Aerosol Retrieval Algorithm for TEMPO

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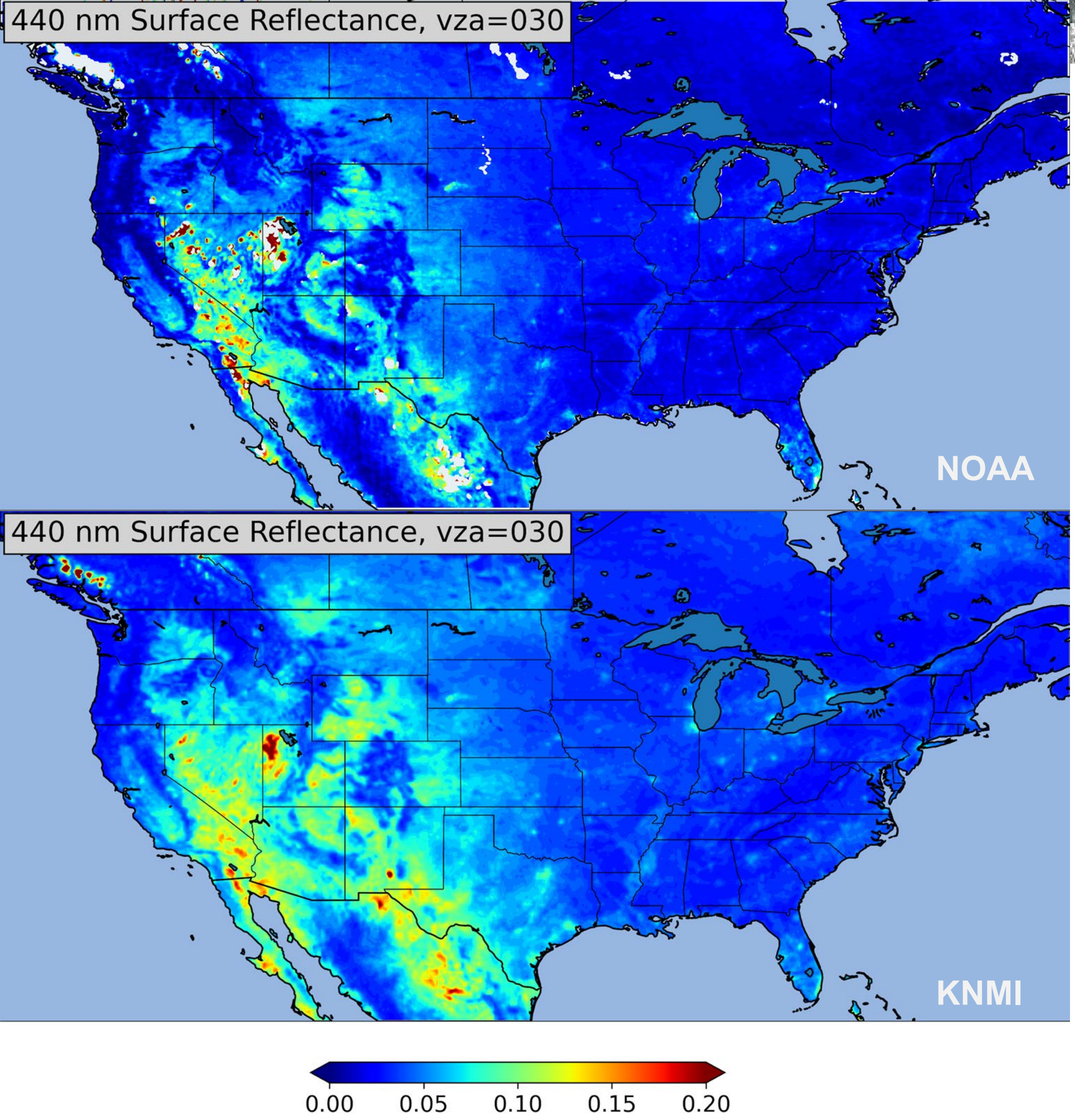
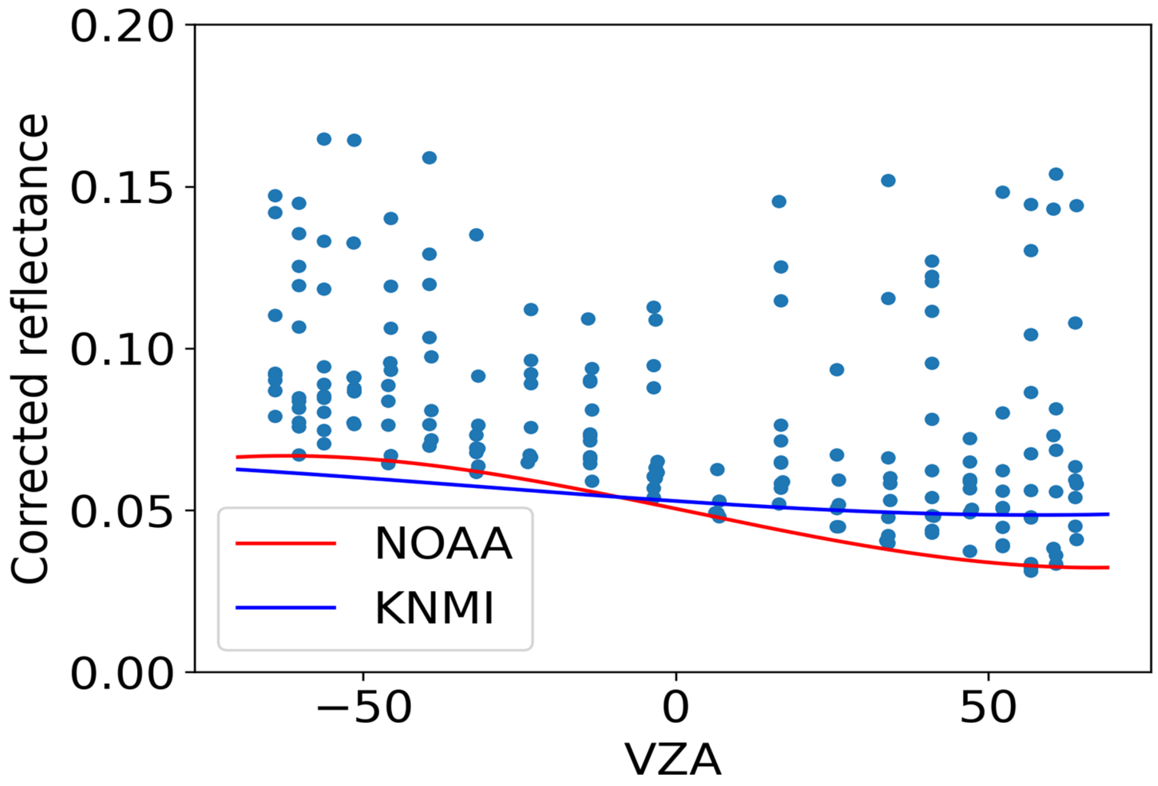
Aerosol Retrieval Algorithm Development

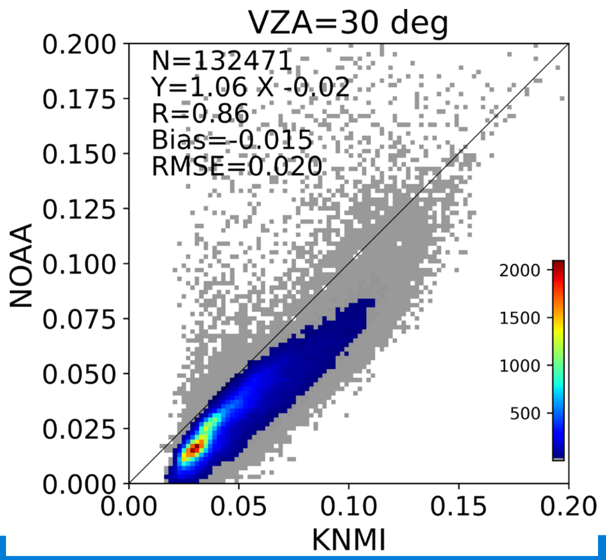
- Enterprise approach in NOAA:
  - Same algorithm is used for different sensors and capable to produce consistent retrievals, including geostationary sensors and polar-orbiting sensors
  - NOAA developed aerosol optical depth (AOD) enterprise retrieval algorithm that runs on VIIRS, ABI, AHI data
  - Code easy to maintain
- Aerosol retrieval for TEMPO and ACX
  - AOD
  - Aerosol layer height (ALH) using O_2B band (688 nm)
- Adapt enterprise aerosol optical depth (AOD) retrieval algorithm from VIIRS and ABI
  - Same algorithm used on both GEO and LEO sensors
- Adapt aerosol layer height (ALH) retrieval algorithm using O_2 bands by Chen et al. 2021
- Use TROPOMI data as proxy
  - TEMPO in orbit but data not available yet

Aerosol Retrieval Algorithm Development

- Spectral selection
  - Hyperspectral measurements are convolved to the bands 354, 388, 416, 440, 494, 670, 687.75, 764, 780, 2314 nm using a triangle function (bands in red are not available in TEMPO)
- Look-up Table (LUT) generation
  - TOA reflectance of the bands for different AOD, ALH, surface reflectance, surface pressure, and Sun-satellite geometry
  - Smoke, dust, generic aerosol models
  - UNL-VRTM
- Directional Lambertian Equivalent Reflectivity (DLER) Database
  - TROPOMI L1b data is regridded into 0.1 degree
  - Atmospheric correction using 0.025 background AOD (from AERONET analysis)
  - Generate lower bound using multiyear data
  - $A_{DLER} = A_{LER} + c_0 + c_1\theta_v + c_2\theta_v^2 + c_3\theta_v^3$







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An enhanced VIIRS aerosol optical thickness (AOT) retrieval algorithm over land using a global surface reflectance ratio database

Hai Zhang, Shobha Kondragunta, Istvan Laszlo, Hongqing Liu, Lorraine A. Remer, Jingfeng Huang, Stephen Superczynski, Pubu Ciren

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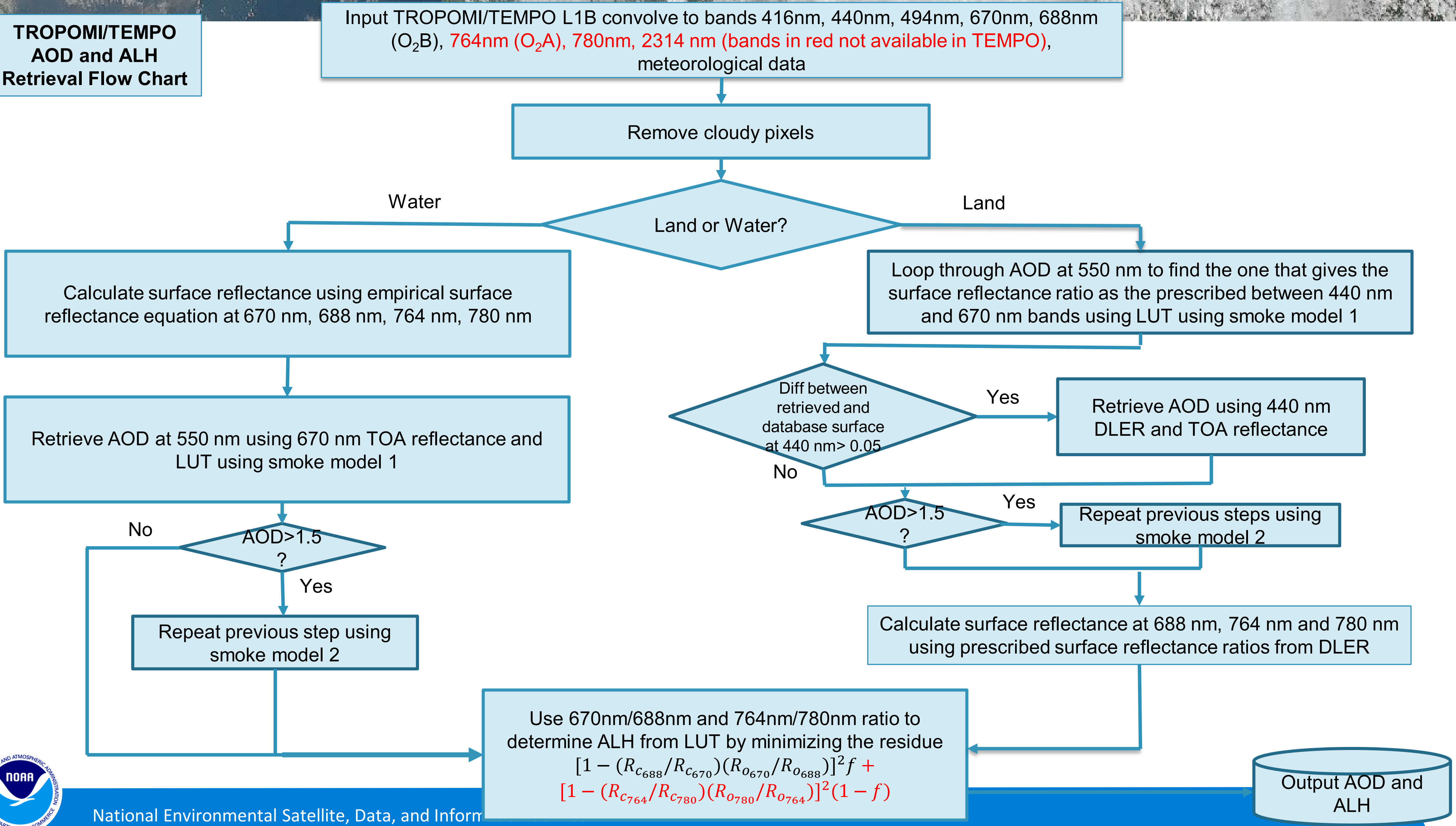
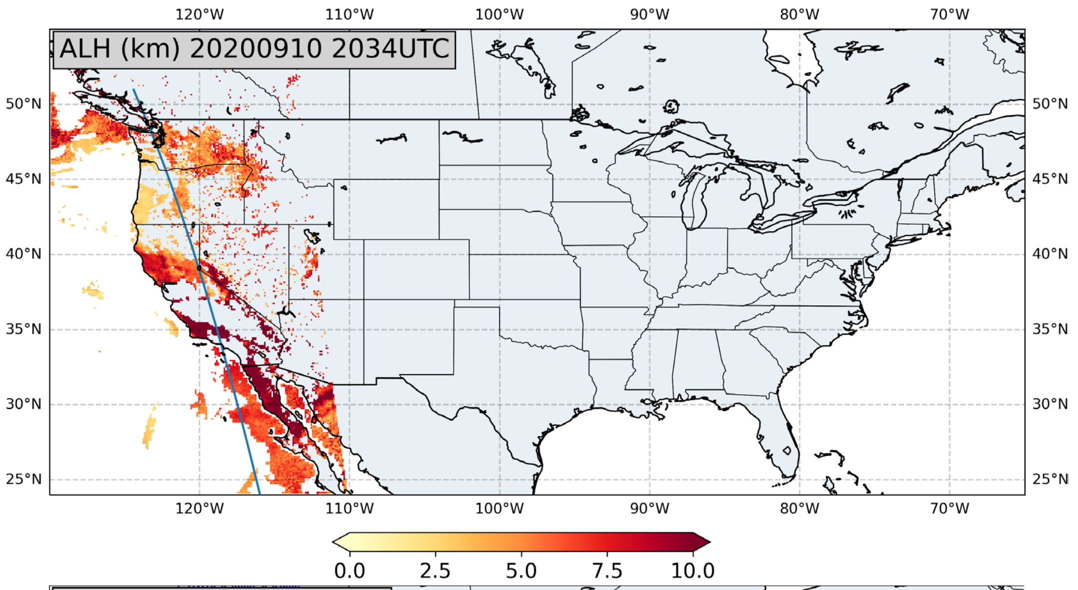
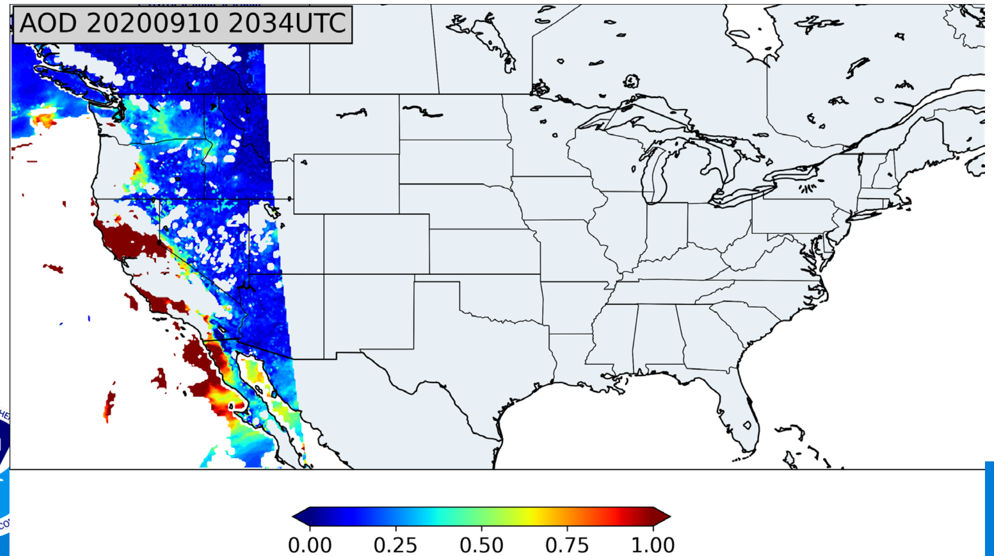
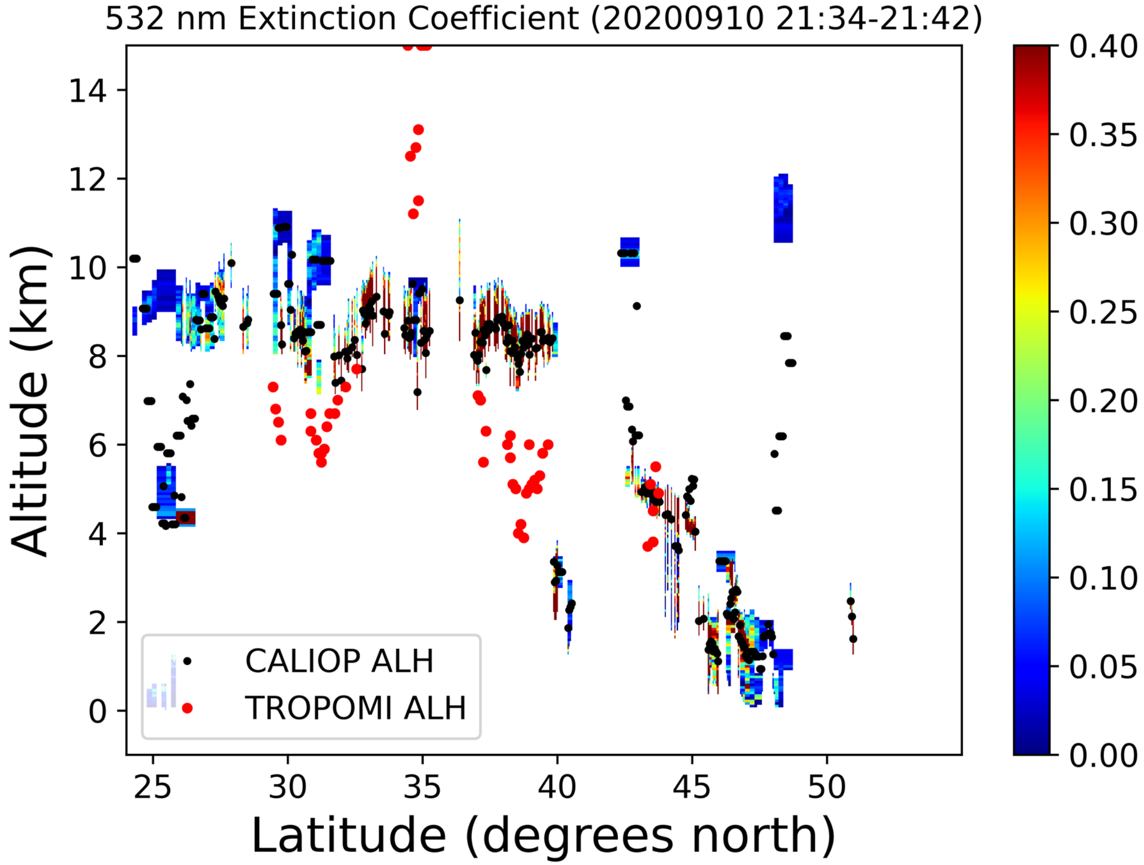
TROPOMI/TEMPO AOD and ALH Retrieval Flow Chart



Example 1: September 10, 2020 2034 UTC

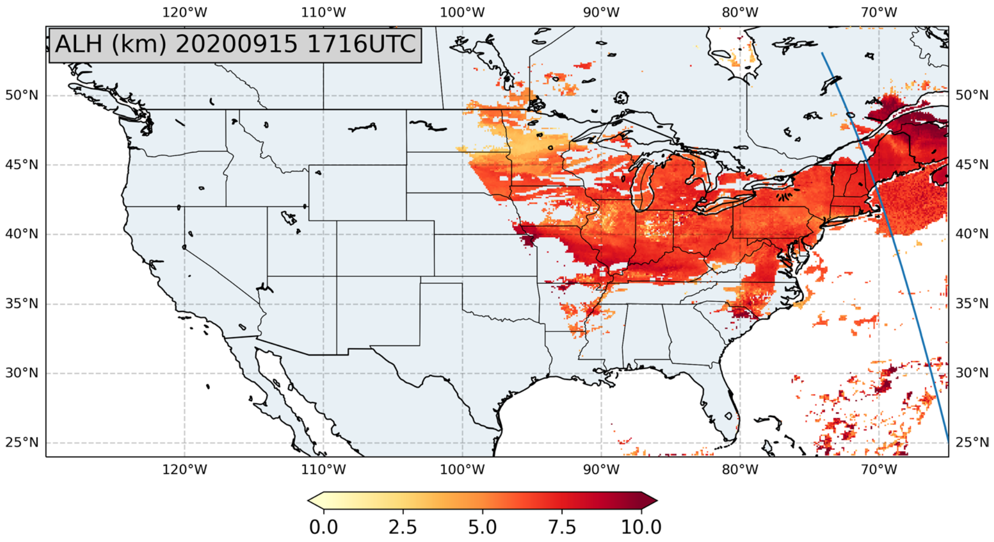


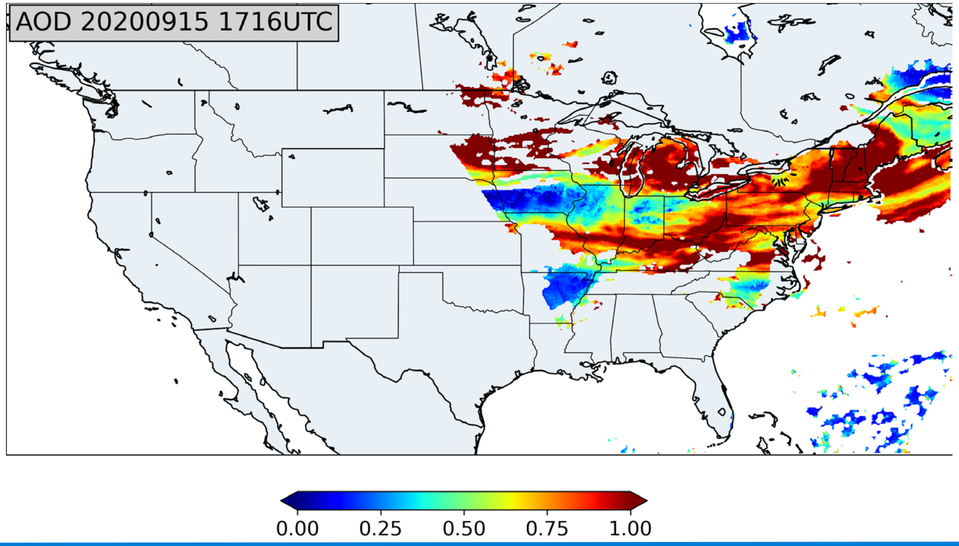


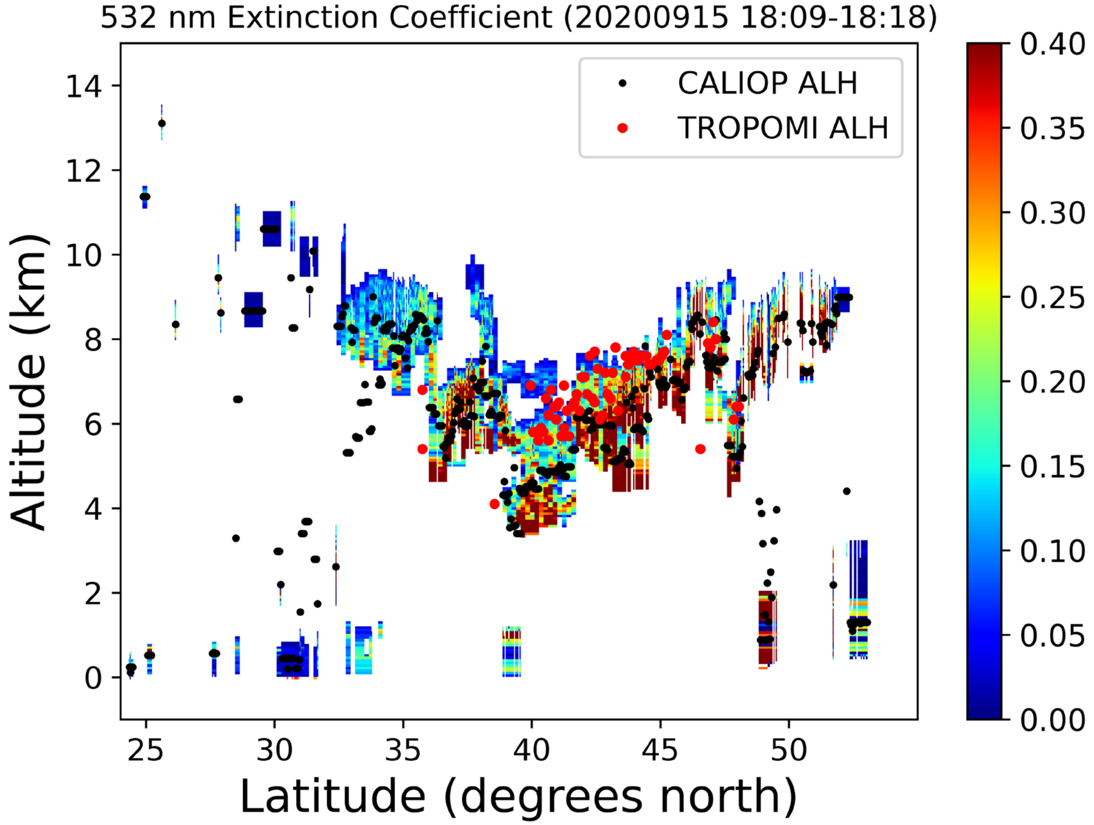


$$ALH = \frac{\sum_{i=1}^{n} \beta_i Z_i}{\sum_{i=1}^{n} \beta_i}$$

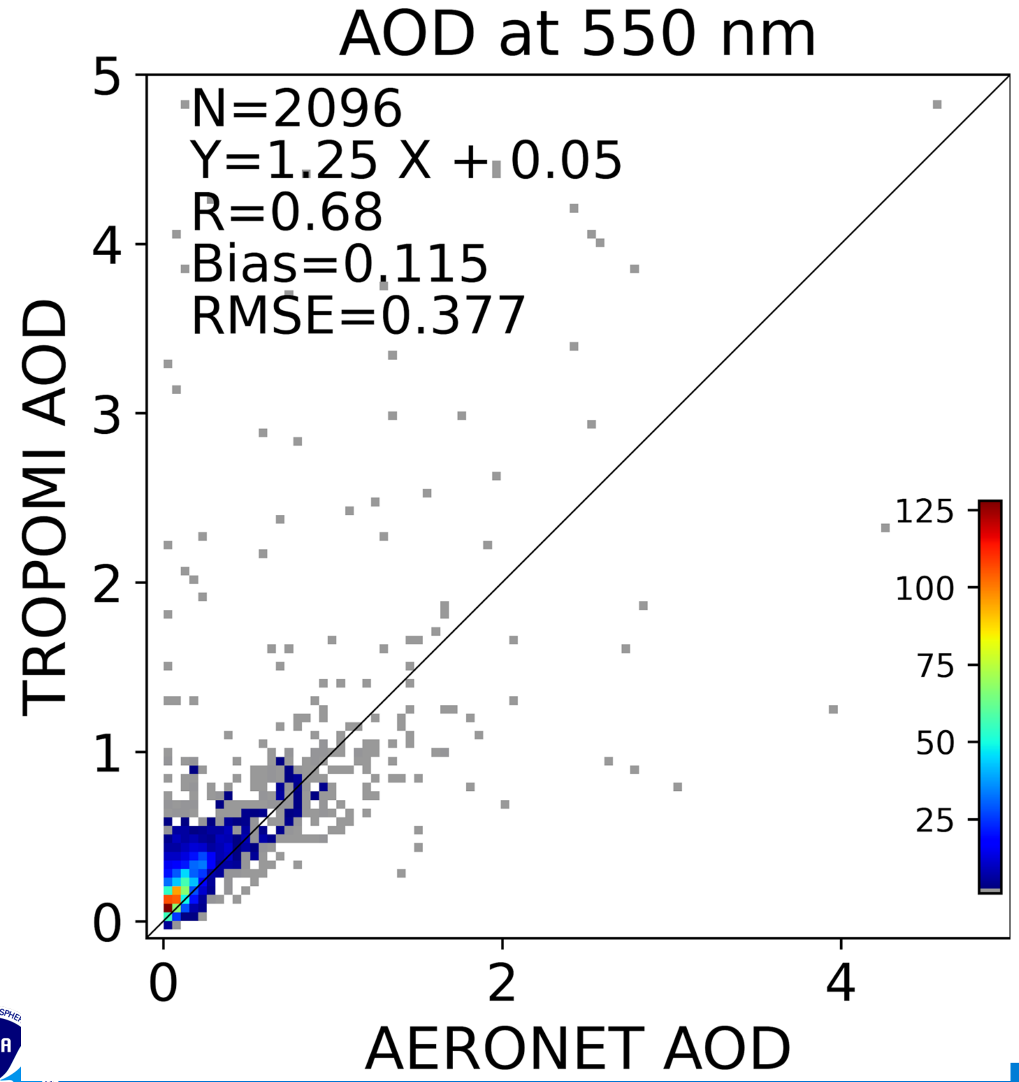
Example 2: September 15, 2020 1716 UTC

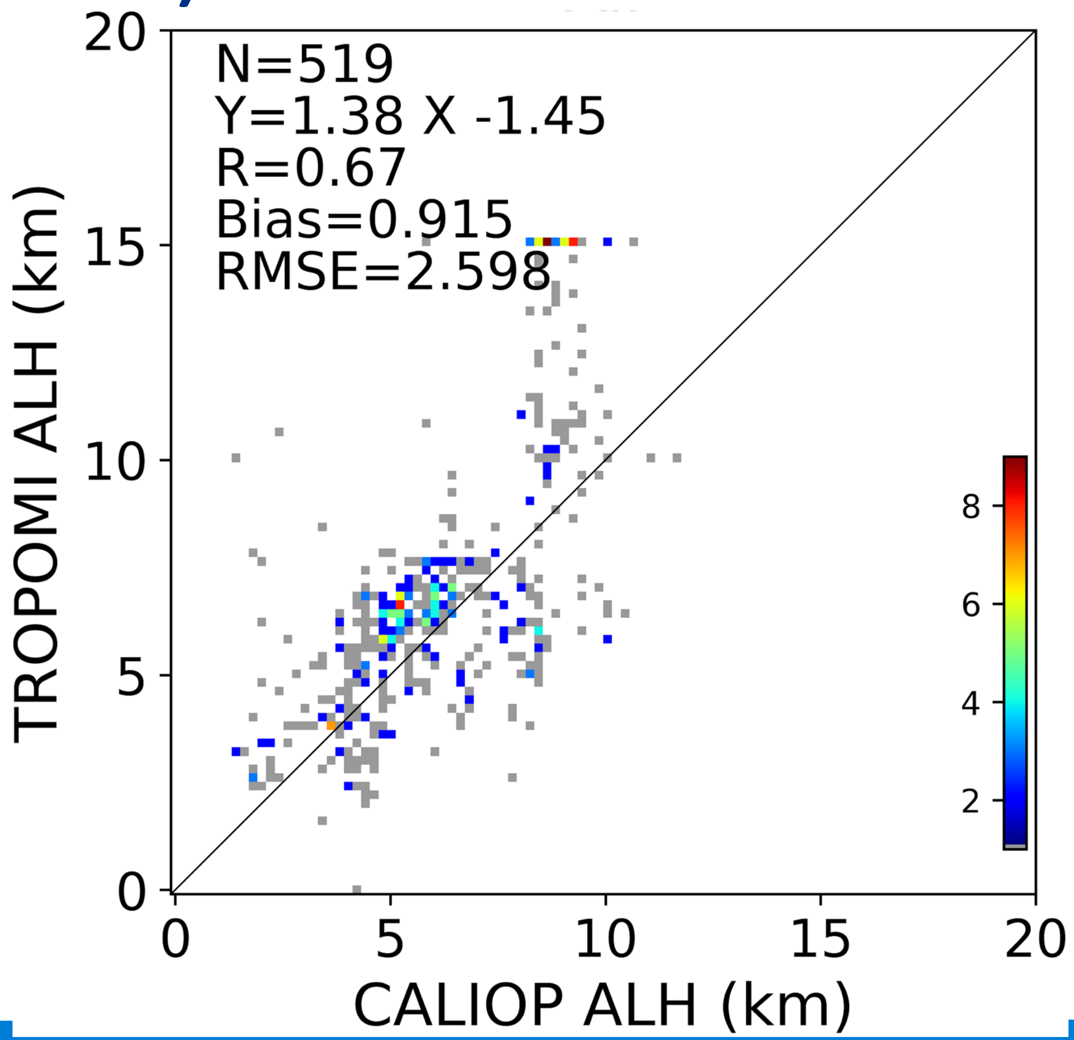






Algorithm Performance (August-September, 2020)



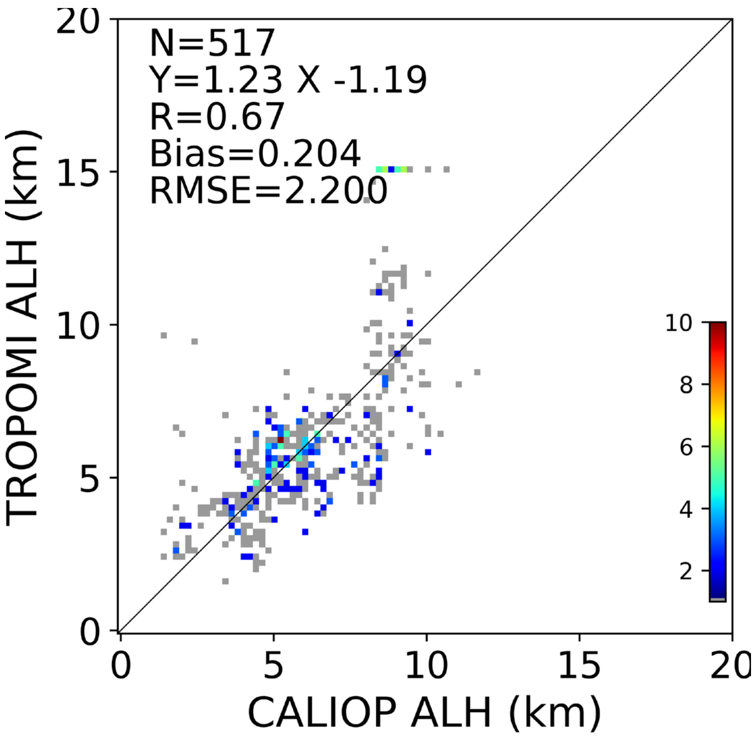


Sensitivity to aerosol model

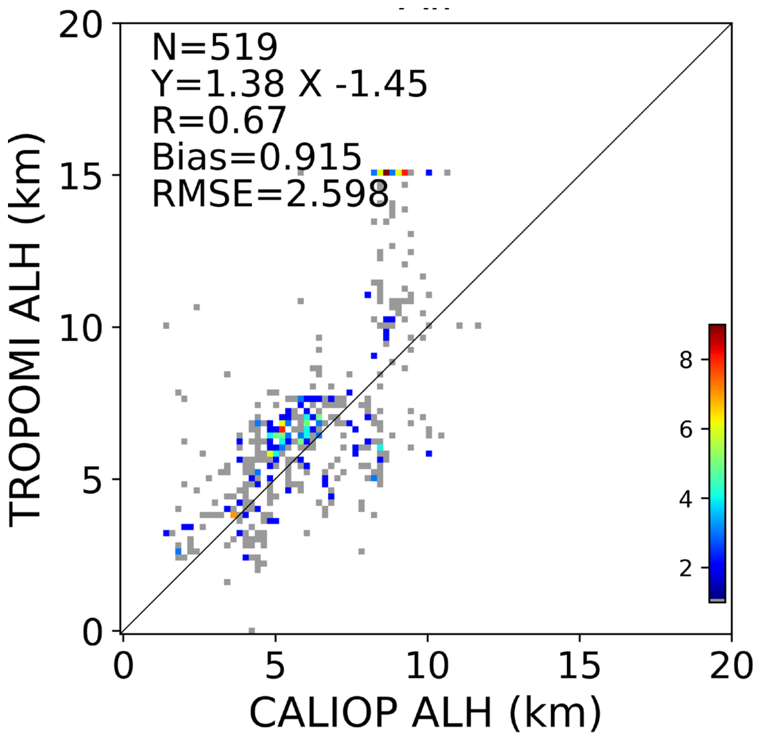
- The two smoke models used were derived from AERONET sites over CONUS
- The smoke model from VIIRS AOD retrieval algorithm was also tested, which is derived from global AERONET sites
- The largest differences of the models are their imaginary refractive indices
- VIIRS smoke model (global) has the largest absorption

AOD=1.0 at 550 nm	Smoke model CONUS 1	Smoke model CONUS 2	VIIRS Smoke model (global)
Real part of refractive index	1.55	1.54	1.51
Imaginary part of refractive index	0.0046	0.0096	0.02
SSA at 550 nm	0.96	0.92	0.87

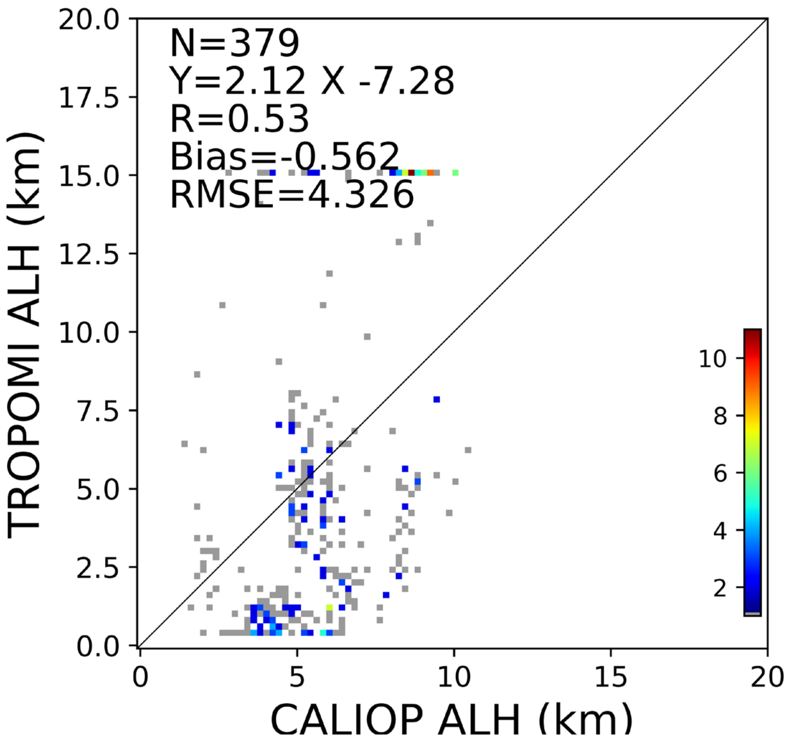
Sensitivity of ALH to aerosol model



Use smoke model CONUS 2

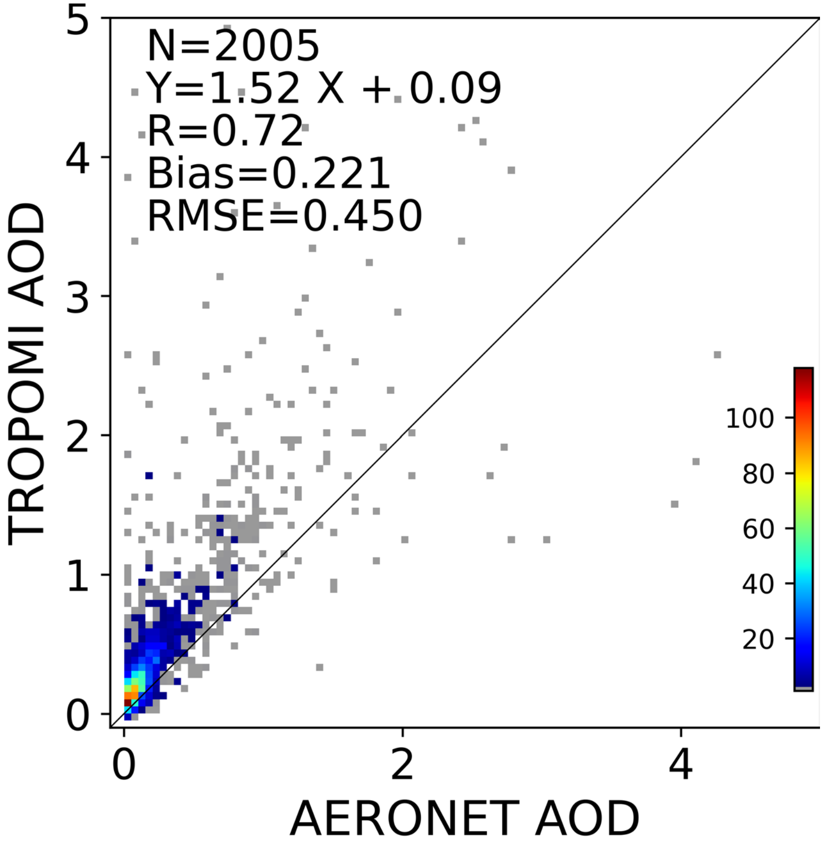


Use smoke model CONUS 1 for AOD < 1.5
Use smoke model CONUS 2 for AOD >=1.5

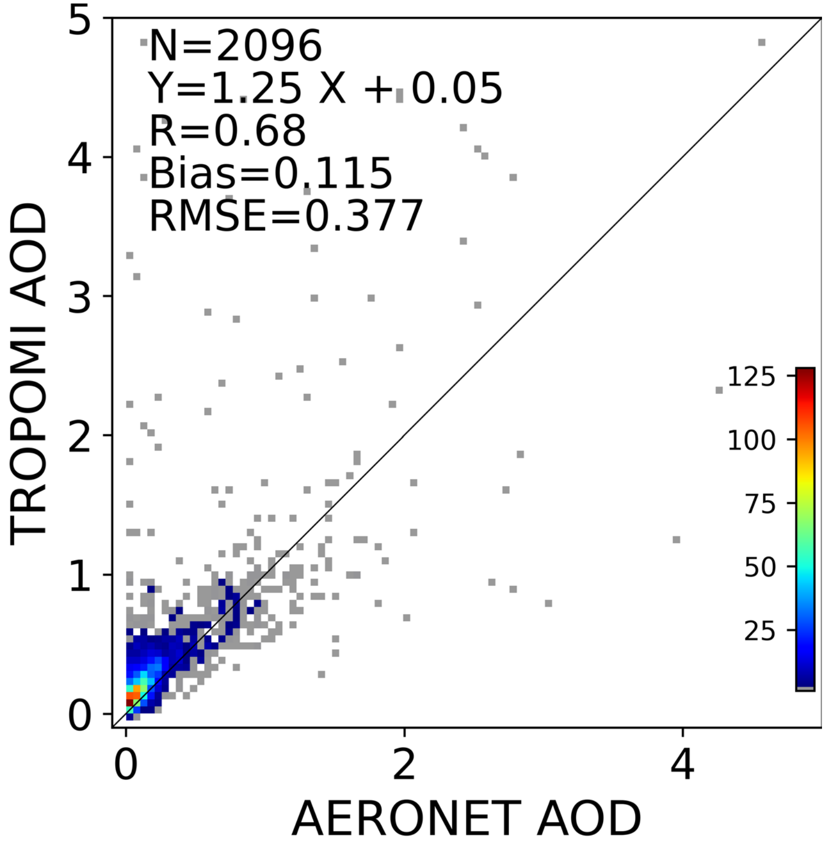


Use the VIIRS smoke model (global)

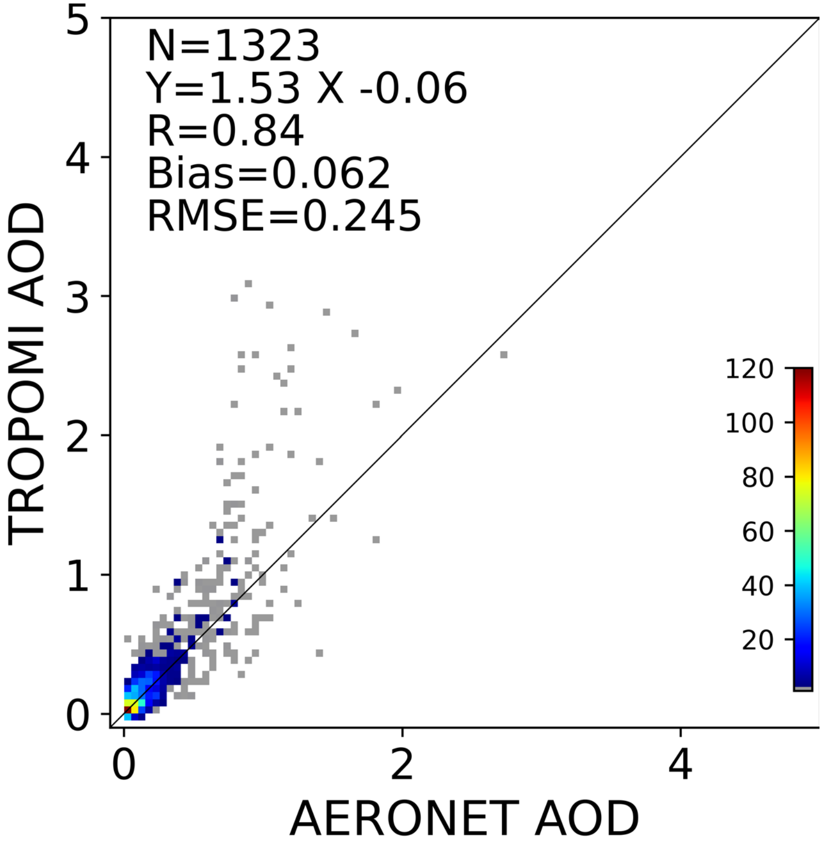
Sensitivity of AOD to aerosol model



Use smoke model CONUS 2



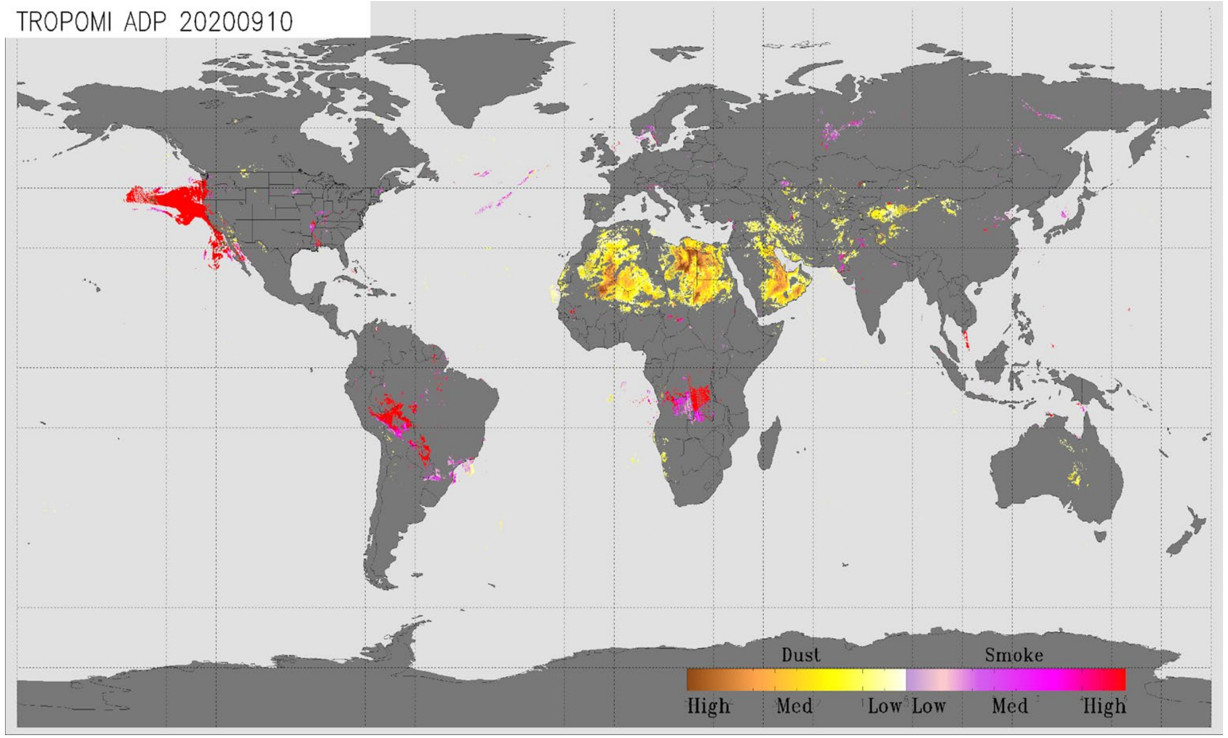
Use smoke model CONUS 1 for AOD < 1.5
Use smoke model CONUS 2 for AOD >=1.5



Use the VIIRS smoke model (global)

Ongoing Aerosol Algorithm Work

- Current work only includes two smoke aerosol models. One smoke model is used for AOD<=1.5 and the other for AOD>1.5
- Only retrieve ALH with UVAI>1.0.
- Plan to add "generic" and "dust" aerosol models. ADP product (smoke and dust mask) will inform which model to choose.
- Work with NASA science team member Omar Torres in using some of his algorithm development and utilize UV observations to derive additional information such as single scattering albedo.



Absorbing Aerosol Index

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

Dust Smoke Discrimination Index

$$DSDI = -10[\log_{10}(R_{412}/R_{2250})$$

Summary

- The aerosol optical depth and aerosol layer height retrieval algorithm was developed for TEMPO using TROPOMI data as proxy
- The LUT and surface DLER database was built
- The retrieval algorithm was tested on TROPOMI data using smoke models and the results compare well with AERONET AOD and CALIOP ALH
- Tests show that ALH retrieval is sensitive to aerosol model selections
- Further development is ongoing so that the algorithm can select aerosol models dynamically and can retrieve SSA