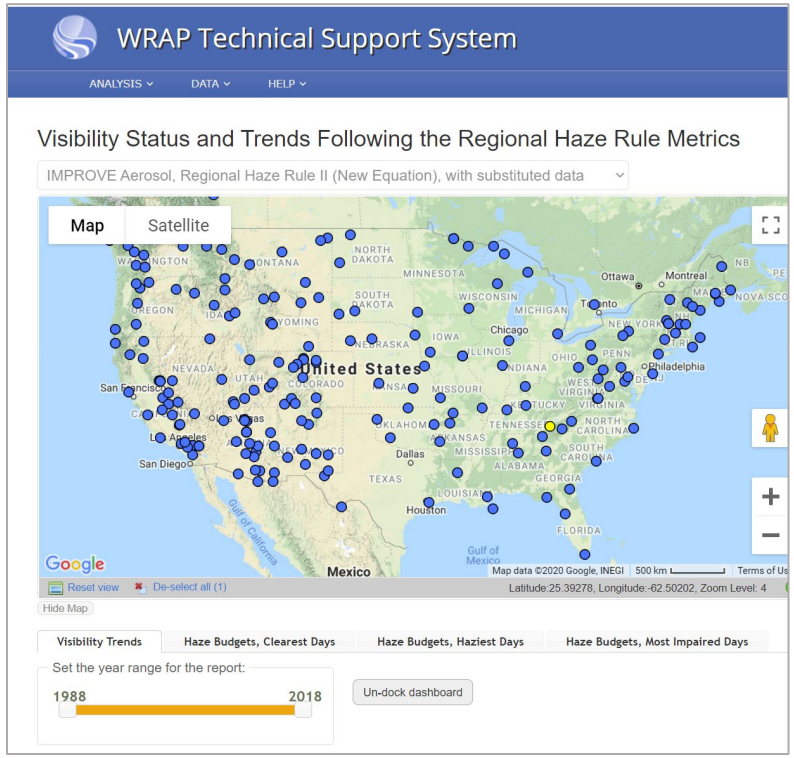
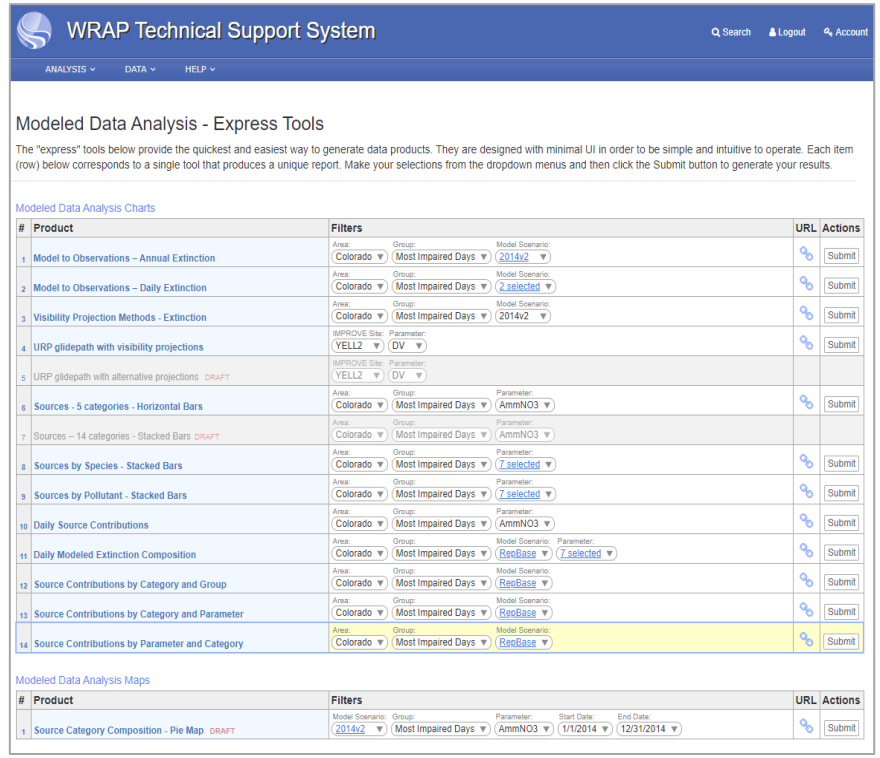
Source Contribution Assessment using WRAP products

Idaho and neighbors case study

December 17, 2020





Long Term Emission Strategies: Example Overarching questions:

- 2014-18 IMPROVE data are the basis of 2028 Regional haze planning targets (slides 6-7)
  (e.g. SIP-required Reasonable Progress Goals to be identified with photochemical modeling),
  - **Weighted Emissions Potential and Ranked Point Sources prioritize source categories**
    - Which sources contributing in that 5-year period and operating in 2028 - need to, and can be, further reduced by 2028? (Rank-point: http://views.cira.colostate.edu/tssv2/WEP-AOI/)
  - **Photochemical model projects response to cumulative emissions changes from 2014-2018 to 2028** (http://views.cira.colostate.edu/tssv2/Express/ModelingTools.aspx)
    - What amount of progress can be estimated in response to emissions reductions by 2028? (2028 projections)
    - Which source categories contribute to 2028 visibility projections (2028 source apportionment)

- How should WEP be used compared to modeled source apportionment? (slides 11-12, 16, 20)
  - WEP identifies 2014-2018 contributions of source sectors and states (slides 10-13, 15-24)
  - Photochemical source apportionment modeling attributes International vs natural vs fire vs US anthropogenic contributions to aerosols in Representative Baseline scenario (slides 14, 25, 26)
    - 2028 source apportionment will also attribute 2028 U.S. anthropogenic contributions to states and emissions sectors (results in Jan 2021)

Analysis process questions (examples, not complete):

For Class I areas in and surrounding ID:

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 or a minor amount of time over ID? (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 for transport to specific Class I areas? (WEP, slides 8-10, etc)

WEP and Rank Point estimate the potential for anthropogenic source contributions on MIDs.

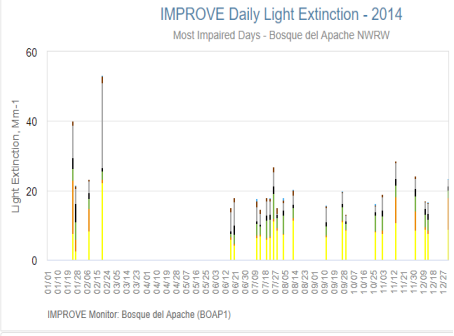
Today's analyses focus on how WEP analyses can assist **prioritizing source sectors** to evaluate for emission changes:

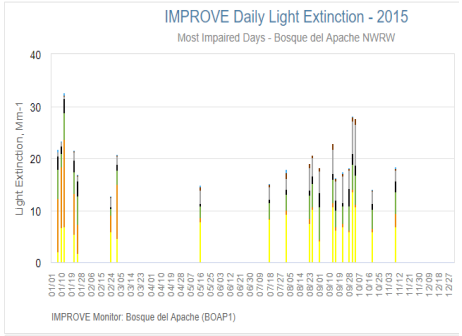
6) Does ID impact Class I areas in neighboring states? If so, what fraction of measured SO4 and NO3 is attributed to ID?
7) Do neighboring states impact ID Class I areas? If so, what fraction of measured SO4 and NO3 is attributed to ID? (WEP)
8) Which source categories are most important? Which of those source categories can ID change? (e.g. ID doesn't have authority to change mobile emissions even if WEP defines large contributions from mobile sources)
9) Are source areas impacting ID Class I areas similar or different? shared source areas? Examine source sectors (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)

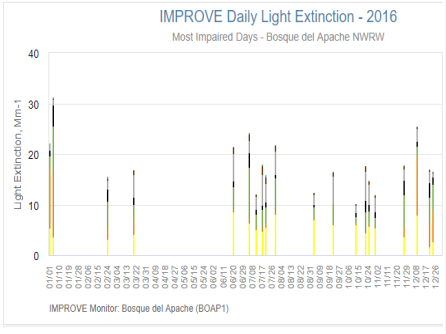
How are Weighted Emissions Potential and Source Apportionment different:

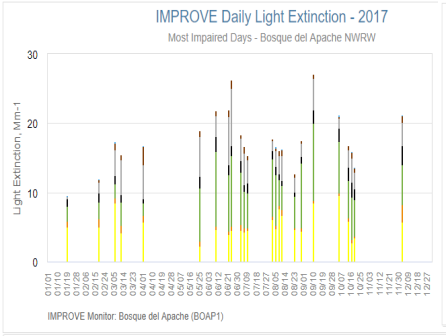
Weighted Emissions Potential (WEP):

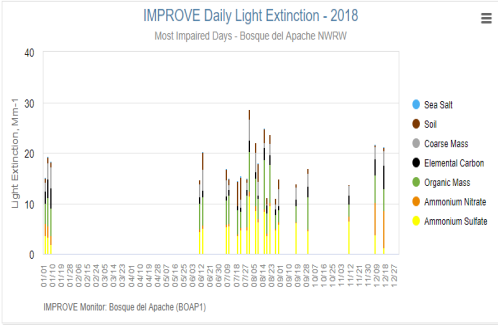
- Meterology
  - 24 most impaired days in each of 5 years, 2014-2018, based on IMPROVE monitoring data.
  - Hysplit back trajectories are released 4 times a day at 4 elevations above the surface at each IMPROVE monitoring site representing a Class I area.





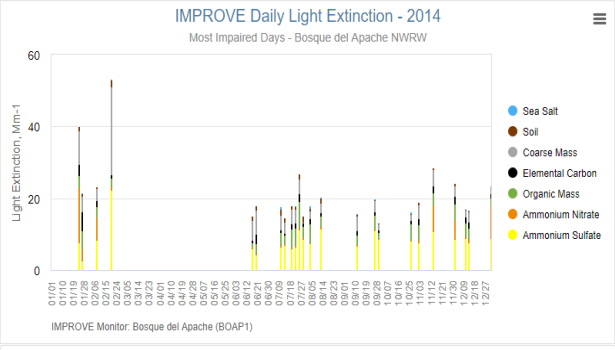




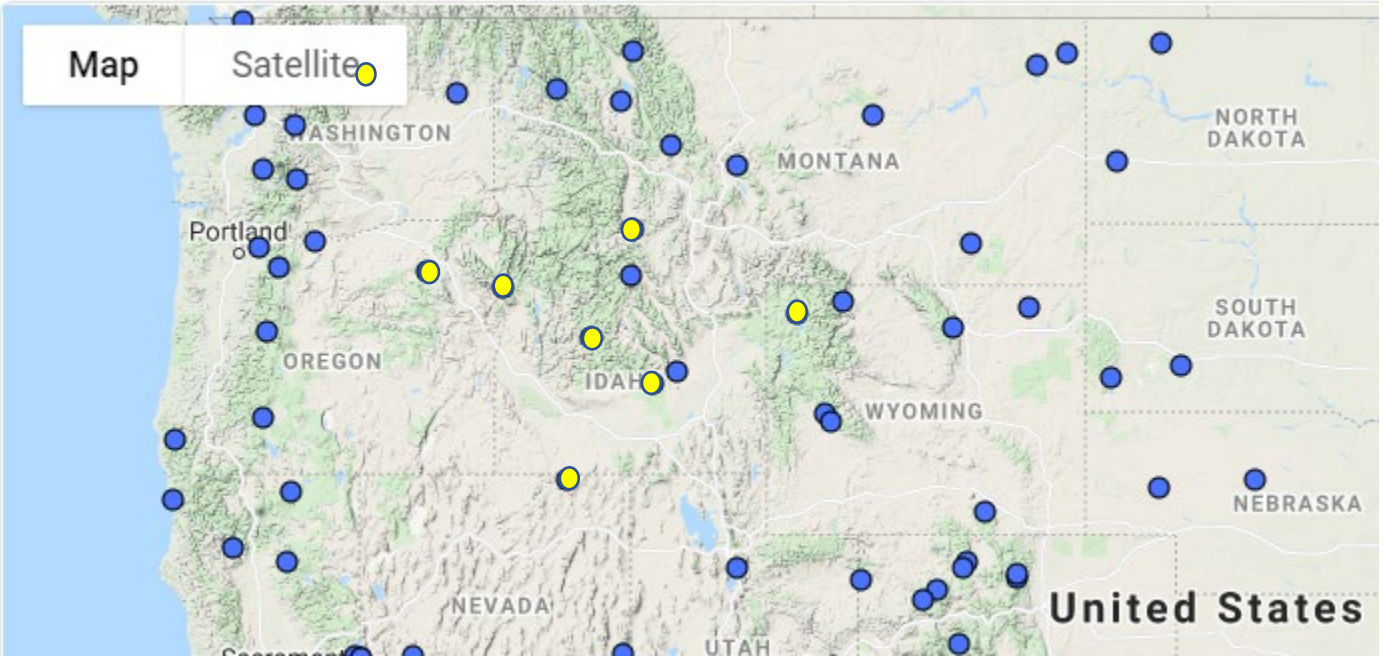


Particle source apportionment tool (PSAT) in the CAMx model

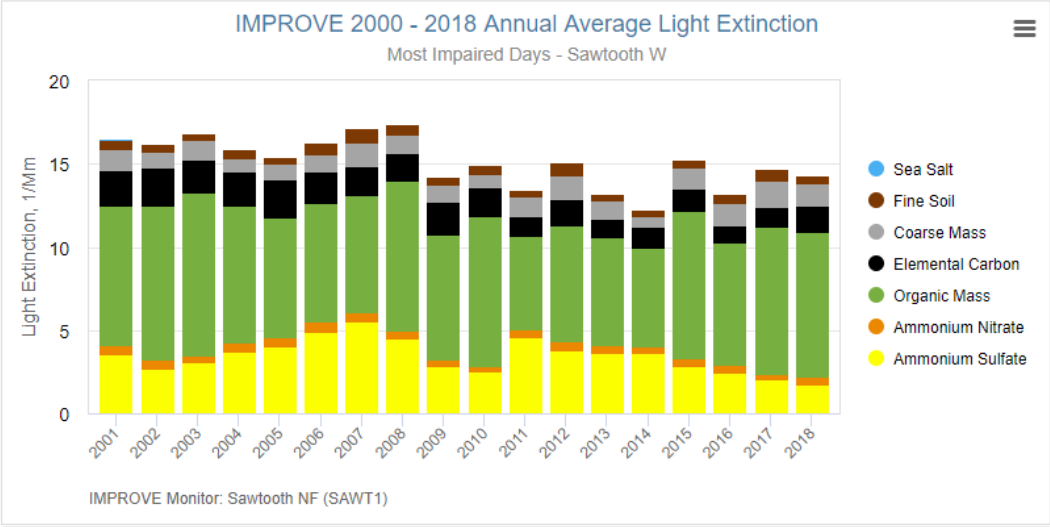
- Meteorology
  - 24 most impaired IMPROVE days in the single 2014 modeling year.
  - 2014 meteorology is generated by the WRF model with some model uncertainty



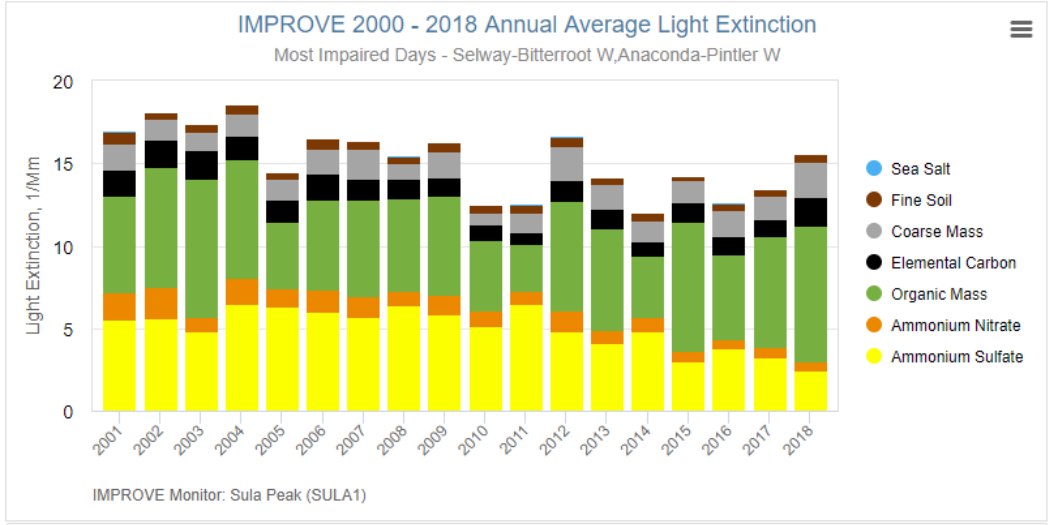
IMPROVE monitoring sites in western U.S.
Highlighted sites represent Class I areas in ID, WY, MT, WA, OR, and NV.



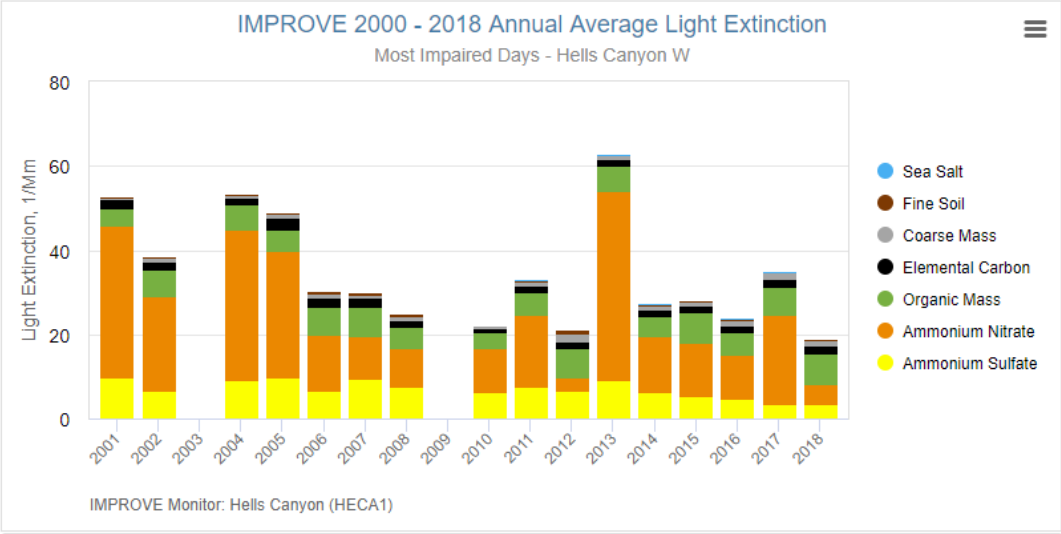
Sawtooth, ID: 2018 Aerosol Extinction = **14.2 Mm^{-1}**



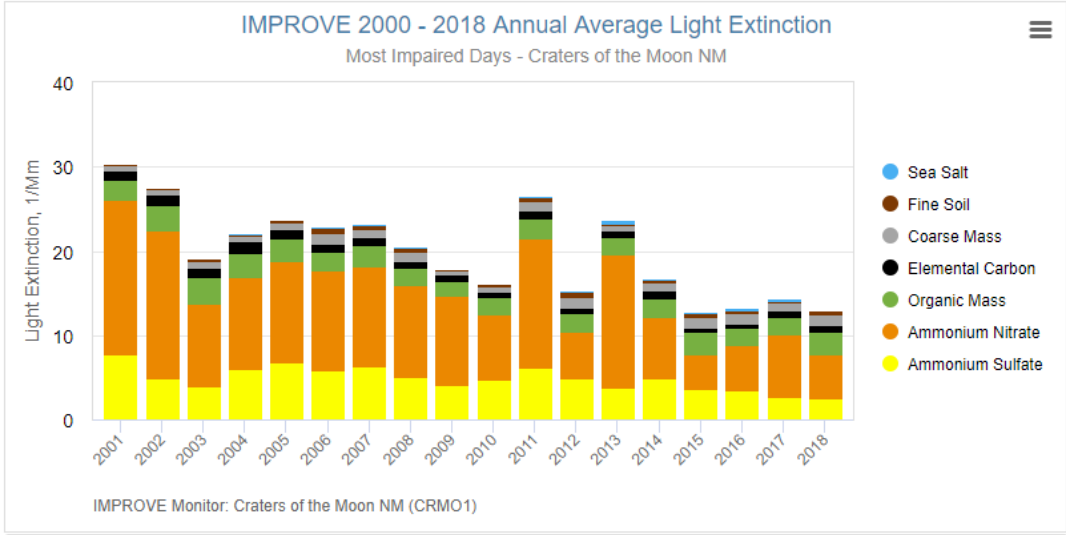
Sula Peak, ID/MT: 2018 Aerosol Extinction = **15.5 Mm^{-1}**



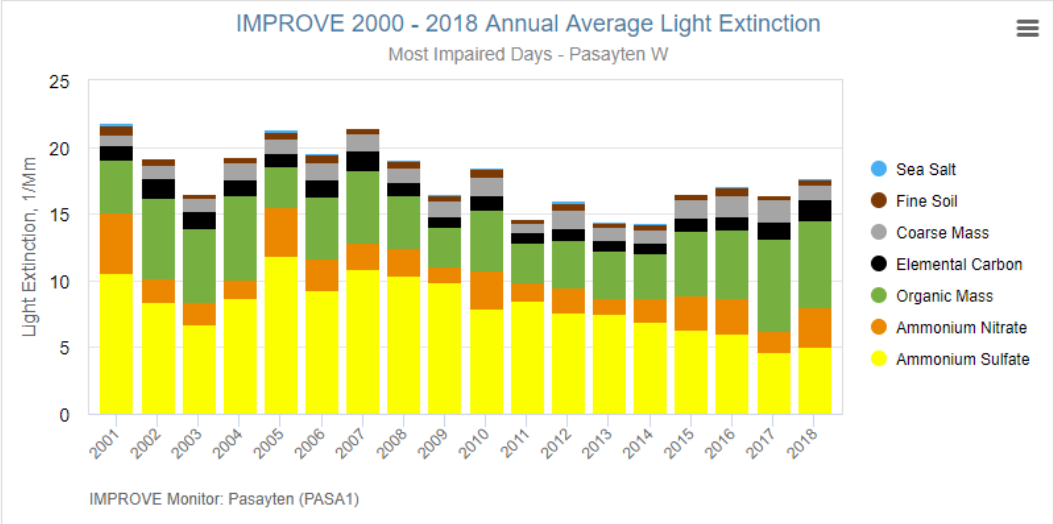
Hells Canyon, ID/OR: 2018 Aerosol Extinction = **19.1Mm^{-1}**



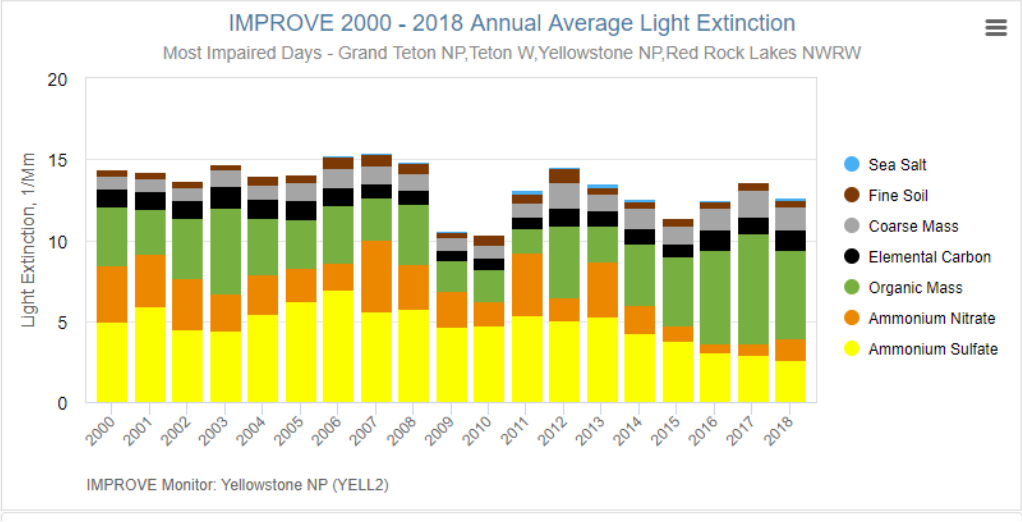
Craters of the Moon, ID: 2018 Aerosol Extinction = **13.0 Mm^{-1}**



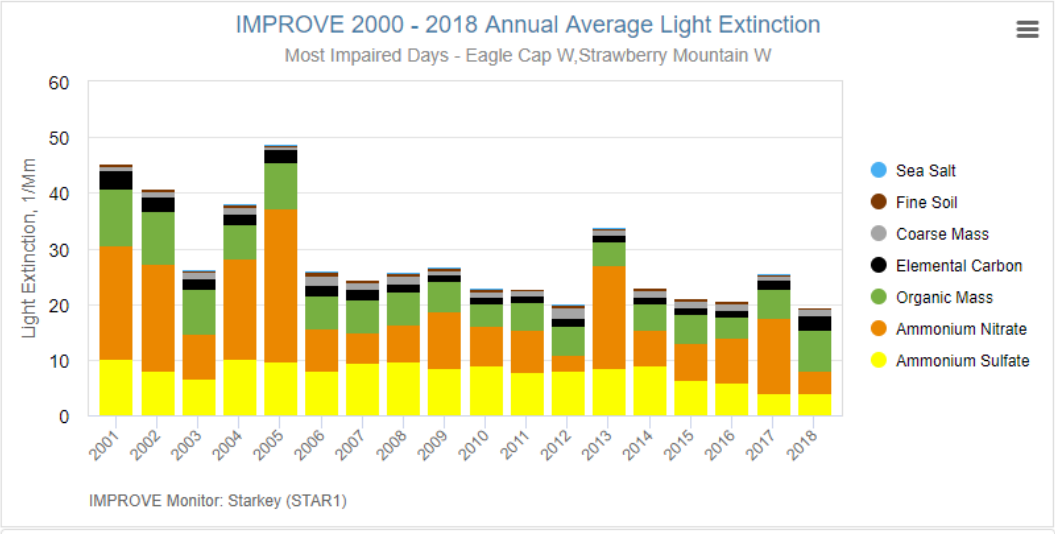
Pasayten, WA: 2018 Aerosol Extinction = **17.7 Mm^{-1}**



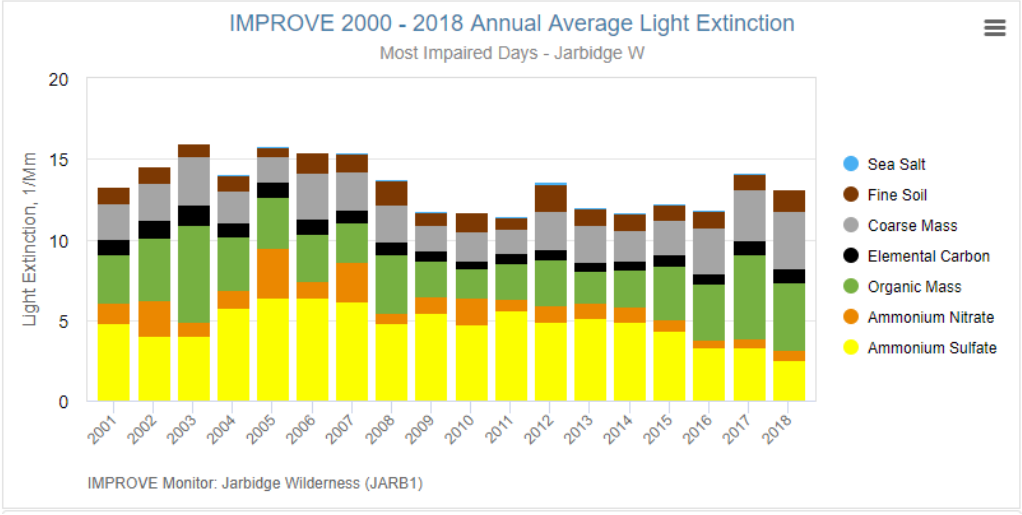
Yellowstone, WY: 2018 Aerosol Extinction = **13.0 Mm^{-1}**



Starkey, OR: 2018 Aerosol Extinction in = **19.5 Mm^{-1}**



Jarbridge, NV: 2018 Aerosol Extinction = **13.0 Mm^{-1}**



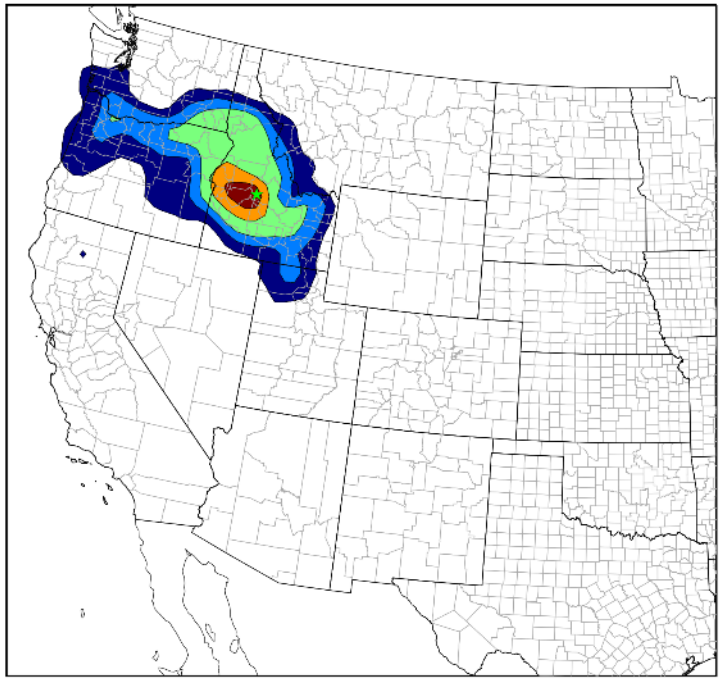
Residence time is the frequency that air masses passed over a location prior to arriving at a specific Class I area, as defined by Hysplit back trajectories, on the most impaired days in 2014-2018 (roughly 120 days).

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.

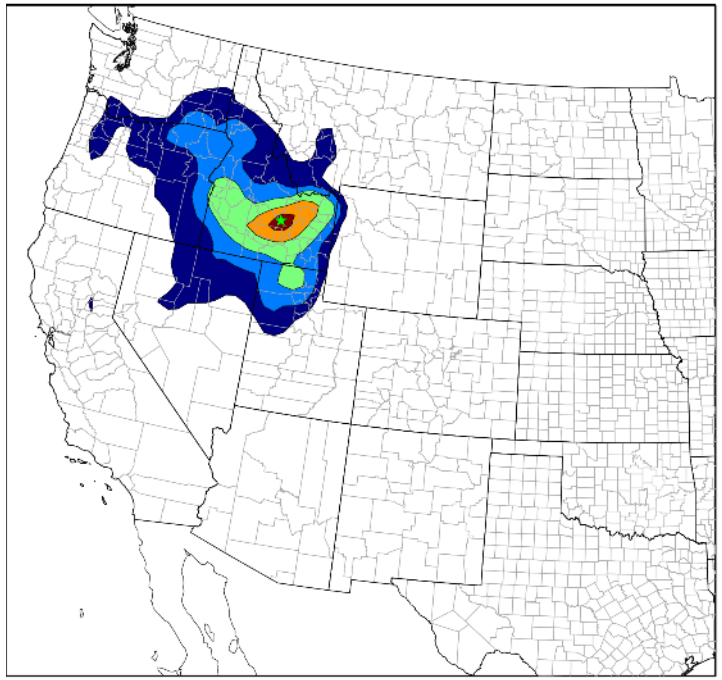
Sawtooth, ID

SAWT1 - 20% Most Impaired Days - All
Residence Time (%)



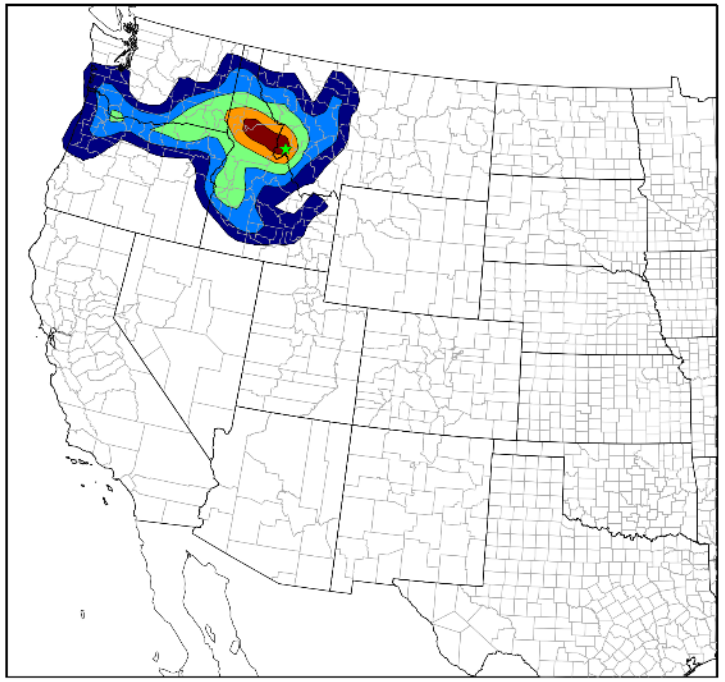
Craters of the Moon, ID

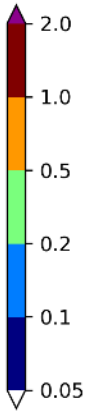
CRMO1 - 20% Most Impaired Days - All
Residence Time (%)



Sula Peak, ID/MT

SULA1 - 20% Most Impaired Days - All
Residence Time (%)



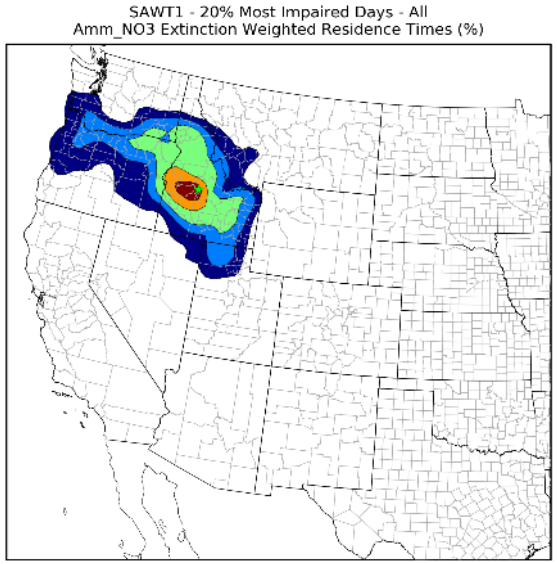


Extinction weighted residence time (EWRT) defines the geographic areas that are most likely to be important when aerosol levels are highest for the most impaired days.

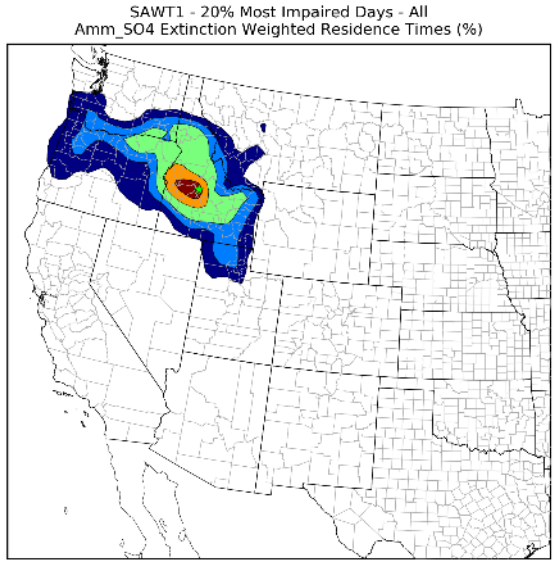
The **Areas of Influence** (AoI) greater than 0.5% (area in orange) and greater than 0.1% (area within bright blue shape) are defined based on EWRT.

Emissions are not included in the EWRT and AoI calculations.

SAWT: Ammonium nitrate



SAWT: Ammonium sulfate



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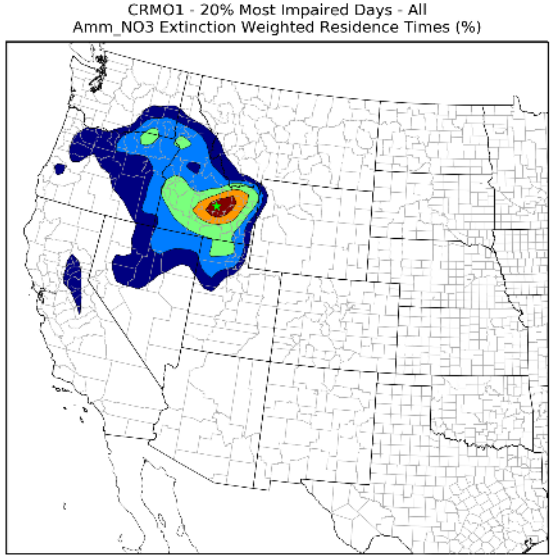

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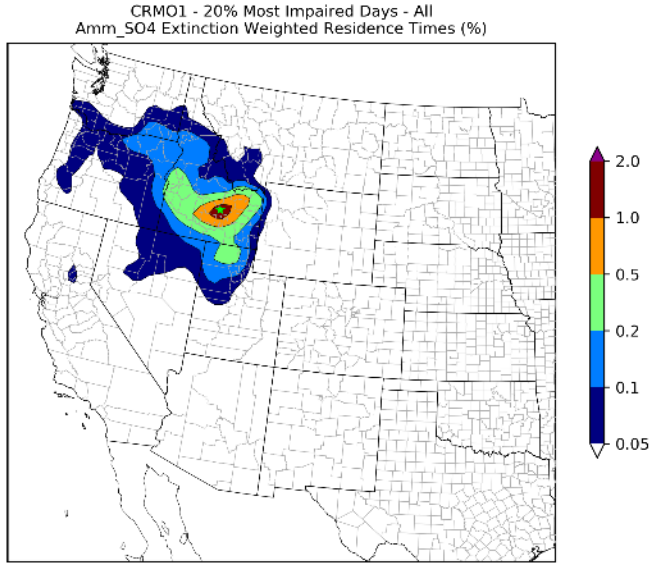
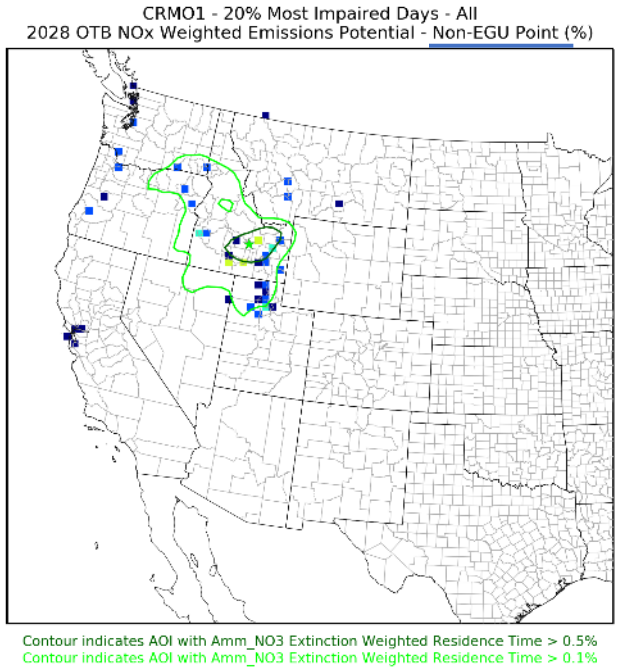


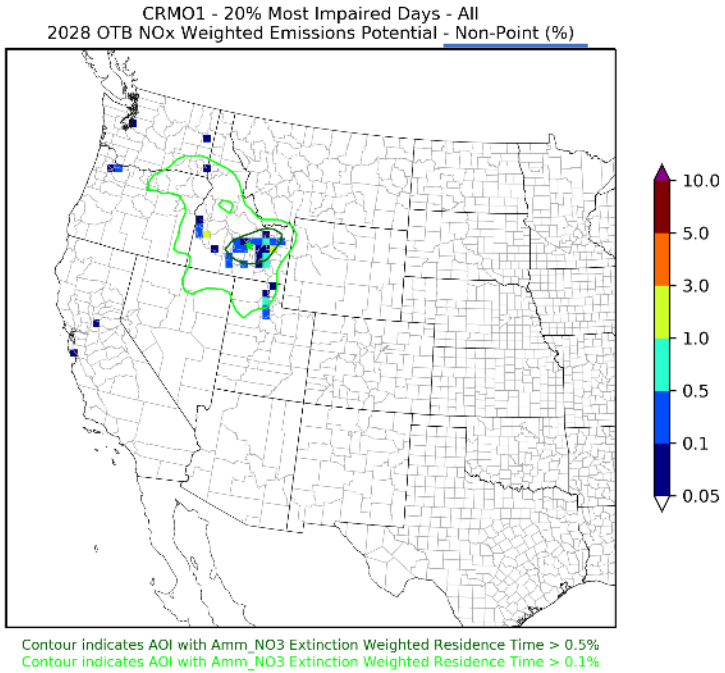
Sawtooth + Crater of the Moon Wilderness Areas: the geographic Areas of greatest Influence (AoI, orange and green shapes) for AmmNO3 and AmmSO4 are southeast to northwest.

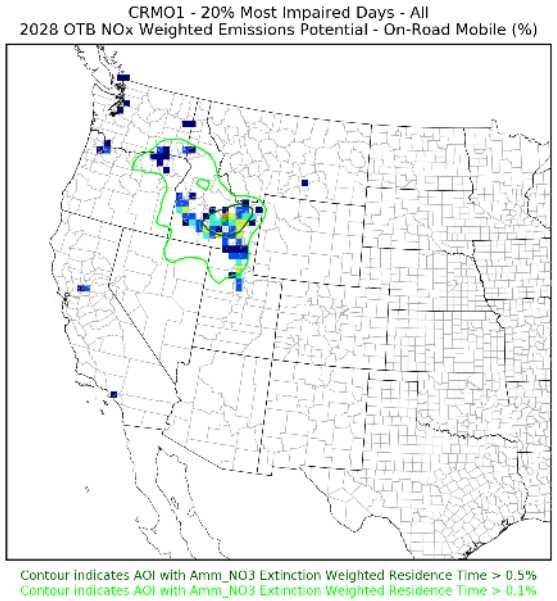
Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

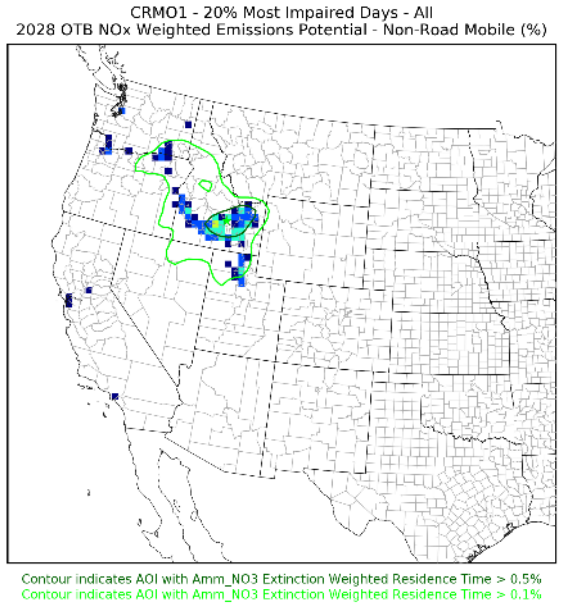
Ammonium Nitrate at Craters of the Moon National Park:

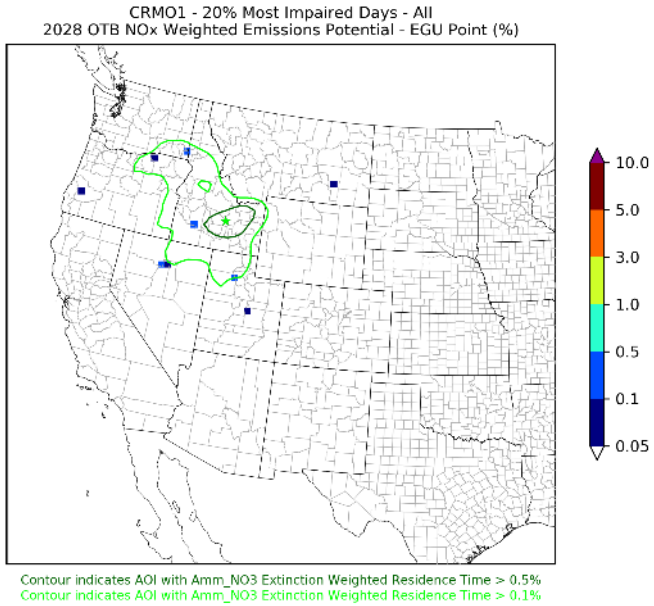
- 2028 WEP (All heights) identifies Non-EGU point, Non-point, and Mobile as local and major source categories.





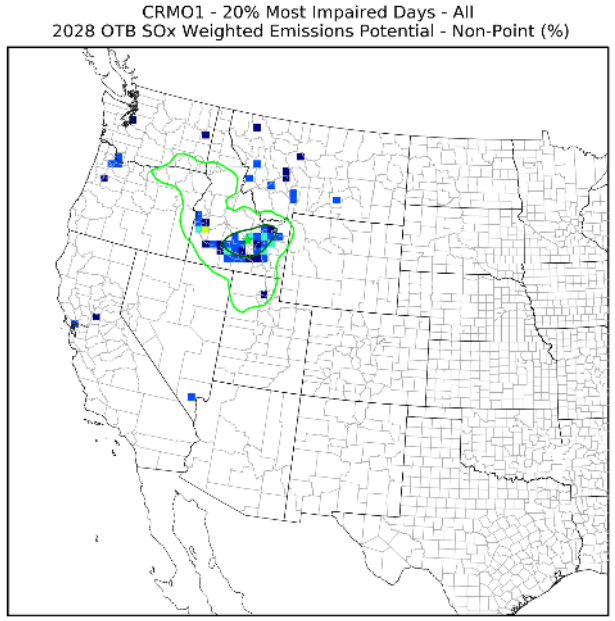




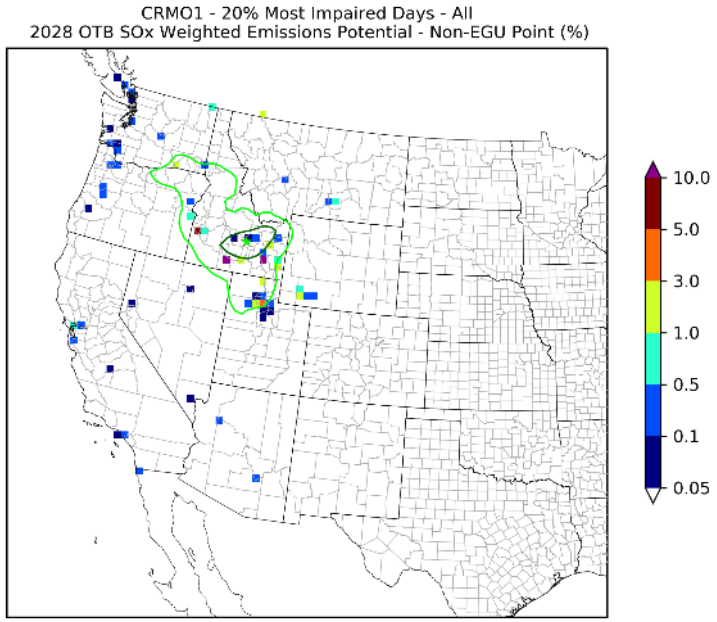


Ammonium Sulfate at Craters of the Moon National Park:

- 2028 WEP (All heights) identifies <u>Non-point</u> and <u>Non-EGU Point</u> major and local source categories



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



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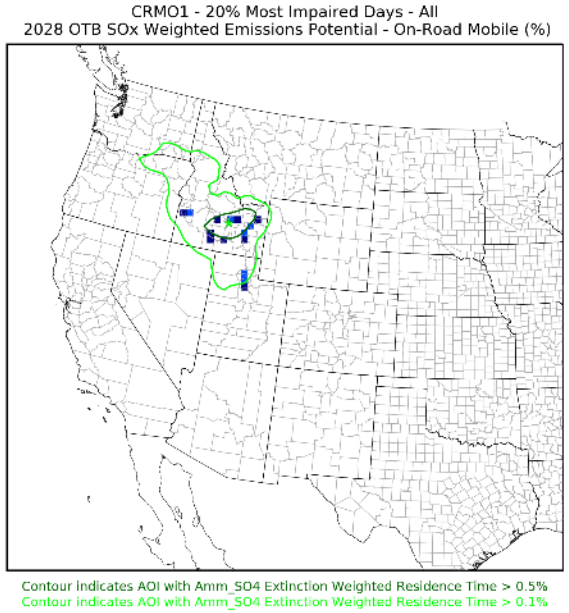

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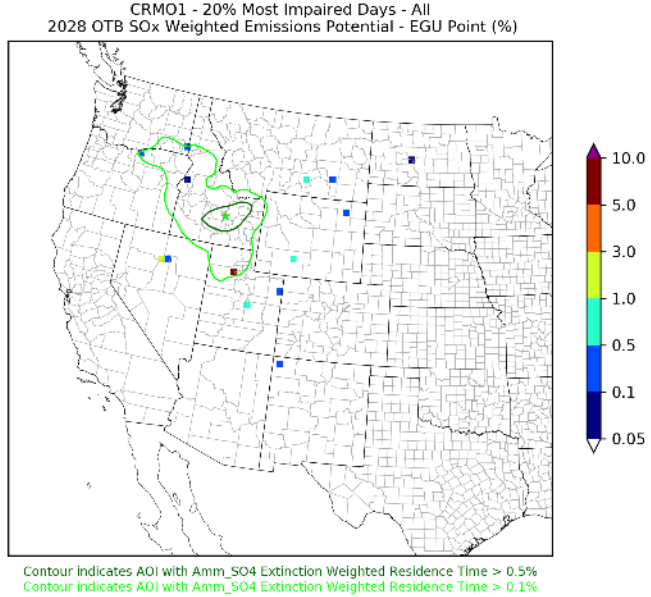

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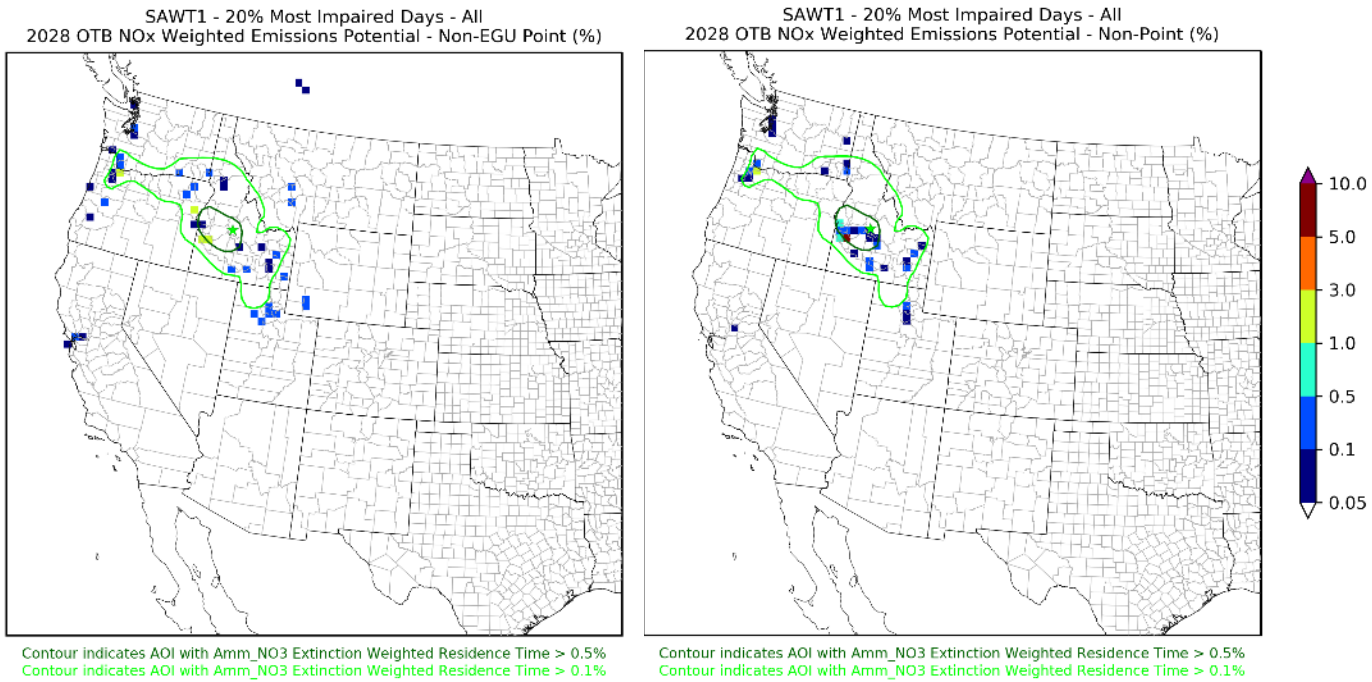
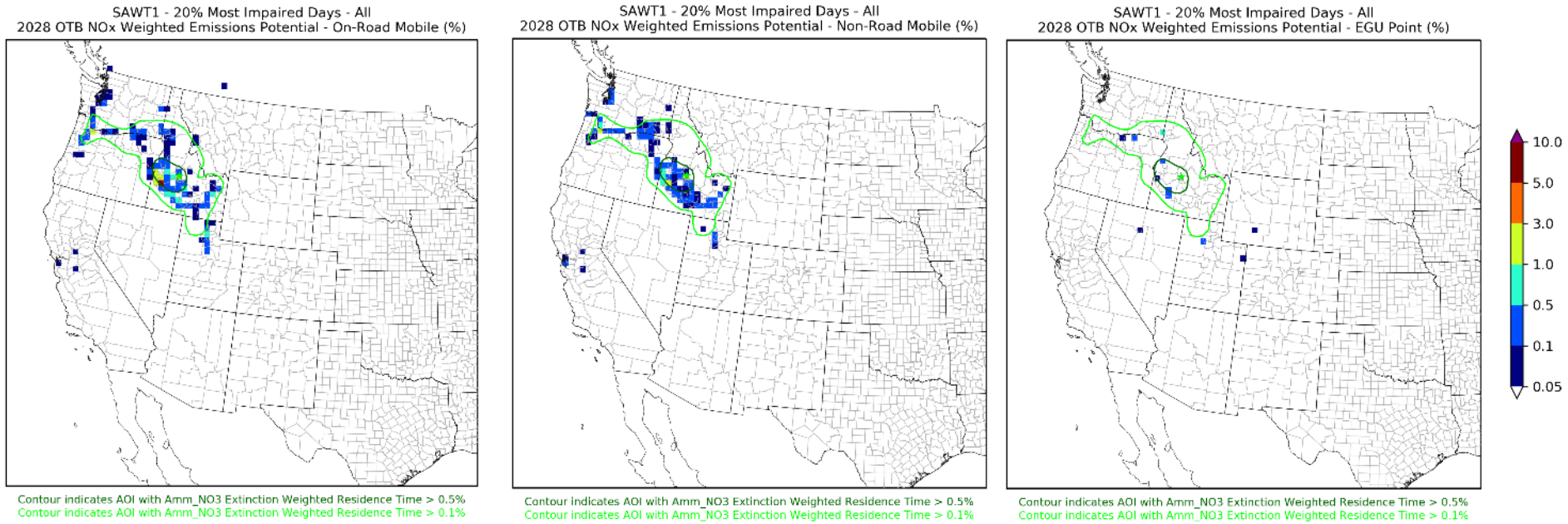
Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

Ammonium Nitrate at Sawtooth Wilderness Area:

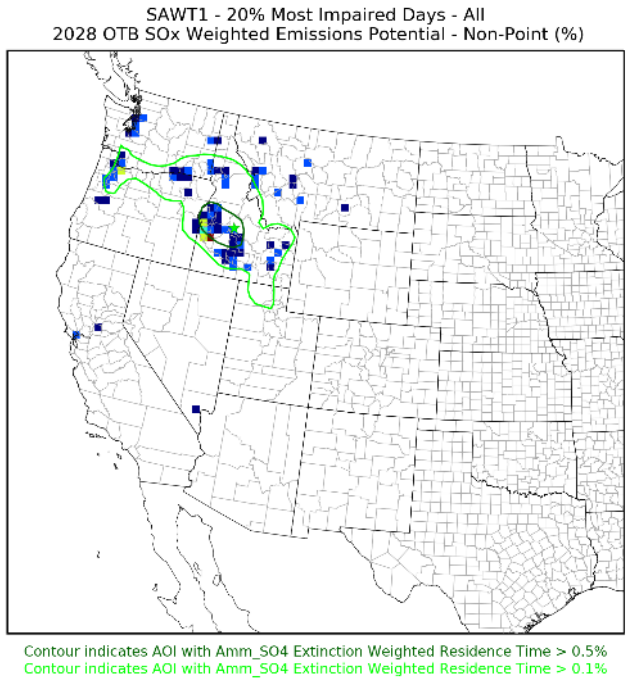
- 2028 WEP (All heights) identifies Non-EGU point, Non-point, and Mobile as local and major source categories.

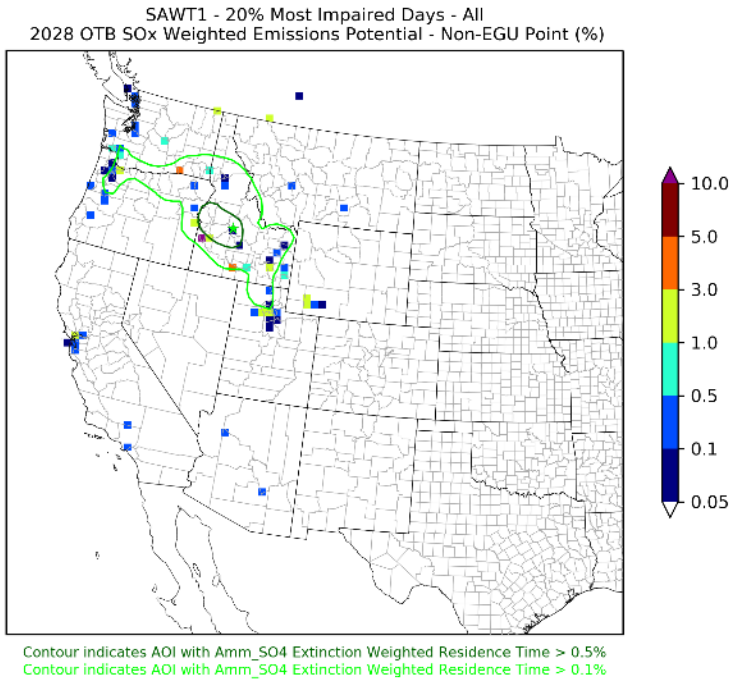


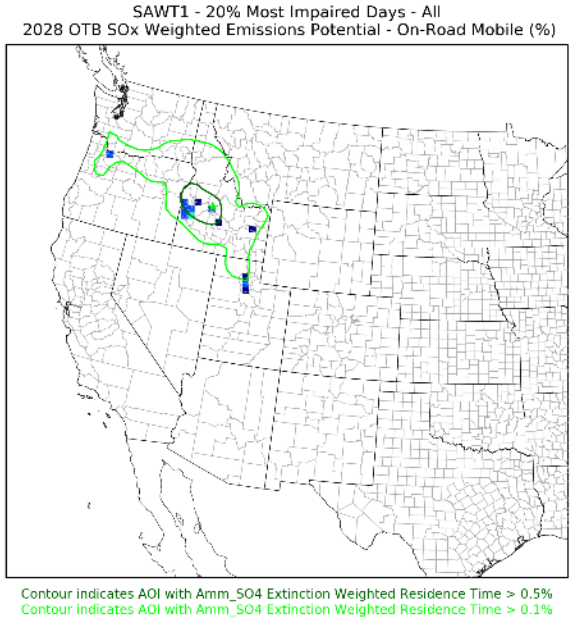


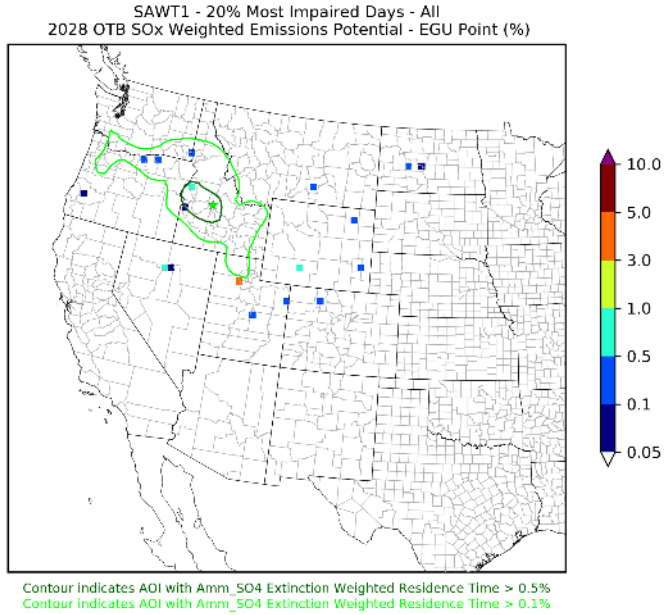
Ammonium Sulfate at Sawtooth Wilderness Area:

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









Representative Baseline source apportionment:

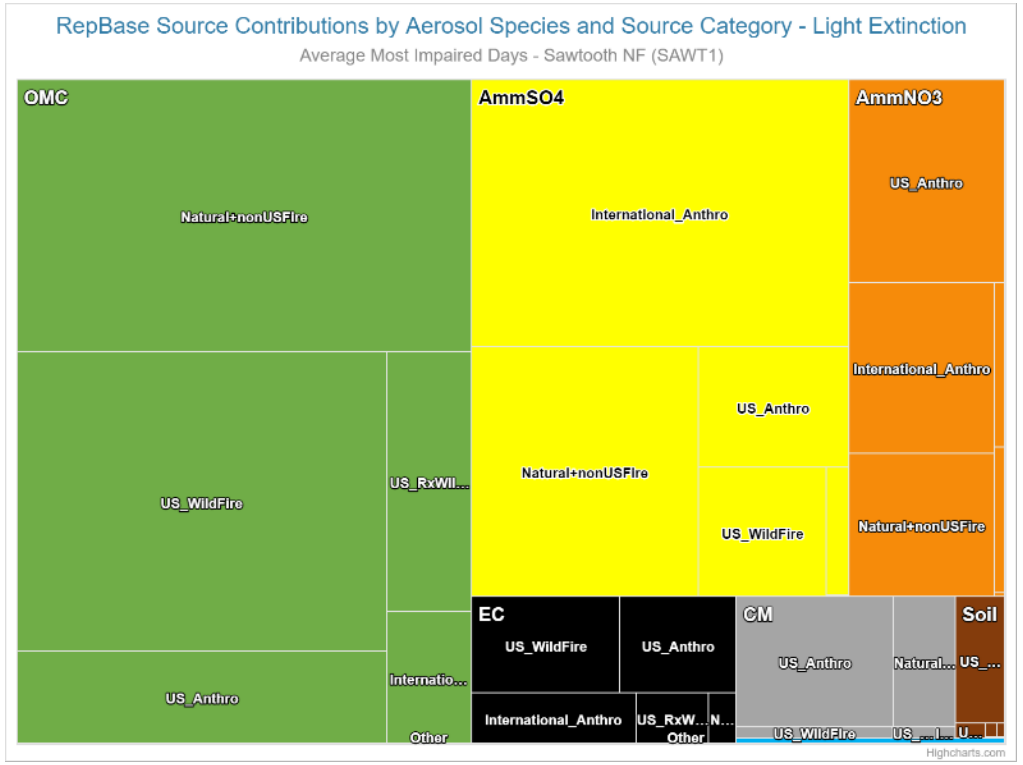
At Sawtooth Wilderness Area:

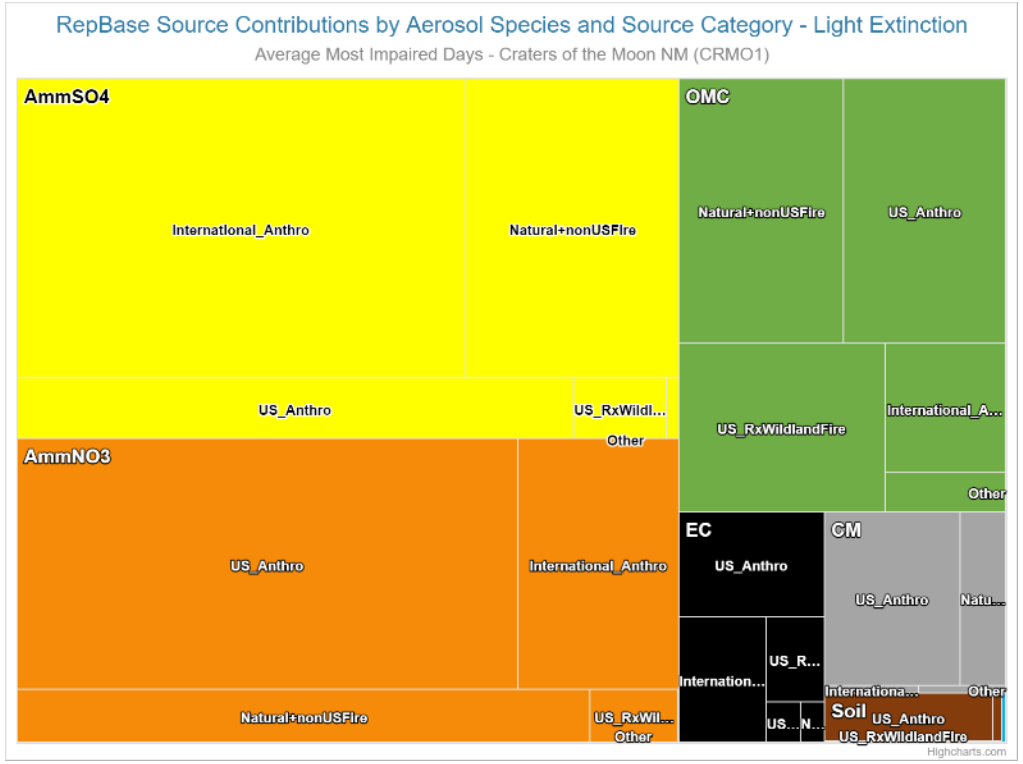
- Organic Carbon is the most important aerosol species. Natural Sources and Wildfire are more important than U.S. Anthropogenic.
- For AmmSulfate, International Anthropogenic and Natural emissions are more important than U.S. anthropogenic emissions.
- For AmmNitrate, U.S. Anthropogenic emissions are most important.

At Craters of the Moon National Park

- AmmSO4 and AmmNO3 are most important aerosol species.
- U.S. Anthro emissions are most important sector for AmmNO3. International Anthro and Natural Sources dominate AmmSO4.

2028OTBa2 source apportionment may show different relative source contributions.





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.

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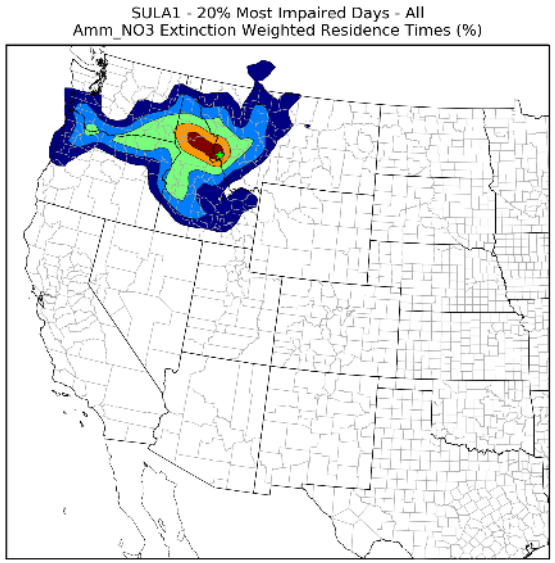
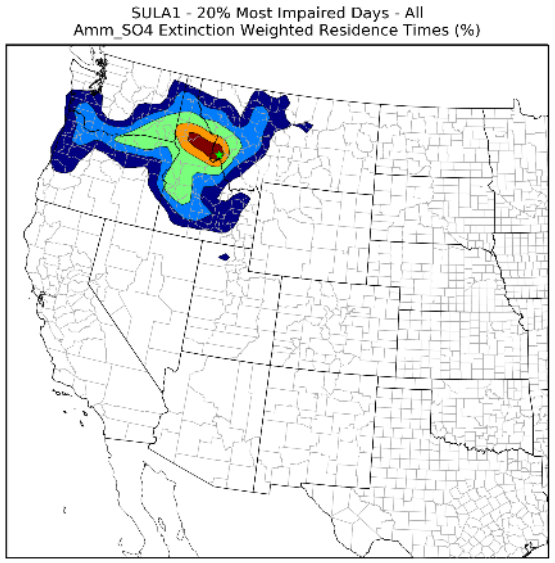
Emissions are not included in the EWRT and AoI calculations.

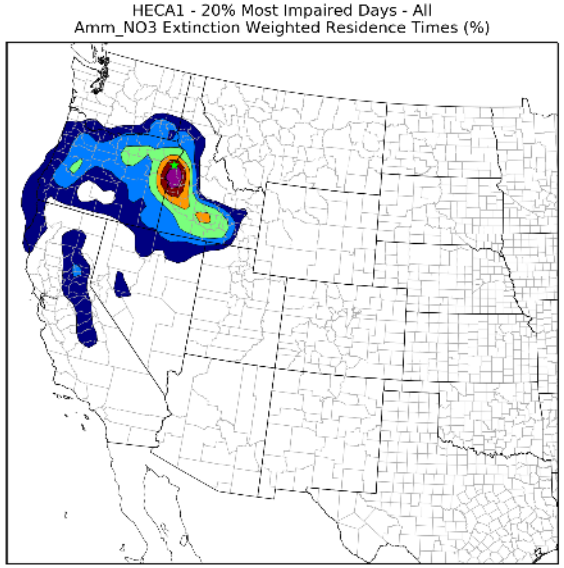
SULA: Ammonium nitrate



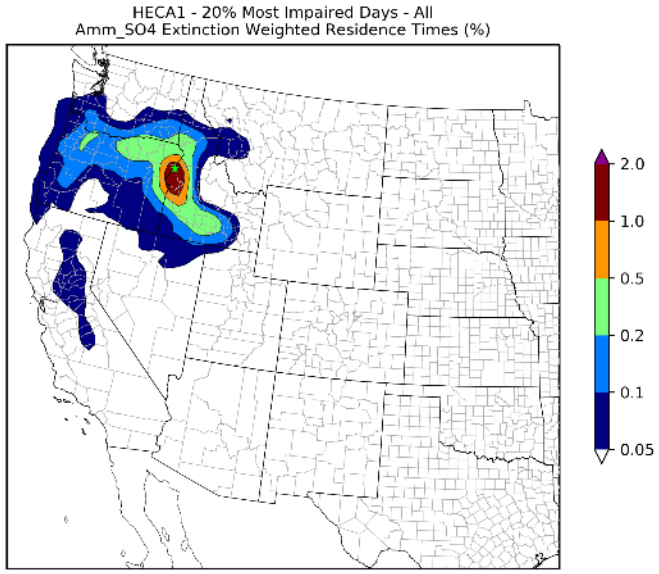
SULA: Ammonium sulfate



HECA: Ammonium nitrate



HECA: Ammonium sulfate



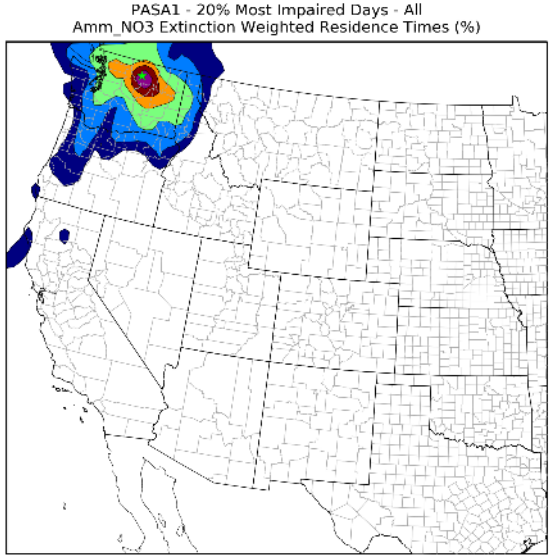
Sula Lake Wilderness Area: the geographic Areas of greatest Influence (orange and green shapes) for AmmNO3 and AmmSO4 are north to southwest. For **Hells Canyon Wilderness Area** the Areas of Influence are predominantly southeast.

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.

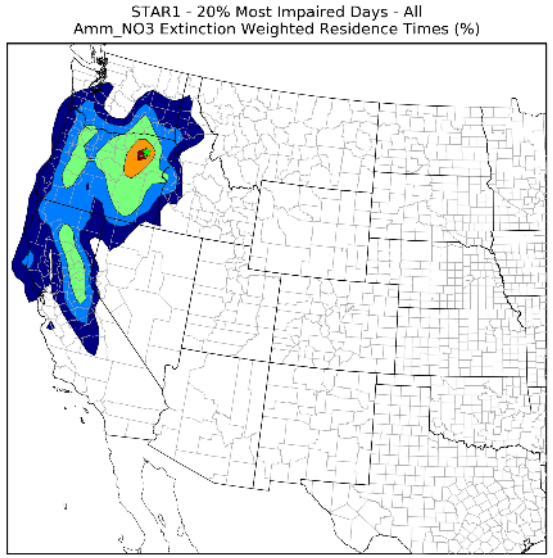
The **Areas of Influence** (AoI) greater than 0.5% (area in orange) and greater than 0.1% (area within bright blue shape) are defined based on EWRT.

Emissions are not included in the EWRT and AoI calculations.

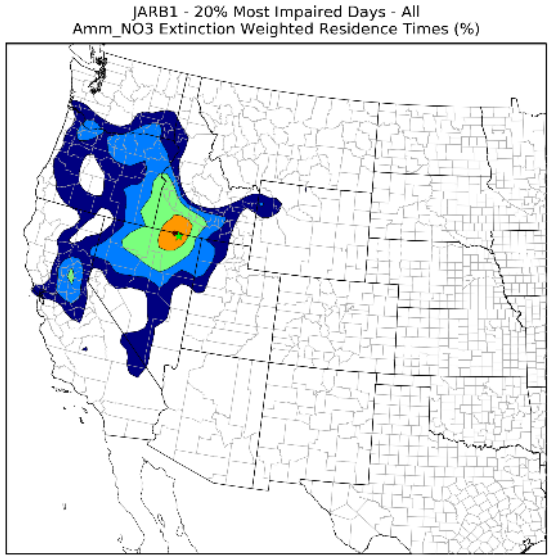
PASA: Ammonium nitrate



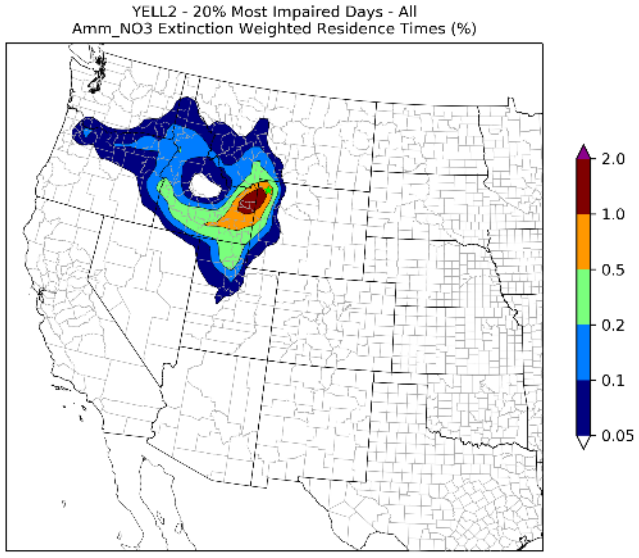
STAR: Ammonium nitrate



JARB: Ammonium nitrate



YELL: Ammonium nitrate

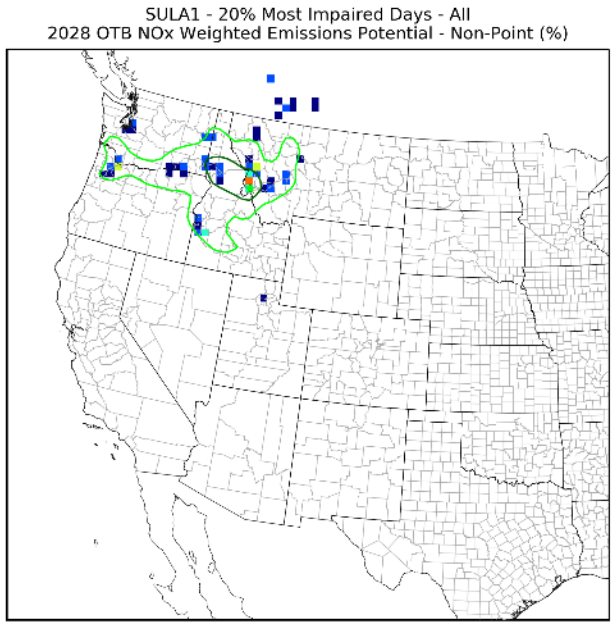


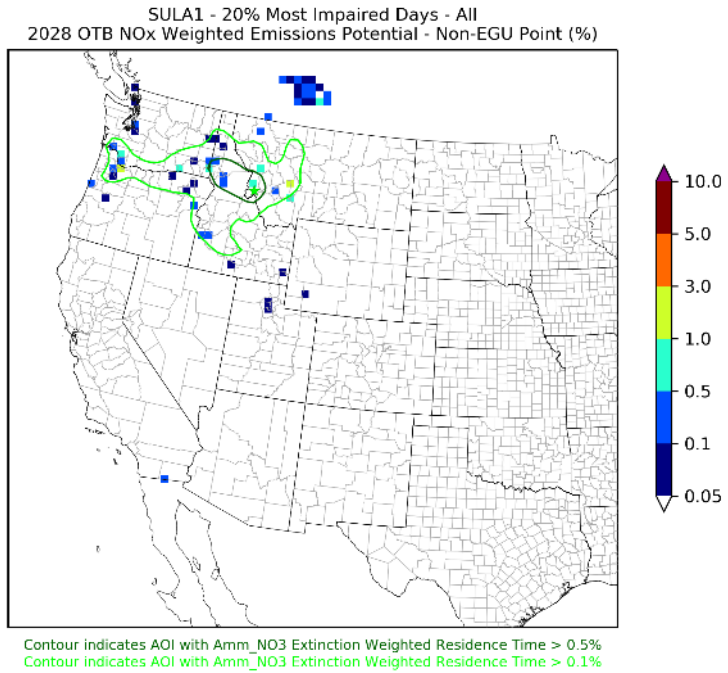
Sula Lake Wilderness Area: the geographic Areas of greatest Influence (orange and green shapes) for AmmNO3 and AmmSO4 are north to southwest. For **Hells Canyon Wilderness Area** the Areas of Influence are predominantly southeast.

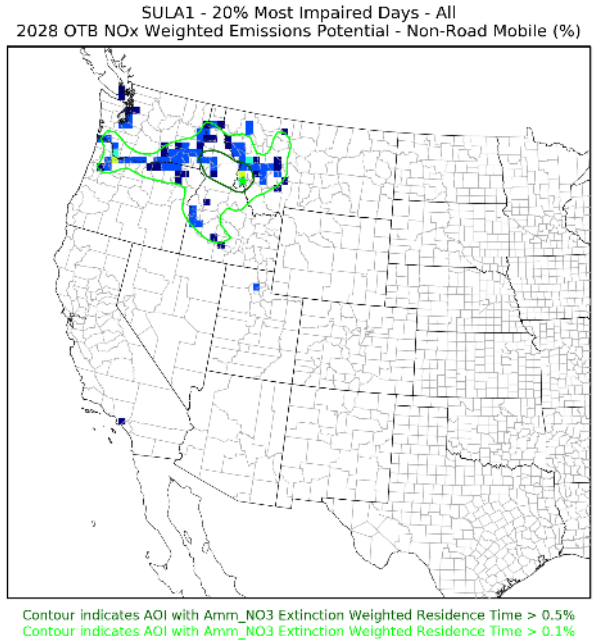
Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

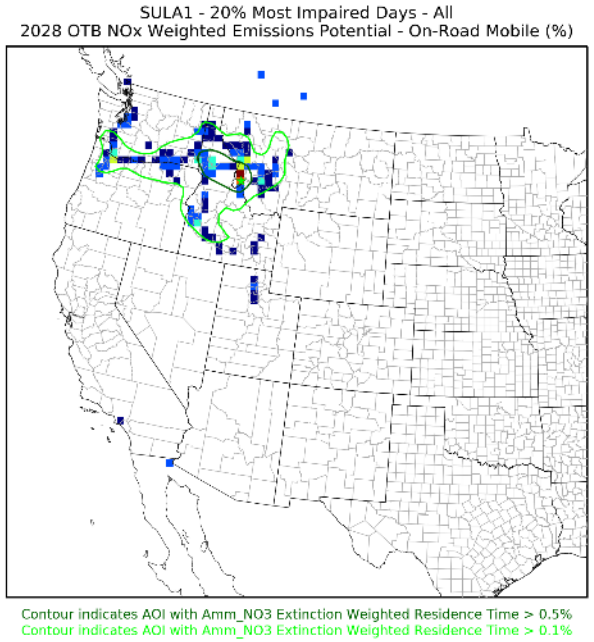
Ammonium Nitrate at Sula Peak (Selway-Bitterroot):

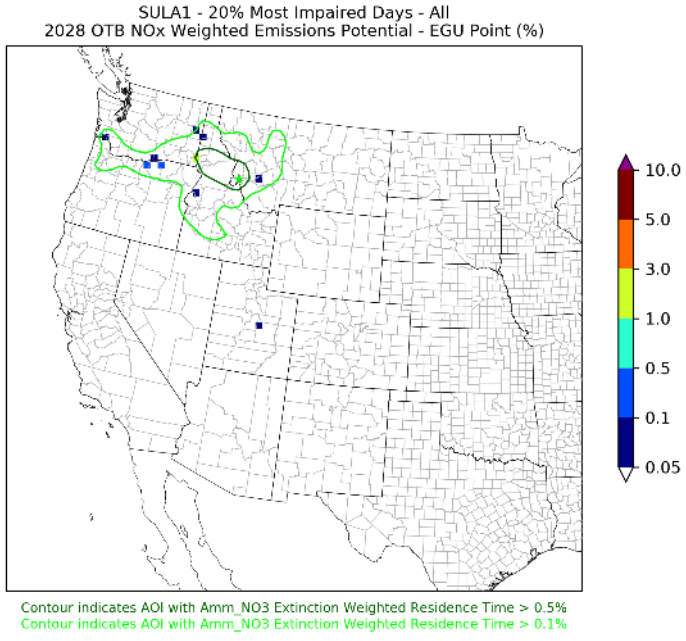
- 2028 WEP (All heights) identifies <u>Non-EGU point</u>, <u>Non-point</u>, and <u>Mobile</u> as local and major source categories.





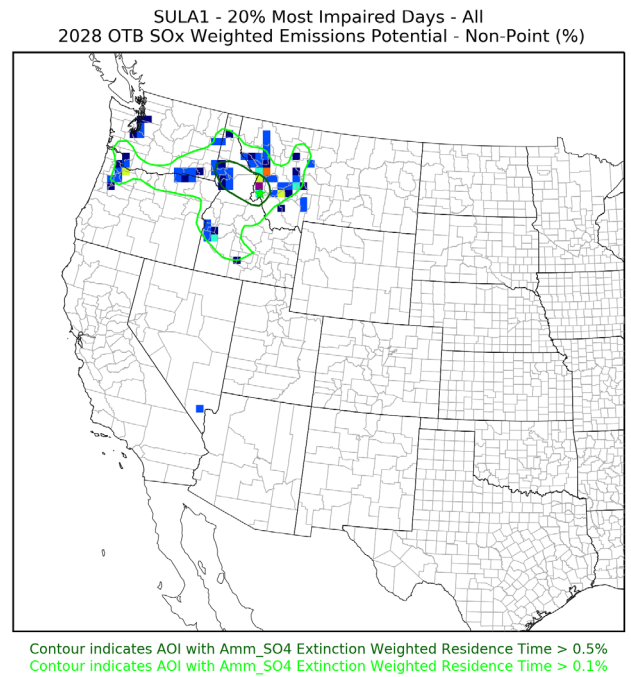


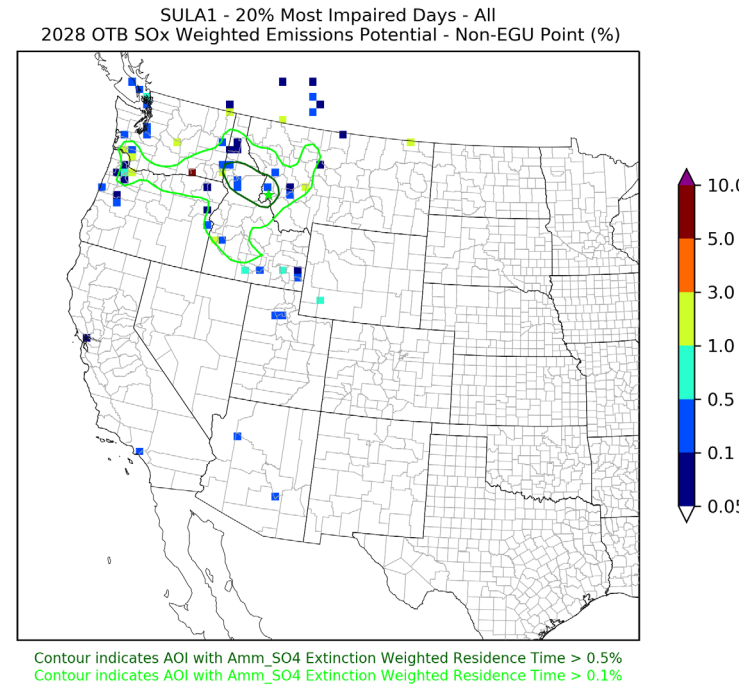


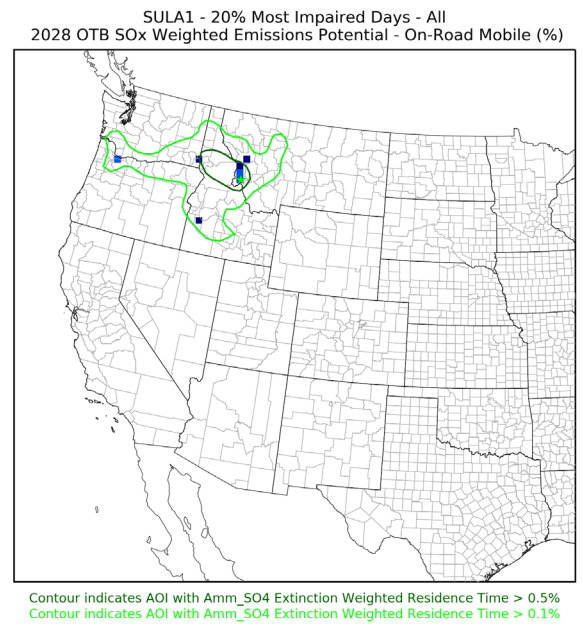


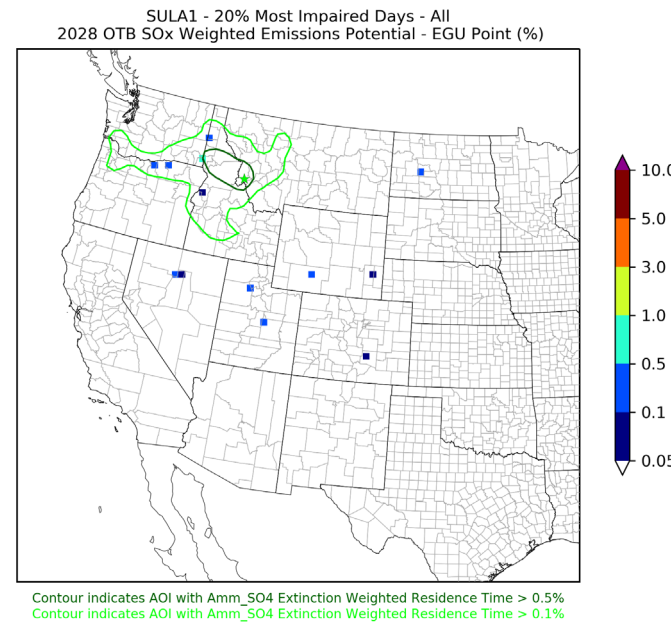
Ammonium Sulfate at SULA (Selway-Bitteroot):

- 2028 WEP (All heights) identifies <u>Non-point</u> and <u>Non-EGU Point</u> major and local source categories







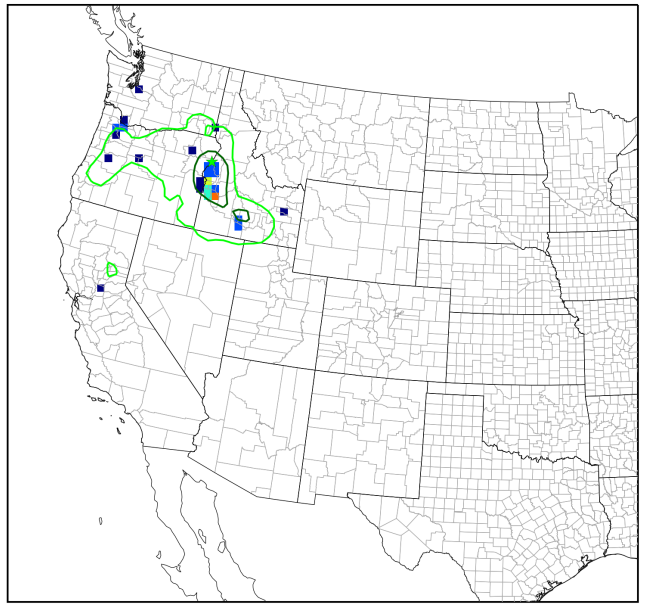


Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

Ammonium Nitrate at Hells Canyon Wilderness Area:

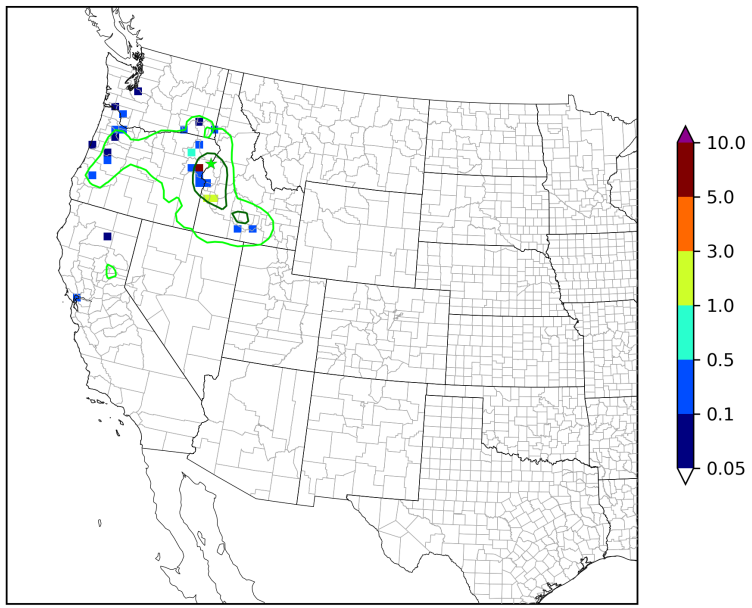
- 2028 WEP (All heights) identifies <u>Non-EGU point</u>, <u>Non-point</u>, and <u>Mobile</u> as local and major source categories.

HECA1 - 20% Most Impaired Days - All
2028 OTB NOx Weighted Emissions Potential - Non-Point (%)



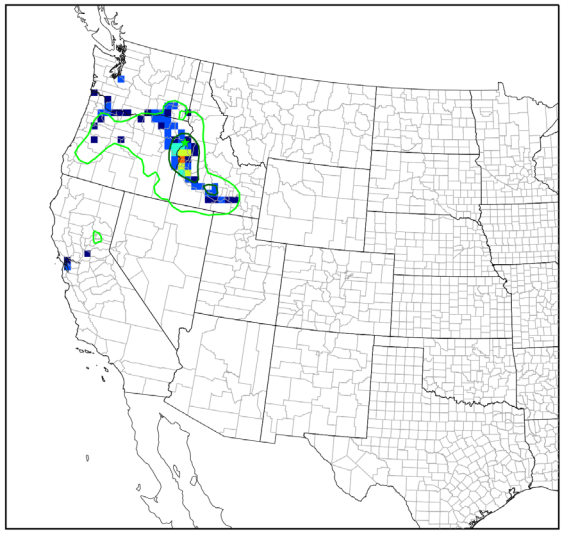
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

HECA1 - 20% Most Impaired Days - All
2028 OTB NOx Weighted Emissions Potential - Non-EGU Point (%)



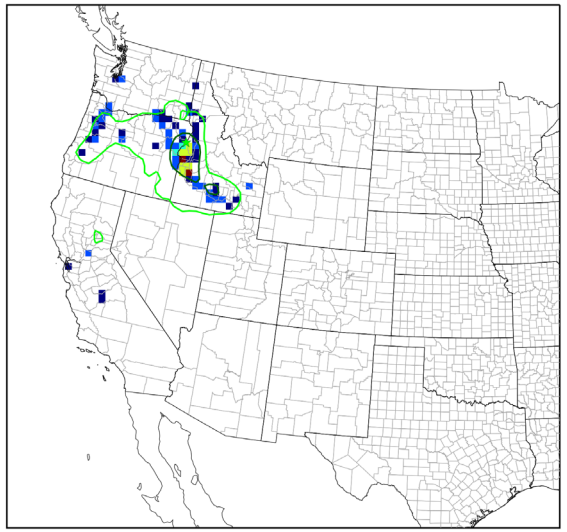
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

HECA1 - 20% Most Impaired Days - All
2028 OTB NOx Weighted Emissions Potential - Non-Road Mobile (%)



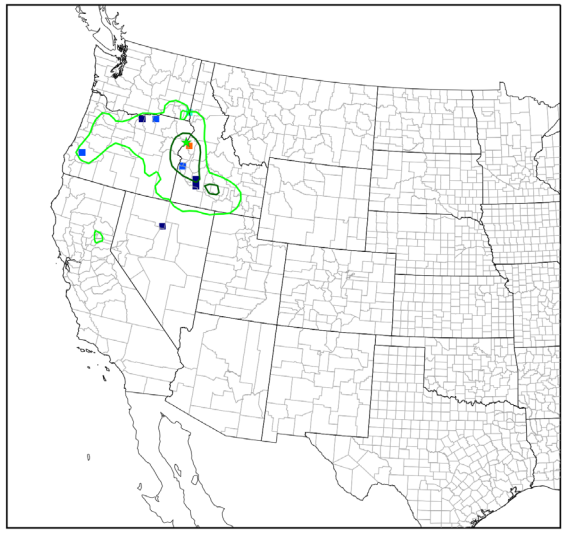
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

HECA1 - 20% Most Impaired Days - All
2028 OTB NOx Weighted Emissions Potential - On-Road Mobile (%)



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

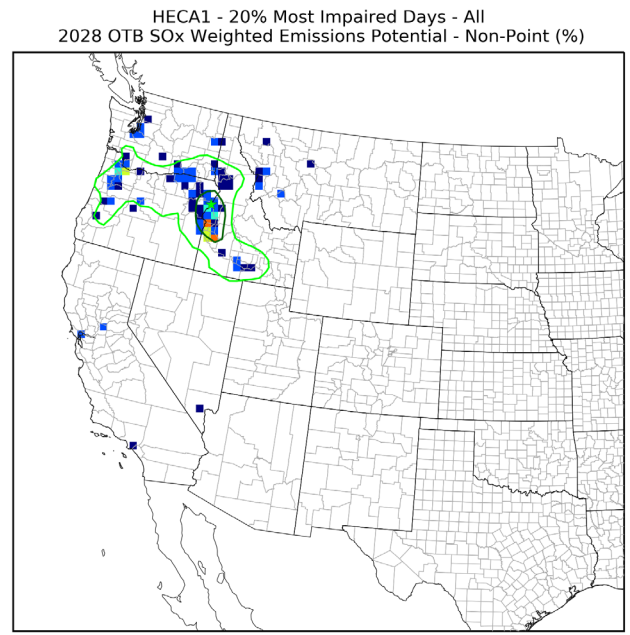
HECA1 - 20% Most Impaired Days - All
2028 OTB NOx Weighted Emissions Potential - EGU Point (%)

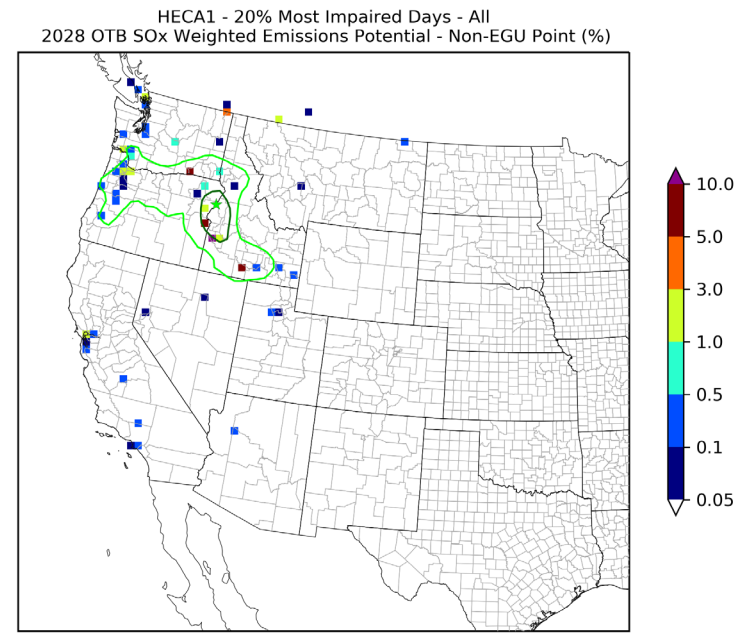


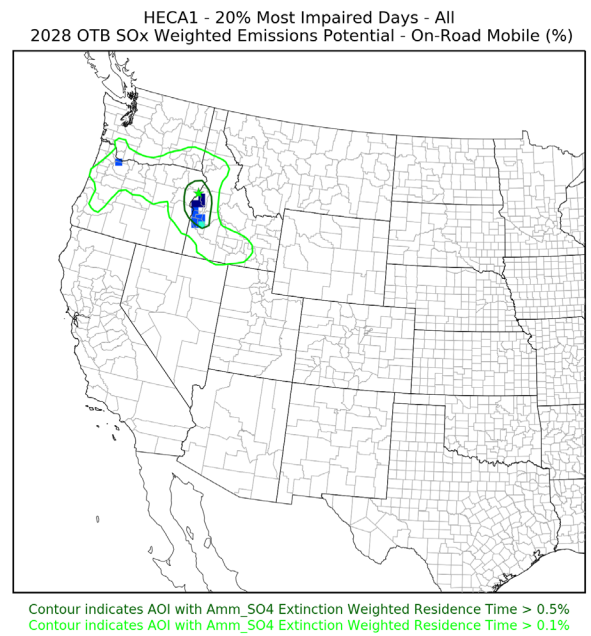
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

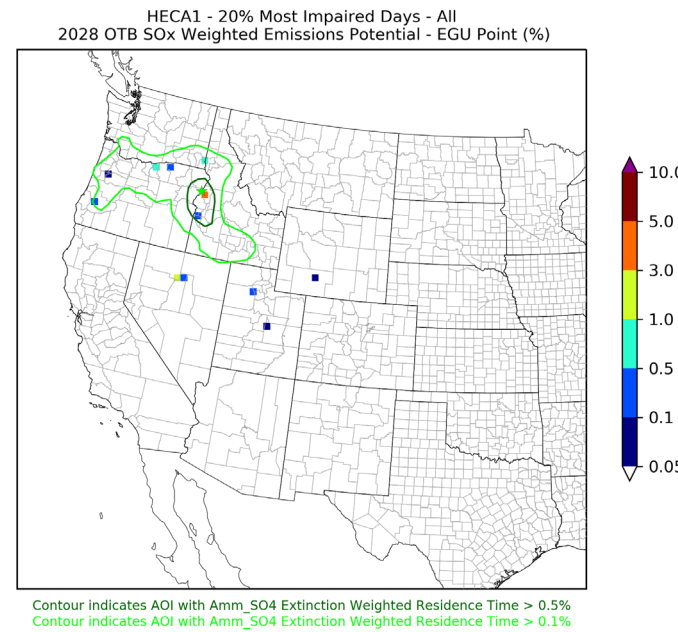
Ammonium Sulfate at Hells Canyon Wilderness Area:

- 2028 WEP (All heights) identifies <u>Non-point</u> and <u>Non-EGU Point</u> major and local source categories





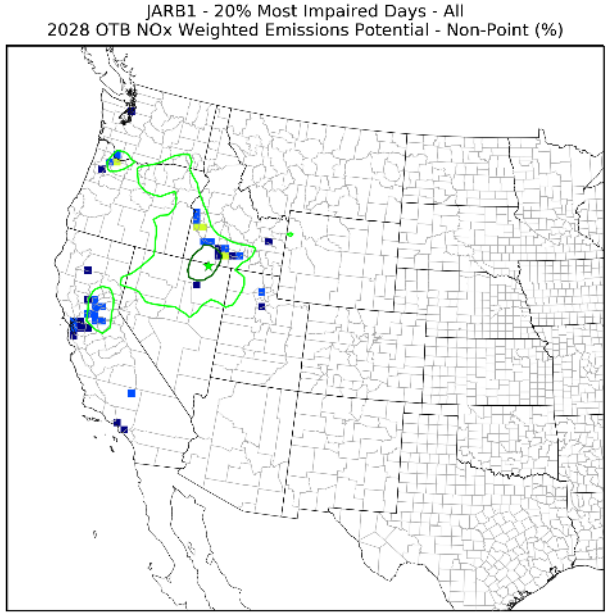


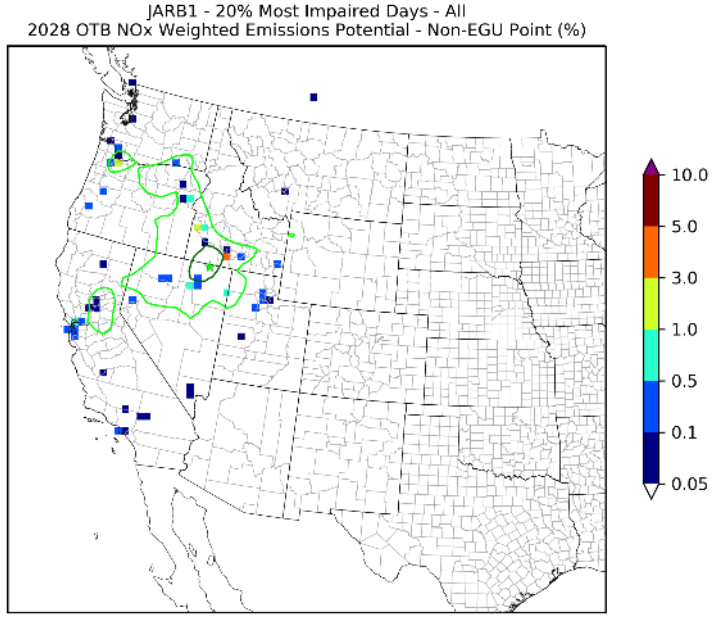


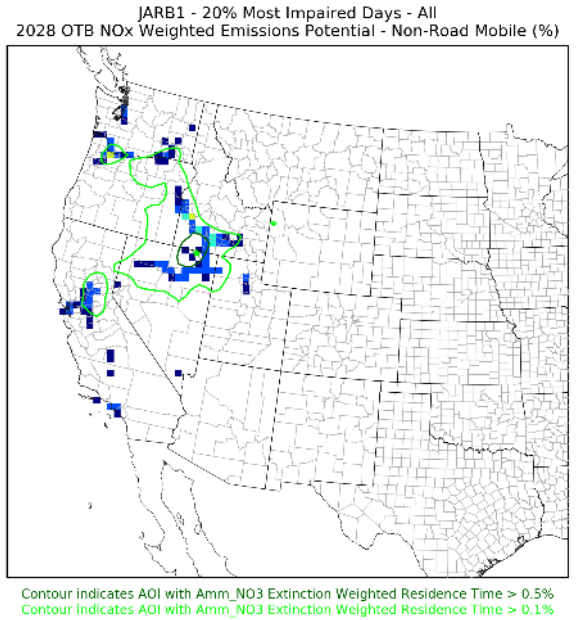
Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

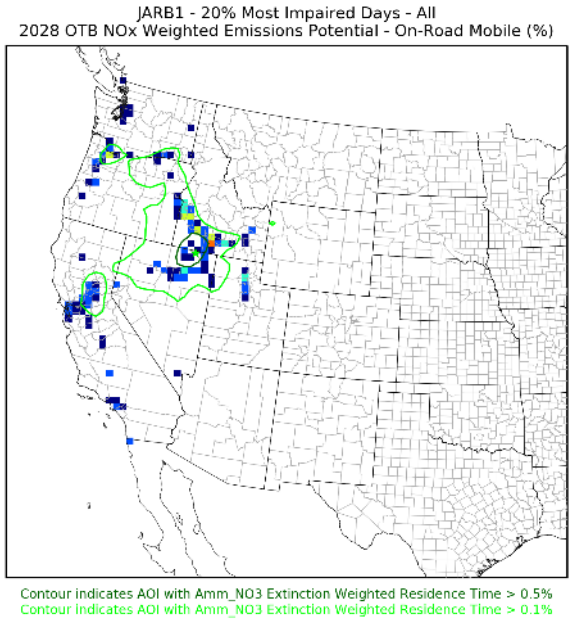
Ammonium Nitrate at Jarbridge Wilderness Area:

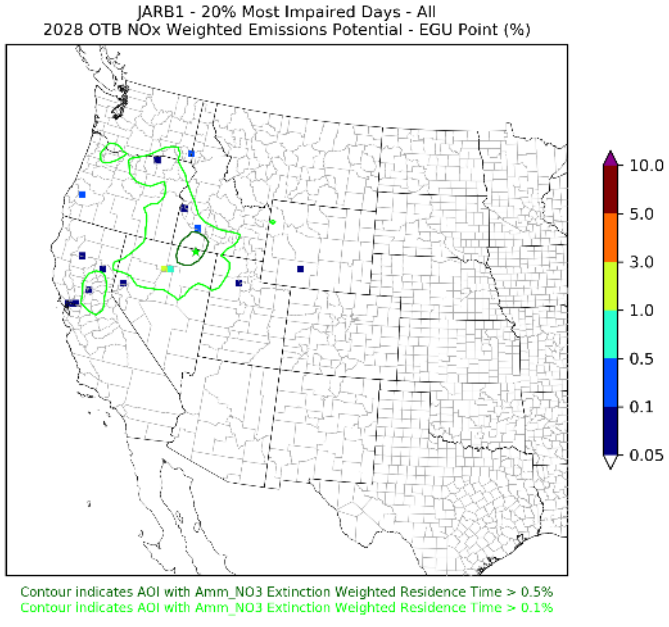
- 2028 WEP (All heights) identifies <u>Non-EGU point</u>, <u>Non-point</u>, and <u>Mobile</u> as local and major source categories.







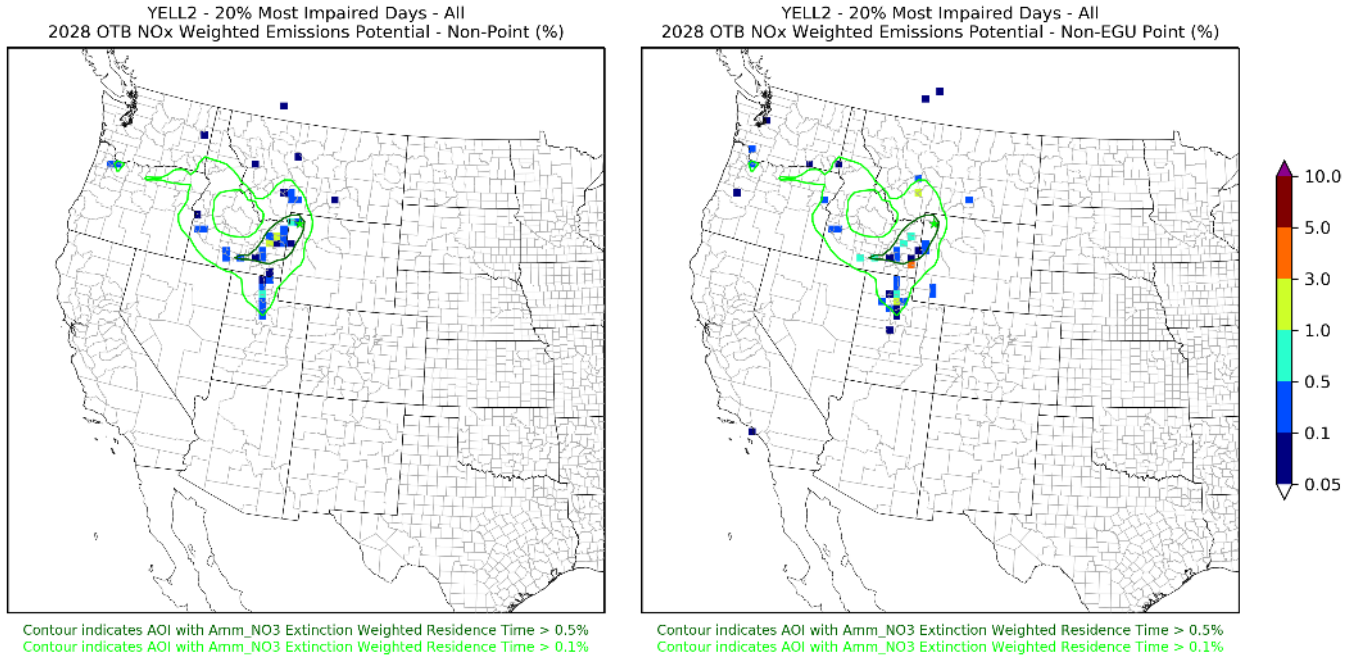


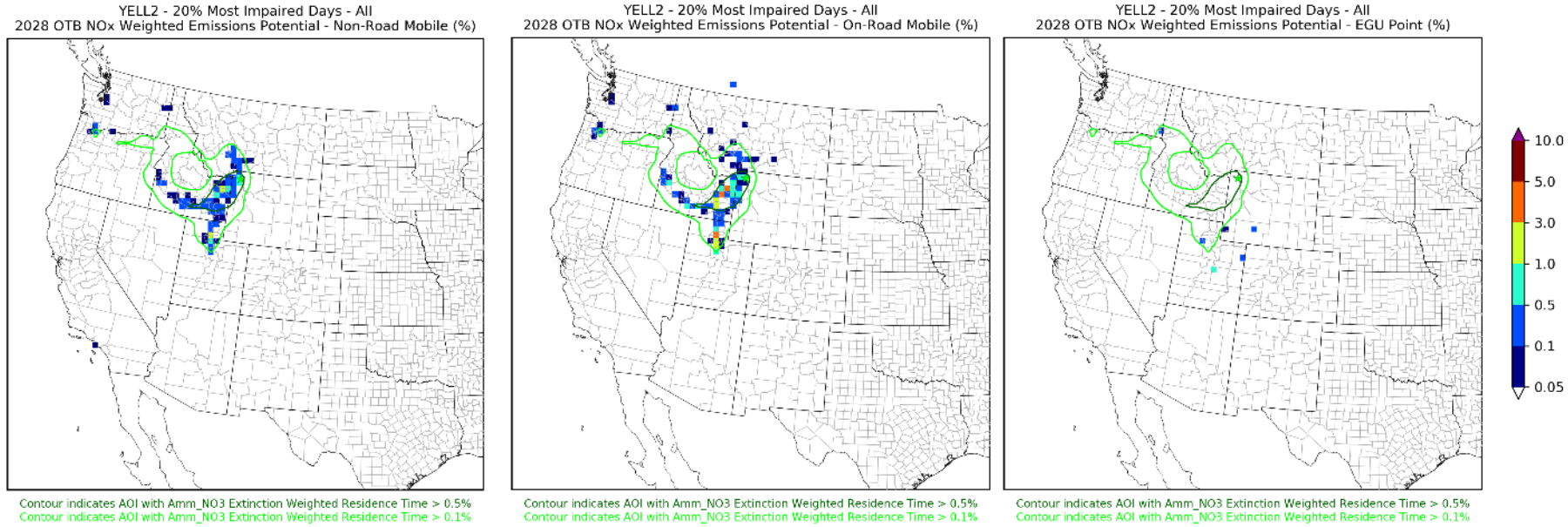


Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

Ammonium Nitrate at Yellowstone National Park:

- 2028 WEP (All heights) identifies Non-EGU point, Non-point, and Mobile as local and major source categories.

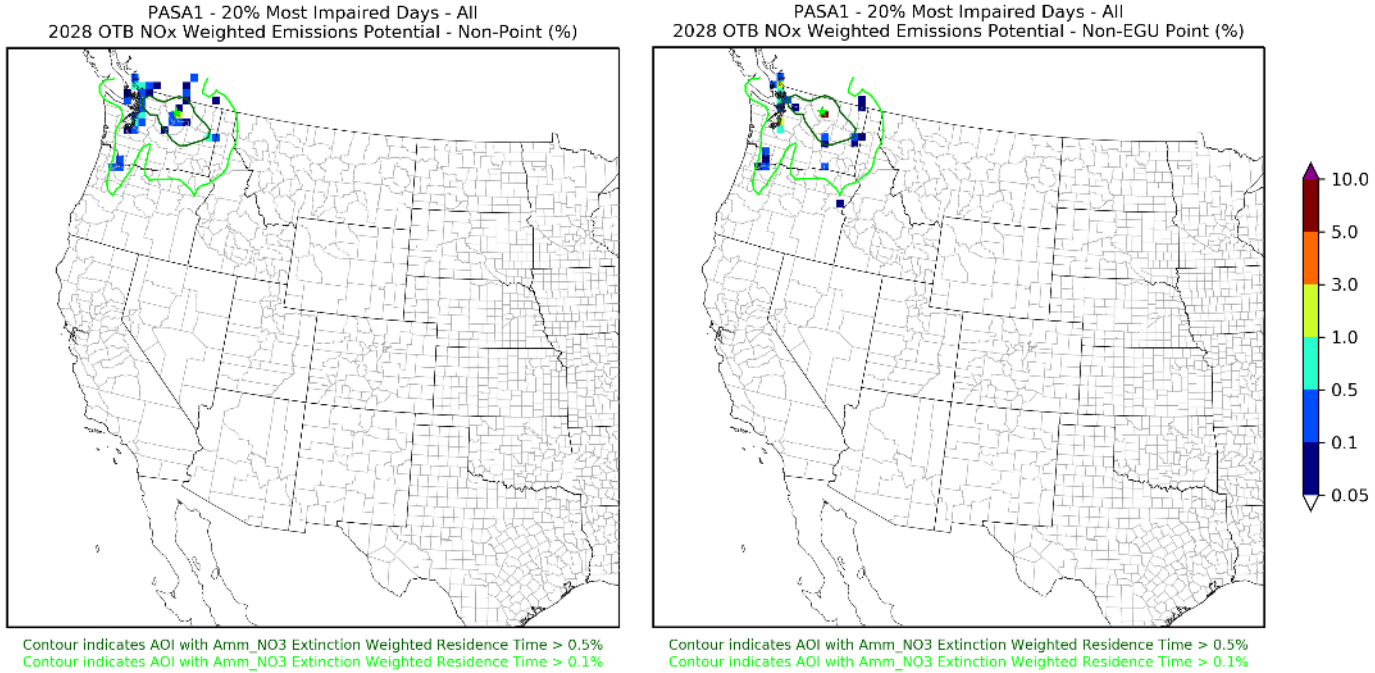


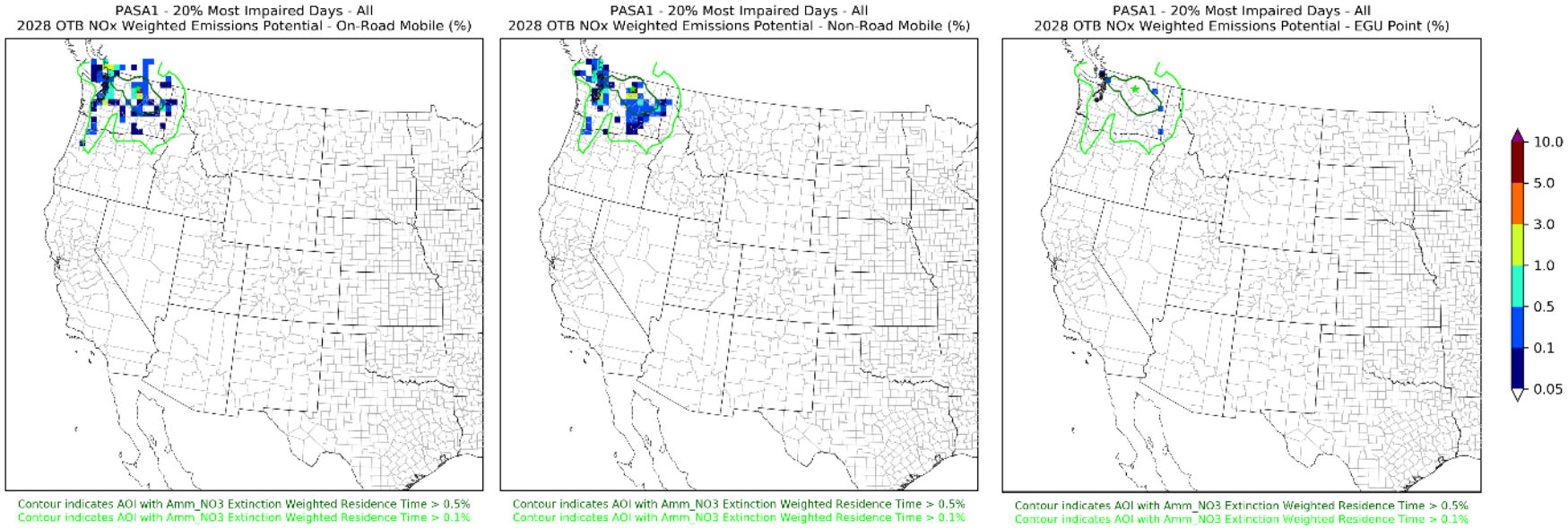


Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

Ammonium Nitrate at Pasayten Wilderness Area:

- 2028 WEP (All heights) identifies <u>Non-EGU point</u>, <u>Non-point</u>, and <u>Mobile</u> as local and major source categories.

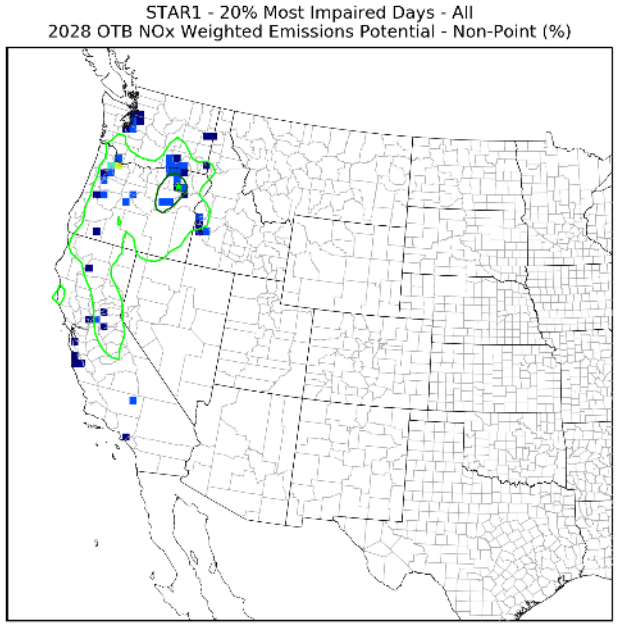




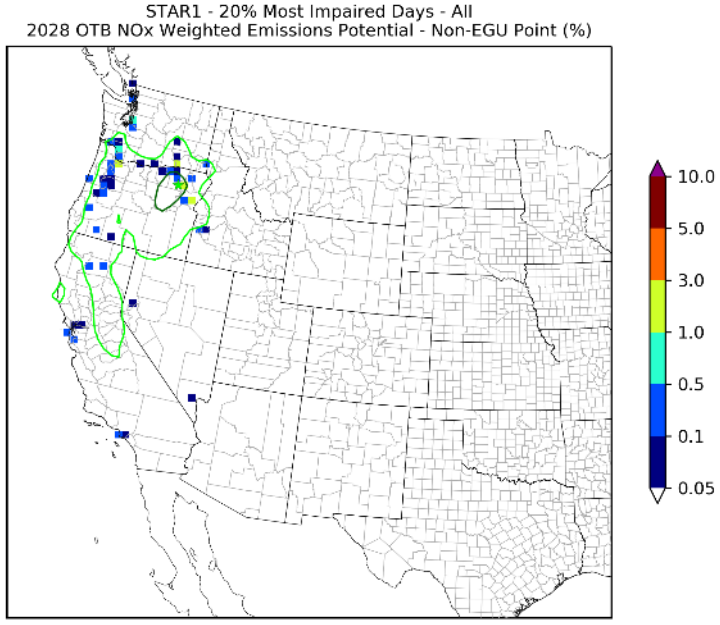
Weighted Emissions Potential combines Emissions and Areas of Influence (in these charts, areas within green outlines)

Ammonium Nitrate at STAR (Strawberry Mtn Wilderness Area):

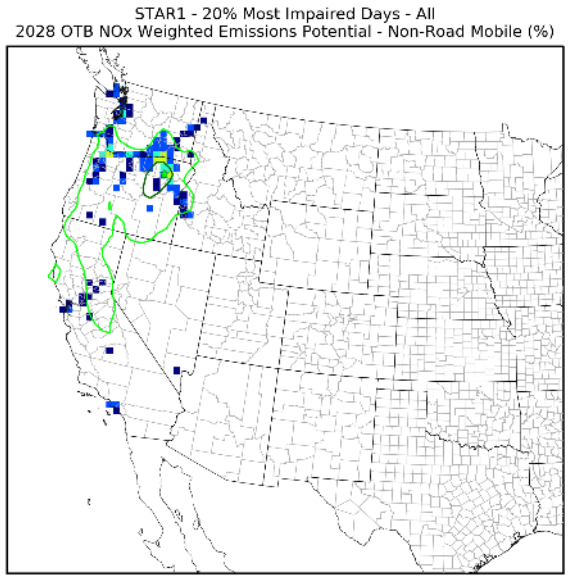
- 2028 WEP (All heights) identifies Non-EGU point, Non-point, and Mobile as local and major source categories.



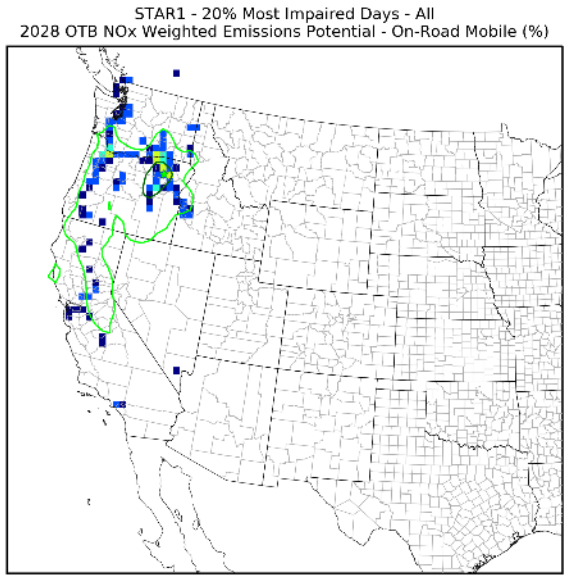
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%



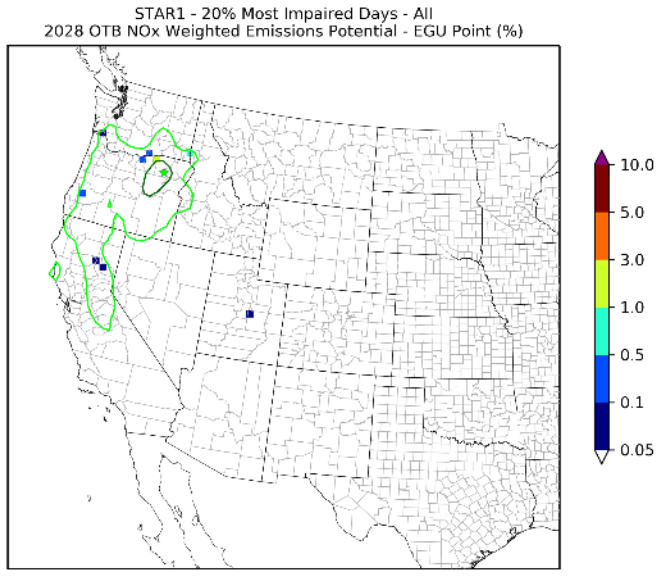
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%



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%



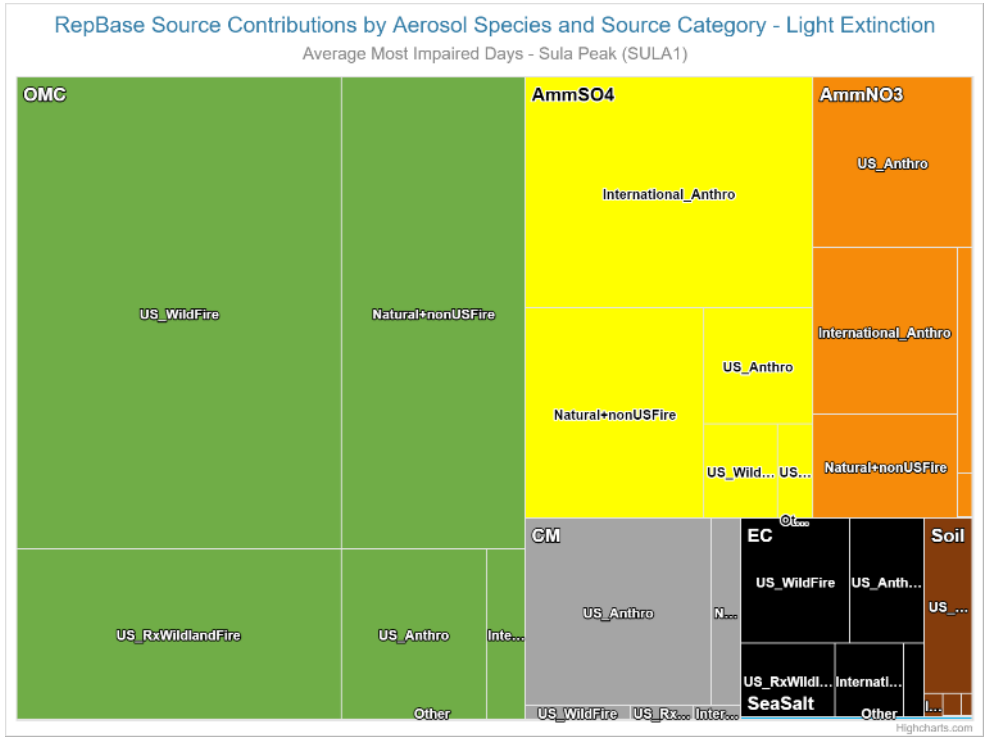
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.5%
Contour indicates AOI with Amm_NO3 Extinction Weighted Residence Time > 0.1%

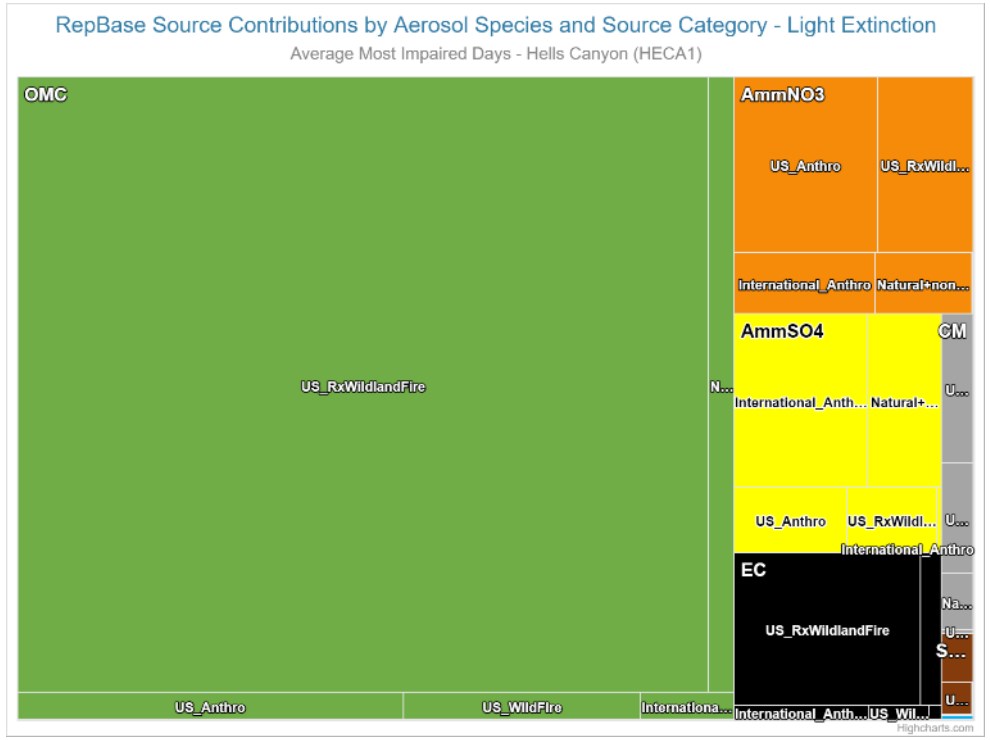
Representative Baseline source apportionment:

At Sula Peak and Hells Canyon, Organic Carbon is the most important aerosol species. U.S. Wildfire, U.S. Wildland Prescribed fire, and Natural Sources are more important than U.S. Anthropogenic.

- For AmmNitrate, U.S. Anthropogenic emissions are most important.
- For AmmSulfate, International Anthropogenic and Natural emissions are more important than U.S. anthropogenic emissions.

2028OTBa2 source apportionment may show different relative source contributions.

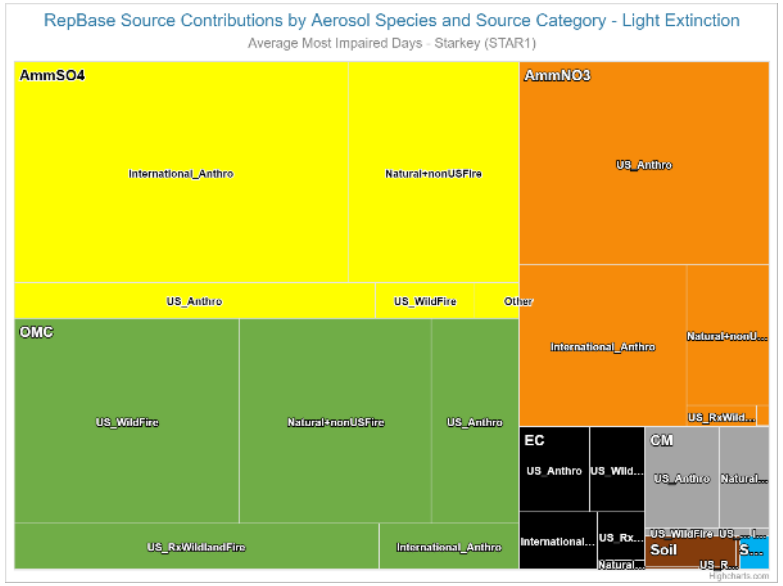
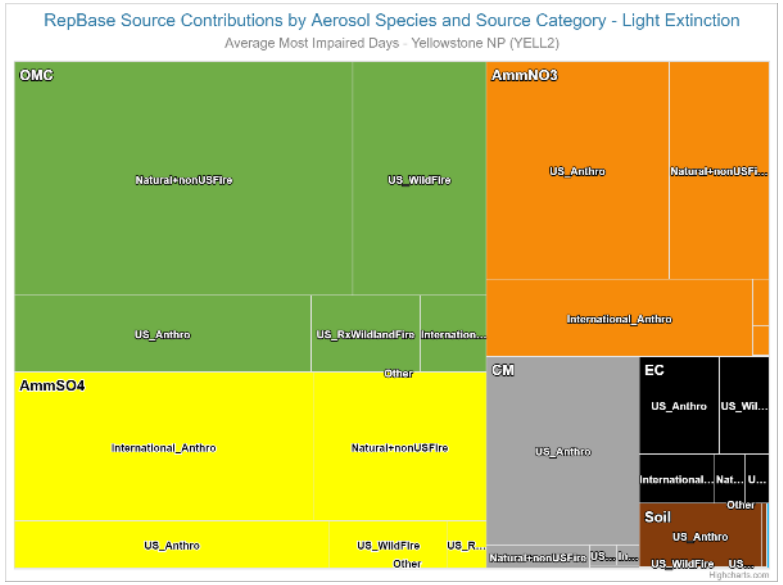
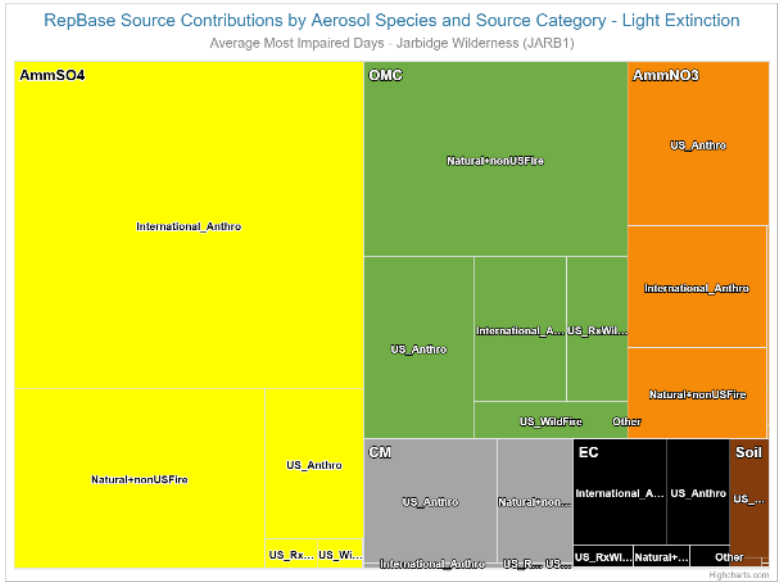




Representative Baseline source apportionment:

At Strawberry Mtns, OR (STAR IMPROVE), Pasayten, WA, and Yellowstone, WY/MT:

- Contributions from Organic Carbon (OMC) and AmmSO4 are similar and larger than AmmNO3.
- For OMC: U.S. Wildfire, U.S. Wildland Prescribed fire, and Natural Sources are more important than U.S. Anthropogenic.
- For AmmSulfate: International Anthropogenic and Natural emissions are more important than U.S. anthropogenic emissions.
- For AmmNitrate: U.S. Anthropogenic emissions are most important

At Jarbridge, NV: AmmSO4 is the most important aerosol and International emissions dominate AmmSO4

2028OTBa2 source apportionment may show different relative source contributions.