THE SMAP IN SITU SOIL MOISTURE SENSOR TESTBED: COMPARING IN SITU SENSORS FOR SATELLITE VALIDATION

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1. INTRODUCTION

One of the most valuable tools in validating satellite based soil moisture estimates, such as those from the Soil Moisture Active Passive (SMAP) mission [1] are large scale in situ networks. Global validation involves networks operated by many different organizations. Existing in situ soil moisture networks use a variety of sensors and their estimates are not immediately interchangeable. A testbed has been established to provide a unique point of comparison for the many techniques that are currently being used or under development. The first of several planned testbeds is being implemented at the Marena Mesonet facility near Stillwater, Oklahoma. NASA, USDA, the Oklahoma Mesonet, and Oklahoma State University are cooperating, along with representatives from the Cosmic-ray Soil Moisture Observing System (COSMOS) and the GPS reflectometry project. The resulting dataset will serve as a basis for sensor intercomparisons of soil moisture networks for the calibration and validation of the SMAP satellite mission.

2. STUDY SITE

SMAP has initiated a testbed activity that will co-locate examples of existing and potential sensors used by in situ networks in order to compare their performance and determine how their estimates can be compared both spatially and temporally. Several criteria were established to determine the optimal testbed location. These include:

- Minimum scale of 700 m of same land use
- Rangeland/Pasture site
- Low Topography
- Deep soil profile (at least 1 meter of soil)
- Expected continuous operation through 2016

- Range of moisture conditions

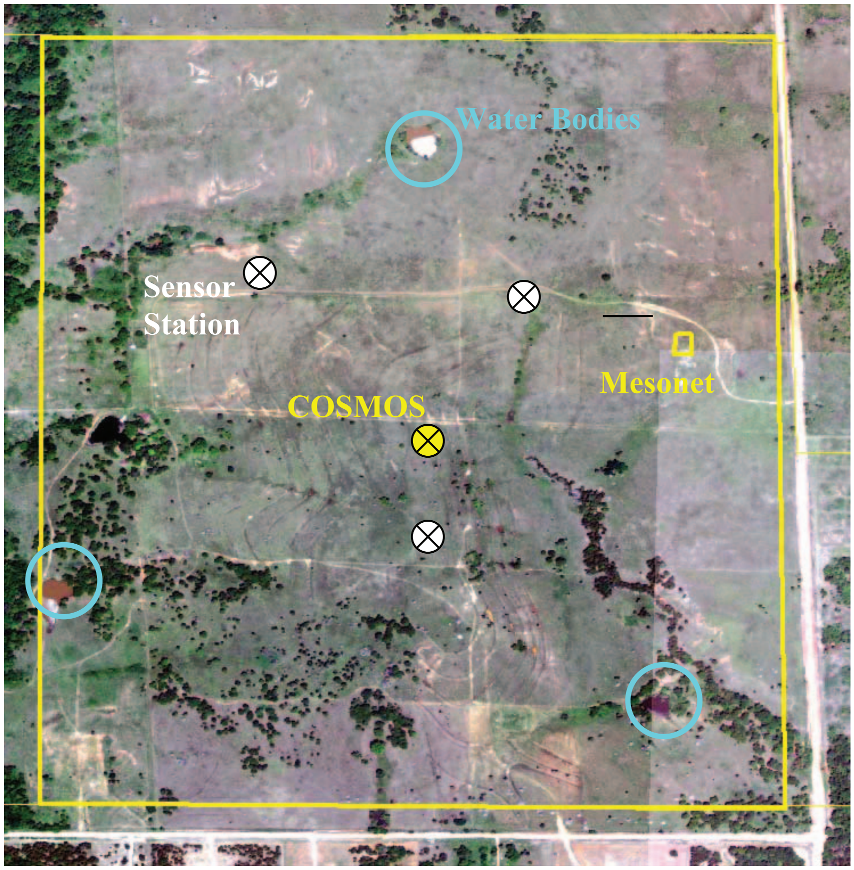

Figure 1: The Marena In Situ Soil Moisture Sensor Testbed with sensor stations indicated. Located at the center will be the COSMOS station. To the east is the MARE Mesonet station.

A location was selected near Marena, Oklahoma, which met most of these criteria. Shown in Figure 1, the Marena site is also the location of the MARE Oklahoma Mesonet site [2][3] and managed by the Oklahoma State University Range Research Station. There is mild topography with small waterbodies surrounding an approximately 700 meter diameter pasture. There will be some ongoing cattle grazing in this pasture so all instrumentation will be installed within cattle panel enclosures to insure there is no disturbance of the surface (or instruments). The stocking rate is low. The fields are on a 3-year burn rotation to prevent Eastern Red Cedar encroachment which is common in this area of Oklahoma. Four in situ stations will be located on 'fire lines', which are boundaries of the burn patterns, thus allowing protection of the equipment from fire damage. At the center of the study site, a full in situ sensor station (defined in Table 1) will be installed along with a COSMOS station [4] and a GPS tower [5]. Two additional GPS stations will be deployed at the two northern stations.

Table 1: Configurations of the sensors at each station.

Sensor	Depths
Stevens Water Hydra Probe	5, 10, 50, 100 cm
Delta-T Theta Probe	5, 10, 50, 100 cm
ECH2O Probe	5, 10, 50, 100 cm
EnviroSMART	10 , 20, 50, 100 cm
CS229-L Heat Dissipation Sensor	5, 10, 50, 100 cm
Time Domain Reflectometer	5, 10, 50, 100 cm
Acclima	5, 10, 50, 100 cm

3. SAMPLING PLAN

In addition to the in situ installations, high density surveys of soil moisture will be collected along with other ancillary information which will be necessary to interpret the new in situ technologies. On a monthly basis, gravimetric sampling will be conducted on the field scale, over approximately 50 points, radiating from the central station. These collections will serve as the ground truth for the larger scale in situ sensors, namely the COSMOS and GPS stations. Additional information to be measured will be surface roughness and vegetation biomass which may affect these technologies. To support this, ground based radiometric measurements will also be collected to scale point measurements to the field scale. In coordination with the burn cycle of the field, sampling campaigns will also be designed to measure the effect of removing the vegetation on the GPS and COSMOS signals.

4. EXPECTED RESULTS

Following the conclusion of the first year of the testbed, an assessment will be made of the different technologies and the experimental design will be adapted to address any new developments. Sensors will be evaluated on accuracy, dynamic range, and moisture response to precipitation. Additional aspects of comparison may include robustness to in situ installation, scalability of sensor signal and reliability of data record. This will lead to future strategies for incorporating diverse network technologies into the SMAP calibration/validation program.

5. REFERENCES

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