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Comparing soil moisture memory in satellite observations and models

Tobias Stacke, Stefan Hagemann, and Alexander Loew
Max Planck Institute for Meteorology, Land in the Earth System, Hamburg, Germany (tobias.stacke@zmaw.de)

A major obstacle to a correct parametrization of soil processes in large scale global land surface models is the lack of long term soil moisture observations for large parts of the globe. Currently, a compilation of soil moisture data derived from a range of satellites is released by the ESA Climate Change Initiative (ECV_SM). Comprising the period from 1978 until 2010, it provides the opportunity to compute climatological relevant statistics on a quasi-global scale and to compare these to the output of climate models.
Our study is focused on the investigation of soil moisture memory in satellite observations and models. As a proxy for memory we compute the autocorrelation length (ACL) of the available satellite data and the uppermost soil layer of the models. Additional to the ECV_SM data, AMSR-E soil moisture is used as observational estimate. Simulated soil moisture fields are taken from ERA-Interim reanalysis and generated with the land surface model JSBACH, which was driven with quasi-observational meteorological forcing data. The satellite data show ACLs between one week and one month for the greater part of the land surface while the models simulate a longer memory of up to two months. Some pattern are similar in models and observations, e.g. a longer memory in the Sahel Zone and the Arabian Peninsula, but the models are not able to reproduce regions with a very short ACL of just a few days. If the long term seasonality is subtracted from the data the memory is strongly shortened, indicating the importance of seasonal variations for the memory in most regions.
Furthermore, we analyze the change of soil moisture memory in the different soil layers of the models to investigate to which extent the surface soil moisture includes information about the whole soil column. A first analysis reveals that the ACL is increasing for deeper layers. However, its increase is stronger in the soil moisture anomaly than in its absolute values and the first even exceeds the latter in the deepest layer. From this we conclude that the seasonal soil moisture variations dominate the memory close to the surface but these are dampened in lower layers where the memory is mainly affected by longer term variations.