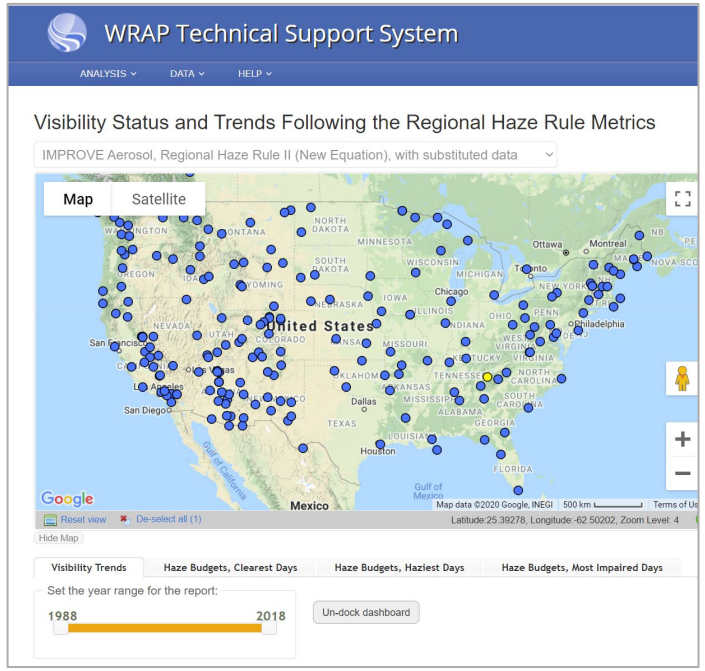
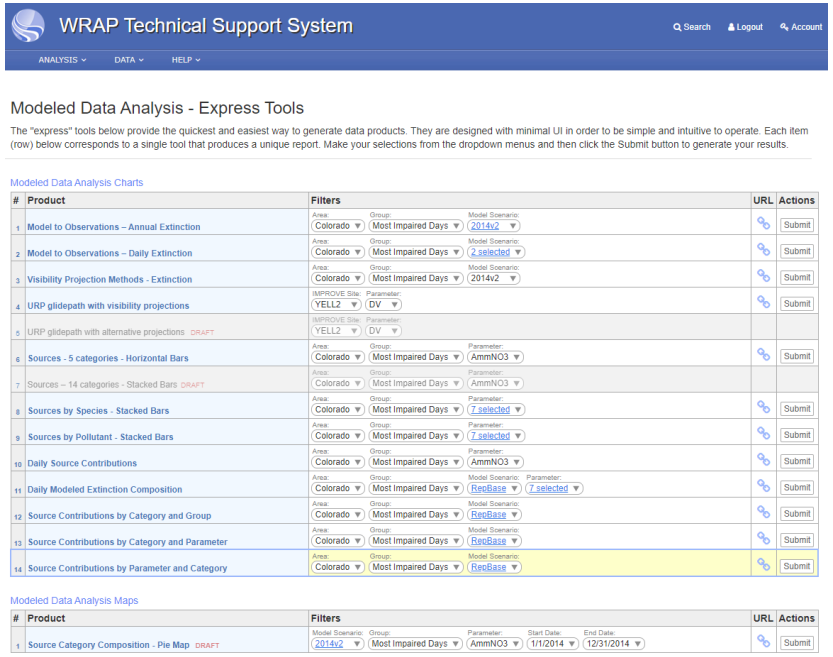
# Source Contribution Assessment using WRAP products
# New Mexico case study
## December 9, 2020





Overarching questions for NM – examples:

- Since 2014-18 IMPROVE data are the basis of 2028 Regional haze planning targets (e.g. SIP-required Reasonable Progress Goals to be identified with photochemical modeling),
  Which sources contributing in that 5-year period and operating in 2028 - need to, and can be, further reduced by 2028? (Rank-point)
  What amount of progress can be estimated in response to emissions reductions by 2028?

  - Weighted Emissions Potential and Ranked Point Sources prioritize source categories
  - Photochemical model projects response to cumulative emissions changes from 2014-2018 to 2028

- How should NM use WEP compared to modeled source apportionment? (slides 11-12, 16, 20)

  - WEP identifies 2014-2018 contributions of source sectors and states
  - Photochemical source apportionment modeling
    - attributes International vs natural vs US anthropogenic contributions to aerosol extinction in Representative Baseline and in 2028
    - Attributes U.S. anthropogenic contributions to states and emissions sectors (results in 2021)

Analysis process questions (not complete):

- For NM and proximate states' Class I areas:

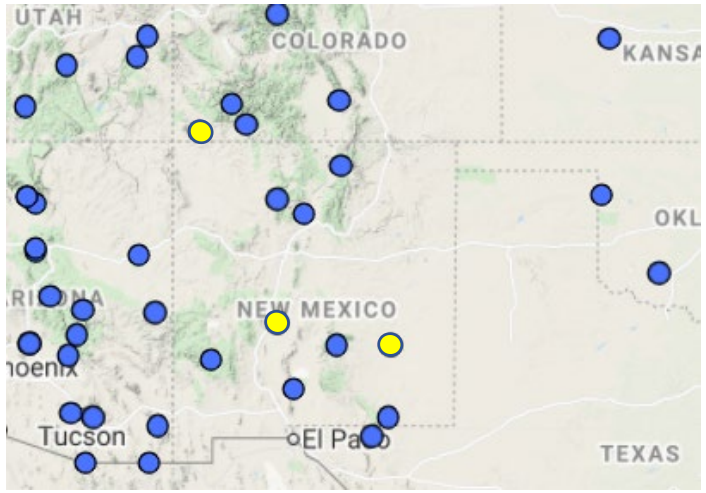
1) What are the measured contributions of SO4 and NO3? (IMPROVE data, slides 2+3)
2) What is the fetch of air masses in that 5-year period? (Residence time analysis, slide 6)
3) Are the air masses spending most their time over NM or just a minor amount of time in NM? (RT analysis, slide 6)
4) How are the SO4 and NO3-weighted RT analyses different or similar to the total MIDs RT analysis? (EWRT, slide 7)
5) What geographic areas have the greatest potential to transport to NM and other states' Class I areas? (WEP, slides 8-10, etc )

- WEP and Rank Point estimate the potential for anthropogenic sources to contribute to aerosols on MIDs.

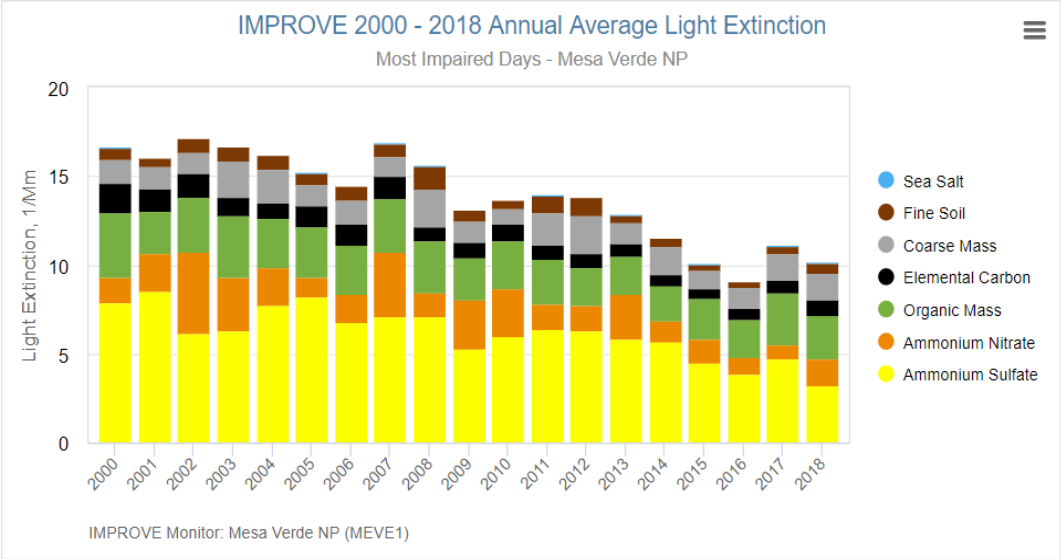
Today's analyses focus on how WEP analyses can assist prioritizing source sectors to evaluate for emission changes:

6) Does NM impact Class I areas in neighboring states? If so, what fraction of measured SO4 and NO3 is attributed to NM? 7) Do neighboring states impact NM Class I areas? If so, what fraction of measured SO4 and NO3 is attributed to NM? (WEP)
8) Which source categories are most important? Which of those source categories can NM change? (e.g. NM doesn't have authority to change mobile emissions even if WEP defines large contributions from mobile sources)
9) Are source areas impacting NM Class I areas similar or different? shared source areas? Examine differences between Oil and Gas area vs. non-EGU point? (WEP)
10) Which individual point sources are actively being considered for control using 4 factor analysis? (Rank_Point)
11) How much can you actually reduce SO2 and NOx emissions from those sources and how much proportionally would those reductions change the measured SO4 and NO3? (Rank_Point)

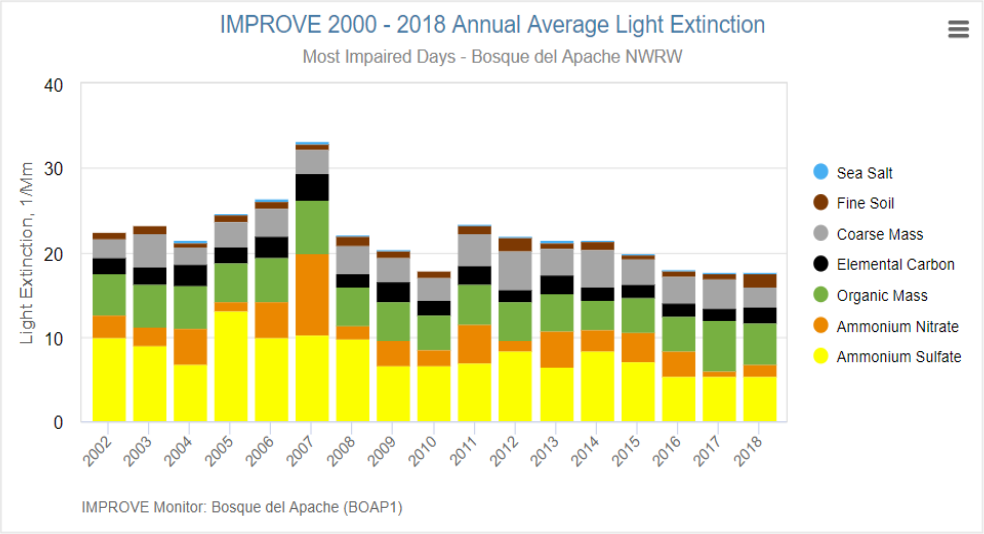
## IMPROVE monitoring site locations



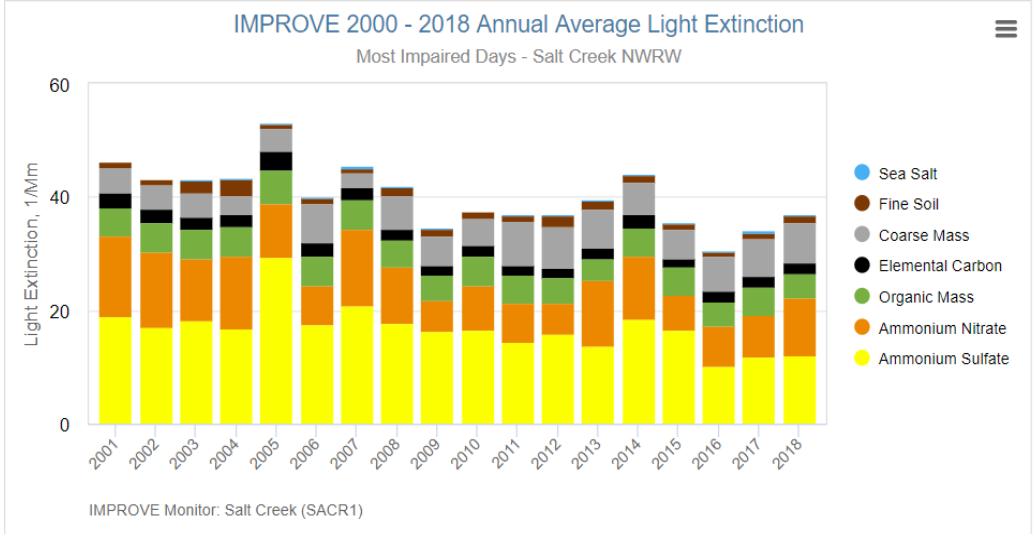

## Mesa Verde, CO: Aerosol Extinction = 10.2 $Mm^{-1}$



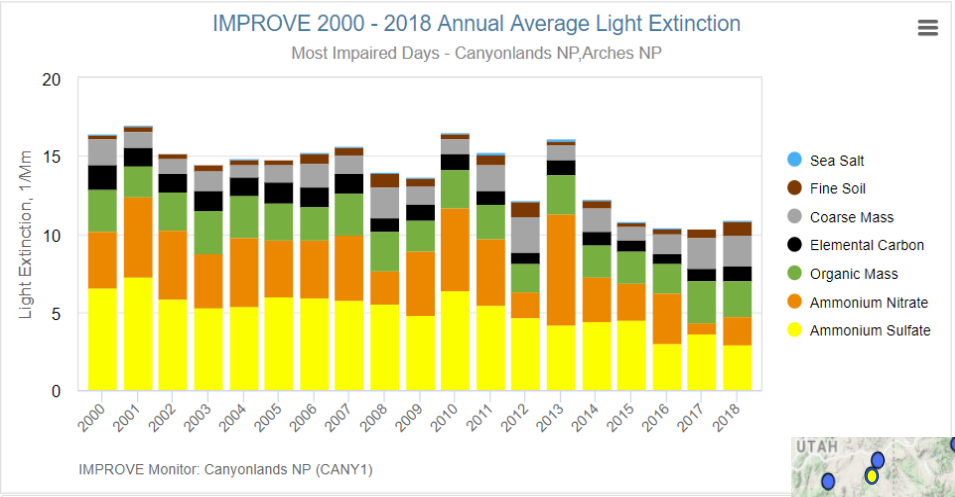

## Bosque del Apache, NM: Aerosol Extinction = 17.7 $Mm^{-1}$



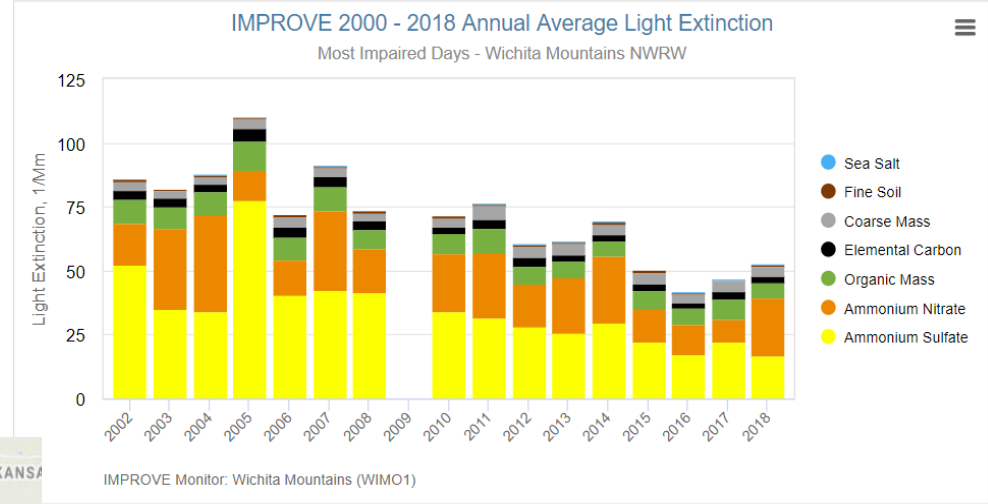

## Salt Creek, NM: Aerosol Extinction = 36.8

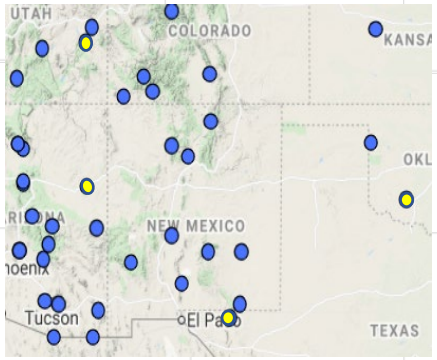


## **Canyonlands, UT:** Aerosol Extinction in 2018 = **10.9 Mm$^{-1}$**



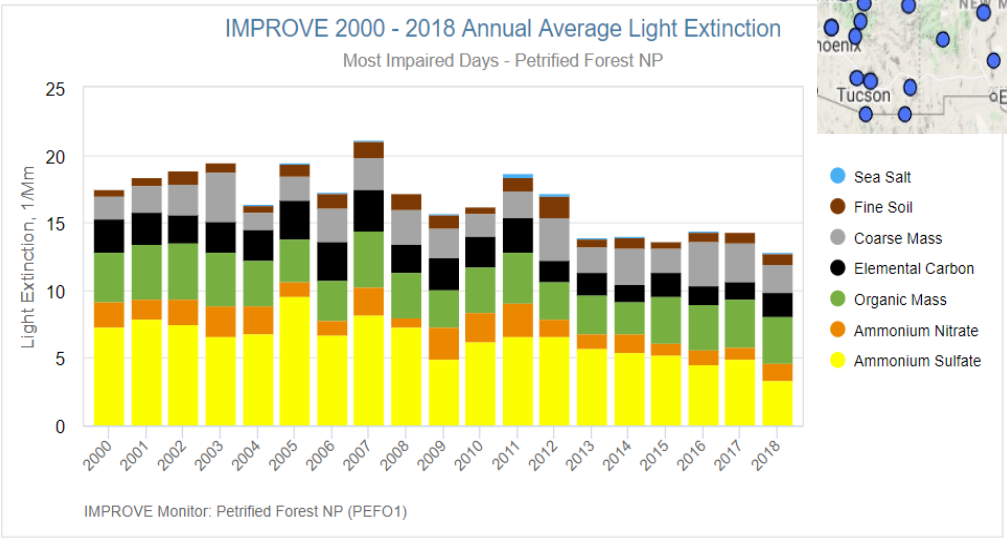

## **Wichita Mtns., OK:** Aerosol Extinction in 2018= **52.9 Mm$^{-1}$**



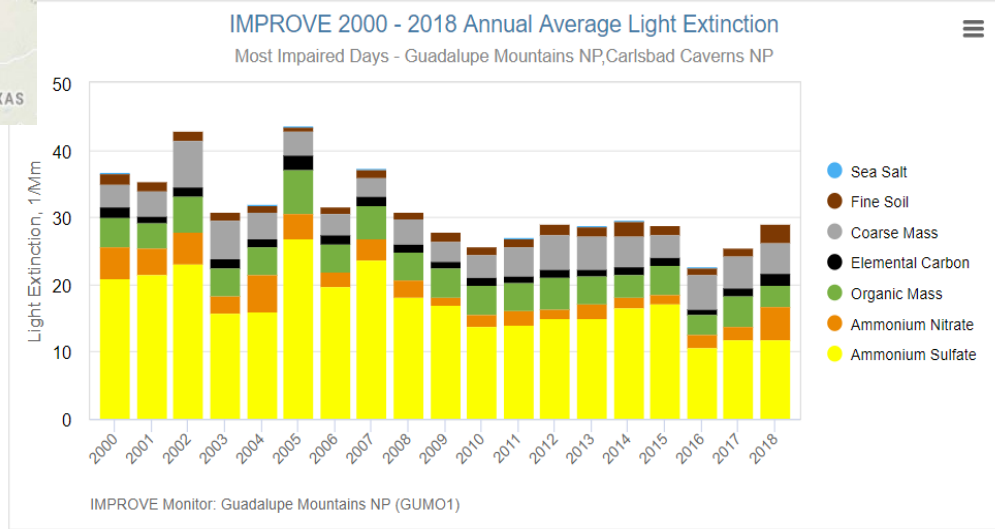

## **Petrified Forest, AZ:**

Aerosol Extinction in 2018 = **14.8 Mm$^{-1}$**




## **Carlsbad Caverns, NM** (represented by Guadalupe Mtns, TX):

Aerosol Extinction in 2018 = **29.1 Mm$^{-1}$**

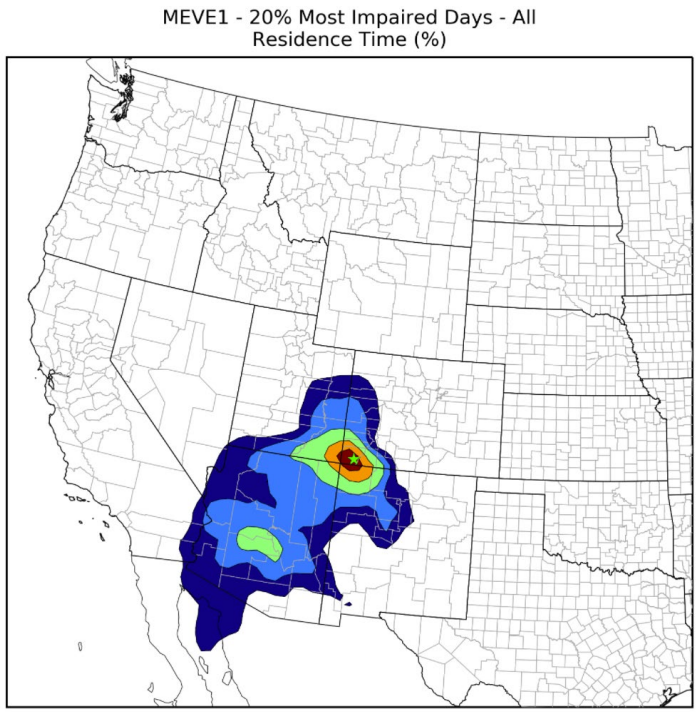


**Residence time** is the frequency that air masses passed over a location prior to arriving at a specific Class I area, as defined by Hysplit back trajectories, on the most impaired days in 2014-2018 (roughly 120 days).

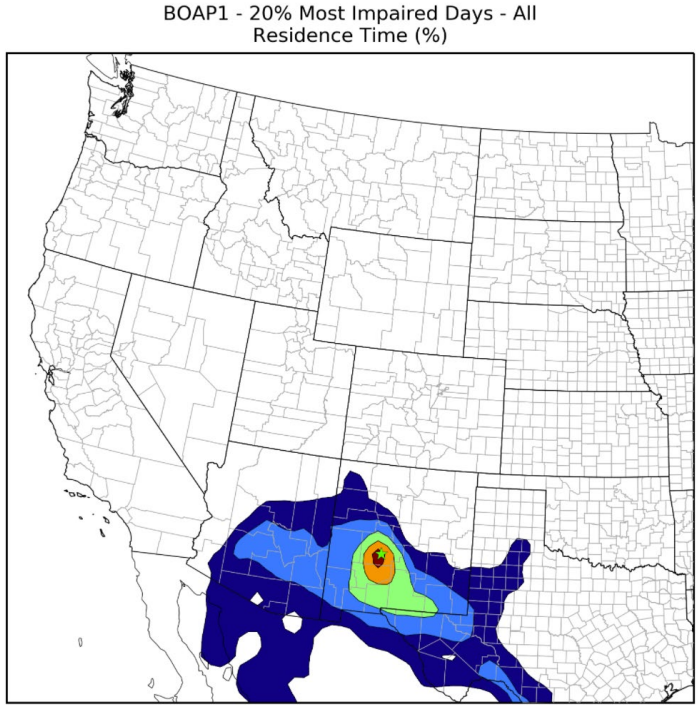
The plots below are composites of all back trajectories released 4 times a day at 4 heights.

In the WEP tool we recommend that users select “All” heights to apply the full strength of the dataset.

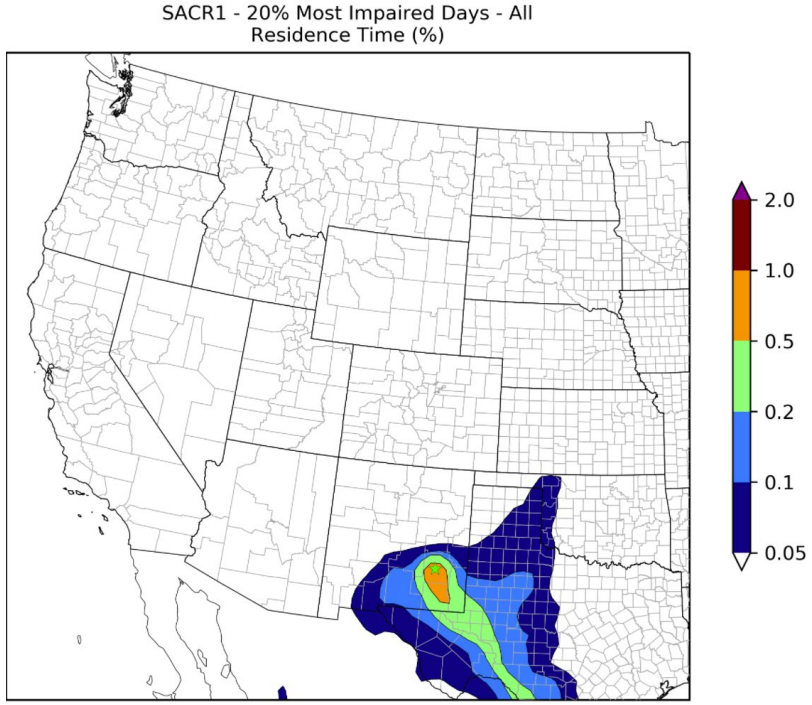
## Mesa Verde




## Bosque del Apache



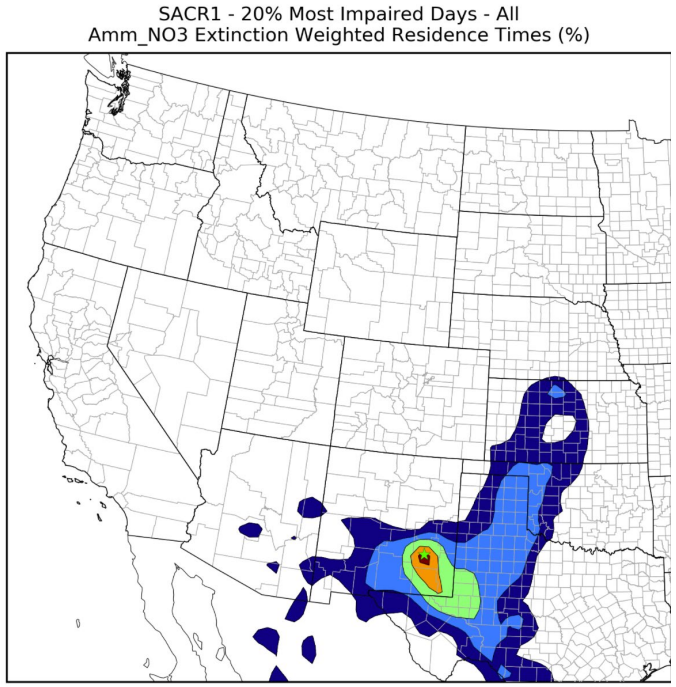

## Salt Creek



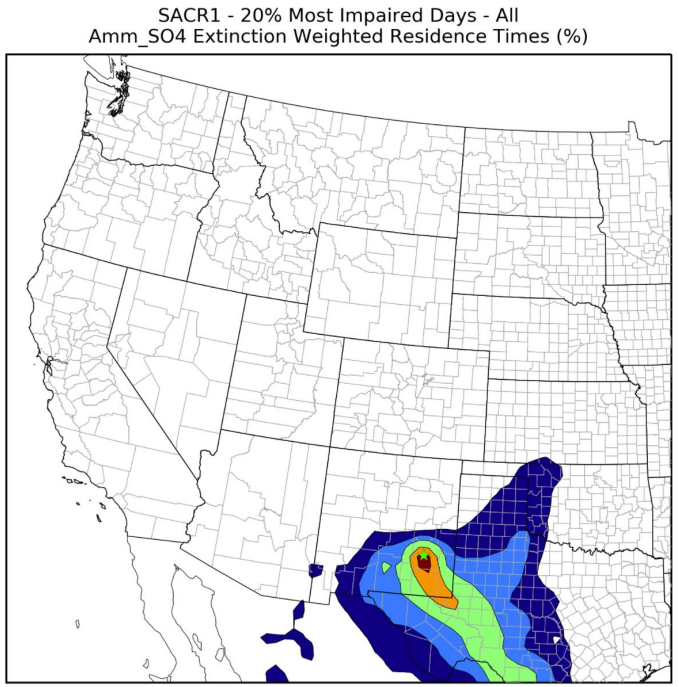
**Extinction weighted residence time (EWRT)** defines the geographic areas that are most likely to be important when aerosol levels are highest for the most impaired days.

The **Areas of Influence** (AoI) greater than 0.5% (area in orange) and greater than 0.1% (area within bright blue shape) are defined based on EWRT.

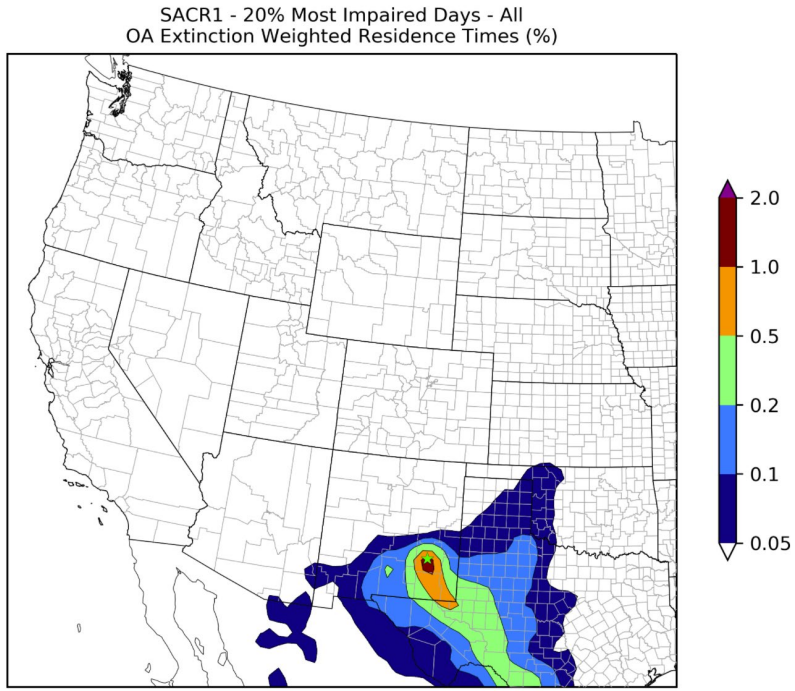
Ammonium nitrate




Ammonium sulfate




Organic Aerosol

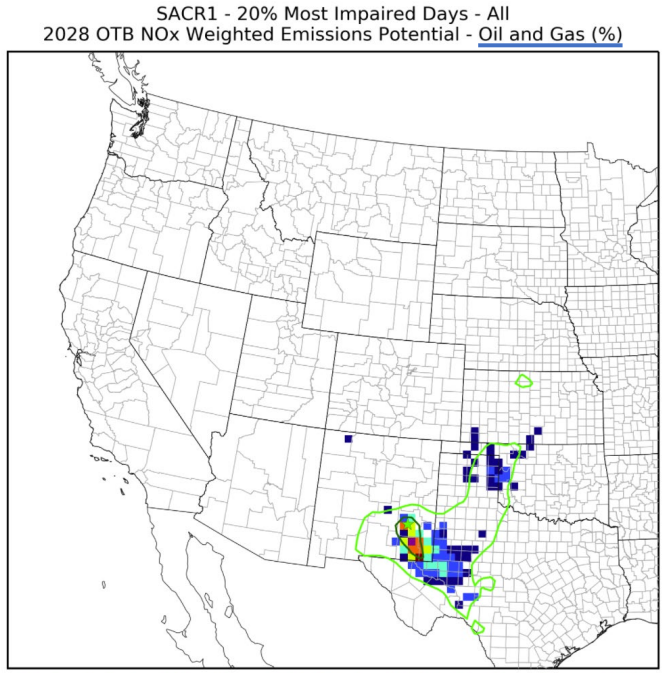



**Salt Creek Wilderness Area**: the Areas of greatest Influence (orange and blue shapes) for AmmNO3, AmmSO4, and Organic Carbon are south and east of the Class I area.

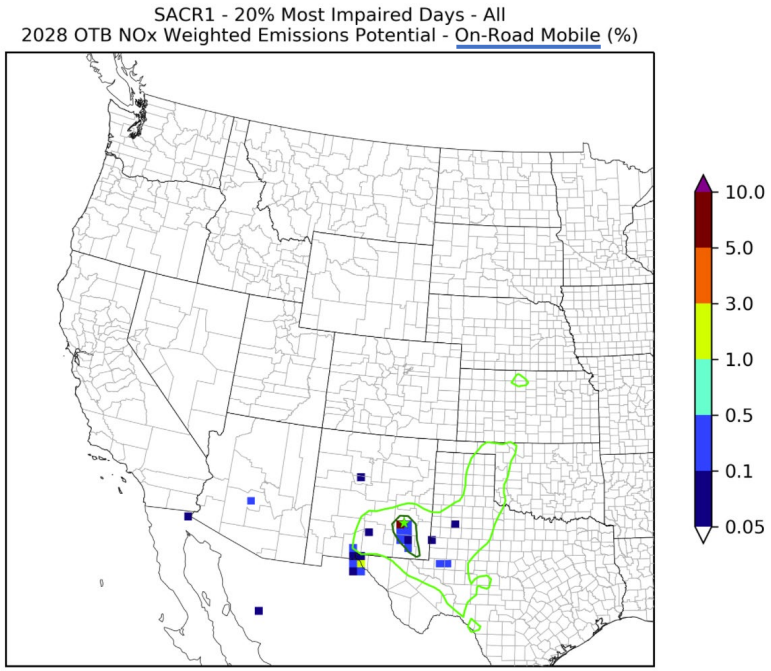
**Weighted Emissions Potential** combines emissions and Areas of Influence (in these charts, areas within green outlines)

**Ammonium Nitrate at Salt Creek Wilderness Area**:

- 2028 WEP (All heights) identifies Oil and Gas and Mobile as local and major source categories.
- EGU and non-EGU point sources and Non-point sources are less important




Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

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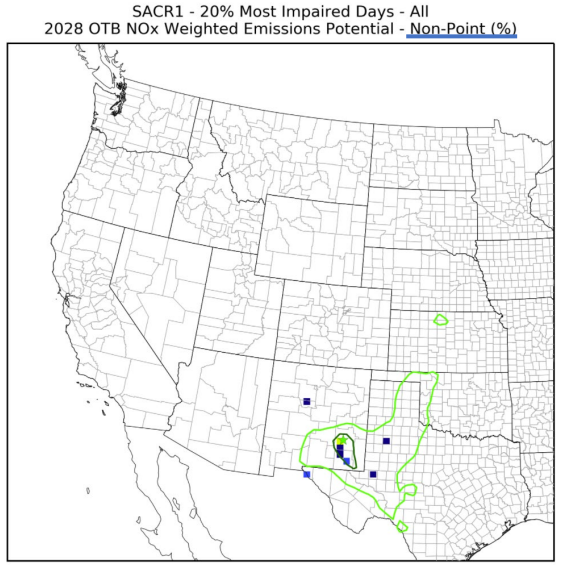


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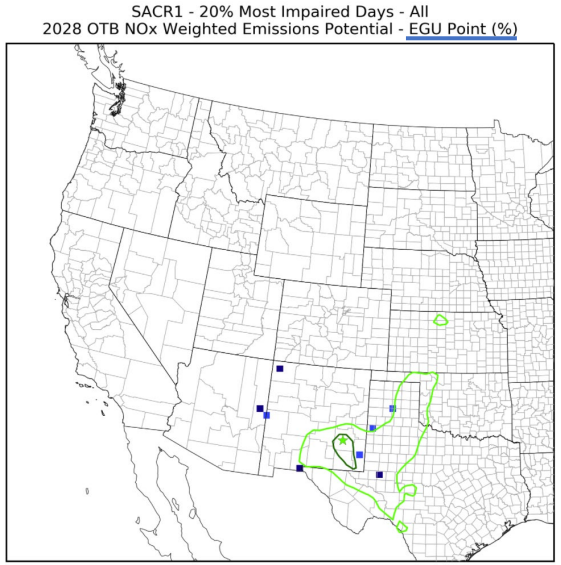


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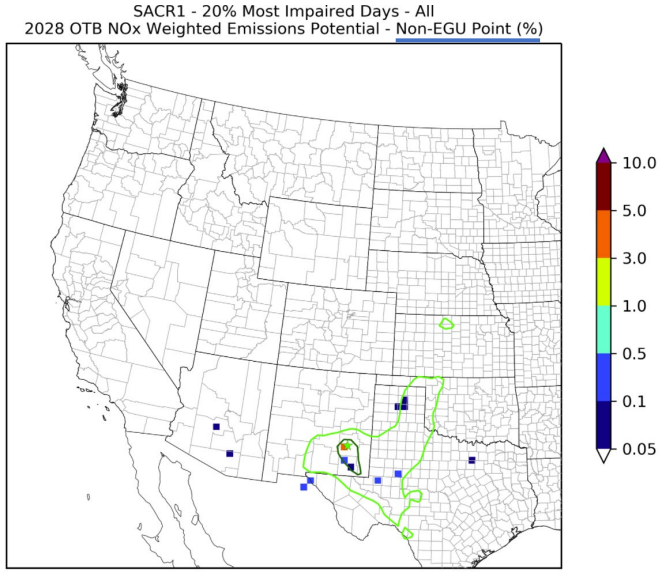


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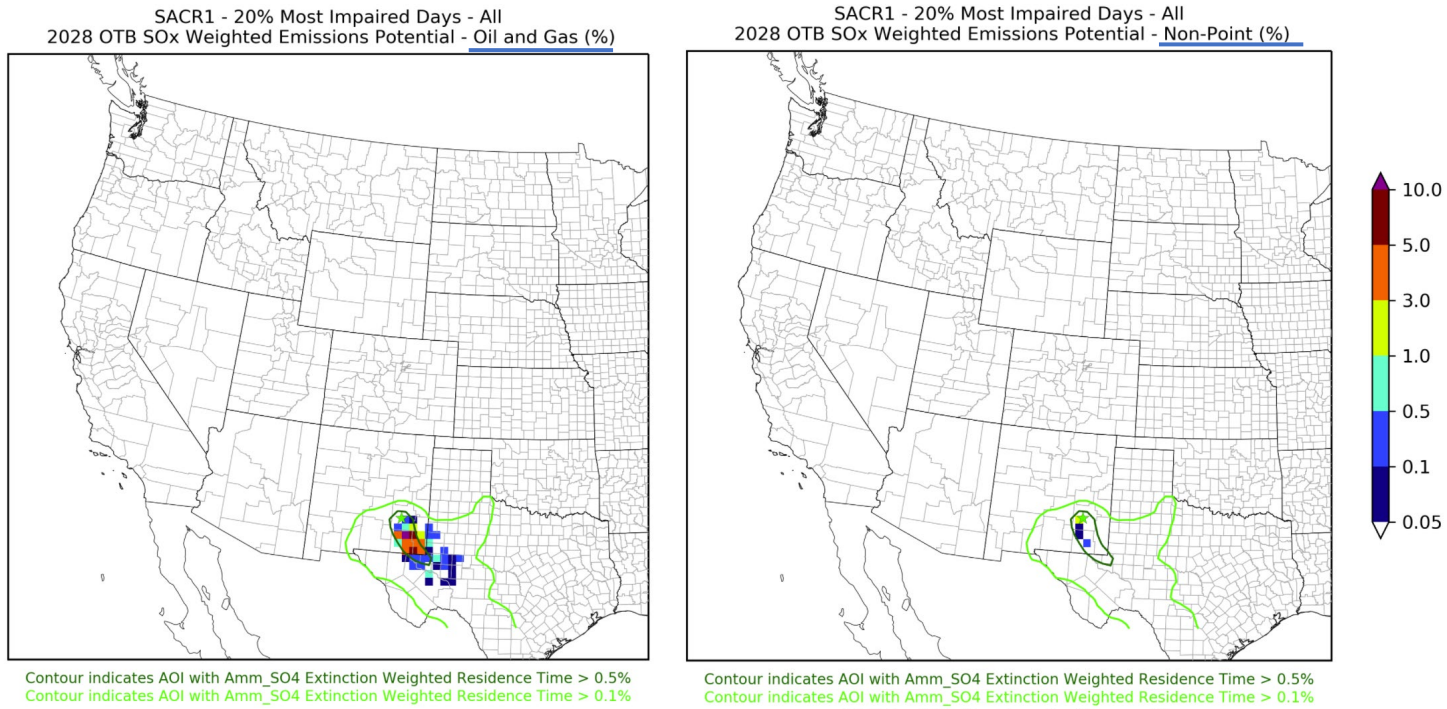
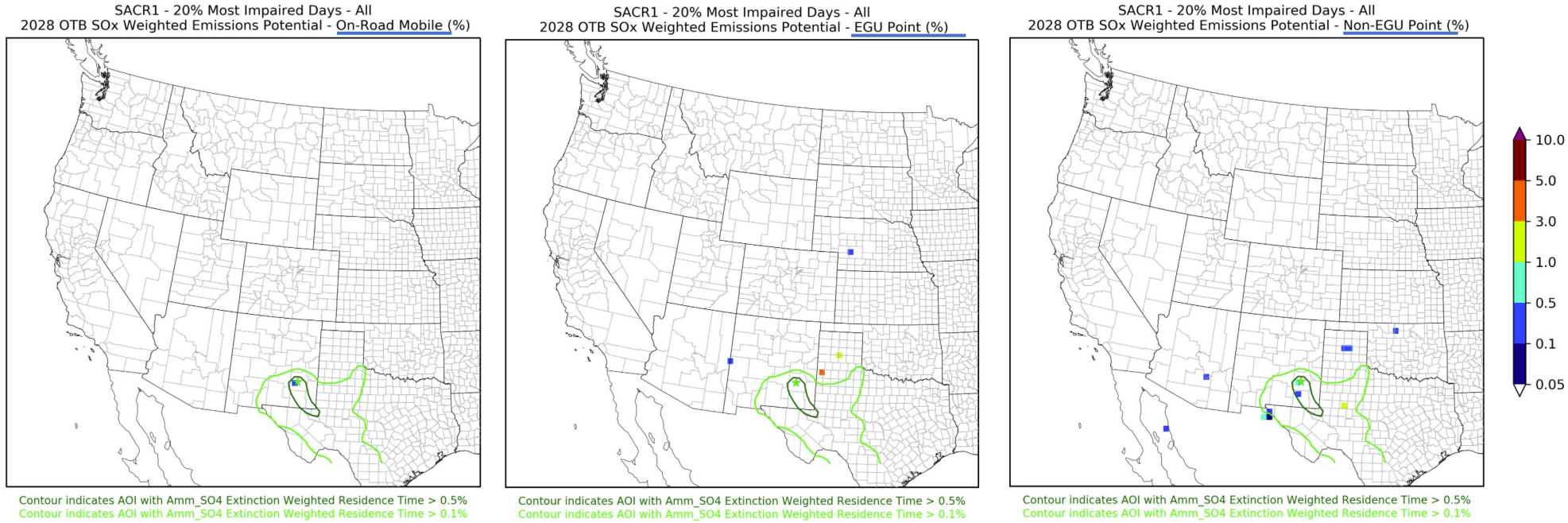
**Ammonium Sulfate at Salt Creek Wilderness Area**:

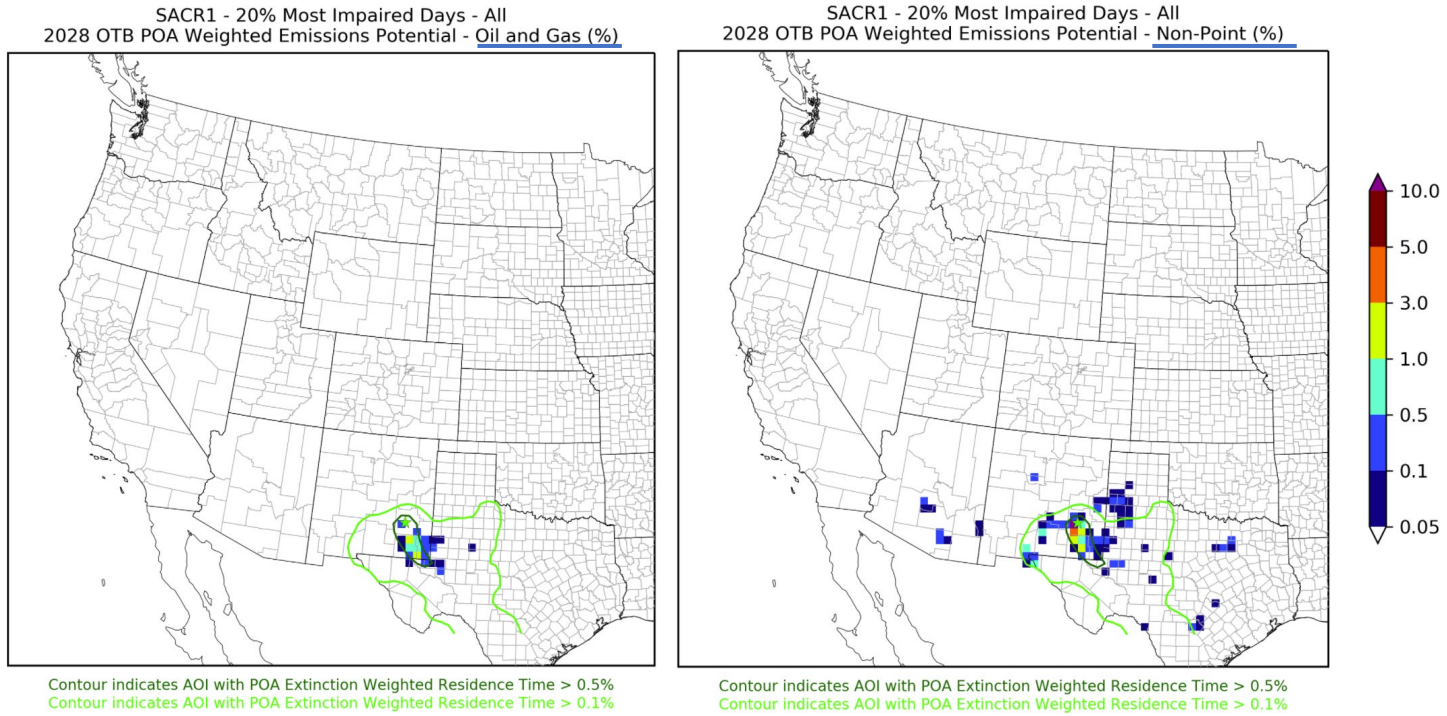
- 2028 WEP (All heights) identifies Oil and Gas as a major and local source category
- EGU, non-EGU point, Non-point and Mobile sources have smaller contributions

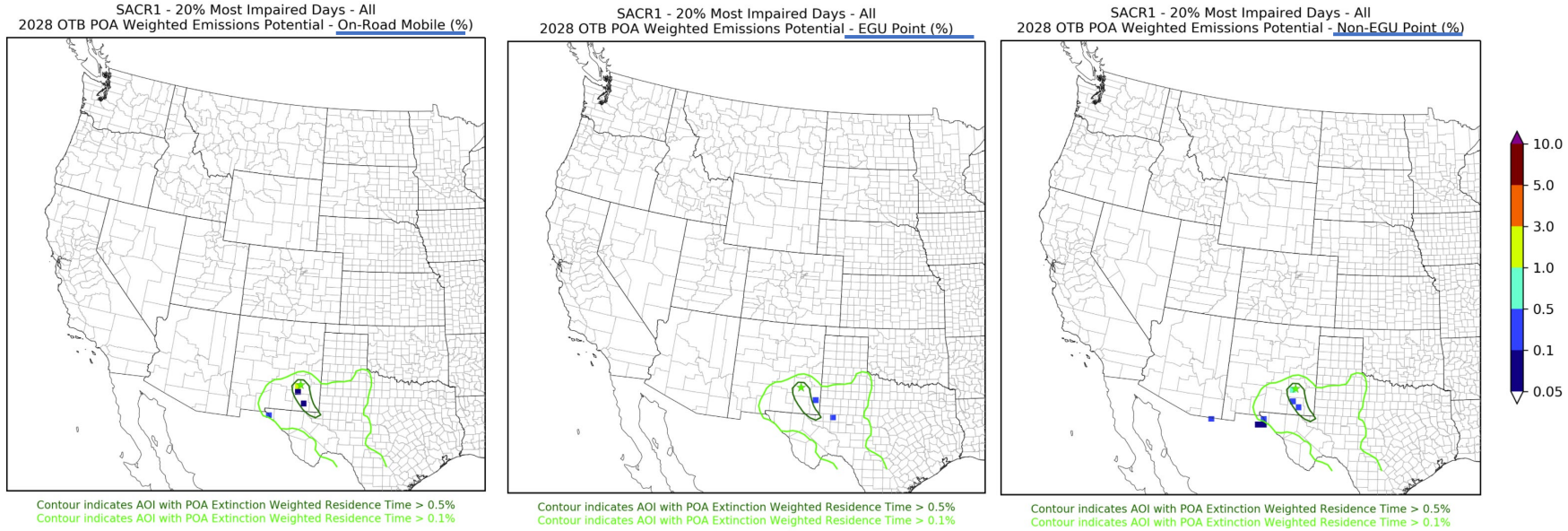


**Primary Organic Aerosol at Salt Creek Wilderness Area**:

- 2028 WEP (All heights) identifies Non-point and Oil and Gas as local and major source categories.

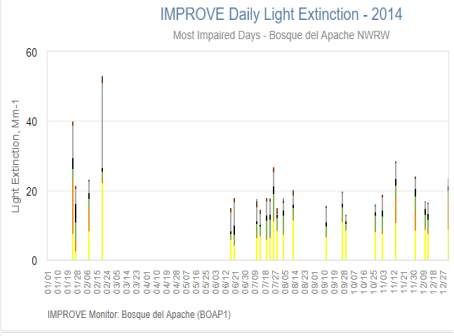


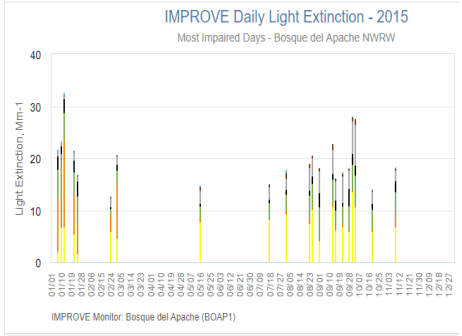



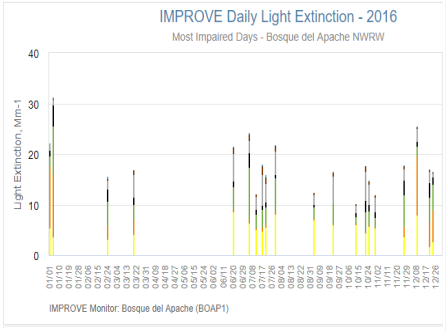
## How are Weighted Emissions Potential and Source Apportionment different:

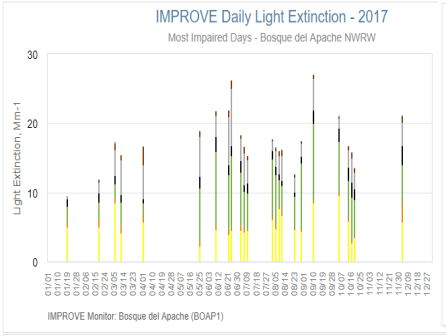
### Weighted Emissions Potential (WEP):

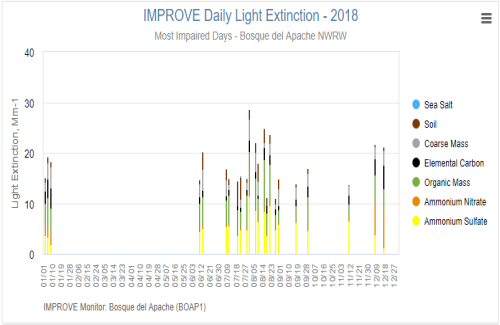
- Meterology
  - 24 most impaired days in each of 5 years, 2014-2018, based on IMPROVE monitoring data.
  - Hysplit back trajectories are released 4 times a day at 4 elevations above the surface at each IMPROVE monitoring site representing a Class I area.



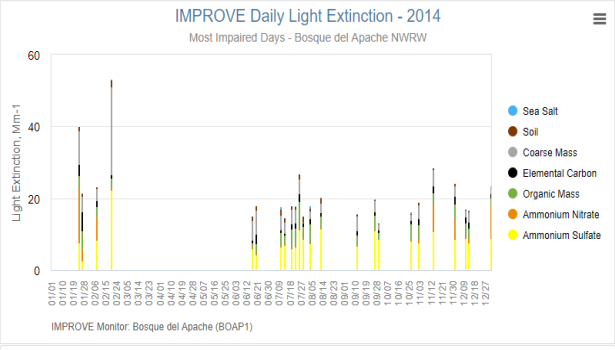




**Particle source apportionment tool (PSAT)** in the CAMx model

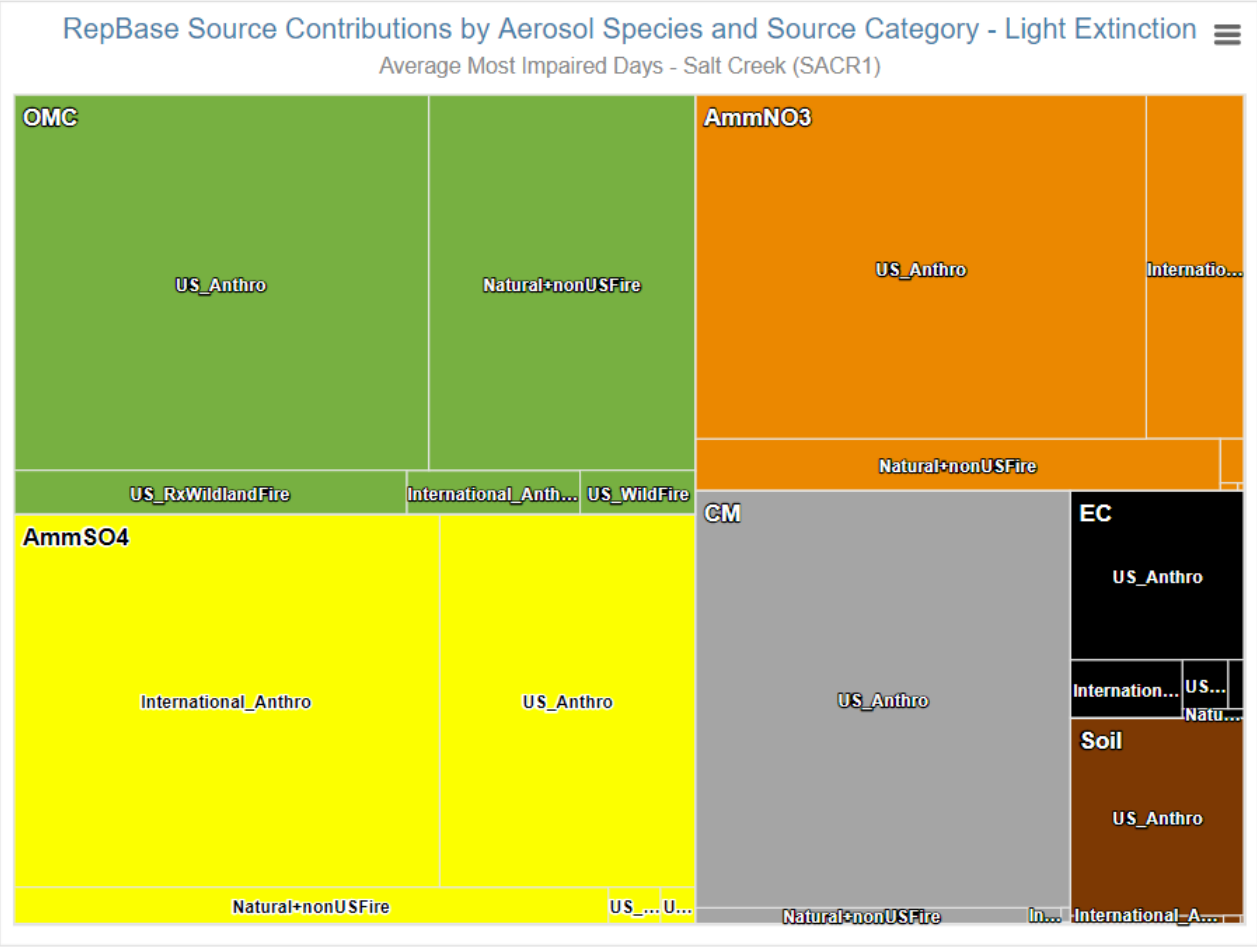
- Meteorology
  - 24 most impaired IMPROVE days in the single 2014 modeling year.
  - 2014 meteorology is generated by the WRF model with some model uncertainty



At Salt Creek Wilderness Area, from Representative Baseline source apportionment:

- U.S. Anthropogenic emissions are largest source category for Organic Carbon, AmmNitrate, Coarse Mass, Soil, and Elemental Carbon.
- International Anthropogenic emissions are more important than U.S. anthropogenic emissions for AmmSulfate.
- Natural Sources and Fire are less important than U.S. anthropogenic sources for all aerosol species.

2028OTBa2 source apportionment may show different relative source contributions



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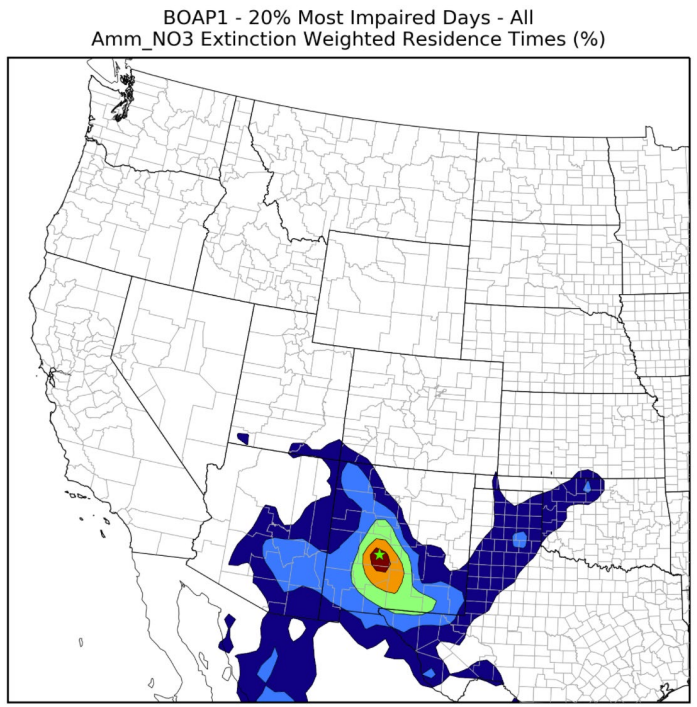
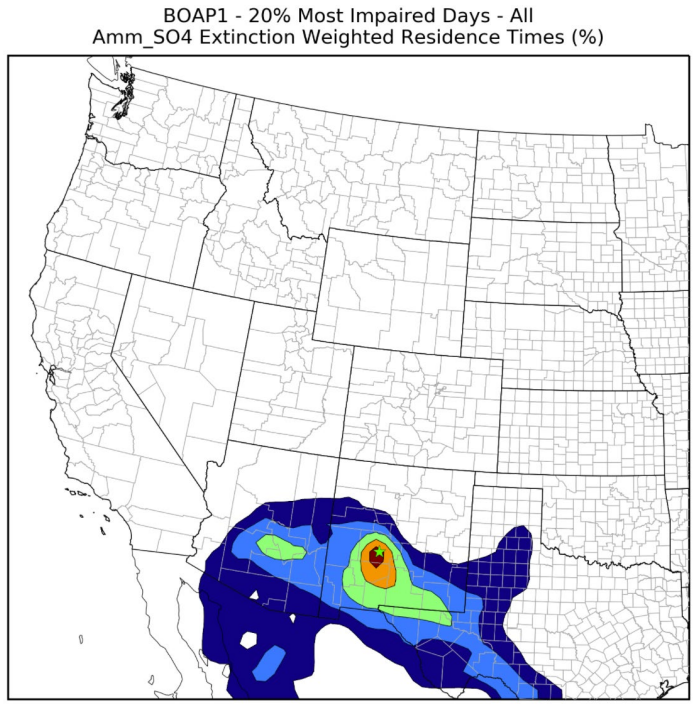
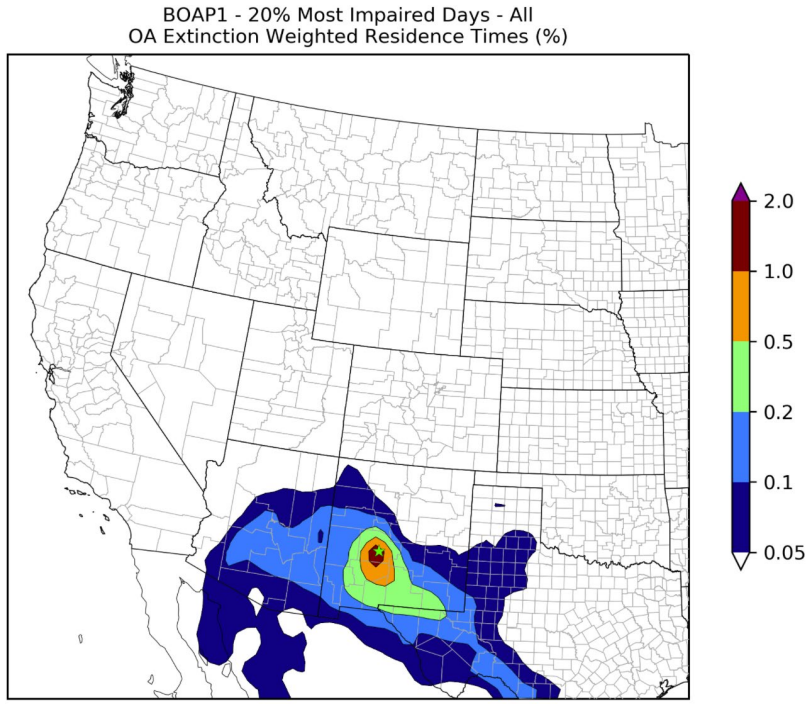
Ammonium nitrate




Ammonium sulfate




Organic Aerosol

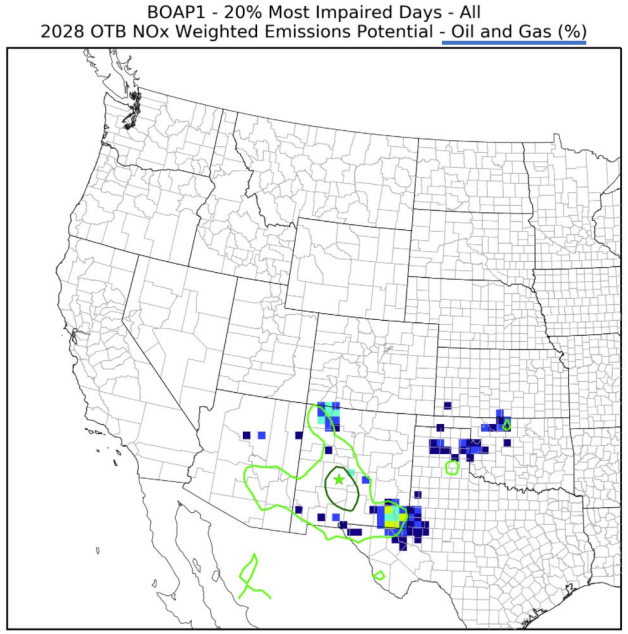



**Bosque del Apache Wildlife Area**: Areas of Influence are **"Bird's Eye"**, mostly southwest to southeast

## Ammonium Nitrate

## Bosque del Apache Wildlife Area:

- 2028 WEP (All heights) identifies local Oil and Gas and Mobile contributions
- EGU and Non-EGU point and Non-point sources are more widely dispersed

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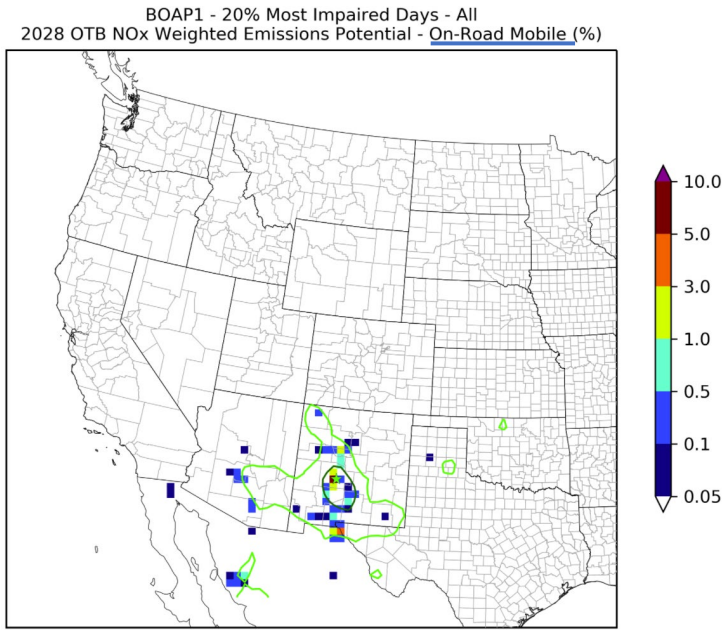


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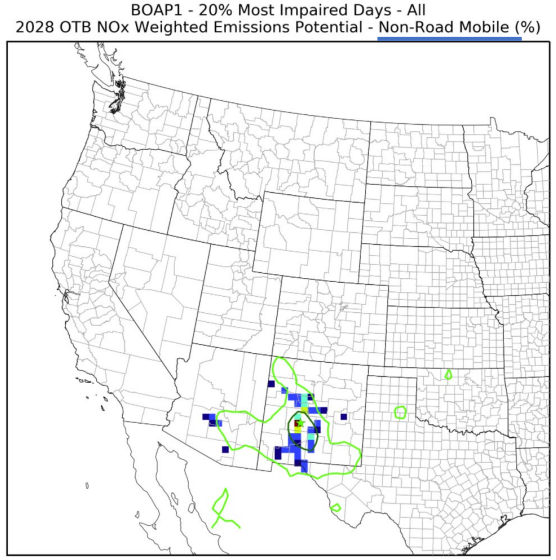


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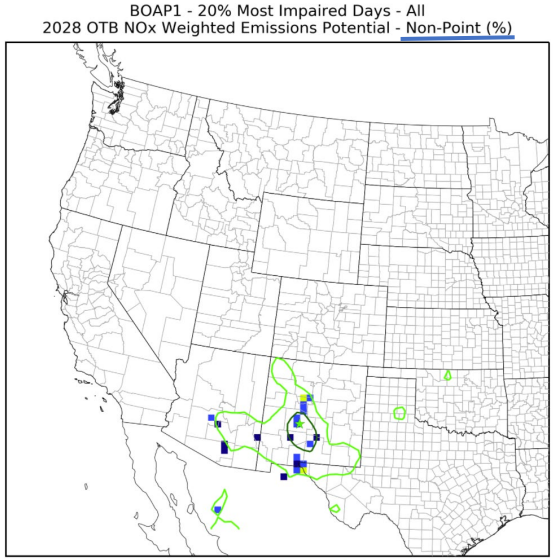


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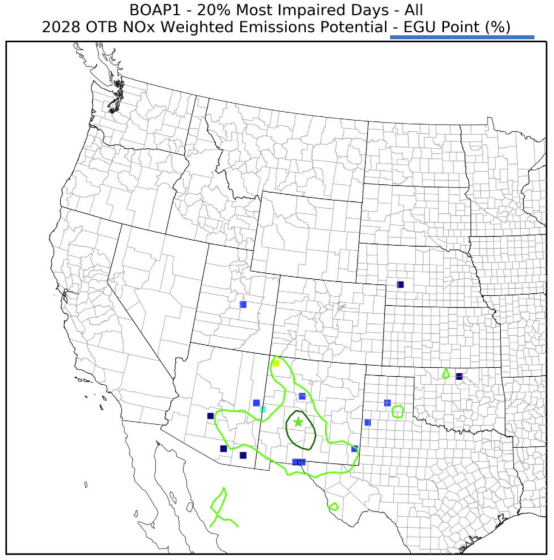
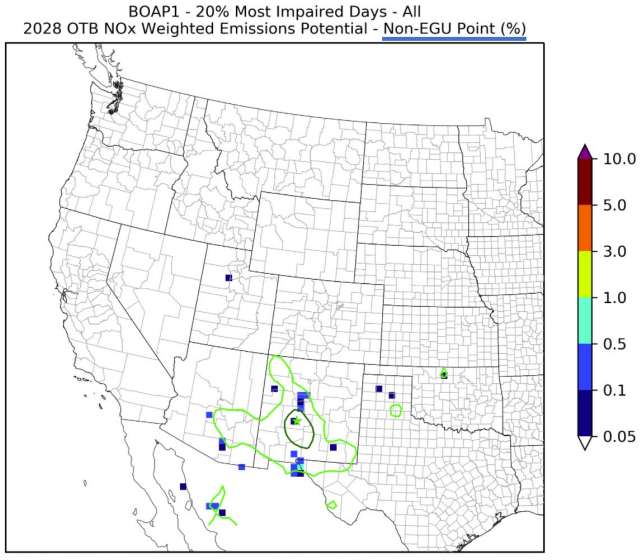


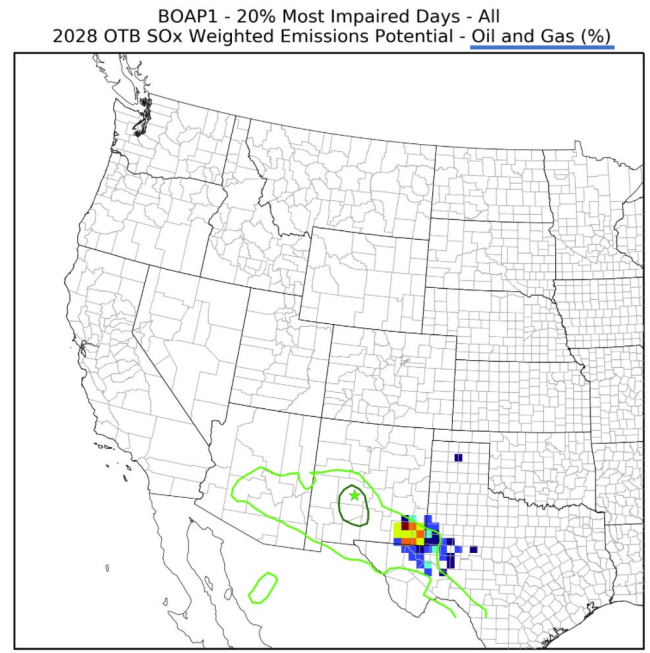

Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%



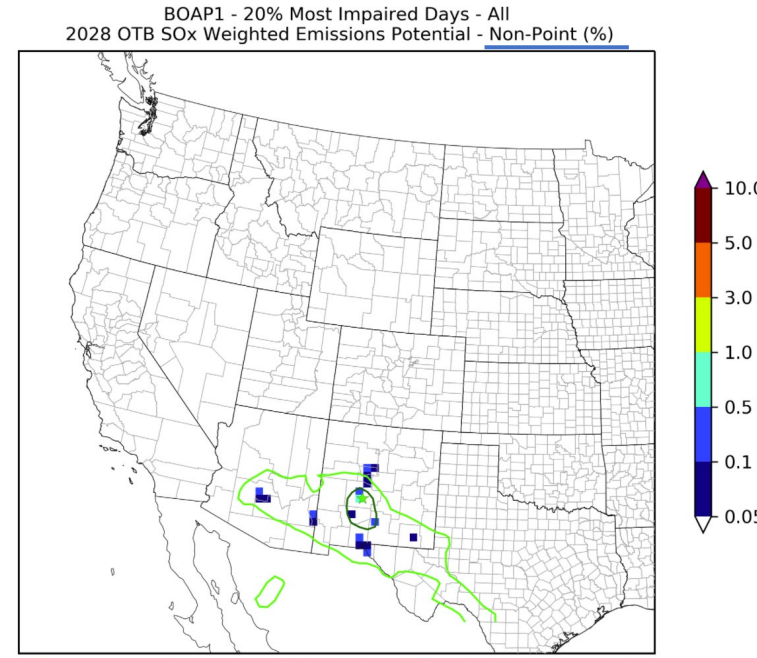

Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

## Ammonium Sulfate at Bosque del Apache Wildlife Area:

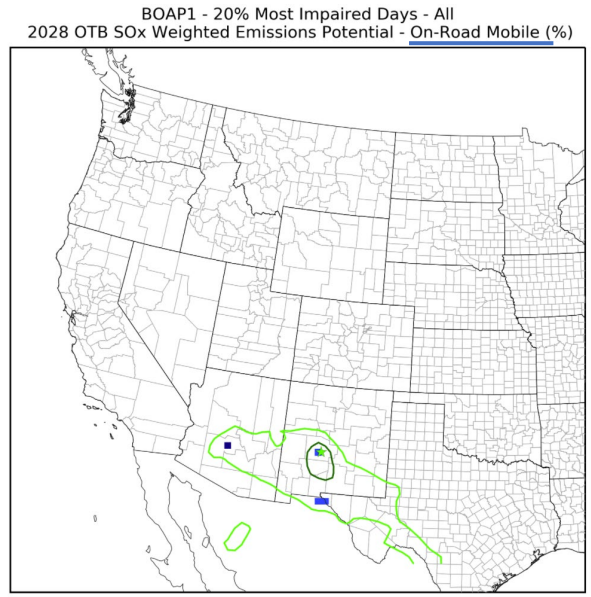
- 2028 WEP (All heights) identifies Oil and Gas and Non-point sources as most important
- Other sources are dispersed



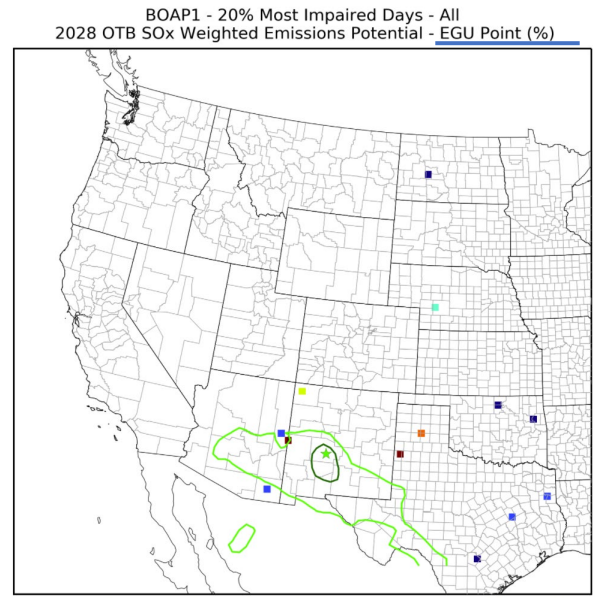

Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.1%



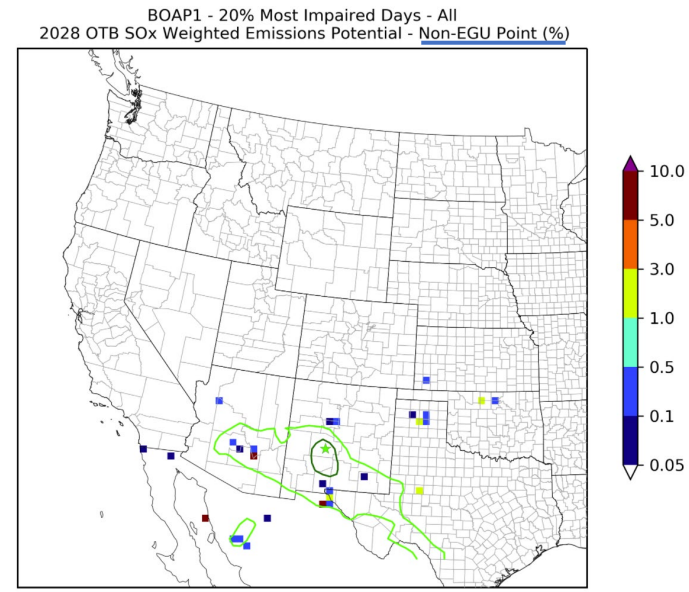

Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.1%




Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.1%




Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.1%

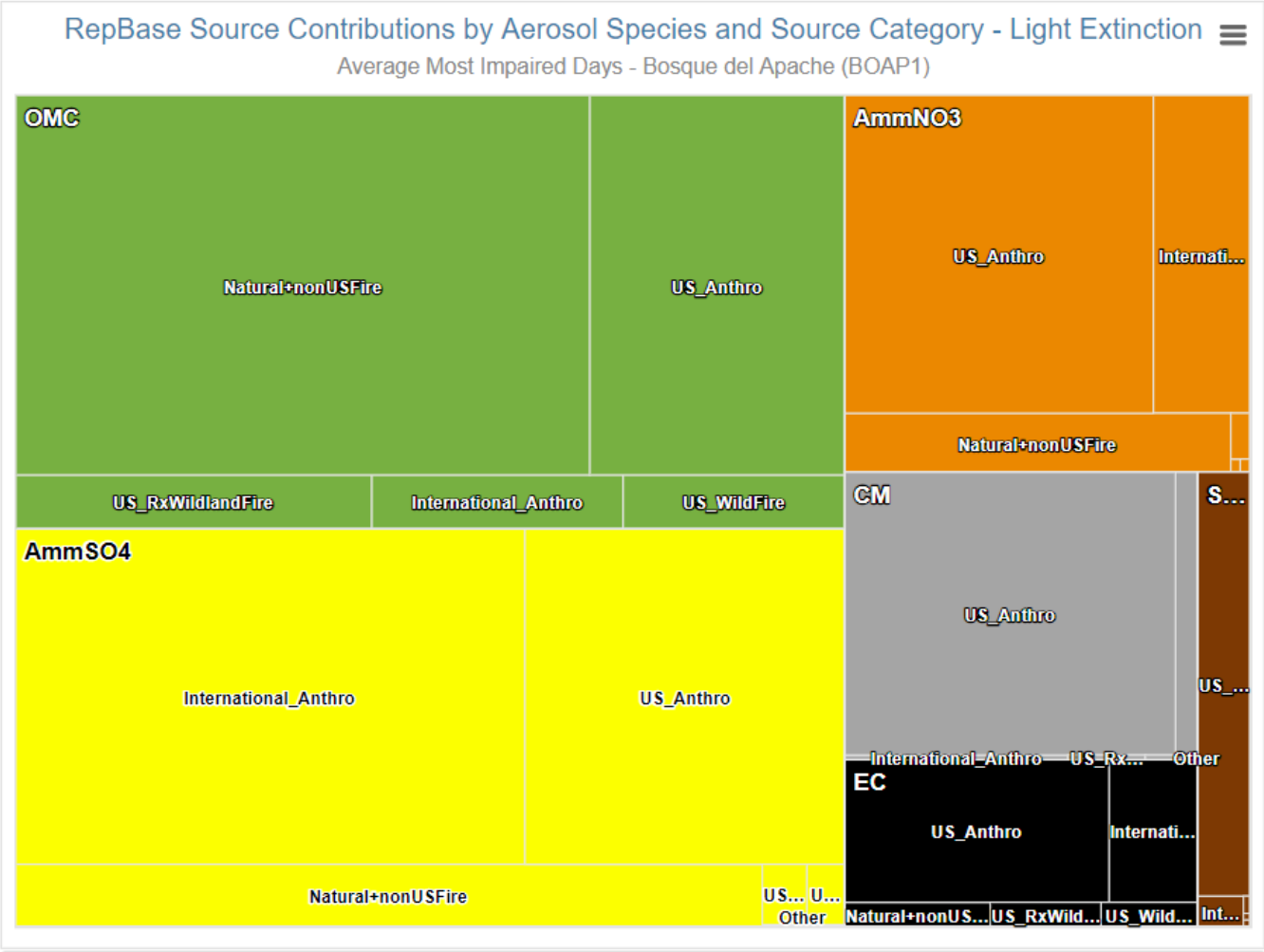



Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_SO4 Extinction Weighted Residence Time > 0.1%

At Bosque del Apache Wildlife Area, from Representative Baseline source apportionment:

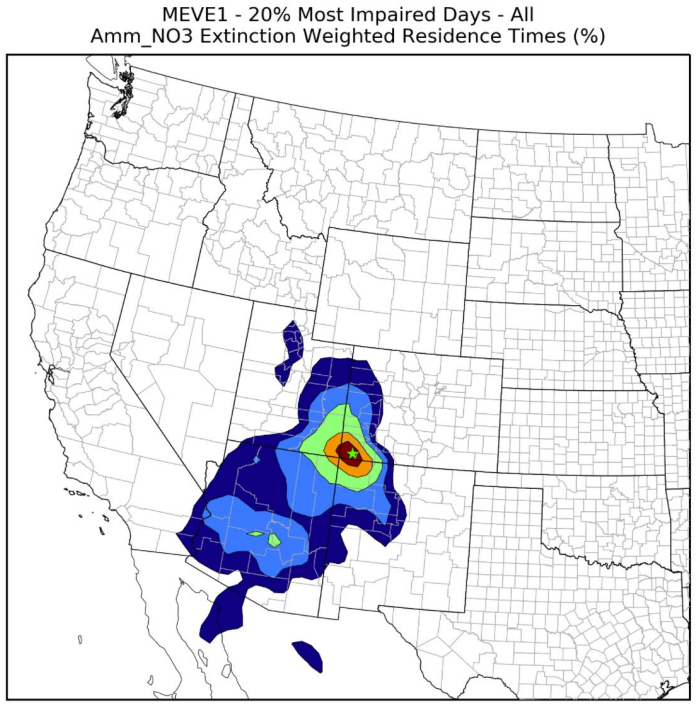
- International Anthropogenic emissions are more important than U.S. anthropogenic for AmmSulfate.
- Natural Sources plus Fire are more important than U.S. anthropogenic sources for Organic Carbon.
- U.S. Anthropogenic emissions are largest source category for AmmNitrate, Coarse Mass, Soil, and Elemental Carbon.

2028OTBa2 source apportionment may show different relative source contributions

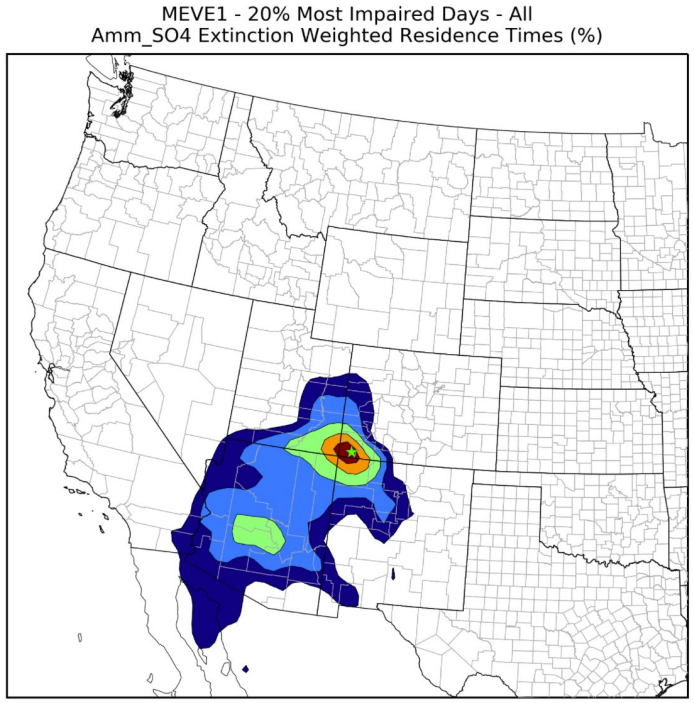


**Extinction weighted residence time** defines the geographic areas that are most likely to be important when aerosol levels are highest on most impaired days

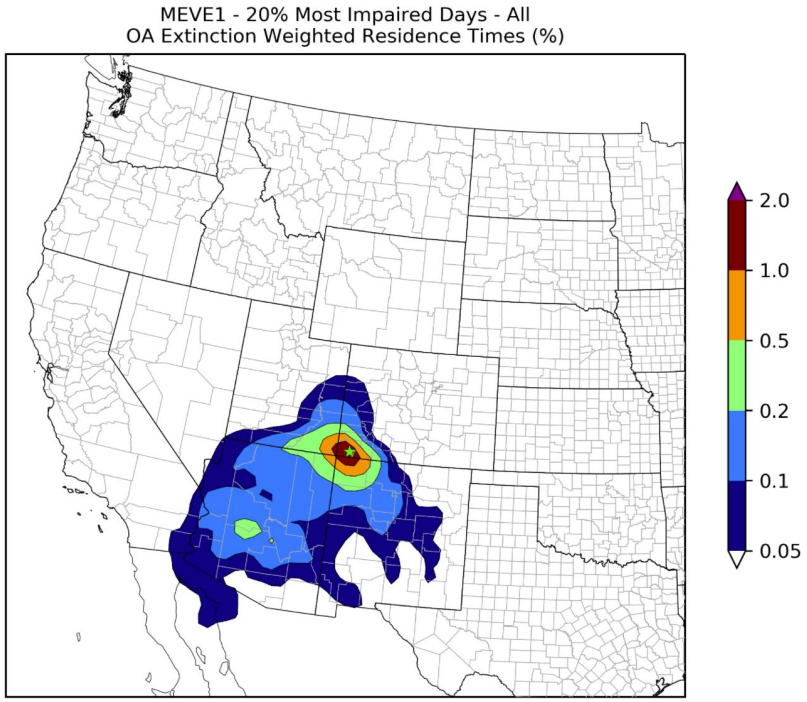
## Ammonium nitrate




## Ammonium sulfate



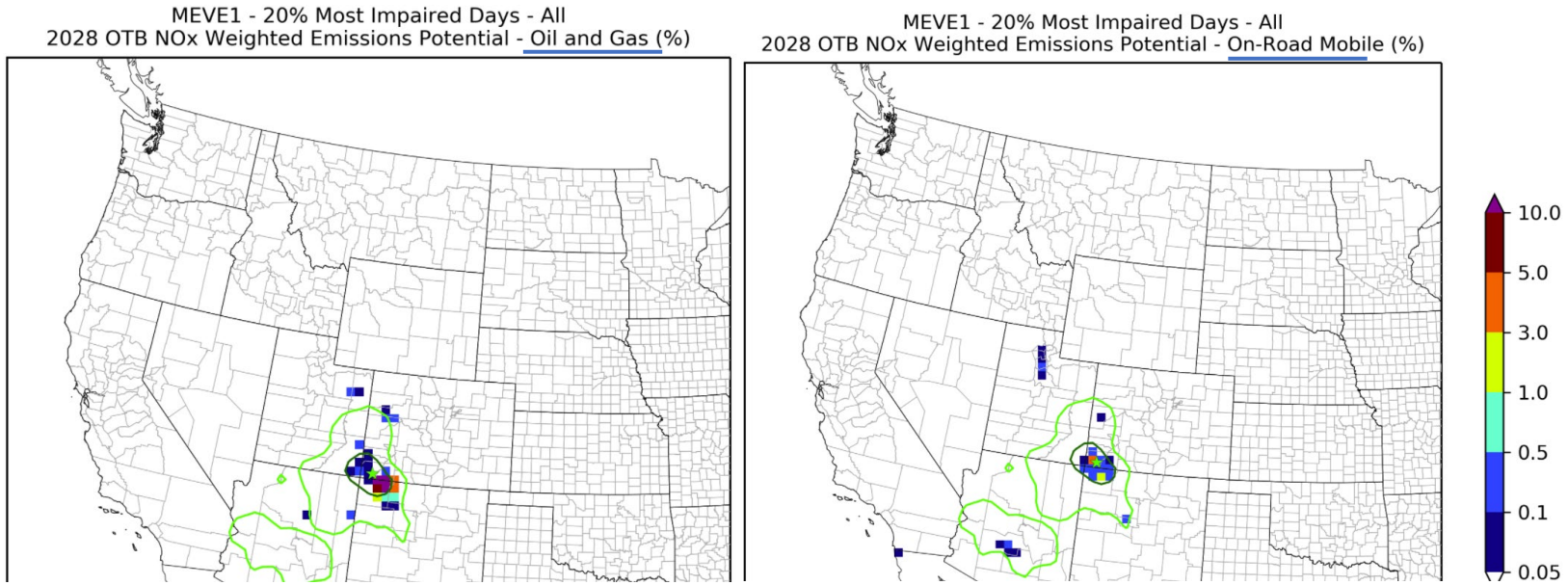

## Organic Aerosol

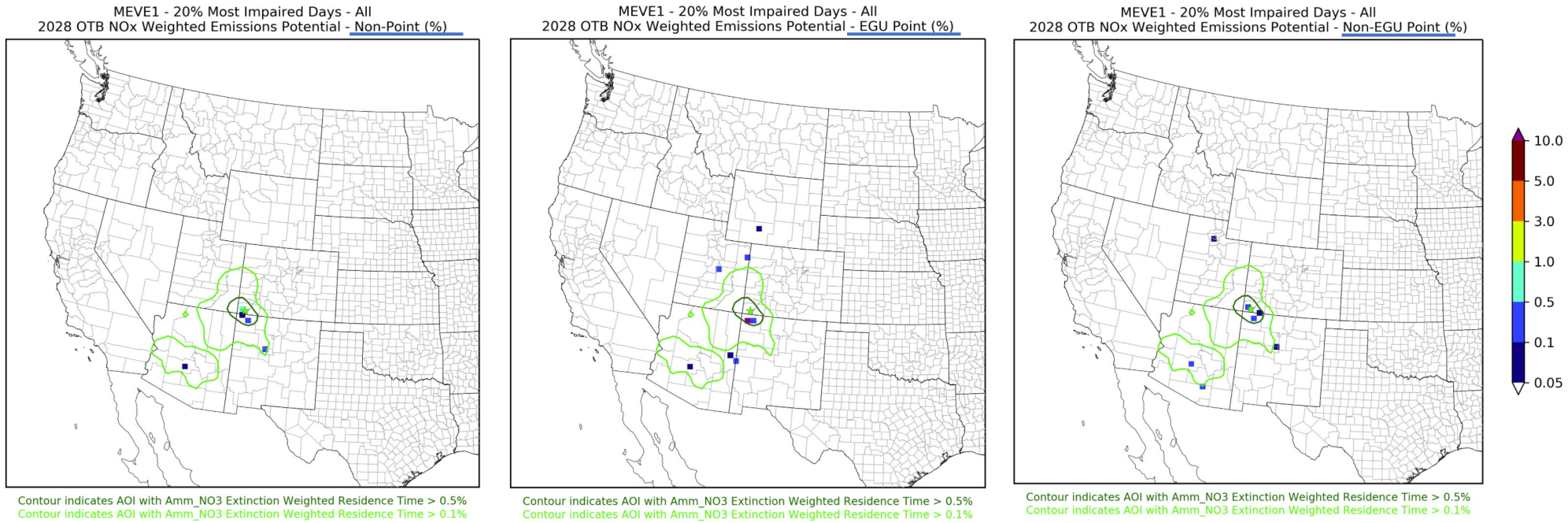



**Mesa Verde National Park**: Areas of Influence greater than 0.5% overlap the “Four Corners”. Areas of Influence greater than 0.1% have mostly southern and western influence.

**Ammonium Nitrate**
**at Mesa Verde National Park**:

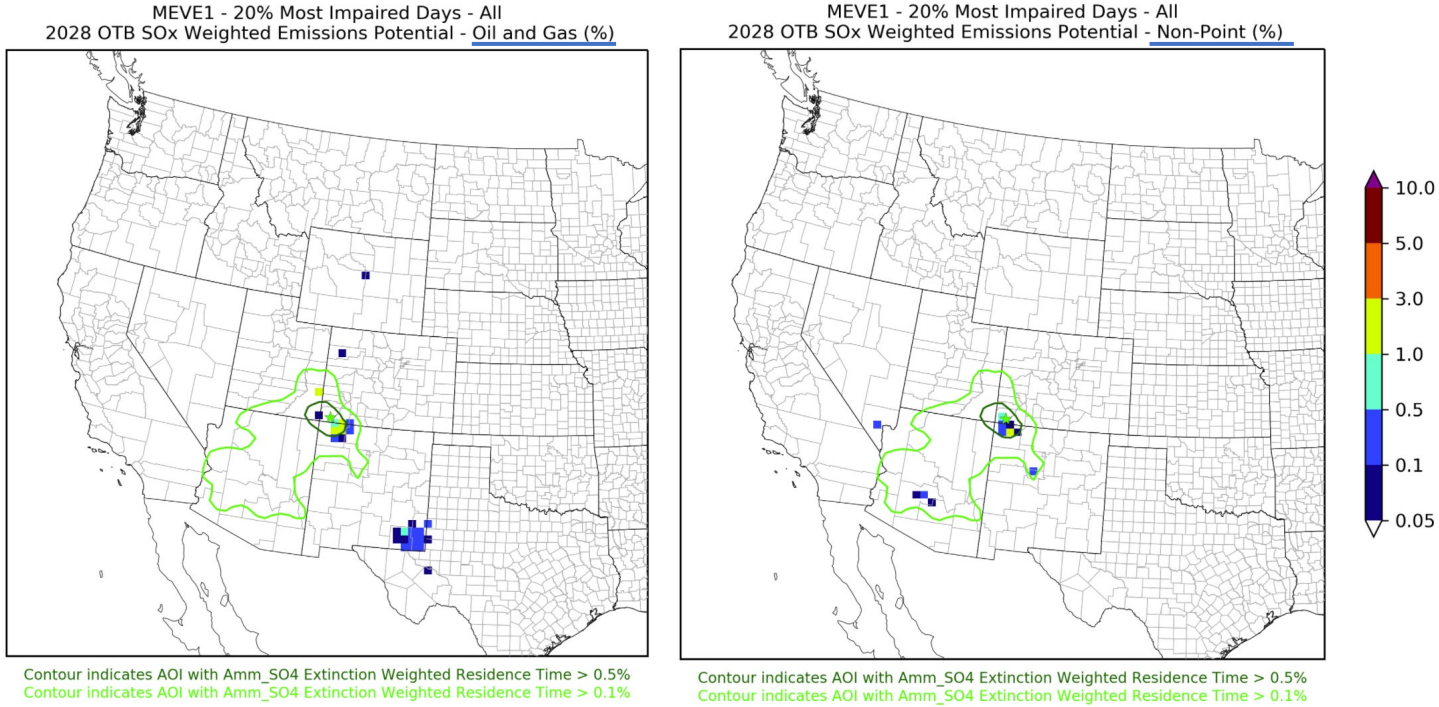
- 2028 WEP (All heights) identifies local Oil and Gas and Mobile contributions as most important
- EGU and Non-EGU point sources are local and dispersed

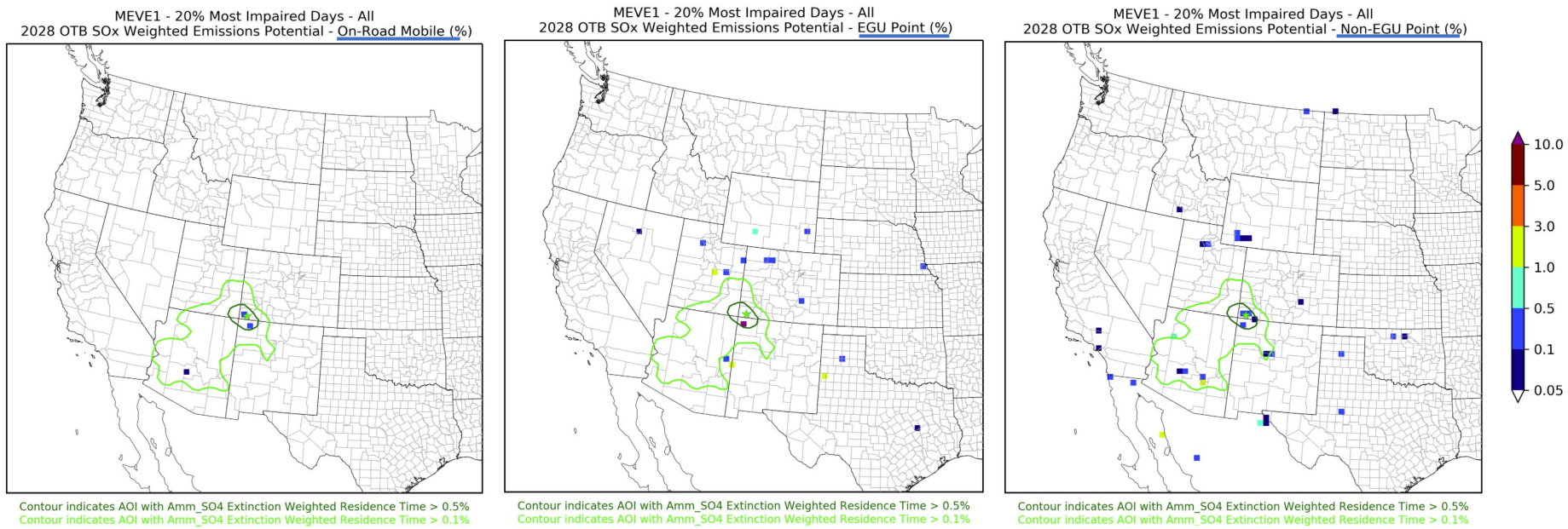


**Ammonium Sulfate**
**at Mesa Verde National Park**:

- 2028 WEP (All heights) identifies local Oil and Gas and Non-point sources as most important
- EGU and Non-EGU point sources are local and dispersed

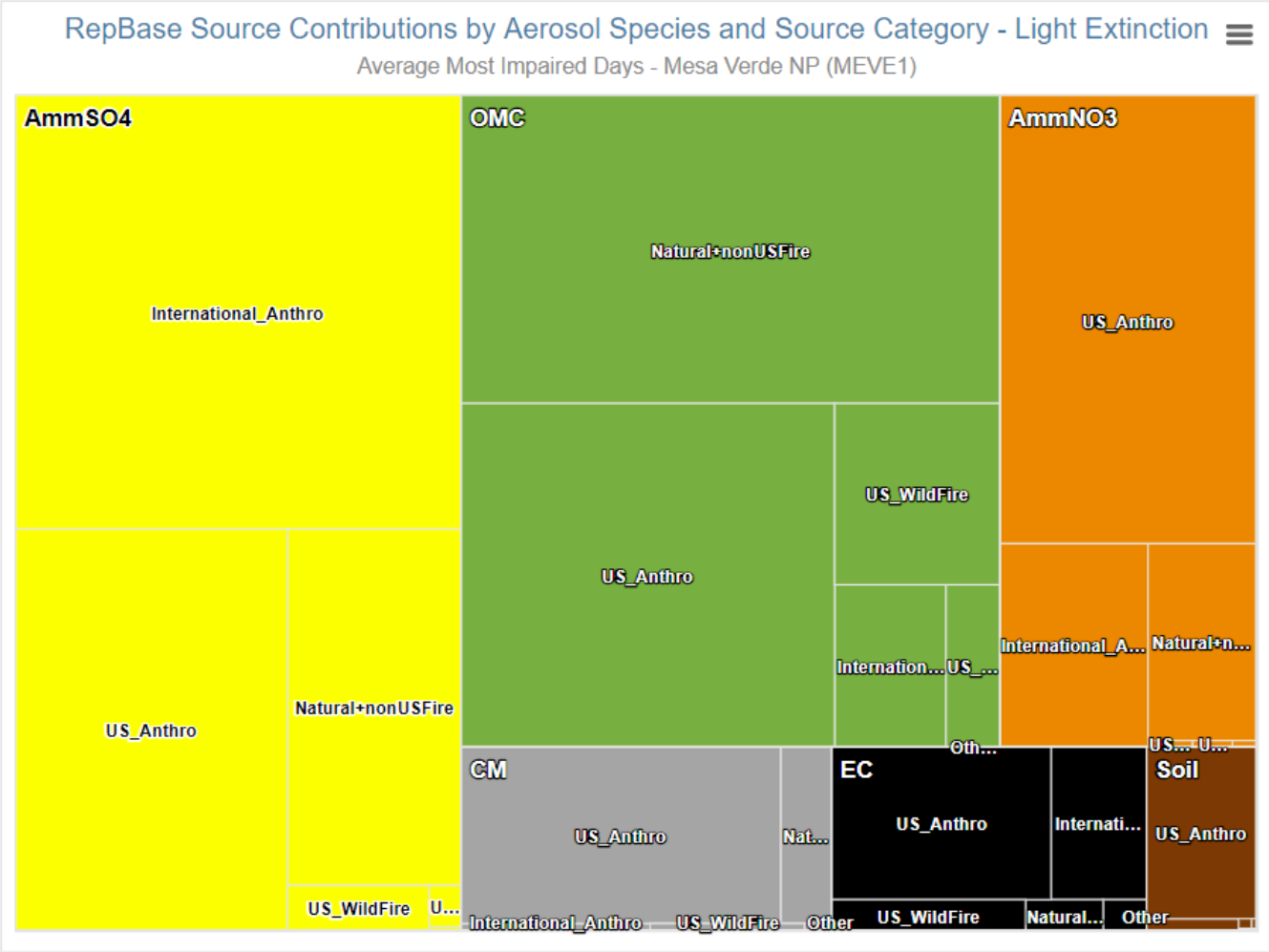


At Mesa Verde National Park, from Representative Baseline source apportionment:

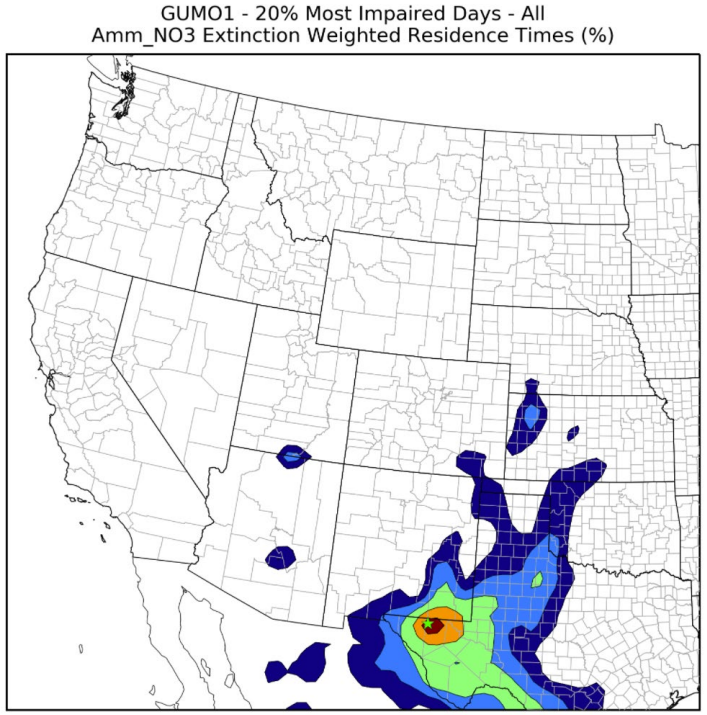
- International Anthropogenic emissions are more important than U.S. anthropogenic for AmmSulfate.
- Natural Sources plus Fire are more important than U.S. anthropogenic sources for Organic Carbon.
- U.S. Anthropogenic emissions are largest source category for AmmNitrate, Coarse Mass, Soil, and Elemental Carbon.

2028OTBa2 source apportionment may show different relative source contributions

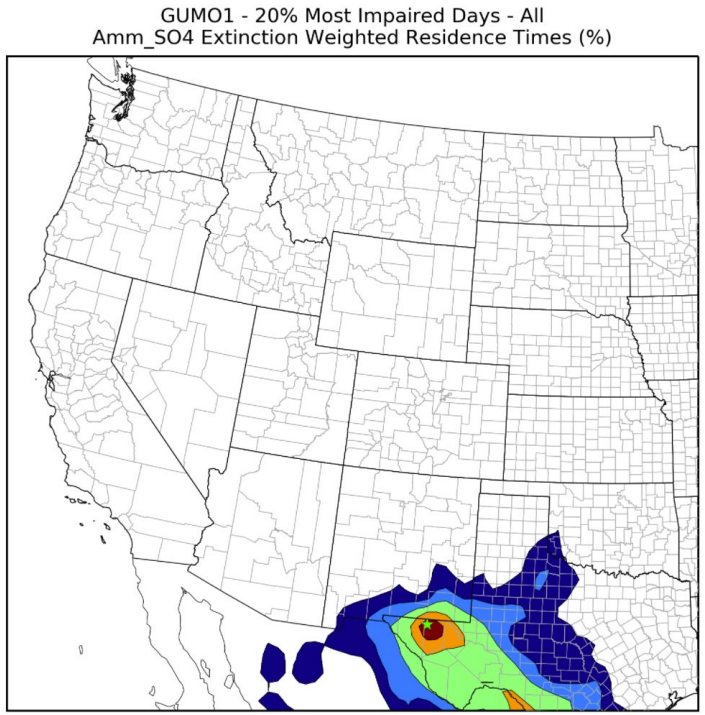


**Extinction weighted residence time** defines the geographic areas that are most likely to be important when aerosol levels are highest on most impaired days

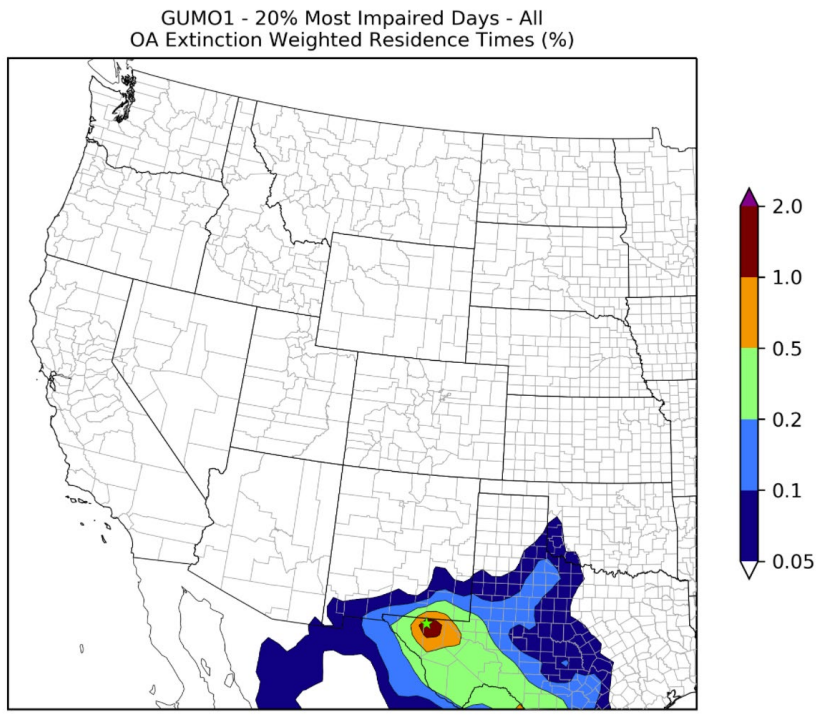
Ammonium nitrate




Ammonium sulfate



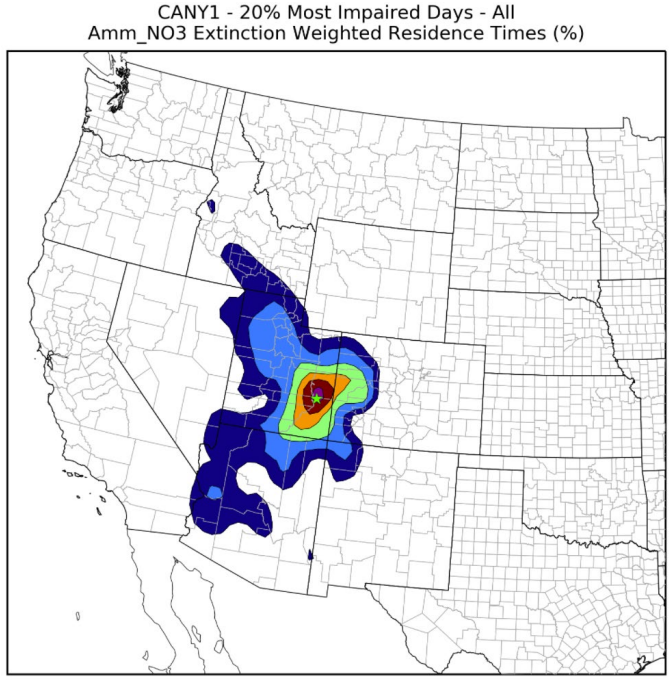

Organic Aerosol



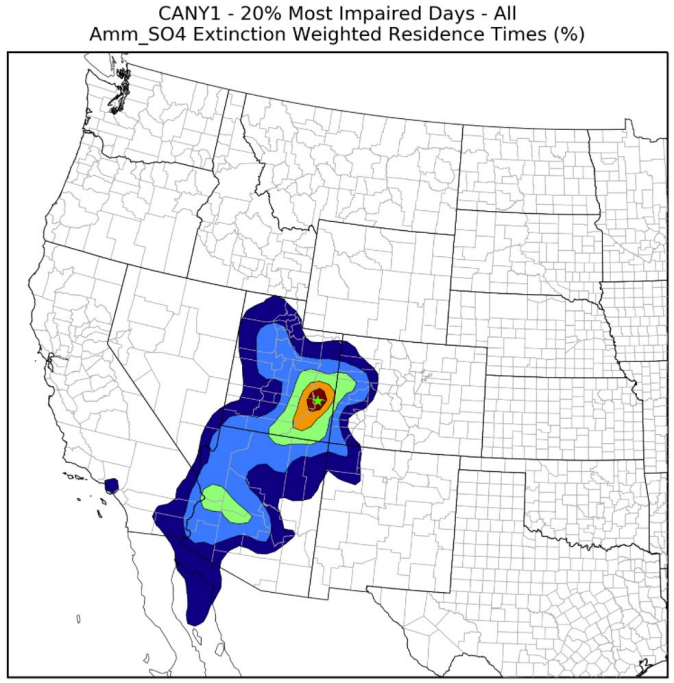

**Guadalupe Mtns/Carlsbad Caverns National Parks**: Areas of Influence have mostly southern and eastern influence.

**Extinction weighted residence time** defines the geographic areas that are most likely to be important when aerosol levels are highest on most impaired days

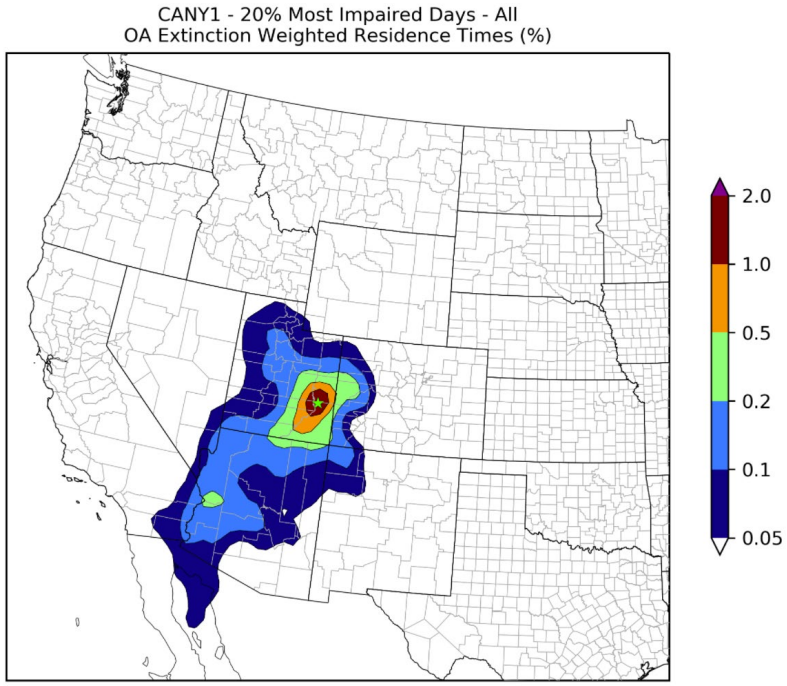
## Ammonium nitrate




## Ammonium sulfate

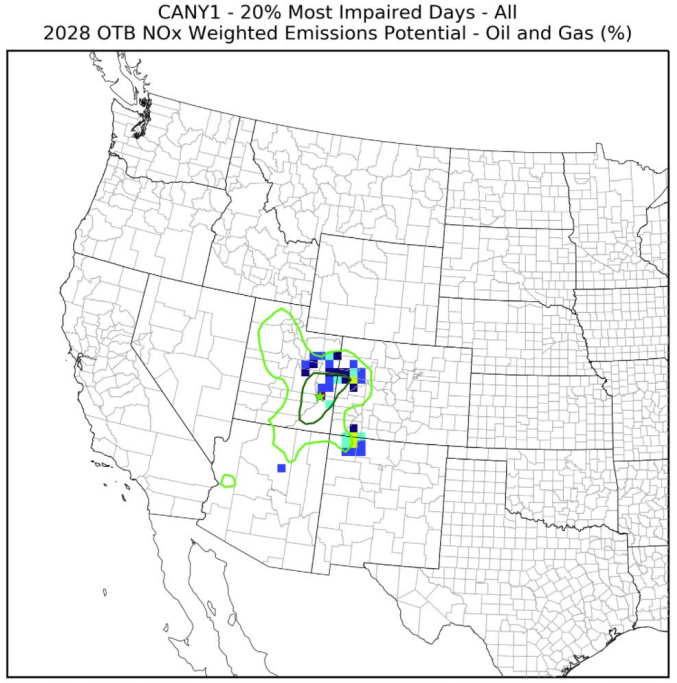


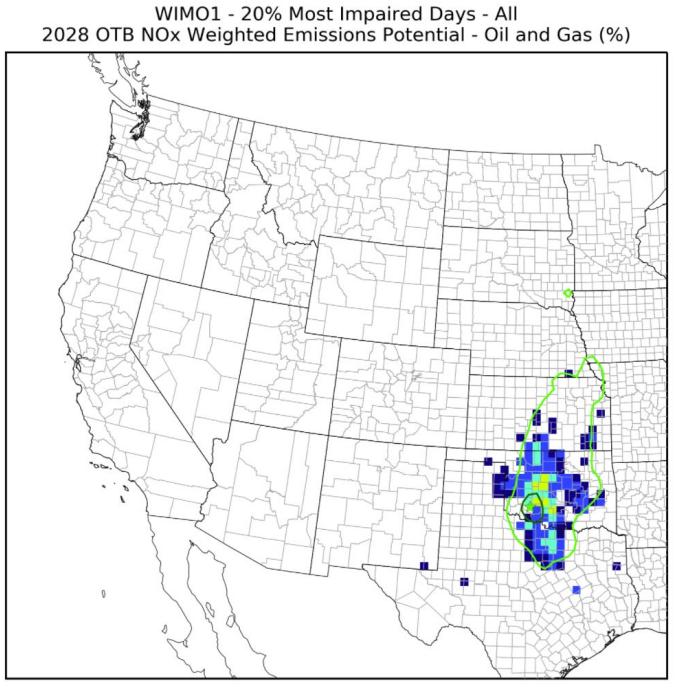

## Organic Aerosol

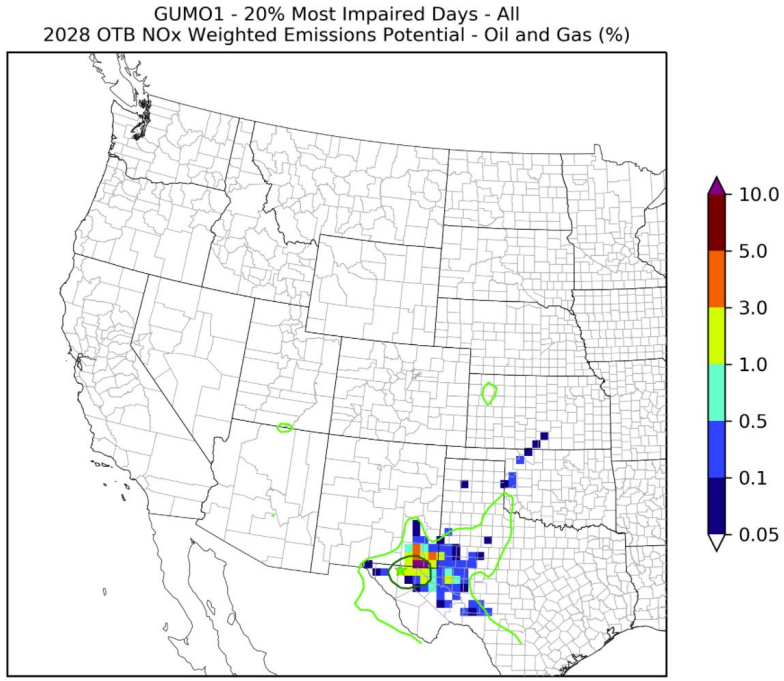



**Canyonlands National Park**: Areas of Influence have mostly western and southern influence.

# Oil and gas contributions generally localized, influence closer to Class I area than EGU and Non-EGU point impacts



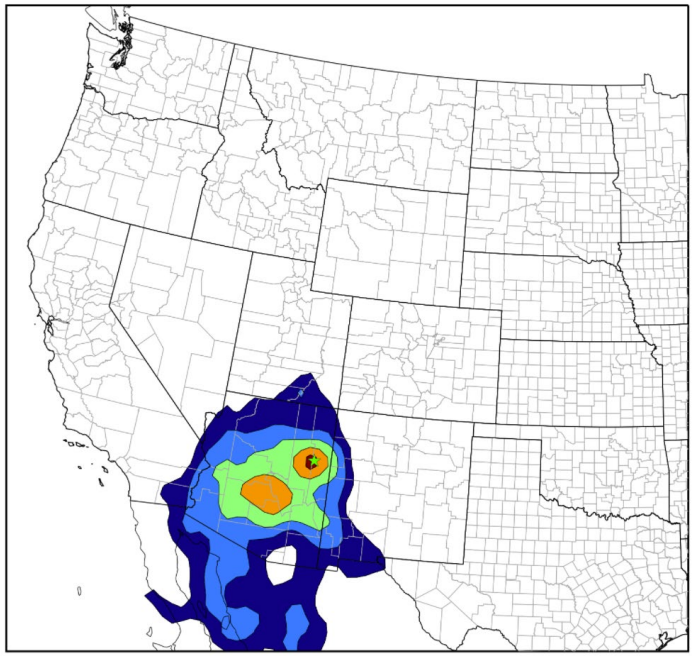



**Extinction weighted residence time** defines the geographic areas that are most likely to be important when aerosol levels are highest on most impaired days

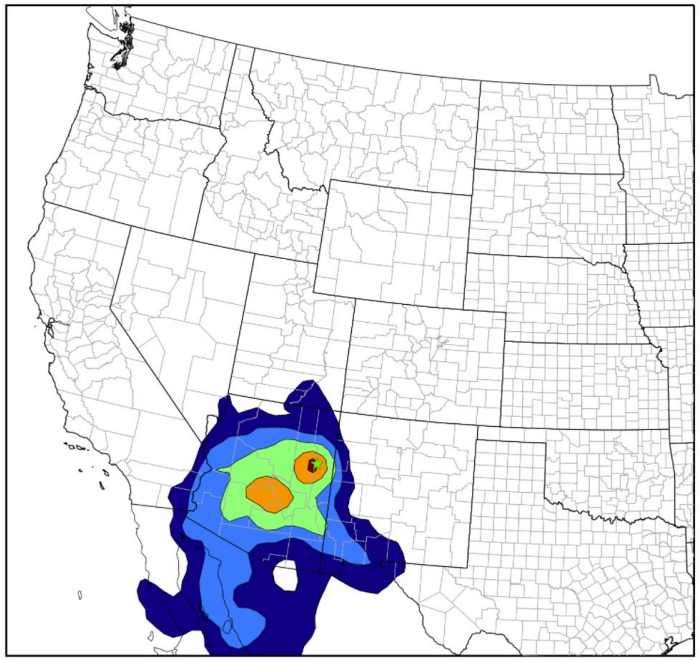
## Ammonium nitrate

PEFO1 - 20% Most Impaired Days - All
Amm_NO3 Extinction Weighted Residence Times (%)



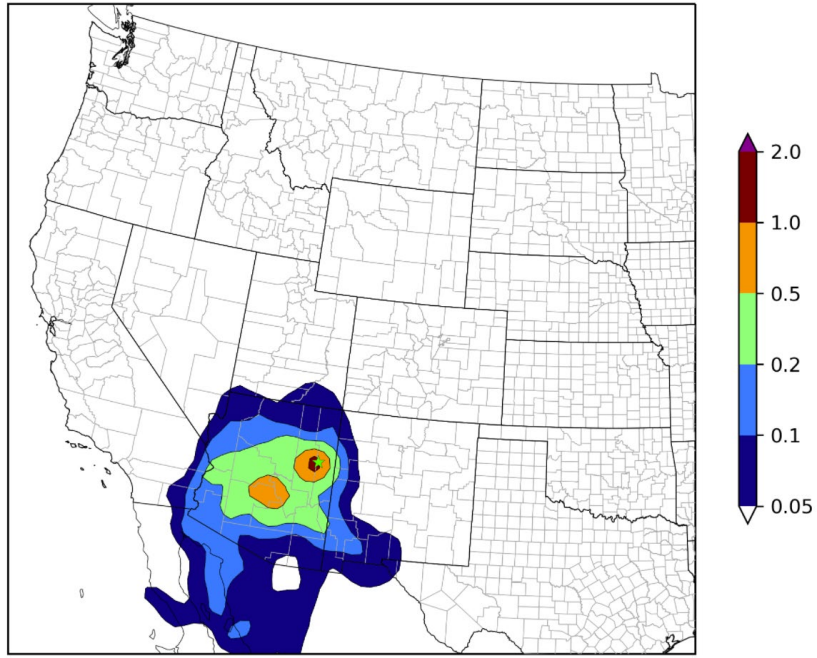
## Ammonium sulfate

PEFO1 - 20% Most Impaired Days - All
Amm_SO4 Extinction Weighted Residence Times (%)



## Organic Aerosol

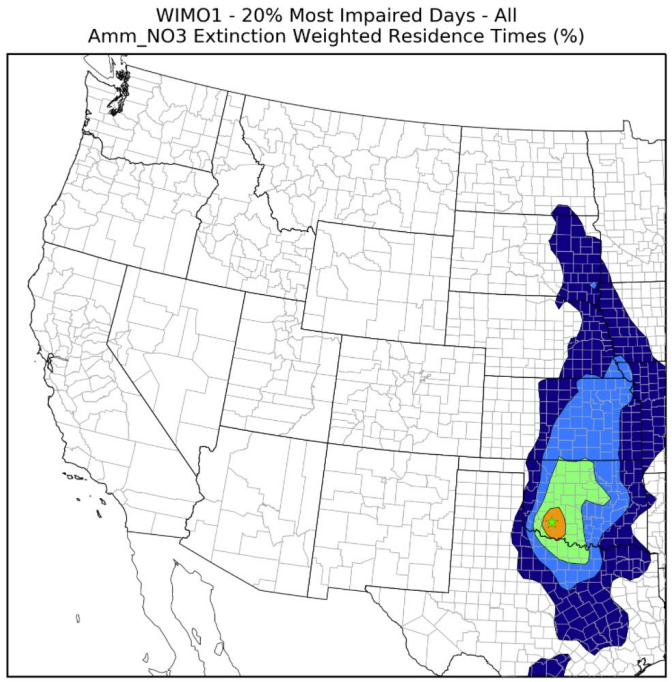
PEFO1 - 20% Most Impaired Days - All
OA Extinction Weighted Residence Times (%)



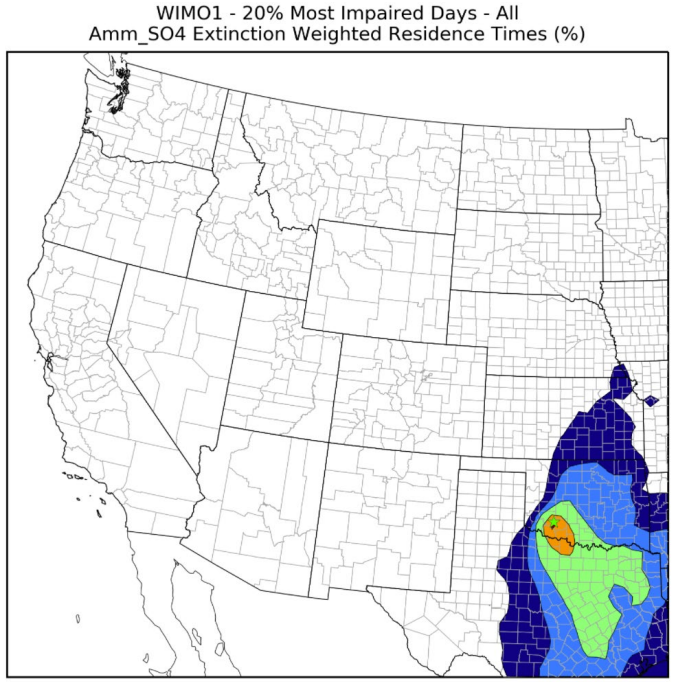

**Petrified Forest National Park**: Areas of Influence have mostly southern and western influence.

**Extinction weighted residence time** defines the geographic areas that are most likely to be important when aerosol levels are highest on most impaired days

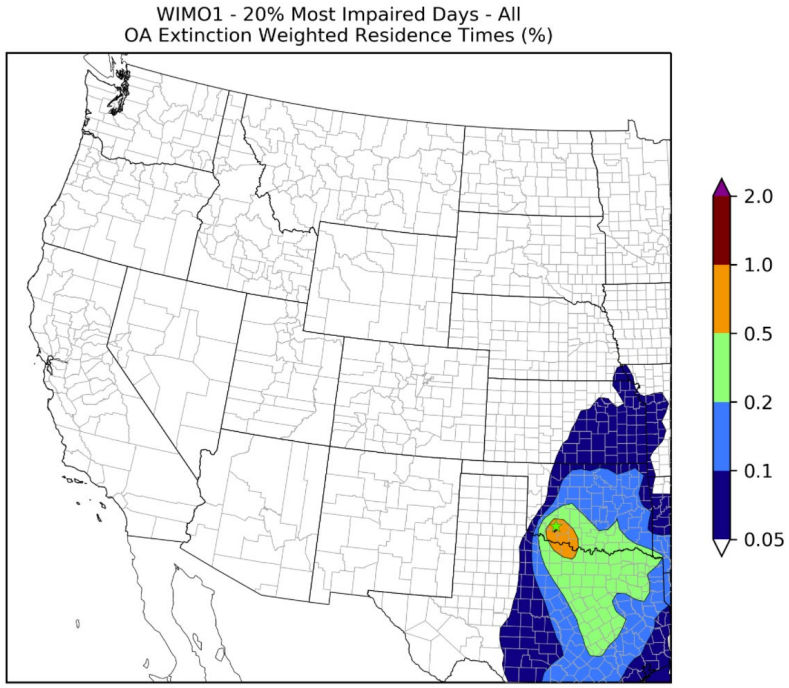
## Ammonium nitrate




## Ammonium sulfate




## Organic Aerosol




**Wichita Mountains National Wildlife Area**: Areas of Influence have mostly northern, eastern, and southern influence.