

# Presentation by Dr. Detlev Helmig Boulder AIR



West: Vance Brand Airport



## Air Quality Monitoring Update



East: Union Reservoir



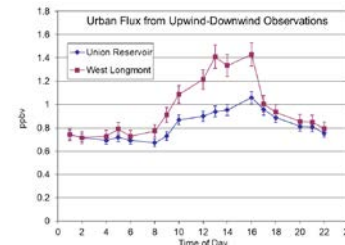
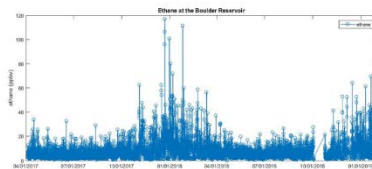
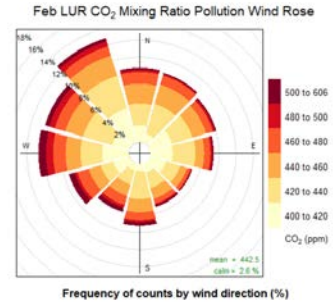
# Longmont Air Quality Now

Detlev Helmig

1. Objectives/Motivation/Background
2. Monitoring Station Development
3. Websites
  - Longmont Air Quality Now
  - AirLive Combined
  - Interactive Tool
4. Data Examples and Interpretation
  - Ozone
  - Methane
  - VOCs [Ethane, Benzene]
  - (CO<sub>2</sub>, Nitrogen Oxides, Particulate Matter)

# Program Objectives

1. Monitor Greenhouse Gases at two Sites Upwind and Downwind of the City of Longmont to Follow Path towards Sustainability
2. Monitor Primary Oil and Gas Emissions
3. Provide Monitoring Data and Interpretation to Public
4. Provide Data to Public, Research Community, Industry Partners



# Monitored Atmospheric Pollutants

- Carbon Dioxide
- Methane
- Volatile Organic Compounds (VOCs; *Ethane, Ethene, Propane, Propene, i-Butane, Acetylene, n-Butane, i-Pentane, n-Pentane, Hexane, Isoprene, Benzene, Toluene, Ethylbenzene, m-, p-Xylene, o-Xylene [BTEX]*)
- Nitrogen Oxides (NO and NO<sub>2</sub>)
- Ozone
- Particulate Matter PM2.5
- Meteorological Variables (Wind, Temperature, Humidity, Radiation)
- + Webcam

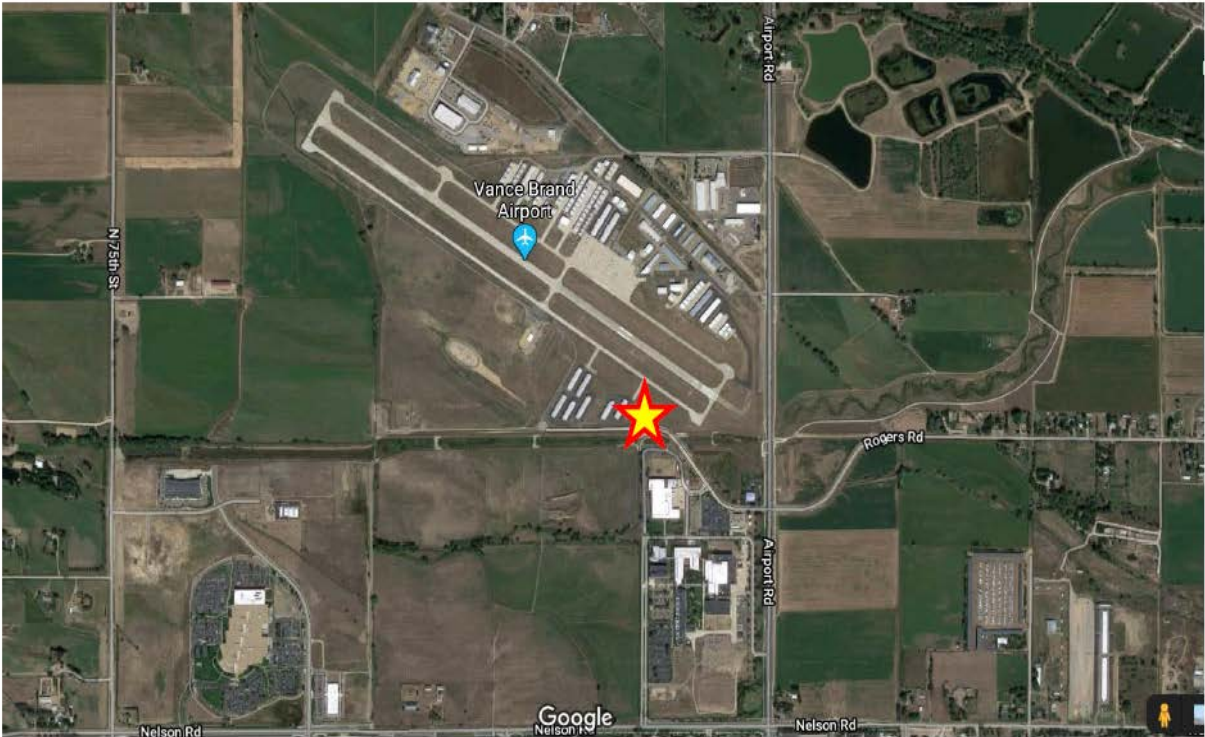
**- > All measurements are automated, continuous, 24/7, 365 days per year, at 1 min – 1 hour time resolution**



# 2. Monitoring Station Development

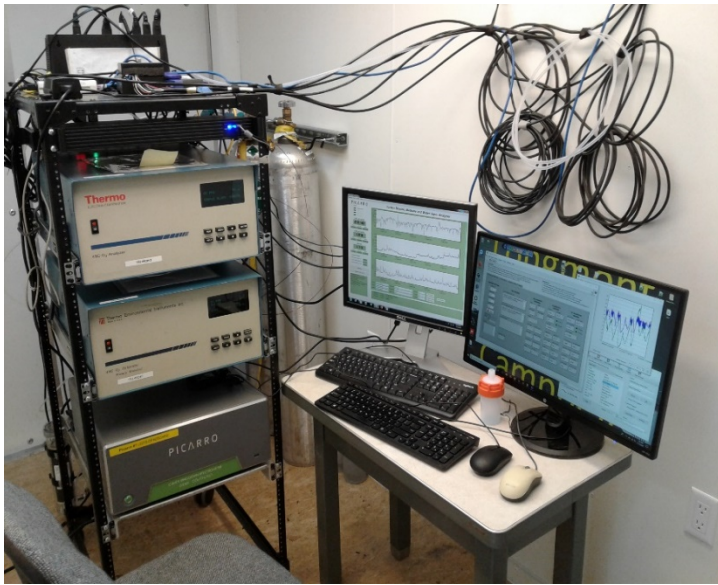
LMA

Longmont Airport; 40.1606222,-105.1597105



Google Earth image with the location of the LMA monitoring site within the fenced airport area indicated by the star.

# Monitoring Station Development - LMA



Tower with Gas Sampling Inlets, Meteorological Sensors, Webcam



LMA instrument trailer with the adjacent meteorological tower.



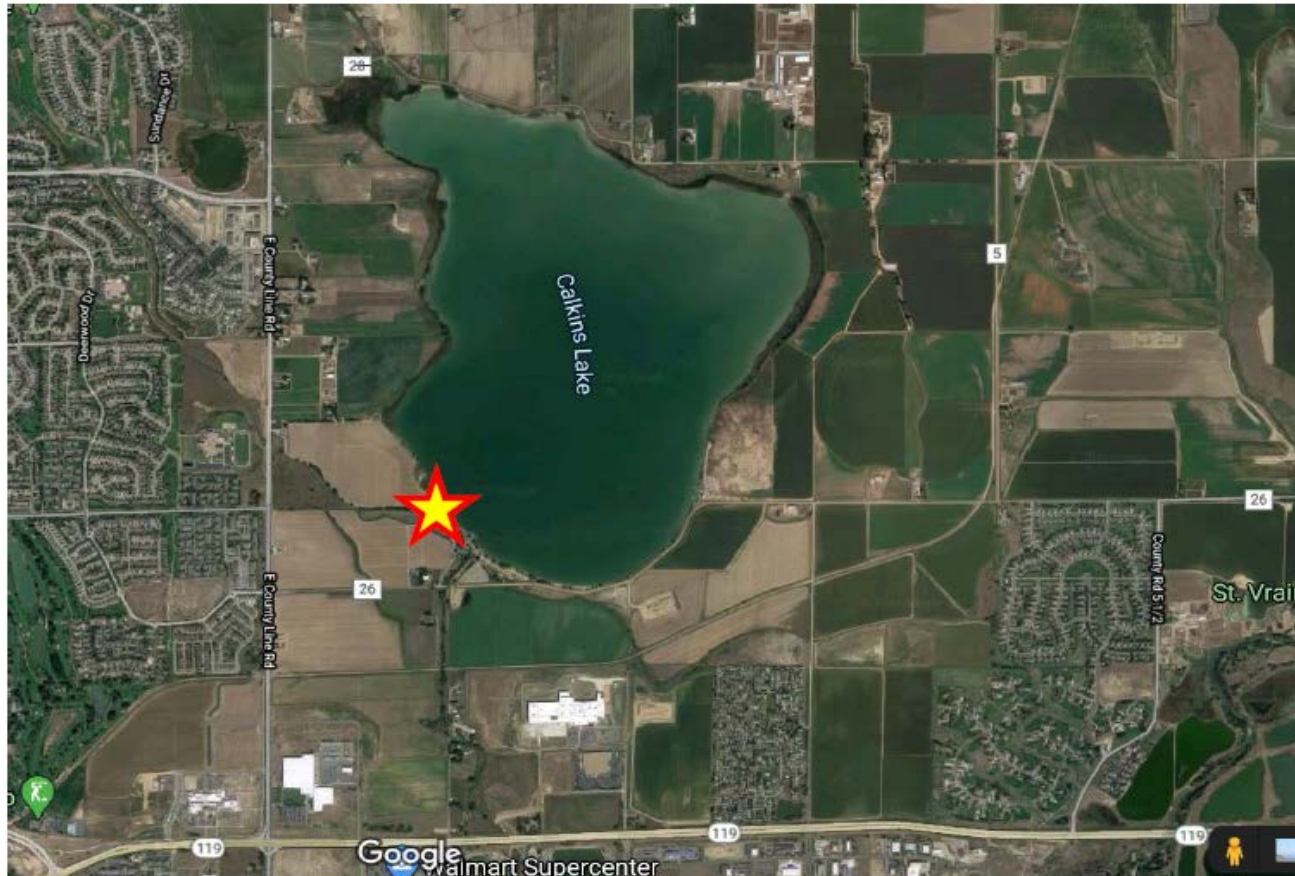
Instruments for

- Ozone
- Methane
- CO<sub>2</sub>
- Communication
- Calibration System
- Data Logging
- Calibration Gas Tanks

# Monitoring Station Development

Longmont Union Reservoir; 40.1761087,-105.0479298

LUR



Google Earth image with the location of the LUR monitoring site on the southwest shore of Union Reservoir indicated by the star.



# Monitoring Station Development



LUR instrument shelter with adjacent meteorological tower

# Monitoring Station Development- LUR



Roof Inlet for Particle Sampling



Tower with Gas Sampling Inlets, Meteorological Sensors, Webcam



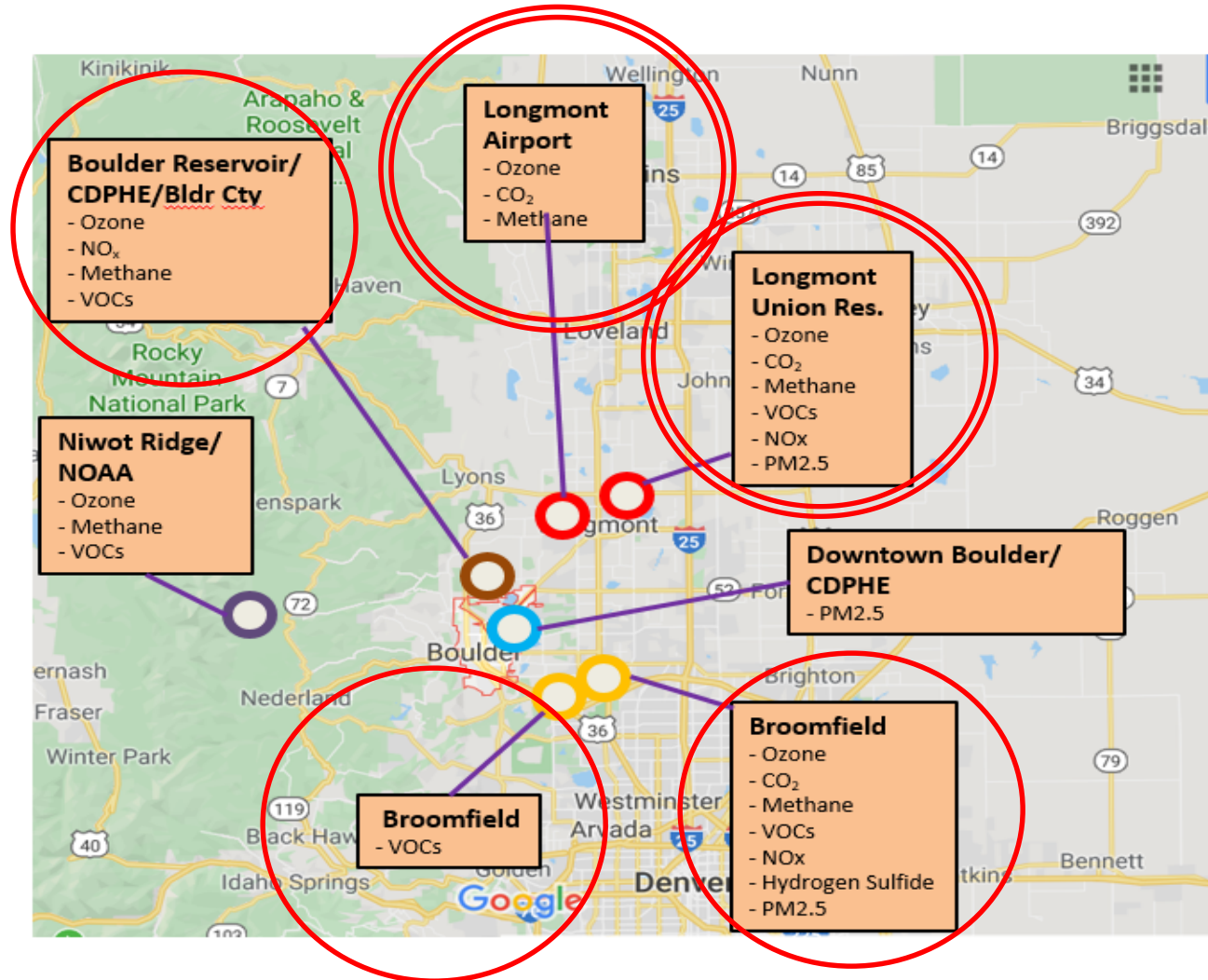
GRIMM EDM-180 Particle Monitor; PM2.5, PM10



Instruments for

- Ozone
- Nitrogen Oxides
- VOCs
- Methane
- CO<sub>2</sub>
- Communication
- Automated Calibration
- Data Logging
- Calibration Gases

# Northern Colorado Front Range Monitoring Network



Current  
Boulder  
A.I.R air  
quality  
monitoring  
sites

The two Longmont monitoring sites and included measurements within the regional network and ongoing atmospheric monitoring in neighboring communities.

# 3. Websites

## Longmont Air Quality Now

Current Conditions	3-Day Graphs	30-Day Graphs	Web Cams	Info	Methods	Contacts
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Union Reservoir



Longmont Municipal Airport



### Meteorological Data Longmont Municipal Airport

	Current	Past 8-hour average	Past 24-hour maximum
🌡️ Temperature (°F)	67.8	59.2	87.2
💧 Relative Humidity (%RH)	57.3	71.7	81.0
☀️ Solar Radiation (W/m <sup>2</sup> )	406.2	35.1	997.8
🌬️ Wind Speed (m/s)	0.2	1.4	9.9
🌬️ Wind Direction (degree)	242.5		

Collection time: 6/1 07:25. Data are collected every minute and reported as 5-minute averages.

### Chemical Measurements Longmont Municipal Airport

	Current	Past 8-hour average	Past 24-hour maximum
🧪 CO <sub>2</sub> (ppm)	430.4	474.5	513.8
🧪 Methane (ppb)	1985.8	2037.3	2298.0
🧪 Ozone (ppb)	22.9	20.9	67.9

Collection times: CO<sub>2</sub>, Methane at 6/1 07:22, Ozone at 6/1 07:23. Data are collected every minute and reported as 5-minute averages.

### Meteorological Data Union Reservoir

	Current	Past 8-hour average	Past 24-hour maximum
🌡️ Temperature (°F)	66.4	63.4	88.6
💧 Relative Humidity (%RH)	68.1	67.2	81.7
☀️ Solar Radiation (W/m <sup>2</sup> )	356.8	32.6	1072.2
🌬️ Wind Speed (m/s)	1.5	1.3	10.7
🌬️ Wind Direction (degree)	91.2		

Collection time: 6/1 07:27. Data are collected every minute and reported as 5-minute averages.

<https://www.bouldair.com/longmont.htm>

# AirLive Combined Data Graphs

## Sites

Boulder Reservoir  
(BRZ)

Longmont Municipal  
Airport (LMA)

Longmont Union  
Reservoir (LUR)

Broomfield Soaring  
Eagle (BSE)

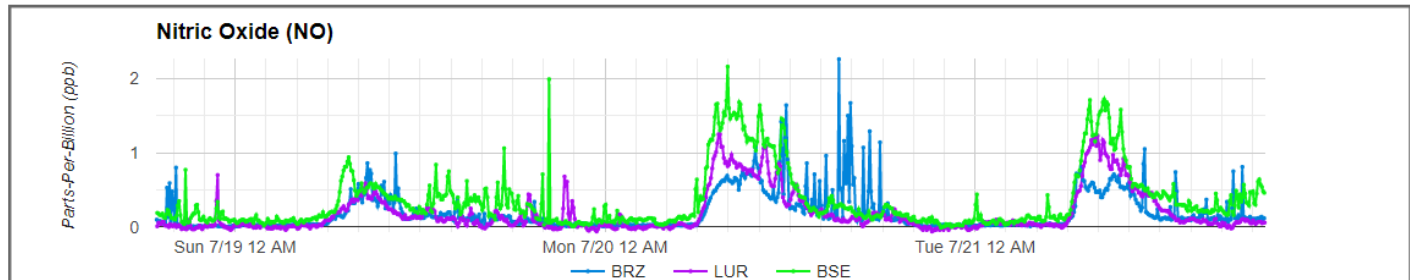
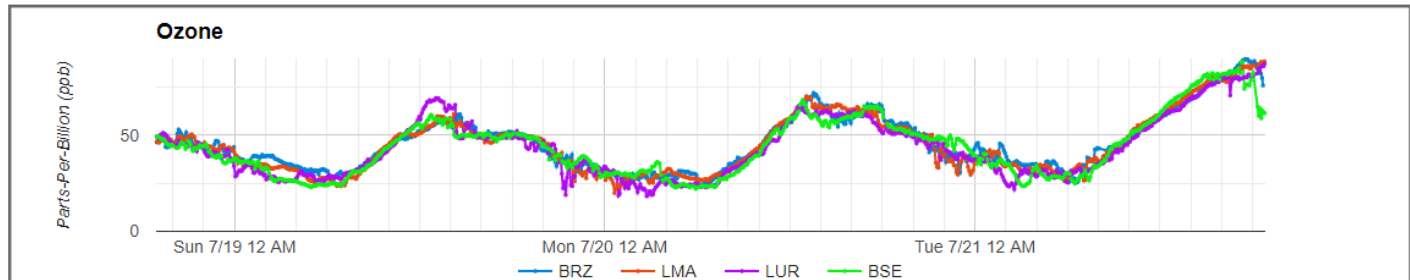
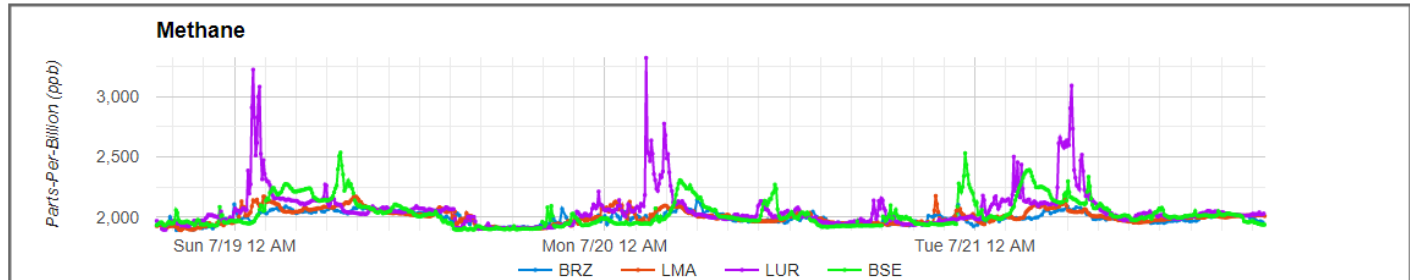
Broomfield Livingston  
(BLV)

## Links

[Boulder Current Conditions](#)

[Broomfield Current  
Conditions](#)

[Longmont Current  
Conditions](#)



<https://www.bouldair.com/NoCoFrontRange.htm>

# Public Websites

Visits since May 24, 2020



1925



1358



1069

# Interactive Data Analysis Tool

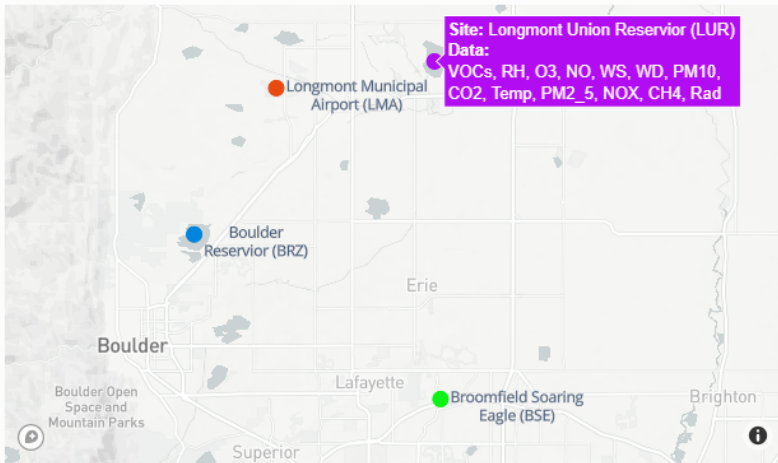
← Home

## Boulder A.I.R. Interactive Data Analysis Tool

\*DISCLAIMER

📄 User Guide

### Site Selection



Many sites mode  One site mode

### Data Selection

- CH<sub>4</sub>     O<sub>3</sub>     WD     WS  
 CO<sub>2</sub>     Rad     Temp     RH  
 H<sub>2</sub>S

VOCs  Display

x

NO<sub>x</sub>  Display

x

PM  Display

x

### Data Window

Dates  →

Or past...

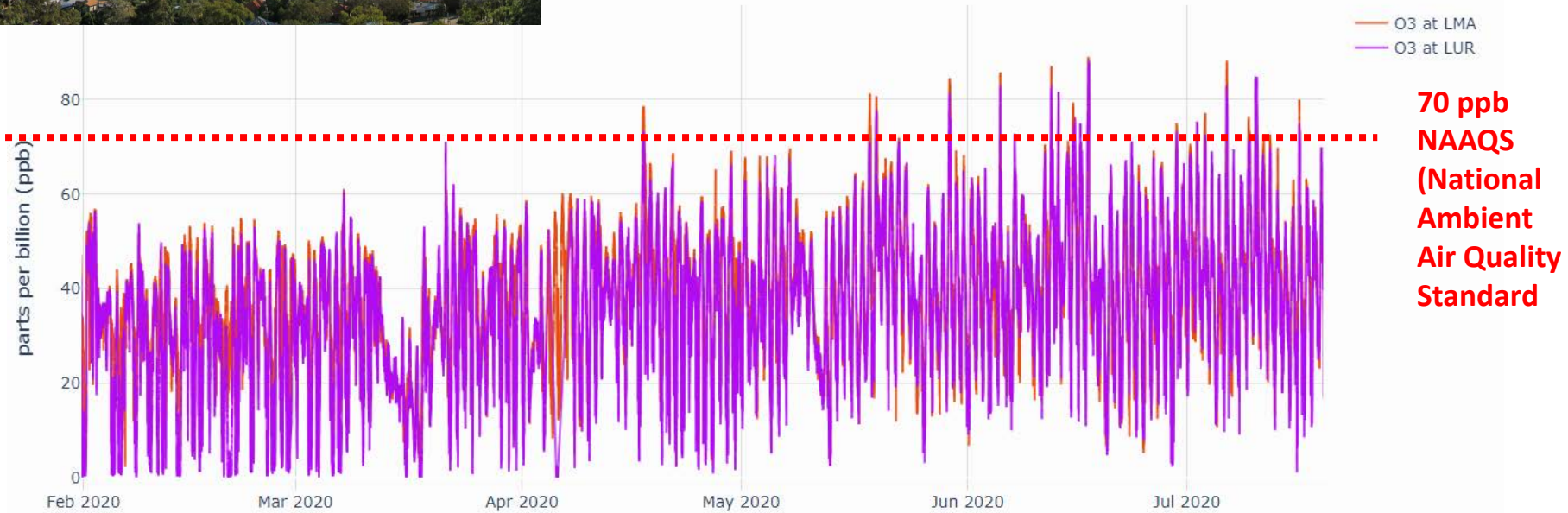
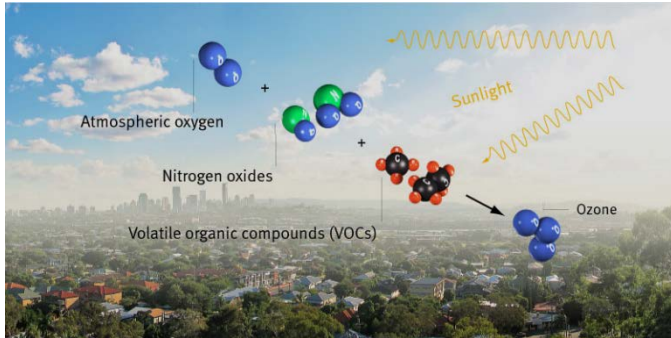
Graph height

Ozone

Currently at private URL; to be linked to public website soon.

# 4. Data Examples and Interpretation - Note: All data are preliminary!

## Ozone

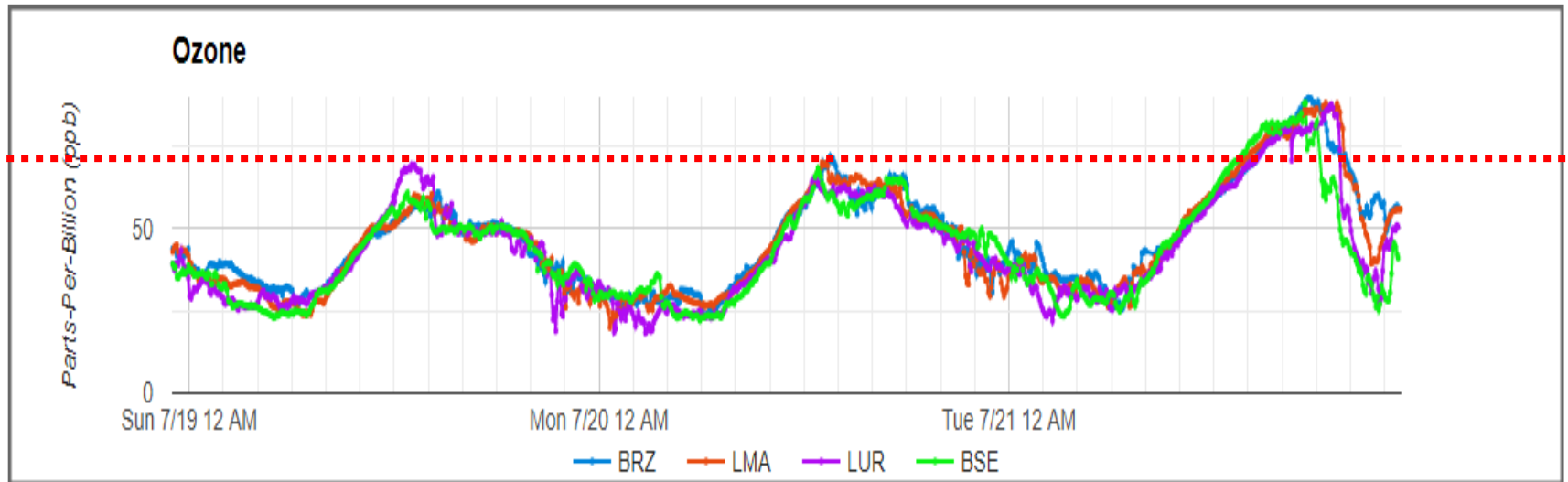


Graph from Interactive Data Analysis Tool



# Data Examples and Interpretation

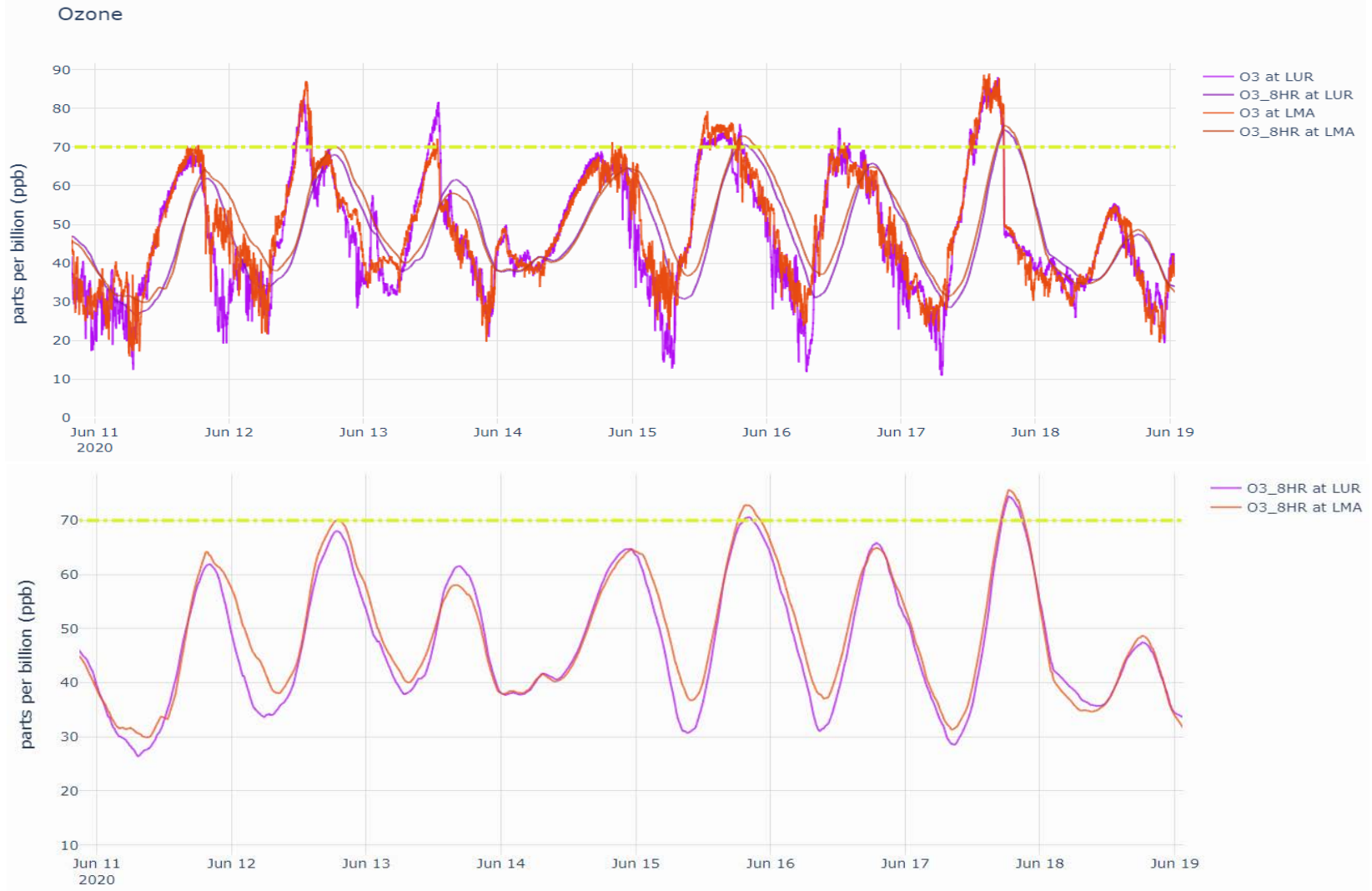
## Ozone



BRZ – Boulder Reservoir  
LMA – Longmont Municipal Airport  
LUR – Longmont Union Reservoir  
BSE – Broomfield Soaring Eagle

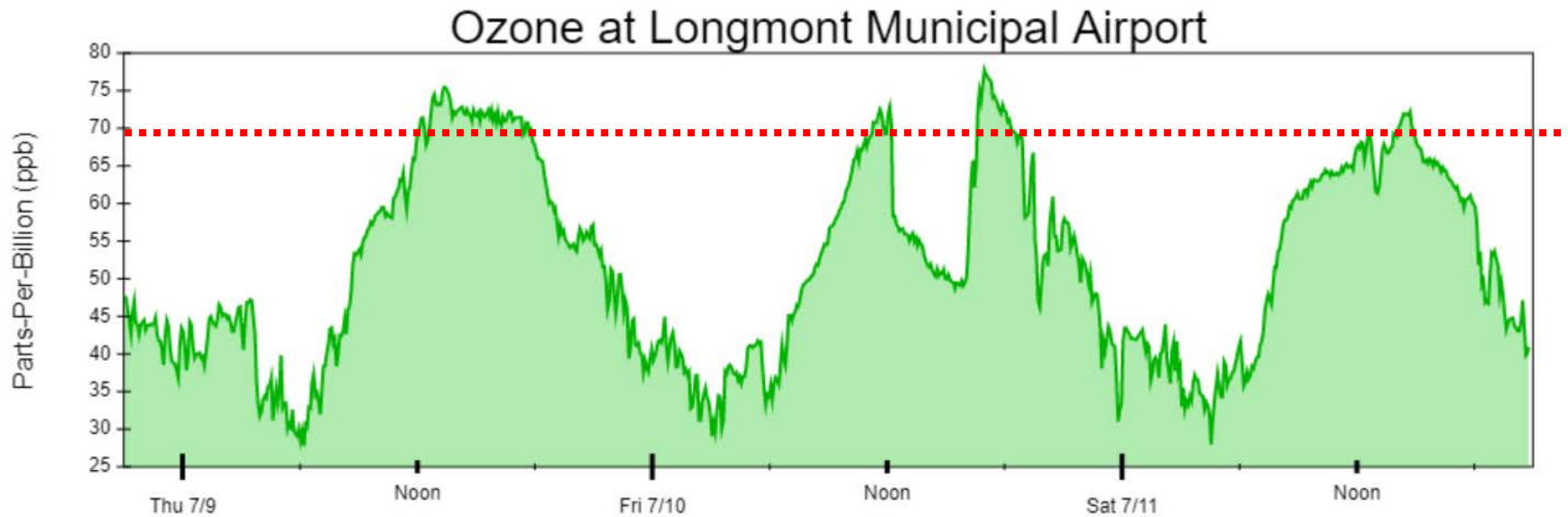
Graph from Interactive Data Analysis Tool

# Ozone National Ambient Air Quality Standard (NAAQS) – 8-hour running mean value: **70 ppb**



# Data Examples and Interpretation – Ozone

## July 10 Event



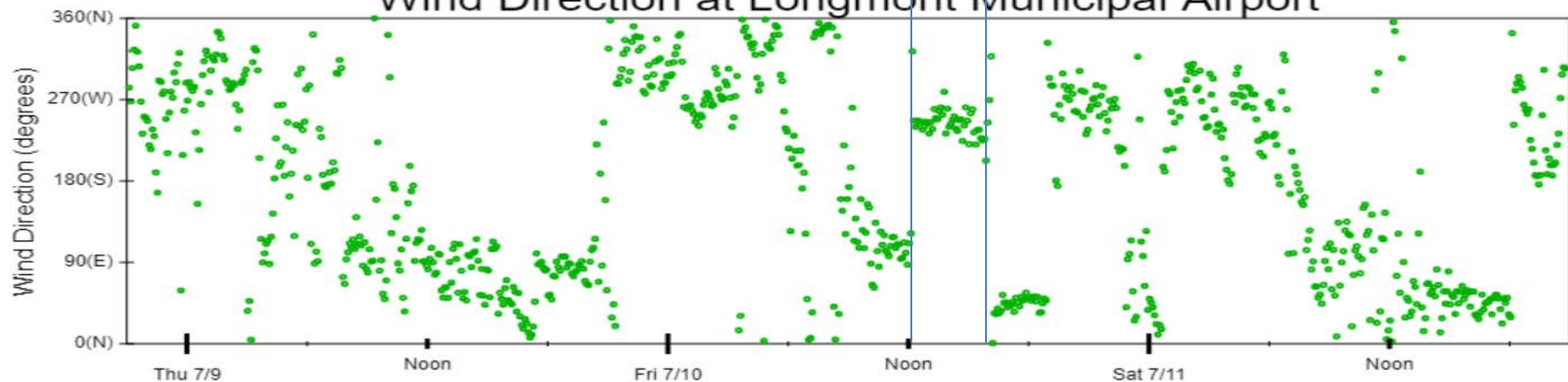
# Ozone at Longmont Municipal Airport



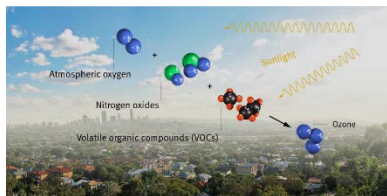
# Wind Speed at Longmont Municipal Airport



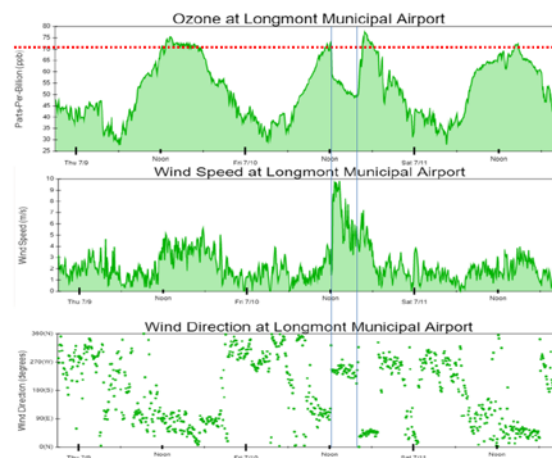
# Wind Direction at Longmont Municipal Airport



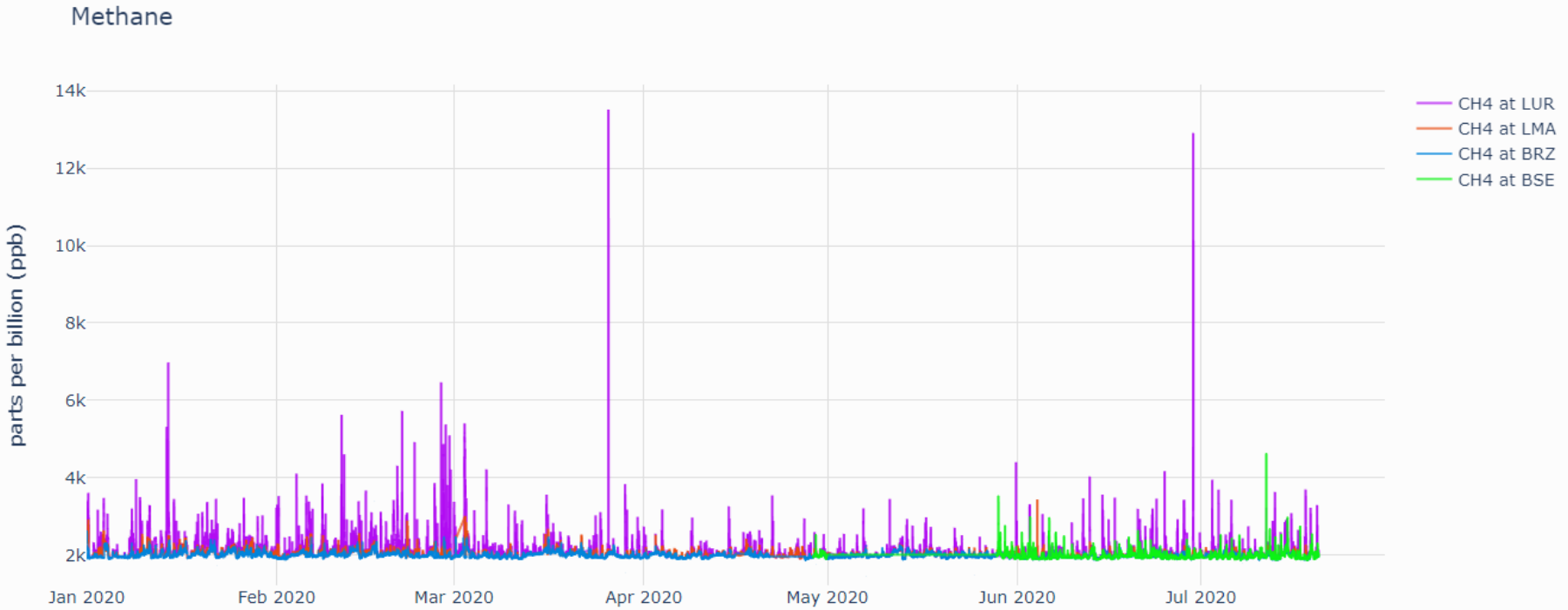
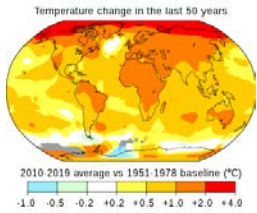
# Ozone Summary



- Ozone is monitored at both LMA and LUR
- Four days with Exceedance of the ozone National Ambient Air Quality Standard this year so far
- So far, exceedances at LMA have been slightly higher than at LUR
- Most times there is higher ozone in easterly winds than in westerly transport



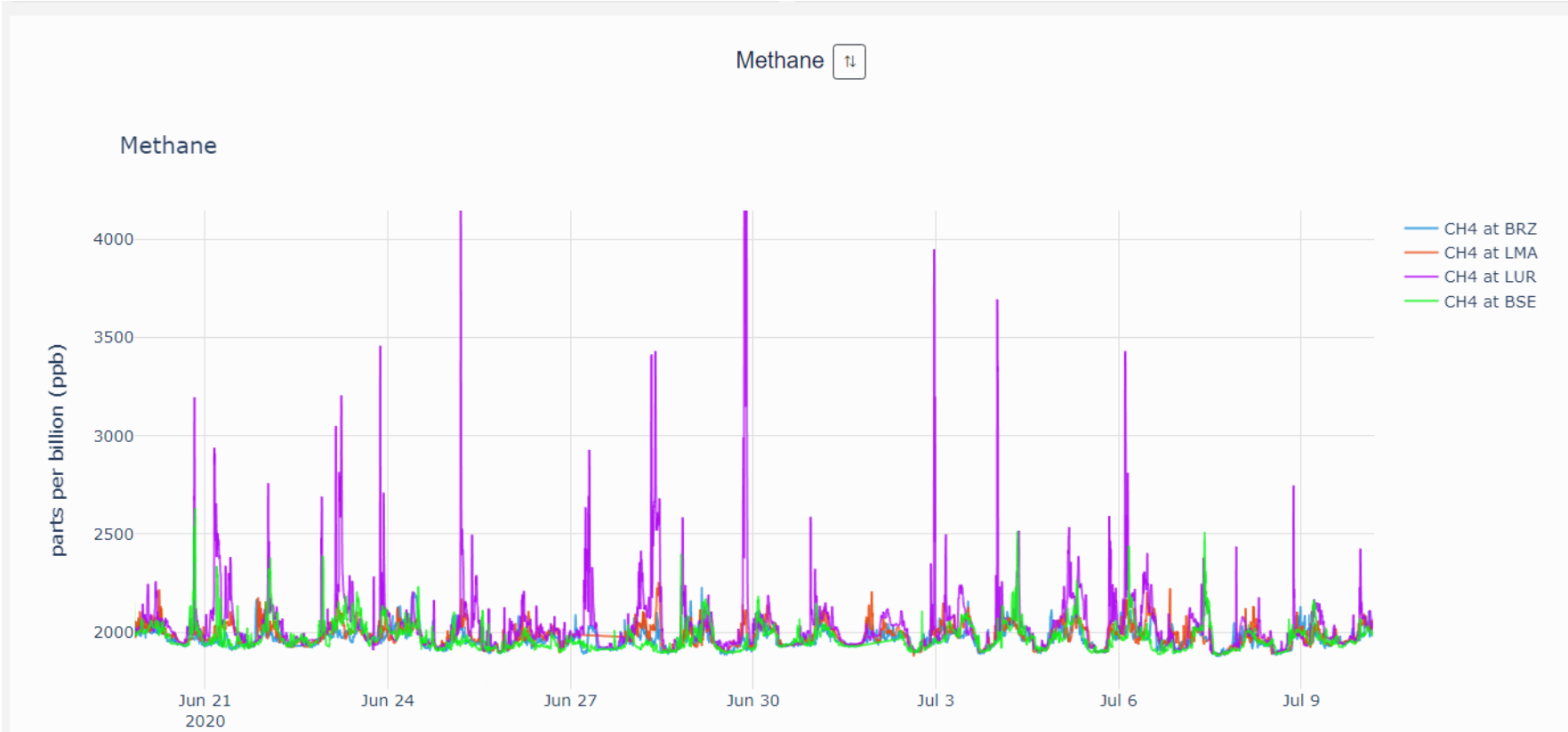
# Data Examples and Interpretation – Methane



- BRZ – Boulder Reservoir
- LMA – Longmont Municipal Airport
- LUR – Longmont Union Reservoir
- BSE – Broomfield Soaring Eagle

Graph from Interactive Data Analysis Tool

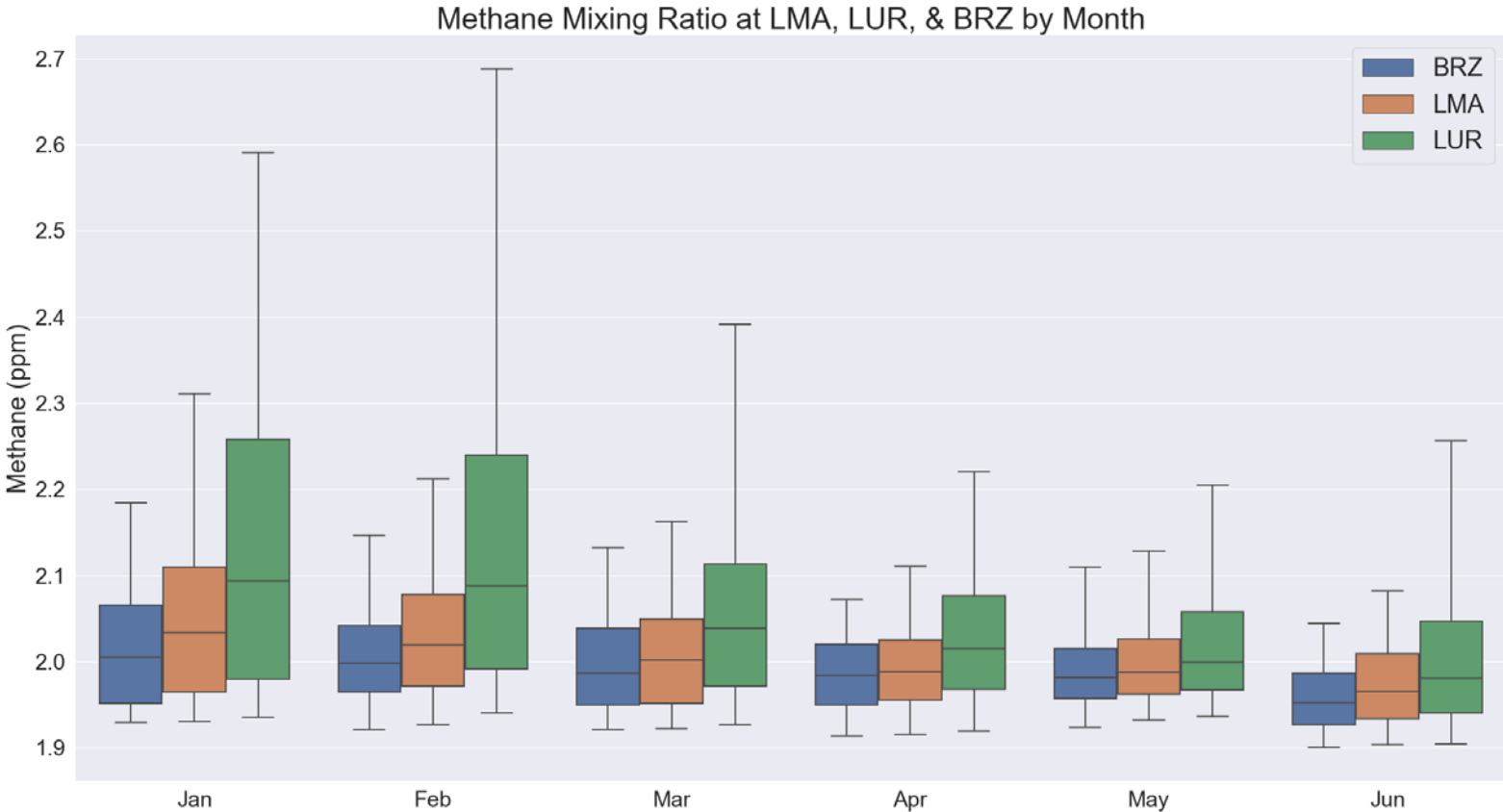
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Graph from Interactive Data Analysis Tool

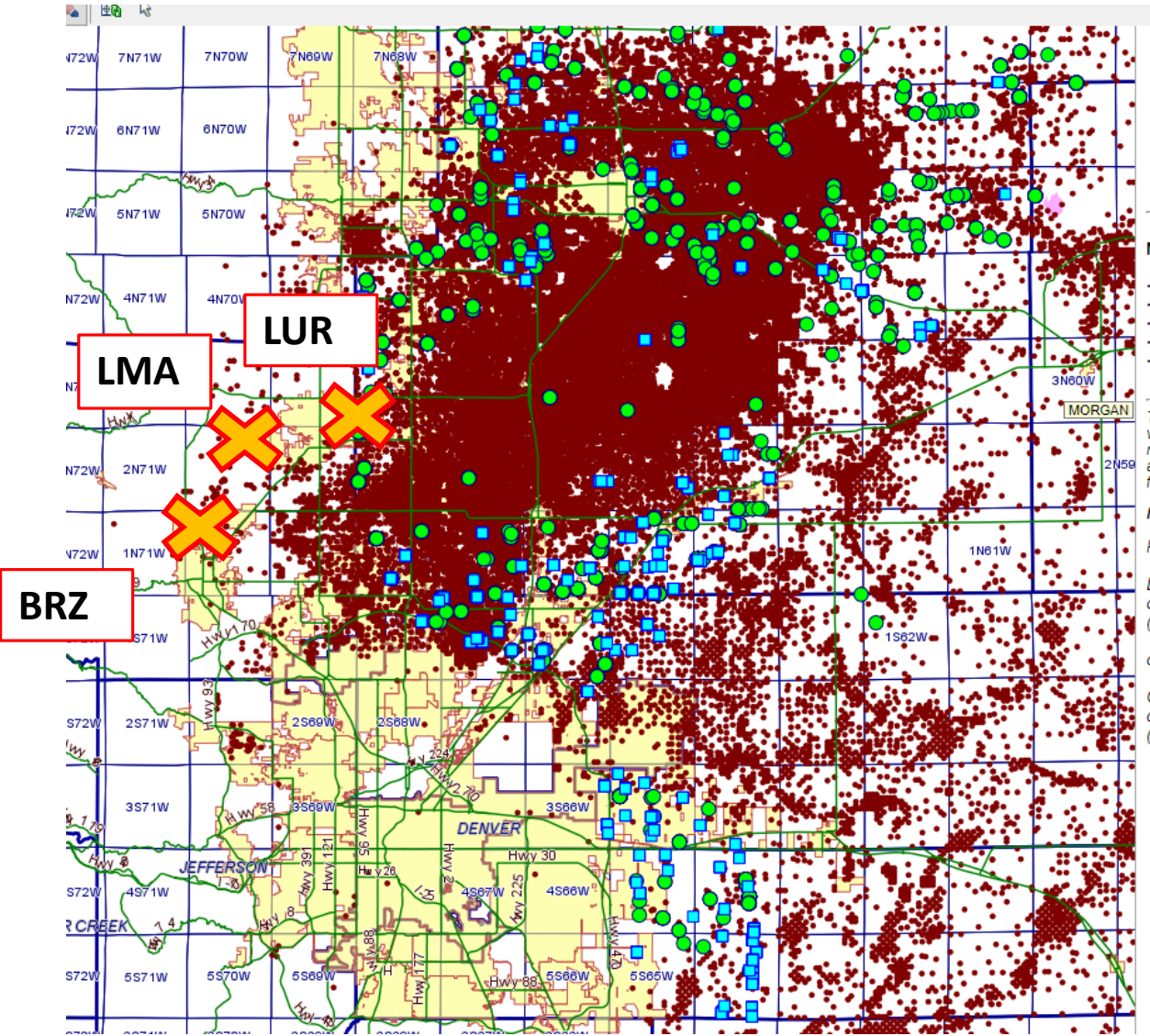
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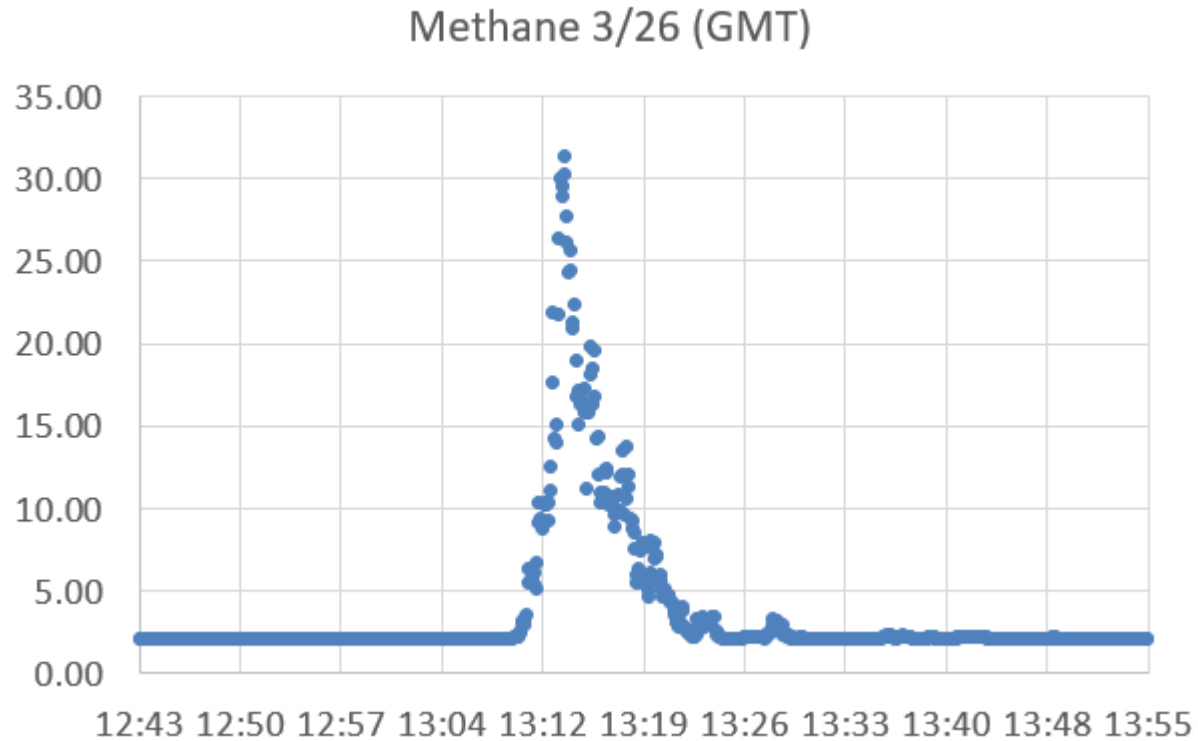


# Site Locations in Relation to current Oil and Gas Wells



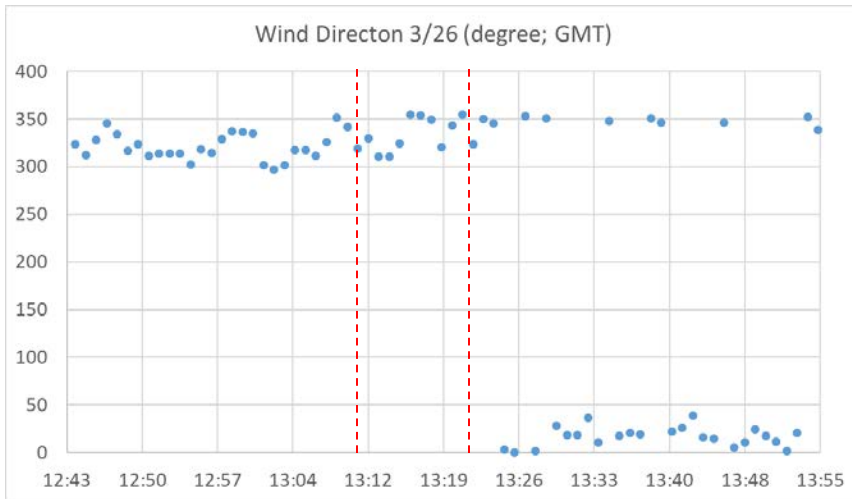
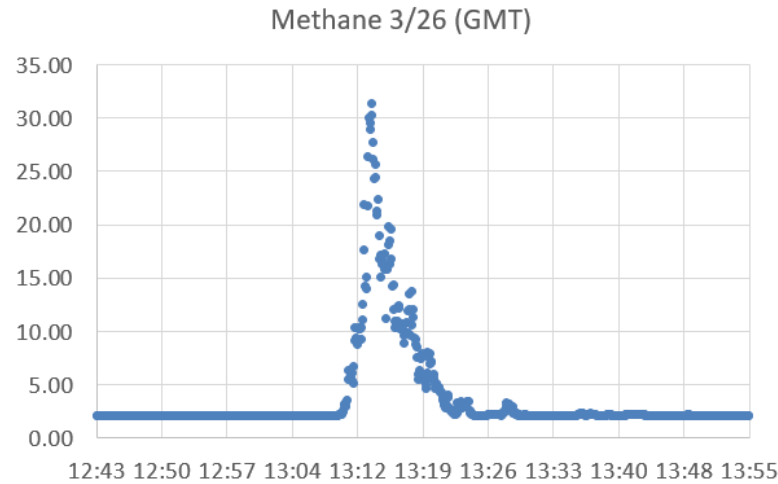
# LUR Methane Spike 3/26/2020

(5 second data)

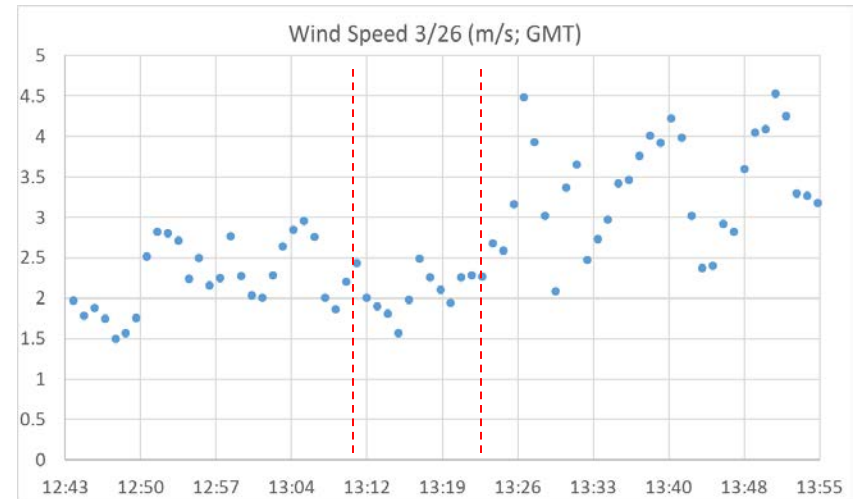


Duration: 13:10 to 13:24 (~ 14 minutes)

# LUR Methane Spike Event Analysis, 13:15 hrs GMT (7:15 a.m.) on March 26

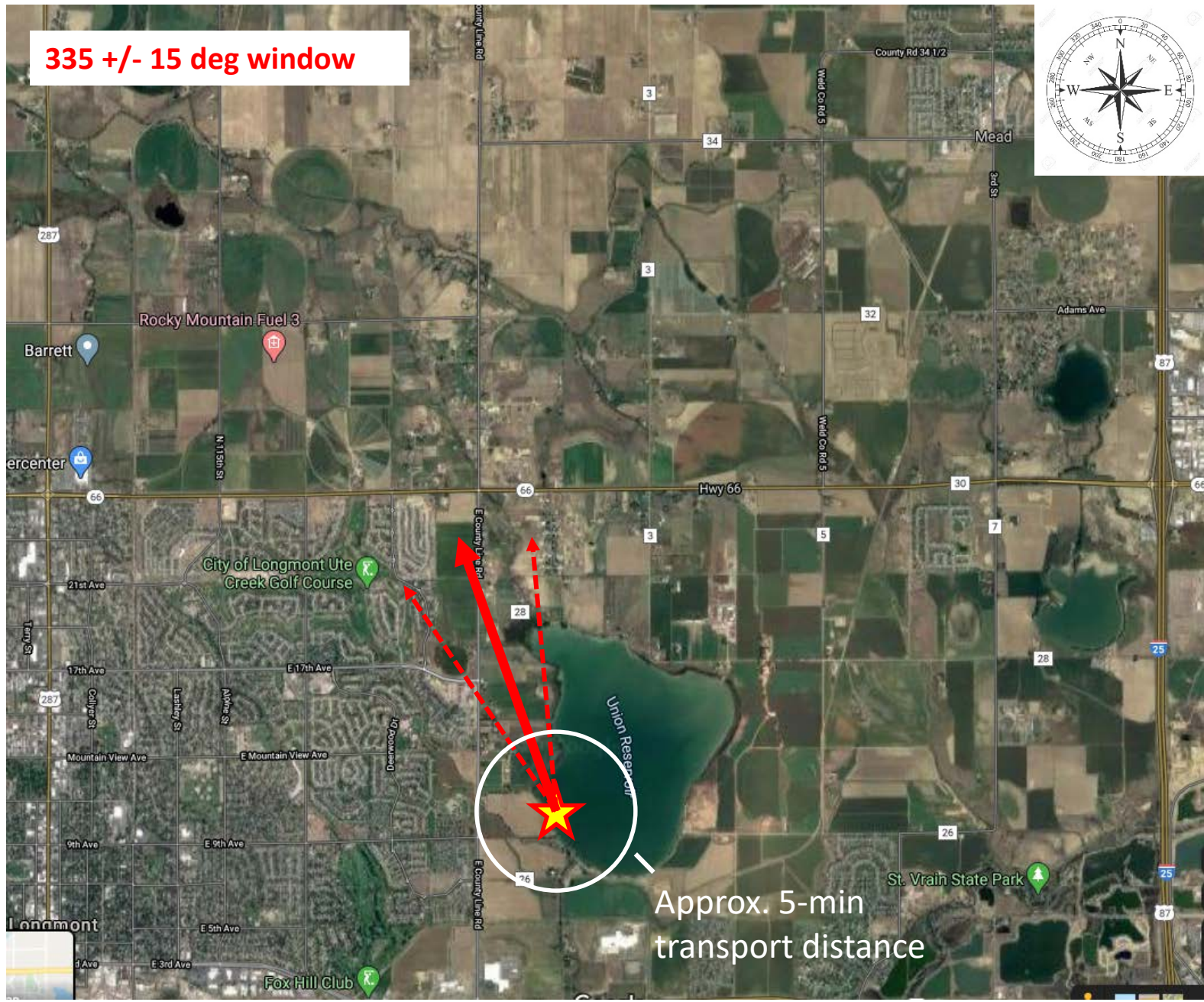
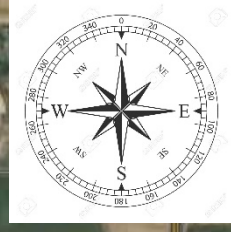


Average Wind Direction: 335 deg



Average Wind Speed: 2.1 m/s

335 +/- 15 deg window

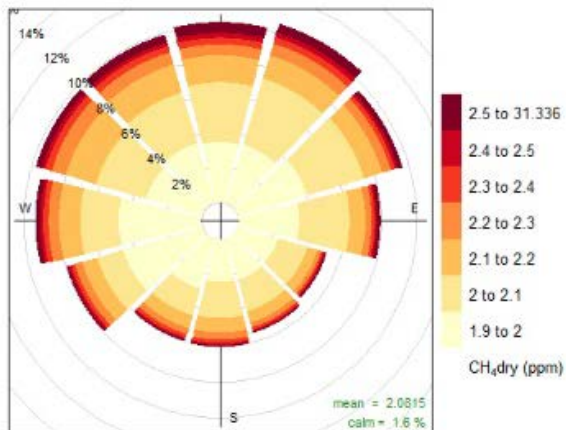


Approx. 5-min transport distance

# Methane – 6 months of data

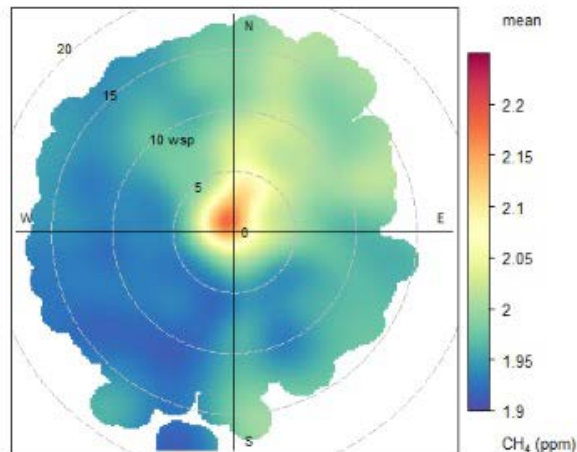
LUR

Six Month CH<sub>4</sub> LUR Pollution Wind Rose



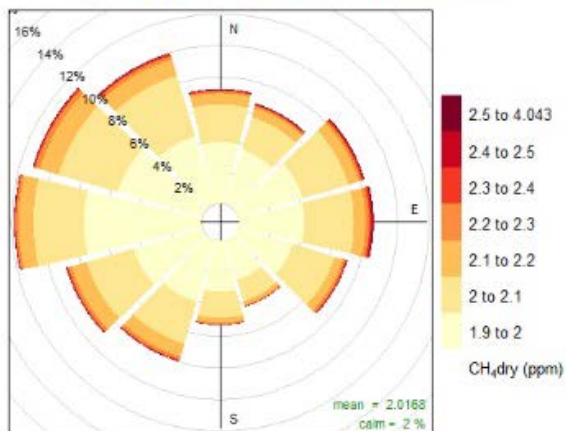
Frequency of counts by wind direction (%)

Six Month LUR CH<sub>4</sub> Mixing Ratio by Wind Direction



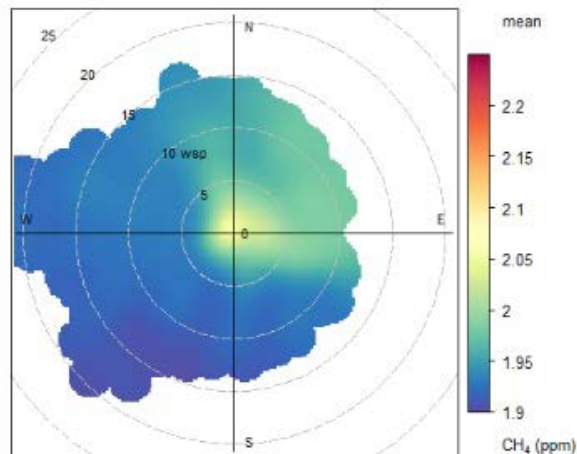
LMA

Six Month CH<sub>4</sub> LMA Pollution Wind Rose

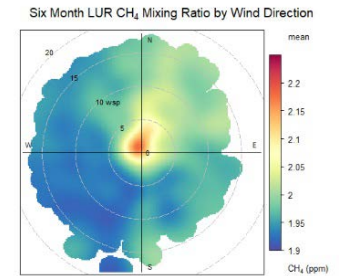
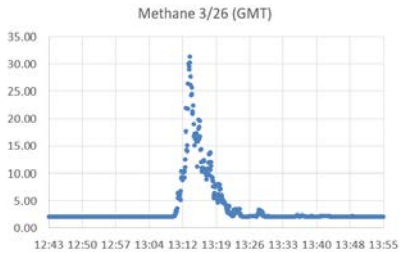


Frequency of counts by wind direction (%)

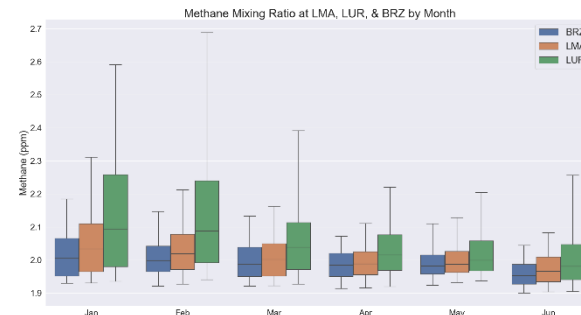
Six Month LMA CH<sub>4</sub> Mixing Ratio by Wind Direction



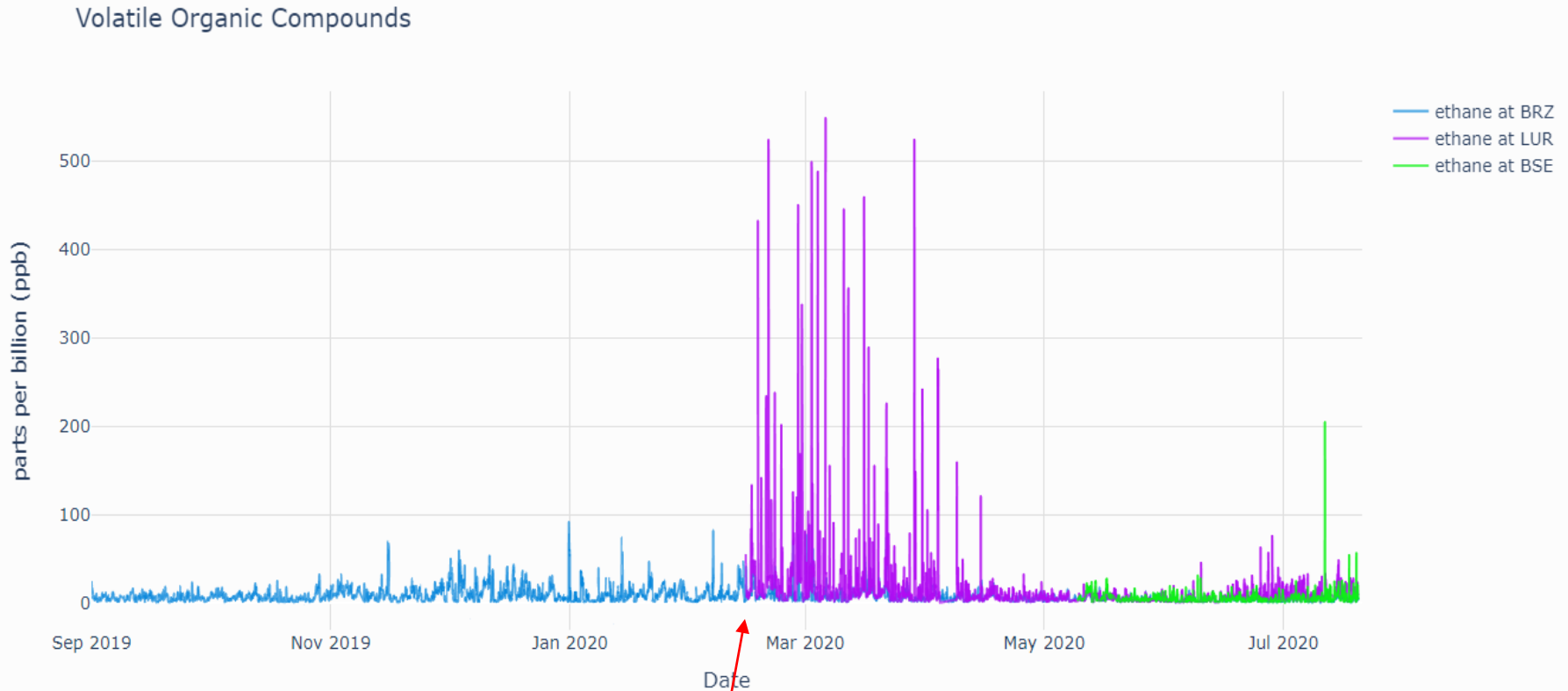
# Methane Summary



- Collecting 5 seconds high resolution data at LMA and LUR
- Seeing a high abundance of spikes, often very short in duration at LUR
- Mean, median, and variability highest at LUR
- Elevated concentrations are mostly associated with northerly to easterly winds



# Data Examples and Interpretation – VOCs: Ethane



BRZ – Boulder Reservoir  
LMA – Longmont Municipal Airport  
LUR – Longmont Union Reservoir  
BSE – Broomfield Soaring Eagle

Start of VOCs  
monitoring at LUR

# Ethane

March 20

Longmont Air Quality Now

Area Report      Longmont Historical Report

Measurement Date: Longmont Monitoring Report

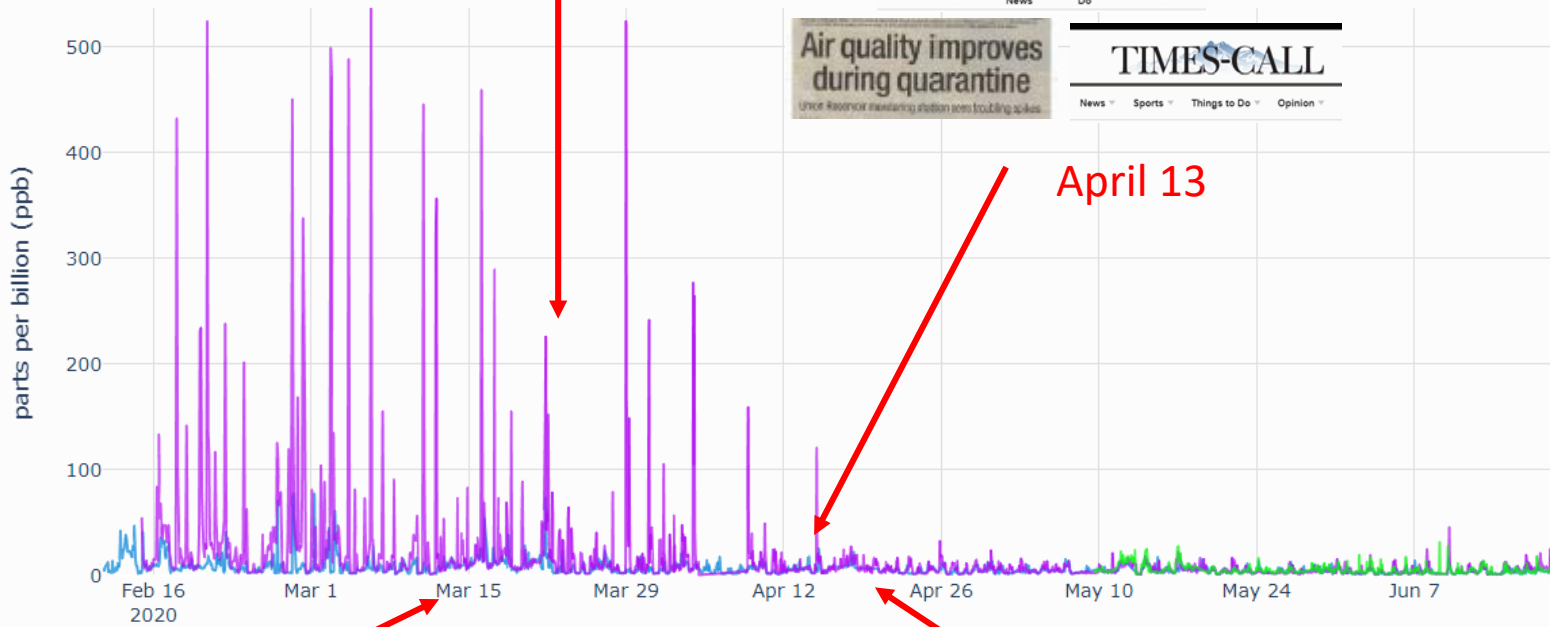
Measurement	Value	Unit	Standard
PM2.5	10.0	µg/m³	35
PM10	15.0	µg/m³	70
Ozone	50.0	ppb	70
CO	0.5	ppm	9.0
SO2	0.1	ppm	3.0
NO2	0.5	ppm	4.0
NOx	0.5	ppm	4.0
Lead	0.0	ppb	1.5

Measurement Date: Longmont Monitoring Report

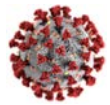
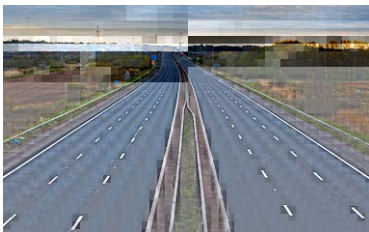
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NO2	0.5	ppm	4.0
NOx	0.5	ppm	4.0
Lead	0.0	ppb	1.5

Volatile Organic Compounds

Volatile Organic Compounds



April 13



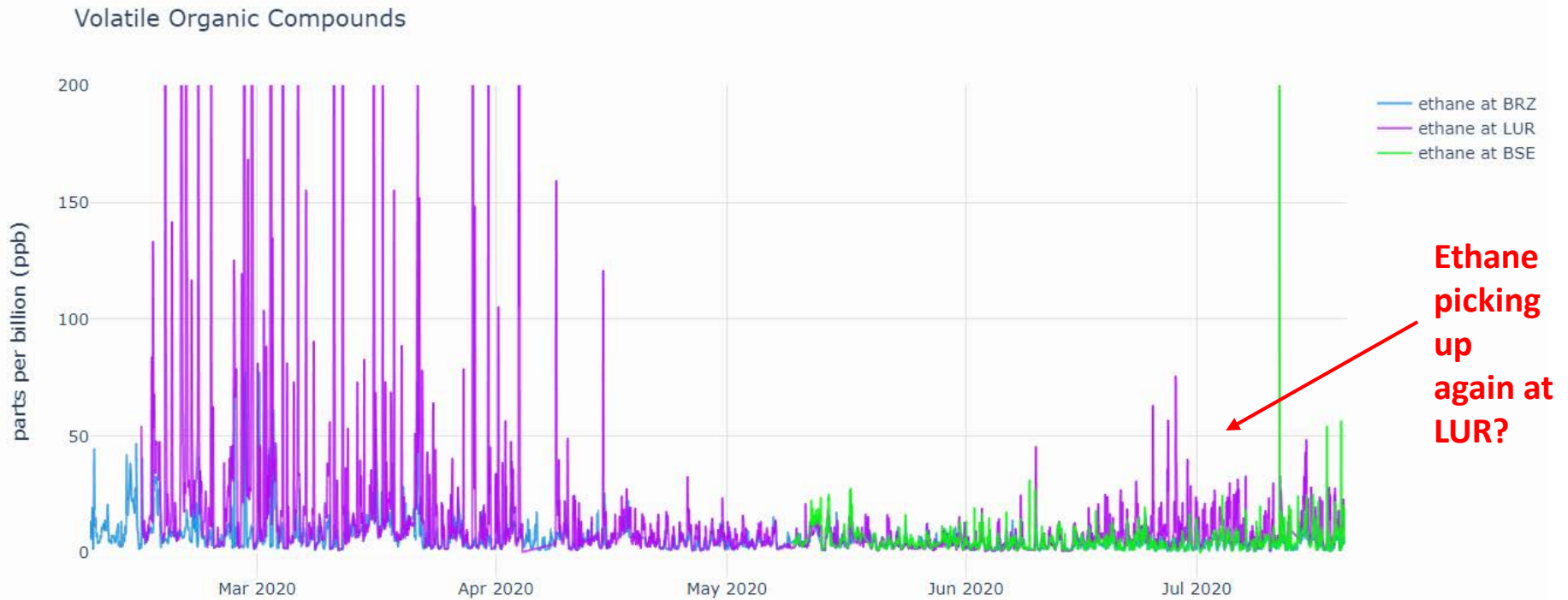
March 12



April 20

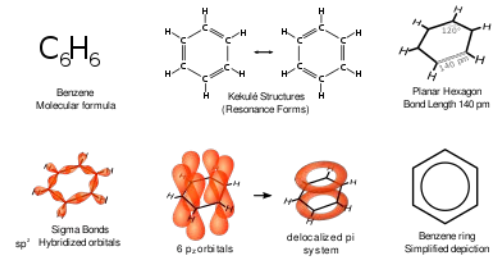


# Data Examples and Interpretation – VOCs: Ethane



BRZ – Boulder Reservoir  
LUR – Longmont Union Reservoir  
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# Data Examples and Interpretation – VOCs: Benzene



## Benzene Health Standards

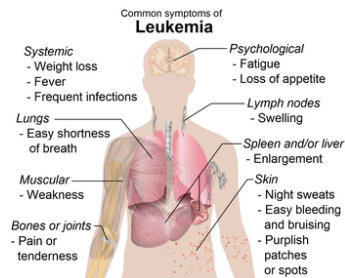
9 ppb

1 ppb

0.94 ppb

No safe limit

- EPA 24-hour standard
- CA continuous long term
- EPA 8-hour for schools etc.
- World Health Organization





A drilling site operated by Extraction Oil and Gas sits just 1,300 feet from Bella Romero Academy in Weld County. / Anthony Camera

## Bella Romero Benzene Levels Worse Than Reported, Analysis Claims

CHASE WOODRUFF | MARCH 11, 2020 | 12:11PM

When Colorado air-quality regulators notified the public of an **elevated benzene reading near Greeley's Bella Romero Academy** last November, they emphasized that the state's air-monitoring equipment had only **detected a single violation** – one 45-minute sample that exceeded health standards out of more than 85 days of testing.

# Benzene



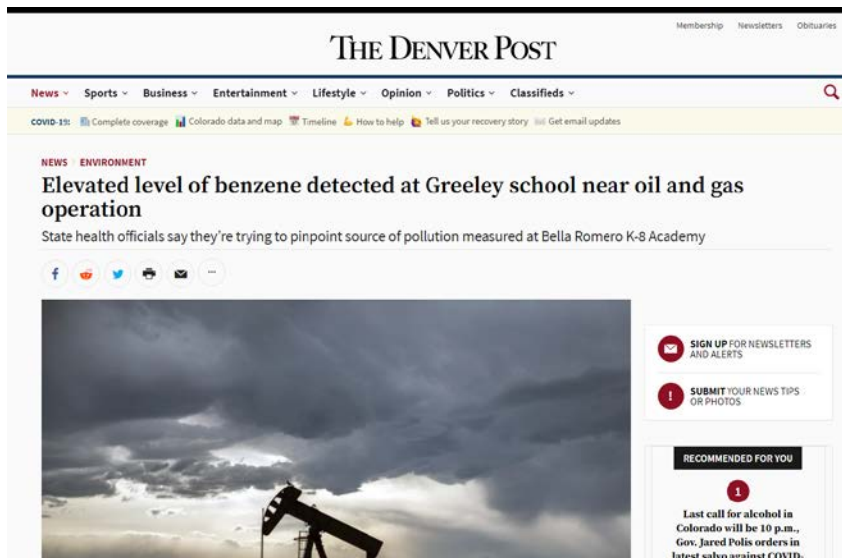
HOME COLAB COVID-19 GREENE GRIEGO LITTAIN GUEST POSTS

Home » The local » Environment/Energy » Report: Benzene-causing factories spiked more than once at Bella Romero

## Report: Cancer-causing benzene spiked more than once at Bella Romero

The report, commissioned by the environmental group 350 Colorado, uses California's more stringent thresholds

By John Hamok · March 11, 2020

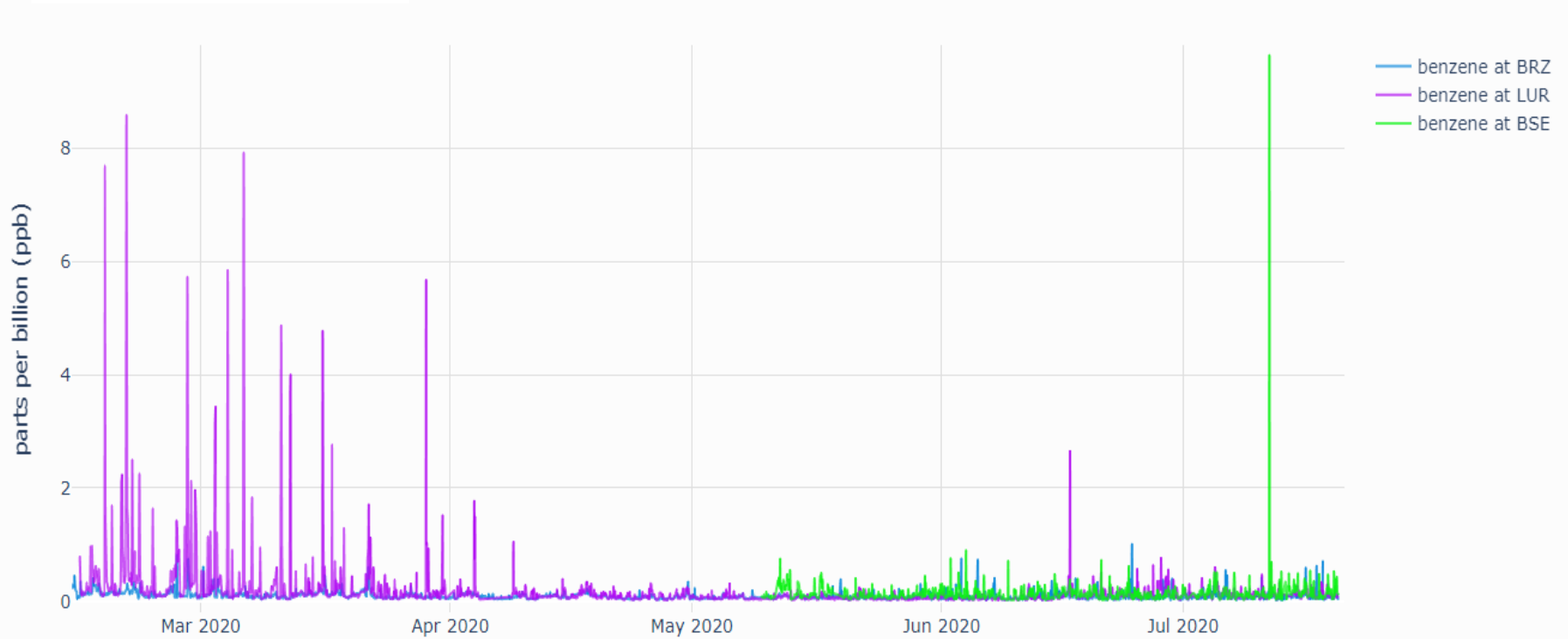


CDPHE Measurement:

One 45-min data value first reported at 10.2 ppb, later revised to 14.7 ppb (CDPHE, 2020)

# Data Examples and Interpretation – Benzene

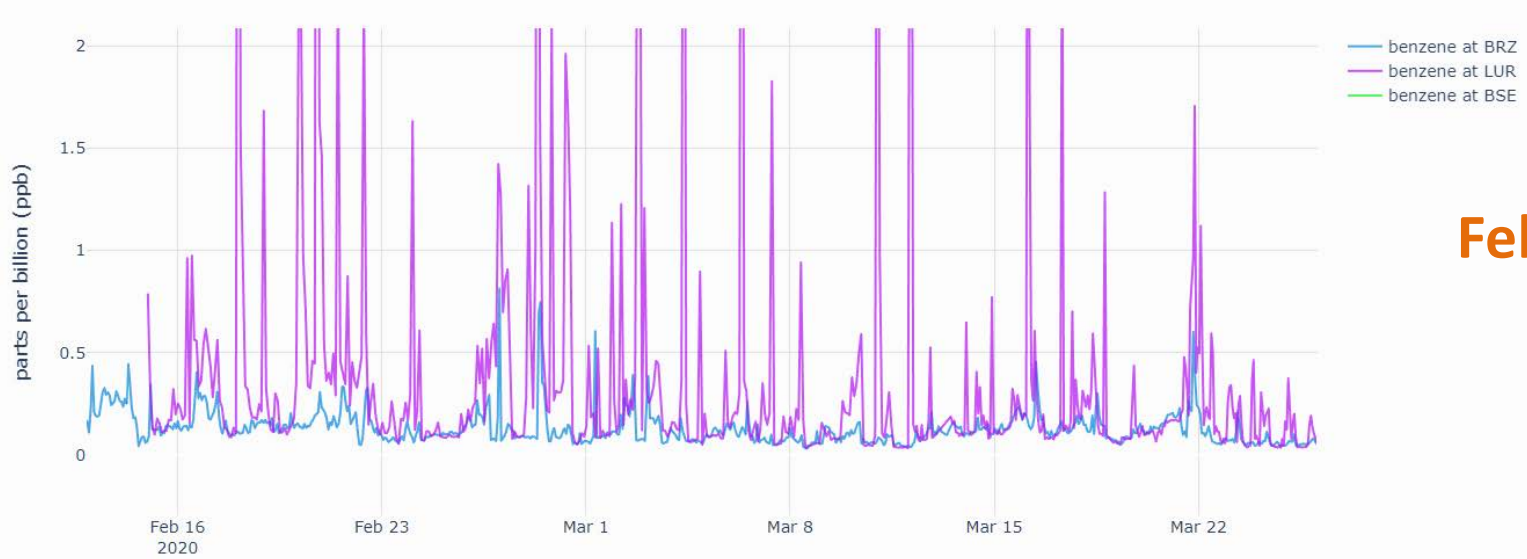
## Benzene



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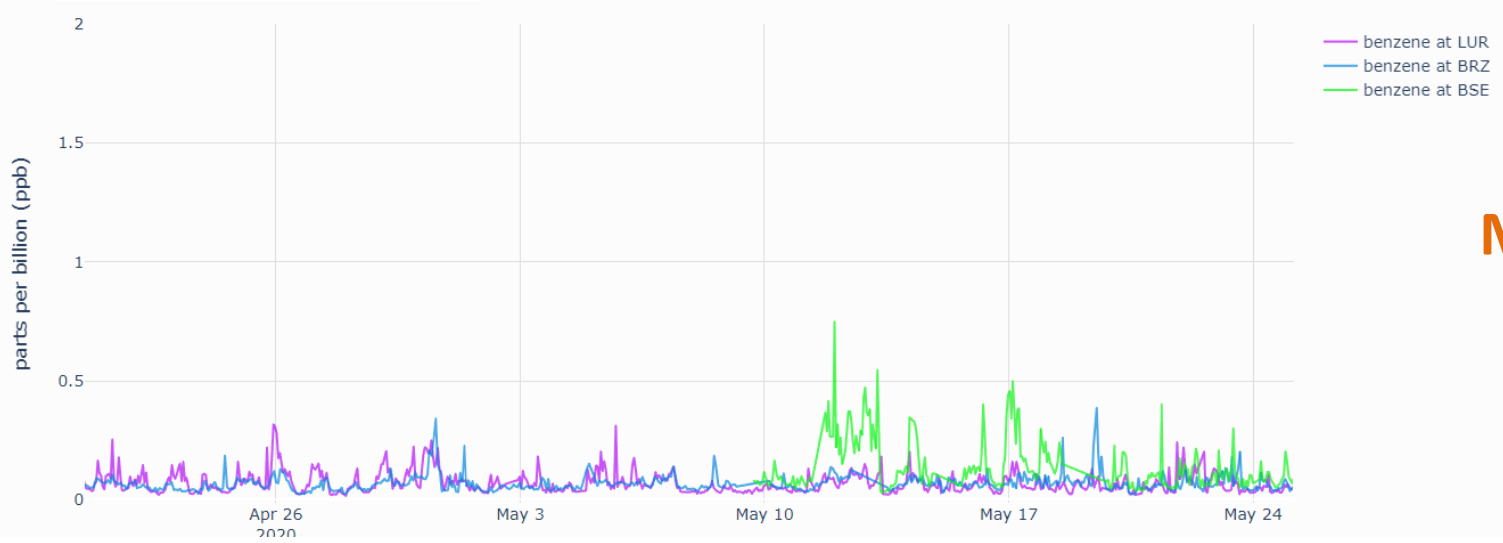
# Benzene

## Benzene



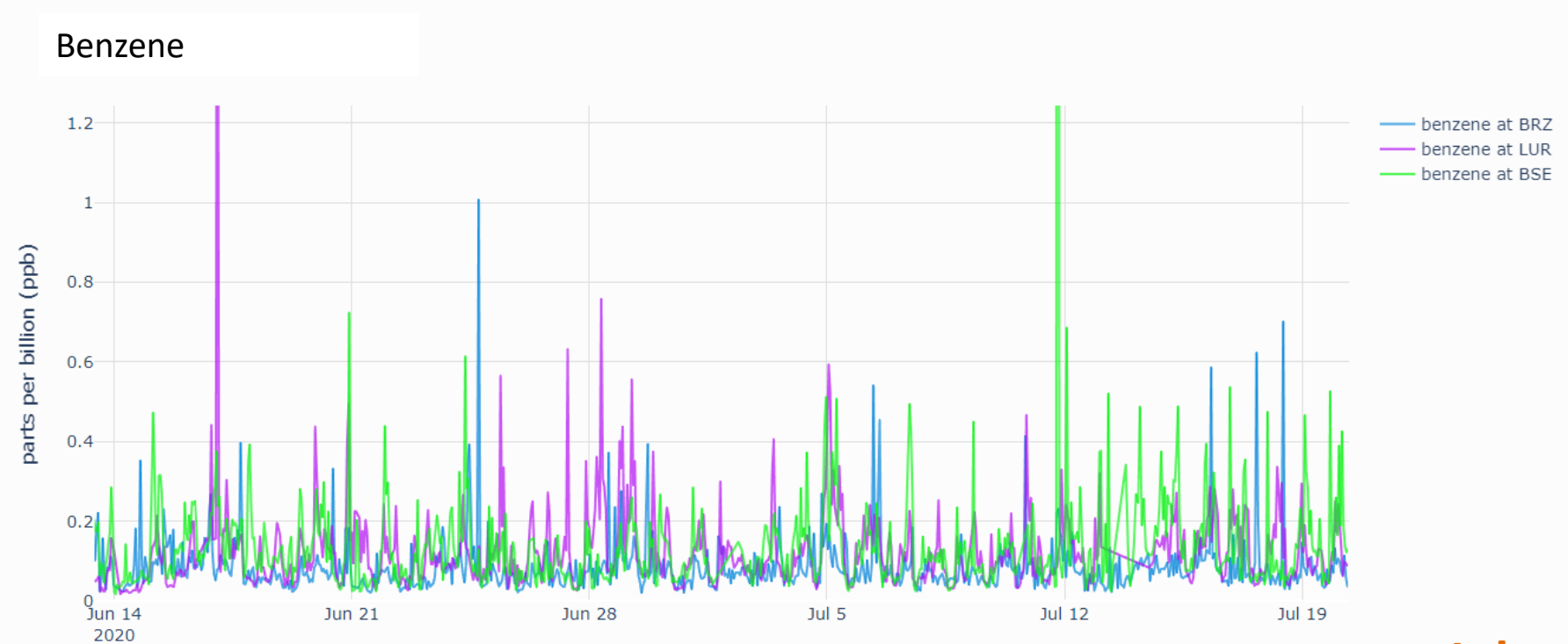
February

## Benzene



May

# Benzene

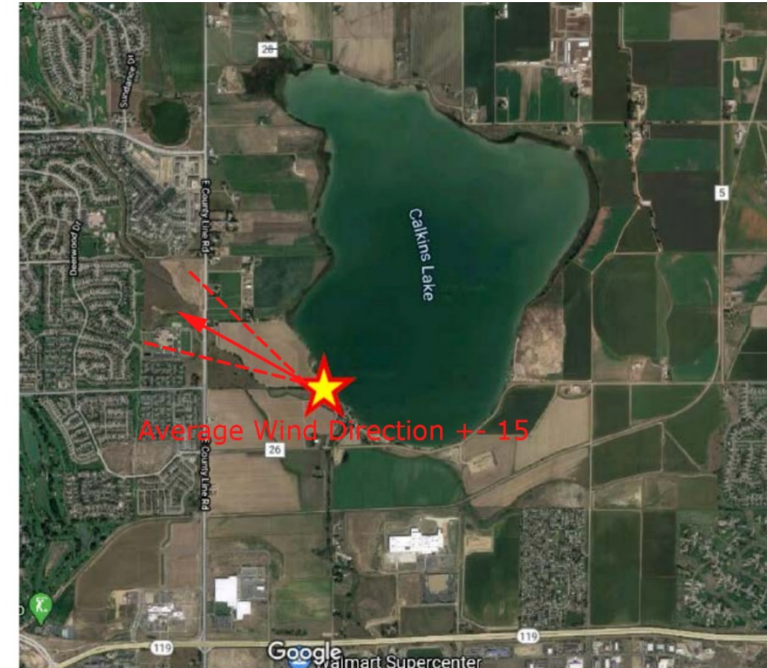
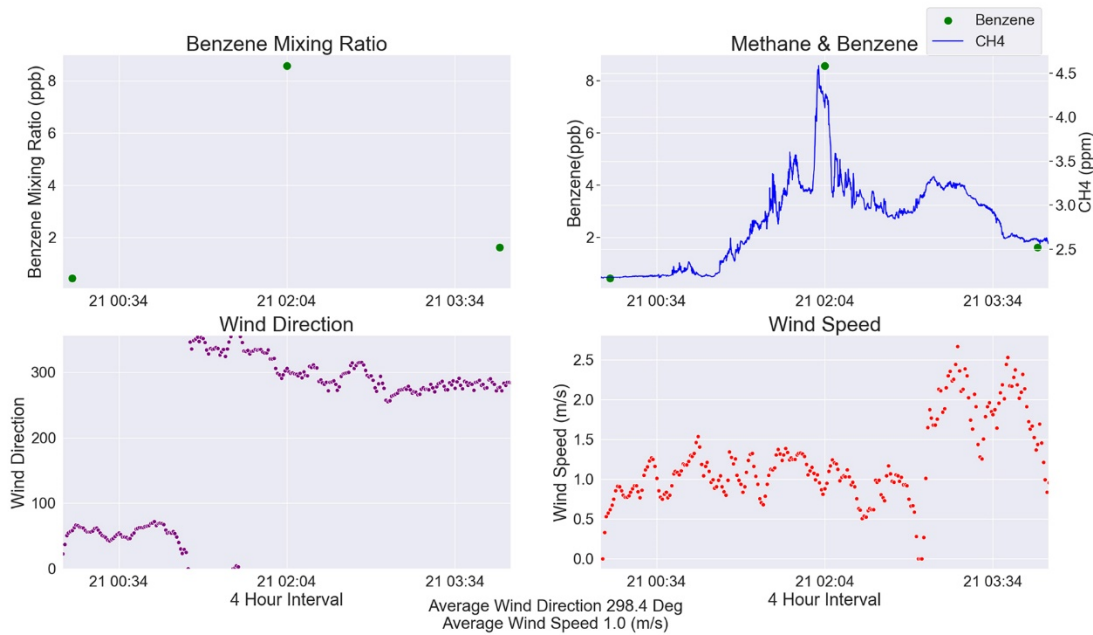


July

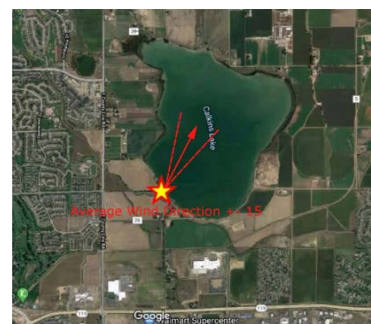
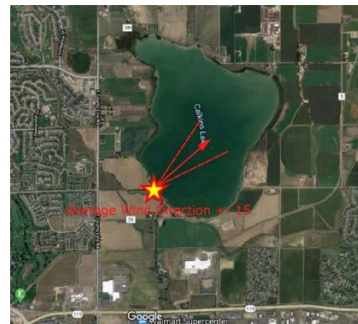
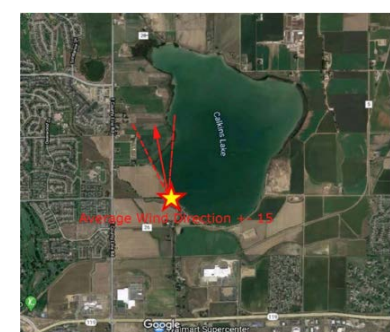
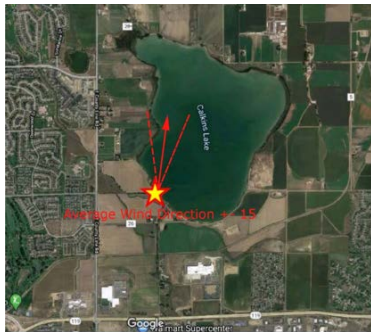
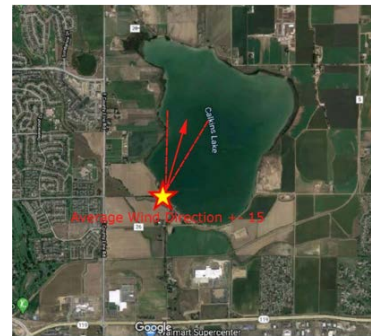
BRZ – Boulder Reservoir  
LUR – Longmont Union Reservoir  
BSE – Broomfield Soaring Eagle

# Where is the Benzene coming from?

## Benzene Peak #1



# Approximate Wind Sector for ten highest Benzene Occurrences (~ 4 – 8 ppb)



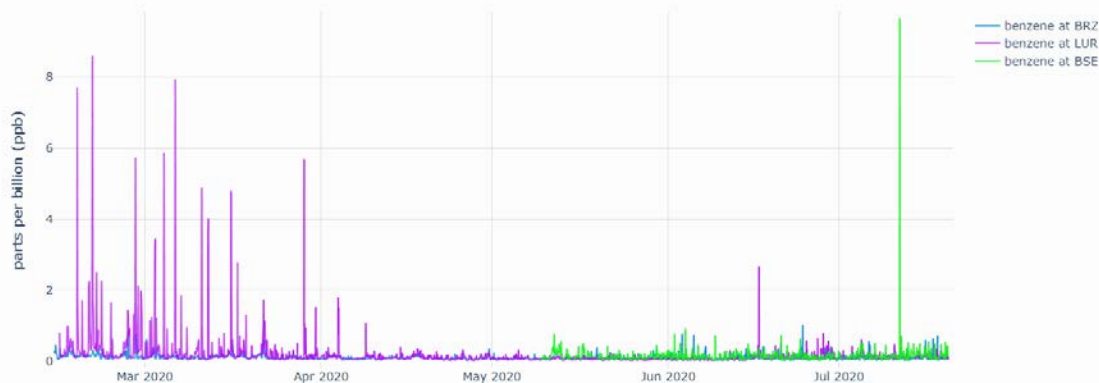


# VOCs/Benzene Summary



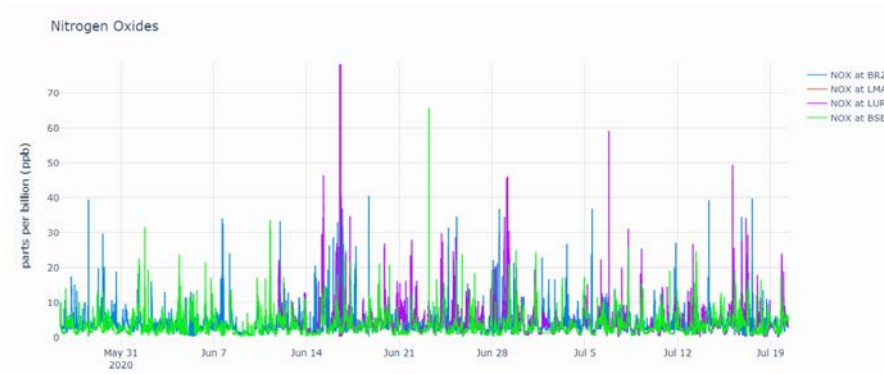
- Hourly VOCs/benzene measurements at LUR
- High abundance of elevated VOCs/benzene during February – March
- Many benzene observations between 1-10 ppb
- Much higher than at all other comparison sites (except one measurement at BSE)
- Elevated levels mostly associated with northwest to easterly winds
- Correlation of benzene with methane indicates oil and gas source
- Levels dropped steeply in April – May – June

Volatile Organic Compounds

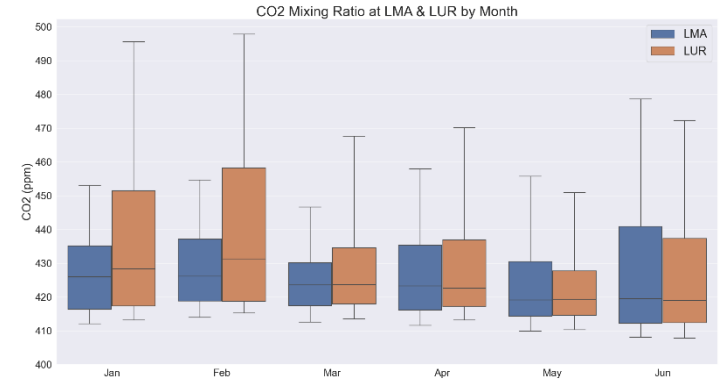


# Other monitored variables not covered in today's presentation

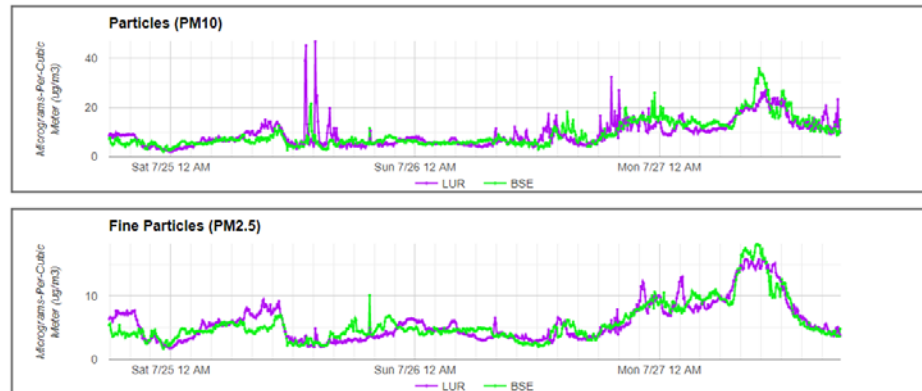
## Nitrogen Oxides



## CO<sub>2</sub>

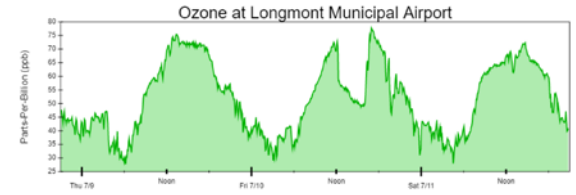
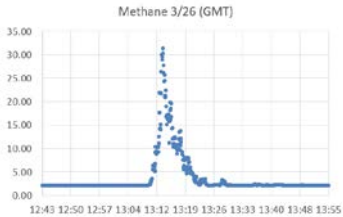


## Particulate Matter



# Year 1 Summary

- Completed installation of two monitoring sites
  - LMA
  - LUR
- All proposed measurements are up and running
  - LMA since September 2019
  - LUR since December 2019 – January 2020
- > 95% data coverage
- Public web portal became live in September 2019
- Developed two additional data analysis web portals
  - > 4000 Visits; increasing visit counts
- Stark differences in data between both sites
- High frequency of oil and gas related emissions at LUR
- Concentration spikes are relatively short
- Numerous high benzene occurrences, mostly during northerly winds
- Steep drop in concentrations of oil and gas emissions tracers throughout the spring



Longmont Air Quality Now			
Location	Temp	Humidity	Wind
Lincoln Reservoir	68.8	80%	10.2
Longmont Municipal Airport	68.8	80%	10.2
<b>Metropolitan Data</b>			
Longmont Municipal Airport			
CO (ppm)	0.6	0.6	0.6
CO2 (ppm)	405	405	405
NO2 (ppb)	15	15	15
SO2 (ppb)	0.5	0.5	0.5
<b>Chemical Measurements</b>			
Longmont Municipal Airport			
CH4 (ppm)	1.5	1.5	1.5
C2H6 (ppm)	0.5	0.5	0.5
C3H8 (ppm)	0.2	0.2	0.2
iC4H10 (ppm)	0.1	0.1	0.1
nC4H10 (ppm)	0.1	0.1	0.1
<b>Metropolitan Data</b>			
Lincoln Reservoir			
Temp (°C)	20.4	20.4	20.4
Humidity (%)	80	80	80
Wind Speed (m/s)	4.7	4.7	4.7
Wind Dir (°)	315	315	315
CO (ppm)	0.6	0.6	0.6
CO2 (ppm)	405	405	405
NO2 (ppb)	15	15	15
SO2 (ppb)	0.5	0.5	0.5

