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Sensitivity of the WRF regional climate model to different dynamical and physical configurations in the Carpathian Basin region

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Recent regional climate projections by the RegCM and ALADIN-Climate models show significant differences in prospective summer precipitation changes for Hungary, located in the Carpathian Basin region in Central Europe. Therefore, to mitigate this uncertainty, we began the adaptation of the Weather Research and Forecasting model for climate modeling purposes, with special focus on precipitation in the warmest season. As a first step, it is essential to assess the sensitivity of the model to different dynamical settings and physical parameterization schemes. For this task, WRF-ARW is one of the most convenient tools as it provides plenty of options for its users.

Hence, in this study, WRF is used to perform short-term historical regional climate simulations at 50 km and 10 km horizontal grid spacing, with several configurations. The coarser domain is in accord with the Med-CORDEX region, so comparison with other simulations might be done in the future. The high-resolution domain covers Hungary as well as the Alps, the Carpathian Mountains and the Dinaric Alps. WRF is forced by the new ERA5 reanalysis at the boundaries, updated at 6-hour intervals. We evaluate the effect of using hydrostatic and non-hydrostatic dynamics and investigate the impact of reducing the number of vertical model levels on simulated climate. Different land-surface models (LSMs), boundary layer, microphysics and cumulus parameterization schemes are also tested. Model results are validated against the E-OBS gridded observational dataset and SYNOP measurements in terms of temperature and precipitation.

Initial results show that the accuracy of temperature simulations depends mostly on the land surface scheme of choice, where an all year around 4-5 °C difference between simulations is possible. Choosing the proper surface scheme caused a decrease of RMSE from 3-6 °C to 0.5-1 °C. Precipitation is well represented in summer but systematically overestimated in other months by about 20 mm in all of the tested configurations.