SOIL MOISTURE ACTIVE PASSIVE (SMAP) CALIBRATION AND VALIDATION PLAN AND CURRENT ACTIVITIES

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1. INTRODUCTION

The primary objective of the SMAP calibration and validation (Cal/Val) program is demonstrating that the science requirements (product accuracy and bias) have been met over the mission life. This begins during pre-launch with activities that contribute to high quality products and establishing post-launch validation infrastructure and continues through the mission life. However, the major focus is on a relatively short Cal/Val period following launch. The general approach and elements of the SMAP Cal/Val plan will be described and along with details on several ongoing or recent field experiments designed to address both near- and long-term Cal/Val.

2. SMAP CAL/VAL PLAN STATUS

Establishing a Cal/Val Plan is a SMAP mission requirement. The plan must provide a means to assess random errors and spatial and temporal biases in the soil moisture and freeze/thaw estimates and a basis for deciding if the SMAP retrievals of soil moisture and freeze/thaw state meet the stated mission science requirements. This plan serves as the basis for implementation of the detailed set of calibration and validation activities that will take place during the SMAP mission lifetime. A draft Cal/Val Plan for SMAP was developed in 2009 that describes the approach and procedures that will be used for calibrating and validating Level 1 through Level 4 SMAP science data products [1].

The SMAP Cal/Val Plan includes and the following activities.

- Pre-launch
  - Acquiring and processing data with which to calibrate, test, and improve models and algorithms used for retrieving SMAP science data products;
  - Developing and testing techniques and protocols used to acquire validation data and to validate SMAP science products in the post-launch phase
- Post-launch
  - Verifying and improving the performance of the science algorithms;
  - Validating the accuracy of the science data products.

A key issue of the SMAP Cal/Val Plan is the recognition of the need for timeliness of Cal/Val activities, if they are to meet the objectives and time line of the project. Pre-launch data collection will have the greatest value early in the algorithm development and selection process. Post-launch Cal/Val focuses on the period from two to fourteen months after launch.

The major elements of validation will be in situ observations, comparisons with other satellite products, field campaigns, and comparisons with model and data assimilation products. At this stage of mission development our efforts are focused on the following items;

- In situ networks - identifying and evaluating resources and establishing active partnerships with existing data providers, establishing and maintaining critical networks, verification of existing networks, and scaling of sparse network observations;
- Prelaunch field experiments (large scale and tower) - resolving the mission definition and candidate algorithms or approaches for all products.

3. DEVELOPING POST LAUNCH IN SITU VALIDATION INFRASTRUCTURE

Following discussions by the SMAP Science Definition Team, Cal/Val Working Group, and a community workshop in June 2009, several activities were initiated that would insure that a robust and high quality data set is available for validation of SMAP products.

3.1. Scaling

A distinguishing feature of most existing in situ networks is their generally low density of observations. Most current networks are data sparse with no more than a single measurement location within a SMAP product grid cell or footprint. Because of soil moisture's inherent spatial variability (on the order of a few meters or less), this is a major issue for soil moisture validation for a space mission like SMAP. The low measurement density is less critical for the SMAP freeze–thaw and related carbon products in which the spatial scale of variability is generally well characterized at the level of an individual landscape unit or tower footprint. A working group was established to develop a general strategy for scaling points and to conduct inter-comparisons and exploratory field studies.

3.2. Compatibility

Another issue regarding the various *in situ* resources, particularly for soil moisture, is the diversity of protocols used to make the measurements. Different sensor technologies, installations, depths, integrating depths, and soil volumes are involved. It would be advantageous to integrate the various resources through standardization and cross-comparison. As a first step in this process, a working group was established to initiate the development of *in situ* instrument test beds. At these sites the various instruments utilized by networks would be installed and compared to reference soil moisture. These analyses would facilitate our understanding of the utility of each data source in subsequent calibration/validation activities. The first of these will be located in Oklahoma.

3.3. Core Sites

Although valuable, these sparse networks cannot meet all of the needs of SMAP mission Cal/Val. Therefore, SMAP will also need to establish a number of core validation sites. As successfully employed in other satellite programs, these representative locations would be well-characterized and have local infrastructure and support available.

4. RECENT VALIDATION FIELD EXPERIMENTS

Current resources limit the scope and scale of field experiments. It is anticipated that major campaigns would be conducted no sooner than 2012. In the interim, several smaller focused campaigns will be conducted that exploit existing resources and cooperation.

4.1. Core Sites Tower (Truck) Based Time Series Observations

Several of the SMAP Algorithm Theoretical Basis Documents (ATBDs) identified a need for additional combined active/passive observation data sets. These require long time series over a variety of cover conditions with supporting ground observation. The first experiment will involve soil moisture and utilize ComRad [2] at a site in Beltsville, MD. Data will be collected throughout the 2010 crop growing season. Subsequent experiments may involve repeat time series observations spanning seasonal freeze/thaw cycles over natural vegetation surfaces, variable snow cover and surface soil conditions.

4.2. Australia Aircraft Experiments

A team from the University of Melbourne, the University of Adelaide, and USDA will conduct a series of one-week soil moisture field campaigns using a new aircraft-based system with an L-band radiometer and an L-band radar. One campaign will be conducted in each season. It is anticipated that these will begin in April 2010. Flights will be designed to provide coincident active/passive data at multiple spatial scales to support radar, radiometer, and combined soil moisture algorithms.

4.3. Canada Aircraft Experiments

The SMAP team will collaborate with the Canadian Space Agency to conduct a two-week (June 2010) soil moisture field campaign in Saskatchewan, Canada. This experiment will build on a planned SMOS validation campaign that will use an aircraft-based L-band radiometer and extensive ground-based sampling over an in situ network domain. SMAP (NASA) will support UAVSAR [3] data acquisition. Other collaborative experiments with CSA partners in support of freeze/thaw algorithm testing may involve aircraft active/passive L-band sampling across regional temperature and moisture gradients during seasonal freeze/thaw transition periods.

REFERENCES

[1] http://smap.jpl.nasa.gov/science/CalVal/

[2] Kurum, M.; Lang, R.H.; O'Neill, P.E.; Joseph, A.T.; Jackson, T.J.; Cosh, M.H. “L-Band Radar Estimation of Forest Attenuation for Active/Passive Soil Moisture Inversion,” IEEE Trans. Geoscience and Remote Sensing, 47:3026 – 3040. 2009.

[3] http://uavsar.jpl.nasa.gov/