SMEX03 QuikSCAT/SeaWinds Backscatter Data: Alabama, Oklahoma, Brazil, Version 1

USER GUIDE

How to Cite These Data

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

Long, D. G. 2008. *SMEX03 QuikSCAT/SeaWinds Backscatter Data, Alabama, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/DROJ79M0DGES. [Date Accessed].

Long, D. G. 2013. *SMEX03 QuikSCAT/SeaWinds Backscatter Data, Oklahoma, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/1M7605BUVA9U. [Date Accessed].

Long, D. G. 2013. *SMEX03 QuikSCAT/SeaWinds Backscatter Data, Brazil, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/3G654A7LLQ16. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0333
or https://nsidc.org/data/NSIDC-0579 or https://nsidc.org/data/NSIDC-0580

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

This data set includes data collected over the Soil Moisture Experiment 2003 (SMEX03) areas of Alabama, Georgia, and Oklahoma, USA, and Brazil. The SeaWinds scatterometer on NASA's Quick Scatterometer (QuikSCAT) satellite collected backscatter data.

1.1 Format

Data are provided as daily SIR files and associated GIF images, 4-day average SIR files and associated GIF images, and animated time series quick look images.

Each SIR file consists of one 512-byte header containing all the information required to read the remainder of the file and the map projection information required to map pixels to latitude and longitude points on the Earth's surface. Pixel values are stored as 2-byte integers in big-endian format. Scale factors to convert the pixel values to native floating point units are stored in the file header.

The SIR file dimensions are 191 columns by 267 rows. SIR images are stored in row-scanned (left to right) order from the lower left corner up through the upper right corner. The origin of pixel 1,1 is the lower left corner of the image. The array index n of the i, j pixel where i is horizontal and j is vertical is given by using the following formula: `n=(j-1)*Nx+i` where Nx is the horizontal dimension of the image.

Image files are provided in GIF format for quick views. The grayscale for each GIF is -30 to 0 dB, black to white. Values less than -32 dB indicate no data. The text in the lower left of the image shows the year and day range of the data. The bright spots are urban areas.

1.2 File and Directory Structure

The top directory level contains subdirectories for each SMEX03 study region and the readme file. For example:

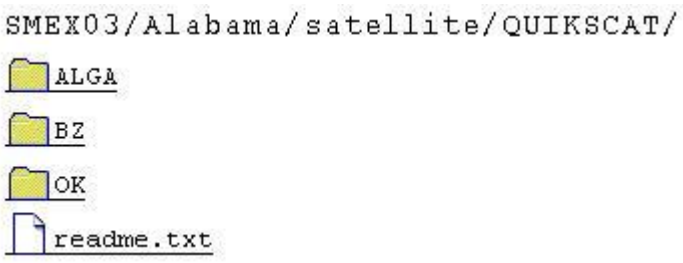

Figure 1. Top Level SMEX03 QuikSCAT Directory Structure.

The second level contains subdirectories for the 4-day average SIR and GIF image files, 4day_avg; the animated time series GIF files, animated_quicklooks; and the daily SIR and GIF files, daily, as shown in Figure 2.

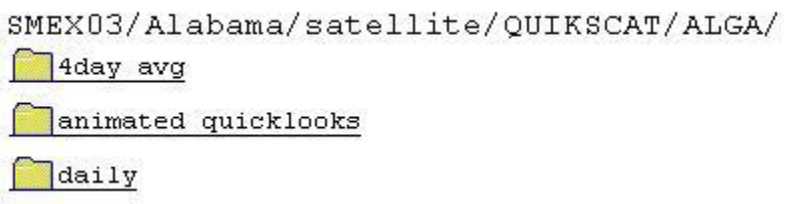

Figure 2. Second Level SMEX03 QuikSCAT Directory Structure.

1.3 File Naming Convention

Animated GIF files

The animated GIF files are named according to the following convention:

Example File Name: `queh.ALGA.gif`

`SENS.SREG.gif`

Where:

Table 1. Animated GIF File Naming Conventions

Variable	Description
SENS	Sensor and polarization name
SREG	SMEX03 study region
gif	Graphics Interchange Format file

Daily and 4-Day Average Files

The SIR and GIF files are named according to the following convention:

Example File Names: `queh-a-NAm03-121-124.sir.ALGA.gif and queh-a-NAm03-121-124.sir.ALGA.gz`

`SENS-T-REGYR-DY1-DY2.RCN.SREG.FT`

Where:

Table 2. SIR and GIF File Naming Conventions

Variable	Description	Values
SENS	Sensor and polarization name.	queh = QuikSCAT egg inner beam, h-pol quev = QuikSCAT egg outer beam, v-pol qush = QuikSCAT slice inner beam, h-pol qusv = QuikSCAT slice outer beam, v-pol qaeh = QuikSCAT ascending pass, egg inner beam, h-pol (Brazil daily files only) qaev = QuikSCAT ascending pass, egg outer beam, v-pol (Brazil daily files only) qash = QuikSCAT ascending pass, slice inner beam, h-pol (Brazil daily files only) qasv = QuikSCAT ascending pass, slice outer beam, v-pol (Brazil daily files only) qdeh = QuikSCAT descending pass, egg inner beam, h-pol (Brazil daily files only) qdev = QuikSCAT descending pass, egg outer beam, v-pol (Brazil daily files only) qdsh = QuikSCAT descending pass, slice inner beam, h-pol (Brazil daily files only) qdsv = QuikSCAT descending pass, slice outer beam, v-pol (Brazil daily files only)
T	Image type code.	a = An image
REG	Region ID code.	NAm = North America SAm = South America Ama = Amazon
YR-DY1-DY2	Date range where:	YR = year DY1 = First day of data used to make image (day of year)

Variable	Description	Values
		DY2 = Last day of data used in image (day of year). If the imaging time crosses the year boundary, DY2 < DY1
RCN	Reconstruction technique.	sir = SIR or SIRF algorithm
SREG	SMEX03 study region.	ALGA = Alabama / Georgia - extracted from the NAm region OK = Oklahoma - extracted from the NAm region BZ = Brazil - extracted from the SAm region
FT	File type.	gz = gzipped file gif = Graphics Interchange Format file

1.4 Spatial Coverage

Alabama / Georgia:

Southernmost Latitude: 28.0° N

Northernmost Latitude: 38.0° N

Westernmost Longitude: 90.0° W

Easternmost Longitude: 80.0° W

Oklahoma:

Southernmost Latitude: 30.0° N

Northernmost Latitude: 40.0° N

Westernmost Longitude: 103.0° W

Easternmost Longitude: 93.0° W

Brazil:

Southernmost Latitude: 17.0° S

Northernmost Latitude: 7.0° S

Westernmost Longitude: 50.0° W

Easternmost Longitude: 40.0° W

1.4.1 Spatial Resolution

The resolution of egg measurements is approximately 35 km x 25 km with a pixel resolution of approximately 4.45 km.

The resolution of slice measurements is approximately 25 km x 6 km with a pixel resolution of approximately 2.225 km.

Note: The effective pixel resolution is somewhat less than listed above.

1.4.2 Projection

Lambert Equal Area projection

The latitude and longitude values for the geolocation of a pixel correspond to the lower-left corner of the pixel.

Note: The box is not square in latitude and longitude. The latitude and longitude lines curve in the images

1.5 Temporal Coverage

Alabama / Georgia: 1 May 2003 to 31 August 2003

Oklahoma: 1 May 2003 to 31 August 2003

Brazil: 1 November 2003 to 31 December 2003

1.5.1 Temporal Resolution

Temporal resolutions are daily and 4-day average time spans.

1.6 Parameter or Variable

Radar Backscatter in units of dB.

1.6.1 Parameter Range

Backscatter values range from -30 to 0 dB. In the GIF images, this is represented by a grayscale from black to white. Values less than -32 dB indicate no data.

1.6.2 Sample Data Record

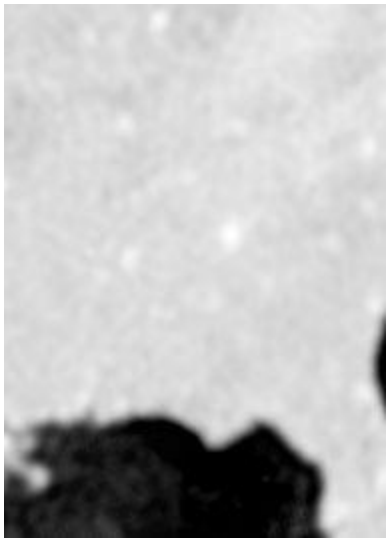

Figure 3. Backscatter Image of Alabama and Georgia. View of 4-Day Average SIR Image File queh-a-NAm03-121-124.sir.ALGA.

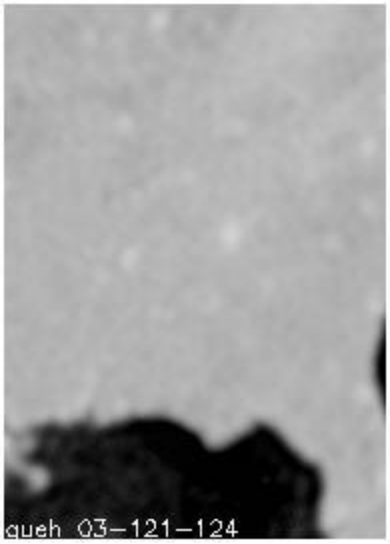

Figure 4. Backscatter Image of Alabama and Georgia. View of 4-Day Average GIF Image File queh-a-NAm03-121-124.sir.ALGA.gif.

2 SOFTWARE AND TOOLS

2.1 Software and Tools

Software for reading the BYU-MERS SIR file format can be downloaded from the NASA SCP Web site and FTP site and is available for C, Fortran, Matlab, and IDL/PV-Wave. Available utilities

include a modified xv program to directly view SIR files, and programs to convert SIR files into .gif, .bmp, .tiff, and geotiff file formats.

GIF images can be accessed with most standard image viewers.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

The NASA SCP datasets are based primarily on a time series of enhanced resolution images made from scatterometer backscatter (sigma0) measurements using the SIR and SIR with Filtering (SIRF) algorithms. For the highest possible spatial resolution, as well as to ensure full coverage over the images, multiple orbit passes are combined. Thus, there is a tradeoff between temporal and spatial resolution. For SeaWinds, sigma0 images are made at the nominal observation incidence angles (46 degrees h-pol and 54 degrees v-pol). From the time series of radar backscatter images and derived products, key climate-related parameters can be extracted for use in global climate change studies.

3.2 Data Acquisition Methods

QuikSCAT collects vertically polarized backscatter measurements at approximately 54 degrees incidence and horizontally polarized measurements at approximately 46 degrees in two forms: eggs and slices. There are thus four types of data:

- queh (egg-horizontal)
- quev (egg-vertical)
- qush (slice-horizontal)
- qusv (slice-vertical).

The egg measurements tend to be less noisy due to more averaging. Ideally slices and eggs have the same mean, but in practice there is some variation due to incidence angle effects. For SMEX03, backscatter images for each type have been created.

The SIR algorithm combines multiple passes to produce enhanced spatial resolution. For the SMEX03 data, both the ascending north-bound orbit passes and descending south-bound orbit passes are combined. Due to orbital geometry and swath width, some individual days do not completely cover the study area especially over areas near the equator. The orbit has a 4-day repeat, so the 4-day images ensure full coverage of the study area and tend to reduce noise.

From the large standard continental images, small regions were extracted such that the latitude and longitude bounds of the SMEX03 study regions are contained within the study boxes.

Because of the geometric issues at the equator noted above, the ascending and descending passes for the Brazil study area are roughly 12 hours apart. Brazil daily images are available in daily combined images and as separate ascending and descending images:

- qaeh (ascending-egg-horizontal)
- qaev (ascending-egg-vertical)
- qash (ascending-slice-horizontal)
- qasv (ascending-slice-vertical)
- qdeh (descending-egg-horizontal)
- qdev (descending-egg-vertical)
- qdsh (descending-slice-horizontal)
- qdsv (descending-slice-vertical).

This reduces the spatial coverage of the single-pass images, but improves temporal resolution.

3.3 Derivation Techniques and Algorithms

The BYU-MERS SIR image format was developed by the BYU-MERS research group to store images of the Earth along with the information required to easily geolocate the image pixels.

In general, SIR image data files are generated using the SIR resolution enhancement algorithm, or one of its variants for radiometer processing. The multivariate SIR algorithm is a non-linear resolution enhancement algorithm based on modified algebraic reconstruction and maximum entropy techniques (Long, Hardin, and Whiting 1993). The single variate SIR algorithm was developed originally for radiometers (Long and Daum 1997), but it was also used for SeaWinds (Early and Long 2001). The SIRF algorithm was successfully applied to study tropical vegetation and glacial ice (Long and Drinkwater 1999).

The multivariate form of the SIR algorithm models the dependence of sigma-0 on incidence angle as shown with the equation:

```
sigma-0 (in dB) = A + B *(Inc Ang - 40 degrees)
```

The relevant range of incidence angle is 15 to 60 degrees. The output of the multivariate SIR algorithm is images of the A and B coefficients. The single variable algorithms used for SeaWinds produce only an A image. A represents the incidence angle normalized sigma-0, effectively the sigma-0 value at 40 degrees incidence angle.

Single variable SIR and SIRF algorithms are used for SeaWinds egg data processing and slice data processing respectively.

3.4 Sensor or Instrument Description

SeaWinds is a radar scatterometer on QuikSCAT. It uses a rotating dish antenna with two spot beams that sweep in a circular pattern. The antenna spins at a rate of 18 rpm, scanning two pencil-beam footprint paths at incidence angles of 46 degrees (h-pol) and 54 degrees (v-pol). The antenna radiates microwave pulses at a frequency of 13.4 GHz across broad regions on the Earth's surface with an 1800 km swath.

The SeaWinds antenna footprint is an ellipse approximately 25 km in azimuth by 37 km in the look (range) direction. There is considerable overlap of these footprints with approximately 8 to 20 of these ellipses with centers in a 25 x 25 km box on the surface. Signal processing provides commandable variable range resolution of approximately 2 to 10 km. The nominal resolution is approximately 6 km — an effective range gate of 0.5 msec. Refer to the JPL SeaWinds on QuikSCAT Web page for more information.

QuikSCAT is in a sun-synchronous, 803 km, circular orbit with a local equator crossing time at the ascending node of 6:00 a.m. +/- 30 minutes.

4 REFERENCES AND RELATED PUBLICATIONS

Early. D. S. and D. G. Long. 2001. Image Reconstruction and Enhanced Resolution Imaging from Irregular Samples. IEEE Transactions on Geoscience and Remote Sensing 39(2): 291-302.

Long, D. G. and D. Daum. 1997. Spatial Resolution Enhancement of SSM/I Data. IEEE Transactions on Geoscience and Remote Sensing 36: 407-417.

Long, D. G. and M. R. Drinkwater. 1999. Cryosphere Applications of NSCAT Data. IEEE Transactions on Geoscience and Remote Sensing 37(3): 1671-1684.

Long, D. G., P. J. Hardin, and P. T. Whiting. 1993. Resolution Enhancement of Spaceborne Scatterometer Data. IEEE Transactions on Geoscience and Remote Sensing 32(3): 700-715.

For additional references, see the NASA SCP Bibliography of Scatterometer Applications over Land and Ice Web site.

Scatterometer Climate Record Pathfinder. 2007. http://www.scp.byu.edu/6 March 2008.

Falcon, Peter and Cecelia Lawshe. "Winds: Measuring Ocean Winds from Space." Missions - SeaWinds on QuikSCAT. http://winds.jpl.nasa.gov/missions/quikscat/index.cfm 20 March 2008.

4.1 Related Data Collections

https://nsidc.org/data/amsre: AMSR-E standard products available at NSIDC

5 CONTACTS AND ACKNOWLEDGMENTS

David G. Long

Brigham Young University

459 Clyde Building

Provo, UT 84602

USA

Acknowledgments:

This work was supported by the NASA Aqua AMSR, Terrestrial Hydrology, Global Water Cycle Programs, Ocean Vector Winds, and Pathfinder programs. QuikSCAT data was obtained through the Jet Propulsion Laboratory (JPL) Physical Oceanography DAAC.

6 DOCUMENT INFORMATION

6.1 Publication Date

6 March 2008

6.2 Date Last Updated

31 March 2021