Direct Aerosol Forcing: Calculation from Observables and Sensitivities to Inputs

Contributors
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Research Highlight

The sensitivity of calculated aerosol direct radiative forcing to input parameters has been examined to determine the consequences of uncertainties in these input parameters on calculated radiative forcing and to identify areas where measurements might be most profitably improved. Input parameters incorporate aerosol optical properties: optical depth τ, single scattering albedo (the fraction of light extinction due to scattering) ω, and asymmetry parameter (a measure of the angular distribution of light scattering) g, as well as surface albedo α. Calculations were made for conditions typical of the three ARM Climate Research Facility (ACRF) sites. Three radiative quantities were also considered: diurnally averaged spectrally integrated F_S(W m^{-2}), diurnally averaged irradiance at 0.55 µm $F_{0.55}$(W m^{-2} μm^{-1}), and spectrally integrated instantaneous forcing $F_S(\theta)$ (W m^{-2}).

Figure 1 represents the contribution to uncertainty in each of the forcing quantities at the top of the atmosphere and surface owing to the uncertainty in each of the input parameters τ, ω, g, α for the three ACRF sites. Uncertainty in the total direct aerosol forcing is denoted by the black bars. For measurement uncertainties used in this study which were typical of best current practice, uncertainty in total modeled forcing for aerosol and environmental conditions representative of the three sites ranges from approximately 20% to as great as 80%, corresponding to a range of 0.6 to 1.1 W m^{-2} at the top of the atmosphere for local diurnally averaged forcing.

For the Southern Great Plains site, the contributions to uncertainty in calculated forcing from uncertainty in optical depth, single scattering albedo, asymmetry parameter, and surface albedo were rather comparable; consequently, reducing the uncertainty in forcing requires focusing on all of these parameters. In contrast, for conditions typical of the North Slope of Alaska site, with high surface reflectance, the dominant source of uncertainty was found to be the aerosol single scattering albedo. These findings suggest that radiative closure at the 1 W m^{-2} level, especially in areas with fairly high aerosol loading, would require aerosol properties to be substantially better characterized than at present.

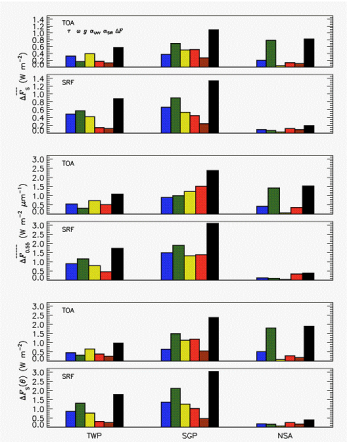

Figure 1.

Reference(s)

McComiskey, A, SE Schwartz, B Schmid, H Guan, ER Lewis, P Ricchiazzi, and JA Ogren. 2008. "Direct aerosol forcing: Calculation from observables and sensitivities to inputs." Journal of Geophysical Research 113, D09202, doi:10.1029/2007JD009170.

Working Group(s)

Aerosol