ECMWF Report on ERS-2 RA for December 2007

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

By: *Saleh Abdalla*

Date: *16 January 2008*

Overview:

Based on the data received at ECMWF during the whole month, on average, 4701 observations arrived at ECMWF every 6 hours of which 67.61% passed the quality control. As can be seen in Figure 1, there was no data gaps during the whole month. The current coverage of the data covers: the North Atlantic, the western coast of North America, the eastern coast of China and around Korea and Japan, the Southern Ocean and the northeaster parts of the Indian Ocean as can be seen in Figure 27. The quality of the received data is as good as usual.

Backscatter:

ESR-2 $<\sigma_0>$ = 10.65 dB (with two main peaks at 10.6 and 10.9 dB).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: + 0.104 m/s

ERS-2 northern hemisphere: + 0.168 m/s

ERS-2 tropics: - 0.228 m/s

ERS-2 southern hemisphere: + 0.197 m/s

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ECMWF Report on ERS-2 RA for December 2007

Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: - 0.501 m/s

ERS-2 northern hemisphere: - 0.522 m/s

ERS-2 tropics (Hawaii): *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: - 0.134 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: - 0.146 m

ERS-2 tropics: - 0.055 m

ERS-2 southern hemisphere: - 0.206 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: - 0.133 m

ERS-2 northern hemisphere: - 0.142 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 and the north eastern parts of the Indian Ocean since 19 October 2006. 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 Ku-Band and Jason altimeter significant wave height data and ENVISAT ASAR Wave Mode Level 1b data are assimilated in the ECMWF wave model.
- There was no ECMWF model change during this month. The current operational IFS cycle is CY32R3 (since 06 November 2007).

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

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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 2007.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for December 2007.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2007.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for December 2007.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2007.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2007 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2007 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2007 (tropics)

Figure 9: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2007 (southern hemisphere)

Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2007 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2007 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2007 (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 2007.

Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for December 2007.

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Figure 16: Global distribution of ECMWF wave heights for December 2007.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2007 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2007 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2007 (tropics)

Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2007 (southern hemisphere)

Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2007 (global).

Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2007 (northern hemisphere).

Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2007 (hawaii).

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for December 2007.

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2007.

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2007.

Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for December 2007.

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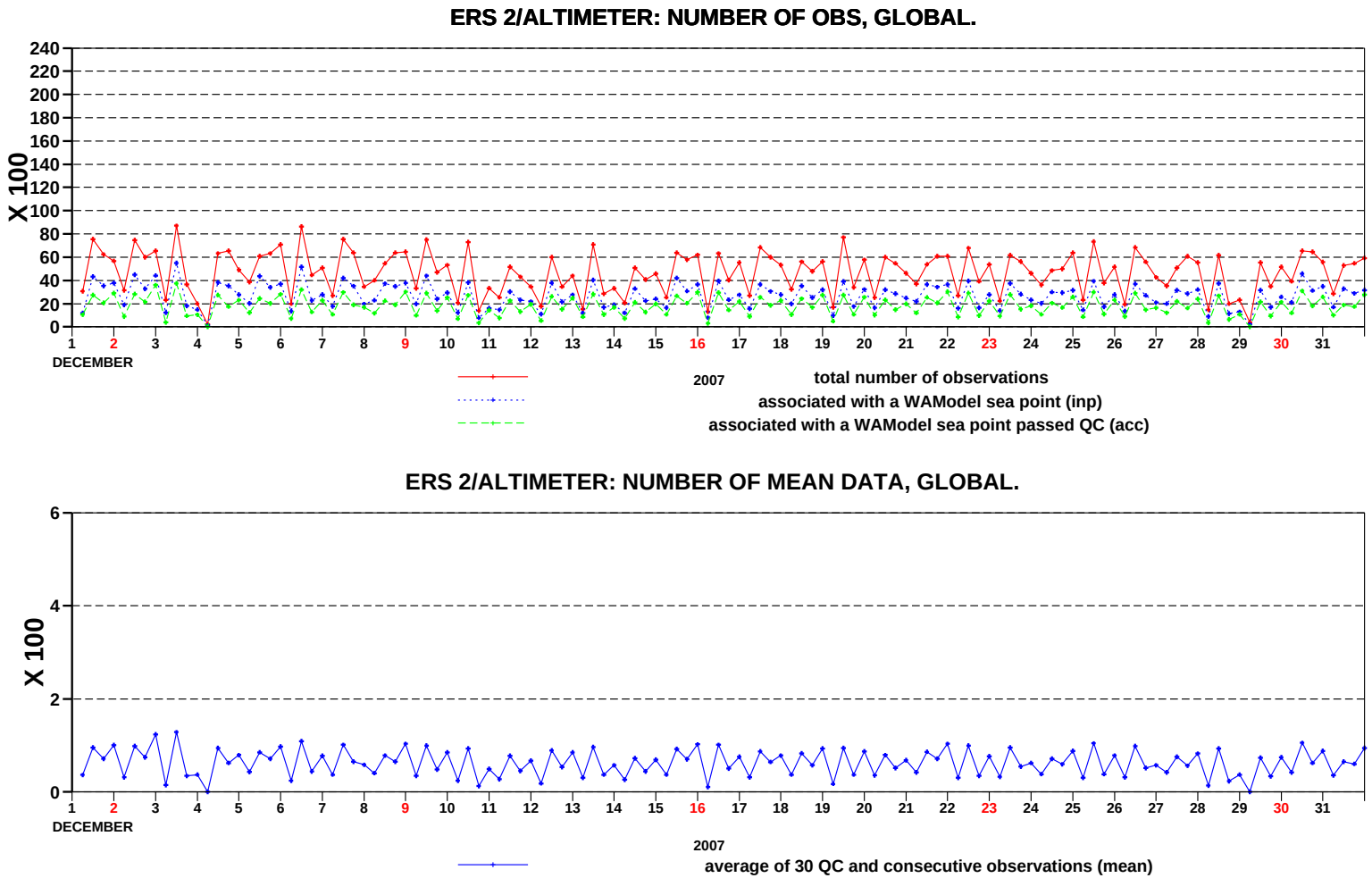


Figure 1:Time series of data reception for ERS-2 Altimeter data for December 2007

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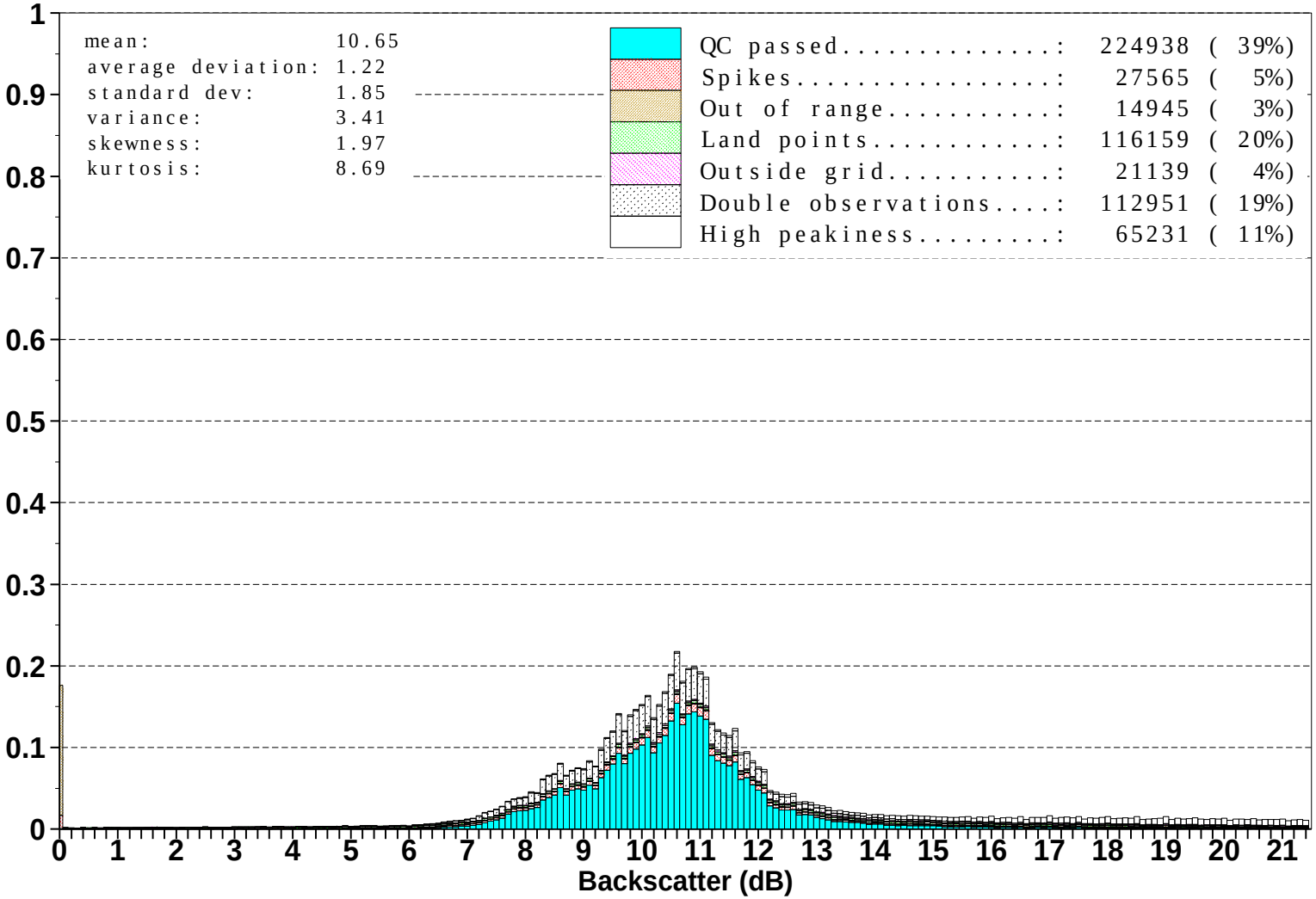


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for December 2007

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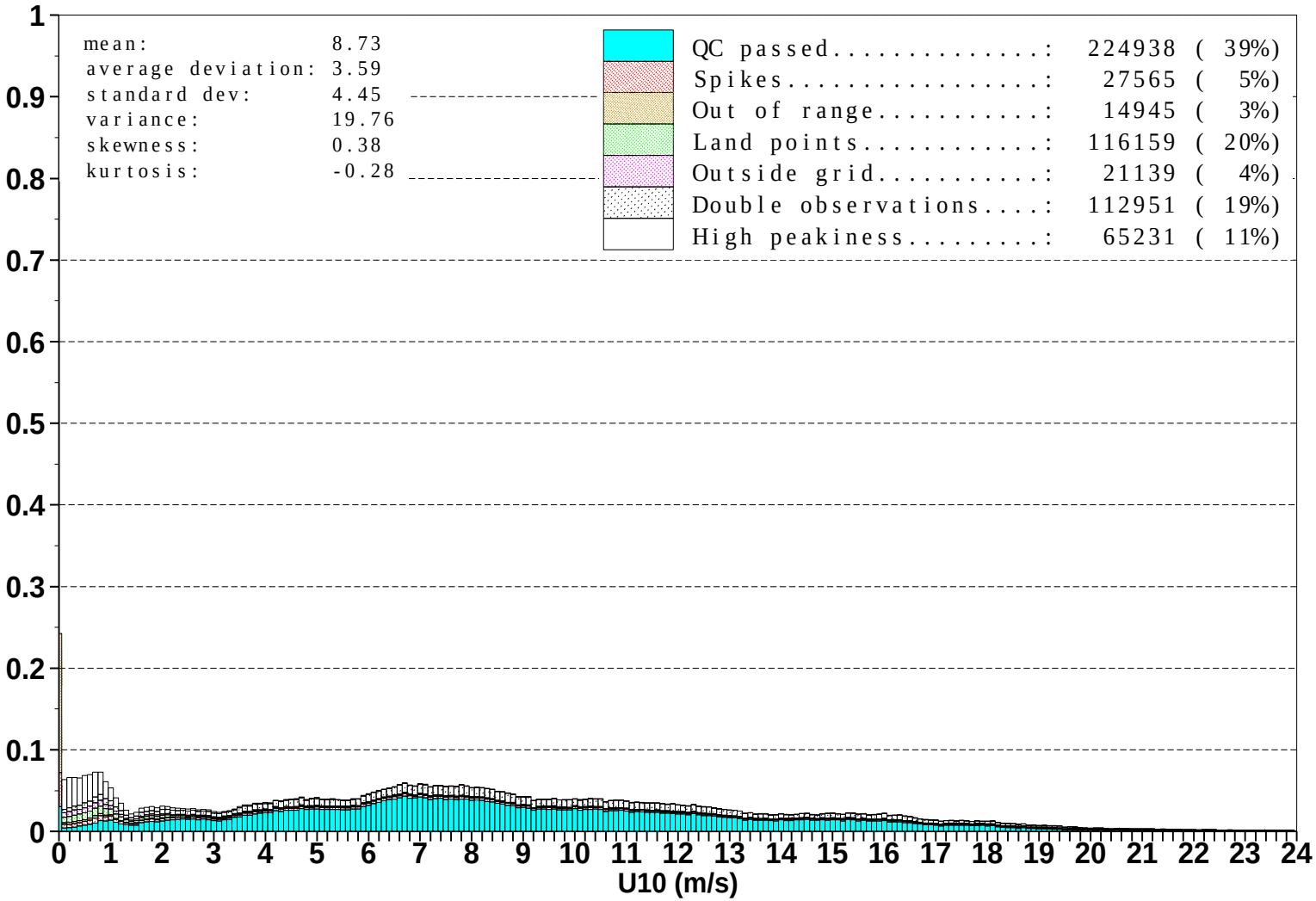


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2007

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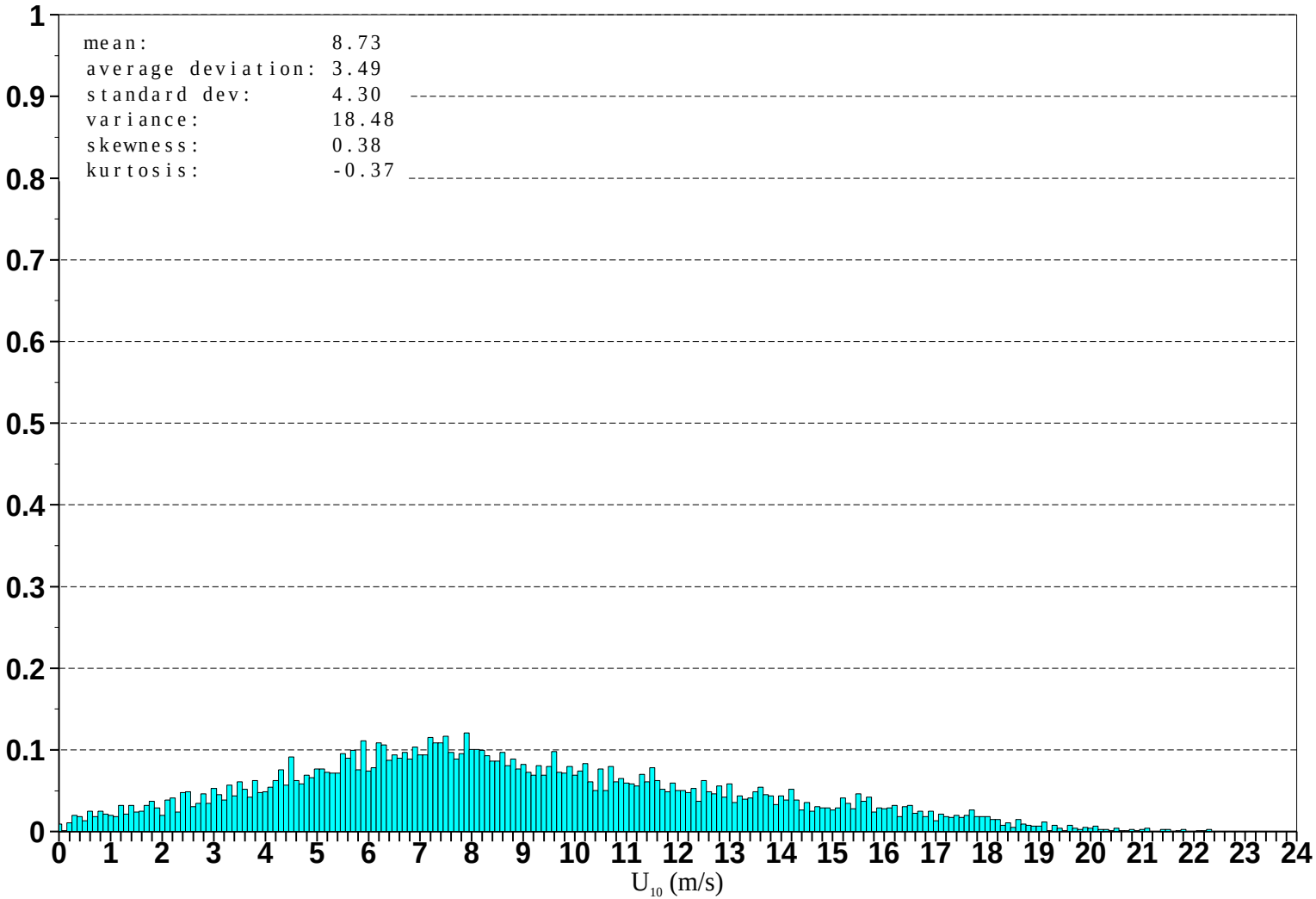


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for December 2007

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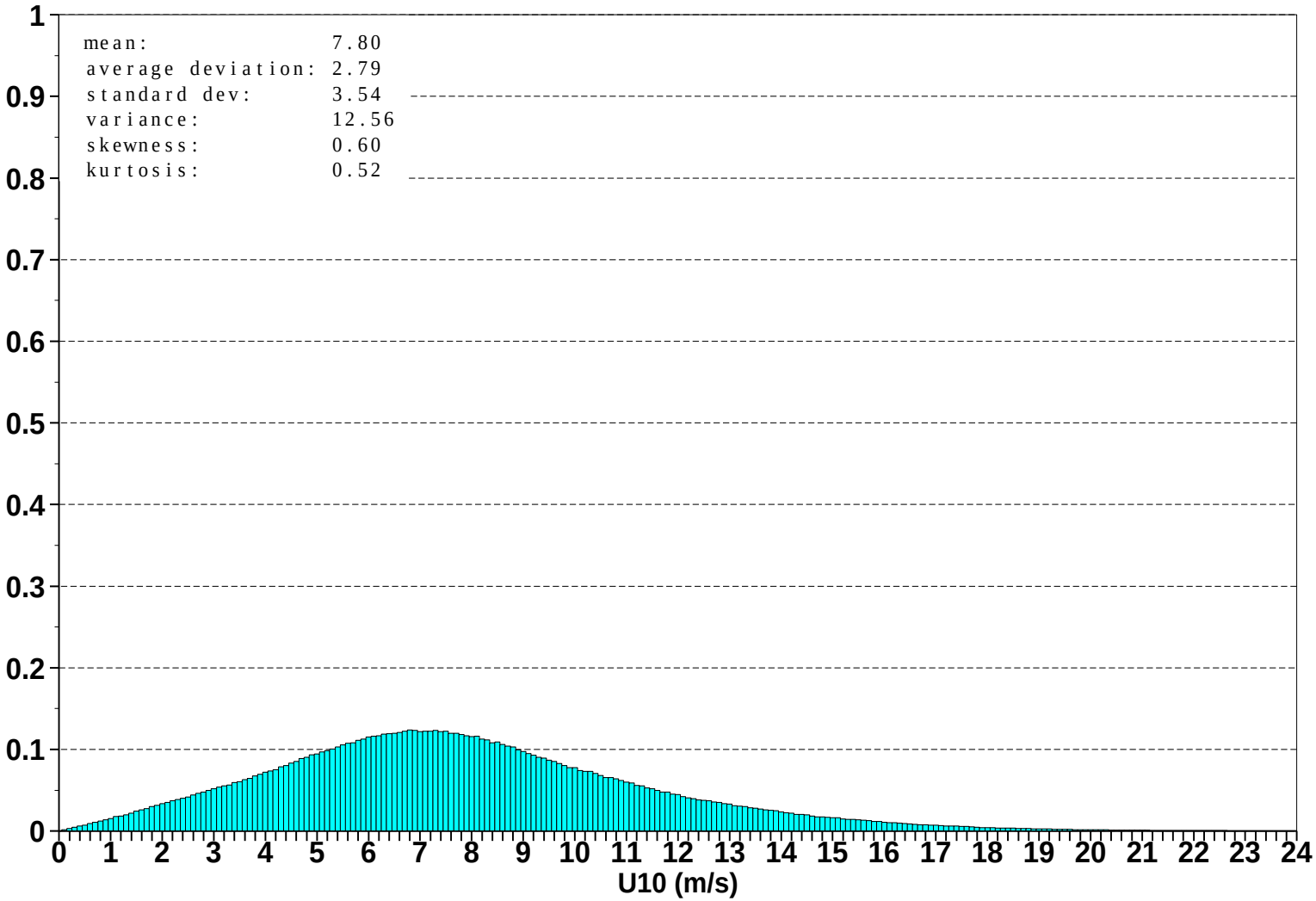
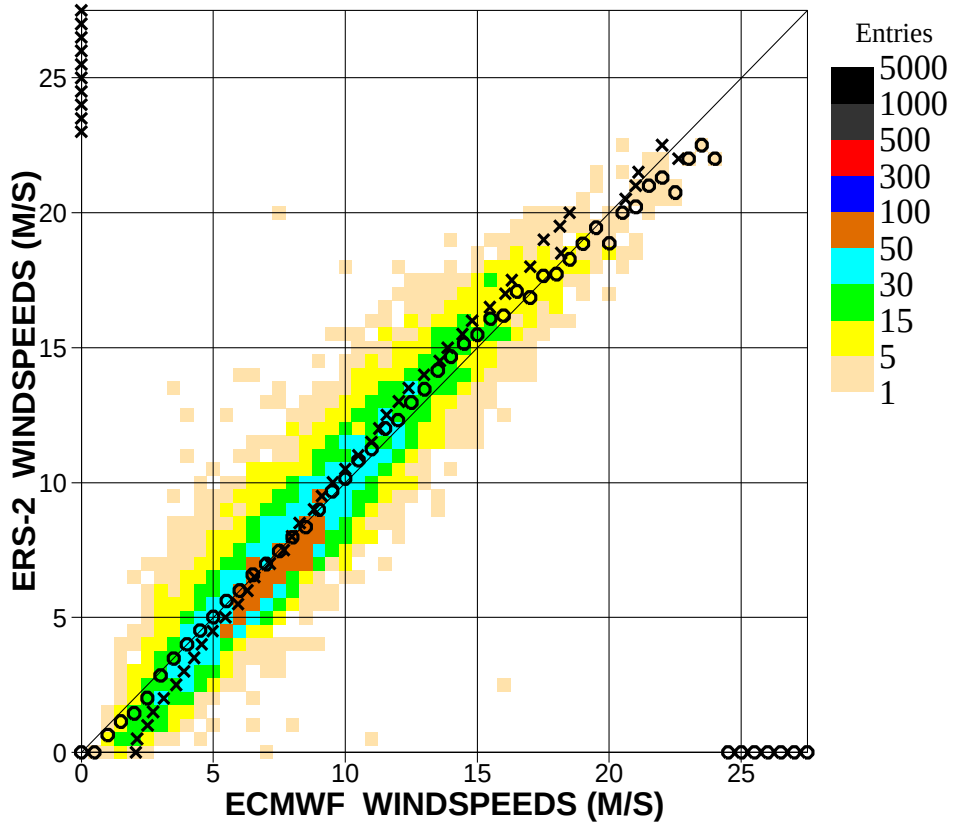


Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2007

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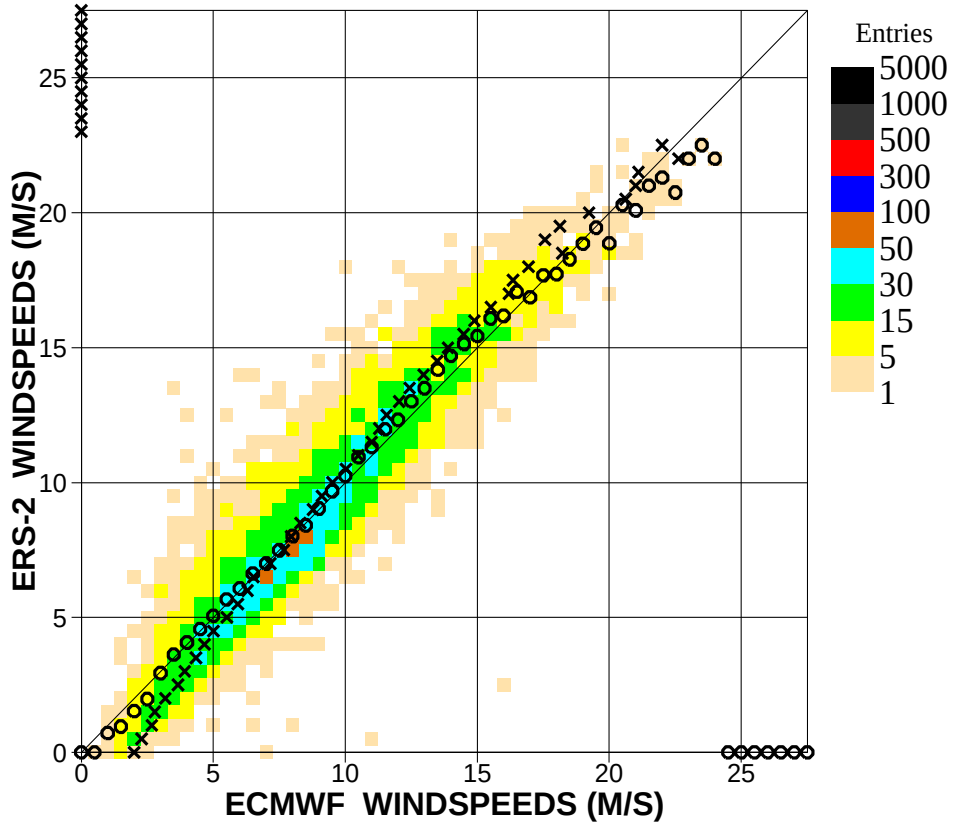
STATISTICS

ENTRIES	7549	
MEAN ECMWF	8.6271	
MEAN ERS-2	8.7310	
BIAS (ERS-2 - ECMWF)	0.1040	
STANDARD DEVIATION	1.4700	
SCATTER INDEX	0.1704	
CORRELATION	0.9405	
SYMMETRIC SLOPE	1.0288	(0.0044)
REGR. COEFFICIENT	1.0420	(0.0043)
REGR. CONSTANT	-0.2584	(0.0410)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2007 (global)

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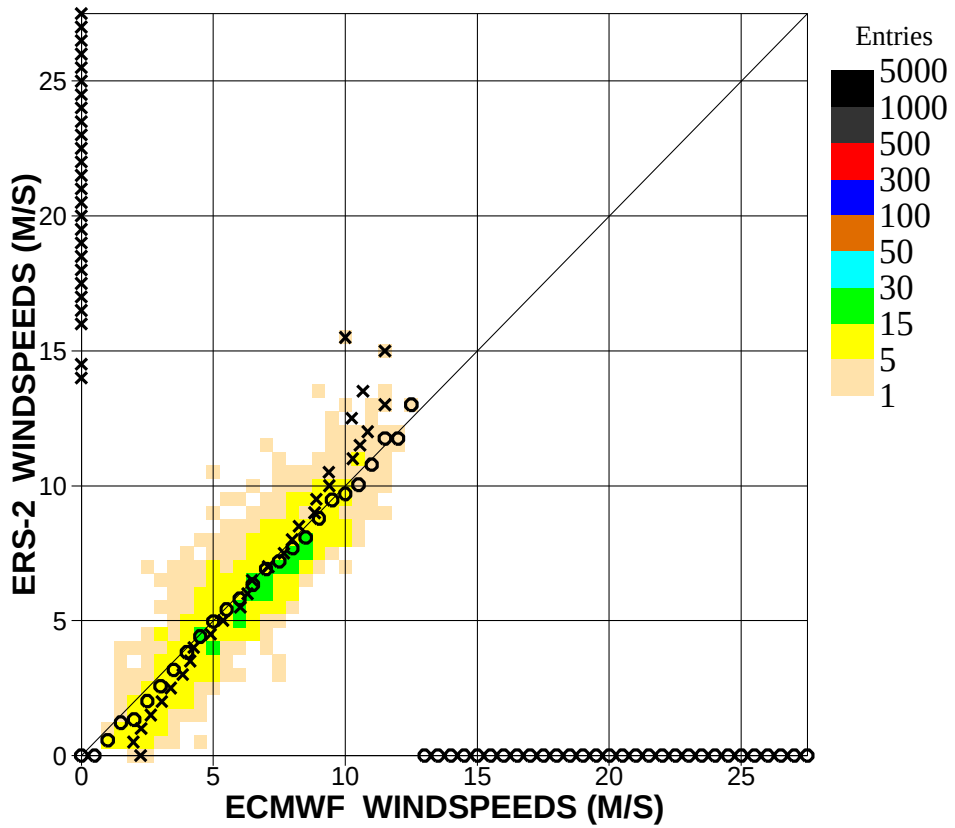


STATISTICS

ENTRIES	5830	
MEAN ECMWF	9.0982	
MEAN ERS-2	9.2664	
BIAS (ERS-2 - ECMWF)	0.1682	
STANDARD DEVIATION	1.5006	
SCATTER INDEX	0.1649	
CORRELATION	0.9394	
SYMMETRIC SLOPE	1.0322	(0.0050)
REGR. COEFFICIENT	1.0352	(0.0049)
REGR. CONSTANT	-0.1522	(0.0491)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2007 (n.hem.)

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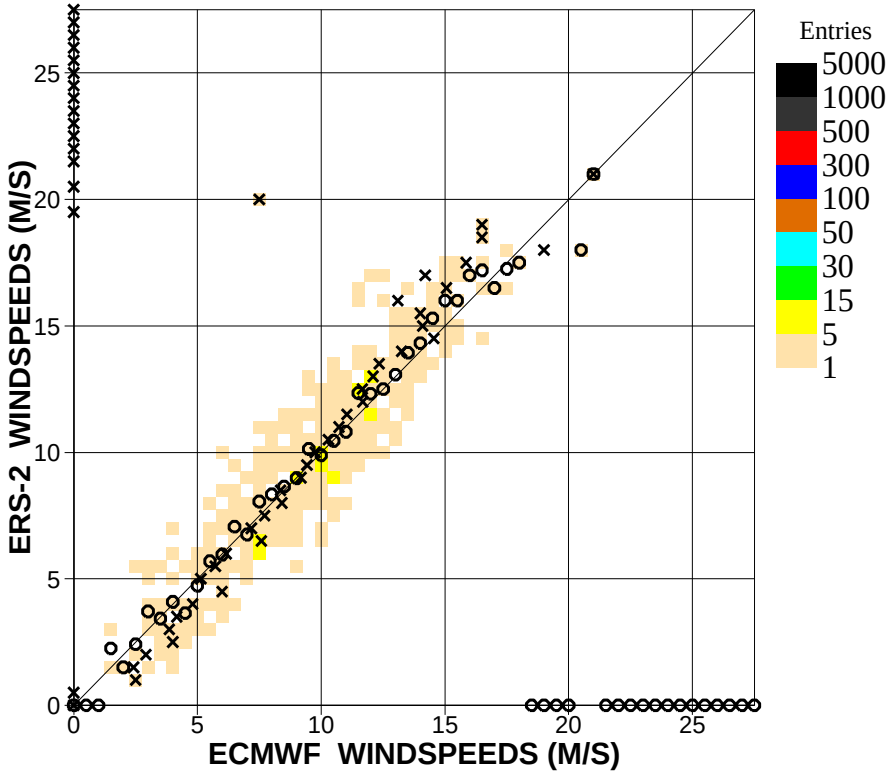
STATISTICS

ENTRIES	1317	
MEAN ECMWF	6.1928	
MEAN ERS-2	5.9645	
BIAS (ERS-2 - ECMWF)	-0.2283	
STANDARD DEVIATION	1.2223	
SCATTER INDEX	0.1974	
CORRELATION	0.8990	
SYMMETRIC SLOPE	0.9881	(0.0138)
REGR. COEFFICIENT	1.0193	(0.0137)
REGR. CONSTANT	-0.3477	(0.0912)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2007 (tropics)

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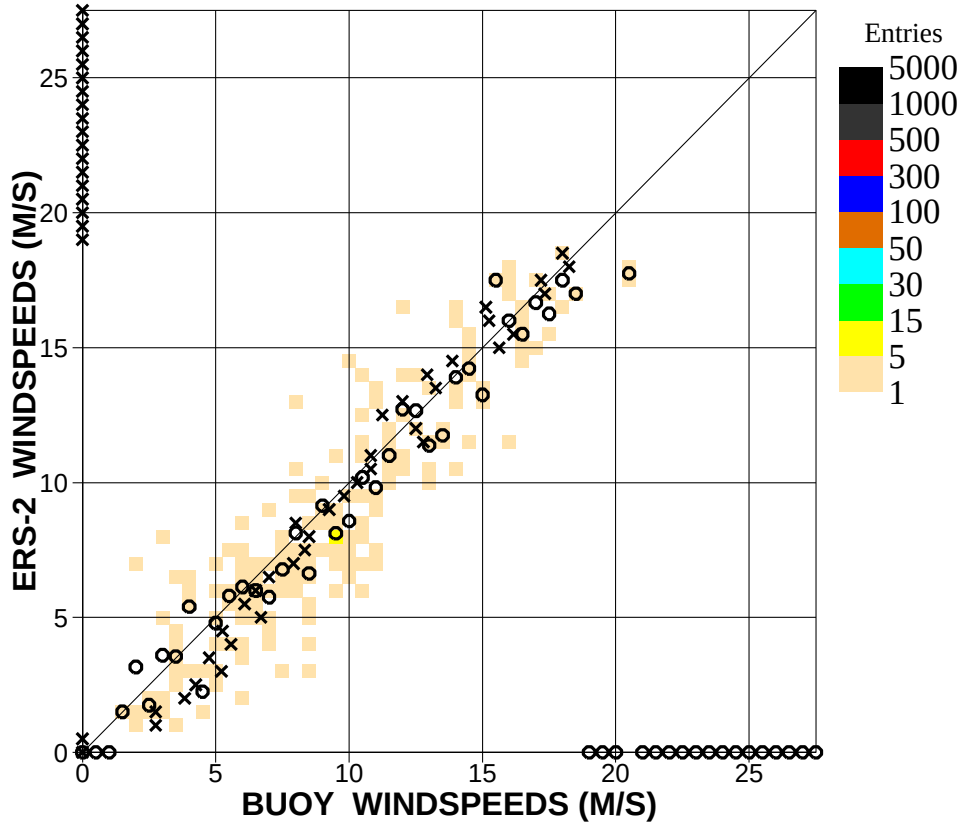


STATISTICS

ENTRIES	440	
MEAN ECMWF	9.5187	
MEAN ERS-2	9.7152	
BIAS (ERS-2 - ECMWF)	0.1965	
STANDARD DEVIATION	1.5749	
SCATTER INDEX	0.1655	
CORRELATION	0.9156	
SYMMETRIC SLOPE	1.0335	(0.0217)
REGR. COEFFICIENT	1.0303	(0.0216)
REGR. CONSTANT	-0.0920	(0.2191)

Figure 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2007 (s.hem.)

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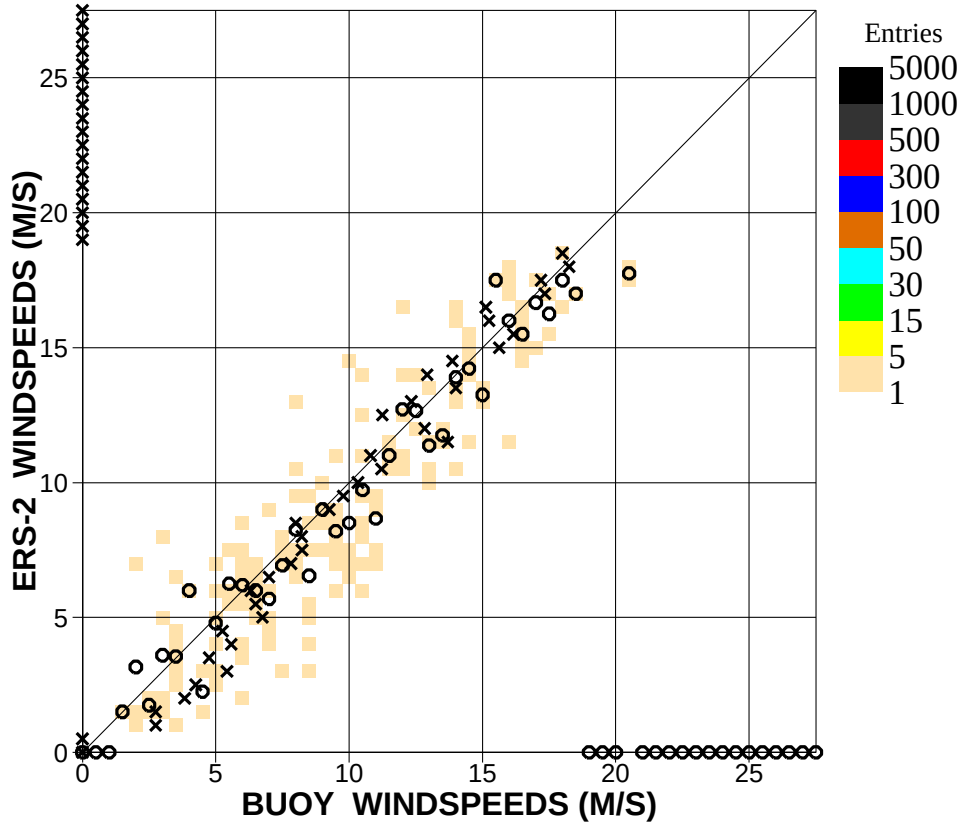


STATISTICS

ENTRIES	219	
MEAN BUOY	9.2367	
MEAN ERS-2	8.7361	
BIAS (ERS-2 - BUOY)	-0.5007	
STANDARD DEVIATION	1.8837	
SCATTER INDEX	0.2039	
CORRELATION	0.8947	
SYMMETRIC SLOPE	0.9616	(0.0318)
REGR. COEFFICIENT	0.9325	(0.0316)
REGR. CONSTANT	0.1232	(0.3181)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2007 (global)

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STATISTICS

ENTRIES	187	
MEAN BUOY	9.3364	
MEAN ERS-2	8.8144	
BIAS (ERS-2 - BUOY)	-0.5219	
STANDARD DEVIATION	1.9451	
SCATTER INDEX	0.2083	
CORRELATION	0.8985	
SYMMETRIC SLOPE	0.9602	(0.0336)
REGR. COEFFICIENT	0.9301	(0.0334)
REGR. CONSTANT	0.1304	(0.3424)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2007 (n.hem.)

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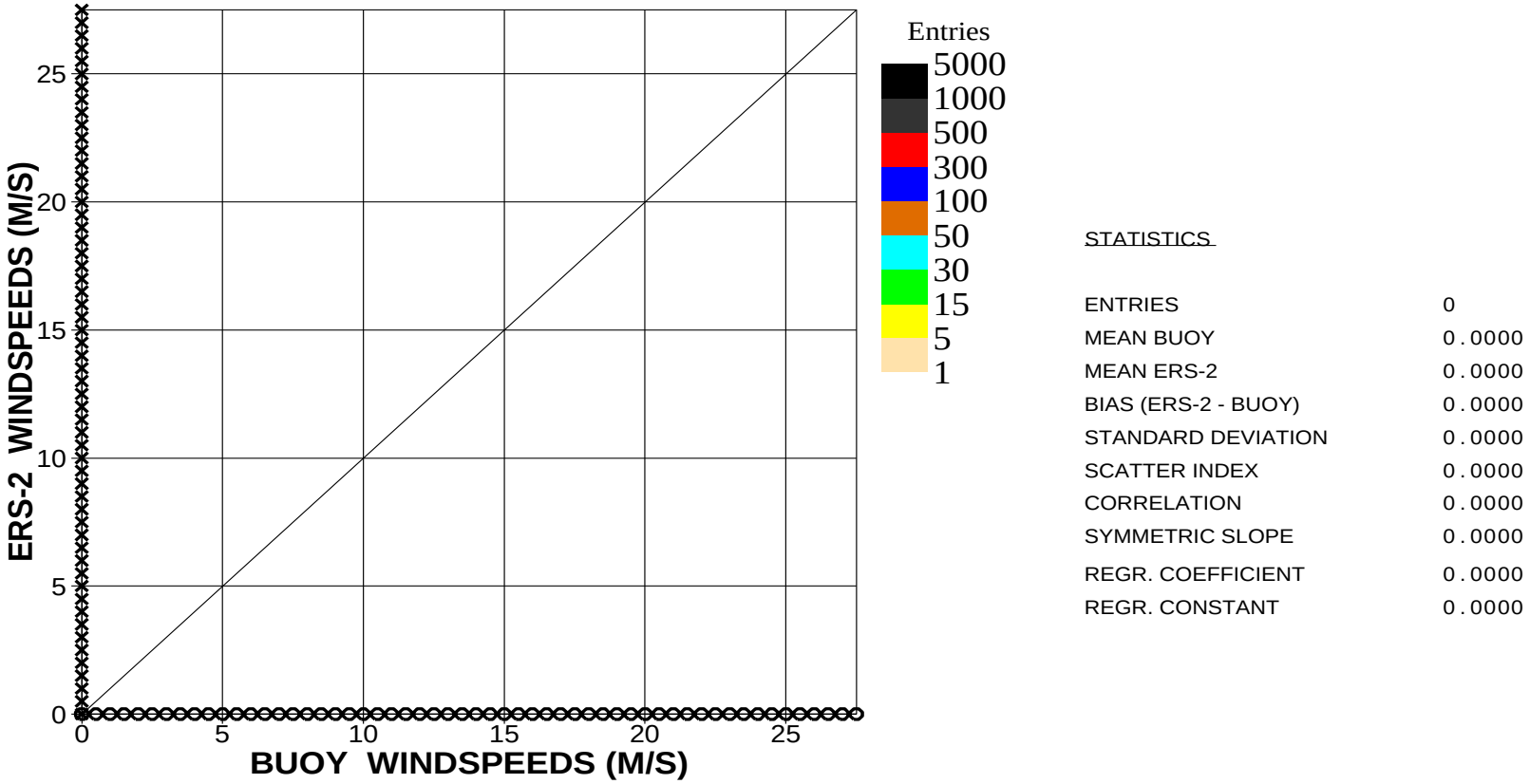


Figure 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2007 (hawaii)

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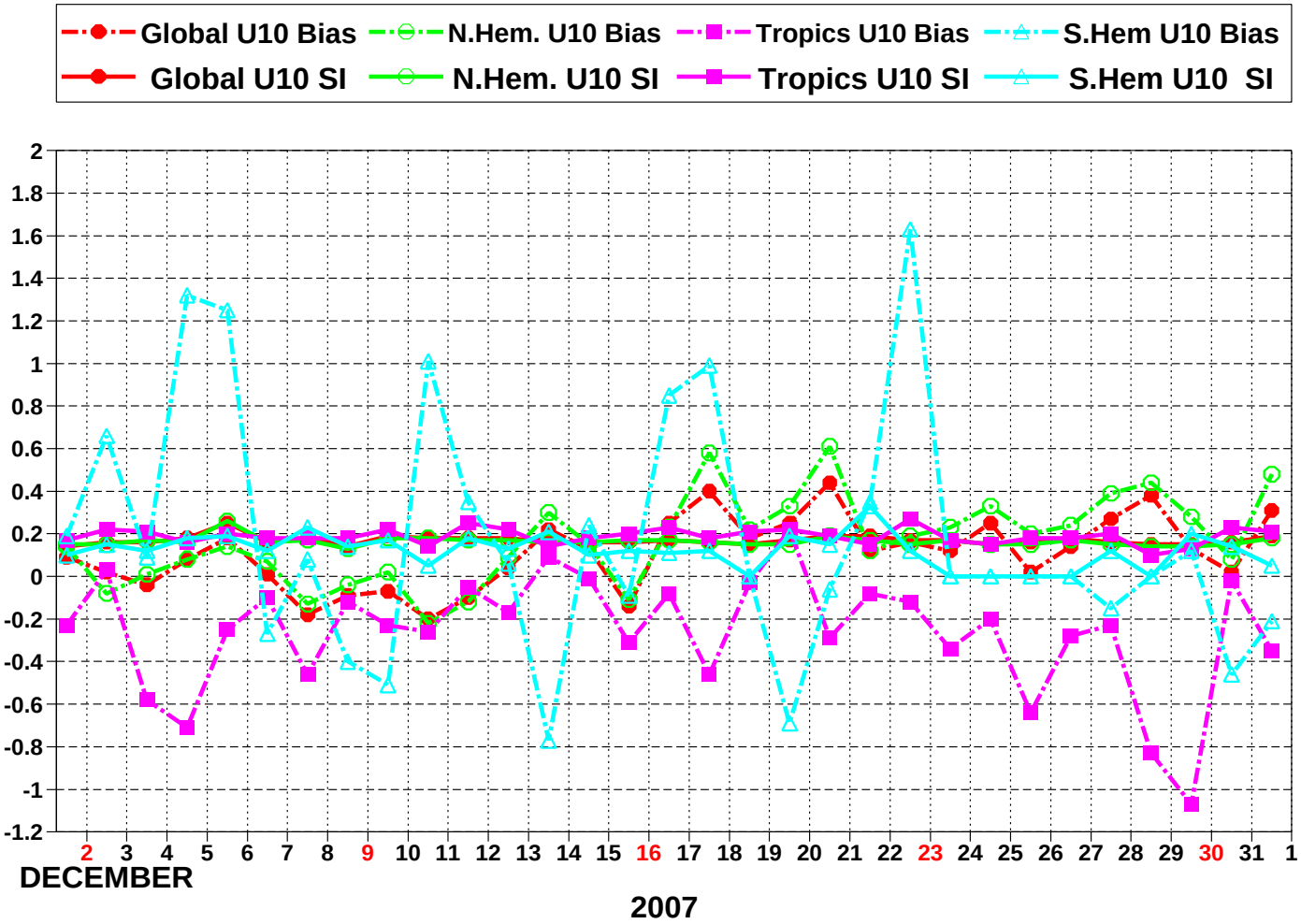


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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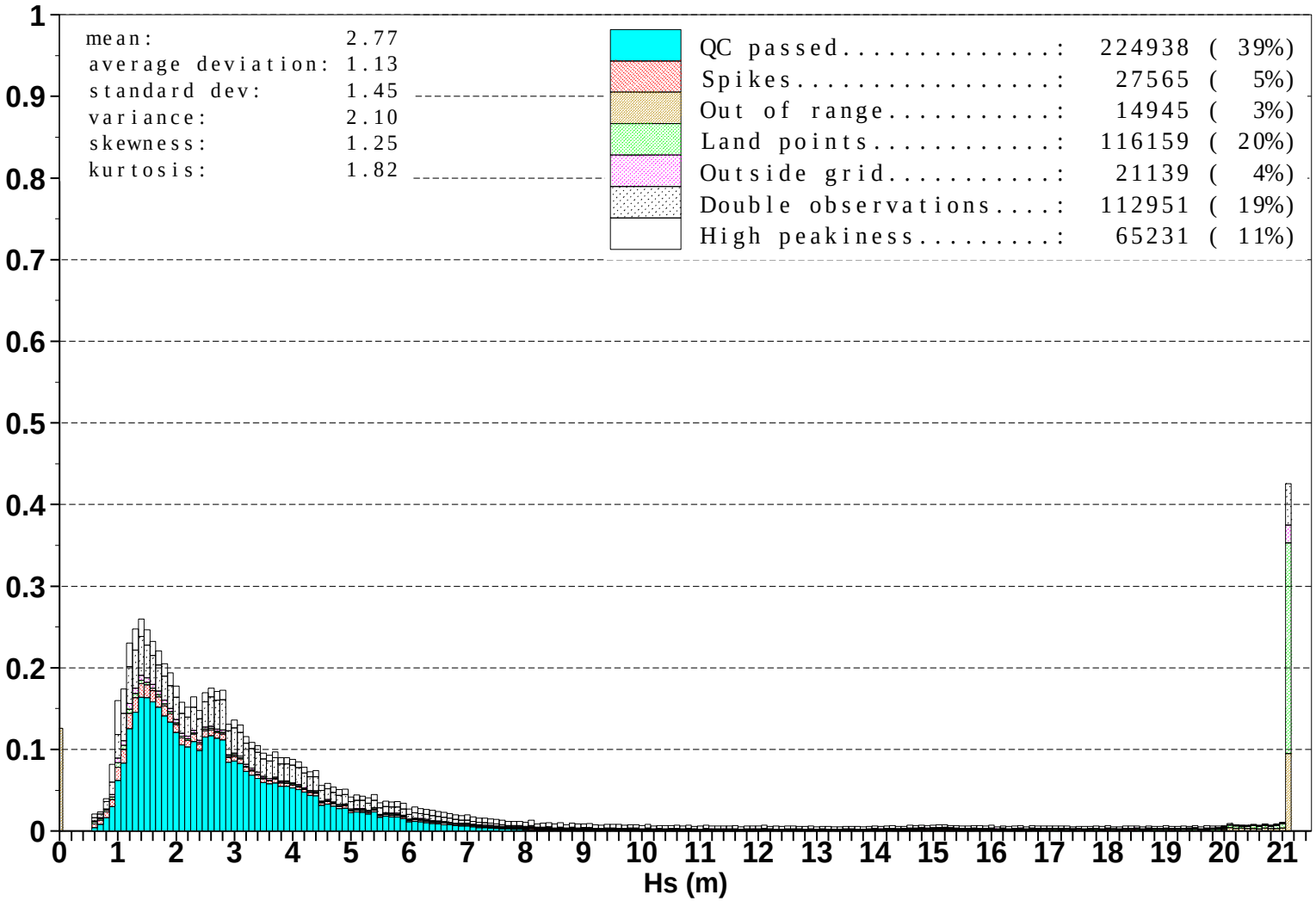


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for December 2007

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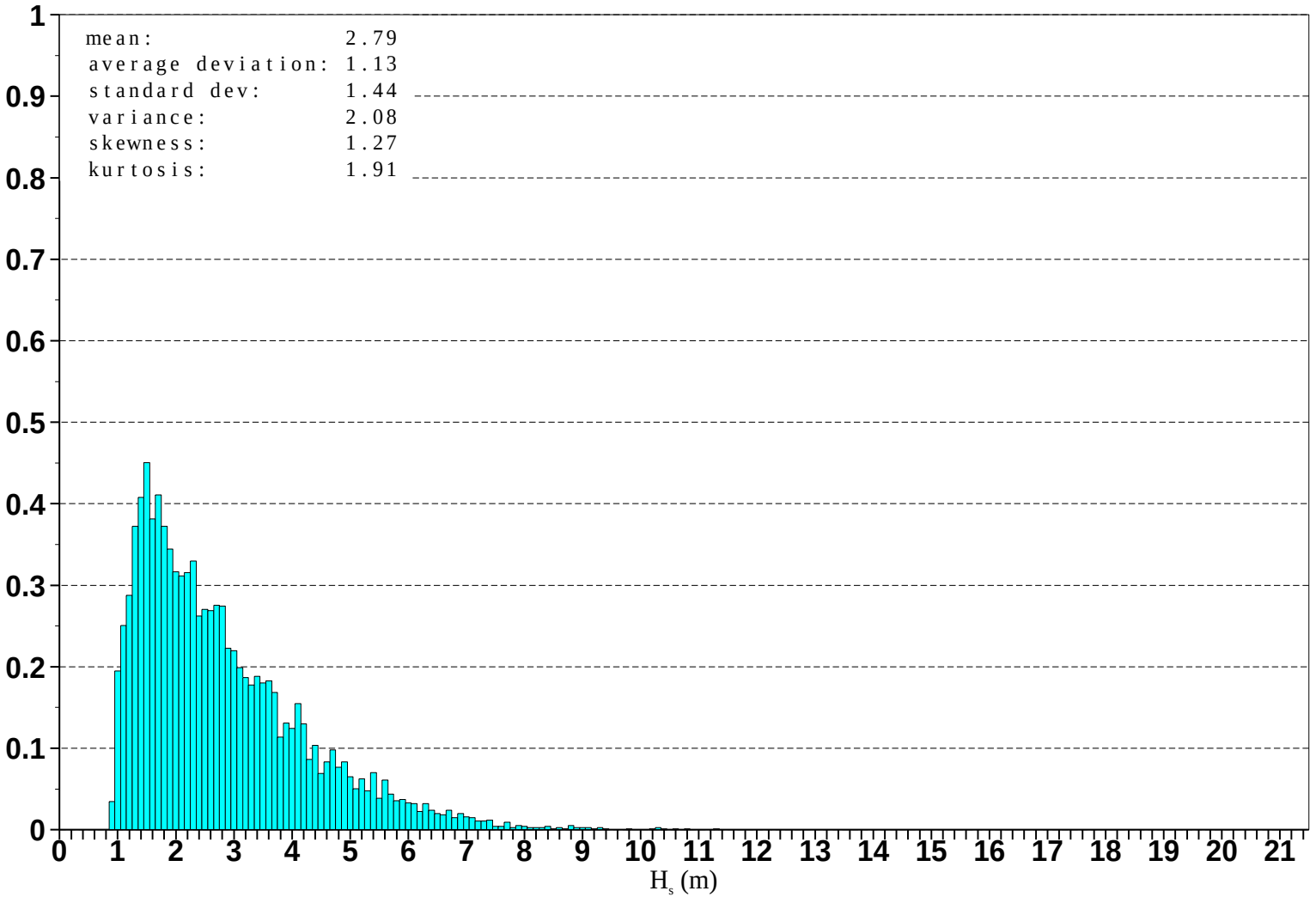


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for December 2007

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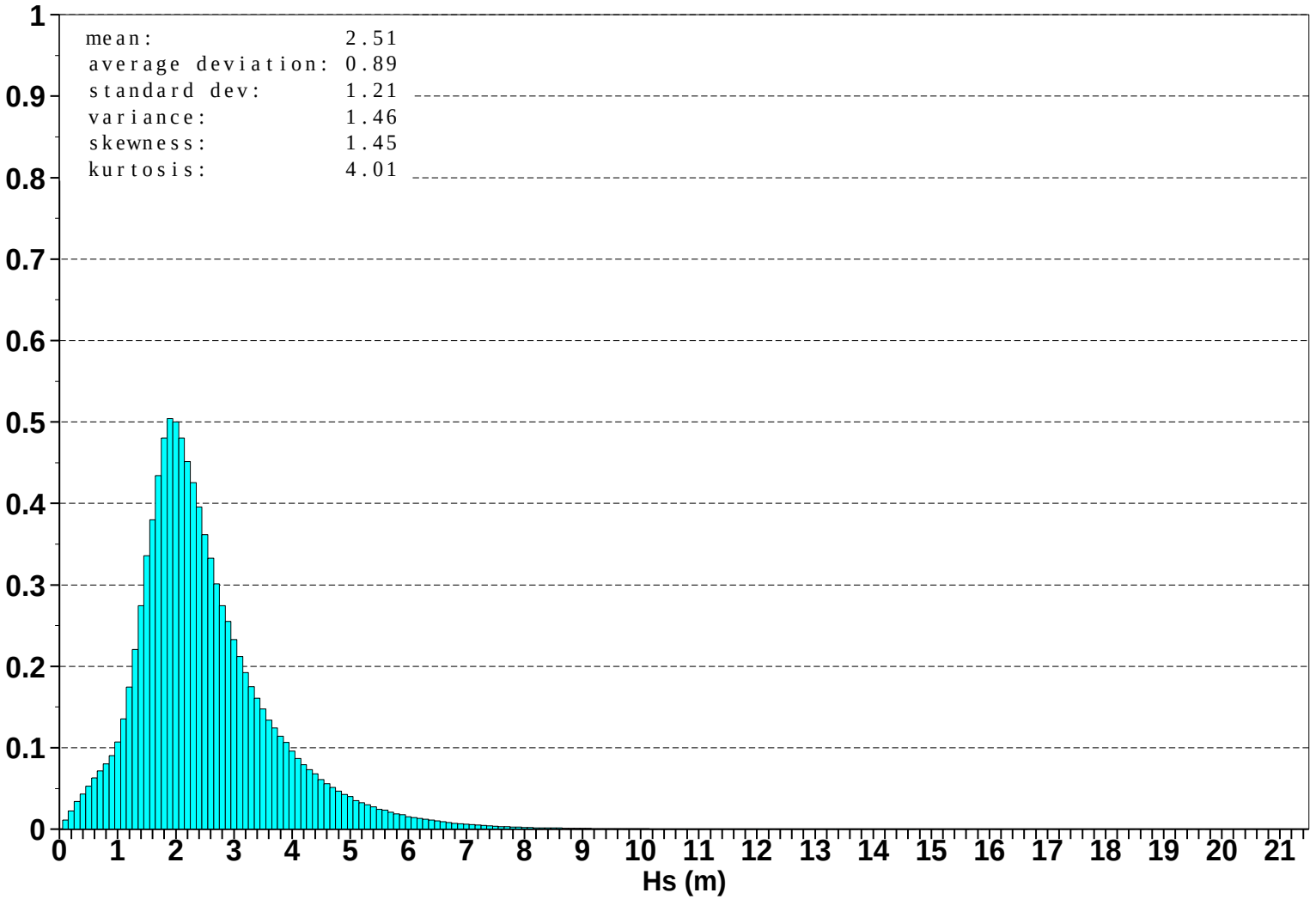
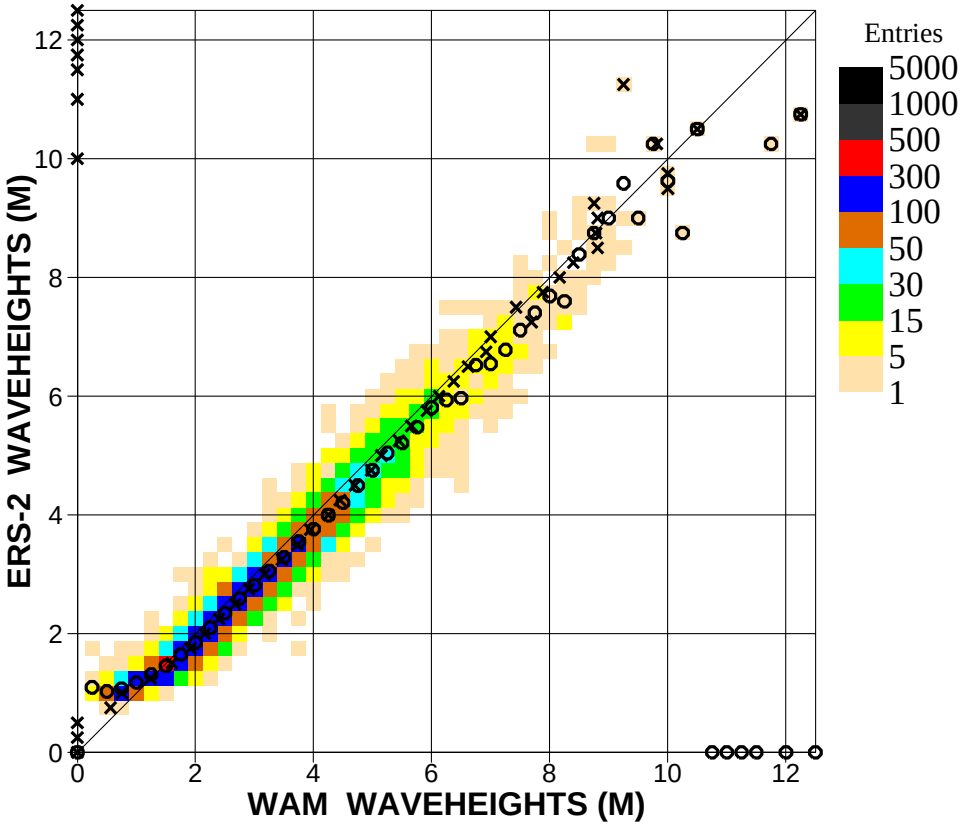


Figure 16: Global distribution of ECMWF wave heights for December 2007

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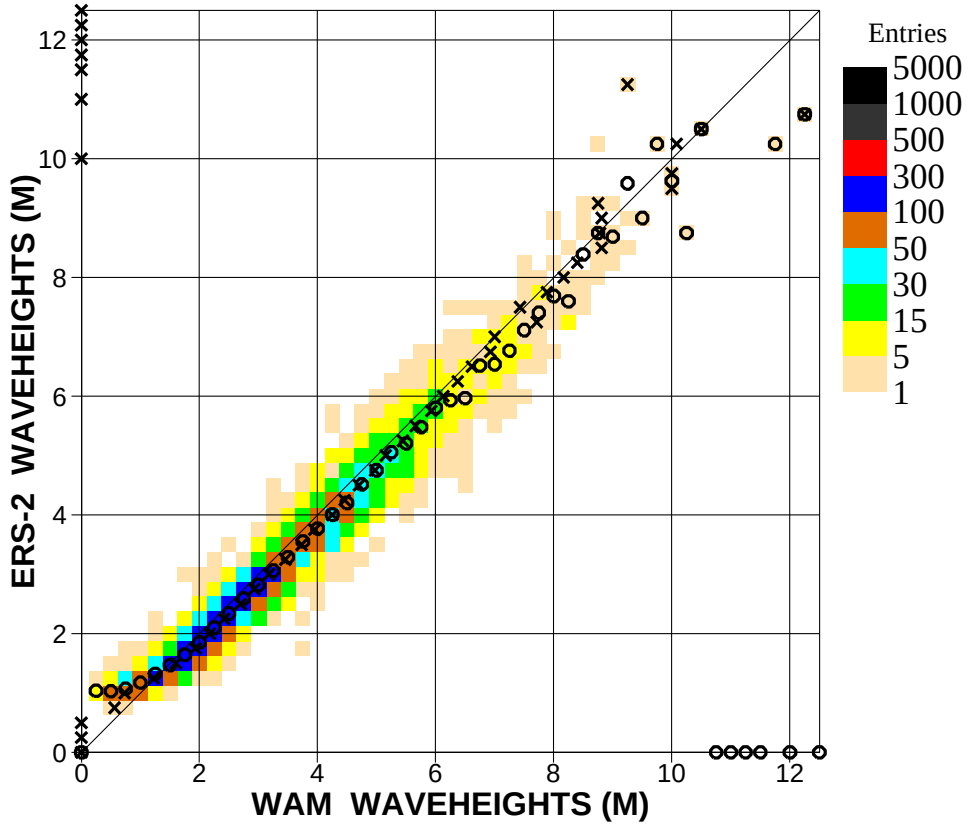


STATISTICS

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MEAN ERS-2	2.7867	
BIAS (ERS-2 - WAM)	-0.1340	
STANDARD DEVIATION	0.3202	
SCATTER INDEX	0.1096	
CORRELATION	0.9784	
SYMMETRIC SLOPE	0.9520	(0.0023)
REGR. COEFFICIENT	0.9240	(0.0022)
REGR. CONSTANT	0.0879	(0.0074)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2007 (global)

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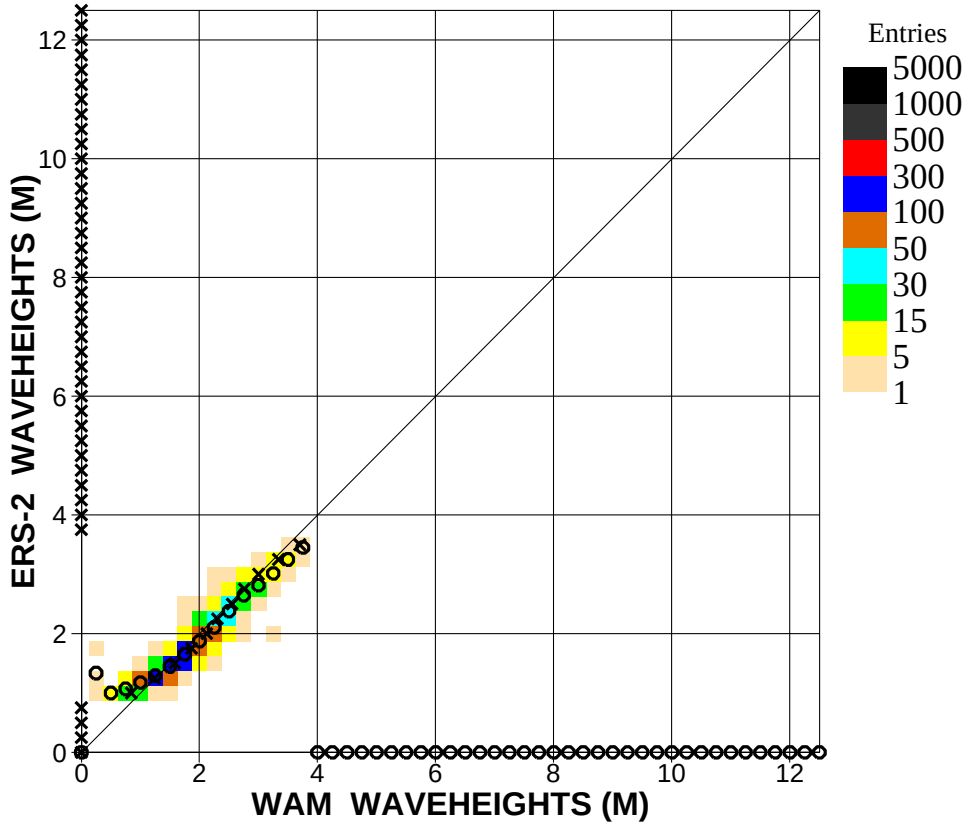


STATISTICS

ENTRIES	5830	
MEAN WAM	3.1479	
MEAN ERS-2	3.0019	
BIAS (ERS-2 - WAM)	-0.1460	
STANDARD DEVIATION	0.3414	
SCATTER INDEX	0.1085	
CORRELATION	0.9773	
SYMMETRIC SLOPE	0.9520	(0.0026)
REGR. COEFFICIENT	0.9239	(0.0026)
REGR. CONSTANT	0.0934	(0.0093)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2007 (n.hem.)

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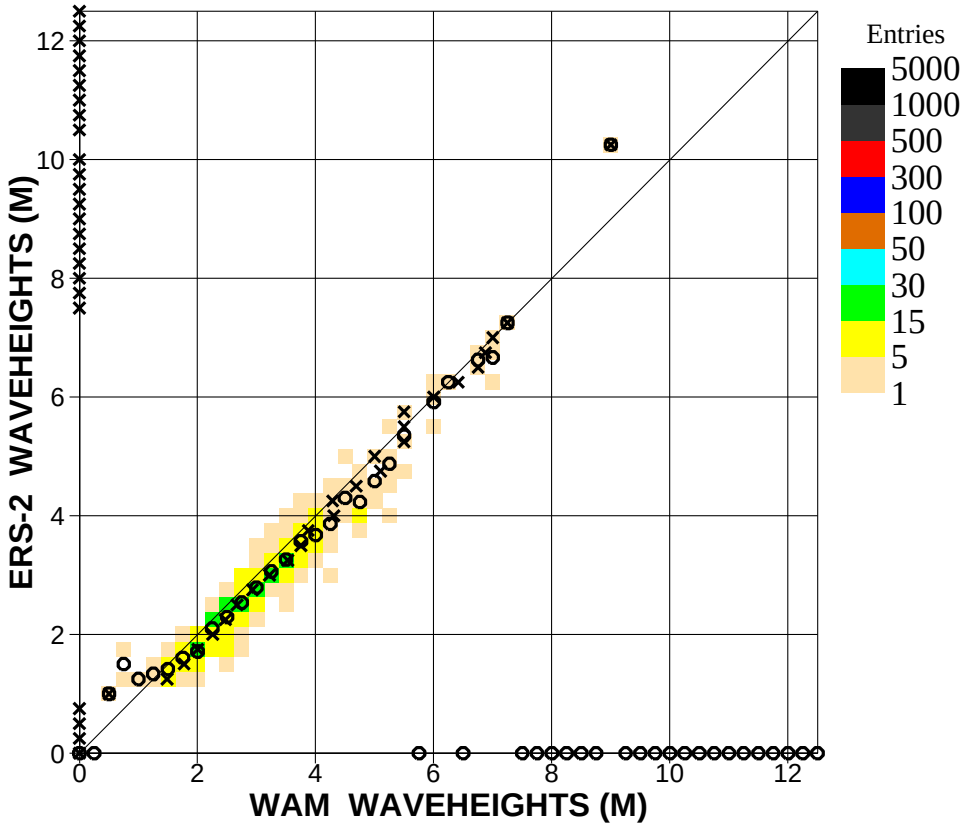


STATISTICS

ENTRIES	1317	
MEAN WAM	1.8284	
MEAN ERS-2	1.7731	
BIAS (ERS-2 - WAM)	-0.0553	
STANDARD DEVIATION	0.1896	
SCATTER INDEX	0.1037	
CORRELATION	0.9434	
SYMMETRIC SLOPE	0.9628	(0.0088)
REGR. COEFFICIENT	0.8362	(0.0081)
REGR. CONSTANT	0.2442	(0.0155)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2007 (tropics)

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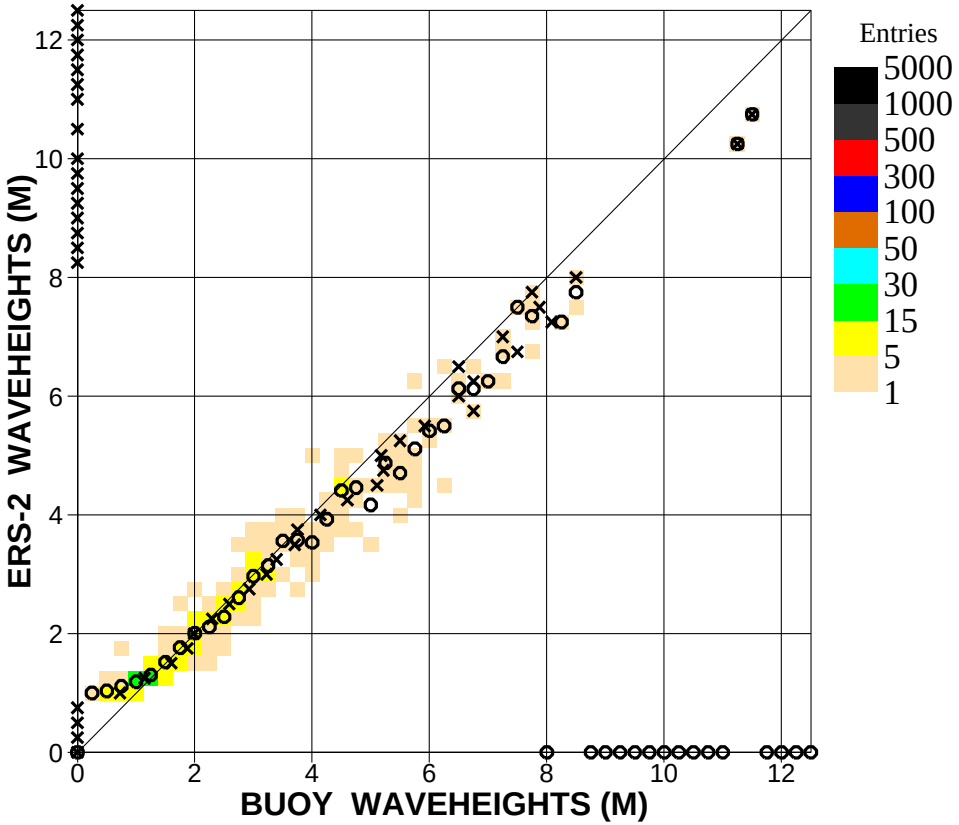


STATISTICS

ENTRIES	440	
MEAN WAM	3.0966	
MEAN ERS-2	2.8909	
BIAS (ERS-2 - WAM)	-0.2057	
STANDARD DEVIATION	0.2928	
SCATTER INDEX	0.0946	
CORRELATION	0.9663	
SYMMETRIC SLOPE	0.9423	(0.0125)
REGR. COEFFICIENT	0.9728	(0.0124)
REGR. CONSTANT	-0.1216	(0.0408)

Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2007 (s.hem.)

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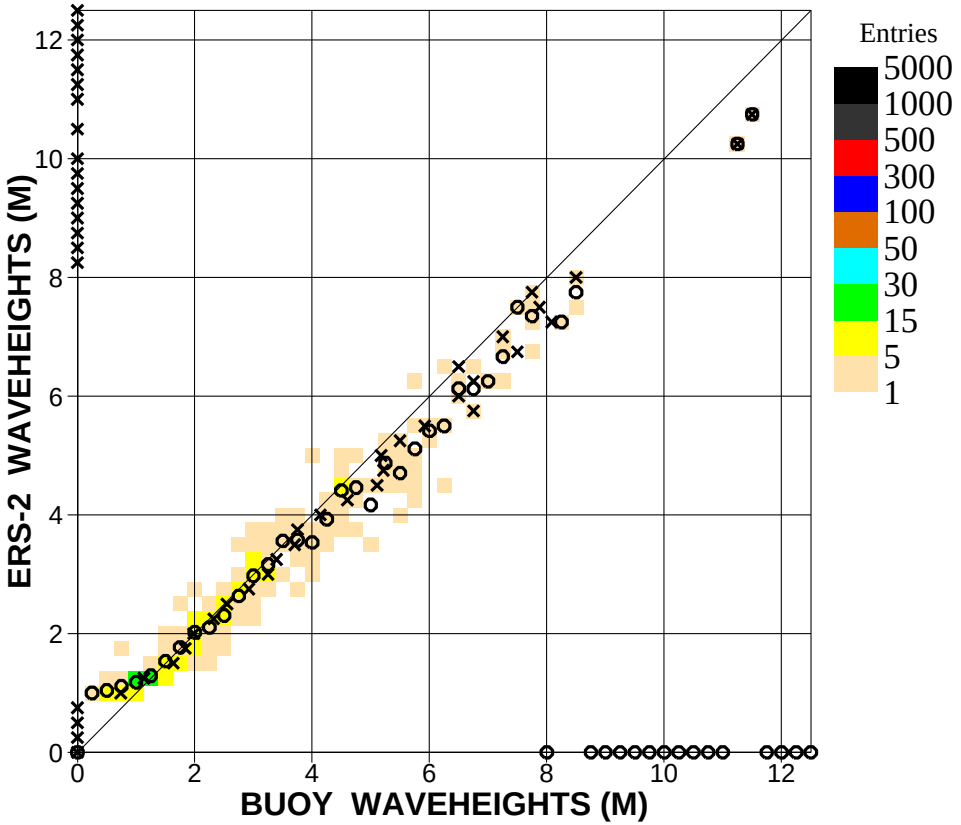


STATISTICS

ENTRIES	345	
MEAN BUOY	3.0495	
MEAN ERS-2	2.9167	
BIAS (ERS-2 - BUOY)	-0.1328	
STANDARD DEVIATION	0.4235	
SCATTER INDEX	0.1389	
CORRELATION	0.9802	
SYMMETRIC SLOPE	0.9367	(0.0103)
REGR. COEFFICIENT	0.8675	(0.0095)
REGR. CONSTANT	0.2711	(0.0342)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2007 (global)

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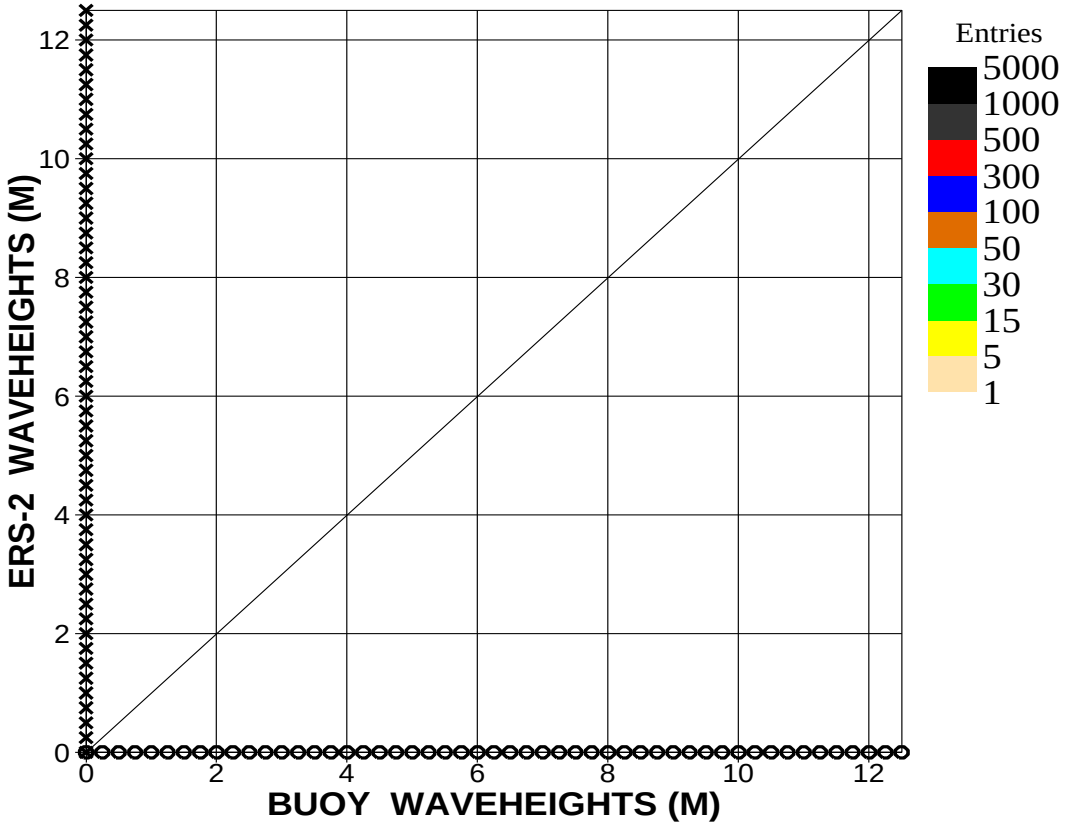


STATISTICS

ENTRIES	308	
MEAN BUOY	3.1744	
MEAN ERS-2	3.0328	
BIAS (ERS-2 - BUOY)	-0.1416	
STANDARD DEVIATION	0.4421	
SCATTER INDEX	0.1393	
CORRELATION	0.9798	
SYMMETRIC SLOPE	0.9357	(0.0110)
REGR. COEFFICIENT	0.8655	(0.0101)
REGR. CONSTANT	0.2853	(0.0379)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2007 (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 2007 (hawaii)

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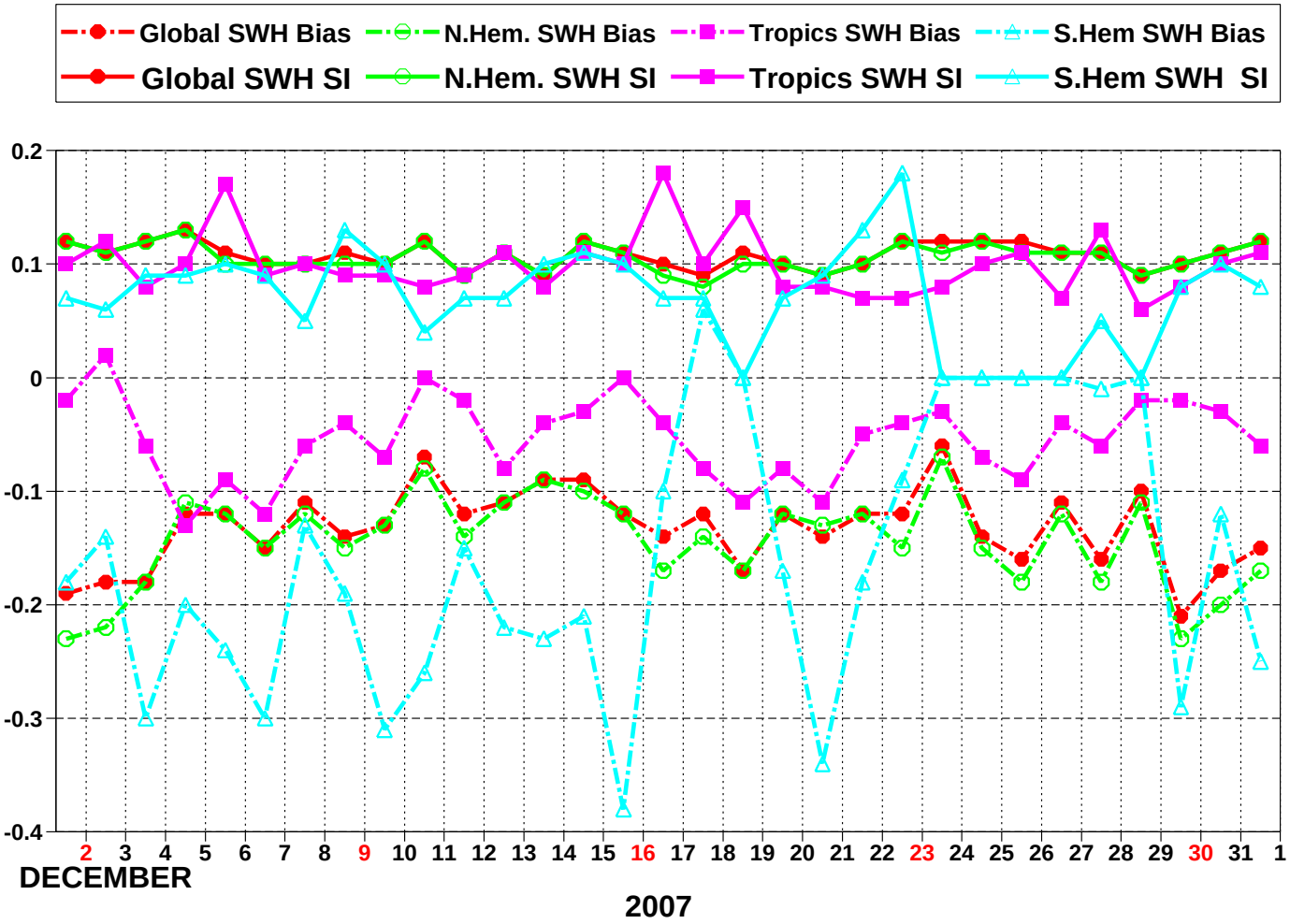


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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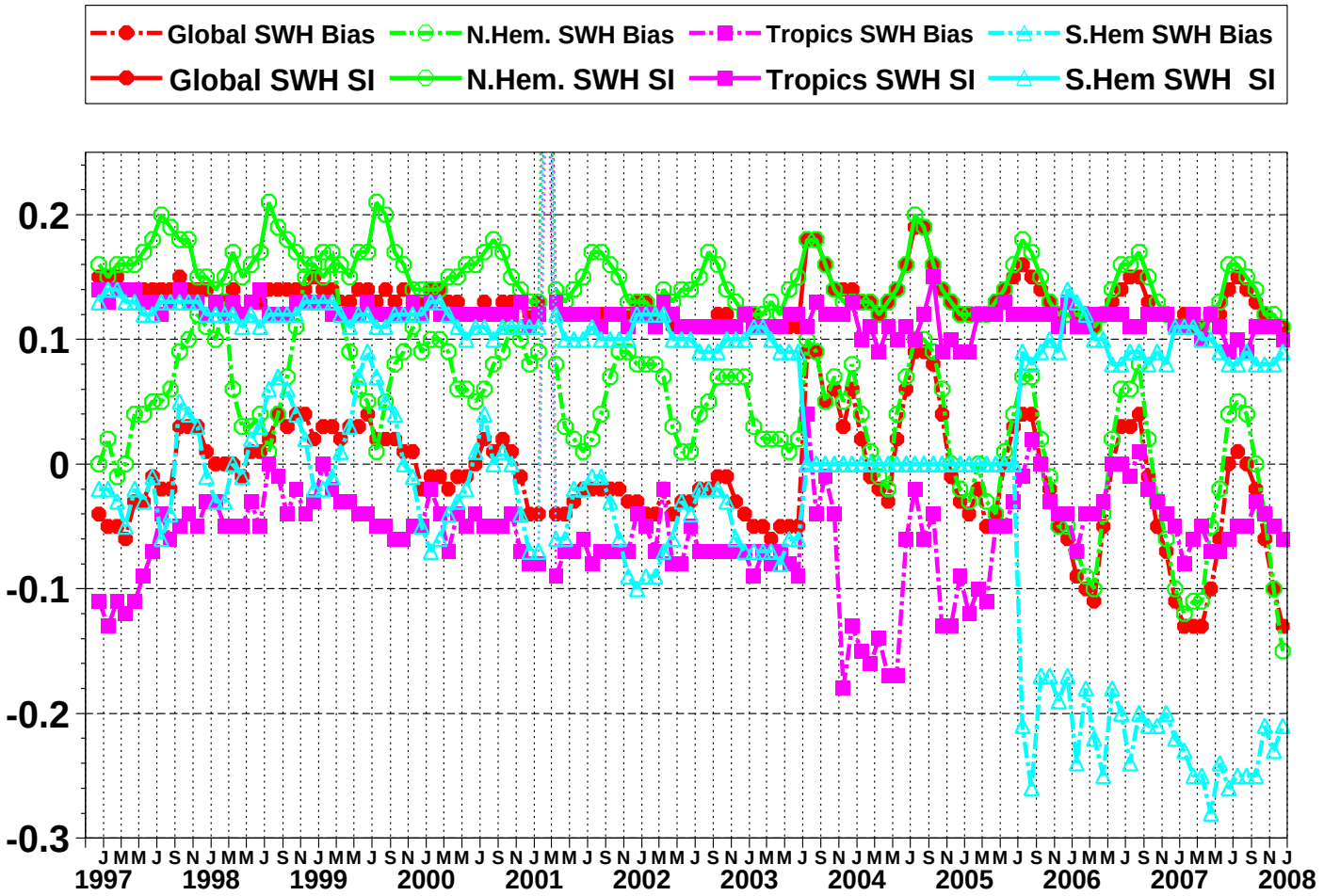


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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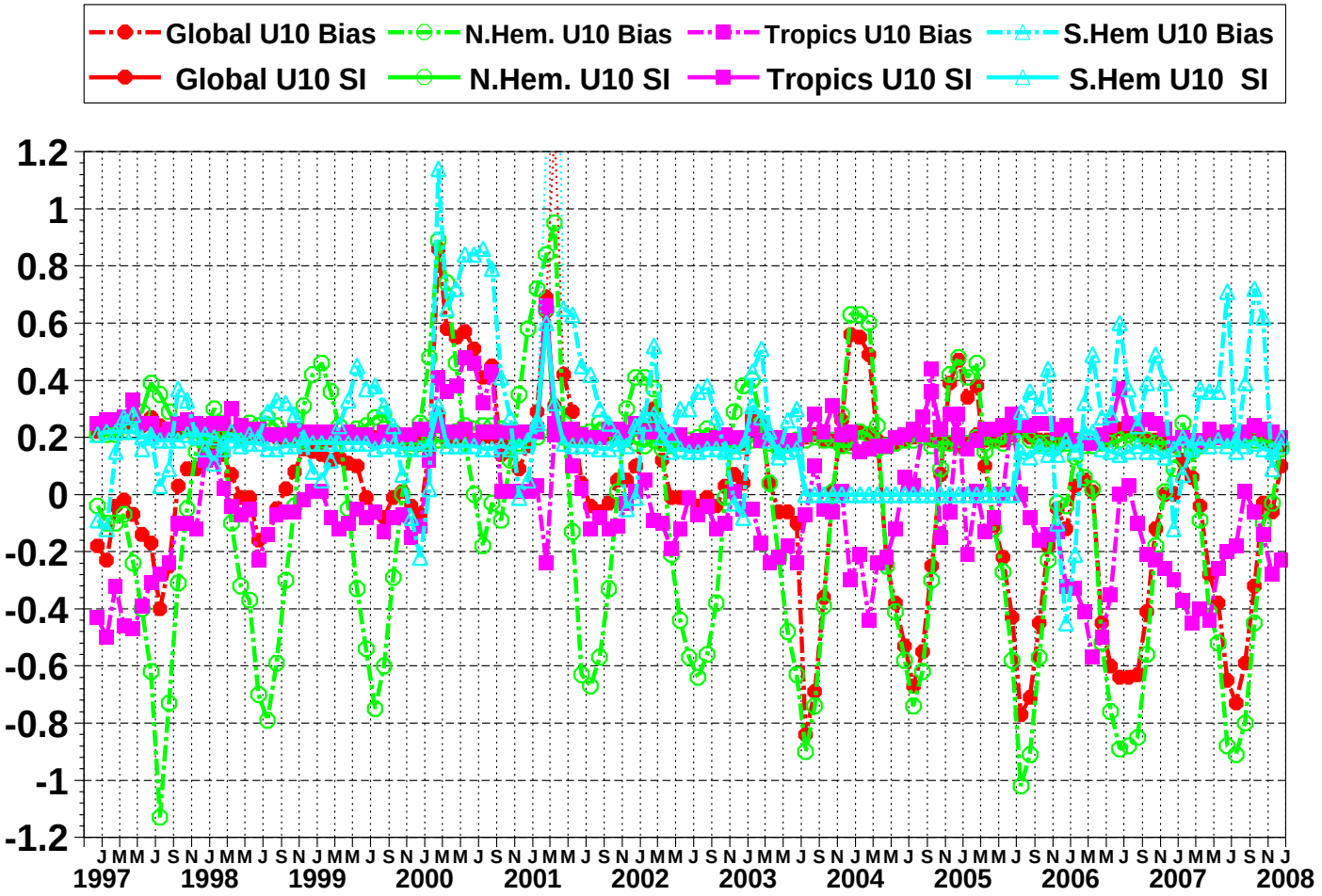


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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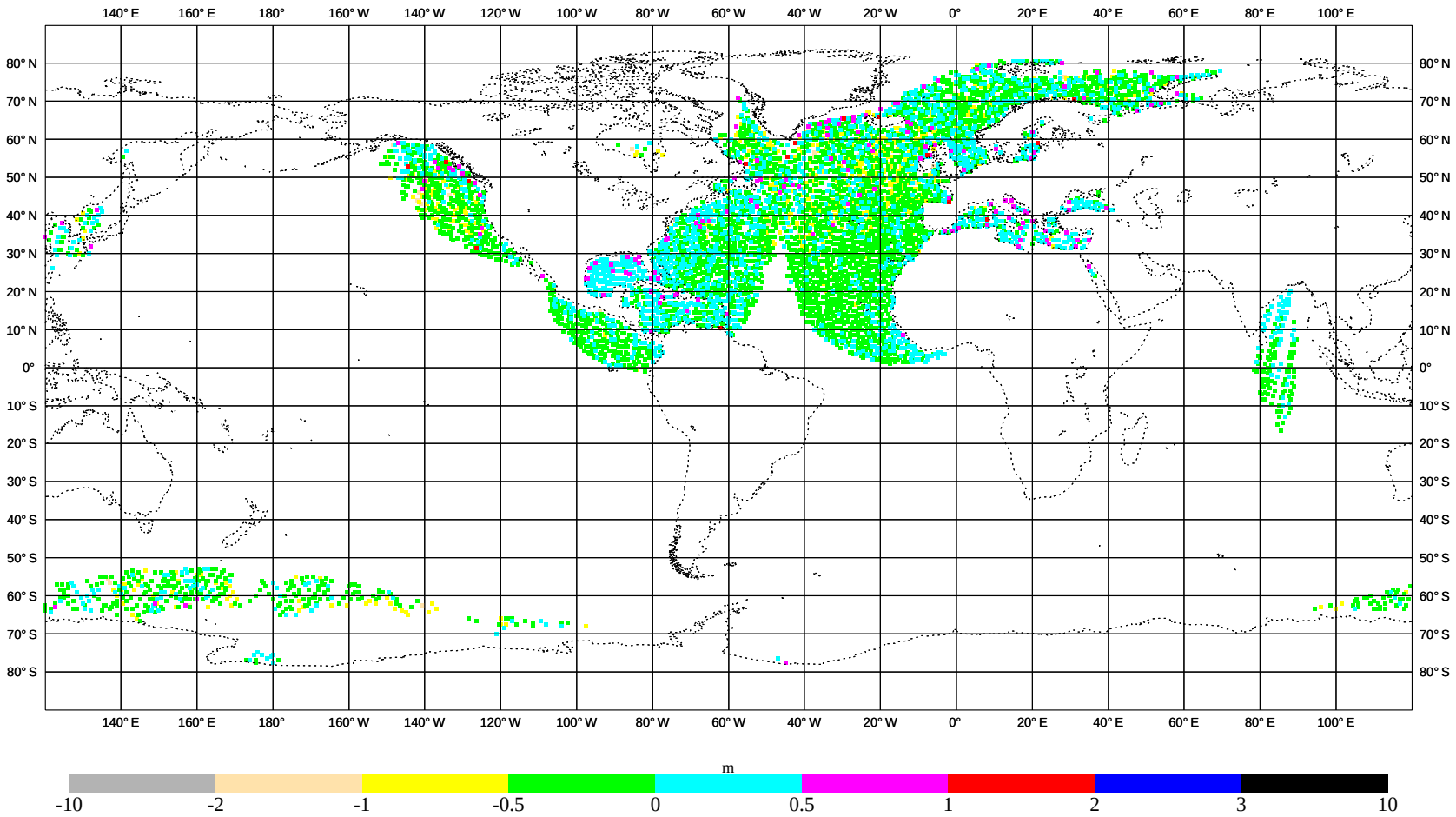


Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for December 2007.

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