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Impact on soil moisture memory using a new 5 layer hydrology scheme

Stefan Hagemann[†]; Andreas Haensler
[†] Max Planck Institute for Meteorology, Germany
Leading author: stefan.hagemann@zmaw.de

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. In the five layer scheme, soil water below the root zone cannot directly be accessed by transpiration, but it can 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. For many catchments, the root zone becomes drier in wet seasons, partially due to the improved and increased bare soil evaporation, and wetter in the dry season due to water supply from layer below root zone via diffusion. Following Koster and Suarez (2001) and Seneviratne et al. (2006), soil moisture memory is indicated in regions where anomalies of soil moisture WS have a high autocorrelation. Thus, in our study we will consider areas, where the autocorrelation is continuously high for several months, to be affected by soil moisture memory processes. The 5 layer scheme, due the water buffer below the root zone, increases soil moisture memory over large parts of South America, Europe, East Asia (Mekong) and Central Africa. It decreases memory, mainly due to improved bare soil evaporation in less vegetated areas, over West Russia, East (Nile) and South Africa (Orange), Australia and Northern Siberia. Memory changes in REMO are less pronounced, but consistent over Eastern Europe, West Russia and Kaukasus.