Satellite Aerosol Layer Height: Opportunities and Challenges

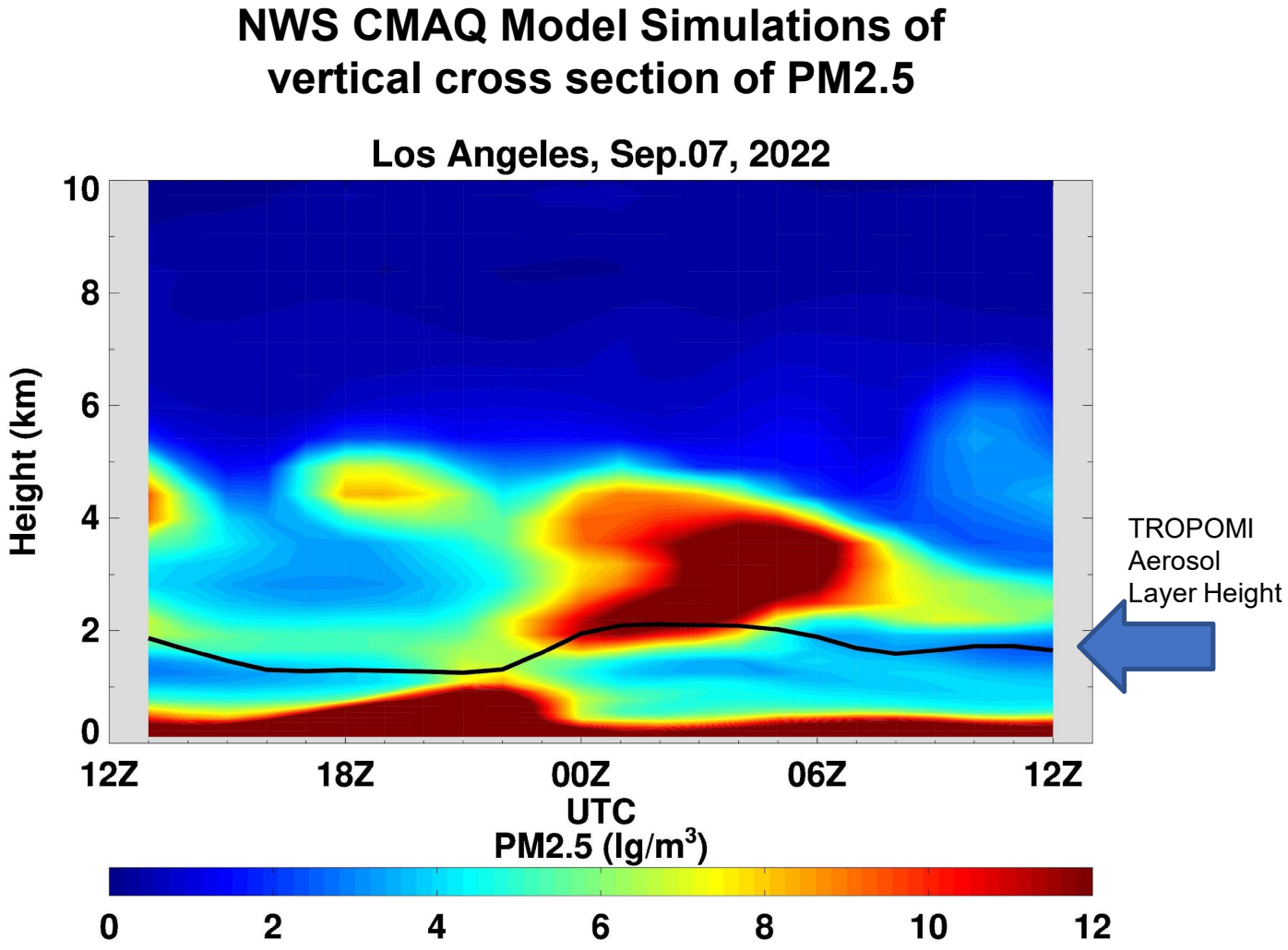
Shobha Kondragunta (NOAA)

Aerosol Layer Height: opportunities

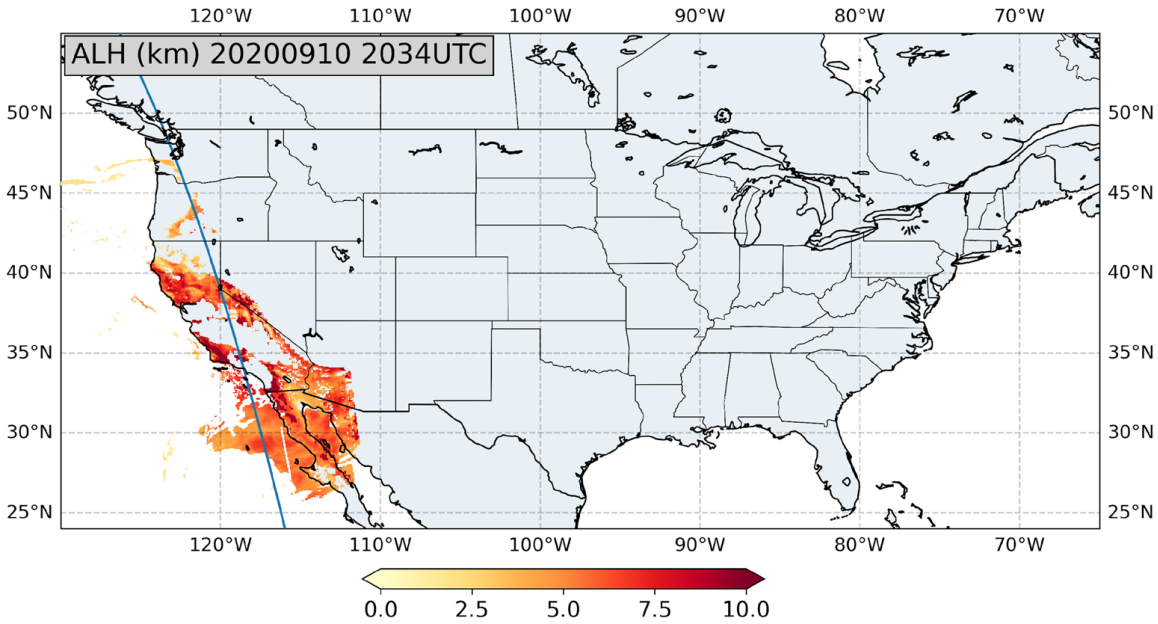
- Useful for scaling observed AOD to surface PM2.5
- Aerosol data assimilation
- Plume injection height for fire emissions in models

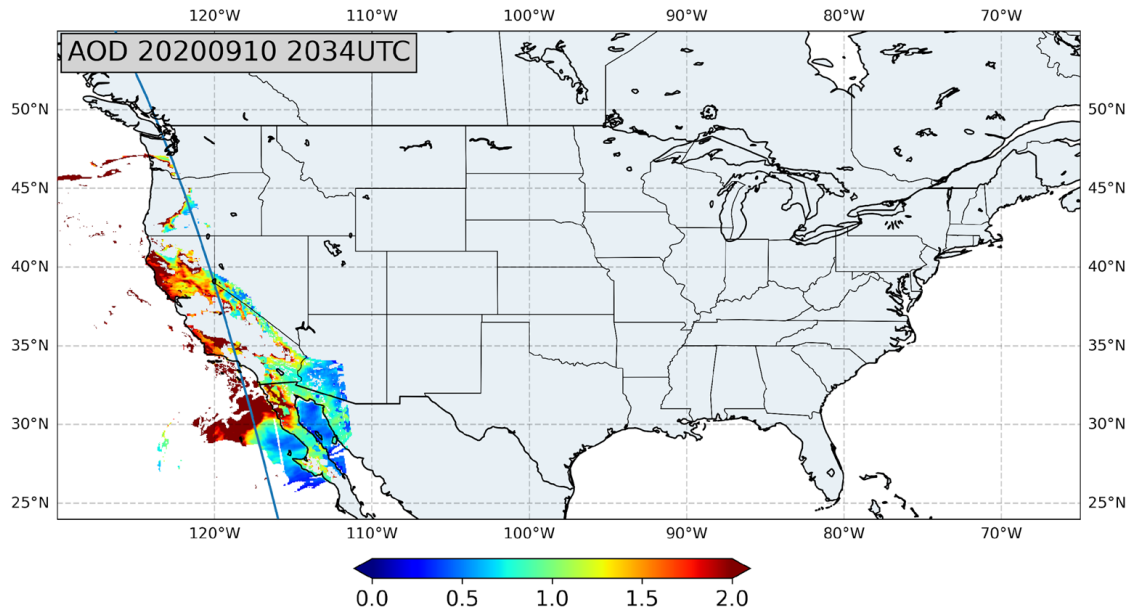
Aerosol Layer Height: challenges

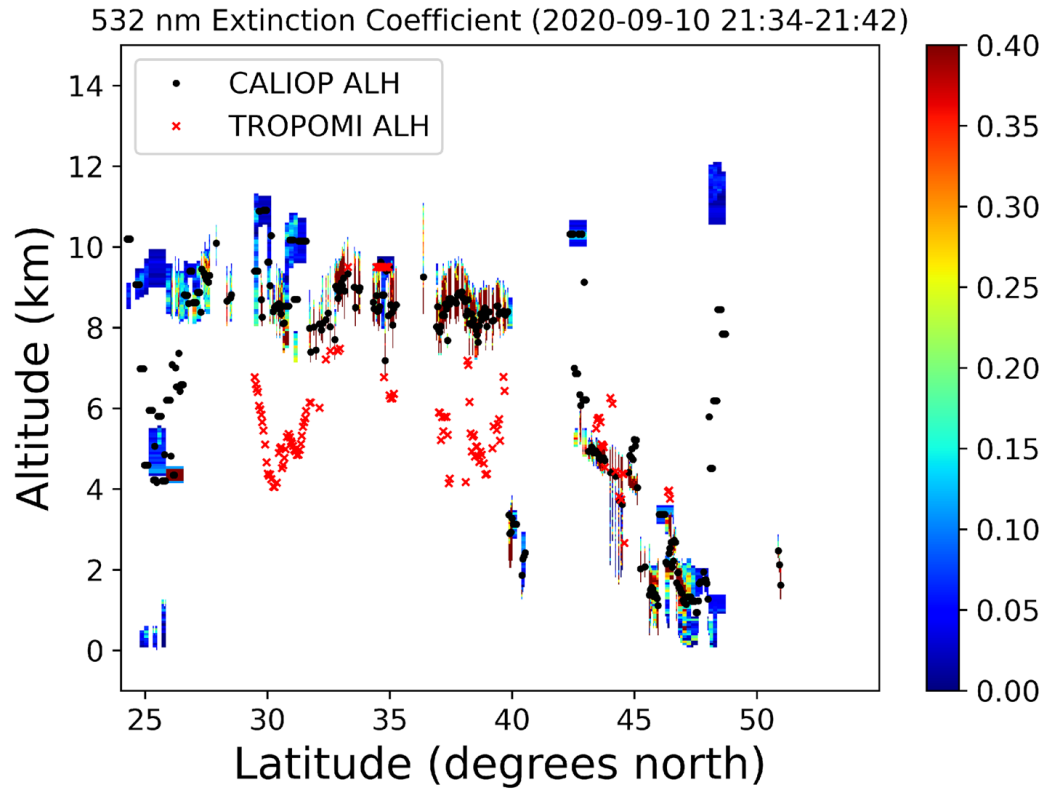
- Retrieval is not a true vertical profile. At best, it is a guesstimate of where the thickest part of aerosol layer is present in the vertical
- No counter part in the model. In the model, vertical profile has a fine structure depending on model vertical resolution, atmospheric dynamics etc.
- Evaluating satellite retrieval of aerosol layer height is very challenging



Source Region Aerosol

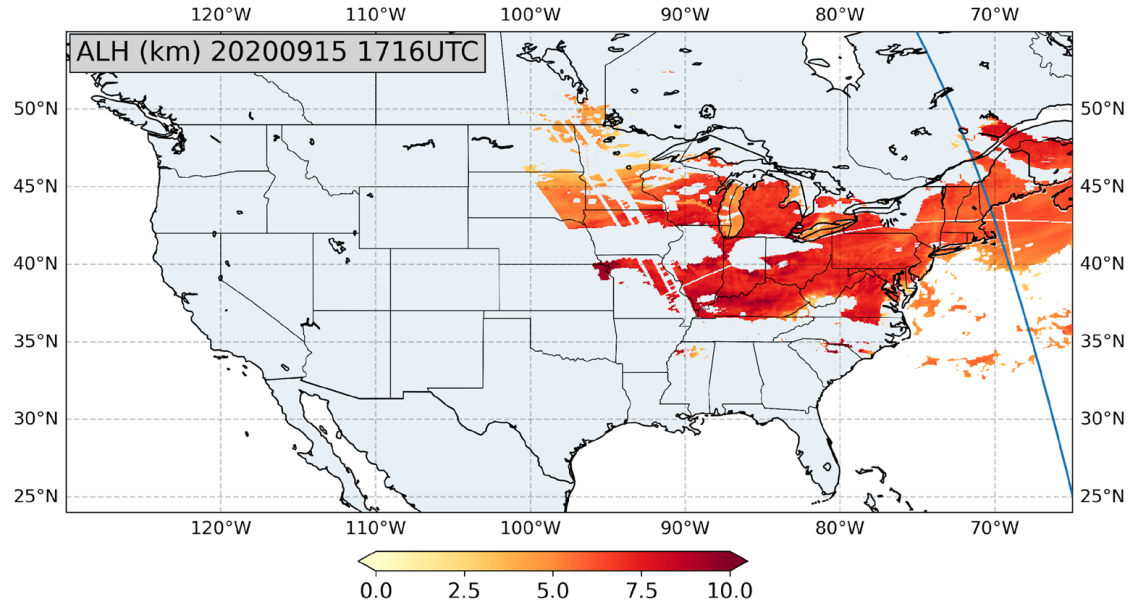


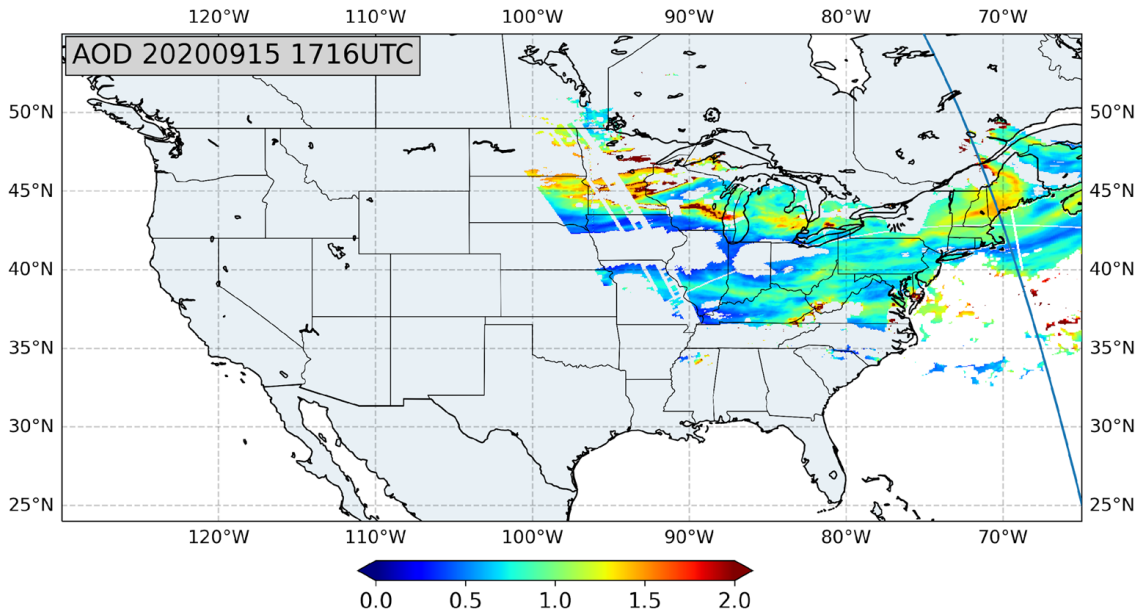


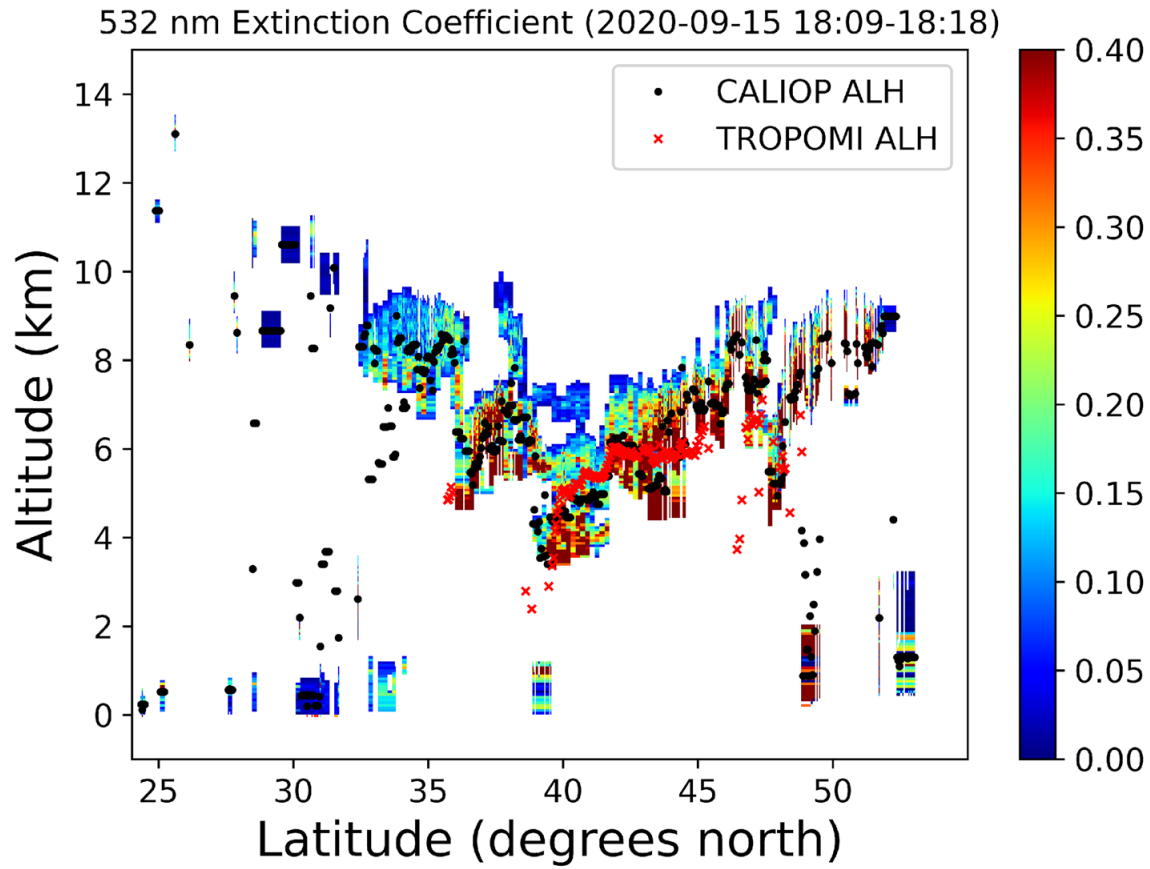


CALIOP data from NASA

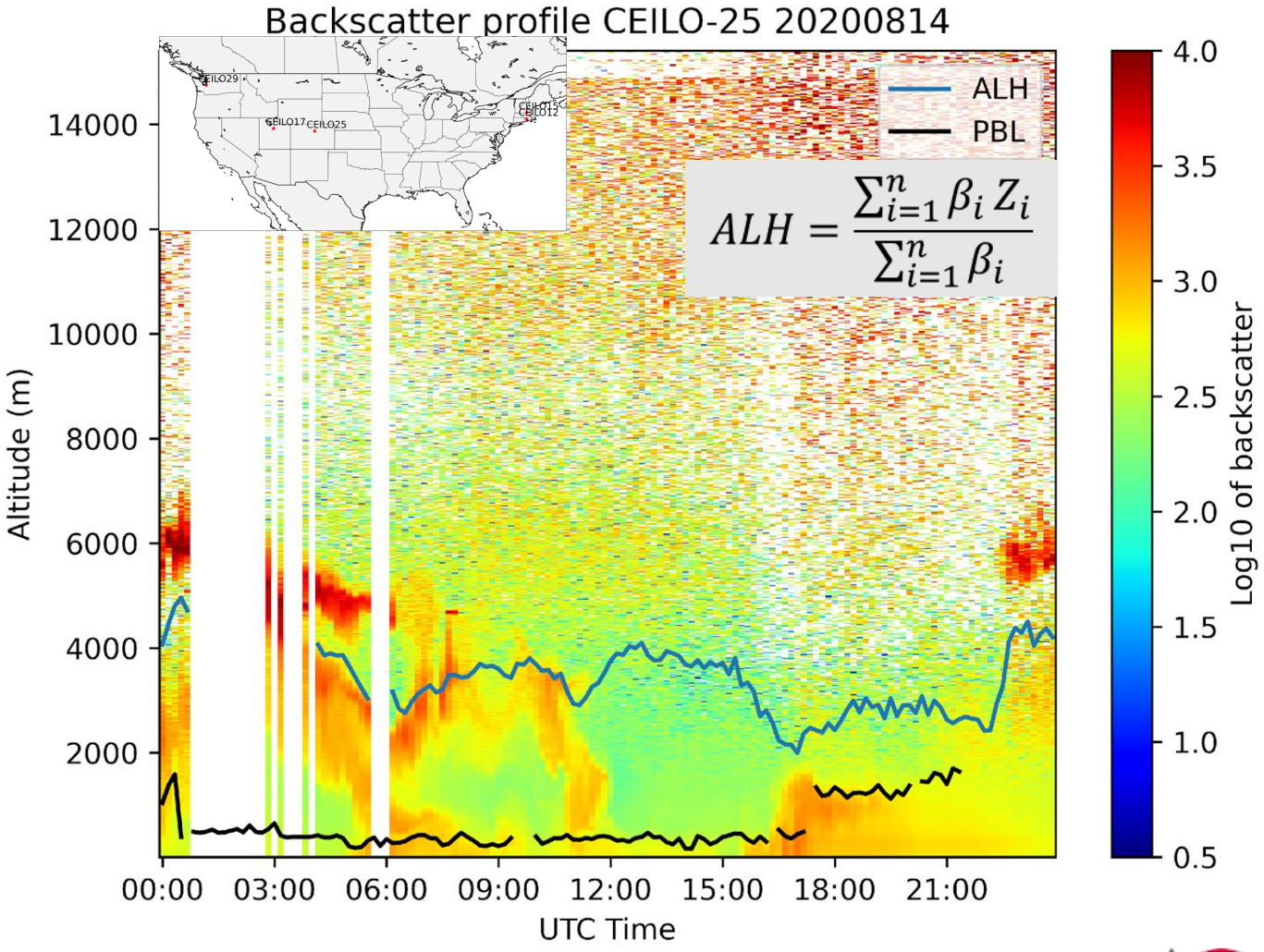
Transported Region Aerosol







CALIOP data from NASA

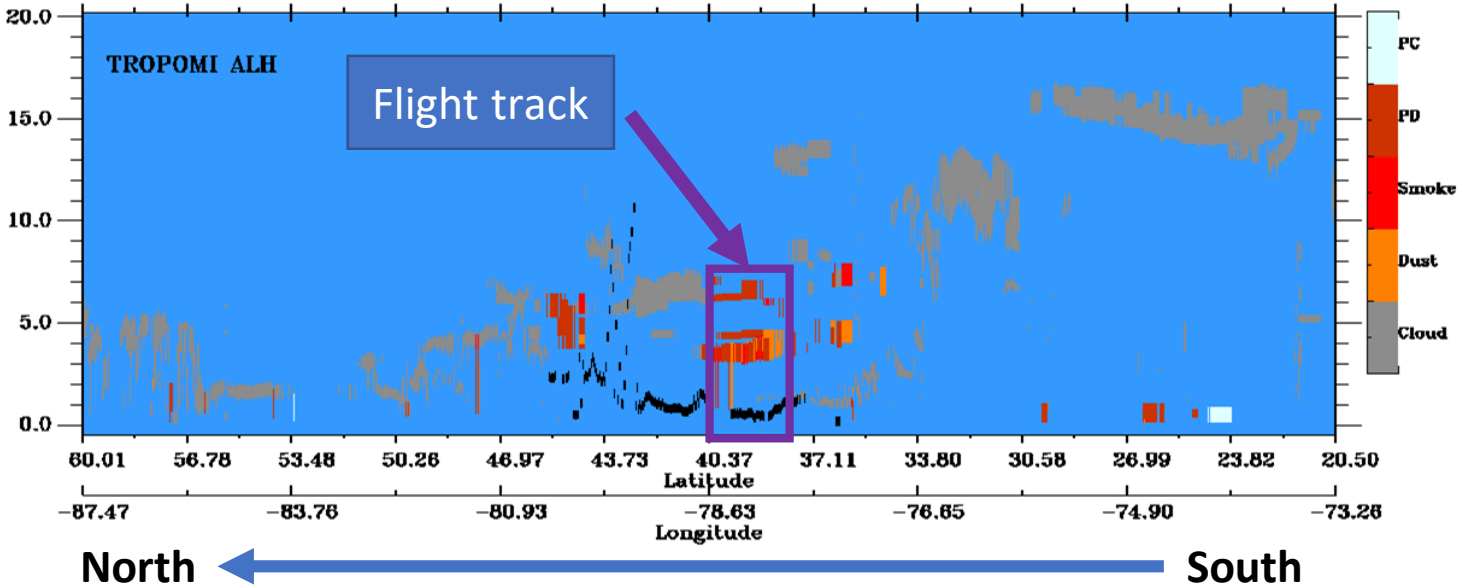


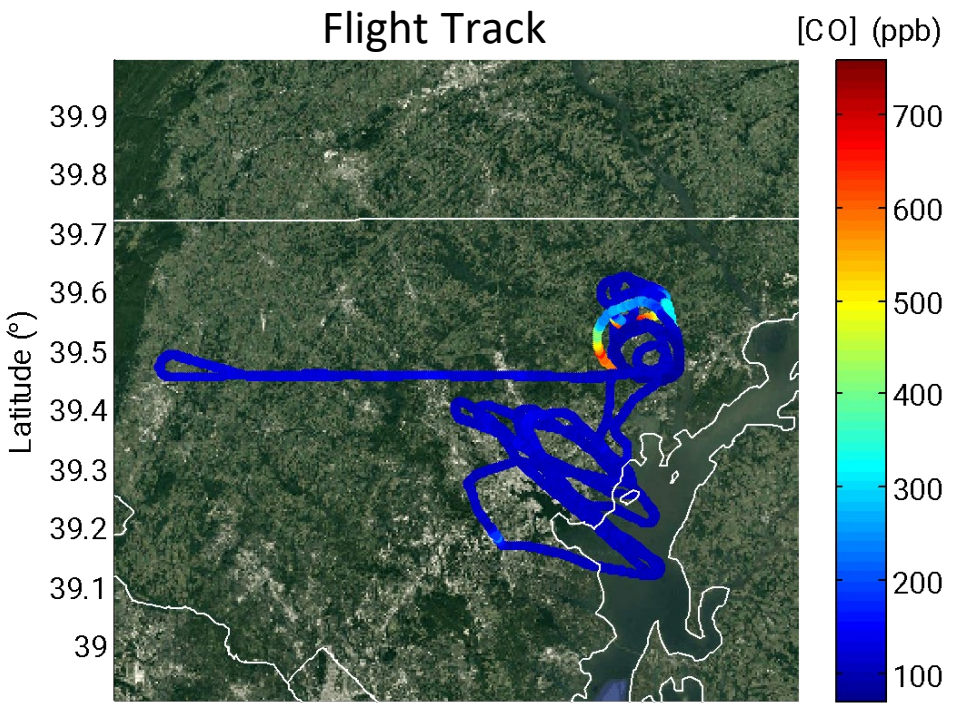
Caicedo, V., R. Delgado, R. Sakai, T. Knepp, D. Williams, K. Cavender, B. Lefer, and J. Szykman, 2020: An Automated Common Algorithm for Planetary Boundary Layer Retrievals Using Aerosol Lidars in Support of the U.S. EPA Photochemical Assessment Monitoring Stations Program. *J. Atmos. Oceanic Technol.*, **37**, 1847–1864, https://doi.org/10.1175/JTECH-D-20-0050.1.

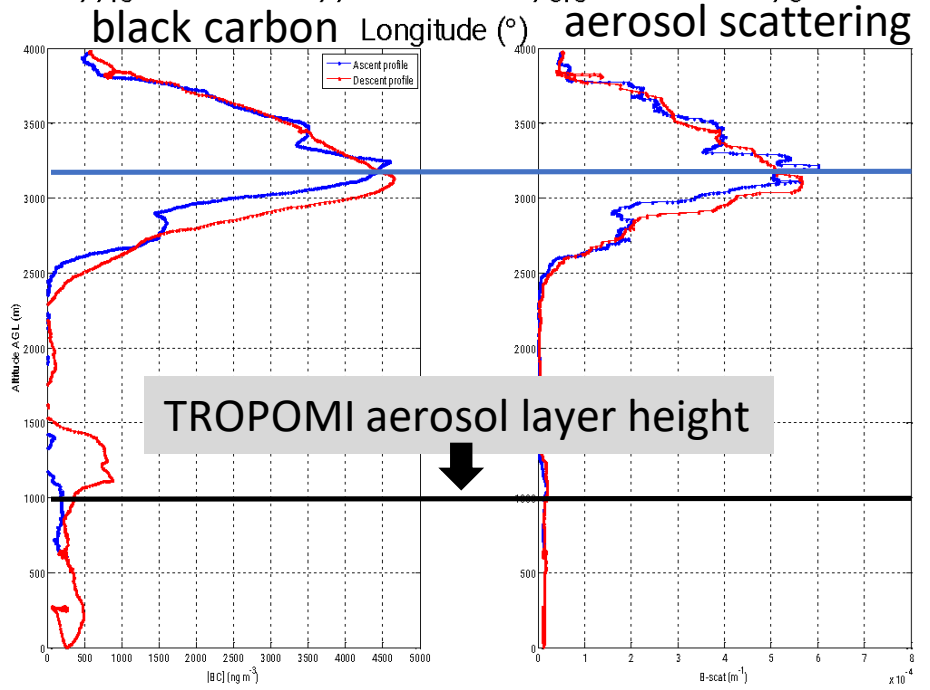
COLORADO
Department of Public Health & Environment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

- Sentinel 5P TROPOMI aerosol layer height (ALH) and CALIOP/CALIPSO Vertical Feature Mask (VFM) overpasses occurred during University of Maryland flight track spiral through the transported smoke plume on September 16, 2020 northeast of Baltimore, Maryland
- TROPOMI ALH derived using O2 A-band absorption reported the smoke at much lower altitude (1Km) than aircraft observations (peak at 3.1 km)
- CALIOP/CALIPSO VFM observed two stratified smoke plumes, one around 3-4 km and one at 5-6 km.







Aerosol Layer Height Retrieval and Validation Challenges

NIER GEMS vs. CALIOP January 01,2021 – September 30, 2022			
Scenario	**Bias (km)**	**Precision (km)**	**RMSE (km)**
AOD < 0.4	0.48	1.42	1.50
0.4 < AOD < 0.8	0.11	1.31	1.32
AOD > 0.8	-0.33	1.32	1.32
Single vertical aerosol layer	0.07	1.33	1.34
Multiple stratified vertical aerosol layers	0.77	1.41	1.60
U Iowa TROPOMI vs. CALIOP September 2020			
All data (UVAI > 1.0)	-1.20	1.91	2.26
Over Land (UVAI > 1.0)	-1.24	1.88	2.25
Over Ocean (UVAI > 1.0)	-1.03	2.05	2.30

GEMS ALH Algorithm Reference

Kim M, Kim J, Torres O, Ahn C, Kim W, Jeong U, Go S, Liu X, Moon KJ, Kim ER. Optimal Estimation-Based Algorithm to Retrieve Aerosol Optical Properties for GEMS Measurements over Asia *Remote Sensing*. 2018; 10(2):162. https://doi.org/10.3390/rs10020162

TROPOMI ALH Algorithm Reference

Chen X, Wang J, Xu X, Zhou M, Zhang H, Garcia L-C, Colarco P, Janz S J, Yorks J, McGill M, Reid J R, de Graaf M, Kondragunta S, First retrieval of absorbing aerosol height over dark target using TROPOMI oxygen B band: Algorithm development and application for surface particulate matter estimates, Remote Sensing of Environment, Volume 265, 2021