ECMWF Report on ERS-2 RA for June 2007

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

By: *Saleh Abdalla*

Date: *13 July 2007*

Overview:

Based on the data received at ECMWF during the whole month, on average, 4815 observations arrived at ECMWF every 6 hours of which 63.94% passed the quality control. As can be seen in Figure 1, there was no data gaps during the whole month. **However, there was some general reduction of data than usual**. 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 $<\sigma_0>$ = 11.71 dB (with a main peak at 11.1 dB and a secondary peak at 11.6 dB).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: - 0.652 m/s

ERS-2 northern hemisphere: - 0.884 m/s

ERS-2 tropics: - 0.199 m/s

ERS-2 southern hemisphere: + 0.710 m/s

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Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: - 1.090 m/s

ERS-2 northern hemisphere: - 1.103 m/s

ERS-2 tropics (Hawaii): *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: - 0.002 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: -0.039 m

ERS-2 tropics: - 0.064 m

ERS-2 southern hemisphere: - 0.262 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: + 0.042 m

ERS-2 northern hemisphere: + 0.041 m

ERS-2 tropics (Hawaii): *missing*

Remarks:

- There was some overall reduction of altimeter data received at ECMWF in near-real time.
- The quality of Altimeter data, both wind speed and significant wave height, is nominal.

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- 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.
- 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.
- ECMWF atmospheric model was changed on 05 and 12 June 2007. The major related change is the assimilation of METOP ASCAT wind product. Assimilation of ENVISAT ASAR Wave Mode wave heights has been resumed. The current operational IFS cycle is CY32R2 (since 5 June 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

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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.

Figure captions:

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

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

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

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

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

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

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

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

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

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

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

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Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for June 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 June 2007.
Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for June 2007.
Figure 16: Global distribution of ECMWF wave heights for June 2007.
Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2007 (global).
Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2007 (northern hemisphere)
Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2007 (tropics)
Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2007 (southern hemisphere)
Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2007 (global).
Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2007 (northern hemisphere).
Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2007 (hawaii).
Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for June 2007.
Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to June 2007.
Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to June 2007.
Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for June 2007.

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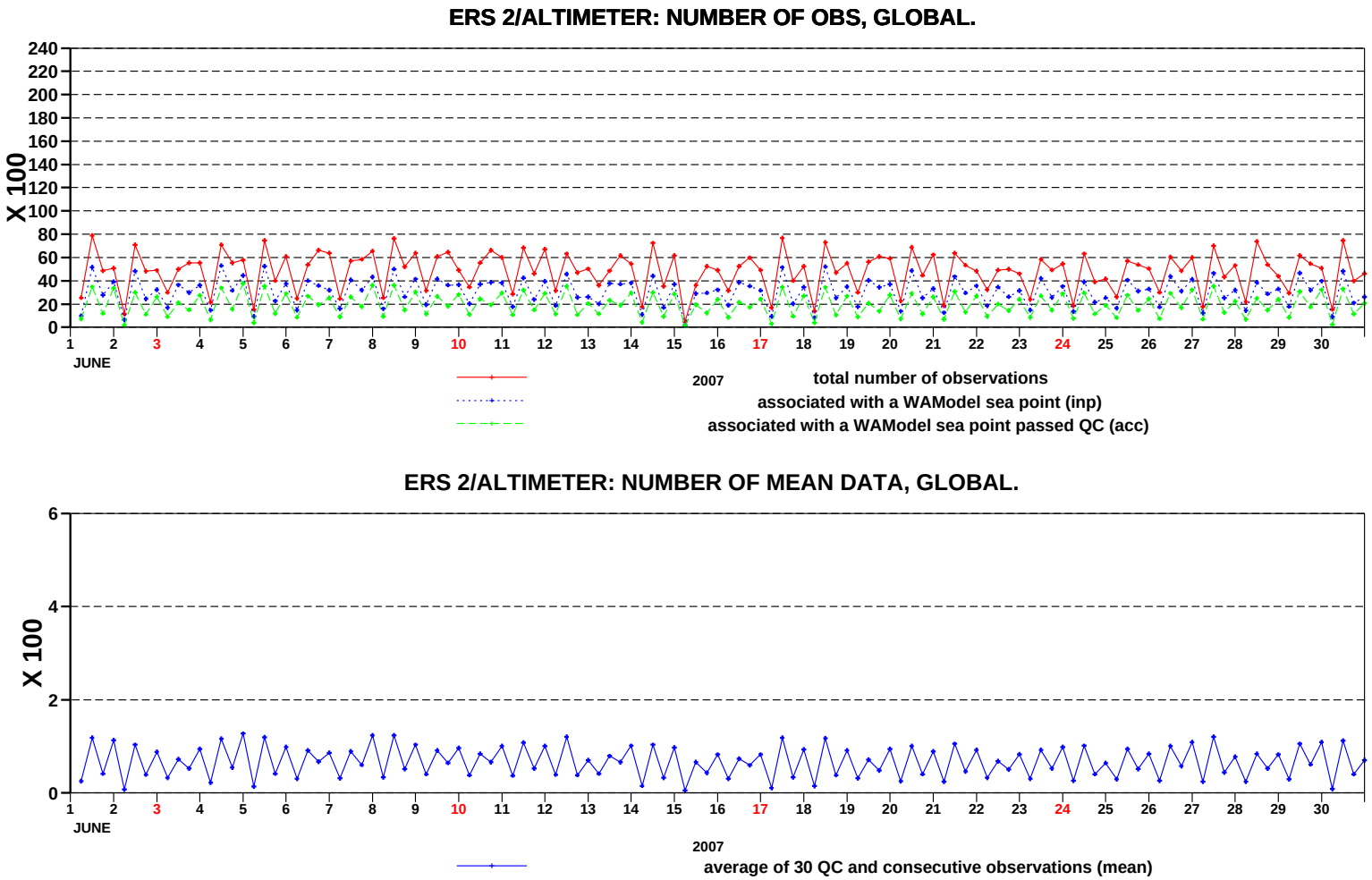


Figure 1:Time series of data reception for ERS-2 Altimeter data for June 2007

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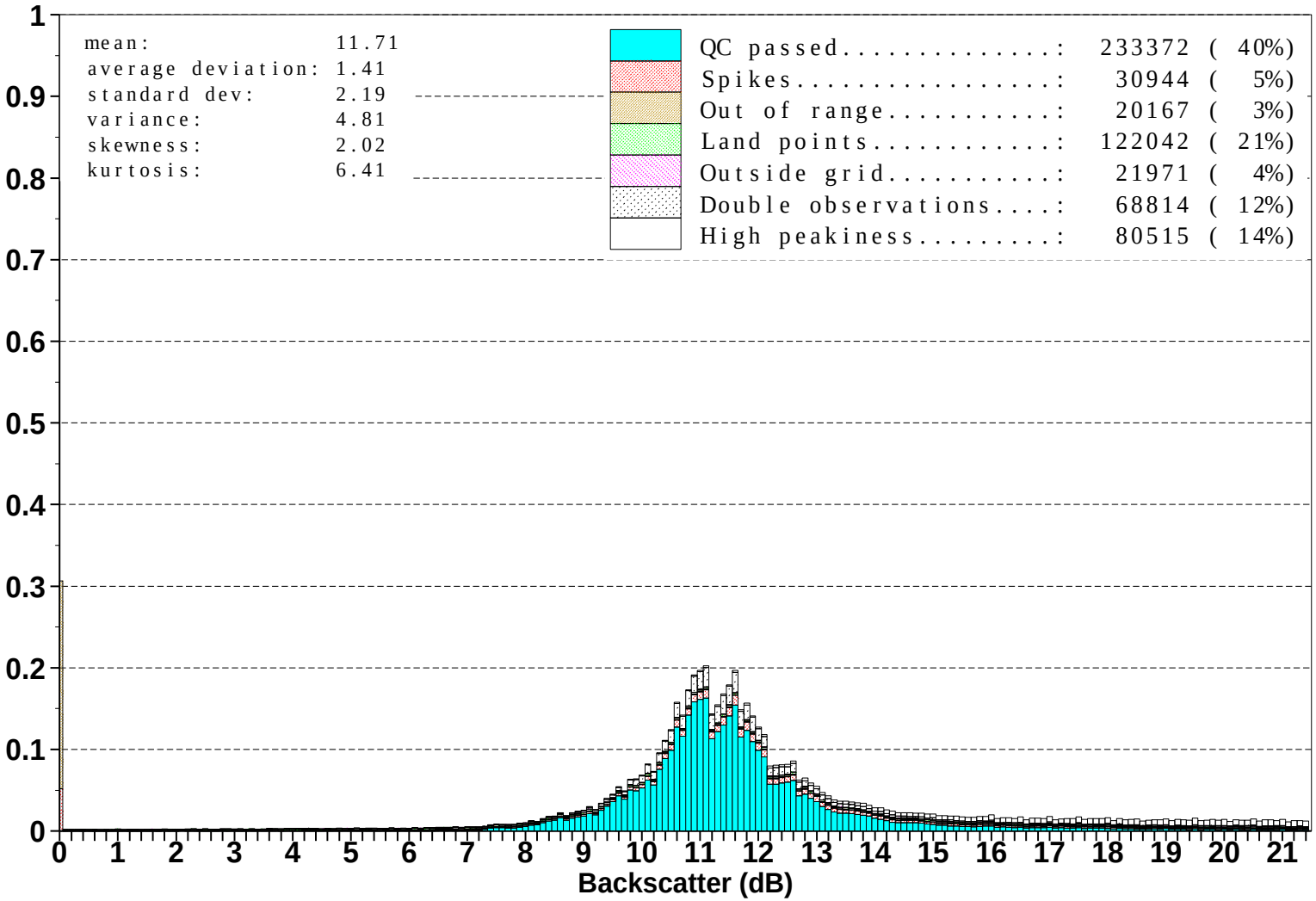


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for June 2007

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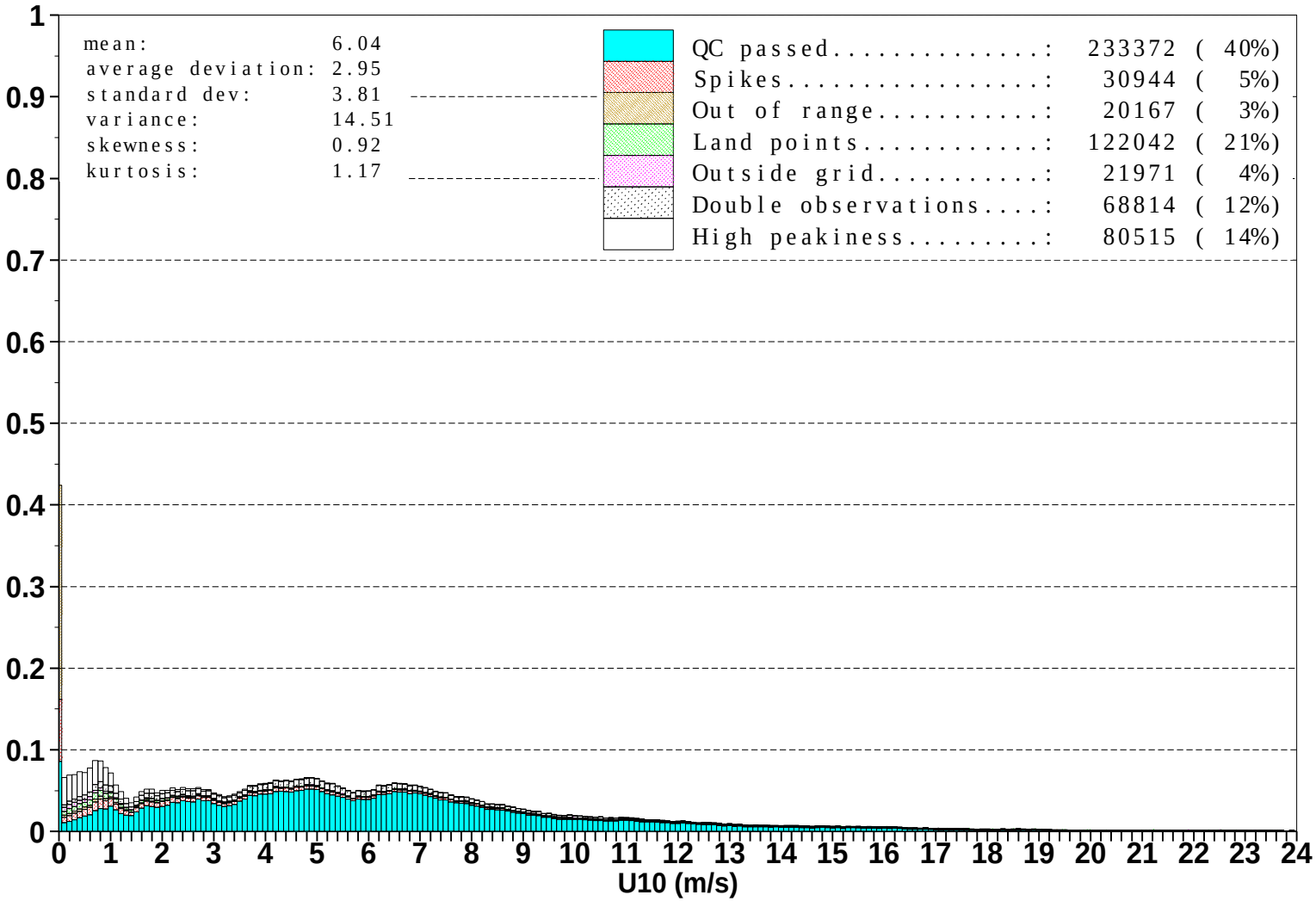


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for June 2007

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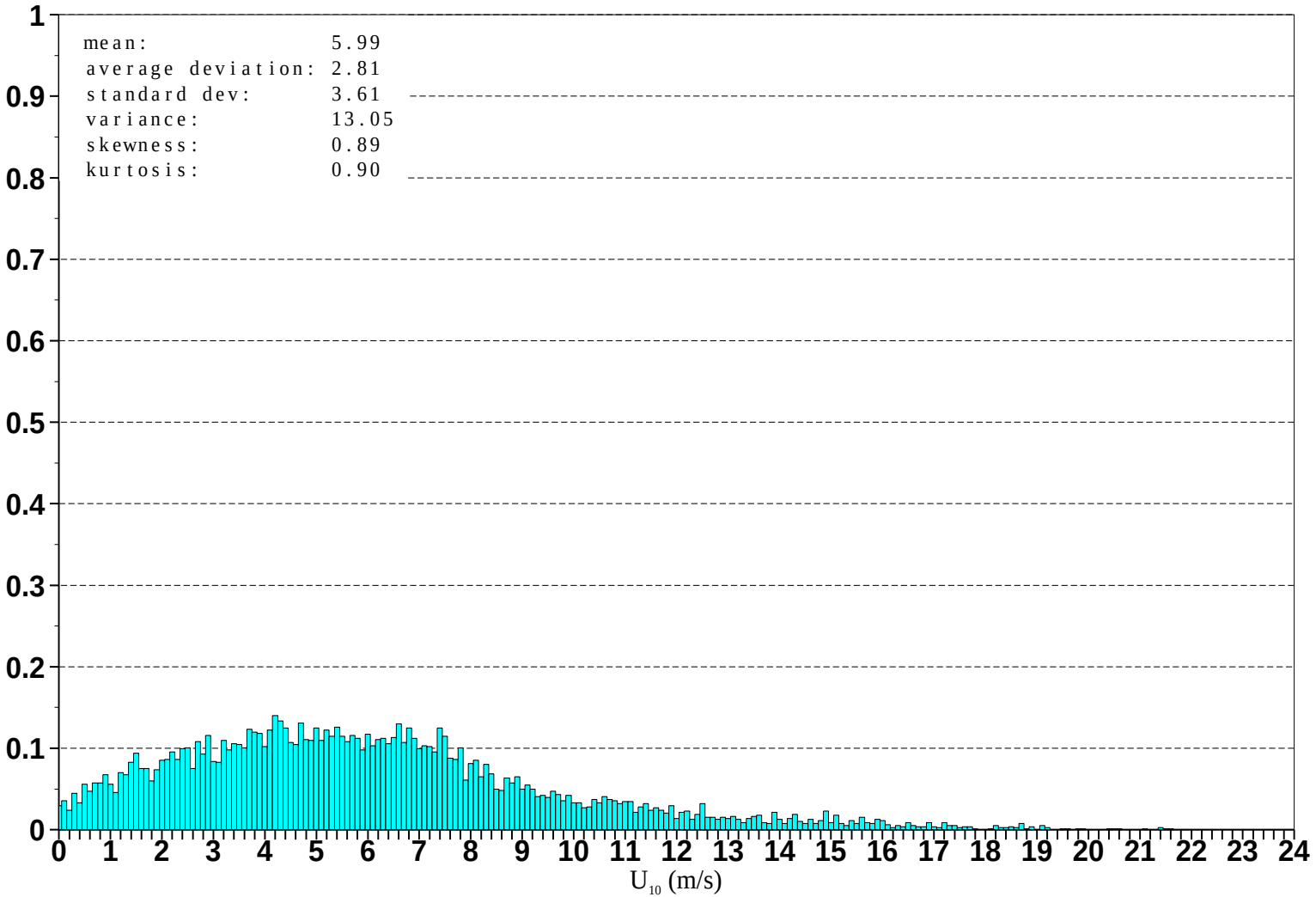


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for June 2007

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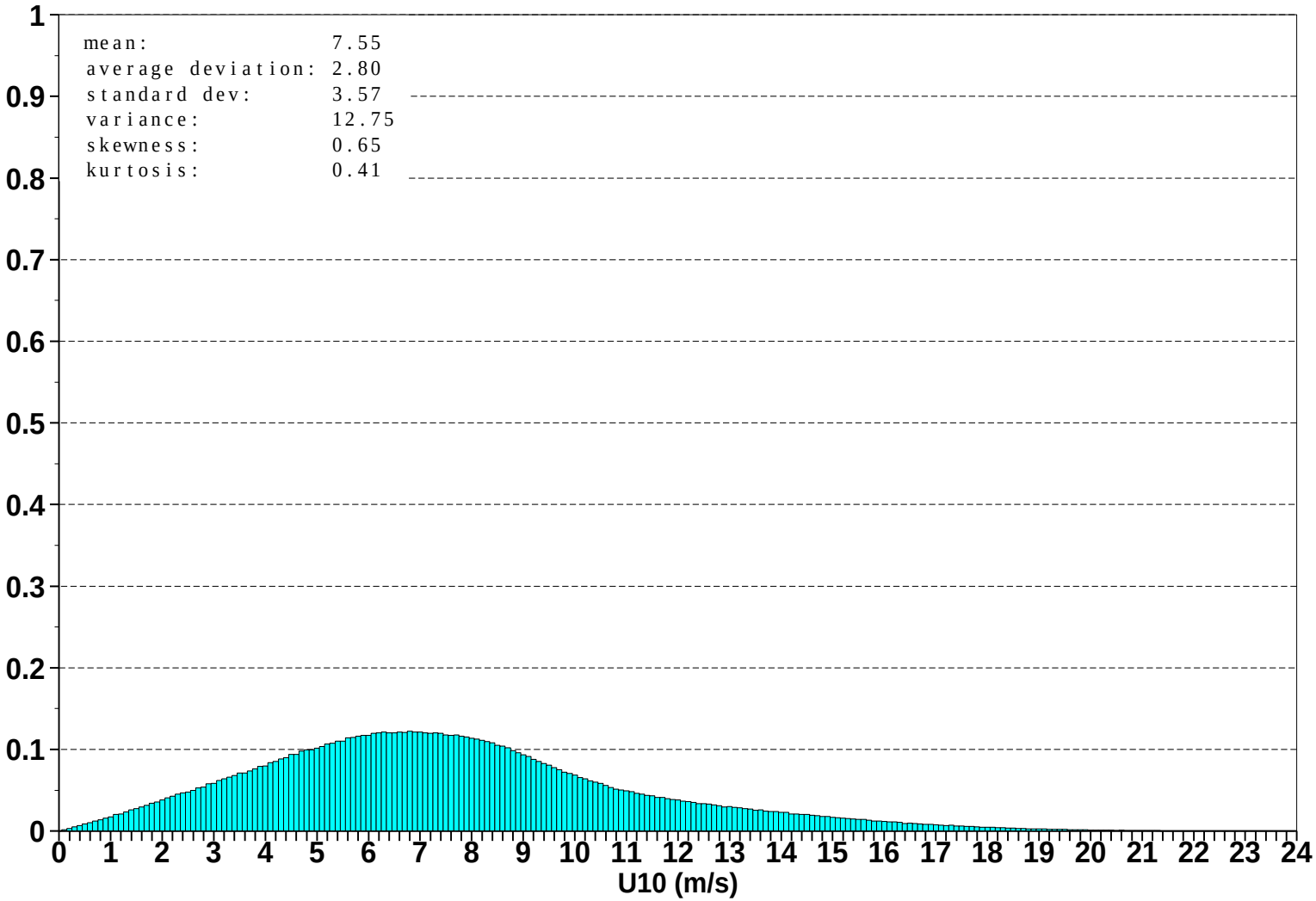
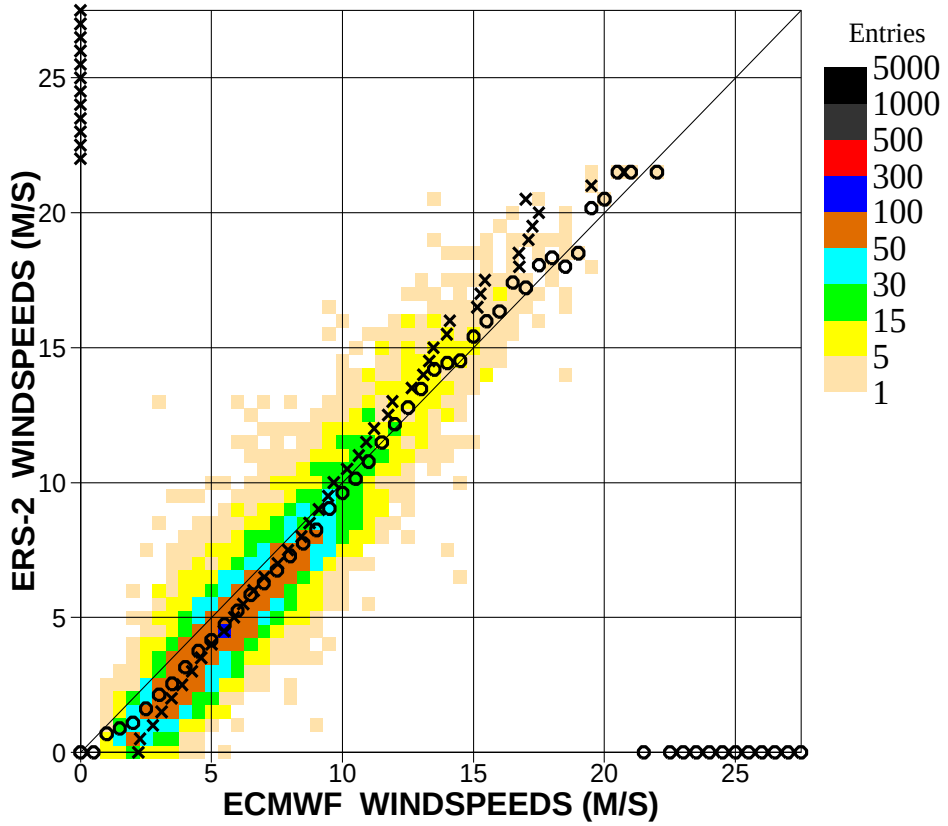


Figure 5: Global distribution of ECMWF ocean surface wind speeds for June 2007

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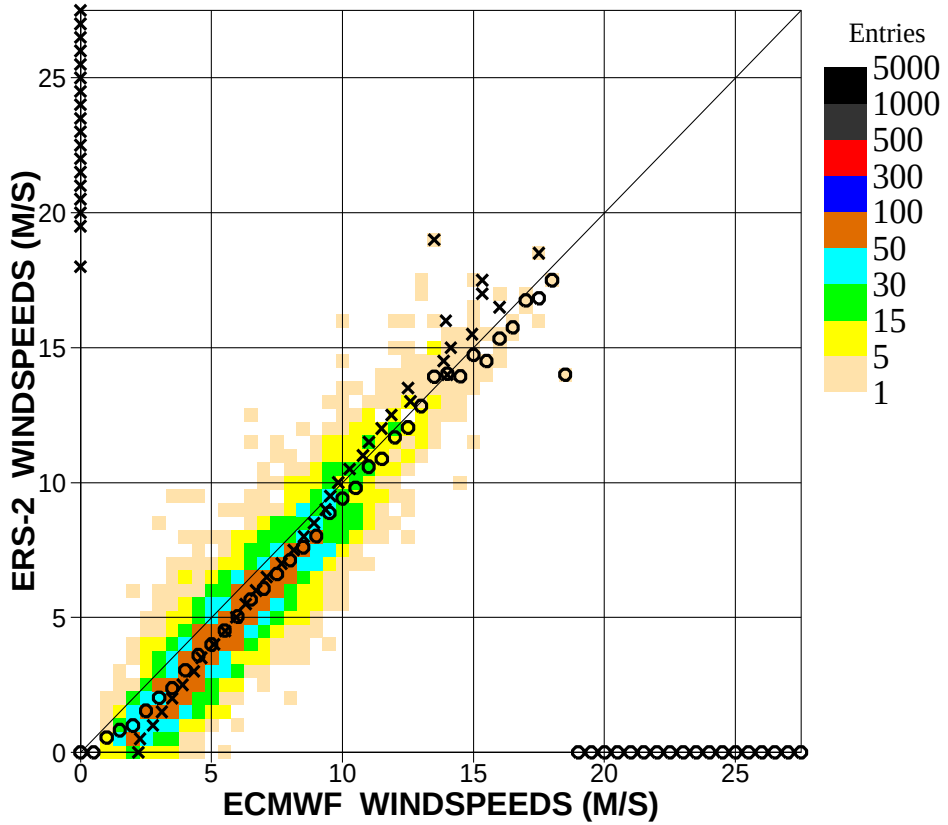
STATISTICS

ENTRIES	7859	
MEAN ECMWF	6.6423	
MEAN ERS-2	5.9906	
BIAS (ERS-2 - ECMWF)	-0.6517	
STANDARD DEVIATION	1.3738	
SCATTER INDEX	0.2068	
CORRELATION	0.9281	
SYMMETRIC SLOPE	0.9558	(0.0053)
REGR. COEFFICIENT	1.0905	(0.0049)
REGR. CONSTANT	-1.2526	(0.0361)

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

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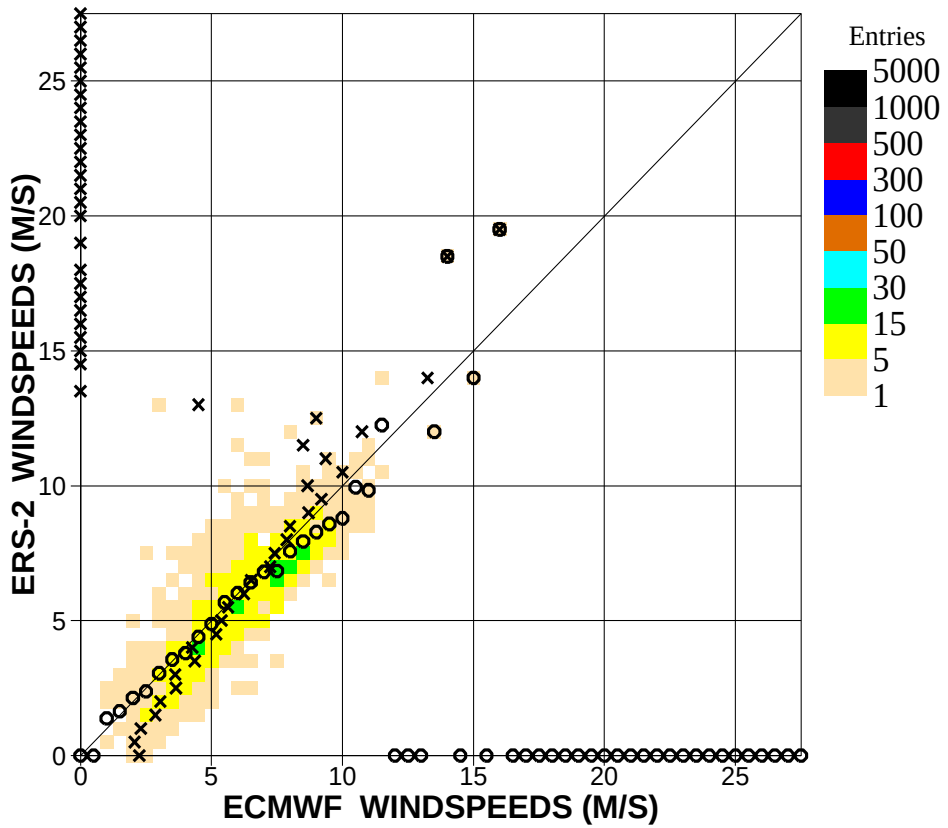


STATISTICS

ENTRIES	6235	
MEAN ECMWF	6.2231	
MEAN ERS-2	5.3397	
BIAS (ERS-2 - ECMWF)	-0.8835	
STANDARD DEVIATION	1.1899	
SCATTER INDEX	0.1912	
CORRELATION	0.9240	
SYMMETRIC SLOPE	0.9084	(0.0060)
REGR. COEFFICIENT	1.0494	(0.0055)
REGR. CONSTANT	-1.1910	(0.0374)

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

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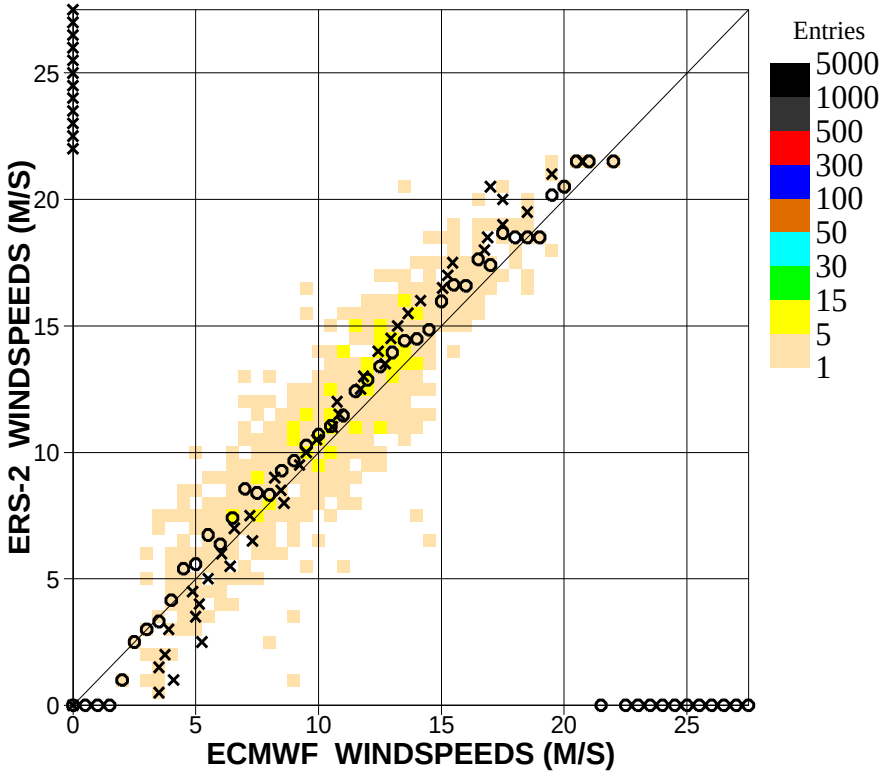
STATISTICS

ENTRIES	876	
MEAN ECMWF	6.0316	
MEAN ERS-2	5.8328	
BIAS (ERS-2 - ECMWF)	-0.1989	
STANDARD DEVIATION	1.3428	
SCATTER INDEX	0.2226	
CORRELATION	0.8296	
SYMMETRIC SLOPE	0.9831	(0.0210)
REGR. COEFFICIENT	0.9130	(0.0208)
REGR. CONSTANT	0.3260	(0.1332)

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

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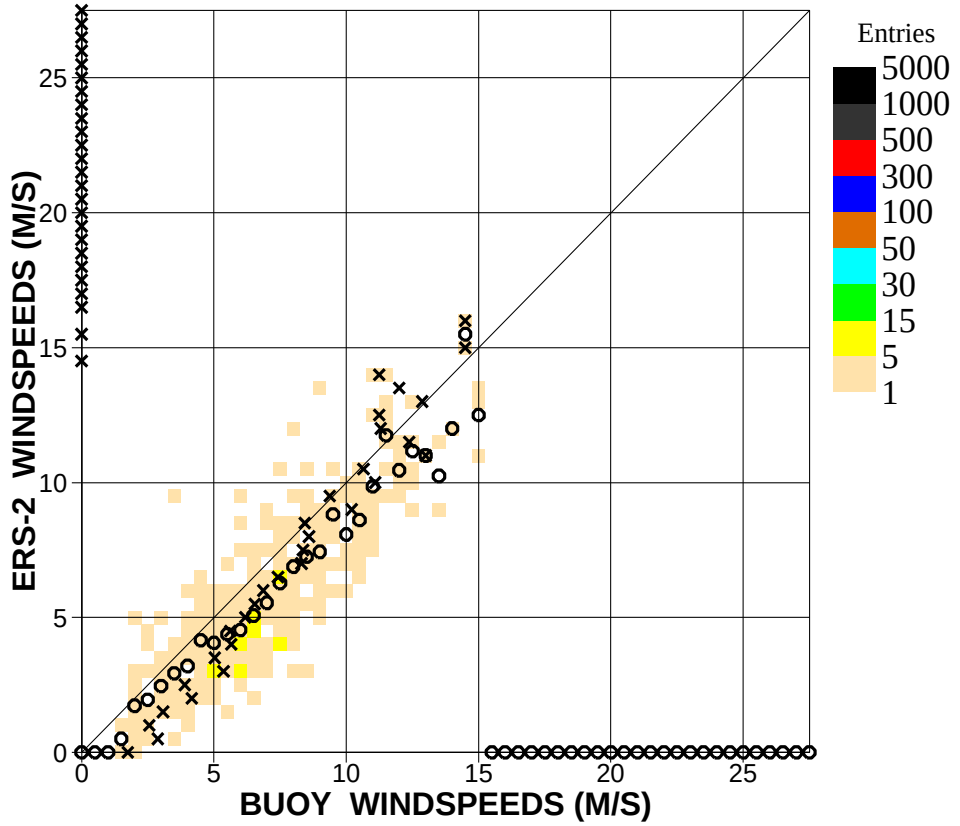


STATISTICS

ENTRIES	770	
MEAN ECMWF	10.7146	
MEAN ERS-2	11.4240	
BIAS (ERS-2 - ECMWF)	0.7095	
STANDARD DEVIATION	1.8029	
SCATTER INDEX	0.1683	
CORRELATION	0.8963	
SYMMETRIC SLOPE	1.0731	(0.0183)
REGR. COEFFICIENT	1.0154	(0.0181)
REGR. CONSTANT	0.5446	(0.2049)

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

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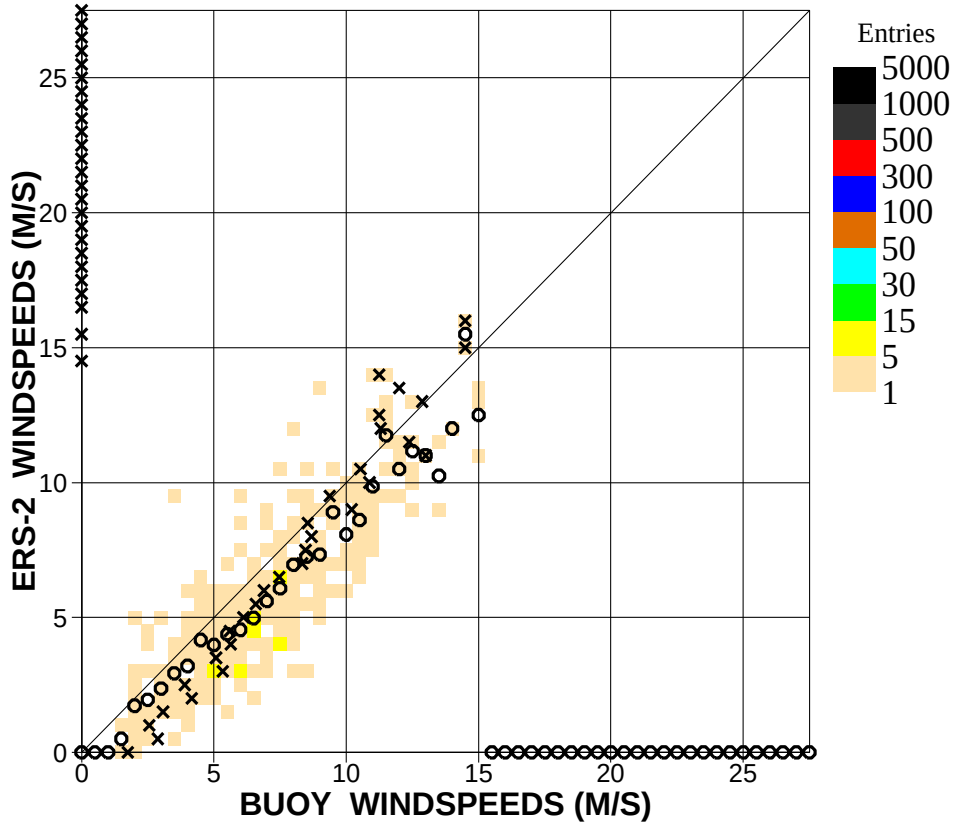


STATISTICS

ENTRIES	373	
MEAN BUOY	6.9283	
MEAN ERS-2	5.8389	
BIAS (ERS-2 - BUOY)	-1.0895	
STANDARD DEVIATION	1.5907	
SCATTER INDEX	0.2296	
CORRELATION	0.8554	
SYMMETRIC SLOPE	0.8791	(0.0292)
REGR. COEFFICIENT	0.9166	(0.0288)
REGR. CONSTANT	-0.5115	(0.2157)

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

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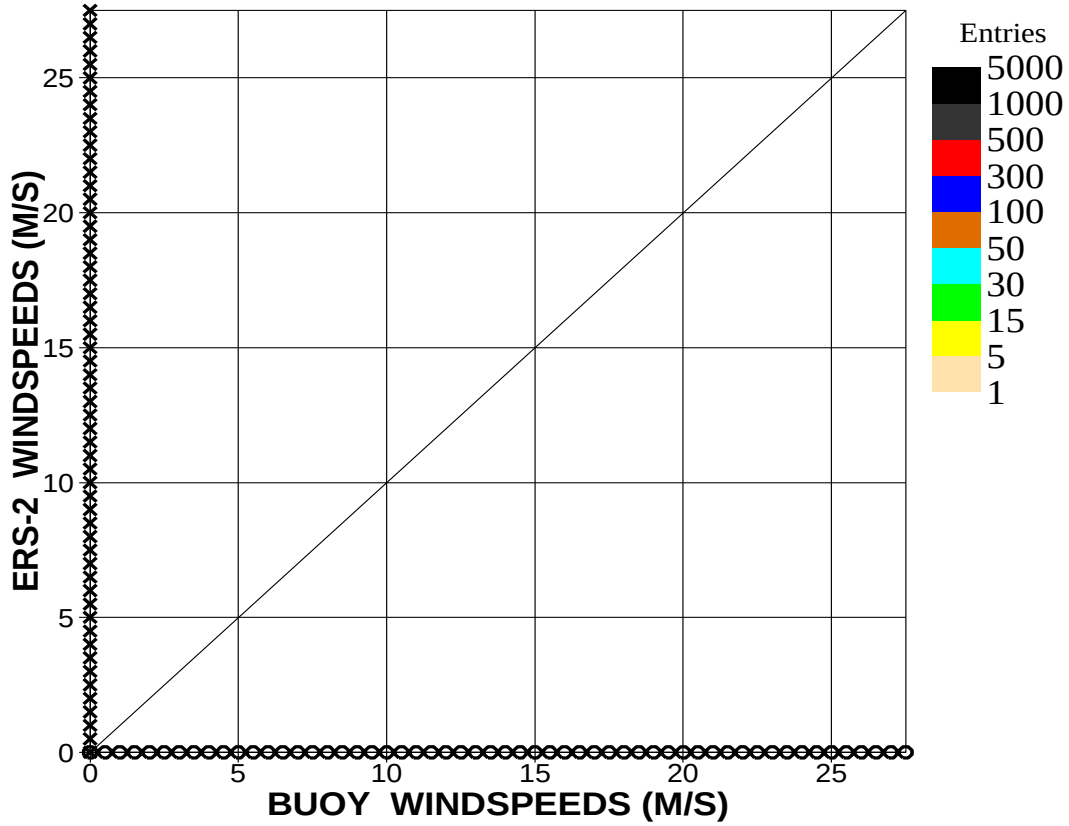


STATISTICS

ENTRIES	349	
MEAN BUOY	6.9039	
MEAN ERS-2	5.8011	
BIAS (ERS-2 - BUOY)	-1.1028	
STANDARD DEVIATION	1.6064	
SCATTER INDEX	0.2327	
CORRELATION	0.8572	
SYMMETRIC SLOPE	0.8784	(0.0301)
REGR. COEFFICIENT	0.9193	(0.0297)
REGR. CONSTANT	-0.5454	(0.2217)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for June 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 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for June 2007 (hawaii)

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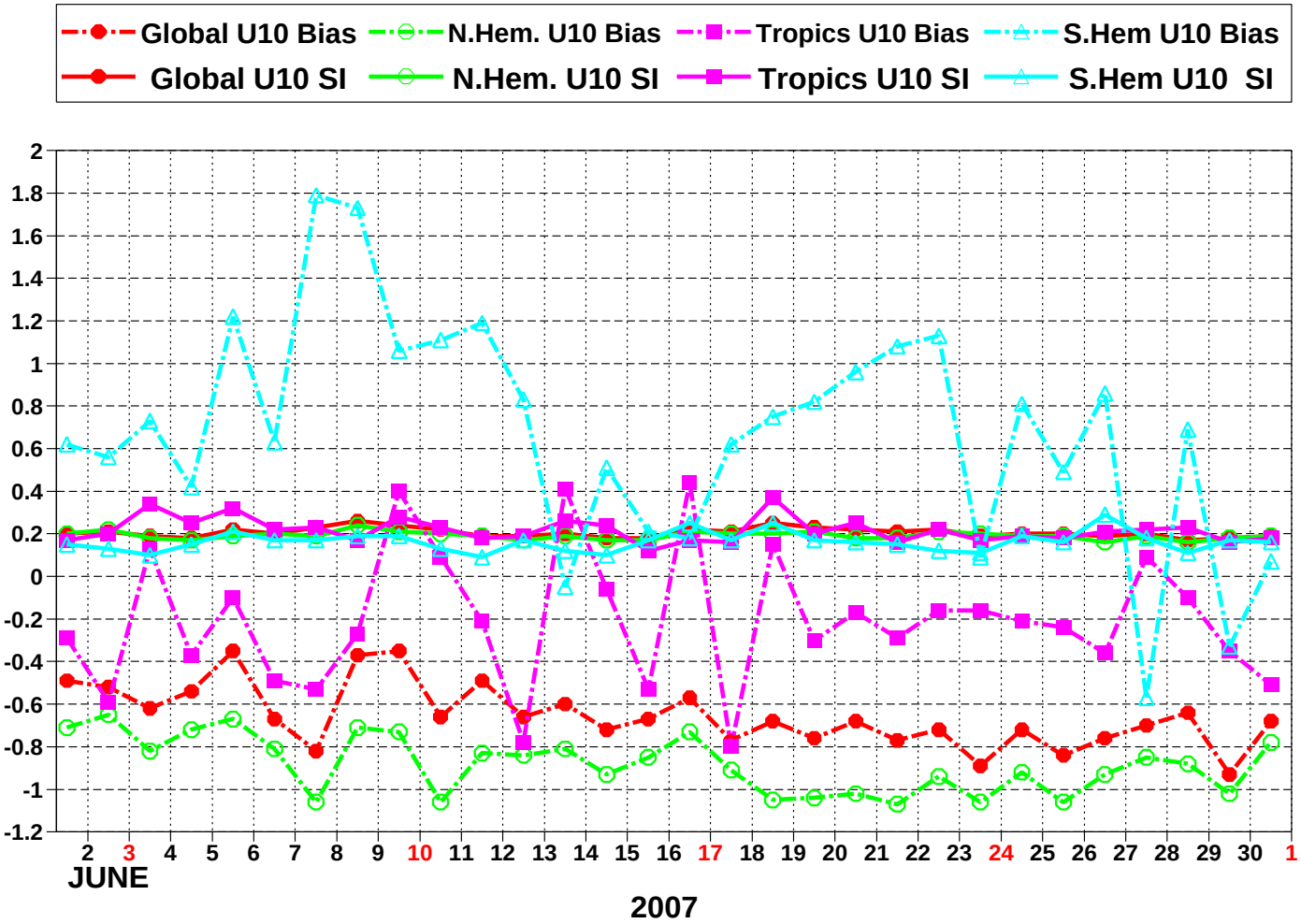


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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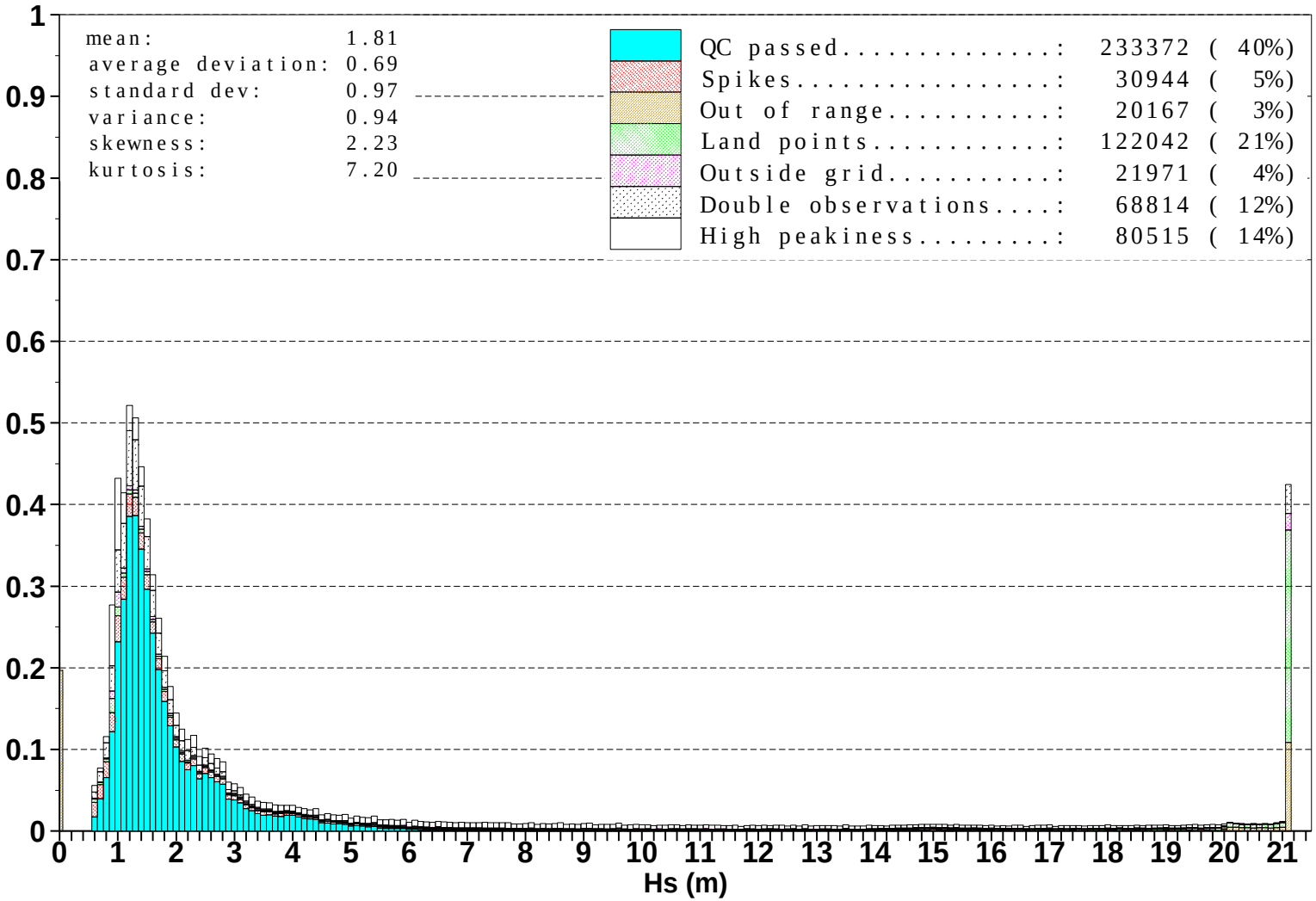


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for June 2007

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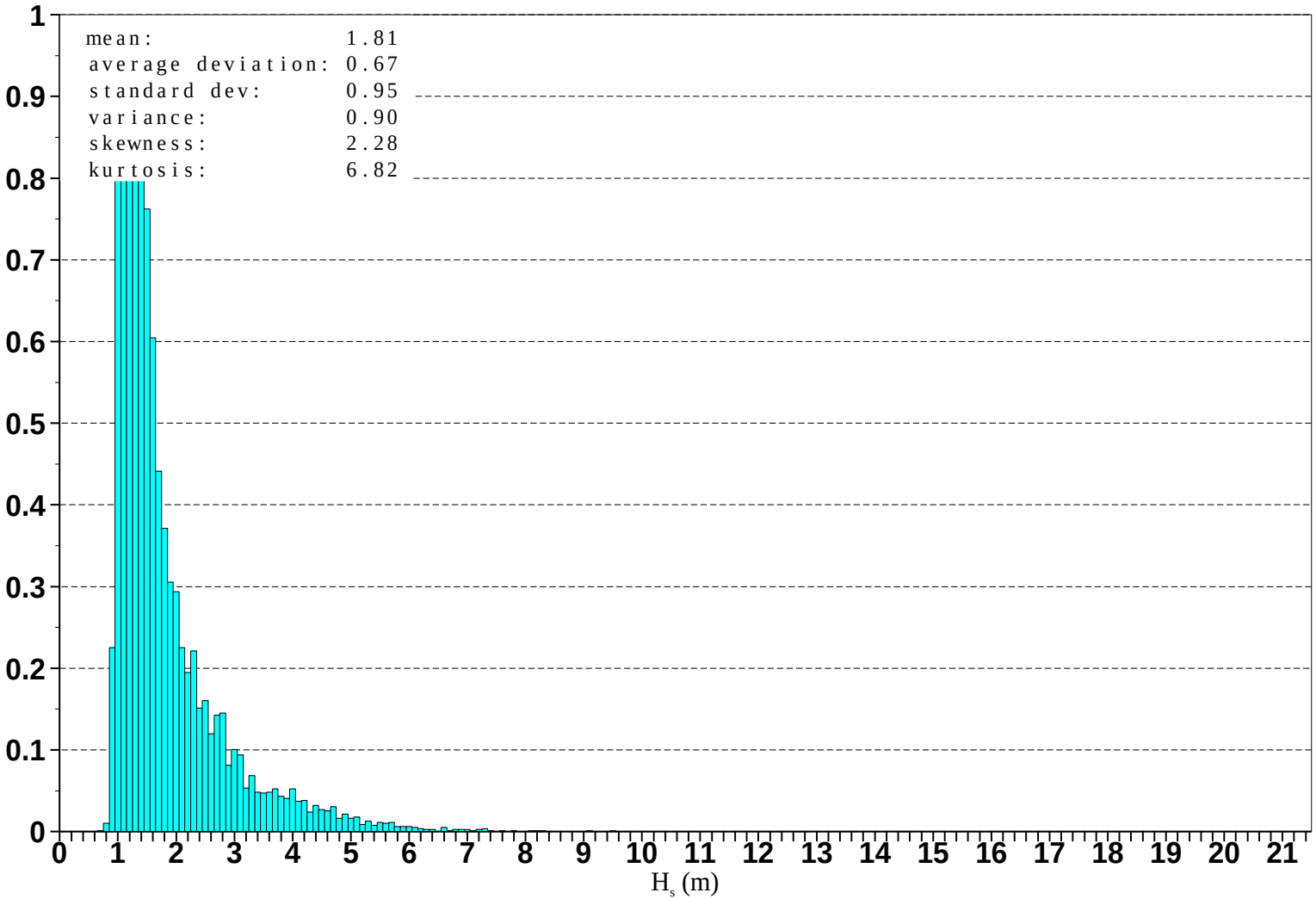


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for June 2007

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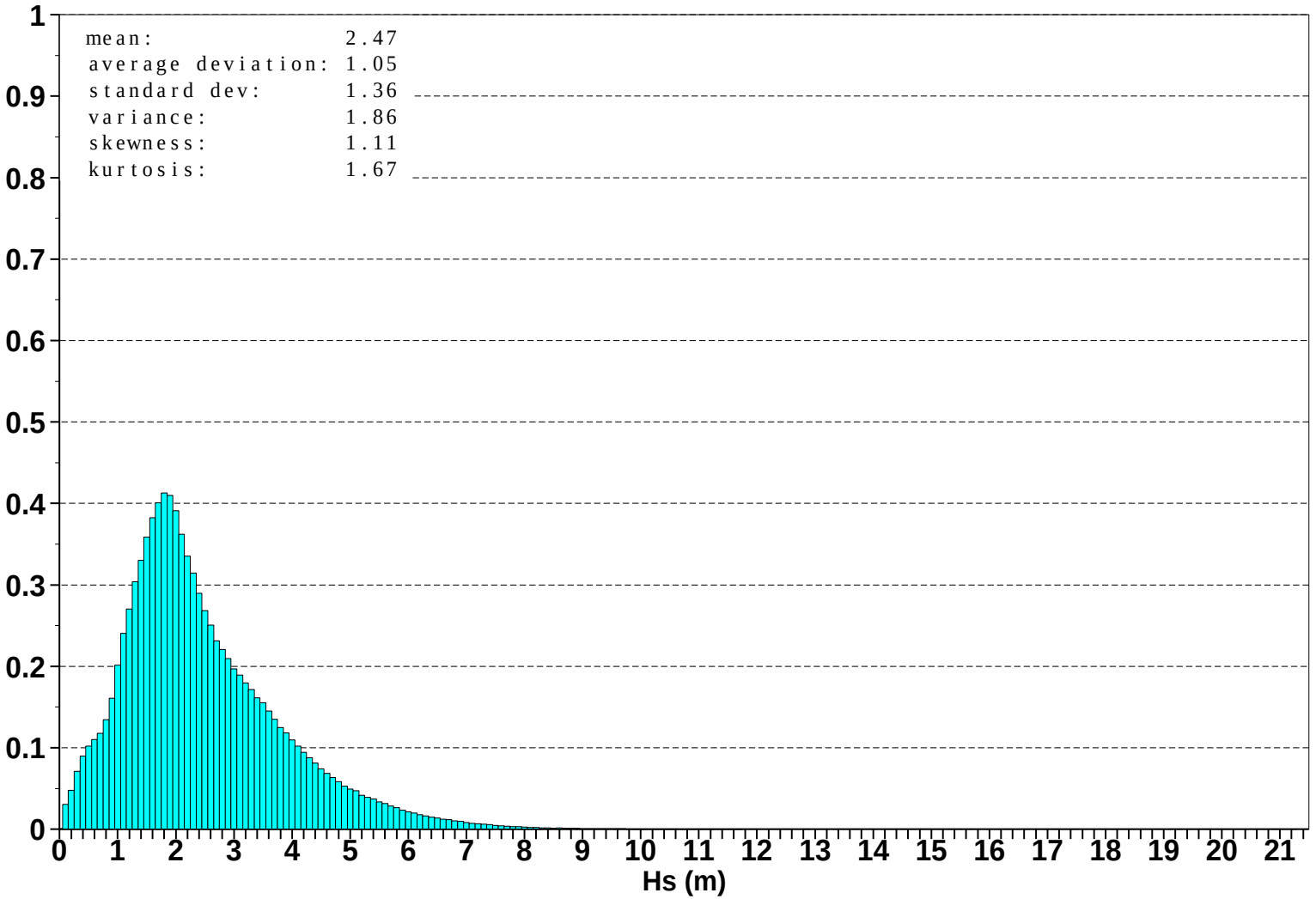
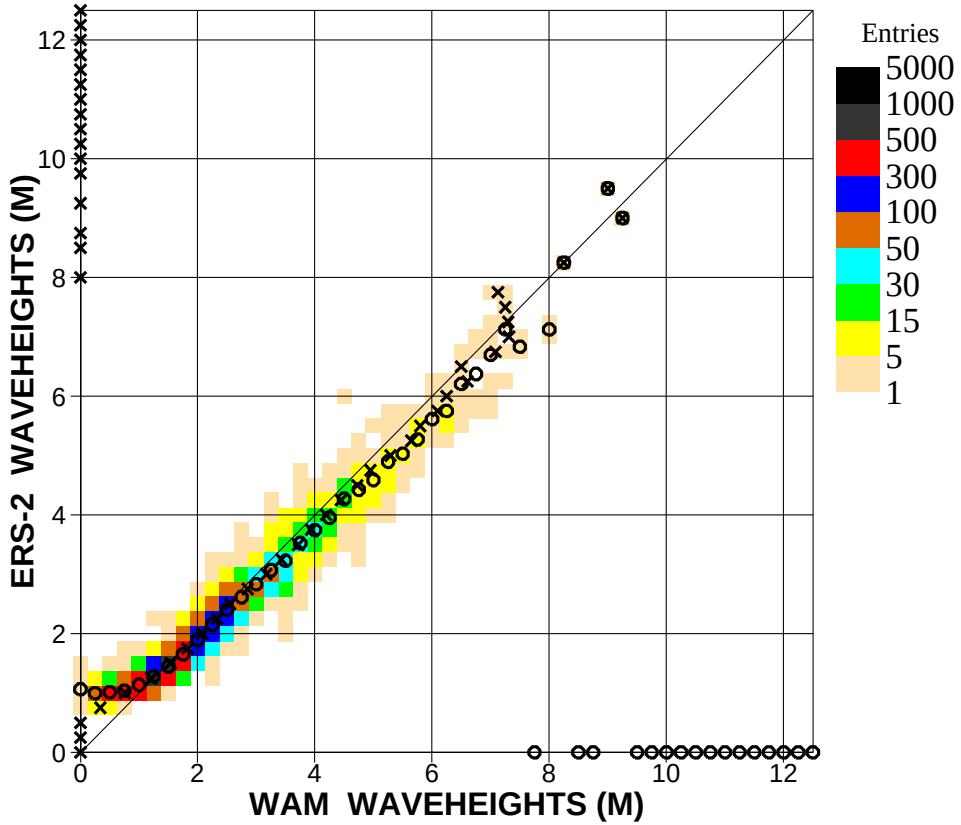


Figure 16: Global distribution of ECMWF wave heights for June 2007

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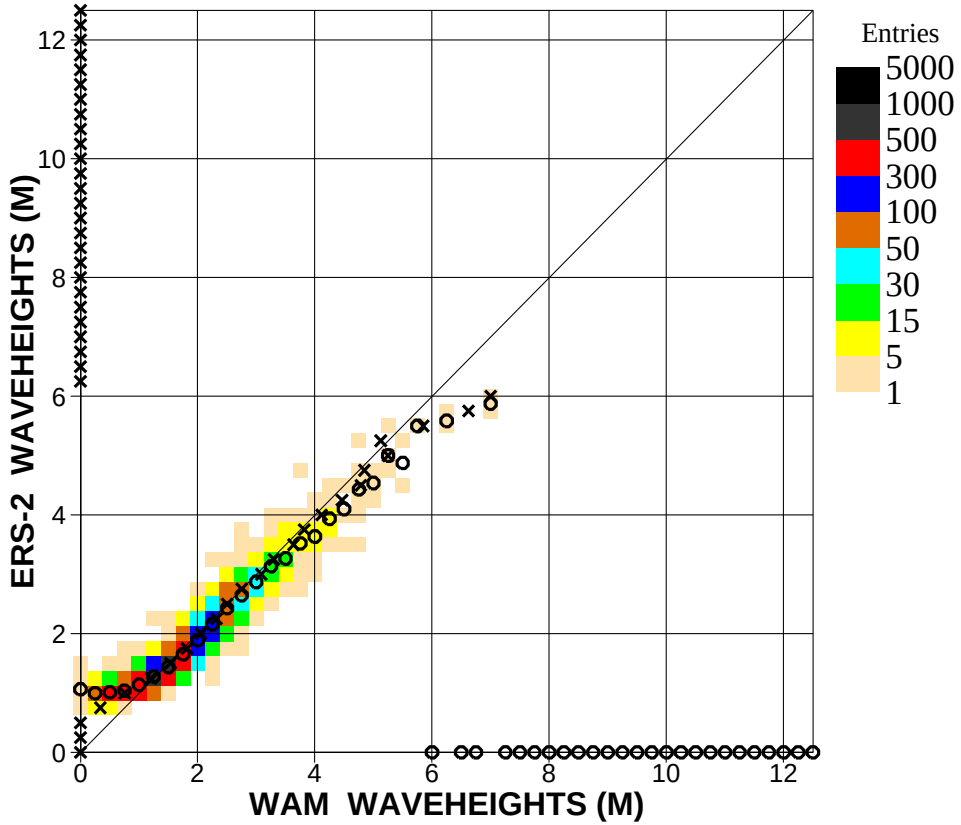


STATISTICS

ENTRIES	7859	
MEAN WAM	1.8095	
MEAN ERS-2	1.8073	
BIAS (ERS-2 - WAM)	-0.0021	
STANDARD DEVIATION	0.2592	
SCATTER INDEX	0.1432	
CORRELATION	0.9757	
SYMMETRIC SLOPE	0.9685	(0.0026)
REGR. COEFFICIENT	0.8567	(0.0022)
REGR. CONSTANT	0.2572	(0.0046)

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

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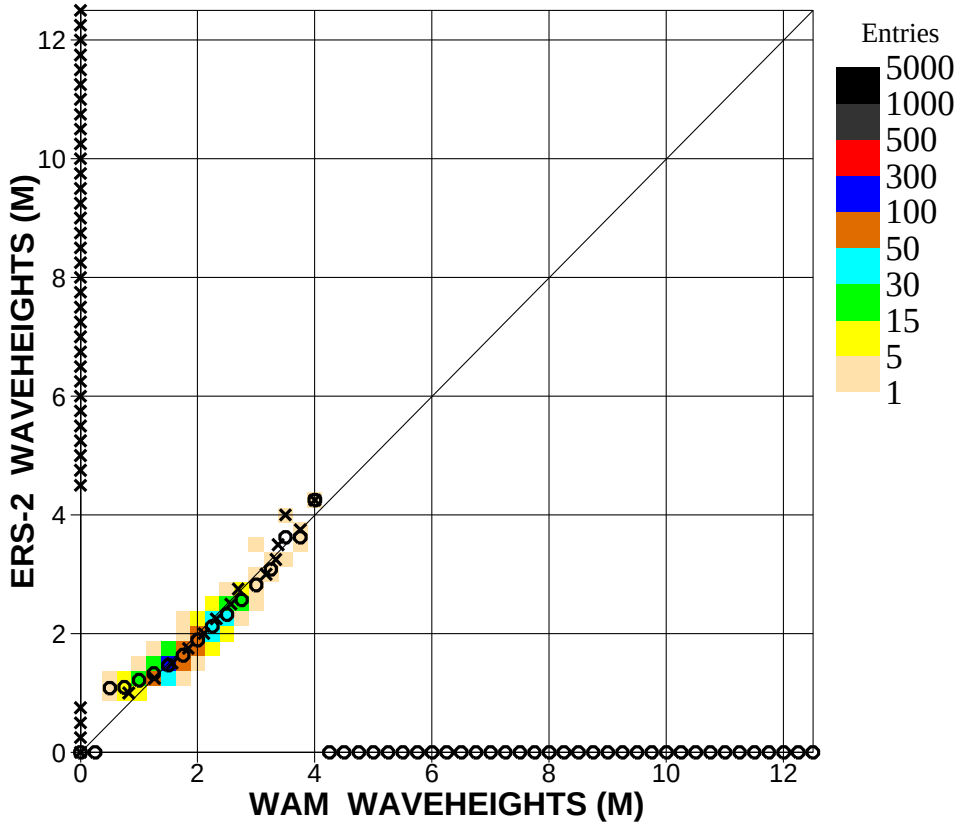


STATISTICS

ENTRIES	6235	
MEAN WAM	1.5293	
MEAN ERS-2	1.5680	
BIAS (ERS-2 - WAM)	0.0387	
STANDARD DEVIATION	0.2410	
SCATTER INDEX	0.1576	
CORRELATION	0.9536	
SYMMETRIC SLOPE	0.9915	(0.0041)
REGR. COEFFICIENT	0.7945	(0.0032)
REGR. CONSTANT	0.3529	(0.0054)

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

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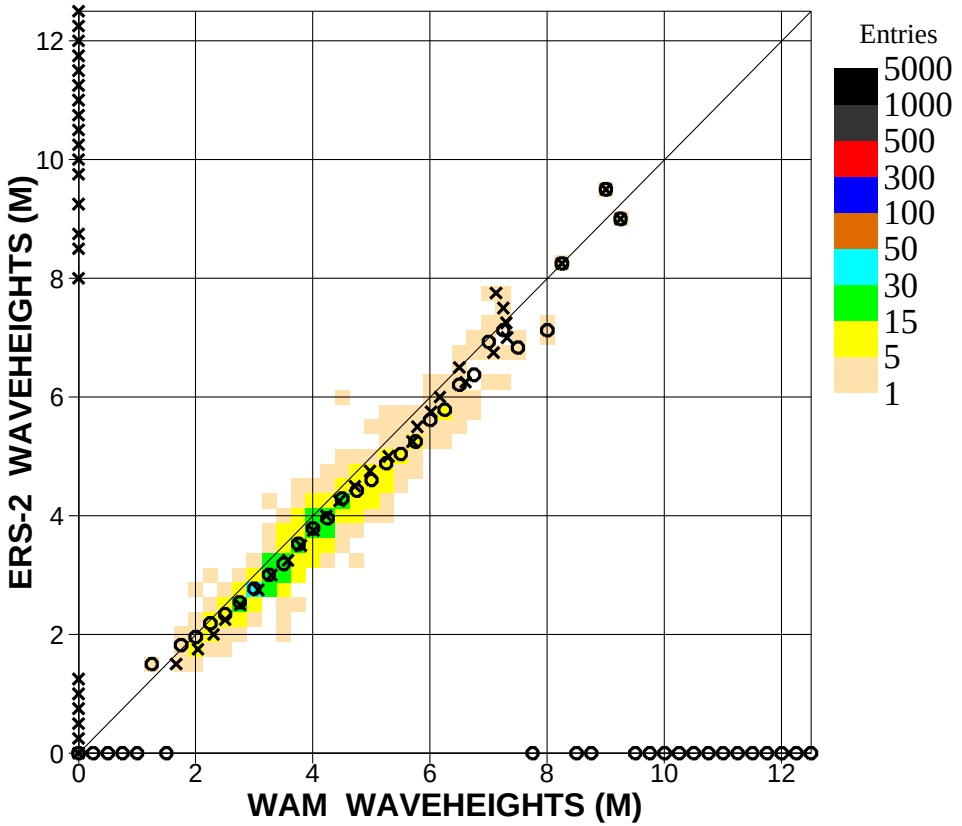
STATISTICS

ENTRIES	876	
MEAN WAM	1.8154	
MEAN ERS-2	1.7512	
BIAS (ERS-2 - WAM)	-0.0642	
STANDARD DEVIATION	0.1618	
SCATTER INDEX	0.0891	
CORRELATION	0.9419	
SYMMETRIC SLOPE	0.9605	(0.0109)
REGR. COEFFICIENT	0.8458	(0.0102)
REGR. CONSTANT	0.2157	(0.0191)

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

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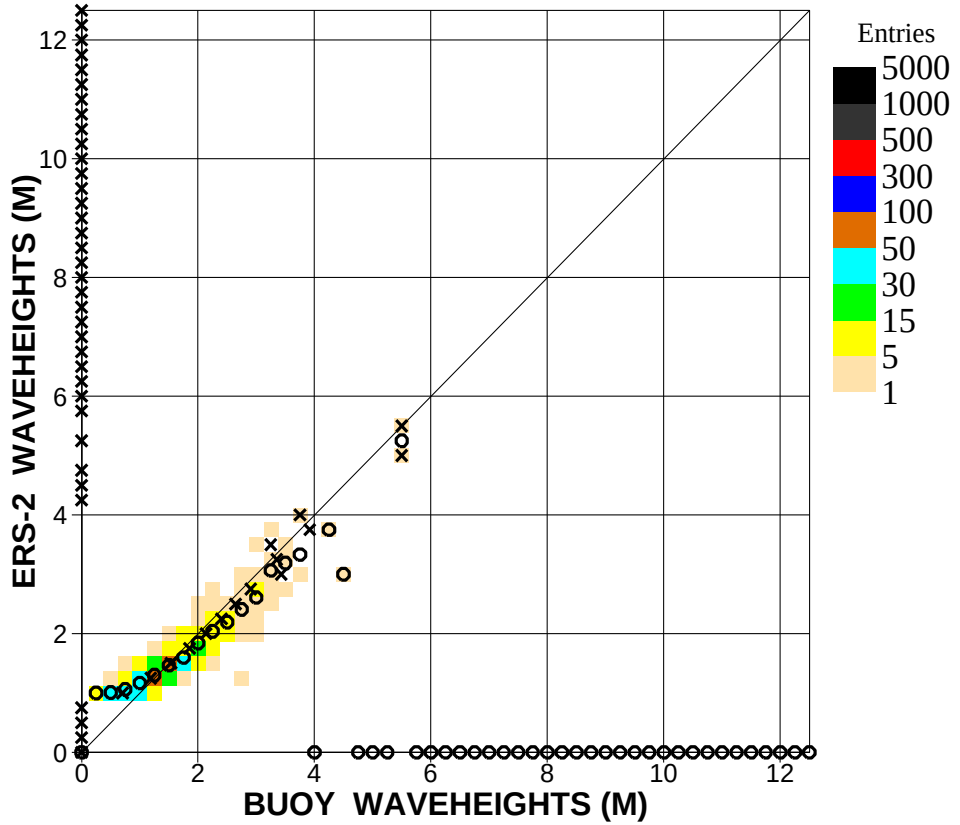


STATISTICS

ENTRIES	770	
MEAN WAM	4.0592	
MEAN ERS-2	3.7976	
BIAS (ERS-2 - WAM)	-0.2616	
STANDARD DEVIATION	0.3186	
SCATTER INDEX	0.0785	
CORRELATION	0.9658	
SYMMETRIC SLOPE	0.9397	(0.0092)
REGR. COEFFICIENT	0.9503	(0.0092)
REGR. CONSTANT	-0.0599	(0.0390)

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

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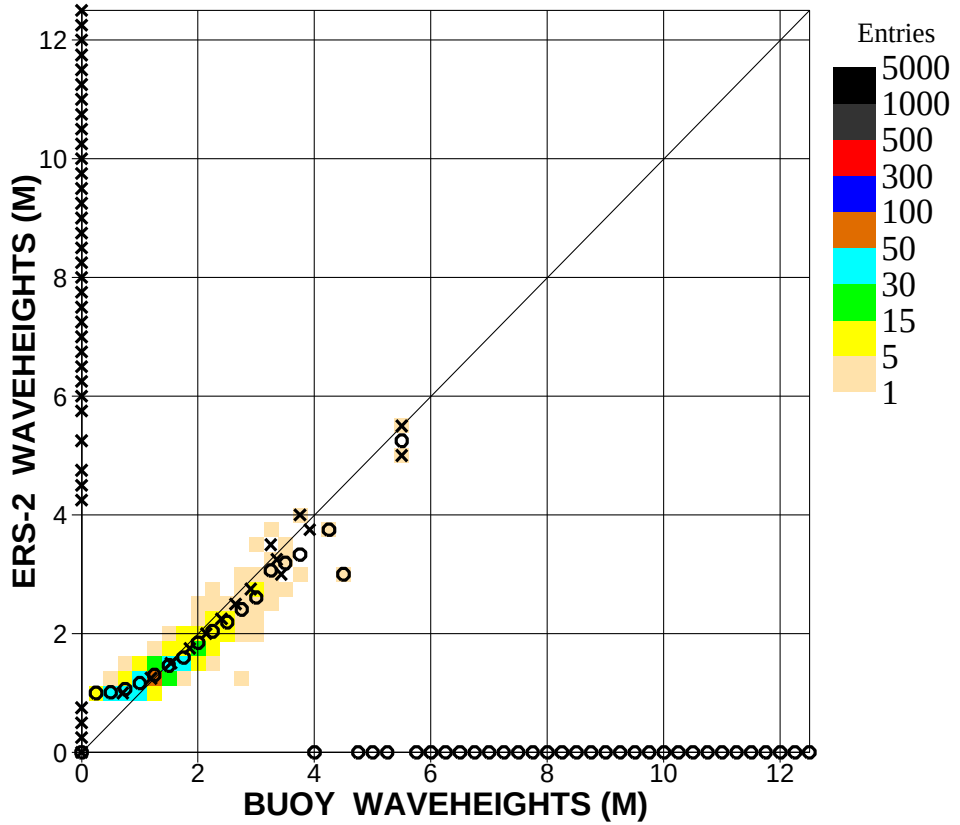
STATISTICS

ENTRIES	587	
MEAN BUOY	1.4695	
MEAN ERS-2	1.5117	
BIAS (ERS-2 - BUOY)	0.0422	
STANDARD DEVIATION	0.3062	
SCATTER INDEX	0.2084	
CORRELATION	0.9305	
SYMMETRIC SLOPE	0.9781	(0.0167)
REGR. COEFFICIENT	0.7019	(0.0114)
REGR. CONSTANT	0.4803	(0.0189)

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

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STATISTICS

ENTRIES	560	
MEAN BUOY	1.4812	
MEAN ERS-2	1.5218	
BIAS (ERS-2 - BUOY)	0.0406	
STANDARD DEVIATION	0.3096	
SCATTER INDEX	0.2090	
CORRELATION	0.9306	
SYMMETRIC SLOPE	0.9767	(0.0170)
REGR. COEFFICIENT	0.7034	(0.0117)
REGR. CONSTANT	0.4799	(0.0195)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for June 2007 (n.hem.)

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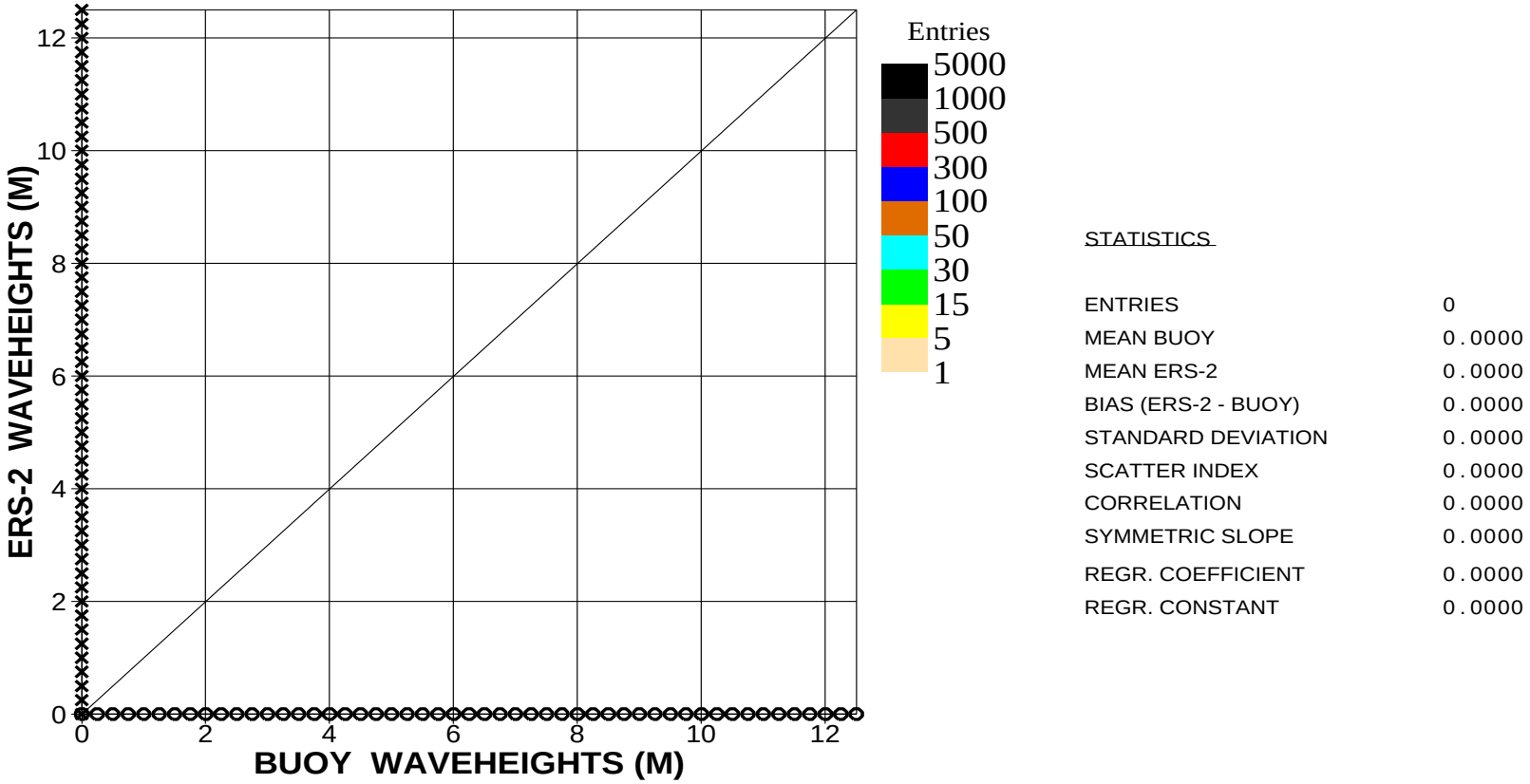


Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for June 2007 (hawaii)

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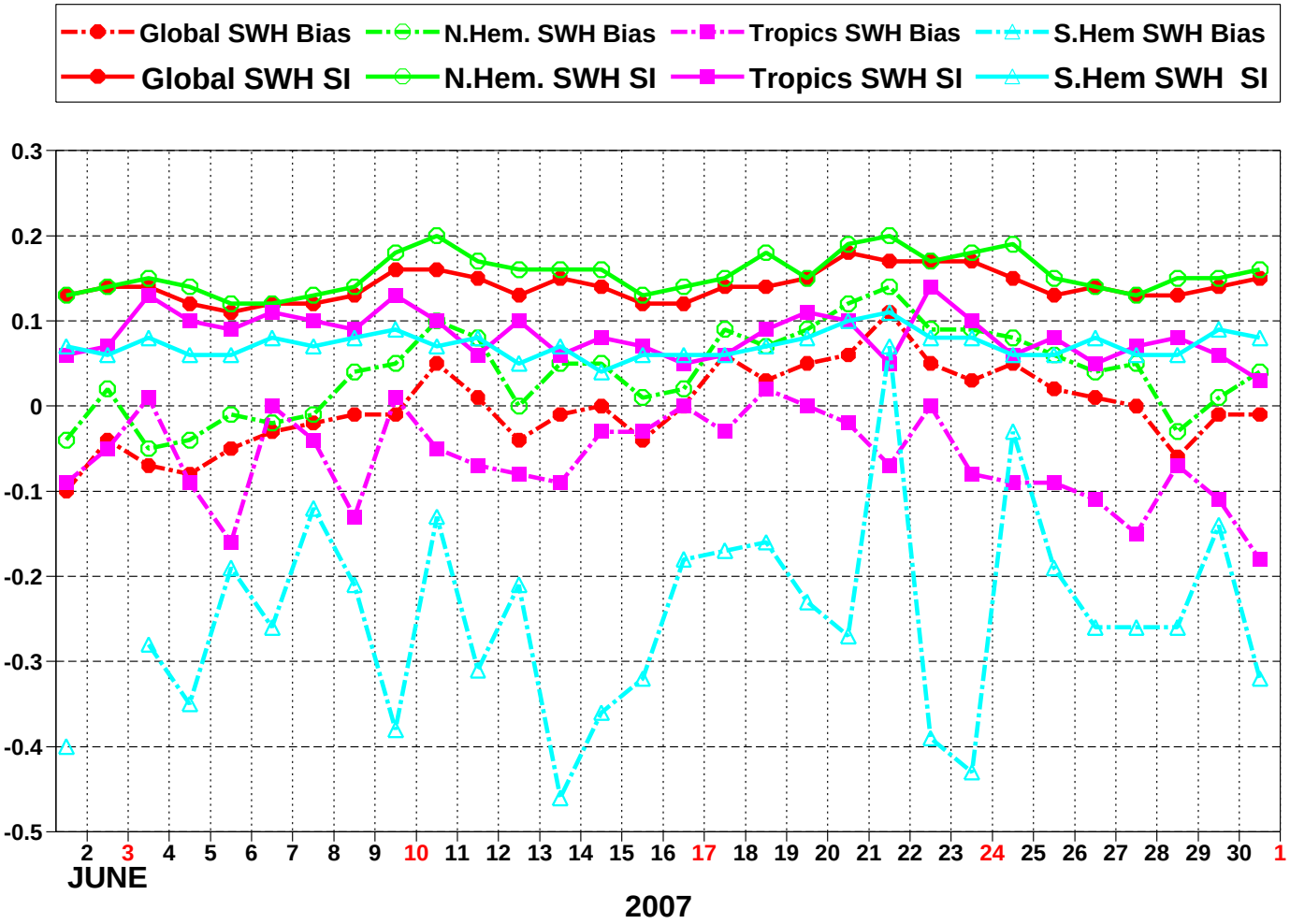


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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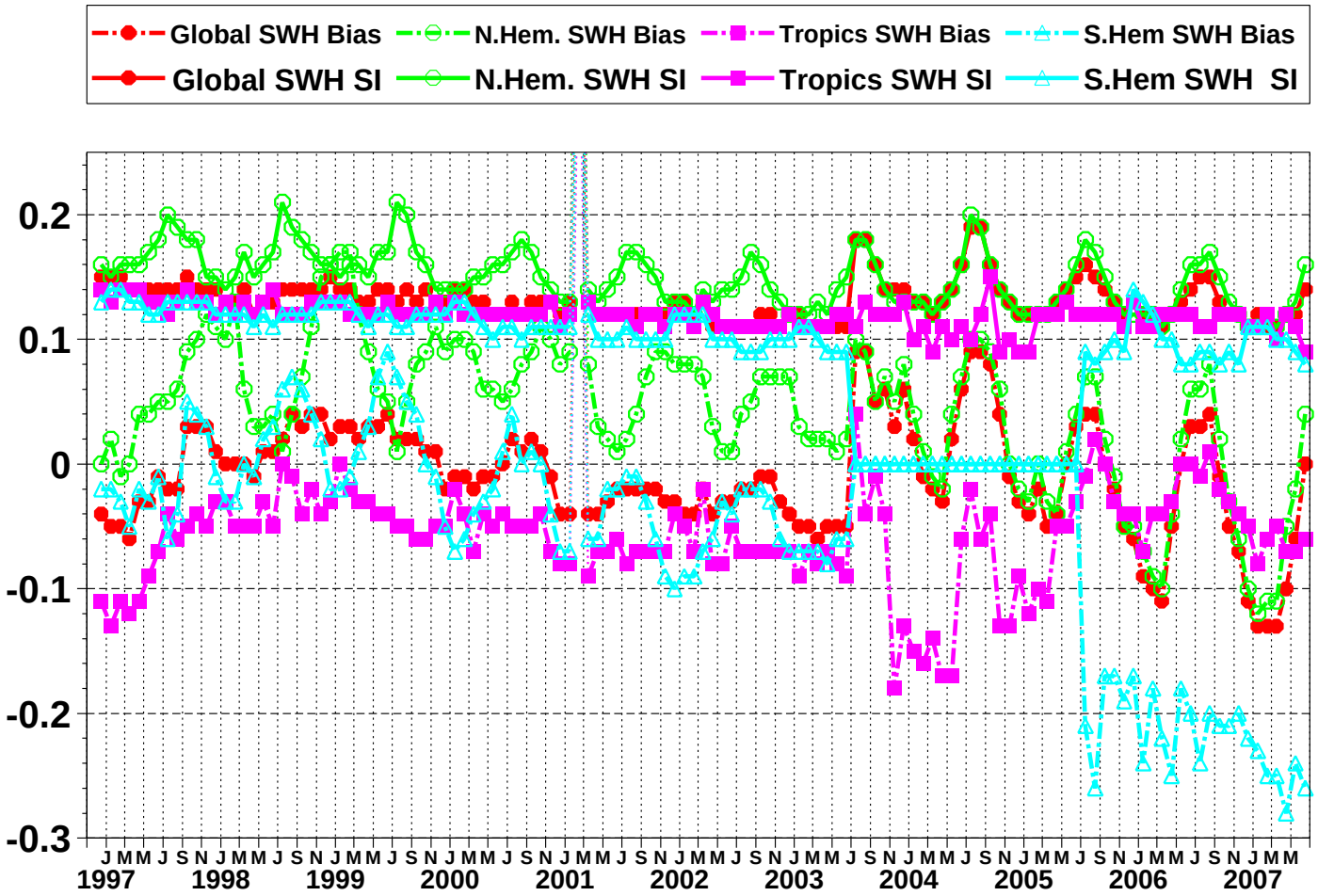


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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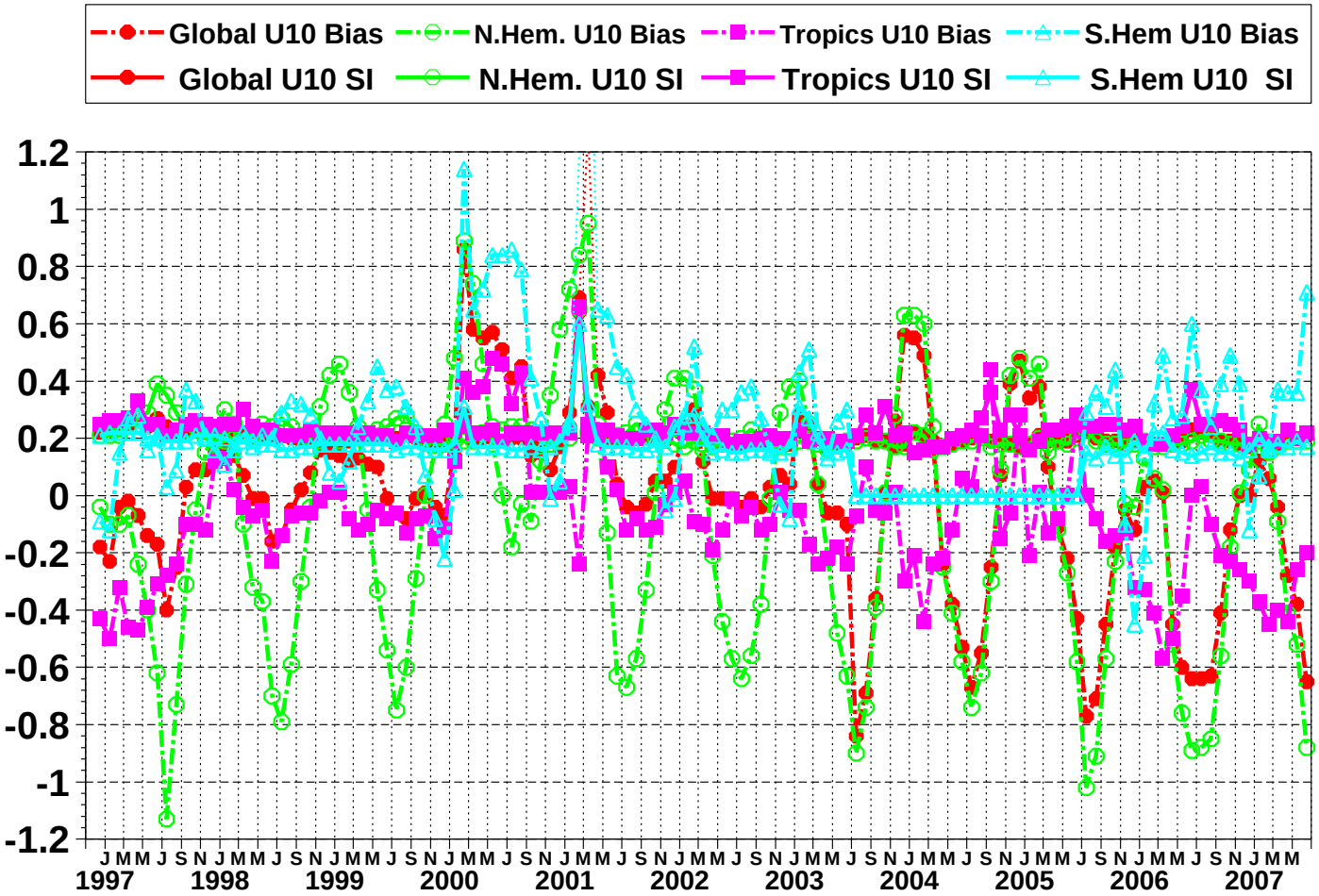


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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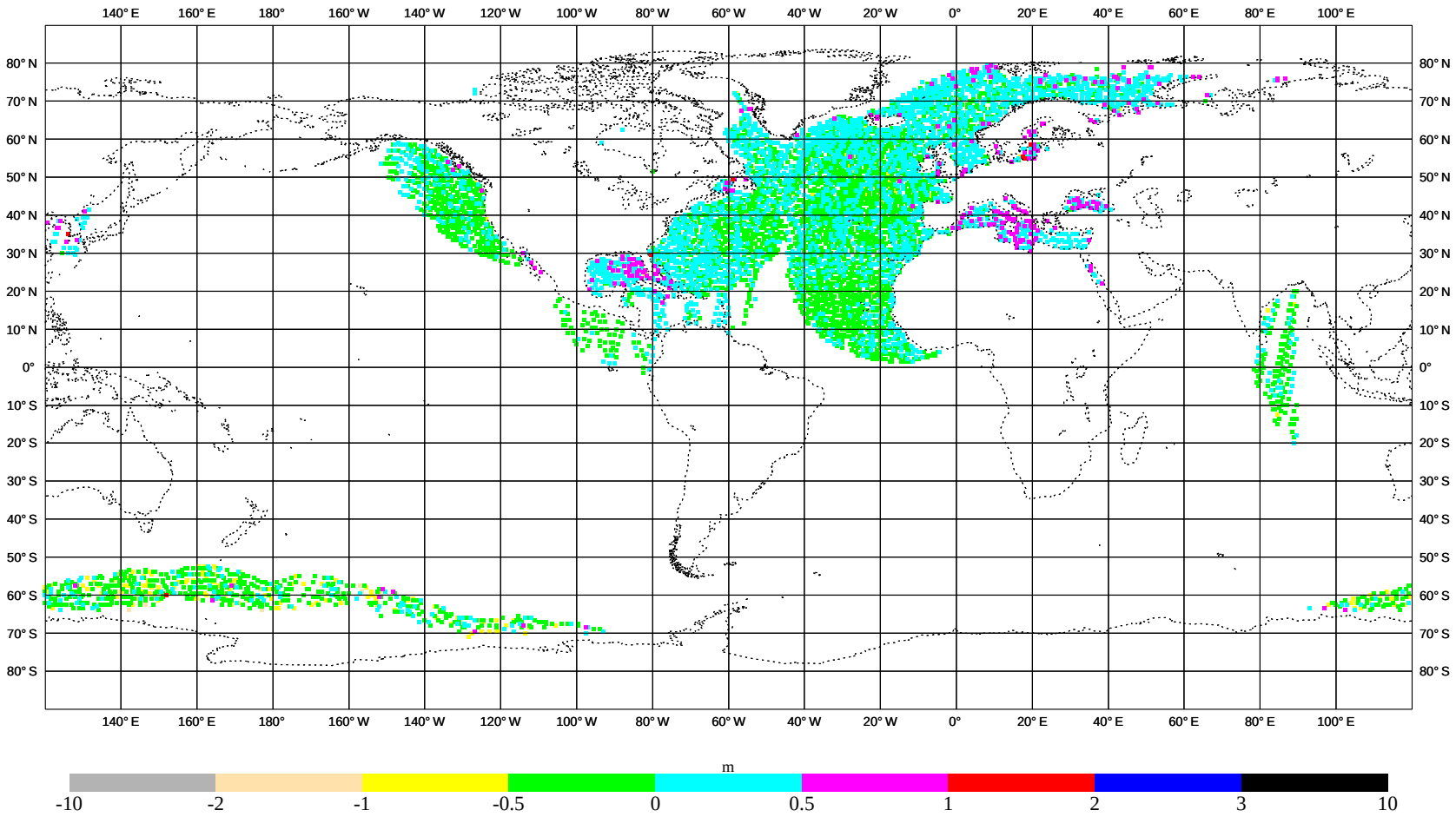


Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for June 2007

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