Atmospheric Aerosol's Response to the Slowdown in Human Activities Due to COVID-19

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Hypothesis

The sources of atmospheric aerosols are both anthropogenic and natural. Globally, as a results of COVID-19, anthropogenic activities have been either on halt or limited. Therefore, we expect to see change in atmospheric loading of aerosols at different spatial and temporal scales.

In this analysis, we use satellite observations of aerosols to understand these changes.

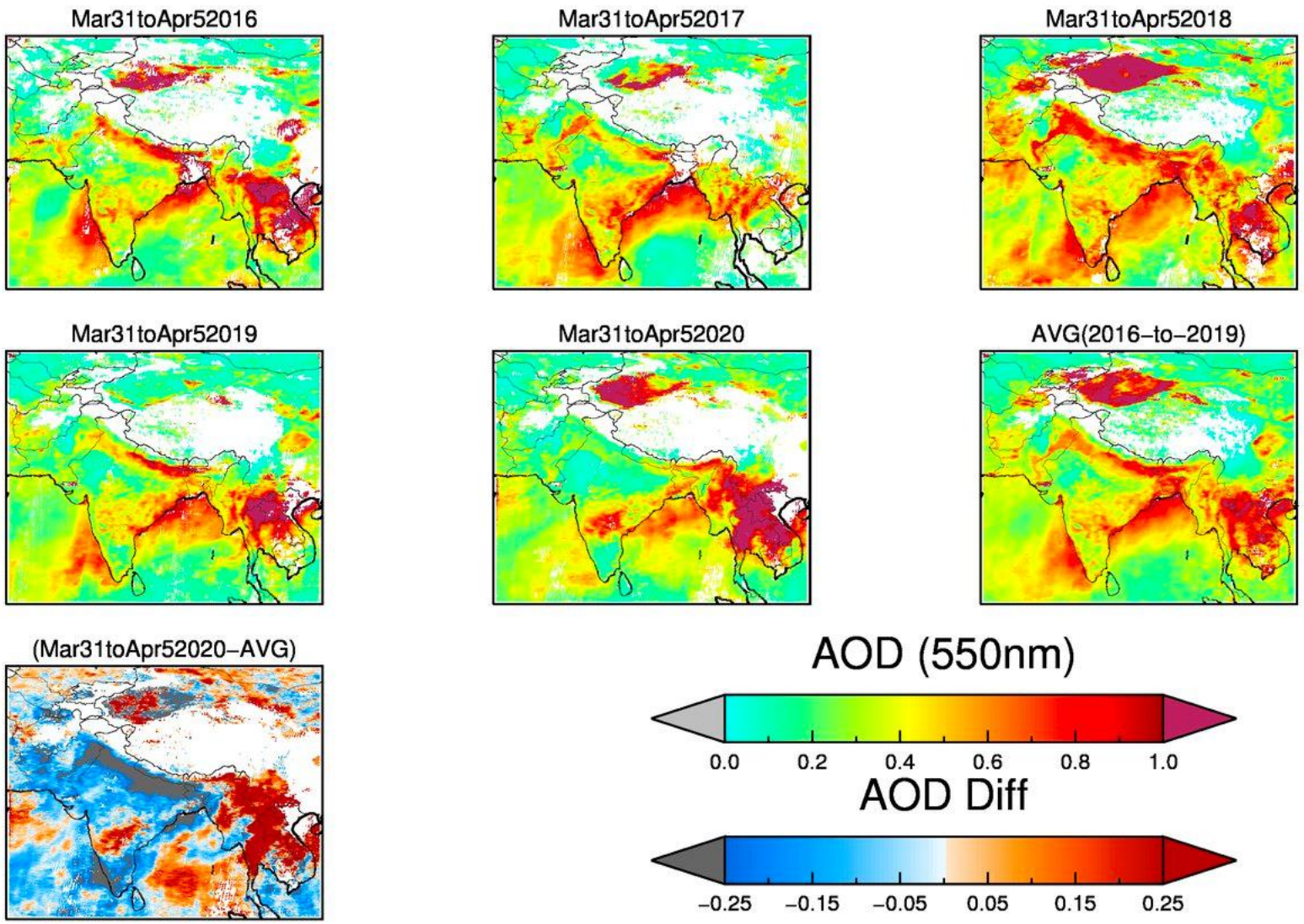
Cautions:

- Although anthropogenic activities have been limited but smoke from biomass burning and dust transport continue to affect many part of the world and can easily offset the shutdown effects.
- Meteorological conditions (i.e. rain, temp., RH, wind) also play a critical role and may affects aerosol loading, which may increase/decrease or offset the shutdown effects.

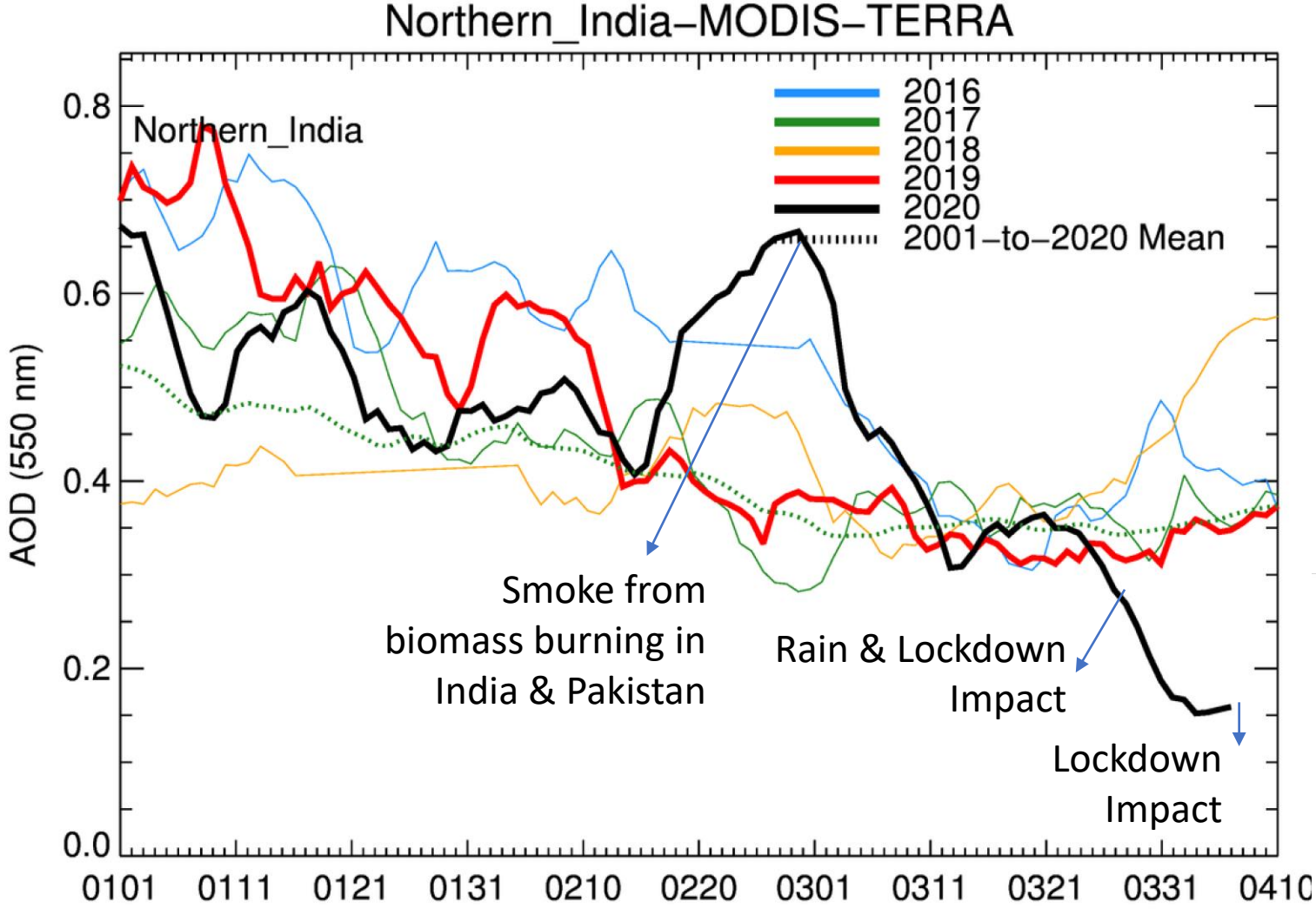
Data, Method

- We use MODIS-Terra & Aqua aerosol optical depth (AOD) at 550 nm retrieval at 10km^2 resolution. The data were processed for the entire record of MODIS mission.
- AOD differences between previous years (and climatology) & 2020 for the same region and period have been calculated to understand the impact of slowdown on atmospheric aerosol loading.

Lockdown started on March 25th

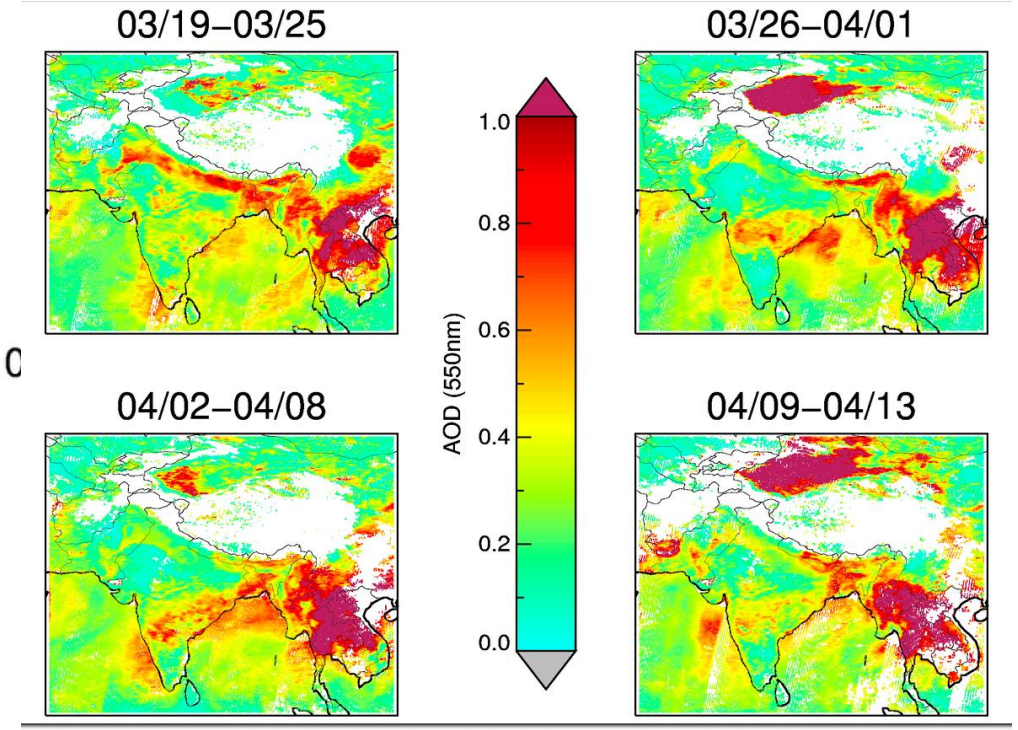


Each panel shows Average AOD values for March 31 to April 5th from MODIS-Terra for 2016 to 2020, the Climatology, and the Difference (2020-AVG) for Indian region. There was heavy rain fall in the northern India from March 26-28, therefore data for that period not used here. The decline in AOD values 2020 compared to the last year and long-term climatology is apparent in the analysis. The reasons for increase in AODs in central/southern part is open biomass burning.



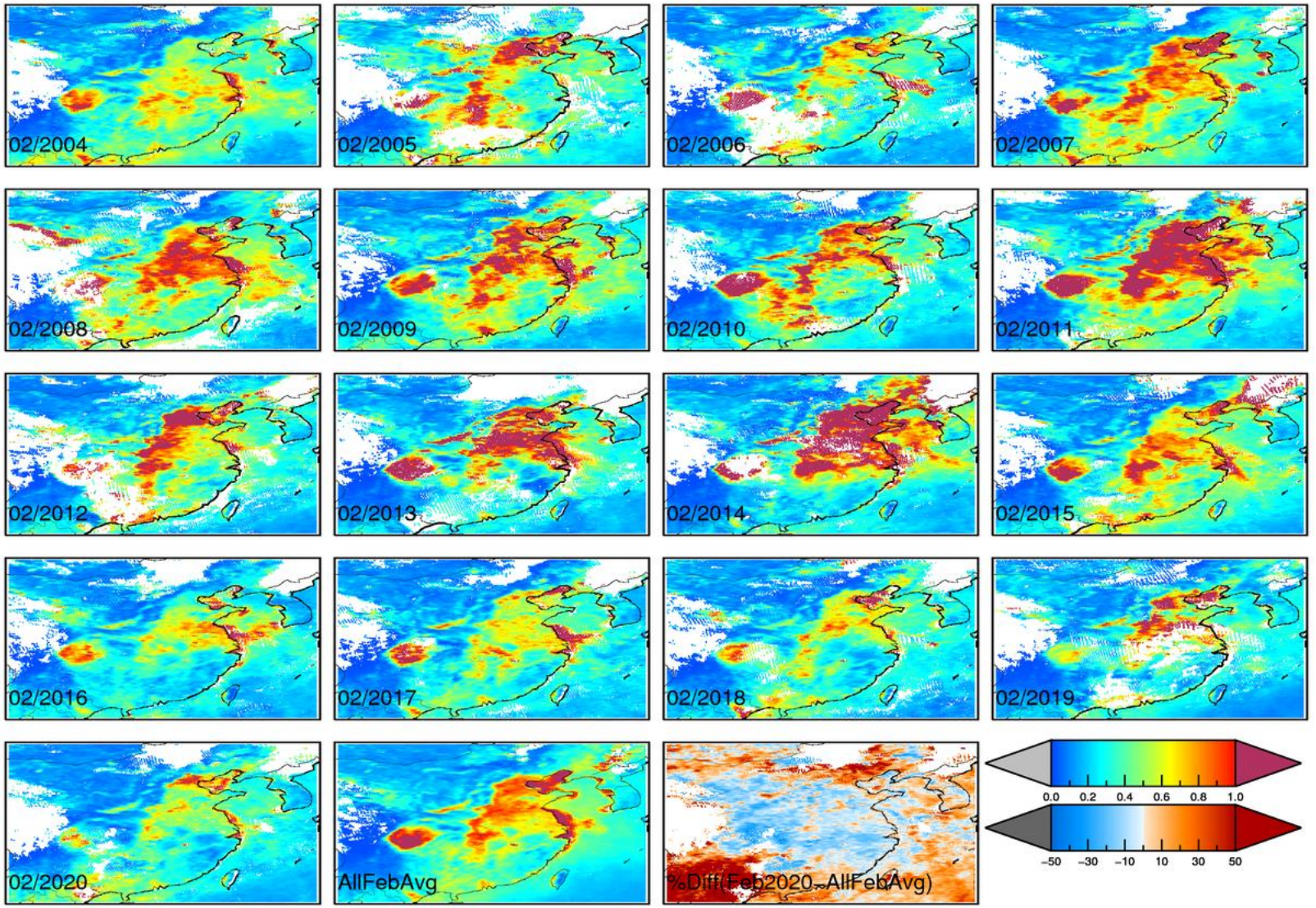
The timeseries shows daily change in AOD from January 1 to April 10. Each color represent different year and dotted line shows long-term climatology. At the time of this analysis, 2020 data were only available until April 5th. The data are averaged for **[24.N,73.E,30.N,85.E]**. Also, daily values are smoothed using 7 day moving average.

The decline in AOD values week by week is apparent in the analysis. The reasons for increase in AODs in central part is due to open biomass burning. Most decline happed in Indo Gangetic Plain where population density is highest in the region. A passing dust storm and increased fires in Nepal during the week of April 9 elevated the AOD values.



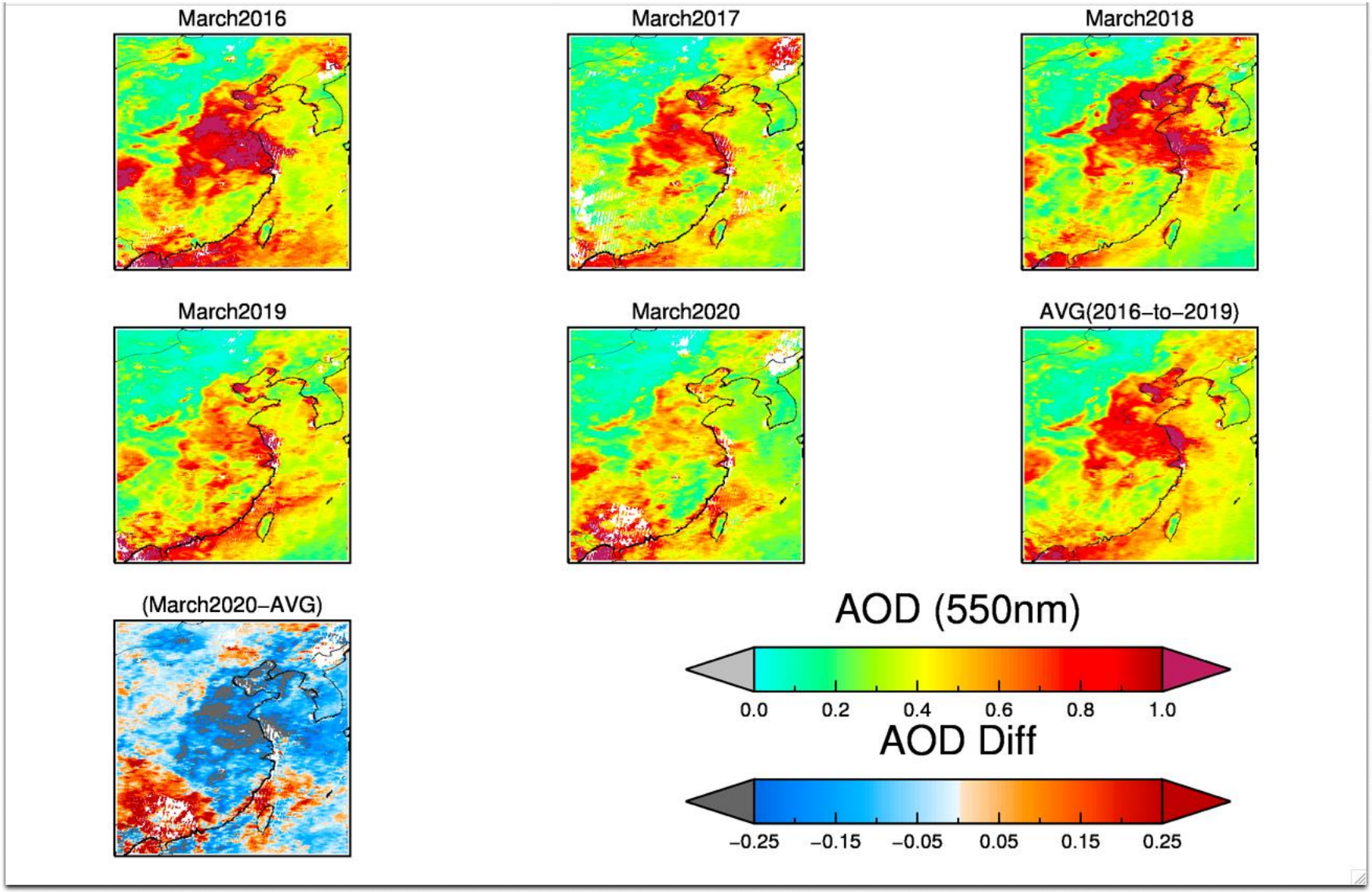
Backup slides for other regions

China in Feb



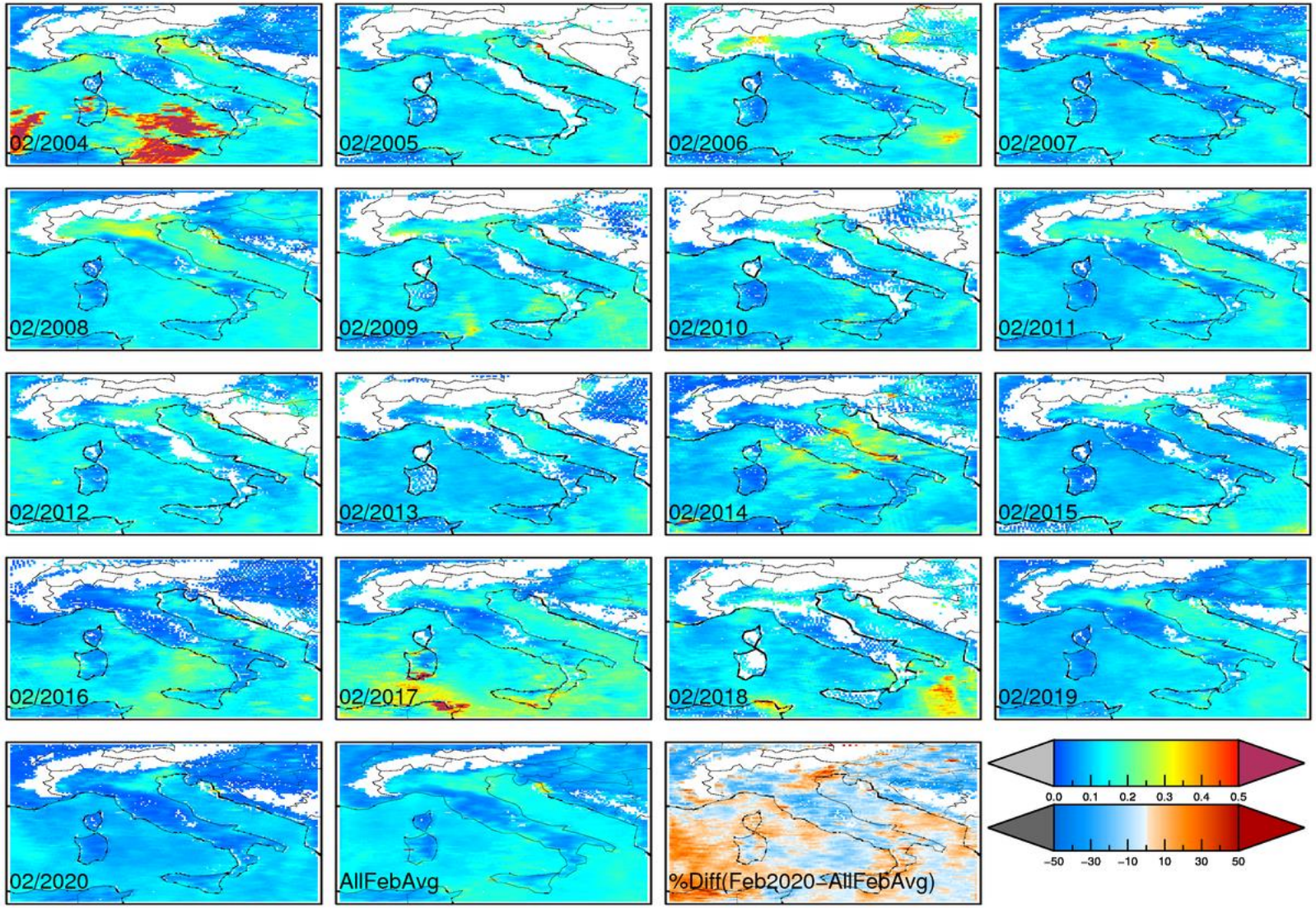
Each panel shows Average AOD values from MODIS-Aqua from 2004 to 2020, the Climatology, and the Difference (2020-AVG) for China Wuhan region. The decline in AOD values in 2020 compared to the last year and long-term climatology is apparent in the analysis. The increase in AODs in southern part of the region is due to smoke transport from south east Asia.

China in Mar



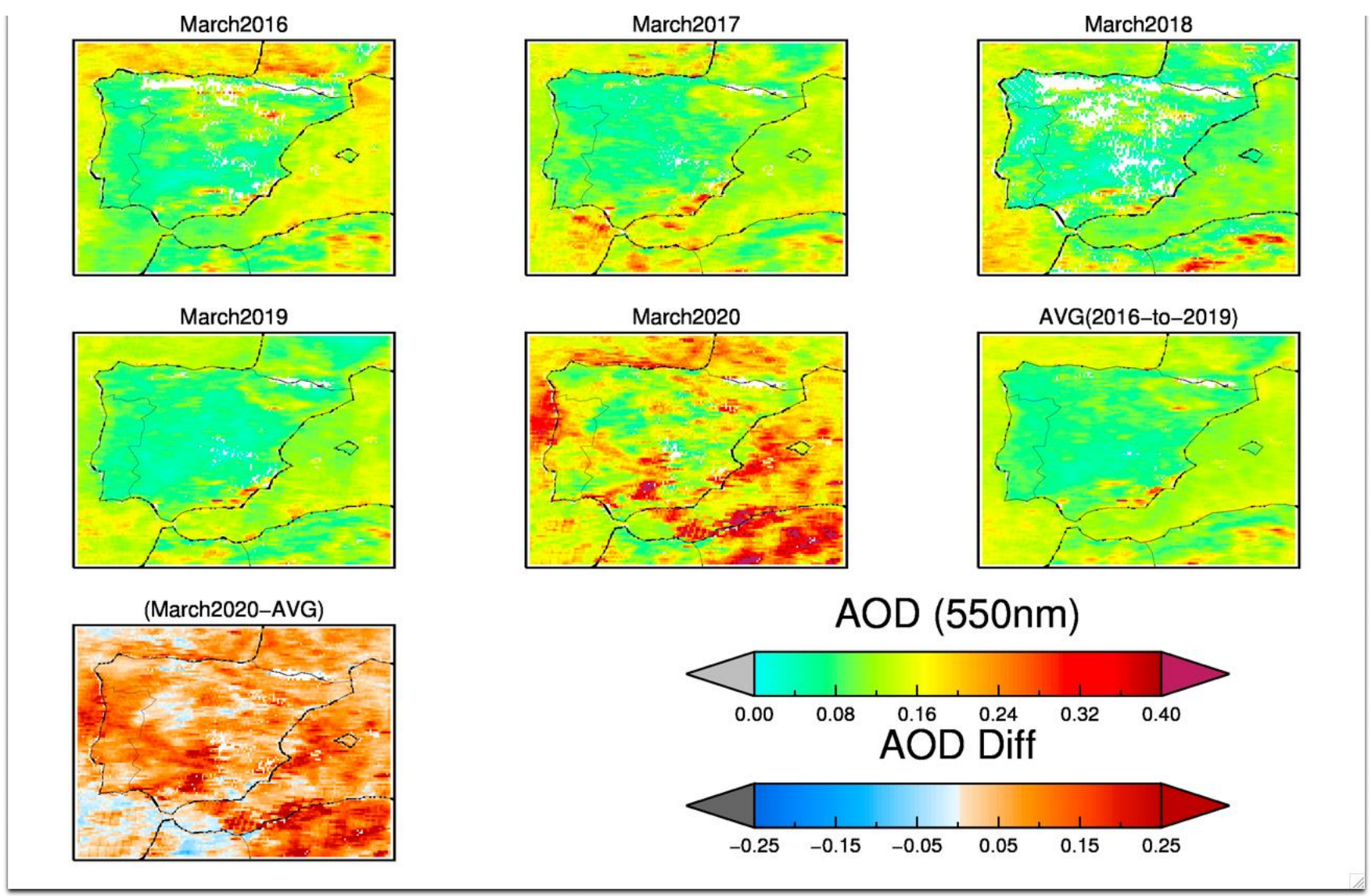
Each panel shows Average AOD values from MODIS-Terra from 2016 to 2020, the Climatology, and the Difference (2020-AVG) for China. The decline in AOD values in 2020 compared to the last year and long-term climatology is apparent in the analysis. The increase in AODs in southern part of the region is due to smoke transport from south east Asia.

Next is Italy



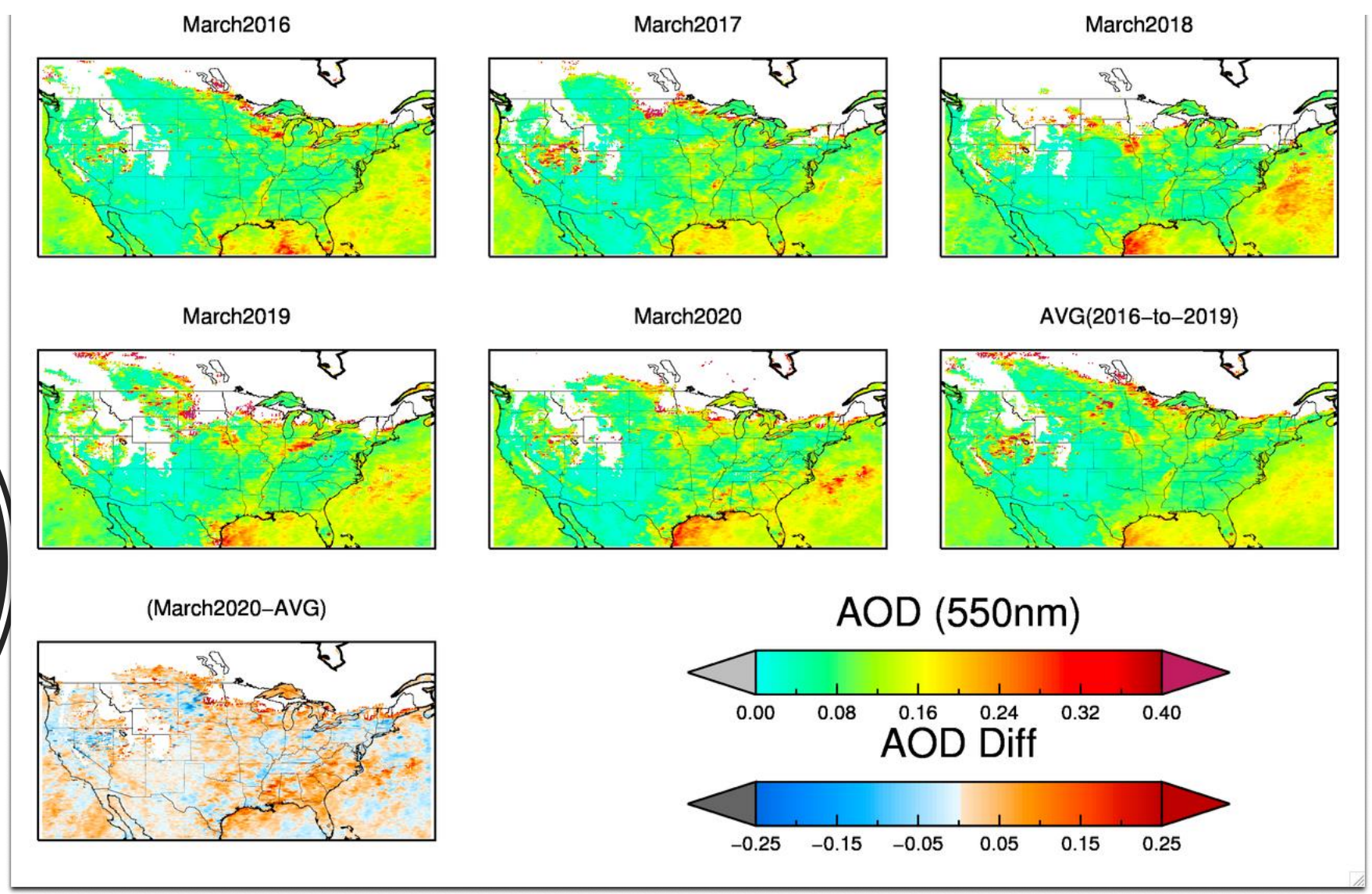
Each panel shows Average AOD values from MODIS-Aqua from 2004 to 2020, the Climatology, and the Difference (2020-AVG) for Italy region. The decline in AOD values 2020 compared to the last year and long-term climatology is apparent in the analysis. The reasons for increase in AODs in northern part is not very clear, may be there was a dust storm.

Spain in March

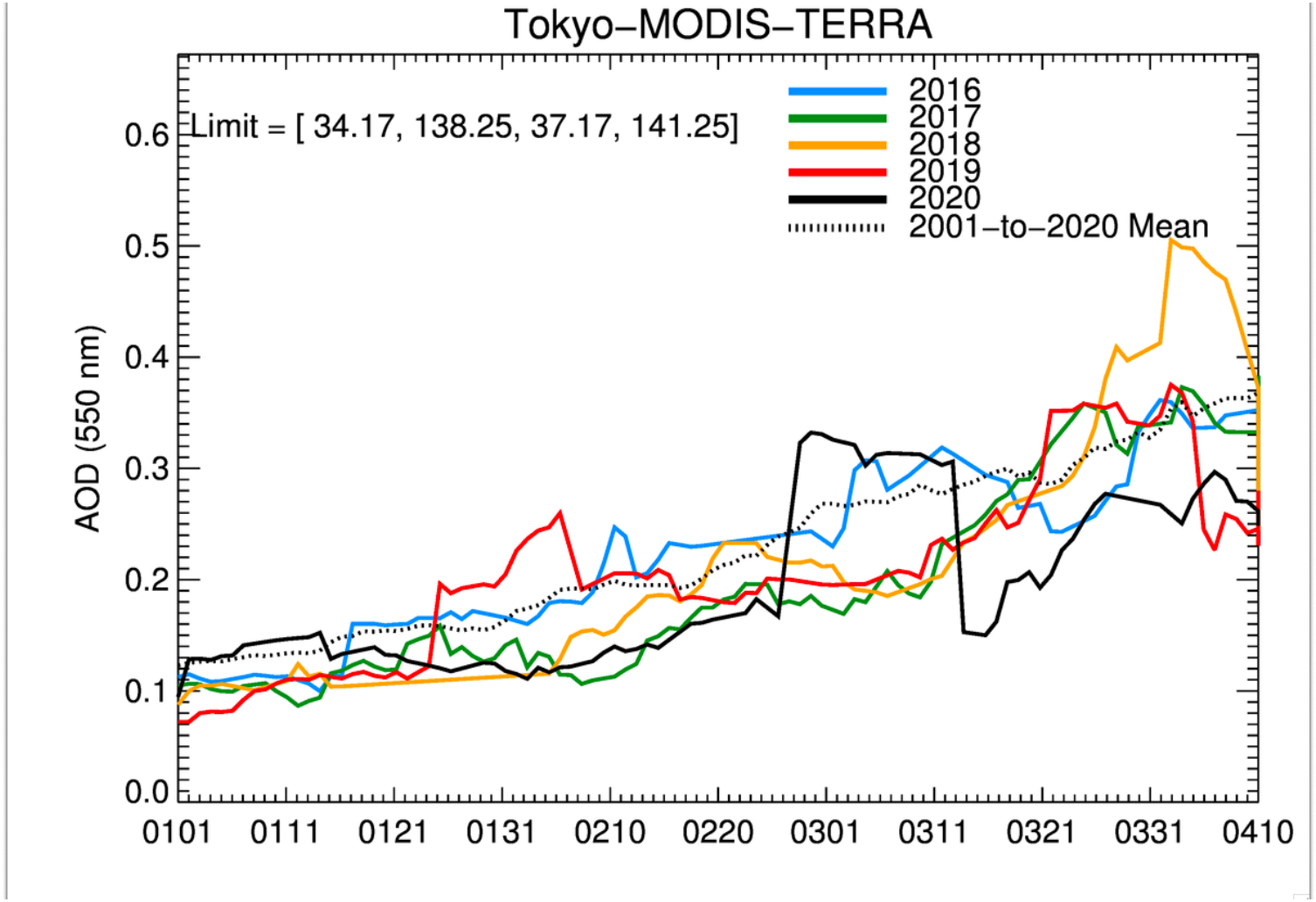


Each panel shows Average AOD values from MODIS-Terra from 2016 to 2020, the Climatology, and the Difference (2020-AVG) for Spain. The 2020 values are much higher and most likely affected by long-range dust transport.

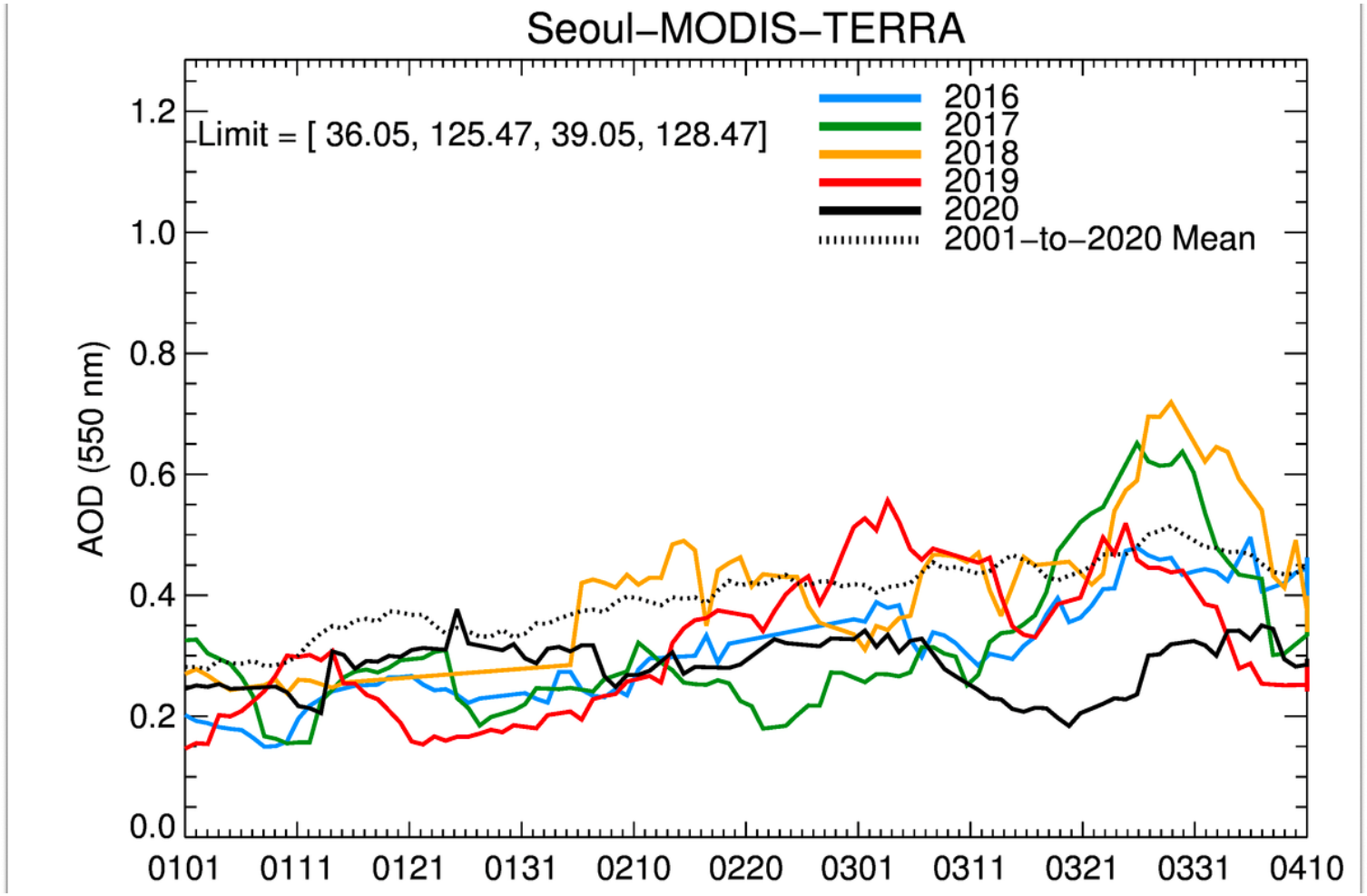
North America in March



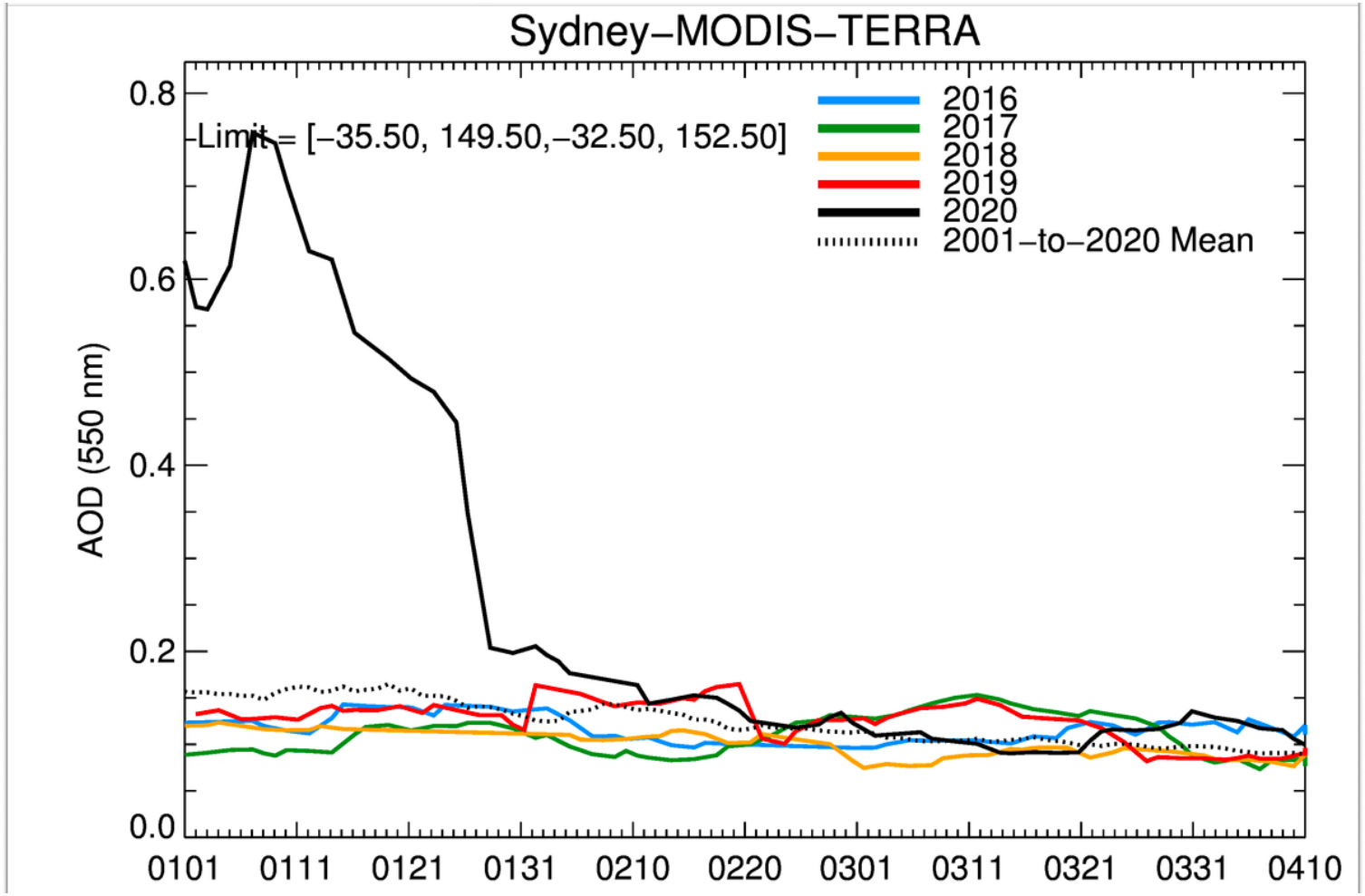
Each panel shows Average AOD values from MODIS-Terra from 2016 to 2020, the Climatology, and the Difference (2020-AVG) for North America.


Tokyo–MODIS–TERRA
Limit = [34.17, 138.25, 37.17, 141.25]
2016
2017
2018
2019
2020
2001–to–2020 Mean
AOD (550 nm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0101
0111
0121
0131
0210
0220
0301
0311
0321
0331
0410

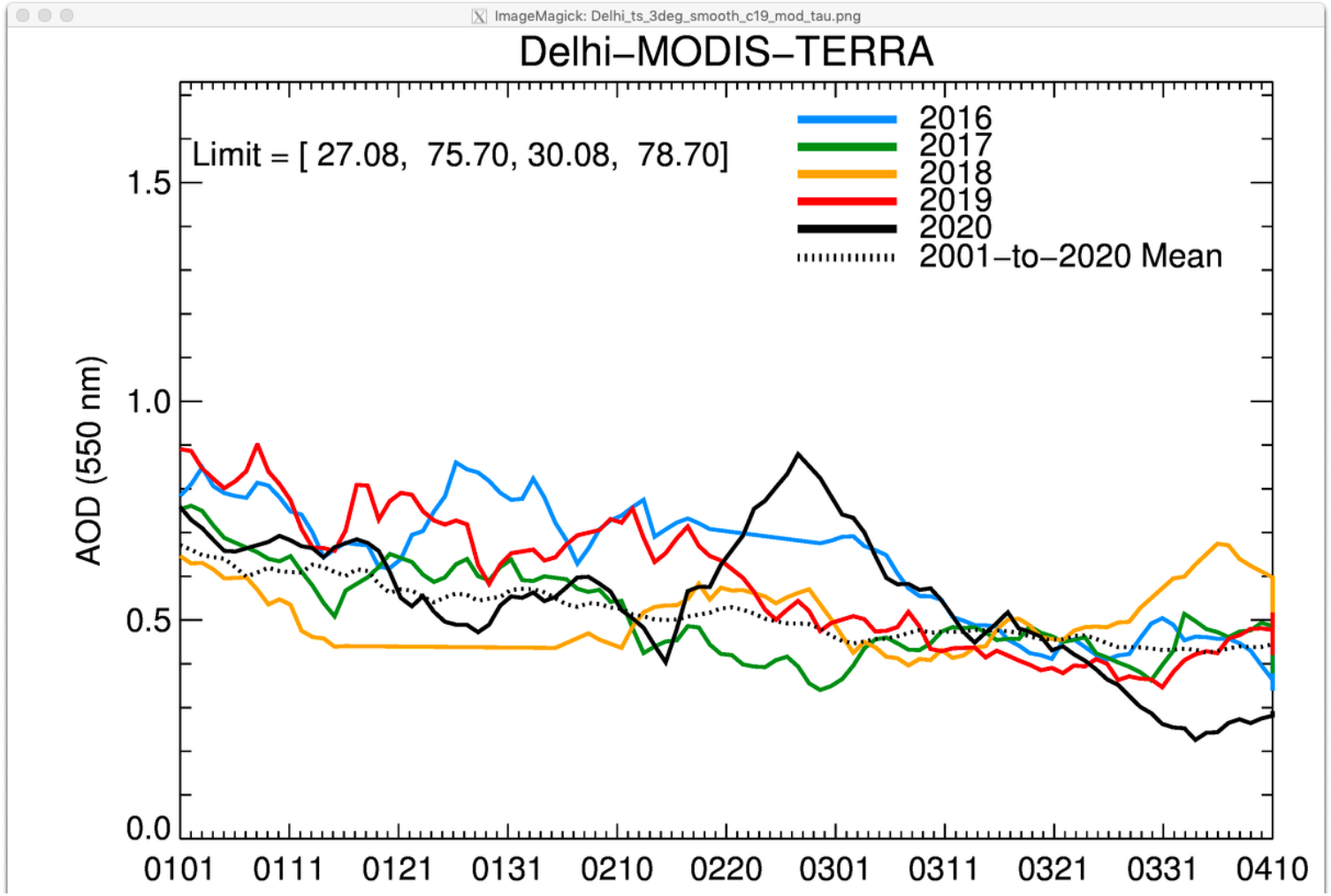
Tokyo-Japan



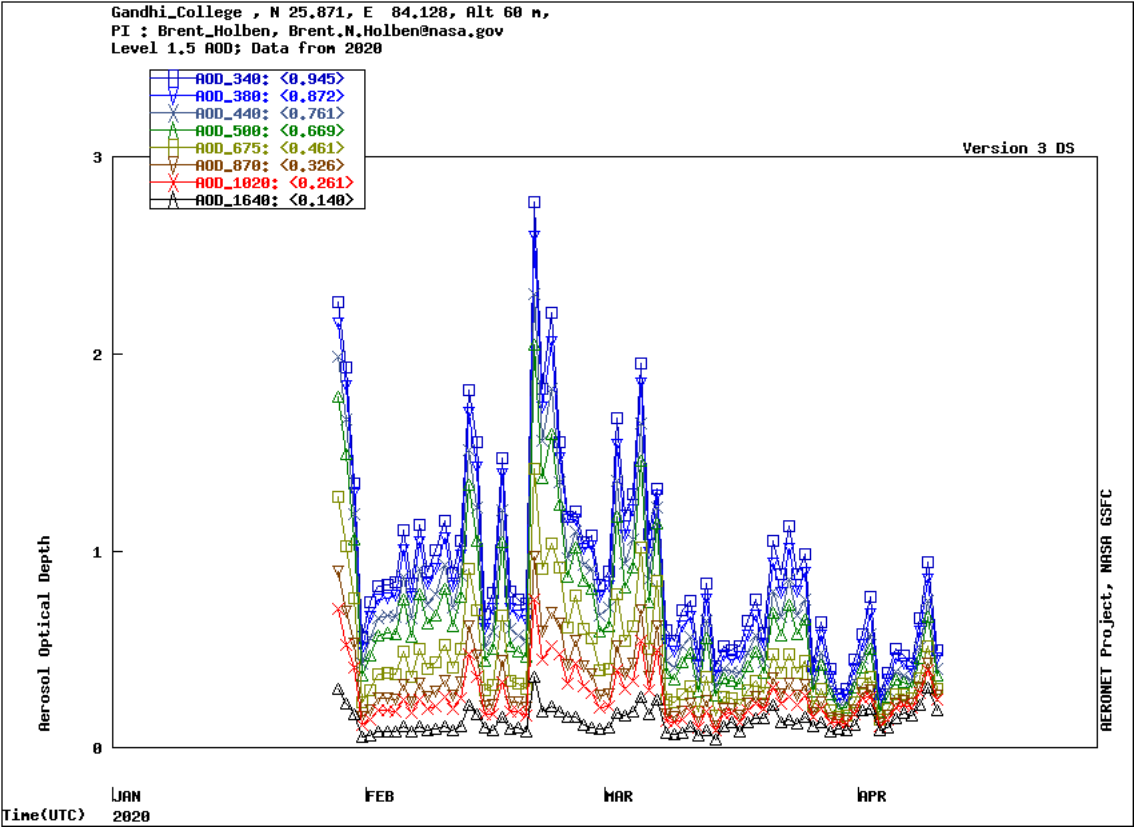
Seoul – South Korea

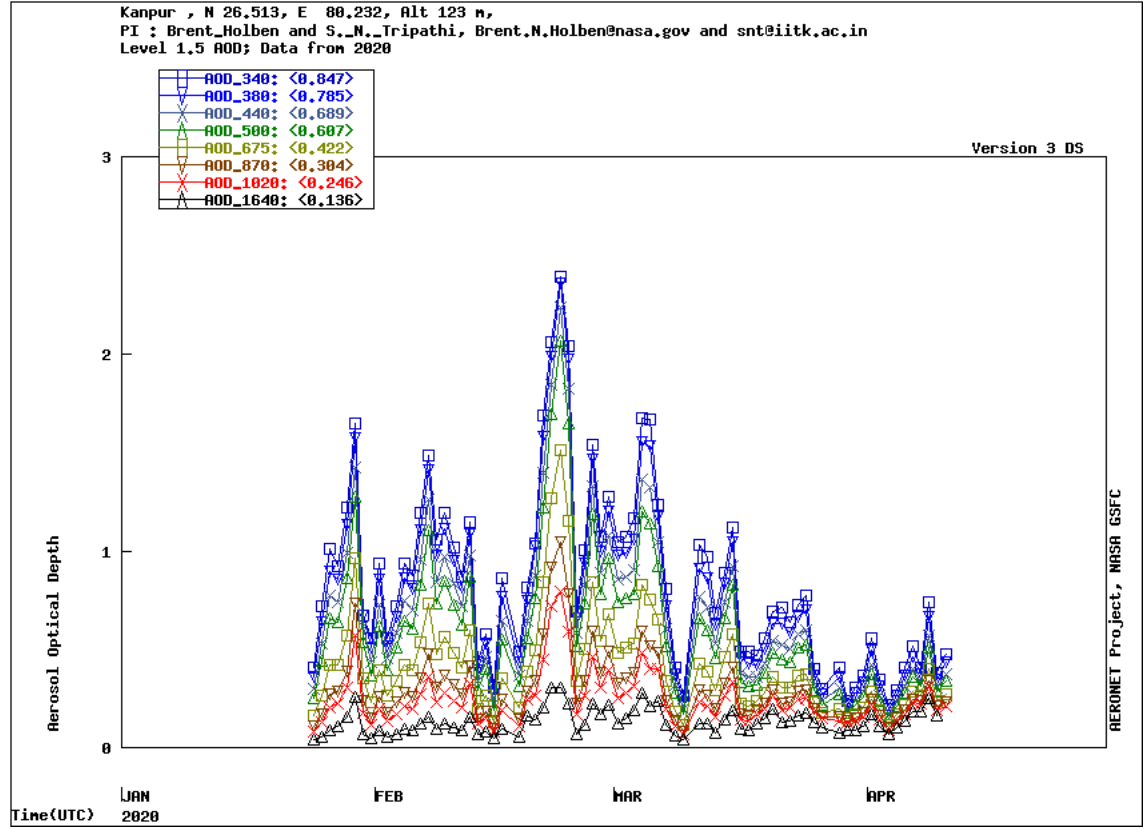


Sydney - Australia

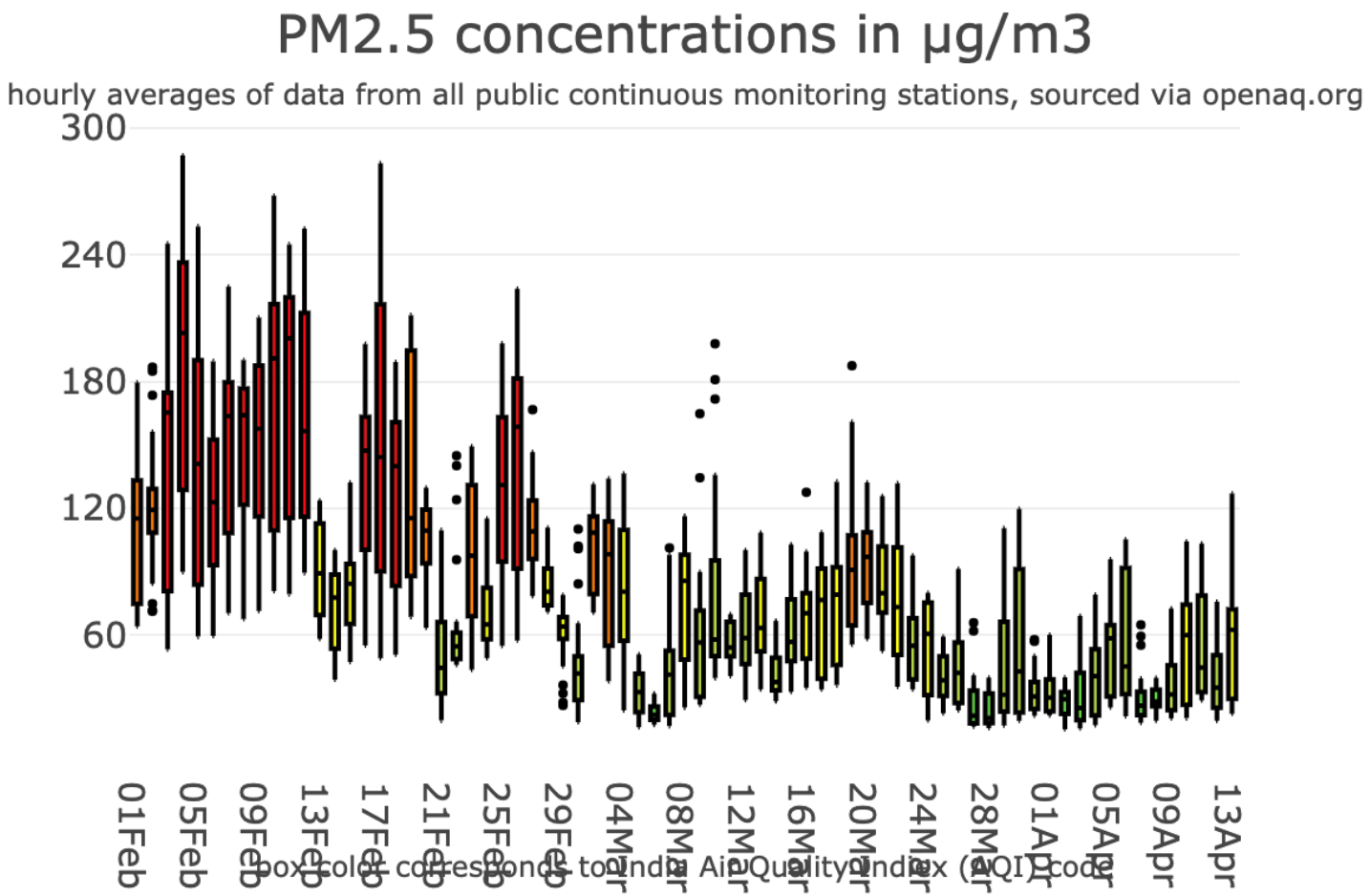

ImageMagick: Delhi_ts_3deg_smooth_c19_mod_tau.png
Delhi–MODIS–TERRA
Limit = [27.08, 75.70, 30.08, 78.70]
2016
2017
2018
2019
2020
2001–to–2020 Mean
AOD (550 nm)
1.5
1.0
0.5
0.0
0101
0111
0121
0131
0210
0220
0301
0311
0321
0331
0410

Delhi -India


Gandhi_College , N 25.871, E 84.128, Alt 60 m,
PI : Brent_Holben, Brent.N.Holben@nasa.gov
Level 1.5 AOD; Data from 2020
AOD_340: <0.945>
AOD_380: <0.872>
AOD_440: <0.761>
AOD_500: <0.669>
AOD_675: <0.461>
AOD_870: <0.326>
AOD_1020: <0.261>
AOD_1640: <0.140>
Version 3 DS
Aerosol Optical Depth
AERONET Project, NASA GSFC
JAN
FEB
MAR
APR
Time(UTC)
2020


Kanpur , N 26.513, E 80.232, Alt 123 m,
PI : Brent_Holben and S._N._Tripathi, Brent.N.Holben@nasa.gov and snt@iitk.ac.in
Level 1.5 AOD; Data from 2020
AOD_340: <0.847>
AOD_380: <0.785>
AOD_440: <0.689>
AOD_500: <0.607>
AOD_675: <0.422>
AOD_870: <0.304>
AOD_1020: <0.246>
AOD_1640: <0.136>
Version 3 DS
Aerosol Optical Depth
AERONET Project, NASA GSFC
JAN
FEB
MAR
APR
Time(UTC)
2020

Ground Air Quality Data - Delhi



Source

https://science.thewire.in/environment/lockdown-air-pollution-north-india-pm25-pm10-nox-ozone/