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# Impact of groundwater – soil moisture interaction on evolution of evapotranspiration and air temperature under climate change

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Groundwater (GW) constitutes by far the largest volume of liquid freshwater on Earth. The most active part is soil moisture (SM), which plays a key role on land/atmosphere interactions. But GW is often stored in deep reservoirs below the soil as well, where it presents slow horizontal movements along hillslopes toward the river network. They end up forming baseflow with well-known buffering effects on streamflow variability, but they also contribute to sustain higher SM values, especially in the lowland areas surrounding streams, which are among the most frequent wetlands. As a result, GW-SM interactions may influence the climate system, in the past but also in the future, with a potential to alleviate anthropogenic warming, at least regionally, owing to enhanced evapotranspiration rate (ET) or higher soil thermal inertia for instance.
To assess where, when, and how much GW-SM interaction affects the climate change trajectories, we use coupled land-atmosphere simulations with the IPSL-CM6 climate model, developed by the Institut Pierre Simon Laplace for CMIP6. We contrast the results of two long-term simulations (1979-2100), which share the same sea surface temperature and radiative forcing, using the SSP5-8.5 scenario (i.e. the most pessimistic) for 2015-2100. The two simulations differ by their configuration of the land surface scheme ORCHIDEE: in the default version, there is no GW-SM interaction, while this interaction is permitted in the second simulation, within a so-called lowland fraction, fed by surface and GW runoff from the rest of the grid-cell. For simplicity, this lowland fraction is set constant over time, but varies across grid-cells based on a recently designed global scale wetland map.
Within this framework, we analyse the impact of the GW-SM interaction on climate change trajectories, focusing on the response of evapotranspiration rates and near-surface air temperatures. The GW-SM interaction can modulate the response to climate change by amplifying, attenuating, or even inverting the climate change trend. Based on yearly mean values over land, we find that the GW-SM interaction amplifies the response of evapotranspiration to climate change, as the mean evapotranspiration rate increases 50% faster over 1980 - 2100 in the simulation with GW-SM interaction. In contrast, the mean warming over land is 1% weaker, shifting from 6.4 to 6.3 °C/100 years; thus attenuated, if the GW-SM interaction is accounted for. In both cases, these values hide important differences across climates and seasons, with mitigation or amplification for both variables, indicating the need for regional and seasonal assessment. We will also further explore how GW-SM interaction impacts the future evolution of heatwaves, in terms

of duration and frequency.