Satellite sensors

TROPOMI

OMPS

VIIRS

The Impact of COVID-19 Shutdown on Particulate Pollution: Analysis of Satellite and Ground Observations

Hai Zhang[1], Shobha Kondragunta[2], Zigang Wei[1]

[1]IMSG at NOAA

[2] NOAA/NESDIS

Introduction

- COVID-19 related lockdown measures led to a decrease in emissions, specifically from transportation sector due to reduced mobility
  - ➢ We investigated the impact on particulate pollution using Suomi NPP VIIRS aerosol optical depth (AOD)
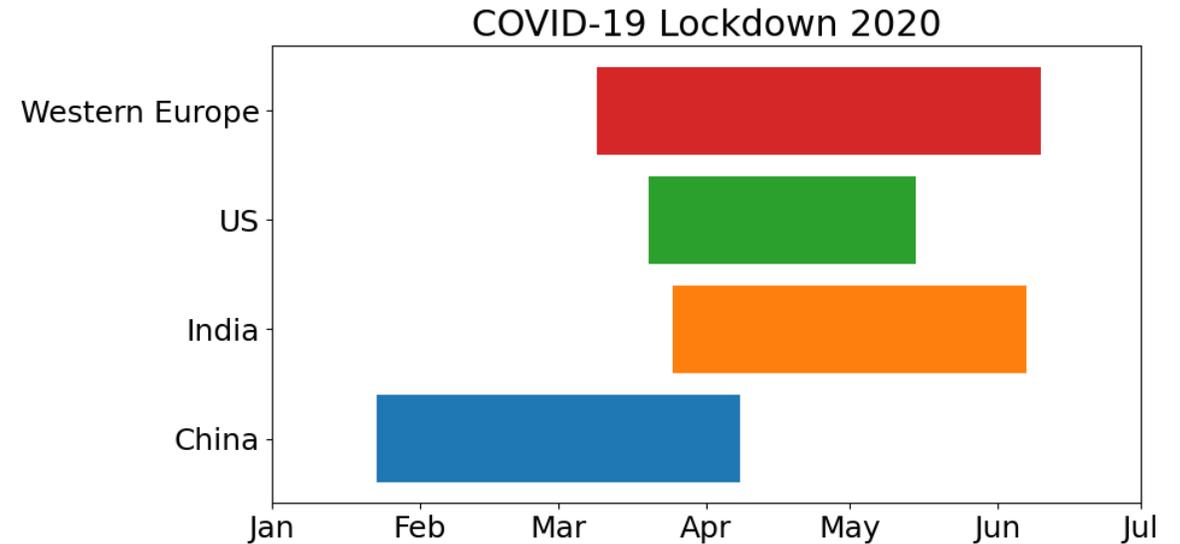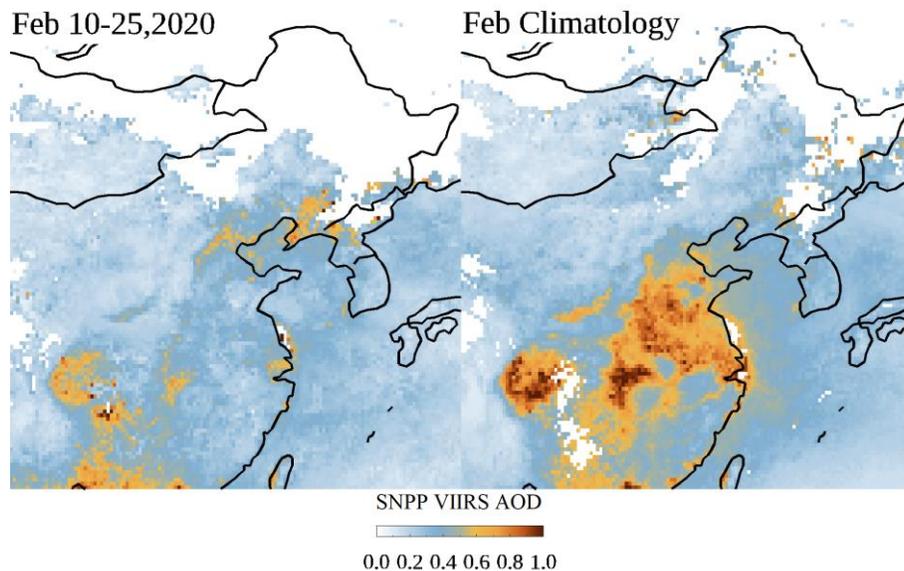
Source: Wikipedia

Disclaimer: trends and seasonality not removed from the data

How to quantify the impact of lockdown measures on AOD changes?

- Most regions that went into lockdown had reduced mobility/traffic emissions, one of the primary source sector for NOx

- Lower AODs in 2020 due to lower emissions but what about the role of transported smoke, dust, and local/regional sulfate aerosols? **How do we extract the signal (reductions in AOD) from anthropogenic emissions changes from natural emissions?**

Aerosol Sources

NO_2	$\rightarrow$	NO_3^-
SO_2	$\rightarrow$	SO_4^{2-}
VOCs	$\rightarrow$	SOA
		Primary particulates
		Transported smoke
		Transported dust

Approach 1	Approach 2
Demonstrated that AOD and NO_2 are correlated and if they correlate well assumption is that source sector is the same*	
• Background NO_2 is 12 µmoles/m^2	• Background NO_2 is 12 µmoles/m^2
• High NO2 and high AOD implies urban/industrial pollution	• NO2 and AOD co-increase or co-decrease if source sector is the same
• Low NO2 and high AOD implies source is transported aerosol	• Filter: $|\Delta NO2| > 5$ µmoles/m^2 and AOD increases or decreases in the same direction
• Filter: NO_2/AOD > 200	

* Wei et al. poster [A005-0026 Correlating Economic Activity Indicators and Tropospheric Column Nitrogen Dioxide during COVID-19 Pandemic in the United States](#)

Approach 1 to filter AOD using NO$_2$
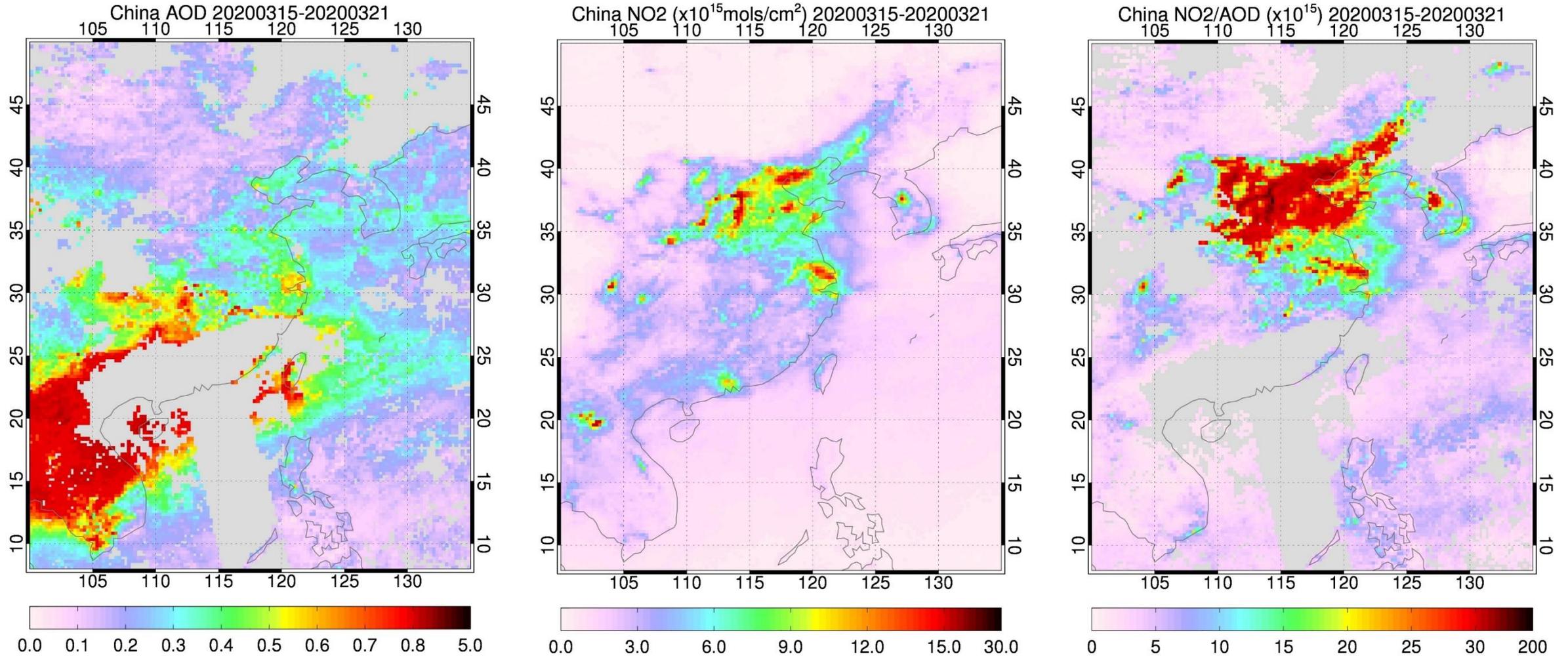
- As China's shutdown continued in March, transport of aerosols (smoke) from Vietnam, Cambodia, northern India dominated in Southern China (left panel)
- Tropospheric NO$_2$ column shows very little pollution in southern China; no local emissions (middle panel)
- Doing NO$_2$/AOD ratio helps isolating aerosols locally generated vs. transported (right panel)

Approach 2 to filter AOD using NO$_2$

February 10-February 25, 2020-2019 AOD Difference

Feb 10-Feb 25, 2020-2019 NO$_2$ Difference ($\mu mol/m^2$)
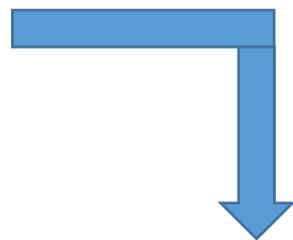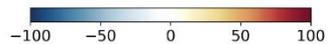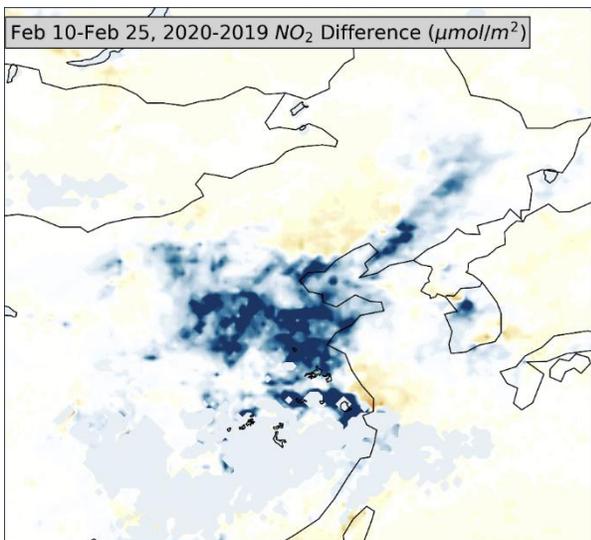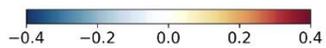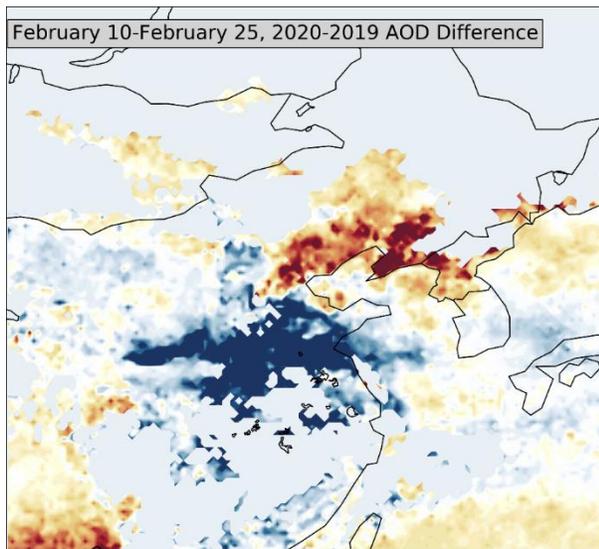
Use NO$_2$ to filter AOD data
- NO$_2$ > 12 μmoles/m^2
- ΔNO$_2$ > 5 μmoles/m^2 with criteria that both AOD and NO$_2$ should either co-increase or co-decrease

Filtered   41% decrease
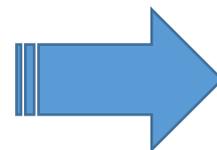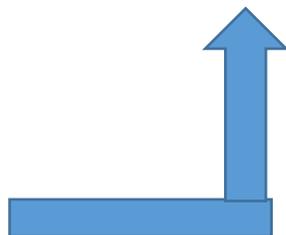
February 10-February 25, 2020-2019 AOD Difference
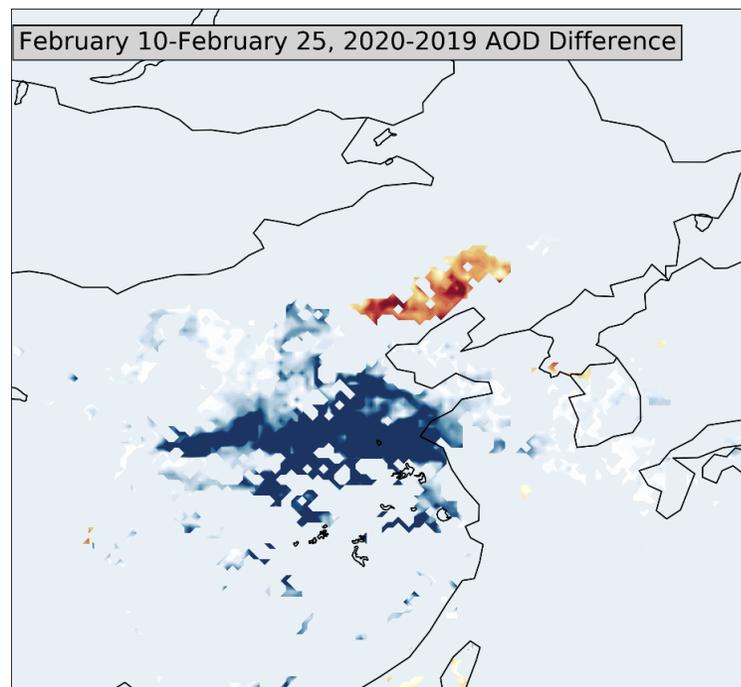
Capture AOD changes when source sector for aerosols/aerosol precursors and NO$_2$ are the same

# Impact of COVID-19 Lockdown Measures on AOD

35% decrease
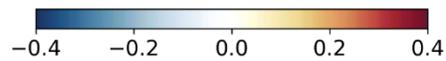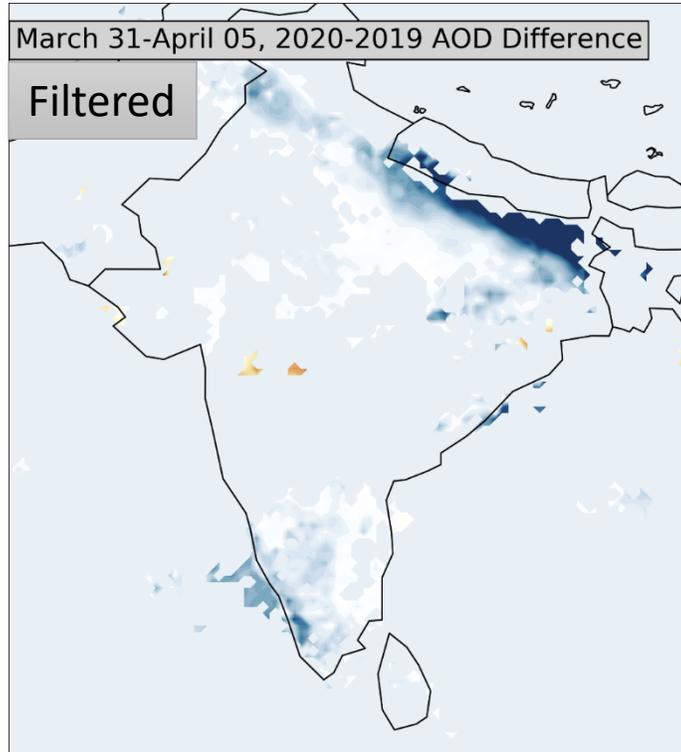
20% decrease
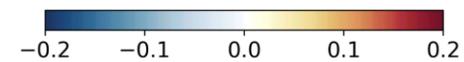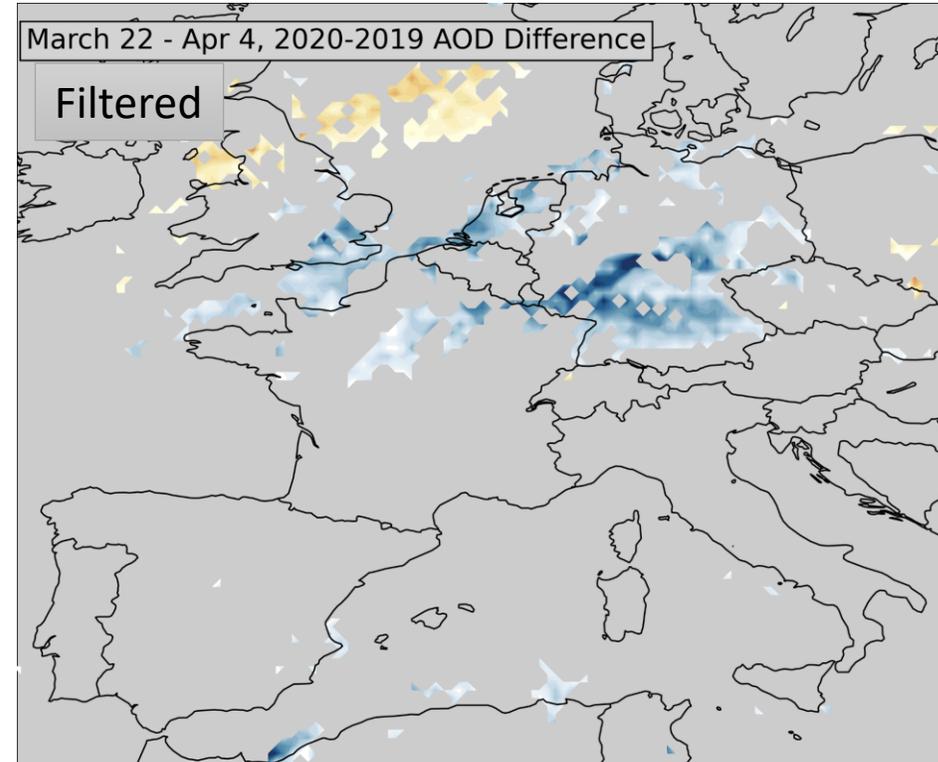
Changes in AOD significant and have implications for developing abatement strategies in polluted regions

# COVID-19 Lockdown Impact: VIIRS AOD Change in US

14% decrease

March 01-31,2019

March 01-31,2020

SNPP VIIRS AOD
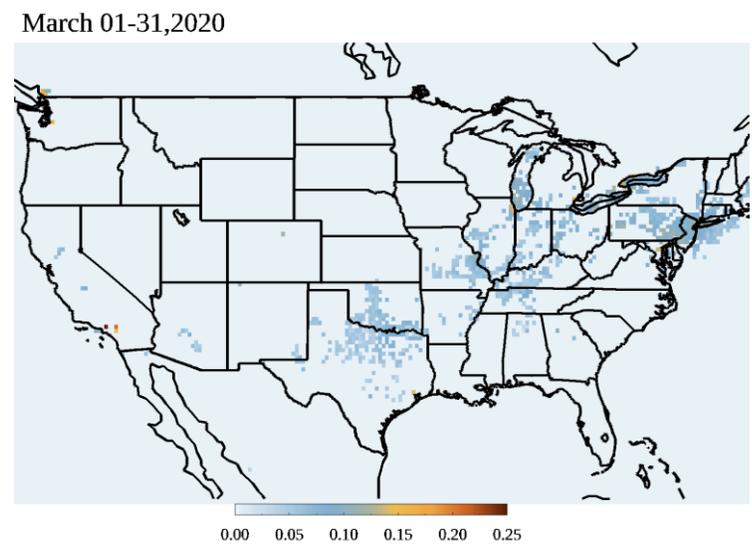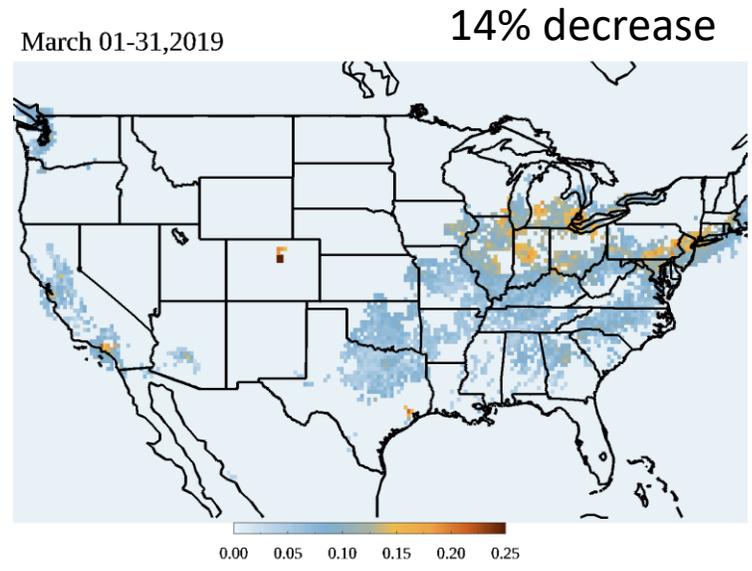
Reductions in Surface PM2.5 (2020-2019)

Washington DC
Chicago
Los Angeles

Feb   Mar   Apr
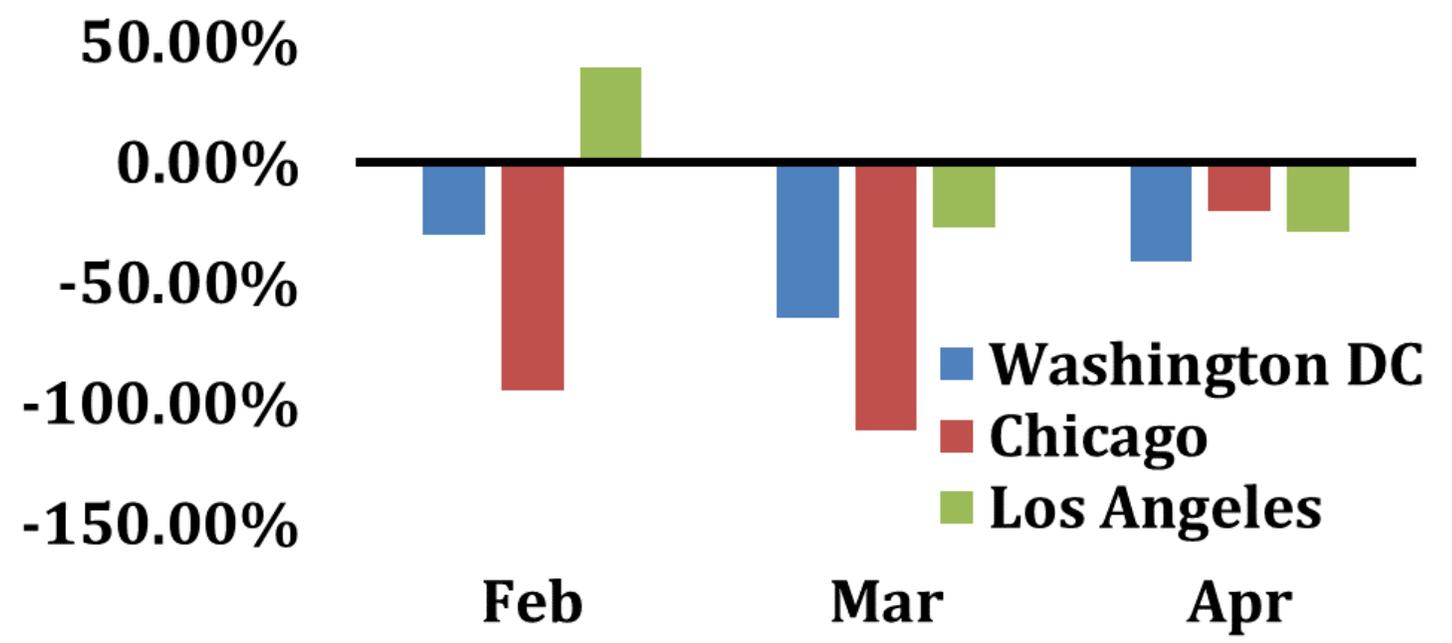
Used another filter used NO_2/AOD ratio (>400)

Conclusions

- Investigated methods to filter AOD using NO_2 data to tease out aerosol signal from urban/industrial sources
  - ➤ Refining thresholds to find a better solution
  - ➤ Need to remove seasonality and trends in data
- Reductions in AOD are observed over polluted areas in China, India, and western Europe due to COVID-19 lockdown measures
  - ➤ In CONUS, AODs are low and no significant reduction of AOD is observed. These results are in agreement with findings from other researchers

TROPOMI Background

Legend: CONUS, China, W. Europe, India, Africa
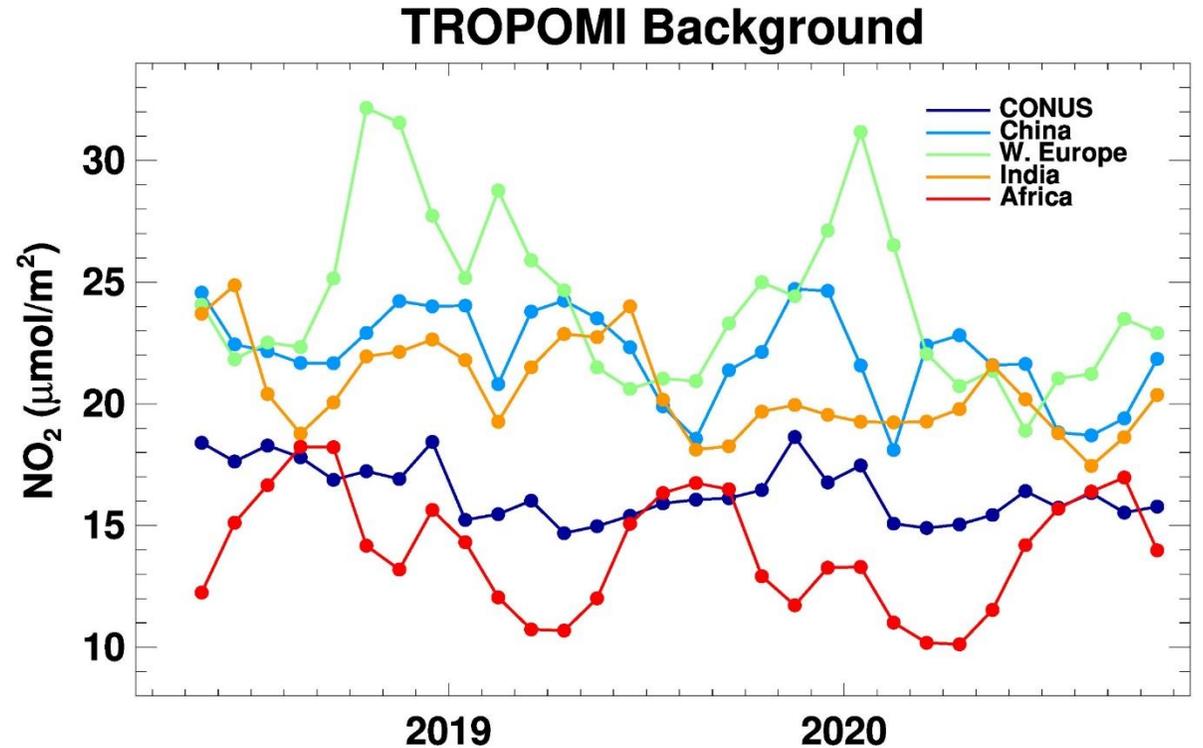
We started with a 12 μmoles/m^2 for background NO_2 in our work. Our analysis shows it varies by season and region.