Geophysical Research Abstracts
Vol. 14, EGU2012-5338, 2012
EGU General Assembly 2012


# Using high-resolution soil moisture modelling to assess the uncertainty of microwave remotely sensed soil moisture products at the correct spatial and temporal support

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Soil moisture is a key variable in the hydrological cycle and important in hydrological modelling. When assimilating soil moisture into flood forecasting models, the improvement of forecasting skills depends on the ability to accurately estimate the spatial and temporal patterns of soil moisture content throughout the river basin. Space-borne remote sensing may provide this information with a high temporal and spatial resolution and with a global coverage. Currently three microwave soil moisture products are available: AMSR-E, ASCAT and SMOS. The quality of these satellite-based products is often assessed by comparing them with in-situ observations of soil moisture. This comparison is however hampered by the difference in spatial and temporal support (i.e. resolution, scale), because the spatial resolution of microwave satellites is rather low compared to in-situ field measurements. Thus, the aim of this study is to derive a method to assess the uncertainty of microwave satellite soil moisture products at the correct spatial support.

To overcome the difference in support size between in-situ soil moisture observations and remote sensed soil moisture, we used a stochastic, distributed unsaturated zone model (SWAP, van Dam (2000)) that is upscaled to the support of different satellite products. A detailed assessment of the SWAP model uncertainty is included to ensure that the uncertainty in satellite soil moisture is not overestimated due to an underestimation of the model uncertainty. We simulated unsaturated water flow up to a depth of 1.5m with a vertical resolution of 1 to 10 cm and on a horizontal grid of 1 km2 for the period Jan 2010 – Jun 2011. The SWAP model was first calibrated and validated on in-situ data of the REMEDHUS soil moisture network (Spain). Next, to evaluate the satellite products, the model was run for areas in the proximity of 79 meteorological stations in Spain, where model results were aggregated to the correct support of the satellite product by averaging model results from the 1 km2 grid within the remote sensing footprint. Overall 440 (AMSR-E, SMOS) to 680 (ASCAT) timeseries were compared to the aggregated SWAP model results, providing valuable information on the uncertainty of satellite soil moisture at the proper support.

Our results show that temporal dynamics are best captured by ASCAT resulting in an average correlation of 0.72 with the model, while ASMR-E (0.41) and SMOS (0.42) are less capable of representing these dynamics. Standard deviations found for ASCAT and SMOS are low, 0.049 and 0.051m3m-3 respectively, while AMSR-E has a higher value of 0.062m3m-3. All standard deviations are higher than the average model uncertainty of 0.017m3m-3. All satellite products show a negative bias compared to the model results, with the largest value for SMOS. Satellite uncertainty is not found to be significantly related to topography, but is found to increase in densely vegetated areas. In general AMSR-E has most difficulties capturing soil moisture dynamics in Spain, while SMOS and mainly ASCAT have a fair to good performance. However, all products contain valuable information about the near-surface soil moisture over Spain.

Van Dam, J.C., 2000, Field scale water flow and solute transport. SWAP model concepts, parameter estimation and case studies. Ph.D. thesis, Wageningen University