III.K.13.G AIR QUALITY MODELING

1. OVERVIEW

Modeling is a critical technical step in many of the planning requirements of the RH Rule. Models are needed for source apportionment, control strategy development and optimization, quantification of incremental impacts of individual source categories, and analysis of cumulative impacts. Air quality and visibility modeling in support of regional haze planning in the WRAP region was the responsibility of the WRAP Regional Haze Planning Work Group (RHPWG[1]) under the direction of the Regional Technical Operations Work Group (RTOWG[2]). The RHPWG/RTOWG used the air pollution emissions data provided by member states to simulate historic air quality conditions (i.e., base year of 2014) and estimate the benefit of emissions reductions programs in the future (i.e., future year of 2028). The WRAP 2014 modeling platform includes all WRAP states except Alaska and Hawaii.

Alaska does not have WRF meteorology available or a photochemical grid modeling platform to perform similar modeling to evaluate impacts to visibility. Due to the funding constraints, it was not possible for Alaska to perform photochemical grid modeling as part of their RH SIP. The development of the URP glidepath for Alaska Class I areas uses two modeling studies performed by others. First, the EPA conducted preliminary modeling for Alaska using a CMAQ photochemical grid model regional modeling platform for the base year 2016 and future year 2028. There are caveats to this work that will be described below in the base year modeling section. Second, UAF ran the GEOS-Chem global chemistry model for the year 2016 that was used to provide estimates of the contributions of international anthropogenic emissions to visibility. The GEOS-Chem modeling is described in Appendix III.K.13.I. In addition to the photochemical grid modeling, AOI, WEP, and Potential Source Contributions (PSC) analyses were performed for the IMPROVE sites in Alaska that represent Class I areas to estimate the sources of emissions within, or near, the state that had the potential to contribute the most to visibility impairment at the IMPROVE sites on most impaired days and other periods.

2. EPA 2016 BASE YEAR CMAQ MODELING

EPA conducted CMAQ photochemical modeling of Alaska and surrounding areas using a 2016 modeling database and 27-km and 9-km grid resolution domains. The base year simulation together with its paired future year simulation are used to calculate relative response factors (RRFs) for each component of $PM_{2.5}$ and CM that are used in making future year visibility projections. The geographic extent of the modeling domains was shown in Figure III.K.13.E-1. Modeling inputs and setup are described in the EPA's Technical Supporting Document[3].

[1] https://www.wrapair2.org/RHPWG.aspx
[2] https://www.wrapair2.org/rtowg.aspx
[3] U.S. Environmental Protection Agency, 2020. Technical Support Document for EPA's Updated 2028 Regional Haze Modeling for Hawaii, Virgin Islands, and Alaska. Office of Air Quality Planning and Standards. July. https://vice.cira.colostate.edu/files/iwdw/platforms/WRAP_2014/WEP_AOI/WEP_AOI_AK_R20201223/DOCS/TSD_HI_VI_AK_2028_Regional_Haze_Modeling_6.pdf

The lateral boundary and initial species concentrations are based on a CMAQ hemispheric simulation at 108-km grid resolution that completely and continuously covers the Northern Hemisphere. The international emission inventories are synthesized from the Hemispheric Transport of Air Pollution Version 2 inventory (EDGAR-HTAPv2) for the year 2010 and projected to 2014 using the Community Emissions Data System (CEDS) inventory. The China emission inventory was developed at Tsinghua University and was representative of 2016. Details of emission development for the CMAQ hemispheric simulation is described in the EPA's Hemispheric Modeling Platform Technical Support Document (TSD).[4]

Model performance evaluation (MPE) of the base year is important to establish confidence in the future year contribution analyses and calculations. EPA evaluated CMAQ performance for PM species component at IMPROVE and other PM monitoring networks. Model performance on the 20% MID and 20% clearest days at individual IMPROVE sites are presented in Figure III.K.13.G-1 that is reproduced from the EPA Alaska CMAQ modeling TSD. The model tends to underestimate sulfate (SO_4) which dominates visibility impairment at Alaska sites on the 2016 MID. The Normalized Mean Bias (NMB) and Normalized Mean Error (NME) for SO_4 (see Table III.K.13.G-1) was compared to numerical "goals" and less stringent "criteria" benchmarks recommended by Emery et al. (2016)[5]. The purpose of MPE benchmarks is not to give a passing or failing grade to a simulation, but rather to put results into the proper context of previous model applications that establish what level of performance can be realistically expected. These benchmarks were developed by analyzing the model performance for regional-scale photochemical grid models mostly in the lower 48 states, and we do not expect photochemical models to perform as well as for Alaska where the concentrations are highly dependent on estimates of international and natural emissions that are not as well-known as U.S. anthropogenic emissions.

Annual NME at DENA1, TRCR1, and SIME1 are 70%, 71%, and 59%, respectively, exceeding the SO_4 error goal and criteria for error (≤35% and ≤50%). The MID NME is higher at DENA1 (73%) and SIME1 (69%). The MID NMB fails the SO_4 bias goal and criteria for bias (≤±10% and ≤±30%) at all three sites. The underestimation of SO_4 could pose an issue for using EPA's CMAQ modeling results for Alaska regional haze modeling. The EPA's CMAQ modeling did not include reactive sulfur emissions from volcanos or oceanic DMS. An analysis of 2014 emissions for a region (based on the WRAP 2014 GEOS-Chem simulation) essentially equivalent to EPA's CMAQ Alaska 27-km domain found that 60% of the reactive sulfur emissions were from volcano degassing and DMS (see Table III.K.13.E-7).

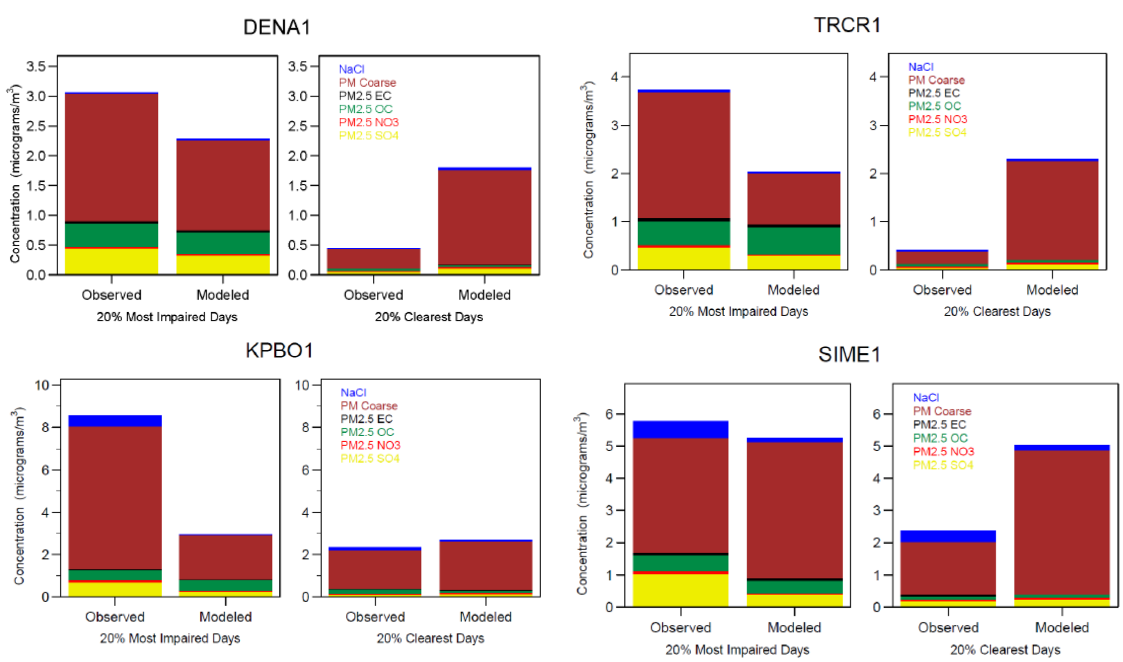
[4] U.S. Environmental Protection Agency, 2019. 2016 Hemispheric Modeling Platform Version 1: Implementation, Evaluation, and Attribution. Research Triangle Park, NC. U.S. Environmental Protection Agency. U.S. EPA

[5] Emery, C., Liu, Z., Russell, A.G., Odman, M.T., Yarwood, G. and Kumar, N., 2017. Recommendations on statistics and benchmarks to assess photochemical model performance. Journal of the Air & Waste Management Association, 67(5), pp.582-598.

Table III.K.13.G-1. 2016 CMAQ model performance of sulfate concentrations across all days and most impaired days.

Site/Days	Mean Obs (µg/m^3)	Mean Model (µg/m^3)	NMB (%)	NME (%)	MB (µg/m^3)	ME (µg/m^3)
DENA1						
All days	0.18	0.18	0.9%	70%	0	0.13
MID	0.44	0.29	-34%	73%	-0.15	0.32
TRCR1						
All days	0.18	0.19	0.3%	71%	0	0.13
MID	0.47	0.22	-48%	68%	-0.23	0.32
SIME1						
All days	0.5	0.25	-51%	59%	-0.25	0.29
MID	1.04	0.34	-67%	69%	-0.69	0.72

Figure III.K.13.G-1. Stacked bar charts detailing the average composition of speciated particulate matter in 2016 on the 20% most impaired days (right) and 20% clearest days (right) at Alaska IMPROVE sites. [Source: EPA's Alaska CMAQ TSD Appendix A]



3. EPA 2028 PROJECTED YEAR CMAQ MODELING

EPA conducted CMAQ modeling for a 2028 emissions scenario to make 2028 visibility projections along with a separate 2028 zero-out U.S. anthropogenic emissions modeling scenario. The zero-out U.S. anthropogenic emission simulations exclude any anthropogenic emission sources located in the U.S. or territories to provide visibility conditions caused by international anthropogenic emissions and natural sources that are beyond the control of states preparing the RH SIP. This included Class 1 and 2 commercial marine vessels but not Class 3 vessels. CMAQ model setup and all other inputs (i.e., meteorological fields, initial concentrations, and boundary concentrations) are unchanged from the 2016 base year simulation.

Table III.K.13.G-2 shows the base and future year deciview values on the 20% clearest days at each Class I area for the base model period (2014-2017) and future year (2028) based on the EPA's CMAQ simulations. For all sites in Alaska, visibility on the 20% clearest days is projected to be below the baseline (2000-2004) visibility condition (see Section III.K.13.D) satisfying the RH Rule requirement of no degradation in visibility for the clearest days since the baseline period.

Table III.K.13.G-2. Observed IMPROVE 2014-2017 base year and projected 2028 future year visibility (deciview) on the 20% clearest days at each IMPROVE site representing Class I areas in Alaska. [Source: EPA's Alaska CMAQ TSD].

Class I Area	IMPROVE site	Base Year (2014-2017) 20% Clearest Days (dv)	Future Year (2028) 20% Clearest Days (dv)
Denali NP	TRCR1	3.34	3.32
Denali NP	DENA1	2.19	2.16
Tuxedni National Wildlife Refuge	KPBO1/TUXE1	4.62	4.23
Simeonof Wilderness Area	SIME1	7.68	7.42

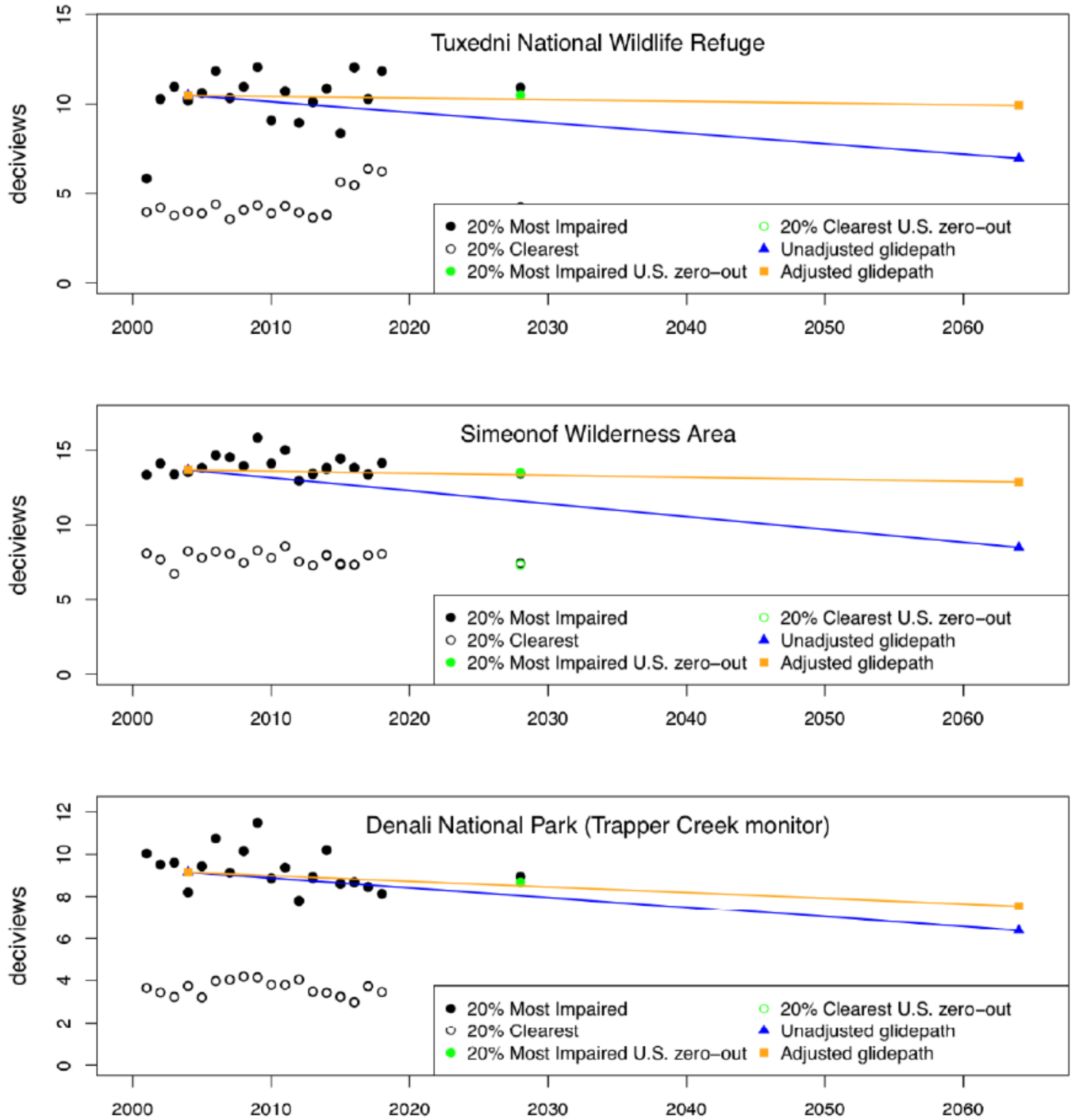
Table III.K.13.G-3 shows the 2028 visibility projections on the 20% MID that are below the 2000-2004 Baseline condition (see Section III.K.13.D). However, they are above the unadjusted and alternative, or "adjusted" (i.e., accounting for international anthropogenic emission contributions) 2028 glidepath. EPA estimated the international anthropogenic contributions to visibility using the hemispheric scale CMAQ zero-out model simulations. Only sulfate was added to the 2064 goal at each of these Class I areas to provide an adjusted glideslope. The estimate of international anthropogenic contribution is based on 2016 emissions and is not considering the contribution of international emissions to nitrate or primary $PM_{2.5}$ components.

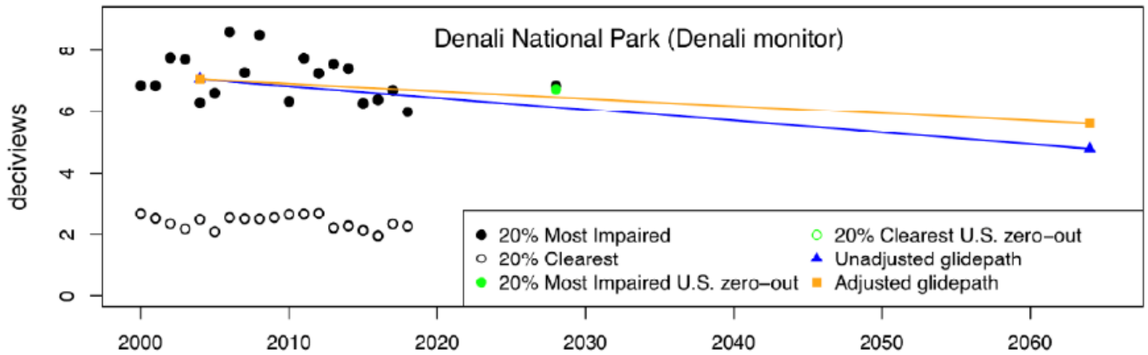
Table III.K.13.G-3. Observed IMPROVE 2014-2017 base year and projected 2028 future year visibility (deciview) on the 20% most impaired days at each IMPROVE site representing Class I areas in Alaska. [Source: EPA's Alaska CMAQ TSD]

Class I Area	IMPROVE site	Base Year (2014-2017) 20% Most Impaired Days (dv)	Future Year (2028) 20% Most Impaired Days (dv)	2028 Unadjusted Glidepath 20% Most Impaired Days (dv)	2028 Adjusted Glidepath 20% Most Impaired Days (dv)
Denali NP	TRCR1	8.99	8.95	8.05	8.52
Denali NP	DENA1	6.86	6.84	6.15	6.47
Tuxedni NWR	KPBO1/TUXE1	11.43	10.9	9.07	10.25
Simeonof WA	SIME1	13.86	13.43	11.6	13.35

Figure III.K.13.G-2 displays the URP Glidepath (blue line) for each Class I area in Alaska and shows that the projected 2028 MID (black solid circle; 2014-2017 base period) lies above the unadjusted and even the adjusted URP Glidepath (orange line). In fact, even when all U.S. anthropogenic emissions are eliminated (green solid circle), the 2028 projected MID is still above the adjusted URP glidepath. These results imply that the concept of glidepath may not be appropriate for Alaska given significant natural sulfur emissions in the area that are highly variable from year to year (see Section III.K.13.E-4) so that it is impossible to achieve the glidepath with controls of U.S. anthropogenic emissions.

Figure III.K.13.G-2. Default and Adjusted URP Glidepath at each Class I area in Alaska and 2028 visibility projections for the MID and clearest days from EPA's Alaska CMAQ modeling TSD. [Source: EPA's Alaska CMAQ TSD]





EPA's URP Glidepath approach was developed for use with Class I areas in the lower 48 states and has several issues when applied to Alaska. EPA's CMAQ modeling also has issues for use in Alaska regional haze modeling. The prevalent issues are as follows:

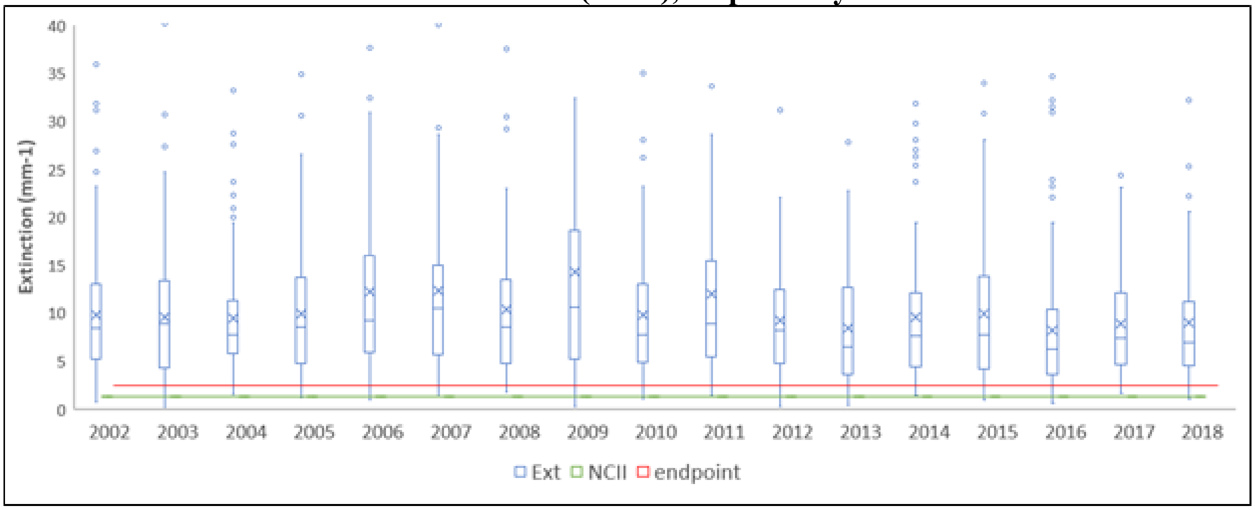
- EPA's CMAQ modeling did not include reactive sulfur emissions from volcanos or oceanic DMS or emissions from Russia. An analysis of the 2014 GEOS-Chem emissions inventory found that ~60% of the reactive sulfur emissions within the EPA's CMAQ Alaska 27-km domain were from volcano degassing and DMS (see Table III.K.13.E-7).

- The IMPROVE MID approach is a flawed visibility impairment metric for Alaska since potentially there can be a large component of natural sulfate from volcanos and DMS. The IMPROVE MID implicit assumption that, with the exception of background natural (NC II) conditions, visibility extinction due to $(NH_4)_2SO_4$ and NH_4NO_3 are mainly anthropogenic in origin is not true in Alaska. The potential influence of volcano emissions to $(NH_4)_2SO_4$ on the MID is shown in Figure III.K.13.E-11.

- The volcanic SO_2 emissions can exhibit significant inter-annual variability. If 2014-2018 are years with more active volcano SO_2 emissions compared to the baseline 2000-2004 at an Alaska Class I area, it will be impossible for the 2028 projection even without U.S. anthropogenic emissions to achieve the glidepaths since the 2014-2018 IMPROVE MID is used as the starting point for the 2028 projections (e.g., 2028 no U.S. emissions point in Figure III.K.13.G-2). The adjusted glidepaths are almost flat for TUXE1 and SIME1 so would not signify any efforts and success in reducing local emissions.

- Both NCII and 2064 endpoint for SO_4 are largely lower than the 25-percentile sulfate extinction at SIME1 (Figure III.K.13.G-3). Whether natural SO_4 is properly accounted for in the 2064 endpoint is difficult to determine without doing air quality modeling with these emissions.

Figure III.K.13.G-3. Whisker plot of sulfate extinction at SIME1. The bottom of each bar is the lower quartile. The red and green line displays the 2064 endpoint and natural conditions II (NCII), respectively.



- Given the issues described above, an alternative MID was developed by screening out IMPROVE days with high observed $(NH_4)_2SO_4$ to account for volcano emission impacts in a similar way to how fire and dust contributions are screened out using carbon and crustal measurements as proxies. New URP glidepaths were developed using the alternative MID with sulfur screening (see Appendix III.K.13.I).

4. ALASKA AREA OF INFLUENCE (AOI) AND WEIGHTED EMISSIONS POTENTIAL (WEP) ANALYSIS

Back-trajectory receptor models are useful tools for identifying source locations that have the potential to contribute to visibility impairment and have been used to facilitate regional haze planning. This section describes an AOI and WEP analysis that uses a back-trajectory model together with air quality measurement data and emission inventories to identify the geographic areas and emission sources with a high probability of contributing to anthropogenically impaired visibility at Class I areas within Alaska. The analysis focuses on the IMPROVE MID from 2014 to 2018 at the IMPROVE sites representing Class I areas in the state. The IMPROVE sites in this analysis are DENA1, TRCR1, SIME1, and TUXE1 that represent three Alaska Class I areas as shown in Table III.K.13.G-4. The TUXE1 site stopped operating in 2014 so the MID from 2012 to 2014 were used instead of the 2014-2018 period as used for the other Alaska IMPROVE sites. The Kenai Peninsula Borough (KPBO1) site was added to replace TUXE1 with 2016 being its first full year, but KPBO1 could not be included in the WEP/AOI analysis as no MID metric data is available for the site. Instead, an AOI and WEP analysis was performed for the 20% highest measured visibility extinction days for $(NH_4)_2SO_4$, NH_4NO_3, and CM at TUXE1 and KPBO1 for the 3 most recent years of available data (2012 to 2014 and 2016 to 2018, respectively).[6]

Table III.K.13.G-4. Alaska Class I Areas and IMPROVE monitoring sites included in the Area of Influence and Weighted Emissions Potential analysis.

Class I Area	IMPROVE Site	Analysis Period
Denali National Park and Preserve	Denali Headquarters Site (DENA1)	2014 - 2018
	Trapper Creek Site (TRCR1)	2014 - 2018
Simeonof Wilderness Area	Simeonof (SIME1)	2014 - 2018
Tuxedni National Wildlife Refuge	Tuxedni (TUXE1)	2012 - 2014
	Kenai Peninsula Borough (KPBO1)	2016 – 2018*

* The KPBO1 IMPROVE site first full year of operation was 2016 so was not included in the analysis of MID as no MID impairment metric data is available for the site as the 95th percentile carbon and crustal thresholds were based on analyzing IMPROVE data from 2000-2014.

A PSC analysis was also performed to characterize the relative potential contributions of natural (e.g., volcano) and anthropogenic (e.g., on-road mobile sources) emission sources groups to the $(NH_4)_2SO_4$ extinction on the MID. The input data, methods, and resulting data products for the WEP/AOI and PSC analyses are described separately in the following sections. Although the procedures used to conduct the Alaska WEP/AOI analysis of anthropogenic emissions and PSC analysis of natural and anthropogenic SO_x emissions are similar, they are very different analysis and need to be viewed separately. Details and more products from the Alaska WEP/AOI and PSC analysis are available on the WRAP TSS website.[7]

A. Area of Influence Analysis Metrics

There are three metrics used to characterize areas and emission sources that have the potential to contribute to visibility degradation at Class I areas.

i. Residence Time Analysis

The residence time (RT) is the cumulative time that trajectories reside in a specific geographical area (the EPA's 9-km domain aggregated to 27-km resolution in this study) and are normalized to display percentage of total trajectory time:

$$\tau_{ij} = \frac{1}{NT}\sum_{k=1}^{N} \tau_{ijk}$$

[6] The 20% highest ammonium sulfate, ammonium nitrate, and CM days at TUXE1 and KPBO1 were identified using the IMPROVE Daily Budgets dataset [http://vista.cira.colostate.edu/DataWarehouse/IMPROVE/Data/SummaryData/RHR_2018/Updated/SIA_daily_budgets_4_20_2.csv]

[7] http://views.cira.colostate.edu/tssv2/WEP-AOI-AK/

where τ_{ij} is the residence time of the k^{th} trajectory at the grid cell (i, j), N is the total number of trajectories, and T is the duration of each trajectory. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model[8,9] was used to calculate 72-hour (3-day) back trajectories arriving at the IMPROVE site location on each of the MID at four times per day (6:00, 12:00, 18:00, 24:00 local standard time) and at four heights above the ground (100 meter (m), 200 m, 500 m and 1,000 m). The 2012 to 2018 meteorological data used in the HYSPLIT model is the NAM hybrid sigma-pressure gridded (NAMS) for Alaska at 12 km resolution.

ii. Extinction Weighted Residence Time

The extinction weighted residence time (EWRT) defines geographical areas with a high probability of influencing visibility (i.e. the area of influence) at each of the IMPROVE sites that has impairment due to $(NH_4)_2SO_4$, NH_4NO_3, OMC and EC:

$$EWRT_{ij} = \sum_{k=1}^{N} b_{ext_k} \tau_{ijk}$$

where b_{ext} is the extinction coefficient attributed to the pollutant (i.e., $(NH_4)2SO_4$, NH_4NO_3, or CM) measured upon arrival of the k^{th} trajectory at the IMPROVE site.

iii. Weighted Emissions Potentials

The WEP determines the potential impacts from sources by combing the EWRT values with anthropogenic emissions (Q) from sources. To incorporate the dilution effects of dispersion, deposition, and chemical transformation along the path of the trajectories, emissions were inversely weighted by the distance (d) between the centers of the grid cell emitting the emissions and the grid cell containing the IMPROVE site. Each grid cell has a horizontal resolution of 27 km x 27 km.

$$\frac{Q_{ij}}{d_{ij}} EWRT_{ij}$$

[8] Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F., (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., 96, 2059-2077, http://dx.doi.org/10.1175/BAMS-D-14-00110.1

[9] Rolph, G., Stein, A., and Stunder, B., (2017). Real-time Environmental Applications and Display sYstem: READY. Environmental Modelling & Software, 95, 210-228, https://doi.org/10.1016/j.envsoft.2017.06.025

B. Emission Input Data

The WEP analysis was performed using both gridded emissions from the EPA 2016 Alaska CMAQ modeling platform and 2014 and 2017 facility-level NEI data. The EPA 2016 gridded emissions of NO_x, SO_x, primary organic aerosol (POA), and EC were used for the analysis of $(NH_4)_2SO_4$, NH_4NO_3, OMC, and EC, respectively, and were aggregated into the following source sectors for the WEP analysis:

- TOTAL_ANTHRO – All anthropogenic emissions
- PT_EGU – Electric generating unit emissions
- PT_NON-EGU – Point source emissions from industrial activities
- OG_AREA_POINT – Oil and Gas area and point sources (Upstream and Midstream)
- NON-POINT – Low-level area source emissions including non-point, agricultural, residential wood combustion, and fugitive dust emissions
- ON-ROAD – On-road mobile source emissions
- NON-ROAD – Off highway mobile source emissions including non-road, airport, commercial marine (C1, C2, and C3), and rail sources

C. AOI and WEP Results

For each Class I area, images of the RT, EWRT, and WEP were generated for the 100 m and 1000 m heights and for a combined analysis in which data from all trajectory heights are aggregated (All). The interpretation of these results can be made qualitatively and quantitatively. The RH Rule has no specific guidance on threshold values for residence time. As an aid to analysis, contour boundaries were added to identify regions with scaled residence time values greater than 0.05%, 0.1%, 0.2%, 0.5%, and 1%. Figures III.K.13.G-4 through III.K.13.G-19 present examples of plot products generated for each Class I area. All plots in this analysis can be found on the Alaska WEP-PSC webpage[10] on the WRAP TSS website.

i. Denali – DENA1

The RT pattern for the MID in 2014-2018 at DENA1 shows a relatively dense, almost bull's-eye pattern with nearby locations having the maximum RT, which diminishes with distance (Figure III.K.13.G-4). The pattern is stretched, however, from the southwest to the northeast, suggesting that sources in Anchorage, Mat-Su, and Fairbanks are principal contributors. The similarity of the unweighted RT (Figure III.K.13.G-4) and the SO_4 EWRT (Figure III.K.13.G-5) plots imply that the MID are largely driven by high SO_4 concentrations, although NO_3 also contributes (Figure III.K.13.G-5). The potential impact from NO_x emission sources can be determined using the WEP plots in Figure III.K.13.G-6 which also shows contour boundaries (in green) to help define the NO_x AOI as those areas with EWRT greater than 0.1% or 0.5%. Non-EGU point NO_x emissions near the DENA1 site are shown to have WEP values exceeding 5%. On-road and non-road mobile sources contribute more than 0.1% of WEP values. The SO_2 WEP plots in Figure

[10] https://views.cira.colostate.edu/tssv2/WEP-AOI-AK/

III.K.13.G-7 indicate that EGU and Non-EGU point SO_2 sources have WEP values exceeding 3%.

Figure III.K.13.G-4. Residence Time (RT) analysis for DENA1 monitoring site and back trajectories that arrive at the site on the Most Impaired Days for each year 2014-2018 at 100 m (left), 1000 m (middle) and all (right) heights above ground.

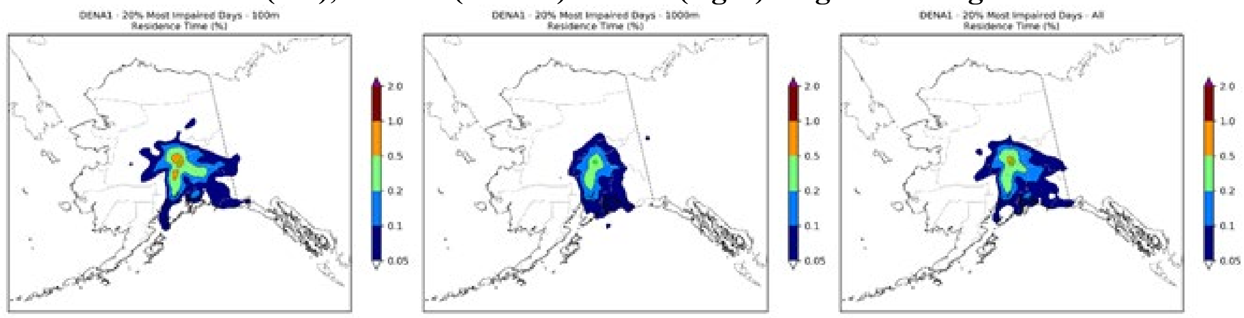


Figure III.K.13.G-5. Extinction Weighted Residence Time (EWRT) analysis for ammonium nitrate (left) and ammonium sulfate (right) at the DENA1 monitor for the Most Impaired Days during 2014-2018 aggregated across all trajectory heights.

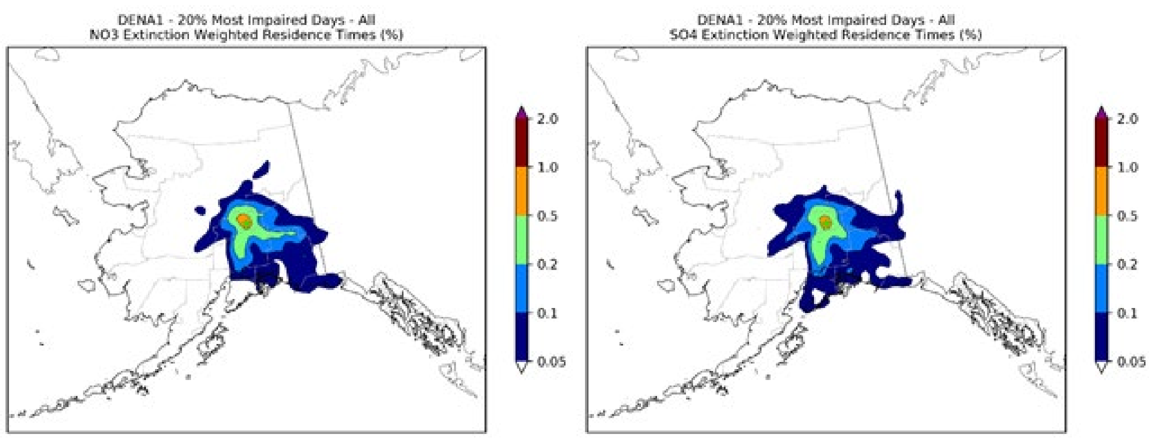


Figure III.K.13.G-6. Weighted Emissions Potential (WEP) analysis for ammonium nitrate extinction at the DENA1 monitor on the Most Impaired Days during each year of 2014-2018 for NO_x emissions from four Source Sectors: (1) total anthropogenic (top left), (2) Oil and Gas (top right), (3) On-road mobile (middle left), (4) Non-road mobile (middle right), (5) EGU point (bottom left) and (6) Non-EGU point sources (bottom right). Results are aggregated across all trajectories' heights.

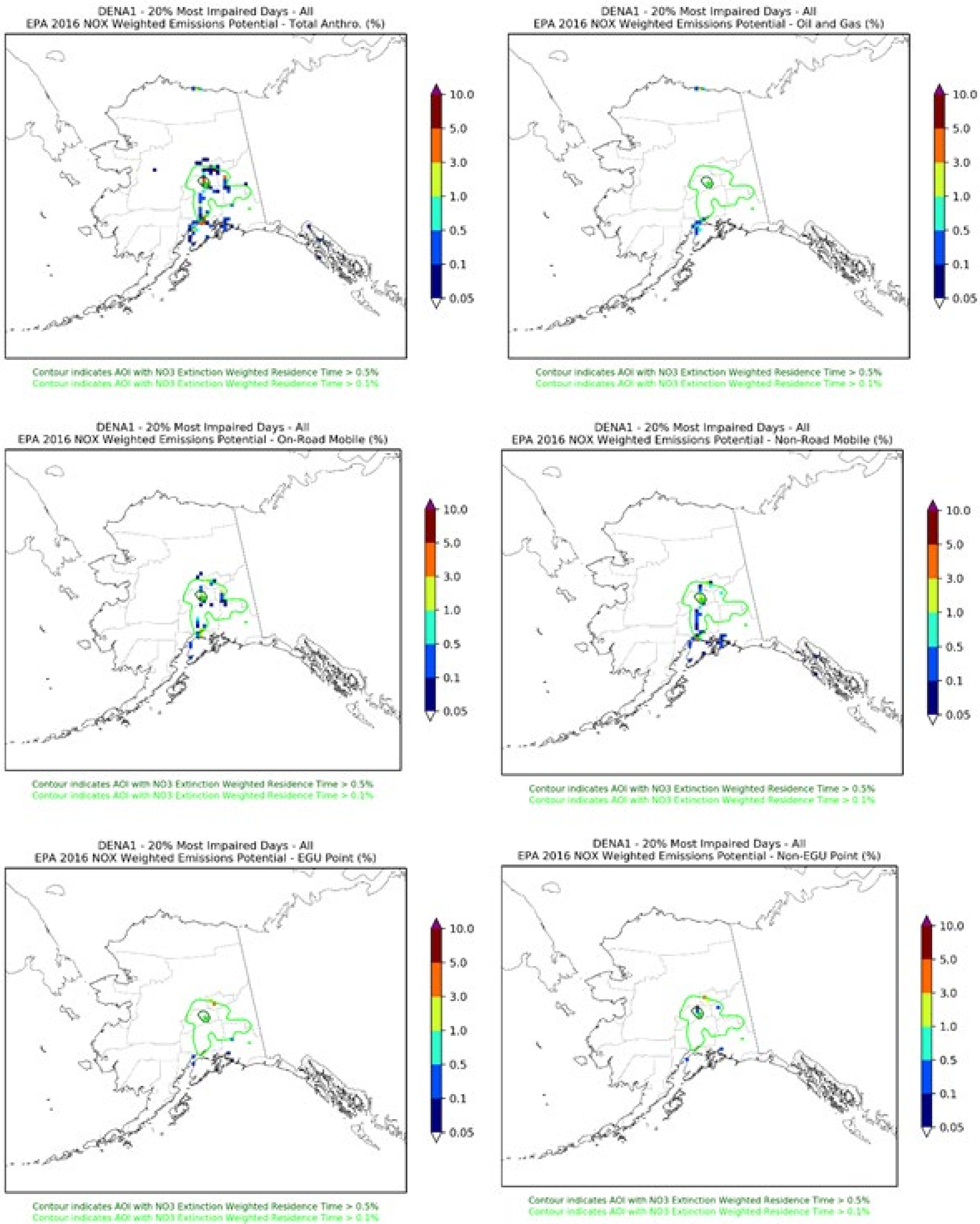
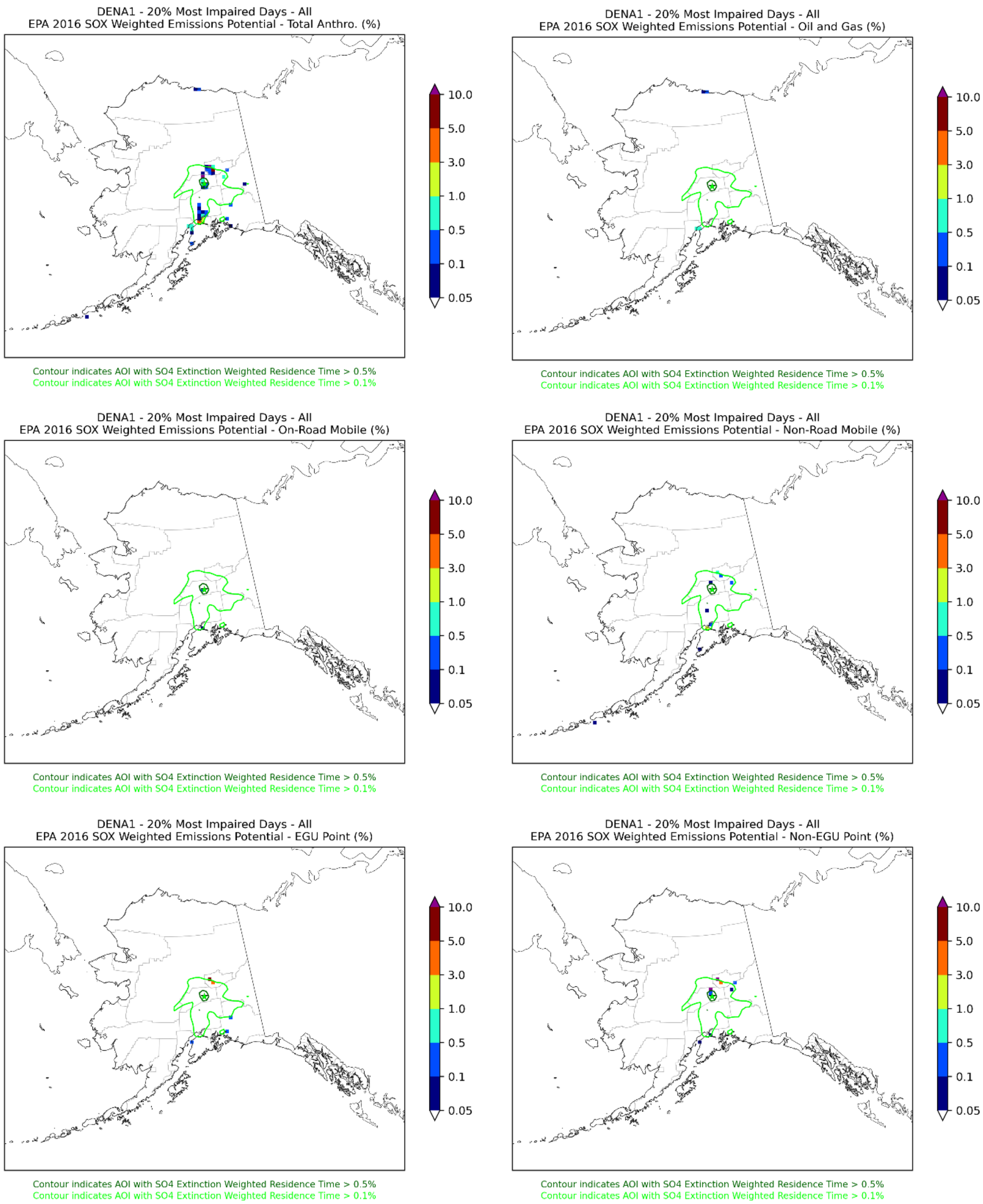


Figure III.K.13.G-7. Weighted Emissions Potential (WEP) analysis for ammonium sulfate extinction at the DENA1 monitor on the Most Impaired Days during each year of 2014-2018 for SO_x emissions from five Source Sectors.



ii. Trapper Creek – TRCR1

A similar, but a less symmetrical, pattern of RT and EWRT is seen in Figures III.K.13.G-8 and III.K.13.G-9 for the MID at Trapper Creek IMPROVE site. The WEP plots show a complex mixture of source contributions. On-road and non-road mobile sources contribute more than 5% of NO_x WEP values while oil & gas and EGU point sources are shown to have WEP values exceeding 3% (Figure III.K.13.G-10). The SO_2 WEP plots (Figure III.K.13.G-11) show non-road mobile and oil & gas SO_2 sources to have WEP values exceeding 5%.

Figure III.K.13.G-8. Residence Time (RT) analysis for TRCR1 IMPROVE monitoring site and back trajectories that arrive at the site on the Most Impaired Days for each year 2014-2018 at 100 m (left), 1000 m (middle) and All (right) heights above ground.

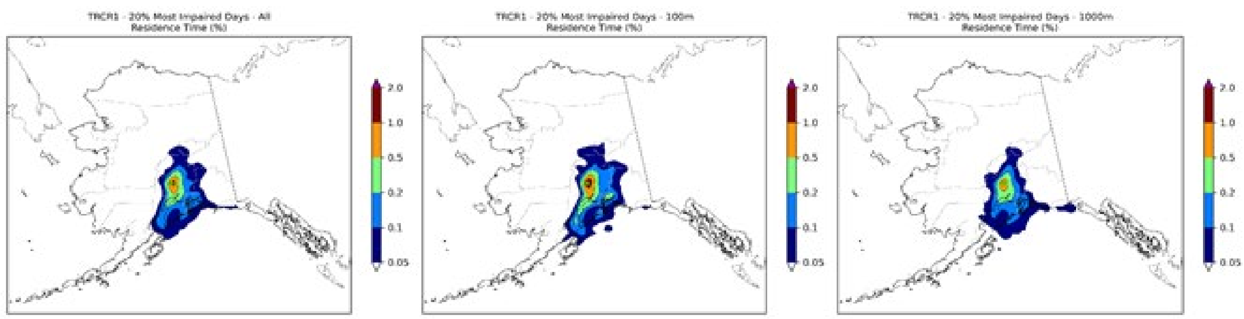


Figure III.K.13.G-9. Extinction Weighted Residence Time (EWRT) analysis for ammonium nitrate (left) and ammonium sulfate (right) at the TRCR1 monitor for the Most Impaired Days during 2014-2018 aggregated across all trajectory heights.

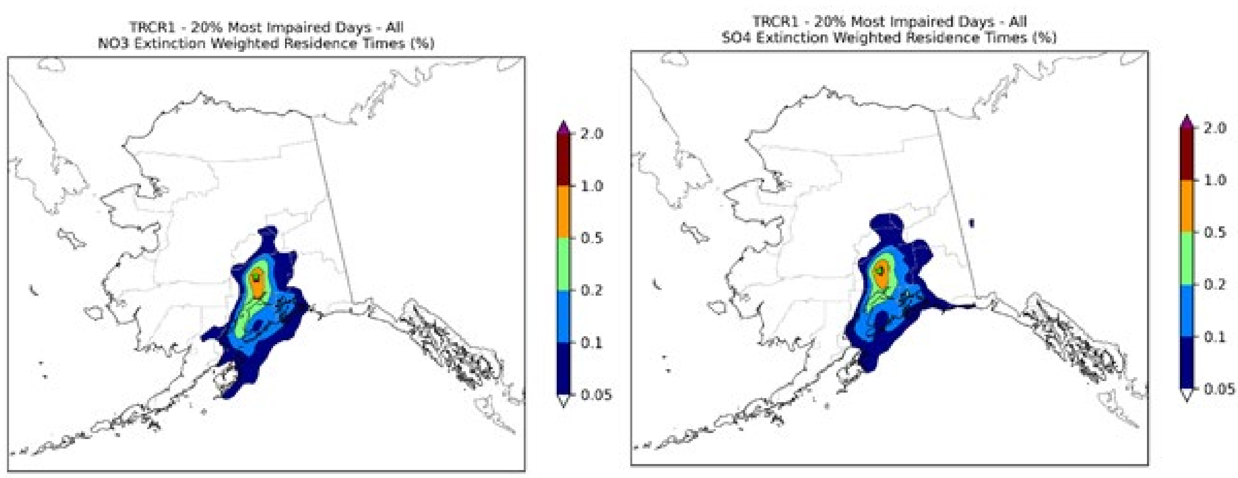


Figure III.K.13.G-10. Weighted Emissions Potential (WEP) analysis for ammonium nitrate extinction at the TRCR1 monitor on the Most Impaired Days during each year of 2014-2018 for NO_x emissions from four Source Sectors.

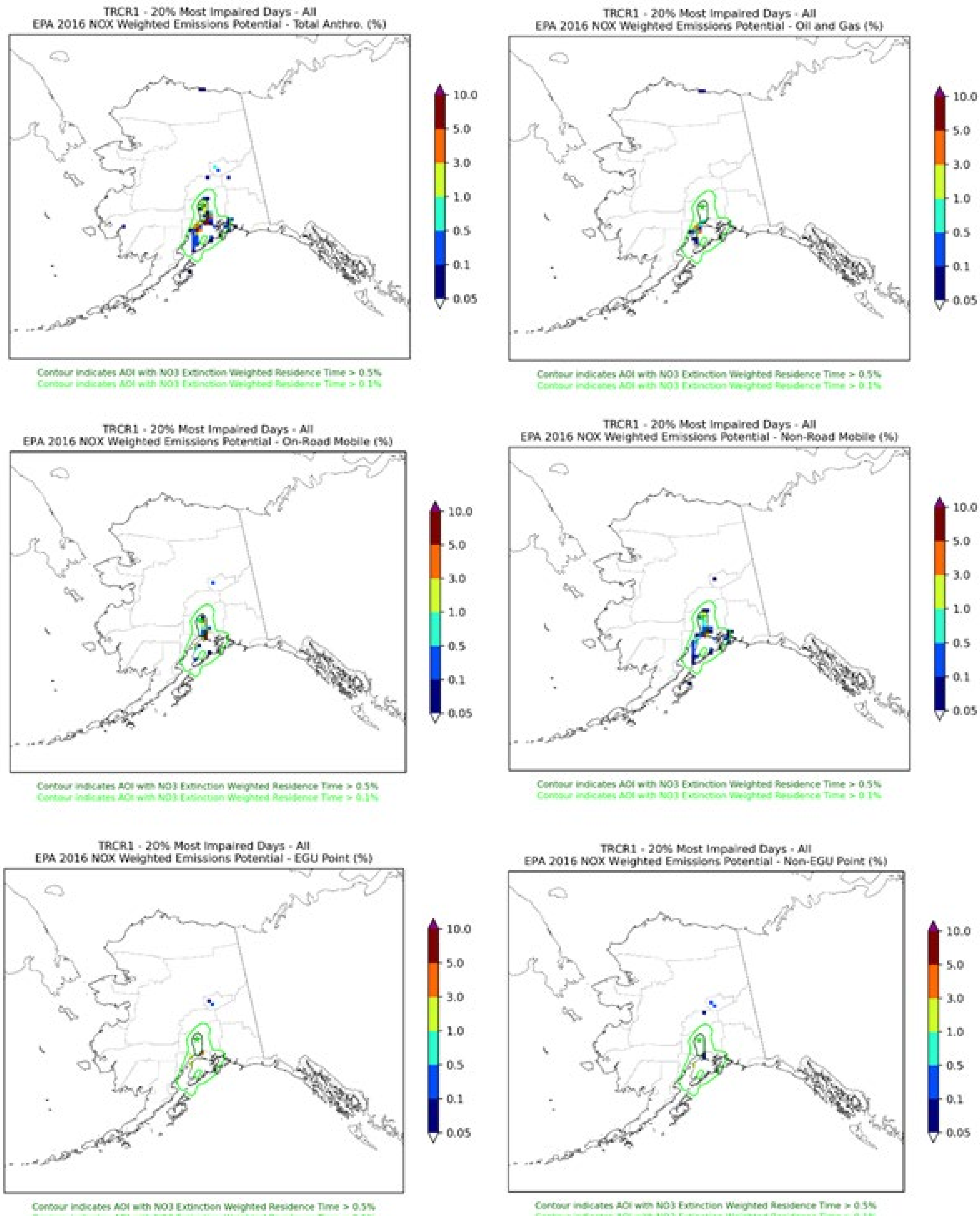
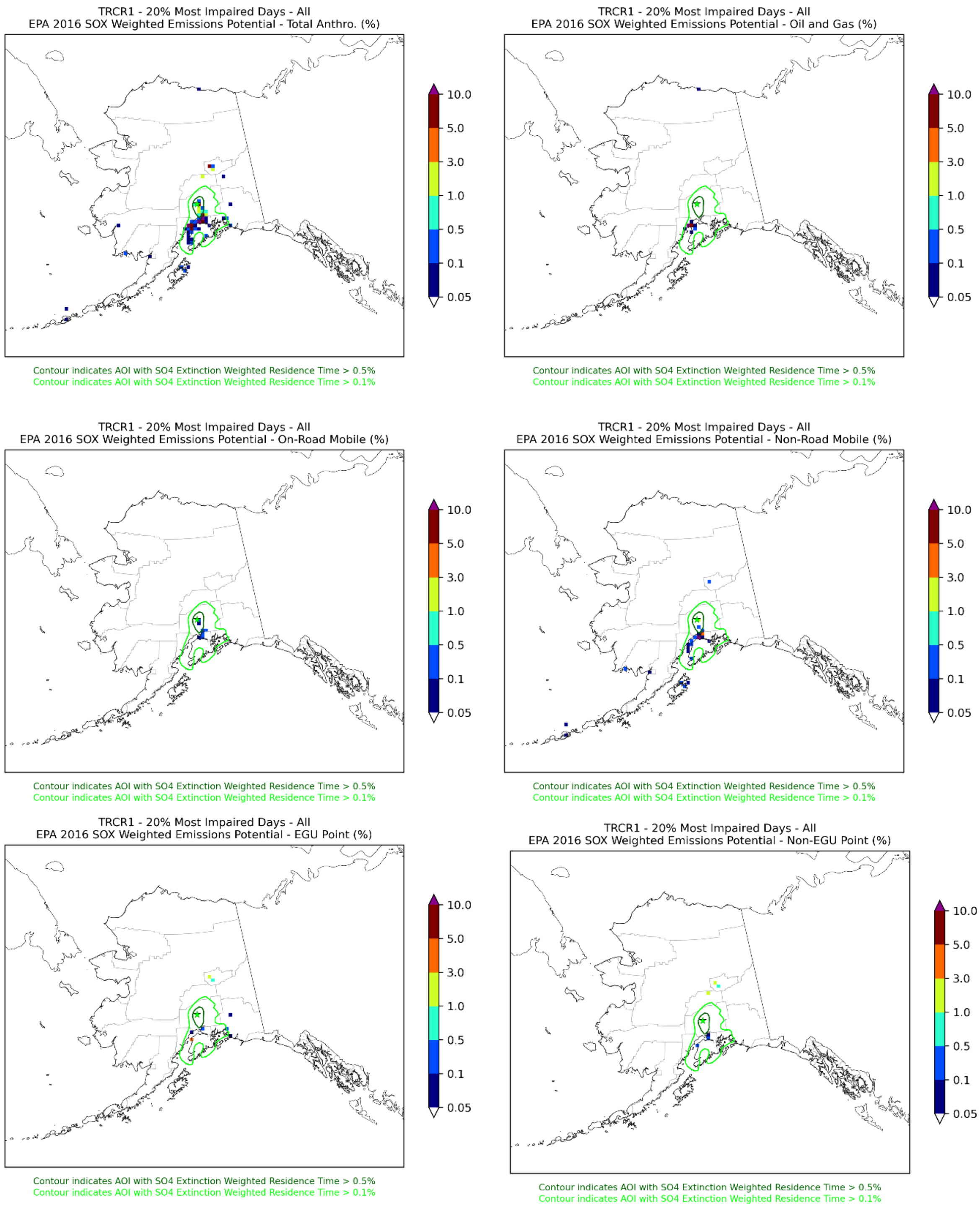


Figure III.K.13.G-11. Weighted Emissions Potential (WEP) analysis for ammonium sulfate extinction at the TRCR1 monitor on the Most Impaired Days during each year of 2014-2018 for SO_x emissions from five Source Sectors.



iii. Simeonof – SIME1

The area of maximum impact on the MID at SIME1 stretches toward the southwest following the Aleutian Island chain, which is primarily open water (Figures III.K.13.G-12 and III.K.13.G-13). The RT of locations in the central part of the state is shown to be much less. However, since the density of anthropogenic emissions within the Aleutian Islands is significantly lower than from the areas within the mainland, it will be important to account for the effect of RT, distance, and emissions density when determining which sources have the potential to have the highest impact at Simeonof (and each of the other sites). Figure III.K.13.G-14 and Figure III.K.13.G-15 show that shipping (non-road) is the dominant anthropogenic source of NO_x and SO_2 impacting the site.

Figure III.K.13.G-12. Residence Time (RT) analysis for SIME1 monitoring site and back trajectories that arrive at the site on the Most Impaired Days for each year 2014-2018 at 100 m (left), 1000 m (middle) and All (right) heights above ground.

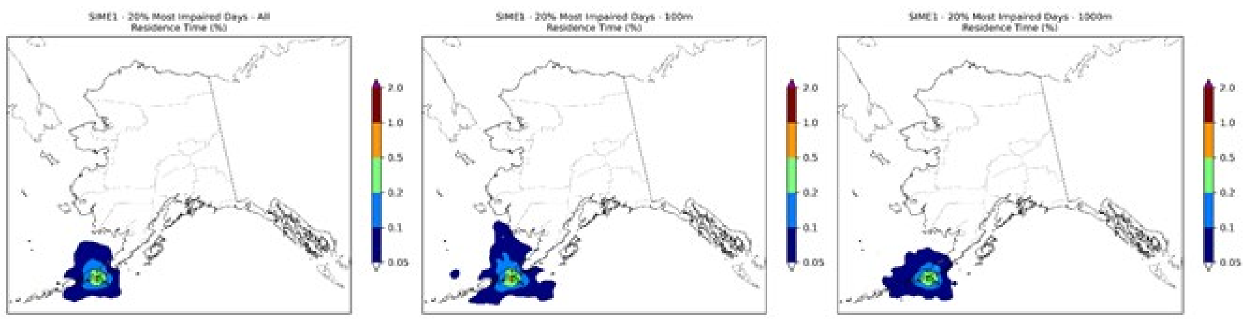


Figure III.K.13.G-13. Extinction Weighted Residence Time (EWRT) analysis for ammonium nitrate (left) and ammonium sulfate (right) at the SIME1 monitor for the Most Impaired Days during 2014-2018 aggregated across all trajectory heights.

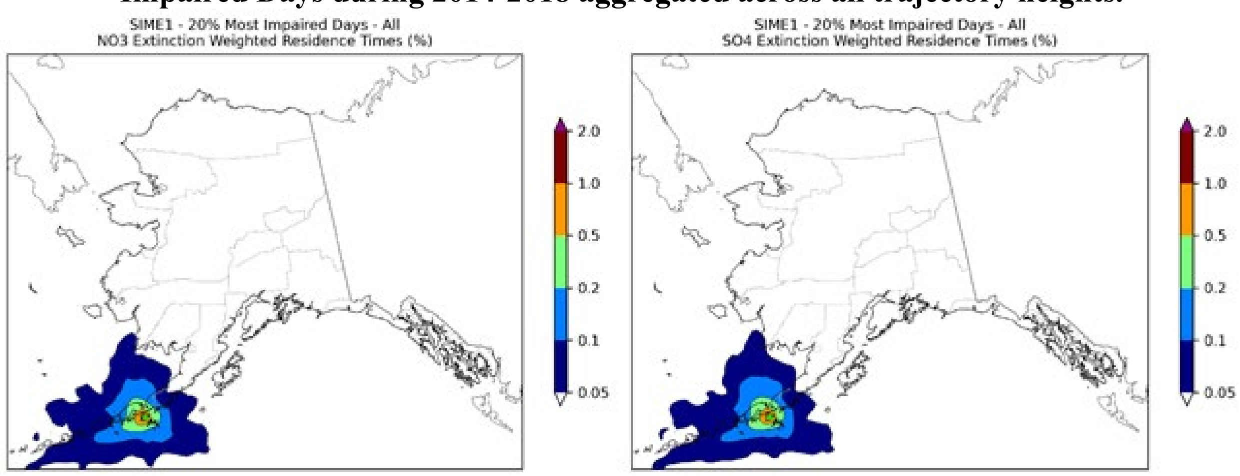


Figure III.K.13.G-14. Weighted Emissions Potential (WEP) analysis for ammonium nitrate extinction at the SIME1 monitor on the Most Impaired Days during each year of 2014-2018 for NOx emissions from four Source Sectors.

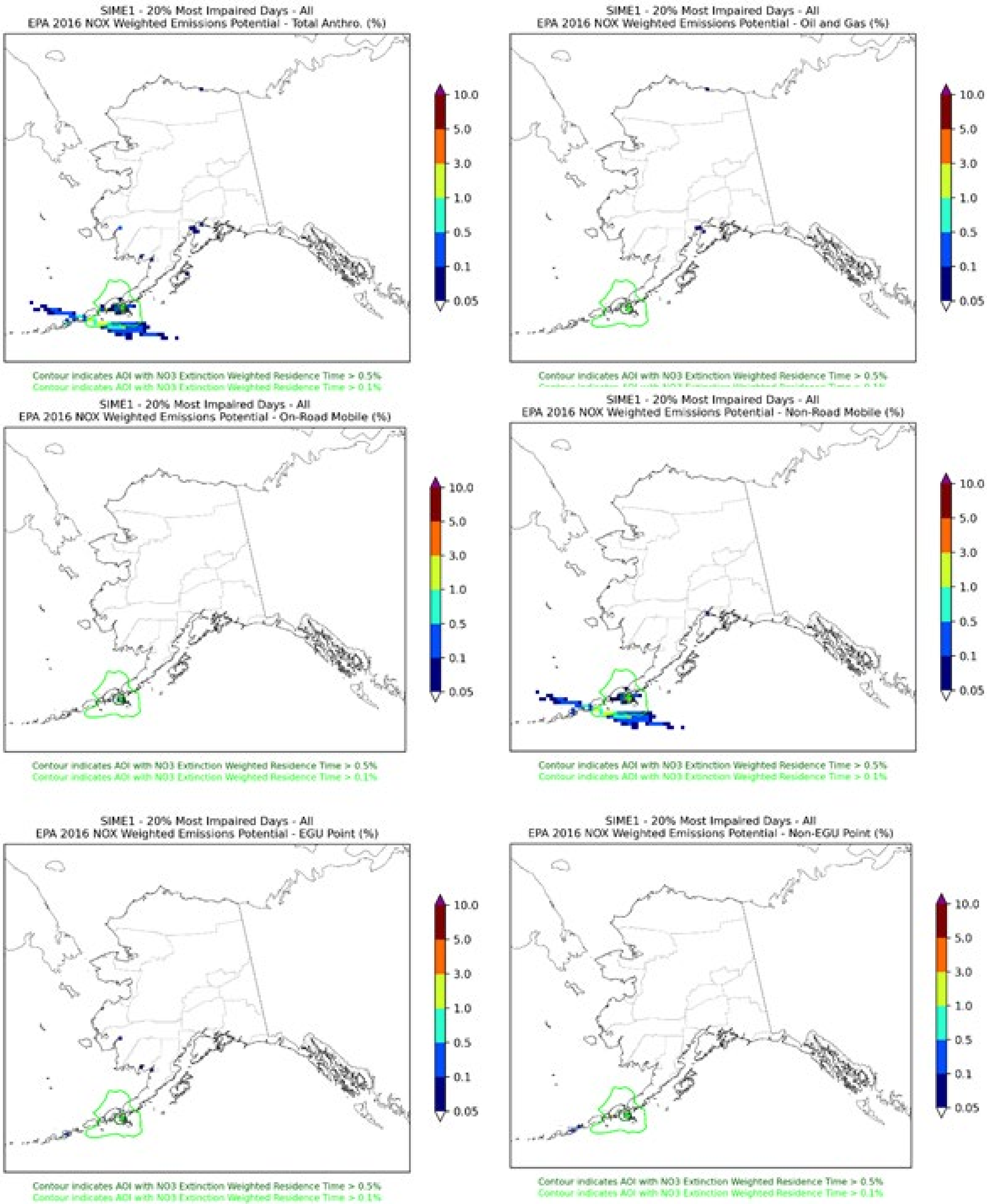
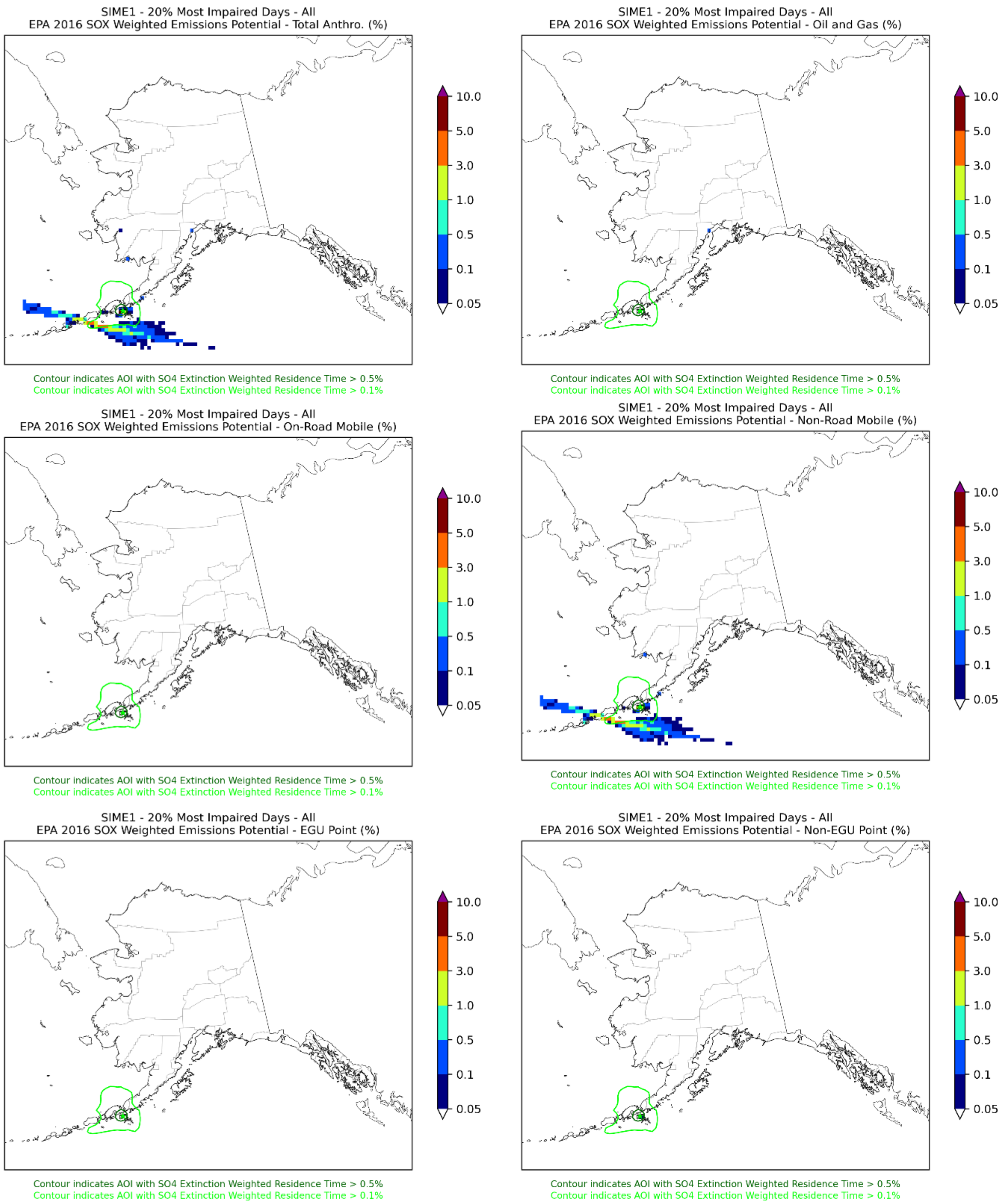


Figure III.K.13.G-15. Weighted Emissions Potential (WEP) analysis for ammonium sulfate extinction at the SIME1 monitor on the Most Impaired Days during each year of 2014-2018 for SO_x emissions from five Source Sectors.



iv. Tuxedni – TUXE1

Figures III.K.13.G-16 and III.K.13.G-17 show that the pattern on the MID for Tuxedni is less symmetrical for the areas with the greatest RT, and areas to the east have greater influence than those to the west. Sources located in the Kenai, Anchorage, and Mat-Su are likely to have a significant impact on this site. Oil and gas sources near Anchorage are shown to be the largest source of NO_x and SO_2 emissions contributing more than 3-5% of WEP values (Figure III.K.13.G-18 and Figure III.K.13.G-19).

Figure III.K.13.G-16. Residence Time (RT) analysis for TUXE1 monitoring site and back trajectories that arrive at the site on the Most Impaired Days for each year 2014-2018 at 100 m (left), 1000 m (middle) and All (right) heights above ground.

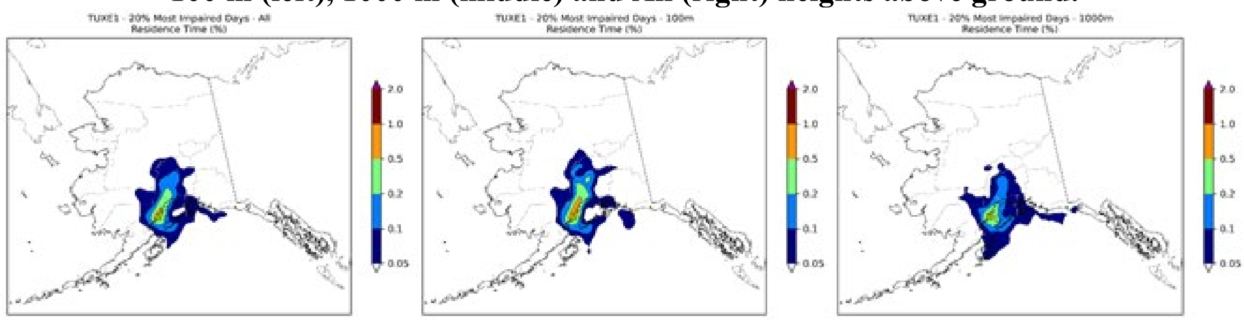


Figure III.K.13.G-17. Extinction Weighted Residence Time (EWRT) analysis for ammonium nitrate (left) and ammonium sulfate (right) at the TUXE1 monitor for the Most Impaired Days during 2014-2018 aggregated across all trajectory heights.

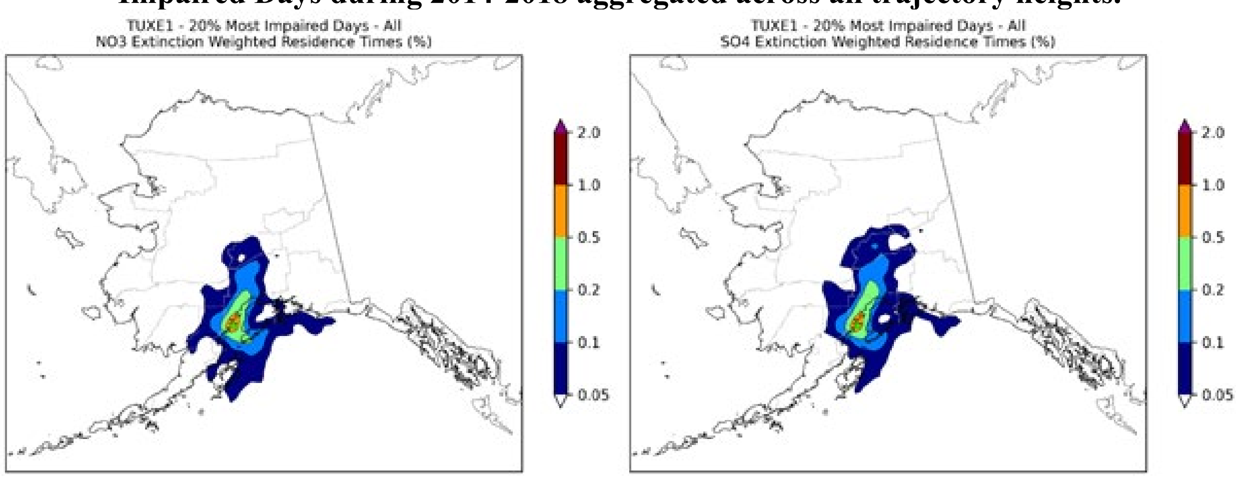


Figure III.K.13.G-18. Weighted Emissions Potential (WEP) analysis for ammonium nitrate extinction at the TUXE1 monitor on the Most Impaired Days during each year of 2014-2018 for NO_x emissions from four Source Sectors.

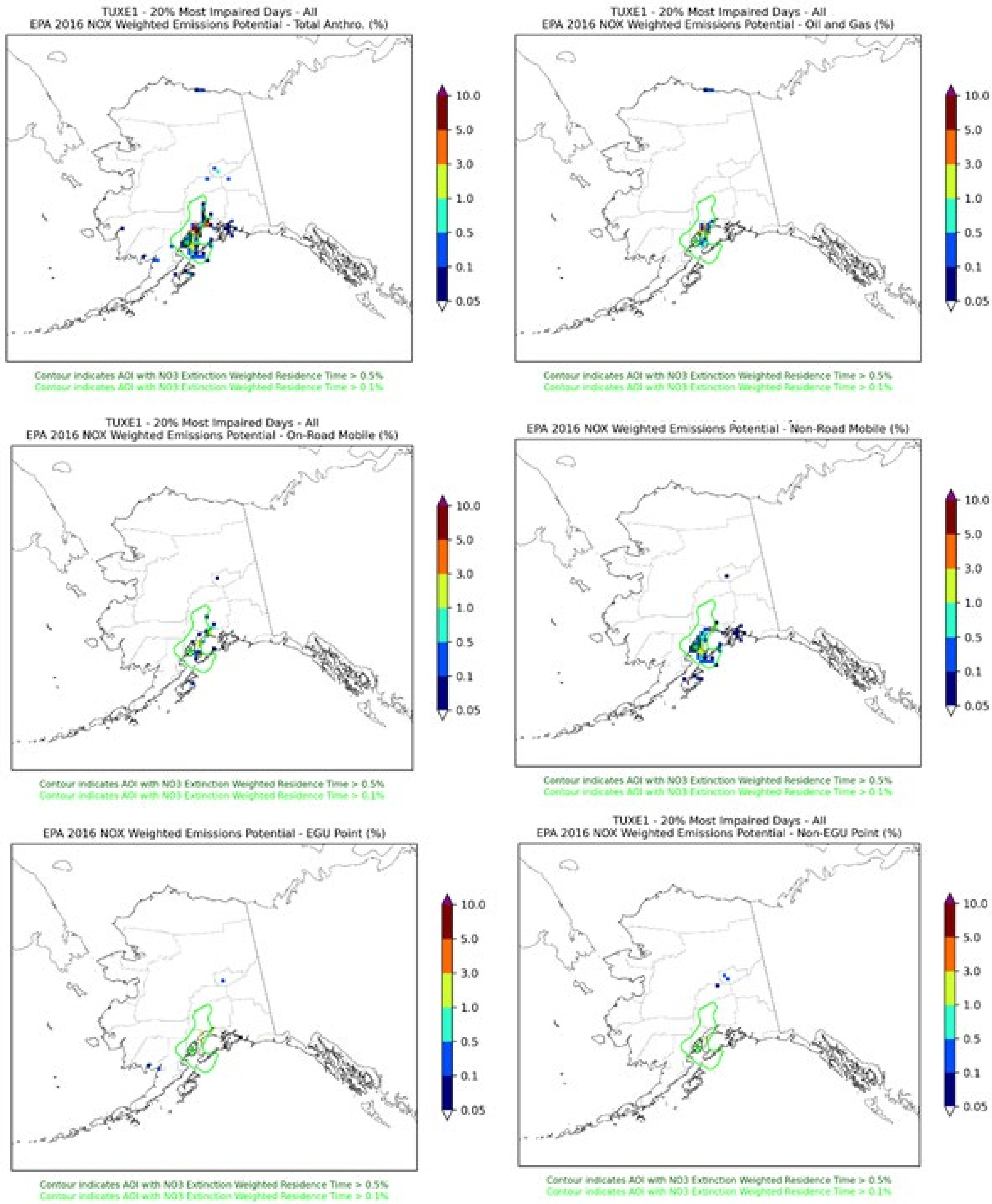
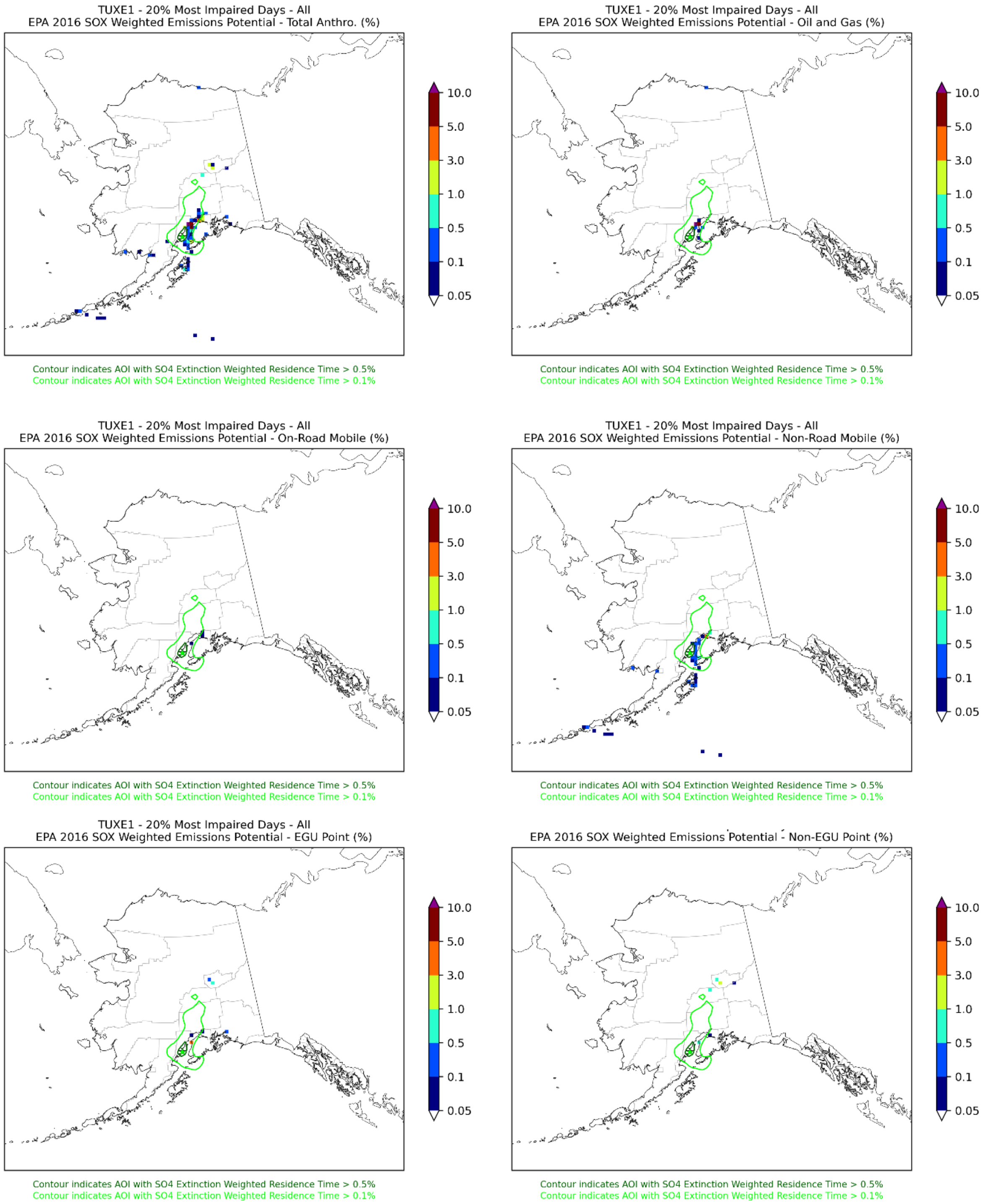


Figure III.K.13.G-19. Weighted Emissions Potential (WEP) analysis for ammonium sulfate extinction at the TUXE1 monitor on the Most Impaired Days during each year of 2014-2018 for SO_x emissions from five Source Sectors.



D. Ranking of Potential Contributions by Facility

SO_2 and NO_x are the main anthropogenic pollutants that affect visibility at Class I areas in Alaska. On an individual basis, point sources are the largest contributors to anthropogenic SO_2 and NO_x emissions; therefore, the state of Alaska elected to focus on point sources in this planning period. The facility-level WEP and Q/d analysis is used to select the sources to be included in four-factor analysis. The top 10 facilities at each Class I area based on the WEP analysis are present in Table III.K.13.G-5 through Table III.K.13.G-12. Both 2014 and 2017 emissions were considered; only the 2017 results are presented below.

Table III.K.13.G-5. Top 10 facilities whose 2017 NO_x emissions have the potential to contribute to visibility impairment due to ammonium nitrate at DENA1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
229000002	Golden Valley Electric Association; Healy Power Plant	Denali Borough (068)	14,041	231	3289	16.4	54079
209000011	Golden Valley Electric Association; North Pole Power Plant	Fairbanks North Star Borough (090)	136,548	843	327	6.2	2017
209000081	Doyon Utilities, LLC; Fort Wainwright (Privatized Emission Units)	Fairbanks North Star Borough (090)	137,560	603	334	4.4	1461
209000002	Aurora Energy LLC; Chena Power Plant	Fairbanks North Star Borough (090)	137,883	592	334	4.3	1432
209000007	University of Alaska; Fairbanks Campus Power Plant	Fairbanks North Star Borough (090)	136,810	316	334	2.3	771
209000001	US Air Force (Eielson); Eielson Air Force Base	Fairbanks North Star Borough (090)	139,142	307	327	2.2	720
212200046	Hilcorp Alaska, LLC; Swanson River Field	Kenai Peninsula Borough (122)	346,110	2121	92	6.1	563
218500022	BP Exploration (Alaska) Inc.; Central Gas Facility (CGF)	North Slope Borough (185)	731,770	5833	43	8.0	346
218500075	BP Exploration (Alaska) Inc.;	North Slope	731,744	8274	29	11.3	327

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
	Central Compressor Plant (CCP)	Borough (185)					
202000001	Anchorage Municipal Light & Power; George Sullivan Plant Two	Anchorage Borough (020)	279,166	277	232	1.0	231

Table III.K.13.G-6. Top 10 facilities whose 2017 SO_x emissions have the potential to contribute to visibility impairment due to ammonium sulfate at DENA1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
229000002	Golden Valley Electric Association; Healy Power Plant	Denali Borough (068)	14041	296	30665	21.1	647333
209000002	Aurora Energy LLC; Chena Power Plant	Fairbanks North Star Borough (090)	137883	628	3316	4.6	15094
209000081	Doyon Utilities, LLC; Fort Wainwright (Privatized Emission Units)	Fairbanks North Star Borough (090)	137560	460	3316	3.3	11090
209000001	US Air Force (Eielson); Eielson Air Force Base	Fairbanks North Star Borough (090)	139142	263	3739	1.9	7062
209000011	Golden Valley Electric Association; North Pole Power Plant	Fairbanks North Star Borough (090)	136548	247	3739	1.8	6770
209000007	University of Alaska; Fairbanks Campus Power Plant	Fairbanks North Star Borough (090)	136810	164	3316	1.2	3971
209000003	Golden Valley Electric Association; Zehnder Facility	Fairbanks North Star Borough (090)	138781	30	3316	0.2	706
226100031	Copper Valley Electric Association; Glennallen Diesel Plant	Valdez-Cordova Census Area (261)	248383	40	4055	0.2	653

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
202000002	Doyon Utilities, LLC; DU-JBER-Electric, Gas, Drinking Water and Sanitary Services	Anchorage Borough (020)	276122	52	3475	0.2	650
229000070	Mystery Creek Resources, Inc.; Nixon Fork Mine, McGrath	Yukon-Koyukuk Census Area (290)	290670	55	957	0.2	180

Table III.K.13.G-7. Top 10 facilities whose 2017 NO_x emissions have the potential to contribute to visibility impairment due to ammonium nitrate at TRCR1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
212200046	Hilcorp Alaska, LLC; Swanson River Field	Kenai Peninsula Borough (122)	178,330	2121	981	11.9	11671
212200031	Chugach Electric Association; Beluga River Power Plant	Kenai Peninsula Borough (122)	130,956	370	2059	2.8	5813
212200104	Alaska Electric and Energy Cooperative; Nikiski Combined Cycle Plant	Kenai Peninsula Borough (122)	190,436	467	1762	2.5	4323
202000001	Anchorage Municipal Light & Power; George Sullivan Plant Two	Anchorage Borough (020)	124,470	277	1714	2.2	3815
212200066	Tesoro Alaska Company, LLC; Kenai Refinery	Kenai Peninsula Borough (122)	189,301	374	1762	2.0	3479
217000005	Titan Alaska LNG, LLC (formerly Fairbanks Natural Gas, LLC); LNG Plant #1	Matanuska-Susitna Borough (170)	99,209	104	3256	1.0	3411

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
212200061	Hilcorp Alaska, LLC; Platform A	Kenai Peninsula Borough (122)	179,771	231	2200	1.3	2822
212200009	Hilcorp Alaska, LLC; Tyonek Platform	Kenai Peninsula Borough (122)	141,390	145	2256	1.0	2316
212200041	Hilcorp Alaska, LLC; Bruce Platform	Kenai Peninsula Borough (122)	173,455	148	2200	0.9	1875
212200062	Hilcorp Alaska, LLC; Platform C, Middle Ground Shoal, Cook Inlet	Kenai Peninsula Borough (122)	183,227	148	2200	0.8	1778

Table III.K.13.G-8. Top 10 facilities whose 2017 SO_x emissions have the potential to contribute to visibility impairment due to ammonium sulfate at TRCR1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
202000002	Doyon Utilities, LLC; DU-JBER-Electric, Gas, Drinking Water and Sanitary Services	Anchorage Borough (020)	121591	52	17713	0.4	7523
229000002	Golden Valley Electric Association; Healy Power Plant	Denali Borough (068)	183170	296	3887	1.6	6290
209000002	Aurora Energy LLC; Chena Power Plant	Fairbanks North Star Borough (090)	308004	628	2029	2.0	4135
209000081	Doyon Utilities, LLC; Fort Wainwright (Privatized Emission Units)	Fairbanks North Star Borough (090)	307600	460	2029	1.5	3035
212200007	Hilcorp Alaska, LLC ; Steelhead Platform	Kenai Peninsula Borough (122)	178162	45	8827	0.3	2217
209000001	US Air Force (Eielson);	Fairbanks North Star	306412	263	2294	0.9	1968

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
	Eielson Air Force Base	Borough (090)					
209000011	Golden Valley Electric Association; North Pole Power Plant	Fairbanks North Star Borough (090)	305506	247	2294	0.8	1856
212200043	Hilcorp Alaska, LLC; Dolly Varden Platform	Kenai Peninsula Borough (122)	180962	28	8827	0.2	1359
202000095	Matanuska Electric Association, Inc; Eklutna Generation Station	Anchorage Borough (020)	107635	12	10646	0.1	1221
209000007	University of Alaska; Fairbanks Campus Power Plant	Fairbanks North Star Borough (090)	306928	164	2029	0.5	1083

Table III.K.13.G-9. Top 10 facilities whose 2017 NO_x emissions have the potential to contribute to visibility impairment due to ammonium nitrate at SIME1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
201000025	Trident Seafoods; Sand Point Facility	Aleutians East Borough (013)	1215	154	7068	127	896134
201300011	Maruha Nichiro Corporation (Peter Pan Seafoods); King Cove Facility	Aleutians East Borough (013)	119760	237	1370	2.0	2709
201600008	City of Unalaska; Dutch Harbor Power Plant (DHPP)	Aleutians West Census Area (016)	424566	639	223	1.5	336
206000003	Alaska Village Electric Cooperative; Bethel Power Plant	Bethel Census Area (050)	614387	679	193	1.1	213
201300005	Trident Seafoods; Akutan	Aleutians East	367911	160	489	0.4	213

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
	Seafood Processing Facility	Borough (013)					
201600003	UniSea, Inc.; Dutch Harbor Seafood Processing Plant	Aleutians West Census Area (016)	425899	394	223	0.9	207
207000001	Nushagak Electric Cooperative, Inc; Dillingham Power Plant	Dillingham Census Area (070)	433325	321	264	0.7	195
212200031	Chugach Electric Association; Beluga River Power Plant	Kenai Peninsula Borough (122)	856164	1862	72	2.2	157
206000004	Naknek Electric Association, Inc.; Naknek Power Plant	Bristol Bay Borough (060)	436012	364	171	0.8	143
212200046	Hilcorp Alaska, LLC; Swanson River Field	Kenai Peninsula Borough (122)	828011	1705	50	2.1	102

Table III.K.13.G-10. Top 10 facilities whose 2017 SO_x emissions have the potential to contribute to visibility impairment due to ammonium sulfate at SIME1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
201000025	Trident Seafoods; Sand Point Facility	Aleutians East Borough (013)	1215	0	82404	0.1	5424
212200069	Hilcorp Alaska, LLC; Monopod Platform	Kenai Peninsula Borough (122)	812887	170	1214	0.2	254
212200043	Hilcorp Alaska, LLC; Dolly Varden Platform	Kenai Peninsula Borough (122)	804131	141	1214	0.2	213
212200034	Alaska Electric and Energy Cooperative; Bernice Lake Combustion	Kenai Peninsula Borough (122)	804741	107	1268	0.1	168

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
	Turbine (BCT) Plant						
212200061	Hilcorp Alaska, LLC; Platform A	Kenai Peninsula Borough (122)	808097	99	1349	0.1	165
206000003	Alaska Village Electric Cooperative; Bethel Power Plant	Bethel Census Area (050)	614387	37	2579	0.1	155
212200008	Hilcorp Alaska, LLC; King Salmon Platform	Kenai Peninsula Borough (122)	809361	69	1214	0.1	103
212290002	Hilcorp Alaska, LLC; Grayling Platform	Kenai Peninsula Borough (122)	807064	27	1214	0.0	40
229000002	Golden Valley Electric Association; Healy Power Plant	Denali Borough (068)	1146828	445	78	0.4	30
218530001	Hilcorp Alaska, LLC; Endicott Production Facility (END)	North Slope Borough (185)	1778854	258	159	0.1	23

Table III.K.13.G-11. Top 10 facilities whose 2017 NO_x emissions have the potential to contribute to visibility impairment due to ammonium nitrate at TUXE1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
212200046	Hilcorp Alaska, LLC; Swanson River Field	Kenai Peninsula Borough (122)	128,612	2121	280	16	4621
212200007	Hilcorp Alaska, LLC; Steelhead Platform	Kenai Peninsula Borough (122)	109,953	297	1516	2.7	4092
212200060	Cook Inlet Pipe Line Company; Drift River Terminal / Christy Lee Platform	Kenai Peninsula Borough (122)	71,417	73	2275	1.0	2339

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT NO_3	Q/d	WEP NO_3
	Aggregated Source						
212200031	Chugach Electric Association; Beluga River Power Plant	Kenai Peninsula Borough (122)	159,537	370	958	2.3	2220
212290002	Hilcorp Alaska, LLC; Grayling Platform	Kenai Peninsula Borough (122)	110,428	144	1516	1.3	1982
212200069	Hilcorp Alaska, LLC; Monopod Platform	Kenai Peninsula Borough (122)	116,804	152	1516	1.3	1972
212200104	Alaska Electric and Energy Cooperative; Nikiski Combined Cycle Plant	Kenai Peninsula Borough (122)	103,788	467	419	4.5	1885
212200043	Hilcorp Alaska, LLC; Dolly Varden Platform	Kenai Peninsula Borough (122)	107,140	133	1516	1.2	1875
212200008	Hilcorp Alaska, LLC; King Salmon Platform	Kenai Peninsula Borough (122)	113,045	129	1516	1.1	1735
212200066	Tesoro Alaska Company, LLC; Kenai Refinery	Kenai Peninsula Borough (122)	104,889	374	419	3.6	1492

Table III.K.13.G-12. Top 10 facilities whose 2017 SO_x emissions have the potential to contribute to visibility impairment due to ammonium sulfate at TUXE1 on the Most Impaired Days for each year in 2014-2018.

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
212200007	Hilcorp Alaska, LLC; Steelhead Platform	Kenai Peninsula Borough (122)	109953	45	22641	0.4	9212

Facility ID	Facility Name	County	d (m)	Q (tpy)	EWRT SO_4	Q/d	WEP SO_4
212200043	Hilcorp Alaska, LLC; Dolly Varden Platform	Kenai Peninsula Borough (122)	107140	28	22641	0.3	5887
212290002	Hilcorp Alaska, LLC; Grayling Platform	Kenai Peninsula Borough (122)	110428	16	22641	0.1	3221
212200008	Hilcorp Alaska, LLC; King Salmon Platform	Kenai Peninsula Borough (122)	113045	15	22641	0.1	2981
212200060	Cook Inlet Pipe Line Company; Drift River Terminal / Christy Lee Platform Aggregated Source	Kenai Peninsula Borough (122)	71417	5	31684	0.1	2075
212200114	BlueCrest Alaska Operating LLC; Cosmopolitan Project	Kenai Peninsula Borough (122)	49844	15	6884	0.3	2055
212200069	Hilcorp Alaska, LLC; Monopod Platform	Kenai Peninsula Borough (122)	116804	9	22641	0.1	1796
229000002	Golden Valley Electric Association; Healy Power Plant	Denali Borough (068)	469484	296	2584	0.6	1631
209000001	US Air Force (Eielson); Eielson Air Force Base	Fairbanks North Star Borough (090)	593139	263	3083	0.4	1366
209000011	Golden Valley Electric Association; North Pole Power Plant	Fairbanks North Star Borough (090)	592412	247	3083	0.4	1287

E. Potential Source Contributions (PSC) Analysis

A PSC analysis was performed to assess the relative potential contributions of anthropogenic and natural emission source groups within the EPA 27-km Alaska modeling domain to $(NH_4)_2SO_4$ extinction on the MID. This is a larger domain and different than the WEP/AOI anthropogenic emissions analysis discussed above that used the extent of the EPA 9-km domain at 27-km resolution. PSC was calculated by integrating (i.e., summing) the WEP across the modeling domain for each source group. In reviewing the results of the gridded WEP/AOI analysis DEC noticed that the EPA modeling platform did not include emissions from the Healy Power Plant.

The PSC analysis includes SO_2 emissions for Healy in 2016 (427.2 tons per year) in the EGU sector.

Unlike the WEP analysis, which only considered anthropogenic emission sources, the PSC analysis also included volcanic emissions of SO_2 and oceanic emissions of DMS. Volcano eruption emissions were not considered in this analysis so just volcano degassing emissions were used. An analysis of 2014 GEOS-Chem emissions for a region essentially equivalent to EPA's CMAQ Alaska 27-km domain found that ~60% of the reactive sulfur emissions were from volcano degassing and DMS (see Section III.K.13.E Emission Inventory and Appendix III.K.13.I). Including these sources in the PSC allows for characterization of potential natural contributions to visibility impairment on the MID and provides context for the potential anthropogenic source contributions.

Table III.K.13.G-13 summarizes the total SO_2 or SO_2 equivalent (i.e., DMS) emissions within the 27-km domain for the various source sectors. The DMS emissions were scaled by a 0.6 factor to account for the fact that it is estimated that only approximately 60% of the DMS emissions are ultimately converted to SO_2. The anthropogenic emissions are from EPA's 2016 CMAQ modeling. DMS was calculated using 2016 meteorology and volcanic emissions were based on satellite inventories for 2014-2018. The volcanic and DMS natural emissions contribute 83% of the SO_2 emissions within the 27-km CMAQ domain. This is higher percentage of natural SO_2 emissions than the 67% contribution estimated analyzing 2014 GEOS-Chem inventories for a similar size domain as described in Section III.K.13.E. These differences are due in part to the CMAQ 2016 modeling not including emissions from Russia as a large portion of Russia is included in the 27-km domain, although uncertainties in calculating volcanic and DMS emissions may also have contributed to the differences.

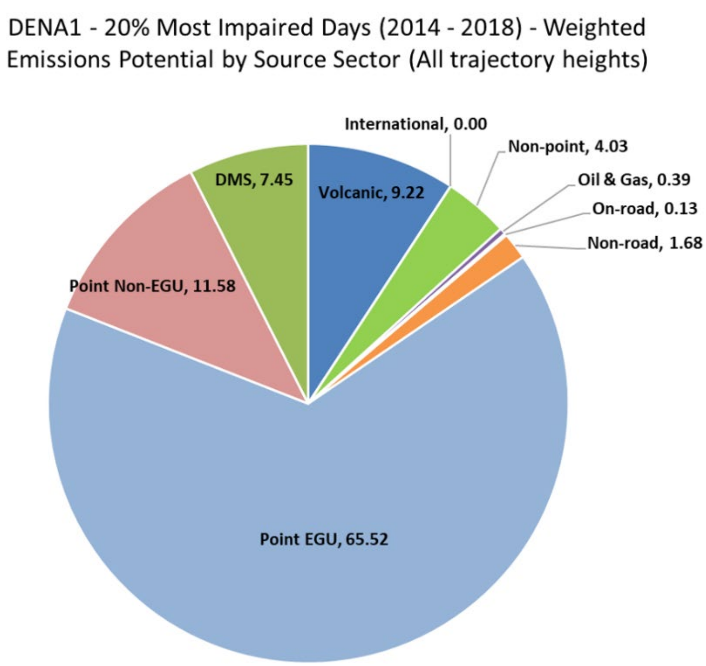
Table III.K.13.G-13. Total 2016 SO_2 emissions (tons per year, TPY) within the 27-km domain by source sector.

Source Sector	SO_2 Emissions	
	(TPY)	(%)
US EGU Point	1,747	0.14%
US Non-EGU Point	1,435	0.12%
US On-Road Mobile	40	0.0%
US Oil & Gas	1,739	0.14%
US+CMV Non-Road Mobile	187,801	15.2%
US Non-Point	1,598	0.13%
International	15,707	1.3%
DMS (2014-2018 average)	454,064	36.7%
Biogenic	0.0	0.0%
Volcanic (2014-2018 average)	573,775	46.3%
Total	1,540,617	100%

The pie charts of PSC for each SO_2 source group as a percentage of the total potential contributions to $(NH_4)_2SO_4$ extinction at the DENA1, TRCR1, TUXE1 and SIME1 on the MID are shown in Figures III.K.13.G-20 through III.K.13.G-23. A significant fraction of the PSC for DENA1 and TRCR1 were from anthropogenic emission sources (approximately 83% and 27%, respectively), while the PSC for TUXE1 and SIME1 were dominated by DMS and volcanic emissions (approximately 3% and 2% from the anthropogenic emission sources, respectively). DMS constitutes a significant fraction (8-23%) of the PSC at all four IMPROVE sites. Volcanic emissions also constitute a significant fraction at all sites but were the dominant source at TUXE1 and SIME1 and half of the PSC at TRCR1. The volcanic contribution increased with proximity to the Alaska Peninsula and Aleutian Islands. Plots of the gridded RT, EWRT, and WEP for each Class I area similar to those done for the AOI/WEP analysis and are available on the WRAP TSS website[11].

While back trajectory analyses such as WEP and PSC can help identify potential sources impacting visibility at Alaska Class I areas, they do not replace and do not represent source apportionment modeling because they do not account for chemical transformation, dispersion, and deposition of pollutants and transport of pollutants from outside of the domain analyzed. Source apportionment needs to account for all sources and global sources from outside of the domain are missing in the PSC. But the PSC does provide a qualitative assessment of the possible relative contributions of SO_2 sources within the analysis domain.

Figure III.K.13.G-20. Potential Source Contribution by Source Sector for SO_x emission contributions to ammonium sulfate extinction at DENA1 on the 20% Most Impaired Days (2014-2018).



[11] https://views.cira.colostate.edu/tssv2/WEP-AOI-AK/

Figure III.K.13.G-21. Potential Source Contribution by Source Sector for SO_x emission contributions to ammonium sulfate extinction at TRCR1 on the 20% Most Impaired Days (2014-2018).

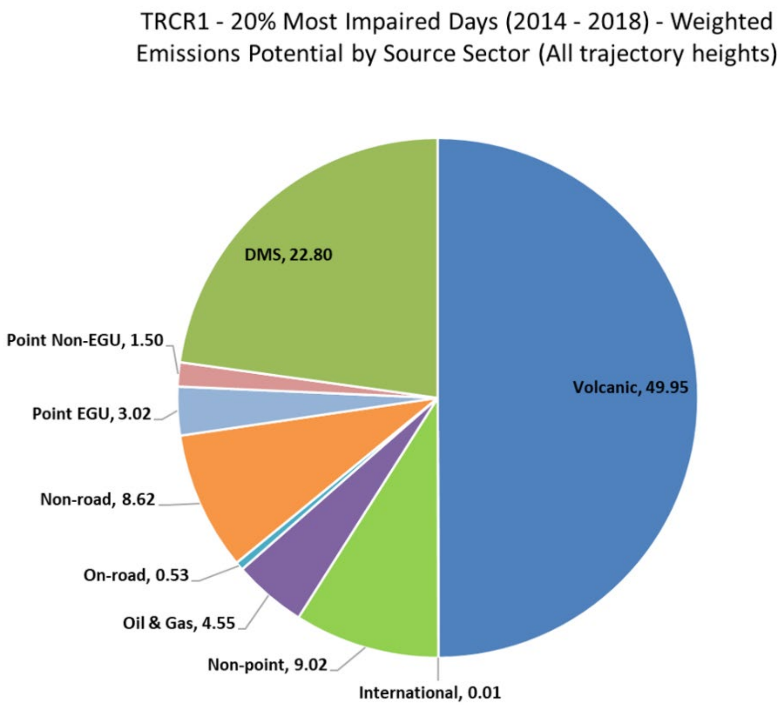


Figure III.K.13.G-22. Potential Source Contribution by Source Sector for SO_x emission contributions to ammonium sulfate extinction at TUXE1 on the 20% Most Impaired Days (2012-2014).

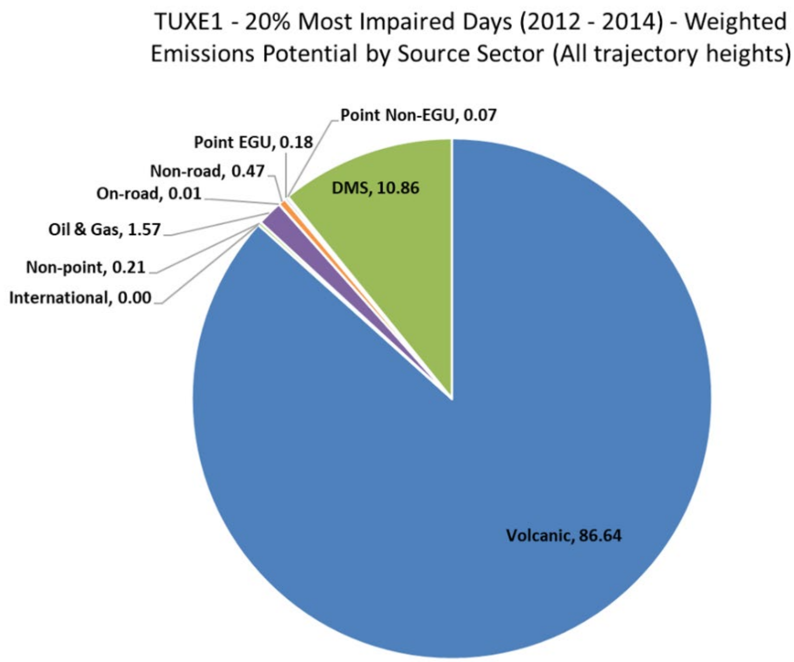


Figure III.K.13.G-23. Sulfate Potential Source Contribution by Source Sector for SO_x emission contributions to ammonium sulfate extinction at SIME1 on the 20% Most Impaired Days (2014-2018).