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Idealized studies of convective summer precipitation in a cloud-resolving model

L. Schlemmer (1), C. Hohenegger (1), C. Bretherton (2), and C. Schär (1)

(1) Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland, (2) Department of Atmospheric Sciences, University of Washington, Seattle, USA

The expected global temperature increase will lead to an increase of the atmospheric humidity content and an intensification of the hydrological cycle. In the global mean, precipitation is projected to increase, but climate models suggest that mean summer precipitation over Europe will decrease. However, despite this decrease in mean, heavy precipitation events are projected to occur more frequently. Changes in extreme precipitation are important to understand, since they pose an enormous threat. Especially in mountainous regions like the Alps, they often imply great socio-economic impacts. The credibility of these projections, with decreases in mean amounts but increases in peak intensity, is somewhat limited, as convection is parameterized in current climate models due to its small-scale nature. Simulations of present-day and future climate performed with a range of regional climate models in the context of the PRUDENCE project have revealed a large spread of the amount and distribution of precipitation. Differences between climate models are especially large in summer, when synoptic-scale forcing is weak and the chosen model formulation has a great influence.

The increasing computer power allows the use with finer grid-spacing in the horizontal, as well as in the vertical direction. The increased resolution enables a more realistic representation of topography and surface fields. Most importantly, the finer grid and the release of the hydrostatic assumption render possible an explicit treatment of convective processes. Here we investigate the response of convection to future climate changes in a cloud-resolving model (CRM) using an extremely high spatial resolution of 1- 2 km. This approach is still far too expensive for standard climate scenarios, but it is becoming feasible for process studies. Using a CRM in an idealized setting, we are trying to infer the response of convection to altered temperature and moisture profiles. The modeling strategy includes a full set of parameterizations, and the atmospheric variables are slowly relaxed towards the prescribed profiles and soil conditions. Results demonstrate how the simulated precipitation amounts and the time of the precipitation peak vary between simulations with different atmospheric background profiles. By systematically altering the environment of convection we try to isolate and assess the key processes that lead to the peculiar precipitation scenarios of the European summer climate.