Physical Oceanography Distributed Active Archive Center (PO.DAAC)

QuikSCAT Level 2B Version 4

Guide Document

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Jet Propulsion Laboratory
Pasadena, California

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1. Abstract:

This ocean surface wind vector dataset is provided as a service to the oceanographic and meteorological research communities on behalf of the NASA/JPL QuikSCAT Project in collaboration with the NASA International Ocean Vector Winds Science Team (IOVWST). This document details the QuikSCAT Level 2B (L2B) Version 4 dataset which provides nominal 12.5 km (pixel spacing) swath bins of ocean surface wind vector retrievals with approximately 90% daily coverage over the global ice-free oceans. This 4th version of L2B reprocessing represents the latest improvements to the geophysical model function (GMF) for wind retrieval, near coast wind retrieval, and quality control. The Version 3 algorithm updates, product development, and calibration/validation information is described in further detail by Fore et al. (2013). The newer updates in Version 4 will be published in the near future. Development and distribution of this dataset is made possible through funding provided by NASA.

2. Acknowledgements:

NOTE: Please refer all questions concerning this dataset to PO.DAAC User Services: podaac@podaac.jpl.nasa.gov.

A significant portion of the research for this document was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. The following people have contributed to the procurement of this dataset and user guide documentation:

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3. Mission Description:

The SeaWinds on QuikSCAT mission is a “quick recovery” mission to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT), when the ADEOS-1 satellite lost power in June 1997. QuikSCAT was launched from California’s Vandenberg Air Force Base aboard a Titan II vehicle on 19 June 1999. QuikSCAT completed more than 10 years of nominal operation when the SeaWinds antenna ceased rotation on 23 November 2009. A similar version of the SeaWinds instrument flew on the Japanese ADEOS-II spacecraft, launched in December 2002. The ADEOS-II mission ended prematurely due to a spacecraft power subsystem failure on 24 October 2003. The QuikSCAT mission has continued to provide data of high quality over more than twenty years since launch. Although, nominal operations ended in November, 2009 when the antenna stopped spinning, accurate normalized backscatter along a narrow 25-km wide swath has been until the present. This nonspinning data set has been used to calibrate other scatterometers including OceanSAT-2, RapidScat, and ScatSAT.

The SeaWinds instrument on the QuikSCAT satellite is a specialized microwave radar that measures near-surface wind speed and direction under all weather and cloud conditions over Earth’s oceans. Scatterometer wind data, combined with measurements from various scientific disciplines, helps to understand mechanisms of global climatic change and weather. These measurements help to determine atmospheric forcing, ocean response and air-sea interaction mechanisms on various spatial and temporal scales. Wind stress is the single largest source of momentum to the upper ocean, driving oceanic motions on scales ranging from surface waves to basin-wide current systems. Winds over the ocean modulate air-sea fluxes of heat, moisture, gases and particulates, regulating the crucial coupling between atmosphere and ocean that establishes and maintains global and regional climate. Measurements of surface wind velocity can be assimilated into regional and global numerical weather and wave prediction models, improving our ability to predict future weather.

As the only remote sensing system able to provide accurate, frequent, high-resolution measurements of ocean surface wind speed and direction under both clear sky and cloudy conditions, scatterometers have played an increasingly important role in oceanographic, meteorological and climatic studies over the past several decades. Scatterometers use an indirect technique to measure wind velocity over the ocean, since the atmospheric motions themselves do not substantially affect the radiation emitted and received by the radar. These instruments transmit microwave pulses and receive backscattered power from the ocean surface. Changes in wind velocity cause changes in ocean surface roughness, modifying the radar cross-section of the ocean and the magnitude of the backscattered power. Scatterometers measure this backscattered power, allowing estimation of the normalized radar cross section (σ_0) of the sea surface. Backscatter cross section varies with both wind speed and direction when measured at moderate incidence angles. Multiple, collocated, nearly simultaneous

σ_0 measurements acquired from several directions can thus be used to solve simultaneously for wind speed and direction.

The first spaceborne scatterometer flew as part of the Skylab missions in 1973 and 1974, demonstrating that spaceborne scatterometers were indeed feasible. The Seasat-A Satellite Scatterometer (SASS) operated from June to October 1978 and proved that accurate wind velocity measurements could be made from space. The SASS cross section measurements have been used to significantly refine the empirical model relating backscatter to wind velocity, and the SASS data have been applied to a variety of oceanographic and meteorological studies. As a much improved extension of the European Space Agency's Earth Remote Sensing (ERS) scatterometer data record (ERS-1/2), the Advanced Scatterometer (ASCAT) provided by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) flown on MetOp-A/B has extended the previous single-swath scatterometer into a dual-swath instrument operating at C-band and providing an extended global time series of ocean surface wind vectors from March 2007 through present. NSCAT was launched on ADEOS-1 (Midori) in August 1996 and returned nearly 10 months of dual-swath, 25-km resolution Ku-band backscatter and wind data until the demise of the spacecraft in June 1997.

3.1 Mission Requirements

The temporal scales of important motions in the atmosphere and the ocean range from seconds to decades, and spatial scales range from meters to tens of thousands of kilometers. Given the wide range of geophysical studies requiring surface wind velocity data, construction of a unified, consistent, achievable set of requirements for a satellite instrument is difficult. Following the successful flight of the Seasat scatterometer (SASS) in 1978, NASA established the interdisciplinary Satellite Surface Stress Working Group to define the scientific requirements for the next spaceborne NASA scatterometer system. As understanding of both science issues and scatterometer capabilities grew during the 1980's, the Working Group report evolved into specific mission requirements. In short, 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; virtually the entire ocean surface must be covered at least once every two days; geophysically useful products must be produced within days after data are acquired; and the instrument must be designed to acquire data for at least three years in order to allow investigation of annual and interannual variability. A summary of the original QuikSCAT requirements is given in Table 1.

Quantity	**Requirement**	**Applicable Range**
Wind speed	2 m/s (RMS error)	3-20 m/s
	10%	20-30 m/s
Wind direction	20_o (RMS error) selected ambiguity	3-30 m/s

Spatial resolution	25 km	σ_0 cells
	25 km	Wind vector cells
Location accuracy	25 km (RMS error)	Absolute
	10 km (RMS error)	Relative
Coverage	90% of ice-free ocean daily	Global
Mission duration	36 months	24-36 Months

Table 1: **QuikSCAT Technical Mission Requirements**

3.2 Satellite Description

The NASA Quick Scatterometer (QuikSCAT) mission employs a variation of the Ball Commercial Platform 2000 (BCP 2000 "QuikBird") bus. QuikSCAT was selected through the NASA Rapid Spacecraft Acquisition program, which required a stable and highly accurate Earth remote-sensing platform. Ball Aerospace and Technologies Corp. (hereafter, Ball) provided the integration and test of the total space segment consisting of the BCP 2000 spacecraft bus and the JPL-supplied scatterometer payload. Ball was responsible for integration of the spacecraft to the launch vehicle and launch support. Ball also provides mission control and operations following launch.

Modifications to the basic BCP 2000 design for this mission were minimal and included a larger propellant tank (76 kg), CCSDS compatible uplink and science data downlink, S-band telemetry downlink, reduced capacity solid-state recorder (8 Gbit), and minor configuration modifications to support payload boxes and the Titan II launch vehicle. Table 2 outlines the nominal orbit parameters for QuikSCAT.

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^{o}

Table 2: Nominal Orbit Parameters

4. Sensor Overview:

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

SeaWinds instrument uses a rotating dish antenna with two spot beams that conically sweep producing a circular pattern on the surface. The antenna radiates microwave pulses at a frequency of 13.4 GHz (Ku-band) across broad regions on Earth's surface. The instrument collects data over ocean, land, and ice in a continuous, 1800-kilometer-wide swath centered on the nadir subtrack, making approximately 1.1 million ocean surface wind measurements and covering 90% of Earth's ice-free ocean surface each day. A pencil-beam scatterometer has several key advantages over a fan-beam scatterometer: it has a higher signal-to-noise ratio, is smaller in size, and provides superior coverage.

4.1 Principles of Operation

Spaceborne scatterometers transmit microwave pulses to the ocean surface and measure the backscattered power received at the instrument. Since 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 normalized radar cross section (σ_o) 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 σ_o and near-surface winds (i.e., the GMF).

The SeaWinds scatterometer design used for QuikSCAT is a significant departure from the fan-beam scatterometers flown on previous missions (Seasat SASS and NSCAT) and the current ASCAT. 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_o (H-pol, inner beam) and 54_o (V-pol, outer beam). 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 σ_o value is then computed for both the "egg" and the best 8 of the 12 "slices" (based on location within the antenna gain pattern).

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 calibration 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 σ_o calculation.

5. Processing Methodology:

Instrument power measurements are calibrated and converted to normalized radar cross section (σ_0) to produce the time-ordered Level 1B (L1B) product. The σ_0 measurements are grouped into an along-track, cross-track grid of "wind vector cells" (WVC) for wind retrieval. A WVC typically contains several measurements looking both forward and backward from both the inner and outer beams. QuikSCAT data products are primarily distinguished by their spatial resolution. Measurements of σ_0 are grouped into both 25 km and 12.5 km WVC resolution. The processing tradeoff is between resolution and noise. Beginning in 2013 with the introduction of Version 3, all Level 2B data is produced at 12.5 km WVC resolution. Version 3.1 and 4 datasets are also produced at 12.5 km. The grouped σ_0 measurements are the Level 2A (L2A) product. The Version 4 data described here are 12.5 km wind (L2B) netCDF data files. No new versions have been made for L1B and L2A products which remain in the HDF-4 (Version 2) format.

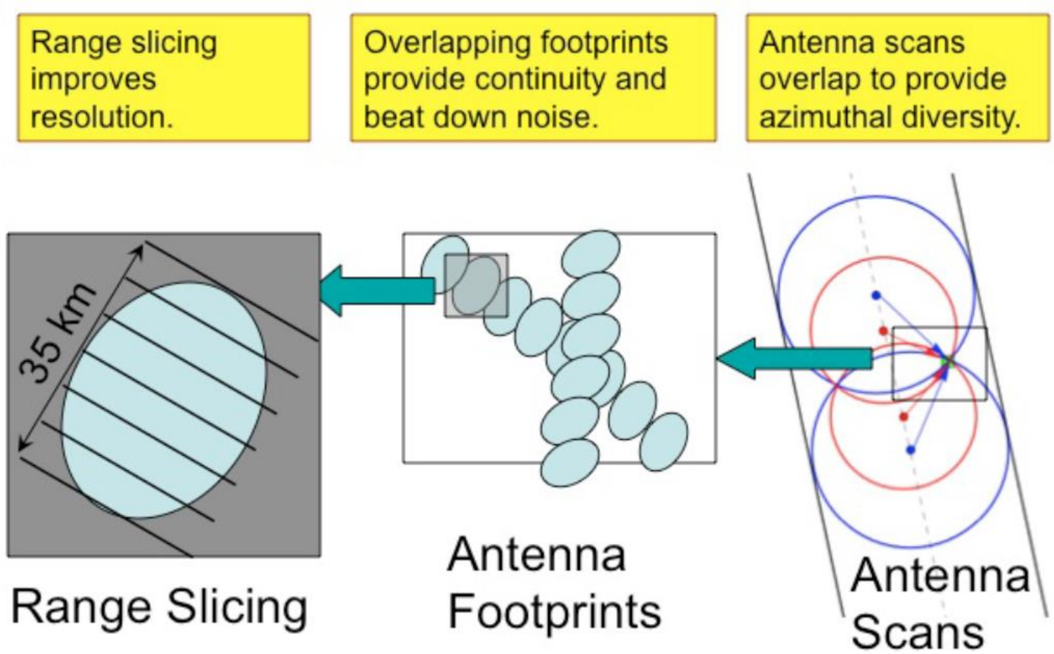


Figure 1. QuikSCAT measurement geometry is shown on three scales. On the left, the smallest scale illustrates the spatial extent for the measurements (about 8 km by 25 km range slices) obtained during a single radar observation.

The QuikSCAT measurement geometry (Figure 1) determines the manner in which wind speed retrievals are made. Range slices are produced by breaking up the energy received by the radar into range-to-target bins. Measurements from different azimuths are required to retrieve wind direction and speed. The middle panel (Figure 1) shows multiple observations (footprints) obtained by the spinning antenna. The rightmost panel (Figure 1) shows a portion of the pattern inscribed on the ground by the two rotating antenna beams. The blue circles are two rotations of the outer 54-degree incidence angle beam, and the red circles are rotations of the inner 46-degree incidence angle beam. The dots at the center of each circle are the location of the spacecraft in its orbit when that circle was inscribed. The black rectangle illustrates where measurements from four different azimuths (arrows) overlap.

Wind retrieval processing is performed in three steps. First, a point-wise maximum likelihood estimate of wind speed and wind direction is computed resulting in multiple ambiguous solutions (typically two to four). Next, a median filter is used to select the best ambiguity. Directional Interval Retrieval (DIR) (Stiles et al. 2002) processing is performed, which uses the directional spread of the objective function and allows the retrieved wind direction to vary within a region of high likelihood about the selected ambiguity. Finally, wind speed measurements are corrected empirically for rain contamination and for biases as a function of cross track distance due to variable instrument geometry. The correction due to rain contamination are made using neural network techniques described in (Stiles and Dunbar, 2010, and Stiles et al, 2014). The addition in version 4 of the second cited neural network significantly improves performance in rainy and high wind conditions. These corrections can be several meters/second for especially rainy conditions. The size of the correction is recorded in the dataset and can be used as a quality estimate as larger corrections imply larger residual errors. The cross-track bias correction is small (a few tenths of a m/s except in rainy conditions) and is used to remove systematic biases that could affect climatological studies. The value of this correction is also reported in the data files.

Version 4 has three important improvements over the previous version 3.1. First, a Sea-Surface Temperature (SST) dependent GMF developed by Lucrezia Ricciardulli of Remote Sensing Systems is used in wind retrieval in order to fix persistent speed biases in Ku-band data over cold ocean. To supplement this new SST-dependent GMF, a new ancillary data variable called “gmf_sst”, providing the SST data used for the wind speed GMF bias corrections, has been added to the data files. This “gmf_sst” data is provided by the NOAA Optimal Interpolation (OI) SST Analysis Version 2 (Banzon and Reynolds, 2018). Second, near coastal winds are retrieved using the Land Contamination Ratio with Expected Sigma-0 (LCRES) technique which retrieves winds significantly closer to the coast than has been done before (Figure 2). Third, flagging is simplified and extra flags are provided. The “distance_to_coast” variable was first introduced in Version 3.1 and is continued through Version 4 as a way for users to keep track of how far away in kilometers a wind vector cell is from the coast and helps quantify the performance of the LCRES algorithm. The distance value is the distance from the centroid of the wind vector cell to the closest 0.1 by 0.1 degree lat/lon grid cell that contains land. All of the legacy flags are preserved and serve the same purpose as in previous QuikSCAT versions 3.0 and 3.1. A new single bit ‘wind_retrieval_likely_corrupted_flag’ specifies the data which is known to have suboptimal performance due to rain, ice, or a few other rare anomalous cases; this situation generally occurs for approximately 3% of the data. Another bit 'wind_retrieval_possibly_corrupted_flag' specifies the data near rain, near ice, or near the coast, that is thought to be high quality but may not match up well with numerical wind models due to either remaining rain/ice/land contamination or variability in the winds near ice, rain, and coasts that are not reflected in the NWPs; this situation generally occurs for approximately 15% of the data. In addition to these two new bits, copious quality information is provided in the data to allow users to tailor flags to meet their own needs.

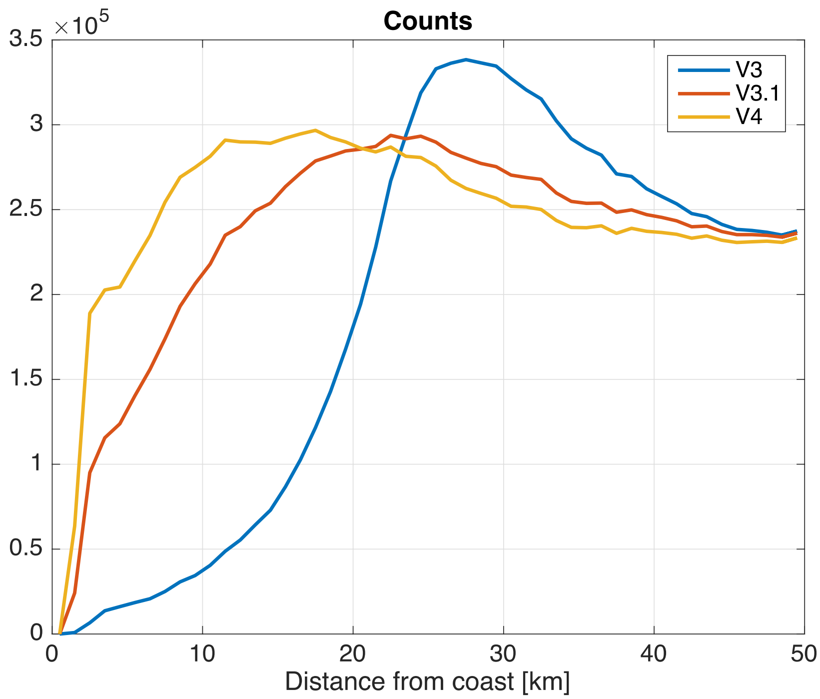


Figure 2. Number of retrieved wind vectors vs. distance from coast comparing different L2B processing versions.

More details of the Version 3 processing methodology are found in Fore et al. (2013): https://podaac-tools.jpl.nasa.gov/drive/files/allData/quikscat/L2B12/docs/fore_et_al_ieee_2013.pdf.

The details regarding the processing lifecycle from telemetry to L2B may be found in the "QuikSCAT Science Data Product User's Manual" (Version 3.0, 2006): https://podaac-tools.jpl.nasa.gov/drive/files/allData/quikscat/L2B12/docs/QSUG_v3.pdf.

The processing team expects to publish the detailed description of the improvements and Cal/Val results in Version 4 in the near future. A very brief Cal/Val summary is provided in Section 6.

The Version 4.1 L2B dataset features a number of additional improvements and changes relative to Version 4.0, including:

1. Winds are now retrieved to within 5-km and 10-km of the coast within oceans/seas and lakes respectively.

2. The “eflags” variable now includes a new flag to indicate where wind retrievals were performed over a lake.

3. Coastal winds are now flagged as poor coastal quality and likely corrupted in orbits with estimated spacecraft pitch error greater than 0.04 degrees, which affects 150 orbits of data where coastal winds are severely contaminated by land due to poor attitude knowledge (note: attitude error tracking can identify pitch error but not yaw error, so when estimated pitch error is far from zero, it implies yaw error is large and uncorrected).

4. Coastal winds are flagged based upon the long term mean wind speed and standard deviation of wind speed for each place on the ground.

5. Four quantities, means and standard deviations computed with and without the land contamination correction algorithm applied (note: higher mean and smaller standard deviation are evidence of land contamination), are used to estimate the expected wind speed bias with respect to neighboring wind vector cells over open water; this bias information is provided by a new netCDF variable called “exp_bias_wrt_oceanward_neighbors”.

6. Wind vector cells with estimated speed bias greater than 0.4 m/s are flagged as poor coastal quality and likely corrupted.

7. Winds within 5-km of the coast of an ocean/sea and 10-km of the coast of a lake are flagged as poor coastal quality and likely corrupted; the larger distance threshold for lakes is due to higher variability in lake water levels.

6. Calibration and Validation:

The Version 4 L2B winds have been compared to ECMWF and WindSAT winds in order to assess accuracy. Version 4 was found to have nearly identical accuracy as Version 3.1 when compared with both ground truth wind datasets. In rain-free conditions, RMS speed error with respect to ECMWF was 1.5 m/s for Version 3.1 and 4; RMS direction error was 18 degrees for both versions. Version 4 has slight improvement over Version 3.1 in the Southern Ocean where correctly modeling influence of SST on backscatter made a significant difference in both wind speed and direction accuracy. This difference is most significant in colder ocean surface temperatures, and more significantly affects the Sigma-0 measured from the outer V-pol beam; thus, the outer edges of the swath, where only V-pol measurements are available, show the most significant bias corrections in these cold water regions. The figure below (Figure 3) demonstrates this difference during a particularly cold time of year in the Southern Oceans. Figure 4 shows the SST data used for the Version 4 data represented in Figure 3.

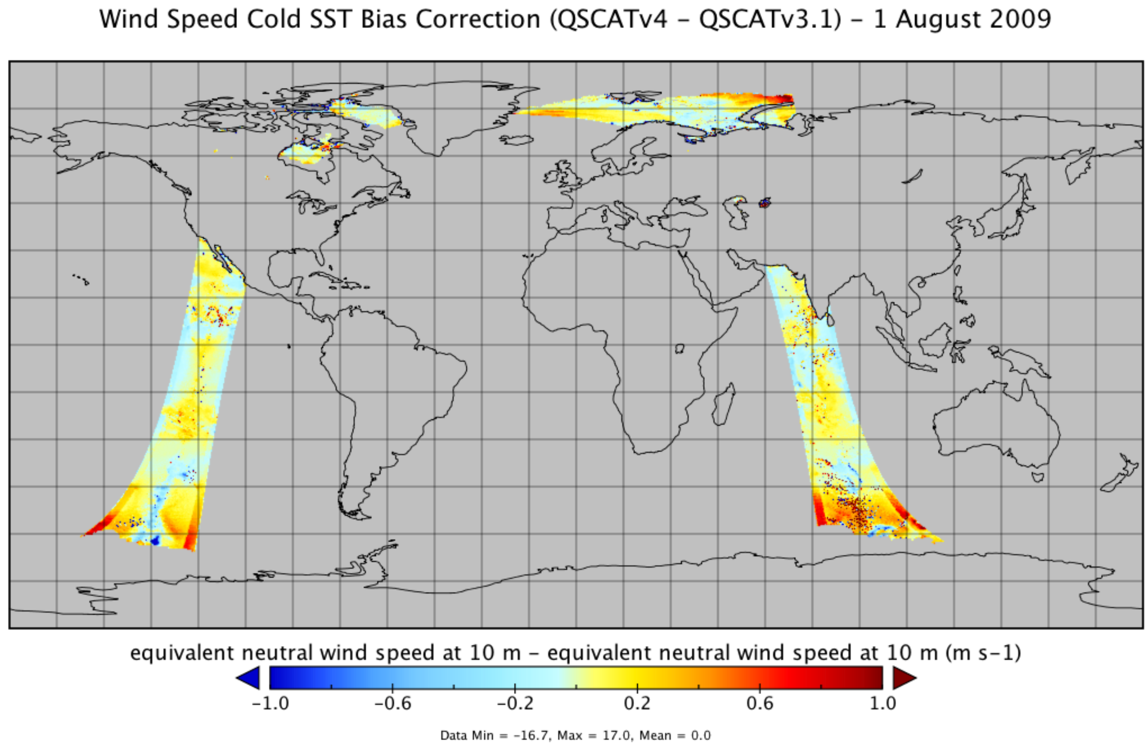


Figure 3. Bias correction in wind speed demonstrated by subtracting wind speed (m/s) data of QuikSCAT L2B Version 3.1 from Version 4.0 from the same orbit. This corresponds to orbit 52686 on 1 August 2009.

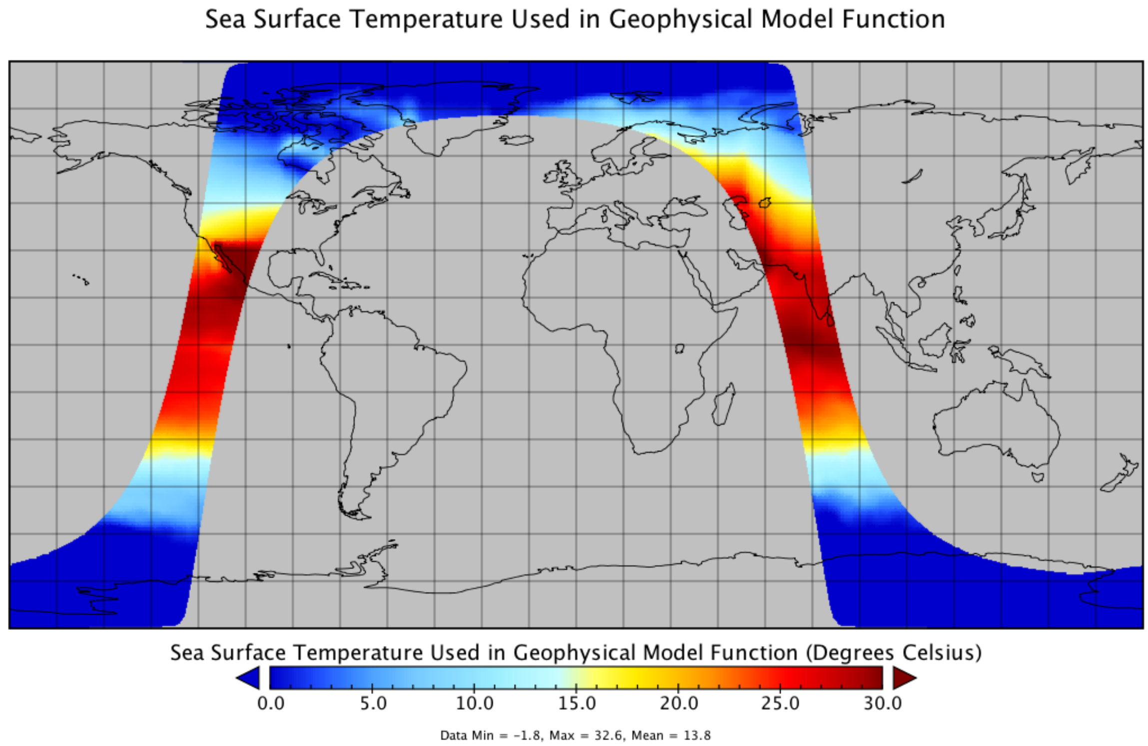


Figure 4. Mapped representation of SST data (degrees Celsius) used in the wind retrieval correction for the Version 4 data on 1 August 2009. This corresponds to orbit 52686 (same as Figure 3).

The Version 4.1 L2B dataset has been validated to retrieve winds within 5-km and 10-km of the coast within oceans/seas and lakes respectively. Figure 5 depicts the impact that land contamination has on the Sigma-0 radar measurement, which degrades the quality of the wind speed retrieval as a function of proximity to land, which is most pronounced during low wind speed (<= 5 m/s) conditions.

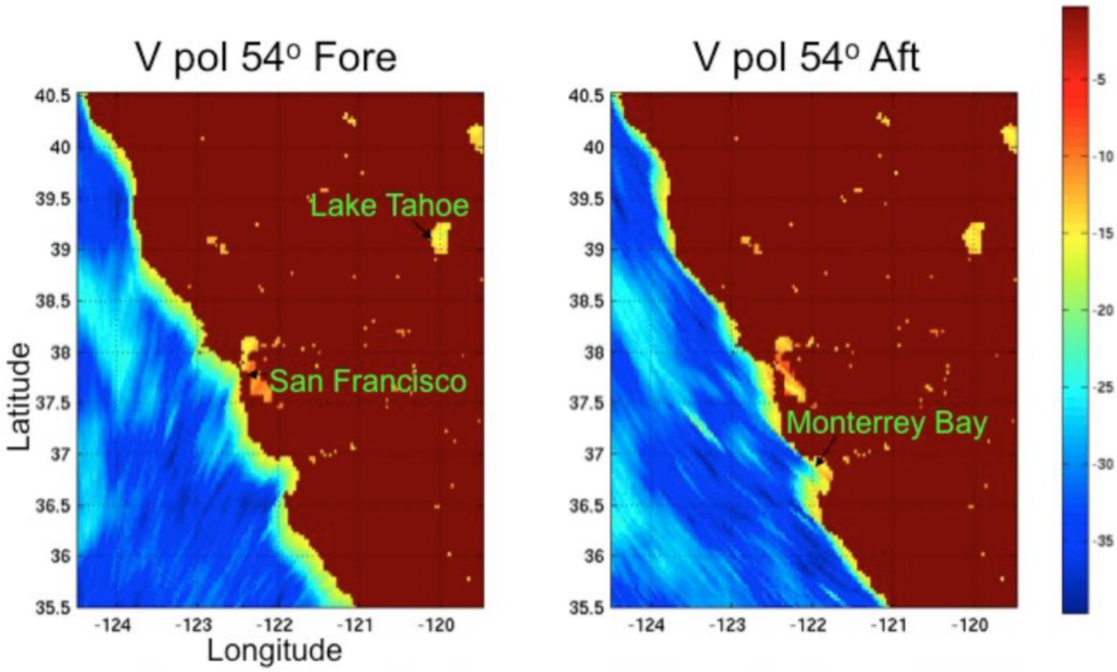
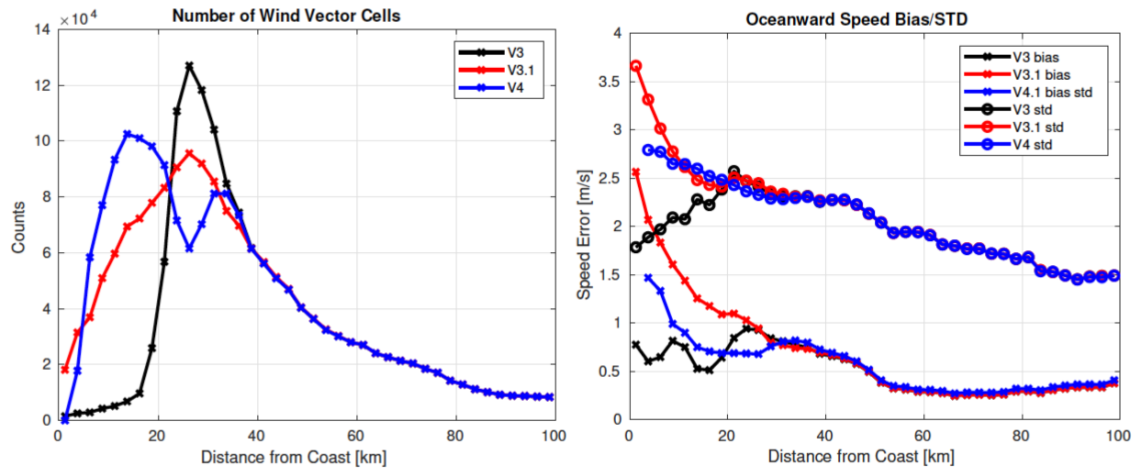


Figure 5. Land contamination in raw Sigma-0 data for low wind (approximately 5 m/s) conditions. Land contaminates Sigm-0 and thus wind up to 30 km from the coast. How far from the coast it is contaminated depends upon the precise orientation of the measurements (i.e., the range slices).

Improved coastal wind speed bias estimation results in closer wind speed retrieval in v4.1/4.0 (hereafter, 4.x) compared to v3.x, as illustrated by the oceanward speed bias comparison chart in Figure 6. Here we observe that the newest processing versions contains many more observations near to coast than v3 – at least 10 times as many buoy hits with v4.x within 20km of the coast. We also notice that agreement from 10 km is only marginally worse than at 40km from shore, while performance at 5km from coast is significantly degraded. All wind vector data that is retrieved within 5km from the coast is flagged as likely contaminated by land.



(a) Counts (b) Speed Differences

Figure 6. (left) Number of buoy matchups as a function of distance to nearest coast in km for versions 3 (no coastal processing), 3.1 (LCR processing), and 4.x (LCRES processing). (right) Mean buoy wind speed difference as a function of distance to nearest coast in km for the same data versions.

7. Dataset Description:

The L2B version 4.1 dataset is being distributed in netCDF-4 format using internal compression (more computationally efficient compared to external compression such as gzip) and adhering to CF v1.6 and ISO-8601 conventions. Each file is unique to a particular calendar day of a year and consists of one complete orbital revolution (assuming no data gaps).

The file naming convention is qs_l2b_RRRRR_v4.1_YYYYMMDDhhmm.nc, where:

qs = QuikSCAT, which is the instrument/platform source of the dataset
l2b = the processing level of the dataset
RRRRR = the 5-digit starting orbital revolution number
V4.1 = Version 4.1, the dataset version identifier of the data file
YYYY = the 4-digit calendar year of the file start time
MM = the 2-digit calendar month of year (e.g., 09 = September)
DD = the 2-digit calendar day of month
hh = the 2-digit hour of the start time of the 1st measurement within the file
mm = the 2-digit minute of the start time of the 1st measurement within the file
.nc = the file extension indicating the usage of netCDF data formatting

The date and time represented by the file name is with respect to GMT (UTC). Greater precision of the start and stop times, including equatorial crossing times, is available in the netCDF global attributes.

7.2 Variable Types

Table 2. Dataset Variable Description

Name	Along Track Cells	Cross Track Cells	Data Type	Missing Value	Description
time	3248	N/A	double	N/A	Defines the mean reference time of all WVC measurements along a given WVC row referenced by the number of seconds since 00Z on 1 January 1999.
lat	3248	152	float	N/A	The latitude value at WVC.
lon	3248	152	float	N/A	The longitude value at WVC.
retrieved_wind_speed	3248	152	float	-9999.f	Equivalent neutral wind speed at reference height of 10 m.
retrieved_wind_direction	3248	152	float	-9999.f	Equivalent neutral wind direction at reference height of 10 m.
rain_impact	3248	152	float	-9999.f	Impact of rain upon wind vector retrieval. Correction applied to speed when this number is greater than 2.5.
flags	3248	152	short	32767s	WVC bit-wise quality flags.
eflags	3248	152	short	32767s	Extended WVC bit-wise quality flags
nudge_wind_speed	3248	152	float	-9999.f	NCEP Model wind speed.
nudge_wind_direction	3248	152	float	-9999.f	NCEP Model wind direction.

retrieved_wind_speed_uncorrected	3248	152	float	-9999.f	Wind speed without rain correction.
cross_track_wind_speed_bias	3248	152	float	-9999.f	Relative wind speed bias due to cross track positon in swath.
atmospheric_speed_bias	3248	152	float	-9999.f	Atmospheric wind speed bias. Speed bias removed by rain correction algorithm.
num_ambiguities	3248	152	byte	0b	Number of ambiguous wind directions found in point-wise wind retrieval prior to spatial filtering.
gmf_sst	3248	152	float	-9999.f	SST value in degrees C from NOAA Optimal Interpolation (OI) SST Analysis Version 2 (Banzon and Reynolds, 2018) product used to retrieve wind vector. This is not a QuikSCAT measurement.
distance_from_coast	3248	152	float	N/A	Distance of wind vector from coast in km. If this value is negative the WVC is over land and no wind vector was retrieved.
exp_bias_wrt_oceanward_neighbors	3248	152	float	-9999.f	Expected bias between the current cell and geographically oceanward neighboring cells.

7.3 Bit by Bit Description of Flags and Eflags Variables

The following tables describes all the bits in the flags and eflags variables, a reader for the bit flags is provided in Matlab in a higher level Software (*/sw/netcdf/MATLAB/*) directory above the data path.

Table 3. Description of quality flag variables.

Variable Name	Bit Number (0=LSB)	Bit Name	Meaning when bit is 1
flags	0	adequate_sigma0_flag	Fewer than 4 sigma-0 values in wind vector cell, winds not retrieved
flags	1	adequate_azimuth_diversity_flag	Less than 20 degrees of azimuth diversity, winds not retrieved
flags	2	undefined	
flags	3	undefined	
flags	4	undefined	
flags	5	poor_coastal_processing_flag	Currently never set (unless wind is not retrieved)
flags	6	wind_retrieval_likely_corrupted_flag	Recommended flag, flags 3% of data when either sea_ice, or rain is present.
flags	7	coastal_flag	At least one measurement in wind vector cell within 20 km of land.
flags	8	ice_edge_flag	At least one measurement in cell determined to be sea-ice contaminated

flags	9	winds_not_retrieved_flag	No wind vector retrieved
flags	10	high_wind_speed_flag	Retrieved wind speed greater than 30 m/s
flags	11	low_wind_speed_flag	Retrieved wind speed less than 3 m/s
flags	12	rain_impact_flag_not_usable_flag	Rain impact (IMUDH) flag is not computed, presence of rain unknown
flags	13	rain_impact_flag	Rain impact (IMUDH) flag, rain detected in cell
flags	14	missing_look_flag	At least one of the four azimuth looks is unavailable for this cell
flags	15	undefined	
eflags	0	rain_correction_not_applied_flag	Rain correction was not applied, this is typical when no rain is present
eflags	1	correction_produced_negative_spd_flag	Rain correction produced a negative speed
eflags	2	all_ambiguities_contribute_to_nudging_flag	All of the ambiguities in the cell were used during nudging

eflags	3	large_rain_correction_flag	Rain correction to wind speed was larger than 1.0 m/s
eflags	4	coastal_processing_applied_flag	Wind vector cell is close to the coast and coastal processing was performed.
eflags	5	undefined	Not utilized
eflags	6	lake_winds_flag	Not utilized
eflags	7	undefined	Not utilized
eflags	8	rain_nearby_flag	Rain detected within 50 km of cell.
eflags	9	ice_nearby_flag	Sea ice detected within 50 km of cell
eflags	10	significant_rain_correction_flag	Rain speed correction was larger than 0.1 m/s
eflags	11	rain_correction_applied_flag	Rain correction was applied, inverse of bit 0.
eflags	12	wind_retrieval_possibly_corrupted_flag	Strict flag, flags 15% of data for which rain or sea ice is nearby or coastal processing performed
eflags	13	undefined	Not utilized
eflags	14	undefined	Not utilized
eflags	15	undefined	Not utilized

7.4 Grid Description

The L2B data are grouped by rows of wind vector cells (WVC). L2B wind vector cells are square pixels of dimension 12.5 km. Each wind vector cell row corresponds to a single cross-track cut of the QuikSCAT measurement swath. Full coverage of the earth's circumference requires 3248 rows at 12.5 km pixel resolution (i.e., a single data file with no measurement gaps).

QuikSCAT's swath extends 900 km on either side of the satellite nadir track, providing a full swath width of 1800 km. Thus, each WVC row nominally contains 148 WVCs. To accommodate occasional measurements that lie outside of the 900 km swath, the L2B data design includes additional WVC values at each end of each row. Each Level 2B WVC row therefore contains a total of 152 WVCs in the 12.5 km product. As an artifact of the orbital inclination and instrument swath width, consecutive orbits will usually start to overlap poleward of ~47° latitude.

7.5 Related Products

All related data products are referenced here:

a) QuikSCAT: https://podaac.jpl.nasa.gov/datasetlist?ids=Platform&values=QUIKSCAT
b) SeaWinds on ADEOS-II: https://podaac.jpl.nasa.gov/datasetlist?ids=Platform&values=ADEOS-II
c) Oceansat-2: https://podaac.jpl.nasa.gov/datasetlist?ids=Platform&values=Oceansat-2
d) ISS-RapidScat: https://podaac.jpl.nasa.gov/datasetlist?ids=Platform&values=ISS

8. Known Issues and Source of Error:

The high wind speed (> 20 m/s) calibration of the data is substantially different from previous versions due to the use of the new GMF that was optimized for consistency with passive microwave wind speed measurements and to include the effects of SST. Due to the lack of ground truth at high winds, it is an open question whether the high wind performance is improved or degraded by the change in GMF. High winds in rainy conditions (e.g. tropical cyclones) are improved over version 3.1 by using the neural network described in (Stiles et al, 2014.)

Although the location of the grid cells are much more regular than previous 12.5 km (Version 2) products, there can still be irregularities in the grid near the edges of the swath due to poor measurement sampling. As was done for previous QuikSCAT products, a grid cell location is defined to be the average centroid of the measurements used to retrieve wind in that cell. Unlike version 2, latitude and longitude locations are now computed for grid cells in which winds are not retrieved (i.e., null WVCs over land). Locations of WVCs without winds are determined independently of the measurement locations. For this reason, there is commonly a noticeable discontinuity in grid locations near land. A further issue to point out is in reference to the start of the dataset, which is on 27 October 1999. This starting point occurs 100 days after the start of L2B version 2, which is done to maintain optimal and consistent quality of the dataset time series by excluding data in which the instrument was not in the final data acquisition configuration.

9. Data Access:

Obtaining Data, Documentation and Read Software:

The data, read software, and documentation are freely available for public download. For immediate access through a variety of public data end points, please visit:

1. L2B:
   a. Version 3.0: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_OWV_COMP_12
   b. Version 3.1: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_OWV_COMP_12_LCR_3.1
   c. Version 4.0: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_OWV_COMP_12_KUSST_LCRES_4.0
   d. Version 4.1: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2B_OWV_COMP_12_KUSST_LCRES_4.1
2. L2A: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_2A_COMP_12
3. L1B: https://podaac.jpl.nasa.gov/dataset/QSCAT_LEVEL_1B_V2
4. L1C: https://podaac.jpl.nasa.gov/dataset/QSCAT_L1C_NONSPINNING_SIGMA0_WINDS_V1

Note: the documentation (/doc) and read software (/sw) are located one directory level above the data directories.

All data granules for L2B prior to Version 4.0 are compressed using the industry standard GNU Zip compression utility. To learn more about the GNU compression utility, please visit the GZIP home page: https://www.gzip.org/. Beginning with L2B Version 4.0, the netCDF files incorporate internal compression that doesn't require any additional software to decompress the data.

MD5 checksum files are also available for all datasets in the data directories to assist you in verifying the integrity of each data file/granule. To learn more about MD5 checksums, you may visit: https://en.wikipedia.org/wiki/MD5

The PO.DAAC Drive HTTPS service is now available to access all data. To use PO.DAAC Drive, you may visit: https://podaac-tools.jpl.nasa.gov/drive/

For information on how to cite this data in presentations or publications, please read:

https://podaac.jpl.nasa.gov/CitingPODAAC

For general news, announcements, and information on this and all other ocean and sea ice datasets available at PO.DAAC, please visit the PO.DAAC web portal: https://podaac.jpl.nasa.gov/

Contact Information:

Questions and comments concerning QuikSCAT Version 3 L2B should be directed to the Physical Oceanography Distributed Active Archive Center (PO.DAAC) at the NASA Jet Propulsion Laboratory (JPL). Please note that email is always the preferred method of communication, but Forum is highly recommended as a first point of entry to address Frequently Asked Questions.

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

WWW: https://podaac.jpl.nasa.gov/forum

Mail: PO.DAAC User Services Office
Jet Propulsion Laboratory
M/S T1721-202
4800 Oak Grove Drive
Pasadena, CA 91109

10. Read Software:

Sample L2B netCDF software readers are currently available in IDL, MATLAB, R and Python at one directory level above the data directories (*/sw/netcdf/*).

11. References:

[1] Banzon, V. and R. Reynolds. 2018. The Climate Data Guide: SST data: NOAA Optimal Interpolation (OI) SST Analysis, version 2 (OISSTv2) 1x1. Version 2. UCAR, CO, USA. Dataset accessed [2017-12-19] at https://climatedataguide.ucar.edu/climate-data/sst-data-noaa-optimal-interpolation-oi-sst-analysis-version-2-oisstv2-1x1.

[2] Fore, A.G., B. W. Stiles, A.H. Chau, A.H., B.A. Williams, R.S. Dunbar, E. Rodríguez, "Point-wise Wind Retrieval and Ambiguity Removal Improvements for the QuikSCAT Climatological Data Set," Accepted for publication in IEEE Trans. Geoscience and Remote Sensing. doi:10.1109/TGRS.2012.2235843, 2013.

[3] Stiles, B.W., B. Pollard, and R.S. Dunbar, "Direction interval retrieval with thresholded nudging: a method for improving the accuracy of quikscat

winds,” Geoscience and Remote Sensing, IEEE Transactions on, vol. 40, no. 1, pp. 79–89, doi:10.1109/36.981351, 2002.

[4] B. W. Stiles and R. S. Dunbar, "A Neural Network Technique for Improving the Accuracy of Scatterometer Winds in Rainy Conditions," in IEEE Transactions on Geoscience and Remote Sensing, vol. 48, no. 8, pp. 3114-3122, Aug. 2010.
doi: 10.1109/TGRS.2010.2049362

[5] B. W. Stiles et al., "Optimized Tropical Cyclone Winds From QuikSCAT: A Neural Network Approach," in IEEE Transactions on Geoscience and Remote Sensing, vol. 52, no. 11, pp. 7418-7434, Nov. 2014.
doi: 10.1109/TGRS.2014.2312333

12. Acronyms:

ADEOS: Advanced Earth Observing Satellite

ASCAT: Advanced Scatterometer (METOP)

CCSDS: Consultative Committee for Space Data Systems

CF: NetCDF Climate and Forecast (CF) Metadata Convention

DIR: Directional Interval Retrieval

ECMWF: European Centre for Medium-Range Weather Forecasts

ERS: Earth Remote Sensing

EUMETSAT: European Organization for the Exploitation of Meteorological Satellites

FTP: File Transfer Protocol

GMF: Geophysical Model Function

GMT: Greenwich Mean Time (also known as Zulu or UTC time)

H-Pol: Horizontally (HH) Polarized

IDL: Interactive Data Language

JPL: Jet Propulsion Laboratory

L2B: Level 2B

LSB: Least Significant Bit

MD5: Message-Digest Algorithm

MetOp-A/B: Meteorological Operational Satellite series A and B (also METOP)

NASA: National Aeronautics and Space Administration

NetCDF: Network Common Data Form

NOAA: National Oceanic and Atmospheric Administration

OPeNDAP: Open-source Project for a Network Data Access Protocol

PO.DAAC: Physical Oceanography Distributed Active Archive Center

QuikSCAT: NASA Quick-recovery Scatterometer

RMS: Root-Mean-Square
SASS: Seasat-A Satellite Scatterometer
SSM/I: Special Sensor Microwave Imager
SST: Sea Surface Temperature
V-Pol: Vertically (VV) Polarized

WindSAT: Satellite-based polarimetric microwave radiometer developed by the Naval Research Laboratory Remote Sensing Division and the Naval Center for Space Technology for the U.S. Navy and the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO).

WVC: Wind Vector Cell

13. Document History

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Citation:

A majority of the document material was provided by Bryan Stiles and Alex Fore, much of which was derived from material derived from Fore et al. (2013) and the previous QuikSCAT user guides.

Citation of the PO.DAAC datasets should follow PO.DAAC general dataset citation guidelines as mentioned here:
https://podaac.jpl.nasa.gov/CitingPODAAC.

To cite the use of the L2B Version 4.0 dataset in a publication (i.e., presentation or manuscript), please use the following template:

> NASA/JPL/SeaPAC. 2018. QuikSCAT Level 2B Ocean Wind Vectors in 12.5km Slice Composites Version 4.0. Ver. 4.0. PO.DAAC, CA, USA. Dataset accessed [YYYY-MM-DD] at https://dx.doi.org/10.5067/QSX12-L2B40

To cite the use of the L2B Version 4.1 dataset in a publication (i.e., presentation or manuscript), please use the following template:

> NASA/JPL/SeaPAC. 2020. QuikSCAT Level 2B Ocean Wind Vectors in 12.5km Slice Composites Version 4.1. Ver. 4.1. PO.DAAC, CA, USA. Dataset accessed [YYYY-MM-DD] at https://dx.doi.org/10.5067/QSX12-L2B41

Document Location:

All associated QuikSCAT documentation may be obtained using the HTTPS PO.DAAC Drive service provided here: https://podaac-tools.jpl.nasa.gov/drive/

The direct PO.DAAC Drive Link for L2B documentation is available here:
https://podaac-tools.jpl.nasa.gov/drive/files/allData/quikscat/L2B12/docs