

Soil Moisture Investigation Update

Jim Washburne¹, Ty P.A. Ferré¹, Bart Nijssen^{1,2} and Martha P.L. Whitaker¹

¹Dept. of Hydrology and Water Resources, and ²Dept. of Civil Engineering and Engineering Mechanics

University of Arizona

Tucson, AZ 85721-0158b

Telephone: 520-626-4107

Email: jwash@hwr.arizona.edu

Introduction

This presentation will review progress that has been made over the last 18 months in developing and implementing seasonal soil moisture campaigns, analyzing student- and citizen-collected data, providing school support throughout the southwest U.S and Northern Mexico, developing research collaborations, designing a low technology soil drying oven, and supporting cross-border collaborations.

Strategic Goals

The primary goal of this investigation is to develop and support the soil moisture protocols. This entails protocol development, training of instructors, GLOBE systems integration, data archive quality checking and soil moisture data analysis. Scientific analysis of pre-2002 data has been limited by its lack of spatial or temporal extent. In an effort to improve the spatial continuity of the surface soil moisture data set, new protocol development and training has focused on the promotion of a semi-annual soil moisture campaign (SMC). This concept attempts to focus multiple schools on regional sampling campaigns during a 9-day time period twice a year. In fact, these campaigns are well suited for broader community involvement and school networking, which are important concepts currently making their way into other aspects of GLOBE. Considerable effort has been devoted to facilitating the integration of GLOBE school networks with ongoing scientific community measurement campaigns (a.k.a. intensive field campaigns - IFC's).

SMC Operational Enhancements

GLOBE prides itself in trying to accommodate school limitations, often related to budgets and expertise, while striving to collect scientifically useful data. It is important to remember that this needs to be an ongoing activity and one that requires resources from the program or investigation. For example, our expectation is that a successful SMC will generate over 100 soil samples (vs. the 6 samples older protocols asked for). Although the idea and practice of gravimetric soil moisture determination is relatively simple, there are two equipment cost issues that could limit its widespread adoption. First, schools are reluctant to purchase soil drying ovens. Second, accurate scales are not available in many GLOBE classrooms. While we hope that scales are obtainable within the school system, drying ovens are not common. Through the development and testing of a self-built light-bulb-powered oven constructed from a 55-gallon drum, we have lowered the oven cost

77% to about \$75. This oven has been tested using four soils and performs as effectively as a standard drying oven (please see our poster by Whitaker et al. for details).

Protocol implementation also requires concentrated effort. When it appeared that many SMC opportunities would be related to cross-border scientific studies, we paid for a Spanish translation of all teacher support materials related to our protocol. To reinforce how easily soils can be collected, we make sure that every teacher we train goes home with a Soil Moisture Campaign Start-up Kit, which includes a soil trowel, several homemade foil sample pouches, a permanent marker for labeling samples and a laminated field protocol guide with a ruler photocopied on one side (at a cost of about \$3/unit).

Community Science

GLOBE science investigations were conceived as the primary scientific users of GLOBE data. Interest from the broader scientific community was expected to follow the publication or demonstrated use of GLOBE-collected data by GLOBE science teams. Another model for the acceptance and use of GLOBE data within the scientific community is more collaborative and requires GLOBE scientists to act more like facilitators than like principal investigators. While there are many ways collaborations between regional scientists and GLOBE schools can develop, we would like to share our experiences with a group of soil scientists who regularly conduct summer IFC's to study the relationship between ground and aircraft collected soil moisture. Last summer's effort is called SMEX03 (the Soil Moisture Experiment 2003). The area of interest stretched from Huntsville, AL to Tifton, GA. By the time we had learned of this opportunity, committed resources to it and gained some amount of recognition, the field campaign was upon us. Although summers may be the optimal time to get a lot of academic researchers together, this does not work well for most schools. Local GLOBE Partnerships are an ideal resource to help coordinate the work and involvement of local teachers. We were lucky in that the Alabama Partnership was conducting statewide implementation training during the IFC study period, and the location of the training workshop happened to coincide with scheduled overflights of aircraft, which collected remotely-sensed soil moisture data. This workshop gave us just-in-time access to a regional group of teachers. Unfortunately, both the training schedule and the teacher's minds were already full, and we were only able to briefly introduce the SMC and collect a limited number of samples. Still, this data was promptly reported and we are still awaiting release of the community data to complete our analysis. Some of the lessons learned from this experience include:

- Provide the teachers with as many of the tools necessary to get started as possible,
- Start training and coordination efforts early,
- Work harder to engage the IFC scientists in local school support and motivation.

On-going Activities

This summer we are working with many of the same scientists in another part of the country in an IFC called SMEX04, which is part of a bigger IFC called the North American Monsoon Experiment (NAME). This observational effort is designed to collect intensive surface and aircraft data related to moisture flows (and the resulting

precipitation) from the Gulf of California into New Mexico and Arizona. The SMEX04 area of interest stretches from Hermosillo, Mexico to the San Pedro Valley of southern Arizona. Our goal is to encourage local schools to make regular and coincident atmospheric and soil moisture observations, particularly during periods when SMEX scientists will be collecting aircraft and satellite remote sensing data, from mid-July to mid-August. While the upper San Pedro has an existing network of GLOBE schools (largely engaged in hydrologic monitoring of the San Pedro River), we have had to build a network of schools in Mexico from scratch. This has required us to coordinate initial planning with GLOBE HQ and the GLOBE country coordinator, identify existing educational infrastructure, develop a new local partnership and conduct teacher training (en Español, of course). So far, this effort has been extremely successful, including equipment grants from the NAME program, a \$15,000 BorderPact grant for Mexican Partnership development from CONAHEC, and collaborative training with the HandsAcross the Border and EcoStart Programs, as well as the GLOBE hydrology investigation (please see our poster by Whitaker et al. for details).

The Mexican teachers seem particularly motivated by this opportunity to become part of a larger scientific enterprise and have scheduled daily measurements in areas they have access to. This is an example of one compromise scientists might need to make when they collaborate with schools or volunteer data collectors – the frequency of sampling is directly related to the ease of access to the sampling location. While the IFC has driven this collaboration forward, it is not our only objective. In fact, it might be argued that the greatest impact of this effort will be the establishment of a new (Mexican) partnership and the local cross-border collaborations that result (both academic, institutional and personal). A few of the lessons learned so far from this exercise have been:

- Cross-border collaboration requires much longer lead times,
- Outside grant funding and/or equipment grants are critical,
- The success of these collaborations are closely tied to the level of effort expended,
- Expect that the science partner will need almost as much mentoring as the school partners.

GLOBEone Activities

This investigation has also been active in and supports the GLOBEone campaign in Blackhawk County, IA. We helped install the fixed soil moisture data logging sites in May and we are planning for the first dual SMC and MUC-athon with the Land cover team in September, 2004 and again in May, 2005. In fact, we hope that schools throughout Iowa will join us in October and April for the regular SMC sampling event. We will be contributing a running commentary on soil moisture probe data to the GLOBEone web site as well as suggestions for classroom integration. Please visit our web site if you would like more information: www.hwr.arizona.edu/globe/sci/SM/SMC/