Abstract

Precipitation is affected by soil moisture spatial variability. However, this variability is not well represented in atmospheric models that do not consider soil moisture transport as a three-dimensional process. This study investigates the sensitivity of precipitation to the uncertainty in the representation of terrestrial water flow. 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 model grid is convection permitting, with a horizontal spacing of 2.8 km. The WRF-Hydro subgrid employs a 280-m resolution to resolve lateral terrestrial water flow. A WRF/WRF-Hydro ensemble is constructed by modifying the parameter controlling the partitioning between surface runoff and infiltration and by varying the planetary boundary layer (PBL) scheme. This ensemble represents terrestrial water flow uncertainty originating from the consideration of resolved lateral flow, terrestrial water flow uncertainty in the vertical direction, and turbulence parameterization uncertainty. The uncertainty of terrestrial water flow noticeably increases the normalized ensemble spread of daily precipitation where topography is moderate, surface flux spatial variability is high, and the weather regime is dominated by local processes. The adjusted continuous ranked probability score shows that the PBL uncertainty improves the skill of an ensemble subset in reproducing daily precipitation from the E-OBS observational product by 16%–20%. In comparison to WRF, WRF-Hydro improves this skill by 0.4%–0.7%. The reproduction of observed daily discharge with Nash–Sutcliffe model efficiency coefficients generally above 0.3 demonstrates the potential of WRF-Hydro in hydrological science.