Geophysical Research Abstracts
Vol. 19, EGU2017-4451, 2017
EGU General Assembly 2017

Bulk convergence behavior of convection-resolving simulations of summertime deep convection over land

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A range of scales are involved in the initiation and organization of summertime deep convection over land. Convection-resolving models (CRMs) can explicitly simulate deep convection and resolve complex topographic structures, and are thus a particularly useful tool to simulate convective precipitation over land for weather and climate applications. However, the truncation of the continuous energy cascade at scales of $\mathcal{O}(1\ \mathrm{km})$ poses a serious challenge, as in kilometer-scale simulations the size of the simulated convective cells is often determined by the grid spacing.

In this study we address the issue of bulk physical convergence across the "grey zone" of deep moist convection in CRM simulations over land. Physical convergence can be interpreted as the sensitivity of flow statistics with respect to the model grid spacing and the physics of the flow. Once bulk convergence is achieved, the representation of the feedbacks of an ensemble of convective cells to the larger scale in a CRM is unaffected by any further refinement of the numerical mesh. We extend the framework introduced by Langhans et al. (2012) by running the COSMO-Model in idealized and real-case setups to study the diurnal cycle of convection and precipitation in summer, both over flat and mountainous terrain. The idealized setups allow to identify those physical processes and parameterizations which yield better convergence properties.

Preliminary results show that the presence of orography improves the bulk convergence behavior of CRM simulations compared to runs over flat terrain. This is reflected in the surface radiation balance, in the bulk heat and moisture tendencies of a large control volume and, ultimately, in the domain-averaged precipitation. Reducing the model complexity by switching off the land-surface and radiation schemes, on the other hand, does not reduce or sometimes even increases the sensitivity to the model grid spacing in higher-resolution simulations.