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Improved global simulation of groundwater–ecosystem interactions via tight coupling of a dynamic global ecosystem model and a global hydrological model

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In up to 30% of the global land surface ecosystems are potentially influenced by the presence of a shallow groundwater table. In these regions upward water flux by capillary rise increases soil moisture availability in the root zone, which has a strong effect on evapotranspiration, vegetation dynamics, and fluxes of carbon and nitrogen. Most global hydrological models and several land surface models simulate groundwater table dynamics and their effects on land surface processes. However, these models typically have relatively simplistic representation of vegetation and do not consider changes in vegetation type and structure. Dynamic global vegetation models (DGVMs), describe land surface from an ecological perspective, combining detailed description of vegetation dynamics and structure, and biogeochemical processes and are thus more appropriate to simulate the ecological and biogeochemical effects of groundwater interactions. However, currently virtually all DGVMs ignore these effects, assuming that water tables are too deep to affect soil moisture in the root zone. We have implemented a tight coupling between the dynamic global ecosystem model LPJ-GUESS and the global hydrological model PCR-GLOBWB, which explicitly simulates groundwater dynamics. This coupled model allows us to explicitly account for groundwater effects on terrestrial ecosystem processes at global scale. Results of global simulations indicate that groundwater strongly influences fluxes of water, carbon and nitrogen, in many regions, adding up to a considerable effect at the global scale.