ENCLOSURE: TECHNICAL SUPPORT DOCUMENT FOR EPA NONCONCURRENCE ON O_3 EXCEEDANCES MEASURED IN CLARK COUNTY, NEVADA ON MAY 9, 2020 AS AN EXCEPTIONAL EVENT

On July 1, 2021, Clark County Department of Environment and Sustainability (CCDES) submitted an exceptional events demonstration for two exceedances of the 2015 8-hour ozone (O_3) National Ambient Air Quality Standards (NAAQS) of 0.070 parts per million (ppm) that occurred at the Walter Johnson and Paul Meyer monitoring sites on May 9, 2020.[1, 2] The demonstration submitted by CCDES stated that the exceedances measured on May 9, 2020 were caused by a stratospheric O_3 intrusion (SOI) over the Pacific Ocean, west of Baja California, that transported O_3-rich air to Clark County, Nevada.[3] Under the Exceptional Events Rule, air agencies can request the exclusion of event-influenced data, and the EPA can agree to exclude these data, from the data set used for certain regulatory decisions if the EPA determines that the agencies have demonstrated that the event meets the rule criteria and requirements.

As described further in this document, the EPA has concluded that this event does not meet the requirements in the Exceptional Events Rule because the demonstration has not sufficiently shown a clear causal relationship between the specific event and the monitored exceedances. This conclusion was based on review of the extensive evidence presented in the demonstration, including satellite imagery and atmospheric models, trajectory analysis, skew-T diagrams, vertical O_3 profiles, meteorological information, ground level monitoring data, matching day analysis, and statistical modeling analysis. The data and analyses presented in the demonstration, though extensive and supportive that an SOI occurred in the SOI source region, do not support that stratospheric air from the SOI source region was transported to the Walter Johnson and Paul Meyer monitoring sites and impacted air quality so as to cause exceedances of the NAAQS. As a result, the EPA is nonconcurring on this exceptional event demonstration.

The remainder of this document summarizes the Exceptional Events Rule requirements, the event that is the subject of the submitted demonstration, the EPA's review process, and the bases for the EPA's determinations regarding the event.

EXCEPTIONAL EVENTS RULE REQUIREMENTS

The EPA promulgated the Exceptional Events Rule in 2007, pursuant to the 2005 amendment of Clean Air Act (CAA) Section 319. In 2016, the EPA finalized revisions to the Exceptional Events Rule. The 2007 Exceptional Events Rule and 2016 Exceptional Events Rule revisions added sections 40 CFR §50.1(j)-(r); §50.14; and §51.930 to title 40 of the Code of Federal Regulations (CFR). These sections contain definitions, criteria for EPA approval, procedural requirements, and requirements for air agency demonstrations. The EPA reviews the information and analyses in the air agency's demonstration package using a weight of evidence approach and decides to concur or not concur. The demonstration must satisfy all of the Exceptional Events

[1] "Exceptional Event Demonstration for Ozone Exceedances in Clark County, Nevada – May 9, 2020 (July 2021)" ("demonstration").
[2] While submitted by CCDES, the demonstration was prepared by Sonoma Technology under contract with CCDES.
[3] See demonstration, p. ES-1.

Rule criteria for the EPA to concur with excluding the air quality data from regulatory decisions. If any one of the criteria are not met, the EPA will nonconcur with the demonstration.

Under 40 CFR §50.14(c)(3)(iv), the air agency demonstration to justify exclusion of data must include:

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

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

C. "Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times" to support requirement (B) above;

D. "A demonstration that the event was both not reasonably controllable and not reasonably preventable;" and

E. "A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event."[4]

In addition, the air agency must meet several procedural requirements, including:

1. submission of an Initial Notification of Potential Exceptional Event and flagging of the affected data in the EPA's Air Quality System (AQS) as described in 40 CFR §50.14(c)(2)(i),

2. completion and documentation of the public comment process described in 40 CFR §50.14(c)(3)(v), and

3. implementation of any relevant mitigation requirements as described in 40 CFR §51.930.

For data influenced by exceptional events to be excluded from use in initial area designations, air agencies must also meet the initial notification and demonstration submission deadlines specified in Table 2 to 40 CFR §50.14. We include below a summary of the Exceptional Events Rule criteria, including those identified in 40 CFR §50.14(c)(3)(iv).

Regulatory Significance

The 2016 Exceptional Events Rule includes regulatory language that applies the provisions of CAA section 319 to a specific set of regulatory actions. As identified in 40 CFR §50.14(a)(1)(i), these regulatory actions include initial area designations and redesignations; area classifications;

[4] A natural event is further described in 40 CFR §50.1(k) as "an event and its resulting emissions, which may recur at the same location, in which human activity plays little or no direct causal role. For purposes of the definition of a natural event, anthropogenic sources that are reasonably controlled shall be considered to not play a direct role in causing emissions."

attainment determinations (including clean data determinations); attainment date extensions; findings of State Implementation Plan (SIP) inadequacy leading to a SIP call; and other actions on a case-by-case basis as determined by the Administrator. Air agencies and the EPA should discuss the regulatory significance of an exceptional events demonstration during the Initial Notification of Potential Exceptional Event prior to the air agency submitting a demonstration for the EPA's review.

Narrative Conceptual Model

The 2016 Exceptional Events Rule directs air agencies to submit, as part of the demonstration, a narrative conceptual model of the event that describes and summarizes the event in question and provides context for analyzing the required statutory and regulatory technical criteria. Air agencies may support the narrative conceptual model with summary tables or maps. For SOI events, the EPA recommends that the narrative conceptual model also discuss the local geography/topography, the meteorological conditions that led to the intrusion, how the O_3-containing stratospheric air created elevated ground-level O_3 concentrations at the affected monitor(s), and the chemistry of typical photochemical O_3 formation in the area, and, under 40 CFR §50.14(a)(1)(i), must describe the regulatory significance of the proposed data exclusion.[5]

Clear Causal Relationship and Supporting Analyses

The EPA considers a variety of evidence when evaluating whether there is a clear causal relationship between a specific event and the monitored exceedance or violation. The EPA has published a guidance document for SOIs that outlines the analyses that should be included to establish the clear causal relationship criterion within an air agency's exceptional events demonstration.[6] For SOI events, air agencies should compare the O_3 data requested for exclusion with seasonal historical concentrations at the air quality monitor. In addition to providing this information on the historical context for the event-influenced data, air agencies should include analyses to establish a clear causal relationship between the event and monitored data. As part of the EPA's strategy to ensure air agencies can "right size" demonstrations and manage resources associated with preparing demonstrations, the EPA intends to use a two-tiered approach to evaluate demonstrations for SOI events. The two tiers are delineated based on an event's potential for influencing O_3 concentrations at a given monitor and the history of non-event O_3 concentrations at the affected monitor(s). This approach recognizes that some intrusion events may clearly stand out from normally occurring O_3 concentrations and, thus, may need less supporting evidence to satisfy the rule requirements, particularly for the clear causal relationship element. Within these two tiers of demonstrations, Tier 1 demonstrations are the simplest and least resource-intensive, and may be sufficient for stratospheric intrusion events that cause obvious O_3 impacts during periods in which O_3 concentrations are typically low and meteorological patterns are suggestive of potential transport from the stratosphere. Tier 2 demonstrations should be used when the relationship between the subject intrusion and the influenced O_3 concentrations is complex and not fully elucidated with the simpler Tier 1

[5] Guidance on the Preparation of Exceptional Events Demonstrations for Stratospheric Ozone Intrusions, EPA-457/B-18-001 (November 2018) ("SOI guidance document"). p. 7.
[6] SOI guidance document

demonstrations. The guidance discusses the types of analyses that could be included within each tier.

Not Reasonably Controllable or Preventable

The Exceptional Events Rule requires that air agencies establish that the event be both not reasonably controllable and not reasonably preventable at the time the event occurred. This requirement applies to both natural events and events caused by human activities; however, it is presumed that SOI events satisfy both factors of the "not reasonably controllable or preventable" element unless evidence in the record clearly demonstrates otherwise.[7]

Natural Event

According to the CAA and the Exceptional Events Rule, an exceptional event must be "an event caused by human activity that is unlikely to recur at a particular location *or* a natural event" (emphasis added). The 2016 Exceptional Events Rule preamble acknowledges that SOIs are natural events. Once an agency provides evidence that an SOI occurred and demonstrates that there is a clear causal relationship between the measurement under consideration and the event, the EPA expects minimal documentation to satisfy the "human activity that is unlikely to recur at a particular location or a natural event" element.

EPA REVIEW OF EXCEPTIONAL EVENTS DEMONSTRATION

On November 30, 2020, CCDES submitted an Initial Notification of a potential Exceptional Event for numerous exceedances of the 2015 8-hour O_3 NAAQS that occurred at monitoring sites within Clark County, Nevada during 2018 and 2020.[8] On July 1, 2021, CCDES submitted an exceptional events demonstration for two exceedances of the 2015 8-hour O_3 NAAQS that occurred at the Walter Johnson and Paul Meyer monitoring sites within Clark County, Nevada on May 9, 2020.[9]

Regulatory Significance

The EPA determined that data exclusion of some of the exceedances referenced in the Initial Notification may have a regulatory significance for an attainment date extension or determination of attainment by the Marginal area attainment date for the Las Vegas, Nevada (NV) nonattainment area (NAA) for the 2015 8-hour O_3 NAAQS, and worked with CCDES to identify the relevant exceedances and monitoring sites affected.[10] Table 1 summarizes the exceedances that CCDES included in the demonstration.

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[7] According to 40 CFR §50.14(b)(6), "Where a State demonstrates to the Administrator's satisfaction that emissions from stratospheric intrusions caused a specific air pollution concentration in excess of one or more national ambient air quality standard at a particular air quality monitoring location and otherwise satisfies the requirements of this section, the Administrator will determine stratospheric intrusions to have met the requirements identified in paragraph (c)(3)(iv)(D) of this section regarding the not reasonably controllable or preventable criterion and shall exclude data from use in determinations of exceedances and violations."

[8] See email from Araceli Pruett, CCDES, to multiple staff at EPA Region 9, dated November 30, 2020.

[9] See letter from Marci Henson, CCDES, to Elizabeth Adams, EPA Region 9, dated July 1, 2021.

[10] See letters from Elizabeth Adams, EPA Region 9, to Michael Sword, CCDES, dated January 26, 2021, and to Marci Henson, CCDES, dated April 26, 2021 and May 4, 2021.

Table 1: 2015 8-hour O_3 NAAQS Exceedance Summary

Exceedance Date	Monitoring Site Name	AQS ID	2015 8-hour Avg. (ppm)
May 9, 2020	Paul Meyer	32-003-0043	0.074
	Walter Johnson	32-003-0071	0.071

Narrative Conceptual Model

The demonstration submitted by CCDES provided a narrative conceptual model in Section 1.4 of the demonstration to describe how O_3-containing stratospheric air was transported from over the eastern Pacific Ocean west of Baja California (also referred to as the SOI source region) into the troposphere and caused the O_3 exceedances at the Paul Meyer and Walter Johnson monitoring sites on May 9, 2020. Additional information addressing narrative conceptual model components was also presented in the Executive Summary and Sections 2 and 3. The narrative conceptual model included characteristics of the Clark County area, such as descriptions of typical O_3 formation, the ambient O_3 monitoring network, meteorology, geography, topography, emissions, and seasonal O_3 variations.[11] The demonstration incorrectly identified that the exceedances at the two sites could lead to an O_3 nonattainment designation for the Clark County area;[12] in fact, the portion of Clark County containing the two monitors is currently designated as the Las Vegas, Nevada (NV) Marginal NAA for the 2015 O_3 NAAQS. Additionally, the demonstration and the conceptual model did not identify the regulatory action for which this event is significant, which is a determination whether the area attained the 2015 O_3 NAAQS by the Marginal area attainment date or qualifies for an attainment date extension.

Section 2 of the demonstration provided: a) a regional description of Clark County and the surrounding area, with respect to topography and climatology; b) an overview of CCDES' monitoring network, including parameters measured and location of the monitors; c) characteristics of non-event historical O_3 formation during the O_3 season as compared to characteristics for the May 9, 2020 SOI event; d) a description of SOI events in general and characteristics specific to the May 9, 2020 SOI event.[13] The demonstration provided results of a comparison of the six-year (2015-2020) historical record and seasonality of maximum daily 8-hour average (MDA8) O_3 concentrations at the Walter Johnson and Paul Meyer monitoring sites compared to May 9, 2020. In the demonstration, "non-event" was defined as all days other than the May 9, 2020 event day. CCDES had identified 15 possible exceptional event days for the year 2018, and 13 possible exceptional event days for the year 2020. These possible exceptional events days were color-coded in the aforementioned six-year historical comparisons. The demonstration also provided an analysis of COVID restrictions' potential effects on O_3 concentrations.[14]

Section 3 of the demonstration contained analyses to demonstrate the Clear Causal Relationship portion of the demonstration.[15]

[11] See demonstration, pp. 2-1 to 2-17.
[12] See demonstration, p. ES-1.
[13] See demonstration, pp. 2-1 to 2-17.
[14] See demonstration, pp. 2-17 to 2-26.
[15] See demonstration, pp. 3-1 to 3-89.

The demonstration cited the 2017 Fires, Asian, and Stratospheric Transport-Las Vegas Ozone Study (FAST-LVOS) as evidence that SOIs can cause exceedances of the O_3 NAAQS in Clark County.[16] More specifically, the narrative cited a paper by Zhang et al.[17] that evaluated stratospheric and other source contributions to O_3 for "two exemplary SOI events" as part of the FAST-LVOS field study on April 23 and May 13, 2017. This highlights the potential relative importance of local contributions, *i.e.*, while there might have been enhanced background O_3 levels due to SOI in the 2017 events, the intrusion did not cause exceedances of the O_3 NAAQS. As part of the EPA's review of the demonstration's narrative conceptual model, the EPA reviewed data from AQS for the Clark County O_3 monitors for April 23 and May 13, 2017, and May 9, 2020. This data can be found in Appendix A to this Technical Support Document (TSD). As can be seen from Table A1 in Appendix A of this TSD, on April 23, 2017 the highest observed MDA8 at any monitor in Clark County was 67 parts per billion (ppb), and the highest on May 13, 2017 was 68 ppb; neither of the 2017 events resulted in exceedances of the O_3 NAAQS being measured in Clark County. Table A2 from the Appendix A of this TSD shows the maximum one-hour average O_3 was 71 ppb on April 23, 2017 and 75 ppb on May 13, 2017; the maximum one-hour average O_3 was 83 ppb on May 9, 2020. This highlights the potential relative importance of local contributions, *i.e.*, while there might have been enhanced background O_3 levels due to SOI in the 2017 events, the two intrusions discussed in the Zhang et al. paper were on days with maximum one-hour average O_3 concentrations 8 ppb lower than that measured on May 6, 2020, and did not result in any monitored exceedances of the O_3 NAAQS in Clark County.

The demonstration asserted that "[t]ypical SOI events in Clark County occur under similar meteorological conditions as those on May 9, 2020."[18] However, there are important differences in the meteorological conditions for the April 23 and May 13, 2017 events from the FAST-LVOS study compared to the May 9, 2020 event. As part of the EPA's review of the demonstration's narrative conceptual model, the EPA reviewed North Las Vegas Airport data (not part of the demonstration) for April 23 and May 13, 2017, and May 9, 2020.[19] This data can be found in Appendix A to this TSD. As can be seen in Appendix A, Table A3 of this TSD, high wind speeds of up to 26 miles per hour (mph) were measured on April 23, 2017, with ten hours measuring wind speeds of 15 mph or above. On May 13, 2017, high wind speeds of up to 29 mph were measured, with eight hours measuring wind speeds of 15 mph or above. In contrast, during the morning hours until the mid-afternoon (through 1:53 PM), the wind speeds on May 9, 2020 were less than or equal to 10 mph, then increased to a peak speed of 17 mph at 16:53 (4:53 PM). Only two hours measured wind speeds of 15 mph or above on May 9, 2020. High wind speeds are typical of an SOI event because high winds can be associated with deep convective mixing and transport of O_3 from the free troposphere to the surface. High wind speeds can also disperse and dilute local emissions of O_3 precursors and thus reduce the local photochemical production of O_3. The evidence from the Zhang paper presented in the demonstration is not convincing that the meteorological conditions on May 9, 2020 were similar to those on April 23

[16] See demonstration, p. 2-6.

[17] Zhang et al., Characterizing sources of high surface ozone events in the southwestern US with intensive field measurements and two global models, Atmospheric Chemistry & Physics, Volume 20, pages 10379–10400, published September 8, 2020, https://acp.copernicus.org/articles/20/10379/2020/acp-20-10379-2020.pdf.

[18] See demonstration, p. 2-6.

[19] https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2017-4-23. https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2017-5-13. https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2020-5-9.

and May 13, 2017. On May 9, 2020, high average temperature (approximately 87 degrees Fahrenheit) [20], along with low wind speeds indicate conditions that were conducive to standard photochemistry and more similar to non-SOI event days.

The demonstration provided results from atmospheric transport models: Global Forecast System (GFS), Whole Atmosphere Community Climate Model (WACCM), and Real-time Air Quality Modeling System (RAQMS) for isentropic potential vorticity (IPV), water vapor, and carbon monoxide (CO) concentrations as evidence for a stratospheric intrusion event that injected ozone-rich stratospheric air into the upper troposphere over the Pacific Ocean west of Baja California on May 7 at 0:00 Universal Time Coordinated (UTC) (May 6 at 16:00 Pacific Standard Time (PST)). While the SOI guidance document acknowledges that "[t]here are a variety of possible products that can help demonstrate that the first stage of an intrusion (stratosphere to FT [free troposphere]) occurred,"[21] it also states that "[a]ny demonstrations that use modeled representations of air quality to show stratospheric transport into the PBL [planetary boundary layer] should provide some evidence that the model is well fit for making that determination: those models that are systematically evaluated daily (and demonstrate relatively low levels of bias and error) are preferable, as are those that assimilate actual air quality data into the simulations."[22] The guidance also states that "[p]rognostic or retrospective air quality models may be used to provide evidence that stratospheric material reached the surface, but these analyses must be accompanied by robust model performance evaluations that support their use for this purpose and the horizontal and vertical grid resolution of the model should be appropriate for capturing an event."[23] The coarse grid global models used in the demonstration do not have adequate spatial resolution for urban O_3 modeling compared to rural O_3 and are not expected to perform well for urban O_3. The models alone are not sufficient to establish that stratospheric O_3 reached the surface and caused the exceedances. Additional analysis of the surface monitoring data and meteorological data is needed to establish that the O_3-rich layer extended to the surface layer and caused the O_3 exceedances.

In many instances, O_3-rich tropospheric air is not mixed into the PBL and does not reach surface monitoring sites. For example, research field studies including the 2013 Las Vegas Ozone Study (LVOS)[24] and the 2017 FAST-LVOS study[25] identified multiple events in which SOI layers were observed in the free troposphere above Las Vegas but did not reach the surface or contributed minimally to surface layer O_3 after mixing with transported plumes that contained enhanced O_3 concentrations from wildfires or international transport. While air quality models can be useful as weight of evidence analysis for supporting the possibility that stratospheric O_3-rich air impacted the surface, the global scale models cited in the demonstration have very coarse scale resolution and large uncertainty in simulating both vertical mixing and surface concentrations of O_3. As discussed below, the analysis of surface monitoring data also does not support the conclusion that the O_3 exceedance was caused by mixing of stratospheric O_3 to the surface.

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[20] See demonstration, p. 3-70.
[21] See SOI guidance document, p. 19.
[22] See SOI guidance document, p. 25.
[23] See SOI guidance document, p. 30.
[24] A. Langford, Las Vegas Ozone Study (LVOS), Final Report (MOU #CBE 602948-13) Clark County Department of Air Quality, July 25, 2014.
[25] A. Langford and C. Senff, Fires, Asian, and Stratospheric Transport-Las Vegas Ozone Study (FAST-LVOS), Report Contract No. CBE 6043188-16) for Clark County Department of Air Quality, December 1, 2019.

Although the demonstration stated that the Cajon Pass and I-15 corridor is an important atmospheric transport pathway from the Los Angeles Basin into the LVV,[26] the demonstration did not provide analysis of monitors' concentrations along this corridor on May 9, 2020 (and days prior), nor did it provide a comparison of the conditions on May 9, 2020 (and days prior) to non-event days that were significantly impacted by transport. Moreover, the demonstration stated that meteorological conditions on May 9 suggest that local and regional O_3 production from surface pollutant precursors should be relatively high[27] but did not demonstrate that SOI, and not this local regional O_3 production, caused the monitored exceedances.

The demonstration information referenced above includes several analyses that were located outside of the demonstration's stated narrative conceptual model and within the detailed technical sections addressing other rule criteria. The SOI guidance document states that narrative conceptual models are expected to "help readers and the reviewing EPA Regional office understand the event formation and the event's influence on monitored pollutant concentrations before the reader reaches the portion of the demonstration that contains the technical evidence to support the requested data exclusion."[28] The detail provided in Section 1.4 did not clearly or completely outline the conceptual model of the event formation and influence on monitored pollutant concentrations; rather, it presented the conceptual model as a summary of the clear causal relationship evidence. The conceptual model section also did not include the types of information outlined in the SOI guidance document. Additional information that reflected the conceptual model requirements was included elsewhere in the demonstration and is described above; however, this information should have been included in the conceptual model portion at the beginning of the demonstration to clearly outline the demonstration's overall characterization of how the event led to the observed exceedances.

Overall, the demonstration contained the elements required for inclusion in the conceptual model portion of the exceptional events demonstration.

Table 2: Documentation of the Narrative Conceptual Model

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 9, 2020	Executive Summary: p. ES-1 Section 1.4: pp. 1-8 to 1-9 Section 2: pp. 2-1 to 2-26 Section 3: pp. 3-1 to 3-89	Sufficient	Yes

Clear Causal Relationship

The demonstration included several analyses intended to support a clear causal relationship between the SOI event and the monitored exceedances. These analyses are presented in Section 3: a) comparison of the SOI event concentrations to historical concentrations; b) analyses addressing stratospheric-tropospheric exchange: satellite imagery and atmospheric models; c) analyses addressing stratospheric air reaching the surface: Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) trajectory analysis, measurements of tropospheric mixing shown in skew-T diagrams, vertical O_3 profiles, and meteorological maps; d) analyses addressing

[26] See demonstration, p. 2-1.
[27] See demonstration, p. 2-16.
[28] See SOI guidance document, p. 7.

impacts of the SOI at the surface: analysis of absolute humidity (AH), temperature, and measured concentrations of O_3, nitric oxide (NO) and nitrogen dioxide (NO_2); e) a matching day analysis; and f) Generalized Additive Model (GAM) statistical modeling.[29] The EPA reviewed the event and the tiering information provided in the SOI guidance document and determined that the appropriate tier for this event is Tier 2.[30] As stated in the SOI guidance document for a Tier 2 demonstration: "More complex relationships between the subject stratospheric intrusion and the influenced ozone concentrations will typically require additional detail to satisfy the clear causal relationship element (i.e., a Tier 2 demonstration). This additional evidence can either show the relative contribution estimates to the exceedance from local and transported anthropogenic pollutants compared to the intrusion contribution (i.e., quantification and apportionment) or show that meteorological conditions were not conducive to local photochemical production of ozone and that the demonstrated intrusion best explains the elevated ozone concentration(s)."[31] As part of the EPA's review of the demonstration's clear causal relationship information, the EPA produced additional figures and tables that were not included in the demonstration. These figures and tables can be found in Appendix A to this TSD.

Comparison with historical concentrations

The demonstration included a comparison with historical concentrations, as required by 40 CFR §50.14(c)(3)(iv)(C). The demonstration compared exceedances to six years of historical data (2015-2020) at the two affected monitoring sites.[32] The data was presented in graphs as well as tables. The graphs show that one of the two monitoring sites (Paul Meyer) measured MDA8 O_3 concentrations above the 99th percentile on May 9, 2020, when using six years of year-round data. When comparing to percentiles calculated only for the five-year history (2015-2019) from the week before and after the exceedance day, the concentrations measured at Paul Meyer and Walter Johnson on May 9, 2020 were equal to the 99th percentile value. Rank-ordered O_3 concentrations show that neither of the two violating monitoring sites had a May 9, 2020 exceedance value that fell within the top five O_3 concentrations in 2020.

Overview of the event and evidence that stratospheric-tropospheric exchange occurred

The demonstration provided an overview of the event, including a description of stratospheric-tropospheric exchange (STE).[33] The demonstration included analysis of satellite data for May 7-10, 2020 to identify possible signatures of a stratospheric intrusion event, such as O_3-rich and extremely dry air in the free troposphere. These analysis products include maps of true color visible imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments onboard the Aqua and Terra satellites, water vapor imagery from Geostationary Operational Environmental Satellite (GOES)-East, and total column O_3 from the Ozone Mapping and Profiling Suite (OMPS) instrument onboard the Suomi National Polar-orbiting Partnership (NPP) satellite.[34] The true color visible and water vapor imagery presented in Figures 3-3 to 3-9 of the demonstration indicate a region of very dry air in the vicinity of the SOI source region (over the eastern Pacific Ocean, west of Baja California) for the period of May 7 00:20 UTC (May 6, 16:20 PST) to May 10 00:20 UTC (May 9 16:20 PST). For the period of May 7 to May 9, 2020,

[29] See demonstration, pp. 3-1 to 3-89.
[30] See demonstration, pp. 1-3 to 1-5. The demonstration was completed as a Tier 2 analysis.
[31] See SOI guidance document, p. 31.
[32] See demonstration, pp. 2-9 to 2-10 and 3-2 to 3-3.
[33] See demonstration, pp. 3-7 to 3-37.
[34] See demonstration, pp. 3-7 to 3-14.

the map of total column O_3 from the OMPS instrument on the NPP satellite (demonstration Figure 3-10) shows an enhancement of total column O_3 over the eastern Pacific Ocean. While these pieces of information support an SOI in the source region extending into the free troposphere, further information is needed to determine whether stratospheric intrusion layers remained in the free troposphere, or if they mixed down into the planetary boundary layer.

The demonstration presented modeling analysis results from atmospheric transport models as evidence of stratosphere-to-troposphere mixing, including RAQMS, GFS, WACCM, and Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) data for O_3, carbon monoxide (CO), and IPV levels.[35] Stratospheric air is characterized by high IPV, high concentrations of O_3, and low concentrations of CO compared to tropospheric air; these characteristics can act as tracers for the mixing of stratospheric air into the troposphere. Demonstration Figures 3-11 (GFS model) and 3-15 (WACCM model) show elevated IPV and elevated O_3 respectively at 0:00 UTC on May 7 (16:00 PST May 6) in the vicinity of the SOI source region. Demonstration Figures 3-23 (RAQMS model) and 3-29 (WACCM model) show reduced CO levels at 0:00 UTC on May 7 (16:00 PST May 6) in the vicinity of the SOI source region.

The visible water vapor, column O_3 satellite imagery, and meteorological data as well as model results for IPV, ozone, and CO levels presented in the demonstration provide evidence to support that STE occurred in the SOI source region over the eastern Pacific Ocean west of Baja California.

<u>Evidence that stratospheric air reached the surface</u>
The demonstration further presented evidence intended to support that O_3-containing stratospheric air was able to penetrate to the lowest levels of the atmosphere, including HYSPLIT trajectory modeling,[36] radiosonde skew-T plots showing vertical profiles of temperature and relative humidity,[37] vertical column measurements of O_3 in the troposphere at the Jet Propulsion Laboratory (JPL) Table Mountain site,[38] and meteorological maps to indicate transport of vertically mixed air from the SOI source region to Clark County.[39]

To examine if air moved from the SOI source area (over the Pacific Ocean, west of Baja California) to LVV as stated in the conceptual model, the demonstration included various different types of HYSPLIT trajectory modeling:

- 72-hour backward trajectories from May 6 to May 9, 2020 23:00 UTC (15:00 PST) at elevations of 50 meters (m), 500 m, and 1000 m above ground level (AGL), from a single starting point in the LVV. As shown in demonstration Figure 3-34, depending on the trajectory height, some of the air parcels transported to the LVV area may have originated from the SOI source region, passing over southern California prior to reaching the LVV.[40]

[35] See demonstration, pp. 3-14 to 3-37.
[36] See demonstration, pp. 3-37 to 3-45.
[37] See demonstration, pp. 3-45 to 3-52.
[38] See demonstration, pp. 3-52 to 3-55.
[39] See demonstration, pp. 3-55 to 3-58.
[40] See demonstration, p. 3-40.

- A matrix of 72-hour backward trajectories from May 7 to May 10, 2020 03:00 UTC (May 6 to May 9, 2020 19:00 PST), at elevations of 500 m, 1000 m, 2000 m and 3700 m, with starting locations on an evenly spaced grid covering Las Vegas, Nevada. All of the trajectories shown in demonstration Figure 3-35 appear to pass across southern California, after which they continue on toward the SOI source region to varying degrees.[41]
- Frequency-weighted back trajectory analysis was presented in demonstration Figure 3-36 with a starting point in the LVV, elevation of 1000 m AGL for the period of May 6, 2020 11:00 UTC (3:00 PST) to May 10, 2020 05:00 UTC (May 9, 2020 21:00 PST). Demonstration Figure 3-36 shows the frequency of some trajectories looping over southwest Utah, across northern Nevada, into Oregon, and others passing through southern California to the coast, with some continuing in the direction of the SOI source region.[42] These different trajectories were not discussed in the demonstration.
- Matrix forward trajectories were run to show air parcel transport patterns from the SOI region to the LVV, initiated on May 7, 2020 at 03:00 UTC (May 6, 2020 19:00 PST) and 05:00 UTC (May 6, 2020 21:00 PST), at elevation of 3000 m AGL. Figures 3-37 (May 6, 2020 19:00 PST) and 3-38 (May 6, 2020 21:00 PST) both show a variety of trajectory paths, including some that could indicate the transport of air from the SOI source region to the LVV, passing over southern California prior to reaching the LVV.[43]

The trajectories presented in the demonstration provide some evidence for the transport of air parcels from the SOI source region to the LVV.

Section 3.3.2 of the demonstration provided evidence of tropospheric mixing via skew-T diagrams.[44] Skew-T diagrams from the National Weather Service (NWS) site in San Diego were presented in demonstration Figure 3-41 for May 8, 2020 00:00 UTC (May 7, 2020 16:00 PST) and Figure 3-42 for May 9, 2020 00:00 UTC (May 8, 2020 16:00 PST). The San Diego skew-T plots showed a dry layer near the surface at 16:00 PST on both May 7 and May 8. In that the demonstration did not include surface monitoring data demonstrating a stratospheric intrusion (e.g. high O_3, low water vapor, low NO_2) for the San Diego area, the indication of a dry layer of air in the skew-T plot, while supportive of possible stratospheric air near the surface, is not sufficient to conclude that stratospheric air reached the surface.

A skew-T diagram from the NWS Las Vegas site for May 10, 2020 00:00 UTC (May 9, 2020 16:00 PST) was also presented in demonstration Figures 3-39 and 3-43. The skew-T sounding on May 9th does not show a dry air layer below 10,000 meters and is not consistent with mixing of a stratospheric intrusion layer to the surface. Though the demonstration indicates "dry air at the surface, indicated by the large horizontal distance between the dew point and the temperature,"[45] Figure 3-51 in the demonstration shows that very low AH is not unusual for Las Vegas in the month of May. For comparison, Figure 3-40 of the demonstration also showed a skew-T sounding for a 2017 stratospheric intrusion event over Grand Junction, Colorado in April 2017.

[41] See demonstration, p. 3-41.
[42] See demonstration, pp. 3-41 to 3-42.
[43] See demonstration, pp. 3-44 to 3-45.
[44] See demonstration, pp. 3-45 to 3-52.
[45] See demonstration, p. 3-50.

This 2017 Grand Junction event was discussed in the SOI guidance document.[46] Figure 3-40 shows a thick layer of very dry air that penetrated deep into the lower troposphere, to within about 4,000 meters above the surface with a dew point of -30 degrees C. The air mass in Figure 3-40 for the Grand Junction 2017 event was both much drier and much closer to the surface than the dry layer shown in Figures 3-39 and 3-43, which was above 10,000 meters and close to the troposphere-stratosphere boundary. Thus, the skew-T sounding presented in Figures 3-39 and 3-43 does not support a finding that there was mixing from the troposphere to the surface in LVV on May 9th.

Section 3.3.2 of the demonstration also included an O_3 mixing ratio and temperature vertical profile (demonstration Figure 3-44) measured by the O_3 Light Detection and Ranging (LIDAR) instrument at the JPL Table Mountain Facility from 20:00 to 22:00 PST (8:00-10:00 pm PST) on May 8, 2020.[47] The JPL Table Mountain Facility is located in southern California, approximately 60 miles northeast of Pasadena, California. As shown in demonstration Figure 3-56, high O_3 concentrations were observed in the Los Angeles region on May 9. The JPL O_3 LIDAR data presented in Figure 3-44 shows enhancements of O_3 from the surface to about 3000 meters AGL (5285 meters above sea level) but does not show atypical enhancement of O_3 in the free troposphere above the JPL site. The demonstration provided forward and backward trajectories (Figures 3-45 to 3-47) to show transport between the SOI source region and the JPL Table Mountain Facility, and between the JPL Table Mountain Facility and the LVV for the period of May 7, 2020 6:00 UTC (May 6, 2020 22:00 PST) to May 9, 2020 5:00 UTC (May 8, 2020 21:00 PST). The trajectories appear somewhat consistent with the transport of some air parcels from the SOI source region passing over the JPL Table Mountain Facility on the way to the LVV on May 9. However, further evidence is needed to differentiate the transport of photochemical O_3 (and O_3 precursors) generated in southern California from stratospheric O_3 from the SOI source region. At any location, baseline stratospheric contribution is the result of the sum of many minor STE events. Some STE will have been minor and shallow, while some will have been deep STE intrusions. STE events that are deep and coherent cause large deviations from "baseline" stratospheric contributions. However, a deep STE intrusion sufficiently far from a surface monitor will likely have been sufficiently dispersed (due to mixing with other air parcels) and processed (chemical losses and physical deposition) such that it is not a coherent event when air parcels from the STE intrusion arrive at the surface monitor. Evidence that the SOI air parcel reached the area, reached the surface, and caused the exceedances at the monitors is critical to support the conceptual model, and a clear causal relationship in such instances.

Section 3.3.3 of the demonstration provided daily upper and daily surface meteorological maps of the U.S. for May 7 – 9, 2020, and a PBL contour map of the southwestern U.S. for May 9, 2020 at 16:00 PST.[48] According to the demonstration, the high and low pressure ridges indicate vertical mixing between the surface and upper levels and transport from southern California. These meteorological maps do not provide compelling evidence that the O_3-rich stratospheric air from the SOI source region reached the surface in the LVV. The meteorological maps do not address or explain the fact that the O_3 mixing ratio vertical profile presented in demonstration

[46] See SOI guidance document, p. 23.
[47] See demonstration, pp. 3-51 to 3-52.
[48] See demonstration, pp. 3-55 to 3-58.

Figure 3-44 did not show atypical enhancement of O_3 in the free troposphere above the JPL Table Mountain Facility.

To further evaluate trajectories for the May 9, 2020 exceedances in Clark County, the EPA performed additional analyses of wind rose data, additional HYSPLIT forward trajectories, and reviewed additional air quality information in areas of southern California. The figures produced in this analysis can be found in Appendix A of this TSD. TSD Figure A1 shows wind roses representing the average wind speed and wind direction for the LVV for the entire 24-hour period of May 9, 2020. The light blue colors illustrate lighter winds with a strong westerly and southwesterly and slight southeasterly component.

TSD Table A3 shows that wind speeds measured on May 9, 2020 at the North Las Vegas Airport weather station (12 km and 7 km northeast of the Paul Meyer and Walter Johnson stations, respectively) ranged from 0 to 17 mph, with only two hours measuring wind speeds at or above 15 mph. From 12:53 AM to 9:53 AM, winds ranged from 0 to 8 mph; from 10:53 AM to 1:53 PM, winds were at or below 10 mph, and from 2:53 PM to 5:53 PM wind speeds ranged from 12 to 17 mph before decreasing to a range of 3 to 8 mph into the late evening. TSD Table A4 shows that the MDA8 O_3 concentration for both Paul Meyer and Walter Johnson on May 9, 2020 occurred at 11:00 AM (i.e., reflecting hourly concentrations from 11:00 AM through 6:00 PM). As discussed earlier in this TSD, the relatively low wind speeds measured on May 9, 2020 in the LVV throughout the day, including through the morning hours, are more characteristic of conditions conducive to local photochemical O_3 production rather than an SOI event.

HYSPLIT forward trajectories were computed using data from the North American Mesoscale Forecast System (NAM) 12 kilometers (km) model for multiple heights (50 m, 1000 m, and 1500 m) starting on May 8, 2020 4:00 AM PST from various areas in southern California, as shown in TSD Figure A2. These forward trajectories depict air parcels moving from southern California northeast into Nevada with several transecting the LVV. This aligns with demonstration Figure 3-35, in which all HYSPLIT back trajectories shown transect southern California prior to reaching the LVV.[49]

In the days leading up to May 9, 2020, southern California was experiencing high O_3 Air Quality Index (AQI) values as depicted in Figures 3-56 and 3-57 in the demonstration.[50] South Coast Air Quality Management District (AQMD) released an announcement on May 5, 2020 noting an impending heat wave and unhealthy values of ground-level O_3 from May 5 through May 8, 2020 (see TSD Figure A3). AQI levels of unhealthy or higher were expected for the Santa Clarita Valley, San Gabriel Mountains, the San Gabriel Valley, the Inland Empire and the San Bernardino Mountains. TSD Figure A3 provides a South Coast AQMD's announcement that notes that the NWS issued heat advisories for the Inland Empire area of San Bernadino and Riverside counties, the Orange County inland areas, Los Angeles County, and an excessive heat warning for the Coachella Valley and the San Gorgonio Pass, and concludes: "Elevated temperatures, which enhance ozone formation rates, coupled with predicted atmospheric inversions that trap pollution near the surface may cause unusually high and persistent levels of ozone pollution." Southern California's O_3 AQI values reached the unhealthy range from May 7-

[49] See demonstration, p. 3-41.
[50] See demonstration, pp. 3-64 to 3-65.

9, 2020 as shown in Figure 3-57 in the demonstration. Demonstration Figure 3-56 shows that monitors from southern California east to Las Vegas measured O_3 concentrations in the 71-85 range on May 9, 2020, and four monitors in southern California measured concentrations in the range of 86-105 ppb. Although winds were light, winds in the LVV had a predominant westerly and southwesterly component that support transport from these regions of southern California (TSD Figure A1).

Overall, the evidence presented in the demonstration does not support that stratospheric air from the SOI source region reached the surface in Las Vegas. Demonstration HYSPLIT trajectories show that some air parcels may have originated from the SOI source region and arrived at Las Vegas. However, the HYSPLIT trajectories presented in the demonstration, as well those generated by the EPA (Appendix A of this TSD) show air parcels from the SOI source region passing over portions of southern California (which was experiencing a heat wave and high AQI values of O_3 attributed to local photochemical production) prior to reaching the LVV. The skew-T plots from the San Diego NWS office did indicate a dry layer of air close to the surface, however, no additional information was provided to support that stratospheric air reached the surface in San Diego (e.g. surface monitoring data showing high O_3, low water vapor, low NO_2), nor was additional information provided to demonstrate that an air parcel travelled from San Diego to the LVV, maintaining SOI enhancements throughout the journey. LIDAR did not show atypical enhancement of O_3 in the free troposphere above the JPL Table Mountain Facility, skew-T plots from the NWS Las Vegas office do not show a dry air layer on May 9th below 10,000 meters, and meteorological maps were inconclusive in showing that stratospheric air from the SOI source region reached the surface in the LVV.

<u>Evidence showing the impacts of the intrusion at the surface</u>
The demonstration included evidence intended to support that the resultant impacts from the intrusion on O_3 concentrations at the surface caused the ozone exceedances at the Walter Johnson and Paul Meyer monitoring sites.

The demonstration presented O_3 concentrations, AH (i.e., water vapor), and temperature from the Jerome Mack site, comparing May 9, 2020 diurnal data to 5th and 95th percentile data from May 2015 – 2019.[51] Figure 3-51 of the demonstration shows that on May 9, 2020, AH values were lower than the five-year (2015-2019) May average, with values dipping below the lowest 5th percentile of the five-year May data through much of the day. On May 9, AH values were below 1 gram per cubic meter for much of the afternoon. The peak MDA8 values on May 9, 2020 occurred in the late morning for the two sites that exceeded, with maximum 1-hour values occurring in the early afternoon. The AH data presented in the demonstration show 95th percentile five-year May data values reaching as high as 10 grams per cubic meter and 5th percentile five-year May data values dipping below 2.5 grams per cubic meter during the afternoon hours. The demonstration did not discuss AH values for other days in May 2020, including for days in May prior to May 9, to show if there was a noticeable effect on the magnitude and diurnal pattern before and during the period of presumed transport of O_3-rich stratospheric air from the SOI source region.

[51] See demonstration, pp. 3-58 to 3-59.

Demonstration Figure 3-54 shows O_3, NO, and NO_2 concentrations measured at Jerome Mack for May 9, 2020 superimposed over the 5th and 95th percentile data for May for the 2015-2019 years when available; demonstration Figure 3-55 shows the same measurements for O_3 and NO_2 at Joe Neal.[52] In demonstration Figures 3-54 and 3-55, NO_2 concentration changes do not strongly coincide with the AH temporal changes shown in demonstration Figure 3-51. In TSD Figures A8 (for Joe Neal) and A10 (for Jerome Mack), we see a regular diurnal pattern of decreasing NO_2 from the early morning to low values in the afternoon in the days prior to and following May 9. The demonstration noted that NO_2 concentrations at Jerome Mack and Joe Neal were approximately average relative to the seasonal average, while NO concentrations at Jerome Mack were low. If air parcels from the SOI source region (with very low NO_2) had arrived at the LVV monitors, one would expect for there to be a noticeable effect. The shapes of the AH, O_3, and NO_2 profiles shown in demonstration Figures 3-51, 3-54, and 3-55 generally follow the same diurnal shape as the May 2015-2019 data. While AH during the afternoon of May 9, 2020 is lower than the 5th percentile data for May for years 2015-2019, the demonstration did not provide sufficient evidence to show that the lower than average AH values were due to the arrival of O_3-rich (with low NO_2 and low water vapor) SOI air rather than other meteorological conditions on that day.

The demonstration presented diurnal O_3 data for May 9, 2020 with five-year (2015-2019) 5th to 95th percentile data from the two exceeding sites (Paul Meyer and Walter Johnson), as well as from the Joe Neal and Jerome Mack sites.[53] As noted in Section 2.3 of the demonstration, mobile sources comprise most of the emissions of total oxides of nitrogen (NO_x) ($NO_x = NO + NO_2$) during the O_3 season, so one would expect for there to be variation due to weekday/weekend patterns. A comparison of May 9, 2020 (a Saturday) to comparable days of the week was not provided in the demonstration. If O_3-rich air had been transported from the SOI source region to the monitors in the LVV, one should see a contemporaneous decrease in NO_2 with increase in O_3 that is not explainable by the normal diurnal NO_2/O_3 pattern. This is not evident in Figure 3-52 through Figure 3-55. While these figures show O_3 concentrations peaking above the 95th percentiles from hour 12 to hour 14 at Paul Meyer, and from hour 13 to hour 14 at Walter Johnson, no contemporaneous decrease in NO_2 occurs at the LVV monitors during the afternoon hours of May 9, 2020. The demonstration itself characterizes the NO and NO_2 concentration at Jerome Mack and Joe Neal as "average" during the May 9 event.[54] Overall, the demonstration did not provide evidence that decreases in NO_2 were inconsistent with the normal diurnal pattern or that the NO_2 decreases were due to SOI.

The demonstration presented a map (Figure 3-56) of observed MDA8 O_3 concentrations that shows elevated O_3 levels throughout southern California to the east of Los Angeles, in the Central Valley, and southern Nevada within the Clark County border. The demonstration also presented maps (Figure 3-57) of daily O_3 AQI for May 7 to May 9, 2020, that show moderate and unhealthy O_3 AQI values across the southwestern U.S.[55] Demonstration Figure 3-56 shows the highest elevated O_3 levels (orange and red dots) in California to be concentrated in southern California and the Central Valley. Demonstration Figure 3-57 shows the level of unhealthy O_3

[52] NO_2 data was available for Jerome Mack from 2017-2020 and for Joe Neal from 2015-2020; NO data was available for Jerome Mack from 2015-2020. See demonstration, pp. 3-62, 3-63 .
[53] See demonstration, pp. 3-59 to 3-63.
[54] See demonstration, p. 3-60.
[55] See demonstration, pp. 3-63 to 3-65.

AQI expanding from southern California to the north and northeast, from May 7 to 9. While SOI can impact ground level monitors across a wide region, meteorological conditions that are conducive to photochemical O_3 can similarly cause O_3 exceedances across a wide region, and it is common for O_3 exceedances caused by photochemical O_3 episodes to occur in areas in the southwest, including southern California, the Central Valley, and Clark County. Many of the areas where this regionally high O_3 was noted are also O_3 NAAs where exceedances are common during favorable meteorology. The demonstration would present stronger support for stratospheric O_3 impacting surface monitors if O_3 exceedances had occurred in both urban and rural areas and at higher elevation monitoring sites that do not typically have O_3 exceedances. As noted in the FAST-LVOS paper, "... the high average elevation of the Southwest and Intermountain West increase the likelihood that descending O_3-rich air will reach the surface."[56] The AQI plot on May 9 could more reasonably be interpreted to indicate high photochemical production of O_3 in Clark County, as well as areas in southern California, and the California Central Valley due to favorable meteorological conditions, and subsequent regional transport of O_3 and precursors from these areas in California to Clark County, rather than transport of stratospheric O_3 from the SOI source region.

To further understand and evaluate the air monitoring and meteorological data during the event, the EPA conducted additional analyses which are presented as tables and figures in Appendix A to this TSD. TSD Table A4 shows the MDA8 O_3 exceedances on May 9, 2020 at the O_3 monitors in Clark County (with the six monitoring sites in the LVV noted), as well as the hours that contributed to the MDA8 O_3. The MDA8 O_3 hours at each exceeding monitoring site occurred at 11:00 AM on May 9, 2020. TSD Table A5 shows the MDA8 O_3 values at four National Park Service (NPS) O_3 monitors surrounding the LVV on both May 8 and May 9. TSD Figure A13 shows the locations of the O_3 monitoring sites in TSD Tables A4 and A5. As can be seen in TSD Table A5, on May 9, 2020 there is a temporal shift in MDA8 O_3 at the Death Valley National Park (DVNP) monitor, with the MDA8 O_3 occurring at 08:00, compared to the MDA8 O_3 at Paul Meyer and Walter Johnson sites occurring at 11:00. TSD Table A5 shows the Mojave National Preserve (MNP) monitor having an exceeding MDA8 O_3 on May 8 as well as May 9. This difference in timing for MDA8 O_3 values for DVNP and MNP compared to Paul Meyer and Walter Johnson may be consistent with both local production in the LVV and transport from southern California or San Joaquin Valley impacting the remote DVNP and MNP on May 8 and ultimately the LVV area on May 9. TSD Figure A4 shows hourly O_3 concentrations from ambient monitors in Clark County and the surrounding areas to the west and southwest of Clark County. The Clark County area monitors show strong diurnal signatures, as do O_3 monitoring sites northeast of Los Angeles, suggesting local photochemical production as a primary contributor to high O_3 concentrations.

A review of the hourly O_3 data in Clark County on May 9 indicates that there were strong gradients in the observed O_3 across the County. For example, as shown in TSD Table A1, of the six O_3 monitors in the LVV (Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, and Jerome Mack), the MDA8 O_3 on May 9, 2020 ranged from 74 ppb at Paul Meyer and 71 ppb at Walter Johnson, to 64 ppb at both Palo Verde and Jerome Mack. As shown in TSD Table A2, for the same set of monitors, the 1-hour maximum O_3 ranged from 83 ppb at Paul Meyer and 79 ppb at Walter Johnson, to 71 ppb at both Palo Verde and Jerome Mack. The Palo Verde monitor

[56] A. Langford et al , p. 21.

is approximately 6.5 km to the west of the Walter Johnson monitor, and 10.2 km to the northwest of the Paul Meyer monitor. The Jerome Mack monitor is approximately 16 km to the east of the Paul Meyer and Walter Johnson monitors. If there had been a substantial contribution of stratospheric O_3 in Clark County on May 9, one would expect to observe less variability in O_3 across the County.

A study of O_3 in Las Vegas found that the highest O_3 concentrations occur seasonally in May and June and are typically measured in the western portion of the Valley.[57] TSD Figure A13 shows that the Walter Johnson and Paul Meyer monitors (the two exceeding LVV O_3 monitors on May 9, 2020) are in the western portion of LVV, consistent with the typical seasonal pattern referenced in the cited study. High O_3 concentrations at Walter Johnson and Paul Meyer are thus not inherently unexpected during the O_3 season.

TSD Figure A6 shows O_3, NO, NO_2, and meteorological parameter data from AQS measured at the Jerome Mack NCore monitoring site in early May 2020. There is a substantial amount of NO_x measured in the late evening of May 8 and early morning hours of May 9 at the Jerome Mack monitoring site prior to violating O_3 concentrations that occurred later that day. This is consistent with local photochemical production of O_3 due to local emissions of O_3 precursors or potentially transport of O_3 precursors from other source areas. As shown in Figures A7 to A10, NO_2 values measured at the Joe Neal and Jerome Mack monitoring sites (sites for which May 2020 NO_2 was available) are elevated in the late evening of May 8 at both sites and in the early morning hours of May 9, 2020 and precede the elevated O_3 values. If stratospheric air was infiltrating the LVV, it is expected that NO_2 values would be lower outside of typical commuting hours as stratospheric air is generally free of pollutants that are typically associated with anthropogenic activity, such as CO and NO_2.[58] In addition to NO_2, local meteorological parameters measured at the sites in question suggest conditions were conducive for local production of O_3. A review of weather data from Weather Underground (wunderground.com) shows that both maximum and daily average temperatures in the Las Vegas area were 10-15 degrees above the historical average for May 9; the maximum temperature on May 9, 2020 was 101 degrees Fahrenheit, only five degrees lower than the historical record high and eight degrees lower than the maximum temperature measured in May 2020.[59] TSD Figure A7 (Joe Neal monitoring site) shows the O_3 values closely trend with temperature. TSD Figures A11 (Walter Johnson monitoring site) and A12 (Paul Meyer monitoring site) show that these two monitoring sites follow a similar diurnal pattern for O_3 and temperature with both O_3 and temperature closely trending with each other. In addition, as shown in TSD Table A3, winds were light (equal to or less than 10 mph) in the LVV during the morning and early afternoon of May 9, 2020. The light winds that did occur in the LVV had a predominant westerly and south westerly component that also support transport from southern California which had been experiencing high O_3 values from May 7 to May 9, 2020.

The evidence presented in the demonstration for low water vapor (i.e., AH), high O_3, and typical NO_x concentrations is insufficient to demonstrate impacts from an SOI on the monitors. Low

[57] Xian and Crane, The study of ozone variations in the Las Vegas metropolitan area using remote sensing information and ground observations, 86th AMS Annual Meeting, p. 4, 2006, https://pubs.er.usgs.gov/publication/70035659.
[58] See SOI guidance document, p. 4.
[59] https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2020-5-9; https://www.wunderground.com/history/monthly/us/nv/north-las-vegas/KVGT/date/2020-5.

water vapor, regionally elevated O_3, and typical NO_x concentrations are not conclusive indicators of a clear causal relationship between an exceedance of the NAAQS and a stratospheric intrusion, especially for southern Nevada where low humidity is common, regionally high O_3 can be associated with regionally favorable meteorology for local O_3 production and O_3 transport from major source regions in California, and photochemical production of O_3 does occur at typical NO_x concentrations. The data presented in the demonstration appear consistent with substantial local photochemical O_3 and are not sufficient to demonstrate a clear causal relationship between the exceedances and a stratospheric intrusion.

Additional analyses

The demonstration included two additional analyses not discussed in the SOI guidance. These types of analyses are outlined in the EPA's guidance document for wildfire O_3 events[60] and are intended to provide a numerical estimation of the quantity of O_3 that can be attributed to an event, *e.g.*, a wildfire, by evaluating the expected O_3 concentration for a day based on typical meteorology and transport patterns. We refer to the wildfire O_3 guidance document as needed later in this section to outline how to evaluate the information presented from these analyses.

The demonstration included an analysis of data from days that were meteorologically similar to the exceedance day.[61] The demonstration identified that on May 9, 2020, maximum temperature was in the 35th percentile, mixing layer mixing ratio was in the 19th percentile, and average wind speed was in the 13th percentile, as compared to the 30-day period surrounding May 9 over a seven-year period.[62] Matching dates were selected based on synoptic and local meteorological conditions. HYSPLIT trajectories were used to cluster dates with similar transport patterns, and then meteorological parameters were used to determine the best matching dates among those in the same cluster. The parameters included daily average wind speed, resultant wind direction and speed, geopotential height, relative humidity, and temperature at elevations corresponding to 1000 millibars (mb) and 500 mb, and daily average atmospheric pressure, maximum temperature, and minimum temperature at the surface. The subset of candidate matching days was further filtered by comparing to meteorological maps at the surface and 500 mb, as well as local meteorological data. The formal analysis only considered the daily statistics and did not analyze information on a more refined time scale (e.g., wind speeds during peak O_3 hours).

A selection of eight days was provided in the demonstration, with two of the eight days highlighted as especially valuable comparisons as the exceedance event and these two days all fell when COVID-19 restrictions were occurring. The days selected had O_3 concentrations ranging from 49 to 68 ppb at the sites that exceeded on May 9, 2020. The demonstration found that concentrations on the identified matching days were below the level of the NAAQS and below the concentrations measured on the event day.

The matching day analysis did not consider several factors in selecting similar days for comparison, such as ambient NO_x concentrations, weekday/weekend effects, O_3 concentrations on the preceding days, and evaluation of timing of wind speeds in the context of O_3 formation. For example, O_3 can build up gradually over several days; wind speeds in the late morning and

[60] "Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations" (September 2016) ("wildfire O_3 guidance document").
[61] See demonstration, pp. 3-65 to 3-70.
[62] See demonstration, p. 3-68.

early afternoon hours, when O_3 production is typically highest, may factor more strongly into the determination of daily maximum 8-hour average concentrations of O_3. The effects of these potential factors were not discussed, weakening the conclusions drawn in the matching day analysis. Additionally, of the eight matching days selected, four of the days had measured concentrations at or above 62 ppb for at least one of the two sites analyzed in the demonstration, while one of the days had measured concentrations above 65 ppb, suggesting that even if the matching days themselves did not measure exceedances, the conditions observed were favorable to elevated O_3 concentrations, and small differences in meteorology between the event day and the selected matching days could be responsible for the higher O_3 values observed on the event day.

While the demonstration did compare May 9, 2020 to other meteorologically similar days, the eight comparison days did not include any day with a measured exceedance at Paul Meyer or Walter Johnson. An analysis of how the exceedance day compared to non-event exceedance days to determine if there were clear differences between those days and May 9, 2020, was not included. As noted previously in this TSD, the event day had high temperatures and low wind speeds, conditions conducive to local O_3 formation. There is also information supporting transport from southern California. The matching day analysis presented in the demonstration does not show that conditions on the event day were notably different than conditions on non-event exceedance days, nor that the event day meteorology in the presence of local area emissions alone was insufficient to cause the measured exceedances on the event day. The demonstration referred to a matching day analysis included as part of an Arizona Department of Environmental Quality (ADEQ) exceptional events demonstration that was concurred on by the EPA and stated that the analysis presented in this demonstration is an expansion of that type of work;[63] however, unlike the demonstration reviewed here, the referenced ADEQ demonstration included a more extensive analysis, including a comprehensive review of exceedance days to show how the event day was unusual in comparison.[64]

To further address the assertion that the SOI caused the O_3 exceedances, the demonstration included information on and analysis of output from a GAM analysis that was developed for monitors in the Las Vegas area.[65] GAMs are statistical models intended to allow for prediction of a response (in this case, MDA8 O_3 concentrations) based on linear and non-linear effects from multiple input variables. The GAM described in the demonstration used 16 separate input variables, primarily meteorological in nature, to predict O_3 concentrations each day at eight monitors in the Las Vegas area.

The demonstration provided several analyses to evaluate the GAM performance. An analysis of GAM residuals (*i.e.*, the difference between the observed concentration and the predicted concentration) found that residuals were close to zero (less than 0.5 ppb) when averaged across the dataset, and similarly when considering all days that were not flagged as exceptional events.[66] The flagged day residuals were larger; average residuals across all 2018 and 2020

[63] See demonstration, p. 3-80.
[64] "Addendum to: State of Arizona Exceptional Event Documentation for Wildfire-Caused Exceedances on June 20, 2015 in the Maricopa Nonattainment Area – September 2016; Additional Evidence that Ozone and Ozone Precursor Emissions From the Lake Fire Reached and Affected Ozone Monitors Within the Maricopa Nonattainment Area" (May 2018), pp. 21-28.
[65] See demonstration, pp. 3-71 to 3-88.
[66] See demonstration, p. 3-76.

flagged days ranged between 6-9 ppb for the five sites within the Las Vegas NAA, and were higher (over 12 ppb) for the sites within Clark County but outside of the NAA.[67] Values for sites outside of the NAA were based on a much smaller number of dates (2-4 as opposed to 11-22) as the monitors outside of the NAA did not exceed on most of the flagged days. As demonstrated by the R^2 values ranging from 0.55 to 0.61 for the various sites, the data presented also show that there is a large amount of variability in concentrations that remains after considering the variables selected.

The wildfire O_3 guidance document states: "Users of regression models should consider the uncertainties in the model's prediction abilities, specifically at high concentrations, before making conclusions based on the modeled results. A key question when considering model uncertainty is whether the model predicts O_3 both higher and lower than monitored values at high concentrations (above 65 or 70 ppb) or whether the model displays systematic bias on these high monitored days." [68] The analysis included in the demonstration attempts to address this concern. The demonstration included a calculation of the average residual of points not flagged as exceptional events with measured concentrations at or above 60 ppb. The average residuals of these higher concentration points were higher than the average of all residuals and the non-flagged day residuals, in the range of 3-5 ppb for all sites. This suggests that some of the 6-9 ppb average residuals reported for the flagged dates at the Las Vegas NAA sites can be explained by the performance of the statistical model at high concentrations, since the flagged dates are typically among the highest concentrations measured.[69] This is common in regression models; points considered for exceptional events demonstrations are typically among the highest observed concentrations at the monitor, and selecting points with high observed concentrations, whether exceptional events or not, will not result in a selection that is normally distributed around the mean of the regression model. Therefore, a positive residual is expected for data with high observed concentrations even considering the typical performance of the model. In other words, the positive residual is not itself indicative of an unusual source of O_3 affecting the monitors.

The demonstration also included a case study analysis of days not flagged as exceptional events where most monitors measured concentrations above 60 ppb, to evaluate the model performance at higher concentrations.[70] The median residuals across all monitors for each day ranged from 0.24 ppb to 3.89 ppb. The demonstration also gave the range (minimum and maximum) of residuals for individual monitors on each case study day. On every case study day, the highest residual for an individual monitor was between 3 and 7 ppb. This further supports that a positive residual of several ppb is common for any individual monitor on higher O_3 days outside of any potential exceptional events impact. In addition, on the case study days selected, the highest concentration measured by any monitor was 72 ppb; residuals might be higher on days that measured higher concentrations.

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[67] Of the sites included in the GAM analysis, the sites that fall within the Las Vegas NAA boundaries are Green Valley, Jerome Mack, Joe Neal, Paul Meyer, and Walter Johnson. The GAM analysis also included three sites (Jean, Indian Springs, and Boulder City) which are operated by CCDES and fall outside of the NAA boundaries but are still within Clark County, and are located to the southwest, northwest, and southeast of the NAA, respectively. Refer to p. 2-3 of the demonstration for a map showing the relative locations of the monitors.

[68] See wildfire O_3 guidance document, p. 28.

[69] See demonstration, p. 3-76.

[70] See demonstration, p. 3-79.

In order to account for the normal variability inherent in the statistical model, the wildfire O_3 guidance document states that the proper calculation to estimate the contribution from an atypical source of O_3 is to compare the sum of the predicted O_3 concentration and the 95th percentile of the residuals for the model to the observed concentration, rather than a direct comparison of the predicted O_3 concentration to the observation.[71] The demonstration showed the residuals for the individual days but did not present a calculation using the 95th percentile values of the residuals.[72] As the positive 95th quantile value for each monitor is presented in Table 3-12, this can be used to determine the potential contribution for each monitor per the method described in the wildfire O_3 guidance document by subtracting the positive 95th quantile value for the monitor in Table 3-12 from the reported residual in Table 3-14. Using this method, a potential SOI contribution of 2 ppb for Paul Meyer, and 5 ppb for Walter Johnson can be calculated. When this potential SOI contribution is subtracted from the observed concentration, the value for Walter Johnson on May 9, 2020 falls below the level of the NAAQS, while the value for Paul Meyer on May 9, 2020 remains above the level of the NAAQS (72 ppb). Based on the information presented in the demonstration, the model does not support that an unusual O_3 source affected monitors in the Las Vegas NAA on May 9, 2020 sufficiently to cause exceedances of the NAAQS; exceedances fall within the range of expected concentrations based on the performance of the statistical model.

Section 2.5 of the demonstration provided an analysis of the possible impact of COVID restrictions on O_3 from decreases in NO_x and volatile organic compounds (VOC) emissions from mobile sources.[73] Daily traffic count data from mid-March to early June was presented for 2019 and 2020. Focusing on the month of May, daily MDA8 O_3 during May 2020 was compared to MDA8 O_3 during May for the previous five years for the Paul Meyer, Walter Johnson, Joe Neal, Jean, Green Valley, and Jerome Mack sites. The demonstration concluded that "the observations do not suggest a month-long high ozone effect due to COVID-19 emission precursor changes."[74] The analysis went on to compare the historical distribution of daily MDA8 O_3 during the month of May with May 2020. The demonstration concluded that "although precursor NO_x emissions decreased during May 2020 due to COVID restrictions, MDA8 O_3 concentrations were not statistically higher than previous years and the EE days cannot be attributed to a consistent month-long increase in ozone concentrations due to the COVID shutdown."[75] Lastly, the COVID impact discussion looked at the GAM analysis (demonstration Section 3.5.2), focusing particularly on May 2020 GAM residuals.[76] The demonstration concluded that high residuals indicate an unknown source of O_3, and suggested this supported the impacts of an SOI. However, as discussed above, high residuals are at least partially an artifact of selection bias and the inherent uncertainly in the model. In addition, given the nonlinear response of O_3, the lower NO_x could result in different impacts on O_3 concentrations during high and low days. Therefore, a month-long increase would not necessarily be expected even if lower NO_x was increasing O_3 on higher O_3 days. In general, showing lack of significant difference between the different years' means is not sufficient to conclude that there was no COVID effect on high O_3 days.

[71] See wildfire O_3 guidance document, p. 28.
[72] See demonstration, p. 3-86.
[73] See demonstration, pp. 2-17 to 2-26.
[74] See demonstration, p. 2-20.
[75] See demonstration, p. 2-20.
[76] See demonstration, p. 3-71.

Overall, the results from the matching day analysis and the GAM model analysis do not support that an unusual source, such as an SOI, caused the O_3 exceedances measured at monitoring sites in the Las Vegas NAA on May 9, 2020.

Conclusion regarding the clear causal relationship criterion

The analyses included in the demonstration do not sufficiently demonstrate a clear causal relationship between the emissions generated by the SOI event and the exceedances measured at the Walter Johnson and Paul Meyer monitoring sites on May 9, 2020. Specifically, the demonstration provided some evidence that stratospheric-tropospheric exchange may have occurred in an area over the Pacific Ocean west of Baja California. However, other evidence presented was inadequate to demonstrate a clear causal relationship between the suggested SOI and the exceedances measured at the two LVV monitoring sites. The evidence was insufficient to show transport of such air from the aforementioned region to Clark County. Evidence presented in the demonstration show that some HYSPLIT trajectories may have originated from the SOI source region, but the air parcels passed over southern California (which was experiencing a heat wave and high levels of O_3) prior to arriving at the LVV. AQI maps of the southwestern U.S. included in the demonstration show increasing levels of high O_3 expanding from southern California to the LVV from May 7 to 9. Skew-T plots from the NWS Las Vegas Office did not show a dry air layer on May 9th below 10,000 meters, which is inconsistent with mixing of a stratospheric intrusion layer to the surface; JPL LIDAR measurements did not show atypical enhancement of O_3 in the free troposphere; and meteorological maps were inconclusive in showing that stratospheric air from the SOI source region reached the surface in the LVV.

Analyses presented to demonstrate SOI impacted the exceeding monitors also did not show a clear causal relationship. Although AH values in the afternoon of May 9, 2020 were lower than the five-year 2015-2019 May seasonal averages, NO_2 concentrations at the Jerome Mack and Joe Neal sites did not show a clear temporal coincidence with the low AH values. Rather, the NO_2 profiles on May 9, 2020 generally follow the diurnal NO_2 profiles for the five-year (2015-2019) May seasonal data. Review of the MDA8 O_3 concentrations for the O_3 monitors in Clark County for May 9, 2020 showed significant variation between the monitors in the LVV, which would not be expected if a regional event such as an SOI had occurred. Additional evidence of an unusual source of O_3 (*i.e.*, matching day analysis and GAM modeling results) did not indicate SOI caused the exceedances at the monitors. In addition, meteorological conditions on May 9, 2020 were conducive to local photochemical production from typical sources in the nonattainment area and transport from areas experiencing high O_3 in southern California. A review of the hourly O_3 data in Clark County on May 9 indicates that there was substantial local photochemical O_3 production, and as discussed earlier in this TSD, there were strong gradients in the observed O_3 across the County. The EPA's review of the demonstration evidence and additional analysis by the EPA (presented in Appendix A of this TSD) indicate that meteorological conditions on May 9, 2020 were conducive to local photochemical production from typical sources in the nonattainment area and that there was likely transport of O_3 from areas experiencing high O_3 in southern California to the LVV. Any potential SOI impact would be difficult to distinguish from these large anthropogenic contributions. The demonstration did not provide evidence or analysis to make this distinction. Insufficient evidence was presented to establish that, following the SOI over the Pacific Ocean west of Baja California, the stratospheric O_3-rich air was transported to Clark County and then caused the exceedances at the ground level monitors.

Table 3: Documentation of the Clear Causal Relationship criterion

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 9, 2020	Section 1: p. 1-4 Section 2: pp. 2-8 to 2-26 Section 3: pp. 3.1 to 3.89	Insufficient	No

Not Reasonably Controllable or Preventable

The Exceptional Events Rule presumes that SOI events are not reasonably controllable or preventable [40 CFR §50.14(b)(6)]. Through the analyses provided to address the clear causal relationship criterion, the demonstration established that an SOI occurred over the Pacific Ocean west of Baja California, Mexico, although the O_3 exceedances in the LVV did not meet the clear causal relationship criterion and were most likely due to anthropogenic pollutants, local photochemistry, and transport from southern California. Therefore, the documentation provided sufficiently demonstrates that the SOI event itself was not reasonably controllable and not reasonably preventable.

Table 4: Documentation of the Not Reasonably Controllable or Preventable criterion

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 9, 2020	Section 5: p 5.1	Sufficient	Yes

Natural Event

The 2016 Exceptional Events Rule preamble acknowledges that SOIs are natural events. The demonstration established the occurrence of an SOI that originated over the Pacific Ocean, west of Baja California, Mexico, although it did not adequately demonstrate the transport of O_3-rich air from the SOI origin to the LVV which subsequently caused the exceedances that were the subject of the demonstration. Thus the demonstration has therefore shown that the SOI event itself was a natural event.

Table 5: Documentation of the Natural Event criterion

Exceedance Date	Demonstration Citation	Quality of Evidence	Criterion Met?
May 9, 2020	Section 4: p 4.1	Sufficient	Yes

Schedule and Procedural Requirements

In addition to technical demonstration requirements, 40 CFR §50.14(c) and 40 CFR §51.930 specify schedule and procedural requirements an air agency must follow to request data exclusion. Table 6 outlines the EPA's evaluation of these requirements.

Table 6: Schedules and Procedural Criteria

	Reference	Demonstration Citation	Criterion Met?
Did the agency provide prompt public notification of the event?	40 CFR §50.14 (c)(1)(i)	August 11, 2021 Letter; Addendum to "Exceptional Event Demonstration for Ozone Exceedances in Clark County, Nevada – May 9, 2020"[77]	No. Notifications were for elevated levels of O_3, but not specific to this event
Did the agency submit an Initial Notification of Potential Exceptional Event and flag the affected data in the EPA's Air Quality System (AQS)?	40 CFR §50.14 (c)(2)(i)	November 30, 2020 email[78]	Yes
Did the initial notification and demonstration submittals meet the deadlines for data influenced by exceptional events for use in initial area designations, if applicable? Or the deadlines established by the EPA during the Initial Notification of Potential Exceptional Events process, if applicable?	40 CFR §50.14 Table 2 40 CFR §50.14 (c)(2)(i)(B)	July 1, 2021 Letter[79]	Yes
Was the public comment process followed and documented? • Did the agency document that the comment period was open for a minimum of 30 days? • Did the agency submit to the EPA any public comments received? • Did the state address comments disputing or contradicting factual evidence provided in the demonstration?	40 CFR §50.14 (c)(3)(v)	August 11, 2021 Letter; Appendix D, "Documentation of the Public Comment Process May 9, 2020 Demonstration"[80]	Yes
Has the agency met requirements regarding submission of a mitigation plan, if applicable?	40 CFR §51.930 (b)	NA	NA

Conclusion

The EPA has reviewed the documentation provided by CCDES to demonstrate that O_3-containing stratospheric air was transported into the troposphere and that this O_3-rich air reached the ground-level monitors and caused exceedances of the 2015 8-hour O_3 NAAQS at the Walter Johnson and Paul Meyer monitoring sites on May 9, 2020. The EPA has determined that the

[77] Letter from Marci Henson, CCDES, to Elizabeth Adams, EPA Region 9, dated August 11, 2021.
[78] Email from Araceli Pruett, CCDES, to multiple staff at EPA Region 9, dated November 30, 2020.
[79] Letter from Marci Henson, CCDES, to Elizabeth Adams, EPA Region 9, dated July 1, 2021.
[80] Letter from Marci Henson, CCDES, to Elizabeth Adams, EPA Region 9, dated August 11, 2021.

flagged exceedances at these monitoring sites on this day do not satisfy the exceptional events criteria. Specifically, although the demonstration presented evidence that an SOI may have occurred over the eastern Pacific Ocean west of Baja California, and that SOI meets the requirement that the event be not reasonably controllable or preventable and a natural event, the demonstration failed to show that there exists a clear causal relationship between the event and the monitored exceedances. This conclusion was based on the review of evidence presented in the demonstration, including meteorological information, atmospheric modeling output, satellite data, HYSPLIT trajectories, ground level monitoring data, analysis of meteorologically similar days, and statistical modeling analysis, as well as review of additional information by the EPA as presented in this TSD. The exceedance day experienced conditions favorable to local O_3 production and transport of anthropogenic O_3 from southern California within the normal summer O_3 season. The weight of evidence, taking into consideration the data and analyses in the demonstration and this TSD, does not support that O_3-rich stratospheric air was transported to the monitors in the LVV and impacted monitors there sufficiently to cause exceedances of the NAAQS. As the weight of evidence does not support a clear causal relationship between the SOI event and the May 9, 2020 monitored exceedances at O_3 monitors in the Las Vegas NAA, the EPA is nonconcurring on this exceptional events demonstration.

APPENDIX A: Supplemental figures and analysis prepared by the EPA.

Figure A1: Wind rose for the LVV on May 9th, 2020 (AirNowTech).

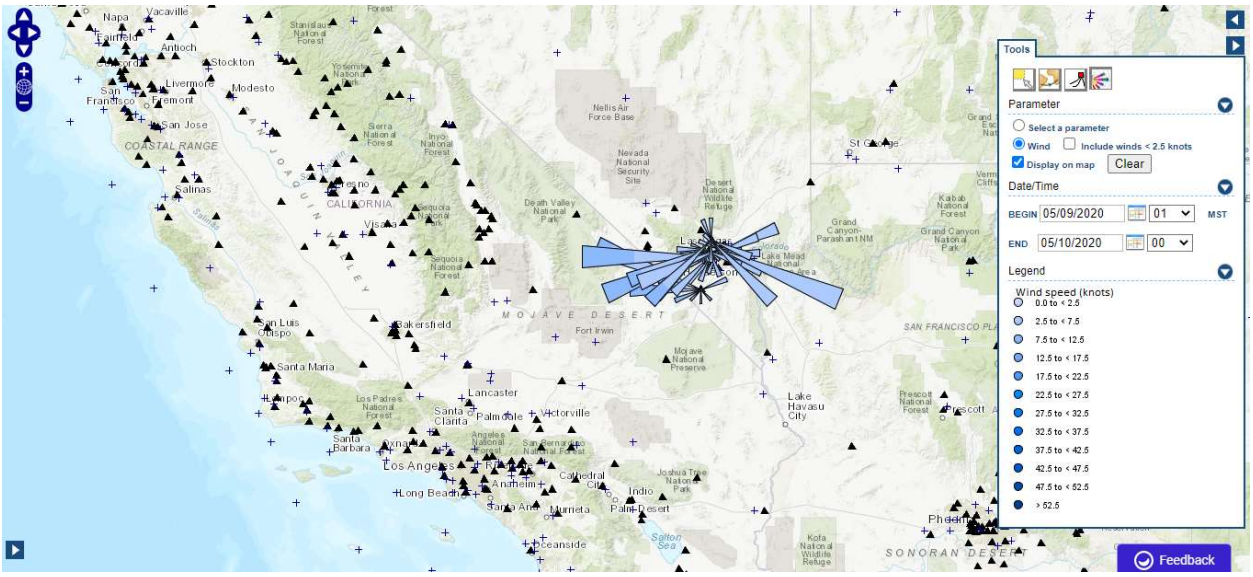


Figure A2: HYSPLIT 72-hour forward trajectories from southern California beginning May 8th, 2020 4:00 am PST using the NAM 12 km for height levels 50 m, 1000 m, and 1500 m (AirNowTech).

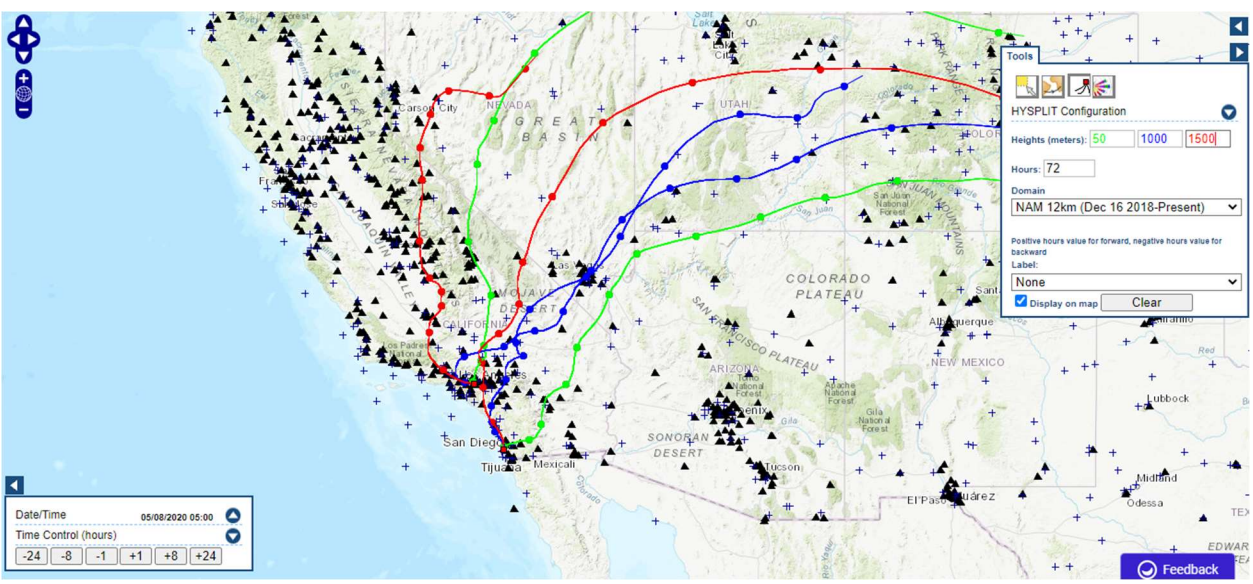


Figure A3: South Coast AQMD ozone advisory valid from May 5, 2020 to May 8, 2020.

South Coast AQMD

www.aqmd.gov

@SouthCoastAQMD

FOR IMMEDIATE RELEASE: May 5, 2020
MEDIA CONTACT:
Bradley Whitaker, (909) 396-3456, Cell: (909) 323-9516
Nahal Mogharabi, (909) 396-3773, Cell: (909) 837-2431
press@aqmd.gov

South Coast AQMD Issues Ozone Advisory Due to Heat Wave

Valid: Tuesday, May 5, 2020 through Friday, May 8, 2020

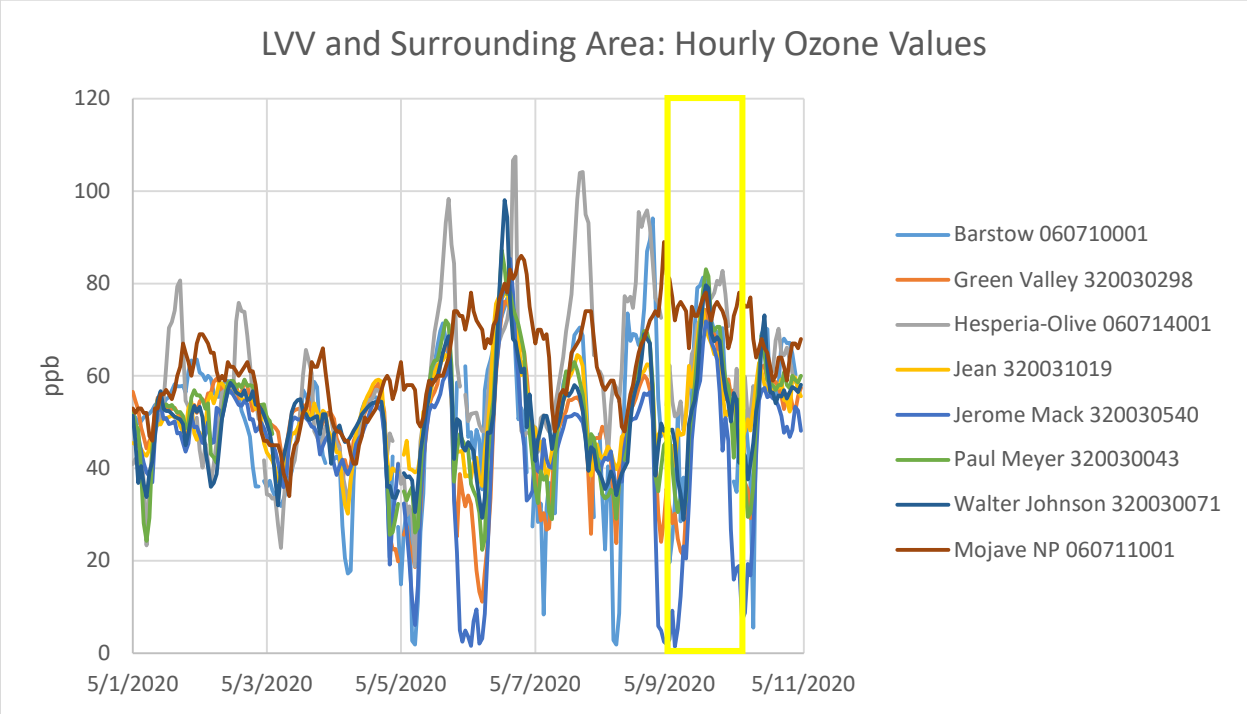
This advisory is in effect through Friday afternoon. South Coast AQMD will issue an update if additional information becomes available.

High temperatures are expected to persist over the next several days throughout the South Coast Air Basin and the Coachella Valley, increasing the likelihood of poor air quality in many areas.

Levels of ground-level ozone (smog) – the predominant summertime pollutant – are likely to reach the **Unhealthy** or higher Air Quality Index (AQI) levels in the Santa Clarita Valley, the San Gabriel Mountains, the San Gabriel Valley, the Inland Empire and the San Bernardino Mountains.

The National Weather Service (NWS) is predicting a heat wave over southern California that will last through Friday. This is due to an upper air high pressure system located over Baja California. As of Tuesday afternoon, the NWS has issued a heat advisory for the Inland Empire area of San Bernardino and Riverside Counties and the Orange County inland areas, which is in effect from 10 am Tuesday until 9 pm on Friday. A heat advisory has also been issued for Los Angeles County and is in effect from 10 am Wednesday through 9 pm on Thursday. The NWS has issued an excessive heat warning for the Coachella Valley and the San Gorgonio Pass, which is in effect from 10 am Tuesday until 9 pm on Friday. For information regarding the NWS warnings and the most current weather information, visit the NWS San Diego (https://www.weather.gov/sgx/) and Los Angeles (https://www.weather.gov/lox/) websites. Elevated temperatures, which enhance ozone formation rates, coupled with predicted atmospheric inversions that trap pollution near the surface may cause unusually high and persistent levels of ozone pollution.

Figure A4: Hourly O_3 concentrations* at LVV and surrounding areas from May 1, 2020 through May 10, 2020.



* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 3/18/2022

Figure A5. Location of the Walter Johnson and Paul Meyer monitoring sites in the LVV.

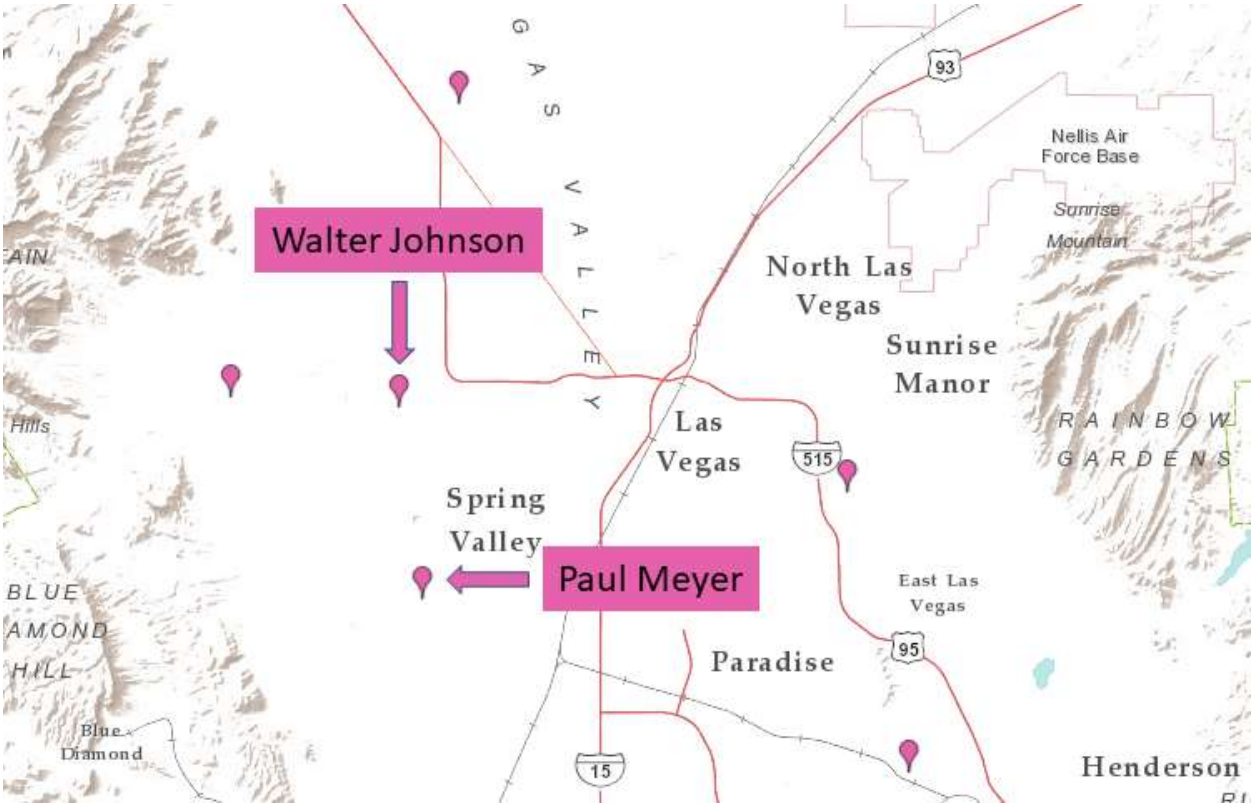
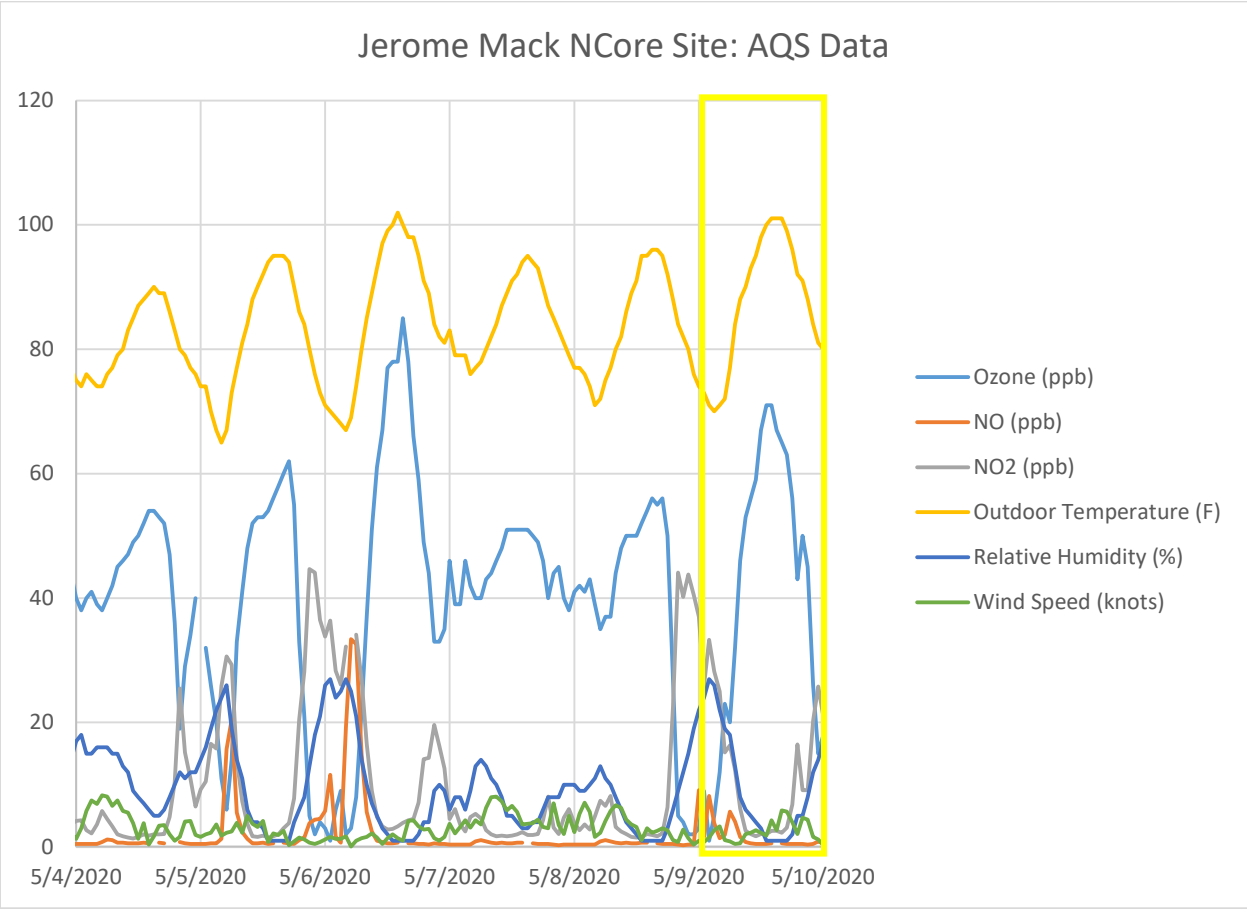
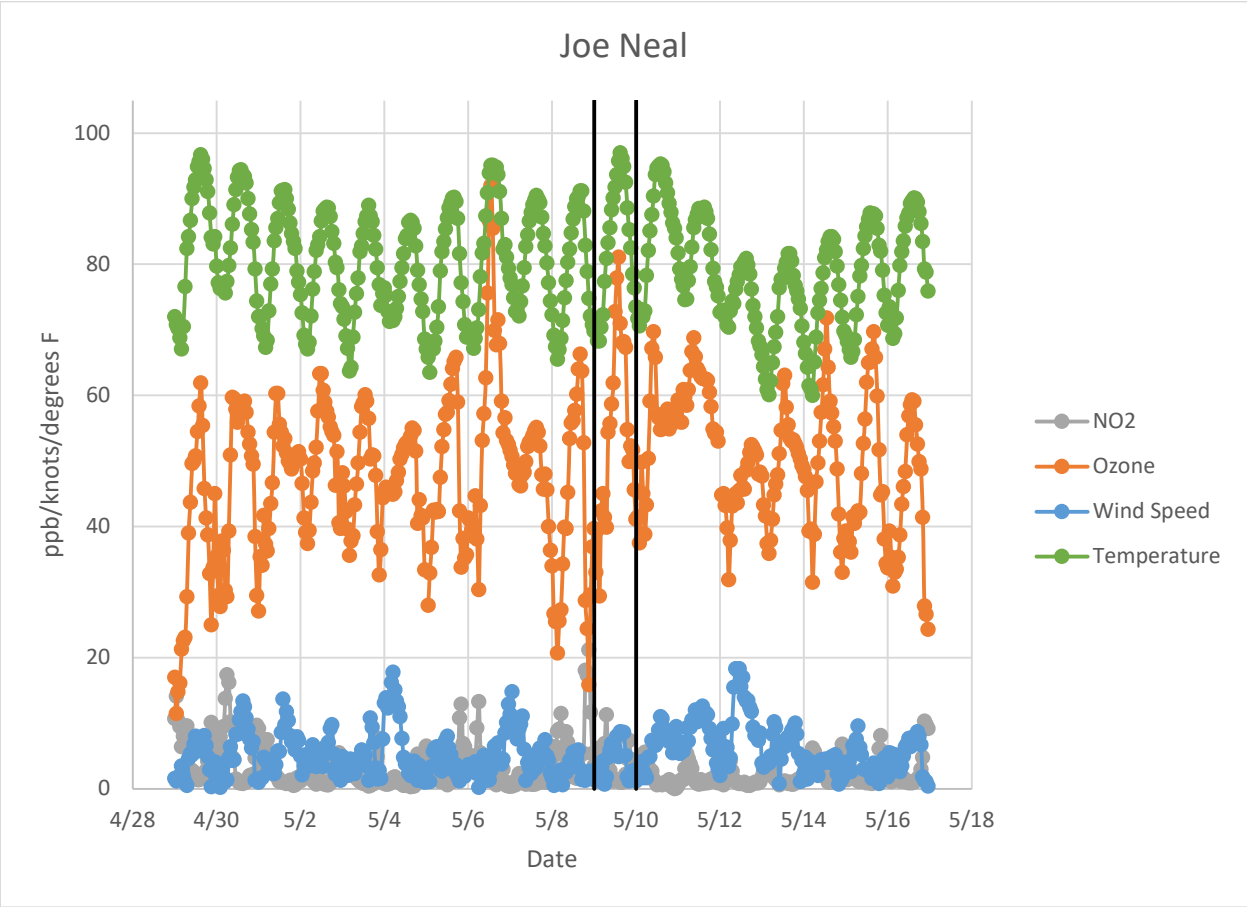


Figure A6: O_3, NO, NO_2, and meteorological monitoring values from AQS* for the Jerome Mack NCore monitoring site.



* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

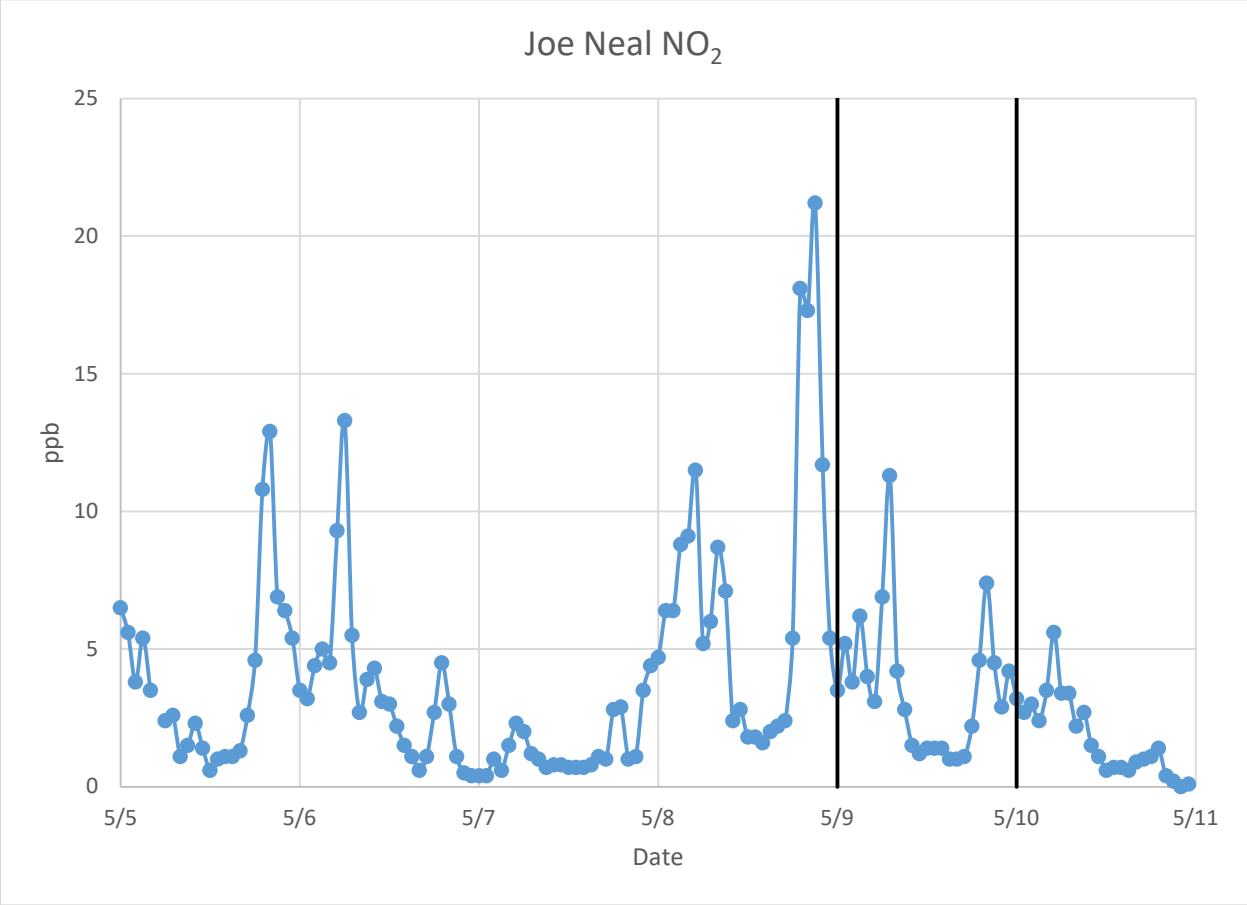
Figure A7: Hourly NO_2, O_3, wind speed, and temperature values from AQS* for the Joe Neal monitoring site from April 29, 2020 through May 16, 2020.



The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am, respectively.

* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

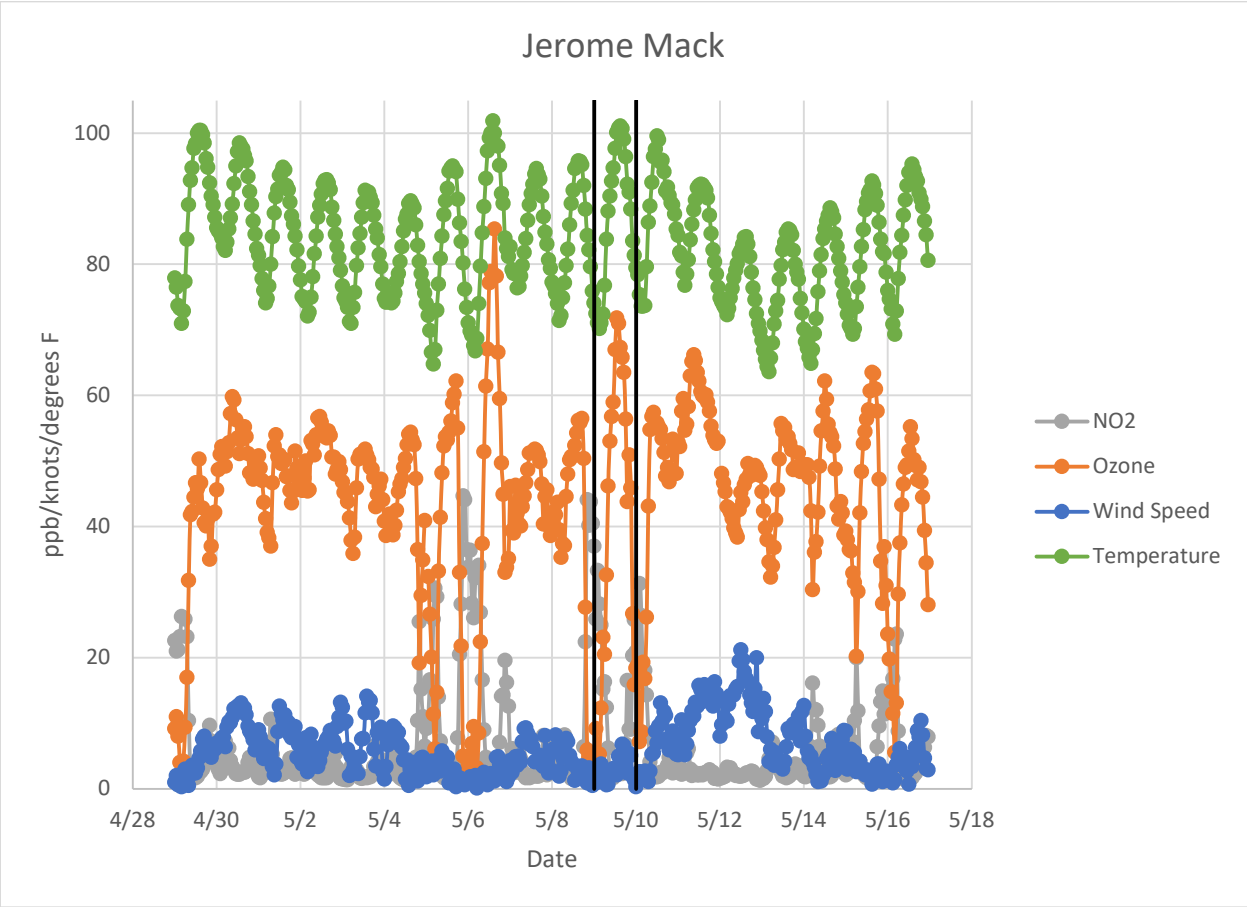
Figure A8. Hourly NO_2 values from AQS* for the Joe Neal monitoring site from May 5, 2020 through May 10, 2020.



The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am respectively.

* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

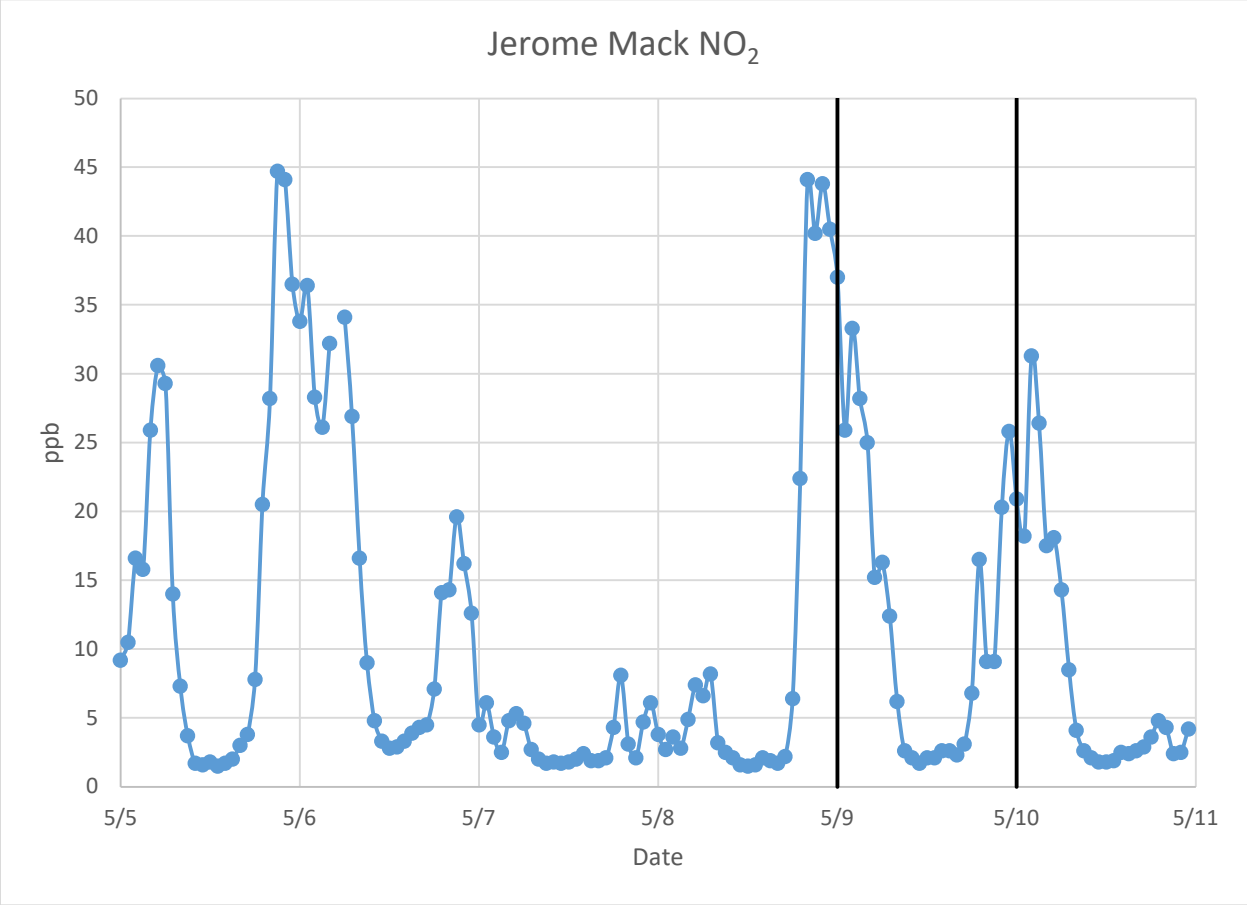
Figure A9: Hourly NO_2, O_3, wind speed, and temperature values from AQS* for the Jerome Mack monitoring site from April 29, 2020 through May 16, 2020.



The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am, respectively.

* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

Figure A10. Hourly NO_2 values from AQS* for the Jerome Mack monitoring site from May 5, 2020 through May 10, 2020.



The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am respectively.

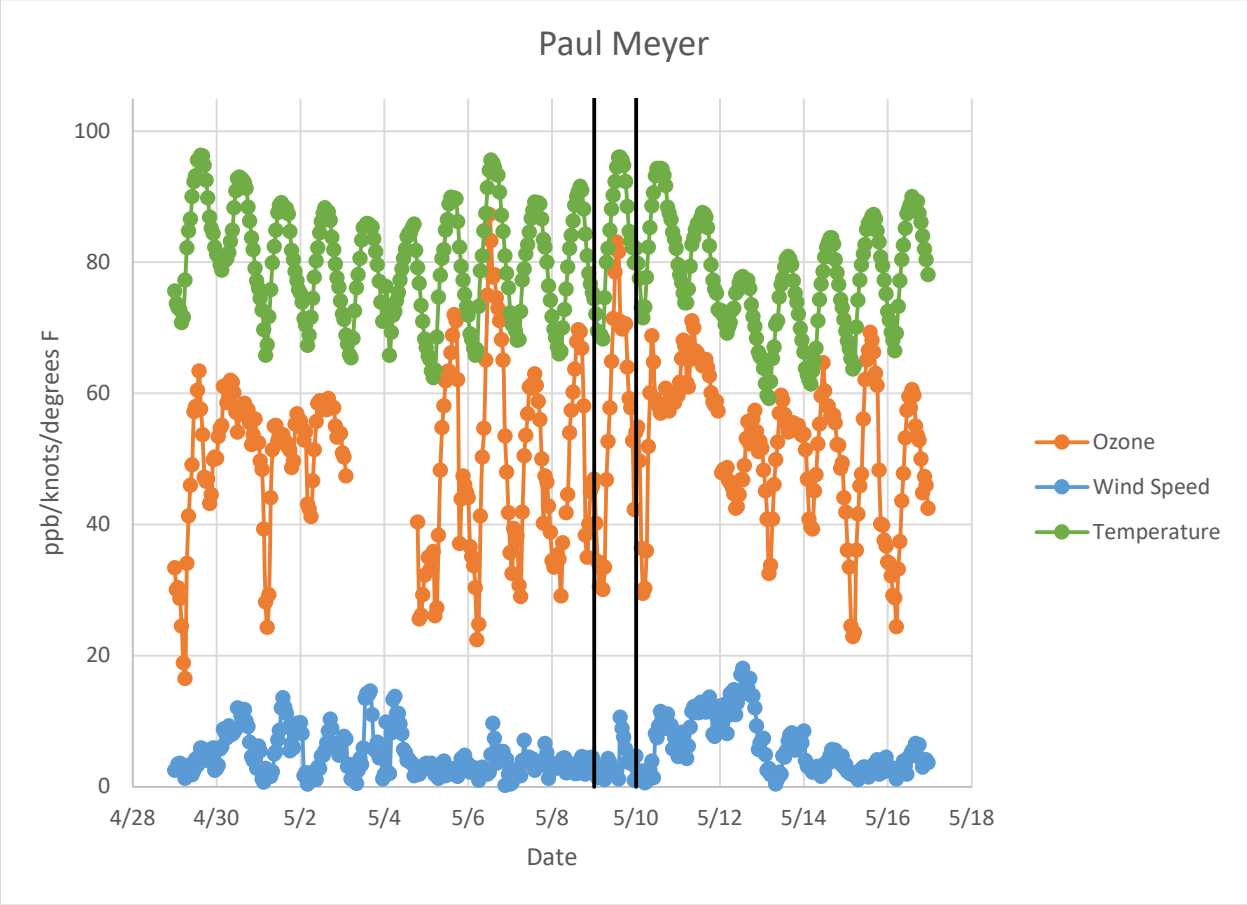
* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

Figure A11: Hourly O_3, wind speed, and temperature values from AQS* for the Walter Johnson monitoring site from April 29, 2020 through May 16, 2020.

The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am, respectively.

* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 7/29/2021

Figure A12: Hourly O_3, wind speed, and temperature values from AQS* for the Paul Meyer monitoring site from April 29, 2020 through May 16, 2020.



The two black vertical lines represent May 9, 2020 12:00 am and May 10, 2020 12:00 am, respectively.

* Values from the EPA's Air Quality System (AQS) database, AMP501 report pulled 8/3/2021

Figure A13: O_3 Monitoring Sites In and Around the LVV.

Table A1: MDA8 O_3 (ppb) at Clark County O_3 Monitors for April 23 and May 13, 2017, and May 9, 2020.

Monitor	Name	In LVV	April 23, 2017 MDA8*	May 13, 2017 MDA8*	May 9, 2020 MDA8*
32-003-0022	Apex		66	63	65
32-003-0023	Mesquite		63	62	59
32-003-0043	Paul Meyer	X	65	65	74
32-003-0071	Walter Johnson	X	67	66	71
32-003-0073	Palo Verde	X	65	65	64
32-003-0075	Joe Neal	X	65	63	70
32-003-0298	Green Valley	X	67	63	69
32-003-0540	Jerome Mack	X	62	63	64
32-003-0601	Boulder City		67	68	66
32-003-1019	Jean		64	58	68
32-003-7772	Indian Springs		65	57	66

* Values from the EPA's Air Quality System (AQS) database, AMP350NW reports pulled 7/8/2021 and 1/14/2022

Table A2: Maximum 1-hour O_3 (ppb) at Clark County O_3 Monitors for April 23 and May 13, 2017, and May 9, 2020.

Monitor	Name	In LVV	April 23, 2017 Max 1-hour*	May 13, 2017 Max 1-hour*	May 9, 2020 Max 1-hour*
32-003-0022	Apex		70	71	71
32-003-0023	Mesquite		68	65	66
32-003-0043	Paul Meyer	X	67	73	83
32-003-0071	Walter Johnson	X	70	75	79
32-003-0073	Palo Verde	X	69	70	71
32-003-0075	Joe Neal	X	67	69	81
32-003-0298	Green Valley	X	70	68	74
32-003-0540	Jerome Mack	X	66	70	71
32-003-0601	Boulder		71	72	72
32-003-1019	Jean		67	60	74
32-003-7772	Indian Springs		68	60	69

* Values from the EPA's Air Quality System (AQS) database, AMP350 reports pulled 1/19/2022 and 2/10/2022

Table A3: Comparison of Wind Speeds (WS)* – April 23 and May 13, 2017, May 9, 2020.

Time	WS (mph) 4/23/2017	WS (mph) 5/13/2017	WS (mph) 5/9/2020
12:53 AM	3	14	3
1:53 AM	0	17	0
2:53 AM	0	29	6
3:53 AM	6	24	5
4:53 AM	0	13	7
5:53 AM	0	23	0
6:53 AM	8	25	3
7:53 AM	9	23	5
8:53 AM	16	20	5
9:53 AM	18	18	8
10:53 AM	22	8	10
11:53 AM	20	3	0
12:53 PM	23	5	5
1:53 PM	22	3	7
2:53 PM	13	9	12
3:53 PM	26	8	15
4:53 PM	18	0	17
5:53 PM	16	5	12
6:53 PM	13	9	8
7:53 PM	15	8	6
8:53 PM	13	3	5
9:53 PM	10	0	3
10:53 PM	3	10	7

miles per hour (mph)
* data for North Las Vegas Airport Station, from Weather Underground
https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2017-4-23
https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2017-5-13
https://www.wunderground.com/history/daily/us/nv/north-las-vegas/KVGT/date/2020-5-9

Table A4: MDA8 O_3 (ppb) at Clark County Monitoring Locations for May 9, 2020.

Clark County O_3 Monitors					
Monitor	**Name**	**Date (2020)**	**In LVV**	**MDA8 (ppb)***	**MDA8 Hours***
32-003-0022	Apex	5/9		65	1100-1800
32-003-0023	Mesquite	5/9		59	1000-1700
32-003-0043	**Paul Meyer**	5/9	X	74	1100-1800
32-003-0071	**Walter Johnson**	5/9	X	71	1100-1800
32-003-0073	Palo Verde	5/9	X	64	1000-1700
32-003-0075	Joe Neal	5/9	X	70	1100-1800
32-003-0298	Green Valley	5/9	X	69	1000-1700
32-003-0540	Jerome Mack	5/9	X	64	1000-1700
32-003-0601	Boulder City	5/9		66	1000-1700
32-003-1019	Jean	5/9		68	0900-1600
32-003-7772	Indian Springs	5/9		66	1200-1900

Yellow highlight indicates an MDA8 O_3 exceedance >70 ppb

Monitors in **bold** included in 5/9/2020 demonstration

* Values from the EPA's Air Quality System (AQS) database, AMP350NW report pulled 7/8/2021

Table A5: MDA8 O_3 (ppb) at NPS O_3 Monitors Surrounding the LVV, for May 8 and 9, 2020.

Surrounding Area O_3 Monitors Outside of LVV					
Monitor	**Name**	**Date (2020)**		**MDA8 (ppb)***	**MDA8 Hours***
32-033-0101	Great Basin NP	5/8	NE of LVV	49	0600-1300
32-033-0101	Great Basin NP	5/9	NE of LVV	55	0900-1600
06-027-0101	Death Valley NP	5/8	W of LVV	62	1400-2100
06-027-0101	Death Valley NP	5/9	W of LVV	73	0800-1500
06-071-1001	Mojave Nat Pres.	5/8	SW of LVV	78	1800-0100
06-071-1001	Mojave Nat Pres.	5/9	SW of LVV	75	1000-1700
04-005-8001	Grand Canyon NP	5/8	E of LVV	57	1300-2000
04-005-8001	Grand Canyon NP	5/8	E of LVV	64	1500-2200

* Values from the EPA's Air Quality System (AQS) database, AMP350NW report pulled 9/7/2021