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Contribution of lateral terrestrial water flow to the hydrological cycle at regional scale: A joint soil-atmospheric moisture tagging procedure with WRF-Hydro

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Water resources management requires an accurate knowledge of the behavior of the regional hydrological cycle components, including precipitation, evapotranspiration, river discharge and soil water storage. Atmospheric models such as the Weather Research and Forecasting (WRF) model provide a tool to evaluate these components. Recent model developments have focused on coupled atmospheric-hydrological modeling systems, such as WRF-Hydro, in order to account for subsurface, overland and river flow and potentially improve the representation of land-atmosphere interactions. The aim of this study is to investigate the contribution of lateral terrestrial water flow to the regional hydrological cycle, with the help of a joint soil-atmospheric moisture tagging procedure newly developed in the so-called WRF-tag and WRF-Hydro-tag models. An application of both models for the high precipitation event on 15 August 2008 in the German and Austrian parts of the Danube river basin (94,100 km2) is presented. The precipitation having fallen in the basin during this event is considered as a moisture source, is tagged and tracked for a 40 month-period until December 2011. At the end of the study period, in both simulations, approximately 57% of the tagged moisture has run off, while 41% has evaporated back to the atmosphere, including 2% that has recycled in the Danube river basin as precipitation. In WRF-Hydro-tag, the surface evaporation of tagged moisture is slightly enhanced by surface flow infiltration, and slightly reduced by subsurface lateral water flow in areas with low topography gradients. This affects the source precipitation recycling by +/- 0.02%.