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From the groundwater to the boundary layer: a fully-coupled hydrometeorologic modeling approach for a catchment of the Alpine foothils

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Through capillary rise, shallow groundwater tables can considerably affect the soil moisture contents within the root layer of the vadose zone and consequently govern the exchange of moisture and energy between the land-surface and the atmospheric boundary layer. In addition, they play an important role for channel flow and substantial quantities of recharge water are subject to lateral redistribution. A combination of these processes can lead to various non-linear dependencies, feedback and back coupling.

As a physically based hydrometeorologic modeling system, WRF-Hydro enables the study of the interactions between the atmospheric boundary layer and the hydrological quantities above and within the soil. However, in its current version a linear storage (bucket) model is employed to simulate the groundwater with single direction from the recharge towards the channel. For an improved representation, we present an extension to the hydrological component of WRF-Hydro that features a 2-dimensional, finite-difference, single-layer, porous groundwater flow model, a Darcy-flux parametrization of vertical water flux from and to the unsaturated zone, and a head-gradient based groundwater coupling to the river channel network.

The developed model system is applied for the diverse Alpine foothill catchment of the Ammer river (650 km^2), in Southern Germany, characterized by complex terrain, ranging from 550 to more than 2200 m.a.s.l. We will present an overview on the model structure and the coupling approach. Moreover, first results of the stand-alone model calibration and the fully coupled application will be shown.