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Role of surface and subsurface lateral water flows on summer precipitation in a complex terrain region: A WRF-Hydro case-study for Southern Germany

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Recent developments in hydrometeorological modeling aim towards more sophisticated treatment of terrestrial hydrologic processes. The standard version of the Weather Research and Forecasting (WRF) model describes terrestrial water transport as a purely vertical process. The hydrologically enhanced version of WRF, namely WRF-Hydro, does account for lateral terrestrial water flows, which allows for a more comprehensive process description of the interdependencies between water- and energy fluxes at the land-atmosphere interface. In this study, WRF and WRF-Hydro are applied to the Bavarian Alpine region in southern Germany, a complex terrain landscape in a relatively humid, mid-latitude climate. Simulation results are validated with gridded and station observation of precipitation, temperature and river discharge. Differences between WRF and WRF-Hydro results are investigated with a joint atmospheric-terrestrial water budget analysis. Changes in the partitioning in (near-) surface runoff and percolation are prominent. However, values for evapotranspiration ET feature only marginal variations, suggesting that soil moisture content is not a limiting factor of ET in this specific region. Simulated precipitation fields during isolated summertime events still show appreciable differences, while differences in large-scale, multi-day rainy periods are less substantial. These differences are mainly related to differences in the moisture in- and outflow terms of the atmospheric water budget induced by the surface and sub-surface lateral redistribution of soil moisture in WRF-Hydro.