Investigating Potential Biases in Aerosol Light Absorption Measurements

C. Walsh[1], E. Andrews[2], J. Ogren[3], P. Sheridan[3], G. Hallar[4], P. Massoli[5], A. Freeman[5], D. Lack[3] and J. Langridge[3]

[1]NOAA Earth System Research Laboratory, Lund University, Lund, Sweden; 612-716-8168, E-mail: christine.walsh@noaa.gov
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309
[3]NOAA Earth System Research Laboratory, Boulder, CO 80305
[4]Desert Research Institute, Reno, NV 89512
[5]Aerodyne Research, Inc., Billerica, MA 01821

Currently, there is no single instrument for quantifying the aerosol light absorption coefficient (σap) that offers accurate measurements, simplicity in use, and reasonable cost. Filter-based techniques, which combine simplicity and low cost, can result in measurement biases under some conditions. Possible discrepancies in the filter-based measurement of σap were investigated utilizing a subset of measurements from two field campaigns: 1) aircraft data from 8 flights over California during the CalNex field campaign of April- May 2010, and 2) data obtained at Storm Peak Laboratory in Steamboat Springs, Colorado, between January- June 2011 during the STORMVEX campaign. Each study differed in aim and instrumentation, but both provided opportunities for addressing uncertainties in determining σap. Here, the potential for biases in the filter-based measurement of σap are considered.

Filter-based measurements of σap are obtained in both of these campaigns with the Particle Soot Absorption Photometer (PSAP). This method has potential measurement biases including interference from scattering particles, which can be corrected for after the measurements are obtained, and from liquid organic aerosols which is not yet well understood or quantified. Reference measurements of σap were provided directly with a Photo-Acoustic Spectrometer (PAS) during the CalNex campaign, and as the difference between aerosol extinction and scattering coefficients, σap = σext - σsp, in the STORMVEX campaign; a Cavity Attenuated Phase Shift extinction monitor measured σext and an integrating nephelometer measured σsp.

Data are then analyzed for consistencies (e.g., closure), potential biases, and relationships to other aerosol properties. The PSAP measurements from CalNex and STORMVEX do not appear to be subject to a bias caused by organic carbon that has been suggested by other experiments. This could be due to differences in the aerosol composition, and/or loading, and should be the focus of further research efforts. Both campaigns provide further insight on the potential for variations and uncertainties that occur during measurements of aerosol σap.

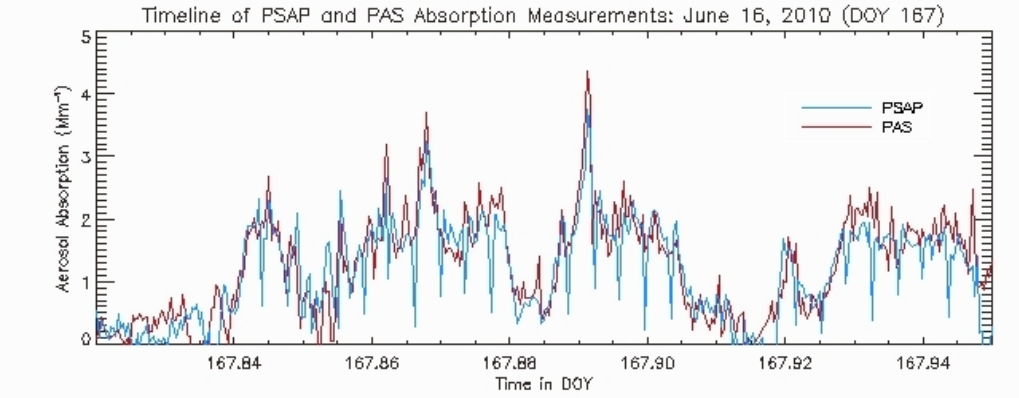

Figure 1. Timeline for the PSAP and PAS absorption measurements for June 16, 2010 (DOY 167) during a research flight on the CalNex field campaign. The flight depicted in figure 1 was where substantial time was spent flying over the agricultural fields of the San Joaquin Valley, over the cities of Fresno and Bakersfield, as well as over the Pacific ocean. It is clear that the σap from both instruments follow closely in measure and magnitude, which was typical for all of the CalNex campaign.