Appendix A. Supporting Media Coverage for Section 3.1.4

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NEWS

Smoke, ozone advisory issued for Thursday and Friday due to wildfires

A plume billows over Healdsburg, Calif., as the LNU Lightning Complex fires burn on Thursday, Aug. 20, 2020. Fire crews across the region scrambled to contain dozens of wildfires sparked by lightning strikes. (AP Photo/Noah Berger)

by: 8NewsNow staff

Posted: Sep 3, 2020 / 10:35 AM PDT / Updated: Sep 3, 2020 / 10:35 AM PDT

LAS VEGAS (KLAS) — The Clark County Department of Environment and Sustainability (DES) is issuing an advisory for Thursday, Sep. 3 to Friday, Sep. 4 for elevated levels of smoke and ozone due to the regional wildfires in the southwest.

Figure A-1. Article entitled "Smoke, ozone advisory issued for Thursday and Friday due to wildfires" (https://www.8newsnow.com/news/smoke-ozone-advisory-issued-for-thursday-and-friday-due-to-wildfires/). Article released by 8 News Now, a local Las Vegas news station, on September 3, 2020.

by: 8NewsNow staff

Posted: Sep 3, 2020 / 10:35 AM PDT / Updated: Sep 3, 2020 / 10:35 AM PDT

LAS VEGAS (KLAS) — The Clark County Department of Environment and Sustainability (DES) is issuing an advisory for Thursday, Sep. 3 to Friday, Sep. 4 for elevated levels of smoke and ozone due to the regional wildfires in the southwest.

DES Division of Air Quality officials say smoke is made of small dust particles and other pollutants that can aggravate respiratory diseases and contribute to ground-level ozone formation.

According to the U.S. Environmental Protection Agency (EPA), people who may be most sensitive to elevated levels of particulates and ozone include individuals with respiratory problems, cardiac disease, young children, or senior citizens.

The EPA recommends consulting your physician if you have a medical condition that makes you sensitive to air quality conditions.

Smoke is made of small particles and other pollutants that can aggravate respiratory diseases and contribute to ground-level ozone formation. Exposure to ozone can induce coughing, wheezing and shortness of breath even in healthy people.

SMOKE AND OZONE TIPS

- Stay indoors when you smell or see smoke.
- Limit outdoor activity and exertion when ozone levels are elevated – exercise makes you breathe heavier and increases the number of particulates you may inhale.
- Keep windows and doors closed. Run your air conditioner inside your house and car. Air conditioning filters out smoke and particles.
- Change your indoor air filters if they are dirty.
- Schedule activities for the morning or evening when ozone levels are usually lower.
- Substitute a less intense activity – walk instead of jog, for example.
- Reduce driving – combine errands into one trip.
- Don't idle your car engine unnecessarily.
- Use mass transit or carpool.
- Fill up your gas tank after sunset. Try not to spill gasoline when filling up, and don't top off your tank.
- Keep your car well maintained.
- Consider landscaping that uses less water and gas-powered equipment to maintain.
- Turn off lights and electronics when not in use. Less fuel burned at power plants means cleaner air.

A seasonal ozone advisory is currently in effect.

Figure A-1 (Cont.). Article entitled "Smoke, ozone advisory issued for Thursday and Friday due to wildfires" (https://www.8newsnow.com/news/smoke-ozone-advisory-issued-for-thursday-and-friday-due-to-wildfires/). Article released by 8 News Now, a local Las Vegas news station, on September 3, 2020.

California fires: NASA satellites reveal poor air quality for large swathes of US

CALIFORNIA is experiencing one of the worst wildfire seasons it has ever seen according to NASA, and the space agency has warned that large swathes of the US are now experiencing poor air quality which could be detrimental to health.

By SEAN MARTIN
PUBLISHED: 06:54, Thu, Sep 3, 2020 | UPDATED: 07:51, Thu, Sep 3, 2020

Figure A-2. Article entitled "California fires: NASA Satellites reveal Poor Air Quality for Large Swathes of US", reported by The Express on September 2, 2020 (https://www.express.co.uk/news/science/1330408/california-fires-map-nasa-satellite-images-wildfires-2020-space).

CALIFORNIA is experiencing one of the worst wildfire seasons it has ever seen according to NASA, and the space agency has warned that large swathes of the US are now experiencing poor air quality which could be detrimental to health.

NASA is using several instruments to monitor the California fires, which continue to blaze across the southwestern state. One such instrument NASA is using is its Multi-angle Imaging SpectroRadiometer (MISR) onboard the Terra satellite.

MISR can highlight how far and high smoke particles are travelling.

By analysing the data, NASA has warned the surrounding states of California, such as Nevada, Oregon and Idaho, are now experiencing poor air quality.

The space agency said: "The smoke plumes generated by the California fires have travelled across vast swaths of western North America in recent weeks, affecting air quality and visibility.

"Airborne smoke particles can increase the risk of cardiovascular and respiratory disease when inhaled, so tracking their spread provides valuable information for local public health officials."

California fires: NASA satellites reveal poor air quality for large swathes of US (Image: GETTY)

Figure A-2 (Cont.). Article entitled "California fires: NASA Satellites reveal Poor Air Quality for Large Swathes of US", reported by The Express on September 2, 2020 (https://www.express.co.uk/news/science/1330408/california-fires-map-nasa-satellite-images-wildfires-2020-space).

Appendix B. Extended Emissions Transport Analysis

To further investigate the transport of emissions from the fires identified in this demonstration, an extended analysis was conducted to investigate emissions and transport of smoke from fires over more than 24 hours. This extended analysis is similar to the analysis presented in Section 3.2.1, Key Factor #1: Q/d Analysis, but includes transport of wildfire smoke emissions for additional days prior to the event (August 30 and 31). This extended analysis was conducted because HYSPLIT modeling, presented in Section 3.1.3, suggests smoke transport from additional fires over a period of more than 24 hours; these fires, the Dolan Fire and SCU Lightning Complex, are included in the analysis. We refer to the resulting value calculated using the 48-hour back trajectories and emissions estimates from prior days as "Extended Q/d" to distinguish these results with the Q/d calculated in accordance with EPA guidance. The Extended Q/d and Q/d are unlikely to be directly comparable to one another due to differences in ozone photochemistry over varying time scales (Jaffe and Wigder, 2012).

The 48-hour HYSPLIT back trajectories and their uncertainty buffers show that transport likely occurred from all identified fires to the exceeding monitors in Clark County (**Figure B-1**). The total emissions from the fires were significant on August 31 (**Table B-1**) and August 30 (**Table B-2**). These extended analyses provide evidence that additional fires (the Dolan Fire and SCU Lightning Complex) emitted ozone precursors in the days leading up to September 2, 2020, including August 30 and 31, and that emissions transport from these and the other identified fires contributed to the wildfire smoke event in Clark County, NV.

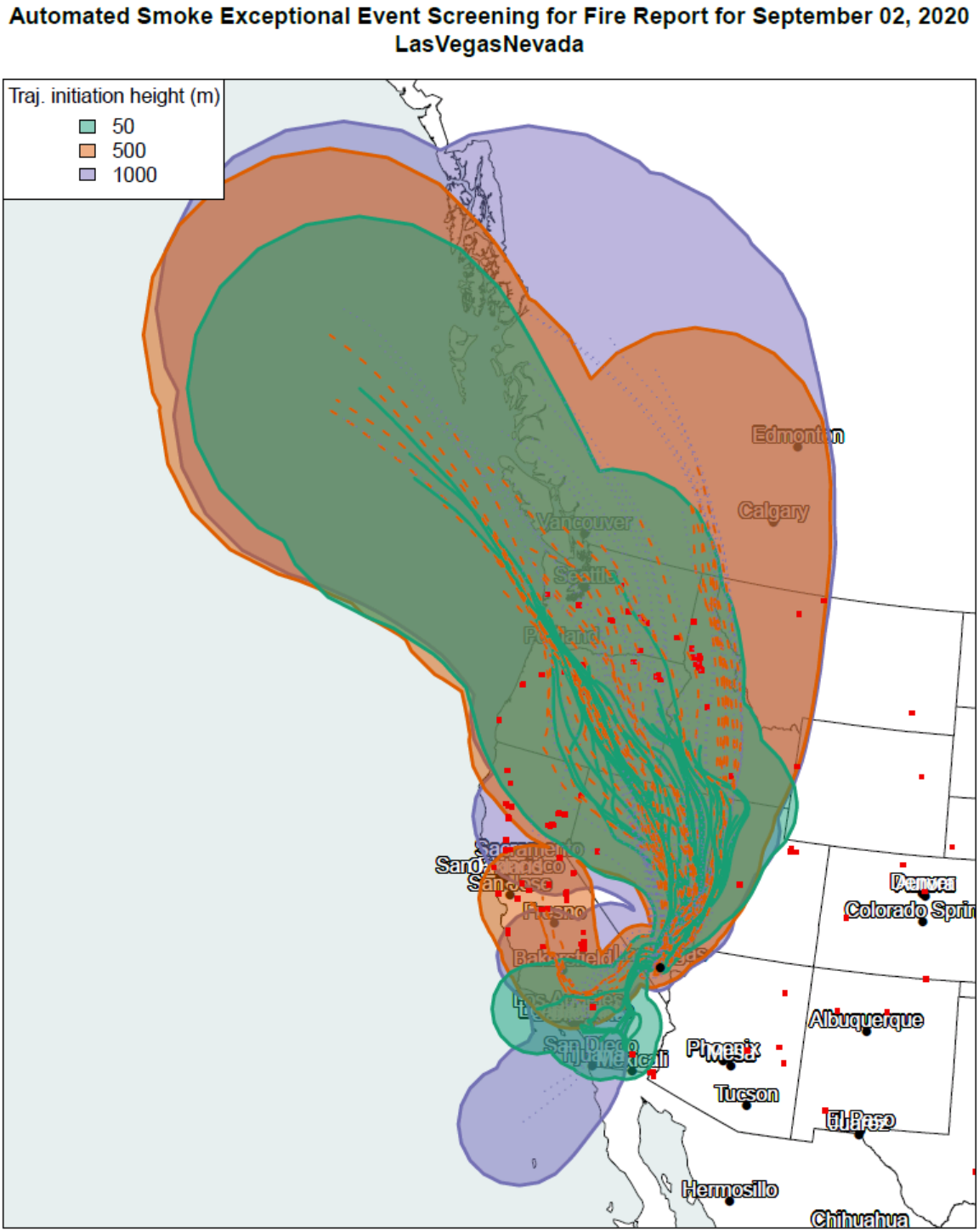


Figure B-1. 48-hour back trajectories for September 2, 2020. Trajectories are shown as solid or dotted lines. The starting height of the back trajectory is indicated by the color. Uncertainty buffers, calculated as 25% of the distance traveled by the trajectory, are shown in colored polygons. Active fires on September 2 are shown as red squares. Fires falling within one or more uncertainty buffer(s) were used to calculate individual and aggregate emissions impact values.

Table B-1. Daily growth, emissions, and Extended Q/d for the fires with potential smoke contribution on August 31, 2020. Growth for all dates were obtained from agency estimates available from the Incident Information System (InciWeb), CAL FIRE, or media reports. Aggregate Q/d calculated for all fires shown is 13.0. Column "E (Tons)" represents the sum of NO_x and Reactive VOC emissions.

Fire Name	Area (Acres)	Daily Growth (Acres)	NO_x (Tons)	VOCs (Tons)	Reactive VOCs (Tons)	E (Tons)	Distance (Km)	Extended Q/d (Tons/km)	Fuel Loading	Fire Size Data Source
White River Fire	15,411	0	0.0	0.0	0.0	0.0	1,138	0.0	Grand fir-Douglas fir forest	https://inciweb.nwcg.gov/incident/7013/
Lionshead Fire	7,965	568	21.9	920.5	552.3	574.2	1,098	0.5	Douglas-fir-western hemlock-western redcedar/vine maple forest	https://inciweb.nwcg.gov/incident/7050/
Red Salmon Complex	25,878	1,909	61.6	1,787.6	1,072.5	1,134.2	907	1.3	Douglas-fir-madrone-tanoak forest	https://inciweb.nwcg.gov/incident/6891/
August Complex	242,941	6,653	136.4	4,378.5	2,627.1	2,763.5	772	3.6	Jeffrey pine-ponderosa pine-Douglas-fir-California black oak forest	https://inciweb.nwcg.gov/incident/6983/
North Complex	62,275	258	9.3	350.8	210.5	219.8	665	0.3	Douglas-fir-madrone-tanoak forest	https://inciweb.nwcg.gov/incident/6997/
Dolan Fire	29,550	116	2.6	19.6	11.8	14.4	580	0.0	California live oak-blue oak woodland	https://inciweb.nwcg.gov/incident/7018/
SCU Lightning Complex	391,150	7,993	2.9	14.4	8.6	11.5	570	0.0	Wheatgrass-cheatgrass grassland	https://www.fire.ca.gov/incidents/2020/8/18/scu-lightning-complex/
Slink Fire	8,300	2,669	63.2	2,281.9	1,369.2	1,432.3	470	3.0	Ponderosa pine-Jeffrey pine forest	https://inciweb.nwcg.gov/incident/7105/
SQF Fire	37,728	2,054	91.6	3,343.9	2,006.3	2,097.9	296	7.1	Red fir forest	https://www.kerntoday.com/september-1st-update-sqf-complex-at-37728-acres/

Table B-2. Daily growth, emissions, and Q/d for the fires with potential smoke contribution on August 30, 2020. Growth for all dates shown were obtained from agency estimates available from the Incident Information System (InciWeb), CAL FIRE, or media reports. Aggregate Q/d calculated for all fires shown is 20.3. Column "E (Tons)" represents the sum of NO_x and Reactive VOC emissions.

Fire Name	Area (Acres)	Daily Growth (Acres)	NO_x (Tons)	VOCs (Tons)	Reactive VOCs (Tons)	E (Tons)	Distance (Km)	Q/d (Tons/km)	Fuel Loading	Fire Size Data Source
White River Fire	15,418	1,027	50.5	2,079.0	1,247.4	1,297.8	1,138	1.1	Grand fir-Douglas fir forest	https://inciweb.nwcg.gov/incident/7013/
Lionshead Fire	7,397	786	30.4	1,273.8	764.3	7,94.6	1,098	0.7	Douglas-fir-western hemlock-western redcedar/vine maple forest	https://inciweb.nwcg.gov/incident/7050/
Red Salmon Complex	23,969	748	24.2	700.4	420.3	444.4	907	0.5	Douglas-fir-madrone-tanoak forest	https://inciweb.nwcg.gov/incident/6891/
August Complex	236,288	15,004	307.7	9,874.4	5,924.6	6,232.3	772	8.1	Jeffrey pine-ponderosa pine-Douglas-fir-California black oak forest	https://inciweb.nwcg.gov/incident/6983/
North Complex	62,017	2,113	76.5	2,873.1	1,723.9	1,800.4	665	2.7	Douglas-fir-madrone-tanoak forest	https://inciweb.nwcg.gov/incident/6997/
Dolan Fire	29,434	3,847	86.7	649.9	389.9	476.7	580	0.8	California live oak-blue oak woodland	https://inciweb.nwcg.gov/incident/7018/
SCU Lightning Complex	383,157	5,000	1.8	9.0	5.4	7.2	570	0.0	Wheatgrass-cheatgrass grassland	https://www.fire.ca.gov/incidents/2020/8/18/scu-lightning-complex/
Slink Fire	5,631	4,131	94.3	3,354.8	2,012.9	2,107.2	470	4.5	Ponderosa pine-Jeffrey pine forest	https://inciweb.nwcg.gov/incident/7105/
SQF Fire	35,674	1,391	62.0	2,264.5	1,358.7	1,420.7	296	4.8	Red fir forest	https://www.kerntoday.com/september-1st-update-sqf-complex-at-37728-acres/

Reference

Jaffe D.A. and Wigder N.L. (2012) Ozone production from wildfires: a critical review. *Atmospheric Environment*, 51, 1-10, May. Available at https://www.sciencedirect.com/science/article/pii/S1352231011012507.

Appendix C. Supporting Figures and Documents for Section 3.3.2

Identification of matching meteorologically similar days includes a comparison of meteorology maps between September 2, 2020, and each date subset from candidate matching days. Surface and upper-level maps for September 2, 2020, and each date listed in Table 3-14 (see Section 3.3.2) show highly consistent conditions. All dates show a surface low pressure system over Clark County. Surface maps for September 2, 2020, and each date in Table 3-14 are shown in **Figure B-1 through B-7**. Upper-level maps show a very low gradient of height contours at 500 mb and an upper-level region of high pressure over Clark County. 500 mb maps for September 2, 2020, and each date in Table 3-14 are shown in **Figure B-8 through B-14**.

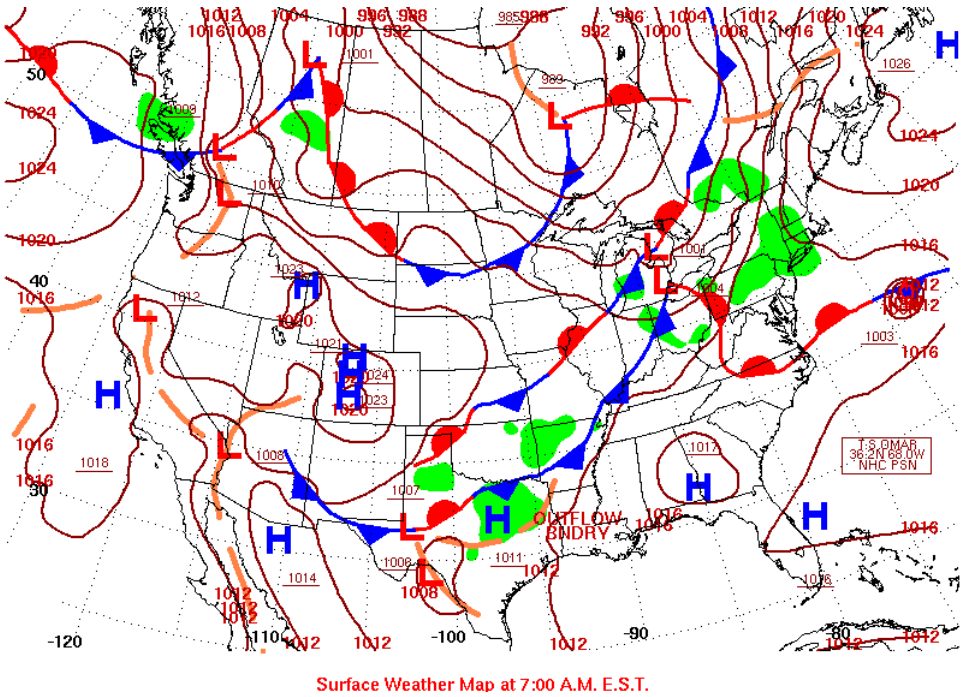


Figure B-1. Surface meteorology map on September 2, 2020 (the event date).

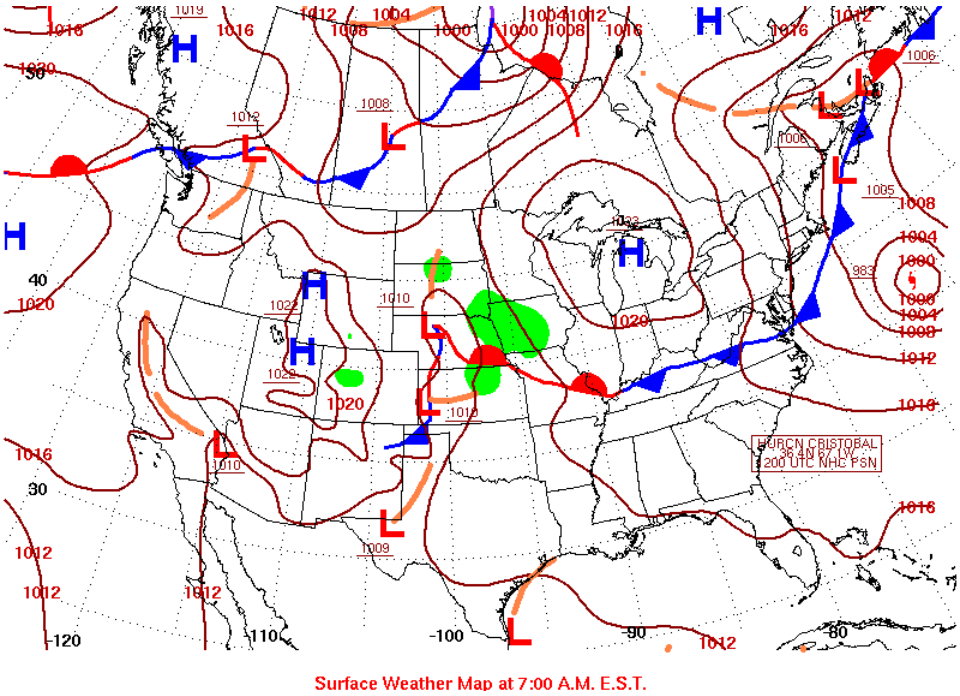


Figure B-2. Surface meteorology map on August 28, 2014.

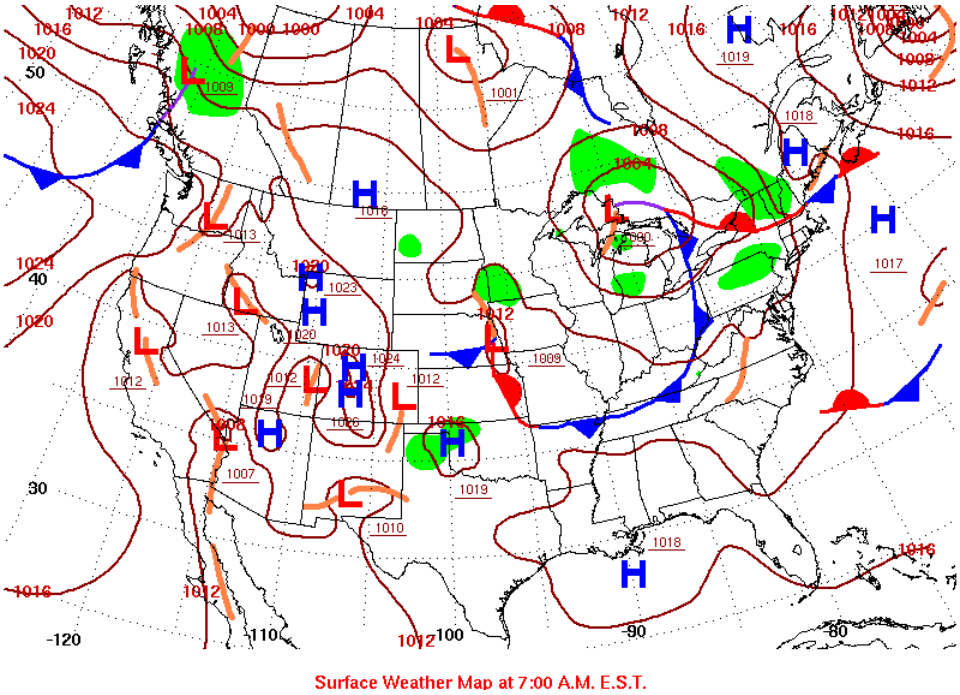


Figure B-3. Surface meteorology map on August 18, 2017.

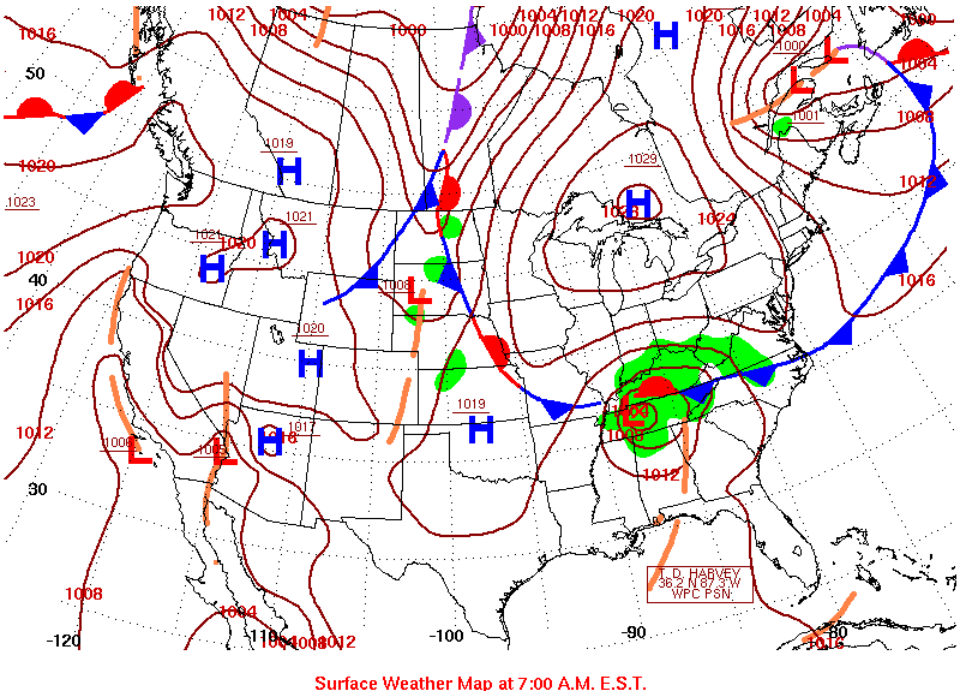


Figure B-4. Surface meteorology map on September 1, 2017.

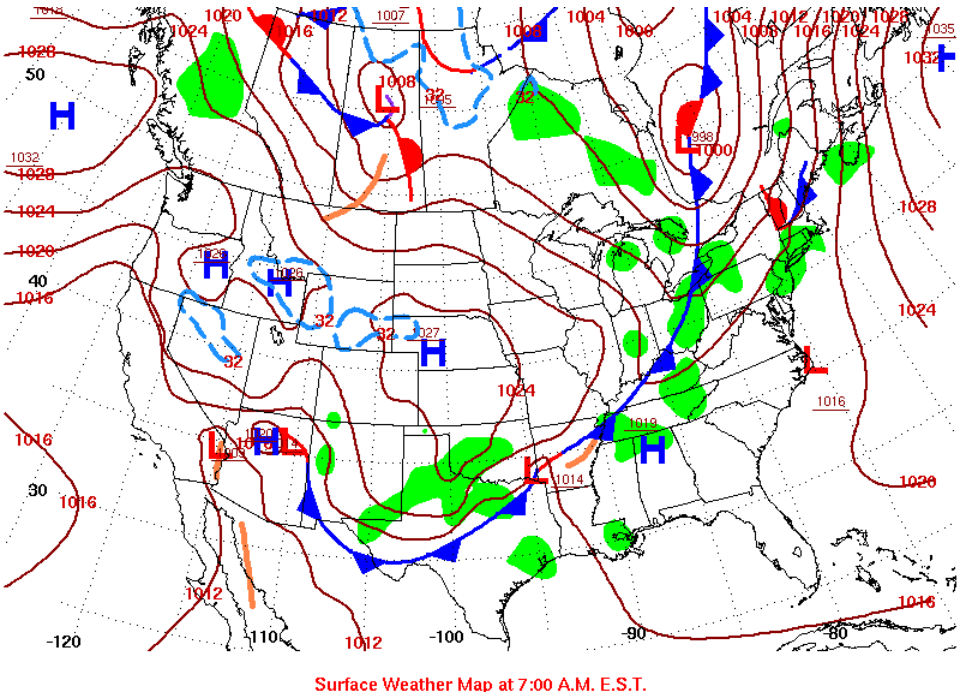


Figure B-5. Surface meteorology map on September 26, 2018.

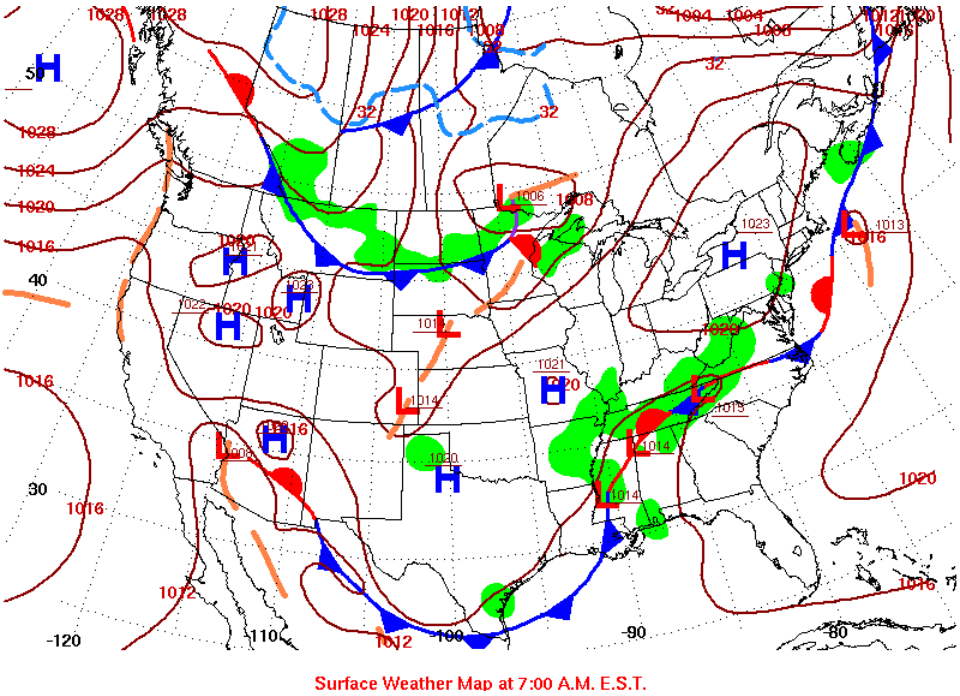


Figure B-6. Surface meteorology map on September 27, 2018.

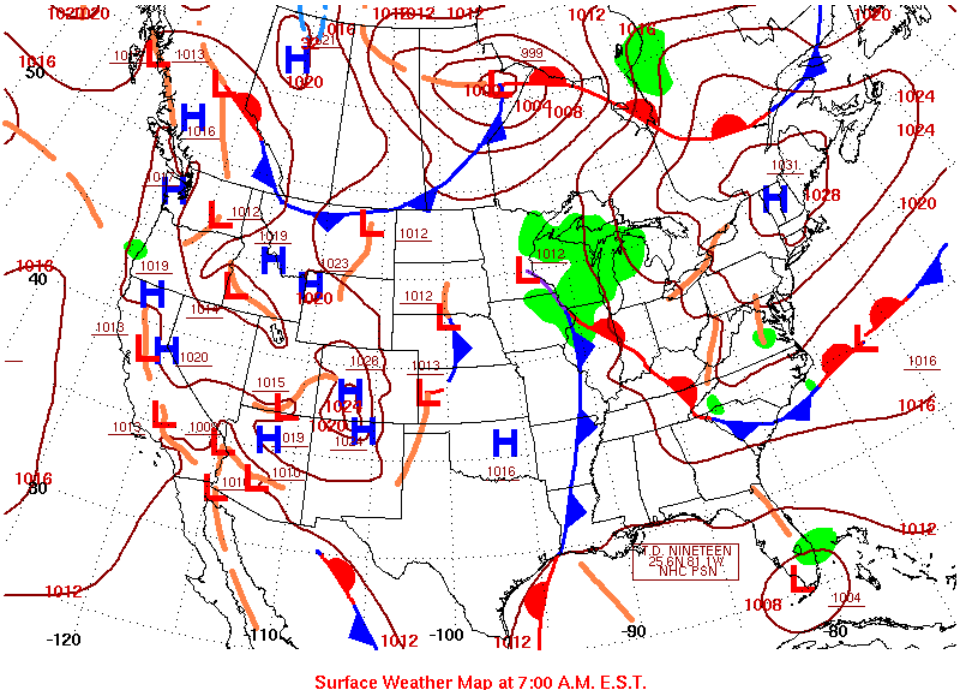


Figure B-7. Surface meteorology map on September 12, 2020.

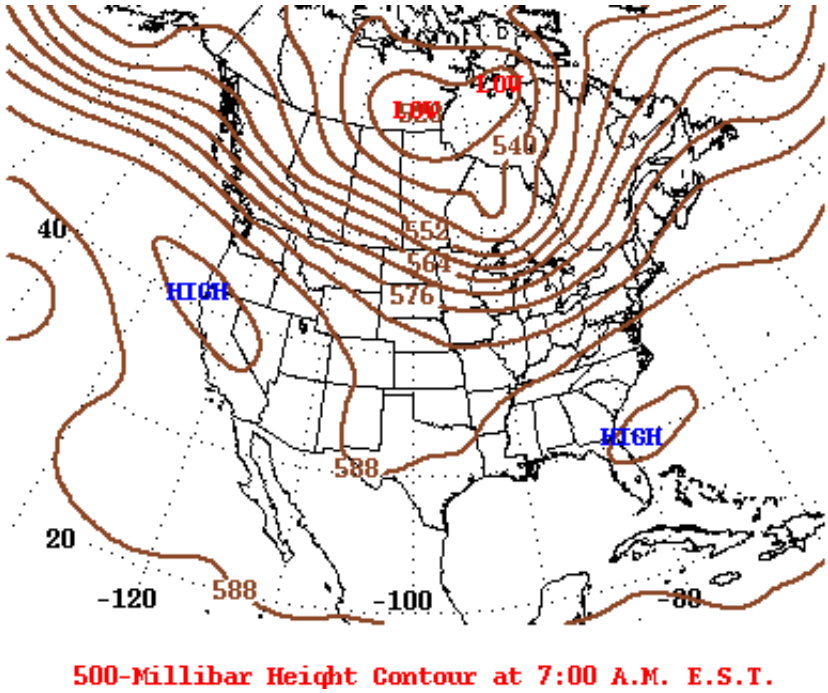


Figure B-8. 500 mb meteorology map on September 2, 2020 (the event date).

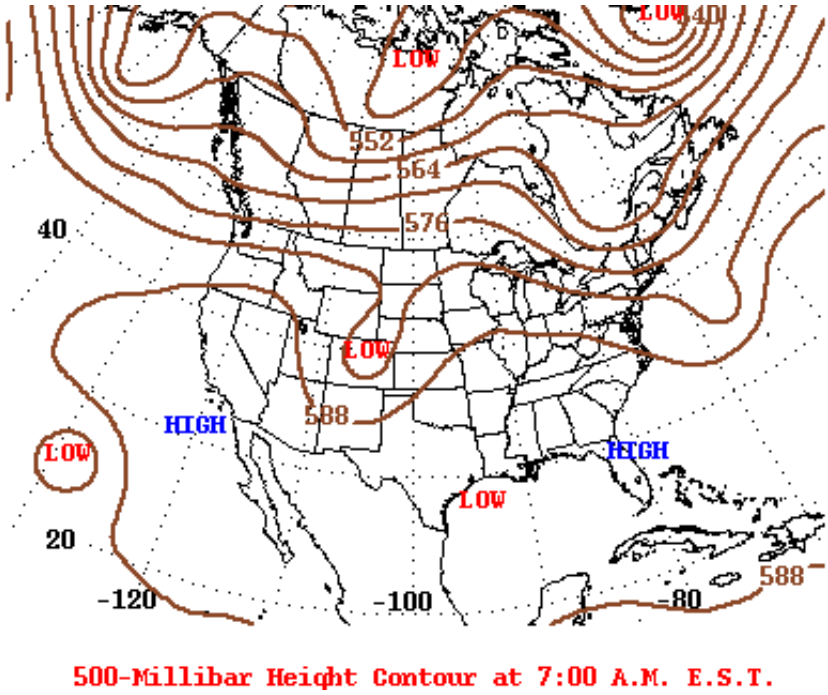


Figure B-9. 500 mb meteorology map on August 28, 2014.

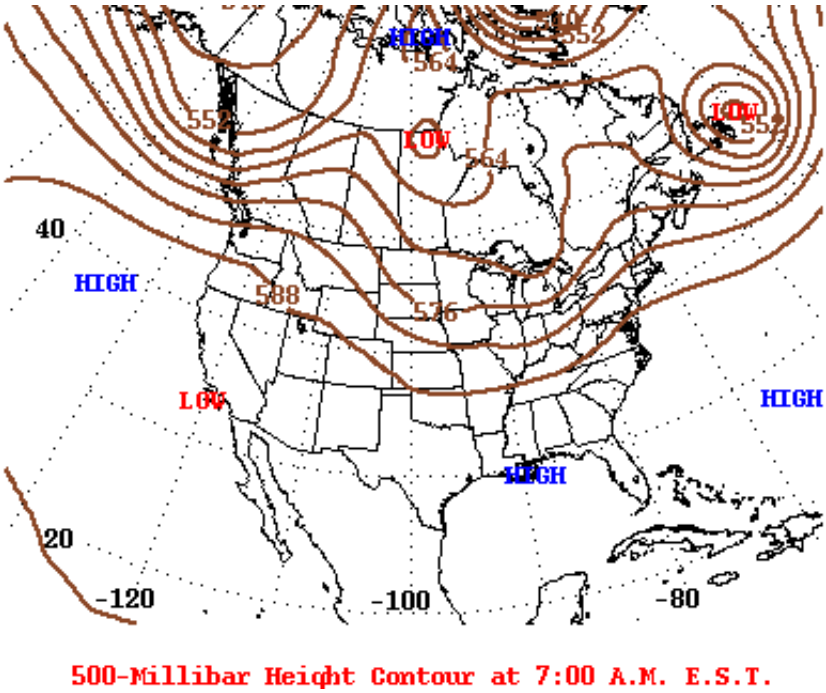


Figure B-10. 500 mb meteorology map on August 18, 2017.

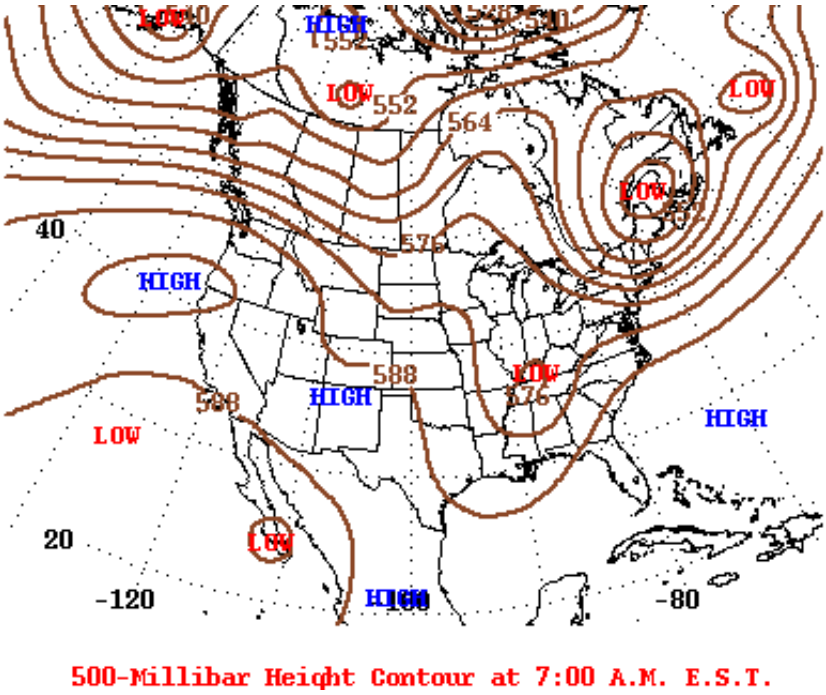


Figure B-11. 500 mb meteorology map on September 1, 2017.

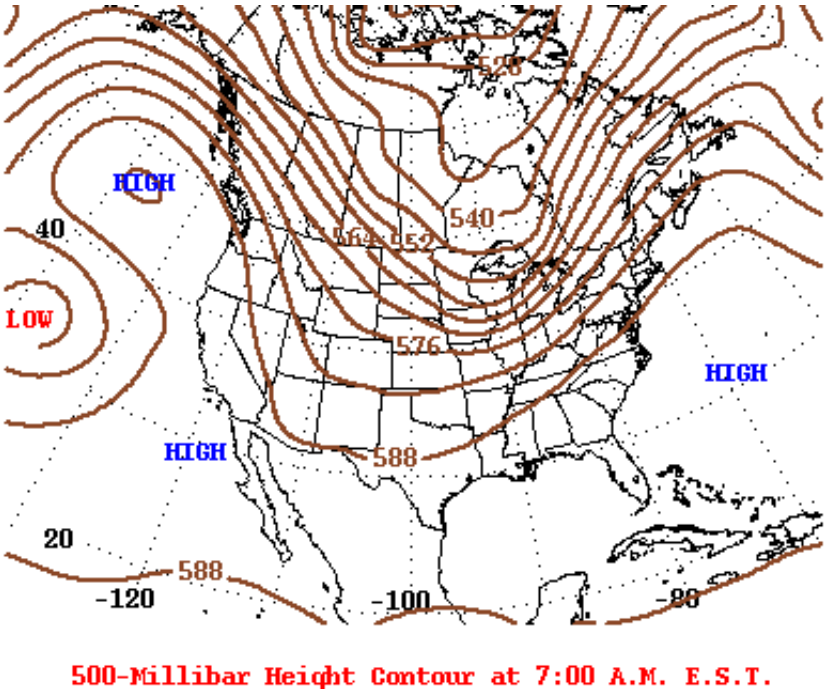


Figure B-12. 500 mb meteorology map on September 26, 2018.

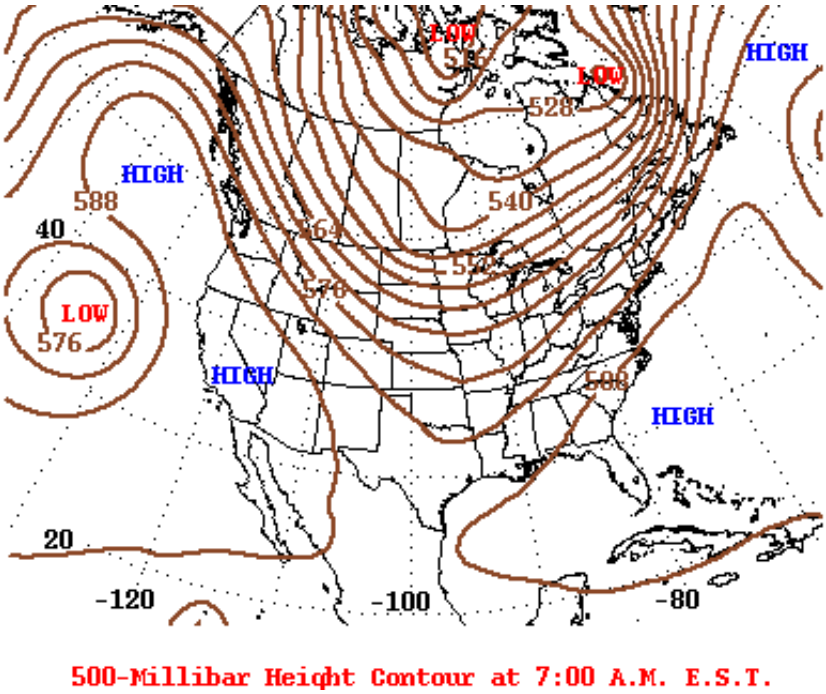


Figure B-13. 500 mb meteorology map on September 27, 2018.

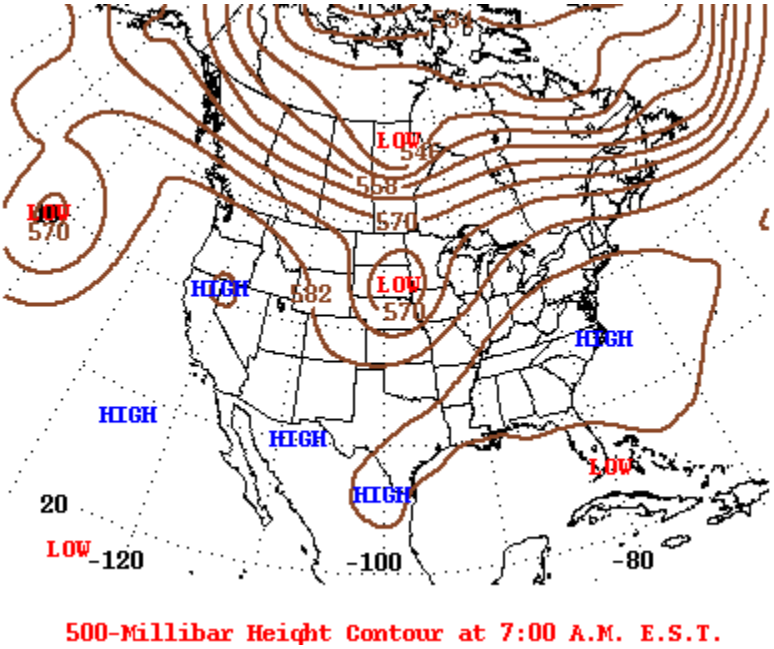


Figure B-14. 500 mb meteorology map on September 12, 2020.

Appendix D. GAM Residual Histograms and Scatter Plots from Concurred Exceptional Event Demonstrations

The following are GAM residual histograms and scatter plots from the concurred Arizona Department of Environmental Quality demonstration (Arizona Department of Environmental Quality 2016) and the submitted Texas Commission on Environmental Quality demonstration (Texas Commission on Environmental Quality 2021) for comparison with our GAM residual analysis. The figures in this Appendix show the good residual results from concurred and currently submitted exceptional events demonstrations to which we compared our results. Based on this comparison, we suggest that our GAM results show a well-fit, unbiased model. A well-fit GAM model should show a normal distribution of residuals at all sites modeled (ADEQ example in **Figure D-1**) and show no pattern or bias between GAM residuals and predicted values (TCEQ example in **Figure D-2**). These figures compare well with our GAM results in Section 3.3.3 of the main report.

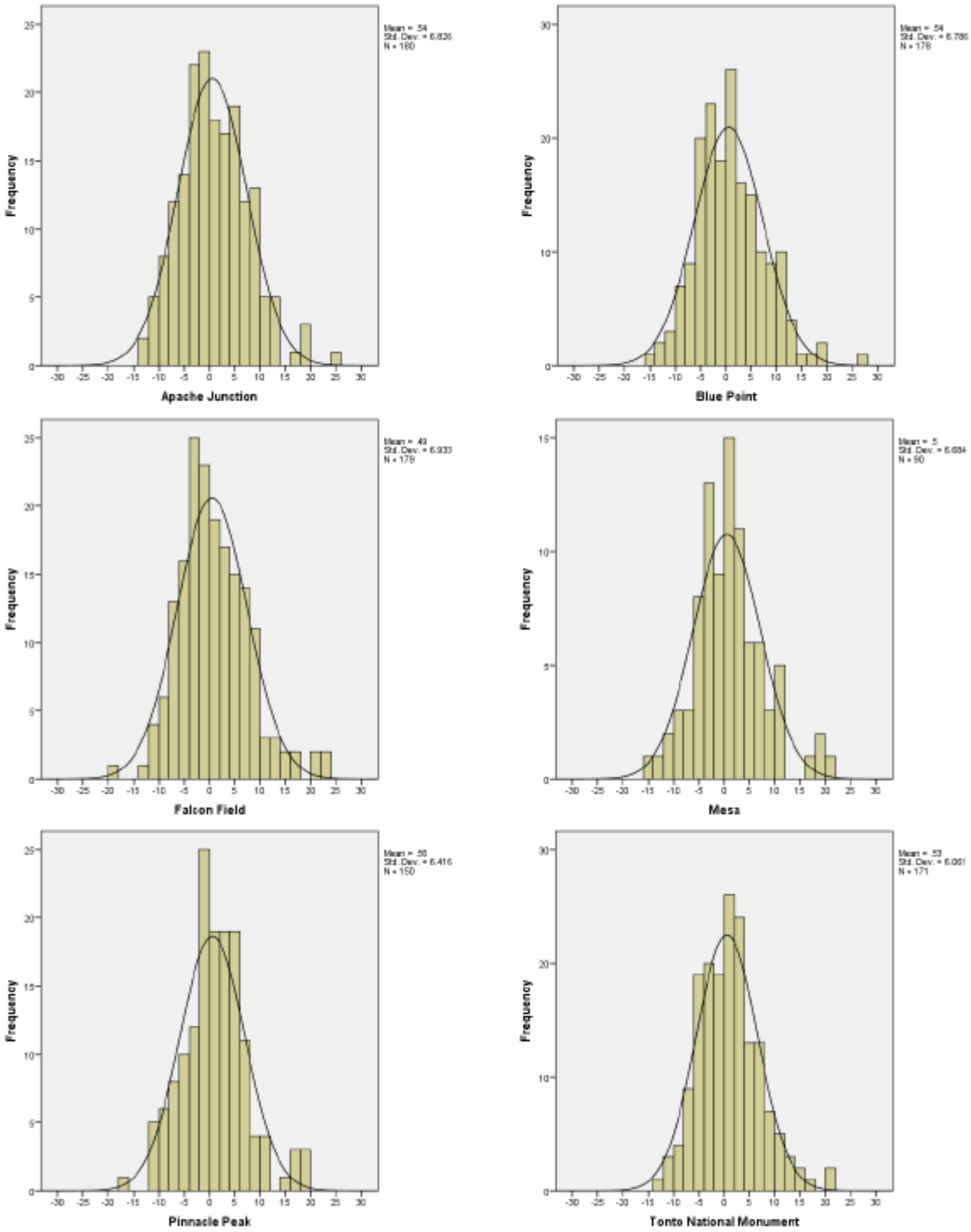


Figure D-1. Histograms of residuals results at each monitoring site from the Arizona DEQ GAM Analysis (Arizona Department of Environmental Quality 2016).

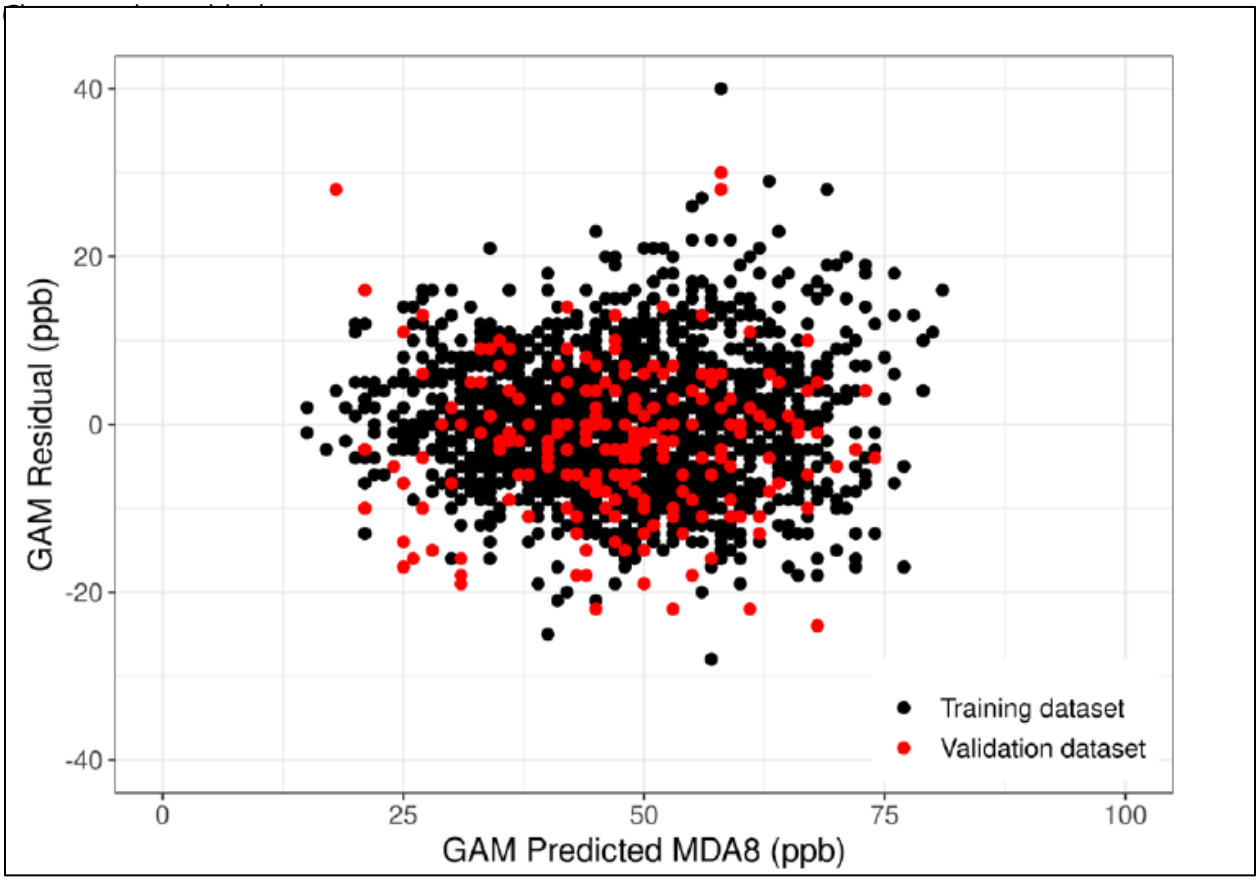


Figure D-2. Scatter plot of GAM residuals (observed – GAM predicted MDA8 ozone) vs. GAM predicted MDA8 ozone from the TCEQ submitted GAM analysis. Training data is shown in black and validation data is shown in red (Texas Commission on Environmental Quality 2021).

References

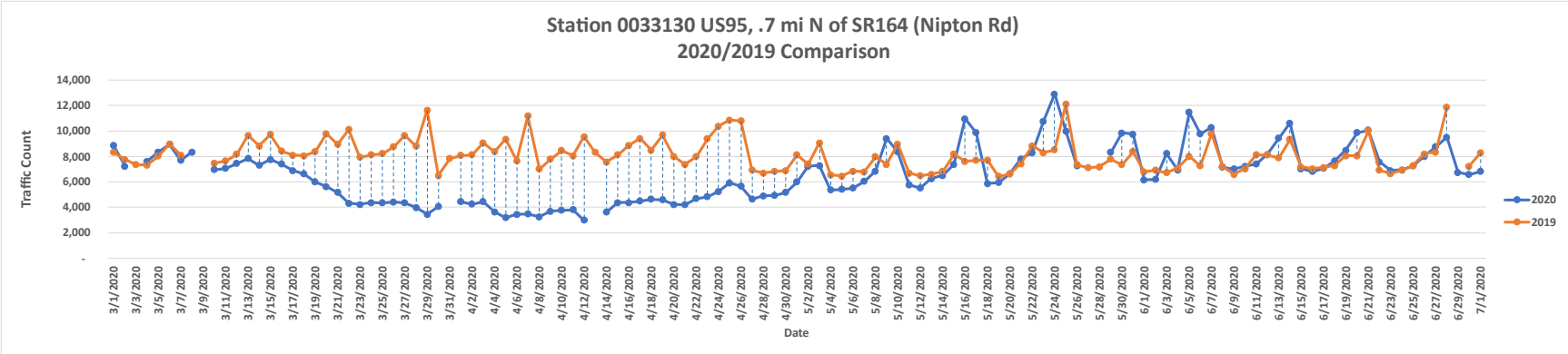
Arizona Department of Environmental Quality (2016) State of Arizona exceptional event documentation for wildfire-caused ozone exceedances on June 20, 2015 in the Maricopa nonattainment area. Final report, September. Available at https://static.azdeq.gov/pn/1609_ee_report.pdf.

Texas Commission on Environmental Quality (2021) Dallas-Fort Worth area exceptional event demonstration for ozone on August 16, 17, and 21, 2020. April. Available at https://www.tceq.texas.gov/assets/public/airquality/airmod/docs/ozoneExceptionalEvent/2020-DFW-EE-Ozone.pdf.

Appendix E. Analysis of COVID Restrictions on Ozone

Mobile emission sources decreased throughout the U.S. during the mobility restrictions for the COVID-19 pandemic beginning in mid-March 2020. Because decreases in nitrogen oxides (NO_x) emissions from mobile sources could result in higher ozone concentrations, we evaluated the potential contribution and sensitivity of the COVID-19 shutdown effects on ozone concentrations and MDA8 ozone on exceptional event (EE) days. Ozone production has non-linear dependence on precursor emissions of NO_x and volatile organic compounds (VOCs), as well as meteorological conditions. Changes in precursors also shift photochemical regimes. Thus, the effects of COVID-induced NO_x emission changes on ozone are complex and uncertain (Kroll et al., 2020). Recent studies have found variable ozone responses during lockdowns across countries, with responses ranging from −2 to +10% (Venter et al., 2020). Park et al., 2020 found spatially disparate effects of higher ozone concentrations downwind of Los Angeles and lower concentrations in the western LA basin. To evaluate the potential influence of COVID-19 shutdown precursor emission decreases or increases in MDA8 ozone, we compared ozone concentrations in May 2020 to the historical climatology, and compared the GAM residuals from May 2020 with those for the same historical record.

Based on 2017 emission inventories in Las Vegas, on-road mobile sources comprise 40% of NO_x emissions and total mobile (vehicle + aviation) emissions comprise 88% of total NO_x emissions for typical ozone season weekday (SIP Plan Revision, Clark County 2015). In contrast, only 11% of VOC emissions originate from on-road mobile sources. The effects of decreased mobility due to COVID restrictions has a significant effect on total NOx emissions, but minimal effect on VOC emissions. To determine the time period for these effects, we compared 2020 daily traffic count data from the Nevada Department of Transportation with that from 2019 across 10 monitoring sites (two examples in **Figure D-1**). On-road traffic activity was significantly reduced from mid-March through early-June 2020 in Clark County compared with 2019. Although aviation activity remained lower than pre-pandemic levels for a longer duration of 2020, commercial aviation represents only 12% of NO_x emissions in Clark County. Thus, the reduced aviation activity had a minimal influence on the precursors available for ozone formation from mid-June 2020 onwards. In this section, we focus on May 2020, the first month of 2020 with EE days.



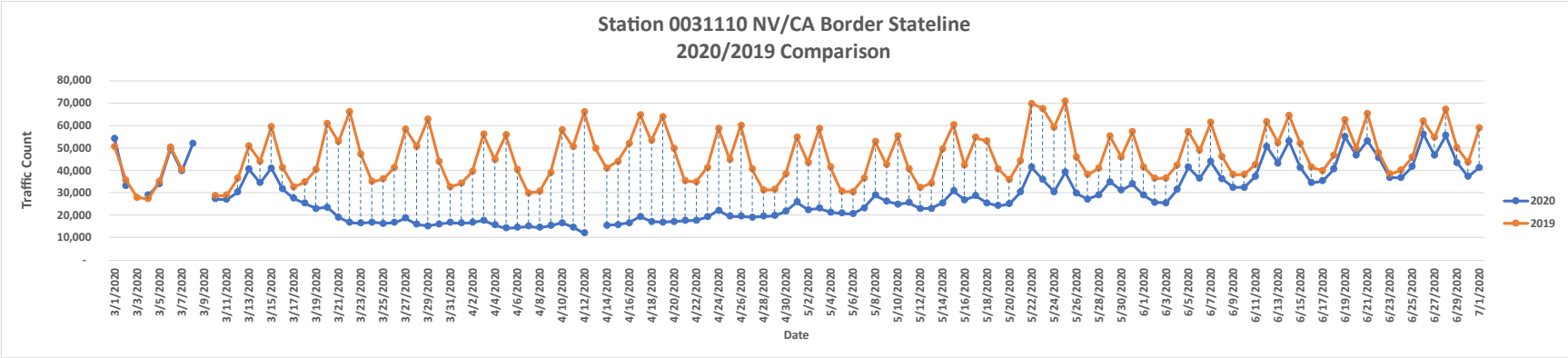
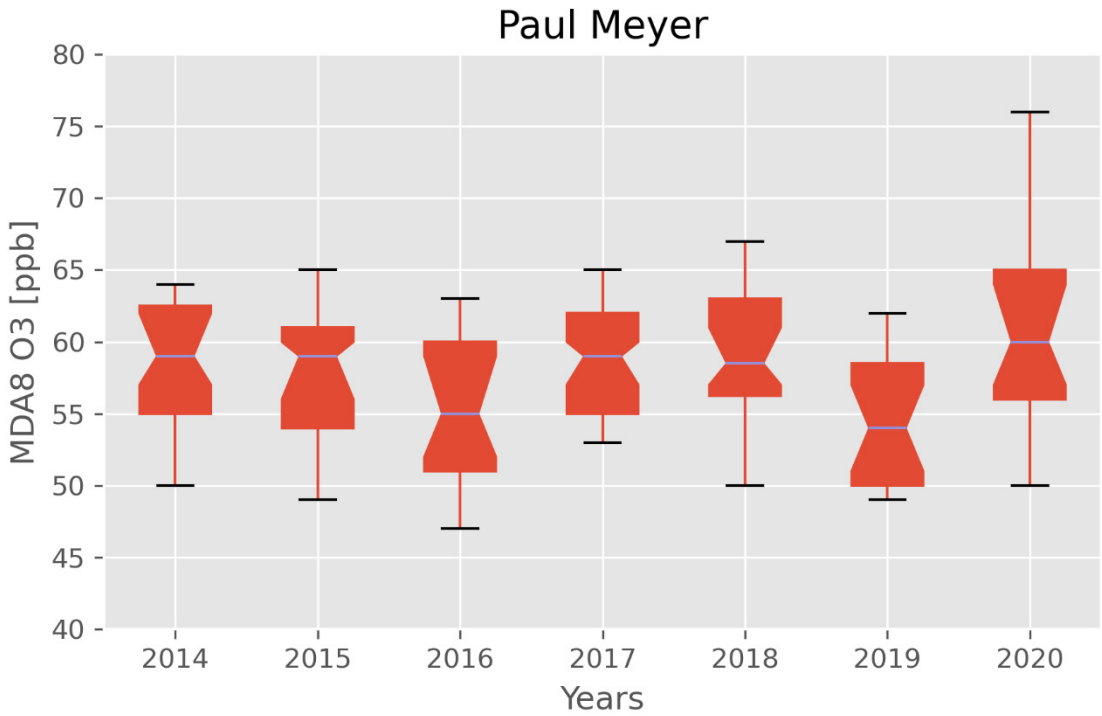


Figure D-1. Time series of 2020 and 2019 traffic counts at two stations: (top) along US95, south of Las Vegas, and (bottom) at the Nevada-California border, west of Las Vegas. Data were provided by the Nevada Department of Transportation.

We performed two sub-analyses for the ozone comparison to historical climatology. First, we compared the distribution of daily MDA8 ozone during May 2020 with those during May in each of the previous 5 years. Across all EE sites, we found median 2020 MDA8 ozone was not statistically different than any of the previous 5 years illustrated by the overlap in the 95th confidence intervals of the monthly medians in previous years with that for 2020 (**Figure D-2**). Furthermore, monthly median MDA8 ozone during May 2020 was not particularly high (much less than 65 ppb) at all sites despite the exceptional event days. This indicates that the EE day exceedances were extreme episodes that did not affect the monthly median. Thus, the observations do not suggest a month-long high ozone effect due to COVID emission precursor changes. Second, we compared the historical distribution of daily MDA8 ozone during May with the observations during May 2020 (**Figure D-3**). Across all EE sites, MDA8 ozone on the exceedance days for a given site rank above the confidence interval of the historical daily median MDA8 ozone. Based on these sub-analyses, we conclude that although precursor NO_x emissions decreased during May 2020 due to COVID restrictions, MDA8 ozone concentrations were not statistically higher than previous years. Therefore, the EE days cannot be attributed to a consistent COVID-shutdown influenced month-long increase in ozone concentrations.

To evaluate the GAM model residuals during the COVID shutdown period, Figure 3-61 in Section 3.3.3 provides a more in-depth look at results from April and May 2020, which are the most heavily affected months of the shutdown/COVID restrictions. The 95th confidence interval of the median GAM MDA8 residuals (shown by the notches in the box plots) overlap between 2020 and most other years, except for 2015 and 2016. The May 2020 median residual with EE days (1.5 ppb) is within the typical GAM model uncertainty (+/- [CI from Figure 3-55 from Section 3.3.3). This analysis shows that the median GAM residuals during May 2020 were within the typical GAM model error during the previous 5 years.

In summary, although mobile source precursor emissions of NO_x decreased during April and May 2020 due to COVID shutdown restrictions, we did not observe statistically higher ozone concentrations, nor a higher residual in the GAM model, during May 2020. We find consistent evidence across analyses that the EE day ozone concentrations cannot be attributed to an increase in ozone concentrations associated with COVID shutdown periods.



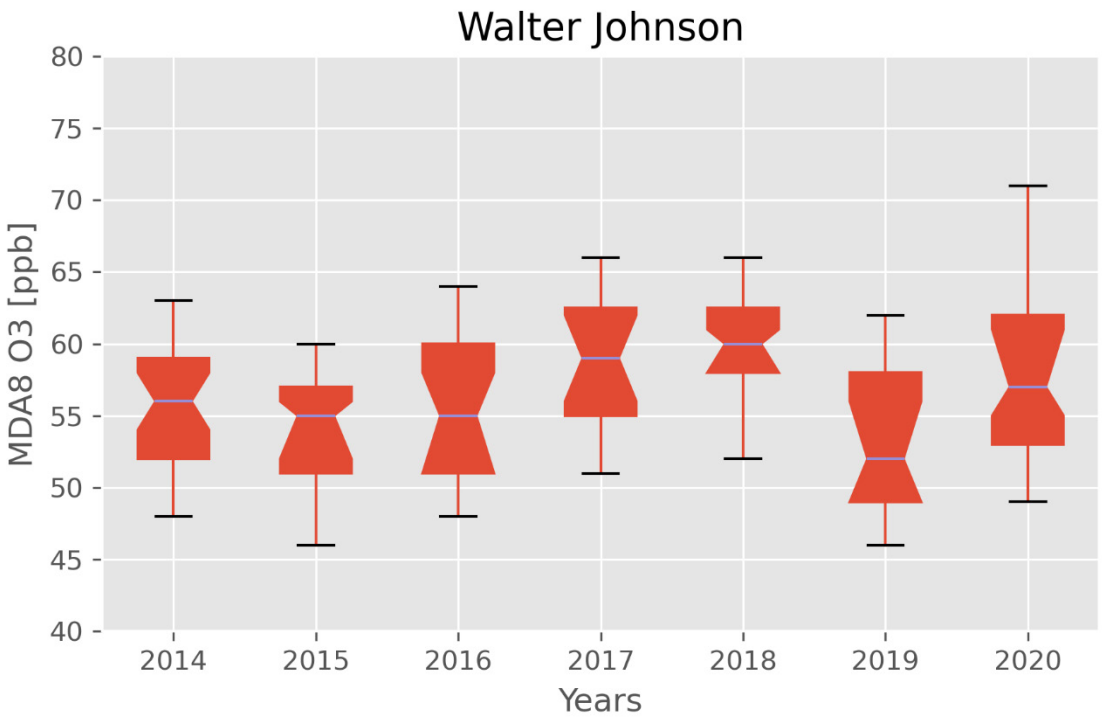


Figure D-2. Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

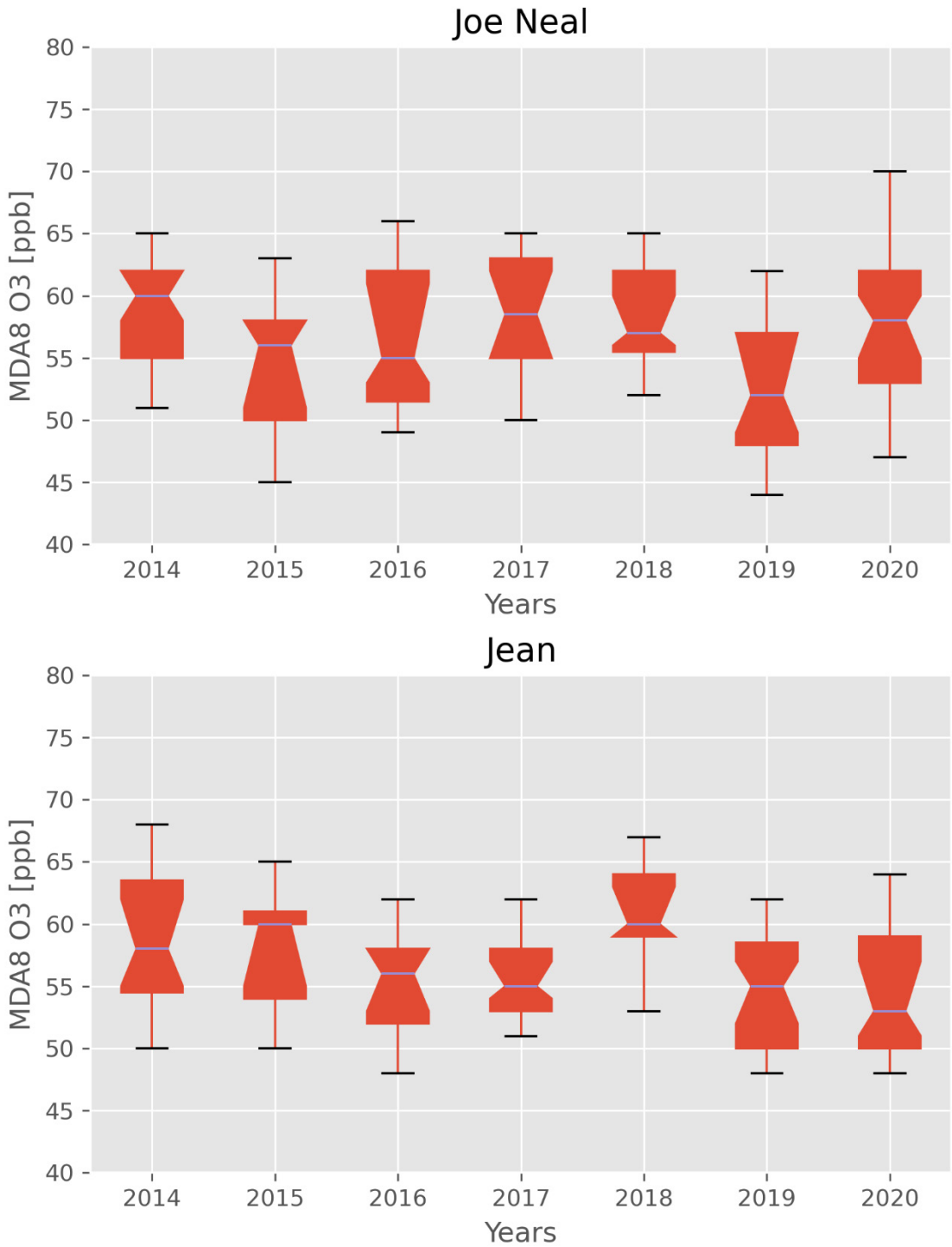
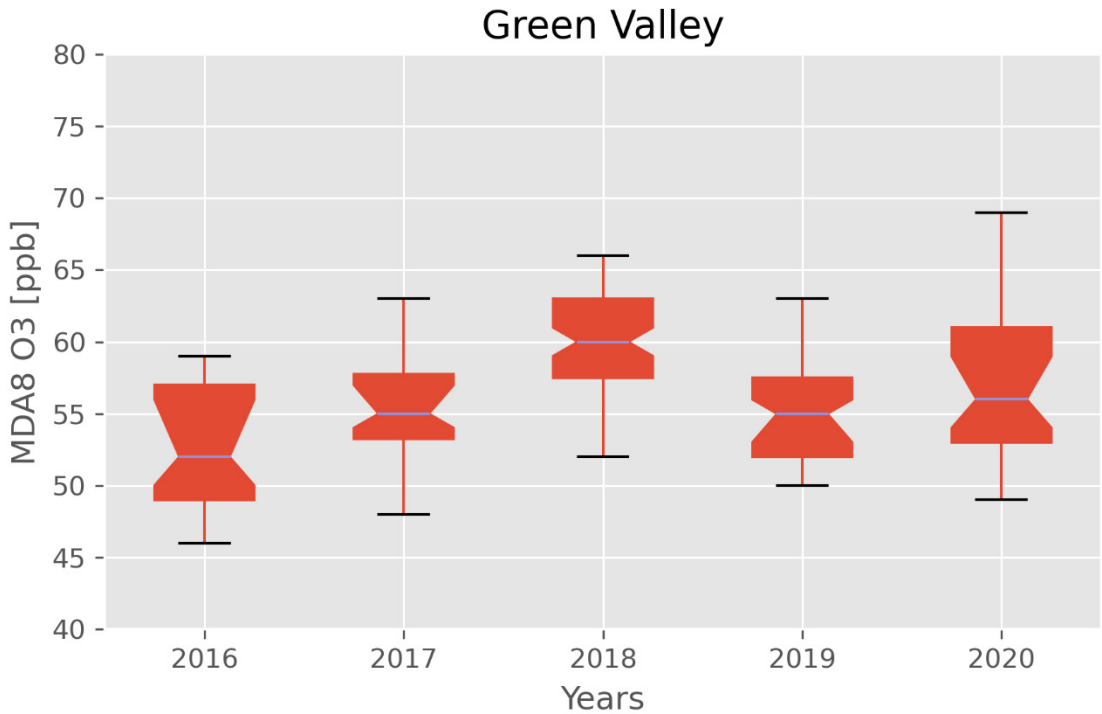


Figure D-2 (Cont.). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



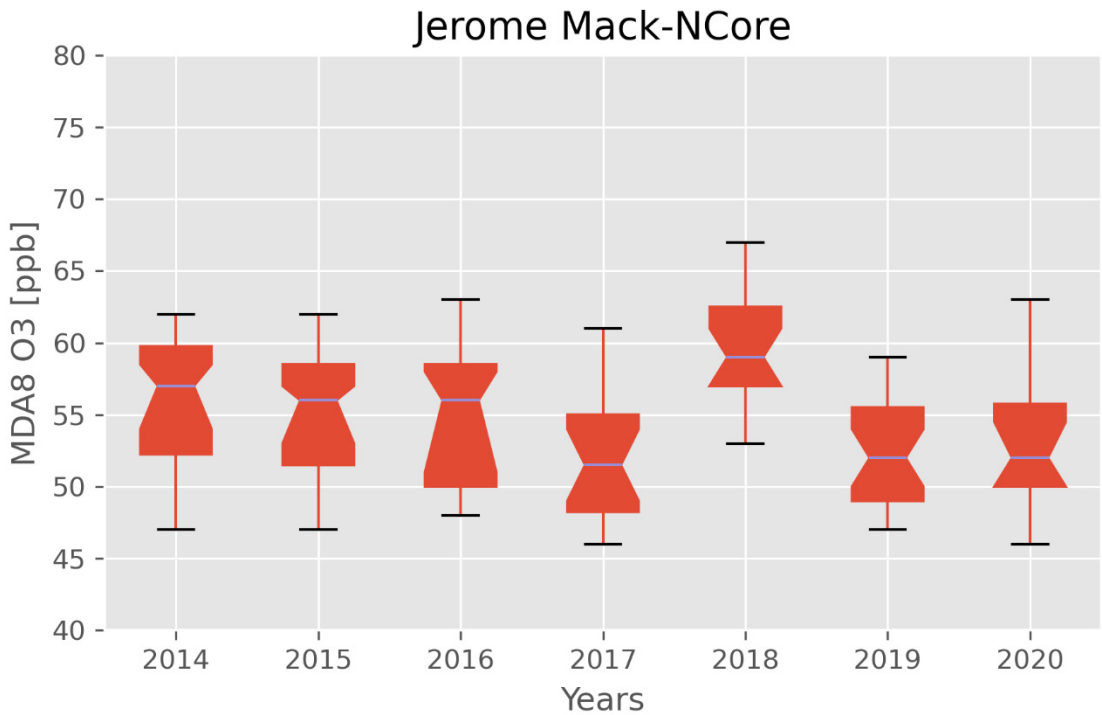
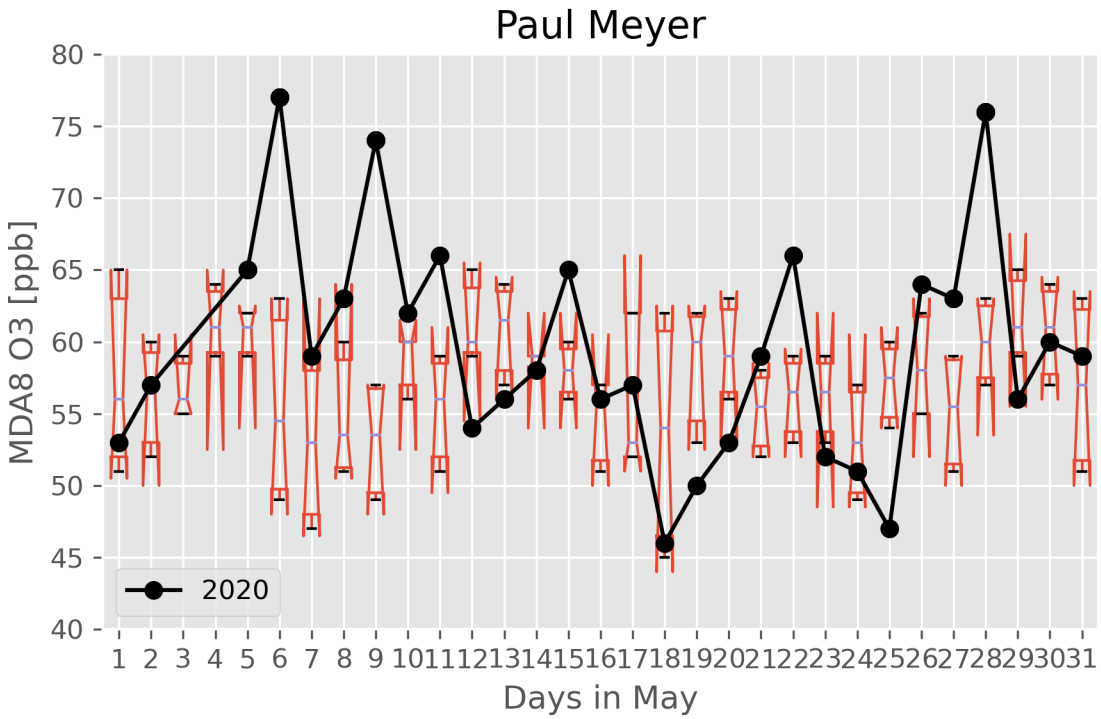


Figure D-2 (Cont.). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



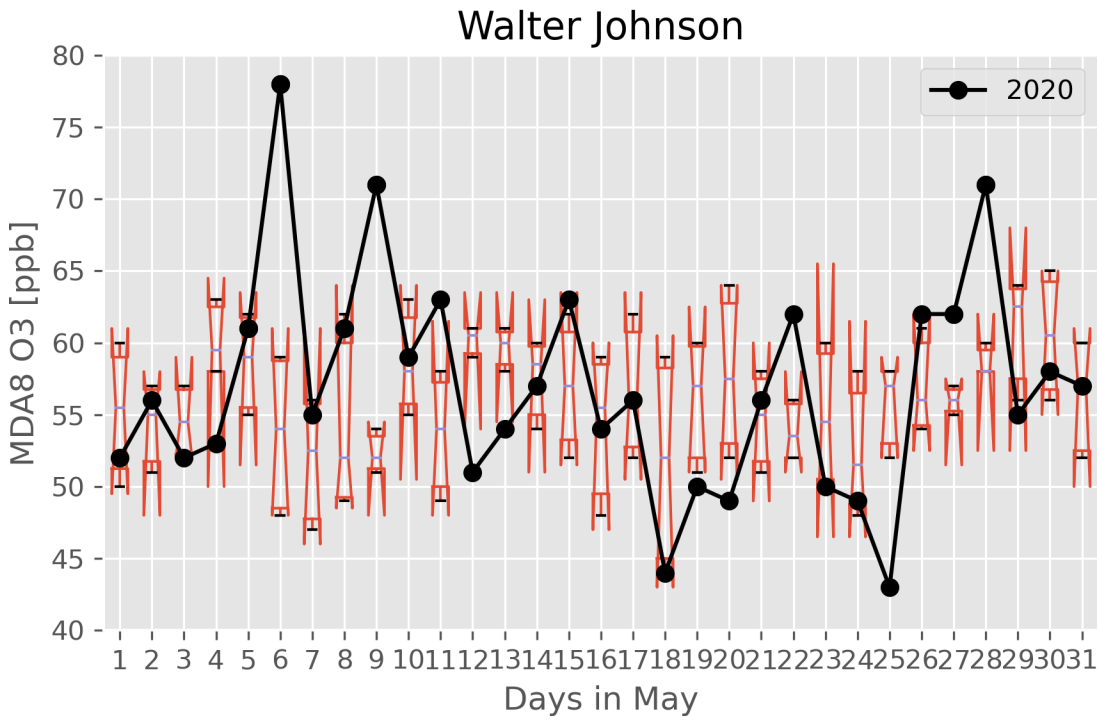
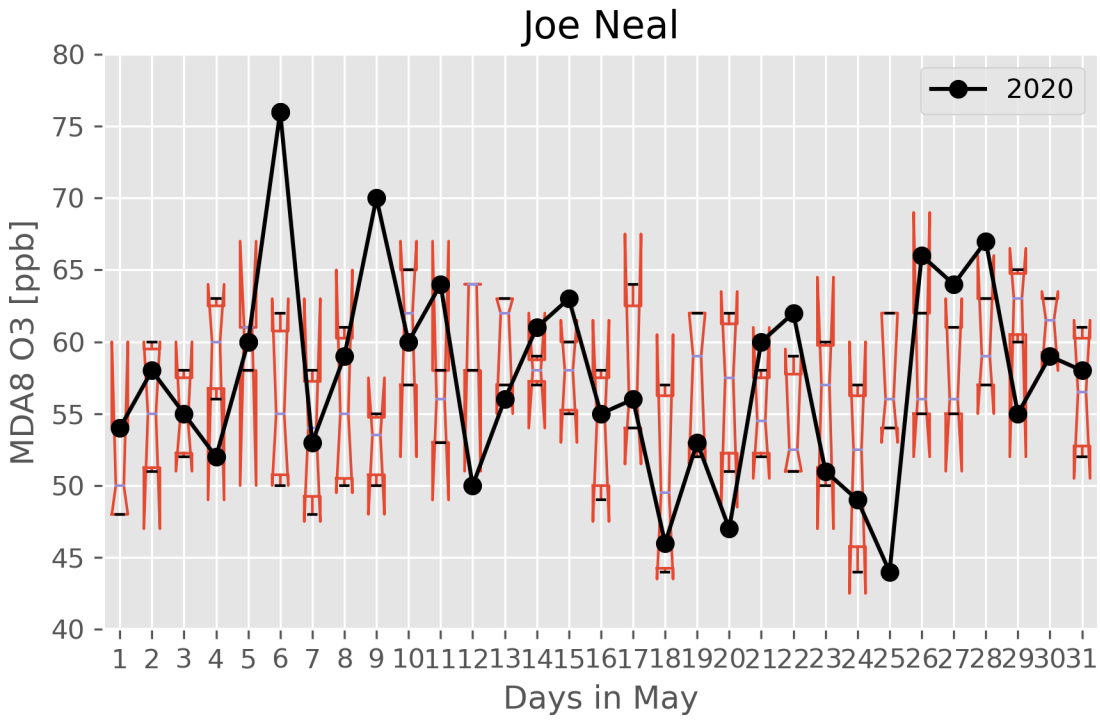


Figure D-3. Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



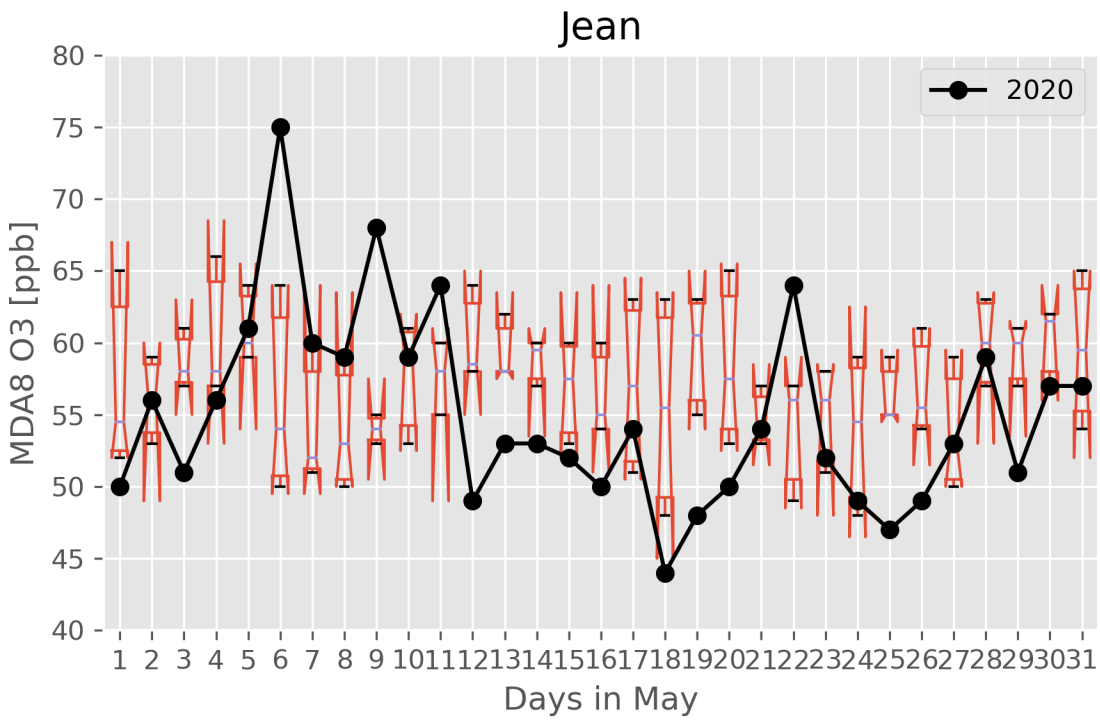
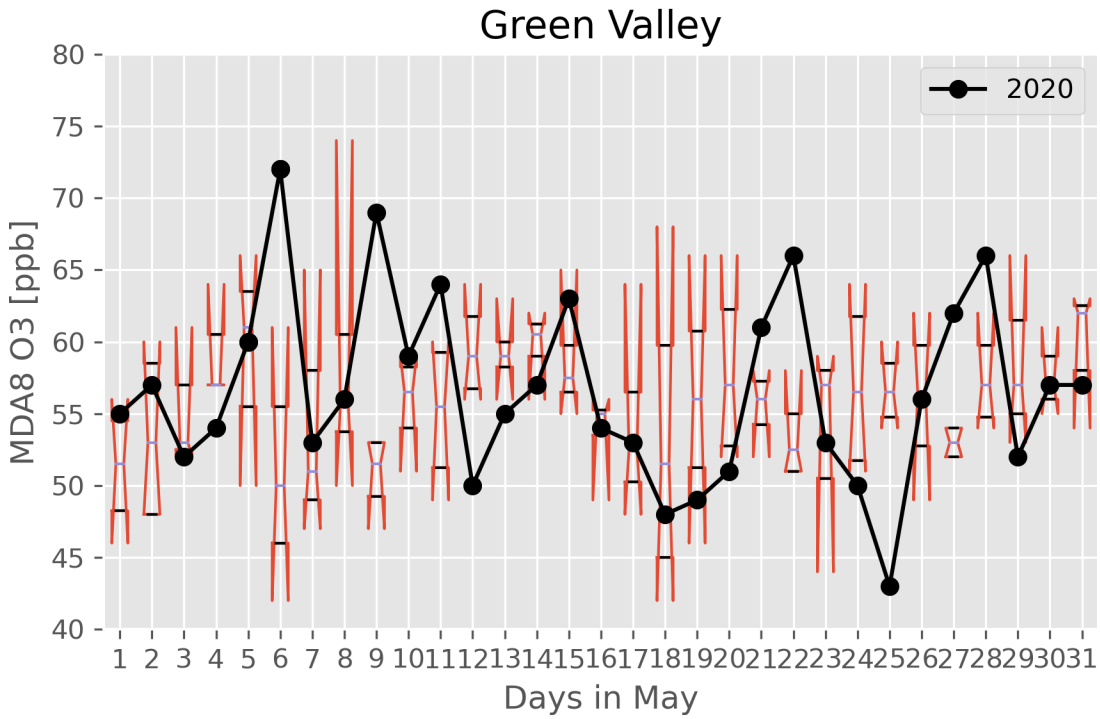


Figure D-3 (Cont.). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



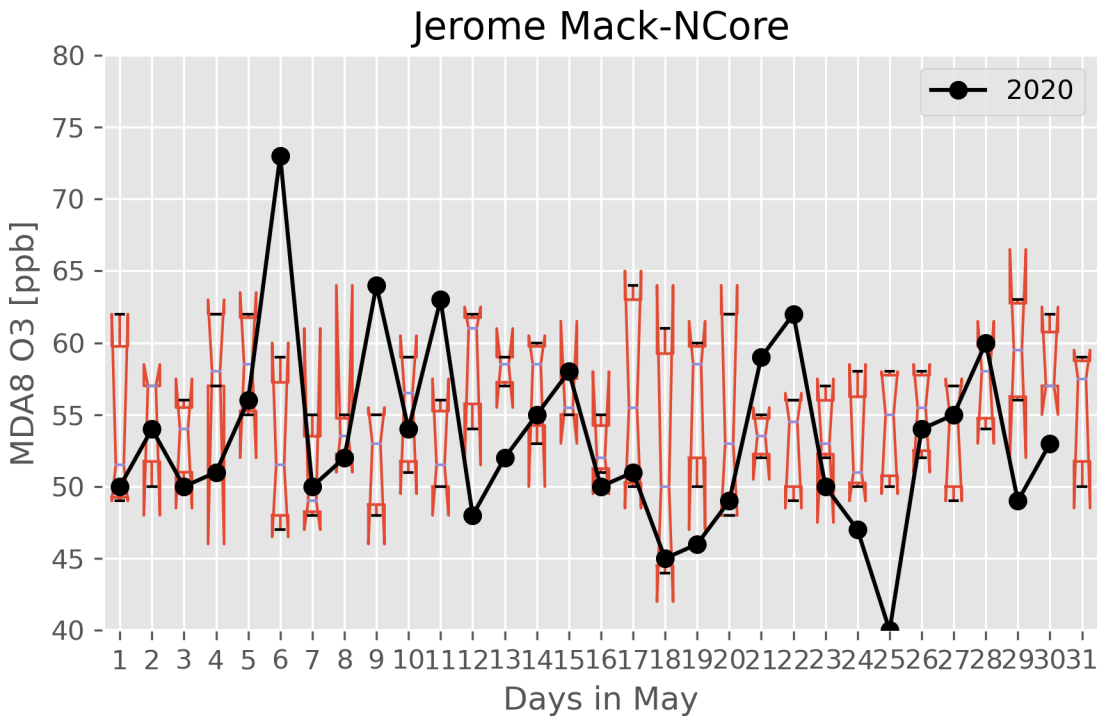


Figure D-3 (Cont.). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

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Appendix F. Documentation of Public Comment Process

This section provides documentation of the public comment process in support of Section 6 of this report.

To be updated once the public comment period has concluded.