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# The effect of horizontal diffusion parameterization in convection-permitting REMO-NH simulations over Germany

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Moving towards convection permitting simulations up to few kilometers scale are emerging solutions to the challenge and complexities in simulating different convective phenomena especially over mountainous regions. In this study we execute sensitivity experiments with the non-hydrostatic regional climate model REMO-NH at convection permitting resolution (~3km). We use this model in three setups where different parameterization schemes for horizontal diffusion are tested. In the first setup “DIFF2” we utilize the standard 2$^{nd}$ order diffusion while the second setup “DIFF4” applies 4$^{th}$ order diffusion. The higher order has a smaller impact on larger scales so that the atmospheric fields exhibit more details, especially in regions with high convective activity. In the third setup “TURB3D”, REMO-NH runs with a new 3D Smagorinsky-type turbulence scheme instead of the artificial diffusion schemes. Though turbulent horizontal diffusion is of second order in this setup, it incorporates a spatially and temporally varying exchange coefficient so that flows with little deformation remain unaffected. The domain of the simulations driven with EURO-CORDEX boundary data covers Germany and the time integration spans the year 2006.

Selected cases reveal a better representation of convective elements in DIFF4 and TURB3D when compared with DIFF2. We cannot compare these individual cases directly to observations since REMO-NH is not a reanalysis but a climate model. However, the spatial precipitation fields deduced from DWD radar data have characteristics which are more similar to DIFF4 and TURB3D than to DIFF2. More details are resolved in DIFF4 and TURB3D since the diffusion mainly act at the smallest spatial scales resolved by the model. DIFF2 smoothes convective activity drastically so that it appears in the form of unrealistically wide convective cells. On the other hand, the statistics of precipitation (seasonal average, standard deviation and 95th percentile) show a better agreement with observations in the simulation DIFF2 and TURB3D. TURB3D appears to be the best compromise regarding the simulation of precipitations fields. However, TURB3D exhibits a warm bias in the 2m temperature field in autumn and winter. Further model development may help to overcome this issue.