

Utah Division of Air Quality

Smoke from August 2015 Western Wildfires Exceptional Events

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Introduction

The Code of Federal Regulations (CFR) provides the definition and criteria for determining whether air quality data is impacted by an exceptional event. The 40 CFR 50.1(j) definition states that “exceptional event means an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event.” The demonstration to justify data exclusion as outlined in 40 CFR 50.14(c)(3)(iv-v) specifies that evidence must be provided that:

1. The event meets the definition of an exceptional event;
2. The event is associated with a measured concentration in excess of normal historical fluctuations, including background;
3. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected air quality in the area;
4. There would have been no exceedance or violation but for the event; and
5. The demonstration must include a public comment process and documentation of such to the Environmental Protection Agency (EPA).

This report provides documentation that the PM_{2.5} violations that occurred in August, 2015 were the result of exceptional events and that these events meet the criteria for data exclusion under the Exceptional Events Rule, as described above. The violations were a direct result from smoke from western regional wildfires caused by natural events that occurred outside of Utah jurisdictional boundaries thus, were not reasonably controllable or preventable.

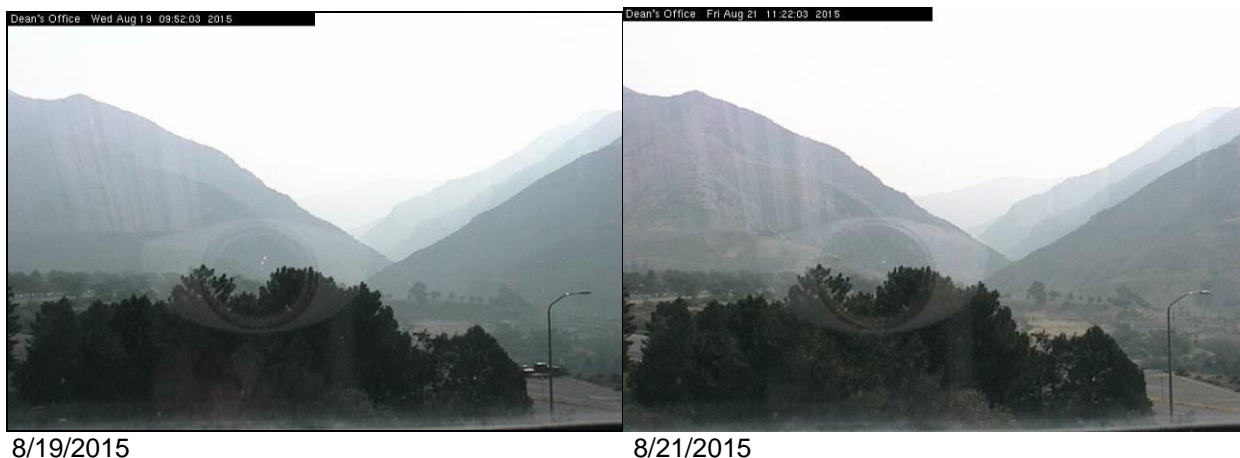
Event Description

Excessive hot and dry conditions across western states lead 2015 to be another severe wildfire year. Wildfire smoke was visible in portions of the Wasatch Front and Cache Valley starting on August 16, 2015.

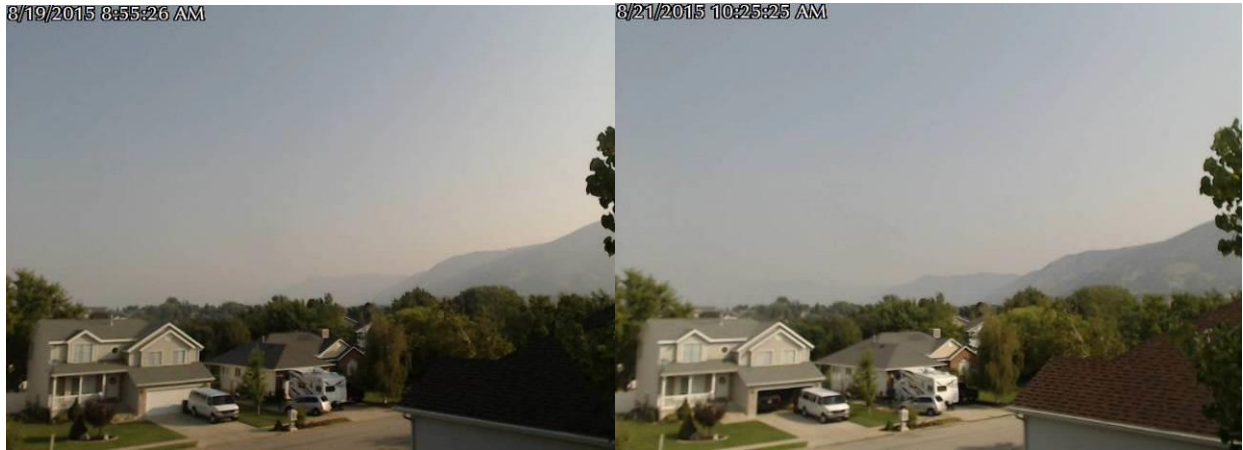


On August 18, 2015, the National Weather Service (NWS) stated that “large fires in Washington, Oregon, Idaho and Montana, combined with northwest flow has made the skies hazy across Utah and Colorado.” Approximately 70 wildfires were burning during this event period in the western states. The National Interagency Fire Center reported on August 23, 2015 that over a million acres had burned.

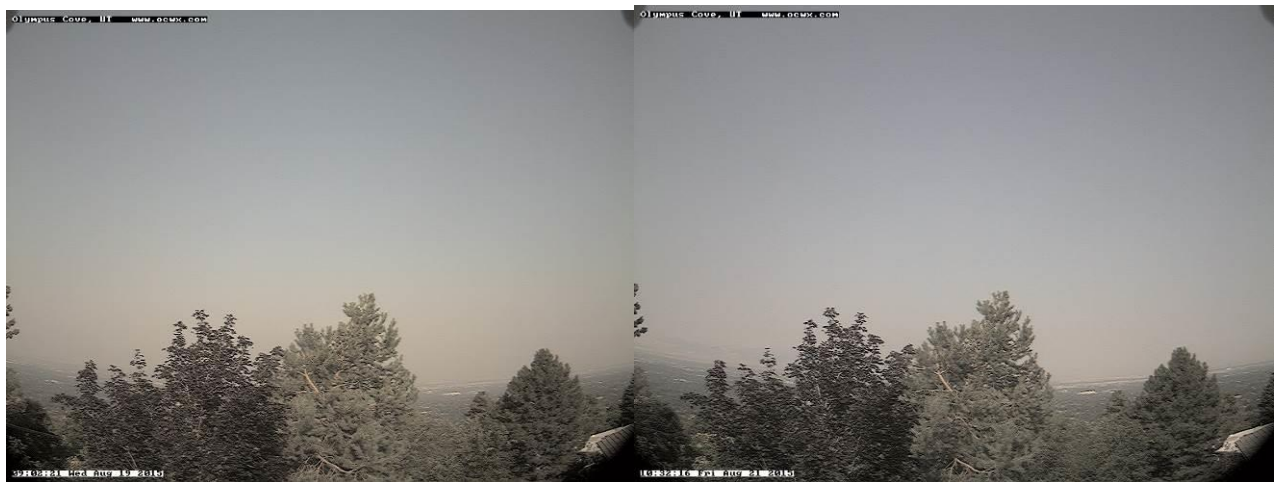
Persistent smoke in Logan Canyon can be seen from these photos taken on August 19 and 21.



Photos taken in South Ogden on the 19th and 21st, similarly show persistent smoke.



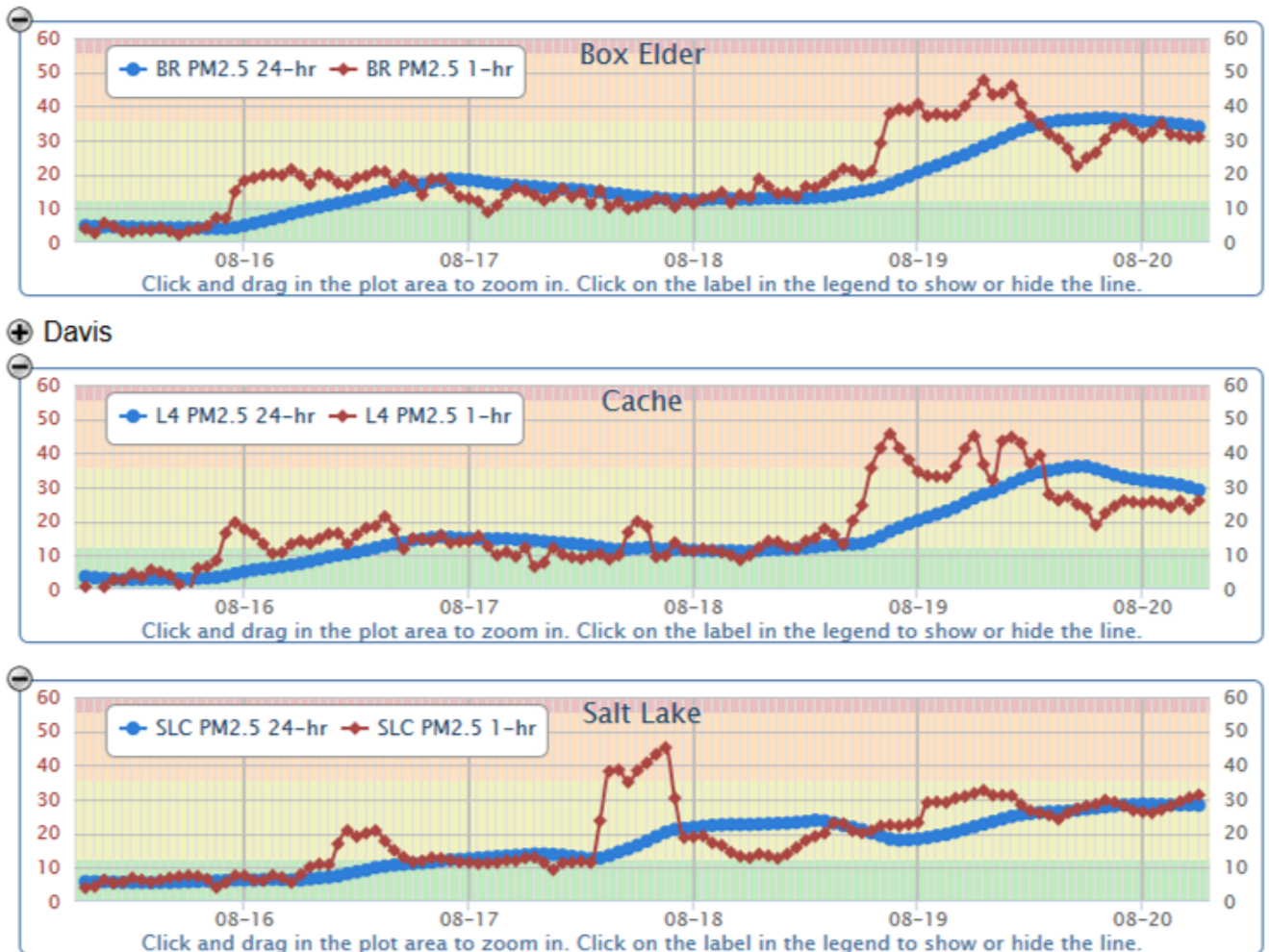
The following photos taken from Olympos Cove show the presence of smoke in the Salt Lake Valley on the 19th and 21st.

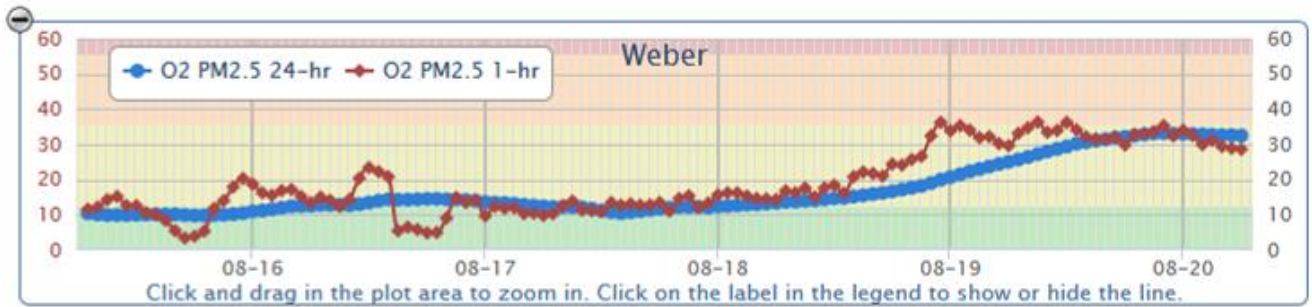


Air Quality Impact

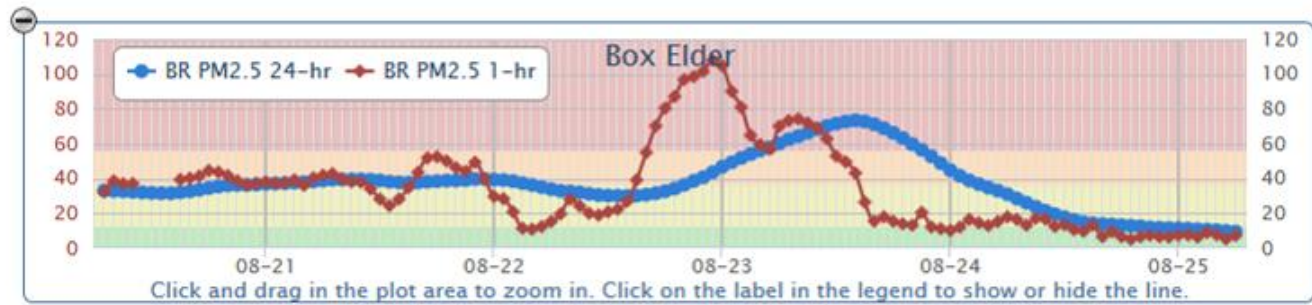
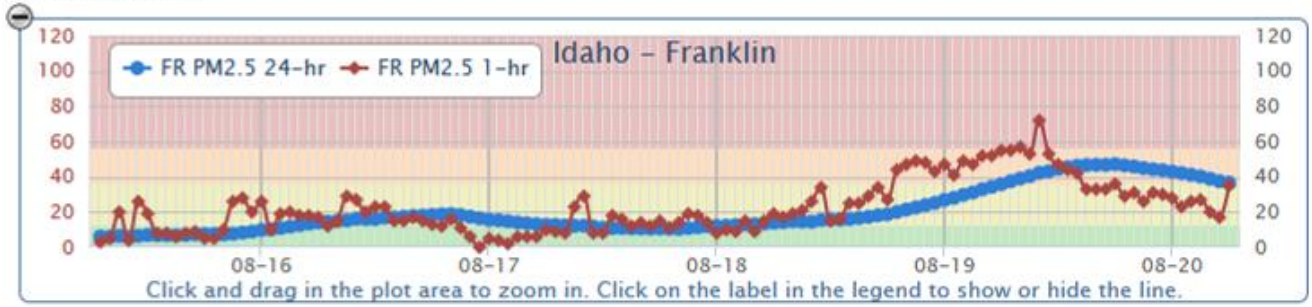
Wildfire smoke arrived in Utah on the 17th. The trend charts show low PM_{2.5} values on the 16th, with creeping values on the 17th.

Smoke dispersion was hampered by low to stagnant wind conditions from the 16th to the 22nd. A shift in the upper atmospheric wind patterns late on the 23rd reduced incoming smoke. Some localized surface winds on the 23rd also helped disperse resident smoke.

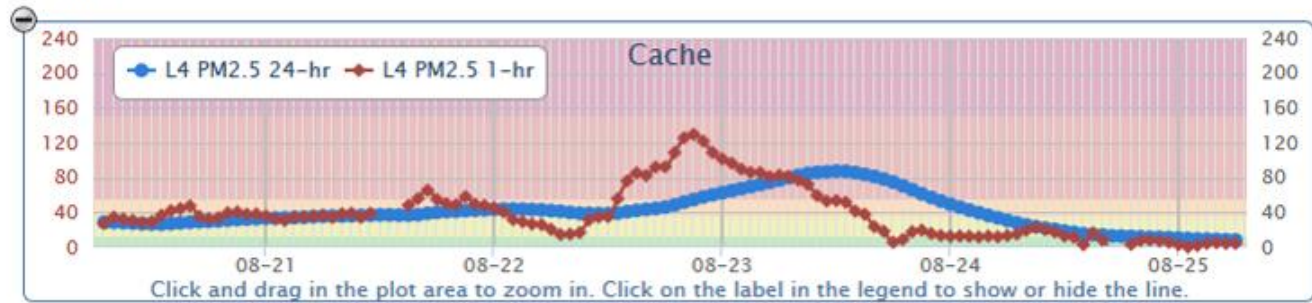


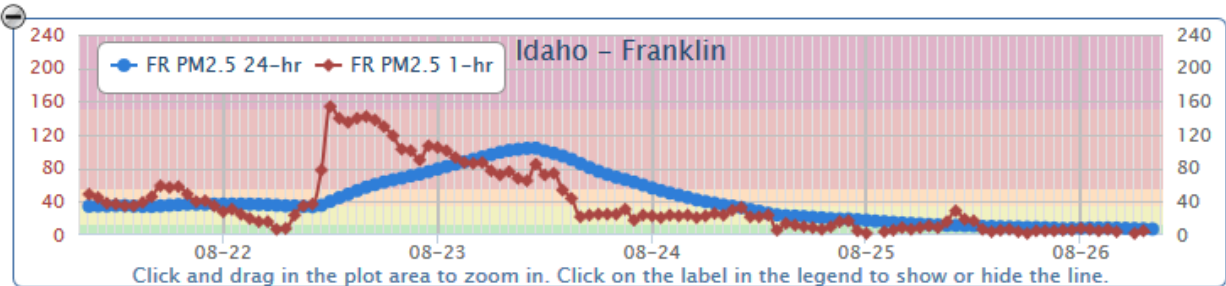


⊕ Duchesne
 ⊕ Washington



⊕ Davis





The PM_{2.5} standard of 35 µg/m³ is based on a 24-hr average. This exceedance can occur by averaging hourly data over 24-hours or by measuring the PM_{2.5} on a filter that operated over a 24-hour period.

The following northern stations contain hourly PM_{2.5} monitors where exceedances of the PM_{2.5} standard occurred: Logan and Ogden.

The following norther stations contain 24-hour filters where exceedances of PM_{2.5} standard occurred: Brigham City, Logan, co-located monitor at Logan, Smithfield and its co-located monitor.

Exceedances are presented for both measurement types.

Brigham City Monitoring Station (BR)

Date	24-hour Filter (µg/m ³)
8/22/2015	43.5

Smithfield (SM) and Co-located Monitor (SX)

Date	L4 24-hour Filter (µg/m ³)	X4 24-hour Filter (µg/m ³)
8/21/2015	38	-
8/22/2015	66.7	66.5
8/23/2015	42.9	-

Logan Monitoring Station (L4) and Co-located Monitor (X4)

Date	L4 Hourly 24-hour Average ($\mu\text{g}/\text{m}^3$)	L4 24-hour Filter ($\mu\text{g}/\text{m}^3$)	X4 24-hour Filter ($\mu\text{g}/\text{m}^3$)
8/21/2015	43.7	40.4	-
8/22/2015	62.9	59.3	59.7
8/23/2015	49.6	45.3	-

Site: Logan			
Units	UG/M3		
Date	21-Aug	22-Aug	23-Aug
Hour			
0:00	32.9	40.9	96.8
1:00	31	32	90.2
2:00	34.7	29.5	86.2
3:00	34.7	26.9	86
4:00	35.6	26.2	81.1
5:00	36.8	20.8	82.9
6:00	34.6	14.9	81.6
7:00	38.4	15.2	77.2
8:00	39.2	17.1	72.4
9:00	34.5	31.8	59.5
10:00	39.2	34.9	53.2
11:00	<	35.3	53.9
12:00	<	56	51.9
13:00	<	76.5	41.7
14:00	48.5	85.7	38
15:00	56.2	82.6	24.1
16:00	65.7	92.4	18.6
17:00	55.2	92.6	6
18:00	50.4	109.1	9.1
19:00	49.1	125.9	18.1
20:00	58.4	129.9	20
21:00	49.6	122	15.9
22:00	48.4	109.1	13.7
23:00	45.2	101.6	12.8
Avg	43.7	62.9	49.6

Ogden Monitoring Station (O2)

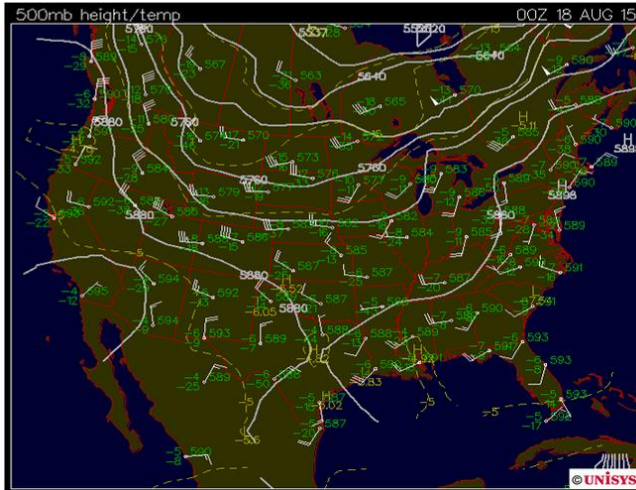
Date	Hourly 24-hour Average ($\mu\text{g}/\text{m}^3$)
8/20/2015	39.2
8/21/2015	35.3

Site: Ogden		
Units	UG/M3	
Date	20-Aug	21-Aug
Hour		
0:00	32.6	47.8
1:00	29.9	39.8
2:00	31.1	37
3:00	29.4	36
4:00	28.9	32.5
5:00	28.6	33.3
6:00	31.2	34.9
7:00	31.6	34.8
8:00	32.7	32.9
9:00	33.1	32.3
10:00	<	24.4
11:00	<	23.8
12:00	B	21
13:00	41.6	27.6
14:00	49.2	35.3
15:00	51.8	35.2
16:00	50.8	35.2
17:00	46.8	35.2
18:00	42.7	39.5
19:00	42.9	39.8
20:00	44.8	41.9
21:00	47.6	41.9
22:00	44	44.5
23:00	52.2	40.6
Avg	39.2	35.3

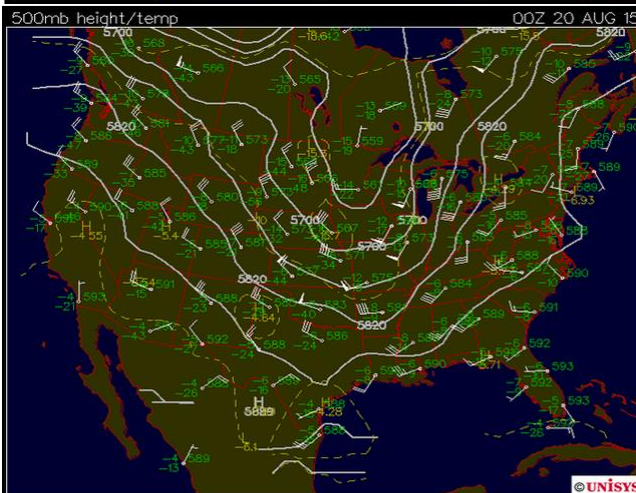
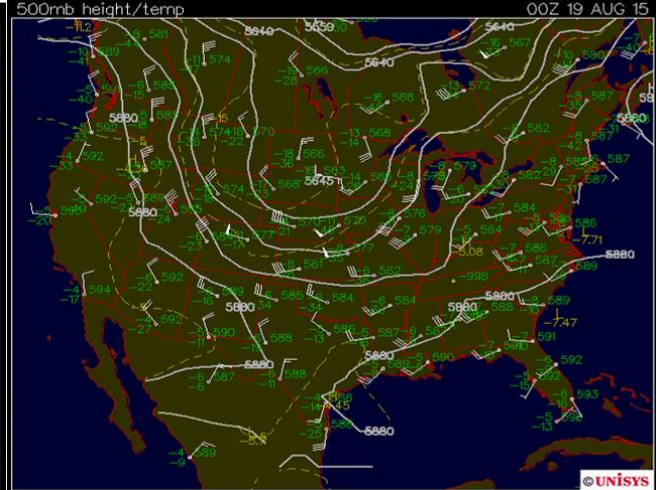
Meteorology

The 500 MB constant pressure analysis illustrates the mid-level wind flow patterns. The contour lines on the 18th indicate smoke flow patterns were predominately from Idaho, Oregon and Washington to northern Utah. The same general flow pattern continued through the 20th.

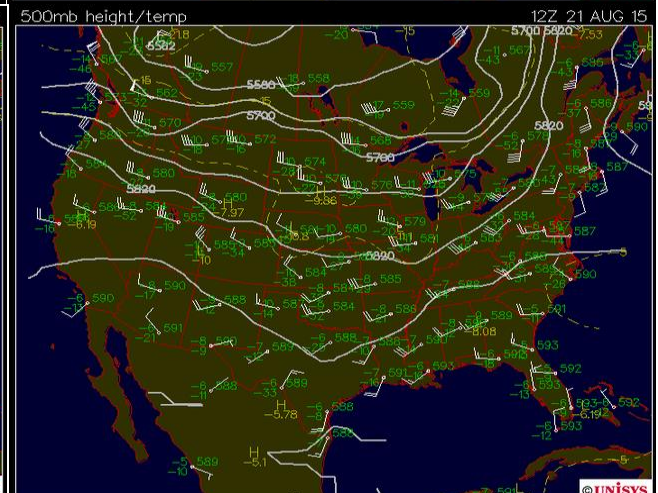
August 18, 2015



August 19, 2015



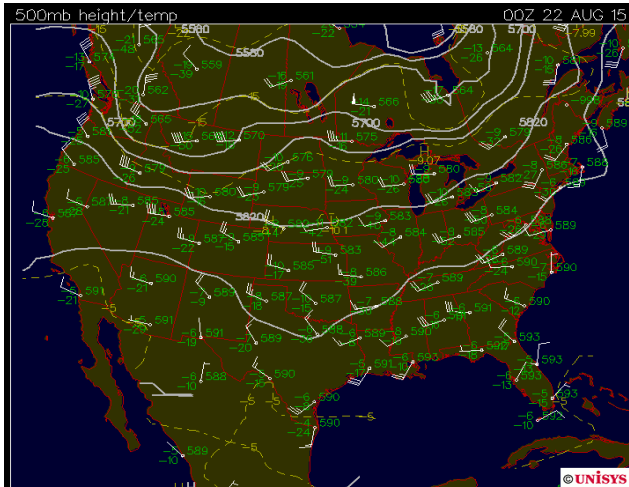
August 20, 2015



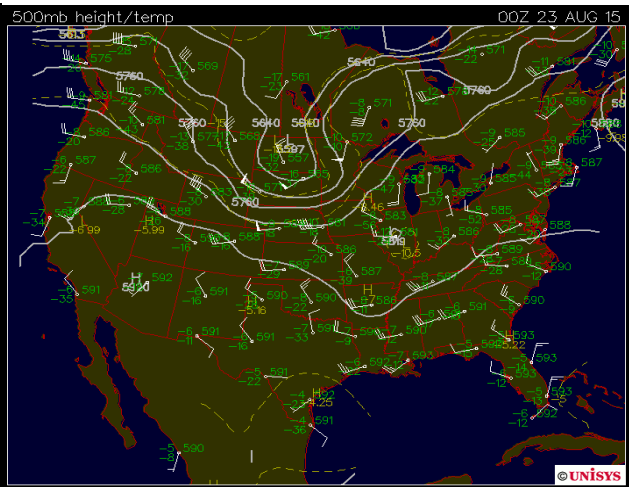
August 21, 2015

A pattern change began on the 21st and 22nd, with the approach of a trough from the northwest. As the trough moved in, the heights began to move south, creating a zonal flow pattern over the west. This pattern moved smoke more from the northern California fires to northern Utah. Progression of the trough inland was followed by rising heights along the west coast, with ridging driving the flow pattern more southeasterly (creating a funneling effect). This caused smoke patterns to drive towards northern Utah from California, Oregon, Washington and Idaho. The same funneling affect can be observed on the contour map for the 23rd.

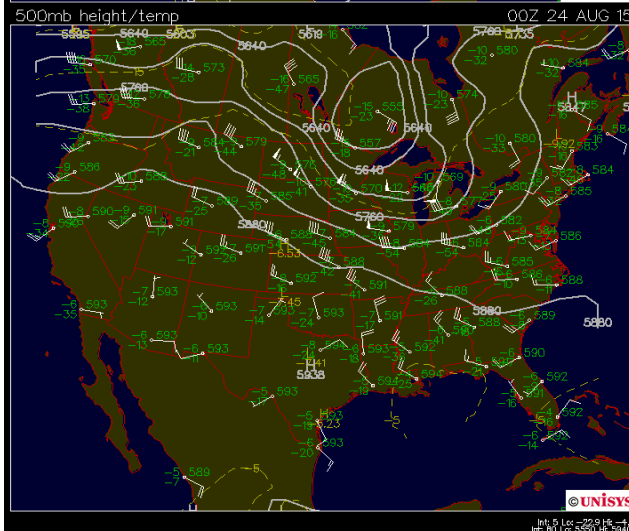
August 22, 2015



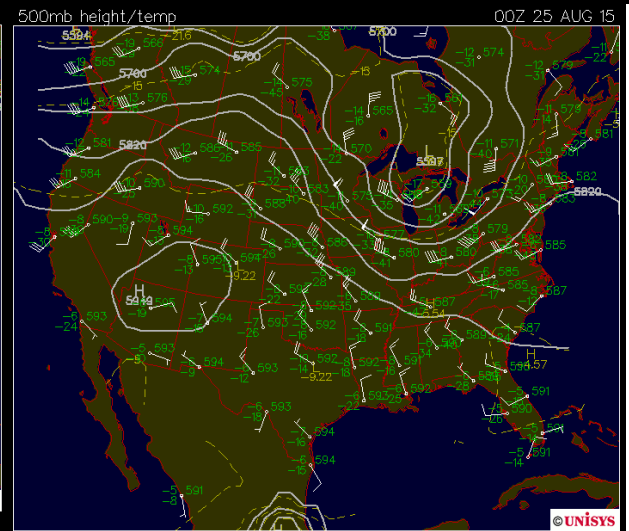
August 23, 2015



August 24, 2015

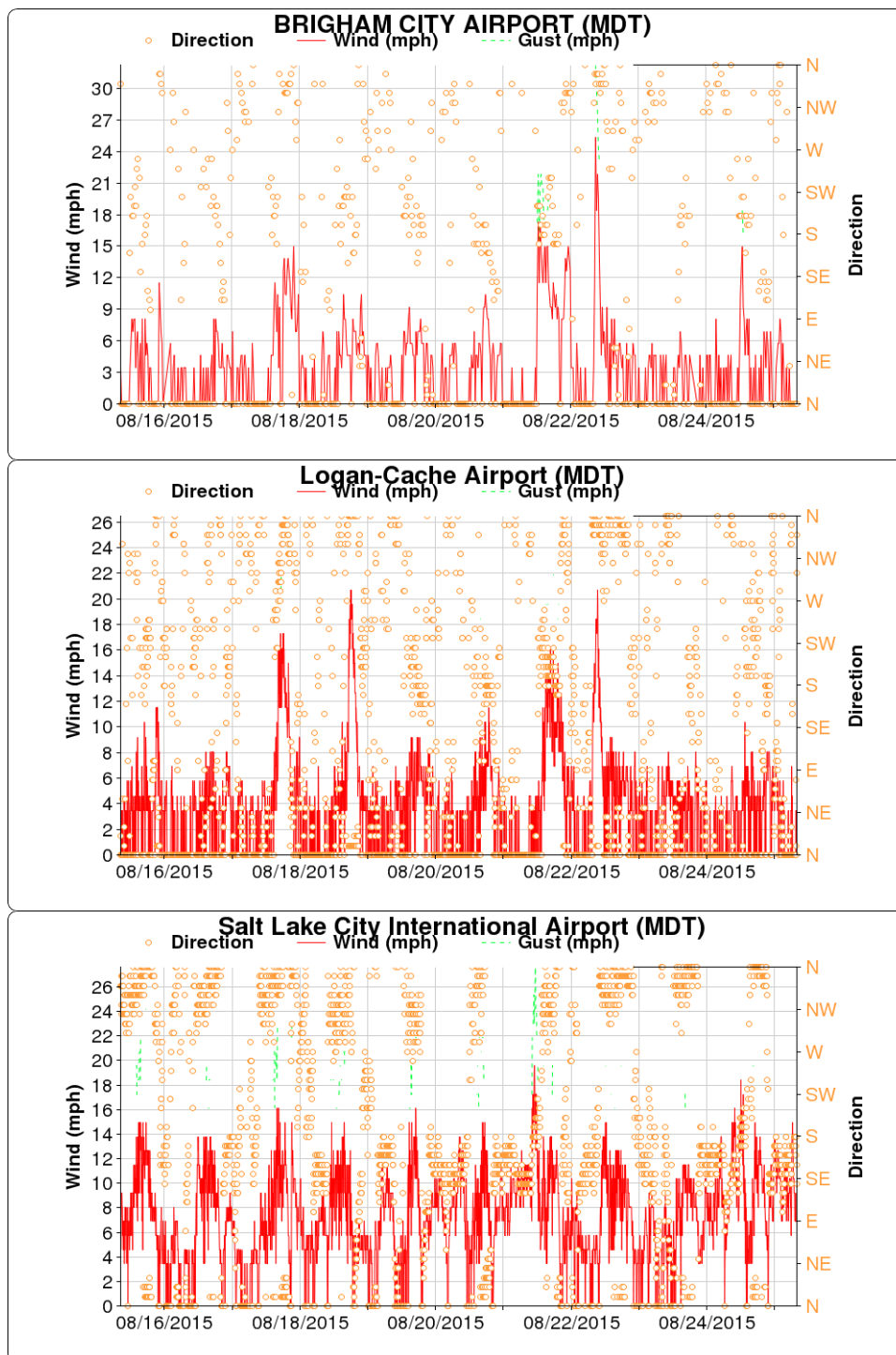


August 25, 2015



By the 24th and certainly the 25th, the mid-level winds were now mostly southwesterly over the western region, moving the smoke more northerly and northeasterly, away from northern Utah. Smokey conditions began to dissipate in northern Utah, with smoke being directed into Canada then into the Midwest.

Surface wind conditions plotted by MesoWest for the area airports, shows that there were low surface wind speeds for most of the event period at Brigham City and Logan. Low wind speed and close proximity to wildfires in surrounding states contributed to the highest measured PM_{2.5} values.



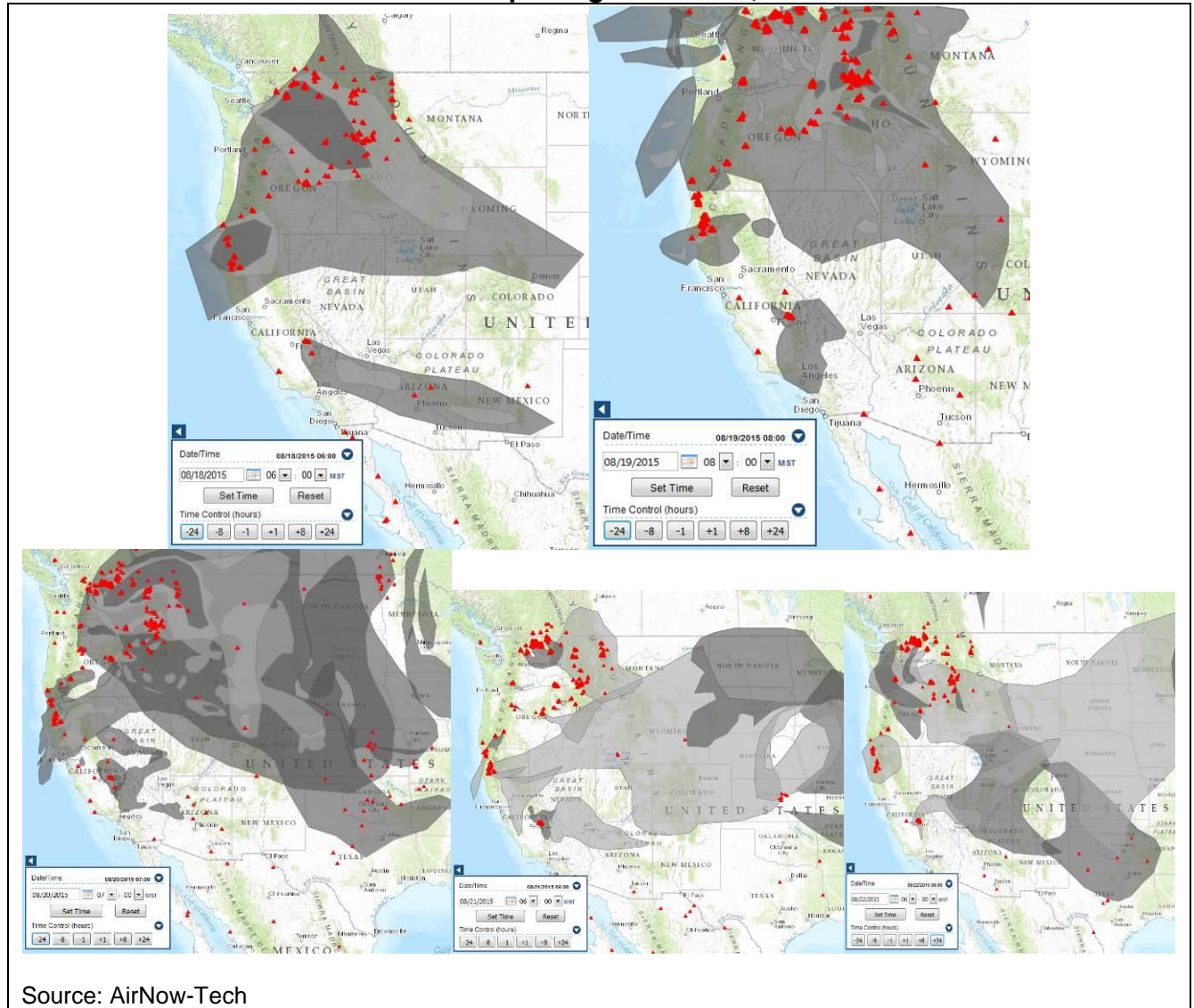
Salt Lake City airport data is substituted for the Ogden airport data because the Ogden data is not available. Fluctuating wind speeds in Salt Lake City helped disburse some smoke, especially on the 24th.

Clear Causal Relationship

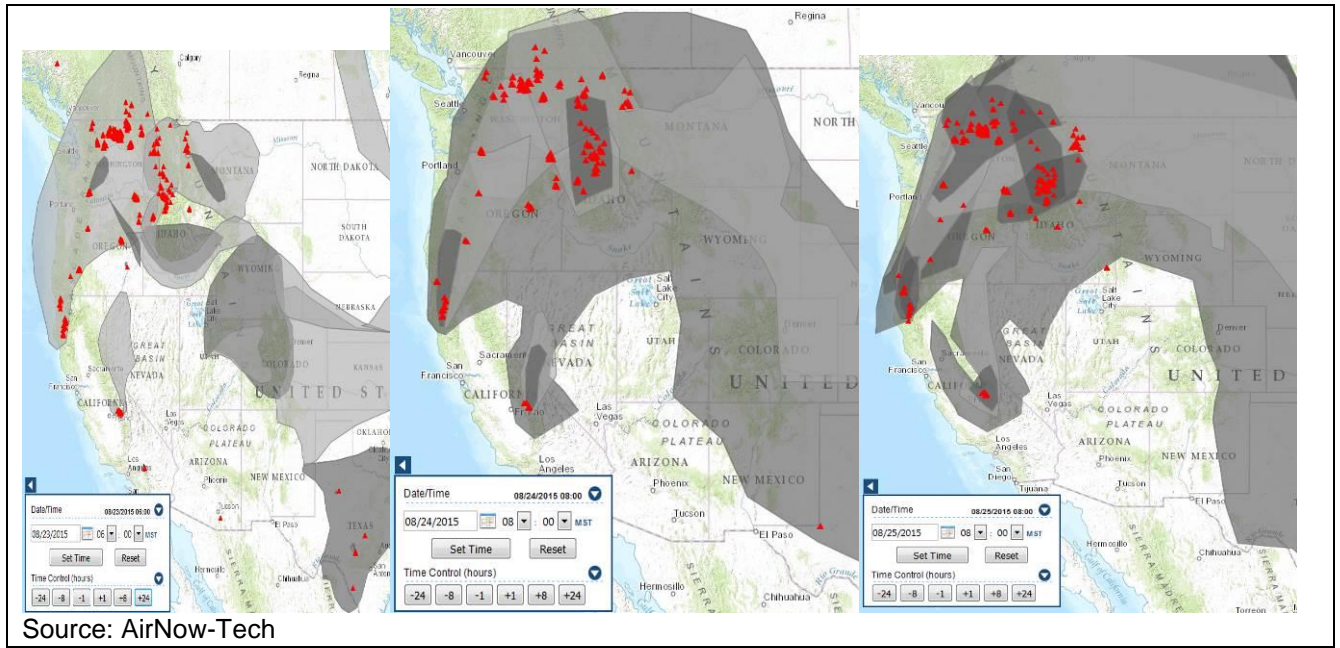
Smoke Trajectory

Fire locations are noted in red markers and smoke plumes are in gray shading. Smoke contribution varied from multiple wildfires on a daily bases due to varying upper atmospheric transport patterns.

Smoke Maps August 18 – 22, 2015



Source: AirNow-Tech

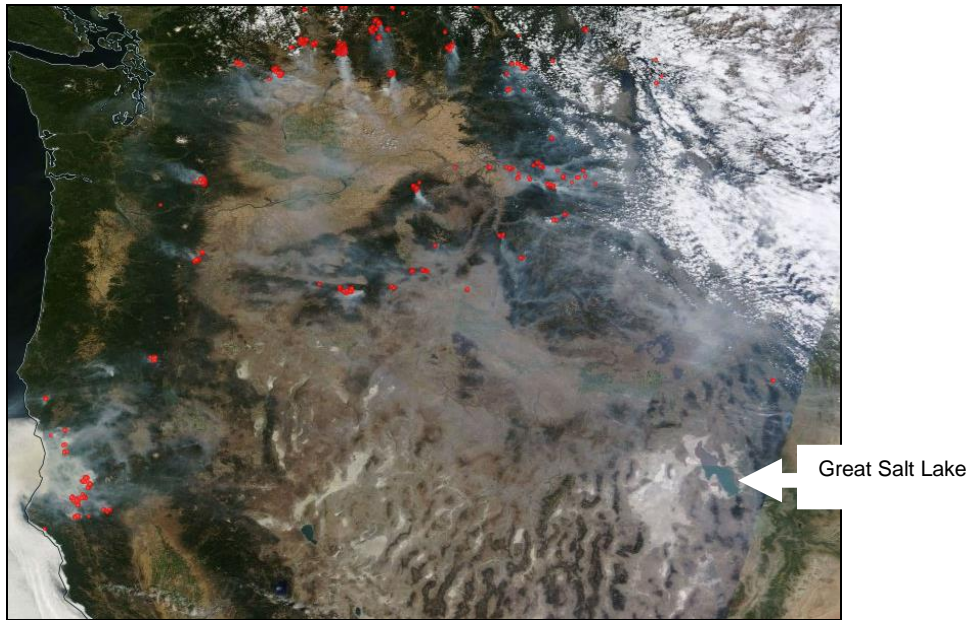


Source: AirNow-Tech

Smoke Maps August 23 – 25, 2015

Satellite Imagery

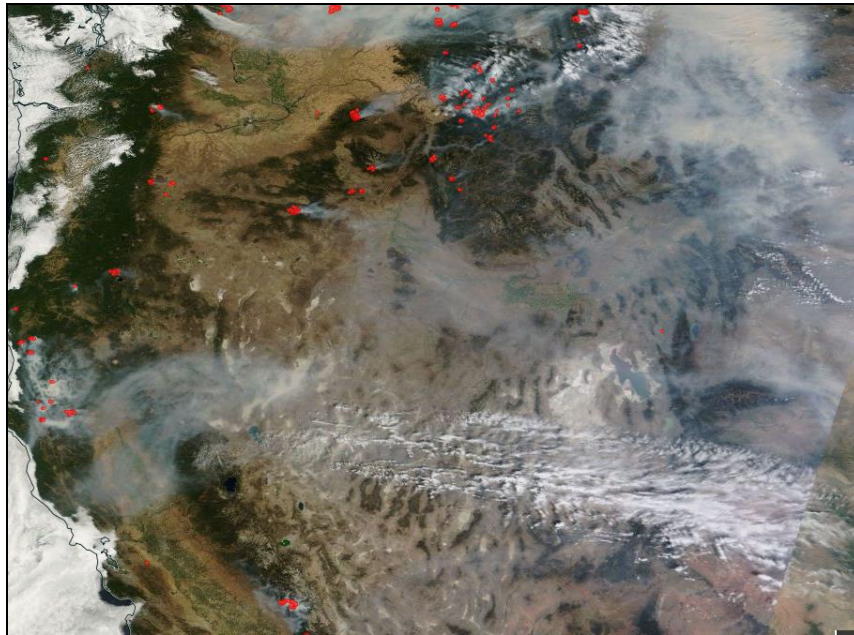
Smoke transport can be visibly verified with Modis satellite imagery. The red markers are the wildfire locations. The off-gray wisps are smoke plumes.



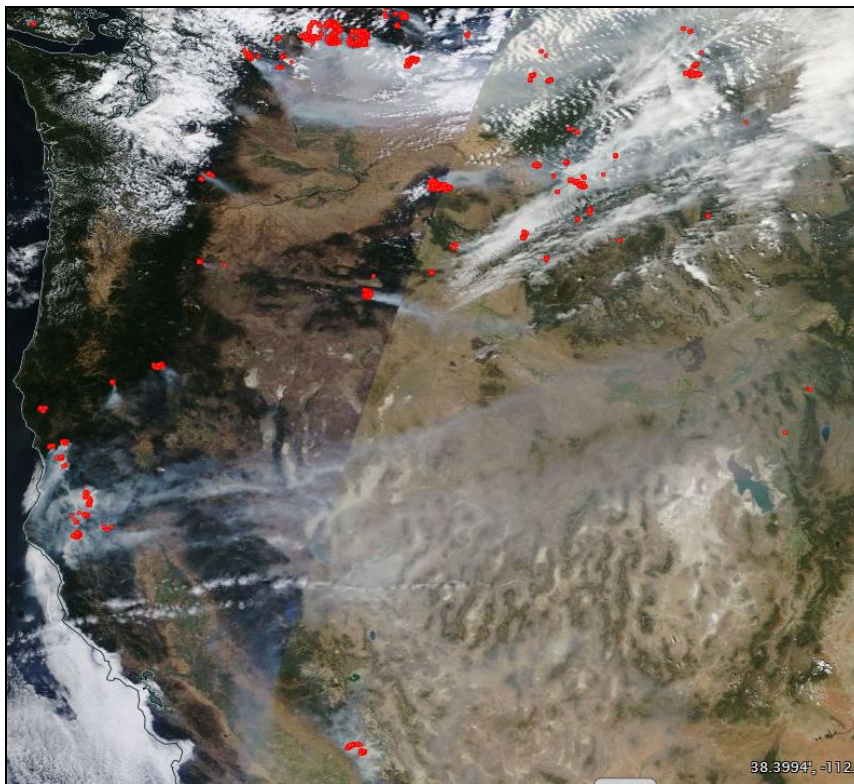
August 18, 2015



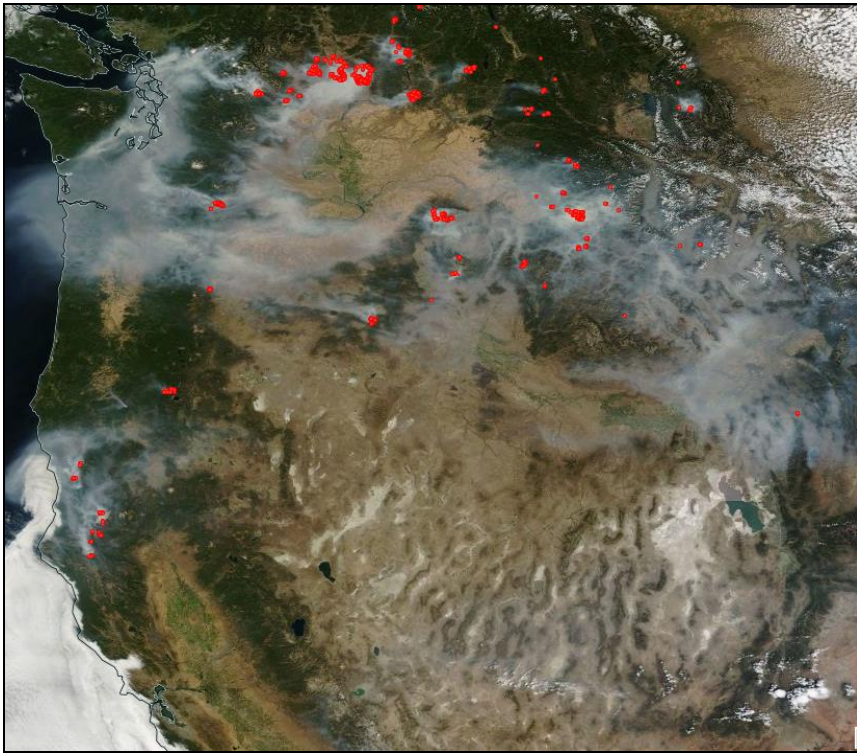
August 19, 2015



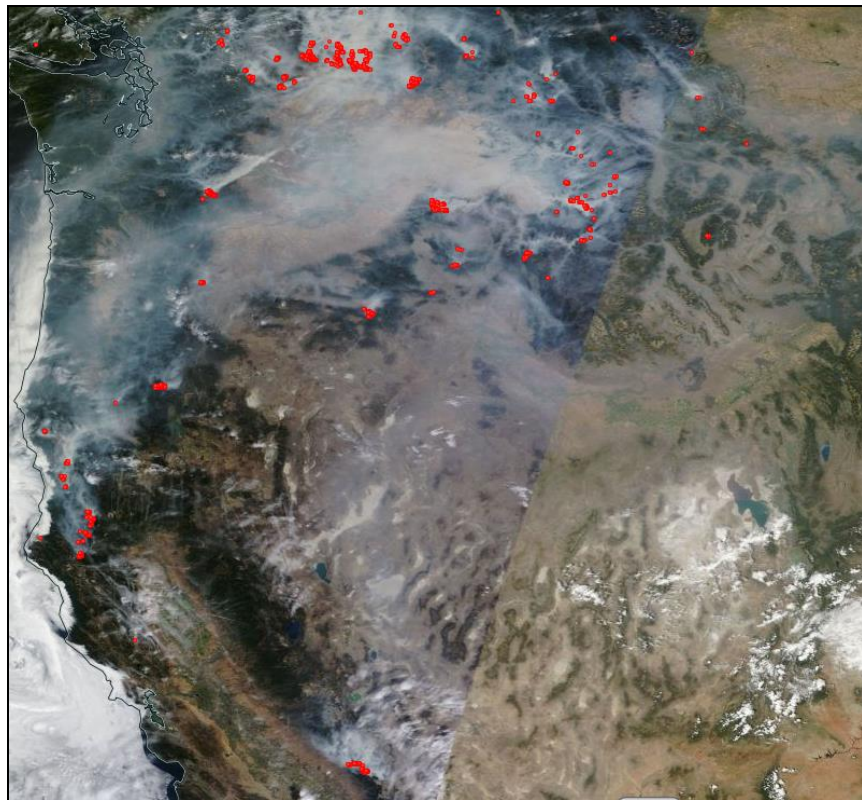
August 20, 2015



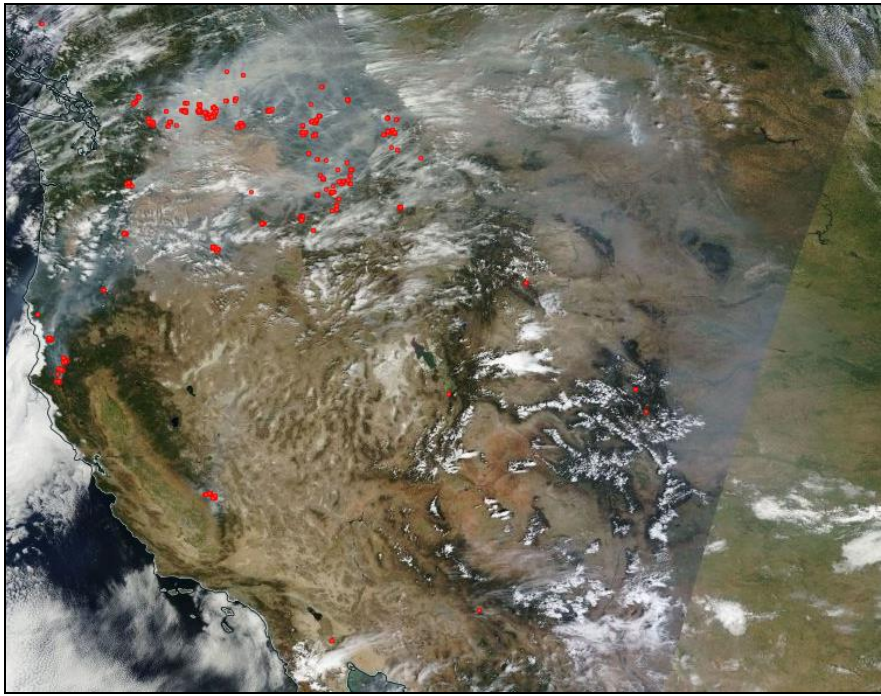
August 21, 2015



August 22, 2015



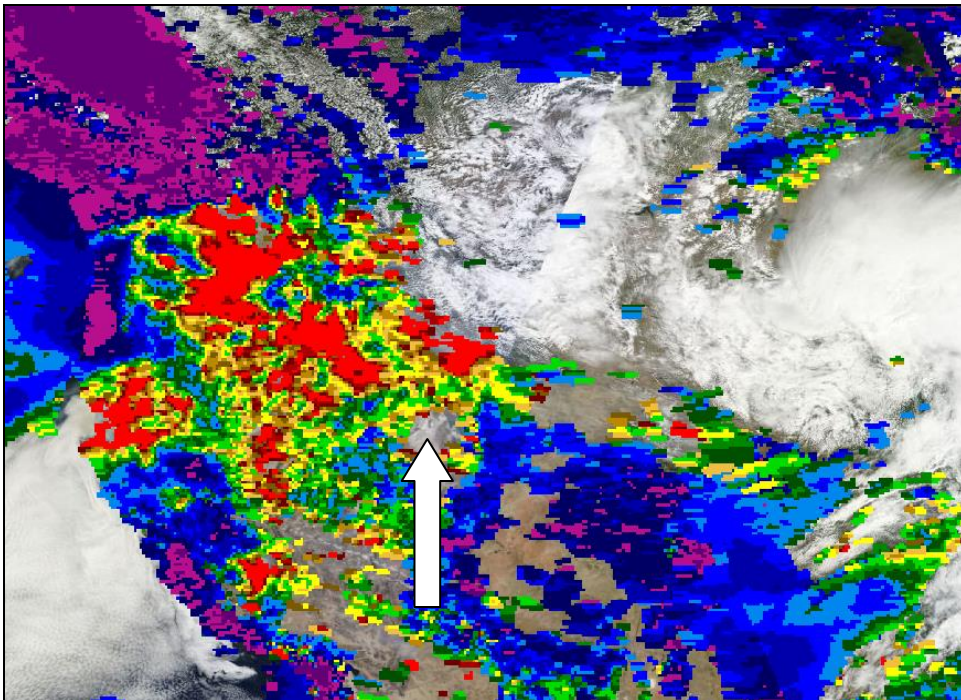
August 23, 2015



August 24, 2015

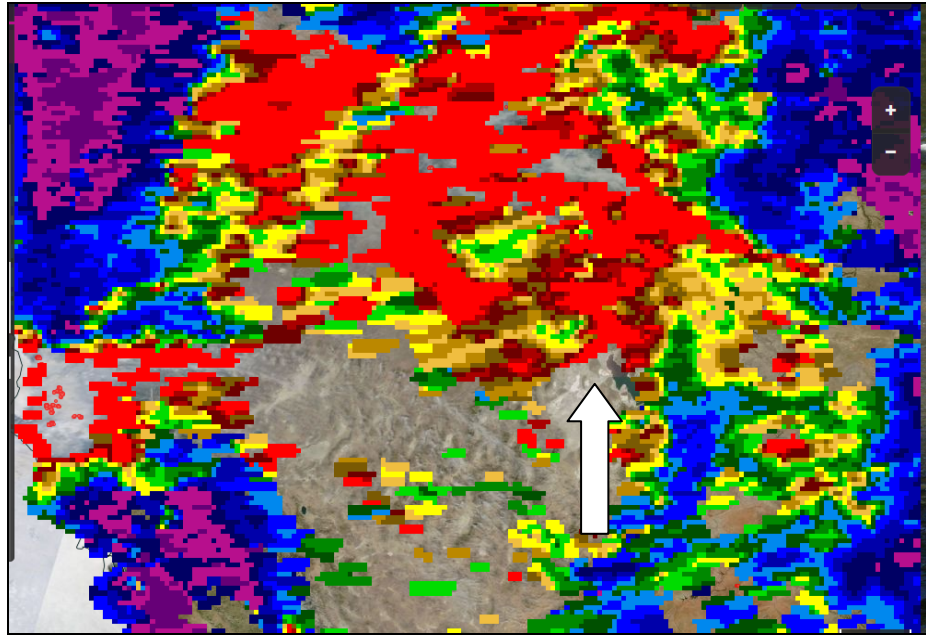
Aerosol Optical Depth

Aerosol optical depth (AOD) measurements can provide supporting evidence of the presence of $PM_{2.5}$ from smoke. AOD intensity is designated by a color code with blue being low AOD and red as the maximum AOD. The AOD overlay often masks geographic features that help us locate areas of interest. The Great Salt Lake Desert does not return an AOD signal, consequently it is used as a geographic marker on these images, designated by an arrow. The following AOD measurements were reported by NASA's Worldview.



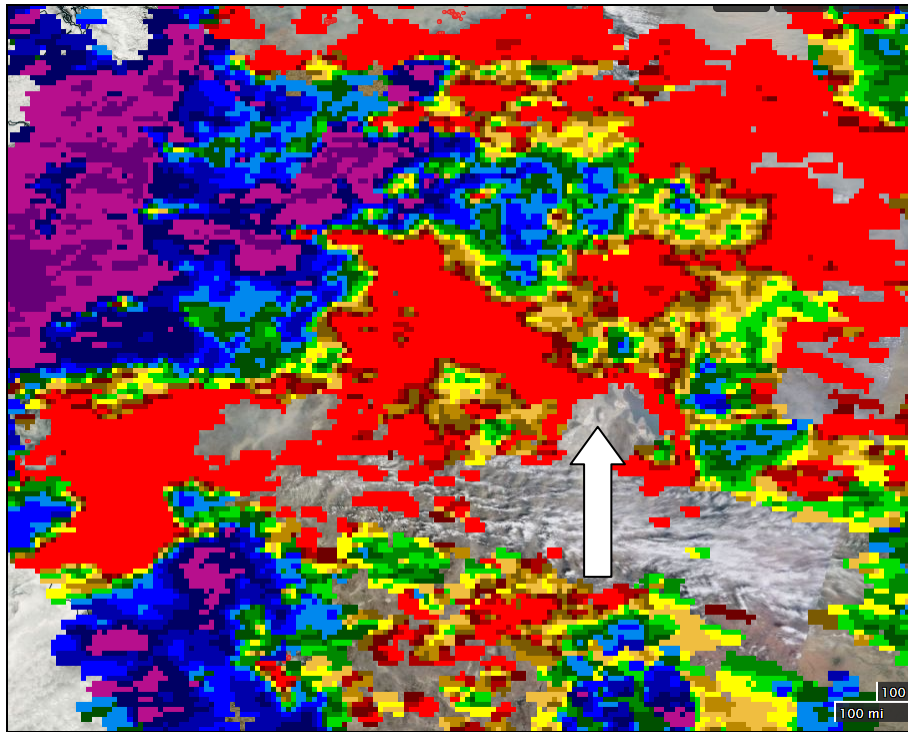
August 18, 2015

The wildfire hot spots are readily recognizable by the intensity of the red clustered areas. Varying degrees of AOD signal return is noted in Northern Utah (green to pink colors). This signal return is consistent with downwind smoke.



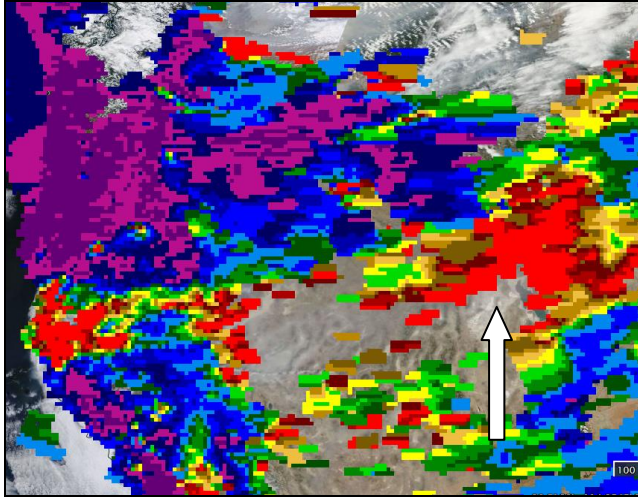
August 19, 2015

The AOD increased throughout Northern Utah (mostly red).

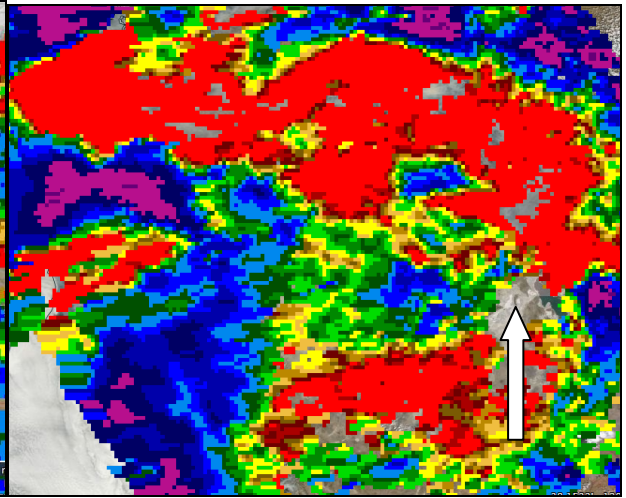


August 20, 2015

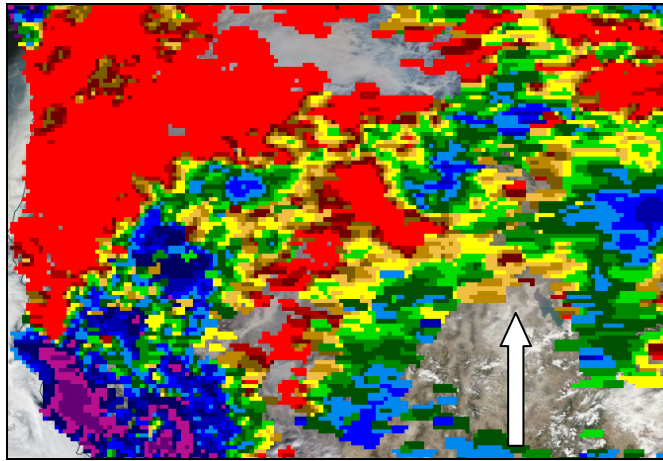
The AOD intensified throughout Northern Utah (all red).



August 21, 2015



August 22, 2015

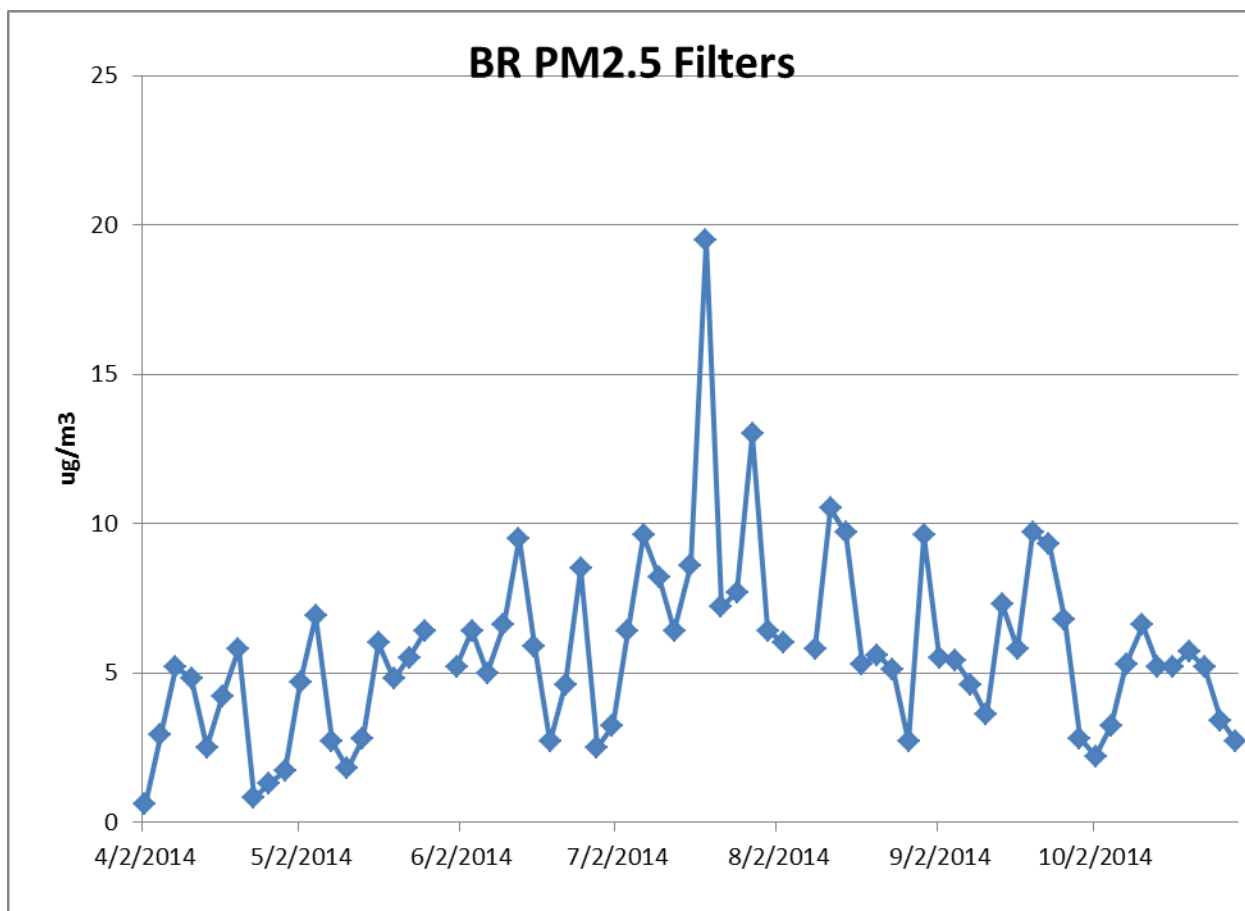


August 23, 2015

Historical Fluctuation

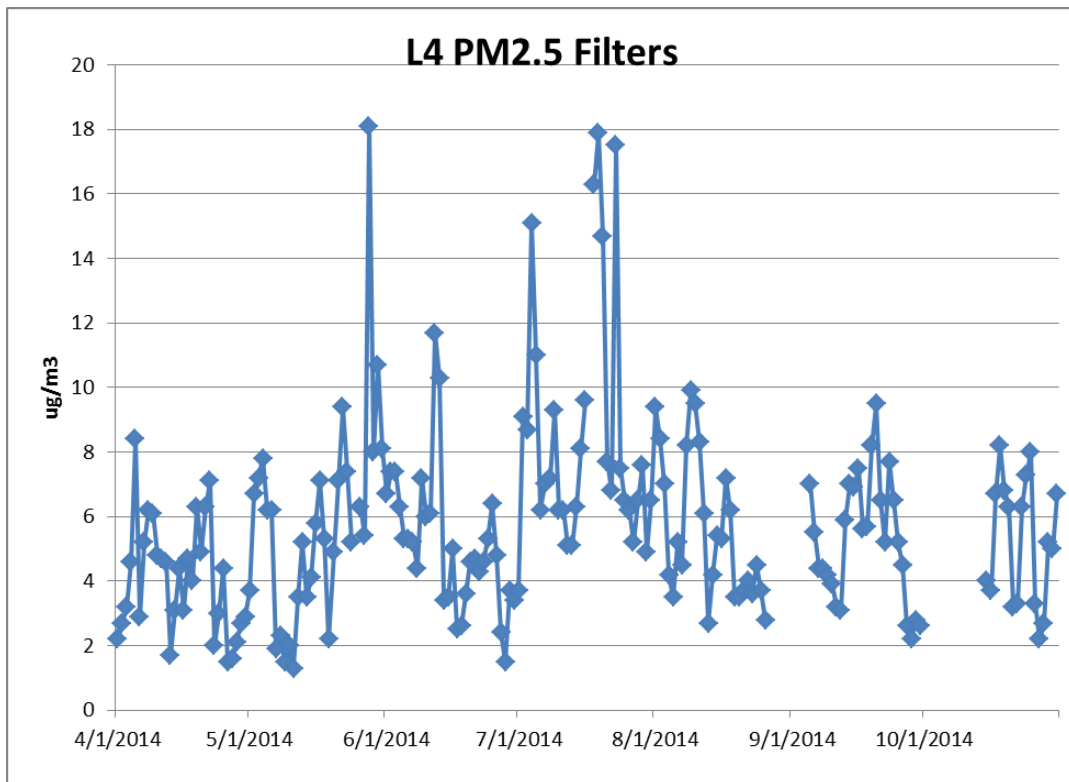
Brigham City

The graph presents filter results for the 2014 wildfire season for the Brigham City station. This historical time frame was selected for comparison because it was a moderately low wildfire year. The highest value during this period was $19.5 \mu\text{g}/\text{m}^3$. The event value is $43.5 \mu\text{g}/\text{m}^3$.

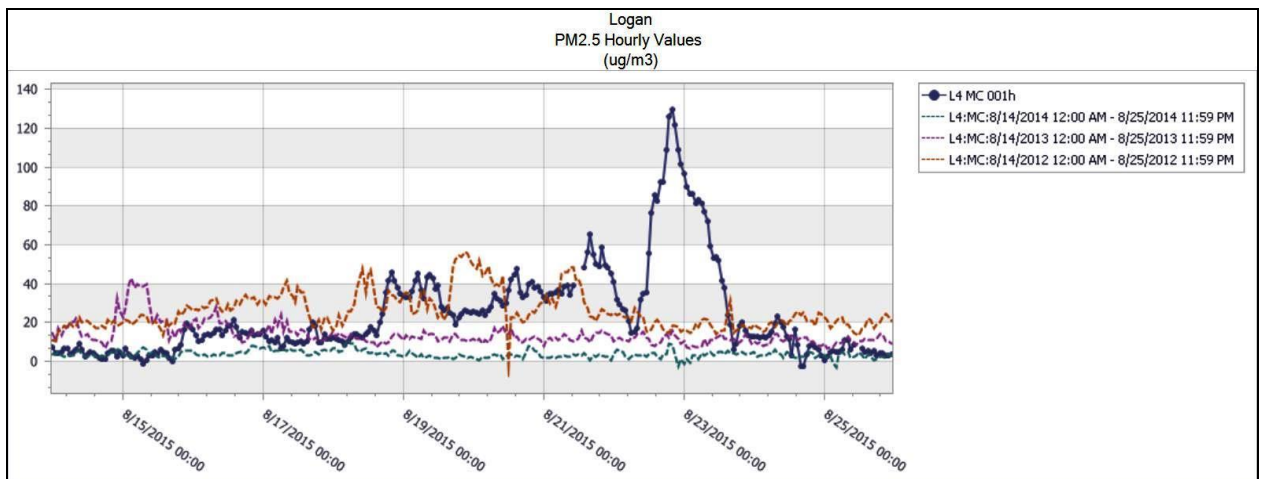


Logan

The same summer 2014 wildfire season filter results are graphed for Logan. The highest value during this period was 18.1 $\mu\text{g}/\text{m}^3$. The event values ranged from 40.4 to 59.7 $\mu\text{g}/\text{m}^3$.

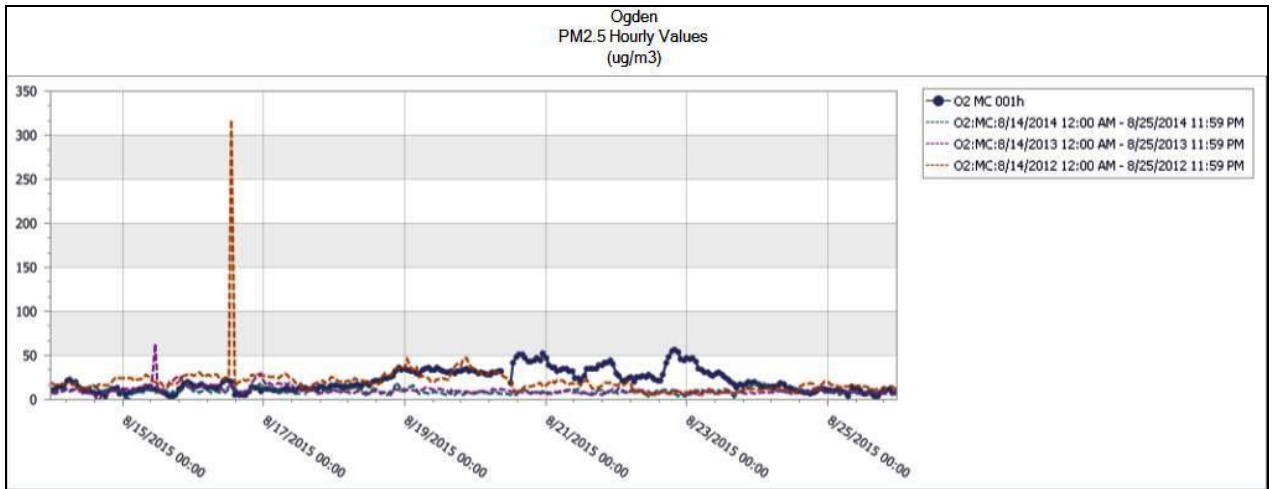


The following plot is for four years of historical hourly values corresponding to the time before the smoke arrived on August 15, 2015 to the dispersion of the smoke on August 25, 2015. The 2015 data is shown in blue. Past western wildfire influences occurred on August 15 and 19, 2013.



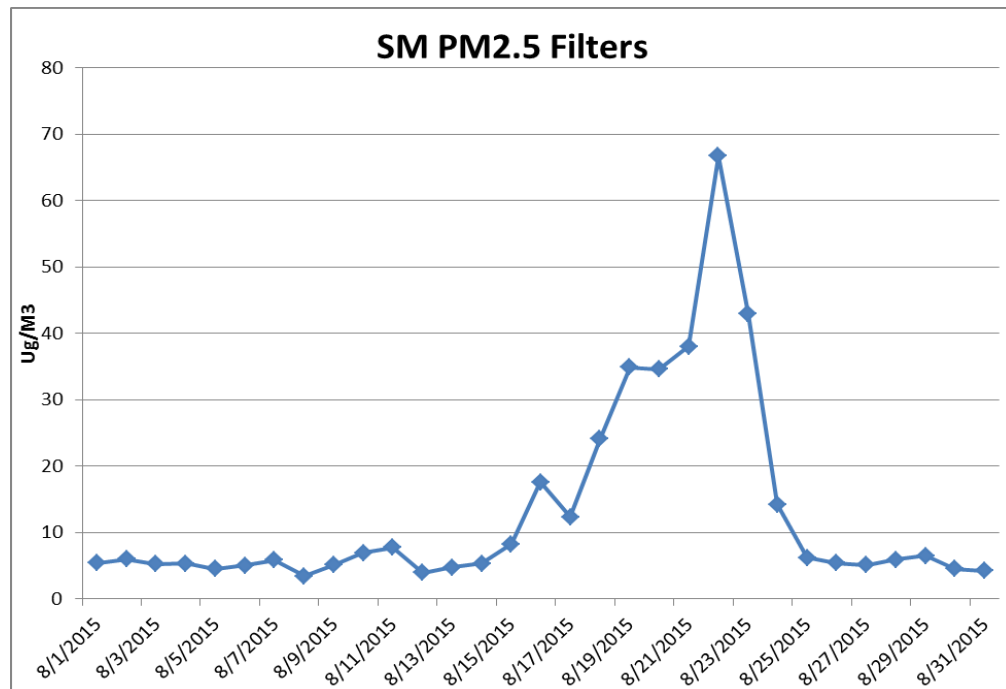
Ogden

The following plot is for four years of historical hourly values corresponding to the time before the smoke arrived on August 15, 2015 to the dispersion of the smoke on August 25, 2015. The 2015 data is shown in blue. Past western wildfire influences occurred on August 15 and 19, 2013.



Smithfield

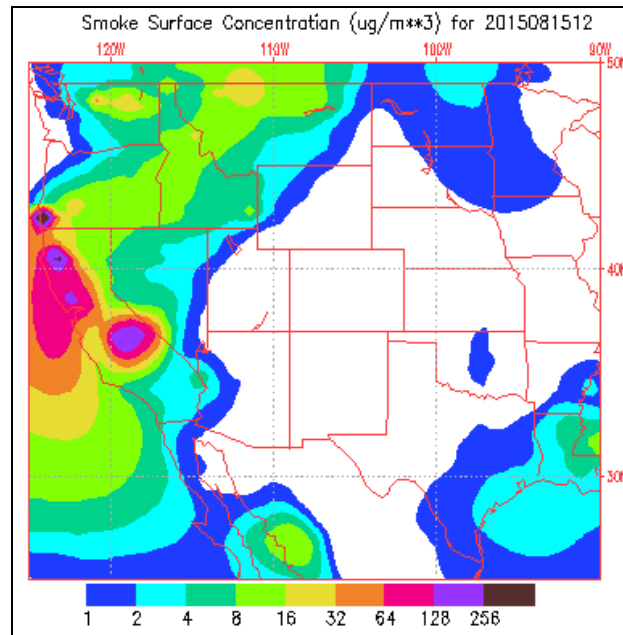
The Smithfield monitoring station is a new station located north of the Logan monitoring station. Historical data is not available however, given its proximity to Logan, it is assumed that the Logan historical data would apply to Smithfield. The August Smithfield filter data are plotted showing low PM_{2.5} values during the early part of the month, a sharp increase mid-month corresponding to the presence of smoke, followed by a sharp decline to normal levels.



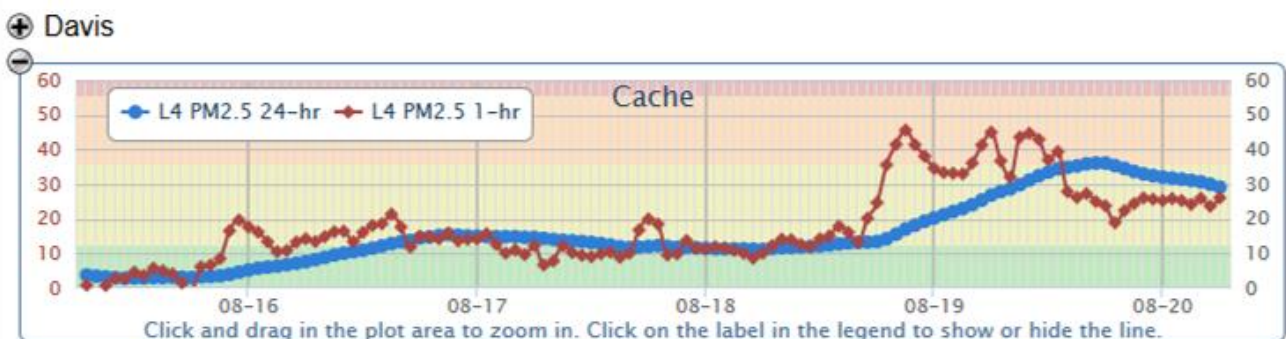
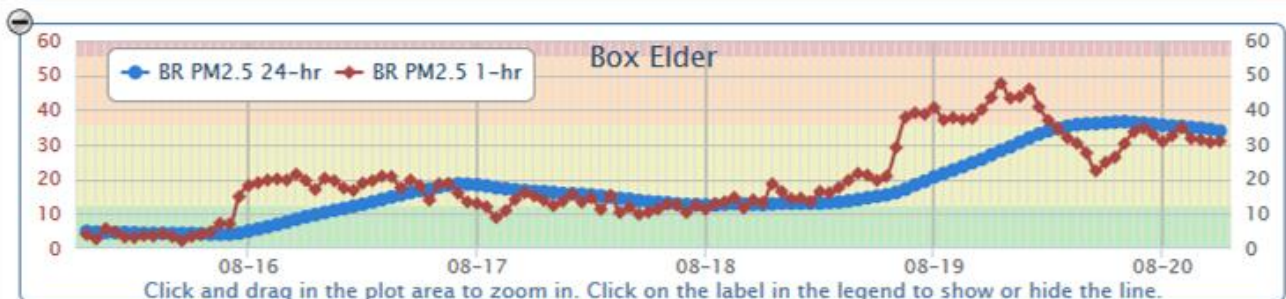
Exceedance But For the Event

Wildfire Apportionment

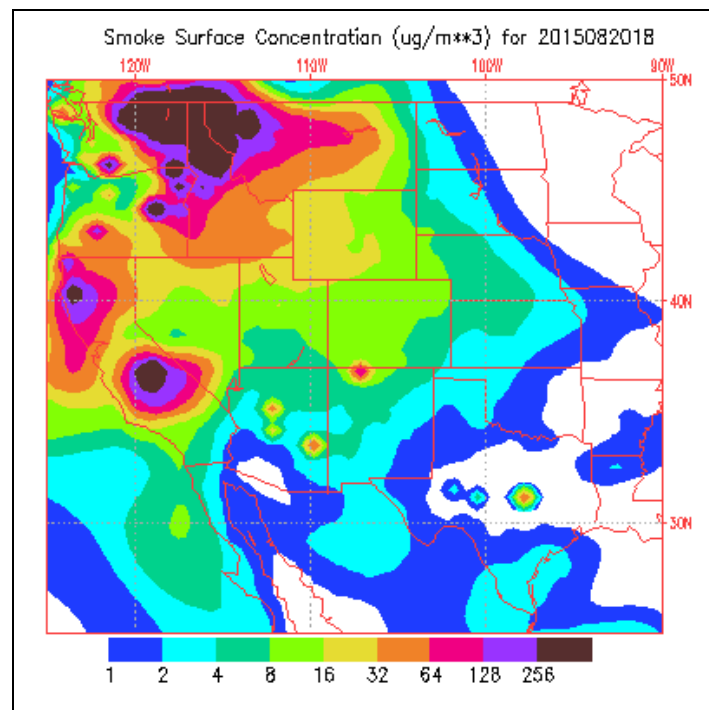
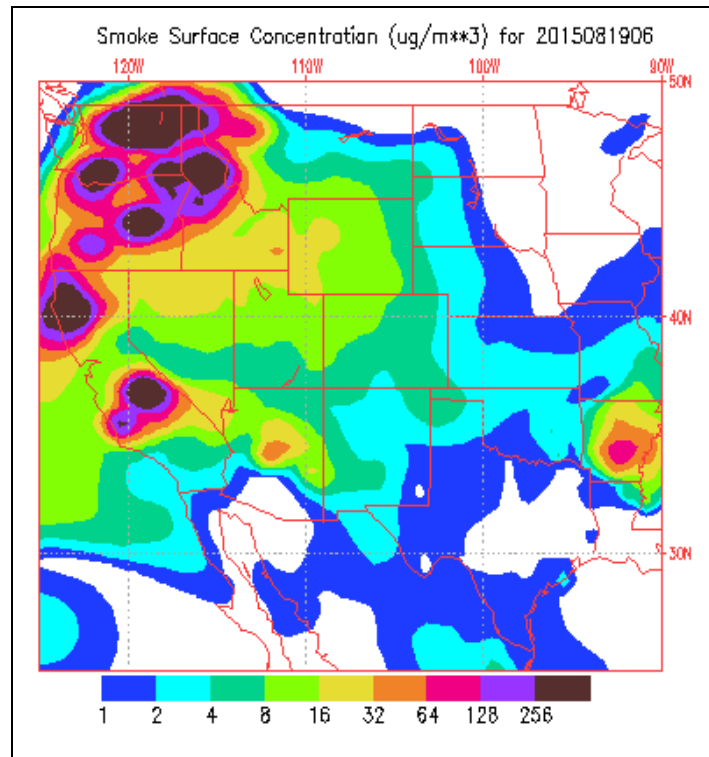
The Naval Aerosol Analysis and Prediction System (NAAPS) provides an estimate of smoke surface concentrations. According to NAAPS, the first smoke migrated to the surface in Northern Utah on the morning of the 15th, as shown on the NAAPS surface smoke map.



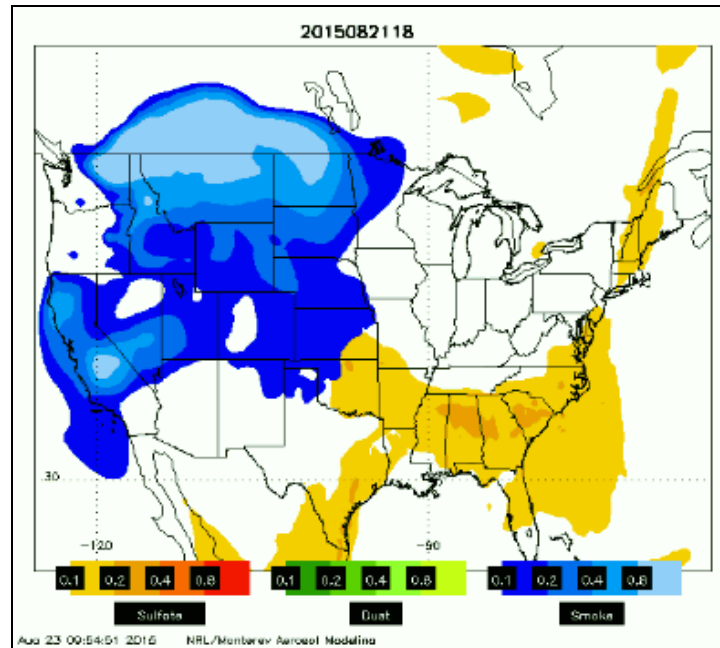
Monitoring data indicates that the smoke first migrated to the surface on the 15th between 8-10 p.m., as shown on the trend chart.



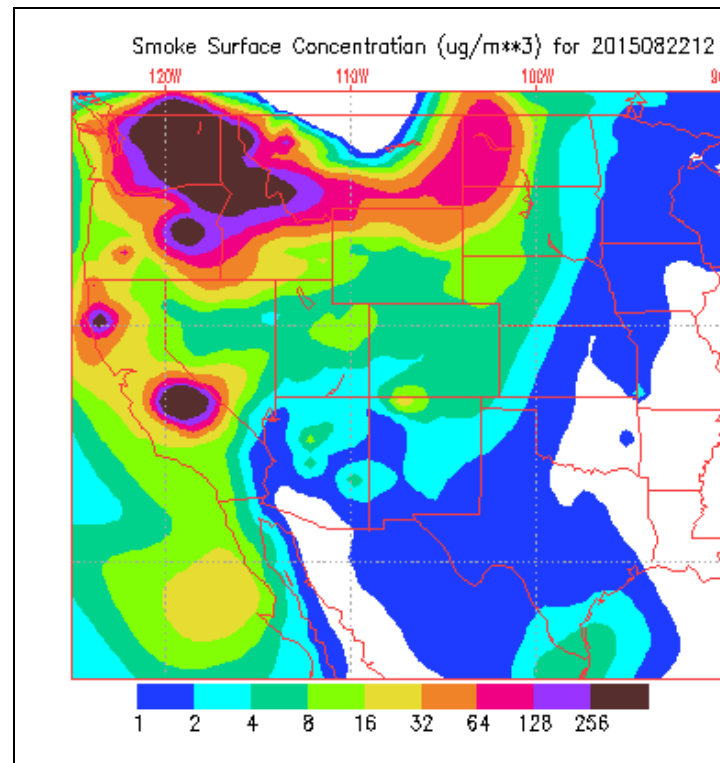
NAAPS ground smoke contribution projections for August 19-20, 2015 ranged from 8-32 $\mu\text{g}/\text{m}^3$ in northern Utah.

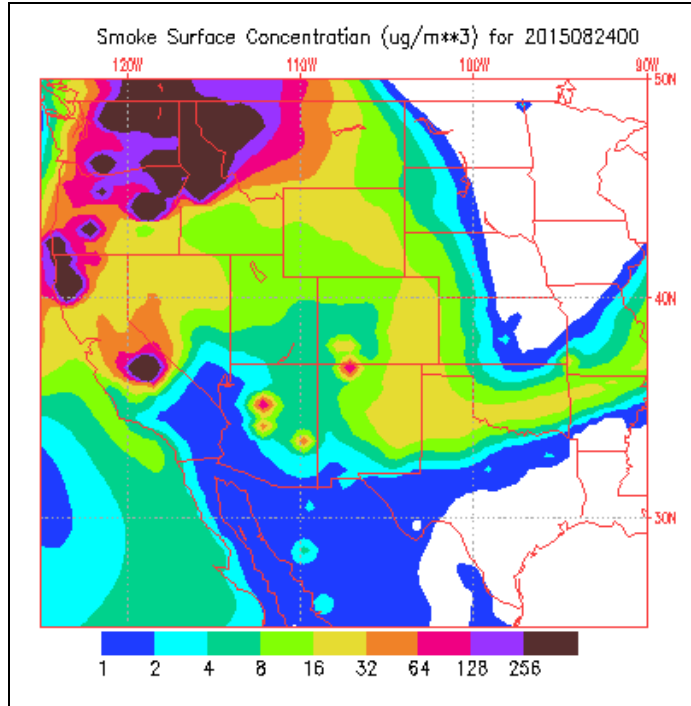
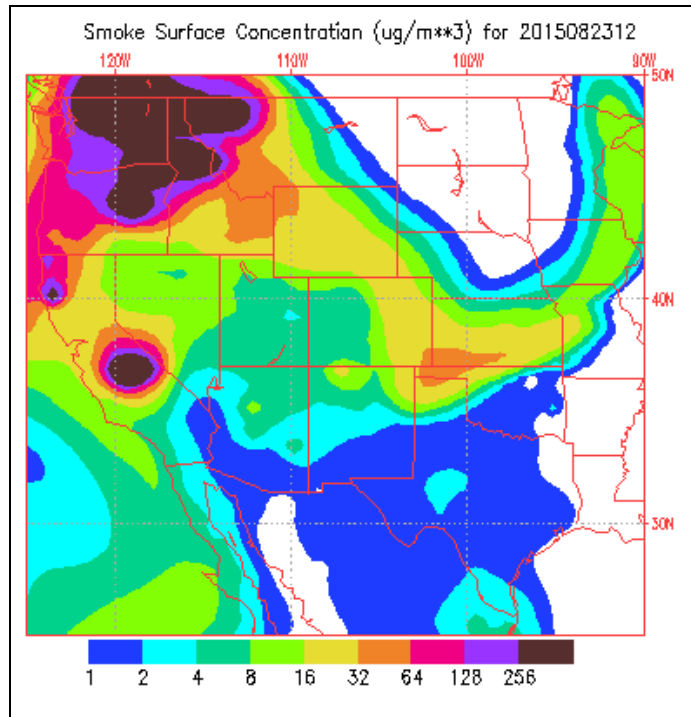


NAAPS ground smoke contribution projections for August 21, 2015 indicated high levels (dark blue) in northern Utah.



NAAPS ground smoke contribution projections for August 22-24, 2015 ranged from 4-16 $\mu\text{g}/\text{m}^3$ in northern Utah.





The summer of 2011 was a low wildfire year statewide therefore, we can compare monthly values from that period to the current event for each monitoring station. Subtracting the monthly means from the maximum values for each monitoring stations, we see that the smoke contributed as much as 52.8 $\mu\text{g}/\text{m}^3$ at the Logan station.

	Brigham City	Logan	Ogden
August 2011 Arithmetic Mean ($\mu\text{g}/\text{m}^3$)	7.8	6.9	8
August 2011 Standard Deviation	3.4	2.5	2.9
Maximum August 2015 Value ($\mu\text{g}/\text{m}^3$)	43.5	59.7	38.3
Net Maximum Smoke Contribution ($\mu\text{g}/\text{m}^3$)	35.7	52.8	30.3

Anthropogenic sources

There were no other known anthropogenic sources other than the western wildfires during the event days that could contribute to these levels of $\text{PM}_{2.5}$ increases across the entire northern Utah region.

Reasonable Controls

The Exceptional Events Rule requires that states have in place reasonable controls during exceptional events. The western wildfires were located outside of the State of Utah, beyond Utah control. None the less, the DAQ smoke management plan includes regulations that address open burning, prescribed burning and wildfire management.

- R307-202. Emission Standards: General Burning. This rule regulates when general burning can be conducted under permits issued by local fire authorities. Open burning periods are established in different parts of the state when the atmosphere can safely disperse smoke and when wildfire hazard is low. This rule also prohibits the burning of certain materials.
- R307-204. Emission Standards: Smoke Management. This rule is designed to mitigate the impact on public health of prescribed fires and wildfires by establishing strict requirements of land owners, state and federal agencies that conduct prescribed fires and actions necessary by the wildfire coordinators during a wildfire event. The state smoke manager (a Bureau of Land Management employee) processes all prescribed fire requests prior to submitting those requests for DAQ director approval. He assures that prescribed fire plans contain a smoke mitigation plan and that the burn will comply with R307-204.

The Department of Natural Resources has fire management jurisdiction in unincorporated and forest lands through R652-120.

- R652-120. Wildland Fire. The State Forester enforces open burning of yard waste through a burn permit in unincorporated lands in the same manner as R307-202 which is designed for incorporated lands. This rule also deals with fire management and suppression and prescribed fire management.

Mitigation

1. News releases during the event advised citizens of the potential health impacts of smoke from the wildfires.
2. Web sites about emissions from wildfire are posted on the DEQ web site. They cover the health impacts of PM and actions a person could take to minimize exposure to PM.

Conclusions

1. The violations of the PM_{2.5} 24-hr standard would have not occurred but for the wildfire smoke. A weight of evidence approach was used in this documentation to support that conclusion by applying analysis of satellite imagery, remote sensing tools and historical comparisons.
2. Wildfire smoke contributed up to an estimated 52.8 µg/m³ of PM_{2.5}.
3. There were no other known anthropogenic sources other than the western wildfires during the event days that could contribute to these levels of PM_{2.5} across northern Utah.
4. Reasonable controls are in place and no foreseeable measures could be put into place to avoid or control naturally derived wildfires. Further, the wildfires were located outside Utah jurisdictional boundaries.
5. This documentation supports the exclusion of the violations under the Exceptional Events Rule.