SNPP VIIRS vs. S5P TROPOMI Smoke Case Analysis

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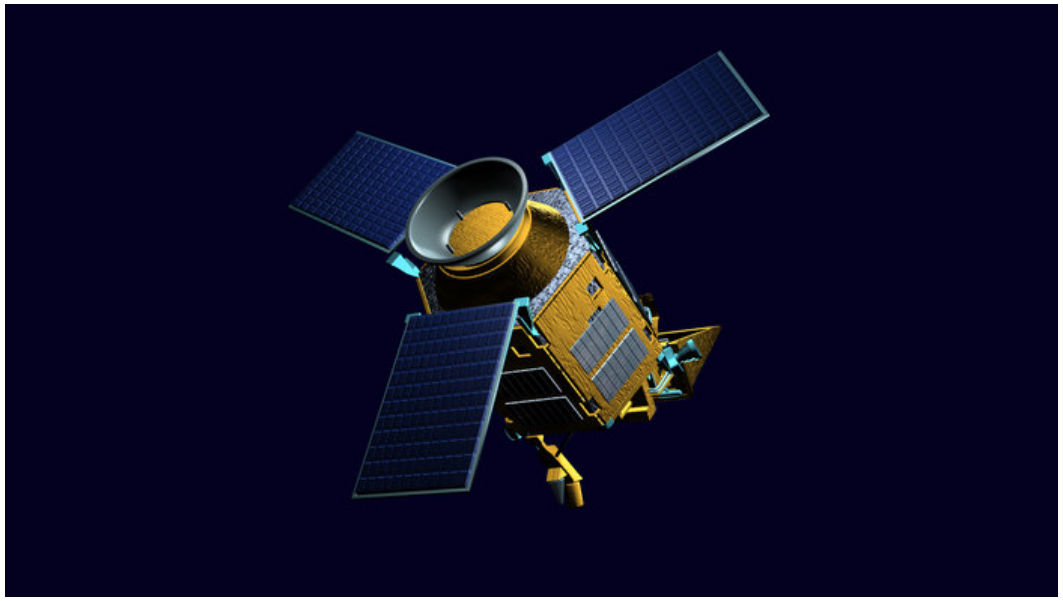
Impact of Smoke on Ozone Production

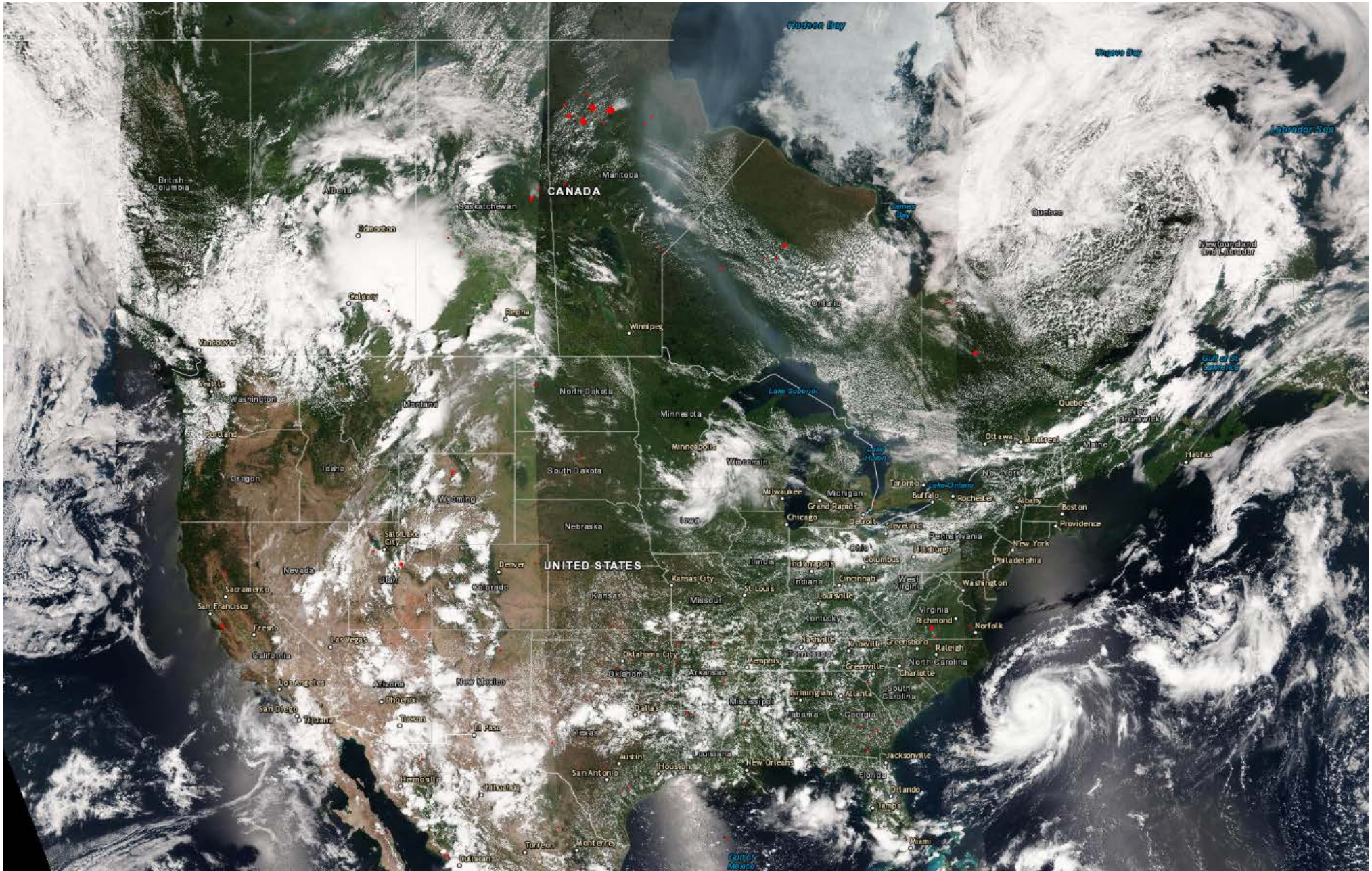
- Fires release large amount of aerosols (smoke particles) and trace gases into the atmosphere
- Forecasters report ozone standard violations when smoke-laden air is transported into their domain
  - Optically thick smoke – ozone levels are low
  - Optically thin smoke – ozone levels increase
- Amount of photochemically produced ozone depends on smoke and NO_2 amount
  - Thick smoke inhibits ozone production by depressing photolysis of NO_2
  - Thin smoke, NO2 present in smoke leads to ozone production
- Is there a potential for SNPP VIIRS and S5P TROPOMI trace gas and aerosol products to explain the role of transported smoke in ozone air quality standard violations in the mid-Atlantic states

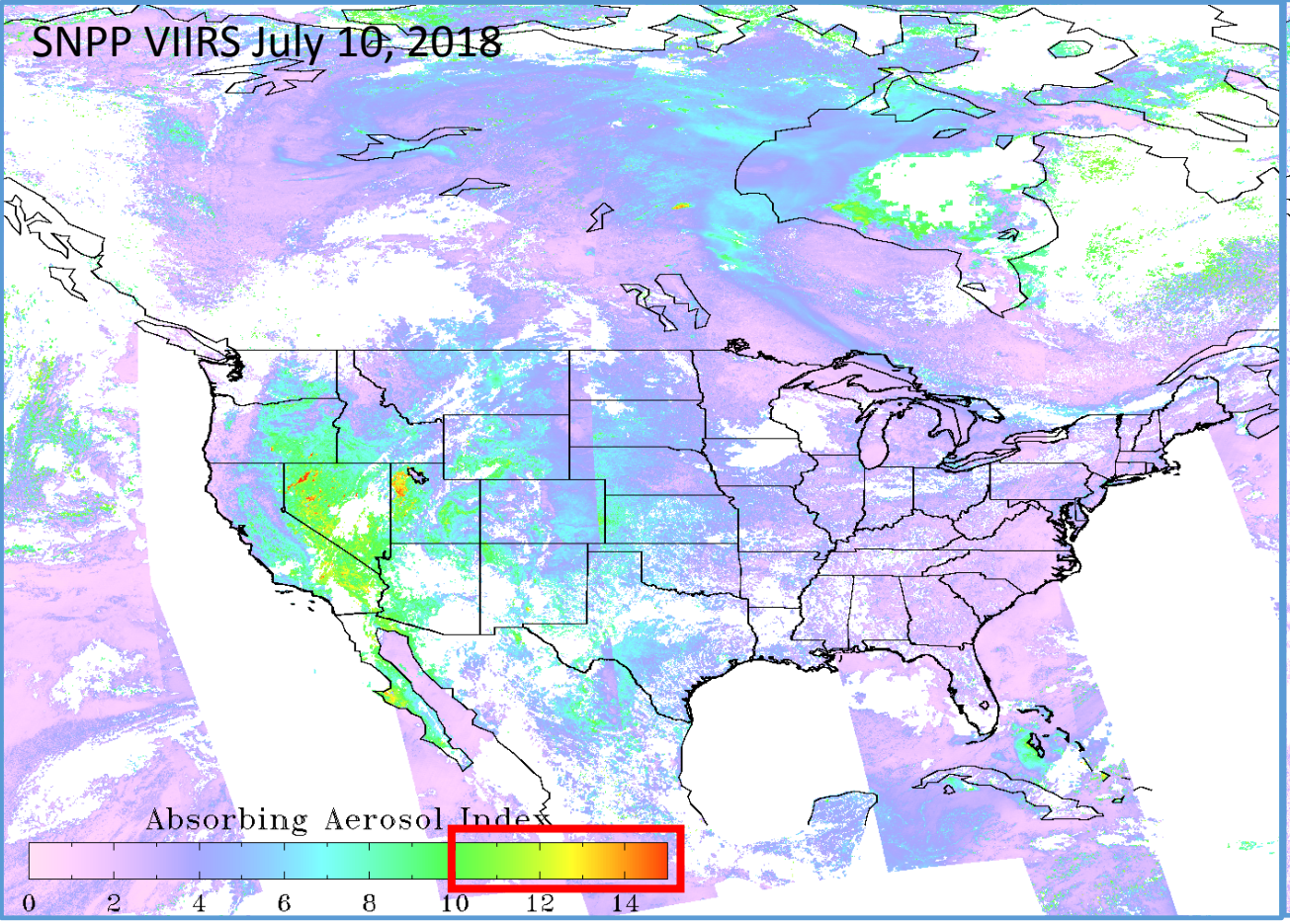
Sentinel 5P TROPOMI

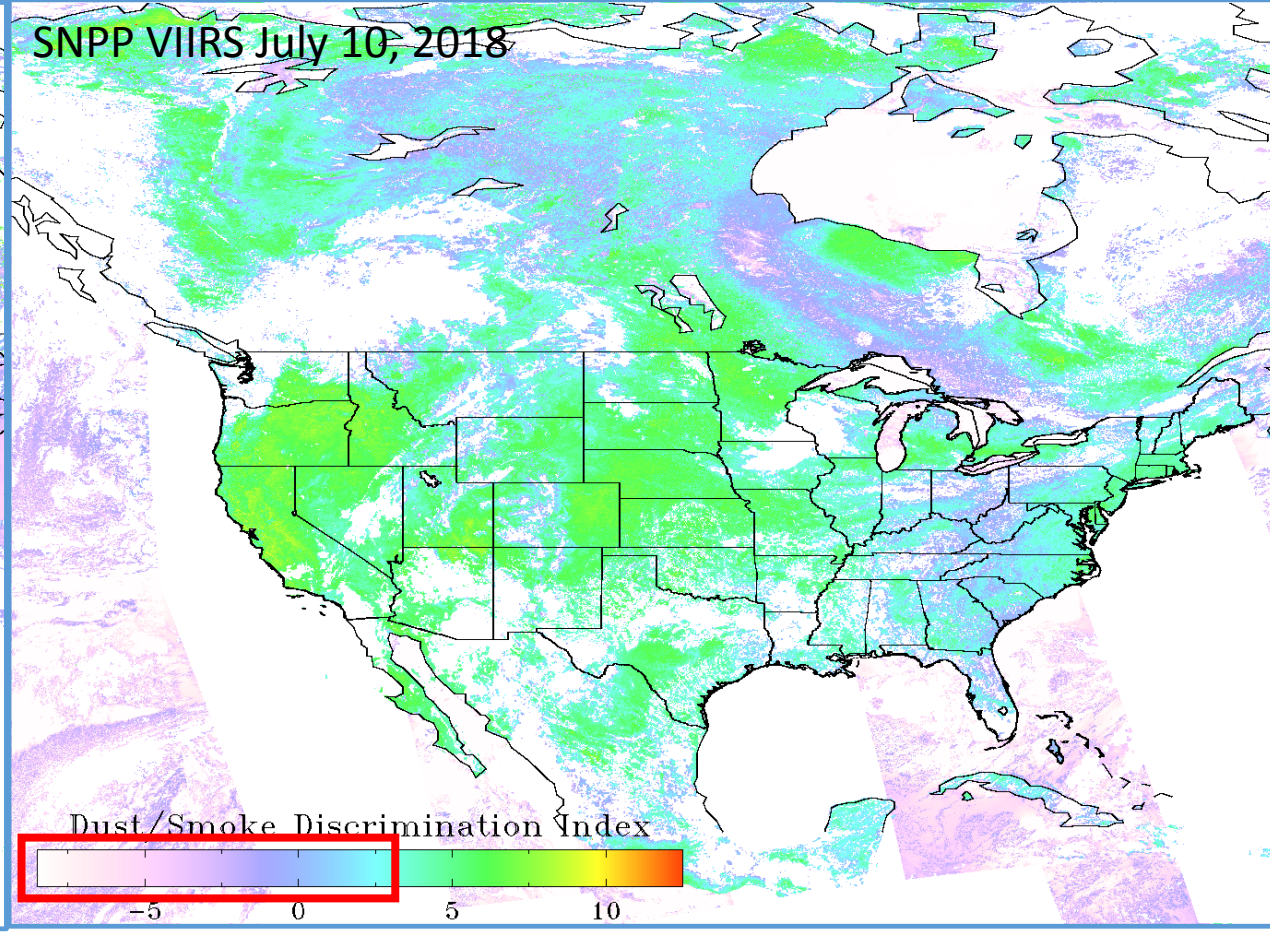


- Launched by European Space Agency on October 13, 2017 as a precursor to operational Sentinel 5 EUMETSAT mission
- Single payload satellite
- Covers UV, UV-VIS, NIR, SWIR hyperspectral bands
  - Spatial resolution: 7 km x 7 km or 7 km x 3.5 km
- Air quality products: NO_2, SO_2, CO, CH_4, HCHO, aerosol layer height, UVAI,

SNPP VIIRS July 10, 2018







Absorbing Aerosol Index

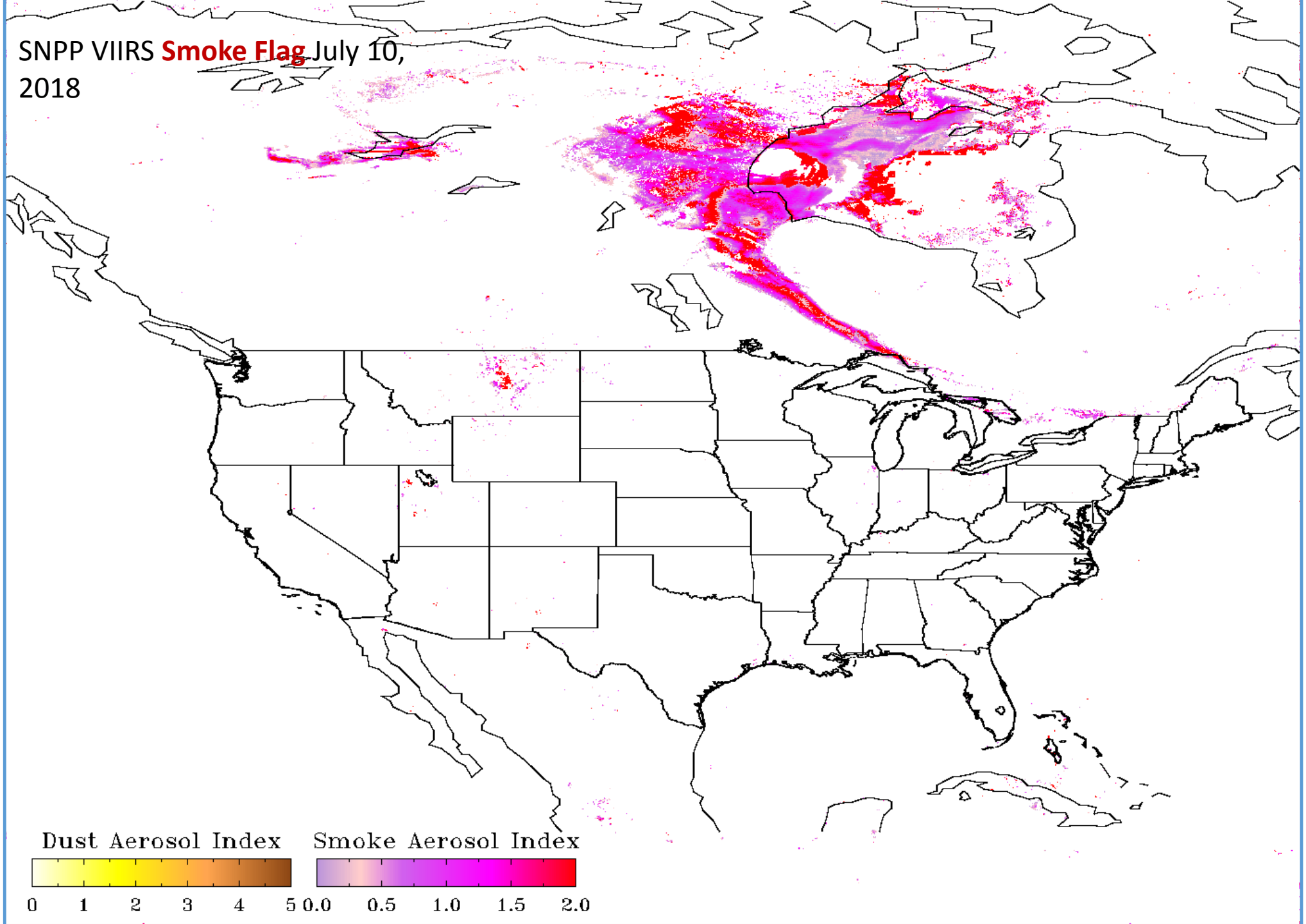
$$AAI = -100[1og_{10}(R_{412}/R_{440}) - log_{10}(R'_{412}/R'_{440})]$$

Dust Smoke Discrimination Index

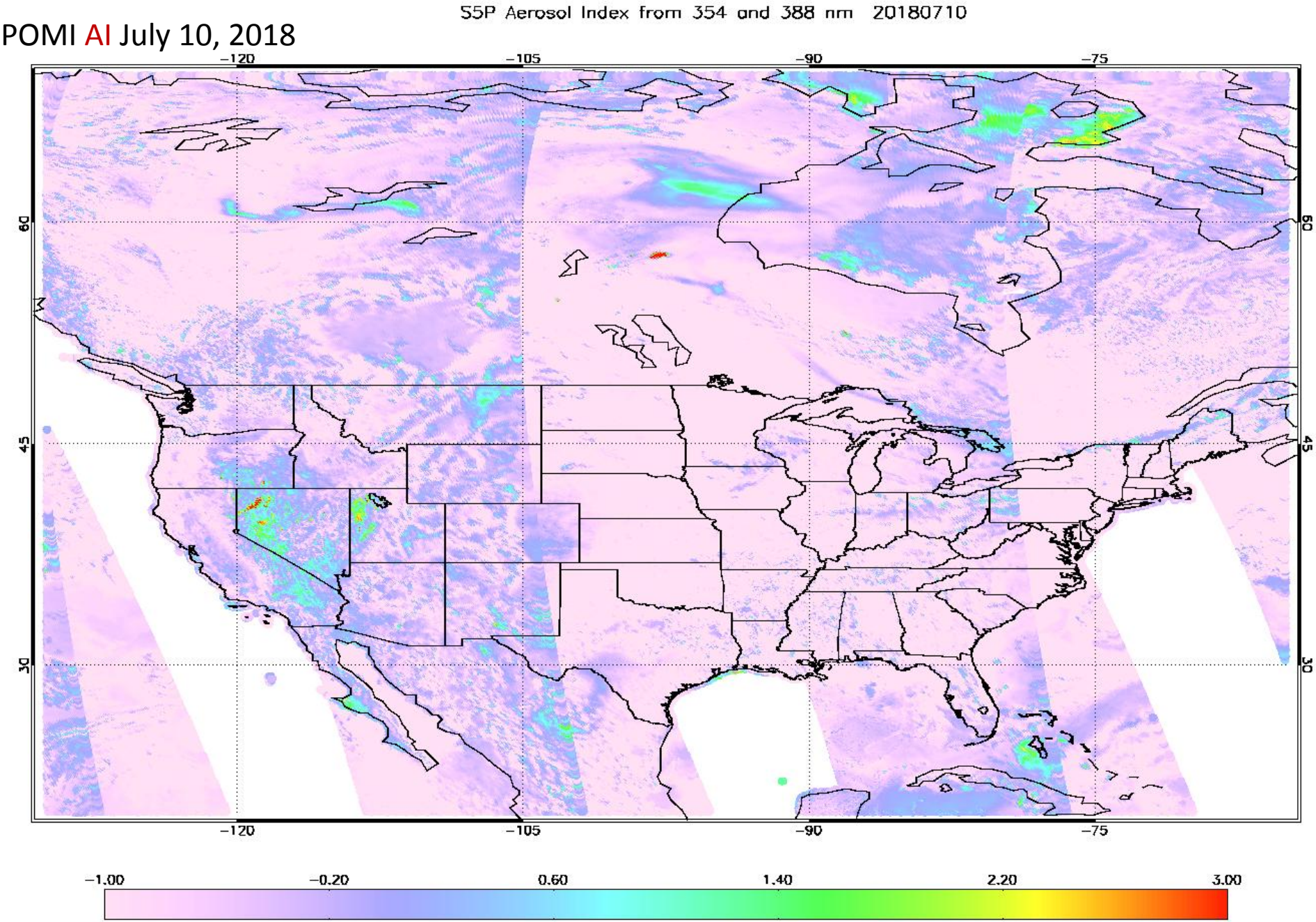
$$DSDI = -10[1og_{10}(R_{412}/R_{2250})$$

Smoke detected if AAI > 10 and DSDI < 3

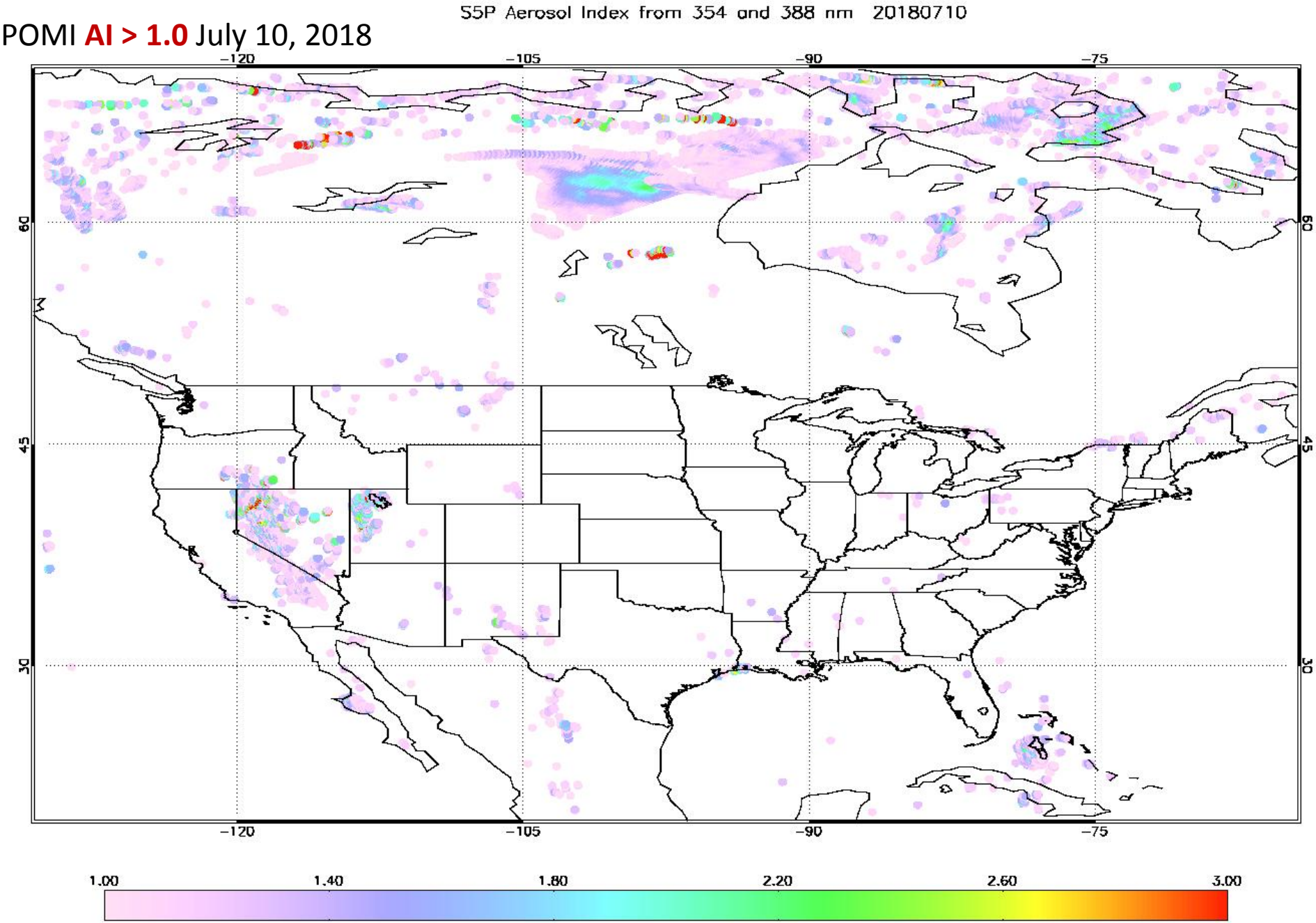
SNPP VIIRS **Smoke Flag** July 10, 2018



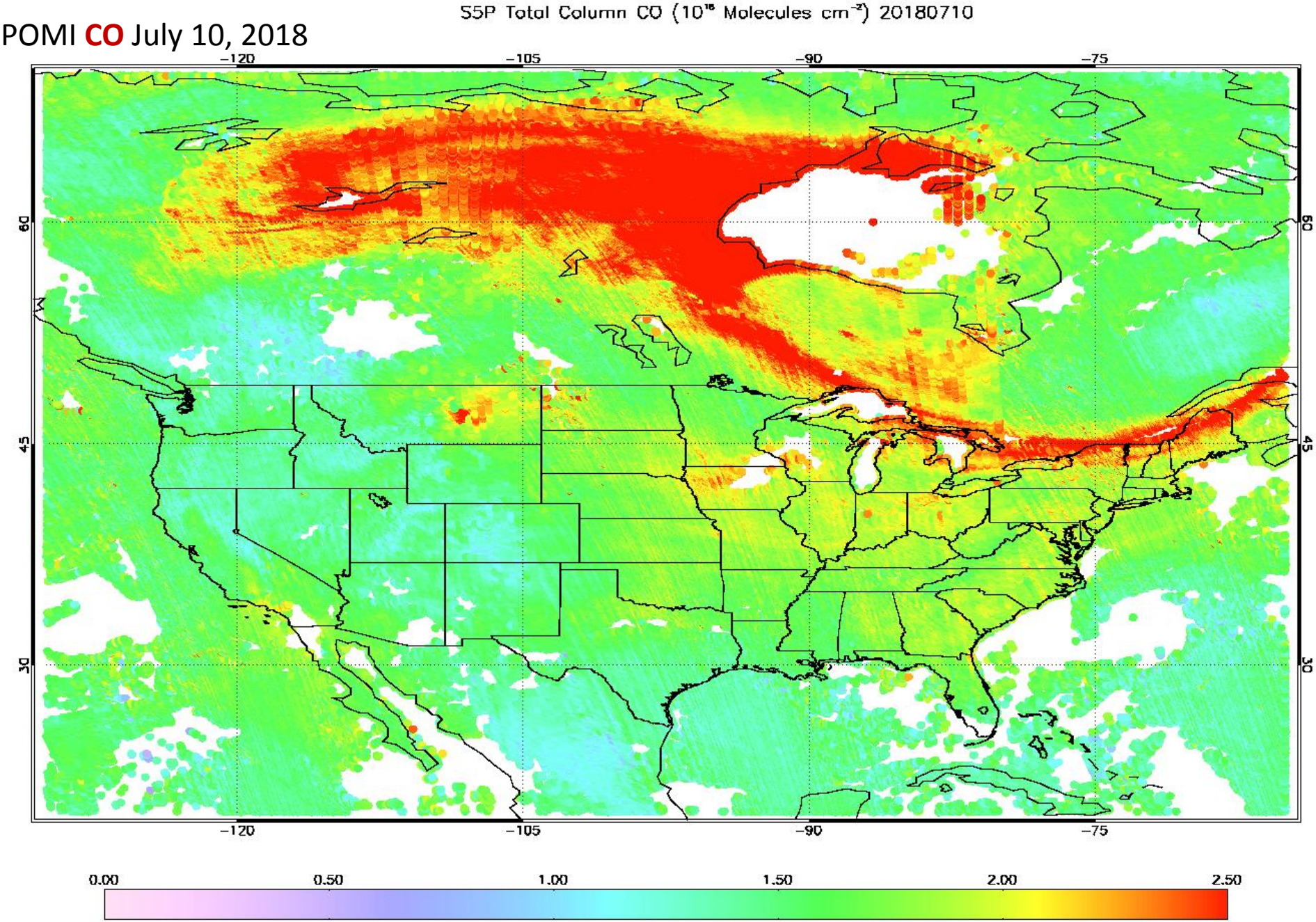
TROPOMI AI July 10, 2018



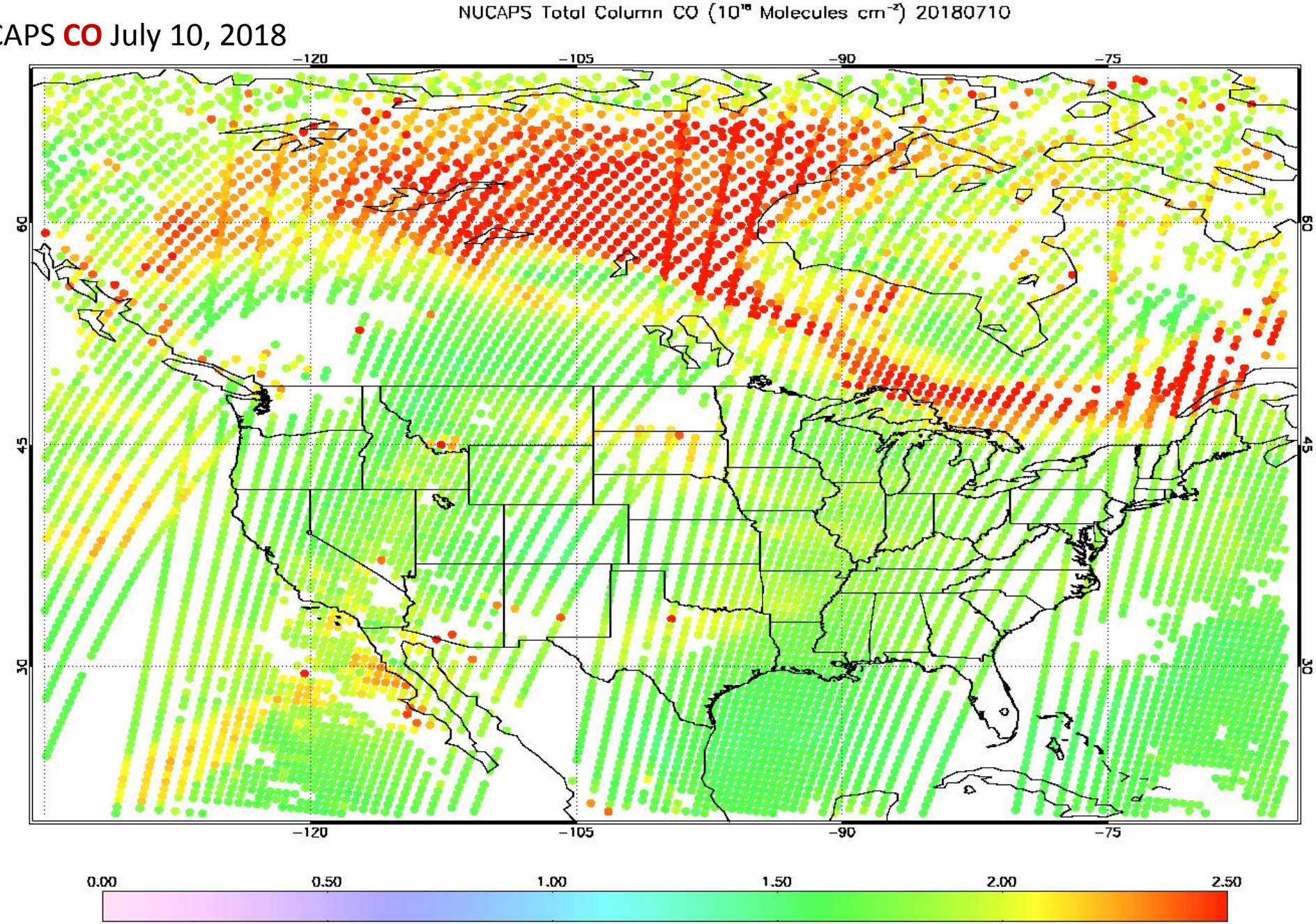
TROPOMI **AI > 1.0** July 10, 2018



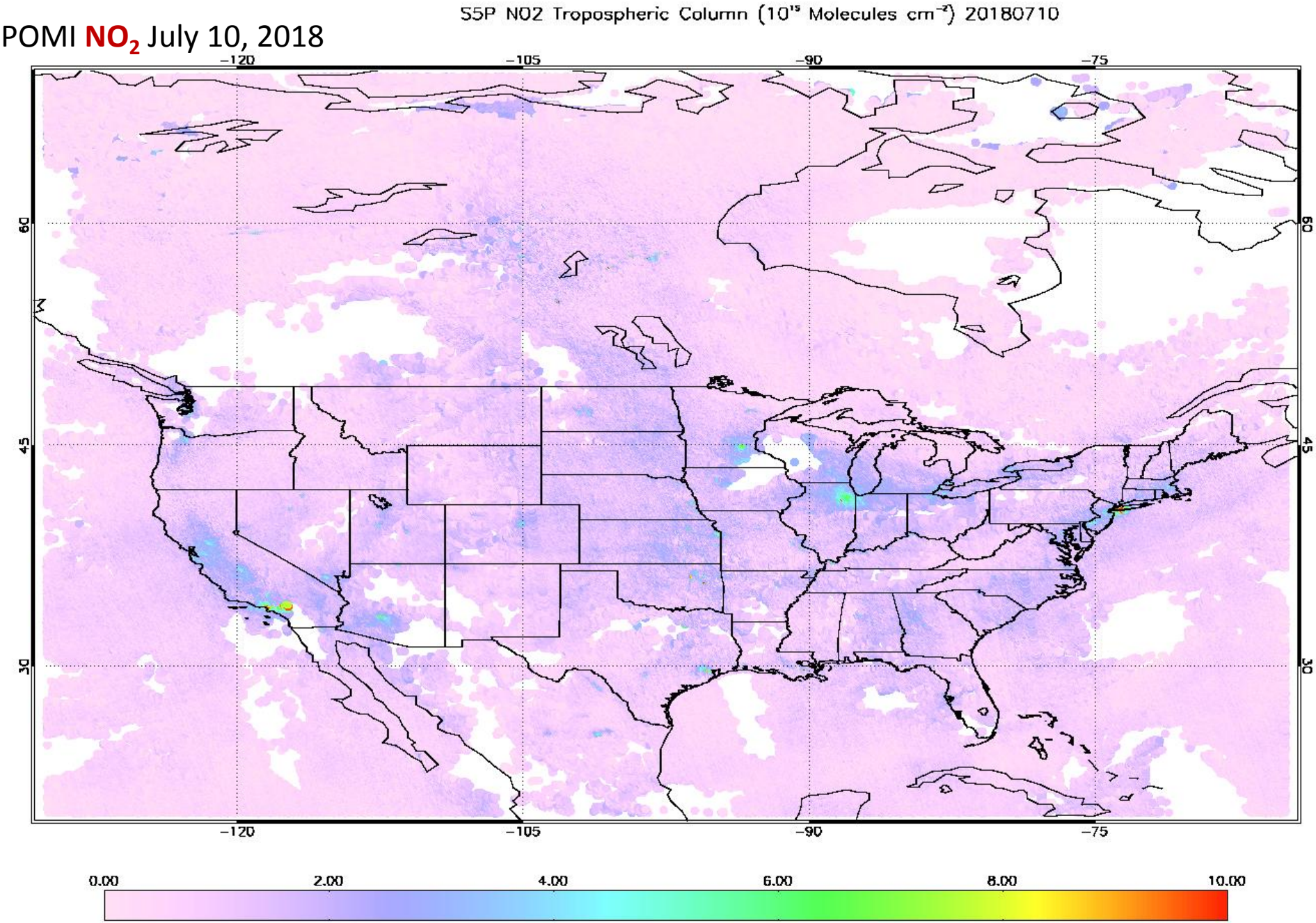
TROPOMI **CO** July 10, 2018



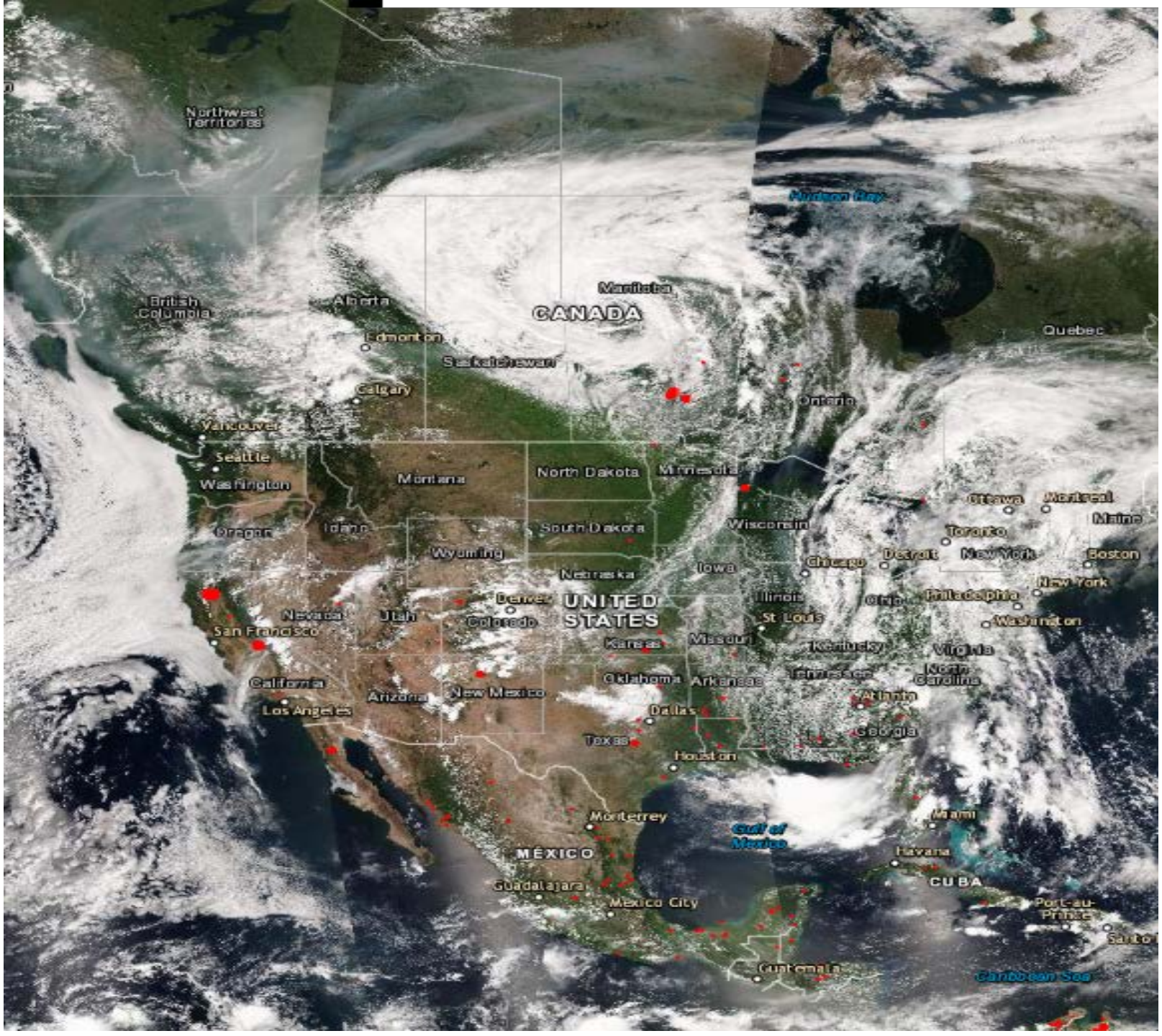
NUCAPS **CO** July 10, 2018

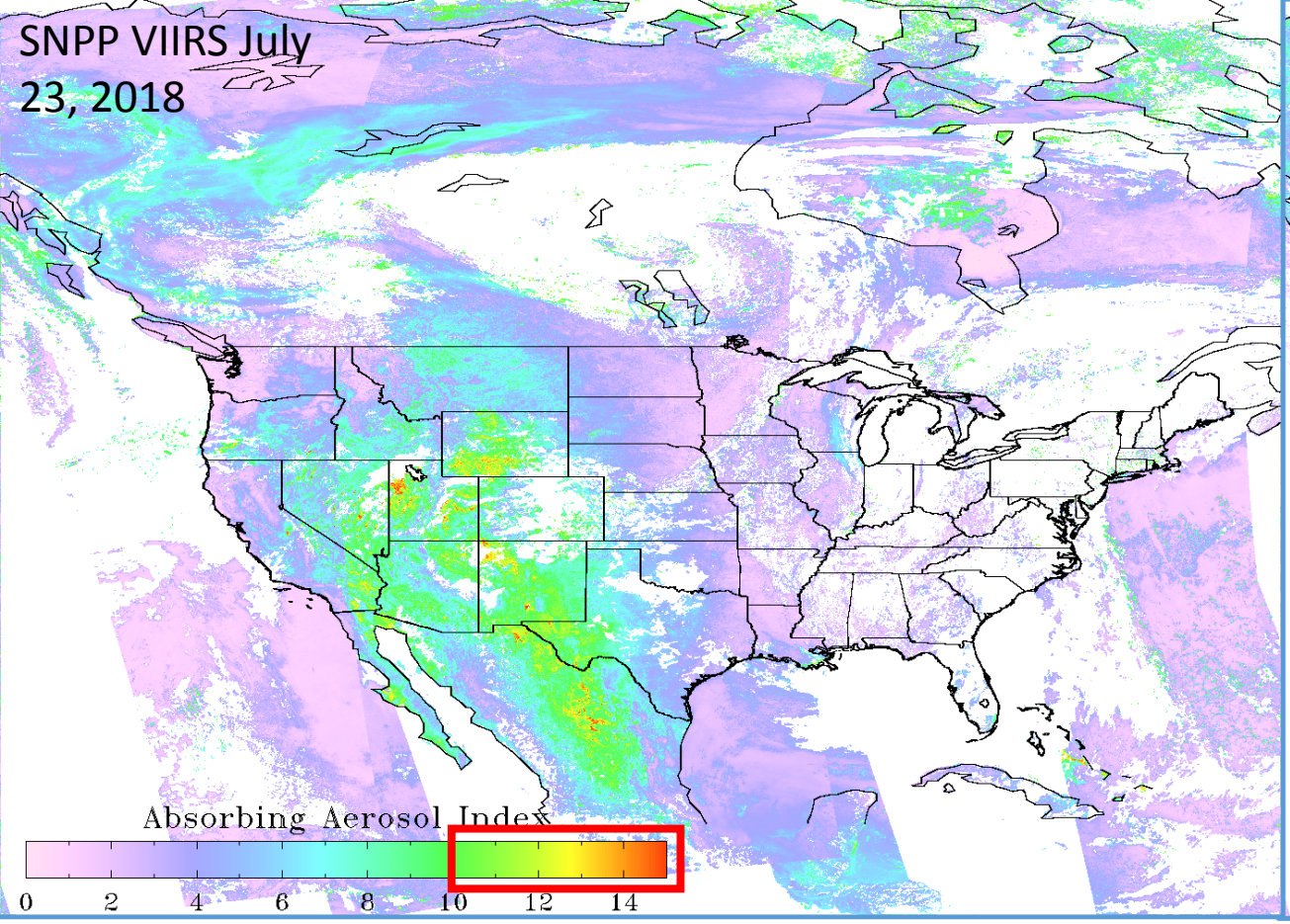


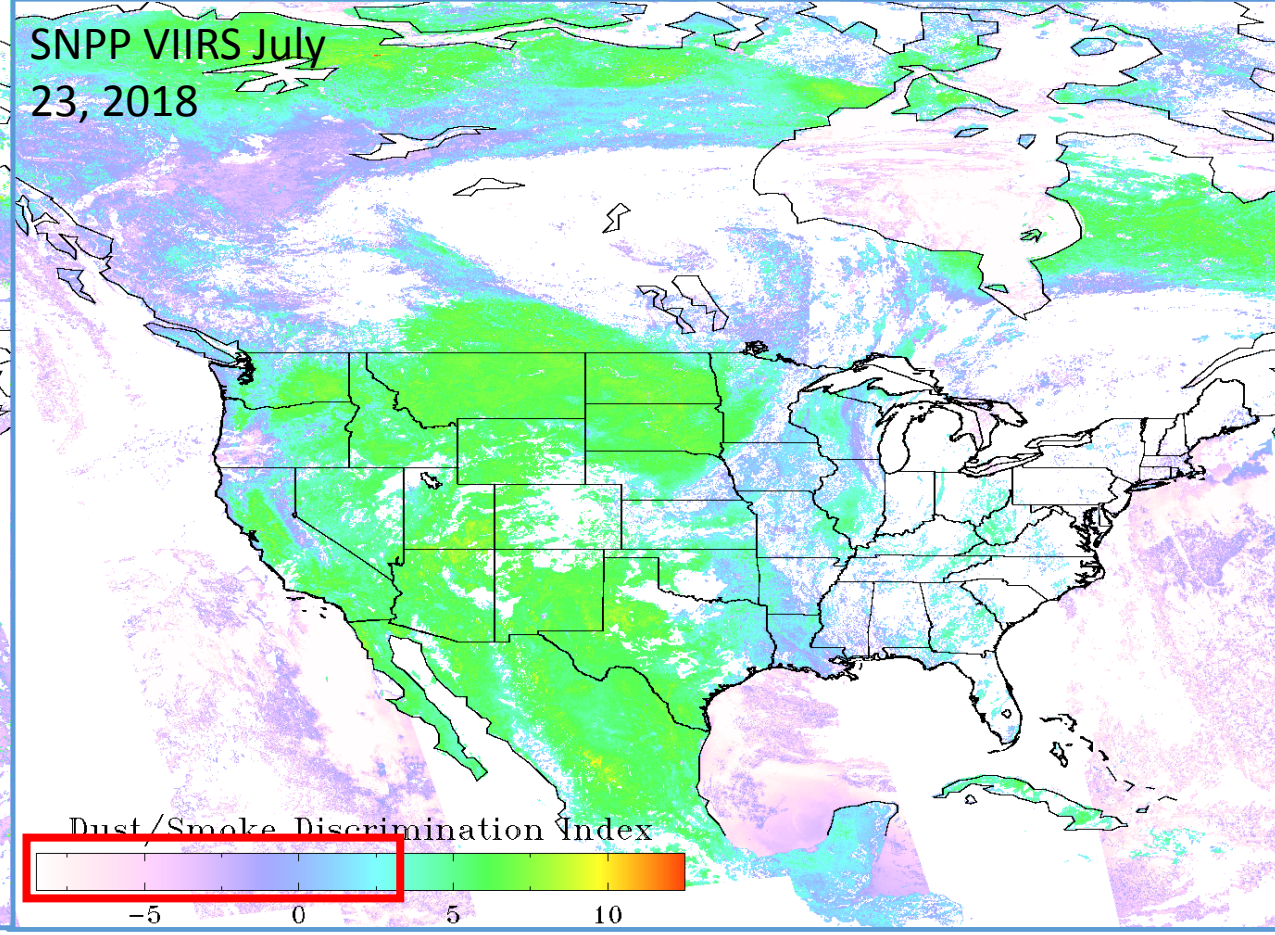
TROPOMI NO_2 July 10, 2018



SNPP VIIRS July 23, 2018







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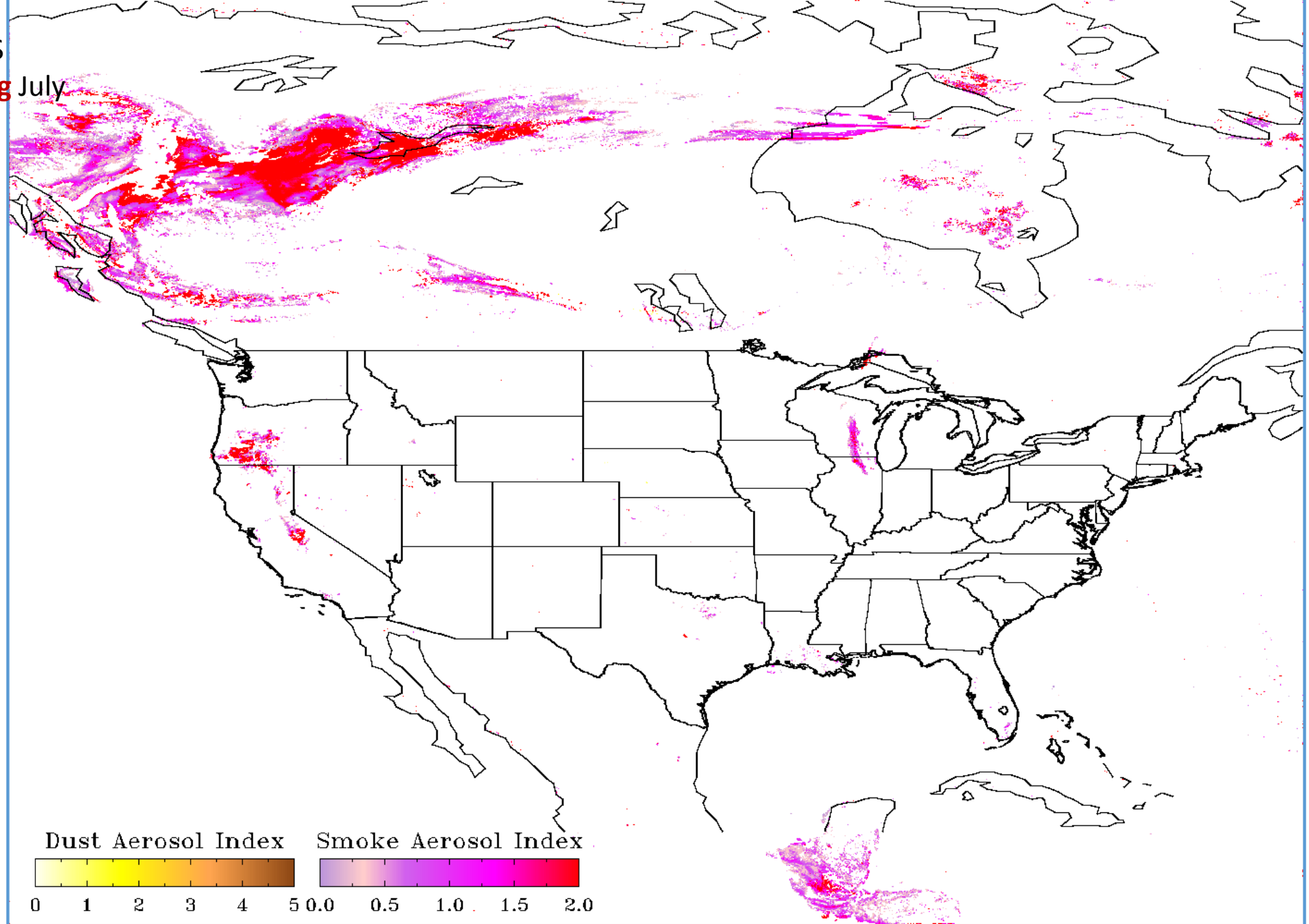
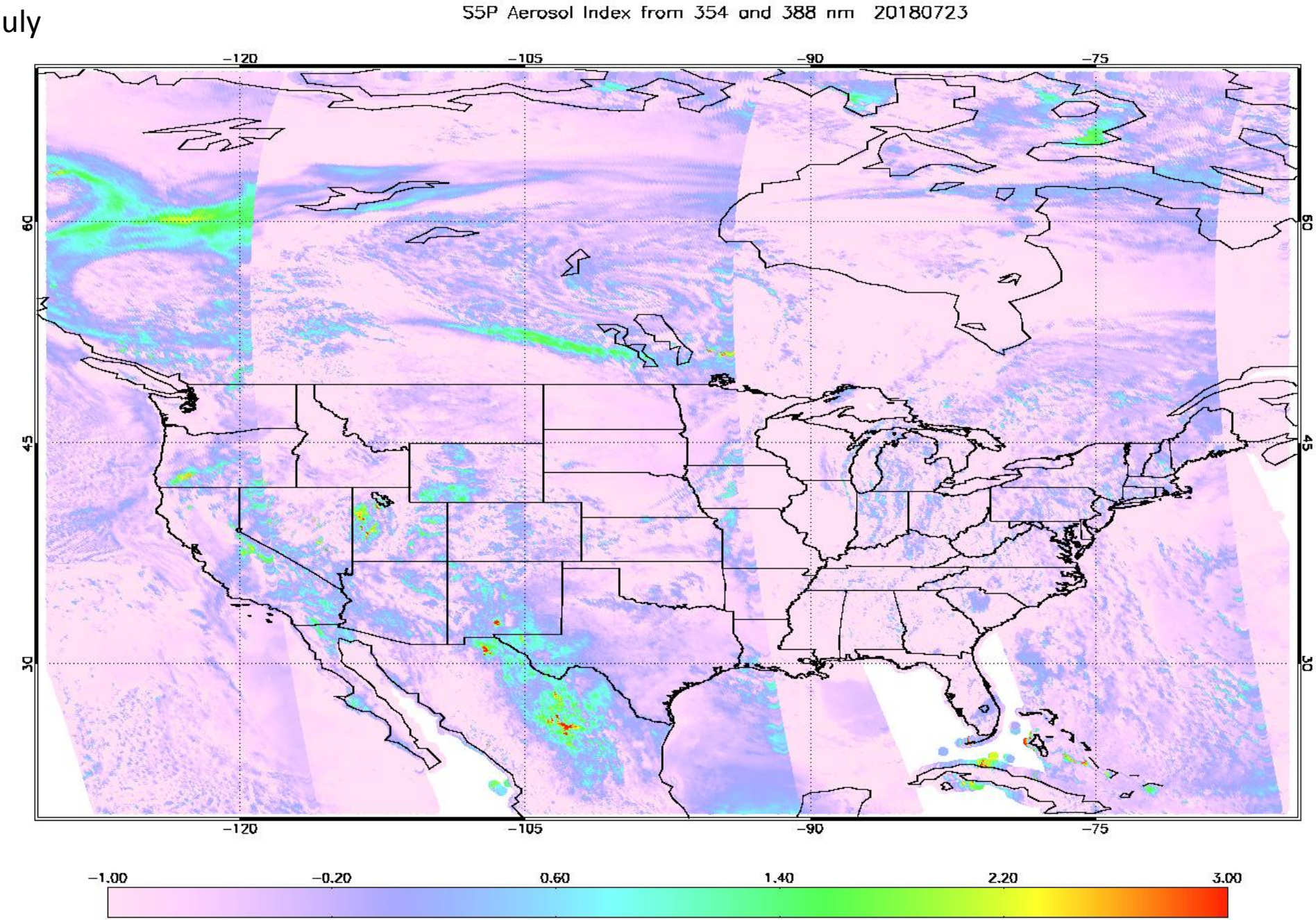
SNPP VIIRS

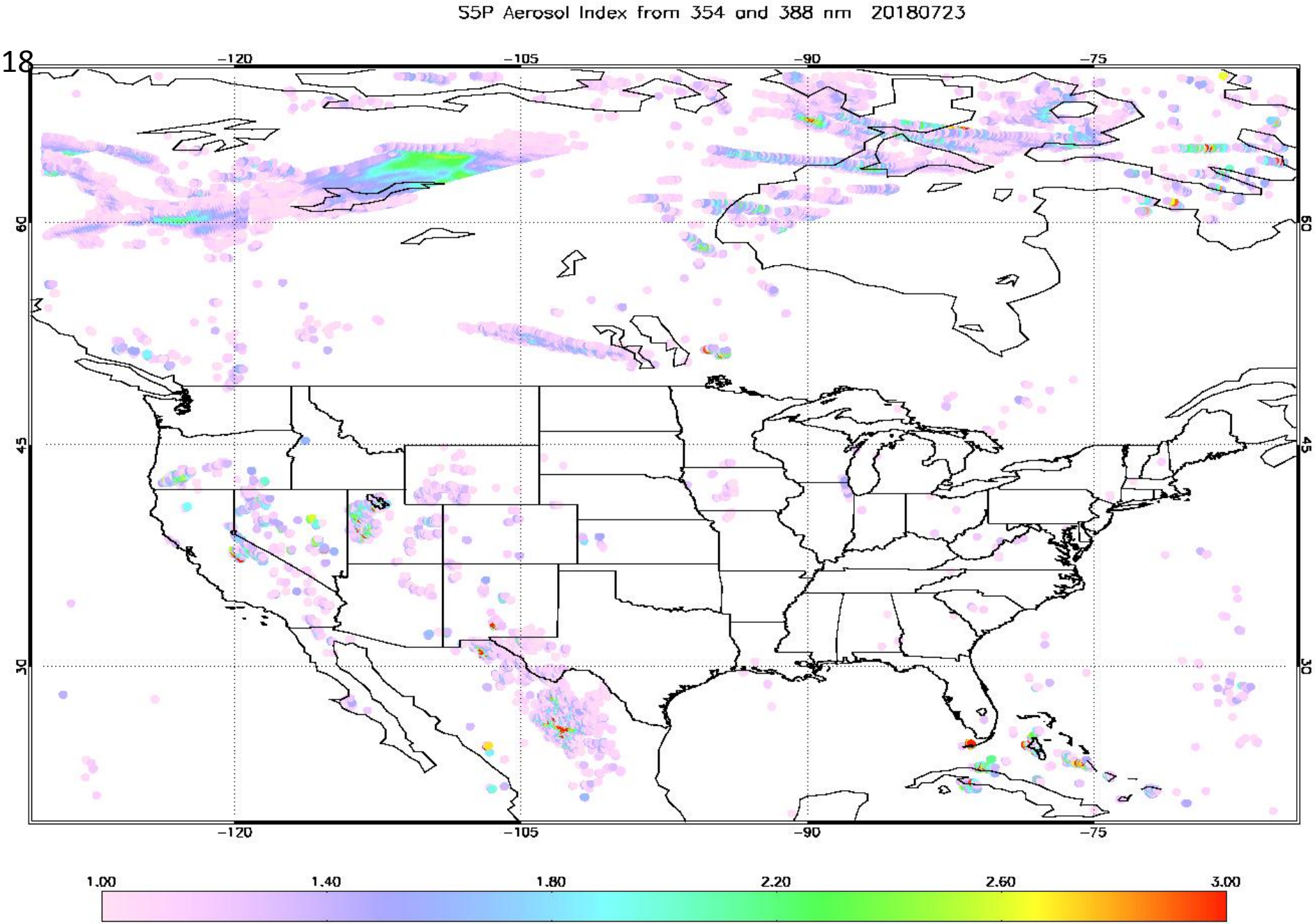
Smoke Flag July 23, 2018



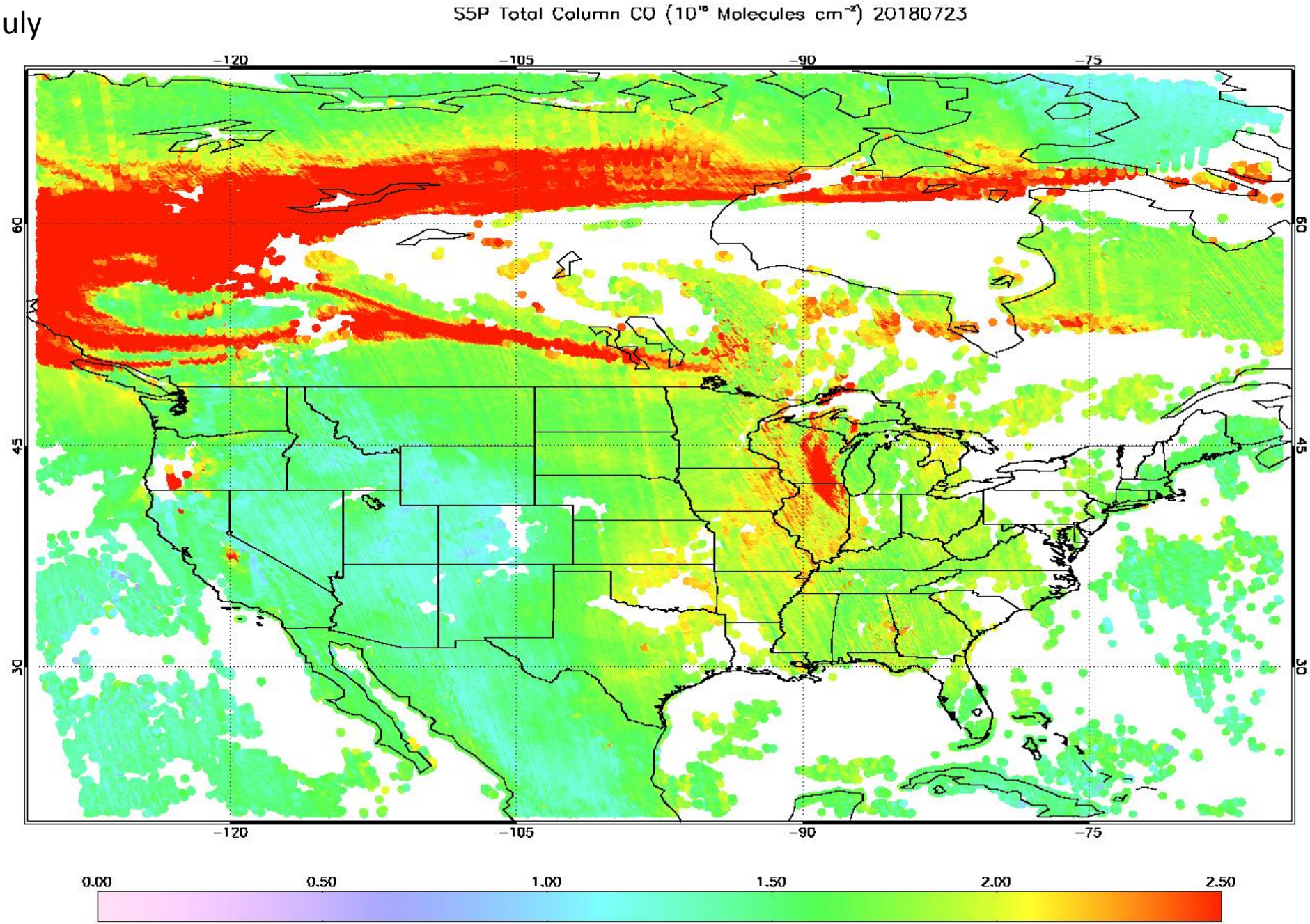
TROPOMI **AI** July 23, 2018



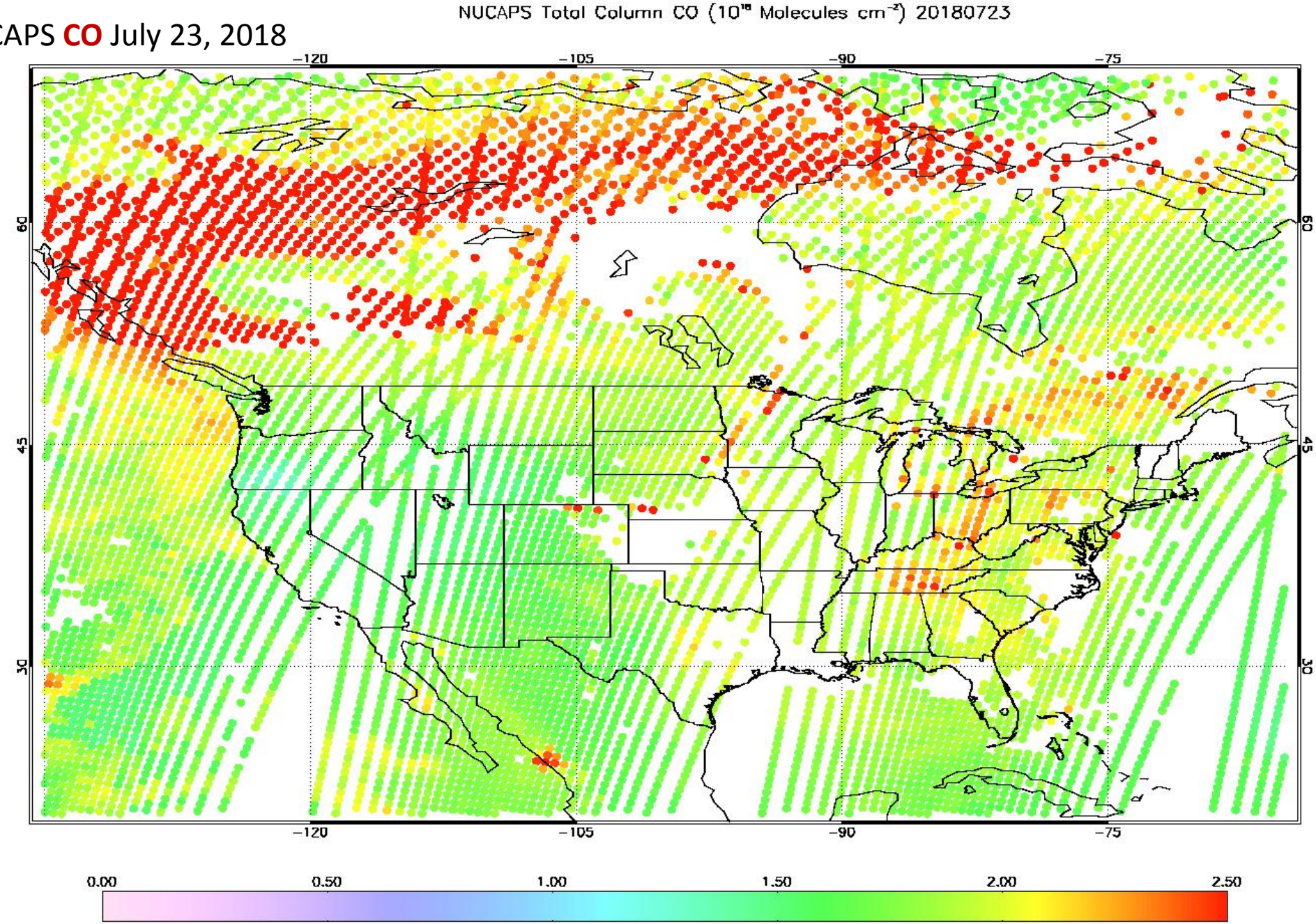
TROPOMI **AI >**
1.0 July 23, 2018



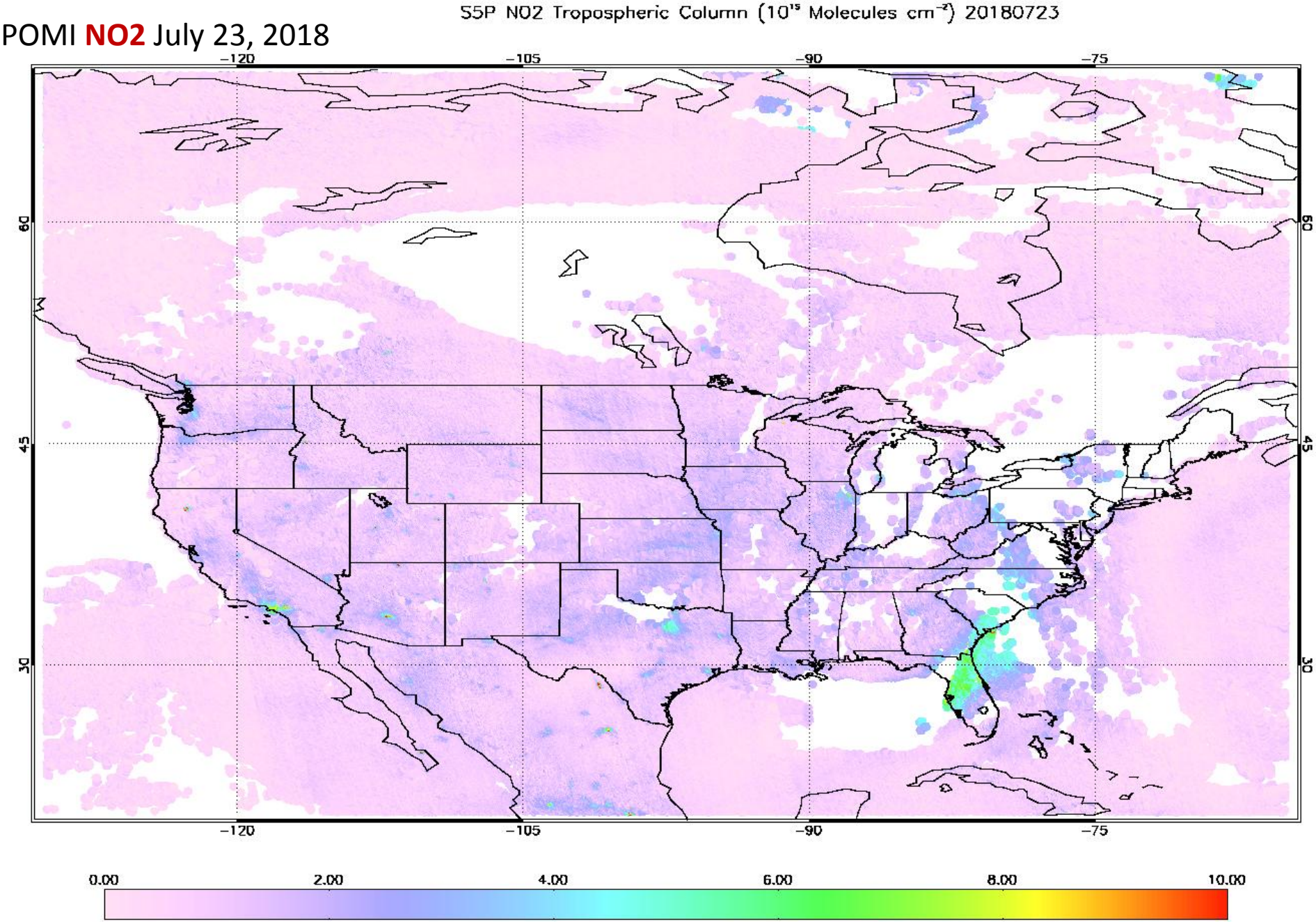
TROPOMI **CO** July 23, 2018

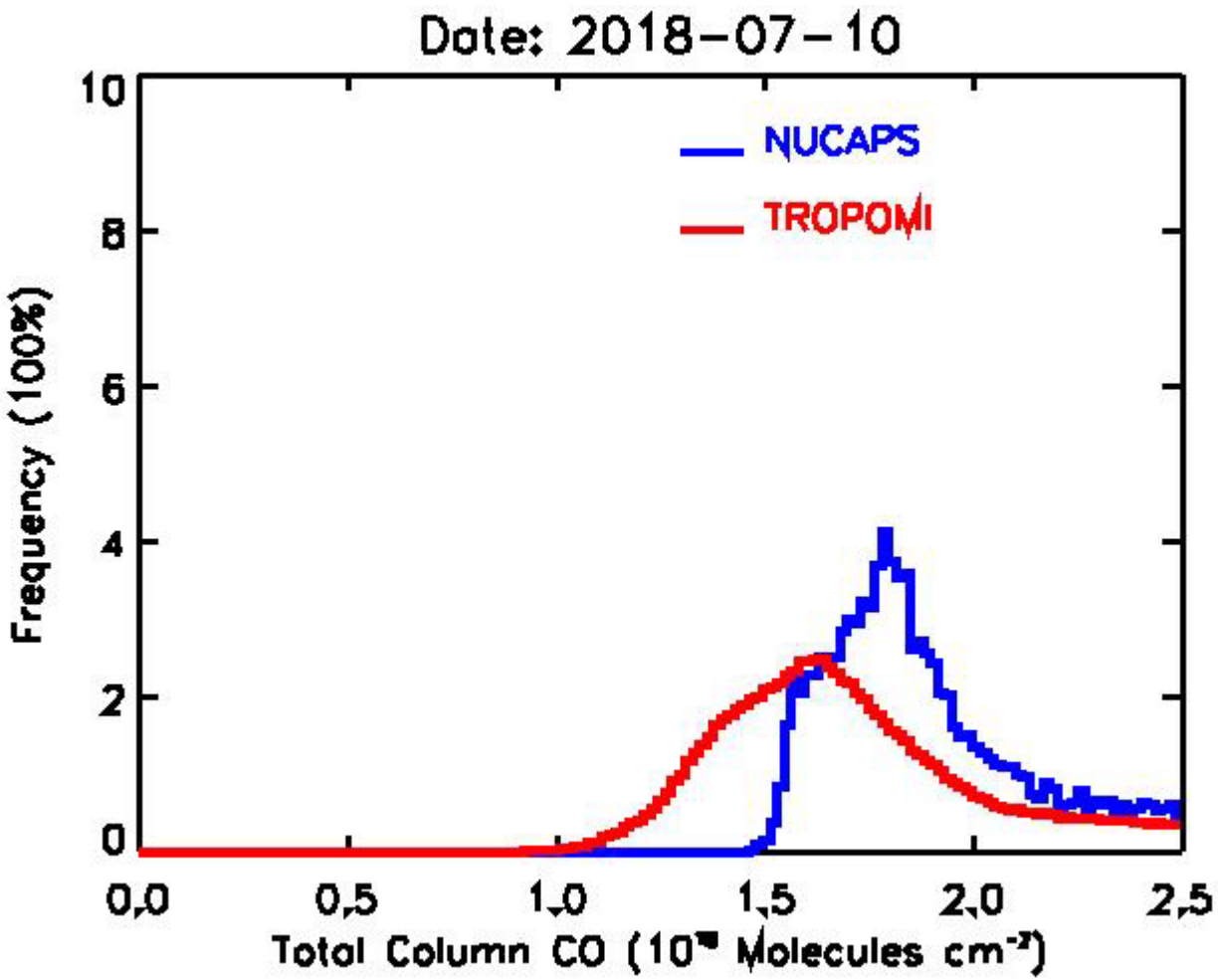


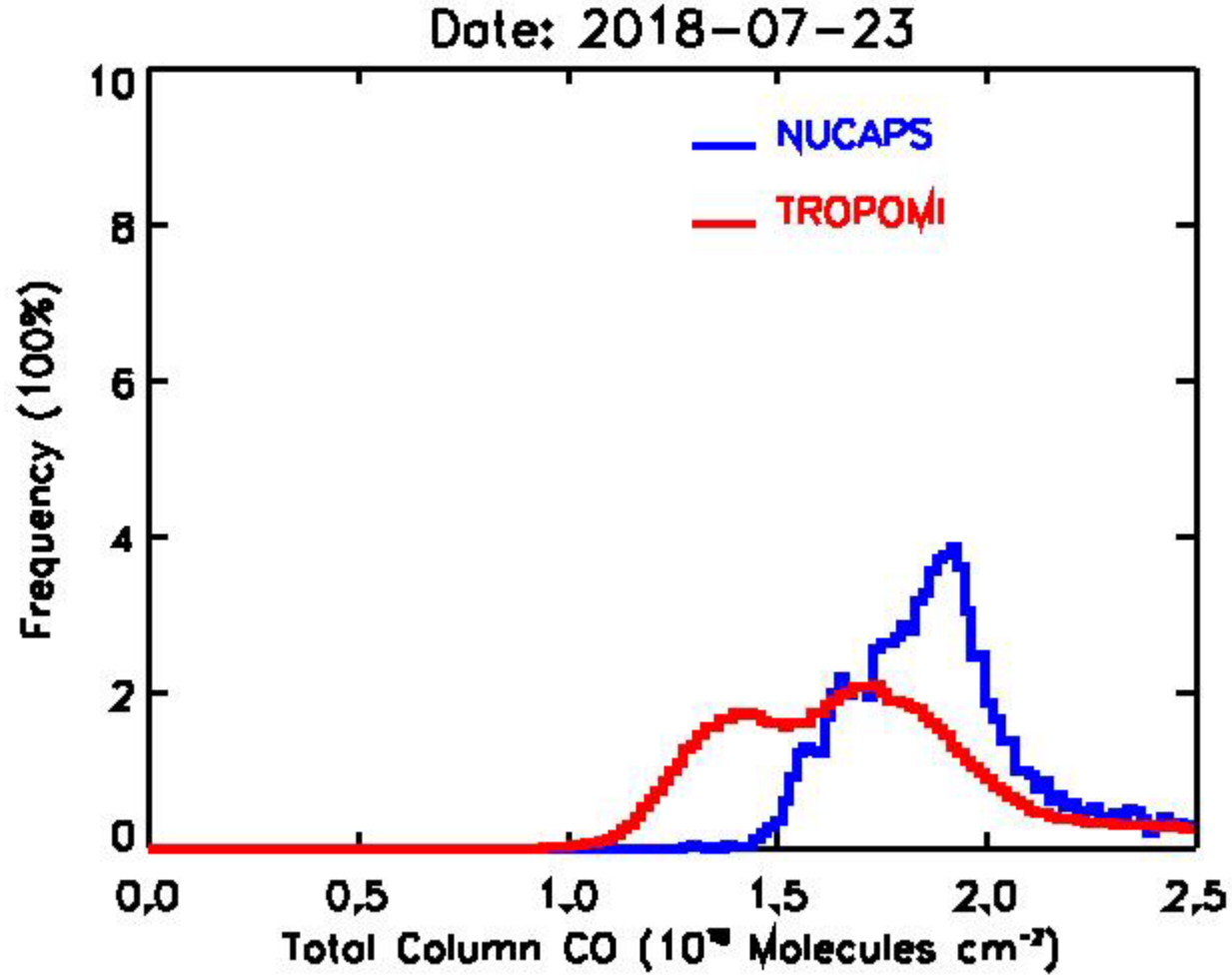
NUCAPS **CO** July 23, 2018



TROPOMI **NO2** July 23, 2018







- More observations in TROPOMI due to higher spatial resolution
- NUCAPS CO peak shifted to higher values than TROPOMI

Summary

- VIIRS true color imagery shows hot spots and smoke
- VIIRS aerosol indices are derived using visible/short-wave IR channels whereas TROPOMI uses UV wavelengths
- VIIRS algorithm does not remove surface contribution
- Analysis shows:
  - TROPOMI AI needs scaling or calibration update?
  - TROPOMI observes smoke over/near clouds that VIIRS missed
  - TROPOMI Carbon Monoxide (CO) plumes are consistent with VIIRS smoke mask. However, parts of CO plume is masked out if QF>0.75 is used.
- TROPOMI NO_2 product does not have enhanced values in smoke plumes

Questions

- Value of TROPOMI trace gas and aerosol index products to forecasters?
- How can forecasters use the products available in near real time through NOAA eIDEA with caveat that products are not available until 5 PM or so?
- Forecasters interested in participating in a test experiment of issuing a forecast with and without TROPOMI products to assess the value of CO, NO_2, and aerosol index please contact me or Amy.