

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:

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Overview Table

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

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1. Contacts and Acknowledgments:

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

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

where z is the surface height in cm.

figure 1a

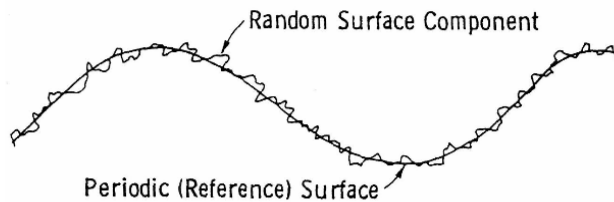


figure 1b

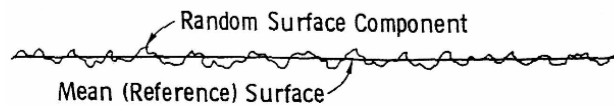


Figure 1a and b, visualization of the two surface roughness components
(Dobson and Ulaby, 1998).

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:

| | | | | | | | | | |
|------|-----------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 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 Digger 3 was used to digitize the roughness pictures. Before scanning, the dimensions of the board were identified in Digger 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

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