Exceptional Event Demonstration for Ozone Exceedances in Clark County, Nevada - June 19 - 20, 2018

June 2021

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ACRONYMS AND ABBREVIATIONS

[TBD]

1.0 OVERVIEW

1.1 INTRODUCTION

Ozone (O_3) exceedances in Clark County are frequently influenced by surrounding wildfires. In the proper weather conditions, wildfire emissions can travel hundreds of miles from the point of origin. This is especially notable from wildfires in California, which cause more exceedances of the National Ambient Air Quality Standard (NAAQS) for ozone in Clark County than fires in other areas because of regionally predominant winds that flow from California to the Las Vegas Valley (LVV) in summer.

Figure 1-1 uses data from annual "Wildland Fire Summary" reports (2014–2018) from the National Interagency Coordination Center (NICC) to show the strong relationship between the number of ozone exceedance days in Clark County and the total area in California burned by wildfires ($R^2 = 0.9091$). The 2018 fire season in California was the most destructive on record, with the NICC reporting a total of 8,054 fires burning an area of 1,823,153 acres. Figure 1-2 shows the high correlation between the area burned (logarithmic value) in California and the number of ozone exceedance days in Clark County from May to August 2018 ($R^2 = 0.9591$), based on the "2018 Wildfire Activity Statistics" report published by the California Department of Forestry and Fire Protection (CAL FIRE). Though it represents only the areas of the state for which CAL FIRE was responsible, that was more than 50% of the total burned area in California.

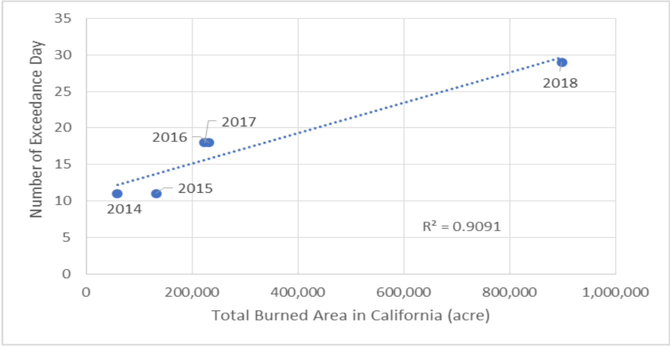

Figure 1-1. Relationship between Total Burned Area in California and Number of Exceedance Days in Clark County in Summer Months (May–August) 2014–2018.

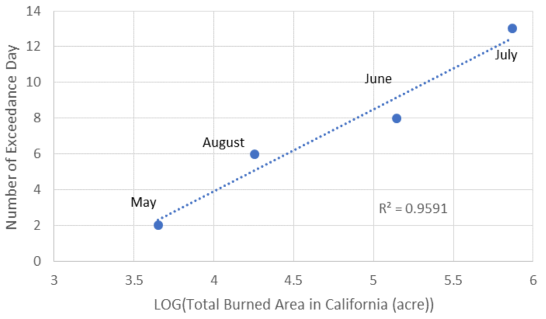

Figure 1-2. Relationship between Log Value of Total Burned Area and Number of Exceedance Days in Summer Months of 2018.

With that background in mind, the Clark County Department of Environment and Sustainability (DES) is concurrently submitting several exceptional events demonstrations of ozone concentrations that exceeded the 2015 ozone NAAQS due to smoke impact on the days in 2018 listed in Table 1-1. All have been prepared consistent with Title 40, Part 50 of the Code of Federal Regulations (40 CFR 50). **This document is submitted for June 19 and 20, 2018, events influenced by smoke from the Planada Fire and other unnamed wildfires in California and the Upper Colony Fire in Nevada.**

The submittal process began with an Exceptional Events Initial Notification sent to EPA Region 9 on November 30, 2020 (Appendix A). With this demonstration package, DES petitions the Regional Administrator for Region 9 of the U.S. Environmental Protection Agency (EPA) to exclude air quality monitoring data for ozone on June 19–20, 2018, from the normal planning and regulatory requirements under the Clean Air Act (CAA) in accordance with the Exceptional Events Rule (EER), codified at 40 CFR 50.1, 50.14, and 51.930.

Table 1-1 lists the maximum daily 8-hour average of ozone (MDA8 ozone) at network monitors on the exceedance days.

Table 1-1. Ozone Monitors Proposed for Data Exclusion

AQSID[1]	**320030043**	**320030071**	**320030073**	**320030075**	**320030298**	**320030540**
Date	**Paul Meyer**	**Walter Johnson**	**Palo Verde**	**Joe Neal**	**Green Valley**	**Jerome Mack**
20180619[2]	72 (10)	72 (14)	—	—	77 (4)	75 (4)
20180620	71 (15)	74 (9)	—	72 (10)	—	—
20180623	72 (7)	76 (4)	71 (5)	72 (9)	75 (6)	72 (10)
20180627	75 (4)	76 (4)	72 (3)	72 (8)	78 (1)	76 (3)
20180714	72 (13)	—	—	—	78 (3)	78 (1)
20180715	—	71 (21)	—	78 (2)	73 (11)	73 (7)
20180716	75 (3)	79 (1)	75 (1)	80 (1)	71 (19)	73 (8)
20180717	74 (5)	77 (3)	74 (2)	—	—	—
20180725	71 (17)	72 (15)	—	—	72 (14)	—
20180726	72 (8)	75 (6)	70 (6)	—	77 (4)	77 (2)
20180727	72 (9)	74 (11)	70 (7)	76 (4)	—	—
20180730	—	—	—	—	73 (11)	72 (11)
20180731	—	73 (13)	—	73 (6)	—	—
20180806	79 (1)	77 (2)	72 (4)	76 (3)	74 (10)	71 (12)
20180807	73 (6)	74 (7)	—	74 (5)	72 (16)	71 (13)

[1] Air Quality System identification numbers (AQSID) and local names identify key monitors.
[2] MDA8 ozone is listed in parts per billion (ppb) with Tier 2, Key Factor 2 ranking of measurement for 2018 season in parentheses.

1.2 EXCEPTIONAL EVENT DEMONSTRATION CRITERIA

40 CFR 50.1(j) states:

> *Exceptional event* means an event(s) and its resulting emissions that affect air quality in such a way that there exists a clear causal relationship between the specific event(s) and the monitored exceedance(s) or violation(s), is not reasonably controllable or preventable, is an event(s) caused by human activity that is unlikely to recur at a particular location or a natural event(s), and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event.

40 CFR 50.14(c)(1)(i) requires that air agencies must “notify the public promptly whenever an event occurs or is reasonably anticipated to occur which may result in the exceedance of an applicable air quality standard” in accordance with the mitigation requirement at 40 CFR 51.930(a)(1). Details on DES’s public notification can be found in Appendix B.

As specified in 40 CFR 50.14(c)(3)(iv), the following elements must be included to justify the exclusion of air quality data from a NAAQS determination:

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s).

2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation.

3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times. However, the EPA Administrator is restricted from requiring a state to prove a specific percentile point in the distribution of data.

4. A demonstration that the event was both not reasonably controllable and not reasonably preventable.

5. A demonstration that the event was a human activity that is unlikely to recur at a particular location, or was a natural event.

“EPA Guidance on the Preparation of Exceptional Events Demonstration for Wildfire Events that May Influence Ozone Concentrations” (EPA 2016) describes a three-tier analysis approach to determine a “clear causal relationship” for exceptional events, which is summarized below. Section 4 of this document, “Clear Causal Relationship,” provides the details of these analyses.

> Tier 1:
> Key factors for this tier are exceedances out of the normal ozone season and/or concentrations that are 5–10 ppb greater than non-event-related concentrations.
>
> Tier 2:
> There are two key factors for this tier: fire emissions & distance (Q/d) and comparison of event ozone concentrations to non-event high-ozone concentrations. This tier may include additional analyses of smoke maps, plume trajectories, satellite retrievals, sounding data, and time series of supporting ground measurements to provide evidence of wildfire emissions transported to local monitors.
>
> Tier 3:
> This tier involves statistical modeling of MDA8 ozone concentrations using generalized additive models (GAMs) to assess wildfire influences on local ozone concentrations.

DES has prepared this package to meet the requirements for seeking EPA concurrence for data exclusion.

This exceptional event demonstration will undergo a 30-day public comment period concurrent with EPA's review, beginning July 1/September 3, 2021. A copy of the public notice, along with any comments received and responses to those comments, will be submitted to EPA after the comment period has closed, consistent with the requirements of 40 CFR 50.14(c)(3)(v). Appendix C documents the public comment process.

1.3 REGULATORY SIGNIFICANCE OF THE EXCLUSION

The Las Vegas Valley, located within Clark County, Nevada, is currently designated as a nonattainment area for the 2015 ozone NAAQS of 70 ppb. Table 1-2 lists the 4th highest 8-hour average ozone recorded at the monitors listed in Table 1-1—including wildfire days in 2018 and excluding wildfire days in 2020—for the most recent three-year period (2018–2020), along with the resulting design value (DV) for each monitor. The table also shows the 4th highest 8-hour average ozone and DVs for 2018 after the requested exceedance days are excluded from the DV calculation (the shaded columns). Since the recalculated DVs meet the 2015 NAAQS, the valley would be reclassified as "attainment" if EPA concurs with this demonstration. EPA concurrence will thus have a significant impact on DES's attainment of the 2015 ozone NAAQS.

Table 1-2. Impact of Wildfire Events on Design Values of 2018–2020 (all values in ppb)

Site Name	Fourth Highest Average			Current	Wildfire Days Excluded	
	2018	2019	2020[1]	Design Value	2018	Design Value
Jerome Mack	75	66	67	69	72	68
Paul Meyer	75	69	70	71	71	70
Joe Neal	76	68	68	70	71	69
Walter Johnson	76	68	70	71	73	70
Palo Verde	72	62	67	67	68	65
Green Valley	77	70	68	71	72	70

[1] Assume wildfire days are excluded.

2.0 AREA DESCRIPTION AND CHARACTERISTICS OF NON-EVENT OZONE FORMATION

2.1 AREA DESCRIPTION

Clark County covers 8,091 square miles at the southern tip of Nevada and has a population of over 2.2 million.[1] More than 95% of the county's residents live in the Las Vegas Valley, which is part of the Mojave Desert and constitutes Hydrographic Area (HA) 212. The valley encompasses about 1600 km^2 and is surrounded by mountains extending 2,000–10,000 feet above its floor (Figure 2-1). The valley slopes downward from west to east (approximately 900 to 500 m above mean sea level), which affects the local climatology by driving variations in wind, temperature, and precipitation.

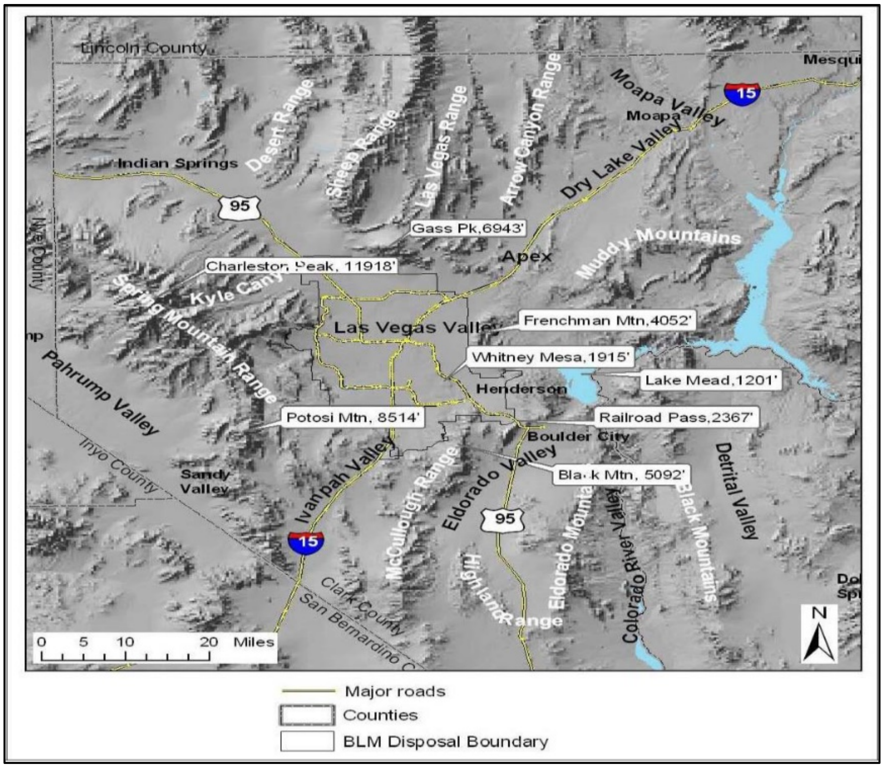

Figure 2-1. Mountain Ranges and Hydrographic Areas Surrounding the Las Vegas Valley.

Valley weather is characterized by low rainfall, hot summers, and mild winters. On average, June is the driest month; monsoons from the Gulf of California increase the humidity and cloud cover in July and August. The Interstate 15 (I-15) corridor through the Mojave Desert and Cajon Pass links Las Vegas with the eastern Los Angeles Basin, about 275 km to the southwest. This corridor is a potential pathway for the export of pollution from Los Angeles to the Mojave Desert and the Las Vegas Valley.

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[1] *Clark County, Nevada 2017 Population Estimates*. Clark County (NV) Department of Comprehensive Planning.

Figure 2-2 shows the locations of Clark County ozone monitors. Most of the stations—Paul Meyer (PM), Water Johnson (WJ), Palo Verde (PV), Joe Neal (JO), Jerome Mack (JM) and Green Valley (GV)—are in the populated areas of the valley (HA 212), but there are outlying stations in Apex, Mesquite, Boulder City, Jean, and Indian Springs. A station at the Spring Mountain Youth Camp was operated as a special purpose monitoring site for part of the 2018 ozone season.

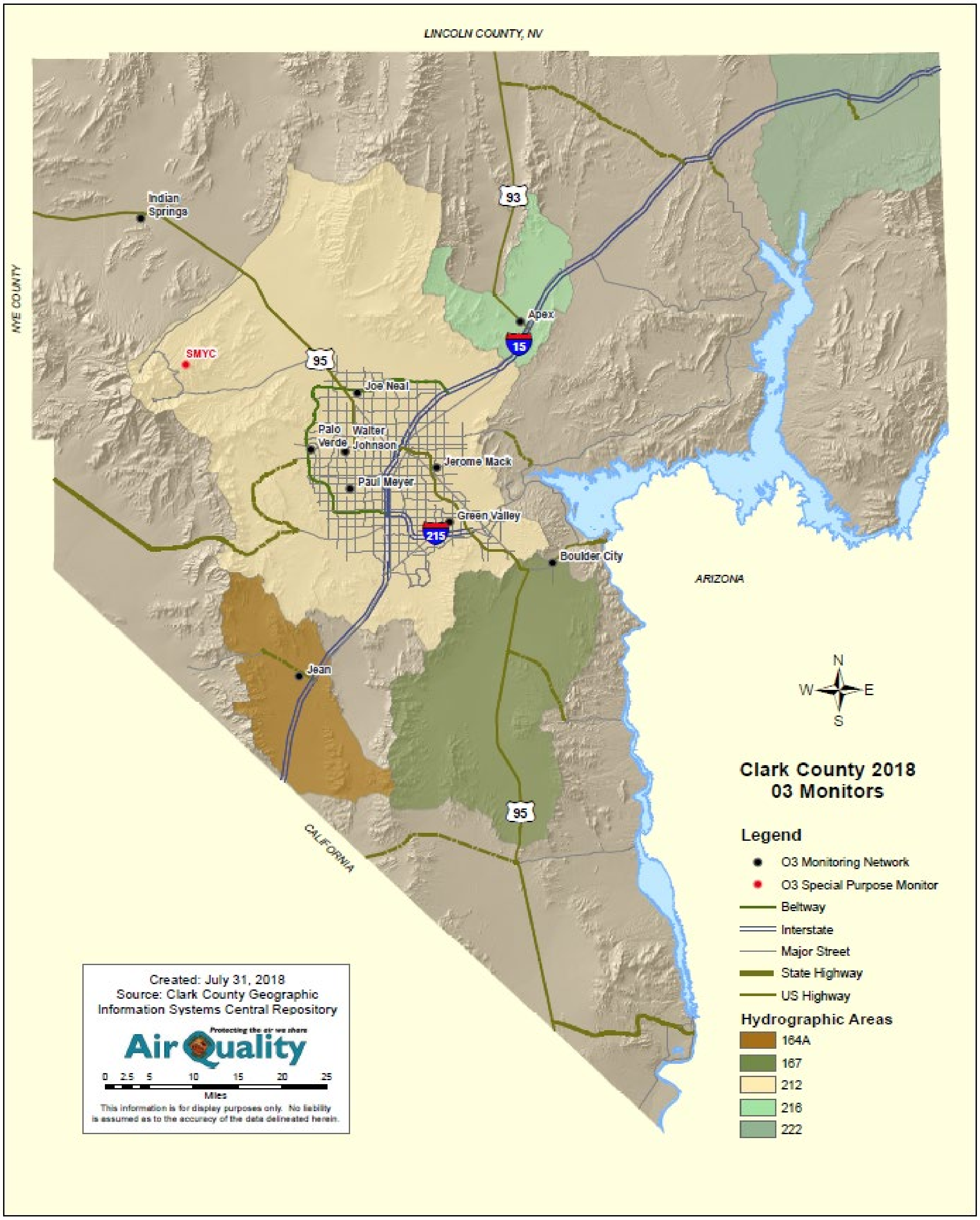


Figure 2-2. Clark County O_3 Monitoring Network.

Figures 2-3 and 2-4 show the locations of Clark County's Federal Equivalent Method (FEM) and Federal Reference Method (FRM) $PM_{2.5}$ monitors, respectively. Most of the stations are located in the populated areas of HA 212, with one outlying station in Jean, Nevada. Jean is considered a regional background site because it is located far enough from the valley to avoid impacts from local emissions. It is upwind of the Las Vegas Valley, but downwind of Southern California.

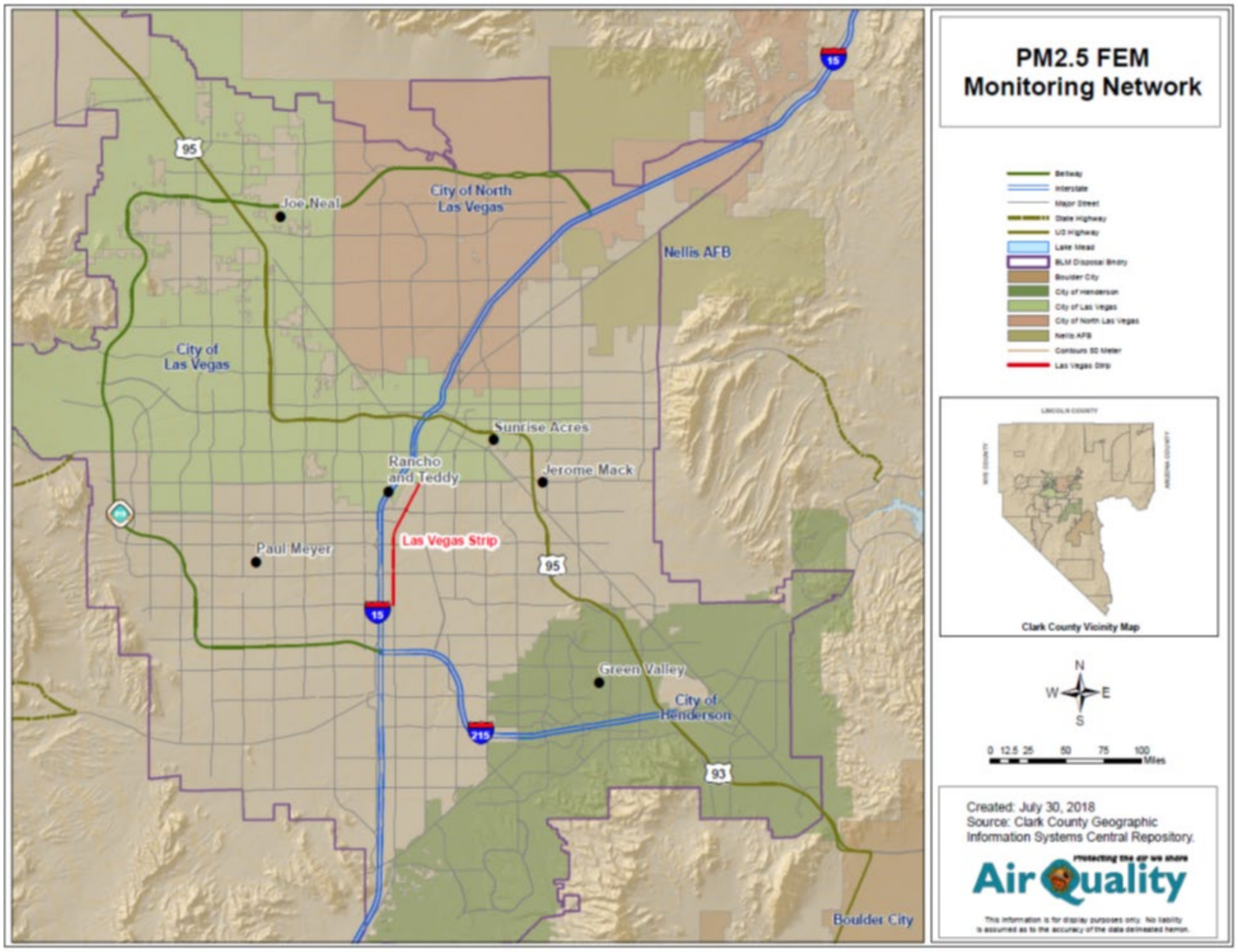
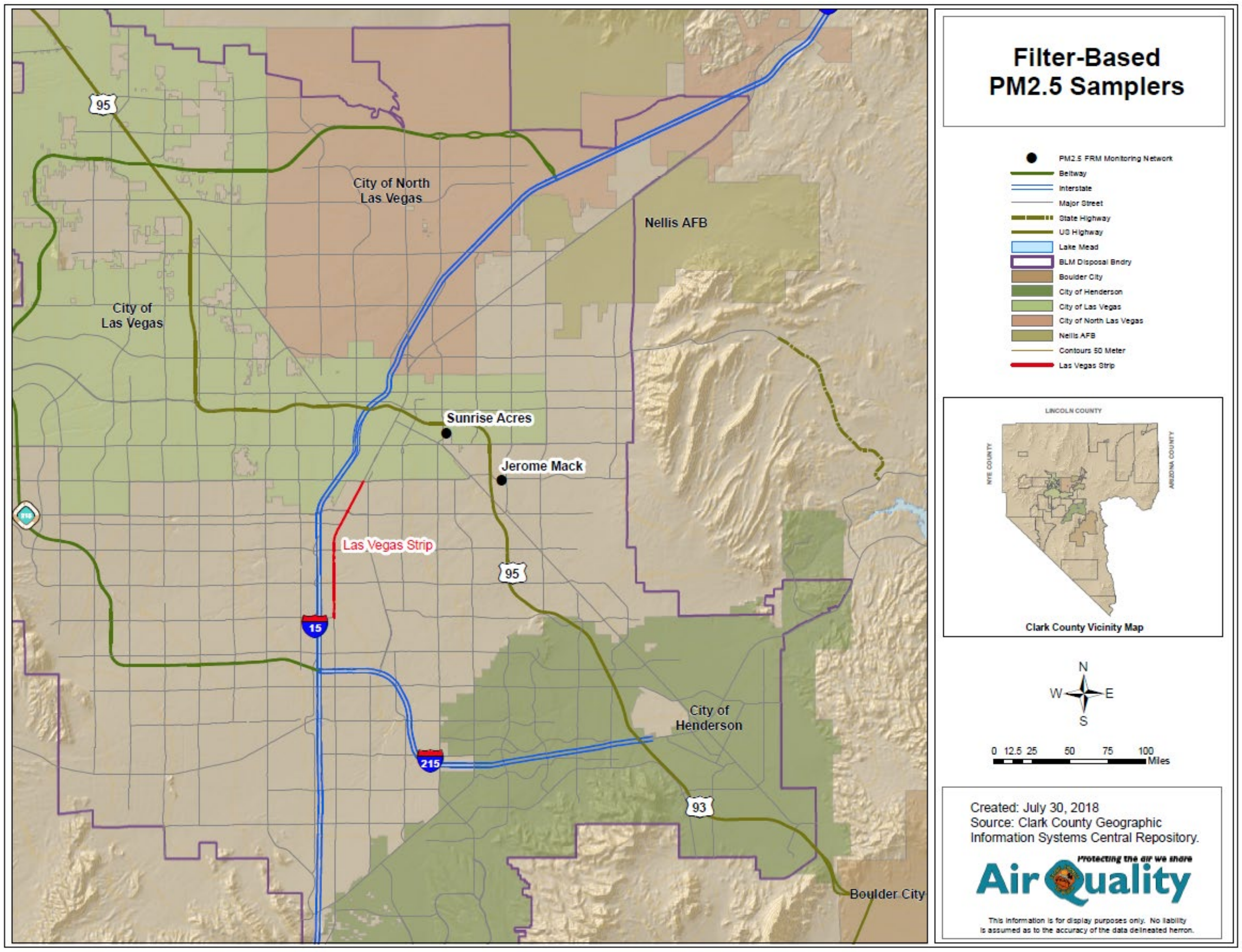


Figure 2-3. Locations of FEM $PM_{2.5}$ Monitors.



Created: July 30, 2018
Source: Clark County Geographic Information Systems Central Repository.

This information is for display purposes only. No liability is assumed as to the accuracy of the data delineated herein.

Figure 2-4. Locations of FRM $PM_{2.5}$ Monitors.

2.2 CHARACTERISTICS OF NON-EVENT OZONE FORMATION

Ozone, a secondary pollutant, is formed by complex processes in the interaction of nitrogen oxides (NO_x), volatile organic compounds (VOCs), temperature, and the intensity of solar radiation. The elevated ozone in the Las Vegas Valley can be characterized as the result of a combination of locally produced ozone under relatively stagnant conditions and different degrees of regional transport from upwind source areas, mainly in California.

2.2.1 Emission Trend

Mobile emission is the largest source of ozone precursors in Clark County. The area adjacent to two major transportation routes, I-15 and U.S. Highway 95, registers the highest emissions in the LVV. Figures 2-5 and 2-6 illustrate the county's ozone planning inventory for NO_x and VOC emissions, respectively, on a typical summer weekday. Throughout the years, ozone has decreased dramatically across much of the eastern United States over the last two decades (He et al.

2013; Lefohn et al. 2010), largely as a result of stricter emission controls on stationary and mobile NO_x sources (Butler et al. 2011; EPA 2012). These same reductions can be seen in California and Clark County.

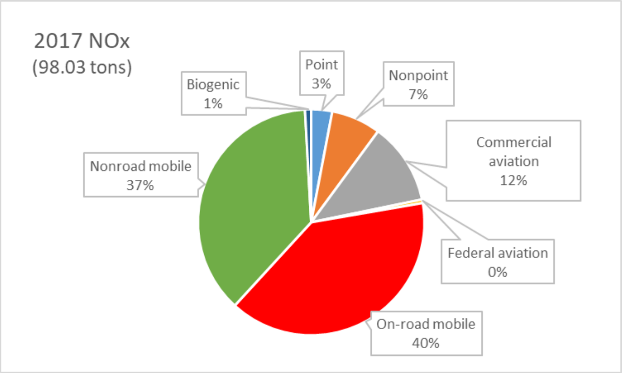


Figure 2-5. Typical Summer Weekday NO_x.

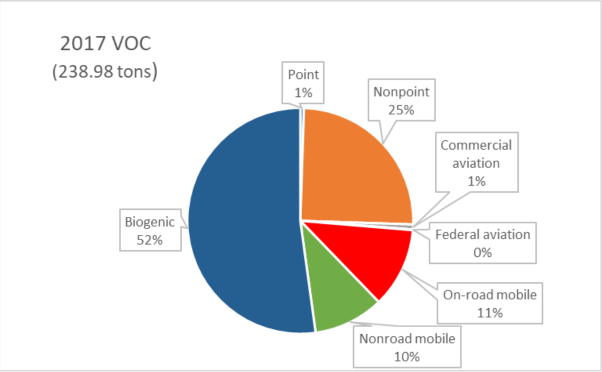
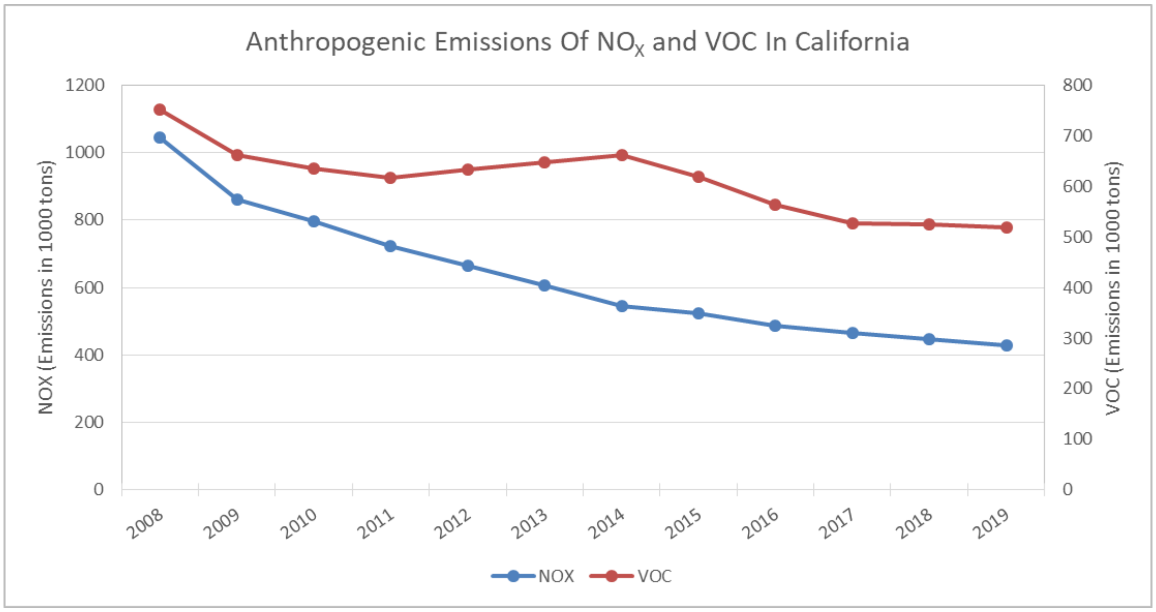


Figure 2-6. Typical Summer Weekday VOCs.

Source: https://www.clarkcountynv.gov/Environmental%20Sustainability/SIP%20Related%20Documents/O3/20200901_2015_O3_EI_ES_SIP_with_Appendices.pdf?t=1619706653363

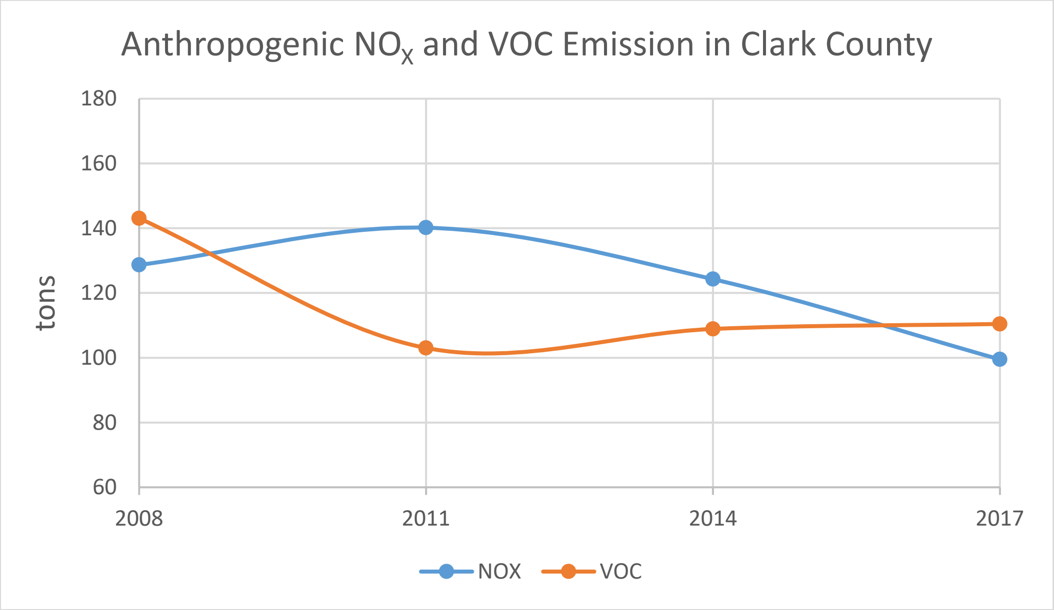
Figure 2-7 shows the downward trends of NO_x and VOC anthropogenic emissions in California from 1990–2019.



Source: https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data (under *State Annual Emissions Trend*).

Figure 2-7. Anthropogenic Emission Trends of NO_x and VOC in California from 2008–2019.

Figure 2-8 shows a downward trend in NO_x emissions and a slight increase in VOC anthropogenic emissions in Clark County from 2008–2017.



Source: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei.

Figure 2-8. Anthropogenic Emission Trends of NO_x and VOCs in Clark County from 2008–2017.

After a substantial reduction in NO_x emissions (approximately 55% in California and 25% locally) over the past 10 years, Figure 2-9 illustrates how the eight-hour ozone 4th-highest averages in Clark County generally trended downward from 2009–2019 (except in 2018).

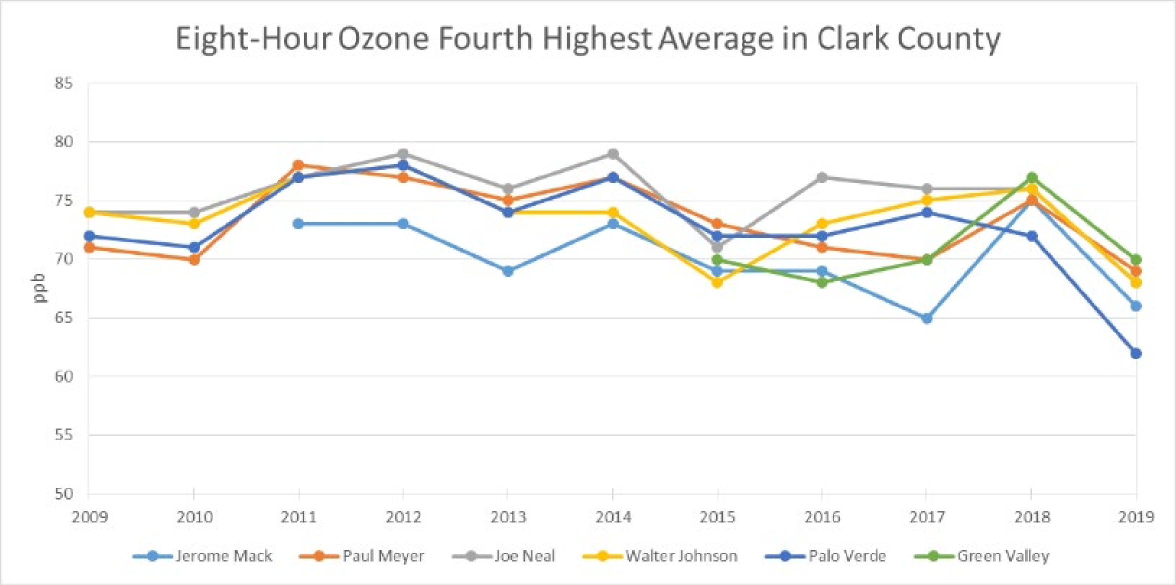


Figure 2-9. Eight-hour Ozone 4th-highest Average at Monitors in Clark County from 2009–2019.

2.2.2 Weather Patterns Leading to Ozone Formation

Most of the high ozone days in the Las Vegas Valley occur from May through August. During these months, warmer temperatures lead to the development of regional-scale southwest-north-east plains-mountain circulations and locally-driven valley and slope flows (Stewart et al. 2002). In general, winds during the nocturnal regime are dominated by downslope flows from the east and southwest converging into Las Vegas; downslope flows have also been observed northeast of the Spring Mountain Range. Southeasterly to southerly wind flow develops during the morning transition period, but the winds shift to the southwest by mid-afternoon as the mixed layer grows in depth and plains-mountain winds driven by the thermal contrast between the land and the Gulf of California develop. This regional-scale flow converges with southeasterly up-valley flow in the Las Vegas Valley, and these winds typically persist until well into the night, when the nocturnal regime prevails again.

The convergence of afternoon southwesterly plain-mountain and southeasterly up-valley flows at the northwestern terminus of the valley frequently results in elevated ozone levels at JO and WJ. Figure 2-10 illustrates the typical ozone season (May–August) diurnal ozone patterns at the 50th and 95th percentiles at all monitors in HA 212. These patterns are based on historic ozone data from 2014–2018.

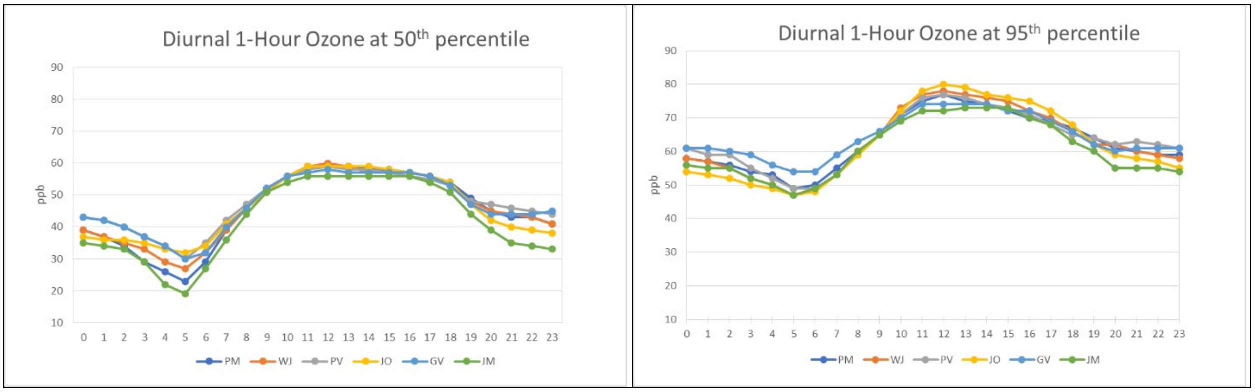
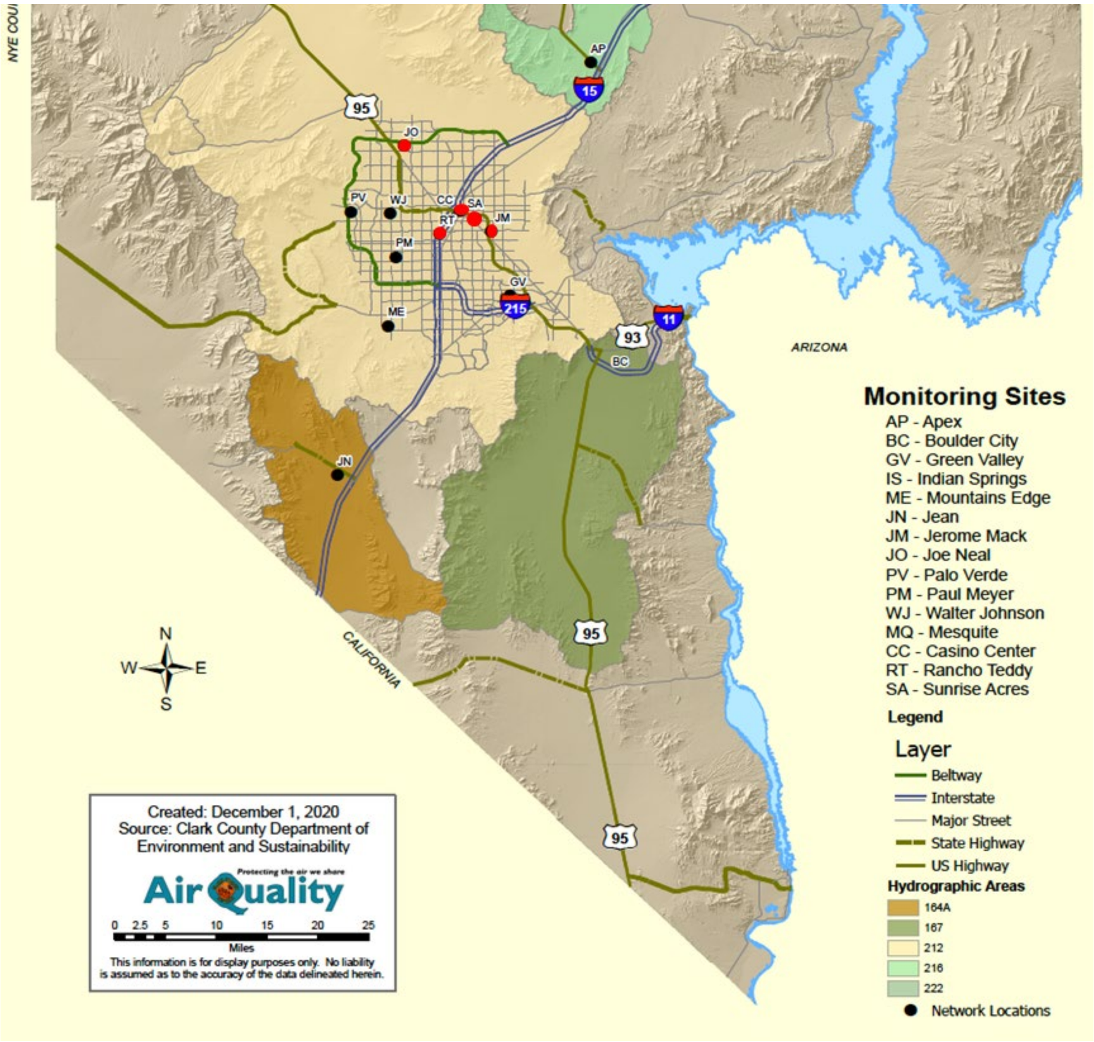


Figure 2-10. Typical Ozone Season 1-Hour Ozone Diurnal Pattern for 50th and 95th Percentile Values at Clark County Monitors.

2.2.3 Weekday and Weekend Effect

Figure 2-11 depicts air quality monitors in the LVV; the NO_2 monitors Rancho Teddy (RT), Casino Center (CC), Sunrise Acres (SA), JM, and JO are marked as red dots. Most anthropogenic precursors are emitted from the urban core and follow a diurnal pattern related to traffic patterns, which peak twice daily at the morning and evening rush hours (Figure 2-12).



Note: Red dots = NO_2 monitors.

Figure 2-11. Locations of NO_2 Monitors.

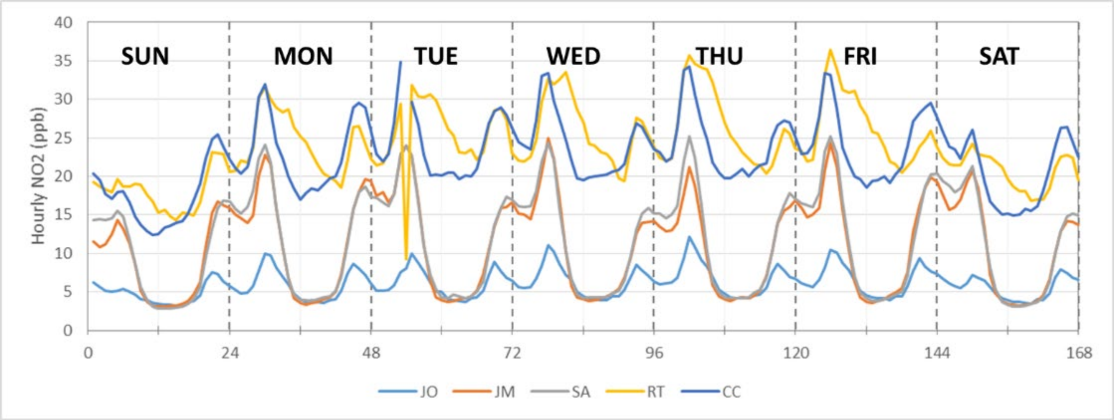


Figure 2-12. Weekly Pattern for 1-Hour NO_2 at Monitors from 2014–2019 (May-August).

Figure 2-13 shows that daily average NO_2 concentrations are lower on weekends than weekdays. The highest NO_2 concentrations are at RT and CC (urban core-downtown), and the lowest are at JO (further downwind). These weekly patterns are based on historic hourly and daily NO_2 concentrations recorded between 2014 and 2019 (May–August).

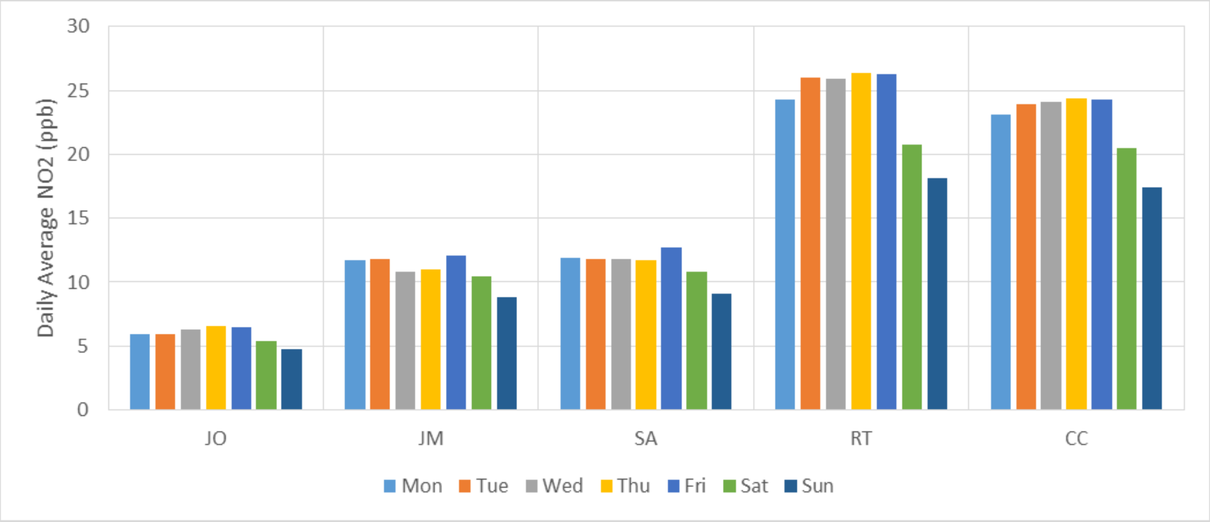


Figure 2-13. Weekly pattern for 24-Hour NO_2 average at Monitors from 2014–2019 (May-August).

Figure 2-14 shows the mean MDA8 O_3 at six monitors in HA 212 (see Figure 2-2) and the upwind monitor at Jean. It shows these sites have a similar weekly pattern, with the highest MDA8 O_3 on Fridays and Saturdays despite significantly lower concentrations of NO_2 (an O_3 precursor) on Saturdays (Figure 2-13). It also indicates MDA8 O_3 at those sites differs minimally between weekdays and weekends, with a maximum difference of 1.7~2.4 ppb. The data in this analysis are based on historic O_3 concentrations recorded between 2014 and 2019 (May–August).

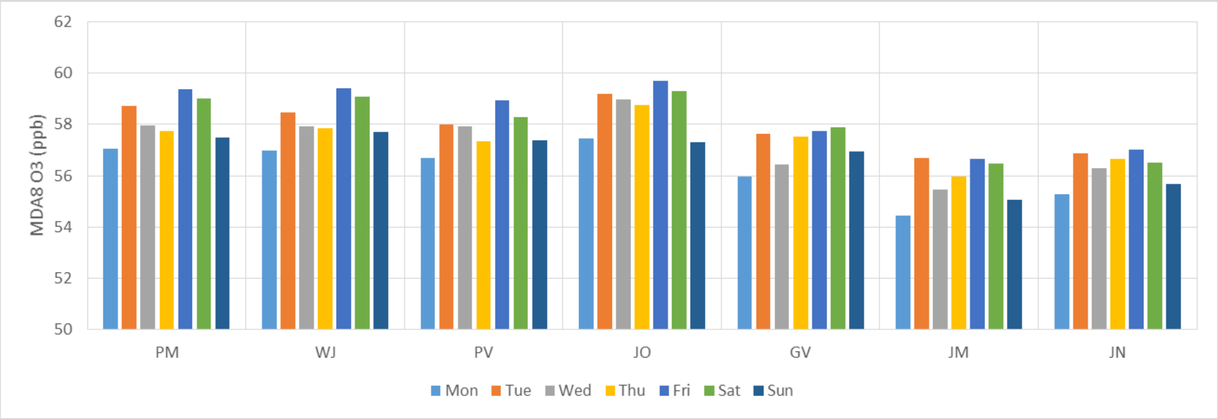


Figure 2-14. Weekly Pattern for MDA8 O_3 Average at Monitors, 2014–2019 (May–August).

3.0 EVENT SUMMARY AND CONCEPTUAL MODEL

3.1 PREVIOUS RESEARCH ON OZONE FORMATION AND SMOKE IMPACTS

The impact of wildfires on ozone concentrations at both local and regional levels has been studied extensively. Nikolov (2008) provides an excellent summary of past studies, as well as a conceptual discussion of the physical and chemical mechanisms contributing to observed impacts. Nikolov concludes that on a regional scale, biomass burning can significantly increase background surface ozone concentrations, resulting in NAAQS exceedances. Pfister et al. (2008) simulated the large fires of 2007 in Northern and Southern California; the authors found ozone increases of approximately 15 ppb in many locations and concluded, "Our findings demonstrate a clear impact of wildfires on surface ozone nearby and potentially far downwind from the fire location, and show that intense wildfire periods frequently can cause ozone levels to exceed current health standards." In a presentation at an emission inventory conference, Pace et al. (2007) modeled the June 2005 California fires, showing that the wildfire impacts added as much as 15 ppb to ozone concentrations in southern Nevada (Figure 3-1).

Finally, in one of DES's own studies (DES 2008), aircraft flights through smoke plumes demonstrated increased ozone concentrations of 15 to 30 ppb in California. Two other field campaign studies (DES 2013 & 2017) conducted by National Oceanic and Atmospheric Administration (NOAA) scientists have shown that large fires in California could have adversely impacted the air quality in Clark County.

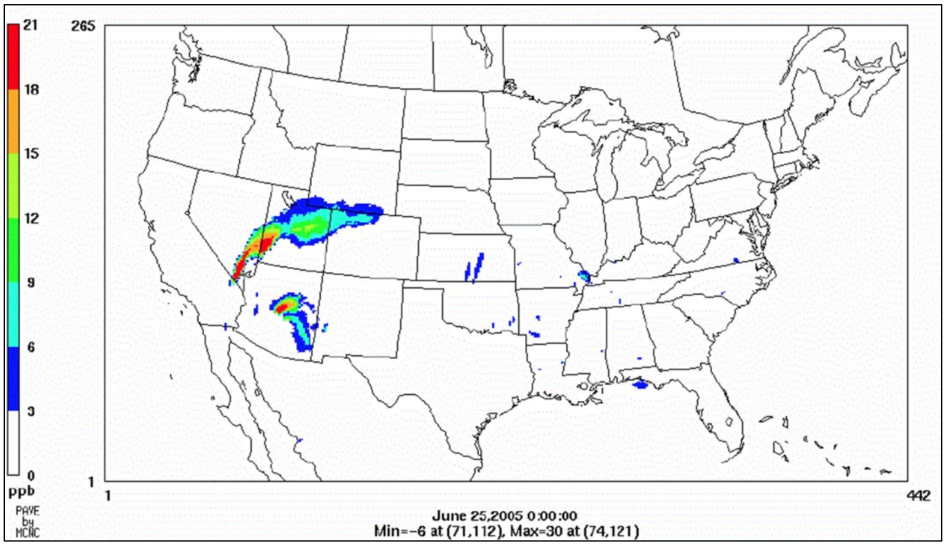
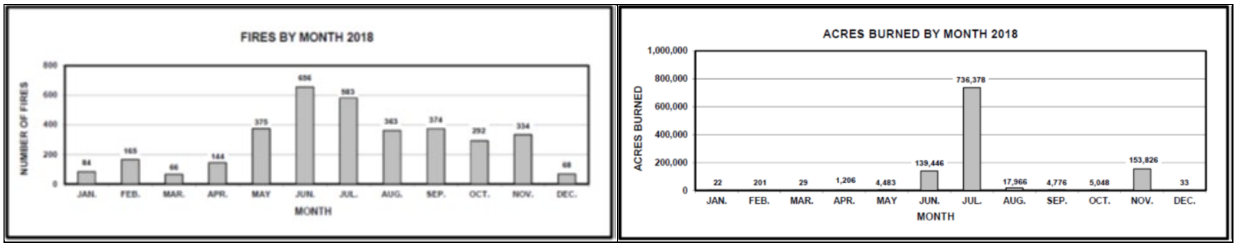


Figure 3-1. Difference ("Fire" / "No Fire") in Maximum 8-hour Ozone for June 25, 2005.

3.2 CALIFORNIA WILDFIRES IN 2018

Wildfires in the western states are worsening every year: they are bigger, hotter, more deadly, and more destructive. In California in 2018, the combination of natural fuel from a record 129 million trees killed by drought and bark beetles (as reported by the United States Forest Service) and compounding atmospheric conditions led to numerous large and small wildfires. The number of fires and burned area increased greatly in June and July, as shown in Figure 3-2. Significant wildfires started breaking out in June of that year; later on in the summer, a series of large wildfires erupted across California, mostly in the northern part of the state, including the destructive Carr and Mendocino Complex Fires.



Source: CAL FIRE 2018 Wildfire Activity Statistics Report.

Figure 3-2. Number of Fires and Acres Burned by Month.

Figure 3-3 shows the more frequent ozone exceedances in the LVV after mid-June, reflecting the impact of the California wildfires during this period.

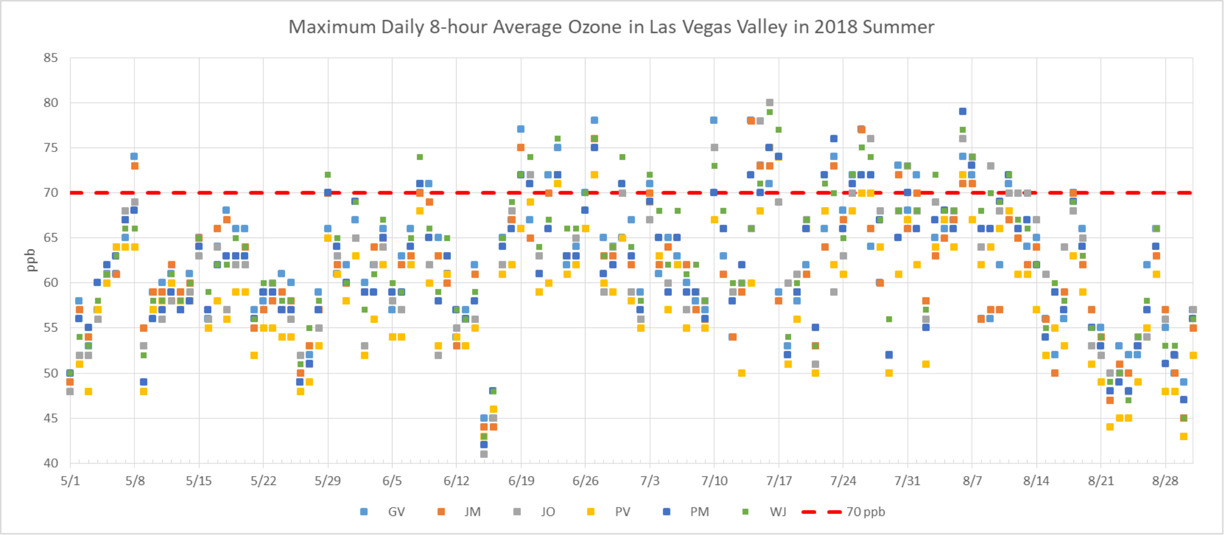


Figure 3-3. MDA8 Ozone Levels at LVV Monitors During 2018 Ozone Season.

3.3 JUNE 19-20, 2018

Several wildfires in California, Nevada and Arizona broke out in mid-June. Figure 4-3 shows the location of wildfires June 15-18, 2018, based on NASA's Fire Information for Resource Management System (FIRMS). They include all the small or large fires detected by different satellites. Two large fires, one in central California and one in western Nevada (near Carson City) had burned more than 1,000 acres. The Planada Fire, which started on June 15 in Merced County, California, burned more than 1,000 acres in the days prior to this event. A total of 4,563 acres burned before the fire was contained on June 21. The second big fire, Upper Colony, started on the morning of June 17 when overheated truck brakes set dry grass on fire in Smith Valley, Nevada, less than 200 km from where the Planada Fire was already burning. The Upper Colony Fire scorched a total of 1,202 acres before it was contained on June 22. Figure 3-5 shows smoke plumes from Upper Colony Fire on June 17 and from Planada Fire on June 18 based on NOAA HMS smoke analysis.

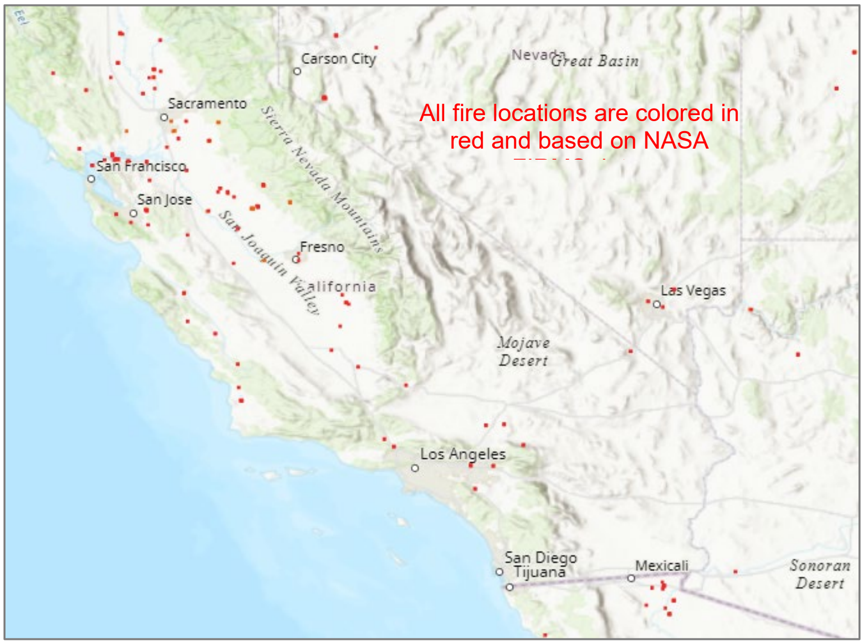


Figure 3-4. Fire Locations June 15–18.

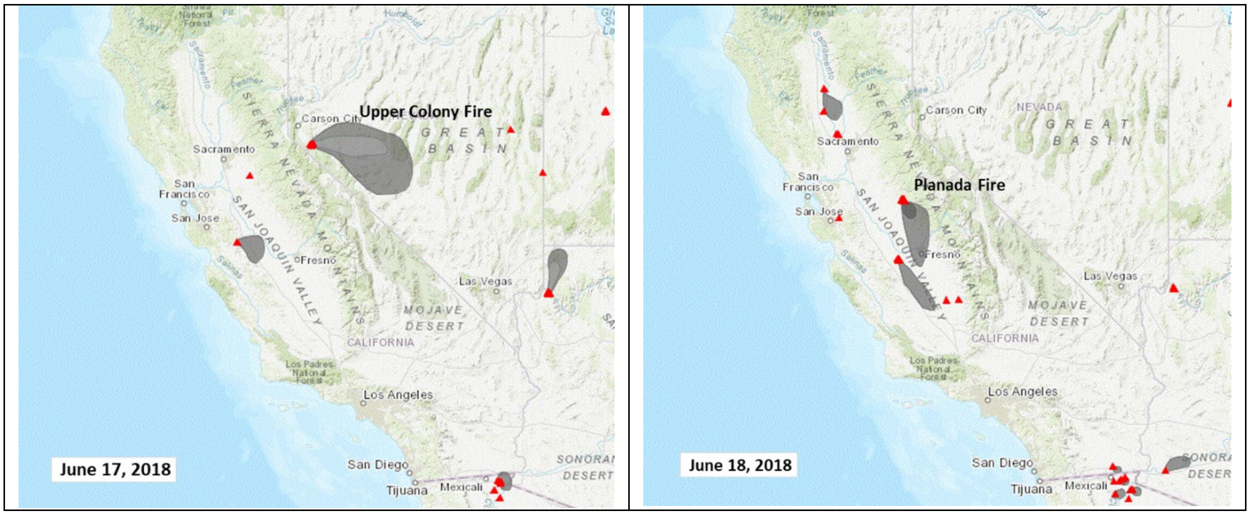
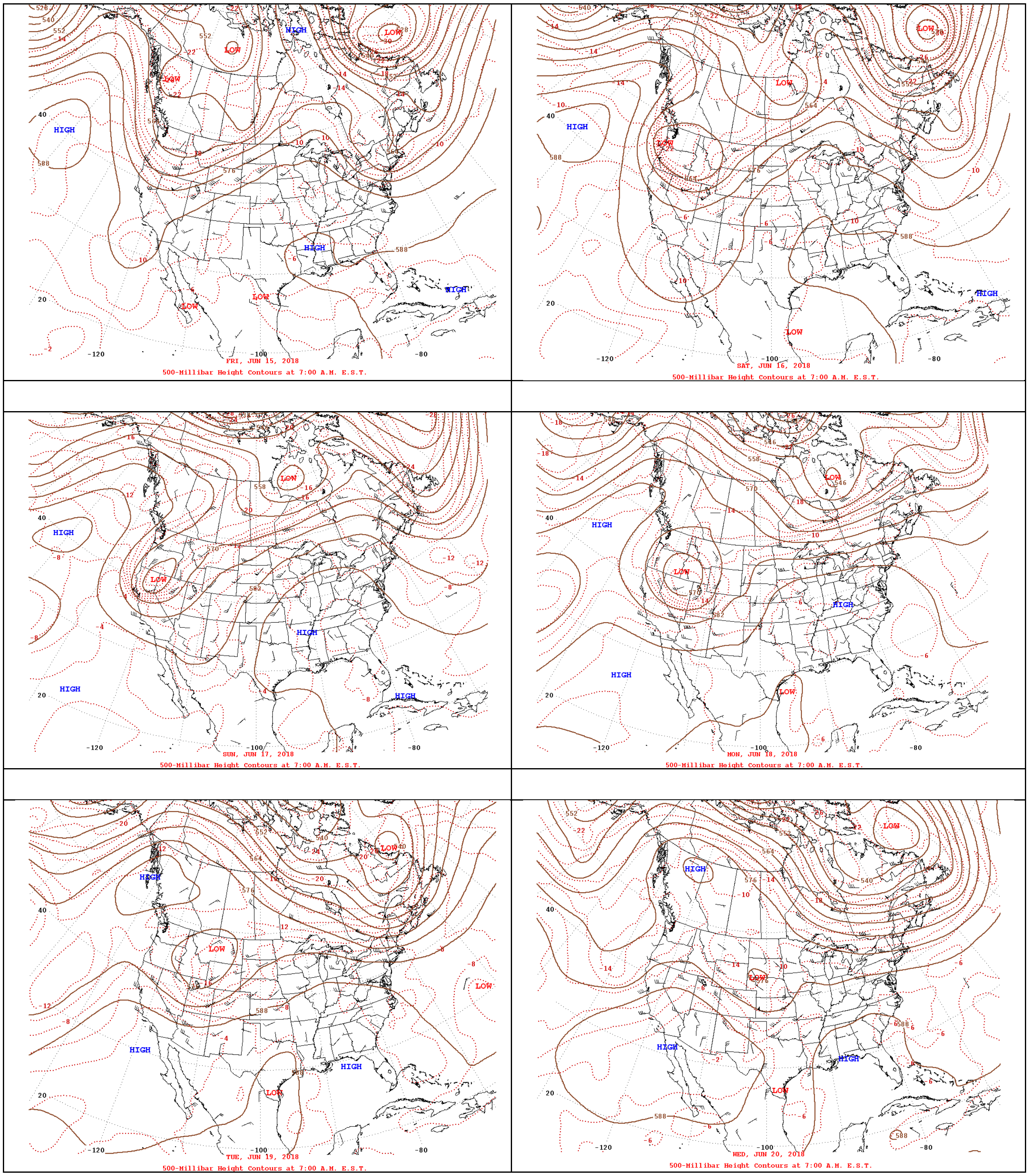


Figure 3-5. NOAA Daily HMS Smoke Analysis on June 17-18.

An examination of the synoptic weather patterns at the 500-mb level from June 15–20 (Figure 3-6) shows a high pressure system moving toward the West Coast and dominating the region on June 19 and 20. The airflow in the region was mainly westerly and northwesterly; consequently, the elevated smoke from the Planada and Upper Colony fires was transported to central and southern Nevada. The continued south-eastward movement of the low-pressure system from British Columbia, Canada, turned north-eastward during June 17–18. At surface, the airflow were generally blowing south-southwesterly to the LVV during June 15-17 and a stationary front was passing through central Nevada (Figure 3-7) and forcing the smoky air down to the surface (i.e., subsidence) from numerous wildfires in California. As a result, the ozone concentration at a downwind site, the Great Basin, a regional background site in central-east Nevada, recorded ozone significantly above normal level for June 17-18 with a peak ozone level of 71 ppb at 11:00 PM on June 17 (Figure 3-8) and the ozone at the monitors in the LVV (Figure 3-9) started to increase significantly since late afternoon on June 17. Beginning June 18, this stationary front reached southern Nevada and slowly moved east. On June 19-20, a stable weather system consisting of high temperatures, a lack of clouds, and light, variable winds was developing in the LVV and favoring ozone formation as shown in Figure 3-10 and 3-11 for surface and upper weather condition, respectively. The local surface wind flow in Figure 3-12 was mainly northwest-north in the morning and light southeast-southwest in the afternoon on June 19 and 20.


FRI, JUN 15, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

SAT, JUN 16, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

SUN, JUN 17, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

MON, JUN 18, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

TUE, JUN 19, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

WED, JUN 20, 2018
500-Millibar Height Contours at 7:00 A.M. E.S.T.

Figure 3-6. 500-mb Weather Patterns at 7 AM EST, June 15–20.

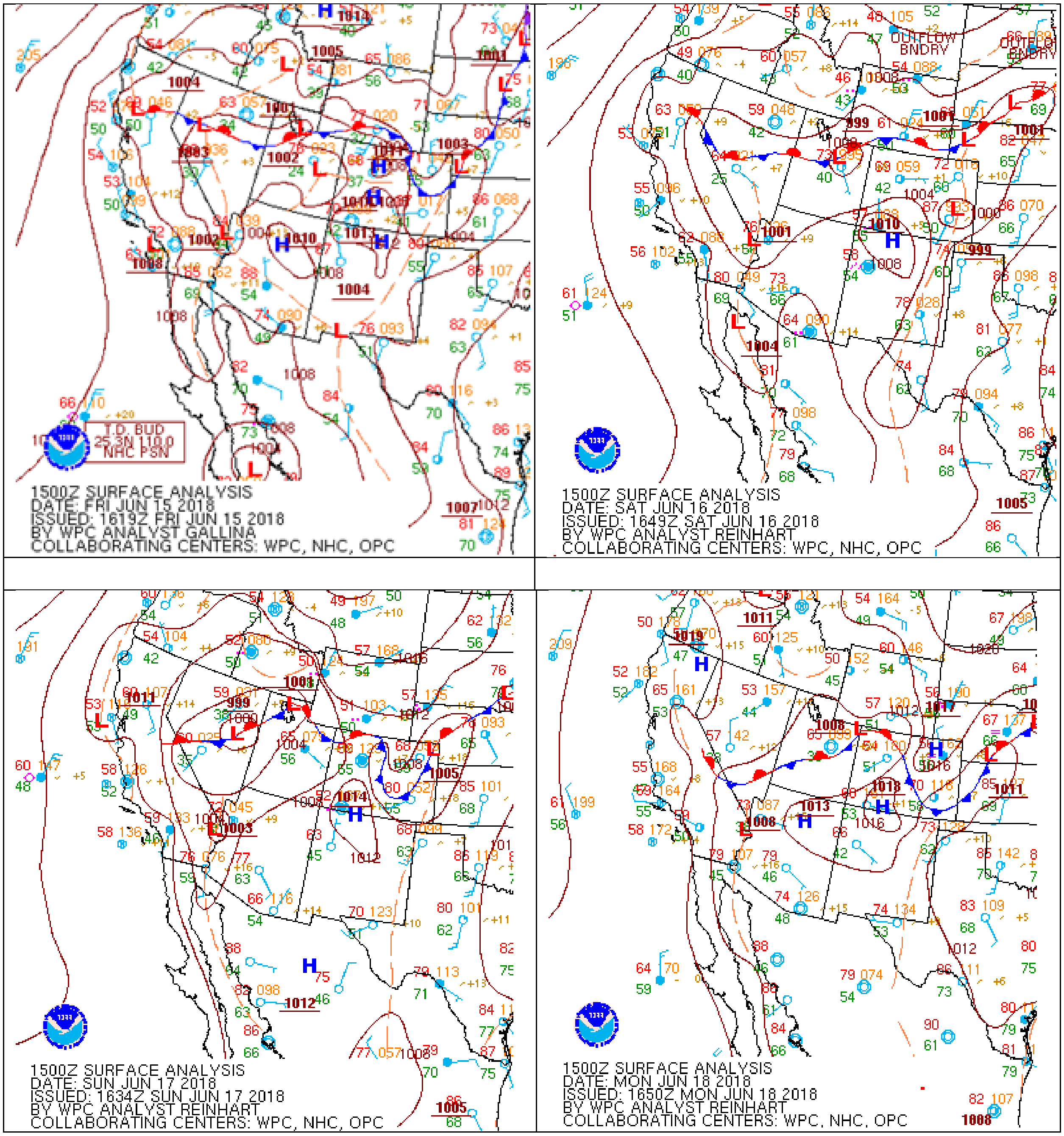


Figure 3-7. Surface Weather Maps, June 15–20 (continued on next page).

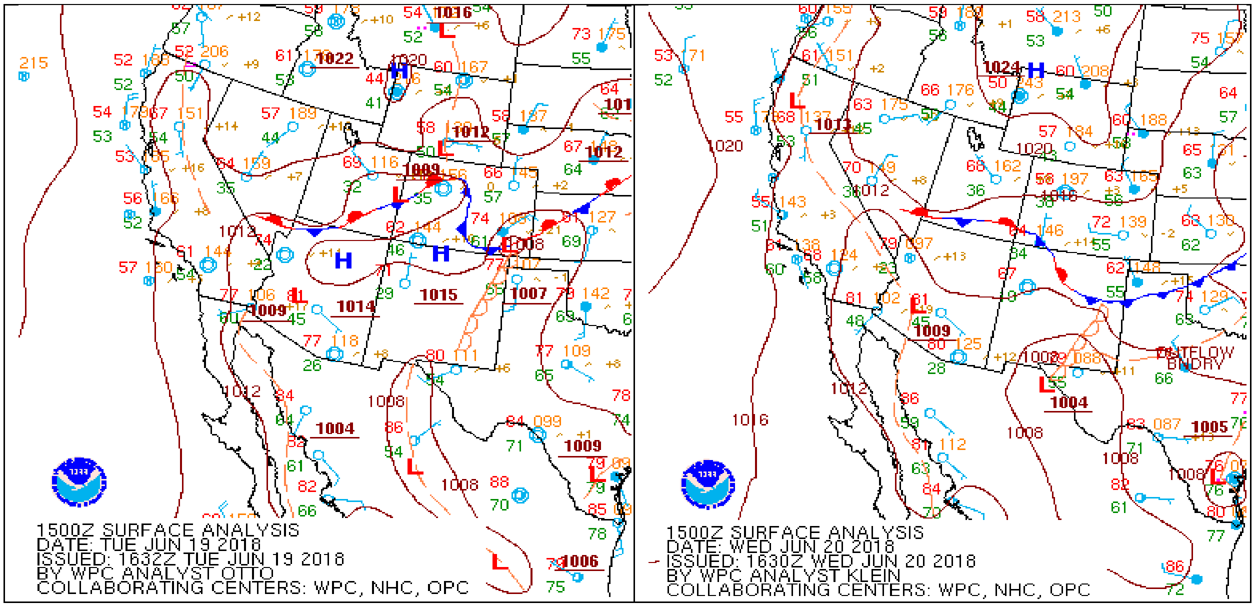


Figure 3-7. Surface Weather Maps, June 15–20 (continued).

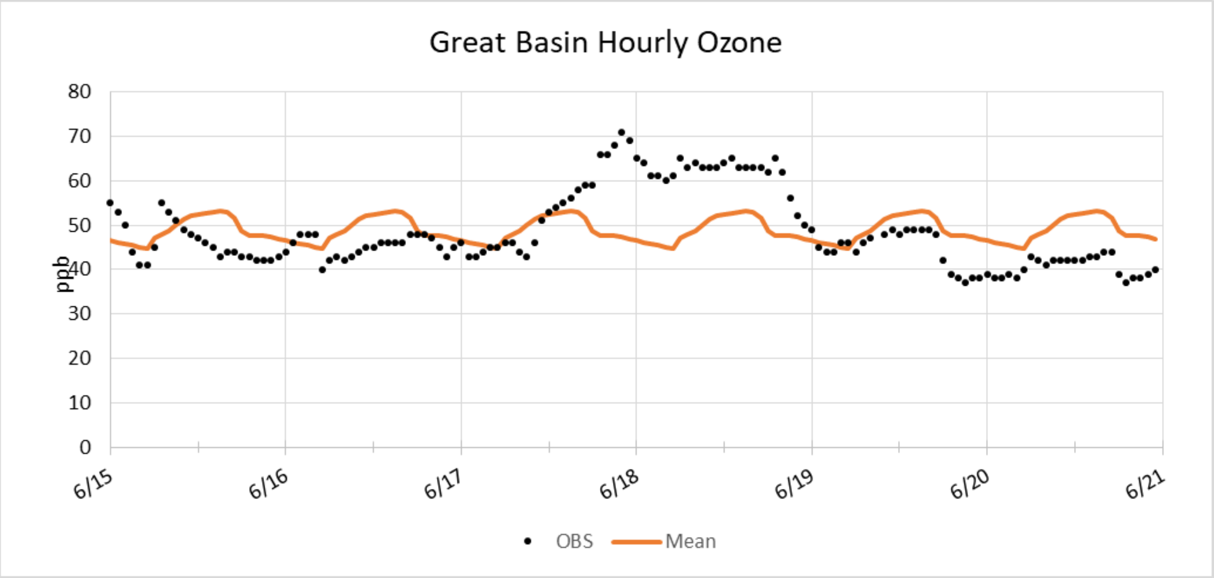


Figure 3-8. Hourly Ozone Concentrations at Great Basin, June 15–20.

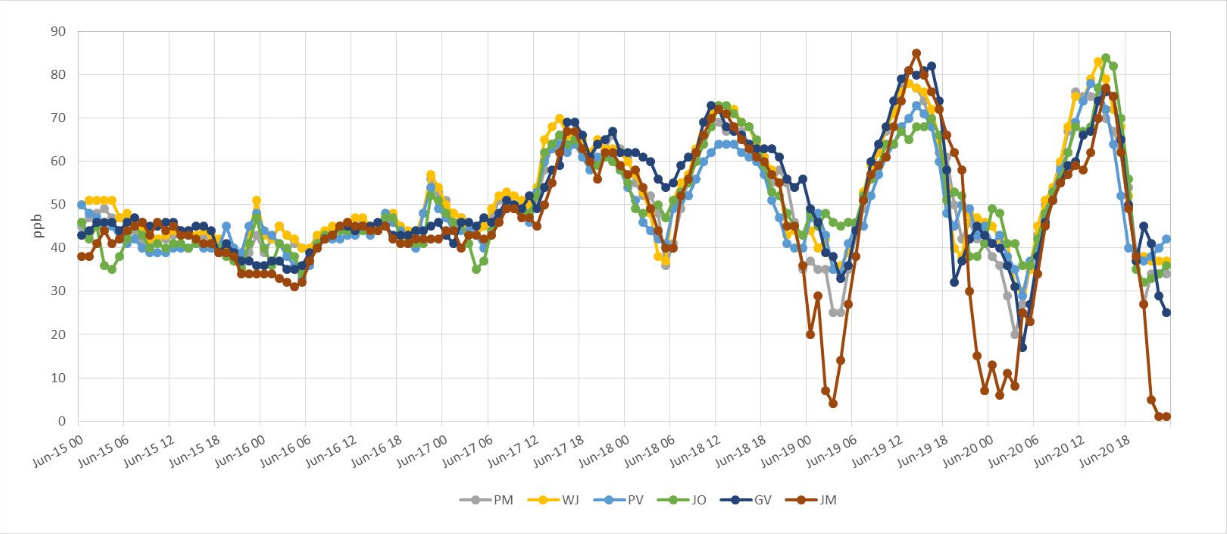
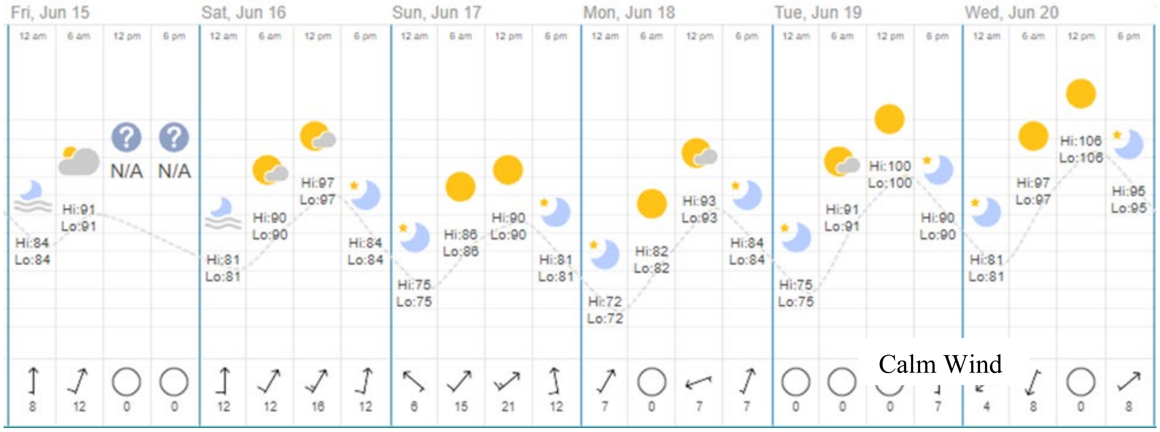
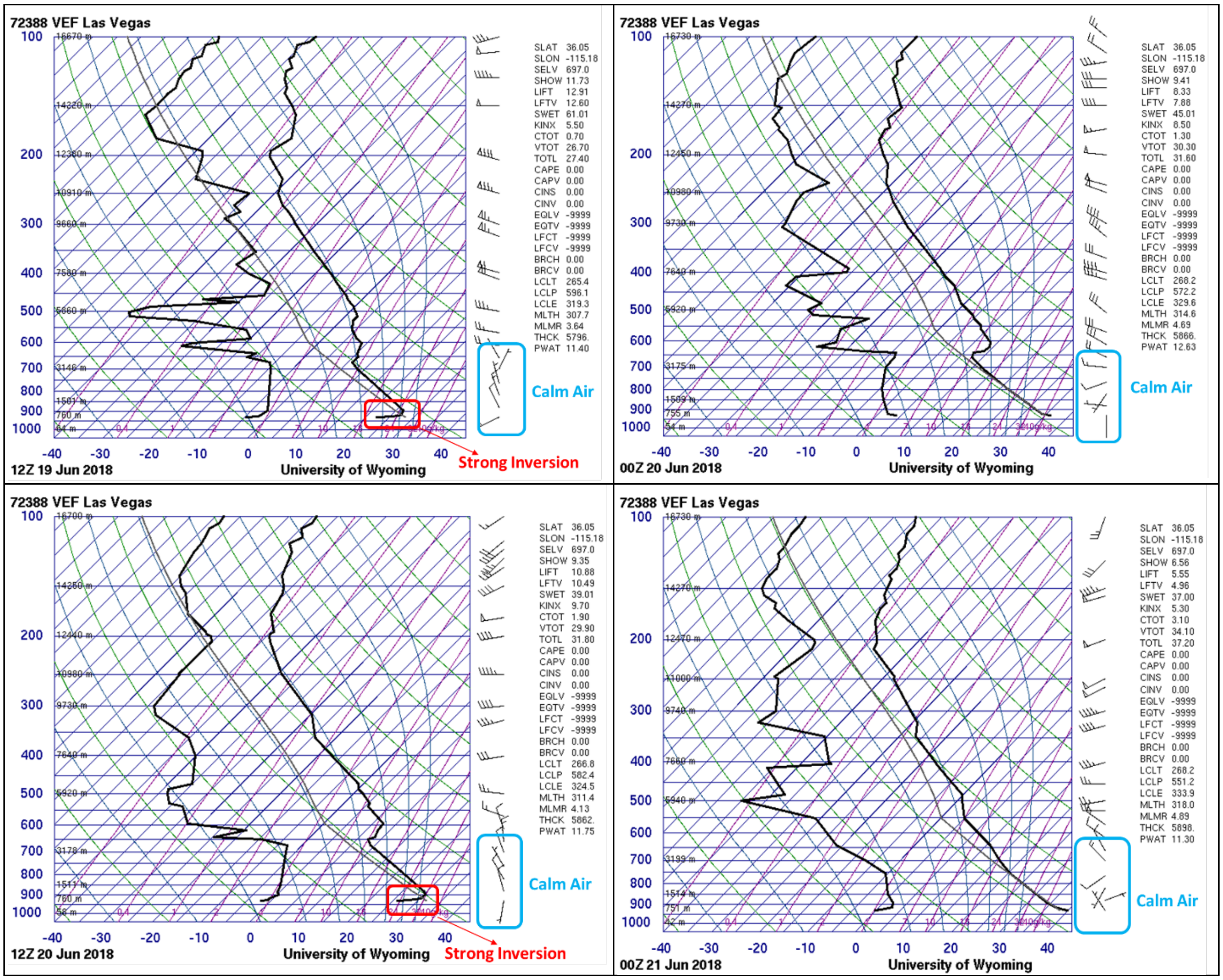


Figure 3-9. Hourly Ozone Concentrations at Paul Meyer (PM), Walter Johnson (WJ), Palo Verde (PV), Joe Neal (JO), Green Valley (GV) and Jerome Mack (JM), June 15–20.



Source: https://www.timeanddate.com/weather/usa/las-vegas/historic

Figure 3-10. Surface LVV Weather, June 15-20.



Source: http://weather.uwyo.edu/upperair/sounding.html

**Figure 3-11.	Upper LVV Weather: Skew-T diagrams from June 19 and 20, 2018.**

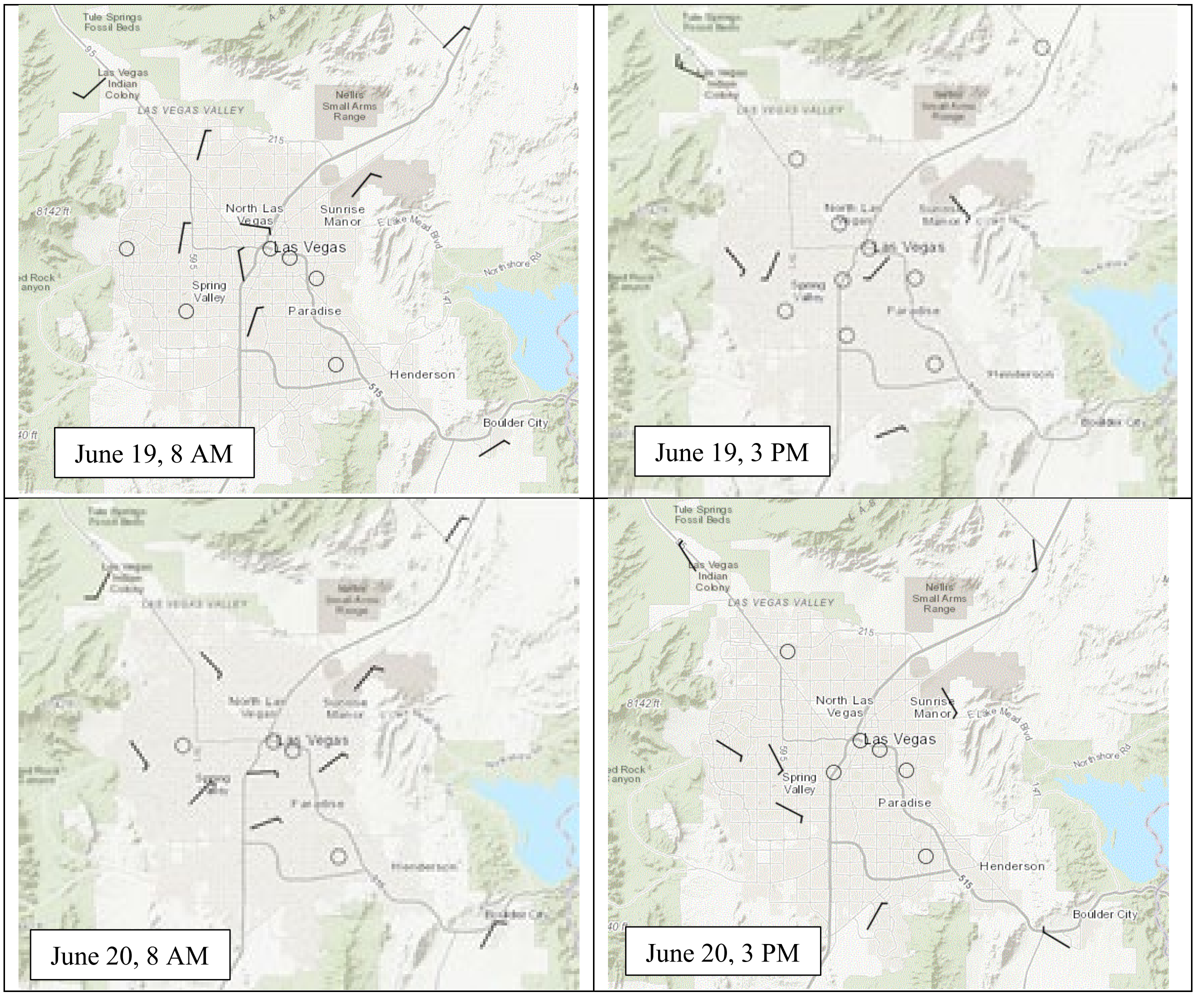
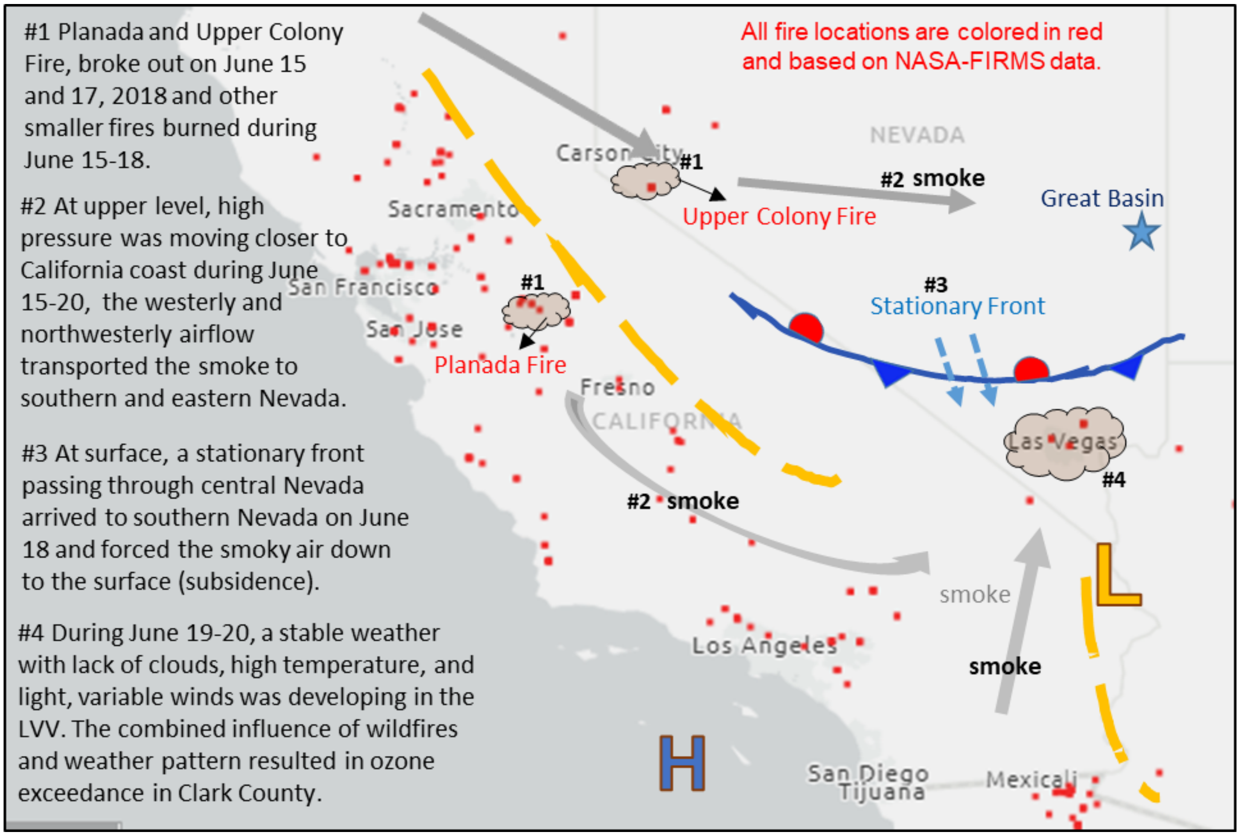


Figure 3-12. Surface Wind in Las Vegas Valley, June 19 & 20.

As a result of stable weather dominance and the transport of ozone and ozone precursors from wildfires into the LVV, four monitors in Clark County on June 19, and three monitors on June 20, recorded exceedances of the 70 ppb 8-hour ozone NAAQS of 2015, as listed in Table 1-1. Figure 3-13 illustrates a simplified conceptual model of the June 19 and 20, 2018, wildfire-influenced ozone event.



#1 Planada and Upper Colony Fire, broke out on June 15 and 17, 2018 and other smaller fires burned during June 15-18.

#2 At upper level, high pressure was moving closer to California coast during June 15-20, the westerly and northwesterly airflow transported the smoke to southern and eastern Nevada.

#3 At surface, a stationary front passing through central Nevada arrived to southern Nevada on June 18 and forced the smoky air down to the surface (subsidence).

#4 During June 19-20, a stable weather with lack of clouds, high temperature, and light, variable winds was developing in the LVV. The combined influence of wildfires and weather pattern resulted in ozone exceedance in Clark County.

All fire locations are colored in red and based on NASA-FIRMS data.

Figure 3-13. Simple Conceptual Model of June 19 & 20 Wildfire-Influenced Ozone Event.

4.0 CLEAR CAUSAL RELATIONSHIP

4.1 ANALYSIS APPROACH

Based on EPA's exceptional event guidance, this package provides Tier 1, Tier 2, and Tier 3 analyses to demonstrate a clear causal relationship between the wildfire event and monitored ozone exceedances. The demonstrations in this section provide (1) a comparison of the ozone data requested for exclusion against historical ozone concentrations at the monitor, and (2) a presentation of the path along which the fire's emissions were transported to the affected monitors. The following analyses and evidence are provided.

Tier 1 Analyses

- Event day's ozone are 5–10 ppb higher than non-event-related concentrations (95th percentiles for hourly seasonal ozone for 2014–2018).

Tier 2 Analyses

- Key Factor #1: Q/d Analysis
- Key Factor #2: Comparison of the event-related MDA8 ozone with historical non-event-related high ozone concentrations (>99th percentile from 2014 to 2018 of MDA8 ozone or the top four highest daily ozone measurements).
- Smoke map
- HYSPLIT backward trajectories
- Satellite retrieval
- Concurrent rise in ozone concentration
- $PM_{2.5}$ speciation data
- Supporting ground measurements

  Event-related diurnal $PM_{2.5}$, NO_2, and CO (wildfire plume components) concentrations showed elevated concentrations and/or changes in diurnal profile consistent with smoke impacts.

Tier 3 Analyses9

- GAM statistical model.

Key factor #1 for a Tier 2 analysis uses an **emissions divided by distance (Q/d)** relationship to estimate the influence of fire emissions on a downwind monitor. If Q/d • (daily aggregated fires) ≥ 100, then the fires satisfy the Q/d test.

A GAM is a type of statistical model that allows the user to predict a response based on the linear and non-linear effects of multiple variables (Wood 2017). A GAM model developed by Sonoma Technology was used to describe the relationship between MDA8 levels ozone and primary (prior day's ozone, meteorological and transport) predictors (2014-2020). The details for the model's construction and verification are described in Section 3.3.3 "GAM Statistical Modeling," of *Exceptional Event Demonstration for Ozone Exceedances in Clark County, Nevada—*

June 22, 2020. By comparing GAM-predicted ozone values with actual measured ozone concentrations (i.e., residuals), we can determine the effect of outside influences (e.g., wildfires or stratospheric intrusions) on ozone concentrations each day (Jaffe et al. 2004). The GAM model results presented in this document contain MDA8 ozone predictions, residuals, positive 95th percentile value, predicted fire influence and percentile rank of positive residuals based on EPA guidance (EPA 2016), which are used to estimate the fire influence under the meteorological conditions recorded at exceeding sites.

4.2 COMPARISON OF EVENT-RELATED CONCENTRATIONS WITH HISTORICAL CONCENTRATIONS

Outside the transport of ozone and its precursors from California wildfires, elevated ozone levels in the LVV correlate to local weather conditions and home-grown (Figure 2-7) and upwind (Figure 2-8) California emissions. The declining ozone trend in the LVV (Figure 2-9) reflects the reduction of these emissions over the years. However, 2018 was an exceptional year, with more ozone exceedances than any of the prior years of 2014–2017 (Figure 1-1).

In general, warm, dry weather is more conducive to ozone formation than cool, wet weather. High winds tend to disperse pollutants and can dilute ozone concentrations. We examined three meteorological variables—daily maximum surface temperature, daily average wind speed, and daily average relative humidity—from 2014–2018 summer months at McCarran International Airport to depict the year-to-year variation of local weather conditions (Figure 4-1).

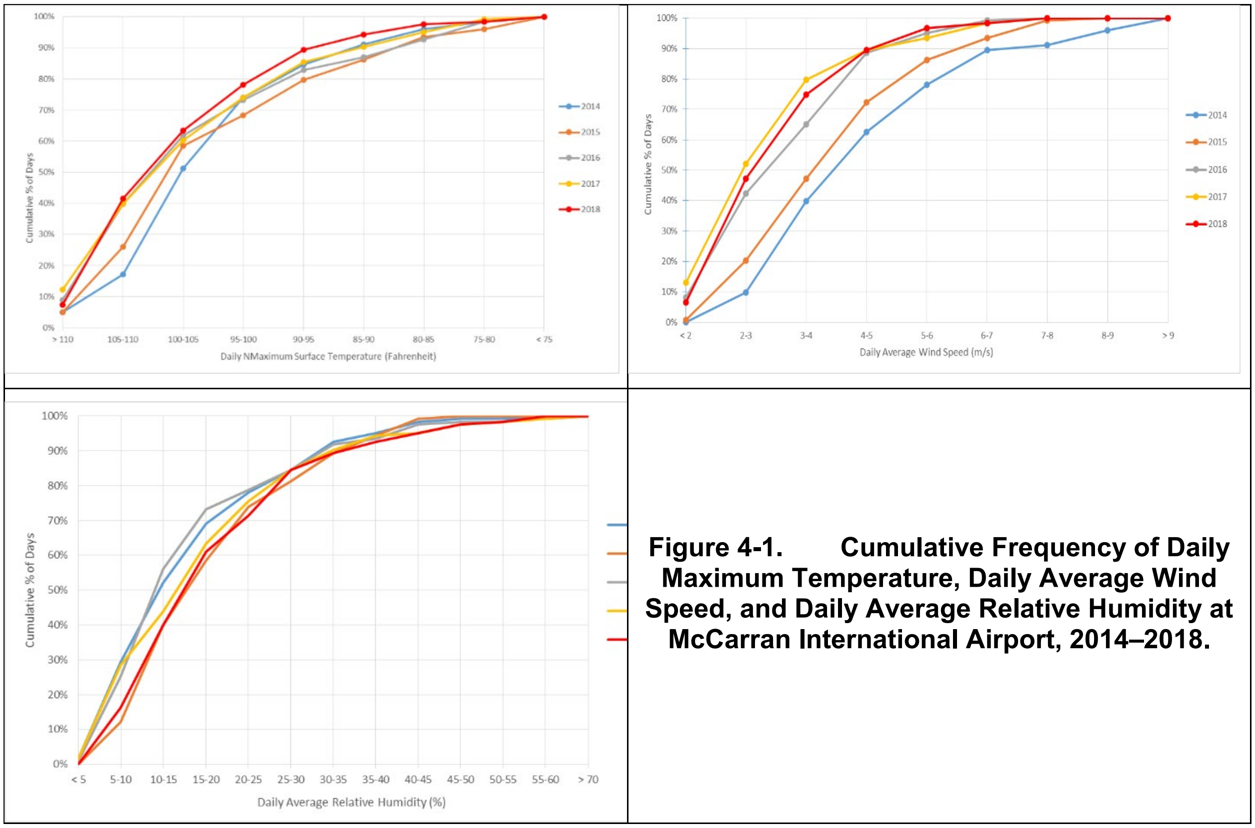


Figure 4-1. Cumulative Frequency of Daily Maximum Temperature, Daily Average Wind Speed, and Daily Average Relative Humidity at McCarran International Airport, 2014–2018.

Overall, 2018 had slightly higher temperatures, lower wind speeds, and slightly more moisture compared to previous years. Yet the mean of the 2018 MDA8 ozone is between 4.4 and 7.2 ppb higher than other years, as shown in Figure 4-2. Compared to 2014–2017, summer 2018 had more California wildfires (Figure 1-1) and relatively stagnant weather conditions (Figure 4-1). Therefore, the background ozone in the LVV increased (Figure 4-2), resulting in a higher number of ozone exceedances than in previous years.

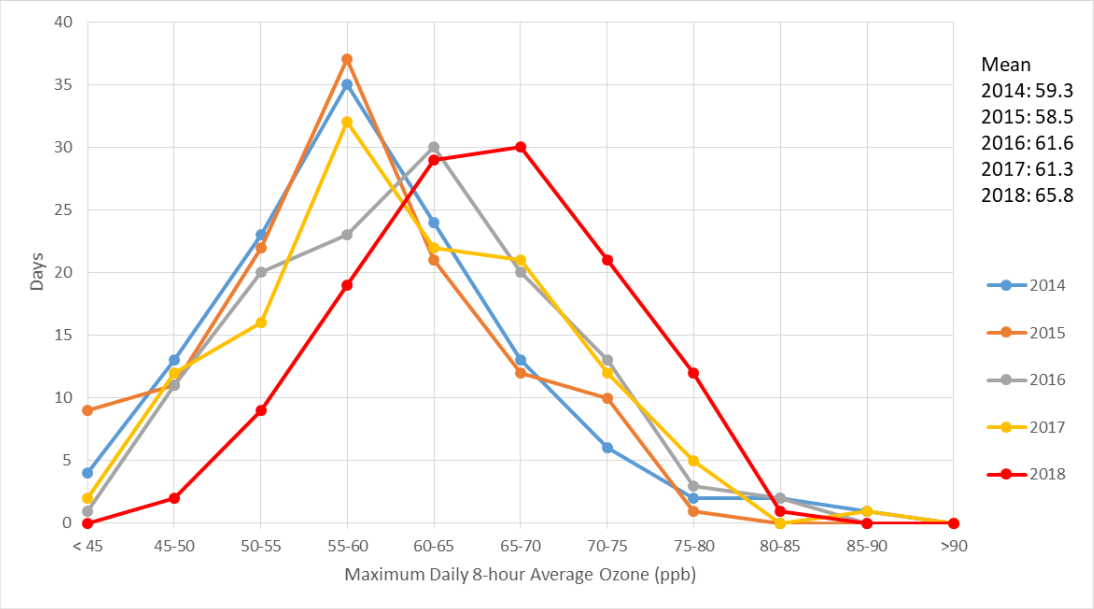


Figure 4-2. Distribution of Days by MDA8 Ozone Levels, 2014–2018.

Figures 4-3 through 4-8 show MDA8 ozone during the 2014–2018 ozone seasons plotted for each monitor against that monitor’s multiseason 95th and 99th percentiles. Red circles indicate the ozone exceedances submitted in the all concurred 2018 exceptional events demonstration. All but the following sites and dates exceeded the 95th percentile: **Walter Johnson on June 19** and July 15; Palo Verde on July 26 and 27; and **Joe Neal on June 20**, 23, and 27.

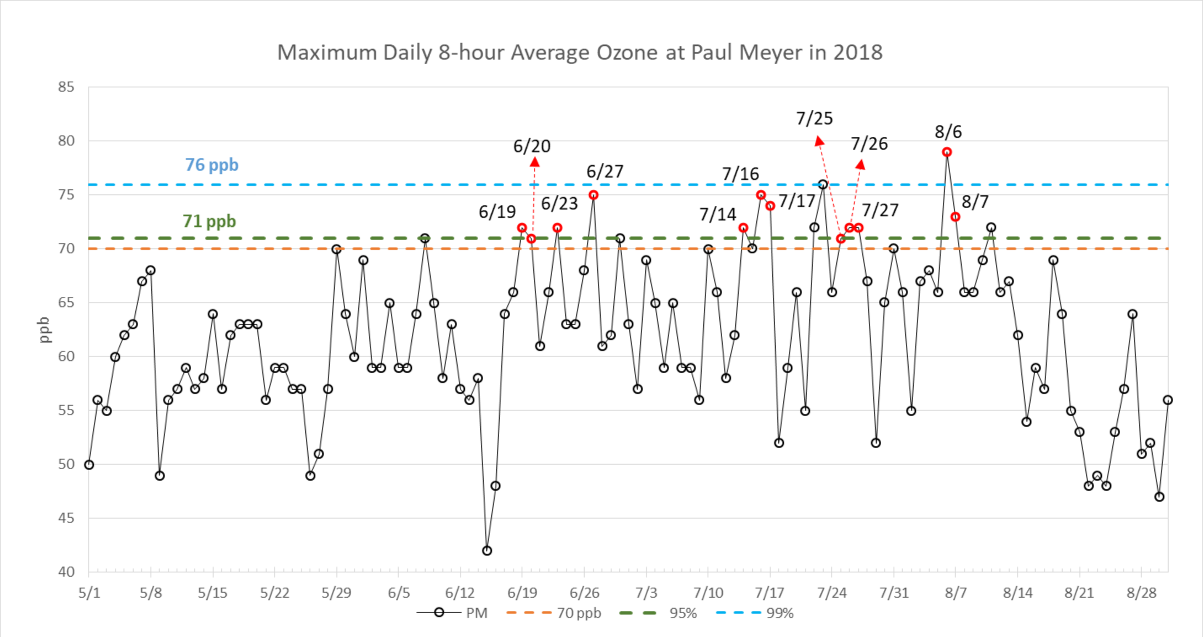


Figure 4-3. MDA8 Ozone at Paul Meyer, 2018 Ozone Season.

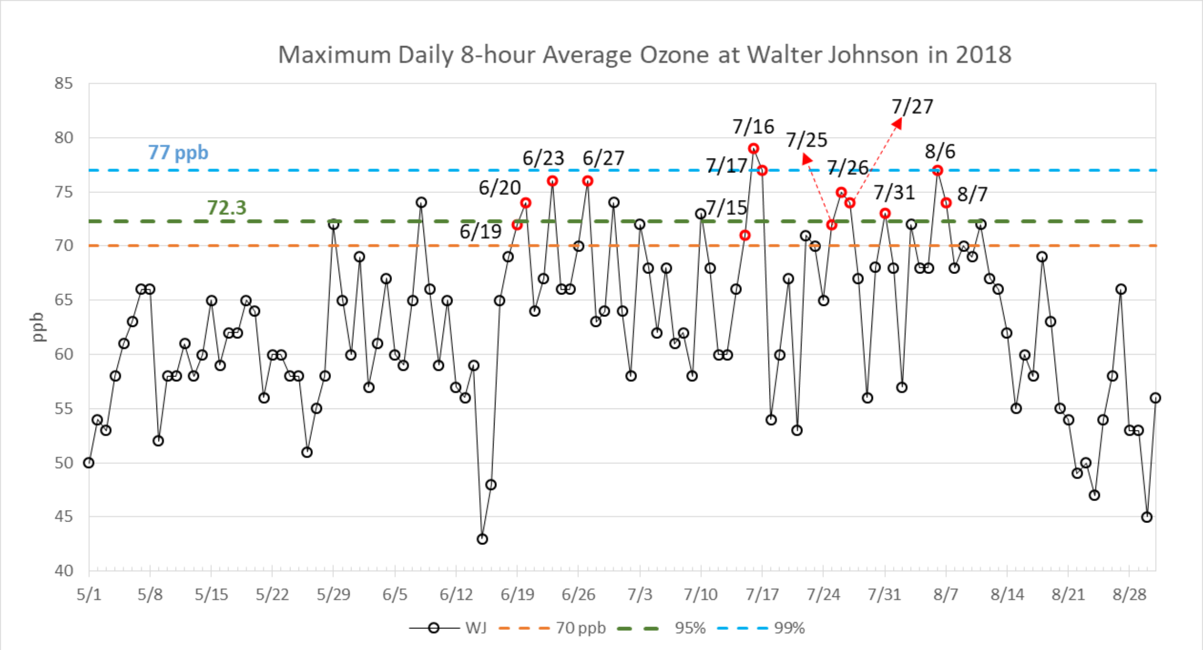


Figure 4-4. MDA8 Ozone at Walter Johnson, 2018 Ozone Season.

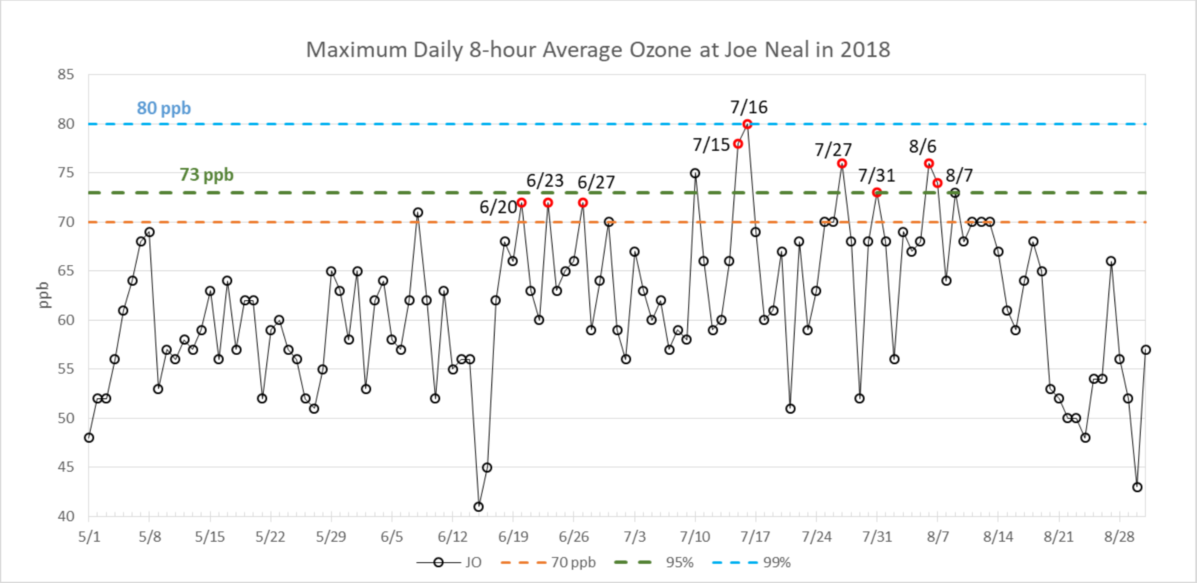


Figure 4-5. MDA8 Ozone at Joe Neal, 2018 Ozone Season.

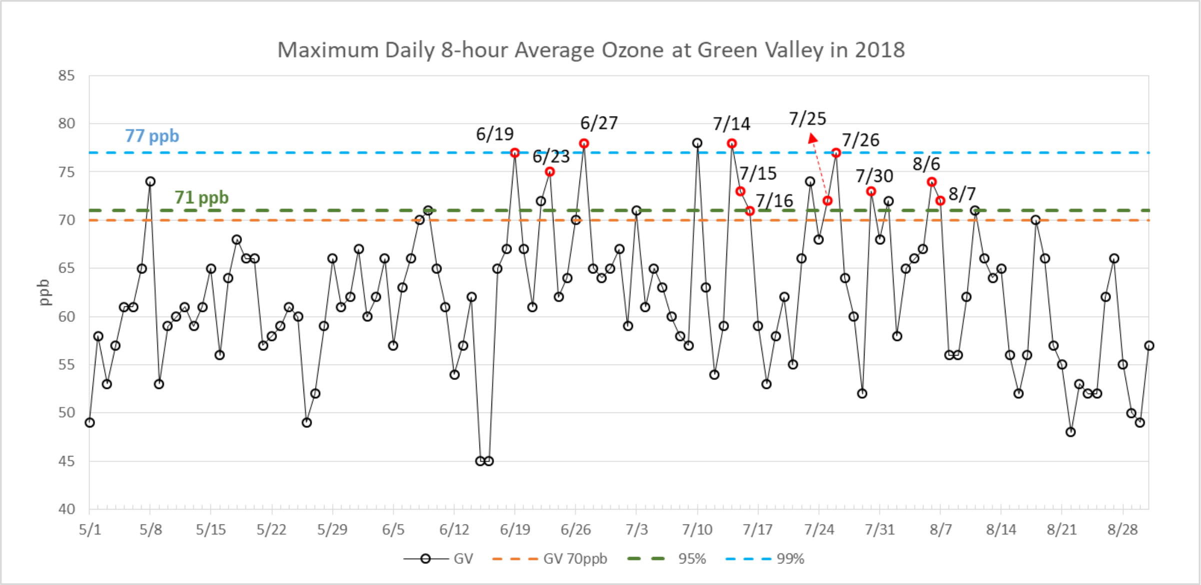


Figure 4-6. MDA8 Ozone at Green Valley, 2018 Ozone Season.

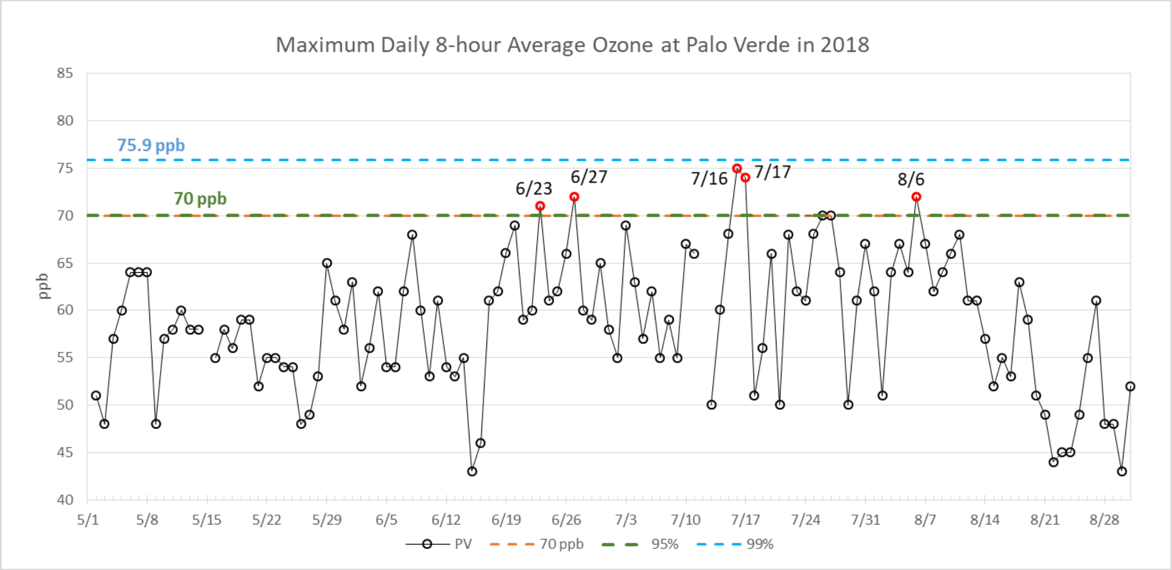


Figure 4-7. MDA8 Ozone at Palo Verde, 2018 Ozone Season.

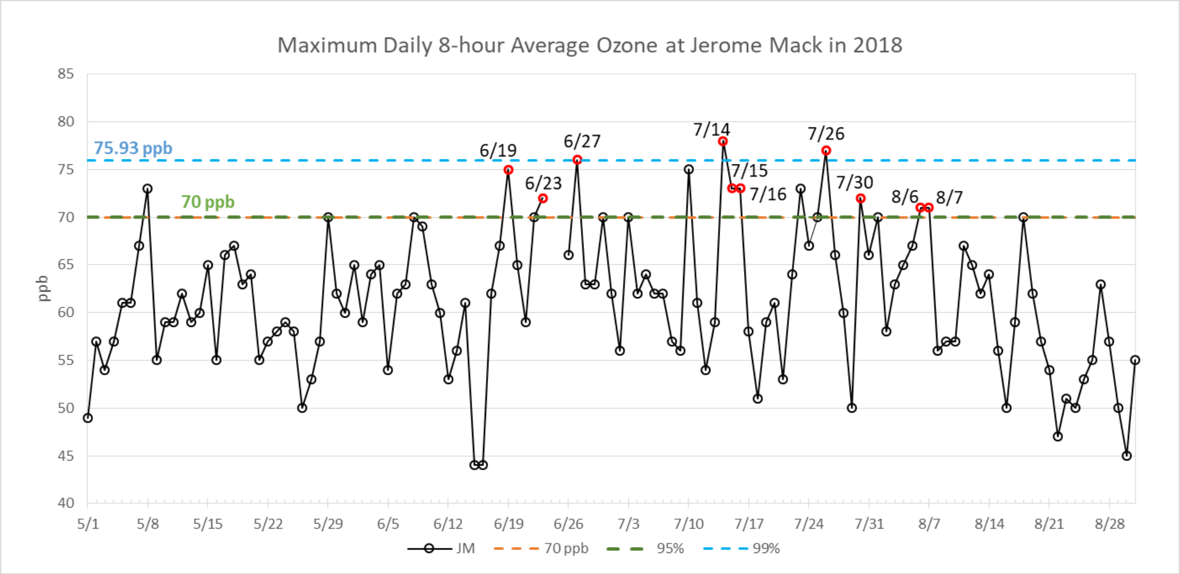


Figure 4-8. MDA8 Ozone at Jerome Mack, 2018 Ozone Season.

The ratio of $PM_{2.5}$ organic carbon (OC) and elemental carbon (EC) has been used to differentiate combustion sources of biomass burning and mobile sources, since biomass burning usually has higher OC/EC ratio (7-15) (Lee et al., 2005; Pio et al., 2008) than gasoline (3.0-4.0) or diesel vehicles (<1.0) (Lee and Russell, 2007; Zheng et al., 2007). The acquired $PM_{2.5}$ of OC and EC from EPA's AQS (https://aqs.epa.gov/aqsweb/airdata/download_files.html) is available only for Jerome Mack in the LVV on a three-day sampling schedule. Figure 4-9 shows OC/EC ratio for May-August in 2018 and 2019 against the median OC/EC ratio of May-August (5.4, orange line) and Sept-April (3.4, green line) according to 2015-2017 and 2019 data. It's clearly shown larger wildfire influence in ozone season months than non-ozone season months and more days impacted by wildfire in 2018 than 2019 (a clean year, the annual fourth highest MDA8 ozone for all monitors below 2015 NAAQS ozone standard) during ozone season months. Figure 4-10 shows a similar OC/EC ratio plot for an upwind monitor located at Rubidoux in Riverside-San Bernardino, CA area with the median value of May-August (6.8, orange line) and Sept-April (3.4, green line). By comparing Figure 4-9 and 4-10, the day variation of OC/EC ratio at Jerome Mack was generally following the variation of OC/EC ratio at Rubidoux and more days in 2018 than 2019 had the OC/EC ratio above median value for both monitors. It strongly indicates Jerome Mack was frequently impacted by California wildfires in 2018.

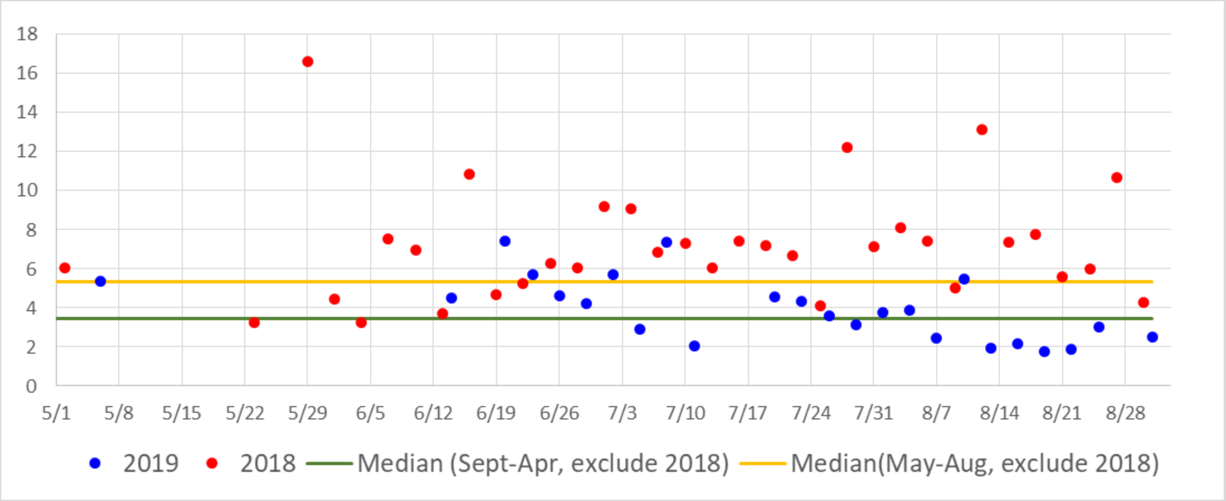


Figure 4-9. **OC/EC ratio at Jerome Mack, 2018-2019 Ozone Season.**

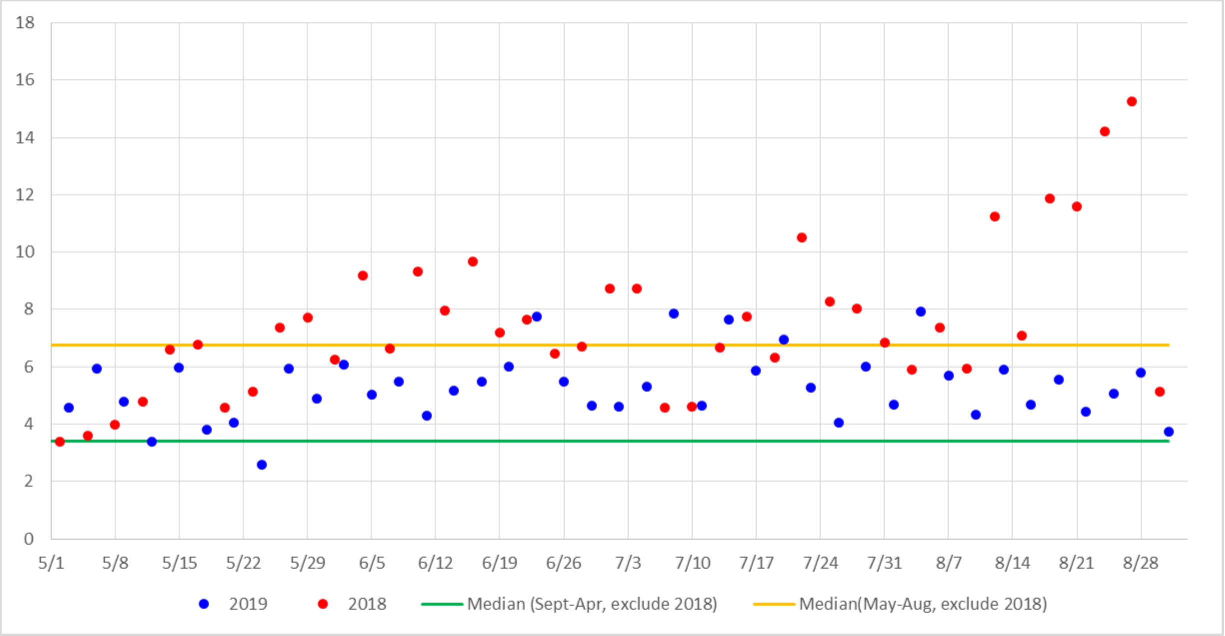


Figure 4-10. **OC/EC ratio at Rubidoux, CA, 2018-2019 Ozone Season.**

4.3 EVENT OF JUNE 19-20, 2018

4.3.1 Tier 1 Analysis: Historical Concentrations

Figures 4-11 and 4-21 show the hourly seasonal percentiles for ozone from 2014–2018 compared to measured hourly ozone on June 19–20, 2018, at exceeding sites. On June 19, ozone at Green Valley and Jerome Mack was above the 95th percentile, including six hours of concentrations at 5–10 ppb and 2–12 ppb, higher than non-event-related concentrations. On June 20, ozone at Walter Johnson and Joe Neal was above the 95th percentile, with a few afternoon hours of concentrations at 2–8 ppb and 1–10 ppb, higher than non-event-related concentrations. These data from exceeding monitors on June 19–20 failed to meet the standard of 5–10 ppb greater than non-event-related concentrations, nor did they occur outside the area's normal high-ozone season. Thus, Tier 2 analyses were performed to provide additional evidence of the clear causal relationship between the wildfire emissions and ozone exceedances.

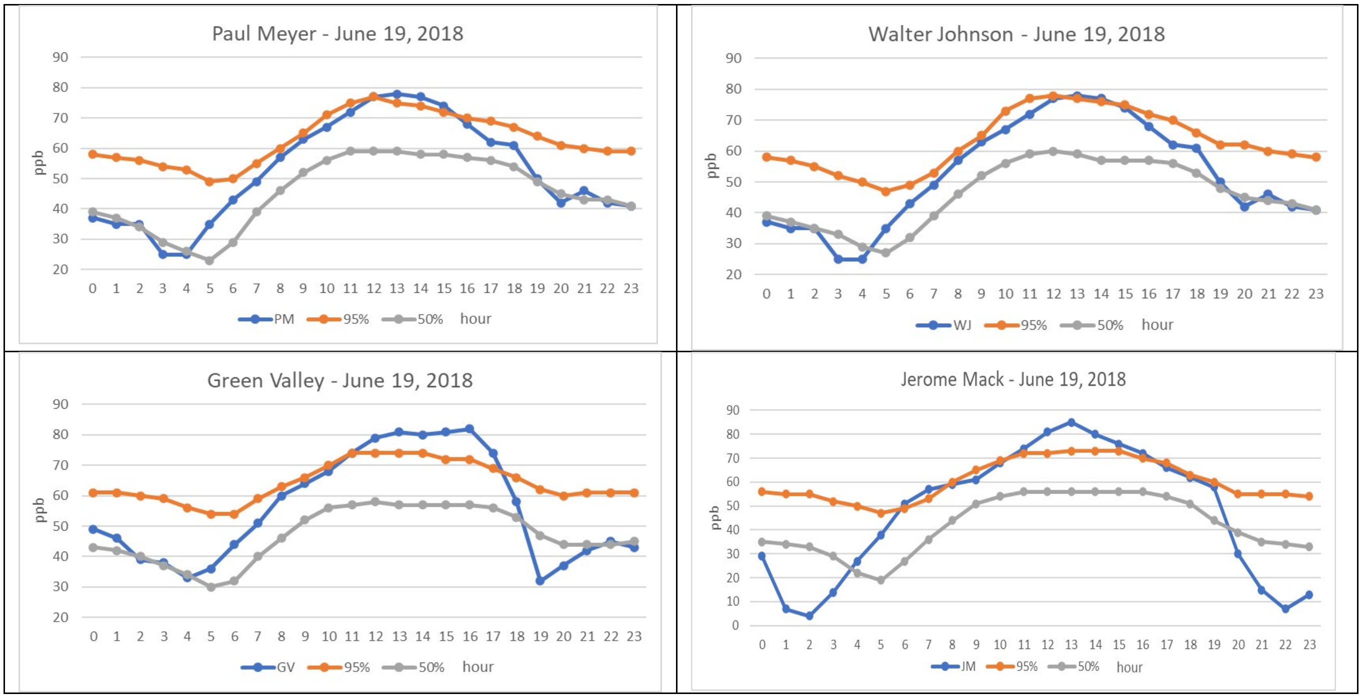


Figure 4-11. 5-Year Hourly Seasonal 95th & 50th Percentiles for O_3 and Observed O_3 on June 19.

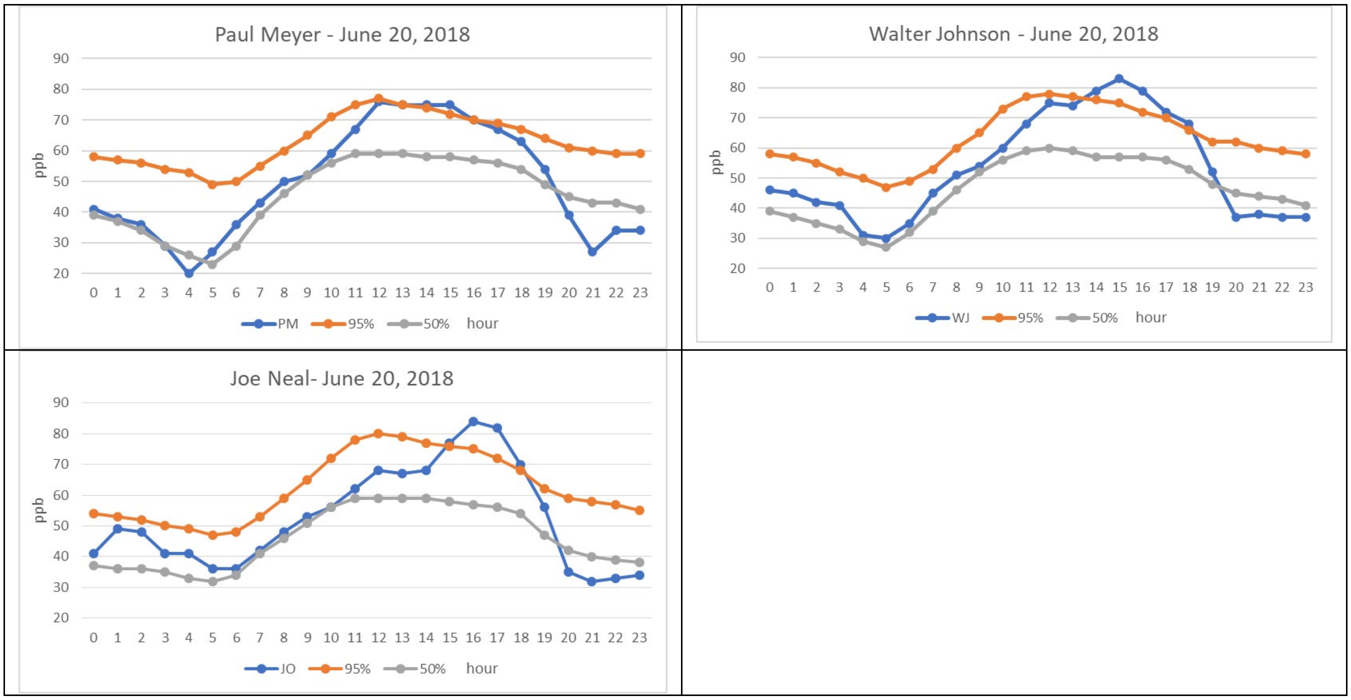


Figure 4-12. 5-Year Hourly Seasonal 95th & 50th Percentiles for O_3 and Observed O_3 on June 20.

4.3.2 Tier 2 Analysis

4.3.2.1 Key Factor #1: Q/d Analysis

The U.S. Forest Service BlueSky Playground version 3 (https://tools.airfire.org/playground/v3/) was used to estimate the emissions of NO_x and VOC. The locations for the Upper Colony Fire and Planada Fire based on CAL Fire and other unnamed central/southern California fires based on the embedded fire data used in BlueSky Daily Runs tool (https://tools.airfire.org/websky/v1/#status) from the U.S. Forest Service were entered into the tool. Default fuels data for those coordinates were selected; “dry” condition is chosen for moisture level. According to the tool, the Upper Colony Fire emitted a total of 3.95 tons of NO_x and 20.75 tons of VOC for June 17-18. For the Planada Fire, the total emissions for June 16-18 were estimated instead of June 15-17 for a higher wildfire impact scenario; the total emissions of NO_x and VOC are 154.54 and 903.59 tons, respectively. For all other central/southern California fires, the total estimated emissions of NO_x and VOC are 62.82 and 331.49 tons approximately for June 16-18. The exceeding monitor, Paul Meyer, Walter Johnson and Green Valley, are located near the center of the nonattainment area and sit approximately 479 and 483 km from the Upper Colony Fire and Planada Fire, respectively. In order to obtain the maximum Q/d value for all other unnamed central/southern California fires, 100 km distance is assumed for each of them. The ratio of Q/d of ~6.2 tpd/km after aggregating the emissions from two large fires and other unnamed California fires is far below the EPA’s threshold of 100 tpd/km.

4.3.2.2 Key Factor #2

Figures 4-3, 4-4, 4-6, and 4-8 compare the historical non-event ozone season concentrations of Paul Meyer, Walter Johnson, Green Valley, and Jerome Mack to the June 19–20 event. The June 19 ozone exceedance met the five-year 99th percentile of MDA8 ozone at Green Valley, was 1 ppb less than the five-year 99th percentile at Jerome Mack, and met the five-year 95th percentile of MDA8 ozone at Paul Meyer and Walter Johnson. On June 20, stagnant weather trapped the ozone and smoke from the prior day in the valley, and local afternoon southeast winds elevated the MDA8 ozone at Paul Meyer, Walter Johnson, and Joe Neal to exceed the NAAQS. Paul Meyer and Walter Johnson met the five-year 95th percentile on June 20, and Joe Neal was 1 ppb below the 95th percentile. Additionally, the MDA8 ozone values of only Green Valley and Jerome Mack on June 19 were the fourth-highest of 2018 (Table 1-1). The Tier 2: Key Factor #2 analysis results thus do not meet the criteria to support a demonstration that ozone exceedances on June 19–20 were caused by an exceptional event, although they are evidence of the presence of an extreme event.

4.3.2.3 Evidence of Fire Emissions Transport to Area Monitors

Smoke Map

The smoke analysis (Figures 4-13 through 4-15) done with the AirFire Tools (SmartFire2 and BlueSky framework with HYSPLIT) developed by the U.S. Forest Service shows the smoke plumes from surrounding wildfires moving into southern Nevada June 16-20. The National Weather Service (NWS) NAM 3-km meteorological 48-hour predictions is selected in USFS-AirFire BlueSky framework. Figure 4-13 shows the transport of smoke from unknown wildfires in southern California from June 14 (4 p.m.) to June 16 (4 p.m.). Figure 4-14 shows the transport of smoke from Upper Colony Fire and nearby Arizona fire from June 17 (4 p.m.) to June 19 (4 p.m.). Figure 4-15 shows the transport of smoke from Planada Fire, unknown other central California fires and nearby Arizona fire from June 18 (4 p.m.) to June 20 (4 p.m.).

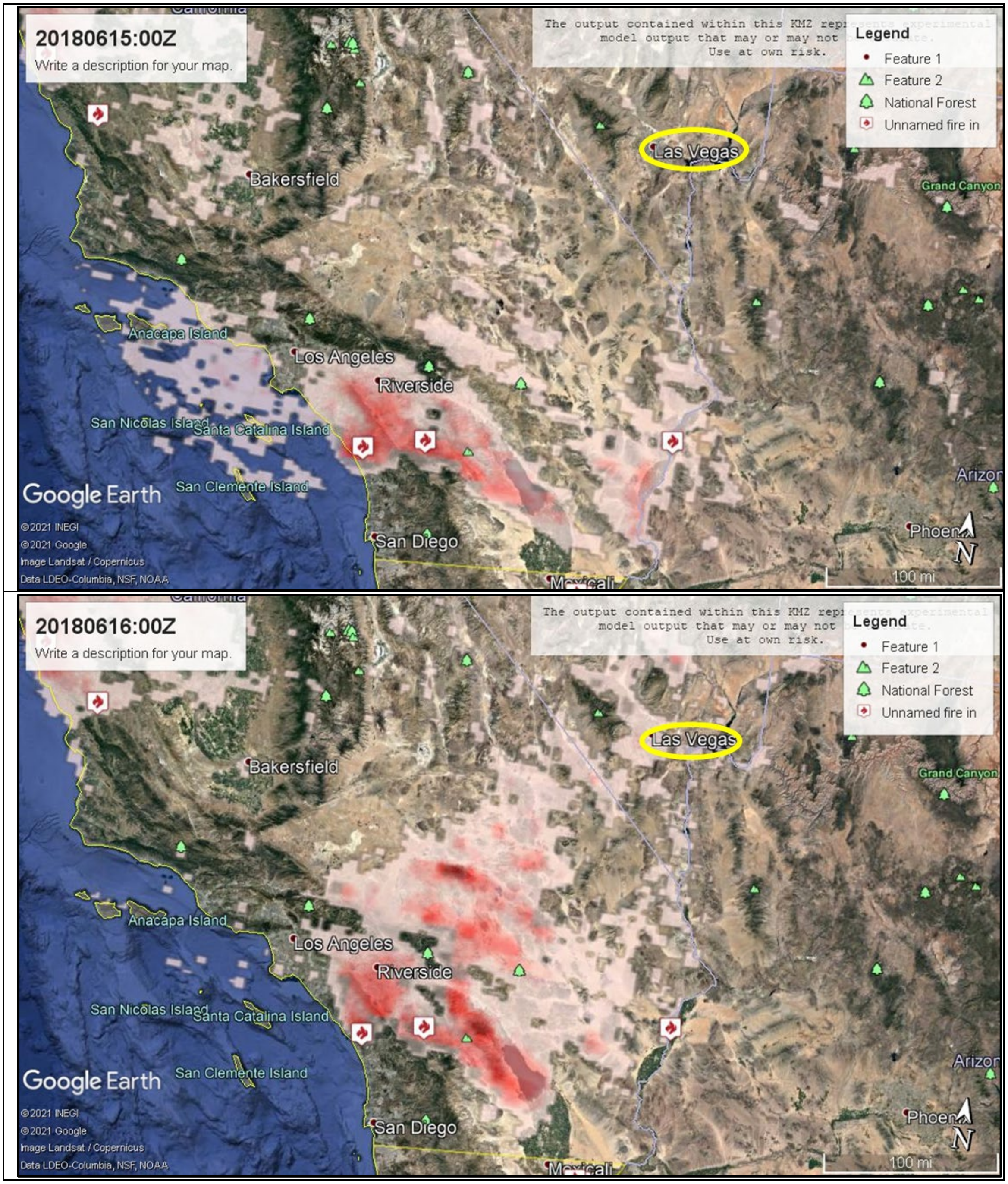


Figure 4-13. PM$_{2.5}$ Daily Maximum for June 14–15 (top); June 15–16 (bottom).

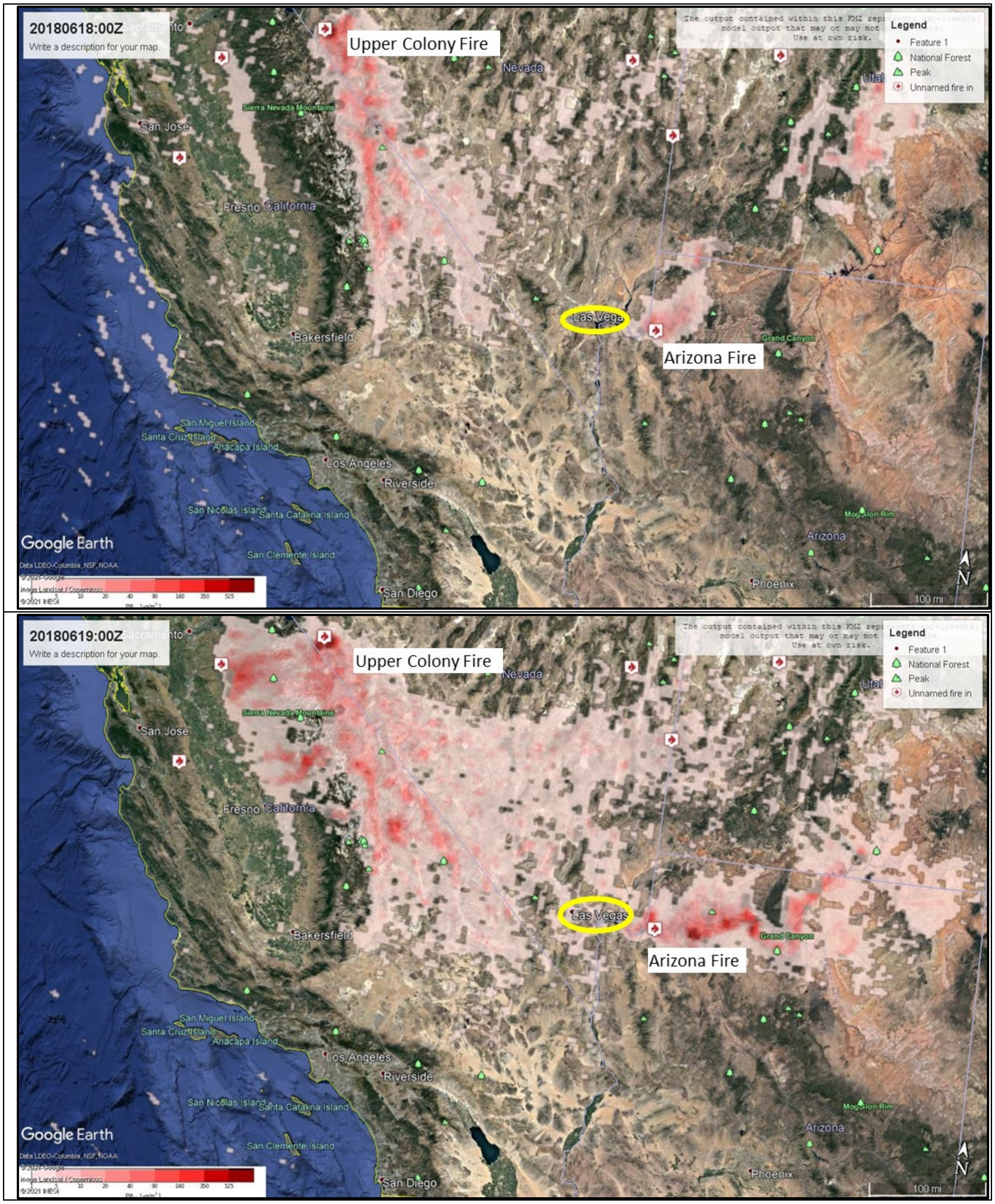


Figure 4-14. PM$_{2.5}$ Daily Maximum for June 17–18 (top); June 18–19 (bottom).

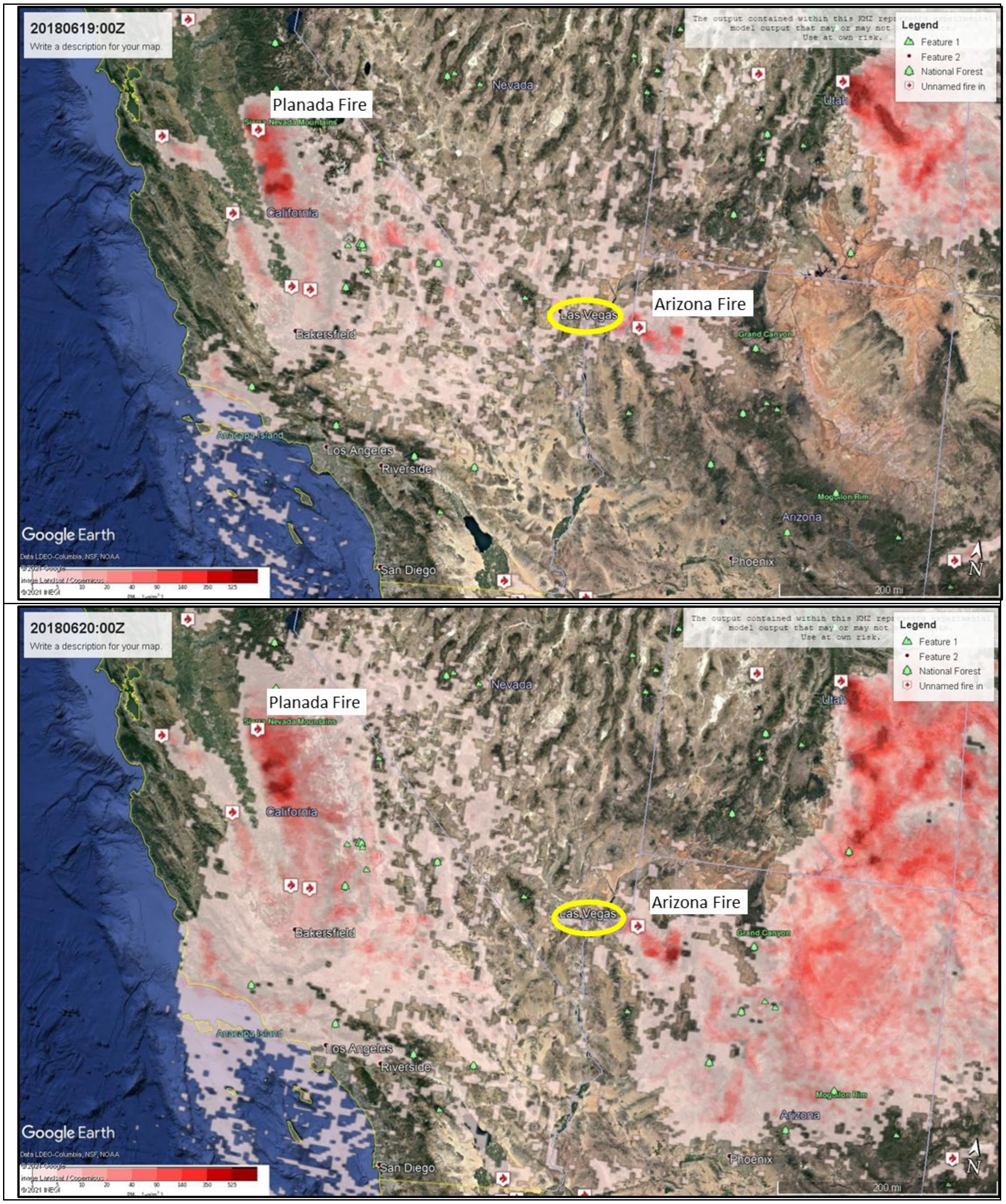


Figure 4-15. PM2.5 Daily Maximum for June 18-19 (top); June 19-20 (bottom).

HYSPLIT Backward Trajectories

The National Oceanic and Atmospheric Administration (NOAA) HYSPLIT model was run to produce back trajectories of air parcel movement at 100 and 1000 meters (Wildfire Guidance recommend within 100~1500 meters) for two exceeding monitors, Walter Johnson and Green Valley, residing two sides of urban core area. Figure 4-16 and 4-17 show the 24-hours backward trajectories of airflows arriving at Walter Johnson and Green Valley at 1 p.m. for June 16-20. Both figures show the air parcel generally traveled southwesterly for June 16-18 and later June 19-20 shifted to northerly to the LVV within the boundary layer. They clearly show that the air from areas near or affected by, smoke, ozone and ozone precursor emissions from southern California fires and Upper Colony Fire.

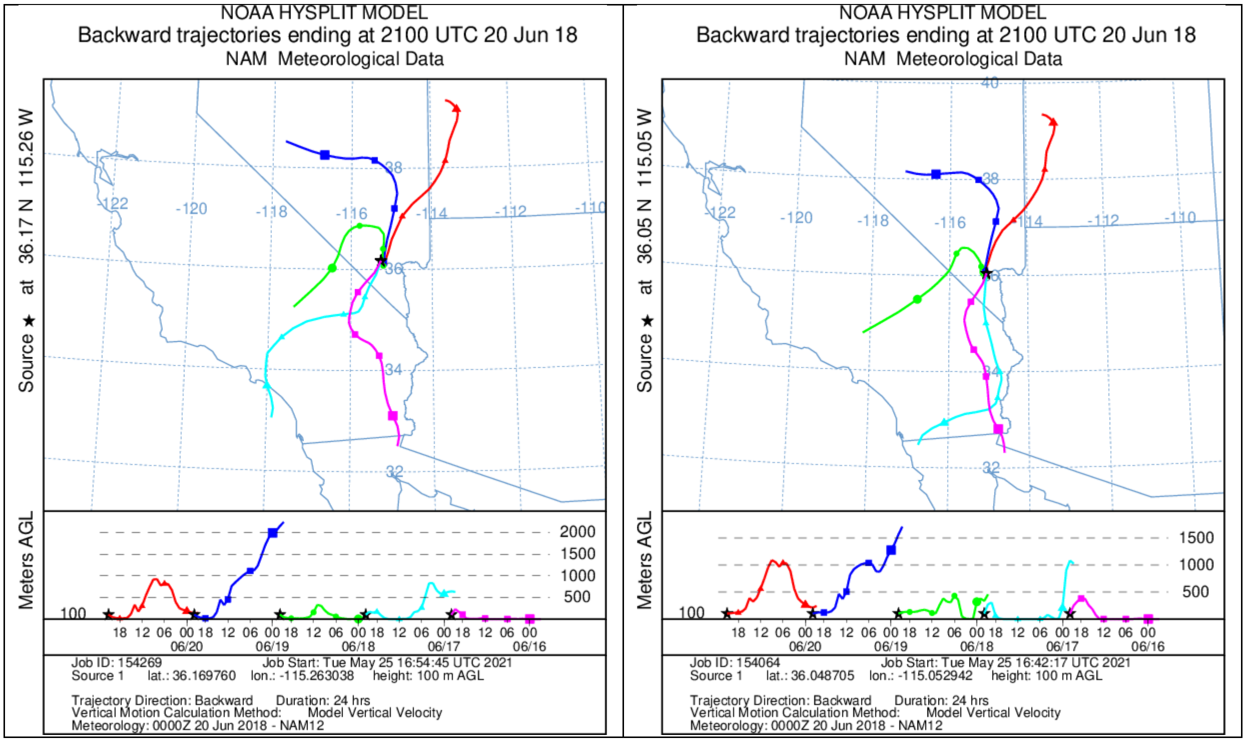


Figure 4-16. 24-hour Backward Trajectories at 100 meters at Walter Johnson (left) and Green Valley (right) for June 16–20.

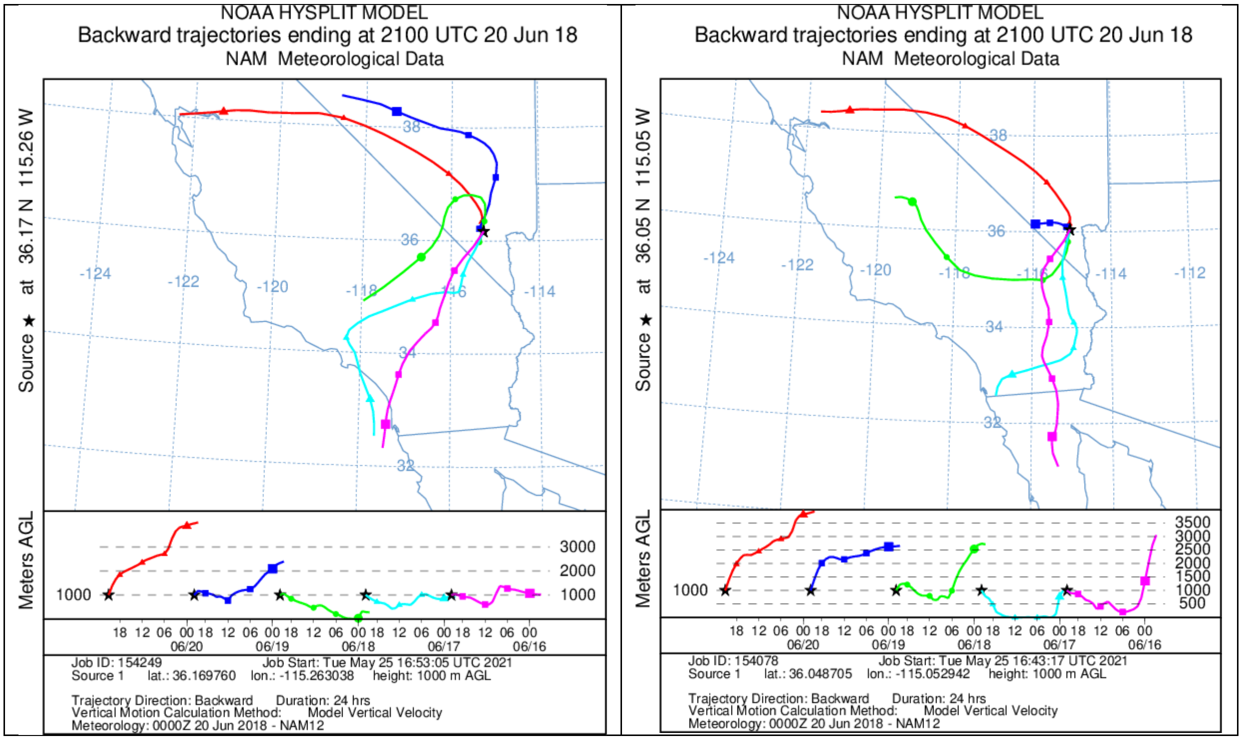


Figure 4-17. 24-hour Backward Trajectories at 1000 meters Walter Johnson and Green Valley for June 16–20.

Satellite Retrieval

The retrieved data from the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite, launched in June 2006 was examined. To make use of this data, we identified the vertical profile of atmospheric aerosols. The best CALIPSO aerosol retrieval over LVV during this time was around 1:30 p.m. PST on June 16. An examination of CALIPSO's orbital track over the southwest U.S. and the vertical profile of corresponding aerosols (Figures 4-18 & 4-19) allowed us to categorize the aerosol types over southern Nevada as polluted continental/smoke, slight elevated smoke, and large polluted dust.

The aerosol type of "polluted dust" is assigned a lidar ratio of 55+22 sr in the CALIPSO V3 and V4 algorithms (Kim et al. 2018). Based on research conducted by Burton et al. (2013), CALIPSO V3 aerosol classifications were compared with measurements made by NASA from the airborne High Spectral Resolution Lidar (HSRL). The results showed poor agreement for smoke (13%) or polluted dust (35%). In particular, the polluted-dust type is overused due to an attenuation-related depolarization bias. They found CALIPSO's identification of internal boundaries between different aerosol types in contact with one another frequently do not reflect actual transitions between aerosol types accurately; therefore, it is reasonable to suspect the large polluted dust could be smoke.

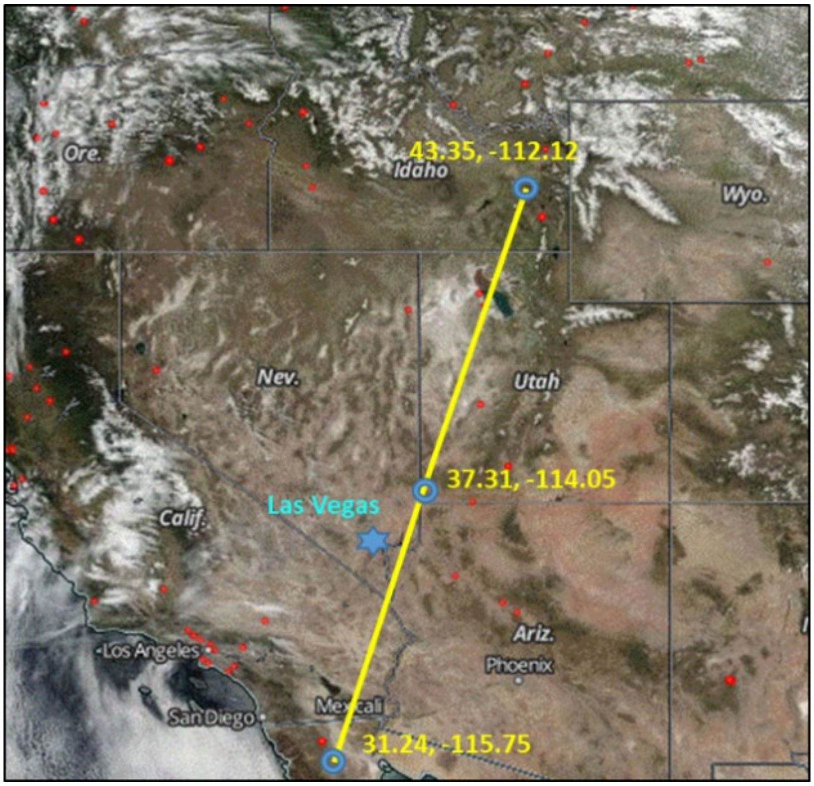
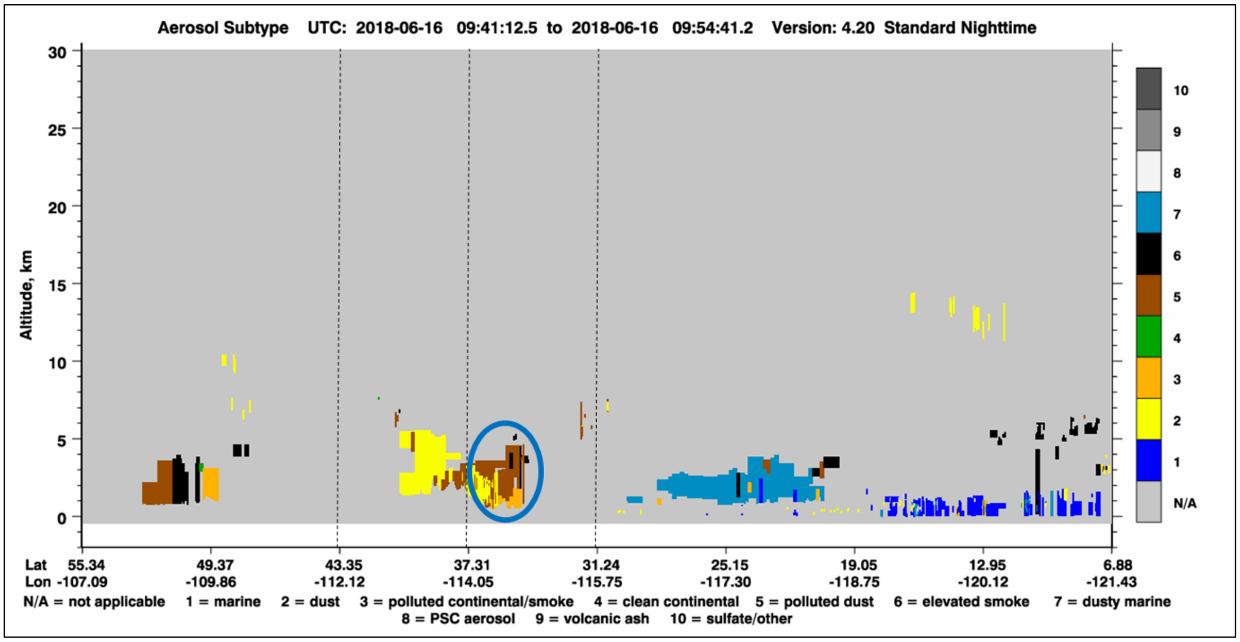


Figure 4-18. **CALIPSO Orbital Track over Southwest U.S. on June 16.**



Note: The upper air near the LVV is circled in blue.

Figure 4-19. **CALIPSO Aerosol Type Vertical Profile Collected on June 16.**

The Skew-T diagram from University of Wyoming (http://weather.uwyo.edu/upperair/sounding.html)) can be used to estimate mixing height in Las Vegas. Figure 4-20 shows the estimated mixing height slightly above 3080 meters at 4 PM on June 16. Comparing the height of smoke near the LVV in Figure 4-19 and the mixing height in Figure 4-20, provides the evidence that the smoke can be mixed downward to the surface in the LVV.

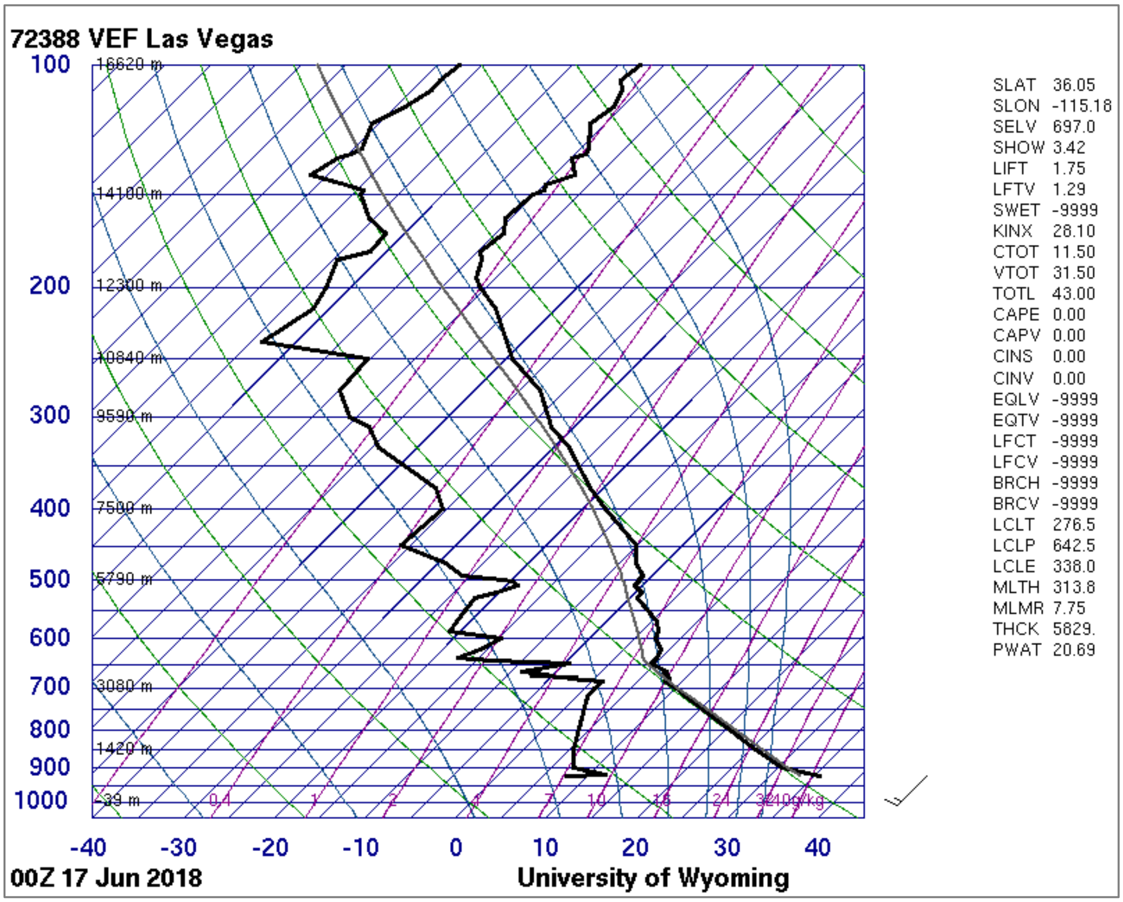


Figure 4-20. Skew-T diagram for June 16, 2018, in Las Vegas.

4.3.2.4 Evidence that Fire Emissions Affected Area Monitors

Concurrent Rise in Ozone Concentrations

We examine the MDA8 O_3 at the monitors outside (Figure 4-21) and within (Figure 2-2) the LVV on June 15-21, 2018. As discussed above, smoke maps, backward trajectories, satellite retrieve and meteorological conditions detailed in Section 3.3 depict the transport of smoke, ozone, and ozone precursor emissions from wildfires in central/southern California, Nevada and western Arizona to the LVV. The widespread smoke on June 17-18 as shown in Figure 4-22 and 4-23 appears to have large influence of ozone concentration at all examined monitors except Mesquite because of its downwind location from the LVV. A relatively small influence of smoke reached to Mesquite on June 18.

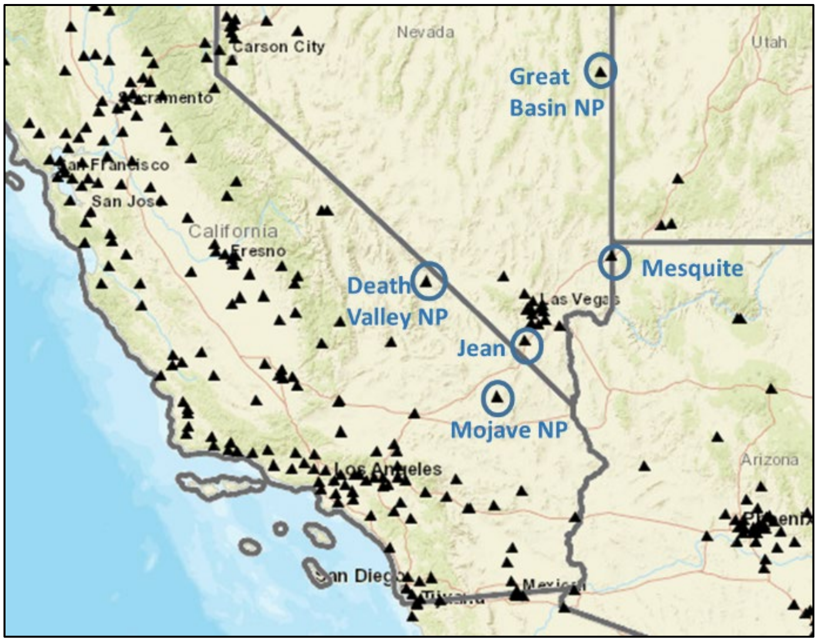


Figure 4-21. Monitors outside the Las Vegas Valley

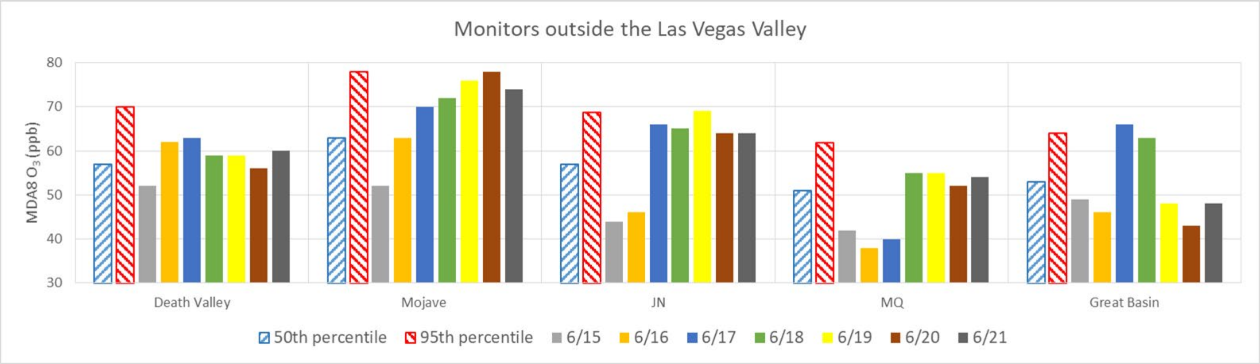


Figure 4-22. MDA8 O_3 at monitors outside the Las Vegas Valley on June 15-21, 2018.

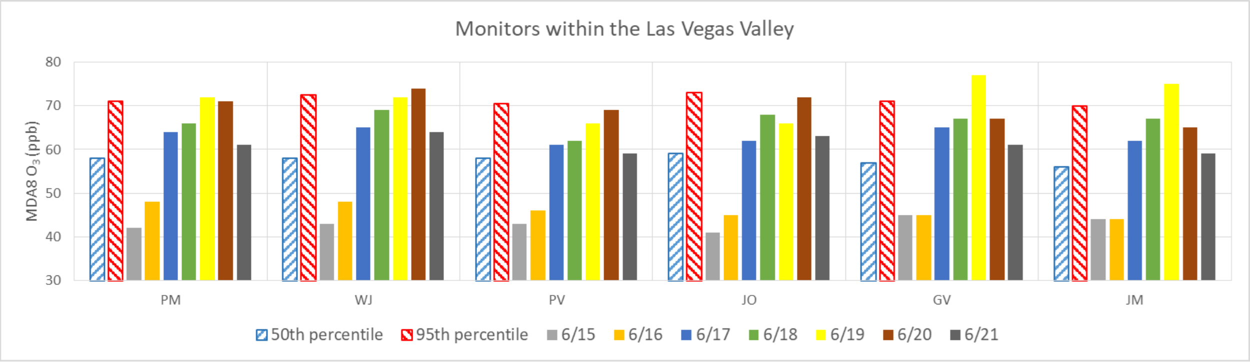


Figure 4-23. MDA8 O_3 at monitors within the Las Vegas Valley on June 15-21, 2018

$PM_{2.5}$ Speciation Data

As depicted in section 4.2, the ratio of $PM_{2.5}$ organic carbon (OC) and elemental carbon (EC) can be used to differentiate combustion sources of biomass burning and mobile sources. Figure 4-24 includes the actual and mean OC/EC ratio at Jerome Mack and Rubidoux, CA and the daily 24-hour $PM_{2.5}$ at Jerome Mack. The variation in OC/EC ratio for Jerome Mack and Rubidoux are similar during this period. The peak OC/EC ratio for both sites on June 16 and the peak 24-hour $PM_{2.5}$ on June 17 indicate the smoke had arrived to the LVV from California before the event day of June 19-20.

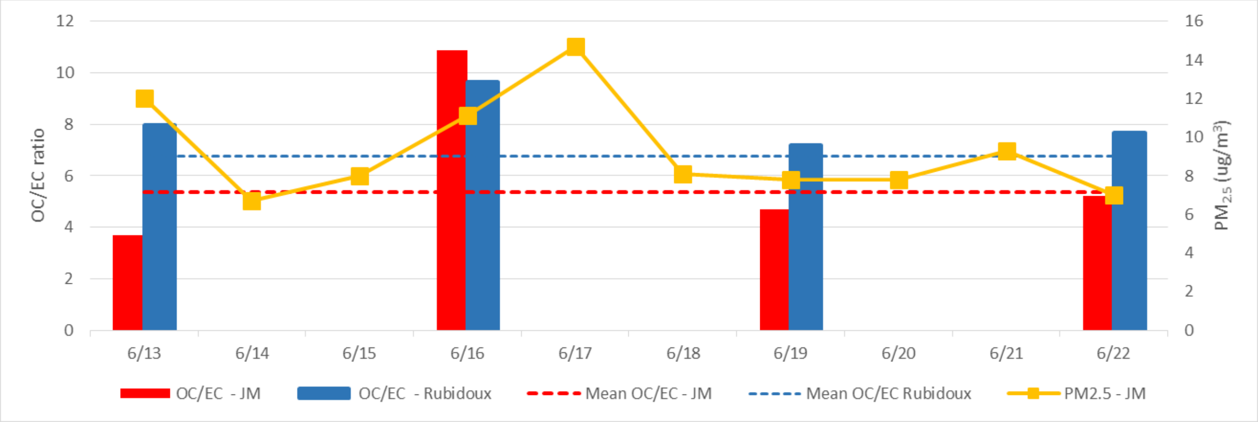


Figure 4-24. Actual and Mean OC/EC ratio at Jerome Mack and Rubidoux, CA and Daily 24-hour $PM_{2.5}$ at Jerome Mack during June 13-22, 2018.

Supporting Ground Measurements

Ground measurements of wildfire plume components (e.g., $PM_{2.5}$, NO_2, CO) can be used to demonstrate that smoke impacted ground-level air quality if elevated concentrations or unusual diurnal patterns are observed. The Jerome Mack monitor is only monitor that record all four pollutants and it had one of the highest exceeding ozone concentrations on June 19, 2018. Figure 4-25 to 4-28 present the hourly levels of O_3, NO_2, $PM_{2.5}$ and CO on June 15–21, along with hourly wind speeds (Figure 4-29); it shows high winds on June 16–17 caused by an easterly-moving stationary front moving towards the LVV (Figure 3-6). The above $PM_{2.5}$ speciation analysis of higher ratio of OC/EC on June 16 in Figure 4-24 supports the wildfire smoke had transported to the LVV. The NO_2 and CO concentration at JM for June 16-17 didn't increase as much as the O_3 and $PM_{2.5}$ may due to the combination effect of higher wind dispersion and mobile emission dominated in urban area. However the diurnal NO_2 at JM (Figure 4-26) and RT (Figure 4-30) show some increase on June 18 and June 16 and the peak NO_2 at RT (Figure 4-30) was near to 95th percentile value on June 18 morning. Therefore, comparing the backward trajectories and time series of wildfire plume components show the smoke were transported to the LVV from central/southern California fires and Upper Colony Fire during June 15-18. A building high pressure and associated stable weather system of high temperatures and light, variable winds as depicted in section 3.3, helping elevate ozone concentrations on June 19–20.

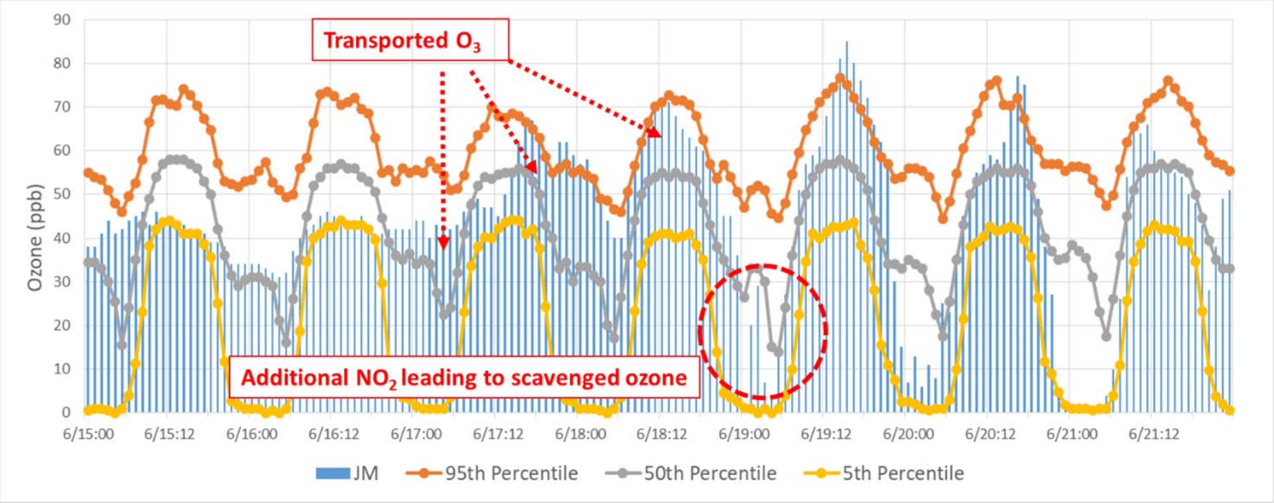


Figure 4-25. **Hourly O_3 Concentrations at Jerome Mack on June 15–21.**

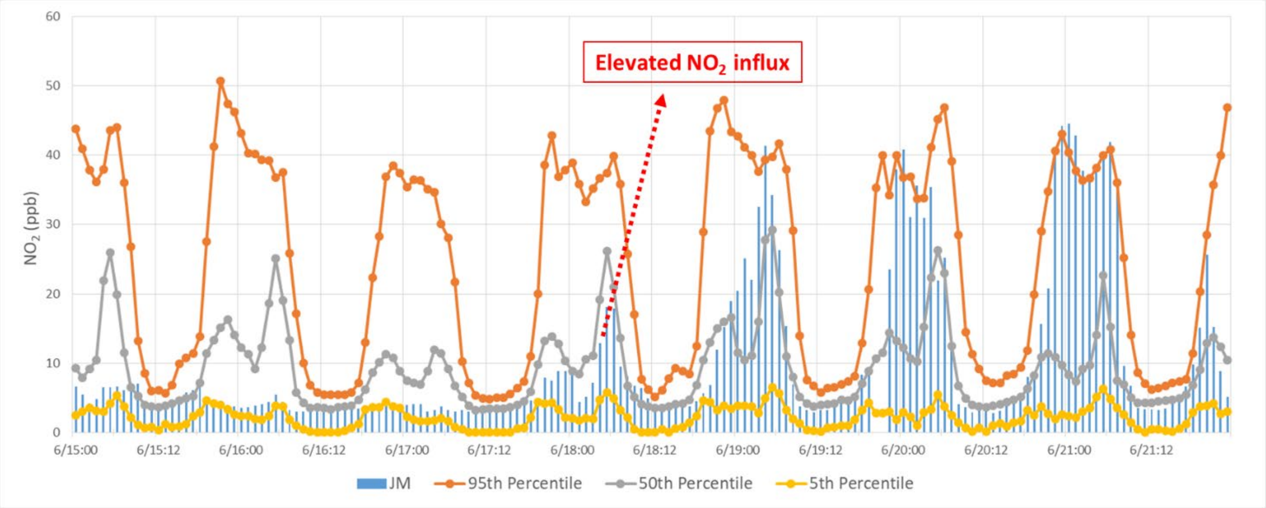


Figure 4-26. **Hourly NO_2 Concentrations at JM on June 15–21.**

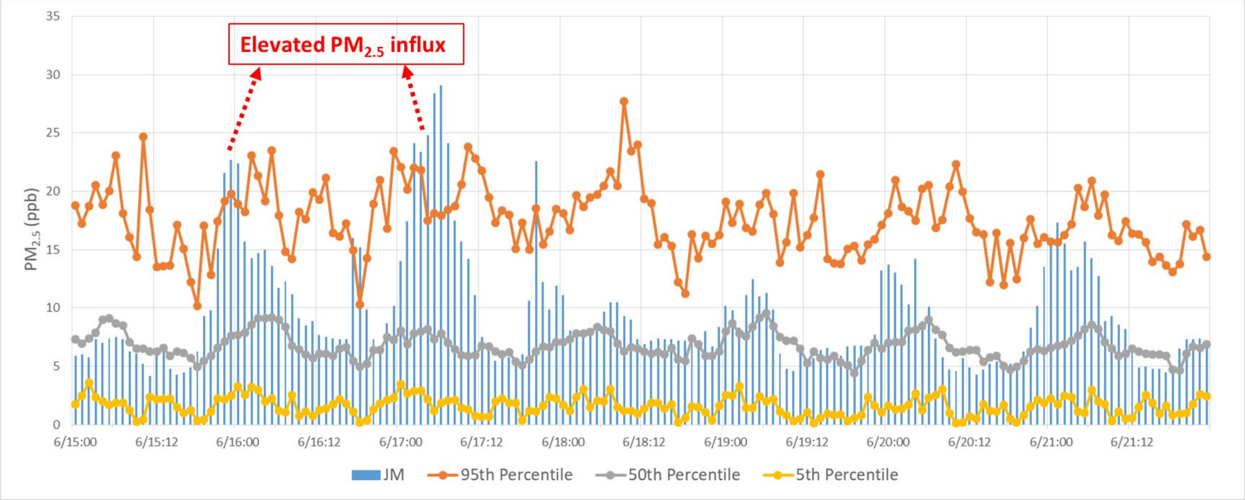


Figure 4-27. **Hourly $PM_{2.5}$ Concentrations at JM on June 15–21.**

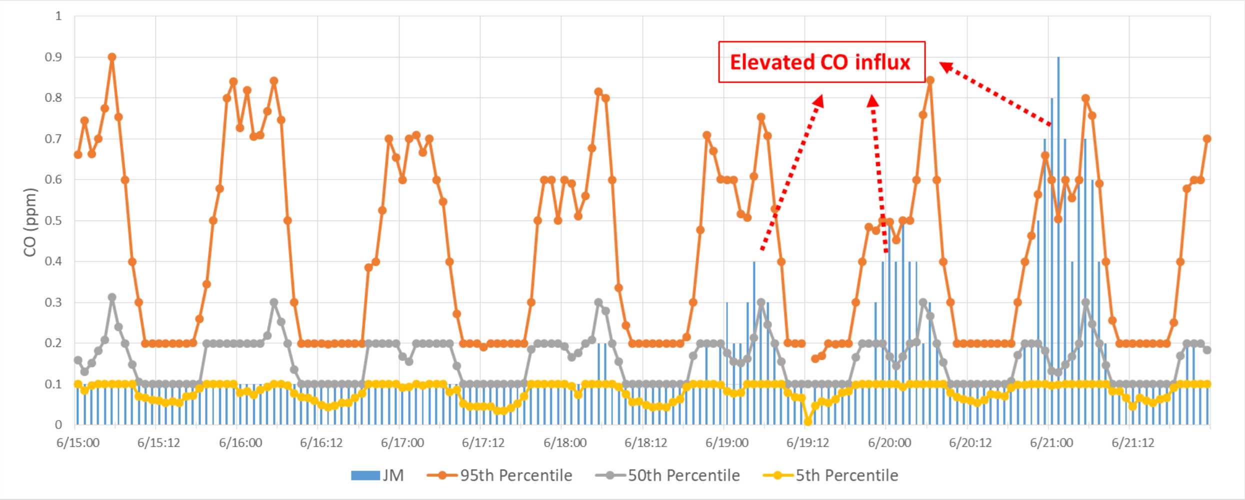


Figure 4-28. Hourly CO Concentrations at JM on June 15–21.

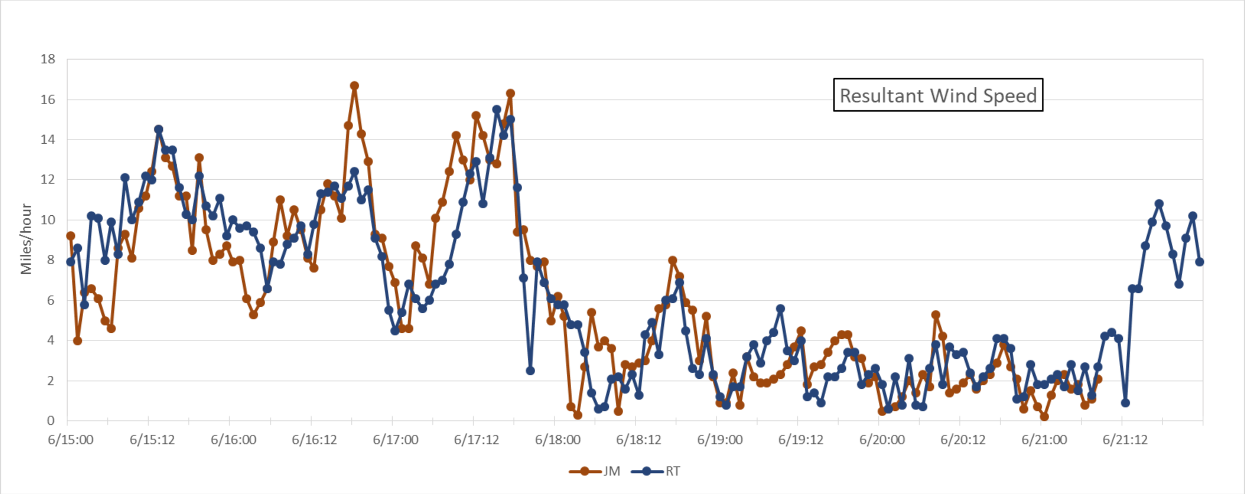


Figure 4-29. Hourly Wind Speed at Jerome Mack and Rancho & Teddy, June 15–21.

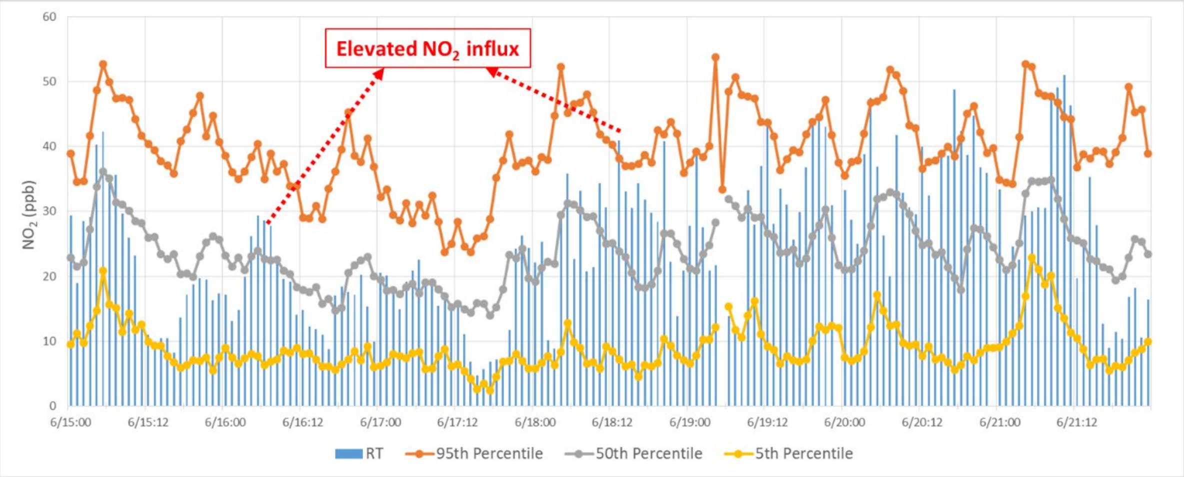


Figure 4-30. Hourly NO_2 Concentrations at RT on June 15–21.

4.3.3 Tier 3 Analysis: Additional Weight of Evidence to Support Clear Causal Relationship

4.3.3.1 GAM Statistical Modeling

Figure 4-30 shows a time series of the predicted and observed MDA8 ozone for June 16-21, 2018. The GAM prediction seem to relatively capture the variation of observed MDA8 ozone at exceeding sites during this period. The results indicate that the monitors would normally not have exceeded the 2015 NAAQS under the meteorological conditions on June 19-20 and suggest that an outside normal variable (e.g., increased emissions from the wildfire) influenced the ozone concentration. Table 4-1 lists GAM results for June 19-20, 2018, at exceeding monitors. GAM residuals show a modeled wildfire impact of between 3.4 and 9.7 ppb for exceeding monitors, with GAM MDA8 ozone prediction values well below the 70 ppb standard at Paul Meyer and Green Valley on June 19. The EPA guidance recommends using an additional step to estimate the ozone contribution from the wildfire (the difference between the observed ozone and sum of predicted ozone and positive 95th percentile value). Simply speaking, the residuals on the wildfire event day would have to be greater than the positive 95th percentile value in order to see any contribution on ozone concentration from wildfire’s impact. As seen in Table 4-1, none of the residuals exceed the 95th percentile value for June 19-20. However, there are two issues with this methodology that need to be considered. First, a large number of wildfires affecting Clark County during 2014-2020 (especially 2018 and 2020) included in GAM modeling cause a very conservative 95th percentile value (positive). Second, with the limitations of regression analysis for ozone production which involve very complex physical and chemical processes with emissions and meteorological conditions, the models are able to explain about 50% of the correlation between predicted and observed concentration (Table 3-16 in the “GAM Statistical Modeling,” of *Exceptional Event Demonstration for Ozone Exceedances in Clark County, Nevada—June 22, 2020*), which is typical of the results seen in other regression analysis studies.

The percentile ranks of positive residual for June 19-20 shown in Table 4-1 range from 68th-93rd and 50th-86th percentiles for the exceeding monitors. The model indicates that only 7 and 14 percent chance for the residual at Green Valley and Joe Neal would be produced under the meteorological conditions on June 19-20. These suggest there were other additional emissions (e.g. wildfire) not counted. As described in section 3.3, the weather conditions on June 19-20 were stable and favor ozone formation. With additional wildfire emissions helped to drive already elevated ozone concentration exceeding 2015 NAAQS.

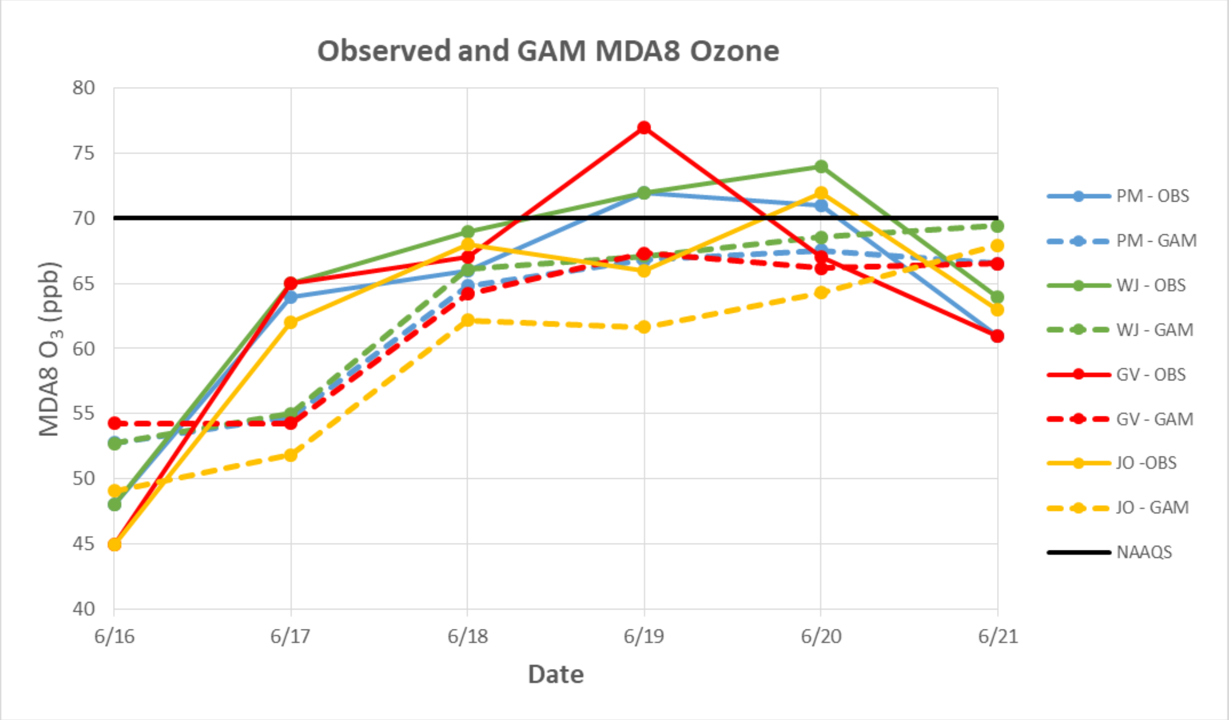


Figure 4-30. Observed and predicted MDA8 O3 at exceeding monitors for June 16-21, 2018.

Table 4-1. June 19–20 GAM Results for Exceeding Sites

Date	Site	MDA8 O_3 (ppb)	MDA8 GAM Prediction (ppb)	GAM Residual (ppb)	Positive 95th Quantile (ppb)	Predicted Fire Influence	Percentile Rank of Positive Residual
6/19/2018	Paul Meyer	72	66.8	5.2	10.5	-5.3	69th
	Walter Johnson	72	67.1	4.9	10.8	-5.9	68th
	Green Valley	77	67.3	9.7	10.1	-0.5	93rd
6/20/2018	Paul Meyer	71	67.6	3.4	10.5	-7.1	50th
	Walter Johnson	74	68.5	5.5	10.8	-5.4	73rd
	Joe Neal	72	64.3	7.7	10.6	-2.9	86th

5.0 NATURAL EVENT

40 CFR 50.14(c)(3)(iv)(E) requires that agencies demonstrate an "event was a human activity that is unlikely to recur at a particular location or was a natural event." 40 CFR 50.1(k) defines a natural event as "an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role." 40 CFR 50.1(n) defines a wildfire as "any fire started by an unplanned ignition caused by lightning; volcanoes; other acts of nature; unauthorized activity; or accidental, human-caused actions, or a prescribed fire that has developed into a wildfire. A wildfire that predominantly occurs on wildland is a natural event." And lastly, 40 CFR 50.1(o) defines wildland as an "area in which human activity and development are essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered."

Based on the documentation provided in Section 3, the events that occurred on June 19–20 fall within the definition of a natural event (40 CFR 50.1(k)). As demonstrated, these wildfires were caused by lighting or human activity and occurred predominantly on wildland, as detailed in Table 5-1, meeting the regulatory definitions outlined in 40 CFR 50.1(n) and (o). DES therefore concludes that these wildfire events can be treated as natural events under the EER.

Table 5-1. Basic Information for Wildfire Events on June 19-20, 2018

Event Date(s)	Fire	Cause	Location–County (State)
June 19-20	Planada	Unknown	Merced (CA)
	Upper Colony	Human activity	Smith Valley (NV)
	Unnamed California fires	Unknown	Central and Southern counties

6.0 NOT REASONABLY CONTROLLABLE OR PREVENTABLE

Based on the documentation provided in Section 3, lightning and human activity (as defined in 40 CFR 50.1(n)) caused the wildfires on wildland (Table 5-1) that influenced ozone concentrations in the LVV on June 19-20, 2018. DES is not aware of any evidence clearly demonstrating that prevention and control efforts beyond those actually made would have been reasonable; therefore, emissions from these wildfires were not reasonably controllable or preventable.

7.0 CONCLUSIONS

The analyses reported in this document support the conclusion that smoke from wildfires impacted ozone concentrations in Clark County, Nevada, on the event days of June 19–20, 2018. Specifically, this document has used the following evidence to demonstrate the exceptional event:

- Statistical analyses of the monitoring data compared to historical concentrations support the conclusion of unusual and above-normal historical concentrations at monitoring sites.
- Backward trajectories support the conclusion of transport of smoke from wildfires to LVV monitoring sites.
- Enhanced ground measurements of wildfire plume components ($PM_{2.5}$, NO_2, and CO) and OC/EC ratios support the conclusion that ozone concentrations at LVV monitoring sites were impacted by smoke from wildfires.
- Aerosols in vertical profile and sounding data support the conclusion that smoke was mixed down to the surface in Clark County.
- Comparisons with non-event concentrations and GAM statistical modeling support the conclusion that the ozone concentrations in Clark County were well above typical summer concentrations.

Based on the evidence presented in this package, the wildfires on June 19-20, 2018 in Clark County were natural events and unlikely to recur. The analyses described satisfy the clear causal relationship criterion for recognition as an exceptional event. Based on this evidence, DES requests that EPA exclude the data recorded at Green Valley, Jerome Mack, Walter Johnson, and Paul Meyer on June 19, 2018, and the data recorded at Jerome Mack, Walter Johnson and Joe Neal on June 20, 2018, from use for regulatory determinations.

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