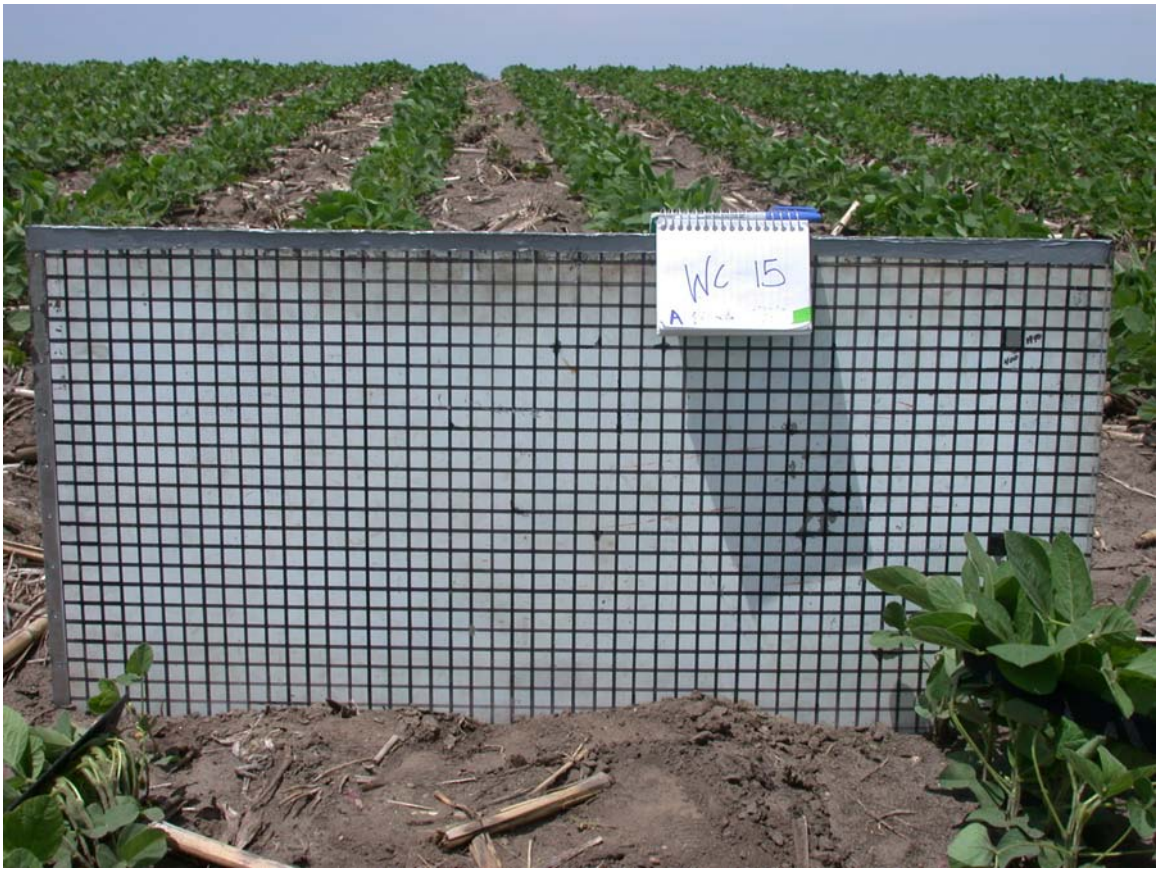
Notice to Data Users:
The documentation for this data set was provided solely by the Principal Investigator(s) and was not further developed, thoroughly reviewed, or edited by NSIDC. Thus, support for this data set may be limited.

SMEX05 Surface Roughness Data: Iowa



An example of a roughness picture taken in the Walnut Creek Experimental Watershed during SMEX05

Summary

This data set includes surface roughness parameters measured in the Walnut Creek watershed area of Iowa, USA for the Soil Moisture Experiment 2005 (SMEX05). Soil surface roughness photos were taken and roughness coefficients were calculated as part of the experiment site characterization protocol. Surface roughness, correlation length, and power coefficients are calculated for each location. The data were collected from 16 June 2005 through 05 July 2005. The total volume of this data set is 19 KB in one ASCII text file. The data 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:

Jackson, Thomas J., Lynn McKee, and Michael H. Cosh. 2009. *SMEX05 Surface Roughness Data: Iowa.* Boulder, Colorado USA: NASA DAAC at the National Snow and Ice Data Center.

Overview Table

Category	**Description**
Data format	ASCII tab-delimited text files
Spatial coverage	41.92º to 42.01º N, 93.58º to 93.92º W
Temporal coverage and resolution	16 June 2005 to 05 July 2005
File naming convention	SMEX05_SR.txt
File size	19 KB
Parameter(s)	root mean square error correlation length power coefficient.
Procedures for obtaining data	Data are available via FTP.

Table of Contents

1. Contacts and Acknowledgments
2. Detailed Data Description
3. Data Access and Tools
4. References and Related Publications
5. Document Information

1. Contacts and Acknowledgments:

Investigator(s) Name and Title:

Thomas J. Jackson, Hydrologist, USDA ARS Hydrology and Remote Sensing Laboratory, Beltsville, MD.
Lynn McKee, Soil Scientist, USDA ARS Hydrology and Remote Sensing Laboratory, Beltsville, MD.
Michael H. Cosh, Hydrologist, USDA ARS Hydrology and Remote Sensing Laboratory, Beltsville, MD.

Technical Contact:

NSIDC User Services
National Snow and Ice Data Center
CIRES, 449 UCB
University of Colorado
Boulder, CO 80309-0449
phone: (303)492-6199
fax: (303)492-2468
form: Contact NSIDC User Services
e-mail: nsidc@nsidc.org

Acknowledgements:

Many graduate students and volunteers worked to collect these field photographs. We would like to thank the Soil Moisture Experiment 2005 Science Team, the National Soil Tilth Laboratory, and Iowa State University for their assistance. Thanks to those who collected and analyzed the data, including Laura Kimes and Iain Wilson. We would also like to thank the National Aeronautics and Space Administration for their generous contributions to the study. This work was supported by the Naval Research Laboratory and the NASA Aqua AMSR-E, Terrestrial Hydrology and Global Water Cycle Programs.

2. Detailed Data Description:

Format:

ASCII tab-delimited text file.

File Naming Convention:

SMEX05_SR.txt

File Size:

The file is 19 KB.

Spatial Coverage:

Southernmost Latitude: 41.92º N
Northernmost Latitude: 42.01º N
Westernmost Longitude: 93.92º W
Easternmost Longitude: 93.58º W

Temporal Coverage:

Measurements were taken from 16 June 2005 through 05 July 2005.

Temporal Resolution:

Measurements were taken once per site.

Parameter Description:

The data file contains the following parameters arranged by column heading and description as shown in Table 1.

Table 1 – Data file parameters and descriptions

Column Heading	**Description**
NAME	Field Id and picture ID, 'wc' means Walnut Creek, ## means field, a-d is sample and ' means perpendicular to first sample.
Lat	Latitude in decimal degrees, WGS84
Long	Longitude in decimal degrees, WGS84
UTM_northing	WGS 84, UTM in meters, zone 15
UTM_Easting	WGS 84, UTM in meters, zone 15
np	Number of digitized points
sigma	Root mean square error (rms height)
L	Correlation length in mm
adj sigma	Root mean square error adjusted for slope
exponent	Power coefficient
Cover (c, sb, alf, for)	crop cover
Direction (n/s, e/w, n/a)	row direction

The Science

The soil roughness of the SMEX05 data set is described using three parameters: root mean square height (*rms* height or sigma), correlation length (L) and the correlation function $f(L)$. The root mean square height describes the random surface characteristics, while the correlation length and correlation function describe the periodicity of the soil surface. The correlation function is characterized by a power coefficient n ranging from '1' to '2', where '1' represents a Gaussian height distribution and '2' represents an exponential height distribution. The periodicity and random components of the soil surface roughness are schematically shown in figures 1a and 1b.

In terms of the mean surface height ($\bar{z}$) and the second moment ($\overline{z^2}$), the *rms* height is represented by:

$$rms = \left(\overline{z^2} - \bar{z}^2\right)^{1/2} \qquad \textbf{Equation 1}$$

where z is the surface height in cm.

figure 1a

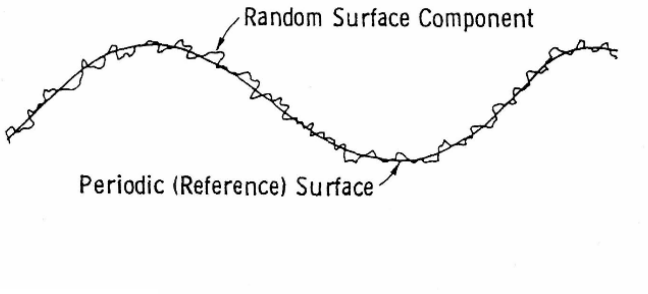


figure 1b

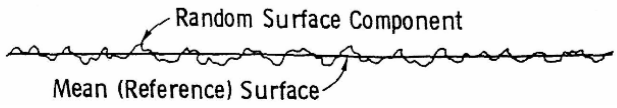


Figure 1a and b, visualization of the two surface roughness components (Dobson and Ulaby, 1998).

To determine the correlation length and the correlation function, the surface autocorrelation curve needs to be computed. The surface autocorrelation is a measure of the degree of correlation between the height $z(x)$ at point x and the height $z(x+d)$ at point x + d. The following equation can be used to calculate the autocorrelation curve:

$$\rho(d) = \frac{\int z(x)z(x+d)dx}{\int z^2(x)dx} \qquad \textbf{Equation 2}$$

Once the autocorrelation curve has been computed, the correlation length can be determined. The correlation length is defined as the distance (*d*) at which the autocorrelation is less than e^{-1} (≈ 0.3678). The computed correlation length can be used to fit the theoretical correlation function to the measured autocorrelation curve by optimizing the power coefficient (*n*). The correlation function is mathematically represented by:

$$\rho(d) = \exp\left(d/L\right)^n \qquad \textbf{Equation 3}$$

Where *L* is the correlation length (cm) and *n* is the power coefficient describing the correlation function, which is dimensionless.

Sampling Strategy

At each site four representative locations were selected for roughness sampling. At each sampling location, one roughness picture was taken along the row direction and one was taken in the cross-row direction. In the absence of row structure, the two pictures were taken at perpendicular angles. Thus, for each site 8 grid board pictures (4 locations, 2 pictures per location) should be available.

However, at some roughness sampling sites, one picture was taken and in other cases pictures were missing. Table 1 gives an overview of the number of pictures taken at each experimental site.

Table 2. Listing of the roughness pictures made during SMEX05 in Iowa.

Site Name	Date	Cross rows				Along rows			
	mm/dd/yy	Site A	Site B	Site C	Site D	Site A	Site B	Site C	Site D
wc01	6/28/2005	X	X	X	X	X	X	X	X
wc04	6/27/2005	X	X	X	X	X	X	X	X
wc05	6/28/2005	X	X	X	X	X	X	X	X
wc06	6/30/2005	X	X	X	X	X	X	X	X
wc10	6/20/2005	X	X	X	X	X	X	X	X
wc11	6/20/2005	X	X	X	X	X	X	X	X
wc12	6/16/2005	X	X	X	Not Digitized	X	X	Not Digitized	Not Digitized
wc13	6/30/2005	X	X	X	X	X	X	X	X

wc15	6/21/2005	X	X	X	X	X	X	X	X
wc18	6/21/2005	X	X	X	X	X	X	X	X
wc19	6/30/2005	X	X	X	X	X	X	X	X
wc21	6/19/2005	X	X	X	X	X	X	X	X
wc22	6/26/2005	X	X	X	X	X	X	X	X
wc33	6/19/2005	X	X	X	X	X	X	X	X
wc34	6/26/2005	Not Digitized	Not Digitized	Not Digitized	Not Digitized	Not Digitized	Not Digitized	Not Digitized	Not Digitized
wc35	7/1/2005	X	X	X	X	X	X	X	X
wc36	7/1/2005	X	X	X	X	X	X	X	X
wc38	7/2/2005	X	X	X	X	X	X	X	X
wc40	7/4/2005	X	X	X	X	X	X	X	X
wc42	6/23/2005	Missing	Missing	Missing	Missing	X	Missing	Missing	Missing
wc43	7/5/2005	X	X	X	X	X	X	X	X
wc45	7/2/2005	X	X	X	X	X	X	X	X
wc46	6/24/2005	Missing	Missing	Missing	Missing	X	Not Digitized	Missing	Missing
wc48	6/18/2005	X	X	X	X	X	X	X	X
wc49	6/18/2005	X	X	X	X	X	X	X	X
wc51	6/23/2005	Missing	Missing	Missing	Missing	Not Digitized	X	X	Missing
wc52	6/27/2005	X	X	X	X	X	X	X	X
wc53	7/3/2005	X	X	X	X	X	X	X	X
wc54	7/3/2005	X	X	X	X	X	X	X	X

Duplicate pictures were taken for several sites. However, for those sites only 8 total photographs were digitized and used for deriving the roughness parameters. Photographic difficulties in forested sites limited the number of usable photographs that were digitized (locations WC42, WC46, WC51). Furthermore, sites with consistent, non-row vegetative cover were not digitized (location WC34).

Digitizing the Pictures

The commercial program Didger 3 was used to digitize the roughness pictures. Before scanning, the dimensions of the board were identified in Didger 3 using reference points on the board. The soil surface was digitized by taking a height measurement at every 1/2 cm (grid scanning). This scanning method provides a random (or normal) distribution of the surface height, which is required for a correct computation of the *rms* height. However, with this method of scanning some variation in the surface height is neglected, which could influence the computation of the correlation length.

Calculation of the Roughness Parameters

The roughness parameters were calculated by a simple spreadsheet program. Because of the variability in x increment of the digitized surface, the surface was re-sampled to the nearest 1 mm. The root mean square error was then calculated. Correlation length was

calculated as the length at which the autocorrelation function is equal to e^{-1}. The power coefficient was determined by visual comparison of the autocorrelation curves and idealized power curves with some guidance by the root mean square error between the curves.

Limitations of the Data Set

The roughness parameters are probably the most unreliable parameter in the process of soil moisture retrieval using microwave remote sensing. The first problem is that the scattering characteristics of natural surfaces are very complex and are still not completely understood. This makes validation of measured roughness parameters very difficult.

Second, the scale at which roughness is measured is not the same as the scale at which roughness affects microwave backscatter and emission. The typical resolution of microwave instruments is around or above 10 meters, while the grid board is only 1 meter long. The values of the *rms* height and the correlation length (L) differ at each scale.

3. Data Access and Tools:

Data Access:

Data are available via FTP at:
ftp://sidads.colorado.edu/pub/DATASETS/AVDM/data/soil_moisture/SMEX05/ancillary_data/surface_roughness/

Software and Tools:

No special tools are required to view these data. The data can be viewed using any Web browser or text editor.

4. References and Related Publications:

Dobson, M. C. and F. T. Ulaby. 1998. Mapping Soil Moisture Distribution with Imaging Radar, 407- 430. In: Henderson, F.M. and A. J. Lewis, 1998, *Principles & Application of Imaging Radar*, John Wiley & Sons, New York.

5. Document Information:

List of Acronyms

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
CIRES – Cooperative Institute for Research in Environmental Sciences
FTP – File Transfer Protocol.
NASA – National Aeronautics and Space Administration
NSIDC – National Snow and Ice Data Center
rms – root mean square
SMEX05 – Soil Moisture Experiment 2005
USDA ARS – United States Department of Agriculture Agricultural Research Service
UTM – Universal Transverse Mercatur
WC – Walnut Creek
WGS84 – World Geodetic System 1984

Document Creation Date:

23 December 2009