Daily ASCAT Surface Wind Fields

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I. Summary

New gridded daily-averaged wind and wind stress fields (*DASCAT)* have been estimated over global oceans from ASCAT retrievals using objective method. The analyses use standard products ASCAT L2b during the period April 2007 through March 2009, and ASCAT L2b 12.5 from April 2009 to present(http://www.osi-saf.org/biblio/docs/ss3_pm_ascat_1_8.pdf). According to the ASCAT sampling scheme (Figure 1), the objective method allowing the determination of regular in space and surface wind fields uses ASCAT observations as well as ECMWF analyses. The latter are considered as the temporal interpolation basis of ASCAT retrievals. The resulting fields have spatial resolutions of 0.25° in longitude and latitude. The calculation of daily estimates uses ascending as well as descending available and valid retrievals. The objective method aims to provide daily-averaged gridded wind speed, zonal component, meridional component, wind stress and the corresponding components at global scale. The error associated to each parameter, related to the sampling impact and wind space and time variability, is provided too. More details about data, objective method, computation algorithm may be found in (Bentamy *et al*, 2011).

The daily wind fields are calculated in near real time with a delay of 48 hours.

This first version is considered as data test that will provide useful insight for near real time production of high space and time resolutions at global and regional scales. Data are available at IFREMER (ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/MWF/L3/ASCAT/Daily/) and freely distributed upon request (Contact : Abderrahim.Bentamy@ifremer.fr and Denis.croize-

fillon@ifremer.fr). The data files are in NetCDF format supported by several scientific softwares.

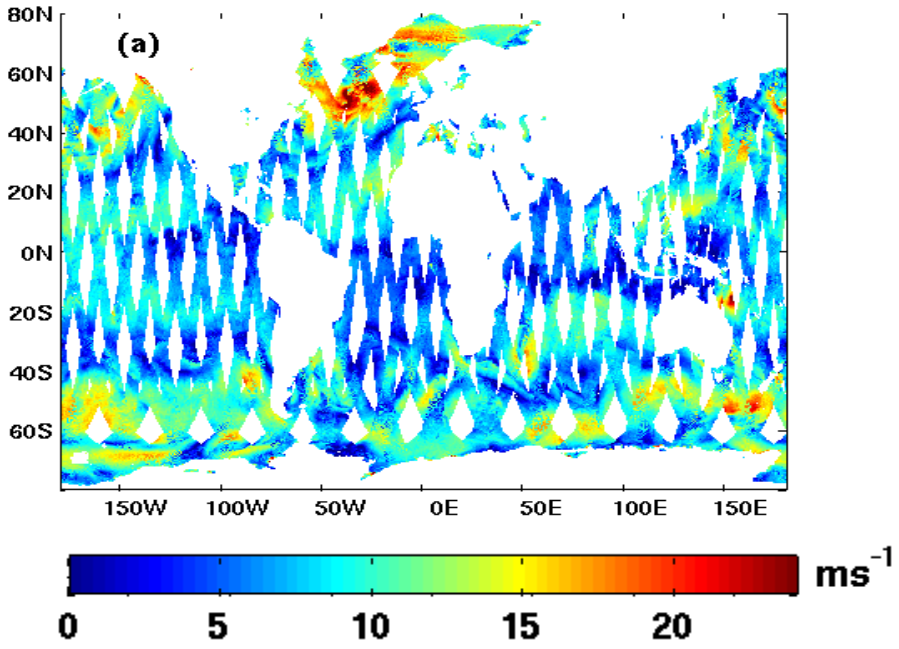

Figure 1 : Example of daily ASCAT retrievals.

II. Accuracy of ASCAT Daily Wind Fields

The quality of the daily-averaged wind speed, zonal and meridional components is first estimated through comparisons with daily-averaged wind data derived from moored buoy measurements. The goal is to meet the accuracy results derived from comparison between remotely sensed wind observations and buoy wind measurements determined by several authors (e.g. Bentamy *et al*, 2008, Verspeek *et al*, 2010). At global scales, daily winds are compared to averaged ASCAT retrievals and ECMWF analyses. The latter procedure aims mainly to investigate how the objective method retains scatterometer observations.

2.1 Buoy comparisons

2.1.1 Wind speed and direction comparisons

Buoy daily estimates are arithmetically calculated from raw valid measurements. They are derived from moorings located off the French and England coasts and maintained by UK Met-Office and/or Météo-France (MFUK), National Data Buoy Center (NDBC) located off and near U.S coasts, and from TAO and PIRATA located in the equatorial Pacific and Atlantic oceans, respectively.

At each buoy location and for each day all available and valid ASCAT estimates occurring within a radius of 0.25° from buoy location are selected and averaged. Then, the former are compared to the daily averaged buoy wind estimates. Figure 2 illustrates the comparison results for wind speed and direction. Table 1 summarizes the related statistical parameters. In general speaking, daily wind speed and direction compare well with buoy estimates. The wind speed correlation coefficients range exceed 0.86. The rms difference (buoy minus *DASCAT*) values are less than 2m/s. One can notice that the comparisons do not exhibit any systematic biases for wind speed and direction at the four buoy arrays.

Table 1 : Statistical parameters characterizing the comparisons between daily buoy and *DASCAT* wind speed and direction estimates ***Std***, ***bs***, ***as***, and ***Cor*** stand for standard deviation, slope of symmetrical linear regression, related intercept, and correlation coefficient, respectively.

	Wind Speed						Wind Direction		
	Length	***Bias***	***Std***	***bs***	***as***	***Cor***	***Bias***	***Std***	***Cor***
MFUK	1963	0.43	1.86	0.85	-0.02	0.89	0	21	1.72
NDBC	11691	-0.19	1.61	0.99	0.22	0.88	-3	23	1.72
TAO PIRATA	5681	0.12	1.07	0.99	-0.03	0.87	-4	18	1.61

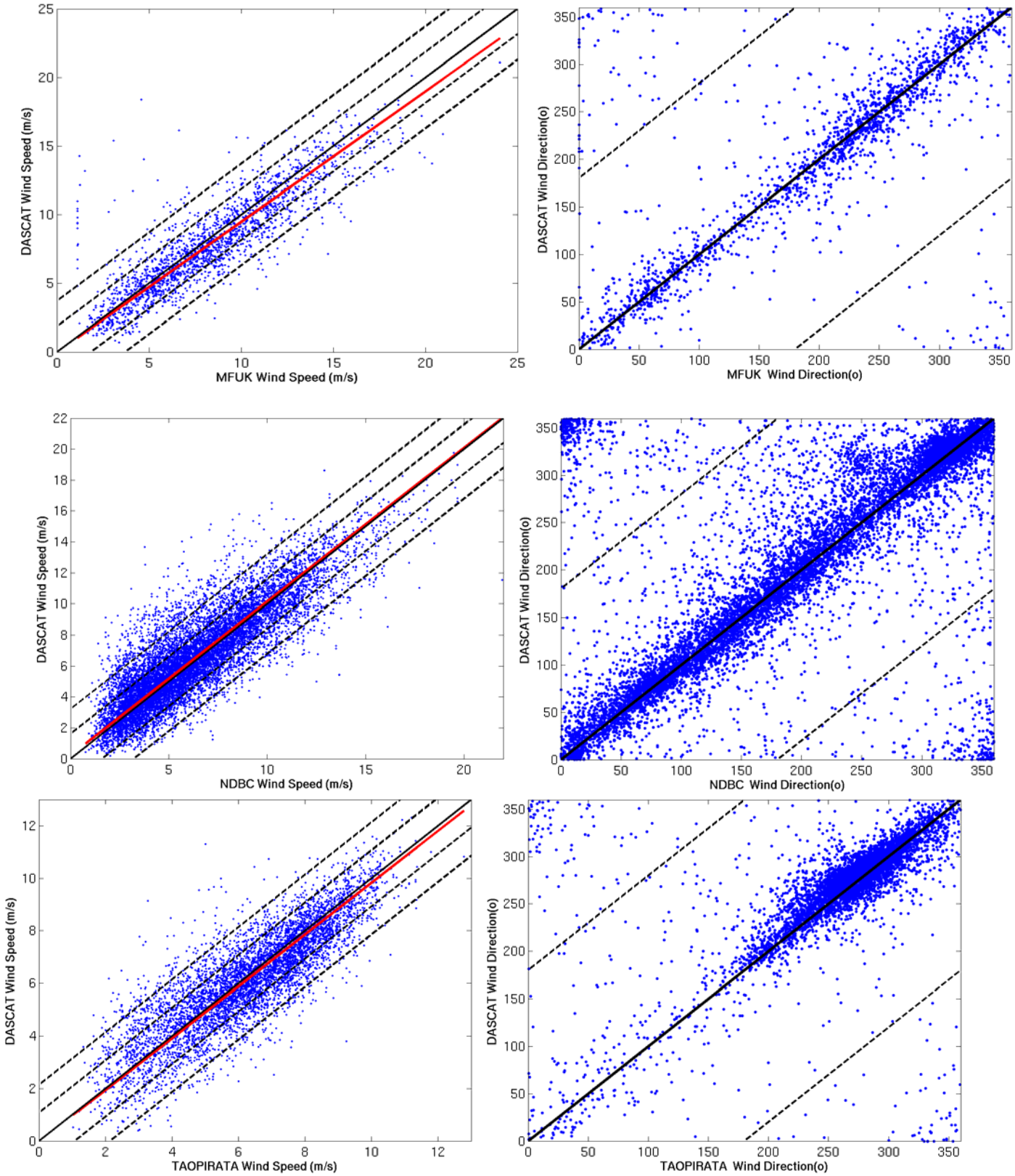

Figure 2: Comparisons of daily wind speeds (left panels) and directions (right panels) from moored buoys (MFUK (1st row), NDBC (2nd row), TAO and PIRATA (3rd row)) and from *DASCAT* during the period April – August 2009. Red line indicates linear regression fit.

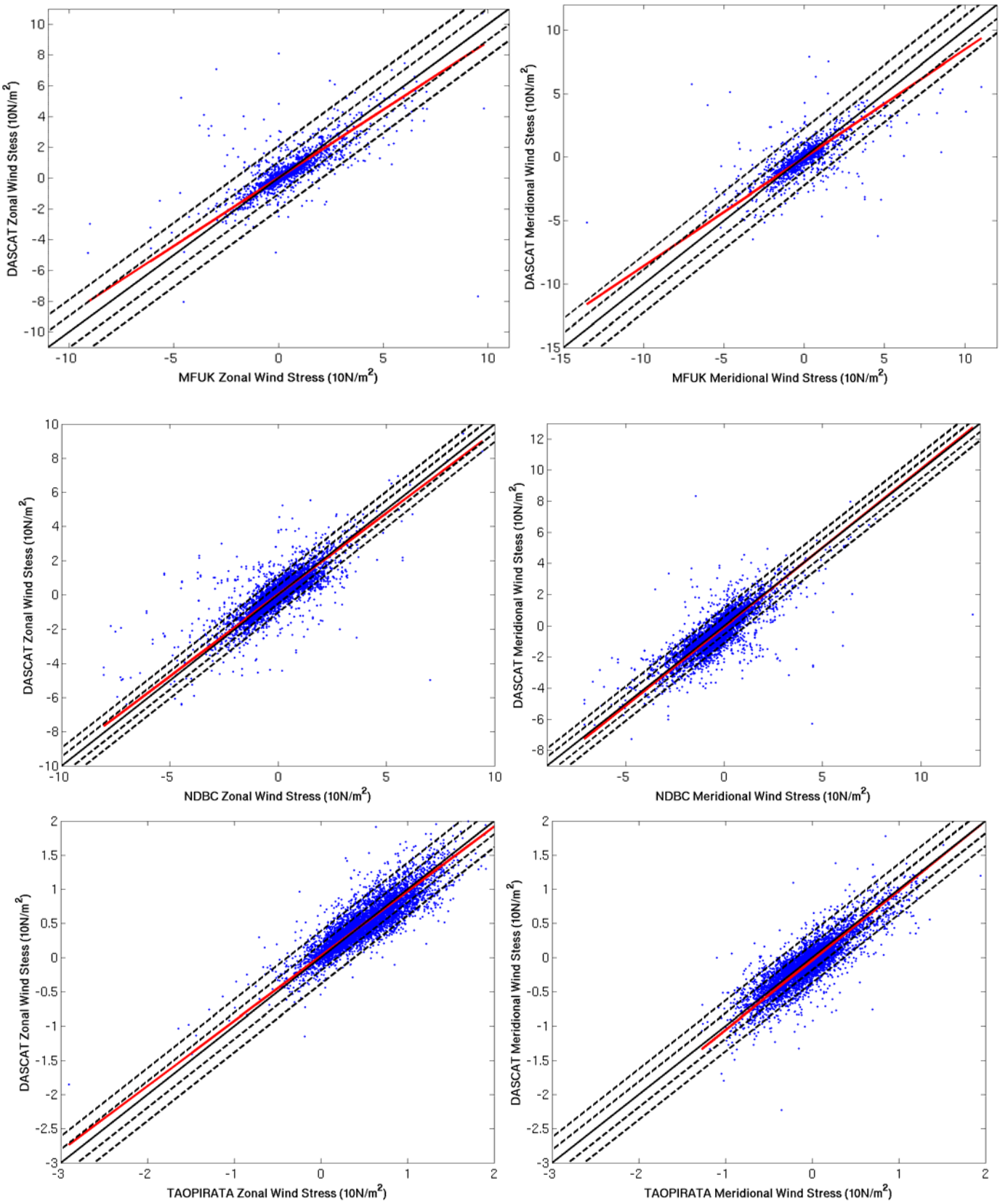

Figure 3: Comparisons of daily zonal (left panels) and meridional (right panels) wind stress from moored buoys (MFUK (1st row), NDBC (2nd row), TAO and PIRATA (3rd row)) and from *DASCAT* during the period April – December 2009. Red line indicates linear regression fit.

2.2 Global wind comparisons

2.2.1 Spatial distribution of remotely sensed comparisons

This section summarizes some results characterizing daily wind comparisons performed over global oceans. The former are achieved through the comparisons between ASCAT wind analyses *DASCAT* and daily averaged winds calculated as arithmetic means from available ASCAT retrievals (L2b), indicated as <*ASCAT*> data, and computed over the *DASCAT* grid map. Such comparisons aim to highlight how *DASCAT* analyses retrieve the remotely sensed wind observations. Figure 3 illustrates *DASCAT* and <*ASCAT*> differences estimated for April 2009. It indicates that the main wind patterns observed by the scatterometer are clearly restored by the daily analyses.

2.2.2 Spatial distribution of numerical model comparisons

The main aim is to assess the spatial and temporal patterns of *DASCAT* gridded winds and to investigate their comparisons to those derived from ECMWF analyses (*DECMWF*). Numerical daily wind estimates are calculated as arithmetic means of the associated four NWP data available at 00h:00, 06h:00, 12h:00, and 18h:00, and spatially interpolated over *DASCAT* daily grids. Spatial distributions of *DASCAT* and *DECMWF* differences are shown in Figure 4.

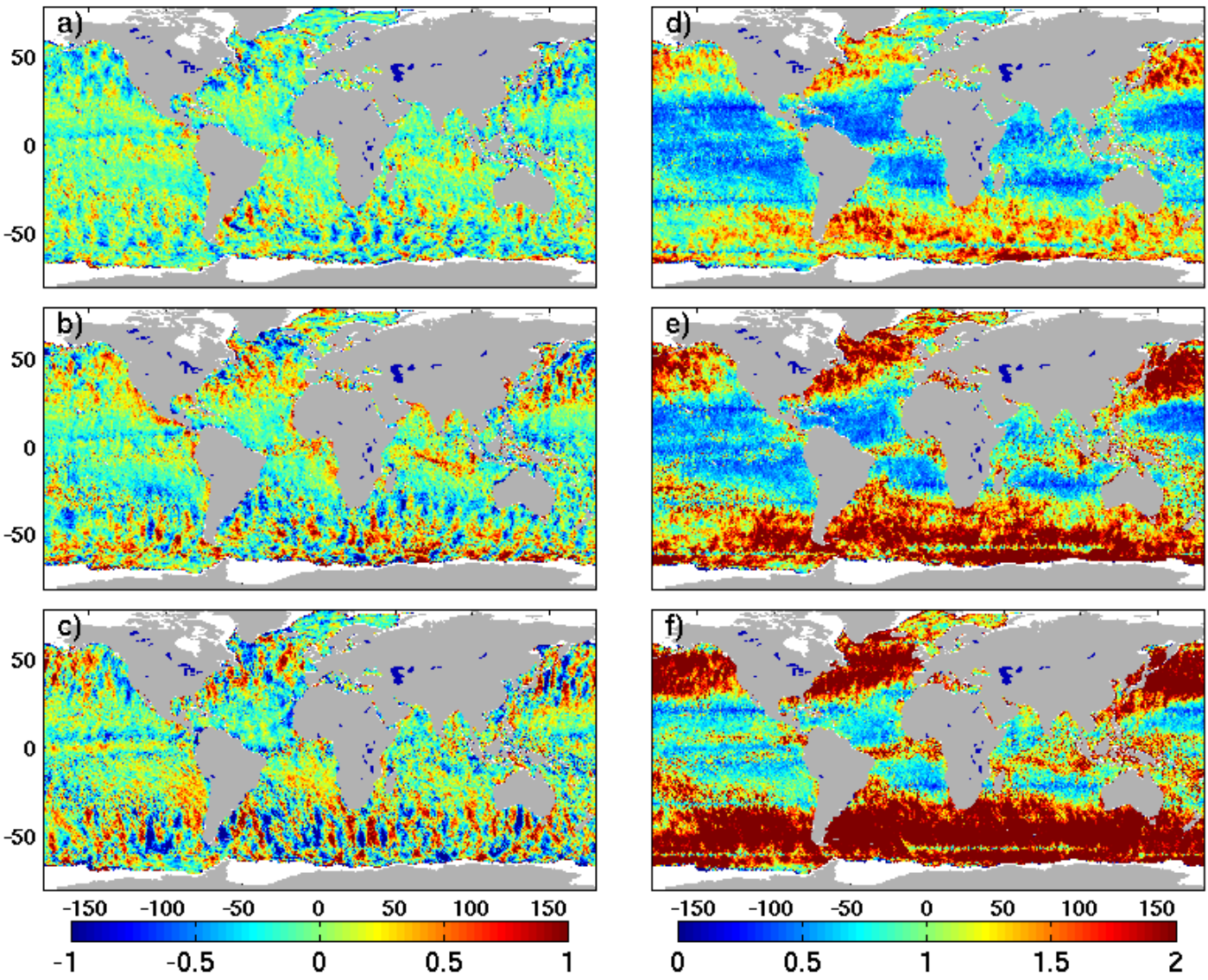

Figure 4: Mean (left) and standard deviation (right) wind differences between collocated *DASCAT* and <*ASCAT*> daily estimates during April 2009. The left panels indicate the wind speed (a), zonal wind component (b), and meridional wind component (c) biases. The corresponding std distributions are shown in d), e), and f) panels, respectively.

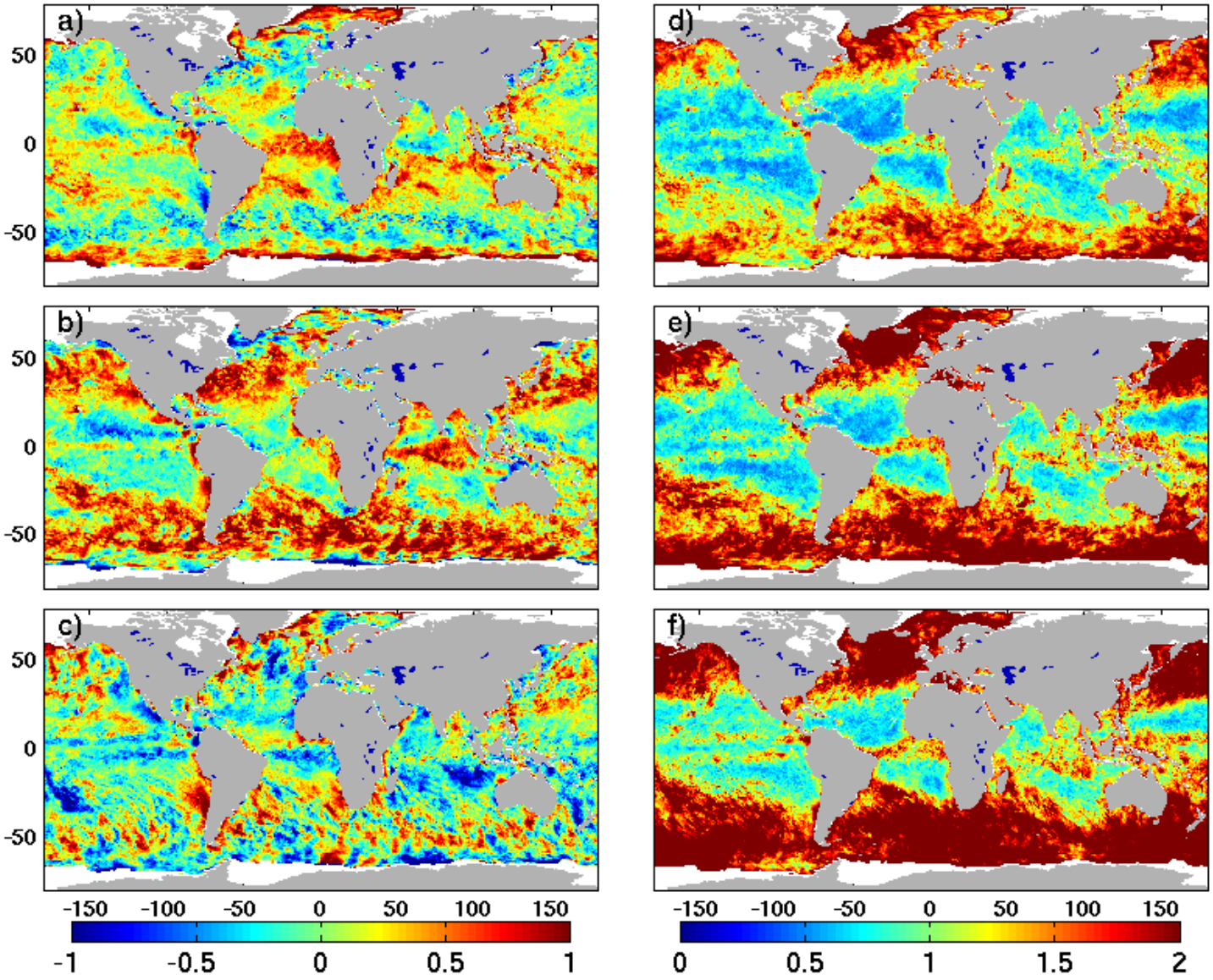

Figure 5: Mean (left) and standard deviation (right) wind differences between collocated *DASCAT* and *DECMWF* estimates during April 2009. The left panels indicate the wind speed (a), zonal wind component (b), and meridional wind component (c) biases. The corresponding std distributions are shown in d), e), and f) panels, respectively.

2.2.3 Statistical comparisons

To further highlight the quality of the resulting daily wind fields *DASCAT*, determined from the comparisons with daily wind estimates <*ASCAT*> and *DECMWF*, statistical parameters characterizing differences and linear correlation are calculated at global scale as well as at several oceanic regions during April 2009. They are provided in Table 3. *DASCAT* and <*ASCAT*> are in good agreement. The related biases are very low and rms wind speed values do not exceed 1.30m/s, while correlation coefficients exceed 0.90.

Table 3 : Statistical parameters characterizing the comparisons between daily ASCAT analyses (*DASCAT*), daily-averaged ASCAT estimates (<*ASCAT*>), and daily-averaged ECMWF analyses (*DECMWF*). Biases (mean differences of *DASCAT*-<*ASCAT*> and of *DASCAT-DECMWF*) and associated rms values are in m/s. *Cor* indicates correlation coefficient.

		Wind Speed		**Zonal**		**Meridional**	
		DASCAT/ <ASCAT>	*DASCAT/ DECMWF*	*DASCAT/ <ASCAT>*	*DASCAT/ DECMWF*	*DASCAT/ <ASCAT>*	*DASCAT/ DECMWF*
Global	***Bias***	-0.06	0.13	0.02	0.31	-0.01	0.00
	Rms	1.15	1.36	1.69	1.83	2.09	2.05
	Cor	0.95	0.92	0.97	0.96	0.93	0.92
Mediterranean Sea	***Bias***	-0.11	0.02	-0.05	-0.04	-0.24	-0.09
	Rms	1.26	1.50	1.89	2.27	1.91	2.18
	Cor	0.90	0.82	0.91	0.85	0.89	0.81
North Atlantic	***Bias***	-0.09	-0.04	0.04	0.33	0.01	-0.04
	Rms	1.23	1.59	1.81	2.19	2.20	2.42
	Cor	0.94	0.87	0.95	0.92	0.93	0.91
Tropical Atlantic	***Bias***	-0.03	0.42	0.02	0.04	-0.07	-0.08
	Rms	0.81	1.10	1.05	1.13	1.31	1.28
	Cor	0.93	0.88	0.95	0.93	0.95	0.95

III. DATA

3.1. Data format

Daily ASCAT wind analysis data files are available in standard netCDF format (http://www.unidata.ucar.edu/software/netcdf). Several scientific and data analysis softwares provide facilities for using such file format.

3.2. File name convention

Daily ASCAT wind analyses are available in separate daily files. They are named as follows:
YYYYMMDD00_YYYYMMDD00_daily-ifremer-L3-MWF-GLO-yyyyddddmmhhmn-01.0.nc.bz2
Where YYYY, MM, DD indicate year, month, and day respectively of daily analysis.
yyyyddddmmhhmn indicates production date.
Files are compressed using bezip command.

3.3. Data file variables

The main variables of each netCDF file are listed in Table 4. They are provided with attributes and specific associated scale and offset factors. More details may be found in Annex1.

Table 4: Datafile variables

Time	Daily analysis date (since January 1st, 1990)	Hours
Latitude	Grid point latitude	Degree
Longitude	Grid point longitude	Degree
Wind Speed	10m wind speed in neutral condition	m/s
Zonal wind component	Eastward wind component	m/s
Meridional wind component	Northward wind component	m/s
Wind stress	Amplitude of wind stress	Pa
Zonal wind stress component	Surface downward eastward wind stress	Pa
Meridional wind stress component	Surface downward northward wind stress	Pa
Wind speed error	Standard deviation of wind speed error derived from the objective method	m/s
Zonal wind error	Standard deviation of zonal wind error derived from the objective method	m/s
Meridional wind error	Standard deviation of meridional wind error derived from the objective method	m/s
Sampling length	Number of ASCAT retrievals used for wind analysis	
Land Ice Mask		

3.4. Data use

ASCAT wind analyses quality is highly related to the ability of the objective method to estimate accurate daily data at grid points and over global oceans from available and valid scatterometer retrievals. The following controls should be applied:

- The grid point should not be over land or ice (use Land Ice Mask variable)
- Wind speed should be strictly greater than 0m/s and lower than 50m/s
- Absolute values of zonal and meridional wind components should be lower than 50m/s
- Wind stress amplitude should be strictly greater than 0Pa and lower than 4Pa
- Absolute values of zonal and meridional wind stress components should be lower than 4Pa.
- Wind speed error should be greater than 0m/s and lower than 10m/s
- Absolute values of zonal and meridional wind component errors should be lower than 10m/s
- Sampling length should be greater than 0.

3.5. Quality control

The quality control of geophysical content of daily ASCAT wind file is performed based on the calculation of the statistical parameters characterizing the difference between *DASCAT* and *DECMWF* wind speed, zonal, and meridional wind component daily estimates. Figure 5 shows time series of difference (*DASCAT – DECMWF*) biases (top) and the related standard deviations (middle) , and of correlation coefficients (bottom). Times series are shown for wind speeds (red colour), zonal component (blue colour), and for meridional component (black colour) from March 11th, 2010 through November 11th, 2011. The statistical parameter time variabilities are quite steady. For instance, wind speed bias, standard deviation, and correlation are of 0.25m/s, 1.35m/s, and 0.91, respectively, along the study period. Only four files associated with higher values for standard deviations, and with low values for correlation coefficients are depicted. They are checked. The departure sources are mainly related to wind variability associated to the remotely sensed data sampling scheme.

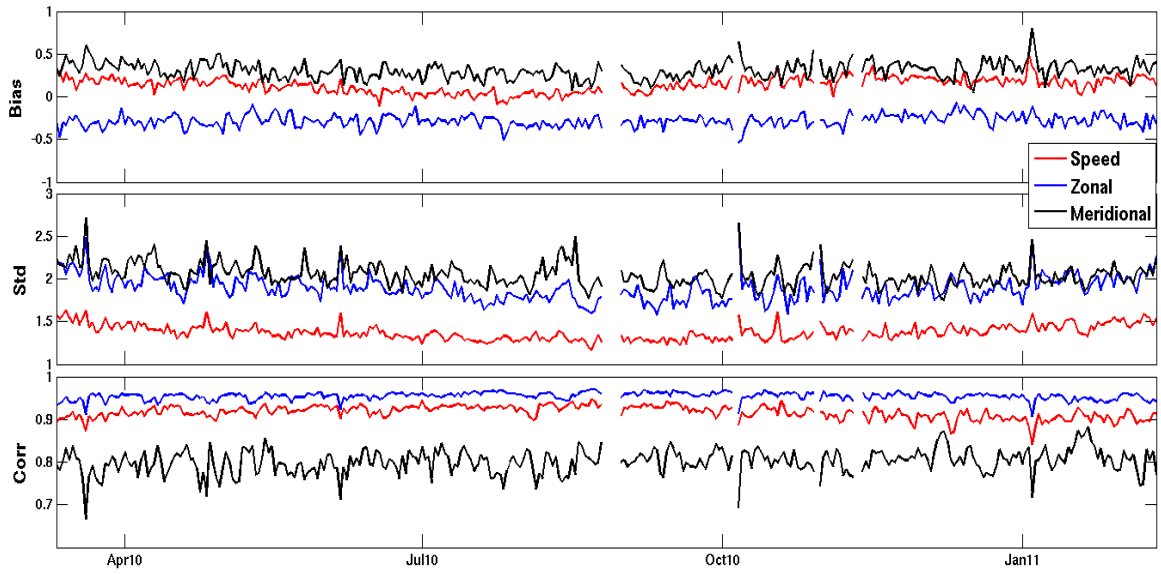

Figure 5 : Time series of statistical parameters characterizing *DASCAT* and *DECMWF* wind comparisons over global ocean. Top through bottom panels show time series of biases (*DASCAT –DECMWF* in this order), standard deviations (*Std*), and correlation coefficients(*Corr*), respectively.

3.6. Data access

Daily ASCAT wind data are available at
ftp://ftp.ifremer.fr/ifremer/cersat/products/gridded/MWF/L3/ASCAT/Daily/

References and Related publications

Bentamy A., H-L Ayina, P. Queffeulou, D. Croize-Fillon ; 2007 : Improved Near Real Time Surface Wind Resolution over The Mediterranean Sea. *Ocean Sci*., 3, 259-271.

Bentamy A. , D. Croize-Fillon, and C. Perigaud, 2008: Characterization of ASCAT measurements based on buoy and QuikSCAT wind vector observations . Ocean Sci., 4, 265-274.

Bentamy A..; D. Croize-Fillon, P.Queffeulou; C. Liu, H. Roquet, 2009: Evaluation of high-resolution surface wind products at global and regional scales. *J. Ocean. Operational*, Vol. 2, N. 2, pp. 15-27(13))

Bentamy A..; D. Croize-Fillon, 2011: Gridded surface wind fields from Metop/ASCAT measurements. In press in *Inter. Journal of Remote Sensing*.

Fairall, C.W., E.F Bradley, J.E. Hare, A.A. Grachev, and J.B. Edson, 2003: Bulk parameterization of air-sea fluxes: updates and verification for the COARE3.0 algorithm, *J. Climate*, 16, 571-591.

Verspeek, J.A., A. Stoffelen, M. Portabella, H. Bonekamp, C. Anderson and J. Figa, 2010: Validation and calibration of ASCAT using CMOD5.n *IEEE Transactions on Geoscience and Remote Sensing*, 48, 1, 386-395.

Vogelzang, J., A. Stoffelen, A. Verhoef and J. Figa-Saldana, On the quality of high-resolution scatterometer winds, J. Geophys. Res., 2010.

Acknowledgements.

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Annex 1

Here are the variables and associated attributes involved in each file(The following list is obtained using ncdump –h command).

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      longitude = 1440 ;

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            latitude:axis = "Y" ;
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            longitude:units = "degrees_east" ;
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            longitude:valid_max = 179.875 ;
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```
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