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

By: Jean Bidlot

Date: 7 February 2000

Overview:

This month around 13447 observations arrived at ECMWF every 6 hours of which 81.62% passed the quality control. No data were received around the transition to the new year due to ESA preventive action for the millenium bug (figure 1). Data coverage was substantially reduced in the six hour time windows centered on the 0 and 6UT from the 16th to the 24th in part due to ECMWF failure to adapt to a change in the BUFR tables made by ESA. Data coverage was also reduced on the 8th at 6UT and on the 30th at 6 and 12 UT.

Note that we are talking about data which have arrived at ECMWF before they were needed for the operational data assimilation.

PLEASE SEE REMARKS BELOW (page 3)

Backscatter:

ESR-2 $<\sigma_0>$ = 11.03 dB (one peak: at 11.1dB)

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ECMWF Report on ERS-2 RA for January 2000

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: 0.156 m/s

ERS-2 northern hemisphere: 0.478 m/s

ERS-2 tropics: 0.117 m/s

ERS-2 southern hemisphere: 0.018 m/s

Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: 0.21 m/s

ERS-2 northern hemisphere: 0.33 m/s

ERS-2 tropics: -0.66 m/s

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: -0.013 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: 0.103 m

ERS-2 tropics: -0.022 m

ERS-2 southern hemisphere: -0.066 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.21 m

ERS-2 northern hemisphere: -0.20 m

ERS-2 tropics: -0.29 m

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Remarks:

If you refer to figure 13, it appears that the bias between model and satellite wind speed changes sign on the 16th of the month whereas no change in the behaviour of the wave height bias is visible (figure 24). There is still no apparent reason why it is so. It coincides with the change in the bufr header. We are not aware of any change to the altimeter wind speed retrieval and therefore puzzled by this abrupt change. Any input from ESA will be appreciated. It is however interesting to note that in the past seasons, the wind speed bias for the northern hemisphere does become positive during the winter months (see figure 26). The transition from negative to positive might actually be a real feature, but the shortage of data for the week following the bufr change might just have enhanced the transition. The behaviour of the wave height bias also indicates that the model winds have not changed indeed since no model changes were made in January.

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

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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.

Figure captions:

Figure 1: Time series of data reception for ERS-2 Altimeter data for January 2000.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for January 2000.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for January 2000.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for January 2000.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for January 2000.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for January 2000 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for January 2000 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for January 2000 (tropics)

Figure 9: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for January 2000 (southern hemisphere)

Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for January 2000 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for January 2000 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for January 2000 (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 January 2000.

Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for January 2000.

Figure 16: Global distribution of ECMWF wave heights for January 2000.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for January 2000 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for January 2000 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for January 2000 (tropics)

Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for January 2000 (southern hemisphere)

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ECMWF Report on ERS-2 RA for January 2000

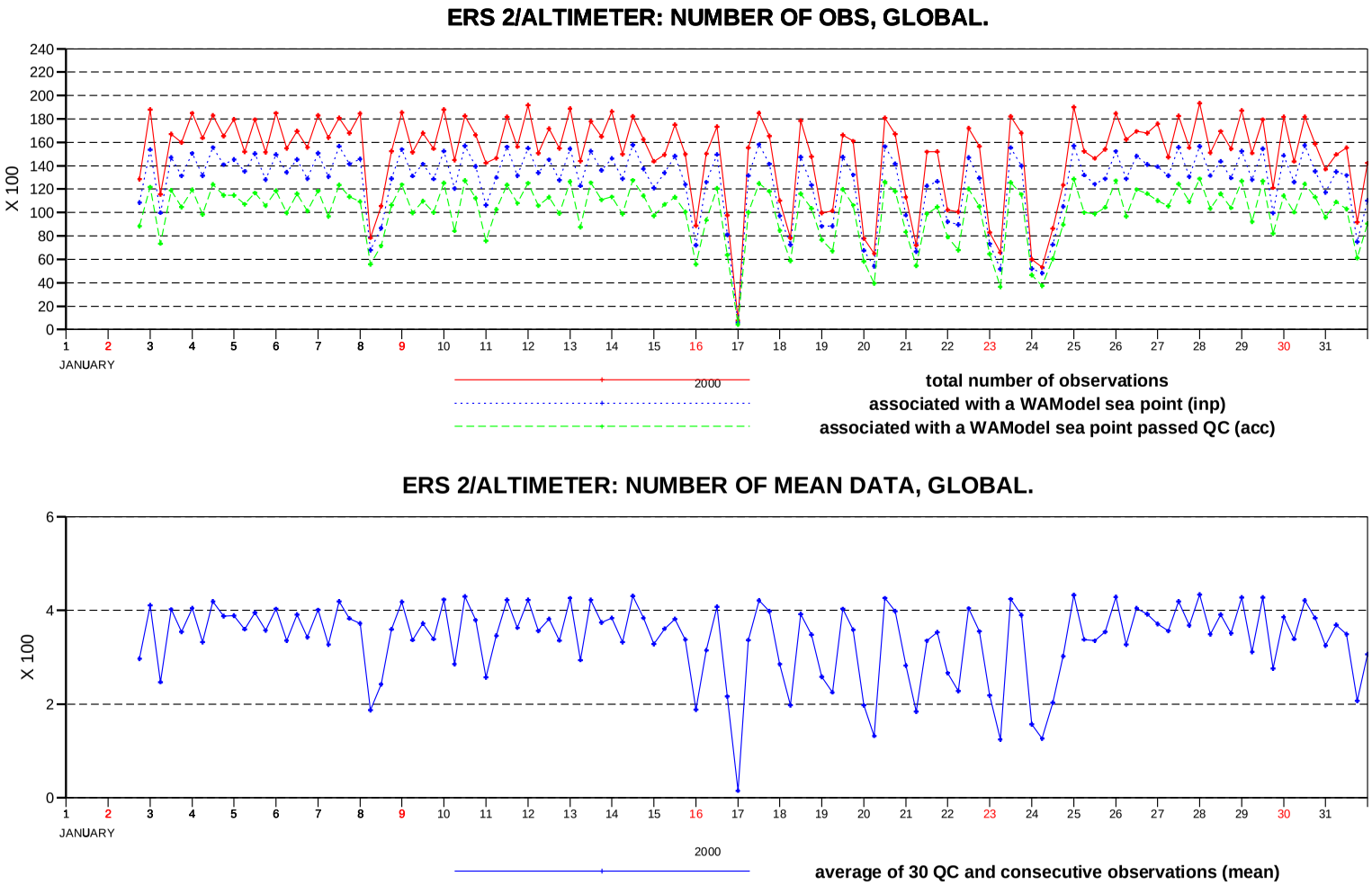

Figure 1: Time series of data reception for ERS-2 Altimeter data for January 2000

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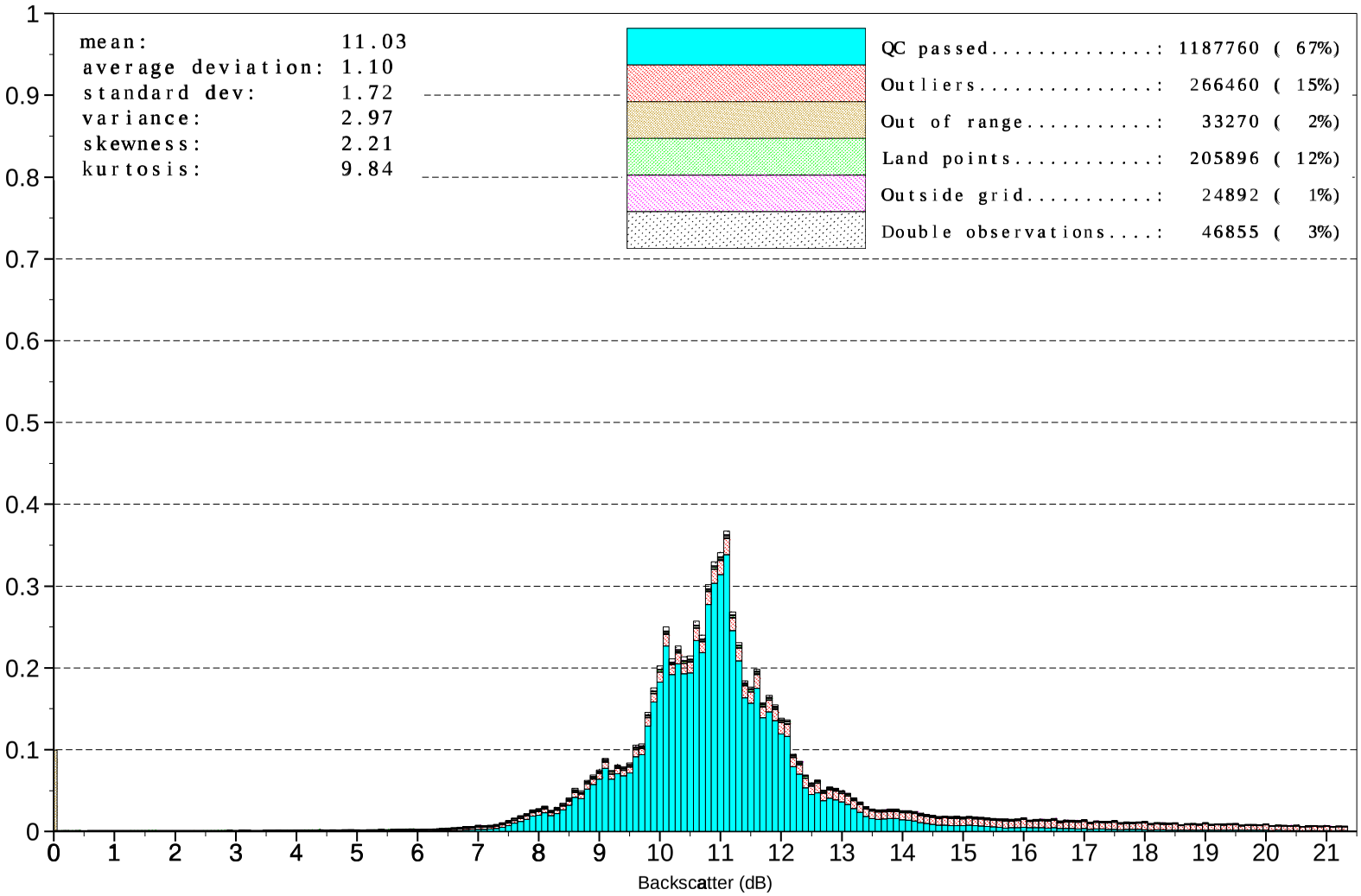

Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for January 2000

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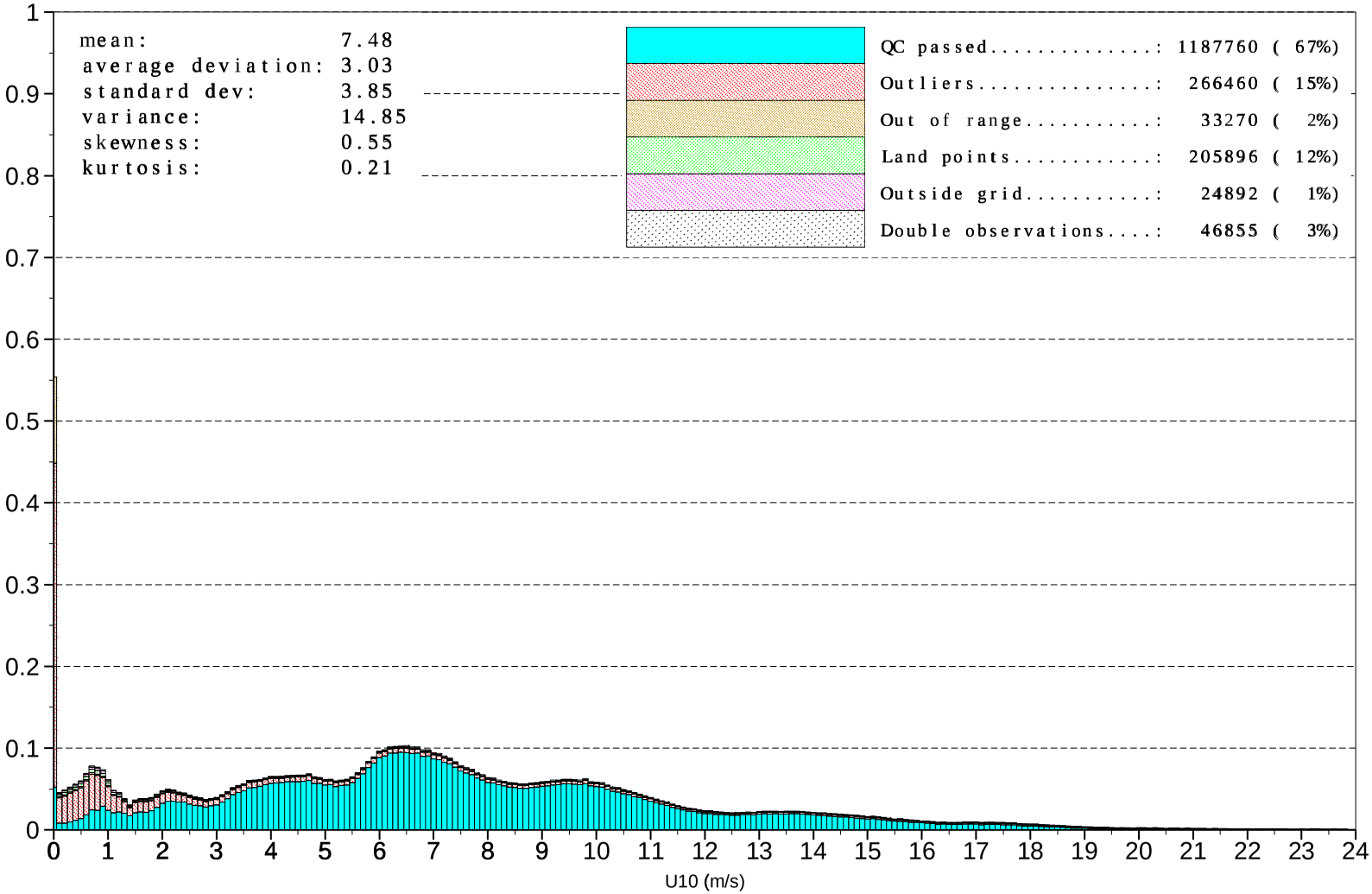

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for January 2000

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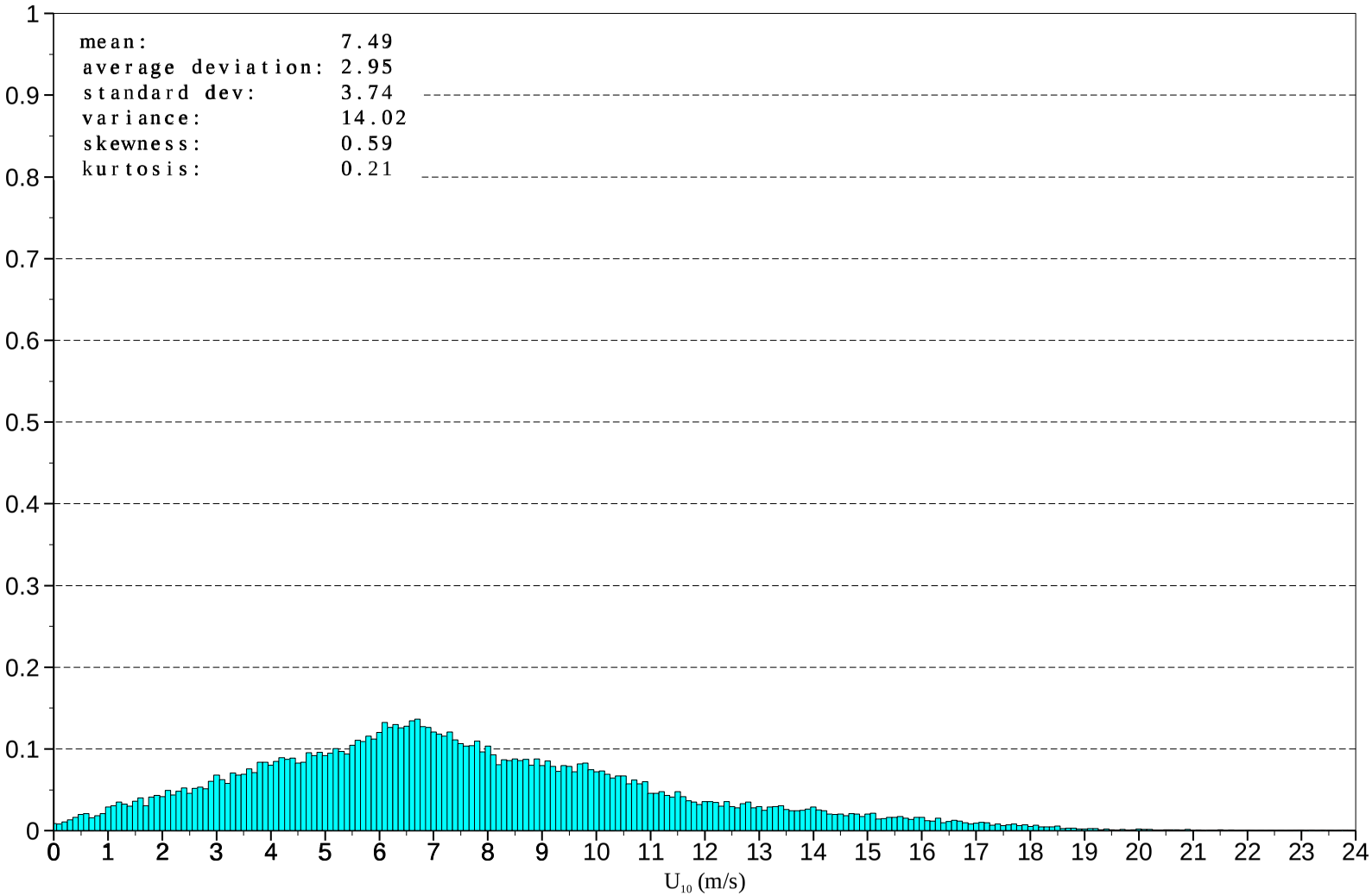

Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for January 2000

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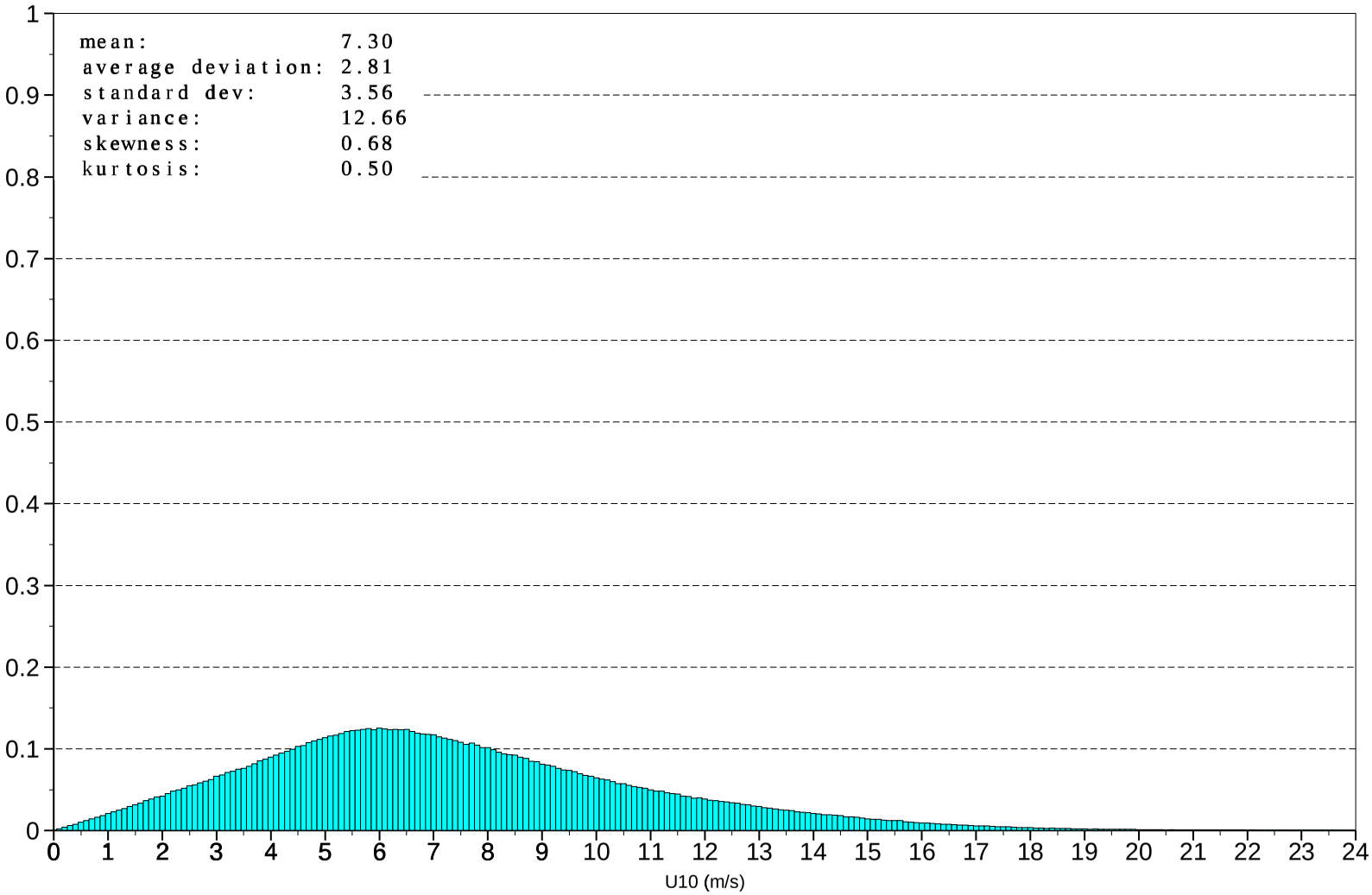

Figure 5: Global distribution of ECMWF ocean surface wind speeds for January 2000

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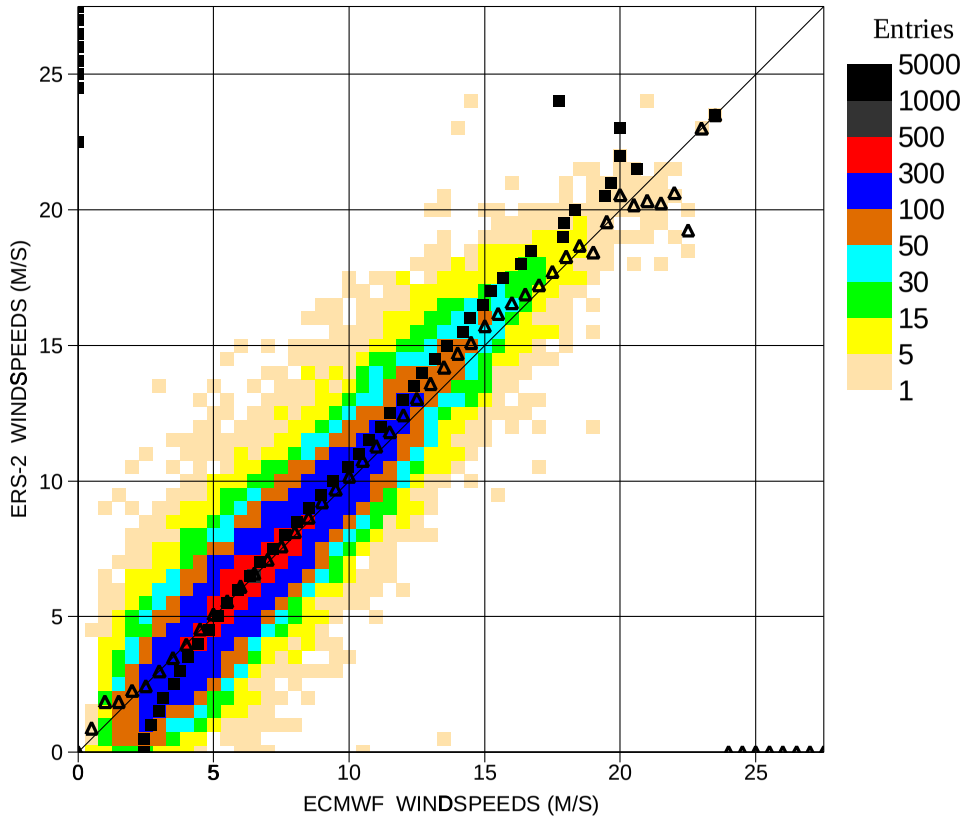

STATISTICS

ENTRIES	39827
MEAN ECMWF	7.3367
MEAN ERS-2	7.4931
BIAS (ERS-2 - ECMWF)	0.1564
STANDARD DEVIATION	1.4367
SCATTER INDEX	0.1958
CORRELATION	0.9241
SYMMETRIC SLOPE	1.0397 (0.0022)
REGR. COEFFICIENT	1.0395 (0.0022)
REGR. CONSTANT	-0.1336 (0.0174)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for January 2000 (global)

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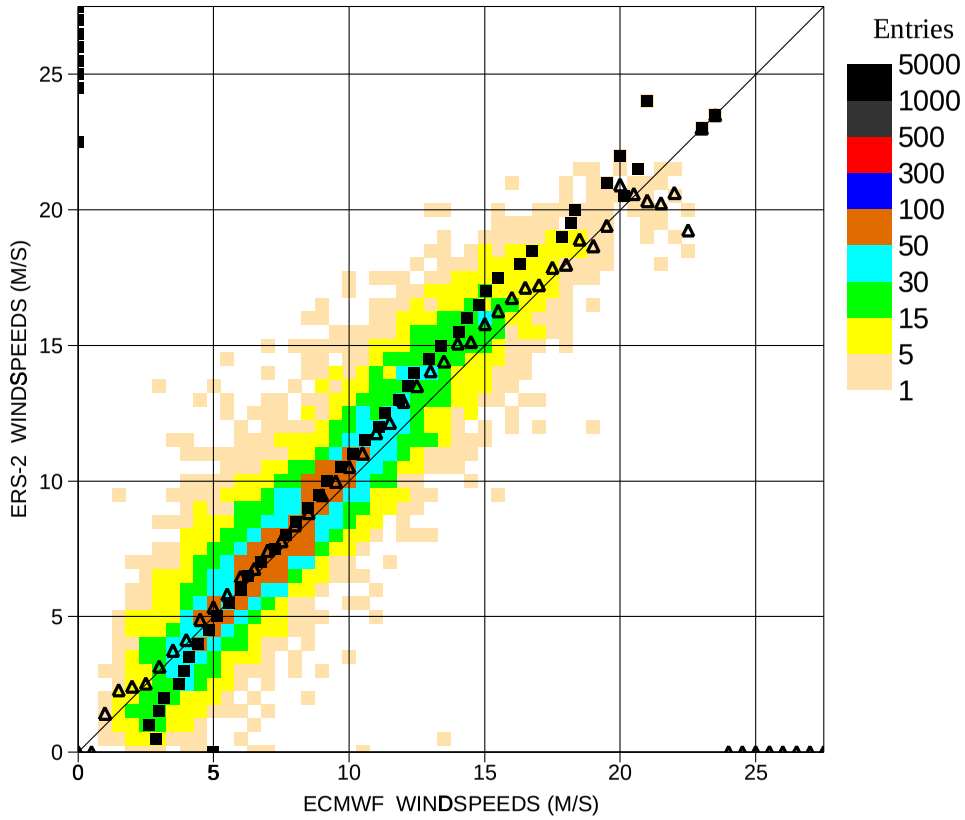

STATISTICS

ENTRIES	9373
MEAN ECMWF	8.6004
MEAN ERS-2	9.0780
BIAS (ERS-2 - ECMWF)	0.4776
STANDARD DEVIATION	1.6118
SCATTER INDEX	0.1874
CORRELATION	0.9244
SYMMETRIC SLOPE	1.0672 (0.0045)
REGR. COEFFICIENT	1.0421 (0.0044)
REGR. CONSTANT	0.1159 (0.0416)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for January 2000 (n.hem.)

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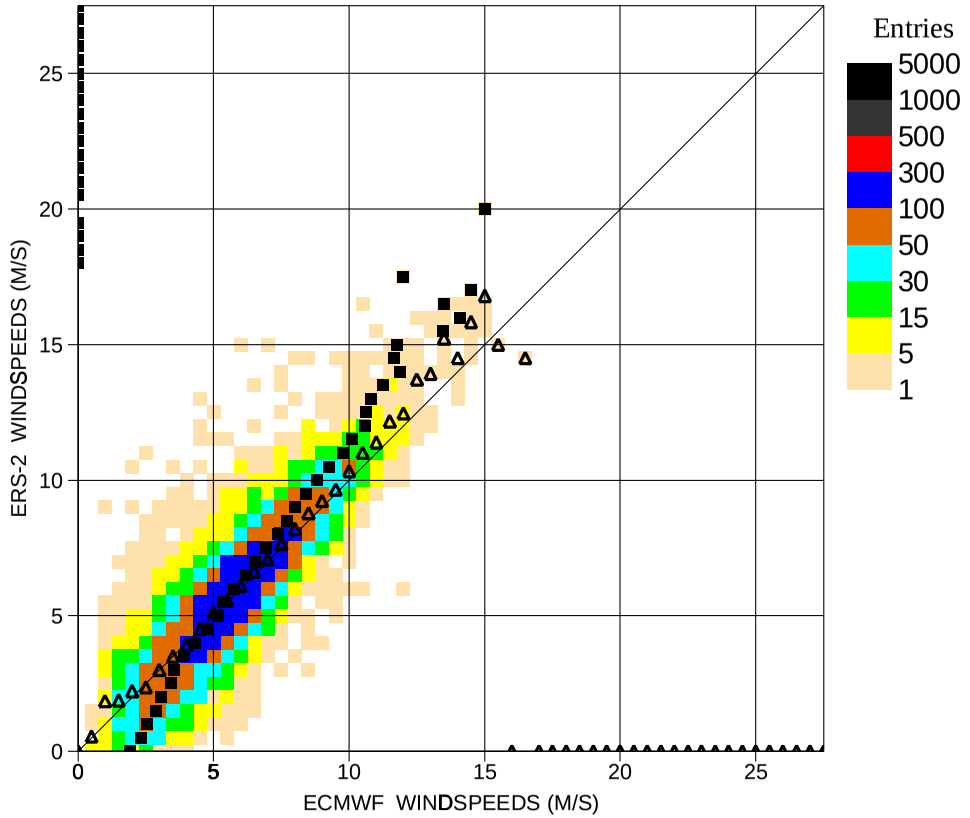

STATISTICS

ENTRIES	12318
MEAN ECMWF	5.7968
MEAN ERS-2	5.9139
BIAS (ERS-2 - ECMWF)	0.1171
STANDARD DEVIATION	1.3132
SCATTER INDEX	0.2265
CORRELATION	0.8691
SYMMETRIC SLOPE	1.0445 (0.0054)
REGR. COEFFICIENT	1.0417 (0.0053)
REGR. CONSTANT	-0.1246 (0.0331)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for January 2000 (tropics)

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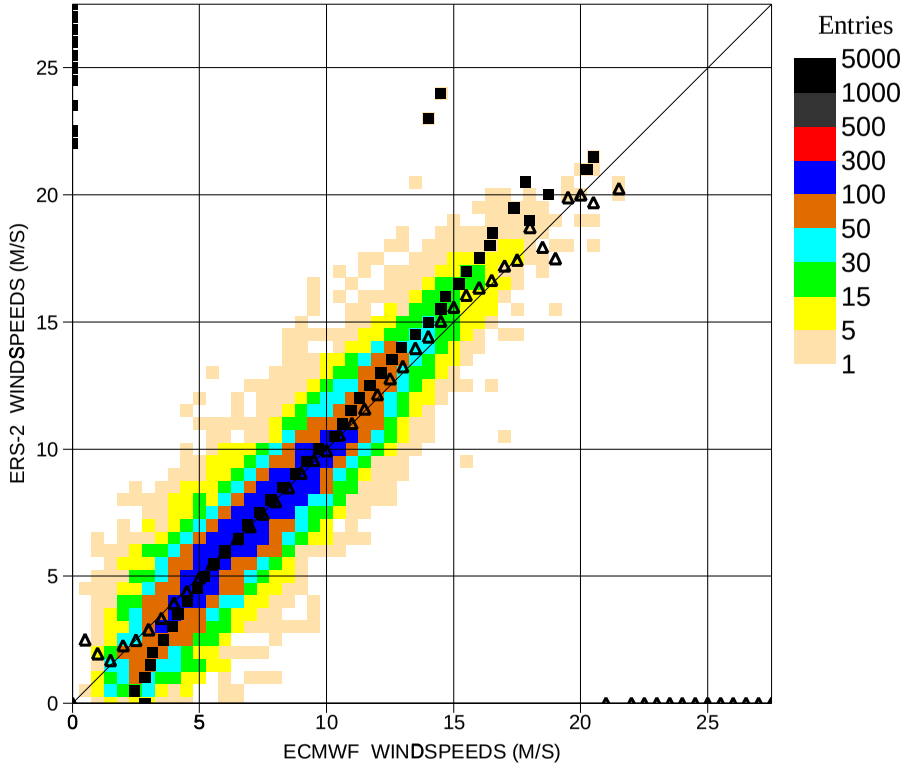

STATISTICS

ENTRIES	18397
MEAN ECMWF	7.7048
MEAN ERS-2	7.7231
BIAS (ERS-2 - ECMWF)	0.0183
STANDARD DEVIATION	1.3934
SCATTER INDEX	0.1808
CORRELATION	0.9272
SYMMETRIC SLOPE	1.0201(0.0031)
REGR. COEFFICIENT	1.0290(0.0031)
REGR. CONSTANT	-0.2050(0.0257)

Figure 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for January 2000 (s.hem.)

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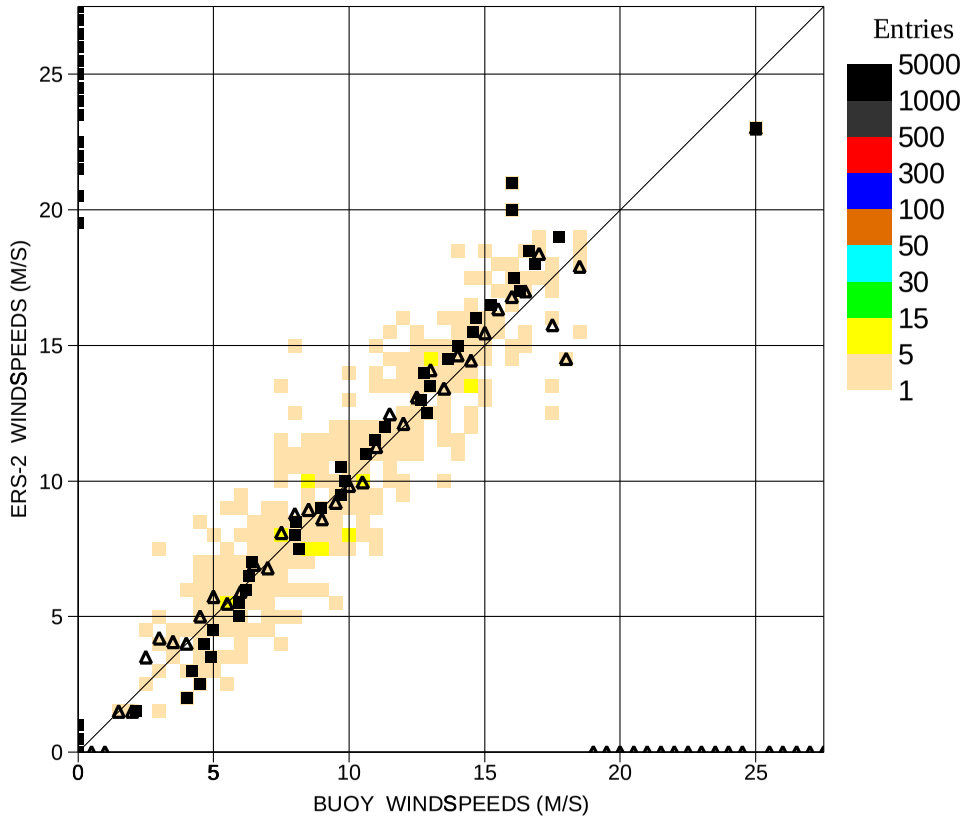

STATISTICS

ENTRIES	480	
MEAN BUOY	9.7867	
MEAN ERS-2	9.9983	
BIAS (ERS-2 - BUOY)	0.2117	
STANDARD DEVIATION	1.6825	
SCATTER INDEX	0.1719	
CORRELATION	0.9132	
SYMMETRIC SLOPE	1.0291	(0.0202)
REGR. COEFFICIENT	0.9832	(0.0201)
REGR. CONSTANT	0.3762	(0.2109)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for January 2000 (global)

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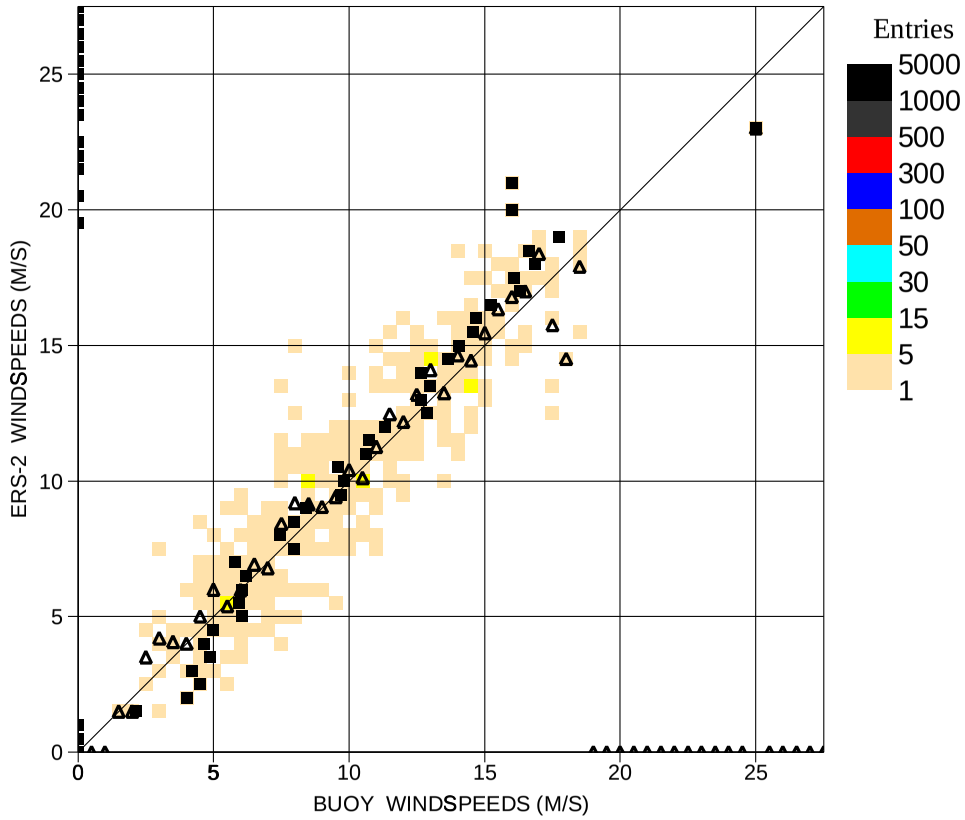

STATISTICS

ENTRIES	423	
MEAN BUOY	9.8847	
MEAN ERS-2	10.2149	
BIAS (ERS-2 - BUOY)	0.3302	
STANDARD DEVIATION	1.7232	
SCATTER INDEX	0.1743	
CORRELATION	0.9156	
SYMMETRIC SLOPE	1.0382	(0.0211)
REGR. COEFFICIENT	0.9769	(0.0209)
REGR. CONSTANT	0.5588	(0.2230)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for January 2000 (n.hem.)

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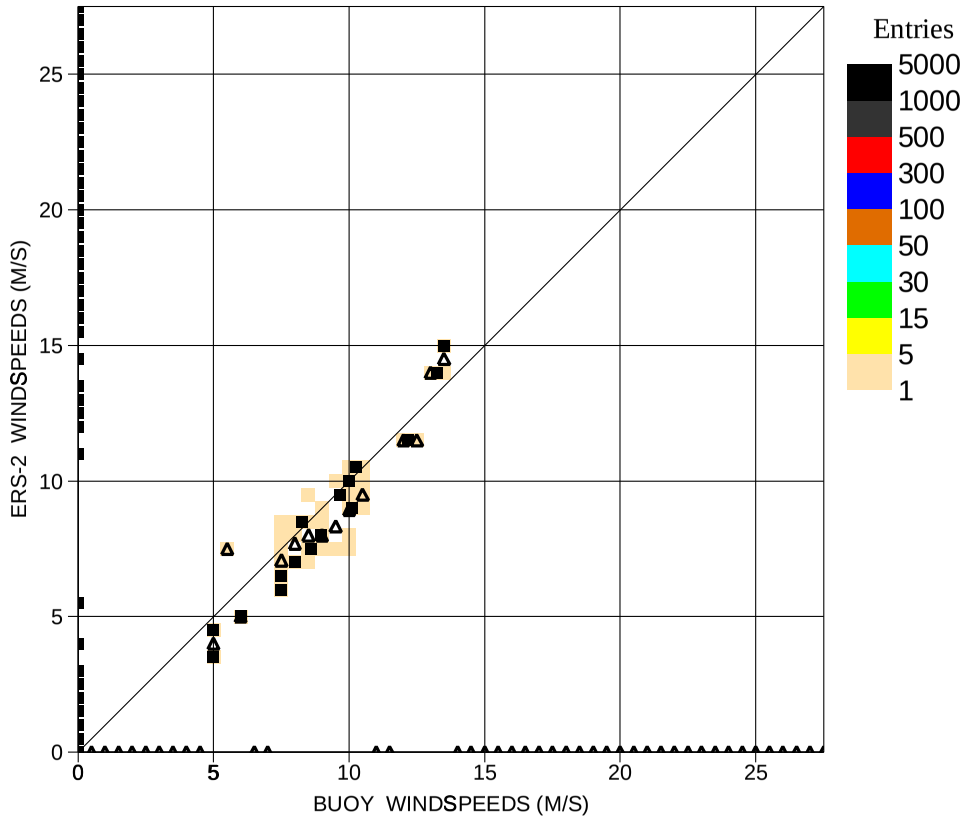

STATISTICS

ENTRIES	54	
MEAN BUOY	9.1821	
MEAN ERS-2	8.5185	
BIAS (ERS-2 - BUOY)	-0.6636	
STANDARD DEVIATION	0.9703	
SCATTER INDEX	0.1057	
CORRELATION	0.8877	
SYMMETRIC SLOPE	0.9370	(0.0745)
REGR. COEFFICIENT	1.0199	(0.0734)
REGR. CONSTANT	-0.8465	(0.6867)

Figure 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for January 2000 (hawaii)

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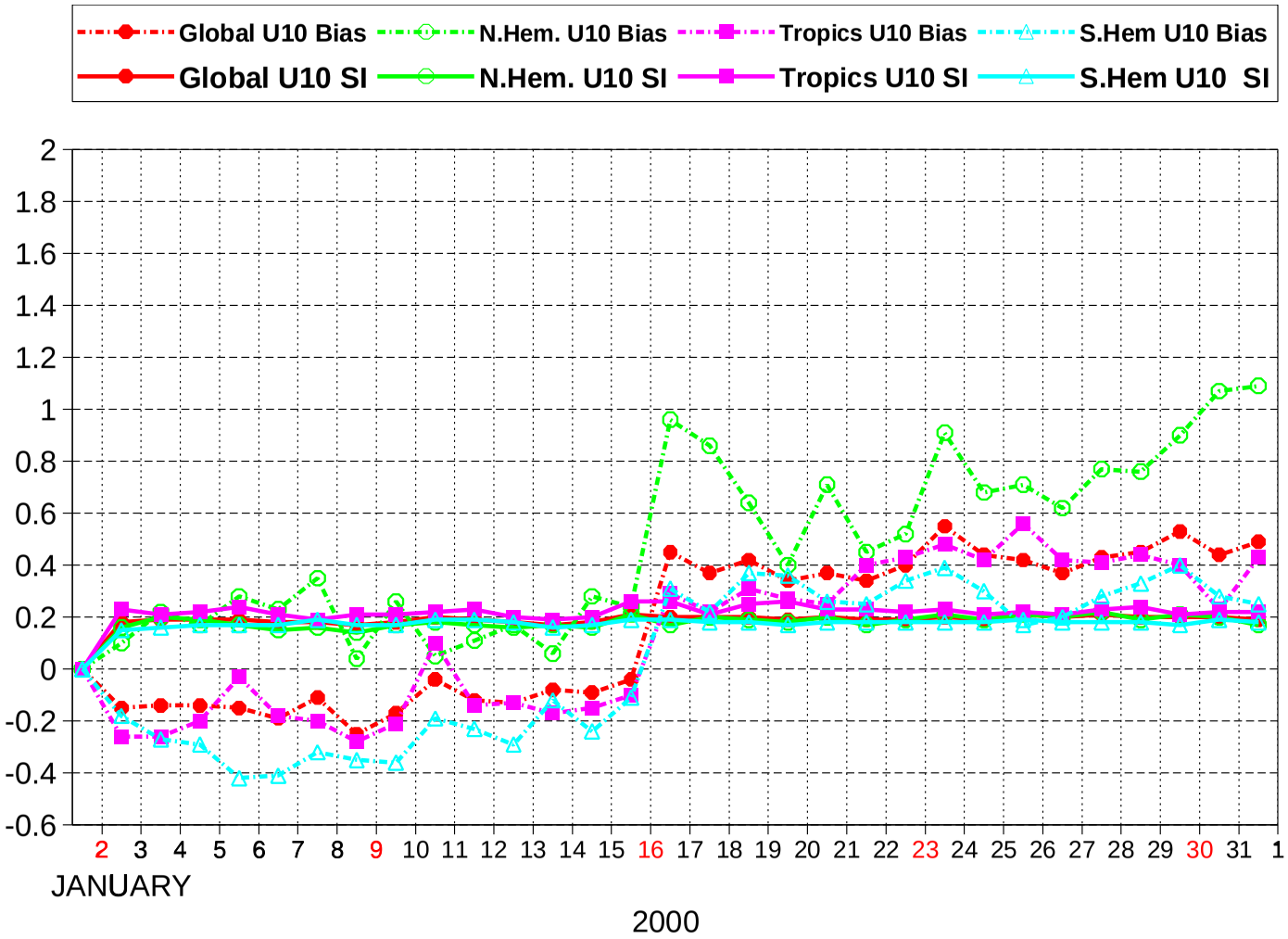

Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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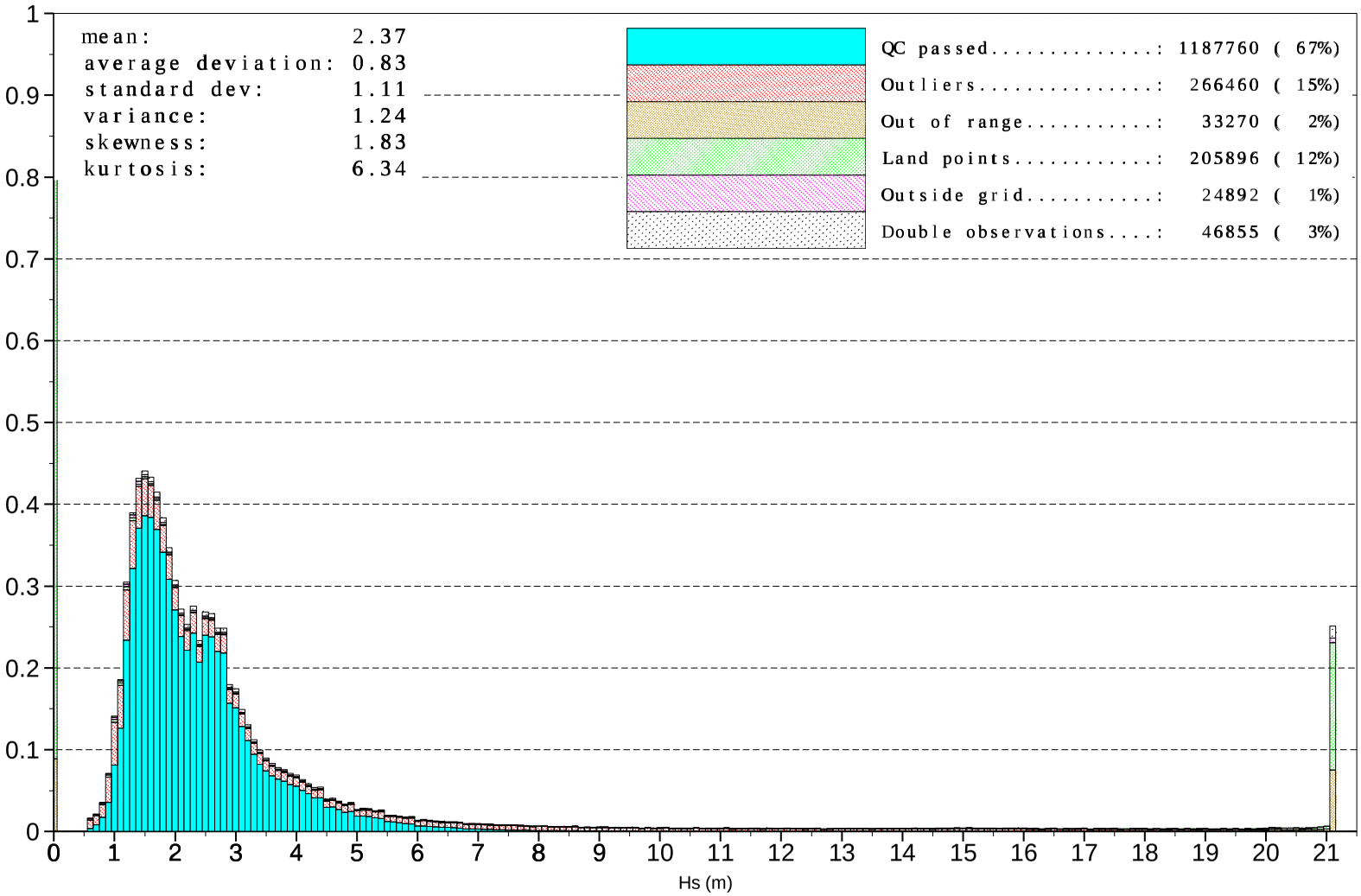

Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for January 2000

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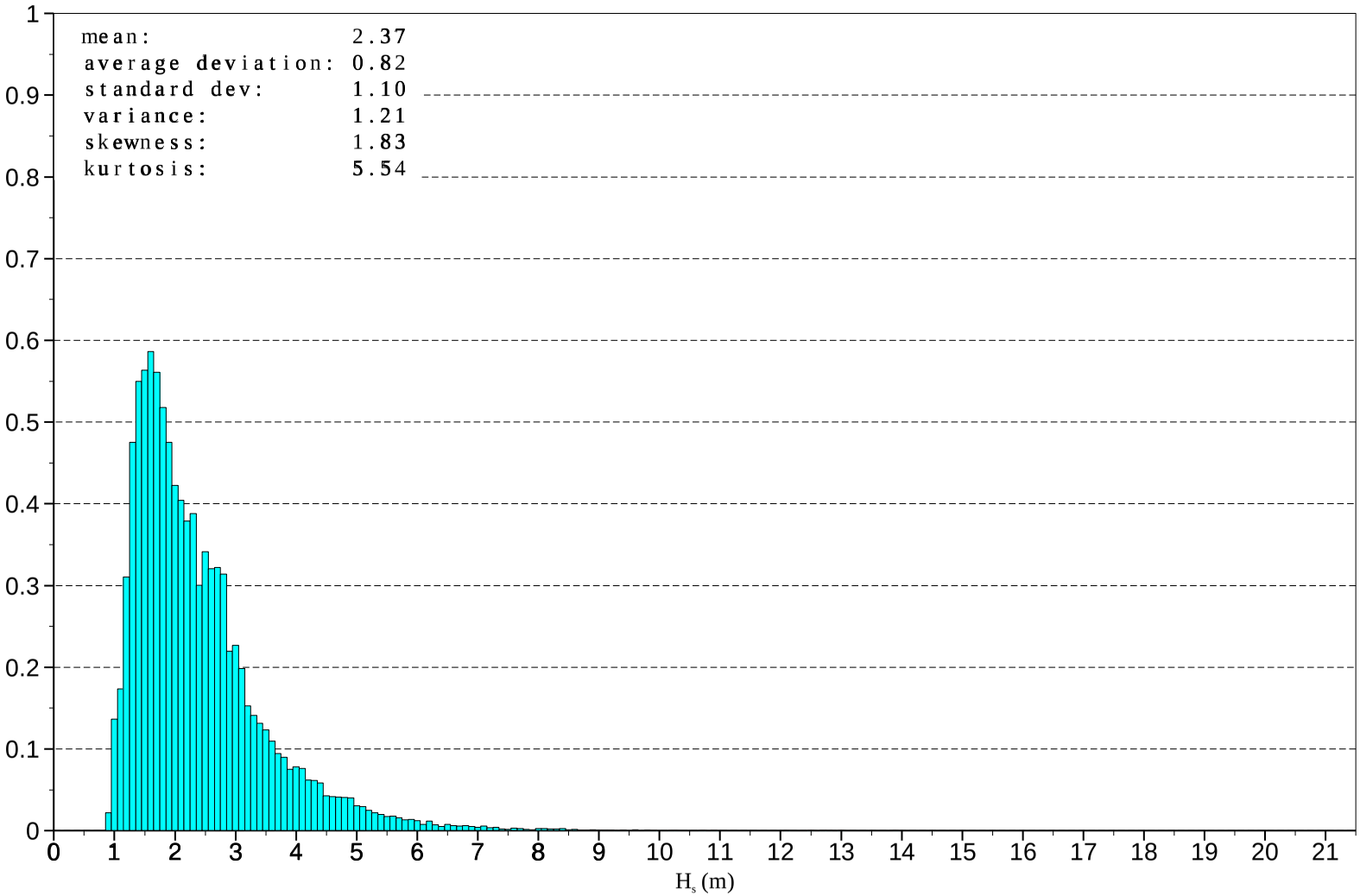

Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for January 2000

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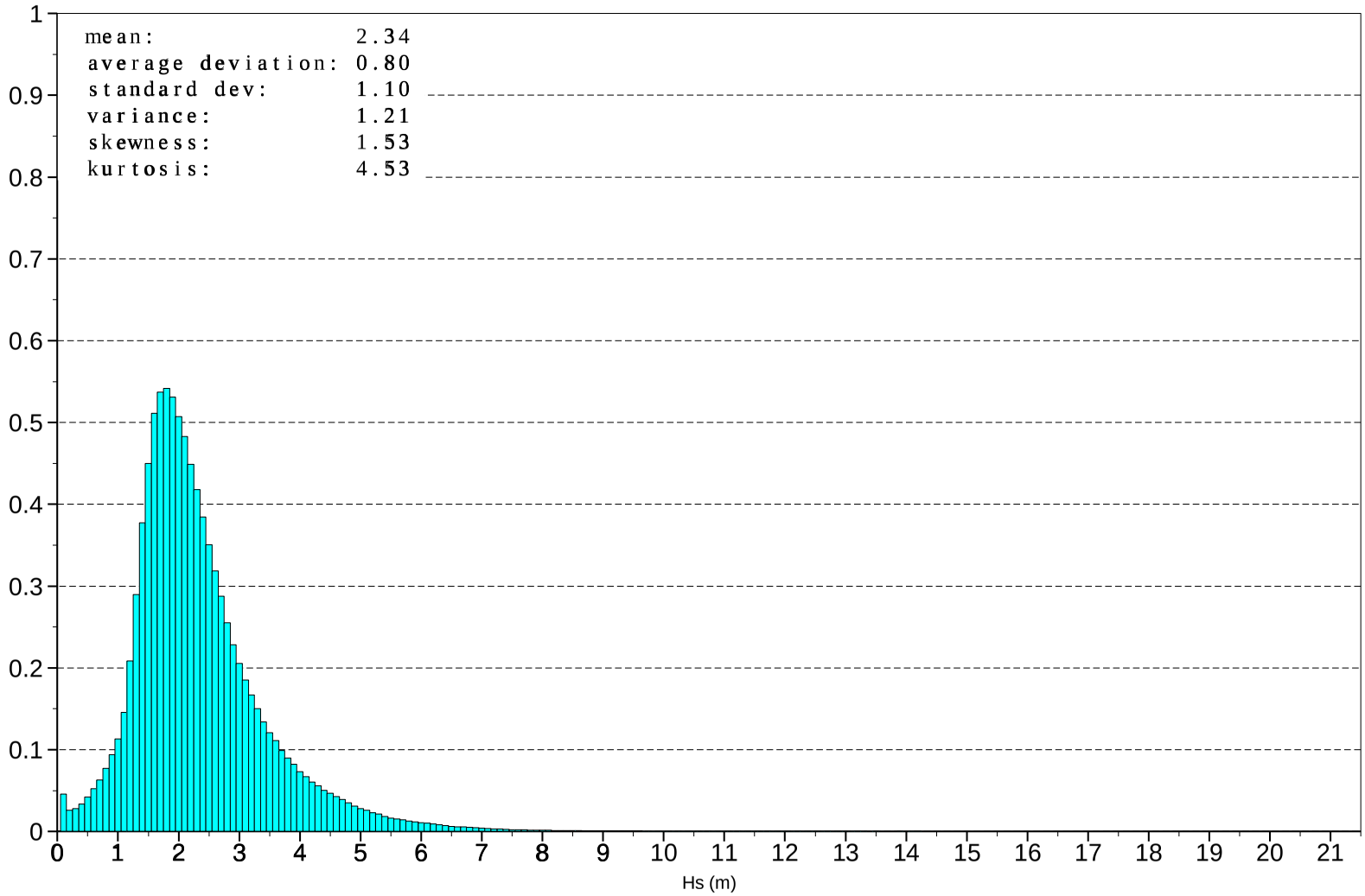

Figure 16: Global distribution of ECMWF wave heights for January 2000

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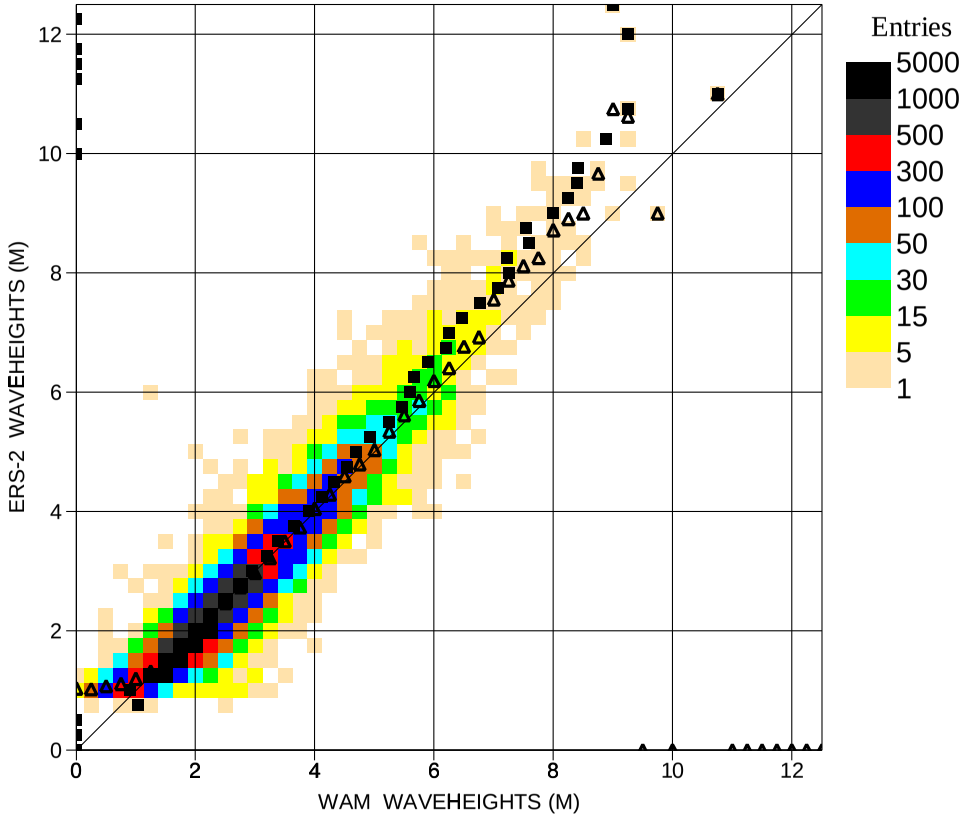

STATISTICS

ENTRIES	39827
MEAN WAM	2.3879
MEAN ERS-2	2.3749
BIAS (ERS-2 - WAM)	-0.0130
STANDARD DEVIATION	0.3248
SCATTER INDEX	0.1360
CORRELATION	0.9557
SYMMETRIC SLOPE	1.0061(0.0016)
REGR. COEFFICIENT	1.0183(0.0016)
REGR. CONSTANT	-0.0566(0.0041)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for January 2000 (global)

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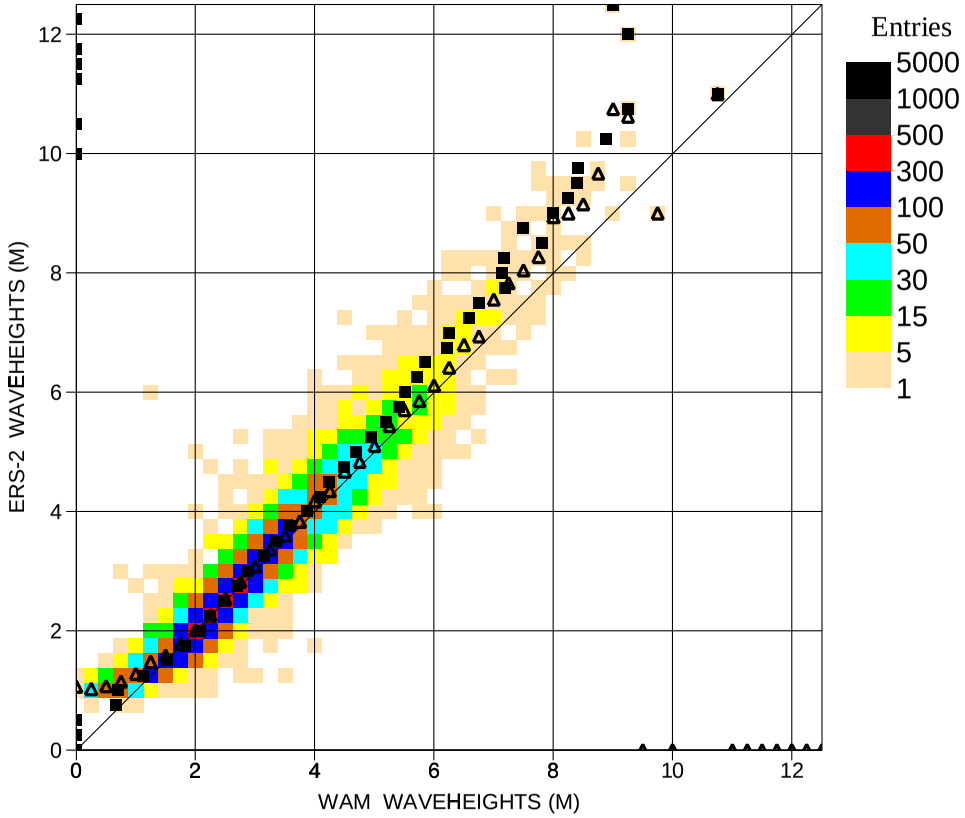

STATISTICS

ENTRIES	9373	
MEAN WAM	2.8708	
MEAN ERS-2	2.9737	
BIAS (ERS-2 - WAM)	0.1029	
STANDARD DEVIATION	0.4037	
SCATTER INDEX	0.1406	
CORRELATION	0.9569	
SYMMETRIC SLOPE	1.0411	(0.0032)
REGR. COEFFICIENT	1.0207	(0.0032)
REGR. CONSTANT	0.0435	(0.0101)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for January 2000 (n.hem.)

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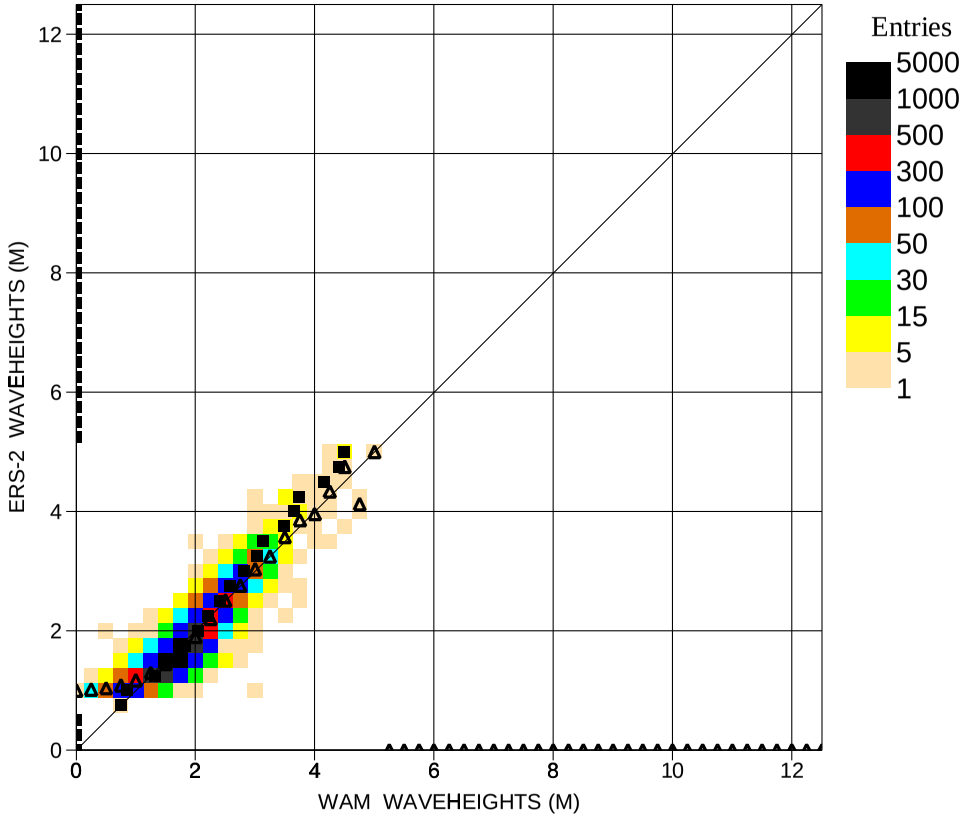

STATISTICS

ENTRIES	12318
MEAN WAM	1.7930
MEAN ERS-2	1.7707
BIAS (ERS-2 - WAM)	-0.0223
STANDARD DEVIATION	0.2318
SCATTER INDEX	0.1293
CORRELATION	0.9092
SYMMETRIC SLOPE	0.9895(0.0038)
REGR. COEFFICIENT	0.9190(0.0038)
REGR. CONSTANT	0.1229(0.0071)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for January 2000 (tropics)

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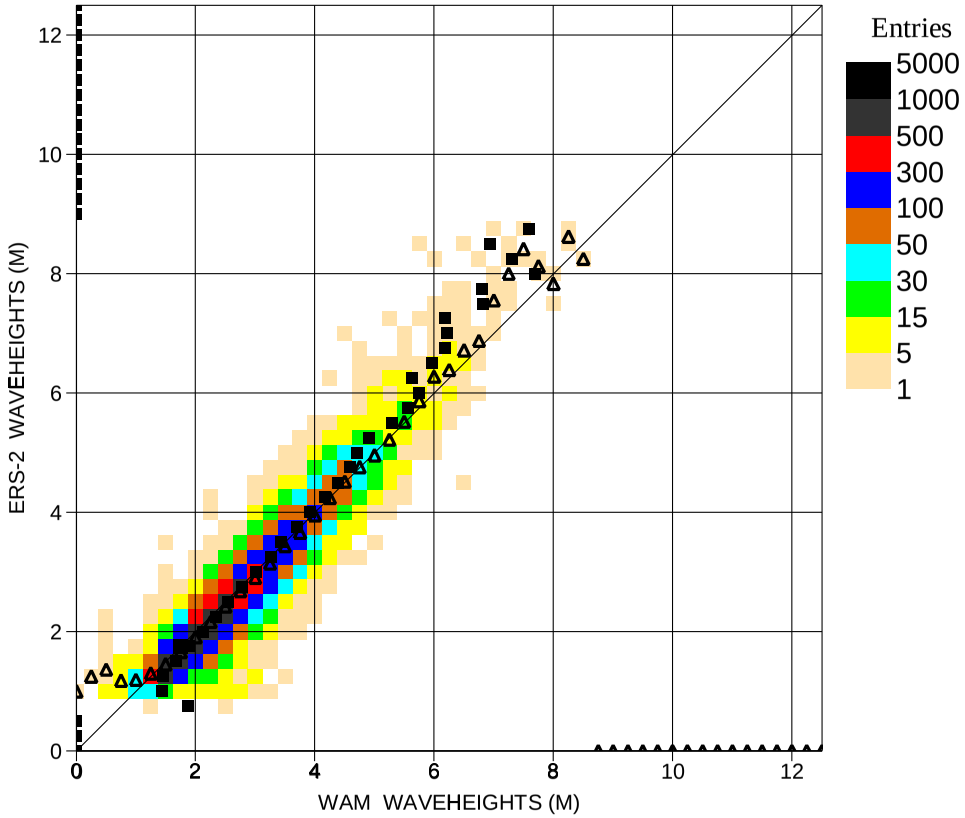

STATISTICS

ENTRIES	18397
MEAN WAM	2.5336
MEAN ERS-2	2.4679
BIAS (ERS-2 - WAM)	-0.0657
STANDARD DEVIATION	0.3169
SCATTER INDEX	0.1251
CORRELATION	0.9498
SYMMETRIC SLOPE	0.9864(0.0025)
REGR. COEFFICIENT	1.0176(0.0025)
REGR. CONSTANT	-0.1103(0.0067)

Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for January 2000 (s.hem.)

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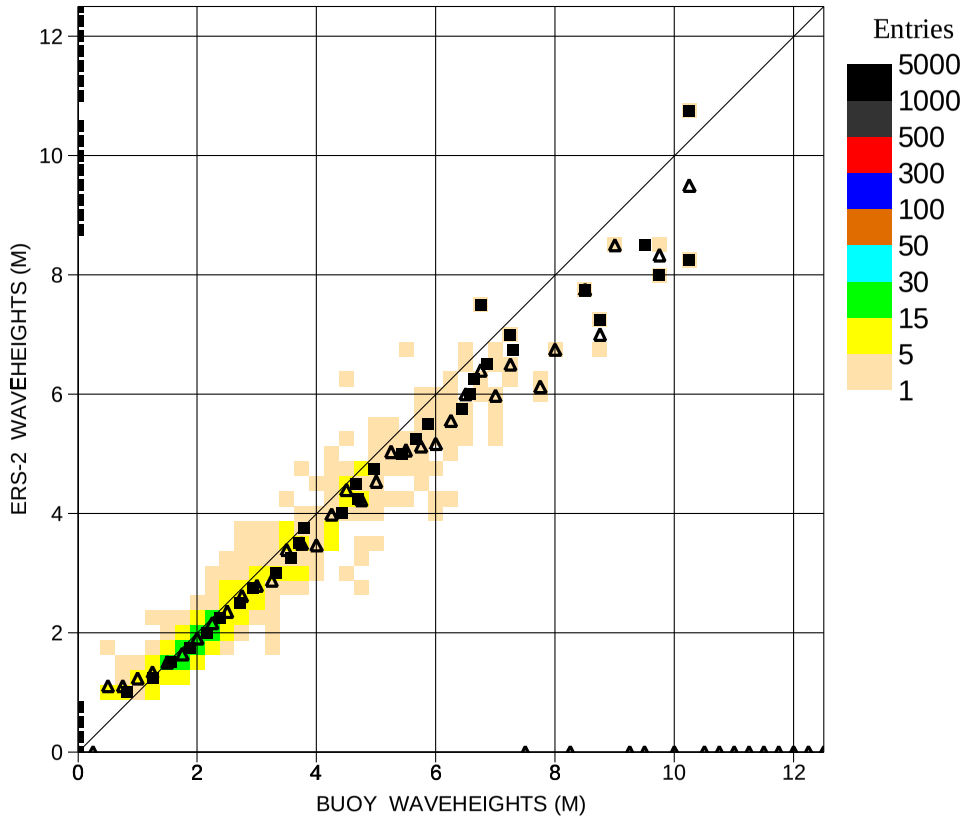

STATISTICS

ENTRIES	652	
MEAN BUOY	3.1806	
MEAN ERS-2	2.9699	
BIAS (ERS-2 - BUOY)	-0.2107	
STANDARD DEVIATION	0.4746	
SCATTER INDEX	0.1492	
CORRELATION	0.9661	
SYMMETRIC SLOPE	0.9215	(0.0094)
REGR. COEFFICIENT	0.8497	(0.0089)
REGR. CONSTANT	0.2673	(0.0323)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for January 2000 (global)

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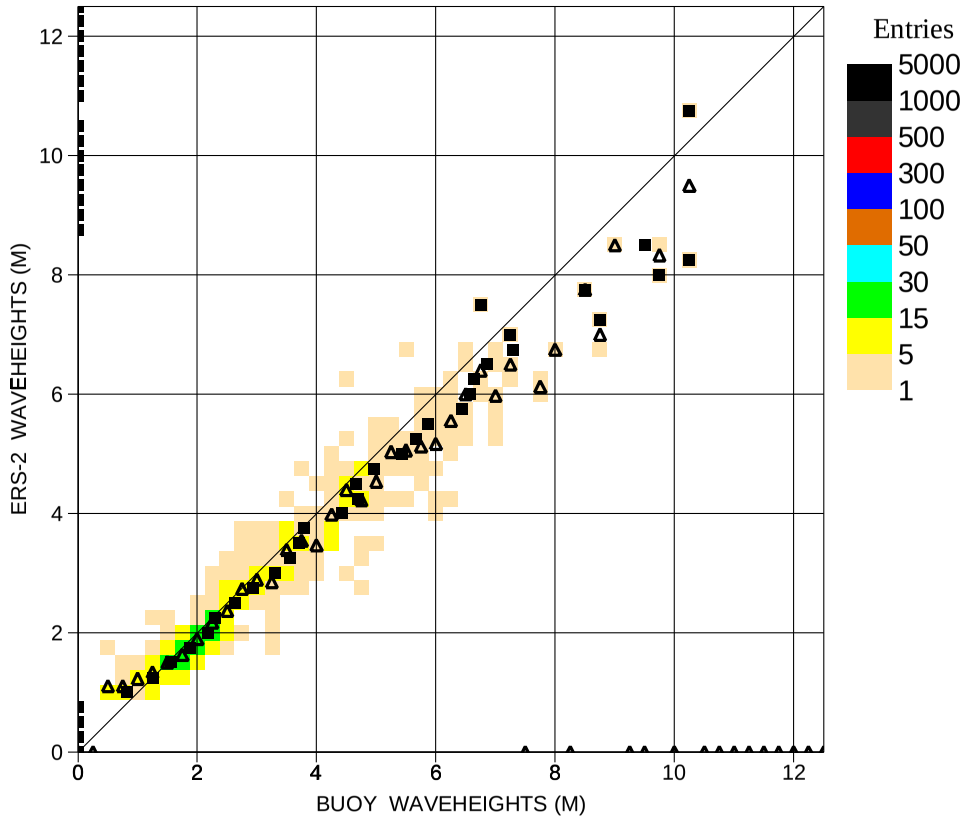

STATISTICS

ENTRIES	593	
MEAN BUOY	3.2348	
MEAN ERS-2	3.0302	
BIAS (ERS-2 - BUOY)	-0.2046	
STANDARD DEVIATION	0.4920	
SCATTER INDEX	0.1521	
CORRELATION	0.9663	
SYMMETRIC SLOPE	0.9231	(0.0098)
REGR. COEFFICIENT	0.8485	(0.0093)
REGR. CONSTANT	0.2856	(0.0344)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for January 2000 (n.hem.)

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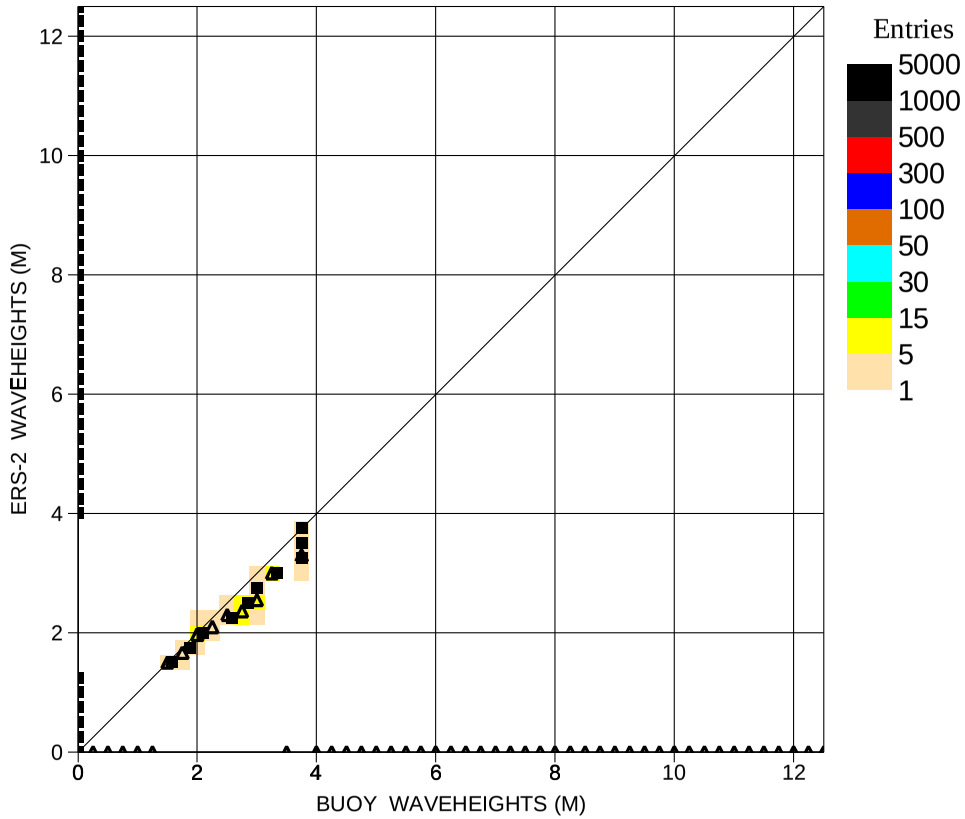

STATISTICS

ENTRIES	56	
MEAN BUOY	2.6690	
MEAN ERS-2	2.3821	
BIAS (ERS-2 - BUOY)	-0.2868	
STANDARD DEVIATION	0.2090	
SCATTER INDEX	0.0783	
CORRELATION	0.9459	
SYMMETRIC SLOPE	0.8887	(0.0396)
REGR. COEFFICIENT	0.7624	(0.0356)
REGR. CONSTANT	0.3472	(0.0973)

Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for January 2000 (hawaii)

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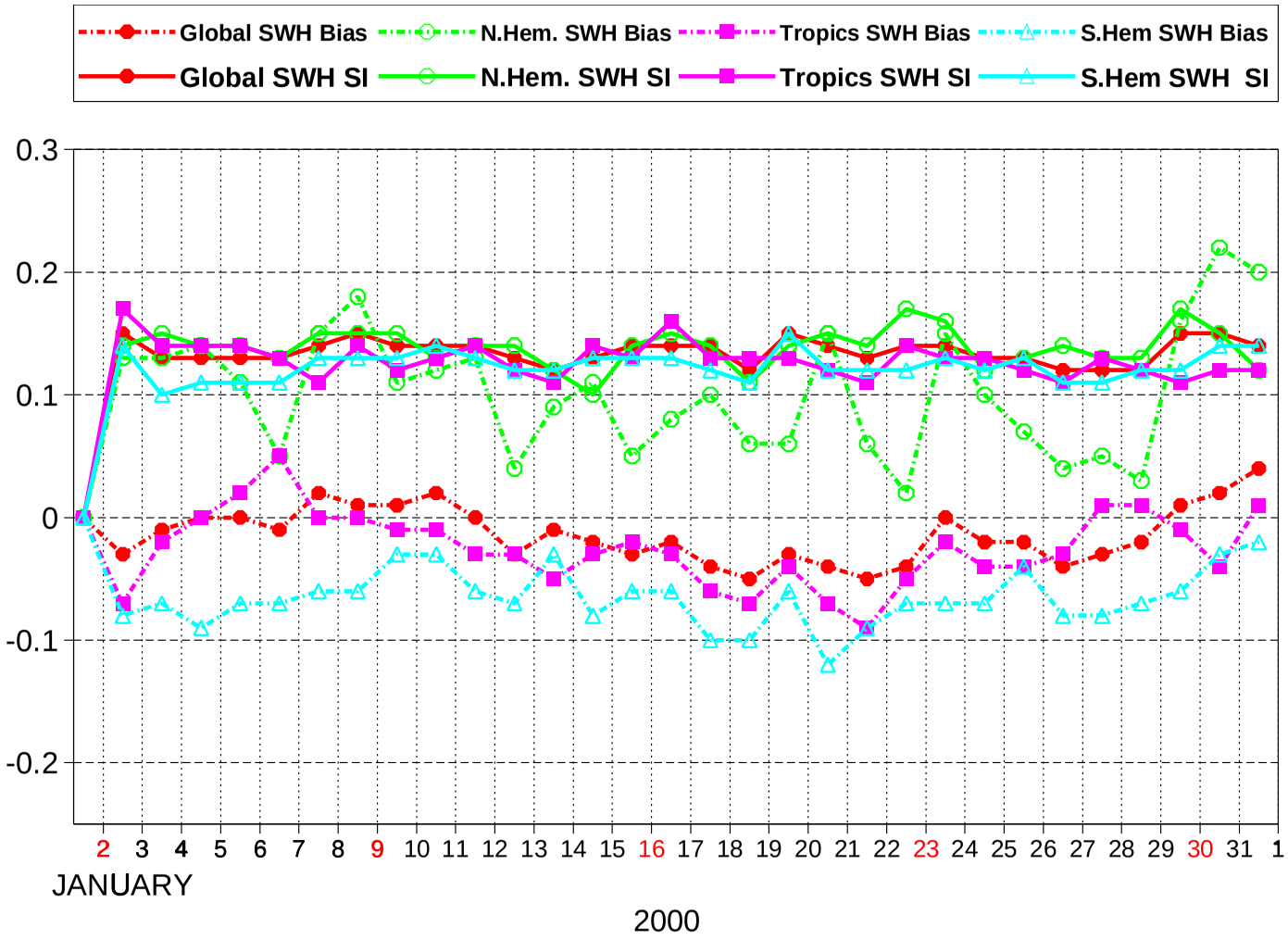

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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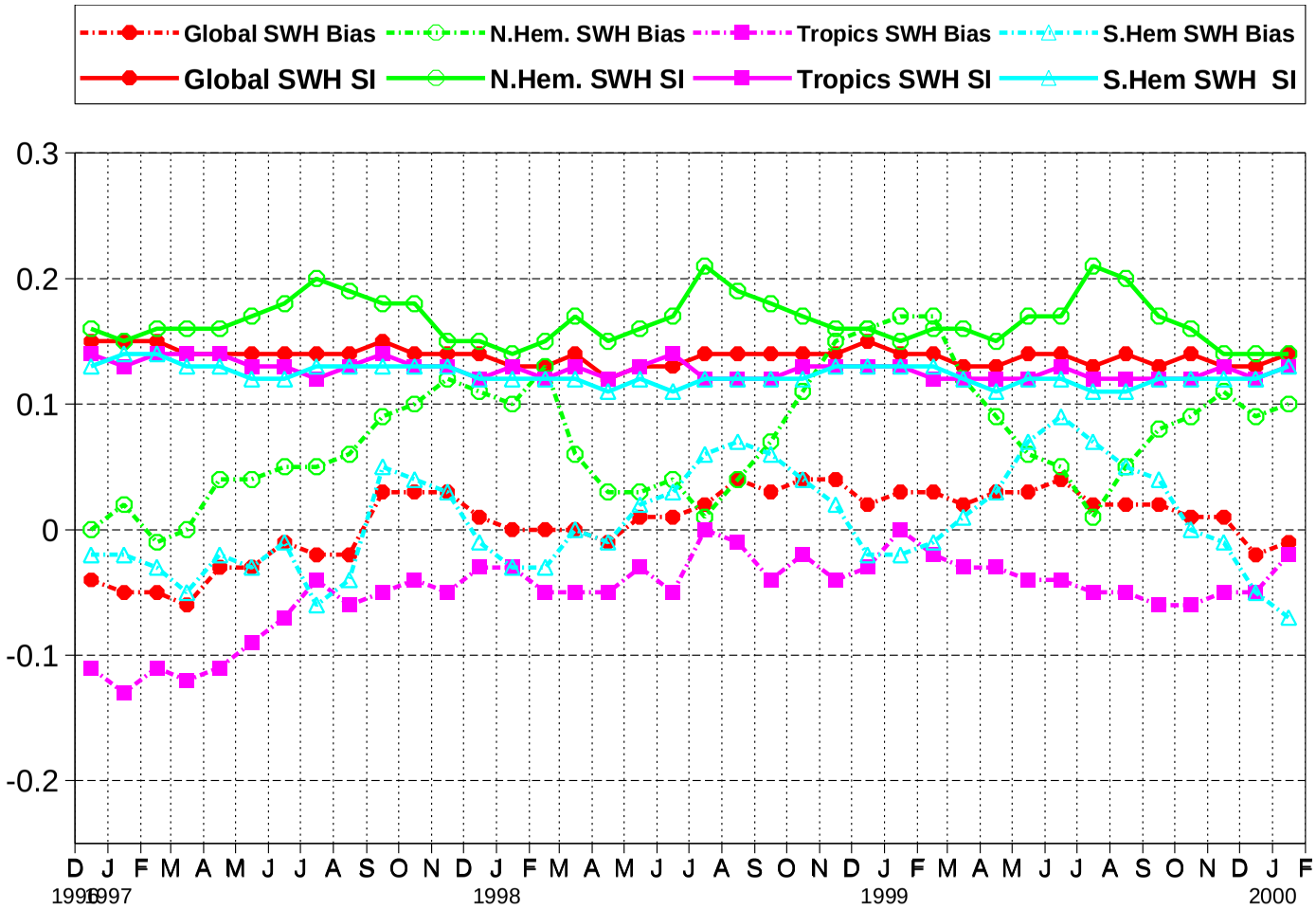

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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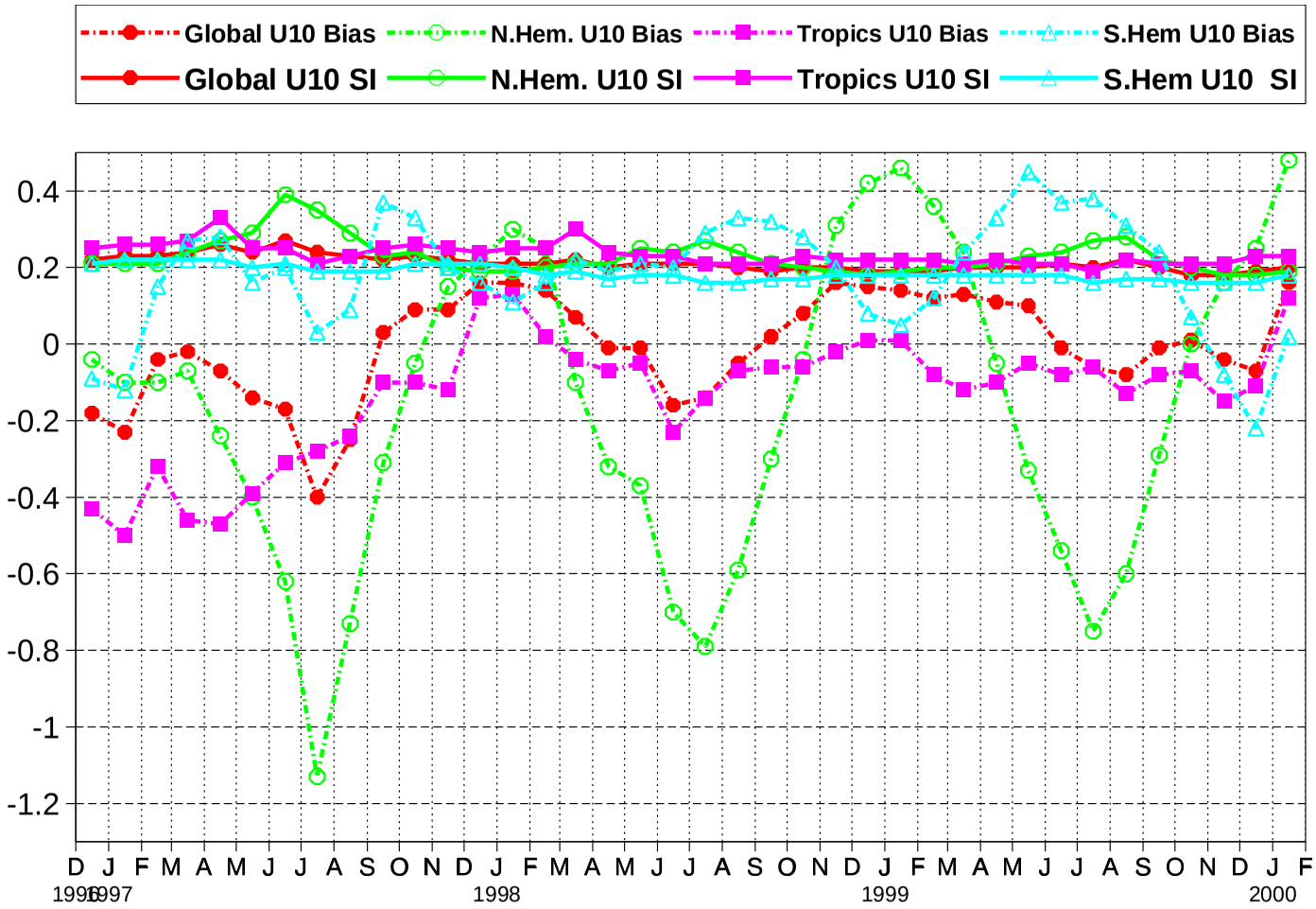

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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