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Air Quality

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Exceptional Event Documentation for the May 23, 2012, 8-Hour Ozone NAAQS Exceedance in Clark County Caused by a Wildland Fire Event.

January, 2014

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ACRONYMS AND ABBREVIATIONS

Acronyms

AOD	Aerosol Optical Depth
AOT	Aerosol Optical Thickness
AQI	Air Quality Index
CAA	Clean Air Act
CFR	Code of Federal Regulations
DAQ	Clark County Department of Air Quality
EER	Exceptional Events Rule
EPA	U.S. Environmental Protection Agency
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
MDA8	Maximum Daily 8-hr Average
NAAQS	National Ambient Air Quality Standards
PST	Pacific standard time
TRE	Topaz Ranch Estates
VOC	volatile organic compound

Abbreviations

°C	degrees Celsius
CO	carbon monoxide
mb	millibars
MSL	mean sea level
NO_x	oxides of nitrogen
O_3	ozone
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppb	parts per billion

1.0 INTRODUCTION

1.1 STATEMENT OF PURPOSE

Clark County has determined that ozone (O_3) concentrations exceeding the National Ambient Air Quality Standards (NAAQS) on May 23, 2012, qualify as an exceptional event under Title 40, Part 50 of the Code of Federal Regulations (40 CFR 50), the final Exceptional Events Rule (EER). The purpose of this document is to petition the Regional Administrator for Region 9 of the U.S. Environmental Protection Agency (EPA) to exclude air quality monitoring data for ozone from the normal planning and regulatory requirements under the Clean Air Act (CAA) in accordance with the EER. This exceptional event demonstration underwent public review and comment before submittal to EPA (see Section 3.5).

On May 23, 2012, Clark County recorded exceedances of the ozone NAAQS across its air quality monitoring network due to smoke plume impacts from a wildfire in northern Nevada. This document demonstrates, in accordance with the EER, that these NAAQS violations would not have occurred without the wildfire impacts.

1.2 SCOPE OF DEMONSTRATION

The EER governs the review and handling of air quality monitoring data influenced by exceptional events (e.g., wildfires). Exceptional events are "events for which the normal planning and regulatory process established by the CAA is not appropriate" (*Federal Register*, Volume 72, p. 13560). In its final rule, EPA intended to:

> Implement section 319(b)(3)(B) and 107(d)(3) authority to exclude air quality monitoring data from regulatory determinations related to exceedances or violations of the National Ambient Air Quality Standards (NAAQS) and avoid designating an area as nonattainment, redesignating an area as nonattainment, or reclassifying an existing nonattainment area to a higher classification if a State adequately demonstrates that an exceptional event has caused an exceedance or violation of a NAAQS.

The EER contains procedures and criteria whereby states can petition EPA to exclude data from regulatory considerations because of an exceptional event that caused an area to exceed the NAAQS for a particular pollutant. The term "exceedance" refers to a measured or modeled concentration greater than the level of one or more NAAQS at a specific air quality monitoring location.

EPA requires states to take reasonable measures to mitigate the impacts of an exceptional event. In accordance with Section 319 of the CAA, EPA defines the term "exceptional event" to mean an event that:

- (i) Affects air quality;
- (ii) Is not reasonably controllable or preventable;
- (iii) Is an event caused by human activity that is unlikely to recur at a particular location or a natural event; and

(iv) Is determined by EPA through the process established in the regulations to be an exceptional event (*Federal Register*, Vol 72, p. 13562, Section IV.D).

The ozone concentrations for May 23, 2012 were flagged in EPA's AQS on October 25, 2012, to indicate that NAAQS exceedances were likely caused by ozone precursor emissions produced by smoke plumes from a wildfire. EPA notes that natural events, which are one form of exceptional events, may recur, sometimes frequently. This is certainly true for natural events such as western wildfires.

In this exceptional event demonstration, Section 2 addresses a conceptual model for ozone air pollution and wildfire impacts in Clark County based on technical studies completed to date. That section describes topography, land use, and meteorology in the context of conditions leading to elevated ozone concentrations, then summarizes the role of local emissions and transport into southern Nevada.

Section 3 describes the Clear Causal Relationship between the NAAQS concentrations and the exceptional event, including laboratory speciation, historical fluctuation, smoke trajectories, and the wildfire impacts on the pollutant concentrations. The EER requires a demonstration of the following criteria to exclude air quality data from the normal planning and regulatory process established by the CAA:

1. The event satisfies the criteria set forth in 40 CFR 50.1(j), which defines an exceptional event.

2. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected the air quality in the area.

3. The event is associated with measured concentrations in excess of normal historical fluctuations, including background.

4. There would have been no exceedance or violation but for the event.

5. Documentation is provided with the submission of the demonstration that the public comment process was followed.

Section 4 provides evidence for the "but for" argument; this section outlines concentration calculations in lieu of measured concentrations to show that the exceedance would not have occurred but for the event.

The EER further requires that Clark County prove it took reasonable and appropriate actions to inform the public of deteriorating air quality caused by wildfire smoke plumes and a possible exceedance of the ozone NAAQS. Section 5 addresses these requirements.

An effort was made to identify separate documentation or explanation for each element of the EER; however, some of the explanation can and should overlap with different elements.

Table 1-1. EER Required Elements and Demonstration.

Element	Section Containing Explanation
Regional background and conceptual model	Section 2.0
Clear causal relationship between exceedance and the event	Section 3.0
Concentration is in excess of historical fluctuation	Section 3.3
"But For" demonstration	Section 4.0
Public participation	Section 5.0

1.3 COMPLIANCE WITH CRITERIA FOR EXCEPTIONAL EVENTS

An exceptional event, as defined in 40 CFR 50.1(j), is

> 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. It does not include stagnation of air masses or meteorological inversions, a meteorological event involving high temperatures or lack of precipitation, or air pollution relating to source noncompliance.

1.4 WILDFIRE DESCRIPTION

On May 23, 2012, regional transport overwhelmed any local contribution to elevated ozone levels. This one-day episode was characterized by the greatest number of sites exceeding the NAAQS, and the highest ozone concentrations reached 80 parts per billion (ppb) as the maximum daily 8-hour average (MDA8). Table 1-2 lists the maximum ozone levels by monitoring site for May 23, as well as the days before and after. Figure 1-1 depicts the diurnal cycles for May 21–May 26. Figure 1-2 shows the ozone network and the associated ozone concentrations for May 23.

Table 1-2 Maximum 8-Hour Ozone Concentrations (ppb)

Site	5/21	5/22	5/23	5/24	5/25
APEX	61	74	72	71	70
Mesquite	53	65	71	68	66
Paul Meyer	64	73	78	73	71
Walter Johnson	64	71	78	73	71
Palo Verde	68	73	72	76	74
Joe Neal	67	69	75	74	73
Winterwood	61	74	80	72	70
Jerome Mack	61	73	77	71	68
Boulder City	64	68	78	74	72
Jean	69	69	67	76	73
JD Smith	64	75	77	73	70

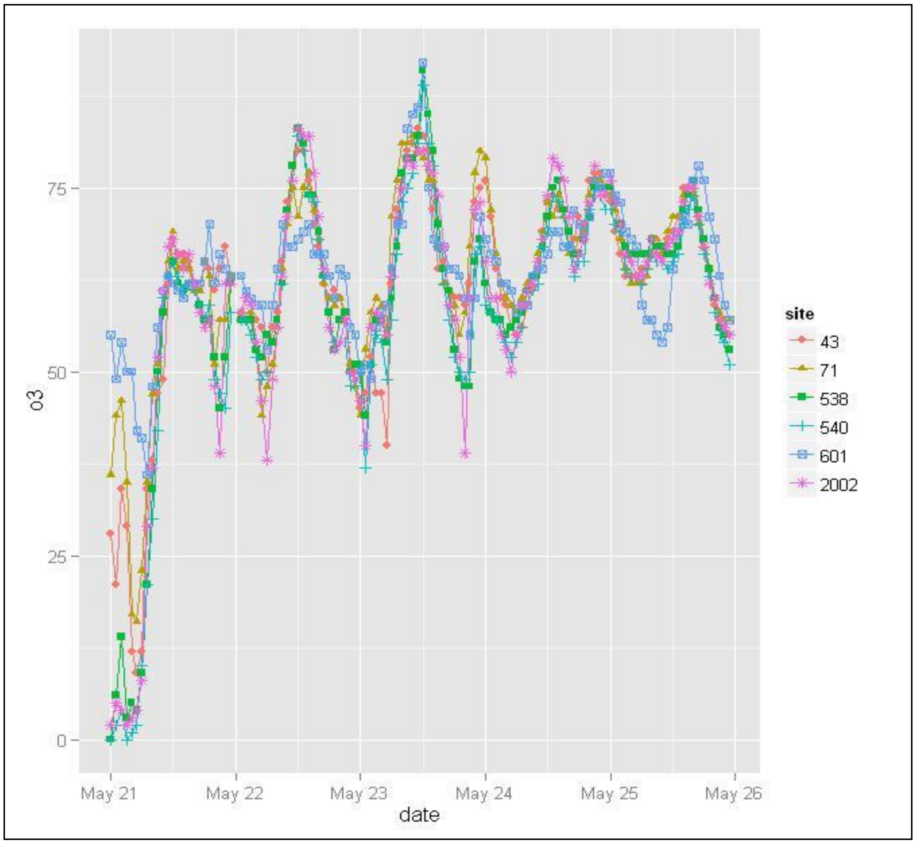


Figure 1-1. Diurnal cycles during 6-day period.

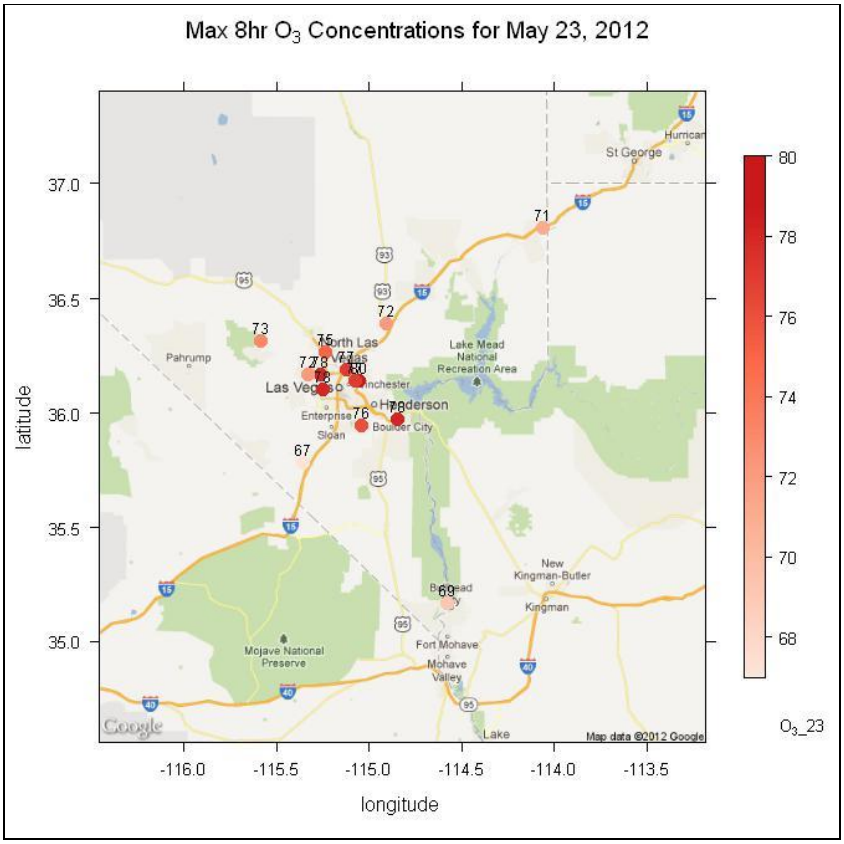


Figure 1-2. Ozone concentrations on May 23, 2012.

The Topaz Ranch Estates (TRE) Fire started at approximately 2:00 pm on Tuesday, May 22. The fire was burning cheat grass, sagebrush, and pinyon pine/juniper on mostly BLM public lands, one mile north of Nevada State Route 208 and three miles east of U.S. Highway 395 near Topaz Lake (about 60 miles south of Reno, Nevada). Two residences and seventeen outbuildings were destroyed early in the incident. Over 360 fire personnel were on-scene, a Type II Incident Management Team assumed command on the fire on Wednesday, May 23. A total of 7,500 acres were burned; the fire was under control on May 26, 2012.

Figure 1-2, a satellite image for May 23, 2012, shows the location of the fire. Wind direction on May 22 and May 23 was from the northwest toward southern Nevada. Figure 1-3 shows the wind roses for Tonopah (town midway between Reno and Las Vegas), and Figure 1-4 depicts the wind data for the North Las Vegas airport.

The ozone NAAQS violations resulted from the transport of ozone and its precursors within wildfire smoke plumes that surrounded the Las Vegas Valley for a few days. The smoke arrived in the Ivanpah, Eldorado, and Las Vegas Valleys between 10:00 and 11:00 PM Pacific standard time (PST) on May 22nd. The weak high pressure duration was too short to qualify as a stagnation period that would have allowed for locally produced ozone to cause the exceedance. Smoke from the wildfire was visible throughout southern Clark County. Surface smoke impacts were documented through laboratory analysis of samples of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) to determine concentrations of wildfire markers (e.g., levoglucosan).

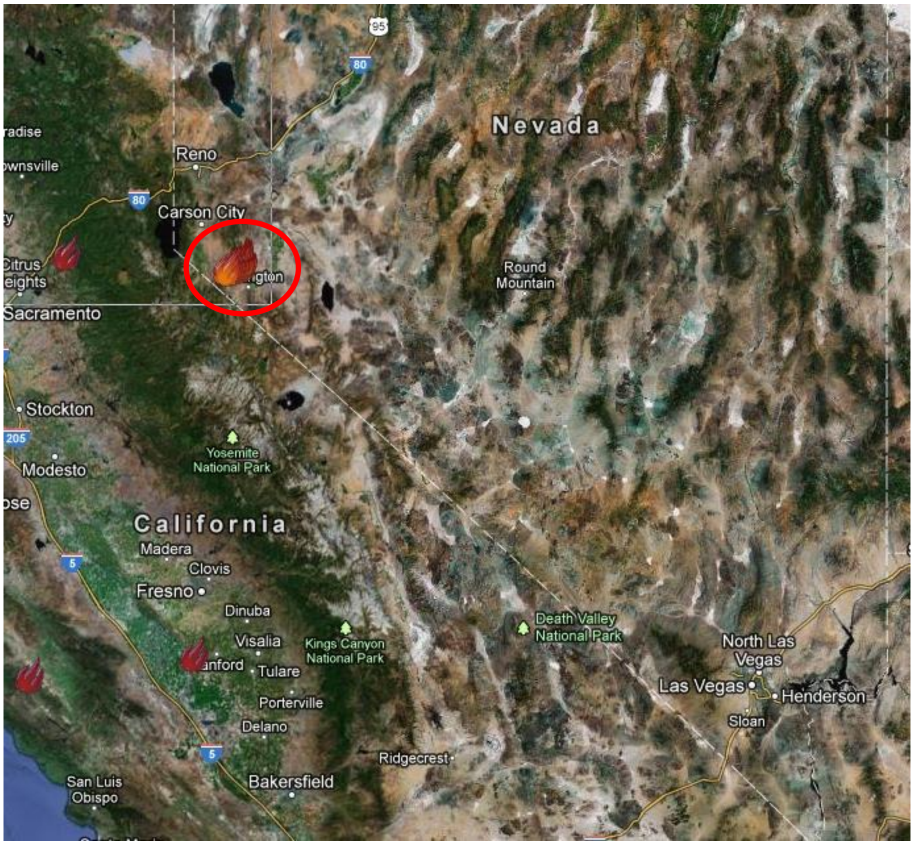


Figure 1-3. Fire location.

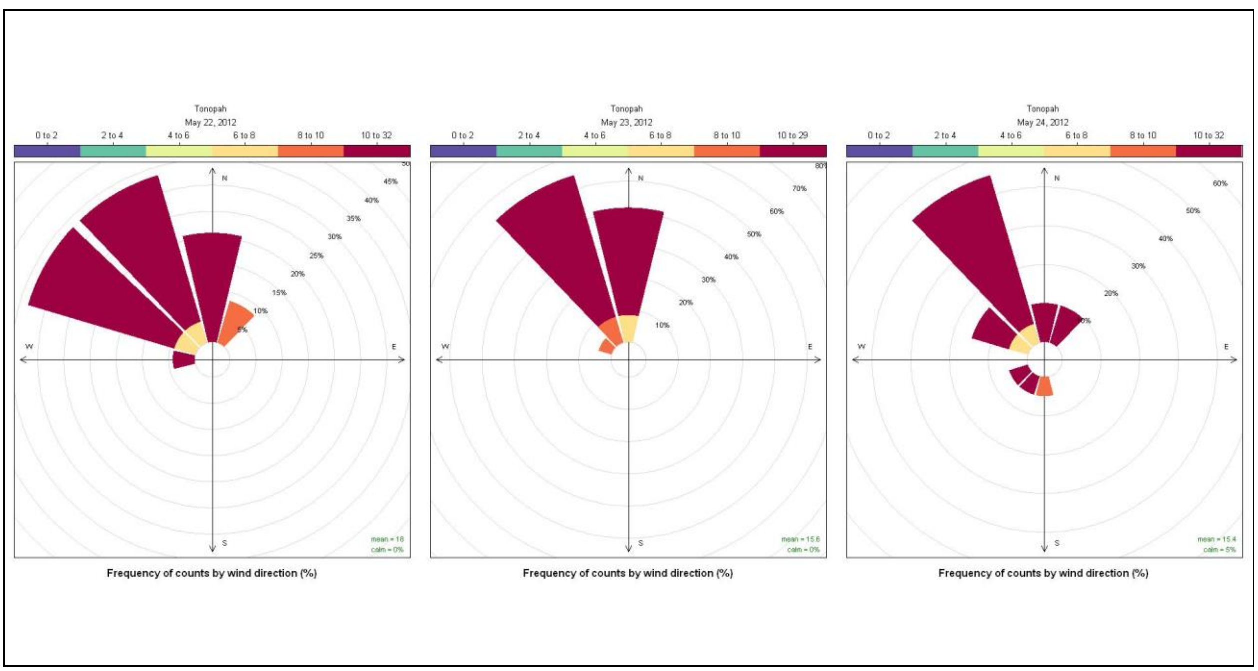


Figure 1-4. Wind roses for Tonopah.

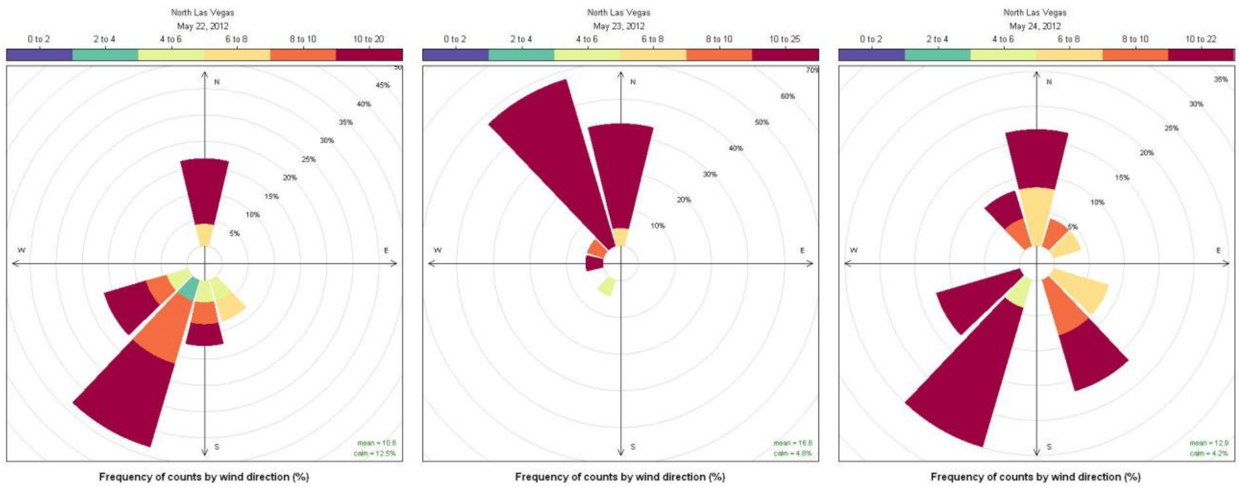


Figure 1-5. Wind roses for North Las Vegas.

The wildfire season in 2012 was the third worst in US history, with 9.2 million acres burned. According to the National Interagency Fire Center, only two years have experienced more area burned: 2006, when 9.9 million acres burned, and 2007, when 9.3 million acres burned. (wunderground.com accessed on Jan 3, 2013).

Of the 9.2 million acres that burned in 2012, approximately 7.3 million acres burned in the Western US. Table 1-3 shows the number of fires and acreage burned per state in 2012.

Table 1-3 Fires in the West in 2012

Wildland		
State	# Fires	# Acres
AZ	1,679	216,025
CA	7,962	814,843
CO	1,490	251,843
ID	1,068	1,538,092
MT	2,207	1,209,992
NM	1,028	372,497
NV	944	613,126
OR	963	1,256,049
UT	1,534	415,266
WA	1,338	260,175
WY	868	446,808
Grand Totals	21,081	7,394,716

1.5 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 in recent years. 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. Moreover, these impacts can be observed in areas that may be hundreds of miles away from wildfire locations.

Individual studies to evaluate the impacts of wildfires on ozone concentrations include both direct observations, such as aircraft flights or ozonesondes, and photochemical or smoke plume modeling. Aircraft flights through smoke plumes have demonstrated increased ozone concentrations of 15 to 30 ppb in California (DAQEM 2008), while ozonesonde measurements in Texas found increased ozone levels aloft of 25 to 100 ppb attributable to long-range transport of smoke plumes from Canada and Alaska (Morris et al. 2006).

Increased levels of ozone from large fires have also been estimated using air quality modeling. McKeen et al. (2002) found that Canadian fires in 1995 increased ozone levels by 10 to 30 ppb throughout a large region of the central and eastern United States. Lamb (2007) found similar results in simulating the impacts of fires in the Pacific Northwest in 2006, with increases of over 30 ppb.

Junquera et al. (2005) further found that within 10 kilometers of a fire, ozone concentrations could increase by up to 60 ppb. In one of the most recent studies, 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. Although the 2007 California fires occurred mostly in Northern California, they added at least 5 ppb to ozone concentrations in southern Nevada. The authors 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."

Finally, in a presentation at an emission inventory conference, Pace et al. (2007) modeled the June 2005 fires, showing that the wildfire impacts added as much as 15 ppb to ozone concentrations in southern Nevada (Figure 1-6). Clark County Department of Air Quality (DAQ) has also carried out technical studies addressing smoke plume impacts on ozone concentrations in southern Nevada (discussed in detail in Section 3).

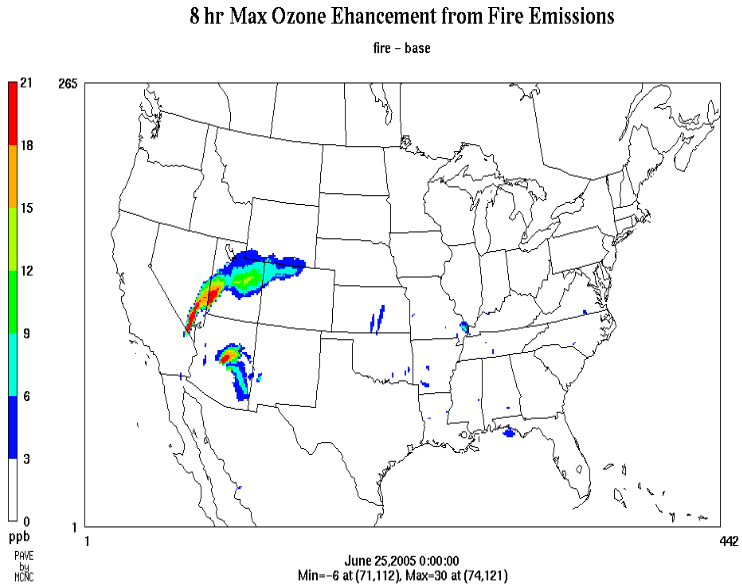


Figure 1-6. Difference in maximum 8-Hour ozone for June 25, 2005.

2.0 CONCEPTUAL MODEL OF OZONE AIR POLLUTION

2.1 TOPOGRAPHY AND METEOROLOGY

Located in southern Nevada, Clark County consists of 8,091 square miles characterized by basin and range topography. It is one of the nation's largest counties, with an area bigger than the states of Connecticut and Delaware combined. The Las Vegas Valley sits in a broad desert basin surrounded by mountains rising from 2,000 feet to over 10,000 feet above the valley floor. The relief map in Figure 2-1 illustrates the basins and mountain ranges surrounding the valley. Terrain within the Las Vegas Valley rises significantly, from approximately 1,200 feet at Lake Mead to 2,000 feet in downtown Las Vegas to over 2,800 feet in the suburbs on the west side of the valley, near the Spring Mountain Range.

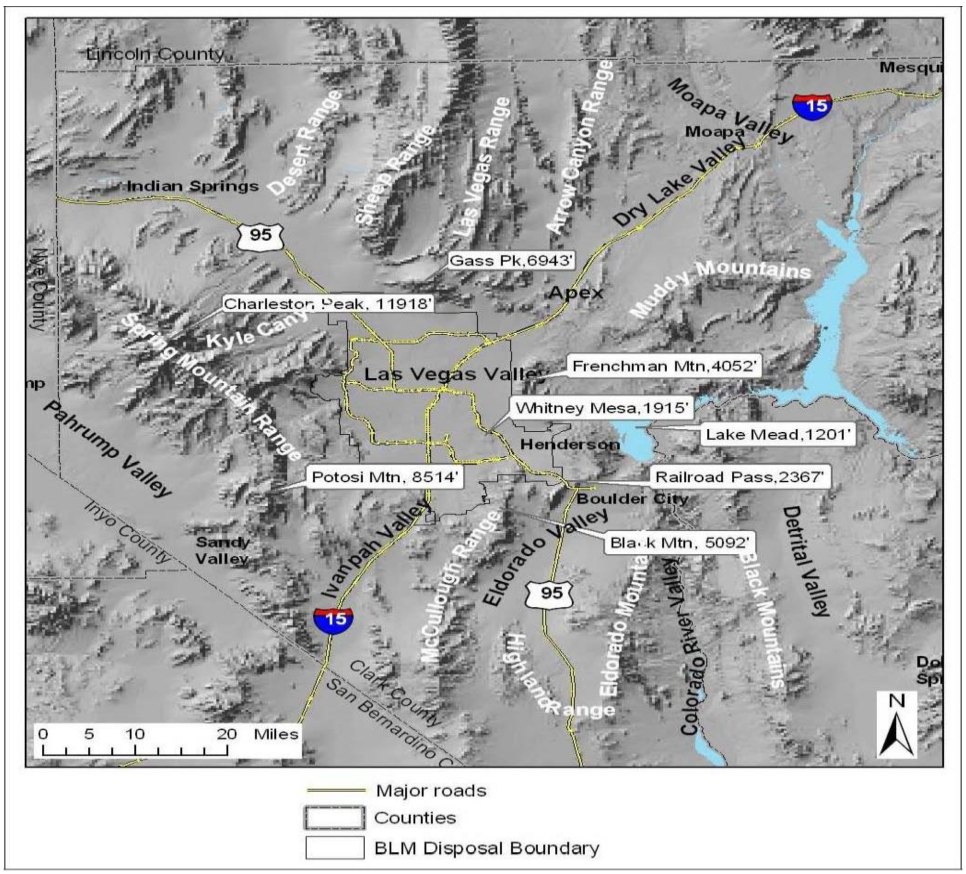


Figure 2-1. Mountain ranges and basins surrounding the Las Vegas Valley.

Although located in the Mojave Desert, Clark County has four well-defined seasons. Summers display the classic characteristics of the desert Southwest: daily high temperatures in the lower elevations often exceed 100 ºF, with lows in the 70s. The summer heat is usually tempered by low relative humidity, which may increase for several weeks during July and August in association with moist monsoonal wind flows from the south. Average annual rainfall in the valley, measured at McCarran International Airport, is approximately 4.5 inches. Table 2-1 lists temperature and rainfall averages in Clark County from 1981-2010.

Table 2-1 Monthly Averages for Temperature and Rainfall (1981-2010)

Month	Maximum (°F)	Minimum (°F)	Average (°F)	Rainfall (inch)
January	58	39.4	48.7	0.54
February	62.5	43.4	52.9	0.76
March	70.3	49.4	59.9	0.44
April	78.3	56.1	67.2	0.15
May	88.9	65.8	77.3	0.12
June	98.7	74.6	86.7	0.07
July	104.2	80.9	92.5	0.4
August	102	79.3	90.6	0.33
September	94	71.1	82.6	0.25
October	80.6	58.5	69.5	0.27
November	66.3	46.5	56.4	0.36
December	56.6	38.7	47.7	0.5

http://www.ncdc.noaa.gov

2.2 POPULATION AND LAND USE

The population of Clark County is just over two million people. More than 95 percent reside in the Las Vegas Valley, which encompasses the cities of Las Vegas, North Las Vegas, and Henderson, along with portions of Boulder City near Hoover Dam. Figure 2-2 depicts land use and vegetation in Clark County along with the two major transportation routes, Interstate 15 and U.S. Highway 95.

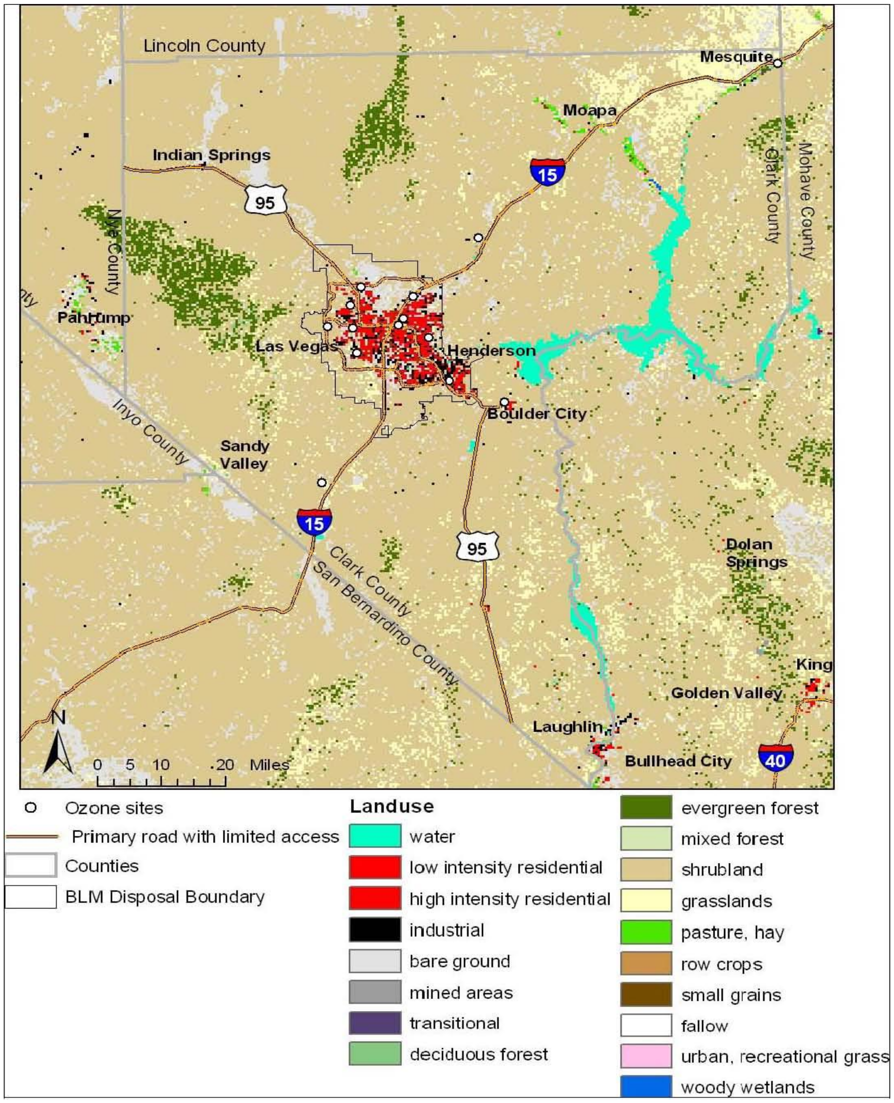


Figure 2-2. Land use and vegetation in Clark County.

2.3 OZONE AIR POLLUTION IN CLARK COUNTY

In 2006, DAQ (formerly called the Department of Air Quality and Environmental Management (DAQEM)) embarked on a research study to characterize and identify the meteorological features that affect the timing and locations of elevated ozone levels in Clark County (see *Ozone Characterization Study*, DAQEM 2006a).

In the study, synoptic weather patterns during the ozone season (May through August) were analyzed using 500 millibar (mb) constant-pressure maps. Specific measured weather parameters including the 500 mb height and the ambient air temperature at the 700 mb level at the Desert Rock NWS upper-air site were used. Temperatures aloft at the 700 mb level are indicative of the mixing potential (stability) of the regional air mass presiding in the area at the time of measurement. That is, warmer air at 700 mb (~10,000 feet or 3,000 meters) is indicative of a stable atmosphere and poor dispersion conditions, while cooler air aloft is associated with more vigorous vertical mixing of pollutants and thus better dispersion. Based on the analysis, it was determined that weather patterns could be characterized into five basic weather types: Pacific Trough, Interior Trough, Pacific Ridge, Interior Ridge, and Flat Ridge. The characteristics and criteria for each weather type are described below.

2.3.1 Pacific Trough

The axis of the long-wave 500 mb trough, or series of short wave troughs, is located off or along the Pacific Coast, producing falling 500 mb heights and increases from a westerly to southwesterly flow. By convention, it was decided that the lowest 500 mb heights during this weather type are west of the Sierra Nevada Mountains. This type of trough influences atmospheric dispersion conditions in the interior southwestern U.S. by slowly eroding the strength and longevity of stable anti-cyclonic air masses; this results in the breaking down of the broad scale subsidence needed to sustain poor dispersion conditions. The Pacific Trough designated weather type, also by convention, includes zonal flow situations characterized by light to moderate straight west to east flow across the western U.S. The southerly component of the onshore flow characteristic of the Pacific Trough weather type may also allow for increased moisture aloft over the interior regions. In general, the 700 mb temperature at the Desert Rock upper-air station is less than 10 ^{o}C (degrees Celsius) during Pacific Trough occurrences.

2.3.2 Interior Trough

When the axis of a long or short wave trough, or a closed cyclonic system, resides in the interior of the southwestern U.S., the synoptic weather type is designated to be an Interior Trough. In this type, the lowest 500 mb heights are east of the Sierra Nevada Mountains. The most significant characteristic of this pattern is the advent of cool air aloft in the interior southwest, and the resultant well-mixed dispersion conditions. Temperatures at 700 mb are usually below 8 ^{o}C, and may be as low as 0 ^{o}C during the early part of the ozone season. When advected moisture is available aloft, considerable cloudiness and escalated precipitation potential may also accompany the Interior Trough synoptic type.

2.3.3 Pacific Ridge

The Pacific Ridge synoptic weather type is directly associated with the mean eastern Pacific ridge, with the axis of highest pressure situated along or west of the Pacific coast. The convention for this feature requires that the highest 500 mb heights be located west of the Sierra Nevada Mountains. The maximum 500 mb heights usually exceed 5,900 meters near the core of the ridge, but at the Desert Rock upper-air site, heights may be considerably lower. Another convention for the Pacific Ridge designation requires that the 500 mb flow over southern Nevada be from a northerly direction (west-northwesterly to northeasterly), reflecting the counterclockwise motion around the anti-cyclonic air mass to the west. During the first half of the ozone season, the northerly flow aloft will result in the advection of cooler, less stable air into the region, while during the latter half of the season, the northerly flow often brings in warmer, drier air. The Desert Rock 700 mb temperature may be as high as 12 ^{o}C (late season), or as low 5 ^{o}C (early season). The Pacific Ridge weather type usually marks the beginning of an anti-cyclonic situation, and often will follow a cyclonic event, especially in the earlier part of the season. It is also not unusual for this type to be the result of the retro-gradating of a ridge located farther east. The Pacific Ridge weather type is usually more transient than other ridging situations, and thus tends to occur for shorter durations, often as a transition into other longer-lived anti-cyclonic regimes.

2.3.4 Interior Ridge

The primary characteristic of the Interior Ridge weather type is the existence of a discernible high-pressure ridge at the 500 mb level over the interior southwestern U.S. The convention for this feature is that the highest 500 mb heights be located east of the Sierra Nevada Mountains. Typically, the interior ridge occupies the Great Basin and Inter-Mountain region and is often centered near the Four Corners area east of Las Vegas. The height of the 500 mb surface over the Desert Rock upper-air site is usually greater than 5,900 m, and sometimes as high as 5,990 meters. The 700 mb temperature in this situation usually exceeds 12 ^{o}C, and can be as high as 16 ^{o}C. The warm temperatures aloft are indicative of strong air mass subsidence in the interior region, and thus valley capping and limited thermodynamic mixing are prevalent; however, because of the lack of cool air advection, the hottest local surface temperatures of the year are usually recorded during Interior Ridge events, but mixing-layer depths may sometimes be deeper due to intense surface heating. Flow aloft at Desert Rock is usually very light and possibly variable when the ridge axis is over southern Nevada and easterly to southeasterly when the ridge center is father east.

2.3.5 Flat Ridge

When the eastern pacific ridge broadens to extend over the ocean and the interior west, with little transitory movement, this weak anti-cyclonic air mass is classified as a Flat Ridge. In this pattern, all of the synoptic scale energy is well to the north and the pressure gradients, both at the surface and aloft, are very weak. The 500 mb surface may not always be as high as in the stronger ridging types (such as the Pacific Ridge and Interior Ridge), but they still are typically greater than 5,900 meters over most of the region. Because this is still a weak anti-cyclonic situation, significant air mass subsidence is prevalent, and as a result, the interior valleys remain capped and stable. This scenario is the most conducive to increased episodic pollution carryover from one day to the next.

Explanations of the charts are attached in Section 10.0 Weather Charts.

2.4 SYNOPTIC WEATHER PATTERNS ASSOCIATED WITH THE EVENT IN MAY 2012

The 200, 500, and 850 mb time-series images for May 22-25, 2012, and the 500 mb chart for May 26, 2012, were examined to determine the synoptic weather patterns prior, during, and after the May 23-24, 2012, event. The synoptic weather patterns are as follows.

<u>May 22</u>
Prior to the event the four 200 mb time-series images in Figure 2-1 indicate that a high pressure Flat Ridge with zonal flow began to breakdown as a low pressure Pacific Trough made its way into the southwestern U.S. The four 500 mb time-series images in Figure 2-2 show that the inter-

face zone between the trough and the ridge was horizontally situated west to east over Clark County. As a result, regional airflow shifted from northwesterly to a west northwesterly direction. The four 850 mb time-series images in Figure 2-3 show a thermal low over Clark County combined with a weak disturbance.

<u>May 23-24</u>

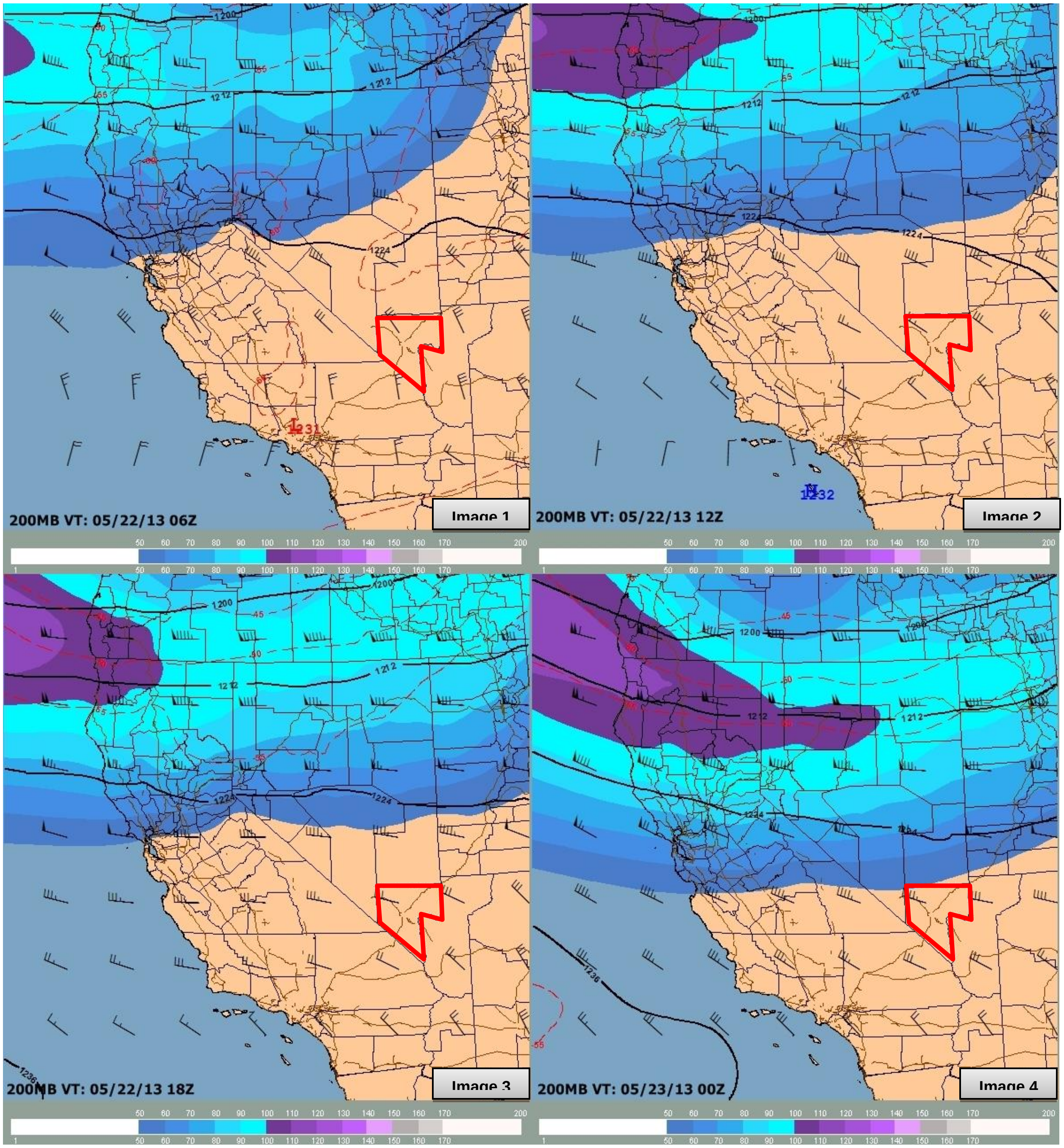
During the event the Pacific Trough strengthened with a more intense northwest to southeast regional airflow (see 200 mb time series images #1-6 in Figure 2-4). As a result, the Jet Max (a point or area of relative maximum wind speeds within a jet stream) was positioned directly north of Clark County. The 500 mb time series images #1-6 in Figure 2-5 show the formation of a long wave trough extending from the Pacific Northwest southward to central California and southern Nevada. The 850 mb time-series images #1-6 in Figure 2-6 show the thermal low system beginning to center itself over southern Nevada with an inverted Pacific Trough. All levels show a northwesterly to southeasterly regional airflow.

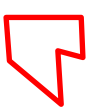
<u>May 25</u>

After the event the Jet Max shifted position to west of Clark County with the Pacific Trough continuing to deepen (see images #7-8 in Figure 2-4). The weather pattern became a closed low centered over Northern California and Oregon (see images #7-8 in Figures 2-5 and 2-6). The three 500 mb time-series images in Figure 2-7 show a strengthening of the closed low over the western U.S. with the center relocating over Clark County. The deepening and repositioning of the Pacific Trough resulted in a shift of the directional airflow from northwesterly to westerly.

<u>Conclusion</u>

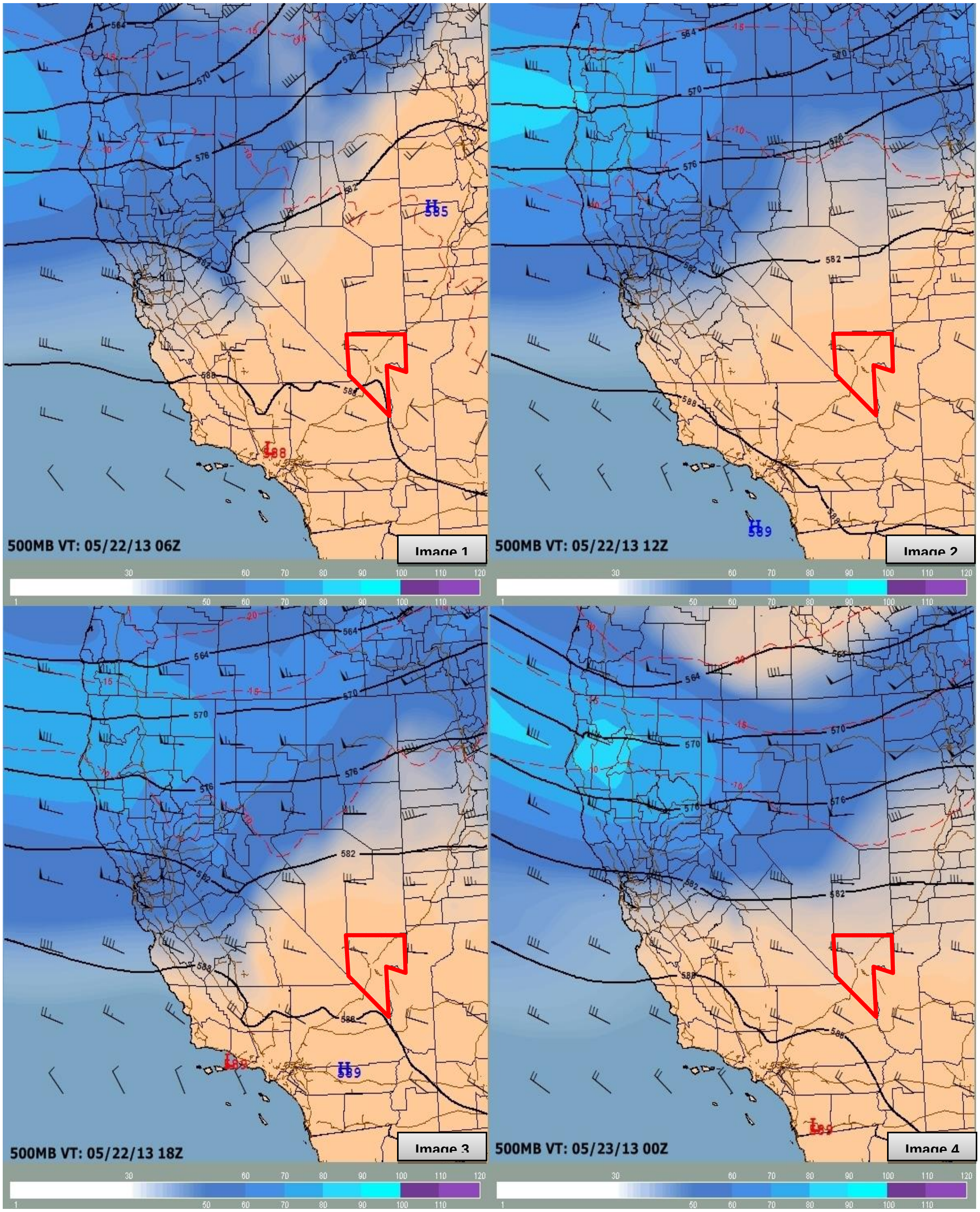
On May 22, a Pacific Trough began to break down the flat ridge as it moved down its backside. On May 23-24, the trough or low-pressure system moved far enough south to cause a directional change in flow at all levels from the northwest. By May 25, the low pressure system dug deep enough to the south to cause another directional shift from the west.





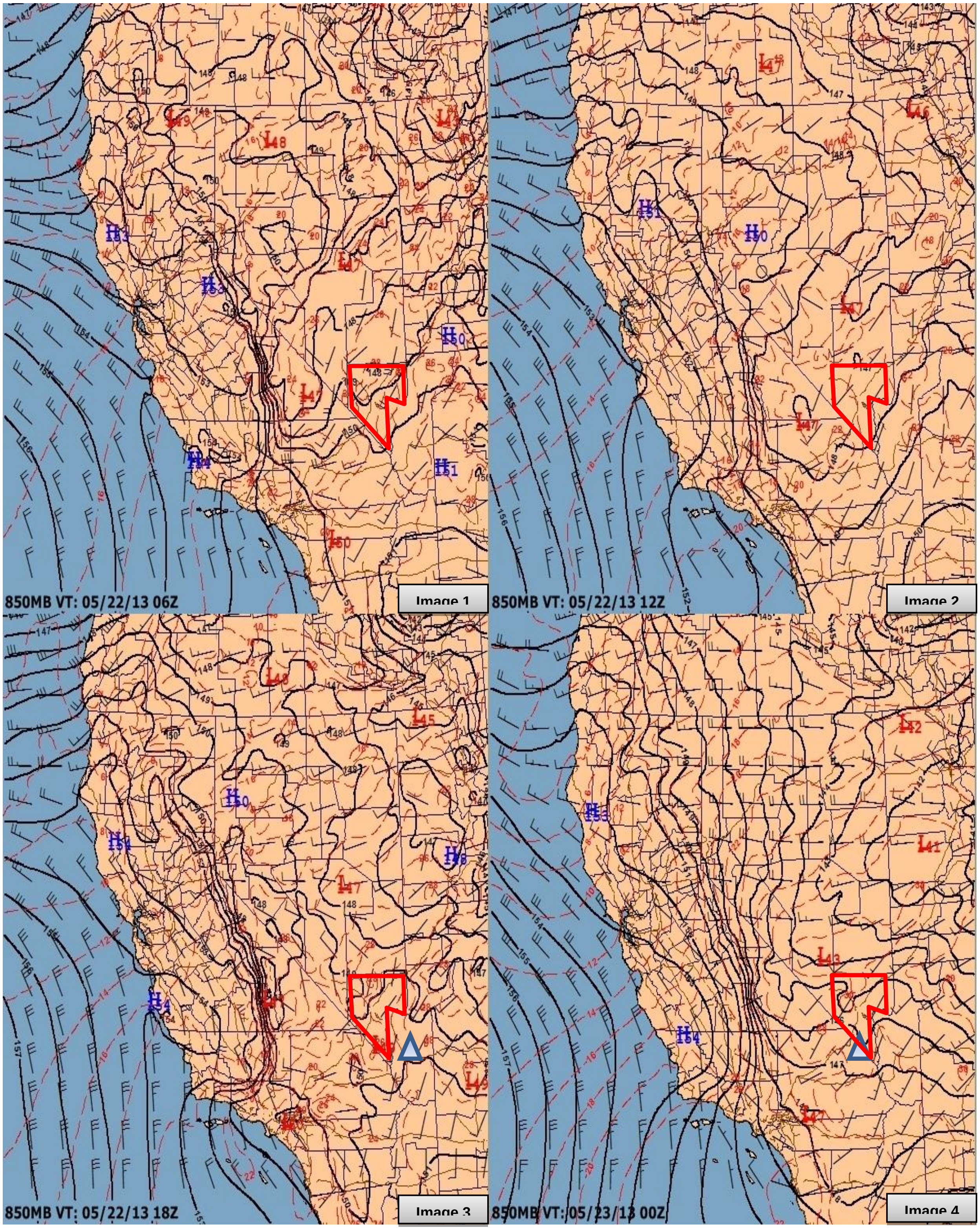
Represents Clark County, NV

Figure 2-1.200 mb weather images for May 22, 2012.



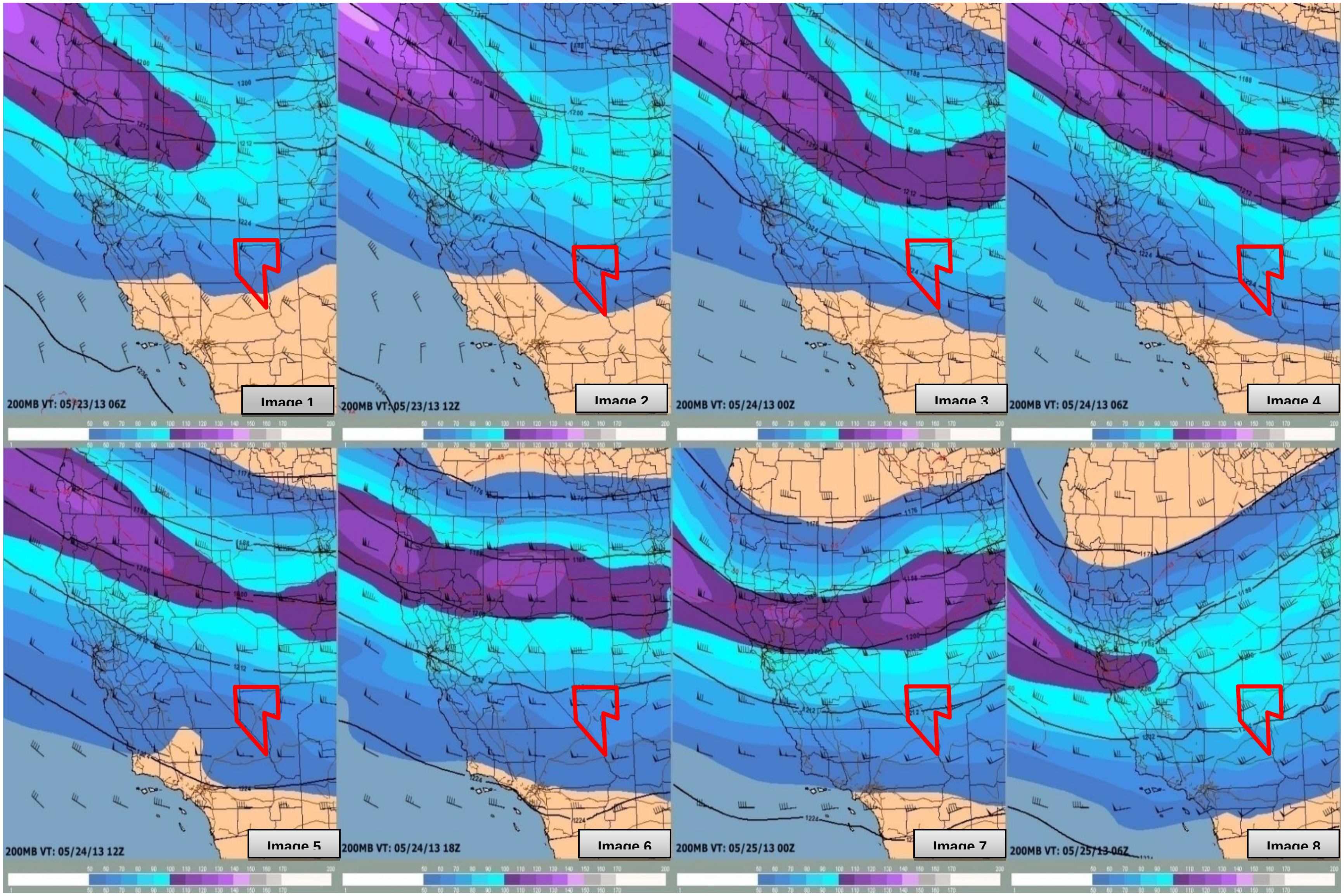
Represents Clark County, NV

Figure 2-2. 500 mb weather images for May 22, 2012.




Represents Clark County, NV

Figure 2-3. 850 mb weather images for May 22, 2012.



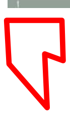

Represents Clark County, NV

Figure 2-4. 200 mb weather images for May 23, 2012, and May 24, 2012.

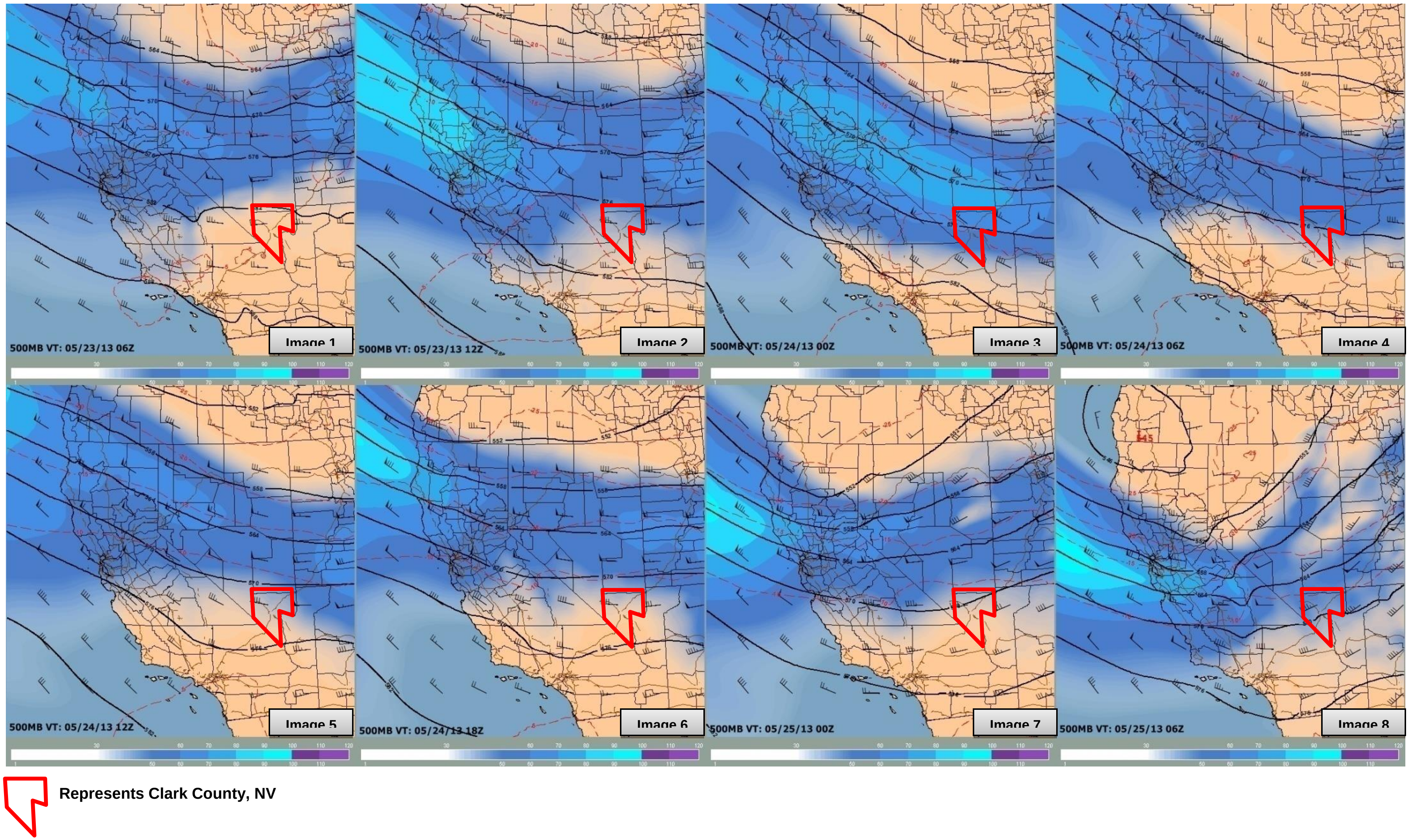


Figure 2-5. 500 mb weather images for May 23, 2012, and May 24, 2012.

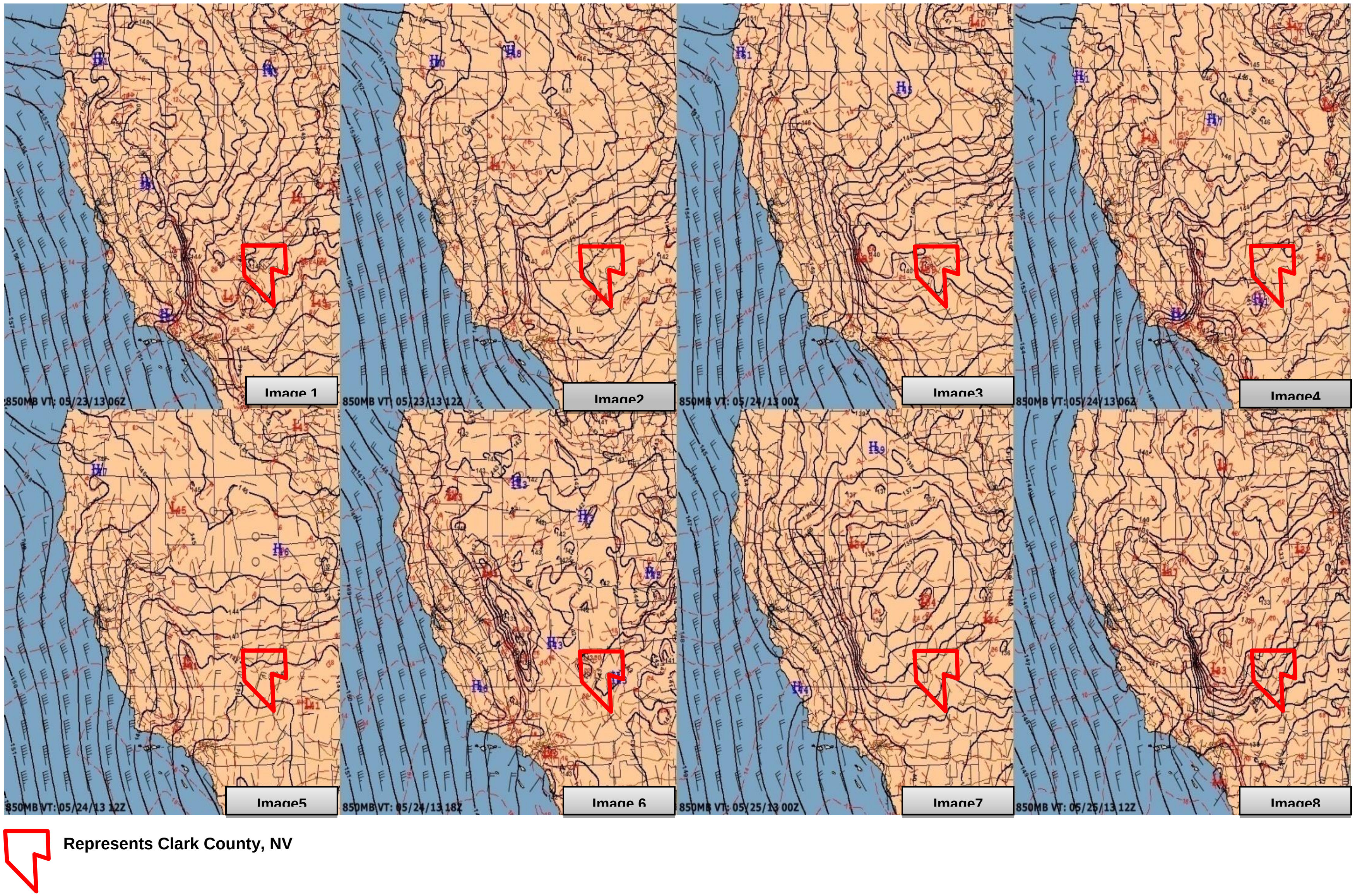
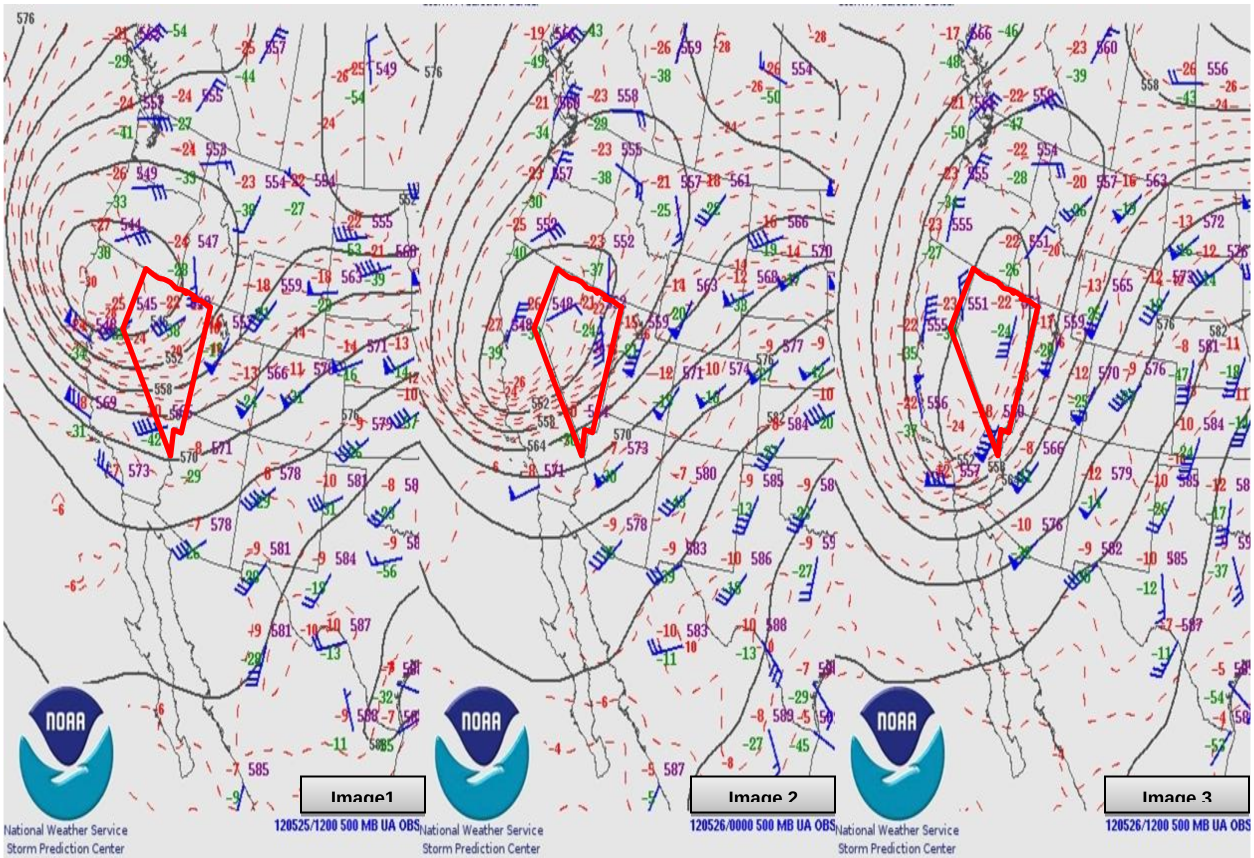


Figure 2-6. 850 mb weather images for May 23, 2012, and May 24, 2012.



Represents Clark County, NV

Figure 2-7. NOAA 500 mb storm prediction images for May 25, 2012, and May 26, 2012.

3.0 CLEAR CAUSAL RELATIONSHIP

3.1 INTRODUCTION

Smoke plumes from wildfires contain a variety of pollutants, including volatile organic compounds (VOCs) and oxides of nitrogen (NO_x)—precursor pollutants in the formation of ozone—and particulate organic and inorganic compounds. Wildfire smoke plumes affect air quality not only through the emissions of primary pollutants, such as CO (carbon monoxide), particulate matter, VOCs, and NO_x, but also through the production of secondary pollutants (i.e., ozone and secondary organic aerosols) when VOCs and NO_x undergo photochemical processing during atmospheric transport. Table 3-1 lists a range of pollutants emitted, expressed as emission factors, which are defined as the mass of compounds released per mass of dry fuel consumed. The table demonstrates that significant amounts of VOCs are released during wildfires. Total VOC emissions exceed those of $PM_{2.5}$, and account for 1 to 2 percent of the carbon fuel burned.

Table 3-1 Chemical Compositions and Emission Factors for Wildfires

Compound or Compound Class	Emission Factors (g/kg)	
	Temperate Forest	Temperate Rangeland
$PM_{2.5}$	11.7	9.7
Organic carbon (wt. percent of $PM_{2.5}$)	45 - 55	40 – 70
Elemental carbon (wt. percent of $PM_{2.5}$)	4 - 8	4 – 10
Elemental Species (wt. percent of $PM_{2.5}$):	~ 3	~ 6
• Potassium (K, wt. percent of $PM_{2.5}$)	~ 1	~ 3
• Chloride (Cl, wt. percent of $PM_{2.5}$)	0.3	2
CO	89.6 ± 13.2	69 ± 17
CO_2	1619 ± 112	1684± 45
Alkanes (C2-C10)	0.8	0.4
Alkenes (C2-C9)	2.2	1.8
Aromatics (BTEX)	0.64	0.42
Oxygenated VOCs:	10.9 – 12.9	N/A
• Methanol	0.31 – 2.03	0.14
• Formic acid	1.17	N/A
• Acetic acid	3.11	N/A
• Formaldehyde	2.25	N/A
• Acetaldehyde	0.24	0.25
• Acetone	0.347	0.25
• Acrolein (propenal)	0.123	0.08
• Furan	0.445	0.1
• 2-methyl-furan	0.521	N/A
• 3-methyl-furan	0.052	N/A
• 2,5-dimethyl-furan	0.053	N/A
• Benzofuran	0.038	N/A
N/A = not available; BTEX = benzene, toluene, ethylbenzene, and xylenes.		

3.2 CAUSAL RELATIONSHIP

3.2.1 Meteorological Conditions

On May 23, ozone NAAQS violations resulted from the transport of ozone and its precursors within wildfire smoke plumes that surrounded the Las Vegas Valley for a few days. The smoke arrived in the Ivanpah, Eldorado, and Las Vegas Valleys between 10:00 and 11:00 PM (PST) on May 22. The weak high pressure duration was too short to qualify as a stagnation period that would have allowed for locally produced ozone to cause the exceedance. Smoke from the wildfire was visible throughout southern Clark County.

According to the Area Forecast Discussion, from the National Weather Service Las Vegas, on May 23:

> "… WINDS ALOFT HAVE ADVECTED IN SMOKE ASSOCIATED WITH THE TOPAZ RANCH ESTATE WILDFIRE SOUTH OF CARSON CITY OVERNIGHT...WITH AND A CAN BE OBSERVED FROM SOUTH OF CARSON CITY STRETCHING SOUTHEAST ACROSS LAS VEGAS AND INTO MOHAVE COUNTY. BOUNDARY LAYER WINDS WILL NOT CHANGE GREATLY OVER THE COURSE OF THE DAY...AND WHILE SMOKE MAY DISPERSE SOMEWHAT AS WE MIX HIGHER ALOFT THIS AFTERNOON...WINDS ALOFT WILL NOT CHANGE ENOUGH TO STOP ANY ADDITIONAL SMOKE FROM MOVING IN UNTIL THURSDAY MORNING. IF THERE IS NOT MUCH THINNING OUT TODAY DURING THE AFTERNOON...TOMORROW MORNING WILL LIKELY BE JUST AS SMOKY...UNTIL SOUTHWESTERLY WINDS PICK UP LATE THURSDAY AFTERNOON AHEAD OF THE NEXT SYSTEM TO IMPACT THE REGION…"

3.2.2 Laboratory Analysis of $PM_{2.5}$ Samples

Smoke plume impacts at the surface during the study period were determined by wildfire markers detected through laboratory analysis of $PM_{2.5}$ samples obtained from the Clark County monitoring network. Figure 3-1 shows the air quality monitoring sites within the County

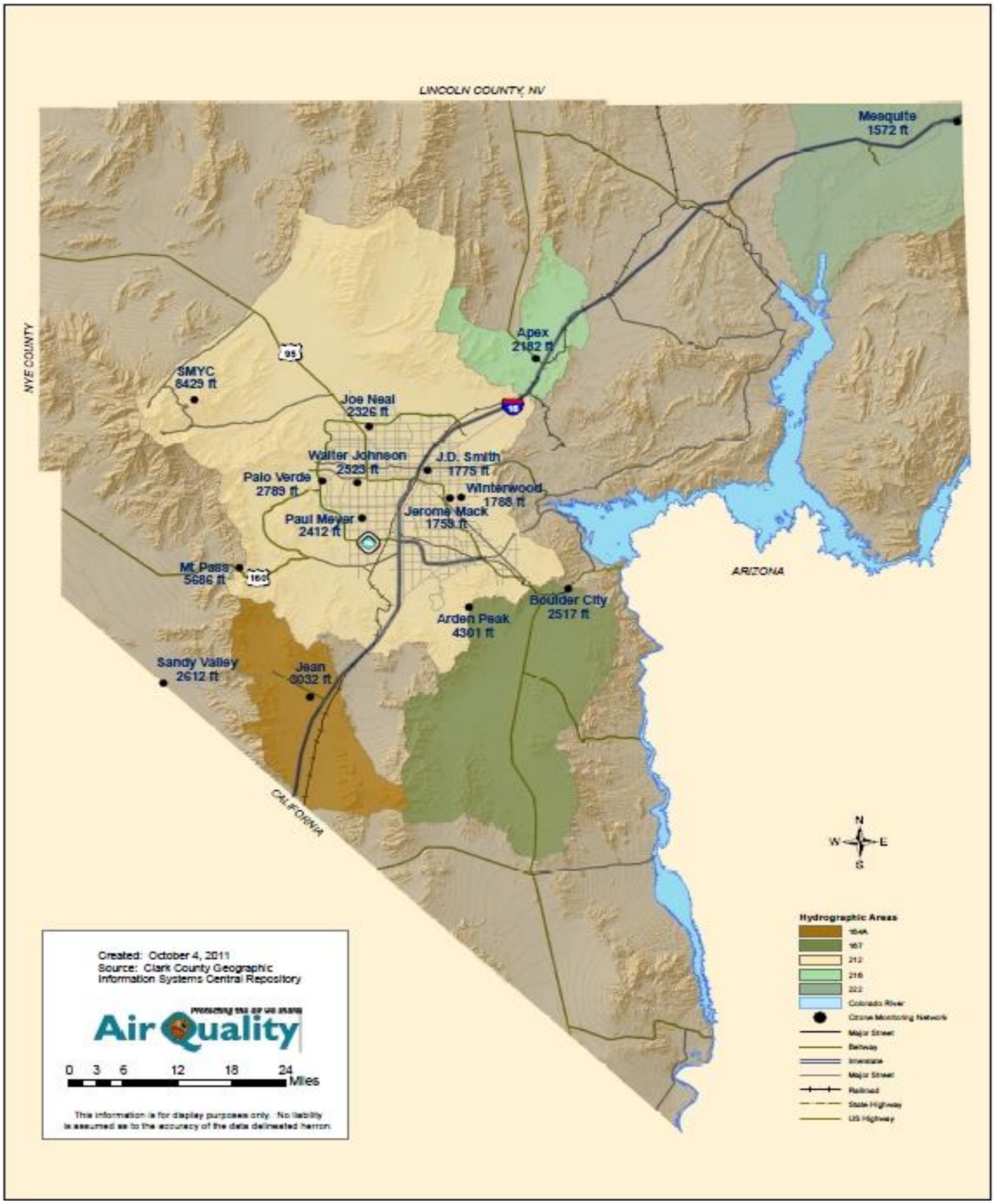


Figure 3-1. Clark County monitoring sites.

Levels of $PM_{2.5}$ track closely with those of levoglucosan, a unique tracer for burning biomass due to its relationship to cellulose. When heated to more than 300 °C, cellulose undergoes various pyrolytic processes that yield tarry anhydro-sugars and volatile products; these give rise to source-specific molecular tracers, primarily the 1,6-anhydride of glucose known as levoglucosan.

Although levoglucosan is widely reported to be abundant in biomass smoke compared to other organic compounds (Fine et al. 2001; Nolte et al. 2001; Schauer et al. 2001; Fine et al. 2002; Hays et al. 2002; Sheesley et al. 2003; Mazzolini et al. 2007), concentrations are highly variable. In Mazzoleni et al. (2007), the overall range of levoglucosan varied from 3 percent to 36 percent of $PM_{2.5}$ mass. The highest percentage was observed for grasses, white pine needles, straws, and mixed woods. Since wildfires typically consume a high percentage of these materials, the concentration of levoglucosan in wildfire emissions is significant in determining where a wildfire originated.

In addition to levoglucosan, methoxylated phenols (methoxyphenols) are often found in biomass combustion emissions and can be significant in determining where a smoke plume originated. Cellulose fibers in plants are bound together in lignin, a complex polymer. The pyrolysis of wood lignins gives rise to methoxyphenols, most often guaiacols and syringols. In the lignin of hardwoods, structural units of guaiacol and syringol are present in even proportions. In the lignin of softwoods, guaiacols are the predominant structural unit.

Mazzoleni et al. (2007) reported that sagebrush and grasses, like hardwoods, emit guaiacols and syringols in similar quantities; however, Mazzoleni noted that pine needles have a high particulate fraction of guaiacols with very few syringols, similar to softwoods. The prescribed burn samples he collected in mixed coniferous forests—Yosemite National Park, California and the Toiyabe National Forest near Lake Tahoe, Nevada—had a high percentage of particulate represented by guaiacols and a very low percentage represented by syringols, as hardwoods do. The prescribed burn samples of desert brushes from central rural Nevada had even percentages of guaiacols and syringols, similar to sagebrush. Mazzoleni et al. (2007) also identified methoxy acids originating from pyrolysis of wood lignin (e.g., vanillic, homovanillic, and syringic acids) in biomass combustion source samples and in-field prescribed burn samples. In general, methoxy acids were found in low abundance in wildland fuels.

In 2011, RTI International, in Research Triangle Park, North Carolina, analyzed six $PM_{2.5}$ filters for traces of levoglucosan to determine the background concentrations at the Jean and Jerome Mack monitoring sites. Three days (one in June, one in July, and one in August) without any fire impacts were chosen for the analysis. Table 3-2 shows the filter numbers and dates. The test results and test procedures can be found in Section 9.0.

Table 3-2 Filter and Sample Days

Jerome Mack	Jean
FD-T0728928-110620	FD-T0728929-110620
FD-T0728978-110720	FD-T0728979-110720
FD-T0729017-110810	FD-T0729018-110810

The results of the analysis (outlined in Table 3-3) showed that there were no detectable levoglucosan concentrations for non-fire days, and therefore the background concentration for levoglucosan during non-fire days is zero.

Table 3-3 Filter Analysis Results

Sample Name	µg/mL
FD-T0728928-110620	0.000
FD-T0728929-110620	0.000
FD-T0728978-110720	0.000
FD-T0728979-110720	0.000
FD-T0729017-110810	0.000
FD-T0729018-110810	0.000

During the 2012 wildfire event, DAQ collected ambient $PM_{2.5}$ samples at Jerome Mack, and RTI International performed a speciation analysis for traces of levoglucosan. After gravimetric mass measurements, all filters were archived and kept in airtight containers in a freezer. Filter samples collected on May 21, May 23, May 24, and May 27 were sent to RTI for analysis. The sample for May 23 was an unscheduled 21-hour run to capture the impacts of the wildfire. Results of the analyses are listed in Table 3-4. Levoglucosan concentrations were elevated during May 23, with some residual levels the next days. The results show that the monitors were impacted by the smoke plume from the TRE fire.

Table 3-4 Analyses Results

Number	Run Date	Levoglucosan (µg)
T1644309	21-May	0.000
T1644323	23-May	1.140
T1644314	24-May	0.705
T1644318	27-May	0.653

The concentration comparison between $PM_{2.5}$, ozone, and levoglucosan (for Jerome Mack) is shown in Table 3-5.

Table 3-5 Pollutant Concentrations

Date	$PM_{2.5}$ (µg/m3)	O_3 (ppb)	Levoglucosan (µg)
21-May	9.92	61	0.000
23-May	12.45	77	1.140
24-May	13.27	71	0.705
27-May	4.08	68	0.653

Since levoglucosan is the most abundant, stable, and universal biomass burning emission marker, the correlation between ozone and levoglucosan concentrations were examined. To obtain a true reading, background ozone levels were subtracted from the average and maximum daily ozone concentrations, i.e., the “background” ozone level was the reading for days when ozone levels were not influenced by wildfire emissions.

The ozone concentration for the day before the event was subtracted from the overall ozone reading for May 23. Only data from the Jerome Mack monitoring site was used for these correlations. As shown in Table 3-5, the ozone concentration on May 21 was 61 ppb, and there were no detectable levels of levoglucosan present. The MDA8 ozone concentration on May 23 for Jerome Mack was 77 ppb. The levoglucosan level was 1.14 µg; therefore, it can be assumed that the wildfire contributed as much as 16 ppb of ozone. The correlation between levoglucosan and ozone during the sampling days was 0.98.

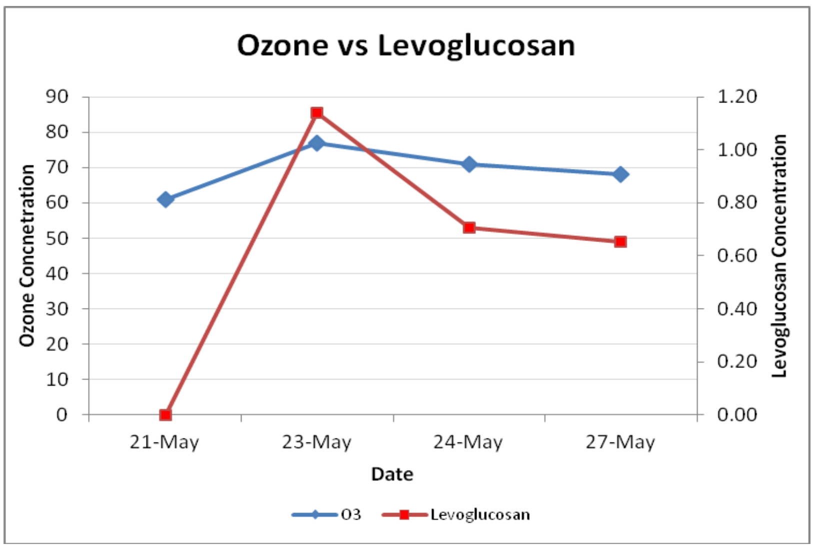
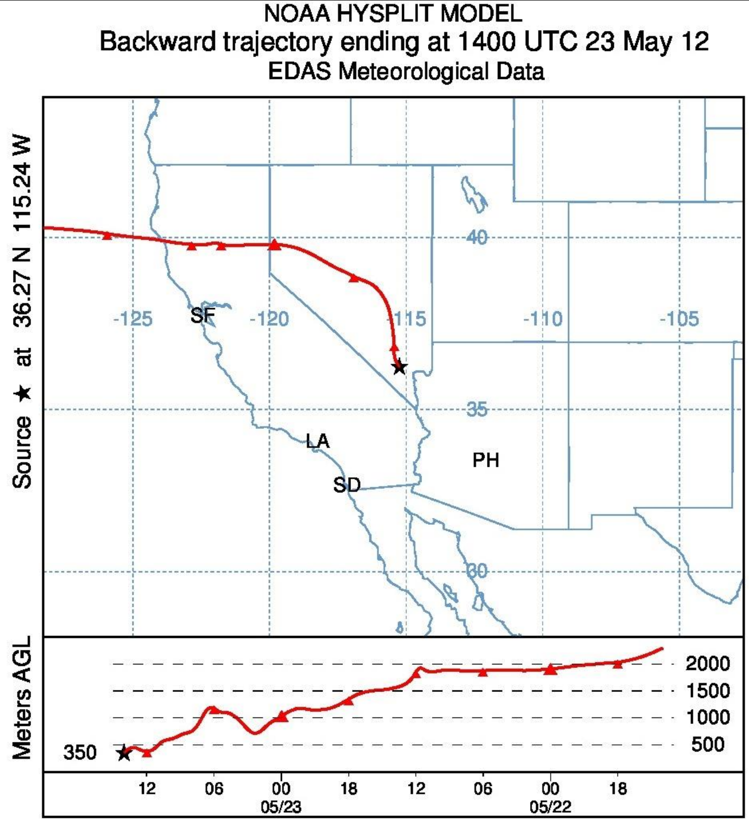


Figure 3-2. Correlation of average ozone and levoglucosan concentrations.

3.2.3 Smoke Plume Trajectory Model

The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model computes simple air parcel trajectories. Its calculation method is a hybrid between the Lagrangian approach, which uses a moving frame of reference as the air parcels move from their initial location, and the Eulerian approach, which uses a fixed three-dimensional grid as a frame of reference. HYSPLIT back-trajectories show the path an air parcel took to reach an area. Applications include tracking and forecasting the release of radioactive material, volcanic ash, and wildfire smoke.

The HYSPLIT plots in Figures 3-3 contain 48-hour back-trajectories for May 23 from 6:00 AM through 15:00 originating in Las Vegas. The back-trajectories demonstrate that the air mass and smoke plume were exacerbating ozone concentrations in Clark County. Figure 3-4 outlines the particulate distribution of the plume on May 23, and shows that the smoke plume clearly impacted Clark County.


NOAA HYSPLIT MODEL
Backward trajectory ending at 1400 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
SF
LA
SD
PH
-125
-120
-115
-110
-105
40
35
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Meters AGL
350
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1500
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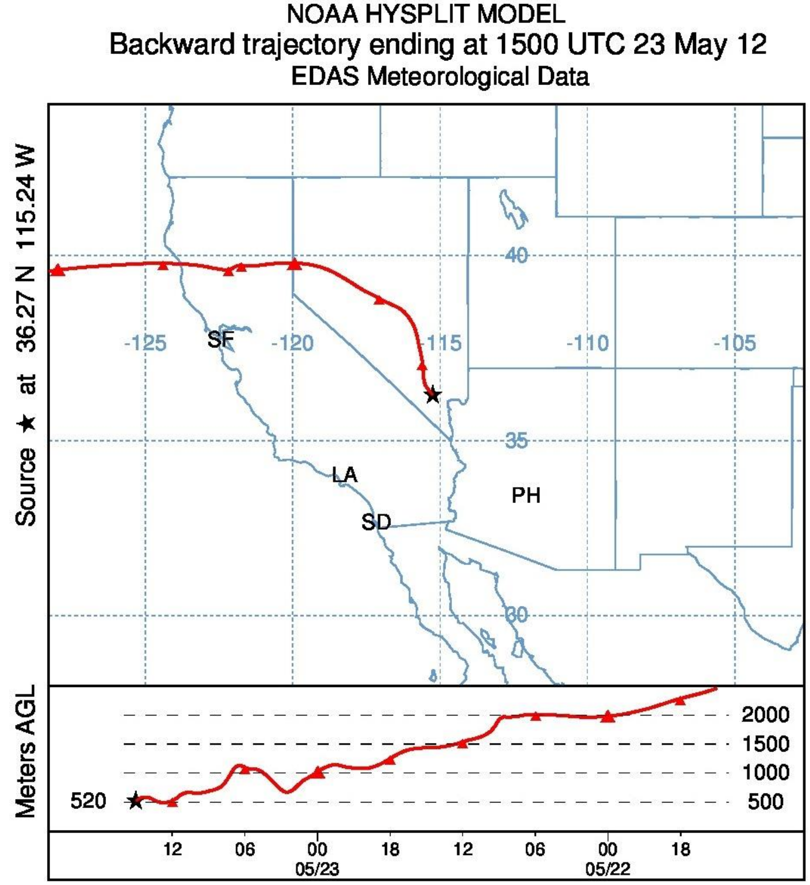
05/22


NOAA HYSPLIT MODEL
Backward trajectory ending at 1500 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
SF
LA
SD
PH
-125
-120
-115
-110
-105
40
35
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Meters AGL
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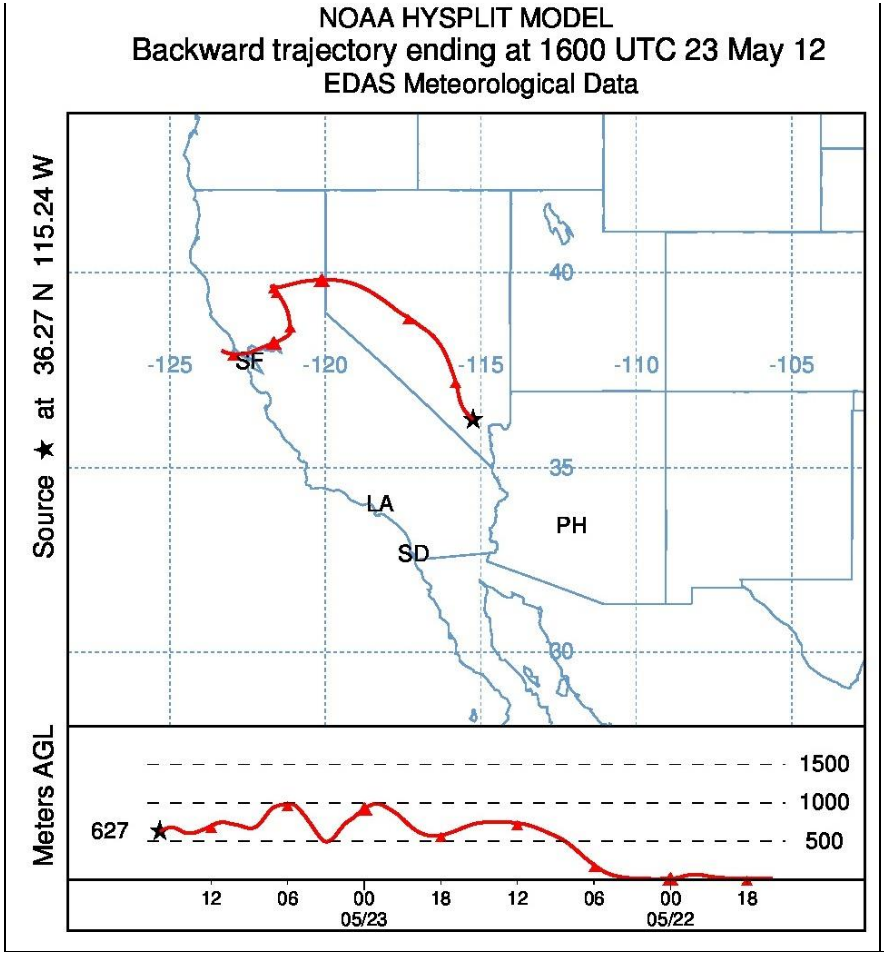
NOAA HYSPLIT MODEL
Backward trajectory ending at 1600 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
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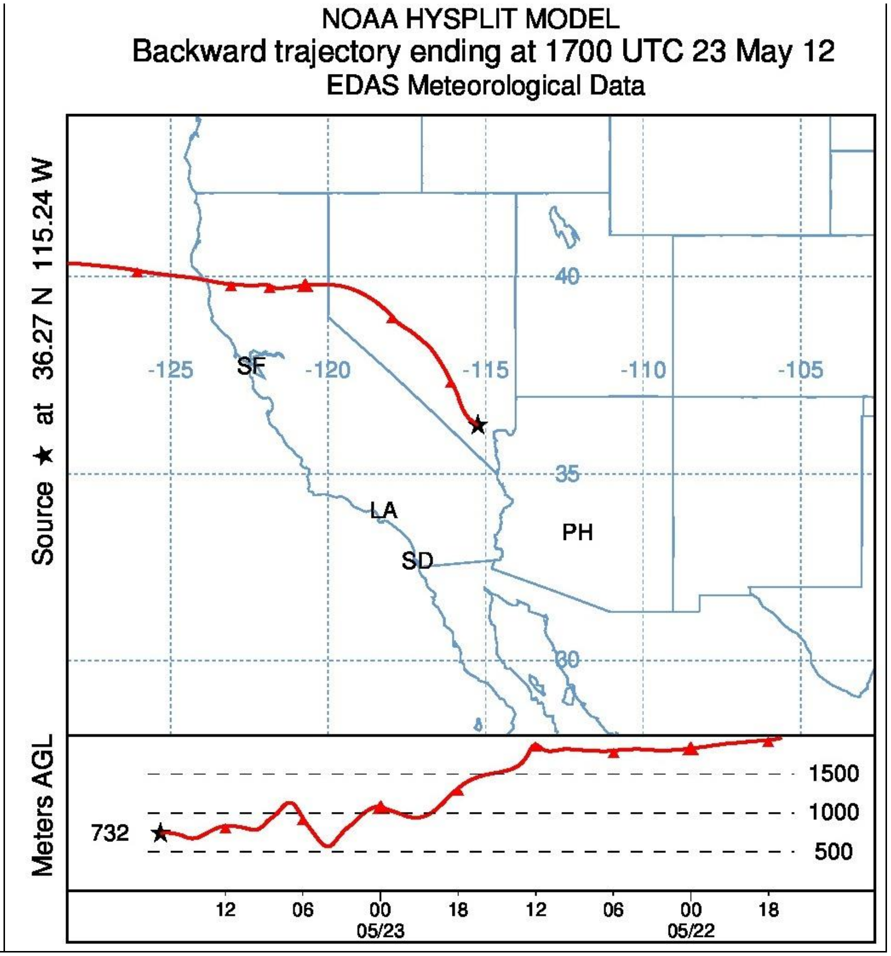
NOAA HYSPLIT MODEL
Backward trajectory ending at 1700 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
-125
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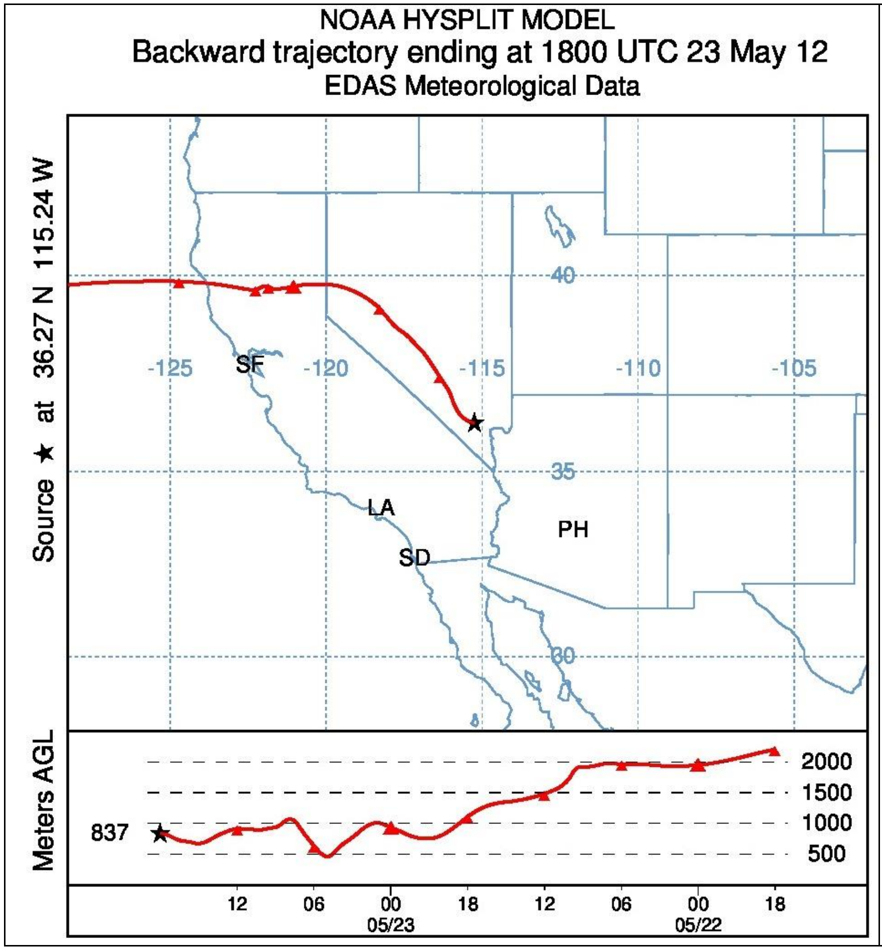
NOAA HYSPLIT MODEL
Backward trajectory ending at 1800 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
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Meters AGL
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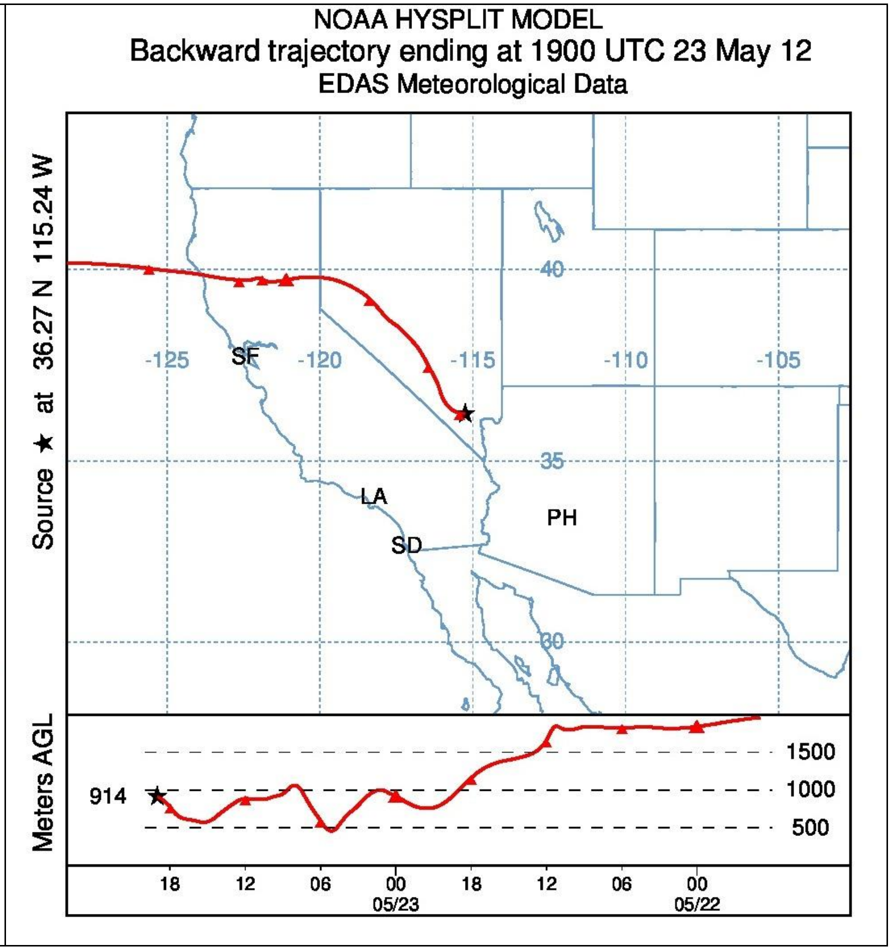
NOAA HYSPLIT MODEL
Backward trajectory ending at 1900 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
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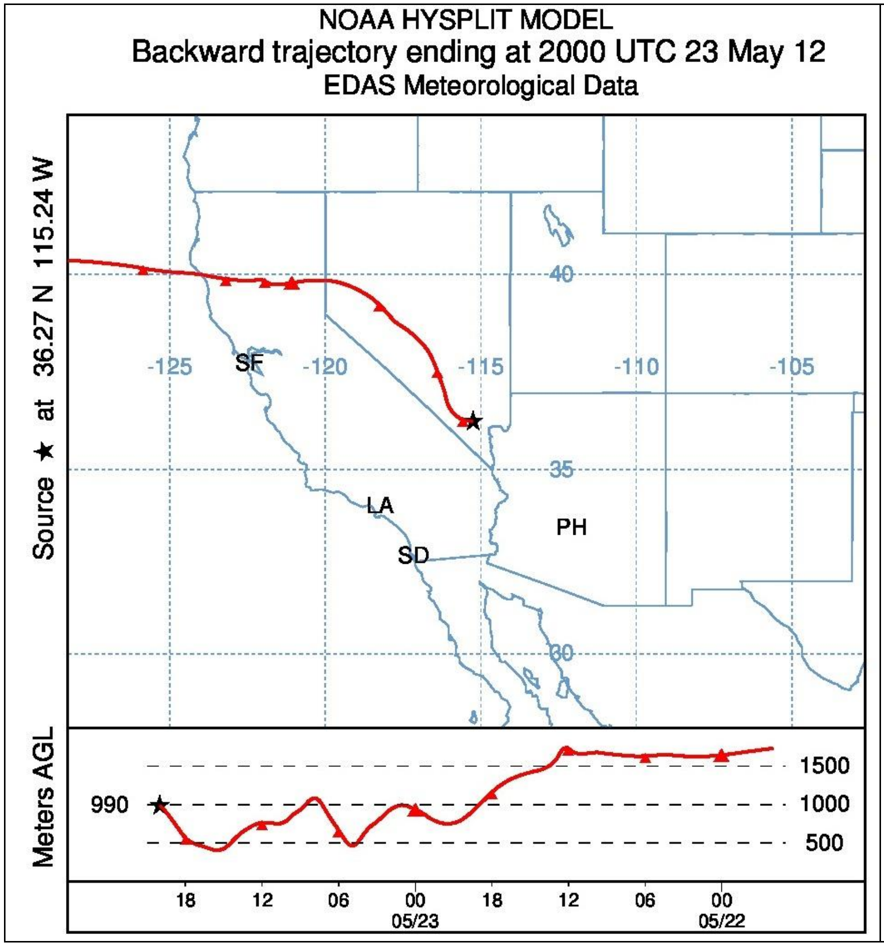
NOAA HYSPLIT MODEL
Backward trajectory ending at 2000 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
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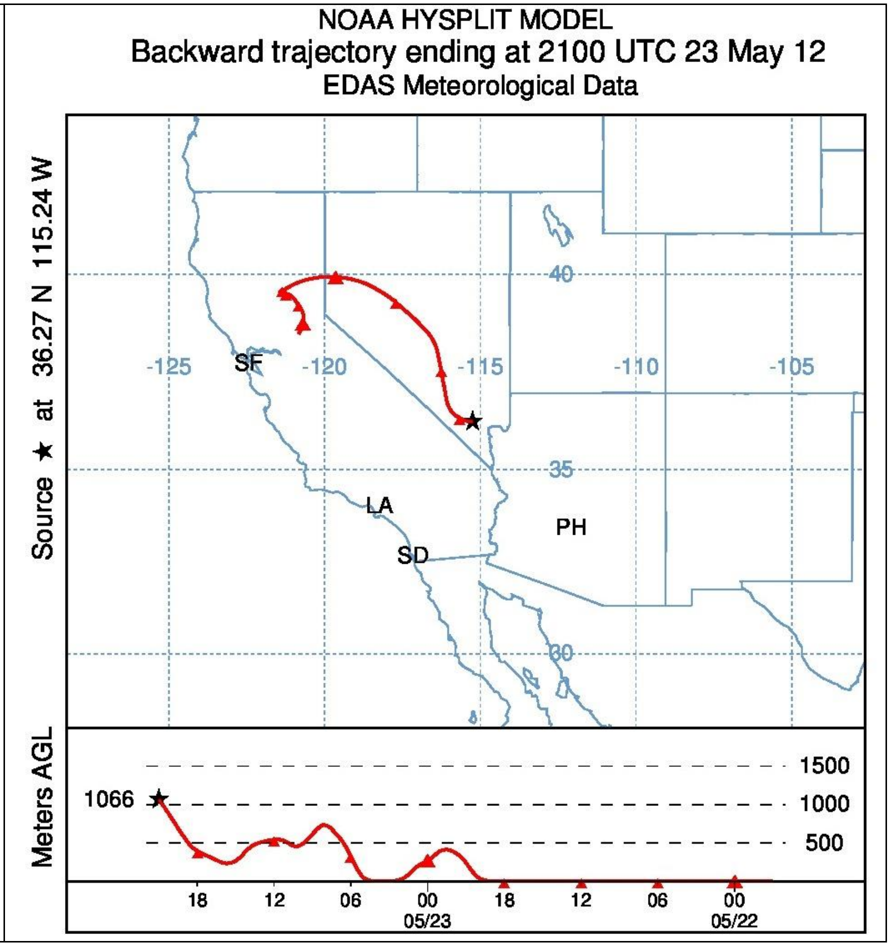
NOAA HYSPLIT MODEL
Backward trajectory ending at 2100 UTC 23 May 12
EDAS Meteorological Data
Source ★ at 36.27 N 115.24 W
SF
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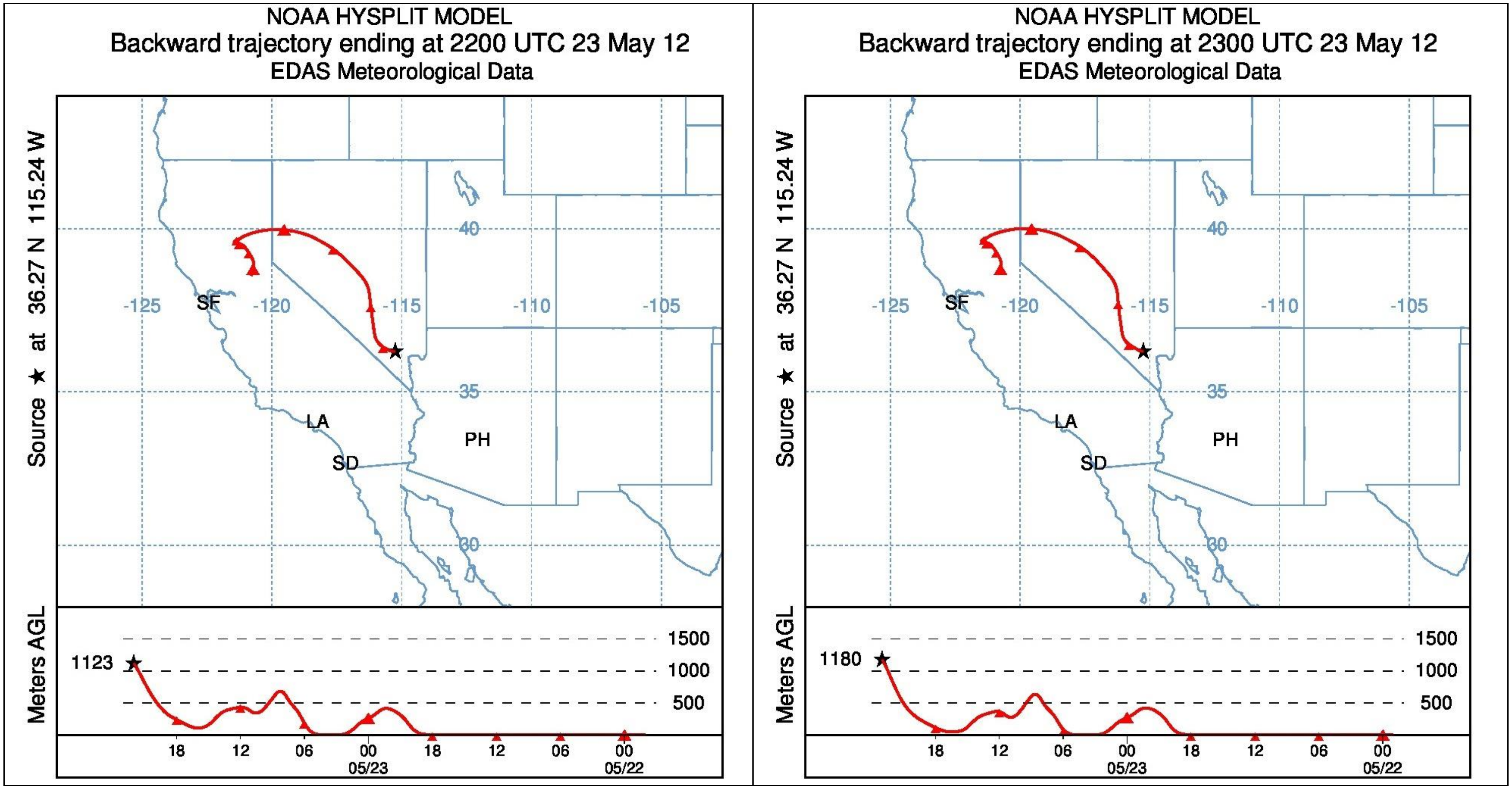

Figure 3-3. Trajectories from 6:00 until 15:00.

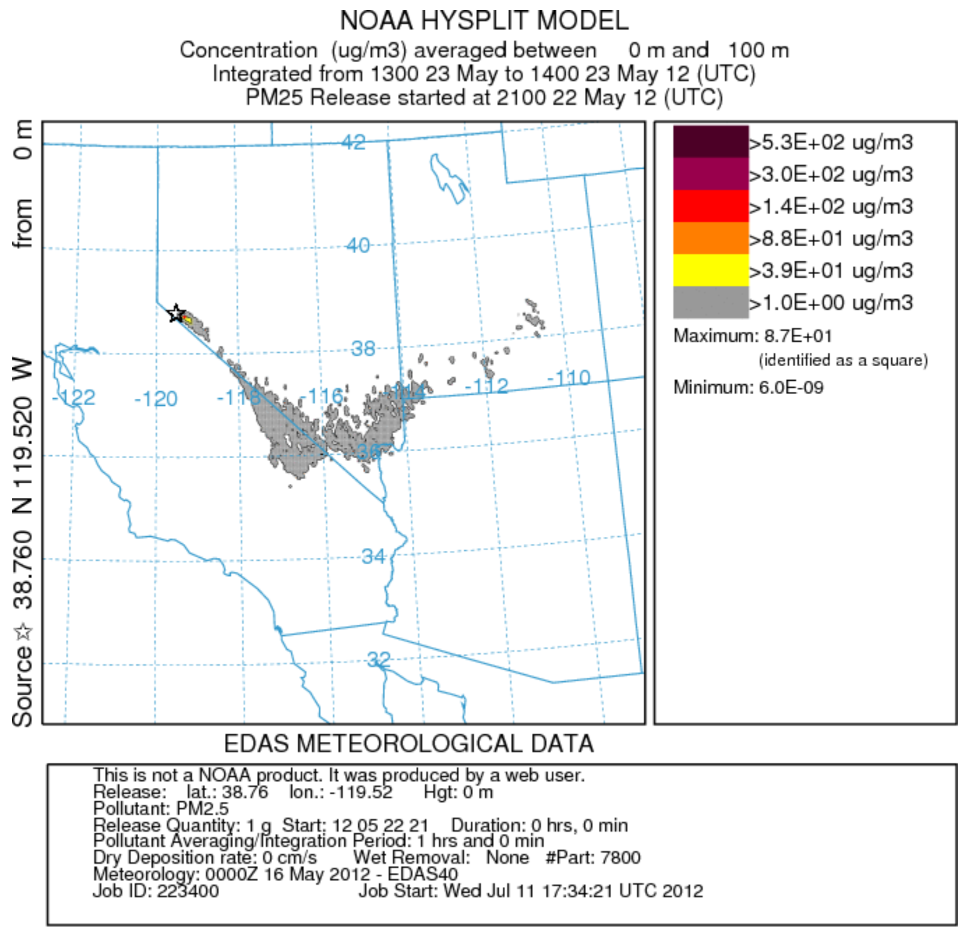

Figure 3-4. Particulate distribution.

3.2.4 Pollutant Concentrations and Wildfire Impacts

High ozone concentrations were recorded starting at 7:00 AM at Walter Johnson, with concentrations reaching 92 ppb at Boulder City at 12:00 PM. The early high concentrations are very unusual for Clark County. A total of seven out of eleven stations violated the ozone NAAQS in Clark County. Table 3-6 lists all the hourly concentrations for all of the ozone monitors in the network.

Table 3-6 Ozone Concentrations for May 23

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
APEX	47	46	32	36	28	28	51	63	66	70	74	75	72	76	75	70	65	60	61	62	62	76	72	61
Mesquite	56	55	50	37	40	48	47	54	58	66	67	68	68	68	70	73	75	69	67	70	76	66	54	48
Paul Meyer	45	47	52	47	47	40	62	72	77	80	81	83	82	80	72	64	65	61	60	60	59	62	73	75
Walter Johnson	44	53	58	60	59	55	71	76	81	81	82	80	79	76	76	67	62	61	59	55	58	67	77	80
Palo Verde	50	55	53	59	55	48	61	60	68	69	73	72	74	71	73	64	64	64	63	61	61	69	79	80
Joe Neal	47	53	57	60	60	61	67	74	77	80	80	77	74	73	70	64	60	62	62	59	52	69	76	78
Winterwood	51	44	51	57	57	54	60	67	77	79	79	82	91	85	80	70	64	61	53	49	48	48	65	68
Jerome Mack	50	37	51	55	54	49	57	66	73	75	77	81	89	81	78	67	62	57	52	50	49	50	66	67
Boulder City	50	51	49	56	58	59	64	70	70	83	85	86	92	75	68	67	67	64	64	63	60	55	60	71
Jean	53	52	51	53	54	48	52	59	62	65	66	71	69	70	70	64	63	67	64	64	61	56	56	52
JD Smith	46	40	56	58	57	55	63	71	75	79	78	80	80	78	77	74	67	59	57	52	39	60	72	73

To further illustrate that ozone concentrations on May 23 were due to an exceptional event, $PM_{2.5}$, CO, ozone concentrations and meteorology were analyzed before, during, and after the event. Figure 3-5 depicts the relationship between ozone, $PM_{2.5}$, CO, and levoglucosan for May 21 through May 27. The graph demonstrates the correlation between the different pollutants on May 23; this provides strong evidence that the elevated concentrations were due to the smoke from the wildfire since these pollutants are the products of combustion.

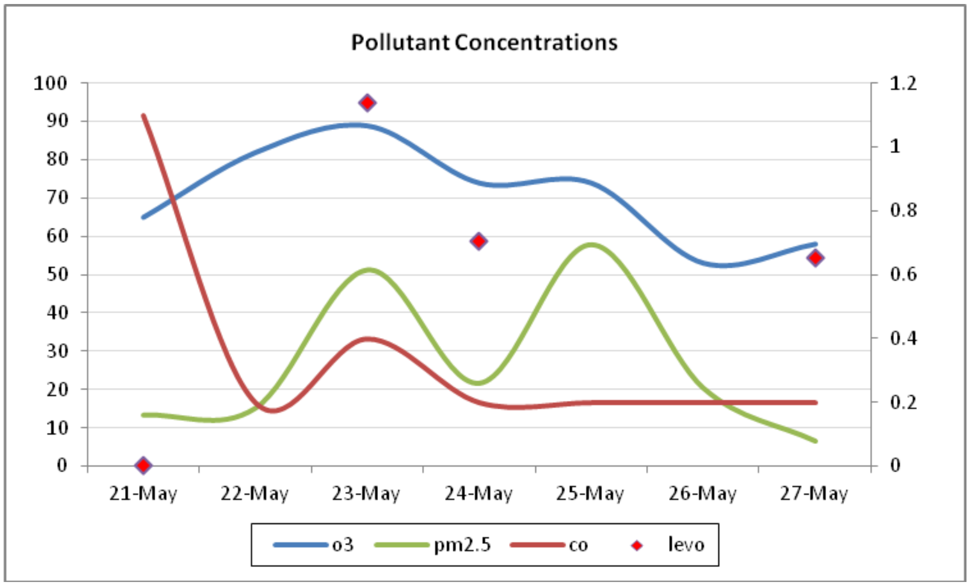

Figure 3-5. Concentrations on May 21 through May 27.

Through a weight-of-evidence approach, this report shows that ozone concentrations on May 23 would not have exceeded the NAAQS "but for" the wildfires.

Figures 3-6 through 3-11 illustrate the diurnal cycle for seven ozone monitoring sites from May 21 through May 25. Ozone values climb in the morning, peak around noon, plateau through the afternoon, and recede in the early evening. The highest ozone concentration occurs during the most intense hours of sunlight, often referred to as the prime ozone cooking period. The highest hourly values occur on the wildfire intrusion day of May 23, with some residual ozone on May 24.

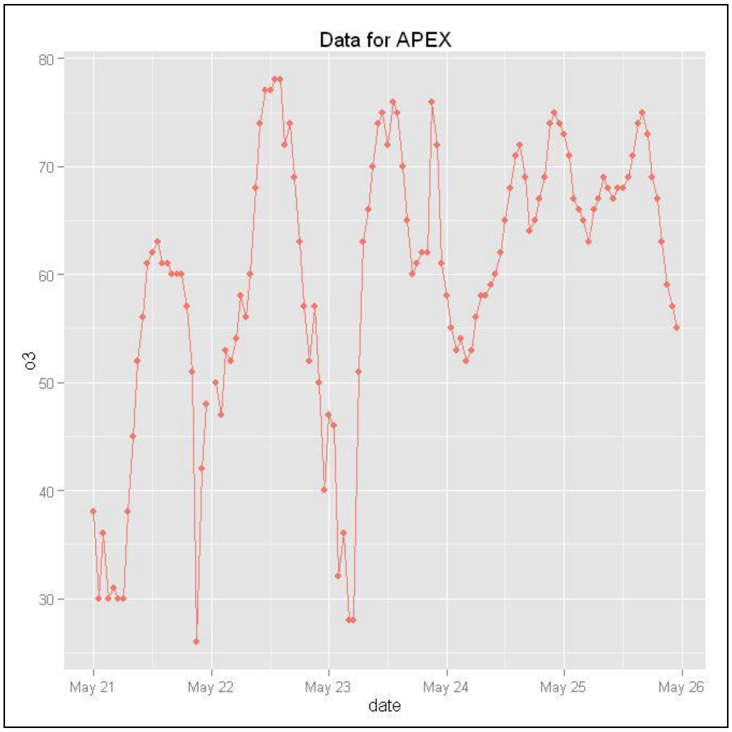

Figure 3-6. Diurnal cycle for Apex.

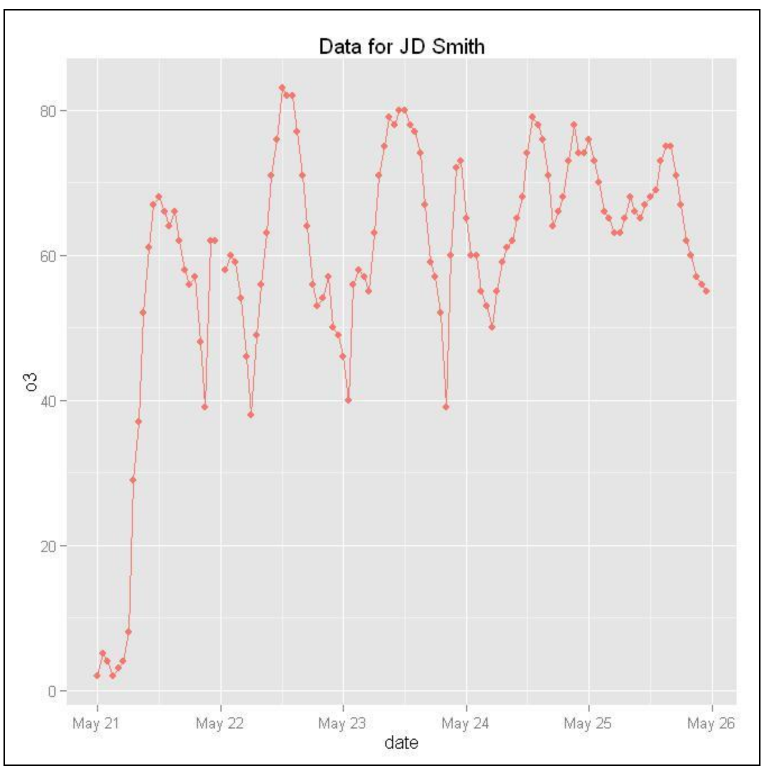

Figure 3-7. Diurnal cycle for J.D. Smith.

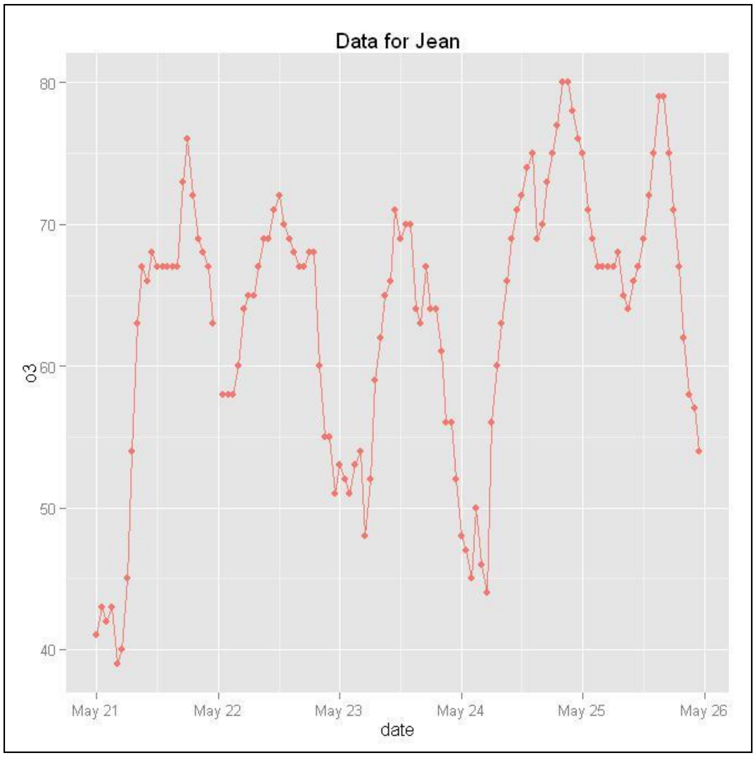

Figure 3-8. Diurnal cycle for Jean.

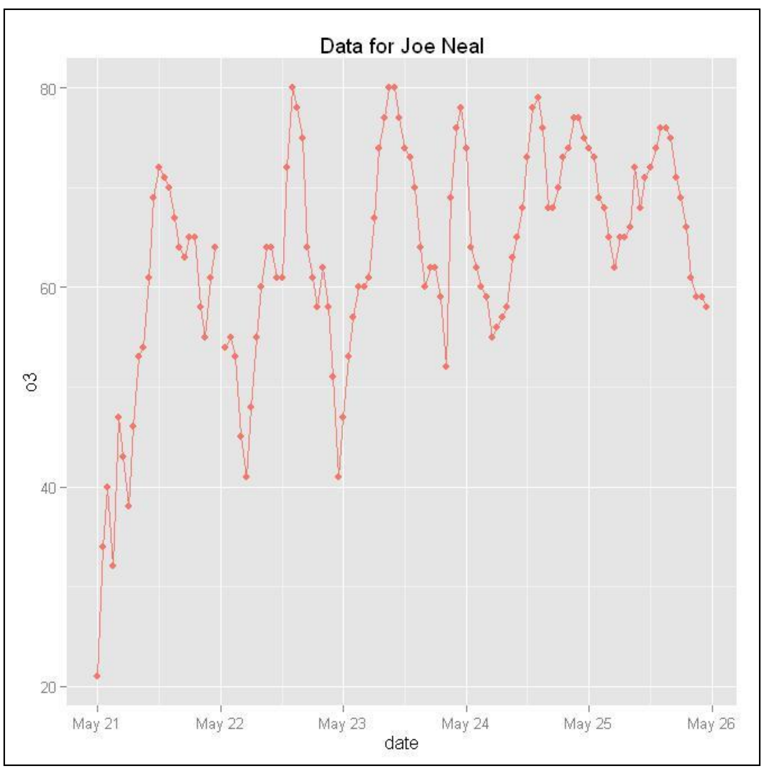

Figure 3-9. Diurnal cycle for Joe Neal.

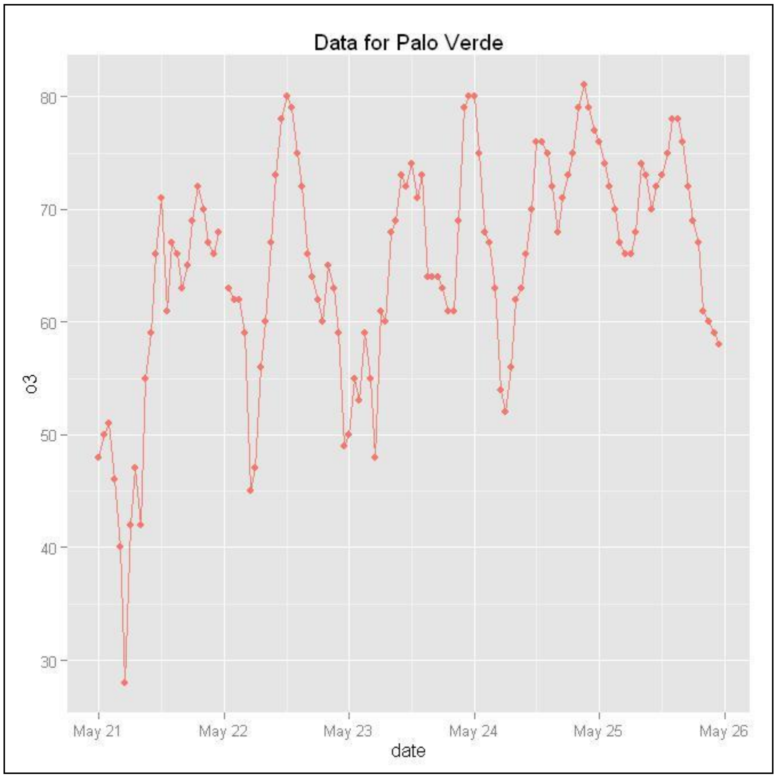

Figure 3-10. Diurnal cycle for Palo Verde.

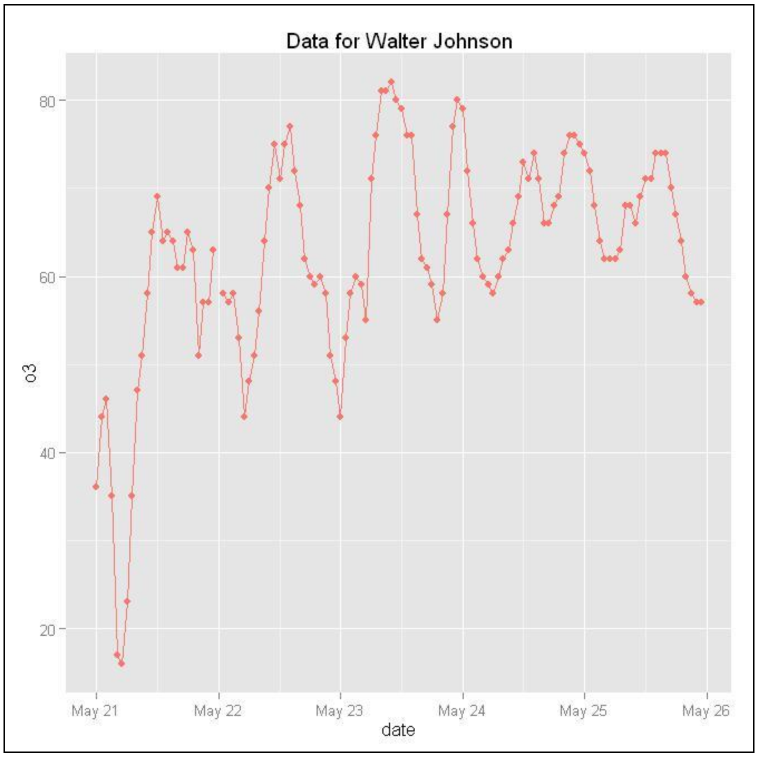

Figure 3-11. Diurnal cycle for Walter Johnson.

Figures 3-12 through 3-13 show the time series for ozone, CO, and $PM_{2.5}$ levels at the J.D. Smith and Jerome Mack stations. (These are the only stations in the network that have collocated ozone, $PM_{2.5}$, and CO monitors.) $PM_{2.5}$ values began to climb early on May 23, and remained high through the evening of May 23. The same pattern can be seen for ozone although there is some residual ozone on May 24. CO levels show the impacts from morning and afternoon traffic in Las Vegas, but are higher in the evening of May 22 and remained throughout the next day.

Figures 3-15 through 3-17 depict the relationships between values of $PM_{2.5,}$ levoglucosan, and ozone for the days the $PM_{2.5}$ samples were analyzed.

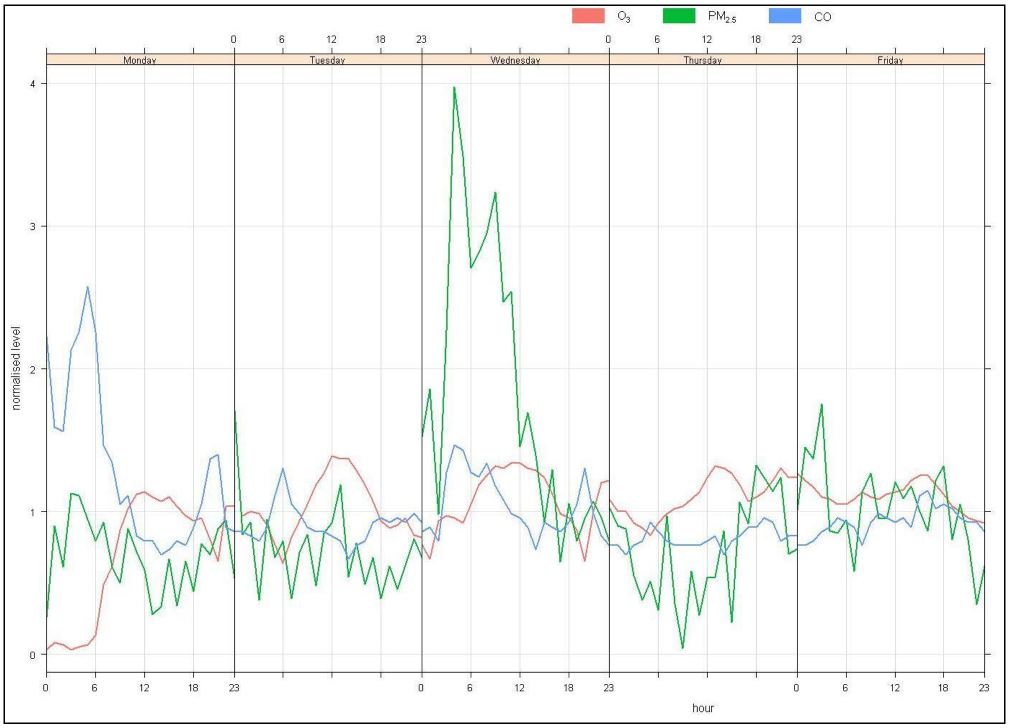

Figure 3-12. Diurnal cycle at J.D. Smith (normalized).

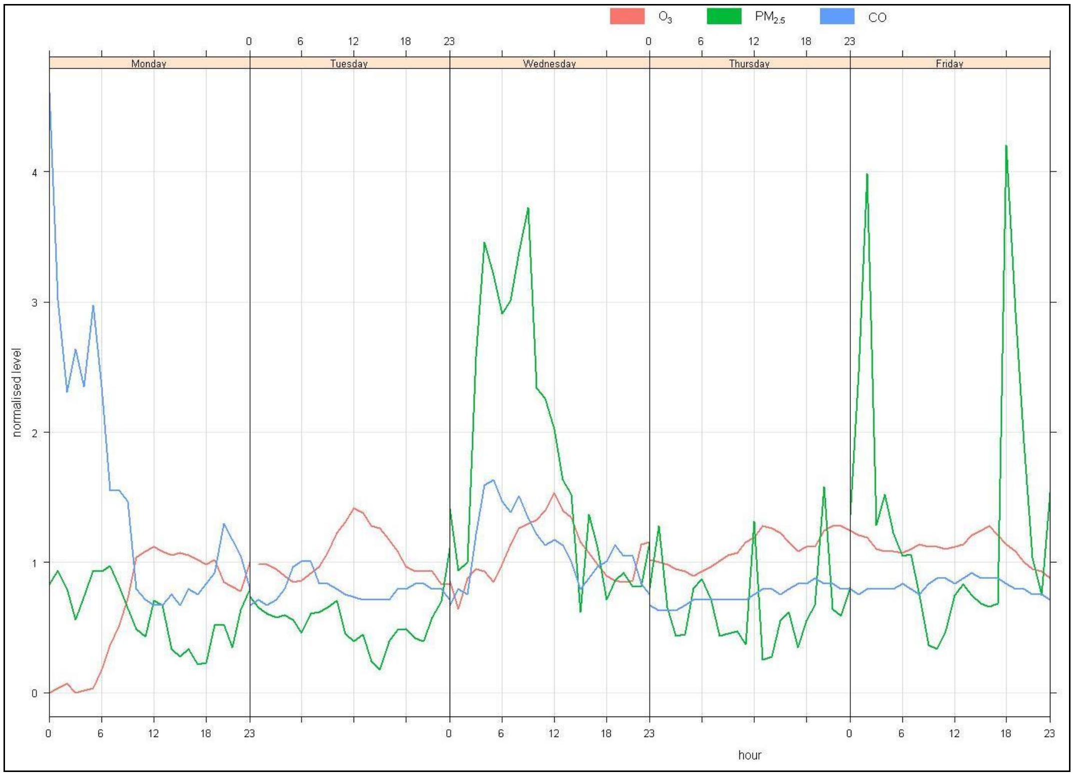

Figure 3-13. Diurnal cycle at Jerome Mack (normalized).

Figures 3-15 through 3-17 show the relationship between ozone, $PM_{2.5}$, and levoglucosan during the sampling days.

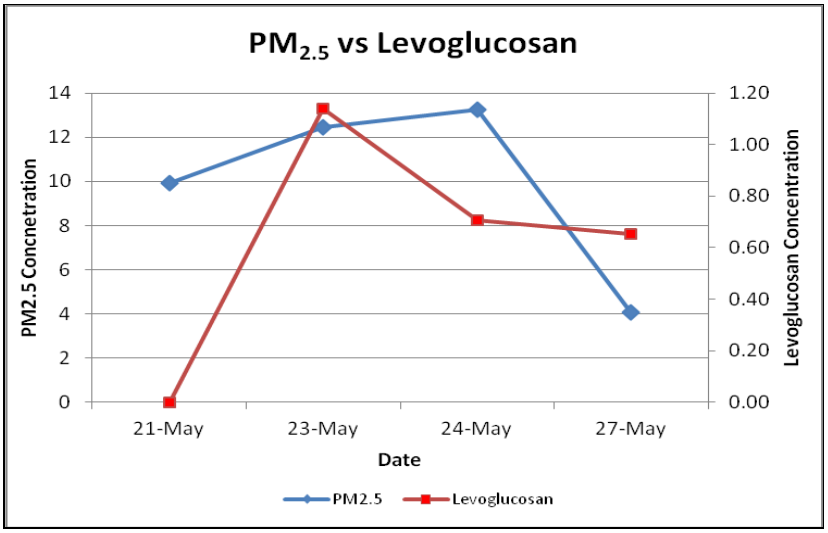

Figure 3-14. $PM_{2.5}$ and levoglucosan concentrations.

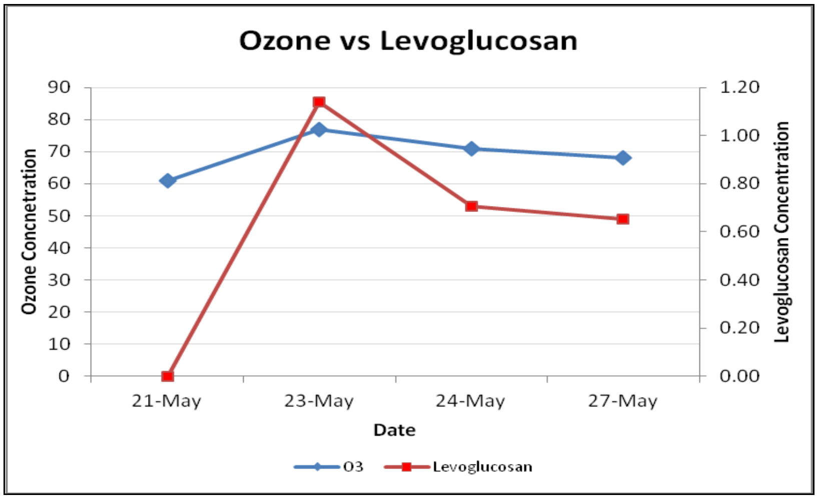

Figure 3-15. Ozone and levoglucosan concentrations.

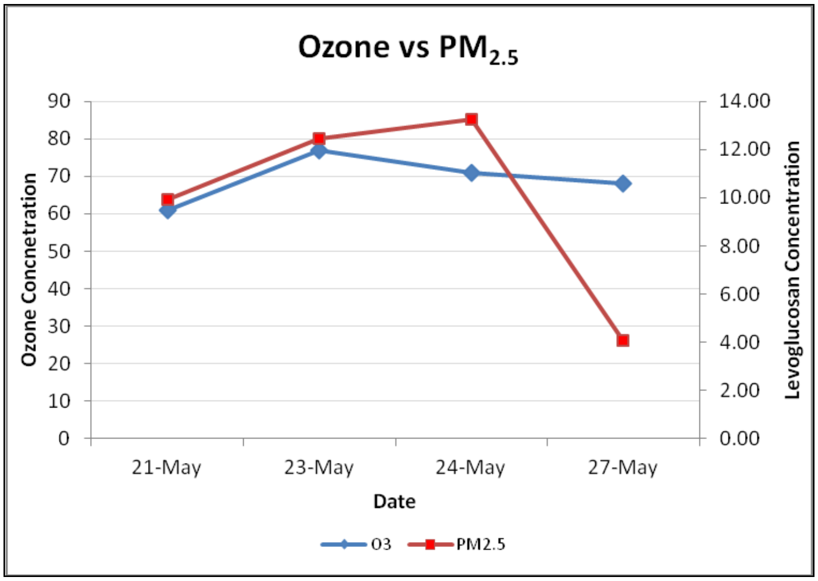

Figure 3-16. Ozone and $PM_{2.5}$ concentrations.

Table 3-7 lists Air Quality Index (AQI) values for ozone, CO, and $PM_{2.5}$ between May 20 and May 27, 2012. Figure 3-18 shows the increase in pollutant concentrations during wildfire days, and Figure 3-19 demonstrates how well the AQI values for ozone**,** $PM_{2.5}$, and CO tracked wildfire impacts. Concentrations of the three pollutants were elevated on wildfire days, providing strong evidence of contributions from the wildfires. The average concentration of ozone during the fire day increased by 39% percent; concentrations of CO and $PM_{2.5}$ increased by 14% and 105%, respectively.

Table 3-7 Pollutant AQI Values

Date	O_3	CO	$PM_{2.5}$
5/20	87	9	33
5/21	80	13	32
5/22	100	3	24
5/23	111	6	70
5/24	101	3	60
5/25	97	3	57
5/26	47	3	17
5/27	47	3	16

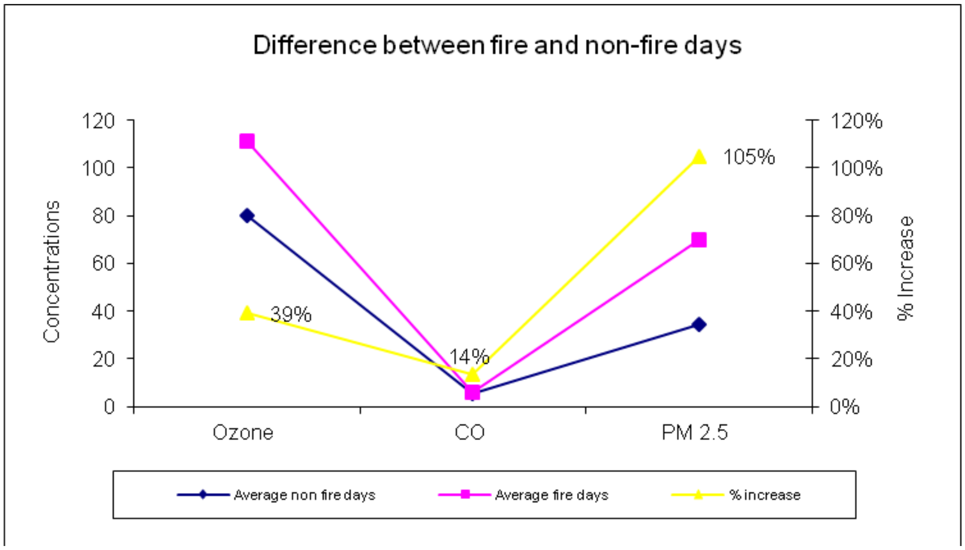

Figure 3-17. Fire and nonfire days.

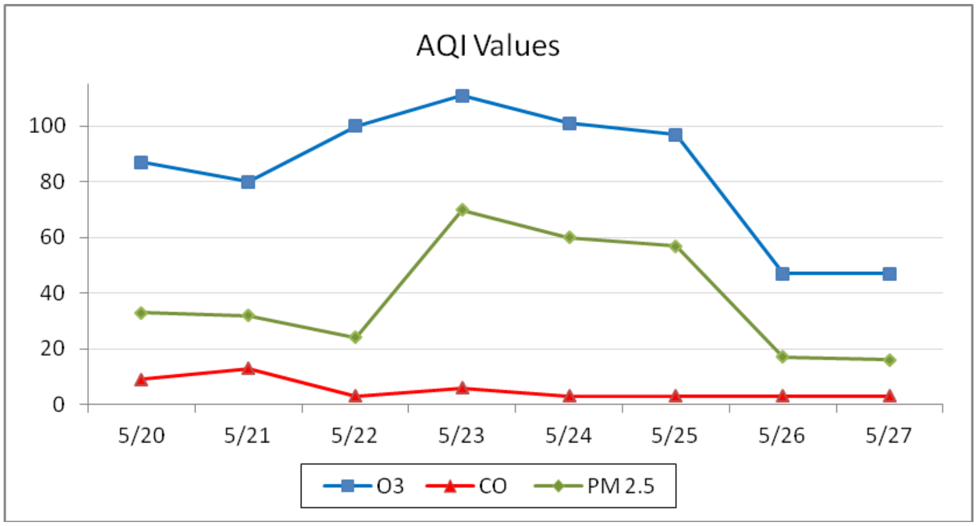

Figure 3-18. Correlation for May 20, 2012, through May 27, 2012.

3.3 OZONE CONCENTRATIONS RELATIVE TO HISTORICAL FLUCTUATIONS

In the preamble to the final EER, EPA states that the magnitude of measured concentrations on days affected by an exceptional event relative to historical, temporally adjusted air quality levels can guide the level of analysis and documentation needed to demonstrate that the event affected air quality. For example, EPA acknowledges that for extremely high concentrations relative to historical values (i.e., concentrations greater than the 95th percentile), less documentation or evidence may be required to demonstrate that the event affected air quality. This "weight of evidence" approach reflects how the EPA has historically treated exceptional events.

On May 23, smoke plumes from the TRE wildfire resulted in some of the highest ozone readings for the season throughout the Clark County air quality monitoring network. Hourly concentrations reached up to 92 ppb (see Table 3-6), while the highest MDA8 of the season was recorded at Winterwood (see Table 3-8). The National Weather Service reported eight miles of visibility, down from the normal 70 miles for a summer day in the Las Vegas Valley. Seven Clark County monitoring sites recorded violations of the NAAQS during the event.

Table 3-8 Four Highest Concentrations in 2012

Station	Highest		Second Highest		Third Highest		Fourth Highest	
	Date	Value	Date	Value	Date	Value	Date	Value
Apex	5/16/2012	**81**	5/15/2012	**80**	6/30/2012	**76**	5/29/2012	**76**
Mesquite	6/5/2012	**72**	6/2/2012	**71**	5/23/2012	**71**	5/16/2012	**69**
Paul Meyer	5/30/2012	**82**	5/29/2012	**79**	5/23/2012	**78**	6/2/2012	**77**
Walter Johnson	5/30/2012	**79**	7/10/2012	**78**	5/29/2012	**78**	5/23/2012	**78**
Palo Verde	5/30/2012	**81**	6/2/2012	**79**	5/29/2012	**79**	5/15/2012	**78**
Joe Neal	8/24/2012	**89**	8/13/2012	**81**	5/30/2012	**80**	5/29/2012	**79**
Winterwood	5/23/2012	**80**	5/30/2012	**78**	5/29/2012	**76**	5/22/2012	**74**
Jerome Mack	5/30/2012	**78**	5/23/2012	**77**	5/29/2012	**76**	5/22/2012	**73**
Boulder City	5/29/2012	**78**	5/23/2012	**78**	6/2/2012	**77**	5/15/2012	**77**
Jean	6/2/2012	**83**	5/29/2012	**82**	5/30/2012	**80**	5/15/2012	**77**
JD Smith	5/30/2012	**79**	5/29/2012	**79**	5/23/2012	**77**	6/2/2012	**76**

Ozone concentrations recorded during the wildfire event were compared with temporally adjusted air quality levels for the previous three years (2009-2011). A three-year historical analysis was considered reasonable; attainment/nonattainment classifications are based on a three-year average, so ozone concentrations before 2009 would not reflect emission control programs implemented recently.

The technical analyses provided in this document, combined with documentation on the location and extent of the wildfire and laboratory analysis of $PM_{2.5}$ samples showing high concentrations of wildfire markers on May 23, 2012, demonstrate that elevated concentrations of ozone on this date is exceptional relative to historical fluctuations and was caused by wildfire impacts.

Figures 3-20 through 3-24 depict three years of MDA8 ozone data from five ozone monitoring sites in Clark County, and show that concentrations on May 23 reflect an exceptional event.

Ozone concentrations were exceptionally high in May 2012, compared with other years. It was determined that the high values on May 15, 16, 29, and 30 were due to regional or international transport.

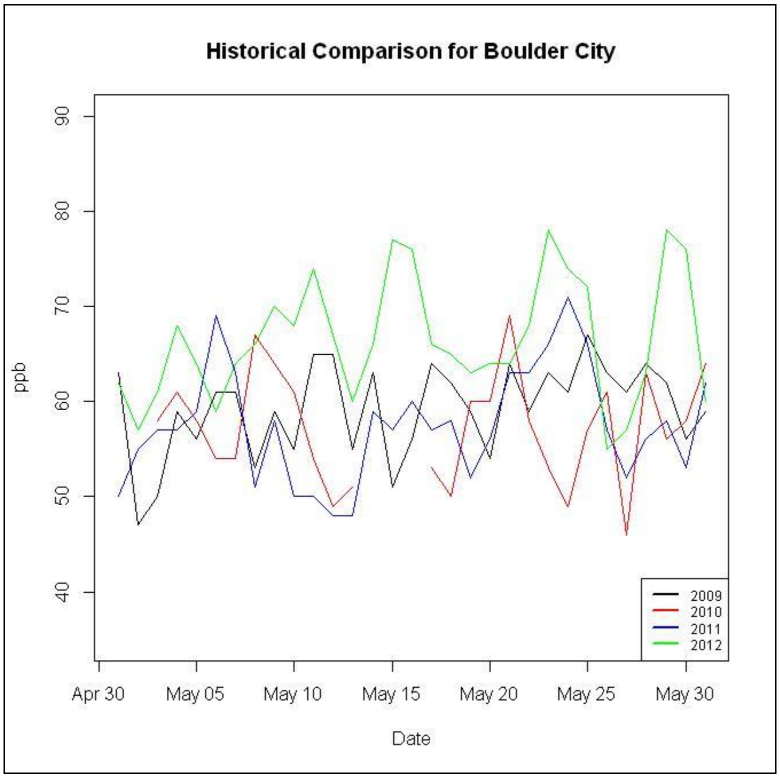

Figure 3-19. Four-year comparison for Boulder City.

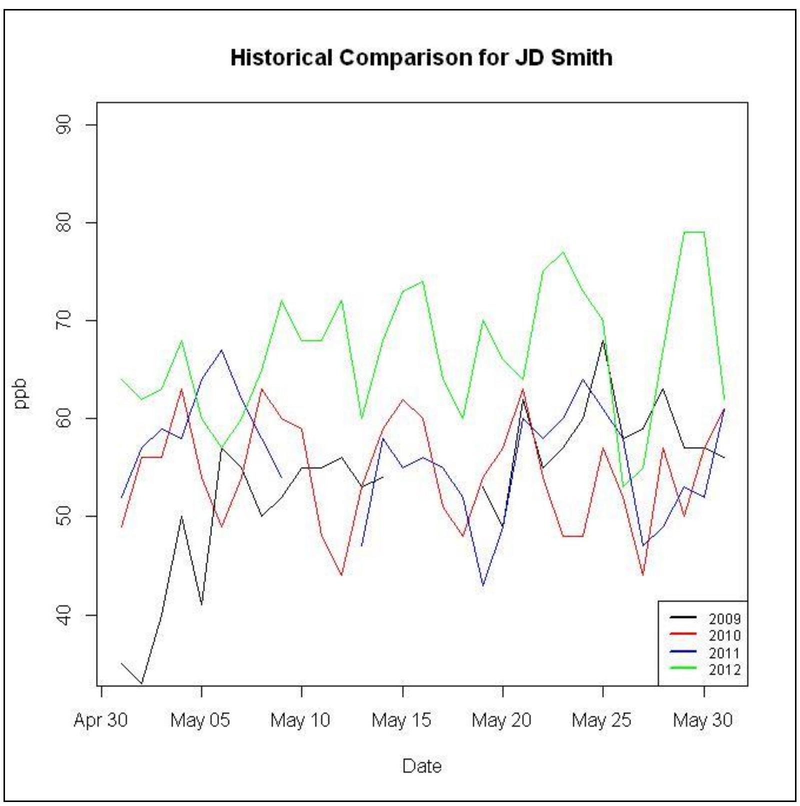

Figure 3-20. Four-year comparison for J.D. Smith.

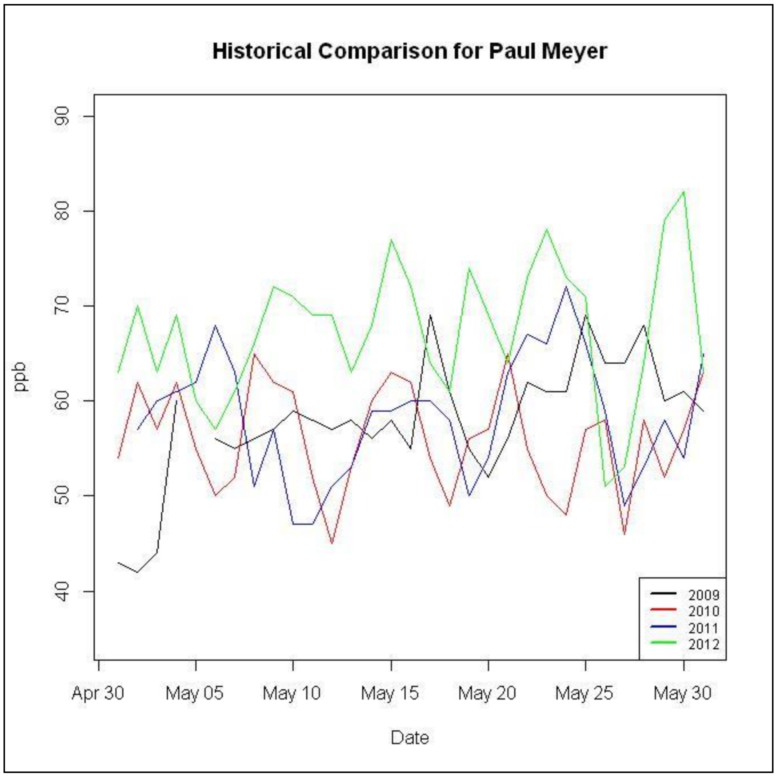

Figure 3-21. Four-year comparison for Paul Meyer.

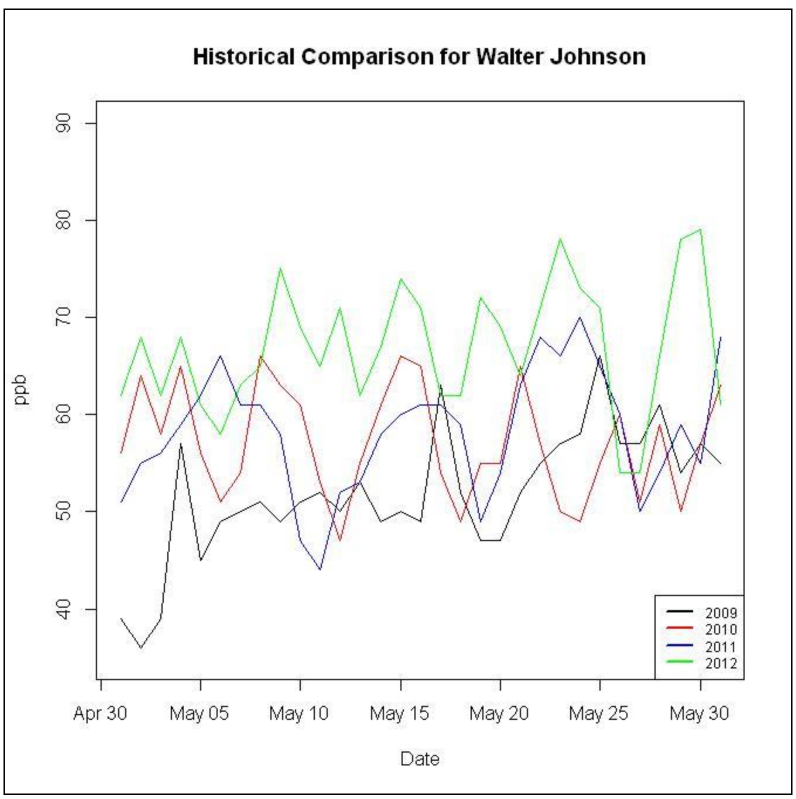

Figure 3-22. Four-year comparison for Walter Johnson.

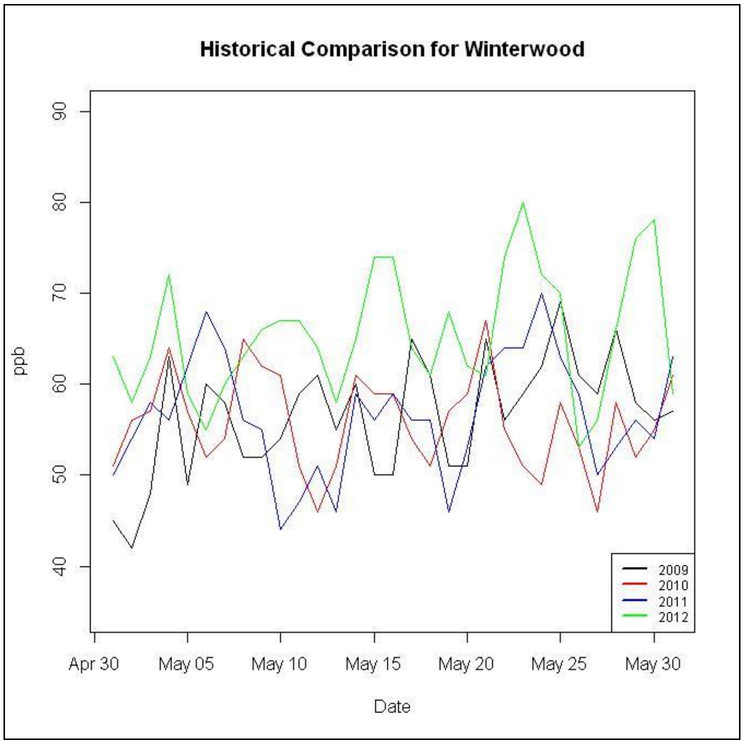

Figure 3-23. Four-year comparison for Winterwood.

For a statistical perspective, hourly MDA8 ozone concentrations were calculated for all days in May over the three-year period of 2009–2011. The data is plotted against the MDA8 concentrations for May 2012 (Figure 3-25). The hourly values for May 2012 were much higher than the average of the three previous years.

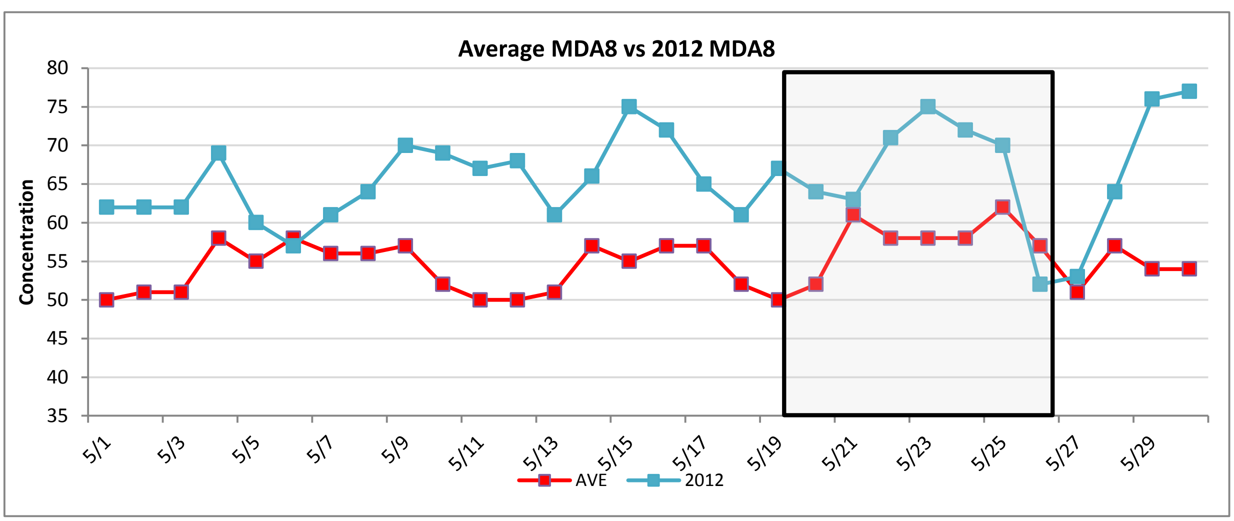

Figure 3-24. Four-year average vs. 2012.

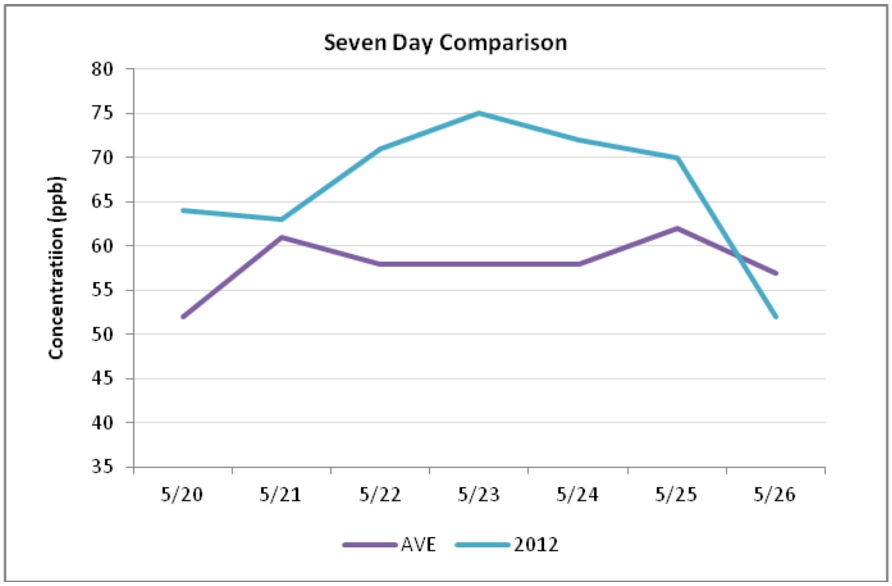

Figure 3-25. Seven-day period.

During the seven-day period depicted in Figure 3-26, concentrations on May 23 are 17 ppb higher than the average for that day during 2009-2011.

The following figures (3-27 through 3-30) show the AQI values for ozone, $PM_{2.5}$, and CO from May 21 to May 25 of each year during a four-year period. As noted in previous sections, some years were impacted by significant regional transport; however, ozone, $PM_{2.5}$, and CO never reached the AQI values they reached in 2012. The data show that concentrations for the event on May 23 were exceptionally high.

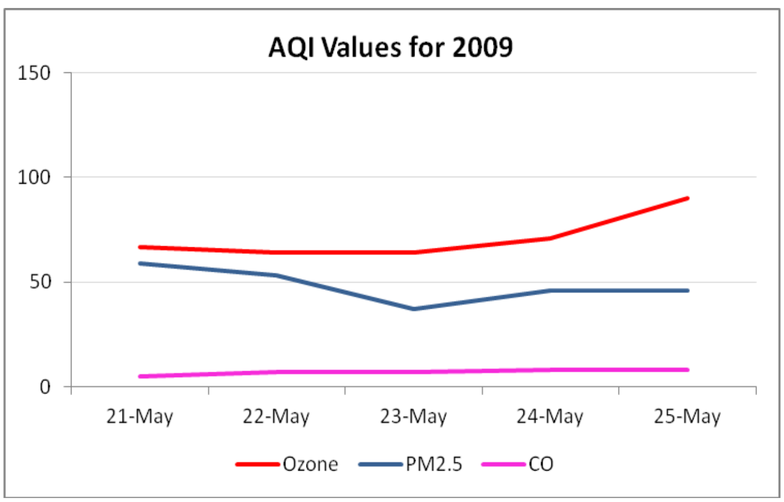

Figure 3-26. O_3, CO, and $PM_{2.5}$ concentrations in 2009.

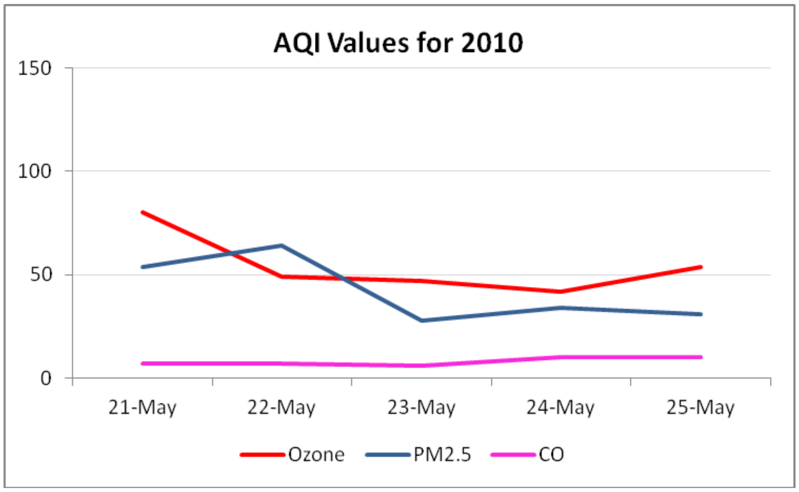

Figure 3-27. O_3, CO, and $PM_{2.5}$ concentrations in 2010.

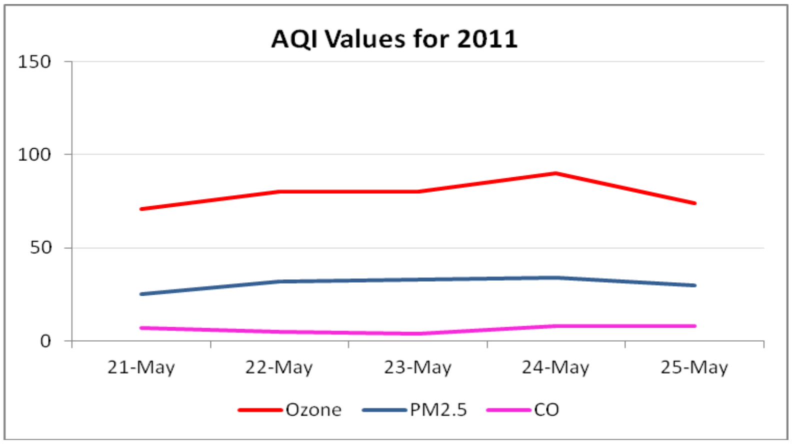

Figure 3-28. O_3, CO, and $PM_{2.5}$ concentrations in 2011.

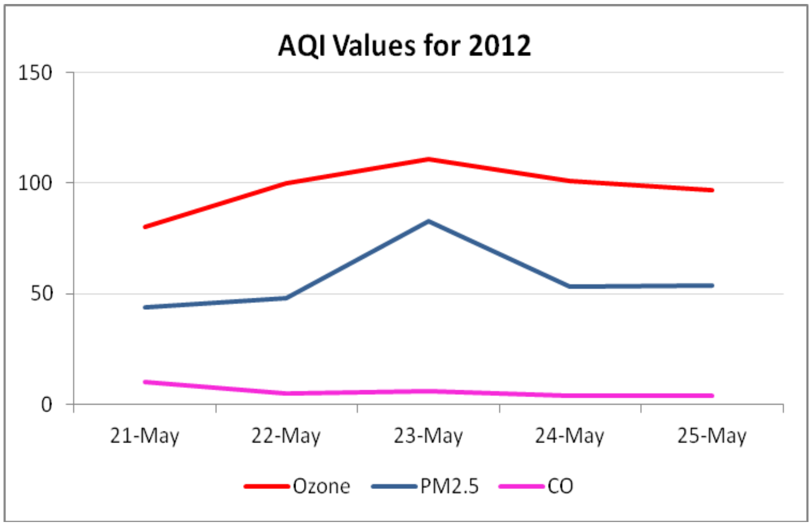

Figure 3-29. O_3, CO, and $PM_{2.5}$ concentrations in 2012.

4.0 THE "BUT FOR" ARGUMENT

4.1 METEOROLOGICAL PARAMETERS AND VISIBILITY CAMERAS

Meteorology is an important variable affecting air quality. Wind patterns maintained smoke plume impacts in southern Nevada during the wildfire episode, and weather data in Figure 4-1 show a remarkably consistent weather pattern before and after the exceptional event. Local anthropogenic emissions of ozone precursor pollutants did not exceed normal weekday or weekend levels. The difference during this period is the accumulation of the wildfire smoke plume, exacerbating ozone concentrations in Clark County.

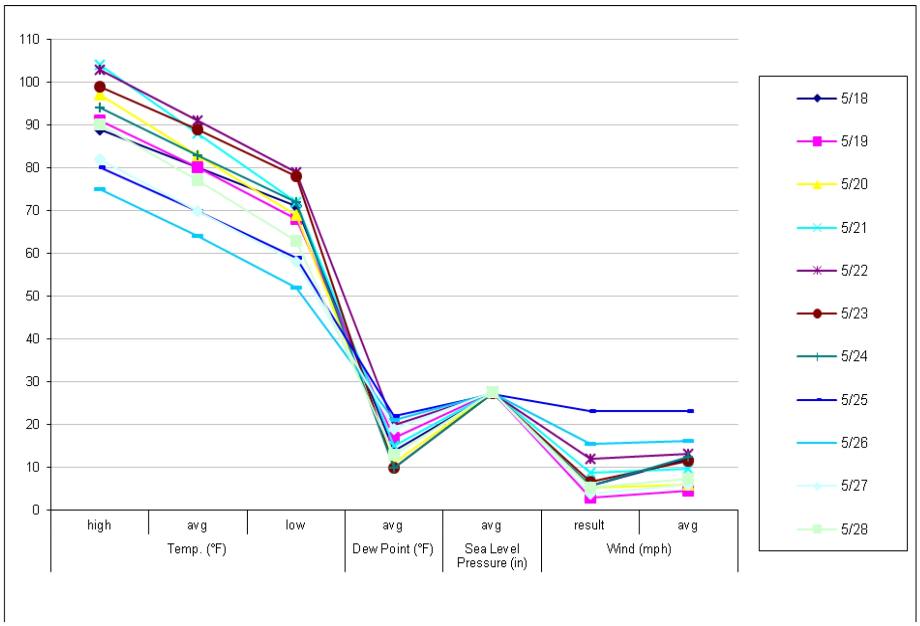

Figure 4-1. Weather data for May 18, 2012, through May 28, 2012.

Documentation provided in previous sections shows that the ozone exceedances on May 23, 2012, would not have occurred but for the fire event in Gardnerville, Nevada.

Wind roses for Tonopah (Figure 1-3), a town 178 miles northwest of Las Vegas, show a northwest wind toward Las Vegas on May 22, 23, and 24. Additionally, the North Las Vegas wind rose (Figure 1-40) for May 23 shows the same wind direction. These data are in agreement with the forward trajectory depicted in Figure 4-2.

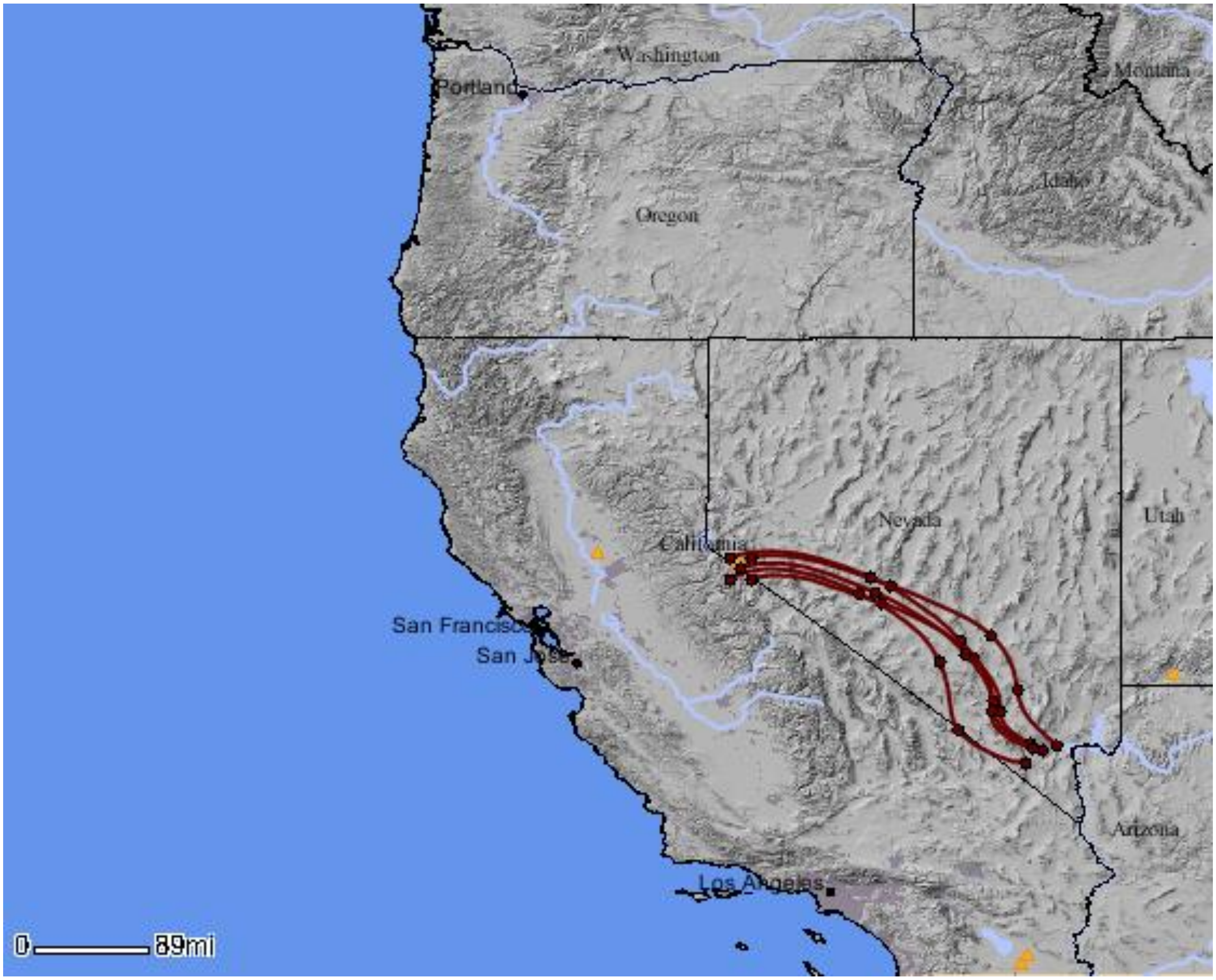

Figure 4-2. Forward trajectory from TRE.

Visibility cameras at the North Las Vegas Airport capture pictures of the downtown area every 15 minutes. Figure 4-3 shows a picture taken on a nonfire day (May 21) at 6:00 AM. Landmarks such as the Stratosphere and the Texas Station Casino are clearly visible. The Stratosphere is five miles away from the NLV Airport, and Texas Station Casino is one mile away. Even Black Mountain, 21 miles away from the airport, is clearly visible.

The pictures in Figures 4-4, 4-5, and 4-6 were taken on the morning of May 23. The Stratosphere and Texas Station Casino are hardly visible, and Black Mountain is not visible at all. These pictures show the impact of the smoke plume from the TRE fire.

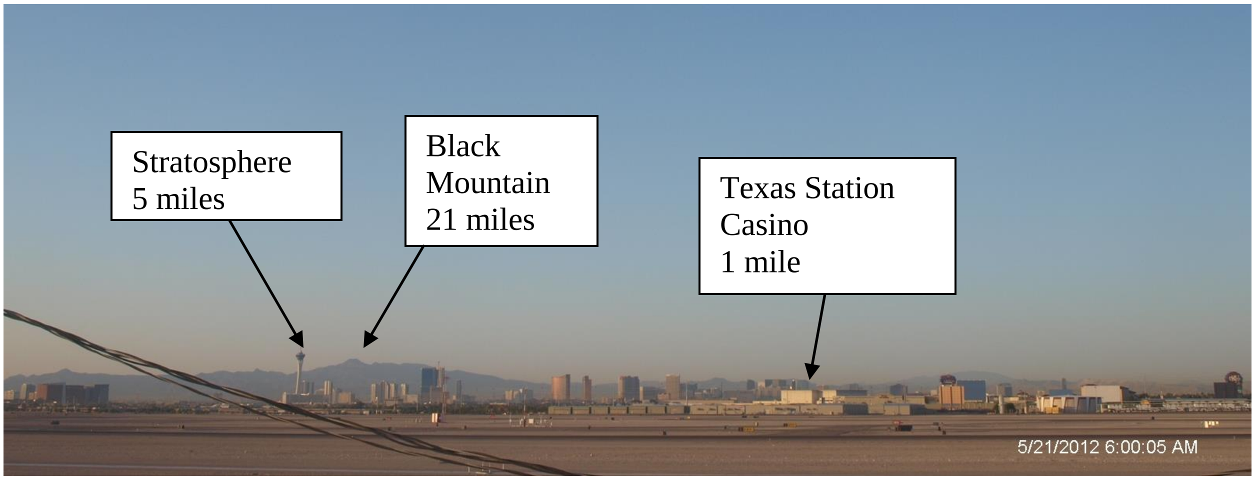

Figure 4-3. Visibility on a nonfire day.

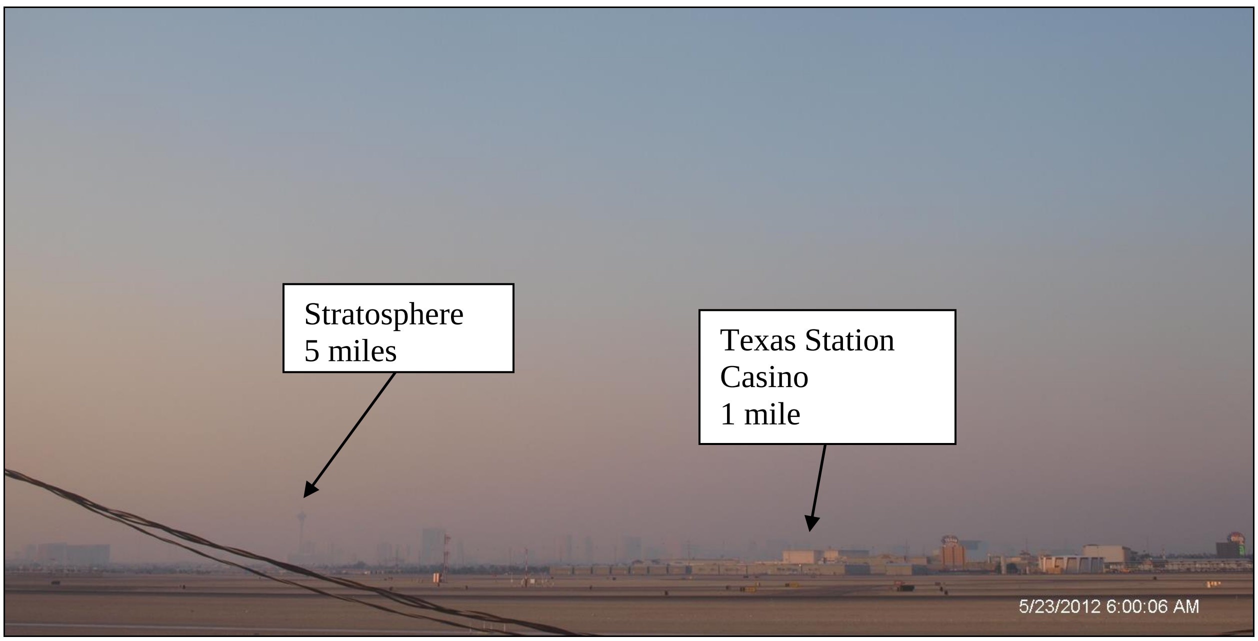

Figure 4-4. Visibility at 6:00.

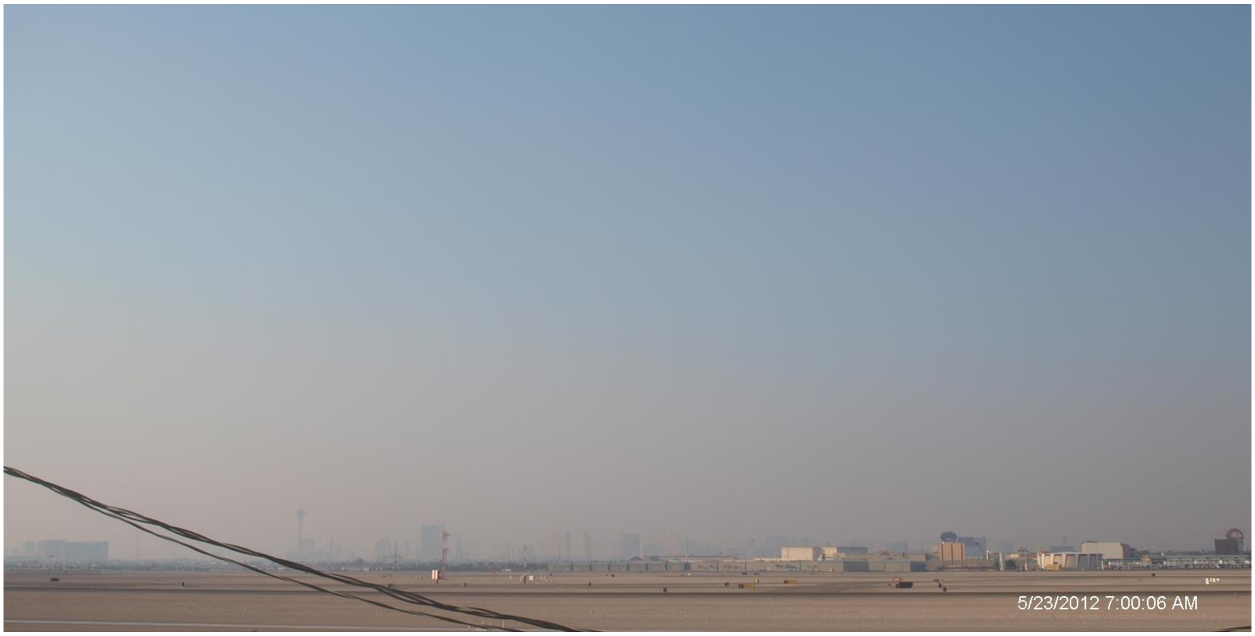

Figure 4-5. Visibility at 7:00.

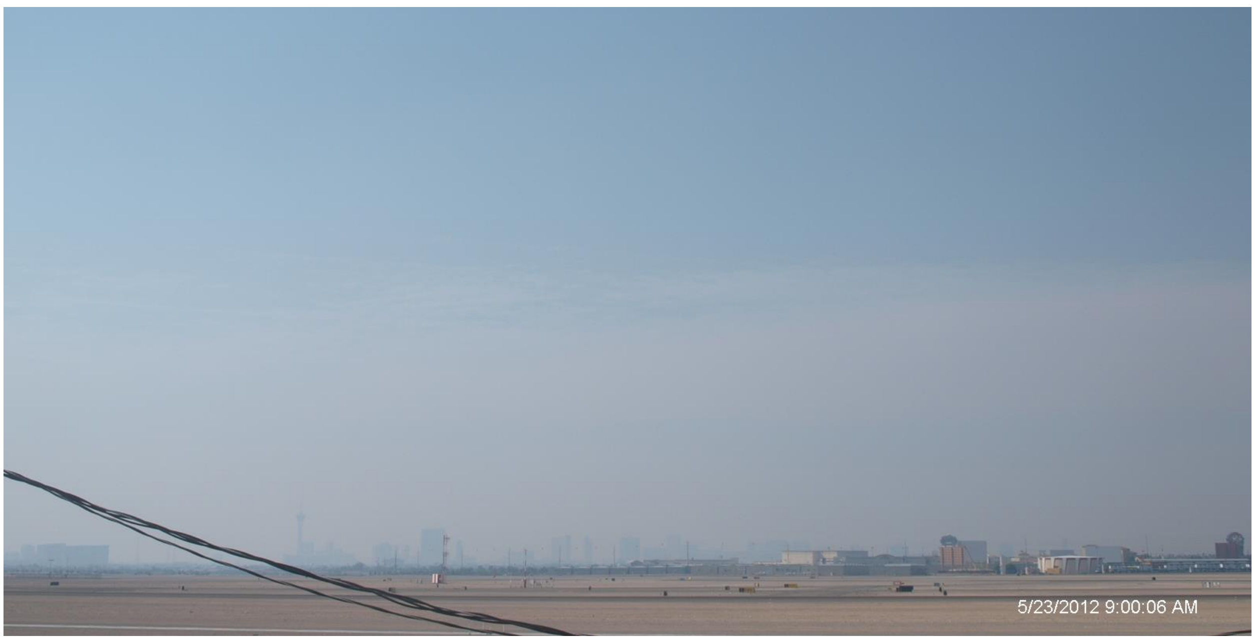

Figure 4-6. Visibility at 9:00.

4.2 OZONE CONCENTRATION CALCULATIONS

4.2.1 Average Concentrations

In this method, the average daily ozone concentration is calculated for each monitoring site, excluding May 23, for the period of May 21 to May 25. This calculated average concentration is a reasonable surrogate for what would have occurred on May 23 given consistent weather patterns and normal anthropogenic local emissions, but no smoke impacts. Table 4-1 provides the average calculated concentration for May 23. Under this approach, average ozone concentrations for the exceptional event days vary from 63-72 ppb throughout the monitoring network.

Table 4-1. Calculated Average for May 23, 2012.

Date	AP	MQ	PM	WJ	PV	JO	WW	JM	BC	JN	JD
21-May	61	53	64	64	68	67	61	61	64	69	64
22-May	74	65	73	71	73	69	74	73	68	69	75
23-May	69	63	70	69	72	70	69	68	69	71	70
24-May	71	68	73	73	76	74	72	71	74	76	73
25-May	70	66	71	71	74	73	70	68	72	73	70

4.2.2 Interpolation

Interpolation is a method of constructing new data points within the range of a set of known data points. This application assumed that the data points for May 23 were missing and used linear interpolation to estimate their values. As shown in Table 4-2, this method yields a minimum concentration of 66 ppb and a maximum concentration of 74 ppb.

Table 4-2. Interpolated Values for May 23, 2012.

Date	AP	MQ	PM	WJ	PV	JO	WW	JM	BC	JN	JD
21-May	61	53	64	64	68	67	61	61	64	69	64
22-May	74	65	73	71	73	69	74	73	68	69	75
23-May	72	66	73	72	74	71	73	72	71	72	74
24-May	71	68	73	73	76	74	72	71	74	76	73
25-May	70	66	71	71	74	73	70	68	72	73	70

4.2.3 Regression Model

The third method is the use of a statistical regression model to predict ozone levels during the days of the exceptional event. An EPA statistical model was used as the initial framework for a generalized additive model, in which the sum of the functions of various predictor variables is used to predict daily maximum 8-hour ozone concentrations. The model does not assume that peak ozone is a linear function of each predictor, but rather uses natural splines to model the functional dependence of ozone on predictor variables other than “day of week” and “year.” The original EPA model was modified through an iterative process to reflect local conditions in Clark County.

The EPA’s Omnibus Meteorological Data Set and daily peak 8-hour ozone of local and upwind areas of Las Vegas Valley for five summer months during 2004-2008 without suspected wildfire days were used to develop a statistical model to identify wildfire events and study their relationships with high ozone episodes.

In general, trajectories should not be interpreted as accurate tracks of air parcels entering the specific area; however, patterns that emerge when analyzing a relatively large number of trajectories should provide a good indication of potential transport due to a prevailing large-scale flow regime. Using the back-trajectories in the Las Vegas Valley with the cluster analysis of the HYSPLIT model, seven clusters were calculated and their mean backward trajectory paths are shown in Figure 4-7. A statistical model was then developed for each cluster by using polynomial regression equations with meteorological predictors and observed peak ozone mixing ratios. For a specific date, the predicted peak 8-hour ozone mixing ratio is calculated based on its predictors and assigned cluster.

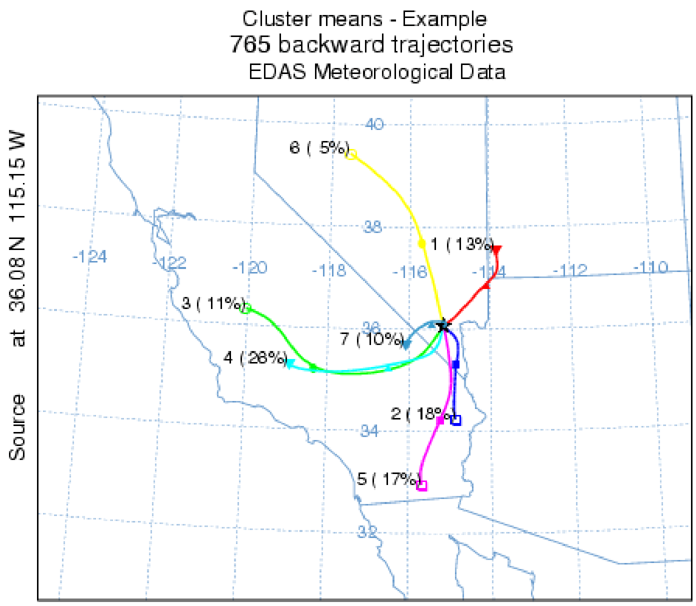

Figure 4-7. The mean trajectory path for each cluster.

By carefully examining the backward trajectory of May 23 in figure 4-8 and the mean backward trajectory of each cluster in figure 4-7, the cluster 6 is selected for the May 22-23 fire event. Table 4-3 lists the parameters used in the model for cluster 6. One of the parameters is the peak 8-hour ozone concentration in upwind northern Nevada during the previous day. Because the ozone in upwind northern Nevada on May 22 was elevated due to smoke impact from the TRE fire, which started on May 22, the peak-8 hour ozone for May 23 was calculated with the actual observed upwind ozone of May 22 and a surrogate upwind ozone of May 21. Table 4.4 shows the upwind ozone of May 22 and 21, the corresponding modeled ozone, and the estimated fire impact on the ozone concentration.

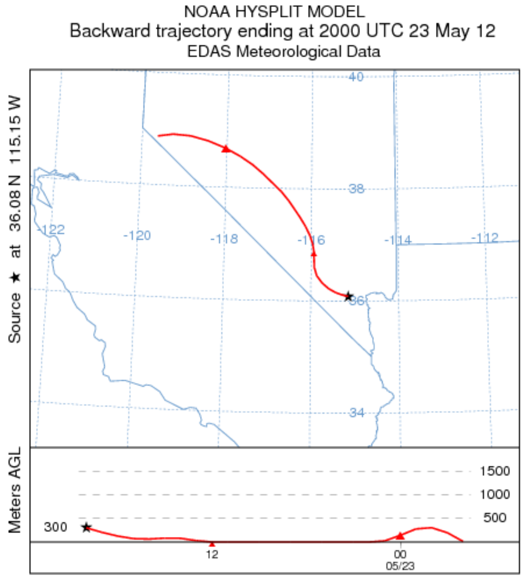

Figure 4-8. 24-hour backward trajectory path for May 23, 2012.

Table 4-3. Regression Model Parameters

Previous-Day peak 8 Hour O_3 in Clark County
Previous-Day 8 Hour O_3 in Northern Nevada
Previous-Day 8 Hour O_3 in Los Angeles Area
Maximum Surface Temperature in Clark County
Average Morning (7-10 AM LST) Wind Speed in Clark County
Average Afternoon (1-4 PM LST) Wind Speed in Clark County
Morning (~1200 UTC) Temperature at 850 mb - Surface Temperature
Maximum Mixing Height (4 AM - 4 PM LST)

Table 4-4. Regression Model Results

Date	Peak 8-hour O_3 (ppb)	Predicted Peak 8-hour O_3 (ppb)[1]	Predicted Wildfire Effect (ppb)	Predicted Peak 8-hour O_3 w/o Fire (ppb)
5/23/2012	80	76.92	5.82	71.10
[1]Predicted ozone concentrations include wildfire impacts.				

4.3 SATELLITE IMAGERY

4.3.1 Aerosol Optical Depth (AOD) and Aerosol Optical Thickness (AOT)[1]

These optical measurements of light extinction are used to represent aerosol content in the entire column of the atmosphere. The optical depth expresses the quantity of light removed from a beam by scattering or absorption during its path through a medium. (AOD is a unitless quantity.)

Table 4-5. AOD Scale

Sample AOD values		Equivalent $PM_{2.5}$ values
0.02	very clean isolated areas	~ 1 µm^{-3}
0.2	fairly clean urban area	~ 12 µm^{-3}
0.4	somewhat polluted urban area	~ 24 µm^{-3}
0.6	fairly polluted area	~ 36 µm^{-3}
1.5	heavy biomass burning or dust event	~ 90 µm^{-3}

The higher the AOD value, the more polluted the area. Figure 4-9 shows the AOD for May 23. The AOD value for the Las Vegas area is between 0.58 and 0.74, which means it is a fairly polluted area.

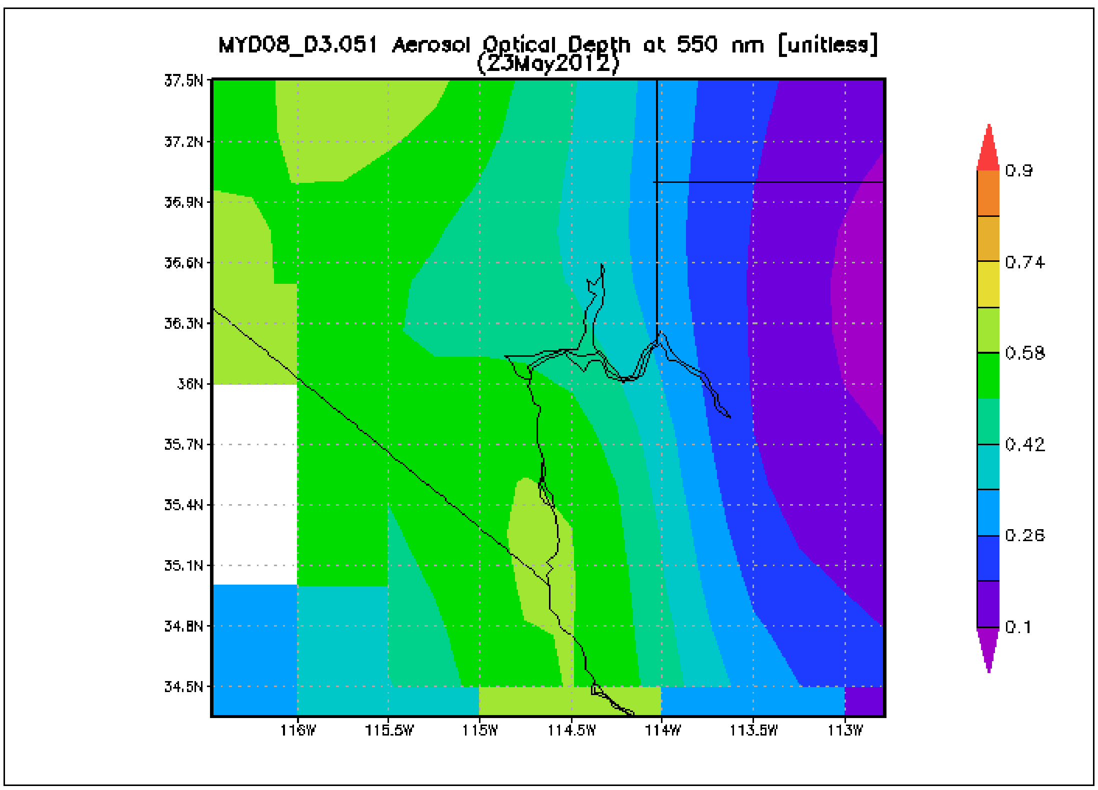

Figure 4-9. AOD for May 23.

[1] http://disc.sci.gsfc.nasa.gov/giovanni/

4.3.2 UV Aerosol Index

The UV Aerosol Index represents detection of uv-absorbing aerosols such as dust and soot. Positive values of Aerosol Index generally represent absorbing aerosols (dust and smoke) while small or negative values represent nonabsorbing aerosols. Figure 4-10 shows the UV Aerosol Index for May 23 for the Clark County area. The indexes show there is a great amount of dust and smoke in the area. Figure 4-11 outlines the data for May 20, and a fairly clean area above Clark County is depicted; the UV Aerosol Index shows that there is little to no dust and smoke present.

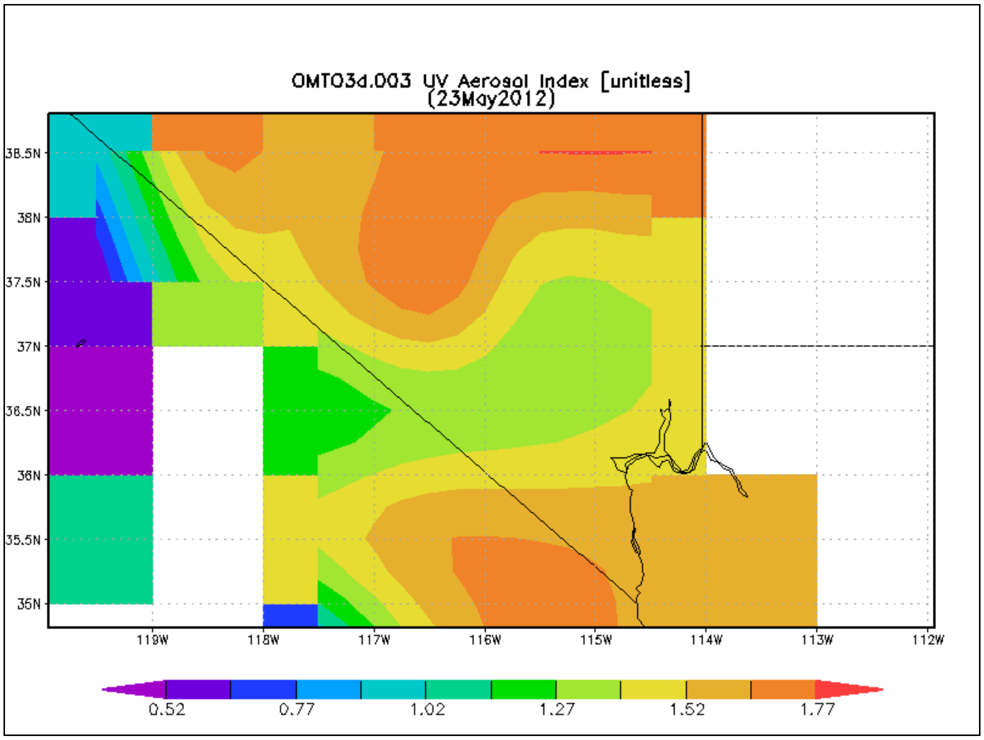

Figure 4-10. The UV Aerosol Index for May 23.

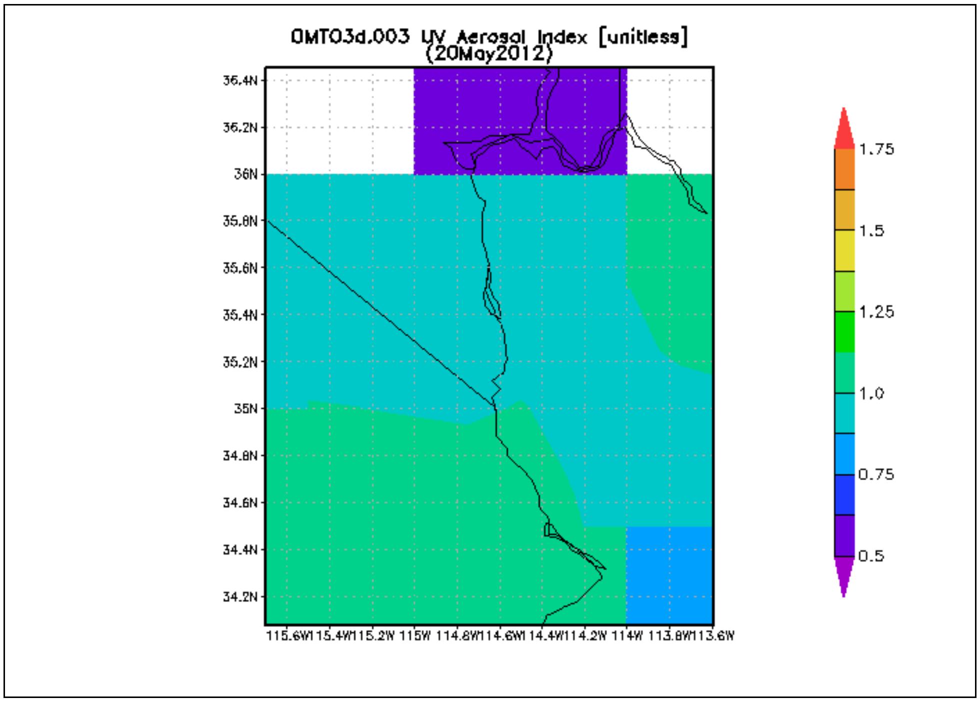

Figure 4-11. UV Index for May 20.

4.3.3 AERONET Data

The AERONET (**AE**rosol **RO**botic **NET**work) program is a federation of ground-based remote sensing aerosol networks established by NASA and other institutions. The data shows the AOT for a daily or monthly timeframe. The Frenchman Flat AERONET site is located between Tonopah and Las Vegas (see Figure 4-12).

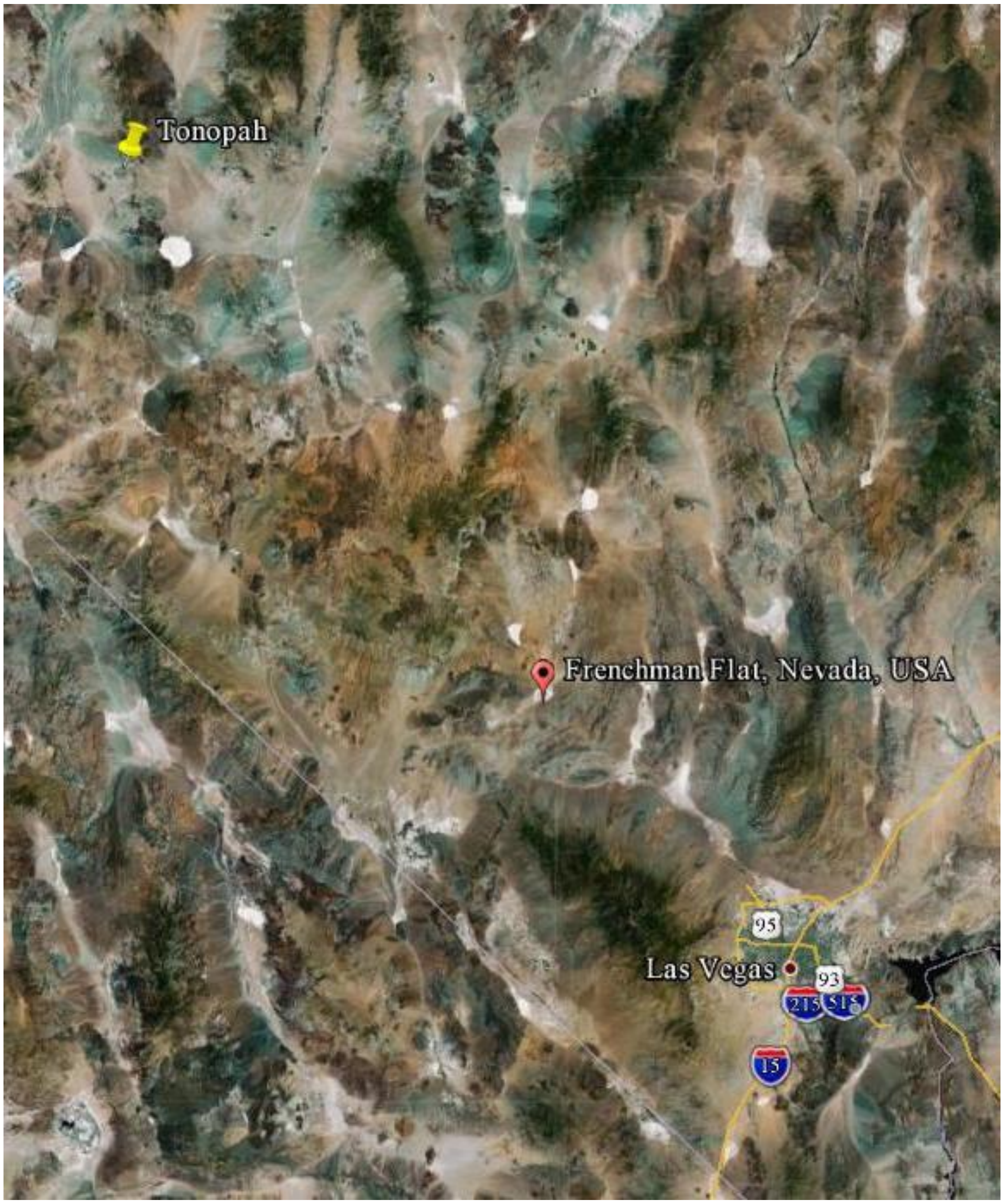

Figure 4-12. Location of Frenchman Flat Station.

http://aeronet.gsfc.nasa.gov/

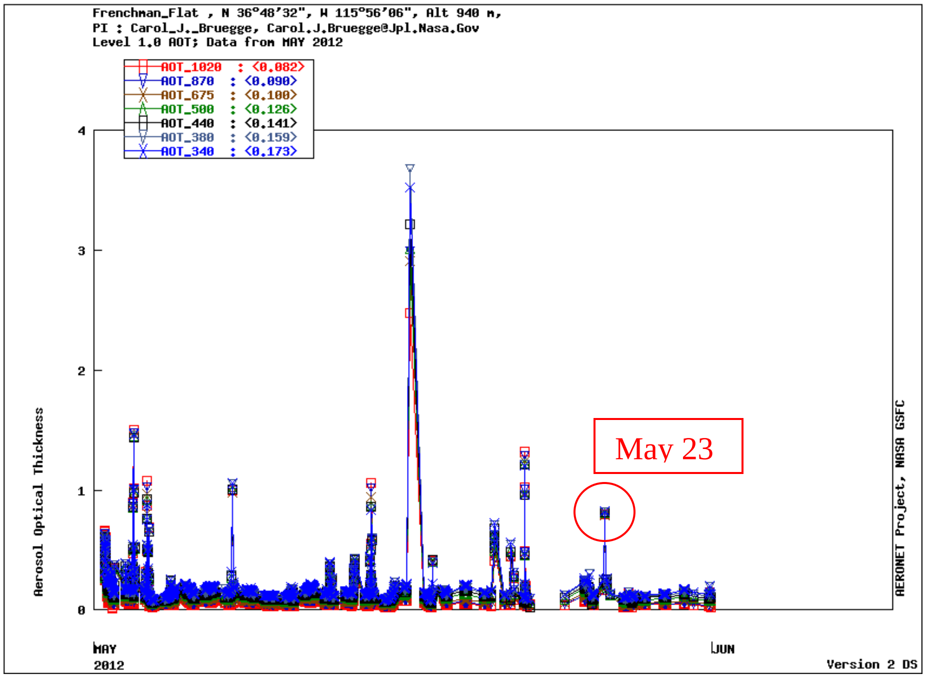

Figure 4-13. AOT for Frenchman Flat.

This station is on the trajectory of the smoke plume (see Figure 4-12). Figure 4-13 shows a high AOT around May 23, and this indicates that dust and smoke were present in the area on May 23.

4.3.4 Site-specific Time-series and Correlations of AOD and Surface $PM_{2.5}$

The site-specific MODIS/GASP (GOES Aerosol/Smoke Product) AOD/$PM_{2.5}$ mass concentration plot details the temporal behavior of the measurements made at a specific monitoring site location. Correlations between the MODIS/GASP AOD observations and $PM_{2.5}$ measurements are also reported. The left vertical axis is mass concentration of $PM_{2.5}$ (scale 0-100) and the right vertical axis is MODIS/GASP aerosol optical depth (scale 0.0-1.6). The graphs in Figures 4-14 and 4-15 show the data for Sunrise Acres and JD Smith. Both graphs indicate a high concentration of $PM_{2.5}$ and a high AOD on May 23. This data proves that smoke was impacting the monitoring sites.

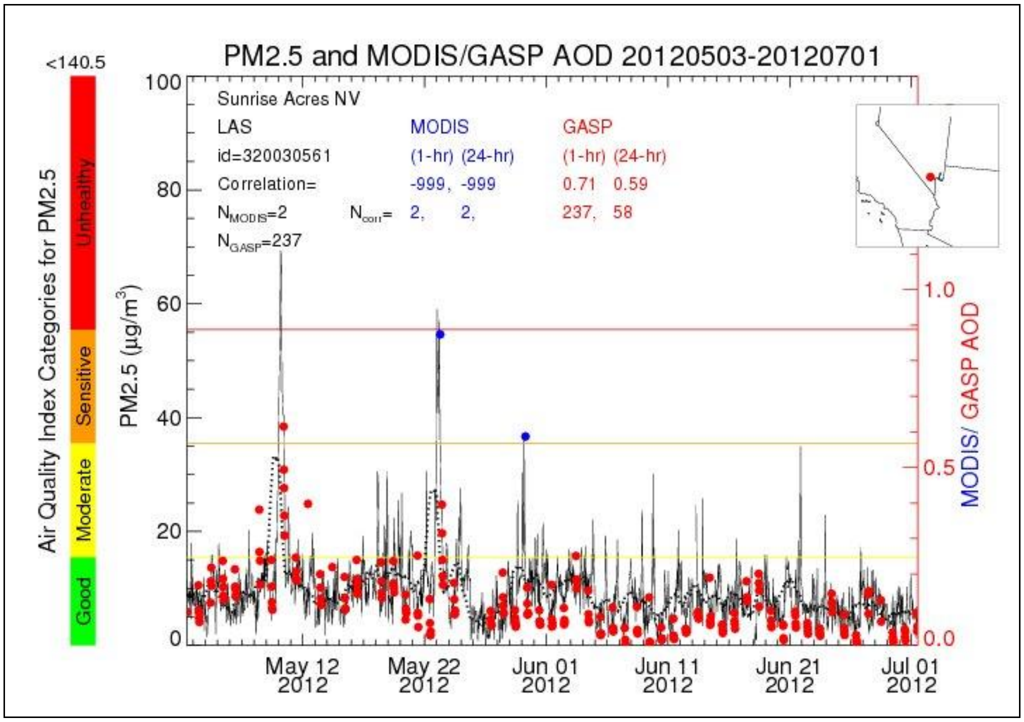

Figure 4-14. Data for Sunrise Acres.

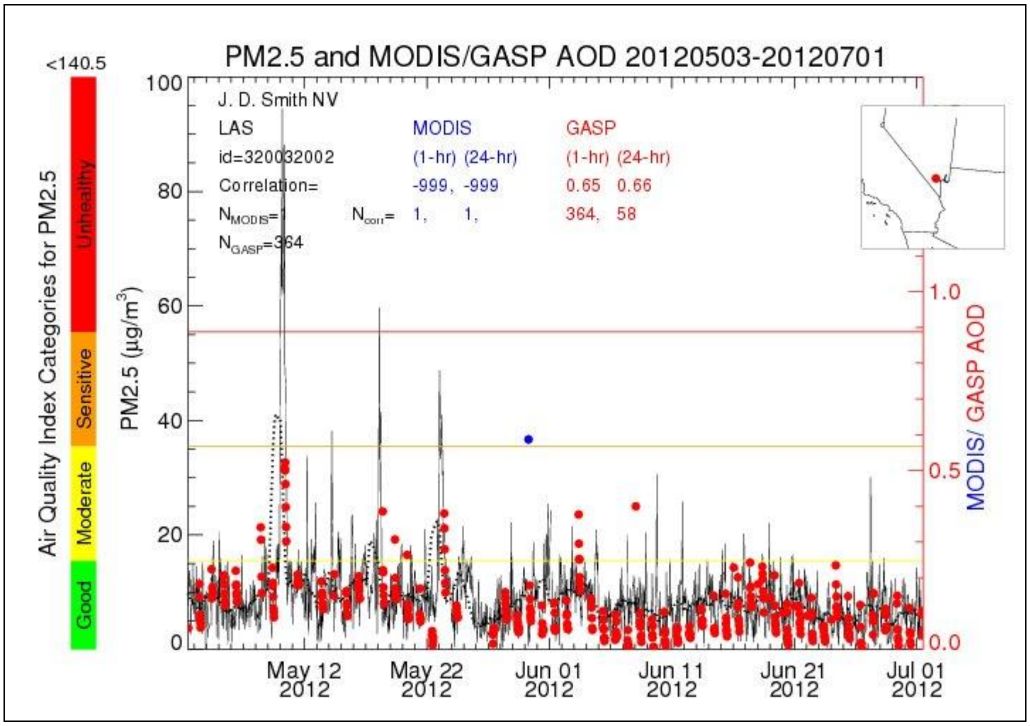

Figure 4-15. Data for JD Smith.

5.0 PUBLIC OUTREACH AND EDUCATION IN RESPONSE TO THE EXCEPTIONAL EVENT

DAQ has in place an education program to protect the public from adverse health problems associated with elevated pollutant levels. Its goals are to inform and educate the public on topics that include:

- How they can avoid exposure and minimize health impacts.
- How they can reduce their contributions to concentrations of the pollutant.
- What types of exceptional events may affect the area's air quality.
- When an exceptional event is imminent or occurring.

To meet these goals, DAQ conducts a comprehensive program that engages in local outreach events to provide information to the public. These include:

- Media press releases issued to the community as needed.
- School and youth outreach programs with classroom and youth group presentations, teacher training, and air quality information packets.
- Participation in community events (e.g., the Clark County Fair, Henderson Parade, Clark County Health and Wellness Fair).
- A Medical Advisory Committee comprised of physicians who work with DAQ and the Southern Nevada Health District to provide health-related information to the public before, during, and after exceptional events.
- Training in air quality reporting for local weather anchors.
- Activities with city, county, and local environmental/health professionals to improve methods for reaching and educating the community.

DAQ has also developed a notification system to contact at-risk populations. These notification avenues include:

- The Clark County School District.
- The Southern Nevada Health District.
- The Clark County Parks and Recreation Department.
- Local municipalities comprised of the cities of Henderson, Las Vegas, North Las Vegas, and Boulder City.

- Local media (e.g., newspapers, radio, and television stations).
- Physicians and sensitive individuals (through a notification service).

DAQ has formed two broad-based stakeholder groups to provide for public review of the justification packages for exceptional events: the Ozone Working Group and the PM Working Group. The groups include members from the following:

- Alpine Geophysics, LLC
- Associated General Contractors
- AVESTOR
- Lhoist North America of Arizona (in Las Vegas, NV)
- City of Boulder City
- City of Henderson
- City of Las Vegas
- City of North Las Vegas
- Clark County Department of Aviation
- Desert Research Institute, Division of Atmospheric Sciences
- Environmental Quality Management, Inc.
- ExxonMobil
- Las Vegas Paiute Tribe
- Nevada Department of Agriculture
- Nevada Department of Transportation
- Nevada Division of Environmental Protection
- Nevada Environmental Coalition
- Nevada Motor Transport Association
- NV Energy, Inc.
- Regional Transportation Commission of Southern Nevada
- Sierra Club, Toiyabe Chapter
- Silver State Materials Corp.
- Southern Nevada Home Builders Association

DAQ also presents reports on justification packages to the Technical Advisory Committee, and posts the packages on its Web site.

6.0 CONCLUSIONS AND RECOMMENDATION

This demonstration makes a clear and compelling case by weight of evidence that the ozone exceedance on May 23, 2012, was due to the influences of a wildfire in northern Nevada. The demonstration also meets the requirements of the EER allowing the EPA to exclude ozone data for that day.

The Tables and Figures used in this report depict the relationships between ozone, $PM_{2.5}$, and CO on May 23, as well as days prior and after the event. Figure 4-1 demonstrates that temperature, humidity, and wind speeds had little influence on the ambient levels of ozone, $PM_{2.5}$, and CO during the subject period. Figure 3-5 depicts a clear causal relationship between the ambient levels of ozone, $PM_{2.5}$, CO, and levoglucosan during the subject period. A strong correlation between ozone, $PM_{2.5}$, and levoglucosan proves that the smoke plume reached ground level and impacted concentrations. The high AQI for ozone, $PM_{2.5}$, and CO tracked nearly identically and were elevated proportionately on the subject wildfire smoke intrusion days.

In addition, this demonstration also analyzed the hourly AQI values for ozone, $PM_{2.5}$, and CO as outlined in Figure 3-18. Figures 3-19 through 3-23 show the variation in diurnal patterns between the nonfire days and the fire day. Section 3.3 shows the historical fluctuation for four years; ozone concentrations were never as high as in 2012 for the period in question.

Furthermore, back trajectories and wind data show that Clark County was impacted by the smoke plume. Additional satellite imagery also shows that southern Nevada was impacted by high levels of smoke and dust.

The demonstration contains information that Clark County took steps to protect the public health through release of a public advisory and cooperation with the local media.

Based on the information contained in this demonstration, EPA should exclude the ozone data for May 23, 2012, as an exceptional event in accordance with the EER.

7.0 REFERENCE

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8.0 AIR ADVISORIES AND NEWS ARTICLES

News Release

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.accessclarkcounty.com

Contact: Stacey Welling
Sr. Public Information Officer

Phone: (702) 455-3201
Cell: (702) 249-3823
E-mail: stac@co.clark.nv.us

For Immediate Release **Wednesday, May 23, 2012**

Air Quality Advisory Issued For Smoke Today Through Thursday Afternoon

Clark County Department of Air Quality (DAQ) issued an advisory today due to smoke from the Tre wildfire burning in Western Nevada, local weather conditions, and existing levels of pollutants. The wildfire is burning just west of Wellington, Nev., in Topaz Ranch Estates. The advisory is in effect today through Thursday afternoon.

Smoke is made of small dust particles and other pollutants that can aggravate respiratory diseases. At this time, unhealthy levels of air pollution are not occurring. Air Quality officials will continue to monitor conditions and will post an alert on the forecast page of the DAQ website if unhealthy levels actually occur. A link to the forecast page is located at http://redrock.clarkcountynv.gov/forecast/

ADDITIONAL INFORMATION:

Airborne smoke/dust is a form of inhalable air pollution called particulate matter, or PM, which aggravates respiratory diseases such as bronchitis and asthma. It may be best for children, the elderly, and people with respiratory diseases to stay indoors. Other suggestions include:

- If you work outdoors, consider wearing a painter's mask or surgical mask. This will help reduce your exposure to dust and particulates.
- Limit outdoor exertion. Exercise, for example, makes you breathe heavier and increases the amount of particulates you are likely to inhale.
- Keep windows closed. Run your air conditioner inside your house and car. Your air conditioner filters out dust and particulates.
- Consider changing your indoor air filters if they are dirty.
- Use your prescription allergy medication or over-the-counter hay fever or sinus medications if you experience symptoms of itchy eyes, a runny nose, or congestion.

Detailed air quality conditions are posted in the monitoring section of the DAQ website. You can receive free air quality forecasts and advisories via e-mail or text message through Enviroflash service. Subscription information is available at www.enviroflash.org.

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News Release

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.ClarkCountyNV.gov

Contact: Stacey Welling
Sr. Public Information Officer

Phone: (702) 455-3201
Cell: (702) 249-3823
E-mail: stac@co.clark.nv.us

For Immediate Release **Wednesday, May 23, 2012**

Air Quality Advisory Revised to Alert Status for Ozone and Particulates Due to Wildfire

Alert Remains in Place Through Thursday Afternoon

Clark County Department of Air Quality revised its advisory to an alert this afternoon due to smoke from the Tre wildfire burning southeast of Carson City, local weather conditions, and existing levels of pollutants. The alert will be in effect until Thursday afternoon.

At this time, unhealthy levels of ozone and particulates are imminent or are occurring because of the fire. Air Quality officials will continue to monitor conditions and will post an update on the forecast page of the DAQ website if unhealthy levels cease. A link to the forecast page is located at http://redrock.clarkcountynv.gov/forecast/.

ADDITIONAL INFORMATION ABOUT OZONE:

Ozone is a gas that occurs naturally in the upper atmosphere and protects earth from the sun's harmful ultraviolet rays. At ground level, ozone is a key ingredient of urban smog during the hottest months of the year in Clark County. Ground-level ozone can build up during the afternoon hours due to a combination of several factors, including strong sunlight, hot temperatures, and pollutants from automobiles and other sources such as transport, wildfires and fireworks. Unhealthy doses of ground-level ozone can reduce lung function and worsen respiratory illnesses such as asthma or bronchitis. Exposure to ozone also can induce coughing, wheezing and shortness of breath even in healthy people. When ozone levels are elevated, everyone should limit strenuous outdoor activity, especially people with respiratory diseases. If you are experiencing breathing difficulties or medical conditions that you think are related to air quality, see your doctor. Officials suggest these tips to help reduce the formation of ground-level ozone:

- Fill up your gas tank after sunset.
- Try not to spill gasoline when filling up, and don't top off your gas tank.
- Keep your car well maintained.
- Use mass transit or carpool.
- Don't idle your car engine.
- Mow your lawn after sunset.

-more-

News Release

ADDITIONAL INFORMATION ABOUT SMOKE & PARTICULATES:

Airborne smoke/dust is a form of inhalable air pollution called particulate matter, or PM, which aggravates respiratory diseases such as bronchitis and asthma. It may be best for children, the elderly, and people with respiratory diseases to stay indoors. Other suggestions include:

- If you work outdoors, consider wearing a painter's mask or surgical mask. This will help reduce your exposure to dust and particulates.
- Limit outdoor exertion. Exercise, for example, makes you breathe heavier and increases the amount of particulates you are likely to inhale.
- Keep windows closed. Run your air conditioner inside your house and car. Your air conditioner filters out dust and particulates.
- Consider changing your indoor air filters if they are dirty.
- Use your prescription allergy medication or over-the-counter hay fever or sinus medications if you experience symptoms of itchy eyes, a runny nose, or congestion.

Detailed air quality conditions are posted in the monitoring section of the DAQ website. You can receive free air quality forecasts and advisories via e-mail or text message through Enviroflash service. Subscription information is available at www.enviroflash.org.

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Clark County is a dynamic and innovative organization dedicated to providing top-quality service with integrity, respect and accountability. With jurisdiction over the world-famous Las Vegas Strip and covering an area the size of New Jersey, Clark is the nation's 14th-largest county and provides extensive regional services to more than 2 million citizens and 42 million visitors a year. Included are the nation's 8th-busiest airport, air quality compliance, social services and the state's largest public hospital, University Medical Center. The County also provides municipal services that are traditionally provided by cities to almost 900,000 residents in the unincorporated area. Those include fire protection, roads and other public works, parks and recreation, and planning and development.

Clark County news releases can be found at www.ClarkCountyNV.gov.
You can also follow the County on Twitter and Facebook and see our videos on YouTube.

Northern Nevada wildfire leads to air quality advisory in Clark County

LAS VEGAS REVIEW-JOURNAL

Posted: May 23, 2012 | 9:38 a.m.

Smoky conditions in the Las Vegas Valley from a wildfire burning in Northern Nevada are expected to continue today.

Clark County officials issued an air quality alert Wednesday afternoon that will remain in effect until this afternoon. Winds are expected to blow the smoke out of the area by afternoon.

Officials said the air pollution was not at unhealthful levels but could affect people with respiratory diseases.

They said they will monitor conditions and post updates on the agency's website: redrock.clarkcountynv.gov/forecast.

The wildfire is burning just west of Wellington in the Topaz Ranch estates in Douglas County, about 400 miles northwest of Las Vegas.

The fire, which destroyed two homes in a rural neighborhood near the California-Nevada line and threatened many more, might have been caused by an illegal burn that had been smoldering at a private residence since the weekend, investigators said .

The Associated Press contributed to this story.

FEMA Declares Topaz Ranch Estates Fire Major Disaster

Posted: May 23, 2012 10:26 AM PDT
Updated: May 23, 2012 11:05 AM PDT

From Senator Dean Heller:

The Federal Emergency Management Agency (FEMA) has declared the Topaz Ranch Estates (TRE) Fire a major disaster. This decision makes the region eligible for assistance in the mitigation, management, and control of burning on publicly and privately owned land.

"I am grateful that FEMA quickly granted Governor Sandoval's request. FEMA's assistance is a welcome contribution in the continued efforts to fight this blaze. My staff and I are monitoring the situation and will assist in any way we can to help direct federal resources to the region. I am pleased this grant has been made available," said Senator Heller.

The state was approved for a Fire Management Assistance Grant, which allows for cost-sharing on eligible firefighting resources. FEMA evaluates threats to lives and property, availability of first responders and their resources, danger conditions, and economic impact when evaluating a major disaster.

Firefighters say 120 homes and 300 outbuildings were threatened late Tuesday. Seventeen outbuildings and some cars had been burned, along with two houses. The 6,400-acre fire is currently 10% contained. Voluntary evacuations are still in effect. No roads are closed.

Douglas County deputies say a preliminary investigation indicates the fire was caused by a private residential open burn which exceeded the regulatory limitations and permit requirements, including the ignition of materials not allowed under the regulations.

The mutual investigation is continuing with the Nevada State Fire Marshall, Douglas County Sheriff's Office and Bureau of Land Management.

9.0 RTI LABORATORY PROCEDURES

<u>Analysis of Teflon Filter Extracts for Levoglucosan – for background concentrations is 2011</u>

The six Teflon filters were extracted using the $PM_{2.5}$ SOP. Briefly, each filter was placed in a 50-mL centrifuge tube and pre-wet with 100 µL ethanol. Then 25 mL deionized water (18MΩ) was added using a calibrated electronic pipette. The centrifuge tubes were placed in a rack in an ultrasonic bath and sonicated for 60 minutes and then transferred to a mechanical shaker in a cold room and shaken overnight at 60 cycles/sec.

The extracts were analyzed on a Dionex Model 3000 Ion chromatograph equipped with a Carbopac PA10 cation separator column and a Dionex Electrochemical Detector operating in the pulsed amperometric mode.

A peak in the chromatogram resulting from the residual ethanol precluded quantitation of the levoglucosan, so it was necessary to lyophilize (freeze dry) an aliquot of each extract to remove the ethanol. The lyophilized aliquots were then brought back to volume with deionized water and analyzed. No levoglucosan was detected in any of the extracts. However, good recovery was obtained for levoglucosan QC samples and for levoglucosan QC samples spiked with ethanol and lyophilized.

Results are summarized in the attached spreadsheet.

<u>Analysis of Teflon Filter Extracts for Levoglucosan – for the samples taken during the May 23, 2012 event</u>

The six Teflon filters were extracted using the $PM_{2.5}$ SOP. Briefly, each filter was placed in a 50-mL centrifuge tube. Then 25 mL deionized water (18MΩ) was added using a calibrated electronic pipette. The centrifuge tubes were placed in a rack in an ultrasonic bath and sonicated for 60 minutes and then transferred to a mechanical shaker in a cold room and shaken overnight at 60 cycles/sec.

The extracts were analyzed on a Dionex Model 3000 Ion chromatograph equipped with a Carbopac PA10 cation separator column and a Dionex Electrochemical Detector operating in the pulsed amperometric mode.

A peak in the chromatogram resulting from the residual ethanol precluded quantitation of the levoglucosan, so it was necessary to lyophilize (freeze dry) an aliquot of each extract to remove the ethanol. The lyophilized aliquots were then brought back to volume with deionized water and analyzed. No levoglucosan was detected in any of the extracts. However, good recovery was obtained for levoglucosan QC samples and for levoglucosan QC samples spiked with ethanol and lyophilized.
Results are summarized in the attached spreadsheet.

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10.0 WEATHER CHARTS

Upper-air pressure charts produced by NOAA models are used in the analysis. The following paragraphs describe the 200 mb, 500 mb, and 850 mb charts.

200 mb

The 200 mb charts altitude is near the level of the core of the jet stream. So the tracks of the jet streams can be seen very clearly on this chart. The jet stream indicates the direction of flow of the wind, which is generally from west to east throughout most of the subtropics, mid- and high-latitudes. It is the steering mechanism for low-pressure systems. Momentum of jet stream carves the trough ridge pattern. If the jet stream winds are greater on the LEFT side of a trough, the trough will become more amplified and move further south. If the jet stream winds are greater on the RIGHT side of a trough, the trough will become less amplified with time and move further north. This pressure level occurs approximately 12,000 meters (about 40,000 feet) above mean sea level (MSL). Features of the charts include the following graphical illustrations.

- The solid lines on the charts are heights of the 200 mb pressure surface in decameters (tens of meters). Thus, a height of 12,100 meters would appear as 1210. As with the surface chart, closely spaced lines indicate stronger winds.
- Areas of low and high pressure are noted. A circular pattern of height lines around a Low-pressure area is called a "closed Low"; at this level, it would indicate a very strong system. A "trough" if low pressure typically appears as a V-shaped pattern of height lines. A "ridge" of high pressure typically appears an inverted V-shaped pattern.
- These charts usually include the wind data at the upper-air station as arrow-shaped line figures. The shaft of the arrow shows the direction from which the wind blows, with the reference point being on the upper-air station location. The "feathers" on the back of the arrow shaft indicate speed: a solid line is ten knots, a triangle is 50 knots. One knot is about 1.15 miles per hour. A colored scale for wind speeds is located on the bottom of these charts.

500 mb

In meteorological applications, a common representation of the synoptic scale weather conditions is the 500 mb pressure pattern chart. This pressure level occurs approximately 5,600 meters (about 18,000 feet) above MSL; it is approximately one-half the average sea-level pressure. Features of the charts include the following graphical illustrations.

The solid lines on the charts are heights of the 500 mb pressure surface in decameters (tens of meters). Thus, a height of 5,600 meters would appear as 560. As with the surface chart, closely spaced lines indicate stronger winds.

- Areas of low and high pressure are noted. A circular pattern of height lines around a Low-pressure area is called a "closed Low"; this indicates a strong system. A "trough" if low pressure typically appears as a V-shaped pattern of height lines. A "ridge" of high pressure typically appears an inverted V-shaped pattern.

- These charts usually include the wind data at the upper-air station as arrow-shaped line figures. The shaft of the arrow shows the direction from which the wind blows, with the reference point being on the upper-air station location. The "feathers" on the back of the arrow shaft indicate speed: a solid line is ten knots, a triangle is 50 knots. One knot is about 1.15 miles per hour. A colored scale for wind speeds is located on the bottom of these charts.

850 mb

In meteorological applications, a common representation of the synoptic scale weather conditions is the 850 mb pressure pattern chart. This pressure level occurs approximately 1,500 meters (about 5,000 feet) above MSL. Features of the charts include the following graphical illustrations.

The solid lines on the charts are heights of the 850 mb pressure surface in decameters (tens of meters). Thus, a height of 1,500 meters would appear as 150. As with the surface chart, closely spaced lines indicate stronger winds.

- Areas of low and high pressure are noted. A circular pattern of height lines around a Low-pressure area is called a "closed Low"; this indicates a strong system. A "trough" if low pressure typically appears as a V-shaped pattern of height lines. A "ridge" of high pressure typically appears an inverted V-shaped pattern.
- These charts usually include the wind data at the upper-air station as arrow-shaped line figures. The shaft of the arrow shows the direction from which the wind blows, with the reference point being on the upper-air station location. The "feathers" on the back of the arrow shaft indicate speed: a solid line is ten knots, a triangle is 50 knots. One knot is about 1.15 miles per hour. A colored scale for wind speeds is located on the bottom of these charts.

11.0 PUBLIC REVIEW AND COMMENT PERIOD

11.1 DAQ WEB PAGE NOTIFICATION

DAQ | Page 1 of 1

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Residents | Visitors | Business | About Clark County | Elected Officials | Services | Departments

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Monday, December 2, 2013

Clark County > Departments > Air Quality

Air Quality

The Department of Air Quality is the air pollution control agency for all of Clark County, Nevada. Established by the Clark County Board of County Commissioners in 2001, Air Quality administers a variety of programs to improve the health and welfare of our citizens by ensuring that the quality of the air in Clark County meets healthful, regulatory standards.

Announcements

Wildfire Ozone Exceedance Event on May 23, 2012
Comment on the draft Wildfire Ozone Exceedance Event Package *More Information*

2014 Annual Stationary Source Invoice Information
Courtesy Notice *More Information*

Transported Dust Exceptional Event on May 10-2012
Comment on the draft Transported Dust Exceptional Event Package *More Information*

How We're Serving You

Small Business Assistance
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http://www.clarkcountynv.gov/depts/airquality/pages/default.aspx 12/2/2013

Air Quality

Wildfire Ozone Exceedance Event on May 23, 2012

The Clark County Department of Air Quality (DAQ) developed an exceptional event documentation package for an exceedance of the Ozone National Ambient Air Quality Standard (NAAQS). On May 23, 2012, Clark County recorded exceedances of the ozone NAAQS across its air quality monitoring network due to smoke plume impacts from a wildfire in northern Nevada. This exceptional event document was written in accordance with the U. S. Environmental Protection Agency (EPA) Exceptional Event Rule, dated March 22, 2007, which defines exceptional events as "... events for which the normal planning and regulatory process established by the federal Clean Air Act (CAA) is not appropriate."

EPA's exceptional event rule and CAA sections 319(b)(3)(B) and 107(d)(3) grant authority to exclude air quality monitoring data from regulatory determinations related to exceedances or violations of the NAAQS, thus avoiding redesignation of an area to a nonattainment status if the agency adequately demonstrates that an exceptional event has caused an exceedance or violation of the NAAQS.

The document will undergo a 30-day public comment period commencing on Sunday December 1, 2013 and ending on Monday December 30, 2013 at 5:00 p.m. The Draft May 23, 2012 Exceptional Event document may be downloaded at: Wildfire Ozone Exceedance Event of May 23, 2012.

The document is also available for inspection at the front counter of the DAQ office, located at 4701 W. Russell Road, Suite 200, Las Vegas, NV. 89118. DAQ is located on the second floor of the Clark County Building Department building.

Comments must be submitted in writing to the DAQ at the address above and to the attention of Jean-Paul Huys, Air Quality Specialist. Mr. Huys can be reached at 455-1684. Comments can also be submitted via email to:huys@ClarkCountyNV.gov. All comments must be received by 5:00 pm Monday, December 30, 2013, the close of the 30-day comment period. Written comments will be retained and considered prior to the submittal of the Exceptional Event Package to the EPA, Region 9, San Francisco, California.

11.2 PUBLIC COMMENT REPORT

Public Notice:	DAQ webpage
Public Comment Period:	December 1, 2013 to December 30, 2013
Comments Received:	None