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Comparison of hydrostatic and non-hydrostatic RegCM regional climate model simulations for the Carpathian region

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Climate models with higher resolution result in a better representation of land surface heterogeneity and fine-scale forcing, which are important for simulating the local and regional aspects of climate accurately. Higher resolution may require different approach and different parameterizations. The current study focuses on the newest model versions of RegCM (RegCM4.5 and RegCM4.6) that are used to compare hydrostatic and non-hydrostatic approaches as well, as different moisture parameterizations. The main goal is to reconstruct the historical (recent past) regional precipitation characteristics (both mean and extremes) of the Carpathian region as reliable as possible. For this purpose, several model experiments at 10 km horizontal resolution were completed for a 10-year period (1981–1990) using ERA-Interim reanalysis data (with 0.75° horizontal resolution) as initial and boundary conditions. Our simulation matrix consists of hydrostatic and non-hydrostatic runs together with the different treatments of moisture, namely, (i) Subgrid Explicit Moisture Scheme (SUBEX) is used to handle non-convective clouds and precipitation resolved by the model, (ii) the new microphysics scheme allows a proper treatment of mixed-phase clouds and a physically more realistic representation of cloud microphysics and precipitation. In this detailed validation study RegCM outputs (e.g. precipitation, temperature, sunshine duration) are compared to the homogenized, gridded CARPATCLIM data (with 0.1° resolution), which are based on the measurements of regular meteorological stations. The validation considers annual, seasonal and monthly means, as well as extreme climatic events. On the basis of the results we can conclude that the outputs of the convection permitting simulations (using non-hydrostatic approach) overestimate the precipitation in the mountainous areas, which is greater than in the simulations using the hydrostatic approach. Comparing the simulations at 10 km resolution, the hydrostatic approach with new microphysics scheme seems to be the most promising over Hungary; however, it underestimates temperature in the Carpathian Mountains. Furthermore, it is planned to drive the regional model with non-hydrostatic core and the convective parameterization scheme switched-off. Non-hydrostatic approach may be more useful when using horizontal resolution below 10 km, so we are planning to complete such runs too.