ROCK FRACTION EFFECTS ON THE SURFACE SOIL MOISTURE ESTIMATES FROM L-BAND RADIOMETRIC MEASUREMENTS

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1. ABSTRACT

Although soil holds a small percentage of the total Earth’s water budget, surface soil moisture plays an important role in the water cycle and the global climate. Two space missions are now being developed to map soil moisture at global scale: the European Space Agency’s Soil Moisture and Ocean Salinity (SMOS), and NASA’s Soil Moisture Active and Passive (SMAP) [1, 2]. SMOS will not only provide soil moisture but also sea surface salinity estimates. SMOS’ payload is a novel L-band radiometer concept called MIRAS (Microwave Imaging Radiometer by Aperture Synthesis), which measures brightness temperatures within a wide field of view (FOV) by means of two-dimensional aperture synthesis interferometry. An important feature of SMOS is that a given pixel on the Earth is imaged at various observation angles as the satellite FOV moves over it, so multi-angular information of each pixel will be available.

A six months calibration and validation (CalVal) phase is scheduled after SMOS launch, now scheduled for October 31st 2008. During this period some field campaigns will be conducted in various sites around Europe. The Valencia Anchor Station (VAS; Requena-Utiel Region, Spain; [3]) has already been selected as a CalVal site because its large area (approximately the size of a SMOS pixel) and its homogeneity (it is covered mostly by vineyards, and in a lower percentage, by other Mediterranean ecosystems).

The SMOS Reference Pixel L-band Experiment (SMOS REFLEX 2006) was planned to monitor changes in the L-band (1.400-1.427 GHz) radiometric signal during the growth stage and withering of vines [4]. A short-term experiment over fully developed vineyards had been previously carried out in the VAS during the SMOS REFLEX 2003 field campaign [5]. The experiment site had a sandy clay loam soil with a 63% sand and 22% clay by volume. Rocks were kept in half the vineyard (from 40% to 80% of rocks) and were partially removed in the other half (from 6% to 30% of rocks) to assess the impact of rock-fraction in the surface soil moisture estimates from passive microwave observations. This is still an open issue at L-band radiometry since few studies have been published [6].

A trailer containing the fully-polarimetric L-band Dicke LAURA radiometer (L-band Automatic Radiometer) and its control rack were installed at the vineyard from July 6th to November 10th, 2006. LAURA was remotely controlled using a Hispasat internet connexion. Automatic radiometric observations were continuously acquired at observation angles from 40 to 65 in 5 steps, and two azimuth angles. Varying the radiometer’s observation angle implied the increase of the vegetation presence within the field-of-view, so its impact on the measured emission should be more noticeable. On the other hand, the azimuth angles were conveniently selected to acquire observations of the two halves of the vineyard and, thus, assess the impact of rock fraction. Hot and cold load calibrations were done between two consecutive scans in observation and azimuth angles. A microwave absorber and the sky were used as hot and cold load targets, respectively.

Ground-truth soil moisture and temperature were registered every 15 minutes at 0, 5, 10, 15, 20, and 40 cm depth using EC-5 sensors by Decagon and thermometers, respectively. Moreover, ML2x probes were installed to measure every 10 minutes the soil moisture in the 0-6 cm layer under vines, between vines, and between rows of vines. A meteorological station from the Spanish National Meteorological Center, located very close to the experiment site, registered the atmospheric temperature at 2 m height, and the wind direction and intensity (every 15 min.), and the accumulated precipitation (hourly). Since, apart
from irrigations, various rainfall events were registered during the experiment, a wide range of soil moisture values (from 0.01 to 0.34 m3/m3) was measured. The leaf area index (LAI) of vines was also measured using a LAI LICOR sensor.

This paper describes the SMOS REFLEX 2006 field experiment and studies the impact of rock-fraction and vegetation on the soil moisture estimates. A least-squares algorithm which minimizes the difference between measured and modelled brightness temperatures has been used. Different options were considered in the soil moisture retrieval study: vegetation parameters and rock-fraction were first assumed to be known, then were left as unknown values. Results are presented and the best retrieval options discussed.

2. REFERENCES


