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An integrated assessment of the catchment-scale energy and water balance using a terrestrial systems modeling platform and observations

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Fully coupled hydrological models close the water and energy cycles while accounting for the dynamic feedbacks between the subsurface, land surface, and atmosphere compartments of terrestrial systems. Diagnoses of their predictive capabilities require spatio-temporal coherent data sets including states and fluxes across the soil-vegetation-atmosphere continuum. This study presents an extensive comparison between numerical simulations carried out using a novel integrated hydrological modeling platform (TerrSysMP) and a suite of cross-compartmental observations obtained from intensive field campaigns and continuous monitoring over the Rur catchment in western Germany during the HOPE experiment (April-May 2013). The observations encompass amongst others rainfall estimates from several X-band radars, atmospheric integrated water vapor estimates from microwave radiometers, radiation and turbulent fluxes at the land surface, and soil moisture retrieval from cosmic-ray probes. A detailed analysis of the radiation components indicates that TerrSysMP systematically overestimates incoming shortwave due to a cloudiness effect, but underestimates incoming longwave due to a lower simulated atmospheric water vapor content. Screening of observed and simulated data for clear sky conditions also reveals mismatches between surface albedo at certain locations within the catchment. Moreover, a preliminary cross-comparison of precipitation and soil moisture suggests that overall the model is able to reproduce catchment dynamics reasonably well while pronounced discrepancies between model and observations were observed in the mountainous region due to the lack of detailed soil parameterization (i.e. soil organic content) and the underestimation of some rainfall events.