Updated EPA 2028 Regional Haze Modeling

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October 15, 2019

Outline

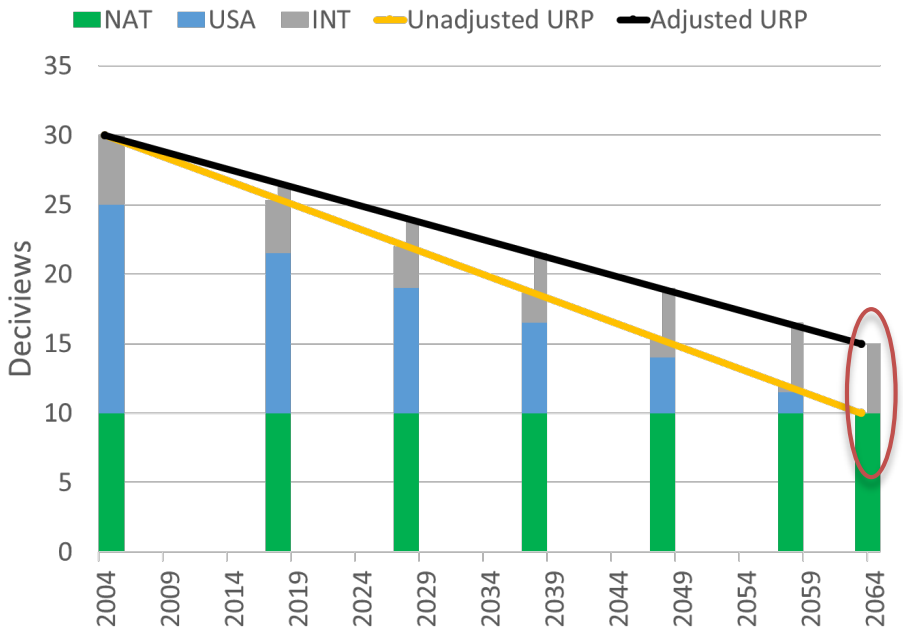
- Background
- 2016 basecase
- 2028 projections
  - Basecase and source apportionment
- 2028 international and sector contributions

EPA Administrator's Regional Haze Roadmap

- Key technical products resulting from the Administrator's Regional Haze Roadmap (September 11, 2018)
  - December 2018 Technical Guidance
    - Final recommendations on methods for selecting the 20% most impaired days and natural conditions
    - Methods for accounting for international impacts to adjust the uniform rate of progress (URP) "glidepath"
  - September 2019 Updated EPA regional haze modeling
    - 2028 visibility projections using updated modeling platform
    - Estimate of US and international source contributions to Class I areas

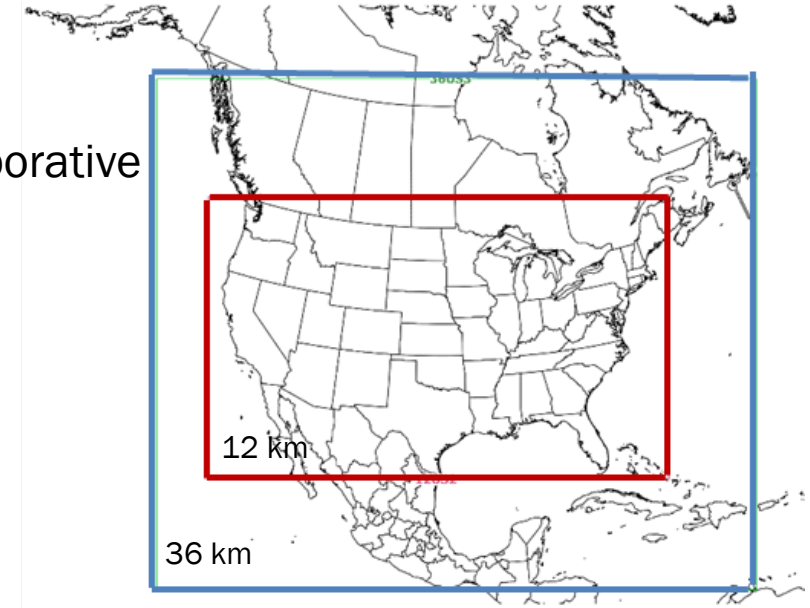
Technical Guidance on Tracking Visibility Progress

- The 2017 Regional Haze Rule revisions require a revised approach to tracking visibility improvements over time.
  - The Technical Guidance finalizes a recommended methodology to develop baseline and current visibility conditions, and natural conditions on the 20% ***most impaired*** and clearest days at Class I areas.
    - The recommended visibility tracking metric focuses on **anthropogenic** visibility impairment
- The 2017 Regional Haze Rule also includes a provision that allows states to propose an adjustment to the URP glidepath to account for anthropogenic international sources (and prescribed fires).
  - The Technical Guidance describes recommended tools and methods to develop optional URP adjustments



Updated EPA Regional Haze Modeling

- New 2016 modeling platform with projections to 2028, including sector-based and international contribution
  - 2028 projected deciviews and glidepath estimates at Class I areas
  - Estimate of international anthropogenic contributions
  - Model improvements from EPA's 2011/2028 platform
    - New 2016 and 2028 emissions from the State/EPA platform collaborative
      - Similar to 2016 beta emissions with a few fixes and updates
    - Regional model improvements
      - Technical updates to CAMx including the ability to separately track international anthropogenic and natural emissions
      - Larger regional domain (including 36km outer domain)
    - Updated international boundary conditions
      - Generated from Hemispheric CMAQ modeling (2016 emissions)



CAMx Model Improvements

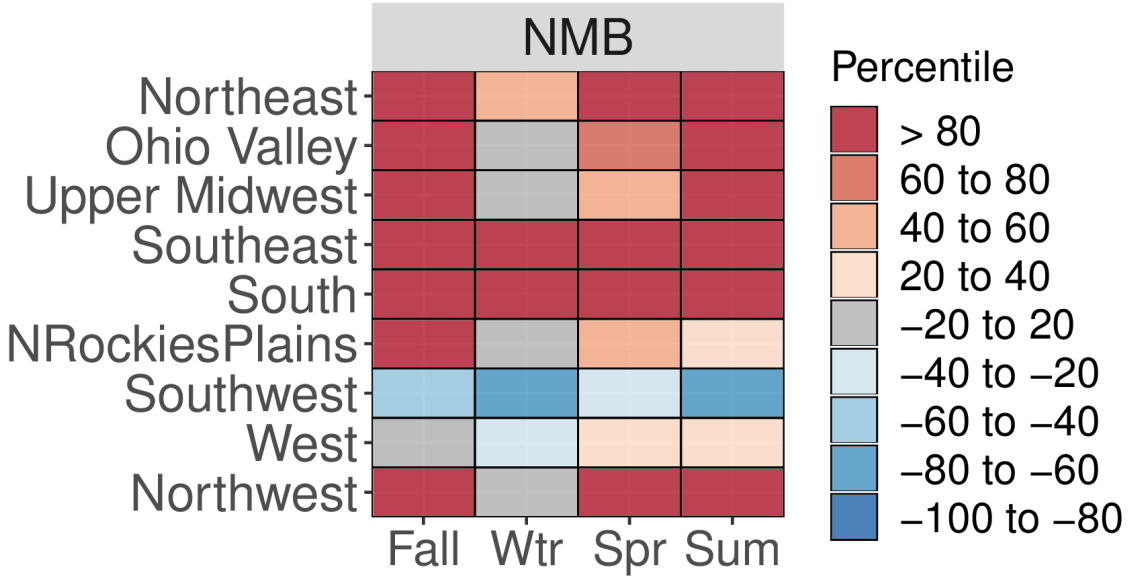
- EPA is using what will eventually become CAMx version 7.0
  - Improvement in biogenic SOA (terpene) yields
    - Decreases biogenic SOA concentrations (especially in the South)
  - Dimethyl sulfide (DMS) emissions and chemistry over the oceans
    - Adds an additional source of natural sulfate
  - Additional explicit elemental PM species (Al, Si, Ti, Mn, Mg, etc.), including tracking within PSAT
    - Allows for better consistency and tracking of fine crustal emissions between CMAQ and CAMx and within PSAT
  - Update to PSAT tracking of boundary conditions
    - Provides ability to separately track international anthropogenic and natural emissions components of the boundary conditions

Model Performance

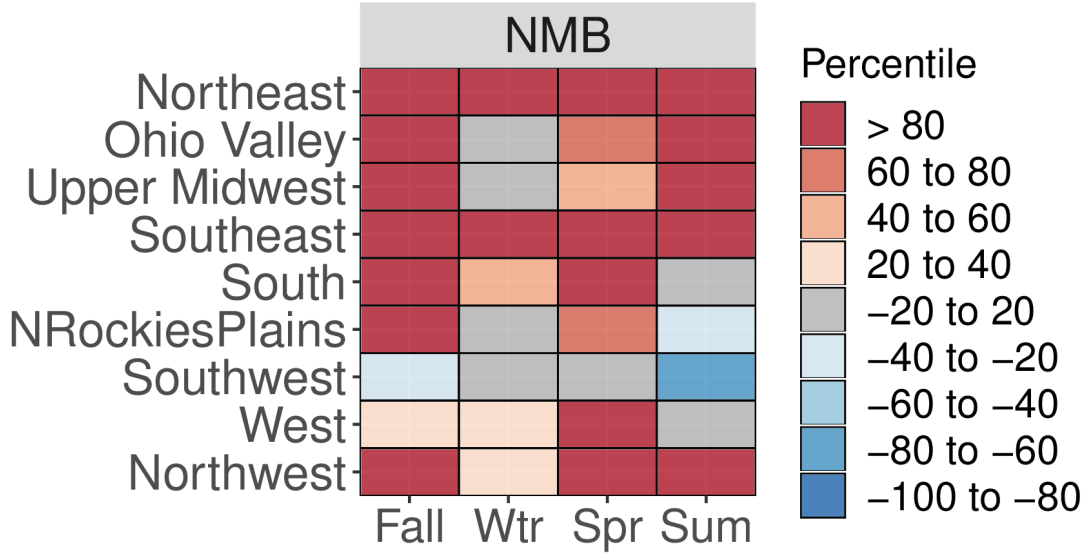
Nitrate Normalized Mean Bias

CAMx 2016ff (beta)

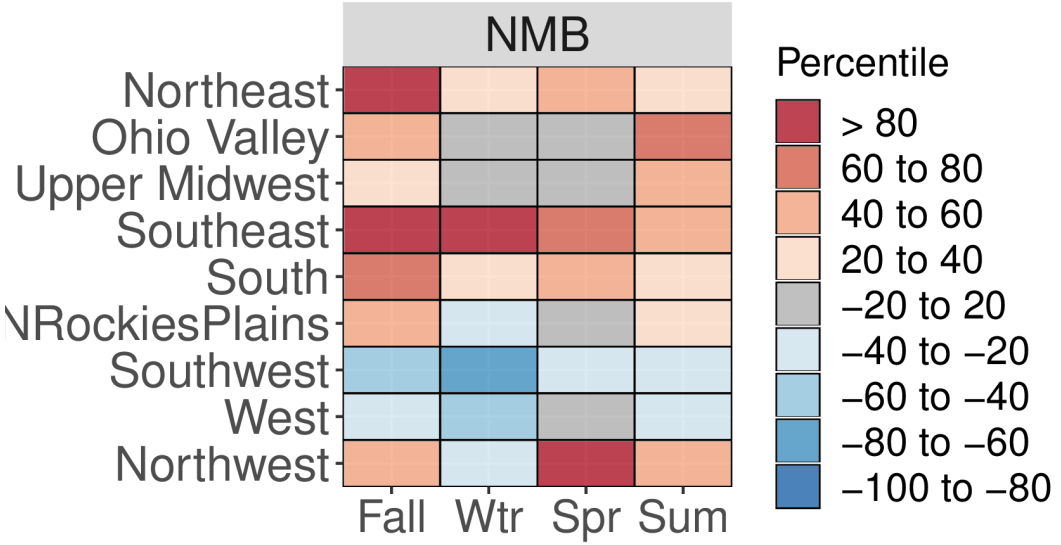
CSN

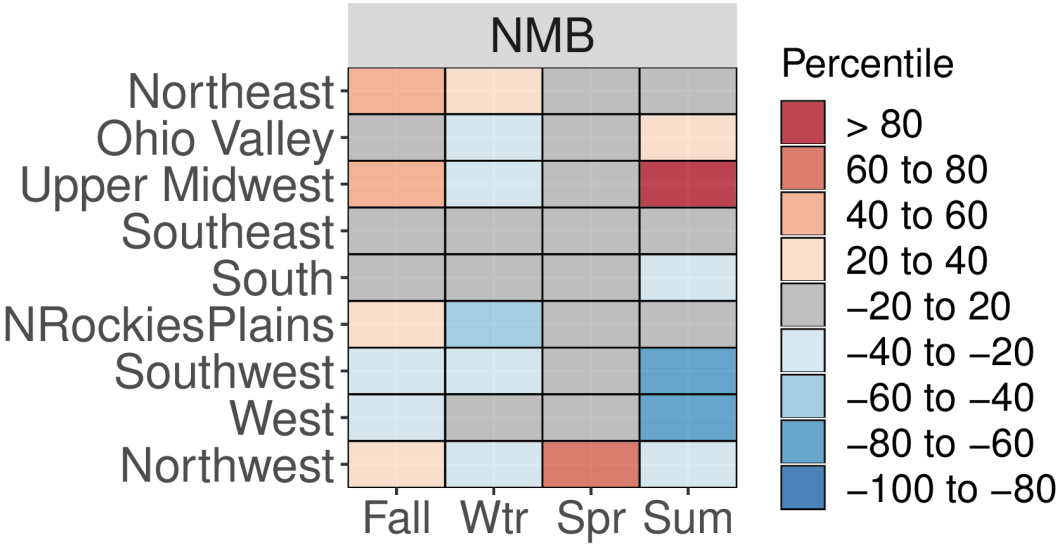


IMPROVE



CAMx 2016fg (final RH platform)



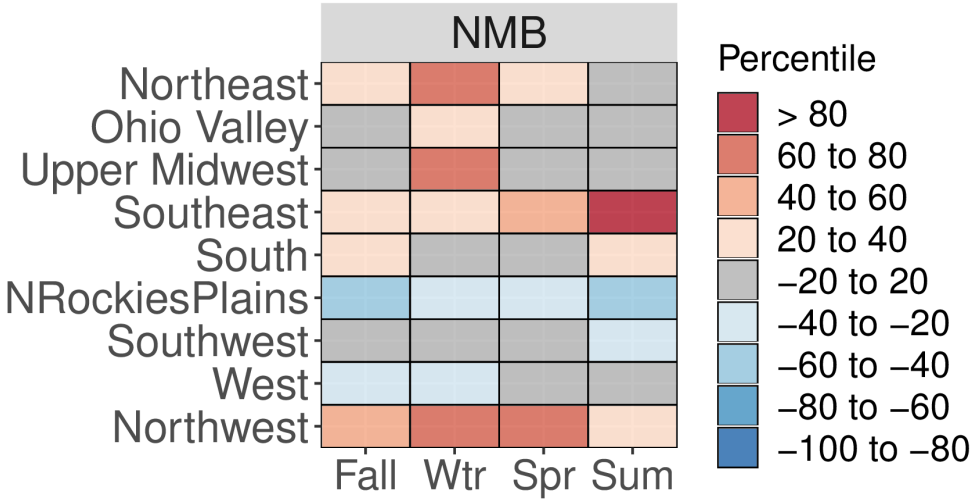


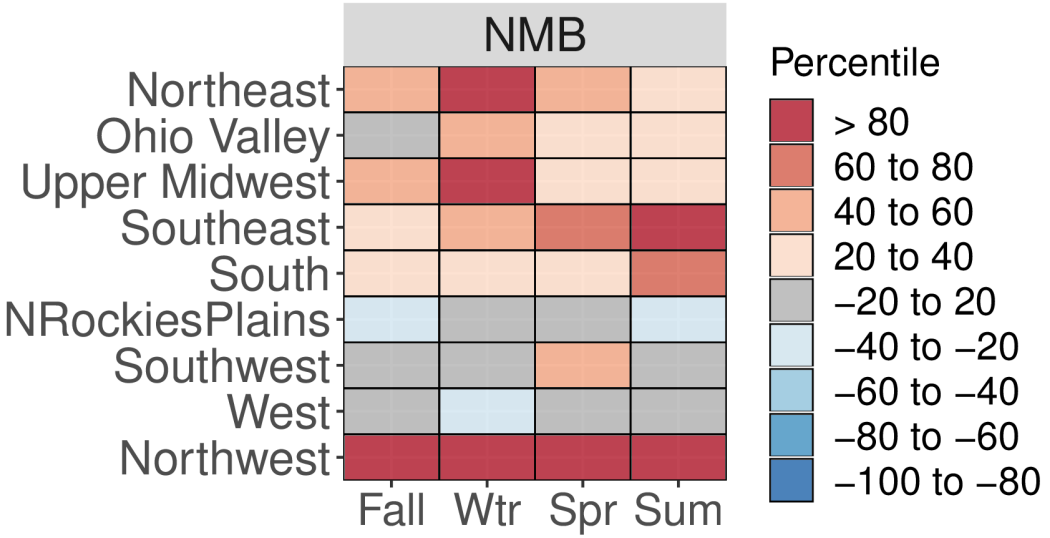
Organic Carbon Normalized Mean Bias

CAMx 2016ff

CAMx 2016fg

CSN





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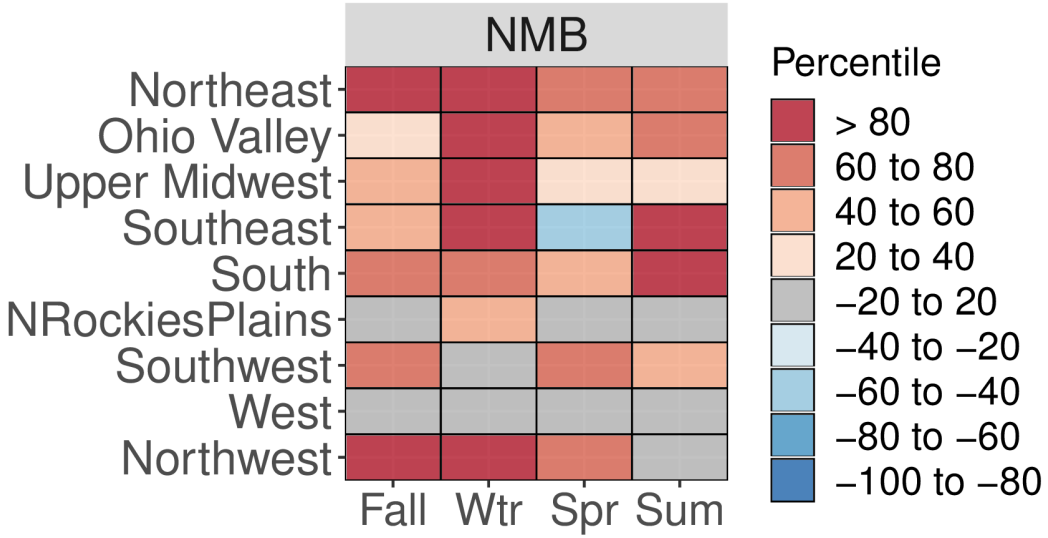
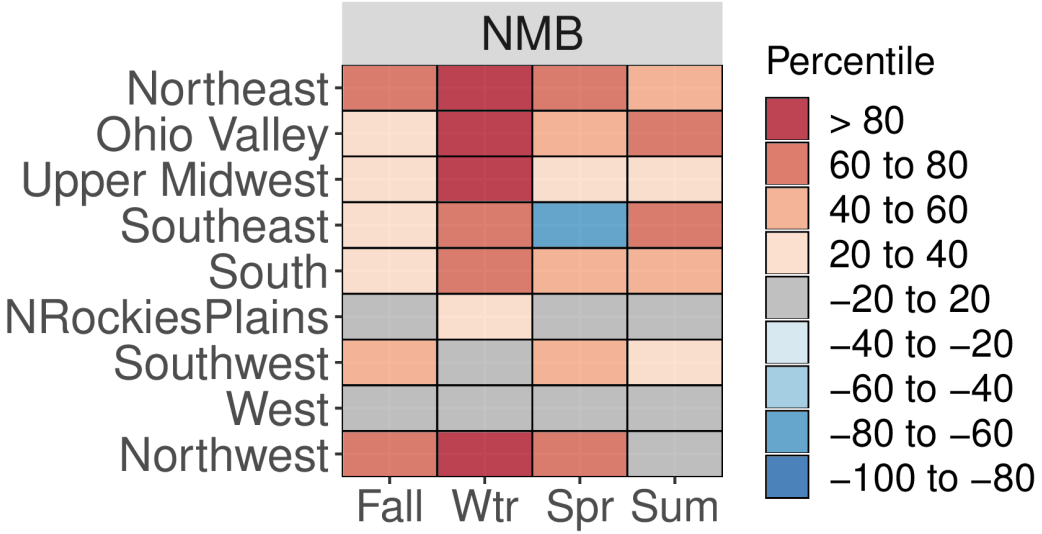


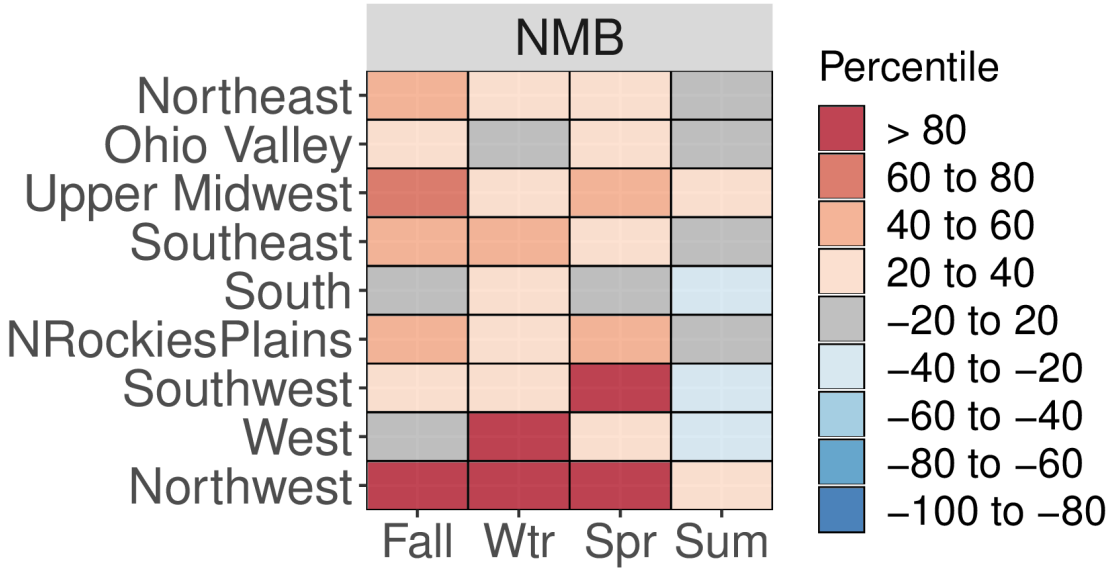


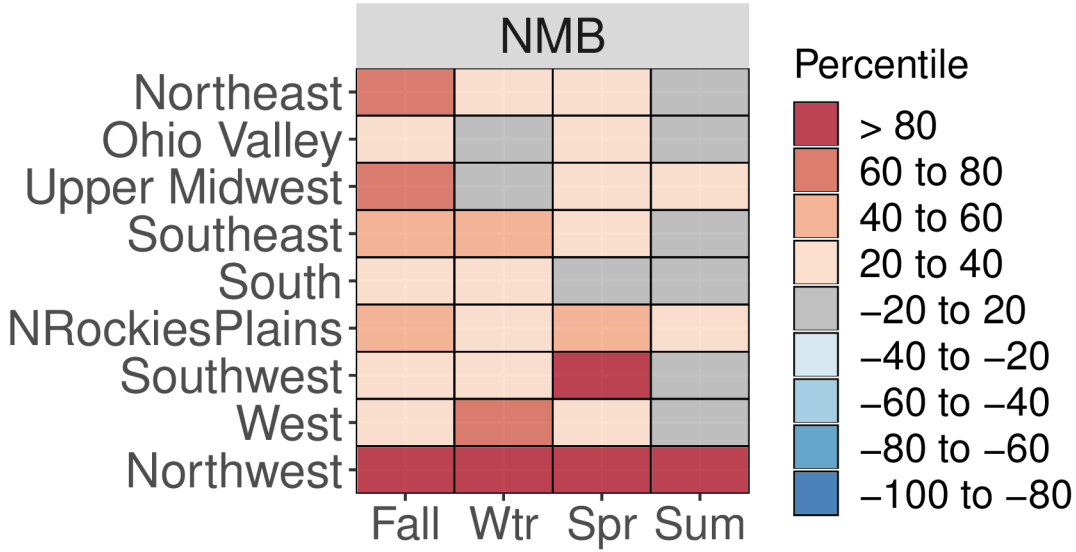
Sulfate Normalized Mean Bias

CAMx 2016ff

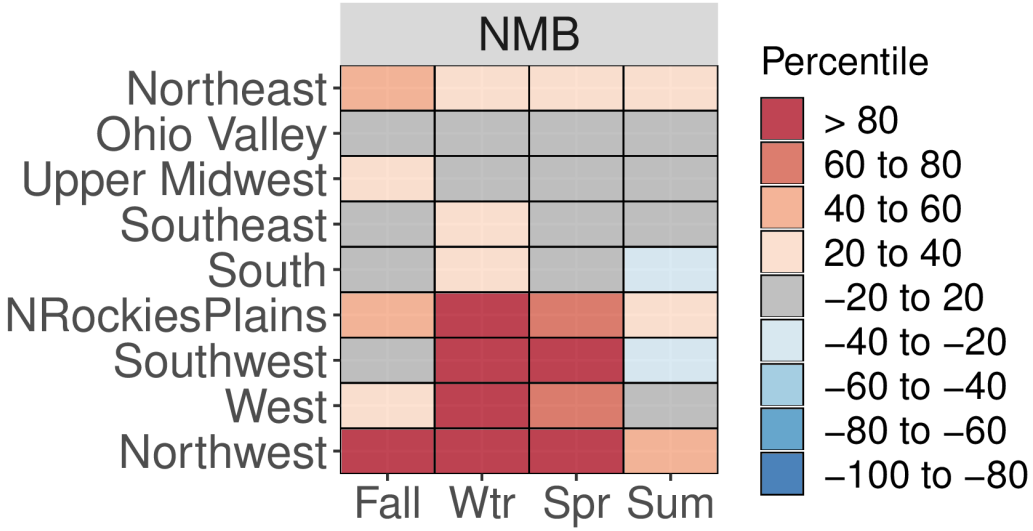
CAMx 2016fg

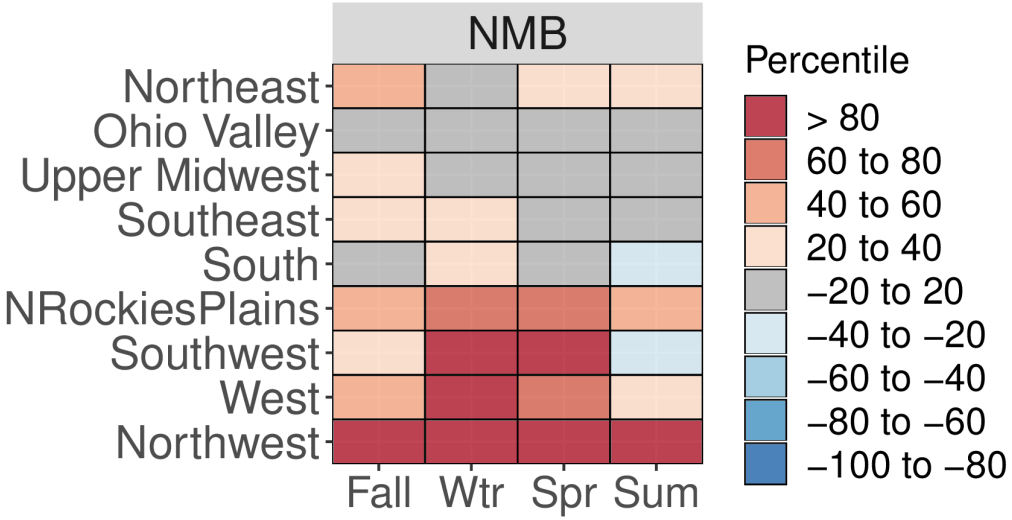
CSN





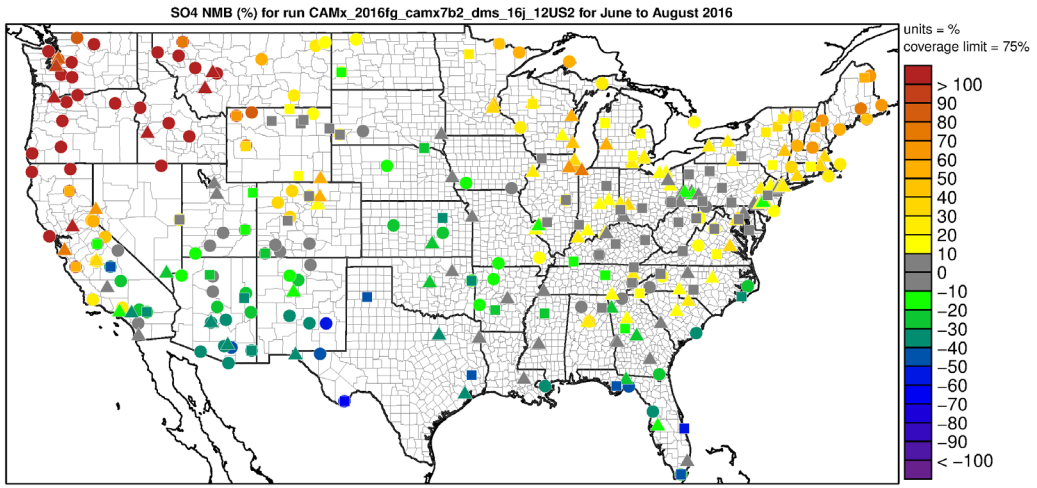
IMPROVE





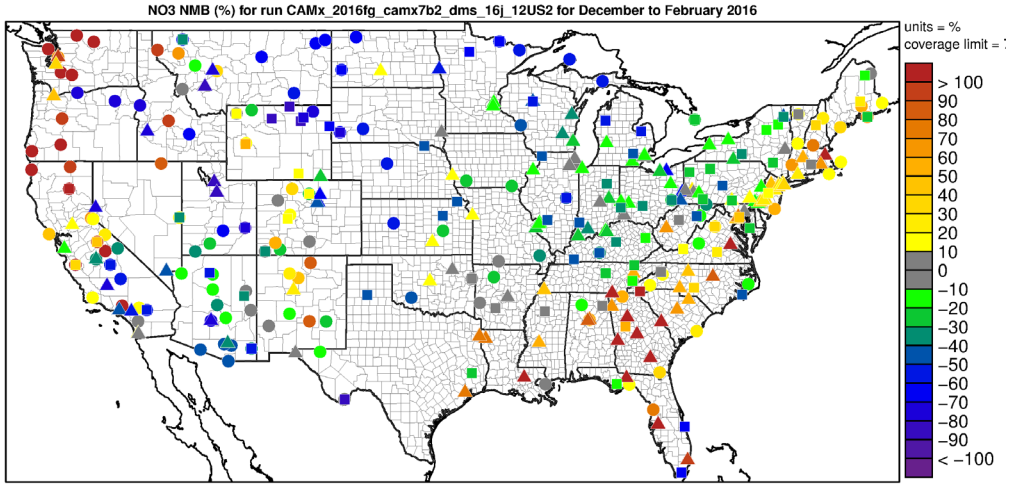
Seasonal Average NMB CAMx 2016fg

Summer Sulfate



CIRCLE=IMPROVE; TRIANGLE=CSN; SQUARE=CASTNET;

Winter Nitrate



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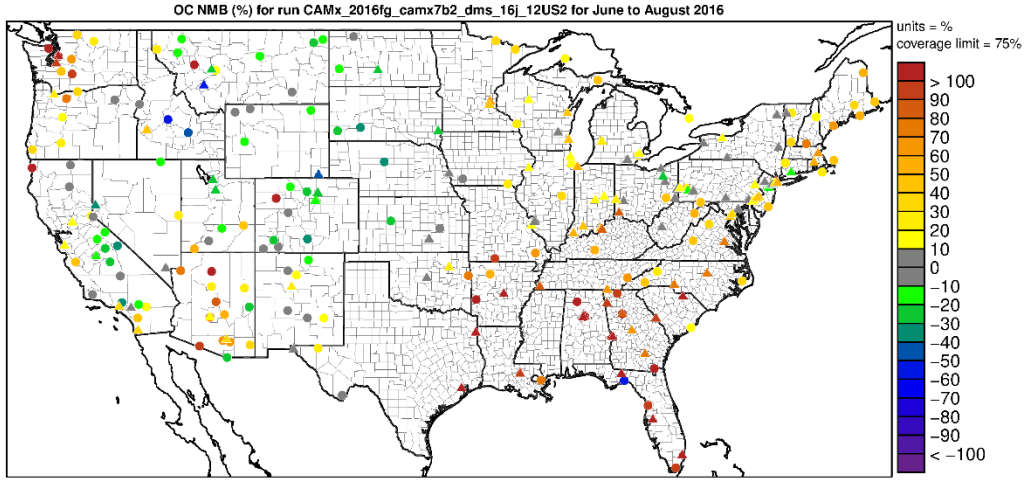
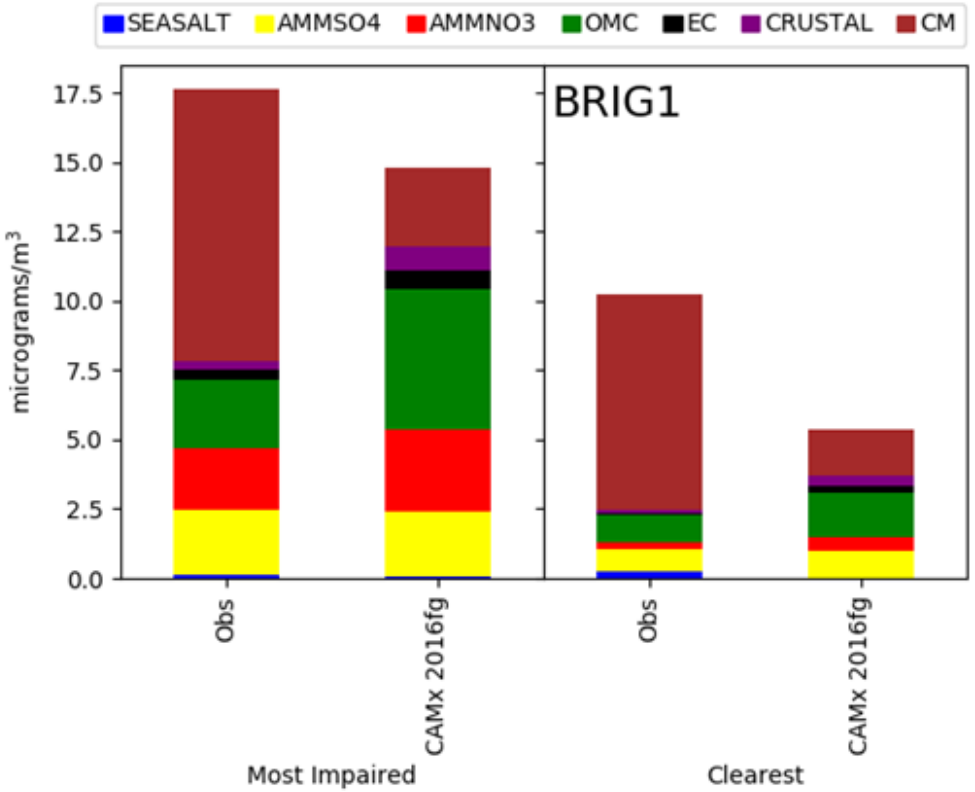
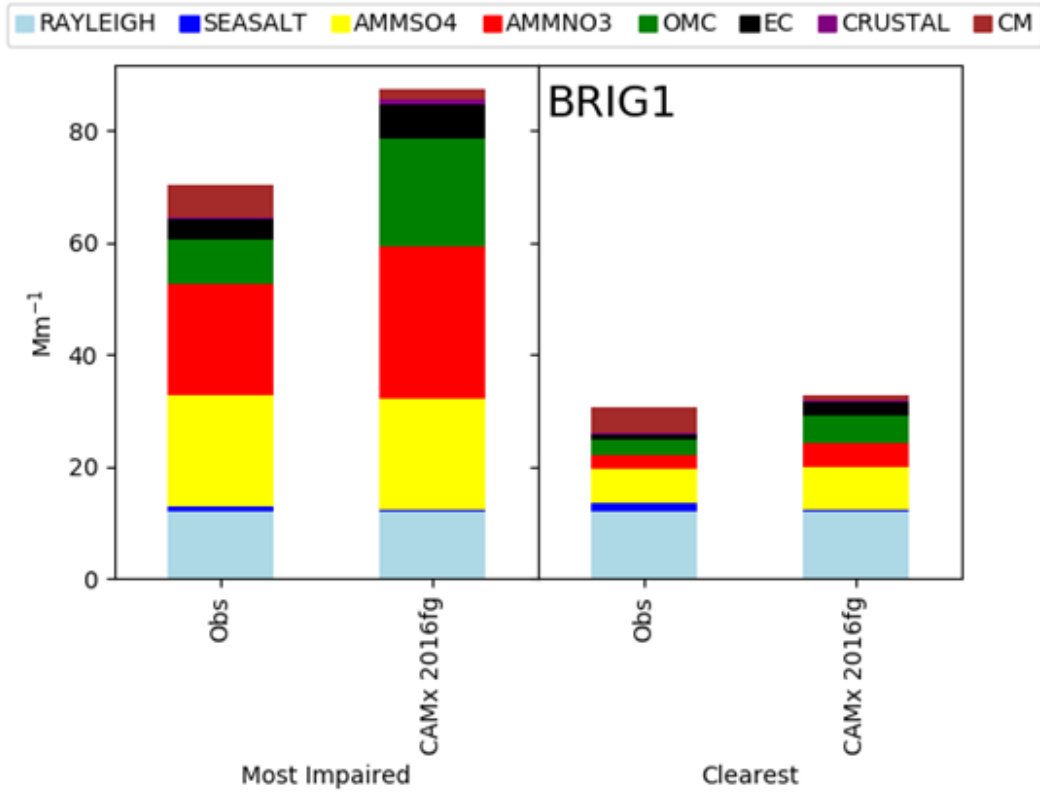
Summer Organic Carbon



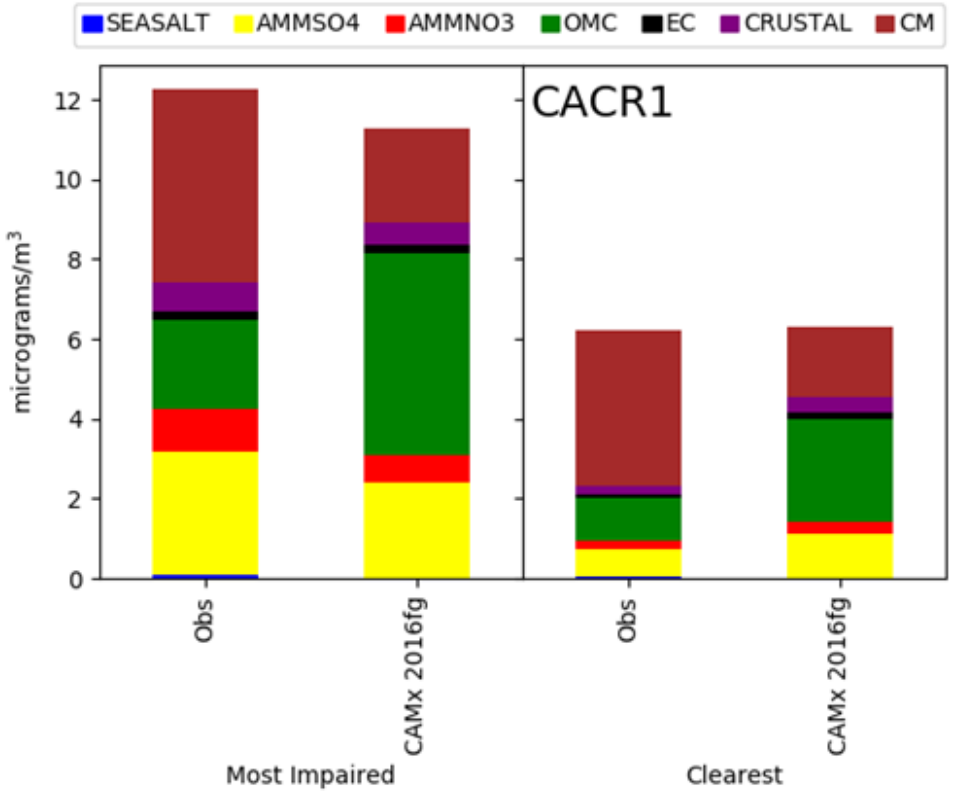
CIRCLE=IMPROVE; TRIANGLE=CSN;

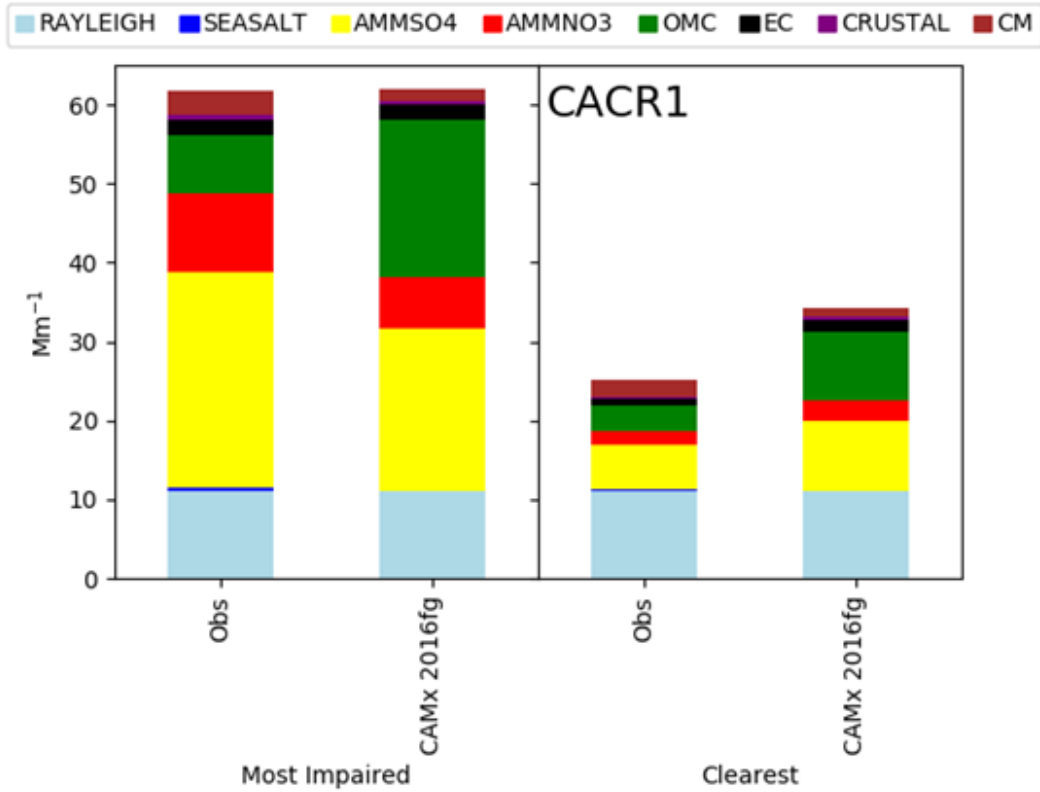
Visibility Model Performance- Brigantine NJ



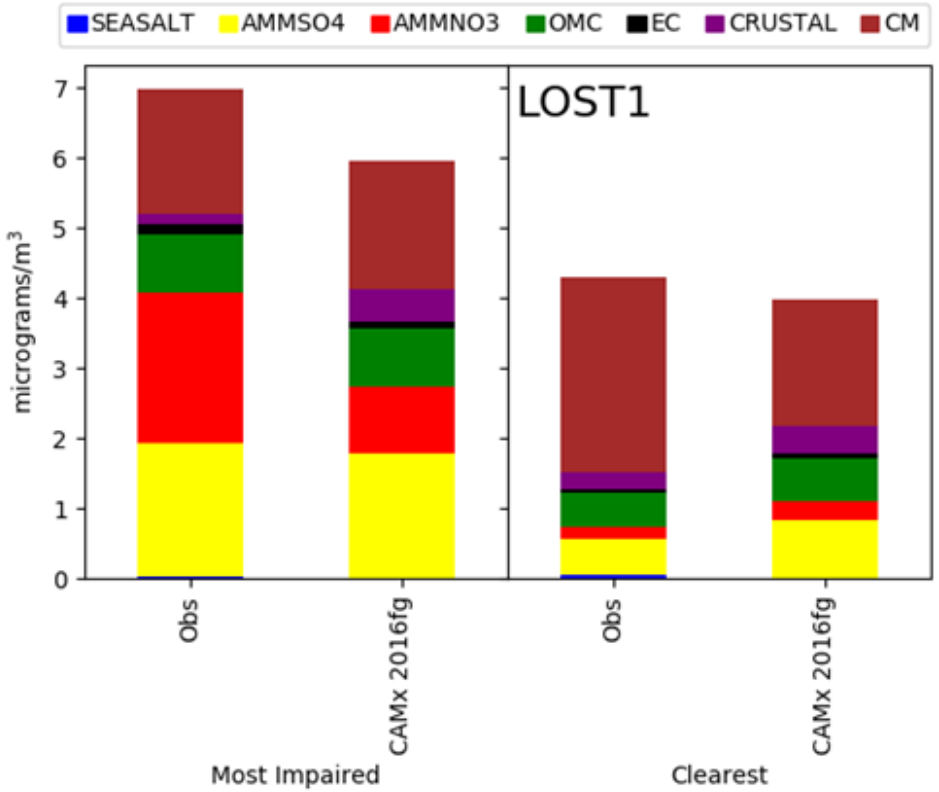


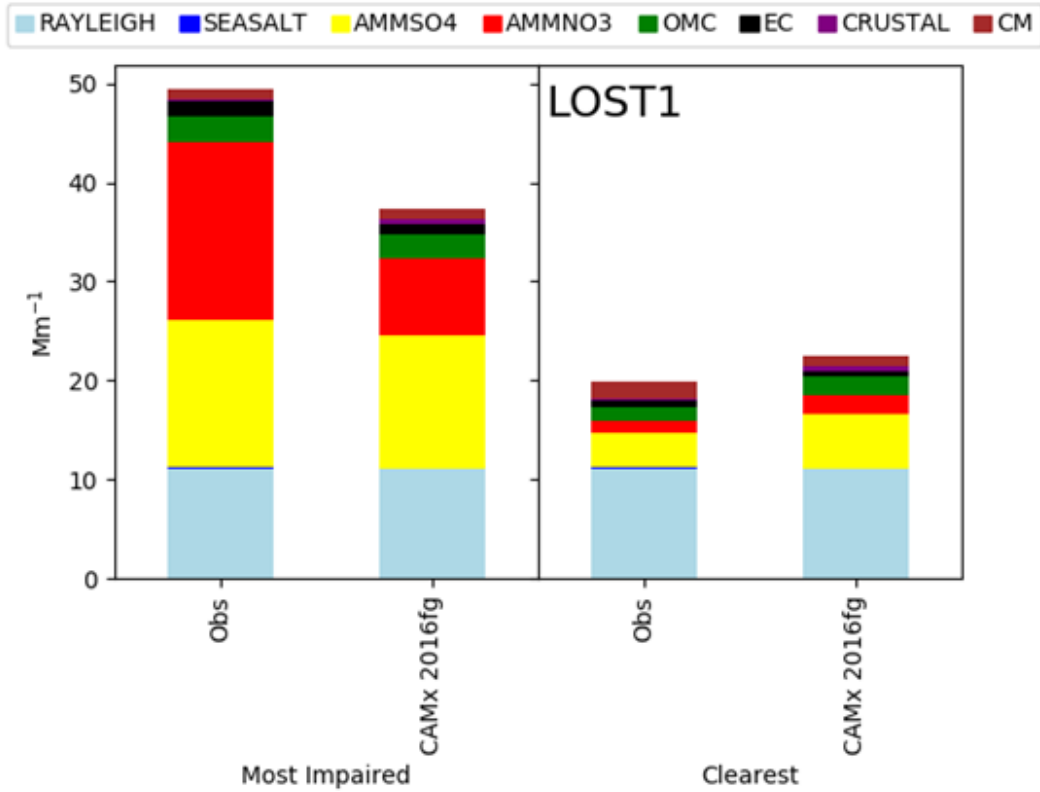
Visibility Model Performance- Caney Creek (AR)



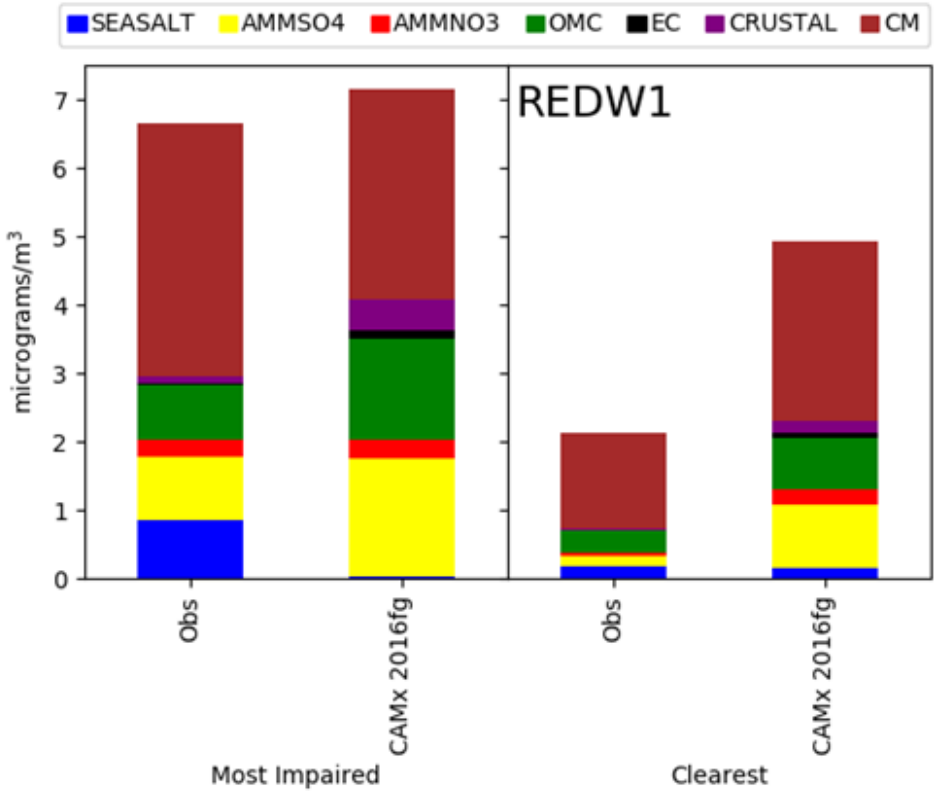


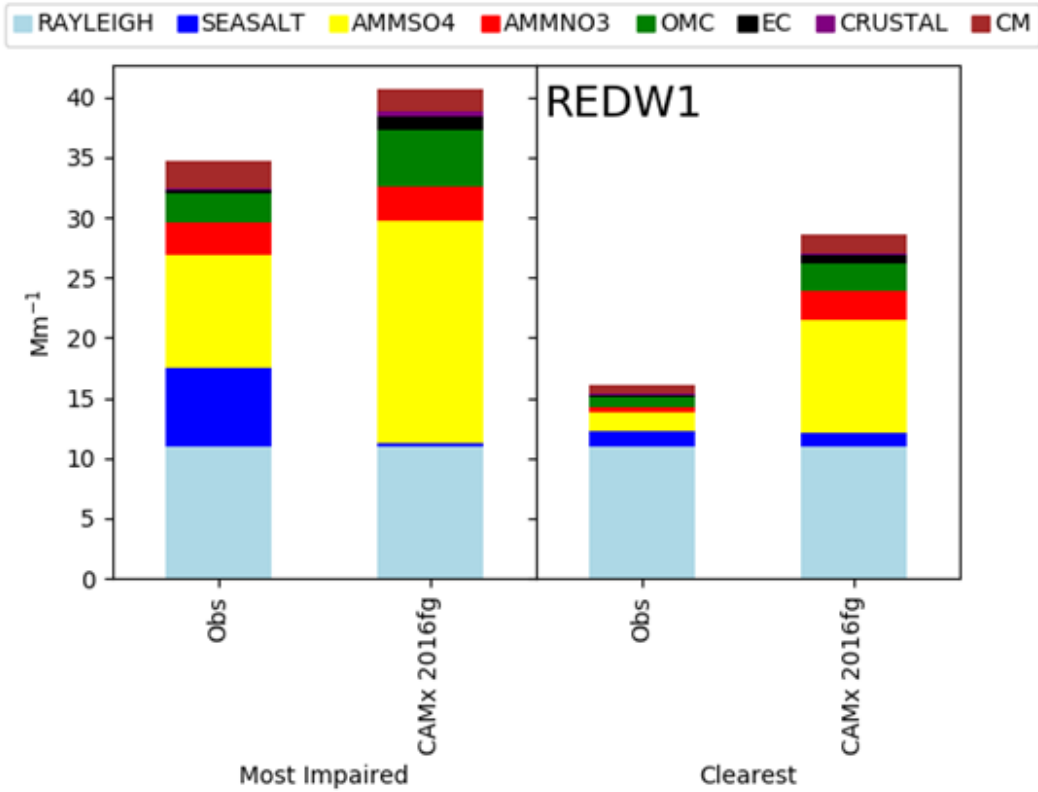
Visibility Model Performance- Lostwood (ND)





Visibility Model Performance- Redwood NP (CA)





Emissions

Emissions TSD: https://www.epa.gov/air-emissions-modeling/2016v72-beta-and-regional-haze-platform

2028 Projected Emissions

- 2028 projections consistent with 2016 base case for Regional Haze includes “on-the-books” emissions controls
- 2028 EGU emissions from IPM
  - November 2018 IPM version
- 2028 boundary conditions were held constant from 2016
  - From 2016 Hemispheric CMAQ
- Wildfire, prescribed fire, and ag fire are 2016 year specific and held constant
- Canadian emissions were projected to 2028 from 2015 based on factors provided by Environment and Climate Change Canada
- Mexico emissions were projected to 2028 from their 2008 inventory
  - Onroad mobile sources were overridden with outputs from MOVES-Mexico
  - We requested new 2016 emissions data from Mexico, but have not received anything yet

CAMx 2016 and 2028 Emissions Sector Totals

		2016fg Annual Emissions						2028fg Annual Emissions				
Tag #	**Tag Name**	**NH3**	**NOX**	**PM2.5**	**SO2**	**VOC**		**NH3**	**NOX**	**PM2.5**	**SO2**	**VOC**
1	Biogenics	-	975,807	-	-	43,161,614		-	975,807	-	-	43,161,614
2	Point EGUs	23,977	1,290,226	133,515	1,540,557	33,771		39,555	804,093	111,632	878,680	29,816
3	Onroad mobile	100,856	4,066,815	130,614	27,550	1,986,602		83,643	1,354,187	63,060	11,550	886,243
4	Nonroad mobile	1,783	1,081,598	102,159	2,198	1,164,615		2,028	604,942	55,094	1,536	825,951
5	C1 & C2 commercial marine	309	514,611	13,720	3,130	9,546		312	287,866	7,945	1,252	5,904
6	C3 commercial marine	96	567,284	6,870	15,144	25,013		139	486,975	9,968	21,969	36,328
7	C3 commercial marine - non-US	-	1,043,852	81,432	657,836	37,557		-	1,482,984	116,059	133,509	53,535
8	Railroads	323	558,732	16,158	364	26,062		340	588,788	17,036	383	27,469
9	Agricultural burning	54,454	10,825	28,632	3,909	18,323		54,454	10,825	28,632	3,909	18,323
10	Agricultural ammonia	2,862,779	-	-	-	186,941		2,990,703	-	-	-	198,161
11	Nonpoint and point oil and gas	4,376	955,824	26,021	57,475	3,092,777		4,394	930,941	30,783	72,187	3,577,561
12	Point non-EGU sources	63,613	1,087,999	261,565	675,797	816,127		64,188	1,140,722	144,393	641,564	820,105
13	Residential wood combustion	15,554	31,492	318,999	7,739	342,959		14,627	32,128	300,284	6,722	326,350
14	US wildfires	125,577	110,960	665,171	59,430	1,804,428		125,577	110,960	665,171	59,430	1,804,428
15	US prescribed fires	128,554	121,368	640,518	56,376	1,513,923		128,554	121,368	640,518	56,376	1,513,923
16	Area source fugitive dust	-	-	1,006,412	-	-		-	-	1,017,675	-	-
17	Non-point	121,721	759,882	499,779	161,732	3,718,709		123,021	763,173	543,498	119,048	3,937,967
18	Canada fires	104,683	134,301	580,958	60,914	1,501,988		104,683	134,301	580,958	60,914	1,501,988
19	Canada anthropogenic	533,657	1,926,159	584,899	1,147,090	2,023,308		730,509	1,244,887	588,794	1,245,794	1,905,101
20	Mexico fires	120,627	347,132	746,107	45,222	2,260,695		120,627	347,132	746,107	45,222	2,260,695
21	Mexico anthropogenic	925,033	3,029,834	677,215	2,344,667	4,649,026		936,519	3,352,508	802,946	2,865,746	5,349,517
22	Oceanic sea salt and DMS	-	-	-	-	-		-	-	-	-	-
	US Anthropogenic Total	**3,249,840**	**10,925,288**	**2,544,443**	**2,495,595**	**11,421,444**		**3,377,404**	**7,004,640**	**2,329,998**	**1,758,801**	**10,690,177**
	Percent change in US anthropogenic between 2016 and 2028							**3.9%**	**-35.9%**	**-8.4%**	**-29.5%**	**-6.4%**

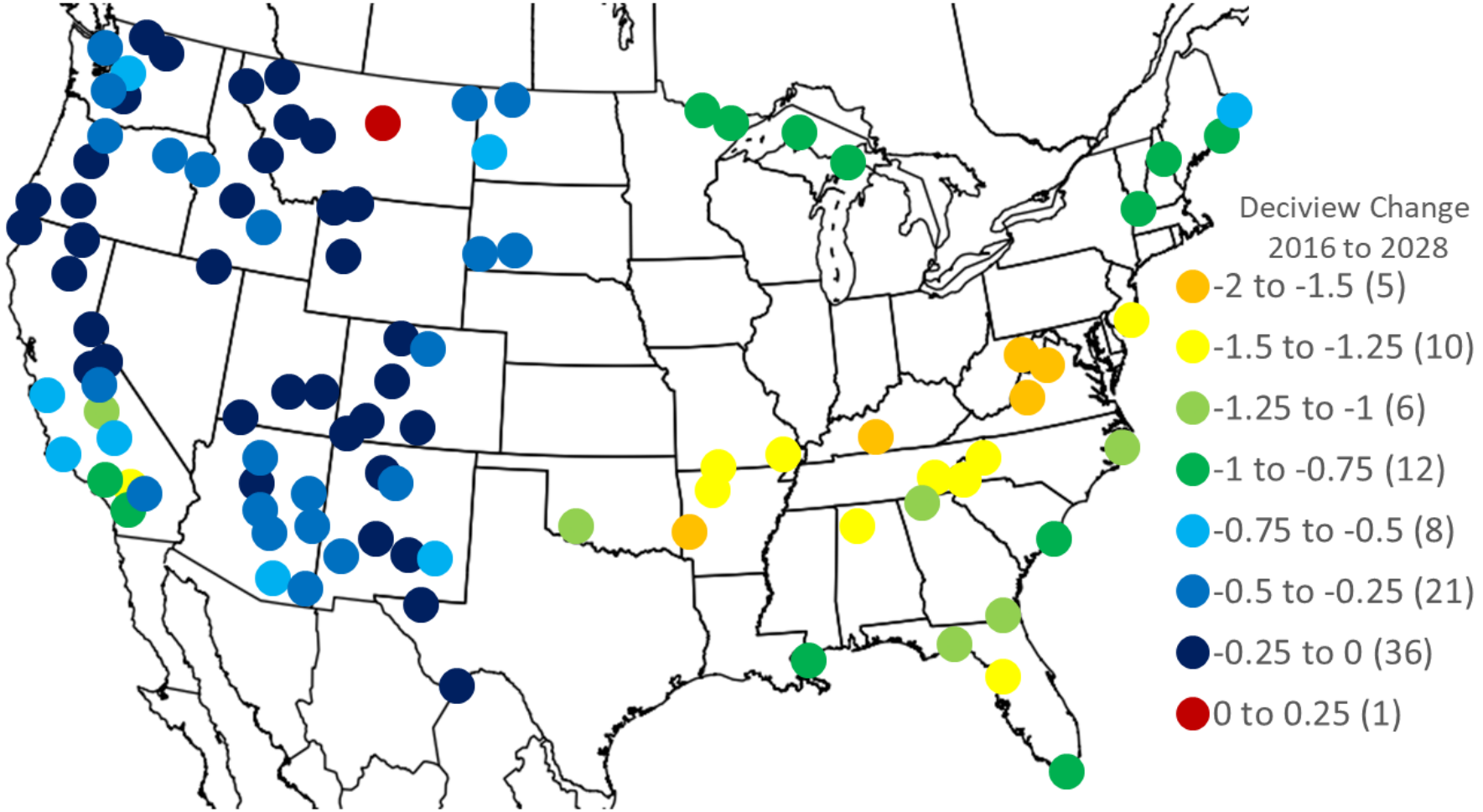
2028 CAMx PSAT 22 Emissions Sectors + Boundary Conditions Tags

Emissions Summary Category	Emissions Sectors (PSAT tags)
US Anthropogenic	On-road mobile Non-road mobile EGUs NonEGU point Oil and Gas Nonpoint (area) Commercial marine (C1C2 and C3 onshore and within ECA) Agricultural fires Rail Residential Wood Anthropogenic Dust* Agricultural ammonia
International Anthropogenic	Anthropogenic Canada Anthropogenic Mexico Offshore C3 marine (outside ECA) International anthropogenic from boundary conditions
Natural	Biogenic* (SOA and nitrate) Wildfires (US, Canada, and Mexico) Natural dust* Sea salt Ocean (sulfate from DMS and sea salt) Natural from boundary conditions
Prescribed Fires (US)	Prescribed fires from US sources

2028 Glidepath Adjustment Components and Deviation from Glidepath

- Glidepath based on linear progress between 2000-2004 IMPROVE data and 2064 natural conditions
- Projected 2028 visibility using CAMx 2016 base case and 2028 future case
  - 2014-2017 IMPROVE data (4-year average) is the anchor point for the future year projection
    - A 5-year average cannot be calculated (yet) because final 2018 IMPROVE data is not available (preliminary data just became available)
  - Species specific modeled RRFs calculated for 2016 to 2028
  - 2028 deciview values calculated using SMAT software
- Calculated 2028 visibility impairment for 99 IMPROVE monitors (142 Class I areas).
  - All 99 sites (142 areas) have a “valid” glidepath.

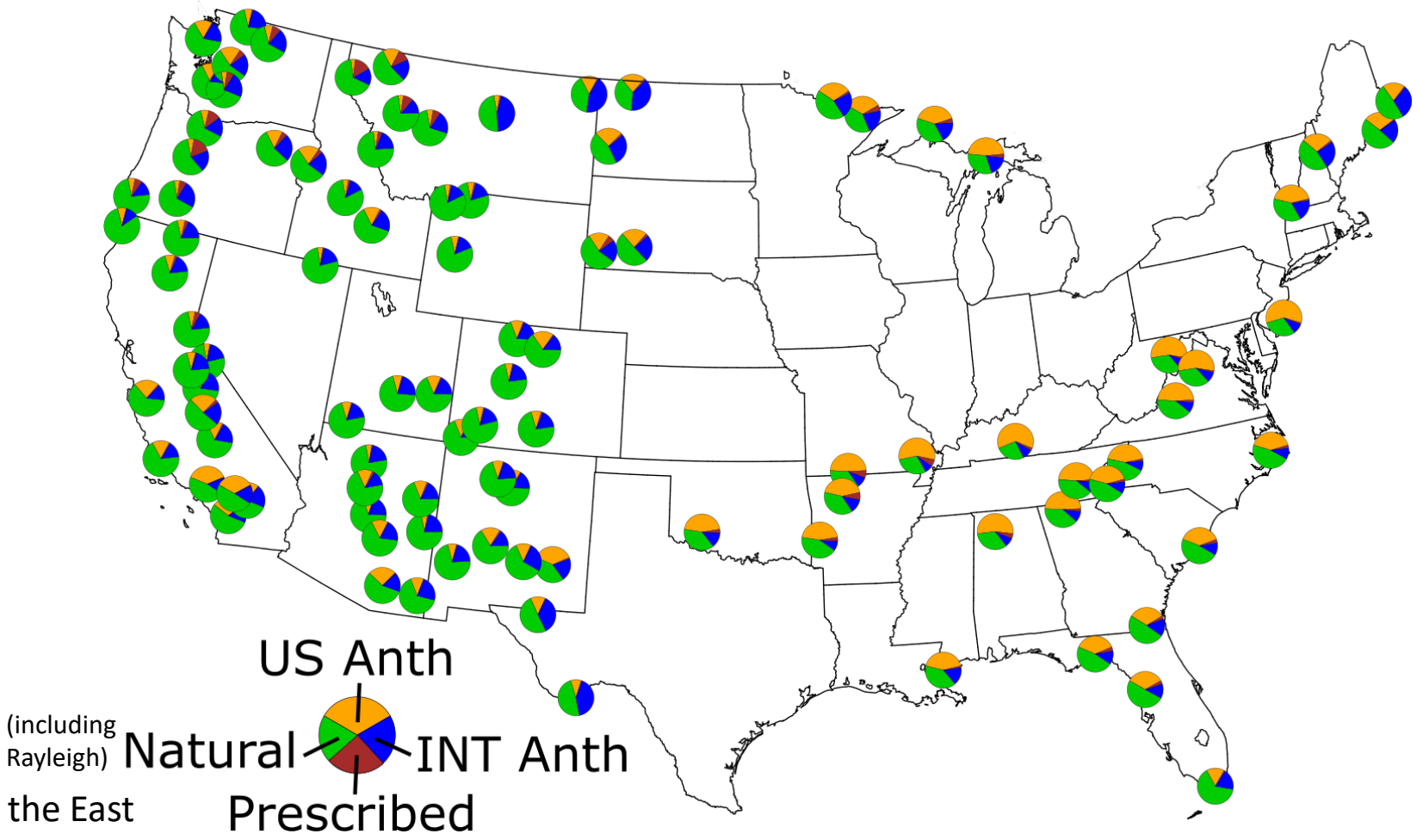
Modeled Change in Visibility Impairment (in deciviews) Between 2016 and 2028 (20% Most Impaired Days)



Relative change based on SMAT calculations

2028 Total Visibility Impairment Components (20% most impaired days)

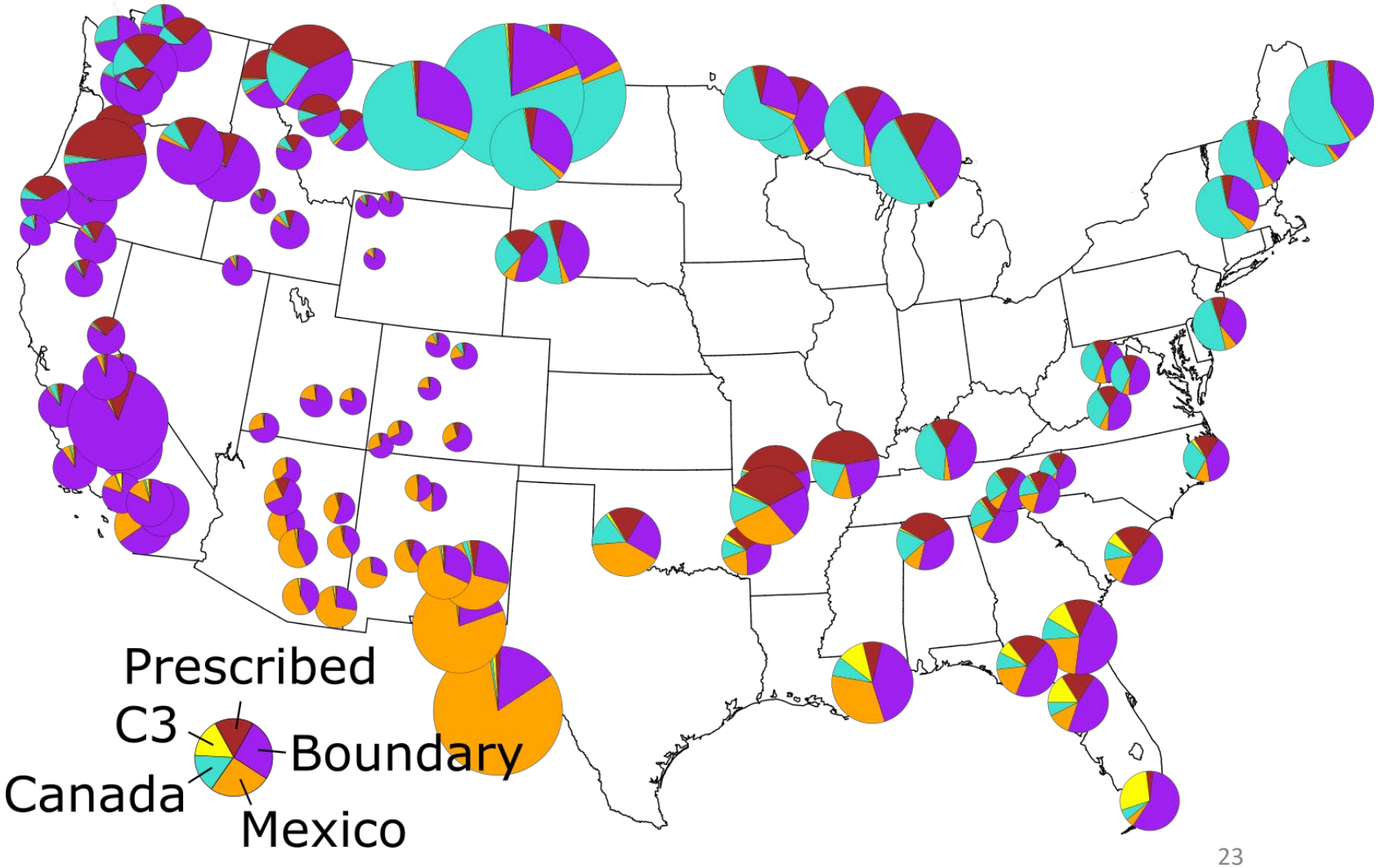
2028 Visibility Impairment	Range (Mm-1)
US anthropogenic	0.98–45.68
International anthropogenic	2.88–19.33
Prescribed Fires	0.03-5.15
Modeled natural (including Rayleigh)	11.72-29.83



- Percentage of US anthropogenic higher in the East
- Percentage of natural higher in the West
- International anthropogenic contribution largest near border areas
- Prescribed fire contribution highest in the Northwest

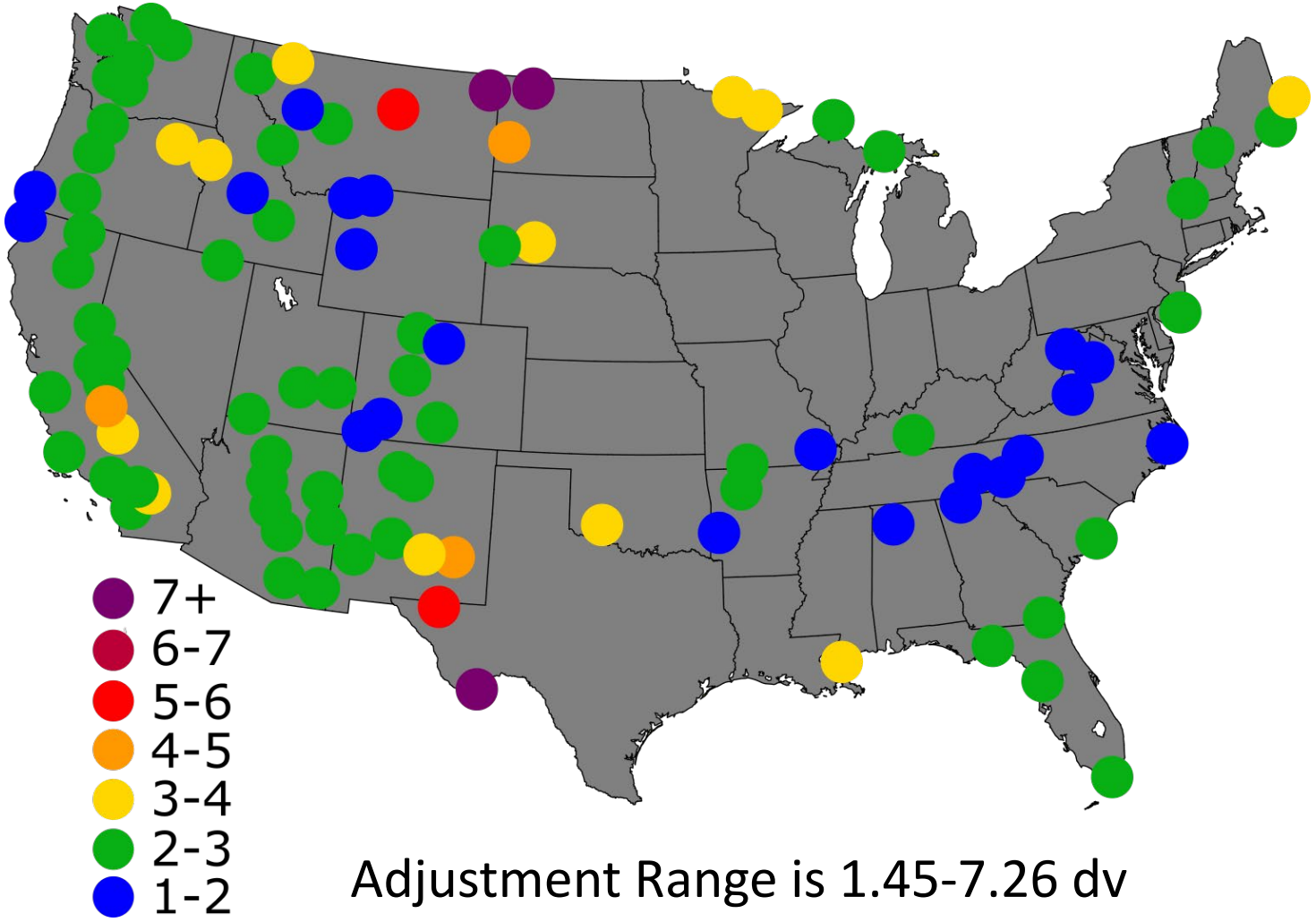
International Anthropogenic and Prescribed Fire Contributions (20% most impaired days)

Glidepath Adjustment components	Range (Mm-1)
Prescribed fires	0.03-5.15
C3 commercial marine outside the US ECA region	0-2.28
Canada anthropogenic	0.01–15.49
Mexico anthropogenic	0.02–14.39
International anthropogenic from outside the 36km domain (boundary conditions)	1.19–11.73



“Default” Glidepath 2064 Endpoint Adjustment in deciviews (20% most impaired days)

Glidepath Adjustment components (international anthropogenic only)
C3 commercial marine from outside the US ECA region
Canada anthropogenic
Mexico anthropogenic
International anthropogenic from outside the 36km domain (boundary conditions)

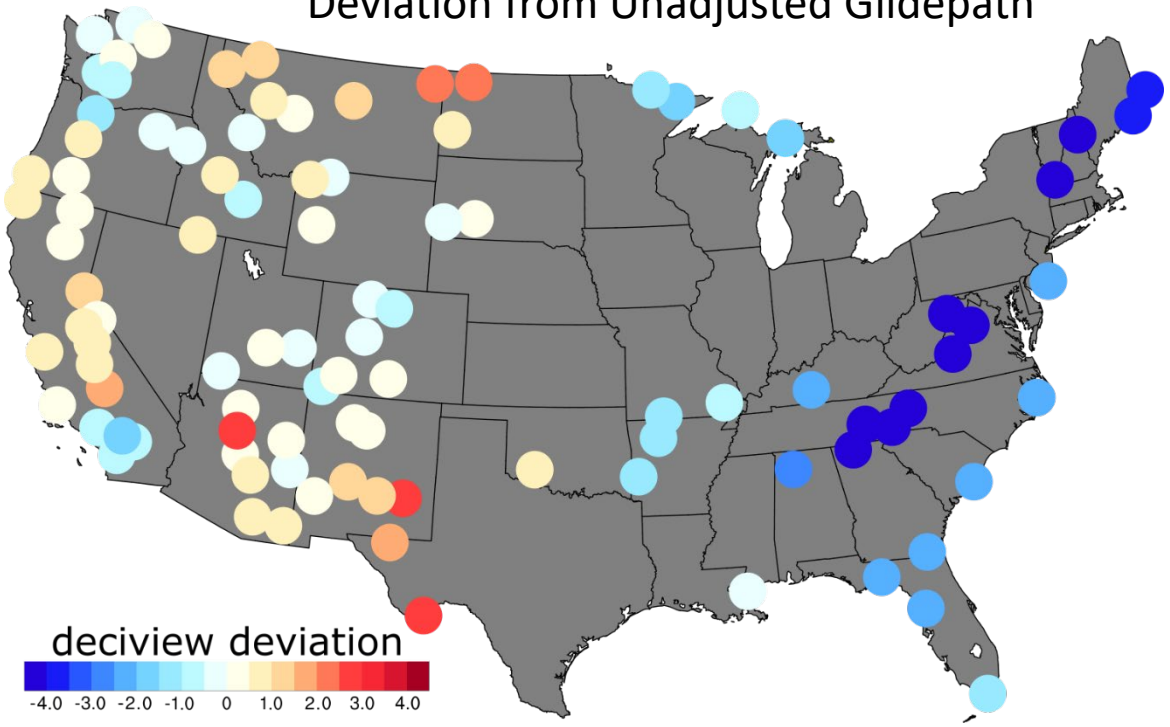


- Glidepath adjustment is highest near border areas
- Adjustment ranges from 15-130% of natural conditions values

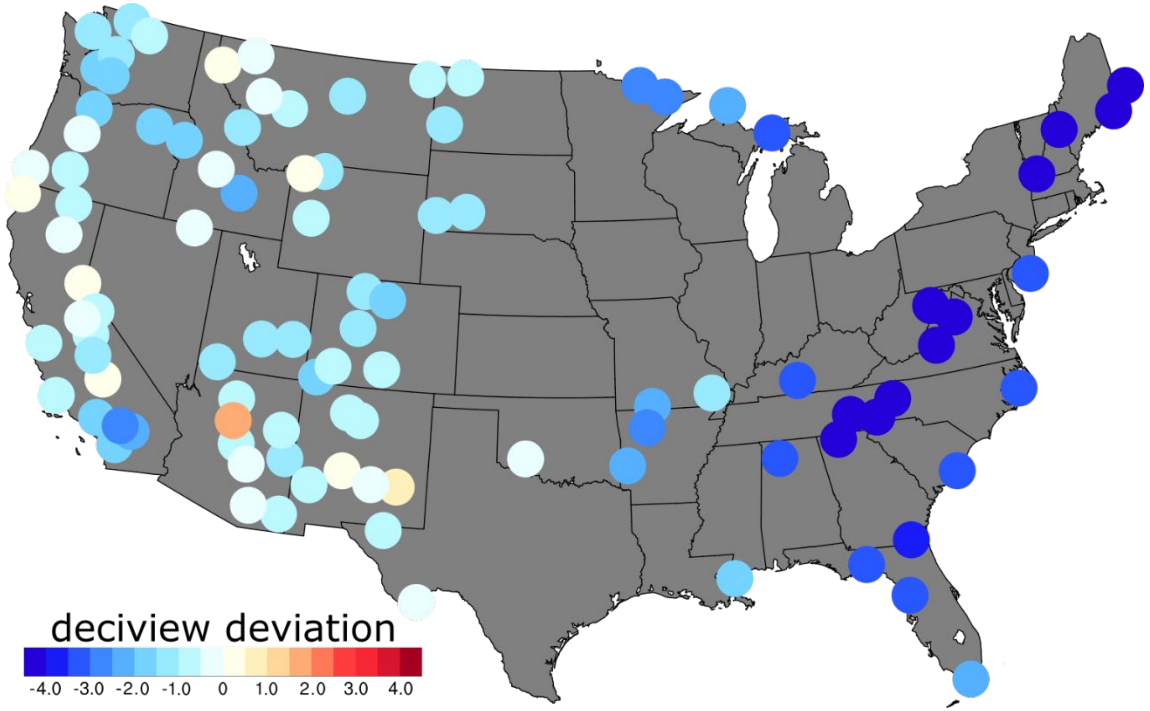
Adjustment Range is 1.45-7.26 dv
Natural conditions range is 3-11 dv

Updated EPA Regional Haze Modeling Deviation from 2028 Glidepath (20% most impaired days)

Deviation from Unadjusted Glidepath



Deviation from Default Adjusted Glidepath



	Unadjusted Glidepath	Adjusted Glidepath
Number of IMPROVE sites below the glidepath	51	91
Number of IMPROVE sites above the glidepath	47	8
Total	99	99

Note that the 99 IMPROVE sites represent 142 Class I areas

Adjustment Calculations

- "Default" adjustment methodology (shown on previous maps) uses relative modeled contributions combined with ambient based natural conditions.
- Potential alternative methodologies include:

  1) Relative international anthropogenic model results + ambient natural conditions (**default**)

  2) Absolute international anthropogenic model results + ambient natural conditions

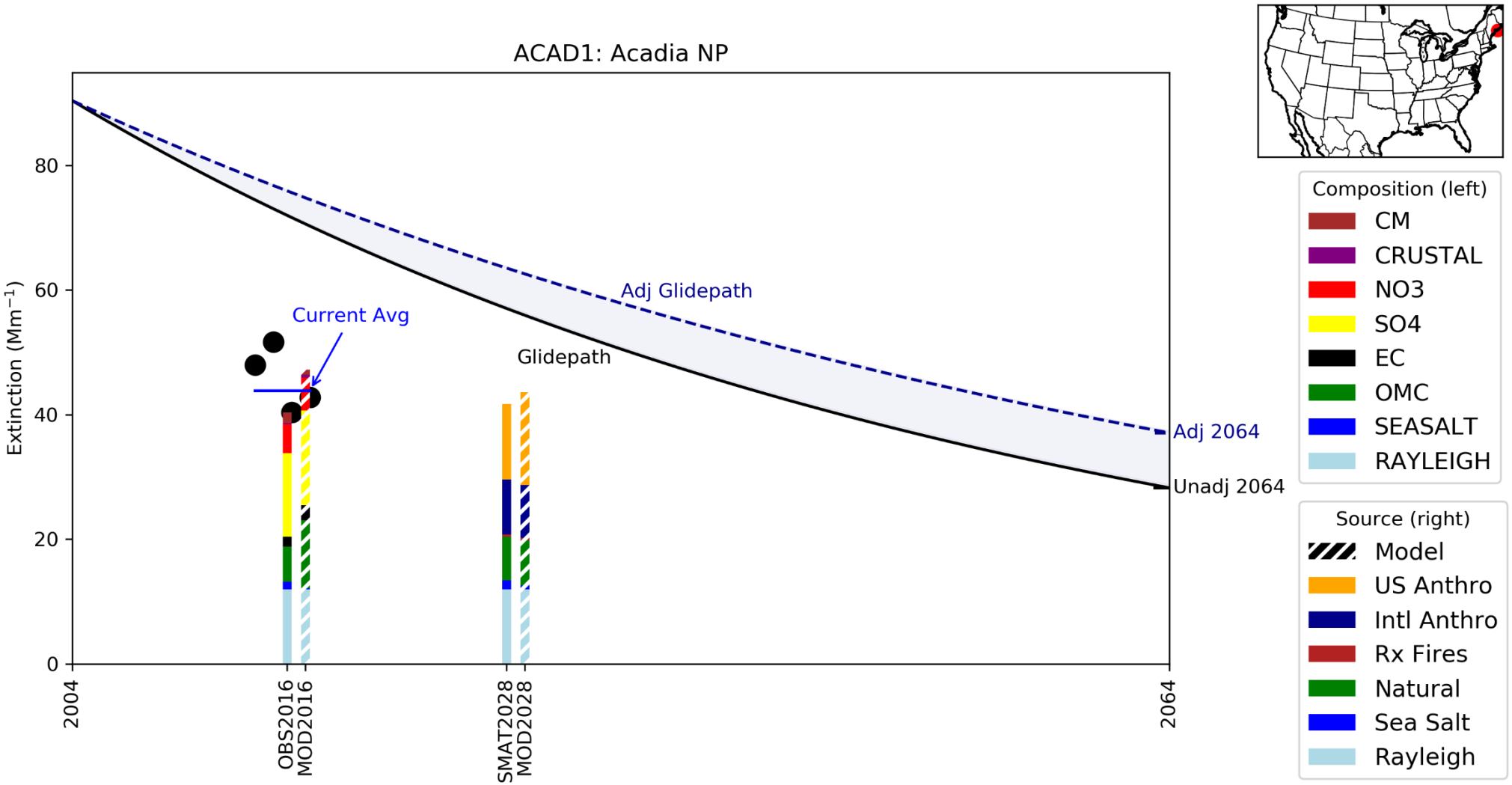
  3) Relative international anthropogenic and prescribed fire model results + modeled natural conditions

  4) Absolute international anthropogenic and prescribed fire model results + modeled natural conditions

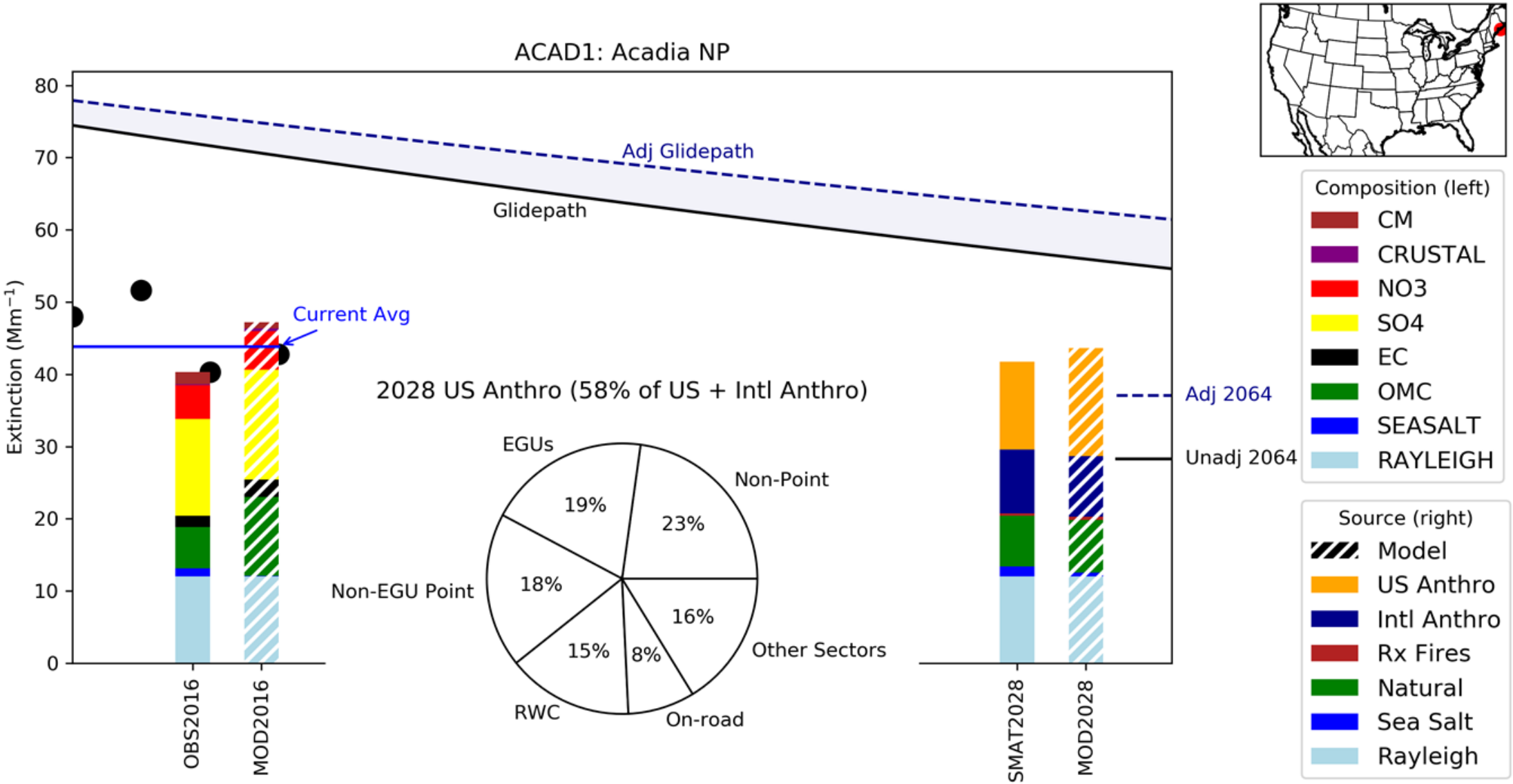
  5) Relative international anthropogenic and prescribed fire model results + ambient natural conditions
- Default adjustment value is number 1 above and the individual IMPROVE site plots show the range of all 5 methodologies
  - If the 2028 projected value is below the range, then it is likely below the glidepath
  - If the 2028 projected is within the range, then further analysis is warranted
    - Further analysis of the international contribution, prescribed fires, and the natural conditions values are needed

Individual IMPROVE Site Glidepath Examples

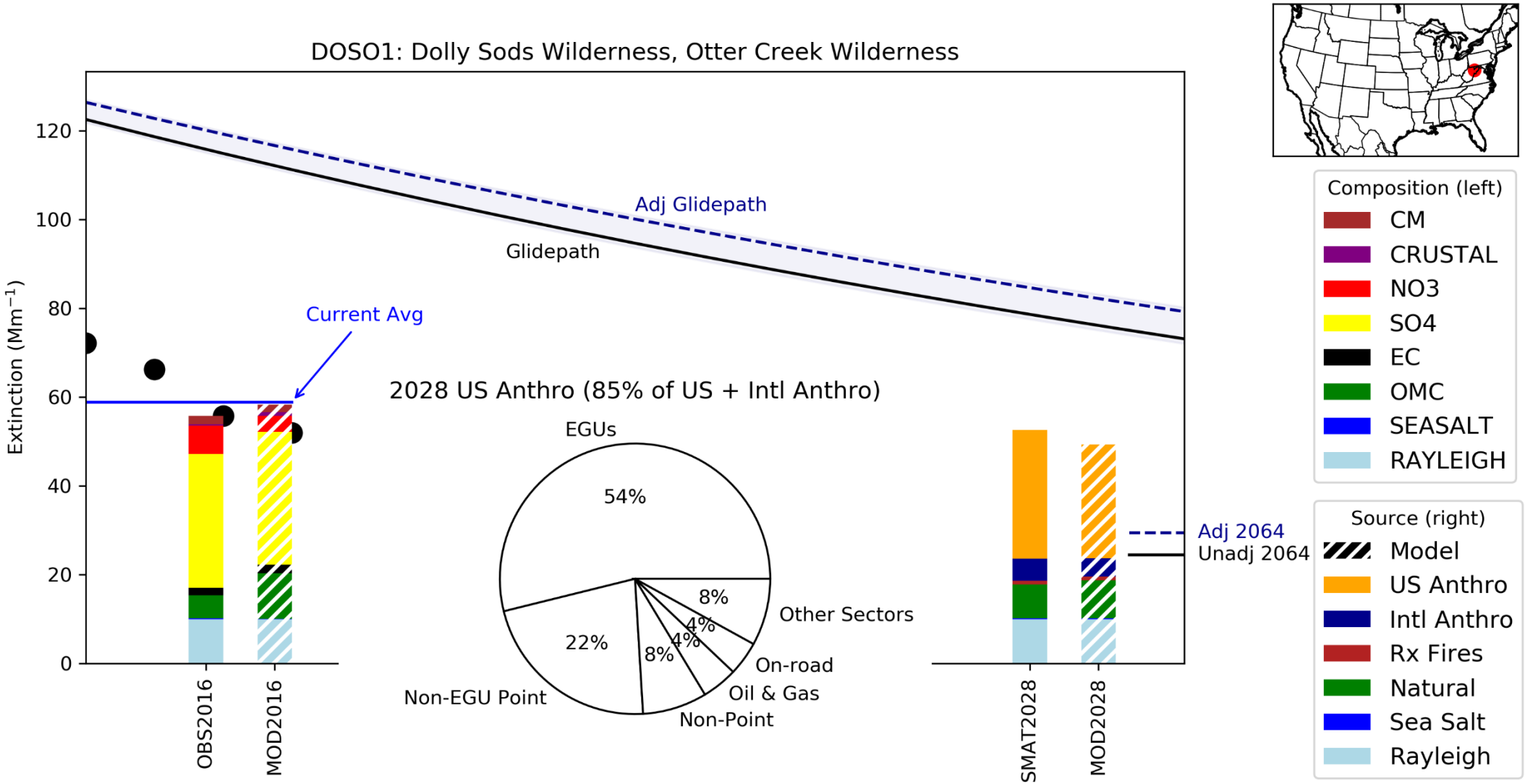
Acadia NP (ME) 2004-2064



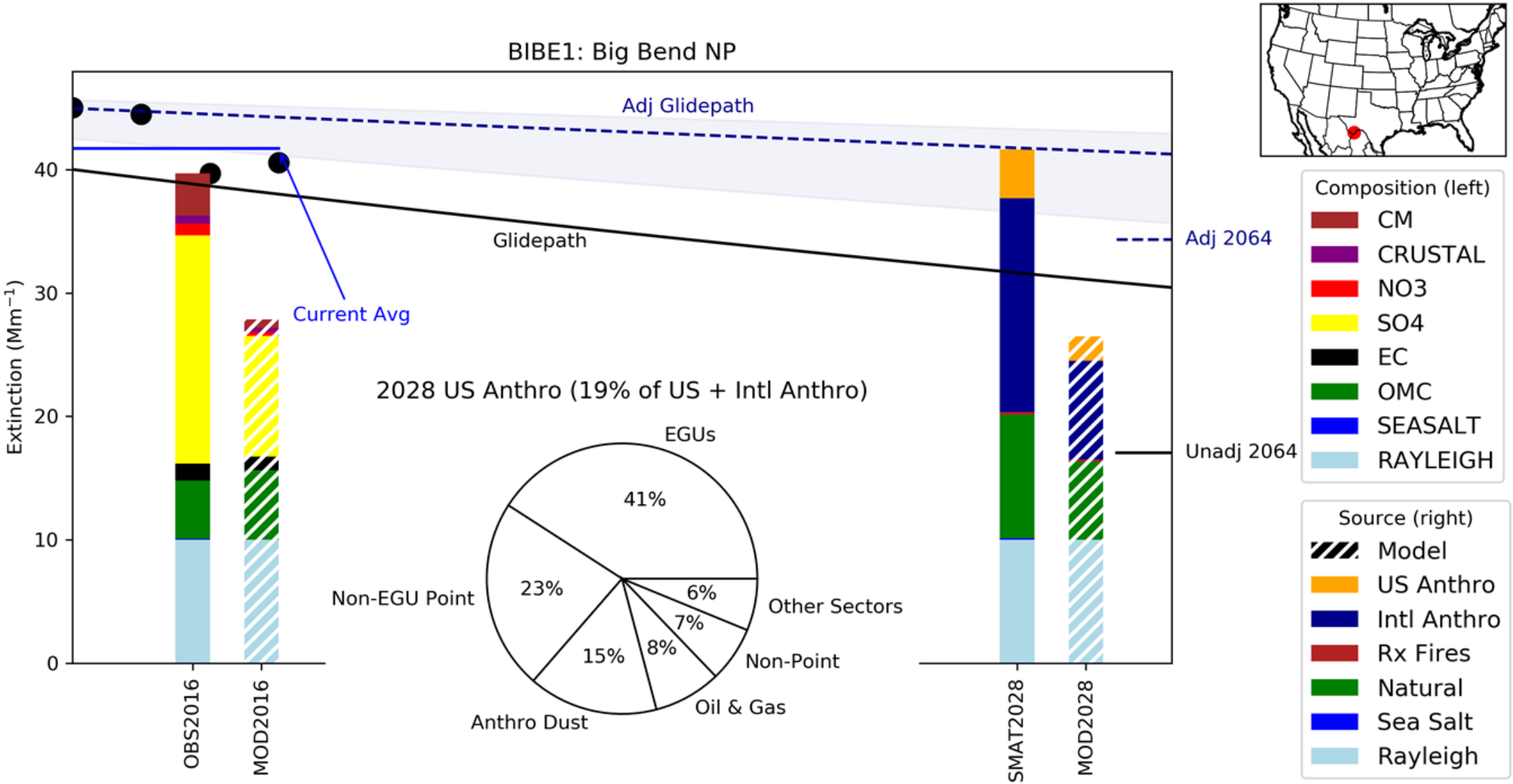
Acadia NP (ME) 2016-2028



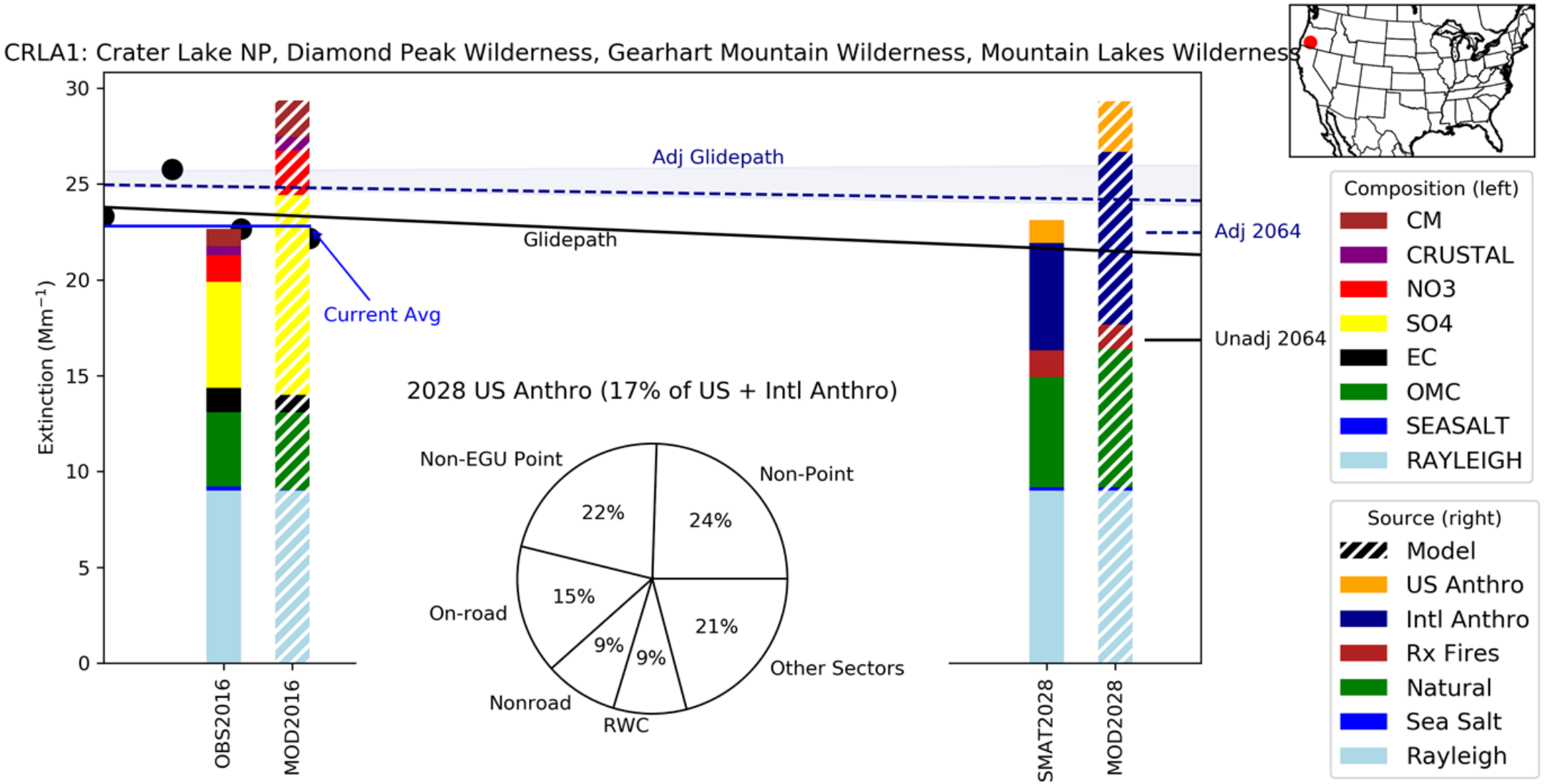
Dolly Sods (WV) 2016-2028



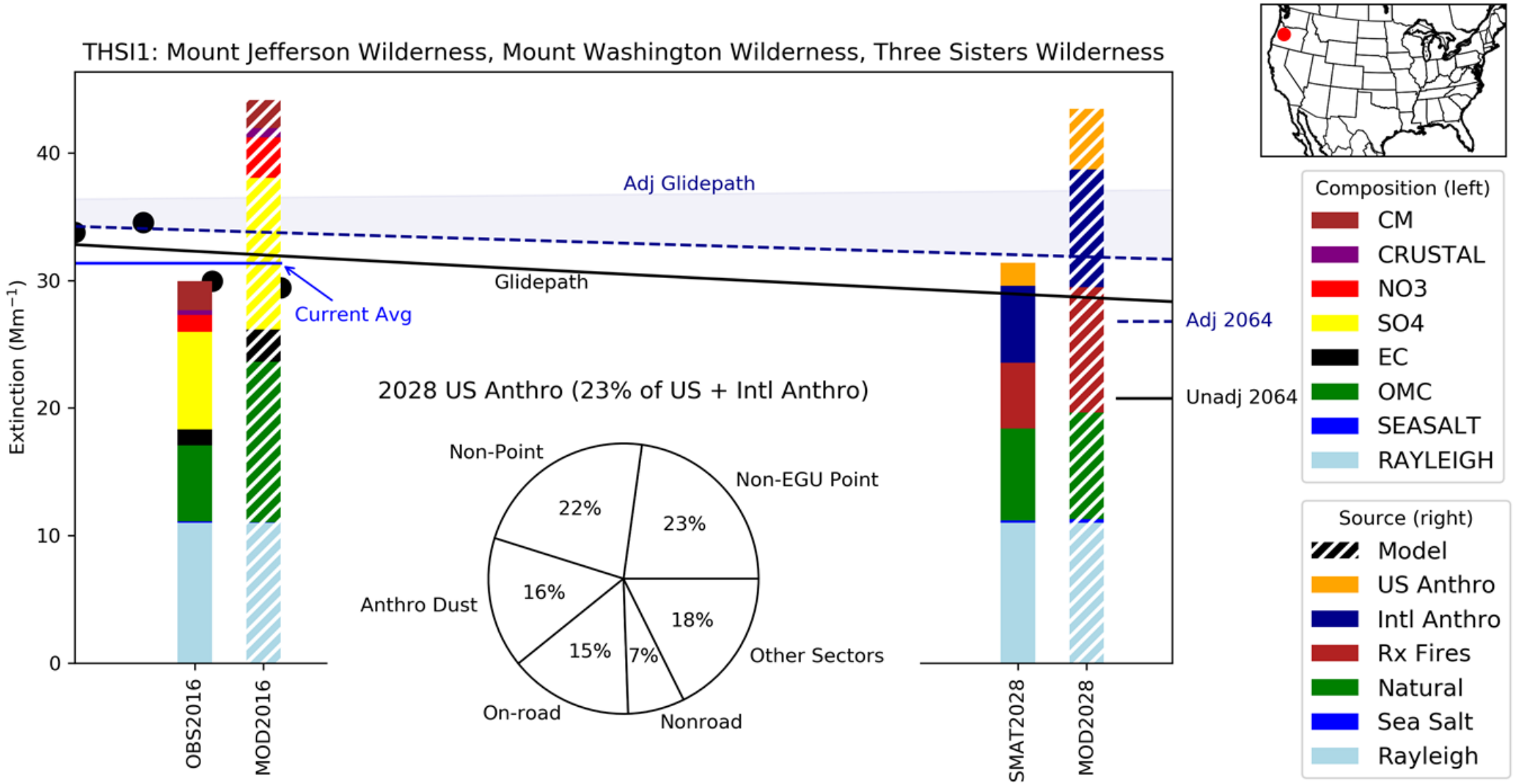
Big Bend NP (TX) 2016-2028



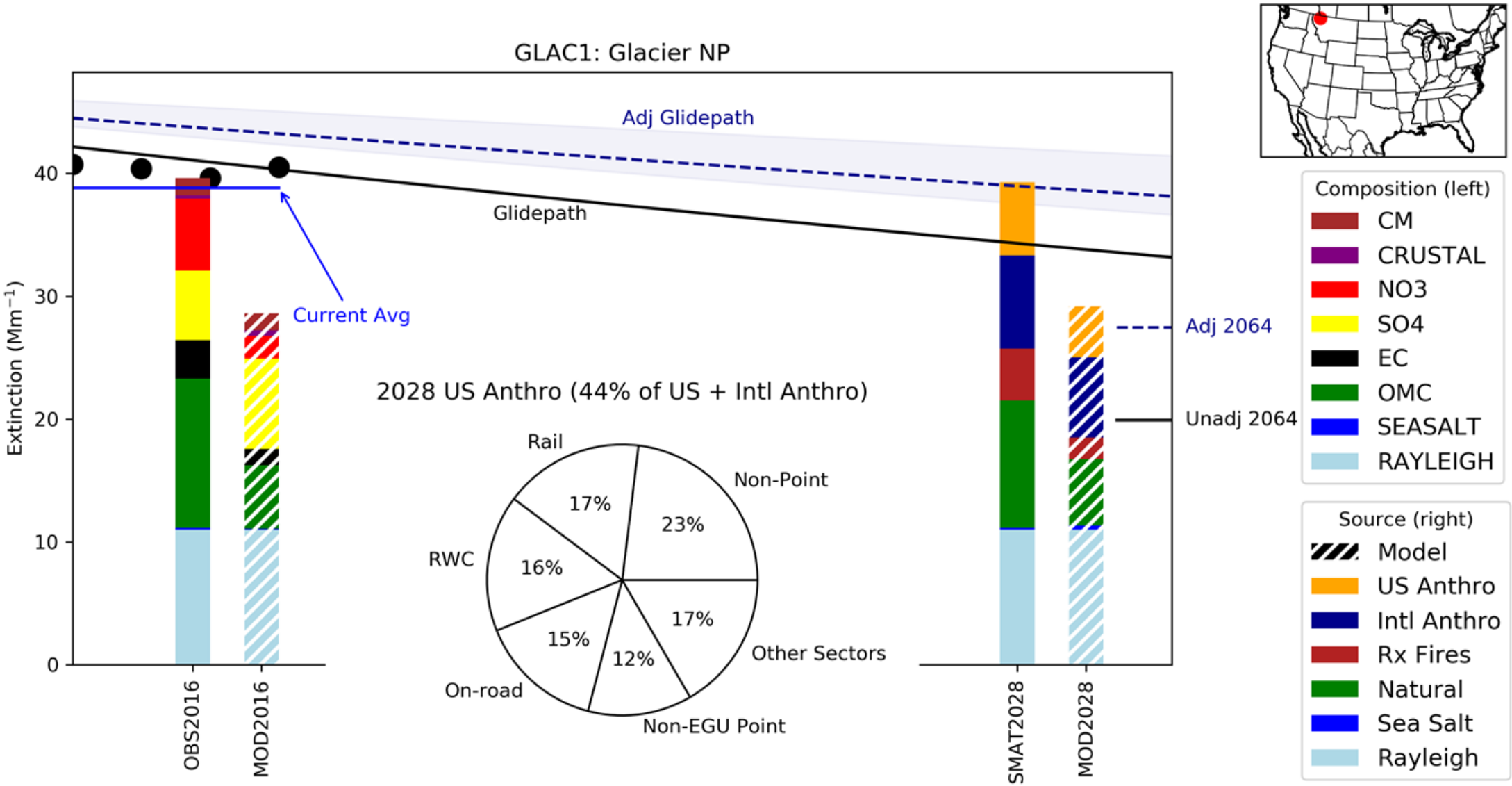
Crater Lake NP (OR) 2016-2028



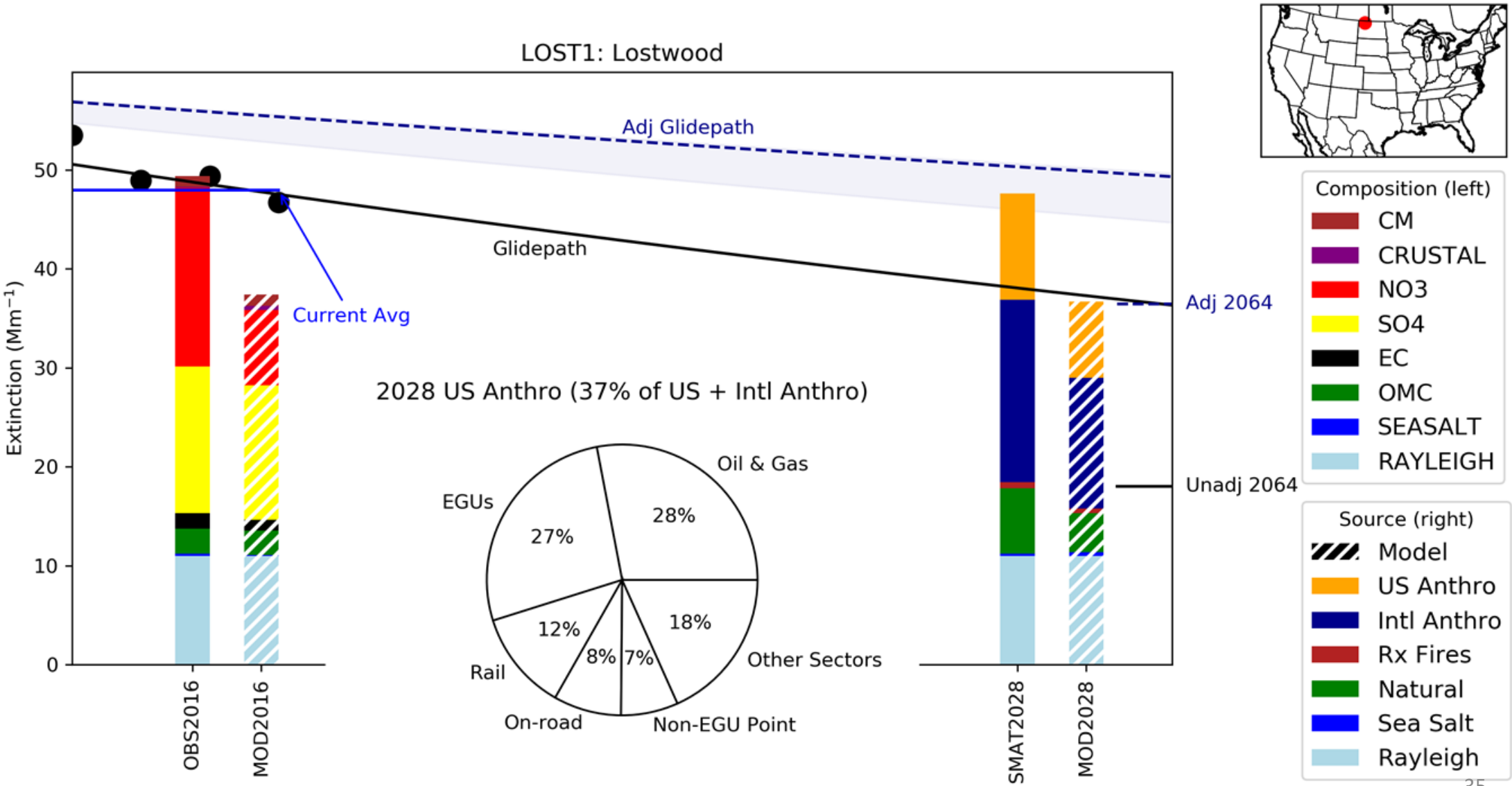
Three Sisters (OR) 2016-2028



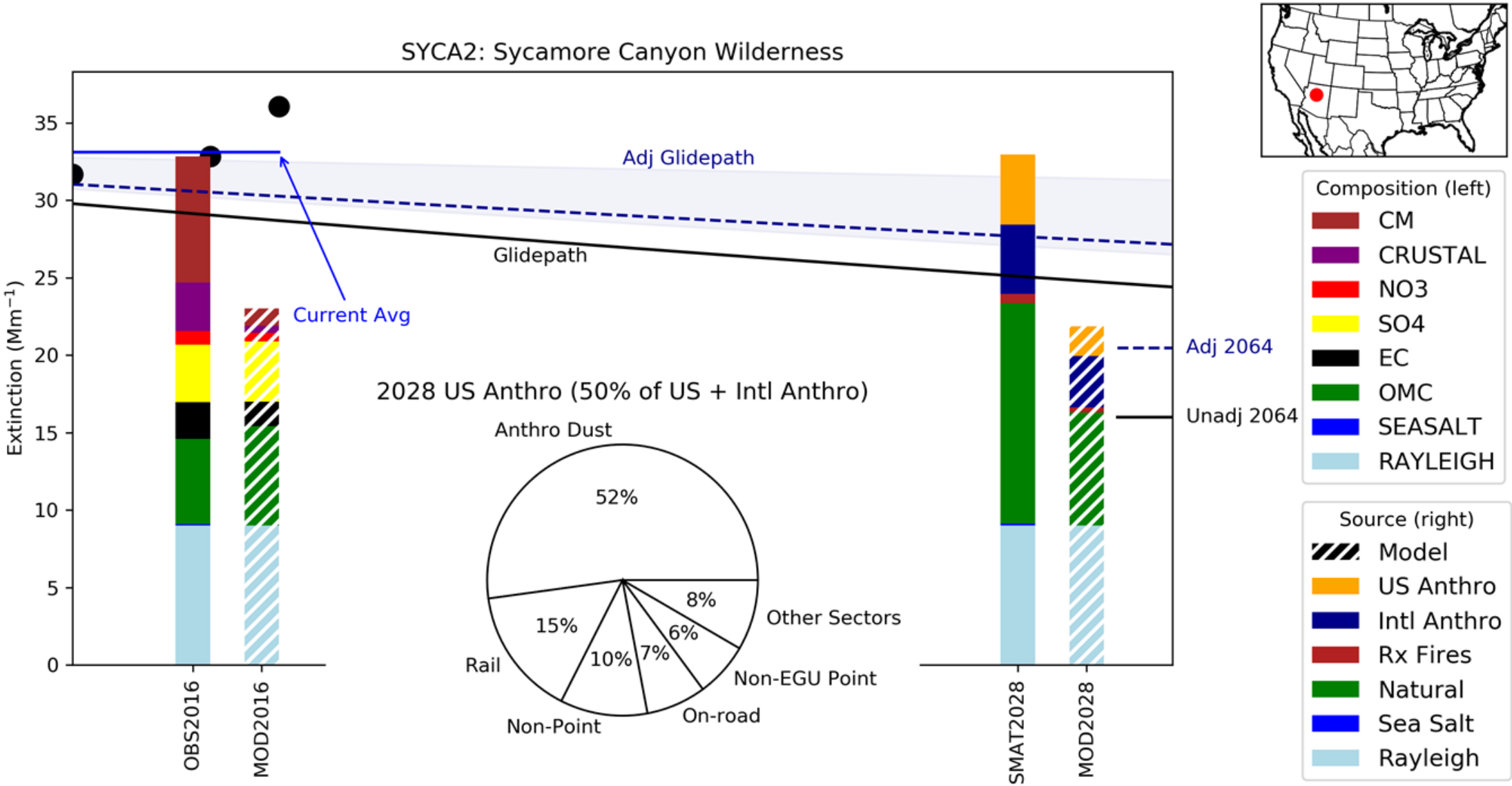
Glacier NP (MT) 2016-2028



Lostwood Wilderness (ND) 2016-2028



Sycamore Canyon (AZ) 2016-2028



2028 Adjusted Glidepath Conclusions

- Nearly all IMPROVE sites (Class I areas) are below the “default” adjusted glidepath in 2028
  - Eight IMPROVE sites remain above the adjusted glidepath
- The modeled glidepath adjustments range from 1.5 to 7 deciviews
  - The largest adjustments are at IMPROVE sites near the Canada and Mexico borders
  - Prescribed fire impacts can be included in the adjustment, but are more uncertain
- Per use in 2nd Planning Period SIPs, recommend that the EPA modeling results and resultant glidepath adjustment be examined on a site-by-site basis.
  - In some cases, recommend further analysis of the modeled international and prescribed fire contributions, ambient natural conditions, and impact of model bias on the results

Modeling Deliverables and Outreach

- Updated 2028 Modeling Technical Support Document: (https://www3.epa.gov/ttn/scram/reports/Updated_2028_Regional_Haze_Modeling-TSD-2019.pdf)
  - 2028 unadjusted and adjusted glidepath projections for Class I areas
  - International anthropogenic and prescribed fire contribution estimates
  - 2028 national sector-based contributions
    - 22 national emissions sectors
- Continue to work on additional data analysis and visualization of model results
- Individual MJO and state consultation
- National regional haze workshop
  - October 28-30th St. Louis, MO

Questions and data requests

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