Air Quality Study Update

Environmental Services, Public Works and Natural Resources

Dr. Jane Turner
Air Quality / Oil and Gas Coordinator
Tuesday, April 6, 2020

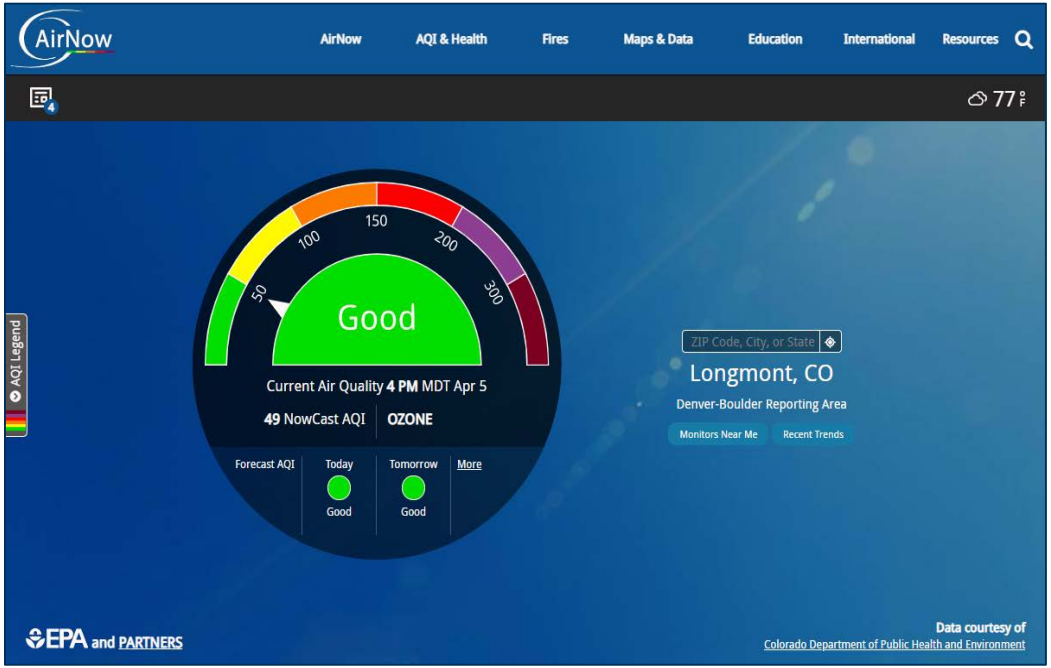
Poor air quality can occur in any season

- **Colder months:** particulate matter, ozone, “smog”
  - Action days = burn restrictions

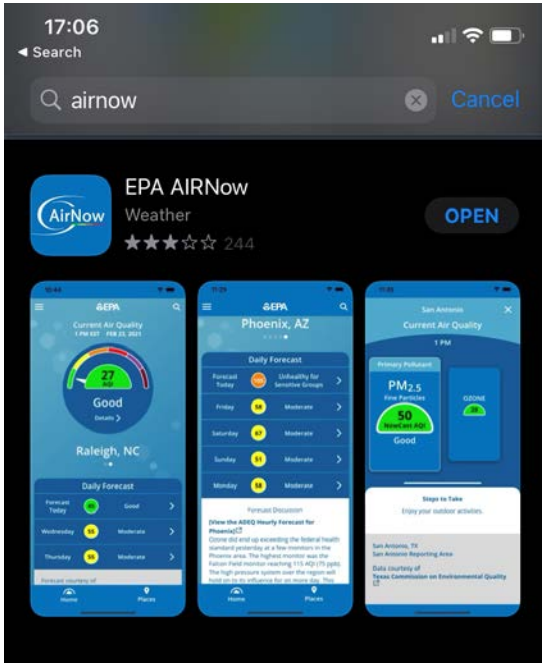
- **Warmer months:** ozone, wildfire particulate matter
  - City’s Air Quality webpage for resources

General Air Quality Information & Forecasts

Website: airnow.gov



Phone app available



City of Longmont Air Quality Study

- **How to stay informed:**
  - City Council Meeting air quality updates
  - Real-time data website https://www.bouldair.com/longmont.htm
  - Sign up for Air Quality eNotifications
    - Search “eNotifications” on City Website
  - Read quarterly air monitoring reports
    - Search “air quality reports” on City Website

Presentation by Dr. Detlev Helmig Boulder AIR

West: Vance Brand Airport

Air Quality Study Update

East: Union Reservoir

Boulder Atmosphere Innovation Research

Longmont Air Quality Study

April 6, 2021, Update

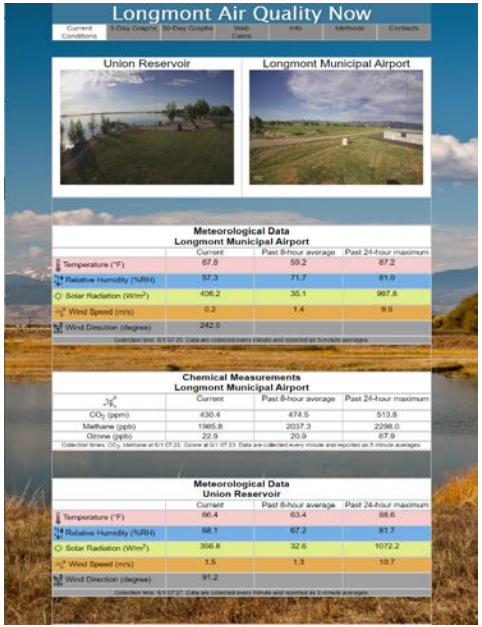
Detlev Helmig

Boulder A.I.R.

Longmont Municipal Airport (LMA)

- Operating since September 2019
- 1.5 Years of data
- > 99 % Data coverage

- Meteorology
- Ozone
- Methane
- CO_2
- Webcam



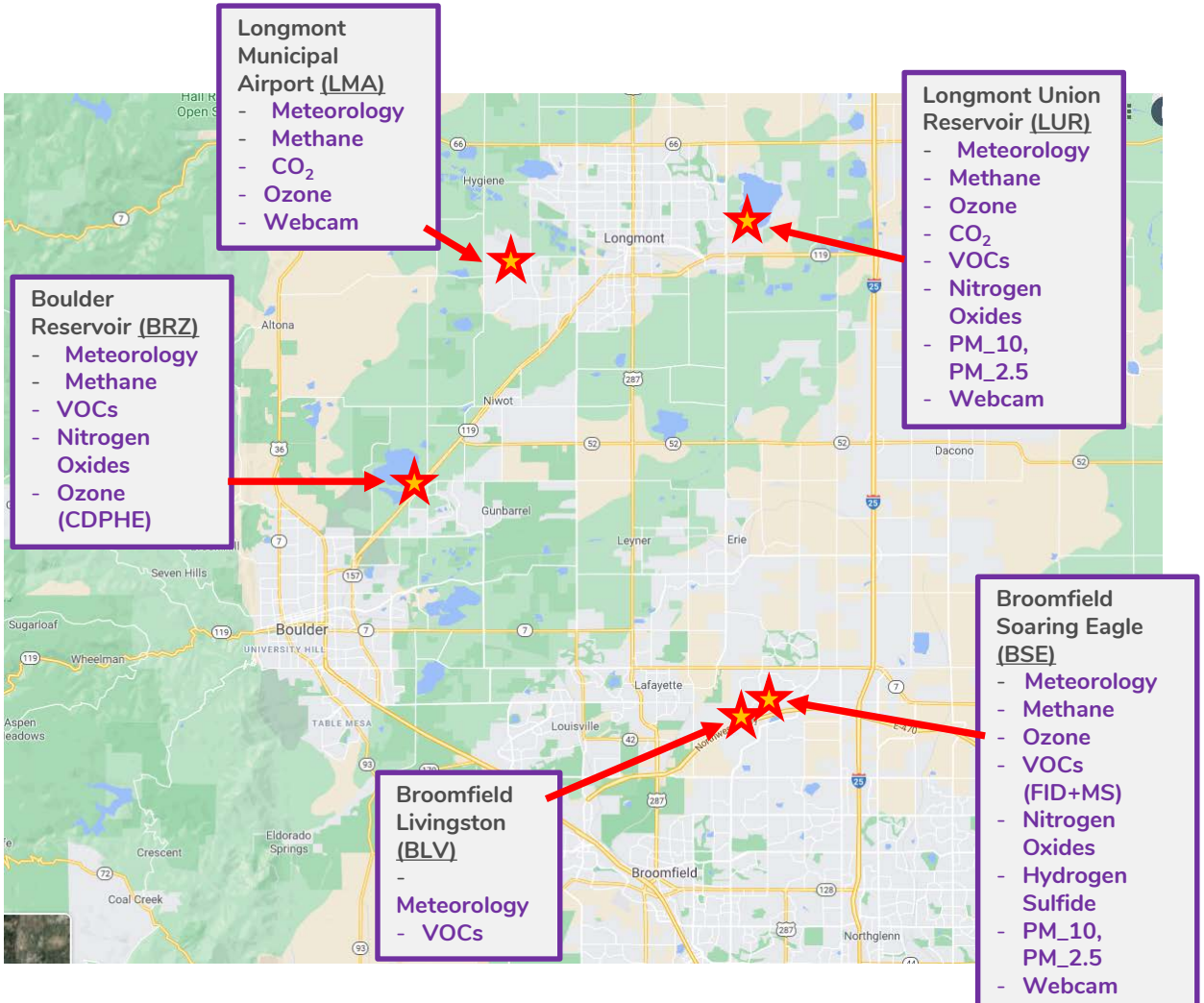
- Since March 2020
- 1 Years of operation
- > 99 % Uptime
- > 15,000 Site visits

New: - Twelve more VOCs plotted
- Interactive Data Analysis Tool (*http://www.bouldairtools.com/interactive/*)
- Combined data website (with BRZ, BSE, BLV)
- Air Quality Alerts (to City Representatives)

Longmont Union Reservoir (LUR)

- Operating since December 2019
- 1.3 Years of data
- > 99 % Data coverage

- Meteorology
- Ozone
- Methane
- CO_2
- Nitrogen Oxides (NO, NO_2, NO_x)
- Volatile Organic Compounds (20 species)
- Particulate Matter (PM2.5, PM10)
- Webcam


Longmont Municipal Airport (LMA)
- Meteorology
- Methane
- CO_2
- Ozone
- Webcam
Longmont Union Reservoir (LUR)
- Meteorology
- Methane
- Ozone
- CO_2
- VOCs
- Nitrogen Oxides
- PM_10, PM_2.5
- Webcam
Boulder Reservoir (BRZ)
- Meteorology
- Methane
- VOCs
- Nitrogen Oxides
- Ozone (CDPHE)
Broomfield Soaring Eagle (BSE)
- Meteorology
- Methane
- Ozone
- VOCs (FID+MS)
- Nitrogen Oxides
- Hydrogen Sulfide
- PM_10, PM_2.5
- Webcam
Broomfield Livingston (BLV)
- Meteorology
- VOCs
Hygiene
Longmont
Altona
Niwot
Dacono
Gunbarrel
Leyner
Erie
Seven Hills
Sugarloaf
Boulder
Wheelman
Lafayette
Louisville
Aspen
Crescent
Eldorado Springs
Coal Creek
Broomfield
Northglenn

Methane, VOCs, Nitrogen Oxides (NO_x), and Ozone Sources

Ethane
+ VOCs
...

Methan
e

Nitrogen Oxides
(NOx)

Ozone

2.5

Presentation Topics

1. General trend in oil and gas high concentration spikes

2. Exceptional, extremely high concentration oil and gas plumes in early 2021

3. Photochemical smog event in March 2021

4. Ozone control recommendations

Note: All data and interpretations are preliminary.

Presentation Topics

1. General trend in oil and gas high concentration spikes

2. Exceptional, extremely high concentration oil and gas plumes in early 2021

3. Photochemical smog event in March 2021

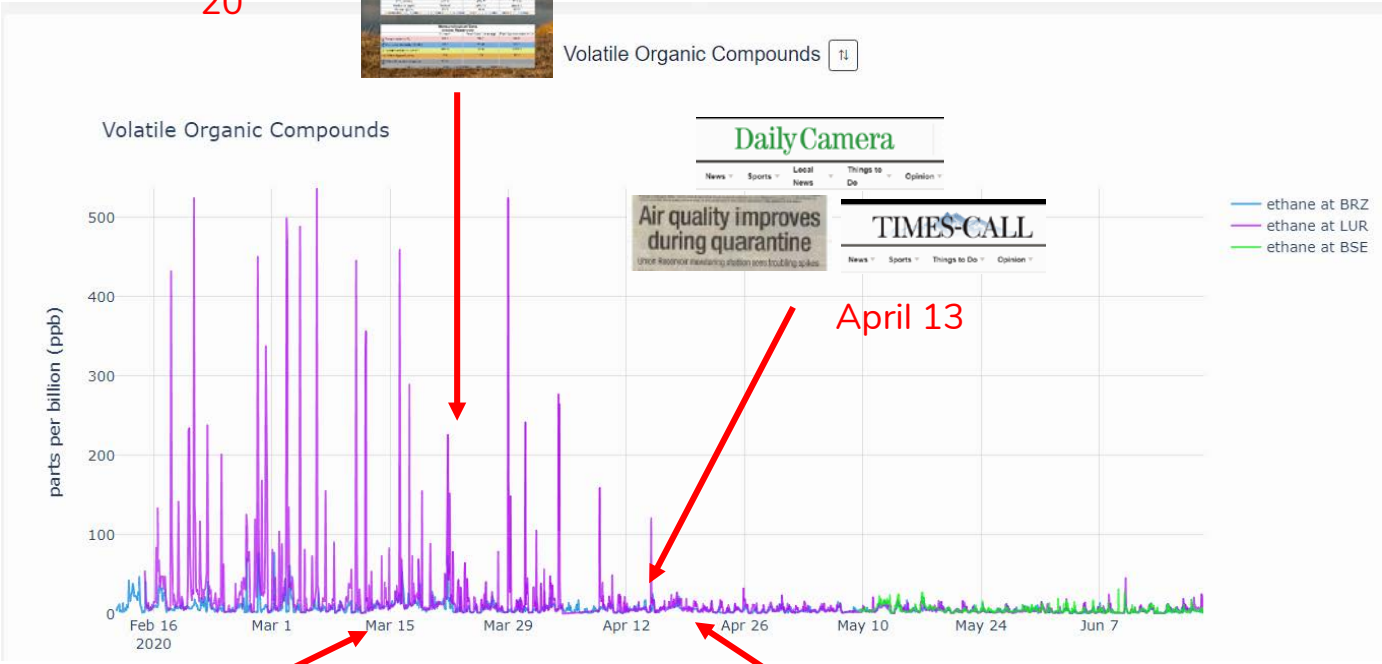
4. Ozone control recommendations

Ethane

Slide from July 28, 2020, presentation to Longmont City Council

March 20

Volatile Organic Compounds



Daily Camera

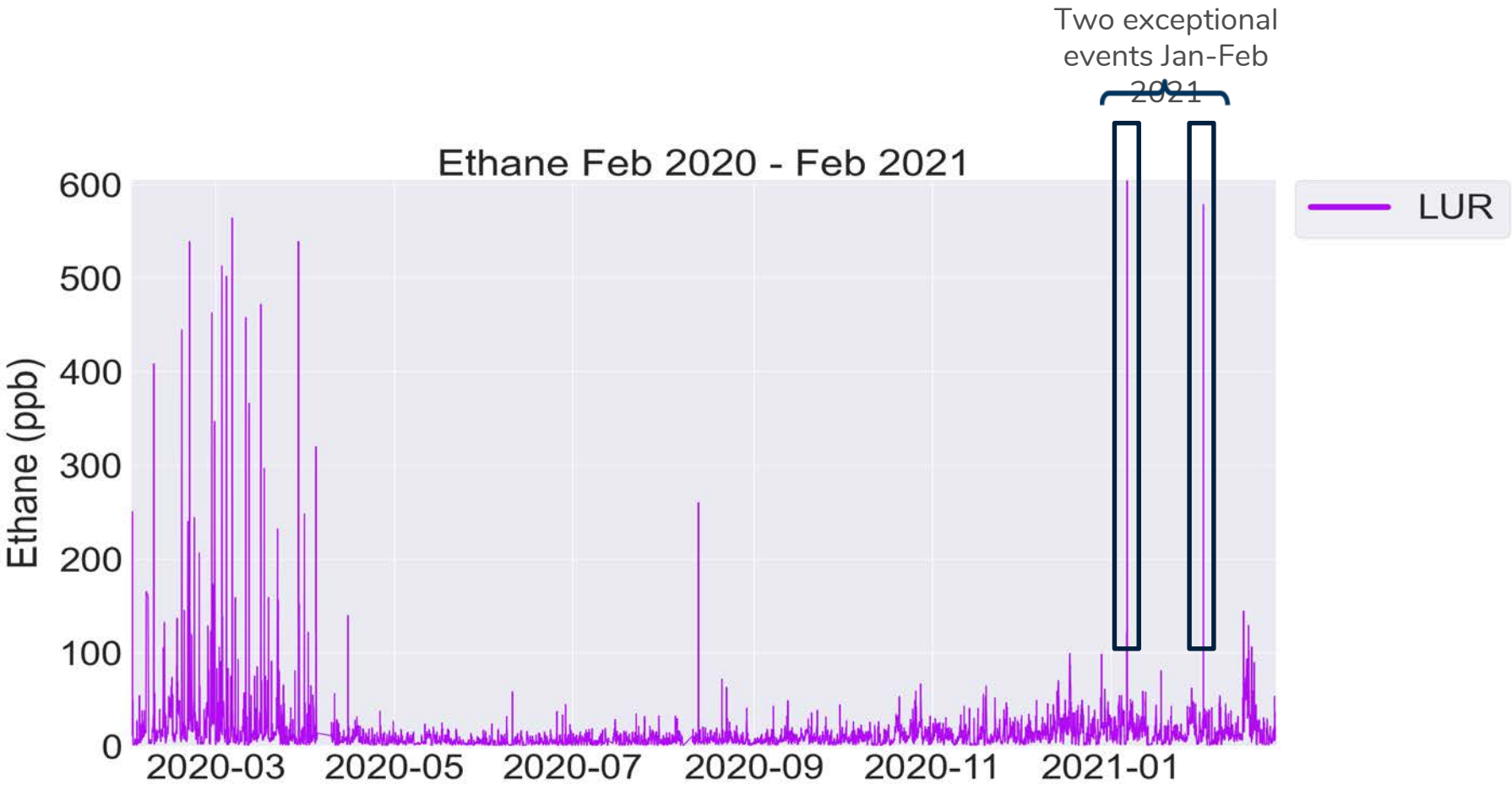
Air quality improves during quarantine

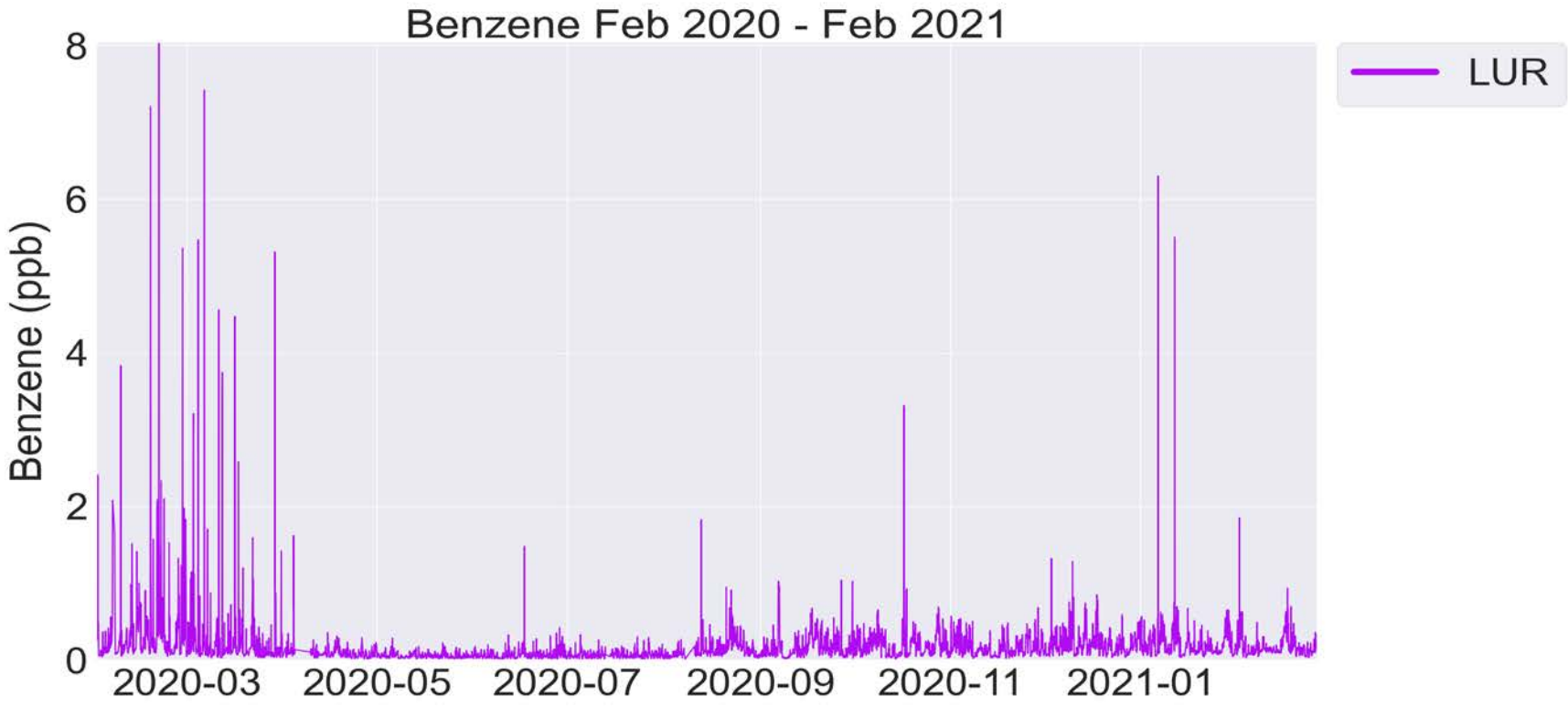
TIMES-CALL

April 13

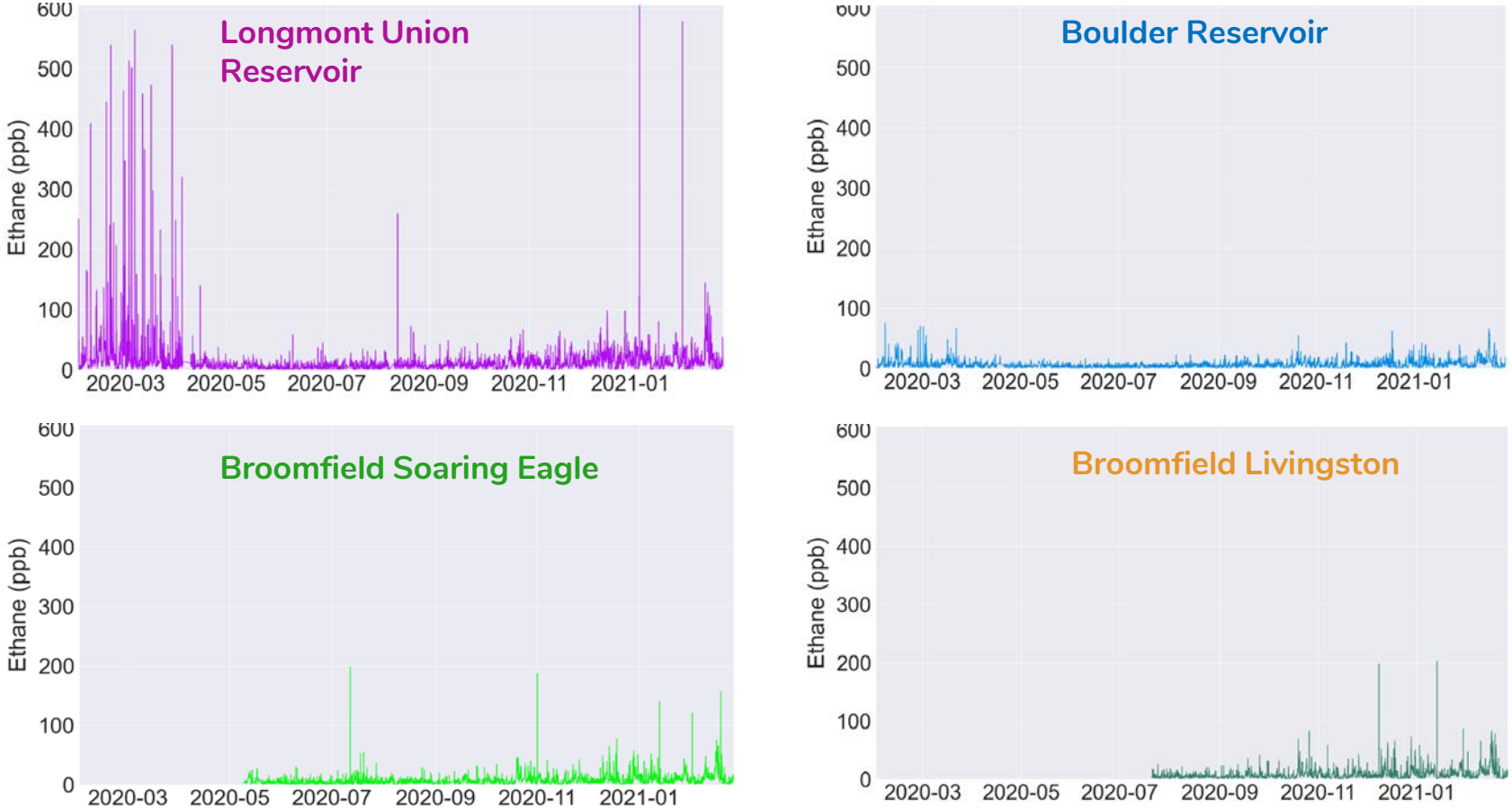
March 12

April 20

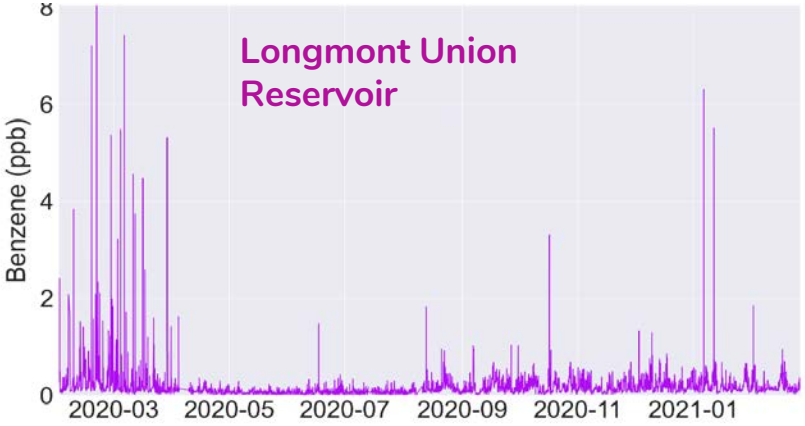

Two exceptional events Jan-Feb 2021
Ethane Feb 2020 - Feb 2021
Ethane (ppb)
600
500
400
300
200
100
0
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01
LUR

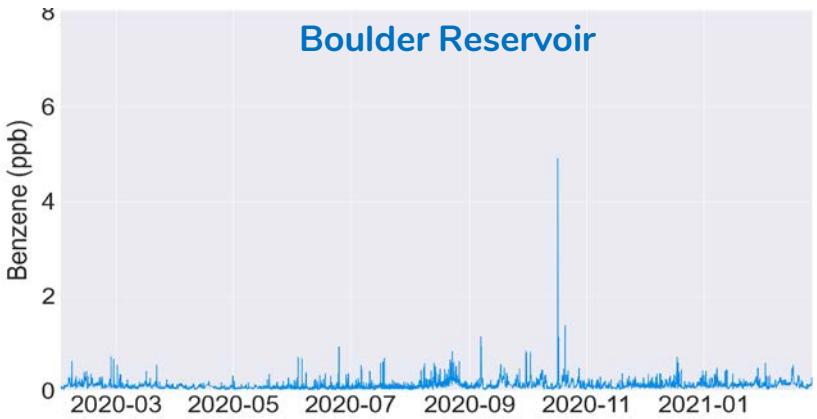

Benzene Feb 2020 - Feb 2021
Benzene (ppb)
0
2
4
6
8
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01
LUR

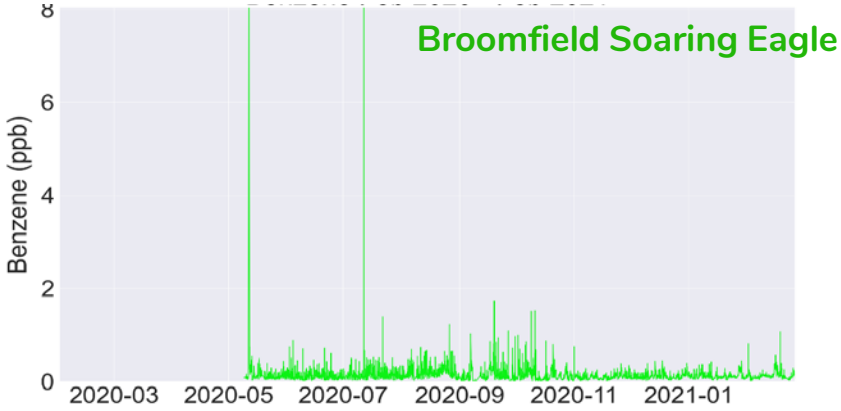
Comparison of Ethane at four Sites

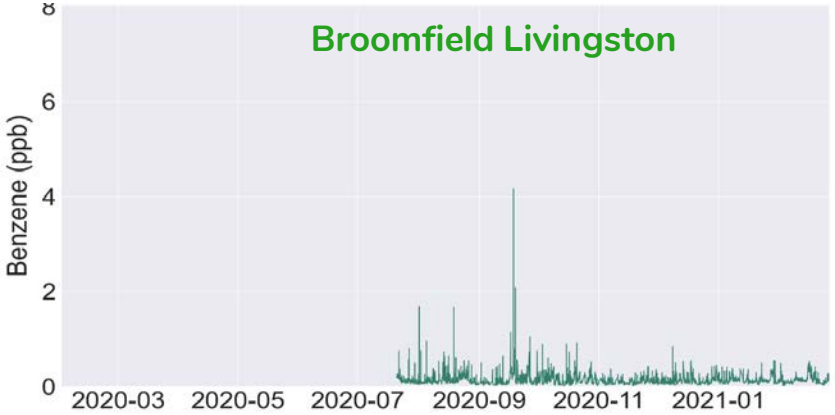


Comparison of Benzene at four Sites

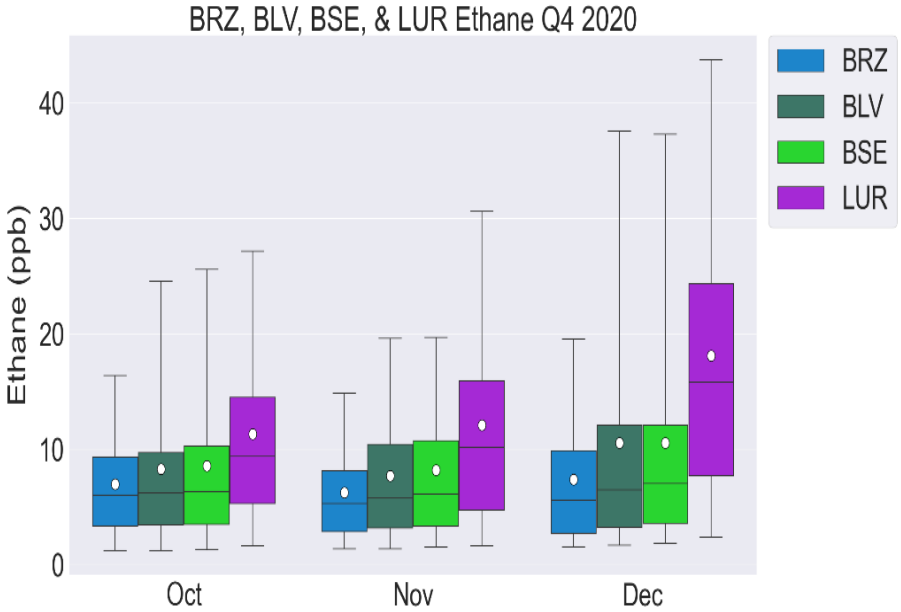


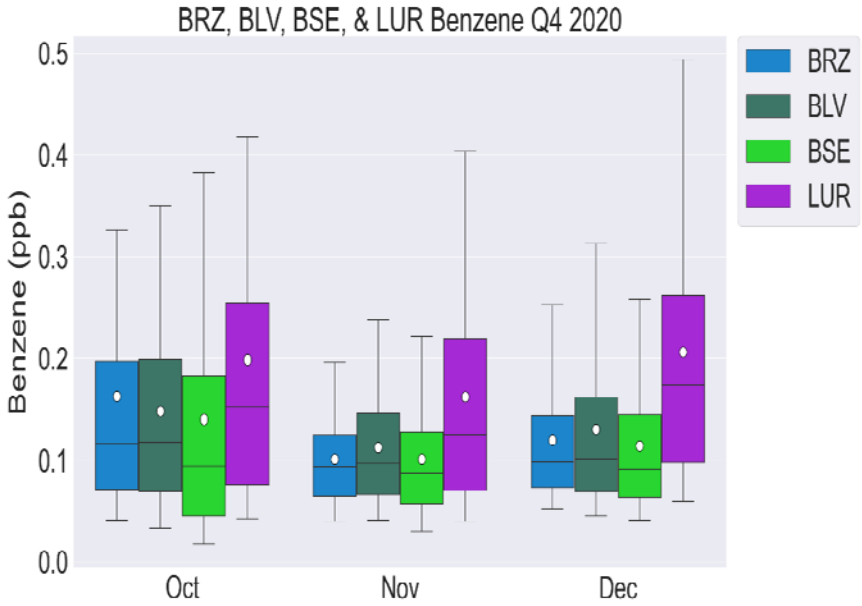






Statistical Comparison of Ethane and Benzene at four Sites





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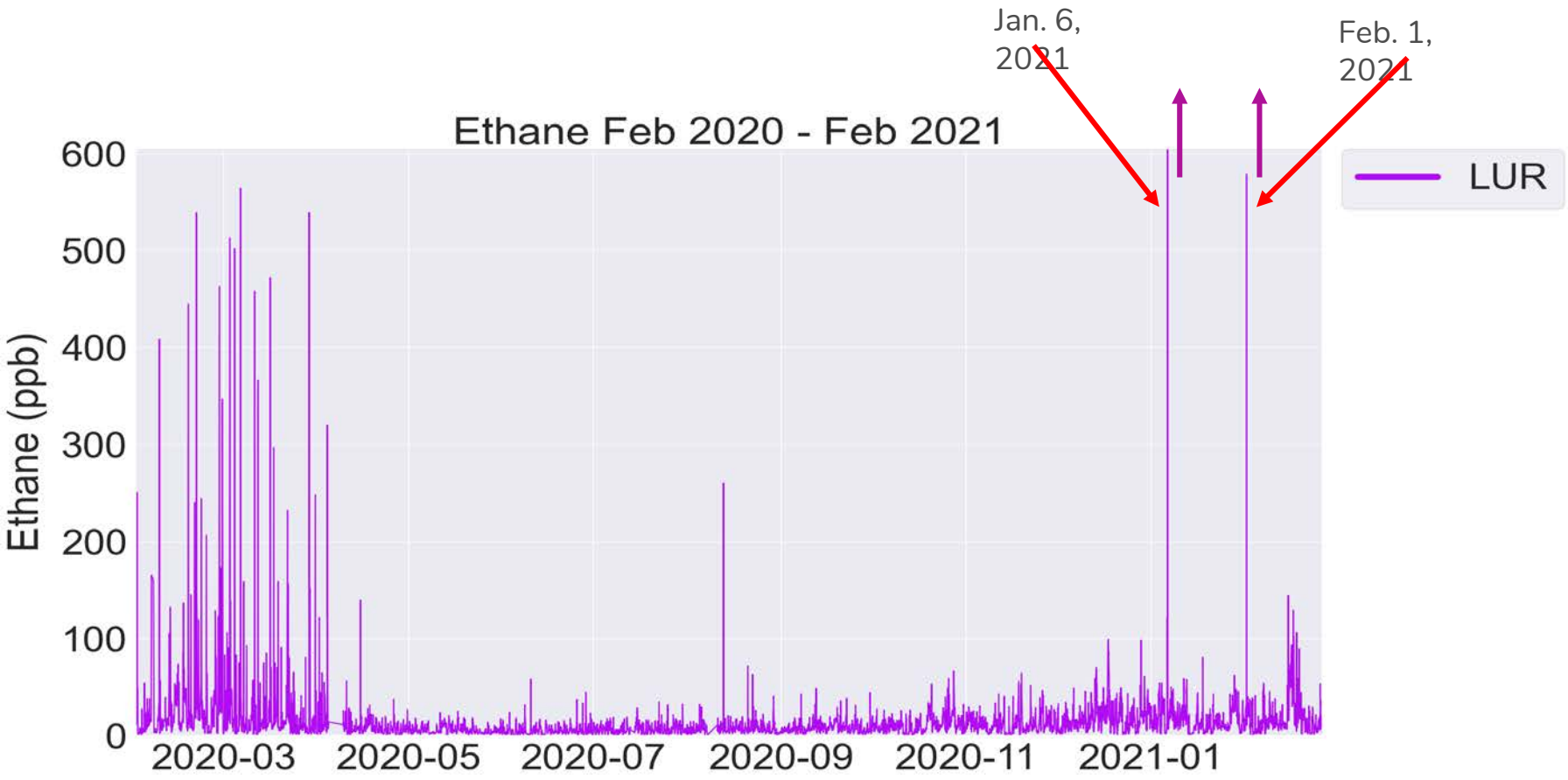
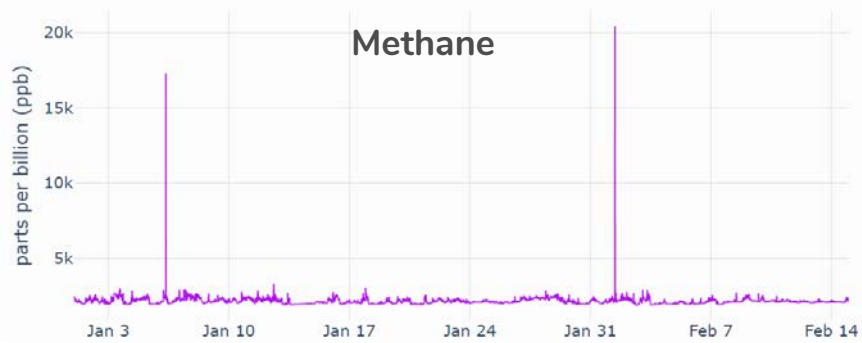
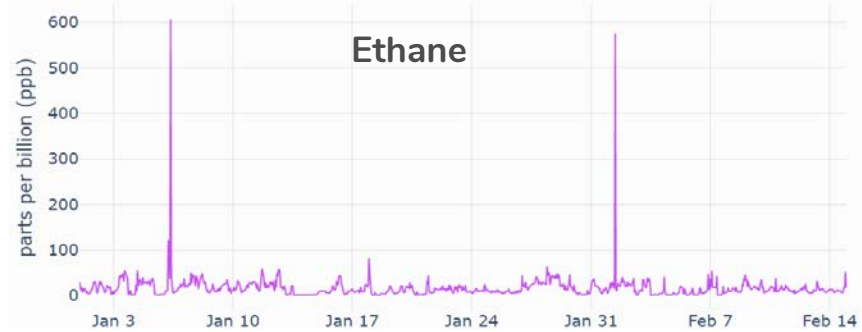
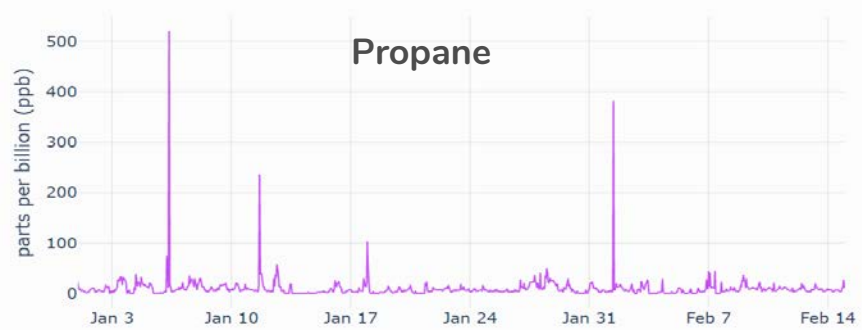
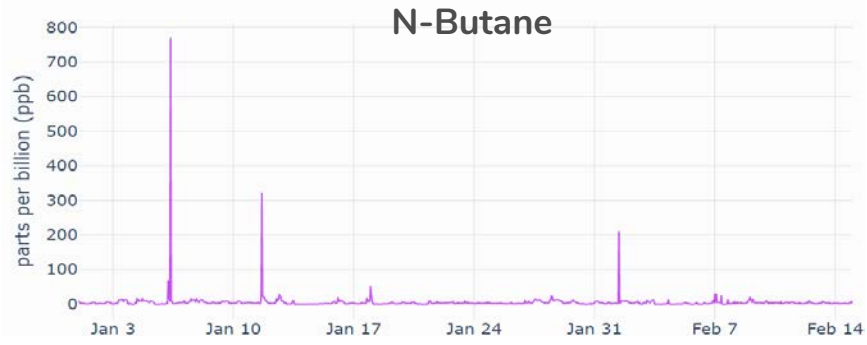

Jan. 6, 2021
Feb. 1, 2021
Ethane Feb 2020 - Feb 2021
LUR
Ethane (ppb)
600
500
400
300
200
100
0
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01

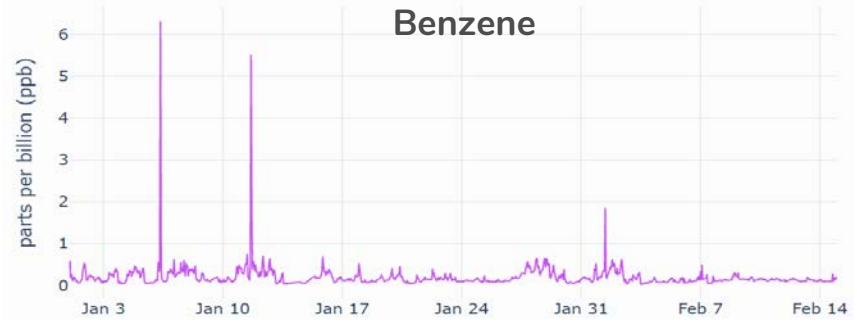
Methane and VOCs in oil and gas plumes



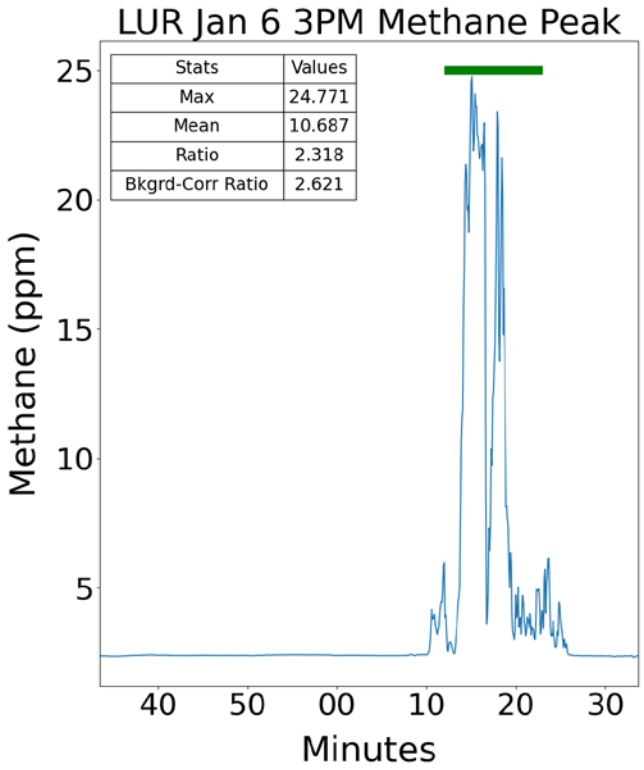


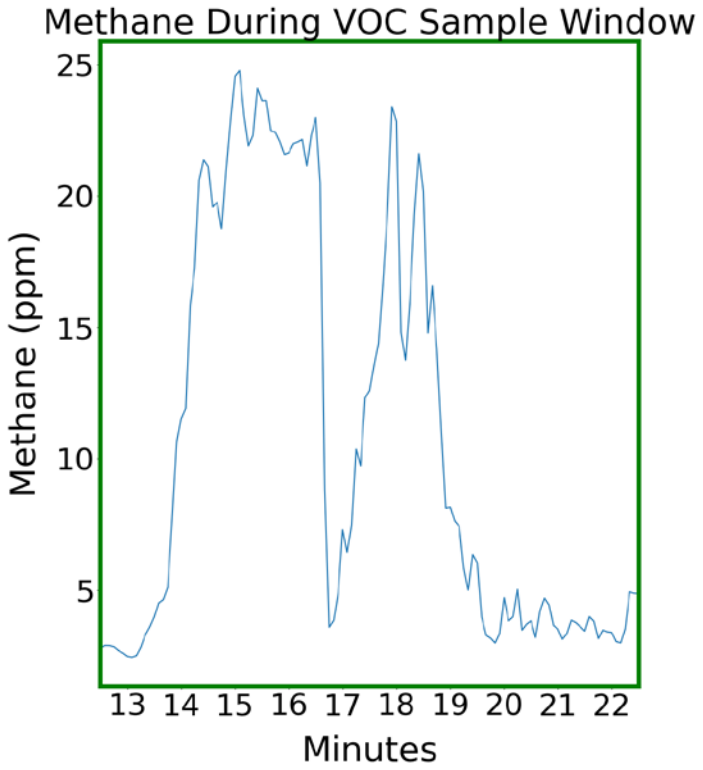






January 6 concentration spike





January 6 and February 1 Concentration Spikes

Event	Compound	Original Quantification (ppb)	Estimated Corrected 10-min Mean Concentration (ppb)	Estimated Peak (5-sec) Concentration (ppb)		Approximate Background (ppb)	Enhancement Factor *(times above background)*
January 6, 2021	Methane	25,000		25,000		1950	12
	Ethane	605 (saturated)	2150	5635		2	1000 - 3000
	Benzene	6.3		16.5		0.1	60 - 160
February 1, 2021	Methane	44,000		44,000		1950	23
	Ethane	579 (saturated)	1055	6963		2	500 - 3500
	Benzene	1.9		12.5		0.1	20 - 120

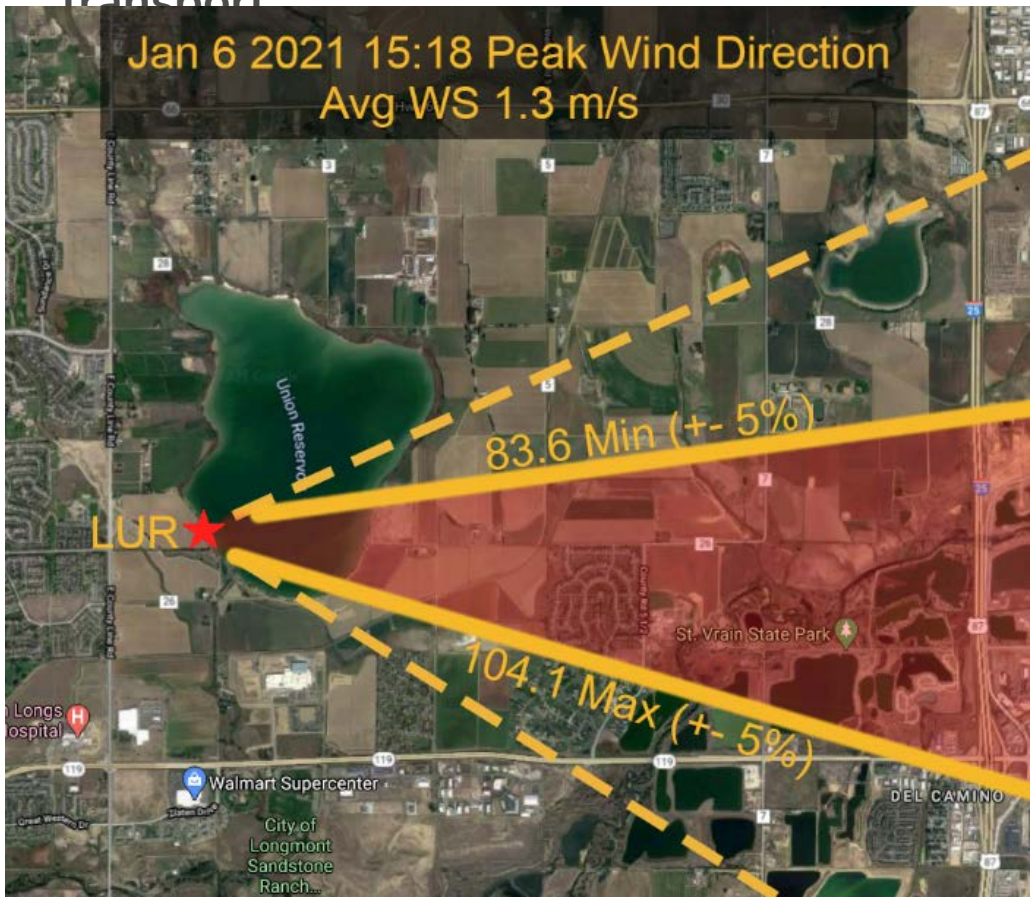
Conditions as LUR during January 6, 2021, plume transport

Webcam Image January 6, 8:10 AM MST

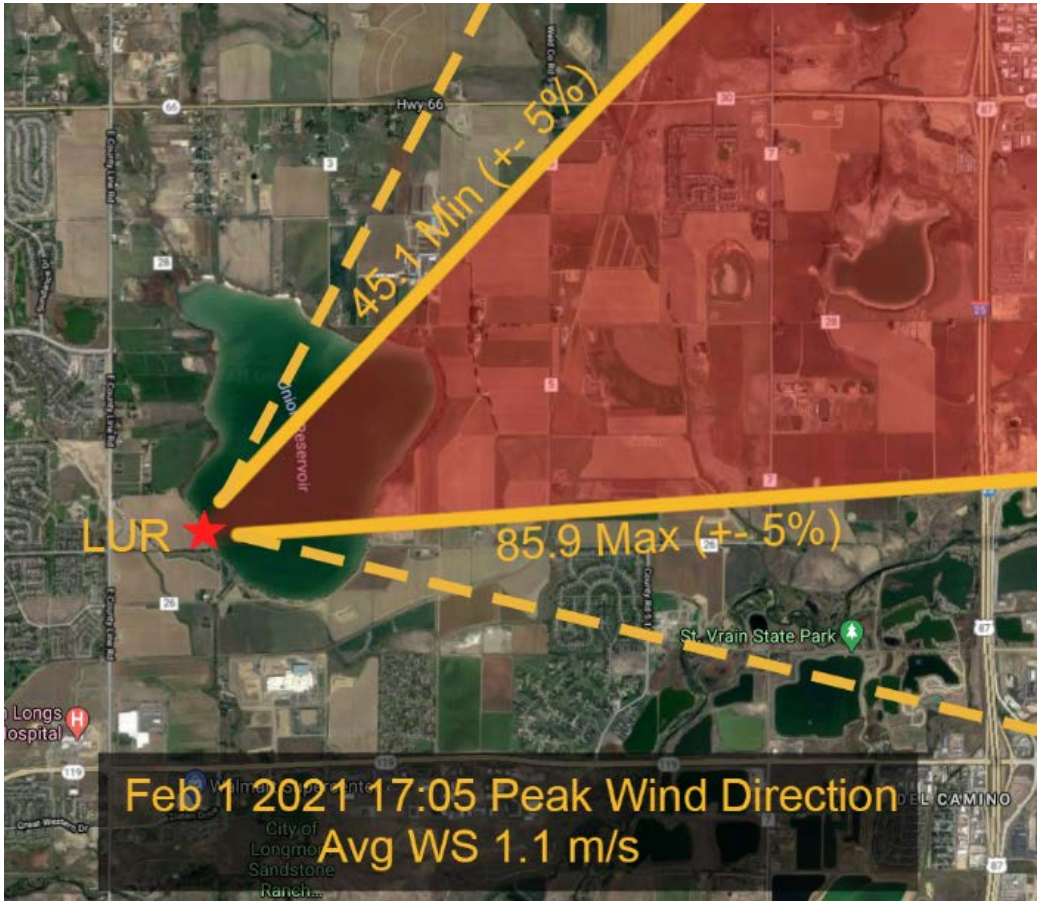
Conditions as LUR during February 1 plume transport

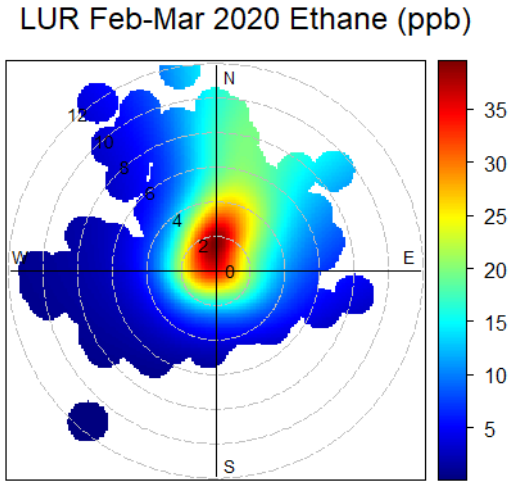
Webcam Image February 1, 4:51 MST

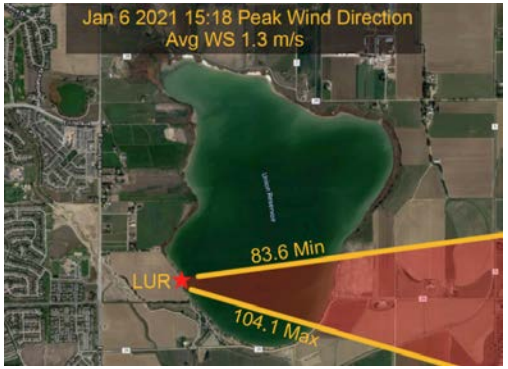
Wind sector during January 6 plume transport

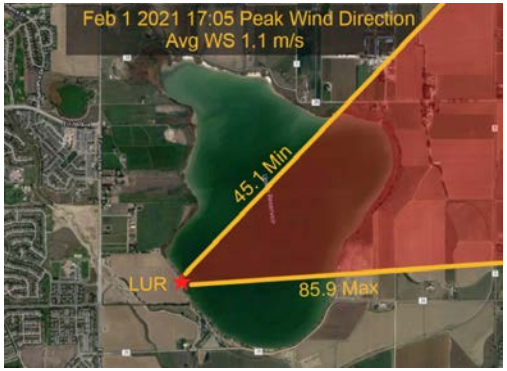


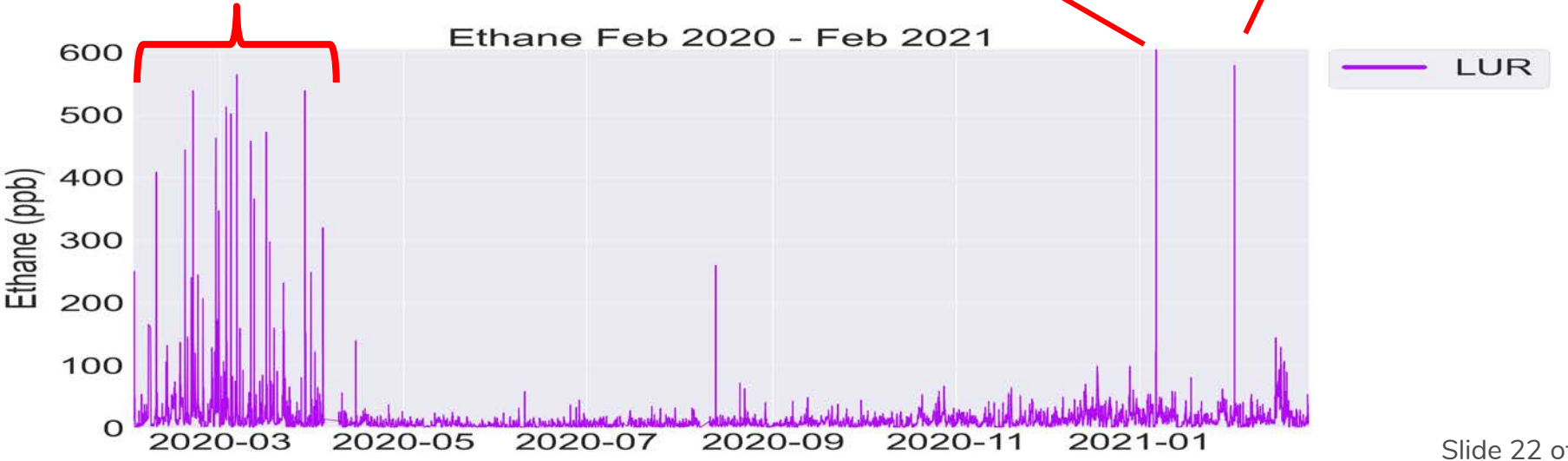
Wind sector during February 1 plume transport

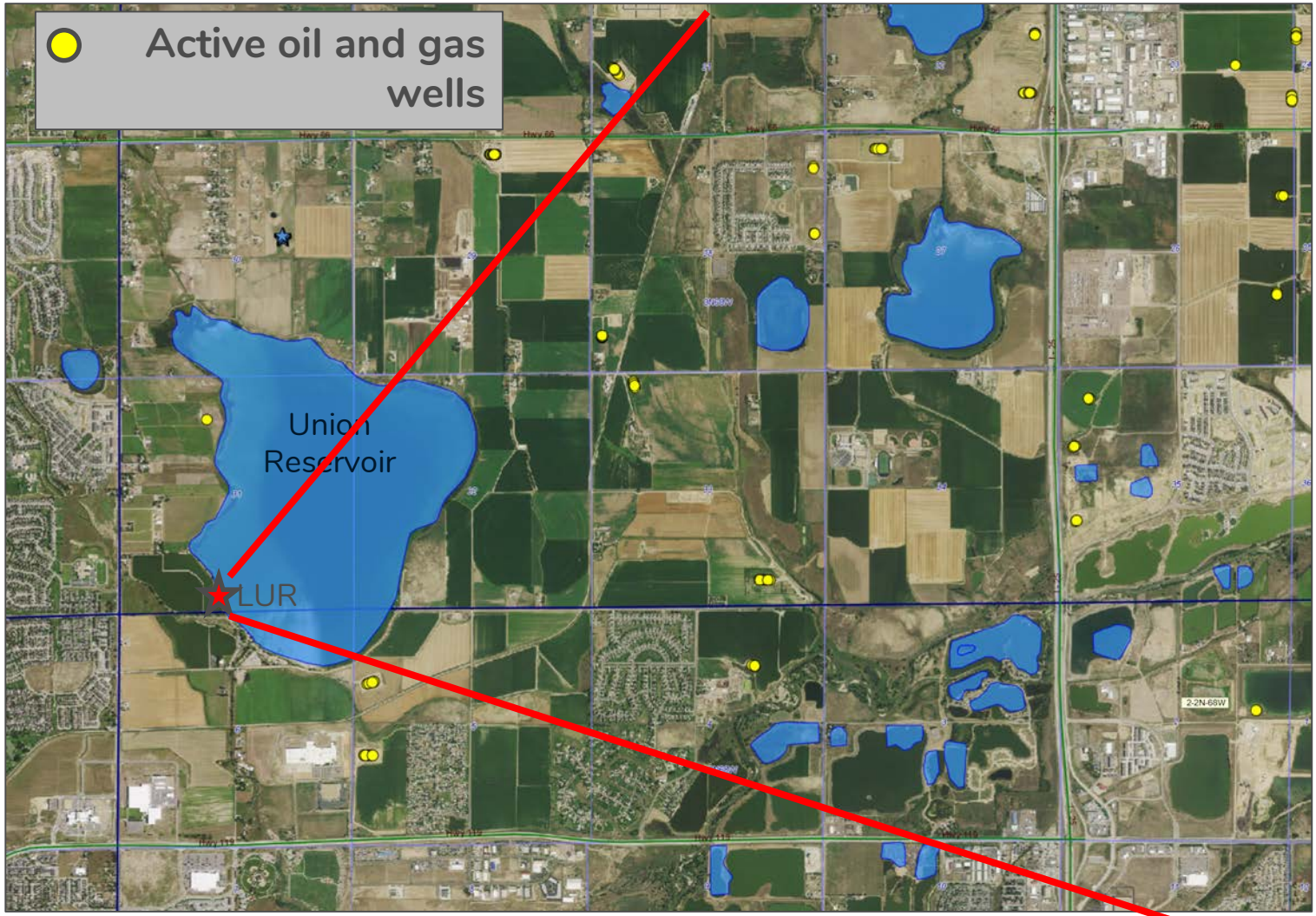



LUR Feb-Mar 2020 Ethane (ppb)
N
E
S
W
35
30
25
20
15
10
5


Jan 6 2021 15:18 Peak Wind Direction
Avg WS 1.3 m/s
LUR
83.6 Min
104.1 Max


Feb 1 2021 17:05 Peak Wind Direction
Avg WS 1.1 m/s
LUR
45.1 Min
85.9 Max


Ethane Feb 2020 - Feb 2021
LUR
Ethane (ppb)
600
500
400
300
200
100
0
2020-03
2020-05
2020-07
2020-09
2020-11
2021-01


Active oil and gas wells
Union Reservoir
LUR
2-2N-68W

Conclusions

1. General trend in oil and gas high concentration spikes
2. Exceptional, extremely high concentration oil and gas plumes in early 2021

- Concentration decline from spring 2020 mostly continues.
- Not associated to seasonality, COVID lockdown, oil and gas pricing.
- Oil and gas VOCs concentrations remain higher at LUR compared to comparison sites, particularly during winter.
- Likely reflects reduction of venting/leading of oil and gas emissions from operations within relatively close proximity (a few miles) to the north of LUR.
- Two plumes observed in January/February defy this general trend.
- Plumes were very short in duration.

    -> Likely from a nearby source

    -> Peak concentrations were extremely high, more than 1000 times above background; highest ever seen in + 30,000 measurements at network sites

Presentation Topics

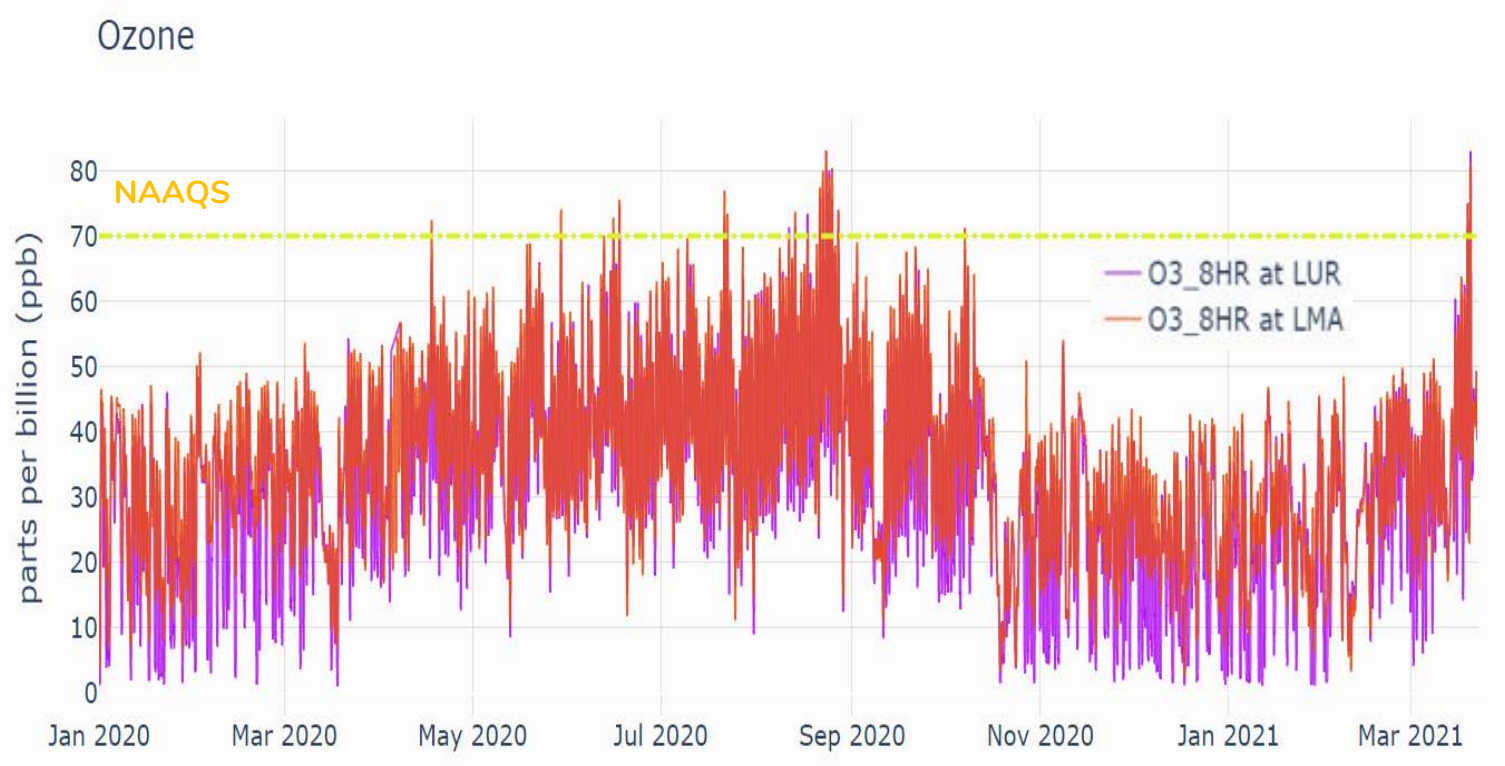
1. General trend in oil and gas high concentration spikes

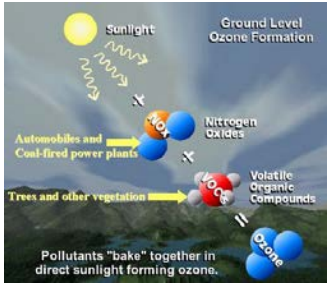
2. Exceptional, extremely high concentration oil and gas plumes in early 2021

3. Photochemical smog event in March 2021

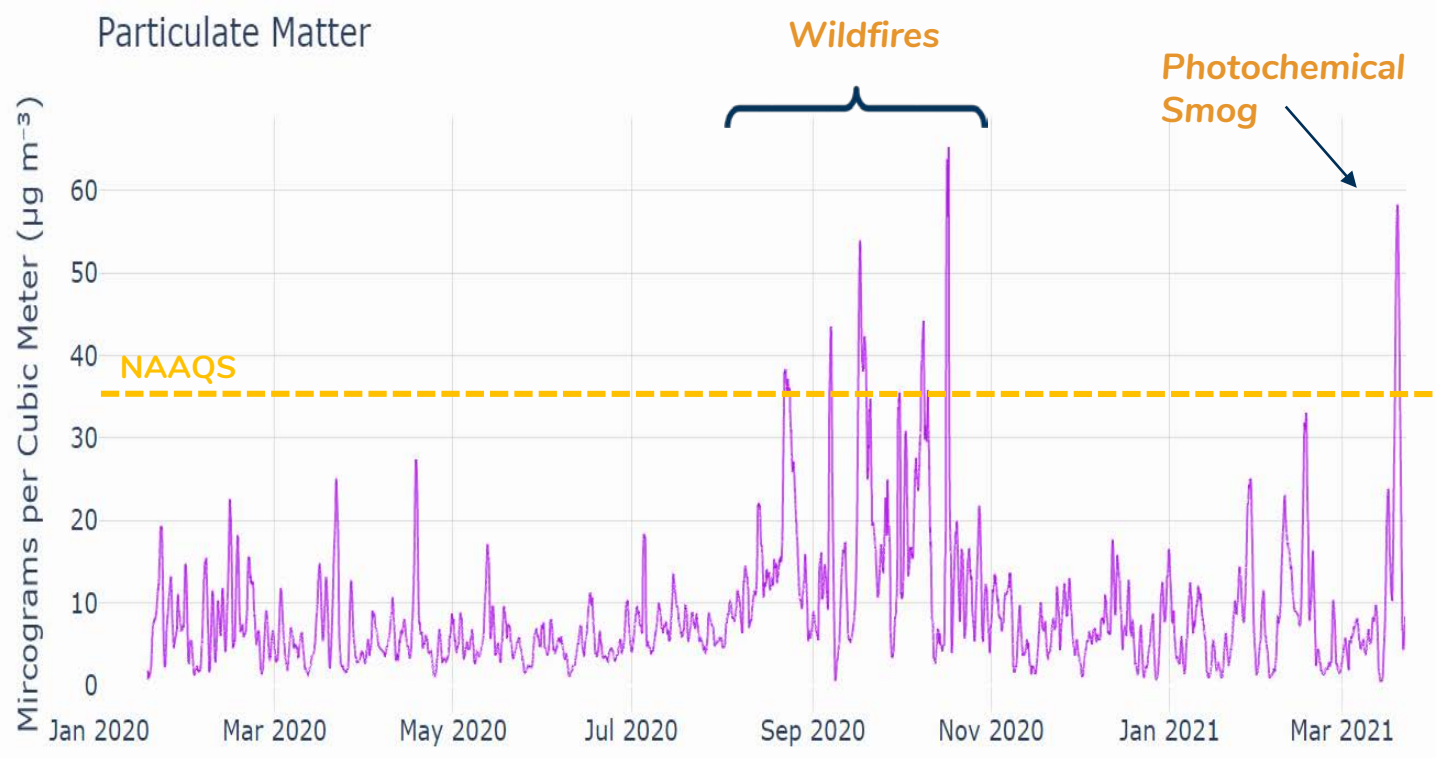
4. Ozone control recommendations

8-hour Ozone at LUR and LMA 2020 - 2021





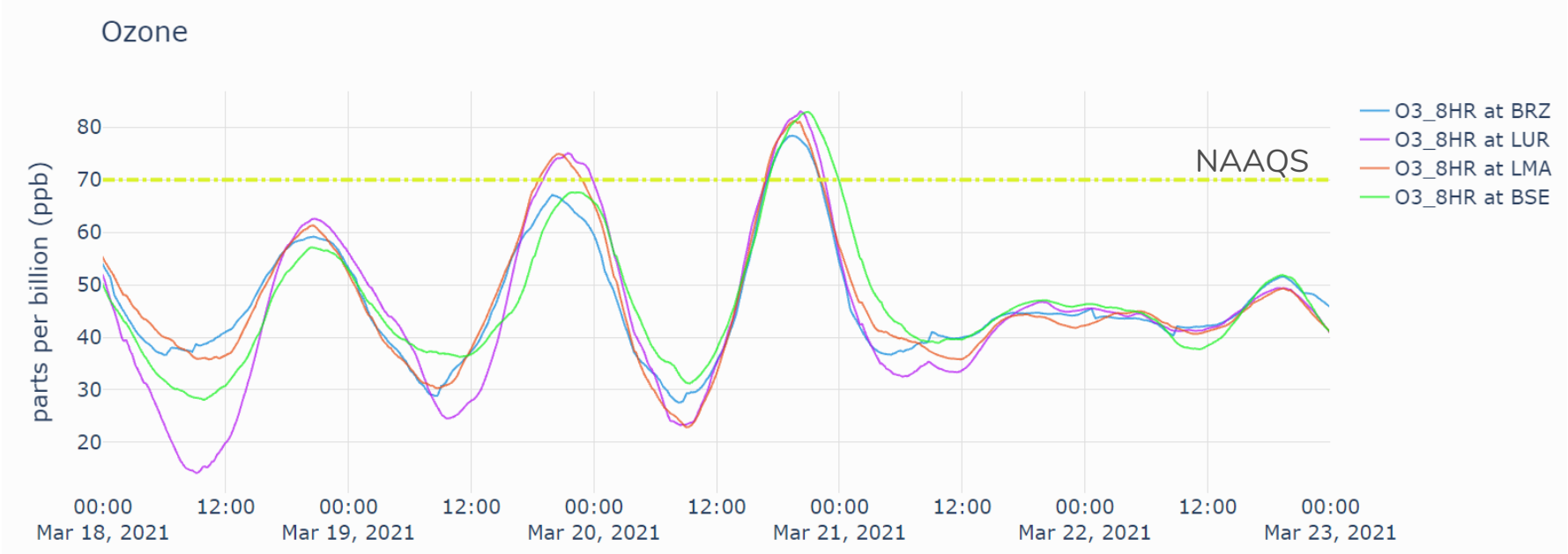
Particulate Matter PM_2.5 (24-hour) at LUR 2020 - 2021



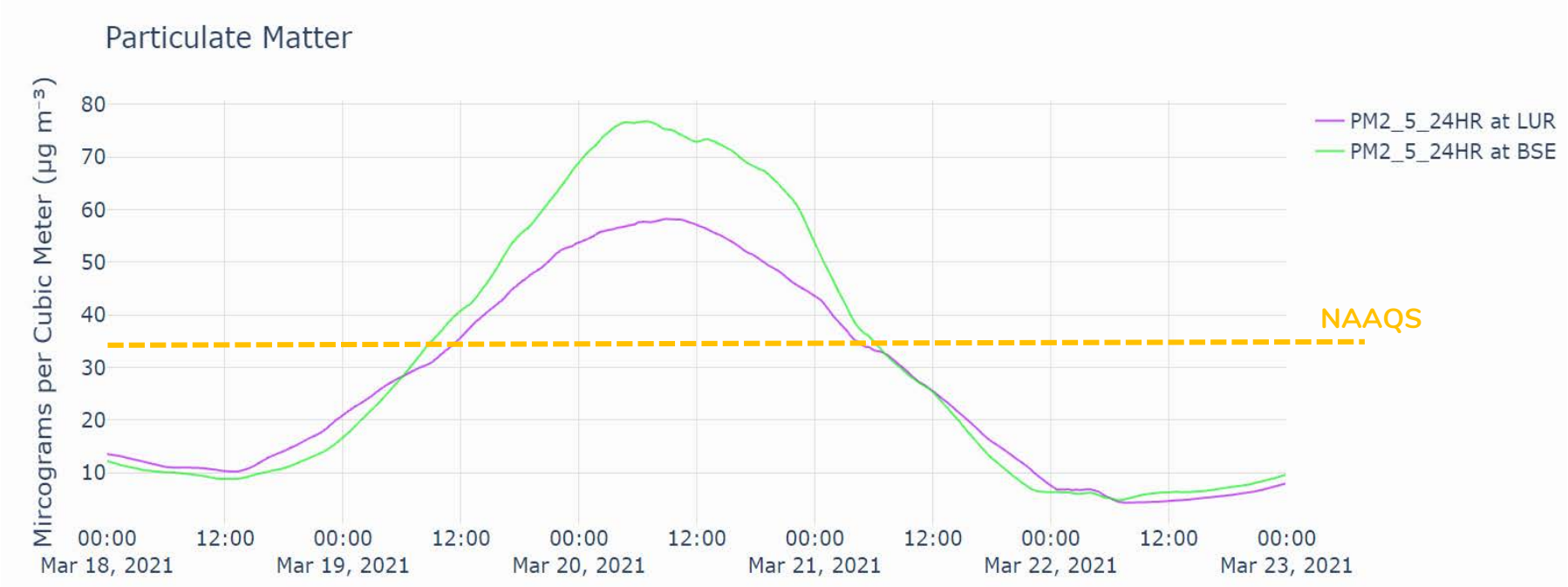
Visibility at LUR during peak pollution event March 21, 2021

March 19 – 7.08 p.m.

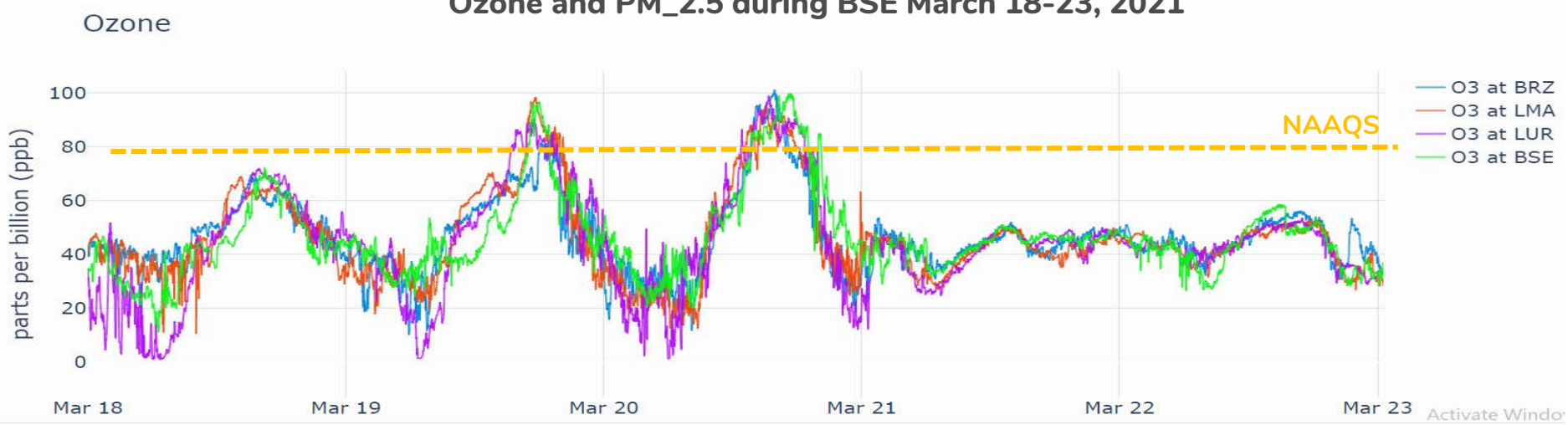
Ozone at four network sites March 18-23, 2021

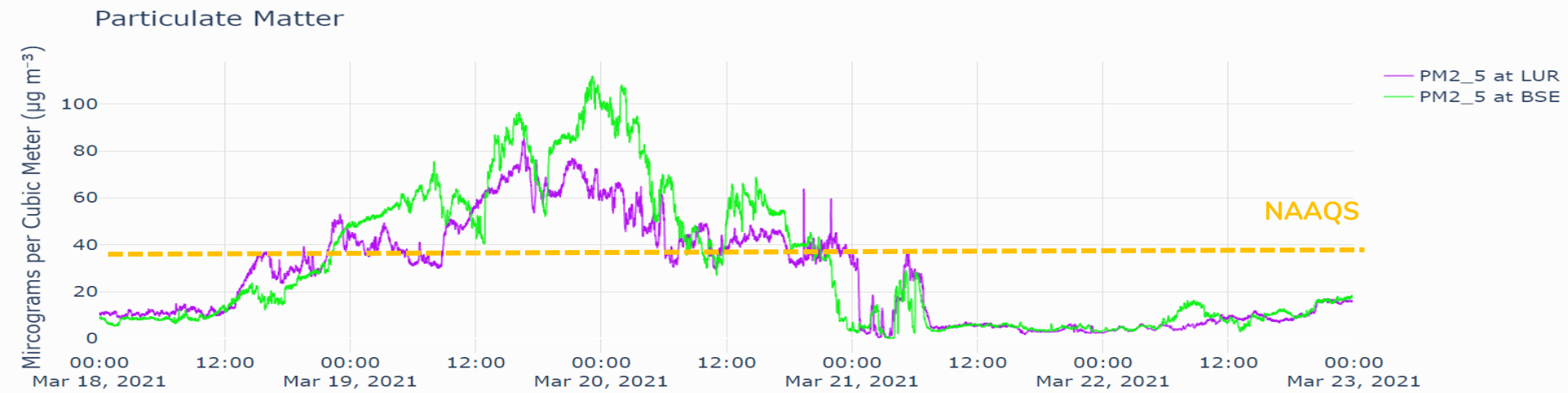


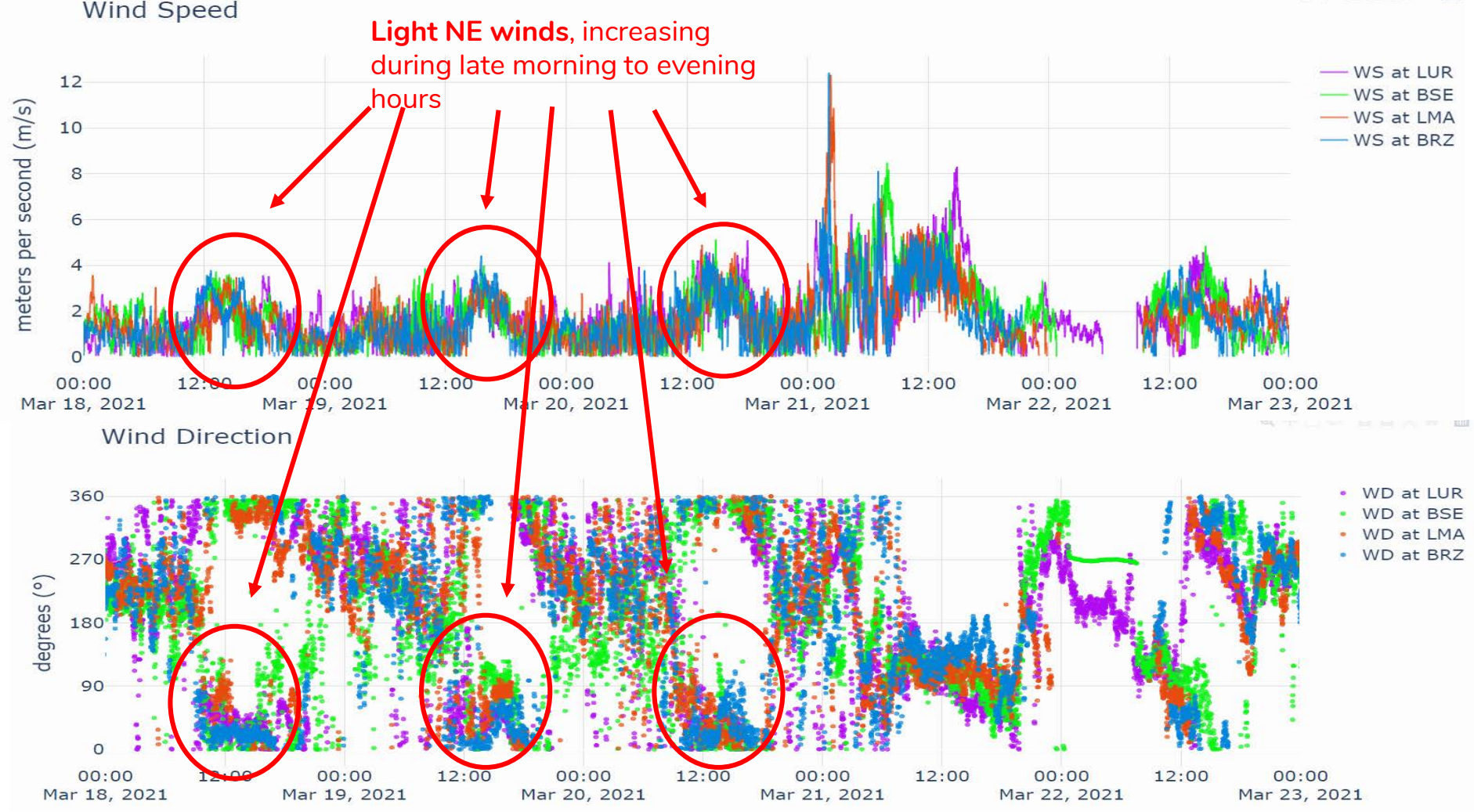
PM_2.5 at LUR and BSE March 18-23, 2021



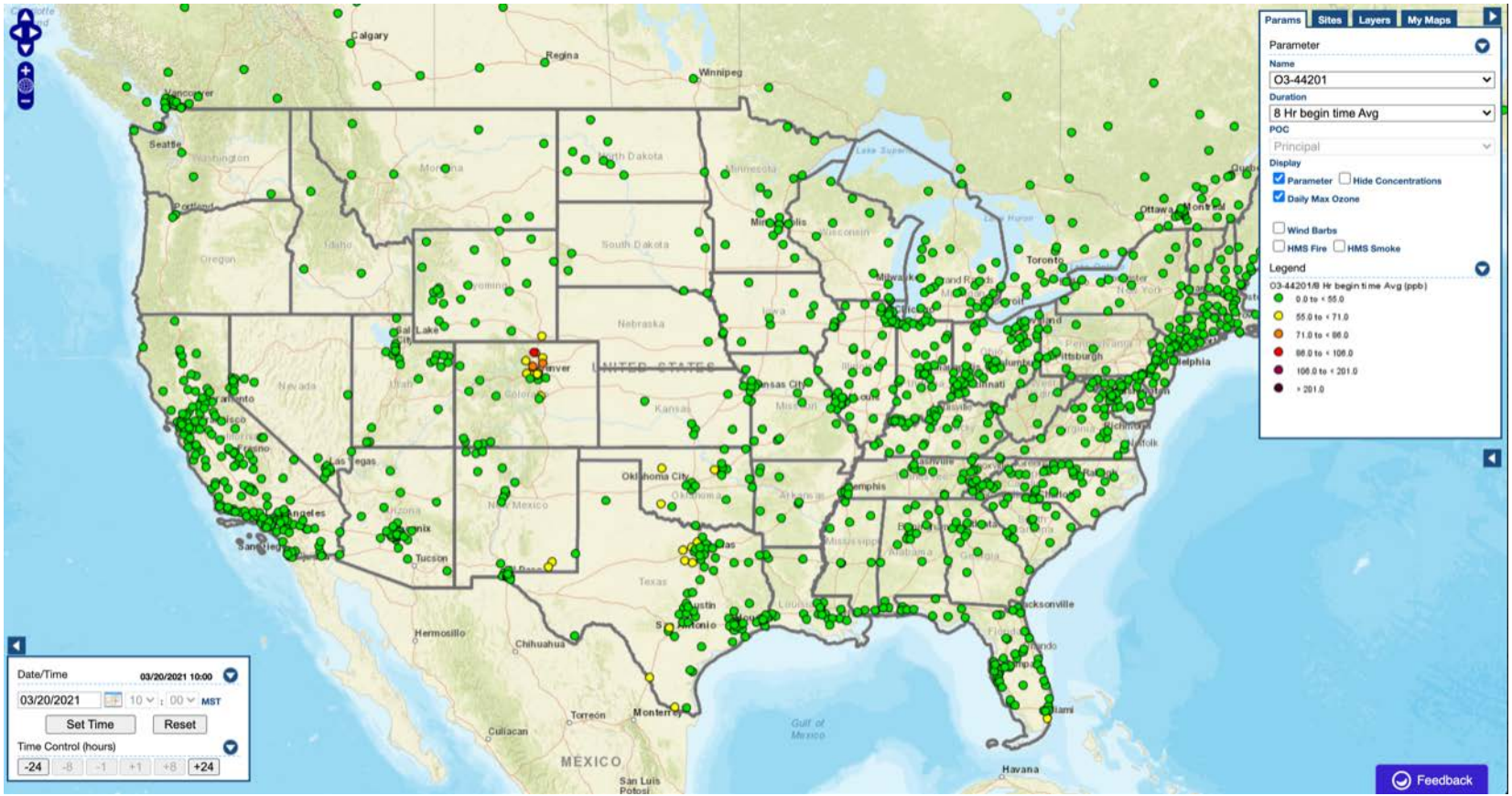
Ozone and PM_2.5 during BSE March 18-23, 2021






Wind Speed
Light NE winds, increasing during late morning to evening hours
meters per second (m/s)
0
2
4
6
8
10
12
WS at LUR
WS at BSE
WS at LMA
WS at BRZ
00:00
Mar 18, 2021
12:00
00:00
Mar 19, 2021
12:00
00:00
Mar 20, 2021
12:00
00:00
Mar 21, 2021
12:00
00:00
Mar 22, 2021
12:00
00:00
Mar 23, 2021
Wind Direction
degrees (°)
0
90
180
270
360
WD at LUR
WD at BSE
WD at LMA
WD at BRZ
00:00
Mar 18, 2021
12:00
00:00
Mar 19, 2021
12:00
00:00
Mar 20, 2021
12:00
00:00
Mar 21, 2021
12:00
00:00
Mar 22, 2021
12:00
00:00
Mar 23, 2021

March 20, 2021, 8-hour ozone maxima in the U.S.



Source: http://airnowtech.org/

Conclusions

3. Photochemical smog event in March 2021

- Remarkable air pollution event March 18-21, 2021.
- Promoted by strong inversion, snow-covered ground, low temperatures.
- Exceedance of ozone NAAQS on two days.
- Exceedance of PM_2.5 NAAQS continuously for three days.
- Worst air quality in the entire US during these days.
- Worst conditions were encountered north of Denver.
- Air flow was dominated by northeasterly flows during the worst conditions.
- VOCs had a strong oil and gas signature.

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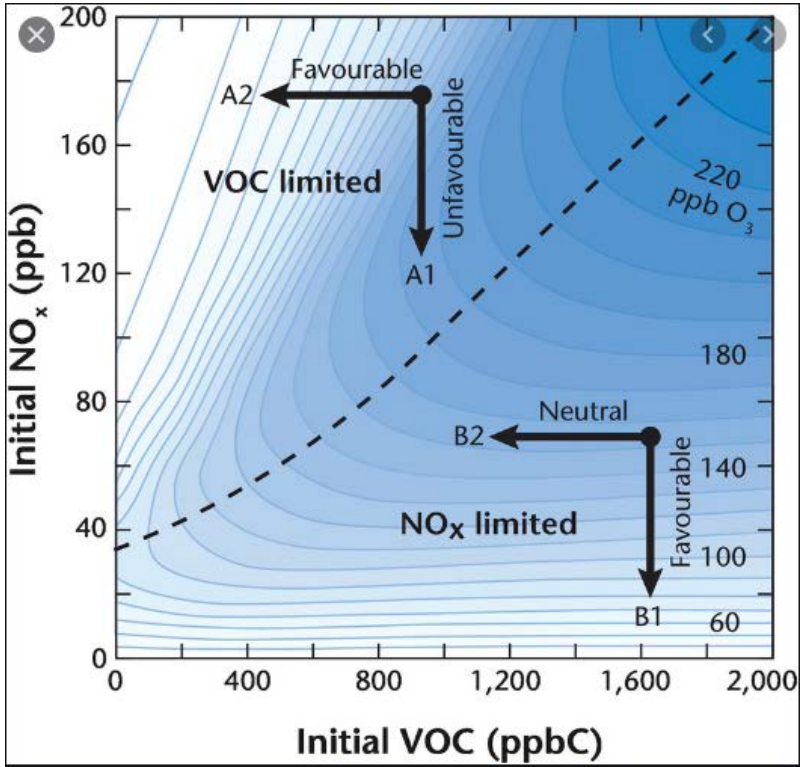
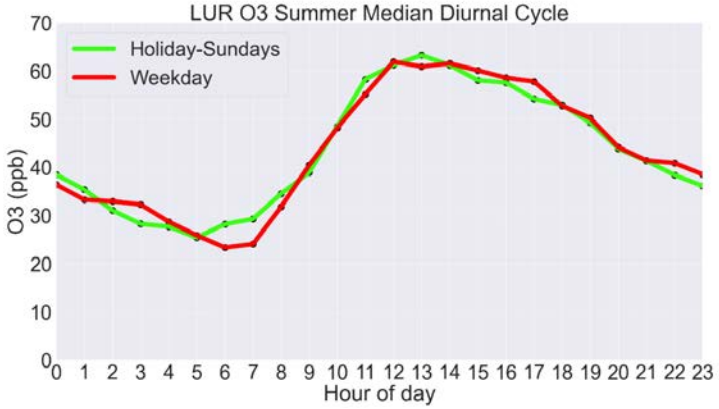
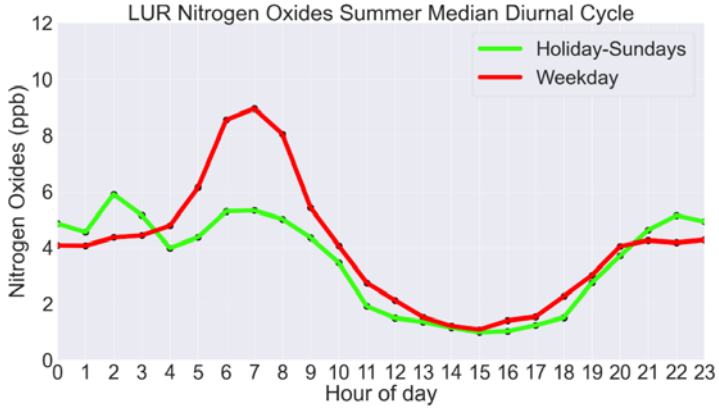
Source: https://seetheair.wordpress.com/2015/10/01/ground-level-ozone-formation/

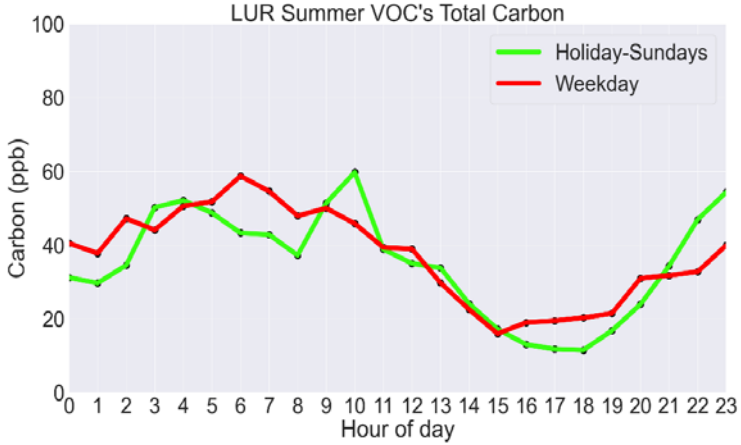


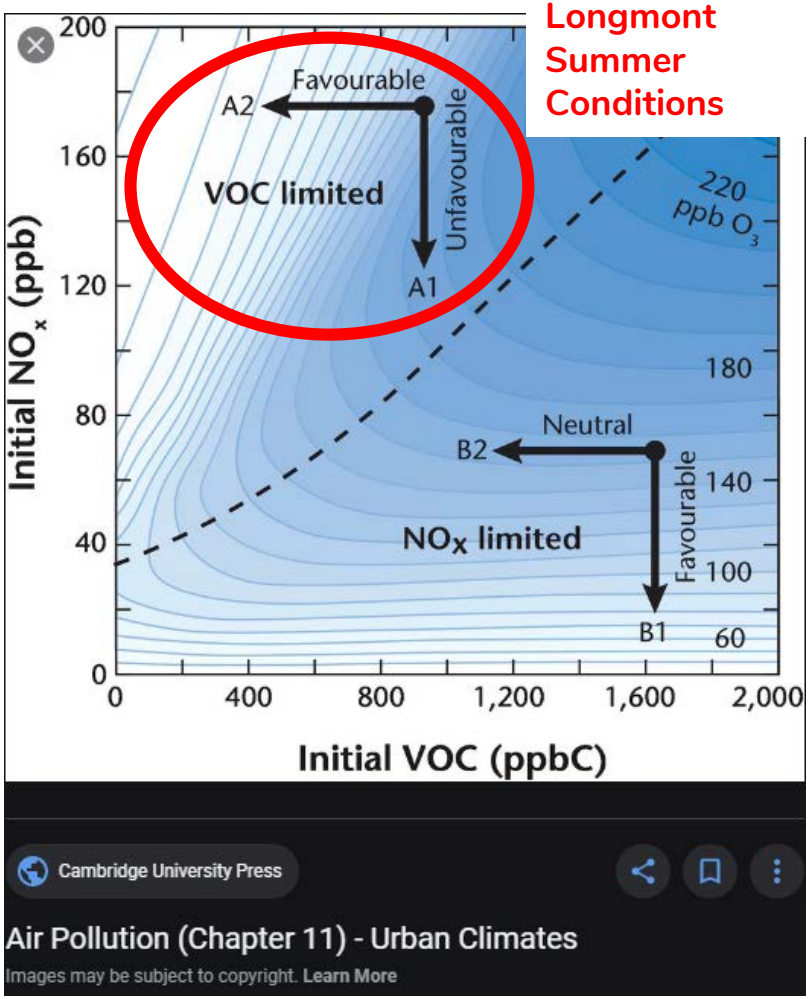
Ozone as a function of VOCs and NO_x

Comparison of ozone, nitrogen oxides, VOCs diurnal cycles during summer 2020

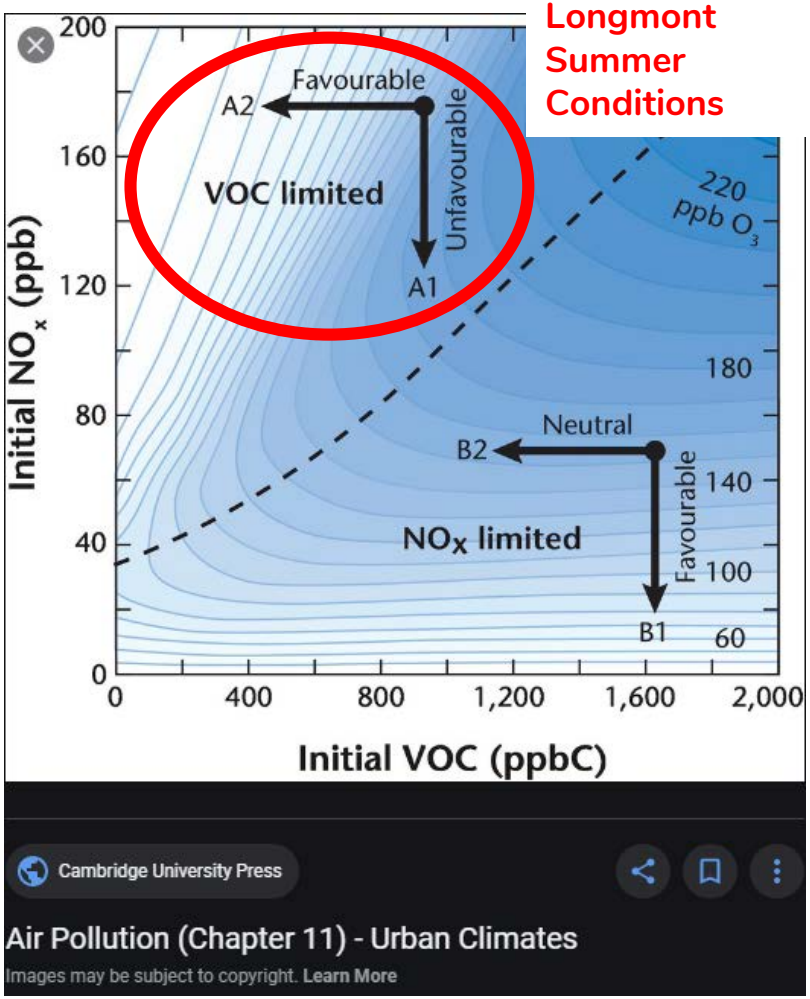








Ozone as a function of VOCs and NO_x



Ozone as a function of VOCs and NO_x

-> VOC emissions do not follow traffic; dominated by oil and gas compounds.

-> Emissions of NO_x show much stronger traffic signature.

-> Summer ozone at LUR not notably sensitive to NOx reductions for 2020 conditions.

-> Reducing VOCs emissions more promising for rapid improvements in summer ozone.

-> BUT, 2020 was very unusual year: COVID lockdown, shift in weekday/weekend traffic; wildfires. Need to revisit with future data.