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Precipitation- and soil moisture variability in Germany: Fully coupled WRF-Hydro vs. standard WRF

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Soil moisture plays a crucial role in land-atmosphere interactions. Land-atmosphere feedbacks are expected to be strongest in transition zones between wet and dry land surfaces. It is therefore questionable whether a physically-enhanced description of soil moisture variability in a numerical model would improve the realism of the simulated atmosphere.
This question is investigated here for a two-year period in Germany, including a one-year spinup time, using the hydrologically enhanced version of the Weather Research and Forecasting WRF model, namely WRF-Hydro. The simulated domain covers Germany and neighboring areas. Atmospheric processes are resolved on a 4km resolution grid with explicit convection, whereas hydrological processes, namely overland flow, subsurface lateral flow and river flow, are resolved on a subgrid at 400 m resolution. This WRF-Hydro setup is run for several values of the surface infiltration parameter, in order to evaluate model result uncertainty originating from uncertainty in the description of terrestrial hydrological processes. Soil moisture variability deduced from this WRF-Hydro ensemble is compared with that deduced from a WRF-standalone ensemble. WRF and WRF-Hydro results are validated with daily gridded E-OBS datasets of precipitation and temperature from the European Climate Assessment & Dataset, and daily discharge data from the Global Runoff Data Center GRDC. The impact of the physically-enhanced description of soil moisture variability in WRF-Hydro is finally investigated with the concept of soil moisture memory.