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Extending the global hydrological model WGHM with a gradient-based groundwater model: Comparison of simulated transient groundwater to temporal changes of global groundwater observations and total waterstorage change to GRACE

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Global-scale hydrological models have recently moved to include gradient-based groundwater models to better represent groundwater-surface water interactions, lateral and vertical flows as well as human water use impacts. G^3M is a new MODFLOW-like groundwater model with a spatial resolution of 5' that replaces the former linear groundwater reservoir in the 0.5° WaterGAP Global Hydrology Model (WGHM).

We present first results of the fully transient integration of the 5' groundwater model into the 0.5° global hydrology model. Main challenges include (1) the simulation of groundwater on with a low spatial resolution, (2) the connection of two models with different grid sizes (between the 5' groundwater model and the 0.5° global hydrology model) and (3) how the fluxes will be exchanged and distributed at different scales to preserve the water balance and to preserve high resolution information from the finer grid-scale of the groundwater model for the 0.5° resolution. The coupling across scales is challenging mostly because of its implications for gaining and losing surface water bodies. Results of a sensitivity analysis for an uncoupled steady-state simulation are discussed along with the implications for a fully transient model. In addition, an alternative approach for simulating flows between groundwater and surface water bodies is presented.

To validate the transient simulations, we compare model results to time series of observed groundwater head. Furthermore, we present a comparison of total water storage change to GRACE. We discuss how the results are influenced by using a gradient-based instead of the linear reservoir approach for modeling groundwater in global hydrological models.