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Global-scale evaluation of two satellite-based passive microwave soil moisture data sets (SMOS and AMSR-E) with respect to modelled estimates

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Global Level-3 surface soil moisture (SSM) maps from the passive microwave Soil Moisture and Ocean Salinity satellite (SMOS)have been recently released. To further improve the Level-3 retrieval algorithm, evaluation of the accuracy of the spatio-temporal variability of the SMOS Level 3 products (referred to as SMOSL3) is necessary. In this study, a comparative analysis of SMOSL3 with a SSM product derived from the observations of the Advanced Microwave Scanning Radiometer (AMSR-E) computed by implementing the Land Parameter Retrieval Model (LPRM) algorithm, referred to as AMSRM, is presented. The comparison of both products (SMOSL3 and AMSRM)was made against SSM products produced by a numerical weather prediction system (SM-DAS-2) at ECMWF (European Centre for Medium-Range Weather Forecasts) for the 03/2010-09/2011 period at the global scale. The latter product was considered here as a "reference" product for the inter-comparison of the SMOSL3 and AMSRM products. Three statistical criteria were used for the evaluation, the correlation coefficient (R), the root-mean-squared difference (RMSD), and the bias. Global maps of these criteria were averaged, taking into account vegetation information in terms of biome types and Leaf Area Index (LAI). We found that both the SMOSL3 and AMSRM products captured well the spatio-temporal variability of the SM-DAS-2 SSM products in most of the biomes. In general, the AMSRM products overestimated (i.e. wet bias) while the SMOSL3 products underestimated (i.e. dry bias) SSM in comparison to the SM-DAS-2 SSM products. In term of correlation values, the SMOSL3 products were found to better capture the SSM temporal dynamics in highly vegetated biomes ("Tropical humid", "Temperate Humid", etc.) Whereas best results for AMSRM were obtained over arid and semi-arid biomes ("Desert temperate", "Desert tropical", etc.). When removing the seasonal cycles in the SSM time variations to compute anomaly values, better correlation with the SM-DAS-2 SSM anomalies were obtained with SMOSL3 than with AMSRM, in most of the biomes with the exception of desert regions. Eventually, we showed that the accuracy of the remotely sensed SSM products is strongly related to LAI. Both the SMOSL3 and AMSRM (slightly better) SSM products correlate well with the SM-DAS2 products over regions with sparse vegetation for values of LAI < 1 (these regions represent almost 50% of the pixels considered in this global study). In regions where LAI>1, SMOSL3 outperformed AMSRM with respect to SM-DAS-2: SMOSL3 had almost consistent performances up to LAI = 6, whereas AMSRM performance deteriorated rapidly with increasing values of LAI.