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# Evaluating the representation of a simplified groundwater scheme for Earth system modeling applications

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Earth system models are key tools for understanding hydrometeorological impacts under changing environment. Their success should rely on representing key processes from bedrock to the atmosphere at an ever increasing spatiotemporal resolution. In particular, the representation of groundwater processes in Earth system and land surface models has received significant attention recently. However, due to high computational demand, continental to global representation of groundwater process is still limited for some key hydrometeorological services, especially those with a stochastic nature (i.e. data assimilation for weather prediction and uncertainty analysis for future climate scenarios). Here, we introduce a number of steps for the development of a new simplified groundwater approach ultimately targeted for Earth system modeling. We first begin by simplifying a more complex 3D hydrological model which is used as a benchmark. This allows us to clearly identify the advantages and limitations of our newly proposed approach. We use a series of synthetic experiments focusing on groundwater contribution to recharge and discharge, respectively. In the second step, we modify the Joint UK Land Environment Simulator (JULES), a widely used land surface model, to incorporate our new groundwater approach. We test the new JULES-groundwater model against the original JULES version using the same set of synthetic experiments. The third and final step evaluates the performance of the new JULES-groundwater model in representing river discharge and evapotranspiration in a regional domain in the UK which is characterized by groundwater-dominated catchments. Our results indicate that the new groundwater approach is able to reproduce the benchmark model with a high level of confidence while requiring much lower computational demand. In addition, the new JULES-groundwater model also shows remarkable agreement with the benchmark model for the synthetic cases, and consequently improved the representation of other hydrological fluxes in our regional experiment in the UK. Our study highlights the importance of fully representing hydrological processes in Earth system models and the expected challenges ahead due to the balance between model realism and computational demand for continental to global applications.