Improvement of the empirical roughness-induced emissivity model for the SMOS mission

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ESA's Soil Moisture and Ocean Salinity (SMOS) satellite was launched on the 2nd of November 2009 from northern Russia. The SMOS single payload consists of a synthetic aperture radiometer operating at L-band (1.4 GHz). It is a challenging mission since this is the first time that such an instrument is put into orbit, and that surface salinity and soil moisture are measured from space. SMOS aims at measuring sea surface salinity (SSS) over the ocean with an accuracy of 1 psu for each overpass at 30-50 Km spatial resolution or 0.1 psu after averaging areas of 200*200 Km in 10-30 days. The instrument provides global salinity and soil moisture maps every 3 days [1, 2]. In the L2 operational processing chain the Geophysical Model Function (GMF), which relates the emissivity of the sea to the SSS (among other geophysical parameters), is defined as the sum of two contributions: the first one is the emissivity due to a flat sea, which is presently assumed to be well explained by the Klein and Swift 1977 model [3]; the second one is the emissivity increase due to the sea surface roughness. For the second term, three different models have been considered in the operational processor, therefore producing three different retrieved salinities [4]. Two of the models are theoretically based (Small Slope Approximation and Two-Scale). The third one is a fully empirical linear model that has been derived from the WISE 2000/2001 field campaign in which an L-band radiometer measured the emissivity of the sea in the north-western Mediterranean Sea [5, 6]. Several airborne campaigns have also been performed, such as COSMOS (2006) and SMOS Validation Rehearsal Campaign (2008). However, the limited amount of data of sea surface emissivity collected in the different campaigns is not representative of the global ocean, nor representative of all sea state conditions. As such, there is, at present, a lack of global measurements of sea surface emissivity to define a global GMF roughness induced model. At the moment, the fully-empirical roughness term defined in the operations processor is linear, and depends on incidence angle and two geophysical parameters: wind speed (WS) and significant wave height (SWH). However, other parameters are expected to contribute to the roughness term. In particular, the Level 2 prototype processor can accommodate up to 3 additional parameters to describe the roughness-induced emissivity: wave age (Ω), wind stress (U*) and mean square slope of waves (MSQS). To tune the empirical GMF and determine which parameters significantly contribute to the modulation of the emissivity, a large amount of auxiliary data co-located in space and time with emissivity measurements is required. With the SMOS launch, global calibrated brightness temperatures will soon be available. These data together with in-situ data (e.g., buoys) and model output (e.g., atmospheric and ocean models) will allow to review and redefine (if needed) the GMF, in particular the fully-empirical roughness term. The GMF which is finally defined in the SMOS operational processor should be as simple (i.e., avoiding parameter inter-correlation) and efficient (i.e., representing the best fit of the measurements) as possible. Non-linear dependencies and wind direction effects will also be thoroughly examined. The results of the fully-empirical roughness term review will be presented at the Symposium. This work will set the grounds for the future development of a fully-empirical GMF, in which the contributions from all geophysical parameters (including the flat sea related ones) are empirically derived.

References

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