ECMWF Report on ERS-2 RA for February 2003

Title: Report on ERS-2 Radar Altimeter wave height and wind speed data.

By: *Saleh Abdalla*

Date: *4 March 2003*

Overview:

Based on the data received during the full month, on average, 16699 observations arrived at ECMWF every 6 hours of which 82.68% passed the quality control. The data coverage, which was rather excellent, can be seen in Figure 1. Data were slightly reduced at time windows centred at 00:00 on the 20th., 06:00 on the 25th. and the 26th. of the month (all times are in UTC). Note that we are talking about the raw data which have arrived at ECMWF before they were processed. Apart from the active impact of the DES Sun- Blinding phenomenon, the quality of the received data is as good as usual.

ECMWF atmospheric and wave models were not changed during this month.

Backscatter:

ESR-2 $<\sigma_0>$ = 10.94 dB (with two peaks at 10.6 and 11.1 dB)

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: 0.245 m/s

ERS-2 northern hemisphere: 0.250 m/s

ERS-2 tropics: -0.168 m/s

ERS-2 southern hemisphere: 0.508 m/s

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Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: -0.426 m/s

ERS-2 northern hemisphere: -0.362 m/s

ERS-2 tropics: -1.181 m/s

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: -0.050 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: 0.017 m

ERS-2 tropics: -0.075 m

ERS-2 southern hemisphere: -0.067 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.13 m

ERS-2 northern hemisphere: -0.14 m

ERS-2 tropics: -0.16 m

Remarks:

- This month there are quite a number of outliers (RA values higher than model) in the scatter plot for the wind speed in the Southern Hemisphere (Figure 9). Most of the outliers can be attributed to the DES sun-blinding phenomenon due to high solar activity. The solar activity was high during the whole of the month.

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- There is a couple of outliers in the scatter plots for the wave heights in the Tropics. Those (and same number of the outliers in wind speed) can be attributed due to a tropical storm which was not predicted accurately by the ECMWF meteorological model.
- Apart from that, the quality of Altimeter data is as good as they used to be. The tendency for improved agreement between RA and model data in the Northern Hemisphere after 18 January 2003 (which was mentioned in the January 2003 report) can be confirmed to some extent for this month. It is not clear if any ESA changes to the RA data or if the ECMWF model changes (on the 13th. of the month) are responsible for this improvement.

Comparison Method:

The Altimeter wave height and wind speed data, as received by ECMWF from ESA through GTS, are the so-called fast delivery products. At ECMWF these data are subject to a quality control method, the details of which are described by Janssen et al. (1989) and Bauer et al. (1992). Consequently, superobservations are formed by averaging 30 consecutive data in order to match the spatial scales of the operational WAM model. Therefore, the collocation statistics are based on the comparison between these superobservations and operational wavemodel products.

In addition, since also wave observations from buoys are received through the GTS, the Altimeter products are also compared against buoy observations. Again, in order to have matching scales, the buoy observations are averaged over a six hour time window. Apart from this, also a height correction is applied to the wind speed observations, since not all buoys observe the winds at the standard height of 10 m. A default observation height of 5 m is assumed, and when available the actual observation height is used. In order to interpolate from the observation height to the standard height a logarithmic wind profile with a roughness length as given by the Charnock relation is assumed, where the Charnock parameter is given the constant value of 0.018.

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Figure captions:

Figure 1: Time series of data reception for ERS-2 Altimeter data for February 2003.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for February 2003.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for February 2003.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for February 2003.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for February 2003.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for February 2003 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for February 2003 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for February 2003 (tropics)

Figure 9: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for February 2003 (southern hemisphere)

Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for February 2003 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for February 2003 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for February 2003 (tropics).

Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI).

Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for February 2003.

Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for February 2003.

Figure 16: Global distribution of ECMWF wave heights for February 2003.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for February 2003 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for February 2003 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for February 2003 (tropics)

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Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for February 2003 (southern hemisphere)
Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for February 2003 (global).
Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for February 2003 (northern hemisphere).
Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for February 2003 (tropics).
Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for February 2003.
Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to February 2003
Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to February 2003

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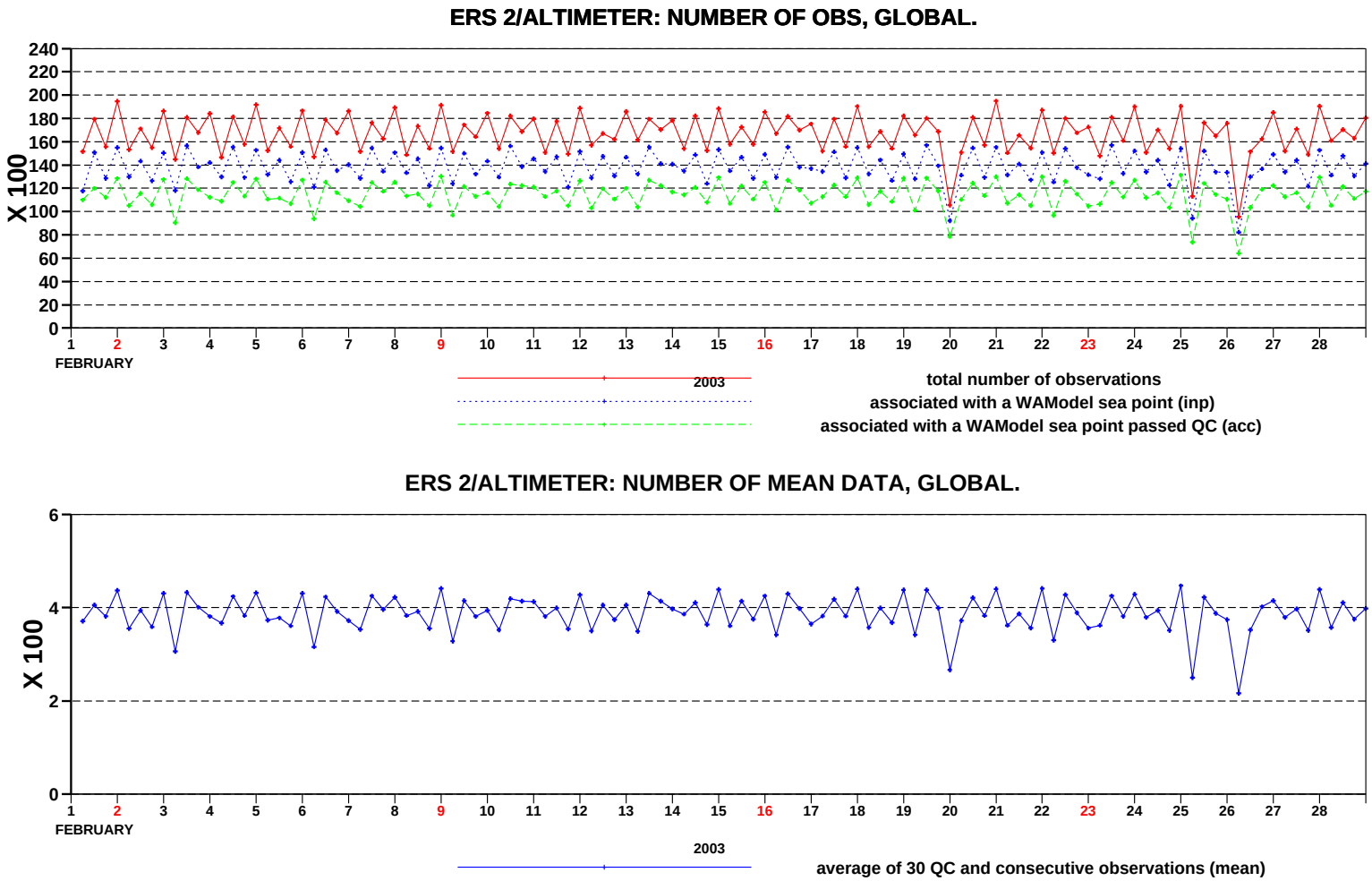

Figure 1: Time series of data reception for ERS-2 Altimeter data for February 2003

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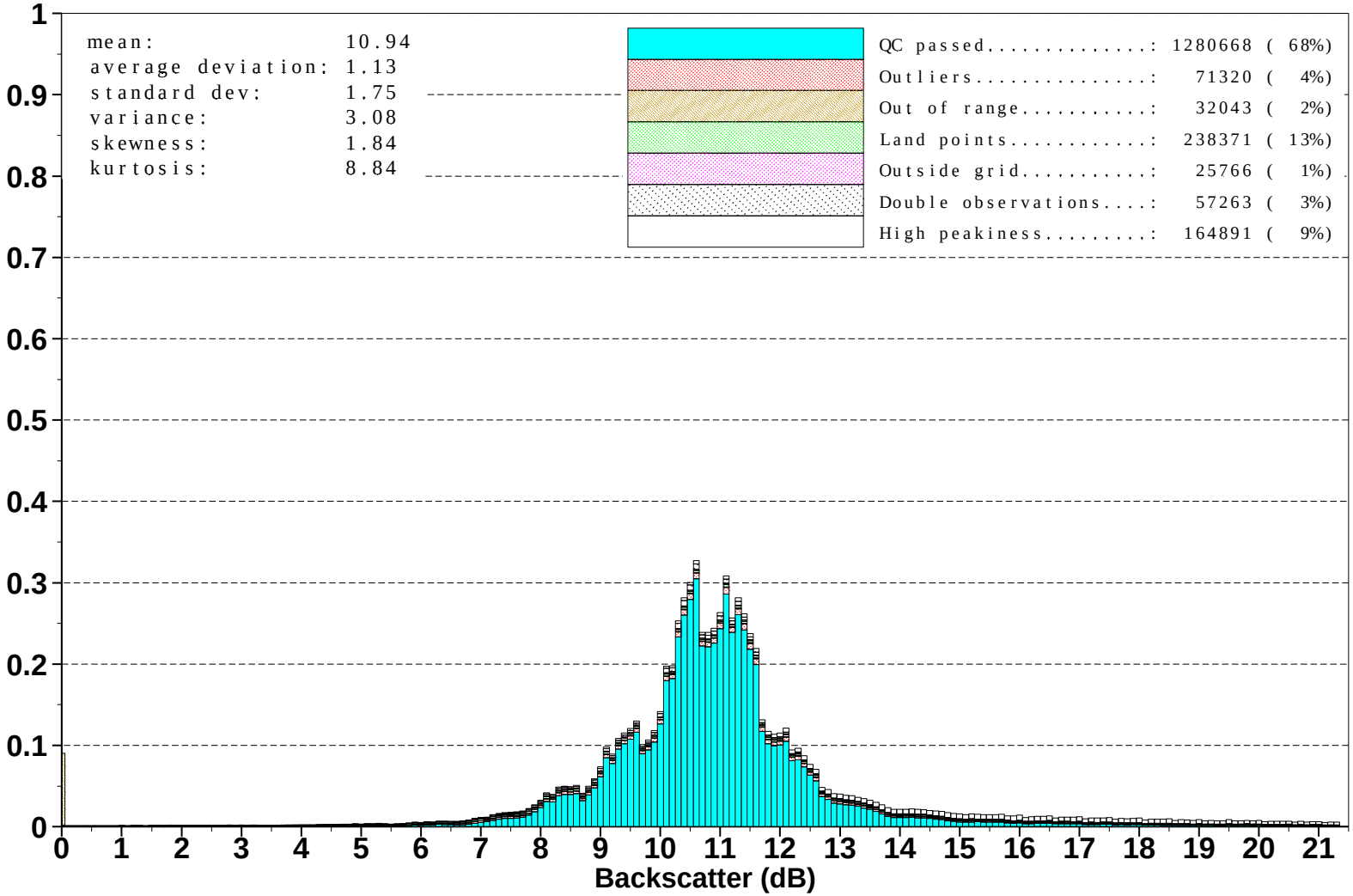

Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for February 2003

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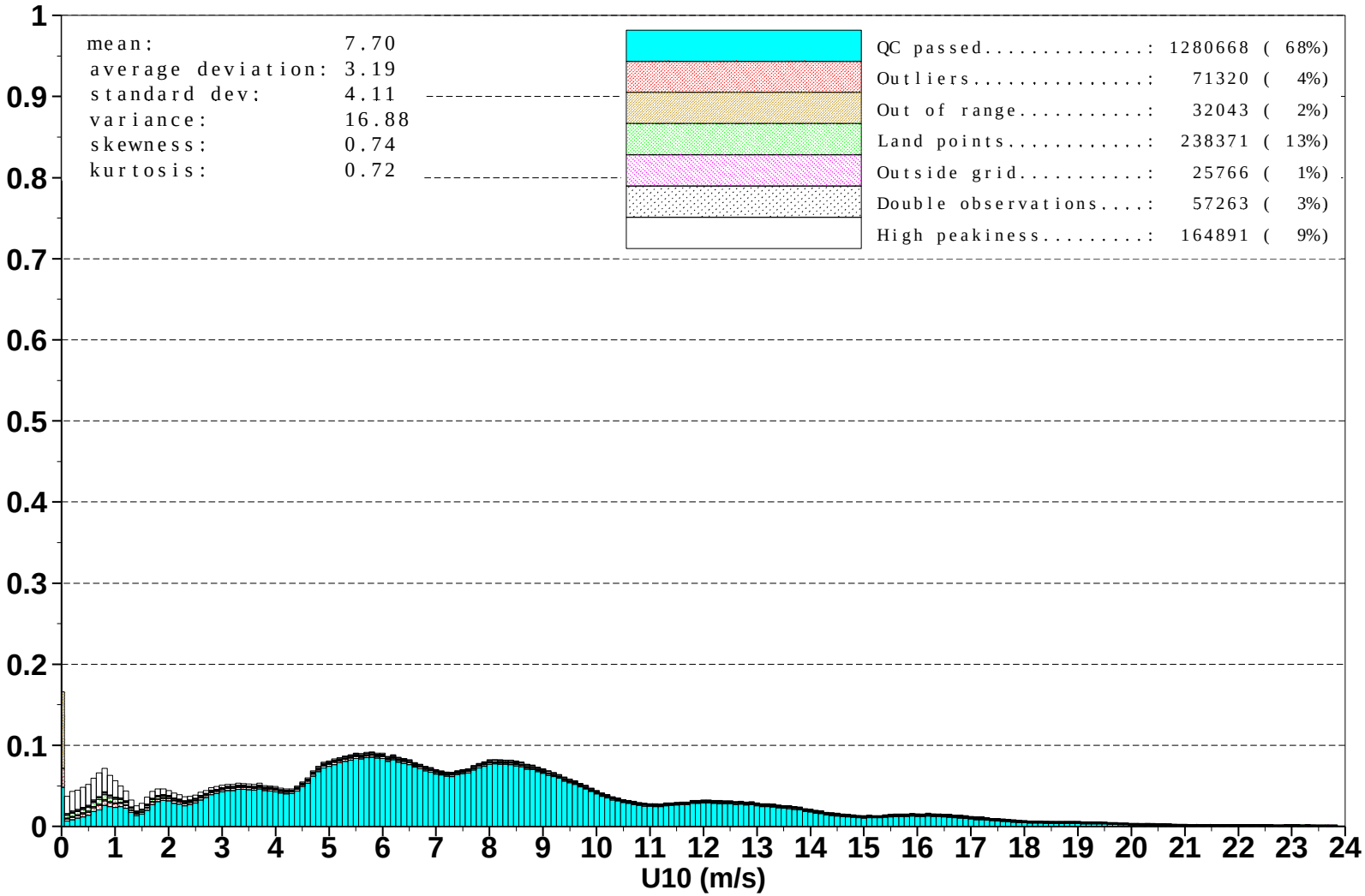

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for February 2003

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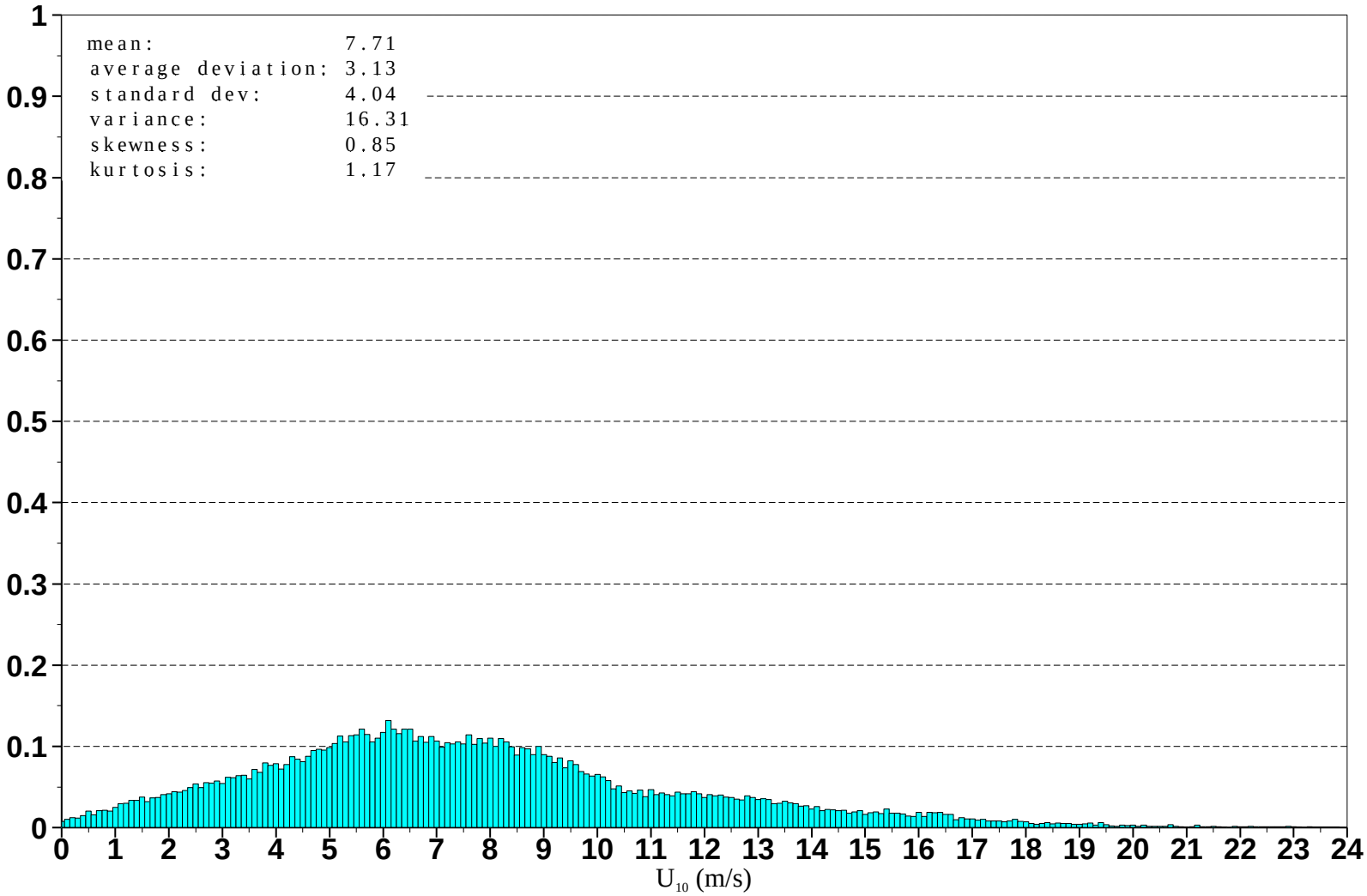

Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for February 2003

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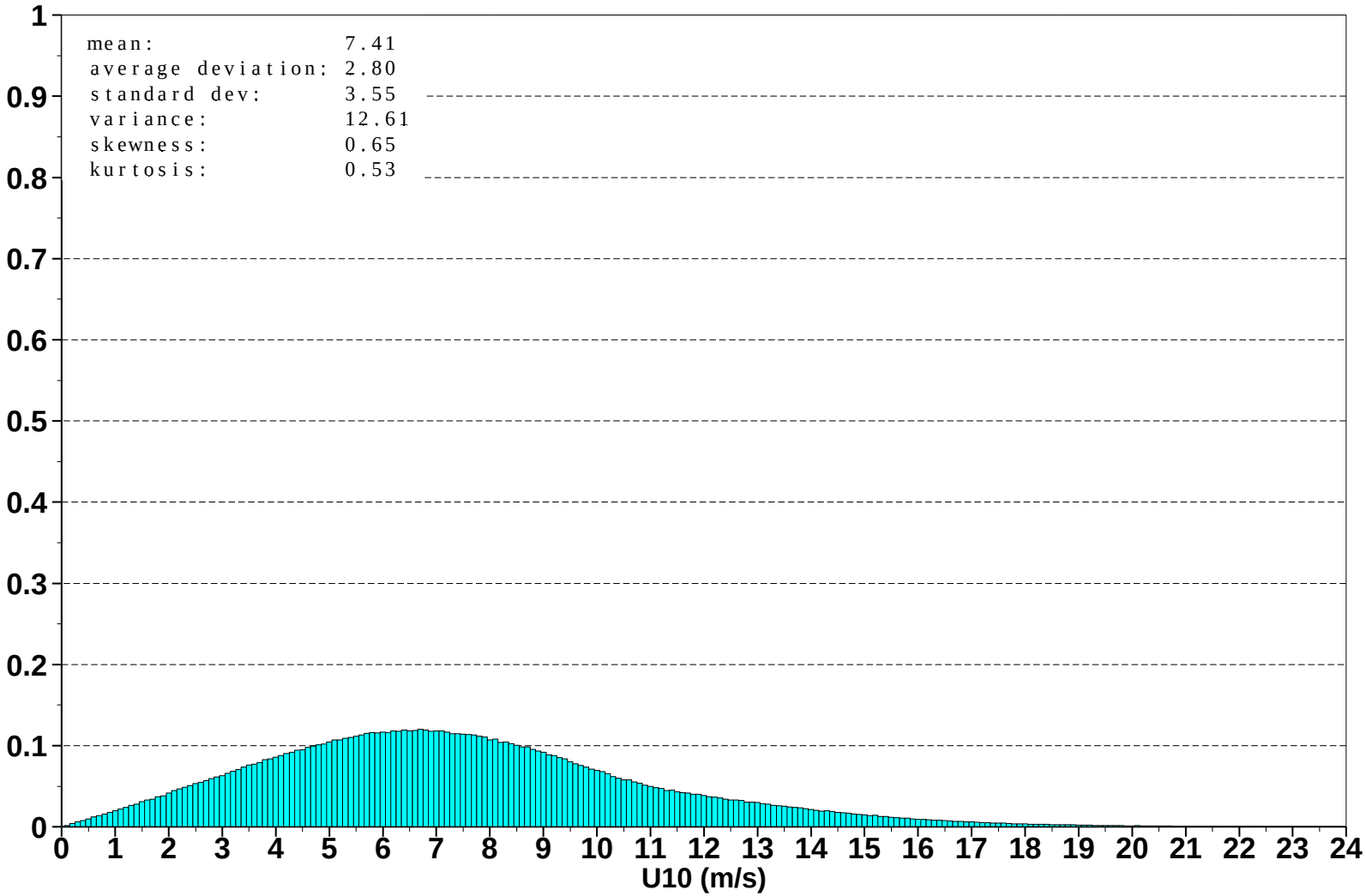

Figure 5: Global distribution of ECMWF ocean surface wind speeds for February 2003

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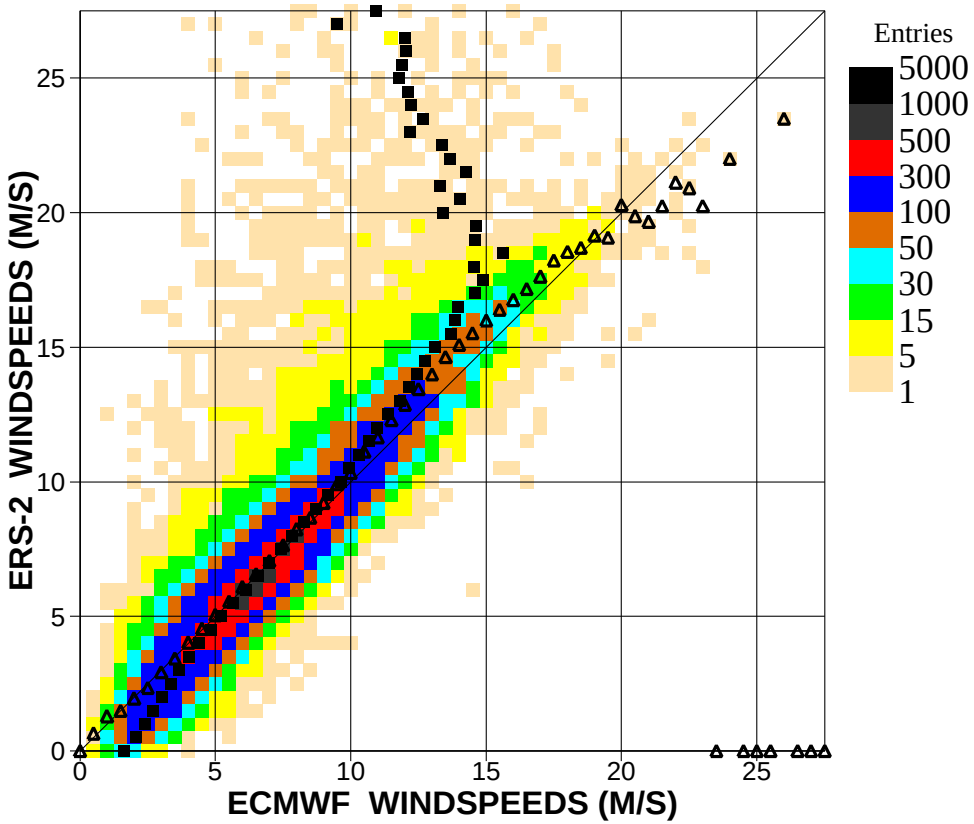

STATISTICS

ENTRIES	43200
MEAN ECMWF	7.4676
MEAN ERS-2	7.7121
BIAS (ERS-2 - ECMWF)	0.2445
STANDARD DEVIATION	1.8143
SCATTER INDEX	0.2430
CORRELATION	0.8961
SYMMETRIC SLOPE	1.0643 (0.0026)
REGR. COEFFICIENT	1.0842 (0.0026)
REGR. CONSTANT	-0.3843 (0.0211)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for February 2003 (global)

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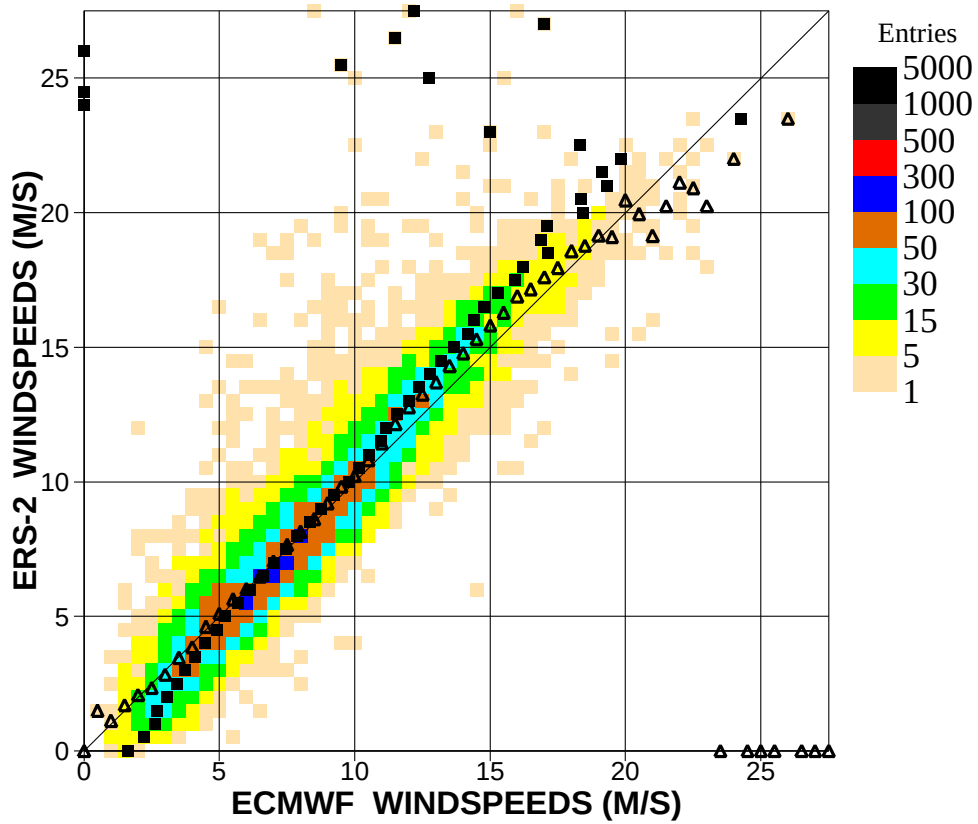

STATISTICS

ENTRIES	9873	
MEAN ECMWF	8.5173	
MEAN ERS-2	8.7668	
BIAS (ERS-2 - ECMWF)	0.2495	
STANDARD DEVIATION	1.5921	
SCATTER INDEX	0.1869	
CORRELATION	0.9319	
SYMMETRIC SLOPE	1.0482	(0.0042)
REGR. COEFFICIENT	1.0604	(0.0042)
REGR. CONSTANT	-0.2650	(0.0388)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for February 2003 (n.hem.)

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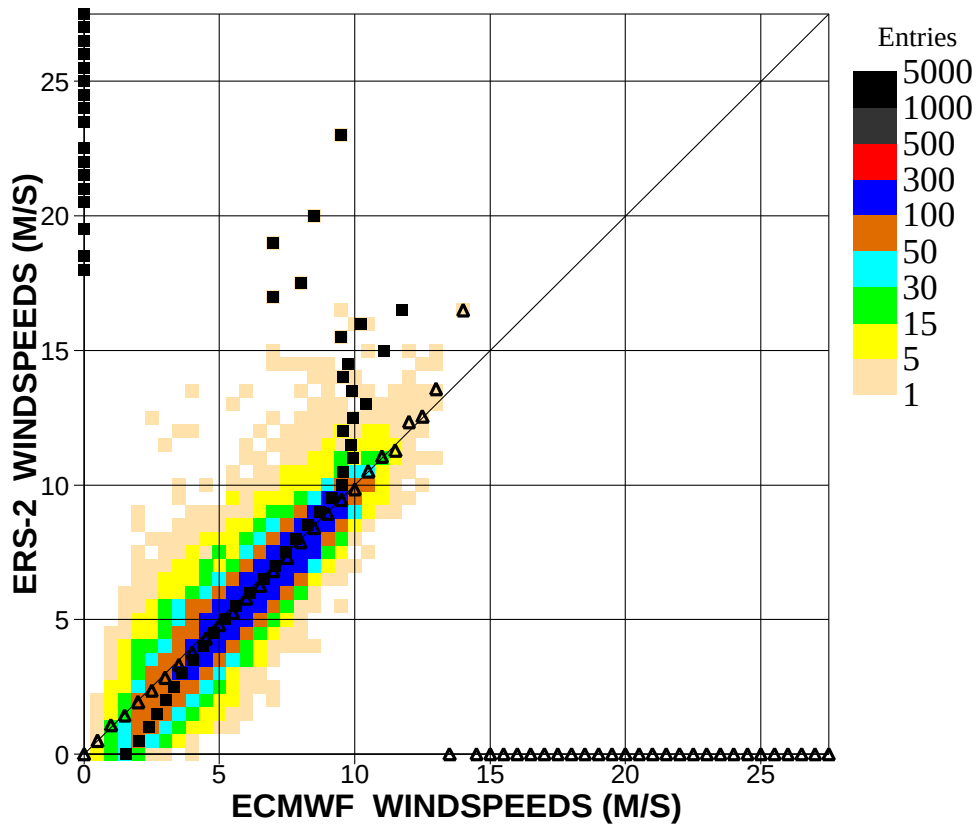

STATISTICS

ENTRIES	13397
MEAN ECMWF	5.9762
MEAN ERS-2	5.8083
BIAS (ERS-2 - ECMWF)	-0.1679
STANDARD DEVIATION	1.1535
SCATTER INDEX	0.1930
CORRELATION	0.8936
SYMMETRIC SLOPE	0.9936 (0.0044)
REGR. COEFFICIENT	1.0122 (0.0044)
REGR. CONSTANT	-0.2408 (0.0281)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for February 2003 (tropics)

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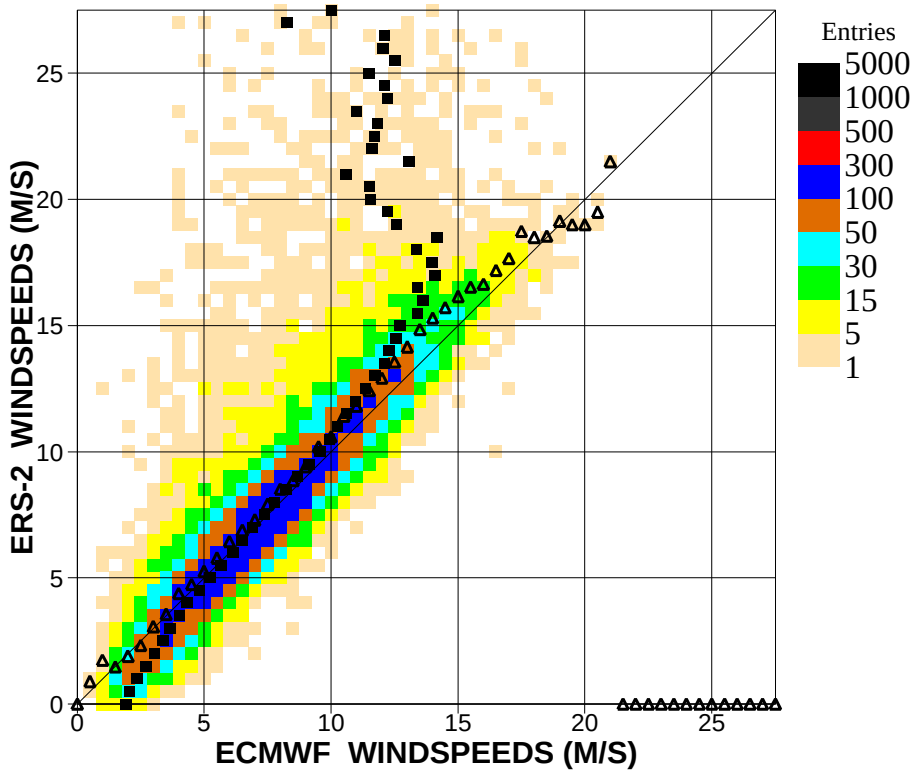

STATISTICS

ENTRIES	20257
MEAN ECMWF	7.9261
MEAN ERS-2	8.4346
BIAS (ERS-2 - ECMWF)	0.5084
STANDARD DEVIATION	2.1789
SCATTER INDEX	0.2749
CORRELATION	0.8603
SYMMETRIC SLOPE	1.0973 (0.0046)
REGR. COEFFICIENT	1.0909 (0.0045)
REGR. CONSTANT	-0.2120 (0.0391)

Figure 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for February 2003 (s.hem.)

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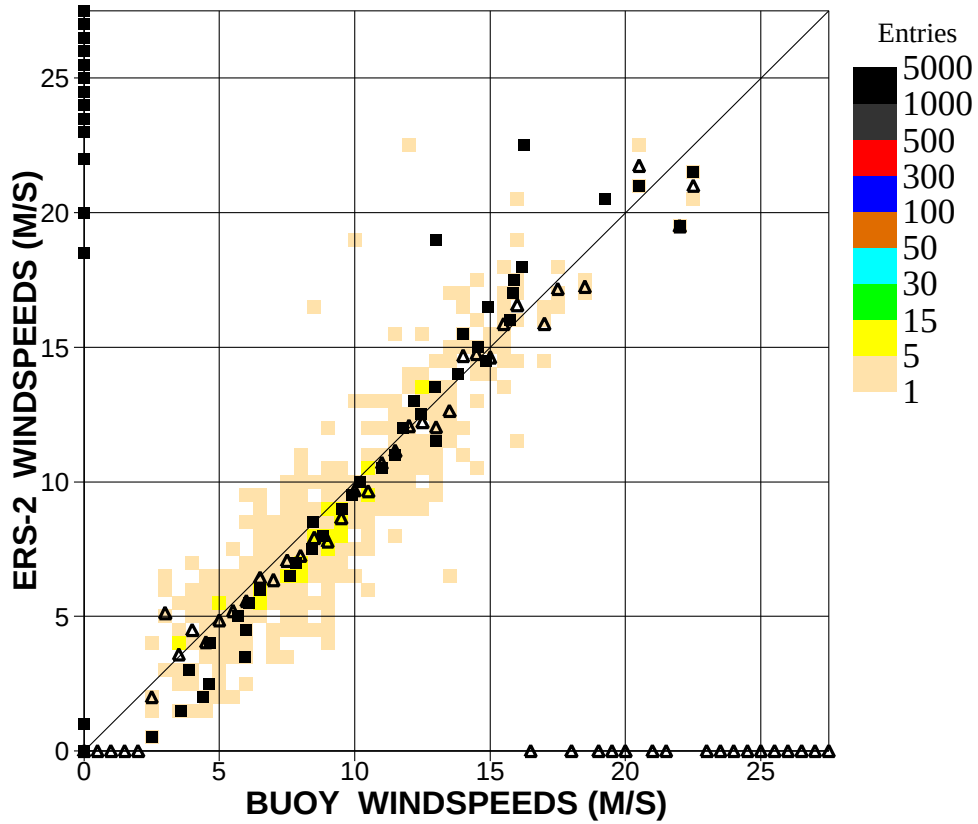

STATISTICS

ENTRIES	508	
MEAN BUOY	9.2186	
MEAN ERS-2	8.7931	
BIAS (ERS-2 - BUOY)	-0.4255	
STANDARD DEVIATION	1.7162	
SCATTER INDEX	0.1862	
CORRELATION	0.8986	
SYMMETRIC SLOPE	0.9745	(0.0217)
REGR. COEFFICIENT	0.9930	(0.0216)
REGR. CONSTANT	-0.3607	(0.2129)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for February 2003 (global)

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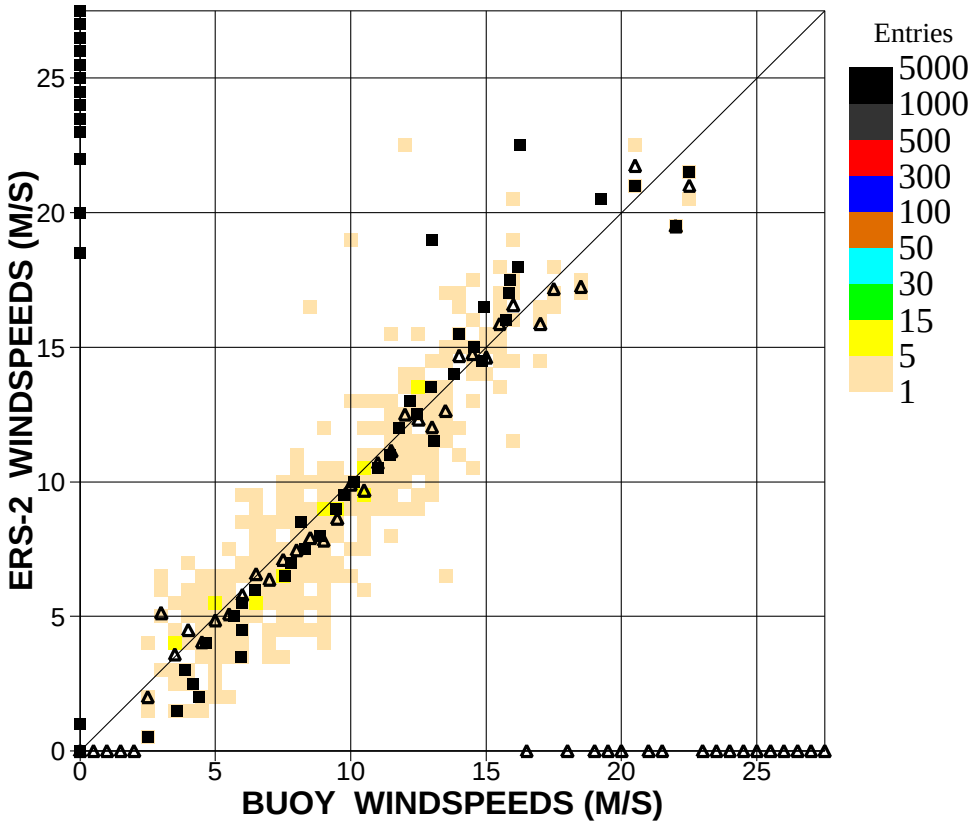

STATISTICS

ENTRIES	453	
MEAN BUOY	9.3034	
MEAN ERS-2	8.9413	
BIAS (ERS-2 - BUOY)	-0.3622	
STANDARD DEVIATION	1.7856	
SCATTER INDEX	0.1919	
CORRELATION	0.8987	
SYMMETRIC SLOPE	0.9816	(0.0229)
REGR. COEFFICIENT	0.9915	(0.0228)
REGR. CONSTANT	-0.2828	(0.2280)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for February 2003 (n.hem.)

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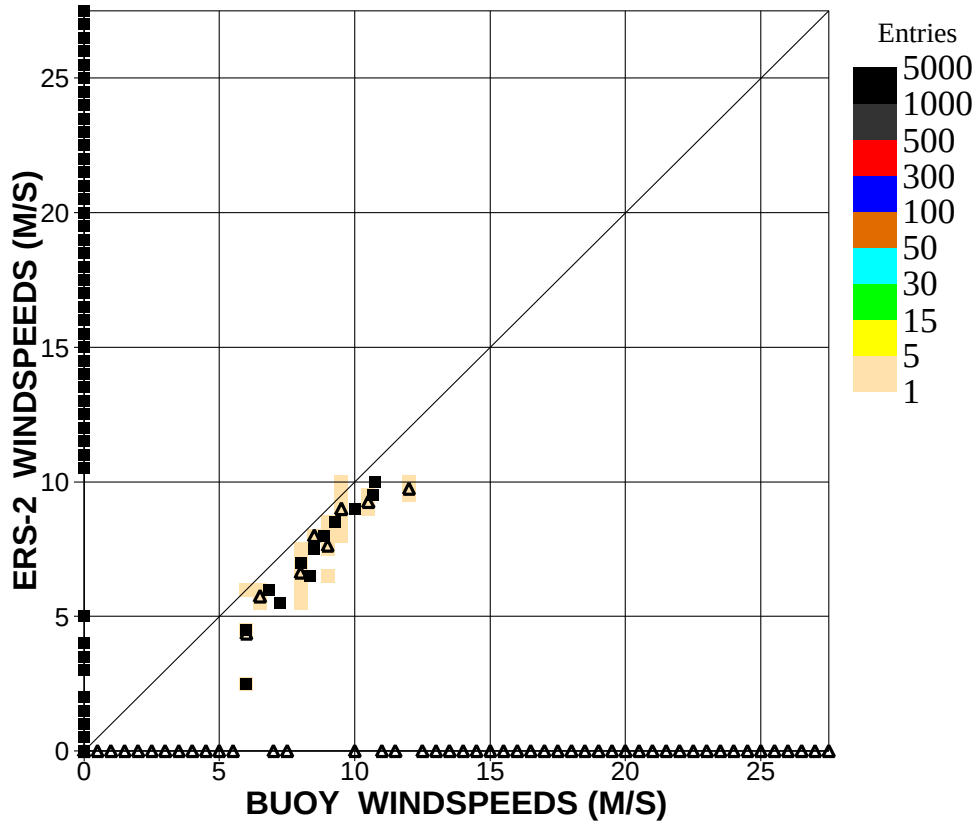

STATISTICS

ENTRIES	29	
MEAN BUOY	8.4814	
MEAN ERS-2	7.3000	
BIAS (ERS-2 - BUOY)	-1.1814	
STANDARD DEVIATION	0.8661	
SCATTER INDEX	0.1021	
CORRELATION	0.8869	
SYMMETRIC SLOPE	0.8717	(0.1038)
REGR. COEFFICIENT	0.9999	(0.1002)
REGR. CONSTANT	-1.1808	(0.8656)

Figure 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for February 2003 (hawaii)

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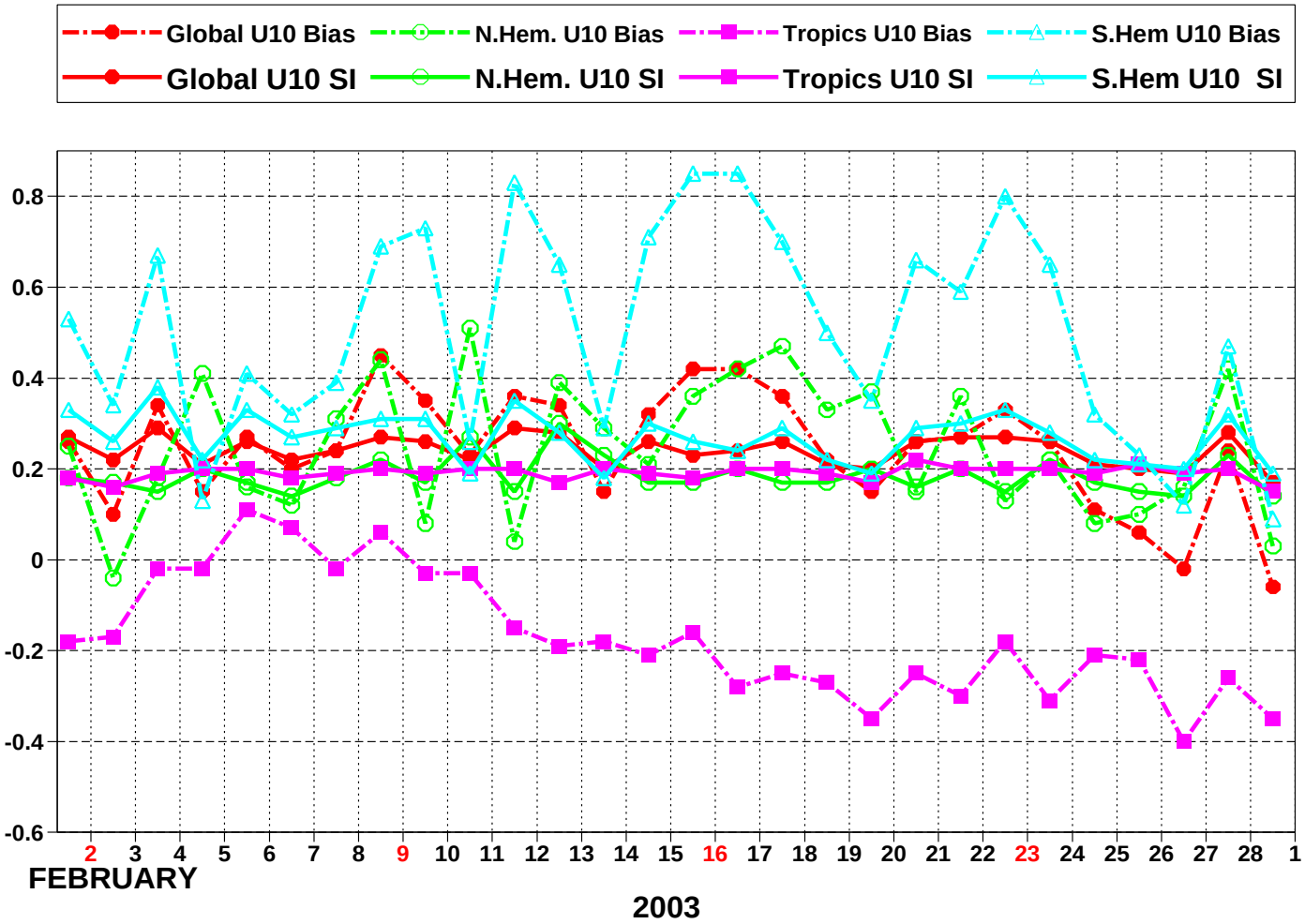

Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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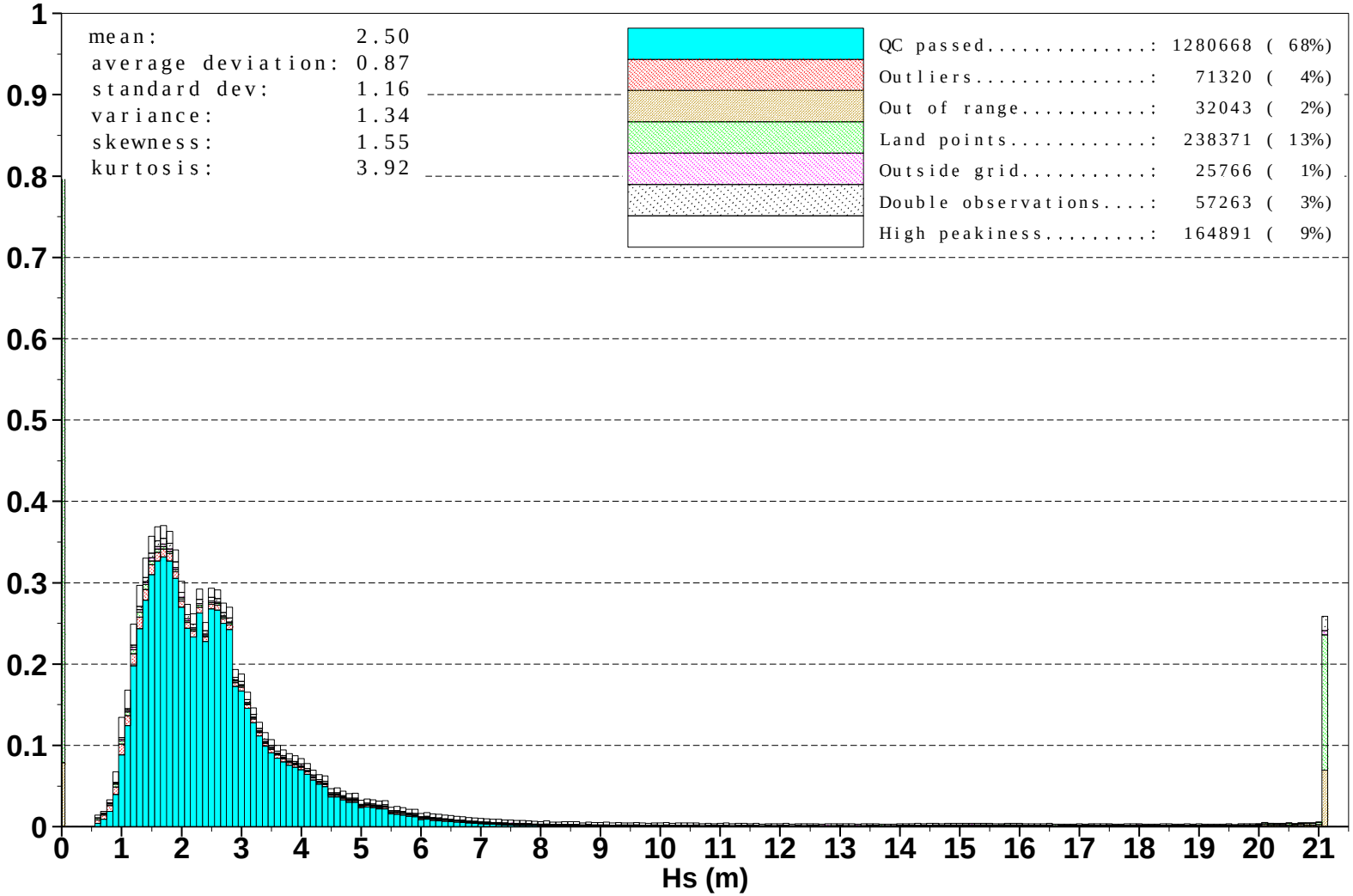

Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for February 2003

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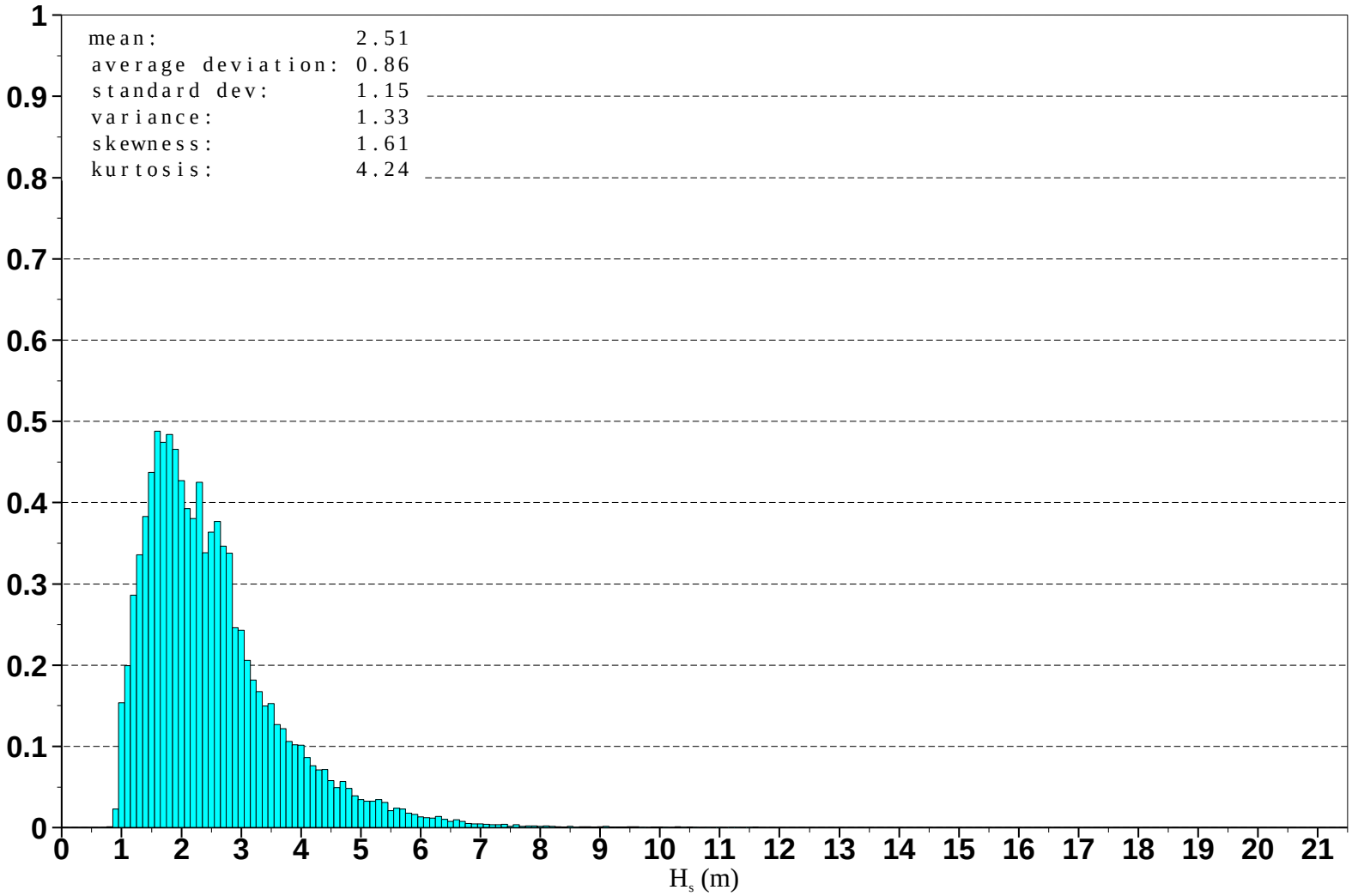

Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for February 2003

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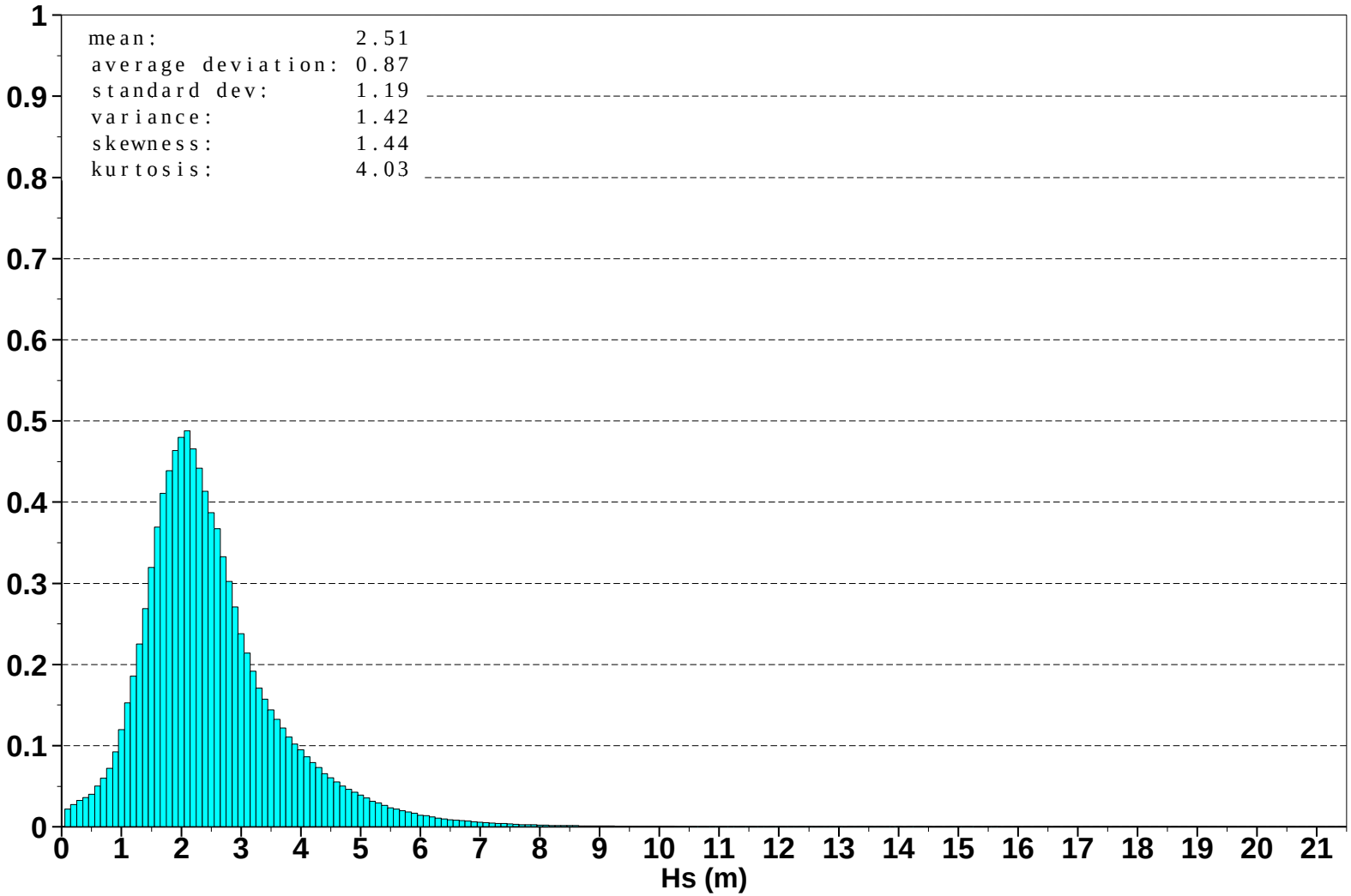

Figure 16: Global distribution of ECMWF wave heights for February 2003

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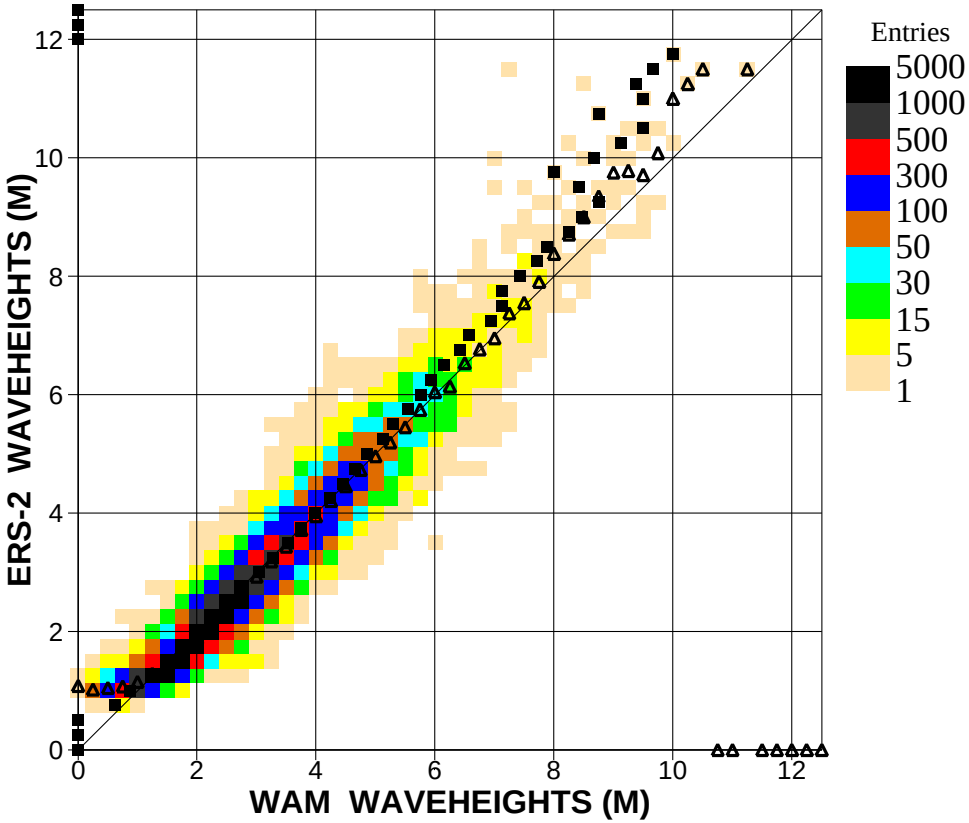

STATISTICS

ENTRIES	43200	
MEAN WAM	2.5596	
MEAN ERS-2	2.5094	
BIAS (ERS-2 - WAM)	-0.0502	
STANDARD DEVIATION	0.2934	
SCATTER INDEX	0.1146	
CORRELATION	0.9670	
SYMMETRIC SLOPE	0.9880	(0.0013)
REGR. COEFFICIENT	0.9930	(0.0013)
REGR. CONSTANT	-0.0324	(0.0035)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for February 2003 (global)

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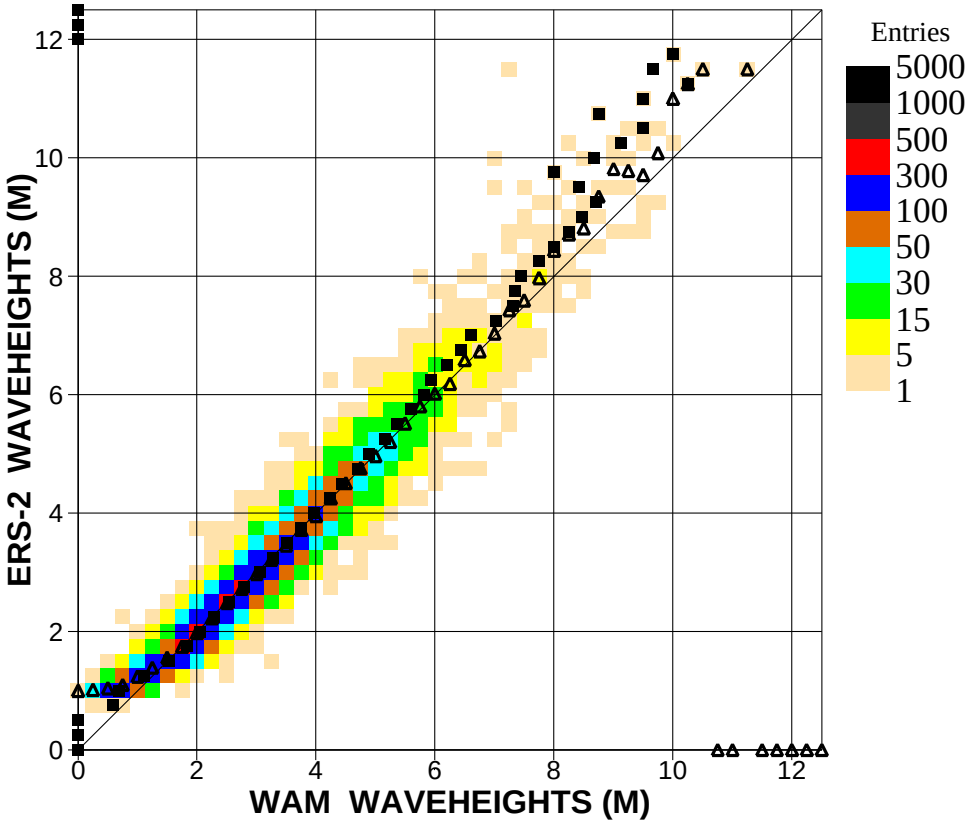

STATISTICS

ENTRIES	9873	
MEAN WAM	2.9559	
MEAN ERS-2	2.9733	
BIAS (ERS-2 - WAM)	0.0174	
STANDARD DEVIATION	0.3551	
SCATTER INDEX	0.1201	
CORRELATION	0.9703	
SYMMETRIC SLOPE	1.0071	(0.0025)
REGR. COEFFICIENT	0.9820	(0.0025)
REGR. CONSTANT	0.0706	(0.0081)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for February 2003 (n.hem.)

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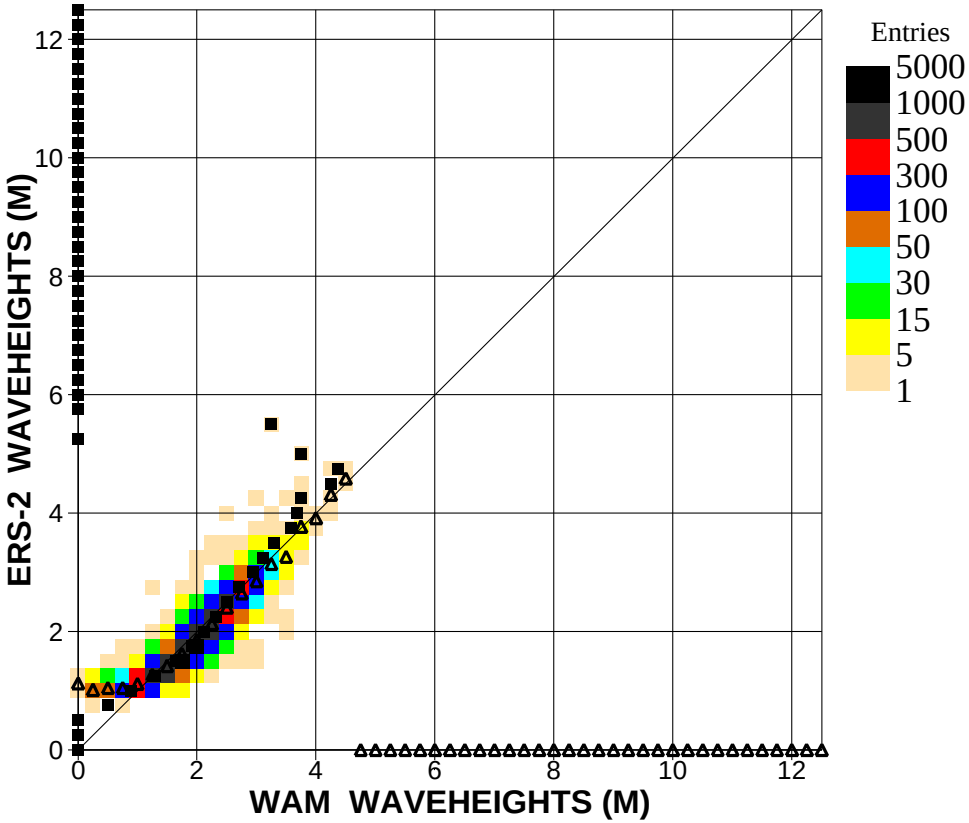

STATISTICS

ENTRIES	13397	
MEAN WAM	1.9073	
MEAN ERS-2	1.8326	
BIAS (ERS-2 - WAM)	-0.0748	
STANDARD DEVIATION	0.2143	
SCATTER INDEX	0.1124	
CORRELATION	0.9253	
SYMMETRIC SLOPE	0.9599	(0.0032)
REGR. COEFFICIENT	0.8782	(0.0031)
REGR. CONSTANT	0.1576	(0.0062)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for February 2003 (tropics)

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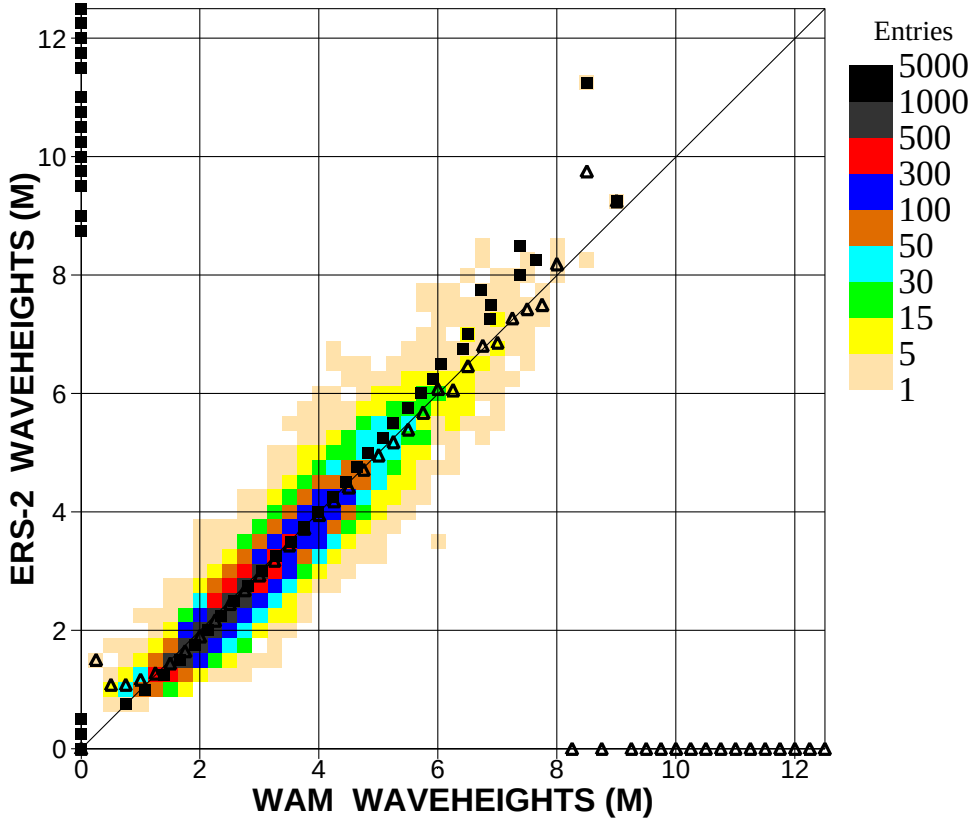

STATISTICS

ENTRIES	20257
MEAN WAM	2.7907
MEAN ERS-2	2.7242
BIAS (ERS-2 - WAM)	-0.0665
STANDARD DEVIATION	0.2995
SCATTER INDEX	0.1073
CORRELATION	0.9604
SYMMETRIC SLOPE	0.9848 (0.0021)
REGR. COEFFICIENT	1.0047 (0.0020)
REGR. CONSTANT	-0.0797 (0.0061)

Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for February 2003 (s.hem.)

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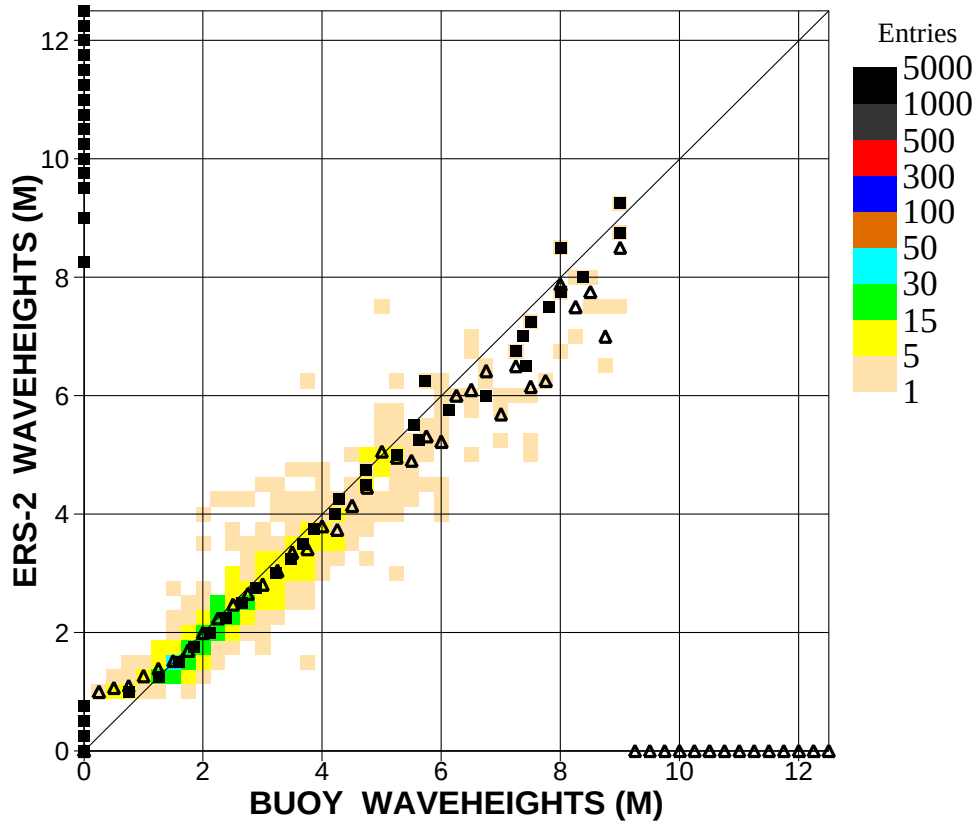

STATISTICS

ENTRIES	808	
MEAN BUOY	3.0345	
MEAN ERS-2	2.9015	
BIAS (ERS-2 - BUOY)	-0.1330	
STANDARD DEVIATION	0.5050	
SCATTER INDEX	0.1664	
CORRELATION	0.9485	
SYMMETRIC SLOPE	0.9473	(0.0106)
REGR. COEFFICIENT	0.8667	(0.0102)
REGR. CONSTANT	0.2715	(0.0349)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for February 2003 (global)

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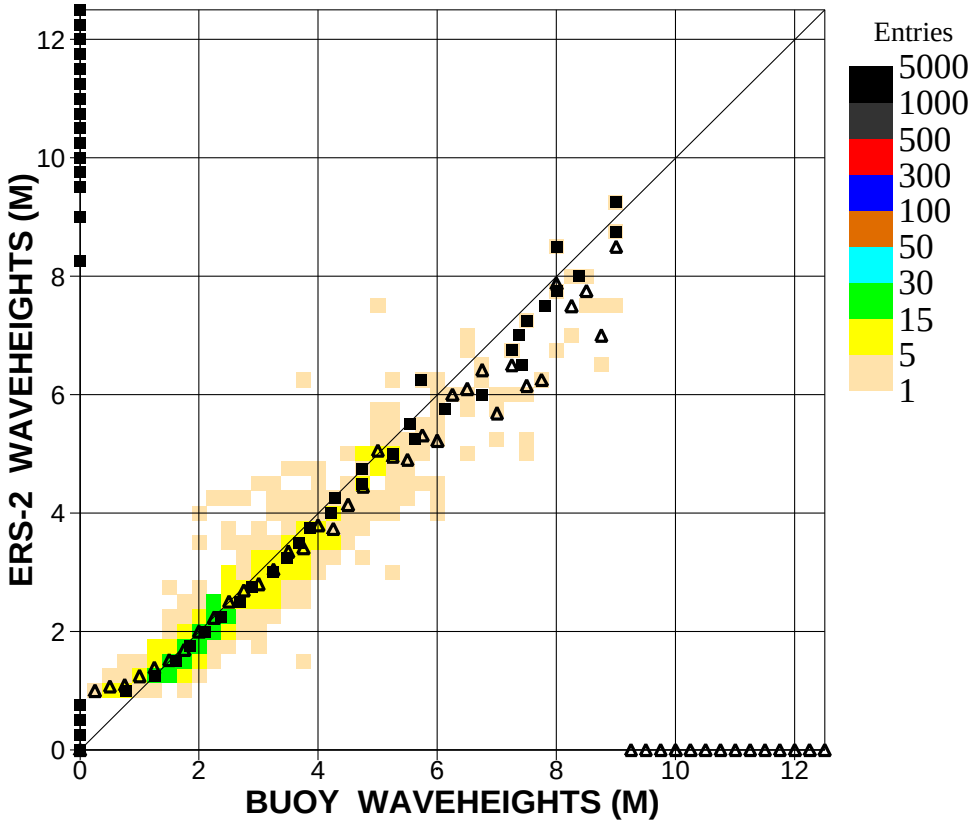

STATISTICS

ENTRIES	750	
MEAN BUOY	3.0894	
MEAN ERS-2	2.9532	
BIAS (ERS-2 - BUOY)	-0.1362	
STANDARD DEVIATION	0.5218	
SCATTER INDEX	0.1689	
CORRELATION	0.9478	
SYMMETRIC SLOPE	0.9469	(0.0111)
REGR. COEFFICIENT	0.8660	(0.0107)
REGR. CONSTANT	0.2778	(0.0372)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for February 2003 (n.hem.)

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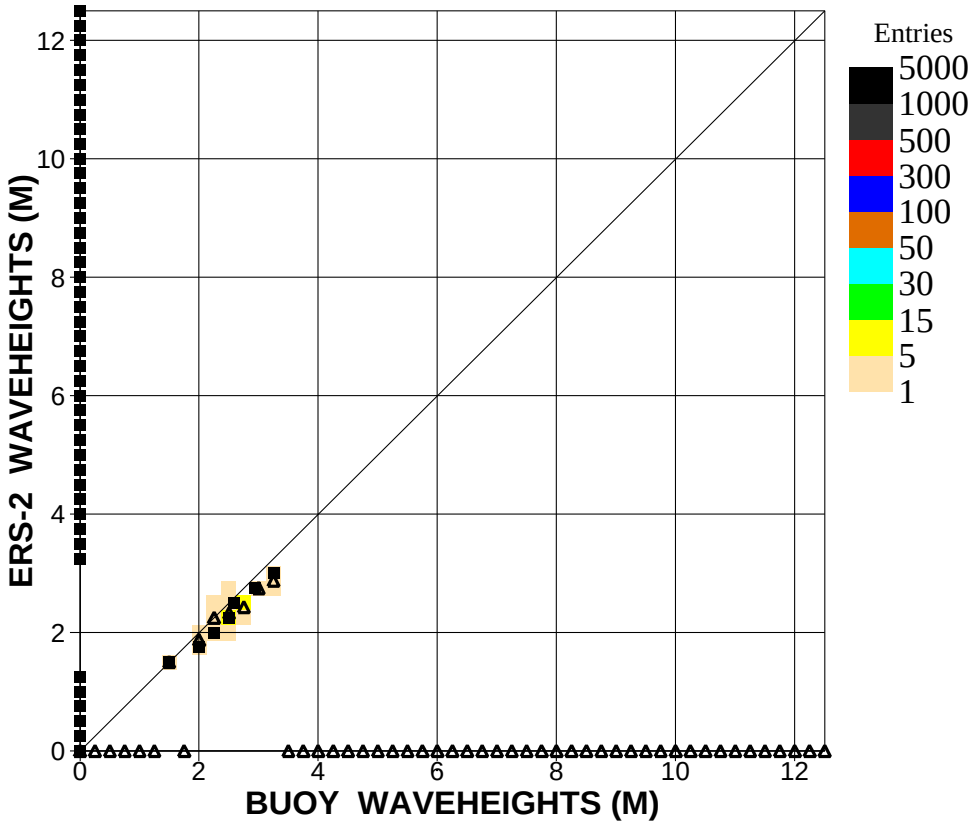

STATISTICS

ENTRIES	31	
MEAN BUOY	2.4672	
MEAN ERS-2	2.3110	
BIAS (ERS-2 - BUOY)	-0.1562	
STANDARD DEVIATION	0.1578	
SCATTER INDEX	0.0640	
CORRELATION	0.8994	
SYMMETRIC SLOPE	0.9363	(0.0772)
REGR. COEFFICIENT	0.8240	(0.0744)
REGR. CONSTANT	0.2781	(0.1854)

Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for February 2003 (hawaii)

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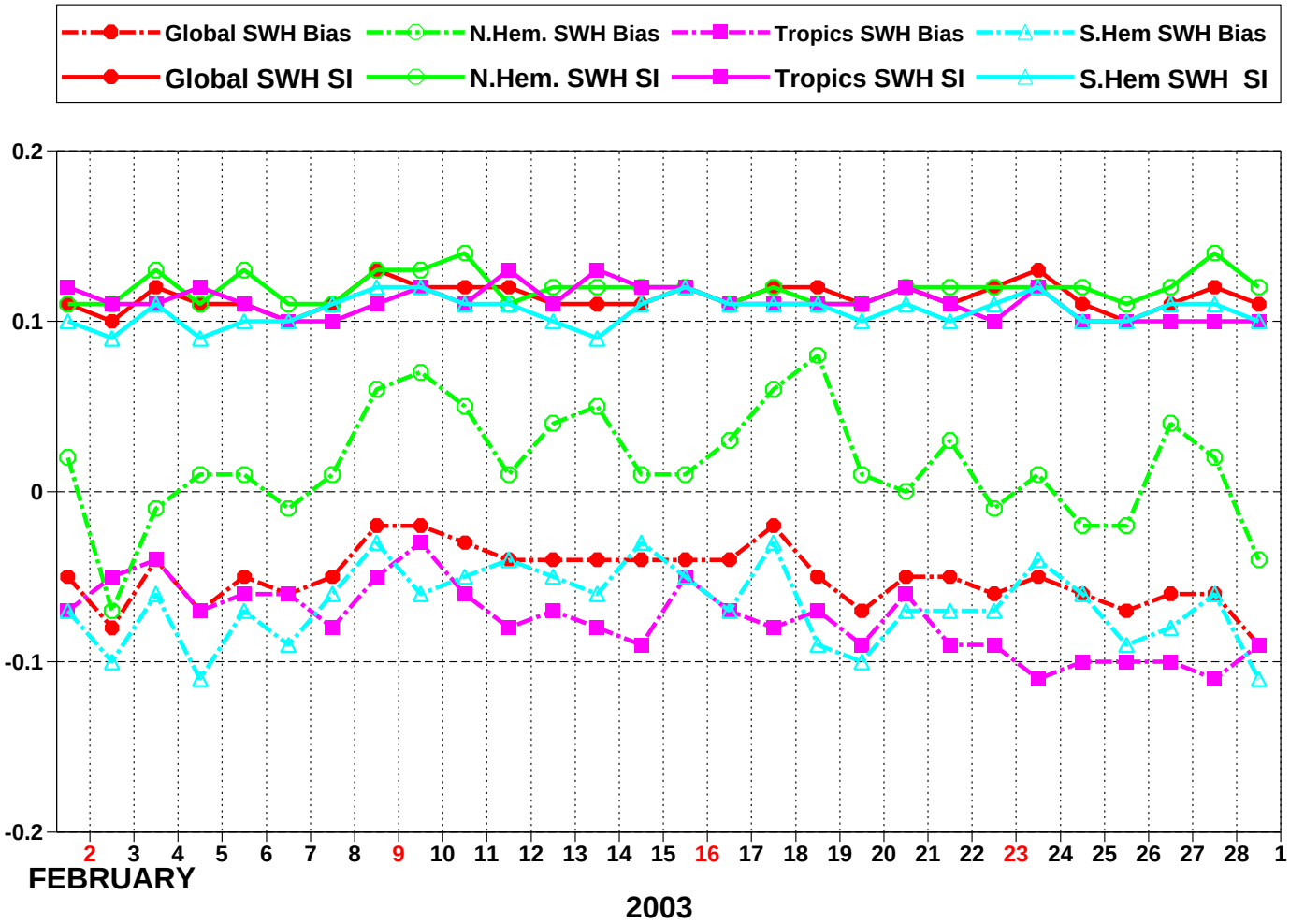

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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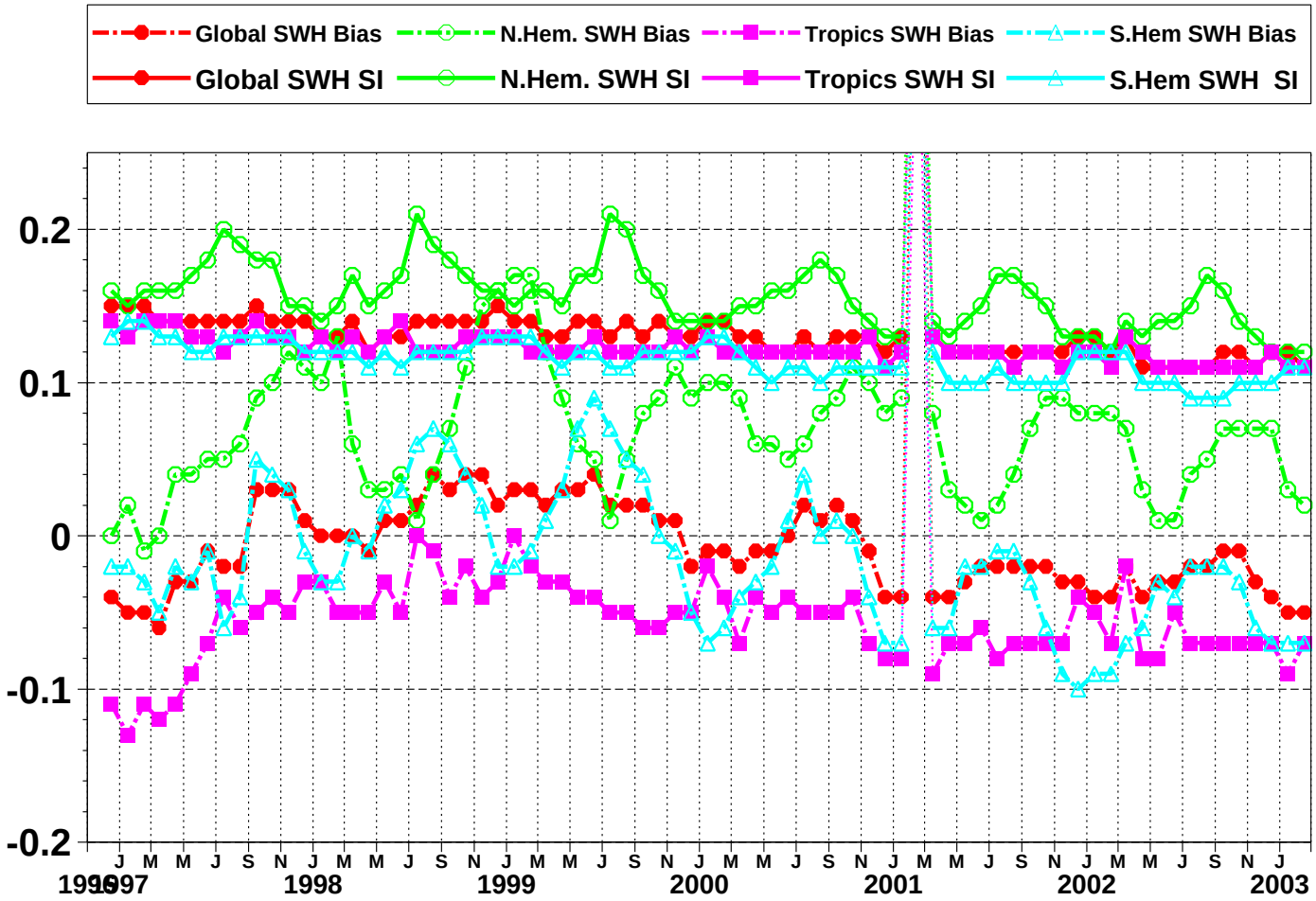

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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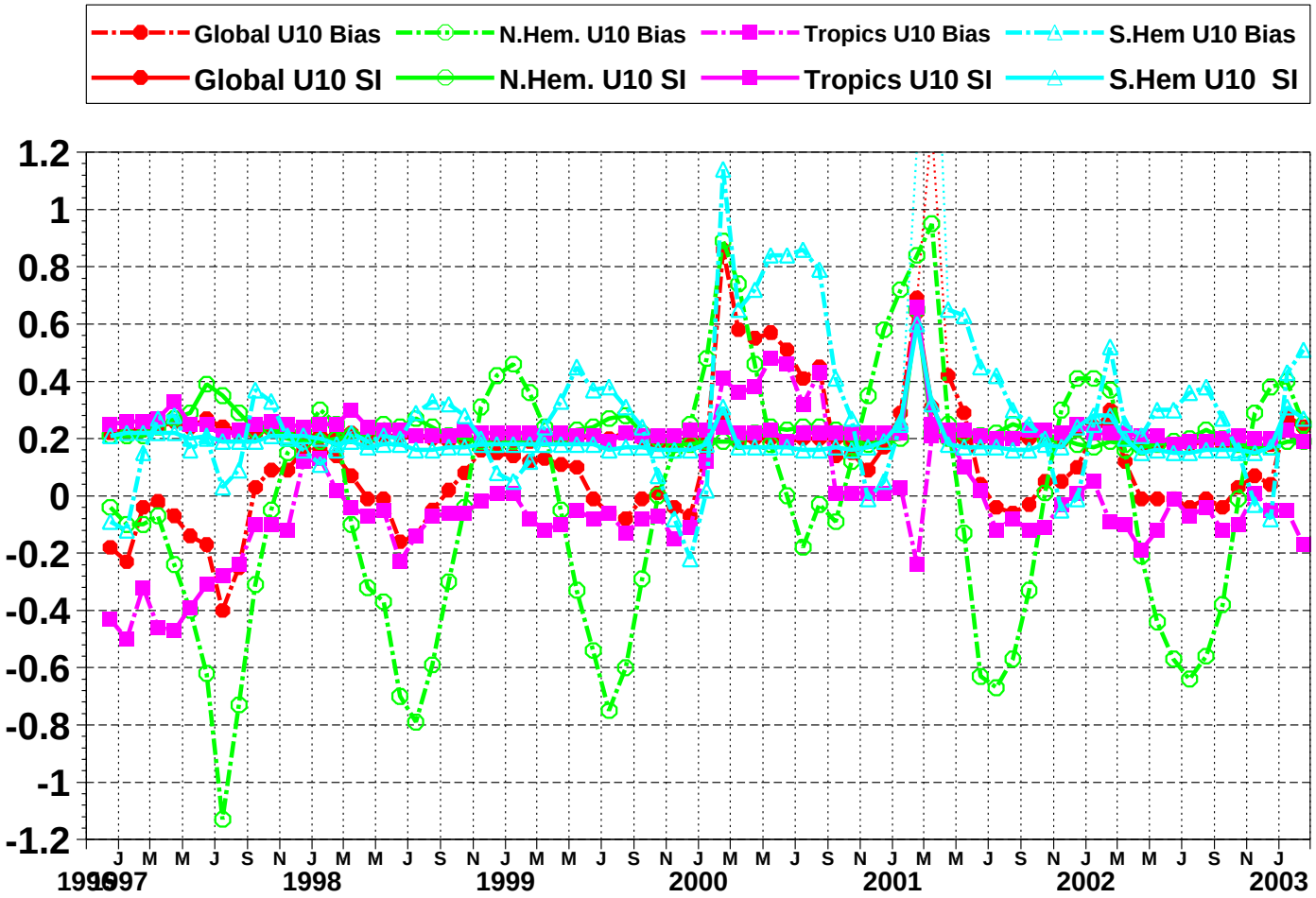

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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