (CAA), nor is it a rule itself. Thus, it does not impose binding, enforceable requirements on any party. States retain the discretion to develop regional haze SIP revisions that differ from this guidance so long as they are consistent with the CAA and the implementing regulations – a core principle of cooperative federalism.

---

[1]For brevity, mandatory Class I Federal areas will often be referred to as "Class I areas" in the remainder of this document.

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

[3]"URP framework" refers to the interrelated Regional Haze Rule requirements regarding the quantification of historical and projected visibility conditions using specific metrics, the quantification of natural conditions, the quantification of the uniform progress that would achieve natural visibility conditions for the 20 percent most anthropogenically impaired days in 2064, the URP glidepath, the setting of reasonable progress goals (RPGs) for the end of the implementation period, and the comparison of the RPG for the 20 percent most anthropogenically impaired days to the URP glidepath.

[4]Previously, states and EPA tracked visibility progress on the 20 percent *worst* visibility days.

EPA generally expects that SIPs which follow this guidance are likely to meet the related applicable statutory and regulatory requirements. Final decisions by EPA to approve a particular SIP revision can only be made based on the requirements of the statute and the Regional Haze Rule, and on whether the SIP submission is the product of reasoned decision making. In addition, final EPA decisions can only be made following a state's final submission of the SIP revision to EPA in accordance with all applicable requirements, including appropriate notice and opportunity for public review and comment. Only final actions taken to approve or disapprove SIP submissions would be final actions for purposes of CAA section 307(b). Therefore, this guidance is not judicially reviewable. This guidance does not change or substitute for any law, regulation, or other legally binding requirement and is not legally enforceable. Due to case-specific circumstances, following the recommendations in this document does not ensure that the related aspects of a SIP will be approvable in all instances, as this guidance may not apply to the facts and circumstances underlying a particular SIP.

We encourage states to discuss with their EPA Regional office early in their SIP development the approach they anticipate taking and how the interpretations and recommendations in this guidance may relate to their SIPs.

1.1 Regional Haze Background

Consistent with the CAA, "regional haze" is defined at 40 CFR 51.300 as "visibility impairment that is caused by the emission of air pollutants from numerous anthropogenic sources located over a wide geographic area. Such sources include, but are not limited to, major and minor stationary sources, mobile sources, and area sources." This visibility impairment is a result of anthropogenic particles and gases in the atmosphere that scatter and absorb (i.e., extinguish) light, thus acting to reduce overall visibility. The primary cause of regional haze is light extinction by particulate matter (PM). For purposes of the Regional Haze Rule, light extinction is estimated from measurements of PM and its chemical components (sulfate, nitrate, organic mass by carbon (OMC), light absorbing carbon (LAC), fine soil (FS), sea salt, and coarse material (CM)), assumptions about relative humidity at the monitoring site, and the use of a commonly accepted algorithm (Pitchford, et al., 2007). These estimates of light extinction are logarithmically transformed to deciview units. The Regional Haze Rule established the deciview haze index as the principal metric for expressing visibility on any particular day. The deciview haze index is calculated from light extinction values and expresses uniform changes in the degree of haze in terms of common increments across the entire range of visibility conditions, from pristine to extremely hazy.

The PM measurements used in the regional haze program are collected by the IMPROVE (Interagency Monitoring for PROtected Visual Environments) monitoring network. The Regional Haze Rule requires states to submit a series of SIPs to protect visibility in Class I areas.

1.2 Statutory Provisions and Regulatory Requirements

In section 169A of the 1977 Amendments to the CAA, Congress established a program for protecting and restoring visibility in certain national parks, wilderness areas, and other Class I areas due to their “great scenic importance.”[5] This section of the CAA establishes as a national goal the “prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas which impairment results from manmade air pollution.” This section also required EPA to issue regulations requiring states to adopt implementation plans containing emission limits as may be necessary to make reasonable progress towards meeting this goal.

In 2017, EPA issued a final rule revising portions of the visibility protection rule promulgated in 1980 and the Regional Haze Rule promulgated in 1999.[6] The revised rule covers EPA’s review of periodic SIPs developed for the second and subsequent implementation periods, among other requirements.

The Regional Haze Rule established the concept of state-set reasonable progress goals (RPG) for the 20 percent most anthropogenically impaired days as a regulatory construct promulgated to implement the statutory requirements for visibility protection. These RPGs reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of its own and other states’ long-term strategies, as well as the implementation of other requirements of the CAA.

The 2017 Regional Haze Rule requires states to determine the baseline (2000-2004) visibility condition for the 20 percent most impaired days and requires that the long-term strategy and RPG must provide for improvement in visibility for the most impaired days, relative to the baseline period. Specifically, states must determine the rate of improvement in visibility that would need to be maintained during each implementation period in order to reach natural conditions by 2064 for the 20 percent most impaired days, given the starting point of the 2000-2004 baseline visibility condition.[7] The “glidepath,” or URP, is the amount of visibility improvement that would be needed to stay on a linear path from the baseline period to natural conditions.

The URP is calculated according to the following formula:

$$URP = [(\text{2000-2004 visibility})_{\textit{20\% most impaired}} - (\text{natural visibility})_{\textit{20\% most impaired}}]/60 \qquad \text{(Eqn. 1)}$$

An example diagram of the URP (in this case for GRSM1 in Great Smoky Mountains National Park) for the entire 2000-2064 period is shown in Figure 1. In this diagram, the URP (orange line) connects the 2000-2004 baseline period with the 2064 endpoint at the estimate of natural visibility conditions.

[5]H.R. Rep. No. 294, 95th Cong. 1st Sess. at 205 (1977).
[6]45 FR 80084 (December 2, 1980) and 64 FR 35714 (July 1, 1999)
[7]See 40 CFR 51.308(f)(1).

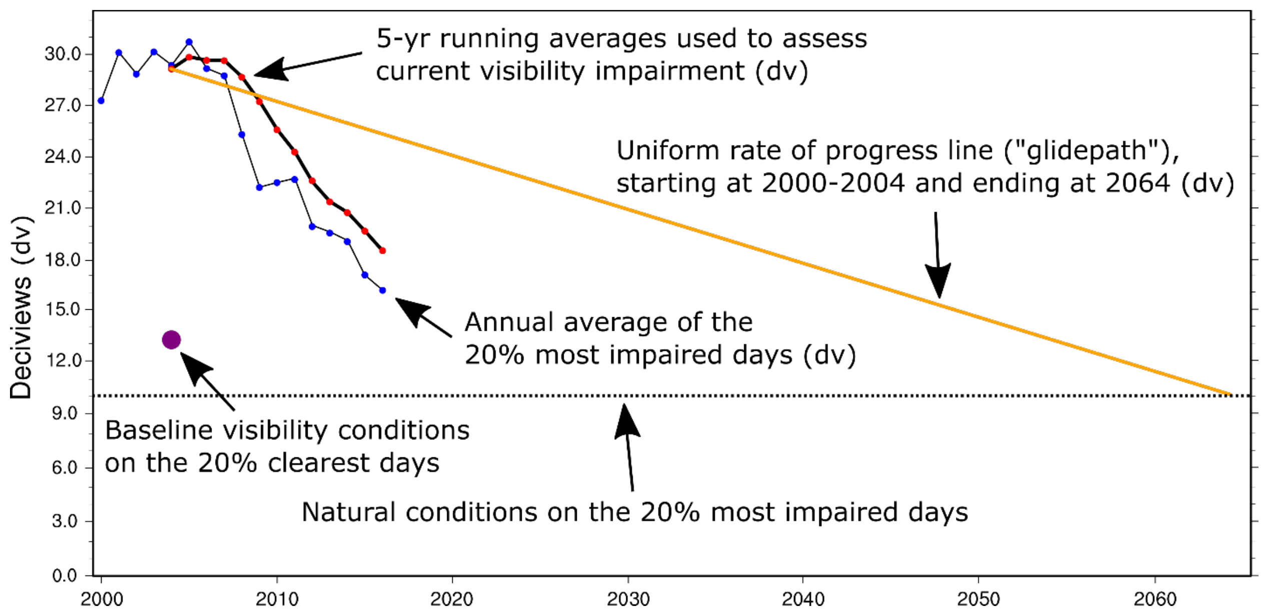


Figure 1. Example diagram showing the important parameters used to calculate the visibility metrics for the Regional Haze Rule

The 2017 Regional Haze Rule also requires states to determine the baseline (2000-2004) visibility condition for the 20 percent clearest days and requires that the long-term strategy and RPG ensure no degradation in visibility for the clearest days since the baseline period.

2.0 Ambient Data Analysis

Among the requirements described in 40 CFR 51.308(f)(1)(i)-(vi), states must calculate the following tracking metrics using available ambient monitoring data (states typically use data collected by the IMPROVE monitoring program):

- Baseline, current, and natural visibility conditions for the 20 percent most anthropogenically impaired and 20 percent clearest days. These six conditions must be quantified in deciviews.
- The URP between the baseline visibility condition for the most impaired days and the natural visibility condition for the most impaired days. The URP must be quantified as the visibility improvement (in deciviews per year) that would need to be maintained during each implementation period in order to attain natural visibility conditions by 2064. The rule also allows states to propose an optional adjustment to the URP to account for impacts from anthropogenic sources outside the U.S. and from certain wildland prescribed fires.

The 1999 rule text defined “most impaired days” and “least impaired days” by referring to highest and lowest levels of “visibility impairment” caused by manmade air pollution. The 1999 final rule preamble stated that the least and most impaired days were to be selected as the monitored days with the lowest and highest actual deciview levels, respectively, without distinguishing between the natural and anthropogenic contributions to reduced visibility.[8] In 2003, EPA issued guidance describing in detail the steps for selecting and calculating light extinction on the "worst" and "best" visibility days (EPA, 2003a). Consistent with the 1999 final rule preamble, the 2003 guidance recommended that states determine the most and least impaired days based on which days had the highest and lowest overall deciview values, rather than determining and selecting the days with the highest and lowest anthropogenic impairment. However, because natural haze due to wildfires or dust storms can be larger than anthropogenic impairment for some Class I areas (particularly in the western U.S.), this approach resulted in some days with large natural sources of haze being included in the 20 percent most impaired days metric.

The 2017 Regional Haze Rule defines *visibility impairment* or *anthropogenic visibility impairment* as "any humanly perceptible difference due to air pollution from anthropogenic sources between actual visibility and natural visibility on one or more days. Because natural visibility can only be estimated or inferred, visibility impairment also is estimated or inferred rather than directly measured."[9] In this definition, the Regional Haze Rule's definition of *visibility impairment* is synonymous with anthropogenic impairment. A metric that reflects both the fraction of the actual light extinction that is above natural levels (in Mm^{-1}) as well as the logarithmic relationship between light extinction and perceived visibility is, thus, a logical basis for selecting the 20 percent most anthropogenically impaired days. One such metric is the difference (the "delta deciviews") between the total deciview value that exists (or is projected to exist) and the deciview value that would have existed if there were only natural sources causing reduced visibility. This is the metric that EPA recommends be used. We recommend that states use Equation 2 to calculate anthropogenic visibility impairment:

$$\Delta\, dv_{\text{anthropogenic visibility impairment}} = dv_{total} - dv_{natural} \qquad \text{(Eqn. 2)}$$

where dv_{total} is the overall deciview value for a day, and $dv_{natural}$ is the natural portion of the deciview value for a day The Regional Haze Rule does not specify how dv_{total} and $dv_{natural}$ are to be determined; that is the subject of some of EPA's recommendations in this document.

2.1 Recommendations for estimating daily natural and anthropogenic visibility fractions and light extinction budgets and calculating the 20% most impaired and 20% clearest days

The first step in determining $dv_{natural}$ is to split the daily light extinction into natural and anthropogenic fractions. Because these are not directly measured, a statistical or computational method must be used to estimate these fractions. This guidance document presents EPA's current recommendation for estimating these fractions; data for this recommended approach, as well as the results of applying the recommended approach,[10] will

[8] *See* 64 FR 35728.
[9] *See* 40 CFR 51.301.
[10] A state that wishes to follow the EPA-recommended approach may download these completed results and will not have to itself execute the 7 steps discussed in this section. These completed results are available at http://vista.cira.colostate.edu/Improve/rhr-summary-data.

be provided by the IMPROVE program to states for their use on an annual basis. EPA may provide refinements to this method or additional recommended methods through additional guidance as such methods become available.

In general, the recommended approach to splitting daily light extinction into natural and anthropogenic fractions is to estimate the natural contribution to daily light extinction and then attribute the remaining light extinction to anthropogenic sources. The natural contributions are grouped into two types – “episodic” and “routine.” Episodic natural contributions are those that occur relatively infrequently. These may differ in number and size from year to year and likely result from extreme events. Routine natural contributions are those that occur on all or most days in a year or season and are more consistent from year to year. Large wildfires and strong dust storms are examples of episodic natural contributions from extreme events, while biogenic secondary aerosol is an example of a routine natural contribution.[11] It is useful to make this distinction because the values used by most states in the first implementation period to represent natural visibility conditions, the “NC-II” estimates,[12] are generally recognized as representing long-term averages influenced by routine natural sources but not episodic natural sources (EPA, 2003b). As explained below, the annual average NC-II estimates are used in the recommended method described in this section, but in a manner that is consistent with the premise that they represent only the influences of routine natural sources.

The recommended steps (1 through 7) to estimate natural and anthropogenic light extinction and the 20 percent most impaired days for the year are detailed below, using an example for Mesa Verde National Park (MEVE1). Note that the values throughout this example are unique to MEVE1 and have been included for illustrative purposes only. Each Class I area is treated individually, and these values do not apply to any site other than MEVE1. A flow chart summarizing these steps is shown in Figure 2.

[11]The EPA recognizes that natural emissions can also include volcanic emissions. The approach described in this guidance document does not attempt to account for haze formed from natural volcanic emissions. We encourage states with Class I areas affected by volcanic emissions to work with their EPA Regional office to determine an appropriate approach for determining which days are the 20 percent most anthropogenically impaired days.

[12]“NC-II” refers to a set of estimates of natural conditions for each Class I area contained in Regional Haze Rule Natural Level Estimates Using the Revised IMPROVE Aerosol Reconstructed Light Extinction Algorithm, available at http://vista.cira.colostate.edu/improve/publications/graylit/032_NaturalCondIIpaper/Copeland_etal_NaturalConditionsII_Description.pdf. As called for in the agency’s “Regional Haze Reform Roadmap” (September 11, 2018, the agency may be updating the natural visibility conditions estimates in spring 2019, as necessary.

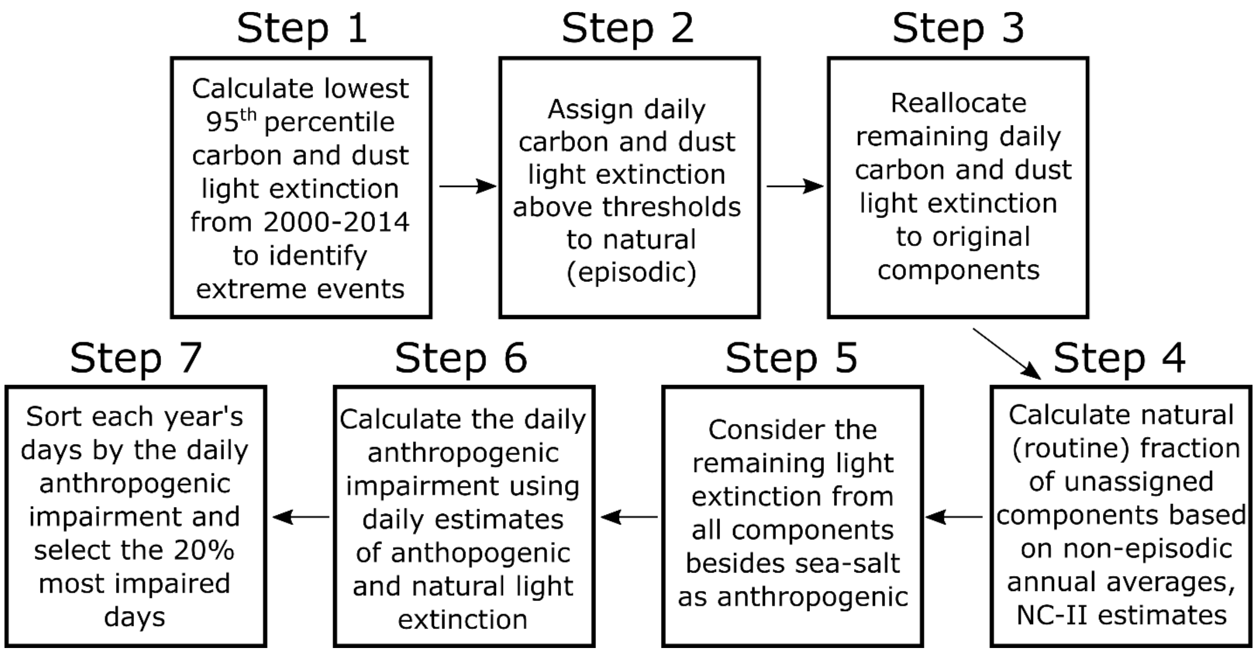


Figure 2. Flow chart of the 7 steps involved in calculating the 20% most impaired days.

Step 1: Establish light extinction thresholds to identify extreme events

Analysis from the first implementation period showed that smoke from wildfires (mainly composed of OMC and LAC) and dust storms (mainly composed of CM and FS) are major contributors to light extinction at many Class I areas (Tombach, 2008). For each Class I area, using data from the IMPROVE monitor associated with the area, identify for each year the 95th percentile 24-hour carbon (OMC + LAC) light extinction (Spracklen, et al., 2007) (Jaffe, et al., 2008). Choose the year between 2000 and 2014 with the lowest such value. This year represents the “low wildfire” year of this period. Also, choose the year with the lowest 95th percentile 24-hour dust (CM + FS) light extinction. This year represents the “low dust storm” year of this period. The 95th percentile carbon and dust values for these years will serve as the threshold values used to identify impacts on carbon and dust light extinction from extreme episodic events in that year and other years. At Class I areas where episodic influences vary significantly from year to year, it will not be unusual for more than five percent of the monitored days to be affected by extreme episodic events in years other than the “low wildfire” and “low dust storm” years. Thus, this approach allows a different number of high carbon days or high dust days in different years to be identified as ones with extreme episodic impacts, but all the days that are identified will have carbon or dust concentrations at least as high as the respective threshold. EPA believes this method for calculating threshold values for identifying episodic light extinction is reasonable and practical to apply to the large set of IMPROVE data, and our investigations have indicated that the results (i.e., the days selected as the 20 percent most impaired) would not be substantially different if slightly different percentile values were used for this purpose. However, some areas with a high frequency of episodic wildfire smoke or dust impacts even in the “low wildfire” or “low dust storm year” could use a lower percentile value. At other sites, the year representing the lowest wildfire or dust storm thresholds may have no episodic impacts and such sites could use a higher percentile value. States may use other reasonable thresholds for determining impacts from extreme natural events if they explain why another method is appropriate for their individual Class I areas.

The 95th percentile value will be the 0.95×n measured value sorted from lowest to highest. If 0.95×n is not an integer value, the 95th percentile value is the monitored value such that it and all lower values are more than 95 percent of the sample. For MEVE1 in 2003, there were 105 complete values for carbon. For MEVE1 in 2003, 0.95×105 is 99.75, so the 95th percentile value would be the 100th value counting up from the lowest value, out of 105 (the sixth value counting down from the highest value). In 2003, the 100th highest carbon value is 25.36 Mm^{-1}. Repeat this process to get a 95th percentile value for each year from 2000 to 2014 for carbon and dust. The results for each of these years for MEVE1 are shown in Table 1.

Table 1. 95th percentile values for carbon and dust light extinction (in units of Mm^{-1}) from 2000-2014 at MEVE1.

Year	Annual 95th percentile carbon light extinction	Annual 95th percentile dust light extinction
2000	12.68	7.732
2001	7.002	6.686
2002	16.14	19.60
2003	25.36	16.45
2004	5.937	5.498
2005	9.640	5.658
2006	7.813	5.326 (lowest)
2007	11.72	5.685
2008	7.545	9.257
2009	10.55	10.35
2010	7.109	13.30
2011	5.289	9.726
2012	10.66	8.930
2013	5.396	8.223
2014	5.054 (lowest)	9.281

The years 2014 and 2006 have the lowest carbon and dust 95th percentile values for MEVE1, respectively. The year 2014 was in this sense the "low wildfire" year at MEVE1, such that the 95th percentile value for carbon in 2014 becomes the threshold for identifying extreme wildfire-affected days in any year, with the same concept applying to dust from natural sources and the year 2006. The 95th percentile value of carbon in 2014 was 5.054 Mm^{-1}, and the 95th percentile value of dust in 2006 was 5.326 Mm^{-1}. National maps of the light extinction thresholds to identify extreme carbon and dust events are shown in Figures 3 and 4.

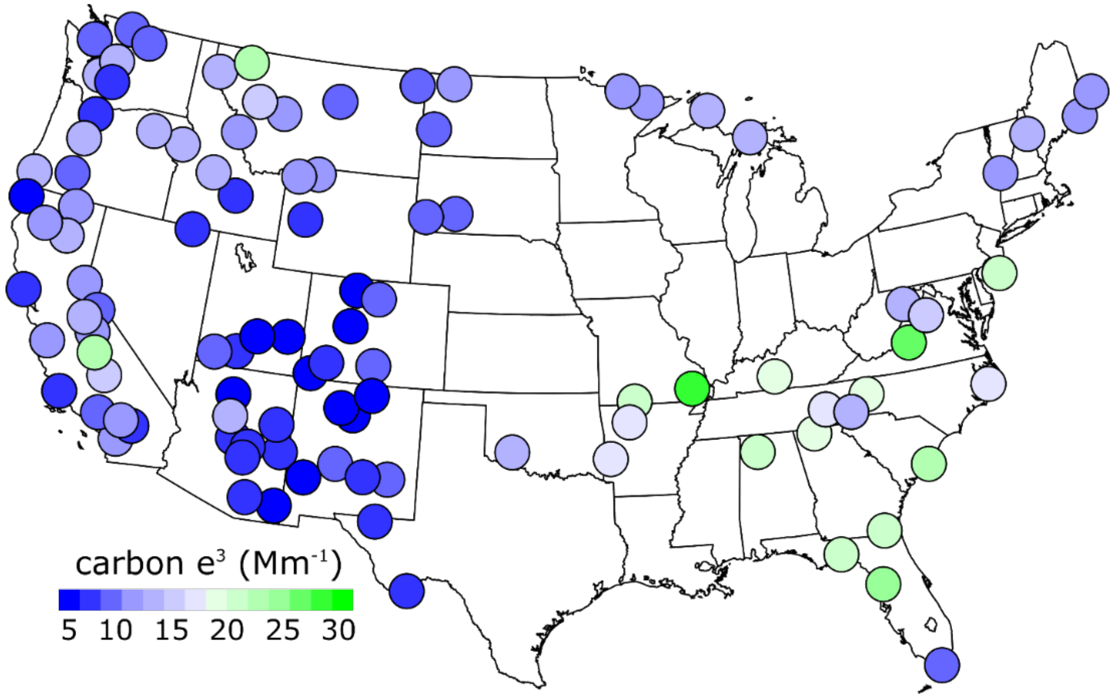


Figure 3. Site-specific extinction thresholds of carbon from extreme episodic events

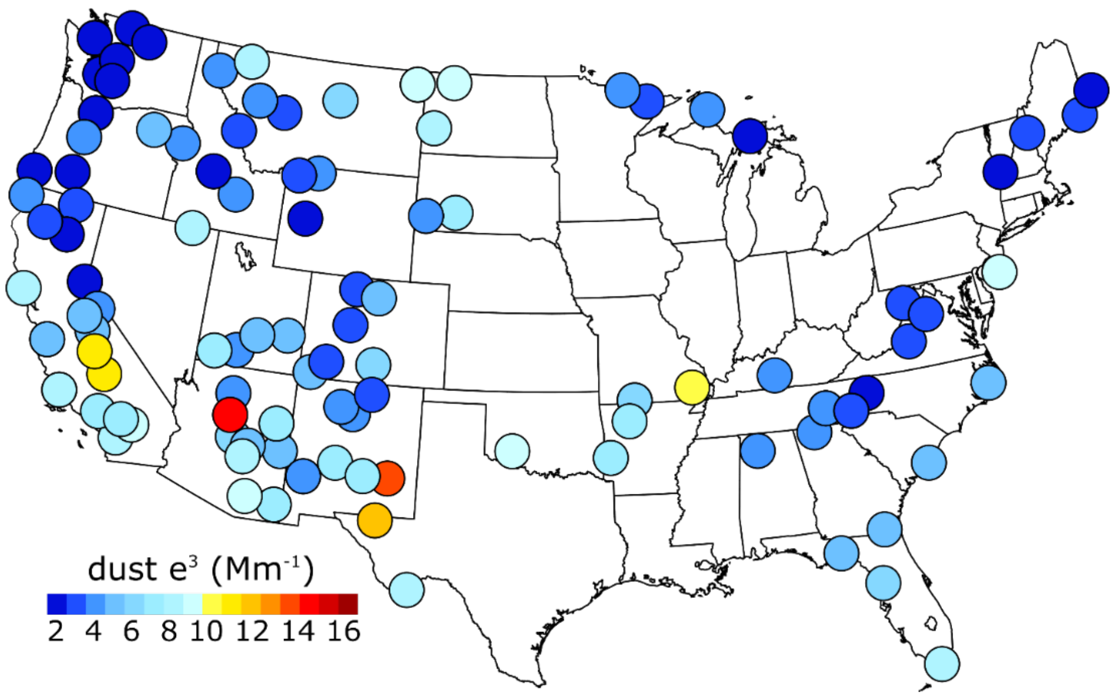


Figure 4. Site-specific extinction thresholds of dust from extreme episodic events

Step 2: Assign the portions of daily carbon and dust light extinction that are in excess of these thresholds to "natural (episodic)"

The IMPROVE light extinction data for a specific day (May 12, 2003) at MEVE1 are shown in Table 2. The light extinction from carbon (25.36 Mm^{-1}) on this day is greater than the threshold of 5.054 Mm^{-1}. Therefore, 25.36 minus 5.054 or 20.31 Mm^{-1} is assigned to natural (episodic). Carbon light extinction in the amount of 5.054 Mm^{-1} remains to be split between natural (routine) and anthropogenic in Step 4 below, after the combined value of carbon is reallocated to OMC and LAC (Step 3). The dust-related light extinction of 2.699 Mm^{-1} is less than the threshold value of 5.326 Mm^{-1}, therefore no dust-related light extinction is assigned to natural (episodic). However, the 2.699 Mm^{-1} value for dust-related light extinction does need to be split between natural (routine) and anthropogenic in Step 4 below, after the combined value of dust is reallocated to FS and CM (Step 3). A summary of the episodic thresholds and the light extinction assigned to natural (episodic) is shown in Table 2.

Step 3: Reallocate the daily combined carbon and dust light extinction remaining after assigning values over the threshold values to "natural (episodic)" into OMC, LAC, FS, and CM.

Separate the combined carbon back into OMC and LAC and separate the combined dust back into FS and CM based on the original percentages of the individual PM species to the grouped light extinction. For example, at MEVE1 on May 12, 2003, the total carbon light extinction was 25.36 Mm^{-1}, with OMC light extinction of 21.78 and LAC Mm^{-1} light extinction of 3.576 Mm^{-1}. The total dust light extinction was 2.699 Mm^{-1} with 1.141 Mm^{-1} from FS and 1.558 Mm^{-1} from CM. Therefore, on May 12, 2003, carbon light extinction was 85.88 percent from OMC and 14.10 percent from LAC; dust light extinction was 42.27 percent from FS and 57.72 percent from CM. Separate the estimates of natural (episodic) and the remaining light extinction from carbon back into OMC and LAC and the remaining light extinction from dust back into FS and CM, using these percentages. Table 2 shows the results of these calculations for this example day at MEVE1. For example, of the 20.31 Mm^{-1} of carbon assigned to natural (episodic), 17.44 Mm^{-1} (or 85.88 percent) is reallocated to OMC and 2.864 Mm^{-1} (14.10 percent) is reallocated to LAC. States may use other approaches than the one recommended here.

Table 2. Total and speciated light extinction (in units of Mm^{-1}) for an example day (May 12, 2003) at MEVE1

PM Species	Total Light Extinction	Threshold	Light extinction associated with natural (episodic)	Light extinction remaining after episodic treatment
Sulfate	2.963	NA	0	2.963
Nitrate	0.8055	NA	0	0.8055
Carbon (OMC + LAC)	25.36 (21.78 + 3.576)	5.054	20.31 (17.44 + 2.864)	5.054 (4.340 + 0.7126)
Dust (FS + CM)	2.699 (1.141 +1.558)	5.326	0	2.699 (1.141 +1.558)
Sea salt	0.001469	NA	0	0.001469
Rayleigh	9.0	NA	0	9.0
TOTAL	40.83	NA	20.31	20.52

Step 4: Split the remaining components of light extinction into natural (routine) and anthropogenic based in part on the NC-II estimates (Copeland, et al., 2008)***.***

In order to split the remaining components of light extinction into natural (routine) and anthropogenic components, we recommend allowing the natural (routine) to vary daily based on the NC-II estimates weighted by the ratio of the light extinction remaining after removing episodic contributions to the non-episodic annual average extinction. At most Class I areas, the use of this ratio results in higher natural (routine) values in the summer and lower values in the winter.

Starting with the daily results from Step 3 for all days with complete data in a year, calculate the annual average light extinction values for each PM species, excluding light extinction already attributed to episodic events. The non-episodic annual averages for 2003 at MEVE1 are shown in Table 3.

For all PM species except sea salt (which is treated as entirely natural (routine)), use the existing NC-II annual average natural light extinction values (which are distinct from the "p90" values), the daily light extinction values, and the annual averages for the site (for both, excluding the light extinction already attributed to episodic events) to calculate a daily estimate of natural (routine). These three input values appear in Table 3 for the May 12, 2003, MEVE1 example. (Table 3 is not intended to show a calculation using these values. The way these input values are used to complete the calculation of anthropogenic versus natural light extinction for a given day is described below the table.)

Table 3. The remaining light extinction at MEVE1 on May 12, 2003 (in units of Mm^{-1}), after applying thresholds to allocate some light extinction to natural (episodic). The NC-II average light extinction estimates and the 2003 annual average light extinction excluding the episodic light extinction are also shown.

PM species	Light extinction remaining after episodic treatment (Step 3)	NC-II average natural light extinction	2003 annual average non-episodic light extinction	Natural (routine) light extinction (Step 4)	Anthropogenic light extinction (Step 5)
Sulfate	2.963	0.5741	4.103	0.4146	2.548
Nitrate	0.8055	0.5829	1.599	0.2936	0.5119
OMC	4.340	1.831	3.194	2.489	1.851
LAC	0.7126	0.2	0.8624	0.1653	0.5467
FS	1.141	0.5	0.8793	0.6490	0.492
CM	1.558	1.726	2.351	1.144	0.4140
Sea salt	0.001469	0.01822	0.02806	0.001469	0
Rayleigh	9.000	9.000	9.000	9.000	0
TOTAL	NA	NA	NA	14.16	6.36

The calculation formula in Step 4 using daily and annual average inputs like those shown in Table 3 depends on whether, for a given PM species, the annual average light extinction value (excluding episodic events) for the particular year is greater than or less than the NC-II estimate of annual average natural light extinction. For a site and PM species with an annual average light extinction value (excluding episodic events) less than the NC-II estimate, all of the daily light extinction is assigned to natural (routine). This results in the natural (routine) light extinction being different each day, with the annual average being less than the NC-II estimate. For a site and PM species with an annual average light extinction value (excluding episodic events) greater than the NC-II estimate, the daily estimates of natural (routine) light extinction are calculated by multiplying the total daily light extinction for each species by the ratio of the NC-II annual average estimates and the annual average non-episodic light extinction. This results in the natural (routine) light extinction being different each day and the annual average of the daily estimates of natural (routine) light extinction equaling the NC-II annual average value. The daily contributions to natural (routine) are calculated according to Equation 3:

$$\text{natural(routine)}=\frac{\text{daily extinction} \times \text{NC-II estimate}}{\text{non-episodic annual average}} \qquad \text{(Eqn. 3)}$$

An example for the OMC light extinction on May 12, 2003, at MEVE1, using extinction values from Table 3, is shown below.

$$\text{natural(routine)}_{OMC}=\frac{4.340 \times 1.831}{3.194} = 2.489 \text{ Mm}^{-1}$$

Repeat this calculation for LAC, FS, CM, sulfate, and nitrate light extinction (not shown here). States may use other reasonable methods for estimating routine natural and anthropogenic fractions if they explain why another method is appropriate for their individual Class I areas.

Step 5: Consider the remaining light extinction from sulfate, nitrate, OMC, LAC, FS, and CM as "anthropogenic."

Starting with the daily total light extinction measured on each day, subtract the daily natural (episodic) and daily natural (routine) to find the daily anthropogenic light extinction attributable to each PM species and overall, i.e., the light extinction budget. For the May 12, 2003, MEVE1 example, the daily total light extinction was 40.83 Mm^{-1}, daily natural light extinction was 34.46 Mm^{-1} (20.31 episodic + 14.16 routine), and daily anthropogenic light extinction was 6.36 Mm^{-1} (see Tables 2 and 3).

Step 6: Calculate anthropogenic impairment for each day using the daily estimates of natural and anthropogenic light extinction, according to Equation 2.

For each day at the Class I area of interest, convert the daily total and natural light extinction to deciviews and calculate anthropogenic impairment according to Equation 2. At MEVE1, for May 12, 2003, the anthropogenic impairment is calculated as:

$$\Delta\ dv_{\text{anthropogenic visibility impairment}} = 10 \times \ln\frac{40.83}{10} - 10 \times \ln\frac{34.46}{10} = 1.695\ dv$$

Step 7: Sort each year's days with complete data by the anthropogenic impairment value and choose the 20 percent most impaired days based on this value.

Perform these calculations for each day at the Class I area of interest, then rank the days within each year from high to low by anthropogenic impairment where a rank of 1 is the most impaired day (*i.e.*, the day with the highest anthropogenic impairment value). At MEVE1, this day, May 12, 2003, with an anthropogenic impairment value of 1.695 deciviews, is a relatively low impairment day and was ranked 99 out of 105 total days with complete observations. Therefore, based on anthropogenic impairment, this day is *not* one of the 20 percent most impaired days for 2003.[13] Average the deciviews of total haze on the 20 percent most impaired days for each year to obtain a single value for the associated visibility condition for each year (for MEVE1 in 2003, which had 105 complete observations, 21 days will be in the 20 percent most impaired).

States may choose alternative approaches for estimating natural and anthropogenic contributions to light extinction, but the Regional Haze Rule requires states to choose the 20 percent most impaired days based on anthropogenic impairment. In other words, while Steps 1 through 6 described above are EPA recommendations and states are not precluded from using other approaches to determine the anthropogenic impairment on each day, the Regional Haze Rule requires states to follow Step 7 as it is described here.

The 2017 Regional Haze Rule revisions introduced a new term for describing the days with the lowest light extinction and deciview values: *clearest days*. These days are *not* to be selected

[13]In contrast, if ranking this day based on either total light extinction or overall visibility conditions (the ranking would be the same with these two metrics), as the EPA's guidance for the first implementation period recommended, this day would be ranked 14 out of 105 days with complete observations and would be one of the 20 percent of days with the haziest visibility conditions.

based on the lowest anthropogenic impairment (as referring to them as the 20 percent least impaired days as in the 1999 Regional Haze Rule would suggest). These will be the days with the lowest values of the deciview index. It is unnecessary to split the data into "natural" and "anthropogenic" fractions. Rather, the days are to be sorted for each year by total deciviews, and the 20 percent of days with the lowest deciviews are the 20 percent clearest days. When 0.2 multiplied by the number of monitored days in a year with complete data is not an integer, an "extra" day should not be included in the set of clearest days, which means that the percentage of days in this set may be a value somewhat below 20 percent.

2.2 Calculating the baseline, current, and natural visibility conditions

The 2017 Regional Haze Rule continues to define the period for establishing baseline visibility conditions as 2000 to 2004 for the second and future implementation periods.[14] Visibility conditions averaged over these 5 baseline years are the starting point for calculating the URP and drawing the URP line for all implementation periods of the Regional Haze Rule. It is important to note that in the 2017 Regional Haze Rule, the term "most impaired days" has a different meaning than EPA and states gave to that term in the first implementation period. The "baseline visibility condition (in deciviews) for the 20 percent most impaired days" in a state's SIP submission for the second implementation period will likely have a different value than the baseline values used in SIPs for the first implementation period, even if there have been no revisions to the IMPROVE data for the 2000-2004 period. The differences will be largest at Class I areas impacted by fire and dust events in the baseline period. If a state chooses an alternative approach for estimating natural and anthropogenic contributions to light extinction, it is likely that the baseline visibility condition will have a different value than with the recommended approach.

The period for calculating current visibility conditions in the 2017 Regional Haze Rule is the 5-year period ending with the most recently available data. Due to the laboratory, data analysis, and quality assurance procedures of the IMPROVE program, there is some delay between the date of the filter collection and the date the data are ready for use in analyses. Current visibility conditions must be calculated based on the annual average level of visibility impairment for the 20 percent most impaired and the 20 percent clearest days. The current visibility condition for each set of days is the average of the valid annual values from the 5-year period ending with the most recently available data set as expressed in deciviews. Five years are averaged to account for variability in meteorology and emissions. Data completeness requirements for valid years are described in the 2003 Regional Haze Rule visibility tracking guidance (EPA, 2003a). Incomplete or missing data from some IMPROVE sites may require the combination or substitution of data from multiple IMPROVE sites for the ongoing visibility tracking of the Regional Haze Rule. The appropriate EPA Regional office should be consulted when data completeness issues arise.

---

[14] It is recommended that the data for the 2000-2004 baseline period be refreshed prior to analysis due to periodic revisions in the methods for calculating ambient concentrations from measurements made on filters and for filling in missing or invalidated data.

The URP framework requires states to determine a single value for the "natural visibility condition" for the 20 percent most impaired days. Given the inherent day-to-day variability of natural processes (e.g., windblown dust, fire, volcanic activity, biogenic emissions, etc.), it follows that even if there were no anthropogenic sources, visibility would not be constant and would vary day-to-day. Also, visibility due only to natural sources has never occurred in modern times and, therefore, has never been directly measured nor could it be directly measured. It must be estimated. Even if past natural conditions could be known with certainty, future natural conditions may be different. The steps for estimating natural and anthropogenic fractions of light extinction recommended in this guidance are based on estimates of natural visibility conditions for each monitored day in the past, with a given past day having the potential for both routine and episodic contributions to natural conditions. An additional step is needed to get the single value for the "*natural visibility condition*." Under the Regional Haze Rule, the single value of the natural visibility condition for the 20 percent most impaired days is used in several ways:

1. The value of the natural visibility condition is to be compared to the "current visibility condition," i.e., the most recent 5-year average of actual visibility for the 20 percent most impaired days. (51.308(f)(1)(v)).
2. The URP can be calculated as the difference between the 2000-2004 baseline visibility condition and the natural visibility condition for the 20 percent most impaired days, divided by 60 years. In other words, the "glidepath" can end at the natural visibility condition in 2064. (51.308(f)(1)(vi)).[15]
3. The future year (2028 for the second implementation period) RPG for the 20 percent most impaired days is compared to its value on the URP line, which can use the natural visibility condition estimate as its endpoint. (51.308(f)(1)(vi)).

We are recommending that states set the single value of the natural visibility condition for the 20 percent most impaired days to be equal to the average of the new estimates of daily natural visibility conditions estimated for the particular days that have been identified as the 20 percent most impaired days from 2000-2014. This method takes advantage of the already calculated daily "natural (episodic)" and "natural (routine)" estimates of light extinction produced in steps 1 through 3. These revised natural visibility conditions are consistently lower in magnitude than the "p90" NC-II haze estimates (representing the average conditions for days between the 80^{th} percentile and the 100^{th} percentile) and generally more similar in magnitude to the annual average NC-II haze estimates. (Gantt, et al., 2018) describes in greater detail the methodology, seasonality, composition, and trends in the natural visibility conditions, and a summary of the natural visibility condition estimates for each IMPROVE site can be found in Appendix A.

When following the recommended approach to select the 20 percent most impaired days based on anthropogenic impairment, days with large impacts from extreme, episodic natural events such as fires and dust storms are no longer selected. Therefore, these extreme impacts

[15] If an adjustment is made to the URP for impacts from international anthropogenic emissions or wildland prescribed fires, the glidepath would not end at the natural visibility condition.

generally will not be included in estimates of natural visibility conditions that will be compared with the most impaired days. This addresses past feedback from the first implementation period that the natural and current visibility conditions were inconsistent because 1) the “p90” NC-II Natural Haze estimates developed by the Natural Haze Levels II Committee in 2007 failed to include effects from large episodic natural events (Tombach, 2008) and 2) the 20 percent of days with the worst overall visibility included these extreme episodic natural influences. In addition to avoiding selecting historical days dominated by extreme natural events when calculating the single value of the natural visibility condition that will be used in calculating the URP, it is important to recognize that the 20 percent most impaired days will be distributed across seasons of the year differently than the 20 percent haziest days used for the first implementation period (Gantt, et al., 2018). Because the revised national visibility condition value is calculated from estimates of daily natural contributions on the most impaired days, this recommended natural visibility condition value is more consistent within the framework.

At most Class I areas, these updates to the baseline and natural visibility conditions in recommended approach result in a time series that is less influenced by natural events and reflects the substantial visibility improvements that have occurred in many areas of the United States between 2000 and 2016 (see Figure 5).

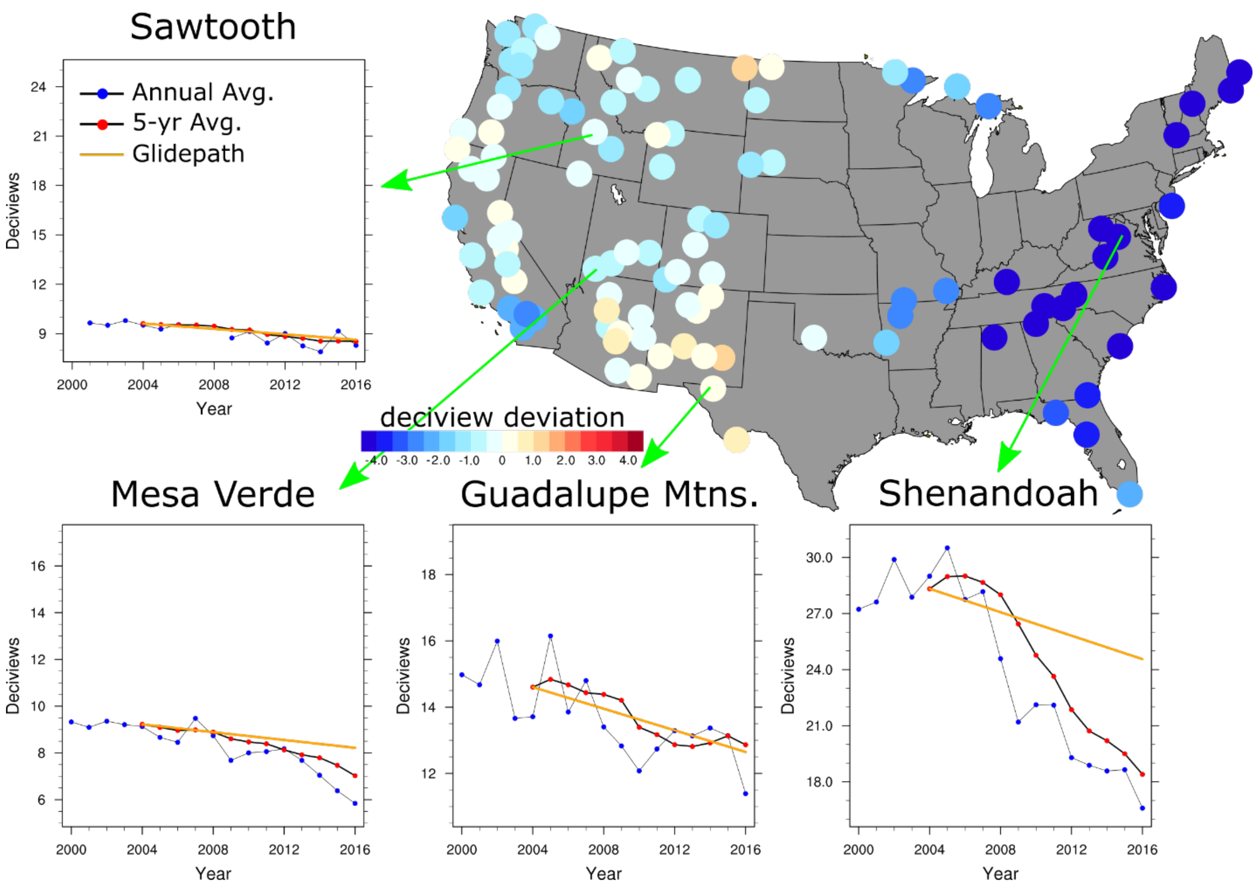


Figure 5. National map of current visibility conditions relative to the URP in 2012-2016 based on the 20 percent most impaired days (recommended approach).

3.0 Adjustment of the Uniform Rate of Progress for Impacts from International Anthropogenic Emissions

Visibility at Class I areas is impacted not only by natural and anthropogenic emissions from within the U.S., but also by natural and anthropogenic *international* emissions. Due to the fact that international anthropogenic emissions are beyond the control of states preparing regional haze SIPs, the Regional Haze Rule allows states to propose an adjustment of the 2064 URP to account for international anthropogenic impacts, if the adjustment has been developed using scientifically valid data and methods. The URP can be adjusted by adding an estimate of the visibility impact of international anthropogenic sources to the value of natural visibility condition to get an adjusted 2064 endpoint.[16]

The optional adjustment to the URP for international anthropogenic emissions is in addition to another optional adjustment relating to certain prescribed fires. Specifically, the rule also allows states to include an adjustment of the URP to account for impacts from certain wildland prescribed fires. The information and procedures for prescribed fire adjustments are expected in practice to be similar to the recommended international anthropogenic adjustment procedure provided in this guidance. Therefore, this section of the guidance document may be useful in either case. Note that preliminary EPA regional haze modeling (based on 2011 fire emissions) (EPA, 2017) indicates that prescribed fire impacts on the 20 percent most impaired days at most Class I areas are likely to be small and, thus, any adjustment to the URP would also be small. This section focuses on anthropogenic international emissions and their impacts.

3.1 URP Adjustment in the Regional Haze Rule

The relevant international anthropogenic URP adjustment language in the Regional Haze Rule is at 40 CFR 51.308(f)(1)(vi):

> (B) As part of its implementation plan submission, the State may propose (1) an adjustment to the uniform rate of progress for a mandatory Class I Federal area to account for impacts from anthropogenic sources outside the United States and/or (2) an adjustment to the uniform rate of progress for the mandatory Class I Federal area to account for impacts from wildland prescribed fires that were conducted with the objective to establish, restore, and/or maintain sustainable and resilient wildland ecosystems, to reduce the risk of catastrophic wildfires, and/or to preserve endangered or threatened species during which appropriate basic smoke management practices were applied. To calculate the proposed adjustment(s), the State must add the estimated impact(s) to the natural visibility condition and compare the baseline visibility

[16]The EPA expects that the revised approach of selecting the most anthropogenically impaired days for purposes of defining RPGs and tracking progress, which focuses progress tracking on days not affected by large episodic natural events such as dust storms and wildfires, will also largely resolve any concerns stemming from the same types of natural emission sources in other countries. Because the recommended method for identifying the most anthropogenically impaired days is based entirely on information from IMPROVE monitoring sites, it can be executed without detailed information on the emissions from natural sources outside the U.S.

> condition for the most impaired days to the resulting sum. If the Administrator determines that the State has estimated the impact(s) from anthropogenic sources outside the United States and/or wildland prescribed fires using scientifically valid data and methods, the Administrator may approve the proposed adjustment(s) to the uniform rate of progress.

The URP is based on 1) PM species measurements that do not distinguish between PM due to natural, U.S. anthropogenic, and international anthropogenic emissions, and 2) the "natural visibility condition" endpoint that should not include any anthropogenic contribution (see Figure 1). The natural visibility condition endpoint, therefore, assumes no anthropogenic international contribution in 2064 and the default URP slope reflects a hypothetical uniform decrease in both U.S. and international anthropogenic haze contributions. The rule provision that allows states to include an international adjustment allows for the modification of the URP slope to account for international anthropogenic contributions that states cannot control.

The Regional Haze Rule allows for an adjusted URP but does not prescribe a particular adjustment methodology. To inform this adjustment to the URP, EPA recommends the use of chemical transport models (CTMs) as the most broadly applicable method for attributing pollutant concentrations to emissions sources. Two key issues with using CTMs for this purpose are addressed below: what year should be used to estimate international anthropogenic impacts, and how to apply the models to quantify international anthropogenic impacts.

3.2 Year Selection for Estimating International Contribution

Estimating international anthropogenic visibility impact is a function of transport patterns and emissions. Both meteorology and emissions are year-specific, so the first choice in photochemical modeling is determining what year to simulate. For example, the estimation could be based on a current or recent year, the implementation period end year (e.g., 2028, 2038, etc.), or the URP endpoint (2064).

To illustrate the potential impacts of international emissions, Figure 6 shows hypothetical effects of adjusting the 2064 endpoint to account for international emissions at a hypothetical Class I area. The URP lines in Figure 6 illustrate how the URP slope is impacted by different estimates of international impacts. The URP represented by the orange line shows an unadjusted URP that assumes both U.S. and international anthropogenic impacts will decrease uniformly to zero in 2064. The black URP line represents an adjusted URP, assuming constant international anthropogenic impacts over time. In both URP series, the U.S. anthropogenic contribution is uniformly decreasing in each period.[17]

[17] In the example figure, the U.S. visibility impairment improvement is calculated as a fixed percentage in each implementation period. However, consistent with the Regional Haze Rule, there is no regulatory requirement to achieve "uniform progress." The actual improvement in visibility impairment during each implementation period may vary.

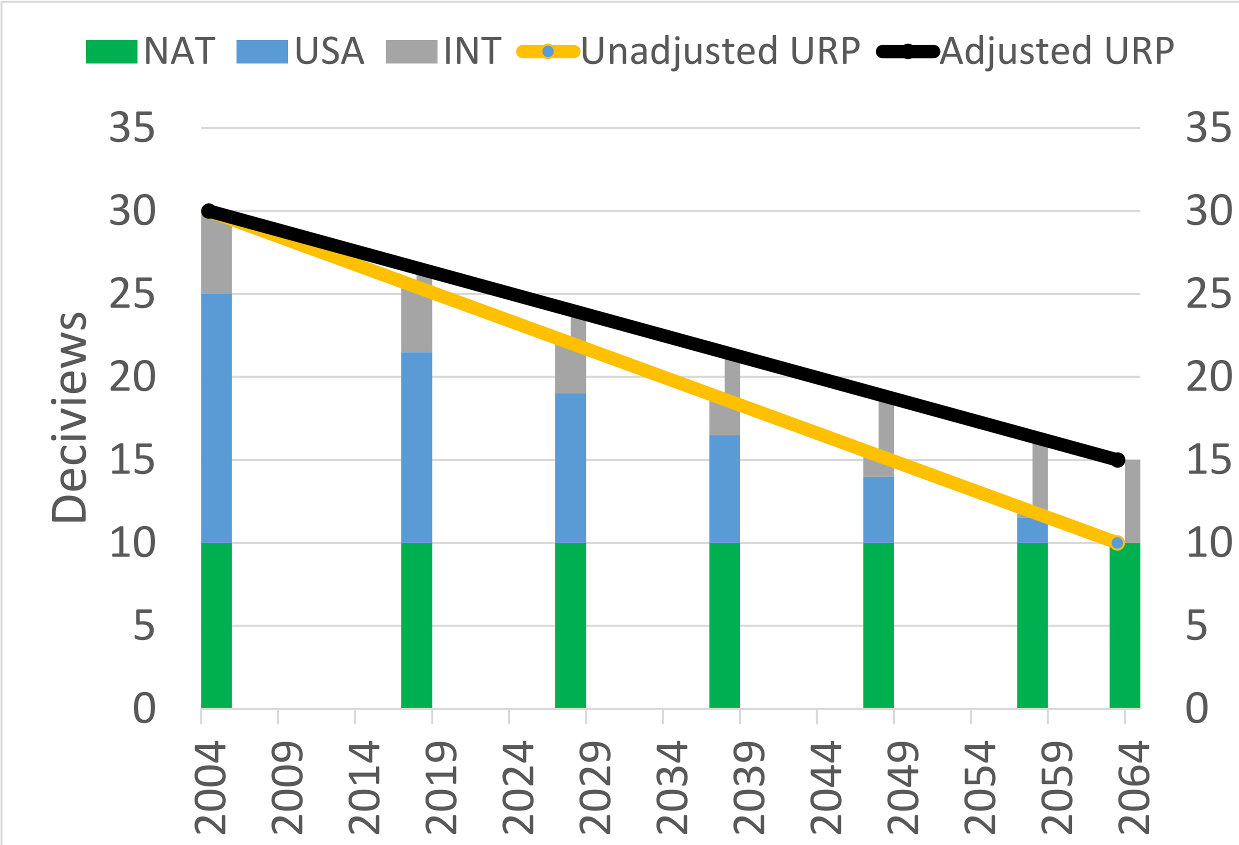


Figure 6. URP lines based on alternate international projections. For each year except 2004, there are two bars representing two different possibilities (1st: decreasing international (INT); 2nd: constant international). Note that both realizations have the same decreasing U.S. anthropogenic (USA) contribution and same constant natural conditions (NAT).

Projecting international emissions to 2064 may be speculative and somewhat uncertain. EPA therefore believes that recent year estimates of visibility impacts are most appropriate to use in estimating international adjustments. There are existing recent estimates of global PM and PM precursor emissions that have been used in various modeling studies (Galmarini, et al., 2016; Janssens-Maenhout, et al., 2015; Li, et al., 2015; Hoesly, et al., 2018). Therefore, for the second implementation period, EPA recommends estimating international impacts in a recent year, with more recent years being best able to reflect current international emissions and trends. In choosing the analysis year, additional practical considerations, such as the availability of emission information or modeling results may constrain a state's options. For example, it may only be practical to use 2011, 2014, or 2016 base year international emissions to calculate the adjustment because only that information is readily available.

In some cases, additional data on emissions trends may be used to estimate future year international impacts, if future changes are well known. This is especially relevant for North American emissions sources (generally within the regional modeling domain), where future trends in some non-U.S. emissions sectors (e.g., on-road mobile sources and commercial ships) may be relatively well characterized in existing inventories. Since 2028 is the end of the second implementation period, it is the most likely future modeling analysis year. To the extent that high-quality international emissions projections are available, it may be appropriate to calculate international anthropogenic adjustments based on 2028 emissions.

Since international anthropogenic visibility impacts are likely to change in the future, in subsequent planning periods, a new international adjustment can be made for each implementation period. In this way, an iterative process over time allows the glidepath to be periodically adjusted to reflect future trends in international anthropogenic emissions. Eventually, as we get closer in time to the URP endpoint, the international anthropogenic visibility impact will become less uncertain.

3.3 Estimating the Anthropogenic International Visibility Impacts

The methods to quantify international visibility impacts are largely independent of the chosen year. The Regional Haze Rule requires that a state's approach be based on scientifically valid data and methods. Due to long-range transport and secondary PM components involved in international transport, photochemical chemical transport modeling (CTM) is the preferred approach for quantifying international contributions to visibility. Detailed guidance on performing CTM simulations is available in EPA's photochemical modeling guidance for ozone, $PM_{2.5}$, and regional haze (EPA, 2018).

Using CTMs, there are several potential ways to quantify international anthropogenic impacts in Class I areas:

1) The simplest approach is to perform brute force "zero-out" model runs, which involves at least two model runs: one "base case" run with all emissions, and one with anthropogenic emissions from outside of the U.S. removed from the original base case simulation. The difference between these simulations provides an estimate of the air quality impact due to the international anthropogenic emissions.

2) An alternative approach to isolating international anthropogenic impacts in photochemical grid models is "photochemical source apportionment." Some photochemical models have been developed with a photochemical source apportionment capability, which tracks emissions from specific sources or groups of sources and/or source regions through chemical transformation, transport, and deposition processes to estimate the apportionment of predicted $PM_{2.5}$ species concentrations (Kwok, et al., 2013; Kwok, et al., 2015; Ramboll, 2018). Source apportionment can be used to track PM formed from international anthropogenic emissions sources.

From the CTM runs, whether based on brute-force or source apportionment (or a combination of both), PM species concentration increments due to international anthropogenic emissions can be calculated for each of the 20 percent most impaired days (for each Class I area). The PM concentration increments on the 20 percent most impaired days are then converted to extinction and averaged. The "delta deciview" adjustment factor associated with the international anthropogenic impact can then be calculated as follows[18]:

$$\Delta dv=10\ln\left(bext_{natural\ conditions}+bext_{international\ anthropogenic}\right)/\ bext_{natural\ conditions} \qquad \text{(Eqn. 4)}$$

The Class I area-specific adjustment factor (in deciviews) is added to the natural conditions value for each Class I area to get the adjusted URP.[19] In this process, the following issues should be given appropriate treatment:

The air quality model (or combination of models) that is used.

The modeling system typically includes a global/hemispheric modeling simulation and a regional photochemical modeling simulation. The global component is often used to supply "boundary" conditions to the regional simulation. To the extent practical, the modeling platforms with the two scales should be consistent using the same (or similar) meteorology, vertical resolution, emissions, and representation of chemical species. This is particularly true for the international emissions but is also true for gas-phase and aerosol modeling components. The consistency is particularly important when performing anthropogenic zero-out and/or source apportionment simulations that cross horizontal grid scales (going from a lower resolution global/hemispheric model to a higher resolution nested regional model).[20]

The validity of the estimates of both international and U.S emissions.

Before estimating source contributions, the "*basecase*" simulation, both for global and regional models, should be able to reasonably reproduce historical PM measurements and calculated visibility values. Thus, model performance evaluation and diagnostic evaluation should both play a role as described in the photochemical modeling guidance (EPA, 2018) (Simon, et al., 2012). This will provide confidence that both U.S. and international emissions and visibility impacts are reasonably well represented.

After the *basecase* has been evaluated and shown capable of representing historical PM and visibility, then the models can be used to quantify international impacts. Quantifying the international sources, as previously stated, may be done using zero-out (sensitivity) or source apportionment model runs, or a combination of both.[21] Unless the international impacts are primarily from the portions of North America included in the smaller scale (regional) modeling simulation, the modeling will likely require coordinated efforts between a global/hemispheric and regional CTM simulation. When this is the case, it is especially important to understand the

[18]There may be multiple ways this aggregation across days might be done, keeping in mind that the URP line is in units of deciviews, so the adjustment must also be in units of deciviews.

[19]Note that the Regional Haze Rule does not allow a state to subtract an estimate of the impacts of international anthropogenic sources when projecting the RPGs for the end of the implementation period, as an alternative to adding international anthropogenic impacts to the 2064 endpoint of the URP glidepath.

[20]The boundary between the global and regional models should be sufficiently far removed from U.S. emissions sources and/or the Class I areas being considered.

[21]For example, zero-out modeling could be used in the global or hemispheric model to feed boundary conditions to the regional model. Then source apportionment technology could be used to track international anthropogenic emissions within the regional model. The available options depend on the source apportionment capability of the chosen global, hemispheric, and/or regional CTMs.

harmony of inventories at the different scales. Regardless of the technology used for quantification of source contributions (sensitivity or source apportionment), the most important aspect is appropriate selection of source sectors and domains over which they apply.

Previous studies provide guidance on which inventories need to be considered in international contribution analysis. The majority of studies have focused on ozone because of its long-range transport capability (Zhang, et al., 2011; Emery, et al., 2012). Estimating international contribution continues to evolve and applications should review all emission sectors and consider the appropriate divisions between natural, international anthropogenic, and domestic anthropogenic sources.

When the emissions inventory coverages cross scales (global to regional), the emissions should be consistent between the two scales and the sensitivity (zero-out) or source apportionment should also be consistent between the two scales. Emissions that cross scales include aircraft and international shipping. These inventories require special consideration if they are used in estimating international contributions. The assignment of domestic versus foreign emissions depends on the jurisdiction of the waters and/or air space. Where the assignment is unclear, the appropriate EPA Regional office should be consulted. For brute force modeling, the "boundary conditions" for the regional perturbation simulation would be provided by a consistent perturbation in the global model.

Model contributions will vary, and a range of estimates should be considered and discussed to provide context. Particularly for sensitivity modeling, the sequential order of emission perturbations influences the result (zeroing the international source or the local source give different answers). Thus, two estimates of international source contribution can be developed and used to characterize a range of possible results. This is particularly important for haze that is strongly influenced by secondary organic aerosol and/or nitrate. For example, nitrate concentrations can increase when removing international sulfate due to chemical displacement. Estimates of all species should be characterized and the realism of the estimate considered before simply adding to natural conditions.

Because the adjustment factor will be added to the endpoint of the URP and ultimately used to calculate an adjusted URP for comparison with the RPG, it is important that the modeling be consistent across the URP framework (e.g., the same or similar model, domain, meteorology, and emissions should be used in both the RPG modeling and in the modeling used to adjust the endpoint).

3.4 EPA Review of an International URP Adjustment

EPA's approval for a URP adjustment will be part of EPA's review of the full SIP submission for the second implementation period, and not a separate action in advance of SIP submission. In this way, EPA's decision to approve or not approve the adjustment will be made in the context of the complete SIP submission, with public notice and an opportunity to comment. States are encouraged to consult with their EPA Regional office during the development of any proposed adjustment approach. Any proposed adjustment must be adequately documented to allow public comment and EPA review. An adequate explanation of the adjustment will necessarily show the unadjusted and adjusted values for the 2064 endpoint and for the URP.

Whether and what adjustment should be made to the URP to account for impacts from international anthropogenic emissions will be a new issue for the SIP for each implementation period. EPA's approval of an adjustment approach included in the SIP revision due in 2021 does not mean that the same adjustment will be automatically approved if included in the SIP revision due in 2028, for example.

References

Baker, K. R., Emery, C., Dolwick, P. & Yarwood, G., 2015. Photochemical grid model estimates of lateral boundary contributions to ozone and particulate matter across the continental United States. *ATMOSPHERIC ENVIRONMENT,* 12, Volume 123, pp. 49-62.

Baker, K. R. & Kelly, J. T., 2014. Single source impacts estimated with photochemical model source sensitivity and apportionment approaches. *Atmospheric Environment,* 10, Volume 96, pp. 266-274.

Copeland, S., Pitchford, M. & Ames, R., 2008. *Regional Haze Rule Natural Level Estimates Using the Revised IMPROVE Aerosol Reconstructed Light Extinction Algorithm,* s.l.: http://vista.cira.colostate.edu/improve/Publications/GrayLit/032_NaturalCondIIpaper/Copeland_etal_NaturalConditionsII_Description.pdf.

Dolwick, P. et al., 2015. Comparison of background ozone estimates over the western United States based on two separate model methodologies. *ATMOSPHERIC ENVIRONMENT,* 5, Volume 109, pp. 282-296.

Emery, C. et al., 2012. Regional and global modeling estimates of policy relevant background ozone over the United States. *ATMOSPHERIC ENVIRONMENT,* 2, Volume 47, pp. 206-217.

EPA, 2003a. *Guidance for Tracking Progress Under the Regional Haze Rule,* s.l.: https://www3.epa.gov/ttnamti1/files/ambient/visible/tracking.pdf.

EPA, 2003b. *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule,* s.l.: https://www3.epa.gov/ttnamti1/files/ambient/visible/natural.pdf.

EPA, 2017. *Documentation for the EPA's Preliminary 2028 Regional Haze Modeling,* RTP, NC: U.S. Environmental Protection Agency .

EPA, 2018. *Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze,* RTP, NC: U.S. Environmental Protection Agency.

Galmarini, S. et al., 2016. Technical note: Harmonization of the multi-scale multi-model activities HTAP, AQMEII and MICS-Asia: simulations, emission inventories, boundary conditions and output formats. *Atmospheric Chemistry and Physics Discussions,* Volume 2016, pp. 1-20.

Gantt, B., Beaver, M., Timin, B. & Lorang, P., 2018. Recommended metric for tracking visibility progress in the Regional Haze Rule. *Journal of Air & Waste Management,* 68(5), pp. 438-445.

Henderson, B. H. et al., 2014. A database and tool for boundary conditions for regional air quality modeling: description and evaluation. *GEOSCIENTIFIC MODEL DEVELOPMENT,* Volume 7, pp. 339-360.

Hoesly, R. M. et al., 2018. Historical (1750–2014) anthropogenic emissions of reactive gases and aerosols from the Community Emissions Data System (CEDS). *Geoscientific Model Development,* 1, Volume 11, pp. 369-408.

Jaffe, D. et al., 2008. Interannual Variations in PM2.5 due to Wildfires in the Western United States. *Environ. Sci. Technol,* Volume 42, p. 2812–2818.

Janssens-Maenhout, G. et al., 2015. HTAPv2.2: a mosaic of regional and global emission grid maps for 2008 and 2010 to study hemispheric transport of air pollution. *Atmospheric Chemistry and Physics,* Volume 15, pp. 11411-11432.

Kwok, R. H. F., Baker, K. R., Napelenok, S. L. & Tonnesen, G. S., 2015. Photochemical grid model implementation and application of VOC, NOx, and O3 source apportionment. *Geosci. Model Dev.,* 1, Volume 8, pp. 99-114.

Kwok, R. H. F., Napelenok, S. L. & Baker, K. R., 2013. Implementation and evaluation of PM2.5 source contribution analysis in a photochemical model. *Atmospheric Environment,* 12, Volume 80, pp. 398-407.

Lam, Y. F. & Fu, J. S., 2009. A novel downscaling technique for the linkage of global and regional air quality modeling. *Atmos. Chem. Phys.,* 12, Volume 9, pp. 9169-9185.

Li, M. et al., 2015. MIX: a mosaic Asian anthropogenic emission inventory for the MICS-Asia and the HTAP projects. *Atmospheric Chemistry and Physics Discussions,* Volume 15, pp. 34813-34869.

Pitchford, M. et al., 2007. Revised algorithm for estimating light extinction from IMPROVE particle speciation data. *J. Air & Waste Manage. Assoc.,* 57(11), pp. 1326-1336.

Ramboll, 2018. *User's Guide COMPREHENSIVE AIR QUALITY MODEL WITH EXTENSIONS Version 6.50,* Novato: s.n.

Simon, H., Baker, K. R. & Phillips, S., 2012. Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012. *Atmospheric Environment,* Volume 61, pp. 124-139.

Spracklen, D. et al., 2007. Wildfires drive interannual variability of organic carbon aerosol in the western U.S. in summer. *Geophys. Res. Lett.,* Volume 34.

Tombach, I., 2008. *Natural Haze Levels Sensitivity, Assessment of Refinements of Estimates of Natural Conditions. Prepared for the Western Governors Association,* s.l.: http://www.wrapair.org/forums/aamrf/projects/NCS/Haze_Sensitivity_Report-Final.pdf.

Zhang, L. et al., 2011. Improved estimate of the policy-relevant background ozone in the United States using the GEOS-Chem global model with 1/2° × 2/3° horizontal resolution over North America. *Atmospheric Environment,* 12, Volume 45, pp. 6769-6776.

APPENDIX A.

Site	First Implementation Period Approach			Recommended Approach			e3 (Mm-1)	
	Baseline Visibility Condition for 20% Haziest Days (2000-2004)	Current Visibility Condition for Most Impaired Days (2012-2016)	NC-II P90 (2064)	Baseline Visibility Condition for 20% Most Impaired Days (2000-2004)	Current Visibility Condition for 20% Most Impaired Days (2012-2016)	Derived-NC (2064)	carbon	dust
ACAD1	23.21	16.50	12.43	22.01	15.28	10.39	10.44	3.11
AGTI1	23.50	17.65	7.64	21.62	16.73	7.63	10.85	8.86
BADL1	17.14	14.71	8.06	14.98	12.56	6.09	9.17	7.49
BALD1	11.51	10.19	6.24	8.64	7.55	4.04	6.65	5.42
BAND1	12.23	10.71	6.26	9.70	8.88	4.59	5.60	4.36
BIBE1	17.30	15.29	7.16	15.57	14.25	5.33	7.60	8.59
BLIS1	12.63	12.64	6.05	10.06	9.39	4.91	11.14	2.84
BOAP1	13.80	14.06	6.73	11.61	10.98	5.36	9.38	7.83
BOWA1	19.99	16.51	11.61	18.94	14.58	9.11	11.11	3.16
BRCA1	11.65	9.29	6.80	8.42	6.88	4.08	6.13	4.26
BRID1	11.12	10.84	6.45	7.96	6.58	3.90	7.75	2.83
BRIG1	29.01	21.62	12.24	27.43	20.44	10.69	20.15	9.07
BRIS1[a]		21.29	11.93		19.67	9.28	18.10	9.12
CABI1	14.09	14.27	7.52	10.73	9.97	5.65	13.14	4.13
CACR1	26.36	20.68	11.58	23.99	19.22	9.47	16.84	7.80
CANY1	11.25	9.91	6.43	8.79	7.36	4.11	5.53	5.02
CAPI1	9.97	9.97	6.03	8.62	7.27	4.13	5.07	5.14
CHAS1	26.10	19.96	11.03	24.62	18.12	8.97	24.69	6.68
CHIR1	13.43	11.94	7.20	10.50	9.78	4.93	4.81	7.87
COHU1	30.30	20.15	10.78	28.83	18.59	9.52	18.17	4.44
CRLA1	13.74	12.96	7.62	9.36	8.64	5.22	8.67	2.37
CRMO1	14.00	14.08	7.53	11.91	9.28	4.97	7.26	4.72
DENA1	9.86	9.25	7.31	7.06	6.97	4.79	3.58	1.60
DOME1	19.43	17.95	7.46	17.20	15.42	6.18	14.13	11.58
DOSO1	29.05	19.96	10.39	28.29	18.88	8.92	13.57	3.40
EVER1	22.31	18.06	12.15	19.54	15.33	8.34	10.00	7.90
GAMO1	11.29	10.97	6.38	8.95	7.50	4.66	10.17	3.03
GICL1	13.11	11.11	6.66	8.93	8.02	4.22	5.73	4.40
GLAC1	20.47	16.91	9.18	16.19	13.69	6.99	22.24	7.50
GRCA2	11.66	9.56	7.04	7.94	6.95	4.18	5.97	4.74
GRGU1	22.82	15.20	11.99	21.93	13.92	9.78	12.07	3.23
GRSA1	12.78	10.63	6.66	9.66	8.28	4.45	8.01	6.69
GRSM1	30.28	19.66	11.24	29.16	18.42	10.05	16.09	4.48
GUMO1	17.19	14.93	6.65	14.60	12.86	4.83	6.25	12.95
HACR1[b]	13.33	9.16	7.43	12.67	8.37	4.78	1.24	2.01
HAVO1	18.86	19.01	7.17	18.66	18.82	5.64	1.65	1.93
HECA1	18.55	17.17	8.32	16.51	13.09	6.57	13.88	5.00
HEGL1	26.75	20.73	11.30	25.17	19.32	9.30	20.30	6.84
HOOV1	12.87	11.84	7.71	8.97	7.91	4.91	8.92	4.00
IKBA1	13.35	11.80	6.68	11.19	9.52	5.22	6.78	6.14
ISLE1	20.74	17.46	12.37	19.53	16.03	10.15	12.05	4.22
JARB1	12.07	12.85	7.87	8.73	7.82	5.23	7.45	8.00
JARI1	29.12	20.18	11.13	28.08	18.70	9.48	26.27	3.13
JOSH1	19.62	14.97	7.19	17.74	13.15	6.09	7.82	9.81
KAIS1	14.75	15.45	7.12	12.67	11.45	5.98	11.16	5.19
KALM1	15.51	14.40	9.44	13.35	12.12	7.80	12.46	2.43
KPBO1[c]	14.11	12.94	11.31	10.47	10.48	6.96	3.39	2.32
LABE1	15.05	15.03	7.85	11.29	9.92	6.16	10.38	3.81
LAVO1	14.15	12.69	7.31	11.50	9.97	6.14	12.36	2.59
LIGO1	28.77	19.15	11.22	28.05	17.36	9.70	18.22	2.83
LOST1	19.57	18.37	8.00	18.27	15.89	5.88	10.17	9.28
LYEB1[d]	24.45	17.11	11.73	23.57	16.07	10.23	11.44	2.75
MACA1	31.37	23.04	11.08	29.83	22.03	9.79	19.44	4.28
MELA1	17.72	17.75	7.89	16.63	15.50	5.95	9.14	9.09
MEVE1	13.03	9.88	6.81	9.22	7.03	4.20	5.05	5.33
MING1	29.54	22.34	11.62	26.65	20.70	9.28	28.55	10.81
MOHO1	14.86	13.14	8.43	12.10	9.74	6.60	7.75	2.74
MONT1	14.48	15.15	7.73	10.84	9.61	5.43	14.92	4.89
MOOS1	21.72	15.64	12.01	20.66	14.07	9.97	11.13	2.54

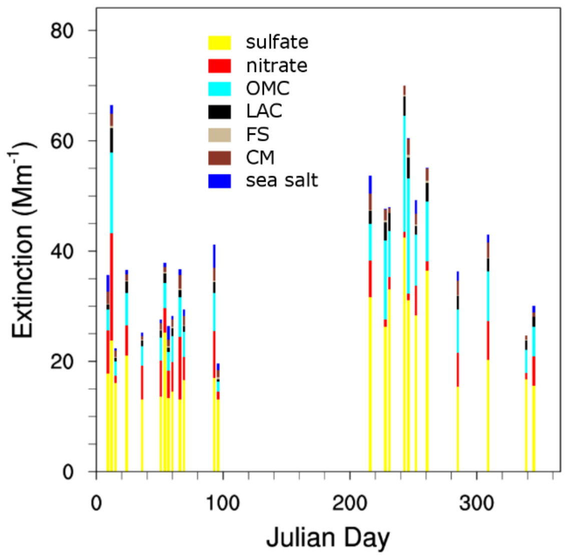
Site	First Implementation Period Approach			Recommended Approach			e3 (Mm^{-1})	
	Baseline Visibility Condition for 20% Haziest Days (2000-2004)	Current Visibility Condition for Most Impaired Days (2012-2016)	NC-II P90 (2064)	Baseline Visibility Condition for 20% Most Impaired Days (2000-2004)	Current Visibility Condition for 20% Most Impaired Days (2012-2016)	Derived-NC (2064)	carbon	dust
MORA1	18.25	14.93	8.54	16.53	13.35	7.66	13.33	2.53
MOZI1	10.52	9.16	6.08	7.29	5.63	3.16	5.70	3.23
NOAB1	11.46	11.30	6.83	8.78	7.17	4.54	10.18	4.23
NOCA1	13.96	12.65	8.39	12.57	10.42	6.79	8.20	1.97
OKEF1	27.13	20.47	11.44	25.34	18.73	9.47	20.65	5.50
OLYM1	16.74	13.38	8.44	14.93	12.24	6.88	8.78	1.76
PASA1	15.23	13.94	8.25	10.41	9.17	5.97	9.42	2.58
PEFO1	13.21	10.73	6.49	9.82	8.49	4.21	6.75	7.84
PINN1	18.46	16.03	7.99	17.02	14.35	6.96	11.33	5.88
PORE1	22.81	19.98	15.77	19.38	15.94	9.75	6.78	8.23
RAFA1	18.86	16.08	7.57	17.00	14.14	6.85	7.65	8.20
REDW1	18.45	17.88	13.91	13.64	12.70	8.54	5.86	4.44
ROMA1	26.48	20.21	12.12	25.25	18.32	9.79	23.38	5.35
ROMO1	13.83	11.54	7.15	11.12	8.66	4.93	8.54	5.32
SACR1	18.03	17.33	6.81	16.54	15.36	5.50	9.01	14.44
SAGA1	19.94	14.83	6.99	17.89	13.63	6.12	8.49	7.11
SAGO1	22.17	15.98	7.30	20.43	14.80	6.19	11.94	7.77
SAGU1	14.83	12.69	6.46	12.64	10.96	5.16	6.15	9.62
SAMA1	26.03	20.64	11.67	24.30	18.17	9.19	21.26	5.22
SAPE1	10.17	9.13	5.72	7.66	6.66	3.36	5.66	4.53
SAWT1	13.78	17.12	6.42	9.62	8.52	4.67	12.35	2.57
SENE1	24.16	19.20	12.65	23.62	18.41	11.11	13.67	2.52
SEQU1	24.62	21.10	7.70	23.23	19.20	6.29	23.11	11.47
SHEN1	29.31	19.71	11.35	28.32	18.40	9.52	15.06	3.92
SHRO1	27.89	18.65	11.47	27.32	16.87	10.01	13.99	3.09
SIAN1	13.67		6.59	10.76		5.14	6.77	5.91
SIME1	18.56	16.97	15.60	13.67	13.69	8.49	3.42	4.63
SIPS1	29.03	20.95	10.99	27.71	19.77	9.55	21.66	4.79
SNPA1	17.84	15.54	8.43	15.37	13.07	7.25	12.33	1.79
STAR1	18.57	14.54	8.92	14.53	11.53	6.59	13.10	5.66
SULA1	13.41	15.55	7.43	10.06	8.53	5.48	11.78	3.22
SWAN1	25.49	19.06	11.55	24.40	17.44	9.79	16.47	5.01
SYCA2[e]	15.26	14.59	6.65	12.16	11.45	4.68	13.12	15.93
THRO1	17.74	15.97	7.80	16.35	13.70	5.96	9.87	8.71
THSI1	15.34	15.28	8.79	12.80	11.48	7.30	12.62	4.01
TONT1	13.94	12.47	6.54	11.34	10.63	5.06	7.14	8.76
TRCR1	11.61	10.03	8.40	9.16	8.85	6.38	5.11	2.38
TRIN1	16.32	16.02	7.90	11.97	10.45	6.24	10.36	3.61
ULBE1	15.14	14.31	8.16	12.76	10.79	5.87	9.82	6.17
UPBU1	26.27	20.57	11.57	24.25	18.85	9.43	17.22	7.72
VIIS1	17.02	18.49	10.68	14.29	15.60	8.53	2.60	21.54
VOYA2	19.27	17.08	12.06	17.75	15.04	9.38	11.48	4.14
WEMI1	10.33	9.17	6.21	7.81	6.74	3.98	6.51	3.93
WHIT1	13.70	13.21	6.80	11.31	10.41	4.89	7.16	7.13
WHPA1	12.76	12.02	8.35	10.48	8.51	6.15	6.89	2.41
WHPE1	10.41	9.11	6.08	7.35	7.02	3.53	5.13	3.50
WHRI1	9.61	7.93	6.06	6.30	5.18	3.02	4.92	3.56
WICA1	15.84	13.55	7.71	13.09	10.63	5.64	8.02	4.62
WIMO1	23.81	19.53	7.53	22.15	18.79	6.92	13.95	9.94
YELL2	11.76	12.26	6.44	8.30	7.65	3.98	10.08	3.06
YOSE1	17.63	15.84	7.64	13.52	11.89	6.29	13.14	5.19
ZICA1[f]	12.97	10.32	6.70	10.72	8.66	5.08	5.54	6.90

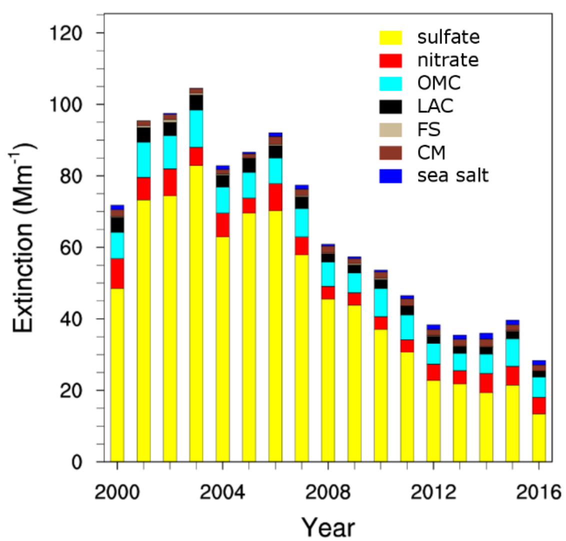
[a]Site data combined with BRET1 starting 01-01-08
[b]Site data combined with HALE1 starting 01-01-08
[c]Site data combined with TUXE1 starting 01-01-15
[d]Site data combined with LYBR1 starting 01-01-12
[e]Site data combined with SYCA1 starting 01-01-16
[f]Site data combined with ZION1 starting 01-01-04

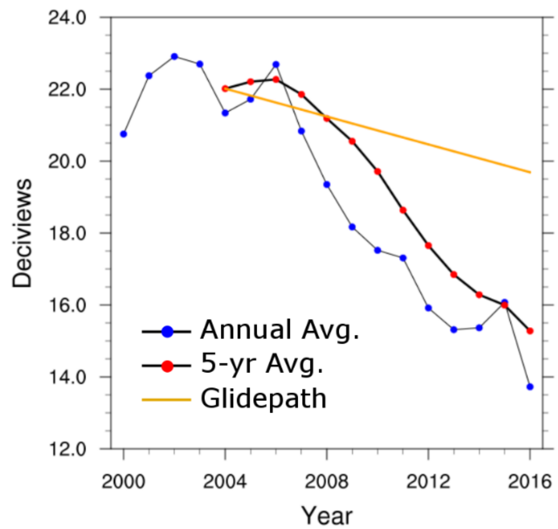
APPENDIX B

For each of the following sites, the left column gives the total extinction budget for days classified as the 20 percent most impaired in 2015 (or 2013 when noted), middle column gives the time series from 2000-2016 of the annual average total extinction budget for days classified as the 20 percent most impaired , and right column shows the visibility conditions on the 20 percent most impaired days from 2000 to 2016. For all extinction budget figures, the following color scale applies: sulfate (yellow), nitrate (red), OMC (teal), LAC (black), FS (tan), CM (brown), and sea salt (blue). For all visibility conditions figures, the blue points are annual average values; red points are 5-year averages and the orange line is the glidepath between 2000-2004 and 2064.[22]

Acadia National Park, ME

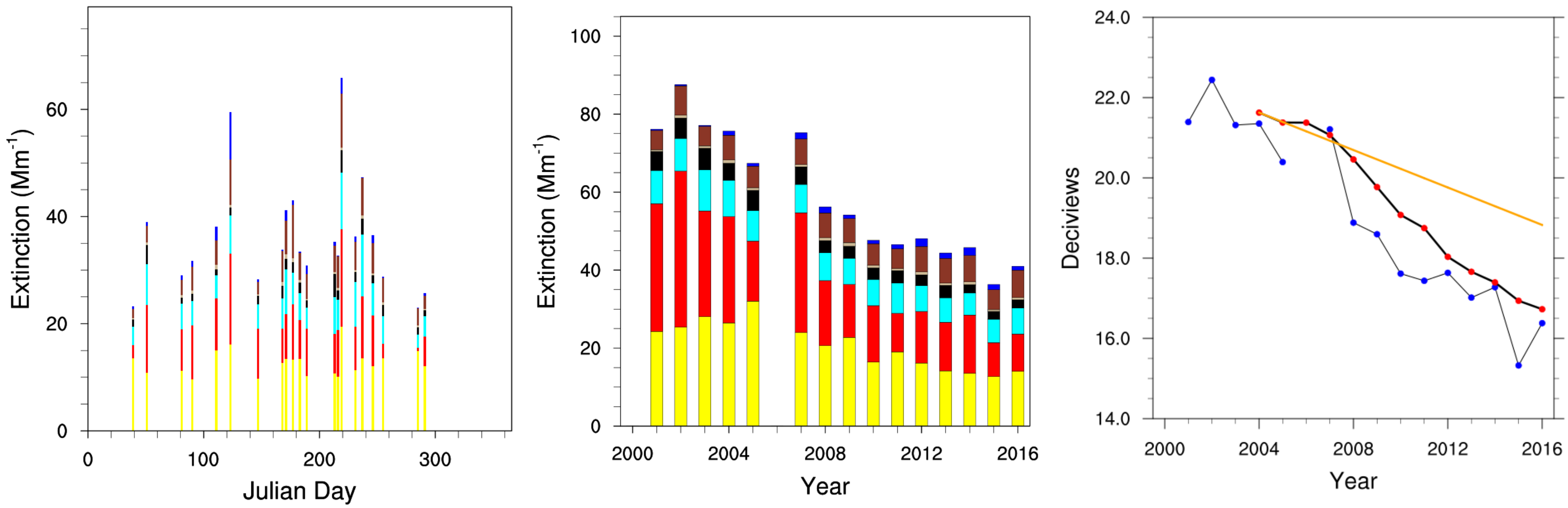




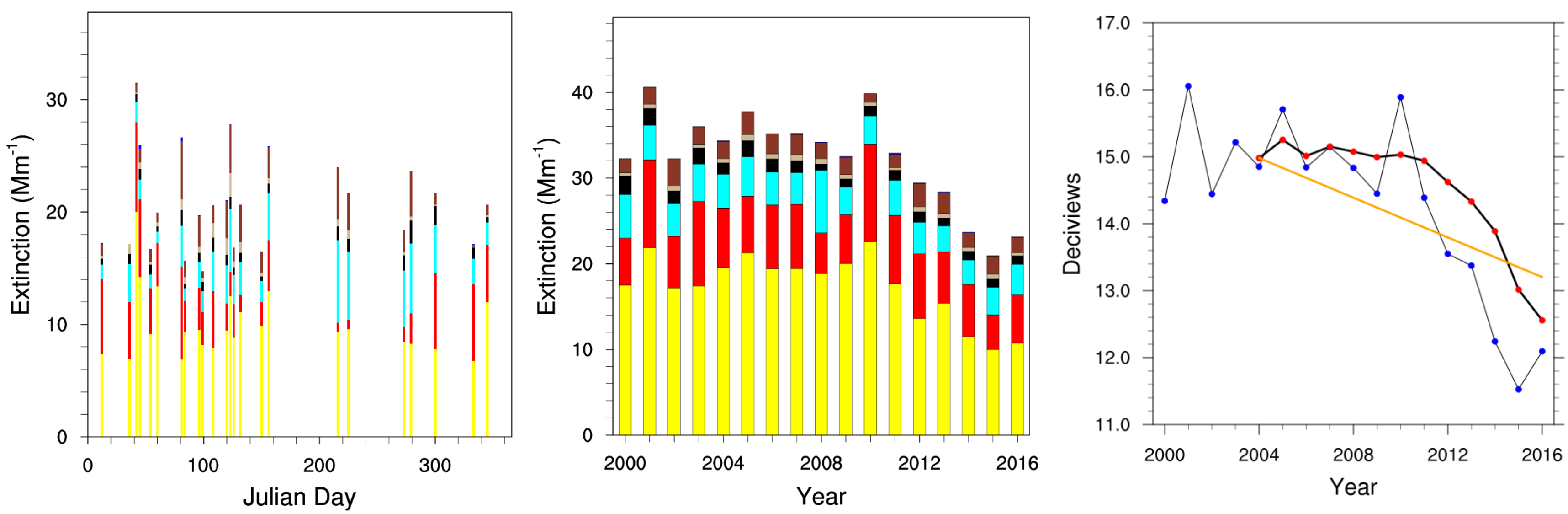


[22]Updated site-specific graphics summarizing visibility status and trends following the Regional Haze Rule metrics can be found at http://views.cira.colostate.edu/fed/SiteBrowser/Default.aspx?appkey=SBCF_VisSum.

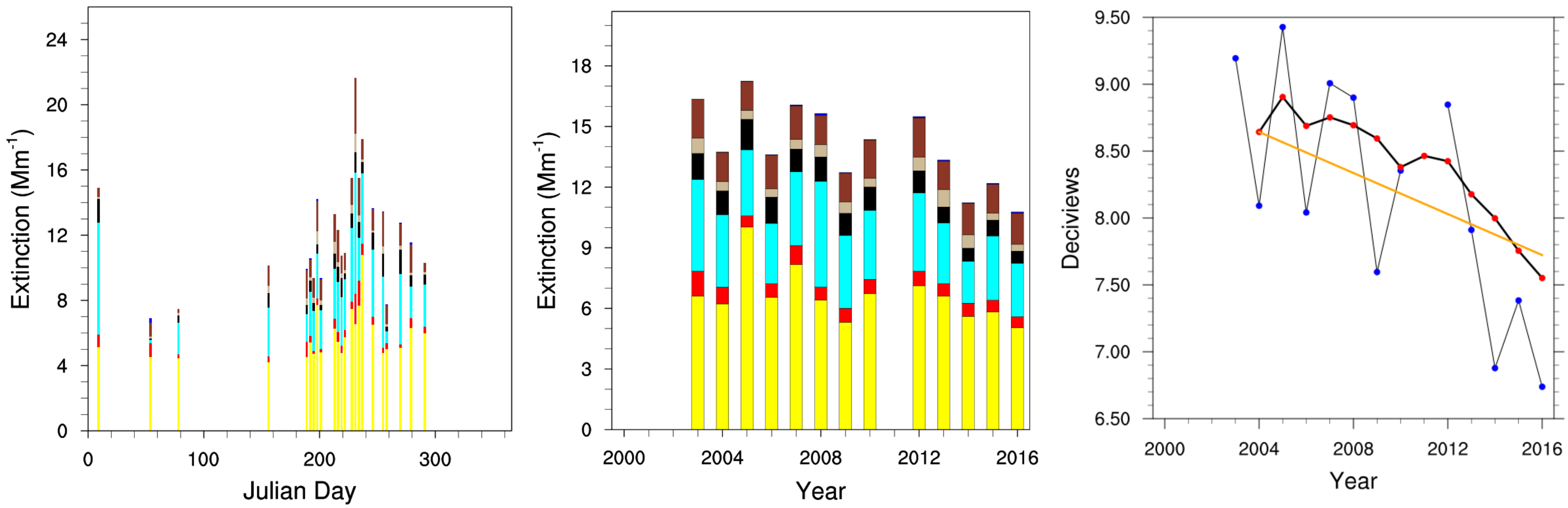
Agua Tibia, CA



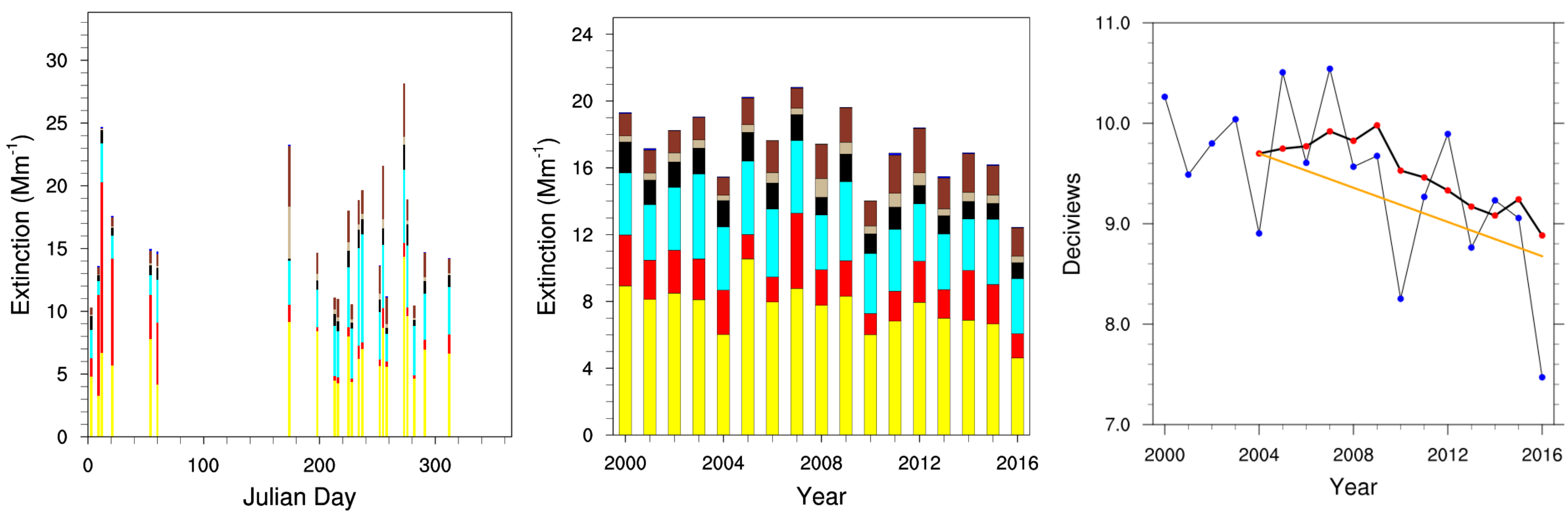
Badlands National Park, SD



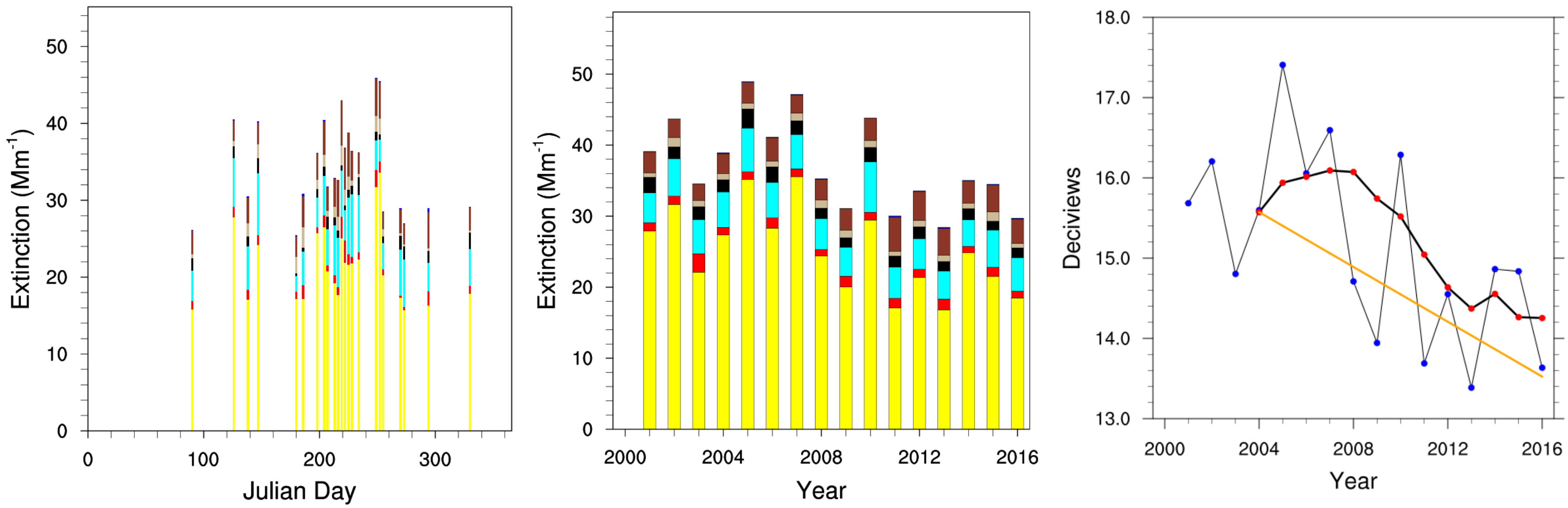
Mount Baldy, AZ



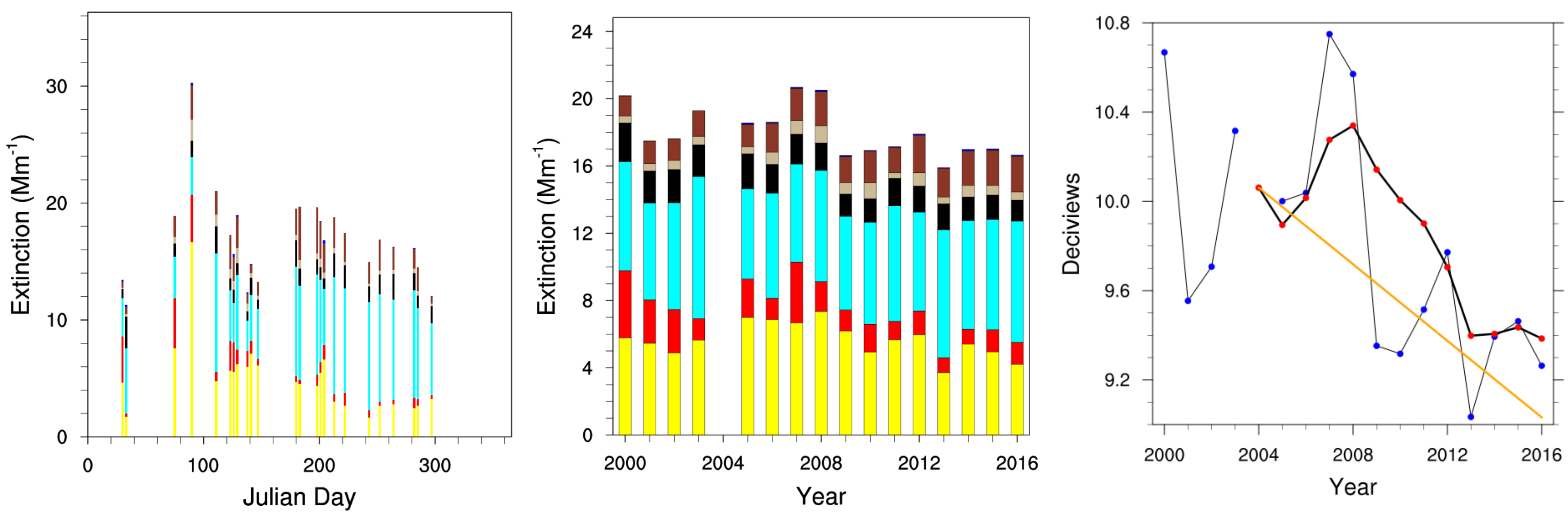
Bandelier National Monument, NM



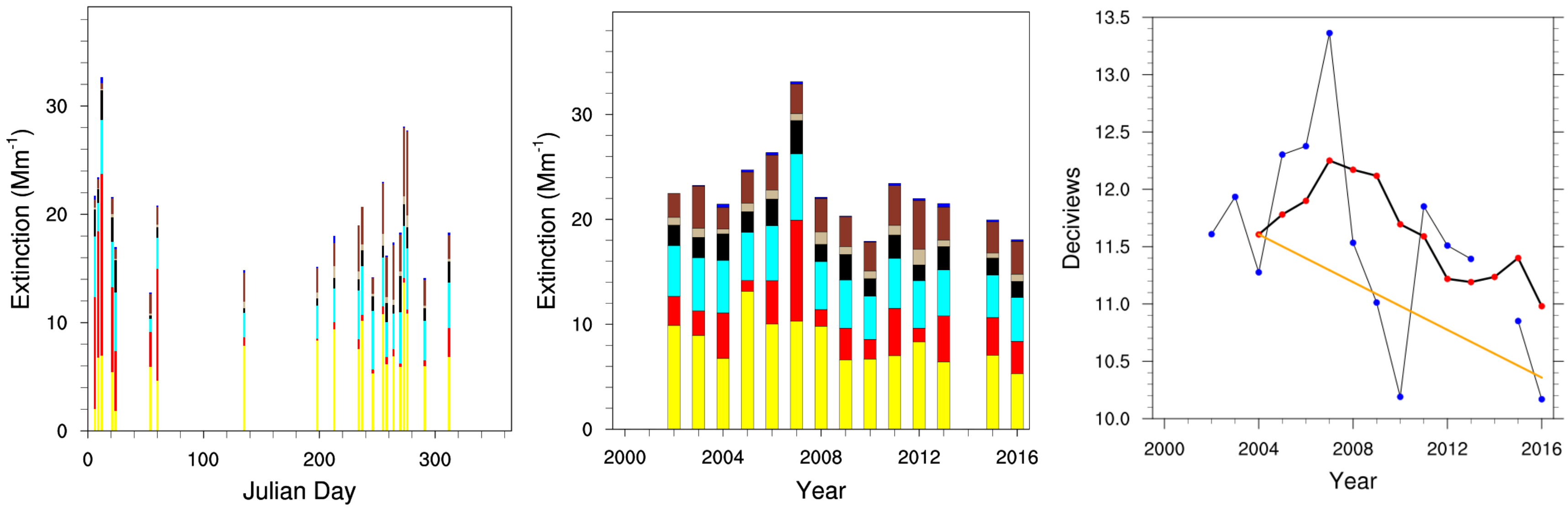
Big Bend National Park, TX



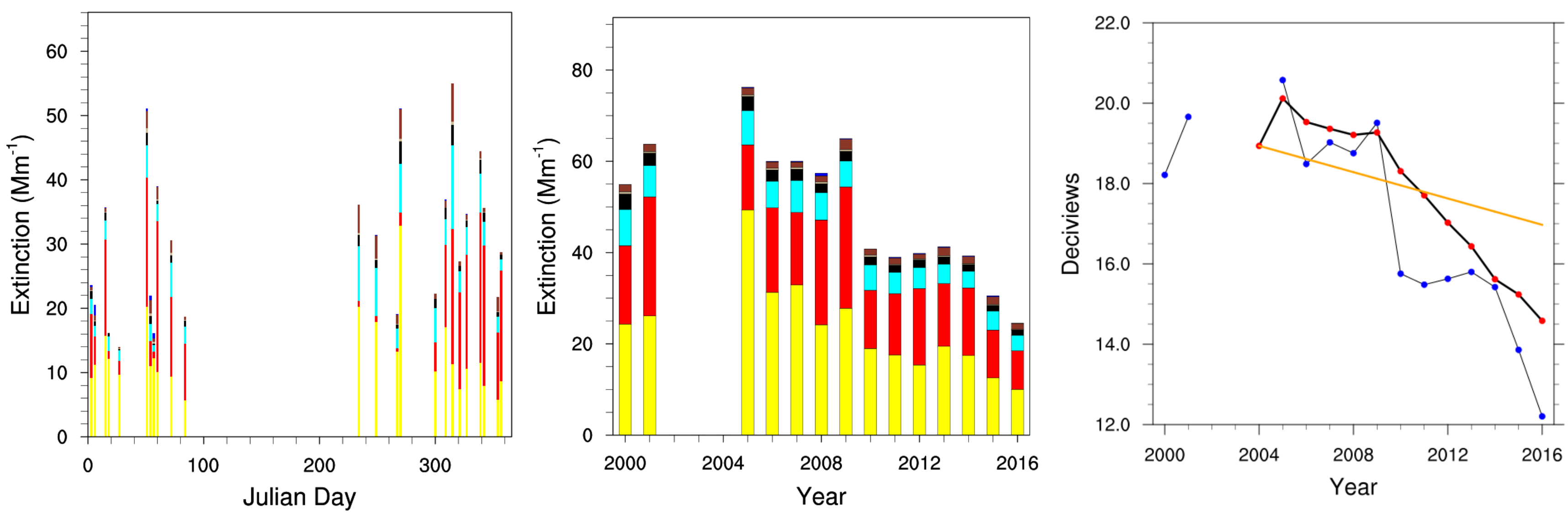
Bliss State Park, CA



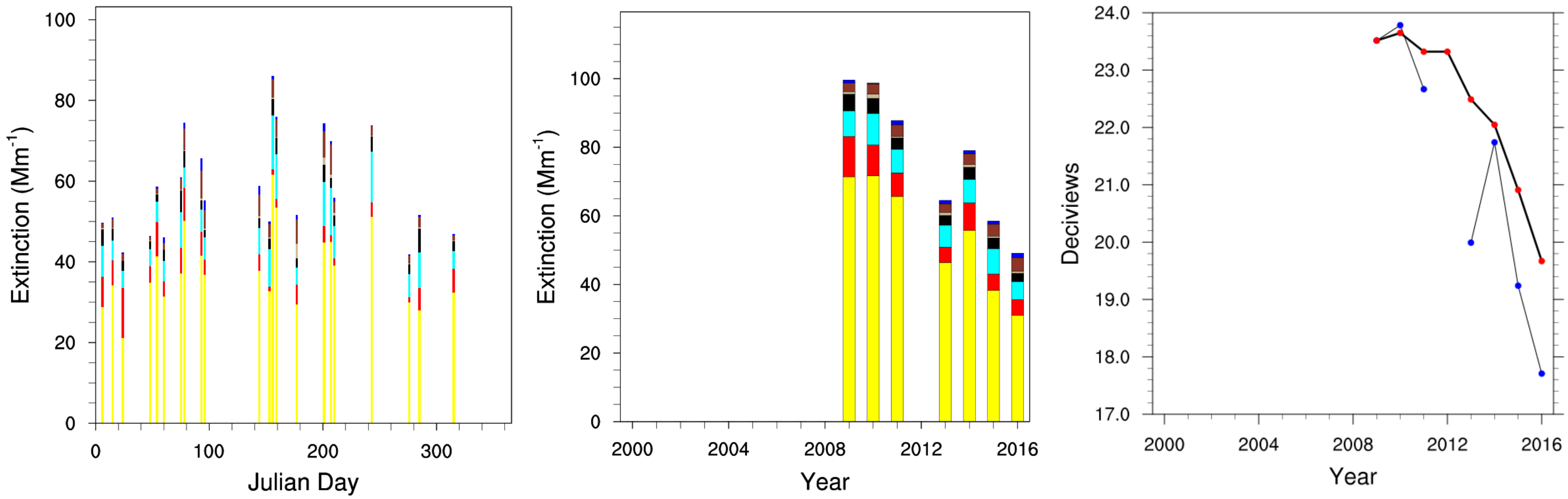
Bosque del Apache, NM



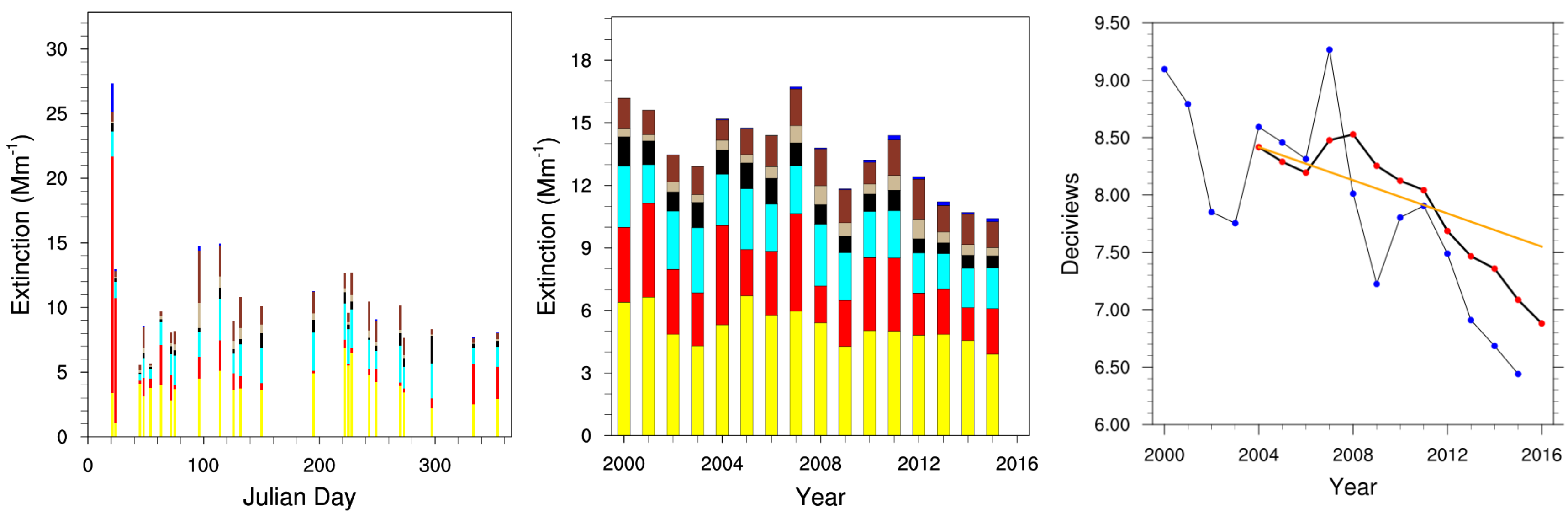
Boundary Waters Canoe Area, MN



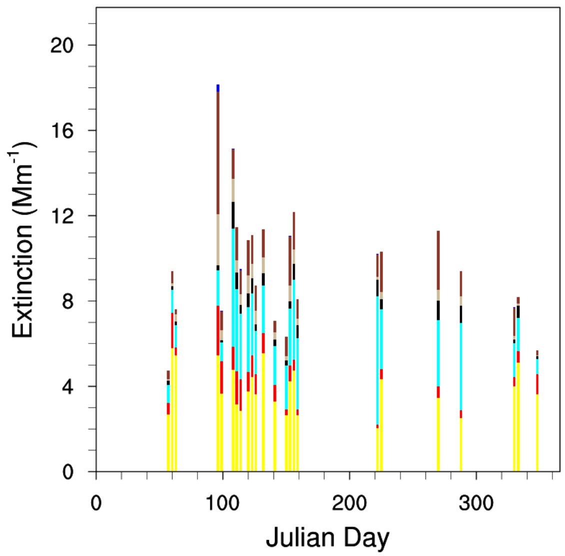
Breton Island, LA

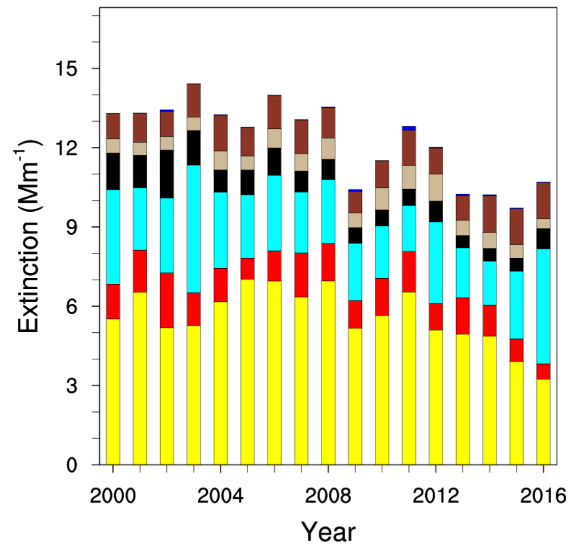


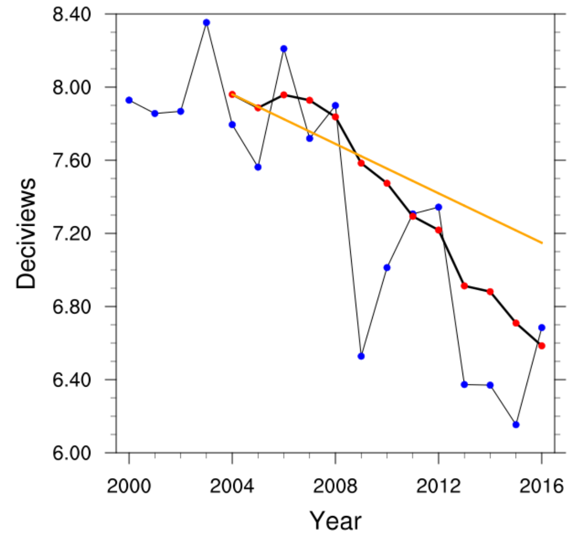
Bryce Canyon National Park, UT



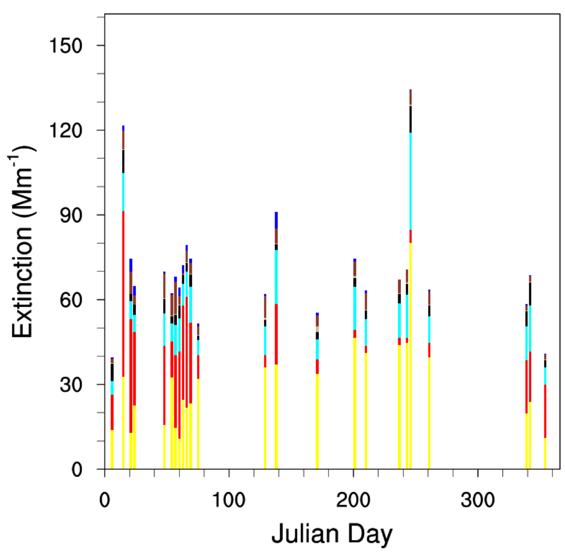
Bridger Wilderness, WY

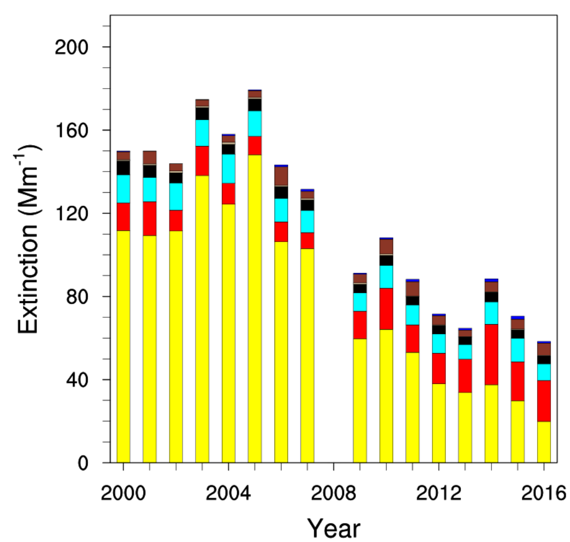


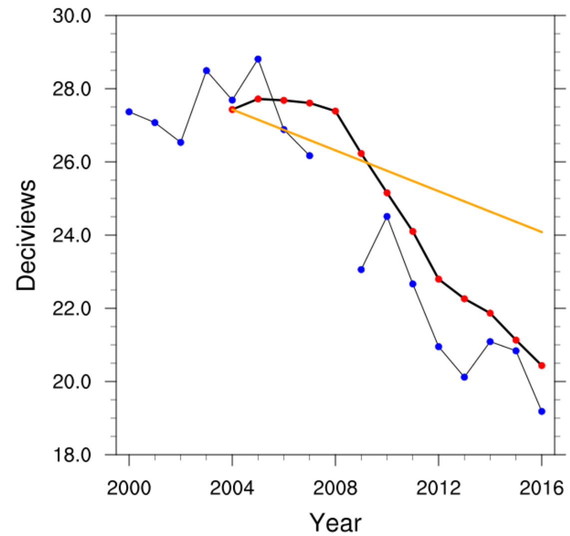




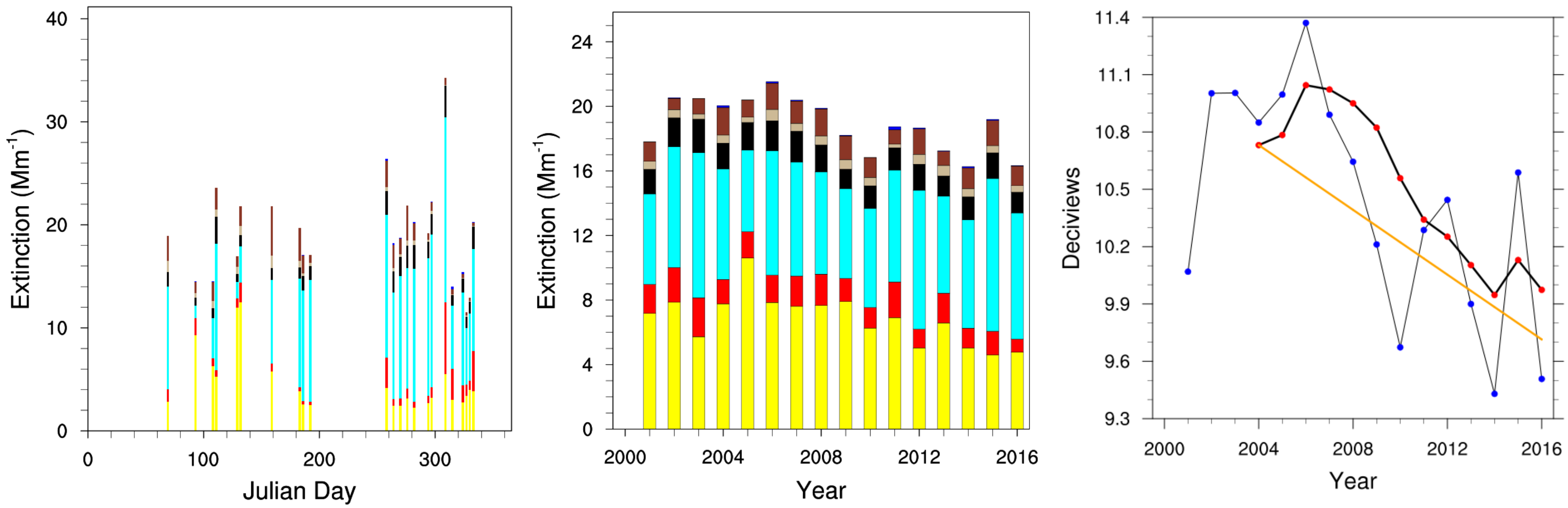
Brigantine National Wildlife Refuge, NJ



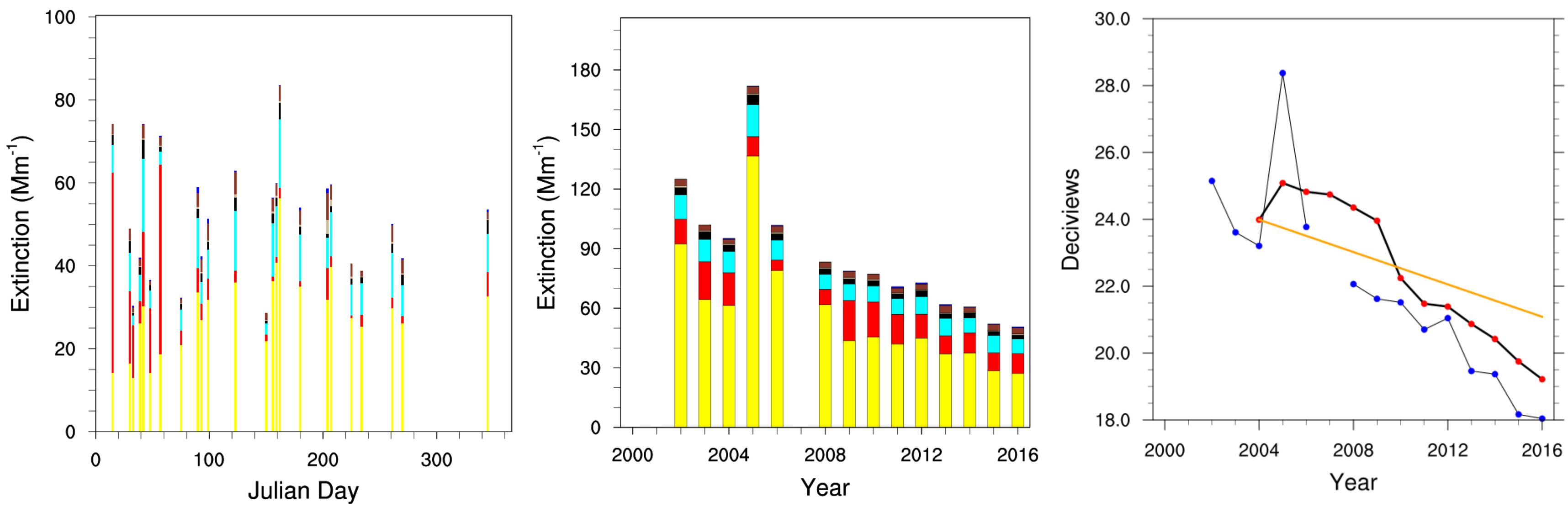




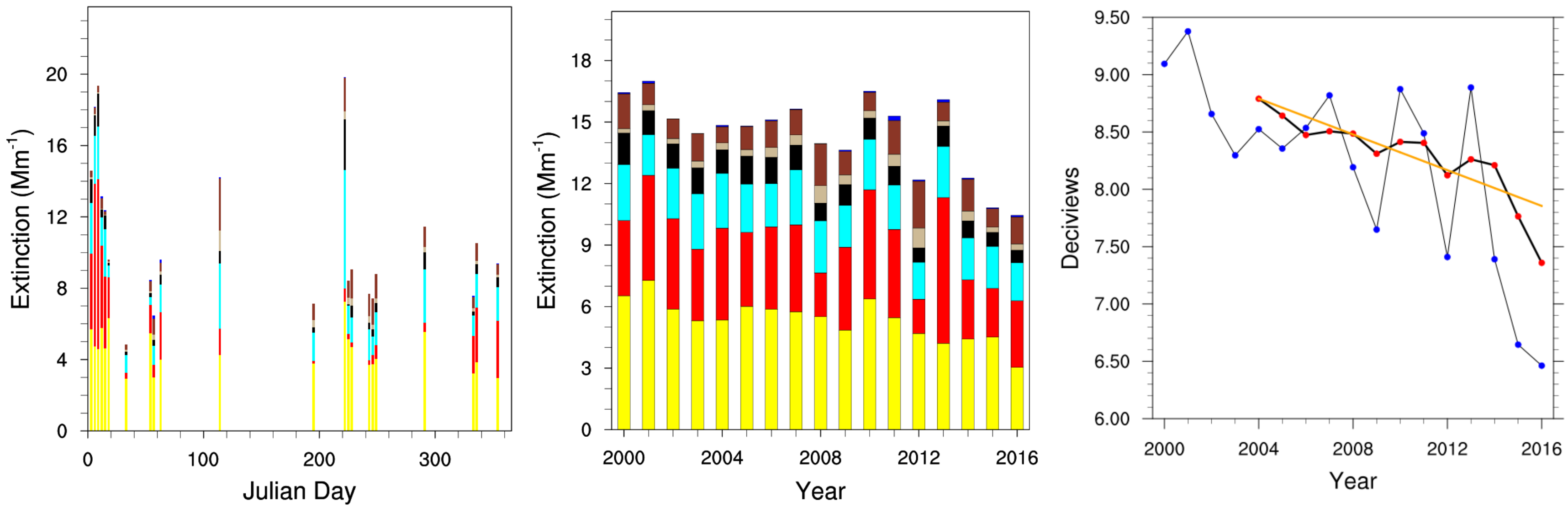
Cabinet Mountains, MT



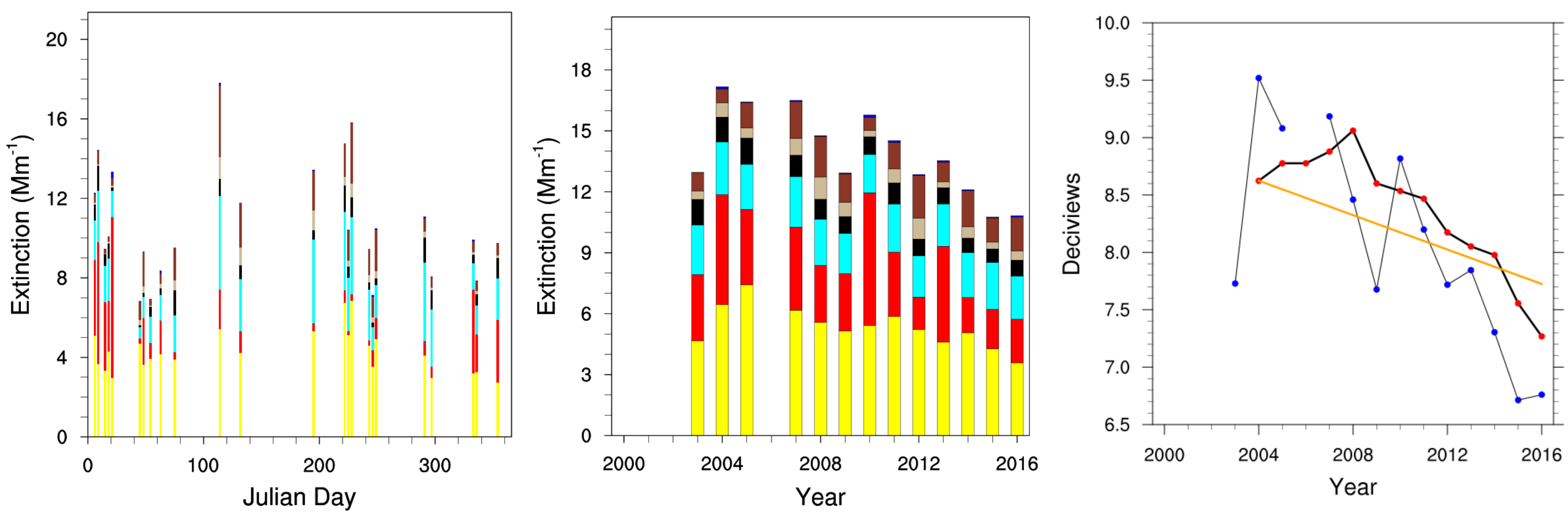
Caney Creek, AR



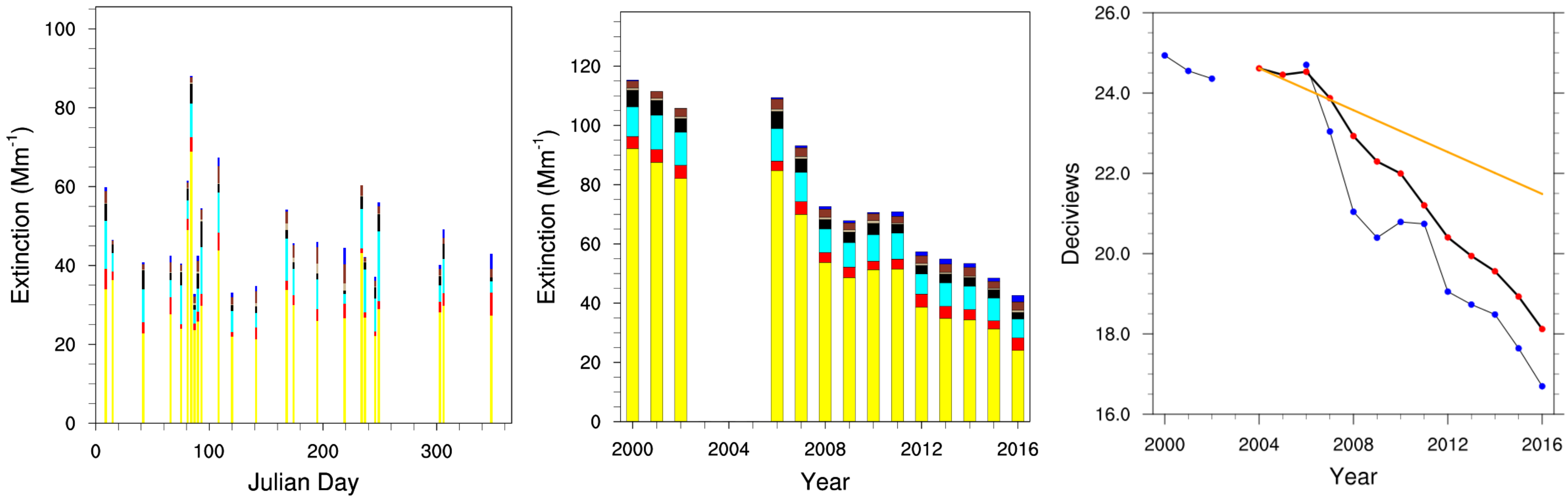
Canyonlands National Park, UT



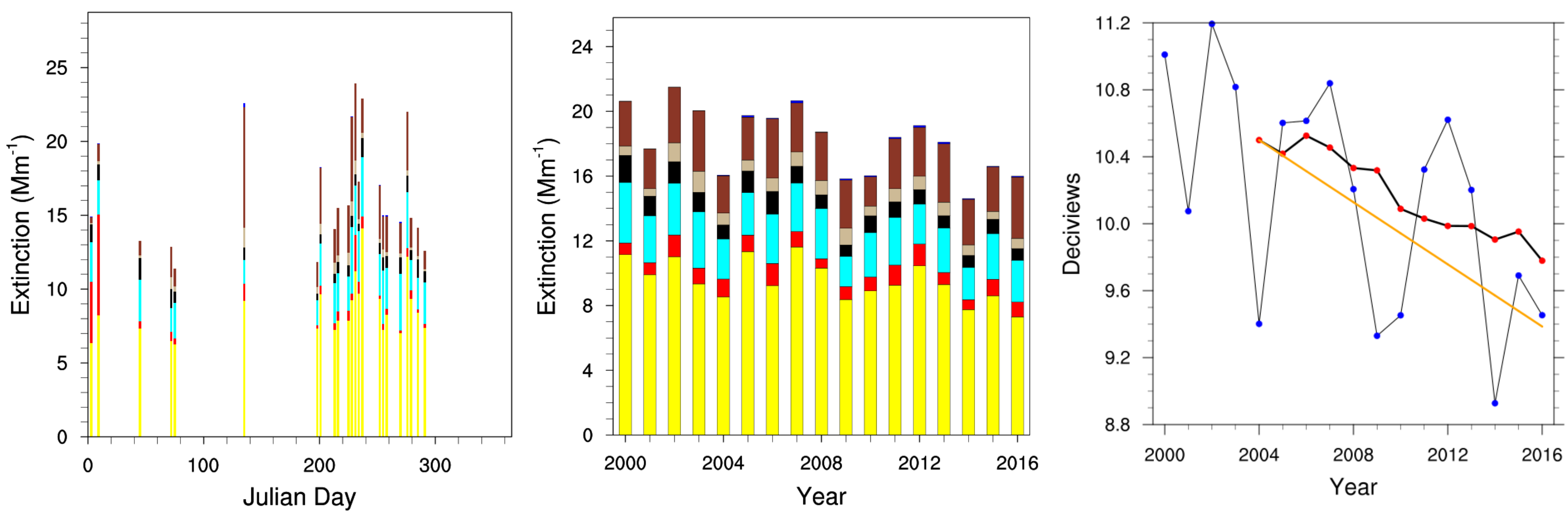
Capitol Reef National Park, UT



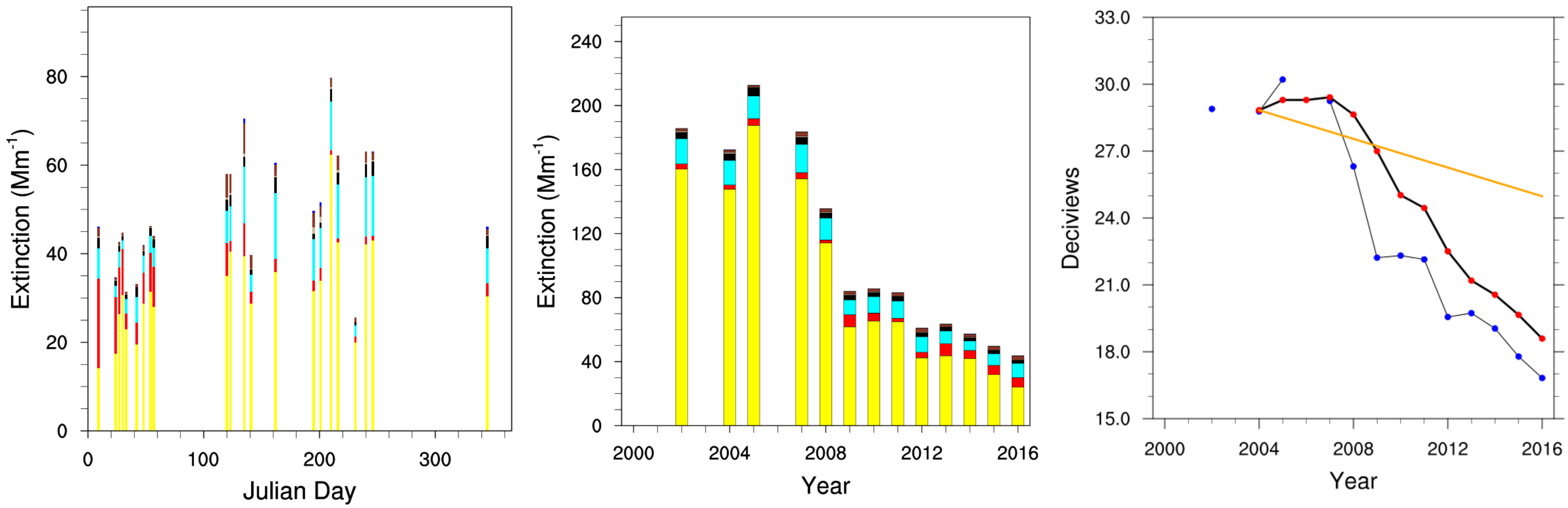
Chassahowitzka National Wildlife Refuge, FL



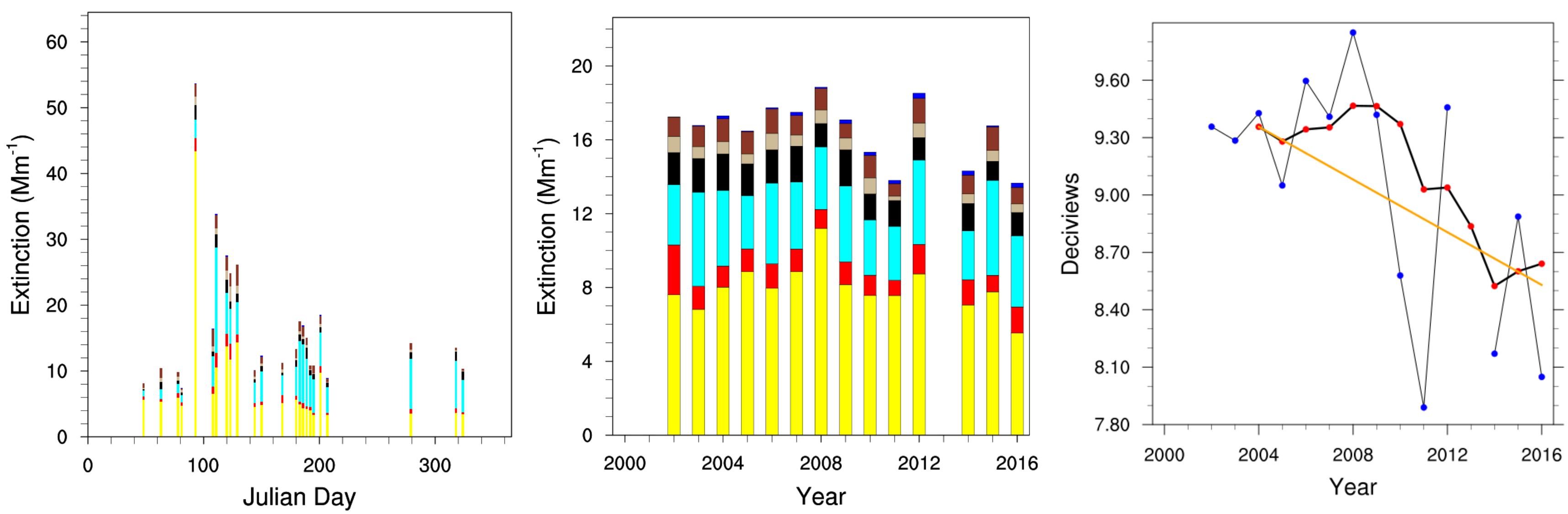
Chiricahua National Monument, AZ



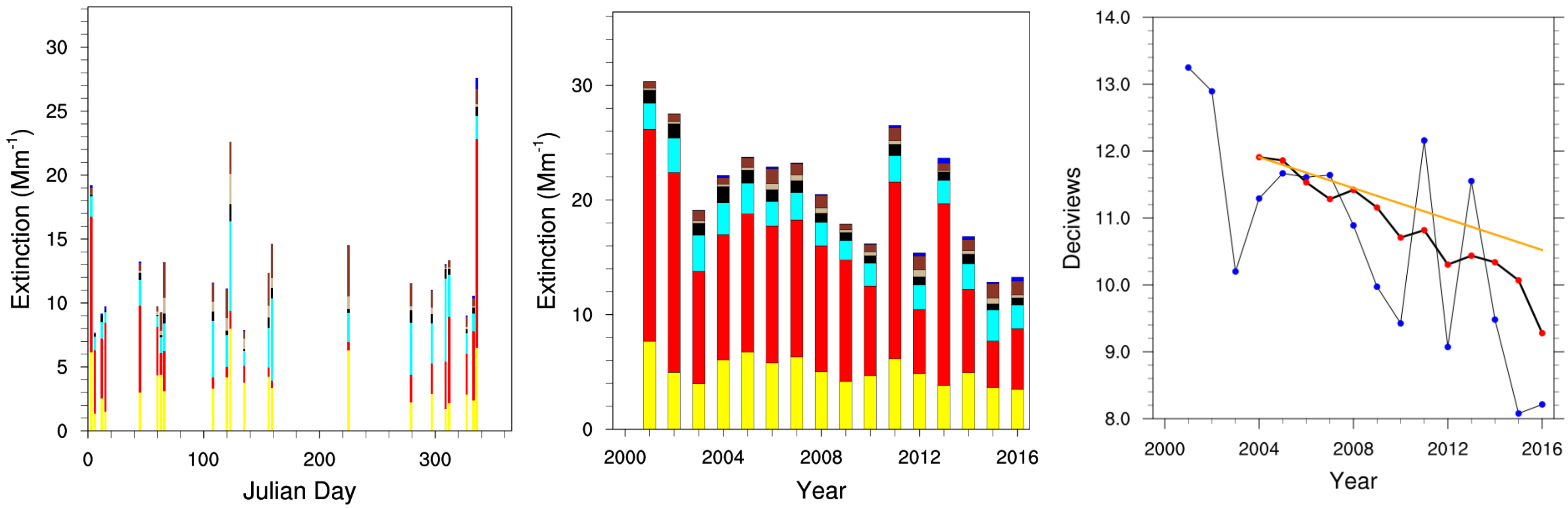
Cohutta, GA



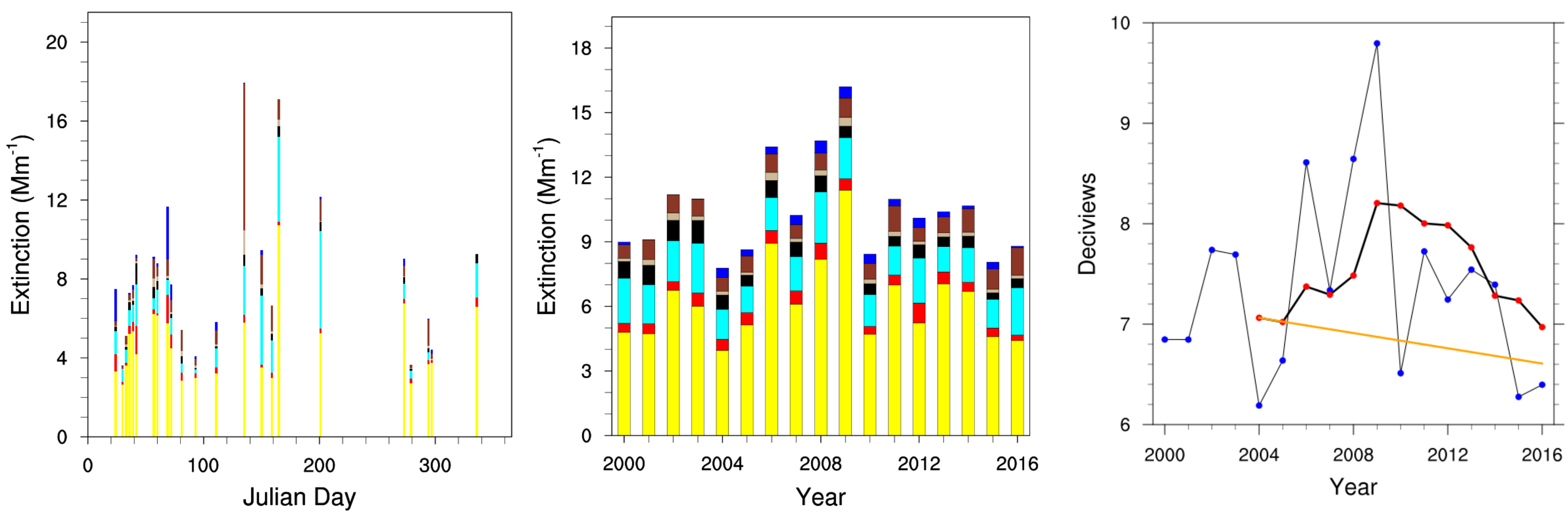
Crater Lake National Park, OR



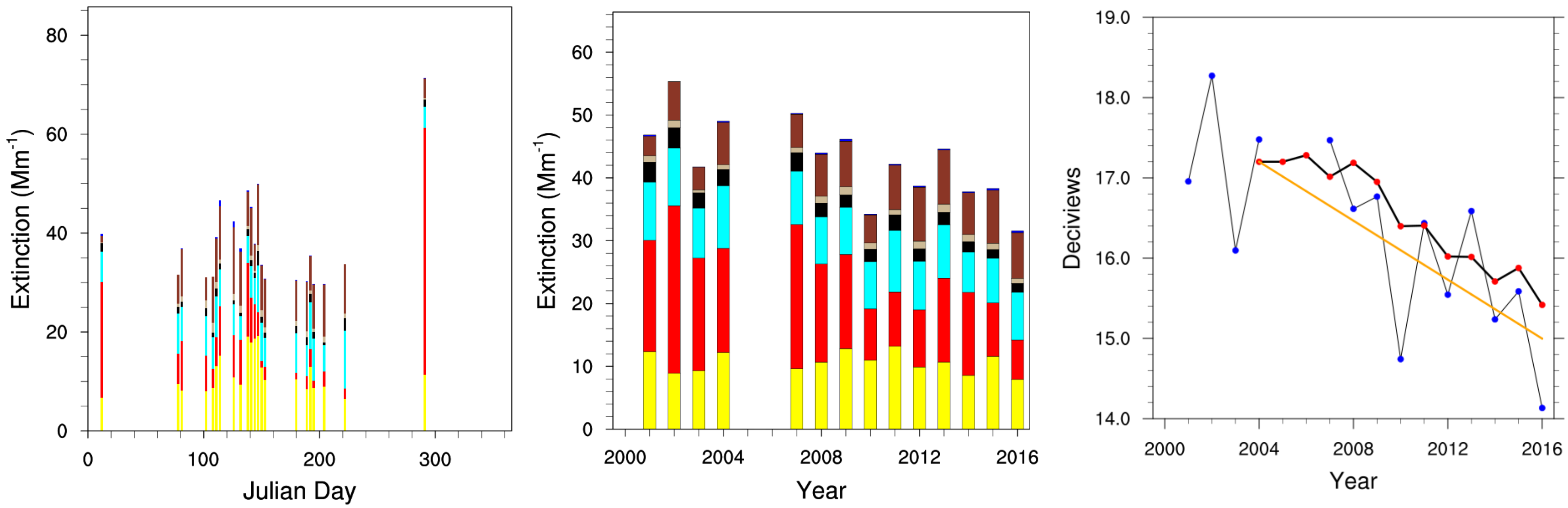
Craters of the Moon National Monument, ID



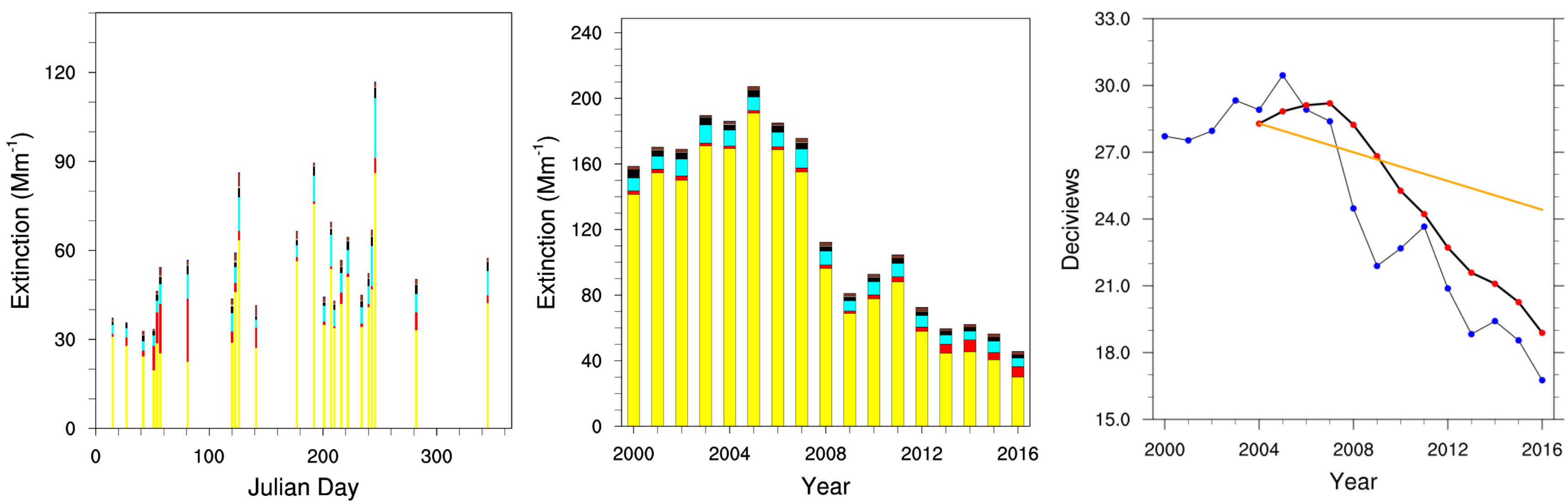
Denali National Park, AK



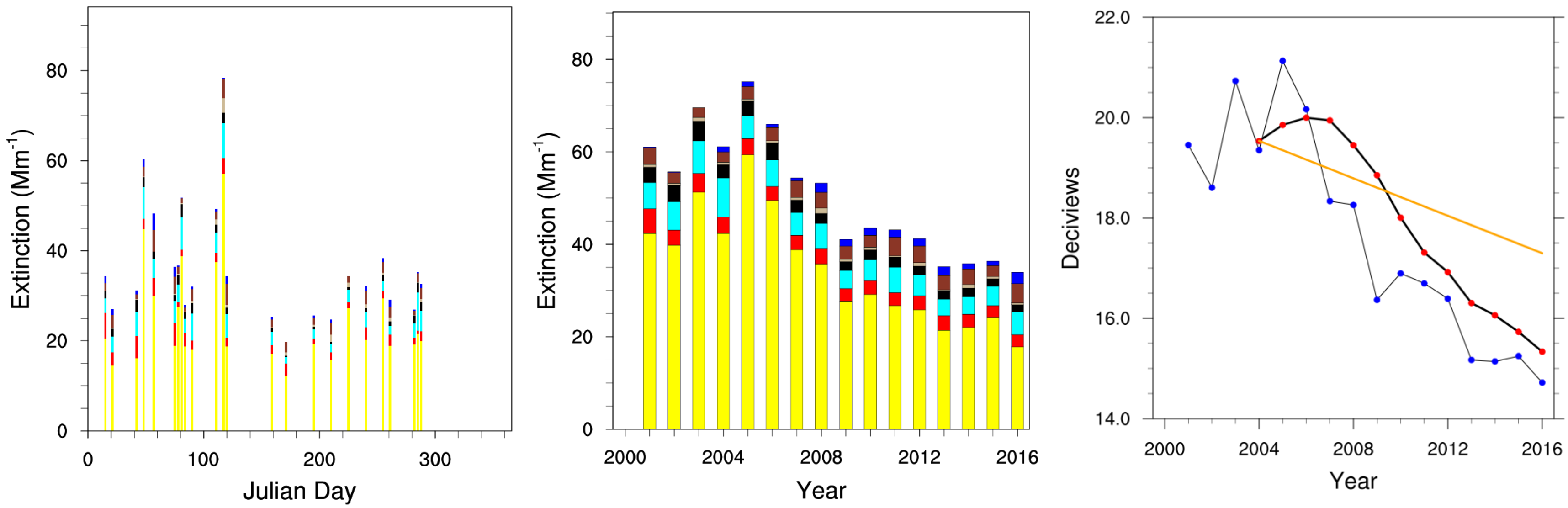
Dome Lands Wilderness, CA



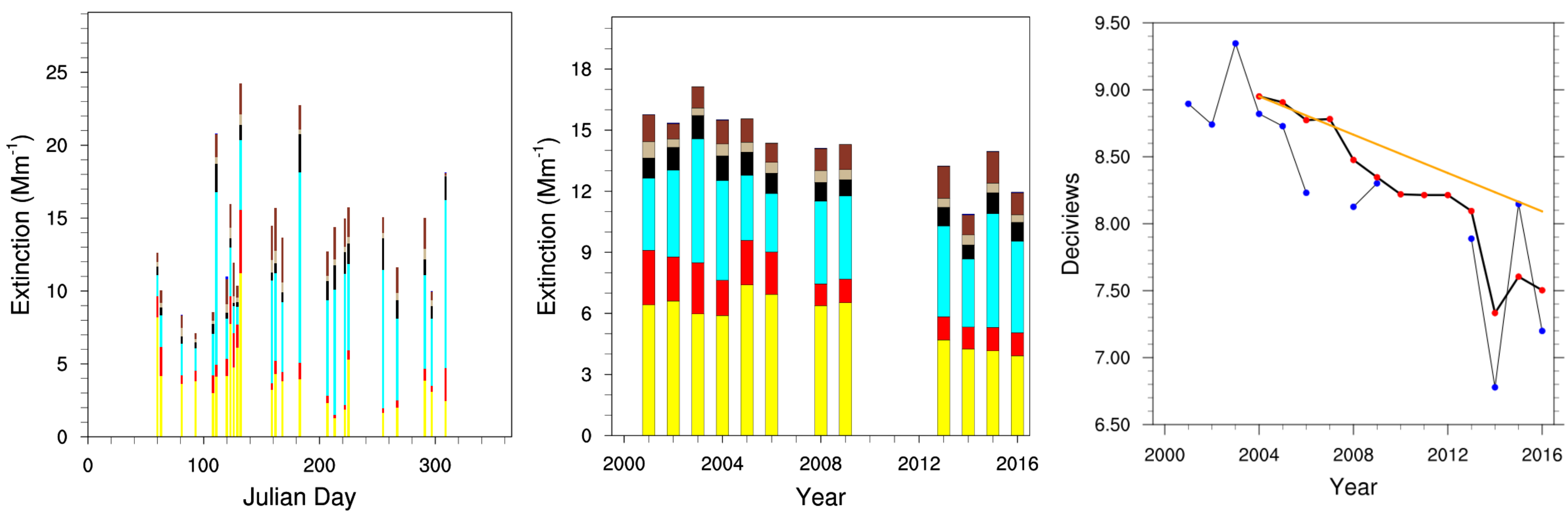
Dolly Sods Wilderness, WV



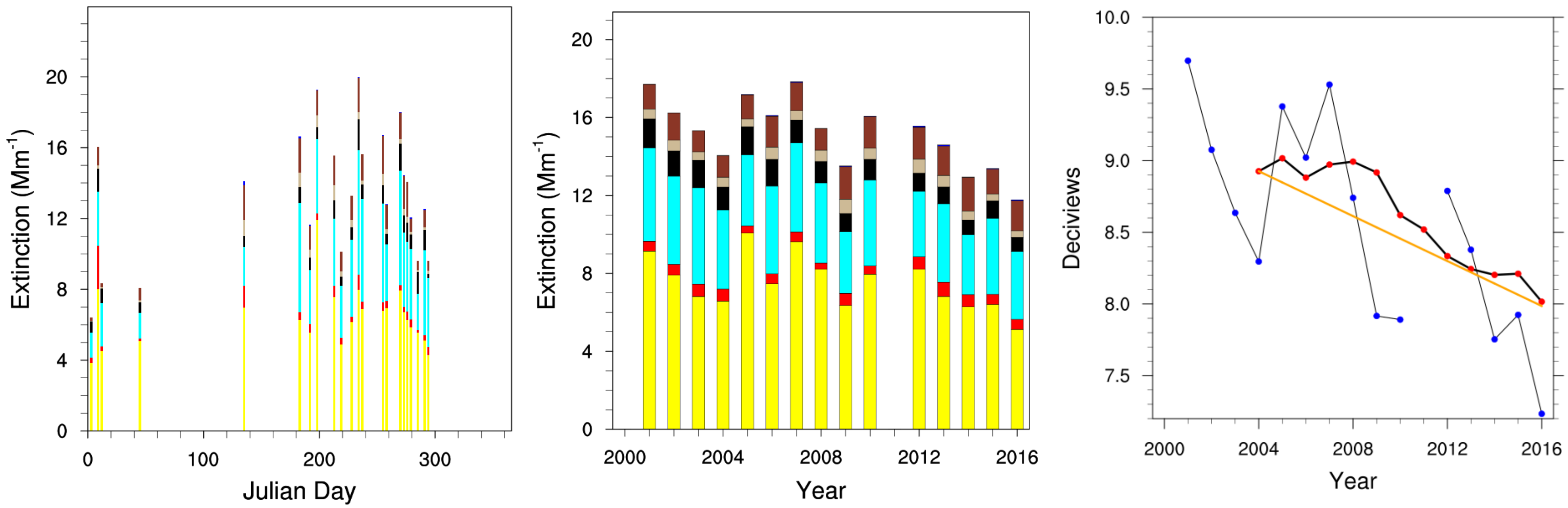
Everglades National Park, FL



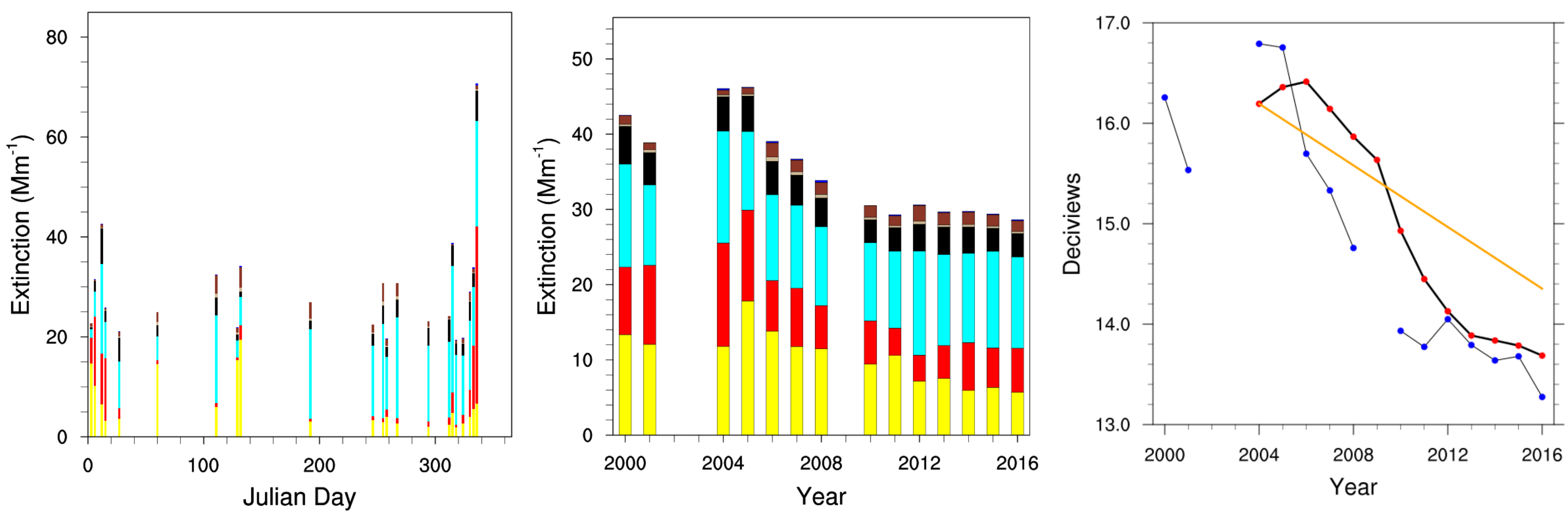
Gates of the Mountains, MT



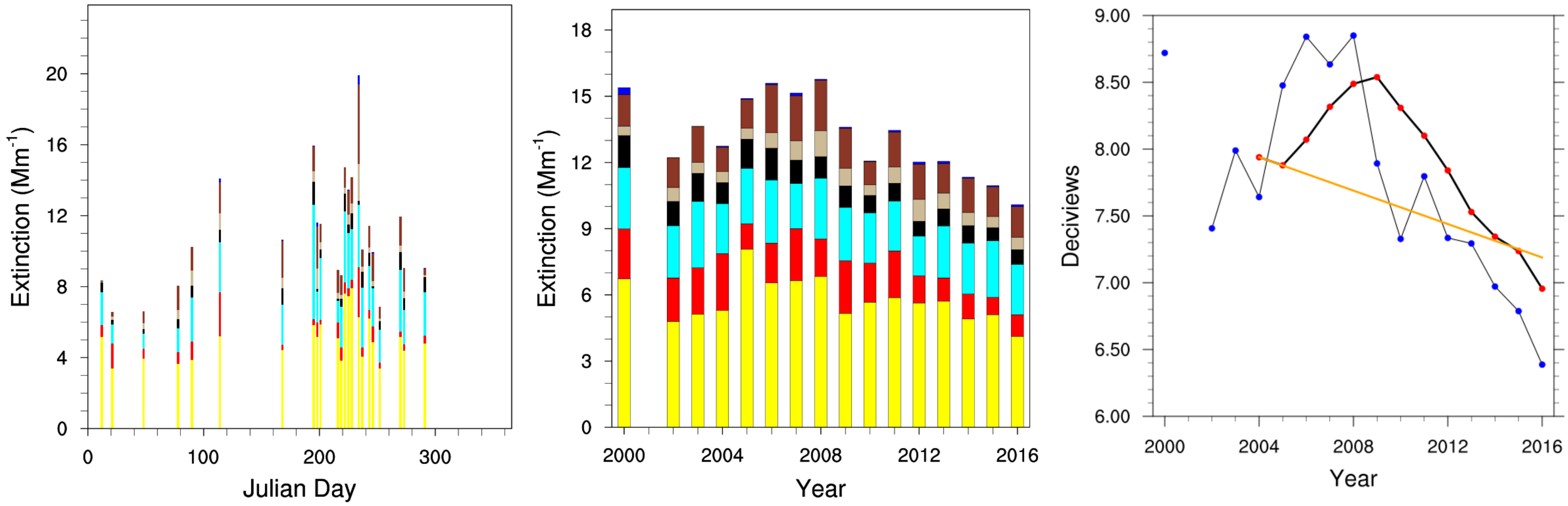
Gila Wilderness, NM



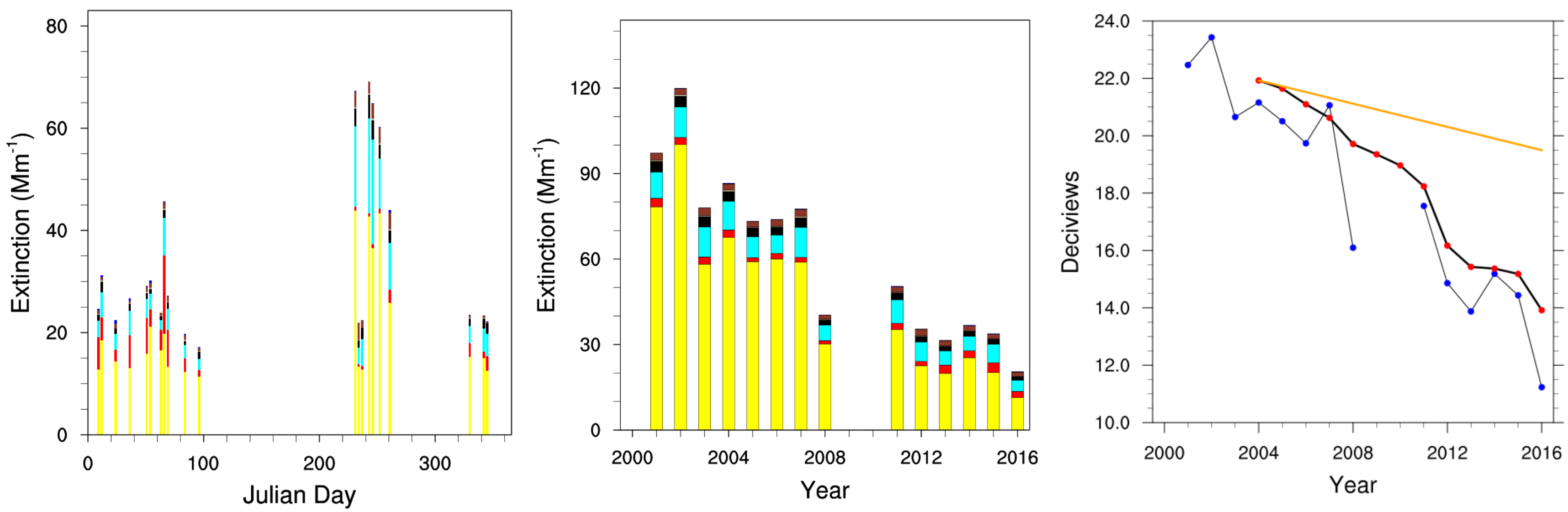
Glacier National Park, MT



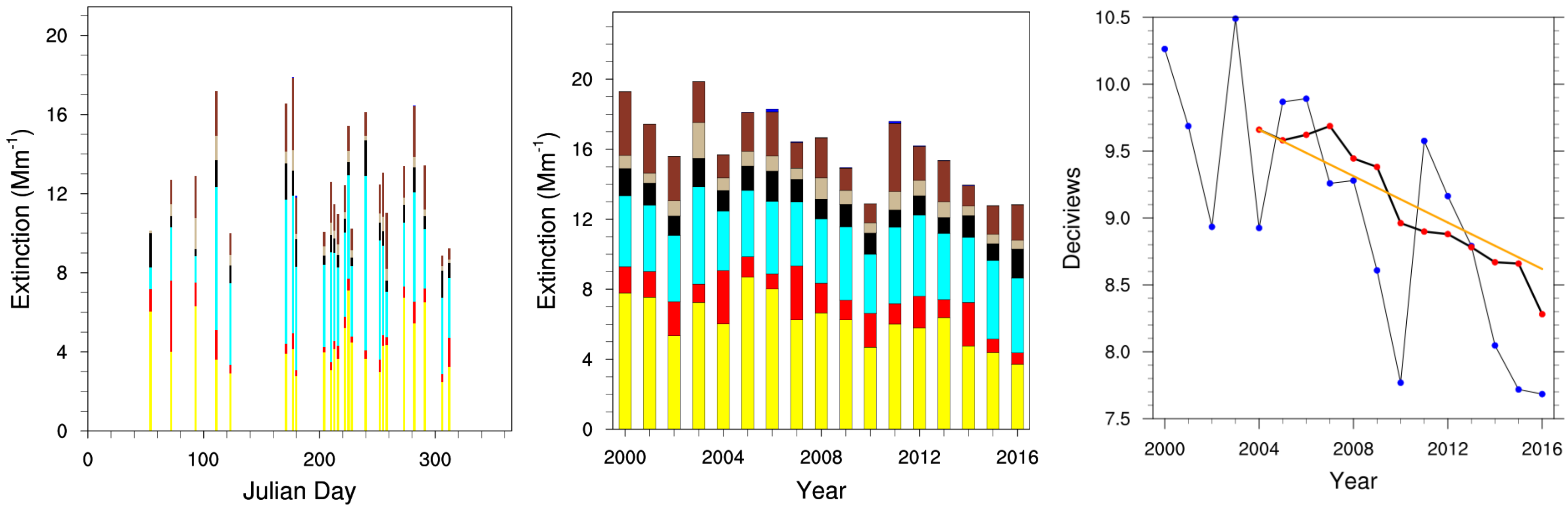
Grand Canyon National Park, AZ



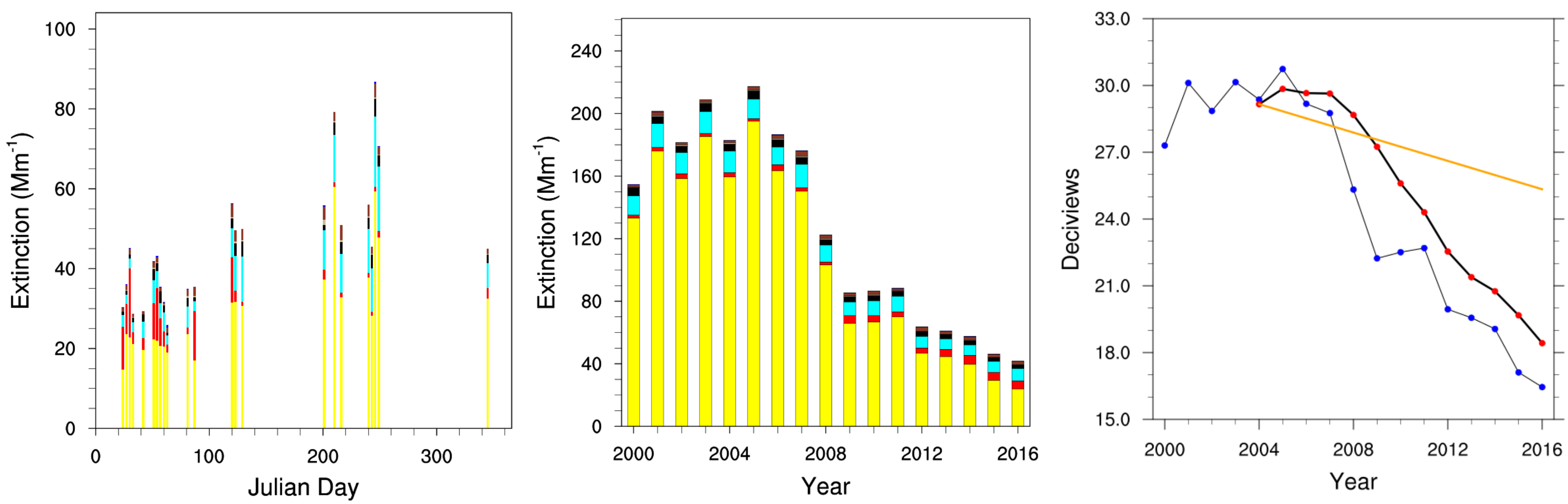
Great Gulf Wilderness, NH



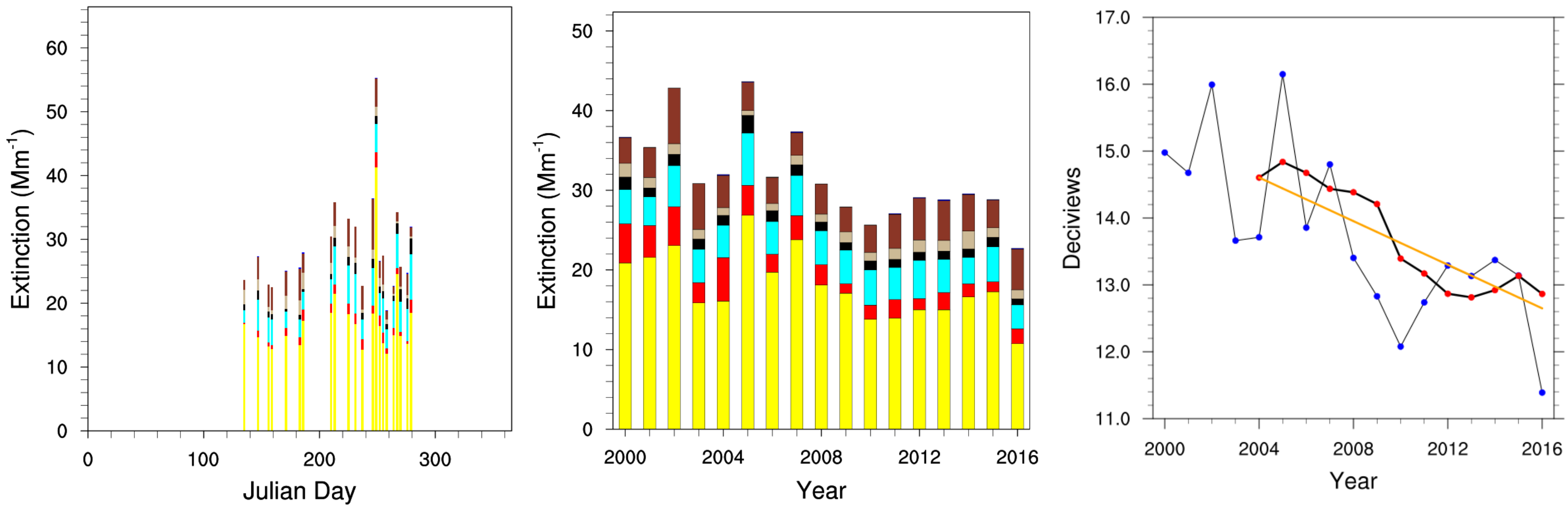
Great Sand Dunes National Monument, CO



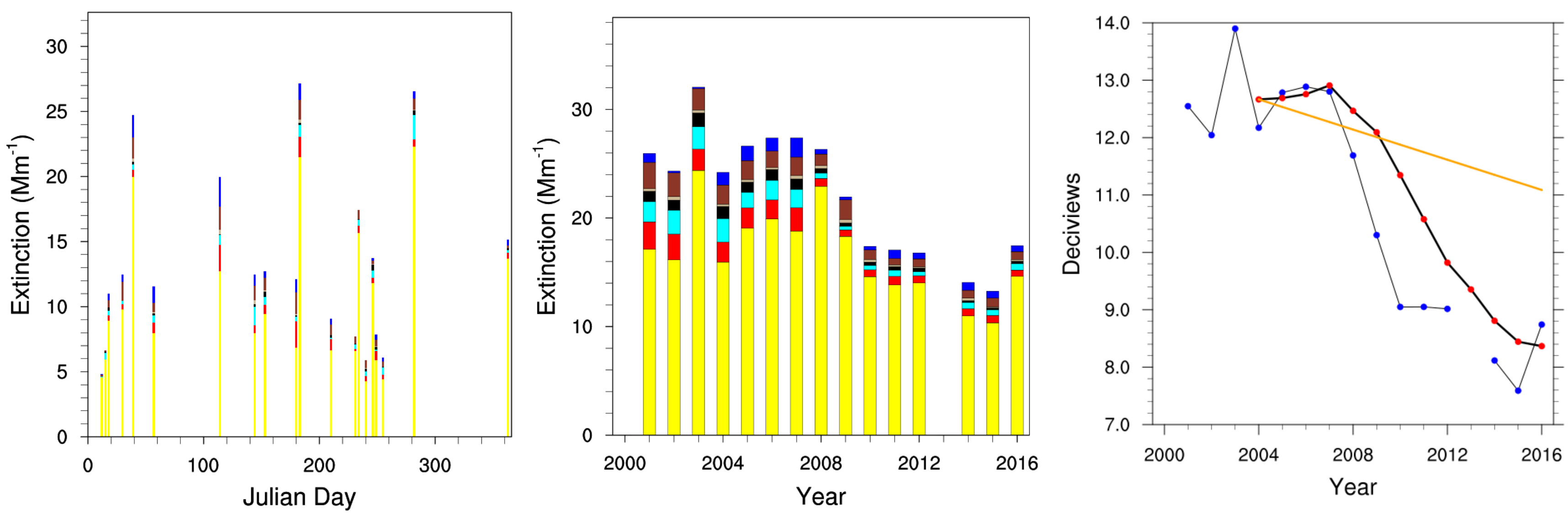
Great Smoky Mountains National Park, TN



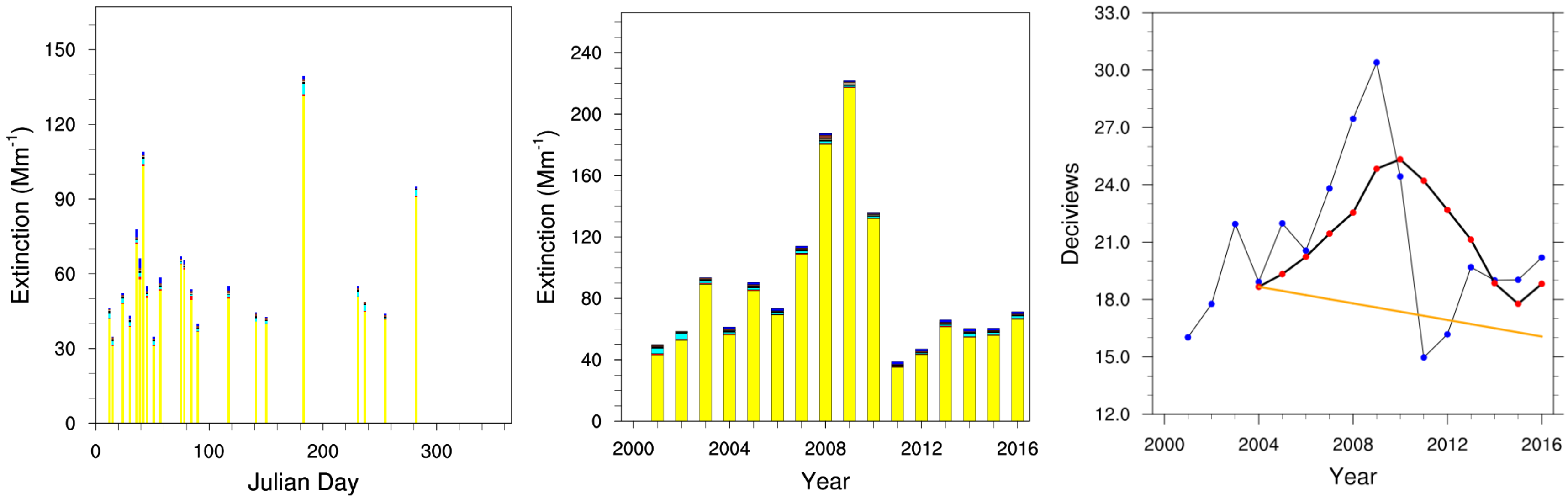
Guadalupe Mountains National Park, TX



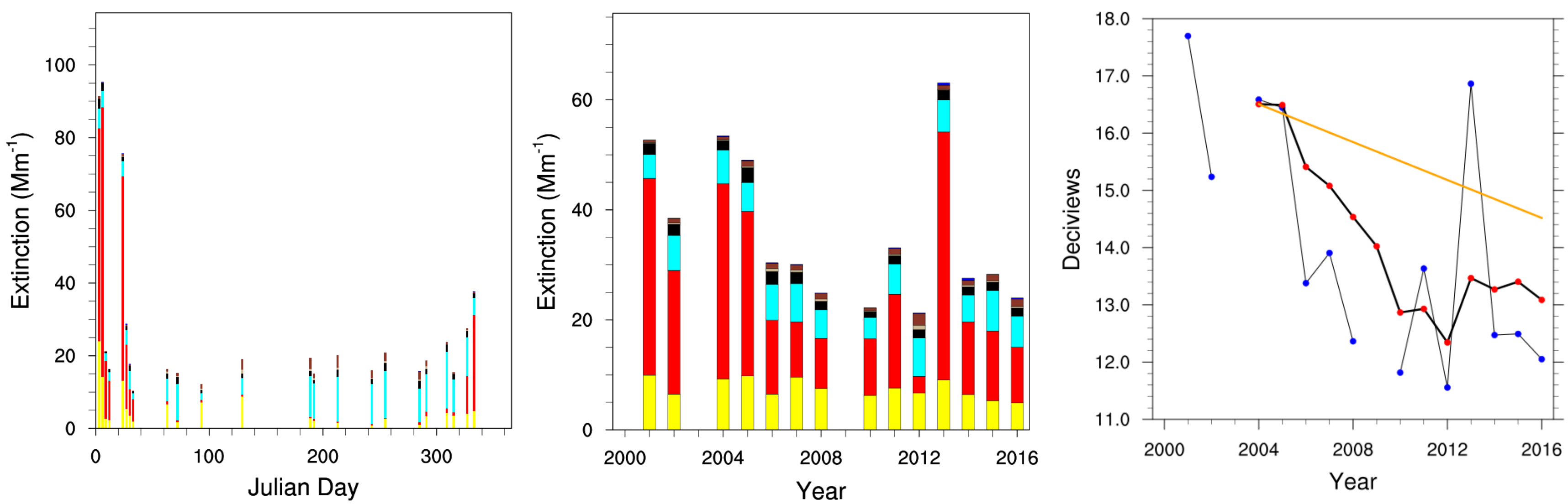
Haleakala National Park, HI (combined HALE1 and HACR1 starting 01/01/2007)



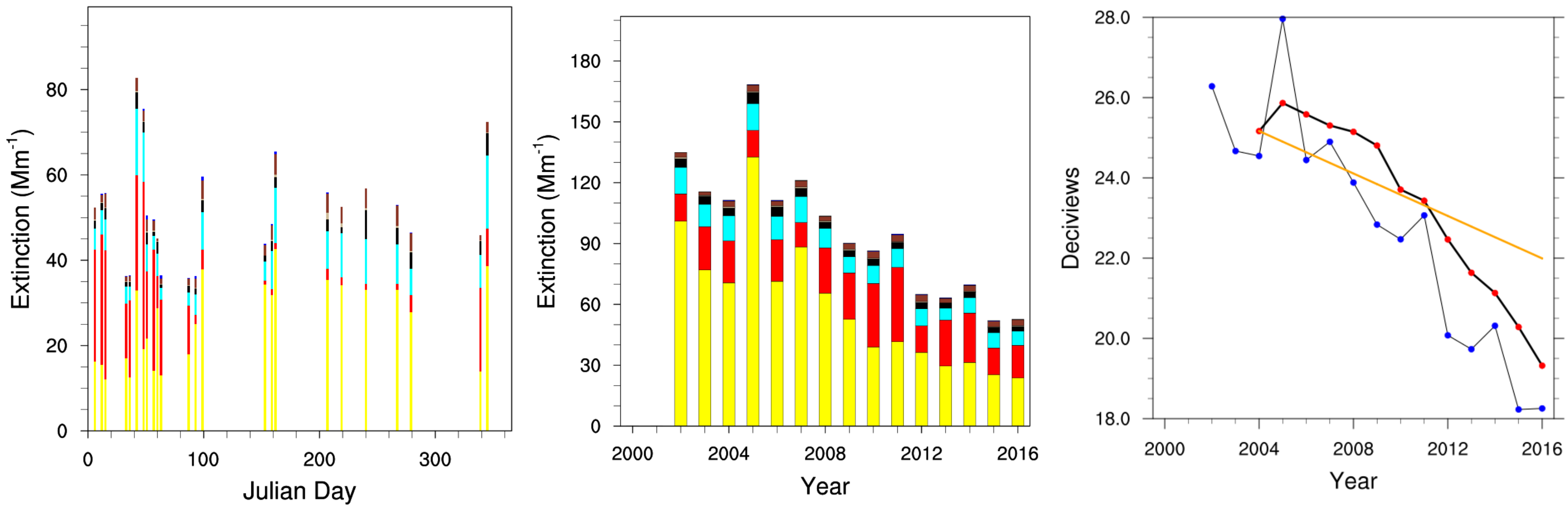
Hawaii Volcanoes National Park, HI



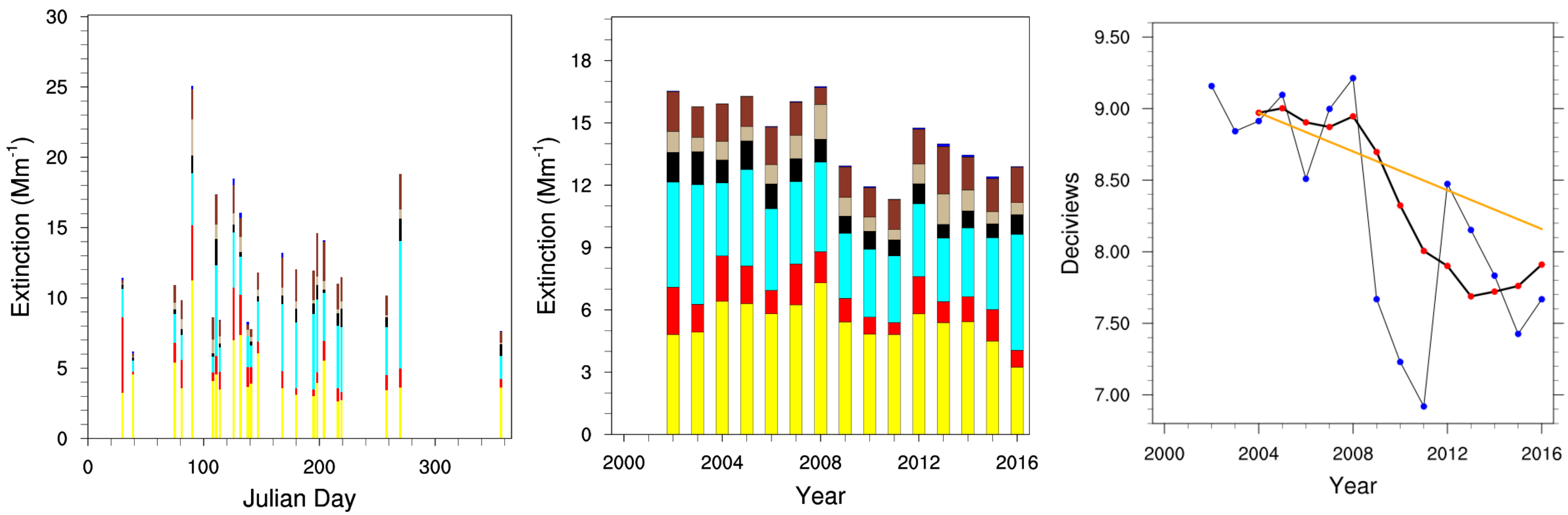
Hells Canyon, OR



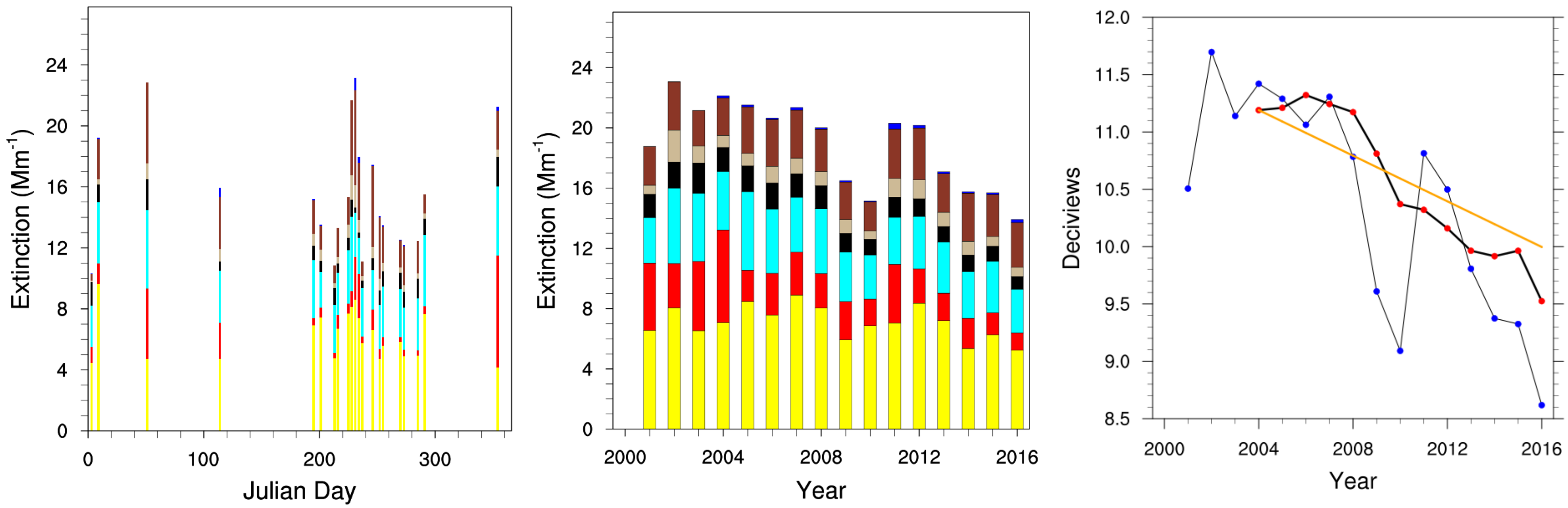
Hercules-Glades, MO



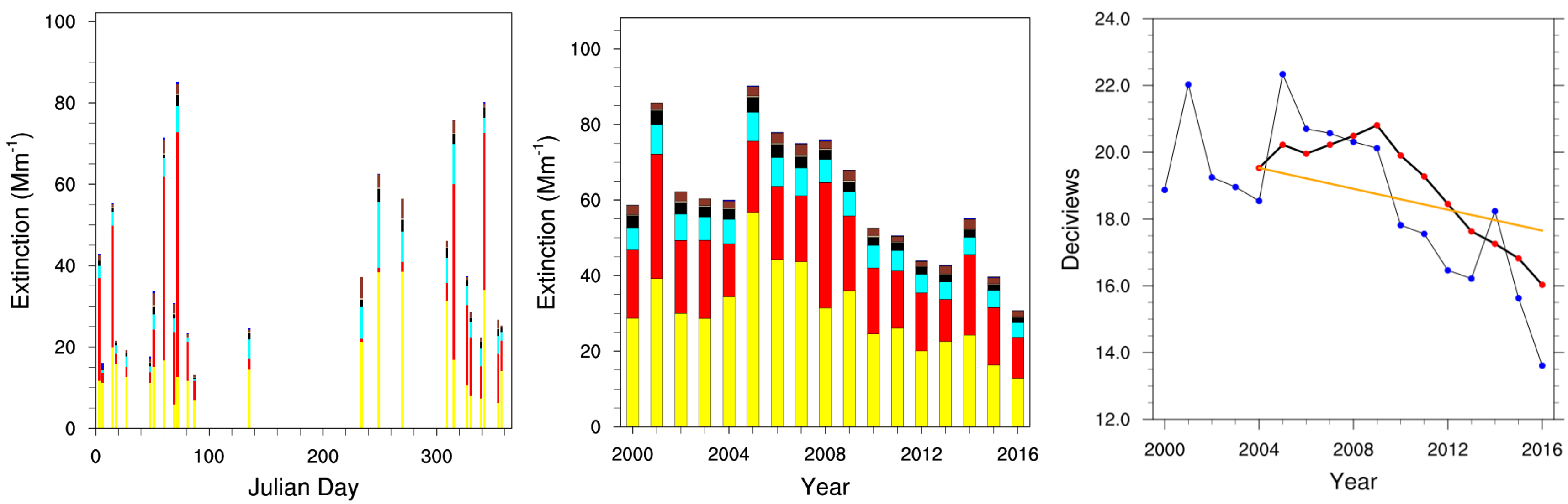
Hoover, CA



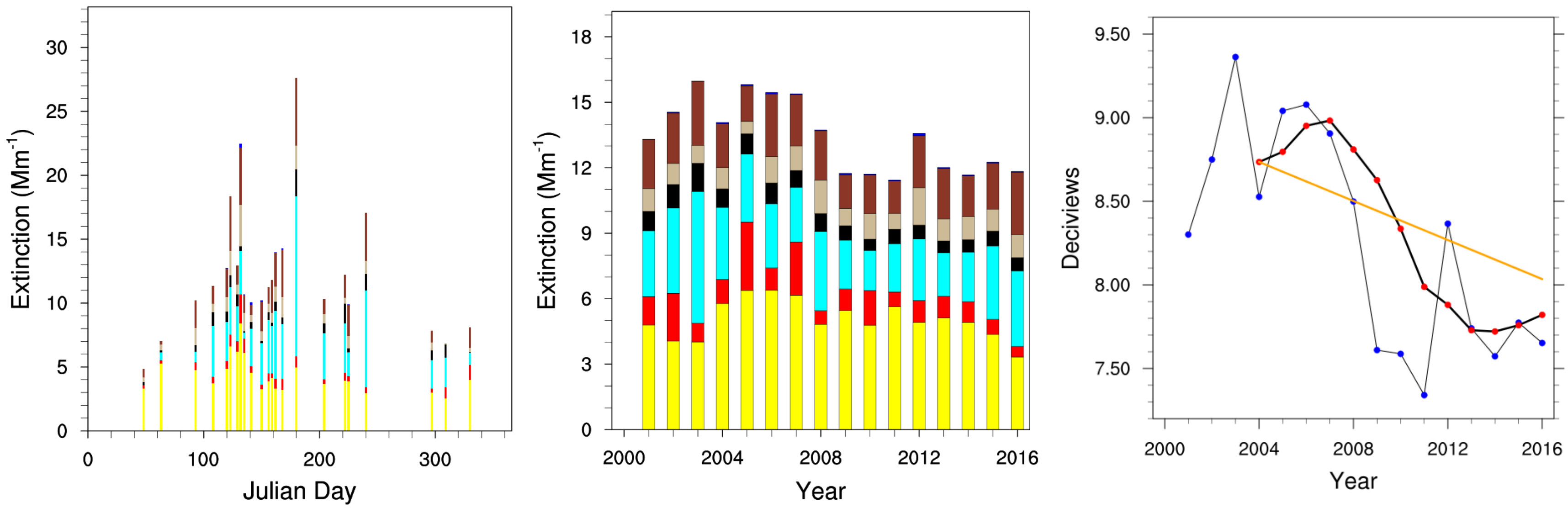
Ike's Backbone, AZ



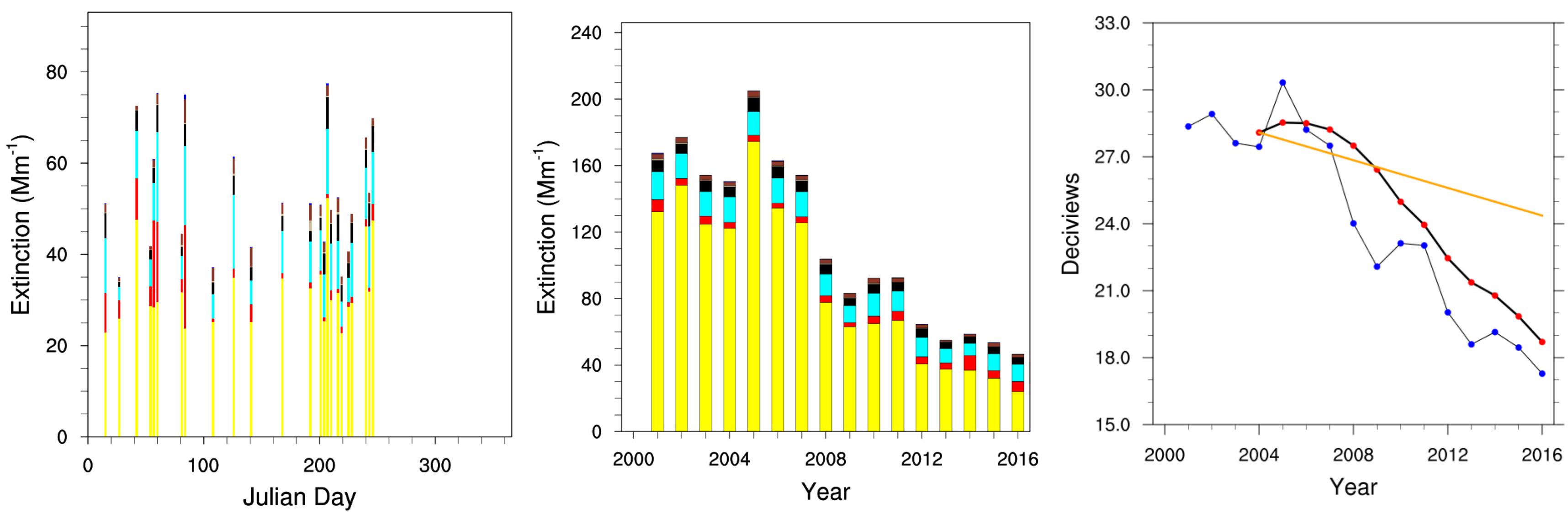
Isle Royale National Park, MI



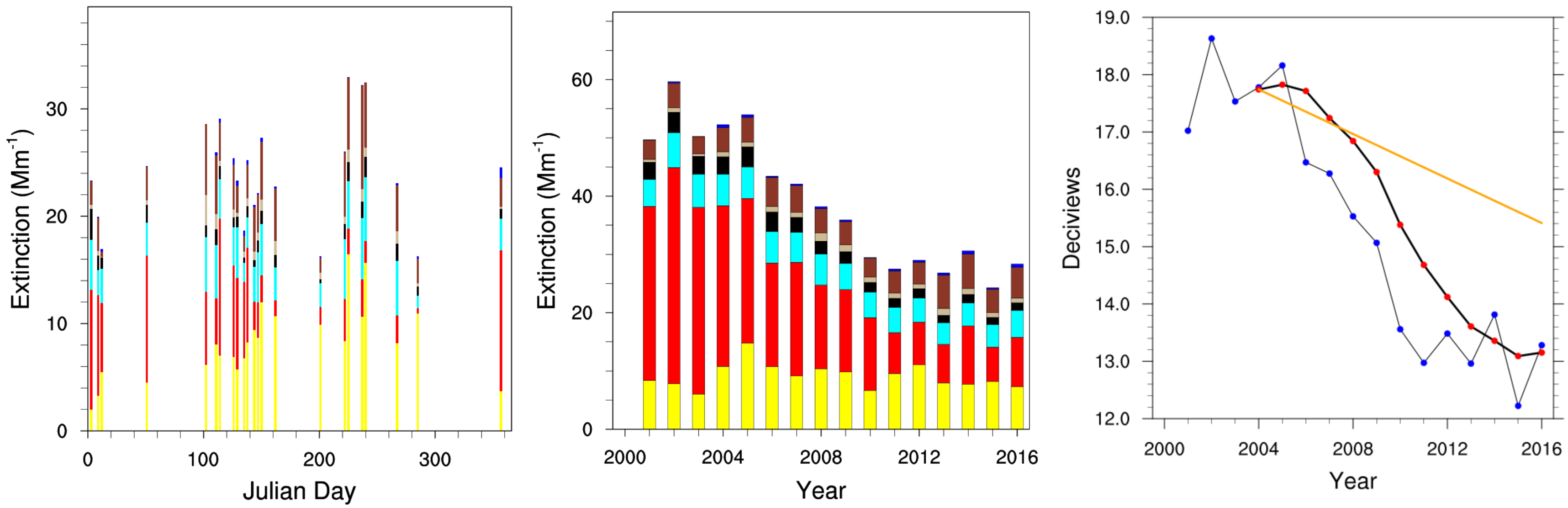
Jarbidge Wilderness, NV



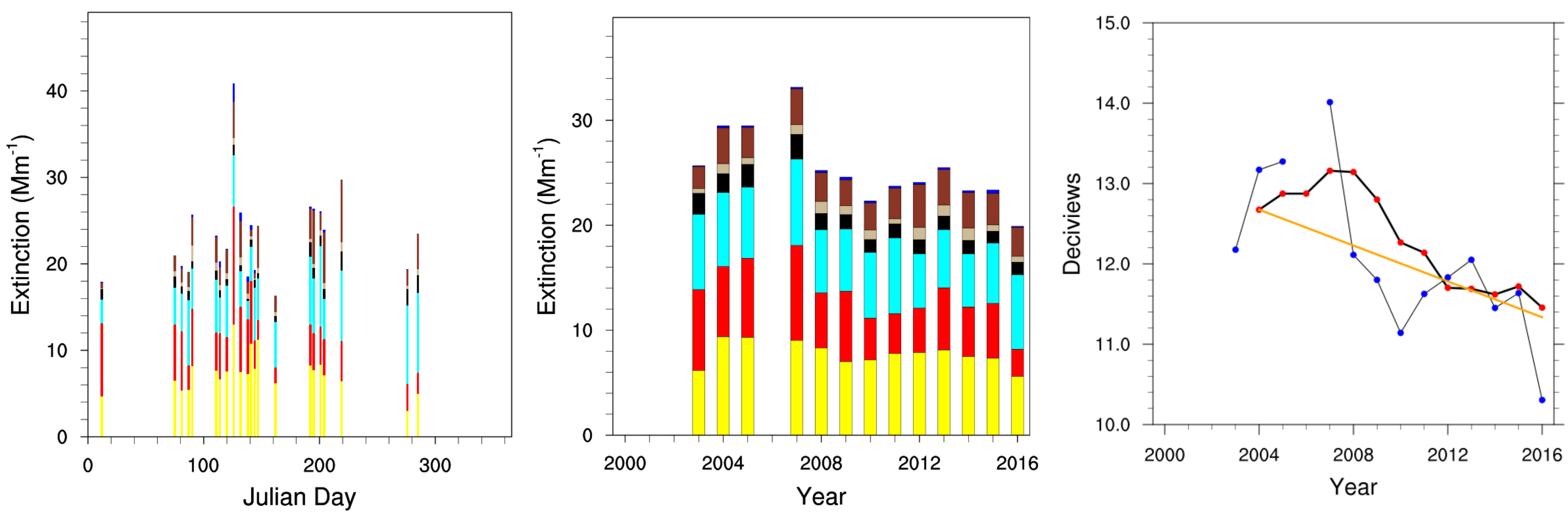
James River Face Wilderness, VA



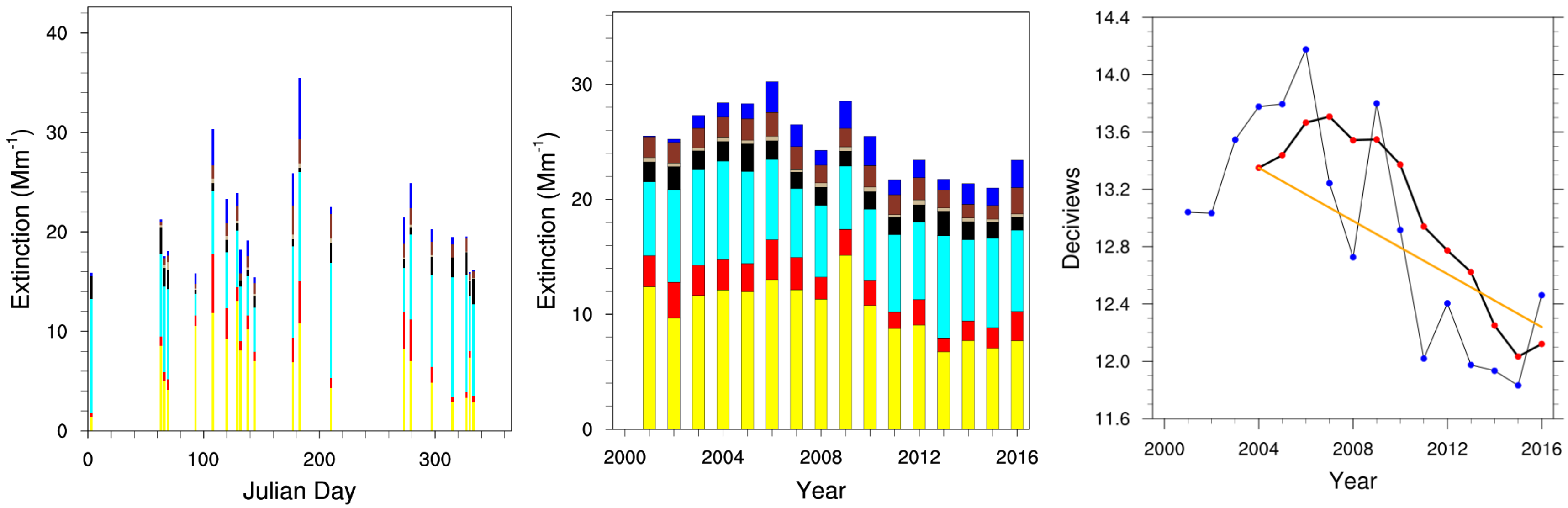
Joshua Tree National Park, CA



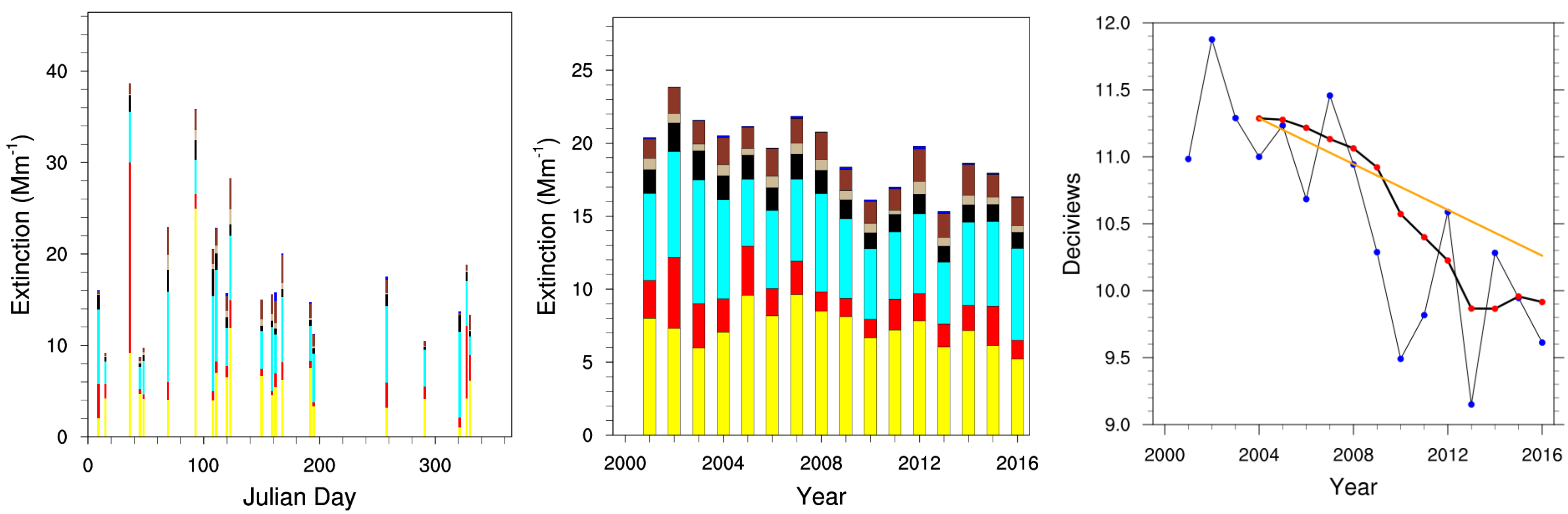
Kaiser, CA



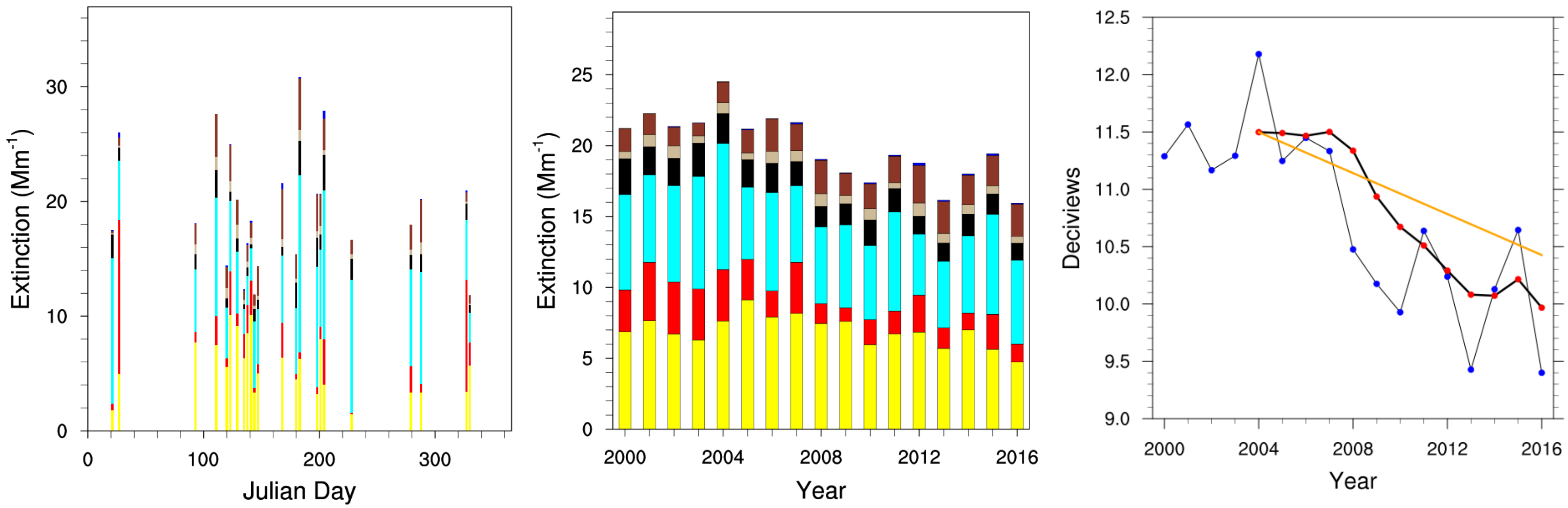
Kalmiopsis, OR



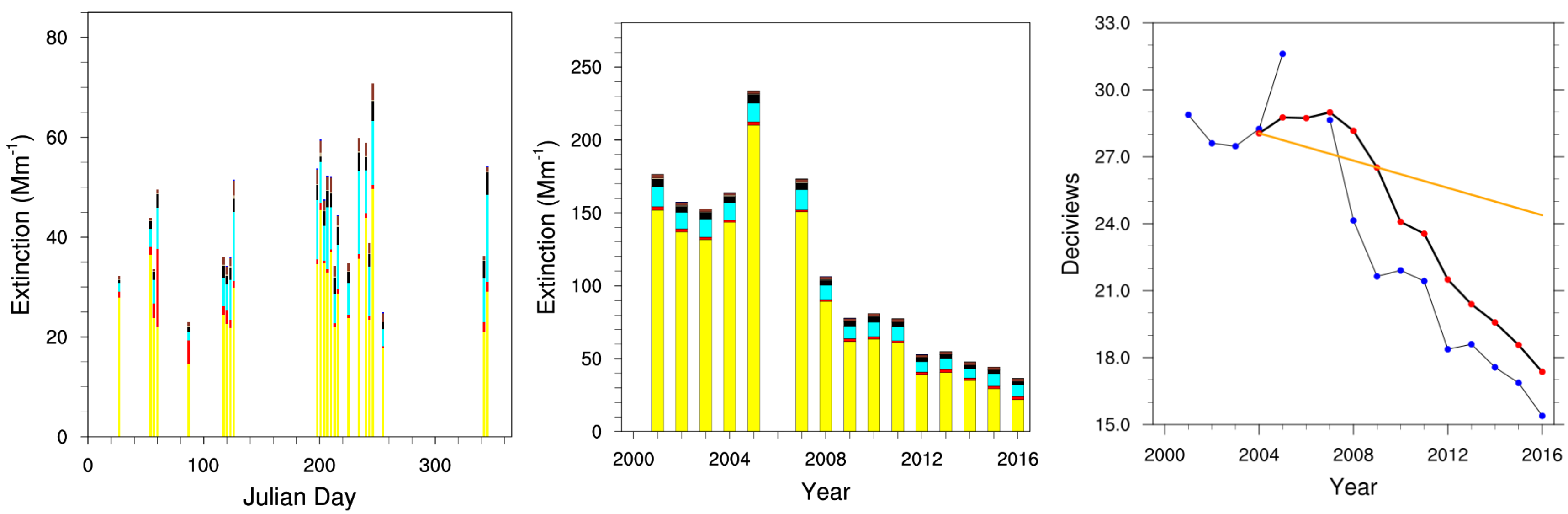
Lava Beds National Monument, CA



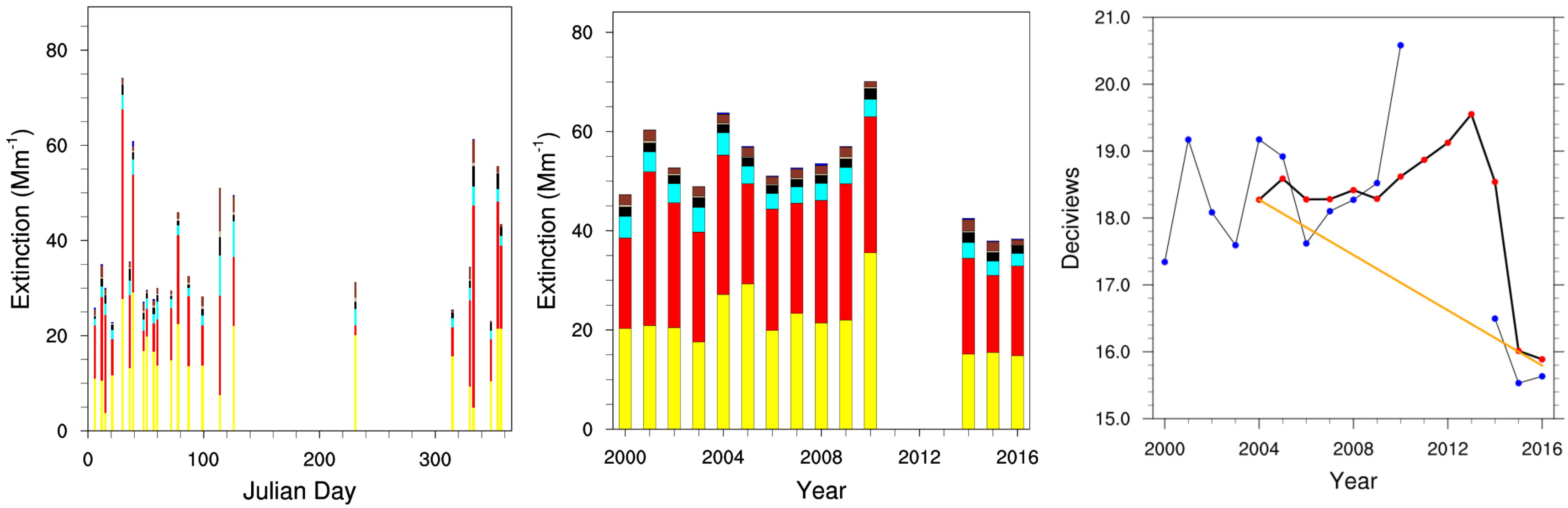
Lassen Volcanic National Park, CA



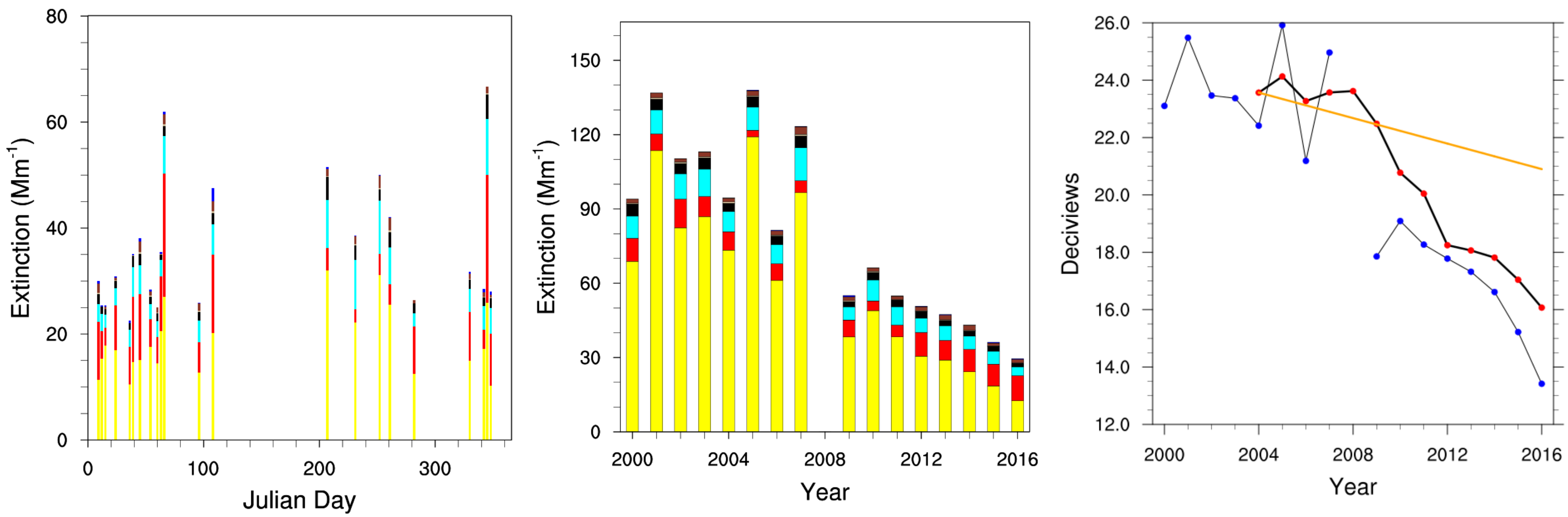
Linville Gorge, NC



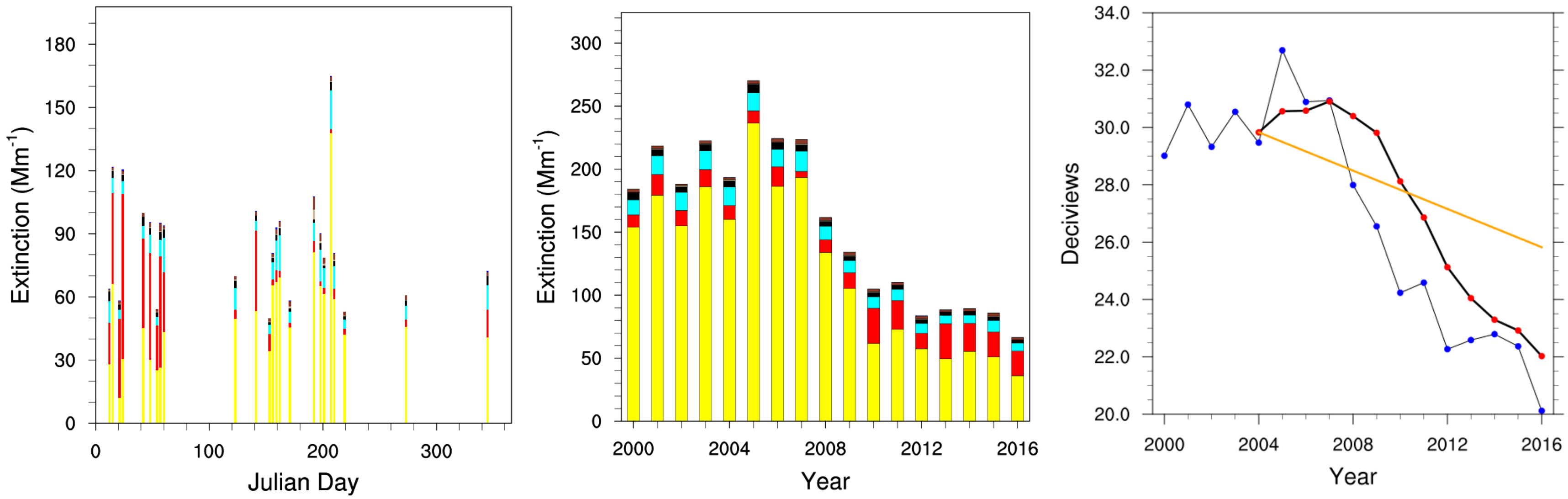
Lostwood, ND



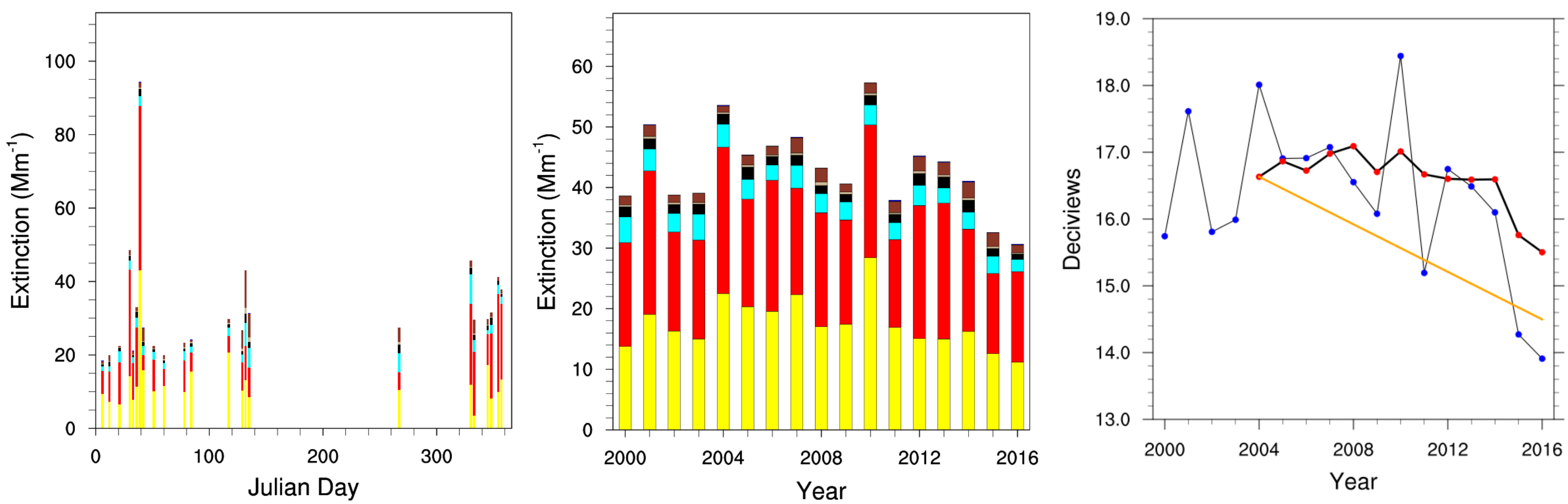
Lye Brook Wilderness, VT (combined LYBR1 and LYEB1 starting 01/01/2012)



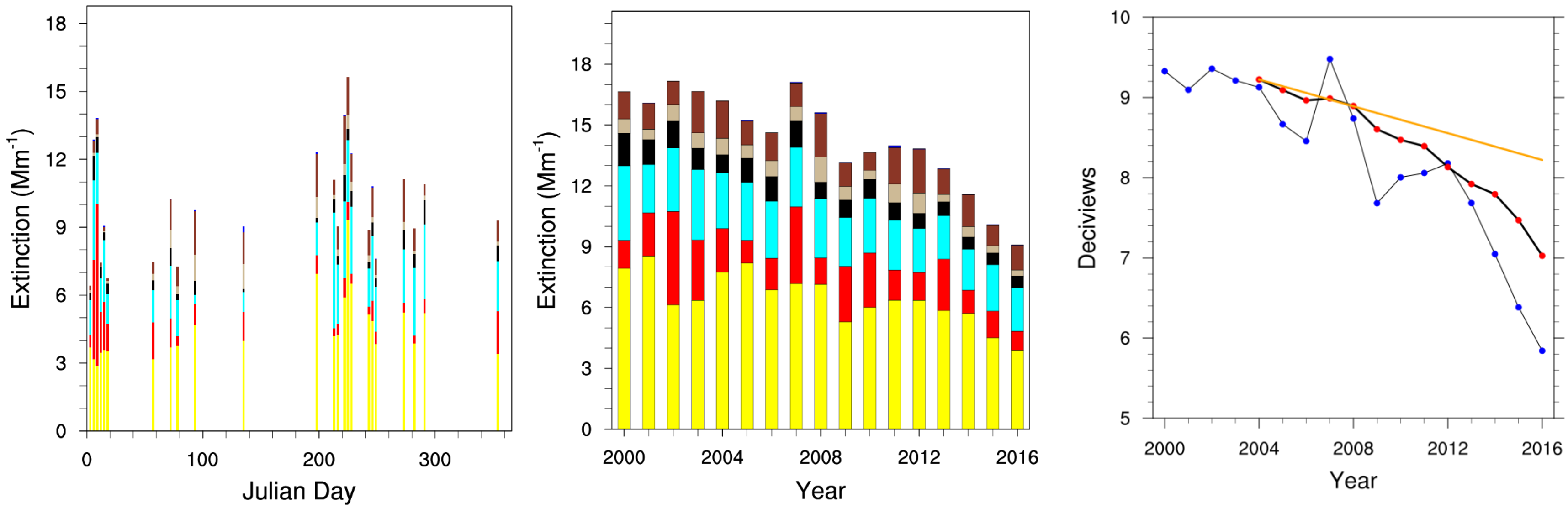
Mammoth Cave National Park, KY



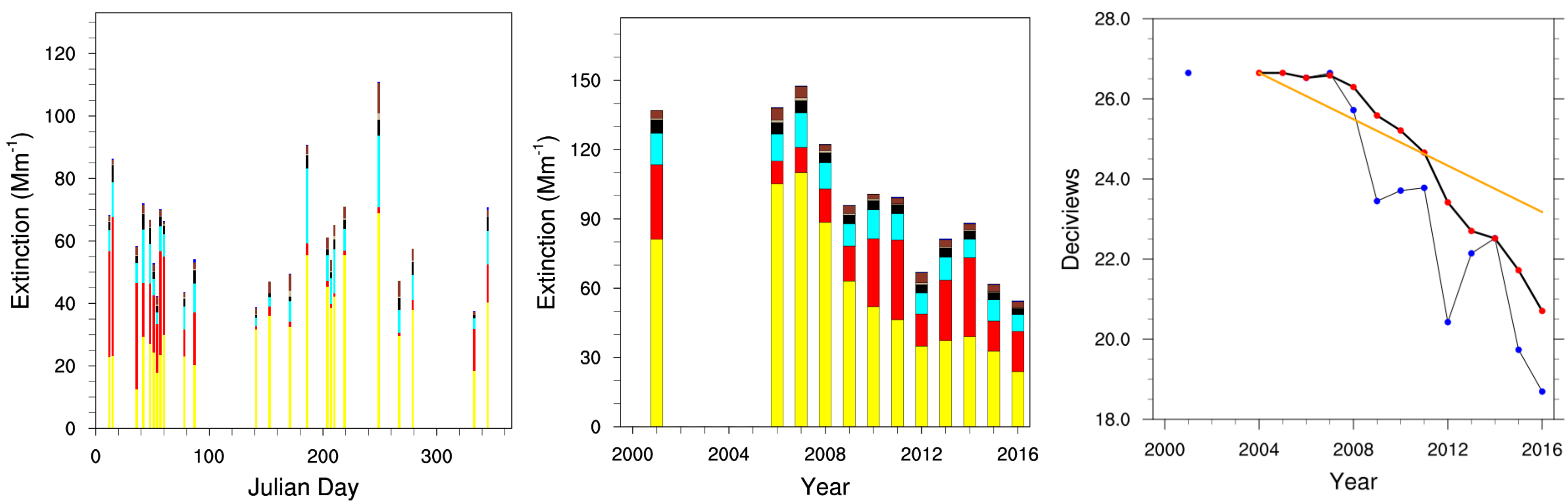
Medicine Lake, MT



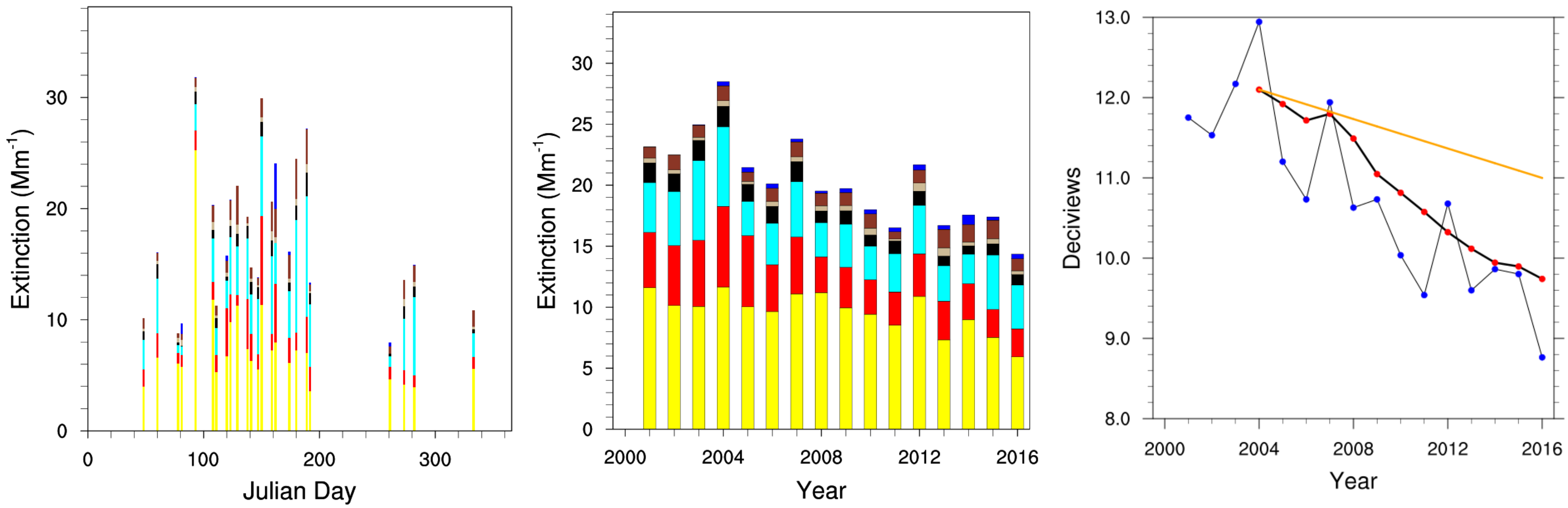
Mesa Verde National Park, CO



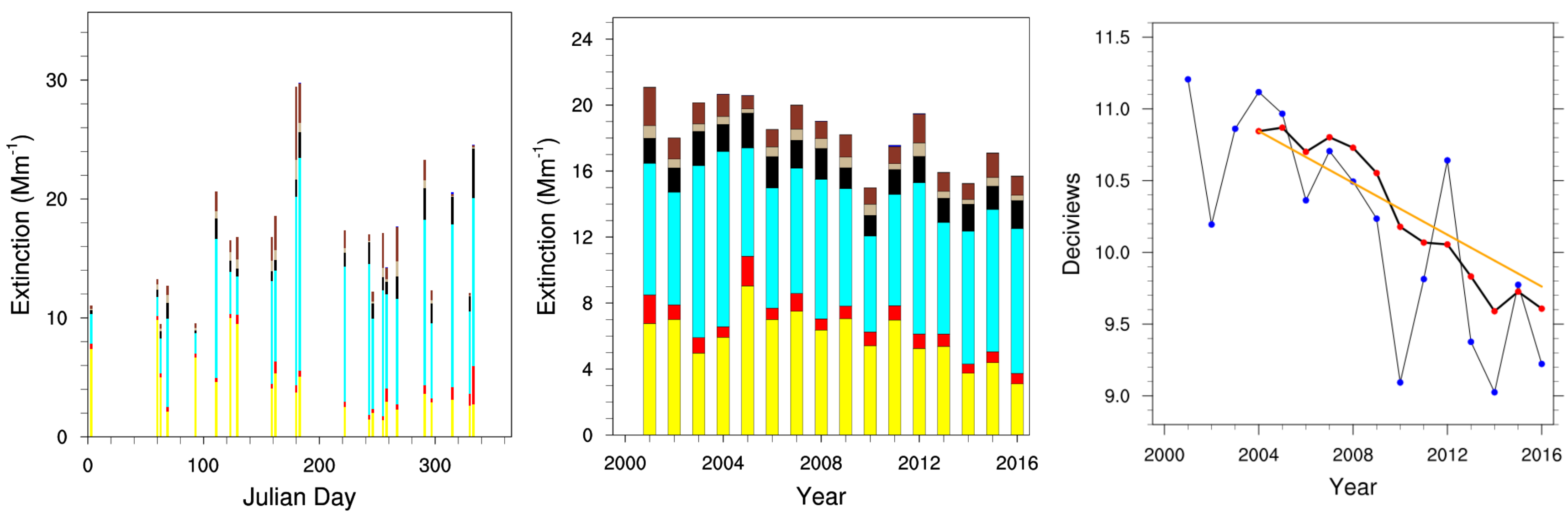
Mingo, MO



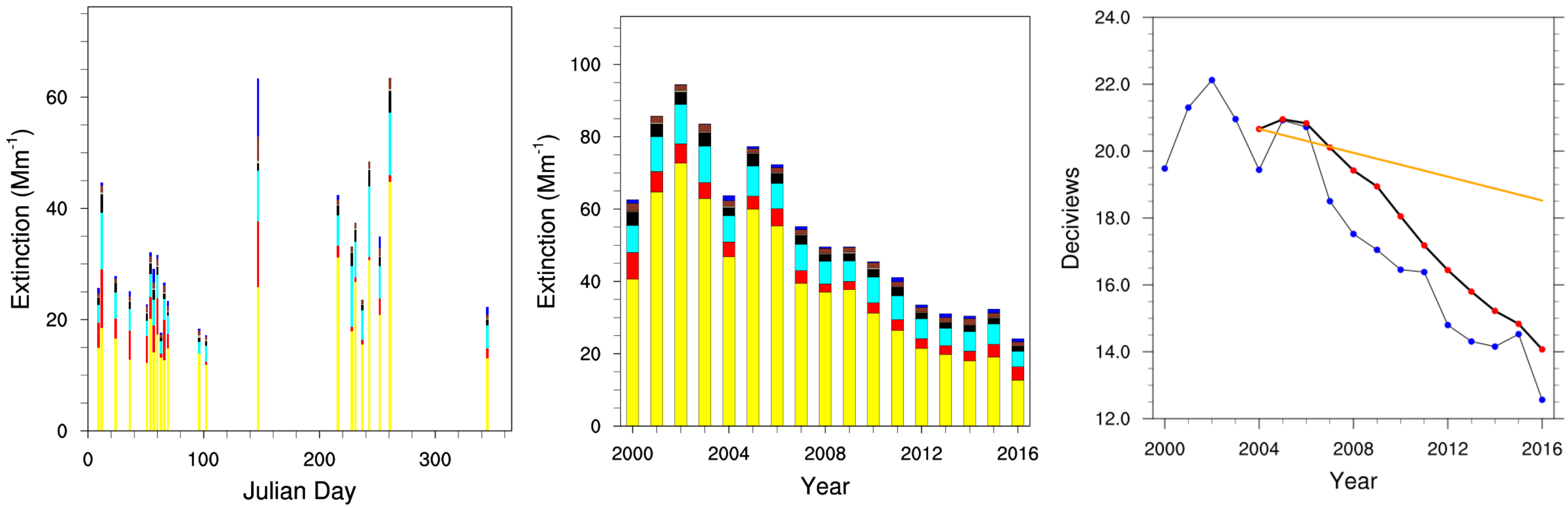
Mount Hood, OR



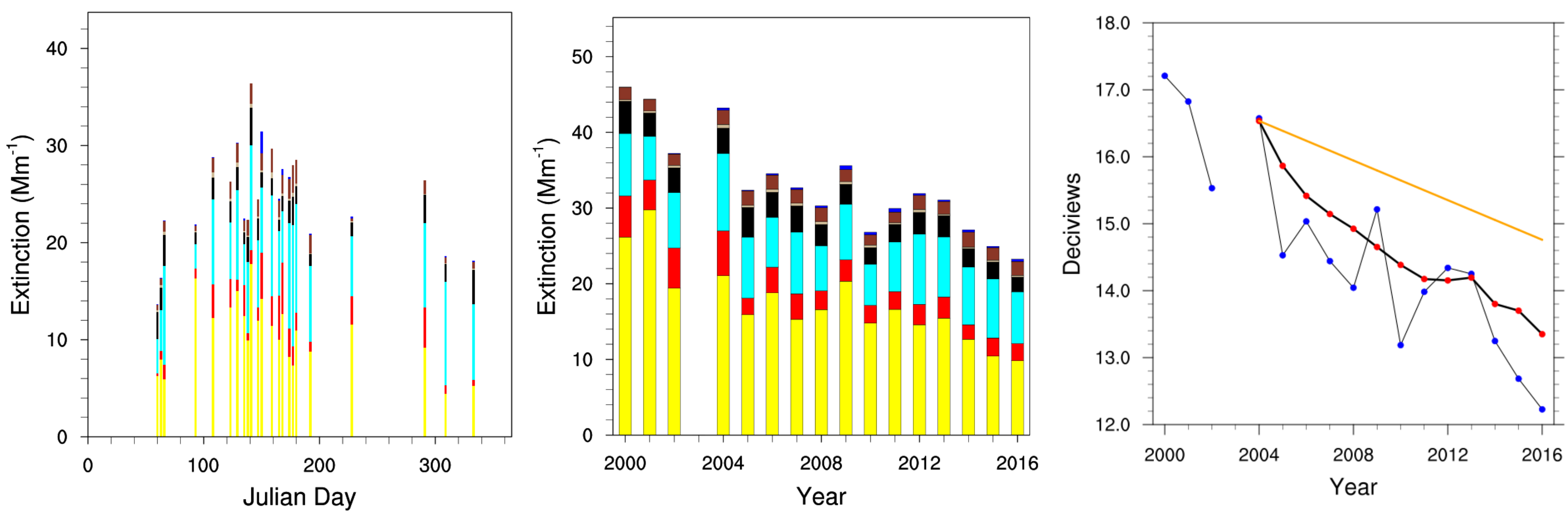
Monture, MT



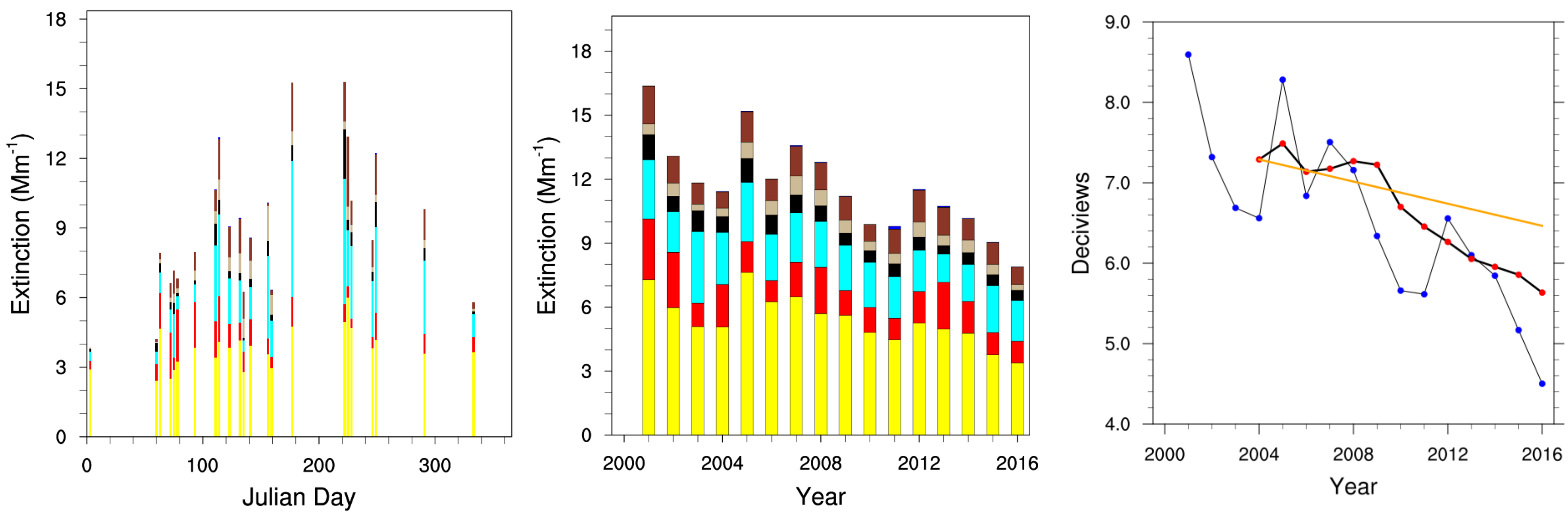
Moosehorn National Wildlife Refuge, ME



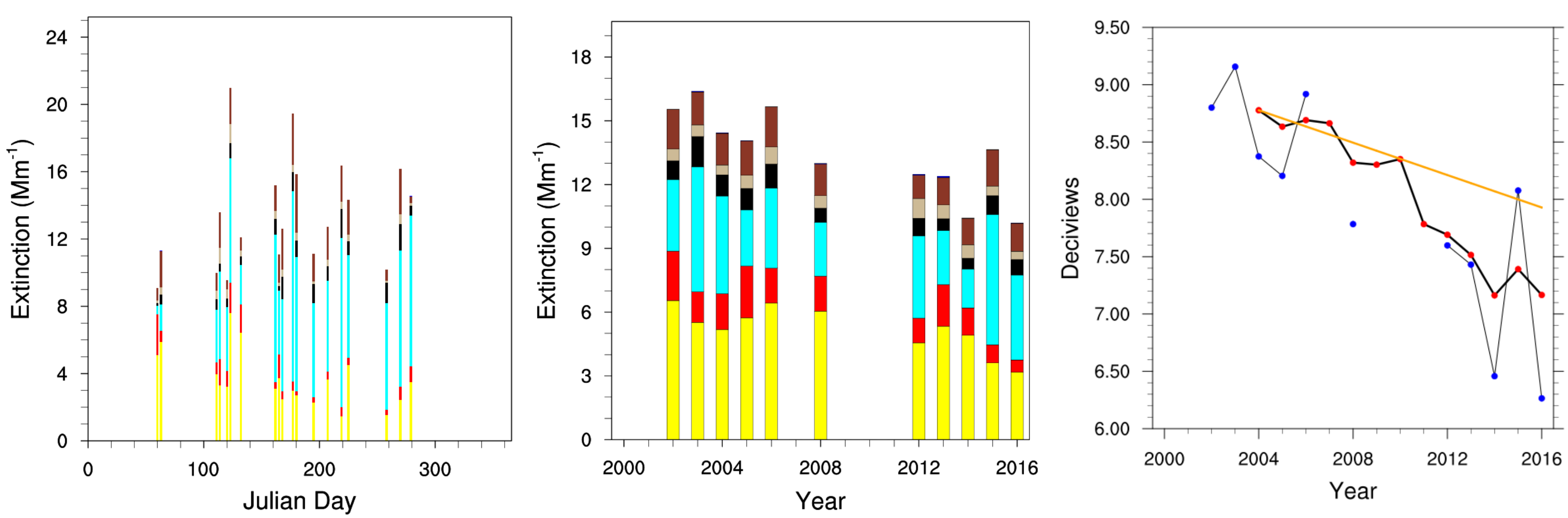
Mount Rainier National Park, WA



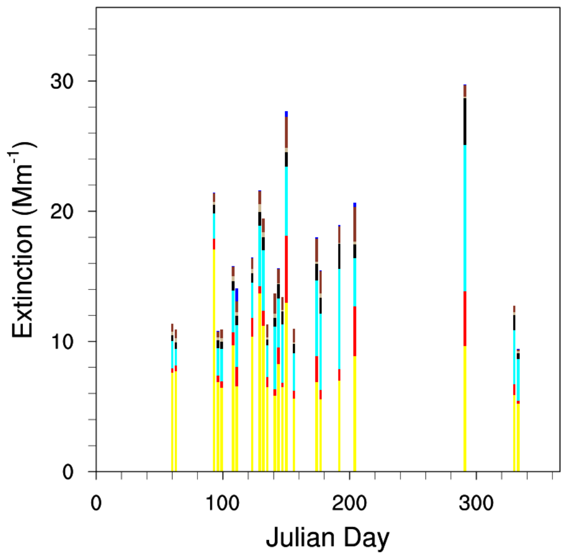
Mount Zirkel Wilderness, CO

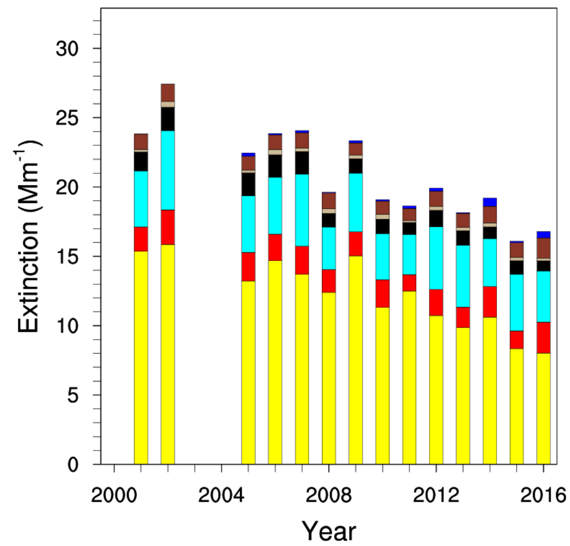


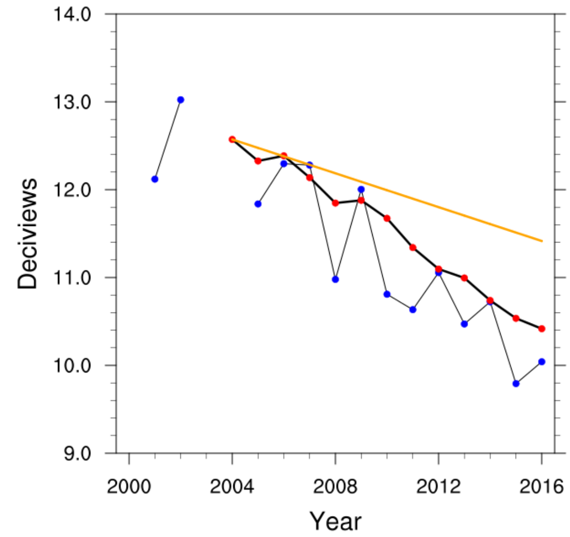
North Absaroka, WY



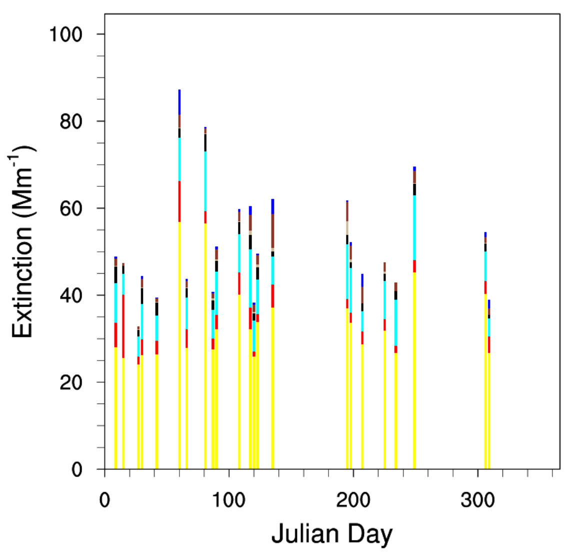
North Cascades National Park, WA

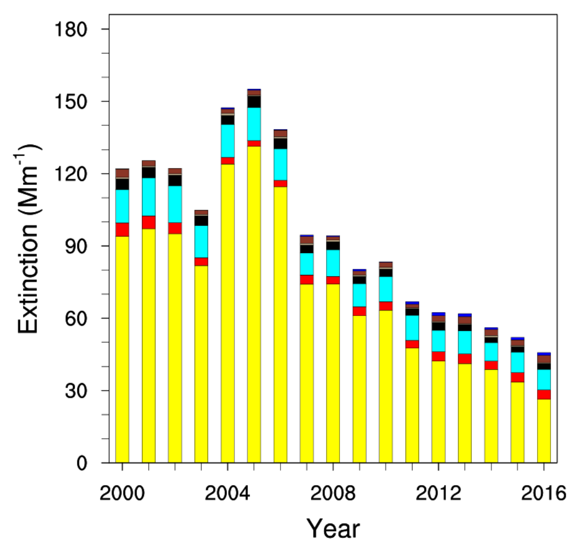


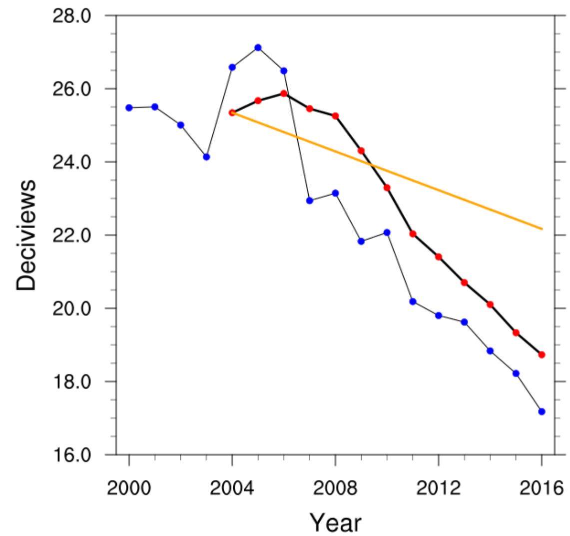




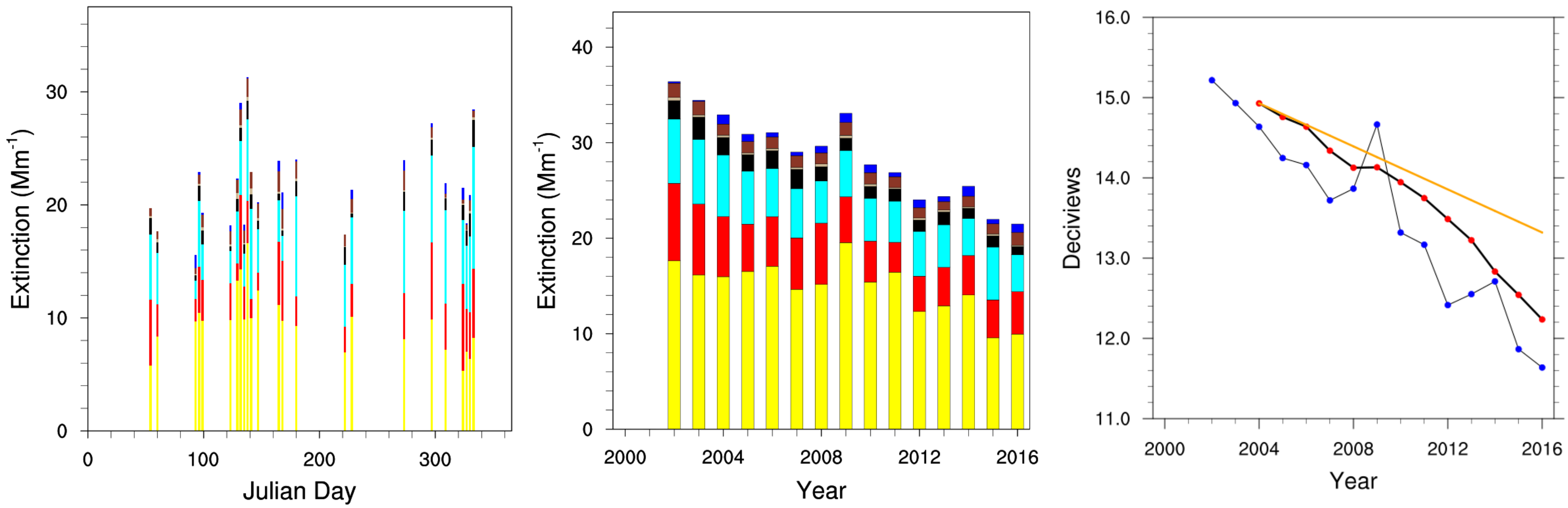
Okefenokee National Wildlife Refuge, GA



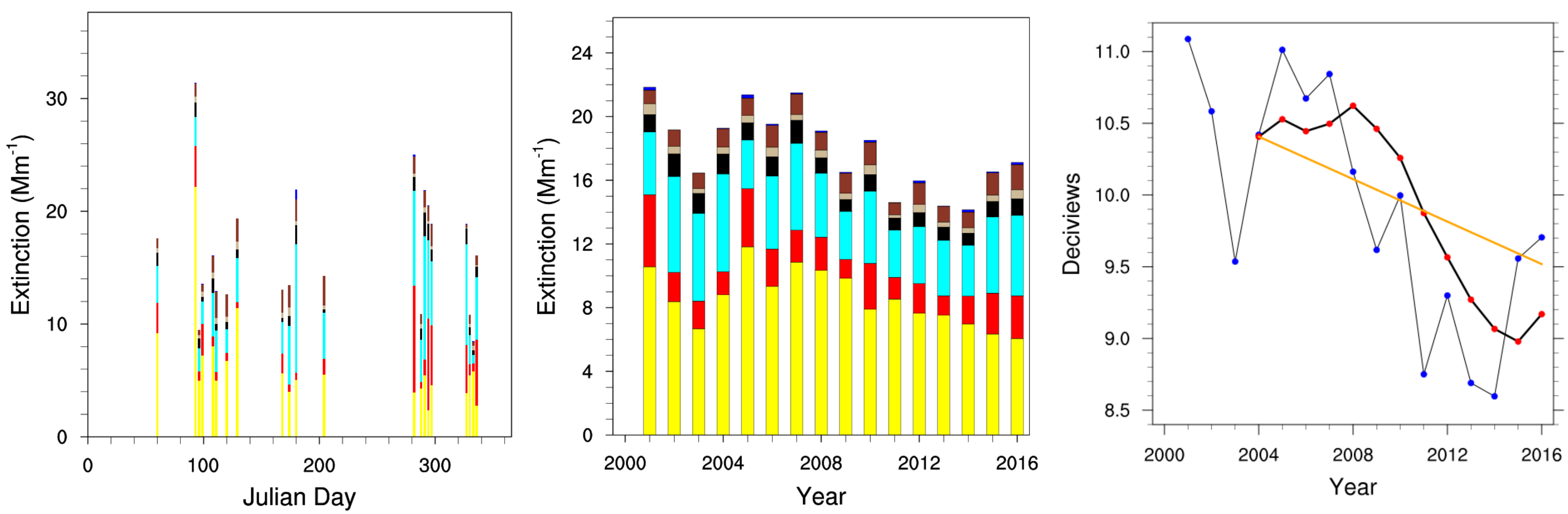




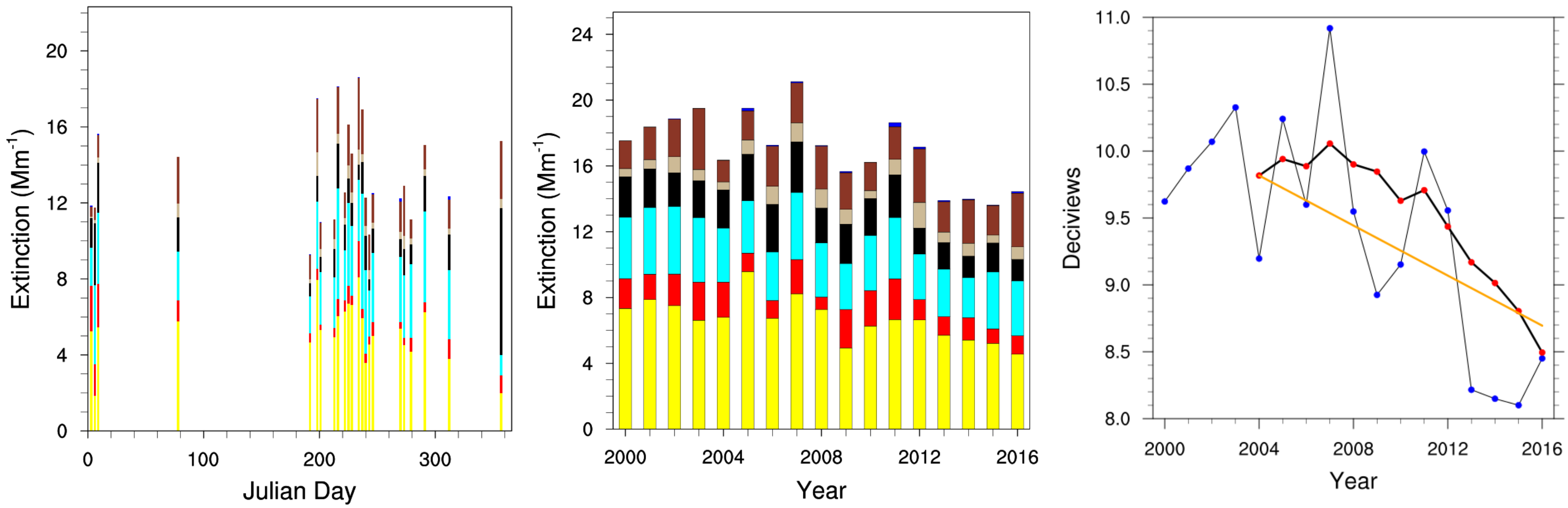
Olympic National Park, WA



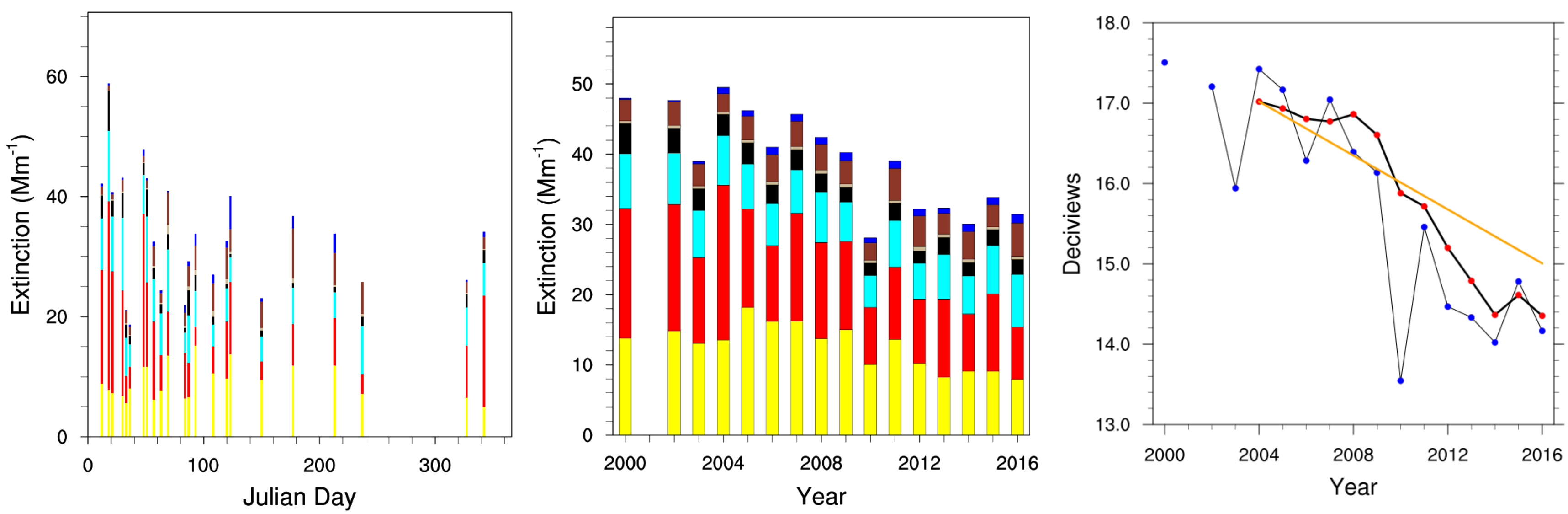
Pasayten, WA



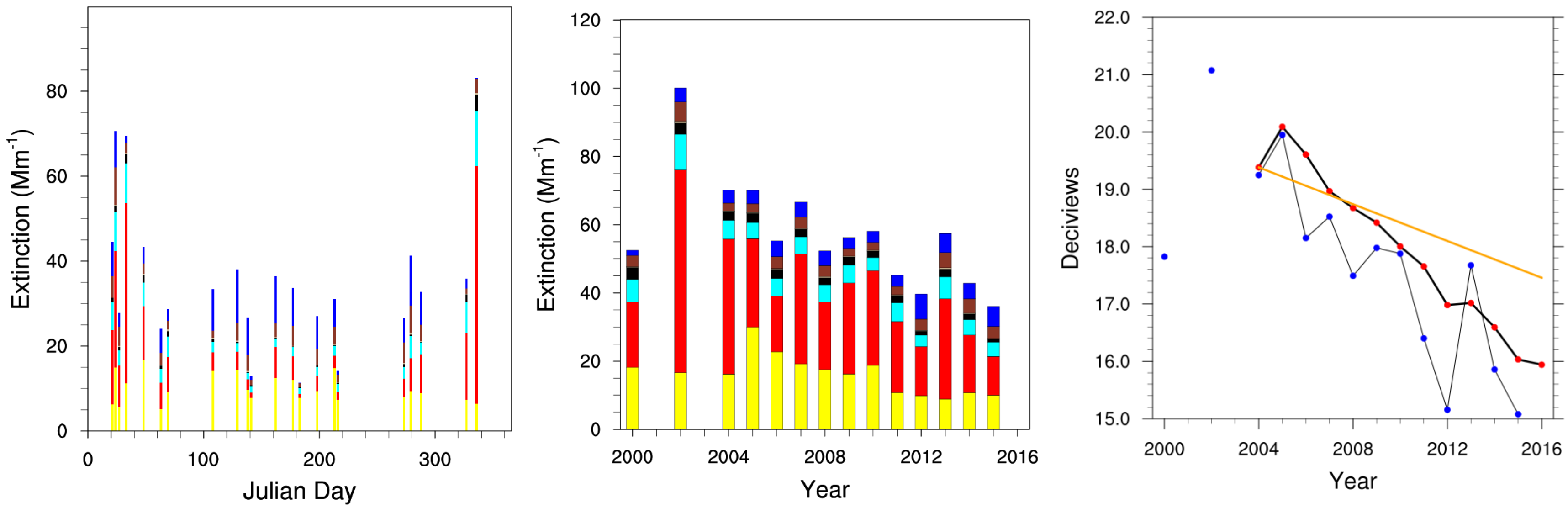
Petrified Forest National Park, AZ



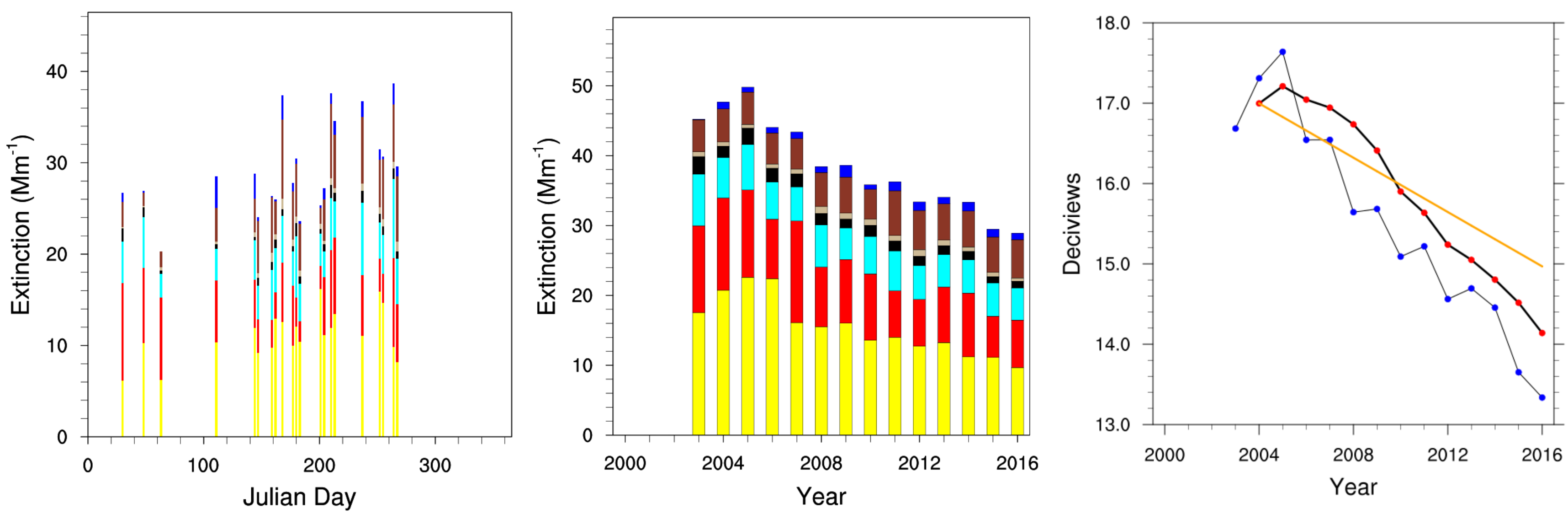
Pinnacles National Monument, CA



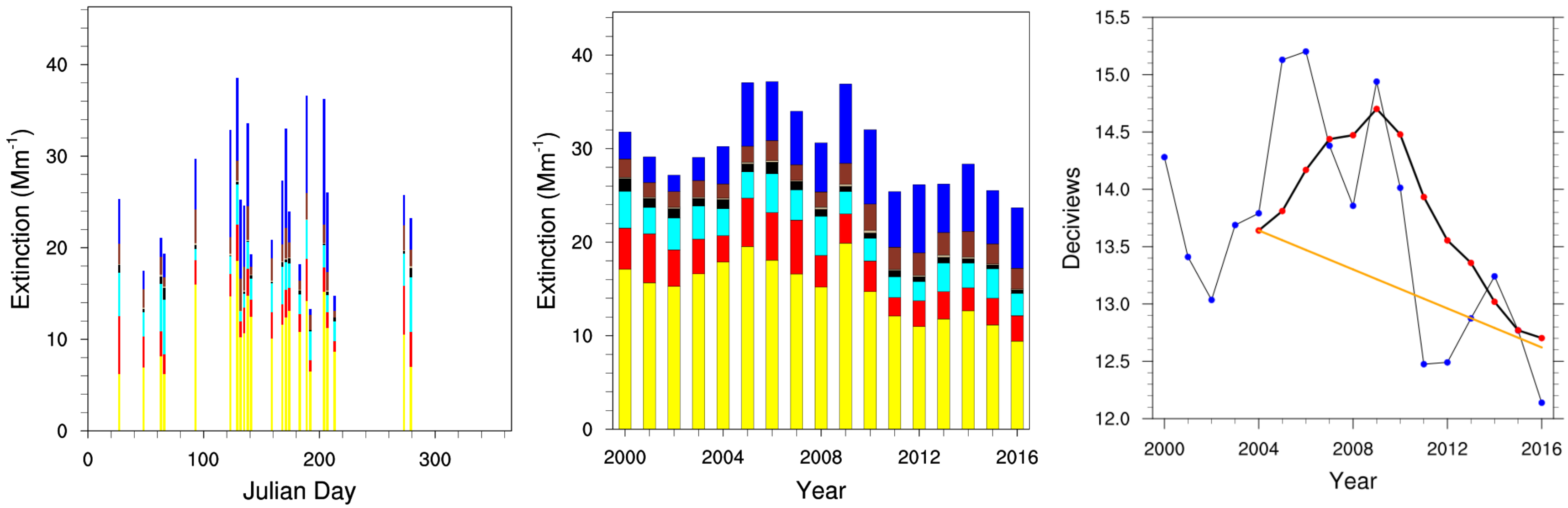
Point Reyes National Seashore, CA



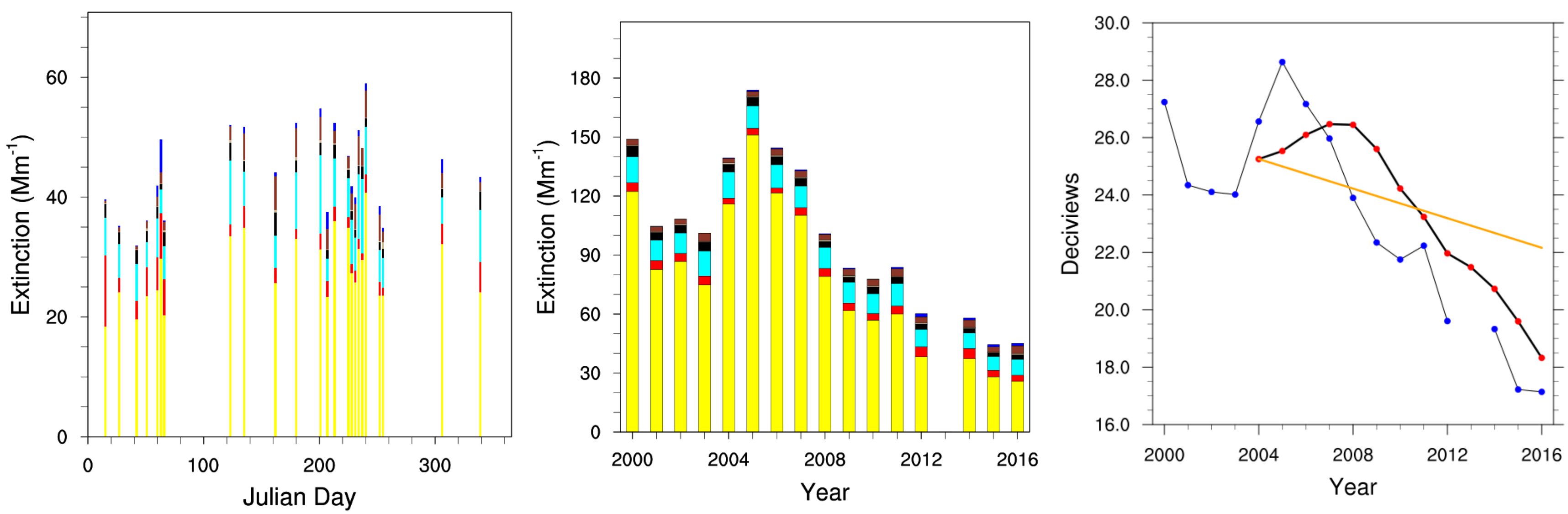
San Rafael, CA



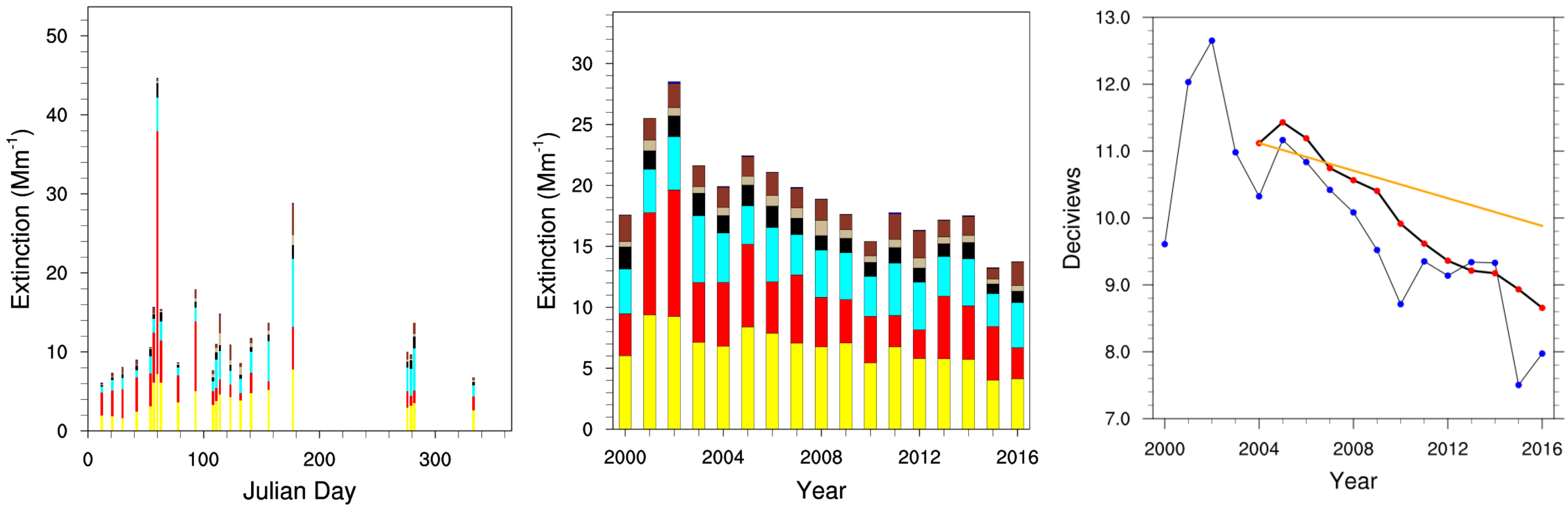
Redwood National Park, CA



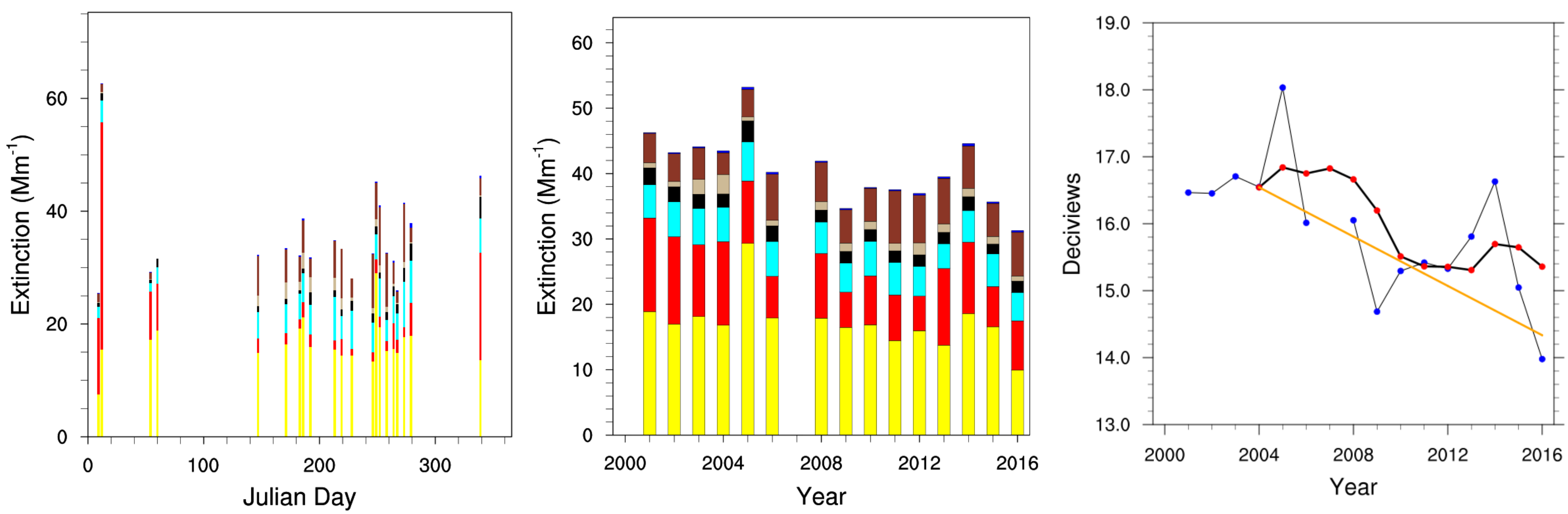
Cape Romain National Wildlife Refuge, SC



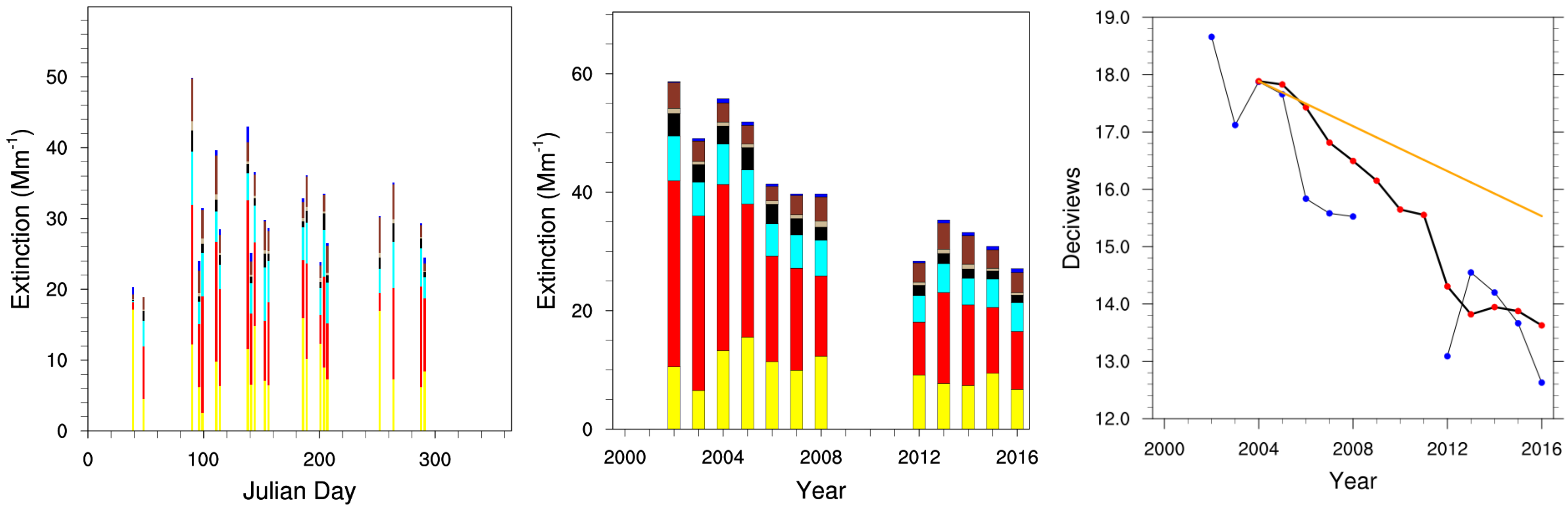
Rocky Mountain National Park, CO



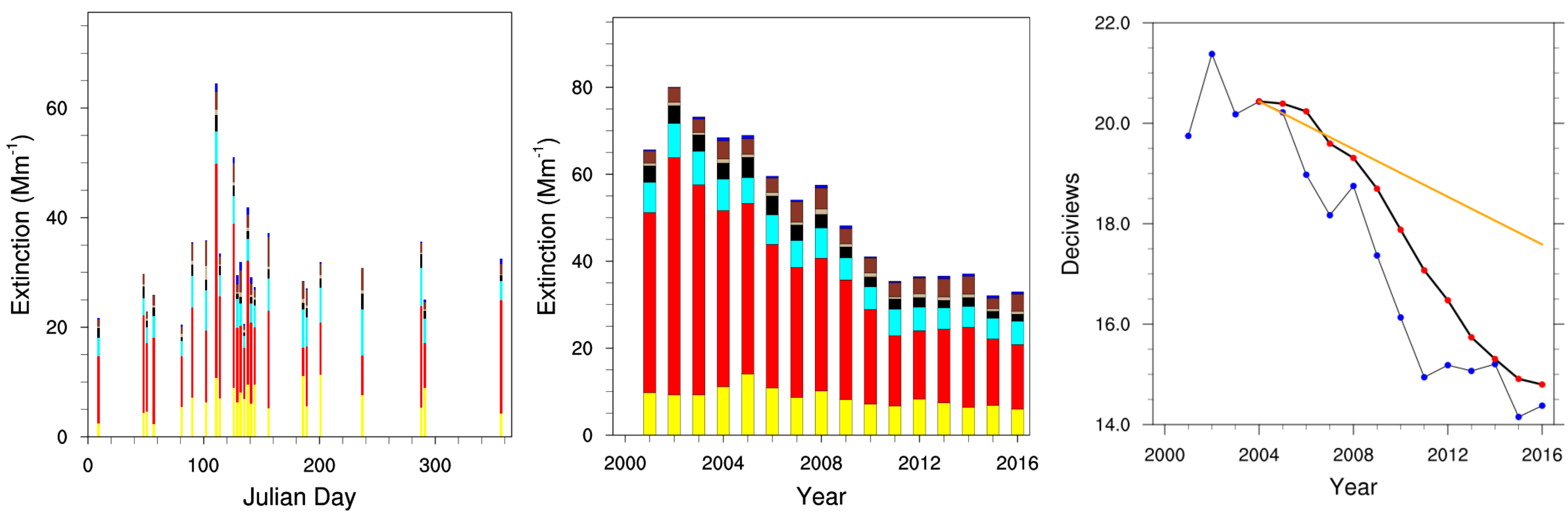
Salt Creek, NM



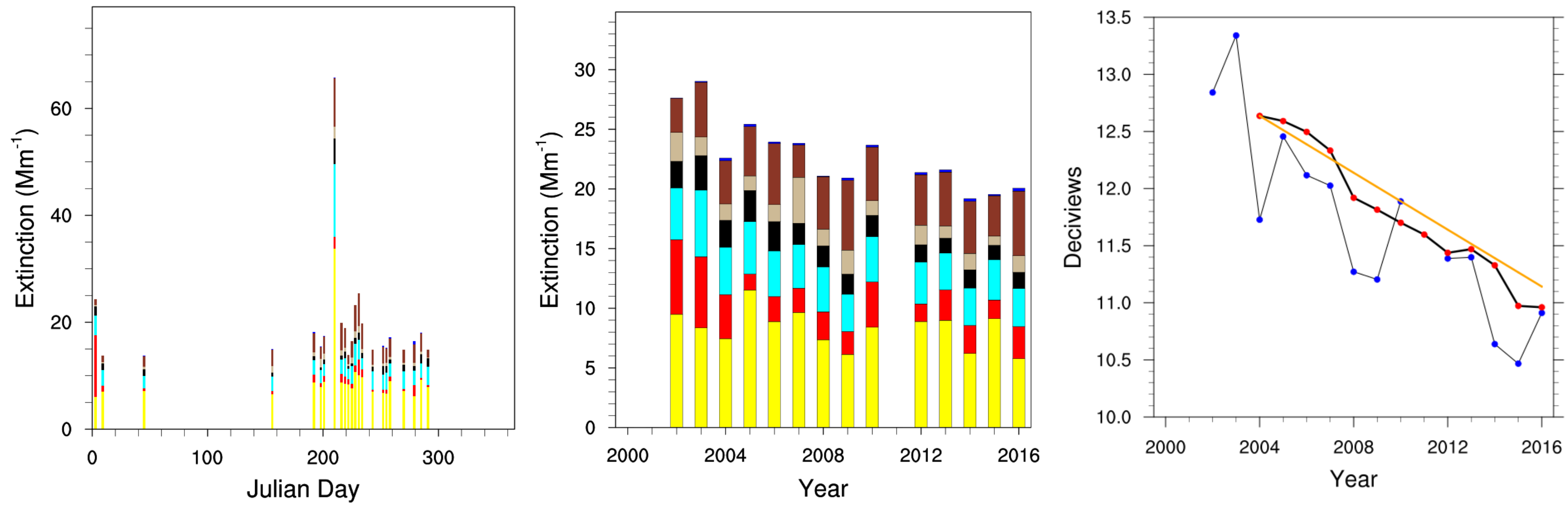
San Gabriel, CA



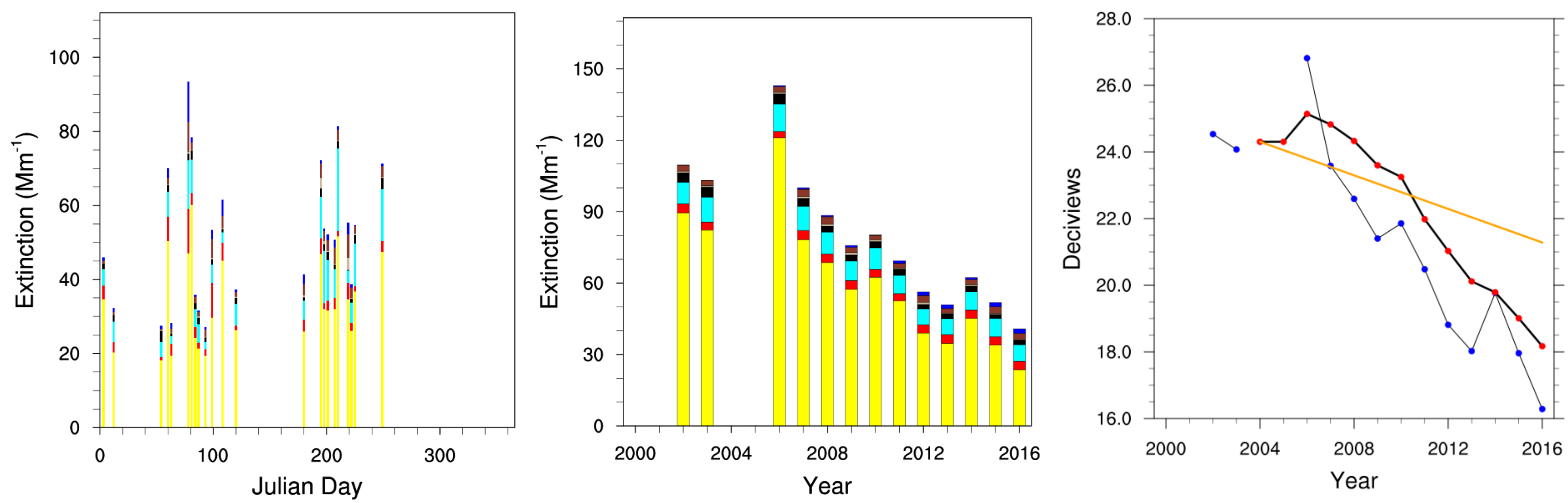
San Gorgonio Wilderness, CA



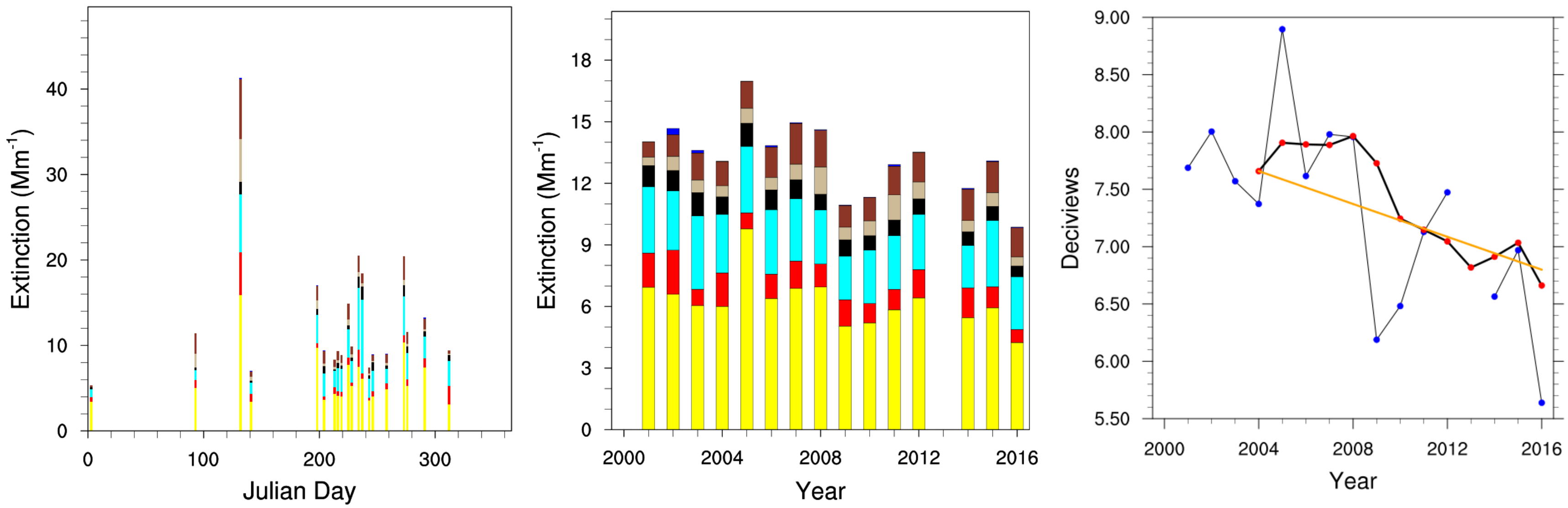
Saguaro National Monument, AZ



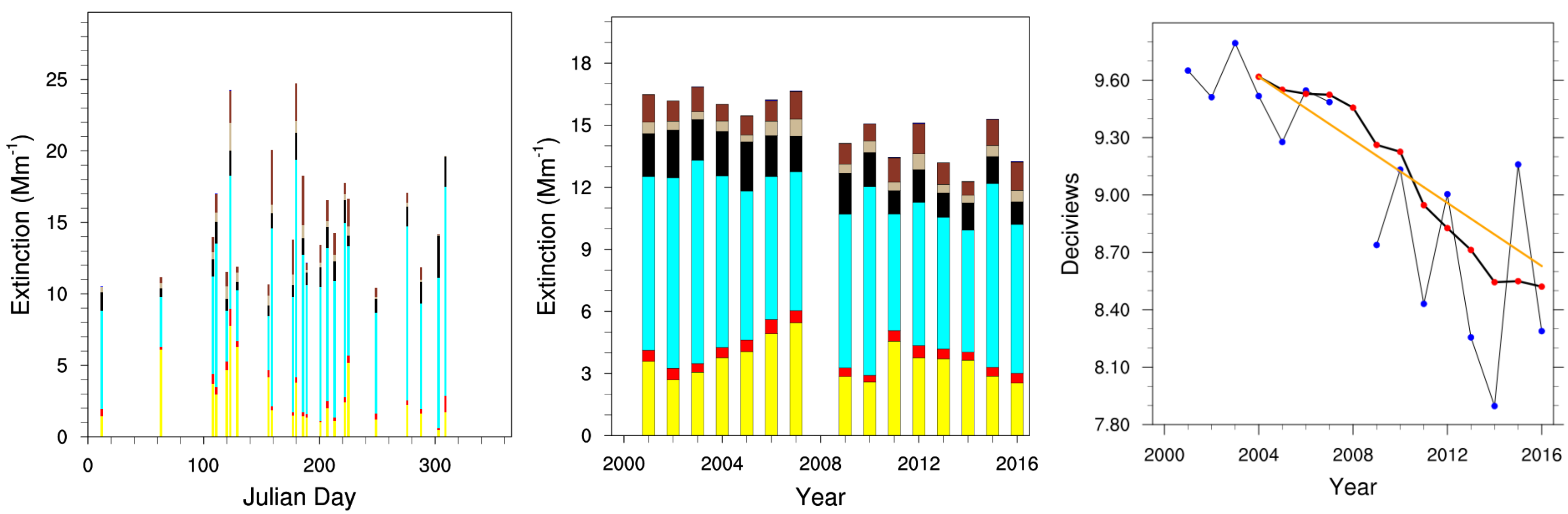
St. Marks, FL



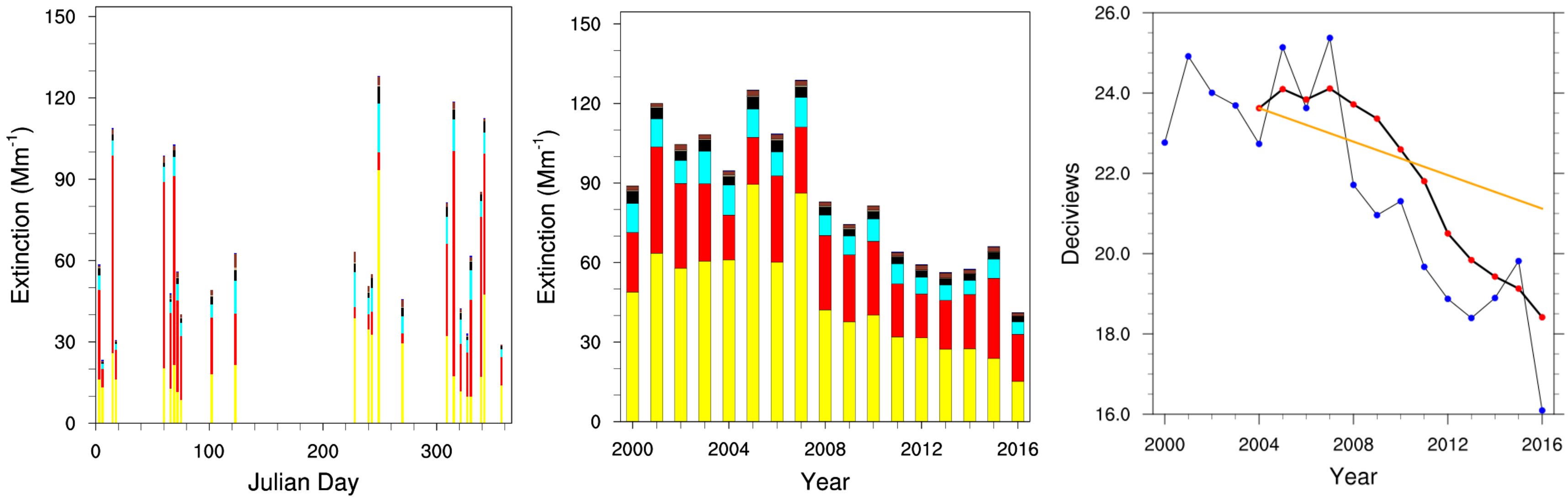
San Pedro Parks, NM



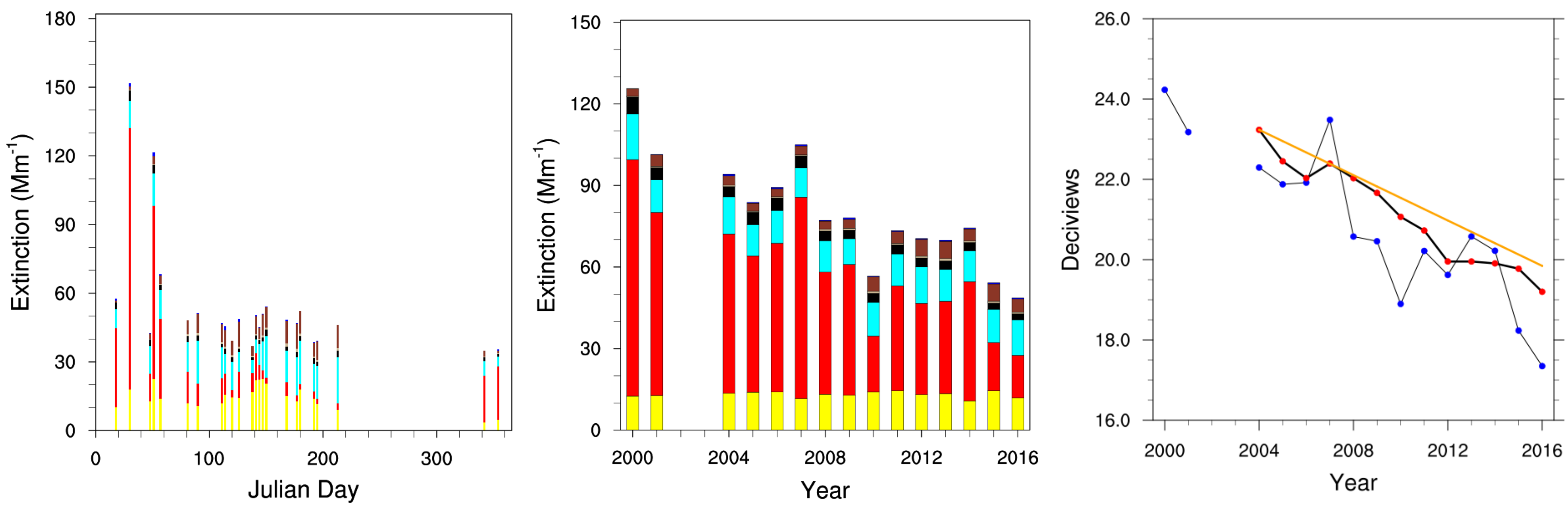
Sawtooth National Forest, ID



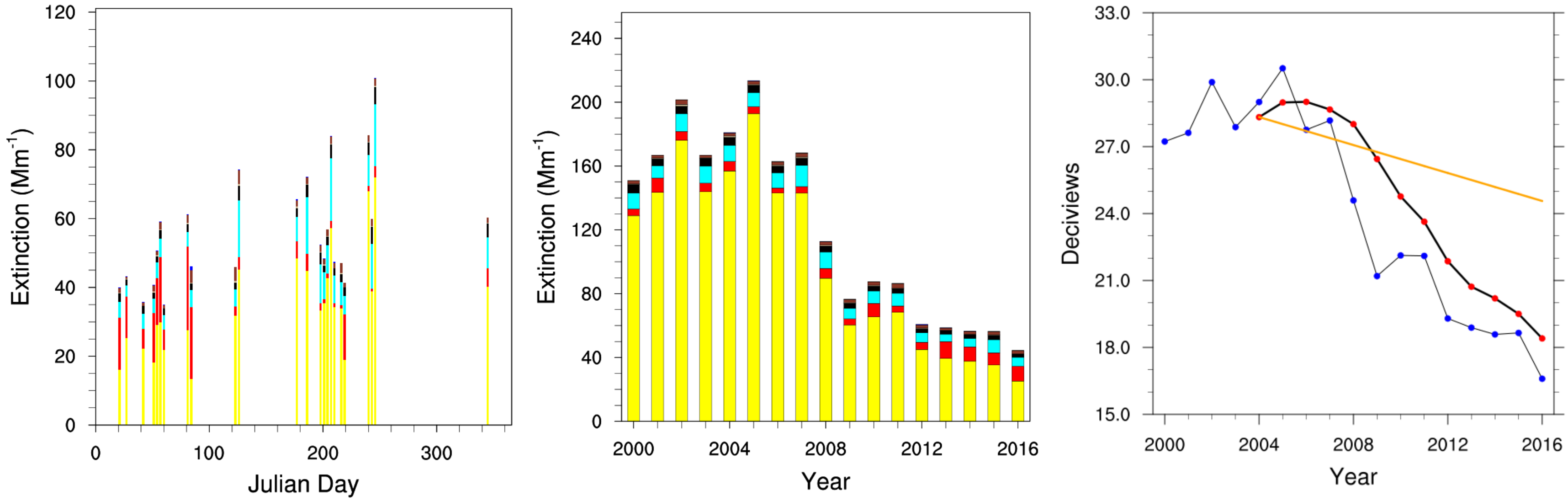
Seney, MI



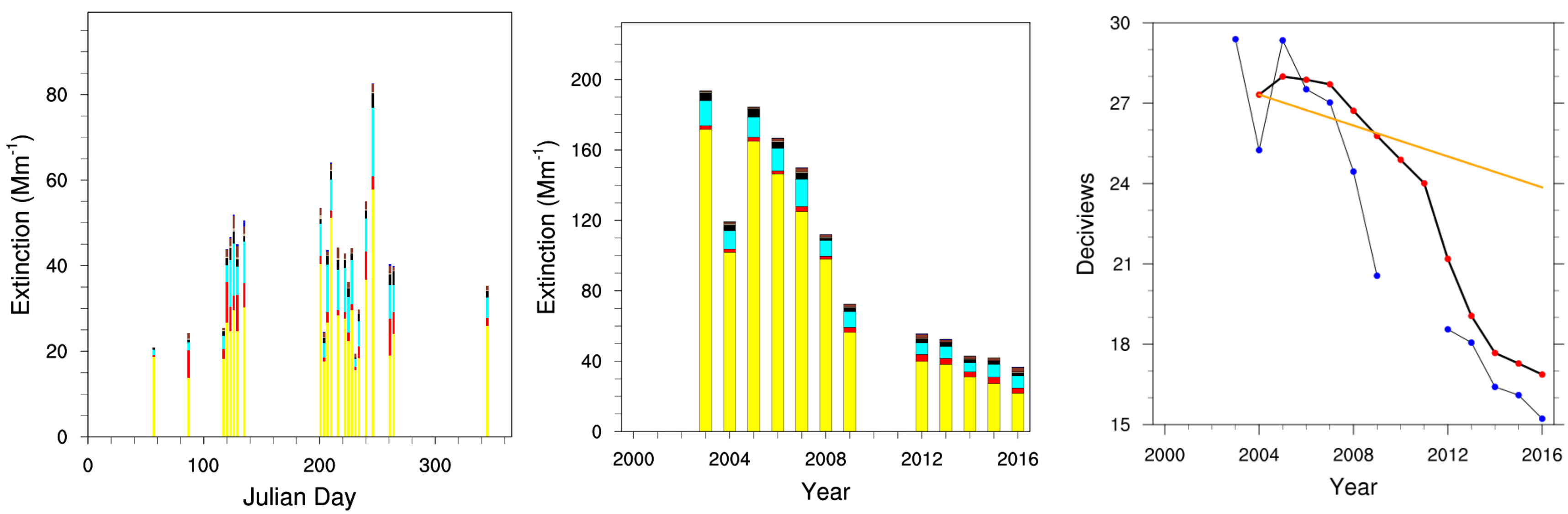
Sequoia National Park, CA



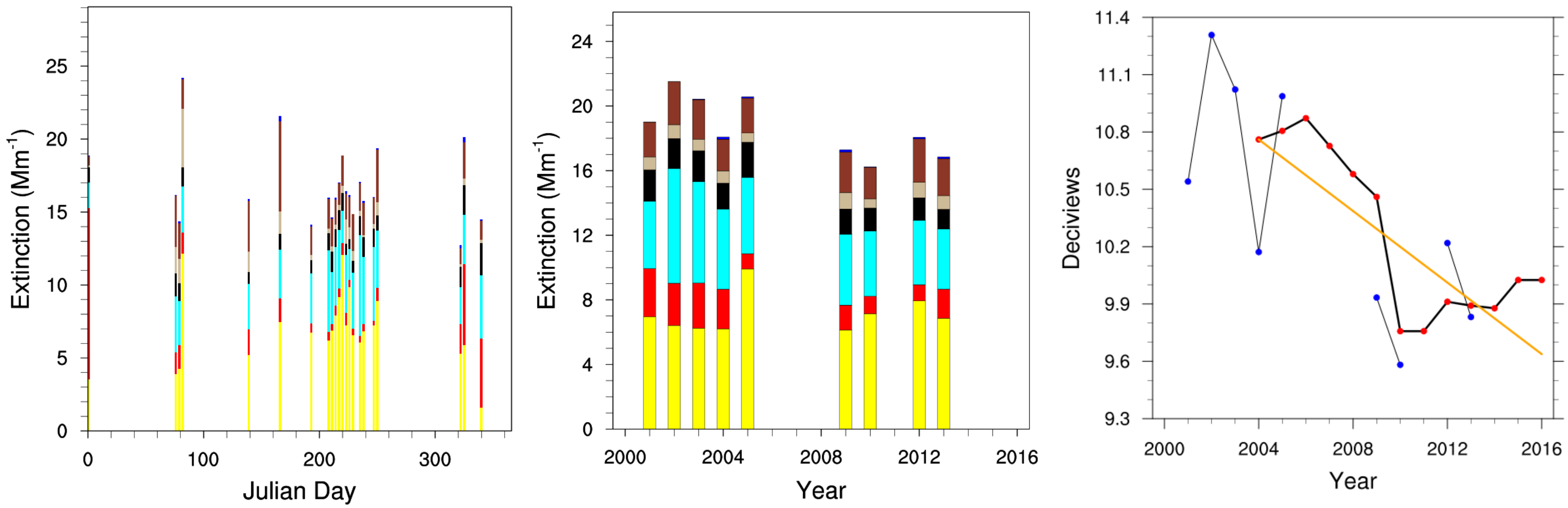
Shenandoah National Park, VA



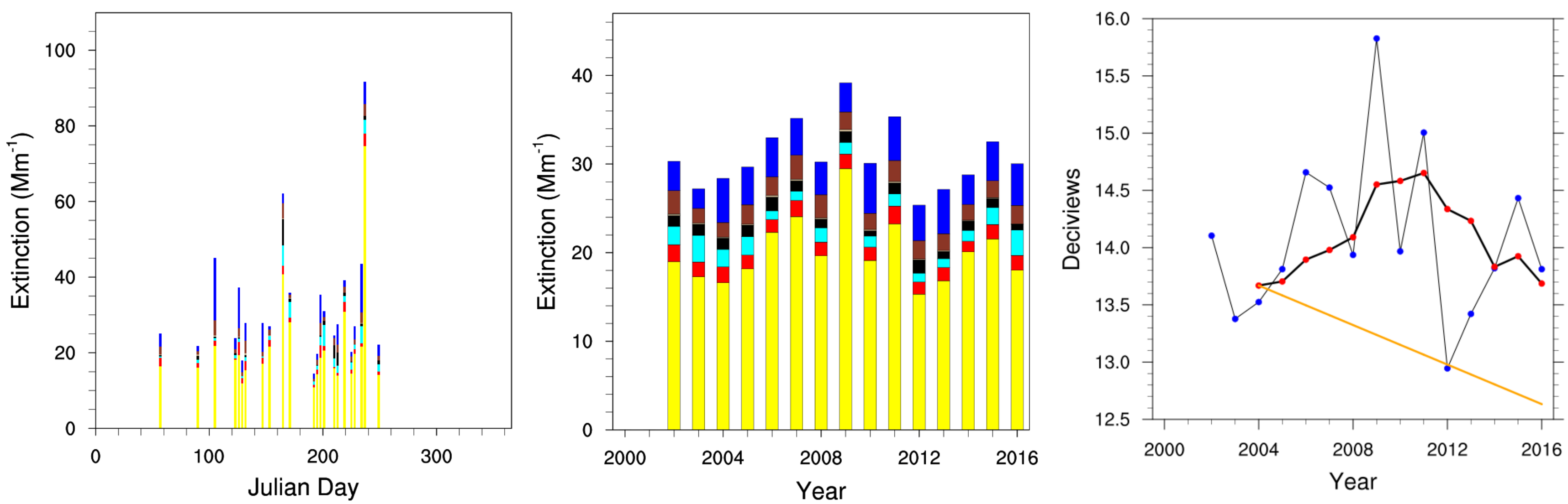
Shining Rock Wilderness, NC



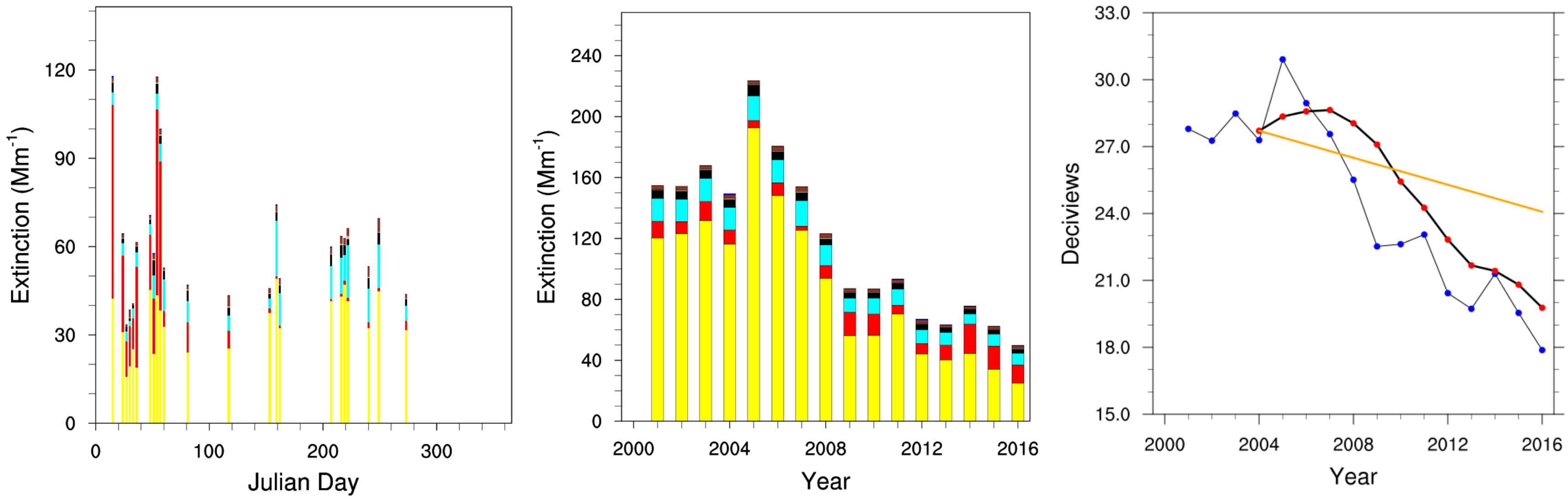
Sierra Ancha, AZ (2013 data shown on figures in left column)



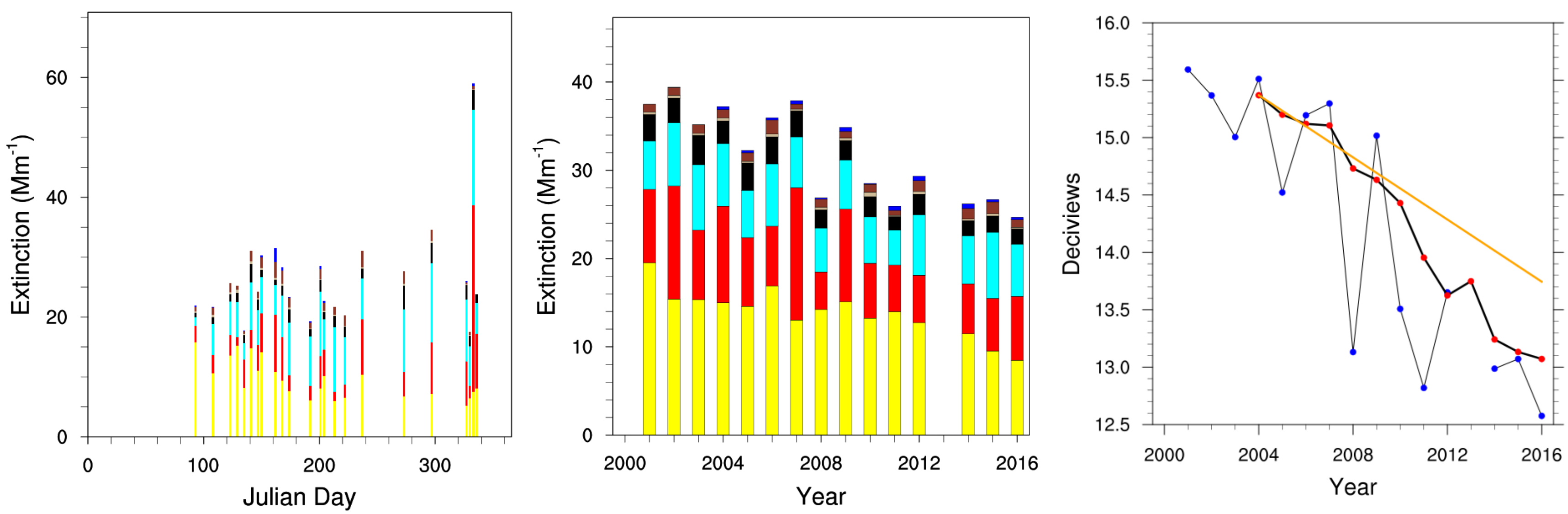
Simeonof, AK



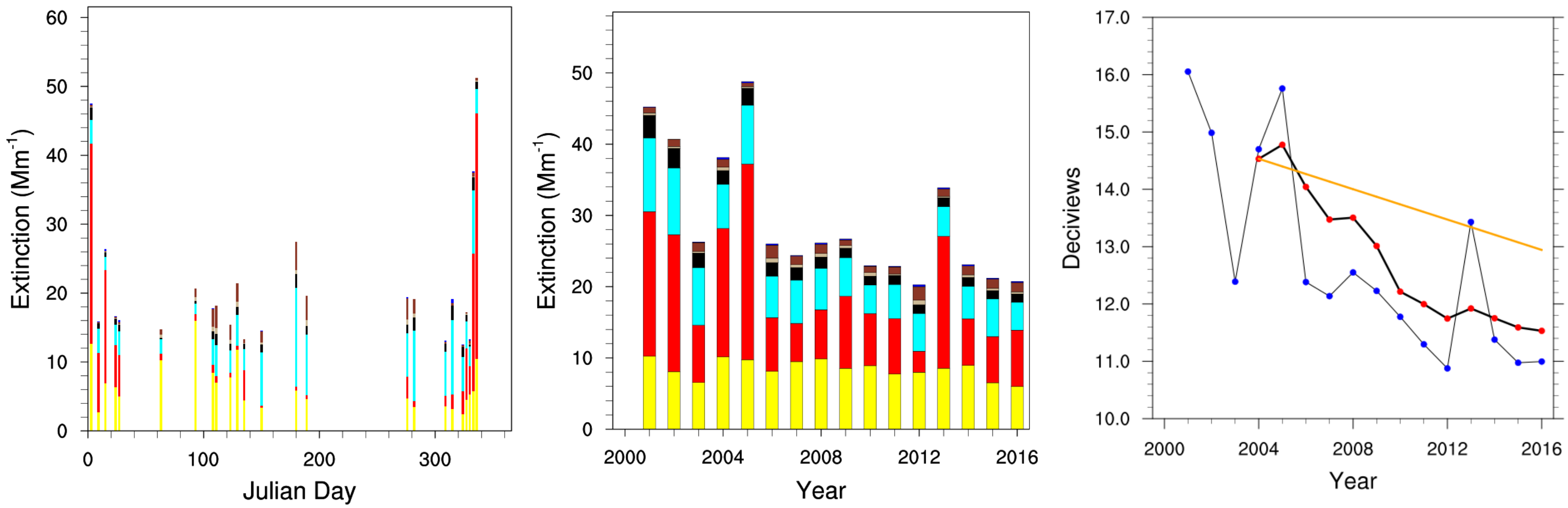
Sipsey Wilderness, AL



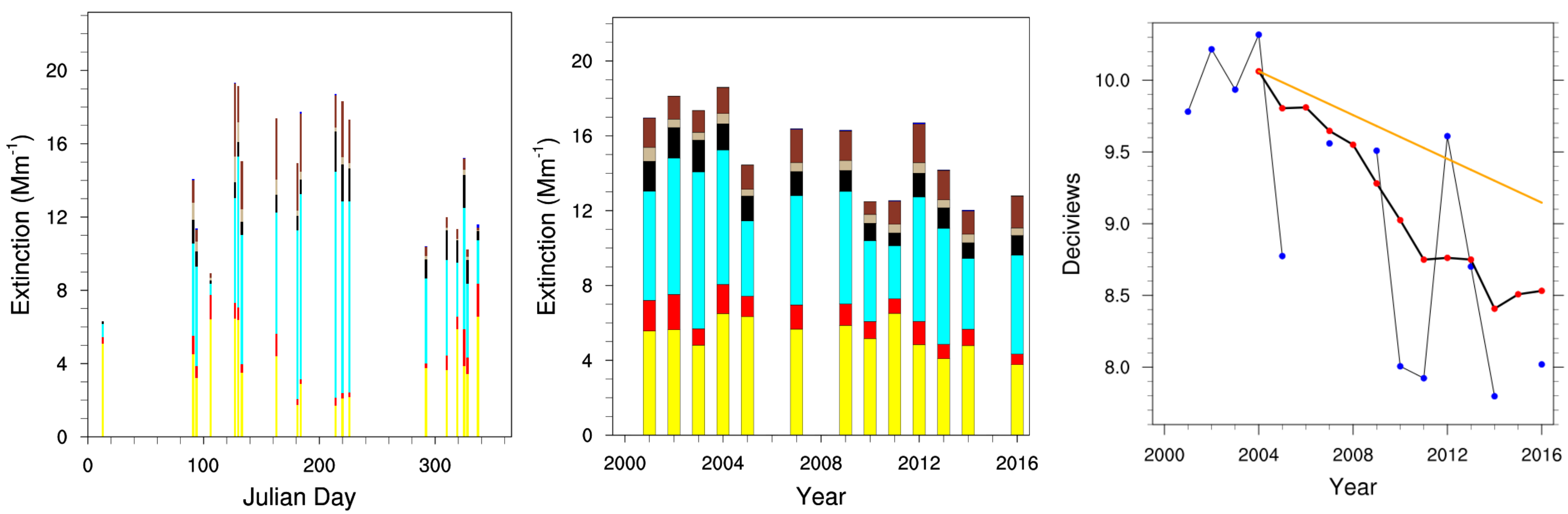
Snoqualmie Pass, WA



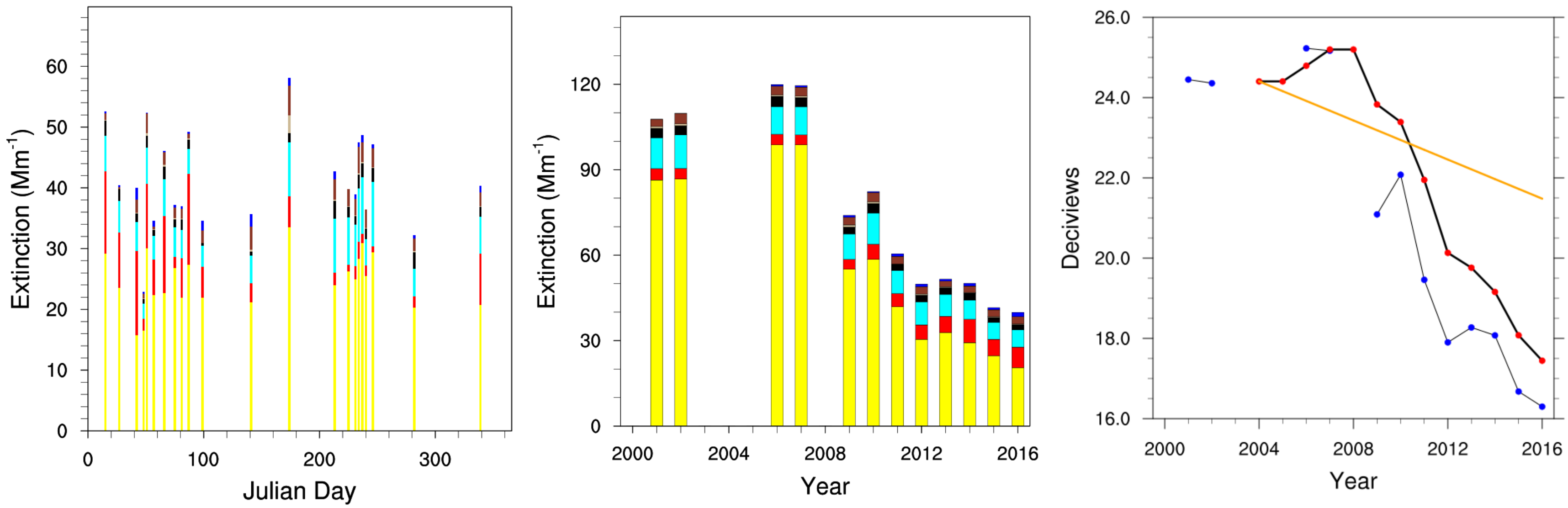
Starkey, OR



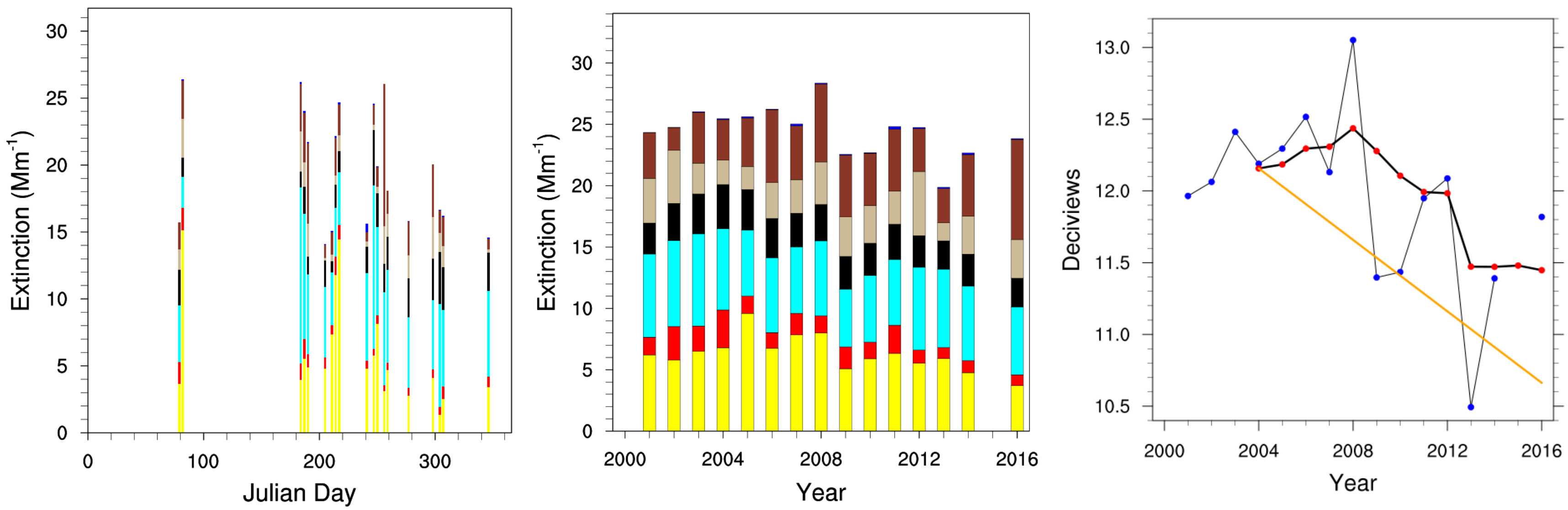
Sula Peak, MT (2013 data shown for figures in right column)



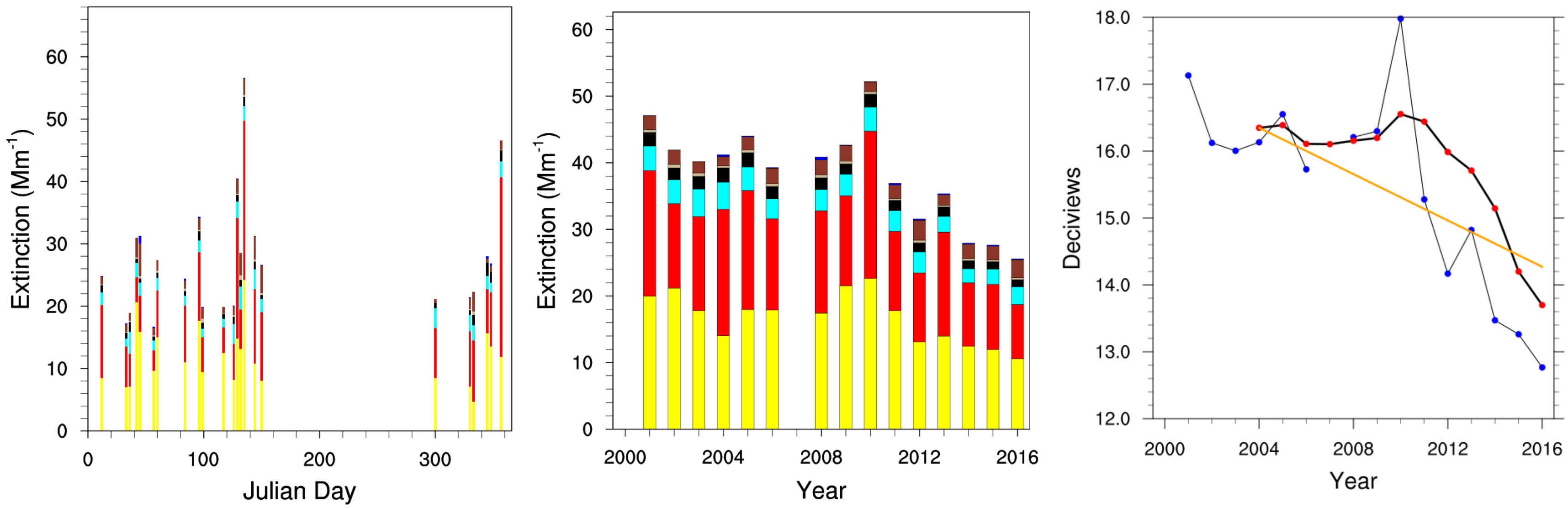
Swanquarter, NC



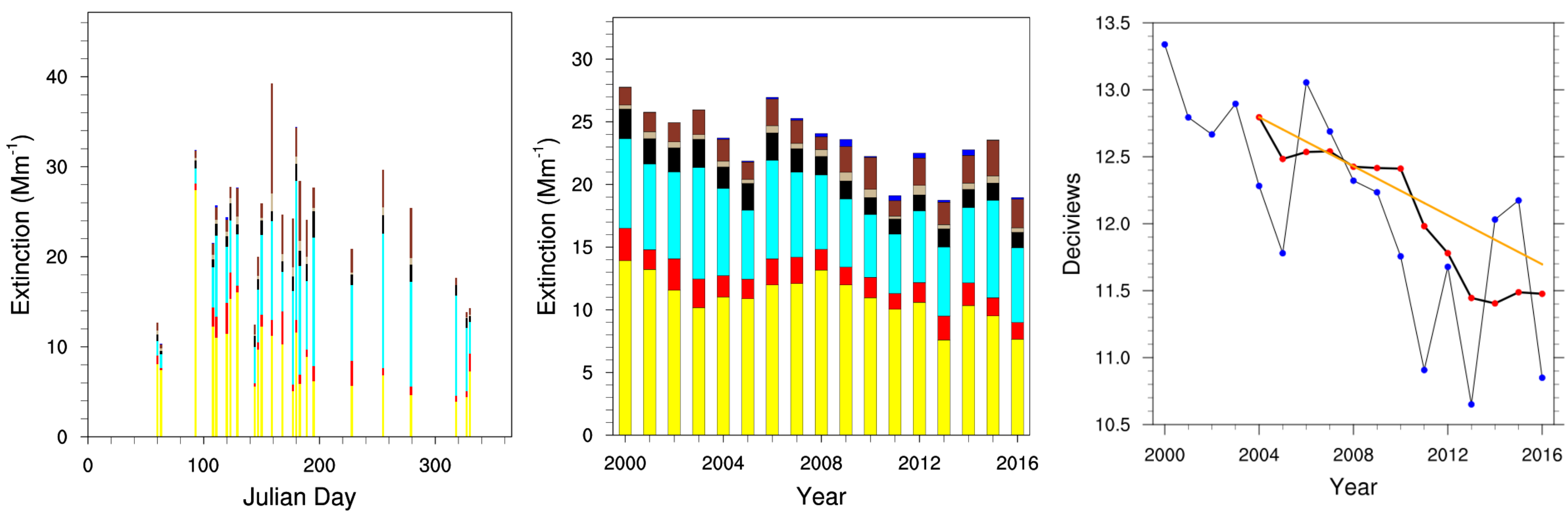
Sycamore Canyon, AZ (2013 data shown for figures in right column)



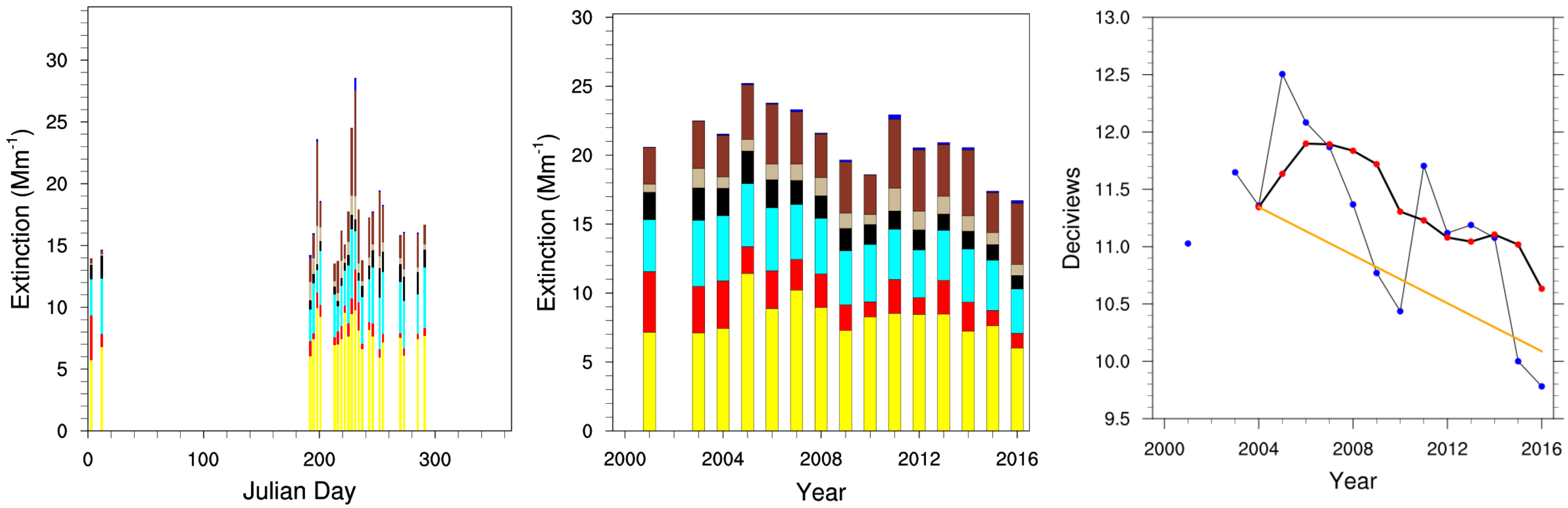
Theodore Roosevelt, ND



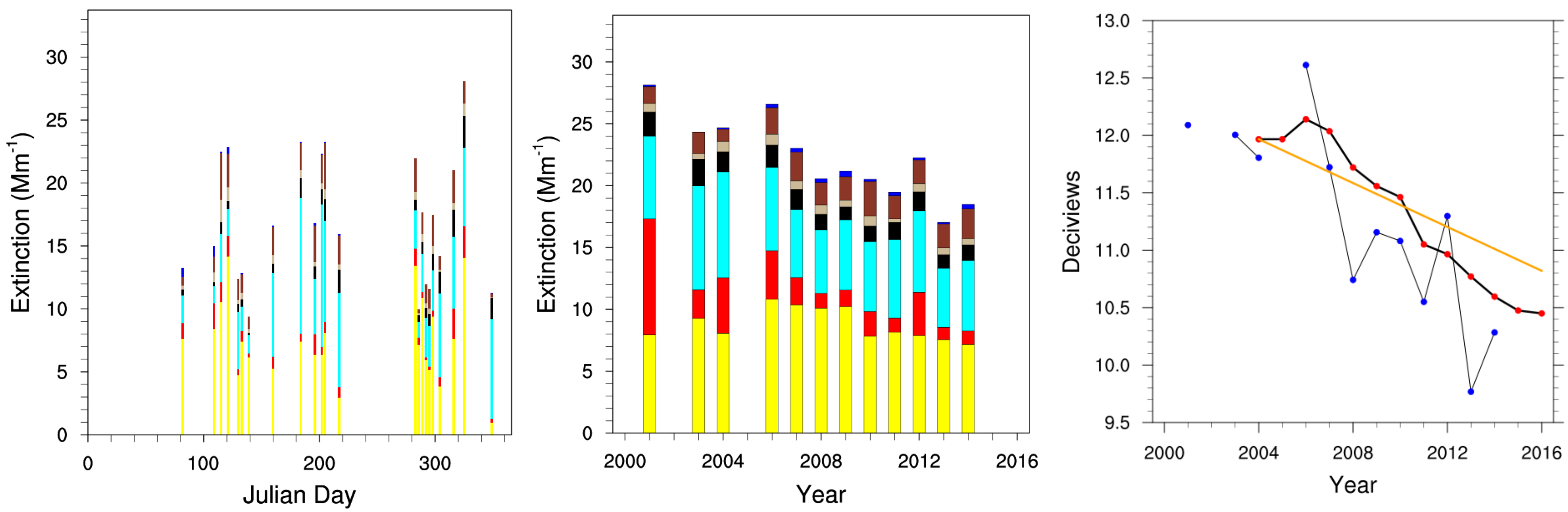
Three Sisters Wilderness, OR



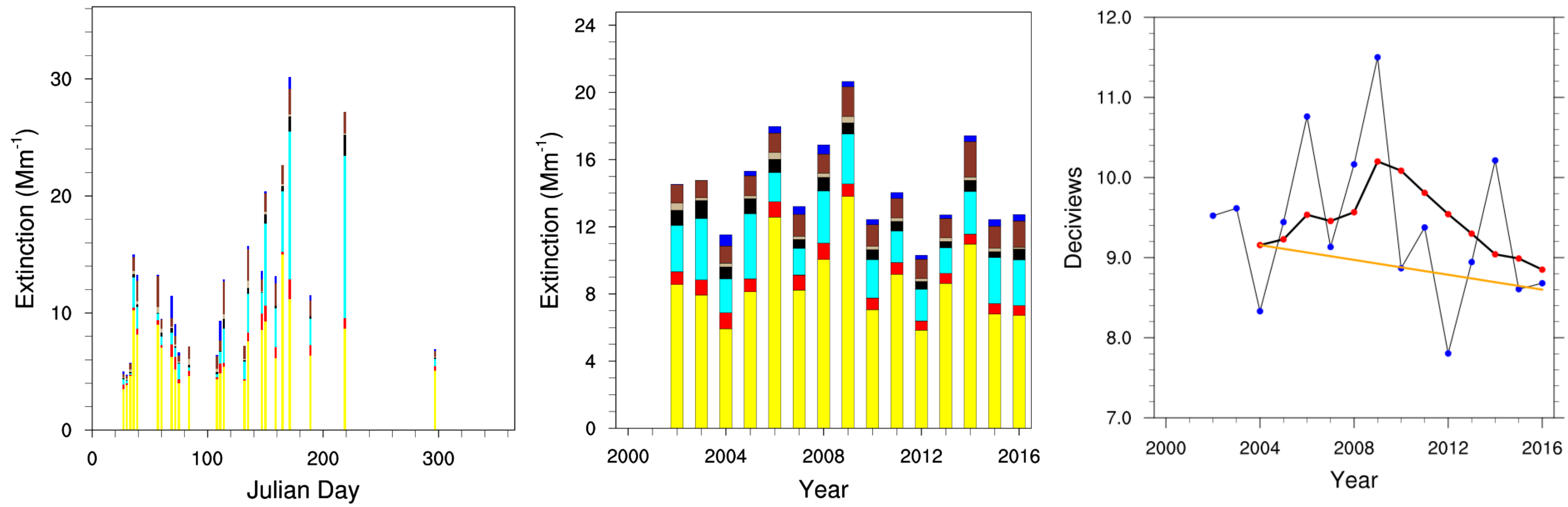
Tonto National Monument, AZ



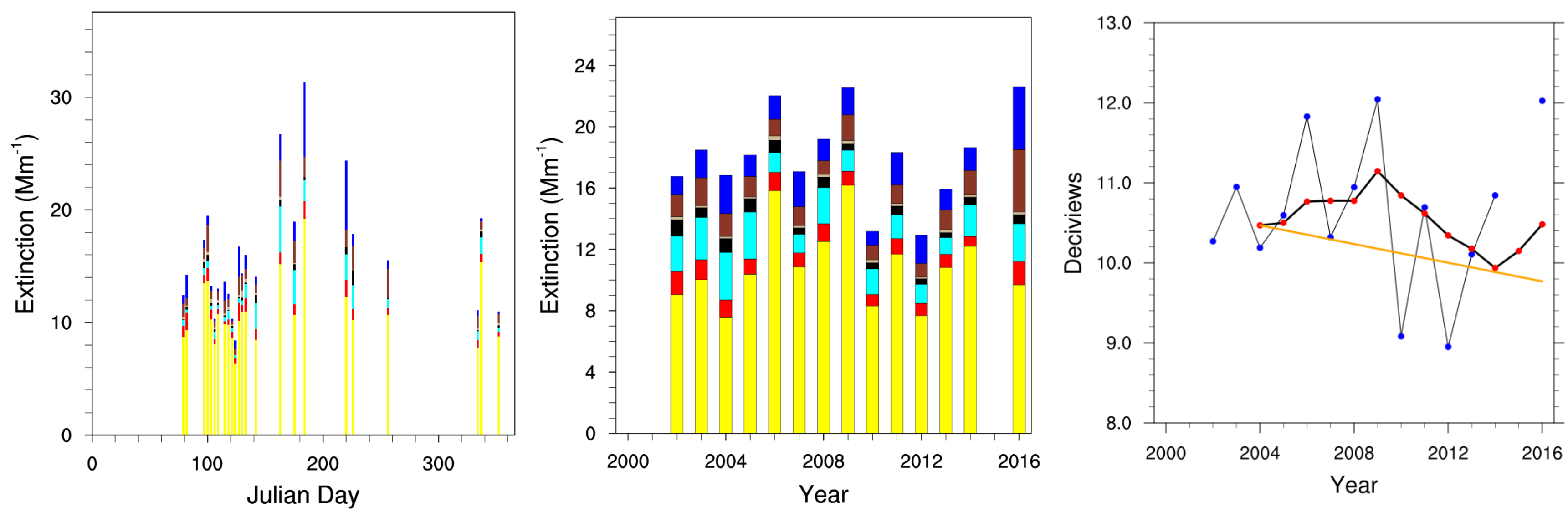
Trinity, CA (2013 data shown for figures in right column)



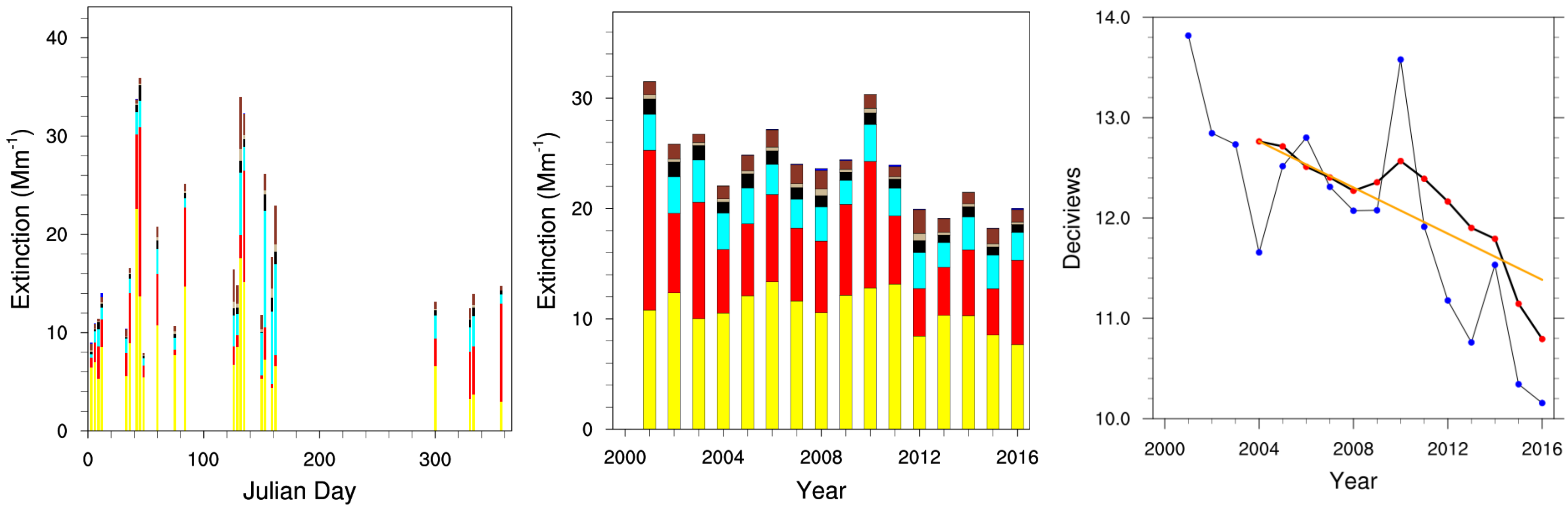
Trapper Creek, AK



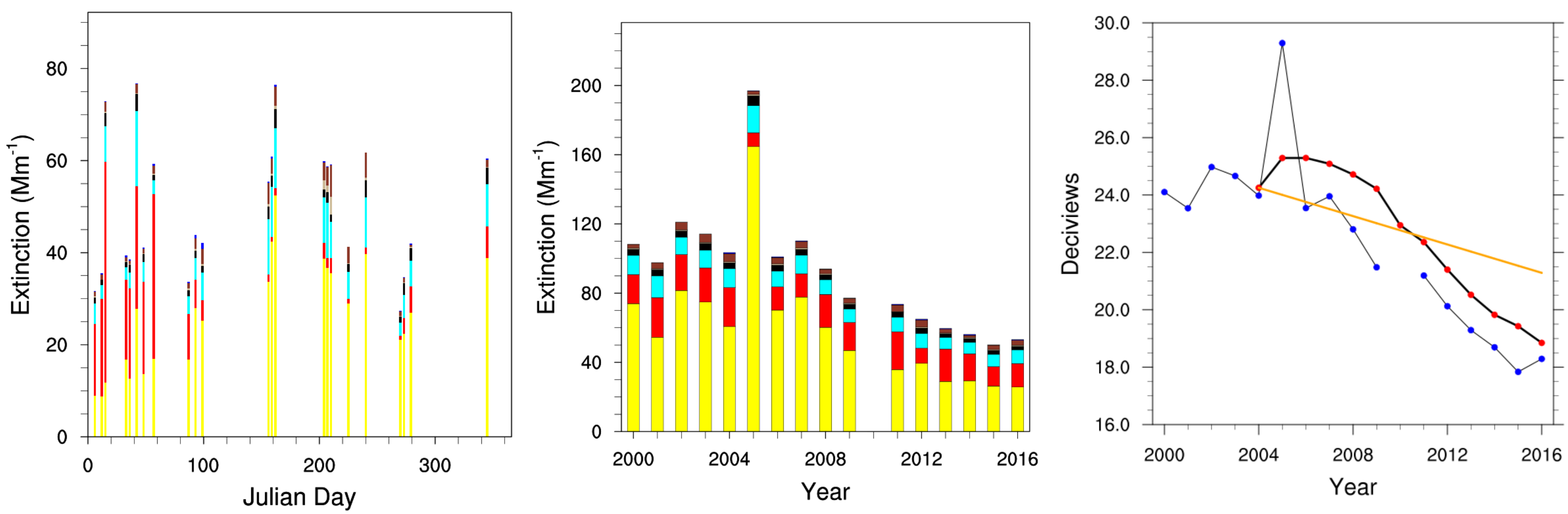
Tuxedni, AK (2013 data shown for figures in right column)



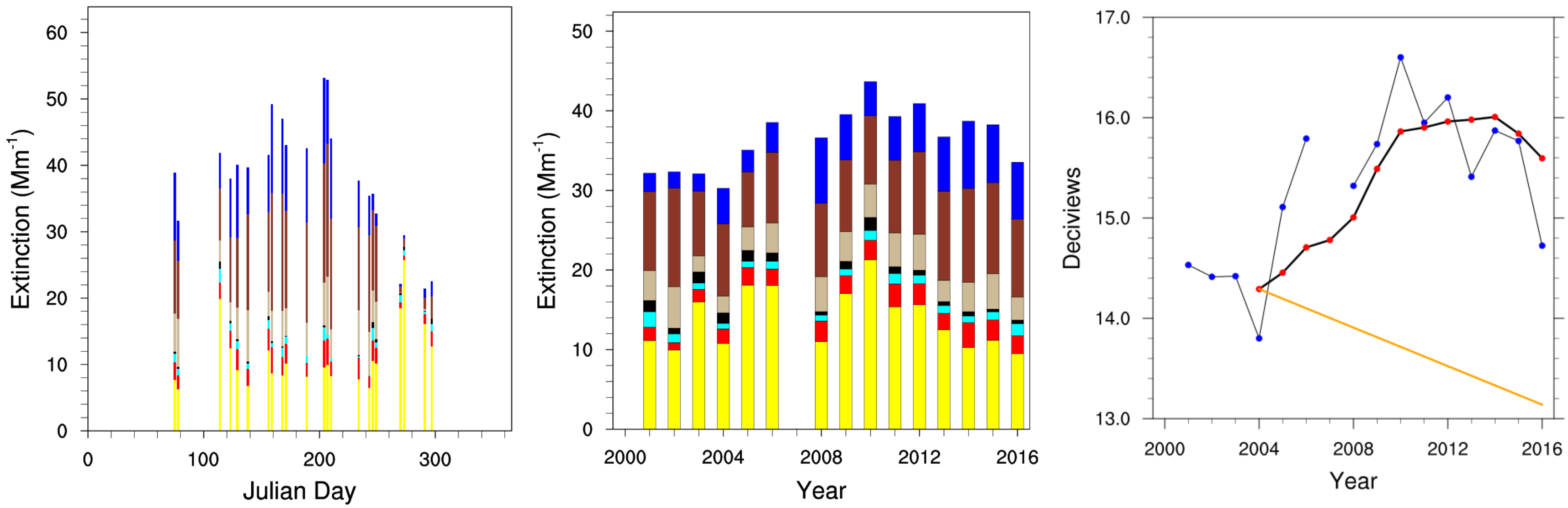
UL Bend, MT



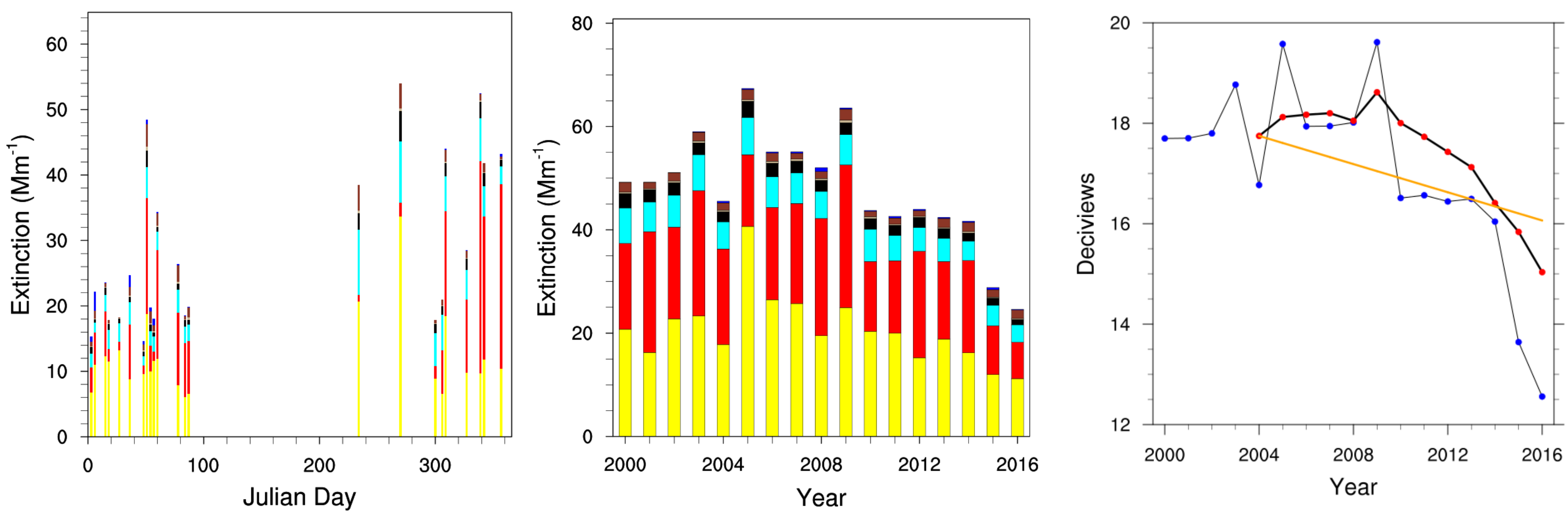
Upper Buffalo Wilderness, AR



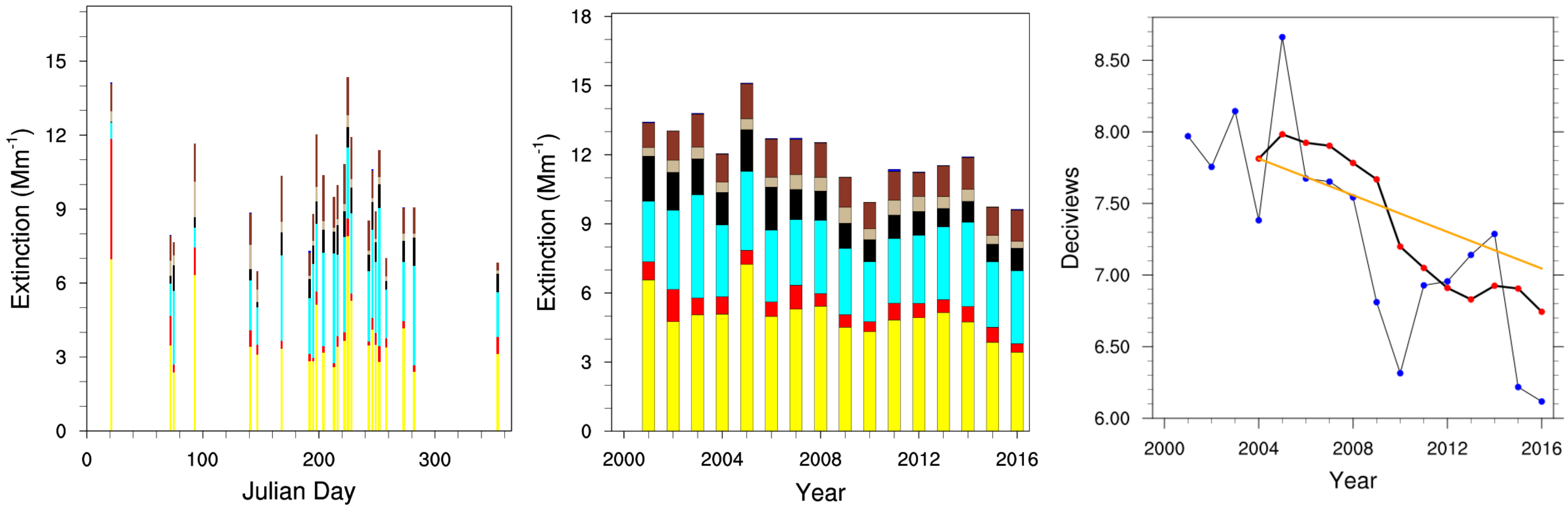
Virgin Islands National Park, VI



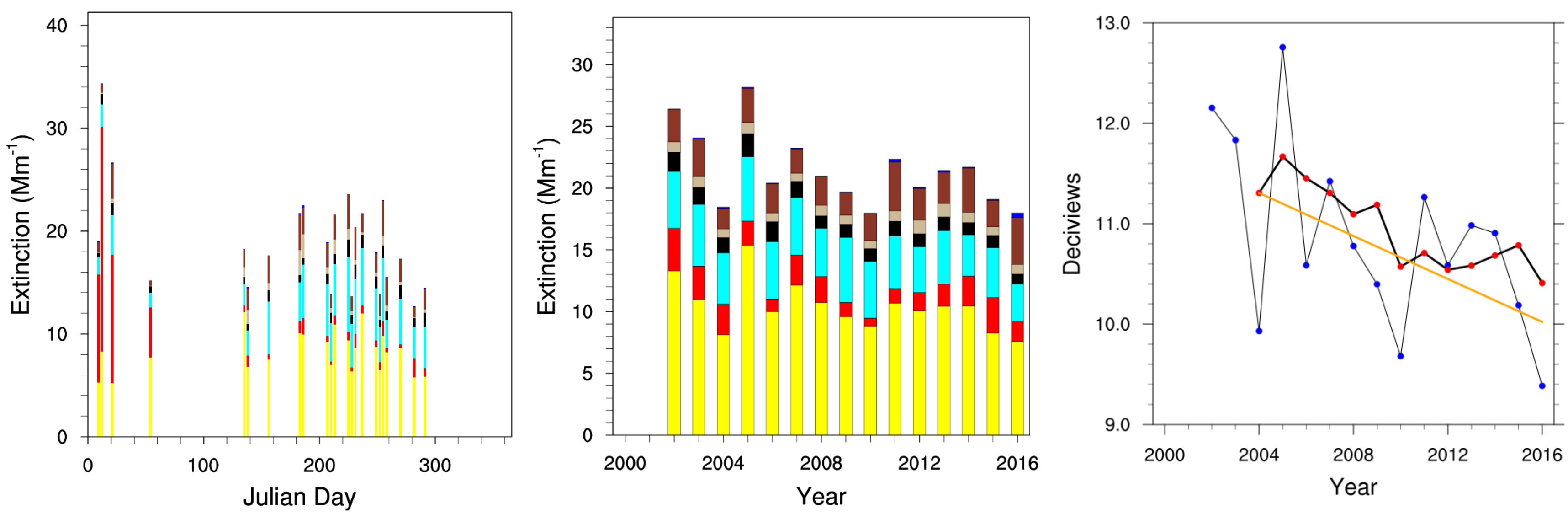
Voyageurs National Park, MN



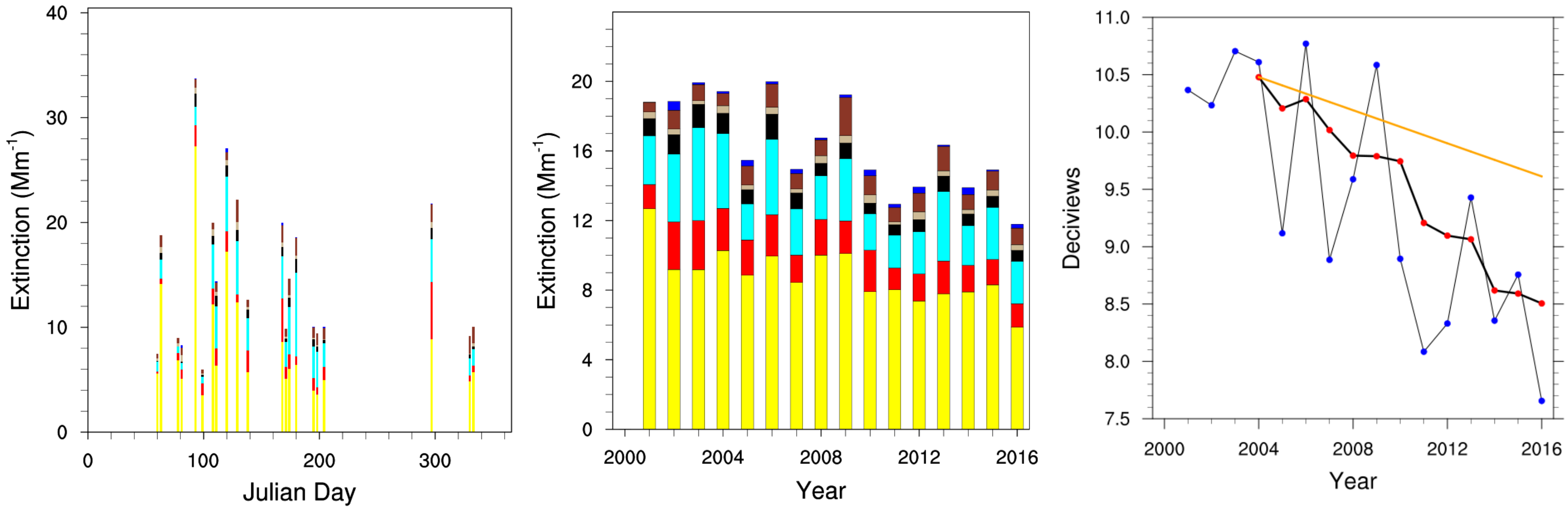
Weminuche Wilderness, CO



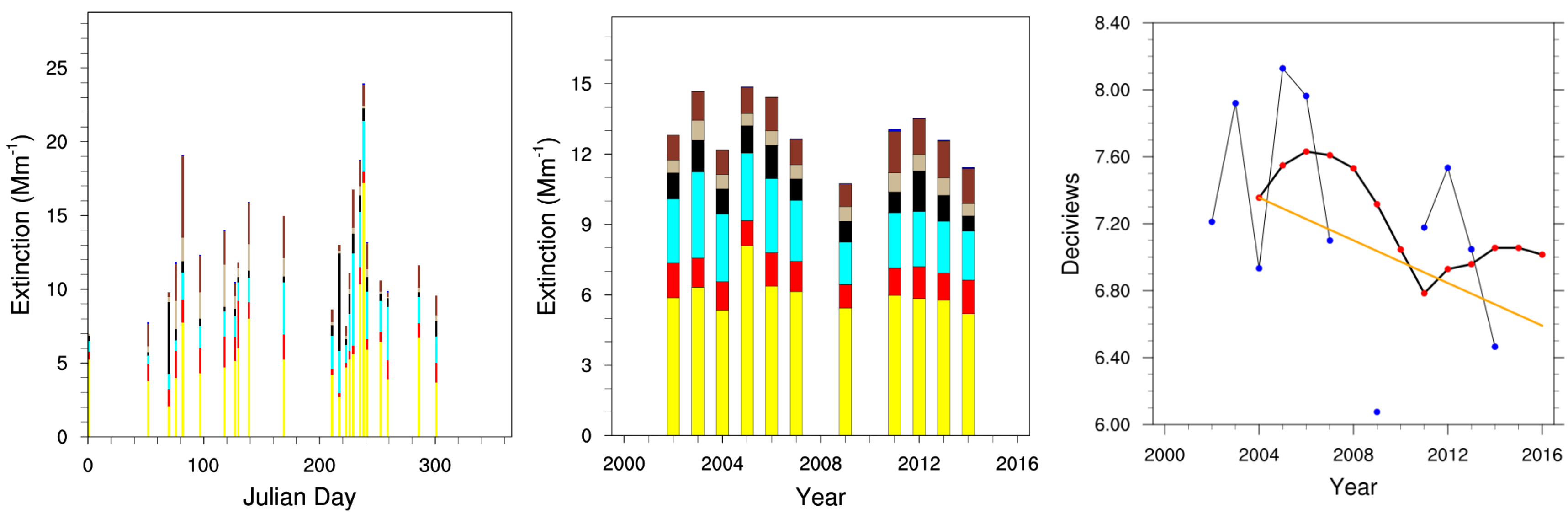
White Mountain, NM



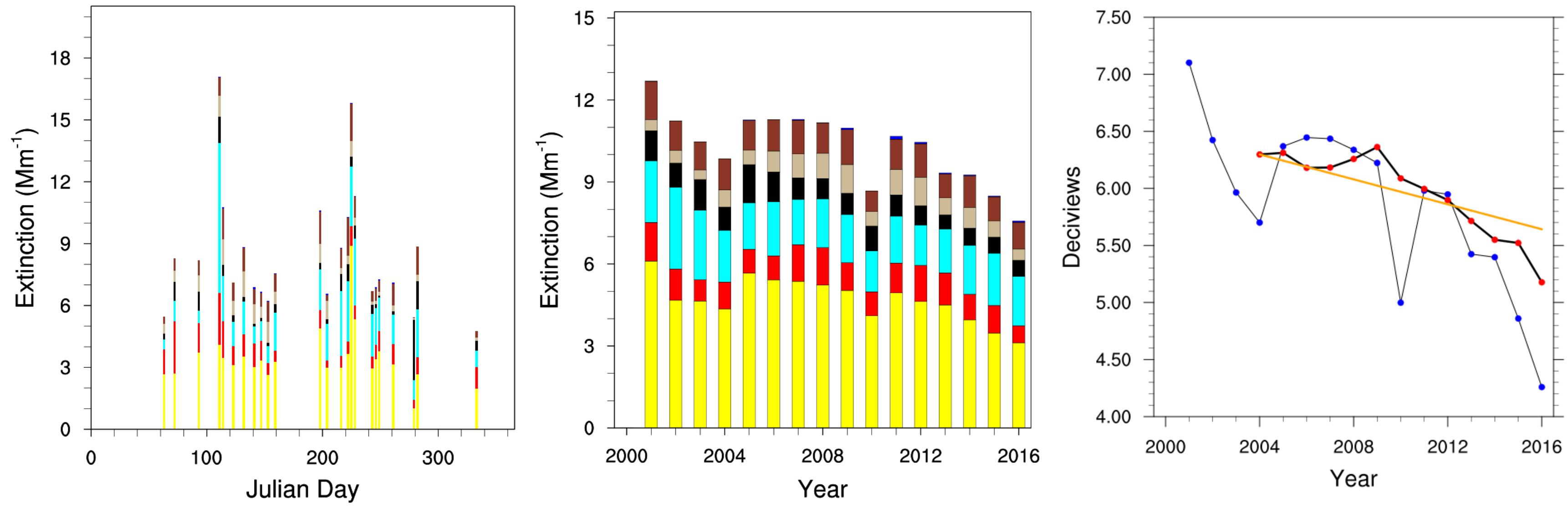
White Pass, WA



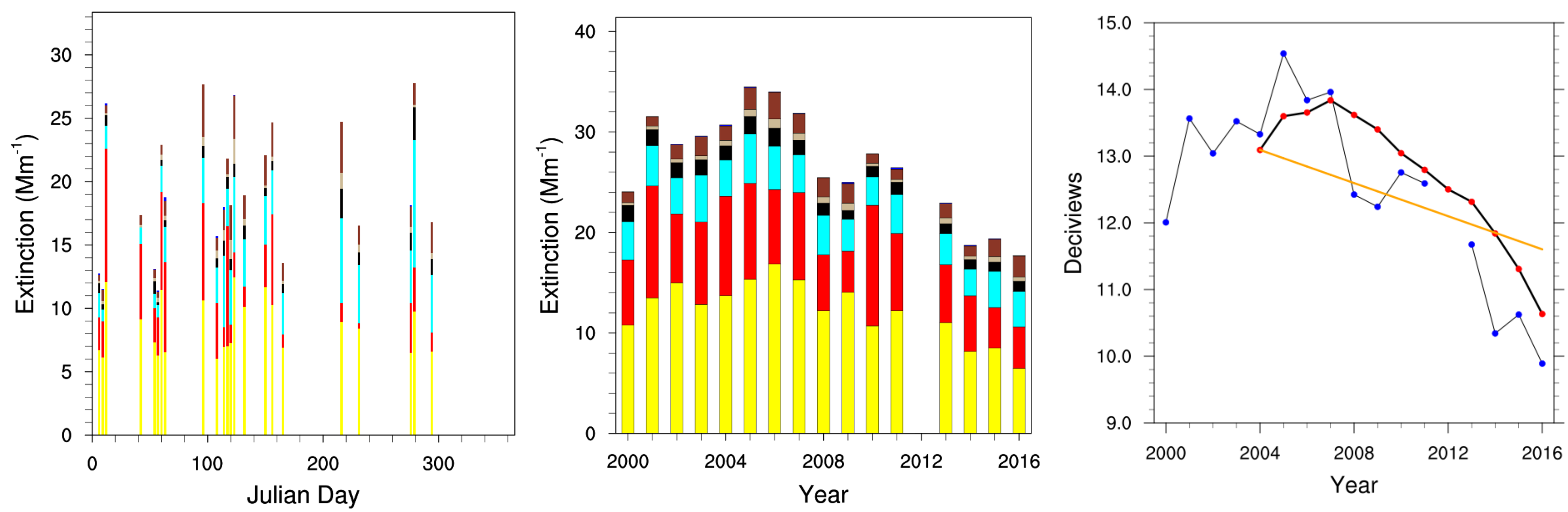
Wheeler Peak, NM (2013 data shown for figures in right column)



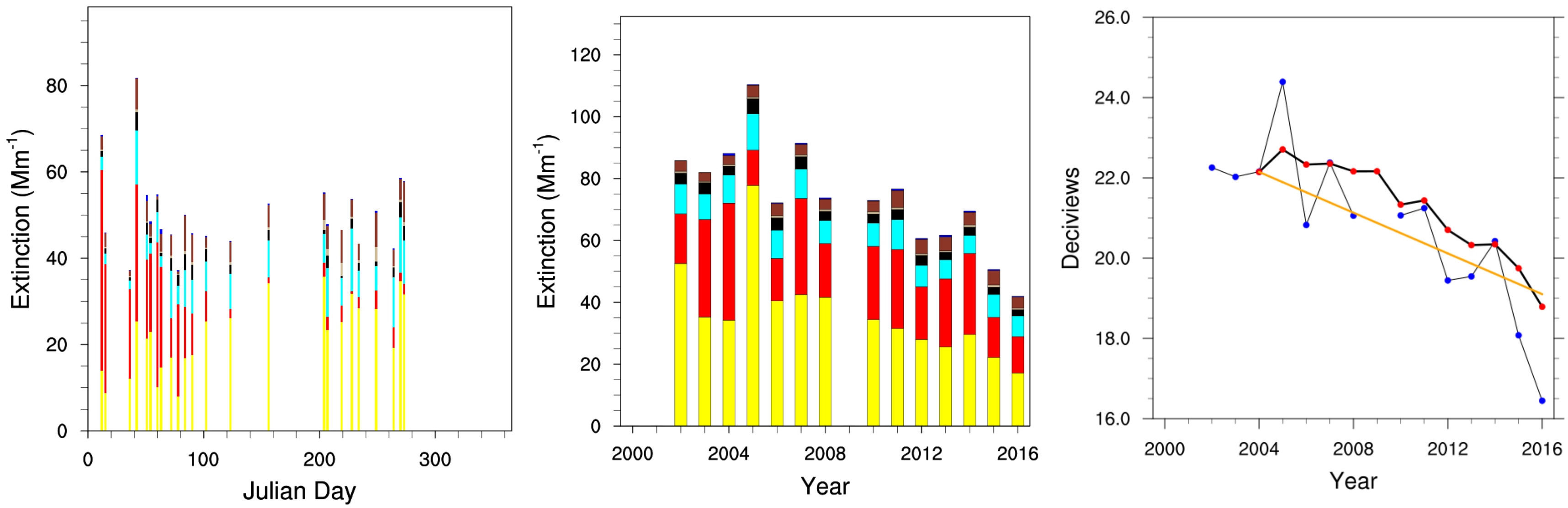
White River National Forest, CO



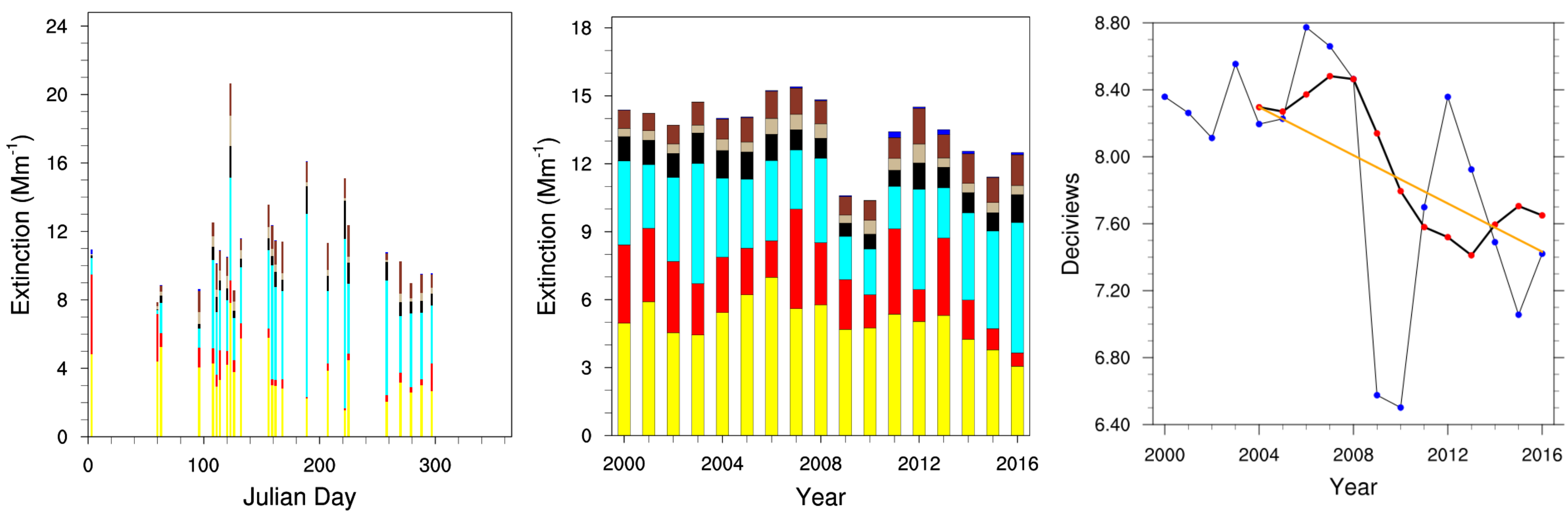
Wind Cave, SD



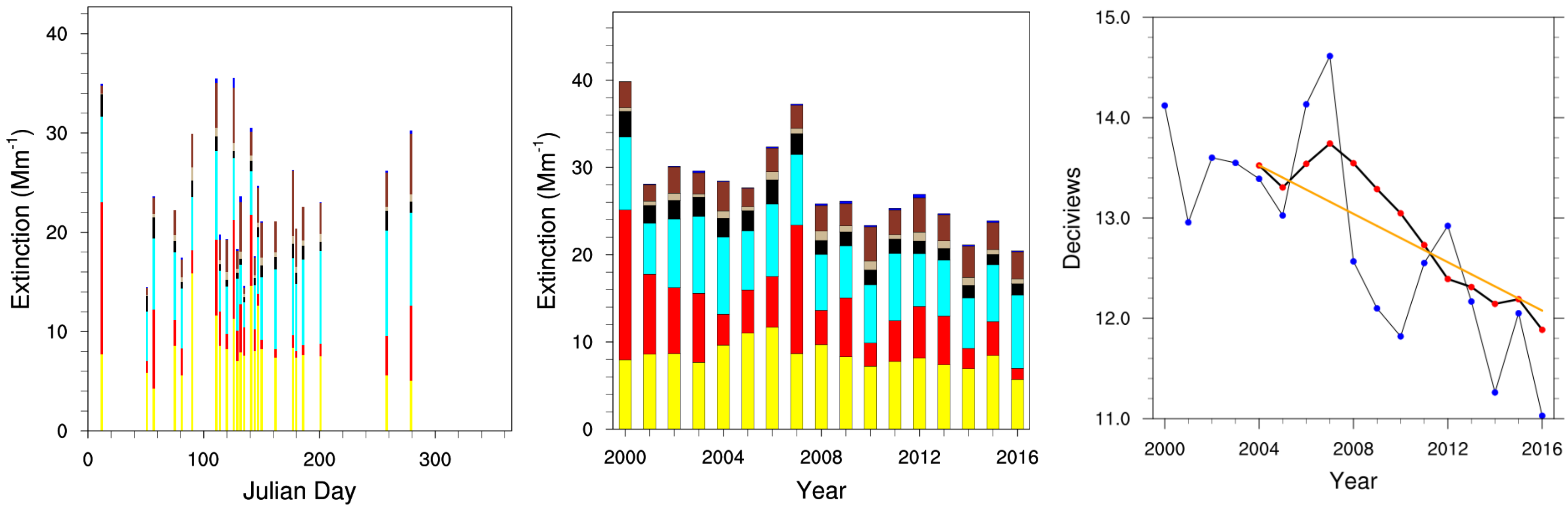
Wichita Mountains, OK



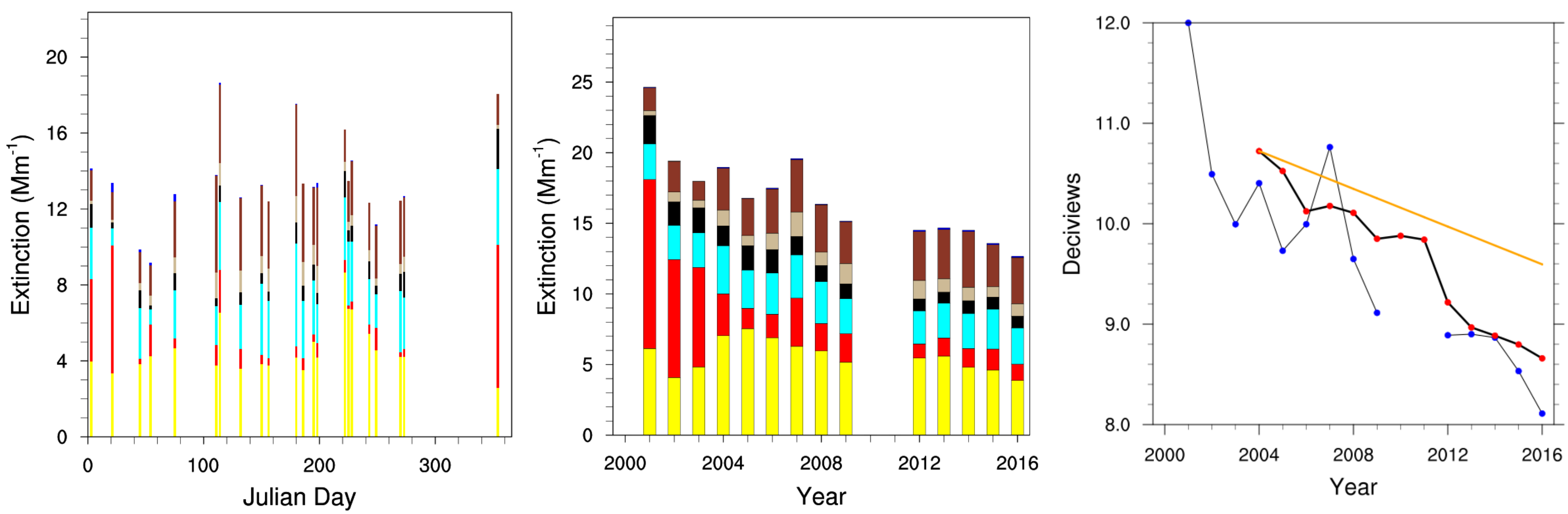
Yellowstone National Park, WY



Yosemite National Park, CA



Zion National Park, UT (combined ZION1 and ZICA1 starting 1/1/04)



United States Environmental Protection Agency	Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC	Publication No. EPA-454/R-18-010 December 2018