EVALUATION OF SMAP LEVEL 2 SOIL MOISTURE ALGORITHMS USING SMOS DATA

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1. Introduction

The objectives of the SMAP (Soil Moisture Active Passive) mission are global measurements of soil moisture and land freeze/thaw state at 10 km and 3 km resolution, respectively. SMAP will provide soil moisture with a spatial resolution of 10 km with a 3-day revisit time at an accuracy of 0.04 m^3/m^3 [1]. In this paper we contribute to the development of the Level 2 soil moisture algorithm that is based on passive microwave observations by exploiting Soil Moisture Ocean Salinity (SMOS) satellite observations and products. SMOS brightness temperatures provide a global real-world, rather than simulated, test input for the SMAP radiometer-only soil moisture algorithm. Output of the potential SMAP algorithms will be compared to both *in situ* measurements and SMOS soil moisture products. The investigation will result in enhanced SMAP pre-launch algorithms for soil moisture.

2. Methodology and Approach

ESA's SMOS mission has been designed to observe soil moisture and ocean salinity [2, 3]. SMOS is a 2-D synthetic aperture microwave radiometer operating at 1.4 GHz and was launched in 2009. Here, microwave observations from the SMOS mission will be used to simulate SMAP observations at a constant incidence angle of 40 degrees. This will provide a brightness temperature data set that closely matches the observations that will be provided by the SMAP radiometer.

These observations provide an opportunity to develop a testbed to evaluate different SMAP algorithms. Several algorithms are being considered for the SMAP radiometer-only soil moisture retrieval. (a) The Single Channel Algorithm (SCA) is based on the radiative transfer equation and uses the channel that is most sensitive to soil moisture (H-pol). In this approach, ancillary data are used to correct brightness temperatures for the effects of physical temperature, vegetation (ancillary data base derived from MODIS data), roughness, and soil texture (static ancillary data sets) [4]. (b) The Land Parameter Retrieval Model (LPRM) is a two-parameter retrieval model (soil moisture and vegetation water content) for passive microwave data based on a microwave radiative transfer model. It uses the microwave polarization difference index at 1.4 GHz and emissivity to parameterize vegetation water content and estimate soil moisture [5]. (c) The Dual-Channel Algorithm (2CA) uses multiple polarizations to iteratively solve for soil moisture and vegetation water content [6]. (d) The Reflectivity Ratio (RR) approach uses radar observations to correct for roughness and vegetation to estimate soil moisture from the radiometer measurements [7].

This work will also aid in the development and selection of the different land surface parameters (roughness and vegetation parameters) needed in the soil moisture algorithm. The options for vegetation and surface temperature observations will also be evaluated. Different approaches and ancillary datasets are being considered for the SMAP mission. The use of the ancillary dataset is dependent on the choice of the soil moisture algorithm. For example, the impact of using (a) SMOS estimated vegetation optical depth, (b) MODIS-based vegetation climatology data, or (c) actual MODIS observations on the performance of the soil moisture retrievals will be evaluated.

The first step in this investigation will be implementation of the single channel algorithm. This work will focus on development of a SMOS-based soil moisture product using the SCA. The selection of different vegetation and surface temperature sources on the performance of soil moisture retrievals will be evaluated using the SCA.

3. Evaluation of Results

Several different datasets will be used to evaluate the performance of the SMAP soil moisture algorithm: (a) SMOS soil moisture estimates, (b) European Centre for Medium-Range Weather Forecasts (ECMWF) model-derived soil moisture estimates, (c) USDA ARS *in situ* watershed network observations, and (d) other international *in situ* soil moisture observations.

The USDA ARS watersheds provide a dense network of soil moisture observations which are long-term and high quality soil moisture measurements at a passive microwave satellite spatial resolution scale. Four soil moisture networks (Walnut Gulch, Arizona; Little Washita, Oklahoma; Little River, Georgia;

and Reynolds Creek, Idaho) were developed and used as part of the AMSR-E validation program [8]. Table 1 provides a brief summary of the watershed characteristics.

Table 1. USDA ARS Watershed Characteristics.

Watershed	Size (km^2)	Soil Moisture Sites	Climate	Annual Rainfall (mm)	Topography	Land Use
Little Washita, OK	610	16	Sub humid	750	Rolling	Range/wheat
Little River, GA	334	29	Humid	1200	Flat	Row crop/forest
Walnut Gulch, AZ	148	21	Semiarid	320	Rolling	Range
Reynolds Creek, ID	238	19	Semiarid	500	Mountainous	Range

In situ observations from other international locations (if available) will also be used to evaluate soil moisture results. This would allow comparison over a greater range of climate, geographic, and vegetation conditions.

4. References

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