

***Interactive comment on “HSRL-2 aerosol optical measurements and microphysical retrievals vs. airborne in situ measurements during DISCOVER-AQ 2013: an intercomparison study” by Patricia Sawamura et al.***

**Anonymous Referee #3**

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The study describes the retrieval products and measurements of HSRL-2, an airborne multi-wavelength lidar, from two phases of the DISCOVER-AQ experiment and evaluates them with accompanying in situ aerosol measurements. The data products discussed are particle number concentration, surface area, volume, effective radius, extinction and backscattering.

As far as I know, lidar-based studies hitherto either stayed largely in the domain of optical properties or explored microphysical retrievals with a small number, if any, of measurements. The present study distinguishes itself from them by providing as many

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as >700 data points of microphysical retrieval products. The fairly thorough analysis will prove useful if, as it seems likely, the HSRL-2 microphysical retrieval products are to be used for the studies of aerosol effects on climate and air quality.

I have one issue with the data analysis.

I suspect the real part of dry refractive index is systematically overestimated. That is because of the discrepancy in particle size between the two sets of measurement being compared: The submicron particles that the UHSAS observed are held accountable for the extinction by the particles up to 5  $\mu\text{m}$  that the nephelometer and PSAP observed.

To reduce the systematic error, one could compare size distribution and extinction for an identical size range. An impactor is commonly used to pass particles under 1  $\mu\text{m}$  aerodynamic diameter. Its passing efficiency modeled for geometric diameters (see, for example, paragraph [21] of Howell et al., 2006) allows adjustment of the measured size distribution for the particles behind it. Optimize the dry refractive index for the adjusted dry size distribution and the scattering and absorption measured behind the impactor.

The overestimate in refractive index, which I think should be noted in the manuscript, has implications. It invites a systematic bias in the calculated extinction and backscattering except the extinction in the vicinity of the nephelometer and PSAP wavelengths (i.e., 532 nm extinction). So the behind-the-impactor retrieval may help explain the systematic biases shown in Figure 7. This possibility makes it worth trying even if the random error is to be magnified for the smaller coefficients and the uncertainty in the impactor passing efficiency.

Minor suggestions.

Page 1. Line 1. Insert “and” after “radii”.

Page 2. Line 18. Replace the slash after  $\text{dsm}$  with a period.

Page 3. Line 14. “not necessary”. Why? Low ambient RH?

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Page 3. Line 16. Remove “of more than 700 lidar retrievals” because it is said in line 18.

Page 4. Line 21. Insert “, the latter” after “California”.

Page 5. Line 5. Use the Greek letter instead of mu.

Page 5. Line 11. The first sentence is unclear. Is it necessary?

Page 6. Line 18. Are these wavelengths correct?

Page 6. Line 29. Replace “proportional” with “related”.

Page 8. Line 13. The vertical resolution of 5 m corresponds to  $\sim 1$ s for typical aircraft vertical speeds. But, while the TSI nephelometer records every second, it does not resolve scattering coefficient for each second. The residence time of particles in the TSI nephelometer is closer to 5s under typical flow rates.

Page 10. Line 16. Is “approximately” necessary? Also Page 16. Line 8.

Page 10. Line 29. Replace “measurements” with “measurements”.

Page 11. Line 2. Replace “sensitive” with “sensitivity”.

Page 13. Line 15. Replace “seem” with “seems”.

Page 13. Line 28-30. Isn't this because the particles sampled in California were somewhat smaller than those in Texas, as implied in Figure A2? Smaller particles are less prone to inlet loss. Can you show the bias for the 532 nm extinction as a function of the Angstrom exponent? The 532 nm extinction is a good choice here because it should be barely affected by the refractive index bias mentioned above.

Page 16. Line 2. What does “a preliminary assessment . . .” refer to?

Page 18. Line 32. Make “I” small.

Figure 2. Note the particle size range for the  $dN/d\log D$  ( $< 1\mu$ m) and the measured

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scattering and absorption ( $< 5\mu$ m).

Figure 3. Make the “O” as large as “H” in the upper right box.

Figure 4. Indicate that the values refer to the fine-mode only. Perhaps also for Figure 5 and 6.

Figure 6. Should “ $q1+1.5\times IQR$ ” read “ $q3+1.5\times IQR$ ”? Also, what is the significance of  $1.5\times IQR$ ? Why is this expression used instead of another set of percentiles like 5% and 95%?

#### Reference

S. G. Howell, A. D. Clarke, Y. Shinozuka, V. Kapustin, C. S. McNaughton, B. J. Huebert, S. J. Doherty, and T. L. Anderson, 'Influence of Relative Humidity Upon Pollution and Dust During Ace-Asia: Size Distributions and Implications for Optical Properties', *Journal of Geophysical Research-Atmospheres*, 111 (2006), D06205, doi:10.1029/2004JD005759.

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