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Simulating spatially distributed catchment response using a fully-integrated surface-subsurface model based on dual calibration with streamflow and evapotranspiration

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We use above-ground hydrological fluxes (streamflow and evapotranspiration (ET)) to calibrate an integrated hydrological simulator for a headwater catchment located in the Scottish highlands. Our study explores the feasibility of simulating spatially distributed catchment response in a physically based framework whilst having only preliminary data about the subsurface hydrological parameters. Furthermore we investigate the added value of insitu ET data in the calibration process.

Transient simulations are performed with a fully integrated surface-subsurface hydrological model HydroGeoSphere and calibration of model parameters is done in PEST framework. In the first calibration step only the stream hydrograph is included using the original time series alongside with log-transformed hydrograph and weekly flow volumes in the objective function. ET is estimated with energy balance technique using above canopy temperatures, humidity and net radiation measured within the catchment. In the second calibration step, the ET time series are introduced in the calibration objective function. Parameter identifiability along with uncertainty in the model output will be examined as a part of the model calibration for both calibration steps. Furthermore, the post-calibration model will allow us to simulate spatially distributed hydrological fluxes and to distinguish between different water sources that make up the stream hydrograph using the hydraulic mixing-cell method.

Preliminary simulations have shown that transient and spatially distributed surface water, subsurface water and evaporative fluxes of a headwater catchment can be reproduced in integrated modelling framework using only above-ground hydrological data in model calibration. We hypothesize that the evapotranspiration dataset informs the catchment water budget and water transmission rates and is therefore useful in constraining subsurface hydraulic parameters, such as hydraulic conductivities, which are typically inferred from subsurface field investigations. Finally, spatially distributed model output along with stream water sources and fluxes, as interpreted from the hydraulic mixing-cell method, will be compared with results from previous conceptual modelling work in the study catchment to discuss the level of agreement between the two modelling approaches.