ECMWF Report on ERS-2 RA for December 2009

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

By: *Saleh Abdalla*

Date: *2 February 2010*

Overview:

Based on the data received at ECMWF during the whole month, on average, 3538 observations arrived at ECMWF every 6 hours of which 69.54% passed the quality control. As can be seen in Figure 1, there was no data during the 6-hour time windows centred at (all times are UTC):

- 06:00 and 18:00 on the 13th, and
- from 00:00 to 12:00 on the 16th (both inclusive) of the month.

The current coverage of the data covers: the North Atlantic, the western coast of North America, the eastern and southeastern coasts of Asia, the Southern Ocean and around South Africa (recently no data arrived from this station) as can be seen in Figure 27. The quality of the received data is as good as usual.

Backscatter:

ESR-2 $\langle s_0 \rangle$ = 10.85 dB (with a main peak at 11.1 dB).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: +0.234 m/s

ERS-2 northern hemisphere: +0.405 m/s

ERS-2 tropics: -0.182 m/s

ERS-2 southern hemisphere: +0.258 m/s

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Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: -0.143 m/s

ERS-2 northern hemisphere: +0.014 m/s

ERS-2 tropics (Hawaii): *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: -0.055 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: -0.102 m

ERS-2 tropics: +0.065 m

ERS-2 southern hemisphere: -0.080 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.117 m

ERS-2 northern hemisphere: -0.133 m

ERS-2 tropics (Hawaii): *missing*

Remarks:

- The quality of Altimeter data, both wind speed and significant wave height, is nominal.
- Note that the large fluctuations in the Southern Hemispheric (and Tropical) bias in Figures 13 and 24 are basically due to the limited number of daily measurements.

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- According to ESA (EOHelp message of 4 July 2003), the recording capabilities of ERS-2 are declared permanently unavailable following the failure of the ERS-2 tape recorder on 22 June 2003. The ERS-2 tape recorders were used to record the ERS-2 Low Rate mission globally for a period of 8 years of continuous acquisition. The global coverage is, therefore, discontinued. The ERS-2 Low Rate mission will be continued within the visibility of ESA ground stations over Europe, North Atlantic, the Arctic and western North America. Coverage extended to include eastern coast of China and around Korea and Japan since 25 June 2005, the Southern Ocean since 4 July 2005, the north eastern parts of the Indian Ocean since 19 October 2006 and around South Africa since 23 May 2008 (no data was received recently from this station). Current coverage can be seen in Figure 27.
- Assimilation of ERS-2 RA wave heights into ECMWF wave model was stopped on 21st. of October 2003 and replaced by ENVISAT RA-2 Ku-band wave heights. Both instruments can not be assimilated at the same time as both satellites follow the same track with relatively short time separation (both can be assimilated safely if they were not so close).
- ENVISAT RA-2 Ku-band significant wave height and ASAR Wave Mode Level 1b data as well as Jason-1 and Jason-2 altimeter significant wave height data are assimilated in the ECMWF wave model.
- ECMWF models were not changed this month. The current operational IFS cycle is CY35R3 (since the 8th of September 2009).

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.

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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.

Figure captions:

Figure 1: Time series of data reception for ERS-2 Altimeter data for December 2009.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for December 2009.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2009.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for December 2009.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2009.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2009 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2009 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2009 (tropics)

Figure 9: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2009 (southern hemisphere)

Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2009 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2009 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2009 (hawaii).

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 December 2009.

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Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for December 2009.

Figure 16: Global distribution of ECMWF wave heights for December 2009.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2009 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2009 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2009 (tropics)

Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2009 (southern hemisphere)

Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2009 (global).

Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2009 (northern hemisphere).

Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2009 (hawaii).

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for December 2009.

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2009.

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2009.

Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for December 2009.

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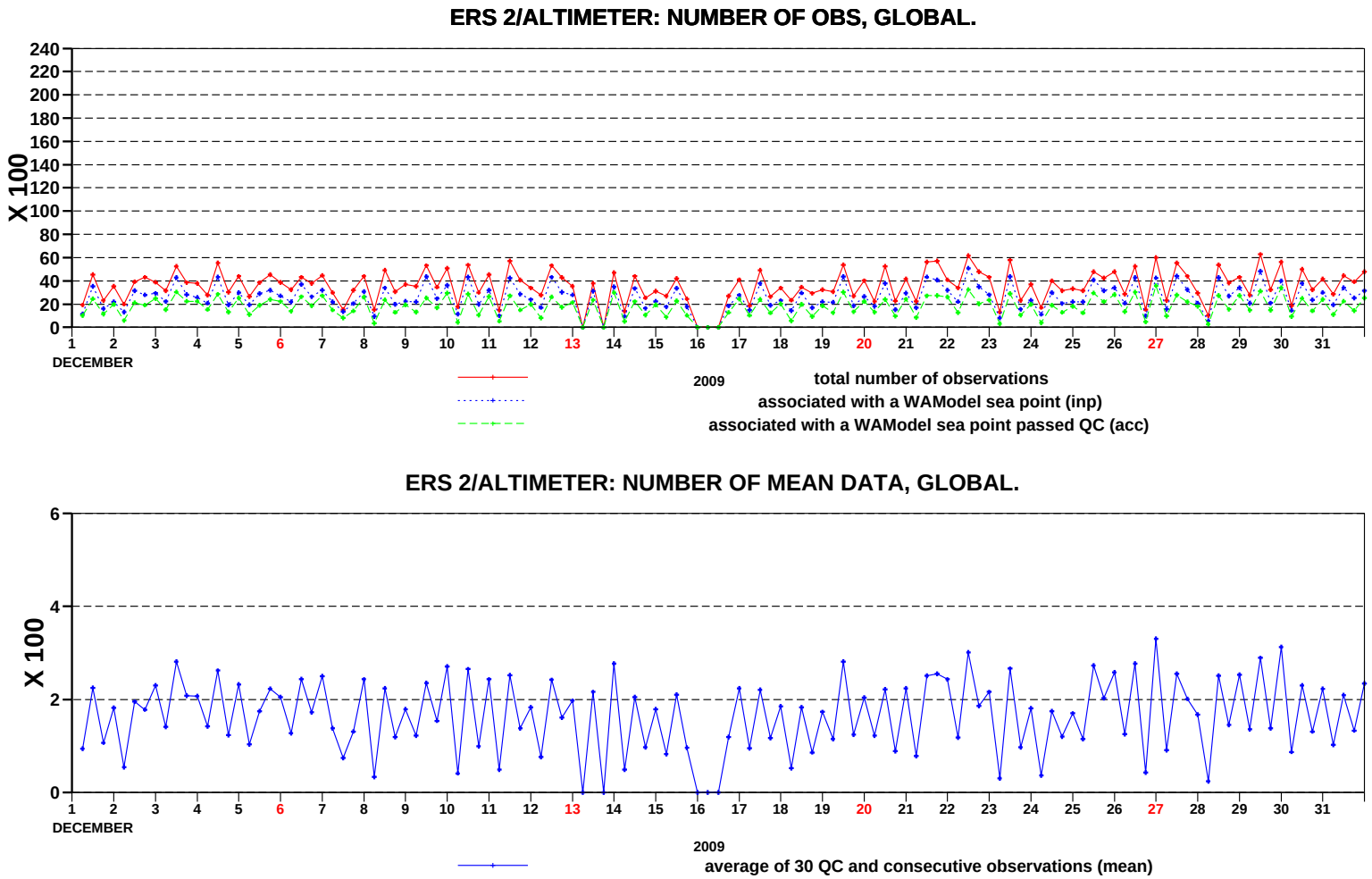


Figure 1:Time series of data reception for ERS-2 Altimeter data for December 2009

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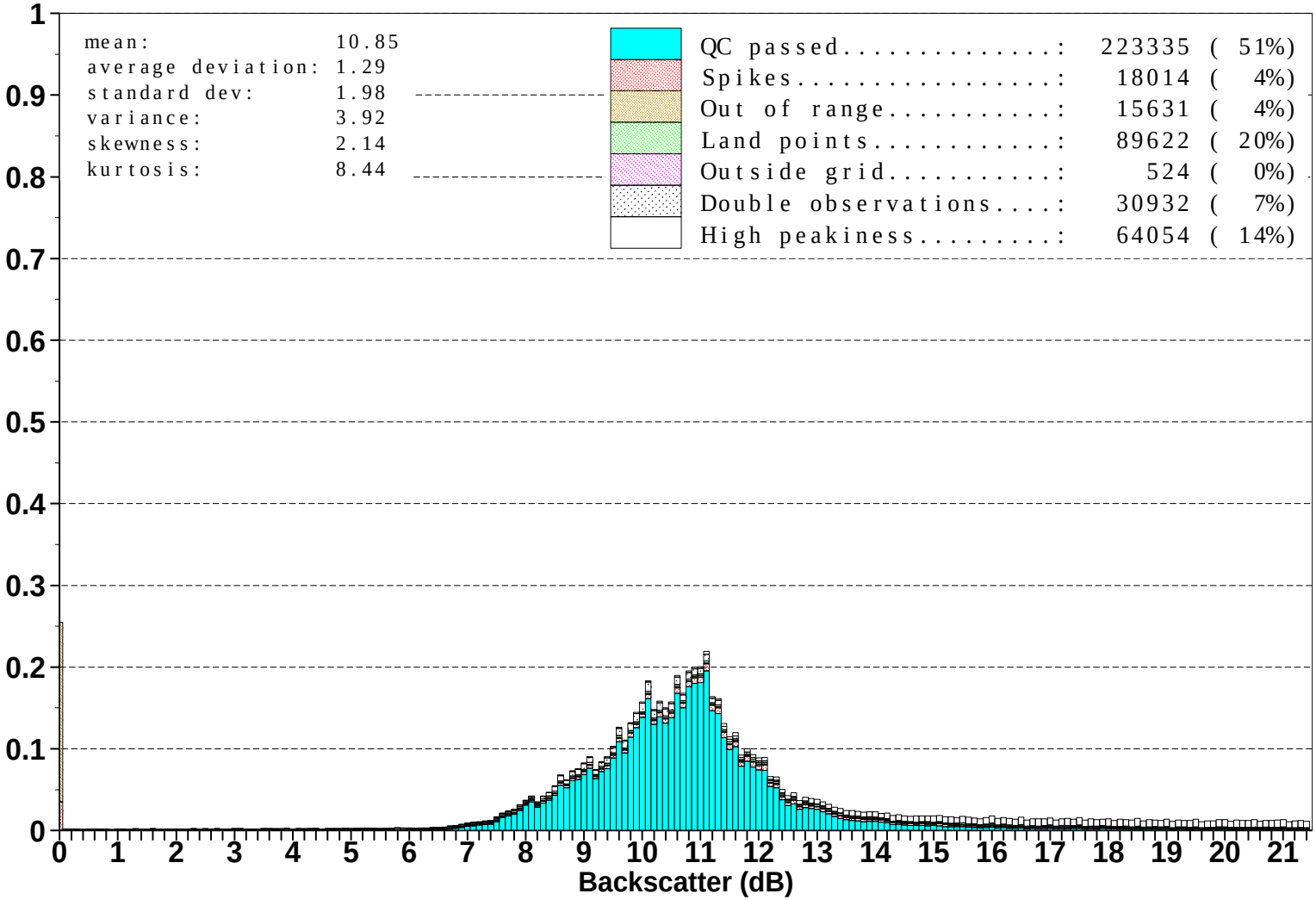


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for December 2009

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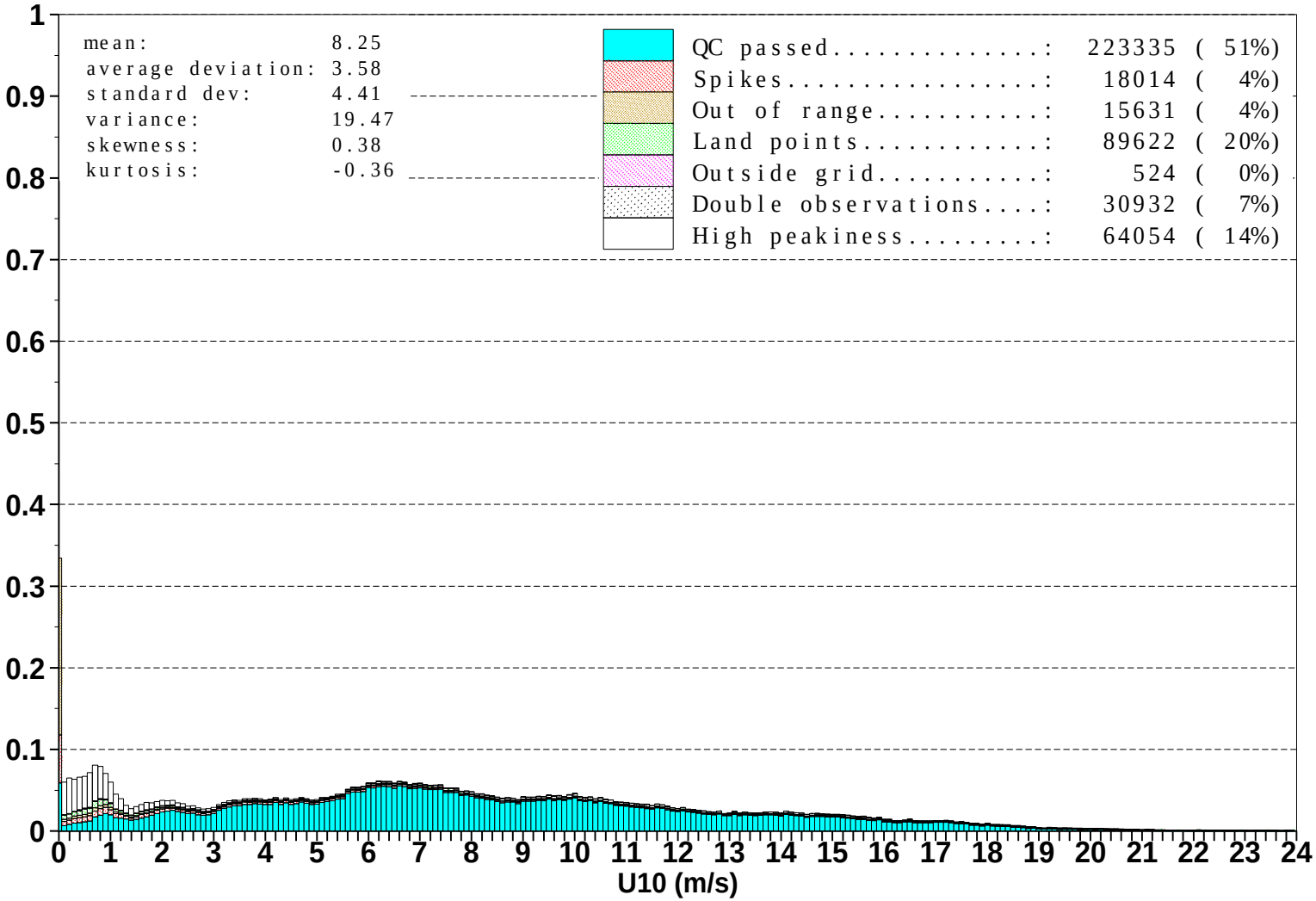


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2009

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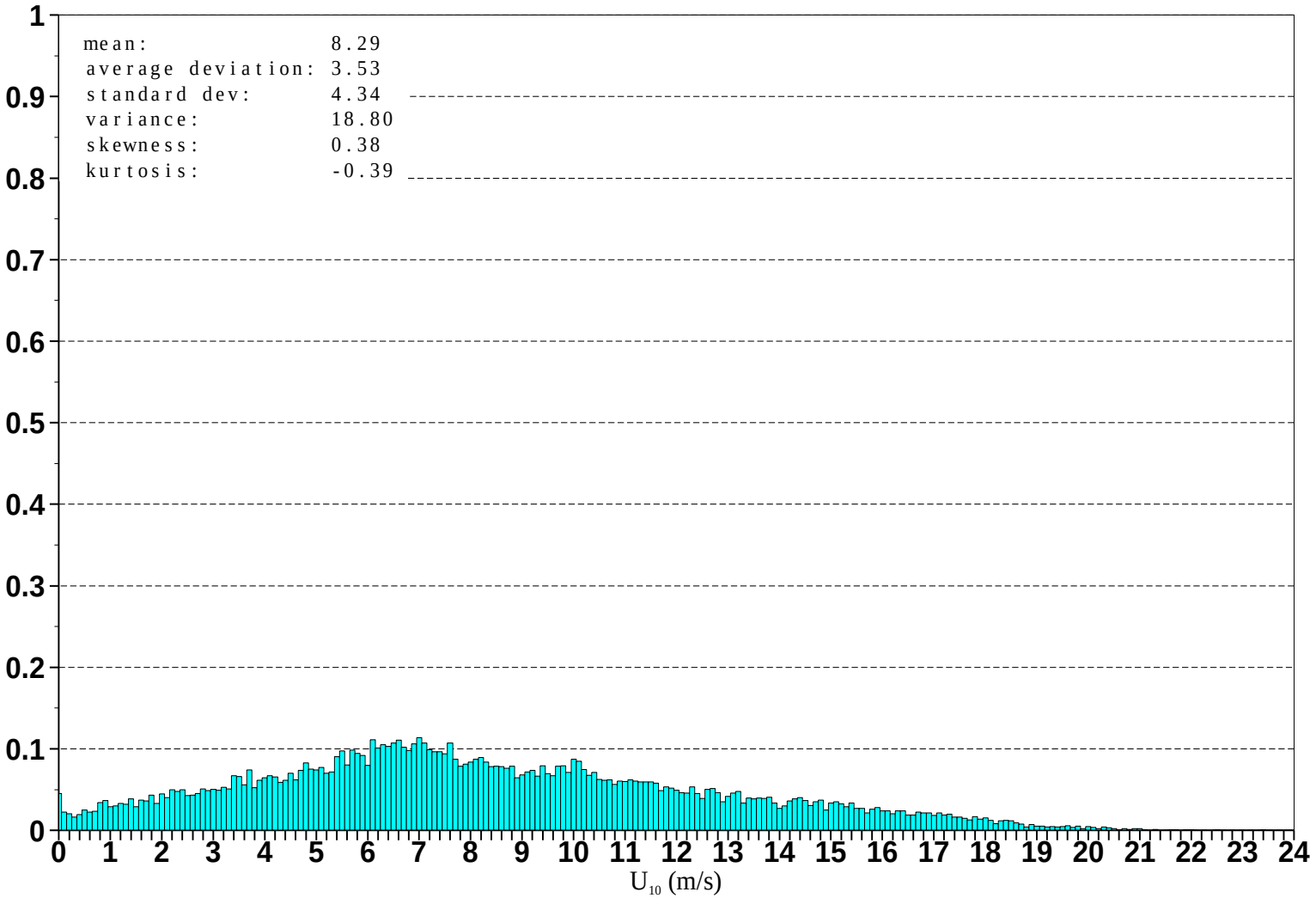


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for December 2009

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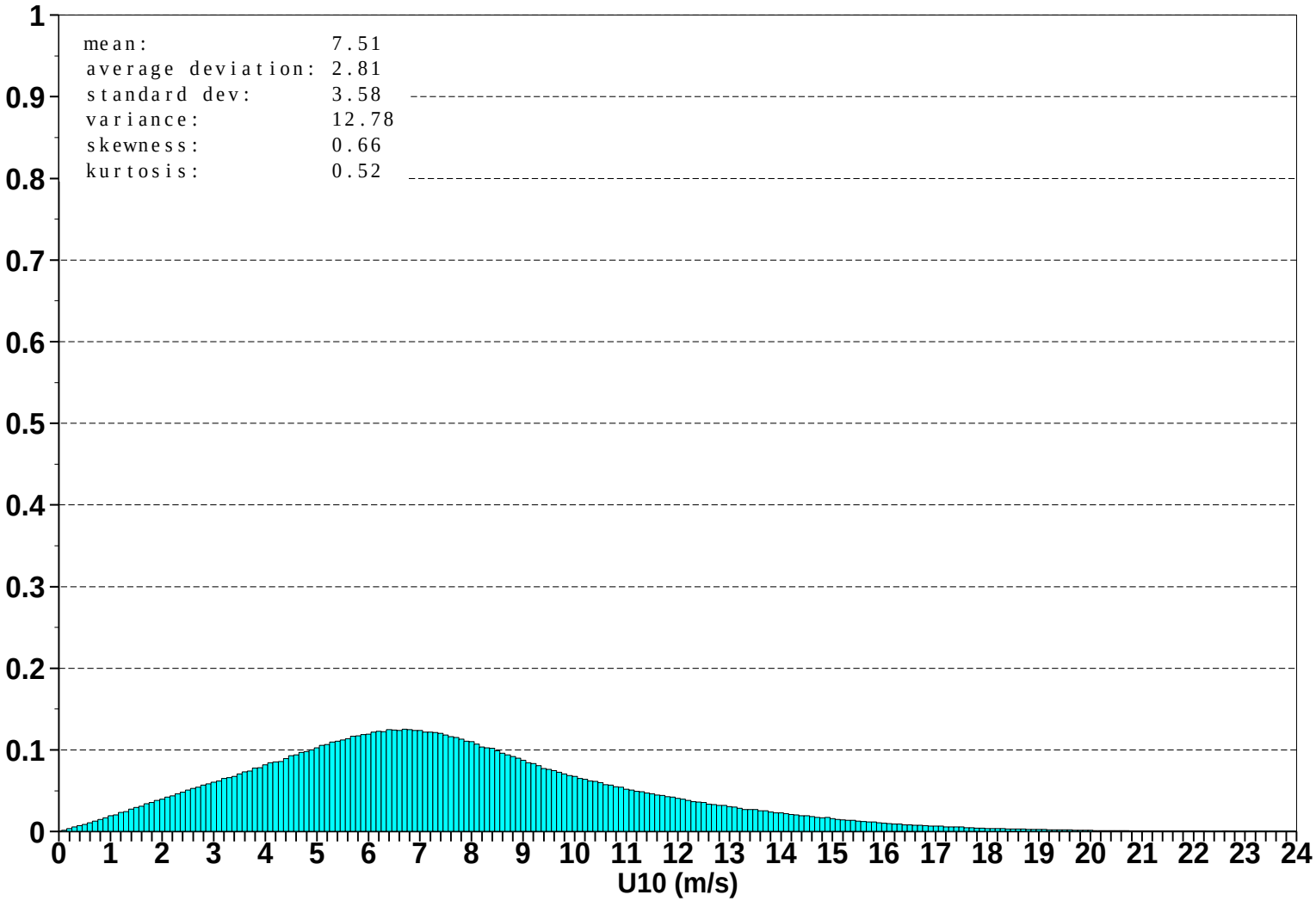
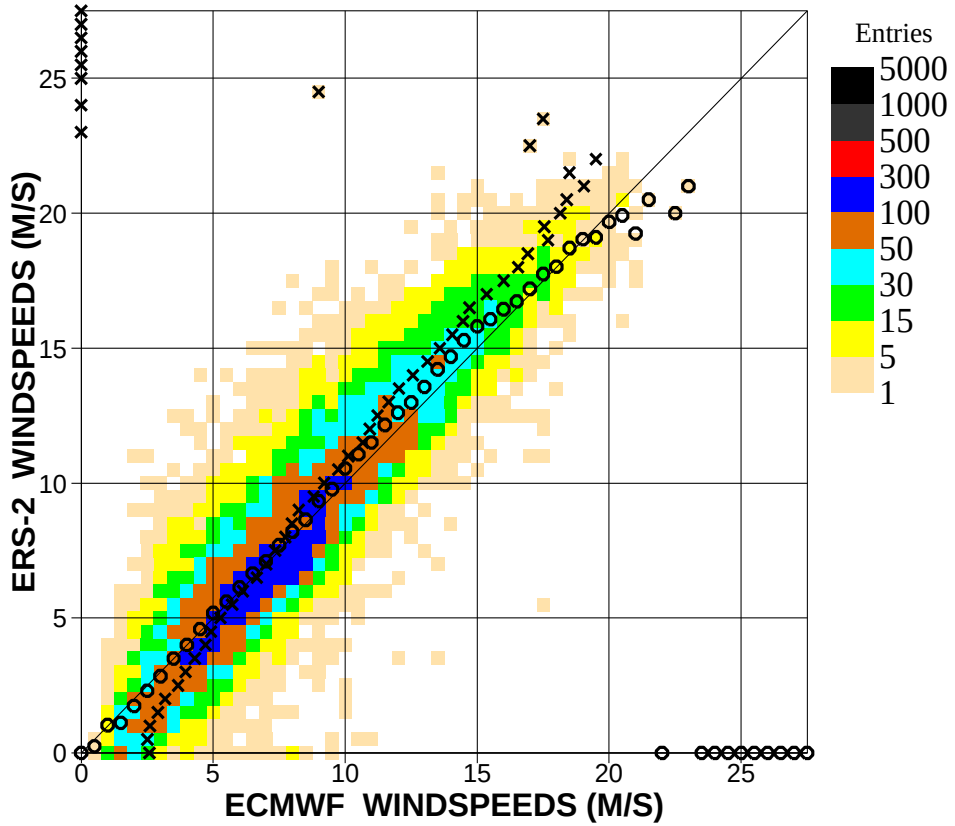


Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2009

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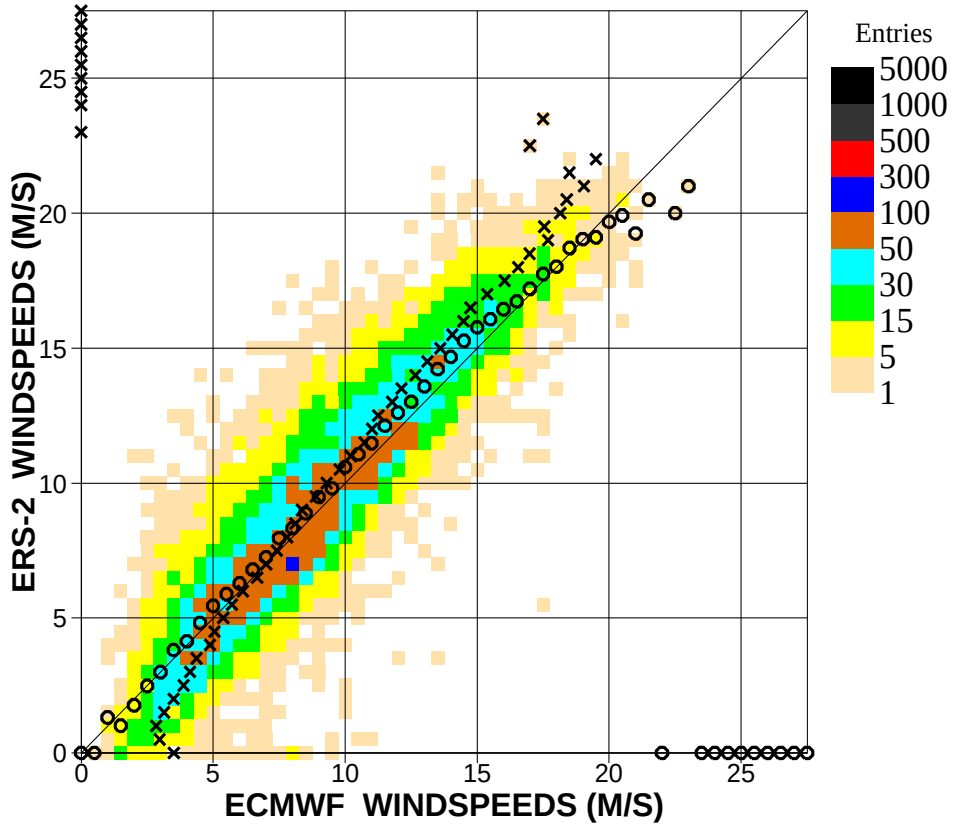
STATISTICS

ENTRIES	19931
MEAN ECMWF	8.0515
MEAN ERS-2	8.2872
BIAS (ERS-2 - ECMWF)	0.2356
STANDARD DEVIATION	1.7427
SCATTER INDEX	0.2164
CORRELATION	0.9169
SYMMETRIC SLOPE	1.0521 (0.0033)
REGR. COEFFICIENT	1.0550 (0.0033)
REGR. CONSTANT	-0.2075 (0.0289)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2009 (global)

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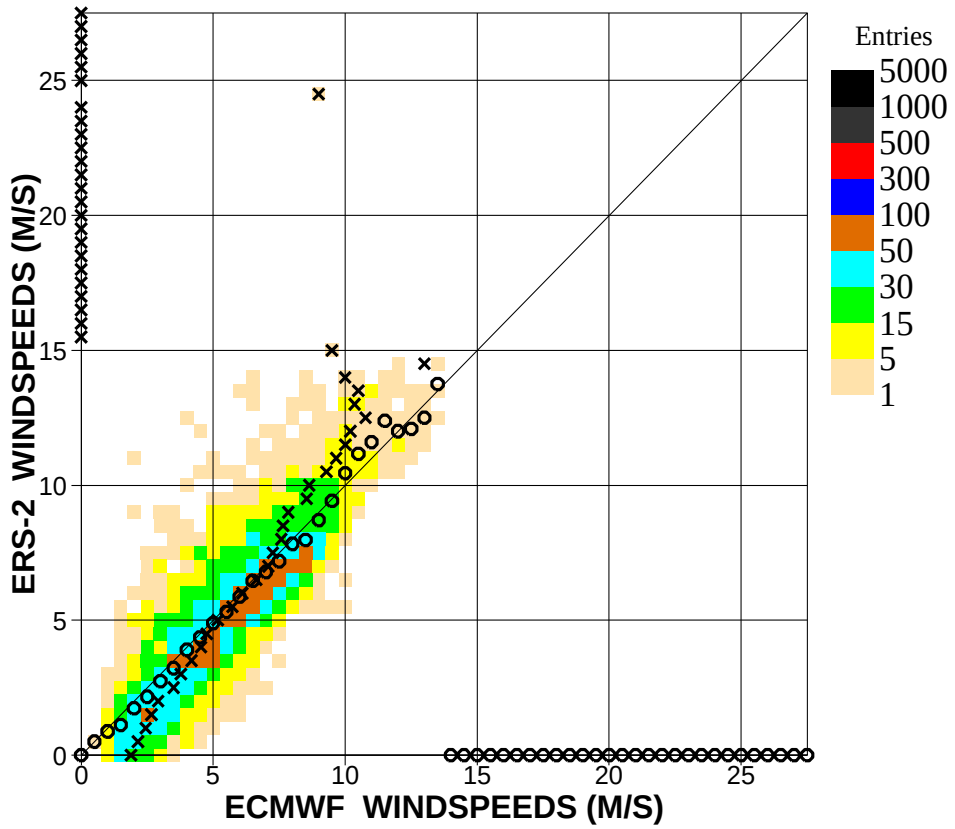


STATISTICS

ENTRIES	13441	
MEAN ECMWF	9.0834	
MEAN ERS-2	9.4881	
BIAS (ERS-2 - ECMWF)	0.4047	
STANDARD DEVIATION	1.8186	
SCATTER INDEX	0.2002	
CORRELATION	0.9078	
SYMMETRIC SLOPE	1.0583	(0.0041)
REGR. COEFFICIENT	1.0284	(0.0041)
REGR. CONSTANT	0.1471	(0.0404)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2009 (n.hem.)

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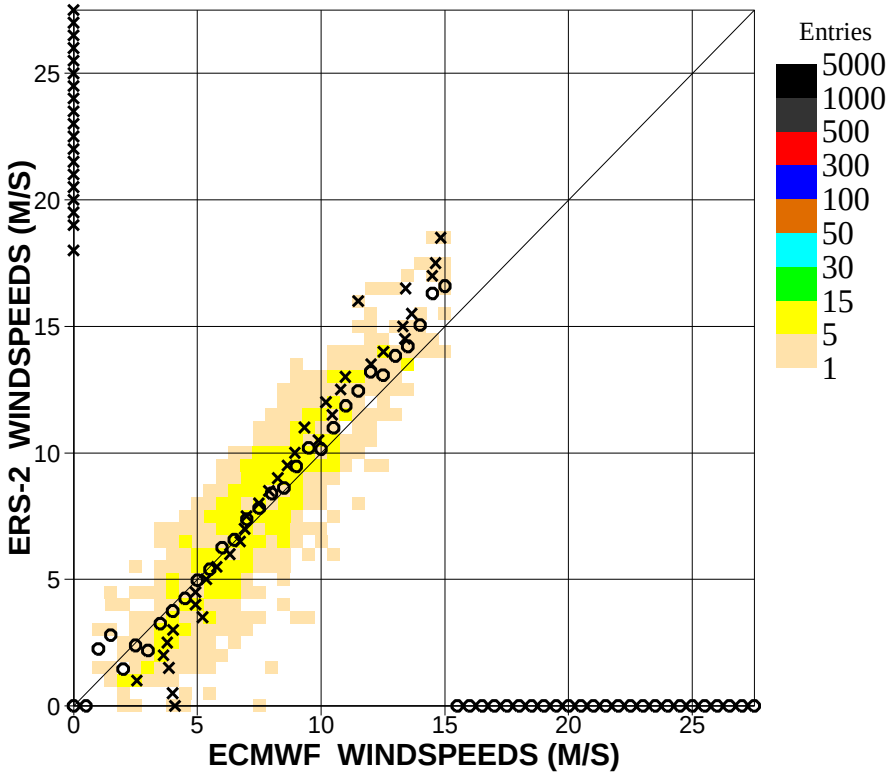
STATISTICS

ENTRIES	5550	
MEAN ECMWF	5.6070	
MEAN ERS-2	5.4248	
BIAS (ERS-2 - ECMWF)	-0.1823	
STANDARD DEVIATION	1.4721	
SCATTER INDEX	0.2625	
CORRELATION	0.8568	
SYMMETRIC SLOPE	1.0065	(0.0084)
REGR. COEFFICIENT	1.0292	(0.0083)
REGR. CONSTANT	-0.3462	(0.0506)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2009 (tropics)

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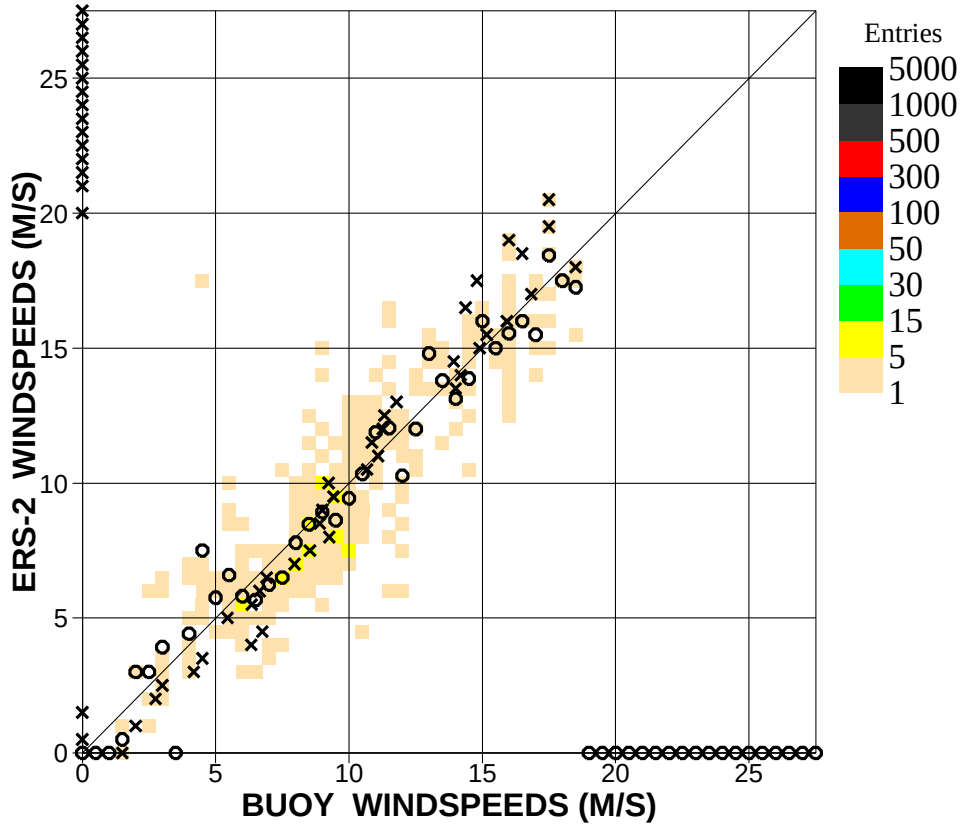


STATISTICS

ENTRIES	1083	
MEAN ECMWF	7.5723	
MEAN ERS-2	7.8303	
BIAS (ERS-2 - ECMWF)	0.2580	
STANDARD DEVIATION	1.6961	
SCATTER INDEX	0.2240	
CORRELATION	0.8908	
SYMMETRIC SLOPE	1.0663	(0.0178)
REGR. COEFFICIENT	1.1299	(0.0175)
REGR. CONSTANT	-0.7259	(0.1420)

Figure 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2009 (s.hem.)

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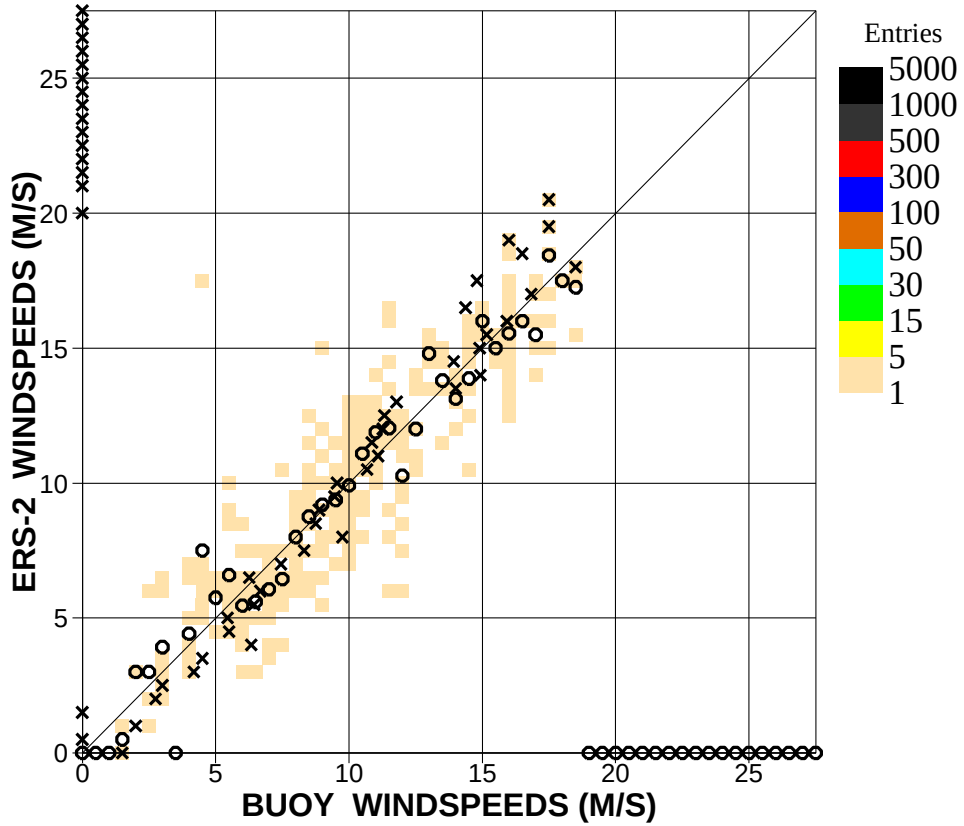


STATISTICS

ENTRIES	384	
MEAN BUOY	9.8282	
MEAN ERS-2	9.6857	
BIAS (ERS-2 - BUOY)	-0.1426	
STANDARD DEVIATION	1.8778	
SCATTER INDEX	0.1911	
CORRELATION	0.8827	
SYMMETRIC SLOPE	0.9958	(0.0258)
REGR. COEFFICIENT	0.9399	(0.0256)
REGR. CONSTANT	0.4485	(0.2690)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2009 (global)

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STATISTICS

ENTRIES	301	
MEAN BUOY	10.1756	
MEAN ERS-2	10.1894	
BIAS (ERS-2 - BUOY)	0.0138	
STANDARD DEVIATION	1.9616	
SCATTER INDEX	0.1928	
CORRELATION	0.8917	
SYMMETRIC SLOPE	1.0076	(0.0277)
REGR. COEFFICIENT	0.9324	(0.0274)
REGR. CONSTANT	0.7020	(0.3002)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2009 (n.hem.)

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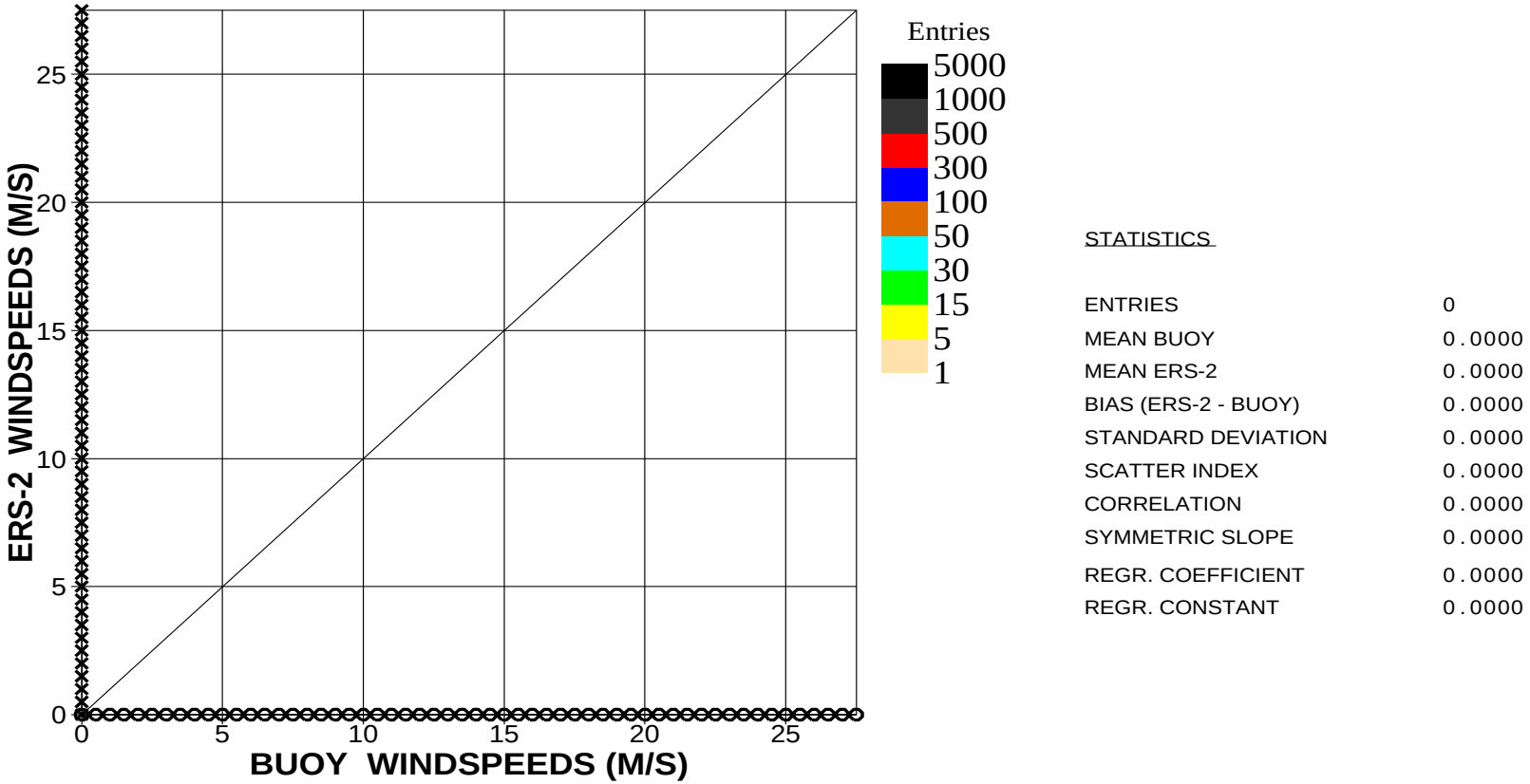


Figure 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2009 (hawaii)

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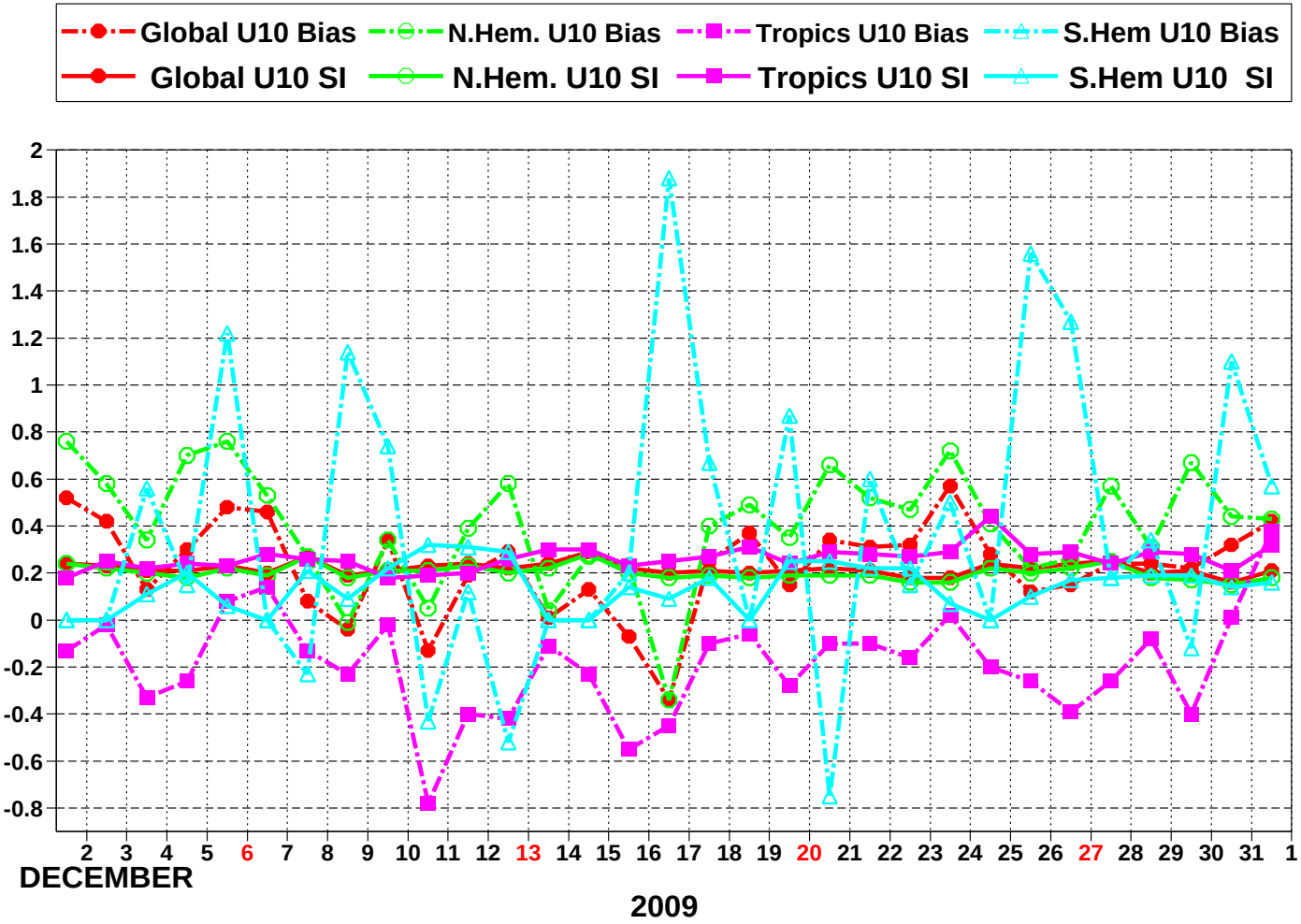


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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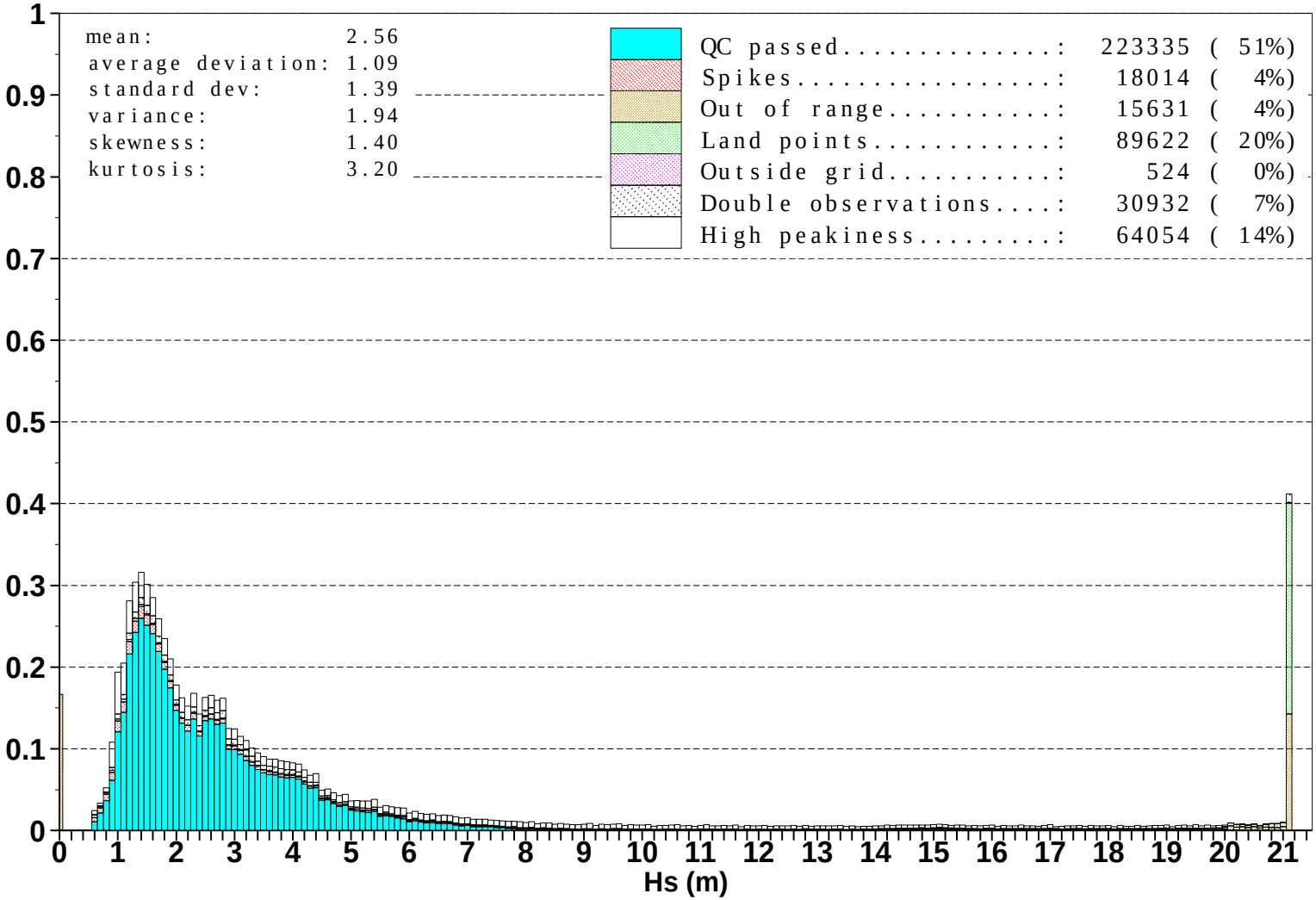


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for December 2009

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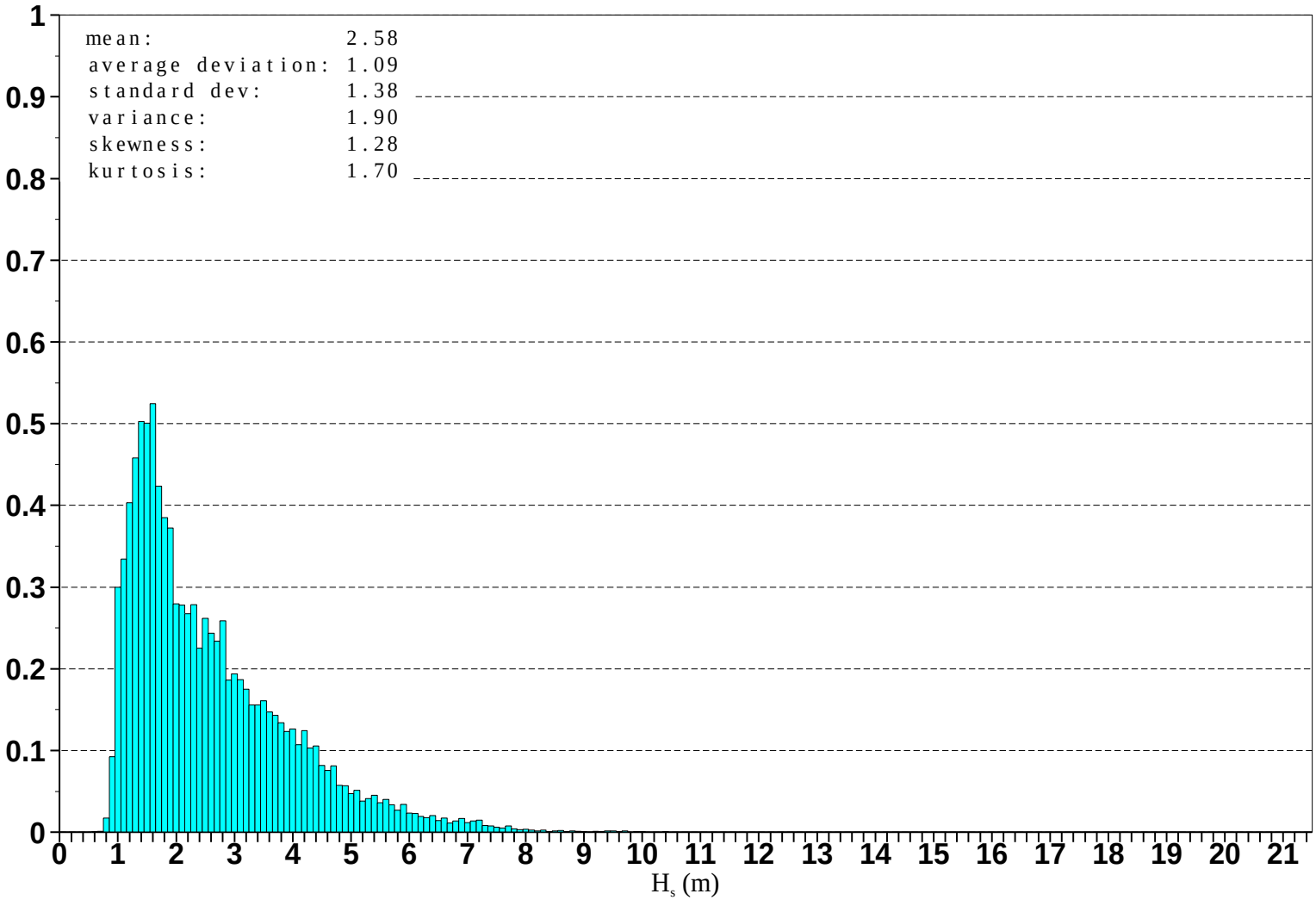


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for December 2009

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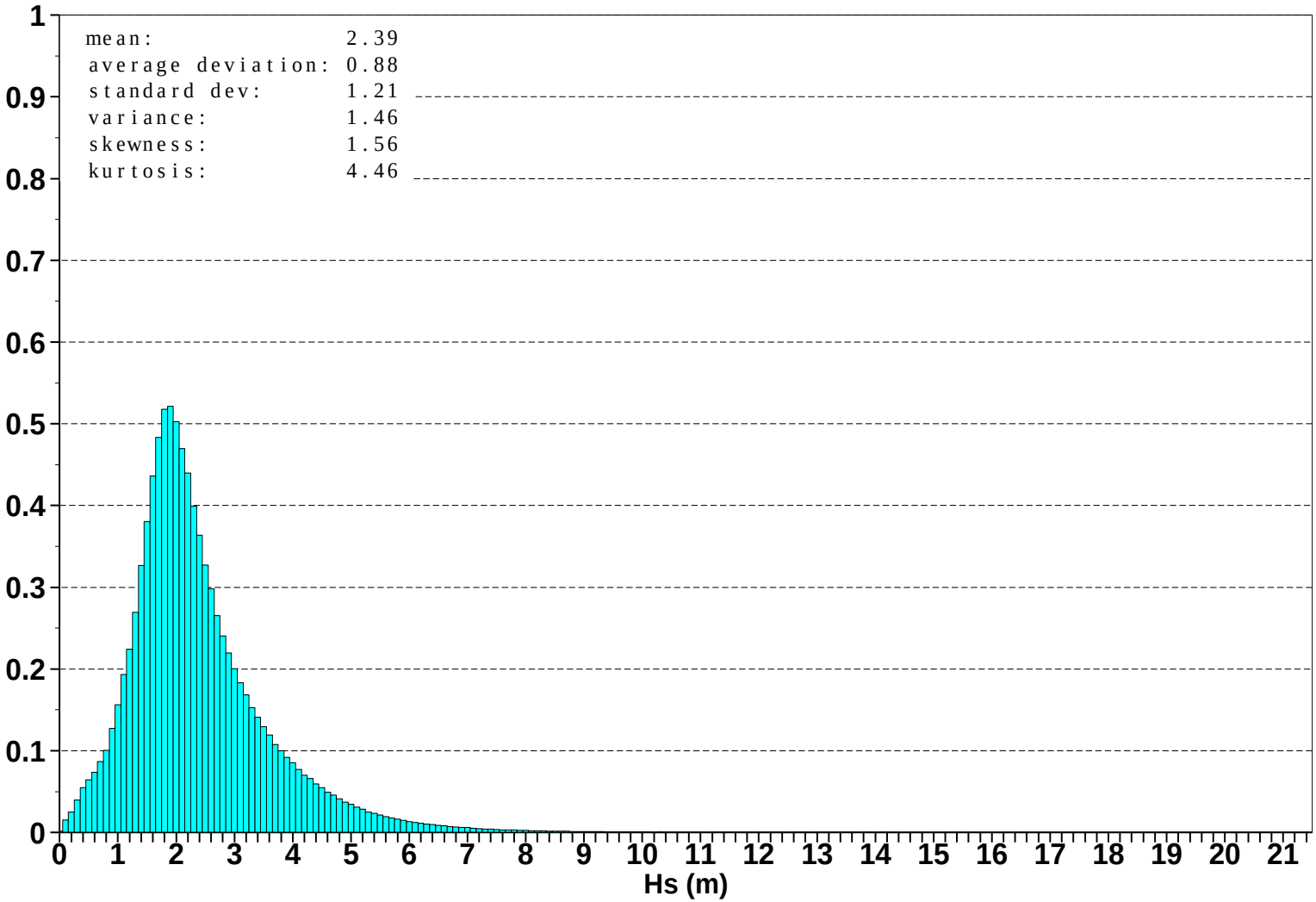
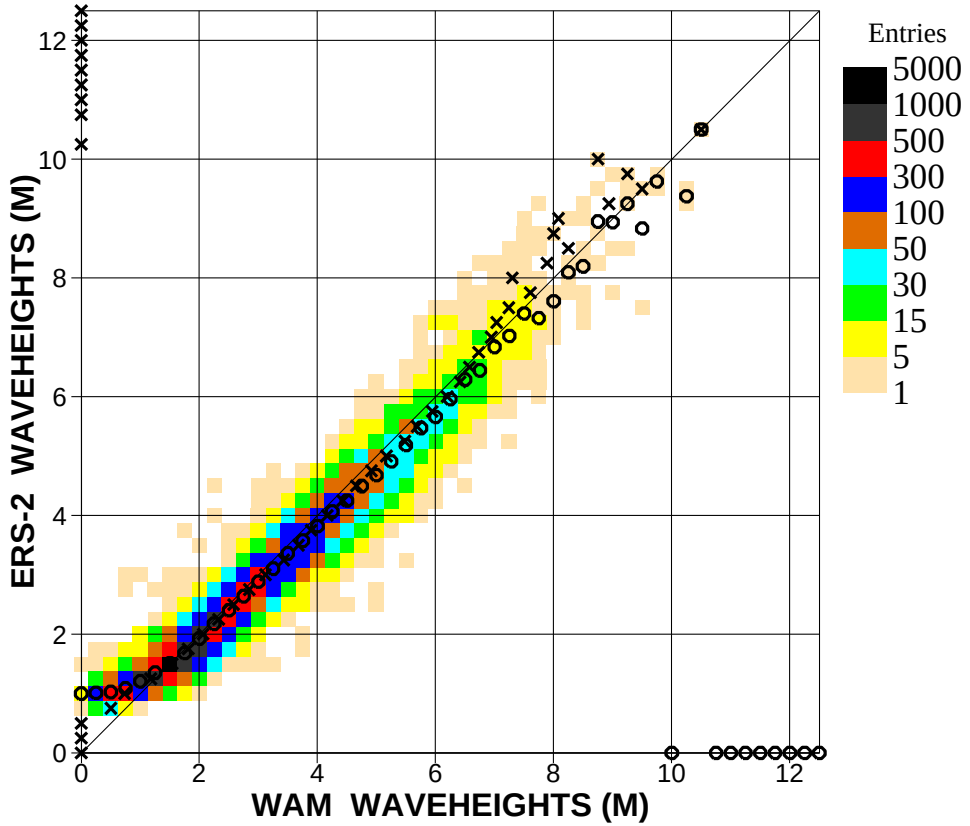


Figure 16: Global distribution of ECMWF wave heights for December 2009

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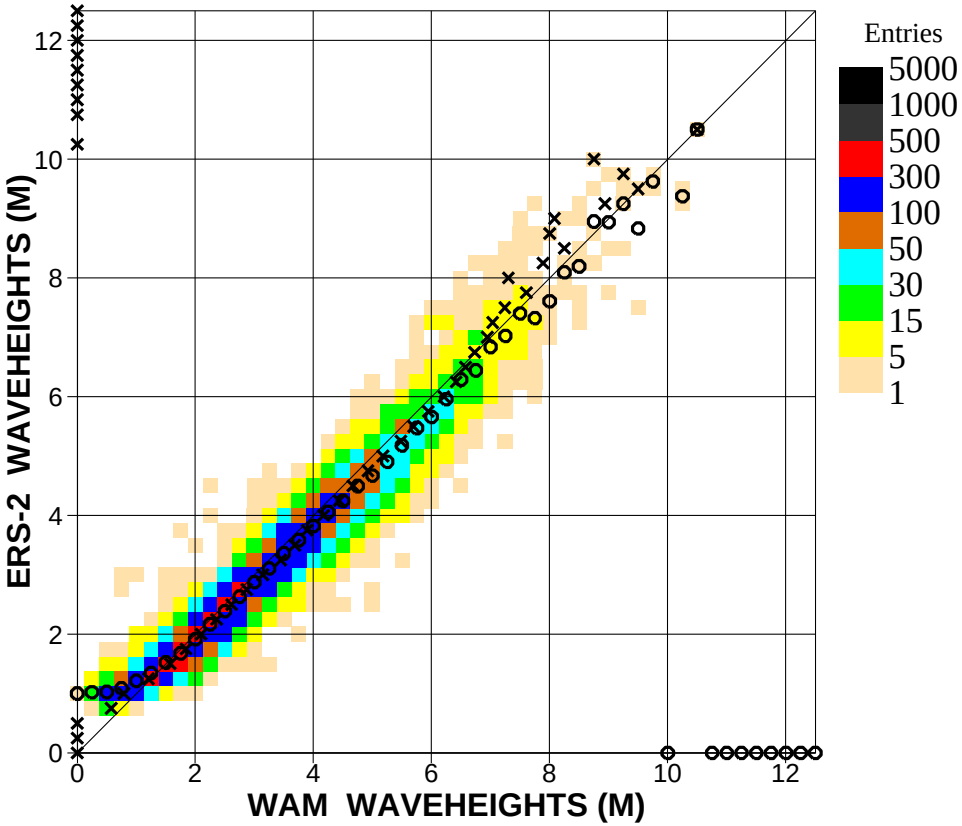


STATISTICS

ENTRIES	19846
MEAN WAM	2.6397
MEAN ERS-2	2.5847
BIAS (ERS-2 - WAM)	-0.0550
STANDARD DEVIATION	0.3398
SCATTER INDEX	0.1287
CORRELATION	0.9745
SYMMETRIC SLOPE	0.9672 (0.0015)
REGR. COEFFICIENT	0.9047 (0.0015)
REGR. CONSTANT	0.1966 (0.0045)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2009 (global)

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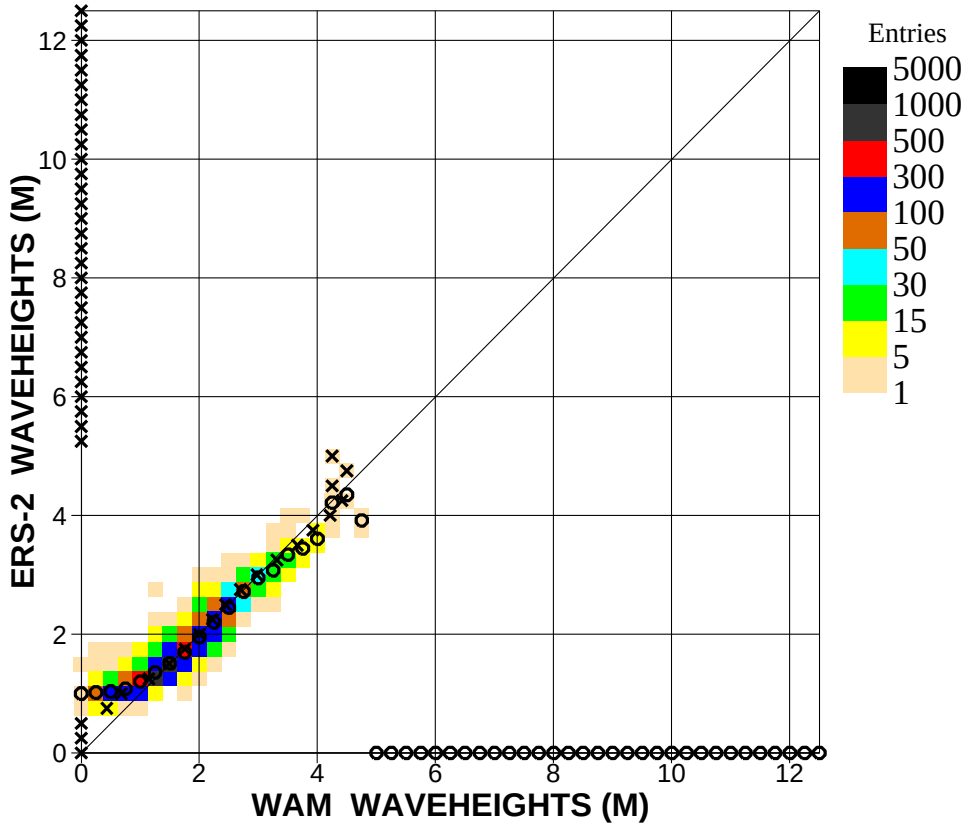


STATISTICS

ENTRIES	13387	
MEAN WAM	3.0774	
MEAN ERS-2	2.9756	
BIAS (ERS-2 - WAM)	-0.1018	
STANDARD DEVIATION	0.3689	
SCATTER INDEX	0.1199	
CORRELATION	0.9717	
SYMMETRIC SLOPE	0.9623	(0.0020)
REGR. COEFFICIENT	0.9174	(0.0019)
REGR. CONSTANT	0.1524	(0.0066)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2009 (n.hem.)

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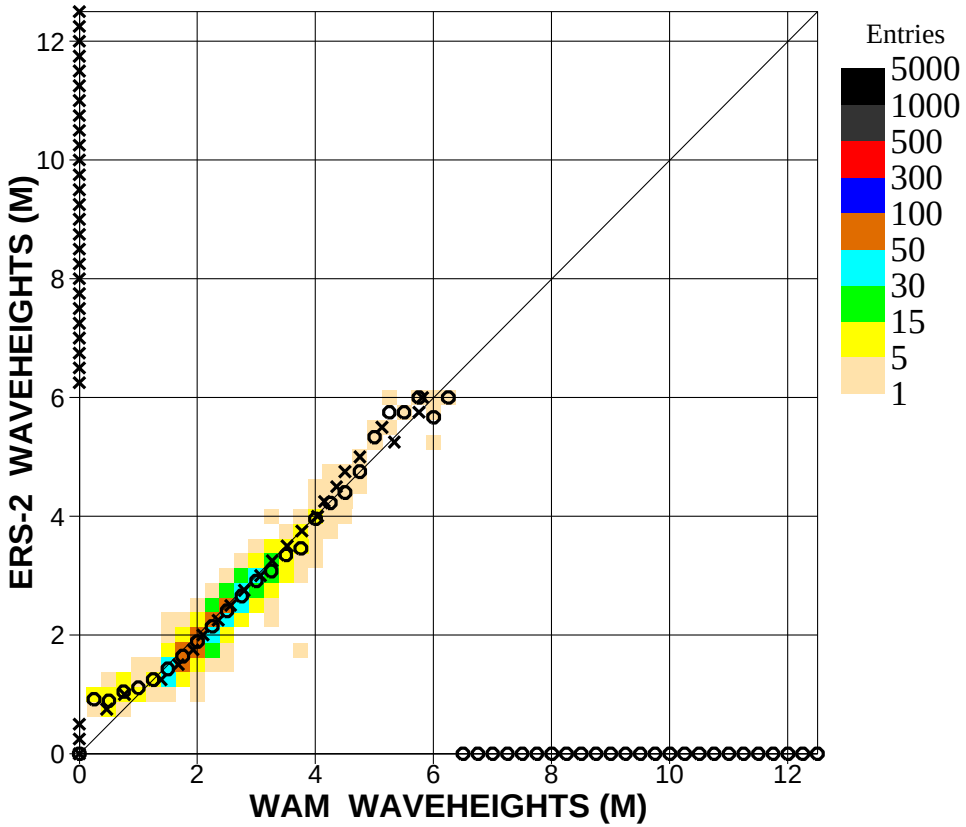


STATISTICS

ENTRIES	5525	
MEAN WAM	1.6164	
MEAN ERS-2	1.6815	
BIAS (ERS-2 - WAM)	0.0651	
STANDARD DEVIATION	0.2359	
SCATTER INDEX	0.1460	
CORRELATION	0.9428	
SYMMETRIC SLOPE	1.0123	(0.0049)
REGR. COEFFICIENT	0.7836	(0.0037)
REGR. CONSTANT	0.4150	(0.0065)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2009 (tropics)

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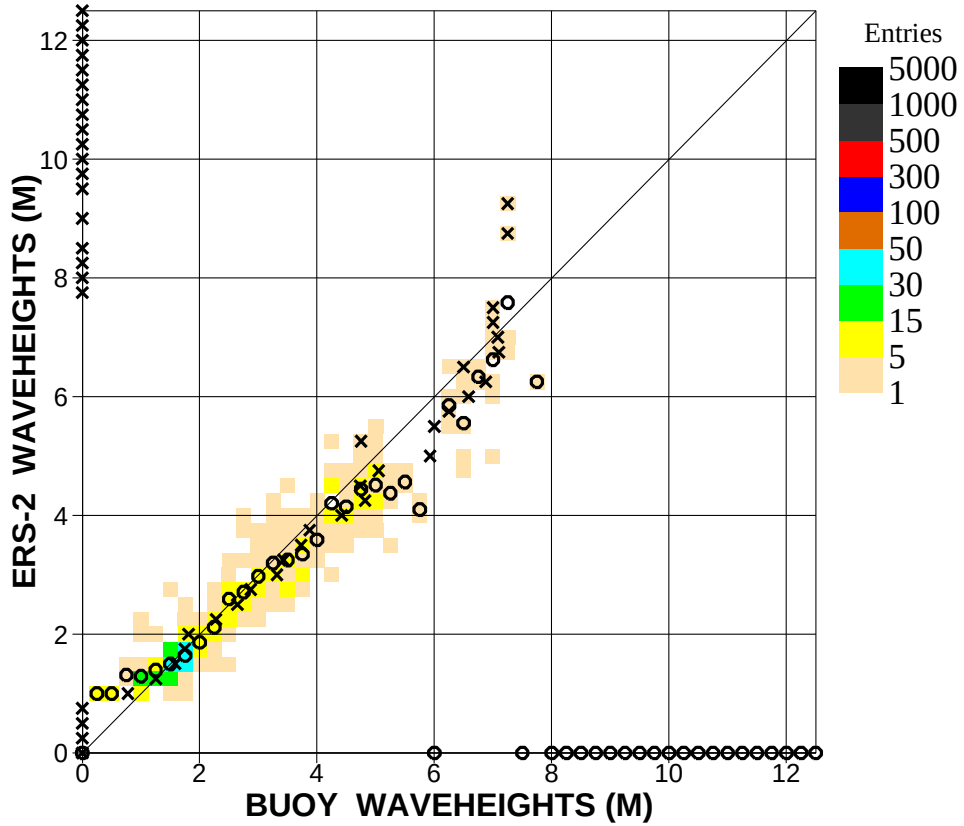


STATISTICS

ENTRIES	1076	
MEAN WAM	2.3573	
MEAN ERS-2	2.2771	
BIAS (ERS-2 - WAM)	-0.0802	
STANDARD DEVIATION	0.2397	
SCATTER INDEX	0.1017	
CORRELATION	0.9561	
SYMMETRIC SLOPE	0.9678	(0.0088)
REGR. COEFFICIENT	0.9401	(0.0088)
REGR. CONSTANT	0.0609	(0.0219)

Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2009 (s.hem.)

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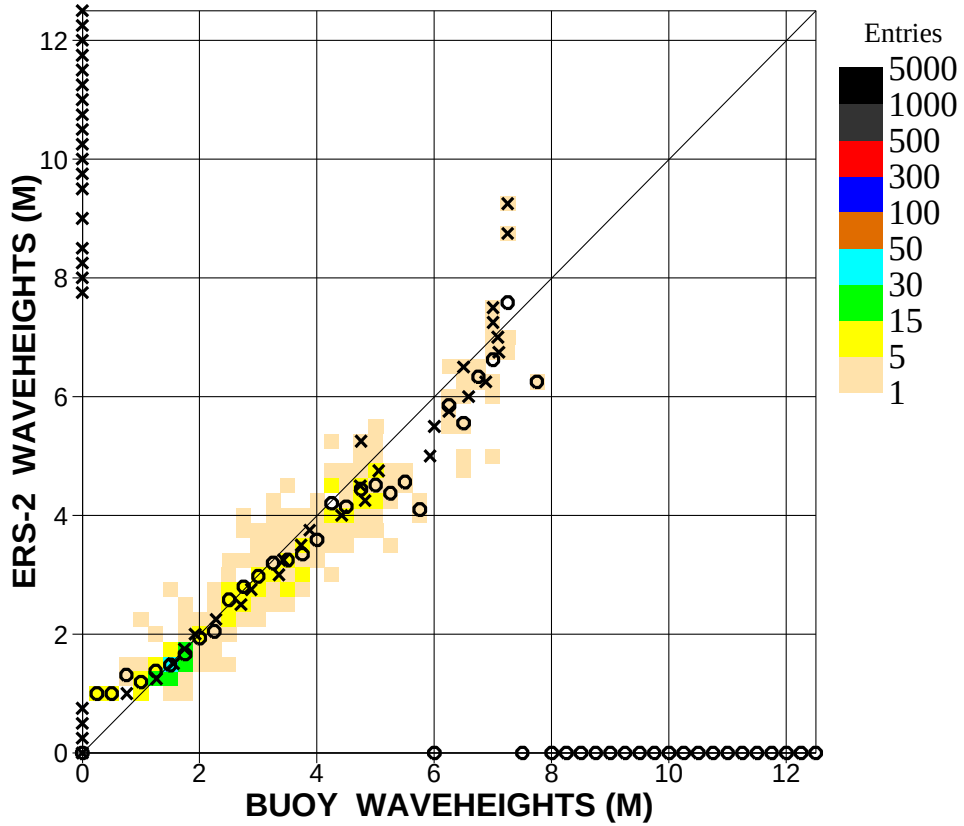


STATISTICS

ENTRIES	597	
MEAN BUOY	2.8525	
MEAN ERS-2	2.7356	
BIAS (ERS-2 - BUOY)	-0.1169	
STANDARD DEVIATION	0.4651	
SCATTER INDEX	0.1630	
CORRELATION	0.9620	
SYMMETRIC SLOPE	0.9446	(0.0106)
REGR. COEFFICIENT	0.8664	(0.0101)
REGR. CONSTANT	0.2641	(0.0333)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2009 (global)

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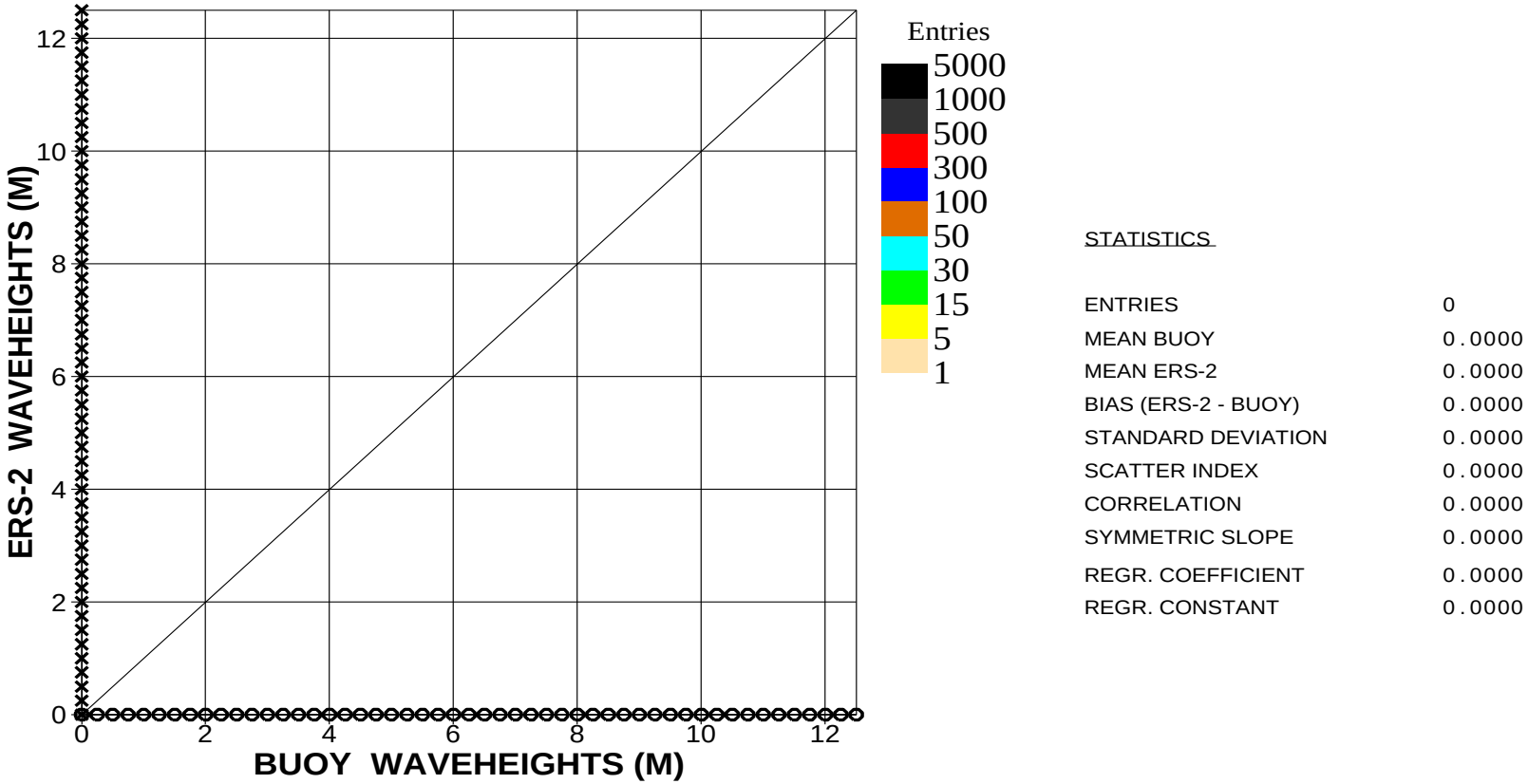


STATISTICS

ENTRIES	505	
MEAN BUOY	3.0541	
MEAN ERS-2	2.9213	
BIAS (ERS-2 - BUOY)	-0.1328	
STANDARD DEVIATION	0.4891	
SCATTER INDEX	0.1601	
CORRELATION	0.9609	
SYMMETRIC SLOPE	0.9430	(0.0117)
REGR. COEFFICIENT	0.8638	(0.0111)
REGR. CONSTANT	0.2832	(0.0389)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2009 (n.hem.)

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STATISTICS

ENTRIES	0
MEAN BUOY	0.0000
MEAN ERS-2	0.0000
BIAS (ERS-2 - BUOY)	0.0000
STANDARD DEVIATION	0.0000
SCATTER INDEX	0.0000
CORRELATION	0.0000
SYMMETRIC SLOPE	0.0000
REGR. COEFFICIENT	0.0000
REGR. CONSTANT	0.0000

Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2009 (hawaii)

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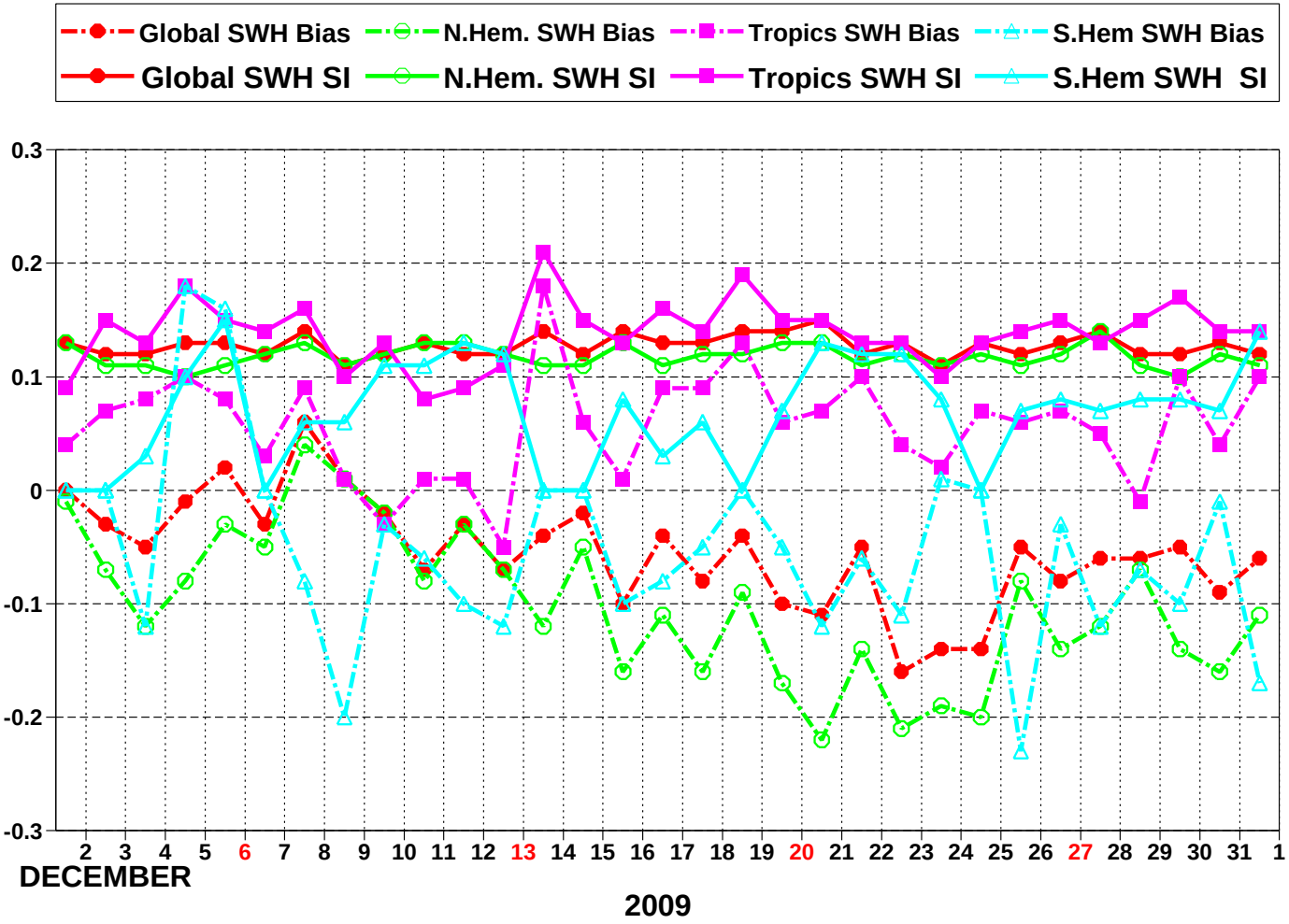


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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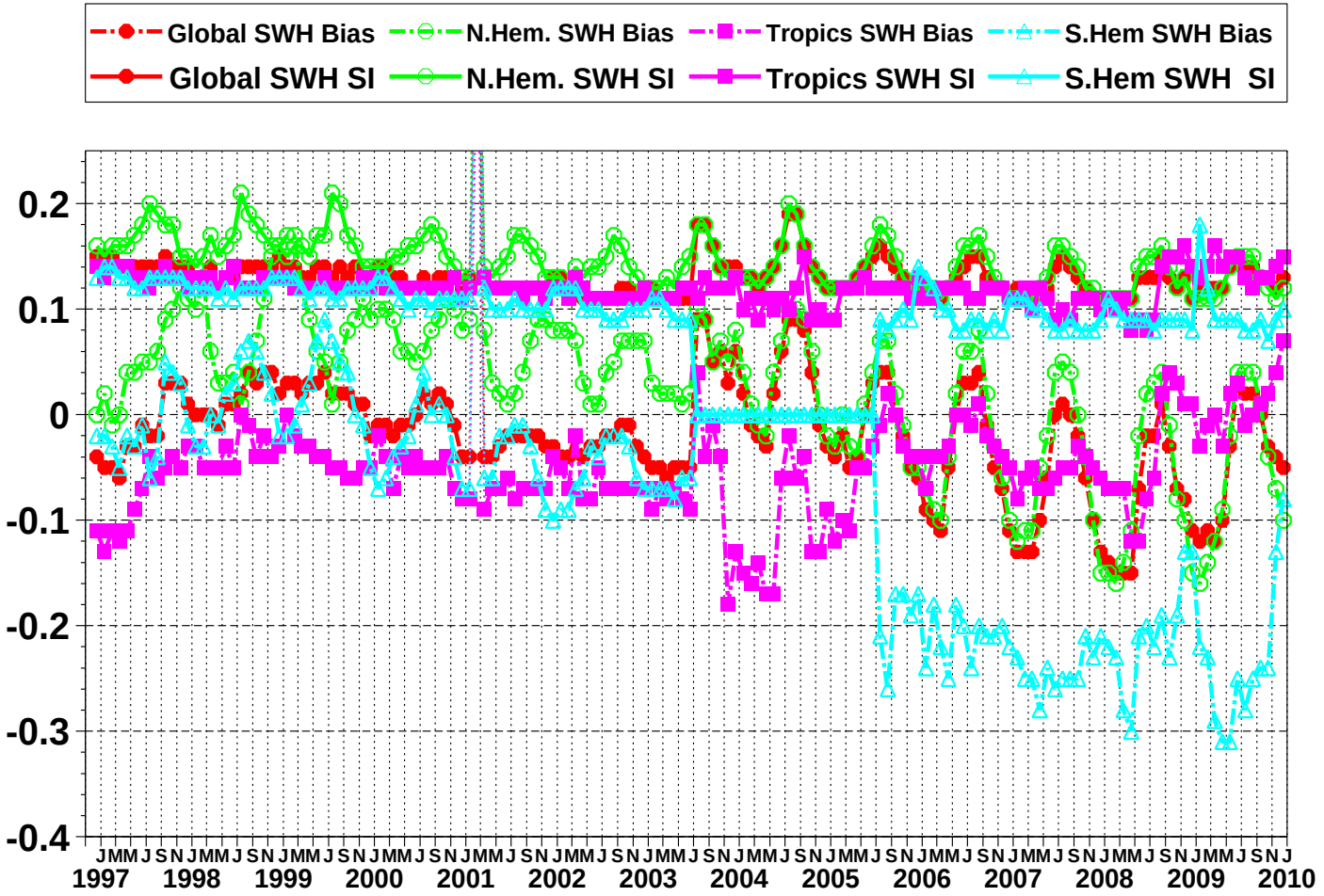


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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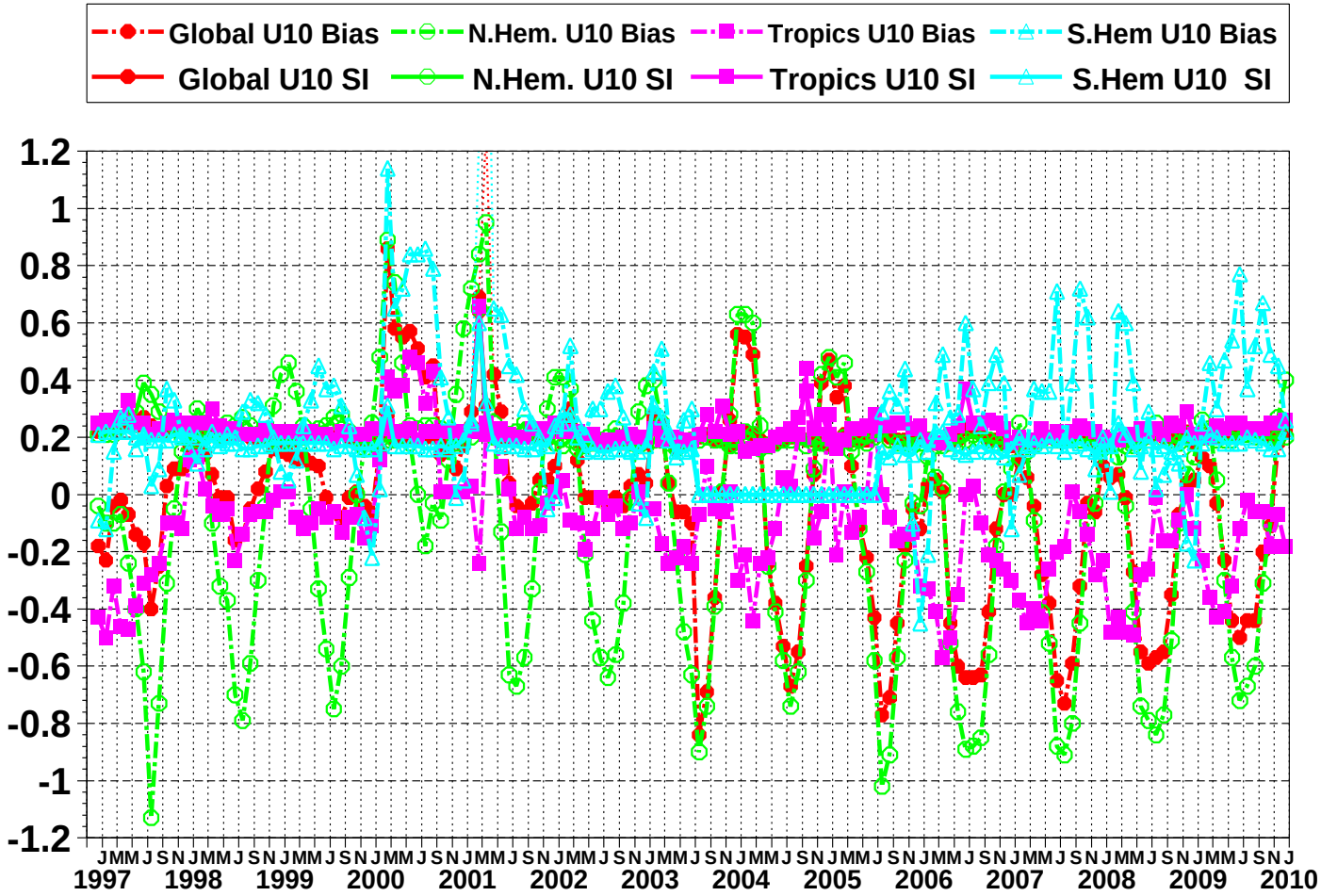


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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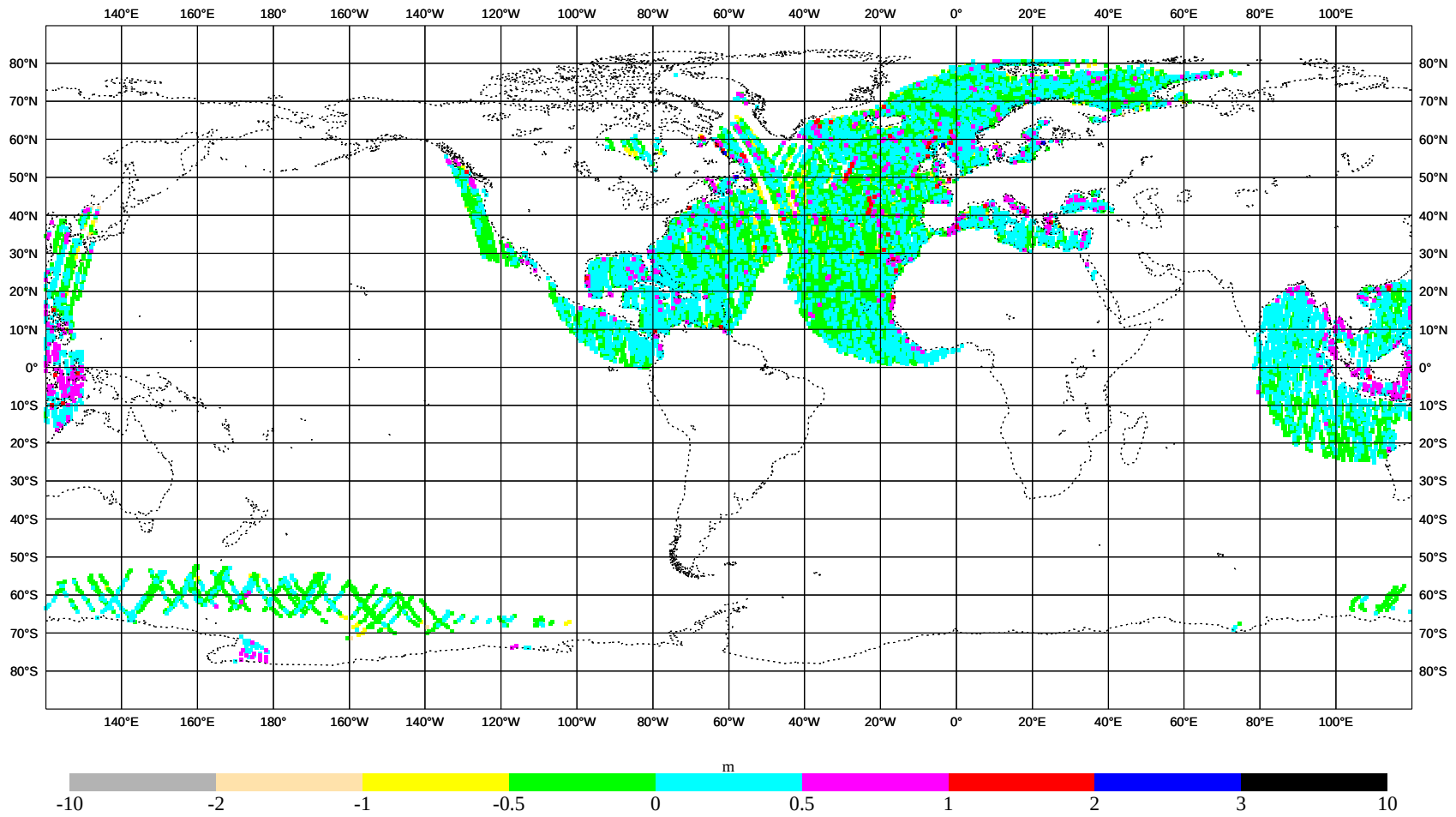


Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for December 2009.

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