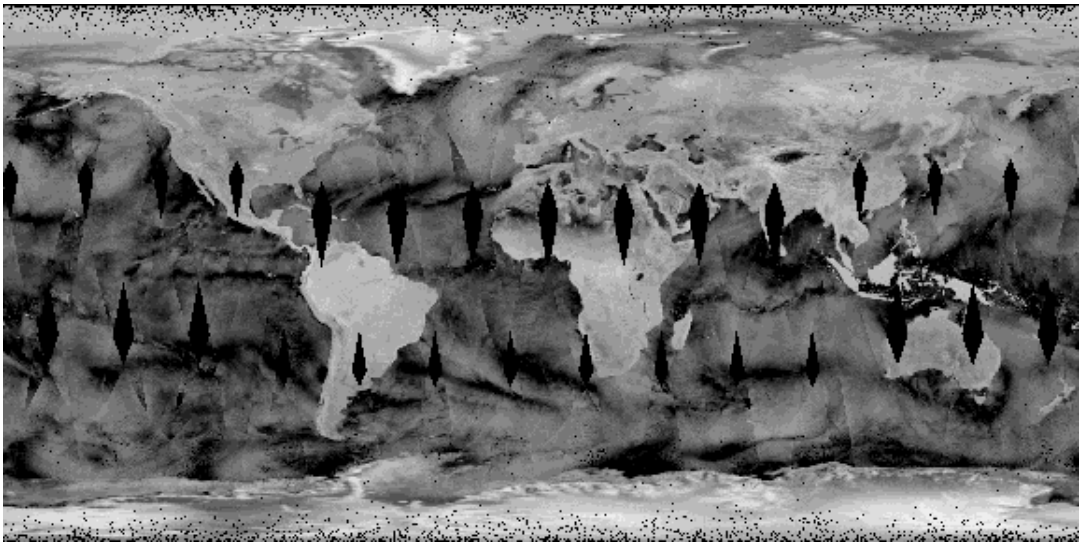
BYU Daily Browse Images of QuikSCAT Sigma-0 Measurements (D. Long)



Click on image for higher resolution

Summary:

The QuikSCAT on SeaWinds scatterometer provides normalized radar cross section (sigma-0) measurements of the Earth's surface. While originally designed for wind observation, scatterometers have proven useful in a variety of land and ice studies. To aid in the selection of regions and time periods for study, Brigham Young University has produced this global sigma-0 browse product. This product consists of spatial and temporal averages of QuikSCAT Level 1B sigma-0 values over a one-day period.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

BYU Daily Browse Images of QuikSCAT Sigma-0 Measurements (D. Long).
JPL PO.DAAC Product 121

Data Set Introduction:

Though the mission was cut short by the loss of the host spacecraft, NSCAT was an unqualified success. In addition to advances from its primary wind observation mission, NSCAT data has also had an impact on a variety of polar ice and tropical vegetation studies. In particular, NSCAT data very effectively maps the extent of sea ice. It is clear that scatterometers can continue to play an increasingly important role in monitoring tropical vegetation and polar ice in the future.

As a follow-up/replacement for the NSCAT mission, the QuikScat/SeaWinds scatterometer (QuikSCAT) measures the near-surface ocean wind field with unprecedented coverage and resolution. QuikSCAT makes dual polarization measurements of the normalized radar cross section (sigma-0) at both vertical and horizontal polarization.

This dataset consists of sigma-0 browse images for three regions:

1. the entire globe,
2. the northern hemisphere, and
3. the southern hemisphere.

See Data Description for examples. The global images are rectangular lat/lon grids covering the entire globe with a resolution of 5 pixels/deg, or about 22.5 km/pixel at the equator. It well suits mid-latitude regions but distorts polar regions. Hence, separate hemispheric products are created, well-suited for high-latitude regions. Those images are polar stereographic projections using a 70° reference latitude with a nominal grid size of about 22.5 km. The polar views include only measurements above a high latitude cutoff of 52°

Objective/Purpose:

The sigma-0 browse products are intended to help users identify features of interest directly in the QuikSCAT sigma-0 measurements by providing a spatial and temporal (over one day) average view of the QuikSCAT sigma-0 measurements. The resulting images can be used to identify areas of potential interest over land, ice, and ocean.

Summary of Parameters:

One browse image, stored in its own file, is produced per day for each combination of:

- 3 regions: global, north, and south
- 2 polarizations: horizontal and vertical
- 3 image types: average, standard deviation, and count

Data Description has examples for each combination.

Discussion:

The sigma-0 browse products are produced from QuikSCAT L1B data. Only egg measurements flagged as "usable" in the L1B files are utilized. Overlapping swaths are averaged.

The L1B files report measurements in two forms, *eggs* and *slices*, which differ in their spatial sizes and shapes. The nominal instantaneous QuikSCAT antenna footprint is an ellipse. However, the on-board range-doppler processing incorporated in the instruments improves the resolution. Using the on-board processor, 12 individual measurements are obtained for each footprint, though only 8 are reported in the L1B data product. These individual measurements are *slices*. The slices are typically 6 km long (depending on the instrument mode and antenna beam) by 25 km wide. The summed measurements of the 8 center slices are *egg* measurements and are reported in the standard L1B product. The effective resolution of the egg measurement nearly matches the elliptical 3 dB antenna footprint (approximately 15 km by 25 km depending on the antenna beam and instrument mode). Although lower in resolution, the egg measurements have smaller measurement variance (K_P^2) than slice measurements and are also less sensitive to calibration errors. For this reason the browse product defined here is based on the egg measurements.

To produce the browse images, the center of each L1B egg measurement is located. The measurement is averaged into the image grid element (pixel) in which the center of the measurement falls, i.e. the measurements are gridded into earth-located pixels based on their location. The effective resolution of the image products is less than the pixel resolution, or approximately 55-60 km at the equator. The resulting images are temporal averages over a one-day period of all the sigma-0 measurements whose centers fall within each image pixel area. We note that using slice sigma-0 measurements rather than egg sigma-0 would improve the effective resolution somewhat, though not significantly.

While NSCAT made sigma-0 measurements over a broad range of incidence angles, QuikSCAT makes measurements at each of two nominal incidence angles, 46° and 54.1°, corresponding to the inner and outer beams. The inner beam measurement is horizontal-polarization while the outer beam is vertical. Since it is undesirable to combine measurements from different polarizations, measurements from each beam are kept separate. We note that the variation in incidence angle over an orbit is small, typically less than a few tenths of a degree. For this reason, the incidence angle variation is not considered in this browse product.

The browse image products are stored in the BYU Microwave Earth Remote Sensing (MERS) SIR file format. The file format includes a header which contains location transformation information. In addition to the SIR files, the PO.DAAC FTP site also

contains GIF images of some of the SIR files, namely the average sigma-0 measurements.

Related Data Sets:

The QuikSCAT L1B data set is available only to selected researchers. However, the following related data sets are available at JPL's PO.DAAC:

- SeaWinds on QuikSCAT Level 3 Daily, Gridded Ocean Wind Vectors (JPL QuikSCAT Project). JPL PO.DAAC Product 109
- SeaWinds on QuikSCAT Level 2B Ocean Wind Vectors in 25 Km Swath Grid (JPL QuikSCAT Project). JPL PO.DAAC Product 108
- NSCAT Scatterometer Ocean Wind Products CD-ROM (JPL). JPL PO.DAAC Product 085
- NSCAT scatterometer global 25km Sigma-0 and Ocean Winds (Dunbar). JPL PO.DAAC Product 084
- NSCAT Scatterometer Science Product, Levels 1.7, 2, 3 (JPL). JPL PO.DAAC Product 066

Other QuikSCAT-based data sets from the MERS Lab will soon be available at PO.DAAC:

- BYU Enhanced Resolution Images of QuikSCAT Sigma-0 Measurements (D. Long) JPL PO.DAAC Product 122
- BYU QuikSCAT-Derived Antarctic and Arctic Sea-Ice Extent Maps (D. Long) JPL PO.DAAC Product 123

Several Level 3 products (such as this one) have been produced by members of the SeaWinds on QuikSCAT Science Working Team. A list of the publicly available QuikSCAT Level 3 products produced by SeaWinds on QuikSCAT Science Working Team members can be found on the PO.DAAC SeaWinds on QuikSCAT Web Site Links Page.

2. Investigator(s):

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3. Theory of Measurements:

"Spaceborne scatterometers transmit microwave pulses to the ocean surface and measure the backscattered power received at the instrument. The atmospheric motions themselves do not substantially affect the radiation emitted and received by the radar." [Dunbar et al, 2000]

In addition to its primary wind observation mission, NSCAT has also had an impact on a variety of polar ice and tropical vegetation studies [Long and Drinkwater, 1999]. It is clear that scatterometers will continue to play an increasingly important role in monitoring tropical vegetation and polar ice in the future.

4. Equipment:

NOTE: This section was obtained entirely from the QuikSCAT Science Data Product User's Manual [Dunbar et al, 2000]. Please refer to the User's Manual for more information.

Sensor/Instrument Description:

Collection Environment:

The SeaWinds instrument is a specialized microwave radar onboard the QuikSCAT satellite.

Source/Platform:

The QuikSCAT satellite was launched into a sun-synchronous, 803-kilometer, circular orbit on 19 June 2000 with a local equator crossing time at the ascending node of 6:00 A.M. ± 30 minutes.

Nominal Orbital Parameters	
Recurrent Period	4 days (57 orbits)
Orbital Period	101 minutes (14.25 orbits/day)
Local Sun Time at Ascending Node	6:00 A.M. ± 30 minutes
Altitude above Equator	803 km
Inclination	98.616°

Source/Platform Mission Objectives:

The Satellite Surface Stress Working Group mission requirements are:

Quantity	Requirement	Applicable Range
Wind Speed	2 m/s (rms)	3-20 m/s
	10%	20-30 m/s
Wind Direction	20° (rms) selected ambiguity	3-30 m/s
Spatial Resolution	25 km	sigma-0 cells
	25 km	Wind Vector Cells
Location Accuracy	25 km (rms)	Absolute
	10 km (rms)	Relative
Coverage	90% of ice-free ocean every day	
Mission Duration	36 months	

Key Variables:

The SeaWinds instrument on QuikSCAT is an active microwave radar designed to measure electromagnetic backscatter from wind-roughened ocean surface.

Principles of Operation:

Spaceborne scatterometers transmit microwave pulses to the ocean surface and measure the backscattered power received at the instrument. The atmospheric motions themselves do not substantially affect the radiation emitted and received by the radar.

Sensor/Instrument Measurement Geometry:

The SeaWinds instrument uses a rotating dish antenna with two spot beams that sweep in a circular pattern. The antenna radiates microwave pulses at a frequency of 13.4 GHz across broad regions on Earth’s surface. The instrument collects data over ocean, land, and ice in a continuous, 1,800-kilometer-wide band centered on the spacecraft’s nadir subtrack, making approximately 1.1 million ocean surface wind measurements and covering 90% of Earth’s surface each day.

QuikSCAT/SeaWinds is a conically scanning pencil-beam scatterometer. The SeaWinds scatterometer design used for QuikSCAT is a significant departure from the fan-beam scatterometers flown on previous missions (Seasat SASS and NSCAT). QuikSCAT employs a single 1-meter parabolic antenna dish with twin offset feeds for vertical and horizontal polarization. The antenna spins at a rate of 18 rpm, scanning two pencil-beam footprint paths at incidence angles of 46° (H-pol) and 54° (V-pol). The transmitted radar pulse is modulated, or "chirped", and the received pulse (after Doppler compensation) is passed through an FFT stage to provide sub-footprint range resolution. The range resolution is commandable between 2 km and 10 km, with the nominal value set at about 6 km. The nominal pulse repetition frequency is 187.5 Hz (also commandable). Each telemetry frame contains data for 100 pulses. Signal and

noise measurements are returned in the telemetry for each of the 12 sub-footprint "slices." Ground processing locates the pulse "egg" and "slice" centroids on the Earth's surface. The sigma-0 value is then computed for both the "egg" and the best 8 of the 12 "slices" (based on location within the antenna gain pattern).

Manufacturer of Sensor/Instrument:

Jet Propulsion Laboratory

Calibration:

Specifications:

The system must measure winds between 3 and 30 m/s with an accuracy better than (the greater of) 2 m/s or 10% in speed and 20° in direction with a spatial resolution of 50 km.

The sigma-0 measurement accuracy is estimated to be ±0.1 dB.

Frequency of Calibration:

QuikSCAT generates an internal calibration pulse and associated load pulse every half-scan of the antenna. In ground processing, the load pulses are averaged over a 20-minute window, and the cal pulses over a 10-pulse (approximately 18-second) window, to provide current instrument gain calibration needed to convert telemetry data numbers into power measurements for the sigma-0 calculation.

QuikSCAT "programmability" includes commanding of major mode selection and range resolution, antenna spin rate and PRF, and the ability to uplink new Doppler compensation and range tracking tables as changes in the orbit occur, or to conduct special engineering tests. Mode changes will be made periodically to obtain additional calibration data.

Other Calibration Information:

Operating Modes

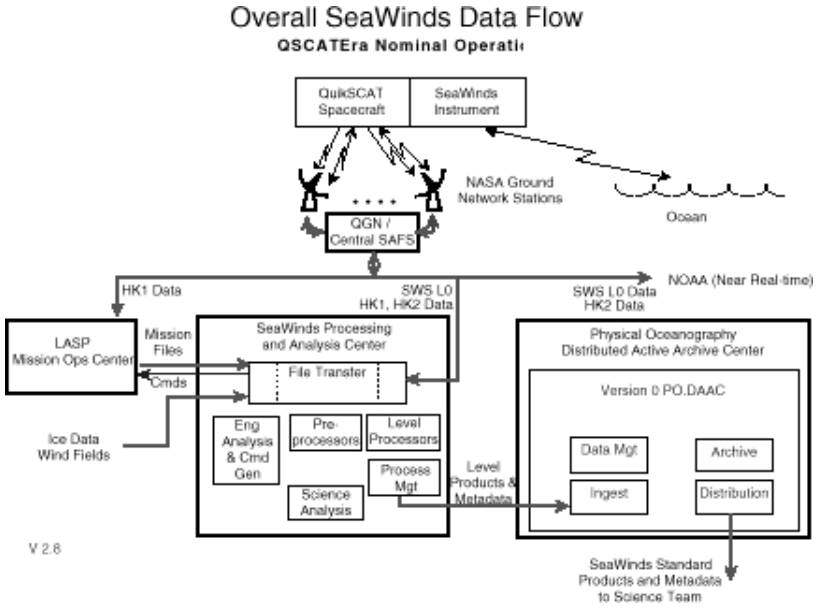
- Mode 0: Wind Observation Mode Wind observation mode is the primary science mode for QuikSCAT, and will be in effect more than 95% of the time.
- Mode 1: Receive-Only Mode In Receive-only mode, the transmitter is turned off while the receiver collects data at the antenna ports. This mode was used during Cal/Val to assess radio frequency interference and internal receiver biases. No science data is returned.
- Mode 2: Continuous Calibration Mode In Continuous Calibration mode, QuikSCAT performs only calibration/load cycles in place of normal pulse transmission cycles. This mode provides the most accurate receiver calibration data, and will be used periodically throughout the mission. No science data is

returned.

5. Data Acquisition Methods:

NOTE: This section, except the description of the MERS Lab, was obtained from the QuikSCAT Science Data Product User's Manual [Dunbar et al, 2000]. Please refer to the User's Manual for more information.

The data flow diagram below shows the principal segments of the ground system, which consist of the NASA Ground Network, the Mission Operations Center (MOC), the SeaWinds Processing and Analysis Center (SeaPAC) at JPL, and the PO.DAAC.



NASA Ground Network and Mission Operations

The NASA Ground Network consists of four main receiving stations at Poker Flats, Alaska, Svalbard, Norway, McMurdo Station in Antarctica, and Wallops Flight Center in Virginia. The spacecraft and instrument telemetry is collected at these stations and forwarded via network to the Central SAFS at Goddard Space Flight Center. From Central SAFS, the spacecraft housekeeping (HK1) data are forwarded to the MOC at LASP in Boulder, Colorado, and the science telemetry (Level 0 and HK2) are sent to JPL and NOAA-NESDIS for science and near-real-time data processing.

Mission Operations Center

The Mission Operations Center at LASP has the principal responsibility for monitoring and commanding the QuikSCAT spacecraft. Instrument commands generated by Engineering Analysis at JPL are forwarded to the MOC for scheduling and uplinking. The MOC is responsible for assessing and maintaining the spacecraft orbit and pointing, sending

commands for maneuvers as needed. Orbit predictions used for scheduling data downlinks and orbit determination from tracking data are performed by the MOC

SeaWinds Processing and Analysis Center (SeaPAC)

The SeaWinds Processing and Analysis Center (SeaPAC) at JPL is responsible for the reception of telemetry data, production and analysis of the science data products, and for delivery of the science products to the PO.DAAC for distribution. The SeaPAC consists of six principal subsystems, described in the following sections.

File Transfer Subsystem (FX)

The FX subsystem is responsible for all external data transfers into the SeaPAC. These include the reception of the science telemetry data from the Central SAFS at GSFC, collection of ice edge data from the National Ice Center, and collection of NWP wind field data from NCEP. While the FX software can be run manually, most of its functions are completely automated

Process Management Subsystem (PM)

The PM subsystem performs the database and automatic job scheduling functions for the SeaPAC, as well as providing a user interface for the SeaPAC operator. Using a rule-based algorithm PM is able to determine when all of the necessary input data for a particular job have become available, and can start that job automatically or inform the operator that the job is ready to be run manually.

Preprocessor Subsystem (PP)

The PP subsystem takes care of the initial processing of the HK2 and Level 0 science telemetry, creating the basic input products for initiating the main science data processing. PP creates time correlation, ephemeris, and attitude files from the HK2, creates the QuikSCAT Level 0 files that are the input to the Level 1A processor, and also extracts and converts NWP data to the format needed by the Level 2B processor.

Level Processor Subsystem (LP)

The LP subsystem is the heart of the science processing, implementing the conversions from Level 0 telemetry up through the Level 2B wind vector products. LP consists of four main programs, one each to produce L1A, L1B, L2A, and L2B data in sequence. LP software incorporates and implements all of the science algorithms, and creates the HDF data products that are delivered to PO.DAAC and to the science community.

Engineering Analysis Subsystem (EA)

The EA subsystem has the primary responsibility to monitor the instrument health and safety. EA focuses mainly on the HK2 and Level 1A data to perform trend analyses on key instrument and spacecraft temperatures, voltages, and other engineering

parameters.

Science Analysis Subsystem (SA)

The SA subsystem performs the primary QA and data analysis functions for the SeaPAC. SA is concerned with assuring that the science algorithms as implemented in the LP are performing correctly, and making algorithm corrections and refinements as needed. SA monitors the science data quality throughout the mission. QA reports are provided with all data products.

Physical Oceanography DAAC

The Physical Oceanography Distributed Active Archive Center (PO.DAAC) receives the science data from the SeaPAC, archives the data, and distributes Level 1B, Level 2A, Level 2B and higher level data products to the QuikSCAT science community, including the BYU MERS Lab. PO.DAAC also acts as the principal long-term archive for all telemetry, Level 0, Level 1A and ancillary files collected during the QuikSCAT mission.

BYU MERS Lab

The Microwave Earth Remote Sensing Laboratory receives QuikSCAT Level 1B data from PO.DAAC and uses the data to create this and other sigma-0 products. The MERS Lab hosts the sigma-0 products on its web site http://www.scp.byu.edu, as does PO.DAAC after copying them.

6. Observations:

Data Notes:

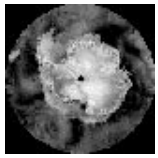
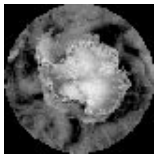
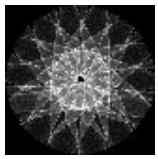
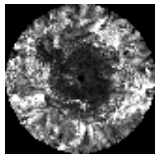
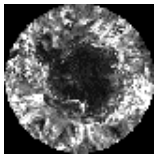
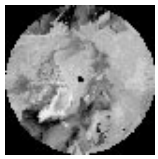
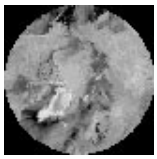
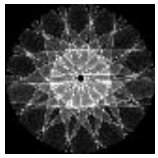
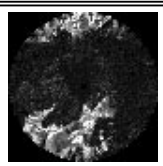
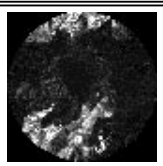
No additional notes.

Field Notes:

No additional notes.

7. Data Description:

18 image products are produced per mission Julian day. The following table has all the sigma-0 browse images for January 1, 2001. Click on any image for higher resolution.

Region	Image Type	**Horizontal** Polarization	**Vertical** Polarization
Global: all lats, all lons	**average** sigma-0		
	count		
	standard deviation		
Southern Hemisphere: lats < -52.0°, all lons	**average** sigma-0		
	count		
	standard deviation		
Northern Hemisphere: lats > 52.0°, all lons,	**average** sigma-0		
	count		
	standard deviation		

Spatial Characteristics:

Spatial Coverage:

Some areas of the Earth's surface are not covered in a single day, resulting in diamond-shaped regions of no coverage in mid-latitude and equatorial averages. The regions of no coverage are larger in the horizontal polarization images than in the vertical ones due to the narrower swath of the horizontal polarization (inner beam) measurements.

Spatial Coverage Map:

The absolute value of a pixel in a count image indicates the number of sigma-0 measurements that hit the pixel during the imaging interval. Zero indicates no data. A negative value in a pixel in a standard deviation image also indicates no data.

Spatial Resolution:

Global images: 1800 by 900 pixels, or 0.20° by 0.20°, or 22.5 km/pixel at the equator.

Polar images (north and south): 388 by 388 pixels, or 22.5 km/pixel using a 70° reference latitude.

Projection:

Global images: rectangular array (cylindrical equidistant).
Polar images: polar stereographic.

Grid Description:

Two auxiliary image files are available for each region. These files contain the longitude and latitude for the center of each pixel. The files are in the same format as the product but have a latitude value or longitude value instead of a sigma-0 value stored in the image.

The naming scheme for the auxiliary files is:

QS_Xb*TR*3C.*date*

T	image type	'x' = longitude 'y' = latitude
R	region	'G' = Global 'N' = Northern Hemisphere 'S' = Southern Hemisphere
date	11-digit date of file production (*yyyydddhhmm*)	

These files are not expected to change over the life of the mission, so only one file of each type per region is created (6 total).

Temporal Characteristics:

Temporal Coverage:

Daily data exist from 19 July 1999 to approximately present. More recent data will be added to this data set as it becomes available.

Temporal Coverage Map:

Not available.

Temporal Resolution:

Each image is a temporal average (or standard deviation or count) over a one-day period of all the sigma-0 measurements whose centers fall within each image pixel area.

Data Characteristics:

Parameter/Variable:

Each file has one image. The image types are:

1. the **average** sigma-0 value
2. the **count**, i.e. the number of measurements, and
3. the normalized **standard deviation** of the measurements

Note on Count: The absolute value of each pixel is the number of hits in that geographic region. The sign of each pixel indicates whether the corresponding average sigma-0 value in normal space (not dB) is negative.

Variable Description/Definition:

See the previous section.

Unit of Measurement:

Average sigma-0 values are in dB. The count is the raw number. Standard deviation is unitless.

Data Source:

The sigma-0 measurements come from QuikSCAT Level 1B data, derived from data taken by the SeaWinds instrument on QuikSCAT.

Data Range:

Image Type	Minimum	Maximum	No Data Indicator
average sigma-0	-32.0	0.0	-33.0
count	0[1]	50	-100
standard deviation	0.0	1.0	-1.0

[1]The absolute value ranges from 0 to 50. See the Note on Count.

Sample Data Record:

Each file contains 1 image; any of the full-sized images in this document is a visualization of the data in its corresponding file.

Each file also has header information. The following sample output was printed by program `sir2gif` as it created the image at the beginning of this document.

```
SIR file header: 'QS_XbvaG3C2001001.20010032220'
  Title:   'Grid image of Globe Revs 08000-08014'
  Sensor:  'QSCAT L1B'
  Type:    'A image  (QS_XbvaG3C2001001.20010032220)'
  Tag:     '(c) 1999 BYU MERS Laboratory'
  Creator: 'BYU MERS QS_SigBrw V1.0'
  Created: ' 3Jan2001'
  Size: 1800 x 900    Total:1620000  Offset: -33  Scale: 500
  Year: 2001  JD range: 1-1  Region Number: 500  Type: 1  Form: 0
  Polarization: 2  Frequency: 13.600000 MHz
  Datatype: 2  Headers: 1  Ver:20
  Nodata: -33.000000   Vmin: -32.000000  Vmax: 0.000000
  Rectangular Lat/Long projection:
   Size (deg):     360.000000 , 180.000000
   Lon, Lat scale: 5.000000 , 5.000000 (pix/deg)
   Offsets:        -180.000000 , -90.000000
  Image Min, Max: -32.000000 , 0.000000
```

File Naming Convention:

The naming scheme for the data files is:

QS_Xb*pTR*3C*yyyyddd.date*

p	polarization	'h' = horizontal 'v' = vertical
T	image type	'a' = average sigma-0 'C' = count 'V' = standard deviation
R	region	'G' = Global 'N' = Northern Hemisphere 'S' = Southern Hemisphere
yyyy	four-digit year	
ddd	three-digit day of year, from 001 to 366	
date	11-digit date of file production (*yyyydddhhmm*)	

The naming scheme for the auxiliary files, as well as their meanings, is described above.

8. Data Organization:

Data Granularity:

The basic granule is one data file. For every combination of region, image type, polarization (see Data Description above), and day, there is a data file.

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary.

Data Format:

The BYU-MERS SIR image format was developed by the Brigham Young University (BYU) Microwave Earth Remote Sensing (MERS) laboratory to store a variety of image types along with the information required to Earth-locate the image pixels.

A SIR format file consists of one or more 512-byte headers followed by the image data and additional zero padding to insure that the file is a multiple of 512 bytes long. The file header record contains all of the information required to read the remainder of the file and the map projection information required to map pixels to lat/lon on the Earth surface. The image pixel values generally represent floating point values and may be stored in one of three ways. The primary way is as 2 byte integers (with the high order byte first), though the pixels may be stored as single bytes or IEEE floating point values. Scale factors are stored in the header to convert the integer or byte pixel values to native floating point units. The image is stored in row-scanned (left to right) order from the lower left corner (the origin of the image) up through the upper right corner. By default, the location of a pixel is identified with its lower-left corner. The origin pixel (1,1) is the lower left corner of the image. The array index n of the (i,j)th pixel where i is horizontal and j is vertical is given by

$$n = (j - 1) \times N_x + i$$

where N_x is the horizontal dimension of the image. The last pixel stored in the file is at (N_x, N_y).

The sir file header contains various numerical values and strings which describe the image contents. For example, the value for a no-data flag is set in the header as well as a nominal display range and the minimum and maximum representable value. Optional secondary header records (512 bytes) can be used to store additional, non-standard information. The standard SIR file format supports a variety of image projections including:

1. Rectangular array (no projection)
2. Rectangular lat/lon array
3. Two different types of Lambert equal-area projections which can be used in either non-polar or polar projections
4. Polar stereographic projections
5. EASE grid polar projection with various resolutions
6. EASE global projection with various resolutions

For the QuikSCAT global sigma-0 browse products, only the rectangular array and polar stereographic projections are used. Also, the naming scheme for sigman-0 browse products is not SIR-standard.

Any of the programs described in Software below decodes SIR headers.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

The earlier Discussion describes the general processing of QuikSCAT Level 1B files into sigma-0 browse images. Data Description shows the three specific types of browse images created from sigma-0 measurements. They are:

- the **average**, expressed in dB of the absolute value. Computation of the average sigma-0 value is done in normal space, not dB, with negative values included. If the resulting average is negative, the sign of the corresponding pixel of the count image is set to negative. In practice, negative averages occur primarily over the ocean in regions of low wind-speed. These pixels are clipped to ±32.5 dB with -33 used to denote no available data. The reference incidence angles are approximately H-pol (inner beam) 46° and V-pol (outer beam) 54°.
- the **count**. The absolute value indicates the number of measurements which hit the pixel during the imaging interval. Negative values indicate that the corresponding average value is negative. Zero denotes no data. These images can be useful in creating multi-day averages and in quality control.
- the normalized **standard deviation** (K_p) of the measurements hitting each grid element divided by the mean value. If the mean is negative, no

estimate is made and zero is returned. A negative value indicates no data.

Data Processing Sequence:

Processing Steps:

The sigma-0 browse products are produced from QuikSCAT L1B data. Only measurements flagged as "usable" in the L1B file are included in the browse product. Overlapping swaths are averaged.

The L1B files are part of a series of level-conversion stages, starting from raw data from the SeaWinds on QuikSCAT instrument and producing more refined products at each stage. See Related Data Sets. Those products are created in the following order:

1. Level 0: Science Telemetry Processing
2. Level 1A: Engineering Unit Converted Telemetry
3. Level 1B: Time-Ordered Earth-Located Sigma-0's
4. Level 2A: Surface Flagged Sigma-0's and Attenuations
5. Level 2B: Ocean Wind Vectors in a 25km Swath Grid
6. Level 3: Daily, Gridded Ocean Wind Vectors

Processing Changes:

None at this time.

Calculations:

Special Corrections/Adjustments:

The header in every SIR file contains the following items to help interpret the raw pixels in the data:

- offset
- scale factor
- data type: 1-byte int, 2-byte int, or 4-byte float
- value to indicate no data

Any of the programs described in Software below decodes SIR headers.

Calculated Variables:

Each file holds one type of data. See Derivation Techniques and Algorithms.

Graphs and Plots:

No additional information.

10. Errors:

Sources of Error:

"When rain is present, measurements of the ocean surface sigma-0 become contaminated for several reasons. Some of the transmitted energy is scattered back towards the scatterometer by the rain and never reaches the ocean surface. Energy backscattered from rain can constitute a significant but unknown portion of the measured echo energy. Some of the transmitted energy is scattered and/or absorbed by the rain and is never measured by the scatterometer. This has the effect of attenuating the echo energy from the ocean. Additionally, the rain roughens the ocean surface and changes its radar cross section." [Huddleston and Stiles, 2000]

Rain also attenuates the signal over land and ice. Generally, however, the land backscatter is larger over land/ice than over the ocean so rain is less of a problem. No correction for rain is applied in generating this or other sigma-0 products.

The normalized standard deviation of sigma-0, known as K_p, is computed to give an estimate of the measurement uncertainty of the backscatter. Major sources of K_p in the scatterometer system are:

1. uncertainty in the receiver noise, known as communication K_p or K_{pc}
2. uncertainties in the geometric and gain parameters, known as retrieval K_p or K_{pr}

Instrument processing is another source of error, as are uncertainty in attitude pointing and various bias errors. The latter two can reduce the effective resolution of the highest resolution images (in effect smearing them), but they are not considered to be important sources of error for most sigma-0 image products including this one.

Since the images are averages over time, sampling variability over the averaging period affects the reported backscatter values.

Over the ocean all backscatter measurements (from a single polarization) falling within a single pixel are averaged. Thus, the forward- and aft-looking measurements are averaged, and the resulting average is over the various azimuth angles of the measurements. The azimuth angles of the measurements hitting a given location vary with pixel location and time and may be further affected by missing or low-quality data. Discontinuities and artifacts can occur at swath edges and in areas where the surface shows significant azimuth dependence (e.g. over the ocean). The normalized standard deviation images can be useful in evaluating temporal and azimuth variation in the backscatter measurements.

Quality Assessment:

Data Validation by Source:

"The SA subsystem performs the primary QA and data analysis functions for the SeaPAC. SA is concerned with assuring that the science algorithms as implemented in the LP are performing correctly, and making algorithm corrections and refinements as needed. SA monitors the science data quality

throughout the mission. QA reports are provided with all data products." [Dunbar et al, 2000]

The QA reports are available on the PO.DAAC FTP site.

Confidence Level/Accuracy Judgement:

Not applicable.

Measurement Error for Parameters:

Information not currently available.

Additional Quality Assessments:

No additional notes.

Data Verification by Data Center:

None.

11. Notes:

Limitations of the Data:

Due to the rotation of the antenna, the cross-track density of sigma-0 measurements varies with more measurements at the outer edges of the swath than at the swath center (swath edges are clearly visible in the count images).

Some areas may not be covered in a single day; see Spatial Coverage.

Sigma-0 measurements may be contaminated when rain is present.

Known Problems with the Data:

As a cautionary note, experience suggests that the sigma-0 images contain many features which can be difficult to explain and can be misleading, in part because forward- and aft-looking measurements are combined. Comparison with the corresponding wind maps is strongly recommended.

Usage Guidance:

None.

Any Other Relevant Information about the Study:

None.

12. Application of the Data Set:

- Sea ice, especially polar
- Tropical vegetation

13. Future Modifications and Plans:

A second SeaWinds instrument is scheduled to fly on Japan's Advanced Earth Observing Satellite (ADEOS-II). ADEOS-II is currently scheduled to be launched in November 2001 from the Tanegashima Space Center, Japan.

For the most current information concerning the SeaWinds on ADEOS-II mission, please refer to the JPL SeaWinds on ADEOS-II web site.

14. Software:

Software Description:

Sample read and display software for SIR files are available in C, FORTRAN, IDL/PV-WAVE, and MATLAB. These programs can be easily modified to meet the requirements of individual users.

Language	Program Name	Description
C	`sir_ez_example.c`	read SIR file, print values of 4 corner pixels
	`sir2byte.c`	convert SIR file to raw, unsigned byte file
	`sir2gif_ez.c`	convert SIR file to GIF
	`sir2gif.c`	
	`sir2bmp.c`	convert SIR file to BMP
Fortran	`fsirexample_EZ.f`	read SIR file, create an unsigned byte file
	`fsirexample.f`	
	`sir2byte.f`	
	`fsir_locmap.f`	read SIR file, create latitude and longitude maps like the auxiliary files
	`fsir_locmap_EZ.f`	
IDL	`xsir_idl.pro`	load SIR file, save to file, display image, do forward/inverse transforms
PV-WAVE	`xsir.pro`, `xsir_pvwave.pro`	load SIR file, save to file, display image, do forward/inverse transforms
MATLAB	`loadsir.m`, `writesir.m`, `showimage.m`, ...	load SIR file, save to file, display image, do forward/inverse transforms

IDL is made by Research Systems, Inc.
PV-WAVE is made by Visual Numerics, Inc.
MATLAB is made by The MathWorks, Inc.
All are copyrighted software tools for numerical analysis and visualization.

Software Access:

The latest versions of the sample read and display software can be obtained via anonymous FTP from ftp://ftp.ee.byu.edu/mers/sir/*lang*, where *lang* = "c", "f", "idl", or "matlab". JPL PO.DAAC also maintains a copy of that software at ftp://podaac.jpl.nasa.gov/pub/ocean_wind/quikscat/sigma0browse/sw.

The IDL and PV-WAVE programs reside in one directory due to the similarity between the languages. `xsir_idl.pro`, `xsir.pro`, and `xsir_pvwave.pro` call the same functions, though the file `loadsir.pro` must be modified for PV-WAVE.

15. Data Access:

Contact Information:

For general questions and comments regarding this dataset, please contact

email: podaac@podaac.jpl.nasa.gov

url: http://podaac.jpl.nasa.gov

phone: (626)744-5508

fax: (626)744-5506

mail: JPL PO.DAAC User Services Office
Jet Propulsion Laboratory
MS Raytheon-299
4800 Oak Grove Drive
Pasadena, CA 91109, U.S.A.

Email is the preferred method of communication.

Dr. David Long of BYU is the source of this dataset. Please contact him with more detailed questions. See Investigator for contact information.

Data Center Identification:

Jet Propulsion Laboratory (JPL)
Physical Oceanography Archive Center (PO.DAAC)

Procedures for Obtaining Data:

This data set is currently available via anonymous FTP at ftp://podaac.jpl.nasa.gov/pub/ocean_wind/quikscat/sigma0browse.

This product is also available on CD-ROM. Orders may be placed using the PO.DAAC on-line order form, http://podaac.jpl.nasa.gov/order, or the Earth Observing System (EOS) Data Gateway, http://poseidon.jpl.nasa.gov/~imsww/pub/imswelcome/.

Data Center Status/Plans:

not available

16. Output Products and Availability:

This data set is currently available via anonymous FTP at ftp://podaac.jpl.nasa.gov/pub/ocean_wind/quikscat/sigma0browse.

17. References:

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18. Glossary of Terms:

See the EOSDIS Glossary for a more general listing of terms related to the Earth Observing System project.

19. List of Acronyms:

ADEOS: Advanced Earth Observing Satellite

EA: SeaPAC Engineering Analysis program set
EOS: Earth Observing System
EOSDIS: Earth Observing System Data and Information System
FTP: File Transfer Protocol
FX: SeaPAC File Transfer program set
GSFC: Goddard Space Flight Center
HDF: Hierarchical Data Format
IDL: Interactive Data Language
JPL: Jet Propulsion Laboratory
L1B: QuikSCAT Level 1B Product
L3: QuikSCAT Level 3 Product
LASP: Laboratory for Atmospheric and Space Physics at the University of Colorado
LP: SeaPAC Level Processor program set
MOC: Mission Operations Center
NASA: National Aeronautics and Space Administration
NCEP: National Center for Environmental Prediction Applications
NSCAT: NASA Scatterometer
NWP: Numerical Weather Prediction
PM: SeaPAC Process Management program set
PP: SeaPAC Preprocessor program set
PO.DAAC: Physical Oceanography Distributed Active Archive Center
QA: Quality Assurance
QuikSCAT: the NASA Quick Scatterometer spacecraft, or
QuikSCAT: usually refers to the SeaWinds instrument on the spacecraft
SA: SeaPAC Science Analysis program set
SAFS: Standard Autonomous File Server
SeaPAC: SeaWinds Processing and Analysis Center
URL: Uniform Resource Locator

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QuikSCAT/SeaWinds Sigma-0 Browse Product" [Long, 2000].

The sir2gif program mentioned in the Software section produced the images in this document using data from the ftp site.

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