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An idealized cloud-resolving framework for the study of mid-latitude diurnal convection over land

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We introduce an idealized cloud-resolving modeling (CRM) framework for the study of diurnal convection over land. The framework is used to study the feedback between the soil and the deep atmosphere from first principles. In our framework the predicted variables are constantly relaxed towards prescribed atmospheric profiles. The relaxation is weak in the lower troposphere, such as to allow the development of a diurnal planetary boundary layer (PBL). The model is run for 30 days. Approximate equilibrium is reached after about 15 days. The modeling strategy includes a set-up with explicit convection and a full set of parameterizations, including a multi-layer soil model.

Using this framework we investigate the sensitivity of the evolution of the diurnal convection and PBL to the stability, the moisture content of the atmosphere and to the soil moisture content. The influence of the latent and sensible heat fluxes on the depth of the PBL as well as the evolution of clouds and resulting precipitation is analyzed.

We confirm that the temperature stratification of the environment has a dominant influence on the depth and intensity of convection. If the background profile is more unstably stratified the evolving convection is considerably deeper and more intense. The atmospheric moisture profile has only little influence on the diurnal cycle of convection in our set-up. Radiative forcing drives convection and evaporation, and this determines the diurnal evolution of the moisture content of the lower atmosphere. Thus the resulting diurnal cycle of convection changes only little between simulations with different humidity profiles.