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► **To cite this version:**

Amen Al Yaari, Jean-Pierre Wigneron, Agnès Ducharne, Ajit Govind, Christophe Moisy, et al.. Evaluation and intercomparison of SMOSL3, AMSR E-LPRM, SM-DAS-2, and ERA-Interim/land soil moisture products. ESA Living Planet Symposium, Sep 2013, Edinburgh, United Kingdom. 2013. hal-02805538

HAL Id: hal-02805538

<https://hal.inrae.fr/hal-02805538>

Submitted on 6 Jun 2020

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Evaluation and Intercomparison of SMOSL3, AMSRE-LPRM, SM-DAS-2, and ERA-Interim/Land Soil Moisture products

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Soil moisture (SM) is considered to be one of the keys to our understanding of land-atmosphere interactions. Until now studies on this topic were mostly based on modelled data. With the recent advances in global SM retrievals from satellite in the past decade we are suddenly in the position to study these processes with observations. However, the uncertainty of these recently developed global satellite-based products is still to a large degree unknown. Global SM datasets are now being produced based on active and passive microwave satellite observations and simulations from Land Surface Models. These include, amongst others, two products based on remote sensing observations: 1) SMOS Level-3 SM products, and 2) AMSR-E_LPRM, derived from the passive microwave AMSR-E sensor using the Land Parameter Retrieval Model (LPRM) and two products based on the ECMWF land surface model: 1) SM-DAS-2: retrieved by ASCAT assimilation in the ECMWF Land Data Assimilation System and 2) ERA-Interim /land: an upgraded land surface for ECMWF ERA-Interim reanalysis. Due to the recentness of most of these global SM products, they have still not been sufficiently evaluated. The objective of this study is to carry out a first evaluation of the agreement between all four products and to evaluate their ability to capture SM dynamics for the 2010-2012 period. The agreement and degree of dispersion between SMOSL3, AMSRE, SM-DAS-2, and ERA-land products were analysed in terms of three statistical criteria: the root mean squared difference (RMSD), bias, and the correlation coefficient during overlap periods. Attempting to enhance our understanding of the reliability of the various products, both datasets based on spatial remote sensing and land surface models were compared with in situ measurements of SM obtained from both the ISMN (<http://www.ipf.tuwien.ac.at/insitu/>) and Fluxnet networks. We focused the comparison of satellite and model derived data against in-situ measurements over three regions with contrasting vegetation types: [1] South America (including transitions between deforested sites to tropical forests), [2] Western-Europe (temperate climate) and [3] African semi-arid regions. Because the Radio Frequencies Interferences (RFIs) effects strongly perturb the SMOS and AMSR-E observations, we selected regions that have very low RFI effects. In general, we found the best correlations between the global satellite and models datasets ($R > 0.80$) in the transition zones between wet and dry climates (e.g. Indian subcontinent, Great Plains of North America, the Sahel, and equatorial Africa), and also in the Western Europe, Eastern Australia, and the South-East region of Brazil. This can be explained by the strong seasonal dynamics of SM in these regions and the strong coupling between SM and precipitation. Satellite and model datasets exhibit weak correlation ($R < 0.40$) in dry regions (e.g. Sahara, Arabian Peninsula, and central Australia) due to the low range of variation of SM in these regions which corresponds roughly to the sensor retrieval accuracy ($\sim 0.04 \text{ m}^3\text{m}^{-3}$). RMSD and bias values were found to be markedly different between satellites and model products in tropical areas. We think that the presence of dense vegetation with complex canopy types limits the accurate detection of SM. In high latitude (boreal zone), tundra (e.g. Northern Canada, Alaska, and north-eastern regions of Russia) significant differences between the satellites and model products were found due to the influence of bound water and the constraint of frozen soil conditions on satellite signal retrievals. The analyses have pointed out the strong spatial correspondence between all products in India, the Sahel region, the South-East region of Brazil, and Eastern Australia. Finally, first results of the comparison of these various products with the in-situ measurements provide new insights into the performance of the various derived SM products.