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APPLICABILITY OF A SIMPLE MODEL FOR COMPUTING DIRECT SHORTWAVE CLIMATE FORCING BY SULFATE AEROSOLS

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Recent estimates of global average forcing of climate caused by direct scattering of shortwave radiation by anthropogenic sulfate aerosol are -0.4 W m^{-2}, uncertain to a factor of somewhat greater than 2. For an aerosol optical depth of 0.1, characteristic of regions which are influenced by proximate anthropogenic emissions, the instantaneous forcing under cloud free sky is ca. 10 W m^{-2}. It is therefore necessary to represent this forcing in climate models, specifically including spatial and temporal variability. Here we examine the accuracy of a simple model for representing the direct shorwave forcing by anthropogenic sulfate, which takes explicit account of aerosol microphysical and optical properties, to determine its accuracy and applicability for use in climate models. The model, which is based on the approach of Charlson et. al. (1991, 1992), expresses the normalized forcing [W m^{-2} per g(sulfate) m^{-2}, or W per gram(sulfate)] in terms of mass scattering efficiency and upscatter fraction (both dependent on particle radius and wavelength) and on such local properties as solar zenith angle (taking into account the solar zenith angle dependence of atmospheric transmission) and surface albedo. This simple model allows evaluation, to good approximation, of the direct shortwave radiative forcing, without the need for an explicit radiative transfer model (e.g. Hansen and Travis, 1974). This approximation can be used also to compare measured and modeled forcing at specific locations, such as the ARM SGP site.

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