Physical Oceanography DAAC

SeaWinds on ADEOS-II Level 2B Ocean Wind Vectors in 25km Swath

(JPL SeaWinds Project)

Guide Document

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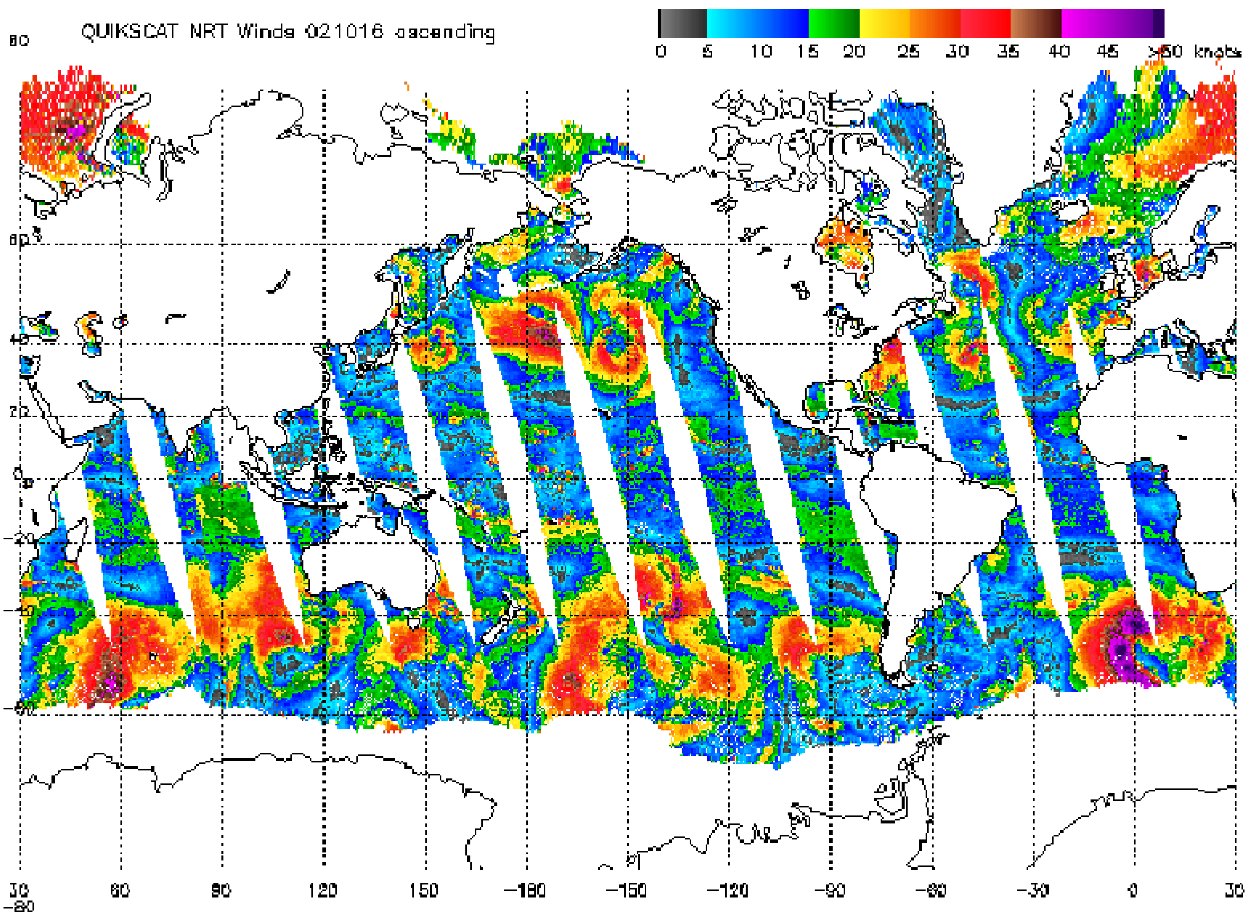
SeaWinds on ADEOS-II Level 2B Ocean Wind Vectors in 25km Swath (JPL SeaWinds Project)



Summary:

The SeaWinds on ADEOS-II Level 2B data set consists of ocean wind vector solutions organized by full orbital revolution of the spacecraft or ‘rev’. Each Level 2B file represents one satellite rev.

This product is also referred to as JPL PO.DAAC product 142.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

SeaWinds Level 2B Ocean Wind Vectors in 25km Swath
JPL PO.DAAC Product 142

Data Set Introduction:

The SeaWinds on ADEOS-II scatterometer provides normalized radar cross section (sigma0) measurements of the Earth's surface. The Level 2B product converts those raw measurements into near-surface wind vectors over the oceans. Each file contains one rev of wind 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. For each wind vector cell, the product contains up to four wind vector solutions, reported in order of descending probability.

Objective/Purpose:

Like the SeaWinds Level 3 product, this data set provides wind velocities 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 vectors along the trajectory of the spacecraft. Also, as the Level 3 data are derived from the Level 2B data, the L2B product does not wash out some information such as:

- the actual latitudes and longitudes of the measured locations
- four potential wind vector solutions
- the rms error of the wind vectors

i.e. the Level 2B product is a more low-level product.

Summary of Parameters:

Section 7's "Data Characteristics" completely lists the HDF variables available in each L2B file. Briefly:

For each row of wind vector cells,

- wvc_row_time: time spacecraft passed over location of the wind vector cell row
- wvc_row: along-track index

For each wind vector cell,

- wvc_lat: latitude
- wvc_lon: longitude
- wvc_index: cross-track index
- num_in_fore: number of sigma0s from the inner beam forward of the spacecraft
- num_in_aft: number of sigma0s from the inner beam aft of the spacecraft
- num_out_fore: number of sigma0s from the outer beam forward of the spacecraft
- num_out_aft: number of sigma0s from the outer beam aft of the spacecraft
- wvc_quality_flag: data quality
- atten_corr: attenuation correction
- model_speed: wind speed derived from NCEP
- model_dir: wind direction derived from NCEP
- num_ambigs: number of ambiguities
- wvc_selection: which ambiguity was selected
- wind_speed_selection: wind speed
- wind_dir_selection: wind direction
- mp_rain_probability: probability of rain
- nof_rain_index: a rain indicator
- amsr_rain_indicator
- srad_rain_rate: rain rate

For each of the four ambiguities of each wind vector cell,

- wind_speed
- wind_dir: wind direction
- wind_speed_err: uncertainty of the wind speed
- wind_dir_err: uncertainty of the wind direction
- max_likelihood_est: estimation of correctness

Discussion:

Each SeaWinds Level 2B 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 processes SeaWinds Level 2A normalized radar cross section (sigma0) measurements and generates the Level 2B Product. 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 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.

Except for wvc_row_time, an HDF SDS object stores every data element in the Level 2B Data. An HDF Vdata object stores wvc_row_time. The number of wvc_row_time entries matches the number of WVC rows in the Level 2B Product.

Except for the element wvc_row, every SDS is an array of at least two dimensions. The first SDS dimension represents the WVC row while the second dimension represents a particular WVC within the row.

The Level 2B Product numbers the wind vector cells from left to right when viewing the orbital swath in the direction of spacecraft flight. Thus, num_ambigs[203,15] lists the number of retrieved ambiguities for the 16^{th} wind vector cell from the left hand side of the swath when facing the spacecraft's forward direction of motion in wvc_row[203].

Several of the Level 2B SDS objects are three-dimensional arrays. For all of these SDS objects, the third array index represents a potential wind solution.

Each WVC includes up to four potential wind velocity solutions. These potential solutions are called 'ambiguities'. The SDS objects wind_speed, wind_dir, wind_speed_err, wind_dir_err and max_likelihood_est list these ambiguities in descending likelihood order. Therefore, the value stored in wind_speed[210,34,0] is the wind speed solution with the greatest likelihood estimator for the wind vector cell stored at array location[210,34]. Likewise, if an entry exists in location wind_speed[210,34,3], its value represents the wind speed solution with the smallest likelihood estimator for the same WVC. The SDS object wvc_selection indicates which of the ambiguities was selected by the median filter ambiguity removal algorithm.

The Level 2B Processor applies an empirically based model function to the set of backscatter measurements in each WVC. Using the sigma0 values, the azimuth angle, the incidence angle, the polarization and the model function, the Level 2B Processor generates a Maximum Likelihood Estimator (MLE) value for each element in a set of wind vector solutions. The Level 2B Product output may list as many as four of the most likely wind vector solutions for each wind vector cell. These potential solutions are known as 'ambiguities'. The ambiguity removal algorithm then determines which of the potential solutions best estimates the near surface wind conditions for each WVC.

Finally, the Direction Interval Retrieval (DIR) algorithm enhances the wind solution selected by ambiguity removal. DIR calculates a range of wind directions that is representative of the selected ambiguity in each wind vector cell. DIR then employs a median filter over the entire swath to determine the optimal wind direction within the calculated range for each wind vector cell. When the Level 2B Processor uses DIR, the metadata element l2b_algorithm_descriptor in the Level 2B Product indicates that the wind direction of the selected ambiguity has been enhanced.

When DIR is in use, the SDS objects wind_speed_selection and wind_dir_selection list the output from DIR processing. Users who have interest in the wind solution based on DIR should employ the data that are stored in these SDS objects. Users who are interested in wind solutions that have not been modified by the DIR algorithm should locate the data element that represents the selected ambiguity in the SDS objects wind_speed and wind_dir. For instance, if wvc_selection[204,30] indicates that the second ambiguity was selected, then the solutions that were not enhanced by DIR processing are located in data elements wind_speed[204,30,1] and wind_dir[204,30,1].

When the Level 2B Processor does not use the DIR algorithm, the SDS objects wind_speed_selection and wind_dir_selection list the wind speed vector selected by ambiguity removal. Thus, if DIR is not in use, and data element wvc_selection[612,54] indicates that the first ambiguity was selected, wind_speed_selection is then equal to wind_speed[612,54,0], and wind_dir_selection is equal to wind_dir[612,54,0].

The Level 2B Processor can incorporate a correction for the effect of the earth's atmosphere on the scatterometer's echo signal. The Level 2B Processor may draw this correction from one of two potential sources: 1) geophysical parameters retrieved from collocated observations of the Advanced Microwave Sensing Radiometer (AMSR), or 2) global climatological maps of average atmospheric attenuations based on SSM/I data to correct the measured sigma0s for atmospheric effects.

The Level 2B Product specifies the number of sigma0 measurements that are located within each WVC. The product lists the potential wind vector solutions and MLEs that the model function generates, and specifies which of those solutions the ambiguity removal algorithm selects. The product includes uncertainty measures for each solution as well as overall quality indicators for the data set within each WVC.

Related Data Sets:

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

- SeaWinds on ADEOS-II Level 3 Daily, Gridded Ocean Wind Vectors
  JPL PO.DAAC Product 142
- SeaWinds on QuikSCAT Level 2B Ocean Wind Vectors in 25 Km Swath Grid (JPL SeaWinds Project)
  JPL PO.DAAC Product 108
- SeaWinds on QuikSCAT Level 3 Daily, Gridded Ocean Wind Vectors (JPL SeaWinds Project)
  JPL PO.DAAC Product 109
- 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

In addition to the products mentioned above, additional Level 3 products will be produced by members of the SeaWinds on ADEOS-II Science Working Team. Many of these products provide the SeaWinds data on coarser grids (0.5° or 1°) or at smaller time intervals (6 or 12 hour maps). Advanced interpolation techniques may also be used to fill gaps in the wind fields. A list of the publicly available SeaWinds Level 3 products produced by SeaWinds on ADEOS-II Science Working Team members can be found on the PO.DAAC SeaWinds on ADEOS-II Web Site Links Page:

http://podaac.jpl.nasa.gov/seawinds/sws_links.html

2. Investigator(s):

NOTE: Please refer all questions concerning the SeaWinds on ADEOS-II Level 2B product to the PO.DAAC SeaWinds Data Team, sws@podaac.jpl.nasa.gov, or the PO.DAAC User Services Office, podaac@podaac.jpl.nasa.gov.

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

SeaWinds on ADEOS-II Level 2B Product Author:

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SeaWinds on ADEOS-II JPL Project Scientist

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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*, 2001]

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

4. Equipment:

NOTE: This section was obtained entirely from the **SeaWinds 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 ADEOS-II satellite.

Source/Platform:

The ADEOS-II satellite was launched into a sun-synchronous, 803-kilometer, circular orbit on 14 December 2002. The local equator crossing time at the ascending node is 10:30 P.M. ± 30 minutes .

The nominal orbit for ADEOS-II 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	10:30 P.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 ADEOS-II 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 QuikSCAT-1 model function was used to obtain the SeaWinds on ADEOS-II ocean wind data.

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 ADEOS-II is a conically scanning pencil-beam scatterometer. SeaWinds 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:

SeaWinds 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.

SeaWinds "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 SeaWinds, 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, SeaWinds 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 obtained entirely from the **SeaWinds Science Data Product User's Manual** . Please refer to the User's Manual for more information.

This section describes the overall design and functionality of the ground processing system for data from ADEOS-II. The parts most relevant for SeaWinds data:

NASDA/EOC

- receives raw data from the ground stations
- sends AMSR Level 1A data to PO.DAAC

- sends raw SeaWinds data to SeaPAC

JPL/SeaPAC

- receives data from PO.DAAC and EOC
- processes data into higher level SeaWinds products
- sends SeaWinds products to PO.DAAC

JPL/PO.DAAC

- receives AMSR L1A data from EOC, sends them to SeaPAC, and stores them for a limited time
- receives SeaWinds data from SeaPAC, archives them (except for near-real-time data), and distributes data products

o The ADEOS-II Mission Operations Interface Specification (MOIS Common Part version 1.1, February 2002, AD2-EOC-96-054) more thoroughly describes the overall ground processing system. Each major component, as identified in the data flow diagram Figure 5.1, is described in a subsection below.

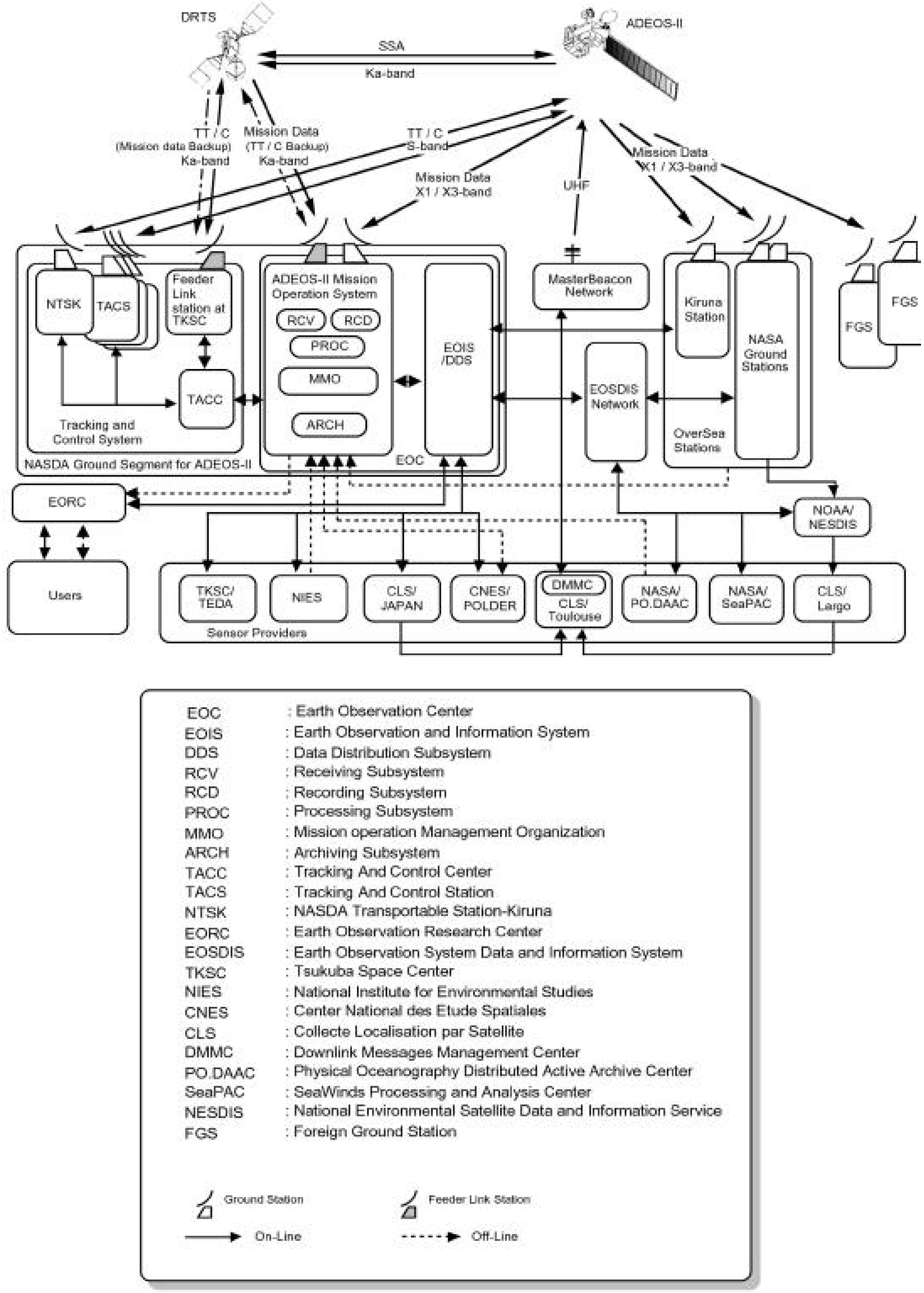


Figure 5-1: ADEOS-II Data Flow

5.1 NASDA Ground Segment for ADEOS-II

5.1.1 ADEOS-II Mission Operation System

ADEOS-II Mission Operation System, located at the Earth Observation Center (EOC) in Hatoyama, is the main planning organization for ADEOS-II mission operations. The ADEOS-II Mission Operation System makes the operation plan of ADEOS-II onboard instruments based on the operation requests from sensor providers such as the SeaWinds project and NASDA PIs. The ADEOS-II Mission Operation System also schedules data downlinks and plans mission data recorder operations (tape management). This system also has some link responsibilities for the spacecraft and archive and processing responsibilities for the NASDA instruments on board ADEOS-II.

5.1.2 Earth Observation Information System/Data distribution and Management Subsystem (EOIS/DDMS)

NASDA's EOIS/DDMS at the EOC provides network services for ADEOS-II operations, distributes standard product data sets and catalog information to users, and provides catalog system interoperability with EOSDIS. Additionally, the Data Distribution Subsystem, part of DDMS, is the primary interface for ADEOS-II mission operations information and data flows between EOC and related agencies using network.

5.1.3 Tracking and Control System

The Tracking and Control System verifies the EOC mission operations plan against satellite constraints, generates the satellite commands, and transmits them. It also acquires the satellite engineering telemetry and ranging data for orbit determination, monitors the safety of the instruments, and activates emergency procedures if necessary, and processes Doppler tracking data to provide predict and definitive satellite ephemeris.

5.2 Earth Observation Research Center (EORC)

EORC develops the higher level processing software for AMSR and other Japanese instruments.

5.3 Overseas Stations

5.3.1 NASA/NOAA Ground Network

The NASA/NOAA Ground Network (NGN) is a NASA management activity for the coordination of data acquisition from passes not available to EOC at Hatoyama, Japan or Kiruna, Sweden. The NGN Data Acquisition Stations (NASA Ground Stations) consist of Alaska SAR Facility located at Fairbanks, Alaska and Wallops Flight Facility at Wallops Island, Virginia.

5.3.2 Kiruna Station

Kiruna Station serves as a Direct Downlink Station of NASDA.

5.4 Sensor Providers

These receive minimally processed data from NASDA/EOC, the NASA/NOAA Ground Network, and Kiruna via network.

5.4.1 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.

5.4.1.1 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 EOC, 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.

5.4.1.2 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.

5.4.1.3 Preprocessor Subsystem (PP)

The PP subsystem takes care of the initial processing of the Level 0 science telemetry, creating the basic input products for initiating the main science data processing. PP creates time correlation, ephemeris, and attitude files, creates the SeaWinds 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.

5.4.1.4 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 3 wind vector products. LP consists of five main programs, one each to produce L1A, L1B, L2A, L2B and L3 data in sequence. LP software incorporates and implements all of the science algorithms, and creates the HDF data products delivered to PO.DAAC and to the science community.

5.4.1.5 Engineering Analysis Subsystem (EA)

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

5.4.1.6 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.

5.4.2 Physical Oceanography Distributed Active Archive Center (PO.DAAC)

PO.DAAC's main function is to receive science data from SeaPAC, archives the data, and distributes Level 1B, Level 2A, Level 2B and Level 3 to the SeaWinds science community. PO.DAAC also archives all telemetry, Level 0, Level 1A and ancillary files collected during the SeaWinds mission.

PO.DAAC also acts as a sensor provider by receiving AMSR L1A data from EOC, which PO.DAAC then forwards to SeaPAC and stores for a limited time.

5.5 Centre National d'Etudes Spatialies (CNES)

CNES manages two instruments on ADEOS-II:

- POLDER observes intensity and polarization of solar radiation reflected by the atmosphere under different viewing angles
- ARGOS DCS is a location and data collection system for studying and protecting the environment

5.6 National Institute for Environmental Studies (NIES)

Japan's NIES and Ministry of the Environment manage the Improved Limb Atmospheric Spectrometer-II, which monitors the high-latitude stratospheric ozone.

5.7 Tsukuba Space Center (TKSC)

TKSC supplies TEDA, the Technical Data Acquisition Equipment, which monitors the space environment and acquires engineering data.

5.8 National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS)

NOAA/NESDIS utilizes SeaWinds and other data in near real-time for weather analysis and forecasting.

6. Observations:

Data Notes:

No additional notes.

Field Notes:

No additional notes.

7. Data Description:

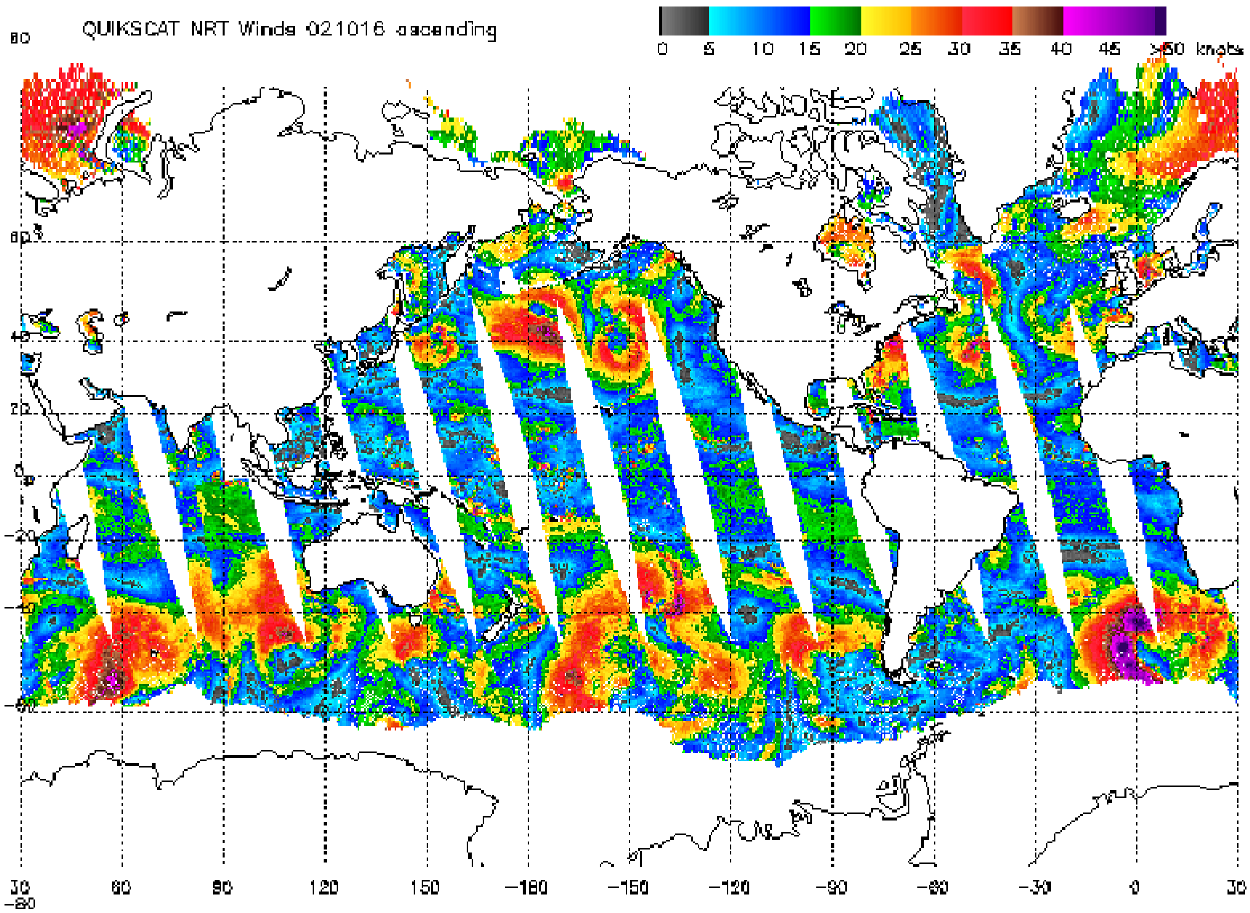
Spatial Characteristics:

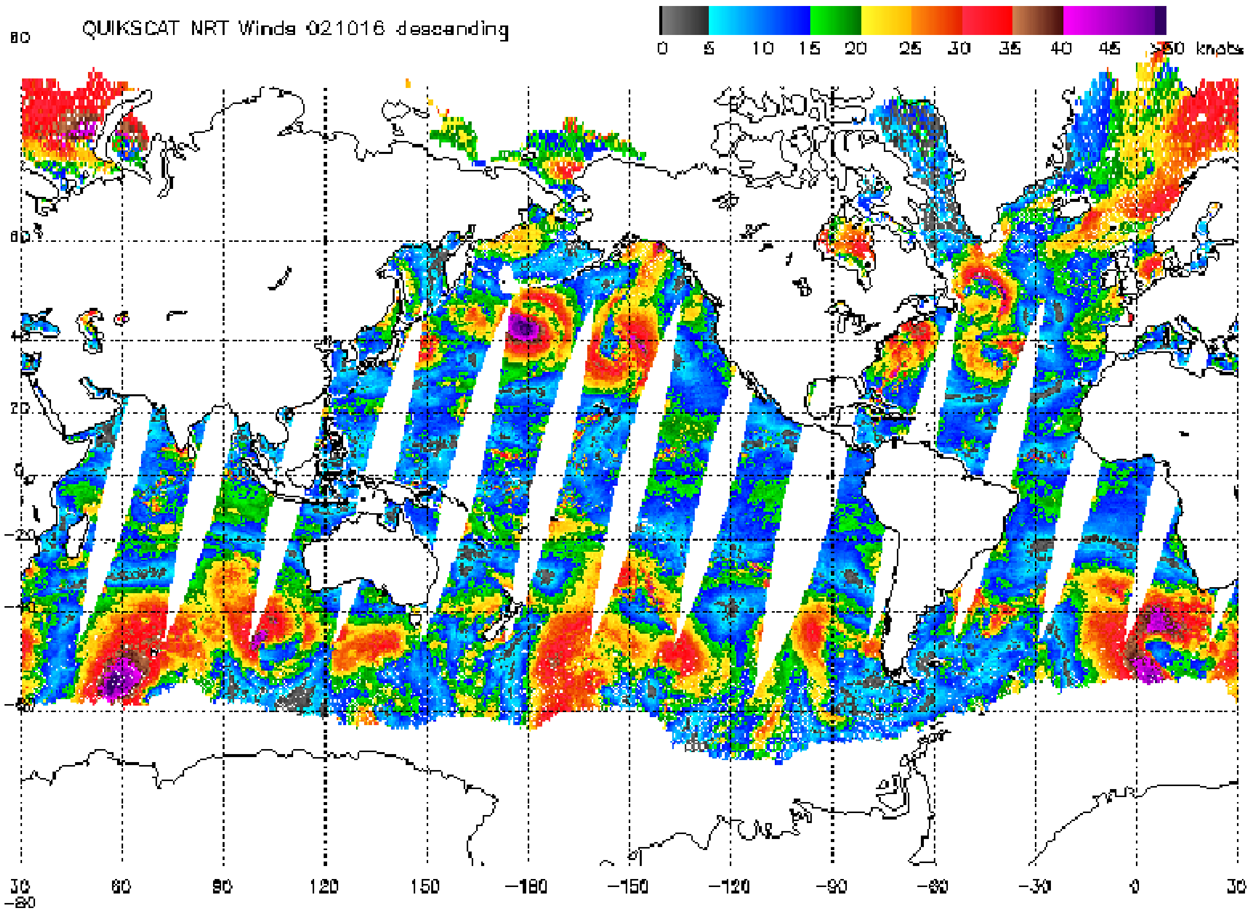
Spatial Coverage:

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 ADEOS-II Level 2B data. (Note: Images are from the QuikSCAT near real-time descending and ascending passes for October 17, 2002.)





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:

Data acquisition begins in January 2003. More 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, or less, of SeaWinds data. A complete rev includes all of the data that pertains to one full orbital revolution of the spacecraft, approximately 104 minutes worth of data.

Data Characteristics:

There are 1 Vdata (wvc_row_time) and 24 Scientific Data Sets within each SeaWinds Level 2B HDF data file.

1. **wvc_row_time:** The time when the nadir path of the SeaWinds instrument passes over the midpoint of the corresponding wind vector cell row. This value provides a representative time for the data which are stored in the corresponding wind vector cell row. Users should note that the wvc_row_time is not equivalent to the time that the data were acquired. Due to the rotating antenna design of the SeaWinds instrument, the measurements in the row may have been acquired a few minutes before or after the specified wvc_row_time. This time character string expression uses UTC format.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
time	char	[1624]	N/A	1993-001T00:00:00.000	2016-366T23:59:60.999

2. **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.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	32

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

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int8	[1624,76]	1	-90.	90.

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

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int8	[1624,76]	1	0.	359.99

5. **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.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	1	76

6. **num_in_fore:** The number of sigma0 measurements used for wind retrieval within the WVC from the inner antenna beam directed toward a position on the Earth forward of the spacecraft.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	32

7. **num_in_aft:** The number of sigma0 measurements used for wind retrieval within the WVC from the inner antenna beam directed toward a position on the Earth aft of the spacecraft.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	32

8. **num_out_fore:** The number of sigma0 measurements used for wind retrieval within the WVC from the outer antenna beam directed toward a position on the Earth forward of the spacecraft.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	32

9. **num_out_aft:** The number of sigma0 measurements used for wind retrieval within the WVC from the outer antenna beam directed toward a position on the Earth aft of the spacecraft.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	32

10. **wvc_quality_flag:** This flag indicates the quality of wind retrieval within a given WVC. The quality of wind retrieval is based on the number and the quality of the sigma0 measurements within the cell. If the Wind Retrieval Flag (bit 9) is set, then all of wind measurement parameters for the associated WVC contain null values. The significance of each of the bit flags is as follows:

Bit Definition

---- --

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 Attenuation Method Data Flag

0 - AMSR used to correct sigma0s for atmospheric attenuation.

1 - Map used to correct sigma0s for atmospheric attenuation.

3-4 Available AMSR Attenuation Flag

0 - All of the WVC sigma0s have AMSR attenuation.

1 - N/A

2 - Some of the WVC sigma0s have AMSR attenuation.

3 - None of the WVC sigma0s have AMSR attenuation.

5-6 AMSR Weather Condition Flag

0 - Collocated AMSR brightness temperatures indicate clear weather for all sigma0s used in wind retrieval.

1 - N/A

2 - Collocated AMSR brightness temperatures indicate light rain for at least one sigma0 used in wind retrieval, no sigma0s are associated with heavy rain.

3 - Collocated AMSR brightness temperatures indicate heavy rain for at least one sigma0 used in wind retrieval.

7 Coastal Flag

0 - No land mass was detected within the WVC.

1 - Some portion of the WVC is over land.

8 Ice Edge Flag

0 - No ice was detected within the WVC.

1 - Some portion of the WVC is over ice.

9 Wind Retrieval Flag

0 - Wind retrieval performed for WVC.

1 - Wind retrieval not performed for WVC.

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 Multidimensional Histogram (MUDH) Rain Flag Usable

0 - The MUDH rain flag for the WVC is usable.

1 - The MUDH rain flag for the WVC is not usable.

13 Multidimensional Histogram (MUDH) Algorithm Rain Flag

0 - The MUDH algorithm does not detect rain.

1 - The MUDH algorithm detects rain.

14 Available Data Flag

0 - Inner beam data with SeaWinds view forward and aft and outer beam data with SeaWinds view forward and aft are available.

1 - Data from at least one of the four possible beam and view combinations are not available.

15 AMSR Rain Indicator Flag

0 - The reported AMSR rain indicator value is usable.

1 - The reported AMSR rain indicator value is not usable.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0x0000	0xFFFF

11. **atten_corr:** The representative atmospheric nadir attenuation for all of the sigma0s in a single wind vector cell. Under nominal processing conditions, the Level 2B Processor adds the attenuation corrections to each sigma0 measurement before wind retrieval begins. atten_corr contains an average attenuation correction value for all of the sigma0s in a single WVC. Thus, the attenuation value that the Level 2B Processor applies to individual sigma0s may differ somewhat from the corresponding value listed in atten_corr.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	0	32.767

12. **model_speed:** The wind speed value which reflects weather conditions at or near the location of the WVC at the approximate time the spacecraft flew over the area. The Level Processor uses the Numerical Weather Product (NWP) from the National Center for Environmental Prediction (NCEP) to generate a representative model speed for each WVC.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	0	70.00

13. **model_dir:** The wind direction value which reflects weather conditions at or near the location of the WVC at the approximate time the spacecraft flew over the area. The Level Processor uses the NWP from NCEP to generate a representative model_dir for each WVC.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	uint16	[1624,76]	0.01	0	359.99

14. **num_ambigs**: The Level 2B Processor generates up to four potential wind vector solutions for each WVC . Each of these potential wind vector solutions are known as ambiguities. This parameter indicates the number of ambiguities associated with the specified WVC. If num_ambigs is zero, then winds were not retrieved for the corresponding WVC.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	4

15. **wind_speed**: The speed component of a wind vector solution for a WVC . This value, along with its corresponding wind direction component, comprises one of up to four potential wind vector solutions for the WVC. Each of these potential solutions is called an ambiguity.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76,4]	0.01	0	50.00

16. **wind_dir:** The direction component of a wind vector solution for a WVC . This value, along with its corresponding wind speed component, comprises one of up to four potential wind vector solutions for the WVC. Each of these potential solutions is called an ambiguity. Wind flowing toward the North is defined as 0 degrees, with positive angles increasing in the clockwise direction.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76,4]	0.01	0	359.99

17. **wind_speed_err:** The rms uncertainty of the wind speed associated with each potential solution for the WVC .

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76,4]	0.01	0	50.00

18. wind_dir_err: The rms uncertainty of the wind direction associated with each potential solution for the WVC .

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76,4]	0.01	0	180.00

19. max_likelihood_est: This parameter indicates the relative likelihood that a particular wind vector solution is correct. The Level 2B Processor applies a Maximum Likelihood Estimator (MLE) to each of the potential wind vector solutions in each WVC. These potential wind vector solutions are known as ambiguities. The greater the MLE output, the more probable its corresponding ambiguity is correct.

ConceptualType	StorageType	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76,4]	0.001	-3.0	1.0

20. wvc_selection: This index specifies which of the potential WVC ambiguities was selected by the ambiguity removal algorithm. A value of zero indicates that none of the ambiguities were selected or there were no ambiguities to select.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
integer	int8	[1624,76]	1	0	4

21. wind_speed_selection: The speed component of a wind vector solution for each WVC . If the Level 2B Processor does not use Direction Interval Retrieval (DIR), this value is equal to the wind speed of the selected ambiguity. If DIR is used, the wind_speed_selection contains a wind speed solution that is based on the selected ambiguity.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	0.0	50.0

22. wind_dir_selection: The direction component of a wind vector solution for each WVC . If the Level 2B Processor does not use Direction Interval Retrieval (DIR), this value is equal to the wind direction of the selected ambiguity. If DIR is used, the wind_dir_selection contains a wind direction solution that is based on the selected ambiguity.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	0.0	359.99

23. **mp_rain_probability:** The probability of a columnar rain rate that is greater than 2 km*mm/hr. This probability value is read directly from a table based on eight input parameters. The space spanned by these parameters can detect whether the set of sigma0s used in wind retrieval contain a noteworthy component created by some physical phenomenon other than wind over the ocean's surface. The most likely phenomenon is rain. A value of -3.00 indicates an inability to calculate a probability value.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.001	-3.0	1.0

24. **nof_rain_index:** An index based upon a simplified version of the standard model function to determine a maximum likelihood estimator and a wind speed for each WVC. The maximum likelihood estimator is based upon the sum of the squared differences between the set of sigma0s that were used to retrieve winds and the corresponding model function sigma0s that would generate the ambiguity with the greatest maximum likelihood estimator. The wind speed is based upon a modified sigma0 which is specifically calculated to be less sensitive to rain. The simplified maximum likelihood estimator is normalized by a tabular empirical estimate for the 95th percentile of the squared difference distribution. These tabular values are indexed by beam polarization, cross track location in the measurement swath, and wind speed. The normalized maximum likelihood estimator is then divided by the number of sigma0s in the WVC, multiplied by thirty, and rounded to the nearest integer value. This metric is most effective for wind speeds under 10 m/sec. The metric is not so effective for wind speeds which are greater than 15 m/sec. Users should employ this flag with caution in high wind speed regions.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
unsigned integer	uint8	[1624,76]	1	0	250

25. **amsr_rain_indicator:** A non-dimensional parameter that reflects the ambient atmospheric conditions. The table below lists three ranges of rain indicator values, specifies the atmospheric conditions that are typical for those numerical ranges, and describes the relative effect of those conditions upon the backscatter signal detected by the SeaWinds instrument.
The value is retrieved using observations of the Advanced Microwave Scanning Radiometer (AMSR).

Rain Indicator Range	Atmospheric Condition and the Effect on the Scatterometer Echo Signal
Less than 0.5	Clear sky or cloudy conditions. Atmosphere attenuates the backscatter signal.
Between 0.5 and 4.2	Light to moderate rain conditions. Atmospheric phenomena attenuate the backscatter signal. Most of the attenuation is due to precipitating hydrometeors.
Greater than 4.2	Heavy rain conditions. Backscatter generated by hydrometeors in the atmosphere dominates the scatterometer echo signal. Phenomena that attenuate the backscatter signal are small by comparison.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	-20.0	100.0

26. **srad_rain_rate:** A representative columnar rain rate for each WVC. The integrated rain rate is based on 13.402 GHz brightness temperatures that were generated using the noise energy level of the SeaWinds instrument.

Conceptual Type	Storage Type	Repetition	Scale	Minimum	Maximum
real	int16	[1624,76]	0.01	0.0	50.0

Sample Data Record:

The following sample output was obtained using program read_sws2b.f using a pre-launch simulated data file SW_S2B10994.20021552206. Please note that all calibrations and offsets have been applied.

TIME: 2001-211T00:36:33.212
WVC ROW: 130.

WVC#	WVC_Qual	WVC Latitude	WVC Longitude	Selected Wind Vector		NWP Wind Vector		Num ambig	Sel ambig	DRE	Wind Vector	MUDH Prob	NOF Index
51.	0X8000	-59.34	99.85	4.41	145.50	7.88	253.42	3.	2.	4.40	157.76	0.00	9.00
52.	0X8000	-59.24	100.24	5.02	118.66	8.07	253.17	4.	3.	5.05	118.66	0.00	3.00
53.	0X8000	-59.17	100.66	5.62	120.62	8.16	253.05	4.	2.	5.61	127.00	0.00	10.00
54.	0X8000	-59.07	101.05	6.73	81.09	8.67	253.05	3.	2.	6.66	93.00	0.00	3.00
55.	0X8000	-58.98	101.47	7.39	81.99	8.59	252.73	3.	1.	7.33	92.19	0.00	9.00
56.	0X8000	-58.91	101.85	8.28	86.99	7.95	250.89	3.	1.	8.27	88.33	0.00	0.00
57.	0X8000	-58.81	102.19	8.53	85.86	7.27	247.66	3.	1.	8.55	88.22	0.00	3.00
58.	0X8000	-58.72	102.62	8.89	77.47	6.56	243.80	4.	1.	9.01	87.88	0.00	4.00
59.	0X8000	-58.63	103.02	9.15	84.56	6.15	239.50	3.	1.	9.21	87.99	0.00	8.00
60.	0X8000	-58.53	103.46	9.94	88.79	5.54	234.06	3.	1.	9.95	88.00	0.00	10.00
61.	0X8000	-58.43	103.79	10.00	79.36	5.34	229.15	3.	2.	10.20	87.91	0.00	7.00
62.	0X8000	-58.35	104.13	9.94	86.45	5.18	224.95	3.	1.	9.99	87.75	0.00	9.00
63.	0X8000	-58.25	104.51	9.76	82.19	5.04	219.24	4.	1.	9.91	86.32	0.00	13.00
64.	0X8000	-58.14	104.94	10.18	84.00	4.89	214.03	4.	1.	10.27	86.24	0.02	6.00
65.	0X8000	-58.05	105.34	10.58	84.65	4.61	206.53	4.	1.	10.64	85.26	0.00	7.00
66.	0X8000	-57.94	105.70	11.30	93.50	4.27	194.85	3.	1.	10.96	84.29	0.02	14.00
67.	0X8000	-57.83	106.08	11.35	86.21	4.12	178.05	3.	1.	11.22	83.16	0.01	18.00
68.	0X8000	-57.76	106.33	11.15	82.05	4.38	166.47	3.	2.	11.19	82.61	0.00	16.00
69.	0XC000	-57.64	106.83	11.61	88.92	4.75	148.45	4.	2.	11.31	82.45	0.00	0.00
70.	0XC000	-57.53	107.15	10.72	75.45	5.29	139.70	4.	2.	11.38	82.09	0.11	0.00
71.	0XC000	-57.43	107.54	13.06	77.44	6.06	129.40	4.	2.	13.41	81.51	0.01	0.00
72.	0XC000	-57.31	107.87	12.99	85.25	6.56	124.02	4.	3.	12.76	81.41	0.00	0.00
73.	0XC000	-57.20	108.27	12.70	78.41	7.18	116.83	4.	1.	12.93	81.09	0.01	0.00
74.	0XC000	-57.09	108.64	12.34	73.59	7.76	110.97	4.	1.	12.87	80.96	0.00	0.00
75.	0XC000	-56.97	109.00	12.28	53.52	8.26	106.24	4.	1.	12.80	76.00	0.03	0.00

Sample Header/Attribute Information:

The following sample header was obtained using program read_sws_info.f and a pre-launch, simulated SeaWinds L2B file SW_S2B10994.20021552206.

```
HDF info for file:
 SW_S2B10994.20021562238
Number of Datasets=  25
Number of Global Attributes=  46

 Dataset/Name          Rank   Dimensions      Scale        Offset      Data Type
 ----------------------------------------------------------------------------
 0  wvc_row              1   1624      0     0    1.000000000  0.000000000  int16
 1  wvc_lat              2     76  1624     0    0.010000000  0.000000000  int16
 2  wvc_lon              2     76  1624     0    0.010000000  0.000000000  uint16
 3  wvc_index            2     76  1624     0    1.000000000  0.000000000  int8
 4  num_in_fore          2     76  1624     0    1.000000000  0.000000000  int8
 5  num_in_aft           2     76  1624     0    1.000000000  0.000000000  int8
 6  num_out_fore         2     76  1624     0    1.000000000  0.000000000  int8
 7  num_out_aft          2     76  1624     0    1.000000000  0.000000000  int8
 8  wvc_quality_flag     2     76  1624     0    1.000000000  0.000000000  uint16
 9  atten_corr           2     76  1624     0    0.001000000  0.000000000  int16
10  model_speed          2     76  1624     0    0.010000000  0.000000000  int16
```

```
11  model_dir            2     76  1624     0   0.010000000  0.000000000  uint16
12  num_ambigs           2     76  1624     0   1.000000000  0.000000000  int8
13  wind_speed           3      4    76  1624   0.010000000  0.000000000  int16
14  wind_dir             3      4    76  1624   0.010000000  0.000000000  uint16
15  wind_speed_err       3      4    76  1624   0.010000000  0.000000000  int16
16  wind_dir_err         3      4    76  1624   0.010000000  0.000000000  int16
17  max_likelihood_est   3      4    76  1624   0.001000000  0.000000000  int16
18  wvc_selection        2     76  1624     0   1.000000000  0.000000000  int8
19  wind_speed_selectio  2     76  1624     0   0.010000000  0.000000000  int16
20  wind_dir_selection   2     76  1624     0   0.010000000  0.000000000  uint16
21  mp_rain_probability  2     76  1624     0   0.001000000  0.000000000  int16
22  nof_rain_index       2     76  1624     0   1.000000000  0.000000000  uint8
23  amsr_rain_indicator  2     76  1624     0   0.010000000  0.000000000  int16
24  srad_rain_rate       2     76  1624     0   0.010000000  0.000000000  int16

 Index/Attribute Name                    Values
 -----------------------------------------------------------------------------
   0  LongName                           SeaWinds Level 2B Ocean Wind Vectors in 25.0km Swath Grid
   1  ShortName                          SWSL2B
   2  producer_agency                    NASA
   3  producer_institution               JPL
   4  PlatformType                       spacecraft
   5  InstrumentShortName                SeaWinds
   6  PlatformLongName                   Advanced Earth Observing Satellite II
   7  PlatformShortName                  ADEOS-II
   8  project_id                         SeaWinds
   9  data_format_type                   NCSA HDF
  10  QAPercentOutOfBoundsData           0
  11  QAPercentMissingData               6
  12  build_id                           3.2.1/2002-05-30
  13  HDF_version_id                     4.1r5
  14  ProductionDateTime                 2002-156T22:38:27.000
  15  sis_id                             686-644-3-RevB/2000-04-17
  16  OrbitParametersPointer             SW_SEPHG20012102304.20021542036
                                         SW_SEPHG20012110050.20021542157
  17  StartOrbitNumber                   10993
  18  StopOrbitNumber                    10994
  19  EquatorCrossingLongitude           74.92895
  20  EquatorCrossingTime                00:53:47.479
  21  EquatorCrossingDate                2001-211
  22  rev_orbit_period                   6061.643
  23  orbit_inclination                  98.62321
  24  orbit_semi_major_axis               7188638
  25  orbit_eccentricity                 0.001269169
  26  rev_number                         10994
  27  RangeBeginningDate                 2001-211
  28  RangeEndingDate                    2001-211
  29  RangeBeginningTime                 00:28:29.848
  30  RangeEndingTime                    02:09:31.491
  31  amsr_channel                       6.925 GHz v-pol
                                         6.925 GHz h-pol
                                         10.65 GHz v-pol
                                         10.65 GHz h-pol
                                         18.7 GHz v-pol
                                         18.7 GHz h-pol
                                         23.8 GHz v-pol
                                         23.8 GHz h-pol
                                         36.5 GHz v-pol
                                         36.5 GHz h-pol
                                         89.0 GHz A v-pol
                                         89.0 GHz A h-pol
  32  ephemeris_type                     GPS
  33  sigma0_granularity                 whole pulses
  34  OperationMode                      Wind Observation
  35  l2b_expected_wvc_rows              1624
  36  l2b_actual_wvc_rows                1624
  37  median_filter_method               Wind vector median
  38  sigma0_attenuation_method          Attenuation Map
  39  nudging_method                     NWP Weather Map probability threshold nudging.
  40  ParameterName                      wind_speed_selection
  41  l2b_algorithm_descriptor           Uses QSCAT-1 Model Function.  Applies median filter techniqu
                                         removal.  Ambiguity removal median filter is based on wind v
                                         by 7 wind vector cell window.  Applies no median filter weig
                                         Enhances the direction of the selected ambiguity based on th
                                         directions which exceed a specified probability threshold.
  42  InputPointer                       SW_S2A10994.20021562232
  43  ancillary_data_descriptors         SW_PC2B0001.25
                                         SW_MC2B0001
                                         SNWP1200121106
                                         SW_MODL0003
```

```
                                             GLOB0003
                                             SW_CN2B0001.25
                                             SW_MRCL0001.PULS
                                             SW_EMOF0001.25
                                             SW_OBTB0001
 44  QAGranulePointer                        SW_Q2B10994.20021562238
```

File Naming Convention:

SW_S2Bnnnnn.yyyydddhhmm

where:

SW	=	SeaWinds
S2B	=	Level 2B Gridded Product
nnnn	=	The SeaWinds satellite orbital rev number.
yyyy	=	Calendar Year Data were Produced
ddd	=	Calendar 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 ADEOS-II Level 2B 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 24 Scientific Data Sets, 1 Vdata set, and 45 global attributes in each SeaWinds on ADEOS-II Level 2B 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:

NOTE: This section is summarized from Section 5.3 of the **SeaWinds Science Data Product User's Manual**. Please refer to the User's Manual for more information.

Sigma-0 Grouping

The sigma-0 grouping algorithm prepares the SeaWinds sigma-0 data for wind retrieval processing. The data contained in the Level 1B product are grouped by geographic location into wind vector cells (WVC). The grouped sigma-0 data are saved in WVC rows in the L2A product.

Surface Flags

After the sigma-0 data have been assigned to a WVC, each cell is checked for land and sea ice. The land map used is the same CIA land-sea map used for NSCAT. The sea ice mask is generated from weekly National Ice Center ice edge data. Both the land and ice flagging algorithms check the center of the sigma-0 cell against the land-sea map and the ice mask.

SeaWinds on ADEOS-II Level 2B Processing

The Wind Vector Cell Preparation algorithm operates on a row of WVC values, passed from the Grouping algorithm, one WVC at a time. It then must determine if there is sufficient data of sufficient quality to perform wind retrieval. This algorithm checks each WVC to determine the data counts (total and by beam), quality flags, and surface flags. It then computes the centroid of the sigma-0 locations to give a WVC location (latitude/ longitude; the binning grid is essentially "thrown away" at this point), and passes the "good" data to the Wind Retrieval algorithm. Upon return from wind retrieval, the ambiguous wind vector data are placed in the Level 2B output buffer.

Wind Retrieval

An accurate model function is essential to deriving ocean wind vectors from scatterometer measurements. Varieties of Ku-band models exist, some of which are derived from scattering theory, and some which are empirically derived. The tabular form of the model function, using a table of real-space (non-dB) sigma-0 values, is used for SeaWinds, with modifications for the incidence angle range and the resolution of the table in azimuth and incidence angle. The model function used for SeaWinds is the SWS-1 model.

Ambiguity Removal

The SeaWinds ambiguity removal algorithm uses a modified median filter technique to select a unique wind vector out of a set of ambiguous wind vectors at each wind vector cell. The algorithm is a direct adaptation of the ambiguity removal algorithm used for NSCAT.

NWP Initialization of Ambiguity Removal

The baseline ambiguity removal algorithm for SeaWinds incorporates the Numerical Weather Product (NWP) initialization technique used for NSCAT-1 and NSCAT-2 processing. In this "nudging" technique, the median filter algorithm is initialized with either the first or the second ranked wind vector solution, whichever is closer to the direction of the NWP analysis field. The median filter algorithm then proceeds as described above to generate the final wind vector selections.

DIRTH Algorithms

At far swath, ambiguity removal skill is degraded due to the absence of inner beam measurements, limited azimuth diversity, and boundary effects. Near nadir, due to nonoptimal measurement geometry (fore and aft looking measurement azimuths approximately 180° apart), there is a marked decrease in directional accuracy even when ambiguity removal works correctly. Two algorithms were developed, direction interval retrieval (DIR) to address the nadir performance issue, and threshold nudging (TN) to improve ambiguity removal at far swath. The two algorithms work independently and need not be used together. However, both were used to obtain the DIRTH solutions, wind_speed_selection and wind_dir_selection, in the Level 2B product.

Please refer to Stiles [1999] for more information on the DIRTH algorithms.

Level 3

The Level 3 data were obtained from the Direction Interval Retrieval with Threshold Nudging (DIRTH) wind vector solutions contained in the SeaWinds Level 2B product.

Data Processing Sequence:

Processing Steps:

SeaWinds on ADEOS-II 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 3**: Daily, Gridded Ocean Wind Vectors

Processing Changes:

None at this time.

Calculations:

Special Corrections/Adjustments:

Each SeaWinds 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, which is always 0). The scaling factor 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:

See Summary of Parameteres in Section 1 for a complete list of Calculated Variables.

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/seawinds/mission_status_report directory.

Confidence Level/Accuracy Judgment:

Tests of the SeaWinds ambiguity algorithm with simulated wind data show that the vectors closest to the true winds are selected 96% of the time, on average.

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 rain_prob, rain_flag, srad_rain_rate and amsr_rain_indicator Scientific Data Sets are 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 SeaWinds data in order to negate most contamination due to land and ice.

Known Problems with the Data:

The QuikSCAT-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 ADEOS-II. 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:

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.jpl.nasa.gov/missions/seawinds/seaindex.html.

14. Software:

Software Description:

Sample read and display software for the SeaWinds on ADEOS-II Level 2B 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.

Program Name	Description	Notes
read_sws2Bez.c	Simple C program to read the Level 2B data	1
read_sws2B.c	More standard C program to read the Level 2B data	1
read_sws2B.f	FORTRAN-77 program to read the SeaWinds Level 2B data	1
read_sws_info.f	FORTRAN-77 program to read the attributes in SeaWinds Levels 1B, 2A, 2B and 3 data	1
ave_vecmap.pro	IDL program to display a map of wind vectors from a SeaWinds Level 2B file	2
read_sws2B.pro	IDL program to read the SeaWinds Level 2B data	2
read_sws_info.pro	IDL program to read the attributes in SeaWinds Levels 1B, 2A, 2B and 3 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.

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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/seawinds/L3/sw/ directory. These sample programs are also accessible through the PO.DAAC SeaWinds Web Site, http://podaac.jpl.nasa.gov/seawinds/sws_sw.html.

Please note that the global SeaWinds on ADEOS-II Level 2B 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 SeaWinds 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/seawinds/

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 Archive Center (PO.DAAC)

Procedures for Obtaining Data:

The SeaWinds on ADEOS-II Level 2B Daily, Gridded Ocean Wind Vectors data set is available via anonymous FTP to podaac.jpl.nasa.gov in the pub/ocean_wind/seawinds/L2B directory.

This product is also available on 8mm Exabyte tape in UNIX TAR format. 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/~imswww/pub/imswelcome/.

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

Data Center Status/Plans:

Plans to provide the SeaWinds on ADEOS-II data on DVD are currently under consideration.

16. Output Products and Availability:

This data set is available on 8mm tape and via FTP.

17. References:

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*** SeaWinds Science Data Product Users Manual, Overview & Geophysical Data Product, Editor: Lungu, T., JPL D-21551 Jet Propulsion Laboratory, Pasadena, CA, July 2002.

*** Mission Operations Interface Specification (Common) (MOIS) (Common Part), Ver 1.1, February 2002, AD2-EOC-96-054

Collections:

"NSCAT: Scientific Applications," American Geophysical Union collection of NSCAT papers reprinted from *J. Geophys. Res, Geophys. Res Letters, Eos, Transactions*, AGU, 1999.

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 set

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 set

HDF: Hierarchical Data Format

IDL: Interactive Data Language

JPL: Jet Propulsion Laboratory

L1B: SeaWinds Level 1B Product

L2A: SeaWinds Level 2A Product

L2B: SeaWinds Level 2B Product

L3: SeaWinds Level 3 Product

LP: SeaPAC Level Processor program set

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 set

PP: SeaPAC Preprocessor program set

PO.DAAC: Physical Oceanography Distributed Active Archive Center

QA: Quality Assurance

SA: SeaPAC Science Analysis program set

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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Ocean_Wind_Vectors_in_25km_Swath_Grid