Title: **Skill and global trend analysis of soil moisture from reanalyses and microwave remote sensing, *Journal of Hydrometeorology* (American Meteorological Society)**

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Abstract:

In situ soil moisture measurements from 2007 to 2010 for 196 stations from five networks across the world (USA, France, Spain, China and Australia) are used to determine the reliability of three soil moisture products: (i) a revised version of the ERA-Interim reanalysis from ECMWF (ERA-Land), (ii) a revised version of the MERRA reanalysis from NASA (MERRA-Land) and (iii) a new, microwave based multi-satellite surface soil moisture dataset (SM-MW). Evaluation of the time series and anomalies from a moving monthly mean shows a good performance of the three products in capturing the annual cycle of surface soil moisture and its short-term variability. On average, correlations (95% confidence interval) are 0.58(±0.063), 0.67(±0.040) and 0.63(±0.041) for SM-MW, MERRA-Land and ERA-Land. The two reanalysis products also capture the root zone soil moisture well; on average correlations are 0.72(±0.033) and 0.68(±0.036). Global trends analysis for 1988-2010 suggests a decrease of surface soil moisture contents (72% of significant trends are negative, i.e. drying) for ERA-Land and an increase in surface soil moisture (59% of significant trends are positive, i.e. wetting) for MERRA-Land. As the spatial extent and fractions of significant trends in both products differ, the trend reflected in the majority of grid points within different climate classes was investigated and compared to that of SM-MW. The latter is dominated by negative significant trends (73.2%) and is more in line with ERA-Land. For both reanalysis products trends for the upper layer of soil are confirmed in the root zone soil moisture (first meter of soil).

Popular Summary:

Global-scale estimates of soil moisture in the top few centimeters of the soil (or surface soil moisture) can be obtained from satellite remote sensing at microwave (centimeter) wavelengths. Global soil moisture estimates for the surface layer and the so-called root zone layer (in the top 1 meter of the soil) can also be obtained from numerical models of land surface and atmospheric processes that are updated with millions of atmospheric observations per day in a data assimilation system. This paper investigates three such data sets. The first is based on a long-term (1988-present) record of microwave satellite observations ("SM-MW"). The other two data products are long-

term (1979-present) estimates derived from data assimilation systems at NASA ("MERRA-Land") and at the European Centre for Medium Range Weather Forecasts ("ERA-Land"). The paper assesses the skill of these three soil moisture data products and finds that all three products show good performance when compared to in situ observations at 196 locations that are available from 2007 to 2010. Furthermore, the paper assesses the long-term (1988-2010) trends in soil moisture. The majority of locations with statistically significant soil moisture trends in ERA-Land and SM-MW are drying trends whereas in MERRA-Land the majority of significant trends are wetting trends.