

**Notice to Data Users:**  
**The documentation for this data set was provided solely by the Principal Investigator(s) and was not further developed, thoroughly reviewed, or edited by NSIDC. Thus, support for this data set may be limited.**

## SMEX05 Watershed Soil Moisture Data: Iowa

### Summary

This data set combines data for several parameters measured in the Walnut Creek watershed located in Iowa, USA for the Soil Moisture Experiment 2005 (SMEX05). The parameters include gravimetric and volumetric soil moisture, bulk density, and surface and soil temperature. The data were collected from 15 June 2005 through 03 July 2005 using in situ manual sampling, pyrometers, temperature probes, and theta probes. The total volume of this data set is approximately 1 MB. Data are provided in ASCII text files and are available via FTP.

The Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) is a mission instrument launched aboard NASA's Aqua satellite on 04 May 2002. AMSR-E validation studies linked to SMEX are designed to evaluate the accuracy of AMSR-E soil moisture data. Specific validation objectives include: assessing and refining soil moisture algorithm performance; verifying soil moisture estimation accuracy; investigating the effects of vegetation, surface temperature, topography, and soil texture on soil moisture accuracy; and determining the regions that are useful for AMSR-E soil moisture measurements.

### Citing These Data:

Cosh, Michael H. and Thomas J. Jackson. 2009. *SMEX05 Watershed Soil Moisture Data: Iowa*. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.

### Overview Table

Category	Description
<u>Data format</u>	ASCII tab-delimited text
<u>Spatial coverage</u>	41.93° to 42.01° N, 93.58° W to 93.93° W
<u>Temporal coverage</u>	15 June 2005 to 03 July 2005
<u>File naming</u>	WC_GVSM_RAW.txt WC_GVSM_SUM.txt

<u>convention</u>	
<u>File size</u>	59 to 914 KB
<u>Parameter(s)</u>	gravimetric soil moisture, bulk density, volumetric soil moisture, surface temperature and soil temperature
<u>Procedures for obtaining data</u>	Data are available via FTP.

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## 1. Contacts and Acknowledgments:

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### Acknowledgements:

Many graduate students and volunteers worked to collect the field data. We would like to thank the Soil Moisture Experiment 2005 Science Team and the National Soil Tilth Laboratory for their assistance. We would also like to thank the Naval Research

Laboratory and National Aeronautics and Space Administration for their generous contributions to the study. This work was supported by the Naval Research Laboratory, NASA Aqua AMSR, Terrestrial Hydrology and Global Water Cycle Programs.

## 2. Detailed Data Description:

### Format:

ASCII tab-delimited text files.

### File Naming Convention:

All file names contain the letters WC to designate the Walnut Creek watershed site. Raw data files in each directory contain the word RAW and summary data files contain the word SUM as described in Table 1.

WC\_GVSM\_RAW.txt  
WC\_GVSM\_SUM.txt

**Table 1.** Description of File Name Variables

<b>Variable</b>	<b>Description</b>
WC	designates the Walnut Creek watershed site
GVSM	soil moisture file
RAW	raw data file
SUM	summary data file

### File Size:

File sizes range from 59 KB to 914 KB.

### Spatial Coverage:

Southernmost Latitude: 41.9277° N  
Northernmost Latitude: 42.0077° N  
Westernmost Longitude: 93.9289° W  
Easternmost Longitude: 93.5819° W

### Temporal Coverage:

15 June 2005 to 03 July 2005

### Temporal Resolution:

Gravimetric, soil, and surface temperature data were collected daily.

## Parameter or Variable:

### Parameter Description:

Parameters in this data set include gravimetric and volumetric soil moisture, bulk density, and soil and surface temperature. The following table describes the units of measurement and sources of each parameter.

Parameter	Unit of Measurement	Method/Sensor
Gravimetric soil moisture	grams of water per grams of dry soil*100%	manual soil collection
Volumetric soil moisture	grams of water per grams of dry soil*100%	manual soil collection, and electronic sample (Theta Probe)
Bulk density	grams per cubic centimeter (g/cm <sup>3</sup> )	manual soil collection
Surface and soil temperature	degrees Celsius	OS643-LS Infrared Pyrometers And Temperature Probes
Soil Moisture	Water Fraction Volume (m <sup>3</sup> /m <sup>3</sup> )*100%	Theta Probes

### Parameter Range:

The following tables detail the column headings for each data file in the categories of gravimetric sampling, bulk density, soil temperature, and theta probe data.

### Gravimetric Sampling

"WC\_GVSM\_RAW.txt" – Gravimetric Sampling Raw Data Columns

Column Heading	Description
Date	month/day/year
Field	Watershed field identification number
Sample	Number of the site within the field
Lat	WGS84 Latitude in decimal degrees
Lon	WGS84 Longitude in decimal degrees
Easting	WGS84 Universal Transverse Mercator (UTM) Easting in meters, Zone 15
Northing	WGS84 Universal Transverse Mercator (UTM) Northing in

	meters, Zone 15
Time	Start Time of sampling in Central Daylight Time
Dew	Presence of Leaf Wetness Estimation 0- No Dew Present 1- Some Wetness 2- Leaves are Saturated with Wetness
IRT_SG	Infrared Thermometer Reading, Shadowed Ground
IRT_EG	Infrared Thermometer Reading, Sun-Exposed Ground
IRT_SV	Infrared Thermometer Reading, Shadowed Vegetation
IRT_EV	Infrared Thermometer Reading, Sun_Exposed Vegetation
Temp_1cm	Soil Temperature at 1 cm depth
Temp_5cm	Soil Temperature at 5 cm depth
Temp_10cm	Soil Temperature at 10 cm depth
mv_A	Theta Probe millivolt reading in V, position A
mv_B	Theta Probe millivolt reading in V, position B
mv_C	Theta Probe millivolt reading in V, position C
VSM_A_gc	Theta Probe VSM from general calibration in $m^3/m^3$ , position A
VSM_B_gc	Theta Probe VSM from general calibration in $m^3/m^3$ , position B
VSM_C_gc	Theta Probe VSM from general calibration in $m^3/m^3$ , position C
VSM_A_FSC	Theta Probe VSM from site specific calibration in $m^3/m^3$ , position A
VSM_B_FSC	Theta Probe VSM from site specific calibration in $m^3/m^3$ , position B
VSM_C_FSC	Theta Probe VSM from site specific calibration in $m^3/m^3$ , position C
Can_ID_0-1cm	Can identification number for 0-1 cm measure
Can_Wgt_0-1cm	Weight of Can for 0-1 cm measure
Wet_Wgt_0-1cm	Wet weight (g) for 0-1 cm measure
Dry_Wgt_0-1cm	Dry weight (g) for 0-1 cm measure
Can_ID_0-6cm	Can identification number for 0-6 cm measure
Can_Wgt_0-6cm	Weight of Can for 0-6 cm measure
Wet_Wgt_0-6cm	Wet weight (g) for 0-6 cm measure
Dry_Wgt_0-6cm	Dry weight (g) for 0-6 cm measure
GSM_0-1cm	Gravimetric soil moisture in grams of water per grams of dry soil, for 0-1 cm
BD	Bulk Density in $g/cm^3$
VSM_0-1cm	Gravimetrically-based Volumetric Soil Moisture in $m^3/m^3$ for 0-1

	cm
GSM_0-6cm	Gravimetric soil moisture in grams of water per grams of dry soil, for 0-6 cm
VSM_0-6cm	Gravimetrically-based Volumetric Soil Moisture in $m^3/m^3$ for 0-6 cm

"WC\_GVSM\_Sum.txt" - Gravimetric Soil Moisture Summary Data Columns

Date	Month/day/year
Field	Site location identification number
lat	Latitude, Decimal Degree, WGS84
lon	Longitude, Decimal Degree, WGS84
easting	WGS84, UTM Zone 14, in meters
northing	WGS84, UTM Zone 14, in meters
Time	Local Sampling Time Average per field, Central Daylight-Savings Time
Dew	Average of field observations 0 - No Dew Present 1 - Some Wetness 2 - Leaves are Saturated with Wetness
IRT_SG	Average Infrared Thermometer Reading, Shadowed Ground
IRT_EG	Average Infrared Thermometer Reading, Sun-Exposed Ground
IRT_SV	Average Infrared Thermometer Reading, Shadowed Vegetation
IRT_EV	Average Infrared Thermometer Reading, Sun_Exposed Vegetation
Temp_1cm	Average Soil Temperature at 1 cm depth
Temp_5cm	Average Soil Temperature at 5 cm depth
Temp_10cm	Average Soil Temperature at 10 cm depth
Avg_mv	Theta Probe millivolt reading in V, position A
std_mv	Theta Probe millivolt reading in V, position B
avg_gc	Theta Probe VSM from general calibration in $m^3/m^3$ , position A
std_gc	Theta Probe VSM from general calibration in $m^3/m^3$ , position B
avg_fsc	Theta Probe VSM from site specific calibration in $m^3/m^3$ , position B
std_fsc	Theta Probe VSM from site specific calibration in $m^3/m^3$ , position C

Missing data are represented by " ".

**Error Sources:**

## **Theta Probe**

For various reasons, including severe weather restrictions and cultivation, some sites were not sampled on particular days.

## **Geolocation**

Some sampling point locations are listed as located at the centroid of the field because either the standard GPS handheld device would not work through the forest canopy, or there was some error in recording the locations (WC39 for example). Most field locations have an error of 15 meters.

## **3. Data Access and Tools:**

### **Data Access:**

Data are available via FTP at:  
[ftp://sidads.colorado.edu/pub/DATASETS/AVDM/data/soil\\_moisture/SMEX05/ground\\_soil\\_moisture/watershed\\_GSM/](ftp://sidads.colorado.edu/pub/DATASETS/AVDM/data/soil_moisture/SMEX05/ground_soil_moisture/watershed_GSM/)

### **Software and Tools:**

No special tools are required to view these data. A spreadsheet program which recognizes tab-delimited text files is recommended. Word-processing programs and Web browsers will display the data.

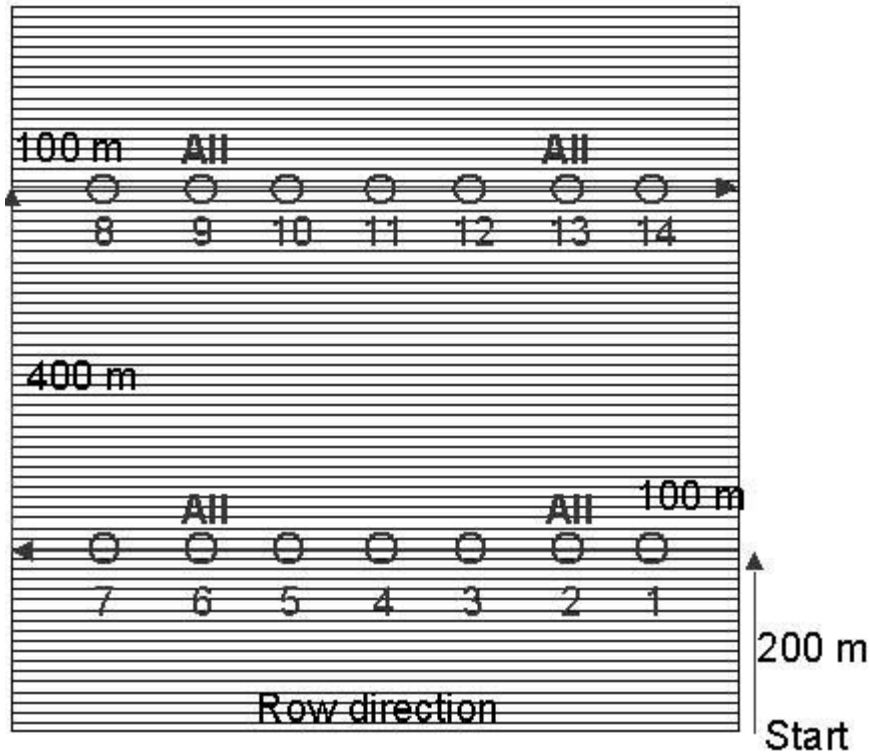
## **4. Data Acquisition and Processing:**

### **Theory of Measurements:**

#### **Section Sampling**

Sampling was performed on sites approximately one quarter section (0.8 km by 0.8 km) in size. As shown in the following figure, 14 points were sampled in a field for a variety of variables, including gravimetric soil moisture, soil temperature, and theta probe measurements.

The sampling site numbers are included in the gravimetric raw data file (WC\_GVSM\_Raw.txt).



WC section sampling layout

## Gravimetric Sampling

Gravimetric samples were taken with scoop tools at sites marked 'All' resulting in 4 samples per field.

## Computing Volumetric Soil Moisture and Bulk Density

Samplers used the following steps to compute volumetric soil moisture and bulk density:

- Compute the gravimetric soil moisture (GSM) and dry mass
- Divide the dry mass of the soil by the volume of the cylinder (1 or 5 cm) to obtain the bulk density (BD)

Compute volumetric soil moisture (VSM):

$$\text{VSM} = \text{GSM} * \text{BD}$$

Note: for the 0-1 cm samples, the 0-6 cm BD was used due to the potential unreliability of the 0-1 cm samples.

## Sensor or Instrument Description:

### Gravimetric

Gravimetric samples were collected manually. In the laboratory they were weighed, dried, and then weighed again.

## Soil Moisture

Gravimetric samples of soil moisture were collected manually via a small scoop tool. In the laboratory they were weighed, dried, and then weighed again.

## Theta Probes

Investigators used theta probes to measure surface volumetric soil moisture. The probes were Type ML2 manually-operated impedance instruments manufactured by Delta-T Devices, Ltd. The theta probes have 4 separate 6-cm stainless steel rods inserted vertically into the soil. Each instrument was connected to a handheld reader, which delivers the electrical pulse, detects the return signal, and converts the period to voltage between 0 V and about 1 V. Watershed surface soil moisture was sampled each morning (between 9:00 a.m. - 12:00 p.m.) during the experiment.

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

$$\text{Theta} = (1.07 + 6.4 * V - 6.4 * V^2 + 4.7 * V^3 - a_0) / a_1$$

where  $a_0$  and  $a_1$  are 1.6 and 8.4, respectively. These estimates are provided in the data files.

Researchers also performed site-specific calibration for each field of sampling. Theta 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.

Field averages were calculated by counting each row reading twice for a total of four data points per sampling site. Field average and standard deviations were calculated by computing the sampling site average, and then computing the average among the 14 field sampling sites. Finally, standard deviations were calculated.

## Processing Steps:

### Gravimetric Processing

Researchers weighed the wet soil obtained in the field, heated the soil in an oven to dry it, and then weighed the dry soil.

## 5. References and Related Publications:

Cosh, M. H., T. J. Jackson, R. Bindlish, J. S. Famiglietti, and D. Ryu. 2005. A Comparison of Soil Moisture Impedance Probe Calibration Techniques, *Journal of Hydrology*, 31(1-4), 49-58.

## **6. Document Information:**

### **List of Acronyms & Abbreviations**

The following acronyms and abbreviations are used in this document:

AMSR-E – Advanced Microwave Scanning Radiometer - Earth Observing System

ASCII – American Standard Code for Information Interchange

BD – Bulk Density

CIRES – Cooperative Institute for Research in Environmental Sciences

fsc – field specific calibration

FTP – File Transfer Protocol

gc – generalized calibration

GSM – Gravimetric Soil Moisture

GVSM – Gravimetrically-based Volumetric Based Soil Moisture

IRT – Infrared Thermometer

NASA – National Aeronautics and Space Administration

NSIDC - National Snow and Ice Data Center

SMEX05 – Soil Moisture Experiment 2005

SUM – Summary data file

TP – Theta Probe

USDA ARS – United States Department of Agriculture Agricultural Research Service

UTM - Universal Transverse Mercator

VSM – Volumetric Soil Moisture

WC – Walnut Creek

WGS84 – World Geodetic System 1984

### **Document Creation Date:**

21 December 2009