EVALUATION AND APPLICATION OF REMOTELY SENSED SOIL MOISTURE PRODUCTS

J. Bolten[1], W. Crow[2], X. Zhan[2], T. Jackson[2], C. Reynolds[3], Matt Rodell[1]

[1]NASA Goddard Hydrological Sciences Branch,
Greenbelt, MD 20771

[2]USDA-ARS Hydrology and Remotes Sensing Lab,
BARC-West, Beltsville, MD 20705

[3]NOAA NESDIS Center for Satellite Applications and Research,
Camp Springs, MD 20746

[4]USDA-FAS Office of Global Analysis, International Production Assessment Division,
Washington, DC 20250

1. INTRODUCTION

Whereas in-situ measurements of soil moisture are very accurate, achieving accurate regional soil moisture estimates derived solely from point measurements is difficult because of the dependence upon the density of the gauge network and the proper upkeep of these instruments, which can be costly. Microwave remote sensing is the only technology capable of providing timely direct measurements of regional soil moisture in areas that are lacking in-situ networks. Soil moisture remote sensing technology is well established has been successfully applied in many fashions to Earth Science applications [1]. Since the microwave emission from the soil surface has such a high dependency upon the moisture content within the soil, we can take advantage of this relationship and combined with physically-based models of the land surface, derive accurate regional estimates of the soil column water content from the microwave brightness temperature observed from satellite-based remote sensing instruments. However, there still remain many questions regarding the most efficient methodology for evaluating and applying satellite-based soil moisture estimates. As discussed below, we to use satellite-based estimates of soil moisture dynamics to improve the predictive capability of an optimized hydrologic model giving more accurate root-zone soil moisture estimates.

The Soil Moisture Active Passive (SMAP) mission was recognized as one of the top priorities of the National Research Council's Decadal Survey of Earth science issued in 2007. The instrument is being designed at the NASA Jet Propulsion Laboratory and is expected to launch in 2013. As the first NASA mission dedicated to soil moisture, SMAP is a very exciting mission designed to provide global mapping of soil moisture and freeze/thaw state at never before seen accuracy, resolution, and coverage (http://smap.jpl.nasa.gov/). The unique approach of a combined active microwave radar and passive microwave radiometer at L-band will give soil moisture estimates at a higher resolution (i.e., ~10 km), and at a greater sensing depth over existing capabilities (i.e., AMSR-E). The SMAP mission is expected to provide full global coverage soil moisture observations every 3 days at the equator and 2 days at the boreal latitudes (>45 N).

The Level 3 SMAP radar/radiometer-derived soil moisture product is expected to have a spatial resolution of ~10km, a 2-3 day full global coverage, and a data latency of ~24 hours. In preparation for the higher resolution/accuracy soil moisture products expected from SMAP, we evaluate the performance of AMSRE soil moisture products (currently the closest real-data example of satellite-based SMAP observations) over multiple landscapes and demonstrate the utility of the future SMAP soil moisture product for the root-zone soil moisture anomaly detection. Our goal is to evaluate the spatial/ temporal characteristics of AMSR-E soil moisture products and demonstrate ways they could be applied toward agricultural forecasting and flood/drought prediction. This work (1) provides a proof of concept for evaluating and using future SMAP data and (2) establishes and test a methodology that will be in place when this data becomes available.

2. METHODS

The framework of this analysis synergistically applies multi-scale airborne and satellite microwave radio brightness observations and derived products to investigate the influence of surface heterogeneity, spatial scale and vegetation on satellite-based soil moisture products. We investigate multi-polarized, horizontal *H* and vertical *V* low-frequency, (L- and C-band) brightness temperature sensitivity to soil moisture for vegetation conditions ranging from bare soils to dense corn canopy using airborne radiometers. The two airborne instruments used are the Passive and Active L- and S-band (PALS) sensor and the Polarimetric Scanning Radiometer (PSR/C) sensor [2-3]. By applying spatial averaging to the co-registered PALS and PSR/C samples, comparisons of observed and simulated multi-scale L- and C-band brightness temperatures with co-located ASMR-E observations over varying vegetation types and soil moisture conditions were possible.

The second phase of this work focuses on demonstrating the utility the AMSR-E derived soil moisture products for improving estimates of agricultural drought, providing supplemental observations of Desert Locust conditions in North Africa, and soil moisture initialization in a land data assimilation system. We integrate (AMSR-E) into multiple land surface models and quantify the correlation of root-zone soil moisture anomalies with observed vegetation and precipitation changes. From these evaluation schemes, we can infer the expected performance and utility of future SMAP satellite-based soil moisture products and develop a framework for applying them in efficiently.

11. REFERENCES

[1] Schmugge, T. 1985 Remote Sensing of Soil Moisture. In: Burt, M. G. A. a. T. P. (ed) *Hydrological Forcasting*. John Wiley and Sons, New York, p 604

[2] Wilson J.W., Yueh S.H., Dinardo S.J., Chazanoff S.L., Kitiyakara A., Li F.K., Rahmat-Samii Y. (2001) - Passive active L- and S-band (PALS) microwave sensor for ocean salinity and soil moisture measurements. IEEE Transactions on Geoscience and Remote Sensing, 39.

[3] Piepmeier, J. R., Gasiewski, A. J., 2001, High-resolution passive polarimetric microwave mapping of ocean surface wind vector fields. *IEEE Transactions on Geoscience and Remote Sensing*, **39**, pp. 606-622.