SMEX03 Regional Ground 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:

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National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

1.1 Format

The data are in tab-delimited ASCII text files. The column headings and the information in each column are described in the following tables.

The raw soil moisture data files, `ON_GVSM_Raw.txt` and `OS_GVSM_Raw.txt`, contain the following information (`ON_GVSM_Raw.txt` does not contain a stop time column).

Column Heading	Description
Date	Month/day/year
Site ID	Site location identifier number
Start_Time (CDT)	Start time of sampling in Central Daylight Time (CDT)
Stop_Time (CDT)	Stop time (CDT); stop time is not included in ON_GVSM_Raw.txt; most sampling was 5-10 minutes in duration
Latitude WGS84	Latitude of sample site in decimal degrees, World Geodetic System 1984 (WGS84)
Longitude WGS84	Longitude of sample site in decimal degrees, WGS84
UTM_Easting WGS84	Easting of sample site in meters, WGS84, Zone 14
UTM_Northing WGS84	Northing of sample site in meters, WGS84, Zone 14
TP-mV A	Impedance probe (ThetaProbe) millivolt reading in V, position A
TP-mV B	ThetaProbe millivolt reading in V, position B
TP-mV C	ThetaProbe millivolt reading in V, position C
TP-VSM_gc A	ThetaProbe volumetric soil moisture (VSM) in m^3/m^3 from general calibration, position A
TP-VSM_gc B	ThetaProbe VSM in m^3/m^3 from general calibration, position B
TP-VSM_gc C	ThetaProbe VSM in m^3/m^3 from general calibration, position C
TP-VSM_scc A	ThetaProbe VSM in m^3/m^3 from site-specific calibration, position A
TP-VSM_scc B	ThetaProbe VSM in m^3/m^3 from site-specific calibration, position B
TP-VSM_scc C	ThetaProbe VSM in m^3/m^3 from site-specific calibration, position C
Can_ID 0-3 cm	Soil can identifier for 0-3 cm sample
Can_Wgt 0-3 cm	Soil can weight in grams for 0-3 cm sample
Wet_Wgt 0-3 cm	Wet weight in grams of soil for 0-3 cm sample
Dry_Wgt 0-3 cm	Dry weight in grams of soil for 0-3 cm sample
GSM 0-3 cm	Gravimetric soil moisture in g/g for 0-3 cm sample
Bulk_Density 0-3 cm	Bulk density in g/cm^3 for 0-3 cm sample

Column Heading	Description
VSM 0-3 cm	Volumetric soil moisture (VSM) in m^3/m^3 for 0-3 cm sample
Can_ID 3-6 cm	Soil can identifier for 3-6 cm sample
Can_Wgt 3-6 cm	Soil can weight in grams for 3-6 cm sample
Wet_Wgt 3-6 cm	Wet weight of soil in grams for 3-6 cm sample
Dry_Wgt 3-6 cm	Dry weight of soil in grams for 3-6 cm sample
GSM 3-6 cm	Gravimetric soil moisture in g/g for 3-6 cm sample
Bulk_Density 3-6 cm	Bulk density in g/cm^3 for 3-6 cm sample
VSM 3-6 cm	VSM in m^3/m^3 for 3-6 cm sample
Total VSM 0-6 cm	Total VSM in m^3/m^3 for 0-6 cm
Scoop?	Was a scoop tool used for this sample? If so, an average bulk density was used for the calculation of VSM.

The summary soil moisture data files, `ON_GVSM_Sum.txt` and `OS_GVSM_Sum.txt`, contain the following information (ON_GVSM_Sum.txt does not contain a stop time column).

Column Heading	Description
Date	Month/day/year
Site ID	Site location identifier number
Start Time (CDT)	Start time of sampling in Central Daylight Time (CDT)
Stop_Time (CDT)	Stop time (CDT); stop time is not included in ON_GVSM_Sum.txt; most sampling was 5-10 minutes in duration
Latitude WGS84	Latitude of sample site in decimal degrees, World Geodetic System 1984 (WGS84)
Longitude WGS84	Longitude of sample site in decimal degrees, WGS84
UTM_Easting WGS84	Easting of sample site in meters, WGS84, Zone 14
UTM_Northing WGS84	Northing of sample site in meters, WGS84, Zone 14
TP-mV average	Average impedance probe (ThetaProbe) millivolt reading in V
TP-mV stdev	Standard deviation of ThetaProbe millivolt reading in V
TP-VSM_gc average	Average ThetaProbe volumetric soil moisture (VSM) in m^3/m^3 from general calibration
TP-VSM_gc stdev	Standard deviation of ThetaProbe VSM in m^3/m^3 from general calibration
TP-VSM_ssc average	Average ThetaProbe VSM in m^3/m^3 from site-specific calibration
TP-VSM_scc stdev	Standard deviation of ThetaProbe VSM in m^3/m^3 from site-specific calibration

The raw temperature data files `ON_Temp_Raw.txt` and `OS_Temp_Raw.txt` contain the following information (some column headings may differ slightly between the two files).

Column Heading	Description
Date	Month/day/year
Site ID	Site location identifier number
Start Time CDT	Start time of sampling in Central Daylight Time (CDT); ON_Temp_Sum.txt has "Local Time CDT"
Stop Time CDT	Stop time of sampling in CDT; stop time is not included in ON_Temp_Sum.txt; most sampling was 5-10 minutes in duration
Latitude WGS84	Latitude of sample site in decimal degrees, World Geodetic System 1984 (WGS84)
Longitude WGS84	Longitude of sample site in decimal degrees, WGS84
UTM_Easting WGS84	Easting of sample site in meters, WGS84, Zone 14
UTM_Northing WGS84	Northing of sample site in meters, WGS84, Zone 14
Apogee IRT	Infrared thermometer reading in degrees Celsius
Temp 1 cm	Soil temperature probe reading in degrees Celsius at 1 cm
Temp 5 cm	Soil temperature probe reading in degrees Celsius at 5 cm
Temp 10 cm	Soil temperature probe reading in degrees Celsius at 10 cm

1.2 File Naming Convention

Files are named `0d_param_type.txt`, where

d	=	either N for Northern or S for Southern
param	=	either GVSM for soil moisture data or Temp for temperature data
type	=	either Raw for raw data or Sum for summary data

1.3 Spatial Coverage

Southernmost Latitude: 34.49º N

Northernmost Latitude: 36.80º N

Westernmost Longitude: 98.29º W

Easternmost Longitude: 97.97º W

1.4 Temporal Coverage

Data were collected from 2 July 2003 to 17 July 2003.

1.4.1 Temporal Resolution

All data were collected daily at multiple sites. The sampling was typically conducted between 11:30 A.M. and 3:00 P.M. local time.

1.5 Parameter or Variable

1.5.1 Parameter Description

Parameters in this data set are: gravimetric soil moisture (GSM), volumetric soil moisture (VSM), bulk density (BD), and surface and soil temperature. The following table describes the units of measurement and sources of each parameter.

Parameter	Units of Measurement	Source/Sensor(s)
Gravimetric soil moisture	Grams of water per grams of dry soil (g/g)	Manual soil collection
Volumetric soil moisture	Cubic meters of water per cubic meters of dry soil (m^3/m^3)	Manual soil collection and impedance probes (ThetaProbes)
Bulk density	Grams per cubic centimeter (g/cm^3)	Manual soil collection
Surface and soil temperature	Degrees Celsius	Infrared thermometers, temperature probes

1.5.2 Sample Data Record

The following sample from ON_GVSM_Sum.txt illustrates the data. The first four data rows are shown; only the first four columns and last four columns of each row are shown (the column headings in the sample indicate the included columns).

Date	Site ID	Start Time	Latitude	...	TP-VSM_gc	TP-VSM_gc	TP-VSM_ssc	TP-VSM_ssc
		CDT	WGS84	...	average	stdev	average	stdev
7/2/2003	ON01	14:01	36.8036	...	0.148	0.012	0.113	0.01
7/3/2003	ON01	11:01	36.8036	...	0.106	0.013	0.074	0.012

Date	Site ID	Start Time	Latitude	...	TP-VSM_gc	TP-VSM_gc	TP-VSM_ssc	TP-VSM_ssc
7/4/2003	ON01	11:20	36.8036	...	0.076	0.005	0.045	0.004
7/5/2003	ON01	11:20	36.8036	...	0.069	0.019	0.039	0.018

1.6 Error Sources

1.6.1 Impedance Probes

Impedance probes (ThetaProbes) were used for volumetric soil moisture sampling. For various reasons, including extremely dry conditions, severe weather restrictions, miscommunication among personnel, and cultivation, some sites were not sampled on particular days. Occasionally, a ThetaProbe rod was broken because of very hard and dry soil conditions. When possible, the broken rod was replaced. When it was not possible to replace the rod, a new instrument was used.

1.6.2 Bulk Density

The coring tool used extracts a known volume of soil that was used to compute a bulk density. There is potential for compaction with this tool, resulting in higher bulk densities when compared to other methods. Occasionally, a scoop tool was used to retrieve a soil sample when soil was excessively dry. This scoop tool does not allow for a bulk density estimate; therefore, the average bulk density from all coring tool samples was used for computation of volumetric soil moisture for scoop samples. Also, the bulk density of the 0-3 cm sample was considered less reliable than the 3-6 cm sample; therefore, the 3-6 cm bulk density was used for all calculations.

2 DATA ACQUISITION AND PROCESSING

2.1 Theory of Measurements

This Oklahoma regional soil moisture site is within a single AMSR-E/Aqua passive microwave footprint (approximately 50 km), and measurements were taken around the time of the Aqua satellite overpass (approximately 13:30 local time). The goal of soil moisture sampling in these regional sites is to provide a reliable estimate of volumetric soil moisture and variance within the AMSR-E footprint.

2.1.1 Sampling

Sampling was performed on sites approximately a quarter section (0.8 km by 0.8 km) in size. In Oklahoma South (OS), a grid of 51 individual sites was sampled, covering approximately 50 km by 100 km (4 by 13 sites; site # 15 was not sampled). In Oklahoma North (ON), a grid of 36 individual sites was sampled, covering approximately 50 km by 75 km (3 by 12 sites). One location in each of the sites was sampled. The sampling was conducted between 11:30 and 15:00 local time.

Volunteers used a coring tool to extract a single soil moisture sample of the 0-3 cm and 3-6 cm soil layers. The coring tool extracts a known volume of soil which is used to compute a bulk density. Occasionally, a scoop tool was used to retrieve a soil sample when soil was excessively dry.

For volumetric soil moisture sampling, the primary measurement was the 0-6 cm dielectric constant at a single location in each site using impedance probes (ThetaProbes). The dielectric constant was converted to volumetric soil moisture using a calibration equation.

2.1.2 Computing Bulk Density and Soil Moisture

In the laboratory, samples were weighed, dried, and then weighed again. Gravimetric soil moisture (GSM) was computed as:

GSM = (wet weight - dry weight) / dry weight

The bulk density (BD) was determined by dividing the dry soil mass by the volume of the sample (3 cm) cylinder.

Volumetric soil moisture (VSM) was computed as:

VSM = GSM * BD

Note: For the 0-3 cm samples, the 3-6 cm bulk density was used due to the unreliability of the 0-3 cm samples. For samples collected with the scoop tool, the average bulk density from all coring tool samples was used for computation of volumetric soil moisture.

2.2 Sensor or Instrument Description

The surface temperature was sampled using handheld infrared thermometers, which are OMEGA OS643-LS Infrared Pyrometers. The instrument has an emissivity of 0.95, accuracy of ± 3%, and temperature range of 0 to 260°C (32 to 500°F). Refer to OMEGA Engineering for more information. Soil temperature was obtained using a temperature probe inserted to depths of 1 cm, 5 cm, and 10

cm. Several different temperature probes were used, but all have a metal rod, plastic top, and digital readout.

Figure 1. OS643-LS
Infrared Pyrometer

Figure 2. Temperature Probe

2.2.1 Impedance Probes (ThetaProbes)

Investigators used impedance probes to measure surface volumetric soil moisture. The probes were Type ML2 ThetaProbe manually-operated impedance instruments manufactured by Delta-T Devices, Ltd. The ThetaProbes have four separate 6 cm stainless steel rods that were inserted vertically into the soil. Each instrument was connected to a handheld reader that delivers the electrical pulse, detects the return signal, and converts the period to voltage between 0 and about 1 V.

ML2 ThetaProbe

The software provided by the probe manufacturer calibrates the theta probes by calculating an estimate of volumetric soil moisture according to the following equation:

$$\text{Theta} = \frac{1.07 + 6.4V - 6.4V^2 + 4.7V^3 - a_0}{a_1}$$

where a0 and a1 are 1.6 and 8.4, respectively. These estimates are provided in the data file.

Researchers also performed site-specific calibration for each field of sampling. Probe voltage readings from a row sampling point were compared to the volumetric soil moisture measured at the same point. A regression relationship was developed and new volumetric soil moisture values were estimated.

For several sites (GA01, GA08, GA09, GA24), recalibration of the probes was inappropriate because of the small dynamic range of the moisture values. For these sites, the general calibration coefficients were used for the site-specific calibration.

3 REFERENCES AND RELATED PUBLICATIONS

Cosh, M. H., T. J. Jackson, R. Bindlish, J. S. Famiglietti, and D. Ryu, A comparison of soil moisture impedance probe calibration techniques, submitted to *Soil and Tillage Research*, 2003.

3.1 Related Data Collections

- AMSR-E Validation Data Sets

4 CONTACTS AND ACKNOWLEDGMENTS

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5 DOCUMENT INFORMATION

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