State of Utah

SPENCER J. COX
Governor

DEIDRE HENDERSON
Lieutenant Governor

Department of
Environmental Quality

Kimberly D. Shelley
Executive Director

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Deputy Director

DAQP-048-21

May 28, 2021

Debra H. Thomas
Acting Regional Administrator
Environmental Protection Agency, Region 8
1595 Wynkoop Street
Denver, Colorado 80202-1129

RE: Retrospective 179B(b) Demonstration for Utah's Northern Wasatch Front Ozone Nonattainment Area

Dear Ms. Thomas:

The Utah Division of Air Quality (UDAQ) is formally submitting an International Transport Demonstration (179B(b)) to the Environmental Protection Agency (EPA) for the Northern Wasatch Front Ozone Nonattainment Area (NWF NAA). UDAQ appreciates EPA's engagement during the development of this demonstration and for the valuable feedback and review received throughout this process.

Section 179B(b) of the Clean Air Act (CAA) allows a nonattainment area to retrospectively avoid re-classification to a higher nonattainment status if a state can demonstrate that the area would have met the National Ambient Air Quality Standard (NAAQS), but for the influence of pollution emanating from an international source. On August 3, 2018, the EPA classified the NWF NAA as a marginal nonattainment area with an attainment date of August 3, 2021 (83 FR 25776). The design value from 2018-2020 is used to determine if the area attained the standard by the attainment date. Validated data in EPA's Air Quality System (AQS) show a 3-year average of the 4th high 8-hour ozone value at Bountiful of 77ppb, which is 7ppb over the NAAQS.

EPA published 179B guidance (EPA-457/P-20-001F, December, 2020) that details what a successful 179B demonstration should include.

Accompanying this letter are three technical analyses that fall short of providing a refined full photochemical demonstration (including source apportionment) that would be preferred, but indicate what would likely be found in such a demonstration. These include a Synoptic Pattern Analysis and a Backward Dispersion HYSPLIT analysis performed by UDAQ's Technical Analysis team, as well as a photochemical analysis performed by Ramboll at the direction of the

Utah Petroleum Association and Utah Mining Association. All three analyses focused on the summer months (June – August) of 2017 with an emphasis on a period of time leading up to and through observed NAAQS 8-hour ozone exceedances.

The UDAQ-led Synoptic Pattern Analysis found that ozone exceedance days largely occur when synoptic scale high-pressure systems are present. As a result of these stable high-pressure systems the NWF experiences a lack of frontal passages, low surface winds, and high temperatures at the controlling monitoring station. These results indicate that local photochemical production of ozone resulting from nearby anthropogenic precursor emissions are the dominant driver of exceedance days in the NWF.

UDAQ performed a backward dispersion analysis using the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model based on maximum daily 8-hr average ozone observations within the NWF during July 2017, when multiple ozone exceedances were observed. The HYSPLIT backward trajectory analysis found that while the NWF is impacted in-part by source emissions from outside the U.S., it did not identify any significant difference in transport patterns between exceedance and non-exceedance days. Current guidance provided by the EPA on 179B(b) states that "the demonstration should include analyses showing that the air quality data on specific days in the past were affected by international emissions to an extent that prevented the area from attaining the standard by the attainment date."

In addition to the two UDAQ-led analyses described above, a photochemical analysis performed by Ramboll identified a relatively consistent contribution of ozone from international sources to background concentrations throughout the intermountain west. However, the model consistently underpredicted ozone concentrations at the controlling monitor site on exceedance days. This underprediction makes it difficult to attribute the total amount of contribution from internationally transported ozone at the controlling monitor.

These three analyses taken together indicate that in the NWF, exceedances of the 8-hour ozone NAAQS typically occur on hot, atmospherically stable summer days and that international transport of ozone contributes consistently to background concentrations throughout the intermountain west, but does not increase in contribution on specific exceedance days.

We believe that this 179B(b) demonstration is novel since it fails to show a significant contribution on specific exceedance days compared to non-exceedance days, but instead indicates that international transport has a relatively constant contribution to background ozone concentrations throughout the NWF NAA. The elevated background concentrations make it particularly difficult to meet the 2015 8-hour ozone NAAQS in the NWF. Beyond the distinction of specific daily contribution vs. regional background, it is UDAQ's understanding that this is the first instance of a 179B(b) demonstration for a non-border region, for which the guidance states "technical demonstrations for non-border areas may involve additional technical rigor and resources compared to a demonstration for border areas."

In addition to the three analyses outlined here and described in detail in the included demonstration, the UDAQ Technical Analysis team has provided a modeling framework for a more refined photochemical model that could be conducted to further examine international contributions of ozone to the NWF. This modeling framework addresses many of the limitations with the work conducted to date, but conceptually is highly similar in nature to the efforts undertaken so far. To perform the full photochemical modeling exercise will require a significant amount of time and resources from UDAQ. It is the belief of the UDAQ staff that this additional modeling effort will not result in any significant new findings, nor will it change the current conclusions outlined above.

UDAQ staff is very concerned that continued work to refine the modeling for this 179B(b) analysis is hindering any progress on the development of the modeling necessary to successfully address the ozone problems in the Uinta Basin, as well as the development of the modeling necessary to complete a successful State Implementation Plan for the NWF NAA, should EPA deny this 179B(b) demonstration. Given that to date, all analyses indicate that Utah's NWF NAA may not meet the traditionally recognized criteria of a 179B(b) demonstration, UDAQ is asking the EPA to review the enclosed materials and quickly provide definitive feedback on the following:

1. Can the novel interpretation of 179B(b) for the NWF result in a satisfactory demonstration?
2. If yes, is the additional modeling exercise outlined in this packet required for a satisfactory 179B(b) demonstration, or are the materials contained herein sufficient?

UDAQ appreciates the consideration of the attached 179B(b) demonstration and we look forward to a written response with EPA's determination.

Sincerely,

Kimberly Shelley

Kimberly D. Shelley
Executive Director

KDS:BCB:RB:jf

May 24, 2021

Deb Thomas
Acting Regional Administrator
United States Environmental Protection Agency Region 8
1595 Wynkoop Street
Denver, CO 80202-1129

Dear Acting Administrator Thomas,

Thank you for the cooperation of your staff in progressing the Clean Air Act Section 179B demonstration for the Northern Wasatch Front Nonattainment Area on behalf of the State of Utah. We have made measurable improvements in Utah's air quality over the years through creative problem solving, innovation, and collaboration between government, industry, and community stakeholders. While we understand that the submission of the 179B demonstration package to the Environmental Protection Agency (EPA) is just one of many steps already taken—and many more to be taken—we commend your efforts to address the complex and real drivers of ozone rather than simply checking a regulatory box.

Over the last 15 years, the Wasatch Front airshed has achieved nearly a 40% reduction in volatile organic compounds (VOC) and NOx emissions—the precursor emissions that lead to both $PM_{2.5}$ and ozone pollution. Despite this effort resulting in a major reduction in $PM_{2.5}$ pollution, the 4th highest daily 8-hour average ozone levels have remained virtually unchanged. Therefore, we strongly encourage your support of a data-driven decision not to continue pursuing policy and regulatory decisions based on the very rigid and limited controls that would be required under a State Implementation Plan (SIP) under a Moderate classification, which have shown little indication of actually reducing ozone over the last decade and a half.

The challenge of international transport of emissions and the resulting elevated ozone in the Western U.S. has been well known amongst the scientific and regulatory community for some time. In 2013, then Department of Environmental Quality (DEQ) Executive Director Amanda Smith testified to congress that a mechanism to account for background ozone would be needed for Utah or we would be destined to failure. This, of course, is exactly what Congress intended in the development of flexibility under Section 179B of the Clean Air Act.

In fact, EPA has published work indicating that only 9-20% of the local ozone comes from in-state, man-made emissions. Of that maximum 20% of in-state, man-man emissions, SIP controls could only be applied to an even smaller slice of sources, further limiting the likely success of an EPA-mandated SIP to improve ozone levels.

To support the technical understanding of the impact of international emissions DAQ is performing air quality chemistry modeling that evaluates the impacts of boundary conditions of ozone and ozone precursor emissions from international sources as well as the transport of anthropogenic and natural emissions from within the United States. This modeling effort is the first time such a global evaluation of ozone formation has been performed by a state regulatory agency. Importantly, the same modelling work that is needed to support a 179B demonstration can provide the Division of Air Quality (DAQ) with invaluable information on what sources and regulatory tools should be targeted to actually improve air quality. Therefore, a successful 179B demonstration would allow DAQ to pursue tools more likely to reduce ozone, even if they don't meet the rigid SIP requirements under a compressed SIP timeframe. Simply put, there is much that could be done to improve air quality that does not "check the box" for a SIP, such as the innovative (and voluntary) production of Tier 3 fuels.

As you are aware, the trajectory Utah is currently on—absent a successful 179B demonstration—will move the state up the scale of ozone nonattainment, where the mandatory requirements of the Clean Air Act for emissions controls will likely result in lasting consequences for the state's economy with negligible impacts on ozone pollution. This, of course, is a lose-lose situation of the highest order for Utah and must be avoided.

We realize that additional modelling work is required and that an updated submission will need to be returned to the EPA. As elected leaders of Utah's executive and legislative branches, we urge you to remain committed to this pathway, and to base the 179B submittal review firmly on the plain language requirements of the Clean Air Act.

The Clean Air Act provides states flexibility in developing strategies to meet air quality standards in an effective, practical, and economical manner. We believe the 179B demonstration will show—via rigorous technical analysis—that "but for" the impact of ozone pollution from international sources, the Wasatch Front would attain the standard by the attainment date. Critically, we also support EPA approving a 179B pathway to provide the intended flexibility under the Clean Air Act to better understand and address this complex challenge and stand ready as partners to help broaden the toolbox with which DAQ addresses this problem, based on solid data, innovation, and cooperation – rather than overly rigid federal mandates.

Sincerely,

Spencer J. Cox
Governor
State of Utah

Deidre M. Henderson
Lieutenant Governor
State of Utah

J. Stuart Adams
President
Utah State Senate

Brad R. Wilson
Speaker
Utah House of Representatives

Utah Division of Air Quality

Clean Air Act 179B(b) Demonstration

Northern Wasatch Front Ozone Nonattainment Area

05/05/2021

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Overview

On October 1, 2015 the US Environmental Protection Agency (EPA) promulgated revised National Ambient Air Quality Standards (NAAQS) for ground level ozone in accordance with Section 107(d) of the Clean Air Act (CAA) and set the new primary standard at 70 parts per billion (ppb). Utah's Wasatch Front often experiences exceedances of the revised NAAQS for ozone during the summer months. As a result of the more stringent standard, the EPA has designated two areas along the Wasatch Front as Marginal Nonattainment for the 2015 Ozone NAAQS, consisting of the Northern and Southern Wasatch Front Nonattainment areas (NAA) (Figure 1). The Northern Wasatch Front (NWF) NAA includes Salt Lake and Davis Counties as well as portions of Tooele and Weber Counties. The Southern Wasatch Front NAA includes portions of Utah County, located south and adjacent to the NWF NAA.

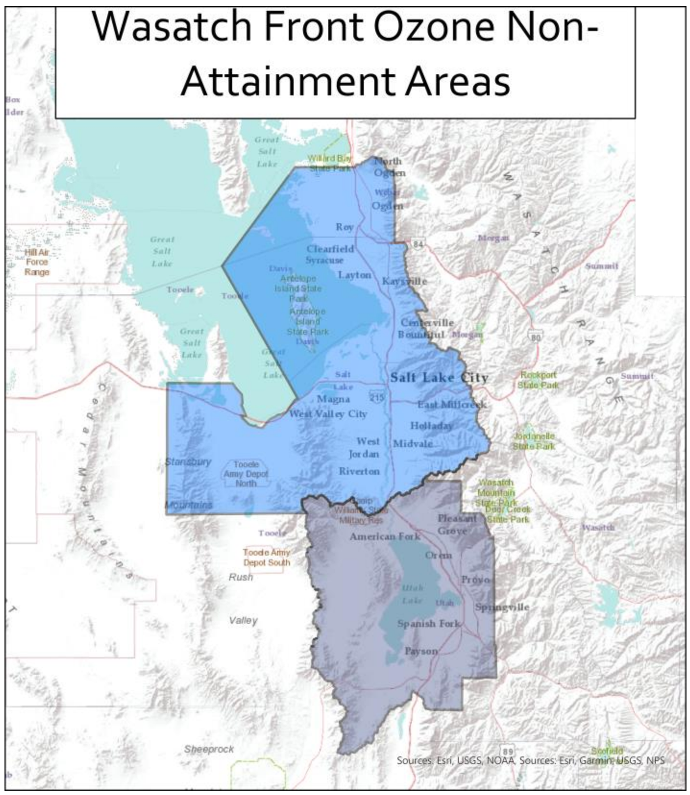

Figure 1: Wasatch Front Ozone Nonattainment Areas. Northern Wasatch Front area identified by light blue polygon. Southern Wasatch Front area identified by dark blue polygon

On August 3, 2018, the EPA classified both nonattainment areas as marginal with an attainment date of August 3, 2021 (83 FR 25776). The design values from 2018-2020 are used to determine if the areas attained the standard by the attainment date. Validated data in EPA's Air Quality System (AQS) shows a 3-year average of the 4th high 8-hour ozone value at the NWF Bountiful monitor of 77ppb, and the Southern Wasatch Front Spanish Fork and Lindon monitors of 69ppb (Figure 2, Table 1). Therefore, the NWF NAA did not attain the standard by the attainment date and the

Southern Wasatch Front did. Failure to attain the standard by the attainment date will result in the NWF being reclassified to moderate nonattainment.

Table 1: Ozone values from sites in NWF NAA from 2018 - 2020. Values calculated in accordance with 40 CFR §50 Appendix U.

Ozone Summary Table						
Site ID	Site Name	County	Annual 4th Highest			Three Year Average
			2018	2019	2020	2018-2020
49-057-1003	Harrisville	Weber	77	64	74	71
49-011-0004	Bountiful	Davis	80	73	80	77
49-035-2005	Coperview	Salt Lake	79	67	75	73
49-035-3006	Hawthorne	Salt Lake	74	73	75	74
49-035-3010	Rose Park	Salt Lake	80	71	80	77
49-035-3013	Herriman	Salt Lake	78	70	73	73
49-045-0004	Erda	Tooele	74	65	70	69
49-035-4001	Lindon	Utah	79	62	68	69
49-049-5010	Spanish Fork	Utah	73	66	70	69

Ozone along the Wasatch Front has a mix of sources, both local and non-local. These sources can also be derived from both anthropogenic and natural sources, including stratospheric transport, wildfires, biogenic emissions as well as US and international anthropogenic sources. Intercontinental transport of pollutants is especially persistent during the spring and summer seasons[1]. Persistent global circulation patterns establish a direct transport route linking the Asian east coast and the US west coast. A semi-permanent low-pressure system off the coast of China lofts pollutant-laden air to the mid and upper free troposphere. Fast winds within that region of the atmosphere then move this air and associated pollutants eastward toward the U.S. Pacific coast. This occurs within days to weeks with ozone persisting for extended periods at these altitudes due to the relative lack of chemical sinks and low temperatures in this part of the atmosphere. A semi-permanent high-pressure system over the U.S. Pacific Coast then brings the upper tropospheric air back down to the surface over the western US.
This vertical transport of air from aloft is also enhanced by complex topography which creates winds that enhance down slope mixing[2]. This leads to high-altitude locations throughout the western US experiencing greater impacts from intercontinental transport of ozone as compared to lower-elevation locations. This intercontinental transport persists throughout the summer season in Utah, leading to enhancements of local background ozone concentrations[3].

[1] Langford, A.O., Alvarez, R.J., Brioude, J., Fine, R., Gustin, M.S., Lin, M.Y., Marchbanks, R.D., Pierce, R.B., Sandberg, S.P., Senff, C.J., Weickmann, A.M., Williams, E.J., 2017. Entrainment of stratospheric air and Asian pollution by the convective boundary lauer in the southern U.S. *J. Geophysical Res. Atmos., 122*, 1312-1337, doi:10.1002/2016JD025987.
[2] EPA, 2015. “Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone, White Paper for Discussion” (December 30, 2015). https://www.epa.gov/ground-level-ozone-pollution/background-ozone-workshop-and-information.

Section 179B(b) of the CAA allows a NAA to retrospectively avoid reclassification to a higher nonattainment status if the air agency with jurisdiction over the NAA can demonstrate that the area would have met the NAAQS but for the influence of pollution emanating from an international source. Given that the NWF, along with much of the intermountain west, is impacted by the effects of increased background concentrations resulting from international transport, the UDAQ has compiled the materials outlined here in consideration of a 179B(b) demonstration allowing for relief from the upcoming reclassification to moderate status.

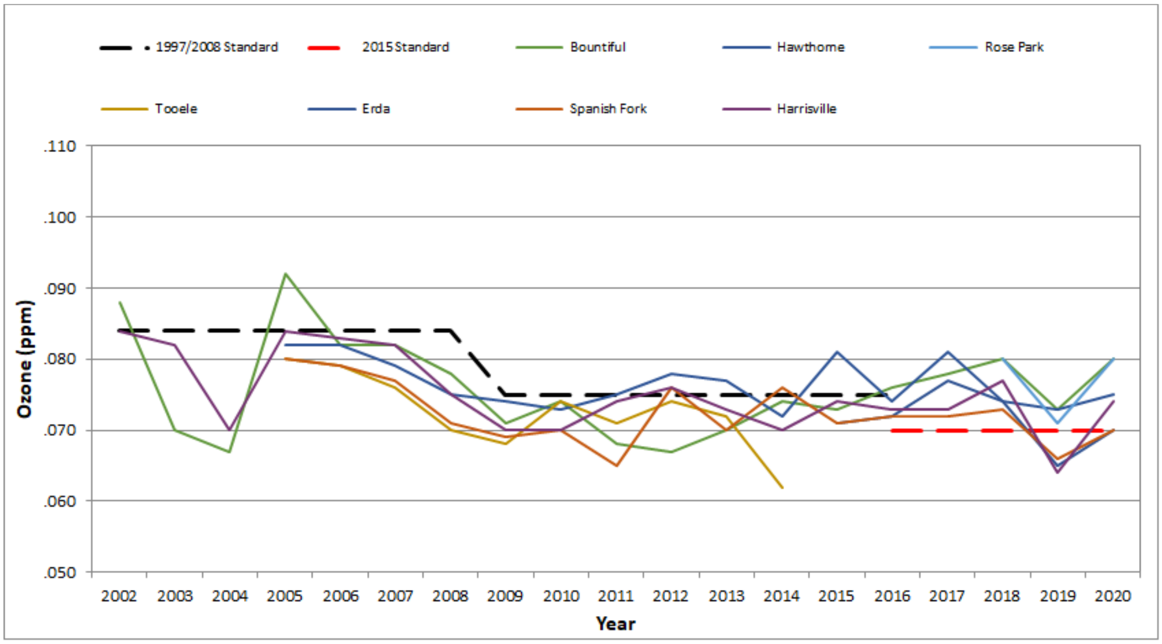

Figure 2: Ozone monitoring data from all monitors located in the NWF NAA. Dashed lines indicate NAAQS standards, with the 2015 standard identified by red dashed line. Controlling monitoring site Bountiful in orange with DV 77 ppb in 2020.

Synoptic Pattern Analysis

To identify potential days in the NWF NAA impacted by internationally transported ozone, a qualitative synoptic analysis of the meteorological conditions during the summer 2017 ozone season was performed. The analysis was completed for May 26th through August 30th 2017 (Figure 3; APENDIX A). Additional exceedances were measured in September 2017, but due to the potential impact from wildfire emissions they were excluded from this analysis.

[3] Jaffe, D.A., O.R. Cooper, A.M. Fiore, B.H. Henderson, G.S. Tonnesen, A.G. Russell, D.K. Henze, A.O. Langford, M. Lin, T. Moore, 2018. Scientific assessment of background ozone over the U.S.: Implications for air quality management. Elem. Sci. Anth., 6: 56. DOI: https://doi.org/10.1525/elementa.309.

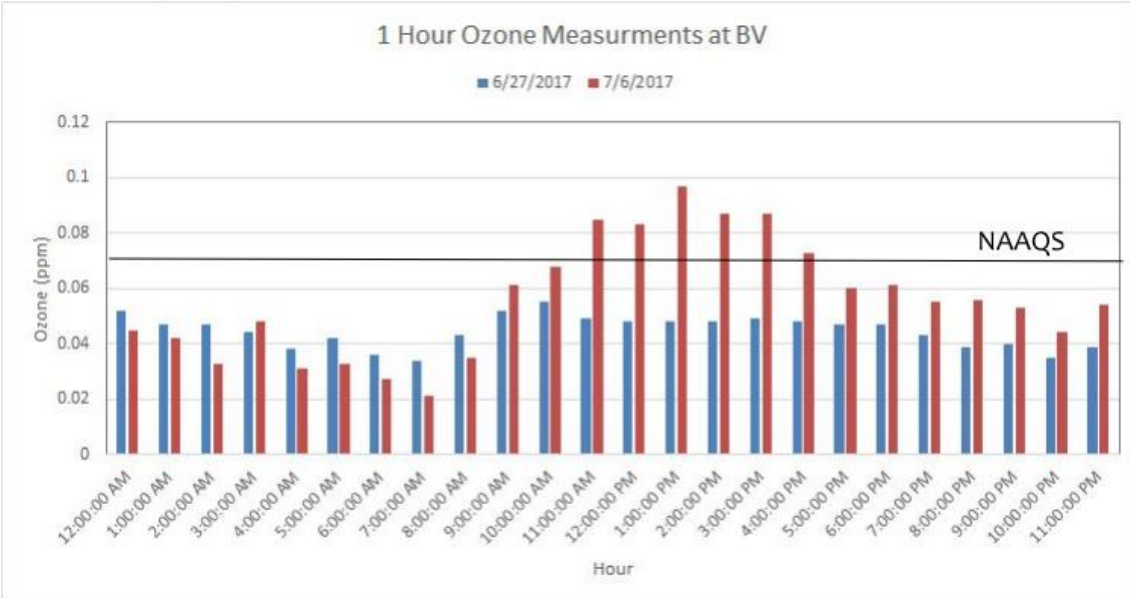

Figure 3: One-hour ozone measurements at controlling monitor showing difference between exceedance (7/6/2017) and non-exceedance day (6/27/2017).

This analysis was conducted using the available meteorological data including: ground base measurement to understand surface conditions, 500mb and other upper air charts to understand larger scale air transport, vertical temperature profiles to understand stability and vertical air movement, radar to understand storm movement, and satellite imagery to understand cloud dynamics. Additionally, archived National Weather Service forecast discussions to help add context to the measurements were used.

During the summer months several periods of elevated ozone were measured. These periods were dominated by high pressure, sunny clear skies, and little to no winds, ending when a disturbance would move through the areas bringing increased winds, and potential moisture (Figure 4).

Strong cold fronts have the potential to increase subsidence of upper air toward the ground increasing the impact of international emissions. During the period of analysis ozone emissions decreased during the passage of cold fronts. This is likely due to the increased ground winds, cloud formation, and mixing of the area reducing the concentration of ozone at the ground. This does negate the potential of a very strong cold front has had or will have the potential to increase ozone measurements at ground monitoring stations.

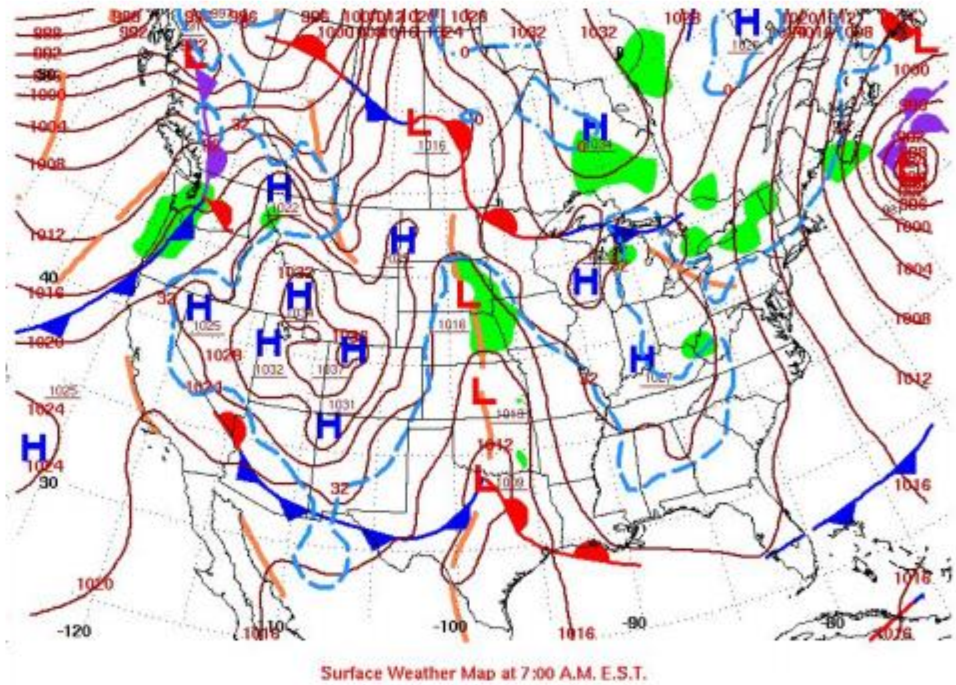

Figure 4: Surface chart from 07/06/2017 showing strong high-pressure system over NWF NAA and much of the intermountain west

Questions were raised about the possibility of international emission increasing due to subsidence during prolonged high-pressure events. Subsidence can be observed as an inversion on the vertical temperature profile. The inversion develops aloft as a result of air gradually sinking over a wide area and being warmed by adiabatic compression. It is generally associated with increased winds, the temperature warms at or near the dry adiabatic lapse rate, and an increase in the dewpoint depression. A review of the vertical temperature profiles during the 2017 summer shows subsidence during much of the season. Some days have more subsidence than others, this appears to be independent from whether ground level monitors measured an exceedance or not.

The results of the qualitative synoptic meteorology analysis indicated that while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions.

HYSPLIT Backward Dispersion Analysis

To determine the influence of international anthropogenic source emissions on local ozone concentrations along the NWF, a backward dispersion analysis was conducted using the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model.

Considering Utah's complex terrain and its potential impact on wind flow characterization above the ground surface, a backward dispersion analysis was performed rather than a backward trajectory analysis. Compared to backward trajectory analyses, backward dispersion analyses follow plumes rather than single-point air masses. Backward dispersion includes the effects of turbulent motion, where each trajectory is described by a probability distribution of particles rather than its average pathway. This allows for a greater representation of wind trajectories. Also, considering Utah's complex topography, including turbulent vertical mixing processes helps better simulate vertical air movement. Initial backward trajectory calculations showed that particle trajectories occasionally intersect the ground, leading to irreversible velocity information loss. This occurred even when different release heights were considered. Backward dispersion model also uses a continuous release, therefore representing multiple initial conditions for backward trajectories.

The objective of this analysis is to help assess general transport patterns between upwind geographical regions and the Salt Lake Valley. While this analysis does not account for any source emissions or air pollutant formation, transformation and removal, it can be used to determine predominant meteorological pathways influencing receptor sites. It provides a comprehensive assessment of source-receptor relationships.

Simulations were configured based on maximum daily 8-hour average ozone concentrations (MDA8 O_3) observed at Bountiful Viewmont monitoring station during July 2017, when multiple ozone exceedances were observed (Figure 3). July 2017 also corresponds to the episode that was selected for a proposed 179B(b) photochemical demonstration. Release start time corresponds to the last hour over which MDA8 O_3 occurs. The source location was configured to continuously and uniformly release a vertical line-source of a generic gas tracer between 100 and 1000 m above the monitor. This altitude range helps characterize air throughout the planetary boundary layer (PBL). The starting altitude of 100 m was also selected to avoid interference with Utah's complex terrain. 80,000 computational particles were released over 8 hours with 10,000 particles released per hour. The number of released particles was based on a series of sensitivity tests where the total number of released particles was changed. Trajectories were tracked backward in time for 120 hours (i.e. 5 days) on each simulation day. Input meteorological data was retrieved from the Global Data Assimilation System (GDAS), which has a 3-hourly temporal resolution and a 0.5-degree latitude by a 0.5-degree longitude resolution and which uses hybrid sigma-pressure surfaces.

Frequency plots showing the fraction of particles in a given region were then developed in ArcGIS for every exceedance and non-exceedance day using the hourly trajectories for each day (Figure 5 & APPENDIX B). This fraction is an indication of where particles spent time and likely interacted with emissions before eventually reaching receptor sites in the Salt Lake Valley. While this analysis, which is limited by the coarse grid spacing of the meteorological domain, does not accurately resolve sub-grid turbulent mixing, it helps illustrate the historical path of air that arrived at a receptor area during a given period of time.

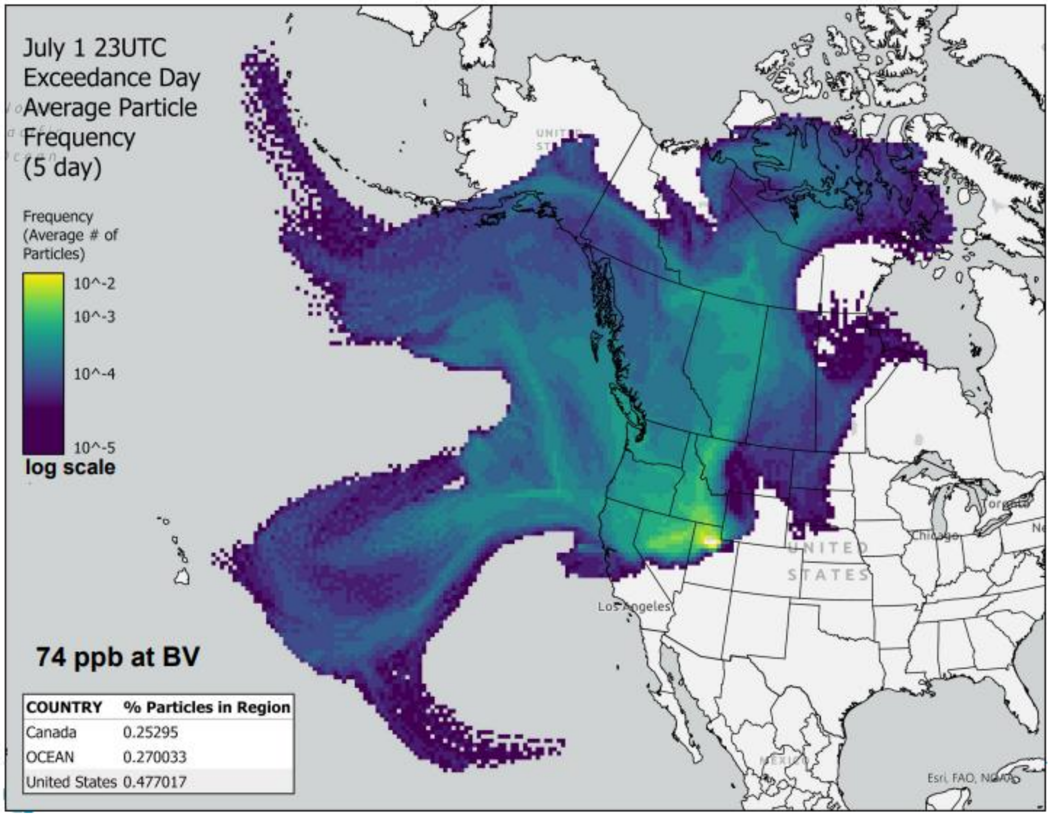

Figure 5: 5-day average frequency plot showing the fraction of particles in a given region for 07/01/2017. Data is plotted on log-scale. Plots for all day included in analysis are available in APPENDIX B.

Results from the HYSPLIT analysis suggest that while receptor sites in Utah are impacted to some extent by source emissions outside the US, transport patterns between ozone exceedance and non-exceedance days are not significantly different (Figure 6). Air masses originated from Canada and Mexico during both exceedance and non-exceedance days, with the fraction of particles over Canada being greater during exceedance days but small compared to that from US regions. Air masses originating from Asia were also evident but associated with exceedingly small fractions of particles. While this analysis has some limitations, including not being constrained by source emissions, using “population count” as a proxy for urban emissions (APPENDIX B), significant emission contributions from outside the US are not expected over the considered time frame.

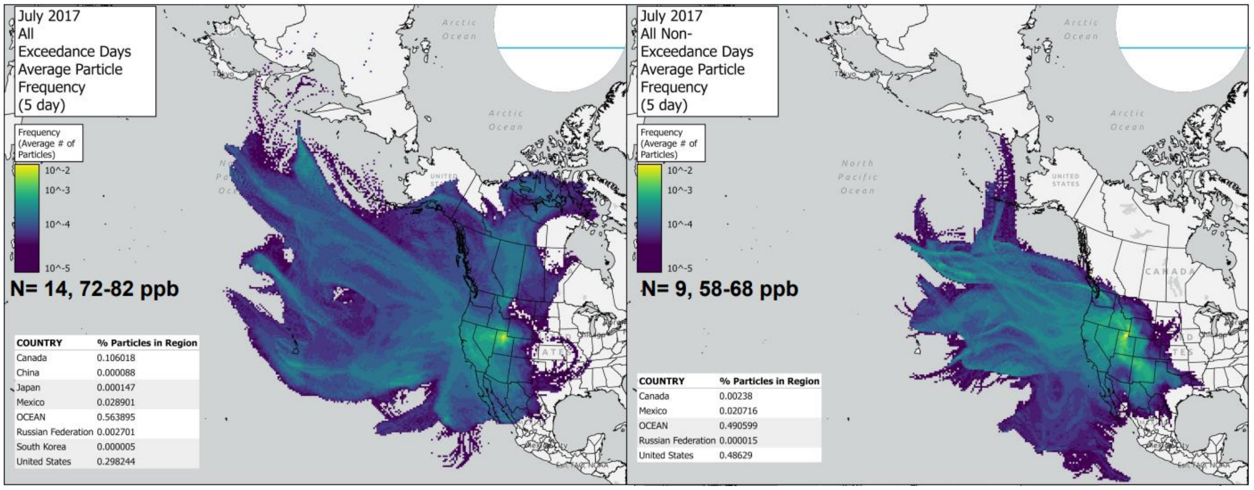

Figure 6: 5-day average particle frequencies for all exceedance days (left) and non-exceedance days (right). Data is plotted on log-scale.

Ramboll CMAQ & CAMx Analysis

To evaluate the potential applicability of the Section 179B(b) provisions for the NWF NAA, Ramboll conducted a preliminary modeling analysis that quantitatively estimated the contribution from global international transport of ozone. They applied both the Community Multiscale Air Quality (CMAQ)[4] and the Comprehensive Air quality Model with extensions (CAMx)[5] photochemical models using EPA-derived meteorology and emission datasets representing conditions during. They also considered two approaches, a sensitivity analysis and a source apportionment method.

For the sensitivity analysis, which was conducted using CMAQ, two simulation runs were considered. These included a base case where all emission sources were included and a sensitivity scenario where emissions from international anthropogenic sources were zeroed out. The contribution of international anthropogenic emission sources to local ozone concentrations was then assessed by scaling the DV at each monitoring site by the relative modeled change in ozone between the baseline and scenario cases (relative response factor). The source apportionment analysis, which was conducted in CAMx, consisted of tracking emission contributions from Utah, the rest of the US, and international anthropogenic sources to total ozone at Wasatch Front monitors. A similar scaling approach was then followed for quantifying the contribution of international anthropogenic sources to local ozone (Figure 7).

[4] EPA, 2020. CMAQ: The Community Multiscale Air Quality Modeling System website: https://www.epa.gov/cmaq.
[5] Ramboll, 2020. Comprehensive Air Quality Model with extensions website: http://www.camx.com/home.aspx

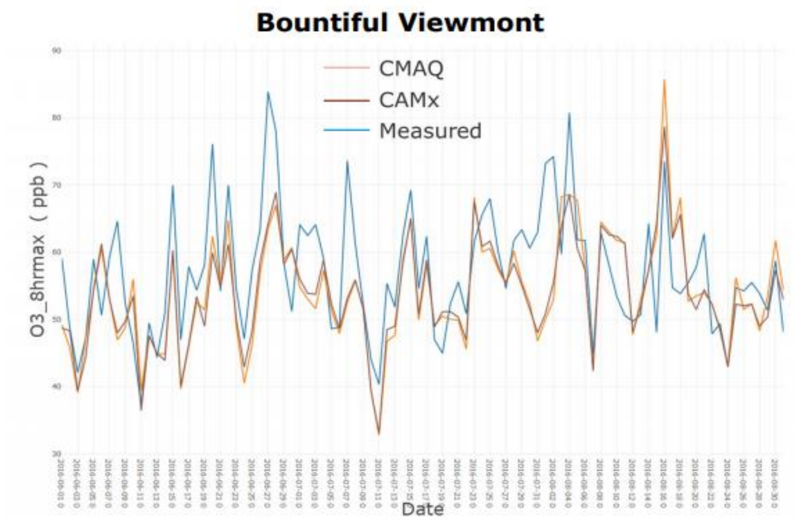

Figure 7: Time series of MDA8 Ozone from CMAQ and CAMx Beta MP and controlling monitoring within NWF NAA

Ramboll concluded that results from both approaches and models show that the Wasatch Front would attain the 70ppb ozone standard in the absence of international anthropogenic contributions (Figure 8, Table 2). The current highest DV for the non-attainment area is 77 ppb which corresponds to 6.1 ppb above the 70.9 ppb concentration necessary to attain. According to the DV scaling technique, modeled international contributions range between 8.7 to 12.7 ppb at the most limiting monitoring site. These concentrations exceed the 6.1 ppb, which if removed, will bring down the Northern Wasatch Front area to attainment. Moreover, modeled international contribution is nearly 10 ppb at the highest DV site on average during the summer. This contribution is also nearly constant throughout the summertime ozone season (Figure 8).

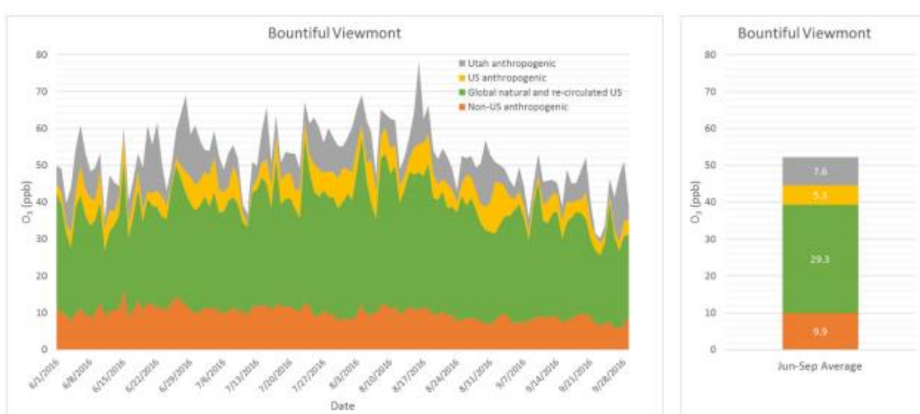

Figure 8: Time series of MDA8 ozone source apportionment results over June-September 2016 at the Bountiful Viewmont monitoring site (left), and summer-average contributions (right). The IAE contribution is shown at the bottom in orange, and all colored contributions sum to the total ozone at the top of each graph.

It is noteworthy that both models show an underprediction in ozone on high ozone days, most likely due to a lack of local ozone production, which could lead to an overestimation in the international contributions to local DVs (Figure 7). By underestimating local contributions, the relative response factor which is defined as the ratio of modeled ozone from the sensitivity case to the baseline case, will be underpredicted (numerator goes down when international contributions are removed), leading to an underprediction in the projected DV. Ramboll, however, estimates that the related error is likely less than 2 ppb and therefore does not change their overall conclusion that the NWF would attain the standard but for the contribution of international anthropogenic emissions. Ramboll's complete study report is attached (APPENDIX C).

Table 2: Ozone DV scaling results from Ramboll analysis at each Wasatch Front monitoring based on simulated ozone over June-September 2016 from the CAMx V1 MP OSAT results.

Site	County	2017-2019 DV[1]	Modeled RRF	OSAT DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	77	0.8346	64.3
490353006 Hawthorne	Salt Lake	76	0.8293	63.0
490353013 Herriman	Salt Lake	75	0.8224	61.7
490450004 Erda	Tooele	72	0.8375	60.3
490570002 Ogden	Weber	71	0.8297	58.9
490571003 Harrisville	Weber	71	0.8432	59.9
Southern Wasatch Front				
490490002 Provo	Utah	N/A	0.8326	N/A
490495010 Spanish Fork	Utah	70	0.8330	58.3

[1] Based on latest EPA-official 2017-2019 DVs (https://www3.epa.gov/airquality/greenbook/jdtc.html). Data collection at Provo ended prior to 2019 but DVs at that site never exceed 72 ppb going back to 2013.

Conceptual Model Framework

To further support findings from the analyses conducted to-date including the synoptic pattern analysis (APPENDIX A), HYSPLIT analysis (APPENDIX B) and Ramboll's photochemical modeling (APPENDIX C), the UDAQ could conduct a more rigorous analysis that would optimize the photochemical model performance for NWF NAA. Such a demonstration would build on Ramboll's analysis but include additional enhancements to better represent emissions inputs and meteorology for Utah's NWF.

Compared to Ramboll's modeling demonstration, the UDAQ proposed model would implement the following modifications:

- Higher-resolution modeling domains including a 4 km domain covering Utah and parts of neighboring states nested within a 12 km domain over the Western US. This is in contrast to a 12 km domain covering the continental United States used by Ramboll.
- Two-way nesting in photochemical air quality model.

- Updated and more recent emissions data and inputs. The proposed modeling will leverage EPA's 2017 modeling platform as opposed to Ramboll's modeling which used EPA's 2016 modeling platform. The 2016 platform is based on the 2014 National Emissions Inventory (NEI) while the 2017 modeling platform is based on the 2017 NEI and includes some methodology updates.
- Utah-specific meteorology with land use modifications specific to the Great Salt Lake to better represent Utah's topography.
- Application of hybrid vertical coordinate in WRF meteorological model, which is more appropriate for representing areas with complex topography.

It is anticipated that these refinements will help improve the photochemical model performance. These modifications will particularly help better represent the contribution of local sources to ozone concentration. However, despite these enhancements, the findings and implications of such modeling analysis are not expected to significantly differ from Ramboll's conclusions. The improvements will most likely lead to a better representation of local ozone source contributions on high ozone days. These contributions were underestimated in the modeling conducted by Ramboll and potentially led to an overestimation in the contribution of international sources to local DVs. By better simulating local ozone production, the contribution of international sources to ozone concentrations is likely to decrease. A detailed modeling protocol outlining what a full photochemical demonstration would look like, if conducted by UDAQ, can be found in APPENDIX D.

Conclusions

Ramboll's preliminary modeling and DAQ's backward dispersion and synoptic patterns analyses suggest that receptor sites in the NWF NAA are impacted by international sources during the summer exceedance season. This influence is, however, observed consistently throughout the spring and summer and not just on high ozone exceedance days. The amount is also relatively small in comparison to the composition total of ozone. While a more rigorous air quality modeling employing higher resolution and area-specific meteorology and emission inventories as outlined in the Conceptual Modeling Framework section and in APPENDIX D of this demonstration could be conducted, the findings and their implications are not expected to change.

As demonstrated in the three technical analyses outlined in this demonstration and supported in existing literature, high elevation sites throughout the intermountain west, including the NWF NAA, experience elevated background concentrations of ozone throughout the spring and summer season with some additional contributions from international anthropogenic sources. The analyses included in this demonstration provide evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA.

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Public Comments

The UDAQ released this 179B(b) demonstration for public review and accepted comments from May 5th, 2021 to May 26th, 2021. During this 20-day period UDAQ received 30 comments from members of the general public, industry and non-profit organizations:

Commenter #1
Date: Monday, May 24, 2021
As a resident of Salt Lake City, I am alarmed to learn of the proposed rule change that invokes section 179B(b) of the Clean Air Act (CAA).
There is no realistic opportunity for the public to analyze and critique a document like this in a matter of 20 days.
The only possible rationale for UDAQ seeking "relief" from reclassification would be either profit protection of corporations whose emissions contribute to ozone, or an economic benefit to the community at large.
Please give the public reasonable notice too understand these proposed changes that will impact or quality of life here in the Salt Lake valley.

Commenter #2
Date: Saturday, May 22, 2021
A quick review of the American Lung Association's recent city report card gives SLC an F with 74 orange ozone days. This should be alarming to you and every elected official because it is well-known that ozone inflames the lung's linings.

If you think you and any other Wasatch Front resident is exempt from ozone's harmful affects, you are wrong. On days of high ozone (which stretches into Summit and Wasatch counties), you and every other resident breathes it in on average 10,000 times a day.

Please work to protect all of our health. This means taking serious measures to reduce ozone levels and educating our largely uneducated and unsophisticated legislators. That is your job. Please do it. Hundreds of people die prematurely in SLC because of air pollution. Please take this seriously.

Commenter #3

Date: Monday, May 24, 2021

Regarding the Utah division of air quality proposed rule change invoking section 179B(b) of the Clean Air Act.

There is no "safe level" of ozone. It is this department's duty and responsibility NOT to endanger and further weaken the Clean Air Act by allowing "moderate levels" of ozone in the Utah valley. All of us deserve to breathe clean ozone free air. Toxic air does not discriminate we all breathe it.

Commenter #4

President, Utah Physicians for a Healthy Environment

Date: Sunday, May 16, 2021

Utah Physicians for a Healthy Environment (UPHE) has learned that UDAQ posted a proposed rule change that invokes section 179B(b) of the CCA on May 5, with a deadline for comments of May 25 on a "Demonstration" document regarding Northern Wasatch Front Ozone Nonattainment. UPHE has numerous problems with the process and the intent behind seeking to avoid the emission reduction obligations required by a moderate NAA designation for ozone.

First, regarding the process. The Demonstration document is 145 pages long with detailed atmospheric modeling and complex meteorological data. There is no realistic opportunity for the public to analyze and critique a document like this in a matter of 20 days, and it is a cynical gesture that UDAQ would even present it to the public with that time frame. Challenging or recalculating the data would require hiring experts to review the information in a completely unrealistic time frame, and at a cost that no non-profit, non-governmental, or non-corporate entity could afford. Guidance from the EPA includes this directive:

"In addition to providing a conceptual model and evidence of international anthropogenic emissions transport to the subject area in a demonstration, EPA encourages air agencies to conduct and document (in the demonstration) a public comment process for all section 179B demonstrations prior to submitting the demonstration to EPA. In addition to coordinating with their respective EPA Regional office throughout the development of any section 179B demonstrations, EPA also recommends that air agencies notify their respective EPA Regional office when the state public comment process begins. In the case of a section 179B(a) 'prospective' demonstration, the public comment process would be documented as part of completeness requirements in the associated SIP. In the case of a section 179B(b)–(d) ‘retrospective’ demonstration, the air agency would likely need to conduct a demonstration-specific public comment process to include in its stand-alone submission.”

UDAQ cannot satisfy those guidelines providing a time line of 20 days to the public. UPHE formally requests a minimum of a 60 day extension of the comment period given the complexity of the Demonstration document.

Second, UPHE disputes that UDAQ is fulfilling its mandate to protect public health by appealing for “relief from the upcoming reclassification to moderate status.” In fact, the term “relief” is telling because it carries the obvious implication that achieving air quality goals that protect public health is considered a burden by UDAQ (or to some entity that is pressuring UDAQ to pursue this Demonstration document). This begs the question, “From whom did the directive come to pursue this?”

If the appeal were to be successful, the end result would be that UDAQ would be “relieved” of an obligation to reduce Utahns exposure to ozone. Obviously ozone that originates internationally has the same health consequence as ozone the originates locally. Hundreds of medical studies have revealed the serious health hazard of ozone, and virtually all relevant medical organizations have called for the ozone NAAQS to be made more strict.

Furthermore, like with particulate pollution, the medical research is absolutely clear, there is no safe level of exposure to ozone. We mention just one of many studies, published in one of the world’s most prestigious medical journals, *JAMA*, that illustrate the impact on human health. Following over 7,000 patients for 18 years, from areas with typically less ozone than in Utah, researchers found that exposure to an increase of just 3 ppb ozone for ten years was associated with as much loss of lung function and lung tissue as smoking a pack a day of cigarettes for 29 years. With studies like this and many others it is unconscionable that UDAQ would be maneuvering to provide even less protection to Utahns from ozone.

Third, even non-experts can see that the document is flawed and is confusing if not self contradictory. On page 8, it says, “while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions.” But on page 13 the document says, “The analyses included in this demonstration provide evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA.”

The document presents data that indicates “attainment” status for SWF, but “non-attainment” for NWF. It would be logical to assume that given the proximity of SWF and NWF both areas would be equally impacted by international drift of ozone or its precursors. If so, the logical assumption is that there are more local sources in NWF than in SWF. Empirically, that is the case. There are more industrial sources of ozone precursors in NWF, which could, and should be considered as targets for reduction rather than seeking regulatory escape by invoking 179B. One example is emblematic. Controversial aerial pesticide spraying is conducted by the Salt Lake City Mosquito Abatement District repeatedly during the high ozone season. Studies from California have found that VOCs generated from aerial pesticide spraying can increase local ozone levels as much as 15 ppb, persisting for up to two days. With multiple spraying events through out the late spring, summer and fall, there is no reason for UDAQ not to regulate/prohibit this activity. But it currently does not merely because it is a “mobile” source.

Furthermore, the document suggests that there is similar attribution from international sources on days of exceedance and days of compliance with the standard. If so, that too indicates that international sources are not the cause of failure to meet the standard, even if they do contribute to Utah ozone levels.

Fourth, this is an issue of environmental justice. The populated area of the state of Utah exposed to the most air pollution is the West side of Salt Lake City, West Bountiful, and North Salt Lake. This is the same area most heavily populated by communities of color, and the economically disadvantaged. This is also the same area that is exposed to the VOCs from aerial pesticide spraying and other environmental neurotoxins. This area will suffer dramatically more air pollution and other environmental contaminants if the inland port is allowed to proceed. If a moderate NAA designation for ozone is maintained in the NWF, the community will retain at least one regulatory defense against being victimized by a significant new source of pollution.

Fifth, the only possible rationale for UDAQ seeking “relief” from reclassification would be either profit protection of corporations whose emissions contribute to ozone, or an economic benefit to the community at large. The first is obviously illegitimate. The second is not the mandate of UDAQ. Nonetheless, with the Wasatch Front having the lowest unemployment rate and fastest economic growth in the country, any attempted economic justification for failing to protect public health by pursuing relief from reclassification is equally inappropriate.

Sixth, it is disturbing to say the least that UDAQ appears to have spent a considerable amount of tax payer money, including staff time and contracting with a third party, towards achieving the goal of allowing Utahns to be exposed to more ozone. We estimate that thousands of man-hours were devoted to this dubious project with an unstated but undeniable goal of undermining public health, and at a cost to Utah taxpayers of at least hundreds of thousands of dollars. In short this appears to be scandalous behavior by an agency of state government.

In addition to granting the comment period extension, we request that UDAQ release a full disclosure of the cost to Utah tax payers of this Section 179B(b) Demonstration project, as well as any entity that requested this action from the agency.

Commenter #5

Date: Monday, May 24, 2021

UDAQ,

Don’t renege on your duty to protect air quality. Don’t seek relief from the Clean Air Act, or delay taking action to reduce ozone levels.

Commenter #6

Date: Saturday, May 22, 2021

I'm writing to ask that the public comment period for this proposal be extended for at least 30 days. The allotted 20 days is insufficient for the public to digest and respond to this complex 145-page document. Given the serious impact that the contemplated action would have on our air quality, I think the public should be given adequate time to understand and respond to the proposal.

Commenter #7
Date: Tuesday, May 25, 2021
he public to I am submitting comment on the proposed rule plan and changes of the UDAQ titled "Northern Wasatch Front Ozone International Transport Demonstration 179B(b)"
I am a physician licensed to practice medicine in the State of Utah.
My training is in Internal Medicine. My training includes diagnosis and treatment of respiratory illness and injury due to all forms of insult including toxic inhalation. Toxic inhalation includes ozone.
It is of concern that I only became aware of this proposed rule plan and change recently. It is clear that the public at large has not been made aware that the UDAQ intends to not make efforts to attain compliance with existing ground level ozone standards. It is of even greater concern that a minimal 20 day comment period has been put in place for the public to express concerns. This matter is of significant consequence to the health of those living in the Northern Wasatch Front which includes where I live in Riverton Utah.
The document outlining the proposed rule plan and changes is some 145 pages long and highly technical. It is not reasonable or realistic to allow only 20 days for a thorough of this information. I, therefore, request that the comment period be extended by a minimum of 60 days. It is not at all clear what urgent need would require not allowing a longer time for review and comment.
It is also not at all clear why UDAQ is proposing this rule change. The mission of this agency should be to protect the air quality of Utah citizens.There is no level of ozone in the air that is safe for humans to breathe. The ground level standards are in place to protect humans from more substantial harms of higher levels. The goals of UDAQ should be to examine methods to meet these standards. It seems that rather than expending resources to the purpose of mitigating ozone levels, UDAQ has expended resources to find ways to avoid meeting the standards.
The public needs to understand why the UDAQ is not interested in examining and proposing methods to mitigate non-attainment of ground level ozone standards. This rule seems to be interested in protecting practices that create increases in ground level ozone rather than protecting the health of the public by meeting ground level ozone standards.
In summary, this proposed rule does not make sense based on the published information. It is also not reasonable to give a minimal review period for a complex technical document. Please provide an extended period of time for review.
UDAQ should be protecting the health of Utah's citizens. It should not be in the business of finding ways to avoid compliance with air quality standards as appears to be the case in this proposed rule plan and change.

Commenter #8
Date: Monday, May 24, 2021

As a physician, I have many problems with your proposal.
1. The UDAQ should be looking for ways to improve air quality, not reduce it.
2. Ozone is detrimental to human health. We know there is no safe level of exposure to ozone.
3. Your document is huge, and the public, including me, needs more time to evaluate the data.
Thank you for considering my input.

Commenter #9
Date: Wednesday, May 26, 2021
I am submitting the following comments on the proposed rule plan and changes of the UDAQ titled "Northern Wasatch Front Ozone International Transport Demonstration 179B(b)":
1. Efforts to notify the public of this proposed rule plan and change have been very inadequate and the public comment period is far too short to be fair and meaningful. I believe that at least a 60 day extension to the comment period be granted and that UDAQ should make a greater effort to publicize this proposed plan and changes.
2. It is nonsensical that the Northern Wasatch Front would be impacted by international emissions and not the Southern Wasatch Front. This argument does not hold water.
3. No mention in the 143 page document is made of major contributors to ozone such as the development of the Utah Inland Port and all the vehicle traffic it is stimulating, nor the repeated summertime aerial spraying of pesticides by the Salt Lake City Mosquito Abatement District, an activity that can generate volatile organic compounds that can substantially increase local ozone levels. These blatant omissions suggest a deliberate and disingenous attempt to turn a blind eye to the major polluters in this valley.
4. It appears the UDAQ is acting in the best interests of the wealthy and powerful in this community who continue to build out the valley without regard to the environmental impacts. UDAQ is apparently choosing to disregard its mandate to first and foremost protect public health.
The only possible rationale for UDAQ seeking "relief" from reclassification would be either profit protection of corporations whose emissions contribute to ozone, or an attempt to stimulate the local economy (which is not included in UDAQ's mandate).
I am urging UDAQ to do a better job of notifying the public of this proposed plan and changes, extend the public comment period and stop pandering to the wealthy and powerful, and instead fulfill its mandate to tell the truth and protect public health.

Commenter #10
Date: Wednesday, May 19, 2021

As there is no safe level of Ozone and the Wasatch Front has significant air quality problems, a "moderate" designation will not adequately protect the public health. A 20 Day comment period is miniscule, given the level of this problem. The comment period needs to be at least 60 more days. The Wasatch Front, perhaps the fastest growing economic area in the country, is beset by current and prospective polluters. Currently, aerial pesticide spraying is continuing during high ozone season. Additionally, failure to make accommodations for the potential devastation of the current air quality by the Inland Port is a failure to consider the health of people living in this region. Any reclassification is inappropriate at this time; rather, increased monitoring and a disaster plan is more what citizens can hopefully expect from the Utah DAQ.

Commenter #11
Date: Saturday, May 22, 2021
There are numerous problems with the proposed rule change of 179B(b). The responsibility of UDAQ is to protect the public by ensuring the best quality air. What is being proposed is environmental injustice. I am strongly opposed to this change!!

Commenter #12
Date: Friday, May 14, 2021First, I request a 60 day extension of the public comment period on the May 5, 2021 Clean Air Act 179B(b) Demonstration posted by DAQ. 20 days is not long enough for the public to review this complex document or secure expert help to aid in that effort. 20 days is also insufficient to meet the expectations of EPA – as outlined in the 2020 Guidance – for public involvement in such a demonstration.
Second, I have requests associated with the document itself:

- Please provide to the public the studies cited in footnotes 1 and 3 of the main document.
- Please clarify certain citations.

o DAQ cites the EPA Whitepaper (footnote 2) for the following: “This vertical transport of air from aloft is also enhanced by complex topography which creates winds that enhance down slope mixing.” Please provide a citation to the actual document and a page number for the specific citation.

o Just above this sentence there is a lengthy statement that starts with the sentence “This vertical transport of air from aloft is also enhanced by complex topography which creates winds that enhance down slope mixing . Please clarify the basis/ provide a citation for these sentences.

o DAQ states: “Strong cold fronts have the potential to increase subsidence of upper air toward the ground increasing the impact of international emissions.”   Please provide a citation for that statement if one exists.

Commenter #13
Date: Saturday, May 22, 2021
We are members of Utah Physicians for a Healthy Environment. We are grateful for what you’ve done to protect our health by protecting our air quality in the past. The Clean Air Act is designed to protect our health. PLEASE don’t try to avoid implementing the emission reduction obligations on ozone. Your task is to protect citizens, NOT

corporations.
Please allow more time for public comment. Twenty days is NOT a sufficient amount of time for such a complex issue.
Why do you seek “relief” from the upcoming reclassification to moderate status? It’s your obligation to meet the standards that have been set, rather than to feel burdened by the obligations your agency needs to meet. One reason we see for your agency wanting “relief” is to protect corporate profits, which is not a legitimate reason.
Your organization was created to protect Utahns air quality. There is no safe level of exposure to ozone. Please fulfill your obligation to all of us by doing the job your organization was created to do.

Commenter #14
Date: Monday, May 24, 2021
I have read the Northern Wasatch Front Ozone International Transport Demonstration 179B(b) and had some concerns with the methodology and results presented in it.
- The estimate of ozone from international sources (8.7-12.7 ppb) is much higher than values in published literature (e.g. Langford et al 2017 estimate it is closer to 4-5 ppb: https://doi.org/10.1002/2016JD025987)
- The report concludes by saying that they estimate that their error to be less than 2 ppb, but that seems implausible based on the poor model-data agreement that appears in the report (eg Figure 7).
- Given the large uncertainties in emission inventories (both inside the US and especially outside of the US), how confident can we be in international emissions and how much uncertainty does that contribute to an estimate of international contributions? Uncertainty from emission inventories (both international & domestic) should be explicitly quantified in the final modeling product.
- The assertion that the contribution from international transport is relatively constant through the summer does not seem plausible given synoptic variability. See for example this global animation of CO2 that shows waves of pollution coming from Asia: https://www.youtube.com/watch?v=x1SgmFa0r04&ab_channel=NASAGoddard
- A model should also estimate the contribution from stratospheric intrusions.
I look forward to seeing the results from UDAQ’s upcoming modeling efforts. Please feel free to contact me if you have any questions.

Commenter #15
Date: Monday, May 24, 2021
We understand that the department has proposed a rule change would which result in the the avoidance of emissions reduction obligations required by a moderate Nonattainment Areas (NAA) designation for ozone. My wife and I strongly oppose the department avoiding any obligation to reduce ozone - ozone has a very negative effect on the air we breath.
We hope you rescind this proposal and have the department assume it’s responsibility to minimize ozone in the air we breath.

Commenter #16

Date: Sunday, May 23, 2021
Just 20 days to comment? Seriously? That is all you gave the public? On a 145 page document? That is not right.
I understand that the issue is one of Ozone non attainment ("Bad down here, okay up there"). I further understand that DAQ is **happy** with allowing China-originated Ozone to not be counted as we further pollute our air here in the valley.
This is truly sickening, literally and figuratively. As a citizen, I strongly object.

Commenter #17
Date: Saturday, May 22, 2021
It is really disheartening to see evidence of your lack of good faith and of good judgment with this rule change. This is cynical bureaucracy claiming to protect our air, when once again you are acting to damage it. How many local people have to get sick and die from your lack of proper action before you will stop being lackeys to corporate power and protect the people of Utah?

Commenter #18
Date: Monday, May 24, 2021
I do not think that UDAQ is fulfilling its mandate to protect public health by appealing for "relief from the upcoming reclassification to moderate status." In fact, the term "relief" is telling because it carries the obvious implication that achieving air quality goals that protect public health is considered a burden by UDAQ (or to some entity that is pressuring UDAQ to pursue this Demonstration document). This begs the question, "From whom did the directive come to pursue this?"
Furthermore, as with particulate pollution, the medical research is absolutely clear. **There is no safe level of exposure to ozone.**
3. **Even non-experts can see that the document is flawed and is confusing if not self-contradictory.** On page 8, it says, "while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions." But on page 13 the document says, "The analyses included in this demonstration provide evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA."
4. **This is an issue of environmental justice.** The populated area of the state of Utah exposed to the most air pollution is the West side of Salt Lake City, West Bountiful, and North Salt Lake. This is the same area most heavily populated by communities of color and those economically disadvantaged. This is also the same area that is exposed to the VOCs from aerial pesticide spraying and other environmental neurotoxins. Additionally, this area will suffer dramatically more air pollution and other environmental contaminants if the inland port is allowed to proceed.
5. **The only possible rationale for UDAQ seeking "relief" from reclassification would be either profit protection of corporations whose emissions contribute to ozone, or an economic benefit to the community at large.** The first is obviously illegitimate. The second is not the mandate of UDAQ.

6. **It is disturbing to say the least that UDAQ appears to have spent a considerable amount of taxpayer money**, including staff time and contracting with a third party, towards achieving the goal of allowing Utahns to be exposed to more ozone.

Commenter #19
Date: Sunday, May 23, 2021
Are you kidding?
"Public Comment" should mean the public has enough time to study the issue sufficiently to make substantive comments.
Otherwise, you flood the system with off-the cuff (i.e. easily dismissed) comments by the public.
The issue: the Northern Wasatch Front Ozone Nonattainment. We (Salt Lake Indivisible) are profoundly committed to dealing with the emissions poisoning the Salt Lake Valley.
We want to provide responsible, well-informed public comment to this document.......but that is impossible by May 25th.
ARe you kidding?
Just one of may points can be made to object to this ruse: "...relief from the upcoming reclassification to moderate status" clearly shows your intent. Your job is the public health, dependent on air quality. But it is a burden from which you want an exemption. Unacceptable.
Delay the deadline that deadline at least 60 days,so the public has an opportunity to make informed comment.

Commenter #20
Date: Saturday, May 22, 2021
I agree with UHPE that this document is flawed and contradictory. Please allow more time for review and revision by your staff as well as ordinary citizens.

Commenter #21
Date: Saturday, May 22, 2021
I'm writing in support of extending the comment period for the proposed rule change bearing on section 179B(b) of the Clean Air Act in order to allow further time for public review of the proposed changes.
It would also be of use while members of the public and scientific communities review the proposed changes if there were a full disclosure of the cost to Utah taxpayers of this Section 179B(b) Demonstration project, as well as a record of any entity that requested this action from UDAQ.
Thanks so much for the consideration from your office and UDAQ, and for your service to the state. I hope you are enjoying a pleasant weekend and not reading work emails at all until Monday.

Commenter #22
Date: Sunday, May 23, 2021
I am strongly against this or any rule change that dows not improve air quality.

Commenter #23

Date: Monday, May 24, 2021

I recently learned that UDAQ has proposed a rule change invoking section 179B(b) of the Clean Air Act regarding Northern Wasatch Front (NWF) Ozone Nonattainment. I have several problems with the process and intent behind UDAQ's apparent attempt to avoid the emission reduction obligations required by a moderate Nonattainment Area's (NAA) designation for ozone. My main concerns are as follows:

1. The Demonstration document UDAQ provided is lengthy but contains no atmospheric modeling or detailed meteorological data. This makes it unrealistic to analyze and assess this document in less than three weeks. I would recommend making an extension.
2. The document is confusing and self-contradictory. There are several examples of this and no need to list them here.
3. I reject the idea that UDAQ is fulfilling its mandate to protect the public by appealing for "relief from the upcoming reclassification to moderate status." Wouldn't protecting the public involve actually achieving air quality goals? Note, of course, that THERE IS NO SAFE LEVEL OF HUMAN EXPOSURE TO OZONE.
4. Where is the environmental justice? The most air pollution exposure is by the population west of Salt Lake City, West Bountiful, and North Salt Lake. These areas are also the most heavily populated by communities of color and/or economically disadvantaged.
5. I see no legitimate reason for UDAQ to seek "relief" from reclassification. The UDAQ is supposed to protect the public.
6. It appears that UDAQ spent a lot of taxpayer money, staff time, and even contracted with a third party to try to achieve the goal of allowing the Utah public to be exposed to MORE ozone. I expect there will be an audit by the legislature.

In addition to extending the comment period, I expect UDAQ to release a full disclosure of the cost to Utah taxpayers of the Section 179B(b) Demonstration project.

Commenter #24

Date: Saturday, May 22, 2021

As a resident of Salt Lake City and a healthcare provider, I have some serious concerns regarding a proposed rule change that invokes section 179B(b) of the Clean Air Act (CAA) on May 5, with a deadline for comments of May 26 on a “Demonstration” document regarding Northern Wasatch Front (NWF) Ozone Nonattainment.

I agree with **Utah Physicians for a Healthy Environment and the concerns that there are "numerous problems with (your) process and the intent behind seeking to avoid the emission reduction obligations required by a moderate Nonattainment Areas (NAA) designation for ozone.**

1\. Regarding the process, the Demonstration document is 145 pages long with detailed atmospheric modeling and complex meteorological data. **There is no realistic**

opportunity for the public to analyze and critique a document like this in a matter of 20 days, and it is a cynical gesture that UDAQ would even present it to the public with that time frame. UDAQ cannot satisfy those guidelines providing a time line of 20 days to the public. UPHE formally requests a minimum of a 60-day extension of the comment period given the complexity of the Demonstration document.

2. **UPHE disputes that UDAQ is fulfilling its mandate to protect public health by appealing for "relief from the upcoming reclassification to moderate status."** In fact, the term "relief" is telling because it carries the obvious implication that achieving air quality goals that protect public health is considered a burden by UDAQ (or to some entity that is pressuring UDAQ to pursue this Demonstration document). This begs the question, "From whom did the directive come to pursue this?"

Furthermore, as with particulate pollution, the medical research is absolutely clear. **There is no safe level of exposure to ozone.**

3. **Even non-experts can see that the document is flawed and is confusing if not self-contradictory.** On page 8, it says, "while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions." But on page 13 the document says, "The analyses included in this demonstration provide evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA."

4. **This is an issue of environmental justice.** The populated area of the state of Utah exposed to the most air pollution is the West side of Salt Lake City, West Bountiful, and North Salt Lake. This is the same area most heavily populated by communities of color and those economically disadvantaged. This is also the same area that is exposed to the VOCs from aerial pesticide spraying and other environmental neurotoxins. Additionally, this area will suffer dramatically more air pollution and other environmental contaminants if the inland port is allowed to proceed.

5. **The only possible rationale for UDAQ seeking "relief" from reclassification would be either profit protection of corporations whose emissions contribute to ozone, or an economic benefit to the community at large.** The first is obviously illegitimate. The second is not the mandate of UDAQ.

6. **It is disturbing to say the least that UDAQ appears to have spent a considerable amount of taxpayer money**, including staff time and contracting with a third party, towards achieving the goal of allowing Utahns to be exposed to more ozone.

In addition to granting the comment period extension, we request that UDAQ release a full disclosure of the cost to Utah taxpayers of this Section 179B(b) Demonstration project, as well as any entity that requested this action from the agency."

Commenter #25

Date: Monday, May 24, 2021

I am concerned that when the DAQ posted a proposed rule change on May 5, 2021, invoking section 179B(b) of the Clean Air Act (CAA), it set a deadline for public comments of May 26, 2021 on the "Demonstration" document regarding Northern Wasatch Front (NWF) Ozone Nonattainment. That document is quite extensive, and the timeframe for public comments is therefore not adequate for thoughtful public input.

The proposed rule change has potentially significant implications for public health, energy, and environmental impacts and policy-making at the state and local levels.

I request that you authorize a 60-day extension of the public comment period for this proposed action by the DAQ, so that Utahns have more time to review and analyse the document referenced above.

Commenter #26

Date: Monday, May 24, 2021

I have also learned that the Utah Division of Air Quality (UDAQ) posted a proposed rule change that invokes section 179B(b) of the Clean Air Act (CAA) on May 5, with a deadline for comments of May 25 on a “Demonstration” document regarding Northern Wasatch Front (NWF) Ozone Nonattainment. UPHE has numerous problems with the process and the intent behind seeking to avoid the emission reduction obligations required by a moderate Nonattainment Areas (NAA) designation for ozone. There isn't enough time for all of us to review this, there are several problems with it, including some contradictory wording.

Please extend the comment period, or discontinue with the idea that we can handle more ozone or more pollution in the area. It is also injurious to certain people who live near the airport. We are at our max or more, to what we can inhale.

Thank you for your time.

PROTECTING THE WEST'S LAND, AIR, AND WATER

May 26, 2021

Ryan Bares and Liam Thrailkill
Utah Division of Air Quality
195 North 1950 West
Salt Lake City, UT 84116
via email:
rbares@utah.gov
lthrailkill@utah.gov

Re: Northern Wasatch Front Ozone International Transport Demonstration 179B(b)

Dear Ryan Bares and Liam Thrailkill,

Please accept and consider the following comments on the Northern Wasatch Front Ozone International Transport Demonstration 179B(b) posted to the public by the Division of Air Quality for the first time on May 5, 2021. I make these comments on behalf of HEAL Utah, the Utah Chapter of the Sierra Club, Utah Physicians for a Healthy Environment and Western Resource Advocates.

I. Background

Ground-level ozone, the primary component of urban smog, is a corrosive pollutant formed by the reaction of volatile organic compounds ("VOCs") and oxides of nitrogen ("NOx") in the atmosphere in the presence of sunlight. 80 Fed. Reg. at 65,302-04. Power plants, industrial sources, and motor vehicles are among the largest sources of those precursor pollutants. Exposure to ozone, for even short time periods, is linked to significant human health impacts, including the aggravation of asthma attacks, cardiovascular and respiratory failure, and even premature death. Children, the elderly, and adults with asthma are particularly at risk. *Id*. at 65,304.

To protect against these significant public health threats, Congress directed EPA to adopt National Ambient Air Quality Standards ("NAAQS") for ozone, "the attainment and maintenance of which . . . are requisite to protect the public health" with an adequate margin of safety. 42 U.S.C. § 7409(b)(1). In 2015, EPA issued a new eight-hour ozone standard that is more protective of human health than the old standard. 80 Fed. Reg. at 65,453 (codified at 40 C.F.R. § 50.19). The revised 2015 NAAQS will deliver substantial health benefits. EPA estimates that implementation of the standard would, every year, prevent up to 878 premature

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550 W. Musser Street
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deaths, thousands of asthma attacks, and tens of thousands of lost school and work days, resulting in $5.8 billion dollars in avoided public health costs and lost productivity.[1]

In August 2018, the Northern Wasatch Front (NWF) was designated as a "marginal" nonattainment area (NAA) for the 2015 8-hour ozone NAAQS. DAQ Demo at 4. Under federal law, the NWF has until August 2021 to attain the 2015 8-hour ozone standard. *Id.* If monitoring data from 2018 to 2020 shows that the NWF NAA has not met the health-based ozone standard by August 2021, the NWF NAA would be designated as a "moderate" NAA. The attainment date for a moderate NAA is August 2024.[2]

A moderate NAA must meet significant requirements designed to protect public health and the environment and to bring a NAA into compliance with the NAAQS as expeditiously as possible. These requirements include an attainment demonstration, a 15% reduction of precursor emissions over 6 years, contingency measures in case the area fails to attain the standard, and the application of reasonably available control technology (RACT) to major sources of volatile organic compounds (VOCs) and nitrogen oxides (NO_X).[3]

Data from the last three years – 2018 to 2020 – show that the design values (the average of the 4th highest 8-hour ozone concentration recorded for each of the three years) are quite high when compared to the ozone standard of 70 parts per billion (ppb).[4] For example, the design values for the Bountiful and Rose Park monitoring stations are 77 ppb and for both of these stations, the 4th highest ozone concentrations in 2018 and 2020 were 80 ppb. DAQ Demo at 5. Moreover, monitoring data submitted by Utah to EPA shows that the 8-hour ozone standard was exceeded 13 times in Rose Park in 2020 and 19 times in 2018.[5]

The 2018-2020 design values indicate that the NWF NAA has failed to attain the 2015 ozone standard and will be designated as a moderate NAA. DAQ Demo at 4. This designation acknowledges that high concentrations of ozone along the NWF pose a significant threat to the health and welfare of its millions of residents, especially the young and elderly, and directs the State of Utah to come up with emission reduction strategies that will improve air quality sufficiently to bring the NAA into compliance with the ozone standard as soon as possible.

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[1] EPA, Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone, at tables ES-5 through ES-10, https://www.epa.gov/sites/production/files/2016-02/documents/20151001ria.pdf).

[2] https://www.epa.gov/ground-level-ozone-pollution/required-sip-elements-nonattainment-classification

[3] *Id.*

[4] *See* 80 Fed. Reg. 65292 (Oct. 26, 2015).

[5] https://www.epa.gov/outdoor-air-quality-data/monitor-values-report

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II. The DAQ 179B(b) Demonstration

Rather than focusing on reducing emissions of ozone precursors in the NWF NAA, the Division of Air Quality (DAQ) has prepared a 179B(b) Demonstration[6] that purports to show "but for" anthropogenic international emissions – anthropogenic emissions emanating from outside the U.S. – the NWF NAA would have attained the 2015 ozone standard as of August 2021. *See* Clean Air Act, section 179B(b), 42 U.S.C. § 7509a(b).[7] Were the 179B(b) Demonstration successful, the consequences to the people living and working along the NWF would be severe.

DAQ claims and appears to adopt the results of modeling conducted at the behest of the Utah Mining Association and Utah Petroleum Association. DAQ Demo at 11-13. According to DAQ, this modeling shows that international emissions contribute between 8.7 and 12.7 ppb to ozone concentrations at monitoring stations in the NWF NAA. DAQ Demo at 11 ("According to the DV scaling technique, modeled international contributions range between 8.7 to 12.7 ppb at the most limiting monitoring site."). DAQ then asserts that due to this contribution, the design values at various NWF monitoring stations may simply be reduced by a "relative response factor" or RRF, which various from 0.8432 to 0.8224. DAQ Demo at 13. The monitored design value is then multiplied by the respective RRF to arrive at a new design value that DAQ claims "will bring down the NWF area to attainment." DAQ Demo at 12.

Taking Bountiful as an example, the application of the RRF would mean that monitored concentrations of ozone in that city could reach as high as or higher than **85 ppb**[8] and still the State of Utah would be excused from taking the steps needed to bring the NWP NAA into compliance with the ozone standard as expeditiously as practicable.[9] Although its citizens would be suffering the significant health impacts and rates of death and disease that occur when individuals are exposed to concentrations of ozone 15 ppb above the ozone standard, the State of

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[6] Importantly, Congress designed 179B for use in "very limited circumstances" where an area was failing to attain "because of emissions from **immediately adjacent areas in a foreign country**." S. Rep. No. 98-436, at 38 (1984) (emphasis added). The legislative history mentions four U.S. cities that could benefit from the provision: El Paso, Texas, Nogales and Douglas, Arizona, and San Diego, California. 136 Cong. Rec. 5061 (1990). All of these communities lie north of a Mexican metropolitan area.

[7] As discussed below, DAQ does not actually claim that "but for" anthropogenic international emissions, the NWF NAA would have attained the 2015 ozone standard in August 2021. Rather, DAQ concludes that "this demonstration provide[s] evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA." DAQ Demo at 14. Showing a contribution on exceedance and non-exceedance days is a far cry from a "but for" showing.

[8] Recall that the design value represents the annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years.

[9] *See* DAQ Demo at 13. The Utah Mining Association/Utah Petroleum Association model ascribes a RRF of 0.8346 to the Bountiful design value. 85 ppb multiplied by 0.8346 equals 70.9 ppb, the lowest design value that is considered to violate the 2015 8-hour ozone standard.

Utah would **not** have to complete an attainment demonstration, would **not** have to show a 15% reduction in precursor emissions over six years, would **not** have to develop contingency measures in case the NWF NAA fails to meet the attainment deadline, and would **not** have to apply RACT to major sources of VOCs and NO_X. Essentially, as concentrations of ozone continued to climb, as long as the 4th highest annual concentration averaged over three years remained below **85 ppb**, the people of the NWF would be entitled to **no** Clean Air Act protections and **no** relief from the dangerous levels of air pollution they are being forced to breathe.

Given the harsh consequences that would result should the 179B(b) Demonstration be successful, it is critical that DAQ's submission constitute a convincing, rigorous, unbiased and well-substantiated effort that meets the "but for" requirements of 179B(b) and the weight of the evidence test imposed by EPA guidance. Because, as explained in detail below, the DAQ demonstration does not fulfill these criteria, it should be dismissed and DAQ should begin the critical job of reducing emissions of ozone precursors in the NWF NAA.

III. The 179B(b) Demonstration Falls Well Short of the 179B(b) "But For" and "Weight of the Evidence" Tests.

As DAQ acknowledges:

> Section 179B(b) of the CAA allows a NAA to retrospectively avoid reclassification to a higher nonattainment status **if** the air agency with jurisdiction over the NAA can demonstrate that the area would have met the NAAQS **but for** the influence of pollution emanating from an international source.

DAQ Demo at 6 (emphasis added). Moreover, by its title, Utah's 179B(b) Demonstration claims to be just that – a demonstration that meets the legal requirements of section 179B(b) of the Clean Air Act, which provides:

> any State that establishes to the satisfaction of the Administrator that, with respect to an ozone nonattainment area in such State, such State would have attained the national ambient air quality standard for ozone by the applicable attainment date, **but for** emissions emanating from outside of the United States, shall not be subject to the provisions of section 7511(a)(2) or (5) of this title or section 7511d of this title.

42 U.S.C. § 7509a(b) (emphasis added).

Yet, DAQ admits that, at best, its analysis shows only that there is "evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA." DAQ Demo at 14. Therefore, even when DAQ is stating its best case for the NWF NAA being excused from reclassification to a moderate NAA, the agency can only assert that its "demonstration" provides evidence that international emissions contribute to ozone concentrations, both on exceedance and non-exceedance days. Because, as DAQ admits, such a

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showing is not adequate to make a 179B(b) demonstration, DAQ's efforts to claim "relief" from reclassification necessarily fail.

A. DAQ's Synoptic Pattern Analysis

There are plenty of reasons that DAQ is unwilling to claim more than there is evidence of a contribution by international emissions – particularly emissions from Asia.[10] DAQ's first effort to meet the "but for" test employs a qualitative synoptic analysis of the meteorological conditions during the 2017 summer ozone season. DAQ Demo at 6. The goal of this analysis is to "identify potential days in the NWF NAA impacted by internationally transported ozone[.]" *Id.* In part, DAQ is trying to determine if international emissions might increase when there were subsidence events during the summer months. DAQ Demo at 7. Presumably, DAQ is suggesting that subsidence episodes could function to bring international emissions into the NWF NAA such that the area would experience the ozone concentrations that lead to exceedance days.

However, no such connection was found. Rather, DAQ found that "while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions." DAQ Demo at 8. This means that DAQ has not been able to "identify potential days in the NWF NAA impacted by internationally transported ozone", DAQ Demo at 5, and therefore has failed to establish a key element of an adequate 179B(b) demonstration. For example, EPA 179B Guidance[11] explains that a valid 179B(b) demonstration will include, in part:

> A summary of the meteorological and atmospheric conditions that lead to high concentrations at the monitor on days <u>influenced by international anthropogenic emissions</u> and days <u>not influenced by international anthropogenic emissions</u> [that includes]:
>
> - the meteorological conditions associated with high concentration days influenced by international emissions, including a description of the route traveled by transported pollution, such as distance and altitude; [and,]
> - the meteorological conditions associated with high concentration days not influenced by international emissions.

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[10] Although it is not altogether clear, it appears that DAQ is seeking to show that emissions from Asia are somehow responsible for the NWF NAA's inability to meet the 2015 ozone standard. *E.g.* DAQ Demo at 5 ("Persistent global circulation patterns establish a direct transport route linking the Asian east coast and the US west coast."). Of course, the NWF NAA is not on the west coast.

[11] EPA, Guidance on the Preparation of Clean Air Act Section 179B Demonstrations for Nonattainment Areas Affected by International Transport of Emissions (December 2020).

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EPA Guidance at 9-10. By failing to establish a relationship between weather conditions and high ozone days influenced by international emissions, the 179B(b) Demonstration has failed to pass the first step of a "weight-of-evidence" test.

B. DAQ's HYSPLIT Backward Dispersion Analysis

Next, DAQ undertakes a HYSPLIT backward dispersion analysis to "determine the influence of international anthropogenic source emissions on local ozone concentrations along the NWF[.]" DAQ Demo at 8. Again, DAQ was seeking to "determine predominant meteorological pathways influencing receptor sites" in the Salt Lake Valley. DAQ Demo at 8. Again, DAQ was unable to show that international anthropogenic sources were large contributors relative to U.S. contributions on exceedance days or establish a relationship between international emissions and exceedances of the ozone standard. Rather, DAQ concluded:

> Results from the HYSPLIT analysis suggest that while receptor sites in Utah are impacted to some extent by source emissions outside the US, transport patterns between ozone exceedance and non-exceedance days are not significantly different (Figure 6).

DAQ Demo at 10. Importantly, the agency also conceded that "[a]ir masses originating from Asia were also evident but associated with exceedingly small fractions of particle." DAQ Demo at 10.

Thus, DAQ's second effort to support its 179B(b) Demonstration was unsuccessful. The backward dispersion analysis – meant to determine the influence of international emissions on local ozone concentrations – concluded only that ozone concentrations in the NWF NAA "are impacted to some extent by source emissions outside the U.S." As a result, DAQ's Demonstration has failed to pass the "weight-of-evidence" test.

EPA Guidance states that modeling like HYSPLIT is intended to establish a relationship between international sources and local receptors, noting that "[m]easured exceedances should be connected to international source emissions by meteorological analysis." EPA Guidance at 31. The goal of backward trajectory and backward dispersion models is to show that international contributions are larger on exceedance days and substantially larger than domestic contributions.[12] Because DAQ's modeling did not make any such finding, its HYSPLIT modeling actually undermines rather than supports its 179B(b) Demonstration.

[12] EPA Guidance at 36 ("When exceedance days show larger fractions of NPSC from international anthropogenic sources, this adds to the weight of evidence that international anthropogenic sources contribute to exceedances."); *id.* at 38 ("When the fraction of NPSC is substantially larger on exceedance days than typical days, this strengthens the weight of evidence.").

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C. Ramboll's CMAQ and CAMx Analysis Created for UMA and UPA

Finally, DAQ turns to the "Ramboll CMAQ & CAMx Analysis" to support its 179B(b) Demonstration. Initially, as discussed below, we find it troubling that DAQ appears to accept this analysis uncritically and without disclosing upfront that it was prepared at the behest of the Utah Mining Association and Utah Petroleum Association. As DAQ and Ramboll underscore, this sensitivity analysis and source apportionment methods run for the Utah Mining and Utah Petroleum associations are "preliminary." DAQ Demo at 11.

Despite the fact that both DAQ and Ramboll consider the CAMx and CMAQ efforts to be rather crude beginnings in an effort to support a 179B demonstration, *e.g.* DAQ Demo at 14 (apparently conceding that Ramboll did **not** use "Utah-specific meteorology" in its models); Ramboll Analysis at 20 (stating "[a] more rigorous State-led modeling analysis employing high resolution and area-specific meteorology and emission inventories is warranted to confirm these results and to support a Section 179B demonstration."), DAQ seems to rely heavily on the Ramboll report to claim – sort of – "that the Wasatch Front would attain the 70ppb ozone standard in the absence of international anthropogenic contributions." DAQ Demo at 12.

However, DAQ does admit that both Ramboll models underpredict ozone on high ozone days and may overestimate "international contributions to local" design values. DAQ Demo at 13. DAQ concludes only that Ramboll maintains that despite these modeling inaccuracies, "the NWF would attain the standard but for the contribution of international anthropogenic emissions." DAQ Demo at 13.

First, it is critical that despite Ramboll's claims, DAQ does **not** assert that its demonstration has met the "but for" test. *See* DAQ Demo at 14 (concluding only that "[t]he analyses included in this demonstration provide evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA.").

Second, the Ramboll conclusions do not meet the standards EPA sets forth in its 179B guidance. Relative to sensitivity and source apportionment modeling, EPA repeats the same mantra, explaining that a convincing demonstration will establish that on exceedance days, vis-à-vis non-exceedance days, both that international emission contributions are larger and that international emissions are larger than domestic contributions.

> When results show that international contributions are larger on exceedance days and meaningfully larger than domestic contributions, the weight of evidence will be more compelling.

EPA Guidance at 44. The preliminary Ramboll analysis has not shown either of these outcomes. Rather, at best,[13] the analysis shows, as DAQ itself explains, that international emissions impact the NWF NAA, but there is no relationship between the degree of that impact and exceedance

[13] We point out additional weaknesses in the Ramboll analysis below.

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days. The Ramboll modeling also confirms that indeed, international emission contributions are **not** larger than U.S contributions.

For example, Figure 8 depicts in orange that averaged over the summer of 2016, international anthropogenic emissions contribute 9.9 ppb to total ozone concentrations, while Utah and U.S. anthropogenic emissions – totaling 13.3 ppb – and global natural and re-circulated U.S. emissions together contributed something like[14] 42.6 ppb. Further, Figure 8 appears to show that around August 17, 2016, when there were several exceedance days in Bountiful, U.S. and Utah anthropogenic sources, not including re-circulating or natural U.S. emissions, contributed something like 31 ppb to ozone concentrations, while international sources contributed around 10 ppb. DAQ Demo at 13. Thus, Ramboll's analysis actually undermines the 179B(b) Demonstration rather than supporting it because Ramboll shows that international contributions are **not** larger on exceedance days and are **not** meaningfully larger than domestic contributions.

In sum, as DAQ seems to acknowledge, its demonstration is not adequate to meet the 179B(b) "but for" test. As DAQ explains, the demonstration shows only that there is "evidence that internationally transported ozone contributes to the ozone concentrations on exceedance and non-exceedance days in the NWF NAA." DAQ Demo at 14. Moreover, the three sets of analyses described in the document undermine rather than support DAQ's 179B(b) Demonstration. The demonstration modeling shows that rather than being larger on exceedance days, ozone from international sources contributes to ozone concentrations in the NWF NAA on both exceedance and non-exceedance days and that there is no correlation between international emissions and exceedance days. The modeling also shows that international contributions are not larger than domestic contributions and that indeed, on exceedance days, international contributions decrease and may be dwarfed by domestic contributions.

IV. The 179B(b) Demonstration Does Not Address and Does Not Meet the Requirements of EPA Guidance.

As already discussed and as DAQ apparently acknowledges, the 179B(b) demonstration is not adequate to meet the "weight of the evidence" test that EPA will apply to a state submission.[15] Initially, we find it disconcerting that DAQ does not discuss the results of its modeling and the

[14] The numbers in this table are difficult to read. Moreover, domestic contributions must include, at a minimum, Utah and U.S. anthropogenic emissions, including re-circulating U.S. anthropogenic emissions, as well as U.S. natural emissions. Even when domestic contributions are limited to anthropogenic contributions, the total calculated by Ramboll (which apparently does not include recirculating anthropogenic contributions) exceeds Ramboll's calculation of international contributions.

[15] EPA Guidance at 7 ("Given the extensive number of technical factors and meteorological conditions that can affect international transport of air pollution, EPA believes that section 179B demonstrations should be evaluated based on the weight of evidence of all information and analyses provided by the air agency.").

Ramboll modeling in the context of the December 2020 EPA Guidance. Indeed, DAQ does not even mention the weight of the evidence test or the modeling outcomes that the EPA would find compelling. At a minimum, such an analysis would allowing members of the public to meaningfully comment on the 179B(b) Demonstration because they would better understand the degree to which DAQ believes it has met the weight of the evidence test. For this reason, we ask DAQ to explain if and the extent to which it believes it has established the "but for" test by the weight of the evidence and whether and how it has presented modeling that EPA would find convincing.

Turning to the EPA Guidance to further inform these comments confirms that the 179B(b) Demonstration is not adequate to negate Utah's obligation to its citizens to adopt emission reductions that will bring the NWF NAA into compliance with the ozone standard as soon as possible.

First, EPA acknowledges that it will be harder for a state like Utah, located away from an international border, to submit a convincing 179B(b) Demonstration: "[T]echnical demonstrations for non-border areas may involve additional technical rigor and resources compared to demonstrations for border areas." EPA Guidance at 6. Both DAQ and Ramboll concede that their modeling is preliminary. *E.g.* DAQ Demo at 13 ("[]DAQ could conduct a more rigorous analysis that would optimize the photochemical model performance for NWF NAA"); DAQ Demo at 14 (apparently conceding that Ramboll did **not** use "Utah-specific meteorology" in its models); Ramboll Analysis at 20 (stating "[a] more rigorous State-led modeling analysis employing high resolution and area-specific meteorology and emission inventories is warranted to confirm these results and to support a Section 179B demonstration."). Therefore, on its face, the demonstration is insufficiently rigorous and resource intensive.

Second, EPA also puts a premium on identifying the sources of the international emissions that, in this case, DAQ believes are influencing ozone concentrations in the NWF NAA: "The conceptual model should also identify which regions and sources meaningfully contribute to the international portion of emissions that influence ambient concentrations in the area of interest." EPA Guidance at 19. DAQ does not identify any such regions or sources (other than to vaguely refer to Asia, Canada and Mexico). EPA also states that "[a] comprehensive emissions analysis is an important component of a section 179B demonstration." EPA Guidance at 39. This emissions analysis should include domestic emissions. *Id.* DAQ does not undertake a comprehensive emissions analysis, even for domestic or Utah emissions.

Third, and importantly, DAQ consistently fails to address EPA's request that DAQ identify particular days and particular monitoring stations that it considers influenced by international anthropogenic emissions. For example, EPA explains that the "kinds of information that would typically be useful to include in a conceptual model" includes:

- "A list of the monitor(s) and days that the air agency has identified as influenced by international anthropogenic emissions;" [and,]

- "A description of the key differences between the measured exceedances influenced by international emissions concentrations and typical exceedances influenced by local, non-international emissions. It would be helpful to include a table of the relevant monitor data (e.g., date, hours, monitor values, and design value calculations with and without the international emissions)[.]"

EPA Guidance at 19. EPA elaborates further:

> A well-constructed conceptual model of pollutant formation and transport for the area can assist in the determination of international transport impacts by highlighting the contrast between locally formed pollutant days and the internationally influenced days in question.

EPA Guidance at 18-19.

Rather than identifying, comparing and contrasting specific days or monitoring stations, DAQ acknowledges that its analysis does not distinguish between or find differences among any particular days or monitoring stations, much less identify specific days during the relevant 2018 to 2020 timeframe that are relevant to its analysis.

Fourth and relatedly and as discussed above, DAQ's demonstration does not address or find a key component of an adequate 179B(b) demonstration – a relationship between international emissions and days that exceed the ozone standard (or contribute to a violation of the standard):

> A retrospective demonstration pursuant to sections 179B(b)-(d) (i.e., one intended to avoid a reclassification by showing that an area would have attained the standard but for international emissions) should illustrate that air quality was influenced by international emissions on specific days during the years that contribute to the design value calculation for the area.

EPA Guidance at 6; *see also* EPA Guidance at 19-20 (requesting that a state provide "[a] summary of the meteorological and atmospheric conditions that lead to high concentrations at the monitor on days influenced by international anthropogenic emissions and days not influenced by international anthropogenic emissions" that includes "the meteorological conditions associated with high concentration days influenced by international emissions, including a description of the route traveled by transported pollution, such as distance and altitude" and "the meteorological conditions associated with high concentration days not influenced by international emissions."); EPA Guidance at 31 (To establish an international source-receptor relationship "measured exceedances should be connected to international source emissions by meteorological analysis."); EPA Guidance at 40 ("Using air pollution modeling techniques – such as chemical transport models or dispersion models is the most complete way to estimate the contribution of international emissions to monitors exceeding the NAAQS.").

Rather, as DAQ admits, its analysis shows no correlation between international emissions and high ozone days. For example, DAQ explains that its synoptic pattern analysis indicates only

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that "while international emissions are likely to have an impact on Utah ozone measurements, differences between ozone exceedance and non-exceedance days do not appear to be correlated with changes in international emissions." DAQ Demo at 8. DAQ concludes that its HYSPLIT backward dispersion analysis shows only that "while receptor sites in Utah are impacted to some extent by source emissions outside the US, transport patterns between ozone exceedance and non-exceedance days are not significantly different." DAQ Demo at 10. Similarly, according to DAQ, the Ramboll analysis reveals only that

> that receptor sites in the NWF NAA are impacted by international sources during the summer exceedance season. This influence is, however, observed consistently throughout the spring and summer and not just on high ozone exceedance days.

DAQ Demo at 14.

Finally, EPA Guidance consistently states that a compelling 179B demonstration will show that, on exceedance days, the contribution from international emissions is "meaningfully" larger than contributions from domestic sources:

> When a section 179B demonstration shows that international contributions are larger than domestic contributions, the weight of evidence will be more compelling than if the demonstration shows domestic contributions exceeding international contributions."

EPA Guidance at 7; *see also* EPA Guidance at 43 ("The range of results should demonstrate that international anthropogenic sources were large contributors relative to U.S. contributions on exceedance days."); EPA Guidance at 44 ("When results show that international contributions are larger on exceedance days and **meaningfully** larger than domestic contributions, the weight of evidence will be more compelling."); EPA Guidance at 36 ("When exceedance days show larger fractions of NPSC from international anthropogenic sources, this adds to the weight of evidence that international anthropogenic sources contribute to exceedances."); EPA Guidance at 38 (same).

However, DAQ admits that it could not show that that international anthropogenic sources were large contributors relative to U.S. contributions on exceedance days, explaining that the influence of international contributions "is also relatively small in comparison to the composition total of ozone." DAQ Demo at 14. Moreover, as explained above, examination of Figure 8 – a figure prepared by Ramboll at the behest of UMA and UPA – indicates that around August 17, 2016, when there were several exceedance days in Bountiful, U.S. and Utah anthropogenic sources, not including re-circulating or natural U.S. emissions, contributed something like 31 ppb to ozone concentrations, while international sources contributed around 10 ppb. DAQ Demo at 13. Plainly, 10 is not greater than 31.

Thus, reference to EPA Guidance indicates that DAQ's Demonstration has failed to meet the 179B(b) "but for" test as well as EPA's weight of the evidence test. DAQ's unwillingness to

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acknowledge or address EPA's guidance considerably weakens its purported demonstration and makes it very difficult for the public to evaluate or comment on this crucial document.

V. The 179B(b) Demonstration Is Improperly Based on a Modeling Exercise Paid for by the Utah Mining Association and Utah Petroleum Association that DAQ Appears to Adopt without any Vetting.

Although Ramboll prepared its CAMx and CMAQ analysis for the Utah Mining Association and Utah Petroleum Association, DAQ does not disclose this fact in its demonstration. The agency also fails to critique the Ramboll analysis in any way and seems to adopt the Ramboll modeling exercise in total without question.

This approach to an analysis done at the behest of third parties is inappropriate and fails to safeguard the interests of the public DAQ is duty bound to serve. This apparent adoption of the Ramboll analysis without critique also undermines DAQ's efforts to meet the 179B(b) "but for" test as well as EPA's weight of the evidence test. For example, EPA Guidance contains an extensive discussion of sensitivity and source apportionment analyses that Ramboll purports to carry out. *E.g.* EPA Guidance at 41 to 44. EPA also explains what types of outcomes from these types of analyses it considers to be compelling. *E.g.* EPA Guidance at 43 ("The range of results should demonstrate that international anthropogenic sources were large contributors relative to U.S. contributions on exceedance days."); EPA Guidance at 44 ("When results show that international contributions are larger on exceedance days and **meaningfully** larger than domestic contributions, the weight of evidence will be more compelling.").

Yet, DAQ does not explain the extent to which it believes the Ramboll analyses comports with EPA Guidance or is persuasive based on what EPA considers to be compelling modeling outcomes. Plainly, such an approach lacks rigor, appears biased and fails to support DAQ's demonstration.

VI. The Ramboll CMAQ & CAMx Is Not Compelling.

There are additional reasons not already mentioned above that the Ramboll analysis is unconvincing. First, Ramboll attempts to show that international emissions are causing the NWF's non-attainment by comparing the estimated international anthropogenic contribution to the margin by which the NWF exceeds the ozone NAAQS. Inexplicitly, Ramboll bases this analysis on the summer of 2016 in Bountiful, DAQ Demo at 11-12, and then extrapolates this analysis to what happened everywhere in the NWF during 2018 to 2020. DAQ Demo at 13 (Table 2). This degree of extrapolation is not persuasive and fails to justify DAQ's request that it be excused from the requirements of the Clean Air Act that apply to moderate nonattainment areas.

Second, Ramboll admits that both its models underpredict ozone on high ozone days, DAQ Demo at 13, the very days that matter most to the 179B(b) "but for" test and the EPA weight of

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the evidence test. This, combined with the other weakness that plague the Ramboll analysis, further confirms that the modeling effort is not compelling.

Third, Ramboll also concedes that this underprediction is most "likely due to a lack of local ozone production, which could lead to an overestimation in the international contributions to local" design values. DAQ Demo at 13. To address this model failure, Ramboll references a 10,000-foot monitoring site in the Colorado Rockies. Ramboll at 12. Ramboll claims that "its remote location results in little influence from local urban areas and so it provides an indication of higher elevation, regional and global scale ozone concentrations over the western US." *Id.*

Initially, it is quite an assumption to presume that one monitoring site can reflect regional and global ozone concentrations over the entire western US. Further, this assumption appears to contradict EPA's conclusion that

> While some surface monitoring locations in certain rural areas in the inter-mountain western U.S. can be substantially affected by USB O_3, multiple analyses have shown that even the most remote O_3 monitoring locations in the U.S. are at least periodically affected by U.S. manmade emissions. As a result, the EPA believes that it is inappropriate to assume that monitored O_3 levels at a remote surface site (e.g., Grand Canyon or Yellowstone National Parks) can be used as a proxy for USB O_3.[16]

Without explanation and in light of EPA's assessment, Ramboll's efforts to insist that its modeling is representative necessarily fail.

Furthermore, and again without explanation, Ramboll suggests that it can evaluate the performance of its model by referencing a site at 10,000 feet above sea level that does not share any of the characteristics of the NWF NAA. In particular, it appears that the problem with the Ramboll modeling is a failure to capture ozone that is produced locally in the NWF. However, it is difficult to understand how reference to a site that is not near urban emission sources can help evaluate model results for the 4300 foot Salt Lake Valley. Because Ramboll does not adequately justify its decision to use the Colorado site to assess its model, the analysis is unavailing.

Fourth, neither Ramboll's modeling nor atmospheric science support the idea that the international contribution can be precisely determined by subtracting the zeroed-out design value from a reference value. There may be an inverse relationship between local ozone formation and longer-range ozone transport, due to the fact that ozone reaches a chemical equilibrium at a certain concentration. Ramboll has not shown that the zeroed-out method accurately accounts for the possibility that the local contribution would increase if the international contribution were removed.

[16] EPA, Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone, White Paper for Discussion (December 2015) at 7.

Fifth, Ramboll claims that its findings are in keeping with EPA analysis. However, in its White Paper, EPA concluded that:

> Existing modeling analyses indicate that U.S. manmade emission sources are generally the dominant contributor to the modeled exceedances of the 2015 O3 NAAQS, nationally and within individual regions across the country. Higher O_3 days generally have smaller fractional contributions from USB across all regions. When averaged over the entire U.S., the models estimate that the mean USB fractional contribution to daily maximum 8-hour average O_3 concentrations above 70 ppb is less than 35 percent.[17]

Sixth, as discussed above, Ramboll considers its modeling to be preliminary and admits that much more needs to be done to before its modeling can support a 179B(b) demonstration. Ramboll at 20. Ramboll concludes that "[a] more rigorous State-led modeling analysis employing high resolution and area-specific meteorology and emission inventories is warranted to confirm these results and to support a Section 179B demonstration."

Finally, DAQ seems to acknowledge the weaknesses in the Ramboll analysis, noting that it reveals only that

> that receptor sites in the NWF NAA are impacted by international sources during the summer exceedance season. This influence is, however, observed consistently throughout the spring and summer and not just on high ozone exceedance days.

DAQ Demo at 14.

Taken together, these short comings indicate that the Ramboll report is not adequate to support DAQ's efforts to meet the "but for" requirements of 179B(b) and the weight of the evidence test imposed by EPA guidance. Because the DAQ demonstration does not fulfill these criteria, it should be dismissed and DAQ should begin the critical job of reducing emissions of ozone precursors in the NWF NAA.

VII. Conclusion

In sum, the weight of the evidence uniformly discredits the idea that international anthropogenic emissions are a substantial factor in causing non-attainment in the NWF NAA. DAQ has not produced sufficient evidence to suggest that the NWF NAA is uniquely affected by international anthropogenic emissions. To the contrary, it appears that the NWF is too far from Asia, Mexico or Canada to be meaningfully impacted by emissions from these countries and continent. While the component of the boundary condition that can be attributed to international anthropogenic emissions may have a modest impact on NWF NAA's ozone levels, this impact is tiny in comparison to the impact caused by domestic sources, including the Wasatch Front itself.

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[17] EPA, Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone, White Paper for Discussion (December 2015) at 3

Based on the above and in light of your duty to protect public health and welfare and the environment, we urge you to drop efforts to make a 179B(b) demonstration and to instead focus your efforts on reducing ozone concentrations in the NWF NAA.

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VIA ELECTRIC SUBMISSION TO:
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May 26, 2021

Utah Division of Air Quality
P.O. Box 144820
195 North 1950 West
Salt Lake City, UT 84114-4820

Subject: Chevron Salt Lake Refinery Comments UDAQ's 179B Demonstration for the Northern Wasatch Front Ozone Nonattainment Area

To Whom It May Concern,

The Chevron Products Company Salt Lake Refinery ("Chevron") appreciates the opportunity to provide these comments regarding the Utah Division of Air Quality ("UDAQ") Clean Air Act 179B(b) Demonstration for the Northern Wasatch Front Ozone Nonattainment Area. The Salt Lake Refinery has four comments.

1. We kindly request that EPA allow time for UDAQ to perform the photochemical modeling necessary to *quantify* the international ozone contribution. We believe it will show that the Wasatch Front would attain the 70 ppb ozone standard, but for emissions emanating from outside the U.S. (as the Ramboll modeling shows).
2. Ozone transportation from Asia to the intermountain west is well-documented and even discussed in EPA's 179B guidance document (December 2020). We urge EPA *not* to rely on, or require of UDAQ, methodologies only applicable to border states. Instead, we believe the 179B "test" is simple – would the area attain the 70 ppb standard but for emissions emanating outside the U.S.? This is the only question that needs to be answered in a 179B demonstration. The amount of international emissions compared to local emissions should not be a factor in determining if a non-attainment area meets the "but for" test. Further, the amount of international emissions on exceedances versus non-exceedances days does not seem relevant to Utah's 179B demonstration. We do not see any rationale for why the international emissions should be higher on exceedances days. If international emissions were removed from the total ozone concentration, would the area attain the standard? We believe this is the test required by the Clean Air Act.
3. Chevron believes the statement on page 73 "Results do not suggest a strong impact from international emissions sources on local ozone concentrations" is premature and unfounded. The HYSPLIT analysis only evaluates transport **below 1,000 meters,** which is too low to capture all of the ozone transported from Asia to Utah. Further, **if international ozone contributes enough to put the Northern Wasatch Front above 70 ppb, then it is significant**. The CAA does not specify a minimum concentration; rather,

EPA should consider whether the international contribution is policy relevant. 8.7 to 12.7 ppb ozone (page 12) is hardly insignificant.

4. Chevron questions the relevance of the statement in the "Conclusions" section on page 14 of the 179B demonstration, "The amount is also relatively small in comparison to the composition total of ozone." UDAQ seems to be suggesting the amount of international emissions is relatively small compared to total ozone. The same could also be said for local emissions. Regardless of which contribution is more or less, we do not believe either needs to be proven for a successful 179B demonstration. In a presentation to UDAQ and EPA on April 9, 2021, Dr. Dan Jaffe (University of Washington, author of many scientific papers on ozone, including "Evaluation of ozone patterns and trends in 8 major metropolitan areas in the U.S.," January 2021) presented a slide showing that background ozone (all sources that can't be regulated (international pollution, biogenic, lightning, soil, and stratospheric ozone)) makes up the **majority of ozone** on the 10 highest ozone days in summer (for EPA Region 8, which includes Utah). Dr. Jaffe's data show that **57 ppb falls into the category of background ozone**, while less than 13 ppb falls into the category of local (Jaffe D.A., Fiore A.M. and Keating, T.J. 2020. Importance of Background O3 for Air Quality Management. EM November 2020).

If you have any questions regarding this request, please contact Rachel Agnew at 801-539-7264 or RachelAgnew@chevron.com.

Sincerely,

Serena Yau

Serena Yau

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May 26, 2021

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Sent via email to: rbares@utah.gov and lthrailkill@utah.gov

Subject: Comments from Utah Petroleum Association (UPA) and Utah Mining Association (UMA) Regarding Northern Wasatch Front Ozone International Transport Demonstration 179B(b)

The Utah Petroleum Association ("UPA") and Utah Mining Association ("UMA") (jointly, the "Associations") thank the Utah Division of Air Quality ("UDAQ") for providing this opportunity to comment on the proposed demonstration regarding the influence of international emissions on air quality in the Northern Wasatch Front ("NWF") ozone nonattainment area ("NAA") under §179B(b) of the federal Clean Air Act ("CAA") (the "Proposed Demonstration").

UPA was founded in 1958 and its members comprise every segment of the petroleum industry in Utah. UPA's members include five companies that own and operate petroleum refineries - Big West, Chevron, HollyFrontier, Marathon Petroleum, and Silver Eagle – within the NWF NAA. Thus, we have an interest in the air quality and pursuit of attainment in the area.

UMA was founded in 1915 and represents Utah mine operators and service companies which support the mining industry. Numerous UMA member companies operate within the NWF NAA, the largest of which is Rio Tinto Kennecott, whose Bingham Canyon Mine is one of the largest copper mines in the world and one of the very few which operates in a densely populated urban interface area. UMA has an interest in air quality and reaching attainment in order to protect the health of the communities in which our member companies operate.

Under the 2015 ozone National Ambient Air Quality Standard ("NAAQS"), the Environmental Protection Agency ("EPA") designated the NWF as nonattainment with a classification of Marginal and an effective date of August 3, 2018, thus establishing the attainment date of August 3, 2021.[1] Under the CAA, if an area fails to attain the NAAQS by the attainment date, EPA shall reclassify

[1] See 40 CFR Part 51 Subpart CC §51.1303 Table 1 which sets the attainment date for Marginal ozone nonattainment areas under the 2015 ozone NAAQS to three years after the effective date of designation.

it by operation of law to a higher nonattainment classification,[2] a process commonly called "bump up".

Notwithstanding bump up requirements for areas that fail to attain the NAAQS, CAA §179B allows an area to remain at its current classification without bump up to the next higher classification if the area would attain "but for emissions emanating from outside the United States."[3]

Ozone in the NWF poses a complex situation influenced by many factors including local, domestic, and global anthropogenic emissions; wildfires; other biogenic or natural emissions and occurrences; the Great Salt Lake; and meteorology. The NWF has a large amount of "background" ozone which is ozone that neither Utah nor the United States ("U.S.") federal government can control including that caused by various natural sources and by emissions emanating from outside the U.S. In particular, the influence of international anthropogenic emissions on the intermountain west has been recognized for decades and is well-documented in scientific literature. The component of NWF ozone generated by local emissions comprises a relatively small portion of total NWF ozone.

Amanda Smith, the former Executive Director of the Utah Department of Environmental Quality, summed the situation up perfectly as she concluded in testimony before the U.S. Congress that ". . . mechanisms to account for background ozone that can't be controlled must be in place . . .. Otherwise, states such as Utah might not be able to develop successful state implementation plans and will be essentially set up for failure."[4]

Section 179B of the CAA provides an essential mechanism for the NWF. When submitted, the Proposed Demonstration will be the the first such demonstration for a non-border state. It will be essential that EPA consider the Proposed Demonstration fairly and appropriately based on the applicable legal standard and the compelling weight of evidence. A successful NWF CAA §179B demonstration ("Demonstration") will provide the essential time for Utah to determine what if any control strategies may ultimately bring the area back into attainment, develop regulations to put appropriate control strategies in place, and allow the effect of control strategies to come to fruition.

The Associations commend UDAQ for developing the Proposed Demonstration for the NWF NAA and submitting it to EPA. Moving ahead with it attests to UDAQ's knowledge of the complexities of NWF ozone and of what it will take to successfully meet CAA requirements.

A successful Demonstration for global transport to the NWF recognizes the large and relatively constant influence of global emissions on NWF ozone as sufficient to meet the CAA §179B requirement that the area "would have attained the national ambient air quality standard for ozone by the applicable attainment date, but for emissions emanating from

[2] CAA §181(b)(2)(A).

[3] See CAA §179B(a)(2) in general and §179B(b) for ozone nonattainment areas.

[4] "Background Check: Achievability of New Ozone Standards"; Hearing before the Subcommittee on Environment Committee on Science, Space, and Technology; House of Representatives; One Hundred Thirteenth Congress, First Session; June 12, 2013; Serial No. 113-35.

outside of the United States." Meeting the "but for" test establishes policy relevance and approvability, and it constitutes the <u>only</u> criteria for which the Demonstration must meet.

The Proposed Demonstration includes photochemical modeling performed by Ramboll using EPA's 2016 national modeling platform. It provides the best and most applicable analysis available at this time of the influence of international emissions on NWF ozone and provides a preliminary demonstration that the area meets the "but for" test.

As described in Ramboll's report, the Proposed Demonstration presents a unique challenge in Utah for several reasons:[5]

1. Utah is well-removed from international borders.
2. Ozone is a secondary compound formed from complex non-linear chemical interactions among nitrogen oxide ("NOx") and volatile organic compound ("VOC") emissions from a multitude of sources.
3. Relative to its NAAQS, ozone has a substantial global background that is derived from both natural and anthropogenic processes, including the stratosphere.
4. Ozone can persist for days to weeks in the mid to upper troposphere, which extends its source attribution to the global scale.

Therefore, ***photochemical models, which can address <u>all</u> of these processes, are the <u>only</u> tools capable of comprehensively assessing and quantifying ozone source-receptor linkages on international scales and on time scales ranging from days to seasons.***

As we discuss below, UPA encourages UDAQ to proceed with more locally specific modeling of the NWF to bolster Ramboll's preliminary modeling. As Ramboll and UDAQ point out, the modeled international ozone contribution to NWF may be somewhat overestimated in EPA's 2016 modeling platform potentially due to several issues. Localized modeling should help to determine a more accurate number. Nevertheless, Ramboll estimates that the error is likely within 2 parts per billion ("ppb")[6] of the 8-13 ppb total design value impact[7], whereas the amount of ozone reduction needed to meet the "but for" test of CAA §179B is 6-7 ppb for a current design value of 77-78 ppb. Thus, the modeled design value impact includes a buffer of 2-6 ppb and application of exceptional events due to recent regional wildfires would lower the design value to provide additional buffer.

We urge EPA to allow UDAQ the time needed to complete the locally specific modeling.

We have additional suggestions to consider for the Proposed Demonstration as follows:

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[5] "Modeling International Ozone Contribution to Wasatch Front Nonattainment Areas." Ramboll, Novato, CA (February 2021) ("Ramboll Modeling Report"), p. 20.
[6] Ramboll Modeling Report, p. 12.
[7] Ibid, p. 4.

- The Demonstration need only show that the NWF would have attained "but for emissions emanating from outside the United States," in accordance with the plain language of the CAA. Attempts to meet a different standard do not serve a useful purpose.
- Technical considerations unique to transport along border areas should not be used to evaluate Demonstrations for global transport to non-border areas and should be removed from the Proposed Demonstration. EPA should not expect to see them included.
- The Proposed Demonstration would be enhanced and strengthened by:
  - Including a more fulsome discussion of all the components of NWF ozone instead of focusing only on the component that results from international emissions
  - Addressing other information in the conceptual model as applicable
  - Providing more expansive weight of evidence, drawing on the scientific literature consistent with the conceptual model and photochemical modeling results
  - Correcting misstatements and erroneous conclusions

We discuss each of these in detail below.

A. UDAQ should proceed with the additional modeling and EPA should provide UDAQ with sufficient time to do so.

Ramboll's preliminary modeling exercise suggests that CAA §179B provisions are applicable for the NWF. In that study, it was important to quantify the ability of EPA's national-scale modeling platform to sufficiently replicate historical 2016 ozone patterns in space and time relative to monitored ozone data along the NWF.

Good performance helps establish trust that the model is correctly characterizing chemical and physical processes and responds correctly to input modifications. In particular, the complex topography of the NWF influences meteorology and air quality patterns, presenting challenges to any air quality modeling exercise. The 12 kilometer ("km") grid resolution of the EPA's national modeling platform does not adequately resolve the local terrain features, nor details in urban vs. rural (biogenic) emission distributions, adding to model uncertainty with respect to the mix of local vs. regional ozone production and transport. Furthermore, while EPA develops the best possible nationwide information at each iteration of their modeling platform, EPA does not spend the considerable time necessary to fine-tune model inputs and treatments by which to optimize model performance in specific areas of the US.

A more rigorous State-led modeling analysis employing higher resolution and area-specific meteorology and emission inventories is warranted to support the Demonstration. The final EPA guidance on 179B demonstrations describes many analyses that could be performed,[8] each providing specific insights into the amount, frequency, and transport mechanisms associated with international contributions. Taken together, multiple lines of evidence from an array of analyses help strengthen the weight of evidence for a successful demonstration.

[8] "Guidance on the Preparation of Clean Air Act Section 179B Demonstrations for Nonattainment Areas Affected by International Transport of Emissions" EPA-457/P-20-001F, December 2020 ("179B Guidance" or "guidance").

Therefore, the Associations support proceeding with the additional photochemical modeling. Furthermore, we urge EPA to ensure UDAQ has sufficient time to do so. We provide specific recommendations regarding the photochemical modeling protocol later in these comments.

B. The NWF meets all legal criteria for a successful Demonstration. EPA should approve the Demonstration.

a. Requirements of CAA §179B

A successful CAA §179B demonstration need only show that the area would have attained the NAAQS "but for" the influence of international emissions. CAA §179B(a) states:

> *Implementation Plans and Revisions.— Notwithstanding any other provision of law, an implementation plan or plan revision required under this Act* ***shall be approved by the Administrator if—***
>
> *(1) such plan or revision meets all the requirements applicable to it under the Act other than a requirement that such plan or revision demonstrate attainment and maintenance of the relevant national ambient air quality standards by the attainment date specified under the applicable provision of this Act, or in a regulation promulgated under such provision, and*
>
> *(2) the submitting State establishes to the satisfaction of the Administrator that the implementation plan of such State would be adequate to attain and maintain the relevant national ambient air quality standards by the attainment date specified under the applicable provision of this Act, or in a regulation promulgated under such provision, but for emissions emanating from outside of the United States.*
> (emphasis added)

While this portion of §179B might appear to have greater relevance to NAAs classified as Moderate or higher which require certain emissions control strategies and a specific demonstration of attainment as part of the State Implementation Plan ("SIP"), the provision applies equally to Marginal areas. The CAA discusses several "plan requirements" for Marginal areas including emissions inventory, major source air permitting, periodic inventory updates, emissions statements, and offset requirements.[9] In discussing the requirements for §179B, EPA stated, "The EPA believes the CAA's specific provisions for ozone Marginal areas in section 182(a) rather than general nonattainment provisions in section 172(c)(1) prescribe the specific SIP revision requirements for such areas."[10]

Moreover, EPA stated, "[I]f a Marginal area (which is not otherwise required to submit an attainment demonstration) were to submit to the EPA a demonstration that they could attain the

[9] See CAA §182(a).
[10] "Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area State Implementation Plan Requirements" final rule; Federal Register, Vol. 83, No. 234; December 6, 2018 ("final 2015 Implementation Rule"); p. 63010.

standard but for international emissions, the EPA would be able to evaluate that demonstration similarly to demonstrations submitted by higher classified areas."[11] In other words, EPA would consider how photochemical modeling and other elements of the demonstration show attainment of the NAAQS but for emissions emanating from outside of the U.S.

CAA §179B(b) which is specific to ozone NAAs states:

> *(b) Attainment of Ozone Levels.— Notwithstanding any other provision of law, any State that establishes to the satisfaction of the Administrator that, with respect to an ozone nonattainment area in such State, such State* ***would have attained the national ambient air quality standard for ozone*** *by the applicable attainment date,* ***but for emissions emanating from outside of the United States, shall not be subject to the provisions of section [181(b)(2)]***[12,13] *or (5) or section 185. [emphasis added]*

These two provisions, §179B(a) and §179B(b), provide all of the requirements for an ozone NAA to be eligible for treatment under §179B and not be subject to bump up. In addition to meeting the applicable SIP requirements, ***CAA §179B requires only that the State establish that the area would have attained "but for emissions emanating from outside the United States."***

In other words, a 179B demonstration need only meet this "but for" test to be policy relevant and approvable. The plain language of the CAA adds no other limitations on the use of §179B. Furthermore, under §179B(a), the Administrator ***shall approve*** such a demonstration.

b. Relative comparisons of ozone

Any attempt to establish that international emissions influence on NWF ozone is greater on exceedance days than on non-exceedance days disagrees with the conceptual model describing "semi-permanent" pressure systems that transport global ozone aloft to the elevated terrain of the western U.S. Along the U.S./Mexico border, the influence of emissions emanating from outside the U.S. varies significantly through the ozone season depending whether the wind comes out of the south on a given day. On the other hand, for long-range global transport, the influence may be relatively constant through the ozone season as the 179B Guidance infers with its use of the

[11] "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements" final rule; Federal Register, Vol. 80, No. 44; March 6, 2015 ("final 2008 Implementation Rule"), p. 12294.

[12] See "State Implementation Plans; General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990", General preamble for future proposed rulemakings; Federal Register, Vol. 57, No. 74; April 16, 1992 ("General Preamble"), note 41 on page 13569, which states, "Note that the statute contained an erroneous reference to section 181(a)(2) instead of 181(b)(2)." EPA has not changed their position on this reference; the recently finalized 179B Guidance, states, "EPA's longstanding view is that CAA section 179B(b) contains an erroneous reference to section 181(a)(2), and that Congress actually intended to refer here to section 181(b)(2)." See also note 7 on page 3 of the 179B Guidance.

[13] CAA §181(b)(2) refers to reclassification of ozone nonattainment areas upon failure to attain the NAAQS, in other words bump up.

term "semi-permanent" in its syntheses of scientific literature regarding global transport to the U.S. west coast[14] and as shown for the NWF in the Ramboll Modeling Report.[15]

The near-constant influence of global emissions on NWF ozone qualifies for treatment under CAA §179B(b) as long as the NAA would have attained but for these global emissions.

Similarly, it does not matter if peak ozone on certain days is primarily attributable to local or internationals sources or even if the relative amount of locally formed ozone exceeds the amount attributable to global sources on exceedance days, as long as the area would have attained "but for emissions emanating from outside the United States."

EPA received feedback about these issues in comments on the draft 179B Guidance and discussed them in its response to the comments for the draft guidance.

- The response to comments summarized EPA's position in the draft guidance as, "'The range of results should demonstrate that international anthropogenic sources were large contributors relative to U.S. contributions on exceedance days.' and 'When results show that international contributions are larger on exceedance days and meaningfully larger than domestic contributions, the weight of evidence will be more compelling.'"

- EPA summarized the commenters' rationale for opposing this position in the draft guidance as, "This comparison is not rooted in the statute and therefore oppose EPA's position in the draft guidance. Request EPA to clarify that an approvable demonstration does not have to show that international emissions solely or primarily caused the exceedances."

- EPA advanced its original position in the draft with minor clarifications and explained in the response to comments:

> *The legislative history supports the conclusion that Congress designed section 179B to apply to nonattainment areas with large amounts of international transport that made attainment of the NAAQS difficult, if not impossible, through controls on domestic sources. As such, it makes sense that a comparatively large international contribution would support a successful 179B demonstration more than if the domestic contribution were larger.* ***The guidance frames this as a recommendation rather than a requirement. This approach maintains flexibility*** *for states and EPA to later make decisions based on area-specific facts. Alternatively, if the guidance did not have a recommendation for what would make*

[14] See Section 2.2 regarding long-range transport in 179B Guidance, specifically the discussion of the synthesis of literature on p. 9. See also Proposed Demonstration, p. 5.
[15] See time series in Proposed Demonstration, pp. 109-112.

> *a strong demonstration, the guidance would not be as helpful to states or to EPA when evaluating a demonstration.*[16] *(emphasis added)*

In other words, EPA makes it clear in the response to comments that ***statements in the guidance regarding the size of international contributions relative to domestic contributions are not requirements and allow flexibility to make decisions based on area-specific facts.*** Nonetheless, for the NWF, the Ramboll Modeling Report shows nearly 10 ppb of influence from global emissions on NWF ozone,[17] a large international contribution at 14% of the level of the NAAQS.

c. Congress intent for CAA §179B

No matter how large the international contribution and no matter how the international contribution compares to local and domestic contributions to ozone in the NWF area, neither Utah nor the U.S. Federal government can control the international contribution. Congress intended for CAA §179B to address this situation for ozone and other air pollution that neither the state nor the U.S. federal government can control. In comparing and contrasting the interstate transport provisions of the CAA to the provisions of §179B regarding the influence of international emissions, EPA stated the following:

> *. . . . [T]he kind of concerns that led Congress to adopt section 179B for international border areas—concerns that areas not be held accountable for pollution over which they exercise no control.*[18]
>
> *The fact that upwind States are subject to the requirements of section 110(a)(2)(D) [related to interstate transport] but other countries are not provides a possible explanation as to why Congress explicitly provided that ozone nonattainment areas not be reclassified upwards if they would have attained by their attainment dates "but for emissions emanating from outside" the United States (section 179B(b)) but provided no such express exemption from the reclassification provisions in the case of domestic transport. See IV 1990 Legis. Hist. 5741–42 (remarks of Sen. Gramm introducing the international provision and Sen. Baucus supporting it; Senator Gramm stated: "It is unfair to hold El Paso accountable for pollution that is generated in a foreign country that they have no control over. So what this amendment does it says that in assessing whether or not the State implementation plan has been met, and when assessing the levels of ozone * * * pollution that is being generated across the border has to be taken into account so that*

[16] See "Review of Draft CAA Section 179B Guidance on International Emissions" from "EPA – Section 179B Guidance Briefing for OMB – September 16, 2020" ("Response to Comments for the Guidance") located in the docket for the guidance comments, Docket Number EPA-HQ-OAR-2019-0668 located on regulations.gov ("Docket") at https://www.regulations.gov/document/EPA-HQ-OAR-2019-0668-0025 (accessed on May 17, 2021).

[17] Proposed Demonstration, p. 94.

[18] "Approval and Promulgation of Air Quality Implementation Plans; Connecticut; One-Hour Ozone Attainment Demonstration and Attainment Date Extension for the Greater Connecticut Ozone Nonattainment Area" Final Rule; Federal Register, Vol. 66, No. 2; Wednesday, January 3, 2001 ("Connecticut One-Hour Attainment Date Extension"); p. 638.

> *our cities and regions will be judged based on what they do. * * *. [The State, region and city] will have the opportunity to come to EPA an[d] say that they are in compliance in terms of their emissions, that their failure to meet the overall standards is due to something that is happening in a sovereign foreign country over which they exercise no control." Senator Baucus stated that, "It is clear that cities like El Paso in the State of Texas do not have control of their own destiny themselves. Much of the air that affects them is from outside, from another country, over which the Senator said the State of Texas and EPA in this country has virtually no control.").*[19] (p. 640)

In the NWF, neither Utah nor the U.S. federal government has control over the very significant portion of NWF ozone caused by the influence of international emissions, just exactly the situation that Congress intended to address by including §179B in the CAA.

d. Applicability of CAA §179B to non-border areas

Finally, EPA has made it clear that 179B applies equally to non-border areas as to border areas. In the implementation rule for the 2008 ozone NAAQS, EPA stated, "The EPA does not believe this provision is restricted to areas adjoining international borders."[20] EPA reaffirmed this in the implementation rule for the 2015 ozone NAAQS[21] and reiterated it again in the 179B Guidance.[22]

e. Conclusion regarding legal requirements for an approvable demonstration

In conclusion, the NWF meets all statutory requirements for a successful 179B demonstration. In the absence of regulatory requirements, a successful demonstration need only show that the area would have attained "but for emissions emanating from outside the United States."

C. Considerations for approving a Demonstration for a border state do not necessarily apply to non-border states.

The mechanisms of international transport to border areas and non-border states differ. The 179B Guidance includes separate sections to discuss international transport of pollutants in these two different situations.

The section on "near-border transport" states, "Pollutants from near-border international emissions sources, such as industrial facilities and motor vehicles, are transported on a scale comparable to the distance extending across large metropolitan areas."[23] This near-border transport depends on the direction the wind blows over the short distance from one side of the border to the closest air quality monitor on the U.S. side. To-date, the only §179B demonstrations that EPA has approved are for near-border demonstrations for transport from Mexico to the U.S., with prevailing winds on exceedance dates blowing from the south. These situations may be

[19] Connecticut One-Hour Attainment Date Extension, p. 640.
[20] Final 2008 Implementation Rule, p. 12294.
[21] Final 2015 Implementation Rule, p. 63010.
[22] 179B Guidance, footnote 12, p. 5.
[23] 179B Guidance, p. 8.

characterized by short-term trajectory modeling, a gradient of ground-level air pollutant concentrations from south to north extending away from the border, wind roses on exceedance days, and comparisons of wind direction between exceedance days and non-exceedance days.

In contrast, the section of the 179B Guidance on long-range transport discusses transport from Europe, Russia, and Asia to the western U.S., transport that occurs in the middle to upper free troposphere based on semi-permanent pressure systems and which occurs over the course of days to weeks.[24] This type of transport cannot be demonstrated with lower-level trajectories, ground level pollution gradients, wind roses, and comparisons between exceedance and non-exceedance days. As noted above, ***photochemical modeling must be used to demonstrate long-range transport and its influence on local ozone, considering all of the technical complexities involved.***

As EPA has not yet approved a §179B demonstration for a non-border state, currently it has no examples of such a demonstration. Thus, the 179B Guidance, which draws on existing approved demonstrations, includes no examples of a demonstration for a non-border State.

In the Response to Comments for the Guidance, EPA discussed this issue:

- EPA summarized the draft guidance by saying, "Recommend states provide additional lines of evidence for non-border areas including photochemical modeling. All examples of analyses are from demonstrations that the agency has acted on which have all been from areas along the US-Mexico border."

- Commenters to the 179B Guidance stated, "The guidance is too focused on example analyses for areas along the Mexican border. The guidance should further clarify which analyses are relevant for border areas vs non-border areas and how to conduct specific analyses for non-border areas."

- EPA concluded by stating, "EPA has not yet acted on any demonstrations for areas not along the Mexican border, so we do not have actual examples to add for non-border areas. The near-border demonstrations are being used for illustrative purposes but have applicability to both types of areas. However, in response to these comments, the current version clarifies that ***more examples may become available as additional demonstrations are submitted and approved***."[25] (emphasis added)

Thus, ***Utah has an opportunity to define the types of evidence*** that a §179B demonstration for a non-border area might include.

Furthermore, the administrative records for ozone and CAA §179B are replete with statements from EPA suggesting that each §179B demonstration is unique and must be considered on a case-by-case basis. For example, in the proposed 2008 Implementation Rule:

[24] 179B Guidance, p. 9.
[25] Response to Comments for the Guidance, pp. 4-5.

> *The EPA believes that the best approach for addressing the potential impacts of international transport on nonattainment is for states to work with the EPA on a case-by-case basis to determine the most appropriate information and analytical methods for each area's unique situation. We will work with states that are developing plans pursuant to section 179B, and ensure the states have the benefit of the EPA's developing understanding of international transport of ozone and its precursors.*[26]

EPA made a similar statement in the final 2015 Implementation Rule:

> *The EPA encourages air agencies to coordinate with their EPA Regional office to identify approaches to evaluate the potential impacts of international transport and to determine the most appropriate information and analytical methods for each area's unique situation. The EPA will also work with air agencies that are developing attainment plans for which CAA section 179B is relevant, and ensure the air agencies have the benefit of the EPA's understanding of international transport of ozone and ozone precursors.*[27]

And more recently, EPA stated in the 179B Guidance:

> *The guidance describes certain recommended analyses and other supplemental analyses that can be provided as part of a section 179B demonstration. Because each nonattainment area is unique, area-specific factors may affect the types of analyses that would be appropriate for any particular area.*[28]

Ozone in the NWF and its influence from global transport are unique from any other CAA §179B demonstration that EPA has acted on to-date. Attempts to make the evidence in a demonstration for long-range transport mirror the evidence used in a near-border transport demonstration will be ineffective. ***The Proposed Demonstration for the NWF must recognize these long-range transport differences and EPA must also recognize the differences during its review of the Proposed Demonstration.***

D. An expanded discussion of the conceptual model of NWF ozone would enhance the Demonstration.

The conceptual model "is intended to frame the 'state of the knowledge' for air quality in the nonattainment area," includes a variety of information, and should provide the context for reviewing the more detailed analyses. It provides consistency with the detailed analyses and "promote[s] a shared understanding and interpretation of results."[29]

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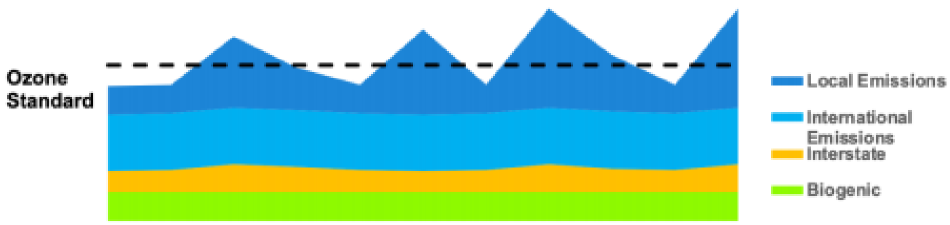
[26] "Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements" proposed rule; Federal Register, Vol. 78, No. 109; June 6, 2013 ("proposed 2008 Implementation Rule"), p. 34205.
[27] Final 2015 Implementation Rule, p. 63010.
[28] 179B Guidance, footnote 15, p. 7.
[29] 179B Guidance, pp. 18-19.

The Proposed Demonstration includes a discussion of the conceptual model of transport from Asia to the NWF, the history of the NWF NAA, and a summary of recent ozone air monitoring data.[30]

a. Several components of NWF ozone

While the Proposed Demonstration accurately describes global transport to the NWF, an expanded discussion of other sources or components contributing to NWF ozone would establish the context, the relative magnitude of the internationally influenced component to other components of NWF ozone, why attempts at controlling ozone formed from local emissions may not provide sufficient reductions to bring the NWF into attainment, and the importance of the international emissions component to meeting CAA requirements.

At the February 3, 2021, Air Quality Board meeting, UDAQ staff presented a hypothetical diagram visualizing the components comprising NWF ozone, similar to the following:



In these comments, we discuss this hypothetical diagram to illustrate the various components of NWF ozone, how they work together to result in local ozone exceedances, and the importance of the component caused by international emissions.

In the diagram above, we show the component attributed to local emissions as slightly smaller than in the UDAQ staff diagram because studies show that local emissions contribute up to only 20% of the total NWF ozone during the ozone season. For example, the Ramboll Modeling Report shows 15% of the ozone season average attributed to local ozone, including the peaks.[31] Information derived from results of an older modeling study presented in EPA's 2015 Background Ozone Whitepaper indicates the local component of NWF ozone varies by county from 9% to 20% of the total, with the greater amount being in Salt Lake County.[32]

Similar to the Ramboll results, the diagram shows the local emissions component as varying from day to day.

[30] Proposed Demonstration, p. 5.
[31] See Proposed Demonstration, p. 94. Percent of total derived from the stacked bar on the right side of the figure.
[32] "Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone, White Paper for Discussion"; December 30, 2015 ("2015 Background Ozone Whitepaper"); Table 2c.

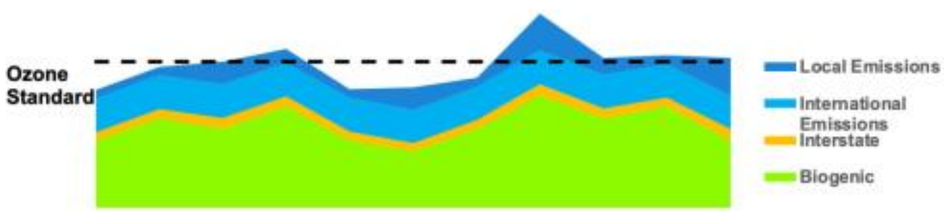
Additional changes to the diagram can provide a greater understanding of other components of NWF ozone. For example, more realistically, the biogenic component would be shown much larger. The Ramboll Modeling Report results show it as 56% of the total, ozone season average, nearly three times larger than the component attributed to international anthropogenic emissions. The biogenic component varies significantly with variations in temperature and moisture as well as other factors that cause changes in emissions from plants.

The biogenic component of our hypothetical diagram includes something else that varies, namely wildfire emissions. Recent analyses performed by Dr. Dan Jaffe show that wildfires contribute as much as a few ppb to NWF ozone design values[33] in amounts that vary depending on many factors including location, size, and number of fires; wind direction and other meteorological factors; VOC content of the materials burning; etc.

Consistent with the varying nature of the emissions contributing to the biogenic component, the Ramboll Modeling Report shows the biogenic or natural component varying by more than 10 ppb from day to day.[34]

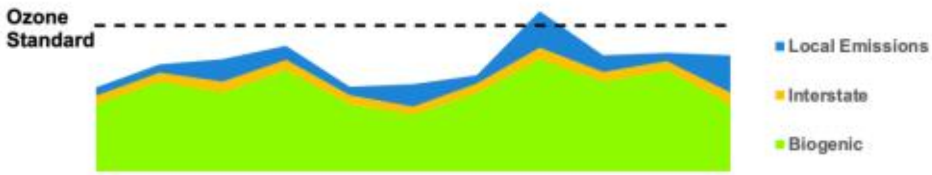
Furthermore, the original diagram showed the interstate component as too large. The Ramboll Modeling Report indicates this component to be roughly half of the international component and roughly two-thirds of the local emission component.

Thus, the diagram of the components of NWF ozone might better resemble the following, where we modified the biogenic component to be relatively larger and more variable and we made the interstate component smaller:



[33] See analyses for Salt Lake City in "Evaluation of Ozone Patterns and Trends in 8 Major Metropolitan Areas of the U.S.", Final Report, CRC Report No. A-124, March 2021, published by the Coordinating Research Council, Inc., located on their "Published Reports" webpage at https://crcao.org/published-reports-full/ (accessed on May 18, 2021). See also presentation slide deck, "Evaluation of O_3 patterns and trends in 8 major metropolitan areas in the U.S., CRC project: A-124; Salt Lake City results: The Western Challenge", presented by Dr. Dan Jaffe, University of Washington, to to UDAQ and EPA on April 9, 2021. (Collectively, "Recent Jaffe Studies").
[34] Proposed Demonstration, p. 94.

Finally, we use the hypothetical diagram to examine the critical issue for the Demonstration, namely whether the area would have attained but for emissions emanating from outside the U.S. The diagrams above include a relatively large and constant component attributed to international emissions,[35] similar to the Ramboll photochemical modeling results and consistent with the conceptual model of global transport to the NWF. While the local emissions and the biogenic emissions components vary and peaks of these components may result in total ozone exceeding the level of the NAAQS on certain days when one or both of these components peak, the following diagram, identical to the one directly above but with the component attributed to international emissions removed, shows attainment "but for the emissions emanating from outside the United States:"



These diagrams provide a useful description of the components of NWF ozone, their relative size, and the role played by the component from international emissions vis-à-vis CAA §179B. Nonetheless, these diagrams have limitations in that they are not quantitative nor are they accurately drawn to scale. These limitations could be addressed with a similar exercise using photochemical modeling output or some other approach.

***No matter how approached, adding a fulsome discussion of the various components of NWF ozone, their relative size, and how each does or does not vary would enhance the explanation of the importance of the international emissions component*.** Not including this discussion in the conceptual model can lead the reader to the erroneous conclusion that NWF ozone is due entirely or nearly entirely to the influence of international emissions.

b. Additional information for the conceptual model

EPA's 179B guidance provides a list of the types of information that should be included to fully characterize a conceptual model of ozone events.[36] Additional conceptual model topics that would be helpful to this Proposed Demonstration and be responsive to the guidance include:

- A map of existing ambient monitors with descriptions of the sites and any other relevant information
- A description of recent pollutant trends in ozone and precursors

[35] We interpret the "international emissions" component of the diagram to be only the anthropogenic portion of international emissions.
[36] 179B Guidance, p. 19.

- A summary of conditions during high ozone days:
  - Months when high ozone days occur
  - Typical spatial patterns on high ozone days
  - Precursor emissions by sector that contribute to the local and regional contribution (e.g., mobile, commercial, residential, industrial, biogenic)
  - The diurnal evolution of meteorology, emissions, and chemical regime during high ozone days

c. Conclusion about the conceptual model

In conclusion, the conceptual model could better respond to the guidance by addressing some of the suggestions outlined here and especially discussing the various components of NWF ozone.

E. The Demonstration should draw more on scientific literature as weight of evidence.

The transport of Asian air pollution to the intermountain west and the large amount of "background" ozone in the intermountain west are well-documented in the scientific literature. The Proposed Demonstration should draw on some of these references as weight of evidence.

a. Definition of weight of evidence

In the interagency review process for the 179B Guidance, the White House Office of Management and Budget ("OMB") Reviewer requested that EPA remove the term "weight of evidence" from the guidance document, stating, "Reviewer believes that WOE has a strongly quantitative and prescriptive connotation at EPA in other programs." Instead, EPA and the Reviewer discussed the issue and EPA added footnote 15 on page 7 of the 179B Guidance:

> *Throughout this guidance document, the term "weight of evidence" is used to describe the collective analysis by which we evaluate CAA section 179B demonstrations. The guidance describes certain recommended analyses and other supplemental analyses that can be provided as part of a section 179B demonstration.* ***Because each nonattainment area is unique, area-specific factors may affect the types of analyses that would be appropriate for any particular area****. If the state provides multiple analyses as part of a section 179B demonstration, EPA recommends the state describe the analyses performed, databases used, key assumptions and outcomes of each analysis,* ***and why an air agency believes that the evidence, viewed as a whole, supports a conclusion that the area would not attain, or would have attained, but for international emissions****. The EPA will consider the weight of this evidence in considering whether to approve any section 179B demonstration.*[37] (emphasis added)

[37] See "Summary of OMB and Interagency Working Comments on draft Guidance under EO12866/13563 Interagency Review" located in the Docket at https://www.regulations.gov/document/EPA-HQ-OAR-2019-0668-0025 (accessed on May 17, 2021).

Thus, weight of evidence plays an important role in a successful demonstration to support the conclusion of how the area meets CAA §179B. Later in these comments (section F), we address how some of the evidence provided meets or does not meet this definition.

b. Background ozone concentrations

In the 2015 Background Ozone Whitepaper, EPA defines U.S. background ("USB") to be ozone formed from sources or processes *other than* U.S. manmade emissions of NOx, VOC, methane ("CH_4"), and carbon monoxide ("CO"),[38] and thus USB includes ozone formed from international emissions sources. Several sources discuss background ozone and indicate a substantial amount of background exists in the intermountain west and at higher elevations compared to other locations.[39]

EPA reports:

> *[T]he effects of USB O3 [ozone] are most notable at a relatively small number of sites in the inter-mountain western U.S. . . . [T]here are 26 counties with at least one site where the 2012-2014 design value exceeds 70 ppb. Across these 26 counties, there is a wide range of the extent to which USB influences O3 design values. . .. In other urban locations, such as Las Vegas (Clark County, NV) or Salt Lake City (Salt Lake County, UT), the contribution from U.S. manmade emissions is smaller, with values around 30 percent.*[40]

Table 2c of the paper indicates 20% of the ozone design value in Salt Lake County attributes to man-made sources in the State of Utah and 30% to man-made sources throughout the U.S., based on source apportionment modeling using a 2011-based modeling platform.

The amount of background ozone in EPA Region 8, which includes Utah and other intermountain west states, has been estimated to be 57 ppb, or 81% of the NAAQS. This far exceeds the amount in EPA Region 2, in the northeastern part of the U.S., which has been estimated to be 42 ppb, or 60% of the NAAQS, a difference between the two Regions of 15 ppb or 21% of the NAAQS.[41] Thus, NAAs in EPA Region 8 have a significantly smaller headspace to reduce to meet the ozone NAAQS and consequently a relatively higher hurdle to clear.

Studies report that the amount of background ozone has increased in recent years and may continue to increase.[42]

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[38] 2015 Background Ozone Whitepaper, p. 2.

[39] See for example Jaffe, D.A., O.R. Cooper, A.M. Fiore, B.H. Henderson, G.S. Tonnesen, A.G. Russell, D.K. Henze, A.O. Langford, M. Lin, T. Moore, 2018. "Scientific assessment of background ozone over the U.S.: Implications for air quality management." *Elem. Sci. Anth.*, 6: 56. DOI: https://doi.org/10.1525/elementa.309 ("Scientific Assessment"), p. 7, which states that North American background "contributes to some of the highest observed days in the intermountain west." (North American background does not include the influence of man-made emissions in Canada and Mexico.)

[40] 2015 Background Ozone Whitepaper, p. 11.

[41] "The Importance of Background Ozone for Air Quality Management"; Jaffe, Daniel A., Fiore, Arlene M., and Keating, Terry J.; EM, November 2020, Figure 1.

[42] See, for example, 2015 Background Ozone Whitepaper, p. 8, which states, "Ambient data analyses have shown that mid-tropospheric O3 concentrations in remote areas, within the U.S. and globally, have

c. Global natural emissions contribution

EPA has stated that the influence from international natural emissions may be referenced in the weight of evidence[43,44]. A large proportion of ozone in the lower atmosphere is of natural origin and includes contributions from the stratosphere. Natural ozone levels in the lower atmosphere range 10-30 ppb across the globe, while global anthropogenic contributions increase the background to 30-50 ppb, or 40-70% of the NAAQS.[45] Background ozone from all natural and anthropogenic sources outside the US commonly reaches 60 ppb or more in the elevated intermountain western U.S. due to the combination of high elevation and global climatological circulation patterns.[46]

d. Global CH_4

Besides the typical ozone precursors that we usually consider (NOx and VOC), CH_4 and CO are also ozone precursors. Both CH_4 and CO are included in the chemistry mechanisms of all photochemical models because, like VOC, they are sources of radicals that drive oxidant chemistry. However, their reaction rates are sufficiently slow that on regional and intra-annual scales, ozone sensitivity to their emissions is small (CO with a lifetime of ~2 months)[47] and practically zero (CH_4 with a lifetime of ~10 years)[48]. However, there is nearly 20 times more CH_4 (~1800 ppb)[49] than CO (~100 ppb)[50] in the troposphere, and over the course of its 10-year timescale, CH_4 can yield a large quantity of global background ozone. The doubling of tropospheric CH_4 concentrations since preindustrial times suggests that global anthropogenic CH_4 emissions now generate a large fraction of background ozone. Agricultural activities including

been increasing over the past two decades at a rate of approximately 0.4 ppb/year within an overall uncertainty range of 0.1 to 0.7 ppb/year. Whether this trend continues is largely dependent upon global changes in emissions of methane, as well as changes in other manmade O3 precursor emissions outside of the U.S., which are highly uncertain. Additionally, climate change has the potential to affect global background O3 levels via changes in temperatures, wildfire emissions, synoptic weather patterns and other factors that influence O3."

43 Response to Comments for the Guidance, p. 2.

44 179B Guidance, p. 5.

45 Scientific Assessment.

46 2015 Background Ozone Whitepaper.

47 https://scied.ucar.edu/learning-zone/air-quality/carbon-monoxide#:~:text=A%20typical%20concentration%20of%20CO,several%20months%20in%20Earth's%20atmosphere

48 Stocker, Thomas (ed.). *Climate change 2013 : the physical science basis : Working Group I contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. New York. ISBN 978-1-10741-532-4. OCLC 881236891.

49 https://gml.noaa.gov/ccgg/trends_ch4/.

50 https://scied.ucar.edu/learning-zone/air-quality/carbon-monoxide#:~:text=A%20typical%20concentration%20of%20CO,several%20months%20in%20Earth's%20atmosphere

livestock and crops (especially rice and burning activities) contribute roughly 50% of global anthropogenic CH_4 emissions.[51]

A modeling study in 2005 estimated effects of global anthropogenic CH_4 reductions on U.S. ozone air quality, which states that a 10% reduction would decrease surface ozone by 0.4-0.7 ppb.[52] Similarly, recent global climate modeling determines that a 20% global CH_4 reduction would result in an average ozone reduction of 1-2 ppb over the northern hemisphere.[53] Given that anthropogenic sources comprise ~70% of global total CH_4 emissions[54] and that 80% of that fraction is emitted by countries outside of North America and Europe,[55,56] international anthropogenic contributions to US ozone are arguably much larger than 1-2 ppb. If we assume chemical linearity, which is appropriate for the low reactivity of CH_4, removal of the resulting 60% of global anthropogenic CH_4 emissions would lead to an average ozone reduction of 3-6 ppb over the northern hemisphere. These estimates are consistent with previous global modeling that report 3-4 ppb ozone reductions from 50% anthropogenic CH4 reductions.[57]

e. Studies showing international emissions contribution to ozone in the intermountain west

In a presentation made to the Clean Air Act Advisory Committee ("CAAAC"), EPA presented graphical depictions of the influence of international emissions on ozone concentrations throughout the U.S., based on "zero out" modeling performed for the 2018-2020 Ozone Policy Assessment. It shows the largest impacts along the U.S. Mexico border and throughout the intermountain west, with up to 20% of NWF ozone or 10+ ppb on the top ten ozone modeled days attributed to international anthropogenic sources. The presentation also points out that even some rural, high-elevation areas can be near the NAAQS with low U.S. anthropogenic contributions.[58]

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[51] Intergovernmental Panel on Climate Change ("IPCC"), available at https://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=welcome#citation.
[52] West, J.J. and Fiore, A.M., 2005. Management of tropospheric ozone by reducing methane emissions. *Environmental science & technology*, 39(13), pp.4685-4691. https://pubs.acs.org/doi/pdf/10.1021/es048629f.
[53] Butler, T., Lupascu, A. and Nalam, A., 2020. "Attribution of ground-level ozone to anthropogenic and natural sources of nitrogen oxides and reactive carbon in a global chemical transport model." *Atmospheric Chemistry and Physics*, 20(17), pp.10707-10731
[54] *Introduction to Atmospheric Chemistry*, Daniel J. Jacob, Princeton University Press, 1999 (last edited January, 2004). http://acmg.seas.harvard.edu/people/faculty/djj/book/bookchap11.html.
[55] The Organisation for Economic Co-operation and Development (OECD) includes countries in North America, Europe, Australia/New Zealand, Japan/Korea and some of South America. Non-OECD countries are located in Africa, India, most of Asia including China, Russia, and most of South America.
[56] A full list of citations related to global Reasonable Concentration Pathway (RCP) scenarios reported by the IPCC is available at https://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=welcome#citation.
[57] Fiore, A. M., Jacob, D.J.; Field, B.D.; Streets, D.G.; Fernandes, S.D.; Jang, C., 2002. Linking ozone pollution and climate change: the case for controlling methane. *Geophys. Res. Lett.*, 29, 1919.
[58] See "Transboundary Air Pollution, Briefing for the Clean Air Act Advisory Committee"; November 7, 2019, located on the CAAAC website at the "International Transport" link at https://www.epa.gov/caaac/2019-epa-clean-air-act-advisory-committee-meeting (accessed on May 19, 2021).

f. Weight of evidence conclusion

The Proposed Demonstration would be strengthened by including discussion of and reference to various studies showing the relatively large amount of USB ozone in the intermountain U.S., the relatively large amount of the background ozone attributed to emissions emanating from outside the U.S., and the role and approximate magnitude of global natural emissions and global CH_4 emissions on USB. Any weight of evidence included in the Proposed Demonstration should address EPA's description of Weight of Evidence.

F. Some of the conclusions drawn in some of the analyses in the Proposed Demonstration do not follow from the technical analyses and should be removed.

Outside Ramboll's photochemical modeling results, it is not apparent how the synoptic and HYbrid Single-Particle Lagrangian Integrated Trajectory ("HYSPLIT") analyses support the conclusions on page 14 of the Proposed Demonstration:

> *This influence [from the international ozone contribution] is, however, observed consistently throughout the spring and summer and not just on high ozone exceedance days. The amount is also relatively small in comparison to the composition total of ozone.*

As noted in our comments above, it is not necessary to demonstrate that an international ozone influence is elevated on high ozone exceedance days, or that the amount of contribution is small in comparison to total ozone. International contributions only need to meet the "but for" test of CAA §179B.

a. Synoptic analyses

We recognize that synoptic analyses were valuable in selecting UDAQ's 2017 photochemical modeling episode; however, the limited and often misstated information provides no explanation to non-meteorologists about how the maps, figures, and National Weather Service ("NWS") discussions in the main document and Appendix A support conclusions about global transport to the intermountain west. The only relevant clue, which is not brought forth or highlighted, is a single inconspicuous comment in the NWS forecast discussion:

> *Westerly flow will* ***mix down from aloft*** *as the day progresses today and tomorrow, bringing a dry breeze to the region*[59] (emphasis added).

It would be helpful to explain how the agency finds evidence for the influence of international transport from weather maps.[60] While the synoptic analyses correctly characterize conditions that lead to ozone exceedance events, it misstates that these mechanisms limit or minimize international ozone contributions:

> *The majority of ozone exceedance days share these synoptic characteristics:*

[59] Proposed Demonstration, Appendix A, p. 22.
[60] Proposed Demonstration, Synoptic Pattern Analysis, p. 6.

- *High pressure (no downwelling of upper tropospheric ozone)*
- *No coincidental frontal passage (no stratospheric intrusion or downwelling)*
- *Low surface winds (no non-local surface transport)*
- *Sunshine (no large convective systems adding lightning NOx or upper level ozone to the local mix)*[61]

Rather, regional high pressure ***is the result of deep tropospheric downwelling***, and it is this downward compressing (warming) motion that brings dry (cloudless), ozone-laden air from aloft toward the surface. Daytime boundary layer mixing and deep vertical circulations induced by complex terrain help to bring that air to the surface. Light surface winds during such events are usually driven by, and thus evidence for, the presence of such mixing and terrain-driven circulations.

Further, the Proposed Demonstration states, "…the 2017 summer shows subsidence during much of the season,"[62] ***which indicates consistent subsiding air and hence a high potential for international contributions.***

Brief frontal passage events, stratospheric ozone intrusion, wet convection, and lightning NOx are ***not relevant*** to the issue of international/intercontinental ozone transport. On page 23 (May 27 – June 07 summary), the Proposed Demonstration states, "Peak ozone measurements do not coincide with frontal passage, which would be expected with long range transport of international emissions." This misstatement should be removed, as ***ozone is rarely elevated during frontal passage due to increased ventilation, cooler temperatures, and cloudy skies***.

International contributions do not cause higher peak ozone concentrations, but rather elevate the minimum ozone floor.

It would be helpful to provide more explanation of how vertical temperature soundings (page 21) can be used to support the conclusions. We note that the July 6 exceedance day exhibits near adiabatic and super-adiabatic conditions from the surface to about 500 millibar ("mb") (~5500 meters or ~18,000 feet), which indicates deep mixing throughout that altitude range.[63] On the other hand, the June 27 non-exceedance day adiabatic layer extends only through 700 mb (~3000 m or ~10,000 ft). The presence of morning surface-based inversions is not relevant to peak afternoon ozone. Conclusions would benefit from providing this type of information.

In summary, the Proposed Demonstration would benefit from including more guiding explanations for how the synoptic analyses support conclusions about international ozone influences instead of how meteorological mechanisms minimize their contributions. The synoptic analyses should state that conditions leading to ozone exceedance events also contribute to international ozone

[61] Proposed Demonstration, pp. 6 and 31.
[62] Proposed Demonstration, p. 8.
[63] Adiabatic in this context refers to a neutrally stable tropospheric temperature profile. An adiabatic temperature profile allows for, is maintained by, and thus is an indicator of consistent mechanical or convective mixing. Super-adiabatic refers to an unstable temperature profile where cool temperatures overlay warm temperatures that result in energetic convective overturning. Therefore, the presence of both are diagnostic indications of turbulent mixing through the adiabatic and super-adiabatic depth.

contributions, particularly that persistent regional high pressure during the ozone season leads to persistent downwelling from aloft. Additionally, our analyses of the example vertical temperature soundings given in Appendix A suggest deeper mixing on the exceedance day than the non-exceedance day. Frontal passage, stratospheric ozone intrusion, wet convection and lightning NOx are not relevant.

a. HYSPLIT dispersion

The HYSPLIT analyses also provide insufficient information in the main document and Appendix B to support conclusions. We found several unsubstantiated conclusions but identified other conclusions that could be drawn from the discussion and figures provided but were not included.

First, the Proposed Demonstration opens the discussion on page 8 with the phrase, "To determine the influence of international anthropogenic source emissions…". The HYSPLIT trajectory analyses cannot determine the influence of transport but can only present certain qualitative evidence for possible transport paths and durations.

Further, the Proposed Demonstration states on page 9 that the analysis "provides a comprehensive assessment of source-receptor relationships." We do not find sufficient evidence in the Proposed Demonstration that the assessment is comprehensive. For example, the analyses extend only 5 days into the past, and considers an initial NWF particle volume extending 1000 meters above the surface. Definitively, HYSPLIT cannot address Asian ozone ***concentration*** contributions to the NWF, much less ***global contributions***, which would be necessary to meet the claim for a comprehensive assessment.

We do not see ample evidence for how the HYSPLIT analyses support the conclusions in Appendix B, page 73:

> *Results do not suggest a strong impact from international emission sources on local ozone concentrations:*
> - *Peak ozone measurements do not coincide with frontal passage, which would be expected with long range transport of international emissions*
> - *No significant difference in transport patterns between exceedance and non-exceedance days*
> - *Increased particle count over the US compared to other urban regions*

As we stated above, and as accurately repeated in the Proposed Demonstration in describing the conceptual model of trans-Pacific transport, frontal passage is not the delivery mechanism for international ozone contributions, but rather it is the downwelling associated with semi-permanent high pressure systems.

We see large differences in trajectory patterns extending toward Asia between exceedance and non-exceedance days in the provided figures. Like forward dispersion patterns, backward dispersion will of course lead to smaller trajectory "counts" with distance and time; but that is not evidence that ***global*** international transport is small or infrequent.

Again, the demonstration does not need to establish that international ozone contributions are dominant, just whether their absence would lead to attainment.

A key issue with the HYSPLIT dispersion analyses is that it relies on coarse meteorological analyses (3-hourly, 0.5 degree or ~50 km horizontal resolution) that cannot adequately resolve the local meteorological conditions of the NWF, and thus cannot reliably characterize initial dispersion of the backward particle paths.

The Proposed Demonstration is unclear on whether the dispersion analyses include effects of random turbulent motion. On page 9, it states, "Backward dispersion includes the effects of turbulent motion." Later on page 9, it states that the analysis "does not accurately resolve sub-grid turbulent mixing." By definition, sub-grid processes cannot be resolved, their effects can only be estimated. It would be helpful to include a better description of which processes are explicitly included in the analyses with a reference to HYSPLIT documentation for a technical description of how "dispersion" operates in backward mode.

Other statements in the Proposed Demonstration are unclear.

- On page 9, it states that "trajectories occasionally intersect the ground, leading to irreversible velocity information loss" and that "this occurred even when different release heights were considered." The meaning and consequences of these statements are absent.

- Also, on page 9, it states, "The starting altitude of 100 m was also selected to avoid interference with Utah's complex terrain." It is not clear why UDAQ wishes to avoid influences of terrain; and to really avoid terrain would require minimum initial altitudes of 1000 to 2000 meters above the NWF floor.

- Additionally, the analyses extended the initial vertical line source of particles to only 1000 m to "characterize air throughout the planetary boundary layer." As described in the Ramboll Modeling Report, vertical mixing of air is a critical process in the NWF, and depending on meteorological conditions, it occurs up to 3000 m during the daytime, thus providing a continuous upward ventilation of local emissions and a drawing down of pollutants from the mid-troposphere.[64] Therefore, the particle initialization does not extend high enough.

- Finally, the Proposed Demonstration states on page 9, "The number of released particles was based on a series of sensitivity tests where the total number of released particles was changed." It would be helpful to elaborate on this point to explain the purpose of these tests, how and why the analyses settled on their final number, and how this selection impacts the analyses and conclusions.

When describing frequency plots (fraction of particles in a given region), on page 9 the Proposed Demonstration states, "This fraction is an indication of where particles spent time and likely

[64] Ramboll Modeling Report, p. 21.

interacted with emissions before eventually reaching receptor sites in the Salt Lake Valley." It would be helpful to clarify this statement and present a conceptual model of the process. For example, was the fraction calculated only for particles that reached the surface or were within the boundary layer over the source regions, or for all particles extending well into the mid troposphere?

Based on Figure 6 on page 11 (and others in Appendix B), the Proposed Demonstration states that there was little difference in backward dispersion results between exceedance and non-exceedance days. In contrast to this statement, ***we see that exceedance days do have more distant reaches to Asia than non-exceedance days, which would support more direct/efficient international transport paths to the NWF.***

On page 10, the Proposed Demonstration states, "Air masses originating from Asia were also evident but associated with exceedingly small fractions of particles" and "using 'population count' as a proxy for urban emissions (APPENDIX B), significant emission contributions from outside the US are not expected over the considered time frame." All this is true when only considering 5 days of transport. The question then is, over which areas did the air parcels pass over prior to that? And to reiterate***, smaller trajectory fractions derived from this methodology is not evidence that global international transport is small or infrequent.***

As Ramboll stated in their photochemical modeling report, which is provided in whole in UDAQ's Proposed Demonstration, relying on trajectory analyses to identify periods of global international ozone transport is problematic and insufficient.[65] No matter how long a parcel or airmass persists over a local area, there is always a substantial fraction of air containing ozone that originated elsewhere around the globe. From another perspective, with enough time, all air parcel trajectories extending backward had, at some point, passed over other parts of the world. This is an issue that is fairly unique to ozone relative to other criteria pollutants such as sulfur oxides, NOx and particulate matter.

G. The Associations have some recommendations for the photochemical modeling protocol.

Based on our review of the Modeling Protocol in Appendix D, we provide the following suggestions for consideration:

- Re-label Appendix D as "Modeling Protocol" as it does not contain any information about a conceptual model of ozone events in the NWF.
- Page 119, third item under "Emission Model, SMOKE": replace "CAMx CB AE6" with the more accurate description "CAMx CB6", as AE6 refers to a specific aerosol chemistry mechanism used in the CMAQ photochemical model.
- Page 119: It would be helpful to clarify the meaning of the statement "Inventories collected by UDAQ are not included in this demonstration", including a rationale for

[65] Ibid, page 21.

why UDAQ elected not to use their local EI data for some or all sectors and counties. The 2017 National Emissions Inventory ("NEI") platform should conceivably include Utah county-level inventory data submitted by UDAQ to EPA (whether for 2017 or a previous year). The Demonstration should broadly identify those inventory sectors submitted to EPA and present in the 2017 NEI, and those sectors independently compiled or estimated by EPA that will be used in the refined modeling.

- Page 133: It would be helpful to clarify the meaning of the statement "No Utah-specific MOVES data are leveraged in this demonstration." Is this referring to MOVES county-level configuration (e.g., local activity data, fuel specifications, inspection/maintenance programs, fleet mix/age) and/or all emission factors generated by MOVES? According to EPA's 2017 NEI documentation Utah submitted MOVES county database tables for up to 29 counties covering most MOVES variables.[66] **Use of locally specific data for MOVES is critical to characterizing on-road mobile emissions, which are the dominant fraction of the total NWF ozone precursor inventory.**

H. Conclusion

In conclusion, the Associations support the Demonstration and provide recommendations to enhance and strengthen it.

The Associations fully support the need to improve NWF air quality. Air quality controls must be science based and should be selected based on effectiveness and relative costs. NWF ozone poses a unique set of challenges to achieving these goals considering the relatively large amount of background ozone.

The nearly constant ~10 ppb of ozone in the NWF resulting from emissions emanating from outside the U.S. meets the criterion of CAA §179B. This large international component strongly suggests that attaining the NAAQS will be a difficult and possibly elusive goal. This is especially true when compared to the amount by which the NWF exceeds the NAAQS. Furthermore, the majority of ozone in the NWF, the biogenic plus international components, cannot be controlled by UDAQ.

A successful Demonstration will allow Utah the time needed to more fully understand NWF ozone, identify the most effective control strategies, put them in place, and allow them to come to fruition. The Demonstration will allow this process to occur unfettered by the confines of SIP requirements.

EPA should approve the Proposed Demonstration based on the single statutory criterion and the strong weight of evidence, providing the NWF with relief from the bump up provisions of CAA

[66] "2017 National Emissions Inventory: January 2021, Updated Release, Technical Support Document." U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Emissions Inventory and Analysis Group, Research Triangle Park, NC (EPA-454/R-21-001, February 2021) https://www.epa.gov/sites/production/files/2021-02/documents/nei2017_tsd_full_jan2021.pdf

§181(b)(2). Clearly, the NWF would have attained the 2015 ozone NAAQS "*but for emissions emanating from outside the United States.*"

Sincerely,

Rikki Hrenko-Browning
President
Utah Petroleum Association

Brian Somers
President
Utah Mining Association

cc: Bryce Bird bbird@utah.gov
Becky Close bclose@utah.gov
Dave McNeill DMcNeill@Utah.gov

APENDEX A: Synoptic Analysis

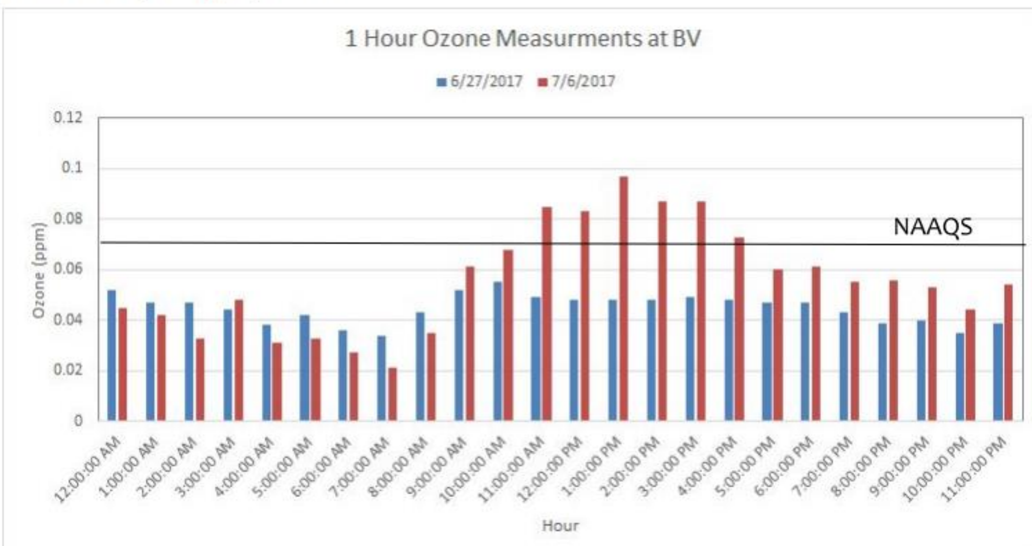
Summary of Exceedance Day Meteorology

The majority of ozone exceedance days share these synoptic characteristics:

- High pressure (no downwelling of upper tropospheric ozone)
- No coincident frontal passage (no stratospheric intrusions or downwelling)
- Low surface winds (no non-local surface transport)
- Sunshine (no large convective systems adding lightning NOx or upper level ozone to the local mix)

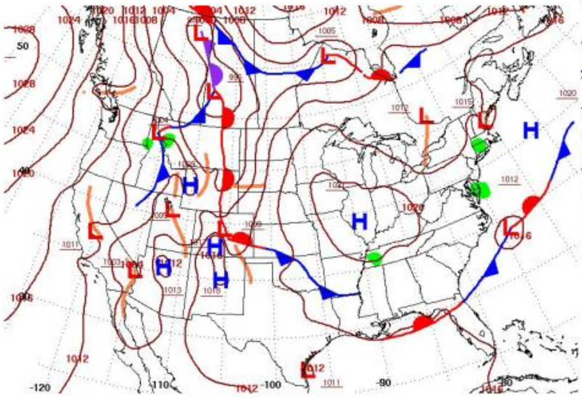
1 Hr. Ozone June 27th vs. July 6th

The one hour ozone measurements at the State of Utah's Bountiful monitor show the difference between the non exceedance day June 27, 2017, and the exceedance day July 6, 2017.

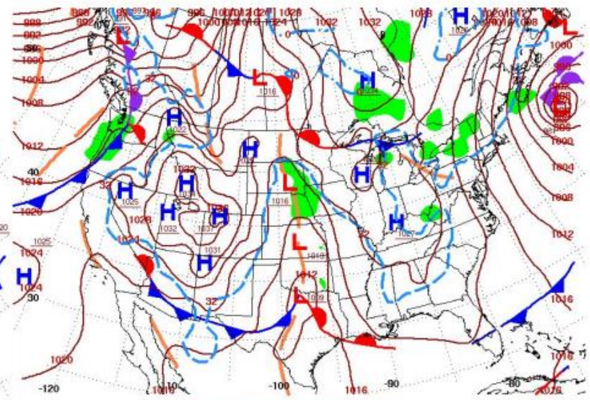


Surface Chart

A weak cold front moved through the monitoring area June 27th. This coincides with a decrease in measured ground level ozone.



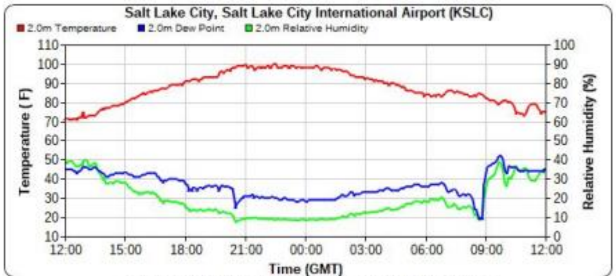
Surface Weather Map at 7:00 A.M. E.S.T.

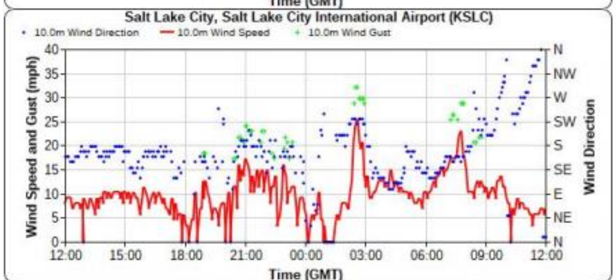


Surface Weather Map at 7:00 A.M. E.S.T.

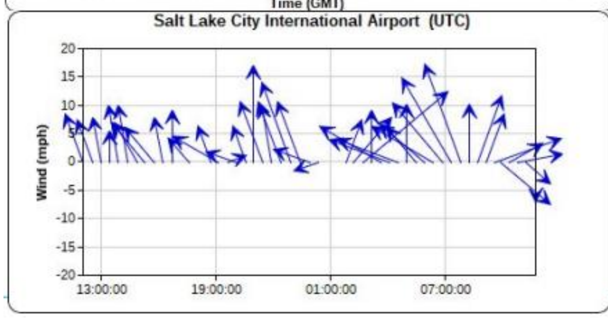
Following few days after the passage of the front, a period of increasing stagnation moved into the area. With high pressure settling in across much of the inner mountain west July 6th.

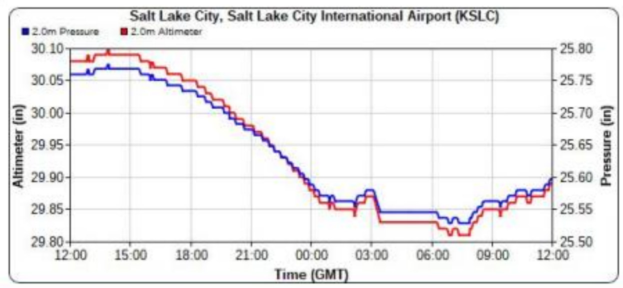
June 27 Charts



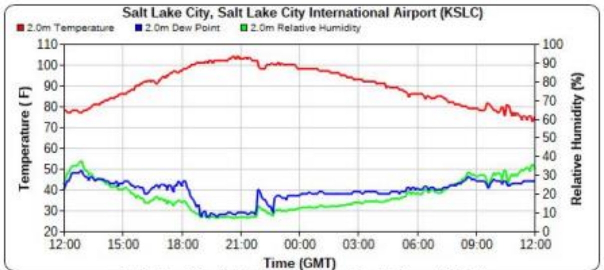


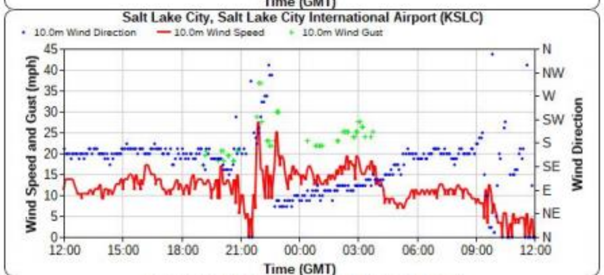
The ground based measurements indicate the passage of a cold front on June 27. This front was not associated with an increase in ozone measurements, rather it is associated with a decrease in ozone across much of the wasatch front ambient air monitor network.

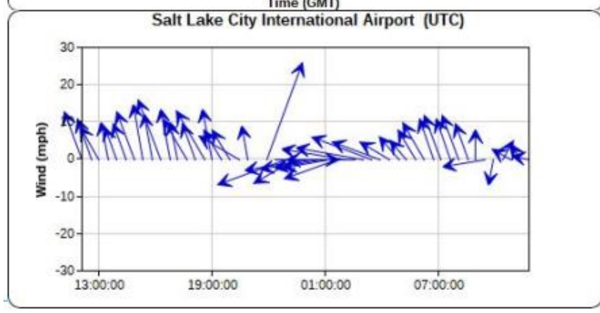




July 6 Charts

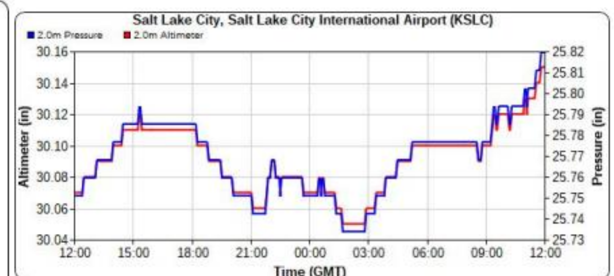






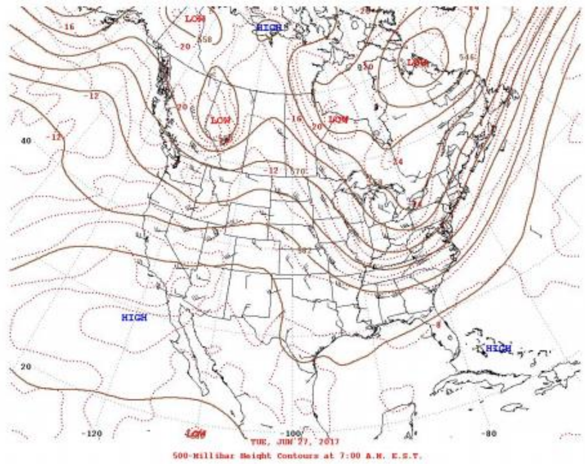
The ground based measurements show a slight increase in pressure on July 6th.

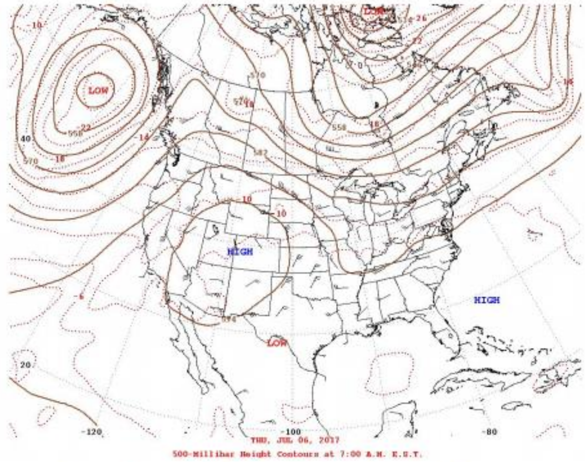
Afternoon clouds were not widespread enough to prevent an ozone exceedance.



500 mb Chart

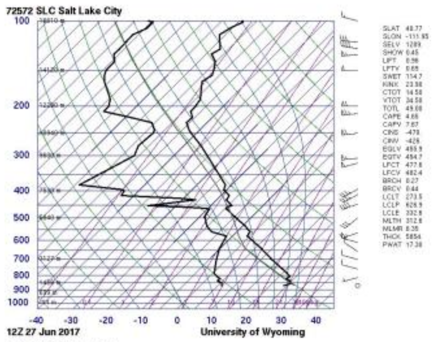
The upper level winds on June 27th show mostly zonal flow.

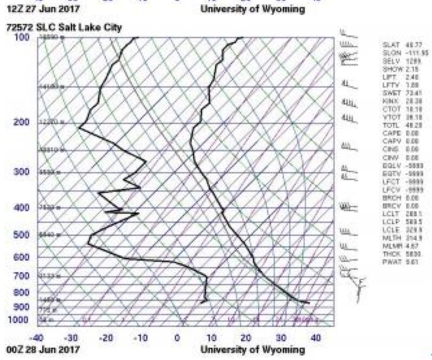




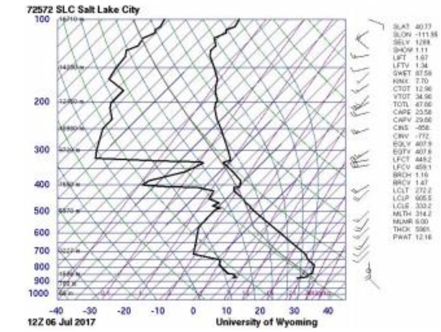
The upper level winds on July 6th show a ridge. This is associated with increased pressure

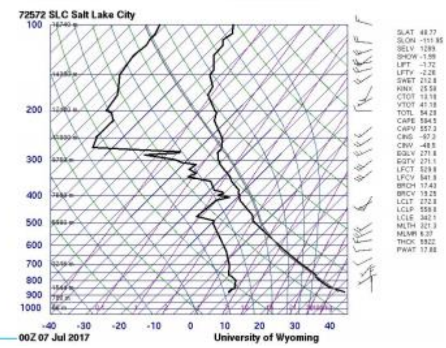
Vertical Temperature Soundings





Both days show weak morning inversion conditions, with these conditions disappearing with afternoon warming. The morning inversion was stronger the morning of July 6th.





NWS Forecast Discussion June 27th

288
FXUS65 KSLC 270944
AFDSLC

Area Forecast Discussion
National Weather Service Salt Lake City UT
344 AM MDT Tue Jun 27 2017

.SYNOPSIS...A weak upper trough will cross the region tonight and Tuesday. Additional weak troughs will clip northern Utah through Thursday.

&&

.SHORT TERM (THROUGH 12Z THURSDAY)...
Water Vapor Satellite shows a shortwave trough crossing Idaho. 400-200mb MDCARS wind observations place a 60-90kt subtropical westerly jet was nosing into Utah from California. GOES/SLC 00Z RAOB/HRRR indicate that precipitable water values vary from 0.10"-0.20" central and southern mountains to 0.40"-0.60" northern valleys.

Passage of a cold front will take the edge off of temperatures across the north and central areas, with the boundary stalling near Interstate 70 late day. Left exit of aforementioned jet will continue to support high-based showers and thunderstorms into the morning hours. Despite developing strong instability this afternoon, the passage of this feature should limit convective chances. For valleys played as dry thunderstorms with gusty winds.

Westerly flow will mix down from aloft as the day progresses today and tomorrow, bringing a dry breeze to the region.

Northern stream wave currently over British Columbia should near northern Utah tomorrow, touching off isolated to scattered high-based shower and thunderstorms across the north. Given the cooling aloft and jet dynamics from the associated jet, elected not to use the dry thunderstorm wording for the northern valleys.

.LONG TERM (AFTER 12Z THURSDAY)...
The shortwave trough continues to slide southeast across the area through the day Thursday. With continued cold advection northwest flow, Thursday will likely be the coolest day of the week in many locations. The airmass behind the cold front looks fairly dry, but cannot currently rule out isolated mountain convection Thursday and Friday, primarily in the Uintas.

A relatively flat ridge looks to build over the west coast Thursday night, then shift over Utah on Friday and early Saturday, bringing a warming trend for those two days. Southwesterly flow increases a bit Saturday afternoon, as a weak trough slides into the Great Basin from the west. Models are still struggling a bit with this wave, including whether to cut it off over Nevada or push it across northern Utah as an open wave. For now, have kept some slight chance POPs in the higher terrain of Utah and across the far northwest on Saturday afternoon, to account for the possibility of increased instability with/ahead of the shortwave.

Despite different fates for this disturbance, global models re-converge on Sunday and Monday, building a ridge over the forecast area heading into early next week. Have maintained above normal temperatures and mostly dry conditions for days 5-7.

&&

.AVIATION...
West winds at the SLC terminal as of 0930Z are expected to switch back to the south or become light and variable around 11-13Z. Northwesterlies will eventually pick up a bit again through the afternoon hours. VFR conditions should prevail under mostly clear skies.

&&

.FIRE WEATHER...
ERC values have risen to between the 80th and 96th percentile across southern and central Utah. Far northeast Utah remains below 50th percentile, but the remainder of northern Utah is climbing above the 50th percentile.

Multiple concerns regarding fire weather. The Haines index will be a 6 today and tomorrow across central and southern Utah. Haines index will increase back to a 6 across the entire region next weekend.

Some of the driest RH values the region sees will continue to occur today and tomorrow while it remains warm despite the passage of a shallow cold front this morning. West southwest winds will respond by increasing. A Red Flag Warning is in place for much of the state of Utah today and tomorrow. Isolated high-based showers and thunderstorms primarily across the north and east early this morning may exaggerate the hazard bringing potential for lightning and gusty/erratic dry microburts. Luckily this threat should end this morning.

Another round of isolated to scattered high-based showers and thunderstorms primarily across the north re-develop tomorrow afternoon and evening, again bringing the hazard of lightning
...truncated 32 lines...

NWS Forecast Discussion July 6th

644
FXUS65 KSLC 061034
AFDSLC

Area Forecast Discussion
National Weather Service Salt Lake City UT
434 AM MDT Thu Jul 6 2017

.SYNOPSIS...Strong high pressure aloft will remain locked in across the western states through the upcoming weekend.

&&

.SHORT TERM (Until 06z Monday)...The strong upper ridge locked in across the western CONUS will remain the dominant feature throughout the short term forecast period.

The center of ridge currently near the Utah/Colorado border is progged by the GFS/ECMWF to shift slightly west and center over Utah by Friday. The bulk of the available mid-level moisture will remain on the periphery of the high center, which means limited convection for the forecast area the next couple of days. Any convection that does form over Utah will be high-based with little or no precip and the potential for strong microburst winds.

Increasingly strong westerlies across the Pacific Northwest and northern Rockies late in the weekend will serve to weaken the ridge over the Great Basin. This weakening will allow a little more moisture to work into northern/western Utah late Sunday, and bring slightly cooler temps to northern Utah due to increased cloud cover and slightly cooler near 700 mb temps.

.LONG TERM (After 06Z Monday)...The persistent upper ridge will be in place across the CWA through Monday before shifting eastward for the remainder of the long term forecast period. Mid-level moisture will remain in place Monday keeping convective coverage widely scattered or lower, with the main area impacted across the southern two thirds of the CWA.

As the ridge shifts eastward Tuesday, expect moisture to deepen. Model trends may indicate coverage of convection may be higher than currently forecast. If model runs continue to show deeper moisture Tuesday into Wednesday, pops may need to be increased with subsequent packages. By Thursday, drier air begins to advect into the area from west to east, keeping pops restricted to the Wasatch spine and east.

&&

&&

.AVIATION...Southeasterly winds at the SLC terminal are shift to the northwest between 20-22Z. Isolated high bas convection is expected across northern Utah this afterno evening. This may bring the threat of strong, gusty and winds to the terminal between 21-01Z.

&&

.FIRE WEATHER...The strong upper ridge centered over the Basin will remain the dominant feature across Utah throu upcoming weekend. Very hot temperature with low humiditi continue, with generally fair to poor RH recoveries the couple of nights.

Sufficient mid-level moisture and strong surface heating to high-based convection during the afternoon and early hours today and Friday. Looking at little no chance at w rains, with a few dry thunderstorms possible. Have added weather zone 498, the Grand Staircase, to the existing R Warning in the morning forecast package.

A modest increase in moisture this weekend will lead to increase in areal coverage of showers/storms statewide. of wetting rains will improve slightly, and then mainly the higher terrain.

&&

.SLC WATCHES/WARNINGS/ADVISORIES...
UT...Excessive Heat Warning from noon today to 10 PM MDT
UTZ019-021.

Red Flag Warning from noon today to 10 PM MDT Frida
479-481>484-488-492-493-496-498.

Heat Advisory until 10 PM MDT this evening for UTZ0

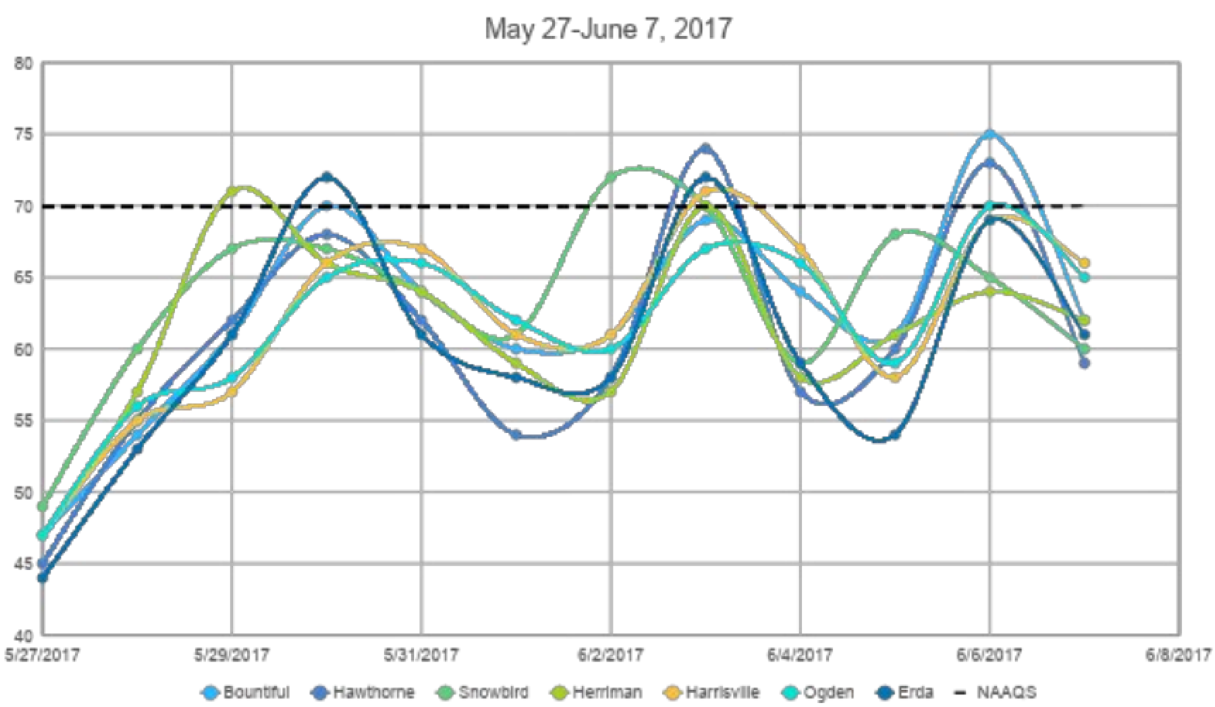
WY...None.
&&

$$

May 27- June 07

- High pressure aloft caused a period of stagnation. This with sunny conditions and low ground level winds contributed to the increased Ozone.
- A weak trough moved through the area June 1st bringing stronger winds and reduced ozone measurements, before stagnation conditions returned and increased ozone.
- Strong south winds prior to a cold front moved through northern Utah June 5th reduced ozone measurements, followed by a stagnate June 6th.
- Peak ozone measurements do not coincide with frontal passage, which would be expected with long range transport of international emissions.

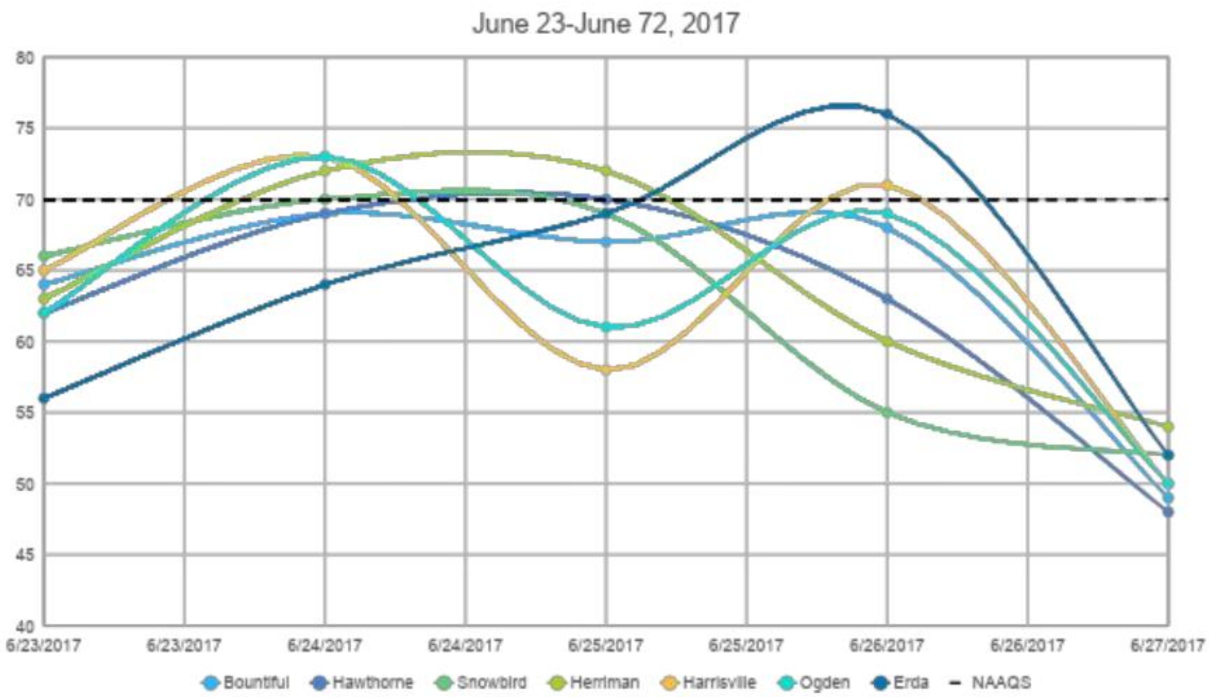
May 27- June 07: MDA8 O3 (ppb)



June 24 – June 26

- Strong high pressure aloft returned to the area at the beginning of this event.
- Dry and sunny with high pressure ended Tuesday June 27th with increased moisture and lower temperatures.
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

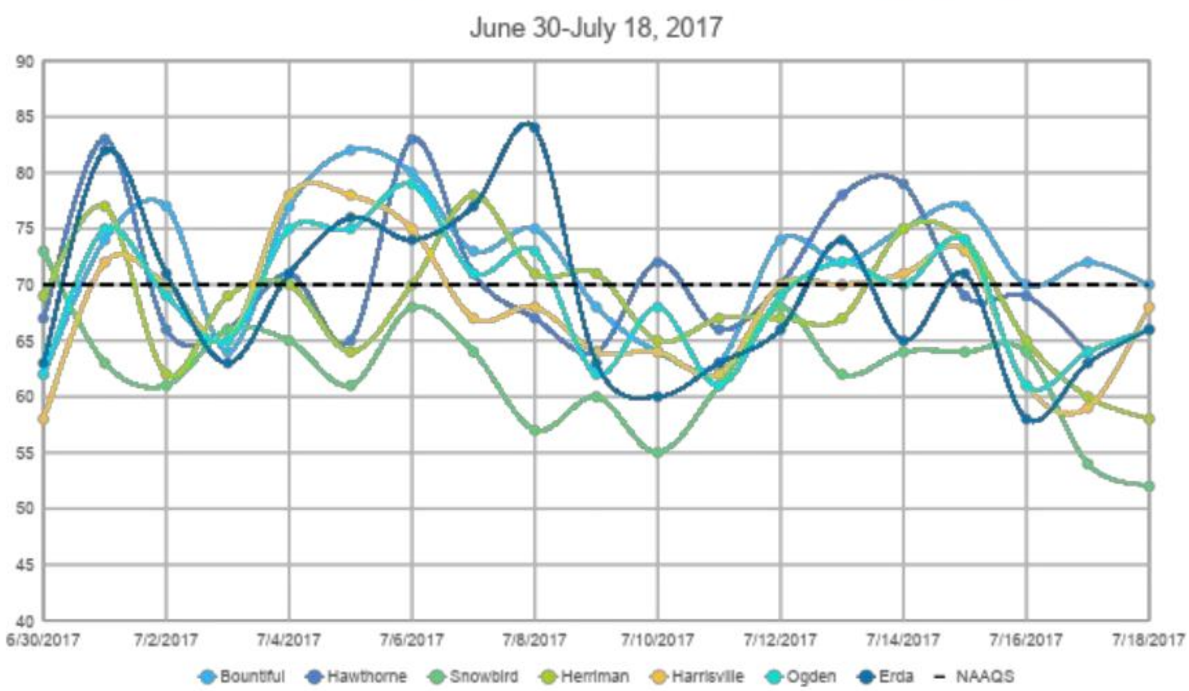
June 24 – June 26: MDA8 O3 (ppb)



June 30 – July 17

- High pressure aloft covered much of the western desert region. Variability in measurements between days and across locations mainly due to local cloud cover.
- The high-pressure weakened slightly July 10th-12th, then quickly re-strengthen. Cloud cover and storms greatly impacted where elevated ozone was observed.
- A weak and shallow cold front moved through northern Utah July 16th bringing spotty storms and increased surface winds in the 10-20 mph range with gusts in the mid. 20's.
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

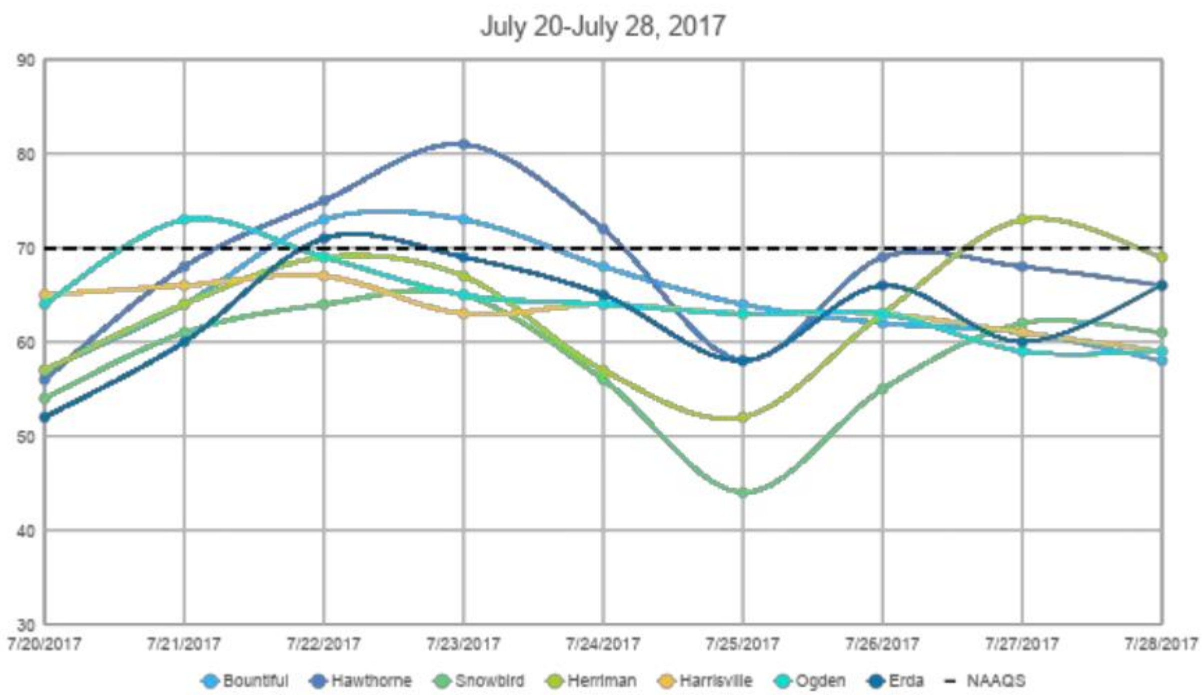
June 30 – July 17: MDA8 O_3 (ppb)



July 20 – July 28

- A mid-level ridge brought dry conditions mostly clear skies over the weekend, then moving east after the beginning on the week.
- Moisture started to move in July 24th creating isolated clouds and thunderstorms creating spotty ozone formation
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

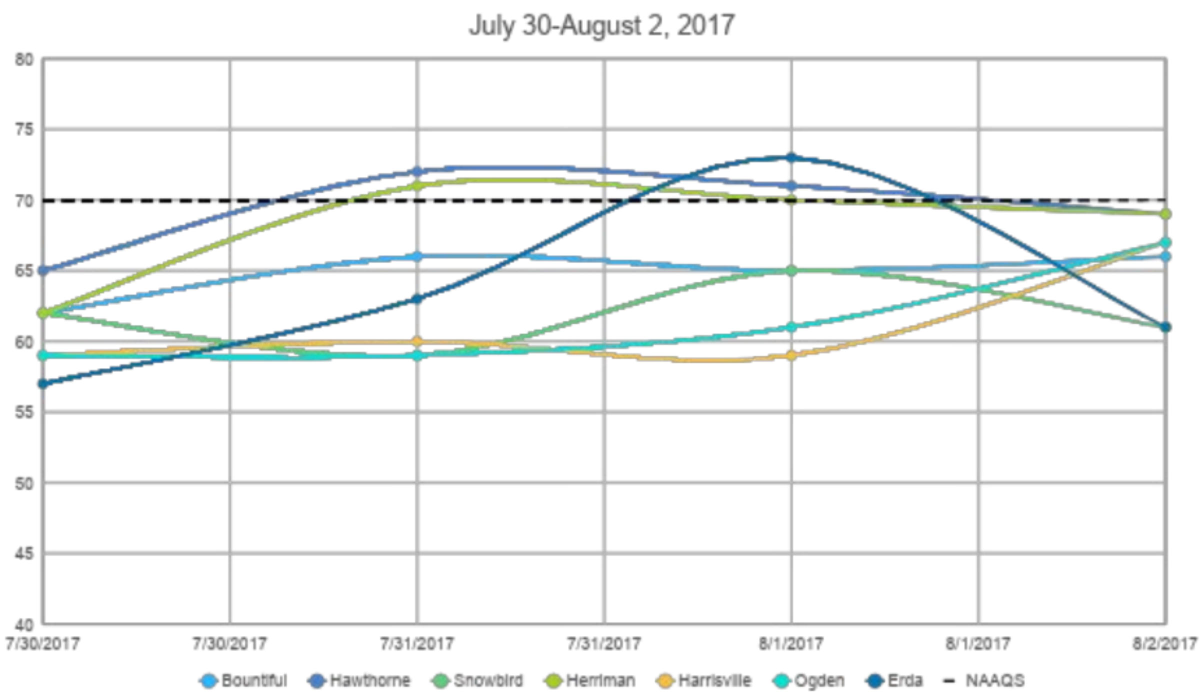
July 20 – July 28: MDA8 O3 (ppb)



July 30 – August 02

- Hot, dry, upper level high pressure, and clear skies, combined for the perfect conditions for ozone formation.
- A few scattered clouds August 1st afternoon impacted ozone formation.
- Increased winds August 2nd reduced ozone measurements.
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

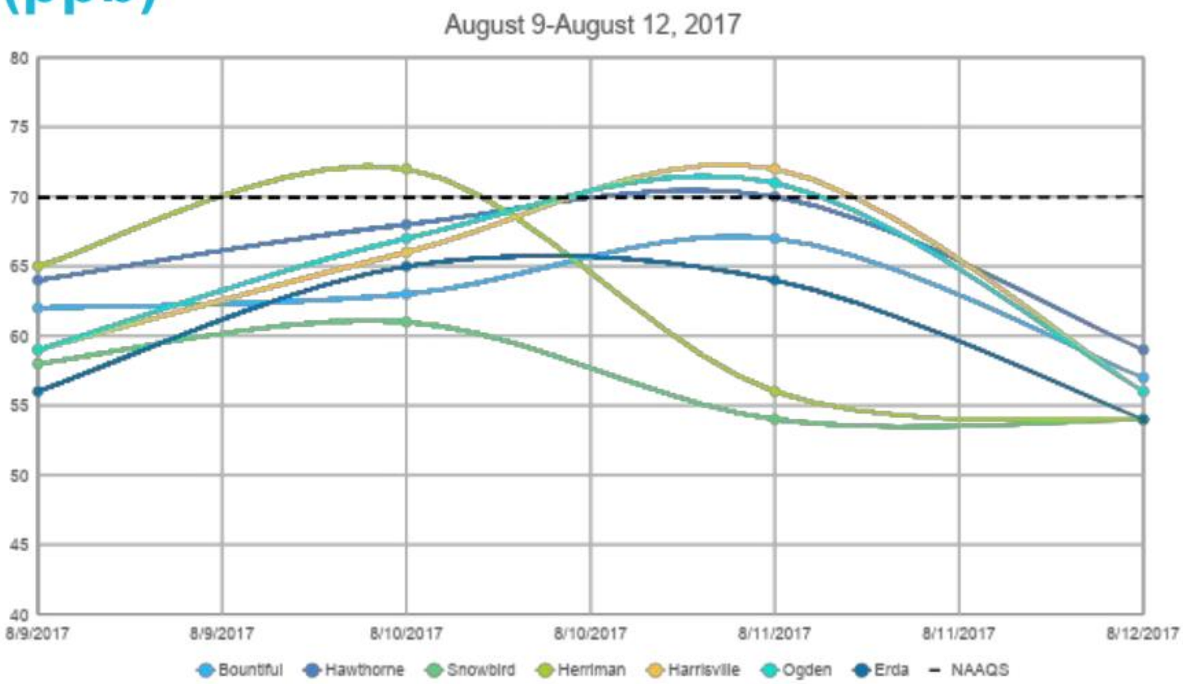
July 30 – August 02: MDA8 O3 (ppb)



August 09 – August 12

- A slight drying trend for two days allowed for increased solar radiation, and thus increased ozone in populated locations.
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

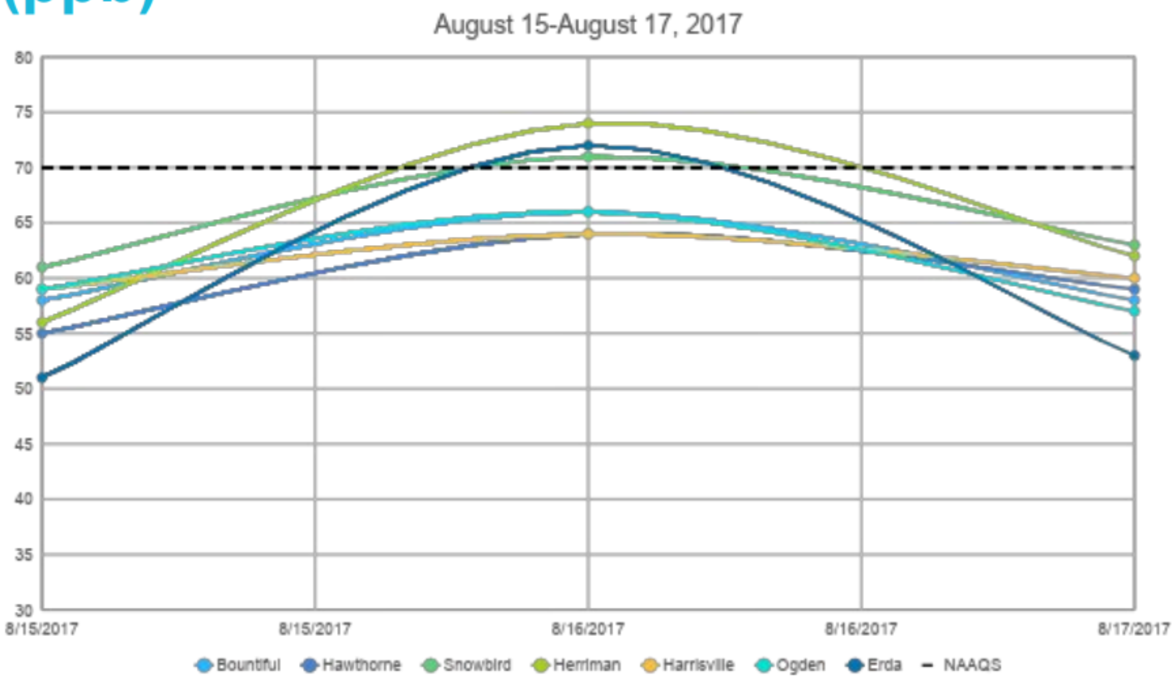
August 09 – August 12: MDA8 O3 (ppb)



August 15 – August 17

- Smoke/Haze was observed. Clear skis for most of the day, followed by evening clouds associated with a weak feature.
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

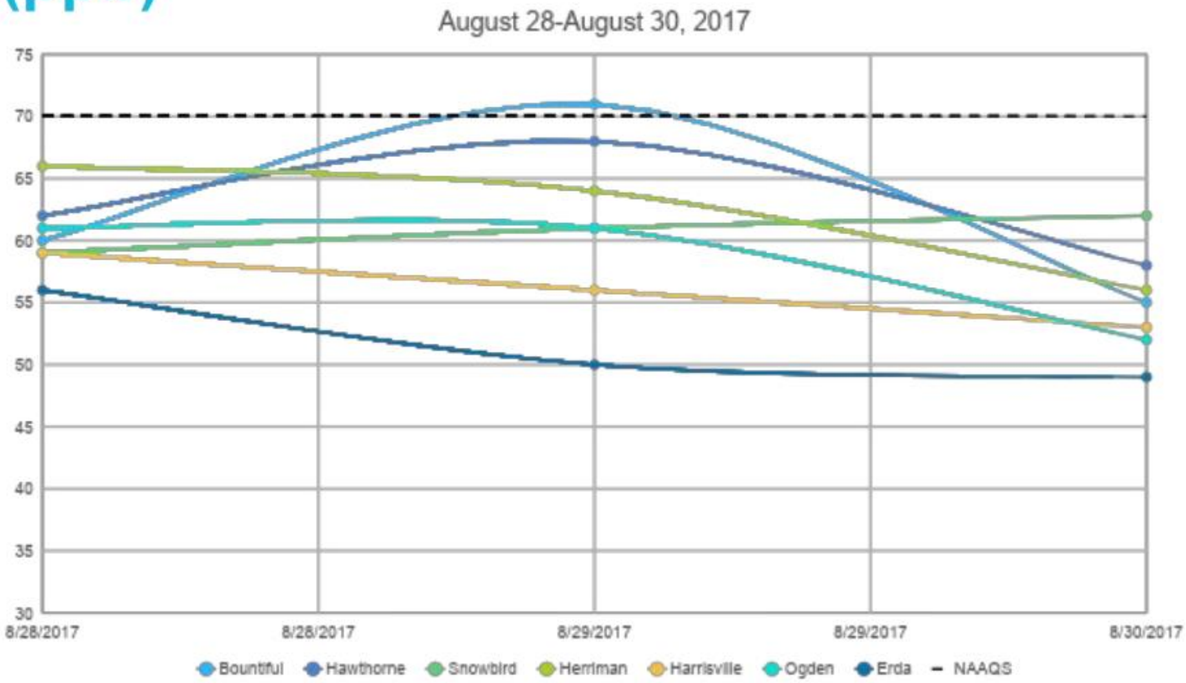
August 15 – August 17: MDA8 O3 (ppb)



August 28 – August 30

- Potential smoke impact on Ozone.
- High pressure aloft continued, allowing to warm dry conditions. Afternoon and evening clouds
- Peak ozone measurements do no coincide with frontal passage, which would be expected with long range transport of international emissions.

August 28 – August 30: MDA8 O3 (ppb)



Summary of Exceedance Day Meteorology

The majority of ozone exceedance days share these synoptic characteristics:

- High pressure (no downwelling of upper tropospheric ozone)
- No coincident frontal passage (no stratospheric intrusions or downwelling)
- Low surface winds (no non-local surface transport)
- Sunshine (no large convective systems adding lightning NOx or upper level ozone to the local mix)

APPENDIX B: HYSPLIT Back-Trajectories

HySPLIT Backward Dispersion

- Simulations configured based on MDA8 O3 measurements
- Assumed vertical line source with particles distributed uniformly between 100 and 1000 m over monitor
- 80,000 particles released over 8 hours with 10,000 particles released per hour

CAVEATS: not accounting for chemical transformation, physical loss processes and emission sources.

For each exceedance, non-exceedance day, frequency plots showing the fraction of particles in a given region were developed.

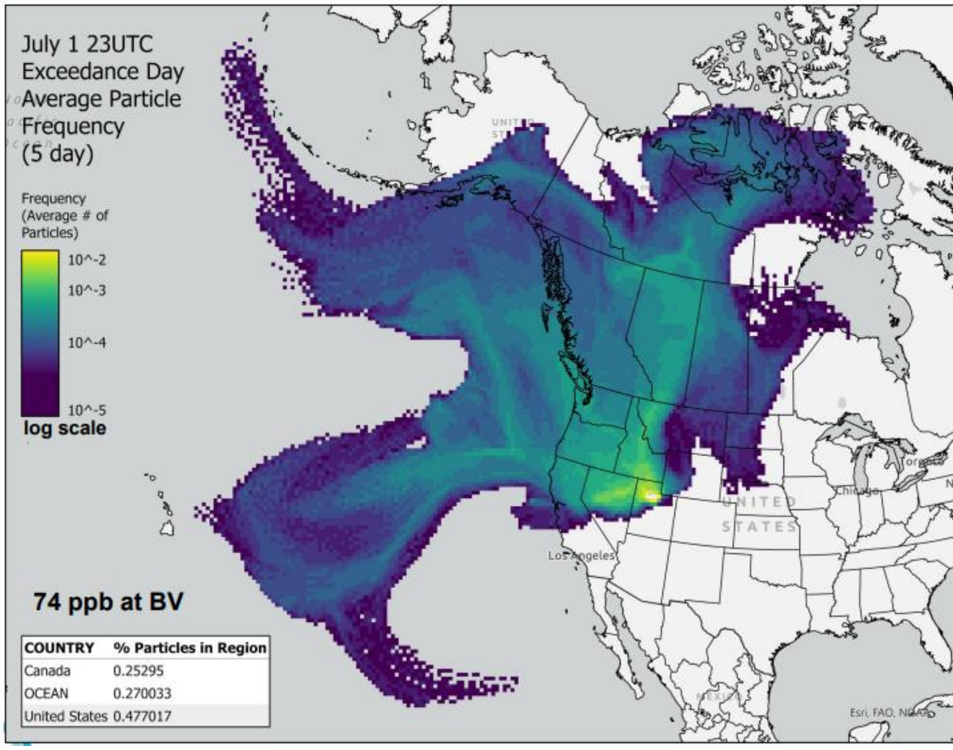
Backtrajectories represent the predominant meteorological pathway influencing Bountiful site, where particles over a given region are assumed to interact with source emissions within that region.

Only July 2017 plots are shown. Almost all exceedances occurred during this month.

Configuration	
Starting Location	Bountiful
Total run time	120 hours (5 days) backwards
Emission Rate (1/hr)	10,000
Hours of Release	8
Release Start Time	Last hour of 8-hr period over which MDA8 O3 occurs

Exceedance

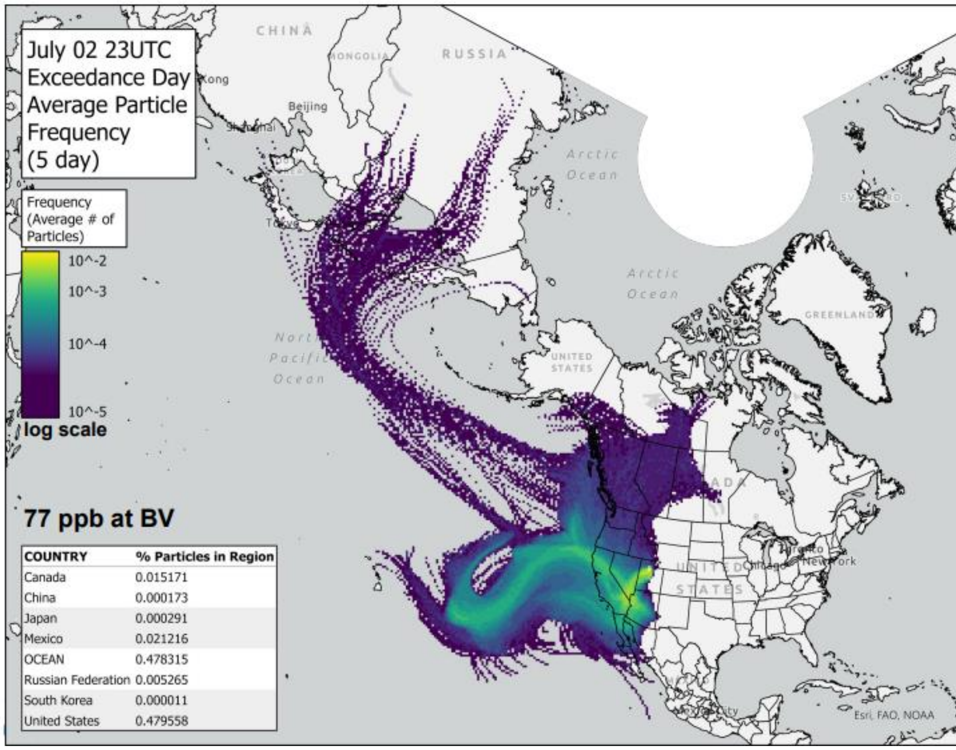
July 1 Average Particle Frequency



Division of Air Quality

Exceedance

July 2 Average Particle Frequency

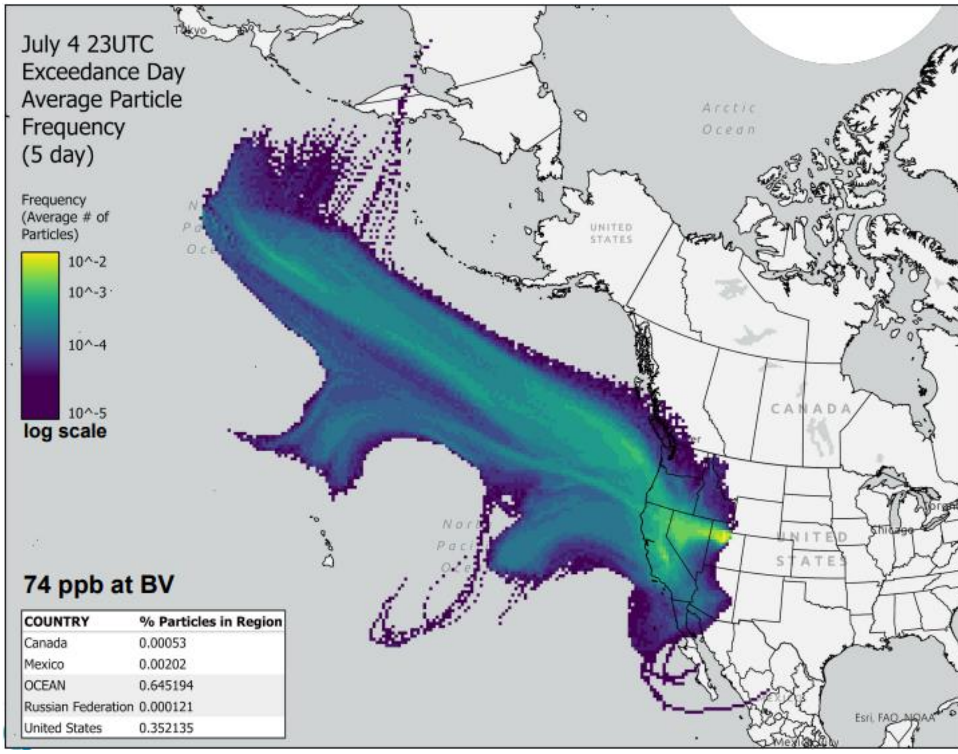


COUNTRY	% Particles in Region
Canada	0.015171
China	0.000173
Japan	0.000291
Mexico	0.021216
OCEAN	0.478315
Russian Federation	0.005265
South Korea	0.000011
United States	0.479558

Division of Air Quality

Exceedance

July 4 Average Particle Frequency

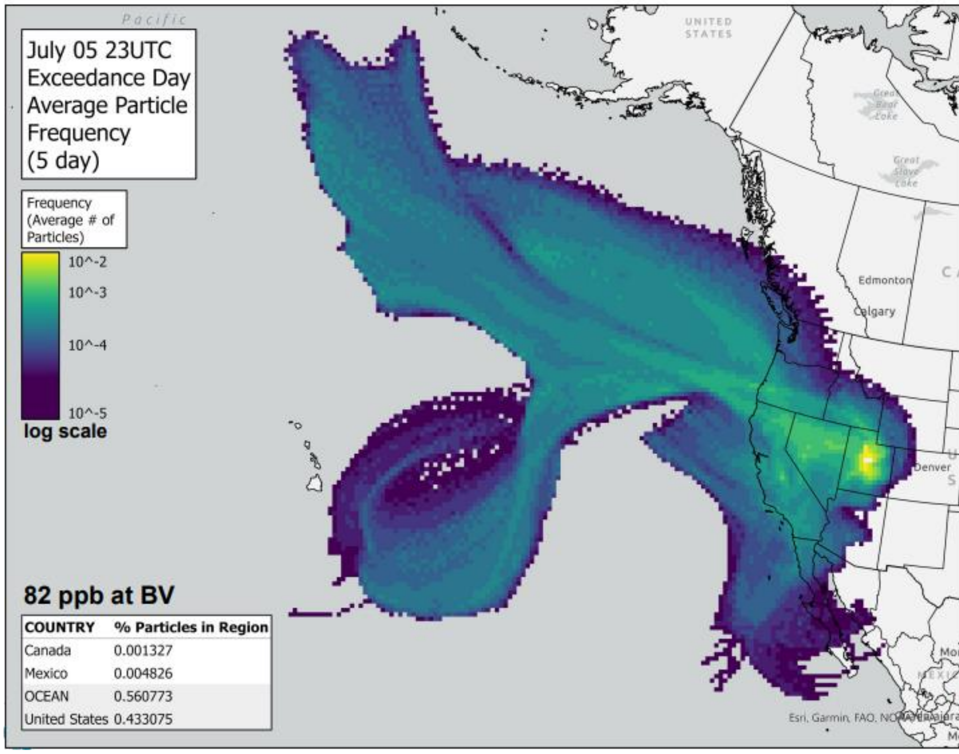


COUNTRY	% Particles in Region
Canada	0.00053
Mexico	0.00202
OCEAN	0.645194
Russian Federation	0.000121
United States	0.352135

Division of Air Quality

Exceedance

July 5 Average Particle Frequency

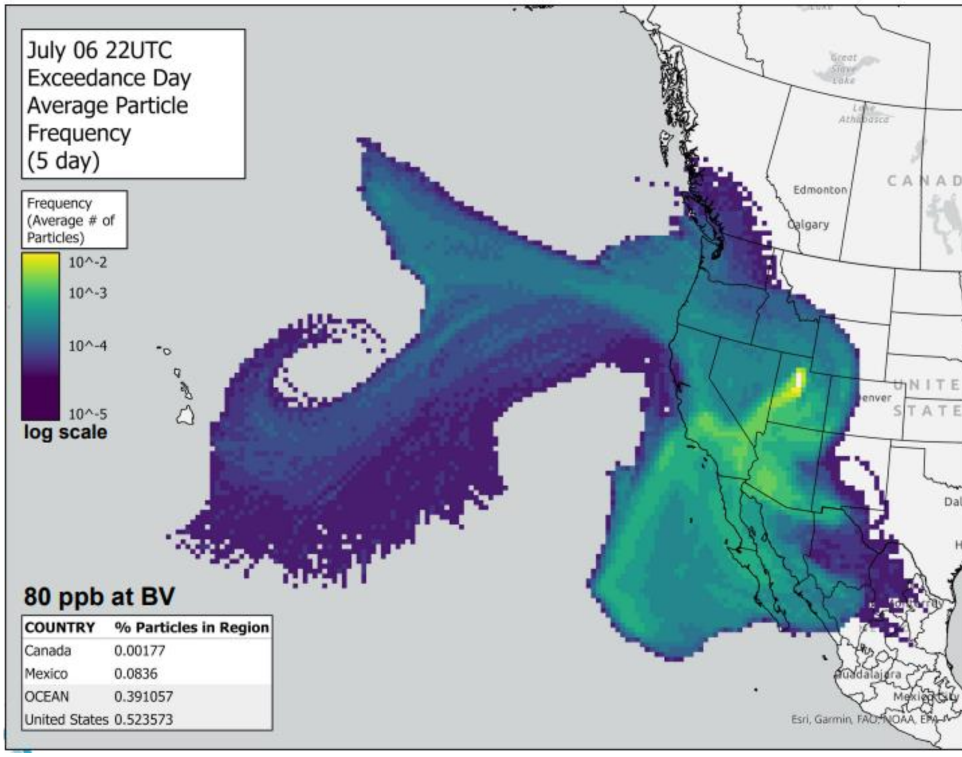


COUNTRY	% Particles in Region
Canada	0.001327
Mexico	0.004826
OCEAN	0.560773
United States	0.433075

Division of Air Quality

Exceedance

July 6 Average Particle Frequency

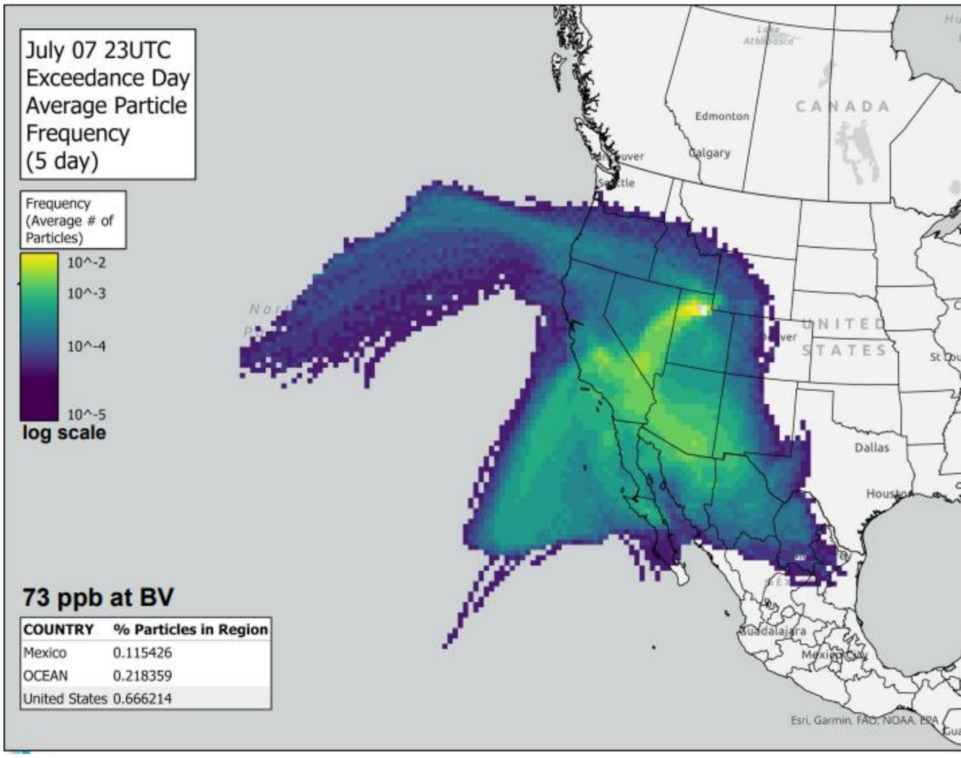


COUNTRY	% Particles in Region
Canada	0.00177
Mexico	0.0836
OCEAN	0.391057
United States	0.523573

Division of Air Quality

Exceedance

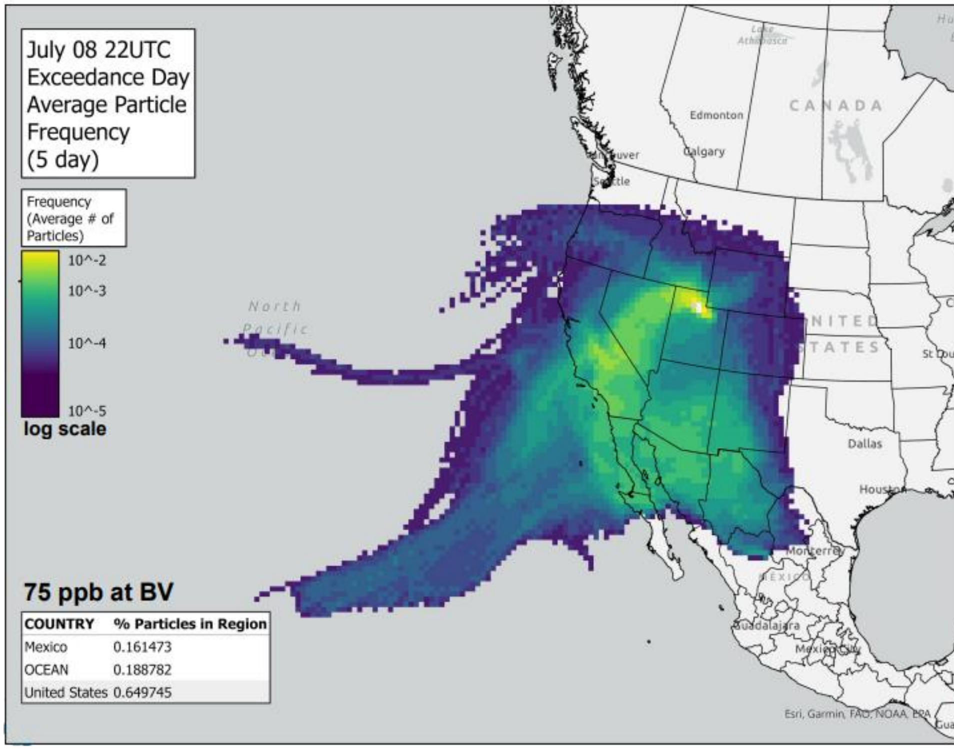
July 7 Average Particle Frequency



Division of Air Quality

Exceedance

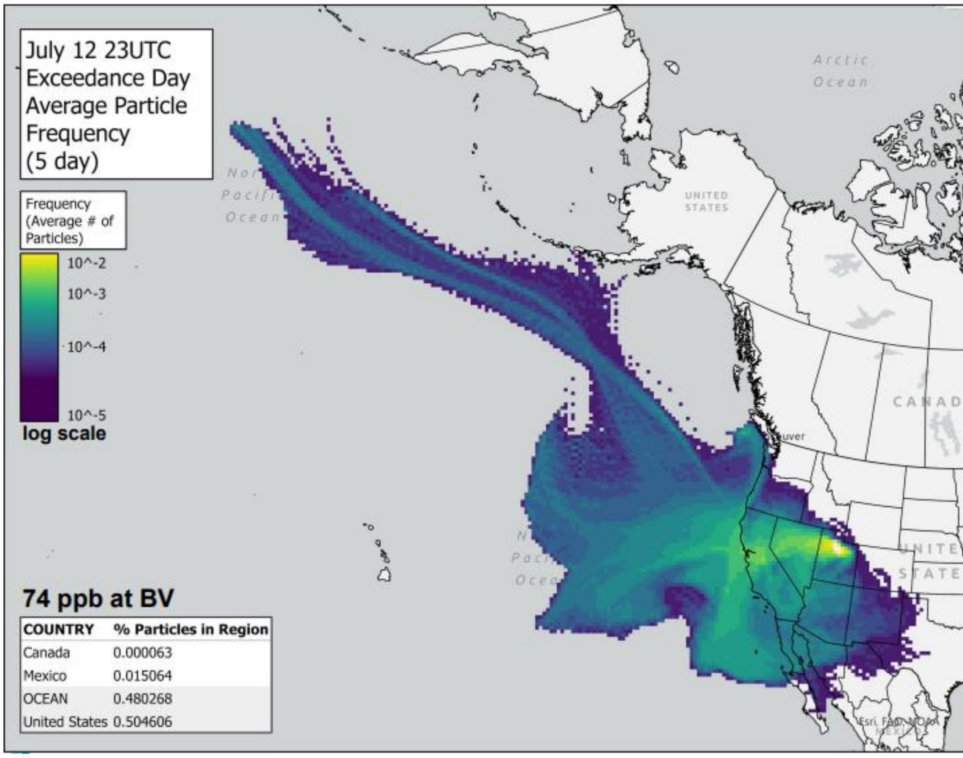
July 8 Average Particle Frequency



Division of Air Quality

Exceedance

July 12 Average Particle Frequency

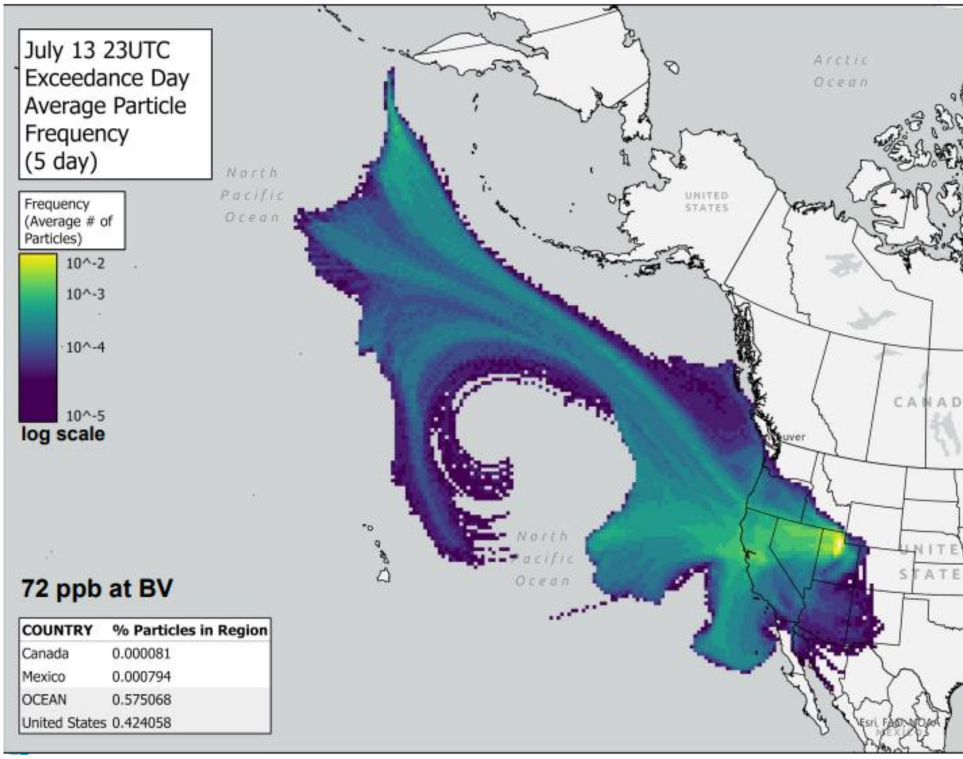


COUNTRY	% Particles in Region
Canada	0.000063
Mexico	0.015064
OCEAN	0.480268
United States	0.504606

Division of Air Quality

Exceedance

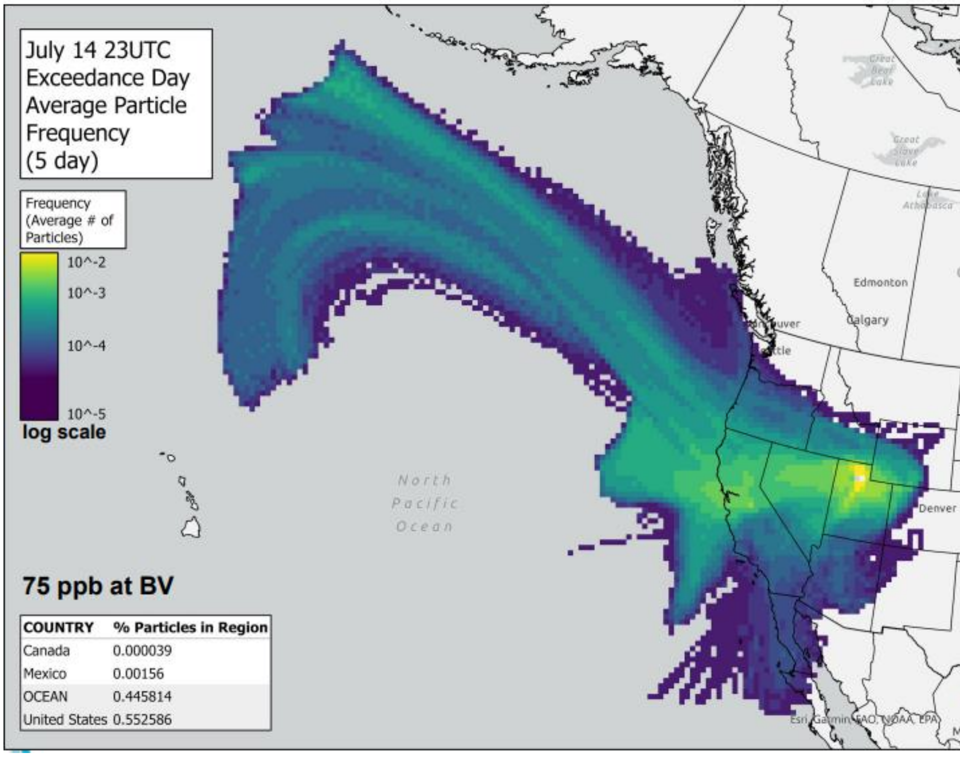
July 13 Average Particle Frequency



Division of Air Quality

Exceedance

July 14 Average Particle Frequency

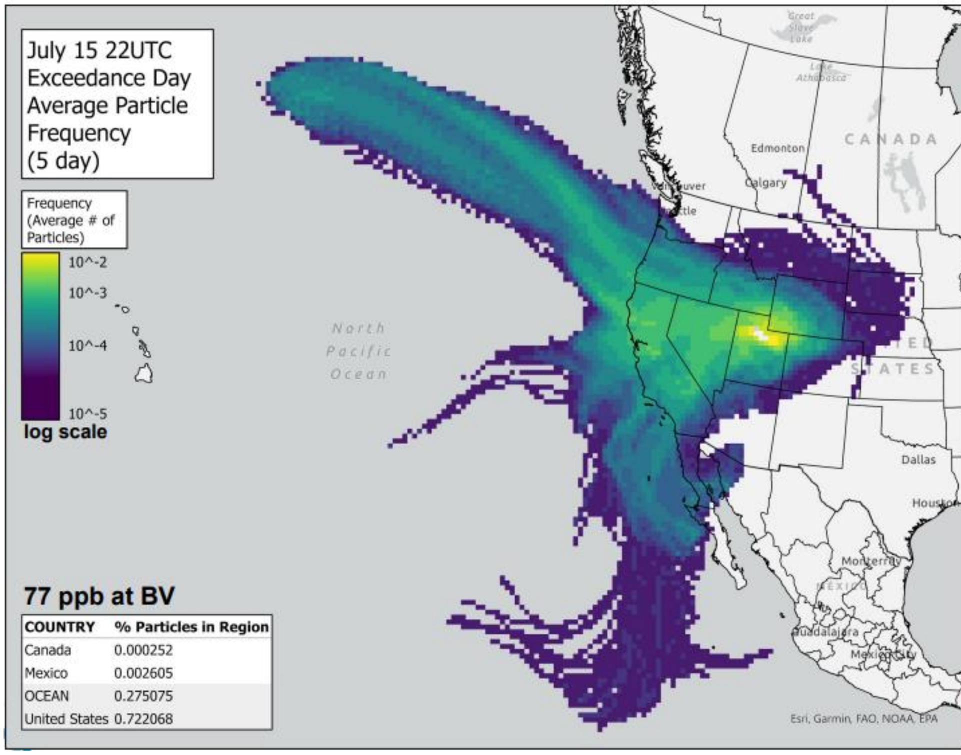


COUNTRY	% Particles in Region
Canada	0.000039
Mexico	0.00156
OCEAN	0.445814
United States	0.552586

Division of Air Quality

Exceedance

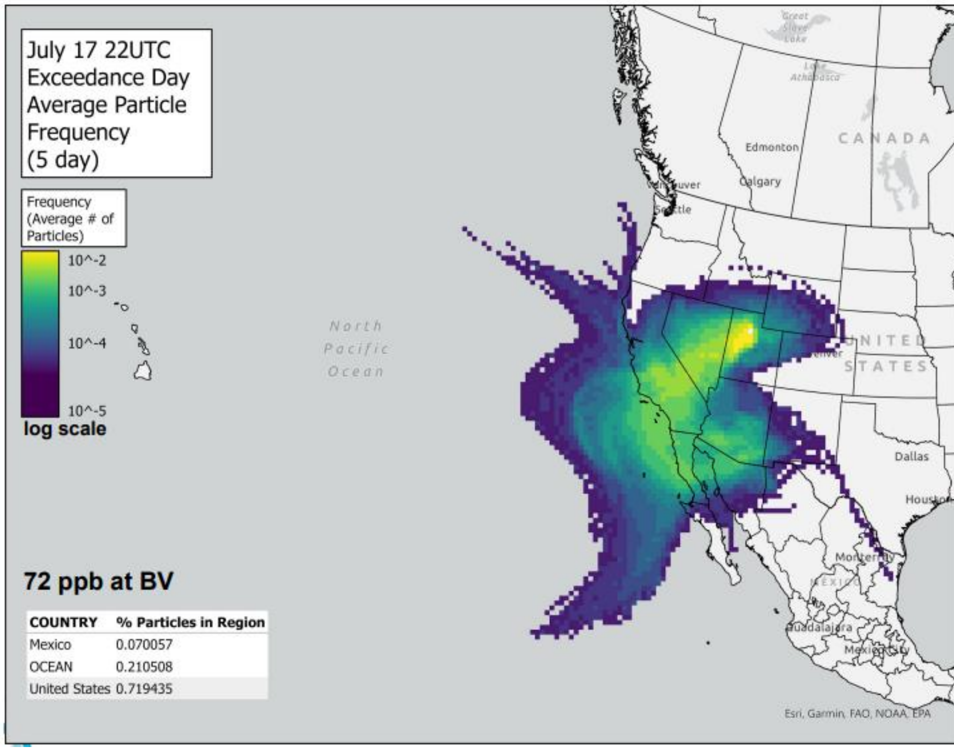
July 15 Average Particle Frequency



Division of Air Quality

Exceedance

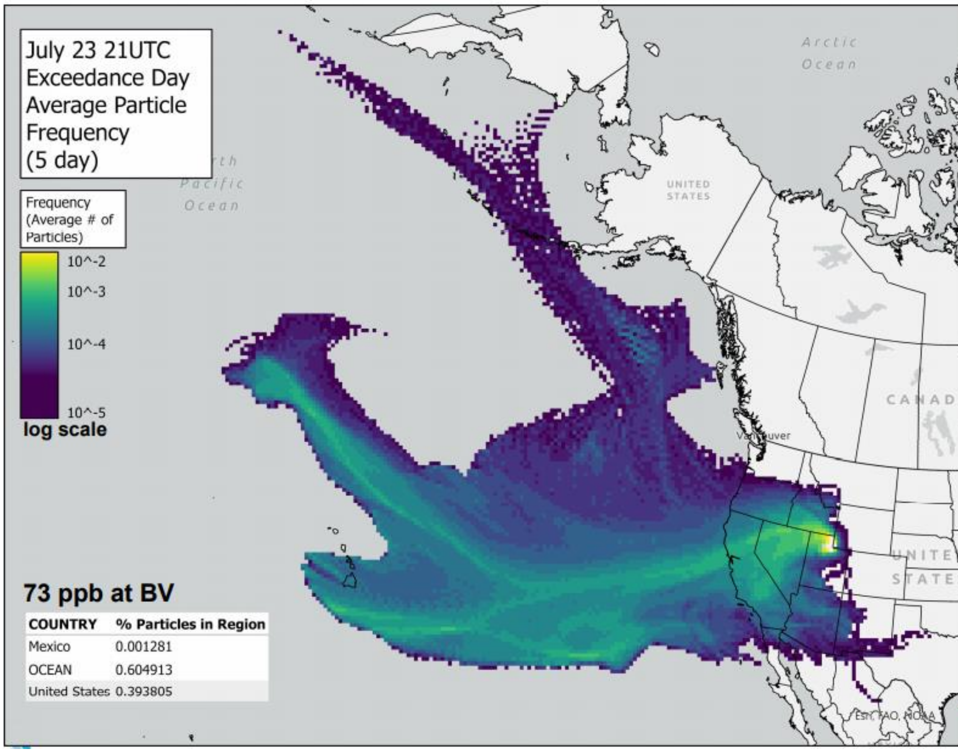
July 17 Average Particle Frequency



Division of Air Quality

Exceedance

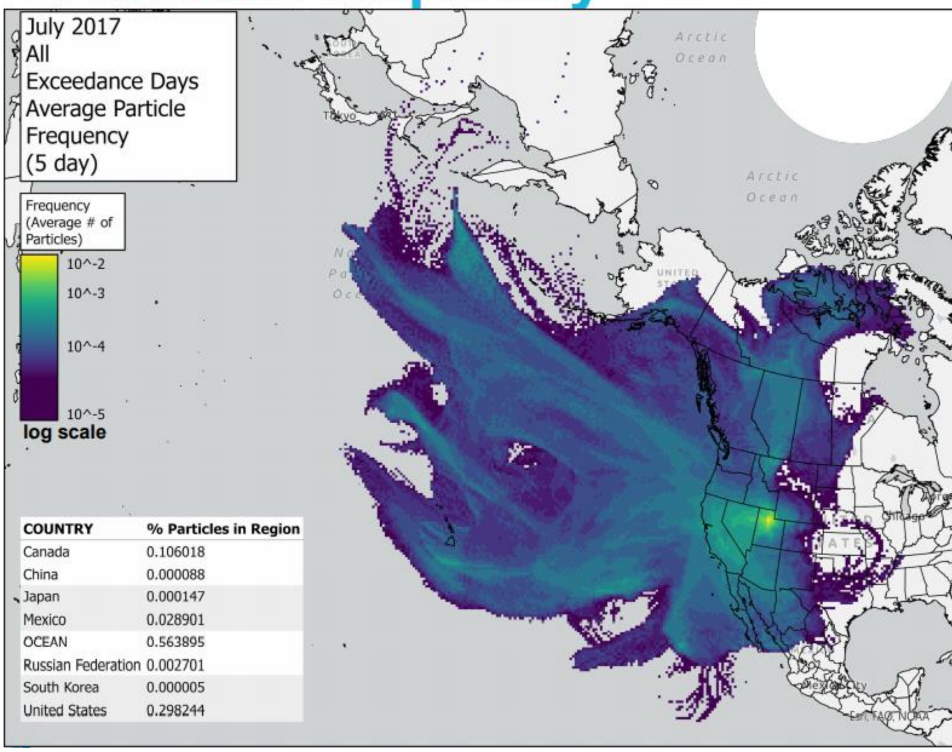
July 23 Average Particle Frequency



Division of Air Quality

Exceedance

July Exceedance Days (all) Average Particle Frequency

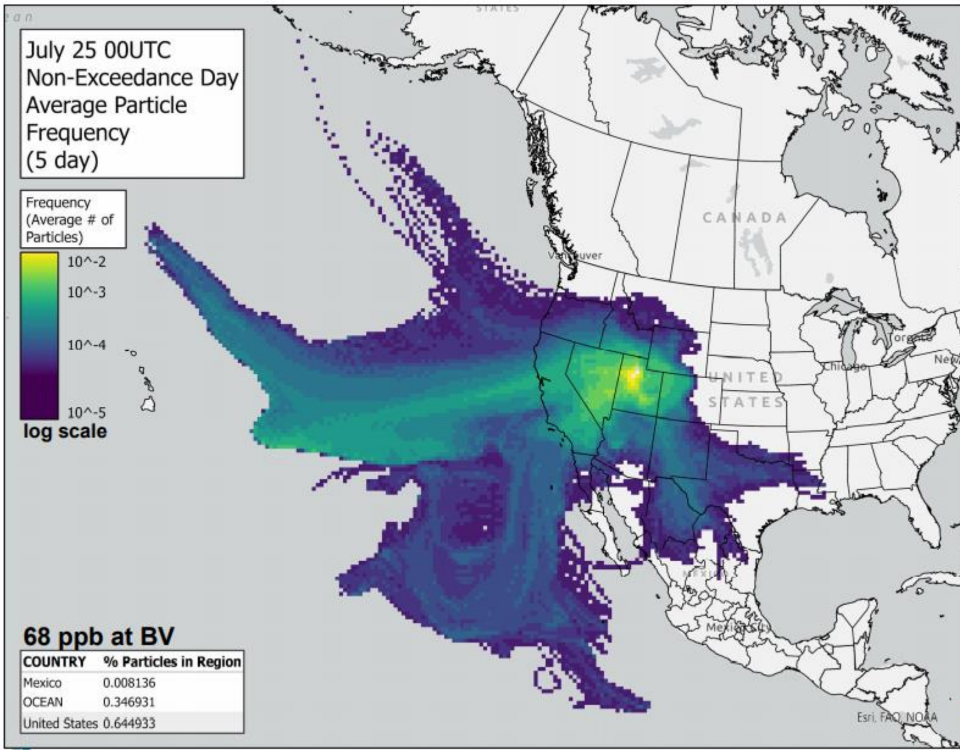


COUNTRY	% Particles in Region
Canada	0.106018
China	0.000088
Japan	0.000147
Mexico	0.028901
OCEAN	0.563895
Russian Federation	0.002701
South Korea	0.000005
United States	0.298244

Division of Air Quality

Non-Exceedance

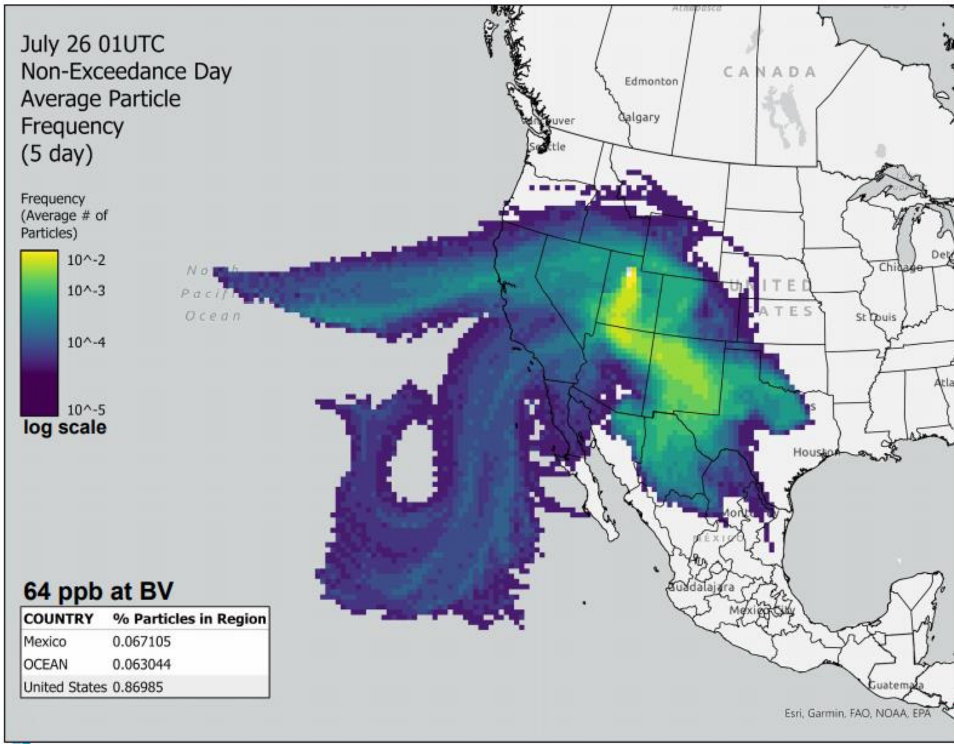
July 25 Average Particle Frequency



Division of Air Quality

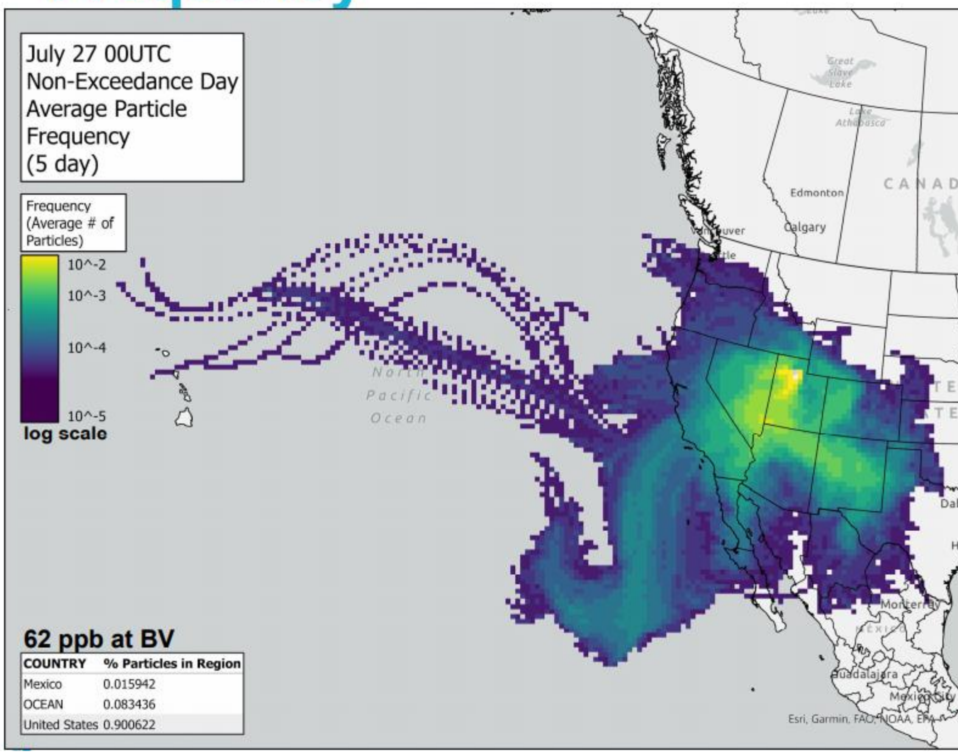
Non-Exceedance

July 26 Average Particle Frequency



Division of Air Quality

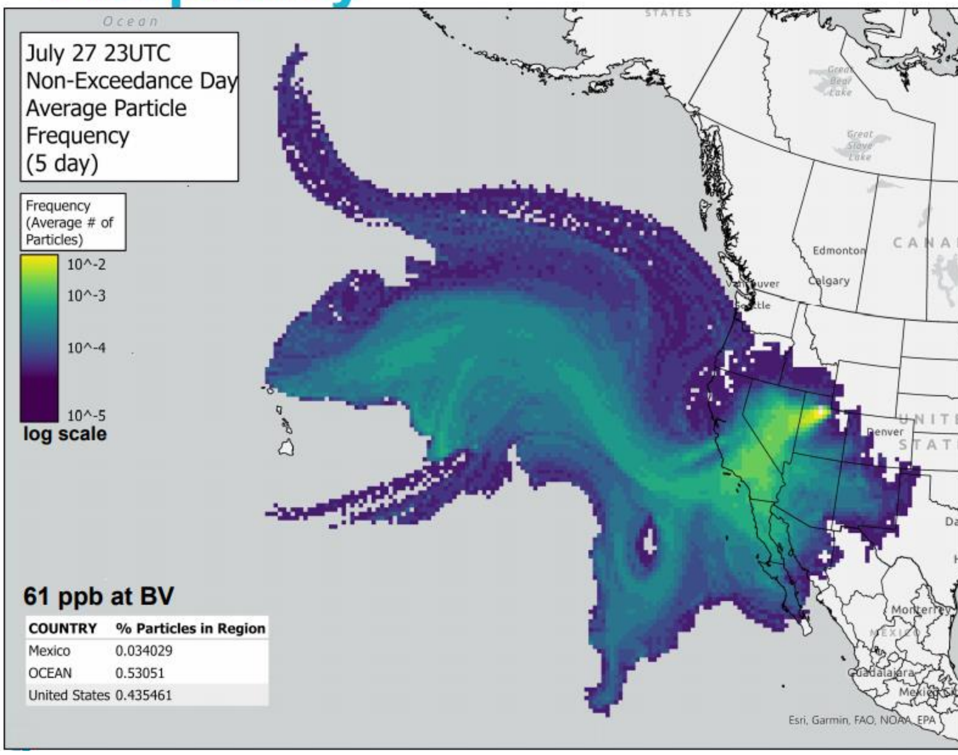
Non-Exceedance
July 27-00UTC Average Particle Frequency



Division of Air Quality

Non-Exceedance

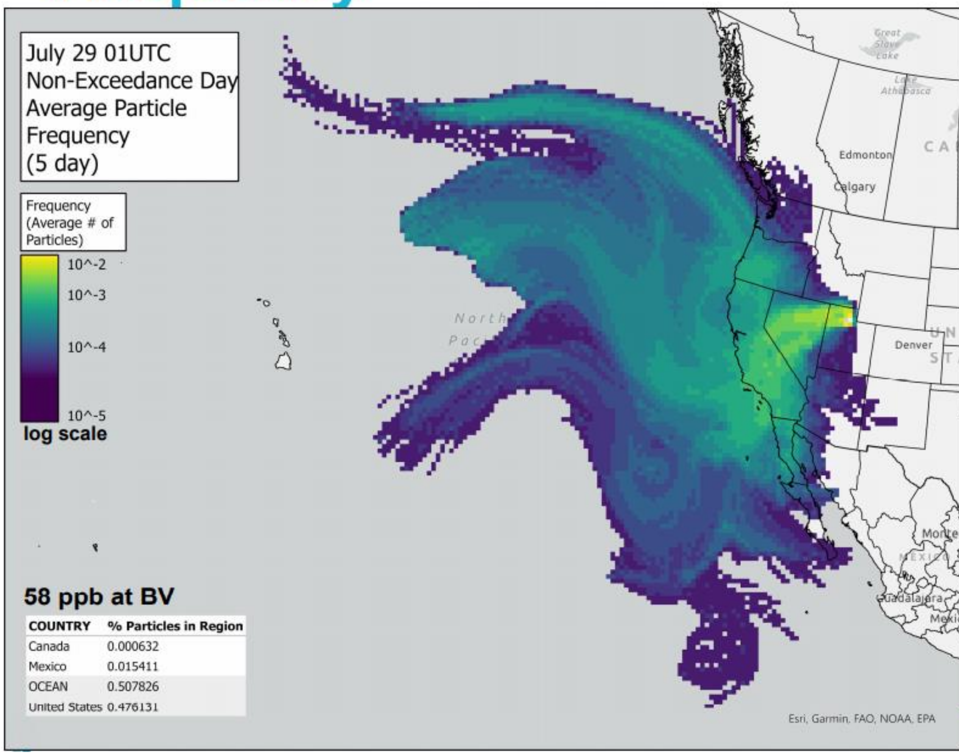
July 27-23UTC Average Particle Frequency



Division of Air Quality

Non-Exceedance

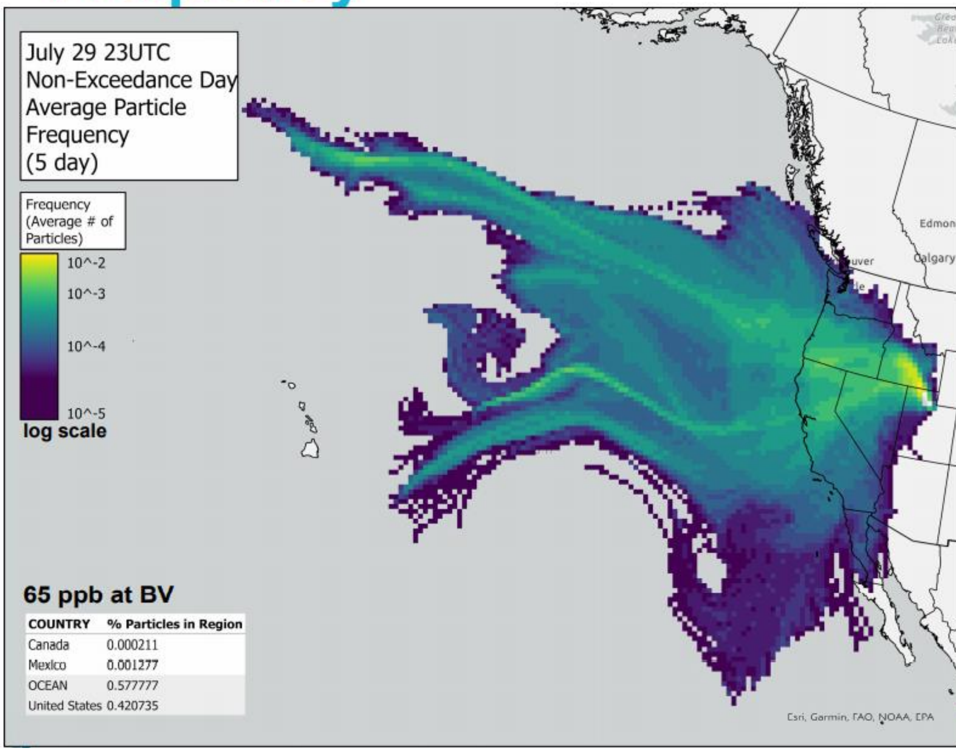
July 29-01UTC Average Particle Frequency



Division of Air Quality

Non-Exceedance

July 29-23UTC Average Particle Frequency

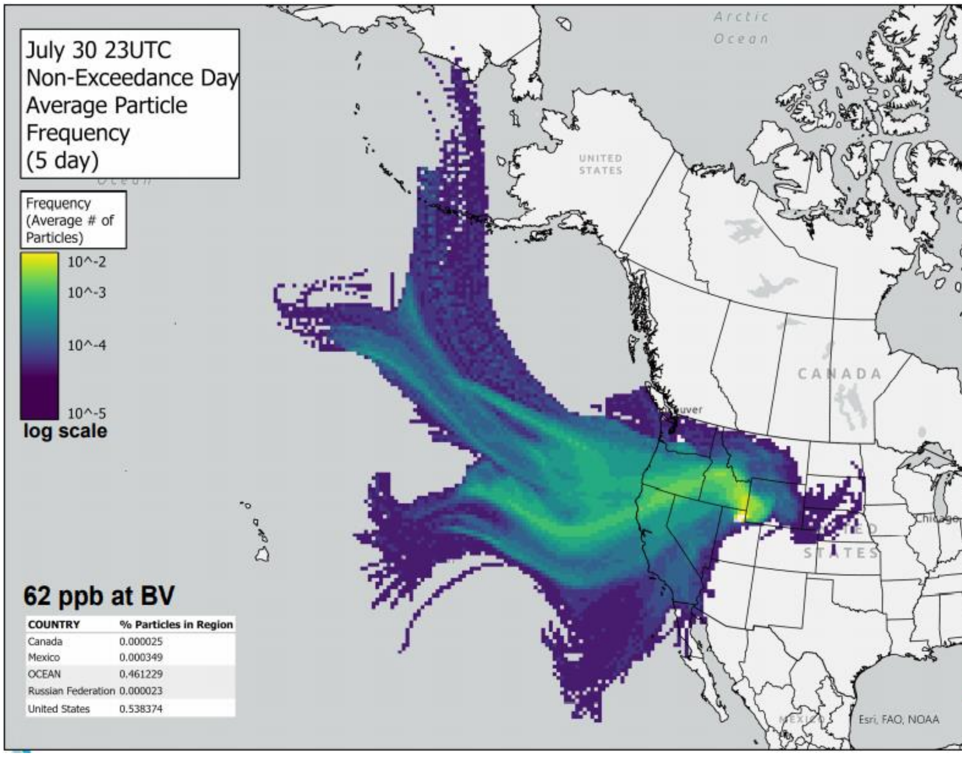


COUNTRY	% Particles in Region
Canada	0.000211
Mexico	0.001277
OCEAN	0.577777
United States	0.420735

Division of Air Quality

Non-Exceedance

July 30 Average Particle Frequency

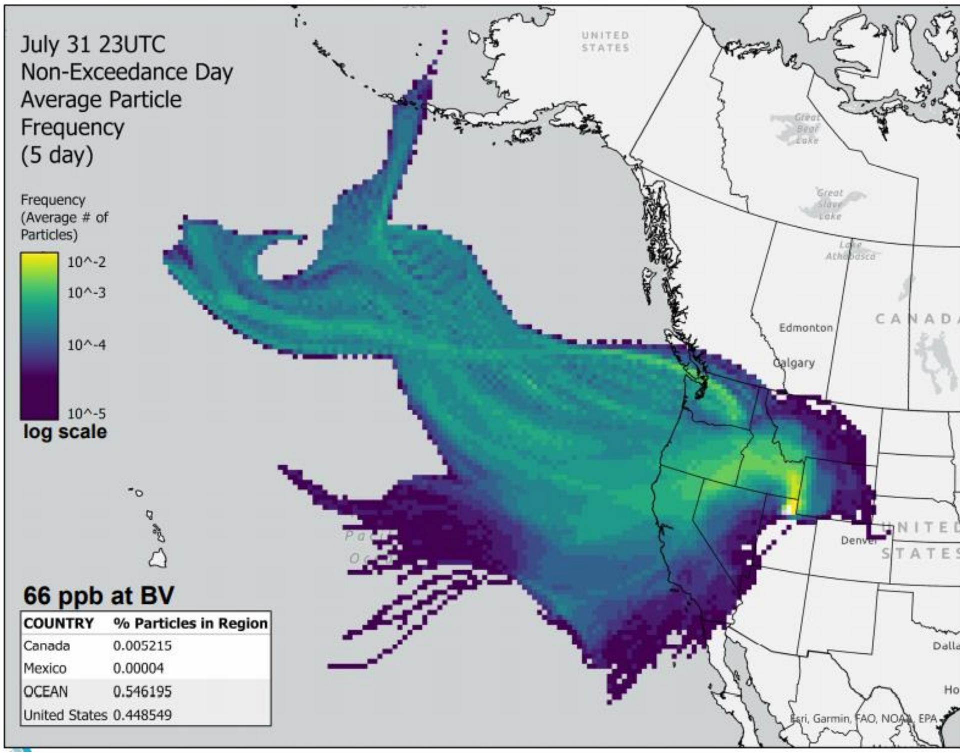


COUNTRY	% Particles in Region
Canada	0.000025
Mexico	0.000349
OCEAN	0.461229
Russian Federation	0.000023
United States	0.538374

Division of Air Quality

Non-Exceedance

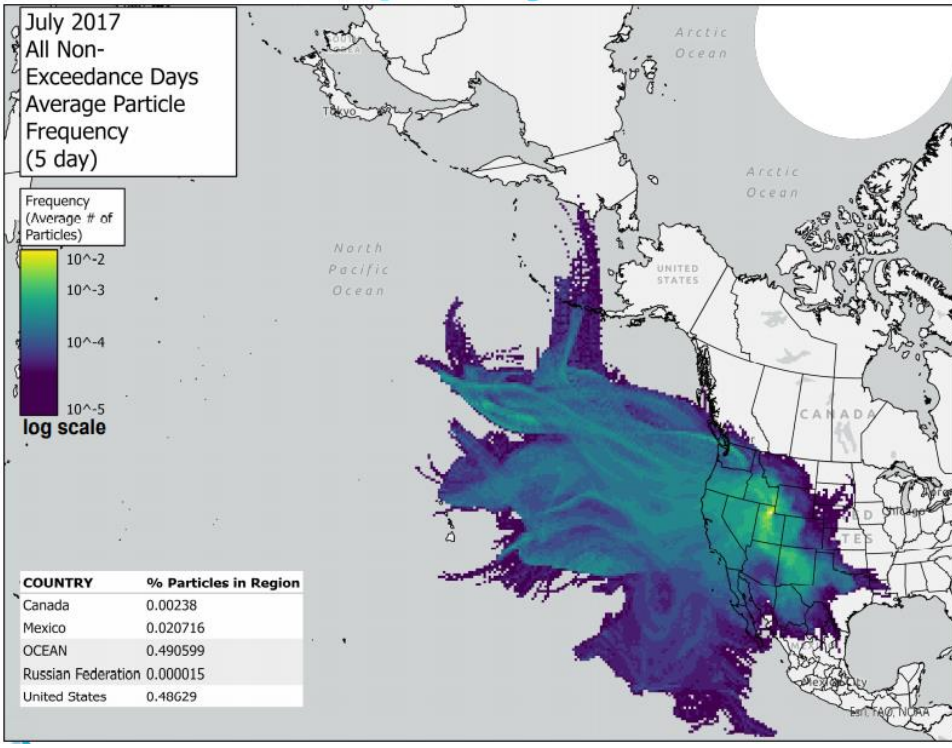
July 31 Average Particle Frequency



Division of Air Quality

Non-Exceedance

July Non-Exceedance Days (all) Average Particle Frequency

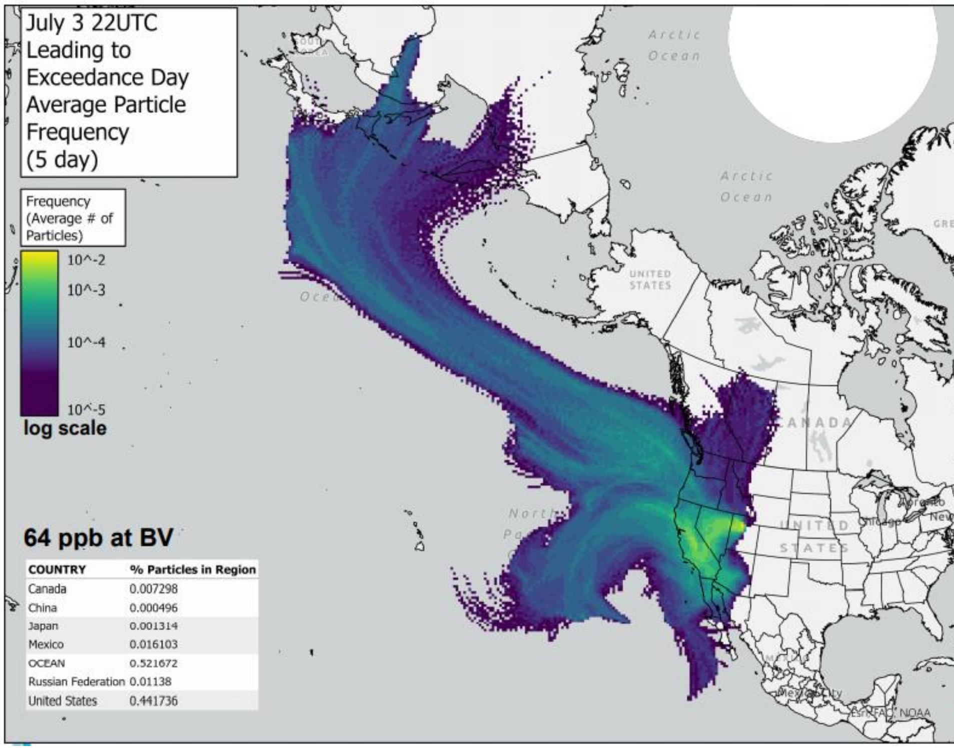


COUNTRY	% Particles in Region
Canada	0.00238
Mexico	0.020716
OCEAN	0.490599
Russian Federation	0.000015
United States	0.48629

Division of Air Quality

Leading to Exceedance

July 03 Average Particle Frequency

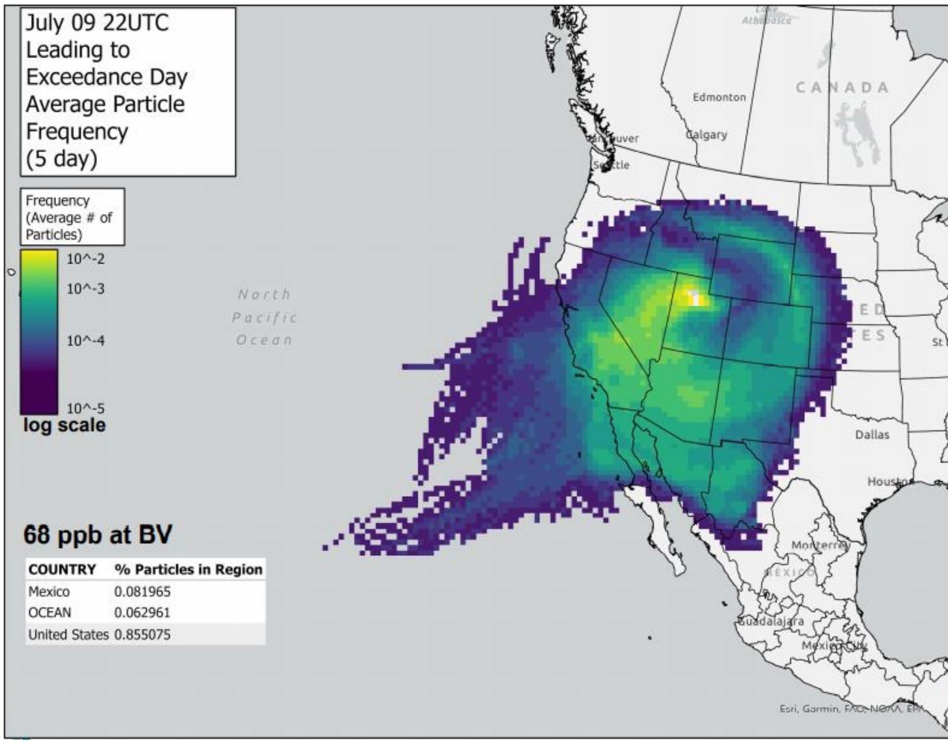


COUNTRY	% Particles in Region
Canada	0.007298
China	0.000496
Japan	0.001314
Mexico	0.016103
OCEAN	0.521672
Russian Federation	0.01138
United States	0.441736

Division of Air Quality

Leading to Exceedance

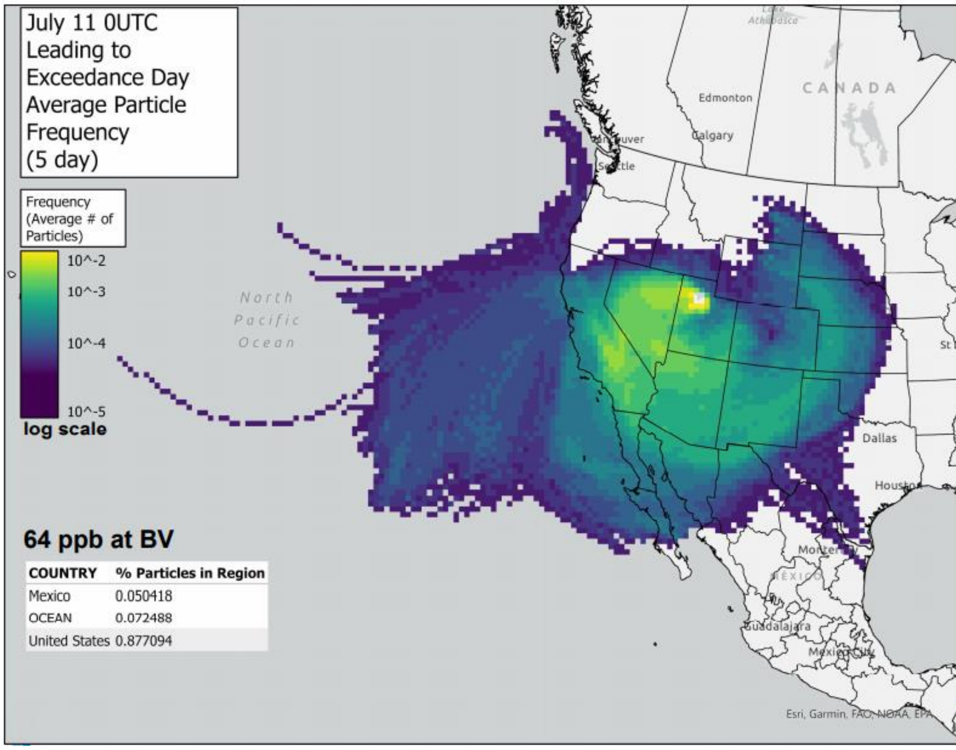
July 09 Average Particle Frequency



Division of Air Quality

Leading to Exceedance

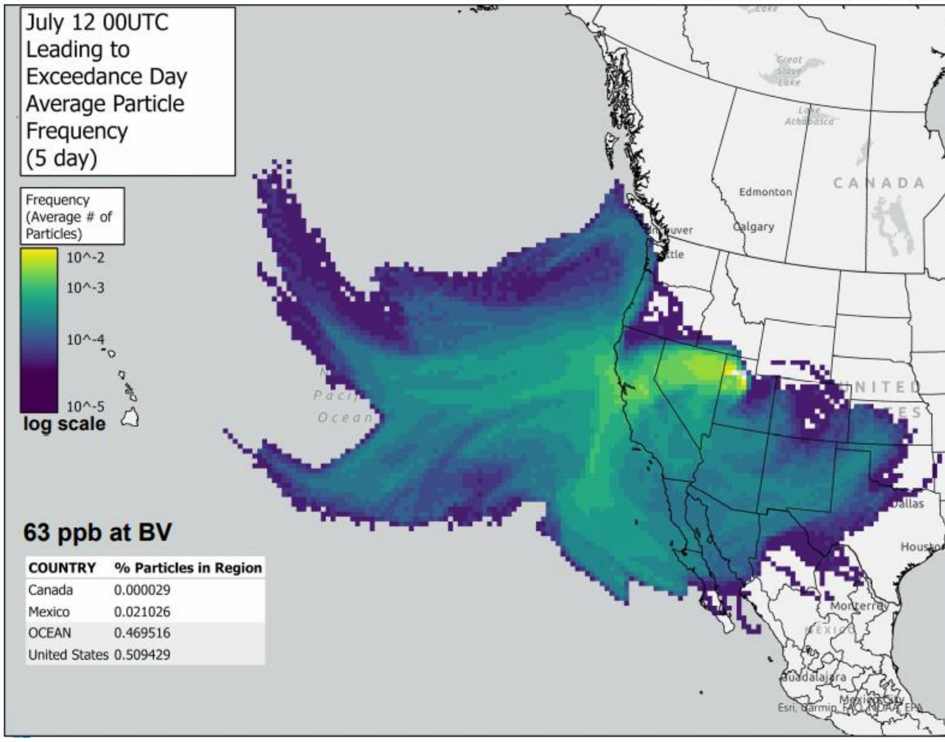
July 11 Average Particle Frequency



Division of Air Quality

Leading to Exceedance

July 12 Average Particle Frequency

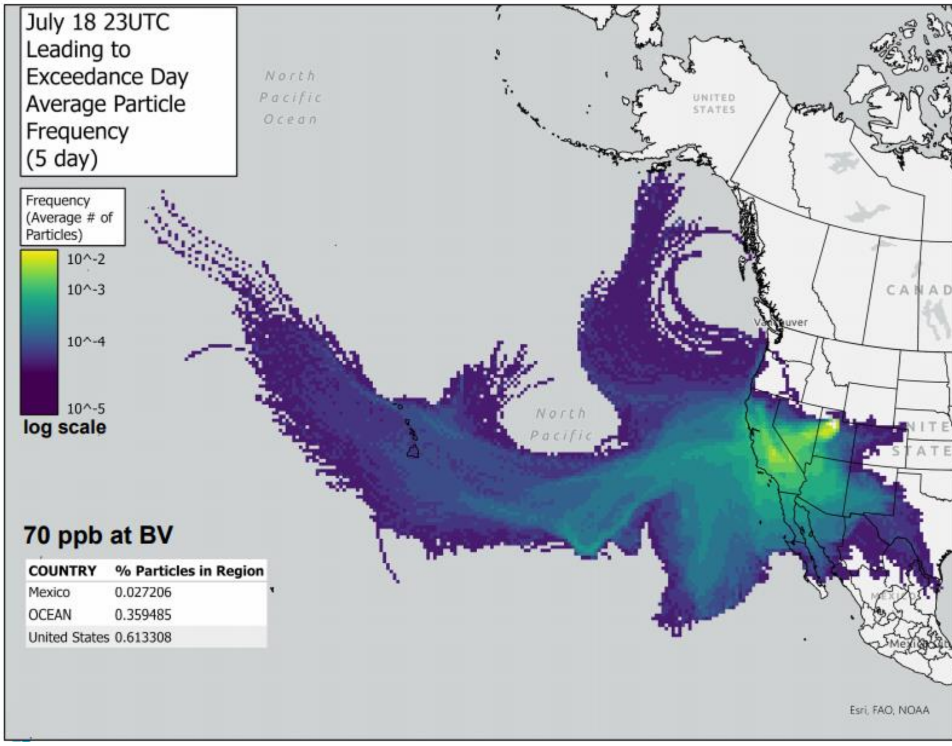


COUNTRY	% Particles in Region
Canada	0.000029
Mexico	0.021026
OCEAN	0.469516
United States	0.509429

Division of Air Quality

Leading to Exceedance

July 18 Average Particle Frequency

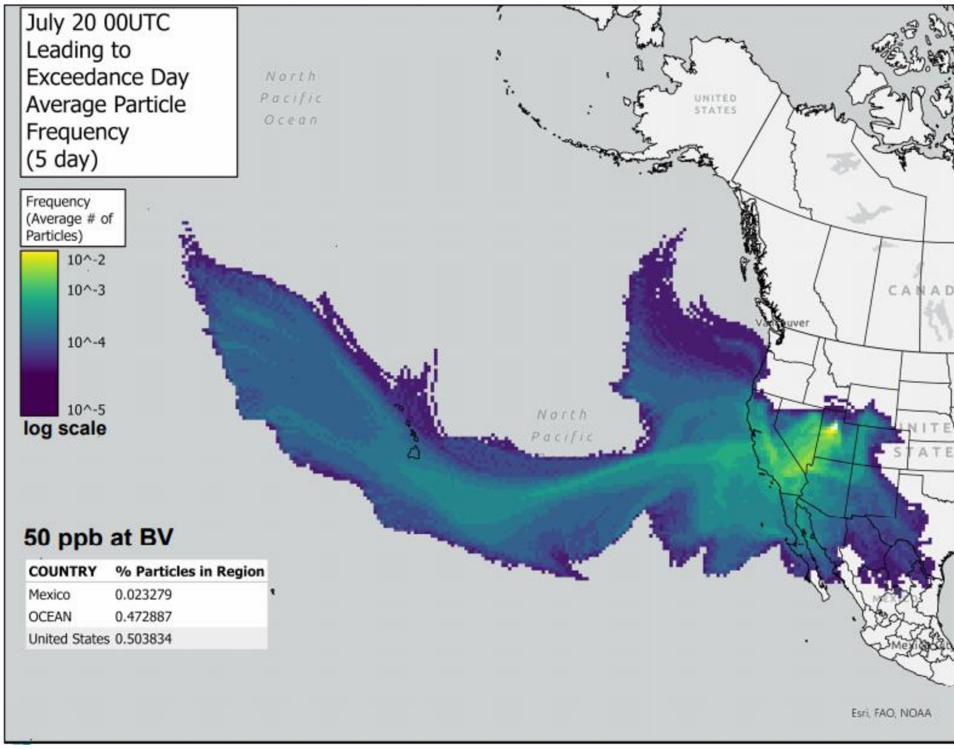


COUNTRY	% Particles in Region
Mexico	0.027206
OCEAN	0.359485
United States	0.613308

Division of Air Quality

Leading to Exceedance

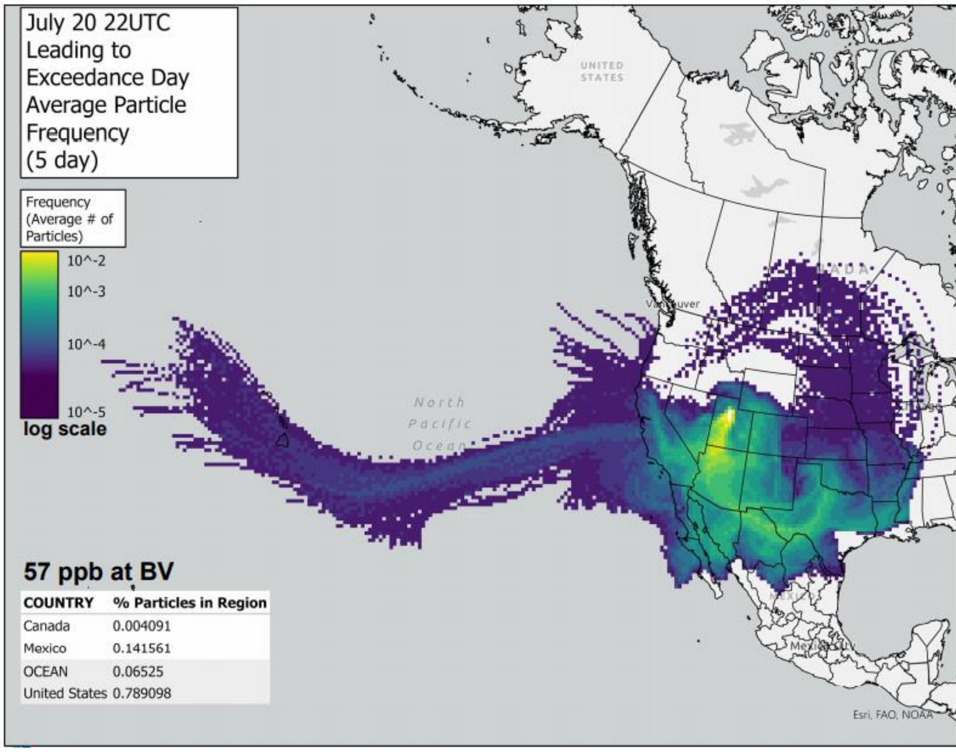
July 20-00UTC Average Particle Frequency



Division of Air Quality

Leading to Exceedance

July 20-22UTC Average Particle Frequency

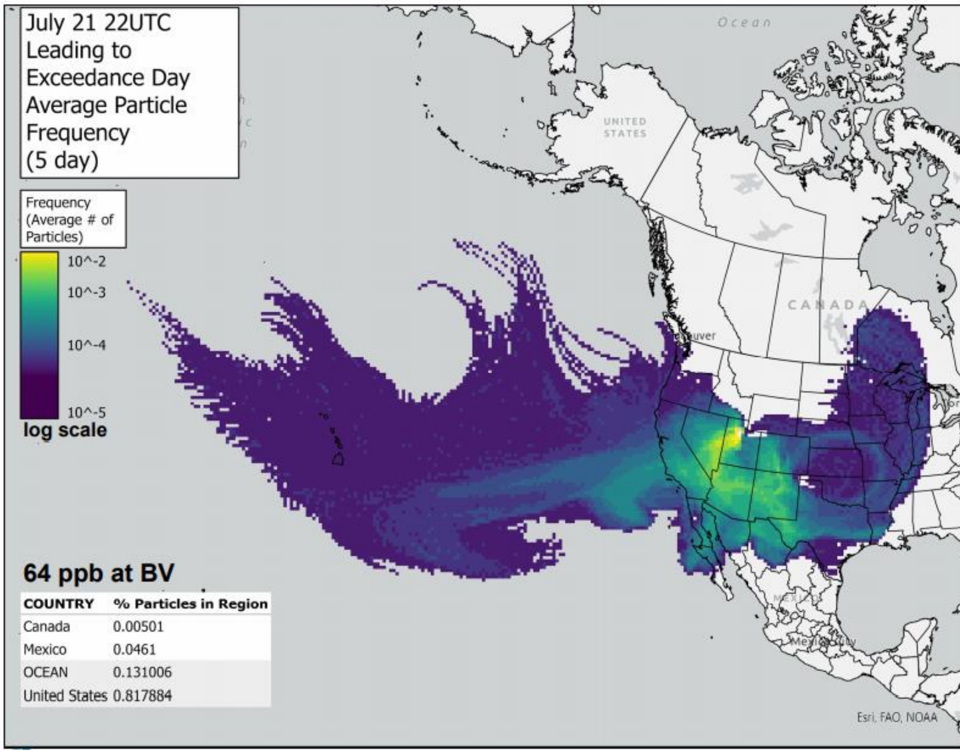


COUNTRY	% Particles in Region
Canada	0.004091
Mexico	0.141561
OCEAN	0.06525
United States	0.789098

Division of Air Quality

Leading to Exceedance

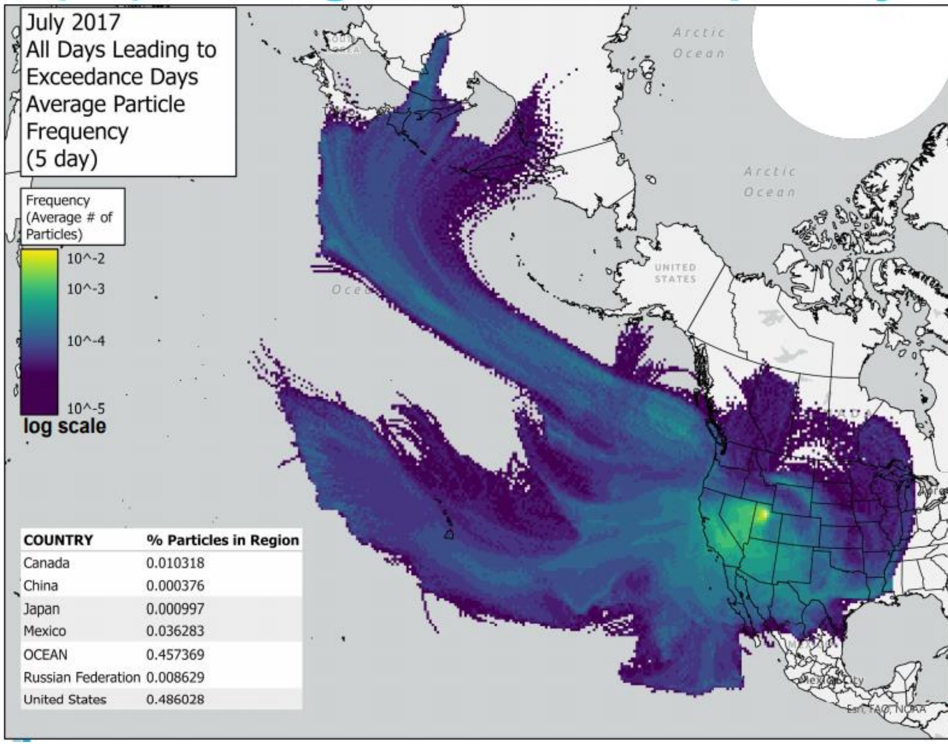
July 21 Average Particle Frequency



Division of Air Quality

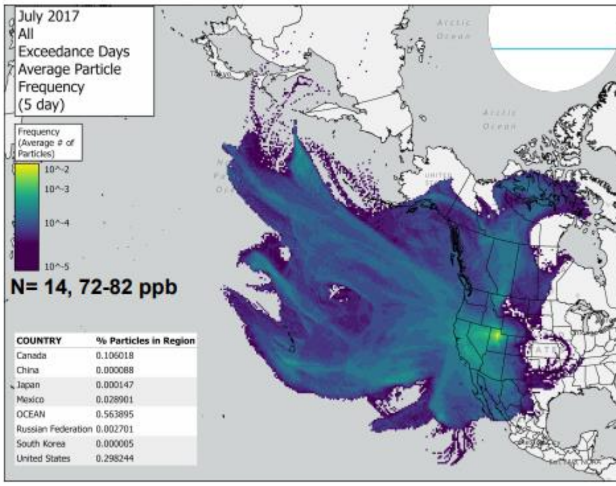
Leading to Exceedance

July Leading to Exceedance Days (all) Average Particle Frequency

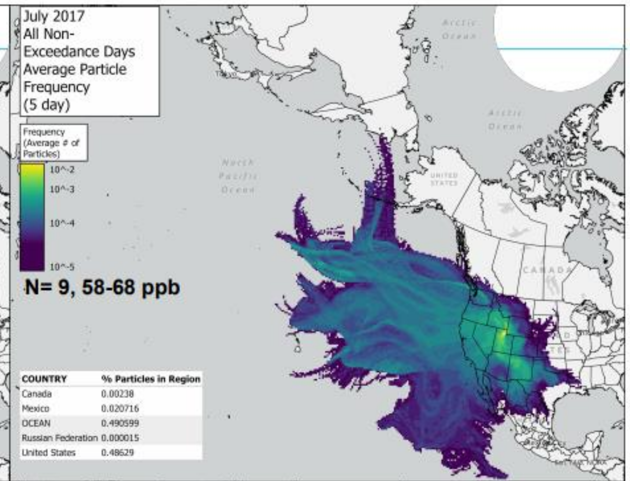


COUNTRY	% Particles in Region
Canada	0.010318
China	0.000376
Japan	0.000997
Mexico	0.036283
OCEAN	0.457369
Russian Federation	0.008629
United States	0.486028

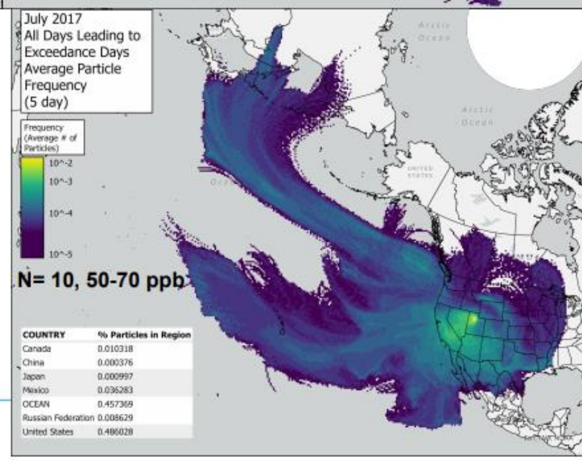
Division of Air Quality



COUNTRY	% Particles in Region
Canada	0.106018
China	0.000088
Japan	0.000147
Mexico	0.028901
OCEAN	0.563895
Russian Federation	0.002701
South Korea	0.000005
United States	0.298244



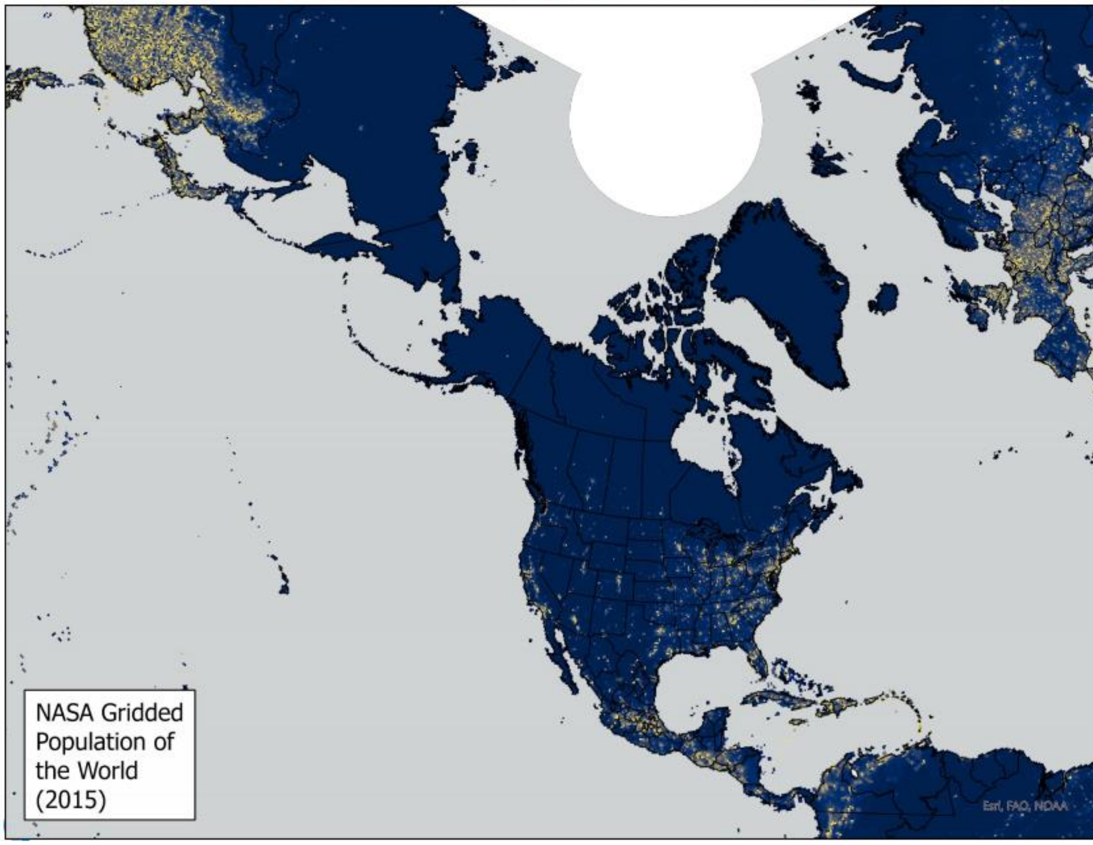
COUNTRY	% Particles in Region
Canada	0.00238
Mexico	0.020716
OCEAN	0.490599
Russian Federation	0.000015
United States	0.48629

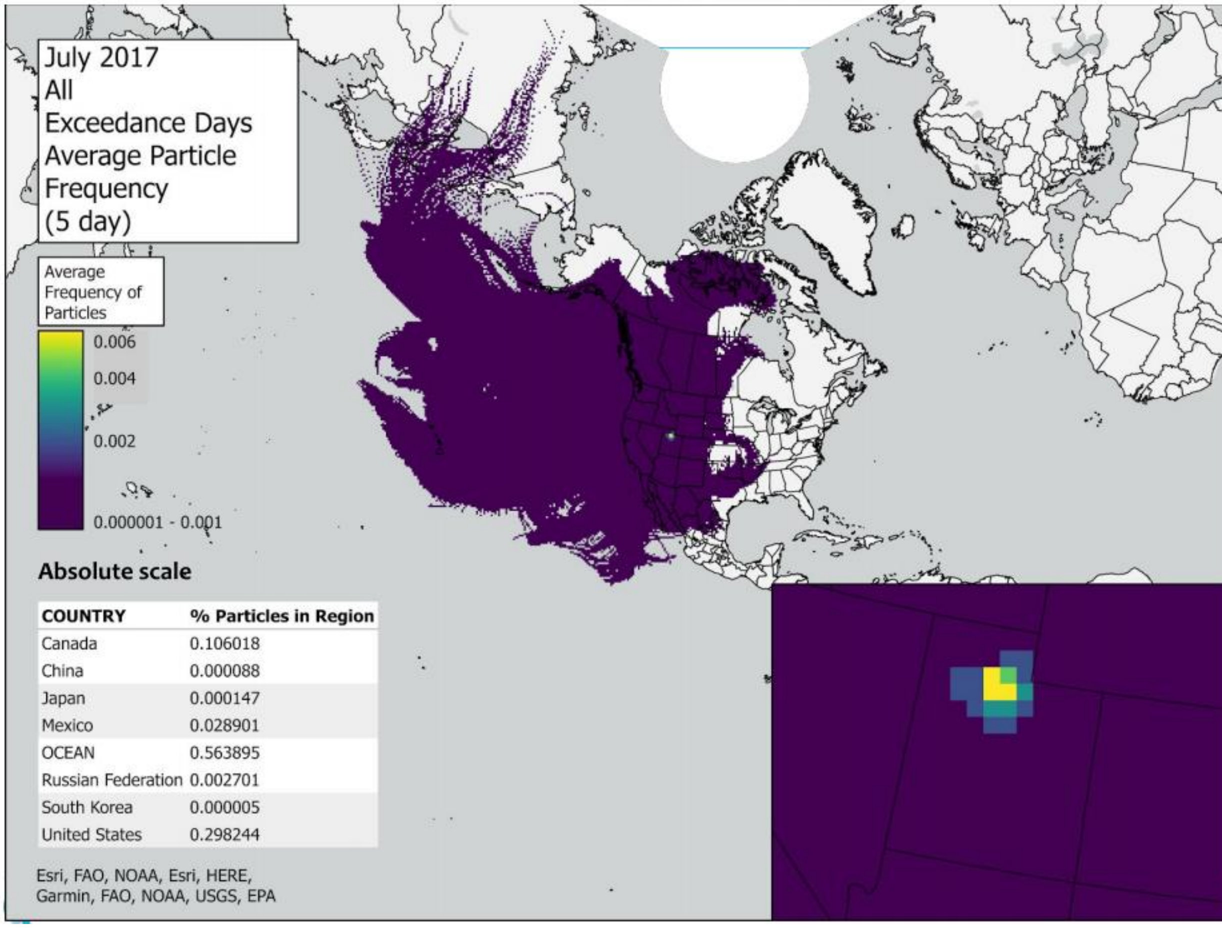


COUNTRY	% Particles in Region
Canada	0.010318
China	0.000376
Japan	0.000997
Mexico	0.036283
OCEAN	0.457369
Russian Federation	0.008629
United States	0.486028

- No significant difference in transport patterns between exceedance and non-exceedance days.
- While the fraction of particles over Canada increased during exceedance days compared to non-exceedance days, this fraction is smaller than that over the US. Also, using "population count" (see next slide) as a proxy for urban emissions, significant emission contributions from outside the US are not expected.

Gridded World Population (NASA) 2015





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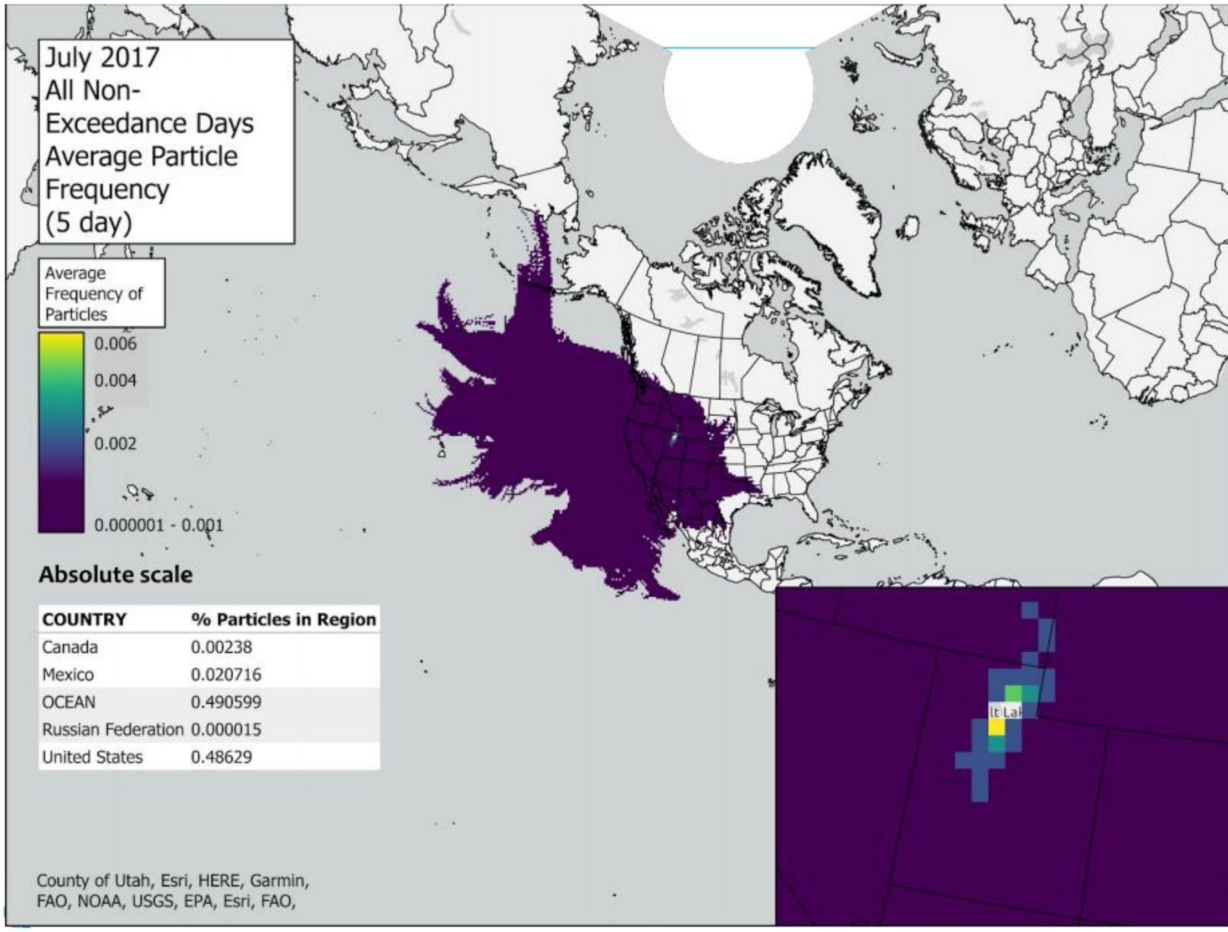
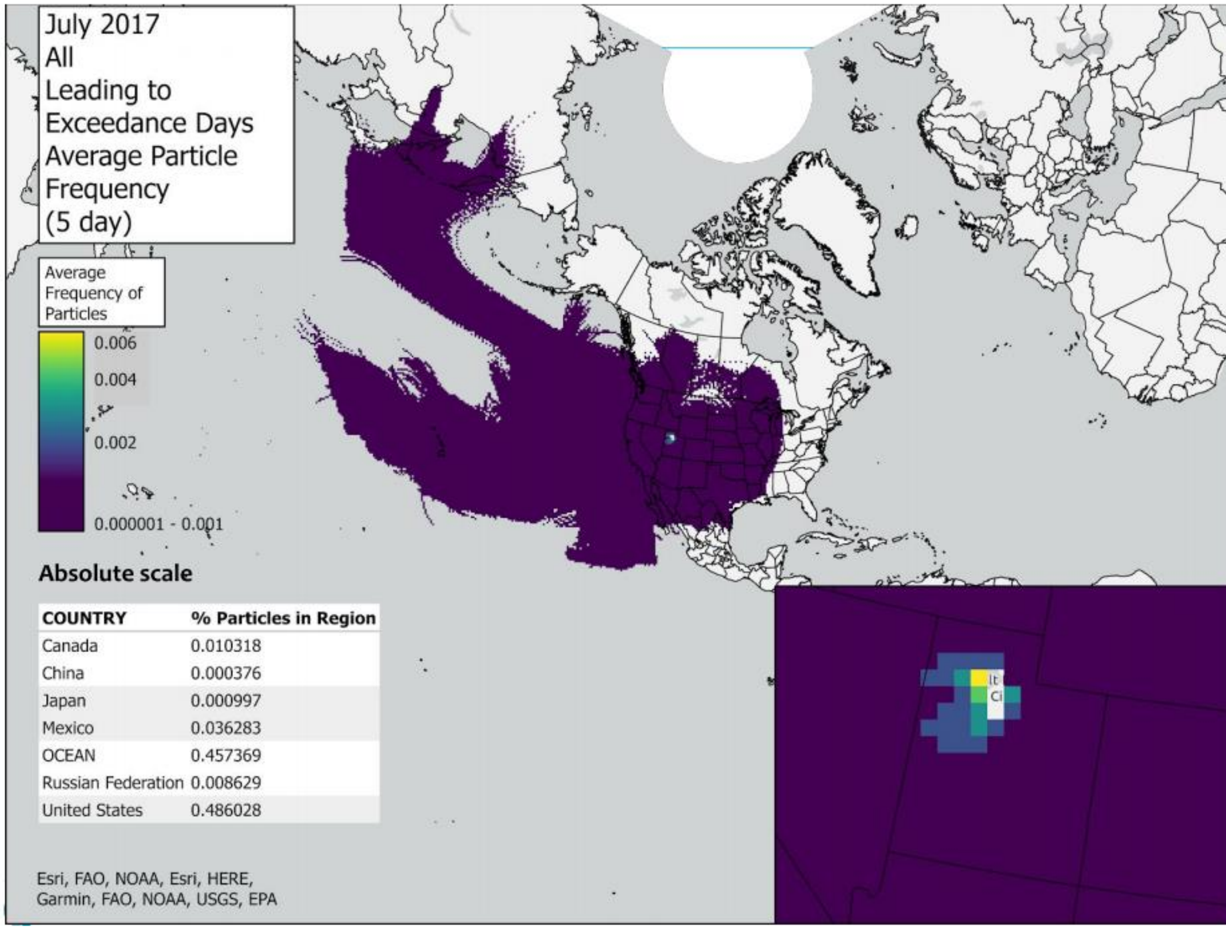

July 2017
All Non-
Exceedance Days
Average Particle
Frequency
(5 day)
Average
Frequency of
Particles
0.006
0.004
0.002
0.000001 - 0.001
Absolute scale
COUNTRY | % Particles in Region
Canada | 0.00238
Mexico | 0.020716
OCEAN | 0.490599
Russian Federation | 0.000015
United States | 0.48629
County of Utah, Esri, HERE, Garmin,
FAO, NOAA, USGS, EPA, Esri, FAO,



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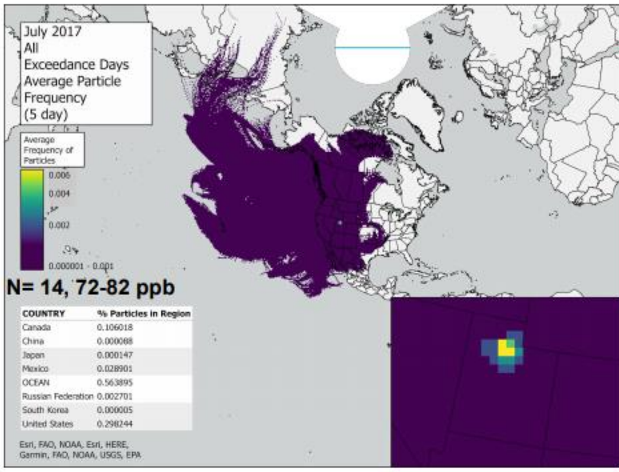
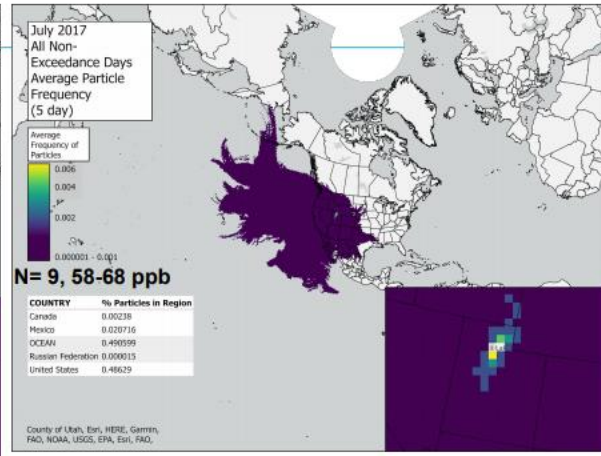
United States	0.486028



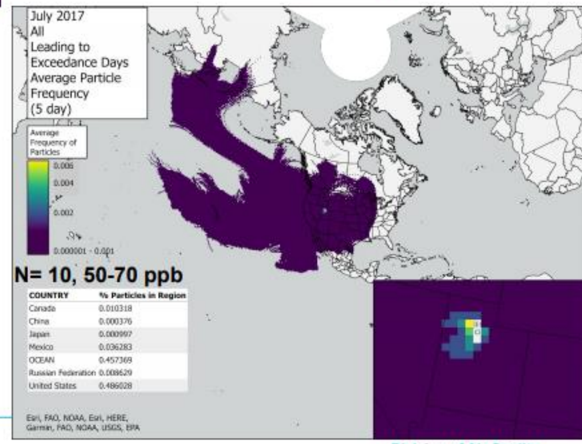
COUNTRY	% Particles in Region
Canada	0.106018
China	0.000088
Japan	0.000147
Mexico	0.028901
OCEAN	0.563895
Russian Federation	0.002701
South Korea	0.000005
United States	0.298244



COUNTRY	% Particles in Region
Canada	0.00238
Mexico	0.020716
OCEAN	0.490599
Russian Federation	0.000015
United States	0.48629

Absolute scale

- No significant difference in transport patterns between exceedance and non-exceedance days.
- While the fraction of particles over Canada increased during exceedance days compared to non-exceedance days, this fraction is smaller than that over the US. Also, using "population count" as a proxy for urban emissions, significant emission contributions from outside the US are not expected.

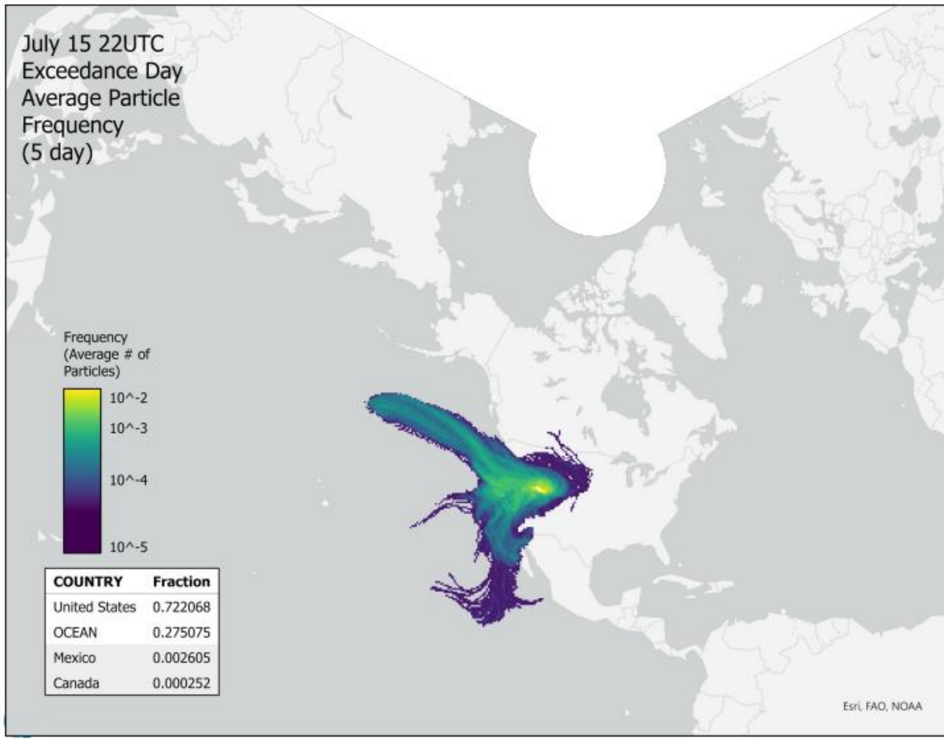


COUNTRY	% Particles in Region
Canada	0.010318
China	0.000376
Japan	0.000997
Mexico	0.036283
OCEAN	0.457369
Russian Federation	0.008629
United States	0.486028

Division of Air Quality

Exceedance (5day backcast, large domain)

July 15 Average Particle Frequency

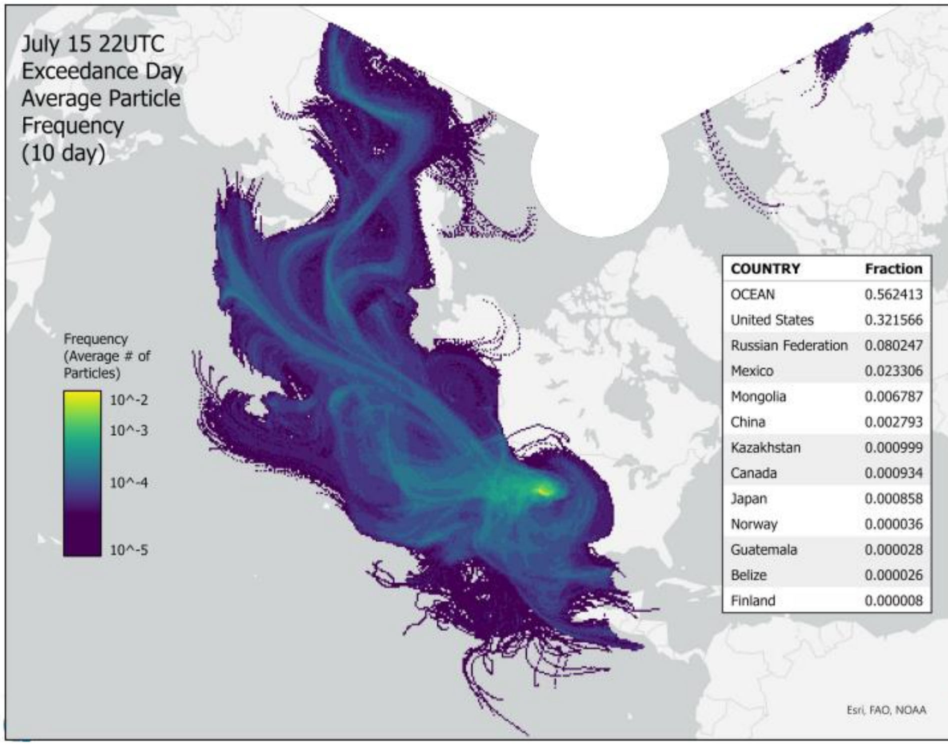


COUNTRY	Fraction
United States	0.722068
OCEAN	0.275075
Mexico	0.002605
Canada	0.000252

Division of Air Quality

Exceedance (Extended 10 day backcast)

July 15 Average Particle Frequency

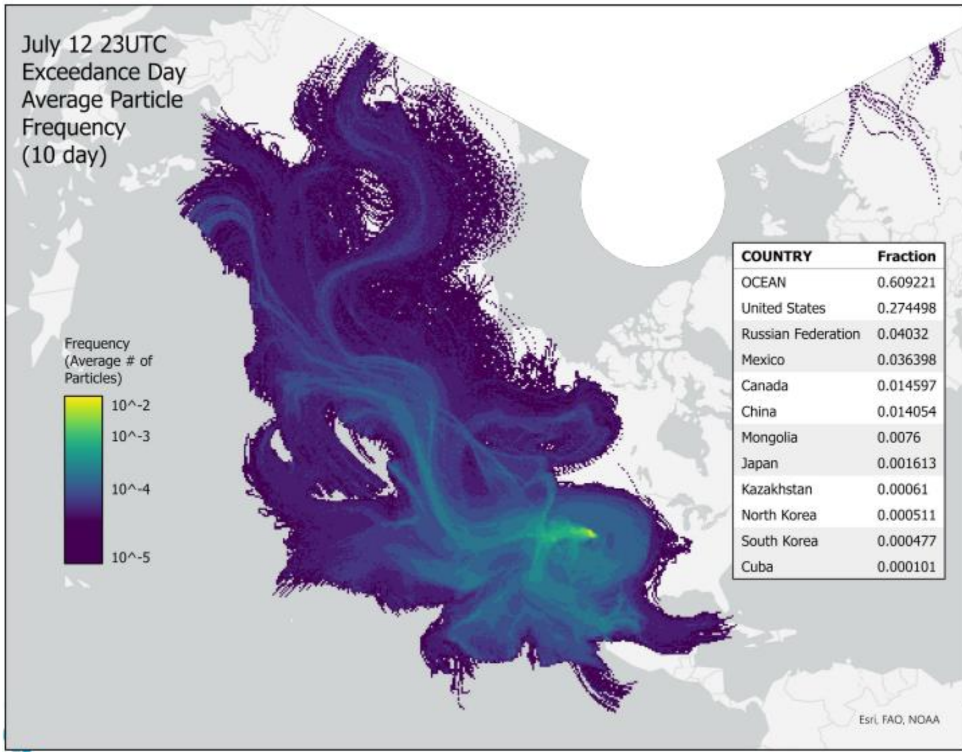


COUNTRY	Fraction
OCEAN	0.562413
United States	0.321566
Russian Federation	0.080247
Mexico	0.023306
Mongolia	0.006787
China	0.002793
Kazakhstan	0.000999
Canada	0.000934
Japan	0.000858
Norway	0.000036
Guatemala	0.000028
Belize	0.000026
Finland	0.000008

Division of Air Quality

Exceedance (Extended 10 day backcast)

July 12 Average Particle Frequency



COUNTRY	Fraction
OCEAN	0.609221
United States	0.274498
Russian Federation	0.04032
Mexico	0.036398
Canada	0.014597
China	0.014054
Mongolia	0.0076
Japan	0.001613
Kazakhstan	0.00061
North Korea	0.000511
South Korea	0.000477
Cuba	0.000101

Division of Air Quality

Key Findings

- Overall consistent findings between the synoptic patterns and HYSPLIT backward dispersion analyses
- Results do not suggest a strong impact from international emission sources on local ozone concentrations:
    - Peak ozone measurements do not coincide with frontal passage, which would be expected with long range transport of international emissions.
    - No significant difference in transport patterns between exceedance and non-exceedance days
    - Increased particle count over the US compared to other urban regions

APPENDIX C: Ramboll CAMQ & CAMx Report

Prepared for:

Utah Petroleum Association
Utah Mining Association
Salt Lake City, UT

Prepared by:

Ramboll US Consulting, Inc
7250 Redwood Blvd., Suite 105
Novato, California 94945

February 2021
1690015142

Modeling International Ozone Contribution to Wasatch Front Nonattainment Areas

Bright ideas. Sustainable change.

Modeling International Ozone Contribution to Wasatch Front Nonattainment Areas

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EXECUTIVE SUMMARY

The United States Environmental Protection Agency (EPA, 2020a) has designated two areas along the Wasatch Front of Utah as Marginal Nonattainment for the 2015 Ozone National Ambient Air Quality Standard (NAAQS). The monitored "design value" (DV) determines the air quality status of each area. An area violates the 2015 ozone NAAQS when the DV exceeds 70 parts per billion by volume (ppb).

These areas must attain the ozone NAAQS by August 3, 2021 based on ambient air monitoring during 2018-2020. If an area fails to attain, EPA will "bump up" the nonattainment classification from Marginal to Moderate unless the State of Utah requests and receives relief under established provisions of the Clean Air Act. The requirements for Moderate nonattainment areas include the development of a State Implementation Plan (SIP) that specifies new control measures and demonstrates attainment of the ozone NAAQS by August 3, 2024 based on monitoring during 2021-2023. Furthermore, if an area again fails to attain, EPA will reclassify the area to Serious, thereby requiring even more controls.

A study by EPA (2015) shows less than 20% of the ozone in the Wasatch Front results from in-state anthropogenic (human-made) precursor emissions while nearly 60% results from the combination of natural and international anthropogenic emissions. The Utah Division of Air Quality (UDAQ, 2017) reports that less than half of the 20% of ozone from in-state precursor emissions emanate from sources within the State's jurisdiction to control. **Considering extensive precursor controls already implemented to address the fine particulate matter NAAQS, additional controls will be costly and will minimally impact ozone.** In fact, despite a 37% decrease in Wasatch Front precursor emissions over 2005-2017, and related success in improving ambient fine particulate matter, ambient ozone has not responded similarly.

As summarized by EPA (2020c), persistent global circulation patterns establish a direct transport route linking Asia to the western US, which brings pollutant-laden air to North America within days to weeks. Complex topography enhances vertical transport from aloft, and thus high-altitude locations throughout the western US experience the greatest ozone impacts from intercontinental transport. This transport mechanism is especially persistent throughout the summer season.

The Clean Air Act provides an opportunity for nonattainment areas impacted by international contributions to avoid a reclassification to a higher nonattainment level if they fail to attain at current or future nonattainment classifications. According to Section 179B of the Act, the State may develop a technical demonstration showing that the Wasatch Front would attain the ozone standard "but for" the contribution from international emissions.

This study evaluated the potential applicability of the Section 179B provisions for the Wasatch Front Ozone Nonattainment Areas. Specifically, we conducted a preliminary modeling analysis that quantitatively estimated the contribution from global international anthropogenic ozone transport to the Wasatch Front. Ramboll applied two state-of-the-science photochemical models using EPA-derived meteorology and emission datasets representing conditions during 2016 (EPA, 2020b). For one model, we removed international anthropogenic contributions and assessed the resulting ozone contribution at Wasatch Front air quality monitors (a method referred to as sensitivity analysis). For the other model, we tracked the separate emission contributions from Utah, the rest of the US, and international anthropogenic sources to total ozone at Wasatch Front monitors (a method referred to as source apportionment).

Final 179B demonstration guidance developed by EPA (2020c) describes both approaches, and furthermore our methodology followed standardized modeling techniques recommended by EPA (2018) for use in State Implementation Plan (SIP) ozone attainment demonstrations. Following the explicit steps in both of those sets of recommendations, we used modeling results in a relative manner to scale current monitored ozone DVs along the Wasatch Front to estimate what they would be in the hypothetical absence of international transport.

Results from both models show that the Wasatch Front would attain the 70 ppb ozone standard in the absence of international anthropogenic contributions. The current highest DV for the area is 77 ppb, or 6.1 ppb above the 70.9 ppb concentration necessary to attain (by rule the decimal is truncated to 70 ppb). According to the DV scaling technique, modeled international contributions are 8.7 to 12.7 ppb at the most limiting monitoring site (Figure ES-1). Source apportionment results show that the modeled summer-average international contribution at the highest DV site is nearly 10 ppb (Figure ES-2) and is nearly constant throughout the summertime ozone season. Furthermore, these model results are consistent with results previously reported by EPA (2015, 2019) for the same area.

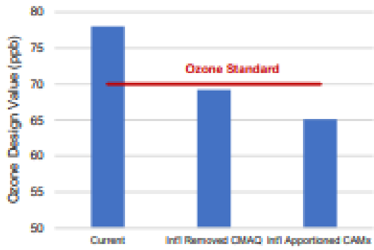

Figure ES-1. Current peak monitored ozone (left) and model-scaled peak ozone without international anthropogenic contributions (middle and right).

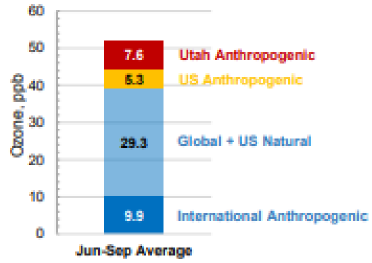

Figure ES-2. Modeled summer-average ozone contributions at the Bountiful Viewmont monitor site.

According to our analysis, both models tend to underpredict on high ozone days at Wasatch Front monitors, most likely from a lack of local ozone production rather than a lack of background ozone entering Utah. This underestimation may lead to a slight overestimate of the international contributions to local DVs, but we estimate that the related error is likely less than 2 ppb. This amount does not change our overall conclusion that the Wasatch Front would attain the standard but for the contribution of international anthropogenic emissions.

This preliminary modeling exercise suggests that Section 179B provisions are applicable for the Wasatch Front Ozone Nonattainment Areas. A more rigorous State-led modeling analysis employing higher resolution and area-specific meteorology and emission inventories is warranted to confirm these results and to support a Section 179B demonstration.

1.0 INTRODUCTION

1.1 Background

The United States Environmental Protection Agency (EPA, 2020a) has designated two areas along the Wasatch Front of Utah as Marginal Nonattainment for the 2015 Ozone National Ambient Air Quality Standard (NAAQS). The Northern Wasatch Front Nonattainment Area includes Salt Lake and Davis Counties and portions of Tooele and Weber Counties. The Southern Wasatch Front Nonattainment Area includes a part of Utah County. The monitored "design value" (DV) determines the air quality status of each area.[1] An area exceeds the 2015 ozone NAAQS when the DV exceeds 70.9 parts per billion by volume (ppb).[2] The 2017-2019 peak DV for the Southern Wasatch Front indicates that the area has attained the ozone NAAQS, while the Northern Wasatch Front has continued to exceed with a peak DV of 77 ppb over the same period.[3]

The federal Clean Air Act sets requirements for States to address nonattainment areas. Requirements for Marginal ozone areas include a comprehensive emission inventory, a Nonattainment New Source Review program, and a Transportation Conformity Demonstration. The Wasatch Front areas must attain the ozone NAAQS by August 3, 2021 based on monitored DVs from 2018-2020. If an area fails to attain, EPA will "bump up" the nonattainment classification from Marginal to Moderate unless the State of Utah requests and receives relief under established provisions of the Clean Air Act (discussed below).

The Clean Air Act requirements for Moderate nonattainment areas are more onerous and include the development of a State Implementation Plan (SIP) that demonstrates attainment of the ozone NAAQS by August 3, 2024 based on DVs from 2021-2023. In addition to the requirements for Marginal areas, the SIP must include reductions in VOC emissions by 15% compared to the 2017 baseline level, Reasonably Available Control Technology for major stationary sources, increased air permit offset ratio for major projects and major modifications, and additional controls as needed to demonstrate attainment. Emission reductions from controls implemented before January 1, 2018 will not count toward the required 15% VOC reduction for Moderate nonattainment areas. Furthermore, if an area again fails to attain, EPA will reclassify the area to Serious, thereby requiring even more controls.

Ozone is not emitted, but rather chemically formed. In the lower atmosphere, ozone forms from precursor emissions that react in the presence of sunlight, including nitrogen oxides (NOx), volatile organic compounds (VOC), methane and carbon monoxide (CO). Natural ozone levels in the lower atmosphere range 10-30 ppb across the globe, while anthropogenic (human-caused) contributions increase the global background to 30-50 ppb, or 40-70% of the NAAQS (Jaffe et al., 2018). Background ozone commonly reaches 60 ppb or more in the elevated intermountain western US because ozone naturally increases with altitude and complex terrain induces deep mixing of mid-tropospheric air to ground level (EPA, 2015).

Based on numerous studies summarized by EPA (2020c), persistent global circulation patterns establish a direct transport route linking Asia to the western US. Rising air currents in low pressure systems over the western Pacific loft pollutant-laden air from eastern Asia into the mid and upper troposphere, which is transported to North America within days to weeks. Ozone can persist at such

[1] For ozone, the EPA defines the DV at each monitoring site as the 3-year average of the annual 4th-high of the maximum daily 8-hour average (MDA8) ambient concentration (40 CFR §50.19).

[2] The ozone NAAQS is defined as 0.070 ppm, where Appendix U to 40 CFR Part 50 (Section 3, paragraph (e)) requires the design value to be reported in ppm with additional digits to the right of the third decimal place truncated.

[3] Based on latest EPA-official 2017-2019 DVs (https://www3.epa.gov/airquality/greenbook/jdtc.html).

altitudes because of low temperatures and relative lack of chemical sinks. Sinking air within high pressure systems over the eastern Pacific brings upper tropospheric air back to the surface over the western US. Complex topography enhances vertical transport from aloft, and thus high-altitude locations throughout the western US experience the greatest ozone impacts from intercontinental transport. This transport mechanism is especially persistent throughout the summer season.

The State's ability to reduce ozone locally is limited because of the amount of ozone generated by local sources over which the State has no control, and contributions from other states, other countries and natural sources. A study by EPA (2015) shows less than 20% of the ozone in the Wasatch Front results from in-state anthropogenic emissions while nearly 60% results from the combination of natural and international anthropogenic emissions (Figure 1). The Utah Division of Air Quality (UDAQ, 2017) reports that of the 20% of ozone generated from Utah VOC and NOx emissions, 65% are attributed to mobile sources over which the State has no control,[4] 30% emit from difficult-to-control area sources,[5] and 15% emit from electric generation and industrial sources. Considering extensive controls already implemented for $PM_{2.5}$ and its precursors (including NOx and VOC) on local stationary sources, additional controls will be costly and will minimally impact ozone. In fact, despite a 37% decrease in Wasatch Front NOx+VOC emissions over 2005-2017, and related success in improving ambient $PM_{2.5}$, ambient ozone has not responded similarly (Figure 2).

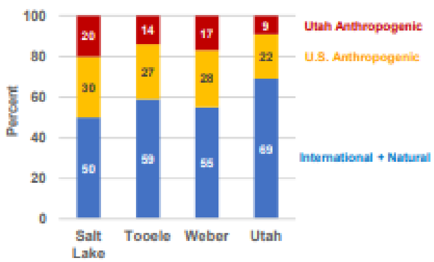

Figure 1. EPA (2015) ozone source apportionment in Wasatch Front Counties, Utah.

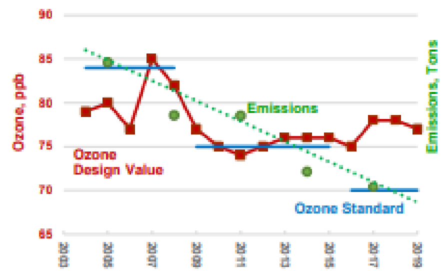

Figure 2. Trends in Wasatch Front NOx+VOC emissions and ozone DV relative to the ozone NAAQS.

The Clean Air Act provides an opportunity for nonattainment areas impacted by international contributions to avoid a reclassification to a higher nonattainment level. According to Section 179B of the Act, the State may develop a technical demonstration showing that the Wasatch Front would attain the ozone standard "but for" the contribution from international emissions. If submitted prior to reclassification to Moderate based on exceeding 2018-2020 DVs, and EPA approves the 179B demonstration that the area ***would have attained the standard*** but for international contributions, the area would remain at Marginal. EPA (2020c) calls this a "retrospective demonstration". If submitted after reclassification to Moderate, and EPA approves the demonstration that the area ***would attain the standard by the next attainment date*** if not for the international contributions, the area would remain at Moderate. EPA (2020c) calls this a "prospective demonstration". In the latter

[4] Mobile sources include both on-road vehicles (cars and trucks) and off-road equipment (agriculture, construction, mining, rail, air, etc.). Utah must rely on emission reductions from motor vehicle fleet turnover.
[5] Area sources include widespread population-based activity such as residential and commercial sources such as gas stations, dry cleaners, restaurants, paint shops, etc.

case, all additional Moderate area SIP requirements would still apply other than a demonstration that the area will attain the NAAQS by the attainment date.

1.2 Objectives of This Study

This study evaluated the potential applicability of the Section 179B provisions for the Wasatch Front Ozone Nonattainment Areas. The analysis followed EPA guidance for 179B demonstrations, adhered to EPA SIP modeling guidelines, and applied EPA modeling datasets to quantitatively estimate the contribution from global international anthropogenic ozone transport along the Wasatch Front.

To meet the study objectives, Ramboll applied two state-of-the-science photochemical models using EPA-derived meteorology and emission datasets representing conditions during 2016 (EPA, 2020b):

1) For one model, we removed international anthropogenic contributions and assessed the resulting ozone contribution at Wasatch Front monitors, a method referred to as sensitivity analysis.

2) For the other model, we tracked the separate emission contributions from Utah, the rest of the US, and international anthropogenic sources to total ozone at Wasatch Front monitors, a method referred to as source apportionment.

Final 179B guidance developed by EPA (2020c) describes both approaches, and furthermore our methodology followed standardized modeling techniques recommended by EPA (2018) for use in ozone SIP attainment demonstrations. The guidance states on page 41, "Chemical Transport Modeling (CTM) is the preferred approach for quantifying international contribution for pollutants with a secondary component (such as O_3 and $PM_{2.5}$, which are formed, at least in part, as a result of photochemical reactions of precursor gases in the atmosphere."

Adhering to the explicit steps in those recommendations, we applied model results in a relative manner to estimate how current monitored ozone DVs in the Wasatch Front would change in the hypothetical absence of international transport.

Section 2 describes the modeling systems employed in this study and procedures to assess model-predicted international contributions. Section 3 summarizes model performance in replicating measured ozone levels at Wasatch Front monitors during the summer of 2016 from which to establish a level of confidence in model outcomes. Section 4 presents modeling results from the two approaches, and Section 5 presents our conclusions.

2.0 MODELING SYSTEM AND APPROACH

2.1 Modeling System

This study employed the EPA (2020b) 2016 national Modeling Platform (MP), which provides emissions, meteorology, and boundary condition inputs for two state-of-the-science photochemical grid models: the Community Multiscale Air Quality (CMAQ; EPA, 2020d) and the Comprehensive Air quality Model with extensions (CAMx; Ramboll, 2020). These inputs allow for a full calendar-year (2016) simulation of air quality over the US. The temporal resolution is hourly and the grid resolution over the conterminous US (CONUS) domain is 12 km (Figure 3).

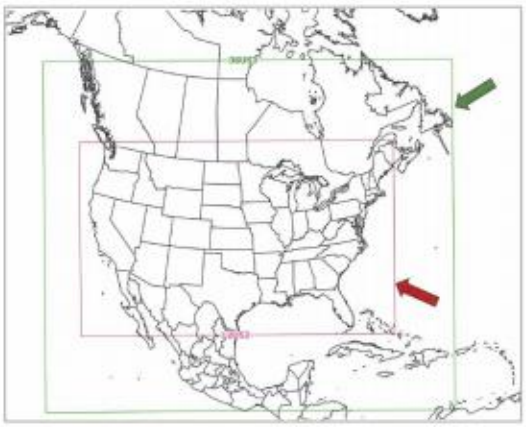

Figure 3. Depiction of the EPA 2016 MP modeling domains: the outer domain (green) covers most of North America with 36 km grid spacing; the inner domain (red) covers the US at 12 km grid spacing. Applications described in this report were run on the inner grid.

EPA developed several MP versions since 2018: the initial version is called "Beta" while the current version is called "V1". These versions are primarily related to North American emission updates; see EPA (2020b) for detailed information on data sources for US, Canadian, and Mexican anthropogenic precursor emissions, and the process to estimate natural precursor emissions (biogenic, lightning NOx, fires, oceanic).

EPA developed meteorological fields (winds, temperature, pressure, humidity, clouds/precipitation, turbulence parameters, etc.) using the Weather Research and Forecasting Model (WRF; NCAR, 2020).

EPA derived boundary conditions (i.e., space/time-varying characterization of pollutant inflow) for the North American domain from a previous CMAQ application over the entire northern hemisphere using anthropogenic and natural global emissions generated from several international inventories and models. EPA ran the hemispheric CMAQ for two scenarios:

1) a "Base" case that includes emissions from all sources and activities representative of 2016

2) a "Zero Rest of World" (ZROW) case that excludes all non-US anthropogenic emissions, leaving only US and global natural emissions.

North American boundary conditions were prepared for both scenarios.

In 2019, EPA used both sets of boundary conditions with the CMAQ Beta MP to run the BASE and ZROW scenarios on the finer-scale US domain but ran only the CAMx Beta MP for the BASE scenario. Additionally, EPA conducted a general model performance evaluation for the CMAQ and CAMx BASE scenarios that included statistical and graphical comparisons of simulated ozone against monitored ozone across the US.[6] We analyzed these products with a focus on the Wasatch Front, as described in Section 3.

2.2 Modeling International Ozone Contributions

Our approach applied two key methodologies, sensitivity analysis and source apportionment, recommended by EPA's (2020c) 179B guidance document for ozone assessments, as well as by EPA's (2018) photochemical modeling guidance for SIPs. This helped to establish a plausible range of international anthropogenic emission (IAE) contributions in the Wasatch area and to provide a weight of evidence.

The sensitivity analysis quantified how simulated concentration patterns respond to changes in certain input parameters. As described above, EPA had previously performed the necessary modeling for this type of assessment. We obtained EPA's CMAQ Beta MP output files for their BASE and ZROW scenarios, which contained gridded (12 km resolution over the US) MDA8 ozone concentrations for every day of 2016. The ZROW case represents the ozone pattern resulting from direct removal of IAE contributions, and the difference between the BASE and ZROW scenarios each day and at each grid cell represents the pattern of ozone response from removing IAE. We extracted these ozone data for the June-August summer ozone season from the portion of the modeling grid that covers the Wasatch Front nonattainment areas.

The source apportionment methodology quantified how simulated total concentrations are apportioned into contributions from different source regions and/or sectors. Apportionment is identical to sensitivity differencing when concentrations result from linear processes (e.g., dust or other inert PM), but can differ substantially when concentrations result from non-linear processes (e.g., ozone chemistry). In the latter case, apportionment changes when the chemical environment is altered, such as modeling a different emission scenario. As the model runs, source apportionment internally tracks contributions from emissions, dispersion, chemistry, and removal among the targeted source regions/sectors.

Preexisting modeling results for this method were not readily available, so we ran CAMx with its Ozone Source Apportionment Technology (OSAT). We applied CAMx/OSAT for the BASE scenario over the June-September 2016 ozone season using the EPA V1 MP, and tracked three source regions (Utah, other US, and non-US) and two sectors (anthropogenic and natural). Non-US emissions included anthropogenic and natural sources within the North American CAMx domain (Canada, Mexico and oceanic sources outside a 200 km coastal zone) and from outside the modeling domain (via BASE and ZROW boundary conditions).

It was important to quantify the ability of both CMAQ (Beta MP) and CAMx (V1 MP) to sufficiently replicate historical 2016 ozone patterns in space and time relative to monitored ozone data along the Wasatch Front. Good performance helps establish trust that the model is correctly characterizing chemical and physical processes and responds correctly to input modifications. In particular, the

[6] The products from the performance evaluation are distributed by the Lake Michigan Air Directors Consortium (LADCo, 2020).

complex topography of the area influences meteorology and air quality patterns, presenting challenges to any air quality modeling exercise. In this case, the 12 km grid resolution of the EPA's national MP does not adequately resolve the local terrain features, nor details in urban vs. rural (biogenic) emission distributions, adding to model uncertainty with respect to the mix of local vs. regional ozone production and transport. Furthermore, while EPA develops the best possible nationwide information at each iteration of the MP, EPA does not spend the considerable time necessary to fine-tune model inputs and treatments by which to optimize model performance in all areas of the US. Our Wasatch-specific model performance evaluation is detailed in Section 3.

2.3 Assessing Contributions to Ozone DVs

We followed EPA (2018) modeling guidance for SIP demonstrations to assess the contribution of IAE on local Wasatch Front monitored DVs. The approach involved scaling the DV at each monitoring site by the relative modeled change in ozone between the baseline and scenario cases. This process is codified in EPA's Software for the Modeled Attainment Test – Community Edition (SMAT-CE) software (EPA, 2020e). The software allows use of year-specific modeling to apply to a range of recent DV years. The specific approach in this analysis is summarized below.

We started with the EPA's 2016 CMAQ Beta MP output files from their BASE and ZROW scenarios, which contain gridded maximum daily 8-hour average (MDA8) ozone concentrations over the entire US domain. We supplied gridded MDA8 ozone concentrations over June-August to SMAT-CE and the software identified the grid cells containing Wasatch Front monitor locations. At each site, the program averaged modeled MDA8 ozone concentration over at least 10 days exceeding 60 ppb for use in the DV scaling function.

SMAT-CE calculates a site-specific "relative response factor" (RRF), which is the ratio of average MDA8 ozone in the ZROW case ($\bar{C}_{ZROW}$) to the average MDA8 in the BASE case ($\bar{C}_{Base}$) over the modeled high ozone days. The program then applies the RRF to the selected DV to yield the adjusted DV for the ZROW scenario. This is shown mathematically below:

$$DV_{scaled} = DV_{monitored} \times \underbrace{\left(\frac{\bar{C}_{ZROW}}{\bar{C}_{Base}}\right)}_{\text{RRF}}$$

Model-scaled DVs less than or equal to 70.9 ppb indicate attaining monitors "but for" the contribution from IAE.

We followed a similar approach for CAMx OSAT results. For the RRF numerator, we supplied the tagged MDA8 ozone concentrations representing ozone from all sources except the apportioned IAE component, averaged over at least the top 10 days exceeding 60 ppb in total ozone over June-September. For the RRF denominator, we supplied the average total MDA8 ozone (all sources inclusive of IAE) over those same days.

3.0 MODEL PERFORMANCE EVALUATION

3.1 CMAQ Beta MP Ozone

We evaluated CMAQ-predicted MDA8 ozone at each of the 9 Wasatch Front monitoring sites operating during June-August 2016 (Figure 4). Appendix A provides time series of MDA8 ozone and Table 1 presents summer-average statistical results against observed MDA8 values over all sites (LADCo, 2020).

Figure 4. Satellite map view of the Wasatch Front and locations of monitoring sites supporting the model performance evaluation.

Table 1. CMAQ Beta MP model performance statistics for MDA8 ozone over 9 Wasatch Front monitoring sites during June-August 2016. Correlation refers to the linear correlation coefficient (R), bias refers to normalized mean bias (signed error), and error refers to normalized mean error (unsigned error). Values shown in green meet performance criteria benchmarks suggested by Emery et al. (2016).

	Correlation (R)	Bias	Error
All days June-August	0.63	-7%	11%
Observed Days > 60 ppb	0.34	-13%	14%
Criteria benchmark	>0.50	<±15%	<25%

Table 1 shows that CMAQ adequately replicates 2016 summertime MDA8 ozone throughout the Wasatch Front with statistical results within criteria benchmarks (Emery et al., 2016). This means that model bias, unsigned error, and correlation coefficient are consistent with photochemical model performance levels historically achieved throughout the US, and typical of western US applications. Model performance degrades on days when observed MDA8 exceeded 60 ppb, with consistent underpredictions. On these days, correlation is significantly lower and outside benchmarks, which means there is less systematic model-measurement agreement (i.e., more random effects) in day-to-day variability. This is partly because of fewer model-observation pairs on this subset of days.

The underprediction on high ozone days adds uncertainty to the IAE contribution assessment since the DV scaling calculation focuses on the high days. The specific source of the underprediction can influence the DV scaling analysis, as demonstrated in Table 2 and described in the following hypothetical examples:

- If the cause of bias is spread equivalently across all sources, this is the type of broad systematic error that the RRF approach is designed to mitigate since only relative model changes are applied (i.e., applying a ratio of two runs reflecting the same bias effectively cancels the systematic bias). However, one still needs to be concerned with the influence of compensating over/underprediction biases among model processes in such cases.
- If the primary cause for underprediction is related solely to the IAE contribution (all else being well-predicted), then the IAE contribution would be too small, the RRF would be too large when IAE is removed in the ZROW case, and the DV projections would be too high (not enough IAE contribution is removed).
- If the primary cause for underprediction is related solely to the local/regional contribution (all else being well-predicted), then the IAE contribution would be too large relative to the local/regional contributions, the RRF would be too small when IAE is removed in the ZROW case, and the DV projections would be too low (too much relative IAE contribution is removed).

Table 2. Hypothetical examples of how a model scaled DV changes for different scenarios of model performance: (1) perfect model; (2) both IAE and local/regional contributions are equivalently biased low; (3) IAE is biased low while local/regional contributions are perfect; and (4) local/regional are biased low while IAE is perfect.

	Contributions			Base DV = 77 ppb	
	IAE	**Local/Regional**	**Total**	**RRF**	**Scaled DV**
1) Perfect Model	7.0	70.0	77.0	0.909	70.0
2) All low -15%	6.0	59.5	65.5	0.909	70.0
3) IAE low -15%	6.0	70.0	76.0	0.922	71.0
4) Local/Regional low -15%	7.0	59.5	66.5	0.895	68.9

To assess which of the causes for underprediction might be occurring, we analyzed CMAQ results at a single EPA high-altitude monitoring site called "Gothic" in the Colorado Rockies. Set at an altitude of approximately 3000 m (10,000 ft), this is the closest site to the Wasatch Front that consistently measures mid-tropospheric air. Its remote location results in little influence from local urban areas and so it provides an indication of higher-elevation, regional and global-scale ozone concentrations over the western US.

Figure 5 shows a time series of CMAQ predicted MDA8 ozone against Gothic observations during the summer of 2016. CMAQ exhibits very good agreement with measurements, suggesting that US background and US regional ozone levels are well simulated. This suggests that local ozone production may be the primary cause for underpredictions on high ozone days in the Wasatch Front, which is further supported in our evaluation of CAMx in the next sub-section. Thus, scaled DV projections may be too low (too much relative IAE contribution is removed) like in example (4) in Table 2. From the examples in Table 2, which apply a conservative bias of 15% compared to 7-13% bias reported in Table 1, the estimated error in the scaled DV is likely constrained within 1-2 ppb (compare the scaled DV in example (4) to examples (2) and (3)).

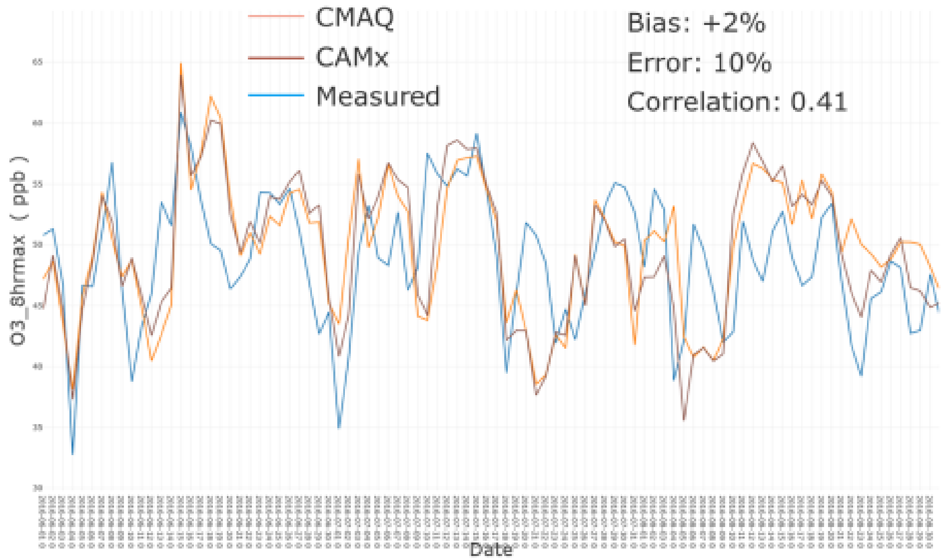

Figure 5. Time series of monitored and predicted MDA8 ozone at the Gothic, Colorado monitoring site. Predictions are taken from EPA Beta MP CMAQ and CAMx simulations (LADCo, 2020).

Balloon-borne ozonesondes are another source of upper-air ozone data; the closest launch site is Boulder, Colorado. While they provide very good vertical resolution of the ozone profile well into the stratosphere, Boulder ozonesondes are launched infrequently and concentrations in the lowest few km are influenced by emissions from Denver and along the Colorado Front Range. We therefore did not include comparisons to ozonesondes in this preliminary modeling analysis.

3.2 CAMx V1 MP Ozone

We evaluated predicted MDA8 ozone from our CAMx V1 MP BASE simulation at each of the same 9 Wasatch Front monitoring sites over the June-September 2016 period. Appendix B provides time series of MDA8 ozone and Table 3 presents summer-average statistical results against observed MDA8 values over all sites. CAMx performance is consistent with and just slightly better than CMAQ, including degraded performance on days when observed ozone exceeded 60 ppb. From the analysis of time series in Appendix B, it is apparent that CAMx performs quite well during September. EPA's CMAQ performance evaluation does not include September, which may be the primary reason for the slightly better statistical values in Table 3.

We further analyzed CAMx performance at the Gothic monitor as well as across the entire inter-mountain western US. Figure 6 displays normalized mean bias for MDA8 ozone at each monitoring site in the region as colored dots, where warm colors (yellow to red) indicate overpredictions and cool colors (green to purple) indicate underpredictions. When considering all days of June-September, bias remains within 10% (well within criteria benchmarks) throughout the region, at both high elevation sites and most sites along the Wasatch Front. Considering only high ozone days greater than 60 ppb, however, Figure 6 reveals more areas of negative bias (underprediction tendency)

Table 3. CAMx V1 MP model performance statistics for MDA8 ozone over 9 Wasatch Front monitoring sites during June-September 2016. Correlation refers to the linear correlation coefficient (R), bias refers to normalized mean bias (signed error), and error refers to normalized mean error (unsigned error). Values shown in green meet performance criteria benchmarks submitted by Emery et al. (2016).

	Correlation (R)	Bias	Error
All days June-August	0.78	-6%	10%
Observed Days > 60 ppb	0.42	-12%	13%
Criteria benchmark	>0.50	<±15%	<25%

scattered across the region, but particularly for all Wasatch Front sites. Note that bias at high altitude sites throughout the Rockies, including Gothic, remains within 10%. This pattern suggests that local ozone production in the Wasatch Front area is indeed underpredicted.

Figure 7 shows time series of CAMx-predicted MDA8 ozone against Gothic measurements. Like CMAQ, the replication of ozone at this isolated high-altitude site is quite good, and even indicates some tendency for overprediction during a few episodes in mid-summer. In fact, bias and error improve during periods when observed MDA8 ozone exceeds 50 ppb. Note again that correlation degrades for this subset of days, but again we attribute that effect mostly to the smaller number of prediction-observation pairs and thus a higher probability of unsystematic (random) error. As seen from the CMAQ evaluation, rather good replication of regional and background ozone throughout the western US, coupled with underestimates of local ozone production in the Wasatch Front, suggest that DV projections from removing the IAE contribution may be too low (too much relative IAE contribution is removed). Based on the conservative analysis described in Table 2, these results continue to indicate that error in the scaled DV is likely constrained within 1-2 ppb.

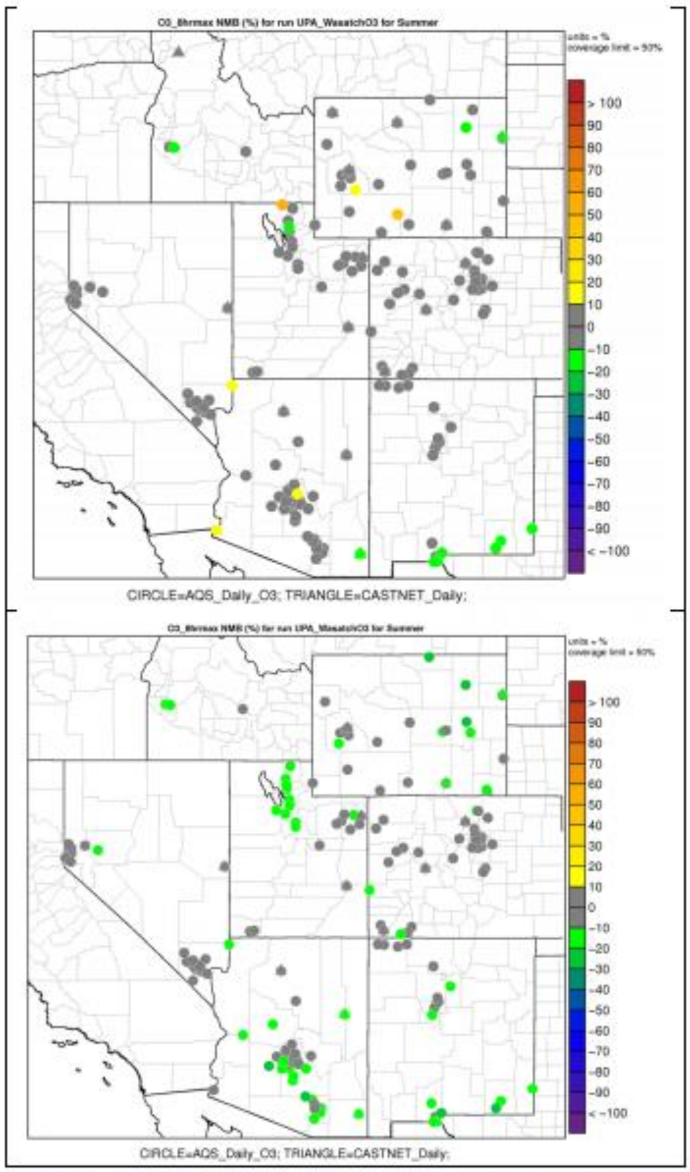

Figure 6. Plots of normalized mean bias (NMB, %) for MDA8 ozone at monitoring sites in the western US. (Top) All days of June-September 2016; (bottom) days at each site when observed MDA8 exceeded 60 ppb. Data from two monitoring networks are shown (AQS and CASTNET).

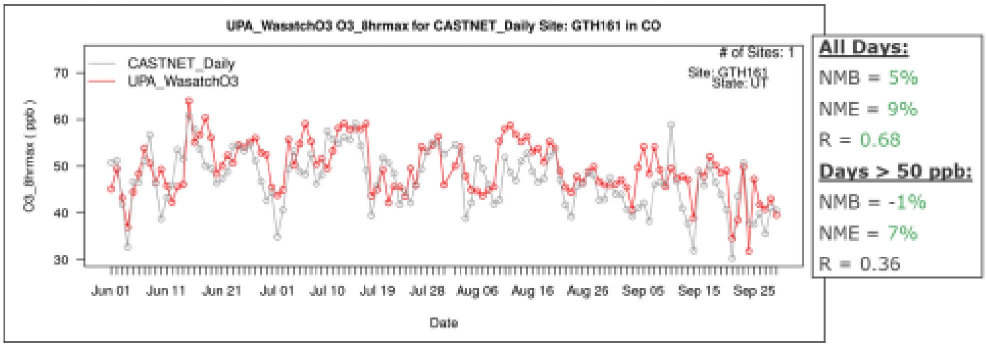

Figure 7. Time series of monitored and CAMx-predicted MDA8 ozone at the Gothic, Colorado monitoring site. Key statistical performance measures are listed on the right for different sets of monitoring days. Green values indicate results that are within statistical criteria benchmarks. NMB refers to normalized mean bias (signed error), NME refers to normalized mean error (unsigned error), and R represents the linear correlation coefficient.

4.0 INTERNATIONAL CONTRIBUTION RESULTS

4.1 Estimates from the EPA CMAQ Beta MP BASE and ZROW Simulations

As described in Section 2.3, we used the EPA's SMAT-CE software to scale DVs at each monitoring site by the relative modeled change in average MDA8 ozone greater than 60 ppb between the 2016 CMAQ Beta MP BASE and ZROW scenarios. We considered only the period of June-August, consistent with EPA's CMAQ BASE model performance evaluation. Model-scaled DVs less than or equal to 70.9 ppb indicate attaining monitors "but for" the contribution from IAE.

Results are shown in Table 4 for modeled RRFs applied to the most recent official 3-year ozone DV period: 2017-2019. At all sites, the CMAQ Beta MP results show that DVs at each site are well below 70 ppb when IAE contributions are removed in the ZROW scenario. Note that the 2017-2019 DV for the single site in the Southern Wasatch Front nonattainment area was already attaining at 70 ppb. We also applied these RRFs to several other DV periods back to 2013 (Appendix C). In all cases the removal of IAE contributions result in DVs well below the 70 ppb standard, with a peak RRF-scaled DV of 69.6 ppb over all of the previous periods. For the 2017-2019 DV period, the peak RRF-scaled DV of 68.3 allows an ample margin for the slight IAE ozone overprediction of up to 2 ppb.

Table 4. Ozone DV scaling results at each Wasatch Front monitoring site using the SMAT-CE tool, based on simulated ozone over June-August 2016 from the EPA CMAQ Beta MP BASE and ZROW results. In every case ZROW results in DV<70 ppb (green), well within attainment.

Site	County	2017-2019 DV[1]	Modeled RRF (ZROW/Base)	ZROW DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	77	0.8869	68.3
490353006 Hawthorne	Salt Lake	76	0.8924	67.8
490353013 Herriman	Salt Lake	75	0.8686	65.1
490450004 Erda	Tooele	72	0.8592	61.9
490570002 Ogden	Weber	71	0.8811	62.6
490571003 Harrisville	Weber	71	0.8784	62.4
Southern Wasatch Front				
490490002 Provo	Utah	N/A	0.8881	N/A
490495010 Spanish Fork	Utah	70	0.8905	62.3

[1] Based on latest EPA-official 2017-2019 DVs (https://www3.epa.gov/airquality/greenbook/jdtc.html). Data collection at Provo ended prior to 2019 but DVs at that site never exceed 72 ppb going back to 2013.

4.2 Estimates from the CAMx V1 MP OSAT Simulations

We followed a similar approach, as explained in Section 2.3, for CAMx OSAT results. Results are shown in Table 5 for modeled RRFs applied to the most recent official 3-year ozone DV period: 2017-2019. At all sites, the CAMx V1 MP OSAT results show that DVs at each site are even lower than the CMAQ ZROW scenario, and this holds for all other DV periods back to 2013 (Appendix D). In all cases the removal of apportioned IAE contributions result in DVs well below the 70 ppb standard, with a peak RRF-scaled DV of 65.1 ppb over all of the previous periods, again allowing ample margin for the slight IAE ozone overprediction of up to 2 ppb.

Table 5. Ozone DV scaling results at each Wasatch Front monitoring site using the SMAT-CE tool, based on simulated ozone over June-September 2016 from the CAMx V1 MP OSAT results. In every case ZROW results in DV<70 ppb (green), well within attainment.

Site	County	2017-2019 DV[1]	Modeled RRF	OSAT DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	77	0.8346	64.3
490353006 Hawthorne	Salt Lake	76	0.8293	63.0
490353013 Herriman	Salt Lake	75	0.8224	61.7
490450004 Erda	Tooele	72	0.8375	60.3
490570002 Ogden	Weber	71	0.8297	58.9
490571003 Harrisville	Weber	71	0.8432	59.9
Southern Wasatch Front				
490490002 Provo	Utah	N/A	0.8326	N/A
490495010 Spanish Fork	Utah	70	0.8330	58.3

[1] Based on latest EPA-official 2017-2019 DVs (https://www3.epa.gov/airquality/greenbook/jdtc.html). Data collection at Provo ended prior to 2019 but DVs at that site never exceed 72 ppb going back to 2013.

Figure 8 presents ozone source apportionment results over the June-September 2016 period at the most limiting (highest) DV site in the Northern Wasatch Front nonattainment area, Bountiful Viewmont. The left side of the figure shows a time series of MDA8 ozone, stratified by the OSAT-tracked contributions. The sum of all individual contributions results in the total MDA8 ozone simulated by CAMx, as shown at the top of the grey area. The right side of the figure shows the June-September average MDA8 ozone contributions, which sum to a total average ozone concentration of about 52 ppb.

OSAT estimates that on average, roughly 58% of MDA8 ozone (30 ppb of 52 ppb) at Bountiful Viewmont is derived from natural emissions globally (including local and US biogenic sources) and a minor amount from US anthropogenic sources that recirculated around the globe back to the Wasatch Front (we did not separately track the small US recirculation portion). Anthropogenic emissions within Utah and the rest of the US contribute on average 10% and 15% of total ozone, respectively. The natural (green), Utah (grey) and US (yellow) contribution estimates vary substantially throughout the summer of 2016. In contrast, IAE contributions (orange) consistently average just below 10 ppb or 20% of total ozone, and at a nearly constant value throughout the summertime ozone season. Additional time series plots for each of the monitoring sites in Tables 4 and 5 are provided in Appendix C.

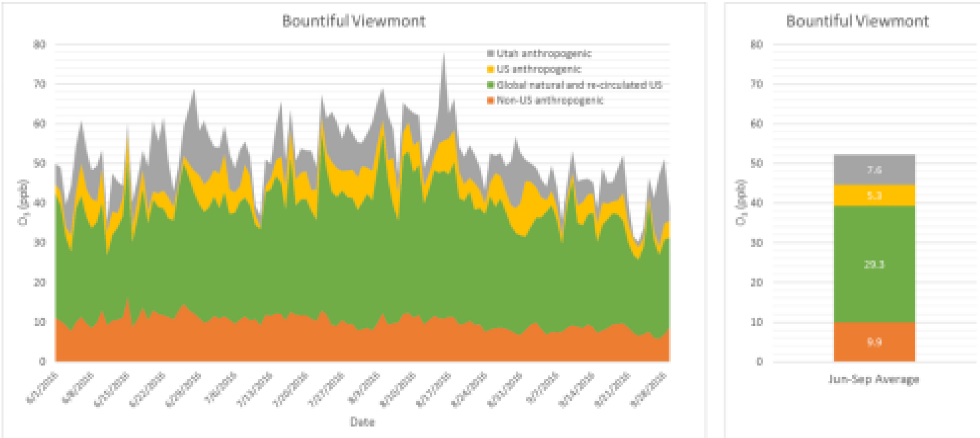

Figure 8. Time series of MDA8 ozone source apportionment results over June-September 2016 at the Bountiful Viewmont monitoring site (left), and summer-average contributions (right). The IAE contribution is shown at the bottom in orange, and all colored contributions sum to the total ozone at the top of each graph.

5.0 CONCLUSION

This preliminary modeling exercise suggests that Section 179B provisions are applicable for the Wasatch Front Ozone Nonattainment Areas. Results from two different models and techniques show that the Wasatch Front would attain the 70 ppb ozone standard but for international anthropogenic contributions.

The current highest DV for the area is 77 ppb, or 6.1 ppb above the 70.9 ppb concentration necessary to attain (by rule the decimal is truncated to 70 ppb). According to the DV scaling technique, modeled international contributions of 8.7 to 12.7 ppb are much greater than the 6.1 ppb exceedance at the most limiting monitoring site. Source apportionment results show that the modeled summer-average international contribution at the highest DV site is nearly 10 ppb and is nearly constant throughout the summertime ozone season. Furthermore, these model results are consistent with results previously reported by EPA (2015, 2019) for the same area.

Regarding model agreement with 2016 MDA8 ozone measurements at the Wasatch Front monitors, both CMAQ and CAMx generally performed adequately well and within statistical benchmarks. This means that both models exhibited a level of agreement with measurements that has typically been achieved for US regulatory modeling. Model performance degraded on days when observed MDA8 exceeded 60 ppb, with more consistent underprediction bias. Evidence presented here points to a higher likelihood that the bias on high ozone days resulted from a lack of local ozone production in both models. Furthermore, that evidence indicates that both models simulated background and US regional ozone levels rather well at rural, high-altitude monitoring sites throughout the intermountain west.

As we demonstrate in Section 3, underestimates of local ozone production may have led to overestimates of IAE contribution in the DV scaling methodology. From our analysis we expect the related error is likely less than 2 ppb, which does not change the overall conclusion that the Wasatch Front would attain the 70 ppb ozone standard but for international anthropogenic contributions.

5.1 Next Steps

A more rigorous State-led modeling analysis employing higher resolution and area-specific meteorology and emission inventories is warranted to confirm these results and to support a Section 179B demonstration. Final guidance on 179B demonstrations (EPA, 2020c) describes many analyses that could be performed, each providing specific insights into the amount, frequency and transport mechanisms associated with international contributions. Taken together, multiple lines of evidence from an array of analyses help strengthen the weight of evidence for a successful 179B demonstration.

Many of the example analyses suggested by EPA (2020c) are most applicable to primary and/or inert pollutants such as PM_{10}, and to relatively short transport paths across local international borders. However, ozone presents a unique challenge in Utah for several reasons: (1) Utah is well-removed from international borders; (2) ozone is a secondary compound formed from complex non-linear chemical interactions among NOx and VOC emissions from a multitude of sources; (3) relative to its NAAQS, ozone has a substantial global background that is derived from both natural and anthropogenic processes, including the stratosphere; and (4) as described in Section 1, ozone can persists for days to weeks in the mid to upper troposphere, which extends its source attribution to the global scale. **Therefore, photochemical models, which can address all of these processes, are**

the only tools capable of comprehensively assessing and quantifying ozone source-receptor linkages on international scales and on time scales ranging from days to seasons.

EPA's 179B guidance emphasizes the analysis of air parcel trajectories, which illustrate the historical path of air that arrived at a receptor area during a given period of time. Given the points above, it is clear that relying on simple screening methods alone (like trajectory analysis) to identify periods of global international ozone transport is problematic and insufficient. No matter how long a parcel or airmass persists over a local area, there is always a substantial fraction of air containing ozone that originated elsewhere around the globe. From another perspective, with enough time, all air parcel trajectories extending backward had, at some point, passed over other parts of the world. This is an issue that is fairly unique to ozone relative to other criteria pollutants such as SOx, NOx and PM.

Trajectory models are limited in their ability to properly address all facets of moving and churning air because:

1) Air "parcels" are treated as singular infinitesimal points that are moved according to a modeled grid of winds with, at minimum, ~10 km resolution spanning a portion of the North American continent (global wind fields are available at much coarser resolution);

2) Coarse grid spacing cannot resolve local-scale three-dimension circulations induced by complex terrain;

3) The important effects of wind shear and the resulting dispersion of an air parcel cannot be treated as singular points because the parcels have no spatial dimensions defining a volume subject to deformation;

4) The important effects of sub-grid turbulent mixing or "diffusion" are not included; these are critical processes that vertically exchange air between the surface and 1-4 km aloft during the daytime, thus providing a continuous upward ventilation of local emissions and a drawing down of pollutants from the mid-troposphere.

Point (4) merits special consideration. Without the capacity to include vertical mixing, trajectory models ignore an important and rather dynamic vertical transport/exchange process. This is particularly relevant during multi-day stagnation periods when simulated point trajectories exhibit only restricted, localized patterns of movement by the resolved wind field. The effects of shears and mixing can be somewhat addressed by tracking multitudes of point parcels initialized throughout a broad three-dimensional volume that extends over the entire air basin horizontally and through 3-4 km vertically. Then the assessment of trajectories should include the entire resulting "cloud" of trajectory paths extending up to a week in time from their initialization point.

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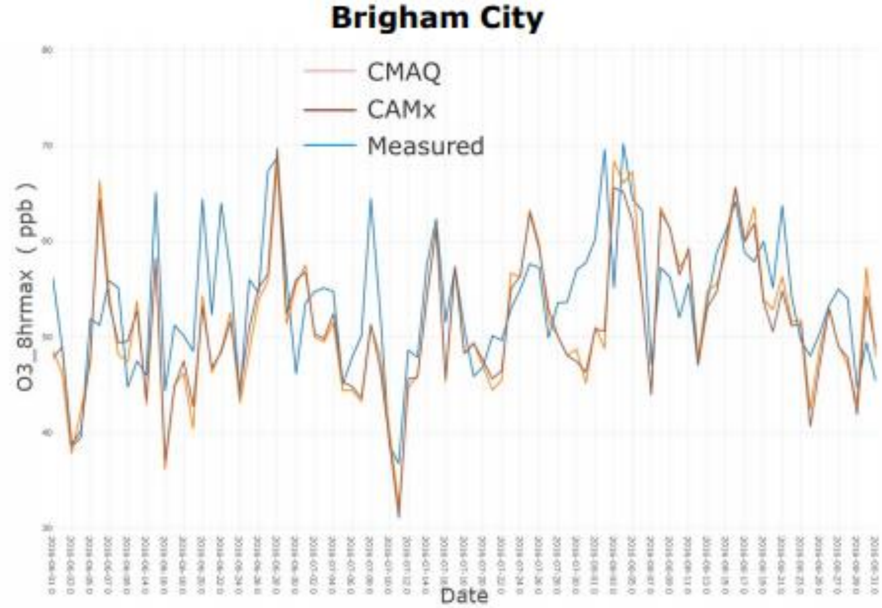
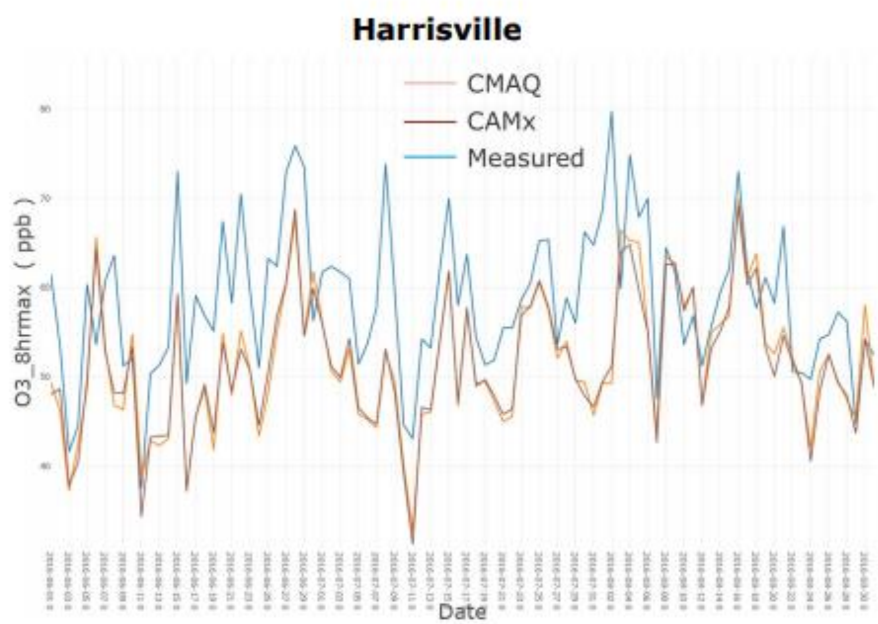
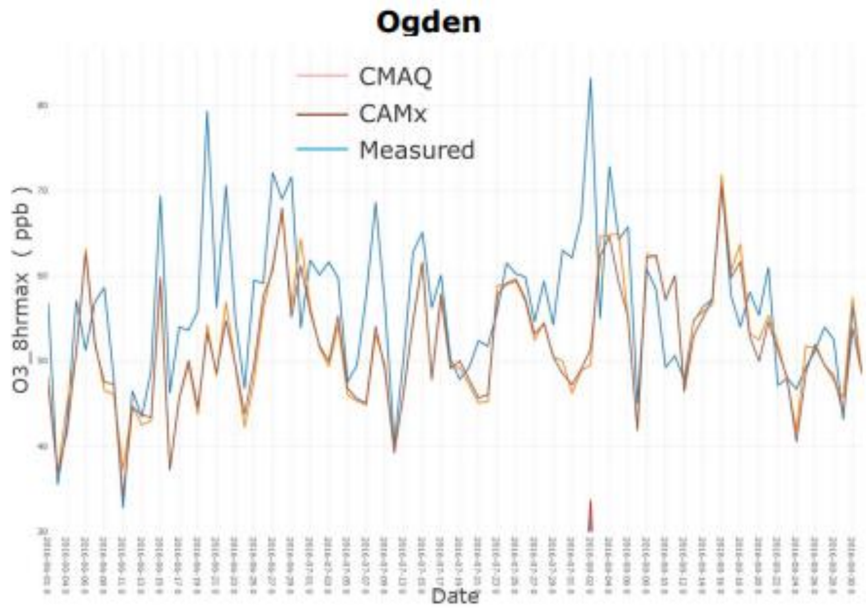
APPENDIX A: TIME SERIES OF MDA8 OZONE FROM CMAQ AND CAMX BETA MP



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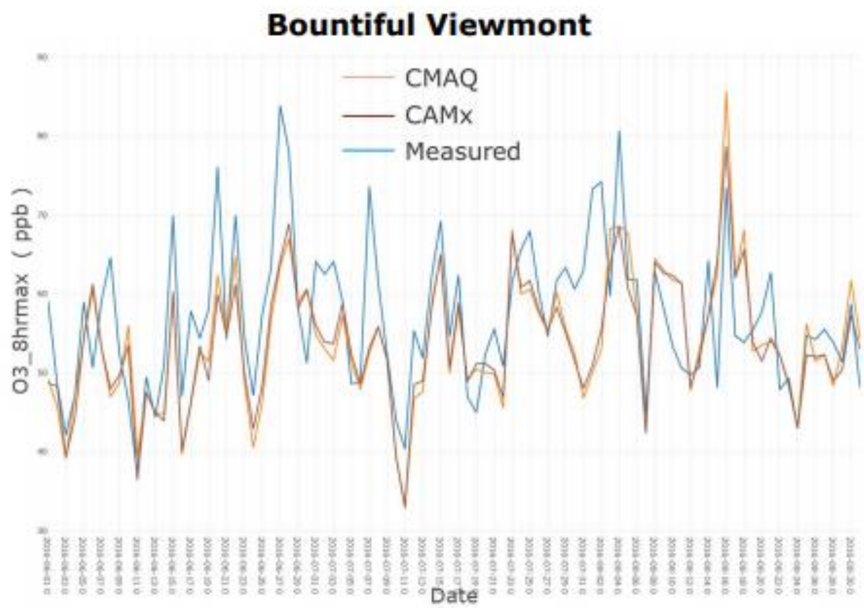
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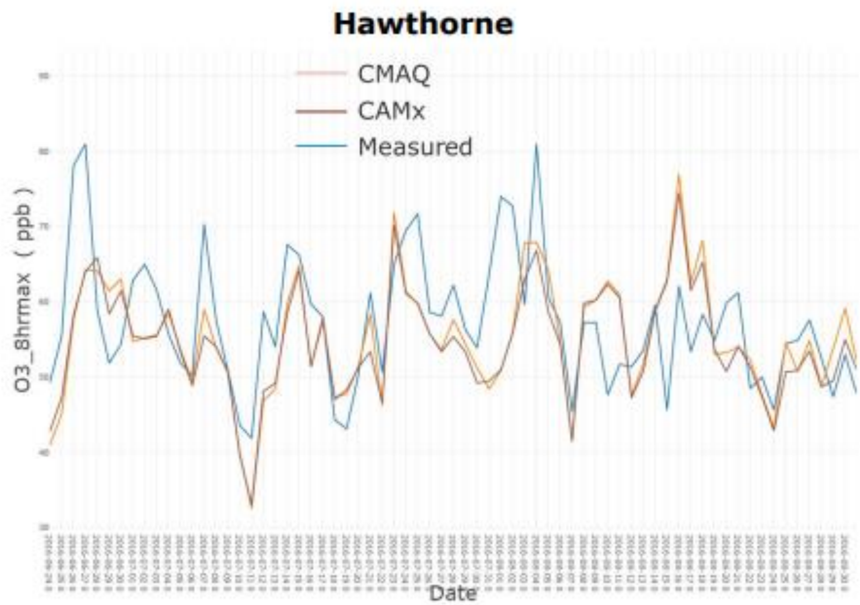
Date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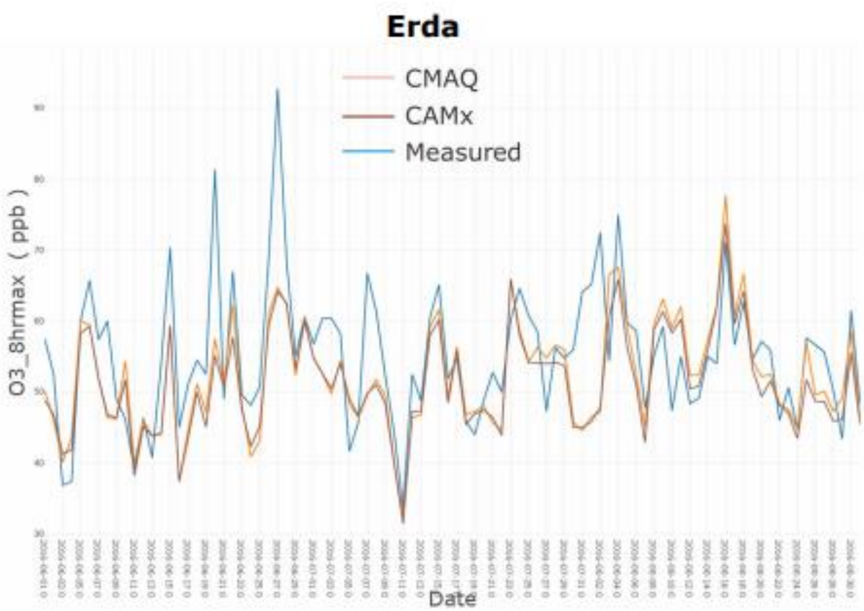
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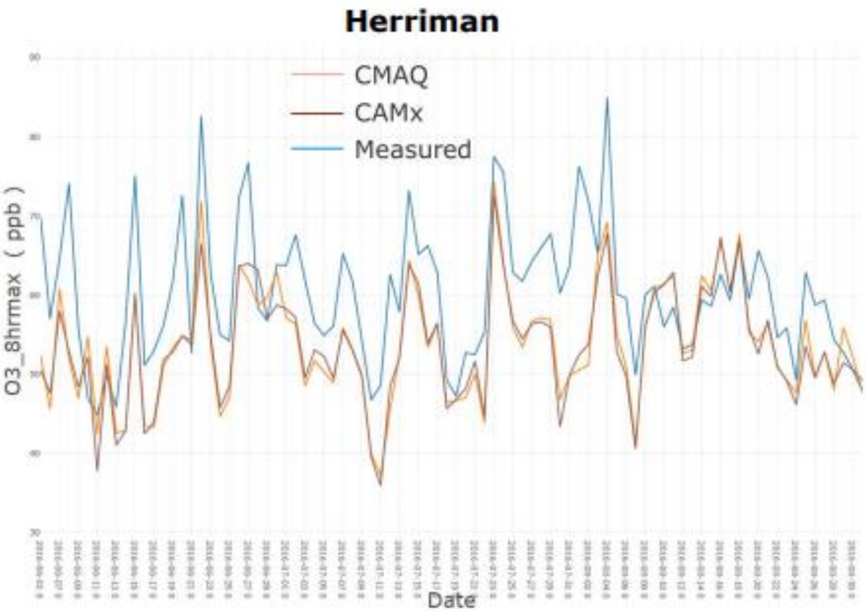
Date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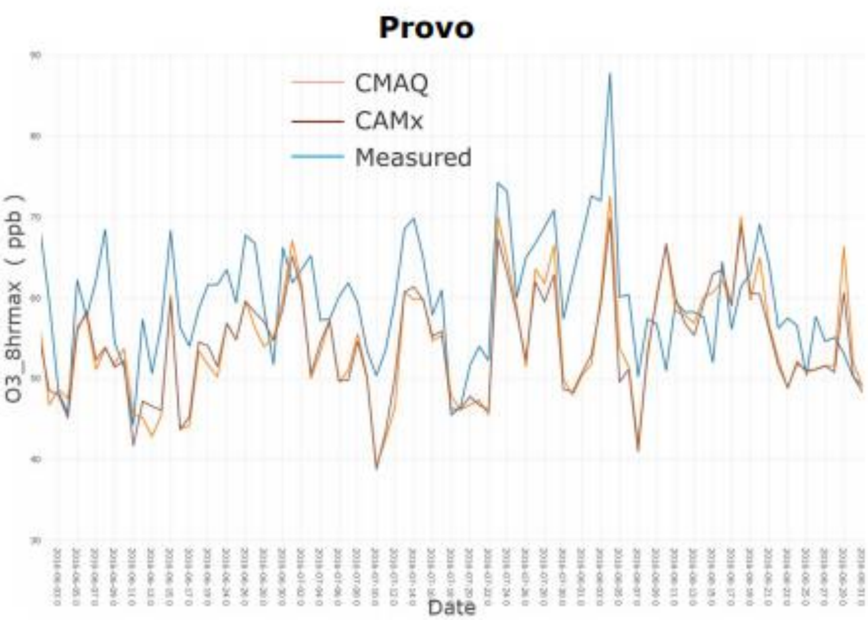
CMAQ
CAMx
Measured
O3_8hrmax (ppb)
Date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CMAQ
CAMx
Measured
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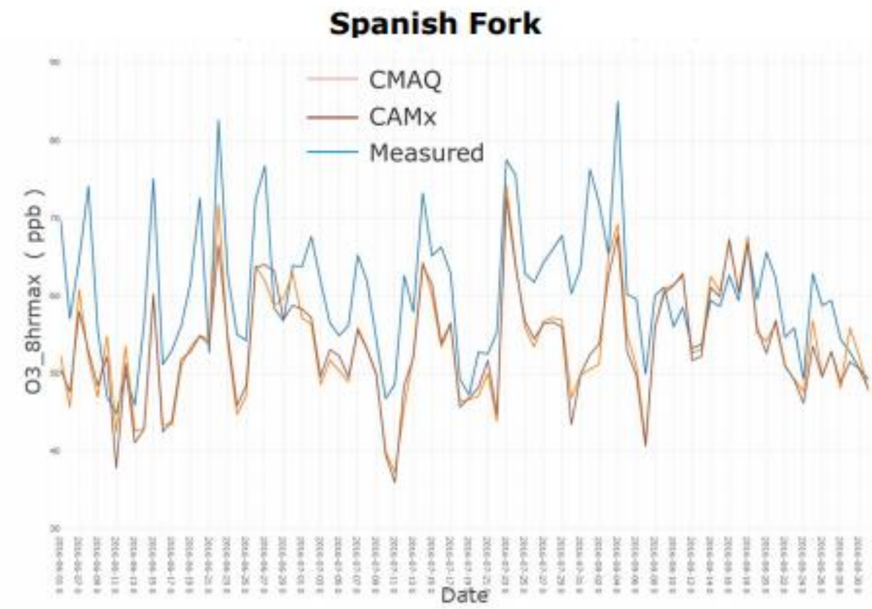
Date

27/37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CMAQ
CAMx
Measured
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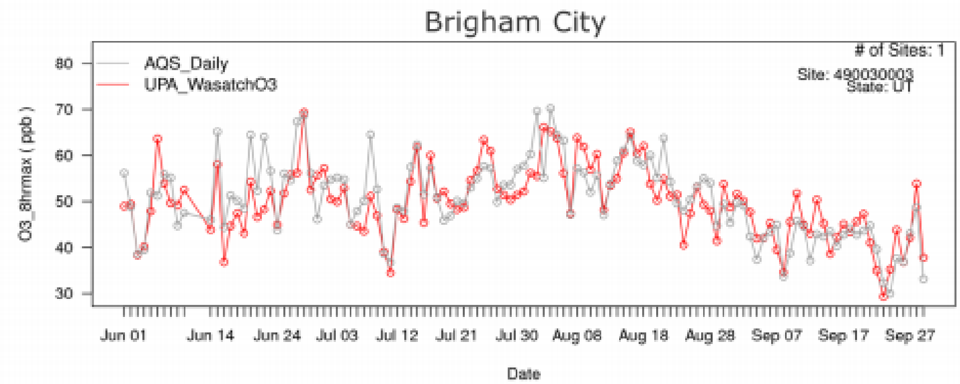
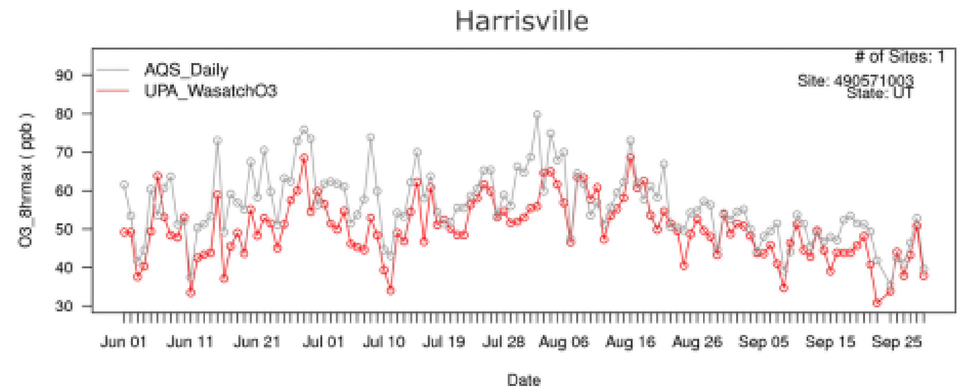
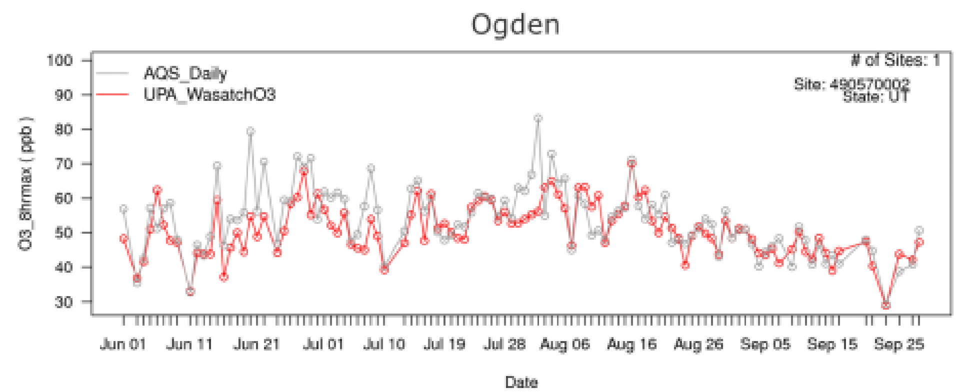
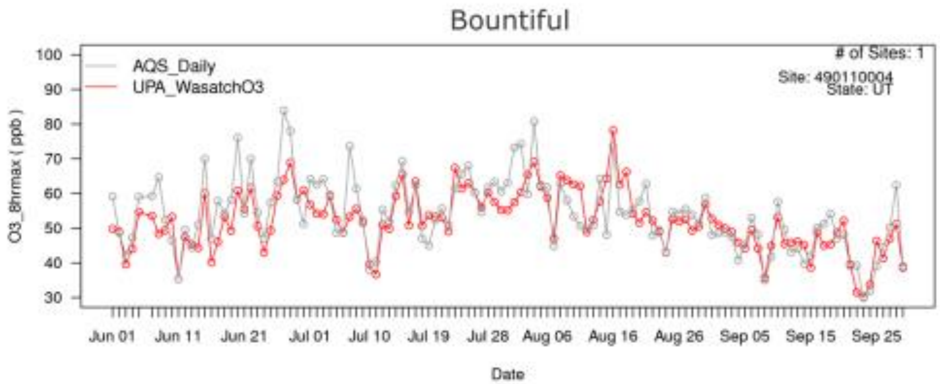
Date

APPENDIX B: TIME SERIES OF MDA8 OZONE FROM CAMX V1 MP





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30
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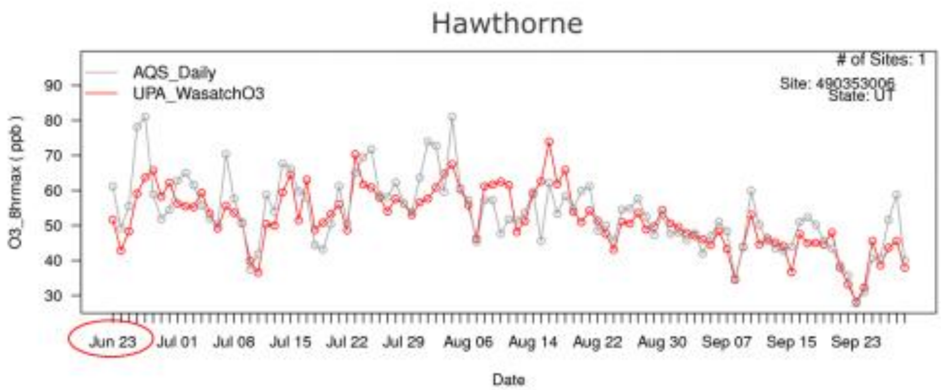
Date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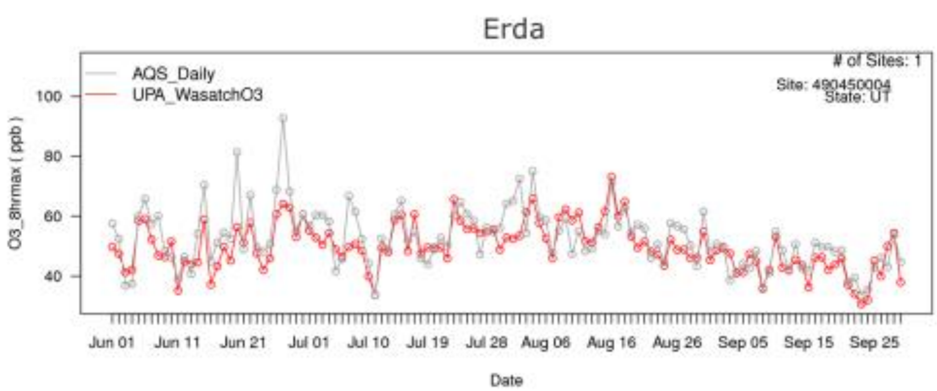
Jun 23 Jul 01 Jul 08 Jul 15 Jul 22 Jul 29 Aug 06 Aug 14 Aug 22 Aug 30 Sep 07 Sep 15 Sep 23
Date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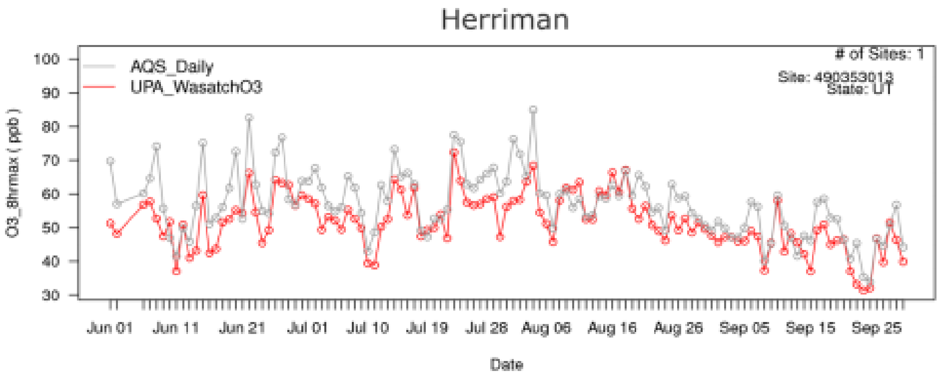

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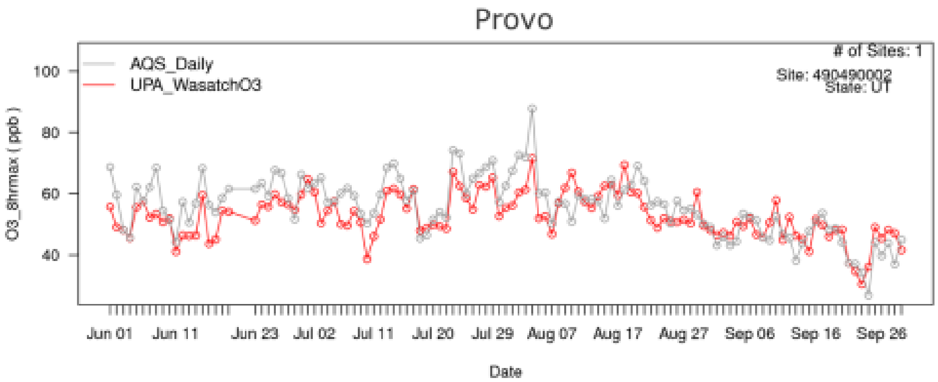

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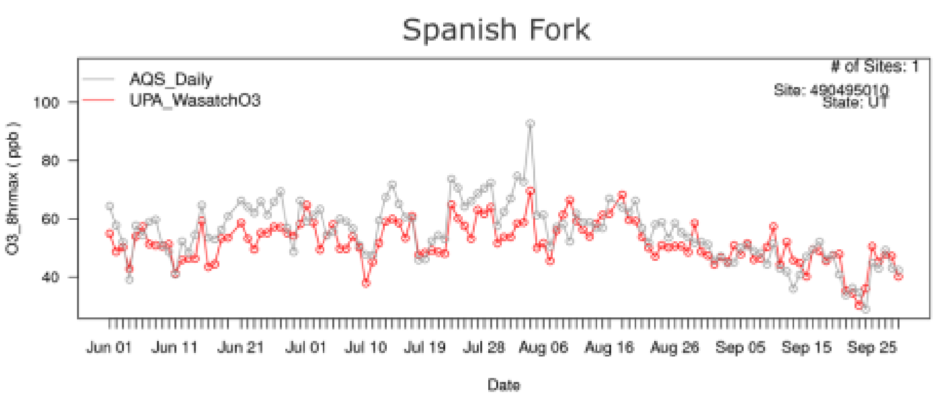
Date



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80
60
40
Jun 01
Jun 11
Jun 21
Jul 01
Jul 10
Jul 19
Jul 28
Aug 06
Aug 16
Aug 26
Sep 05
Sep 15
Sep 25
Date

APPENDIX C: SMAT DV SCALING USING EPA BETA CMAQ BASE AND ZROW OUTPUT

Site	County	2013-2017 Average DV[1]*	Modeled RRF (ZROW/Base)	ZROW DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	74	0.8869	66.0
490353006 Hawthorne	Salt Lake	76	0.8924	68.0
490353013 Herriman	Salt Lake	76	0.8686	66.0
490450004 Erda	Tooele	73	0.8592	62.7
490570002 Ogden	Weber	72	0.8811	63.4
490571003 Harrisville	Weber	72	0.8784	63.5
Southern Wasatch Front				
490490002 Provo	Utah	71	0.8881	63.6
490495010 Spanish Fork	Utah	72	0.8905	64.1

[1] SMAT-CE is delivered with official DV data up through 2017.
* EPA modeling guidance recommends scaling the 3-year average DV: in this case, 2013-2015, 2014-2016, 2015-2017.

Site	County	2015-2017 DV[1]	Modeled RRF (ZROW/Base)	ZROW DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	75	0.8869	66.5
490353006 Hawthorne	Salt Lake	78	0.8924	69.6
490353013 Herriman	Salt Lake	76	0.8686	66.0
490450004 Erda	Tooele	73	0.8592	62.7
490570002 Ogden	Weber	73	0.8811	64.3
490571003 Harrisville	Weber	73	0.8784	64.1
Southern Wasatch Front				
490490002 Provo	Utah	72	0.8881	63.9
490495010 Spanish Fork	Utah	71	0.8905	63.2

[1] SMAT-CE is delivered with official DV data up through 2017.

Site	County	2016-2018 DV[1]	Modeled RRF (ZROW/Base)	ZROW DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	78	0.8869	69.2
490353006 Hawthorne	Salt Lake	76	0.8924	67.8
490353013 Herriman	Salt Lake	77	0.8686	66.9
490450004 Erda	Tooele	74	0.8592	63.6
490570002 Ogden	Weber	75	0.8811	66.1
490571003 Harrisville	Weber	74	0.8784	65.0
Southern Wasatch Front				
490490002 Provo	Utah	N/A	0.8881	N/A
490495010 Spanish Fork	Utah	72	0.8905	64.1

[1] Using EPA-official 2016-2018 DV obtained outside of SMAT-CE.

APPENDIX D: SMAT DV SCALING USING V1 CAMX OSAT OUTPUT

Site	County	2013-2017 Average DV[1]*	Modeled RRF	OSAT DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	74	0.8346	62.1
490353006 Hawthorne	Salt Lake	76	0.8293	63.2
490353013 Herriman	Salt Lake	76	0.8224	62.5
490450004 Erda	Tooele	73	0.8375	61.1
490570002 Ogden	Weber	72	0.8297	59.7
490571003 Harrisville	Weber	72	0.8432	60.9
Southern Wasatch Front				
490490002 Provo	Utah	71	0.8326	59.6
490495010 Spanish Fork	Utah	72	0.8330	59.9

[1] SMAT-CE is delivered with official DV data up through 2017.
* EPA modeling guidance recommends scaling the 3-year average DV: in this case, 2013-2015, 2014-2016, 2015-2017.

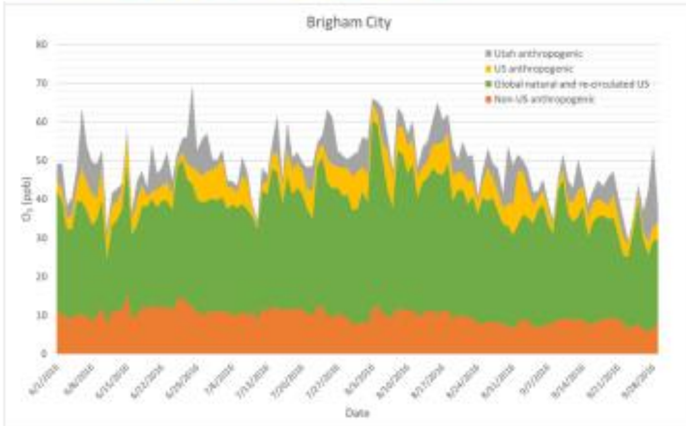
Site	County	2015-2017 DV[1]	Modeled RRF	OSAT DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	75	0.8346	62.5
490353006 Hawthorne	Salt Lake	78	0.8293	64.6
490353013 Herriman	Salt Lake	76	0.8224	62.5
490450004 Erda	Tooele	73	0.8375	61.1
490570002 Ogden	Weber	73	0.8297	60.5
490571003 Harrisville	Weber	73	0.8432	61.5
Southern Wasatch Front				
490490002 Provo	Utah	72	0.8326	59.9
490495010 Spanish Fork	Utah	71	0.8330	59.1

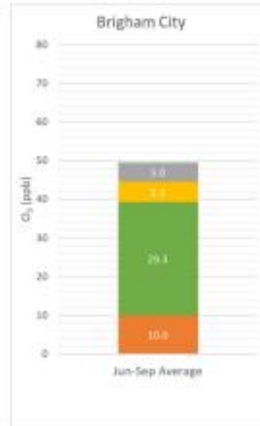
[1] SMAT-CE is delivered with official DV data up through 2017.

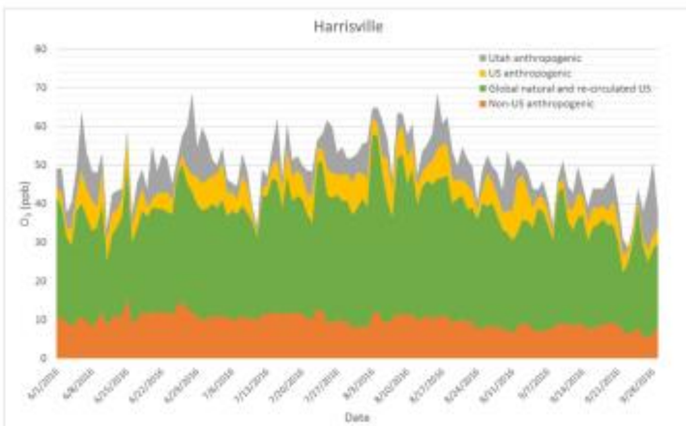
Site	County	2016-2018 DV[1]	Modeled RRF	OSAT DV (≤70.9 Attains)
Northern Wasatch Front				
490110004 Bountiful	Davis	78	0.8346	65.1
490353006 Hawthorne	Salt Lake	76	0.8293	63.0
490353013 Herriman	Salt Lake	77	0.8224	63.3
490450004 Erda	Tooele	74	0.8375	62.0
490570002 Ogden	Weber	75	0.8297	62.2
490571003 Harrisville	Weber	74	0.8432	62.4
Southern Wasatch Front				
490490002 Provo	Utah	N/A	0.8326	N/A
490495010 Spanish Fork	Utah	72	0.8330	60.0

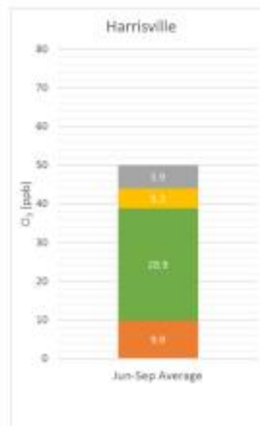
[1] Using EPA-official 2016-2018 DV obtained outside of SMAT-CE.

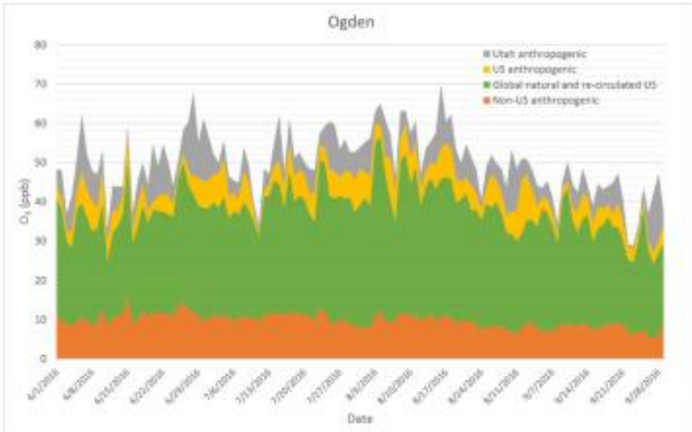
APPENDIX E: TIME SERIES AND SUMMER-AVERAGE OZONE CONTRIBUTIONS FROM OSAT

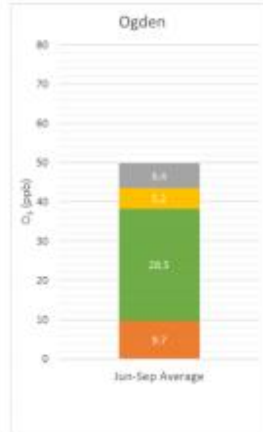


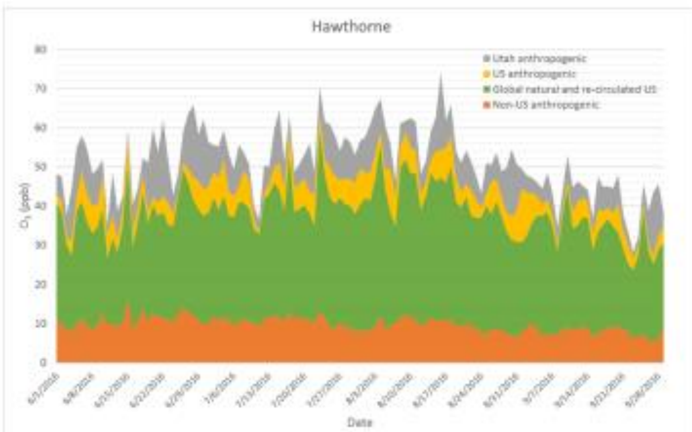


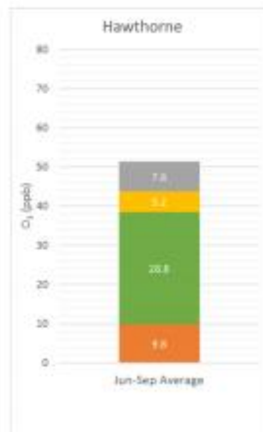


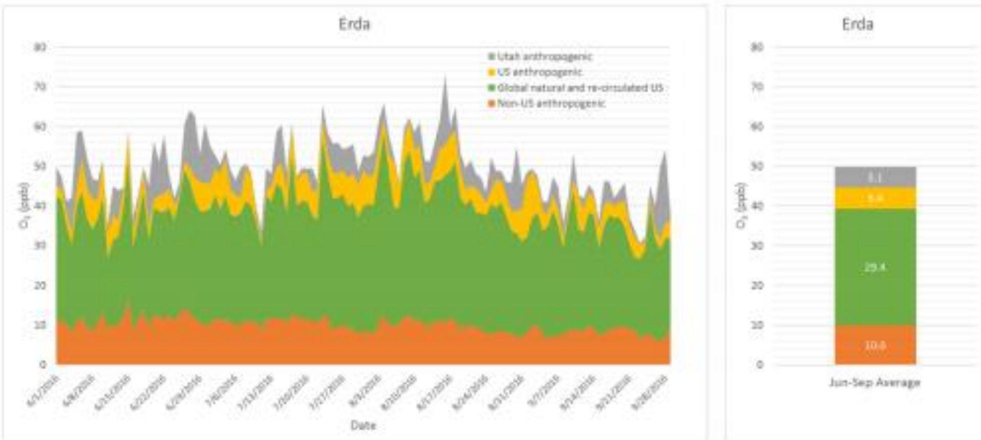



Ogden
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
O3 (ppb)
Date

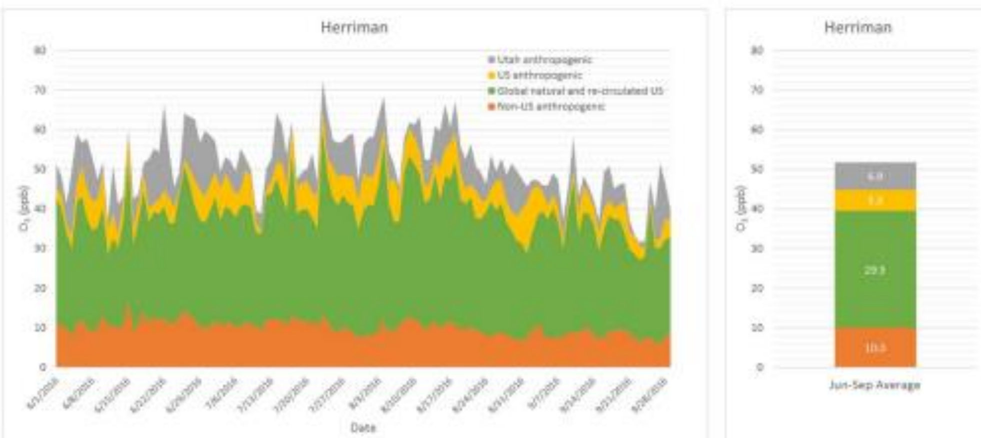

Ogden
O3 (ppb)
Jun-Sep Average


Hawthorne
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
O3 (ppb)
Date

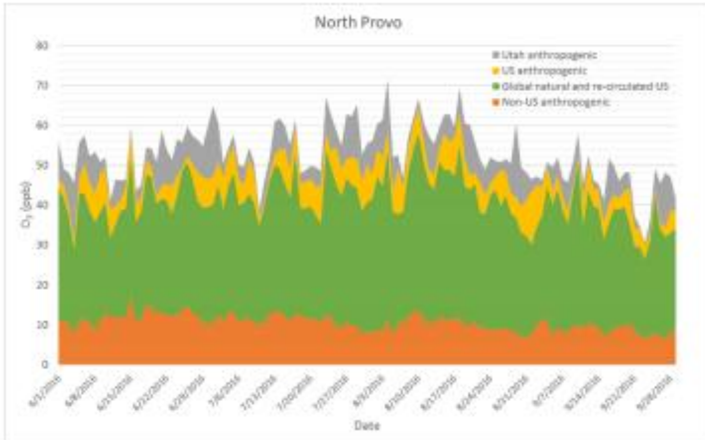

Hawthorne
O3 (ppb)
Jun-Sep Average



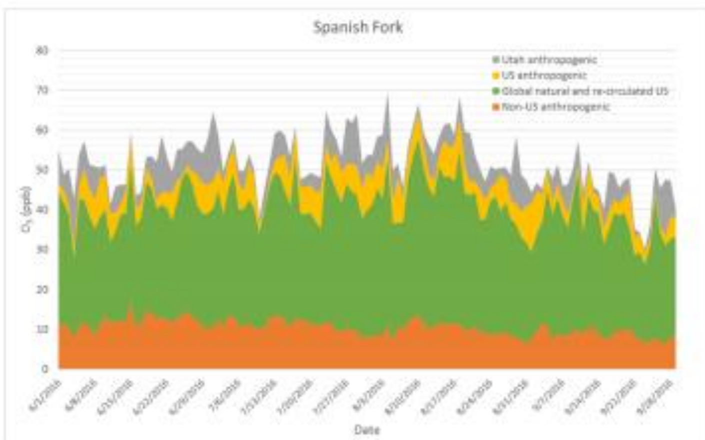
Erda
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
Date
Erda
Jun-Sep Average

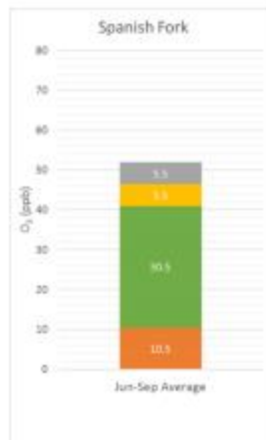


Herriman
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
Date
Herriman
Jun-Sep Average


North Provo
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
O_3 (ppb)
Date


North Provo
O_3 (ppb)
30.9
10.8
Jun-Sep Average


Spanish Fork
Utah anthropogenic
US anthropogenic
Global natural and re-circulated US
Non-US anthropogenic
O_3 (ppb)
Date


Spanish Fork
O_3 (ppb)
30.5
10.5
Jun-Sep Average

Utah Division of Air Quality

179B(b) Demonstration
Northern Wasatch Front
Ozone Non-attainment Area

Modeling Protocol
May 2021

Introduction

Overview of Air Quality Issue

Utah's Wasatch Front often experiences exceedances of the national ambient air quality standard (NAAQS) for ozone during the summer. The US Environmental Protection Agency (EPA) has designated two areas along the Wasatch Front as Marginal Nonattainment for the 2015 Ozone NAAQS. These consist of the Northern and Southern Wasatch Front Nonattainment areas. The Northern Wasatch Front Nonattainment Area includes Salt Lake and Davis Counties and portions of Tooele and Weber Counties while the Southern Wasatch Front Nonattainment Area includes a part of Utah County.

Recent design value (DV) calculations over 2017-2019 indicate that the Southern Wasatch Front area has attained the ozone NAAQS while the Northern Wasatch Front continues to exceed with a peak DV of 77 ppb.

Ozone along the Wasatch Front has a mix of different sources, both local and non-local. These sources can also be derived from both anthropogenic and natural sources, including stratospheric transport, wildfires, biogenic emissions as well as US and international anthropogenic sources. Intercontinental transport of pollutants is especially persistent during the summer season[1]. Persistent global circulation patterns establish a direct transport route linking the Asian east coast and the US west coast. A semi-permanent low-pressure system off the coast of China lofts pollutant-laden air to the mid and upper free troposphere. Fast winds within that region of the atmosphere then move this air and associated pollutants eastward toward the US Pacific coast. This occurs within days to weeks with ozone persisting at these altitudes because of the relative lack of chemical sinks and low temperatures in this part of the atmosphere. Semi-permanent high-pressure system over the US Pacific Coast then brings down the upper tropospheric air back to the surface over the western US. This vertical transport of air from aloft is also enhanced by complex topography by creating winds that enhance O3 mixing down mountain slopes, leading to high-altitude locations throughout the western US experiencing greater impacts from intercontinental transport of O3 as compared to lower-elevation locations[2]. This intercontinental transport persists throughout the summer season in Utah, leading to enhancements of local ozone concentrations[3].

[1] Langford, A.O., Alvarez, R.J., Brioude, J., Fine, R., Gustin, M.S., Lin, M.Y., Marchbanks, R.D., Pierce, R.B., Sandberg, S.P., Senff, C.J., Weickmann, A.M., Williams, E.J., 2017. Entrainment of stratospheric air and Asian pollution by the convective boundary layer in the southern U.S. *J. Geophysical Res. Atmos., 122*, 1312-1337, doi:10.1002/2016JD025987.

[2] EPA, 2015. "Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone, White Paper for Discussion" (December 30, 2015). https://www.epa.gov/ground-level-ozone-pollution/background-ozone-workshop-and-information.

[3] Jaffe, D.A., O.R. Cooper, A.M. Fiore, B.H. Henderson, G.S. Tonnesen, A.G. Russell, D.K. Henze, A.O. Langford, M. Lin, T. Moore, 2018. Scientific assessment of background ozone over the U.S.: Implications for air quality management. Elem. Sci. Anth., 6: 56. DOI: https://doi.org/10.1525/elementa.309.

Related Modeling Analysis

To evaluate the potential applicability of the Section 179B provisions for the Wasatch Front Ozone Nonattainment Areas, Ramboll conducted a preliminary modeling analysis that quantitatively estimated the contribution from global international anthropogenic ozone transport to the Wasatch Front. They applied both the Community Multiscale Air Quality (CMAQ[4]) and the Comprehensive Air quality Model with extensions (CAMx[5]) photochemical models using EPA-derived meteorology and emission datasets representing conditions during 2016. They also considered two approaches, a sensitivity analysis and a source apportionment method.

For the sensitivity analysis, which was conducted using CMAQ, two simulation runs were considered. These included a base case where all emission sources were included and a sensitivity scenario where emissions from international anthropogenic sources were zeroed out. The contribution of international anthropogenic emission sources to local ozone concentrations was then assessed by scaling the DV at each monitoring site by the relative modeled change in ozone between the baseline and scenario cases. The source apportionment analysis, which was conducted in CAMx, consisted of tracking emission contributions from Utah, the rest of the US, and international anthropogenic sources to total ozone at Wasatch Front monitors. A similar scaling approach was then followed for quantifying the contribution of international anthropogenic sources to local ozone. Ramboll concluded that results from both approaches and models showed an underprediction in ozone on high ozone days, most likely due to a lack of local ozone production, which could lead to an overestimation in the international contributions to local DVs. Ramboll, however, estimates that the related error is likely less than 2 ppb and therefore does not change their overall conclusion that the Wasatch Front would attain the standard but for the contribution of international anthropogenic emissions. Ramboll's detailed report is attached.

Proposed Modeling Demonstration

To further support findings from Ramboll's photochemical modeling analysis, the Utah Division of Air Quality (UDAQ) could conduct a more rigorous air quality modeling analysis that would help optimize the photochemical model performance for Utah. Such demonstration would build on Ramboll's analysis but include a few enhancements to better represent emissions inputs and meteorology in Utah.

Compared to Ramboll's modeling demonstration, the following modifications would be implemented:

- Higher-resolution modeling domains.

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4 EPA, 2020. CMAQ: The Community Multiscale Air Quality Modeling System website: https://www.epa.gov/cmaq.

5 Ramboll, 2020. Comprehensive Air Quality Model with extensions website: http://www.camx.com/home.aspx.

A 4 km domain covering Utah and parts of neighboring states and nested within a 12 km domain that covers the Western United States will be used. This is in contrast to a 12 km domain covering the continental United States used by Ramboll.

- Two-way nesting in photochemical air quality model
- Updated and more recent emissions data and inputs. The proposed modeling will leverage EPA's 2017 modeling platform as opposed to Ramboll's modeling which used EPA's 2016 modeling platform. The 2016 platform is based on the 2014 National Emissions Inventory (NEI) while the 2017 modeling platform is based on the 2017 NEI and includes some methodology updates.
- Utah-specific meteorology where land use modifications specific to the Great Salt Lake would be applied to better represent Utah topography.
- Application of hybrid vertical coordinate in WRF meteorological model, which is more appropriate for representing areas with complex topography such as Utah.

It is anticipated that these refinements will help improve the photochemical model performance. They will particularly help better represent the contribution of local sources to ozone concentration. However, despite these enhancements, the findings and implications of such modeling analysis are not expected to differ from Ramboll's conclusions. The improvements will most likely lead to a better representation of local ozone source contributions on high ozone days. These contributions were underestimated in the modeling conducted by Ramboll and potentially led to an overestimation in the contribution of international sources to local DVs. By better simulating local ozone production, the contribution of international sources to ozone concentrations is likely to decrease.

Key Personnel, Participants and Roles

The air quality modeling team at UDAQ will be responsible for preparing and processing the emissions as well as conducting the meteorological and photochemical grid simulations.

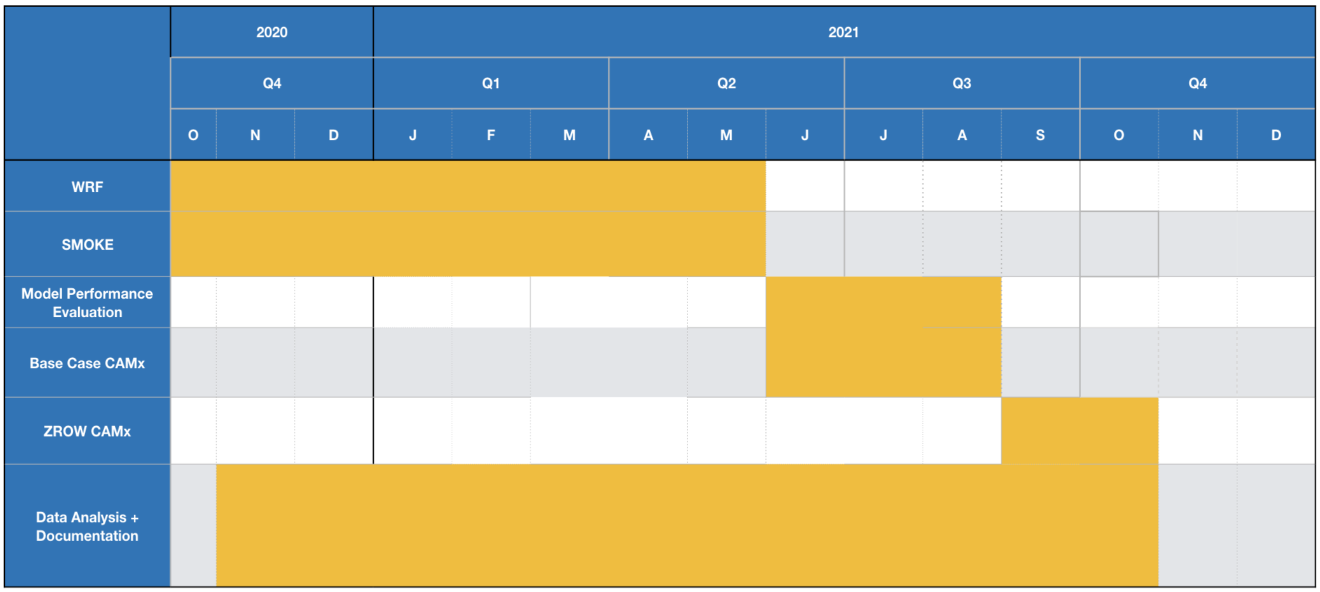
Involvement of External Scientific Experts

The modeling team at UDAQ will work closely with Gail Tonnesen, air quality modeler at EPA Region 8, and Alison Eyth with EPA's emissions modeling team throughout the modeling process. Communication with them has actually already been initiated and technical assistance, particularly with emissions preparation, has been provided. Further communication between EPA and the modeling team is anticipated. Interim deliverables (e.g. preliminary model performance evaluation results, meteorological modeling results, emissions assumptions, ...) will also be frequently shared to allow for corrective action as necessary.

The modeling team also maintains a strong working relationship with Ramboll, the developer of CAMx photochemical model, and will continue to seek technical advice and feedback from them as needed. Ramboll has been providing technical assistance with running the Weather Research and Forecasting (WRF) meteorological model and has completed the GEOS-Chem global simulations needed for providing initial and boundary conditions for the photochemical model.

Schedule for Completion

Table 2. Projected Timeline for Completion of 179B Demonstration



Conceptual Model

Ozone exceedance events in the non-attainment area are typically associated with the following meteorological conditions:

- Presence of an upper level high pressure system that brings warmer temperatures
- Low surface winds and lack of frontal passage
- Thermally-driven upslope and downslope flows

All these conditions are conducive to ozone formation and lead to the accumulation of ozone and its precursors.

Model Selection

Selection Criteria

Models were selected following EPA's guidance for regulatory modeling in support of ozone attainment demonstrations[6]. Key criteria recommended by EPA for model selection include the following:

- The model should have received a scientific peer review
- The model should be demonstrated to be applicable to the problem on a theoretical basis
- Availability and adequacy of databases to support the model application
- Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application.
- A protocol on methods and procedures to be followed has been established
- Model has a user's guide and technical description
- The availability of advanced technical features (e.g., probing tools or science algorithms)
- When other criteria are satisfied, resource considerations may be important and are a legitimate concern.

The Weather Research and Forecasting (WRF) model will be used for meteorological modeling. The Sparse Matrix Operator Kernel Emissions (SMOKE) will be used for emissions modeling of most source categories while the Biogenic Emissions Inventory System (BEIS) will be used for biogenic emissions modeling. The MOtor Vehicle Emissions Simulator (MOVES) will also be used along with SMOKE (SMOKE-MOVES) for mobile source emissions modeling. The Comprehensive Air-quality Model with Extensions (CAMx) will be used for photochemical grid modeling. These models satisfy EPA's model selection criteria and have extensively been used in past State Implementation Plans (SIP) demonstrations by UDAQ and other state and local agencies.

Meteorological Model

Meteorological inputs for the 179B demonstration will be produced using the Weather Research and Forecasting Advanced Research model (WRF-AWR) version 4.2[7]. WRF has been used successfully for previous modeling efforts in Utah, including the PM2.5 SIP for the Wasatch Front. WRF has been used on a regional and national scale for ozone nonattainment work. The WRF simulation will cover the time period of June 14th, 2017 at 12:00:00 UTC to August 2nd, 2017 at 00:00:00 UTC to generate adequate spin-up for the photochemical modeling.

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[6] US EPA. Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze. https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

[7] Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Liu, Z., Berner, J., … Huang, X. -yu. (2019). A Description of the Advanced Research WRF Model Version 4 (No. NCAR/TN-556+STR). doi:10.5065/1dfh-6p97

Emissions Model

SMOKE

The emissions processing model used in conjunction with CAMx is the Sparse Matrix Operator Kernel Emissions Modeling System (SMOKE version 4.7[8]). Modeling staff at UDAQ have been using SMOKE on a regular basis since 2001. The emissions processing model takes the annual, county-wide emissions inventory and reformulates it for use in the air quality model. There are three aspects to this reformulation of the inventory which, in the end, produces a refined version of the inventory for input into CAMx:

1. Temporal: Convert emissions from annual to daily, weekly and hourly values.
2. Spatial: Convert emissions from a county-wide average to gridded emissions.
3. Speciation: Break NOx, VOC, and other grouped emissions into their component subspecies using the latest, Carbon Bond 6 (CAMx CB AE6), speciation profiles.

This modeling demonstration leverages the 2017 NEI platform[9]. Inventories collected by UDAQ are not included in this demonstration. The 2017 platform is configured to prepare emissions for CMAQ. In order to prepare emissions for CAMx, SMOKE is run to prepare emissions for CMAQ, and the resulting outputs are converted to UAM format to be input to CAMx. Conversion is accomplished by scripts developed as part of the 2016 platform[10]. Emissions sectors to be processed are described in the table below.

Table 3. SMOKE Emissions sectors to be processed

Sectors	Description/Examples	Spatial	Temporal
Point/Facility Inventory	EGUs, airports, point oil and gas sources, commercial and industrial facilities	lat-lon location	Continuous Emissions Monitoring System (CEMS) data for EGUs are hourly by unit
Nonpoint (area)	fugitive dust, agricultural, residential, industrial/commercial fuel comb., gas stations, biogenics	county-based	flat // average meteorological adjustments for afdust, but the modeling platform emissions are adjusted based on hourly, gridded met. data
Onroad mobile sources	cars and trucks driving on roads	county-based	hourly emissions and then aggregated & summed for the NEI
Nonroad mobile sources	mobile sources not on roads including rec. marine, construction equip., lawn/garden, tractors	county-based	monthly (summed in the NEI)
Events	wildland and prescribed fires	lat-lon / day	hourly emissions and then aggregated & summed for the NEI

8 https://www.cmascenter.org/smoke/
9 https://www.epa.gov/air-emissions-modeling/2017-emissions-modeling-platform
10 CMAQ to CAMx conversion package: https://gaftp.epa.gov/Air/emismod/2016/v1/cmaq2camx_20nov20.zip

Fires are processed as 3-dimensional emissions sources in SMOKE, because CAMx does not support plume rise calculations for fires. Fires are layered in SMOKE and then converted to CAMx ptsr format. To avoid double-counting these layered fire emissions between the 4km and 12km domains, all fire emissions in the 12km domain that are overlapped by the 4km domain will be zeroed out using a masking script provided by EPA from their 2016 regional haze addendum platform[11].

SMOKE will be run for the modeling episode duration, with an additional 15 days prior to the start of the episode to account for time needed for photochemical model spin-up.

Description of SMOKE-MOVES application

SMOKE-MOVES is the integration of MOtor Vehicle Emission Simulator (MOVES) with SMOKE. This model estimates emissions from onroad motorized vehicles including passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses.

Emissions processing with SMOKE-MOVES occurs in 3 phases:

1. Meteorological processing: Temperature and relative humidity data are prepared for each modeling domain using meteorological data from WRF (processed in MCIP) in a program called *Met4moves*.
2. MOVES: Creates emission rate lookup tables for use in SMOKE
3. SMOKE: Combines the emission rate lookup tables with meteorological inputs to estimate emissions from onroad mobile sources. Emissions are speciated and allocated spatially and temporally. "SMOKE selects the appropriate MOVES emissions rates for each county, hourly temperature, SCC, and speed bin and then multiplies the emission rate by appropriate activity data[12]."

Four emissions calculations are completed and then merged together in SMOKE_MOVES[13]:

- rate-per-distance (RPD) uses VMT as the activity data plus speed and speed profile information to compute on-network emissions from exhaust, evaporative, permeation, refueling, and brake and tire wear processes;
- rate-per-vehicle (RPV) uses VPOP activity data to compute off-network emissions from exhaust, evaporative, permeation, and refueling processes;

[11] Fires masking package: https://gaftp.epa.gov/Air/emismod/2016/beta/2016fg_addendum/2016fg_scripts_addendum_to_2016ff.zip

[12] Description of onroad emissions processing for the EPA 2017 platform, page 32: https://www.epa.gov/sites/production/files/2020-11/documents/2017_emissionschapter.pdf

[13] Description of onroad emissions processing for the EPA 2017 platform, page 33: https://www.epa.gov/sites/production/files/2020-11/documents/2017_emissionschapter.pdf

- rate-per-profile (RPP) uses VPOP activity data to compute off-network emissions from evaporative fuel vapor venting, including hot soak (immediately after a trip) and diurnal (vehicle parked for a long period) emissions; and
- rate-per-hour (RPH) uses hoteling hours activity data to compute off-network emissions for idling of long-haul trucks from extended idling and auxiliary power unit process.

To reduce modeling processing time, a subset of "representative" counties are run in SMOKE-MOVES and then applied to all counties they represent (See section 5.2.3 for Utah 4km domain representative counties).

Description of the Biogenic Emissions Inventory System (BEIS)

BEIS 3.7 is leveraged in this modeling demonstration. BEIS calculates CO, VOC, and NO from biogenic sources (vegetation and soils) using land use and meteorological data. Land use and meteorological data are sourced from WRF and then processed in MCIP before being input to BEIS. Emission factors in BEIS vary from summer to winter. This modeling demonstration leverages the summertime emission factors in BEIS, because the modeling episode is limited to July 2017.

Description of 3D Fires Emissions Modeling in SMOKE

Emissions from fires are calculated as 3D plumes in SMOKE using a SMOKE program called Laypoint. Laypoint uses gridded, hourly meteorological data and stack parameters to calculate the plume rise for all point-source emissions[14]. Wildland fires and burns obviously do not have stacks, so "imaginary stacks" are set at each layer in the 3D model. The "imaginary stacks" inject fire emissions into every vertical layer.

To avoid double-counting emissions plumes from fires, any fires that fall in the area of the 12km domain that is overlapped by the 4km domain are masked and set to zero.

Air Quality Model

The Comprehensive Air-quality Model with Extensions (v7.10) will be used for photochemical modeling. This model is a state-of-the-science photochemical grid model that comprises a "one-atmosphere" treatment of tropospheric air pollution (ozone, particulates, air toxics) over spatial scales ranging from neighborhoods to continents[15]. CAMx is publicly available and is an open-source system that is computationally efficient and flexible. This model meets all model selection criteria recommended by EPA. It also supports two-way grid nesting and includes a subgrid-scale Plume-in-Grid module. CAMx has also been extensively used in past ozone and PM2.5 State Implementation Plan demonstrations by UDAQ and other state and local agencies. EPA ozone

[14] SMOKE 4.7 manual, page 82: https://www.cmascenter.org/smoke/documentation/4.7/manual_smokev47.pdf

[15] Ramboll. User's Guide Comprehensive Air-quality Model with extensions Version 7.10. https://camx-wp.azurewebsites.net/Files/CAMxUsersGuide_v7.10.pdf.

guidance also explicitly mentions that CAMx along with CMAQ are the most commonly used chemical transport models for attainment demonstrations. The most recent version of CAMx (v7.10) will be used for this work. This version includes several updates including updates to chemical reactions for inorganic and simple organic species that play important roles in ozone formation.

Modeling Episode Selection

EPA Episode Selection Criteria

The following criteria were considered for selecting a modeling episode, in conformance with EPA's "Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze[16]":

1. Time period is close to the most recently compiled and quality assured National Emission Inventory (NEI).
2. Observed concentrations during the selected time period are close to the appropriate base year design value and span a sufficient number of days. This ensures that the modeled attainment test applied at each monitor violating the NAAQS is based on multiple days.
3. Time episode is characterized by low pollution days preceding and following high pollution concentration days. This ensures that the modeling system appropriately characterizes low pollution periods, development of elevated periods and transition back to low pollution periods through synoptic cycles.
4. Time period is representative of a variety of meteorological conditions conducive to elevated ozone levels. Selection of time periods which reflect a variety of meteorological conditions that frequently correspond with observed 8-hour daily maxima concentrations greater than the level of the NAAQS at monitoring sites in the nonattainment area.
5. Availability of observed ambient data, meteorology and special studies measurements for the selected time period.

Selected Episode

Summer (July 1 - 31) 2017 was selected as the modeling period. June 15-30 will also be included to allow for sufficient model spin-up time. This episode was selected after a careful examination of several summertime episodes that exhibited multiple ozone exceedances. These included 2014, 2016, 2017 and 2018. Selection was based on an analysis of meteorological conditions and pollutants spatio-temporal trends to ensure that the selected time period satisfies EPA's recommended selection criteria. This included evaluating the number of ozone exceedances per episode, hourly PM2.5 concentrations as well as hourly and daily maximum 8-hr average (MDA8) ozone concentrations. Episodes that were characterized by multiple exceedances and exceedances throughout the non-attainment area were preferred. Factors including emissions and ambient data

[16] https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

availability and the occurrence of wildfires were also considered. The availability of boundary conditions for the photochemical model was also taken into account.

Compared to the other episodes, summer 2017 was characterized by multiple exceedances, with the exceedances occurring throughout the non-attainment area and mostly in July (Figures 1-4 and Table 3).

Table 4. Number of exceedances at monitoring sites within the northern Wasatch Front O3 non-attainment area during June-September 2014, 2016, 2017 and 2018.

Time Period		Monitoring Station						
		Bountiful	**Hawthorne**	**Herriman**	**Erda**	**Harrisville**	**Ogden**	**Brigham City**
2014	**Jun.**	3	0	-	-	2	2	1
	Jul.	3	3	-	-	1	0	1
	Aug.	1	2	-	-	0	1	0
	Sept.	0	0	-	-	0	0	0
2016	**Jun.**	3	2	6	2	4	3	0
	Jul.	1	1	3	0	1	0	0
	Aug.	4	3	3	3	3	3	0

	Sept.	0	0	0	0	0	0	0
2017	**Jun.**	1	2	2	2	3	1	0
	Jul.	14	11	8	10	6	9	2
	Aug.	1	1	2	2	1	1	0
	Sept.	5	5	5	2	1	2	1
2018	**Jun.**	3	4	4	2	1	1	0
	Jul.	3	3	6	1	3	8	3
	Aug.	5	1	9	3	5	6	2
	Sept.	0	0	0	0	0	0	0

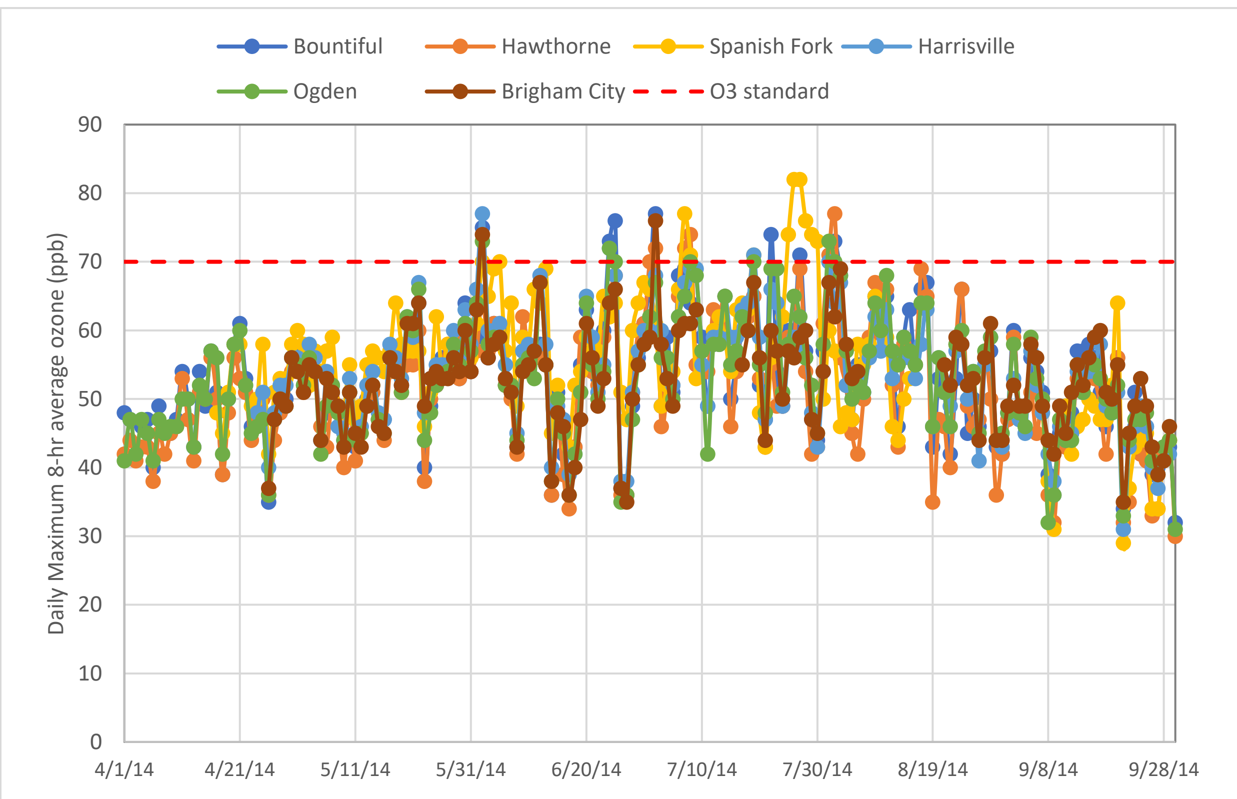

Figure 2. Maximum daily 8-hr average ozone concentration during April-September 2014.

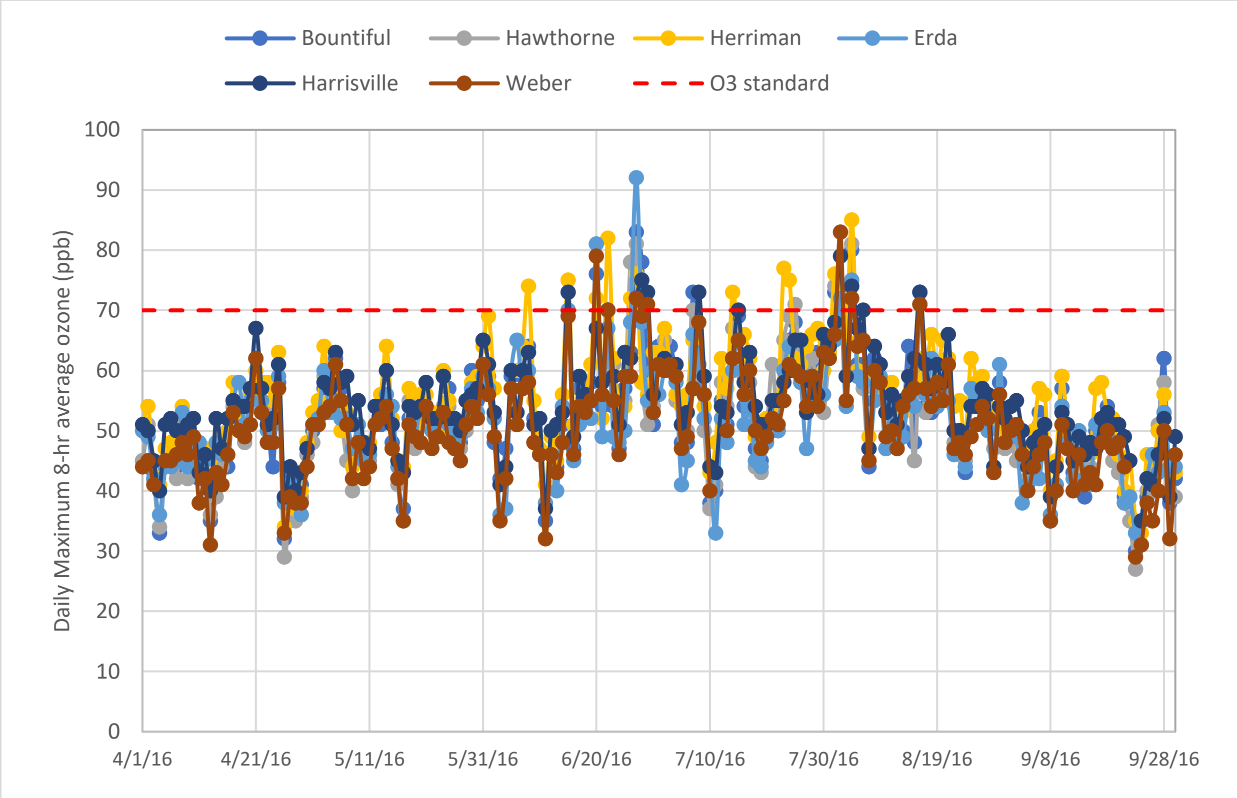

Figure 3. Maximum daily 8-hr average ozone concentration during April-September 2016.

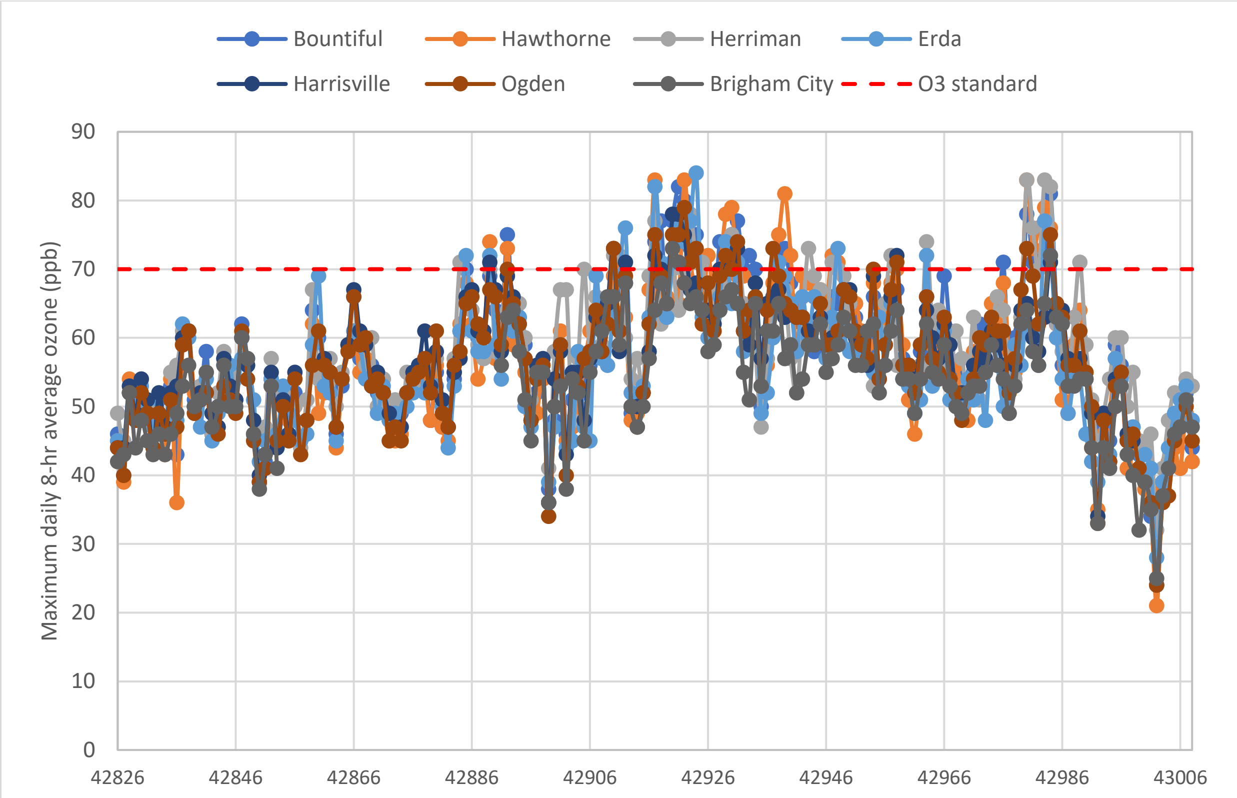

Figure 4. Maximum daily 8-hr average ozone concentration during April-September 2017.

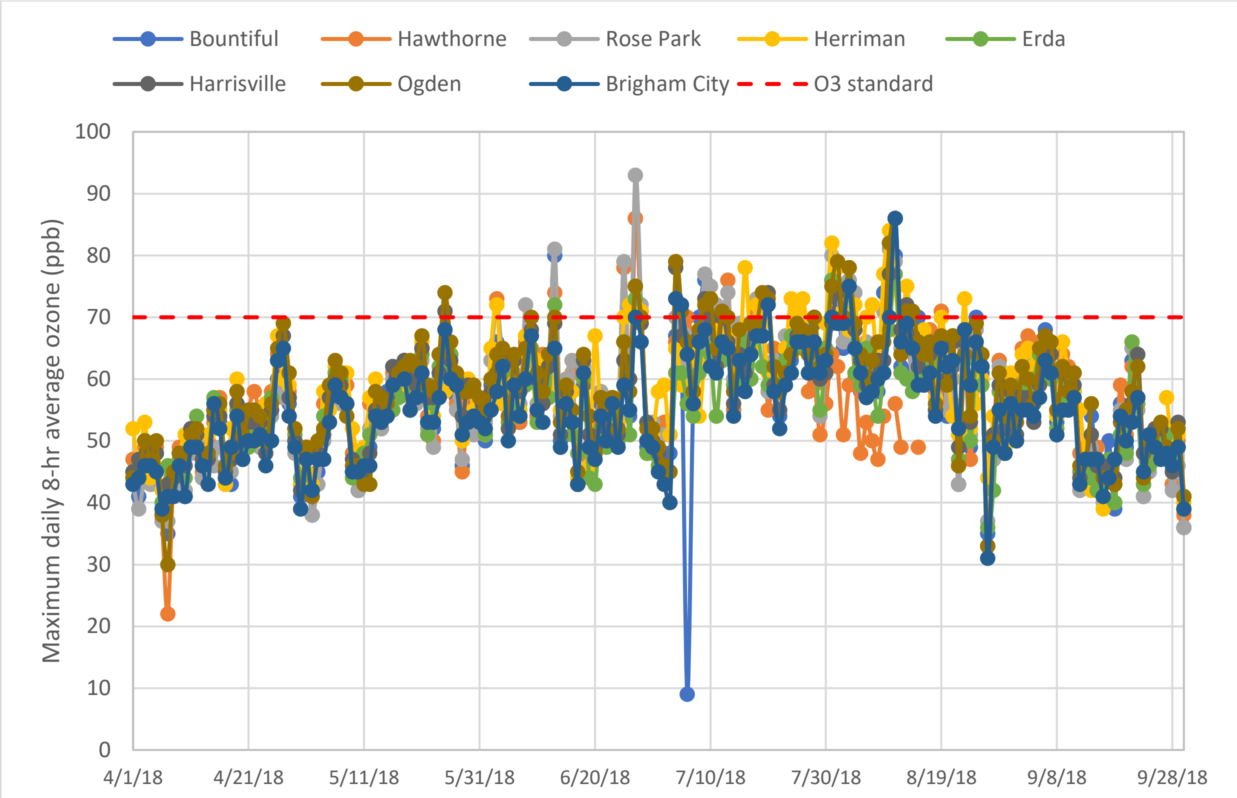

Figure 5. Maximum daily 8-hr average ozone concentration during April-September 2018.

While wildfires occurred during summer 2017, they mostly occurred during September, with wildfire smoke emissions strongly influencing ozone concentrations, as suggested by an examination of satellite imagery from the Hazard Mapping System (HMS), O3 and PM2.5 trends and backtrajectory wind analysis (Figure 5). MDA8 O3 concentrations ranged between 71-82 ppb at Bountiful station during September 2-6 when wildfires were observed and O3 exceedances were measured. PM2.5 concentrations also increased during the same time period, reaching average daily levels as high as 43 ug/m3 at that location. Since exceedances in September are most likely largely driven by wildfire emissions, the month of September is excluded from the modeling episode. Moreover, since most exceedances occurred in July, June and August are also excluded.

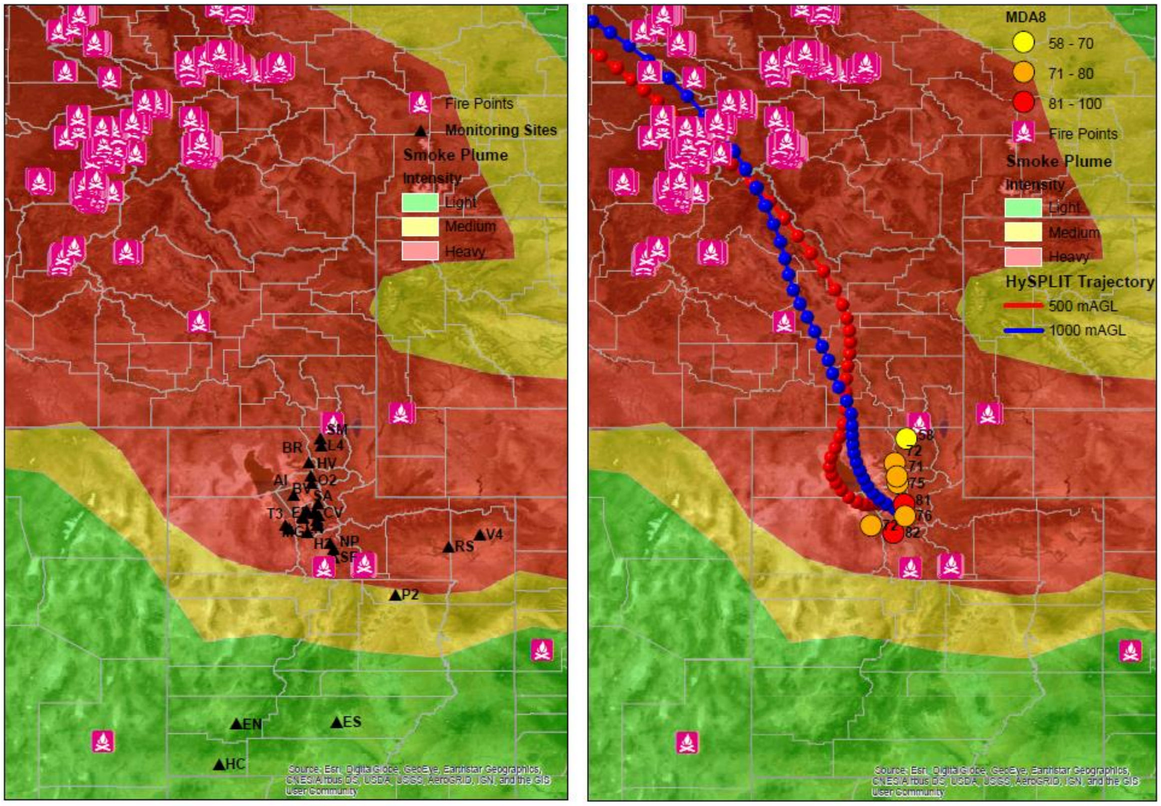

Figure 6. Fire locations, smoke plume intensity, backtrajectories and maximum daily 8-hr average (MDA8) ozone concentration on September 6 2017.

Furthermore, hourly ozone concentrations at receptor sites within the non-attainment area varied from low to high concentrations, which will help evaluate how well the model replicates both high and low ozone concentration days. This 2017 episode also corresponds to a year with the most recent currently available NEI. Routine air quality and meteorological data are also available for 2017, with this year being representative of typical conditions conducive to ozone formation. A detailed examination of synoptic patterns (report attached) during the selected period showed that the majority of ozone exceedance days are characterized by an upper level high pressure system that brings warm temperatures, lack of frontal passage, low surface winds and increased solar radiation; all of which are conducive to the build-up of O3 and its precursors. While wildfire events occurred during July 2017, an examination of hourly PM2.5 concentrations (Figure 6) suggests that their influence on local O3 concentrations was not significant. With the exception of July 4-5, daily average PM2.5 concentrations on exceedance days were less than monthly average + 1 standard deviation July concentrations. GEOS-Chem boundary conditions through Ramboll via contract with the Western States Air Resources Council (WESTAR) are also available for this year.

Modeling Year Selection and Justification

2017 was selected as the modeling year. This year corresponds to the modeling episode and is part of recent base year ozone design value calculations used for determination of non-attainment area classification.

Episodic Modeling Justification

Ozone exceedance events in the northern Wasatch Front NAA are associated with specific conditions including the presence of an upper level high pressure system, increased solar radiation, low surface winds, thermally-driven flows and lack of frontal passage. Compared with the rest of the calendar year, days affected by these conditions are relatively infrequent. Episodic modeling allows us to focus on model performance during these events. It is also computationally more efficient to concentrate on modeling these episodes. The time and effort saved allows us to make rapid improvements to our modeling platform and to conduct sensitivity simulations that help inform how the model is performing.

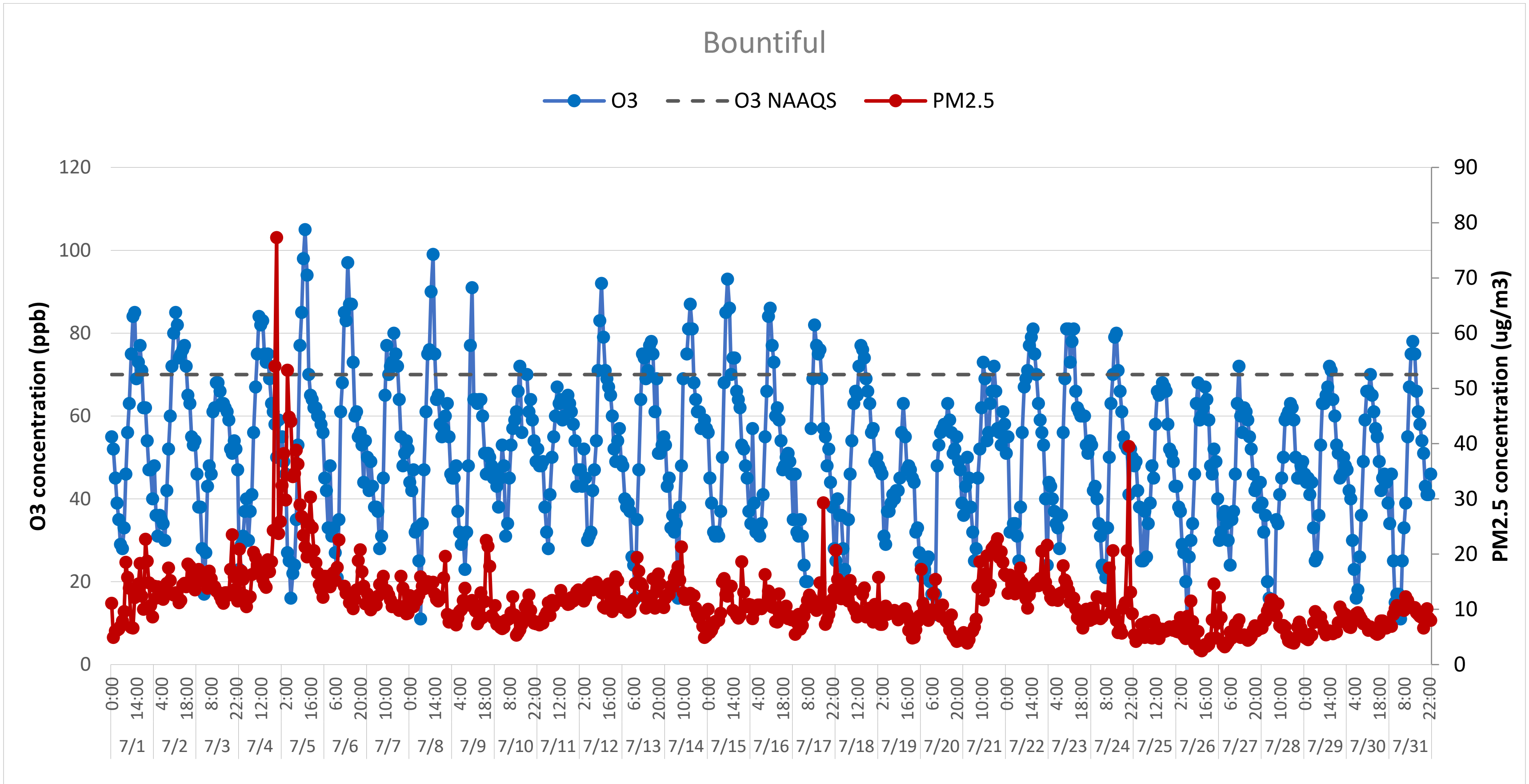

Figure 7. Hourly O3 and PM2.5 concentrations at Bountiful monitoring station during July 2017

Emission Inventories

Emissions Inventory Datasets

All emissions US data are sourced from the 2017 (National Emissions Inventory) NEI as part of the EPA 2017 modeling platform. International emissions from Canada and Mexico are sourced from the EPA 2017 platform.

Emissions Development

Table 5. Spatial and temporal resolution for SMOKE platform sectors, and plume rise calculations.

2017 Platform sector	***Sector description***	***Domain***	***Spatial***	***Inventory resolution***	***Plume rise***
afdust_adj	Met.-adjusted area fugitive dust emissions	12, 4 km	Surrogates	annual	
ag	Agricultural emissions (primarily ammonia)	12, 4 km	Surrogates	annual	
airports	Point source aircraft	*NA**	Point	annual	none
beis	Biogenic emissions based on the BEIS model	12, 4 km	Pre-gridded land use	computed hourly	
cmv_c1c2	C1&C2 Commercial marine vessels	*NA**	Point	hourly	in-line**
cmv_c3	Category 3 (large) Commercial Marine Vessels as points	*NA**	Point	hourly	in-line**
nonpt	Nonpoint sources not in other nonpoint sectors	12, 4 km	Surrogates & area-to-point	annual	
nonroad	Mobile sources that do not drive on roads or railroads, including recreational pleasurecraft	12, 4 km	Surrogates	monthly	
np_oilgas	Nonpoint oil and gas production-related sources	12, 4 km	Surrogates	annual	
onroad	Onroad mobile source gasoline and diesel vehicles from parking lots and moving vehicles	12, 4 km	Surrogates	monthly activity, computed hourly	
onroad_can	Onroad mobile sources for Canada (was othon)	12 km	Surrogates	monthly	
onroad_mex	Onroad mobile sources for Mexico (was othon)	12 km	Surrogates	monthly	
othafdust_adj	Non-US area fugitive dust sources (Canada only)	12, 4 km	Surrogates	annual	
othptdust_adj	Non-US point fugitive dust sources (Canada only)	12, 4 km	Point	monthly	none
othar	Non-US area (i.e., nonpoint) sources	12 km	Surrogates	annual & monthly	

othpt	Non-US point sources	12 km	Point	annual & monthly	in-line**
ptagfire	Point source day-specific agricultural fires (was agfire)	12, 4 km	Point	daily	in-line**
pt_oilgas	Point sources related to oil and gas production	*NA**	Point	annual	in-line**
ptegu	Point sources that are Electric generating units (EGUs)	*NA**	Point	daily & hourly	in-line**
ptfire	Point source day-specific wild and prescribed fires	12, 4 km	Point	daily	in-line**
ptfire_othna	Non-US point source day-specific fires in North America	12 km	Point	daily	in-line**
ptnonipm	Point sources that are not EGUs nor related to oil and gas	*NA**	Point	annual	in-line**
rail	Locomotive sources on railroads	12, 4 km	Surrogates	annual	

**Point source sectors are not gridded. Point source sectors are applicable to all modeling domains regardless of grid resolution, with the exclusion of point source fires. Fires are processed as 3D gridded emissions in SMOKE.*
***The term "in-line" means that the plume rise calculations are done inside of the air quality model instead of being computed by SMOKE.*

Point Source Emissions

The term "in-line" means that the plume rise calculations are done inside of the air quality model instead of being computed by SMOKE. Point sources were processed for the EPA 2017 platform, and post-SMOKE outputs are located in the CMAS Data Warehouse[17]. Point sources are not grid-specific (they are spatially allocated according to their specific latitude-longitude coordinates. Therefore, this modeling demonstration uses the post-SMOKE point source files from the CMAS Data Warehouse directly, and any point sources located outside of our 12km or 4km domains will not be processed.

The EPA 2017 platform was prepared for air quality modeling in CMAQ. Post-SMOKE point sources are processed through the CMAQ to CAMx conversion script provided by EPA.

2D Merged Emissions (12km domain only)

All 2D low-level emissions for the 12km domain are sourced from the 2017 platform post-SMOKE data files available on the CMAS Data Warehouse. The premerged 2D emissions include the following sectors: area fugitive dust (met adjusted, US and Canada), point fugitive dust (Canada only), agriculture, nonpoint, nonpoint oil and gas, nonpoint rail, nonpoint airports, non-US area, and on-road mobile (US, Canada, and Mexico).

[17] https://dataverse.unc.edu/dataset.xhtml?persistentId=doi:10.15139/S3/TCR6BB

2D premerged emissions are gridded to the EPA 12US1 domain. This modeling demonstration uses the 12UDAQ domain, which is keyed to the 12US1 domain. For this reason, 2D emissions are "windowed" from the 12US1 to the 12UDAQ domain, meaning that any grid cells outside the 12UDAQ domain are dropped from the post-SMOKE output file. Following windowing, 2D emissions files are converted to CAMx format.

This preparation of emissions only applies to 12km resolution emissions. The EPA 2017 platform does not provide 4km resolution emissions output. The following sections describe how 4km emissions are generated for this modeling demonstration.

On-road Mobile Source Emissions (4km domain only)

On-road emissions for the 4km domain are calculated in SMOKE-MOVES using inputs and scripts made available in the EPA 2017 platform. No Utah-specific MOVES data are leveraged in this demonstration. 4km resolution on-road emissions rely on Utah's in-house meteorological inputs (MCIP), while 12km on-road emissions were generated by EPA using their MCIP files for the region and time period. Because MOVES requires only temperature and relative humidity data from the meteorological input files, UDAQ does not expect a significant deviation of on-road mobile emissions between the 4 and 12km domains.

SMOKE-MOVES relies on the selection of representative counties to improve model run times (find a national map here on page 6-18). The figure below shows EPA's selection of representative counties for all counties in the 4km domain.

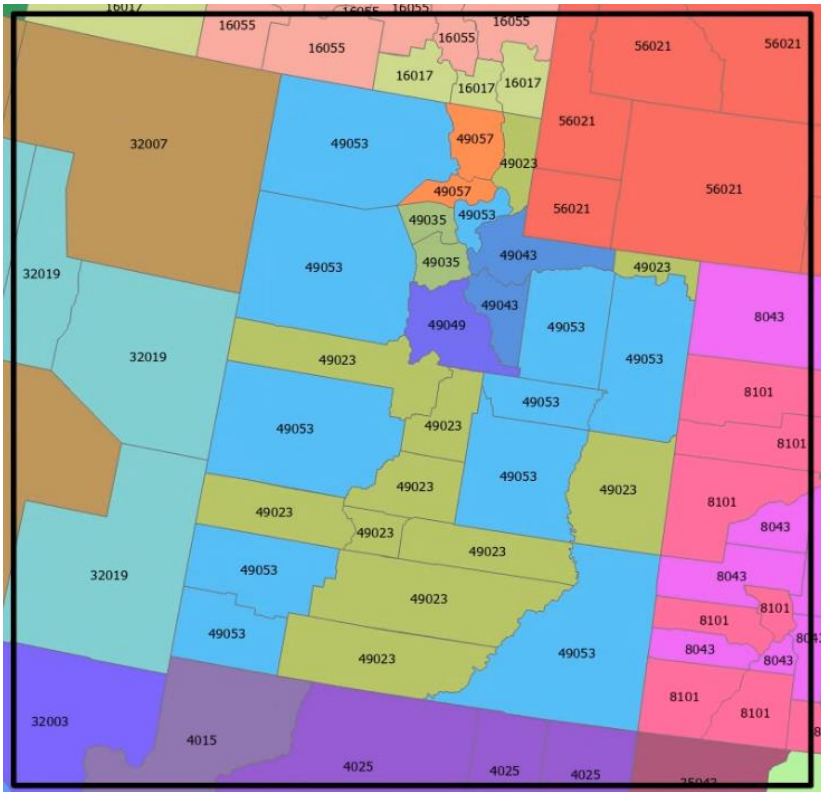

Figure 8. Representative counties for SMOKE-MOVES application

Area and non-Road Source Emissions (4km domain only)

Area and non-Road sectors processed for the 4km domain include: area fugitive dust (met adjusted, US), agriculture, nonpoint, nonpoint oil and gas, nonpoint rail, nonpoint airports, and nonroad. The 4km domain does not extend into Canada or Mexico, so only US sectors are processed here. All emissions inputs are from the 2017 NEI.

Biogenic Emissions

Biogenic emissions for the 12km domain are sourced from the 2017 EPA platform post-SMOKE outputs and then converted to CAMx format.

Biogenic emissions for the 4km domain are generated in SMOKE. First, land use data from the Biogenic Emissions Landuse Database version 5 (BELD5) are gridded for our 4km domain. Then the BELD file is adjusted to improve inland water coverage according to our WRF land use extents. Second, a biogenic season file (BIOSEASON) is generated to describe the length of growing seasons across the 4km domain and our modeling episode. BEIS 3.7 is run with the BELD and

BIOSEASON inputs, resulting in 4km resolution biogenic emissions. These emissions are converted to CAMx format.

Wildfires, Prescribed Burns, Agricultural Burns

Wildland fires and prescribed burns in 2017 are collected through SMARTFIRE2, a GIS based tool that reconciles fire data from the several sources below to identify a latitude/longitude coordinate where the fire originated, and the daily burn acreage.

Inputs to SMARTFIRE for 2017[18] include:

- The National Oceanic and Atmospheric Administration's (NOAA's) Hazard Mapping System (HMS) fire location information
- GeoMAC (Geospatial Multi-Agency Coordination), an online wildfire mapping application designed for fire managers to access maps of current fire locations and perimeters in the United States
- The Incident Status Summary, also known as the "ICS-209", used for reporting specific information on fire incidents of significance
- Incident reports including dates of fire activity, acres burned, and fire locations from the National Association of State Foresters (NASF)
- Hazardous fuel treatment reduction polygons for prescribed burns from the Forest Service Activity Tracking System (FACTS)
- Fire activity on federal lands from the United States Fish and Wildlife Service (USFWS)
- Wildfire and prescribed date, location, and locations from S/L/T activity submitters

Agricultural burns are sourced only from NOAA's HMS. Emissions from agricultural burns only occur during daylight hours.

Fire emissions are calculated in SMOKE within the BlueSky Framework[19]. The framework includes fuel characteristics and fire emission factors in the Fire Emissions Production Simulator. Each fire input into the framework includes its location, dates, type, and size.

QA/QC of Model-Ready Emissions

Quality assurance and quality control (QA/QC) procedures for emissions output vary slightly between the 12km and 4km domains. Because most of the 12km emissions output are sourced directly from EPA 2017 platform post-SMOKE files, QA/QC consists solely of visual inspection

[18] 2017 Platform TSD, page 24: https://www.epa.gov/sites/production/files/2020-11/documents/2017_emissionschapter.pdf

[19] BlueSky Framework, Figure 3-2, page 25 https://www.epa.gov/sites/production/files/2020-11/documents/2017_emissionschapter.pdf

of emissions files in VERDI. Emissions files are windowed to the 12km domain and temporal profiles are applied correctly. All CB6 species are present.

QA/QC of point sources does not occur during the emissions processing phase. Point sources for the demonstration are sourced directly from EPA 2017 platform post-SMOKE files and converted to CAMx format, so QA/QC of these sources will occur during CAMx QA/QC procedures.

For 4km resolution emissions, UDAQ follows QA/QC procedures as recommended by EPA in their Emissions Inventory Preparation for Air Quality Modeling (Base Year) training[20].

Meteorological Model

Meteorological inputs for the 179b demonstration will be produced using the Weather Research and Forecasting Advanced Research model (WRF-AWR) version 4.2. WRF has been used successfully for previous modeling efforts in Utah, including the PM2.5 SIP for the Wasatch Front. WRF has been used on a regional and national scale for ozone nonattainment work. The WRF simulation will cover the time period of June 14th, 2017 at 12:00:00 UTC to August 2nd, 2017 at 00:00:00 UTC to generate adequate spin-up for the photochemical modeling.

Modeling Domains and Vertical Layer Configuration

The WRF model domains will be chosen to accommodate CAMx modeling domains keyed to the US1 12 km domain used by the EPA. The two one-way nested WRF domains are set to the Lambert Conformal Conic projection with horizontal resolution of 12 and 4 km, respectively (Figure 8). Each domain will have 44 vertical levels which are identical to the EPA ORD 108km hemispheric modeling configuration.

[20] QA/QC: slides 69, 82, 94, 140, 143
https://gaftp.epa.gov/Air/emismod/training/BaseYearEmisInvsForModelingTraining_07292019.pptx

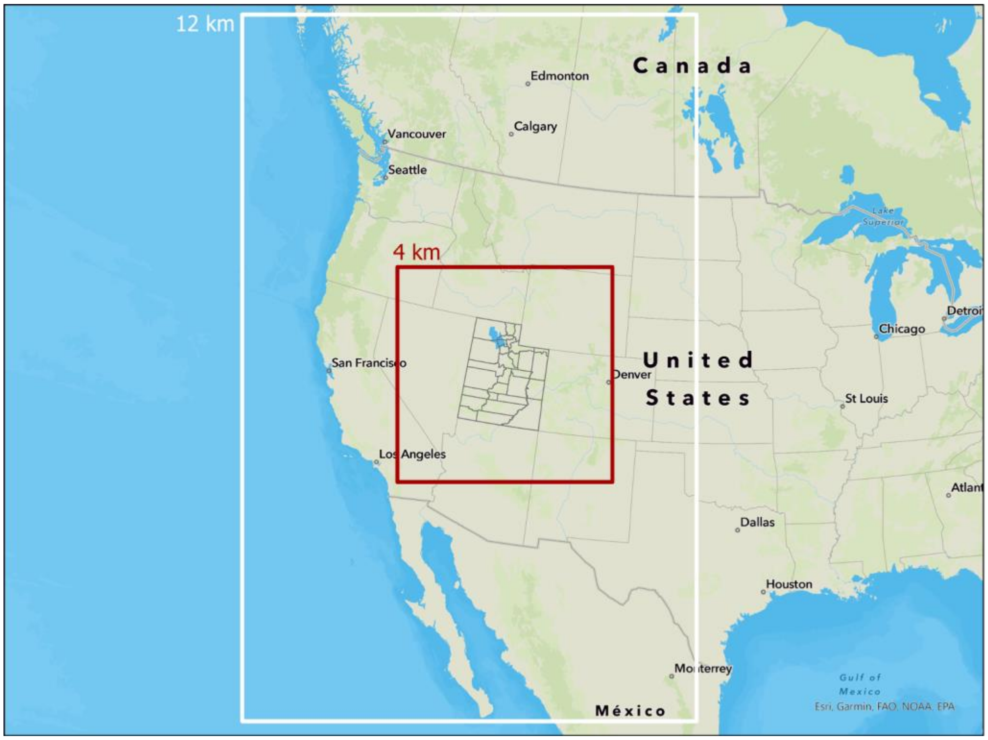

Figure 9. WRF modeling domains

Model Inputs and Settings

Atmospheric Data Inputs

We will use the NCEP North American Mesoscale (NAM) 12 km analysis data (ds609)[21] to inform the boundary conditions of the outermost (12 km) modeling domain and to initialize the innermost domain. Analysis data will be used in 6-hour time intervals throughout the duration of the simulation.

Topographic Data Inputs

WRF will be run using the default MODIS-derived 21 category land use datasets at 30 and 15-arcsecond resolution for the 12 and 4 km domains, respectively.

[21] National Centers for Environmental Prediction/National Weather Service/NOAA/U.S. Department of Commerce. 2015, updated daily. NCEP North American Mesoscale (NAM) 12 km Analysis. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. https://doi.org/10.5065/G4RC-1N91.

Land Use Edits of the Great Salt Lake

The MODIS 21-category land use datasets will be altered to better reflect the extent of the Great Salt Lake following the method established by Malia et al (2018)[22]. This method uses a GSL bathymetry dataset and buoy data to identify the extent of the lake and to better calculate the actual lake depth (instead of the single value used in the traditional MODIS dataset). Areas of the GSL basin that are classified as "lake" will be adjusted to reflect the characteristics of unvegetated salt flats. Better representation of GSL extent and depth also impacts atmospheric circulations like lake breezes[23], and should yield better meteorological model performance.

Model Configuration

WRF simulations for the modeling episode were run in five-and-a-half-day increments with the first 12-hours discarded as model spin-up.

Table 6. WRF domain configurations

Parameter	**D01**	**D02**
Grid size (x, y)	(287, 299)	(291, 291)
Vertical levels	44	44
Vertical coordinates	Hybrid vertical coordinate	Hybrid vertical coordinate
Horizontal resolution	12 km	4 km
Land use	MODIS + lakes	MODIS + lakes
IC/BC	NAM12km/NAM12km	NAM12km/D01

22 Mallia, D. V. (2018). *Simulating High Impact Wildfire and Wind-Blown Dust Events Using Improved Atmospheric Modeling Methods.* Ph.D. Dissertation. University of Utah. Available at: https://collections.lib.utah.edu/ark:/87278/s6pp4hgm

23 Blaylock, B. K., Horel, J. D., & Crosman, E. T. (2017). Impact of Lake Breezes on Summer Ozone Concentrations in the Salt Lake Valley, Journal of Applied Meteorology and Climatology, 56(2), 353-370. Retrieved Apr 29, 2021, from https://journals.ametsoc.org/view/journals/apme/56/2/jamc-d-16-0216.1.xml

Table 7. WRF physics options.

Physics Parameter	D01 (12 km)	D02 (4 km)
Microphysics	Thompson	Thompson
Longwave and shortwave radiation	RRTMG	RRTMG
Land Surface Model	Noah LSM	Noah LSM
Planetary Boundary Layer	MYNN	MYNN
Cumulus Parameterization	Kain-Fritsch	Kain-Fritsch
Analysis Nudging	T, P	None

Model Performance Evaluation

WRF outputs will be compared to observational data using the EPA-developed Atmospheric Model Evaluation Tool (AMET).

Observational Datasets

Meteorological observations of both surface sites and vertical soundings from the Salt Lake City airport will be downloaded from the MADIS data archive. Observed 2-meter temperature, wind direction and wind speed will be used to evaluate model performance on a monthly basis for the innermost domain.

Statistical Evaluation

Multiple statistical metrics will be considered to characterize the meteorological model performance. These include:

1. Mean bias (MB): This metric averages the model/observation residual paired in time and space.
2. Root Mean Square error (RMSE): This performance statistic is a measure of the average distance between predicted and observed values.

3. Normalized Mean Bias: This statistic (in units of percent) normalized MB to the average observed value.
4. Correlation Coefficient (R2): This performance statistic measures the degree to which the modeled and observed values are linearly related. A correlation coefficient of 1 indicates a perfect linear relationship; whereas a correlation coefficient of 0 means that there is no linear relationship between the variables.

In addition to the statistical tests, monthly time series of temperature, wind direction, wind speed, and relative humidity will also be generated. Analysis of additional meteorological variables will be added as needed.

Photochemical Model

Modeling Domains

The modeling domain will consist of a 4 km domain nested within a 12-km one. The 4-km domain covers the state of Utah and parts of neighboring states while the 12-km domain covers the Western United States. It is also aligned with EPA's 12US1 domain. Modeling will be performed using two-way nesting. The 12/4 km nested grid modeling domain configuration is shown in Figure 9. All 44 vertical layers defined in the meteorological model will be considered for modeling.

1.1 Model Inputs and Settings

The latest version 7.1 (v7.1) of CAMx will be used for this modeling demonstration.

Figure 10. CAMx domain configuration

Table 8. CAMx domain specification

Specification	12 km	4 km
dx x dy (m)	12,000	4,000
Southwest Corner X Coordinate (m)	-2,556,000	-1,644,000
Southwest Corner Y Coordinate (m)	-1,728,000	-312,000
# Columns	185	186
# Rows	299	180

Initial and Boundary Conditions

Initial and boundary conditions for the outermost domain (i.e. 12-km domain) will be derived from GEOS-Chem global chemistry model outputs for 2017, with the modeling being performed by Ramboll under contract with WESTAR. Two sets of initial and boundary conditions will be provided with one representing a baseline case that uses best estimates of global natural and anthropogenic emissions and another one representing a sensitivity scenario with all anthropogenic emissions outside the US set to zero. These boundary conditions will be used to support two corresponding CAMx simulations (base and sensitivity case), which will be used to estimate the contribution of international emissions to local ozone concentrations.

Other Model Settings

A summary of model settings is provided in Table 8. Sea salt and lightning NOx emissions will also be calculated in CAMx by running the corresponding CAMx tools.

Table 9. CAMx Settings and Configuration

Horizontal Grid Mesh	12/4-km
12 km	185 x 299 cells
4 km	186 x 180 cells
Vertical Grid Mesh	44 vertical layers, as defined by WRF
Grid Interaction	Two-way nesting
Gas-phase Chemistry	cb6r5
Horizontal Diffusion	Spatially varying
Vertical Diffusion	CMAQ-like Kv
Dry Deposition	Zhang dry deposition scheme
Wet Deposition	CAMx-specific formulation
Gas Phase Chemistry Solver	Euler Backward Iterative(EBI)
Vertical Advection Scheme	Implicit scheme w/ vertical velocity update
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme

Model Performance Evaluation

Ambient Measurements Datasets

Gaseous data collected at UDAQ ambient air monitoring networks will be used for model performance evaluation. These include typical ground-based surface measurements: ozone, NO2, NOx and CO. While limited, VOCs measurements will also be used where available. Measurements collected during special field studies will also be used for model performance evaluation. These include ozone measurements collected during summer 2015 around the Great Salt Lake[24].

[24] 2015 Summer Ozone Study. https://deq.utah.gov/air-quality/great-salt-lake-summer-ozone-study

Operational Evaluation

The Operational Evaluation compares the modeled concentration estimates against concurrent observations using statistical and graphical analysis aimed at determining how well the model simulates the base year observed concentrations. The Atmospheric Model Evaluation Tool (AMET) will be used for this purpose. Spatial visualization tools (VERDI) will be used as necessary.

Statistical Benchmarks and Metrics

Multiple statistical metrics will be considered to characterize the photochemical model performance. These include:

1. Mean bias (MB): This metric averages the model/observation residual paired in time and space.
2. Mean gross error (MGE): This performance statistic averages the absolute value of the model/observation residual paired in time and space.
3. Root Mean Square error (RMSE): This performance statistic is a measure of the average distance between predicted and observed values.
4. Normalized Mean Bias: This statistic (in units of percent) normalized MB to the average observed value.
5. Normalized Mean Error (NME): This performance statistic (in units of percent) is used to normalize the mean error relative to the average observation. This statistic averages the absolute value of the difference (model - observed) over the sum of observed values.
6. (Mean) Fractional Bias (MFB/FB): Fractional bias is determined by normalizing the MB by the average of observed and modeled concentrations.
7. (Mean) Fractional Error (MFE/FE): Fractional error is determined by normalizing the ME by the average of observed and modeled concentrations.
8. Correlation Coefficient (R2): This performance statistic measures the degree to which the modeled and observed values are linearly related. A correlation coefficient of 1 indicates a perfect linear relationship; whereas a correlation coefficient of 0 means that there is no linear relationship between the variables.

In addition to using statistical summaries, the model performance will be evaluated using graphical displays. These include:

1. Time series plots of modeled and observed concentrations at each site
2. Scatter plots of modeled and observed concentrations at each site
3. Soccer plots with purpose to visualize model performance of both bias and error on a single plot
4. Bugle plots

Model performance will be evaluated at individual monitors within the non-attainment area. Model predictions from spin-up days will be excluded from the model performance evaluation analysis. Ozone exceedance and non-exceedance days will also be evaluated separately.

Diagnostic Evaluation

The diagnostic evaluation evaluates various components of the modeling system and focuses on process-oriented evaluation. Indicator ratios and emissions sensitivity simulations will be examined to assess whether the system is NOx-limited or NOx-saturated. Emissions perturbations will also help assess the model's response to changes in emissions inputs from specific source categories.

Quantification of International Anthropogenic Source Contributions

Sensitivity Analysis

To estimate the contribution of international emissions to local ozone concentrations, two simulations will be conducted. These consist of a 2017 base case that includes all emissions and a 2017 case with no international anthropogenic emissions. In the latter scenario, referred to as Zero Out of the Rest of the World or ZROW, anthropogenic emissions from sources outside of the US are eliminated. Contributions of international emissions to ozone concentrations in the non-attainment area are then estimated as the differences in ozone contributions from the two simulations.

Design Value Scaling Approach

Following EPA's modeling guidance for SIP demonstrations, the contribution of international anthropogenic emission sources to local ozone concentrations will be assessed by scaling the DV at each monitoring site by a relative response factor (RRF), defined as the ratio of modeled ozone from the sensitivity case to the baseline case. EPA's Software for the Modeled Attainment Test – Community Edition (SMAT-CE) software[25] will be used for this purpose. Gridded MDA8 ozone concentrations over the modeling episode will be provided to SMAT-CE, which will identify the grid cells containing monitor locations within the NAA and will calculate a site-specific relative response. A site-specific RRF, defined as the ratio of average MDA8 ozone in the ZROW case to the average MDA8 in the base case over select modeled high ozone days, will be calculated. For each site, the RRF will then be applied to the DV to yield the adjusted DV for the ZROW scenario:

$$DV_{scaled} = DV_{monitored} \times \frac{\bar{C}_{ZROW}}{\bar{C}_{base}}$$

[25] EPA, 2020. Photochemical Modeling Tools: SMAT-CE website. https://www.epa.gov/scram/photochemical-modeling-tools.

Data Storage and Archiving Plan

All completed modeling runs will be stored on UDAQ's private group space on the University of Utah's Center for High Performance Computing clusters. A detailed model performance evaluation will also be provided for each of the CAMx and WRF model runs. A model performance evaluation report for the GEOS-Chem runs, submitted by Ramboll, will also be included with the submission.