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Determining the age of river water with a precipitation tagging method in WRF-Hydro: A case in the Swiss Alptal catchment

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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. The main drawback of these atmospheric models, however, is that the terrestrial segment of the hydrological cycle is reduced to vertical infiltration, and that lateral terrestrial water flows are neglected. Recent model developments have focused on coupled atmospheric-hydrological modeling systems, such as WRF-hydro, in order to take into account subsurface, overland and river flow. The first aim of this study is to use WRF-Hydro for evaluating the age of river water, with a so-called precipitation tagging method. This tagging method allows to follow precipitation during its infiltration in the soil, until it percolates, re-evaporates, or runs off in a river bed. The second aim of this study is to compare the WRF-Hydro-derived river water age with stable water isotopes in streamwater, in order to assess the capacity of WRF-Hydro in reproducing realistic terrestrial water pathways. An application to the Alptal catchment, 47 km2, in the Swiss pre-Alps, for the discharge peaks of the summer 2016, is provided. The selected WRF-Hydro setup uses a spatial grid at 2 km horizontal resolution to represent atmospheric processes, and a spatial grid at 100 m resolution to describe lateral terrestrial water flow. The initial and lateral boundary condition is provided by the ECMWF operational analysis. For each precipitation event from summer 2015 to summer 2016, we use a tagging-enabled WRF-Hydro simulation to track the precipitation that fell during these events. This allows to reconstruct the contribution of each precipitating event between summer 2015 and summer 2016 to the discharge peaks observed during summer 2016 in the Alptal catchment.