Linking AOD from Satellites to Surface PM2.5 over the Eastern US Using Aircraft Observations

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Motivation

- Remote sense of surface PM2.5 levels from space can be a great help to the air quality community.
- The need to link PM2.5 at the ground and aerosol optical depth (AOD) from space using aircraft observations.
- In the eastern United States, this should be relatively straightforward, because the aerosols
  - are spatially homogeneous,
  - are of the right size to scatter light efficiently, and
  - are comprised of sulfate and other anthropogenic compounds that are reasonably straightforward to measure. this.

Measurements

UMD Cessna research aircraft observation over the Eastern Shore
-- what: aircraft observations of aerosol scattering, absorption, trace gases over the Eastern Shore in summer 2013 and 2014.
-- when: Summer 2013 and 2014
-- where: the Eastern Shore

GPS Position (Lat, Long, Altitude)

Met (T, RH, P, wind speed/direction)

Trace gases:

O_3: UV Absorption, modified TECO

SO_2: Pulsed Fluorescence, modified TECO

$CH_4/CO_2/CO$: Cavity Ring Down, Picarro

NO_2: Cavity Ring Down, Los Gatos

Aerosol Optical Properties:

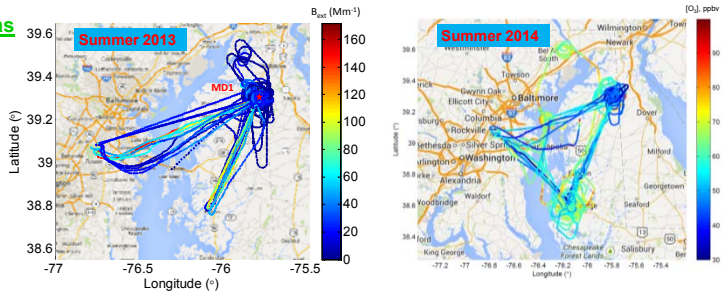
Scattering: b_{scat} (@450, 550, 700 nm), Nephelometer

Absorption: b_{ap} (565 nm), PSAP

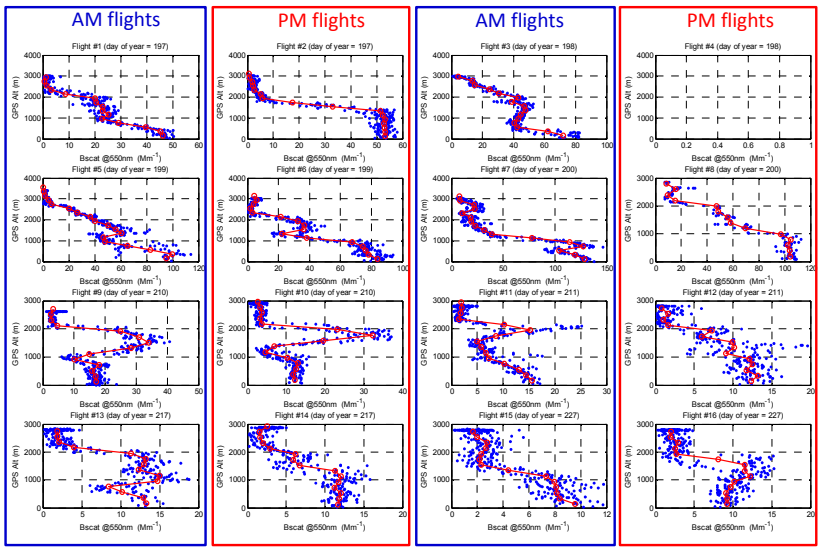
Black Carbon: Aethalometer

Data Acquisition: 1 sec

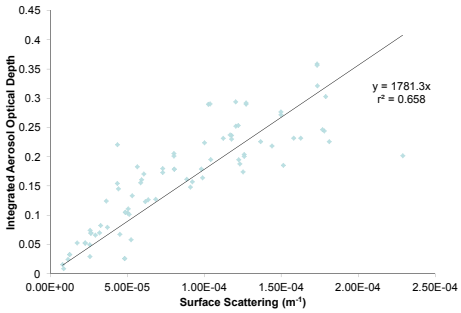
Flight Areas



Aerosol scattering vertical profiles over MD1 in 2013

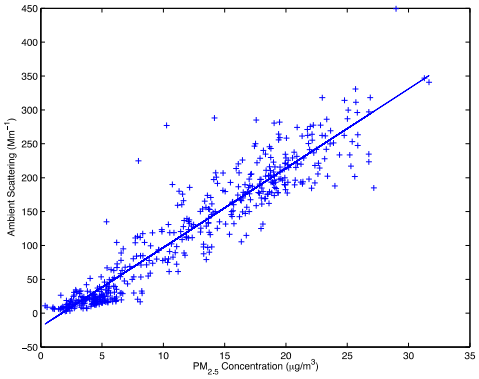


Integrated AOD vs. Surface Scattering from the NASA P-3B during DISCOVER-AQ 2011



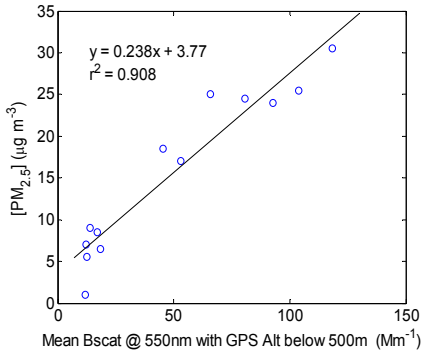
- Integrated AOD from the Cessna shows good correlation with surface scattering
- A robust correlation between AOD and PM2.5 at the surface is possible.

Ambient Scattering vs. PM2.5 from the NASA P-3B during DISCOVER-AQ 2011



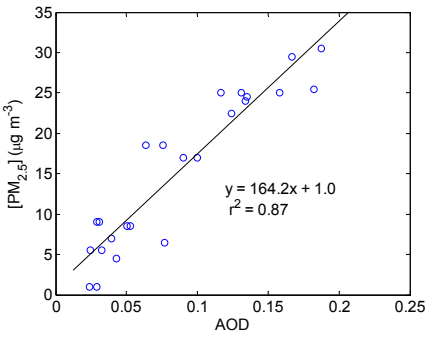
- PM2.5 mass is the integration of masses of SO_4, NO_3, BC and organic matter multiplied by 1.8.
- As shown in the Figure left, the scattering at ambient humidity well correlates with dry scattering,

Scattering below 500m and surface PM2.5 at MD1



- Correlation between the surface PM2.5 concentration and mean aerosol scattering at 550 nm in the layer from the surface to 500 m during the aircraft vertical profiling observations in Millington, MD in summer 2013.
- Each circle represents the data from a flight.

Integrated AOD and surface PM2.5 at MD1 in 2013



- Correlation between the surface PM2.5 concentration and integrated aerosol extinction (designated as AOD) at 550 nm within the aerosol layer during the aircraft vertical profiling observations in Millington, MD in summer 2013.
- Each data point represents the integrated AOD during a flight.

Summary

• Profiles of scattering are well correlated with PM2.5 mass when the measurements are closely co-located in space and time.

• Integrated AOD from the aircraft highly correlated to PM2.5 at the surface.

Further work

• Compare summer 2014 aircraft data with surface PM2.5

• Compare VIIRS AOD to PM2.5 at the surface

• Using the aircraft observations to identify conditions for good/bad correlation between satellite AOD and surface PM2.5.

Acknowledgements

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