Air Quality Data and Transportation-related emissions: Changes over time and COVID-related trends in the Denver, CO region

Identifying options for alternative transportation in the Denver region

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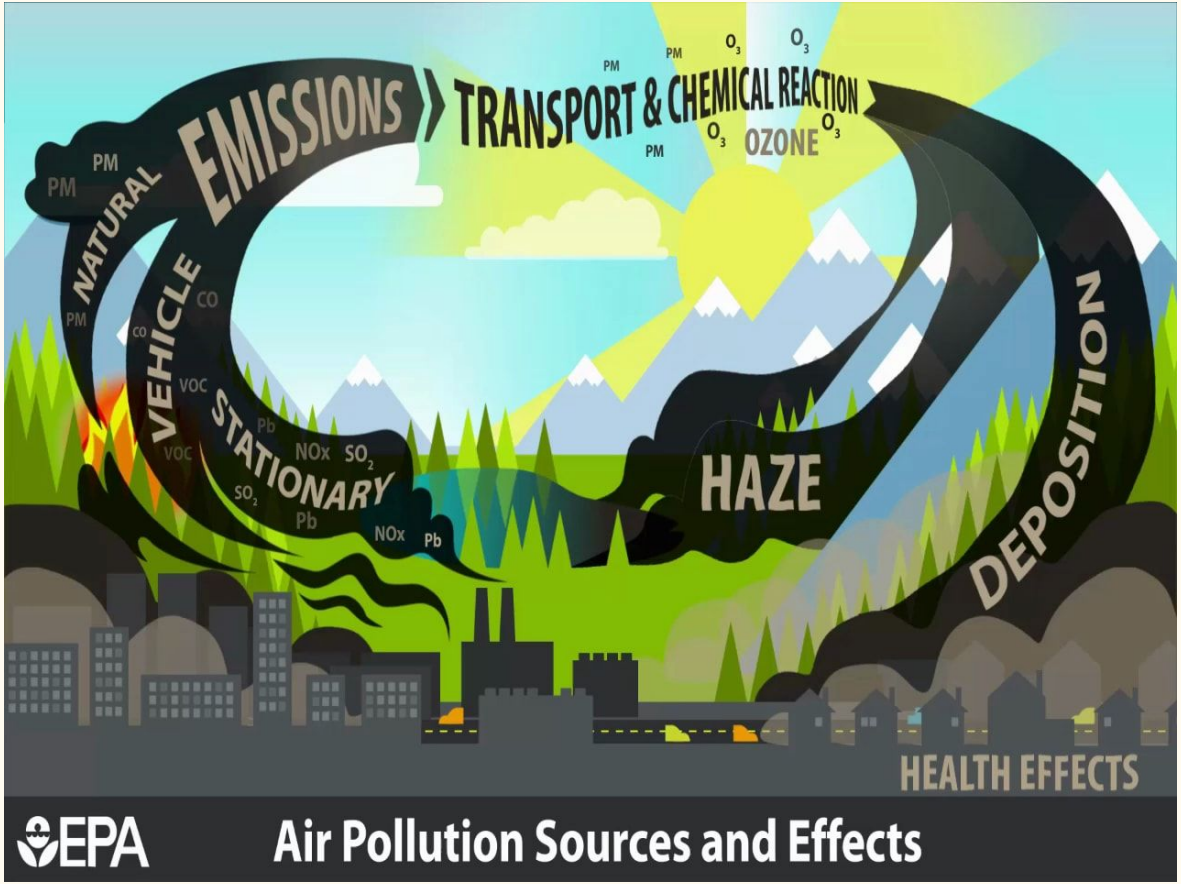
Land Acknowledgement from MSU Denver

MSU Denver acknowledges the indigenous people and land of Auraria and the broader Denver area.

We honor and acknowledge that we are on the traditional territories and ancestral homelands of the Cheyenne and Arapahoe Nations. This area was also the site of trade, hunting, gathering, and healing for many other Native Nations: The Lakota, Ute, Kiowa, Comanche, Apache, Shoshone, and others.

We recognize the Indigenous peoples as the original stewards of the land, water, plants, and animals who called this place home. As these words of acknowledgment are spoken and heard, the ties that these nations have to their traditional homelands are renewed and reaffirmed. Let us also acknowledge the painful history of genocide and forced removal from this territory. We respect the many diverse Indigenous peoples still connected to this land on which we gather. We pay our respect to them and give thanks to all Tribal Nations and the ancestors of this place.

We also want to recognize the community and families of Auraria displaced by the creation of this campus for MSU Denver to have a place that we now call home.



Significance of Issue: Air Quality & Transportation

Vehicle transportation contributes to:

- Poor air quality
- GHG emissions
- Health concerns

Research Questions

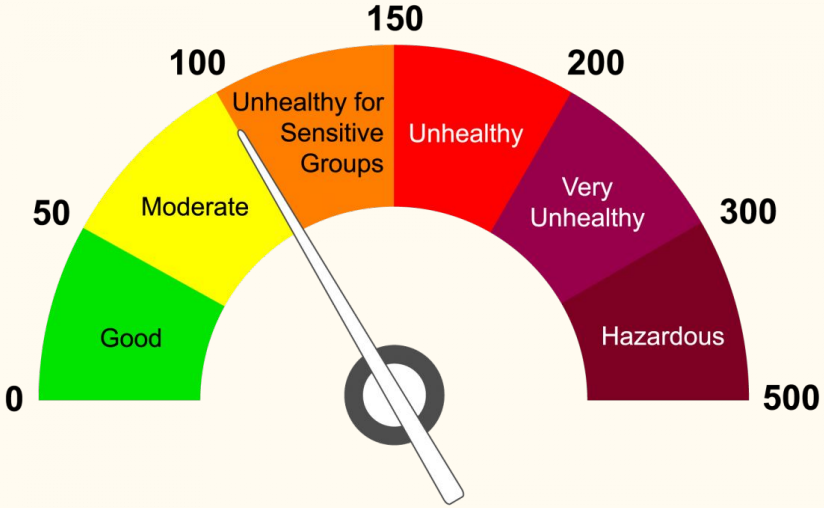
1. How have transportation emissions changed over time in Denver?
2. What factors affect transportation emissions changes in the region? (i.e. COVID - 19)
3. What are transportation alternatives to single occupancy vehicles?

Background: Air Quality & Denver

- Unique geographic location
- “Brown Cloud”
- Clean Air Act (1970)

Source: CBS News, 2014

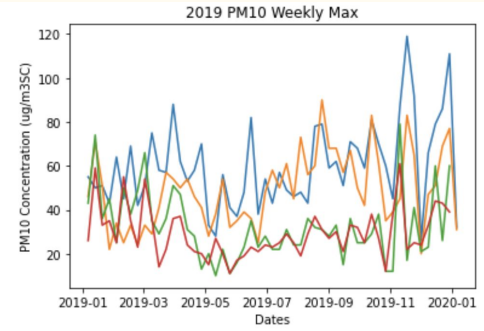
Background: Air Quality & Denver



- Air Quality Index (AQI)
- Criteria Pollutants:
  - Sulfur Dioxide (SO2)
  - Transport-related:
    - Ozone (O3)
    - Particulate Matter (2.5 & 10)
    - Nitrogen Dioxide (NO2)
    - *Carbon Monoxide (CO)*

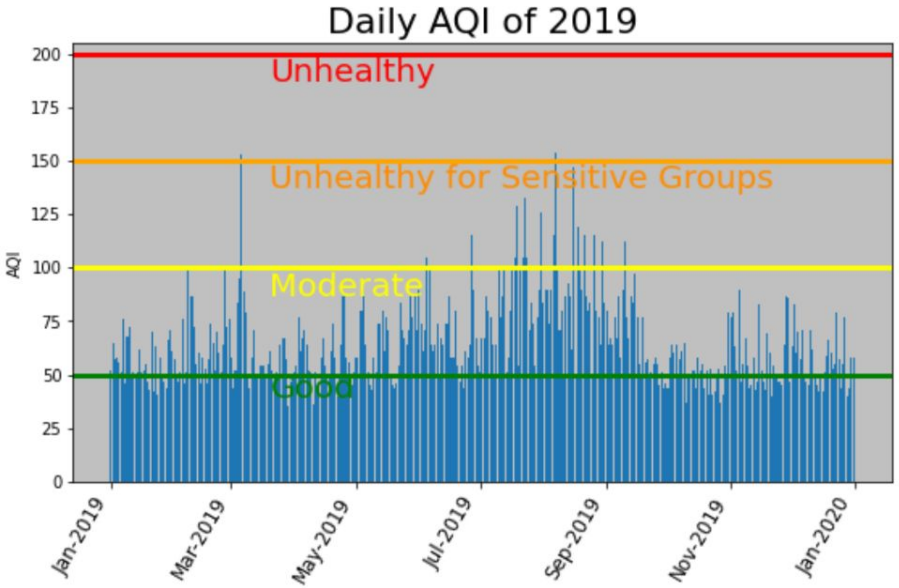
Approach to the research

```
#Sort the dataframe
aqi_year_2019= den_aur_lak_2019.sort_values("AQI")
aqi_year_2020= den_aur_lak_2020.sort_values("AQI")

#define the figure container (e.g. our canvas) and the two plot axes
fig = plt.figure(figsize=(20,5))

#add subplots to the figure
ax1 = fig.add_subplot(1,2,1)
ax2 = fig.add_subplot(1,2,2)

#x-axis is the Dates, y-axis is the AQI
ax1.bar(aqi_year_2019.index, aqi_year_2019["AQI"],)
ax1.set_xticklabels(aqi_year_2019.index, rotation=60, horizontalalignment="right", fontsize=12)
ax1.set_ylim([0,205])
ax1.set_title("Daily AQI of 2019", fontsize=22)
ax1.set_ylabel("AQI")


ax2.bar(aqi_year_2020.index, aqi_year_2020["AQI"])
ax2.set_xticklabels(aqi_year_2020.index, rotation=60, horizontalalignment="right", fontsize=12)
ax2.set_ylim([0,205])
```

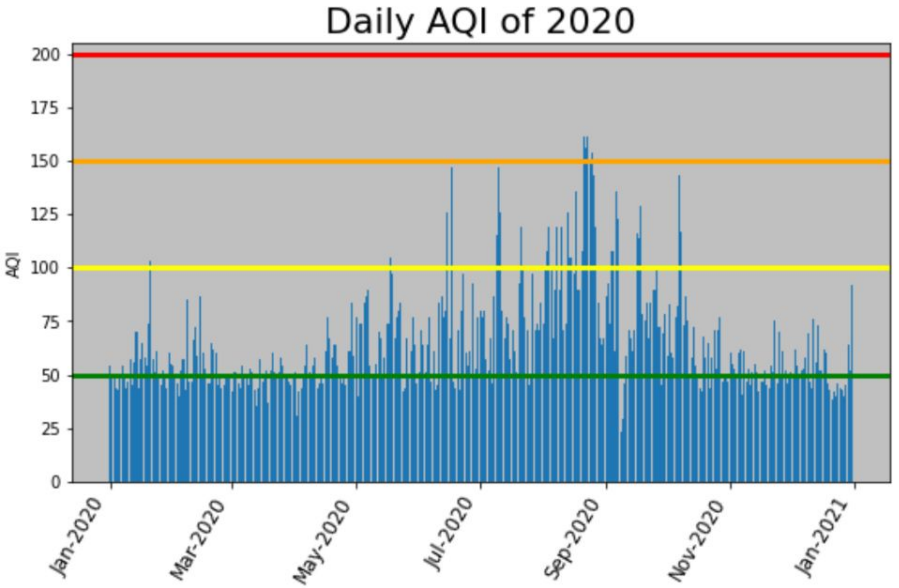


- Explore the air quality data for trends and changes over time and space
- Research transportation-related pollutants and history of air quality in region
- Compare 2019 and 2020 data to see impact of COVID-19 restrictions
- Used Python to read the files and plot data using matplotlib
- Create maps of alternative transportation options to inform stakeholders

Annual AQI for 2019 and 2020 Denver CMSA

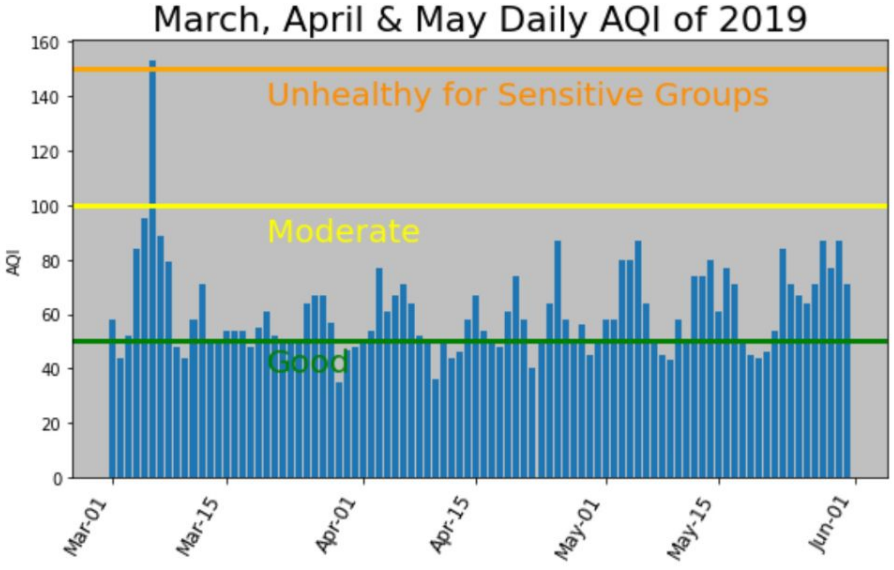


# of days above Good - 274 days
Average AQI- 64.8

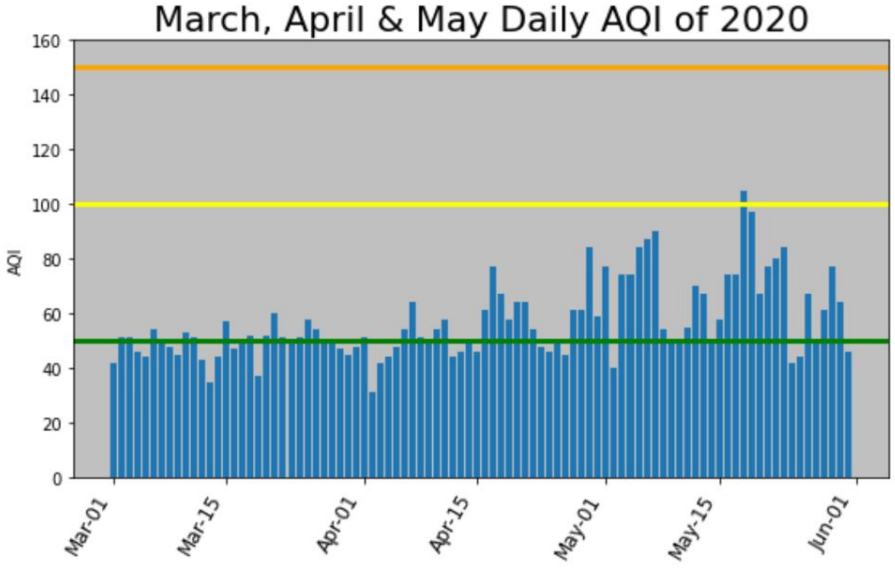


# of days above Good - 247 days
Average AQI- 65.5

March, April, May AQI for 2019 and 2020 Denver CMSA

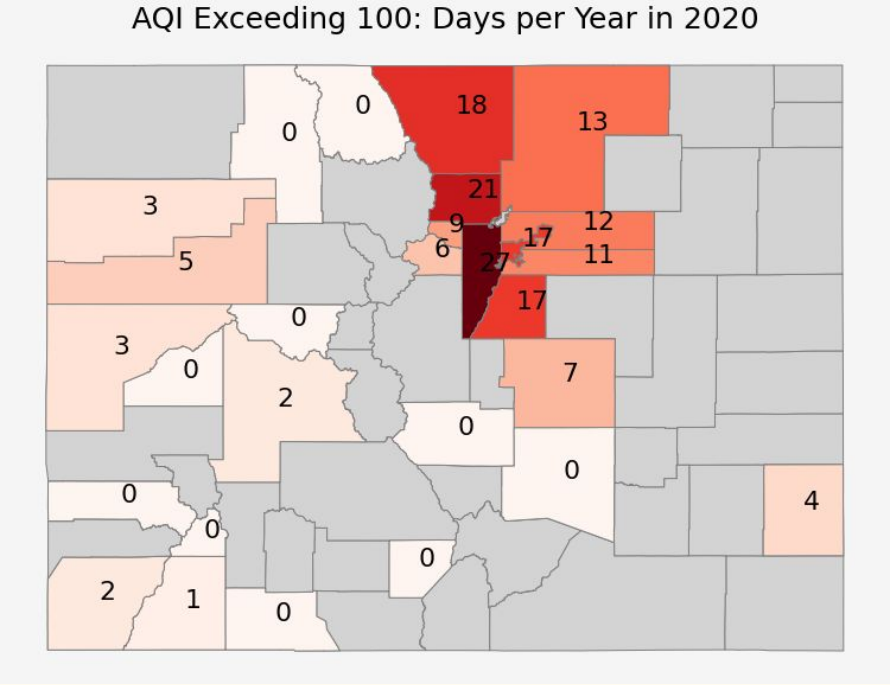


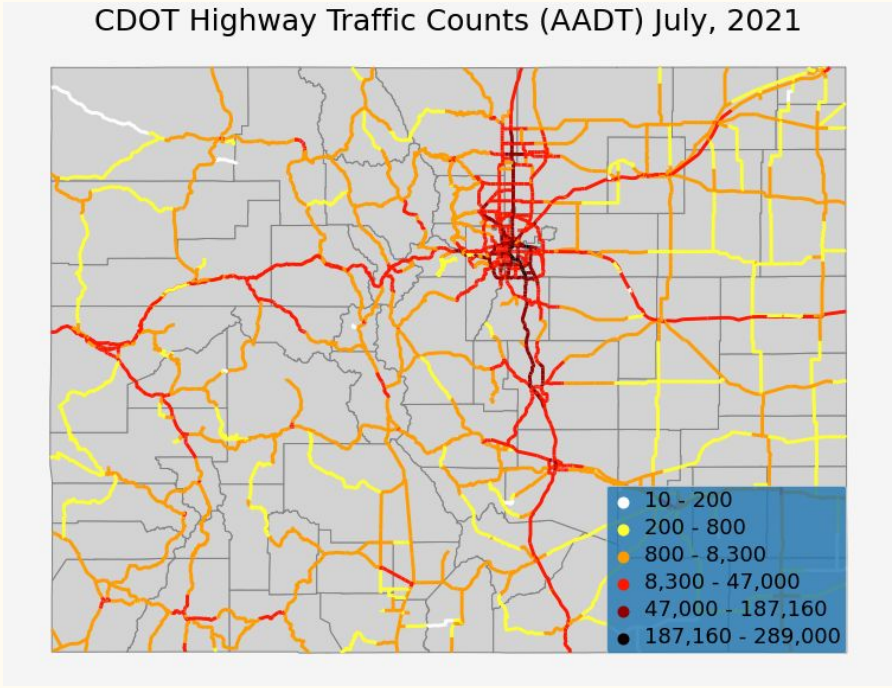
Number of days above Good
March-May: **66**



Number of days above Good
March-May: **53**

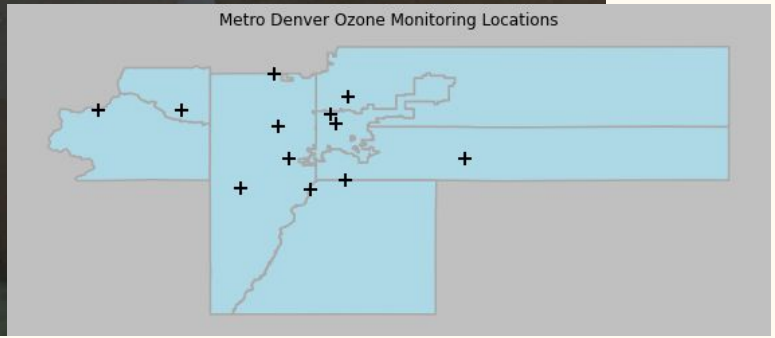
Urban vs. Rural Air Quality:





Criteria Pollutants: PM, NO2, Ozone

La Casa air monitoring station, Denver, Colorado
July 28, 2021, 7:45 pm, AQI 116

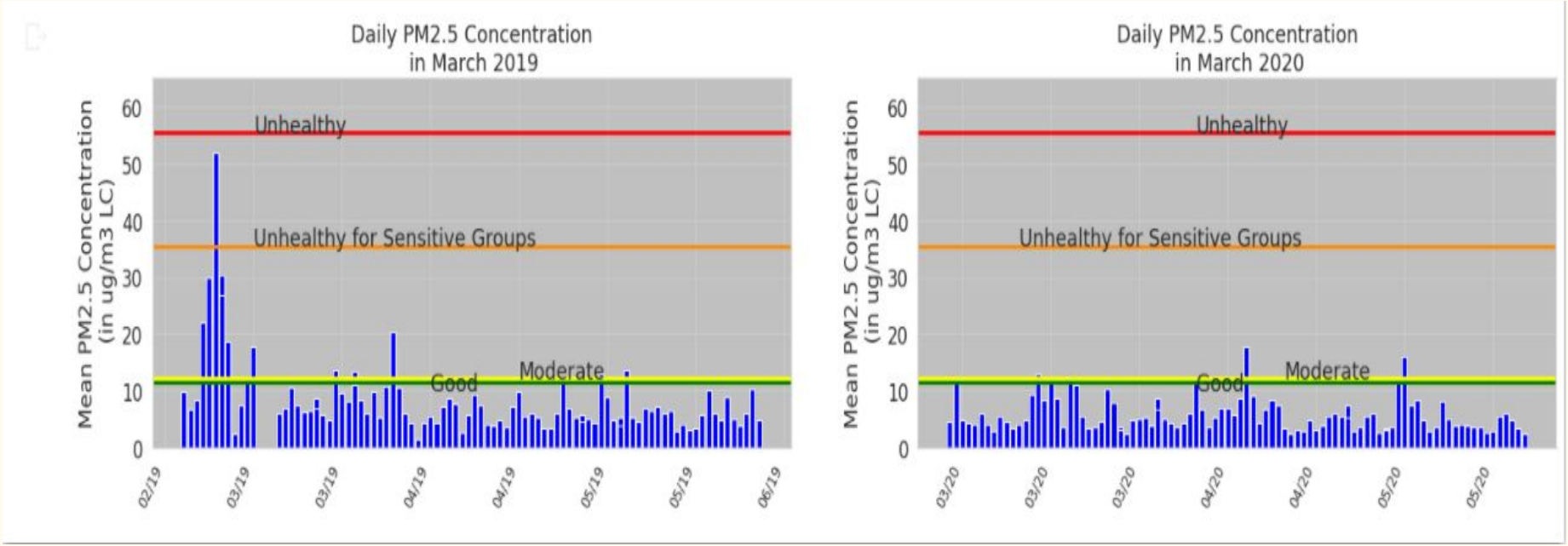


EPA online datasets available:

- Statewide
- Countywide
- Cities
- Stations
- Annual
- Monthly
- Weekly
- Daily

Particulate Matter (PM 2.5)

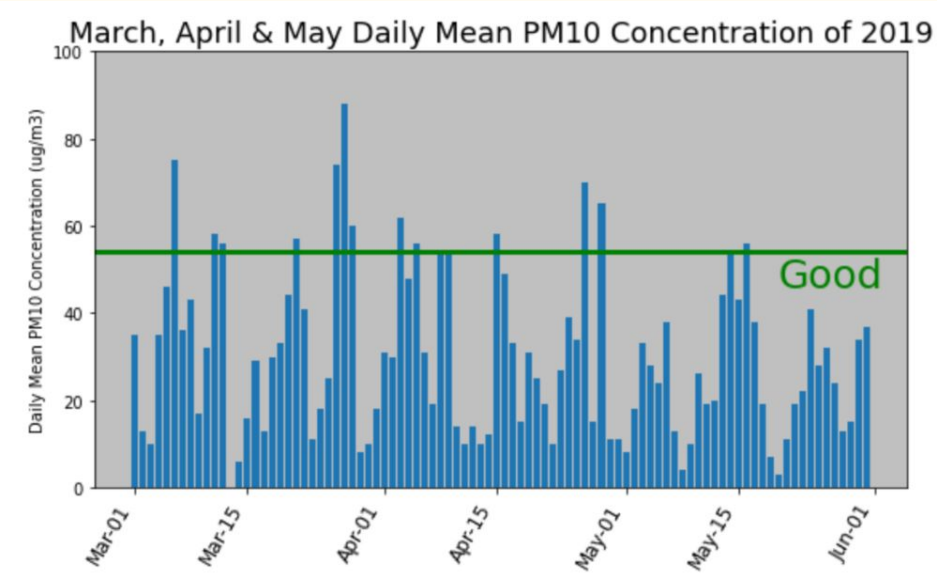
Sources: Gas and Diesel Emissions, Dust, Power Plant Emissions, Fires

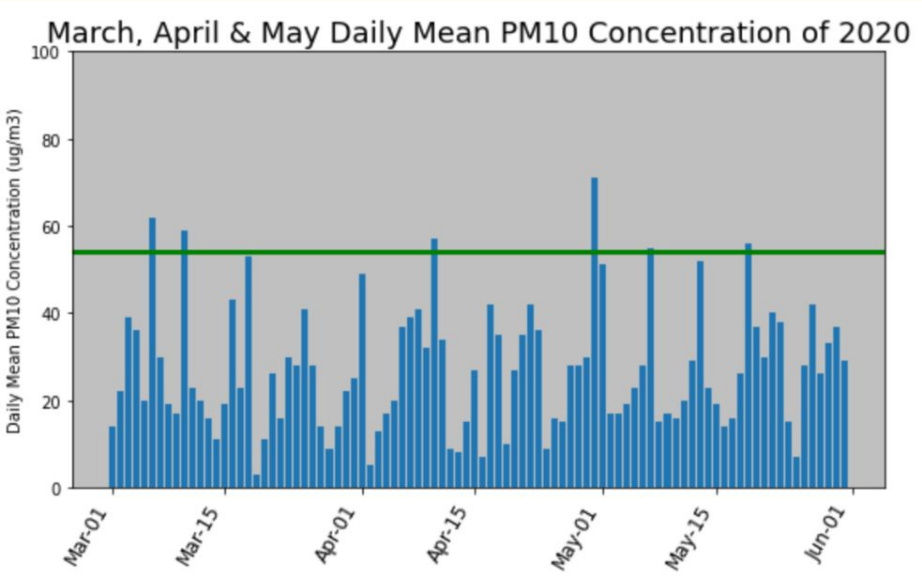


Number of days Moderate and above: 13

Number of days Moderate and above: 3

Particulate Matter 10 (PM 10)



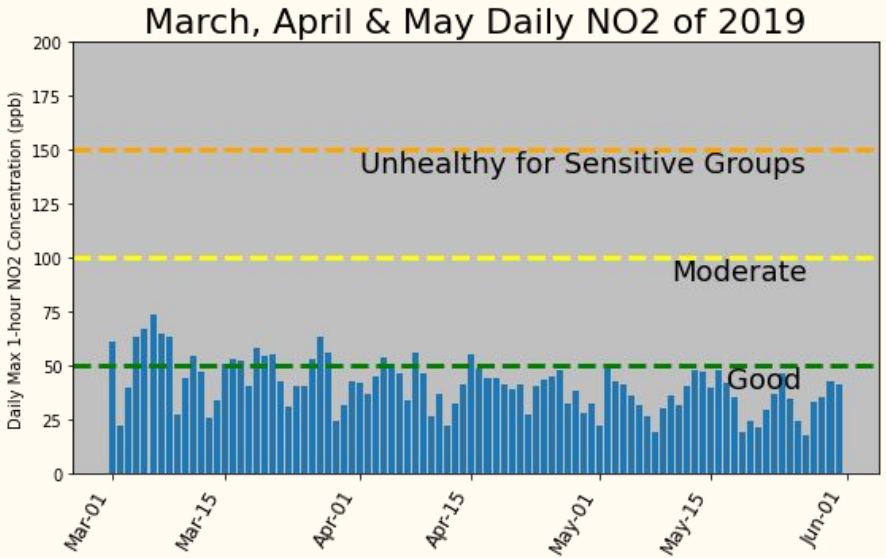


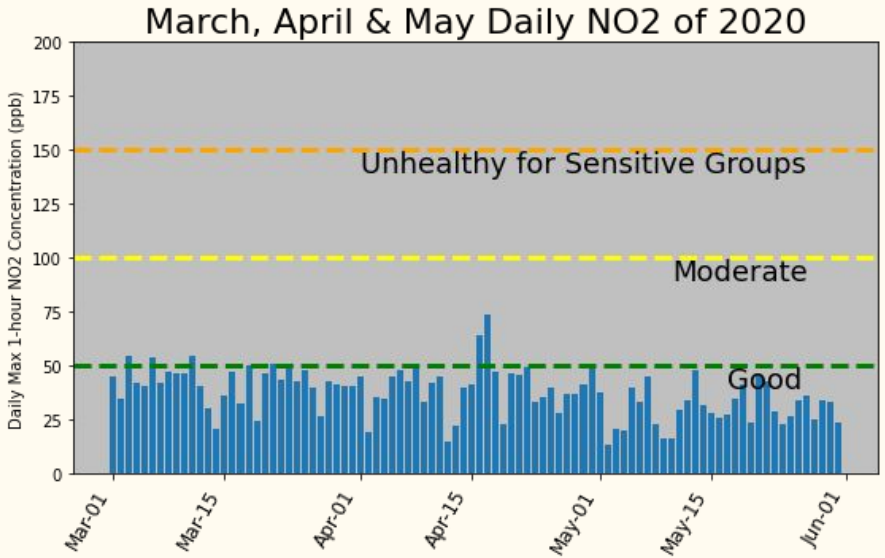
Number of days in Moderate - 14 days
Average: 25.6 ug/m3

Number of days in Moderate - 7 days
Average: 32.9 ug/m3

Nitrogen Dioxide:NO_2

Sources: Burning Fuels



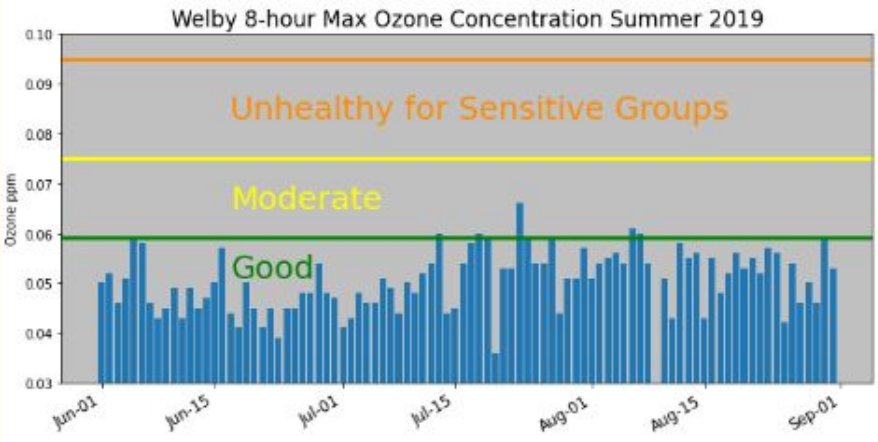


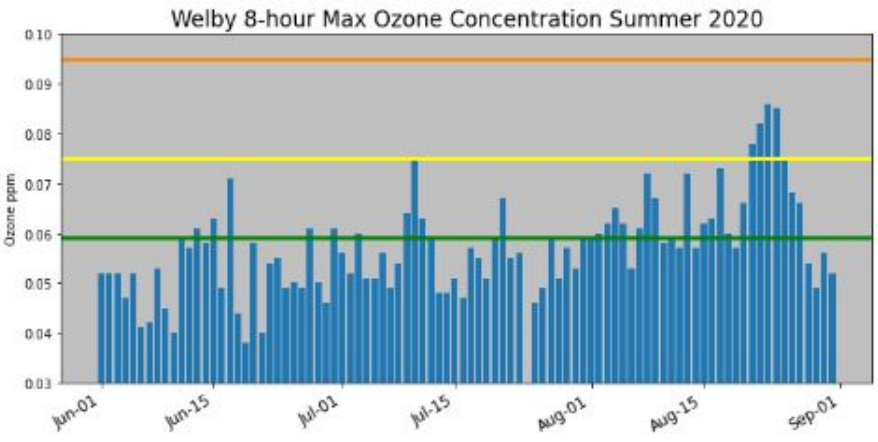
2019 average = ~29 ppb
2019 days above > 50 ppb = 42

2020 average = ~25 ppb
2020 days above> 50 ppb = 12

Ozone

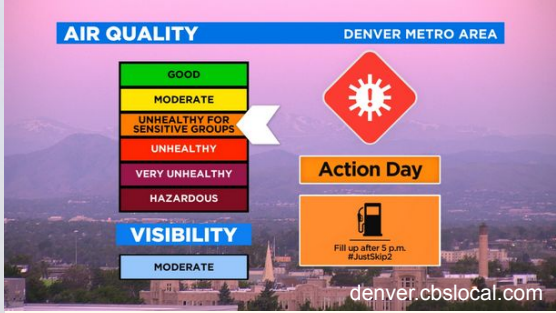
Sources: NO2 + VOCs + PM + Heat/Sun= Ozone





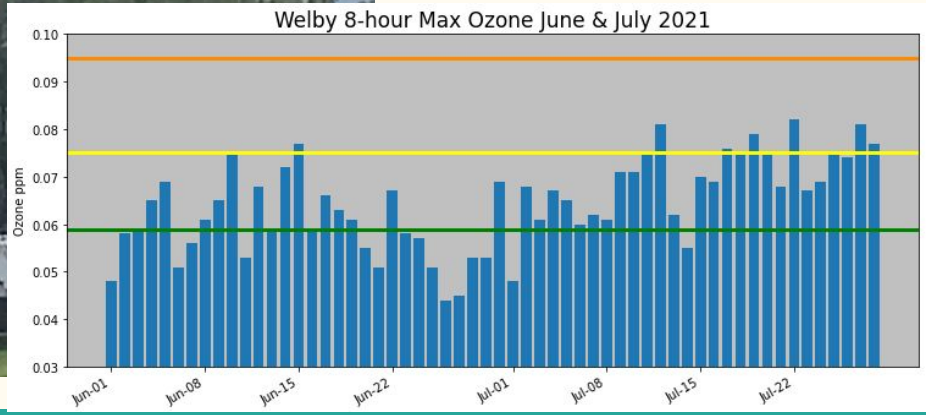
2019 Days above Good (0.059 ppm): 10
2019 Days above Moderate (0.075 ppm): 0
Average: 0.050 ppm

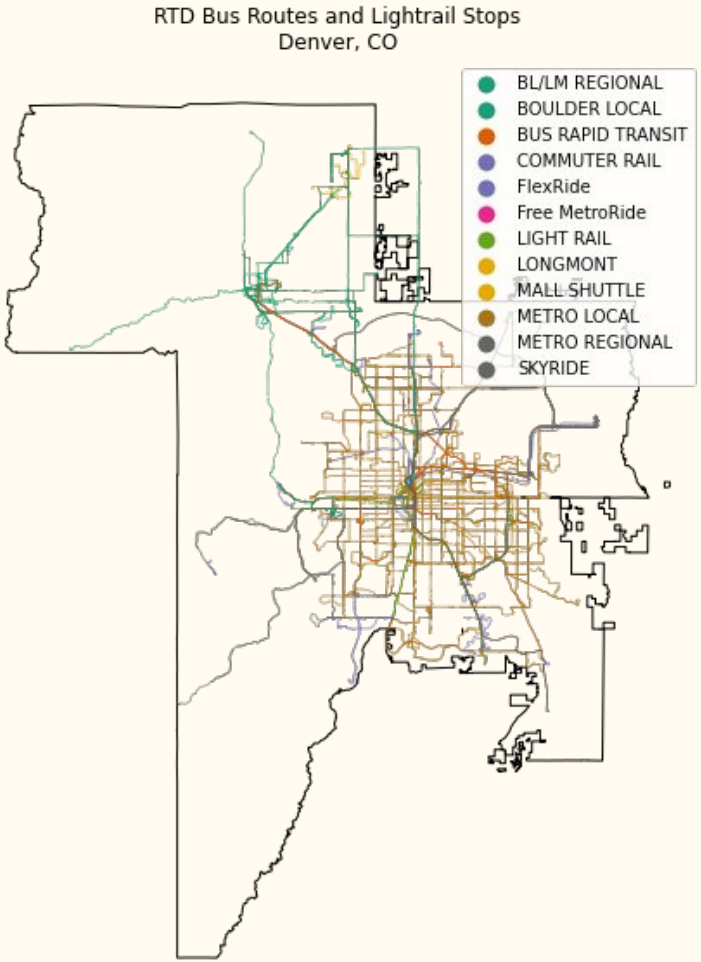
2020 Days above Good (0.059 ppm): 37
2020 Days above Moderate (0.075 ppm): 4
Average: 0.057 ppm



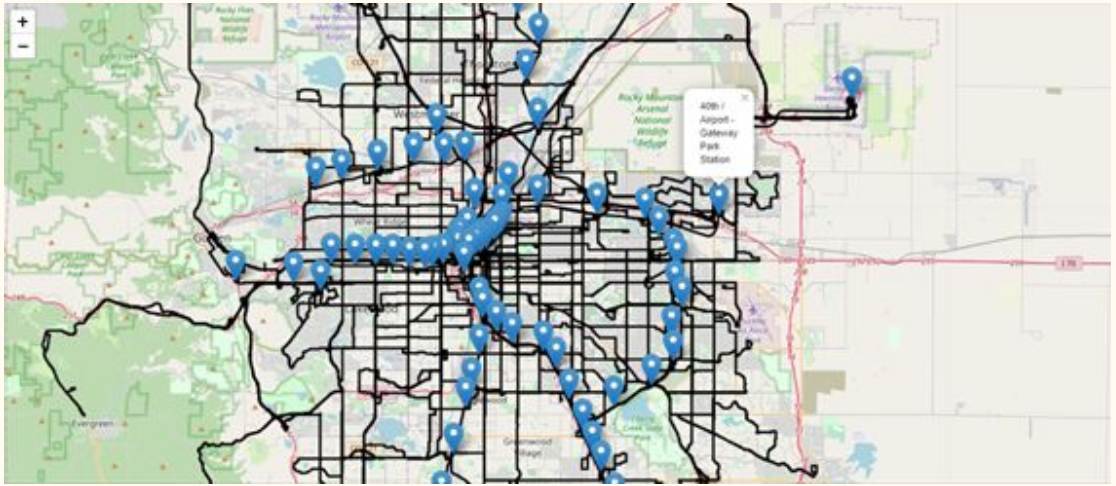
June and July 2021:

Days above Good: 42
Days above Moderate: 13
Average: .0643 ppm



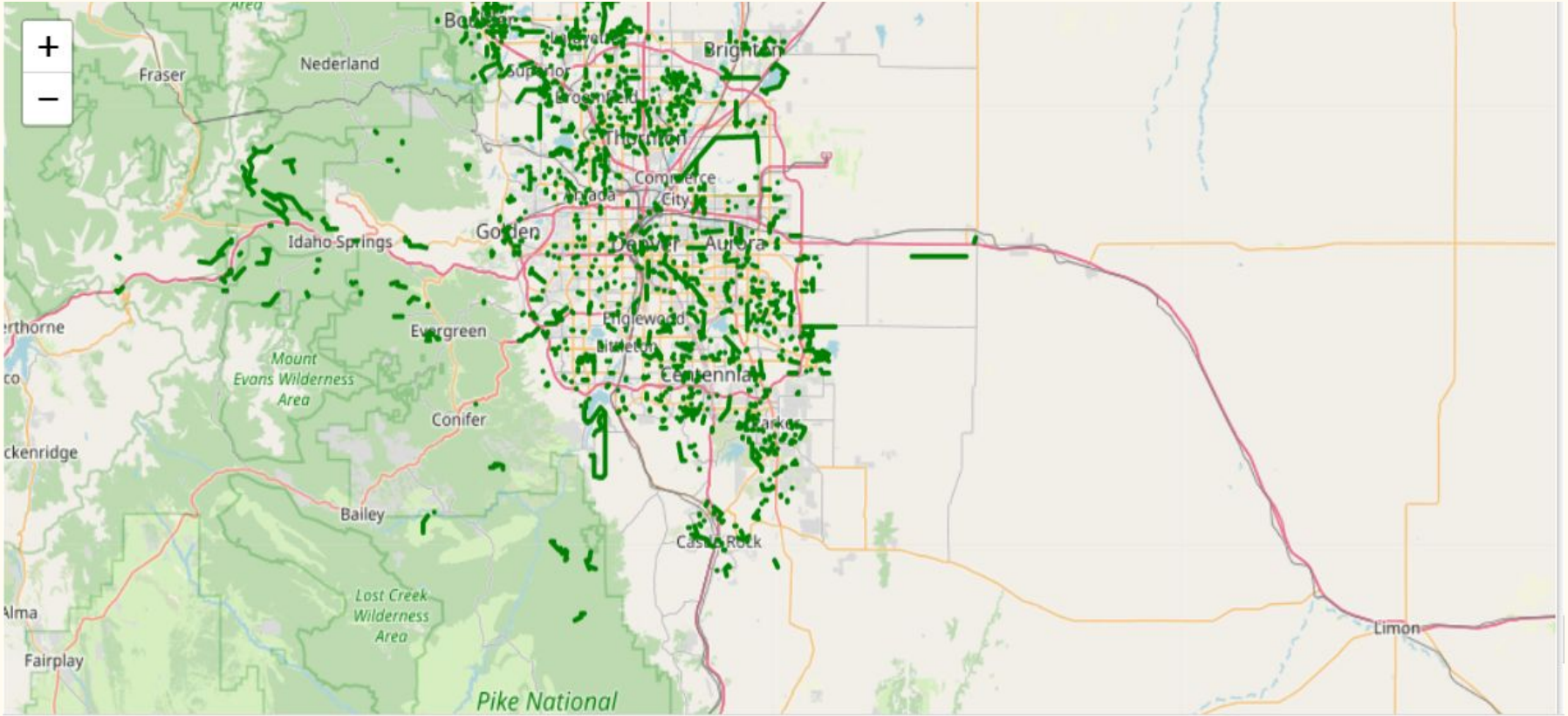


Alternative transportation map: light and commuter rail and bus



Interactive Folium Web Mapping

Bicycle Map of Trails and Facilities



Summary and Conclusions

	2019 Average	2020 Average	2019 number of days above “good”	2020 number of days above “good”	2021 number of days above “good”
Ozone for the year (summer)	0.050 ppm	0.057 ppm	**10**	**37**	**42**

	Number of days **March-May 2019** *Moderate or worse*	Number of days **March- May 2020** *Moderate or worse*
PM 2.5	**13 days**	**3 day**
PM 10	**14 days**	**7 days**
NO2	**42 days**	**12 days**

Future Research

Thank you!

Earth Lab staff

MSU Denver Earth and Atmospheric Sciences

Fellow students and faculty from UTTC, OLC, and CU Boulder

Sources

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https://www.bicyclecolorado.org/initiatives/abcs/