Synthesis of Aerosol Physical, Chemical, and Radiative Properties from Various Sources: Consistency and Closure

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Aerosol direct radiative forcing is determined from a set of optical properties - aerosol optical depth, single scattering albedo, and asymmetry parameter - which can be obtained from a range of different measurement techniques. Every technique has unique benefits and limitations, thus uncertainty and bias in radiative forcing estimates can vary depending on the measurement approach used. Given that a small fraction of these observations are most widely used for climate change studies, a comprehensive assessment of the interrelationship among all measurements would benefit uncertainty reduction. We present a closure study of aerosol products from ground-based *in situ* observations. Physical (size distribution) and chemical composition data are used to derive aerosol optical properties and results are compared to direct measurements of the aerosol light scattering. Since most *in situ* measurements are conducted under dry conditions, a further parameter - the aerosol hygroscopicity or the aerosol particle ability to take up water - needs to be measured to infer the optical parameters at ambient conditions. We use the results of this closure analysis including hygroscopic properties to inform the relationship between detailed *in situ* measurements and remote sensing of aerosol in the ambient column, the latter which are widely used for constraining aerosol radiative effects for climate change analysis.

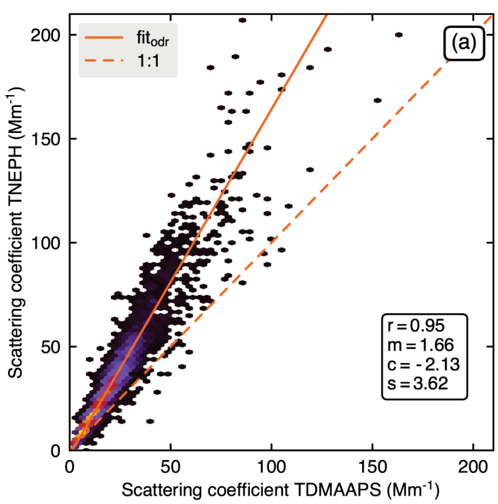

Figure 1. Correlation of measured aerosol light scattering and size distribution derived scattering coefficients for the year 2012 from dry *in situ* measurements at the surface.

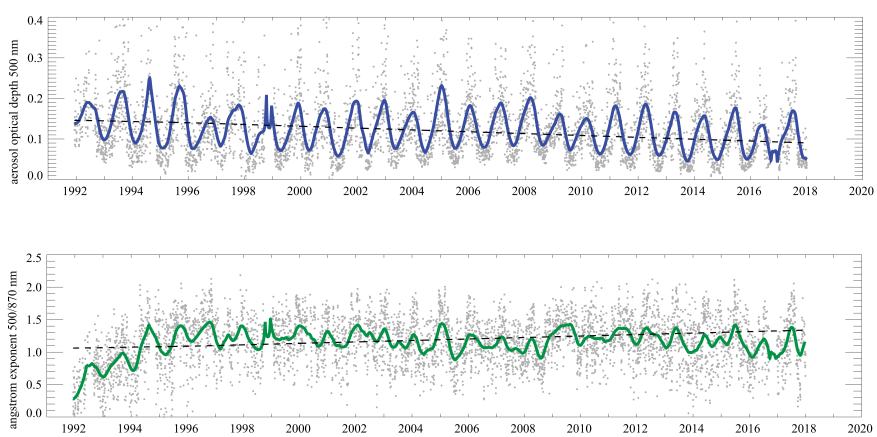

Figure 2. Long-term records of ambient, column aerosol optical depth (light scattering + absorption) and Angstrom exponent (a proxy for size) showing distinct annual cycles driven by relative humidity and longer-term variability that impacts size and scattering.