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Evaluating multi-scale variability of disaggregated SMOS soil moisture product in Australia

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Soil moisture has a strong impact on climate, hydrology and agronomy at different space scales, from the continent global scale to the local watershed. Various technologies have been developed to allow a complete study on a wide range of scales: in-situ campaigns inform on the local dynamics (below meter scale), whereas embedded systems such as aircrafts or satellites give global variations on larger scales. However, because of the technological constraint, these sensors measure soil moisture variability only on specific scales. Moreover, the multi-scale behavior is still poorly represented in actual models, which are often limited to either a local or a global scale... In the last twenty years, research works based on the statistical analysis showed that a large part of the natural phenomena in geophysics present scaling laws, which is the case for soil moisture or land surface temperature for example (Lovejoy et al, 2008). Multi-scale stochastic models have been developed like the Universal Multifractal (UM) model introduced by Schertzer and Lovejoy in 1987.

This study proposes a method based on the UM formalism to better understand the multi-scale behavior of the disaggregated SMOS (Soil Moisture and Ocean Salinity; Kerr et al, 2010) soil moisture product called DisPATCh (Disaggregation based on Physical And Theoretical scale Change; Merlin et al, 2008). This product is obtained from a deterministic disaggregation algorithm that improves the 40 km resolution of SMOS soil moisture data to 1 km resolution. To do that, the algorithm combines SMOS soil moisture with 1 km resolution MODIS auxiliary data (vegetation index and land surface temperature). We focused our study from June to December 2010, on the Southeastern part of Australia. This area was selected because of the many campaigns carried out in the last years to study soil moisture from in-situ, aircraft and satellite sensors. We applied spectral analysis and multifractal analysis (in the framework of the UM model) to the different products, in order to compare the multi-scale variability of DisPATCh to the original SMOS product and the MODIS auxiliary data. We have obtained good scaling laws for SMOS soil moisture and MODIS vegetation index and land surface temperature. However, an unexpected behavior of the DisPATCh spectrum was noticed for the scales smaller than 40 km... This observation raises some questions about the capacity of DisPATCh to properly simulate the soil moisture variability below the SMOS resolution.