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A novel representation of chalk hydrology in a land surface model

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Unconfined chalk aquifers contain a significant portion of water in the United Kingdom. In order to optimize the assessment and management practices of water resources in the region, modelling and monitoring of soil moisture in the unsaturated zone of the chalk aquifers are of utmost importance. However, efficient simulation of soil moisture in such aquifers is difficult mainly due to the fractured nature of chalk, which creates high-velocity preferential flow paths in the unsaturated zone. In this study, the Joint UK Land Environment Simulator (JULES) is applied on a study area encompassing the Kennet catchment in Southern England. The fluxes and states of the coupled water and energy cycles are simulated for 10 consecutive years (2001-2010). We hypothesize that explicit representation for the soil-chalk layers and the inclusion of preferential flow in the fractured chalk aquifers improves the reproduction of the hydrological processes in JULES. In order to test this hypothesis, we propose a new parametrization for preferential flow in JULES. This parametrization explicitly describes the flow of water in soil matrices and preferential flow paths using a simplified approach which can be beneficial for large-scale hydrometeorological applications. We also define the overlaying soil properties obtained from the Harmonized World Soil Database (HWSD) in the model. Our simulation results are compared across spatial scales with measured soil moisture and river discharge, indicating the importance of accounting for the physical properties of the medium while simulating hydrological processes in the chalk aquifers.