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Uncertainties in Global Aerosol-Cloud Interaction and Radiative Effects

Kirsty Pringle, Ken Carslaw, Lindsay Lee, Graham Mann, and Alex Rap
Institute for Climate and Atmospheric Science, University of Leeds, UK (kirsty@env.leeds.ac.uk)

We quantify the uncertainties in the top-of-the-atmosphere (TOA) radiative flux due to uncertainties in aerosol-cloud interaction. We separate the uncertainty due to "clear-air" processes, emissions and processes related directly to aerosol-cloud interaction. The results are based on the GLOMAP global aerosol model using a Gaussian emulator conditioned on 168 1-year simulations. Twenty-eight parameters are varied using a space-filling design and the emulator is then used to carry out a variance-based sensitivity analysis to quantify how sensitive the output is to each input (the main effect) and their interactions (the total effect). Based on the model runs we then compute the cloud drop number concentration in every grid box and the cloud radiative effect in the perturbed parameter runs compared to a baseline run. We also quantify how the uncertainty in the TOA flux due to uncertain aerosol processes compares to that due to uncertain updraught speeds in the clouds, which are not explicitly calculated by the model. Maps of relative contributions to uncertainty reveal where we should put our effort in terms of model development.