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Assessing the measurement of aerosol single scattering albedo by Cavity Attenuated Phase-Shift Single Scattering Monitor (CAPS PM_{ssa})

Julia Perim de Faria (1), Ulrich Bundke (1), Timothy B. Onasch (2), Andrew Freedman (2), and Andreas Petzold (1)

(1) Forschungszentrum Jülich GmbH, IEK-8, 52425 Jülich, Germany, (2) Aerodyne Research, Inc., Billerica, MA 01821-3976, USA

The necessity to quantify the direct impact of aerosol particles on climate forcing is already well known; assessing this impact requires continuous and systematic measurements of the aerosol optical properties. Two of the main parameters that need to be accurately measured are the aerosol optical depth and single scattering albedo (SSA, defined as the ratio of particulate scattering to extinction). The measurement of single scattering albedo commonly involves the measurement of two optical parameters, the scattering and the absorption coefficients. Although there are well established technologies to measure both of these parameters, the use of two separate instruments with different principles and uncertainties represents potential sources of significant errors and biases.

Based on the recently developed cavity attenuated phase shift particle extinction monitor (CAPS PM_{ex}) instrument, the CAPS PM_{ssa} instrument combines the CAPS technology to measure particle extinction with an integrating sphere capable of simultaneously measuring the scattering coefficient of the same sample. The scattering channel is calibrated to the extinction channel, such that the accuracy of the single scattering albedo measurement is only a function of the accuracy of the extinction measurement and the nephelometer truncation losses. This gives the instrument an accurate and direct measurement of the single scattering albedo.

In this study, we assess the measurements of both the extinction and scattering channels of the CAPS PM_{ssa} through intercomparisons with Mie theory, as a fundamental comparison, and with proven technologies, such as integrating nephelometers and filter-based absorption monitors. For comparison, we use two nephelometers, a TSI 3563 and an Aurora 4000, and two measurements of the absorption coefficient, using a Particulate Soot Absorption Photometer (PSAP) and a Multi Angle Absorption Photometer (MAAP). We also assess the indirect absorption coefficient measurement from the CAPS PM_{ssa} (calculated as the difference from the measured extinction and scattering). The study was carried out in the laboratory with controlled particle generation systems. We used both light absorbing aerosols (Regal 400R pigment black from Cabot Corp. and colloidal graphite – Aquadag – from Agar Scientific) and purely scattering aerosols (ammonium sulphate and polystyrene latex spheres), covering single scattering albedo values from approximately 0.4 to 1.0. A new truncation angle correction for the CAPS PM_{ssa} integrated sphere is proposed.