Wildfire and Ozone

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Wildfire

Analysis Day: 20200819
Map Generated: 1155 GMT 20200820
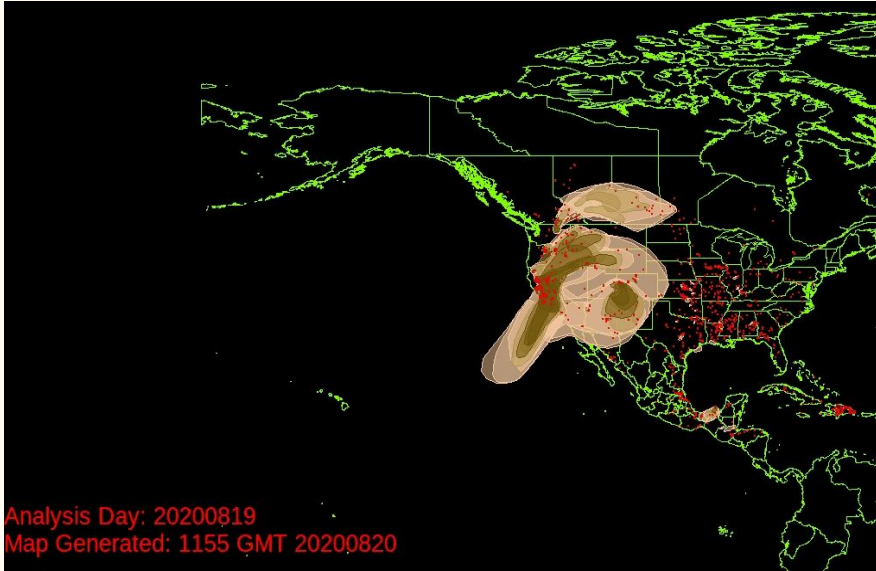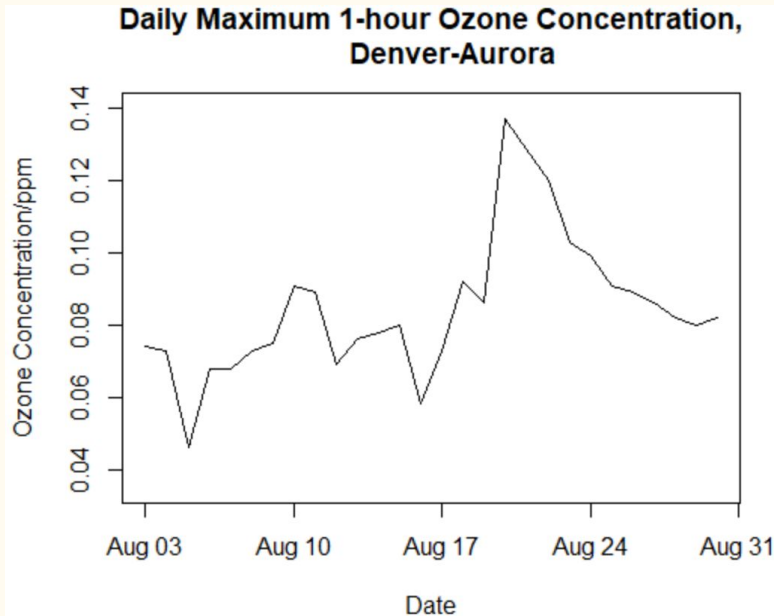
- Smoke detected by HMS(Hazard Mapping System), Aug.19-Aug.23

- Smoke is transported to the east
  ↓
- The pollutants are also transported?

- Ozone

https://satepsanone.nesdis.noaa.gov/FIRE/fire.html

Worse?

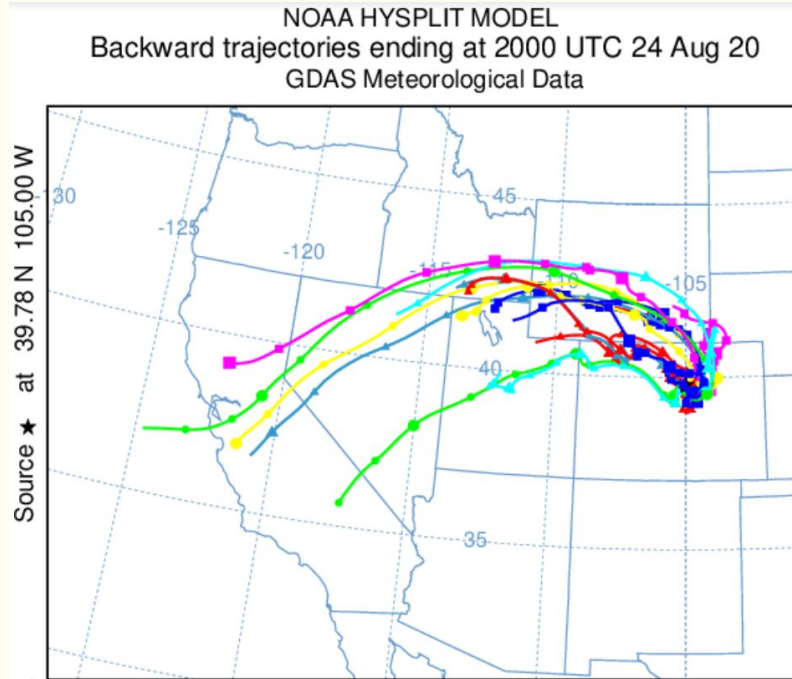Daily Maximum 1-hour Ozone Concentration, Denver-Aurora

- Denver: the 10th most-polluted city by ozone[1].

- Yes, worse indeed. Ozone level is elevated when the smoke permeated.

Does the ozone come from California rather than local events?

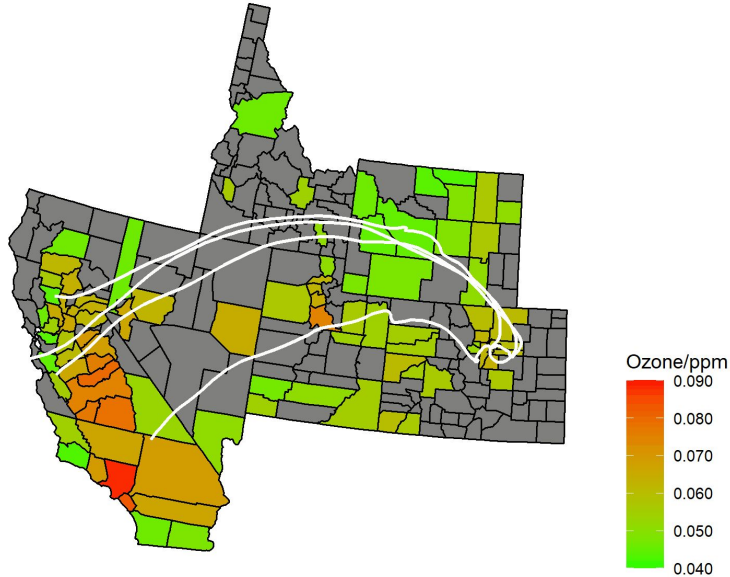1. Cities in California take up 8 of the top 10.
    https://www.stateoftheair.org/city-rankings/most-polluted-cities.html

HYSPLIT trajectories

NOAA HYSPLIT MODEL
Backward trajectories ending at 2000 UTC 24 Aug 20
GDAS Meteorological Data

- The Hybrid Single-Particle Lagrangian Integrated Trajectory model
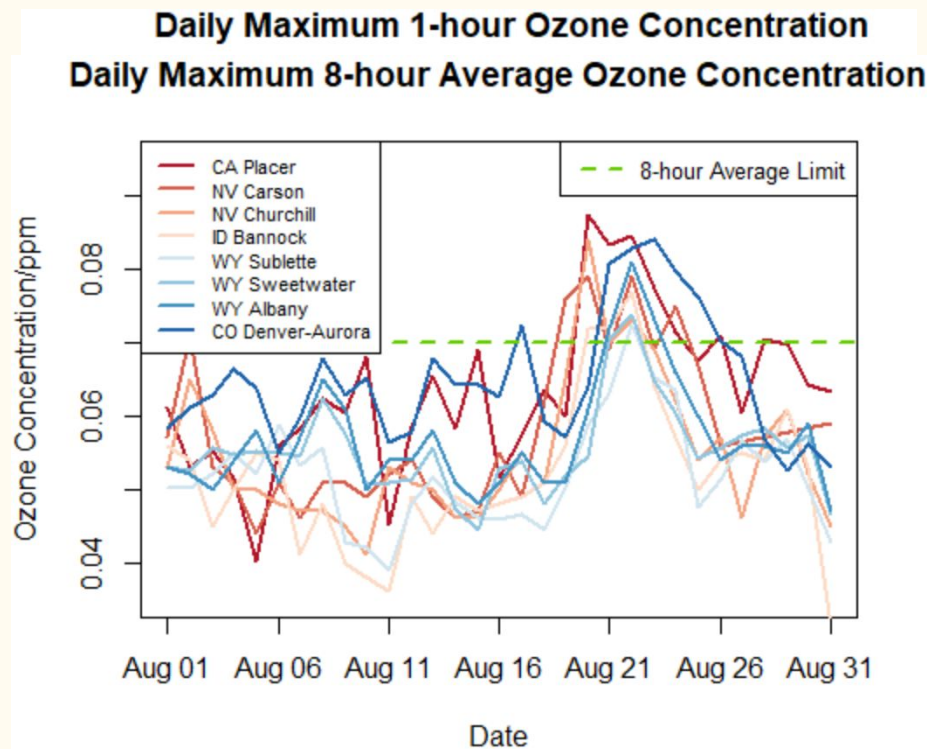- Backward model
- Trace back to California

https://www.ready.noaa.gov/hypub-bin/trajtype.pl?runtype=archive
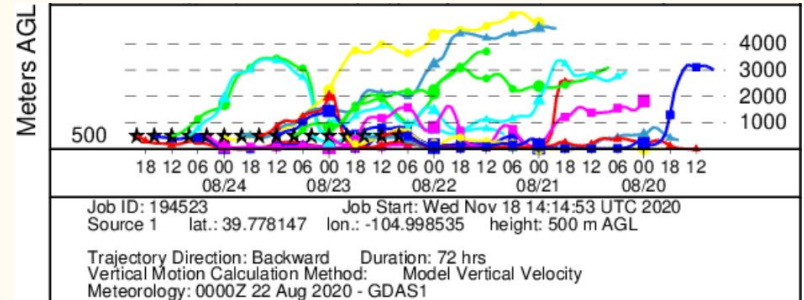
HYSPLIT trajectories

Ozone Concentration During August Wildfire
08/19/2020

Ozone/ppm
- 0.090
- 0.080
- 0.070
- 0.060
- 0.050
- 0.040

- Aug.19 - Aug.24
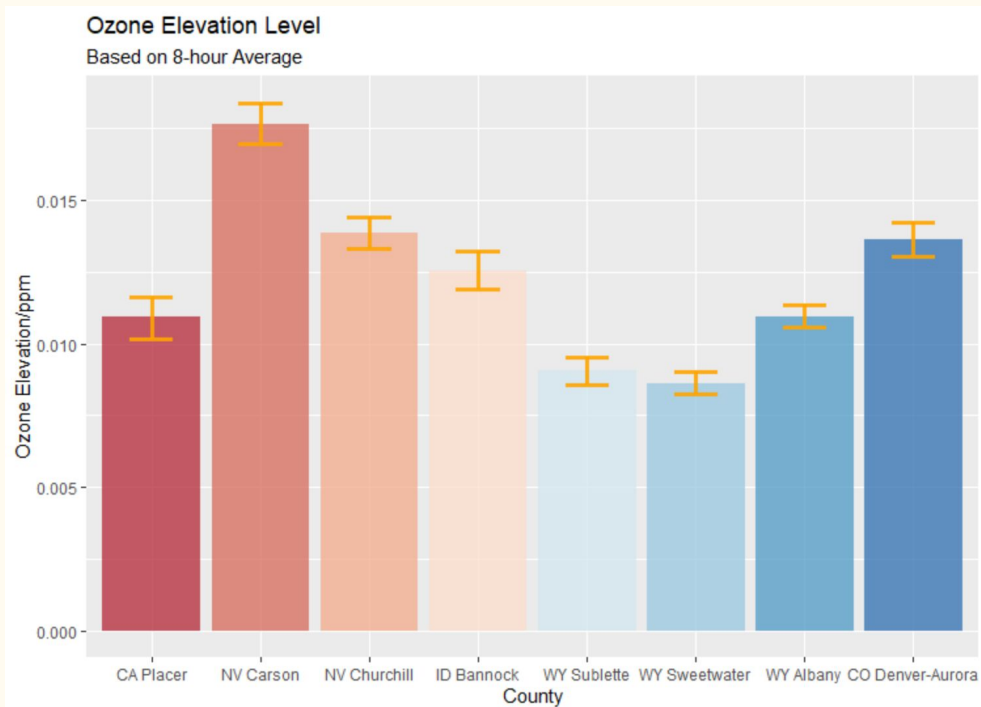- Ozone spread along the trajectories from California to the east

Coincident Peaks in Different Counties

- Along the trajectories
- Exceed the standard
  - 1-hour
  - 8-hour average

Coincident Peaks in Different Counties

——quantitative analysis

Ozone Elevation Level
Based on 8-hour Average

- Get CI from bootstrap
- Ozone and precursors were diluted
- Upswing

Even the ozone comes from California, how do you know for sure it comes from wildfires rather than other pollution sources?
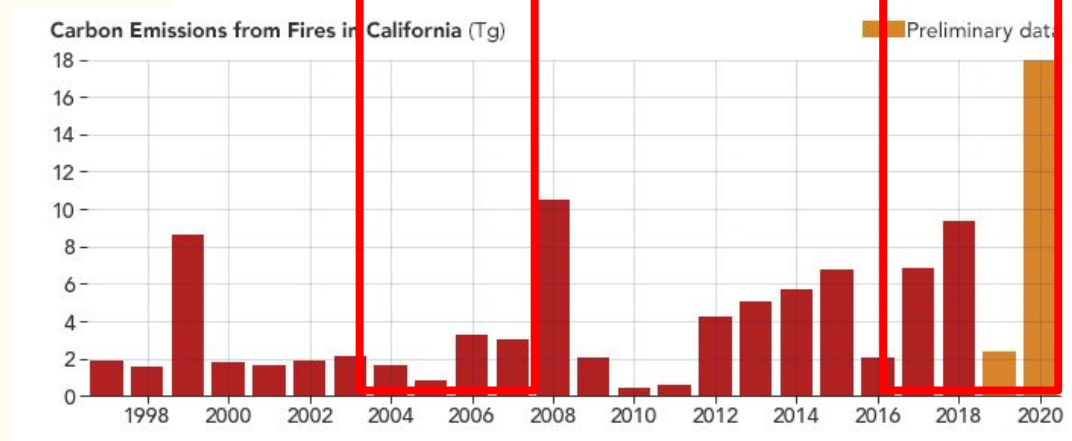
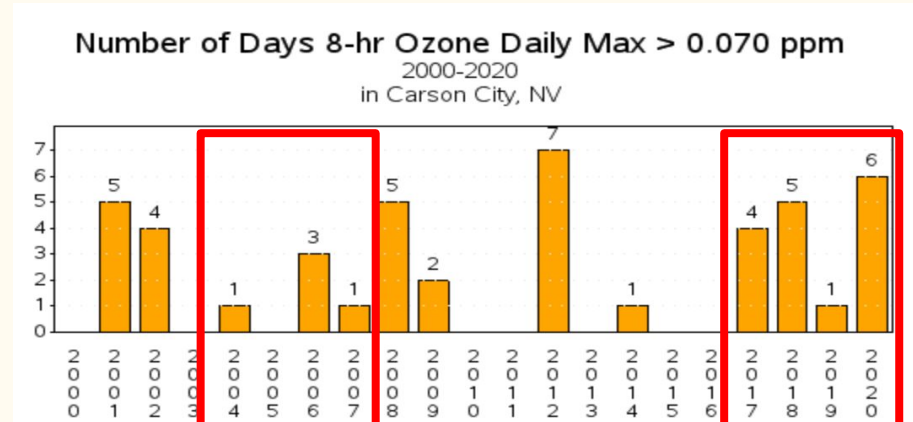We don't know.[1]
But we can speculate.[2]
(And doubt!)

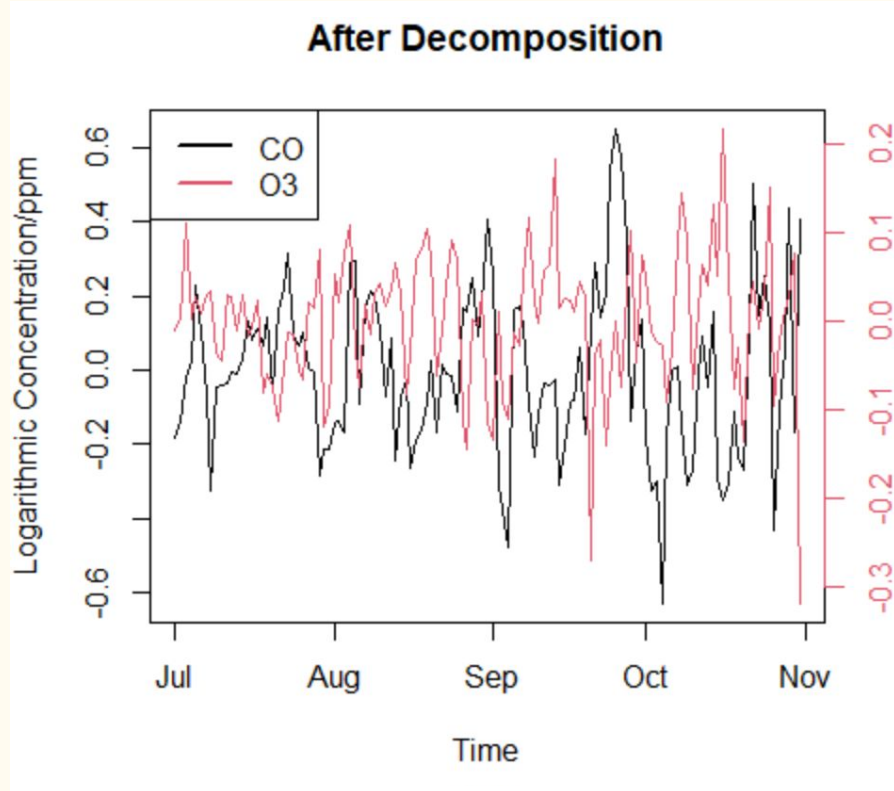1. Physically and chemically.
2. Statistically.

Detrending & t-test

- Numbers of days when ozone exceeds the standard in Carson City, NV ~ carbon emissions from fires in California
- Coincident trend
- Compare the p-value of t-test

Number of Days 8-hr Ozone Daily Max > 0.070 ppm
2000-2020
in Carson City, NV

Carbon Emissions from Fires in California (Tg)

Detrending & t-test

After Decomposition

- Aim: analyze the correlation of O3 and CO
- Obstacle: doomed to be negative correlation because of seasonal trend
- Solution: use loess to detrend the data, then do the regression using residuals

Detrending & t-test

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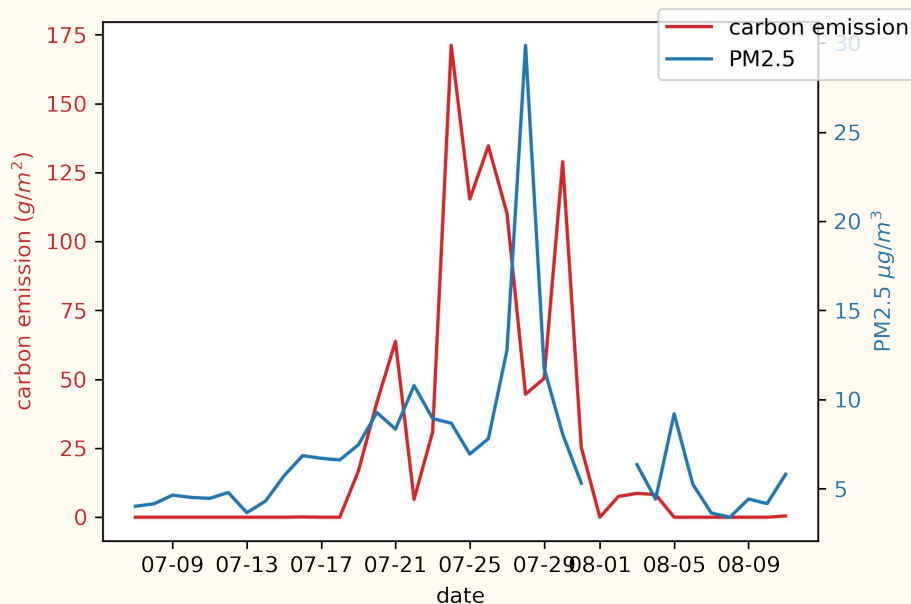
Time series analysis

time = 2020-08-01
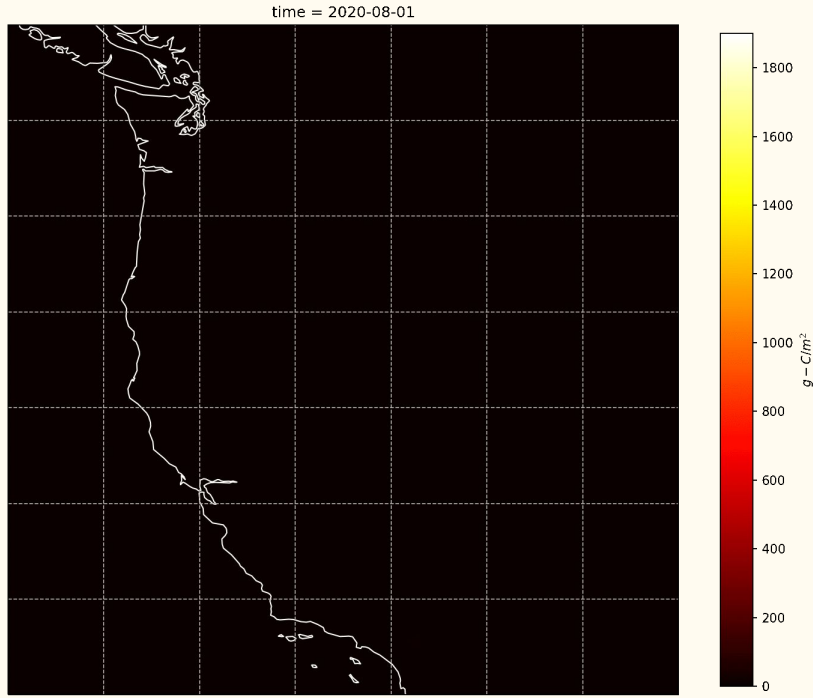
2020 California Wildfire - Carbon emission

GFED4s

- Monthly carbon emission from wildfires
- 0.625x0.625 grid
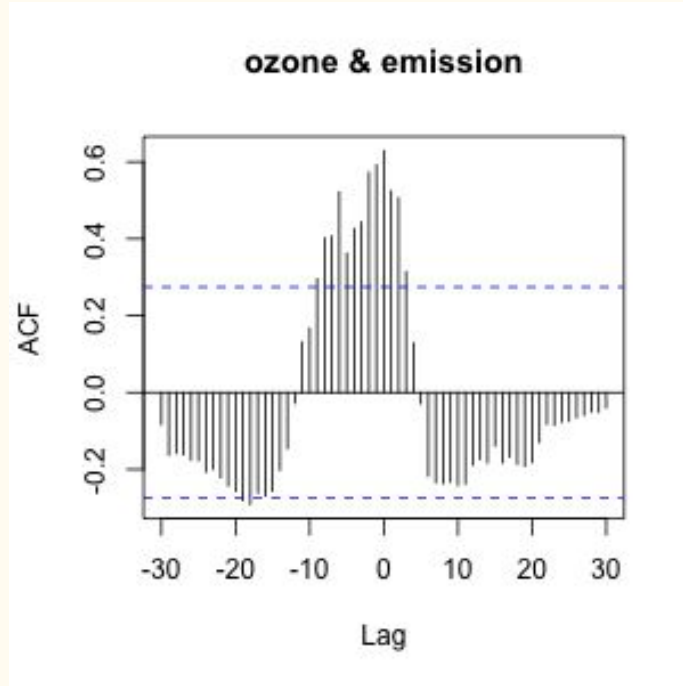- High correlation with HMS (Brey et al.)

Time series analysis

Compare carbon emission from GFED and contaminant level from OpenAQ

- Does contaminant level follow the amount of emission?
- Grid of 2.5x2.5, aggregate emission and contaminant level in that grid
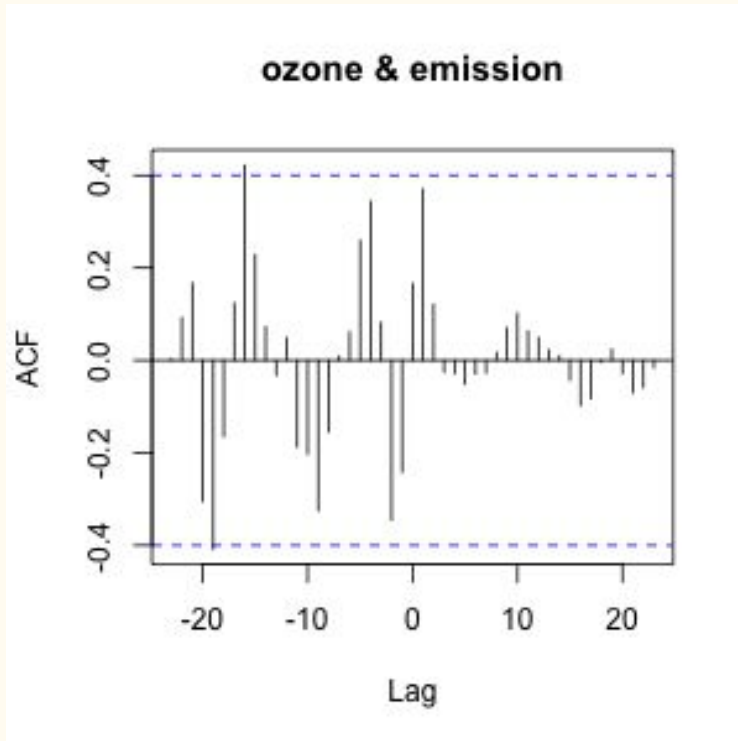- Focus on long fire events
- Use CCF to analyze

Time series analysis

ozone & emission

Does GFED follow OpenAQ dataset?

- Comparison between carbon emission and PM2.5
- Have a significant ACF at lag = 0-3 → carbon emission is likely to have direct and immediate effects on the PM2.5 levels in the adjacent areas
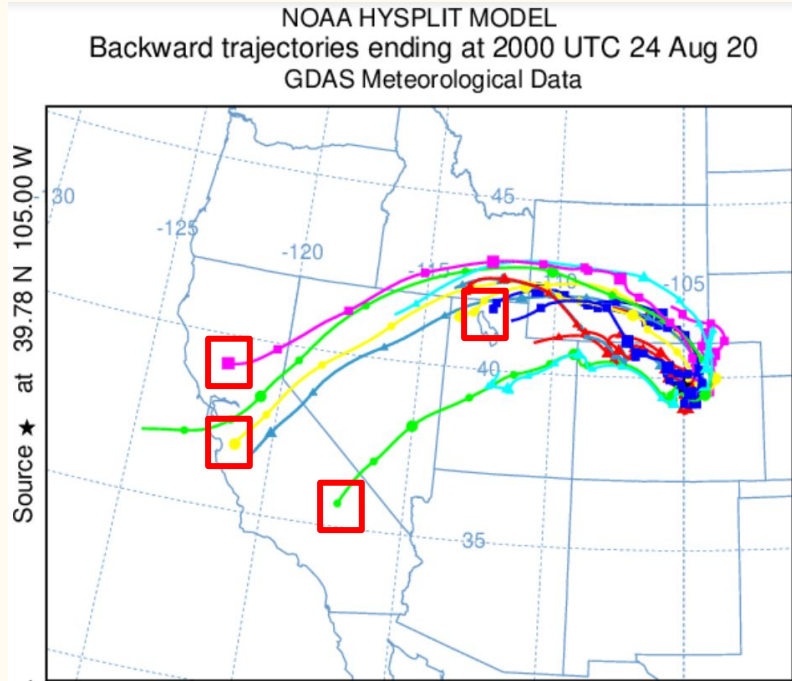
Time series analysis

ozone & emission

Ozone does not seem to correlate well with the emission

- Have different behavior from PM2.5?

Time series analysis

NOAA HYSPLIT MODEL
Backward trajectories ending at 2000 UTC 24 Aug 20
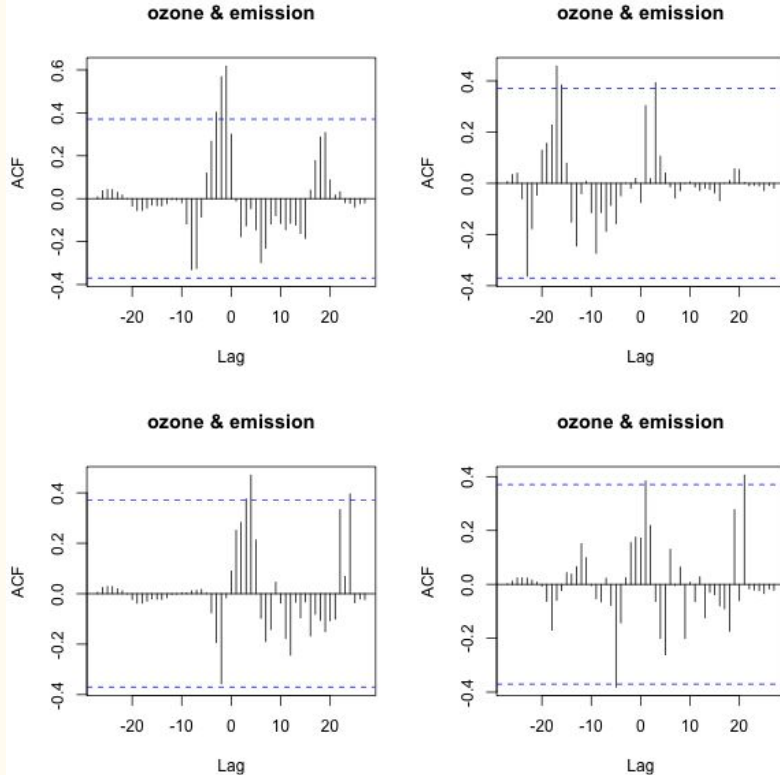GDAS Meteorological Data

Based on the HYSPLIT trajectory, analyze the emission and the ozone level from different regions

- 2.5x2.5 grids in California vs. Denver-aurora

Time series analysis

- Areas shown in the HYSPLIT affected ozone level in Denver-Aurora
- Carbon emission seem to affect ozone level with 0-5-days lag

Time series analysis

Conclusion from time series analysis

- While PM2.5 seem to be directly affected by carbon emission from wildfire, the effect on the ozone levels is more obscure and delayed
- Unlike PM2.5, ozone is not directly produced from the smoke plume → transportation might be a key

Q&A