EPA 2028 Regional Haze Modeling Modeled Oil and Gas Impacts

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Updated EPA Regional Haze Modeling

▸ New 2016 modeling platform with projections to 2028, including sector-based and international contributions

◦ 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
- Larger regional domain (including 36km outer domain)
- Updated international boundary conditions
  - Generated from Hemispheric CMAQ modeling (2016 emissions)

12 km

36 km
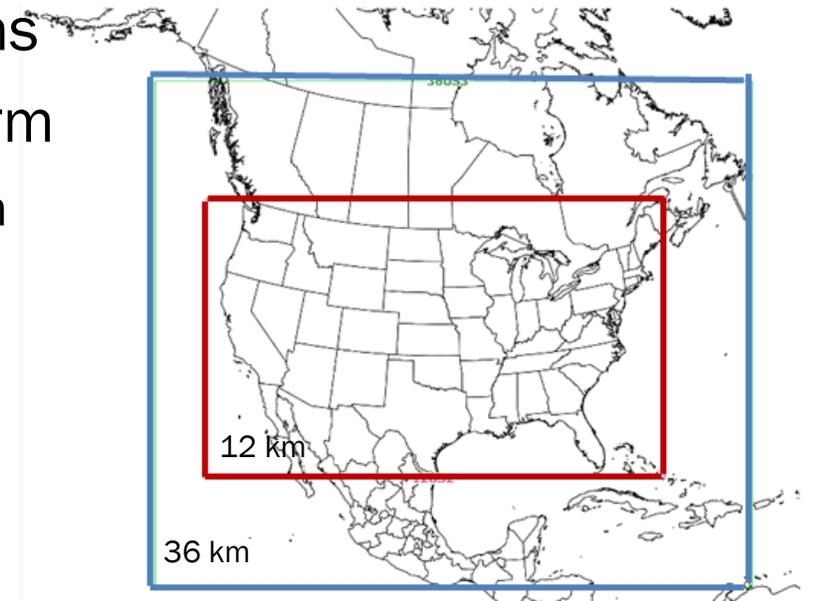
2028 Projected Emissions

- 2028 projections consistent with 2016 base case for Regional Haze includes "on-the-books" emissions and controls
- Oil and Gas emissions- separate point and nonpoint sectors
  ◦ 2016 nonpoint emissions used 2016 well counts and production data
  ◦ 2016 point emissions are a mixture of 2016 data and projections from 2014
  ◦ 2028 emissions grown using AEO 2018 and controls (e.g. NSPS and RICE)
- 2028 EGU emissions from Integrated Planning Model (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

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 Point and nonpoint 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 only

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 Modeled Visibility Impairment

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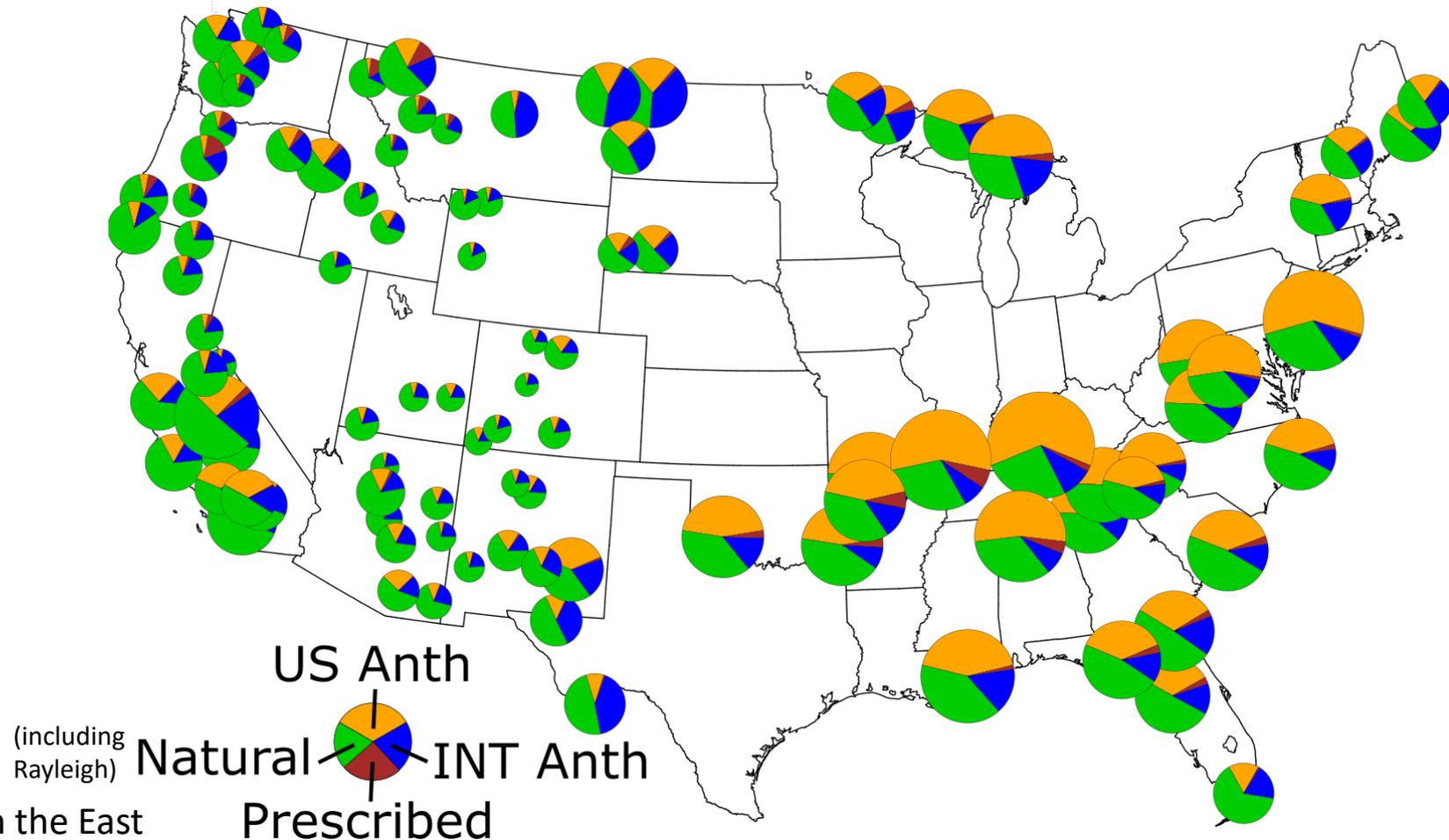
- Percentage of US anthropogenic higher in the East
- Percentage of natural higher in the West
- International anthropogenic contribution largest near border areas
- Prescribed fire contribution highest in the Northwest

Modeled 2028 Oil and Gas Visibility Contribution (20% Most Impaired Days) in Mm-1

Legend:
- 4 to 5 (1)
- 3 to 4 (2)
- 2 to 3 (0)
- 1.5 to 2 (6)
- 1 to 1.5 (7)
- 0.75 to 1 (5)
- 0.5 to 0.75 (11)
- 0.25 to 0.5 (10)
- 0 to 0.25 (57)

Contribution in Mm-1
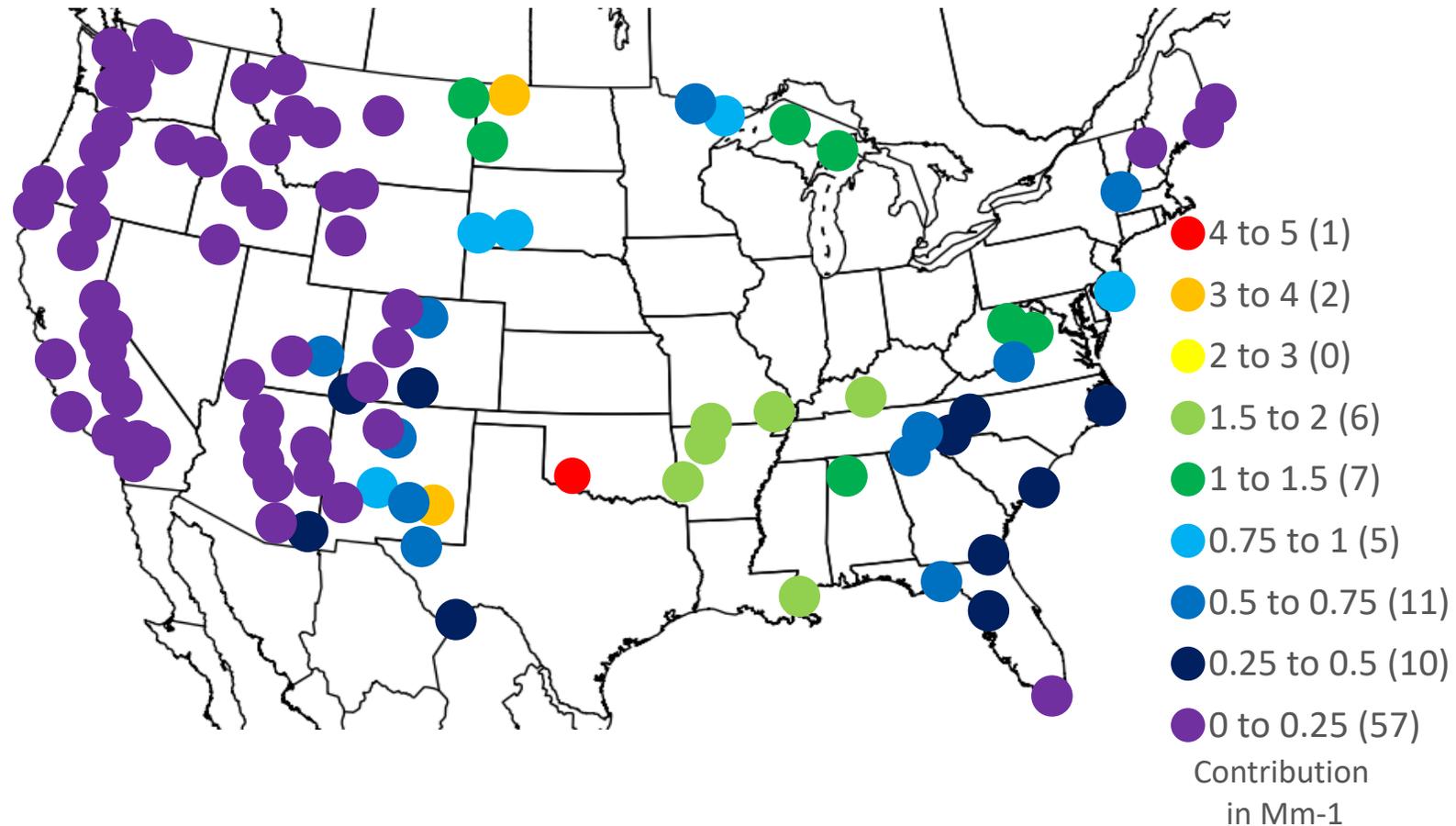
Annual Average PM$_{2.5}$ Species Absolute Modeled Contributions

2028 Annual Average Oil and Gas Contribution to Nitrate

Absolute Nitrate Contribution ug/m3

PM25_NO3 Tag 011
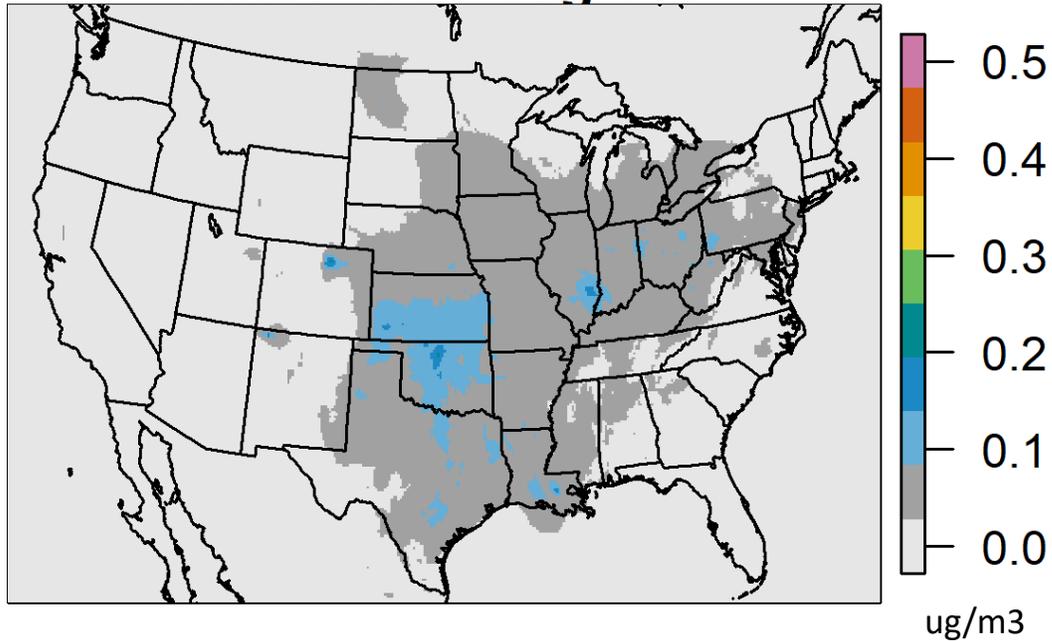
Fraction of Total Modeled Nitrate

Tag 011 / Bulk PM25_NO3
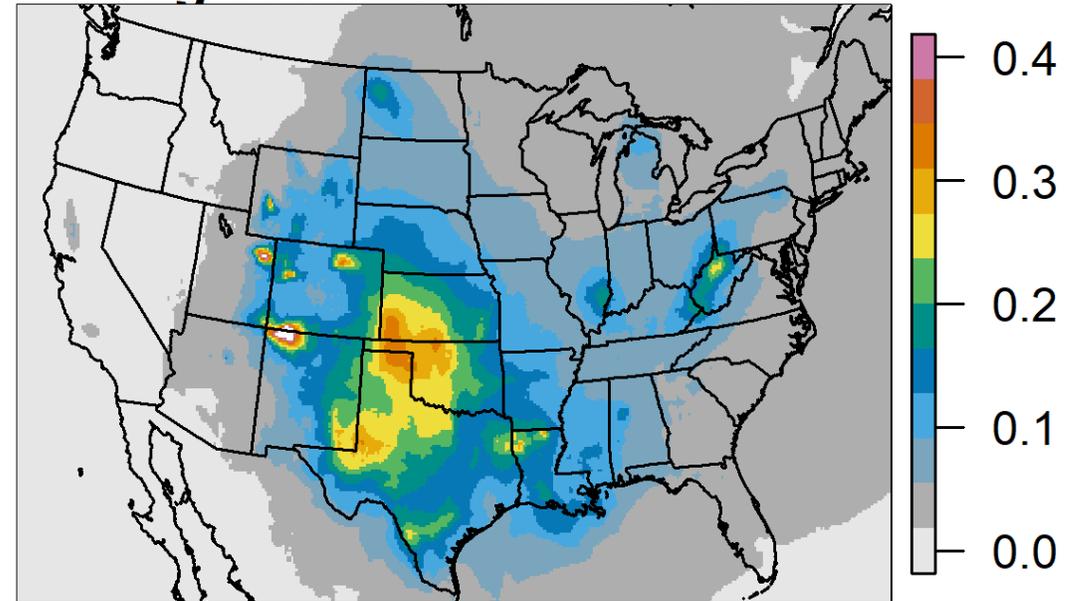
ug/m3

2028 Annual Average Oil and Gas Contribution to Sulfate

Absolute Sulfate Contribution ug/m3

PM25_SO4 Tag 011
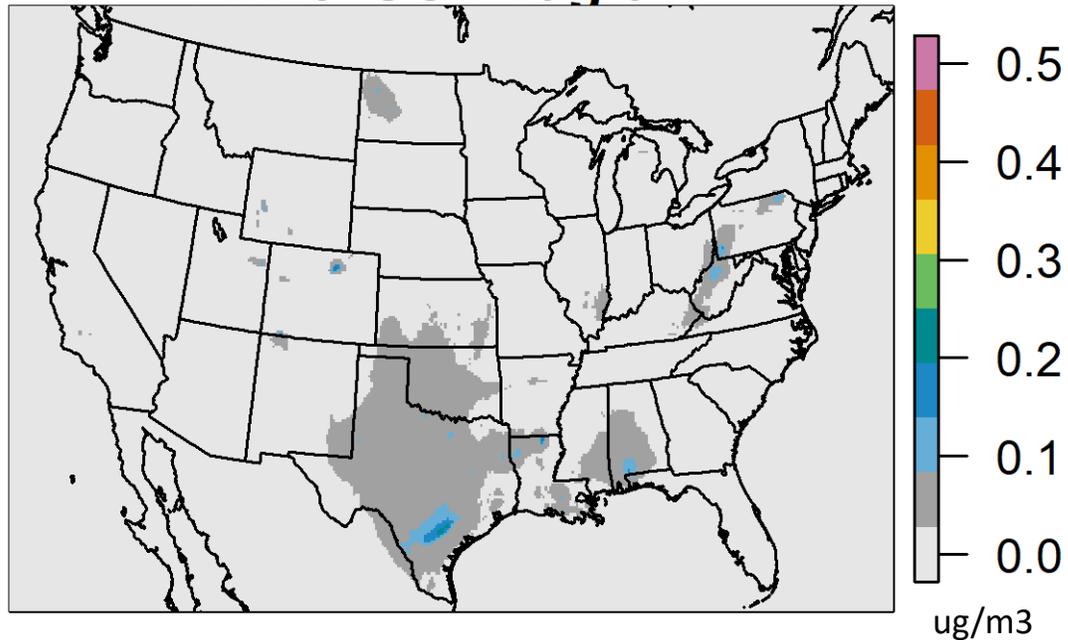
Fraction of Total Modeled Sulfate

Tag 011 / Bulk PM25_SO4
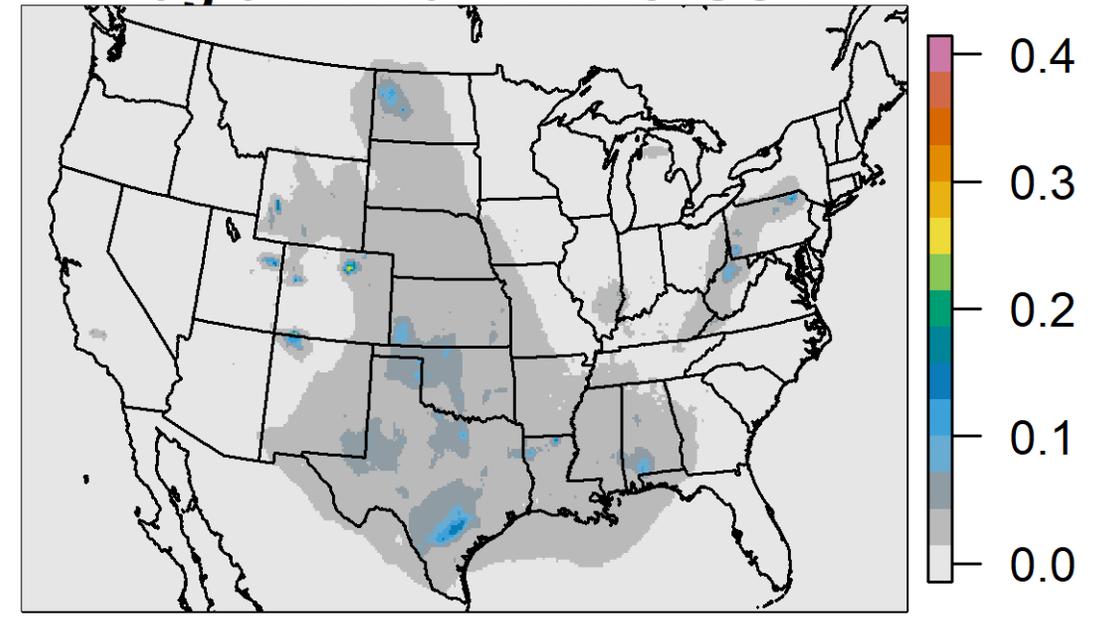
2028 Annual Average Oil and Gas Contribution to Primary Organic Mass

Absolute Primary OM Contribution ug/m3
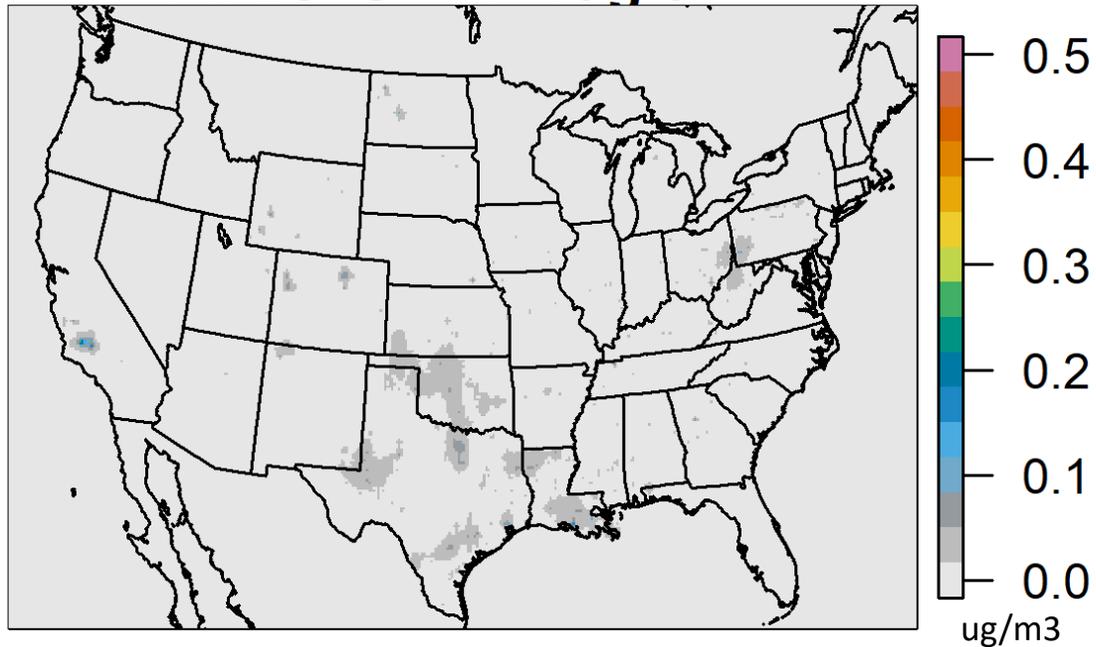
Fraction of Total Modeled Primary OM
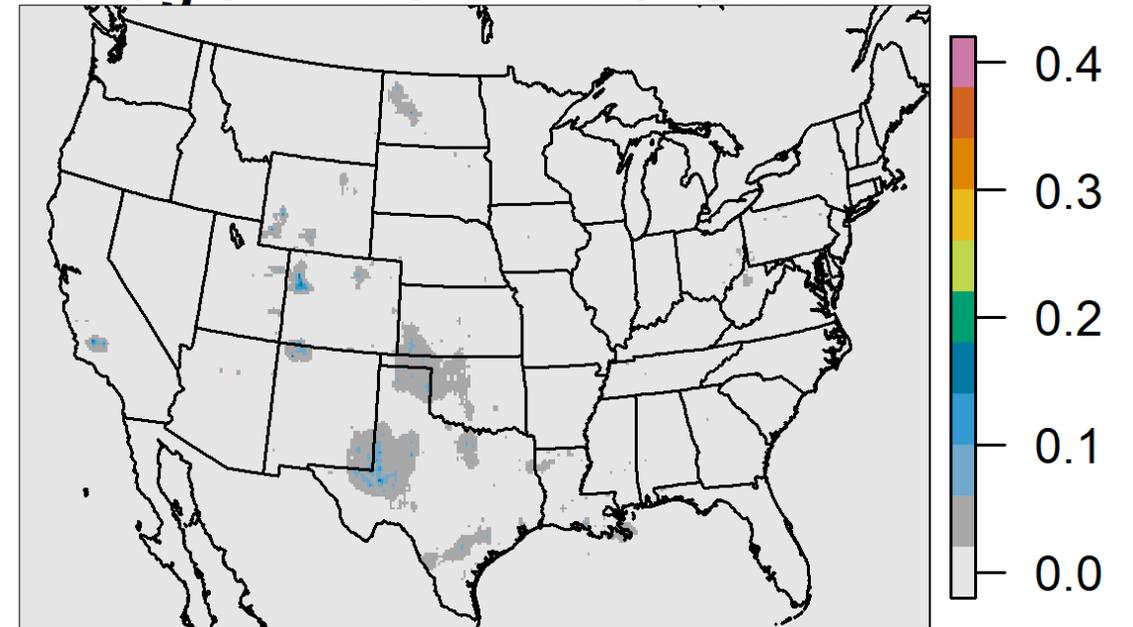
# 2028 Annual Average Canadian Anthropogenic Contribution to Nitrate

Absolute Nitrate Contribution ug/m3
PM25 NO3 Tag 019
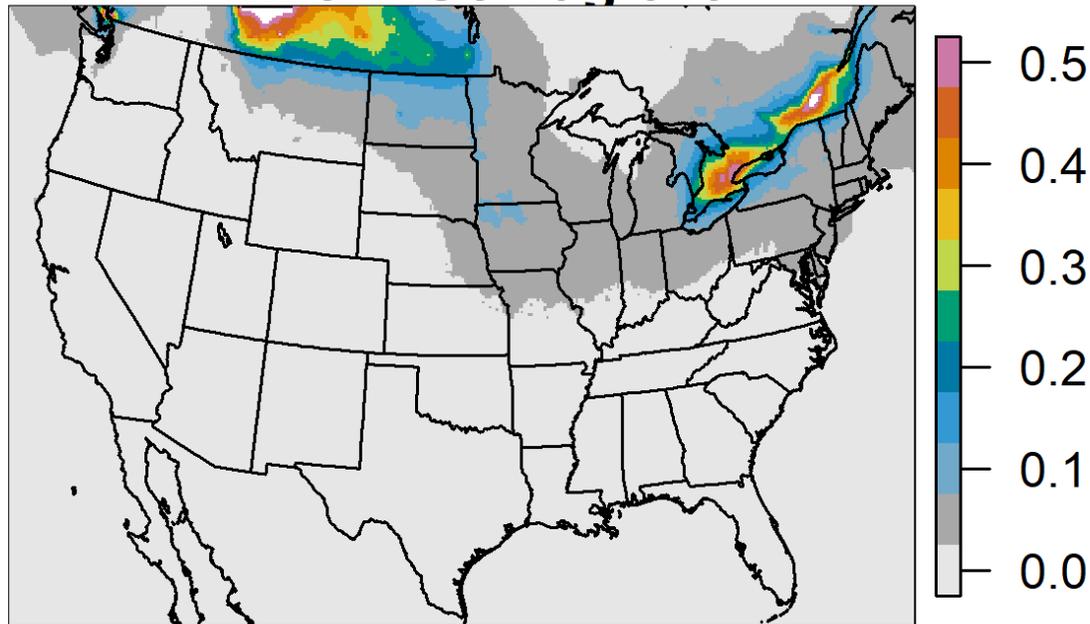
Fraction of Total Modeled Nitrate
**Tag 019 / Bulk PM25 NO3**
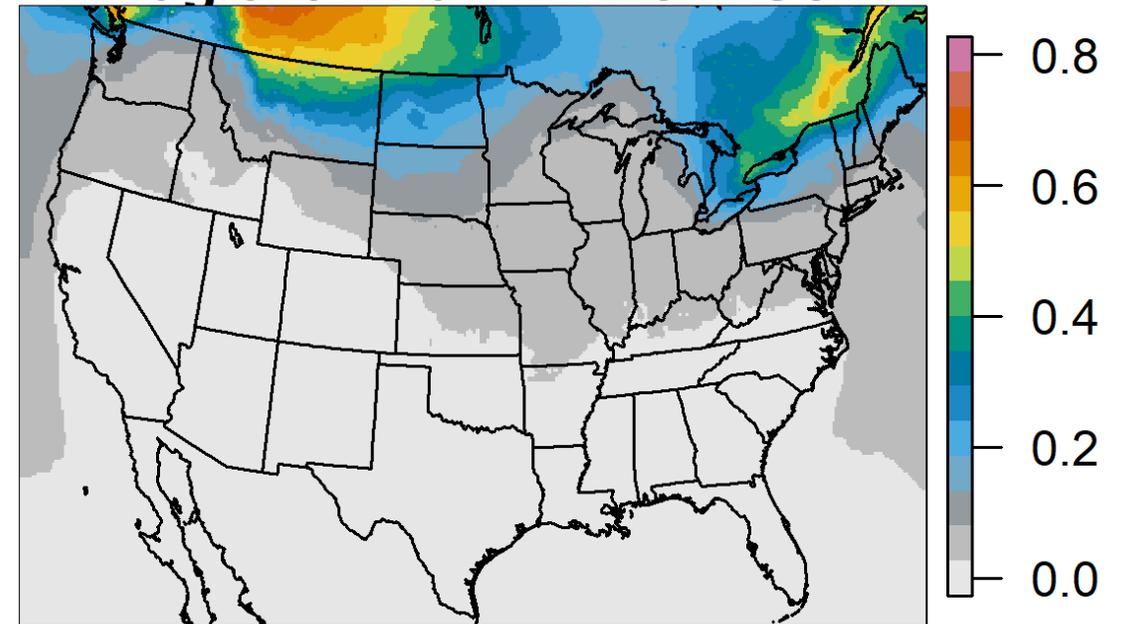
# 2028 Annual Average Canadian Anthropogenic Contribution to Sulfate

Absolute Sulfate Contribution ug/m3
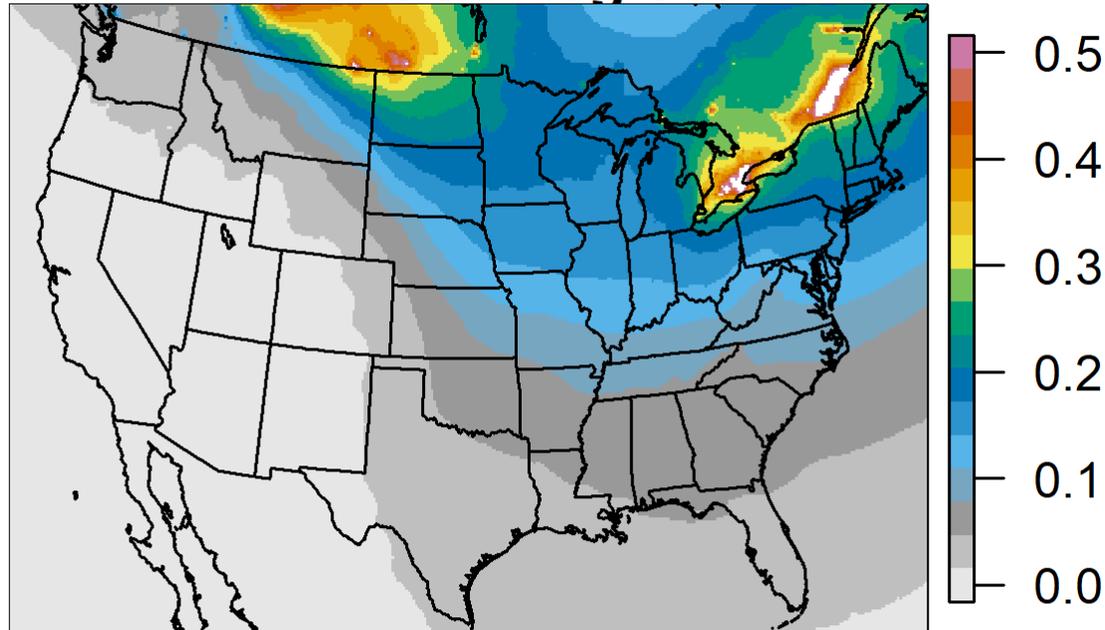
Fraction of Total Modeled Sulfate

PM25_SO4 Tag 019

Tag 019 / Bulk PM25_SO4
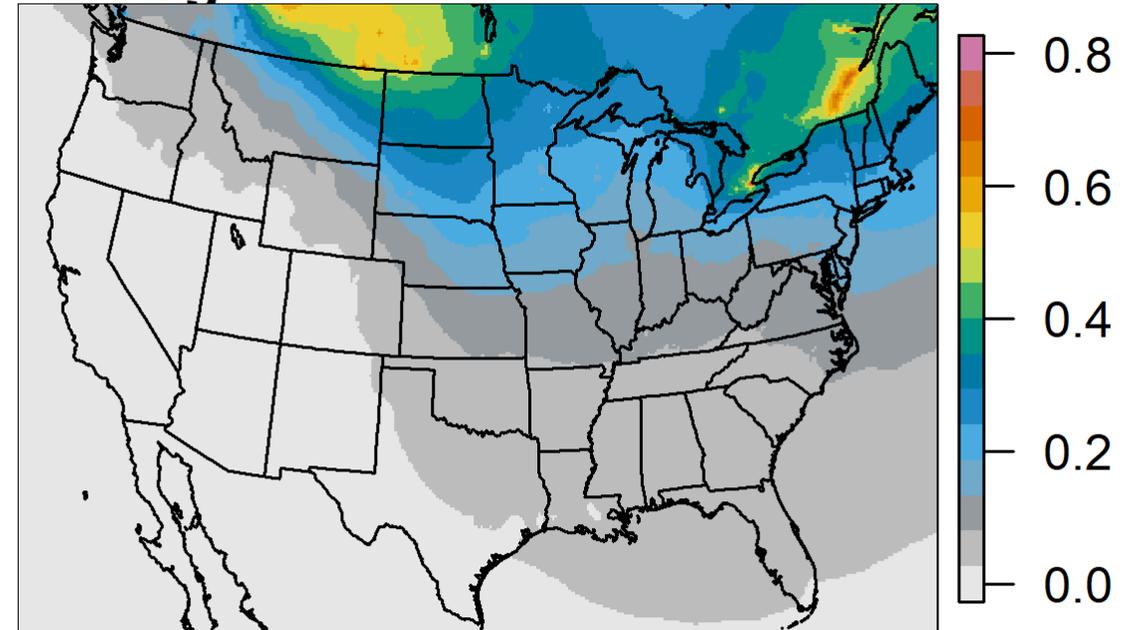
2028 Oil and Gas Contribution Conclusions

▶ Oil and gas 2028 modeled contributions to visibility impairment (on the 20% most impaired days) can be relatively large at Class I areas closest to production areas

▶ At the majority of Class I areas (62 out of 99 sites), modeled oil and gas contributes < 5% of the total US anthropogenic contributions

▶ Nitrate $PM_{2.5}$ represents the largest species contribution from oil and gas (with smaller impacts to sulfate and primary organic mass)

▶ As modeled here, the oil and gas production in Alberta Canada is an important contributor to visibility impairment in the Northern Tier of US States (particularly MT, ND, and MN)

▶ Caveats:
  ◦ The source apportionment modeling did not separately track point and nonpoint O&G emissions
  ◦ The modeling used 2016/2028 *beta* emissions which have been more recently updated to version 1 (October 2019)
  ◦ WRAP has a newer separate oil and gas inventory that differs from beta and v1

APPENDIX

Regional Haze Program Overview: The Clean Air Act's Visibility Provisions

Mandatory Class I Areas

NPS Unit
USFS Unit
FWS Unit

- In 1977, Congress declared as a national goal *"the prevention of any future, and the remedying of any existing, impairment of visibility...from manmade air pollution"* in mandatory Class I Federal areas. CAA §169A(a)(1).
  - Mandatory Class I Federal areas consist of certain national parks and wilderness areas (156 total).

- CAA §169A requires EPA to promulgate rules for state plans to meet the national goal.