

Pilot National Soil Moisture Network

Motivation

Soil moisture is critical for accurate drought prediction, flood forecasting, climate modeling, prediction of crop yields and water budgeting. However, soil moisture data are collected by many agencies and organizations in the United States using a variety of instruments and methods for varying applications. These data are often distributed and represented in disparate formats, posing significant challenges for reuse. Recognizing this need, the President's Climate Action Plan called for the creation of a coordinated national soil moisture network. In response, a team led by NOAA's National Integrated Drought Information System has completed a proof-of-concept pilot project. The pilot, developed collaboratively by Texas A&M and the U.S. Geological Survey, focuses on providing real-time in-situ soil moisture data via standard web services, aggregated from a number of state and federal sources, to feed a map-based visualization and a standard web service. Tools have been developed in order to meet the following use cases: operational drought monitoring, experimental land surface modeling, and operational hydrological modeling. The result of this pilot is a reference architecture that will inform the implementation of an operational national soil moisture network.

Scope

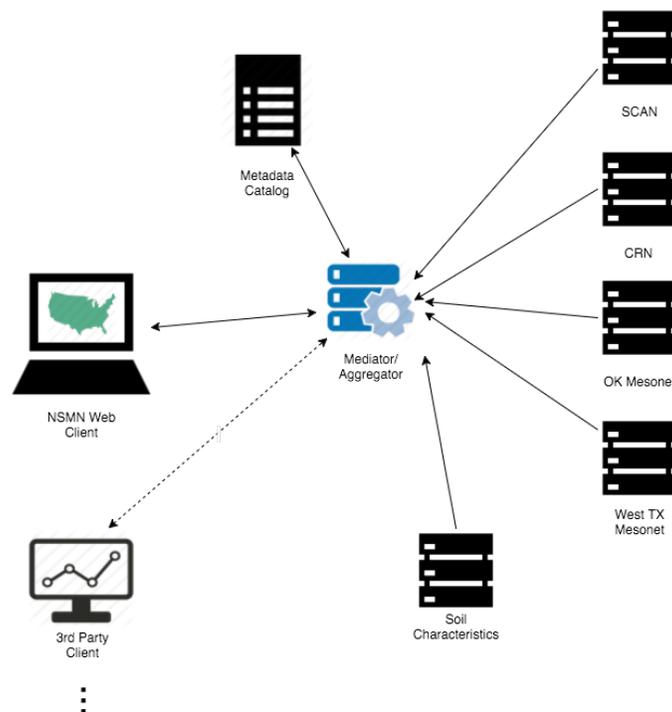
Four in-situ networks were chosen for incorporation in the pilot, two national networks and two state mesonets, based on their near real-time data availability, spatial density, soil characteristic metadata quality, and level of technical support; the U.S. Climate Reference Network (USCRN), Soil Climate Analysis Network (SCAN), Oklahoma Mesonet, and West Texas Mesonet.

The pilot architecture implementation, web application, and web services were built for proof-of-concept and demonstration purposes only. The application, data, and services are not intended for operational use. Minimal support and maintenance will be provided the system as is necessary to support demonstration.

Disclaimer: These data and software are preliminary or provisional and are subject to revision. They are being provided to meet the need for timely best science. The data and software have not received final approval by the U.S. Geological Survey (USGS) and are provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the data.

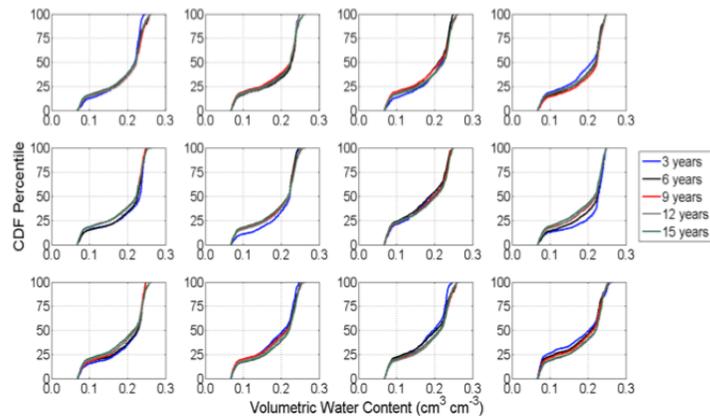
Reference Architecture Design

A distributed network design was chosen a given the focus on real-time data access and availability of web services from data sources. Each soil moisture time-series data set is served from its source via web services. In-situ site metadata and soil characteristic data are stored in the North American Soil Moisture Database and are served out via a web service. Furthermore a mediation and aggregation workflow was developed to intelligently broker, aggregate, normalize, and transform the distributed datasets from their native formats into a single standard output and soil moisture measure. The mediation framework is a critical component of the reference architecture, which allows for distributed hosting and maintenance of data locally by the data owners while simplifying access to the aggregated dataset through a single Sensor Observation Service (SOS) and map-based web application.



Data Products

The pilot provides two soil moisture data products; 1) a volumetric water content data product, represented as a percent of water in the soil, and 2) a soil moisture percentile product which is a measure of how the latest available volumetric water content measurement compares to the historical soil moisture record at that station. Both products are hourly and only latest available values are provided. Soil moisture values are assigned by sensor depth to three bins; 0-10 cm, 10-30 cm, and 30-100 cm. Data products are displayed and provided via web service in reference to these sensor depth bins.



Cumulative distribution functions (CDF) of volumetric water content based on different periods of record were calculated for each station in order to validate the soil moisture percentiles. The 3, 6, 9, and 12 year CDFs were generated by randomly sampling from the entire 15-year period of record. The twelve plots that are shown above are examples of the 1000 randomly generated CDFs. Our results show that relatively stable soil moisture percentiles can be generated at locations that have a relatively short period of record (3 to 6 years). Example shown here is based on data from Lamont, OK (Oklahoma Mesonet).

The mapping component of the pilot web application displays the sites on the map colored based on the soil moisture percentile of the latest value for the site. There are three map visualizations for each of the three sensor depth bins.

Soil moisture data and metadata are accessible via web services. The SOS web service for soil moisture data allows both GetCapabilities and GetObservation operations are supported. Station metadata are accessible through a custom web service for each of the source mesonets.

Soil Moisture SOS Get Capabilities:

http://cida.usgs.gov/nsmn/sos/ok_working.nc?service=SOS&request=GetCapabilities&version=1.0.0

SCAN Metadata Service: <http://128.194.107.250/soilapi/api/metadata/1>

USCRN Metadata Service: <http://128.194.107.250/soilapi/api/metadata/4>

WEST Texas Mesonet Metadata Service: <http://128.194.107.250/soilapi/api/metadata/2>

Oklahoma Mesonet Metadata Service: <http://128.194.107.250/soilapi/api/metadata/3>

Contact

Please direct any questions or comments regarding this pilot to the NSMN pilot creators (nsmn_help@usgs.gov).