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Role of runoff-infiltration partitioning and resolved overland flow on land-atmosphere feedbacks: A case-study with the WRF-Hydro coupled modeling system for West Africa

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The analysis of land-atmosphere feedbacks requires detailed representation of land processes in atmospheric models. Our focus here is on runoff-infiltration partitioning and resolved overland flow. In the standard version of WRF, runoff-infiltration partitioning is described as a purely vertical process. In WRF-Hydro, runoff is enhanced with lateral water flows. The study region is the Sissili catchment (12800 km2) in West Africa and the study period March 2003 - February 2004. Our WRF setup includes an outer and inner domain at 10 and 2 km resolution covering the West African and Sissili region, respectively. In our WRF-Hydro setup the inner domain is coupled with a sub-grid at 500 m resolution to compute overland and river flow. Model results are compared with TRMM precipitation, MTE evapotranspiration, CCI soil moisture, CRU temperature, and streamflow observation. The role of runoff infiltration partitioning and resolved overland flow on land-atmosphere feedbacks is addressed with a sensitivity analysis of WRF results to the runoff-infiltration partitioning parameter and a comparison between WRF and WRF-Hydro results, respectively. In the outer domain, precipitation is sensitive to runoff-infiltration partitioning at the scale of the Sissili area (∼100x100 km2), but not of area A (500x2500 km2). In the inner domain, where precipitation patterns are mainly prescribed by lateral boundary conditions, sensitivity is small, but additionally resolved overland flow here clearly increases infiltration and evapotranspiration at the beginning of the wet season when soils are still dry. Our WRF-Hydro setup shows potential for joint atmospheric and terrestrial water balance studies, and reproduces observed daily discharge with a Nash-Sutcliffe model efficiency coefficient of 0.43.