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Which cloud microphysical processes are dispensable in a global aerosol climate model?

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Clouds are a major component of Earth's energy budget, influencing e.g. the radiative balance and precipitation formation. In turn, cloud properties are determined by the microphysical processes that occur within clouds, e.g. modifying their albedo.
Global climate models employ cloud microphysical schemes to parameterize these processes. The schemes have grown in detail and complexity, but it is doubtful whether this will help us to reduce uncertainty (Carslaw et al., 2018). In fact, cloud microphysics (CMP) and aerosol schemes have become so detailed that they are becoming difficult to constrain with observations (Reddington et al., 2017; Morrison et al., 2020) and to comprehend, while their results are more difficult to interpret. Simplification or removal of single processes within the CMP schemes might offer a remedy that reduces complexity and enhances interpretability. For such simplifications it is first necessary to determine which processes are non-influential so that less accurate descriptions could suffice.
Recently, Proske et al. (2021) applied global sensitivity analysis on an emulated perturbed parameter ensemble (PPE) of four CMP processes, perturbing their effectiveness in the global aerosol climate model ECHAM-HAM. They thereby investigated to which of the four processes the model is most sensitive. They found that accretion and self-collection of ice have a negligible influence while aggregation dominates the response to perturbations.
Here, we extend this analysis to the whole CMP scheme in ECHAM-HAM, creating a PPE of all processes, especially widening the scope to warm microphysics. With the analysis we characterize the scheme, uncover which processes drive the model response and suggest candidates for simplification to ultimately guide model development to a simplified representation of CMP.

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