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# Convergence behavior of convection-resolving simulations of summertime deep moist convection over land

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Convection-resolving models (CRMs) can explicitly simulate deep convection and resolve interactions between convective updrafts. They are thus increasingly used in numerous 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 and properties of the simulated convective features is often determined by the horizontal grid spacing $\Delta x$. Several idealized studies have shown that *structural convergence* of statistics and scales of individual clouds and updrafts is not yet achieved at the kilometer scale. On the other hand, *bulk convergence* of domain-averaged and integrated variables related to the water and energy budgets was found in real-case simulations over the Alpine region.
Idealized simulations of deep moist convection over land are performed at $\Delta x = 8$, 4, 2, 1 km and 500 m to further investigate both the bulk and structural convergence behavior of a CRM. Our analysis shows that bulk convergence is generally attained, while structural convergence is not yet fully achieved. In particular, with increasing resolution the convective cells are more vigorous, and smaller and more numerous cloud features are simulated. However, there is some evidence that the resolution sensitivity of updraft velocities and convective mass fluxes decreases at finer resolution. A number of different experiments are conducted, and it is found that the presence of orography and environmental wind shear yields more energetic structures at scales much larger than $\Delta x$, sometimes reducing the resolution sensitivity compared to runs over flat terrain only.
To assess the convergence behavior of a CRM also in real-case setups, two additional sets of simulations are run at $\Delta x = 4.4$, 2.2, 1.1 km and 550 m. The simulations are conducted for two 9-day periods exhibiting a pronounced diurnal cycle of deep moist convection over the Alpine region, in one set, and over Northern Germany, in the other. Preliminary results reveal a lower resolution sensitivity and better convergence properties for the Alpine case, due to the strong orographic forcing.
Overall our analysis supports the use of kilometer-scale resolutions in CRMs, despite the inability of these models to fully resolve the associated cloud field.