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Quantification of uncertainties associated with indirect aerosol effect parameterizations of various complexities

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Atmospheric aerosols play an important role in the global climate system through modifications of the global radiation budget: directly, by scattering and absorption of radiation and indirectly, by the modification of cloud properties and abundance. In particular the indirect aerosol effects on clouds are subject to large uncertainties.

Global aerosol-cloud climate models allow first quantitative estimates of anthropogenic indirect aerosol effects. However, in addition to the uncertainties in the underlying cloud and aerosol microphysics, the requirement to reduce their complexity for the implementation in global climate models introduces further uncertainty.

In this study we investigate uncertainties in estimates of indirect aerosol effects through studies with the ECHAM5-HAM aerosol-climate model. We employ parameterizations of the aerosol-cloud interactions of various complexities, from simple empirical schemes to explicit activation schemes, in an identical model setup to quantify the contribution of the process parameterization to the uncertainty in the simulated estimates of the indirect aerosol effect. A detailed evaluation of the results with satellite observations of aerosol and cloud parameters will provide strong observational constraints on the simulated aerosol-cloud interactions in the different model setups. Our results help to understand and quantify uncertainties in estimates of the indirect aerosol effects and yield valuable information about the necessary level of detail of

the process representation in global climate models.