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RADIATIVE FORCING OF CLIMATE CHANGE BY ANTHROPOGENIC AEROSOLS

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ABSTRACT

Uncertainties in the forcing change over the historical period are very large with the largest contribution coming from aerosols; both the direct and indirect effects. Sulphate aerosols are perhaps the largest contributor to aerosol forcing and certainly the best characterised; other aerosol species such as organics and nitrates may be contributing comparable forcing, but the measurement data base and theoretical understanding are much less than for sulphate. The direct effect of sulphate aerosols is very sensitive to relative humidity changes but less sensitive to details of the particle composition. From measurements at particular sites there are very large temporal variations in sulphate burden, and likewise there is considerable short-range spatial variability that makes characterisation of the aerosol loading much more difficult than the corresponding problem for the long-lived greenhouse gases. The uncertainties in the direct effect are at least a factor of two; for the indirect effect they are very much larger, being highly sensitive to number concentrations. If the uncertainties in the several forcings are propagated, the overall uncertainty is such that the net forcing over the industrial period could be as great as about 4.5 w/m^2, or as small as - 0.5 w/m^2; that is, slight negative (cooling) forcing. Without greatly narrowing the uncertainty in aerosol forcing, there will be little observational basis for estimating the nature and magnitude of the climatic response to increasing concentrations of greenhouse gases. In view of the large uncertainty in aerosol forcing, it is difficult to justify choice of any specific present value of aerosol forcing as a basis for scaling historical aerosol forcing in climate model runs over the industrial period. Uncertainties in aerosol forcing will be resolved only by increased commitment to measurement.