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Single Scattering Albedo Monitor for Airborne Particulates

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We describe a robust, compact, field deployable instrument (the CAPS PMssa) that simultaneously measures airborne particle light extinction and scattering coefficients and thus the single scattering albedo (SSA) on the same sample volume. With an appropriate change in mirrors and light source, measurements have been made at wavelengths ranging from 450 to 780 nm. The extinction measurement is based on cavity attenuated phase shift (CAPS) techniques as employed in the CAPS PMex particle extinction monitor; scattering is measured using a integrating nephelometry by incorporating a Lambertian integrating sphere within the sample cell. The scattering measurement is calibrated using the extinction measurement. Measurements using ammonium sulfate particles of various sizes indicate that the response of the scattering channel with respect to measured extinction is linear to within 1% up to 1000 Mm-1 and can be extended further (4000 Mm-1) with additional corrections. The precision in both measurement channels is less than 1 Mm-1 (1s, 1σ). The truncation effect in the scattering channel, caused by light lost at extreme forward/backward scattering angles, was measured as a function of particle size using monodisperse polystyrene latex particles (n=1.59). The results were successfully fit using a simple geometric model allowing for reasonable extrapolation to a given wavelength, particle index of refraction and particle size distribution, assuming spherical particles. For sub-micron sized particles, the truncation corrections are comparable to those reported for commercial nephelometers. Measurements of the optical properties of ambient aerosol indicate that the values of the SSA of these particles measured with this instrument (0.91$\pm$0.03) using scattering and extinction agreed within experimental uncertainty with those determined using extinction measured by this instrument and absorption measured using a Multi-Angle Absorption Spectrometer (0.89$\pm$0.03) where the uncertainties are derived from best estimates of the accuracy of the two approaches.