Towards Improved Agreement between Measured and Calculated Total Scattering of Marine Aerosol: TCAP Airborne Data

Kassianov[a] , E., L. Berg[a], M. Pekour[a],C. Flynn[a], J. Tomlinson[a], D. Chand[a], J. Shilling[a], M. Ovchinnikov[a] , J. Barnard[b]

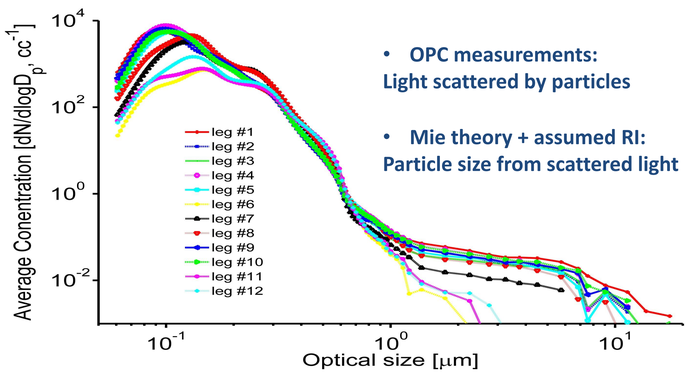
[a] *Pacific Northwest National Laboratory;* [b] *University of Nevada, Reno*

Pacific Northwest NATIONAL LABORATORY

Proudly Operated by Battelle *Since 1965*

Motivation

- Poor agreement between measured and calculated total scattering coefficients has been obtained recently for a "simple" marine case with weakly absorbing aerosol measured over the Southeast Pacific Ocean by several research aircraft during the VAMOS Ocean-Cloud-Atmosphere-Land Regional Experiment (VOCALS-Rex).
- *What level of agreement between measured and calculated values of total aerosol scattering can be achieved using airborne data collected by the DOE Gulfstream 1 (G-1) aircraft over the western North Atlantic Ocean and Cape Cod, Massachusetts during the* ***Two-Column Aerosol Project*** *(**TCAP**)*?

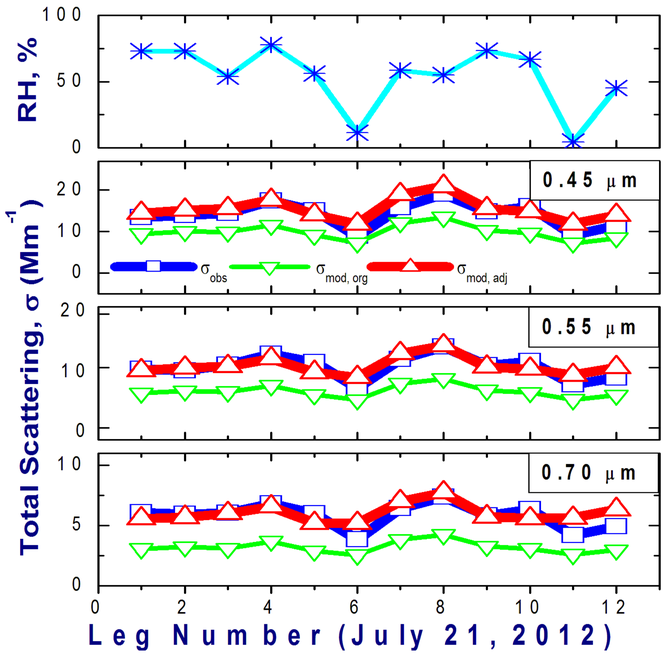


Example of combined size distributions generated for each flight leg (FL) on July 21, 2012. Here and in following plots aerosol characteristics represent FL-averaged values. FLs are defined as periods when G-1 was flying straight and level.

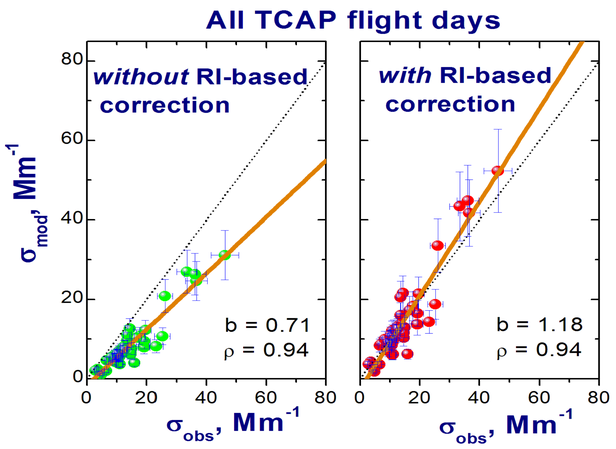
Airborne Measurements

- Size distributions were measured by Optical Particle Counters (OPCs): Ultra-High Sensitivity Aerosol Spectrometer (UHSAS), Passive Cavity Aerosol Spectrometer (PCASP) and Cloud and Aerosol Spectrometer (CAS).
- Chemical composition and black carbon (BC) mass were measured by Aerosol Mass Spectrometer (AMS) and Single Particle Soot Photometer (SP2), respectively.
- The total scattering coefficient at three wavelengths (0.45, 0.55, 0.7μm) was measured at dry conditions by TSI integrating nephelometer; light scattering hygroscopic growth, $f(RH)$, was measured with humidification system.
- Chemical data and *homogeneous internal mixture* are used for estimating both *hygroscopic growth factor* (**HGF**) and complex *refractive index* (**RI**) at ambient RH.

DOE G-1 aircraft with a suite of aerosol/cloud instrumentation



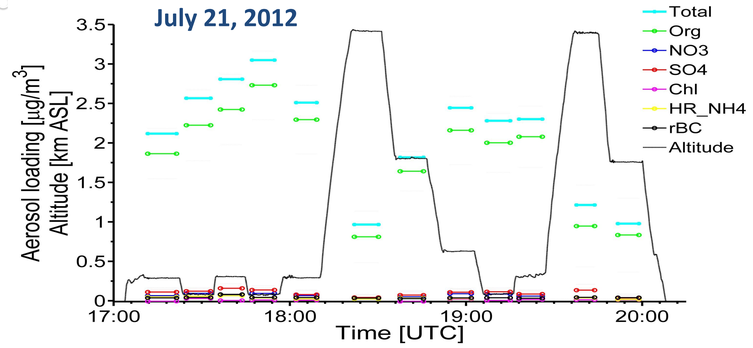
*Example of ambient RH and spectral values of total scattering **measured (blue)** and calculated for **original (green)** and **adjusted (red)** size distributions for each FL.*



Ambient total scattering measured (σ_{obs}) versus ambient total scattering calculated (σ_{mod}) for original (left) and adjusted (right) size distributions at 0.55 μm wavelength for all FLs.

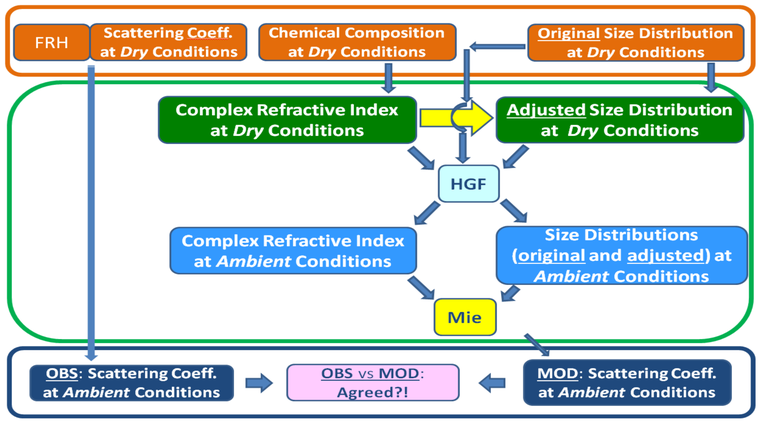
Conclusion

- We demonstrate that despite well-known limitations of aerosol measurements and several assumptions of our approach, we can obtain a good agreement between observed and calculated scattering at three wavelengths (0.45, 0.55, 0.7 μm) using RI-based correction and best available chemical composition data for RI estimation.
- Impact of mixing state and particle morphology/shape on optical properties will be considered in our future studies.



Example of FL-dependent chemical compositions (colored lines) and BC (thick black lines) mass measured by the AMS and SP2, respectively. Altitude (thin black line) as a function of FL is included. This example represents very clean day – see poster (Berg et al., 2015).

Approach (Schematic diagram)



- We introduce an approach for obtaining total scattering coefficient (both non-absorbing and **absorbing** aerosol) at ambient RH from integrated dataset with OPC-derived aerosol size distributions. The introduced approach represents an extended version of popular methods (e.g., *Ames et al.*, 2000; *Liu and Daum*, 2000) developed earlier.

U.S. DEPARTMENT OF ENERGY

ASR Atmospheric System Research

ARM CLIMATE RESEARCH FACILITY

Contact Information: Evgueni.Kassianov@pnnl.gov.

References:

Ames, R. B., J. L. Hand, S. M. Kreidenweis, D. E. Day, and W. C. Malm, 2000: Optical measurements of aerosol size distributions in Great Smokey Mountains National Park: Dry aerosol characterization, *J. Air Waste Manage. Assoc.*, 50, 665–676.

Liu, Y. and P. H. Daum, 2000: The effect of refractive index on size distributions and light scattering coefficients derived from optical particle counters. *J. Aerosol. Sci.*, 31, 945-957.