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A computationally-efficient groundwater flow boundary condition for land surface modelling

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Groundwater is an important component of the terrestrial hydrological cycle. Particularly, shallow groundwater influences about one-third of the global land area. However, the current generation of the Land Surface Models (LSMs) either oversimplify (even neglect) groundwater, or incorporate detailed hydrological models to represent groundwater dynamics. The oversimplified representation of groundwater hydrology can potentially undermine the effect of subsurface processes on land surface mass and energy fluxes. On the other hand, incorporating groundwater dynamics using a detailed hydrological model in the LSMs is computationally demanding, which is disadvantageous for process understanding through model diagnostics (e.g., sensitivity and uncertainty analyses). In this study, we present the theoretical development of a novel boundary condition, namely the Groundwater Flow Boundary (GFB) that can be used in the LSMs to represent groundwater dynamics. We compare our approach with a detailed three-dimensional hydrological model to evaluate the GFB using synthetic test cases targeted for LSM applications (i.e. groundwater recharge and its contribution to discharge). Our results show that the proposed GFB approach can accurately reproduce the hydrological processes simulated by the three-dimensional model in a more computationally-efficient manner.