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Groundwater influence on soil moisture memory, ET fluxes and the seasonal cycle of streamflow in the Iberian Peninsula

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In this work we investigate the memory induced in soil moisture fields by groundwater long timescales of variation in the Iberian Peninsula with the LEAFHYDRO soil-vegetation-hydrology model, which includes a fully coupled water table to soil moisture and river flow via 2-way fluxes. We select a 10-year period (1989-2000) with transitions from wet to dry to again wet long lasting conditions and we carry out simulations at 2.5 km spatial resolution forced by ERA-Interim and a high-resolution precipitation analysis over Spain and Portugal. The model produces a realistic water table that we validate with hundreds of time series (ranging from 4 to 10 years) of observations over the Iberian Peninsula. Modeled river flow is also compared to observations. Over shallow water table regions, results highlight the groundwater buffering effect on soil moisture fields over dry spells and long-term droughts, as well as the slow recovery of pre-drought soil wetness once climatic conditions turn wetter. Groundwater sustains river flow during the dry summers and in turn, particularly in the south of Spain where the summer drought is more pronounced, river seepage feeds groundwater in wide valleys, keeping the water table shallow. The longer lasting wet conditions in the soil when groundwater is considered increases ET, especially in the summer, when it is mostly water-limited. Our results suggest that groundwater interaction with soil moisture should be considered for climate seasonal forecasting and climate studies in general over water-limited regions where shallow water tables are significantly present.