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Does the uncertainty in the representation of terrestrial water flows affect precipitation predictability? A WRF-Hydro ensemble analysis for Central Europe

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Precipitation predictability can be assessed by the spread within an ensemble of atmospheric simulations being perturbed in the initial, lateral boundary conditions and/or modeled processes within a range of uncertainty. Surface-related processes are more likely to change precipitation when synoptic forcing is weak. This study investigates the effect of uncertainty in the representation of terrestrial water flows on precipitation predictability. The tools used for this investigation are the Weather Research and Forecasting (WRF) model and its hydrologically-enhanced version WRF-Hydro, applied over Central Europe during April-October 2008. The WRF grid is that of COSMO-DE, with a resolution of 2.8 km. In WRF-Hydro, the WRF grid is coupled with a sub-grid at 280 m resolution to resolve lateral terrestrial water flows. Vertical flow uncertainty is considered by modifying the parameter controlling the partitioning between surface runoff and infiltration in WRF, and horizontal flow uncertainty is considered by comparing WRF with WRF-Hydro. Precipitation predictability is deduced from the spread of an ensemble based on three turbulence parameterizations. Model results are validated with E-OBS precipitation and surface temperature, ESA-CCI soil moisture, FLUXNET-MTE surface evaporation and GRDC discharge. It is found that the uncertainty in the representation of terrestrial water flows is more likely to significantly affect precipitation predictability when surface flux spatial variability is high. In comparison to the WRF ensemble, WRF-Hydro slightly improves the adjusted continuous ranked probability score of daily precipitation. The reproduction of observed daily discharge with Nash-Sutcliffe model efficiency coefficients up to 0.91 demonstrates the potential of WRF-Hydro for flood forecasting.