Aerosol Lght Scattering Measured by Nephelometry Compared to that Derived from Cavity Ring-down Aerosol Extinction Spectroscopy (CRD-AES)

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Tropospheric aerosols play a critical role in the Earth's radiation balance because they scatter and absorb incoming short-wave radiation (i.e., aerosol direct effect). Traditional in-situ measurement techniques of aerosol optical properties (e.g. extinction, scattering, and absorption) have provided important results; however higher accuracy, better sensitivity, and improved time resolution are needed to reduce the uncertainties in the optical parameters of ambient aerosol and hence, the uncertainty in radiative forcing.

In this work, we compare the performance of a commercial three wavelength integrating nephelometer (TSI, model 3563) and a four wavelength cavity ring-down aerosol extinction spectrometer (CRD-AES) developed in NOAA/ESRL/CSD. The former has been a 'standard' method for the past few decades to measure light scattering. The latter is a new instrument for direct measurement of light extinction. Using dry, non-absorbing, sub-1 µm laboratory generated aerosols and comparison between the nephelometer and CRD-AES we have investigated the uncertainty, wavelength conversion, correction factor, and time resolution associated with traditional aerosol optical property measurements. Our analysis includes: the angstrom exponent dependence, size dependence, signal linearity, spherical vs. non-spherical particles, and calibration procedure. These results are important to evaluate the capabilities and application of these instruments. One application of particular interest is whether the difference between aerosol extinction determined using CRD-AES and scattering determined using an integrating nephelometer is appropriate for (a) use in validation and calibration of absorption instruments and (b) determination of absorption of ambient atmospheric aerosol. With improved understanding of our instrument assumption and limitations we can improve our estimates of aerosol optical property uncertainties.

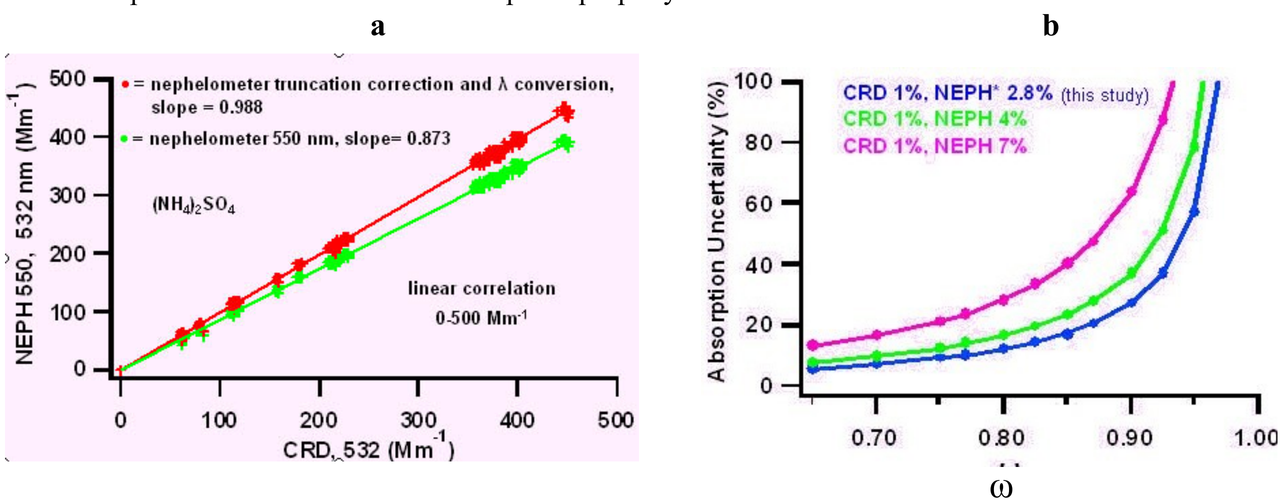

Figure 1. (a) Correlation between CRD and nephelometer (non corrected and corrected) response for non absorbing aerosols.(b) Propagated uncertainty in absorption by using 1% CRD uncertainty and nephelometer uncertainties from literature and the integrated approach (this study)