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Investigating low flow process controls, through complex modelling, in a UK chalk catchment

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The typical streamflow response of Chalk catchments is dominated by groundwater contributions due the high degree of groundwater recharge through preferential flow pathways. The groundwater store attenuates the precipitation signal, which causes a delay between the corresponding high and low extremes in the precipitation and the stream flow signals. Streamflow responses can therefore be quite out of phase with the precipitation input to a Chalk catchment. Therefore characterising such catchment systems, including modelling approaches, clearly need to reproduce these percolation and groundwater dominated pathways to capture these dominant flow pathways. The simulation of low flow conditions for chalk catchments in numerical models is especially difficult due to the complex interactions between various processes that may not be adequately represented or resolved in the models. Periods of low stream flows are particularly important due to competing water uses in the summer, including agriculture and water supply. In this study we apply and evaluate the physically-based Pennstate Integrated Hydrologic Model (PIHM) to the River Kennet, a sub-catchment of the Thames Basin, to demonstrate how the simulations of a chalk catchment are improved by a physically-based system representation. We also use an ensemble of simulations to investigate the sensitivity of various hydrologic signatures (relevant to low flows and droughts) to the different parameters in the model, thereby inferring the levels of control exerted by the processes that the parameters represent.