A CHANGE DETECTION ALGORITHM FOR RETRIEVING HIGH-RESOLUTION SURFACE SOIL MOISTURE FROM SMAP L-BAND RADAR AND RADIOMETER OBSERVATIONS

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I. INTRODUCTION

Soil moisture is a critical hydrological variable that links the terrestrial water, energy and carbon cycles. Global and regional observations of soil moisture are needed to estimate the water and energy fluxes at the land surface, to quantify the net carbon flux in boreal landscapes, to enhance weather and climate forecast skill and to develop improved flood prediction and drought monitoring capability. Active and Passive L-band microwave remote sensing provide a unique ability to monitor global soil moisture over land surfaces with an acceptable spatial resolution and temporal frequency [1].

Radars are capable of a very high spatial resolution ($\sim$ 3km) but, since radar backscatter is hightly influenced by surface roughness, vegetation canopy structure and water content, they have a low sensitivity to soil moisture, and the algorithms developed for retrieval of soil moisture from radar backscattering are only valid in low-vegetation water content conditions [3]. In contrast, the spatial resolution of radiometers is typically low ($\sim$ 40km), they have a high sensitivity to soil moisture, and the retrieval of soil moisture from radiometers is well established [4]. To overcome the individual limitations of active and passive approaches, the Soil Moisture Active and Passive (SMAP) mission of the NASA, scheduled for launch in the 2010-2013 time frame, is combining these two technologies [2]. The SMAP mission payload consists on an approximately 40-km L-band microwave radiometer measuring hh and vv brightness temperatures and a 3-km L-band synthetic aperture radar sensing backscatter cross-sections at hh, vv and hv polarizations. It will provide global scale land surface soil moisture observations with a three day revisit time and its key derived products are: soil moisture at 40-km for hydroclimatology, obtained from the radiometer measurements; soil moisture at 10-km resolution for hydrometeorology obtained by combining the radar and radiometer measurements in a joint retrieval algorithm; and freeze/thaw state at 3-km resolution from the radar measurements. A downscaling algorithm has been developed for combining the high radar resolution and the high radiometer accuracy into an optimal blend for the SMAP 10-km soil moisture product.

II. CHANGE DETECTION ALGORITHM

Change detection techniques are able to monitor temporal evolution of soil moisture by taking advantage of the approximately linear dependance of radar backscatter and brightness temperature change on soil moisture change. A novel downscaling algorithm based on change detection has been developed for retrieving surface soil moisture at 10-km resolution from SMAP L-band radar and radiometer observations. It focuses on the idea of considering the surface soil moisture over a sample 10-km region to be composed of weighted averages of the available radar retrievals within that region and the radiometer retrieval within the radiometer footprint containing the 10-km region. The advantage of this approach is that as more radar retrievals are available within the 10-km region, more spatial structure within a radiometer footprint will become evident and, since the collection of 10-km pixels within the larger scale radiometer footprint is constrained to sum to the value indicated by the radiometer retrieval, the high resolution estimation gracefully keeps the accuracy of the radiometer retrieval.

In preparation for the SMAP mission, an Observation System Simulation Experiment (OSSE) [5] and field experimental campaigns using the Passive and Active L- and S-band airborne sensor (PALS) have been conducted. Sample results of

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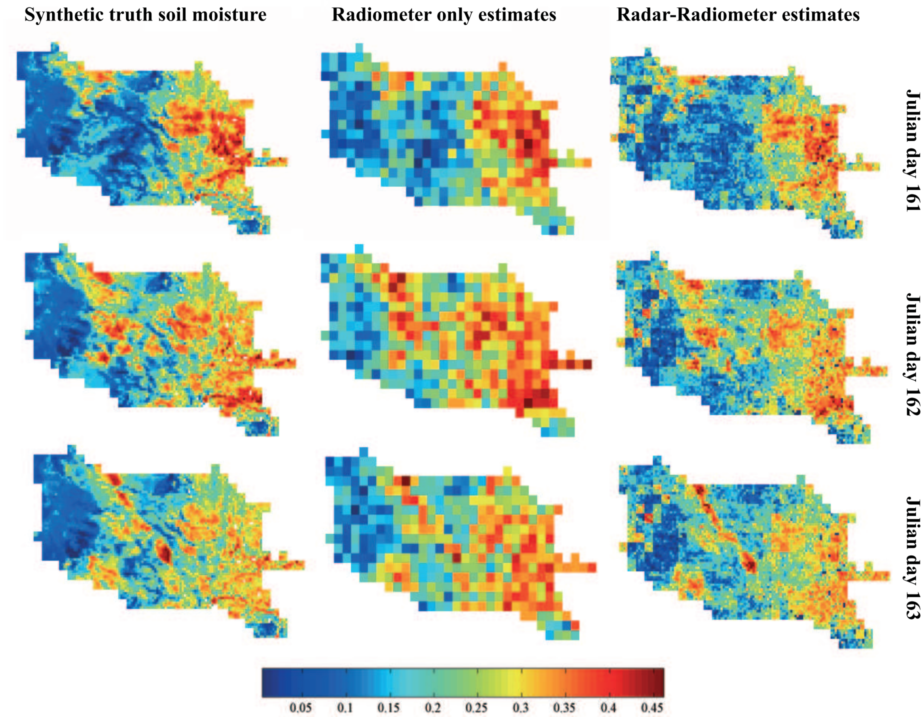

Fig. 1. Sample results (three days) from the Observation System Simulation Experiment for the comparison of higher resolution (10-km) soil moisture disaggregation algorithm with synthetic ground truth soil moisture and with lower resolution (40-km) estimates obtained from a typical radiometer.

applying change detection to the OSSE data (with radar and radiometer noise added) are presented in Fig. 1 for three consecutive days. Comparing with the original soil moisture distributions and the estimates obtained from the inversion of the brightness temperature alone, it can be seen that the active passive disaggregation algorithm reproduces much of the variability seen in the *in situ* soil moisture images and that these details are not captured by the radiometer only method. The main assumptions of the algorithm have been verified using PALS data from the soil moisture experiments held during June-July 2002 (SMEX02) in Iowa [6]. The algorithm error budget is estimated using SMEX02 PALS observations and OSSE data, and it is shown to meet SMAP minimum science requirements. A complete formulation of the algorithm and results of its application to OSSE and SMEX02 data will be presented at the conference.

III. REFERENCES

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