Evaluating the Consistency of All Submicron Aerosol Mass Measurements (Total and Speciated) for the NASA Atmospheric Tomography Aircraft Mission (ATom)

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The Aerodyne Aerosol Mass Spectrometer (AMS) is a widely used instrument to quantify the composition of non-refractory submicron aerosol, in particular, organic aerosol (OA). Past comparisons, particularly of aircraft data in continental areas, have shown good overall agreement with other chemical and optical sensors. Recently, theoretically-based concerns have been raised regarding the overall AMS calibration uncertainties (particularly for OA), although there is no evidence that those apply to aircraft datasets.

The ATom mission sampled the remote marine troposphere from 87S to 82N and from 0 to 12.5 km over the course of four aircraft deployments over the space of 2 years, carrying an advanced aerosol payload that included particle sizing instruments operated by NOAA ESRL, as well as several chemical sensors: UNH Mist Chamber and Filters for inorganic aerosol, NOAA SP2 for black carbon measurements, NOAA PALMS instrument for single particle composition and the CU aircraft high-resolution AMS for non-refractory submicron mass. This provides a unique opportunity to explore the agreement of the different instruments over a very large range of conditions and calibration regimes, and improve our understanding of the various instrumental uncertainties in field data.

Special attention was paid to characterize the AMS size-dependent transmission with in-field calibrations; this provided crucial context when comparing with instruments with very different size cuts. Excellent agreement was found between the AMS calculated volume (including black carbon from the SP2) and the PM1 volume derived from the NOAA particle sizing measurements over three orders of magnitude (slope 0.94). The comparisons for sulfate, OA, and seasalt (the three main components of the remote PM1 aerosol) measured by AMS with the PALMS instrument showed similar consistency once differences in particle detection at different sizes were accounted for.
for. Similarly, comparisons with sulfate from filters showed good consistency once episodes with large supermicron mass were filtered out. Comparisons of the AMS with the mist chamber sulfate were affected by the variable time response of the latter instrument but were overall consistent. Overall, no evidence for AMS calibration artifacts or unknown sources of error was found for these datasets. A comprehensive evaluation of the different sources of uncertainty and their impact on the comparisons was performed, and factors to be considered for performing such intercomparisons and improving the reliability of submicron mass quantification in the future are discussed.