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Comparison of different model setup of RegCM for the Pannonian region

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Regional climate is determined by the interactions of planetary processes as well as large-to-local-scale processes. Planetary and synoptic scale processes are well represented in global climate models (GCMs) that use horizontal resolution in the order of 100 km in century-long simulations. Regional climate models (RCMs) are then used for dynamical downscaling to increase the resolution of regional climate information consistently with the large-scale circulation provided by the driving GCM or by reanalysis data. RCMs are also widely used to provide projections on how the climate may change locally in the case of various possible scenarios. The analysis of any RCM projections starts with the evaluation of the model simulations of past conditions against observations (i.e. reference data) for different regions, and testing the model sensitivity with respect to the parameterizations of important physical processes (e.g. cloud formation and development, radiative processes, etc.).
The current study focuses on the RegCM4.5 and specifically on the comparison of hydrostatic and non-hydrostatic approaches as well as different microphysical parameterizations and planetary boundary layer (PBL) schemes. The main goal of the paper is to simulate the historical regional precipitation characteristics of the Pannonian region as reliably as possible. For this purpose, 8 different model experiments at 10 km horizontal resolution were completed for a 10-year period (1981–1990) using ERA-Interim reanalysis data (with 0.75° resolution) as initial and boundary conditions. Our simulation matrix consists of hydrostatic and non-hydrostatic runs together with different treatments of moisture, namely, the SUBEX and the NogTom schemes. In addition, two planetary boundary layer schemes are tested, the Holtslag and the UW PBL scheme.
In this detailed validation study, RegCM outputs (e.g. precipitation, temperature, sunshine duration, total cloud cover) are compared to the homogenized, gridded CARPATCLIM data (available with 0.1° resolution), which are based on measurements at regular meteorological station sites. The validation considers seasonal and monthly means, as well as extreme climatic events. On the basis of the results we can conclude that the convection permitting simulations overestimate the precipitation in the mountainous areas; furthermore, the overestimation of non-hydrostatic simulations results in a greater overall bias than in the simulations using the hydrostatic approach. Comparing the simulations at 10 km resolution, the hydrostatic approach with the modified SUBEX and UW PBL scheme seems to be the most promising over Hungary; however, it underestimates precipitation in summer over the Carpathian Mountains. Moreover, all simulations overestimate the sunshine duration and most of them underestimate the total cloud cover. Our preliminary analysis shows some inconsistencies, but the simulation results may be improved by evaluating these contradictions in details and understanding their causes.