

BACKGROUND

Quantifying even small changes in water availability would be significant for Montanans who make decisions that balance risks and costs. In 2014 there were 27,800 farm operations across ~60 million acres of land that contributed to 4.2 billion dollars of Montana's revenue. Agriculture is such a large Montana industry that any increase in efficiency from more accurate weather and soil moisture information can translate into several million dollars in statewide savings each year. Whether for irrigated and dryland agriculture, grazing, water supply, or natural resource management too few stations exist to measure meteorological and soil moisture information at the same location to support decision-making based upon local conditions.

CONCEPT

The Montana Climate Office (MCO) is leading the development of a cooperative statewide soil moisture and meteorological information system. It is designed to support decision-making in agriculture, range and forested watershed contexts. This network will add new remote sites and integrate existing cooperator networks to develop the first statewide soil-climate network.

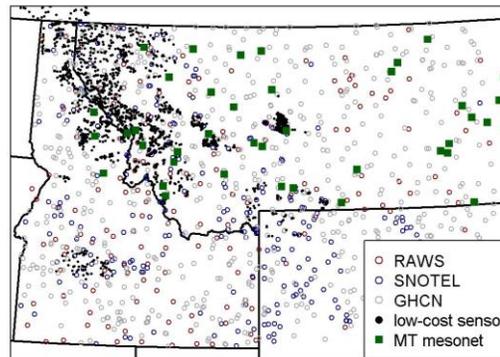
The Montana Mesonet will:

- Combine information from existing data networks

- Establish a minimum of 100 new soil moisture recording sites through partnerships with cooperators.
- Provide an information system for accessing and visualizing historic, real-time and forecasted data.

Initially this effort will focus on agricultural and rangeland areas of Montana. By the fall of 2016 the MCO will have 30 stations located across Montana as part of the Montana Research and Economic Development Initiative (MREDI).

Over time the MCO will respond to many outstanding requests for additional stations in cooperation with local watershed groups, NGO's, private sector, tribal, state, and federal partners.



Permanent weather stations that are operationally downloaded each day in the MCO database and the sites for initial MT Mesonet location (green squares).

A COOPERATIVE FRAMEWORK

No one entity can ensure sustained operation and success of a statewide climate and soil moisture information network. With this in mind the MCO is embracing a cooperative context that will address a diverse set of information needs. The MCO will extend a significant cost reduction on science grade stations to cooperators and will install them as funds become available. We are currently testing the accuracy of 3 manufacturers against "gold standard" National Weather Service stations. The MCO will also ensure that data are quality controlled and accessible in real time through web services and smart devices. An annual service fee (\$400) will cover data transmission fees, computing infrastructure, and maintenance costs. Simply stated, the MCO will not profit from the stations or maintenance of the network beyond the inherent value in facilitating an expansive and publically available soil moisture and climate information network for Montanans.

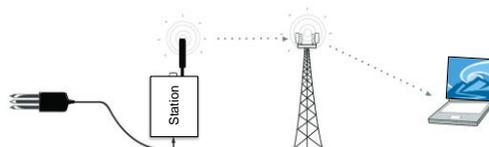


STANDARD SITE CONFIGURATION

Measurement*	Description
Precipitation	Tipping bucket rain gauge
Air Temperature	Shielded thermistor
Relative Humidity	Aspirated thin film capacitance type sensor
Wind Speed and Direction	Propeller type anemometer
Solar Radiation	Pyranometer
Barometric Pressure	Silicon capacitive pressure sensor
Soil Moisture	Volumetric water content using Time Domain Reflectometers at 4", 16" and 32" depths.
Soil Temperature	Encapsulated thermistor at 4", 16" and 32" depths.
Soil Water Electrical Conductivity	Amount of solutes in soil water using at 4", 16" and 32" depths.
Normalized Difference Vegetation Index	Crop greenness and a proxy for vegetation health and productivity
Digital Photos	Photos of site conditions by an onboard camera.

*All sensor measurements are reported at least hourly

DATA MANAGEMENT



All stations are solar powered and will allow users to check the data from virtually anywhere in the world. Data are transmitted from the data-logger's internal module to MCO's secure server via cellular communication. Quality assurance and control checks are applied and the data are available to the user to access, monitor and download at any time. Transmitted data are backed up in the data-logger's memory and at the MCO to provide an extra layer of redundancy and protection.



DATA DELIVERY

Data is delivered in multiple formats such as maps and graphs that dynamically report the latest content. This includes the ability to rapidly summarize point and gridded data by state, county, watershed or ownership unit. Finally a smartphone application will provide users with a mobile tool for viewing data in the field.

USES OF SOIL WATER & CLIMATE DATA

Resource management issues for which long term soil-climate information is needed include:

- To monitor drought onset, duration and magnitude
- To facilitate estimates of crop irrigation demand and irrigation scheduling
- Planting and harvesting scheduling
- To predict the long term sustainability of cropping systems, and watershed health
- To monitor and predict changes range and forest land productivity in relation to soil moisture-temperature changes
- To predict and mitigate pest and disease outbreaks
- To predict changes in runoff that affect flooding and control structures
- To verify and ground-truth satellite and soil moisture model information
- To facilitate natural resource decisions for prescribed burning.
- To develop new soil moisture accounting methods and risk assessments.



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