Appendix A. Supporting Media Coverage for Section 3.1.4

Images and links for media coverage of the August 3 exceptional event detailed in Section 3.1.4 of the main text is presented below in Figures A-1 through A-3.

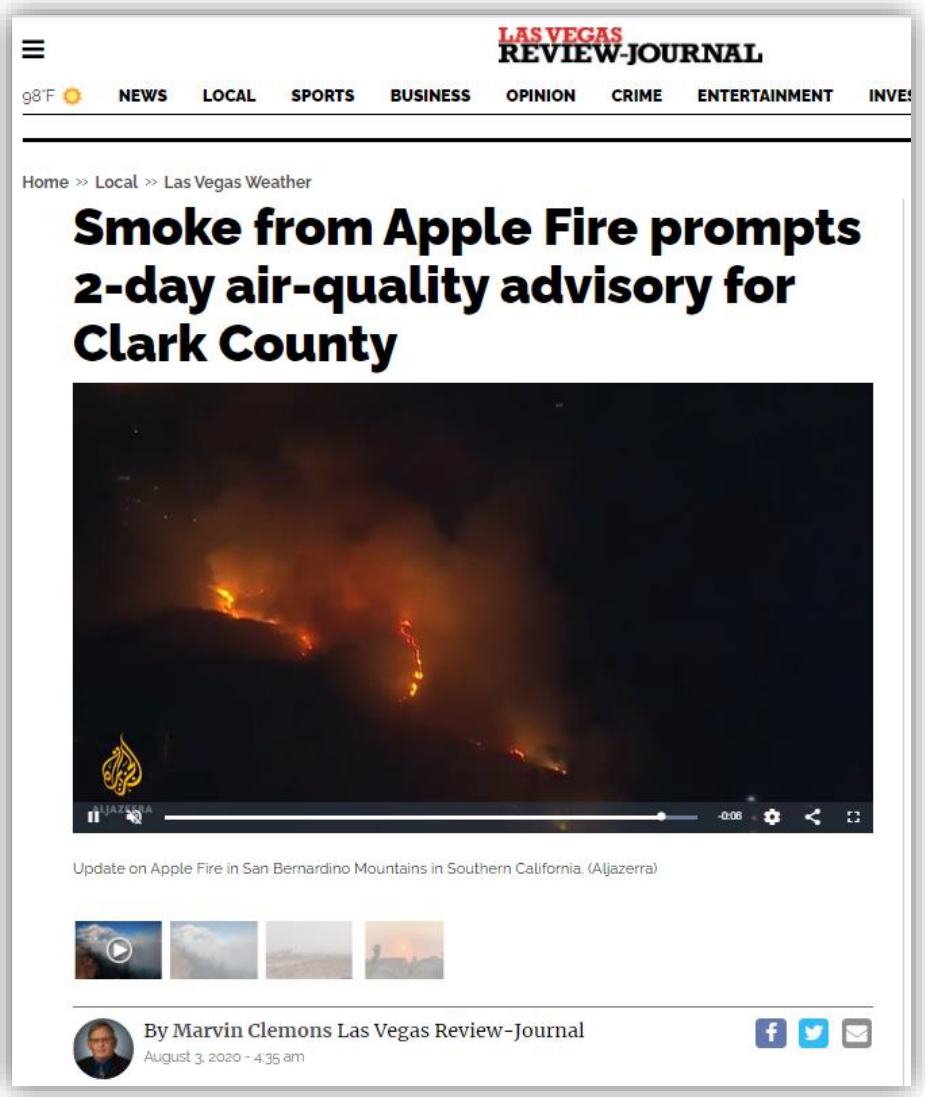

Figure A-1. Article entitled "Smoke from Apple Fire prompts 2-day air-quality advisory for Clark County" (https://www.reviewjournal.com/local/weather/smoke-from-apple-fire-prompts-2-day-air-quality-advisory-for-clark-county-2086924/). Article released by Las Vegas Review-Journal, a local Las Vegas news outlet, on August 3, 2020.

Las Vegas will experience hazy skies Monday, thanks to a wildfire burning in Southern California.

The 20,000-acre Apple Fire erupted over the weekend in the San Bernardino Mountains, sending smoke toward the Las Vegas Valley.

Smoke was expected to affect areas of Arizona, Nevada, Utah, Wyoming and Idaho. The fire was 5 percent contained as of Monday morning, the U.S. Forest Service said.

Anybody with respiratory issues should plan to stay inside, according to a tweet from the National Weather Service.

Air advisory issued

The Clark County Department of Environment and Sustainability issued an advisory for Monday and Tuesday for elevated levels of smoke and ozone due to the Apple Fire east of Los Angeles and other regional wildfires.

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Clark County 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, people who may be most sensitive to elevated levels of particulates and ozone include those with respiratory problems, cardiac disease, young children or senior citizens. Consult your physician if you have a medical condition that makes you sensitive to air-quality conditions.

Figure A-1 (Continued). Article entitled "Smoke from Apple Fire prompts 2-day air-quality advisory for Clark County" (https://www.reviewjournal.com/local/weather/smoke-from-apple-fire-prompts-2-day-air-quality-advisory-for-clark-county-2086924/). Article released by Las Vegas Review-Journal, a local Las Vegas news outlet, on August 3, 2020.

LOCAL NEWS

Smoke, ozone advisory issued due to wildfire smoke

Posted at 2:21 PM, Aug 03, 2020 and last updated 2:21 PM, Aug 03, 2020

The Clark County Department of Environment and Sustainability (DES) is issuing an advisory for Aug. 3-4, for elevated levels of smoke and ozone due to the Apple Fire east of Los Angeles and other regional wildfires.

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.

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Figure A-2. News release entitled "Smoke, ozone advisory issued due to wildfire smoke", reported by KTNV Las Vegas on August 3, 2020. (**https://www.ktnv.com/news/smoke-ozone-advisory-issued-due-to-wildfire-smoke**).

Figure A-3. Article entitled "Smoke advisory issued in Clark County due to California 'Apple Fire'", reported by 8NewsNow (KLAS-TV) on August 3, 2020 (https://www.8newsnow.com/news/local-news/california-apple-fire-spreads-to-20k-acres-smoke-impacts-southern-nevada/).

LAS VEGAS (KLAS) — Smoke from the "Apple Fire" in Southern California has resulted in Clark County issuing a smoke and ozone advisory for Monday and Tuesday.

Firefighters continue to struggle to contain the fire which has scorched more than 20,000 acres east of Los Angeles and resulted in evacuation orders for thousands of people. The fire is south of Big Bear and has burned into the San Bernardino National Forest and is only 5% contained.

Smoke from the fire will impact Southern Nevada for the next few days.

The Clark County Department of Environment and Sustainability officials say the smoke, made of small dust particles and other pollutants, can aggravate respiratory diseases and contribute to ground-level ozone formation. People with respiratory problems or cardiac disease, as well as young children and senior citizens, might want to stay indoors.

Figure A-3 (Continued). Article entitled "Smoke advisory issued in Clark County due to California 'Apple Fire'", reported by 8NewsNow (KLAS-TV) on August 3, 2020 (**https://www.8newsnow.com/news/local-news/california-apple-fire-spreads-to-20k-acres-smoke-impacts-southern-nevada/**).

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-4 provides the concentration and AQI values for all NAAQS pollutants in the Metropolitan/Non-Metropolitan and Greater Las Vegas Metro Area on August 3, 2020. This information was publicly available during the August 3 potential exceptional event. In addition to the near-real-time data available on the DES website, 5-day AQI forecasts were available on August 3 (and are currently are available) to the public here: https://aqportal.clarkcountynv.gov/DES_AQ_Forecast. Figure A-5 shows the public Air Quality Advisory/News Release for the 2020 ozone season, and Figure A-6 shows the public Air Quality Advisory/News Release for August 3, 2020. Additional media coverage and publicly available AirNow AQI maps for the August 3 potential exceptional event date are included in Sections 3.1.2 and 3.1.4 of the main report.

Reporting for August 3, 2020 August 3 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	*	72	**97**	**69**												
Boulder City	**Unhealthy for sensitive groups**	Ozone	*	76	**104**	**72**							37	39.49				
Greater Las Vegas	**Unhealthy for sensitive groups**	Ozone	*	90	**140**	**82**	8	0.721	1	0.8	41	43.9	51	54.14			60	16.65
Indian Springs	**Unhealthy for sensitive groups**	Ozone	*	78	**101**	**71**												
Jean	**Unhealthy for sensitive groups**	Ozone	*	75	**108**	**73**							36	38.72			52	12.86
Mesquite	**Moderate**	Ozone	*	69	**80**	**64**												

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	*	90	**140**	**82**	8	0.721	1	0.8	41	43.9	51	54.14			60	16.65
Casino Center	**Good**	Nitrogen Dioxide									**41**	**43.4**						
Green Valley	**Unhealthy for sensitive groups**	Ozone	*	77	**104**	**72**							43	46.15			56	14.73
Jerome Mack	**Moderate**	Ozone	*	73	**97**	**69**			1	0.8	38	40.1	51	54.14			60	16.65
Joe Neal	**Unhealthy for sensitive groups**	Ozone	*	90	**136**	**81**					13	13.4	43	46.86			51	12.61
Palo Verde	**Moderate**	Ozone	*	77	**100**	**70**							33	35.79				
Paul Meyer	**Unhealthy for sensitive groups**	Ozone	*	84	**126**	**78**							36	38.52			46	11.35
Rancho & Teddy	**Moderate**	PM-2.5					8	0.721			40	42.8					**54**	**13.68**
Sunrise Acres	**Moderate**	PM-2.5					6	0.534			41	43.9	49	53.38			**57**	**15.24**
Walter Johnson	**Unhealthy for sensitive groups**	Ozone	*	87	**140**	**82**							36	39.36			47	11.59

Figure A-4. Air Quality Index values reported by the Clark County Department of Environment and Sustainability on August 3, 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-5. 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.

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Figure A-5 (Continued). 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

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 **Monday, Aug. 3, 2020**

Smoke, Ozone Advisory Issued for Monday and Tuesday Due to Wildfire Smoke

The Clark County Department of Environment and Sustainability (DES) is issuing an advisory for **Monday, Aug. 3 and Tuesday, Aug. 4,** for elevated levels of smoke and ozone due to the Apple Fire east of Los Angeles and other regional wildfires. 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, 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. Consult 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. A seasonal ozone advisory is currently in effect.

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 amount 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.

[more]

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Figure A-6. Smoke and Ozone Advisory issued by the Clark County Office of Public Communication on August 3, 2020, for August 3-4, 2020.

News Release

Air Quality Smoke, Ozone Alert, cont.

SMOKE AND OZONE TIPS, cont.

- 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.

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:

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- AIRNow: Check air quality forecasts, current conditions and the Air Quality Index (AQI) for Clark County at AIRNow's website.

About the Department of Environment and Sustainability

The Department of Environment and Sustainability is the air pollution control agency, regional Endangered Species Act compliance program, and sustainability office for all of Clark County, Nevada. Established as the Department of Air Quality by the Clark County Commission in 2001, it was renamed in 2020 and is comprised of three divisions: Air Quality, Desert Conservation Program and Office of Sustainability. Through these three divisions, DES is ensuring the air we share meets healthful, regulatory standards, administering the County's Multiple Species Habitat Conservation Plan and addressing climate change.

###

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Facebook, Twitter, Instagram, LinkedIn and **YouTube.**

Figure A-6 (Continued). Smoke and Ozone Advisory issued by the Clark County Office of Public Communication on August 3, 2020, for August 3-4, 2020.

Appendix B. Supporting Figures and Documents for Section 3.2.3

In addition to MODIS AOD and AIRS CO satellite retrievals, we examined OMI retrievals of tropospheric NO_2 (Figure B-1). However, the retrievals likely reflect urban sources, such as Las Vegas and Los Angeles, rather than NO_2 from smoke. Even over areas of dense, visible smoke and near actively burning fires, where significant smoke is present in the troposphere, the measurements show little increase in measured NO_2. Therefore, it was determined that NO_2 does not provide strong evidence for or against smoke impacts in on August 3, 2020, in Clark County.

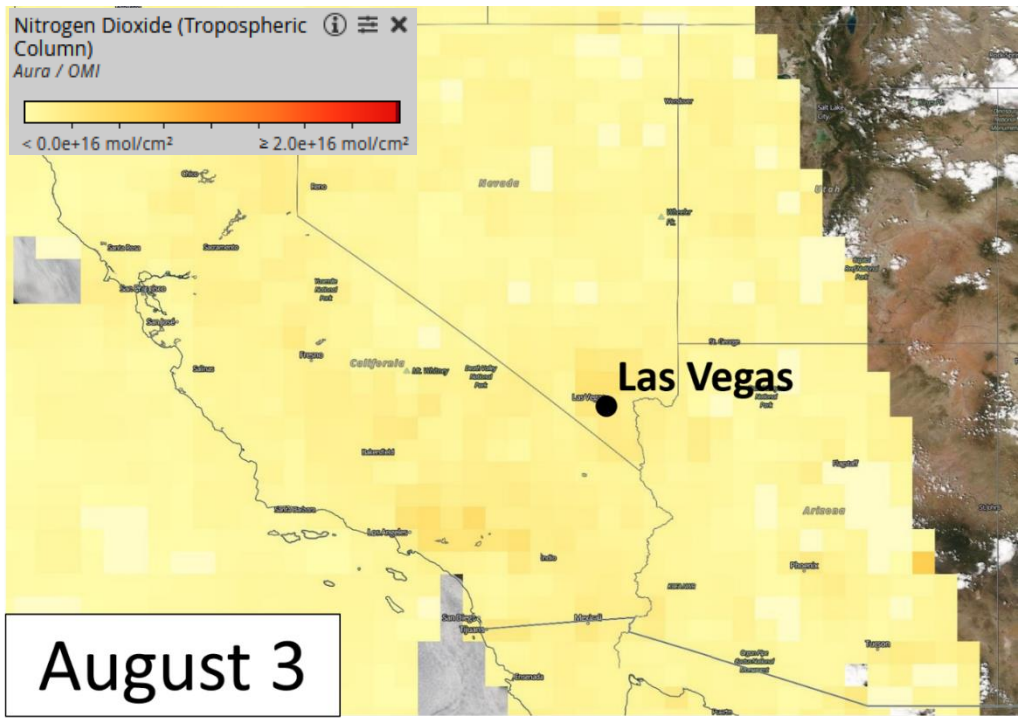


Figure B-1. A zoomed-in view (over Clark County and the Apple Fire) of the OMI Aura NO_2 retrieval during the exceptional event on August 3, 2020.

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 are available in Figures C-1 through C-5 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}. In other words, there should be an accompanying increase in the $PM_{10}/PM_{2.5}$ ratio. Contributions to $PM_{2.5}$ concentrations due to 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 daytime rise in $PM_{2.5}$ at each site on August 3 was not accompanied by an increase in the $PM_{10}/PM_{2.5}$ ratio, and in most cases, the $PM_{10}/PM_{2.5}$ ratio decreased below the diurnal average during the daytime rise in $PM_{2.5}$. This demonstrates that a dust event did not significantly contribute to the elevated $PM_{2.5}$ concentrations measured in Clark County on August 3, 2020, lending evidence to the assertion that wildfire smoke was present at the surface.

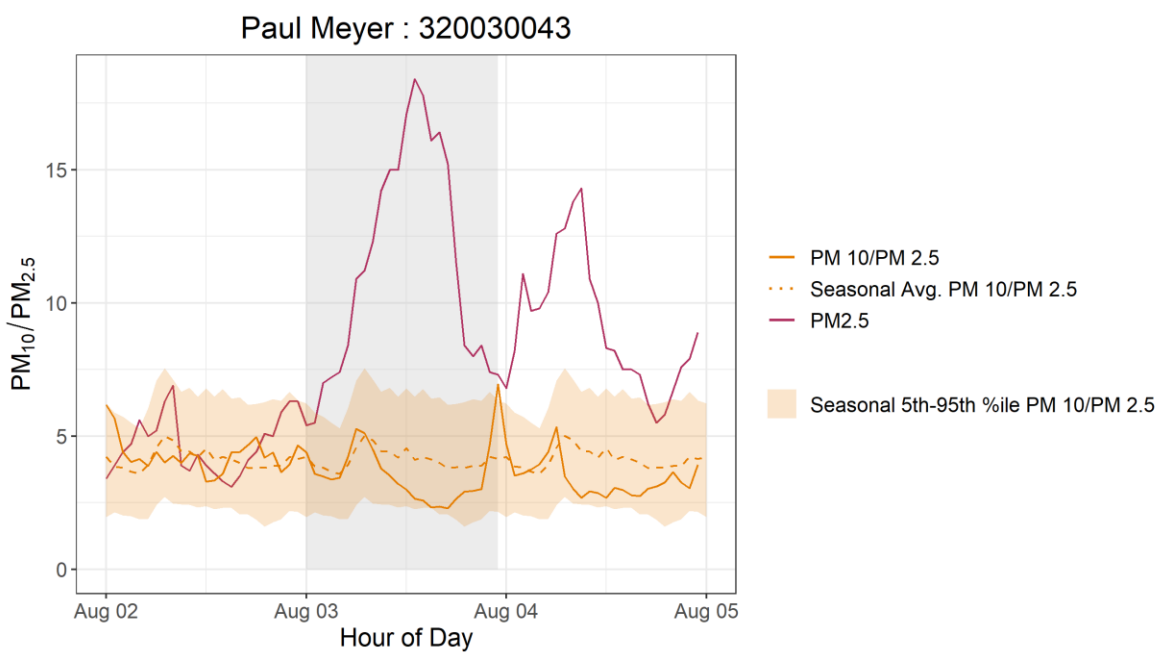


Figure C-1. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Paul Meyer during the August 3, 2020, event period. The seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 3, 2020.

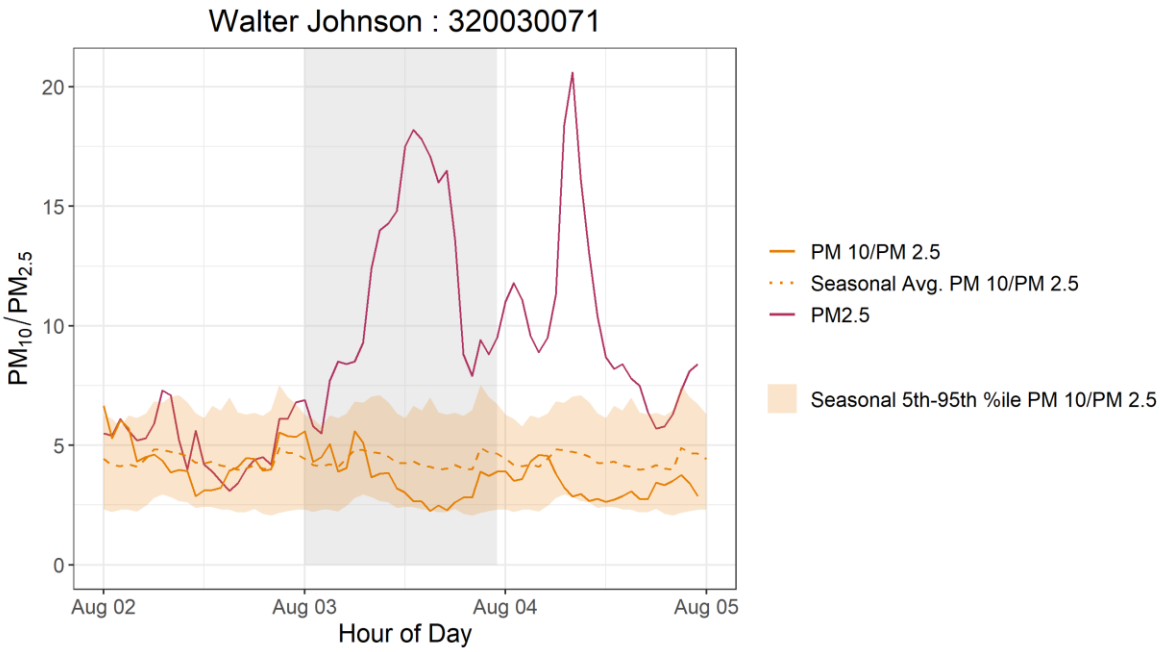


Figure C-2. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Walter Johnson during the August 3, 2020, event period. The seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 3, 2020.

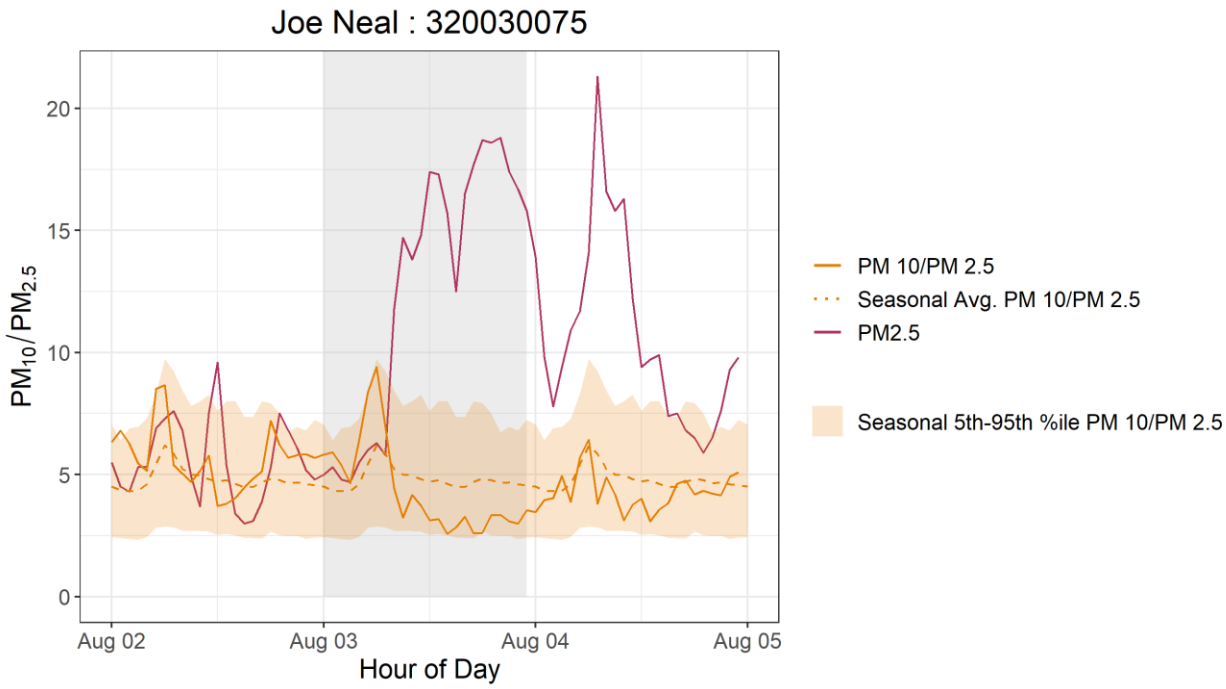


Figure C-3. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Joe Neal during the August 3, 2020, event period. The seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 3, 2020.

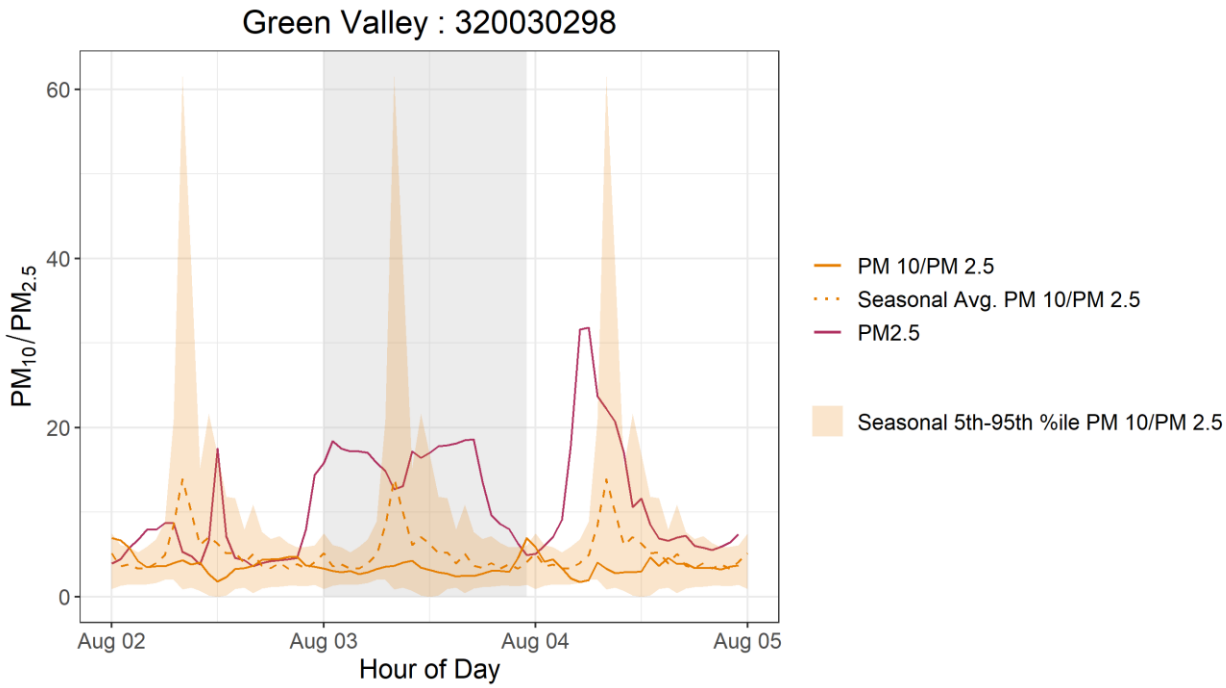


Figure C-4. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Green Valley during the August 3, 2020, event period. The seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 3, 2020.

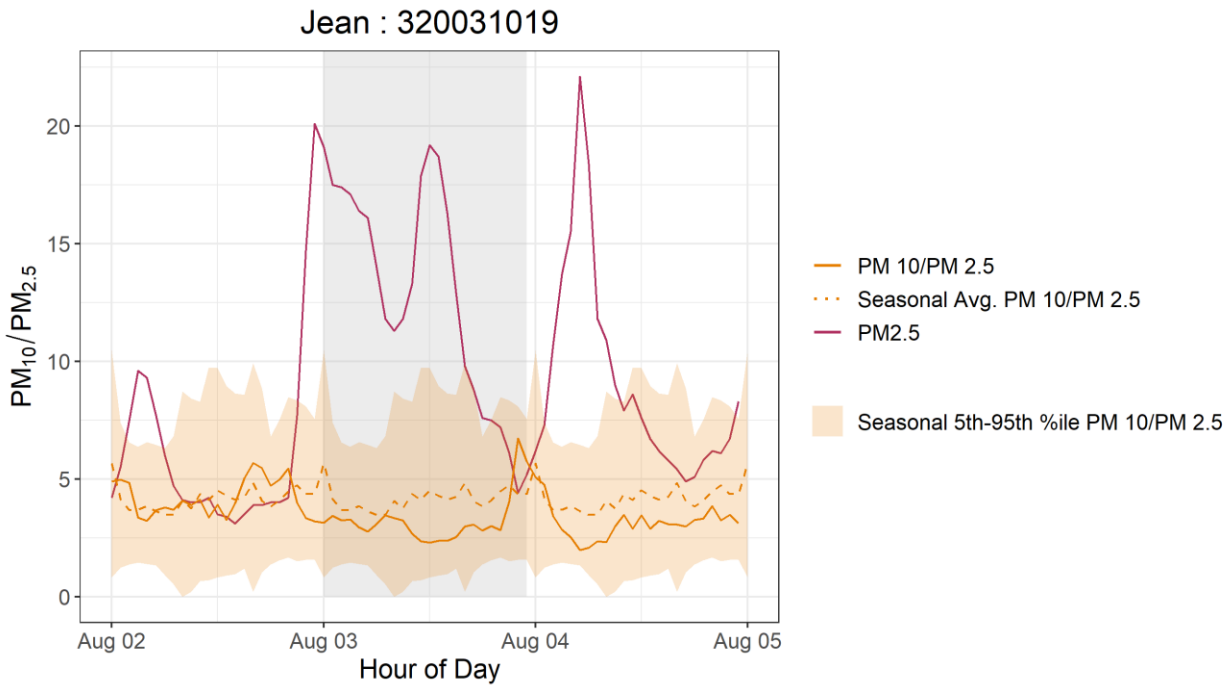


Figure C-5. $PM_{10}/PM_{2.5}$ ratio (yellow) and $PM_{2.5}$ (maroon) concentration at Jean during the August 3, 2020, event period. The seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shown as a dashed line, and the 5th-95th percentile seasonal average hourly $PM_{10}/PM_{2.5}$ ratio is shaded in yellow. The gray bar highlights August 3, 2020.

Concentrations of CO were examined at monitoring sites that experienced an exceedance on August 3, 2020. Elevated or abnormal patterns in CO concentrations can indicate the presence of wildfire smoke at the surface. CO concentrations at the Joe Neal site deviated from the expected diurnal pattern, which is displayed in Section 3.2.4. One year of CO data is available from the Green Valley site, though this upwind site did not show elevated concentrations during the August 3 event period. A plot of CO concentrations during the event period is shown in Figure C-6 below.

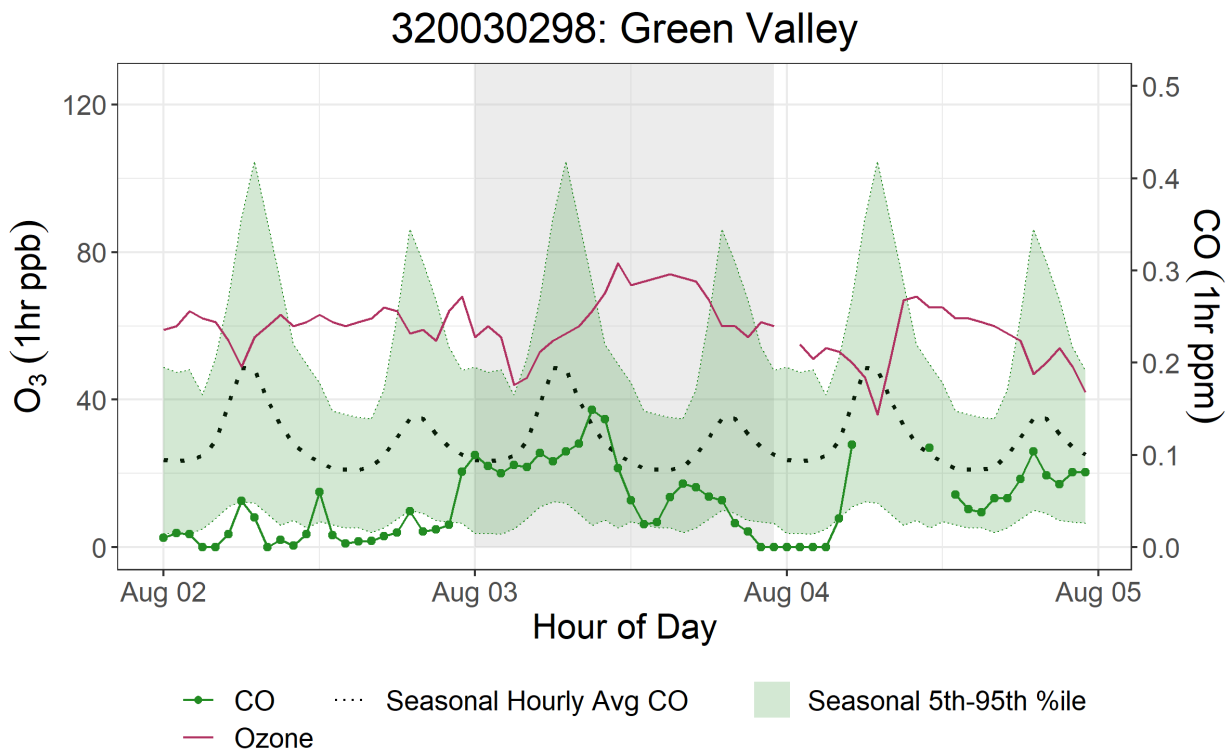


Figure C-6. Ozone (red) and CO (green) concentrations at Green Valley during the August 3 event period. The dashed line shows the seasonal (May–September) average CO diurnal profile. The green shaded area indicates the seasonal 5th to 95th percentile values for statistical reference. The gray box highlights August 3.

Concentrations of NO_x (NO and NO_2) were examined for the August 3 event in Clark County. NO_2 data are available at one event site, Joe Neal (five years of data), as well as the NCore reference site, Jerome Mack (four years of data). NO data are only available at Jerome Mack (five years of data). NO_2 concentrations at the event site were not elevated beyond the diurnal average, though the daily peak occurred later in the morning than usual. This pattern is mirrored at Jerome Mack for both NO and NO_2. Available NO_x profiles Joe Neal and Jerome Mack are displayed in **Figures C-7 through C-9**.

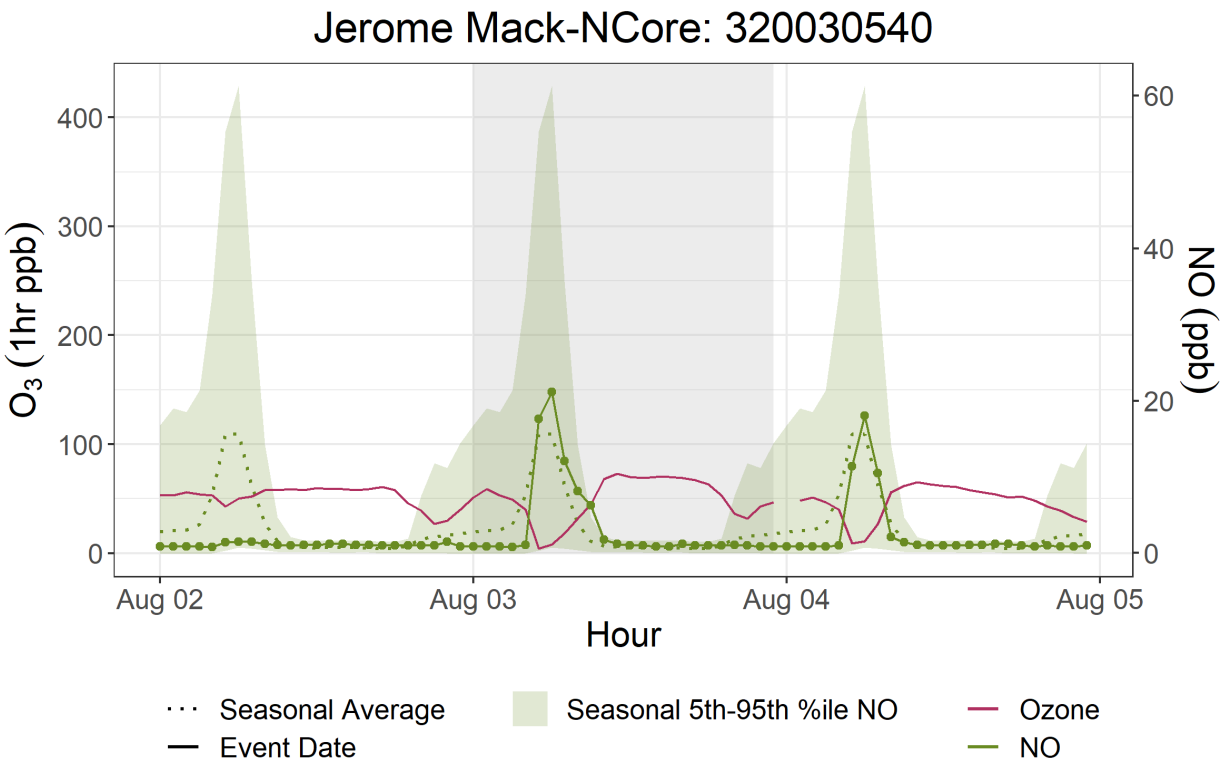


Figure C-7. Ozone (red) and NO (green) concentrations during the August 3 exceptional event at the Jerome Mack NCore monitoring site. The 5-year seasonal (dotted line) and 5th-95th percentile range (shaded area) is also shown. August 3 is highlighted by the gray shaded area.

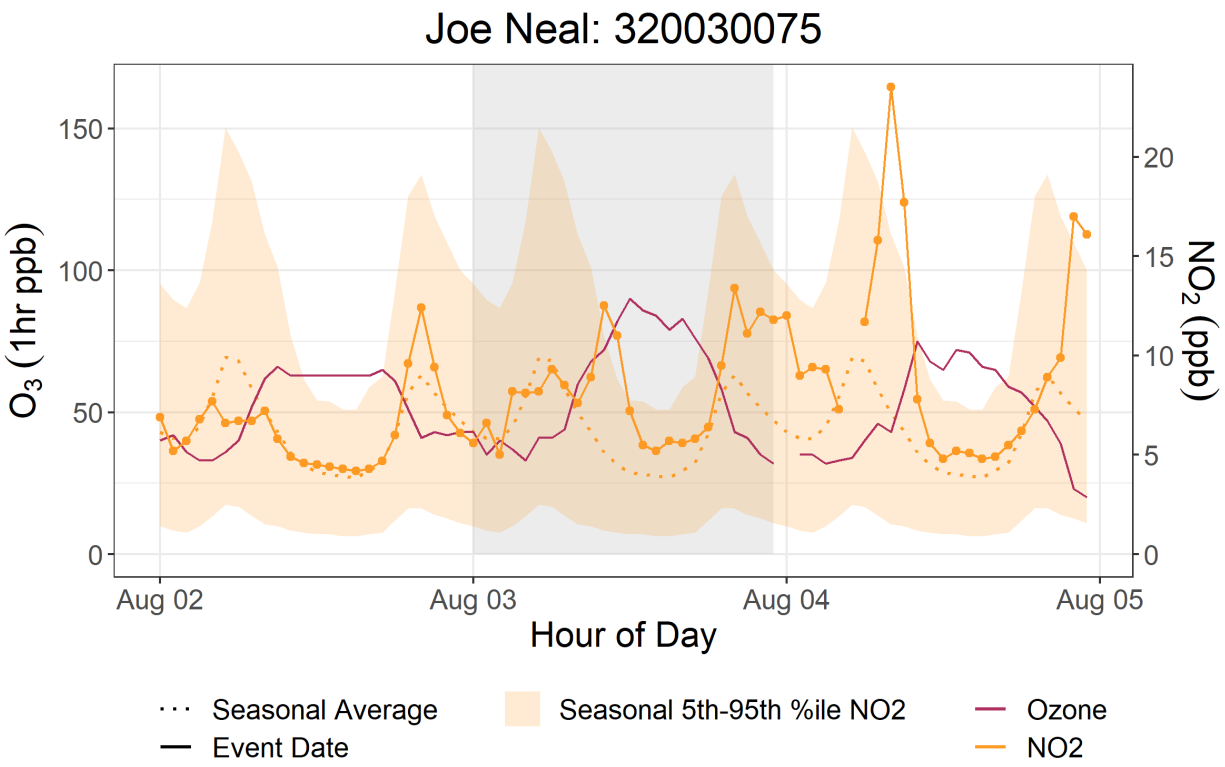


Figure C-8. Ozone (red) and NO_2 (yellow) concentrations during the August 3 exceptional event at the Joe Neal monitoring site. The 5-year seasonal (dotted line) and 5th-95th percentile range (shaded area) is also shown. August 3 is highlighted by the gray shaded area.

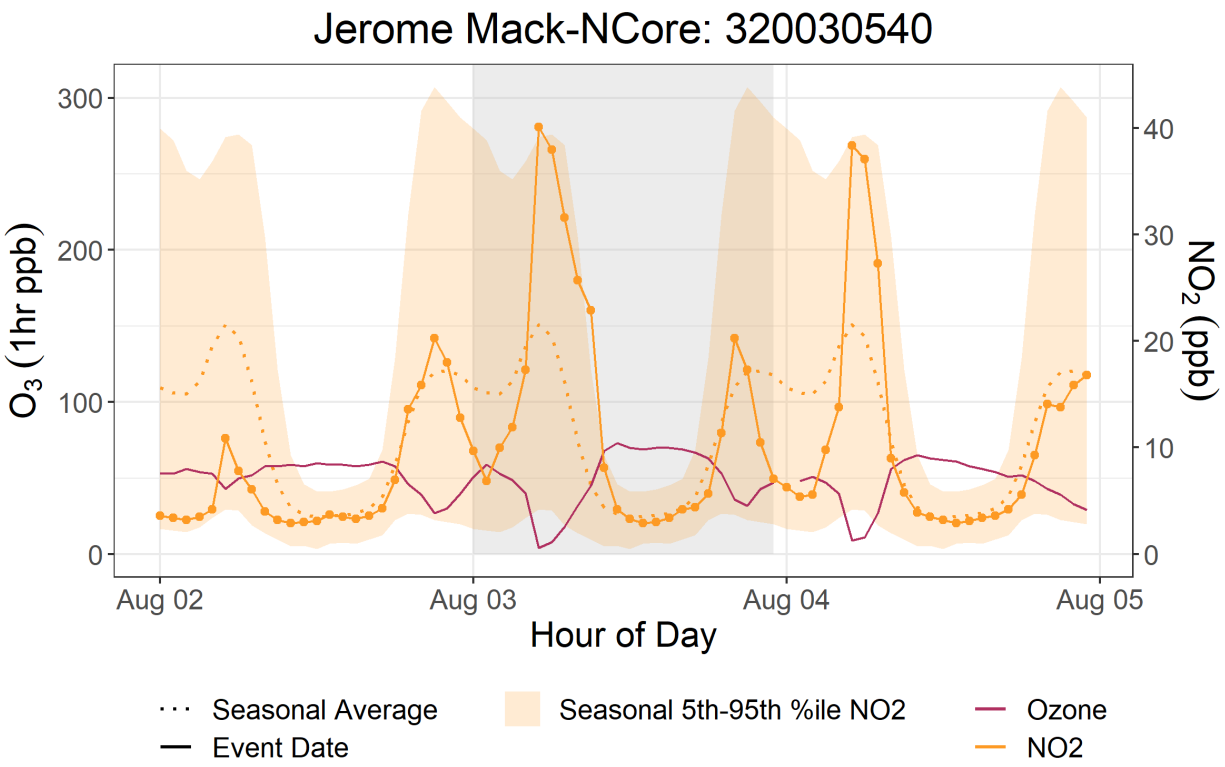


Figure C-9. Ozone (red) and NO_2 (yellow) concentrations during the August 3 exceptional event at the Jerome Mack NCore monitoring site. The 4-year seasonal (dotted line) and 5th-95th percentile range (shaded area) is also shown. August 3 is highlighted by the gray shaded area.

Appendix D. Supporting Figures and Documents for Section 3.3.2

The full subset of matching meteorologically similar days to August 3, 2020, included June 23, 2015. **Table D-1** shows the local meteorological observations for the event date and June 23, 2015. June 23, 2015, is not formally identified as a date with wildfire influence, but examination of NOAA's HMS Smoke Product shows the presence of wildfire smoke in Clark County that originated from fires in California (**Figure D-1**). Due to this evidence that wildfire smoke may have influenced ozone concentrations in Clark County on that day, June 23, 2015, has been omitted from the similar days analysis.

Table D-1. Local meteorological conditions at the Jerome Mack monitoring site on the event date, August 3, 2020, and meteorologically similar date June 23, 2015. PM, WJ, JN, GV, BC, J, and IS refer to monitoring sites Paul Meyer, Walter Johnson, Joe Neal, Green Valley, Boulder City, Jean, 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)						
													PM	WJ	JN	GV	BC	J	IS
2020-08-03	111	97.33	141.8	1.74	2.89	4.38	0	7.95	4.57	528.46	0	5918	78	82	81	72	72	73	71
2015-06-23	107	94.42	180.57	1.1	3.03	8	0	8.18	4.29	528.52	0	5890	71	66	64	67	61	71	75

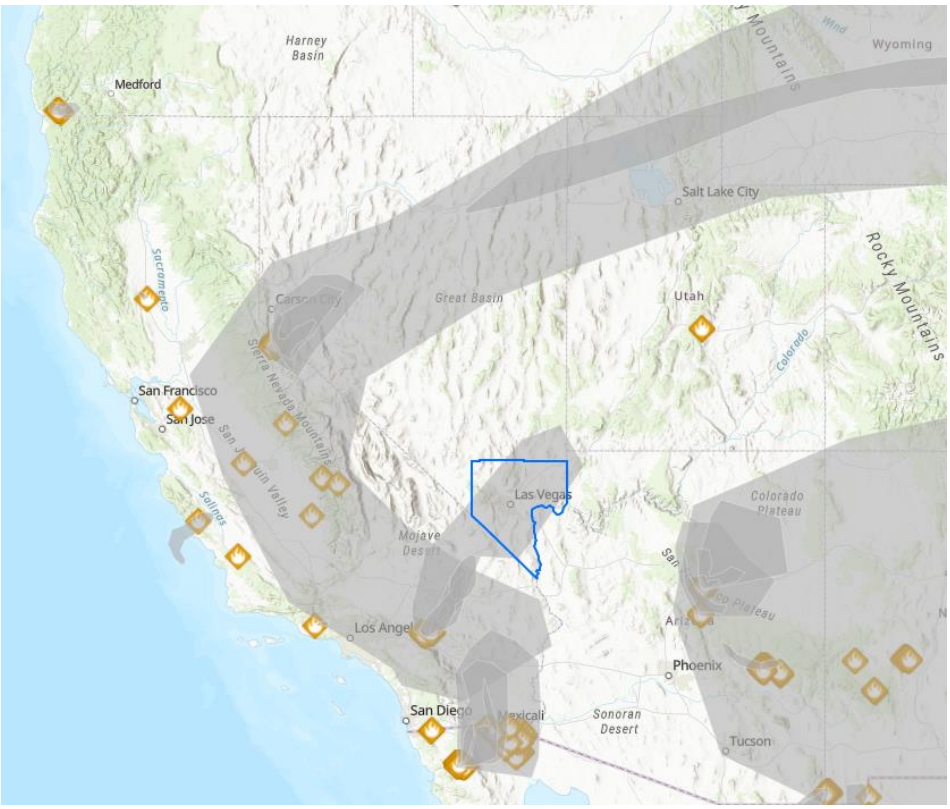


Figure D-1. HMS Smoke and Fire Product on June 23, 2015. Active fires are marked by orange symbols. Smoke extent is shaded in gray. Clark County is outlined in blue.

Identification of matching meteorologically similar days includes a comparison of meteorology maps between August 3, 2020, and each date subset from candidate matching days. Surface and upper-level maps for August 3, 2020, and each date listed in Table 3-18 (see Section 3.3.2) show highly consistent conditions. All dates show a surface low pressure system over Clark County. Surface maps for August 3, 2020, and each date in Table 3-18 are shown in **Figure D-2 through D-16**. Most upper-level maps show a very low gradient of height contours at 500 mb and an upper-level region of relatively high pressure over Clark County. 500 mb maps for August 3, 2020, and each date in Table 3-18 are shown in **Figure D-17 through D-31**.

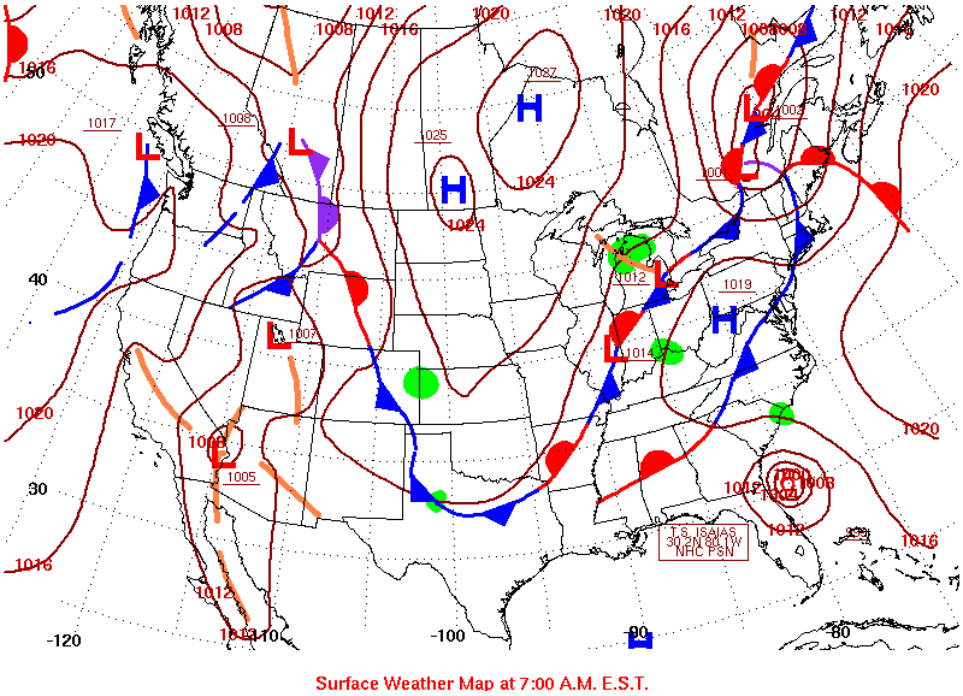


Figure D-2. Surface meteorology map on August 3, 2020 (the event date).

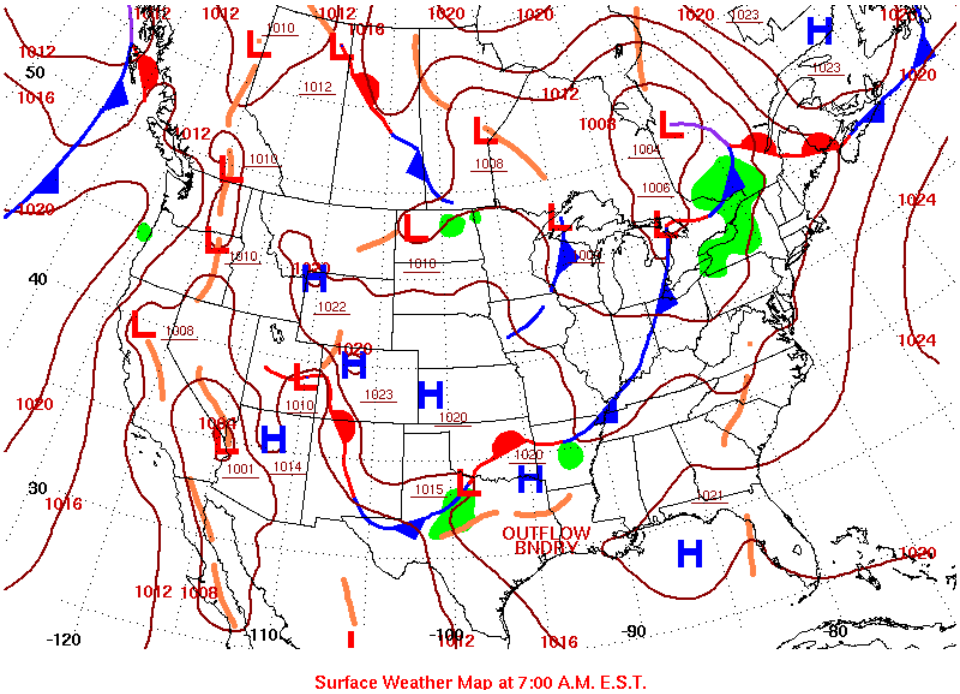


Figure D-3. Surface meteorology map on July 1, 2017.

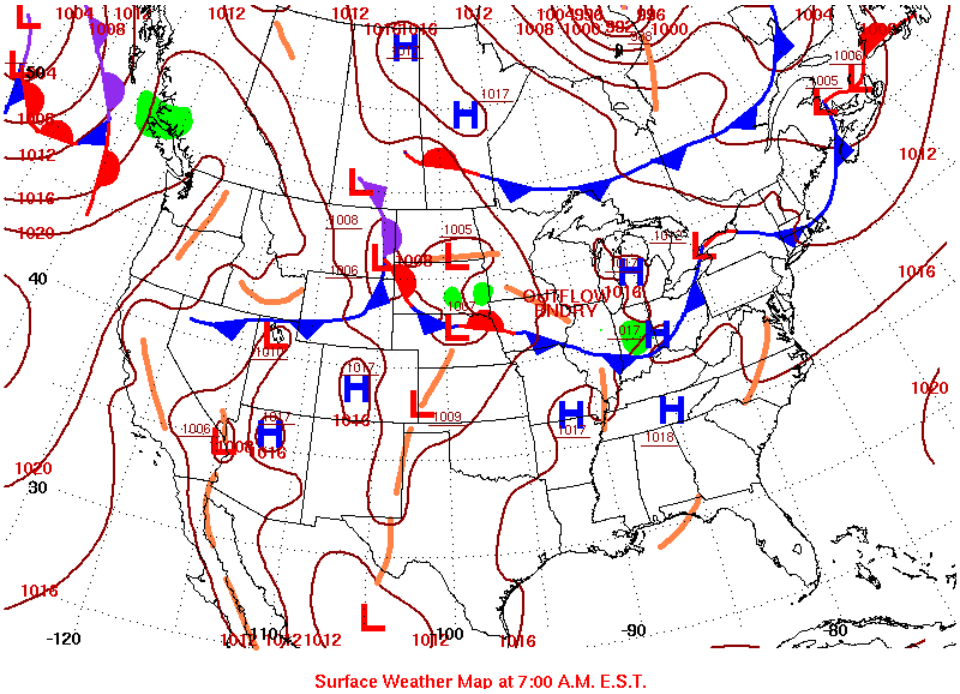


Figure D-4. Surface meteorology map on July 21, 2017.

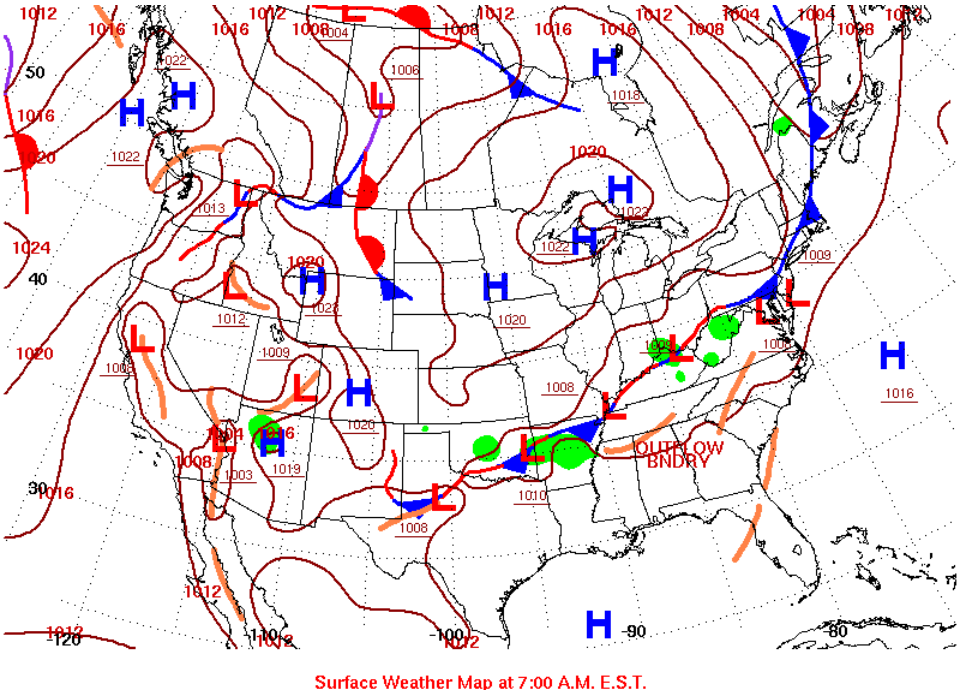


Figure D-5. Surface meteorology map on July 28, 2017.

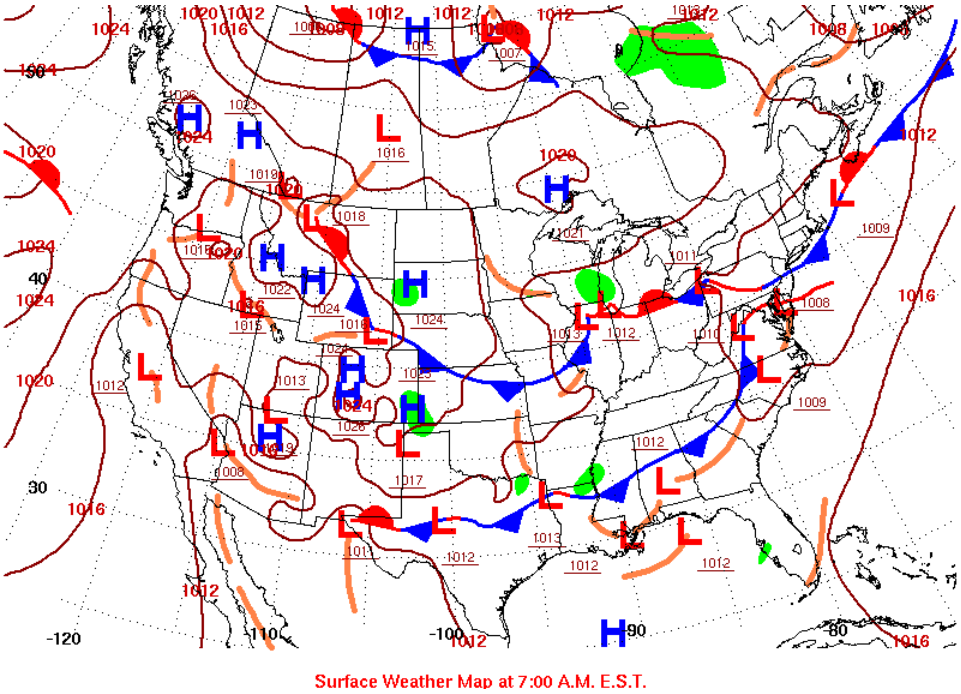


Figure D-6. Surface meteorology map on August 14, 2019.

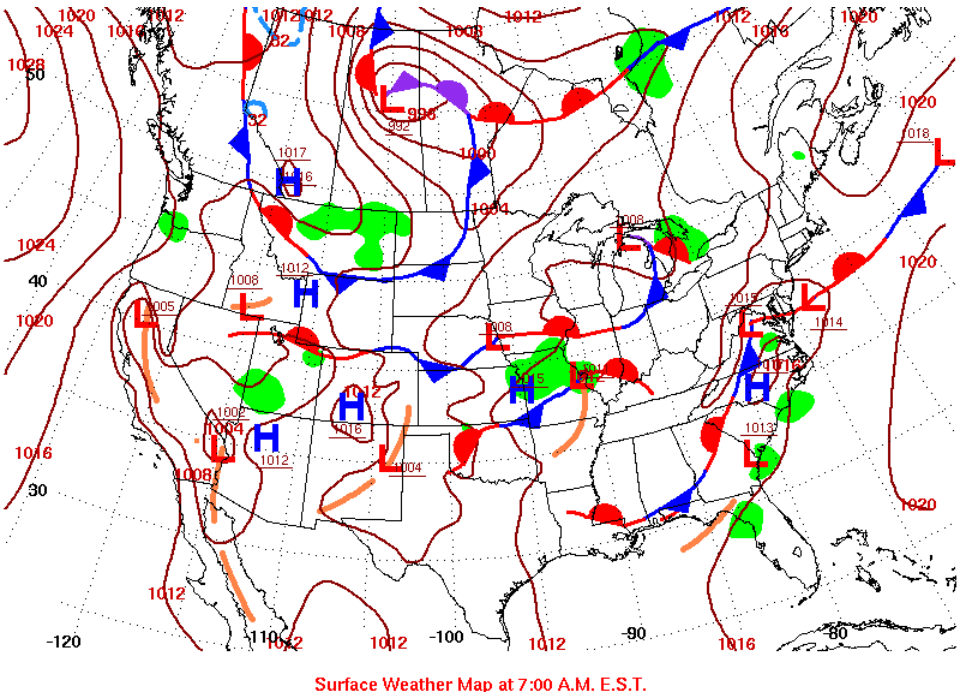


Figure D-7. Surface meteorology map on August 17, 2019.

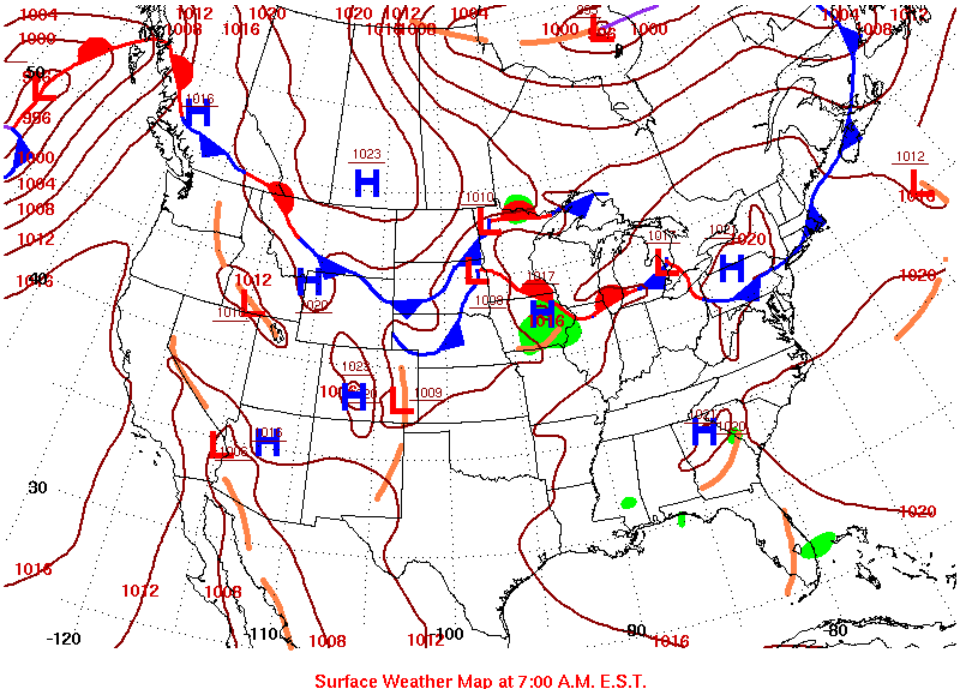


Figure D-8. Surface meteorology map on August 20, 2019.

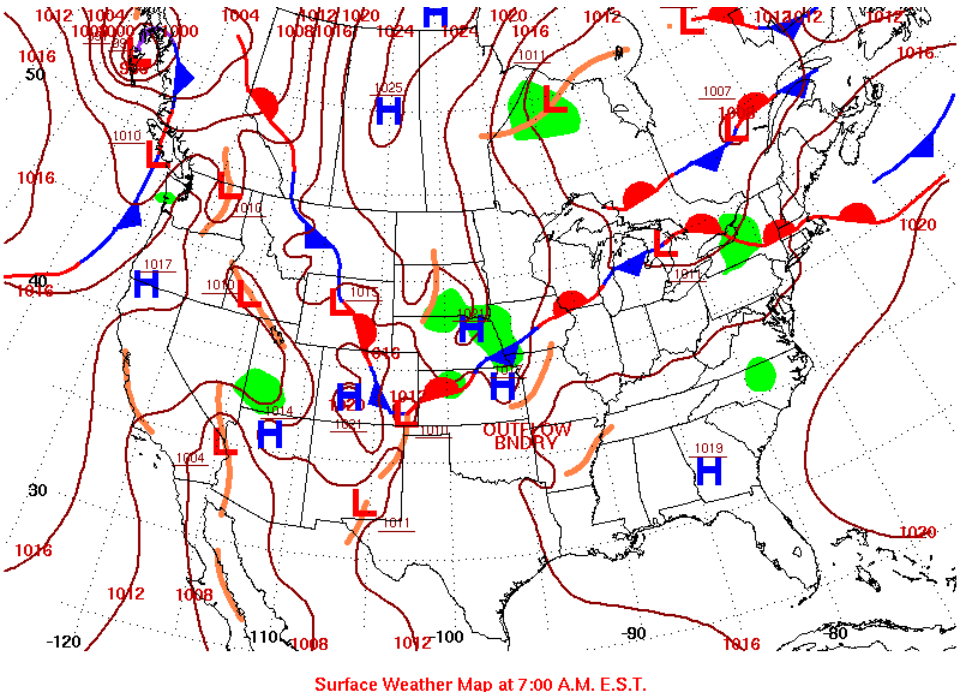


Figure D-9. Surface meteorology map on August 21, 2019.

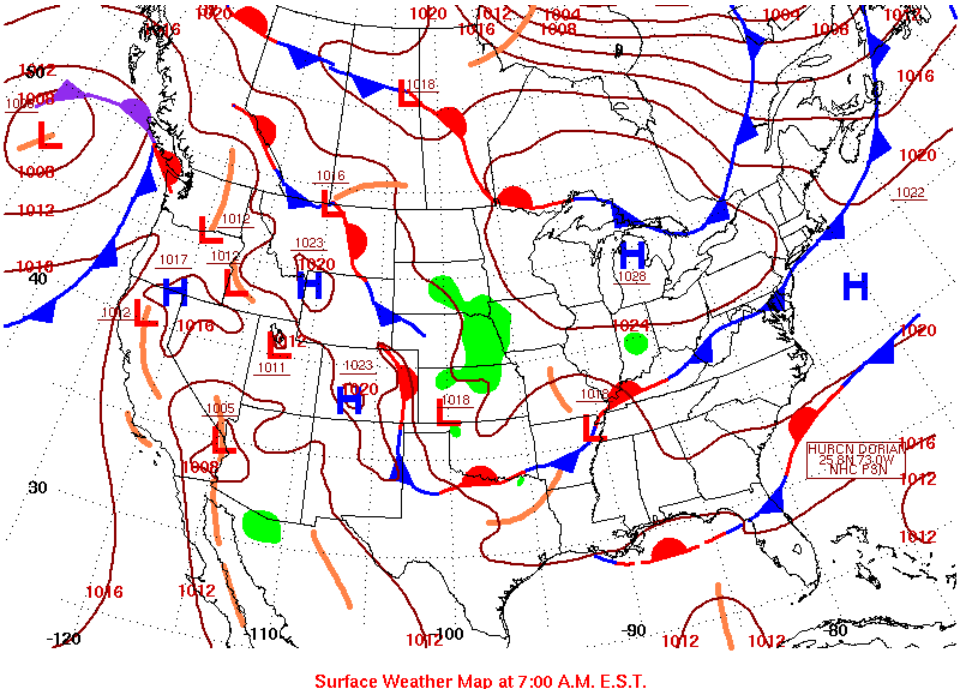


Figure D-10. Surface meteorology map on August 31, 2019.

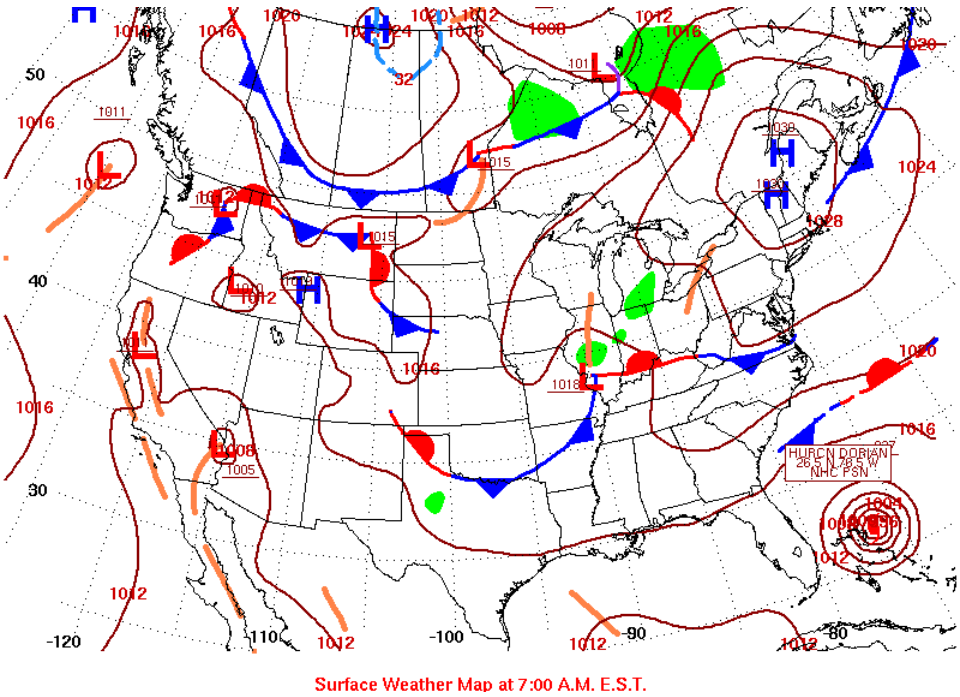


Figure D-11. Surface meteorology map on September 1, 2019.

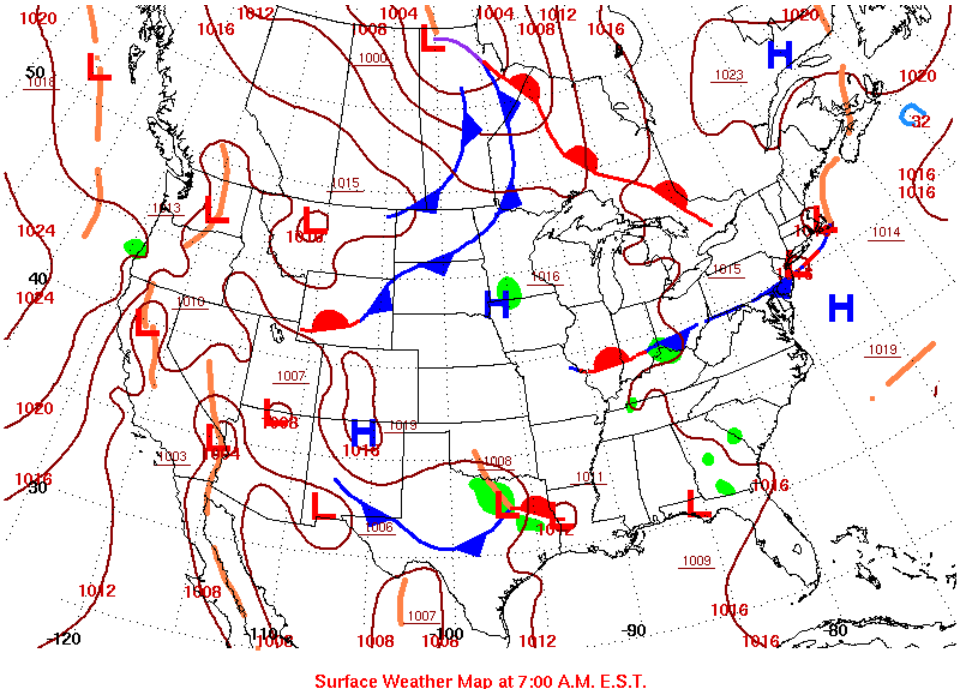


Figure D-12. Surface meteorology map on July 6, 2020.

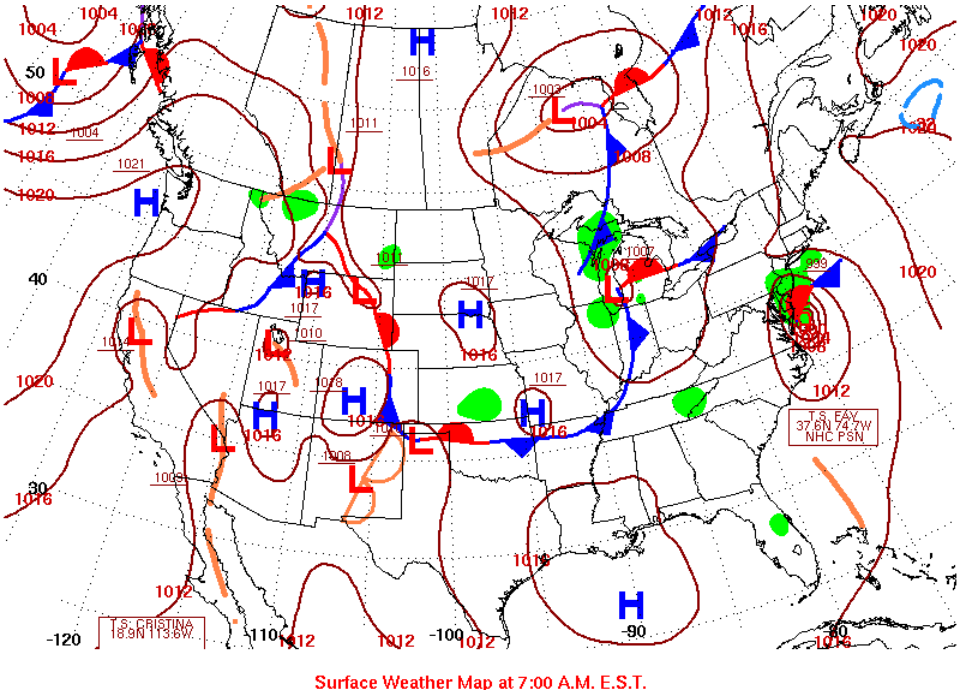


Figure D-13. Surface meteorology map on July 10, 2020.

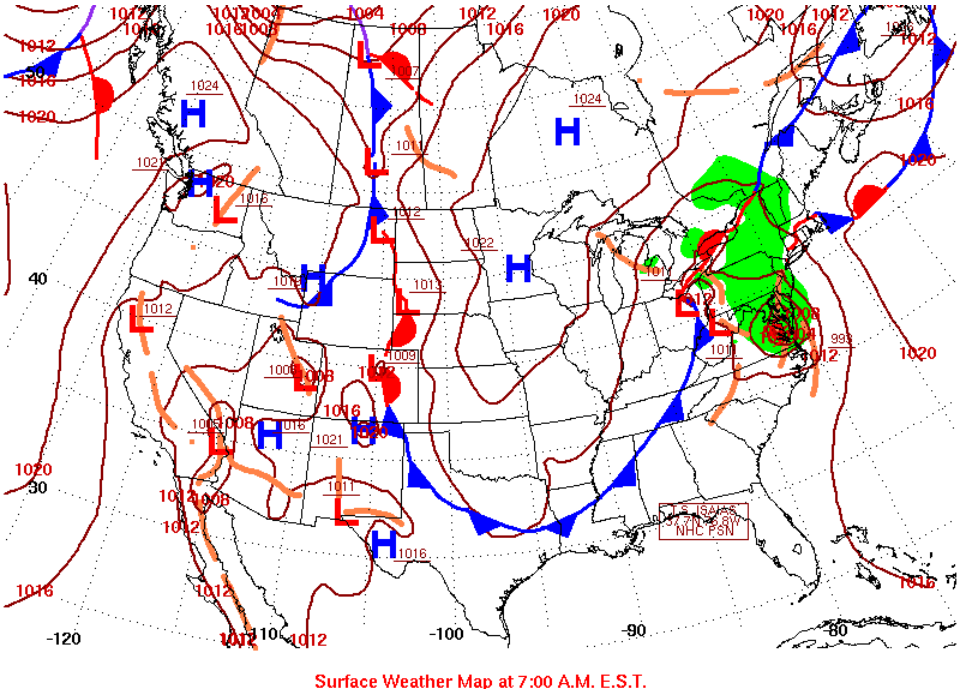


Figure D-14. Surface meteorology map on August 4, 2020.

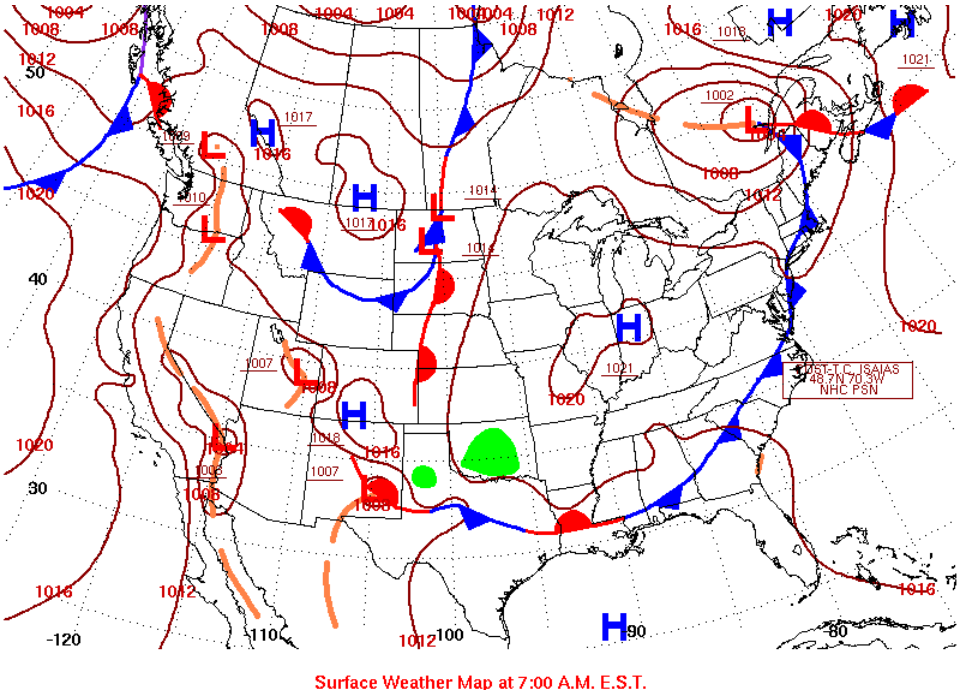


Figure D-15. Surface meteorology map on August 5, 2020.

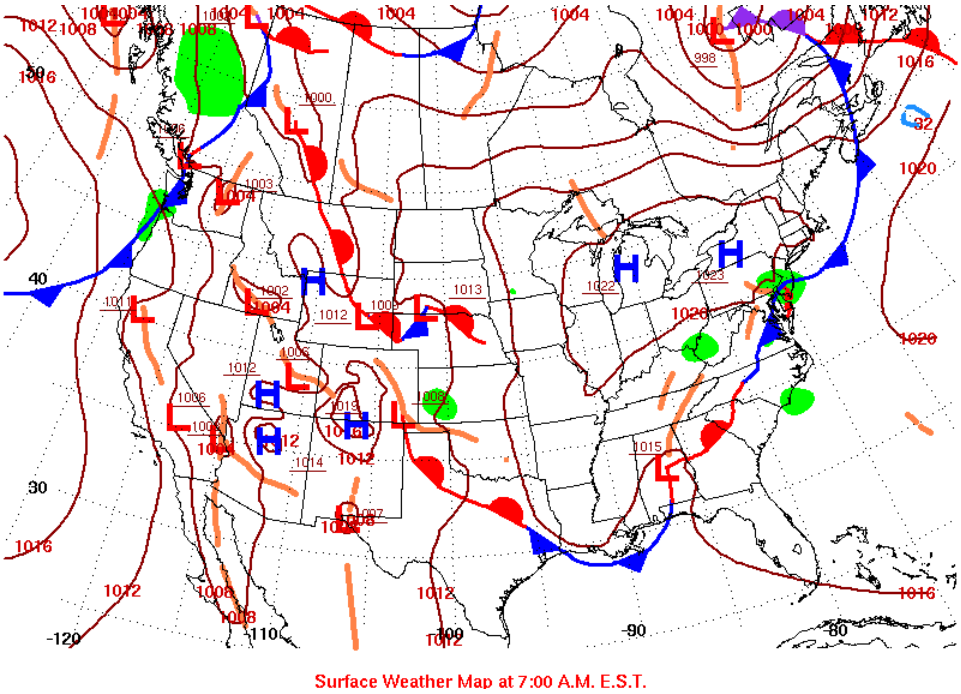


Figure D-16. Surface meteorology map on August 6, 2020.

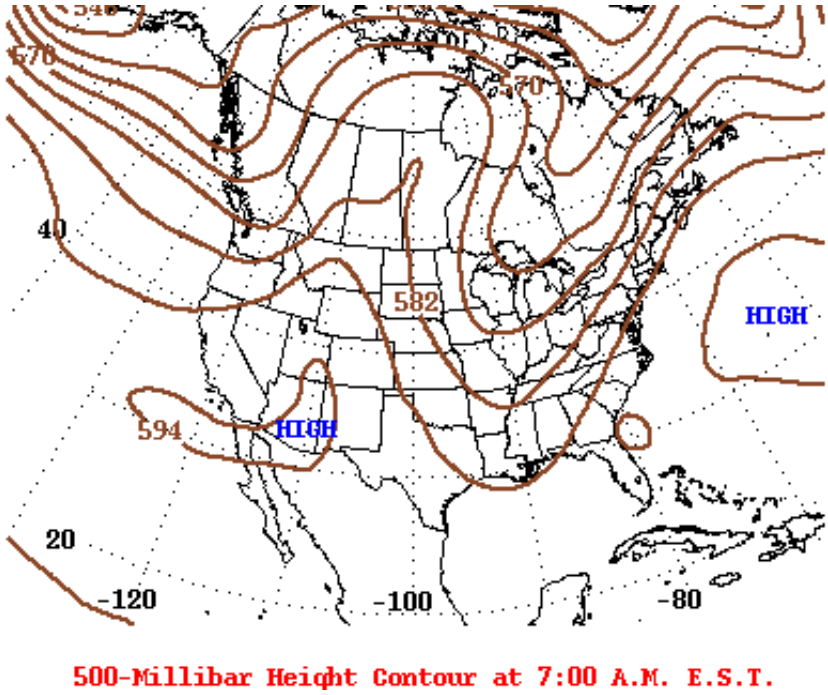


Figure D-17. 500 mb meteorology map on August 3, 2020 (the event date).

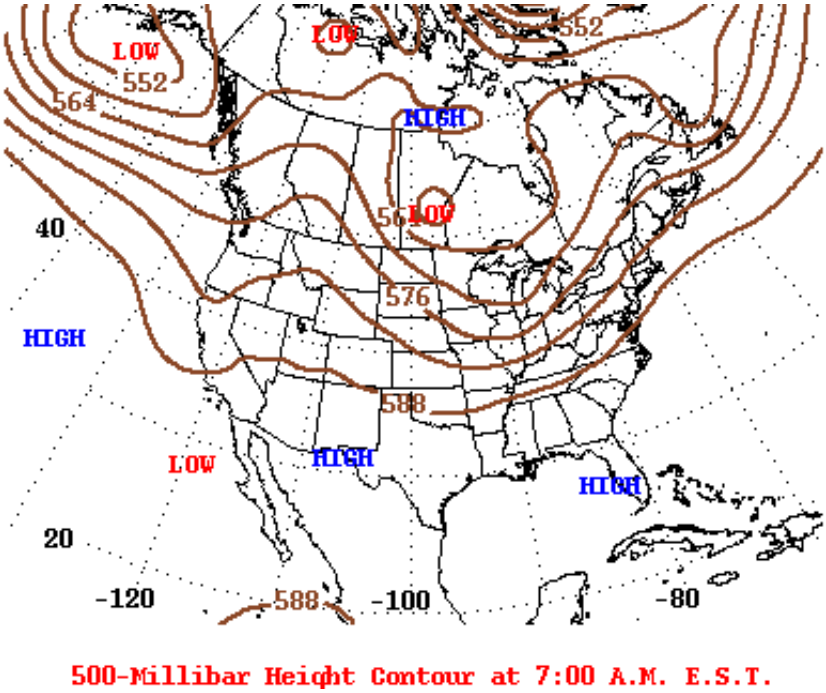


Figure D-18. 500 mb meteorology map on July 1, 2017.

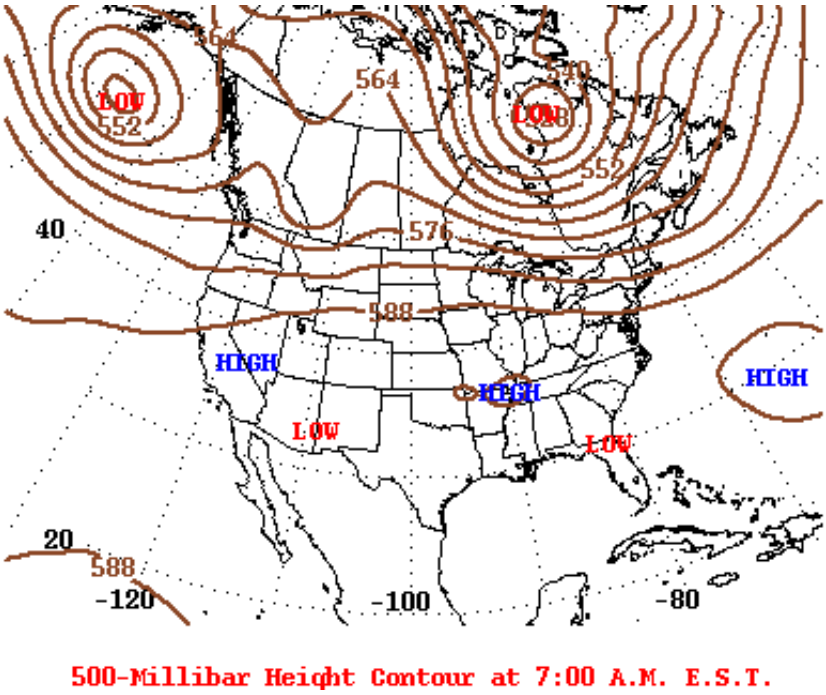


Figure D-19. 500 mb meteorology map on July 21, 2017.

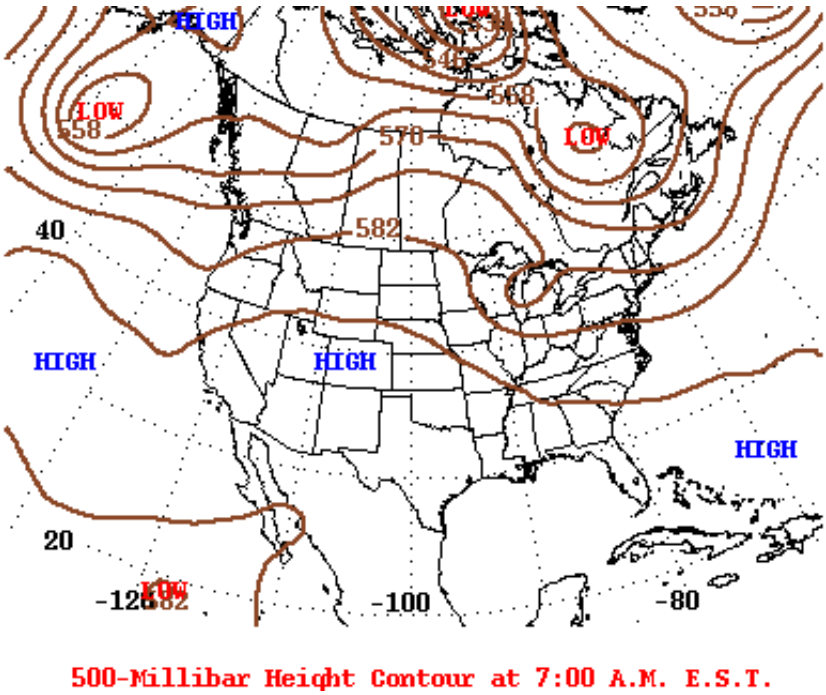


Figure D-20. 500 mb meteorology map on July 28, 2017.

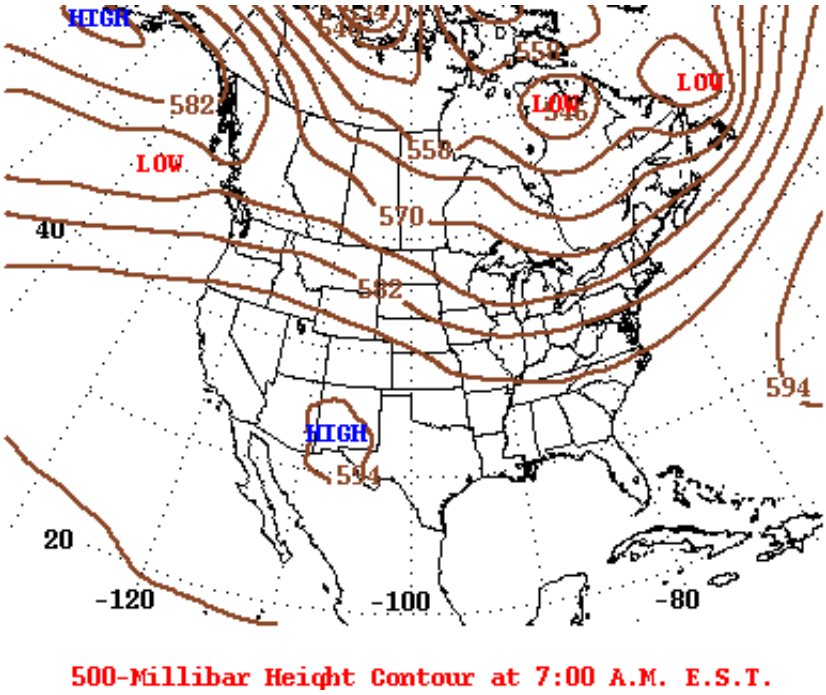


Figure D-21. 500 mb meteorology map on August 14, 2019.

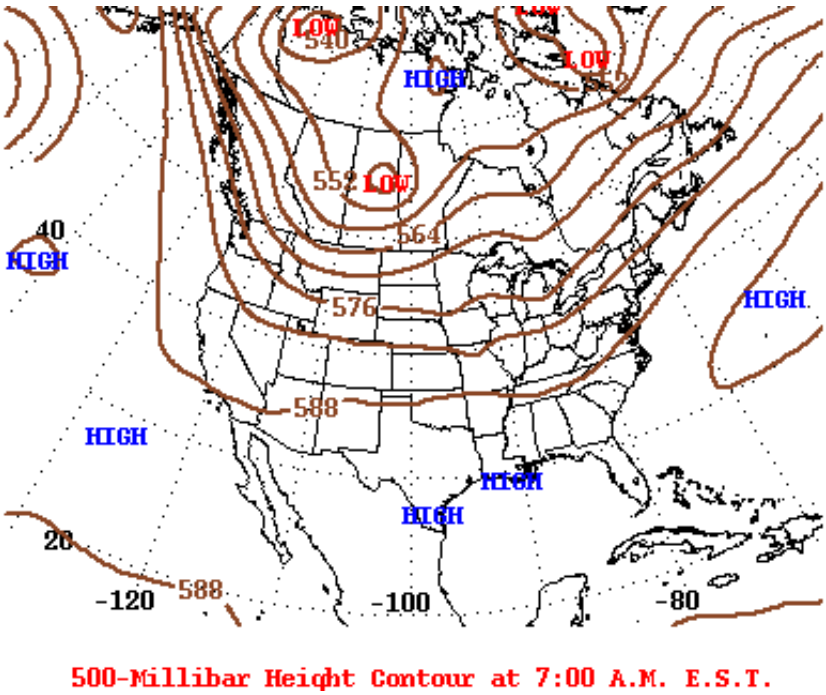


Figure D-22. 500 mb meteorology map on August 17, 2019.

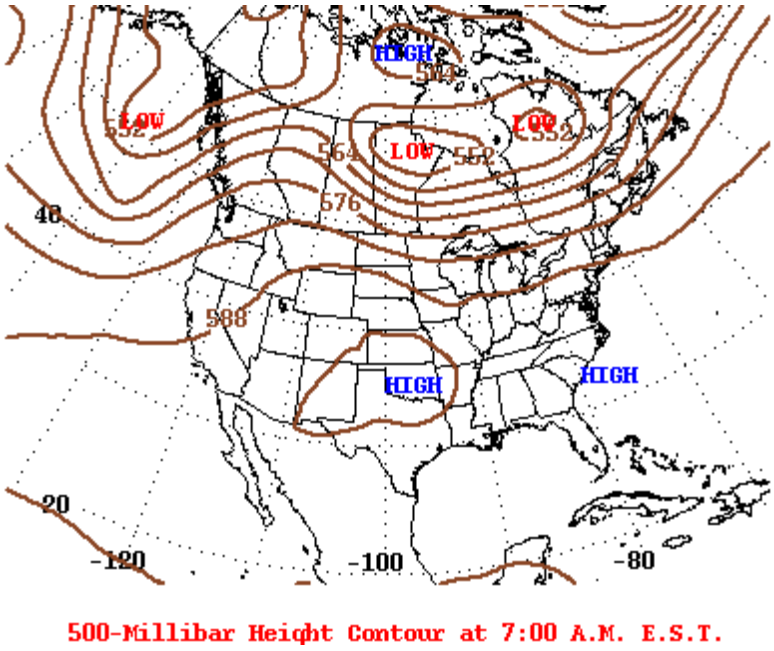


Figure D-23. 500 mb meteorology map on August 20, 2019.

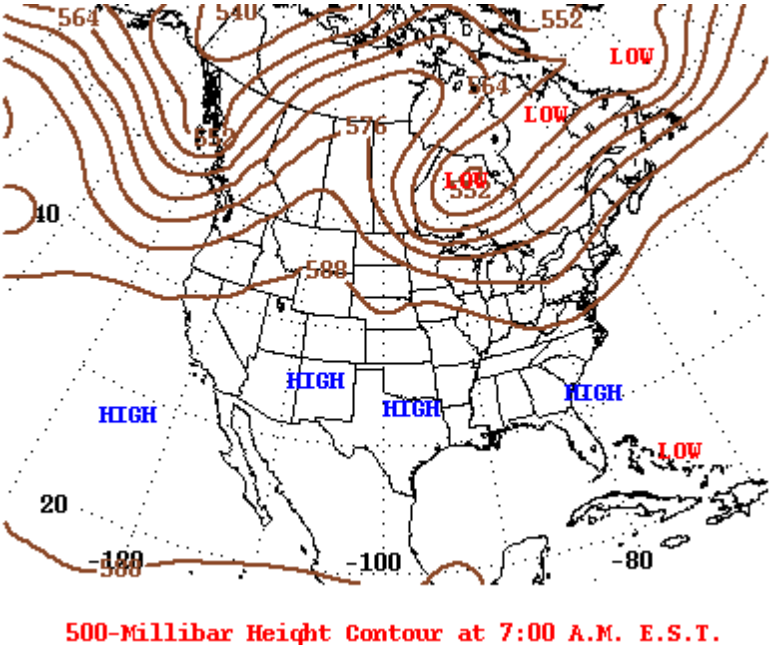


Figure D-24. 500 mb meteorology map on August 21, 2019.

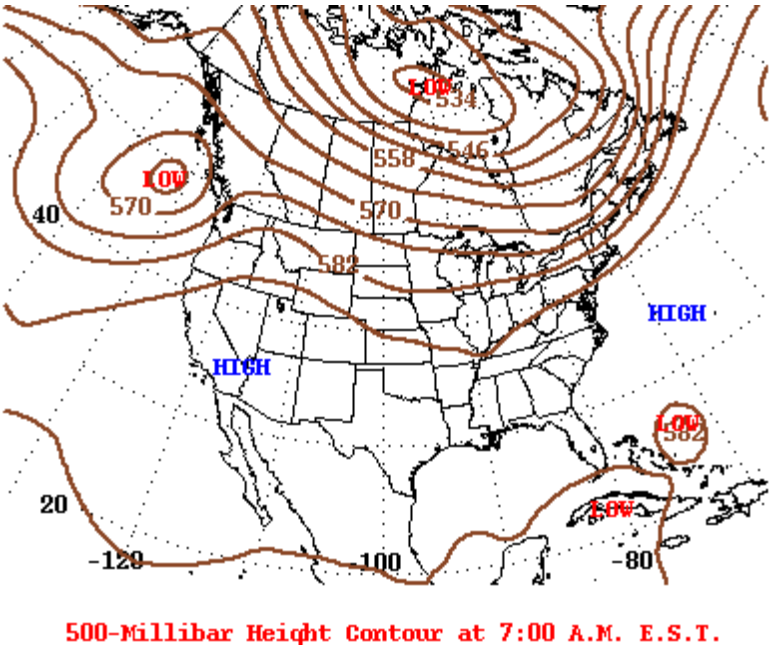


Figure D-25. 500 mb meteorology map on August 31, 2019, 2019.

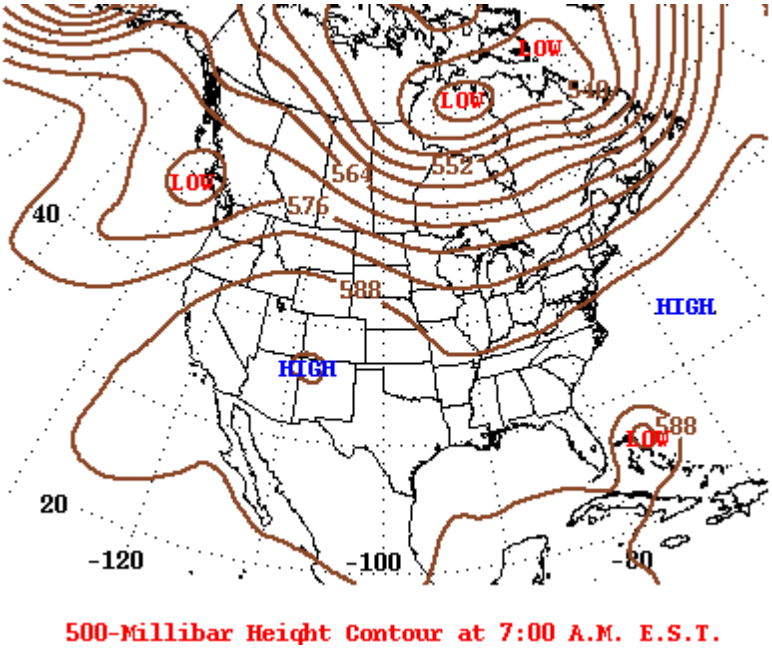


Figure D-26. 500 mb meteorology map on September 1, 2019.

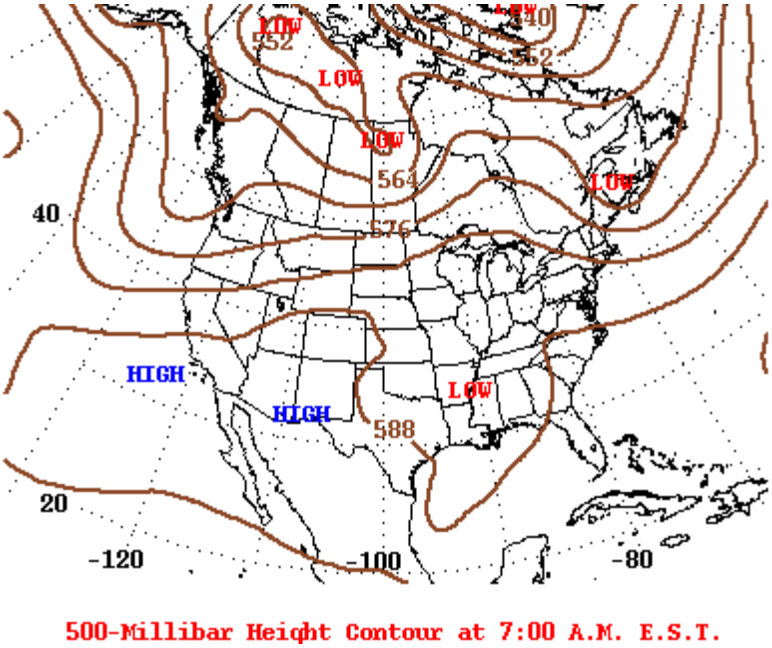


Figure D-27. 500 mb meteorology map on July 6, 2020.

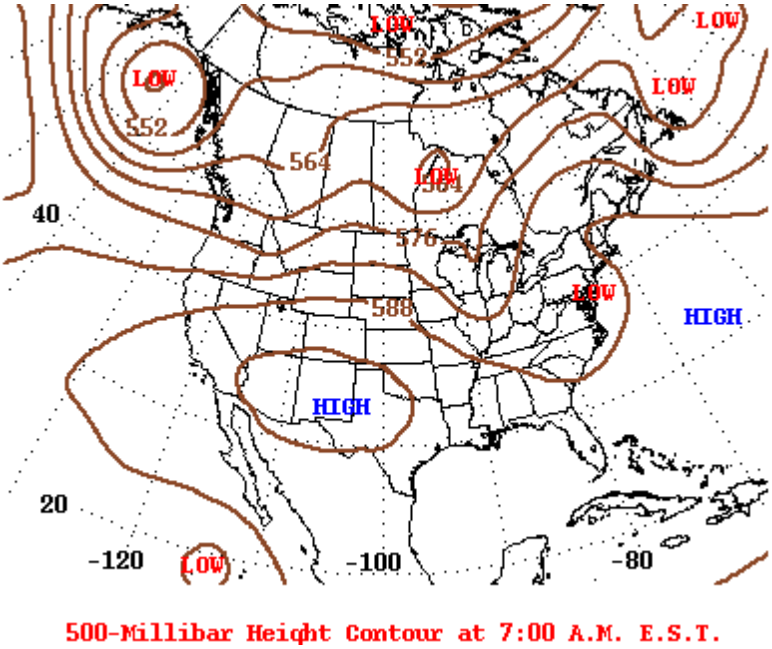


Figure D-28. 500 mb meteorology map on July 10, 2020.

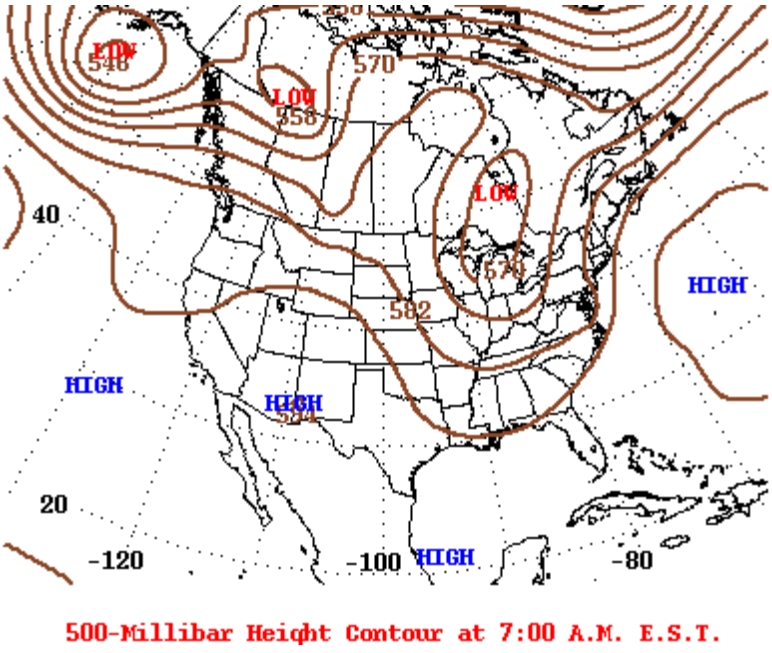


Figure D-29. 500 mb meteorology map on August 4, 2020.

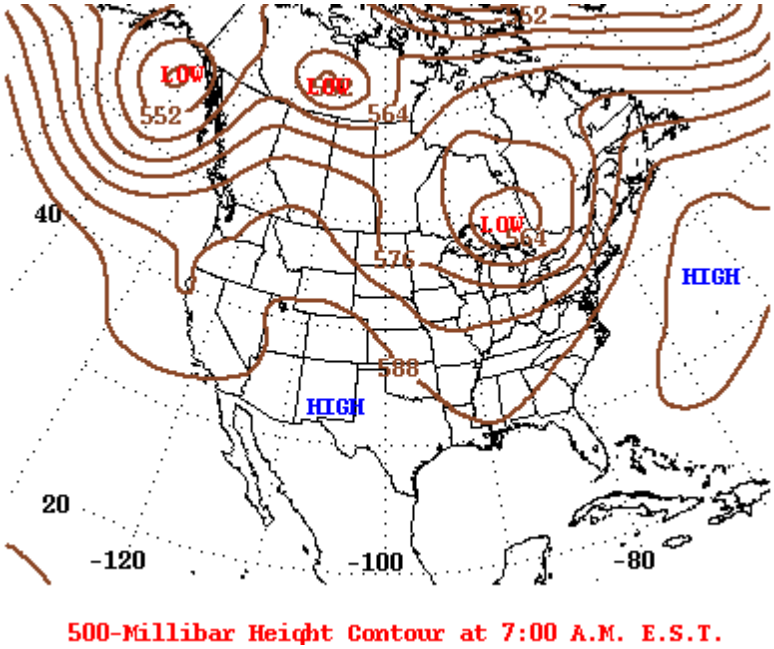


Figure D-30. 500 mb meteorology map on August 5, 2020.

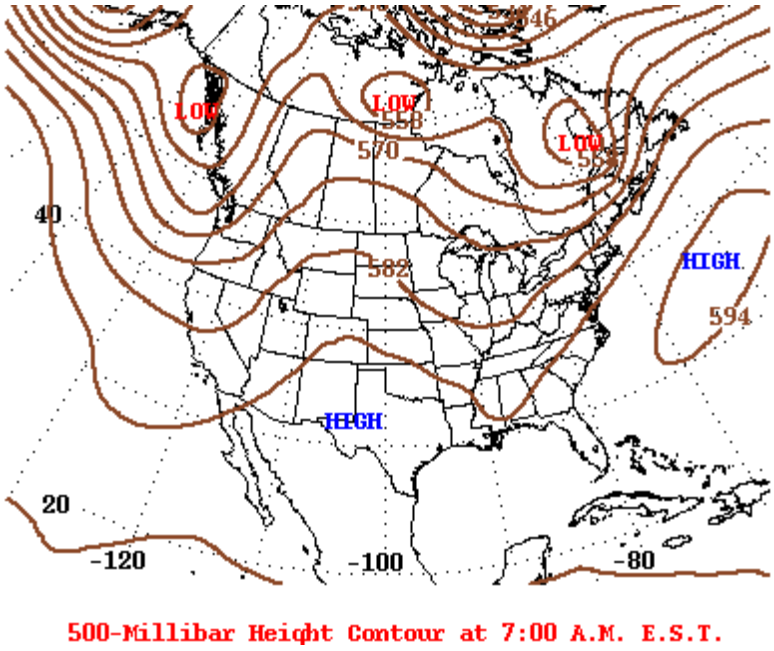


Figure D-31. 500 mb meteorology map on August 6, 2020

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

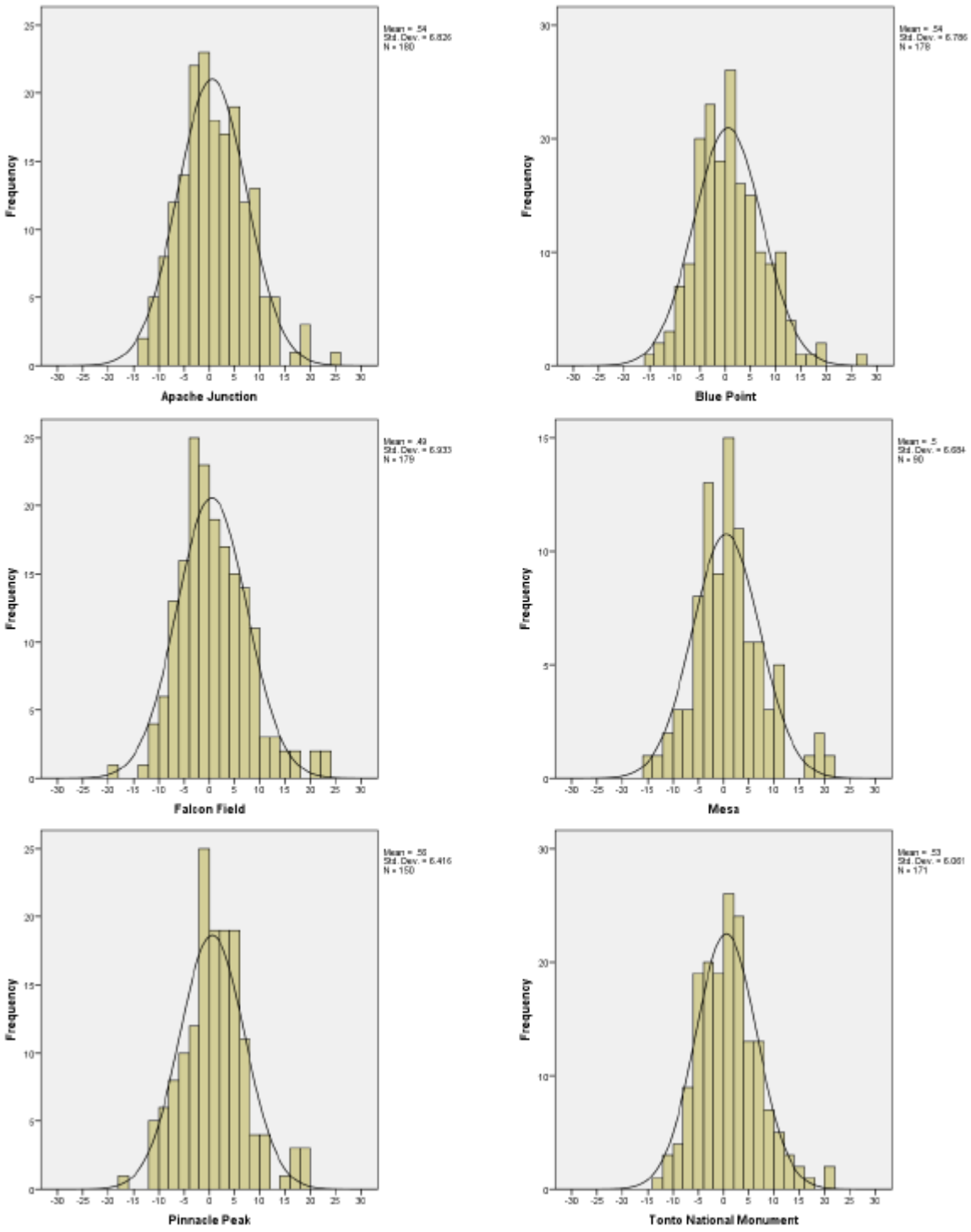


Figure E-1. Histograms of residuals results at each monitoring site from the Arizona DEQ GAM Analysis (Arizona Department of Environmental Quality 2016).

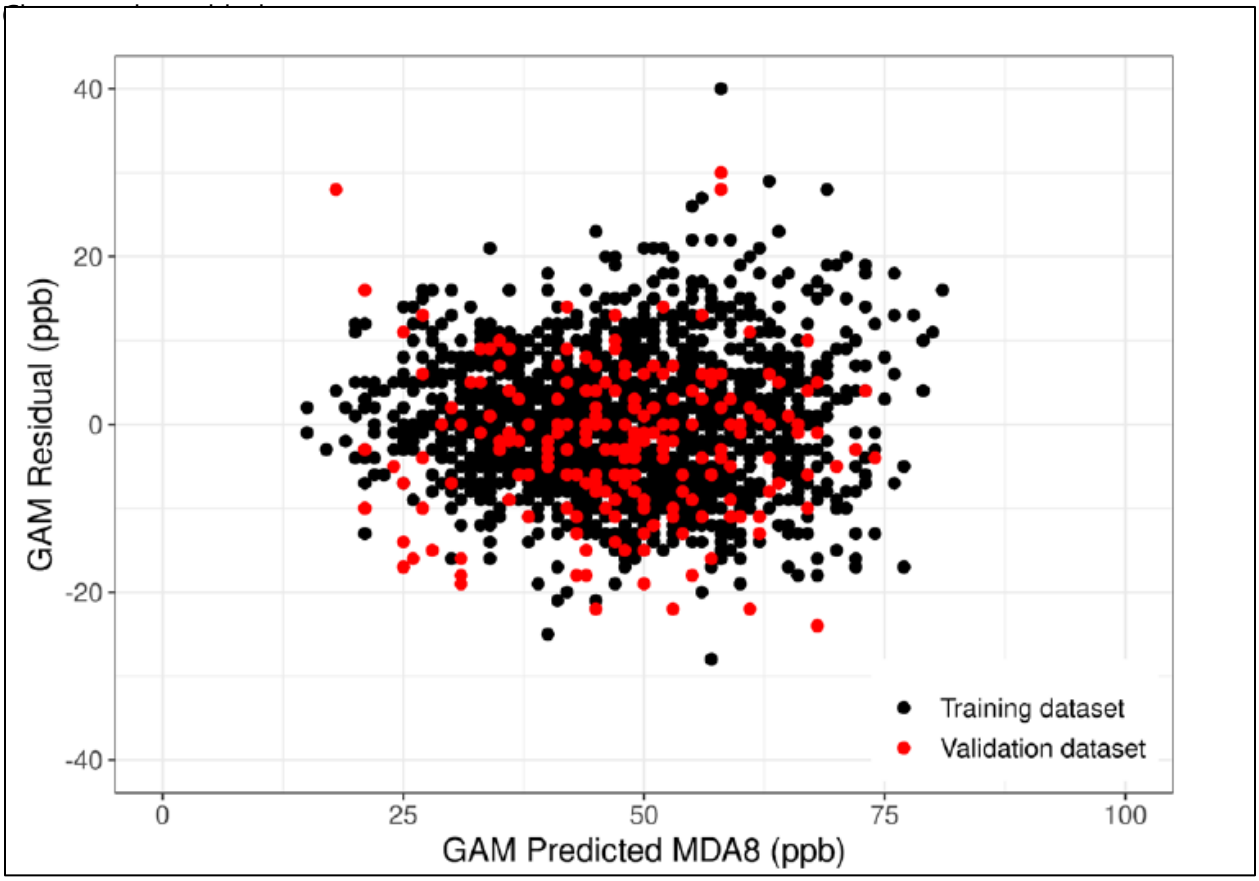


Figure E-2. Scatter plot of GAM residuals (observed – GAM predicted MDA8 ozone) vs. GAM predicted MDA8 ozone from the TCEQ submitted GAM analysis. Training data is shown in black and validation data is shown in red (Texas Commission on Environmental Quality 2021).

References

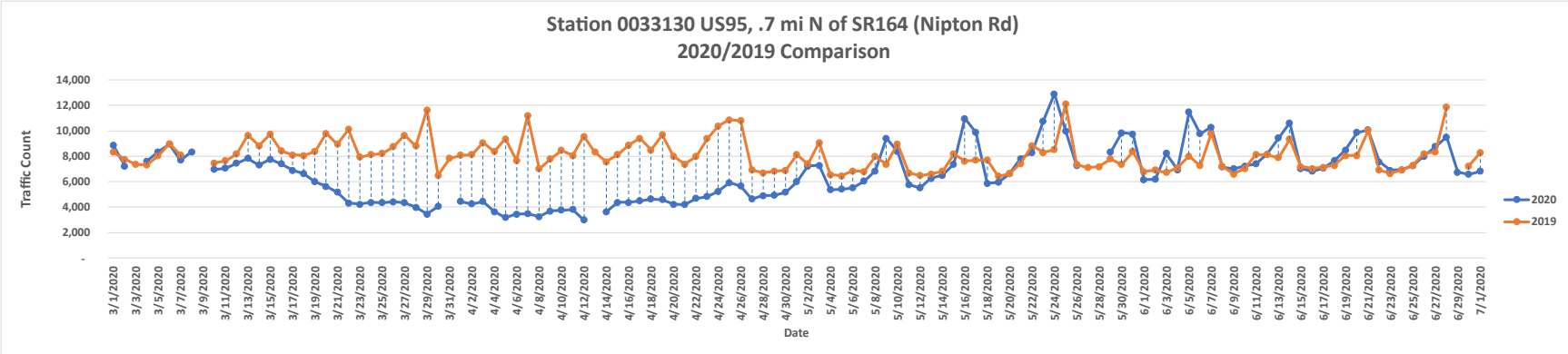
Arizona Department of Environmental Quality (2016) State of Arizona exceptional event documentation for wildfire-caused ozone exceedances on June 20, 2015 in the Maricopa nonattainment area. Final report, September. Available at https://static.azdeq.gov/pn/1609_ee_report.pdf.

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 F. 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 F-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.



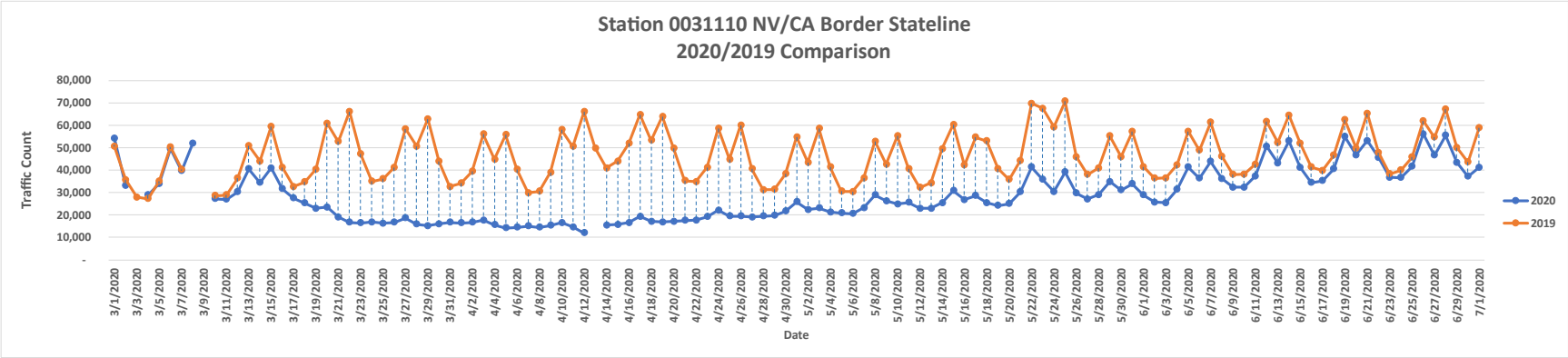
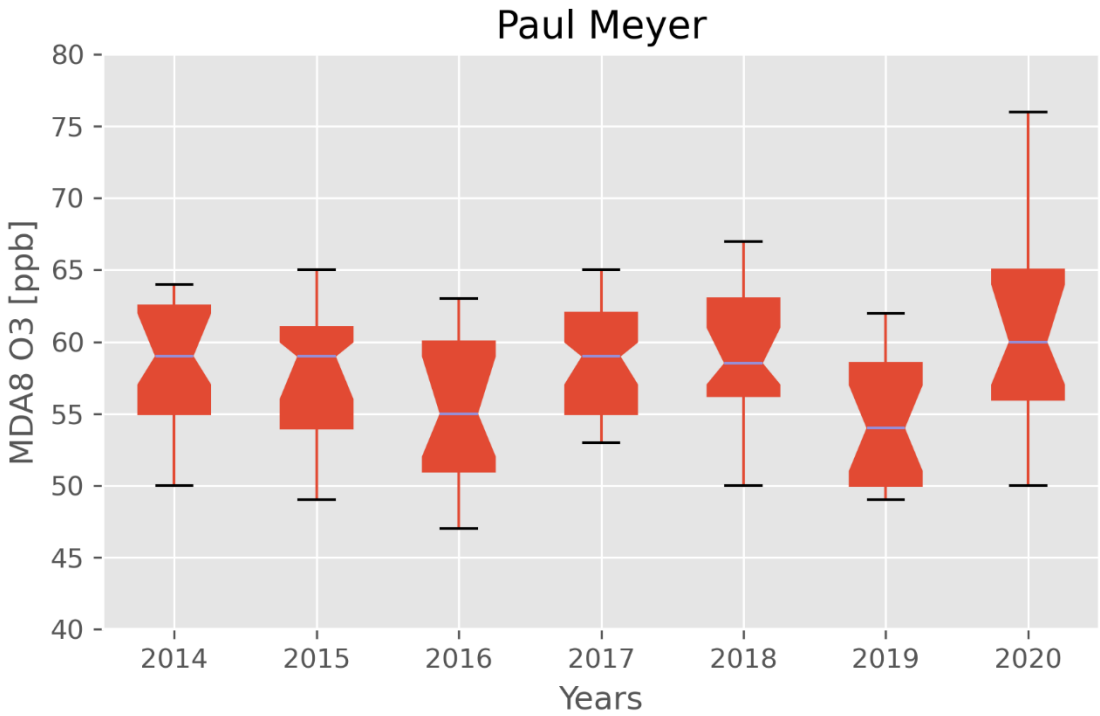


Figure F-1. Time series of 2020 and 2019 traffic counts at two stations: (top) along US95, south of Las Vegas, and (bottom) at the Nevada-California border, west of Las Vegas. Data were provided by the Nevada Department of Transportation.

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 F-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 F-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 3-55 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 3-49 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.



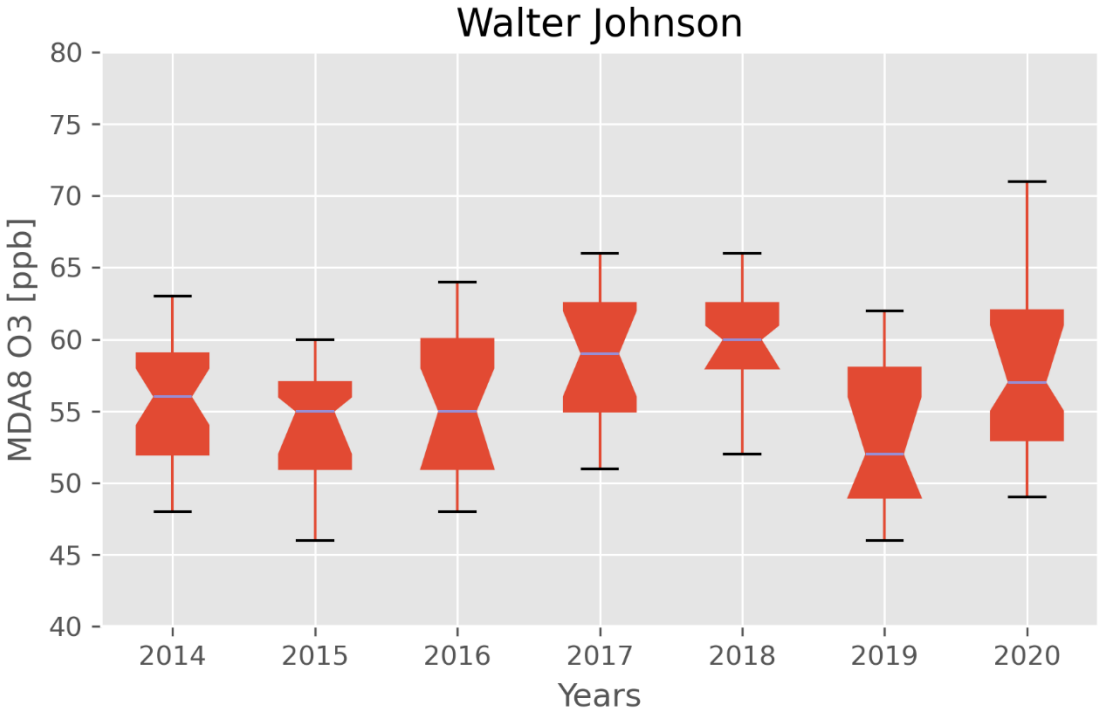
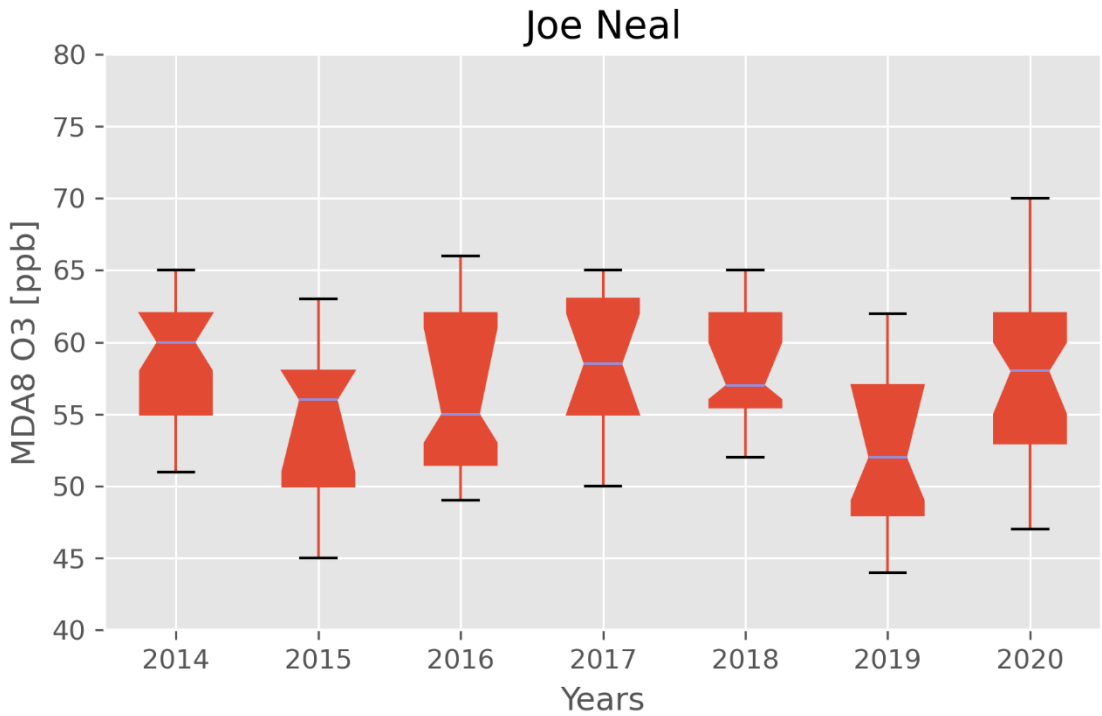


Figure F-2. Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



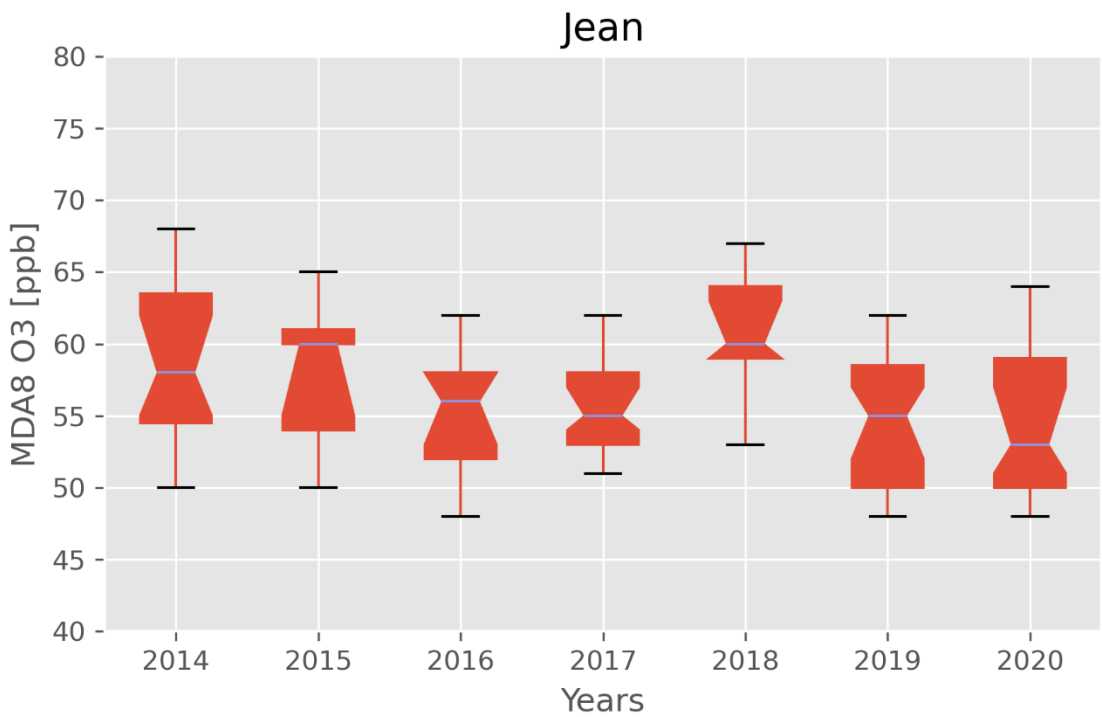
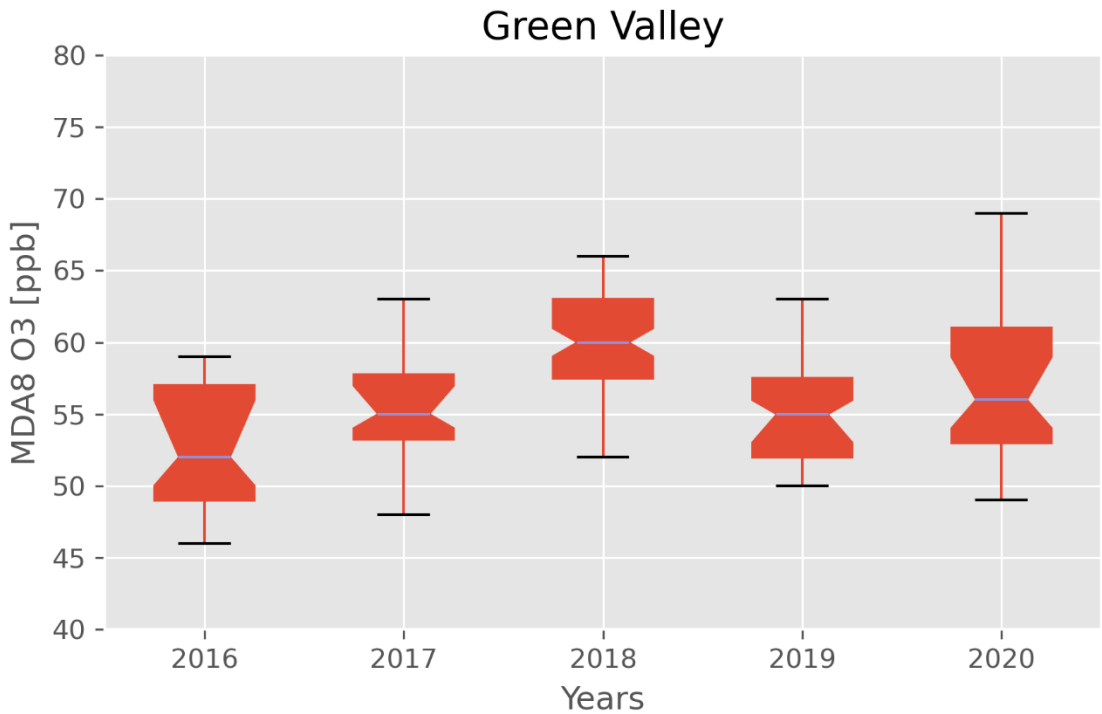


Figure F-2 (Continued). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



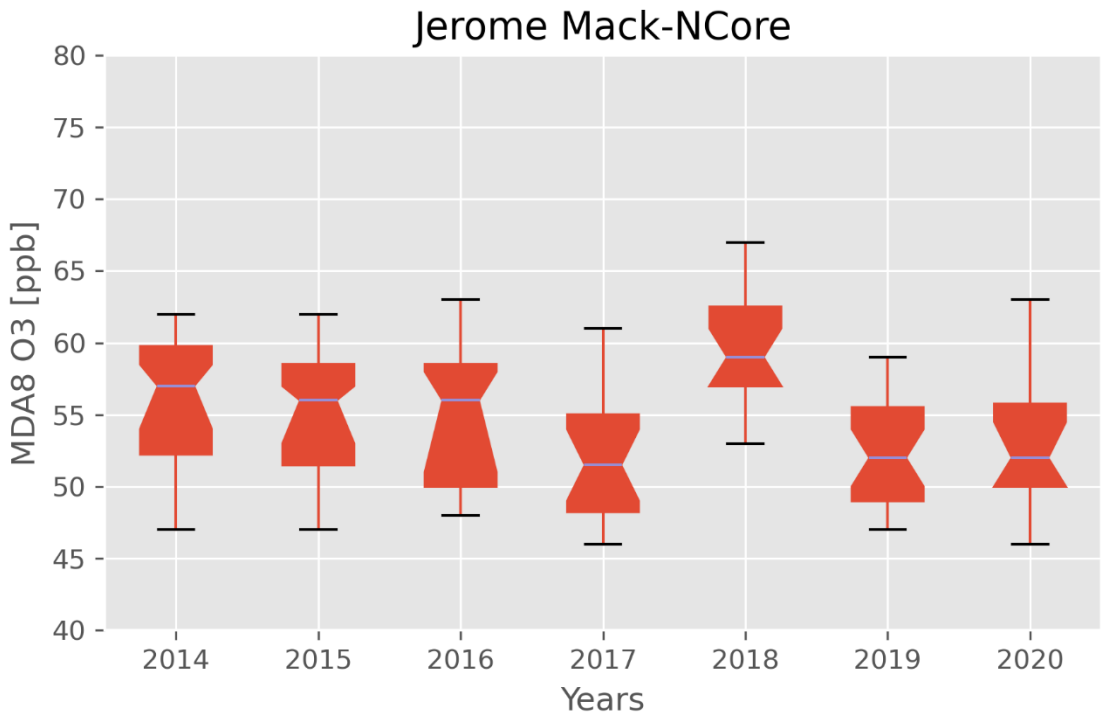
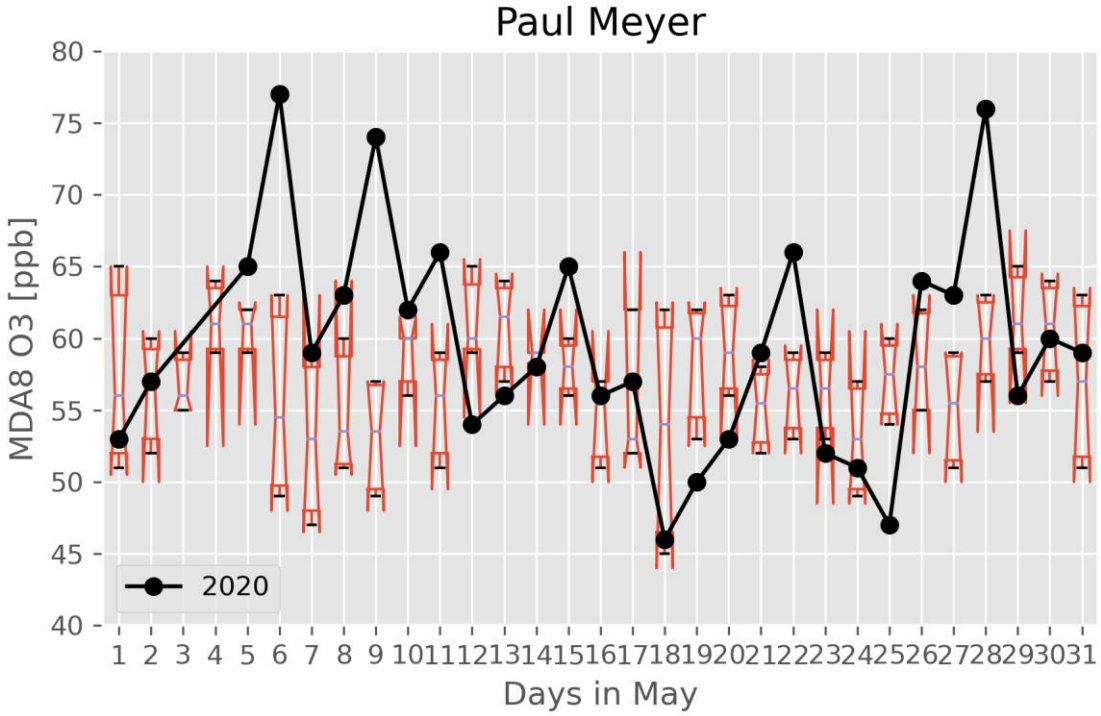


Figure F-2 (Continued). Annual May distributions of MDA8 ozone at sites with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



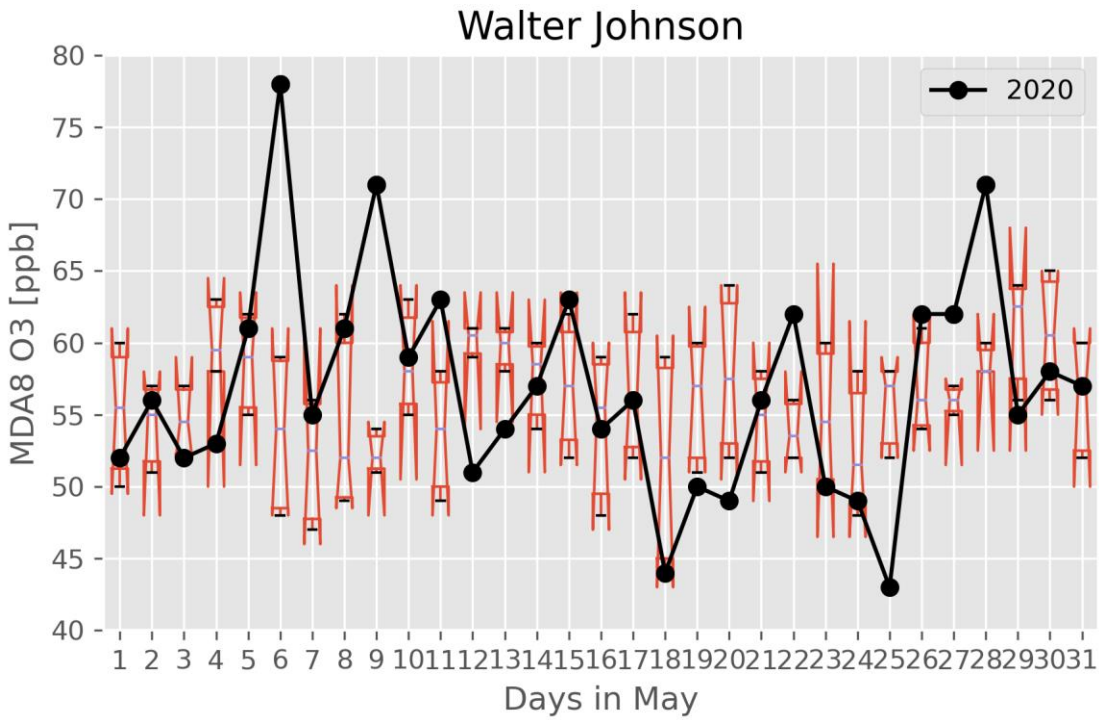
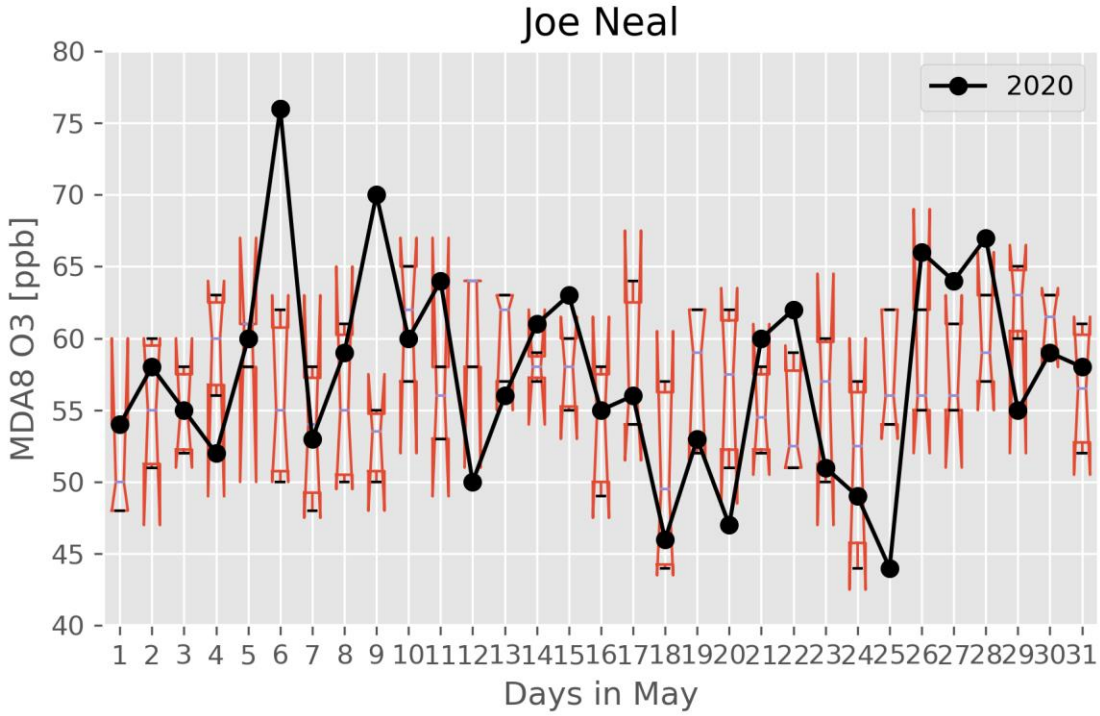


Figure F-3. Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



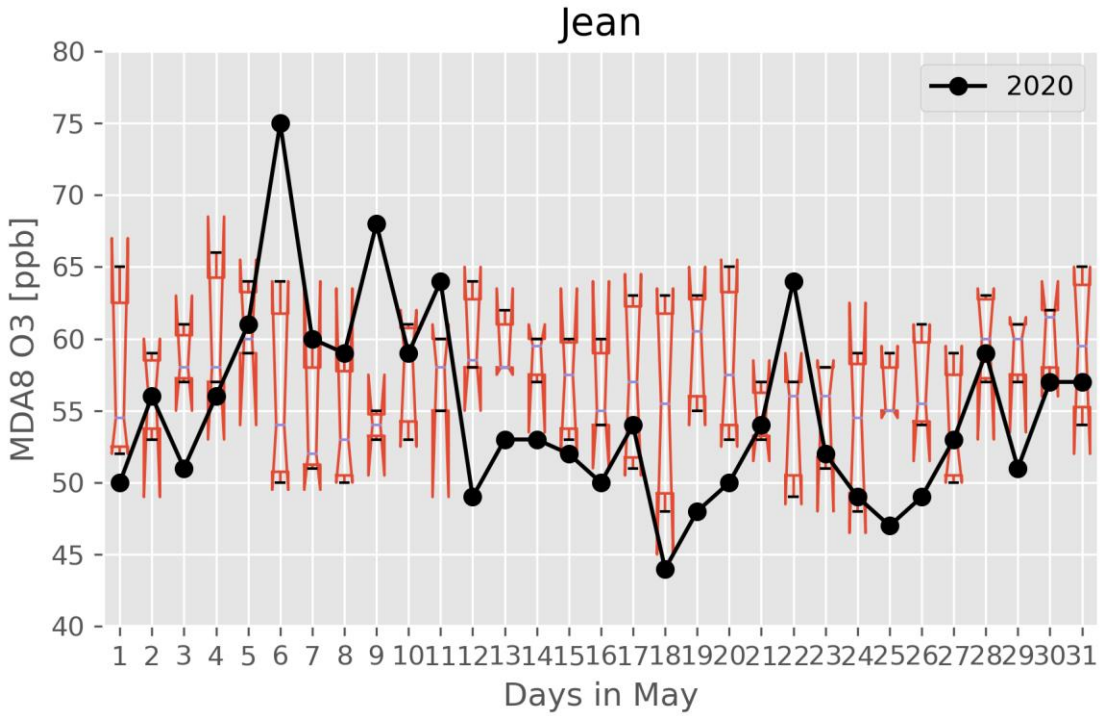
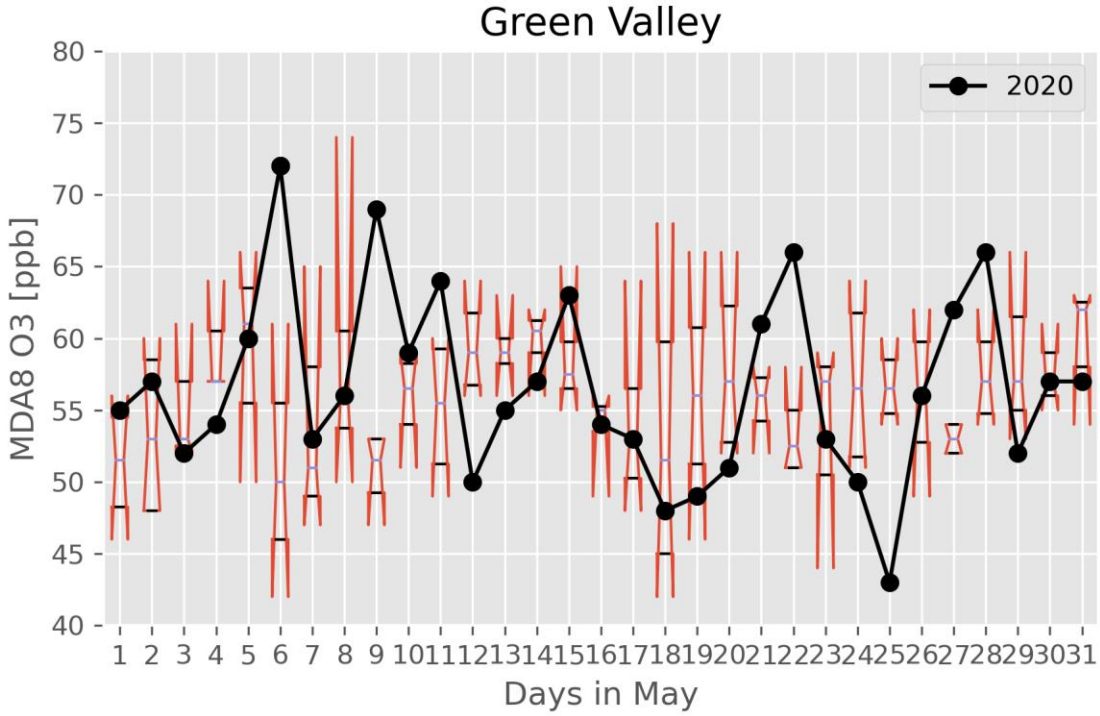


Figure F-3 (Continued). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.



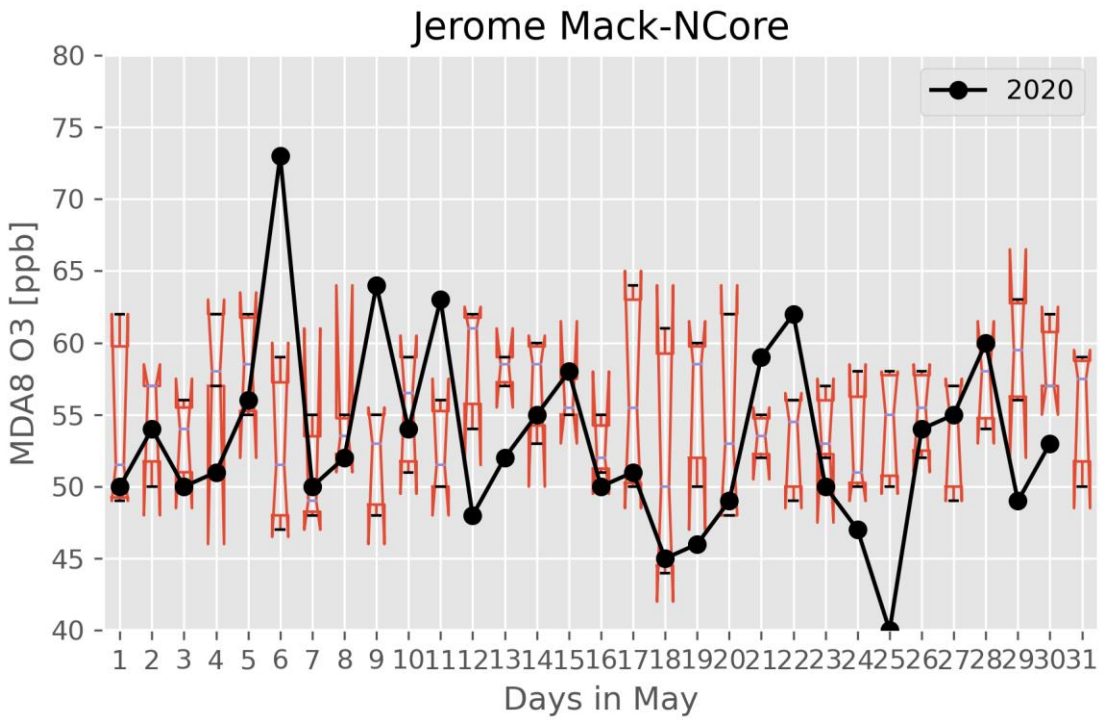


Figure F-3 (Continued). Daily time series of 2014-2019 MDA8 ozone distributions and 2020 MDA8 ozone at each site with exceptional events during May 2020. Notches denote 95th confidence interval of the median, boxes are 25th, 50th and 75th percentiles, and whiskers are 5th and 95th percentiles.

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Appendix G. 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.