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Parametric uncertainty in the aerosol forcing

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Aerosols affect climate via the direct and indirect radiative effects. The direct effect is the mechanism by which aerosols scatter and absorb shortwave and longwave radiation. The indirect effect is the mechanism by which aerosols modify the radiative forcing via microphysically induced effects on clouds. While the direct effect depends on the model radiation scheme, the indirect effect depends crucially on cloud parameterizations which are loaded with several uncertain parameters. Thus, the radiative forcing resulting from the aerosol indirect effect is directly linked to parameter uncertainty.

Previous studies on aerosol radiative forcing have been focused on structural uncertainties, such as uncertainties in aerosol sources, in formulations used to represent aerosols in the model, in parameterizations that relate aerosols and cloud droplets to simulate the indirect aerosol effect, and in cloud schemes. In the present study, we assess another source of uncertainty, the parametric uncertainty resulting from model parameters, given the state-of-art atmospheric model ECHAM5 with fixed cloud parameterization schemes. We approach this problem by performing a probabilistic analysis of numerical simulations within a perturbed physics experiment of hundreds of atmospheric simulations. We allow the troposphere to adjust to the changes in aerosol concentration - as is adequate for an investigation of the indirect effect - while keeping the sea surface temperature constant. This investigation gives us valuable insight into the effect of cloud parameterizations on the indirict aerosol forcing uncertainty.