Direct Aerosol Forcing: Calculation from Observables and Sensitivities to Inputs

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Aerosol radiative forcing, the difference in net radiative flux with and without aerosol, and anthropogenic aerosol radiative forcing, the difference in net radiative flux with and without anthropogenic aerosol, are essential to understanding Earth's radiation budget and changes in this budget over the industrial period. These forcings are highly variable in space and time; locally and instantaneously they can be tens of watts per square meter. Characterization of aerosol direct forcing (the forcing in cloud-free sky) at a given time and location such as at Atmospheric Radiation Measurements (ARM) sites, generally relies on measured aerosol extensive and intensive properties and their dependence on wavelength. Extensive properties, which scale linearly with aerosol amount, include measurements of optical depth (extinction in the total column and its wavelength dependence, often characterized by the Ångström exponent); aerosol forcing is commonly characterized as a "forcing per optical depth." Intensive properties, independent of aerosol amount, are manifested in such measured aerosol properties including single scatter albedo and backscatter fraction as well as on situational variables such as solar zenith angle and surface reflectance (the latter also wavelength dependent). This poster examines the sensitivity of calculated aerosol radiative forcing and forcing per optical depth to extensive and intensive aerosol properties based on the uncertainties with which these are measurable (Figure 1).

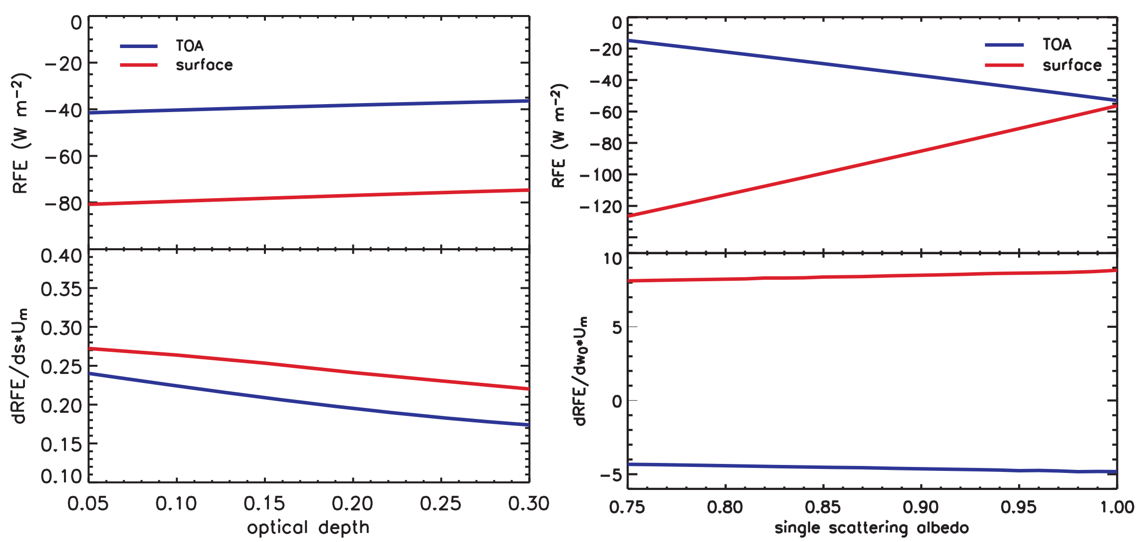

Figure 1. Sensitivity of aerosol direct radiative forcing to selected observed aerosol properties and to measurement uncertainties. A radiative transfer model is used to compute fluxes at the top of atmosphere (TOA) and surface, varying one property at a time while the others are held constant. Sensitivity to the range of observed values is expressed as radiative forcing efficiency (RFE), the direct radiative forcing per unit optical depth (top panes). Sensitivity to measurement uncertainty is expressed as the derivative of RFE with respect to the variation of the aerosol property of interest times its measurement uncertainty (U_m) (bottom panes).