Appendix A. Supporting Media Coverage for Section 3.1.4

An image and link for media coverage of the August 7 exceptional event detailed in Section 3.1.4 of the main text is presented below in Figure A-1.

Figure A-1. Article entitled "Hazy skies remain as Las Vegas high dips a few degrees" (https://www.reviewjournal.com/local/weather/hazy-skies-remain-as-las-vegas-high-dips-a-few-degrees-2089316/). Article released by Las Vegas Review-Journal, a local Las Vegas news outlet, on August 6, 2020.

Thursday's weather conditions in the Las Vegas Valley will be almost a carbon copy of Wednesday's, but a bit cooler and a little less windy. Hazy skies will remain.

Smoke from fires in Southern California, especially the Apple Fire, will make skies hazy for a fourth straight day, according to the latest National Weather Service forecast.

The fire in rugged mountains about an hour east of Los Angeles has consumed 27,569 acres and is 30 percent contained, according to San Bernardino National Forest officials. Winds from the southwest are bringing the smoke toward Southern Nevada.

High of 101 expected

A forecast high of 101 for Thursday is 3 degrees below the Wednesday high at McCarran International Airport. Winds will range from 7 to 13 mph with gusts to 20 mph. An overnight low of 77 is expected.

Figure A-1 (Cont). Article entitled "Hazy skies remain as Las Vegas high dips a few degrees" (https://www.reviewjournal.com/local/weather/hazy-skies-remain-as-las-vegas-high-dips-a-few-degrees-2089316/). Article released by Las Vegas Review-Journal, a local Las Vegas news outlet, on August 6, 2020.

Real-time air quality data, Air Quality Index (AQI) maps, daily air quality forecasts, and event notifications are available on the DES website (https://clarkcountynvairquality.meteostar.com/). Air quality forecasts and current data are also available through EPA's AirNow and EnviroFlash systems. DES issues air quality advisories and alerts to warn the public and regulated community if unhealthy levels of a regulated pollutant are anticipated. These notifications also provide recommendations on reducing exposure and emissions. Advisories are issued when forecast conditions are favorable for pollutant levels to exceed the NAAQS – i.e., to reach the Unhealthy for Sensitive Groups (USG) level on the AQI, or when public health and safety might be in danger. Alerts are issued when air quality levels have already reached the AQI USG level or are expected to reach that level. **Figure A-2** provides the concentration and AQI values for all NAAQS pollutants in the Metropolitan/Non-Metropolitan and Greater Las Vegas Metro Area on August 7, 2020. This information was publicly available during the August 7 potential exceptional event. In addition to the near-real-time data available on the DES website, 5-day AQI forecasts were (and are currently) available on August 7 to the public here: https://aqportal.clarkcountynv.gov/DES_AQ_Forecast. **Figure A-3** provides the public Air Quality Advisory/News Release for the 2020 ozone season. Additional media coverage and publicly available AirNow AQI maps for the August 7 potential exceptional event date are included in Sections 3.1.2 and 3.1.4 of the main report.

Reporting for August 7, 2020 August 7 2020 Select a Different Date

Metropolitan Area or Non-Metropolitan County	Air Quality Rating	Critical Pollutant	Air Quality Index															
			Ozone				Carbon Monoxide		Sulfur Dioxide		Nitrogen Dioxide		PM-10 (Std Cond)		PM-2.5 (Lcl Acpt)		PM-2.5 (Lcl Cond)	
			1-Hour		8-Hour		8-Hour		1-Hour		1-Hour		24-Hour		24-Hour		24-Hour	
			AQI	ppb	AQI	ppb	AQI	ppm	AQI	ppb	AQI	ppb	AQI	µg/m³ (25° C)	AQI	µg/m³ LC	AQI	µg/m³ LC
Clark County -- Region 1																		
Apex	Moderate	Ozone	*	64	71	61												
Boulder City	Moderate	Ozone	*	66	80	64							14	14.81				
Greater Las Vegas	Unhealthy for sensitive groups	Ozone	*	81	104	72	6	0.567	1	0.8	44	46.9	32	34.59			29	7.31
Indian Springs	Unhealthy for sensitive groups	Ozone	*	79	104	72												
Jean	Moderate	Ozone	*	69	90	67							24	26.30			32	7.88
Mesquite	Moderate	Ozone	*	61	61	58												

Monitoring Sites in the Greater Las Vegas Metro Area	Air Quality Rating	Critical Pollutant	Air Quality Index															
			Ozone				Carbon Monoxide		Sulfur Dioxide		Nitrogen Dioxide		PM-10 (Std Cond)		PM-2.5 (Lcl Acpt)		PM-2.5 (Lcl Cond)	
			1-Hour		8-Hour		8-Hour		1-Hour		1-Hour		24-Hour		24-Hour		24-Hour	
			AQI	ppb	AQI	ppb	AQI	ppm	AQI	ppb	AQI	ppb	AQI	µg/m³ (25° C)	AQI	µg/m³ LC	AQI	µg/m³ LC
Clark County	Unhealthy for sensitive groups	Ozone	*	81	104	72	6	0.567	1	0.8	44	46.9	32	34.59			29	7.31
Casino Center	Good	Nitrogen Dioxide									36	38.6						
Green Valley	Moderate	Ozone	*	67	84	65							23	24.45			24	6.03
Jerome Mack	Moderate	Ozone	*	62	71	61			1	0.8	32	33.4	26	27.78			27	6.59
Joe Neal	Unhealthy for sensitive groups	Ozone	*	81	104	72					15	15.5	32	34.59			24	6.00
Palo Verde	Moderate	Ozone	*	68	77	63							20	22.12				
Paul Meyer	Moderate	Ozone	*	74	100	70							24	26.45			27	6.61
Rancho & Teddy	Good	Nitrogen Dioxide					6	0.567			44	46.9					28	6.84
Sunrise Acres	Good	Nitrogen Dioxide					5	0.444			40	42.2	29	31.13			29	7.31
Walter Johnson	Unhealthy for sensitive groups	Ozone	*	78	101	71							23	25.00			25	6.12

Figure A-2. Air quality Index values reported by the Clark County Department of Environment and Sustainability on August 7, 2020.

News Release

County Commission:
Marilyn Kirkpatrick, Chairman
Lawrence Weekly, Vice Chairman
Larry Brown
James B. Gibson
Justin Jones
Michael Naft
Tick Segerblom

Yolanda King, County Manager

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

Contact: Kevin J MacDonald
Public Information Officer

Phone: (702) 455-6131
Mobile: (702) 232-0931
E-mail: kevmac@ClarkCountyNV.gov

For Immediate Release **Tuesday, March 31, 2020**

Seasonal Ozone Advisory Issued Through September

The Clark County Department of Environment and Sustainability issued a season-long advisory for ground-level ozone pollution today that will be in effect from Wednesday, April 1 – Wednesday, Sept. 30.

Ozone is a colorless gas that exists naturally in the Earth's upper atmosphere. At ground level, ozone is a key ingredient of urban smog that can build up during the day in the hottest months of the year because of strong sunlight, hot temperatures, gasoline and chemical vapors, and pollutants from automobiles, wildfires and regional transport. Exposure to ozone can irritate your respiratory system and cause coughing, a sore throat, chest pain and shortness of breath even in healthy people, according to the EPA.

"Even though we're continuing to Stay Home for Nevada as we and the rest of the country work through the COVID-19 pandemic, it is important to remind the community that ozone increases during the warmer months," said Department of Environment and Sustainability Director Marci Henson. "Our Air Quality Division continues to be an essential service to Clark County by enforcing federal, health-based standards. We also remind people they play an important role in helping reduce ground-level ozone."

HELPFUL TIPS TO REDUCE OZONE

Because cars, trucks and other vehicles are major contributors to ozone, people can follow these helpful, everyday tips to reduce ozone:

- 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.

[more]

Clark County news releases may be found at www.ClarkCountyNV.gov.
You may also follow the County on more than 40 social media sites, including
Facebook, Twitter, Instagram, LinkedIn, NextDoor, Pinterest and **YouTube.**

Figure A-3. Seasonal Ozone Advisory issued by the Clark County Office of Public Communication on March 31, 2020, for the 2020 Ozone Season (April 1 to September 30, 2020).

News Release

Environment and Sustainability Seasonal Ozone Advisory, cont.

Also, if you have respiratory issues or other health concerns, consider these tips during ozone season:

- Reduce the time you are active outdoors when ozone levels are elevated, especially if you are engaged in a strenuous activity or have a respiratory disease.
- Schedule activities for the morning or evening when ozone levels are usually lower.
- Substitute a less intense activity – walking instead of jogging, for example.
- Always consult your doctor first for medical advice.

STAY UP TO DATE WITH AIR QUALITY INFORMATION

The Department of Environment and Sustainability monitors air pollution through a network of monitoring sites throughout the Las Vegas Valley. Data is collected from these sites and reported at our monitoring website: AirQuality.ClarkCountyNV.gov. People can stay informed through a couple channels:

- Twitter and Facebook: Read air quality updates in your Facebook news feed or tweets. On Facebook: www.facebook.com/SustainClarkCounty and Twitter: @SustainClarkCty.
- EnviroFlash: Receive daily text or email messages with the latest air quality information. Learn more at www.enviroflash.org. The Dept. of Environment and Sustainability also issues advisories and alerts for ozone and other pollutants such as dust, smoke and other particulate matters.
- AIRNow: Check air quality forecasts, current conditions and the Air Quality Index (AQI) for Clark County at AIRNow's website.

###

Clark County is a dynamic and innovative organization dedicated to providing top-quality service with integrity, respect and accountability. With jurisdiction over the world-famous Las Vegas Strip and covering an area the size of New Jersey, Clark is the nation's 11th-largest county and provides extensive regional services to more than 2.3 million citizens and 45 million visitors a year. Included are the nation's 9th-busiest airport, air quality compliance, social services and the state's largest public hospital, University Medical Center. The County also provides municipal services that are traditionally provided by cities to about 1 million residents in the unincorporated area. Those include fire protection, roads and other public works, parks and recreation, and planning and development.

Clark County news releases may be found at www.ClarkCountyNV.gov.
You may also follow the County on more than 40 social media sites, including
Facebook, Twitter, Instagram, LinkedIn and **YouTube.**

Figure A-3 (cont.). Seasonal Ozone Advisory issued by the Clark County Office of Public Communication on March 31, 2020, for the 2020 Ozone Season (April 1 to September 30, 2020).

Appendix B. Supporting Figures and Documents for Section 3.2.3

Excluding areas outside of the swath width from the AIRS instrument, the maps show smoke transport from the Apple Fire to the Clark County area between August 4 and 7 (**Figure B-1**). Areas of slightly enhanced CO originating from the Apple Fire that spread throughout southern California, southeastern Nevada, and western Arizona can be distinguished during the days leading up to August 7. By August 6, one day before the ozone exceedance, CO concentrations in the Clark County area were up to approximately 95 ppb at 500 hPa (**Figure B-2**). Unfortunately, CO concentrations on August 7 over Clark County are outside the swath width from the AIRS instrument; therefore, Figures B-1 and B-2 do not provide strong evidence for or against smoke impacts.

We additionally examined OMI retrievals of tropospheric NO_2 concentrations (**Figure B-3**). However, over areas of dense, visible smoke, and near actively burning fires (where significant smoke is present in the troposphere), the measurements show only a slight increase in measured NO_2. Therefore, it was determined that NO_2 does not provide strong evidence for or against smoke impacts in Clark County.

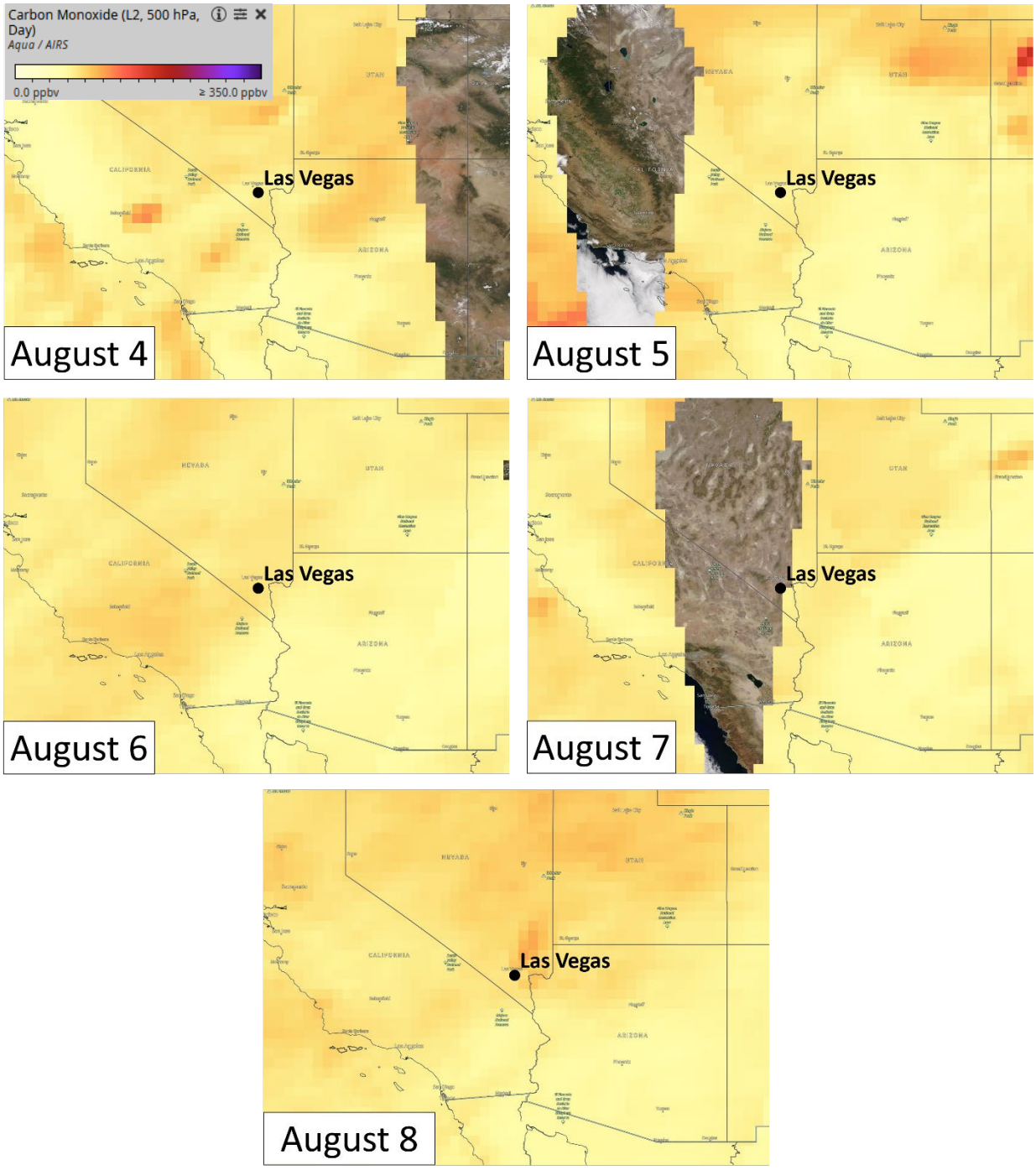


Figure B-1. MODIS Aqua AIRS CO retrievals for the three days before and during the EE on August 7, 2020.

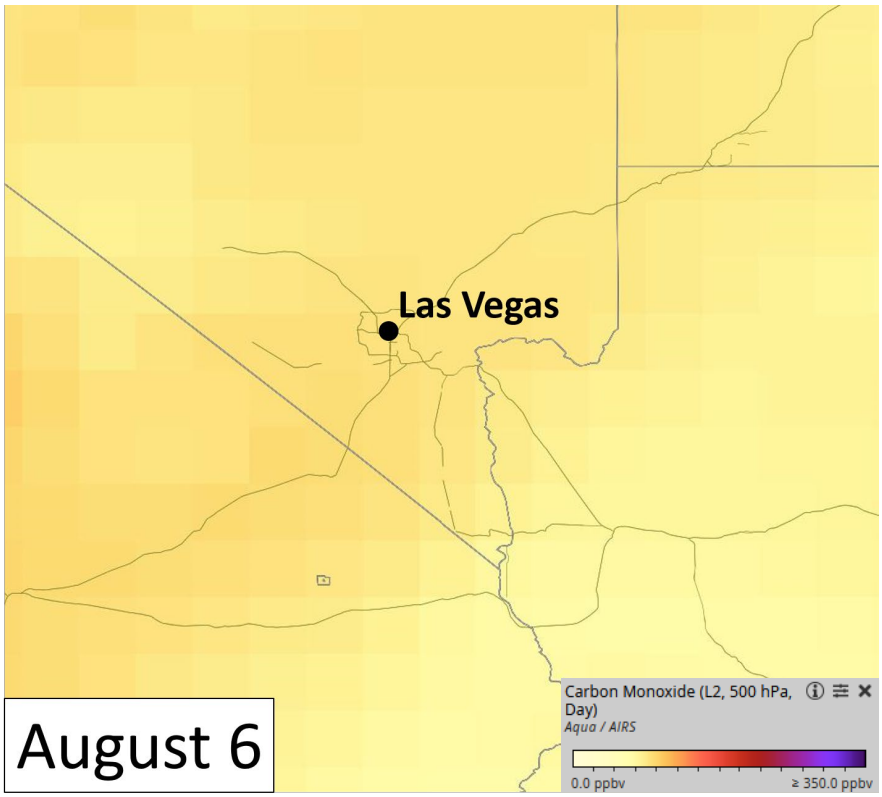


Figure B-2. A zoomed-in view over Clark County and the Apple Fire of the Aqua AIRS CO retrieval during the EE on August 6, 2020.

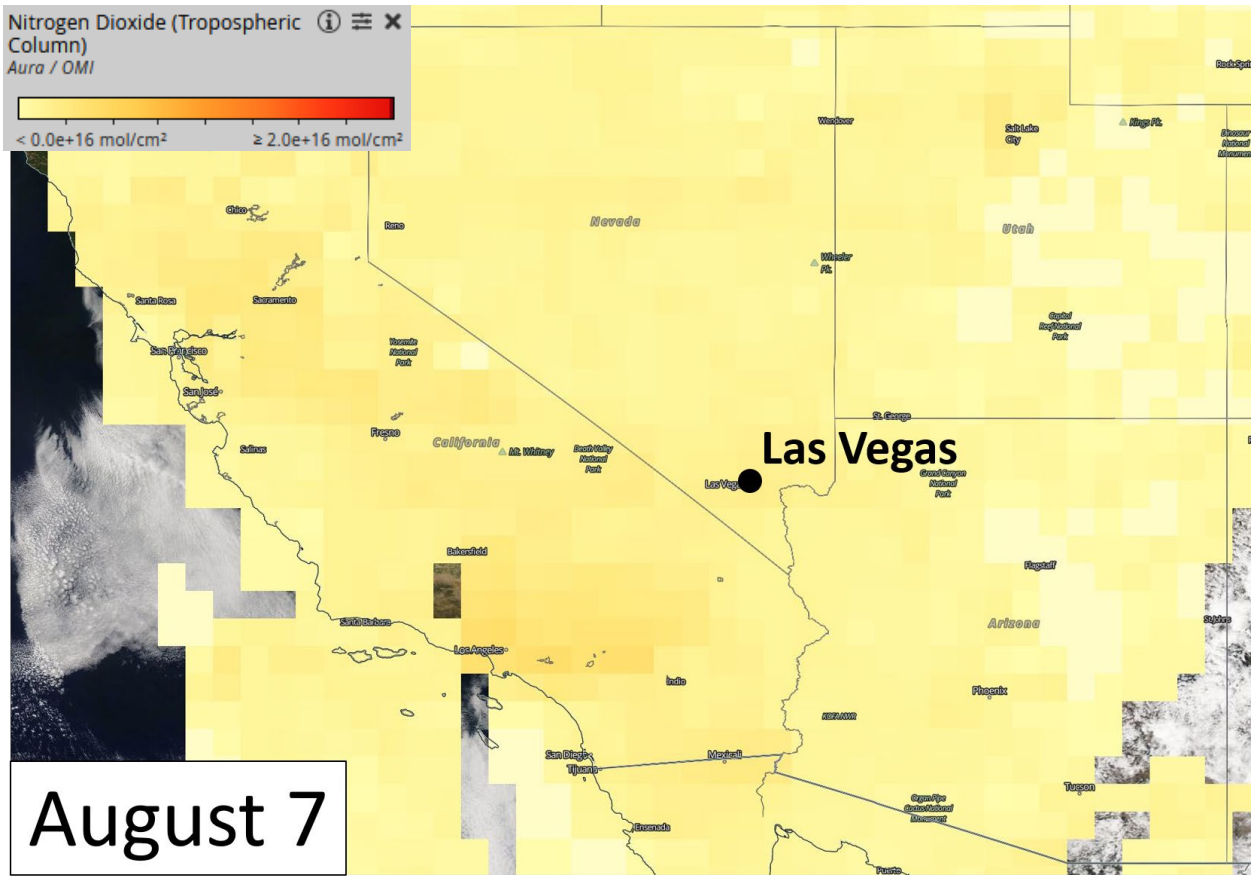


Figure B-3. OMI Aura NO_2 retrieval for the EE on August 7, 2020.

Appendix C. Supporting Figures for Section 3.2.4

The ratio of $PM_{10}/PM_{2.5}$ is examined at each event site where $PM_{2.5}$ and PM_{10} data is available in **Figures C-1 and C-2** to determine if a dust event had a significant contribution to abnormal $PM_{2.5}$ concentrations in Clark County during the event period. Elevated $PM_{2.5}$ concentrations that are caused by a dust event can be identified by an even greater increase in PM_{10}, or, in other words, an accompanying increase in the $PM_{10}/PM_{2.5}$ ratio. Contributions to $PM_{2.5}$ concentrations that arise as a result of a dust event could confound the assertion that wildfire influence in Clark County can be identified by elevated or abnormal levels of $PM_{2.5}$. As seen in the following figures, the abnormal spikes in $PM_{2.5}$ concentrations midday and near midnight on August 6 leading up to the event date were not accompanied by a marked increase in the $PM_{10}/PM_{2.5}$ ratio at either site. At Walter Johnson, the $PM_{10}/PM_{2.5}$ ratio was below the diurnal average during these time periods of interest. At Joe Neal, the $PM_{10}/PM_{2.5}$ ratio was below average during the day on August 6, and increased modestly overnight. Additionally, over the course of August 7 (the event day), the $PM_{10}/PM_{2.5}$ ratios did not exceed the 95th percentile and oscillated around the median ratio for most of the mid-morning and afternoon. This demonstrates that a dust event did not significantly contribute to the abnormal $PM_{2.5}$ concentrations measured in Clark County on August 7, 2020, lending evidence to the assertion that these abnormalities were related to the presence of a wildfire at the surface.

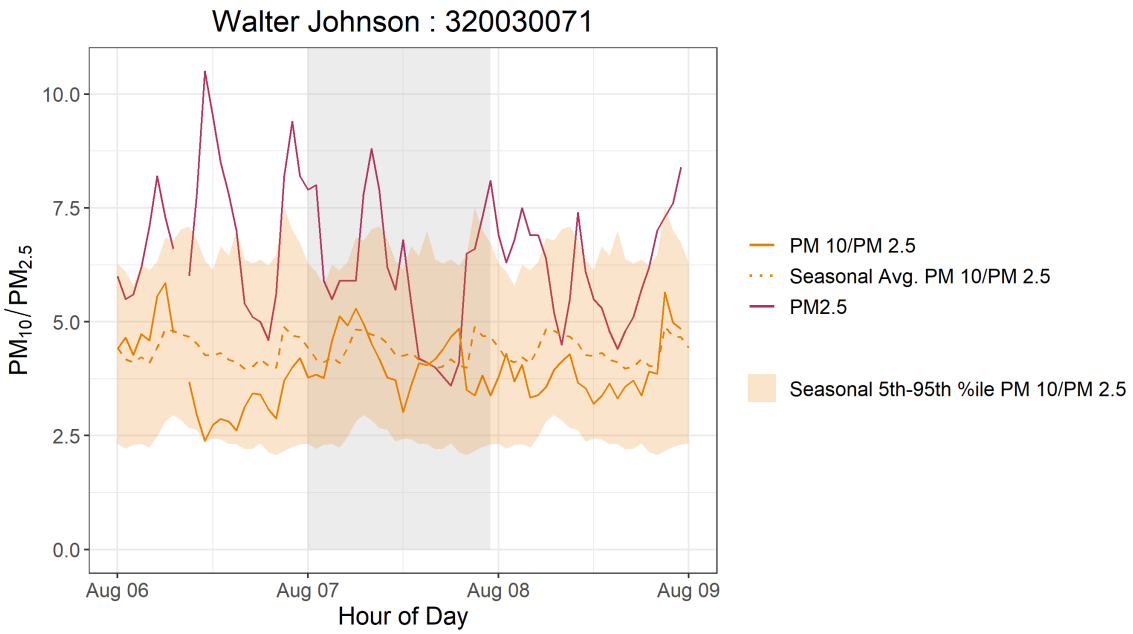


Figure C-1. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Walter Johnson during the August 7, 2020, event period. The seasonal average $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 7, 2020.

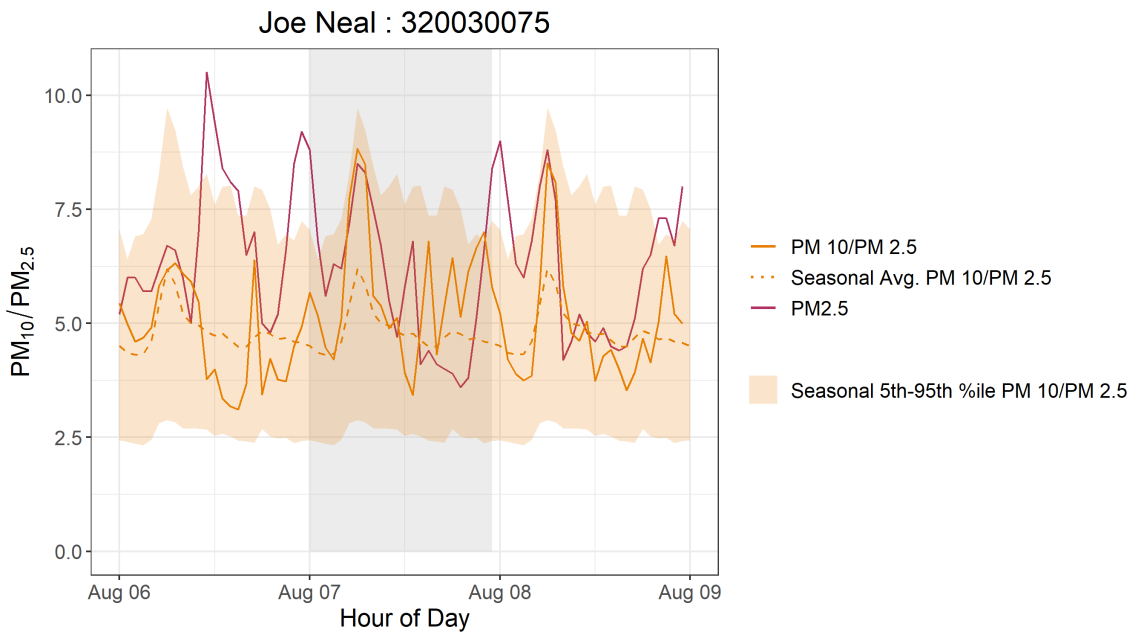


Figure C-2. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Joe Neal during the August 7, 2020, event period. The seasonal average $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 7, 2020.

Appendix D. Supporting Figures and Documents for Section 3.3.1

The Cloud-Aerosol Light Detection and Ranging (LIDAR) and Infrared Pathfinder Satellite Observation (CALIPSO) system is a remote sensing instrument mounted on the CloudSat satellite that provides vertical profile measurements of atmospheric aerosols and clouds. Detected aerosols are classified into marine, marine mixture, dust, dust mixture, clean/background, polluted continental, smoke, and volcanic aerosol types.

The most relevant CALIPSO aerosol retrieval over Clark County for the August 7 ozone event is available at approximately 2:40 p.m. local time on August 7 (Figure D-1 and D-2). Unfortunately, the CALIPSO vertical profile does not capture information directly over Clark County or between Clark County and the Apple Fire during the event. Rather, the CALIPSO aerosol retrieval captures information upwind of the Apple Fire (Figures D-3 and D-4). Therefore, CALIPSO aerosol retrieval does not provide strong evidence for or against smoke impacts.

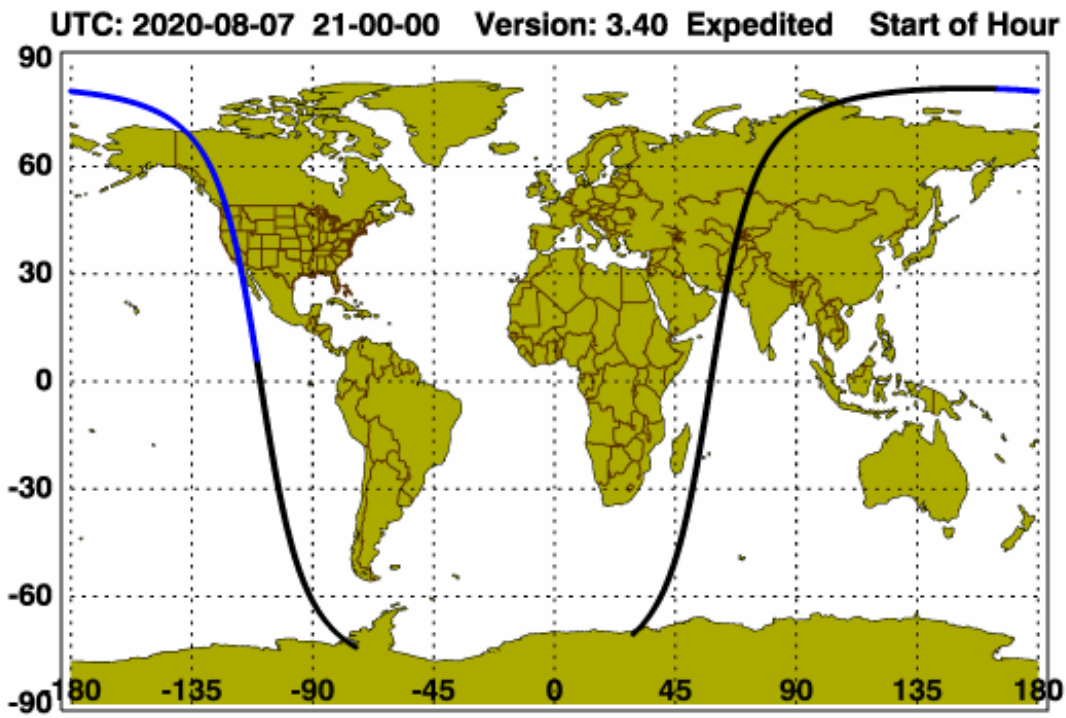


Figure D-1. The CALIPSO retrieval path for August 7, 2020. This overpass was the closest to the Apple Fire and Clark County and the nearest in time.

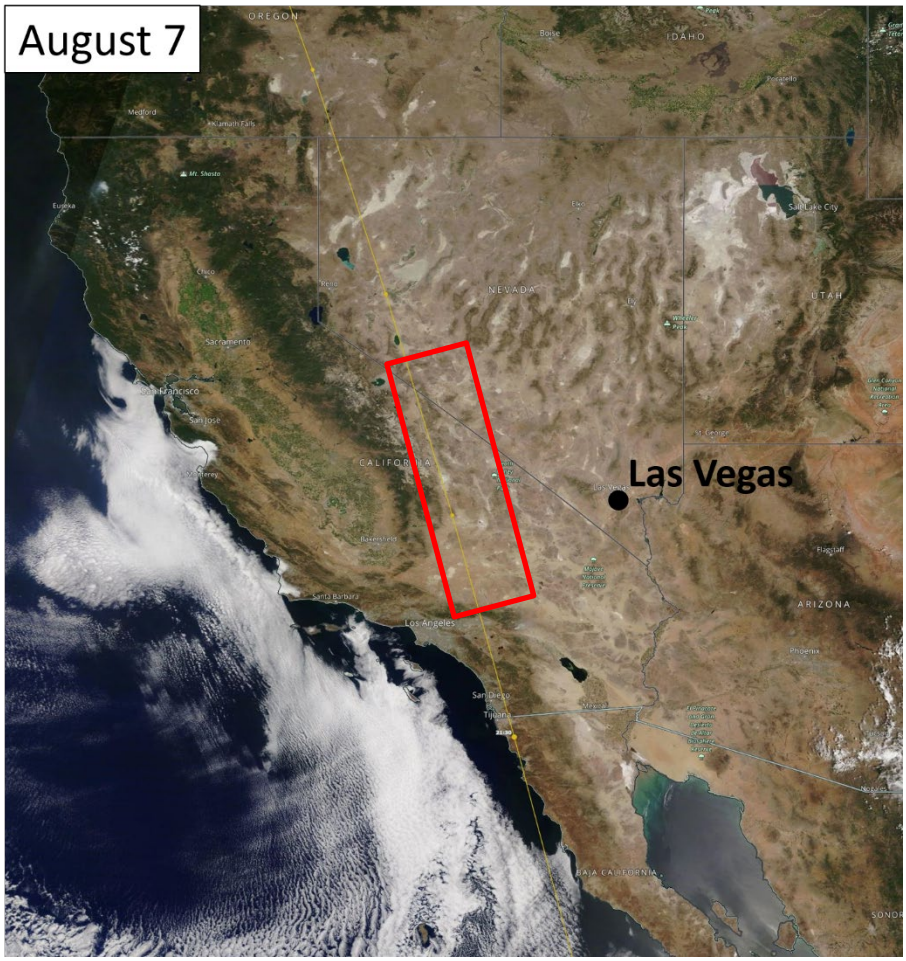


Figure D-2. The CALIPSO retrieval path for August 7, 2020. This overpass was the closest to the Apple Fire and Clark County and the nearest in time.

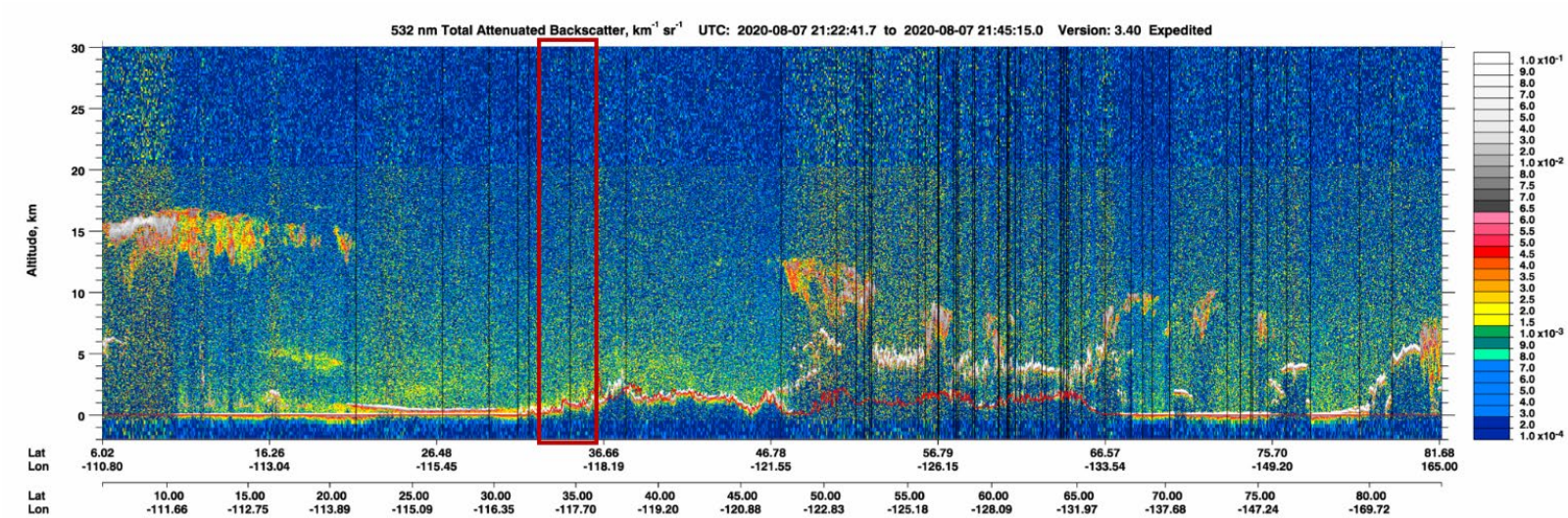


Figure D-3. CALIPSO total column profile backscatter information for the August 7 overpass over the Apple Fire in southern California (approximate areas indicated by a red box).

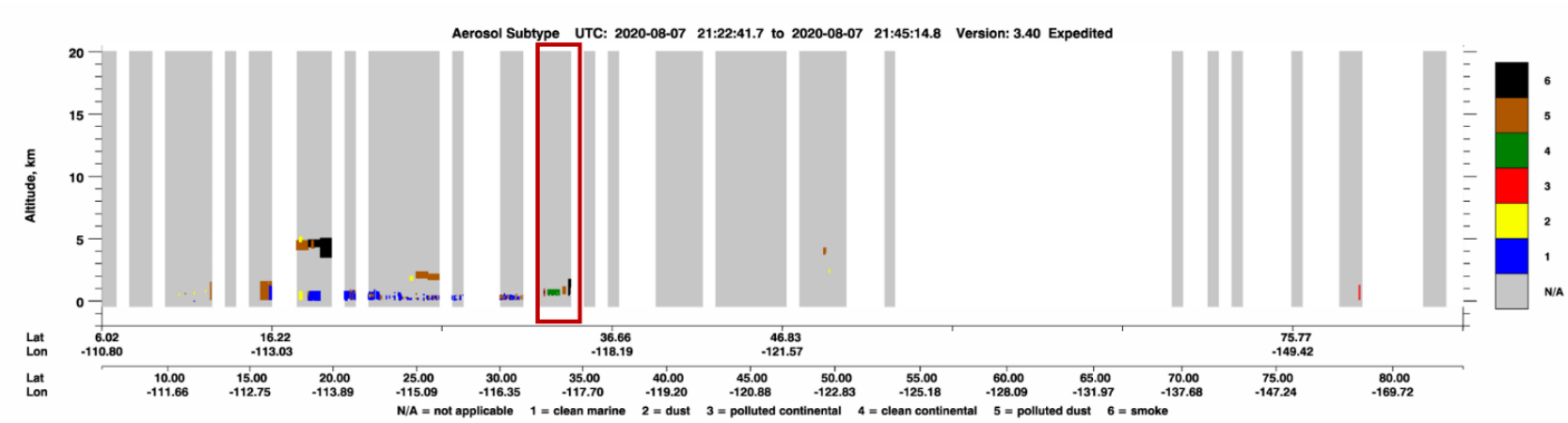


Figure D-4. CALIPSO total column profile aerosol subtype information for the August 7 overpass of the Apple Fire in southern California (approximate areas indicated by a red box).

Appendix E. Supporting Figures and Documents for Section 3.3.2

The full subset of matching meteorologically similar days to August 7, 2020, included June 19, 2015. **Table E-1** shows the local meteorological observations for the event date this meteorologically similar day. June 19, 2015, is not formally identified as a date with wildfire influence, but examination of NOAA's HMS Smoke Product indicates that wildfire smoke was present in Clark County on this date. **Figure E-1** shows the HMS Smoke and Fire products on June 19, 2015. Wildfire smoke is widely present in the southwestern region of the United States, including within the boundaries of Clark County. Additionally, HYPLIT back-trajectories overlaid in this figure ending at 18:00 UTC on June 19, 2015, show transport from the center of the smoke plume toward Clark County at 50 m and 500 m. Due to this evidence that wildfire smoke may have influenced ozone concentrations in Clark County on June 19, 2015, this meteorologically similar day has been omitted from the similar days analysis for August 7, 2020.

Table E-1. Local meteorological conditions at the Jerome Mack monitoring site on the event date, August 7, 2020, and meteorologically similar date June 19, 2015. WJ, JN, and IS refer to monitoring sites Walter Johnson, Joe Neal, and Indian Springs respectively. MDA8 Ozone concentrations at each site are shown.

Date	Max Temp (°F)	Avg Temp (°F)	Resultant Wind Direction (°)	Resultant Wind Speed (mph)	Avg Wind Speed (mph)	Avg RH (%)	Precip (in)	Total GHI (kWh/m^2)	Mixing Layer Mixing Ratio (g/kg)	LCL (mb)	CAPE (J/kg)	500-1,000 mb Thickness (m)	MDA8 Ozone Concentration (ppb)		
													WJ	JN	IS
2020-08-07	103	91.62	132.87	2.11	3.15	8.54	0	8.2	3.93	546.35	0	5848	71	72	72
2015-06-19	109	95.96	136.9	1.63	2.78	6.12	0	9	3.78	507.62	0	5935	73	70	67

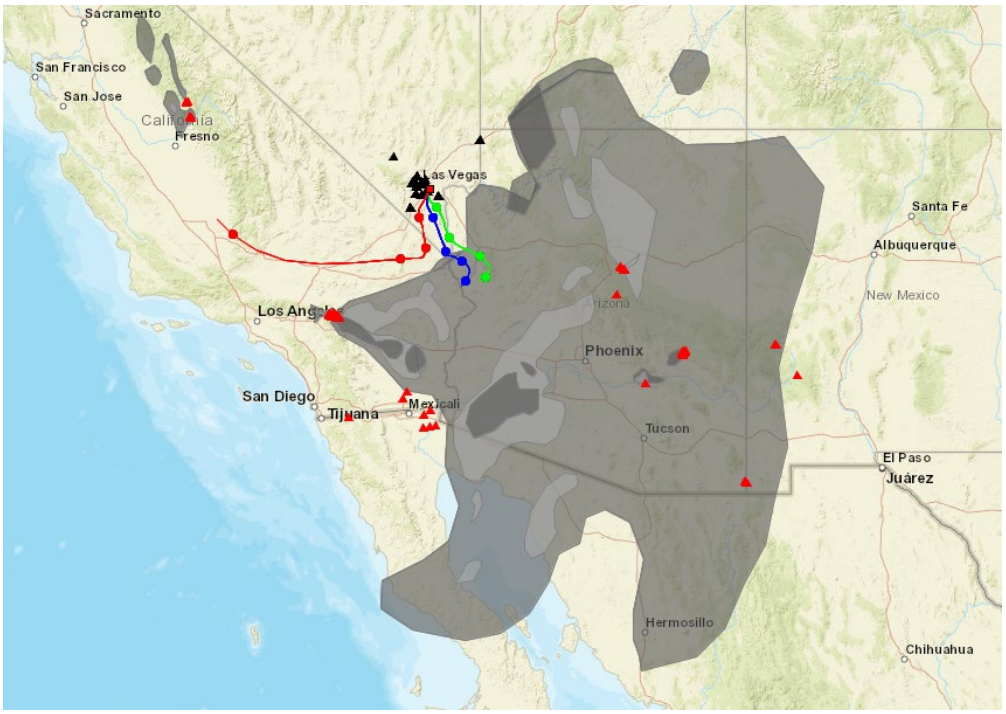


Figure E-1. HMS Smoke and Fire Products on June 19, 2015. Active fires are marked by red triangles, and smoke extent is shaded in gray. 50 m (green), 500 m (blue) and 1000 m (red) HYSPLIT back-trajectories ending on June 19, 2015, at 18:00 UTC are overlaid. HYSPLIT trajectories use 40-km NAM meteorology.

The subset of meteorologically similar days included in the similar day analysis in Section 3.3.2 includes a date - June 8, 2018 - where ozone measurements in Clark County exceeded the 70-ppb standard. Figure E-2 below shows the 18:00 UTC HRRR smoke forecast on June 8, 2018, with smoke particles present in Clark County at the near-surface level. However, modelled HYSPLIT trajectories ending at 12:00 UTC do not show air intersecting any smoke plumes on June 8, 2018 (Figure E-3). Air comes from the Los Angeles basin, which is a reliable source of elevated ozone. In contrast, modelled HYSPLIT trajectories ending at 12:00 UTC on the event date show air arriving in Clark County from the same general direction, but further from the main urban center of Los Angeles (Figure E-3). Further, the overlaid HMS Smoke and Fire products in the plot of the conditions on August 7, 2020, shows air trajectories intersecting a smoke plume. It also shows the penetration of the smoke plume into the boundaries of Clark County.

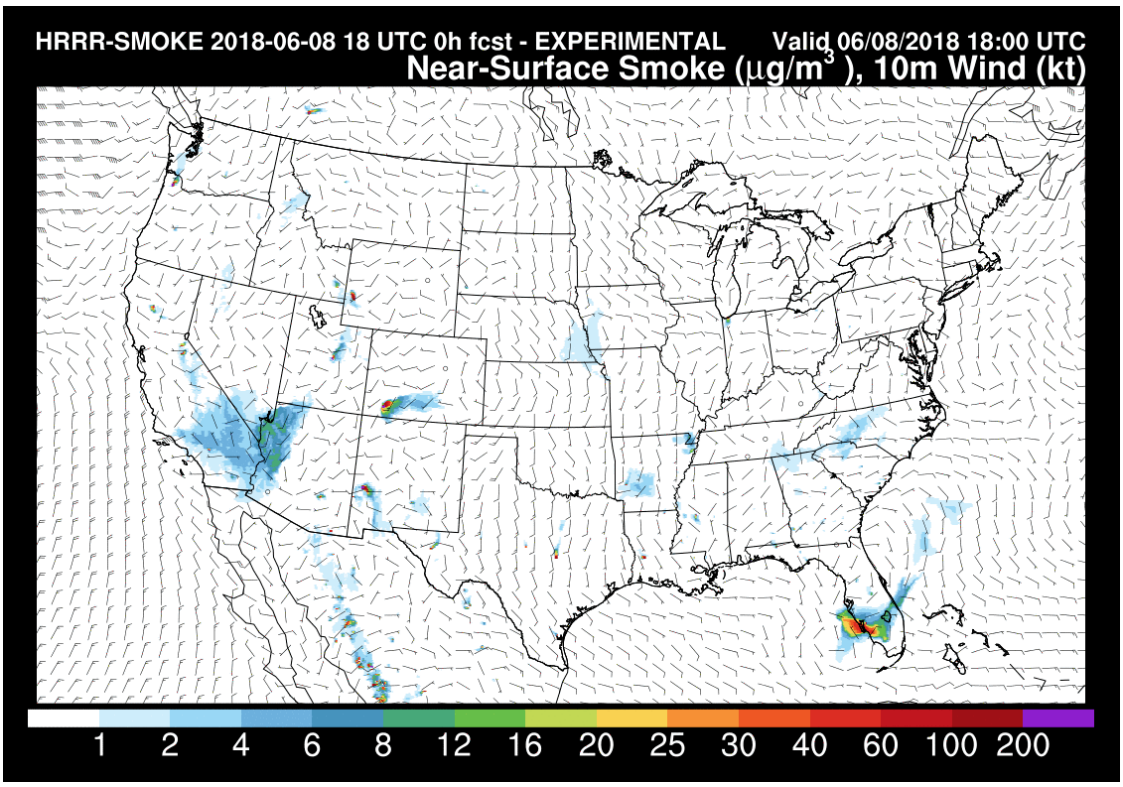


Figure E-2. HRRR-SMOKE forecast for June 8, 2018, at 18:00 UTC.

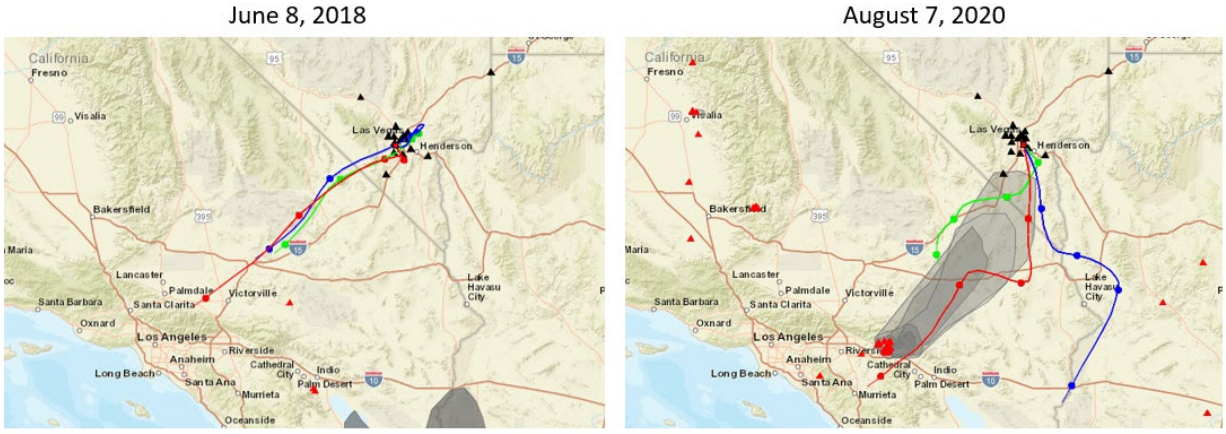


Figure E-3. 50 m (green), 500 m (blue) and 1000 m (green) HYSPLIT back-trajectories ending at 12:00 UTC on June 8, 2018, and August 7, 2020, calculated using NAM 40-km and NAM 12-km meteorology respectively. HMS Smoke and Fire products are overlaid. Shaded grey areas represent the extent of smoke plumes on each date, and red triangles represent active fires.

Identification of matching meteorologically similar days includes a comparison of meteorology maps between August 7, 2020, and each date subset from candidate matching days. Surface and upper-level maps for August 7, 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 August 7, 2020, and each date in Table 3-14 are shown in Figure E-4 through E-20. 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 August 7, 2020, and each date in Table 3-14 are shown in Figure E-21 through E-39.

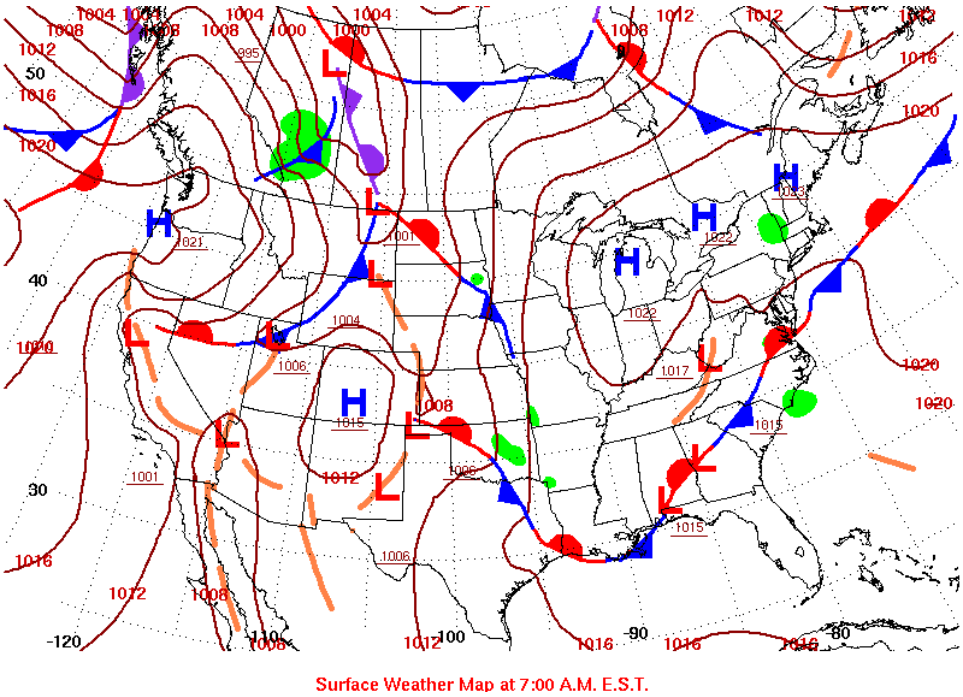


Figure E-4. Surface meteorology map on August 7, 2020 (the event date).

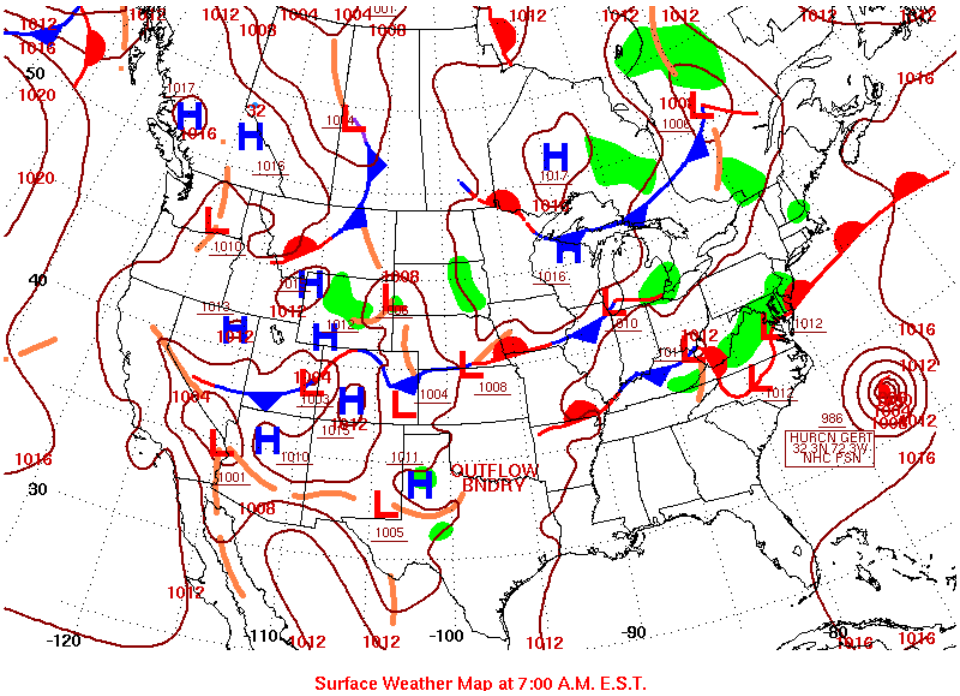


Figure E-5. Surface meteorology map on August 15, 2017.

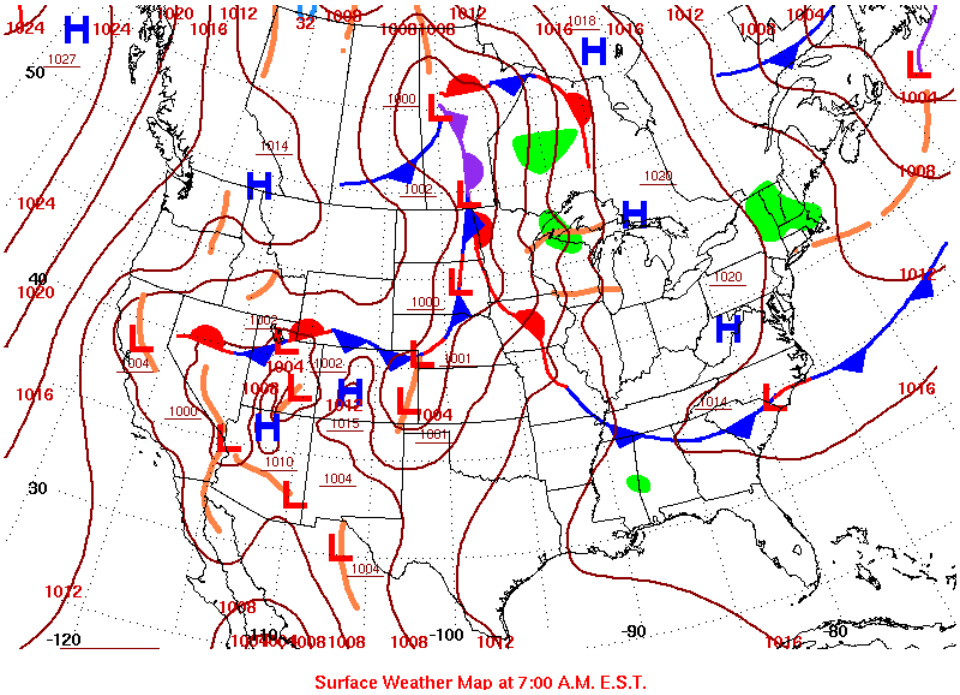


Figure E-6. Surface meteorology map on June 15, 2018.

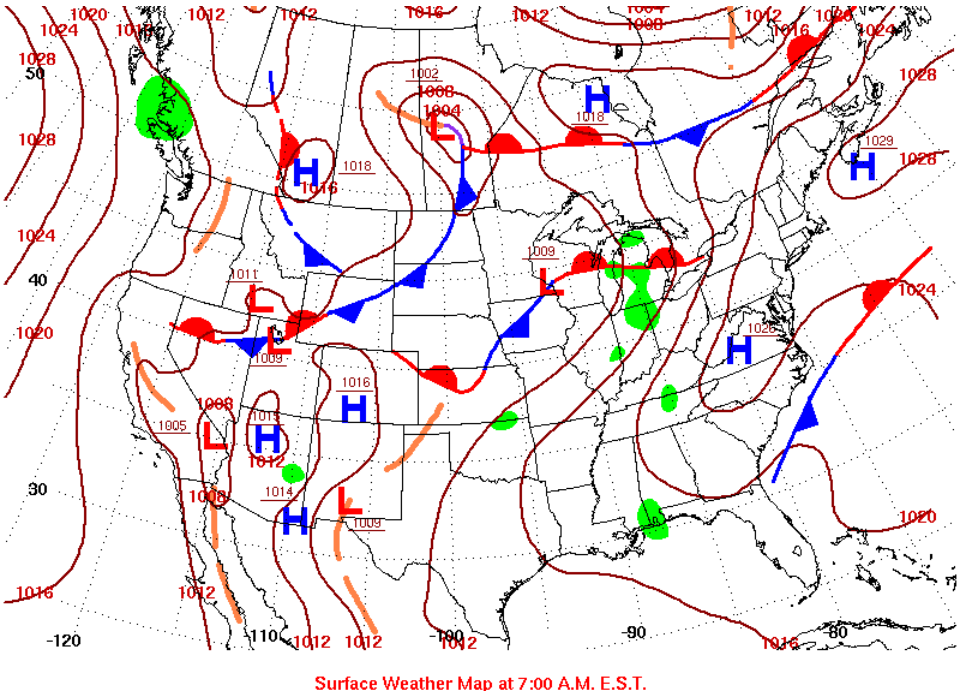


Figure E-7. Surface meteorology map on August 25, 2018.

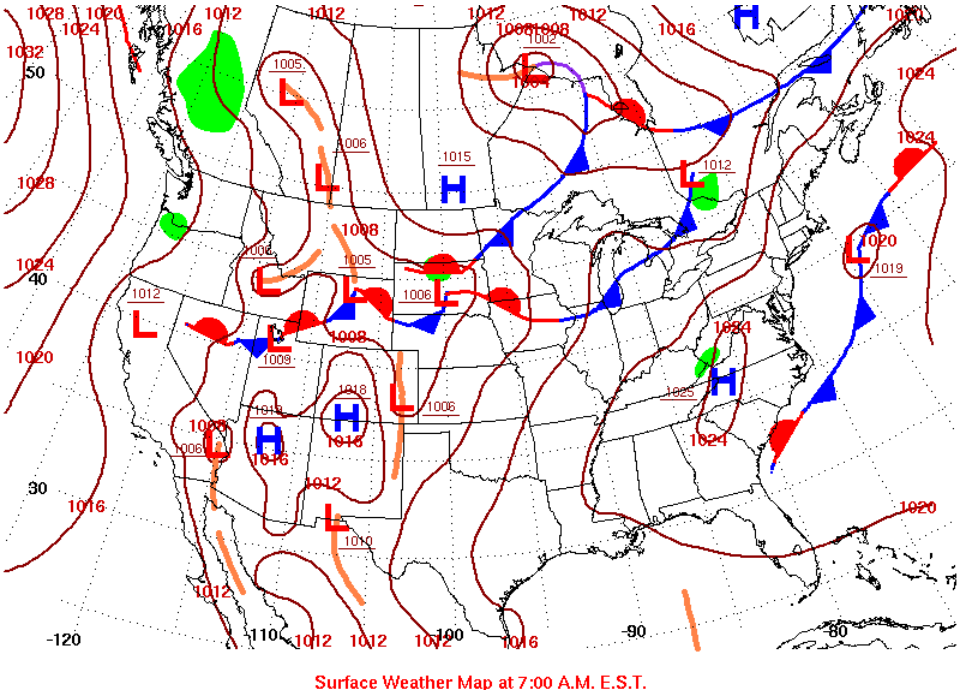


Figure E-8. Surface meteorology map on August 26, 2018.

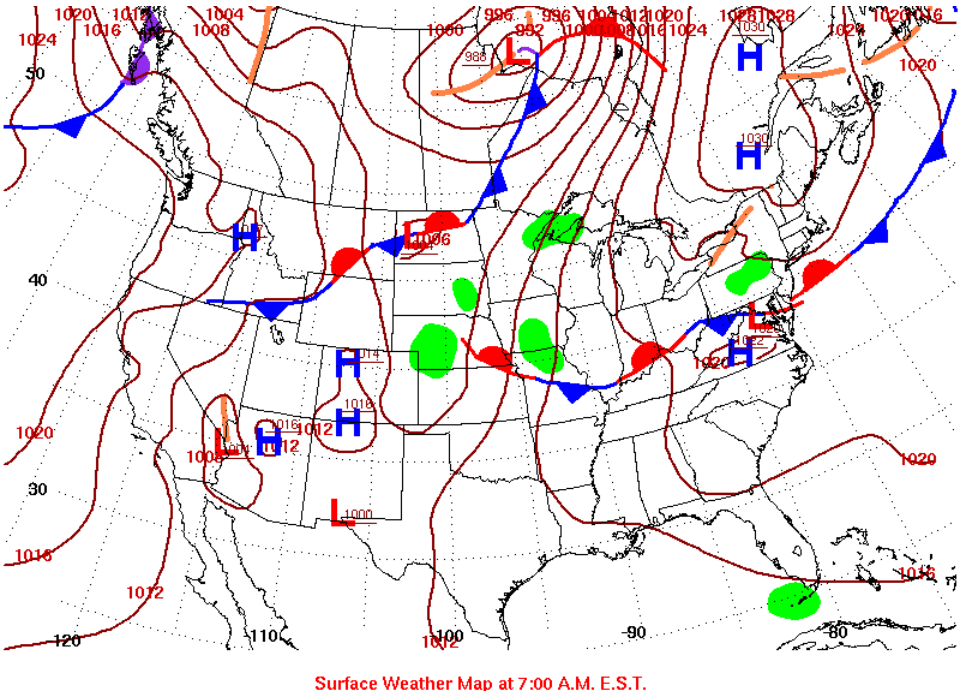


Figure E-9. Surface meteorology map on August 31, 2018.

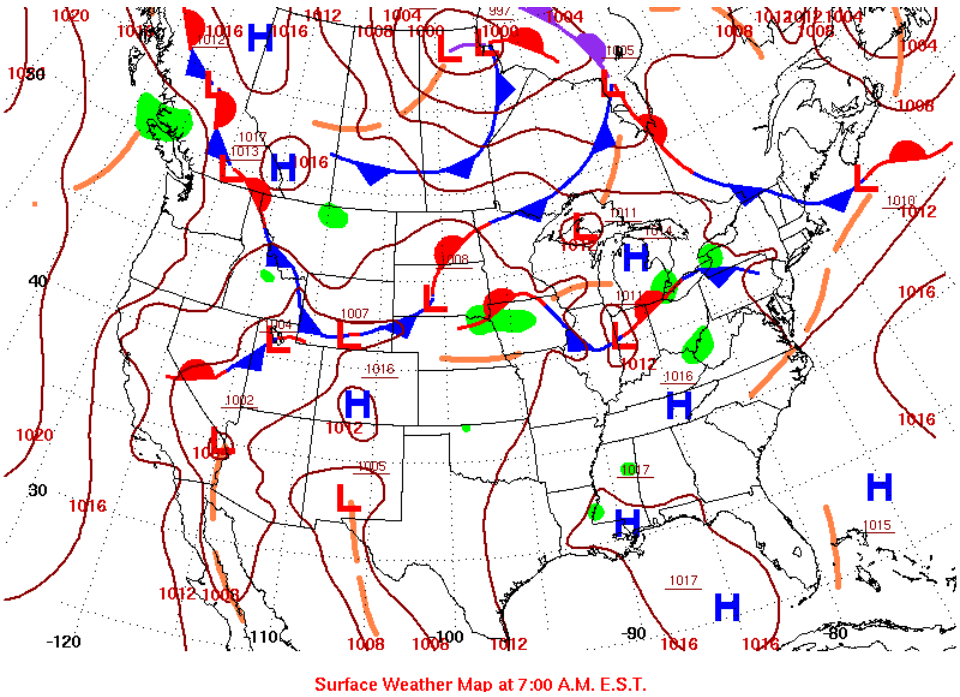


Figure E-10. Surface meteorology map on July 3, 2019.

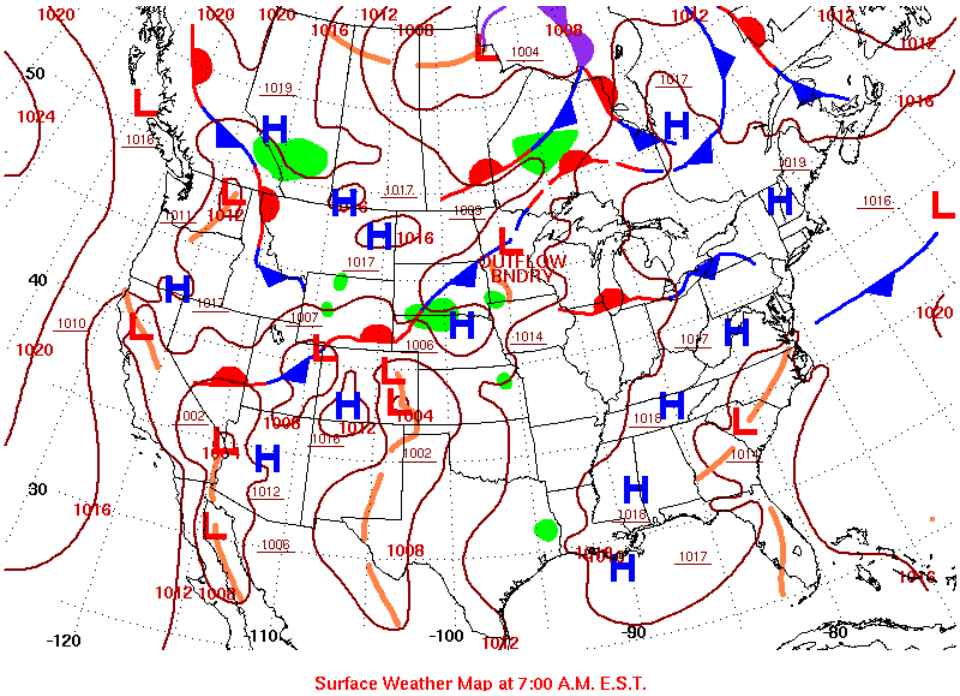


Figure E-11. Surface meteorology map on July 4, 2019.

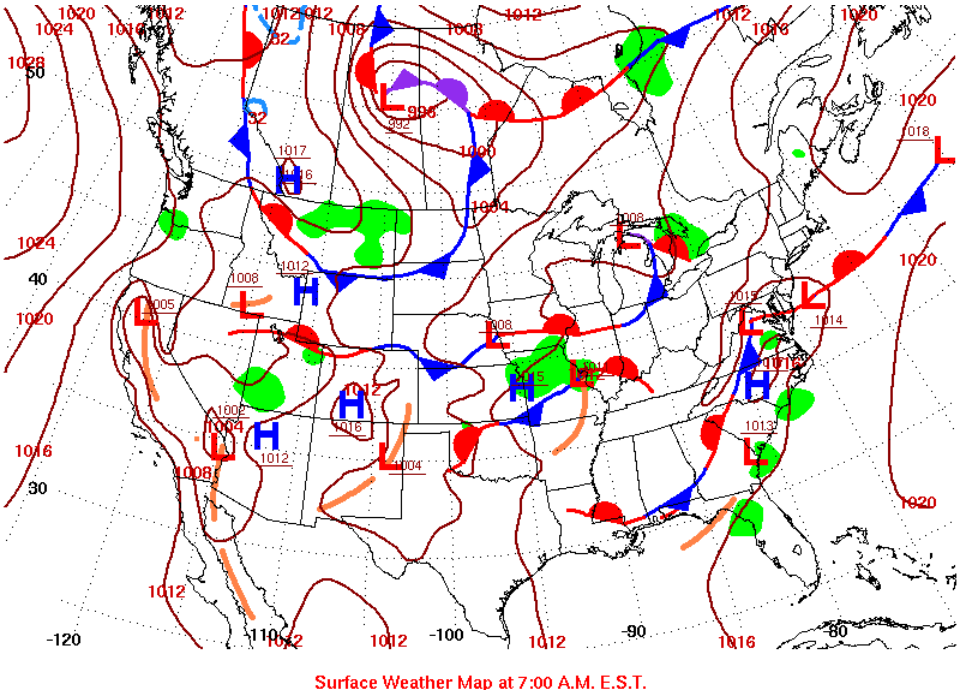


Figure E-12. Surface meteorology map on August 17, 2019.

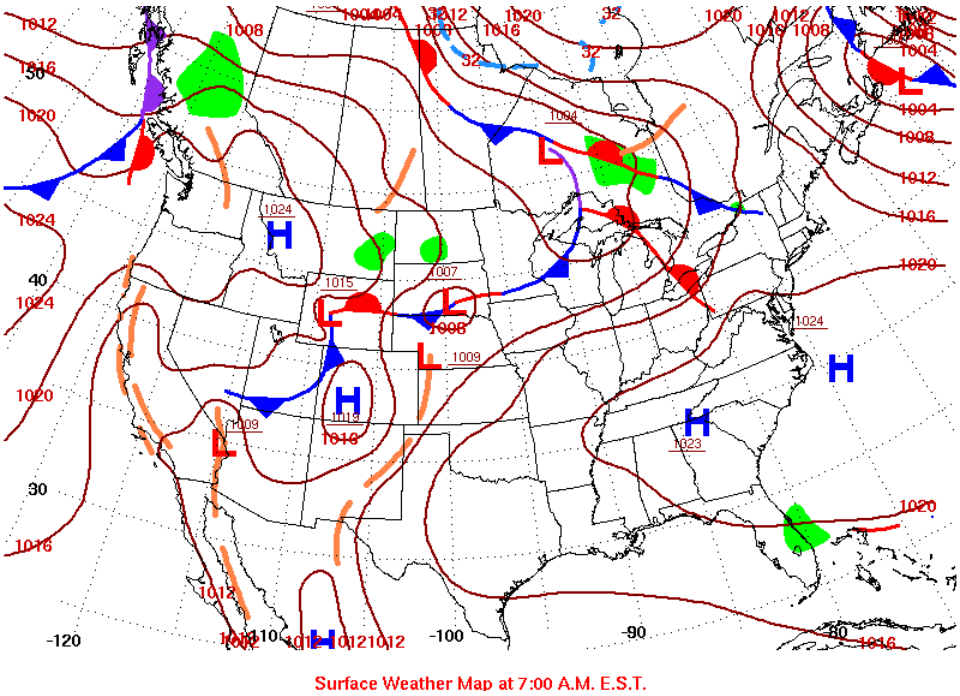


Figure E-12. Surface meteorology map on June 2, 2020.

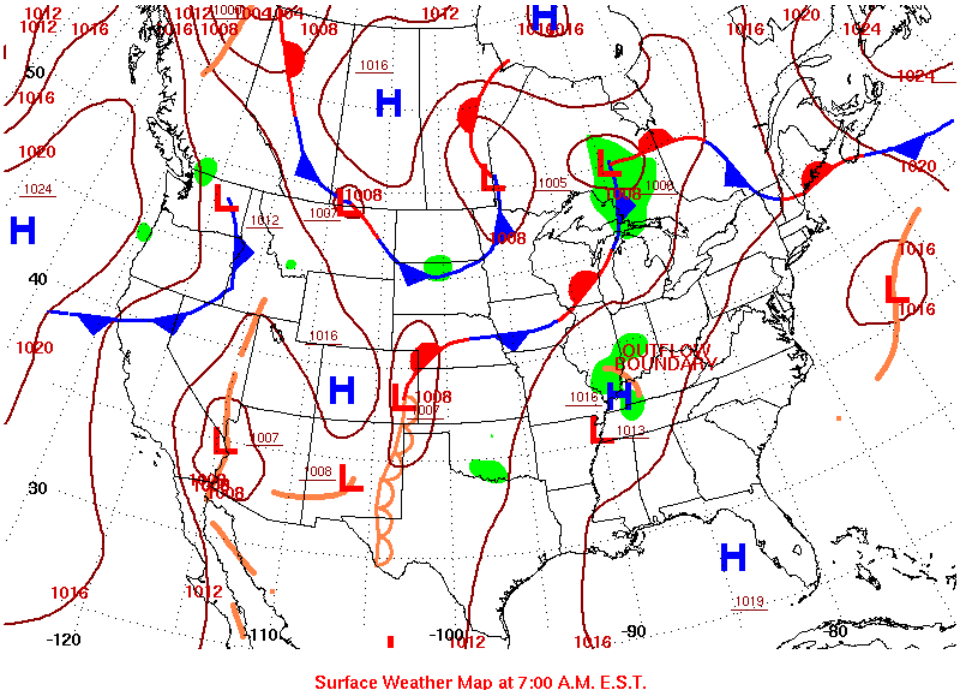


Figure E-13. Surface meteorology map on June 21, 2020.

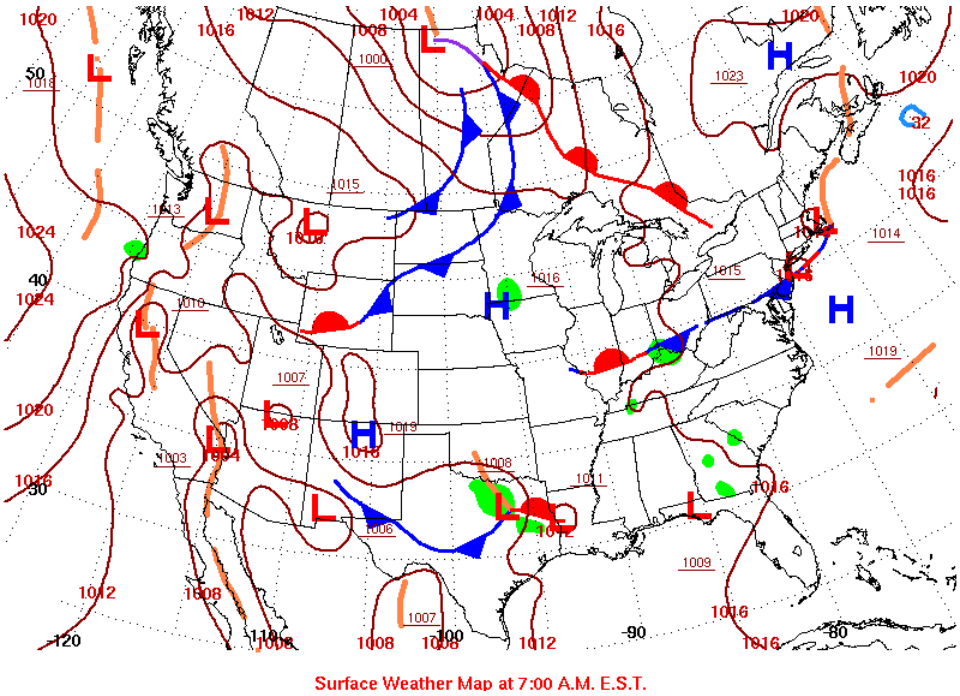


Figure E-14. Surface meteorology map on July 6, 2020.

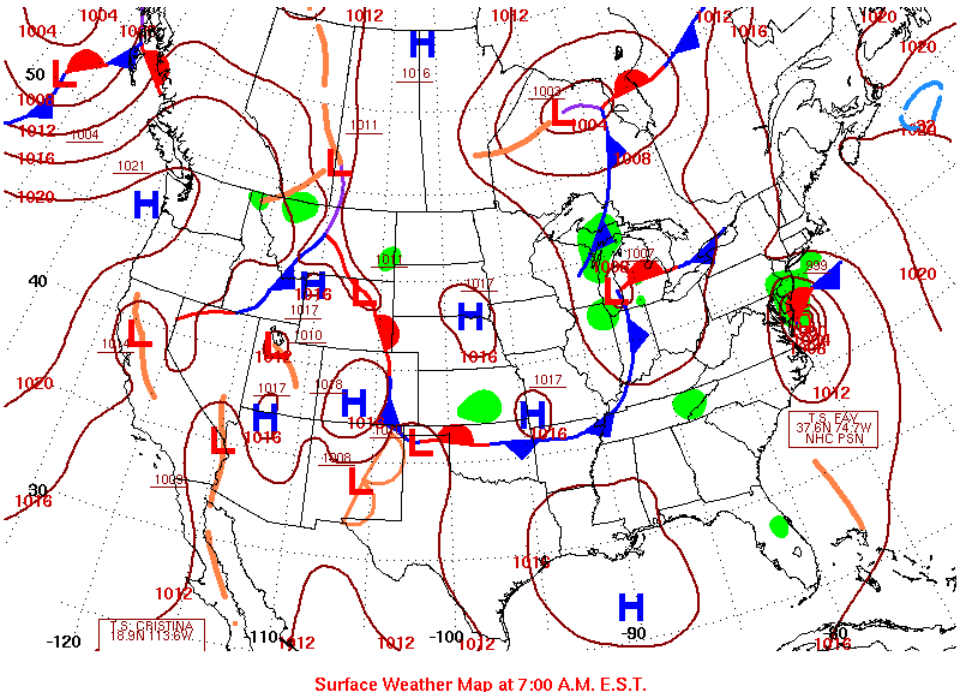


Figure E-15. Surface meteorology map on July 10, 2020.

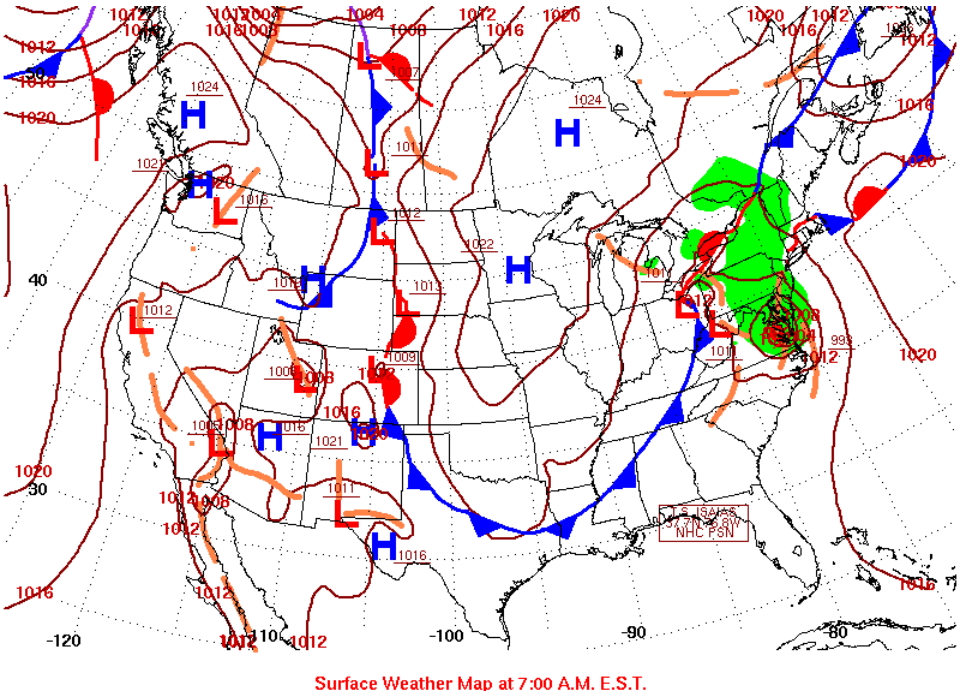


Figure E-16. Surface meteorology map on August 4, 2020.

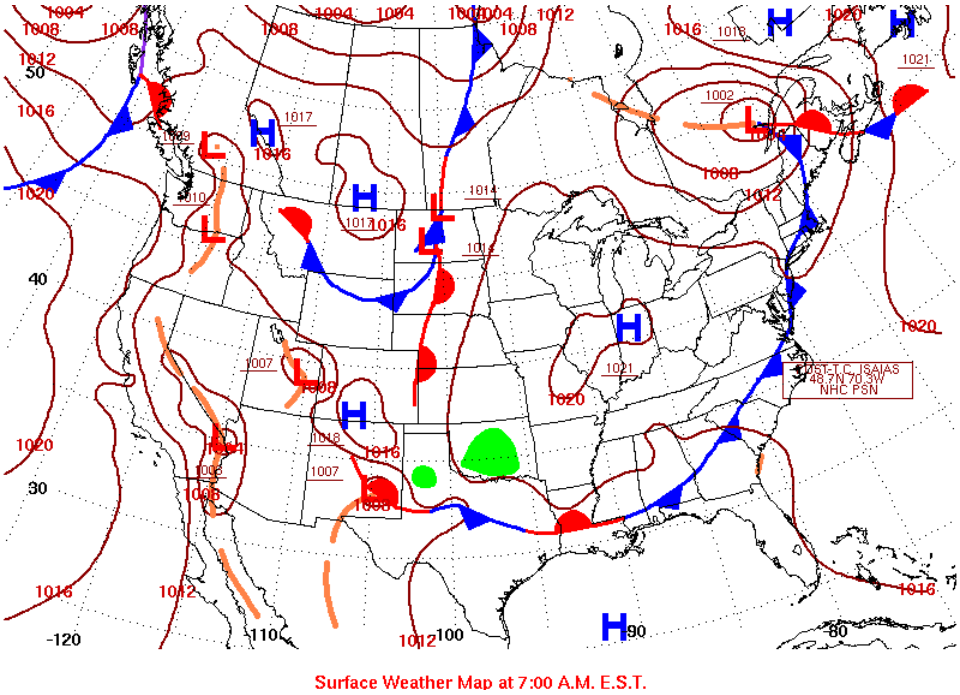


Figure E-17. Surface meteorology map on August 5, 2020.

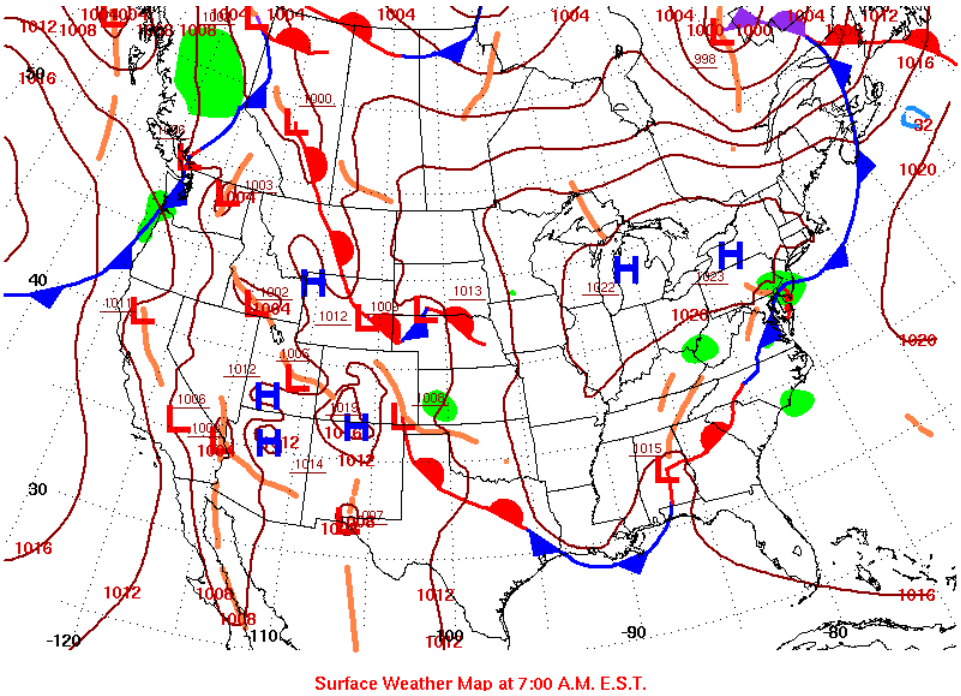


Figure E-18. Surface meteorology map on August 6, 2020.

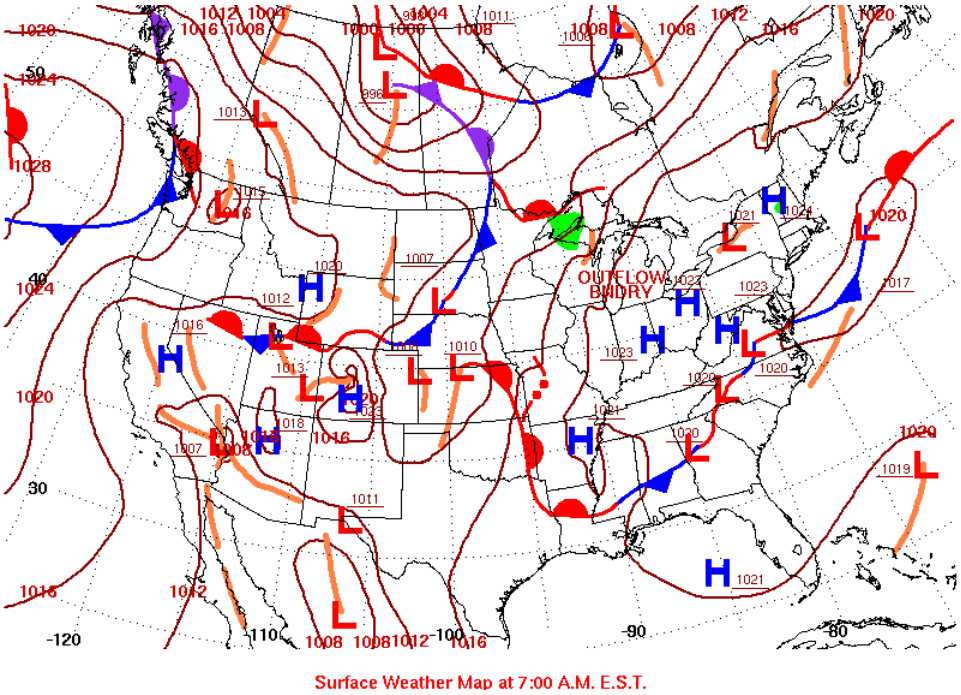


Figure E-19. Surface meteorology map on August 8, 2020.

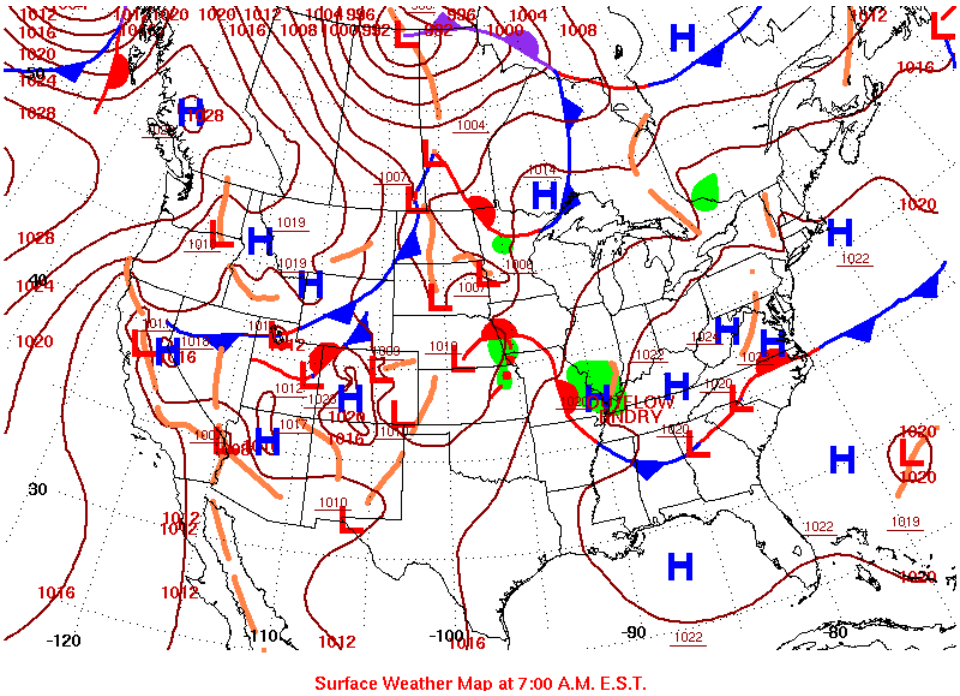


Figure E-20. Surface meteorology map on August 9, 2020.

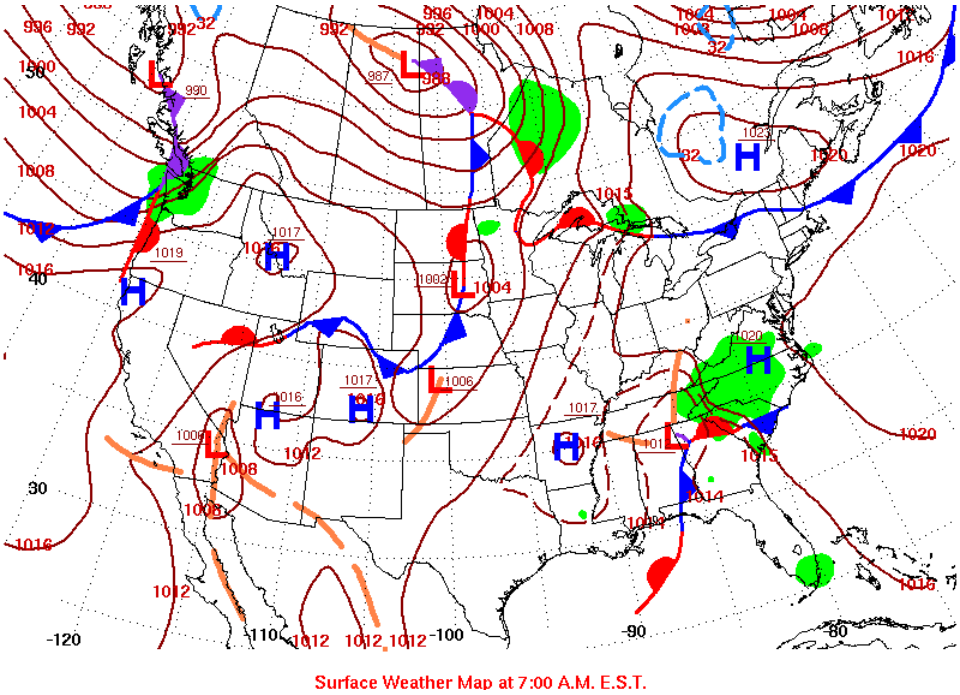


Figure E-20. Surface meteorology map on September 25, 2020.

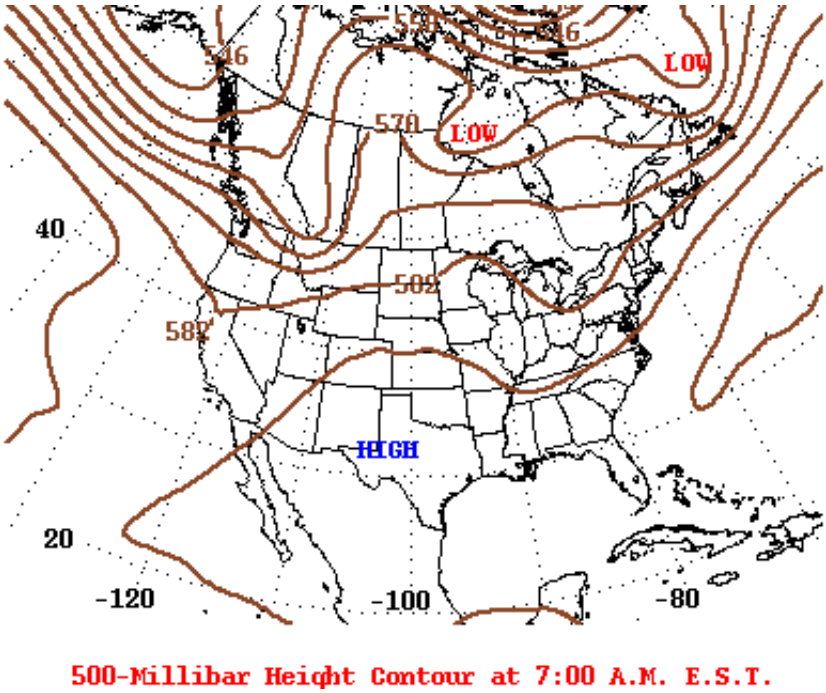


Figure E-21. 500 mb meteorology map on August 7, 2020 (the event date).

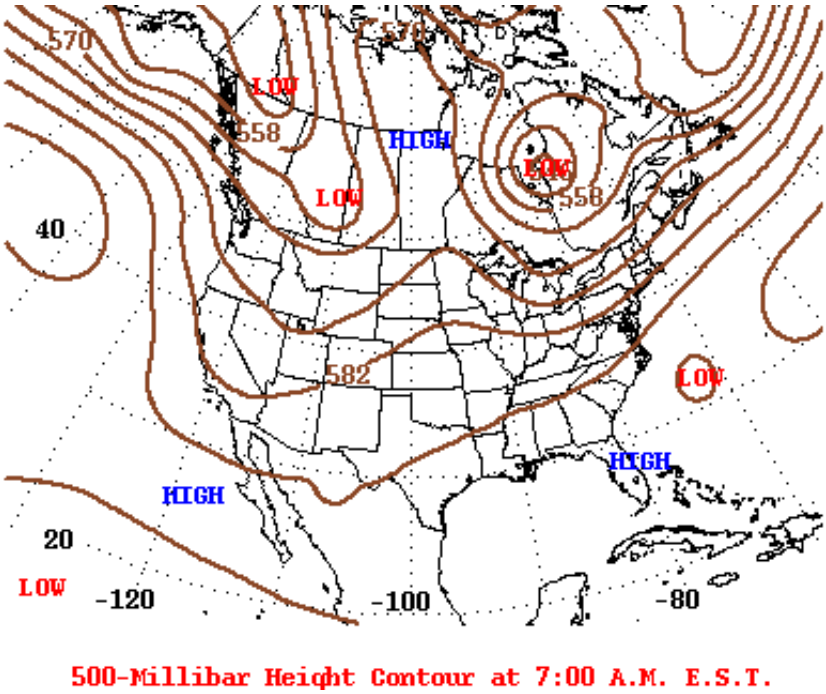


Figure E-22. 500 mb meteorology map on August 15, 2017.

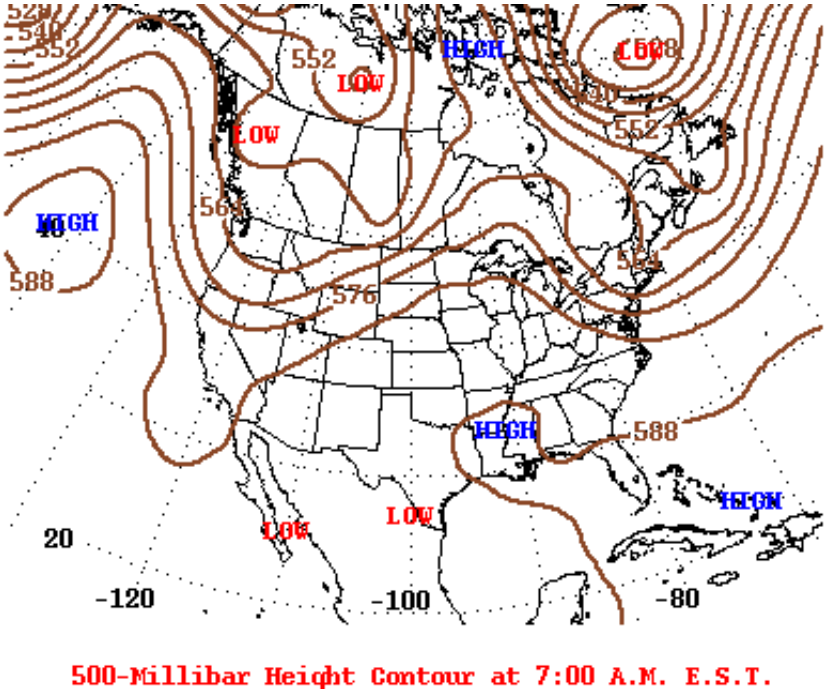


Figure E-23. 500 mb meteorology map on June 15, 2018.

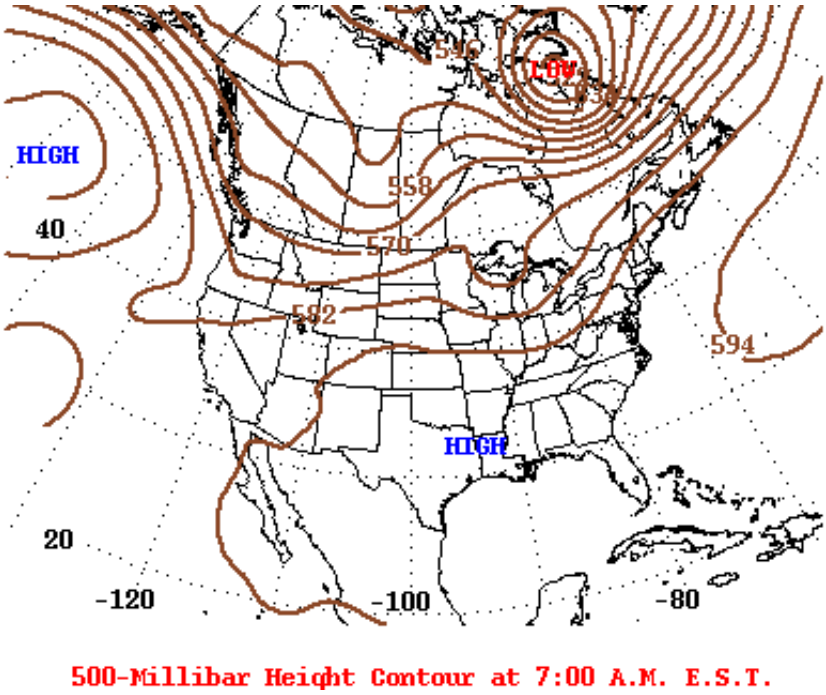


Figure E-24. 500 mb meteorology map on August 25, 2018.

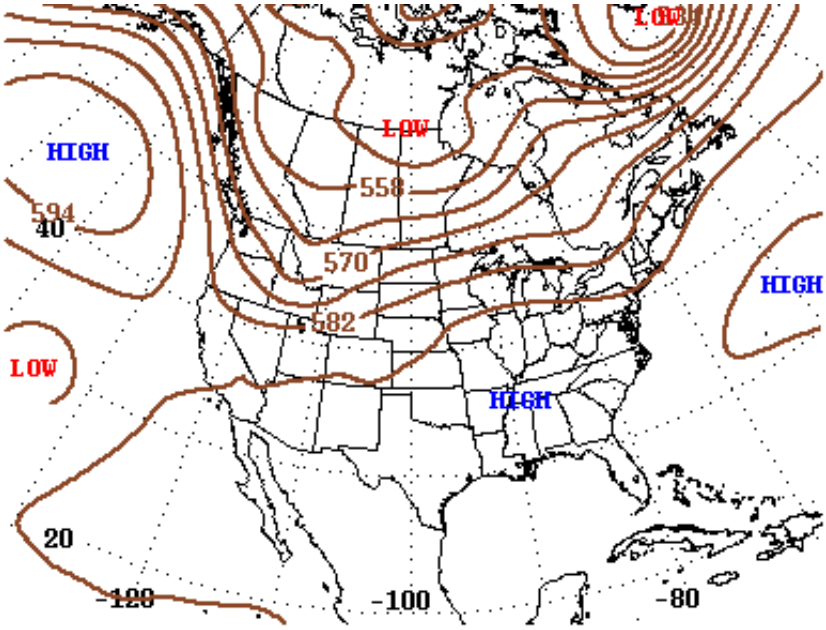


Figure E-25. 500 mb meteorology map on August 26, 2018.

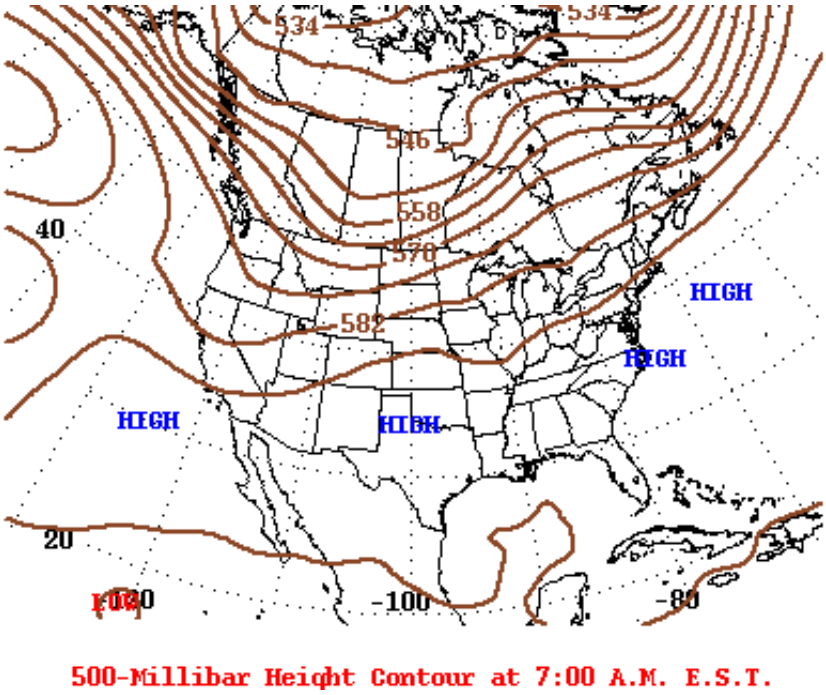


Figure E-26. 500 mb meteorology map on August 31, 2018.

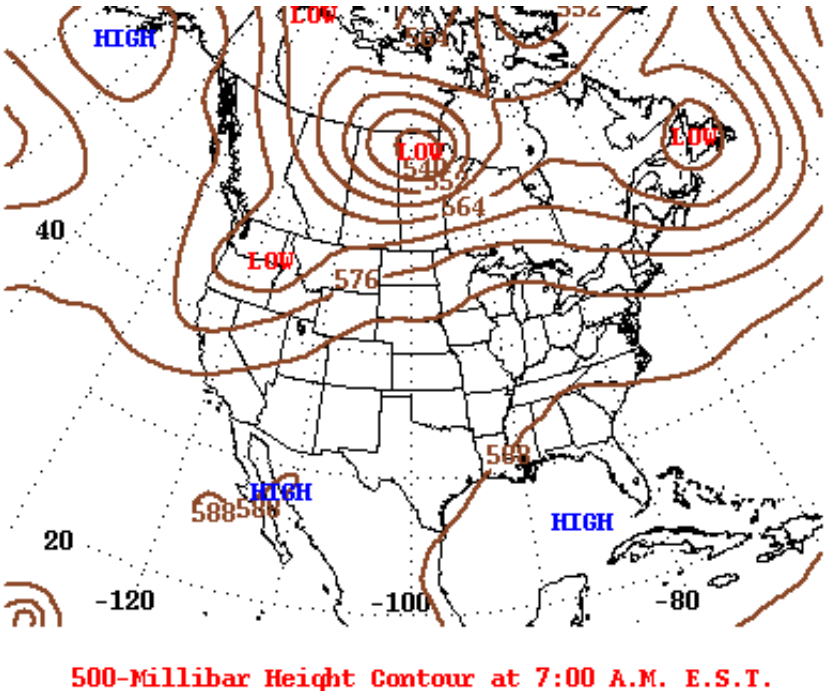


Figure E-27. 500 mb meteorology map on July 3, 2019.

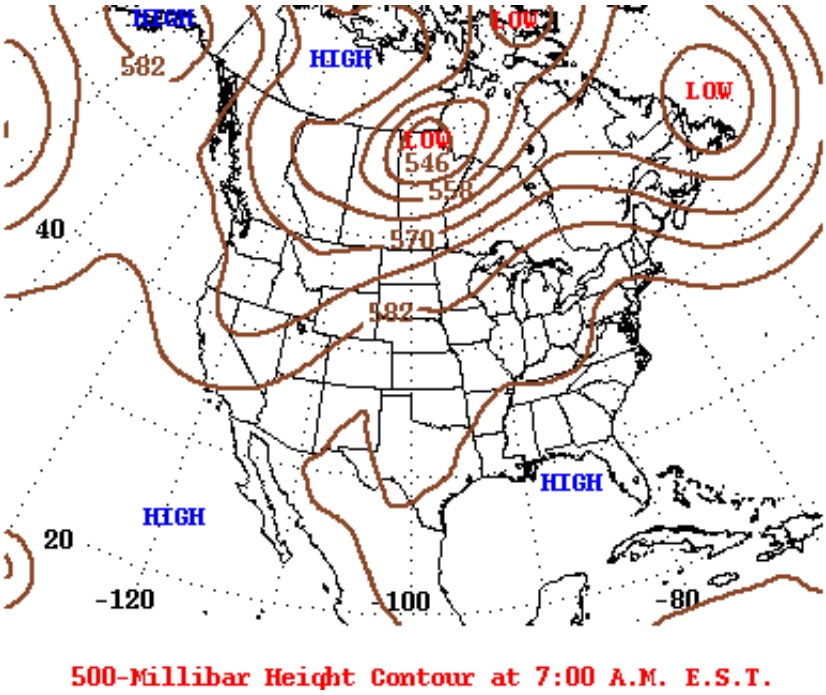
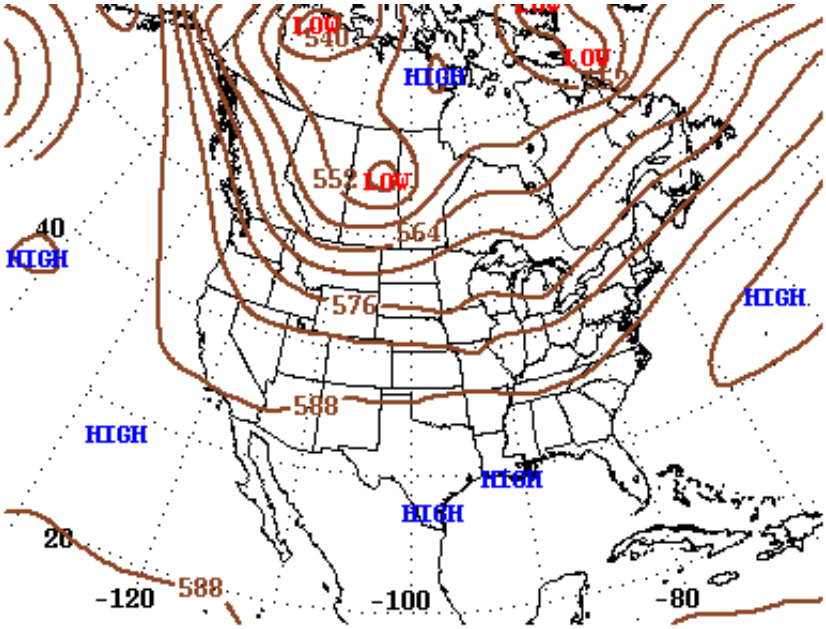
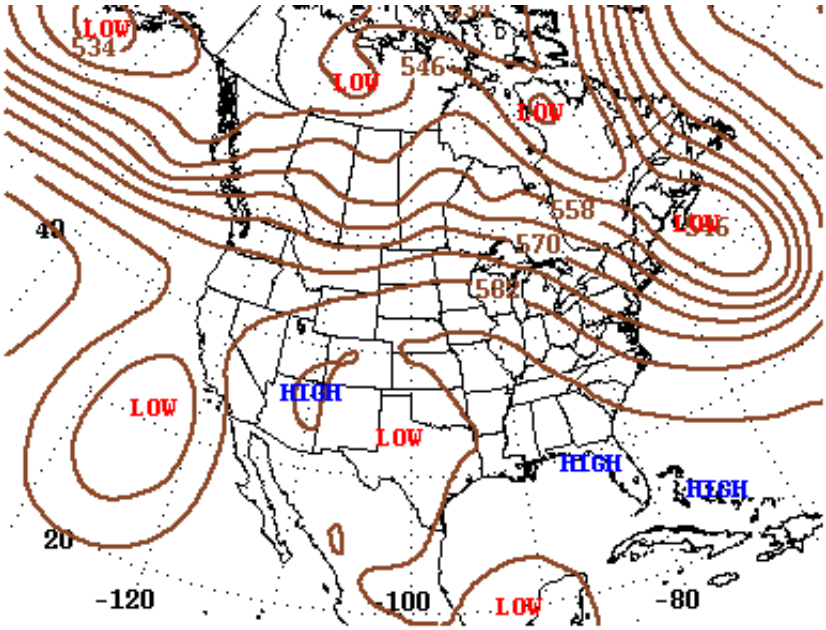


Figure E-28. 500 mb meteorology map on July 4, 2019.



500-Millibar Height Contour at 7:00 A.M. E.S.T.

Figure E-29. 500 mb meteorology map on August 17, 2019.



500-Millibar Height Contour at 7:00 A.M. E.S.T.

Figure E-30. 500 mb meteorology map on June 2, 2020.

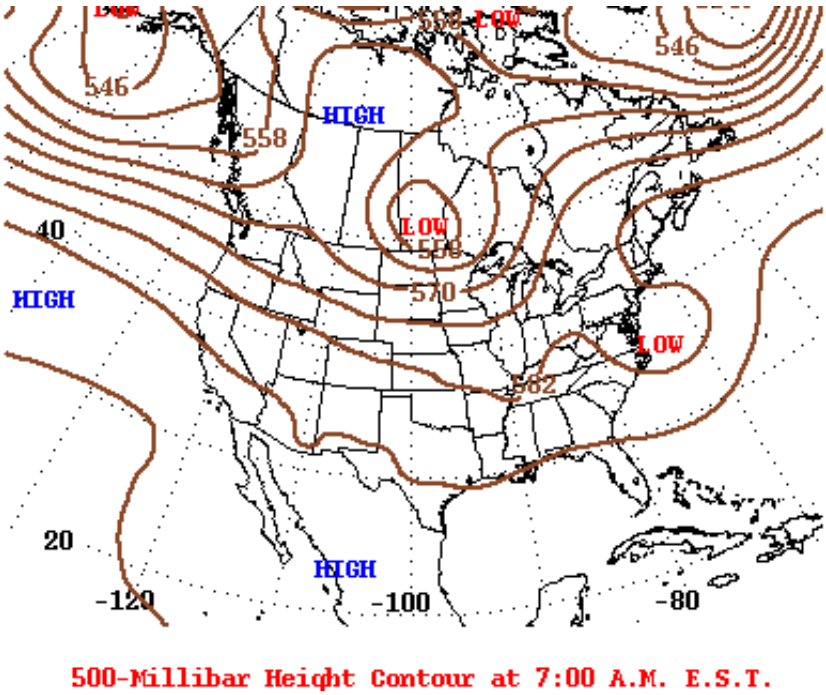


Figure E-31. 500 mb meteorology map on June 21, 2020.

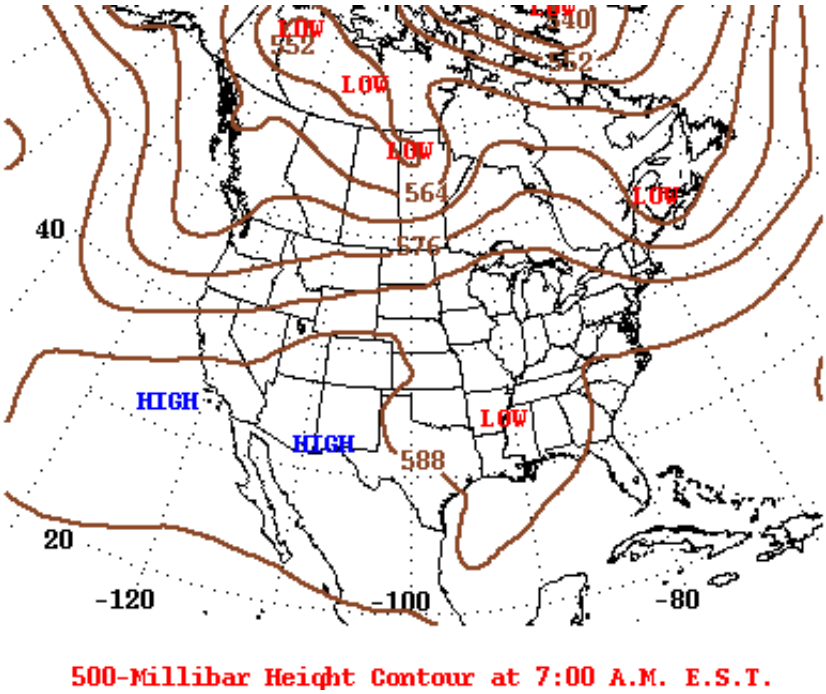


Figure E-32. 500 mb meteorology map on July 6, 2020.

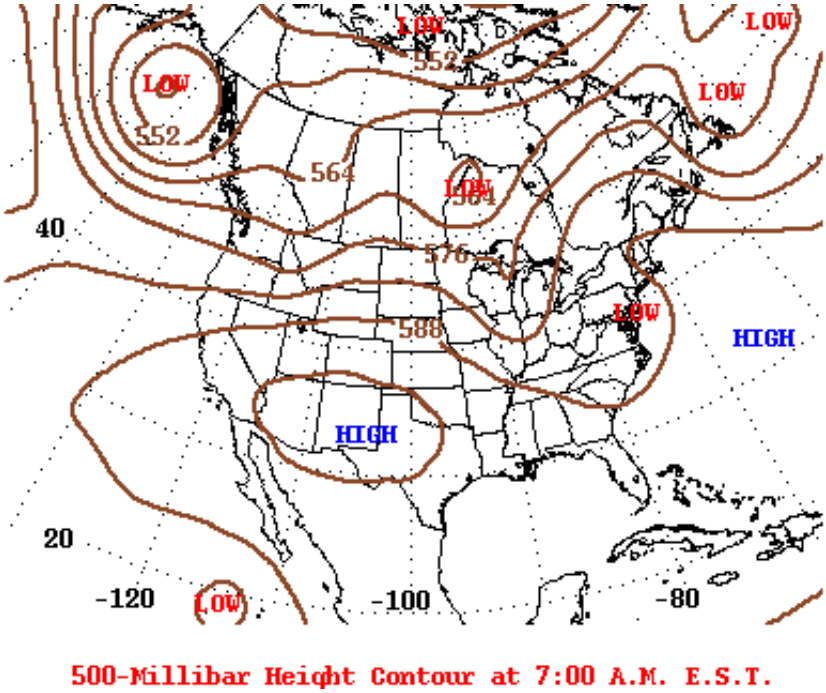


Figure E-33. 500 mb meteorology map on July 10, 2020.

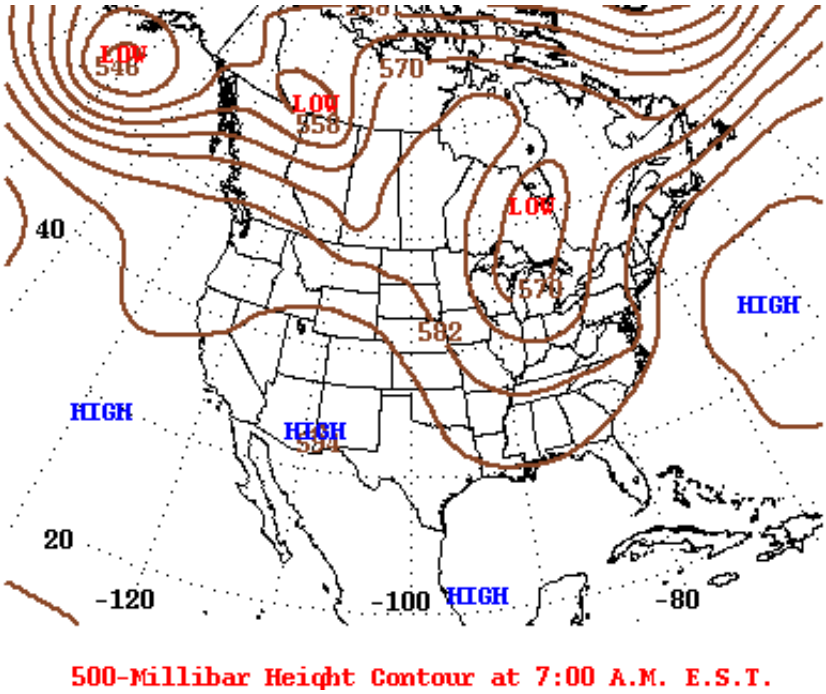


Figure E-34. 500 mb meteorology map on August 4, 2020.

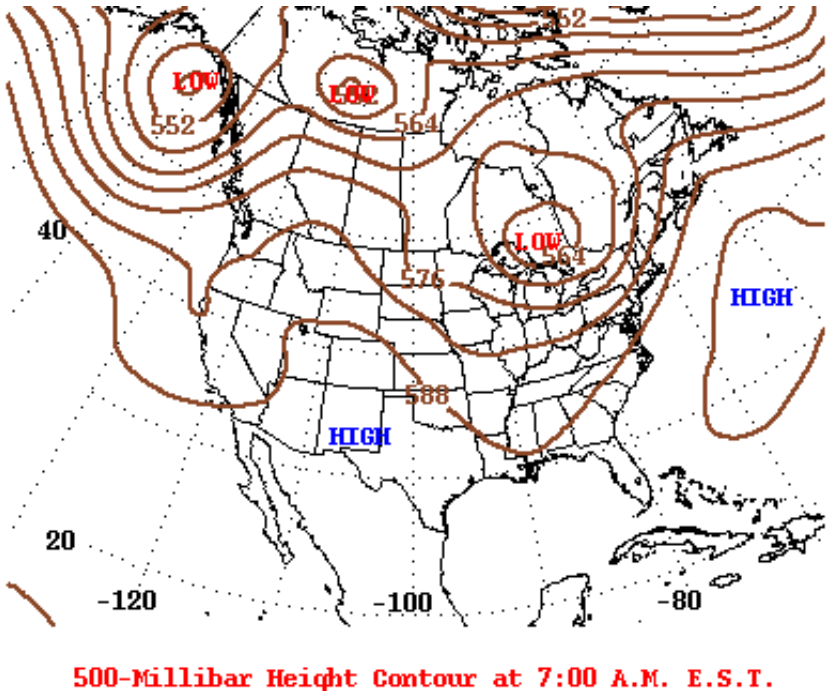


Figure E-35. 500 mb meteorology map on August 5, 2020.

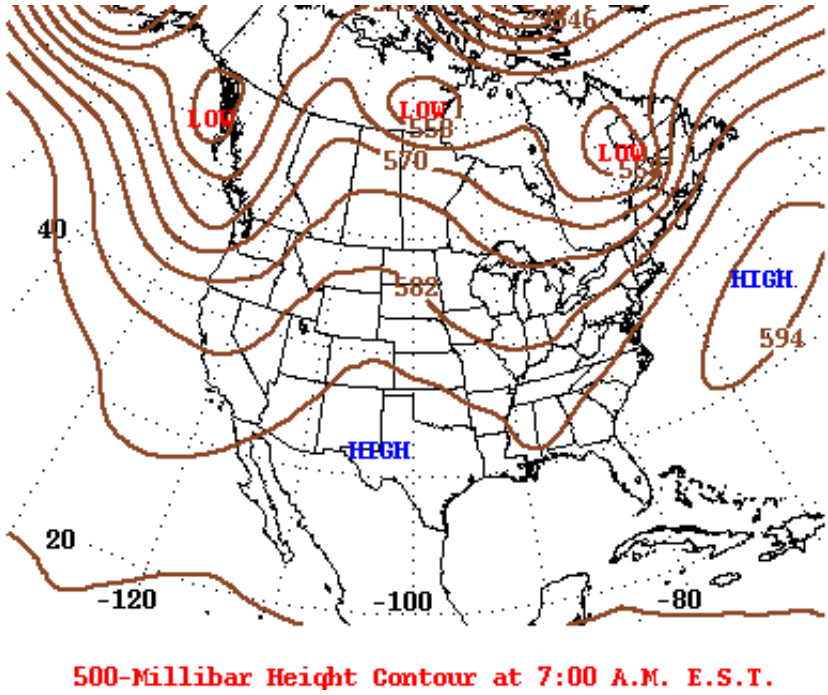


Figure E-36. 500 mb meteorology map on August 6, 2020.

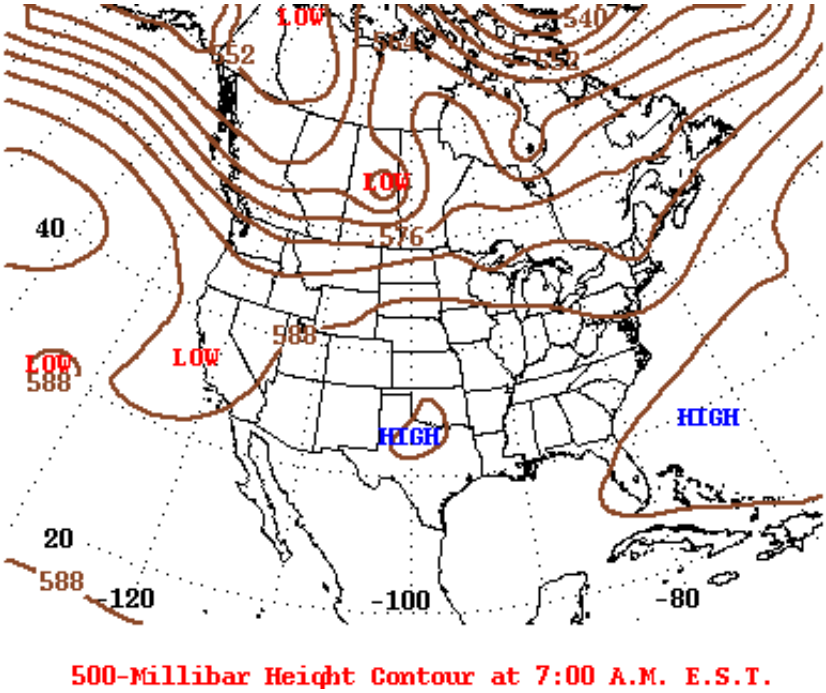


Figure E-37. 500 mb meteorology map on August 8, 2020.

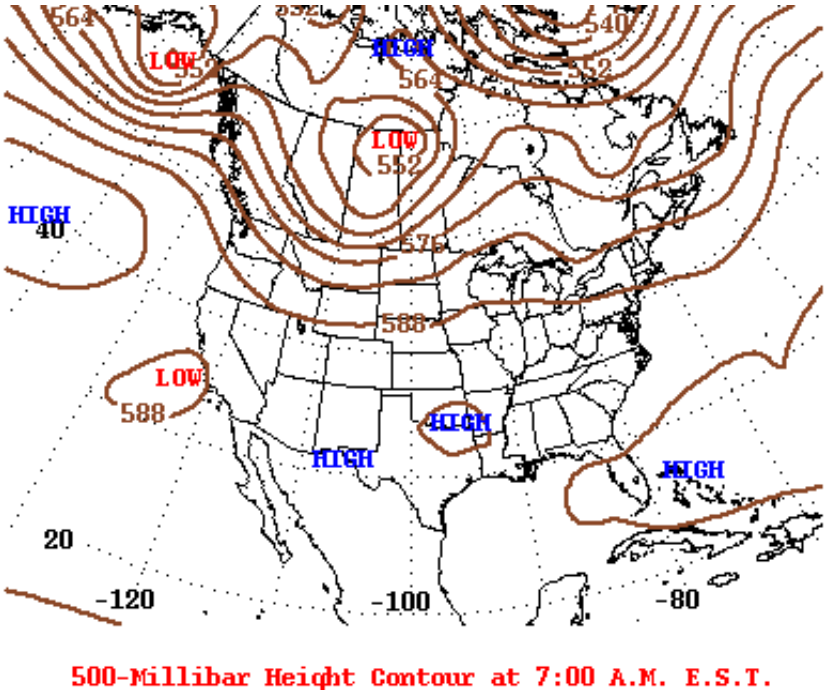


Figure E-38. 500 mb meteorology map on August 9, 2020.

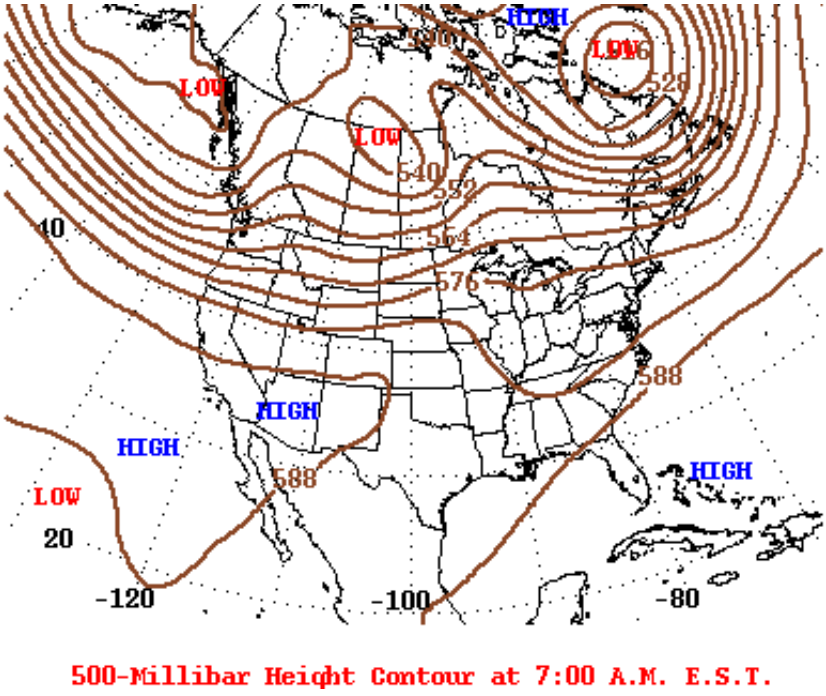


Figure E-39. 500 mb meteorology map on September 25, 2020.

Appendix F. 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 F-1**) and show no pattern or bias between GAM residuals and predicted values (TCEQ example in **Figure F-2**). These figures compare well with our GAM results in Section 3.3.3 of the main report.

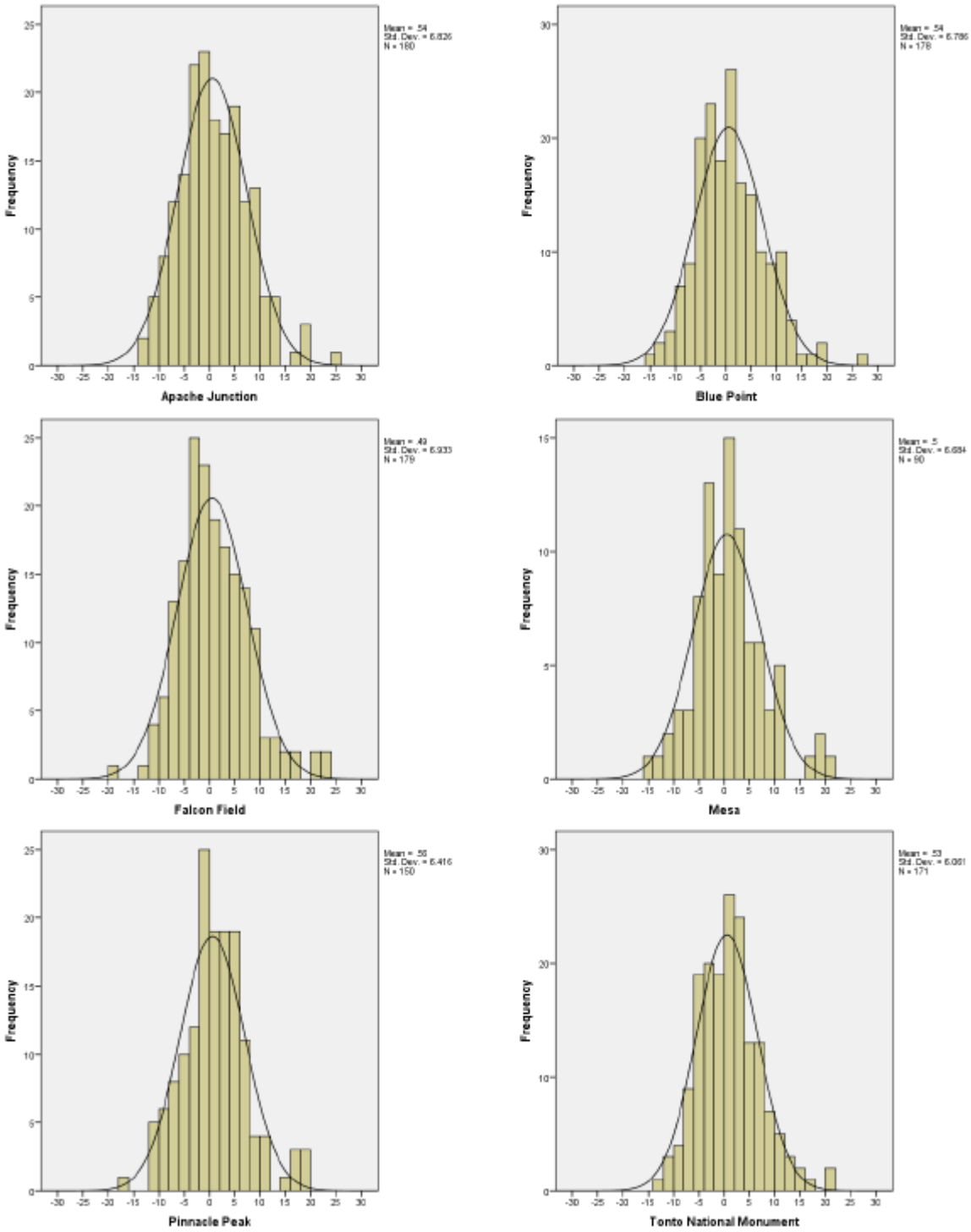


Figure F-1. Histograms of residuals results at each monitoring site from the Arizona DEQ GAM Analysis (Arizona Department of Environmental Quality 2016).

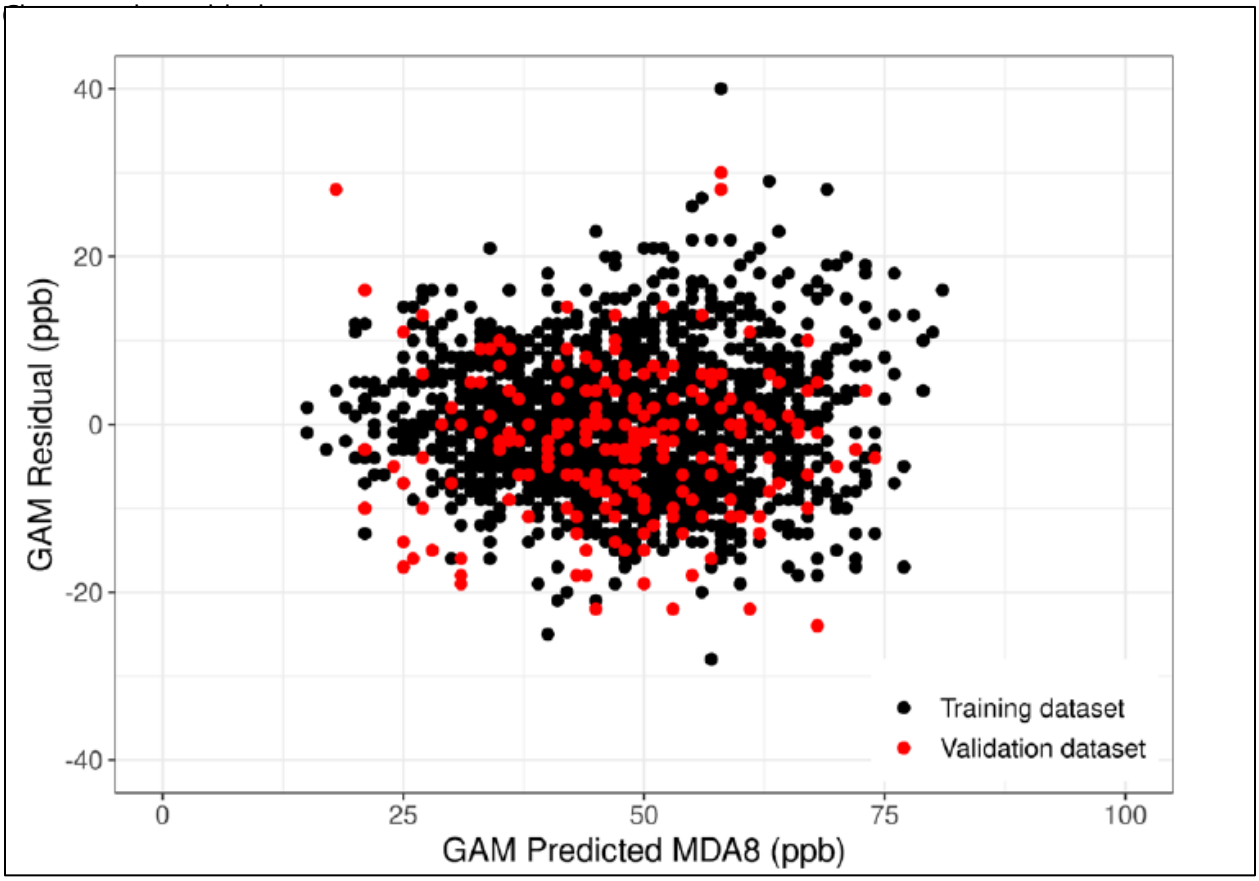


Figure F-2. Scatter plot of GAM residuals (observed – GAM predicted MDA8 ozone) vs. GAM predicted MDA8 ozone from the TCEQ submitted GAM analysis. Training data is shown in black and validation data is shown in red (Texas Commission on Environmental Quality 2021).

References

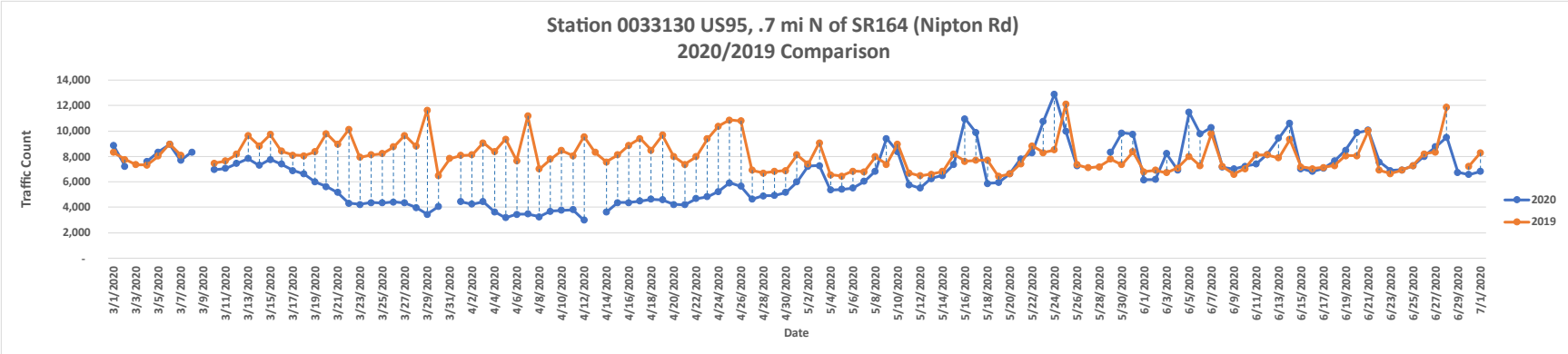
Arizona Department of Environmental Quality (2016) State of Arizona exceptional event documentation for wildfire-caused ozone exceedances on June 20, 2015 in the Maricopa nonattainment area. Final report, September. Available at https://static.azdeq.gov/pn/1609_ee_report.pdf.

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 G. 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 G-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.



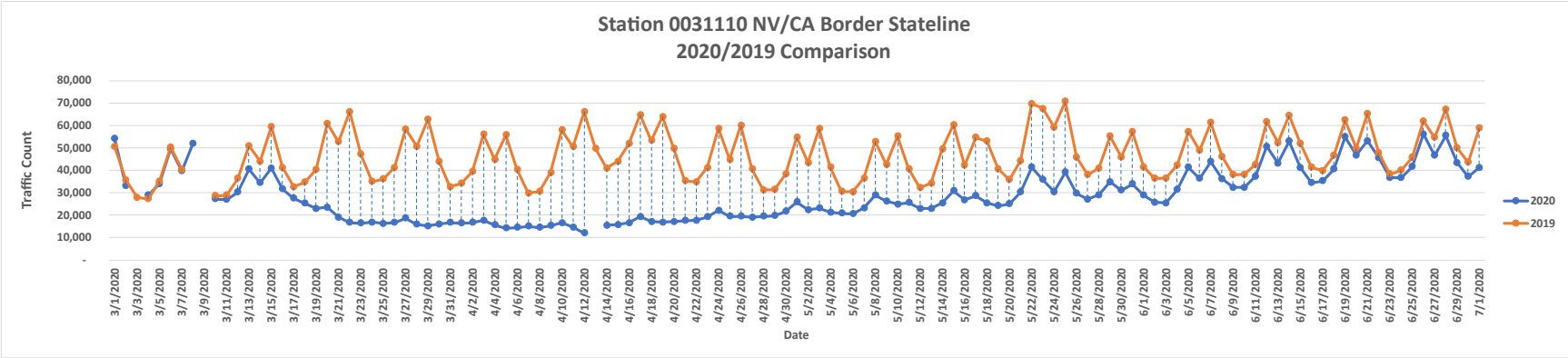


Figure G-1. Time series of 2020 and 2019 traffic counts at two stations: (top) along US95, south of Las Vegas, and (bottom) at the Nevada-California border, west of Las Vegas. Data were provided by the Nevada Department of Transportation.

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 G-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 G-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 3-45 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 3-39 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.

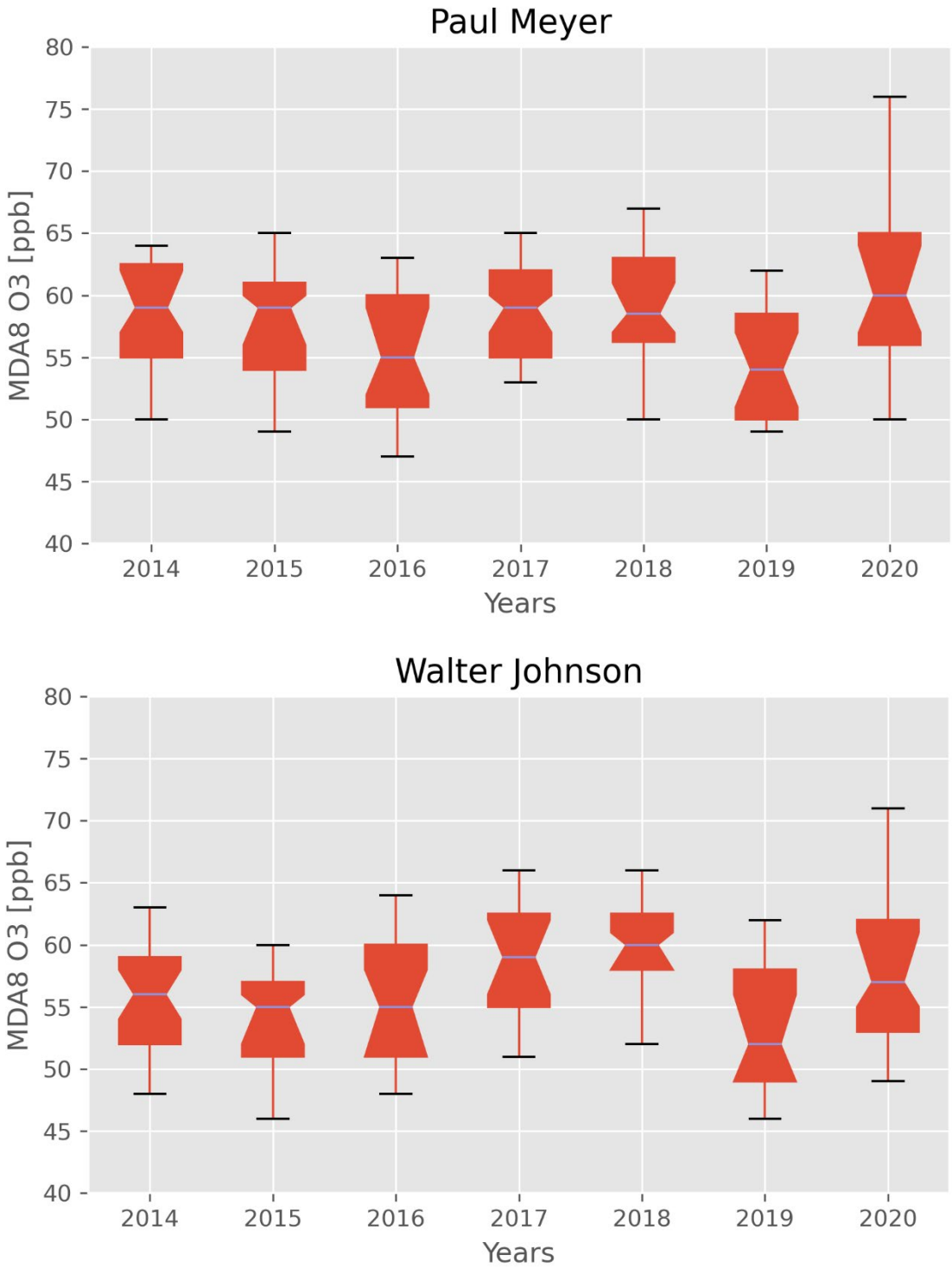


Figure G-2. Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

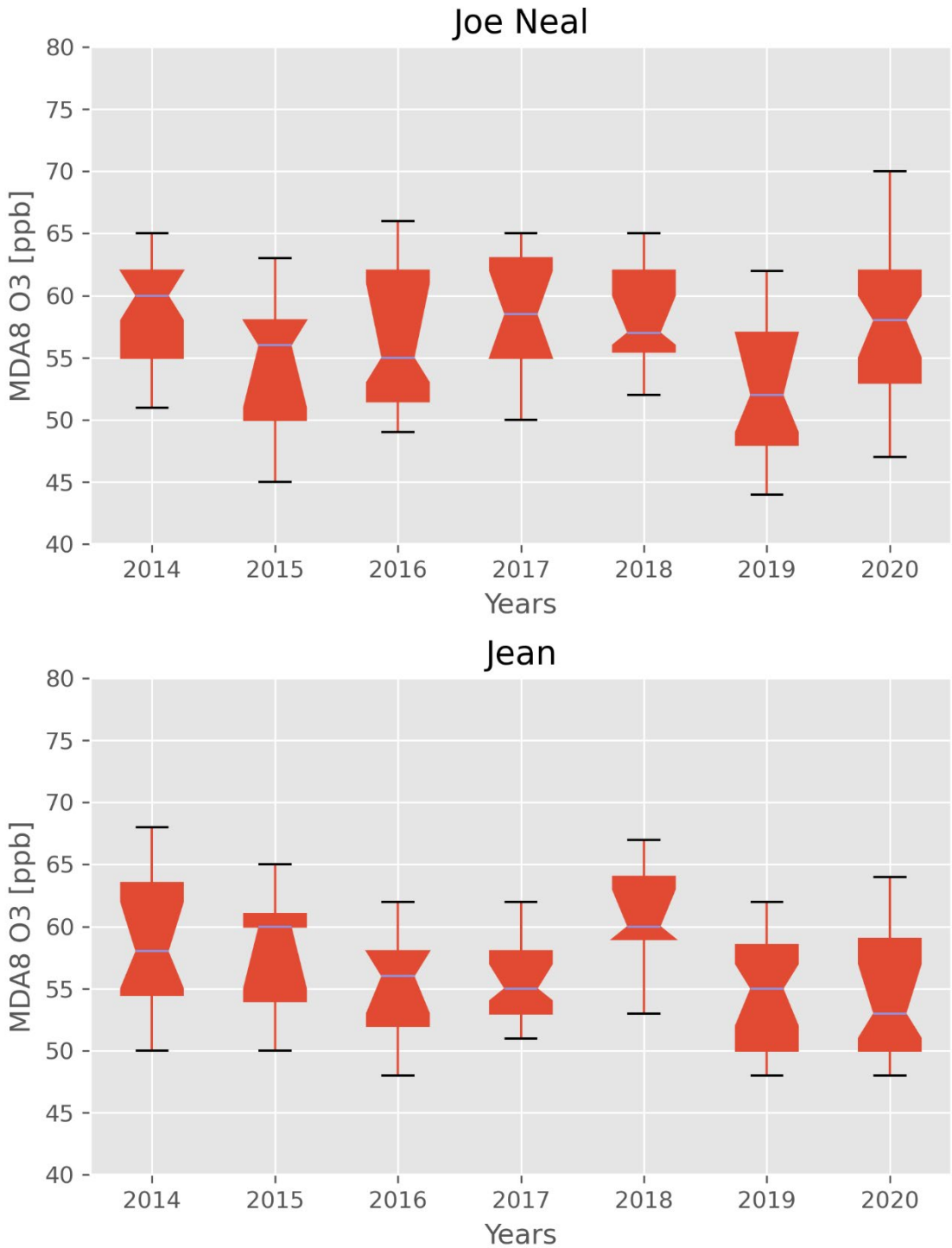
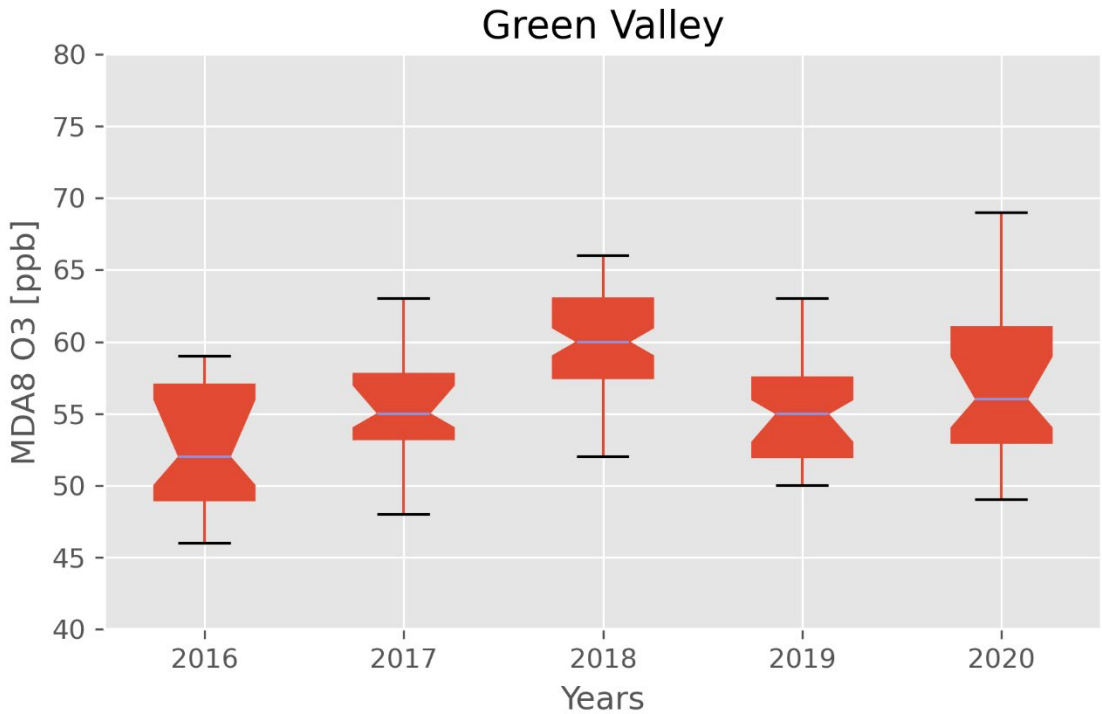


Figure G-2 (Cont.). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



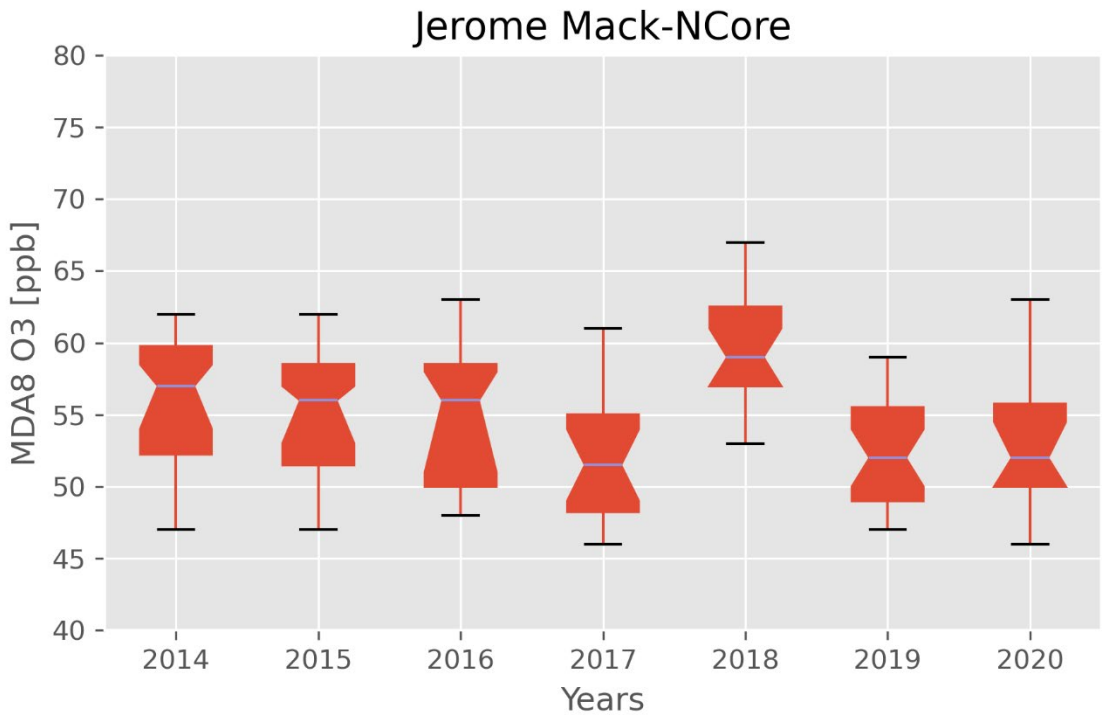


Figure G-2 (Cont.). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

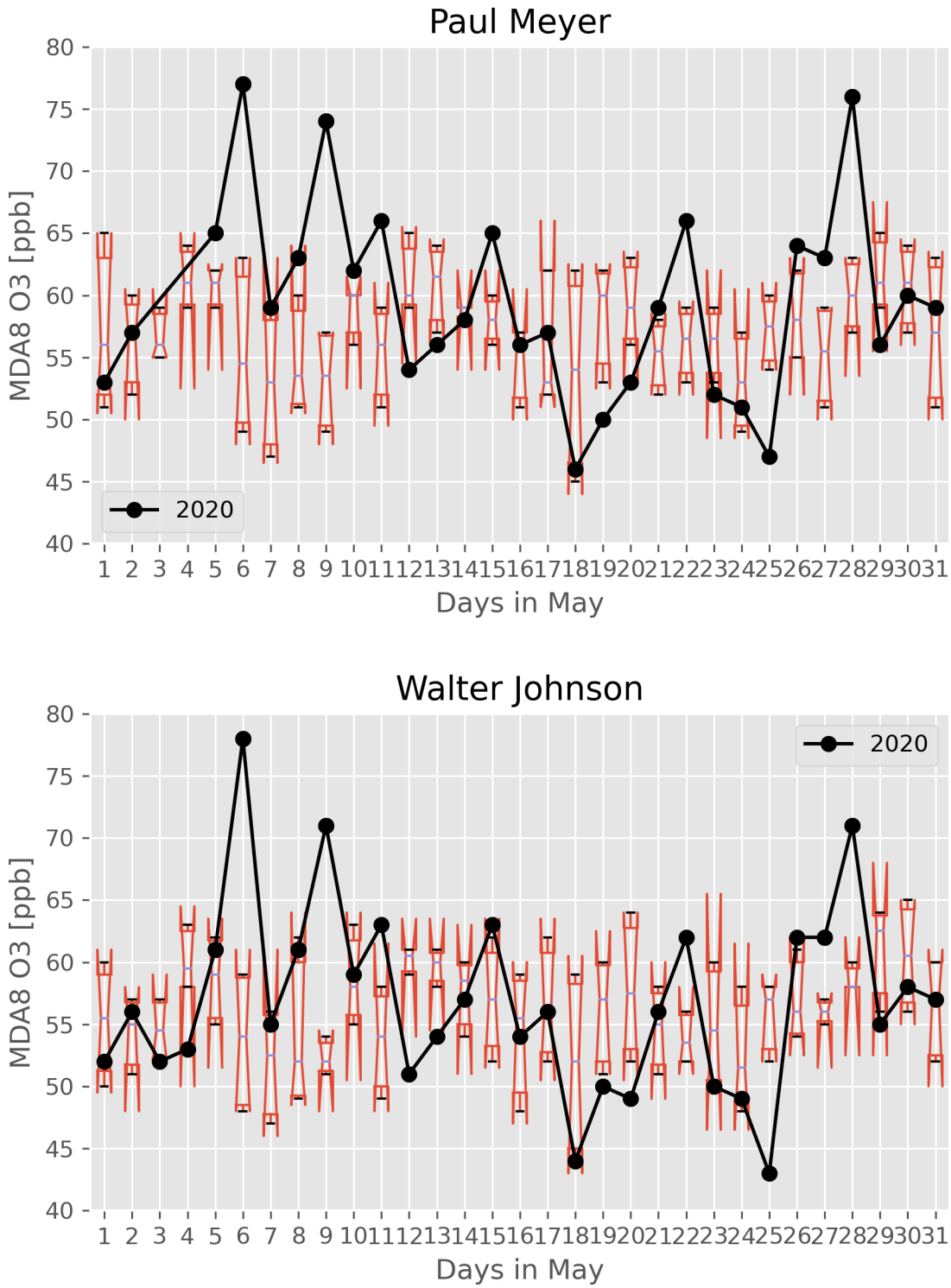
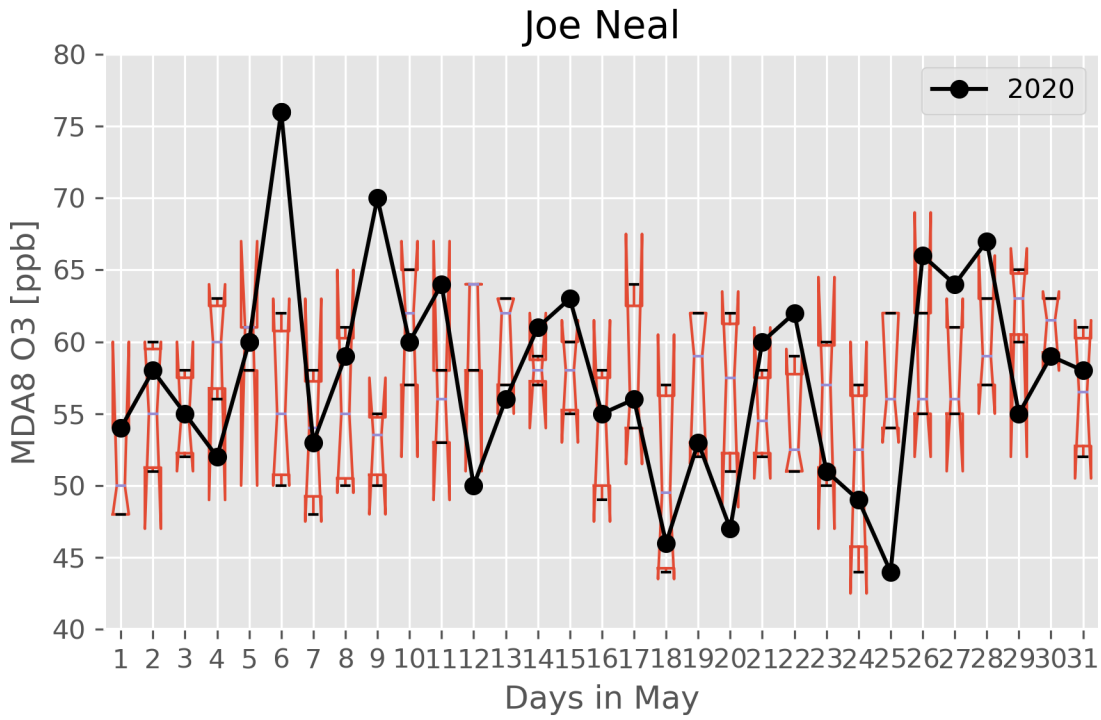


Figure G-3. Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



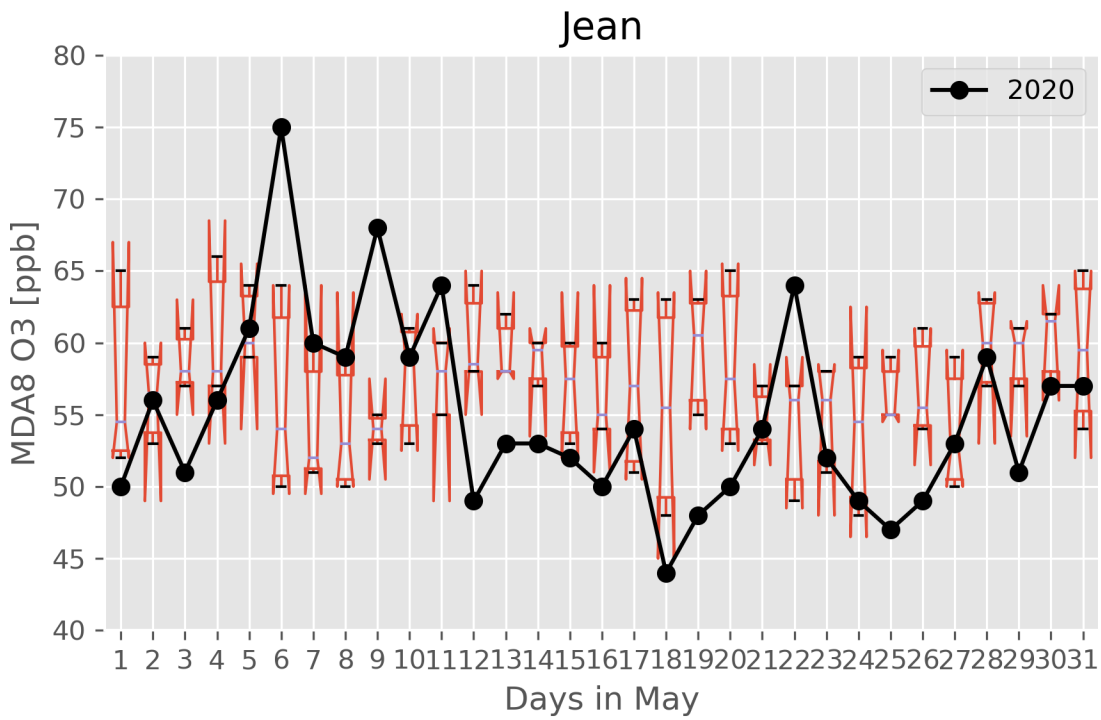
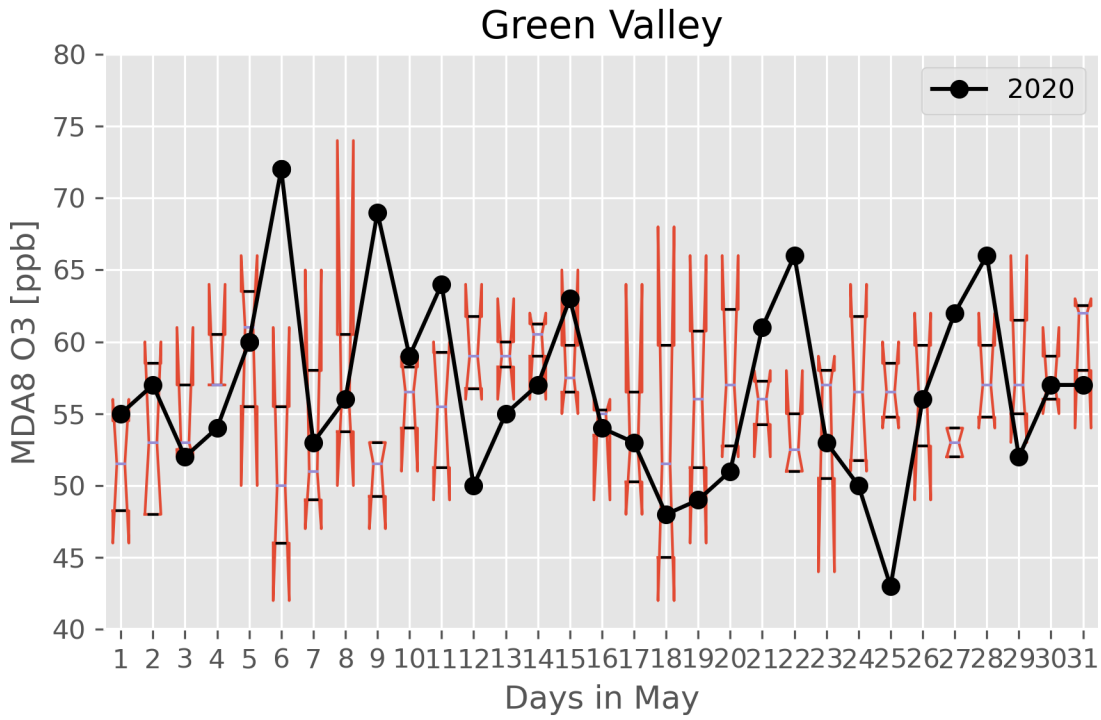


Figure G-3 (Cont.). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



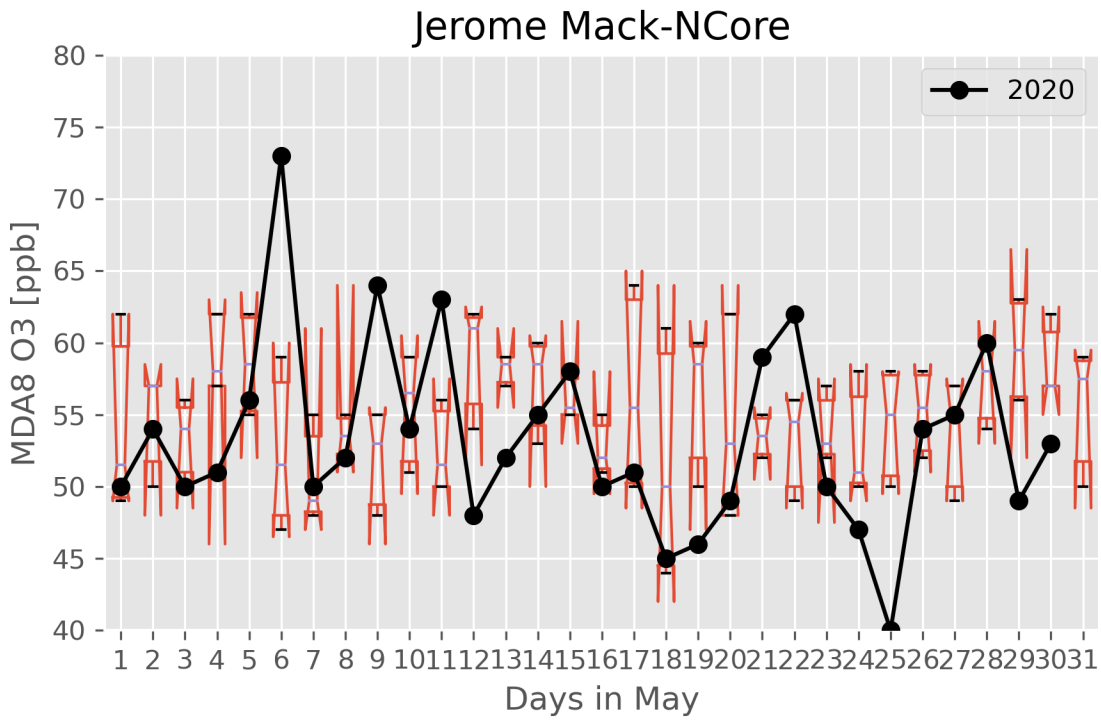


Figure G-3 (Cont.). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

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Appendix H. 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.