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Interaction between soil moisture memory and different climate variables

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A large number of modelling studies show a potential impact of the soil moisture state on regional climate on different time scales. Especially for short prediction periods, perturbations of the soil moisture state may result in significant alteration of surface temperature in the following season. The physical reasoning for such effects are usually attributed to the soil moisture – temperature as well as the soil moisture – precipitation feedbacks.

We designed a model experiment to investigate the time scale until the effect of arbitrary soil moisture initialization is forgotten by the model. This time period is called soil moisture memory and computed for different seasons based on an ensemble of nine, 3 year long, simulations per season. These simulations are done using the coupled land-atmosphere model ECHAM6-JSBACH, which is part of the Max Planck Institute for Meteorology's Earth System Model (MPI-ESM). Soil moisture memory was found to range between few days up to several months. While the longest memory often coincides with either snow-covered conditions or follows on monsoon periods, short memory is computed prior to snow-melt and rainy seasons.

Additionally, the correlations between soil moisture memory and a number of surface variables was investigated. We found that the magnitude of the initial soil moisture perturbations explains at most 50% of the spatial variation in soil moisture memory while the remaining variance is associated with soil properties and – even stronger – with dynamical variables like surface temperature, evapotranspiration and runoff. This effect differs for different seasons and soil moisture regimes which demonstrates the complexity of soil moisture – climate interactions. Further analysis will be focused on the re-occurrence of soil moisture memory after periods of insignificant memory and the possibility of memory transfer between different land surface state variables.