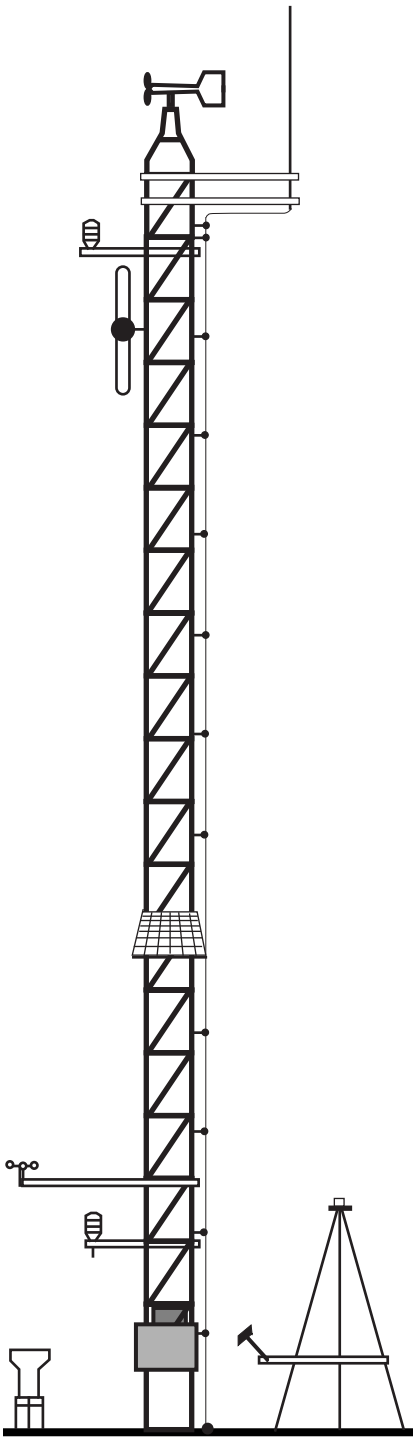
What is the Oklahoma Mesonet?



Overview

The Oklahoma Mesonet is a world-class network of environmental monitoring stations. The network was designed and implemented by scientists at the University of Oklahoma (OU) and at Oklahoma State University (OSU).

The Oklahoma Mesonet consists of 114 automated stations covering Oklahoma. There is at least one Mesonet station in each of Oklahoma's 77 counties.

Definition of "Mesonet"

"Mesonet" is a combination of the words "mesoscale" and "network."

- In meteorology, "mesoscale" refers to weather events that range in size from a few kilometers to a few hundred kilometers. Mesoscale events last from several minutes to several hours. Thunderstorms and squall lines are two examples of mesoscale events.
- A "network" is an interconnected system.

Thus, the Oklahoma Mesonet is a system designed to measure the environment at the size and duration of mesoscale weather events.

At each site, the environment is measured by a set of instruments located on or near a 10-meter-tall tower. The measurements are packaged into "observations" every 5 minutes, then the observations are transmitted to a central facility every 15 minutes – 24 hours per day year-round.

The Oklahoma Climatological Survey (OCS) at OU receives the observations, verifies the quality of the data and provides the data to Mesonet customers. It only takes 10 to 20 minutes from the time the measurements are acquired until they become available to customers, including schools.

As of 1997, no other state or nation is known to have a network that boasts the capabilities of the Oklahoma Mesonet.

The Mesonet is unique in its capability to measure a large variety of environmental conditions at so many sites across an area as large as Oklahoma. In addition, these conditions are relayed to a wide variety of customers very quickly after the observations are taken.

Fun Fact

The average spacing between Mesonet stations is 35 kilometers (19 miles).

History of the Oklahoma Mesonet

In 1982, Oklahoma scientists recognized the need for a statewide monitoring network. At OSU, agricultural scientists wanted to upgrade weather instruments at their research sites. Their primary goal was to expand the use of weather data in agricultural applications.

Meanwhile, scientists from the Norman meteorological community were helping to plan and implement a flood-warning system for Tulsa. The success of Tulsa's rain gauge network pointed to the potential for a more extensive, statewide network.

OSU and OU joined forces in 1987 when they realized that one system would help both universities achieve their respective missions. The two universities approached the Governor's Office and, in December of 1990, the Oklahoma Mesonet Project was funded with $2.0 million of oil-overcharge funds available from a court settlement. Each university contributed nearly $350,000 to bring the grand total to $2.7 million.

In addition, the Oklahoma Law Enforcement Telecommunications System (OLETS) donated the use of its communications infrastructure to help move the data from the remote sites to OU. This subsidy saved the Mesonet Project about $1.6 million each year in communications costs.

Once funding was available, the Mesonet Project progressed quickly. Committees were formed, potential station sites were located and surveyed and instruments were chosen. In late 1991, the first Mesonet towers were installed and, by the end of 1993, 108 sites were completely operational. Three more sites were added soon thereafter to supplement a U. S. Department of Agriculture network in the Little Washita River Basin.

In 1996, three sites were added near Tulsa for an Oklahoma Department of Environmental Quality study of air pollution. Thus, by the fall of 1996, the total number of Oklahoma Mesonet sites was 114.

Fun Fact

A single Mesonet site operates with a quarter of the power of a standard night light.

The Mesonet Site

An Oklahoma Mesonet site (Master #1A) consists of the following: a 100 square-meter plot of land (10 meters by 10 meters), one 10-meter metal tower held in place by three guy wires, a cattle fence, a lightning rod, a solar panel, a battery, a radio transmitter, a special micro-computer called a data logger, instruments attached to the tower, instruments near the tower buried underground, a solar radiation instrument on top of a 2-meter metal tripod and a ground-mounted rain gauge surrounded by a wind screen.

All 114 Mesonet sites are solar-powered. The solar panel captures the sun's energy and converts it into electricity, which charges a battery. It is the battery that powers the entire station. The battery can store enough energy to power a Mesonet site for 10 days without sunlight.

A miniature computer called a "data logger" informs each instrument when it should take a measurement. The data logger also completes any needed computations (such as averaging or computing the maximum wind speed) and sends the data through a radio transmitter at the appointed time.

The data are broadcast over radio waves to a nearby sheriff, police or highway patrol station. The data enters the Oklahoma Law Enforcement Telecommunications System (OLETS) and is sent to OU through the main OLETS office in Oklahoma City.

Certain instruments are located at *every* Mesonet site to measure the "core parameters" (Master #1B). The "core parameters" are as follows:

- air temperature measured at 1.5 meters above the ground,
- relative humidity measured at 1.5 meters above the ground,
- wind speed and direction measured at 10 meters above the ground,
- barometric pressure,
- rainfall,
- incoming solar radiation and
- soil temperatures at 10 centimeters below the ground under both the natural sod cover and bare soil.

Additional instruments are placed at about one-half of the sites to measure "supplemental parameters" (Master #1B). The "supplemental parameters" include the following:

- air temperature at 9 meters above the ground,
- wind speed at 2 meters above the ground,
- leaf wetness,
- soil moisture at 5, 25, 60 and 75 centimeters below the ground,
- soil temperatures at 5 and 30 centimeters below the ground under the natural sod cover and
- soil temperature at 5 centimeters below the ground under bare soil.

All above-ground measurements except leaf wetness are averaged over five-minute intervals. Leaf wetness and all below-ground measurements except soil moisture are averaged over 15-minute intervals. Every 15 minutes, three sets of five-minute above-ground averages and one set of below-ground averages are sent from the site to the base station in Norman. Soil moisture is sampled and reported once every 30 minutes.

The first sites to be selected were those on OSU or OU research land, primarily at OSU agriculture research stations. Many sites are located on property owned by federal, state or local government, academic institutions or foundations (Master #1C). About half of the site locations are on privately owned land. The land owners have loaned a parcel of their land – free of charge – for use by the Mesonet.

Getting Oklahoma Mesonet Data

Oklahoma Mesonet data are distributed to customers in several ways. One method to access Mesonet data is to connect to the Mesonet's computer bulletin board system (BBS). The Mesonet BBS provides recent data files, products and network information for a monthly fee (which is waived for state agencies and schools). In addition, the BBS allows Oklahoma schools to send messages to other teachers, their students, staff at OCS and a host of scientific mentors, all of whom use Mesonet data in their activities.

To access the Mesonet BBS, an individual or an organization will need a computer running either Macintosh™, Win-

Fun Fact

A message sent from the Mesonet base station at OU to the Kenton Mesonet site (in the western Oklahoma Panhandle) will take 5 seconds to arrive. It takes 10 seconds to send a message and receive a reply.

Fun Fact

The most expensive instrument on a standard Mesonet station is the barometer, which costs $1,000.

dows™ or DOS™ operating systems. In addition, a modem connection or an Internet/OneNet connection is necessary. The Mesonet Program will provide software and documentation at minimal cost ($35 at the time of printing). Call a Mesonet Operator at OCS (phone: **405-325-3231**; fax: **405-325-2550**) to determine whether your computer configuration can be used.

World Wide Web users can find Mesonet data and Oklahoma climatological products at the following address: **http://www.ocs.ou.edu/***.

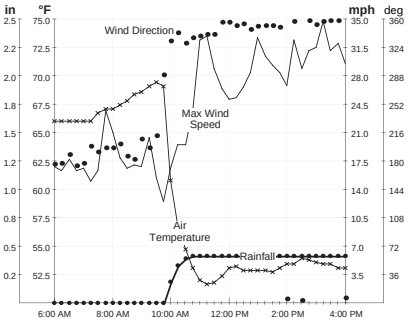
* Some data and products are available only to Mesonet data subscribers.

Mesonet Operator:
Phone: (405) 325-3231
Fax: (405) 325-2550

World Wide Web addresses:
http://okmesonet.ocs.ou.edu/
and
http://www.ocs.ou.edu/

Displaying Mesonet Data

Oklahoma Mesonet data can be displayed using software developed at OCS. Much of the software was designed with teachers as the "beta testers" to verify its usefulness in the classroom. Data can be displayed on standard meteorological "station model plots," line contour maps, color-filled contour maps, vector plots (for wind), graphs and tables. Maps can be animated to provide an easy way to visualize Oklahoma's changing weather.



An example of a Mesonet graph. The four parameters, shown over a period of ten hours, reveal a cold frontal passage.

The display of Mesonet data using OCS software has provided thousands of Oklahoma students the opportunity to conduct *research*. The software is designed to allow students to examine interactions between physical quantities and to visualize cause-and-effect relationships easily.

Mesonet Benefits

When properly used, Mesonet data have the capacity to help save lives, save Oklahoma businesses and taxpayers millions of dollars annually, reduce energy consumption, educate the next generation of citizens and make an incalculable contribution to research projects every year.

The most notable professions that the Mesonet influences are weather forecasting, agriculture, education, emergency management, energy industry, transportation and scientific research.

Weather forecasting

The National Weather Service operates 14 automated weather stations in Oklahoma. These stations usually take atmospheric measurements once every hour. However, much of Oklahoma's most destructive or least predictable weather occurs on a scale small enough to be missed by these federal stations. The Mesonet provides weather forecasters with more frequent and more densely spaced information.

Better forecasts of excessive rainfall and real-time measurement of soil moisture conditions will help to improve the lead time on flood warnings issued by the National Weather Service. These forecasts could allow for the pre-release of water from storage reservoirs before water levels rise too high.

Fun Fact

The least expensive instrument is the soil temperature sensor, called a thermistor, which costs $25.

Instrument Selection for the Mesonet

As in any network of measurement stations, the Oklahoma Mesonet could not support every kind of measurement that was desired. The committee that determined the final list of site measurements had to select which measurements were necessary and practical given a set of constraints. As is often the case in science, there was no obvious "right answer."

The first constraint on the site was that all components had to be automated. Thus, any instrument that required human intervention was unacceptable.

The second constraint was the cost of the instrument. Although automated weather stations operated by the National Weather Service cost over $100,000 per station, the Mesonet had a budget of only $10,000 per station.

Unlike instruments that are used in a laboratory, the sensors on a Mesonet station must be able to survive through Oklahoma's harsh weather conditions year round. Thus, it was essential that each instrument be rugged enough for outdoor use. Some instruments that were intended for use outdoors still had to be modified to work well in Oklahoma's environment. For example, the design of the rain gauges had to be changed because, in Eastern Oklahoma, leaves frequently lodged in the rain gauge funnel, thus preventing the rain from draining properly through the gauge's recording device.

When all electrical needs by the instruments, data logger and radio were added together, the average power usage could not be larger than 1.5 Watts. This constraint limited the use of certain instruments on the station. For example, the inclusion of a device to measure snowfall would have required more power than the station could support. Thus, it was decided that snowfall would not be measured.

Fun Fact

Between March 1, 1994 and August 24, 1997, the Oklahoma Mesonet had the potential to collect a total of 56,775,168 measurements. During that same period 56,730,232 measurements actually were collected.

Agriculture

Agricultural applications of the Mesonet include improved insect and disease advisories, spraying recommendations, irrigation scheduling, frost protection, planting/harvesting recommendations and prescribed burn advisories. Agriculture is such a large Oklahoma industry that any increase in efficiency from more accurate environmental data can translate into several million dollars in statewide savings annually.

Education

The Oklahoma Mesonet provides a unique learning opportunity for Oklahoma schools. Near real-time data are available to public and private schools in Oklahoma for free. Learning activities using Mesonet information range from science and mathematics to economics and communications.

Emergency management

Officials concerned with hazardous chemical spills use the Oklahoma Mesonet to observe wind, precipitation and other conditions to minimize the dangers from the spill. Improved knowledge of the weather helps determine whether any evacuation is necessary.

Mesonet data input to Oklahoma's fire danger rating system assists the Oklahoma Department of Agriculture's Forestry Services in declaring "red flag fire alerts" – days with high potential for the spread of dangerous fires.

Energy savings

Mesonet data are valuable in the renewable energy industry. For example, with Mesonet data to guide their placement, wind and solar generators can provide a source of non-polluting, renewable energy. Long-term data can be gathered on the thermal properties of Oklahoma soils to help designers optimize the size and reduce the installation costs of ground coils used in ground-source heat pumps.

Transportation

Road crews from the Oklahoma Department of Transportation use the Mesonet rainfall and temperature measurements to anticipate which roads to sand during potential icing conditions. Even determining whether the temperature and relative humidity are suitable to allow paint to dry on roads and bridges will save Oklahoma tax dollars.

Research

Mesonet data are used in a host of meteorological, agricultural and hydrological research projects funded by the National Science Foundation, National Aeronautics and Space Administration and the U.S. Departments of Agriculture, Commerce and Energy. In addition, the Mesonet infrastructure is used to support field monitoring activities of the U.S. Department of Agriculture, the Oklahoma Department of Environmental Quality and the Oklahoma Water Resources Board.

Fun Fact

The highest wind speed recorded at an Oklahoma Mesonet site was 113 miles per hour on August 17, 1994 at Lahoma. At that moment, the wind instrument was destroyed by large hail.

Proper siting of Mesonet stations

Siting locations for Mesonet stations had to fulfill a list of general requirements for meteorological and agricultural purposes. These conditions were as follows:

- Rural sites should be selected to avoid human influences present in urban and suburban areas.
- The physical characteristics of a site, including soil properties, should be representative of as large an area as possible.
- A site should be as far away as possible from irrigated areas, lakes and forests to minimize their influence.
- The land surface should be as flat as possible.
- There should be a minimum of obstructions that impede wind flow at the site. (A rule of thumb is that the distance between an obstruction to the wind and the top of the tower should be at least 20 times the height of the obstruction. For example, a 30-foot tree should be no closer than 600 feet from the tower.)
- Sites should have a uniform low-cover vegetation. Bare soil should not be visible except over the bare soil temperature measurements.
- The site should be accessible by vehicles for maintenance.

Substantial funding for the Oklahoma Mesonet is provided by the Oklahoma State Regents for Higher Education.

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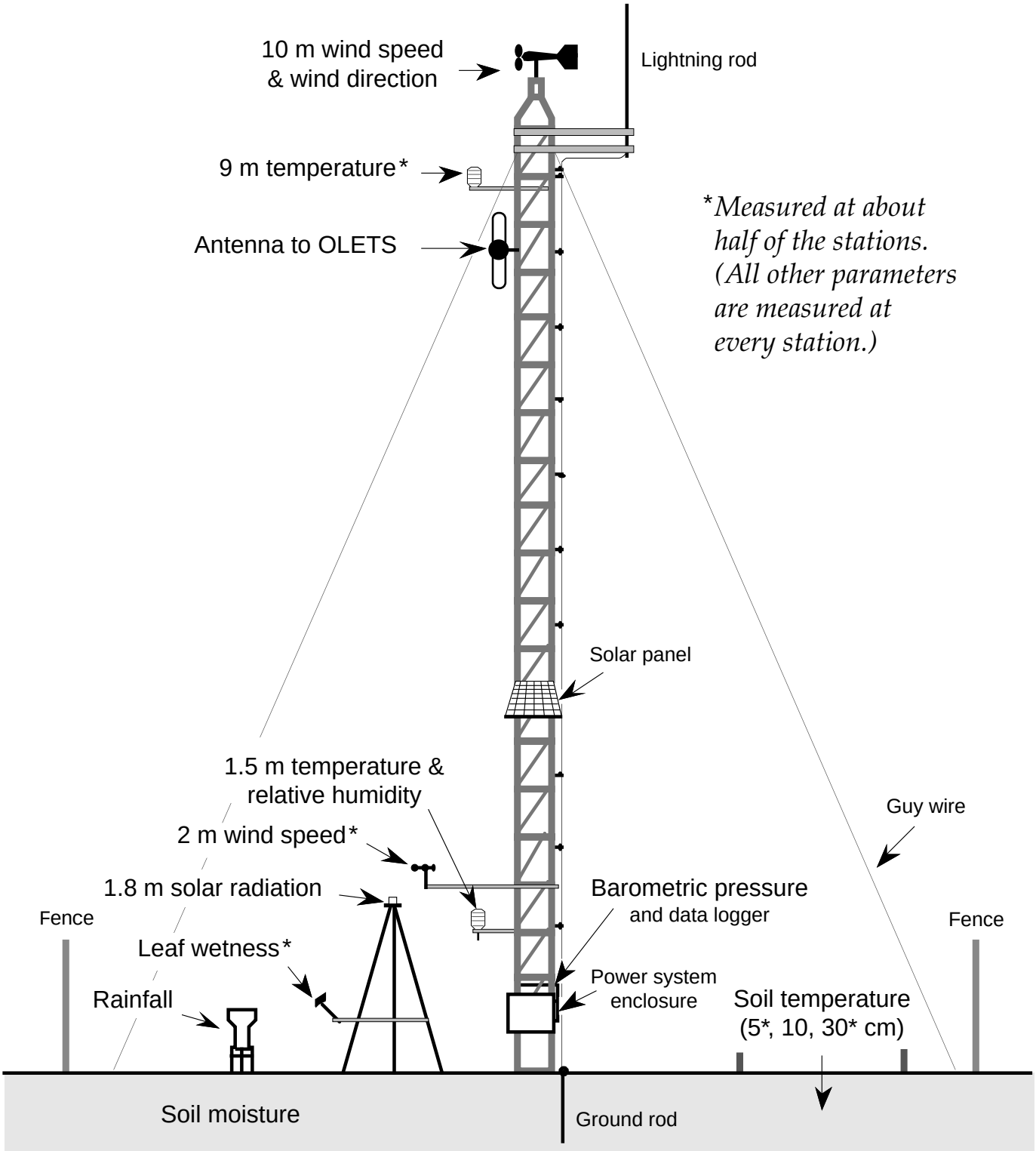
Side View of a Typical Mesonet Station

View to the North



Measurements at Oklahoma Mesonet Sites

Core Parameters

Air Temperature
measured at 1.5 meters above the ground

Relative Humidity
measured at 1.5 meters above the ground

Wind Speed and Direction
measured at 10 meters above the ground

Barometric Pressure

Rainfall

Incoming Solar Radiation

Soil Temperature (under Sod)
measured at 10 centimeters below the ground

Soil Temperature (under Bare Soil)
measured at 10 centimeters below the ground

Supplemental Parameters

9-meter Air Temperature
measured at 9 meters above the ground

2-meter Wind Speed
measured at 2 meters above the ground

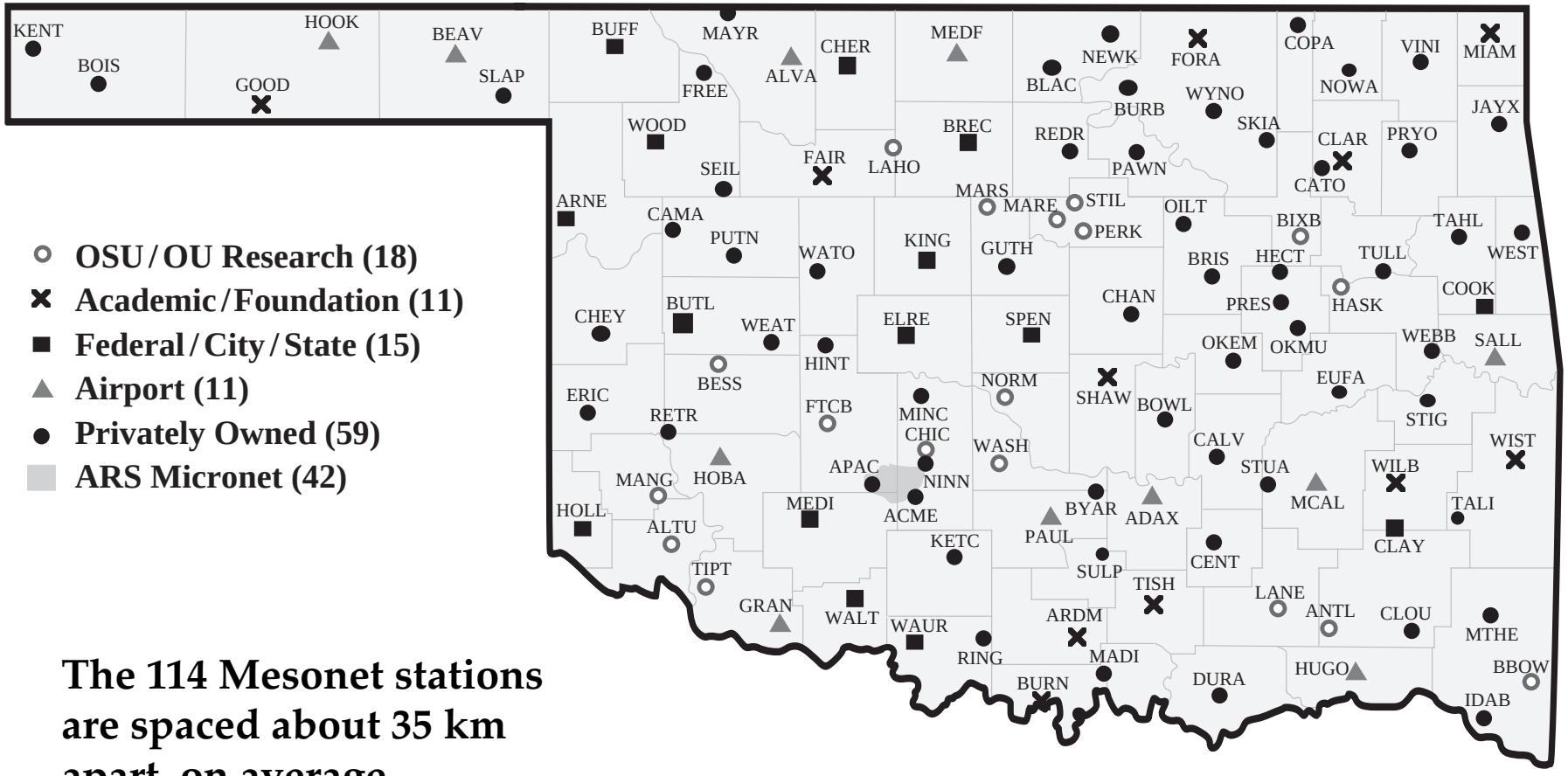
Leaf Wetness

Soil Moisture
measured at 5, 25, 60, and 75 centimeters below the ground

Additional Soil Temperatures
measured at 5 centimeters below the ground under both natural sod cover and bare soil; measured at 30 centimeters below the ground under natural sod cover

Location of Mesonet Sites

(showing land ownership)



- OSU / OU Research (18)
- Academic / Foundation (11)
- Federal / City / State (15)
- Airport (11)
- Privately Owned (59)
- ARS Micronet (42)

The 114 Mesonet stations are spaced about 35 km apart, on average