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Towards the removal of model bias from ESA CCI SM by using an L-band scaling reference

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Merging data from different instruments is required to construct long time data records of soil moisture (SM). This is the goal of projects such as the ESA Climate Change Initiative (CCI) for SM (Gruber et al., 2019), which uses both active and passive microwave sensors. Currently, the GLDAS v2.1 model is used as reference to re-scale active and passive time series by matching their Cumulative Density Function (CDF) to that of the model. Removing the dependency on models is important, in particular for data assimilation applications into hydrological or climate models, and it has been proposed (Van der Schalie et al., 2018) to use L-band data from one of the two instruments specifically designed to measure SM, ESA Soil Moisture and Ocean Salinity (SMOS) and NASA Soil Moisture Active Passive (SMAP) satellites, as reference to re-scale other time series.
To investigate this approach, AMSR-2 SM time series obtained from C1-, C2- and X-band observations using LPRM (Land Parameter Retrieval Model) were re-scaled by CDF-matching (Brocca et al., 2011) using different SMAP and SMOS official (SMAP L2 V005, SMOS L3 V300, SMOS NRT V100&V200) and research (SMOS IC V103) SM products as well as the SMAP and SMOS LPRM v6 SM data used by the ESA CCI. The time series re-scaled using L-band remote sensing data were compared to those re-scaled using GLDAS and were evaluated against in situ measurements at several hundred sites retrieved from the International Soil Moisture Network (Dorigo et al., 2011). The results were analyzed as a function of the land cover class and the Koppen-Geiger climate classification.
Overall, AMSR-2 time series re-scaled using SMAP L2, SMAP LPRM and SMOS IC data sets as reference gave the best correlations with respect to in situ measurements, similar to those obtained by the time series re-scaled using GLDAS and slightly better than those of the original AMSR-2 time series. These results imply that different SMAP and SMOS products could actually be used to replace GLDAS as reference for the re-scaling of other sensors time series within the ESA CCI. However, one must bear in mind that this study is limited to the re-scaling of AMSR-2 data at a few hundred sites.
For a more detailed assessment of the L-band data set to be used for a global re-scaling, it is necessary to investigate other effects such as the spatial coverage or the time series length. SMAP spatial coverage is better than that of SMOS in regions affected by radio frequency interference. In contrast, the length of SMAP time series can be too short to capture the long term SM variability

for climate applications in some regions. The CDF of SMOS time series computed from the date of SMAP launch is significantly different to those of the full length SMOS time series in some regions of the Globe. Possible ways of using a coherent SMAP/SMOS L-band data set will be discussed.