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Revising Hydrology of a Land Surface Model

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Land Surface Models (LSMs) are key elements in guiding adaptation to the changing water cycle and the starting points to develop a global hyper-resolution model of the terrestrial water, energy and biogeochemical cycles. However, before this potential is realised, there are some fundamental limitations of LSMs related to how meaningfully hydrological fluxes and stores are represented. An important limitation is the simplistic or non-existent representation of the deep subsurface in LSMs; and another is the lack of connection of LSM parameterisations to relevant hydrological information. In this context, the paper uses a case study of the JULES (Joint UK Land Environmental Simulator) LSM applied to the Kennet region in Southern England. The paper explores the assumptions behind JULES hydrology, adapts the model structure and optimises the coupling with the ZOOMQ3D regional groundwater model. The analysis illustrates how three types of information can be used to improve the model's hydrology: a) observations, b) regionalized information, and c) information from an independent physics-based model. It is found that: 1) coupling to the groundwater model allows realistic simulation of streamflows; 2) a simple dynamic lower boundary improves upon JULES' stationary unit gradient condition; 3) a 1D vertical flow in the unsaturated zone is sufficient; however there is benefit in introducing a simple dual soil moisture retention curve; 4) regionalized information can be used to describe soil spatial heterogeneity. It is concluded that relatively simple refinements to the hydrology of JULES and its parameterisation method can provide a substantial step forward in realising its potential as a high-resolution multi-purpose model.