Oklahoma Mesonet 5 Minute Meteorological Data (OCS Format)

1.0 General Description

This data set is the Oklahoma Mesonet Five Minute Surface Meteorological data in the Oklahoma Climate Survey (OCS) Format. Fifteen minute surface data which had previously been available as a separate data set is included in this data set, as well as OKMESO Quality Assurance flags. For a full explanation of the format see the Format Description section, number 2.1.

2.0 Detailed Data Description

The Oklahoma Mesonet is a permanent 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 over 110 automated stations covering Oklahoma. There is at least one Mesonet station in each of Oklahoma's 77 counties. The average station spacing is 32 km. Mesonet sites and the stations are predominantly located in rural areas, as free from anthropogenic influences as possible (Shafer et al, 1993).

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 5 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 5 to 10 minutes from the time the measurements are acquired until they become available to the public.

Wind speed and direction are measured at a height of 10m and air temperature and relative humidity are measured at 1.5 m for consistency with existing NOAA cooperative observations and airport stations. The measurements are taken over natural vegetation. The tower stands near the center of a 10 m by 10 m plot of land, surrounded by a cattle-panel fence, 1.3 m high, to secure the area from animals and nearby human activity.

A system of soil-moisture sensors was installed at over 100 Mesonet sites. The system was designed to provide information about the soil-water status at several depths in the soil profile. The system is designed to operate in remote locations, providing automated, continuous measurements with little or no maintenance required.

2.0.1 Instrumentation

Sensor:	R.M. Young 5103 Propeller Vane Anemometer
Measures:	WSPD, WVEC, WDIR, WDSD, WSSD, WMAX
Height:	10 m AGL
Interval:	3-second sampling, averaged over 5 minutes (WMAX is highest of the 3-second samples in the 5-minute interval)
Characteristics:	Speed: 1-60 mps; Direction: 0-355°
Inaccuracy:	Speed: +/-0.3 mps; Direction: +/-3°
Resolution:	Speed: 0.03 mps; Direction: 0.05°

Sensor:	Vaisala HMP45C temperature thermistor and sorption humidity sensor
Measures:	TAIR (1994 through 2003), RELH
Height:	1.5 m AGL
Interval:	3-second sampling, averaged over 5 minutes
Characteristics:	Temperature: -30- 50 E C; Humidity 0 - 100% Coastal Climate unaspirated 12-plate type radiation shield
Inaccuracy:	Temperature: 0.35°C; Humidity 3%
Resolution:	Temperature: 0.01°C; Humidity 0.03%

Sensor:	Thermometrics thermistor
Measures:	TAIR (January 2004 to present)
Height:	1.5 m AGL
Interval:	3-second sampling, averaged over 5 minutes
Characteristics:	-30 to 50°C fast response Coastal Climate unaspirated 12-plate type radiation shield
Inaccuracy:	0.4°C
Resolution:	0.03°C

Sensor:	Vaisala PTB202 Barometer
Measures:	PRES
Height:	0.75 m AGL
Interval:	12-second sampling, averaged over 5 minutes
Characteristics:	700-1100 mb
Inaccuracy:	0.2 mb
Resolution:	0.01 mb

Sensor:	Metone 099M Tipping Bucket Rain Gauge
Measures:	RAIN
Height:	0.6 m AGL
Interval:	Accumulated tips over 5 minutes
Characteristics:	30-cm Gauge, 0.25-mm bucket; Alter style wind screen
Inaccuracy:	1% reading
Resolution:	0.25 mm

Sensor:	LiCor 200 Pyranometer
Measures:	SRAD
Height:	1.8 m AGL
Interval:	3-second sampling, averaged over 5 minutes
Characteristics:	Silicon Cell; Tripod-mounted south of tower
Inaccuracy:	5% reading
Resolution:	0.23 Wm-2

Sensor:	Fenwal Thermistors
Measures:	TS10, TB10, TS05, TB05, TS30
Height:	10 cm depth (sod and bare soil), 5 cm depth (sod and bare soil), 30 cm depth (sod)
Interval:	30-second sampling, averaged over 15 minutes
Characteristics:	-30 - 50°C stainless steel jacket
Inaccuracy:	0.4°C
Resolution:	0.03°C

Sensor:	Thermometrics thermistor
Measures:	TA9M
Height:	9 m AGL
Interval:	3-second sampling, averaged over 5 minutes
Characteristics:	-30 to 50°C fast response
	Coastal Climate unaspirated 12-plate type radiation shield
Inaccuracy:	0.4°C
Resolution:	0.03°C

Sensor:	R.M. Young 3101 Cup Anemometer
Measures:	WS2M
Height:	2 m AGL
Interval:	3-second sampling, averaged over 5 minutes
Characteristics:	0.5 - 50 mps
Inaccuracy:	0.5 mps
Resolution:	0.25 mps

2.0.2 OKMESO Algorithms

Certain instruments are located at every Mesonet site to measure the standard-primary variables. These variables 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 most sites to measure standard-secondary variables. These include the following:

- air temperature at 9 meters above the ground,
- wind speed at 2 and 9 meters above the ground,
- soil moisture at 5, 25, and, 60 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 bare ground.

All above-ground measurements are sampled every 3 s and with the exception of the barometer (which is 12 s) and the rain gauge (which is event driven). The above ground measurements are averaged over 5 min. Soil temperature measurements are sampled every 30 s and averaged into 15-min observations. Soil moisture is sampled once every 30 min. Every 5 minutes, all available observations are sent from the site to the Central Operations Facility in Norman.

The soil moisture sensors measure heat dissipation which translates into water content of the soil. The OKMESO soil moisture data are available via the UCAR/JOSS CODIAC data management system as:

SMEX02 Sub-Surface: OKMESO Soil Moisture Data (various OCS versions)

2.0.3 Site Characteristics

Mesonet sites are predominantly located in rural areas, as free from anthropogenic influences as possible (Shafer et al, 1993). A Site Standards Committee developed a set of recommendations for site characteristics and measurements. These recommendations were followed as closely as possible to assure a consistency in the data reported from the field sites. Instrumentation on the Mesonet was selected to conform as closely to WMO standards as possible. Wind speed and direction are measured at a height of 10 m and air temperature and relative humidity are measured at 1.5 m for consistency with existing NOAA cooperative observations and airport stations. The measurements are taken over natural vegetation. The tower stands near the center of a 10 m by 10 m plot of land, surrounded by a cattle-panel fence, 1.3 m high, to secure the area from animals and nearby human activity. Each site can be viewed at the following URL: http://www.mesonet.org/sites/. Two of the sites (Hobart and McAlester) are co-located with ASOS instrumented towers so that data can be compared between the two networks. Eleven additional sites are located within two km of an NWS Cooperative Observer site. Two towers are installed at the Norman site. One is operational while the other provides an opportunity to compare instrumentation and test network upgrades without affecting the operational sites.

2.1 Format Description

The Oklahoma Mesonet 5 Minute Meteorological data set (OCS Format) contains day files with 2 metadata parameters and 19 data parameters alternating with Quality Assurance codes (except for the BATV parameter, which has no QA code). It is in ASCII columnar format. The Quality Assurance codes are discussed in section 3.0, Quality Control Processing. The metadata parameters of the data file describe the station location and time at which the data were collected. The time of observation is reported in Universal Time Coordinated (UTC). Days begin at UTC hour 0100 and end at UTC hour 0000 the following day.

Note: Data for 1999 have columns for 7 additional soil moisture values and QA flags, but since there is no data for soil moisture in this data set. all values are set to "Missing" ("-998.0").

The first 3 lines of each data file contain copyright notice, version information, and date of creation. The fourth line consists of columnar headings. Metadata and data parameters start on the fifth line.

The data parameters are valid for the reported times, except for rainfall which is an accumulation since 00 UTC. Missing values are reported as negative numbers less than -900 in the data field (e.g. -7999, -998, -999), although it is not known if this will continue. The table below details the data parameters in each record. Each data parameter is followed by an OKMESO QA code (except for the BATV parameter, which has no QA code). For a list of possible QA code values see the Quality Control Section 3.0

No Quality Control was performed on this dataset by UCAR/JOSS.

Parameter	Unit

Station Identifier	Network Dependent
Date and Time of Observation	UTC, YYMMDDhhmm
Relative Humidity (RELH)	percent(0-100)
Air Temperature (TAIR)	Celsius
Wind Speed (WSPD)	m/s
Resultant Vector (WVEC)	m/s
Direction (WDIR)	degrees
Wind Speed Direction Standard Deviation (WDSD)	m/s
Maximum Wind Gust Standard Deviation (WSSD)	m/s
Maximum Wind Gust (WMAX)	m/s
Rainfall (RAIN)	mm
Barometric Pressure (PRES)	Hectopascals (mb)
Solar Radiation (SRAD)	W/m2
Air Temperature at 9 m (TA9M)	Celsius
Wind Speed at 2 m (WS2M)	m/s
Soil temp at 10 cm (TS10), natural sod cover	Celsius
Soil temp at 10 cm (TB10), bare soil	Celsius
Soil temp at 05 cm (TS05), natural sod cover	Celsius
Soil temp at 05 cm (TB05), bare soil	Celsius
Soil temp at 30 cm (TS30), natural sod cover	Celsius
Site battery voltage (BATV)	volts

2.2 Data Remarks

UCAR/JOSS did no conversion on this data. The data are provided "as is" in their original format.

3.0 Quality Control Processing

UCAR/JOSS did no Quality Control processing on this data set. The QA codes were created by the Oklahoma Mesonet. An explanation of their format follows.

The Oklahoma Mesonet's quality-assurance (QA) consists of four principal components:
1) laboratory calibration,
2) on-site intercomparison,
3) automated QA, and
4) manual QA.

In the instrument laboratory, all sensors are calibrated to validate or improve upon factory calibrations. No sensor is deployed in the network without having passed through the laboratory. Technicians verify that each sensor is within the manufacturer's stated specifications and that calibration coefficients match those provided by the manufacturer. Calibration curves are determined for those sensors requiring them. Once validated, the sensor is placed in the stock for deployment at field sites. The instrument laboratory also serves as a location for post-calibration and repair as sensors are returned from the field.

At least three times per year, the accuracy of several types of sensors in the field is verified through comparison to calibrated reference sensors housed in a portable system. Error statistics between the field instrument and a reference instrument, frequently re-calibrated in the laboratory, are determined. Those sensors outside of error bounds are replaced and returned to the laboratory. Other instruments are cleaned and visually inspected.

To make a first pass through the 989,000+ observations that are received at the Mesonet each day, automated QA software includes numerous algorithms to evaluate the data received from remote stations. Automated QA checks are run as the data are ingested and again each night for the previous UTC day's data. The automated QA uses five checks: range, step, persistence, spatial, and like-instrument comparison. Each is useful for detecting certain events. For example, a step test can catch an erroneous spike in the data while a persistence test can detect an instrument which has ceased to report to the datalogger. Spatial and like-instrument tests compare between similar sensors. Each datum is assigned a QA flag, which accompanies the datum from that point forward. The automated QA tests are repeated after one week and one month to reflect additional changes, hole-collection, and the QA Manager's decisions. The automated QA tests interact with a qualparm table. This contains a listing of known problems at any point in a station or sensor's history.

Finally, the Mesonet’s QA meteorologists employ numerous manual techniques to complement automated QA including analysis of monthly statistics to detect sensor drift or bias. In addition to detecting problematic sensors, the QA meteorologists trace the true start time of each problem so that appropriate data can be manually flagged as erroneous. The QA meteorologists are responsible for communicating problems to, and coordinating with, appropriate field technicians to ensure proper resolution. The qualparm table is manually edited and maintained by the QA Manager and provides a means of human override of the automated QA flags. The automated flag is compared against that assigned by the QA Manager, such that if the QA Manager has determined a problem that has not been detected by the automated processes, the qualparm flag will be retained in the QA archive. The fourth aspect is visual inspection of the data. During the day, Mesonet Operators scan the data for potential problems and report such problems to the QA Manager. The QA Manager uses these reports, reports from data users, and morning summaries produced by the automated QA processes to issue trouble tickets, which alert technicians of the need to investigate potential problems. No datum is ever altered. The archive contains the data as they are reported from the field dataloggers. The QA flag is the Mesonet staff's assessment of the quality of the datum, but it is left to the individual researcher to determine whether or not it is appropriate to use the datum in her/his research.

QA FLAG VALUE	QA STATUS	BRIEF DESCRIPTION
0 or g	Good	Datum has passed all QA tests
1 or S	Suspect	There is concern about accuracy of datum
2 or W	Warning	Datum is very questionable but information can be extracted
3 or F	Failure	Datum is unusable
4 or N	Not Installed Yet	Station awaiting installation of sensor
5	Likely Good	Reduce automated QA flag by 1 level
6	Known Good	Set automated QA flag to 0
8 or N	Never Installed	This station is not intended to measure this parameter
9 or M	Missing Data	Datum is missing for this station and parameter

UCAR/JOSS did no Quality Control of this dataset.

4.0 References

Bolton, D., 1980: The computation of equivalent potential temperature.,

Mon. Wea. Rev., 108, pp 1046-1053.

Brock, F.V., K.C. Crawford, R.L. Elliott, G.W. Cuperus, S.J. Stadler, H.L. Johnson, and M.D. Eilts, 1995: The Oklahoma Mesonet: A Technical Overview. Journal of Atmospheric and Oceanic Technology, 12(1): 5-19

Shafer, M.A., T. Hughes, and J.D. Carlson, 1993: The Oklahoma Mesonet: Site Selection and Layout. Eighth Symposium on Meteorological Observations and Instrumentation, Anaheim, CA, Amer. Meteor. Soc., 231-236.

Wallace, J.M., P.V. Hobbs, 1977: Atmospheric Science, Academic Press, 467 pp.

Information on the Mesonet:
http://www.mesonet.org/

List of Mesonet-Related Publications:
http://www.ocs.ou.edu/research/publications.php

Site Information and Photographs:
http://www.mesonet.org/sites/

Instrument Information:
http://www.mesonet.org/instruments/