

# Vertical Profiles of Light-Absorbing Aerosol:

## In-situ and AERONET Observations during NASA DISCOVER-AQ

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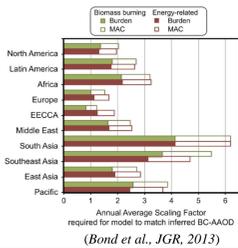
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### Introduction

Understanding the vertical profile of aerosols plays a vital role in utilizing spaceborne, column-integrated satellite observations. The properties and distribution of light-absorbing aerosols are particularly uncertain despite significant air quality and climate ramifications. The NASA DISCOVER-AQ project motivated a statistical assessment of spatial, temporal, and source-related variability for light-absorbing aerosol properties in these distinct regions.

In-situ sampling in conjunction with a dense network of AERONET sensors allowed evaluation of the sensitivity and limitations of remote-sensing data products over a wide range of conditions. AERONET retrievals of absorption aerosol optical depth (AAOD) have been extensively utilized as an observational constraint for global models, requiring significant scaling factors to achieve consistency (right). Here, we compare AERONET AAOD retrievals and AAOD determined from airborne (P-3B) observations.



### Objectives and Impacts

1. Assess AERONET AAOD retrievals using in-situ observations to evaluate the use of model scaling factors
2. Evaluate the AAOD-SSA relationship and dependence on other atmospheric variables

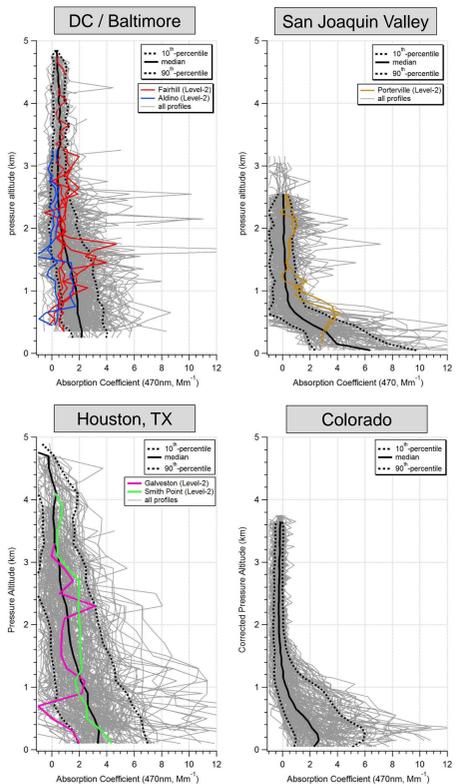
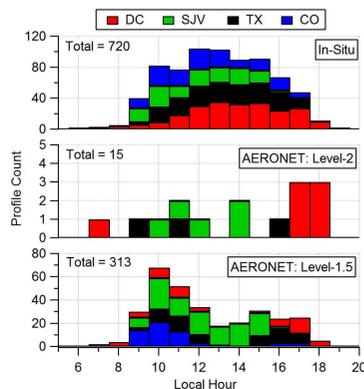
### Conclusions and Future Work

	AAOD difference (AERONET - In-situ)		AAOD ratio (AERONET/In-situ)	
	Level 1.5	Level 2.0	Level 1.5	Level 2.0
DC/Baltimore	0.007	0.013	2.1	5.2
San Joaquin Valley	0.007	0.018	2.9	5.2
Houston, TX	0.005	0.011	1.7	2.6
Colorado	0.011	NA	4.1	NA

- AERONET AAOD is significantly greater than in-situ
- Low AOD and AAOD values make retrievals uncertain, but minimize absolute differences
- SSA generally agreed to  $\pm 0.02$

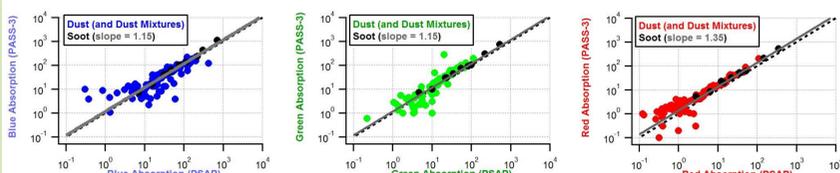
### 1. Vertical Profiles

- Absorption coefficient was measured by a particle soot absorption photometer (PSAP) at 470, 532, and 660 nm wavelengths, corrected by *Virkkula et al. 2010*.
- Profiles were observed during P-3B spirals over 6-8 ground sites 3 times daily, in each region (below).



- AERONET measurements are available at each spiral location and many additional sites throughout each region.
- Profiles at many locations extend to ~20m above the surface (left).
- In-situ profiles covered a significant portion of the day; 09:00 to 17:00 (local).
- AERONET retrieval of AAOD rely on almucantar scans that occurred at ~10:00 and 16:00 (local), except at SJV (above).
- Profiles suggest very different dynamics at each site, especially SJV and CO where a shallow BL limited the aerosol vertical extent.

### 2. Laboratory Absorption Measurement Validation



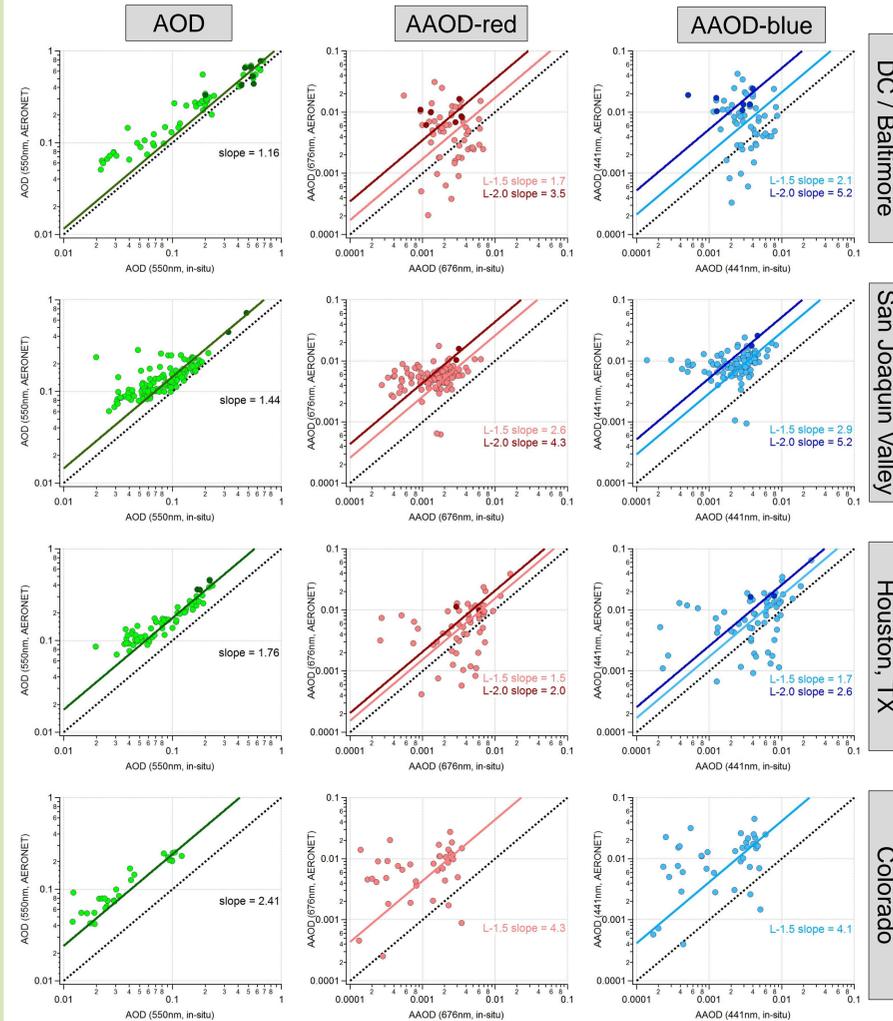
- PSAP measurements suffer from uncertainties and filter artifacts
- Laboratory observations using a DMT PASS-3 (photo-acoustic) showed excellent agreement for soot and dust aerosol

\*\* STEER (Statistical Evaluation of Aerosol Retrievals) - PI: Greg Schuster

### 3. AERONET Comparison

Light-coloring  $\rightarrow$  Level-1.5 data  
Dark-coloring  $\rightarrow$  Level-2.0 data

- Linear extrapolation extended aircraft observations to ground-level if necessary



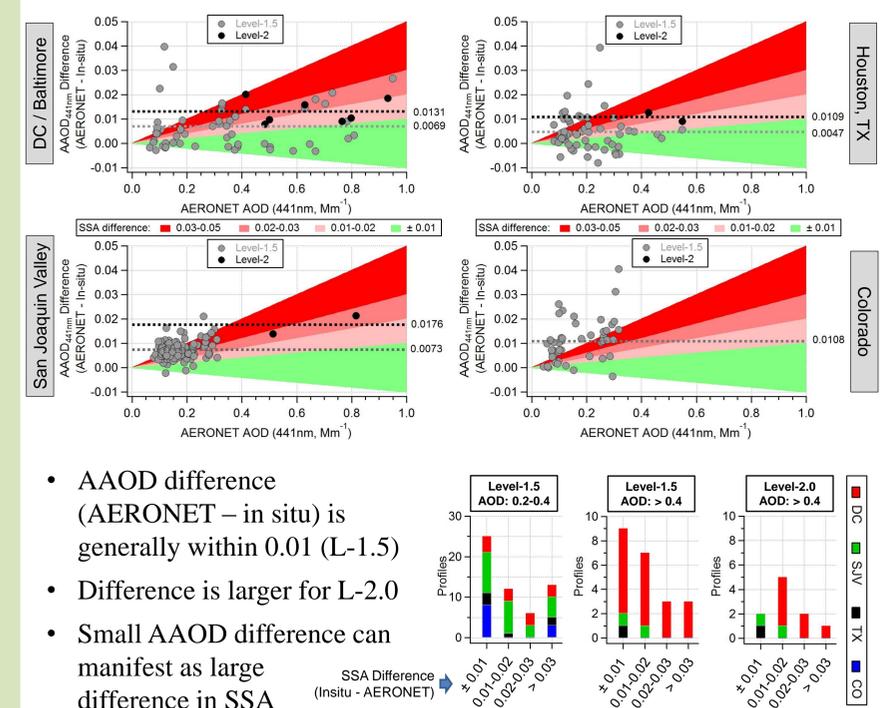
- Good AOD AERONET/in-situ correlation observed at AOD > 0.1, especially for DC

#### Ground-Level Values Necessary to Match AERONET AAOD

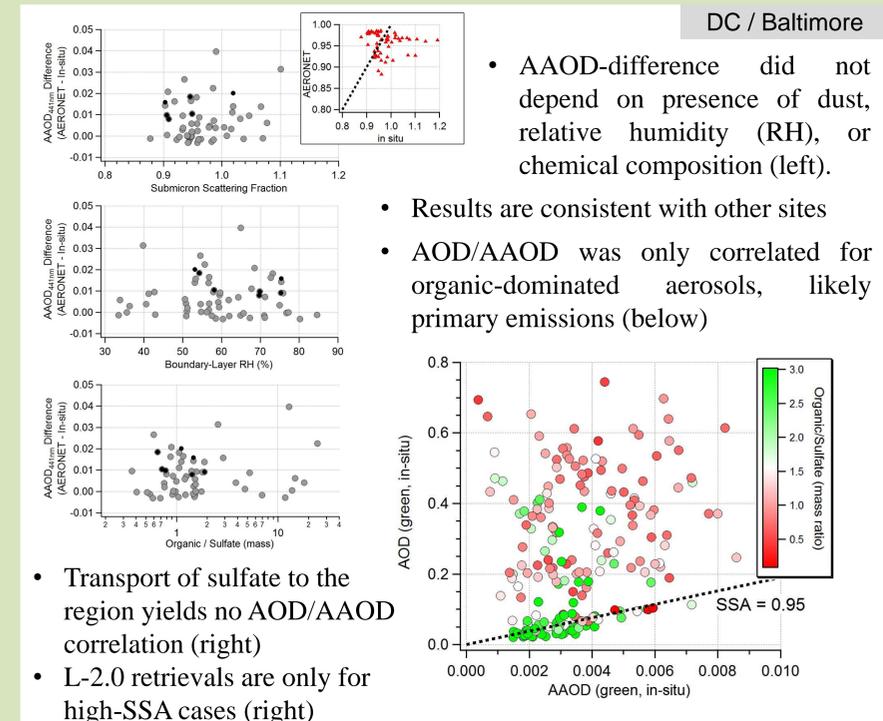
	Absorption (Mm <sup>-1</sup> )	BC mass (μg m <sup>-3</sup> )
DC/Baltimore	46.8 ± 90.6	3.5 - 7.0
San Joaquin Valley	69.0 ± 36.6	5.2 - 10.4
Houston, TX	37.3 ± 76.4	2.8 - 5.6
Colorado	104.1 ± 87.2	7.8 - 15.6

- AERONET AAOD consistently exceeds in-situ by ~2x (L-1.5) and ~4x (L-2.0) for both wavelengths (above)
- Linear correlation between AAOD measurements is weak
- Significant absorption coefficients (and unrealistic BC mass concentrations) would be necessary at the surface to explain AERONET discrepancy (left)

### 4. Influencing Factors



- AAOD difference (AERONET - in situ) is generally within 0.01 (L-1.5)
- Difference is larger for L-2.0
- Small AAOD difference can manifest as large difference in SSA



- AAOD-difference did not depend on presence of dust, relative humidity (RH), or chemical composition (left).
- Results are consistent with other sites
- AOD/AAOD was only correlated for organic-dominated aerosols, likely primary emissions (below)
- Transport of sulfate to the region yields no AOD/AAOD correlation (right)
- L-2.0 retrievals are only for high-SSA cases (right)