Large-eddy simulations of cloud and convective processes

Shallow and deep convective clouds are abundant in the atmosphere. They interconnect the land surface, planetary boundary layer and the deeper atmosphere and allow for a range of complex scale interactions that play a crucial role in determining the weather evolution and the climate. Despite their importance, convective clouds pose a great challenge for atmospheric modeling at all scales. Because they are too small to be explicitly resolved, they need to be parameterized in numerical weather prediction or global climate models. The currently applied parameterizations are often rather simple and at the source of large uncertainties; their limited skill both reflects the complexity of the system and our poor knowledge of the involved processes and scale interactions.

It is the overall goal of this project to improve our conceptual understanding of and our ability to represent and predict shallow to deep convective clouds. Our approach makes use of large-eddy simulations with resolution O(10 m) to systematically document and investigate the cloud properties, life cycle and interactions with the environment. Large-eddy simulations both provide more detailed information and a larger data sample than available observations. A special emphasis of this project is on the diurnal cycle of convection over land, including the interactions and feedbacks with heterogeneous surface properties. Such cases especially emphasize the tight interactions between the land surface, the boundary layer, shallow convection, deep convection, with partially resolved and partially unresolved processes, and thus remain a modeling challenge.