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Impact of groundwater capillary rises as lower boundary conditions for soil moisture in a land surface model

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Groundwater is a key component of the global hydrological cycle. It sustains base flow in humid climate while it receives seepage in arid region. Moreover, groundwater influences soil moisture through water capillary rise into the soil and potentially affects the energy and water budget between the land surface and the atmosphere. Despite its importance, most global climate models do not account for groundwater and their possible interaction with both the surface hydrology and the overlying atmosphere.

This study assesses the impact of capillary rise from shallow groundwater on the simulated water budget over France. The groundwater scheme implemented in the Total Runoff Integrated Pathways (TRIP) river routing model in a previous study is coupled with the Interaction between Soil Biosphere Atmosphere (ISBA) land surface model. In this coupling, the simulated water table depth acts as the lower boundary condition for the soil moisture diffusivity equation. An original parameterization accounting for the subgrid elevation inside each grid cell is proposed in order to compute this fully-coupled soil lower boundary condition. Simulations are performed at high (1/12°) and low (0.5°) resolutions and evaluated over the 1989-2009 period.

Compared to a free-drain experiment, upward capillary fluxes at the bottom of soil increase the mean annual evapotranspiration simulated over the aquifer domain by 3.12 % and 1.54 % at fine and low resolutions respectively. This process logically induces a decrease of the simulated recharge from ISBA to the aquifers and contributes to enhance the soil moisture memory. The simulated water table depths are then lowered, which induces a slight decrease of the simulated mean annual river discharges. However, the fully-coupled simulations compare well with river discharge and water table depth observations which confirms the relevance of the coupling formalism.