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Cloud Microphysics in Earth System Models: From the process to the global scale

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Clouds and cloud microphysics are a critical component of the climate system. The ways that cloud microphysics modify climate will be discussed in the context of critical uncertainties in simulating the current state of the earth system and how it may change. Cloud microphysics controls the radiative effects of clouds, and changes to cloud radiative effects (cloud feedbacks) are the largest uncertainty in climate change projections. Cloud microphysics also confound our estimates of radiative forcing through complex interactions between aerosols and clouds (aerosol indirect effects). Cloud microphysics affects the timing and intensity of precipitation, with profound effects on regional and global climate. Cloud microphysical processes have been studied at the small scale, but are poorly characterized and observed globally. There is a large scale gap between the micro (10^{-6}m) and global (10^{6}m) scales. Complex interactions across scales with cloud dynamics and the cloud environment make simulation in earth system models difficult. New methods, techniques and observations for bridging this scale gap will be discussed. The sensitivity of global models to microphysical parameters, and the relation between cloud microphysical state and climate sensitivity will be demonstrated.