SMEX03 Little Washita Micronet Soil Moisture Data: Oklahoma, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

SMEX03 Little Washita Micronet Soil Moisture Data: Oklahoma, Version 1. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/6T1X2JVKREZU. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0320

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

1.1 Format

Data are provided in tab-delimited ASCII text files. Table 1 lists the column headings and data field descriptions for the files.

Table 1: Column Headings and Data Field Descriptions

Column Heading	Units	Description
Year	YYYY	Year measurement was made
DOY	DDD	Numerical day of year (Julian Date)
HHMM	HHMM	Time of day in Central Standard Time (CST)
Lat	decimal degrees	Latitude (WGS84)
Lon	decimal degrees	Longitude (WGS84)
Easting	meters	UTM Easting Zone 14 (WGS84)
Northing	meters	UTM Northing Zone 14 (WGS84)
AppTarT	°C	Apparent Target Temperature
SenBodT	°C	Sensor Body Temperature
CCT	°C	Corrected Surface Temperature
V1	volts	Voltage 1
V2	volts	Voltage 2
V3	volts	Voltage 3
V4	volts	Voltage 4
RECONST	-	Real Dielectric Constant
IECONST	-	Imaginary Dielectric Constant
TEMP	°C	Soil Temperature
CRECONST	-	Real Dielectric Constant, Temperature Corrected to 25°C

Column Heading	Units	Description
CIECONST	-	Imaginary Dielectric Constant, Temperature Corrected to 25°C
WATERFV	m^3/m^3	Water Fraction Volume (Volumetric Soil Moisture)
NACL	g NaCl/liter	Soil Salinity (grams of sodium chloride per liter)
SCOND	S/m	Soil Conductivity in Siemen/meter
TSCOND	S/m	Temperature corrected (25°C) Soil Conductivity (Siemen/meter)
TSWCOND	S/m	Temperature corrected (25°C) Soil Water Conductivity (Siemen/meter)

1.2 File Naming Convention

Files are named according to the following convention.

LW_Micronet_HPA_####.txt

where #### identifies the Micronet Station ID. See Spatial Coverage for a list of station IDs and locations.

1.3 Spatial Coverage

Southernmost Latitude: 34.8° N

Northernmost Latitude: 35.1° N

Westernmost Longitude: 98.2° W

Easternmost Longitude: 97.9° W

Table 2 lists the geographic locations of the 12 Micronet stations.

Table 2 Micronet Station Locations

Station ID	Latitude (decimal degrees)	Longitude (decimal degrees)	Easting (meters)	Northing (meters)
111	35.0159	-97.9518	595633	3875308

133	34.9491	-98.1281	579612	3867745
134	34.9366	-98.0753	584446	3866402
136	34.9277	-97.9656	594475	3865513
144	34.8790	-97.9171	598963	3860159
146	34.8854	-98.0231	589269	3860769
149	34.8984	-98.1809	574837	3862082
154	34.8552	-98.1370	578889	3857325
159	34.7966	-97.9932	592100	3850948
162	34.8133	-98.1417	578499	3852674
Berg	35.0456	-97.9167	598800	3878636
NOAA	34.9614	-97.9720	593852	3869245

1.4 Temporal Coverage

Data were collected from 1 June 2003 through 31 August 2003.

1.4.1 Temporal Resolution

Hydra Probe and Apogee data were recorded every 30 minutes.

1.5 Parameter or Variable

1.5.1 Parameter Description

Parameters in this data set are volumetric soil moisture (m3/m3), soil temperature (°C), soil conductivity (S/m), soil salinity (g NaCl/liter), and surface temperature (°C).

1.5.2 Sample Data Record

The following sample shows the first four columns and the last four columns for the first five rows of the LW_Micronet_HPA_111.txt file.

Year	DOY	HHMM	Lat	....	NACL	SCOND	TSCOND	TSWCOND
2003	152	0	35.0159	....	0.25	0.0148	0.0149	0.3199
2003	152	30	35.0159	....	0.2422	0.0145	0.0146	0.304

Year	DOY	HHMM	Lat	....	NACL	SCOND	TSCOND	TSWCOND
2003	152	100	35.0159	....	0.2431	0.0145	0.0147	0.3053
2003	152	130	35.0159	....	0.2492	0.0146	0.0148	0.3198

1.6 Quality Assessment

These data have been quality controlled and suspect or missing data have been removed. Consequently, the data are not continuous.

2 DATA ACQUISITION AND PROCESSING

The USDA Agricultural Research Service (ARS) has measured hydrologic conditions in the Little Washita Watershed in southwestern Oklahoma since 1961. In 1994, the ARS began monitoring the meteorological conditions in this watershed with an automated 42-station network called the ARS Micronet. Refer to Figure 1. For more information, visit the ARS Micronet Web site.

During the Summer of 2002, surface soil moisture and surface temperature probes were installed at select Micronet sites to provide coverage for large scale estimation of these parameters. Twelve stations were operational during SMEX03. See the Spatial Coverage section for a list of station IDs and locations.

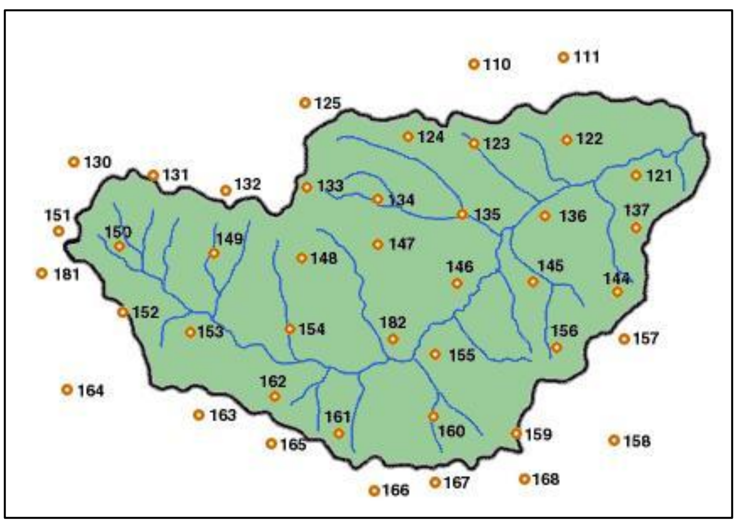

Figure 1. ARS Micronet Stations

2.1 Data Acquisition Methods

HP and IRT measurements were recorded every 30 minutes at 12 Micronet stations in Oklahoma. See the Spatial Coverage section for a list of station IDs and locations.

The HP has three main structural components: a multiconductor cable, a probe head, and sensing tines. The probes were installed horizontally in the soil, with the center tine at a depth of 5 cm. The HP installation techniques aimed to minimize disruption to the site as much as possible so that the probe measurement reflects the undisturbed site.

2.2 Derivation Techniques and Algorithms

2.2.1 Soil Temperature

IRTs are filtered to allow only a specific waveband, about 8 to 14 microns, to be transmitted to the IRT detector. This transmitted energy (E) is converted to temperature (T) via the Stefan-Boltzman Law which states E=σεT4, where ε is the emissivity of the object and σ is the Stefan-Boltzmann constant (5.68 x 10-8 Joules m^{-2} s^{-1} K^{-4}) (Bugbee et al. 1999).

The apparent target temperature also includes an effect due to the casing temperature of the instrument or the Sensor Body (SB) temperature. A formula is provided by the instrument manufacturers to make this correction (Bugbee et al. 1999).

The basic equation to estimate target temperature for a given SB is:

Corrected Target Temperature = Apparent Target Temperature - Sensor Error Correction

and

Sensor Error Correction = (0.25/P)*[(Apparent Target Temperature - H)^2 - K]

where P, H, and K are related to the sensor body temperature T_{sb} as:

$P = 26.168 + 2.8291 * T_{sb} - 0.03329 * T_{sb}^2$	$r^2 = 0.708$
$H = 5.8075 - 0.08016 * T_{sb} + 0.00849 * T_{sb}^2$	$r^2 = 0.674$
$K = -85.943 + 11.740 * T_{sb} + 0.08477 * T_{sb}^2$	$r^2 = 0.893$

2.2.2 Volumetric Soil Moisture, Soil Temperature, and Soil Salinity

The HP soil moisture probe determines soil moisture and salinity by making a high frequency (50 MHz) complex dielectric constant measurement, which simultaneously resolves the capacitive and conductive parts of a soil's electrical response. The capacitive part of the response is most indicative of soil moisture, while the conductive part reflects mostly soil salinity. Temperature is determined from a calibrated thermistor incorporated into the probe head.

The measured raw electrical parameters determined by the HP are the real and imaginary dielectric constants. These two parameters serve to fully characterize the electrical response of the soil at the frequency of operation, 50 MHz. These are both dimensionless quantities. Because both the real and imaginary dielectric constants will vary somewhat with temperature, a temperature correction using the measured soil temperature is applied to produce temperature corrected values for the real and imaginary dielectric constant. The temperature correction amounts to calculating what the dielectric constants should be at 25°C.

As a soil is wetted, the low dielectric constant component, air, is replaced by water with its much higher dielectric constant. Thus as a soil is wetted, the capacitive response, which depends upon the real dielectric constant, increases steadily. Through the use of appropriate calibration curves, the dielectric constant measurement can be directly related to soil moisture. The dielectric constant of moist soil has a small, but significant, dependence on soil temperature. The soil temperature measurement that the HP makes can be used to remove most of the temperature effects.

The output data from an HP consists of a time stamp and four voltages (V1-V4), which are converted to estimate the soil moisture and soil temperature through a program provided by Stevens, the HP manufacturer. Refer to the Stevens Web site for the hydra.exe or the hyd-file.exe program. The program requires the four voltages and a soil classification (sand=1, silt=2, and clay=3). Table 3 lists the soil type used for each station in the Stevens program.

Table 3 Station Soil Classification

Station ID	Calculation Soil Type
111	Silt
133	Sand
134	Sand
136	Silt
144	Sand
146	Silt

Station ID	Calculation Soil Type
149	Silt
154	Silt
159	Sand
162	Sand
Berg	Silt
NOAA	Silt

2.2.3 Error Sources

Corrupted HP voltages resulted from factors such as faulty installation, lightening strikes, and rodent impact. Erroneous samples were removed, therefore, the data are not continuous for every Hydra Probe.

2.3 Sensor or Instrument Description

Surface temperature was measured using an Apogee infrared thermometer. The instrument has a wavelength range of 6.5 to 14 micrometers and an accuracy of ± 0.4°C for targets at 5°C to 45°C and ± 0.1°C when the sensor body and target are at the same temperature. An infrared thermometer (IRT) is used because they are filtered to allow only a specific waveband, about 8 to 14 microns, to be transmitted to the IRT detector. Visit the Apogee Instruments Inc. Web site for more information.

Soil moisture and soil temperature were measured using Vitel Type A Hydra Probes (HP), shown in Figure 2. This version is compatible with Campbell CR-10 data loggers; the temperature output voltage never exceeds 2.5 V. Visit the Stevens Web site for more information.

Figure 2. Vitel Hydra Probe

3 REFERENCES AND RELATED PUBLICATIONS

Bugbee, Bruce, M. Droter, O. Monje, and B. Tanner. 1999. Evaluation and Modification of Commercial Infra-red Transducers for Leaf Temperature Measurement. Advances In Space Research 22:1425-1434.

Please see the USDA SMEX03 Web site for in depth information on the science mission and goal of the SMEX project.

3.1 Related Data Collections

AMSR-E/Aqua Data at NSIDC: AMSR-E standard data products available at NSIDC.

4 CONTACTS AND ACKNOWLEDGMENTS

Thomas Jackson
Hydrology and Remote Sensing Laboratory
US Department of Agriculture (USDA) - Agricultural Research Service (ARS)
Beltsville, MD 20705
USA

Michael Cosh
Hydrology and Remote Sensing Laboratory
US Department of Agriculture (USDA) - Agricultural Research Service (ARS)

Beltsville, MD 20705

USA

Patrick Starks

Grazinglands Research Lab

US Department of Agriculture (USDA) - Agricultural Research Service (ARS)

Beltsville, MD 20705

USA

Gary Heathman

Grazinglands Research Lab

US Department of Agriculture (USDA) - Agricultural Research Service (ARS)

Beltsville, MD 20705

USA

Acknowledgments:

The investigators would like to acknowledge the USDA ARS Grazinglands Research Laboratory and the many graduate students and volunteers who collected the field data.

5 DOCUMENT INFORMATION

5.1 Publication Date

October 2007

5.2 Date Last Updated

22 March 2021