Physical Oceanography DAAC

SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress (JPL)

Guide Document

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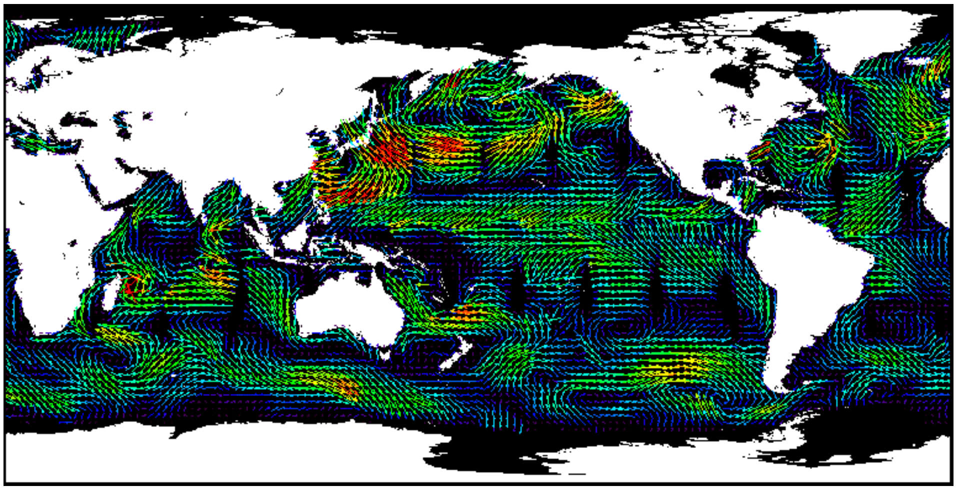
SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress (JPL)



Summary:

The SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress set consists of gridded values of meridional and zonal components of wind stress, drag coefficients and time given in fraction of a day. Two algorithms were used, based on papers by Tang and Liu, 1986 and Large and Pond, 1981 Data are currently available in Hierarchical Data Format (HDF) and exist from July 1999 to present.

The Level 2B Wind Stress data were obtained from the QuikSCAT Level 2B data and therefore are provided on an approximately 25 x 25 km along-track and cross-track axes of the spacecraft measurement swath grid.

This product is also referred to as JPL PO.DAAC product 182.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress (JPL)
JPL PO.DAAC Product 182

Data Set Introduction:

Each file contains one rev of wind stress data grouped by rows of wind vector cells aligned with the along-track and cross-track axes of the spacecraft measurement swath. Level 2B wind vector cells are 25 km squares. Each wind vector cell row corresponds to a single cross-track cut of the SeaWinds measurement swath. Full coverage of the earth's circumference requires 1624 wind vector cell rows.

Objective/Purpose:

Like the SeaWinds Level 3 product, this data set provides wind stress for use in research such as global climatic change and air-sea interaction. Unlike the Level 3 data, the Level 2B product organizes the wind stress vectors along the trajectory of the spacecraft.

Summary of Parameters:

The following parameters are available for both the passes:

- wind stress (U and V components) calculated using both Liu&Tang and Large&Pond algorithms
- drag coefficients, also calculated as above.
- quality flags.
- time in fraction of a day

Discussion:

Each SeaWinds Level 2B-Derived Wind Stress data file contains one 'rev' or less of SeaWinds data. A complete rev includes all of the data that pertains to one full orbital revolution of the spacecraft. By convention, all SeaWinds revolutions begin and end at the southernmost orbital latitude.
The SeaWinds Level 2B Processor generates a grid of wind vector cells (WVC) in alignment with the along-track and cross-track axes of the spacecraft measurement swath. Each WVC is a 25 km square. Every data element in the Level 2B-Derived wind stress product may be

referenced by the wind vector cell's cross-track and along-track indices.The SeaWinds instrument's measurement swath extends 900 km on either side of the satellite nadir track. Thus, each WVC row must contain at least 72 WVC values. To accommodate occasional measurements that lie outside the 900 km swath, the Level 2B data design includes two additional WVC values at each end of each row. Each Level 2B WVC row therefore contains a total 76 WVCs.
HDF Scientifical Data Sets (SDS) objects store every data element in the Level 2B-Derived Data. Except for elements time_frac, and wvc_index, every SDS is an array of at least two dimensions. The second SDS dimension represents the WVC row while the first dimension represents a particular WVC within the row. The Level 2B-Derived product numbers the wind vector cells from left to right when viewing the orbital swath in the direction of spacecraft flight. Thus, wind_stress_U_Liu[203,15] lists the meridional component of wind stress calculated with the Liu& Tang algorithm for the 16th wind vector cell from the left hand side of the swath when facing the spacecraft's forward direction of motion in wvc_row[203].

Before writing wind stress value to the Level 2B daily grid, it was necessary to differentiate between NULL values and wind measurements which were actually 0 m/s. For a NULL value of the wind speed (missing data caused by either land or ice masking, or gap in coverage), the corresponding drag coefficient (CD) was set to –1.0. For a 0 m/s wind speed, the drag coefficient goes to infinity at least for the Large&Pond algorithm. To mark this, the value of the corresponding CD was set to –2.0.

Related Data Sets:

The following related data sets are available at the JPL PO.DAAC:

- SeaWinds on QuikSCAT Level 2B Ocean Wind Vectors in 25 Km Swath Grid (JPL) JPL PO.DAAC Product 108
- SeaWinds on QuikSCAT Level 3-Derived Multialgorithm Surface Wind Stress (JPL) JPL PO.DAAC Product 183

2. Investigator(s):

NOTE: Please refer all questions concerning the SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress product to the PO.DAAC QuikSCAT Data Team, qscat@podaac.jpl.nasa.gov, or the PO.DAAC User Services Office, podaac@podaac.jpl.nasa.gov.

The SeaWinds on QuikSCAT Project is a mission of the NASA Jet Propulsion Laboratory (JPL). Further information on the QuikSCAT Project is available on-line at http://winds.jpl.nasa.gov.

SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress Product Author:

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Dr. Michael Freilich
Oregon State University

SeaWinds on QuikSCAT JPL Project Scientist

Dr. W. Timothy Liu
Jet Propulsion Laboratory

3. Theory of Measurements:

"Spaceborne scatterometers transmit microwave pulses to the ocean surface and measure the backscattered power received at the instrument. Since the atmospheric motions themselves do not substantially affect the radiation emitted and received by the radar, scatterometers use an indirect technique to measure wind velocity over the ocean. Wind stress over the ocean generates ripples and small waves, which roughen the sea surface. These waves modify the radar cross-section (sigma-0) of the ocean surface and hence the magnitude of backscattered power. In order to extract wind velocity from these measurements, one must understand the relationship between sigma-0 and near-surface winds. This relationship is known as the geophysical model function." [*Dunbar et al*, 2000]

The QSCAT-1 model function was used to obtain the SeaWinds on QuikSCAT ocean wind data.

4. Equipment:

NOTE: This section was adapted 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 1999. The local equator crossing time at the ascending node is 6:00 A.M. ± 30 minutes.

The nominal orbit for QuikSCAT is defined by the following parameters:

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 as follows:

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	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. Since the atmospheric motions themselves do not substantially affect the radiation emitted and received by the radar, scatterometers use an indirect technique to measure wind velocity over the ocean. Wind stress over the ocean generates ripples and small waves, which roughen the sea surface. These waves modify the radar cross section (sigma-0) of the ocean surface and hence the magnitude of backscattered power. In order to extract wind velocity from these measurements, one must understand the relationship between sigma-0 and near-surface winds. This relationship is known as the geophysical model function.

The QSCAT-1 model function was used to obtain the SeaWinds on QuikSCAT ocean wind data.

The geophysical product retrieved from QuikSCAT observations is the equivalent of neutral winds at 10-m height (Liu and Tang, 1996), from which the surface wind stress (or momentum flux) can be derived independent of the atmospheric density stratification.

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.

Unlike the fan-beam scatterometers flown on previous missions (Seasat SASS and NSCAT), the SeaWinds instrument on QuikSCAT is a conically scanning pencil-beam scatterometer. 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.

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 in this mode.

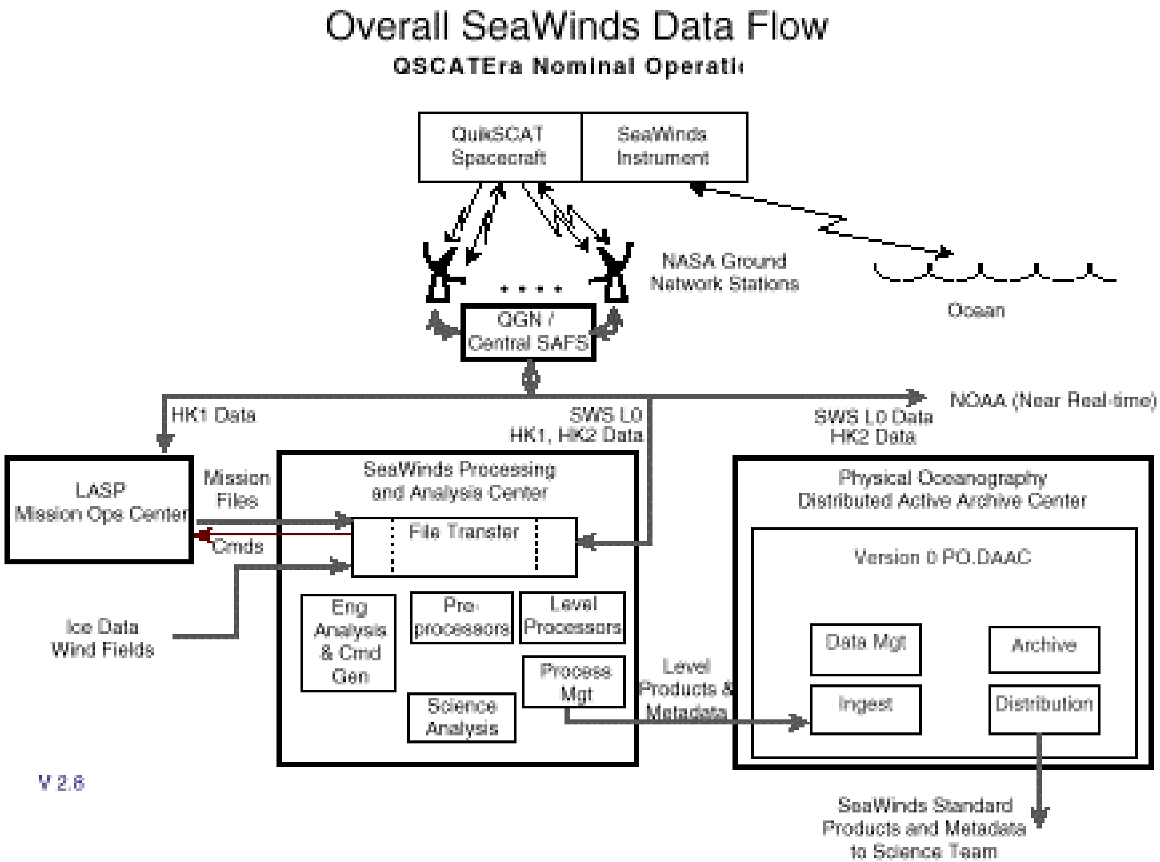
- Mode 2: Continuous Calibration Mode

  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 in this mode.

5. Data Acquisition Methods:

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

The [below] data flow diagram 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.



5.1 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.

5.2 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.

5.3 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.

5.3.1 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.

5.3.2 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.

5.3.3 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

5.3.4 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.

5.3.5 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.

5.3.6 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.

5.4 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. 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.

6. Observations:

Data Notes:

No additional notes.

Field Notes:

No additional notes.

7. Data Description:

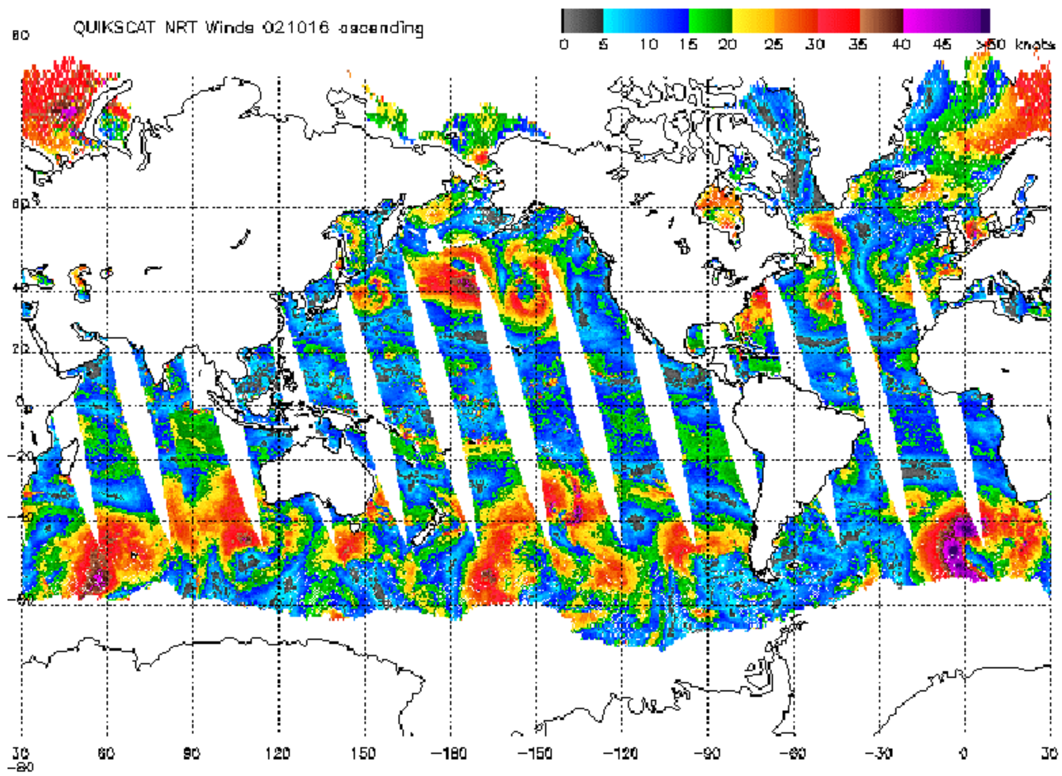
Spatial Characteristics:

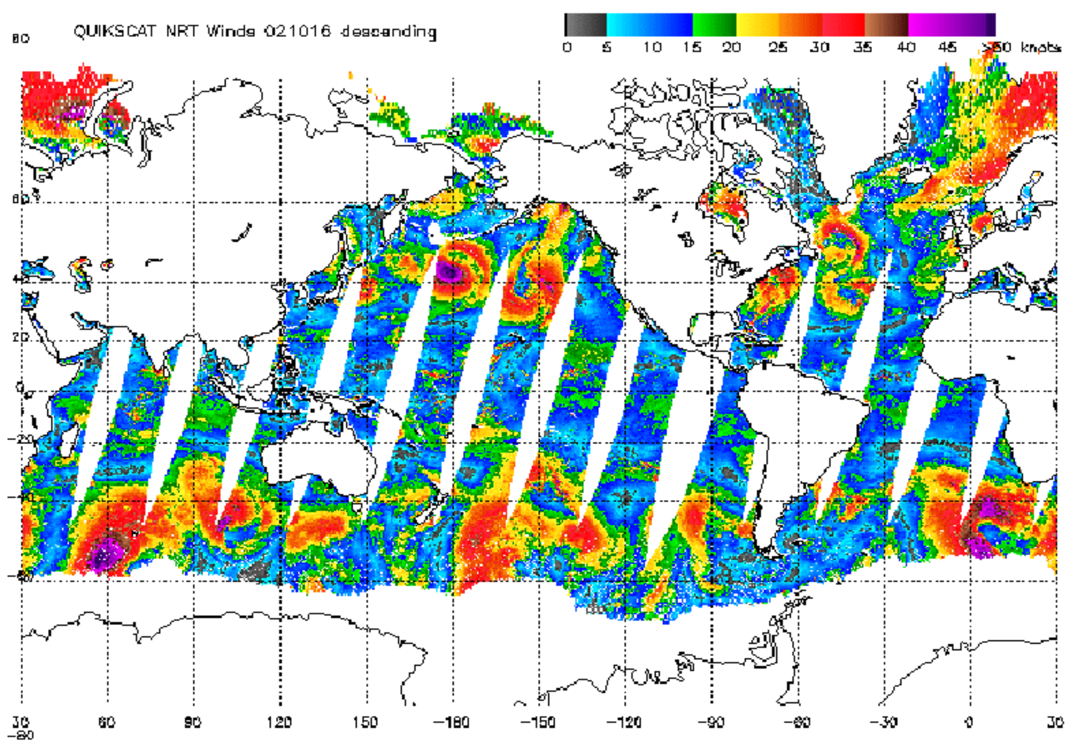
Spatial Coverage:

Global Oceans
Approximately 90% of the ice-free ocean every day.

Spatial Coverage Map:

The following images show a typical coverage for one day of SeaWinds on QuikSCAT Level 2B data. Each file contains a full 'rev' worth of data. (Note: Images are from the QuikSCAT near real-time descending and ascending passes for October 17, 2002.)


QUIKSCAT NRT Winds 021016 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
30 60 90 120 150 −180 −150 −120 −90 −60 −30 0 30


QUIKSCAT NRT Winds 021016 descending
0 5 10 15 20 25 30 35 40 45 >50 knots
30 60 90 120 150 −180 −150 −120 −90 −60 −30 0 30

Spatial Resolution:

The SeaWinds Level 2B data are provided on a grid of 25 km by 25 km cells.

Projection:

Swath data are on a simple, 25km rectangular grid. Full coverage of the earth's circumference requires 1624 wind vector cell rows, each Level 2B WVC row containing a total 76 WVCs.

Grid Description:

The SeaWinds Level 2B Processor generates a grid of WVCs in alignment with the along-track and cross-track axes of the spacecraft measurement swath. Each WVC is a 25km square. Every data element in the Level 2B Product may be referenced by the wind vector cell's cross-track and along-track indices.

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 file contains data for a given rev, thre are 14.25 revs/day.

Data Characteristics:

There are 12 Scientific Data Sets within each QuikSCAT Level 2B-Derived Surface Wind Stress HDF data file:

1. **stress_Liu_U:** zonal component of the wind stress calculated using Liu&Tang algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	- 1.20	1.20	N/m^2	16-bit signed integer

2. **stress_Liu_V:** meridional component of the wind stress calculated using Liu&Tang algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.0005	0.00	-1.20	1.20	N/m^2	16-bit signed integer

3. **stress_Large_U:** zonal component of the wind stress calculated using Large&Pond algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-1.20	1.20	N/m^2	16-bit signed integer

4. **stress_Large_V:** meridional component of the wind stress calculated using Large&Pond algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-1.2	1.2	N/m^2	16-bit signed integer

5. **cd_Liu:** drag coefficient calculated using Liu&Tang algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-2.0	2.5	none	16-bit signed integer

6. **cd_Large:** drag coefficient calculated using Large&Pond algorithm.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-2.0	2.5	none	16-bit signed integer

7. **time_frac:** time in fraction of a day at which ascending pass measurement was

taken

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[1624]	0.0002	0.00	0.00	1.00	fraction of day	16 bit unsigned integer

8. **wvc_quality_flag**

This flag indicates the quality of wind retrieval within a given wind vector cell. Quality of wind retrieval is based on the number and the quality of the σ_o measurements within the cell. If the Wind Retrieval Flag (bit 9) is set, then all of wind measurement parameters for the associated wind vector cell contain null values. The significance of each of the bit flags is as follows:

Bit	**Definition**	**Bit Significance**
0	Adequate Sigma0 Flag	0 - Adequate good sigma0s available for wind retrieval.
		1 - Not enough good sigma0s available for wind retrieval.
1	Adequate Azimuth Diversity Flag	0 - Good azimuth diversity among sigma0s for wind retrieval.
		1 - Poor azimuth diversity among sigma0s for wind retrieval.
2-6	Reserved for future use	Always clear (0)
7	Coastal Flag	0 - No land mass was detected within the wind vector cell.
		1 - Some portion of the wind vector cell is over land.
8	Ice Edge Flag	0 - No ice was detected within the wind vector cell.
		1 - Some portion of the wind vector cell is over ice.
9	Wind Retrieval Flag	0 - Wind retrieval performed for wind vector cell.
		1 - Wind retrieval not performed for wind vector cell.
10	High Wind Speed Flag	0 - Reported wind speed is less than or equal to 30 m/sec.
		1 - Reported wind speed is greater than 30 m/sec.
11	Low Wind Speed Flag	0 - Reported wind speed is greater than or equal to 3 m/sec.
		1 - Reported wind speed is less than 3 m/sec.
12	Rain Flag Usable	0 – Rain flag for the wind vector cell is usable.
		1 – Rain flag for the wind vector cell is not usable.
13	Rain Flag	0 – Rain flag algorithm does not detect rain.
		1 – Rain flag algorithm detects rain.

14	Available Data Flag	0 – Inner beam data with QuikSCAT view forward and aft and outer beam data with QuikSCAT view forward and aft are available.
		1 – Data from at least one of the four possible beam and view combinations are not available.
15	Spare	Always clear (0)

9. **wvc_row:** This data element denotes the along-track location index of the WVC rows in the spacecraft measurement swath. Each WVC is a 25 km square. Each rev can contain a maximum of 1624 WVC rows.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[1624]	1	0.00	1.00	1624.0	N/A	16 bit unsigned integer

10. **wvc_lat:** The geodetic latitude of the centroid of a WVC based on the locations of the sigma0s which contribute to wind retrieval.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-90.0	90.0	none	16-bit signed integer

11. **wvc_lon:** The longitude of the centroid of a WVC based on the locations of the sigma0s which contribute to wind retrieval.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	0.0	360.0	none	16-bit unsigned integer

12. **wvc_index:** This index denotes the cross-track location of the WVC in the spacecraft measurement swath. Each WVC is a 25 km square. Each WVC row contains 76 cells. 38 WVCs are located on either side of the spacecraft nadir track. WVC indices increase from left to right when viewing the orbital swath in the direction of spacecraft flight. The index of the leftmost cell is 1. The index of the rightmost cell is 76.

Dimensions	Scale	Offset	Minimum	Maximum	Units	Storage Type
[76,1624]	0.00005	0.00	-90.0	90.0	none	16-bit signed integer

Sample Data Record:

The following sample output was obtained using program read_qs2bstress.f. Records 500 and 501were read from input file QS_ST2B16681.03Feb061103. Please note that all calibrations and offsets have been applied.

```
Enter the first and last record numbers [1-1624]: 500,501
```

TIME: 0.9739800
WVC ROW: 500.

WVC#	WVC_Qual	WVC Latitude/Longitude		U_Liu	V_Liu	CD Liu	U_Large	V_Large	CD_Large
3.	0X4000	19.12	86.17	0.0239	0.0591	0.0638	0.0184	0.0457	0.0492
4.	0X4000	19.18	86.42	0.0257	0.0526	0.0585	0.0200	0.0410	0.0455
5.	0X6000	19.20	86.65	0.0373	0.0671	0.0767	0.0283	0.0510	0.0584
6.	0X6000	19.26	86.85	0.0547	0.0510	0.0748	0.0417	0.0388	0.0570
7.	0X6000	19.31	87.08	0.0716	0.0645	0.0964	0.0538	0.0485	0.0724
8.	0X6000	19.37	87.37	0.0673	0.0454	0.0812	0.0510	0.0344	0.0615
9.	0X6000	19.40	87.62	0.0275	0.0410	0.0493	0.0218	0.0325	0.0391
10.	0X0000	19.47	87.86	0.0177	0.0282	0.0333	0.0148	0.0236	0.0279
11.	0X0000	19.49	88.05	0.0178	0.0333	0.0377	0.0147	0.0273	0.0310
12.	0X0000	19.53	88.29	0.0192	0.0378	0.0424	0.0155	0.0305	0.0342
13.	0X0000	19.60	88.52	0.0221	0.0432	0.0485	0.0175	0.0344	0.0386
14.	0X0000	19.62	88.78	0.0227	0.0465	0.0518	0.0179	0.0367	0.0408
15.	0X0000	19.66	88.97	0.0218	0.0463	0.0512	0.0172	0.0366	0.0404
16.	0X0000	19.70	89.21	0.0165	0.0393	0.0426	0.0133	0.0317	0.0344
17.	0X0000	19.75	89.47	0.0145	0.0343	0.0373	0.0119	0.0282	0.0306
18.	0X0000	19.81	89.68	0.0112	0.0280	0.0301	0.0095	0.0238	0.0257
19.	0X0000	19.84	89.90	0.0065	0.0225	0.0235	0.0058	0.0201	0.0209
20.	0X0000	19.90	90.16	0.0069	0.0163	0.0177	0.0065	0.0154	0.0167
21.	0X0000	19.95	90.41	0.0062	0.0143	0.0157	0.0060	0.0139	0.0152
22.	0X0800	19.96	90.67	0.0008	0.0076	0.0077	0.0010	0.0089	0.0090
23.	0X0800	20.03	90.88	0.0037	0.0055	0.0066	0.0046	0.0068	0.0082
24.	0X0800	20.06	91.12	0.0043	0.0037	0.0057	0.0055	0.0047	0.0073
25.	0X0800	20.08	91.35	0.0032	0.0019	0.0037	0.0047	0.0029	0.0055
26.	0X0800	20.14	91.59	0.0062	0.0029	0.0069	0.0075	0.0036	0.0083
27.	0X0000	20.17	91.80	0.0134	0.0050	0.0143	0.0133	0.0050	0.0142
28.	0X0000	20.20	92.03	0.0124	-0.0022	0.0126	0.0127	-0.0022	0.0129
29.	0X0800	20.27	92.26	0.0079	0.0011	0.0080	0.0092	0.0013	0.0093

TIME: 0.9740200
WVC ROW: 501.

WVC#	WVC_Qual	WVC Latitude/Longitude		U_Liu	V_Liu	CD Liu	U_Large	V_Large	CD_Large
3.	0X4000	19.35	86.11	0.0257	0.0577	0.0632	0.0199	0.0446	0.0488
4.	0X4000	19.38	86.35	0.0254	0.0597	0.0649	0.0195	0.0461	0.0500
5.	0X4000	19.43	86.58	0.0250	0.0513	0.0571	0.0195	0.0400	0.0446
6.	0X6000	19.49	86.83	0.0342	0.0408	0.0533	0.0269	0.0321	0.0419
7.	0X4000	19.53	87.06	0.0269	0.0433	0.0510	0.0212	0.0342	0.0402
8.	0X6000	19.59	87.30	0.0222	0.0255	0.0338	0.0185	0.0213	0.0282
9.	0X4000	19.59	87.56	0.0179	0.0279	0.0331	0.0149	0.0233	0.0277
10.	0X0000	19.68	87.81	0.0176	0.0325	0.0369	0.0145	0.0268	0.0304
11.	0X0000	19.70	87.98	0.0196	0.0372	0.0421	0.0159	0.0301	0.0340
12.	0X0000	19.75	88.22	0.0187	0.0382	0.0426	0.0150	0.0309	0.0344

13.	0X0000	19.81	88.46	0.0183	0.0390	0.0431	0.0148	0.0314	0.0347
14.	0X0000	19.84	88.70	0.0198	0.0464	0.0505	0.0157	0.0367	0.0399
15.	0X0000	19.90	88.93	0.0173	0.0426	0.0461	0.0139	0.0341	0.0368
16.	0X0000	19.92	89.16	0.0167	0.0450	0.0480	0.0133	0.0358	0.0382
17.	0X0000	19.96	89.41	0.0127	0.0350	0.0373	0.0105	0.0288	0.0306
18.	0X0000	20.03	89.63	0.0094	0.0284	0.0300	0.0081	0.0243	0.0256
19.	0X0000	20.06	89.85	0.0062	0.0195	0.0204	0.0057	0.0179	0.0187
20.	0X0000	20.12	90.09	0.0047	0.0191	0.0196	0.0044	0.0176	0.0181
21.	0X0000	20.15	90.32	0.0054	0.0154	0.0163	0.0052	0.0148	0.0157
22.	0X0800	20.17	90.62	0.0012	0.0088	0.0088	0.0014	0.0099	0.0100
23.	0X0800	20.26	90.81	0.0032	0.0092	0.0097	0.0034	0.0100	0.0106
24.	0X0800	20.26	91.06	0.0043	0.0084	0.0094	0.0047	0.0093	0.0104
25.	0X0800	20.30	91.30	0.0036	0.0027	0.0044	0.0049	0.0037	0.0062
26.	0X0800	20.35	91.53	0.0103	0.0016	0.0104	0.0110	0.0018	0.0111
27.	0X0000	20.37	91.76	0.0430	-0.0068	0.0436	0.0347	-0.0055	0.0351
28.	0X0000	20.43	91.98	0.0375	0.0039	0.0377	0.0308	0.0033	0.0310
29.	0X0880	20.50	92.13	0.0081	0.0017	0.0082	0.0093	0.0019	0.0094

Sample Header/Attribute Information:

The following sample header was obtained using program read_qscat_info.c and QS_ST2B16681.03Feb061103:

Number of Datasets= 12

Number of Global Attributes= 15

	Dataset/Name	Rank	Dimensions			Scale	Offset	Data Type
0	stress_Liu_U	2	76	1624	0	0.000050000	0.000000000	int16
1	stress_Liu_V	2	76	1624	0	0.000050000	0.000000000	int16
2	cd_Liu	2	76	1624	0	0.000050000	0.000000000	int16
3	stress_Large_U	2	76	1624	0	0.000050000	0.000000000	int16
4	stress_Large_V	2	76	1624	0	0.000050000	0.000000000	int16
5	cd_Large	2	76	1624	0	0.000050000	0.000000000	int16
6	wvc_index	2	76	1624	0	1.000000000	0.000000000	uint16
7	wvc_lat	2	76	1624	0	0.010000000	0.000000000	int16
8	wvc_lon	2	76	1624	0	0.010000000	0.000000000	uint16
9	wvc_quality_flag	2	76	1624	0	1.000000000	0.000000000	uint16
10	wvc_row	1	1624	0	0	1.000000000	0.000000000	uint16
11	time_frac	1	1624	0	0	0.000020000	0.000000000	uint16

Index	Attribute Name	Values
0	LongName	QuikSCAT Level 2B Ocean Wind Stress in 25km grid
1	ShortName	QSWSL2B
2	producer_agency	NASA
3	producer_institution	JPL
4	PlatformType	spacecraft
5	InstrumentShortName	SeaWinds
6	PlatformLongName	NASA Quick Scatterometer
7	PlatformShortName	QuikSCAT
8	project_id	QuikSCAT
9	data_format_type	NCSA HDF
10	ProductionDateTime	06-Feb-03-11:03:18
11	HDF_version_id	4.1r5
12	EquatorCrossingLongitude	99.22836
13	EquatorCrossingTime	23:16:45

File Naming Convention:

QS_ST2B_nnnnn.YYMMMDDHHmm

where:

QS	=	QuikSCAT
ST2B	=	Level 2B-Derived Multialgorithm SurfaceWind Stress Product
nnnnn	=	Rev number
YY	=	Calendar Year Data were Produced (2000 based)
MMM	=	Month Data were Produced

DD	=	Day Data were Produced
HH	=	Hour in Twenty-Four Hour Time when Data were Produced
mm	=	Minute Data were Produced

8. Data Organization:

Data Granularity:

The basic granule is one data file. Each data file contains the data for one rev.

A general description of data granularity as it applies to the Earth Observing System Data Gateway (EDG) appears in the EOSDIS Glossary.

Data Format:

The SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data are provided in Hierarchical Data Format (HDF) version 4.1r5. The HDF library and further information about HDF may be obtained from the NCSA HDF web site at http://hdf.ncsa.uiuc.edu.

There are 12 scientific data sets and 14 global attributes in each SeaWinds on QuikSCAT Level 2B-Derived wind stress file. For a description of each scientific data set and global attribute, please refer to the Data Description portion (Section 7) of this document.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

Large and Pond Algorithm

The wind stress τ was computed using the bulk parameterization:

$\tau = \rho_a C_D v_{10} \mathbf{v}_{10}$

where

ρ_a is the air density
C_D is the drag coefficient
$\mathbf{v}_{10}$ is the vector wind at a height of 10 m above sea surface
v_{10} is the scalar wind speed at 10 m

The air density was assigned a constant value of $\rho_a = 1.223$ kg/m³

Wind stress was estimated from each QuikSCAT vector wind observation by bulk parameterization using *Large and Pond* [1981] wind speed dependent drag coefficient. The latest developments in Large and Pond algorithm are an extension to low wind speeds, a cubic fit between stress and wind speed so the drag coefficient goes to infinity at zero wind speed as it should, and coupled heat and evaporation coefficients for the stability calculation. Of course for QuikSCAT winds, these already are "equivalent neutral winds at 10m", so there is no need for height and stability adjustments. Therefore the stress magnitude for a QuikSCAT wind speed ν_{10} is simply

$$\tau = 0.00270\,\nu_{10} + .000142\,\nu_{10}^{2} + .0000764\,\nu_{10}^{3}$$

Liu and Tang Algorithm

Given scatterometer wind speed ν_{10} (m/s) at height z = 10 m, this algorithm evaluates the corresponding frictional velocity u_{sr} and stress τ by iterating equations

z_o=0.11*visa/u_{sr} + 0.011* u_{sr}^2/g

u_{srn} = du * 0.4 / log(z/z_o)

$u_{sr} = u_{srn}$

until convergence is achieved, i.e. $|(u_{srn} - u_{sr})/(u_{sr} + 10^{-08})| < 10^{-6}$

$\tau = \rho_a u_{sr}^2$

where

ν_s = surface current

du = $\nu_{10} - \nu_s = \nu_{10}$, since ν_s=0

z = 10m

g = 9.81 N/$m^2$2

visa = 0.15 x10^{-04}

ρ_a = 1.22 kg/m^3

and u_{sr} is set initialy to 0.04du.

Smith [1980] coefficients were used.

Data Processing Sequence:

Processing Steps:

SeaWinds on QuikSCAT science processing proceeds through a well-defined series of level conversion stages, producing more refined products at each stage. The products are created in the following order:

- **Level 0**: Science Telemetry Processing
- **Level 1A**: Engineering Unit Converted Telemetry
- **Level 1B**: Time-Ordered Earth-Located Sigma-0's
- **Level 2A**: Surface Flagged Sigma-0's and Attenuations
- **Level 2B**: Ocean Wind Vectors in a 25km Swath Grid
- **Level 2B-Derived** Multialgorithm Surface Wind Stress

Processing Changes:

None at this time.

Calculations:

Special Corrections/Adjustments:

Each QuikSCAT Level 2B parameter is stored as an integer. To convert to a real value, multiply the parameter by the scaling factor and add the offset. The scaling factor and offset for each parameter is given in the Data Characteristics section of this document and in the attributes of each Level 2B HDF file.

Calculated Variables:

The SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm Surface Wind Stress product contains the following calculated variables, both :

- u and v components of wind stress caculated using both Liu & Tang and Large & Pond algorithms
- drag coefficients calculated as above
- time in fraction of a day
- quality flags

Graphs and Plots:

No additional information.

10. Errors:

Sources of Error:

"When rain is present, measurements of the ocean surface sigma-0 [from which wind speed is derived] 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]

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

- the uncertainty in the receiver noise, known as communication Kp or Kpc
- the uncertainties in the geometric and gain parameters, known as retrieval Kp or Kpr
- the uncertainty associated with the geophysical model function

Other sources of error include attitude pointing uncertainty, instrument processing, and various bias errors.

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, podaac.jpl.nasa.gov, in the pub/ocean_wind/quikscat/mission_status_report directory.

Confidence Level/Accuracy Judgment:

Tests of the QuikSCAT ambiguity algorithm with simulated wind data show that the vectors closest to the true winds are selected 96% of the time, on average. [Dunbar et al, 2000]

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:

Wind measurements may be contaminated when rain is present. The wvc_quality_flag Scientific Data Set is included in this product to account for possible contamination.

Radar returns from land and ice correspond to different scattering processes than those over open ocean, and can contaminate wind vector estimates. A land mask has been applied to the QuikSCAT data in order to negate most contamination due to land and ice.

Known Problems with the Data:

The QSCAT-1 model function has a tendency to underestimate high winds. There is also insufficient information in its behavior in calm situations.

Usage Guidance:

Wind direction convention

The oceanographic, or flow vector, convention for wind direction is adopted for SeaWinds on QuikSCAT. Under this convention, a wind direction of 0° implies a flow *toward* the north.

Reference Height for Surface Winds

The adopted reference height for all wind vectors is 10 meters.

Any Other Relevant Information about the Study:

None.

12. Application of the Data Set:

- global and regional climate studies
- atmospheric forcing, ocean response and air-sea interaction mechanism research
- input to numerical weather- and wave-prediction models

13. Future Modifications and Plans:

The SeaWinds instrument flies also on Japan's Advanced Earth Observing Satellite (ADEOS-II). ADEOS-II was launched in December 2002 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, (http://winds/missions/seawinds/seaindex.html).

14. Software:

Software Description:

Sample read and display software for the SeaWinds on QuikSCAT Level 2B-Derived Wind Stress data are available in C, FORTRAN-77 and Interactive Data Language (IDL). These programs can be easily modified to meet the requirements of individual users.

The latest versions of the sample read and display software can be obtained via anonymous FTP to the PO.DAAC FTP site, podaac.jpl.nasa.gov, in the pub/ocean_wind/quikscat/stress/L2B/sw/ directory. These sample programs are also accessible through the PO.DAAC QuikSCAT Web Site, http://podaac.jpl.nasa.gov/quikscat/qscat_sw.html.

Program Name	Description	Notes
read_qs2bstress.c	C program to read the SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data	1
read_qscat_info.c	C program to read the attributes in QuikSCAT Levels 1B, 2A, 2B ,3 and 2B-Derived Multialgorithm SurfaceWind Stress data	1
read_qs2bstress.f	FORTRAN-77 program to read the SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data	1
read_qscat_info.f	FORTRAN-77 program to read the attributes in QuikSCAT Levels 1B, 2A, 2B and 2B-Derived data	1
read_qs2bstress.pro	IDL program to read the SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data	2
read_qscat_info.pro	IDL program to read the attributes in QuikSCAT Levels 1B, 2A, 2B, 3 and 2B-Derived Multialgorithm SurfaceWind Stress data	2

Notes:

1) The HDF library (version 4 ONLY) must be installed locally before the read software in C or FORTRAN will work properly. The HDF library and further information about HDF may be obtained from the NCSA HDF web site at http://hdf.ncsa.uiuc.edu.

2)IDL is a software tool used for the analysis and display of scientific data. It is a registered trademark of Research Systems, Inc. The installation of the HDF library is not necessary in order to use the IDL read software, because IDL already contains the HDF library.

Software Access:

The latest versions of the sample read and display software can be obtained via anonymous FTP to the PO.DAAC FTP site, podaac.jpl.nasa.gov, in the pub/ocean_wind/quikscat/L2B/sw/ directory. These sample programs are also accessible through the PO.DAAC QuikSCAT Web Site, http://podaac.jpl.nasa.gov/quikscat/qscat_sw.html.

Please note that the global SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data product is currently only available in Hierarchical Data Format (HDF). The HDF library (version 4 ONLY) must be installed before the C or FORTRAN read software will work properly. The HDF library and further information about HDF may be obtained from the National Center for Supercomputing Applications (NCSA) at http://hdf.ncsa.uiuc.edu.

15. Data Access

Contact Information:

Questions and comments concerning the QuikSCAT Science Data Products should be directed to the Physical Oceanography Distributed Active Archive Center (PO.DAAC) at the NASA Jet Propulsion Laboratory (JPL). Please note that e-mail is always the preferred method of communication.

E-Mail: podaac@podaac.jpl.nasa.gov

WWW: http://podaac.jpl.nasa.gov/quikscat/

Phone: 626-744-5508

Fax: 626-744-5506

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

Data Center Identification:

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

Procedures for Obtaining Data:

The SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data set is available via anonymous FTP to podaac.jpl.nasa.gov in the pub/ocean_wind/quikscat/stress/L2B directory.

Further information about SeaWinds on QuikSCAT data is also available at the PO.DAAC QuikSCAT web site, http://podaac.jpl.nasa.gov/quikscat/.

16. Output Products and Availability:

The SeaWinds on QuikSCAT Level 2B-Derived Multialgorithm SurfaceWind Stress data set is available via anonymous FTP to podaac.jpl.nasa.gov in the pub/ocean_wind/quikscat/stress/L2B directory.

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Smith, S.D., 1980. Wind stress and heat flux over the ocean in gale-force winds. *Journal of Physical Oceanography, 10,* 709-726.

Stiles, B.W., 1999. Special Wind Vector Data Product: Direction Interval Retrieval with Threshold Nudging (DIRTH) Product Description, Version 1.1, Jet Propulsion Laboratory, Pasadena, CA.

Tang, W., and W. T. Liu,1996. Equivalent Neutral Wind, JPL Publication 96-17.

18. Glossary of Terms:

Please refer to 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 subsystem

EDG: Earth Observing System Data Gateway

EOS: Earth Observing System

EOSDIS: Earth Observing System Data and Information System

FTP: File Transfer Protocol

FX: SeaPAC File Transfer program subsystem

GSFC: Goddard Space Flight Center

HDF: Hierarchical Data Format

IDL: Interactive Data Language

JPL: Jet Propulsion Laboratory

L1B: QuikSCAT Level 1B Product

L2A: QuikSCAT Level 2A Product

L2B: QuikSCAT Level 2B Product

L3: QuikSCAT Level 3 Product

LASP: Laboratory for Atmospheric and Space Physics at the University of Colorado

LP: SeaPAC Level Processor program subsystem

MOC: Mission Operations Center

NASA: National Aeronautics and Space Administration

NCEP: National Center for Environmental Prediction

NCSA: National Center for Supercomputing Applications

NSCAT: NASA Scatterometer

NWP: Numerical Weather Prediction

PM: SeaPAC Process Management program subsystem

PP: SeaPAC Preprocessor program subsystem

PO.DAAC: Physical Oceanography Distributed Active Archive Center

QA: Quality Assurance

QuikSCAT: NASA Quick Scatterometer

SA: SeaPAC Science Analysis program subsystem

SAFS: Standard Autonomous File Server

SDS: Scientific Data Set

SeaPAC: SeaWinds Processing and Analysis Center

SWT: Science Working Team

URL: Uniform Resource Locator

UTC: Universal Time Coordinated

WVC: Wind Vector Cell

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