Integration of SMAP, AMSR2 and Sentinel-1 data for Soil Moisture monitoring

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Extended Abstract

Among the satellites dedicated to the soil moisture content (SMC) retrieval that have been recently launched, the Soil Moisture Active Passive (SMAP) mission was characterized by the peculiarity of carrying onboard a radar and a radiometer, both operating at L band. The aim of SMAP was to map the near-surface layer (top 5 cm) SMC on a global scale, with near-daily temporal resolution and enhanced spatial resolution [1-2].

The improvement of the accuracy and the spatial resolution of soil moisture estimates was supposed to be obtained through the fusion of information coming from the radar, at higher resolution (1-3 Km), though more affected by surface roughness and vegetation cover, and the radiometer, at lower resolution (36 Km), though less affected by these surface features. Such instrument design was therefore aimed at estimating SMC at three different spatial resolutions: 36 Km x 36 Km using the radiometer only, 9 Km x 9 Km using the radar/radiometer combination, and 3 Km x 3 Km using the radar only.

Unfortunately, the failure of radar sensor a few months after the launch set a serious constraint on the SMAP capabilities in monitoring SMC and prevented generating any longer the two SMC products at higher resolution, which need radar acquisitions.

An attempt of overcoming this problem was carried out by integrating microwave data coming from SMAP, Sentinel-1 and AMSR2. In particular, the C band SAR backscatter from Sentinel-1 and the multi-frequency AMSR2 brightness temperature (from C to Ka bands) have been considered for compensating the vegetation and roughness effects on the SMC retrieval based on SMAP emission data only. A disaggregation technique based on the Smoothing filter based intensity modulation (SFIM), which was firstly implemented for AMSR-E [3-4] and AMSR2 [5], allowed comparing the radiometric and SAR data with the aim of obtaining a SMC product at enhanced resolution (approximately 10 Km x 10 Km), for replacing the original SMAP Radar + Radiometer product SMAP acquisitions.

Disaggregated microwave data were used as inputs of a retrieval algorithm based on Artificial Neural Network (ANN), which is able to ingest data coming from different sources, thus enabling to exploit the synergy between active and passive acquisitions. The algorithm was defined basing on experimental data from SMEX02 and on forward model simulations. The performances of this approach have been evaluated considering 9 months of SMAP, AMSR2 and S1 acquisitions on a flat agricultural area located in the Po Valley, in northern Italy.

Spatially distributed SMC values generated by the SWBM hydrological model [6] have been used as a reference for validating the algorithm. The synergy of active and passive acquisition resulted in an appreciable improvement with respect to the original SMAP radiometric SMC products, in terms of both accuracy and spatial resolution.

Keywords: Soil Moisture (SM), SMAP, AMSR2, Sentinel-1, Artificial Neural Networks (ANN).

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