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Impact of the description of mixed-phase and ice clouds on the equilibrium climate sensitivity

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Clouds are important in the climate system because of their large influence on the radiation budget. They scatter solar radiation and with that cool the climate. On the other hand, they absorb and re-emit terrestrial radiation, which causes a warming. How clouds change in a warmer climate is one of the largest uncertainties for the equilibrium climate sensitivity (Boucher et al., 2013). While a large spread in the cloud feedback arises from low-level clouds, it was recently shown that also mixed-phase clouds are important for the climate sensitivity. If mixed-phase clouds in the current climate contain too few supercooled cloud droplets, too much ice will be in the form of liquid water in a warmer climate, which overestimates the negative cloud phase feedback and underestimates the equilibrium climate sensitivity (Tan et al., 2016).

Clouds are also an integral part in the hydrological cycle. In mid-latitudes, mixed-phase clouds play an important role as most of the precipitation originates via the ice phase and melts on the way to the surface. However, the ice phase in clouds is much less understood than the warm phase and the simulated ice water content from different models varies greatly (Li et al., 2012). Part of this uncertainty is related to the fraction of supercooled liquid water in mixed-phase clouds.

In this talk, we will show sensitivity studies with the global aerosol-climate model ECHAM6-HAM in which we varied several parameters in the cloud microphysics and convection parameterization schemes, such as the collection efficiencies of ice crystals, the level at which mid-level convection stops and applied extreme assumptions of the supercooled liquid fraction in mixed-phase clouds following Tan et al. (2016). We will analyze the performance of ECHAM6-HAM in these different configurations in the present-day climate as compared to observations and their influence on the equilibrium climate sensitivity.