

GLOBE SOIL MOISTURE MEASUREMENT CAMPAIGNS:
TOWARD SCHOOL-BASED VALIDATION OF SATELLITE MEASUREMENTS
AND MODEL PREDICTIONS

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ABSTRACT

Soil moisture is a critical component of the hydrological cycle, yet scientists currently lack sufficient observational data to characterize soil moisture distributions. Soil moisture measurements based on gravimetric methods are conceptually and operationally simple, offering the opportunity for K-12 students to make scientifically valid and much needed measurements. In the context of the GLOBE program, an effort is underway to mobilize the global K-12 community to participate in periodic, near-surface, gravimetric soil moisture measurements.

This presentation will briefly describe the GLOBE Program, introduce the strategies and goals of the GLOBE Soil Moisture Project (which is a specific facet of the overall Program), and will conclude with a profile sketch of the potential users and type of data set we plan to produce.

Introduction: The GLOBE Program

GLOBE (Global Learning and Observations to Benefit the Environment) is a worldwide hands-on, primary and secondary school-based science and education program. GLOBE is a seven-year-old cooperative effort of schools, federal agencies, universities, and non-government organizations in partnership with 97 countries worldwide. The U.S. program has been supported by NASA, NSF, EPA and the U.S. Department of State, Figure 1 shows a map of the world with GLOBE-participating countries shaded in green; countries who have expressed an interest in GLOBE are shaded in red. The worldwide participation of GLOBE schools is clearly evident in this figure. More impressive is the depth of the program, reaching over a million primary and secondary students in

more than 12,000 schools led by more than 20,000 GLOBE-trained teachers and those numbers are growing every week.

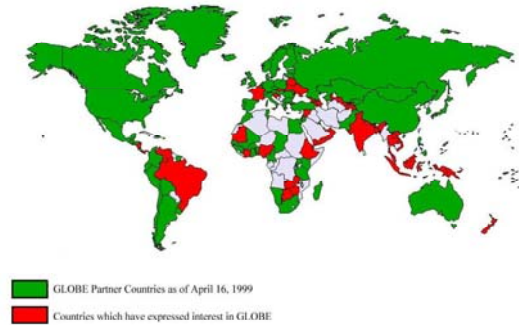


Figure 1. Map showing GLOBE-affiliated countries in green. Countries who have expressed an interest in GLOBE but are not yet participating are shown in red. (Imagine a soil moisture data set acquired from all the countries shown in green!)

At GLOBE-affiliated schools, teachers have been expressly trained to lead students in collecting scientific measurements that are useful to various environmental scientists, including: atmosphere and climate scientists, hydrologists, biologists, and soil scientists. Once students collect their data, they report it over the Internet, thus making it available to other students, as well as scientists worldwide. Students can thus not only study the environment using images created with their data, but also compare their measurements with other students' data from around the globe. Finally, GLOBE students work with real scientists and contribute important contextual and validation data for scientists to use in their research.

The GLOBE Soil Moisture Project

The GLOBE Soil Moisture Project, which commences this year with a revitalized protocol, is

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just one facet of the larger GLOBE Program. Gravimetric soil moisture measurements are well suited to the GLOBE program because they are relatively simple and inexpensive, yet form the accepted standard in the field. A successful project, from our perspective, must overcome two challenges: 1) motivate enough schools – ideally worldwide - to make a scientifically useful data set; and 2) motivate global climate modelers and other scientists to identify ways to use the data and help encourage the K-12 community in this effort.

Despite a previous multi-year effort by the GLOBE program, neither challenge has been satisfactorily met yet. Through a revitalized soil moisture protocol, we plan to overcome these challenges. To ensure that the soil moisture data collected is of scientific use, we are seeking the guidance of scientists who might find this data set useful to their research, including, but not limited to the global climate modeling community. We ask that the scientific community offer guidance to suggest the optimal timing and spatial distribution of semiannual, coordinated soil moisture measurement campaigns. At the same time, we are placing a strong emphasis on building effective local collaborations and partnerships with both academic and agency practitioners to re-energize teachers and students to participate in these measurement campaigns. Through this concerted effort we hope to give K-12 students and teachers an opportunity to contribute to and to work with scientists in a collaborative effort to better understand the global climatological and hydrological cycles.

The New Protocol: A Semi-annual Soil Moisture Data Set

Previously, GLOBE data collection strategies included infrequent soil moisture measurements by only a small number of schools. This resulted in a spatially and temporally inconsistent collection of soil moisture data that few scientists found valuable. Accordingly, a new protocol is proposed with the needs of climate scientists in mind, with the understanding that the goal is to simultaneously facilitate the implementation of this protocol within the constraints of each K-12 teachers' class and school limitations. The proposed protocol suggests the collection of a spatially rich, although temporally limited soil moisture data set. The goal is to motivate the 12,000 schools worldwide to collect a "soil moisture snapshot" by collecting measurements on or around two specific dates, namely the first two weeks of October (which coincides with World

Space Science week and Earth Science week), and the fourth week of April (which coincides with Earth Day week). The students are asked to collect near-surface (0-5 and 10 cm) soil moisture samples in triplicate, and to use GPS technology to georeference these sites whenever possible. Each school is asked to collect samples from as many sites as feasible within an hour's drive of their school. In addition to measuring soil moisture, students are encouraged to collect bulk density samples, observe land cover, describe soil textures, and conduct any other GLOBE measurements that they have the time and interest to collect.

World Space Science week and Earth Day week were selected as targets for data collection campaigns for two main reasons. First, teachers will likely already be discussing environmental science topics in their curriculum, and thus implementing a GLOBE soil moisture measurement campaign will be relatively easy. Second, April and October represent general times of seasonal transition, when soil moisture may be changing from wet to dry (or vice versa), and scientists may find such a data set more useful than one in which soil moisture is very dry or very wet.

To assure scientists that the data GLOBE students collect is "scientific", accuracy and consistency in the data collection strategies is ensured by carefully tested protocols for students and teachers – protocols that define *how*, *when*, and *where* to measure soil moisture (as well as other variables like soil bulk density). Furthermore, the students and teachers are provided with equipment specifications and step-by-step calibration methods. To insure that the data collected is **valuable** scientific data, our aim is to persistently collect gravimetric soil moisture data on a semi-annual basis, resulting in a long-term global data set. Also significant is our goal to achieve strategic regional coverage of soil moisture data collection.

Request for input/advice

We currently request input and advice from all disciplines within the scientific community to assist us in improving our protocol by helping us answer the following questions:

- i) Are the dates we've selected optimal &/or useful to your research? Are other dates preferred?

- ii) What level of accuracy is required and/or desired?
- iii) What kind of spatial coverage is optimal?
- iv) Are there specific portions of the globe that would be especially useful / more critical to cover?
- v) Other concerns, advice, ideas?

By offering your suggestions, you will be helping to refine our strategies for a valuable soil moisture data set that could be useful to your and other scientists' research. We encourage ongoing recommendations and dialogue with our corresponding author.