# NIDIS & SOIL MOISTURE

National Integrated Drought Information System
Drought.gov

## Balancing the Water Budget: Advancements in Soil Moisture Monitoring

Soil moisture is a vital part of the water budget, yet an accurate depiction of this variable has been a serious challenge over the past several decades. In response to this need, NIDIS and USDA are co-leading the development of a strategy for nation-wide monitoring of soil moisture. The goals of the **National Coordinated Soil Moisture Monitoring Network (NCSMMN)** are to establish a national network that integrates multiple soil moisture data sources across federal and state in-situ monitoring networks, satellite remote sensing missions, and numerous modeling capabilities.

Efforts focus on three key elements:

- Improve collaboration and identify funding opportunities to build the national network
- Develop consistent methodology for data collection and installation of in-situ probes including metadata standards
- Develop national multi-platform soil moisture gridded products

## Partners

**NOAA**: Air Resources Laboratory (ARL); Earth System Research Laboratory, Physical Sciences Division (ESRL-PSD); National Environmental Satellite, Data, and Information Service (NESDIS); National Centers for Environmental Information (NCEI); U.S. Climate Reference Network (USCRN); Climate Program Office (CPO) Modeling, Analysis, Predictions and Projections (MAPP), National Weather Service (NWS)

**USDA**: Natural Resources Conservation Service (NRCS), Office of the Chief Economist (OCE)

**NASA**

**USGS**

**National Water Center**

**National Drought Mitigation Center (NDMC)**

**Ohio State University**

**Southern Illinois University**

**Texas A&M**

**State Mesonets**

## NIDIS-supported research activities towards advancing the NCSMMN include:

### NOAA's US Climate Reference Network

Since 2008, NIDIS has provided funding to ARL and NCEI for the procurement of soil moisture sensors, installation, data acquisition integration, data ingest, and quality control/quality assurance for observations at 114 sites in the US. The soil moisture data from the USCRN complements the USDA-NRCS's Soil Climate Analysis Network (SCAN). These two networks are the primary data contributors to the NCSMMN.

### Using Soil Moisture to Improve Drought Monitoring

This project develops a national-scale drought monitoring product integrating multiple, diverse sources of soil moisture information to improve drought early warning.

**Research outcomes:**

- Assessment of the fidelity of various satellite remote sensing- and model-based soil moisture products
- Integration of remote sensing and modeled soil moisture information with in-situ measurements to develop a national-scale, near-real time soil moisture product for drought monitoring
- Design and development of a proof-of-concept cyber infrastructure for delivery of the gridded soil moisture product

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## Collaborative Approach: Building a Soil Moisture Monitoring Community of Practice

Monitoring soil moisture requires sufficient resources and coordination over a diverse range of networks. NIDIS and partners are working to expand the NCSMMN to include citizen scientists, private sector groups, along with state Mesonet programs, regional climate centers, and federal agencies. In 2017, the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS), with NIDIS support, launched a soil moisture reporting option for citizen scientists, which will ultimately benefit the expansion of the network.

## The National Water Model's Soil Moisture Data & the U.S. Drought Monitor

Researchers at NOAA's ESRL-PSD, in collaboration with partners in NOAA's Office of Water Prediction and Climate Prediction Center, are developing prototype products for drought monitoring using NOAA's state-of-the-art National Water Model (NWM). The NWM offers many variables relevant to drought monitoring, including soil moisture at several depths and streamflow, at high-resolution (~250m to 1km).

For farmers, soil moisture indicates the amount of water available for seed development as well as for plants' roots. Streamflow is an indicator of hydrological drought, with low flows indicating potential freshwater shortages. This project uses in-ground soil moisture measurements to evaluate the NWM's soil moisture data and, with regular input from NDMC, is developing new methods to visualize soil moisture and streamflow anomalies that will provide new insight for Drought Monitor authors.

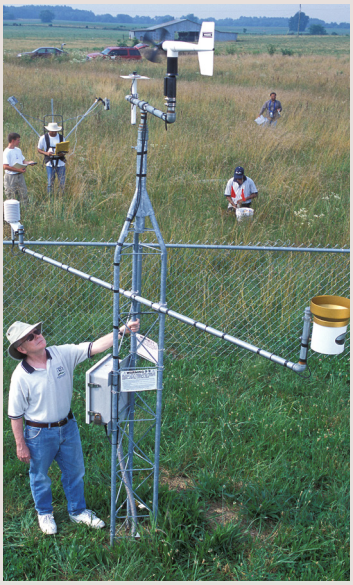
## Interagency Partnerships: In situ Observations, Remote Sensing, & Modelled Data

### In situ Observations

There are numerous in situ instrument networks in the U.S. that continuously measure soil moisture and soil temperature. These networks provide accurate measurements at depths up to 100 cm.

In addition to NOAA's USCRN, USDA's NRCS has managed SCAN since 1991 and has 200 stations across the U.S. and in Puerto Rico and U.S. Virgin Islands.

Many states, including Oklahoma, Nebraska, and parts of Texas, operate Mesonet systems that provide extensive in situ measurements.



### Modelled Data

The North American Land Data Assimilation System (NLDAS), developed by NASA and NOAA, provides spatial representations of relative soil moisture. Models and remote sensing data provide excellent spatial coverage of soil moisture for the U.S., but have coarse resolution. Models need to be calibrated with in situ measurements, which are crucial for improving accuracy. Greater worldwide coverage of in situ monitoring sites placed in variety of different land cover and climatological conditions will improve the outcome of modeling.

### Remote Sensing

Remote sensing observations of soil moisture are made by a number of different agencies. NOAA conducts soil moisture remote sensing through microwave and thermal infrared observations and provides a number of products that show spatial information across the country.

In 2014, NASA launched the Soil Moisture Active/Passive (SMAP) satellite to provide global measurements of soil moisture and its freeze/thaw state. SMAP is designed to make measurements of surface emissions and backscatter, with the ability to measure the soil conditions even in the presence of partial vegetation cover.

On the ground, the Cosmic-Ray Soil Moisture Observing System (COSMOS) is operated by the University of Arizona and determines average soil water content by measuring the flux of low-energy cosmic-ray neutrons above the land surface.