Examining the Soil Moisture Spatial Variability using the ASAR Global Monitoring Mode Soil Moisture Product over the NAFE05 area

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Spatial domain and temporal extent at which soil moisture is studied are important preconditions when analyzing its variability. Proper understanding of its variability in space and time is crucial considering its role as a controlling parameter in many weather and hydrologic models. However, long term forecasting is limited by the lack of adequate observations of soil moisture. The available soil moisture data is either point based (*in situ* measured) or derived using satellite observations. The pixel resolution of the satellite estimates is typically a trade off for their spatial coverage (kilometers at global versus meters at local scale coverage). Accuracy assessment of the satellite estimates is done using *in situ* observed soil moisture monitored either by permanent stations or obtained during extensive field campaigns. There are a very few well-developed soil moisture monitoring networks proving soil moisture in near real time worldwide. Large scale soil moisture field campaigns are limited in temporal (typically up to 4 weeks) and spatial extend. Therefore validation of the coarse resolution satellite estimates (e.g. Advanced Scanning Microwave Radiometer (AMSR-E) – 50 km; Soil Moisture and Ocean Salinity (SMOS) – 40 km) with the point based *in situ* soil moisture can biased; furthermore most of the hydrological processes are better observed at the spatial scale of meters studying the soil moisture spatial variability at such a coarse resolution can lead to inaccurate conclusions. Soil moisture estimates derived from airborne instruments provide the necessary intermediate linkage in terms of spatial resolution (typically from several hundred meters to 1 km) between the point based and the satellite estimates. Airborne missions are however limited in time and coverage.

Long term high resolution soil moisture monitoring by space-borne microwave remote sensing can be achieved either by down-scaling the available coarse radiometer estimates or by using active microwave remote sensing. There exist very few active space-borne instruments that operate at similar spatial resolution as the airborne sensors and at frequency suitable for monitoring soil moisture. Current operational systems are: C-band – Synthetic Aperture Radar (SAR) systems onboard RADARSAT-1/2 and ERS-1/2 and the Advanced Synthetic Aperture Radar (ASAR) on ENVISAT; L-band – the Phased Array type L-band Synthetic Aperture Radar (PALSAR) on ALOS (Advance Land Observing Satellite); spatial resolution ranges form 10 m (ALOS/PALSAR) to 1000 m (ASAR/ENVISAT). The radar backscatter (σ^o) to soil moisture (SM) inversion is considerably more complex then the soil moisture retrieval from brightness temperature (T_B). The stronger influence of the land surface on the radar measured signal and the need of ancillary data [i.e. mean square roughness height (Oh et al 1992), surface correlation length (Fung et al 1992) and many vegetation parameters (Ulaby et al 1990) etc.] make the available retrieval algorithms applicable to very site specific ground conditions and therefore determine the lack of operational algorithm for retrieval of soil moisture from the above listed systems (Moran et al 2006).

A relative soil wetness product has been developed by the microwave remote sensing group (http://www.ipf.tuwien.ac.at/radar) at the Vienna Technical University (VTU), Institute of Photogrammetry and Remote Sensing (IPF). The1 km product is derived using the ENVISAT/ASAR Global Monitoring (GM) Mode and it is not an actual measure of the soil moisture content, but rather a degree of saturation of the top surface layer computed (Wagner and Scipal 2000) by relating the actual observed σ^o value for a particular pixel to a reference backscatter values for dry and wet surface conditions. The methodology has been successfully applied for retrieval at 25 km using scatterometer observed backscatter (see Section II, part C for references); however the ASAR GM 1 km product, which we use, is still in validation stage. If proven accurate and sensitive to soil moisture variations the ASAR GM product would be beneficial in terms of (1) Direct soil moisture monitoring at a resolution suitable for local and watershed applications; (2) Potential use in combined passive – active disaggregation methods (Narayan et al 2006); (3) Improved spatial hydrologic modeling via data assimilation, rather then the commonly used approach of assimilating station observed soil moisture in time;

The main objective of our paper is to carry out a spatial validation of the VTU/IPF ASAR GM soil wetness product over the National Airborne Field Campaign 2005 (NAFE05). The ASAR GM spatial sensitivity to soil moisture has been evaluated by using (1) Data from permanent soil moisture stations; (2) *In situ* measured soil moisture during the field experiment ground observation campaign and (3) Airborne soil moisture derived from the Polarimetric L-band Microwave Radiometer (PLMR). This will allow us to analyze the spatial sensitivity of the ASAR GM product over several different scales and address an important question: Are point obtained measures of soil moisture adequate to achieve accurate validation of a satellite derived product?

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