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Convective precipitation in RCMs: diurnal cycle of precipitation and atmospheric profiles

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Convection is a central element of the European summer climate and also strongly affects the response of our climate system to greenhouse gas forcing. At today's resolution of climate models, convection is parameterized rather than explicitly represented. Simulated summer precipitation has been found to have considerable biases and to underestimate the interannual variability.

In this study, the regional climate model CLM is run over Europe for some selected summer seasons. We run the model at 50 km and 25 km horizontal resolution and on 32 computational levels in the vertical. ERA-40 re-analysis data is used for the initial and lateral boundary conditions. Selected rain gauge and radiosonde stations in Switzerland and Germany are compared against the model output at the corresponding grid points. The mean monthly diurnal cycle of the temperature and humidity profiles were derived at selected locations and compared against radiosonde data.

The simulated diurnal cycle of precipitation has its maximum around 2pm local daylight saving time, whereas the rain gauge climatology yields 8pm. This considerable difference is likely due to biases in the atmospheric profiles. Even though the mean surface temperature is represented quite accurately in the model, the surface diurnal temperature range is underestimated considerably. For instance, the nocturnal boundary layer is much less pronounced in the model than in the observed profiles. Furthermore, the afternoon temperatures are 1–2 °C too cold throughout the whole PBL. Together with a slight overestimation of specific humidity, the negative bias of surface temperature lowers the lifting condensation level. Convective triggering then requires a comparatively shallow PBL, which can lead to considerably earlier convective precipitation during the day.