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Added value and land-atmosphere coupling in convection-permitting WRF climate simulations over a Middle European domain

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High-resolution regional climate models with a more detailed representation of heterogeneous land surface properties, as well as an explicit treatment of deep convection can lead to an improved simulation of meteorological processes and the climate system at the meso-gamma scale.
In this study, results from 10 years of convection-permitting WRF evaluation simulations at 3 km spatial resolution for a central European model domain are analyzed. The 3 km domain is nested into the pan-European Coordinated Regional Downscaling Experiment (CORDEX) EUR-11 (12 km) model grid, driven by ERA-Interim reanalysis data. The simulated time spans (1992-1995, 2002-2003, 2010-2013) cover much of the variability of central European weather conditions.
In our analysis, we focus on two aspects: The first focus is on the validation of precipitation. Results from both resolutions are compared with each other and evaluated against high-resolution reanalysis data and gridded observations. Hourly precipitation data over three regions with a very moderate, low mountain and high mountain topography are compared. Added value in the 3 km simulation is found especially at the sub-daily scale in the reproduction of intensity, diurnal cycle and spatial extent of precipitation. A positive precipitation bias found in both resolutions is more dominant in the 12 km simulation, where too much light precipitation is generated. For different seasons precipitation exhibits clear differences between the simulations whereby largest differences occur in mountainous regions and during the summer months with high convective activity.
The second focus is on the comparison of land-atmosphere coupling strength whereby different metrics focusing on the soil moisture-temperature coupling are used. In both resolutions a clear interannual variability in coupling strength, consistent with the individual climate conditions, is seen. The 3 km simulation generally shows a slightly stronger coupling strength in summer.