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Identifying soil moisture memory effects using MPI-M climate models

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Soil moisture-atmosphere feedback effects play an important role in several regions of the globe. For some of these regions, soil moisture memory may contribute significantly to the development of the regional climate. Identifying those regions can help to improve predictability in seasonal to decadal climate forecasts.
The present study aims to identify soil moisture memory effects by using the global and regional climate models of the Max Planck Institute for Meteorology (MPI-M), ECHAM6 and REMO2009, in two different setups. The first is the standard setup from the currently operational versions of the MPI-M climate models, in which soil water is represented by a single soil moisture reservoir. The second uses a new five soil layer hydrology scheme where the previous bucket soil moisture now corresponds to the root zone soil moisture. In the standard setup, transpiration may access the whole soil moisture above the wilting point over vegetated areas. But in the five layer scheme, soil water below the root zone cannot directly be accessed by transpiration, it can only be transported upwards into the root zone by diffusion following the Richard's equation. Thus, this water below the root zone, which is not present in the standard setup, can act as buffer in the transition between wet and dry periods. A second notable difference between the two setups is the formulation of bare soil evaporation. In the standard setup, this may only occur if the whole soil moisture bucket is almost completely saturated, while in the new setup, it depends only on the saturation of the upper most soil layer. Here, the latter is much thinner than the root zone (bucket) so that bare soil evaporation can occur more frequently, especially after rainfall events.
The new scheme will be shortly presented, and globally, results from two ECHAM6 simulations conducted with AMIP2 SST forcing at T63 resolution will be analysed. The analysis of results will focus on Europe and southern Africa where also regional climate model simulations were conducted with REMO2009 using ERA40 (Europe) and ECMWF operational analysis (southern Africa) data as lateral boundary forcing. Areas will be highlighted where the regional climate seems to be sensitive to the improved representation of soil hydrology in the new setup. Soil moisture memory effects are indicated in regions where this sensitivity is caused by the presence of the soil moisture buffer below the root zone.