How much can uncertainty in aerosol forcing be reduced?

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Abstract

However it is defined, the uncertainty in aerosol radiative forcing has been persistently large since our the first estimates in the 1990s. Since that time we have greatly improved our understanding of aerosol processes, made extensive observations, and developed sophisticated models. So why has the uncertainty not been reduced? Here we attempt to approach the "maximum feasible reduction" in uncertainty in a single climate model by generating a million variants of the model (using perturbed parameter ensembles and emulators) and constraining them using extensive aerosol radiative and microphysical measurements. The initial uncertainty in aerosol forcing is quite large (comparable to the multi-model range) and it is reduced through observational constraint. However, the reduction in uncertainty is less than one might hope for. Our results show that the reduction in uncertainty is limited by three factors: i) the representativeness error associated with heterogeneous aerosol measurements, ii) compensating errors in the model, and iii) structural errors in the model that prevent simultaneously good model skill across multiple observation types. We propose that aerosol forcing uncertainty could be reduced further if a statistically robust link between observations, model errors and uncertainty in forcing could be defined across multiple models.

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