ECMWF Report on ERS-2 RA for June 2009

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

By: *Saleh Abdalla*

Date: *10 July 2009*

Overview:

Based on the data received at ECMWF during the whole month, on average, 3769 observations arrived at ECMWF every 6 hours of which 68.56% 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):

- from 00:00 on the 1st to 12:00 on the 2nd (both inclusive),
- from 18:00 on the 3rd to 12:00 on the 5th (both inclusive), and
- from 00:00 to 12:00 on the 27th (both inclusive) of the 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, the northeaster parts of the Indian Ocean and around South Africa as can be seen in Figure 27. **As was the case during the last few months, there was no data from some ground stations this month as well.** The quality of the received data is as good as usual.

Backscatter:

ESR-2 $<\sigma_0>$ = 11.89 dB (with a main peak at 11.1 dB).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: - 0.497 m/s

ERS-2 northern hemisphere: - 0.723 m/s

ERS-2 tropics: - 0.121 m/s

ERS-2 southern hemisphere: + 0.771 m/s

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ECMWF Report on ERS-2 RA for June 2009

Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: - 0.774 m/s

ERS-2 northern hemisphere: - 0.772 m/s

ERS-2 tropics (Hawaii): *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: +0.030 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: +0.044 m

ERS-2 tropics: +0.027 m

ERS-2 southern hemisphere: - 0.246 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: +0.116 m

ERS-2 northern hemisphere: + 0.120 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. 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 model was not changed during this month. However, the assimilation of Jason-1 significant wave height has been resumed since the 8th. of June 2009. The current operational IFS cycle is CY35R2 (since the 10th. of March 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 June 2009.

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

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

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

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

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

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

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

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

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

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

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for June 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 June 2009.

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Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for June 2009.
Figure 16: Global distribution of ECMWF wave heights for June 2009.
Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2009 (global).
Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2009 (northern hemisphere)
Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2009 (tropics)
Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for June 2009 (southern hemisphere)
Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2009 (global).
Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2009 (northern hemisphere).
Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for June 2009 (hawaii).
Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for June 2009.
Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to June 2009.
Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to June 2009.
Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for June 2009.

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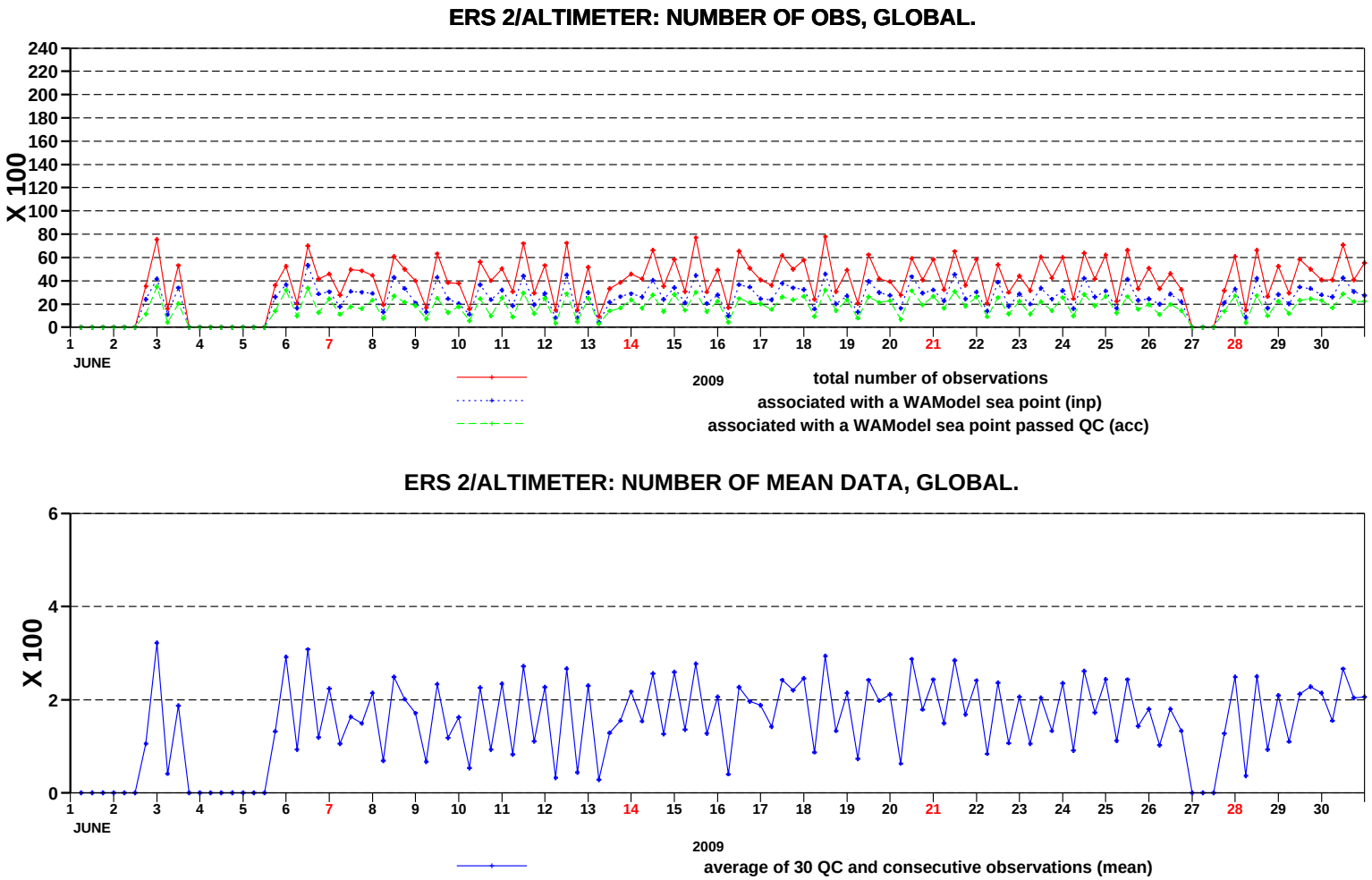


Figure 1:Time series of data reception for ERS-2 Altimeter data for June 2009

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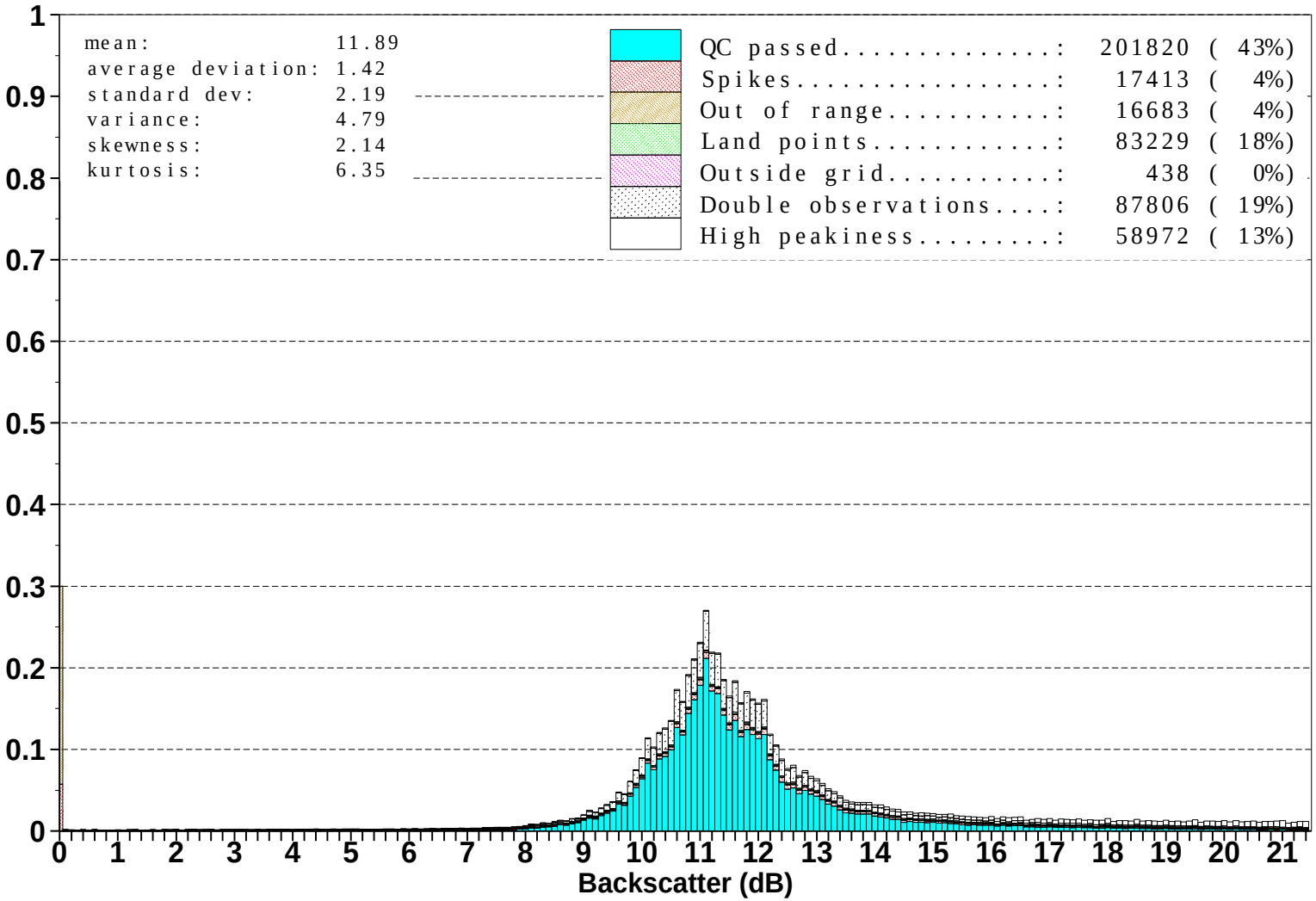


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for June 2009

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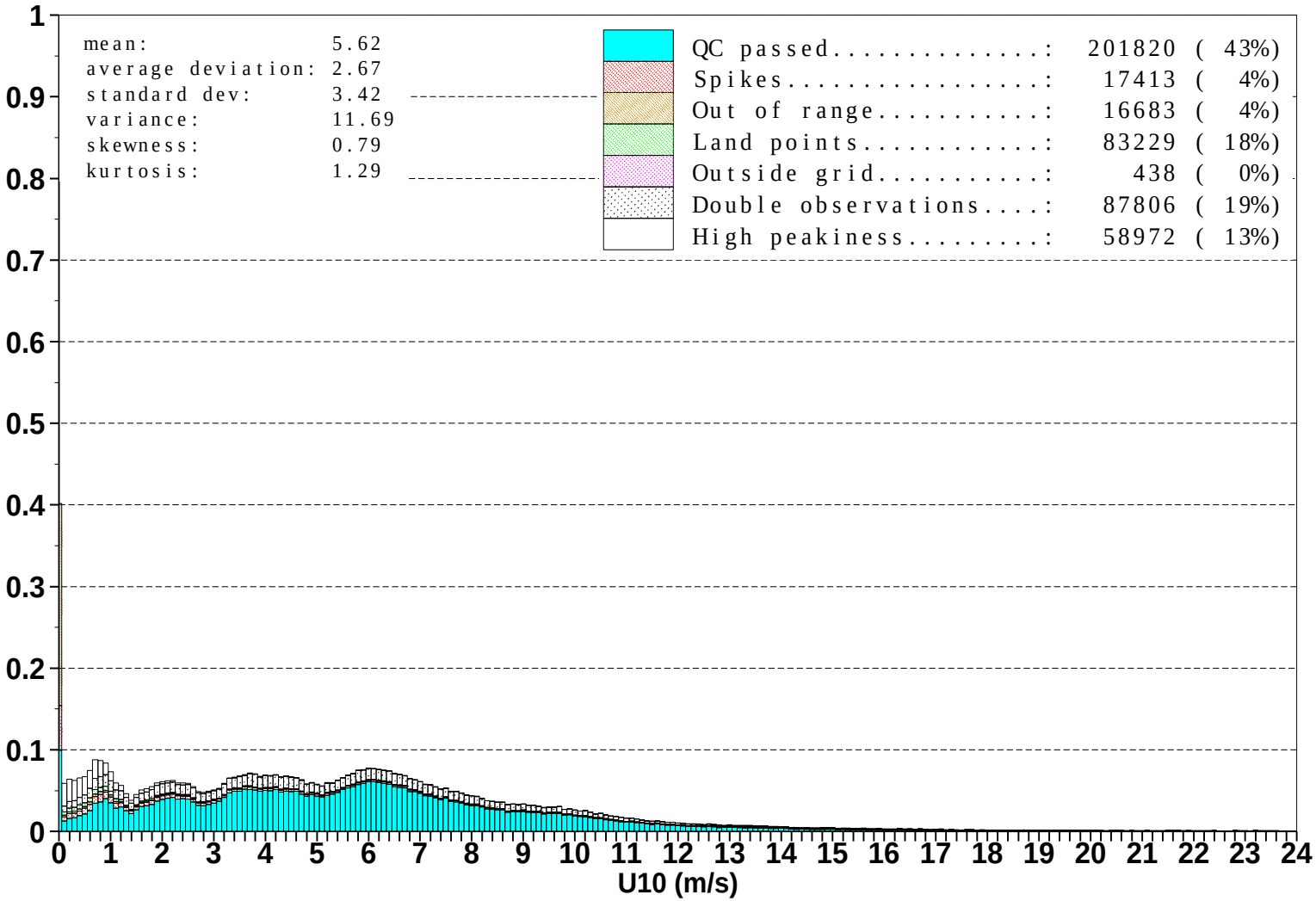


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for June 2009

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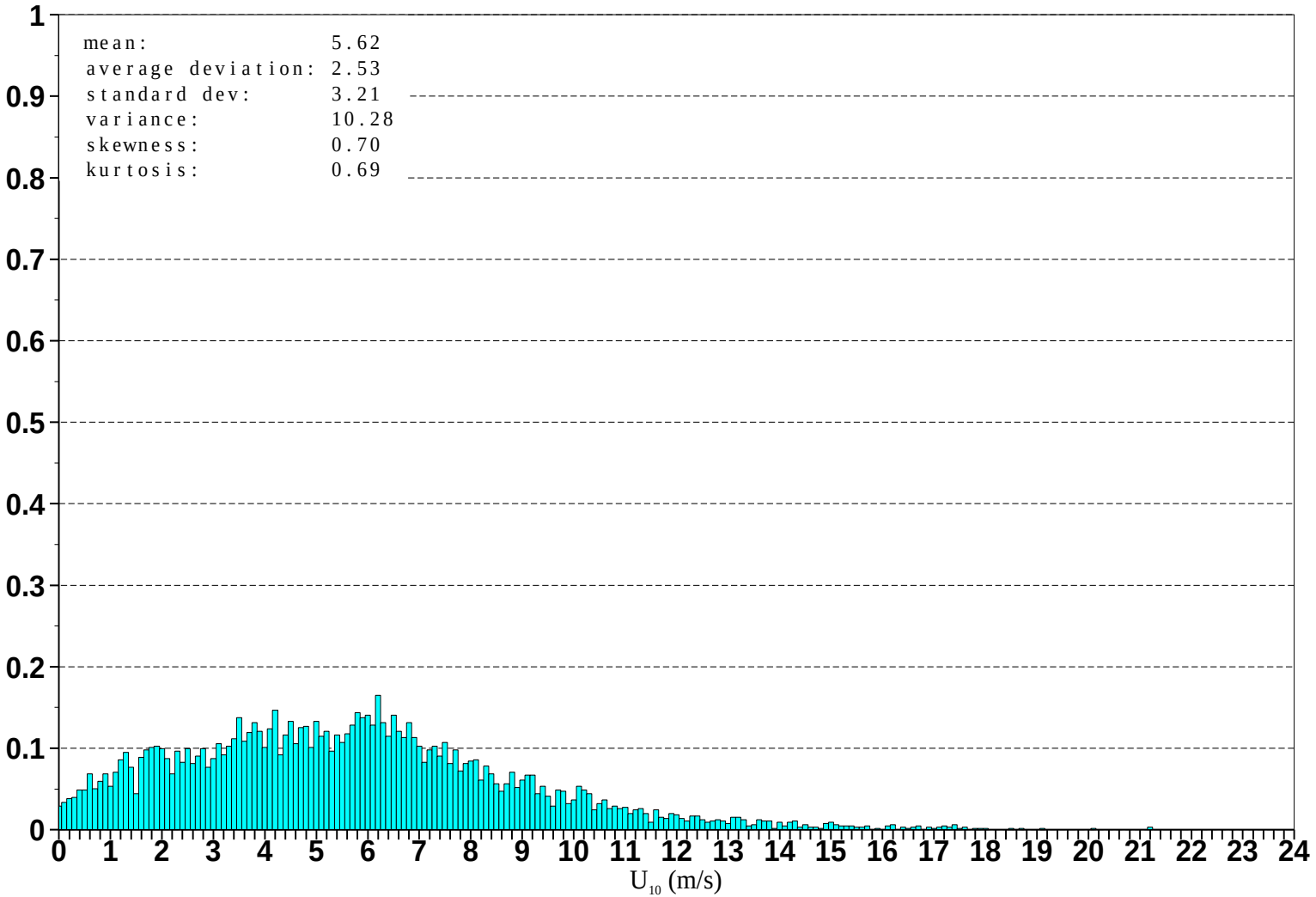


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for June 2009

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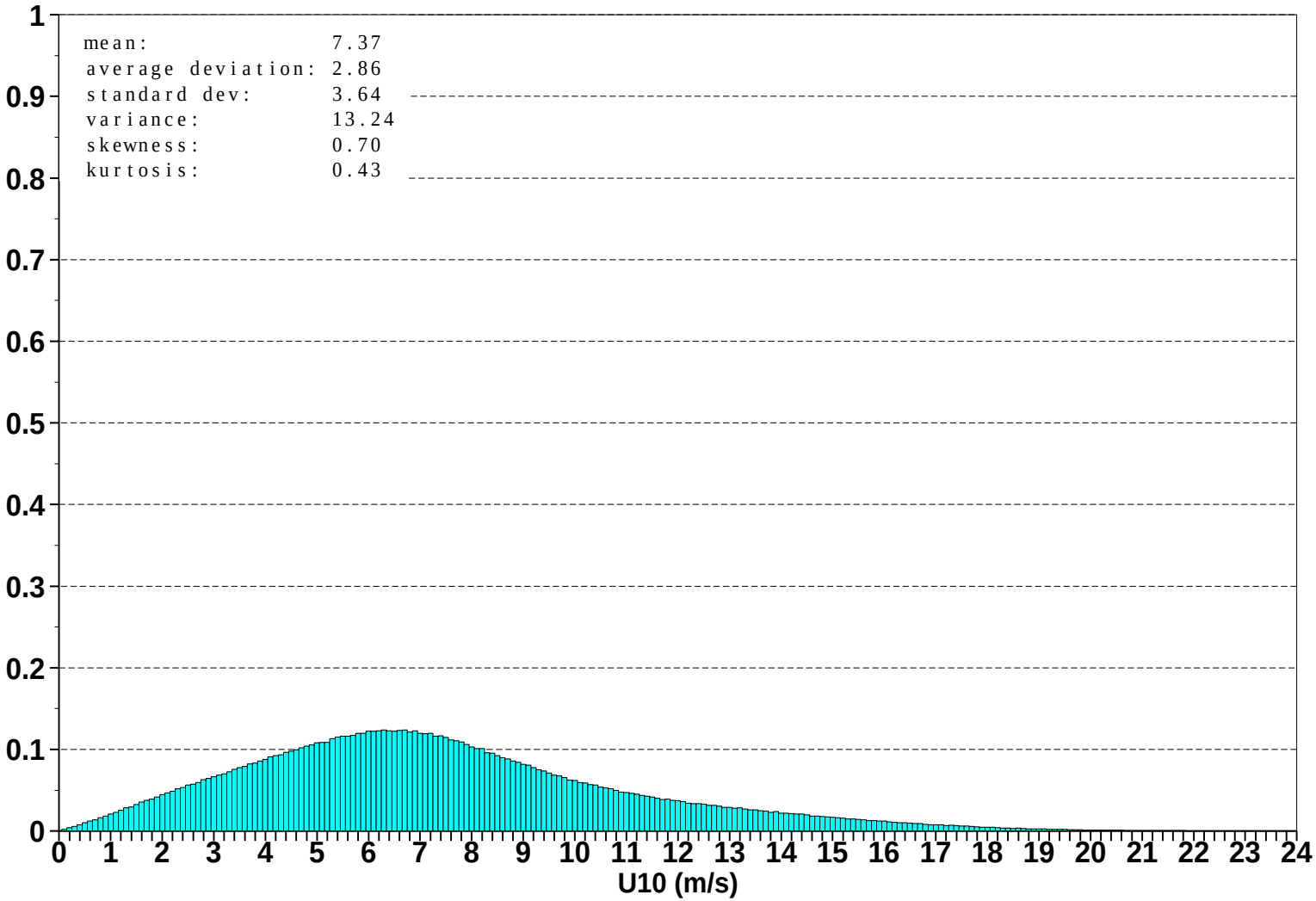
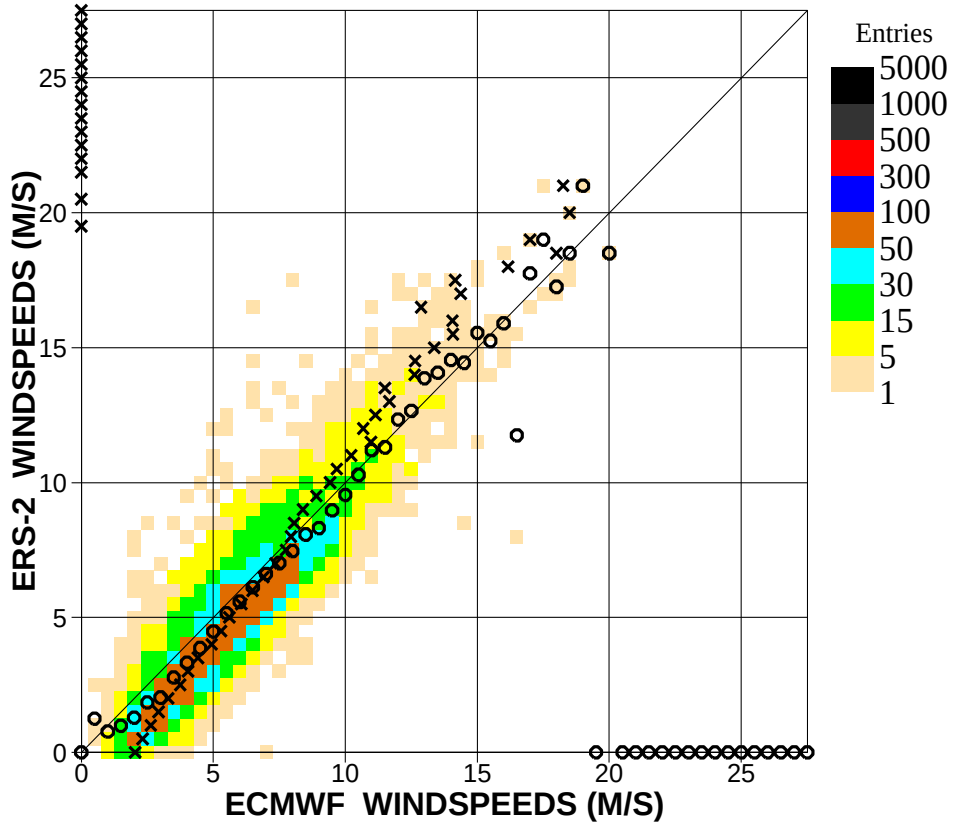


Figure 5: Global distribution of ECMWF ocean surface wind speeds for June 2009

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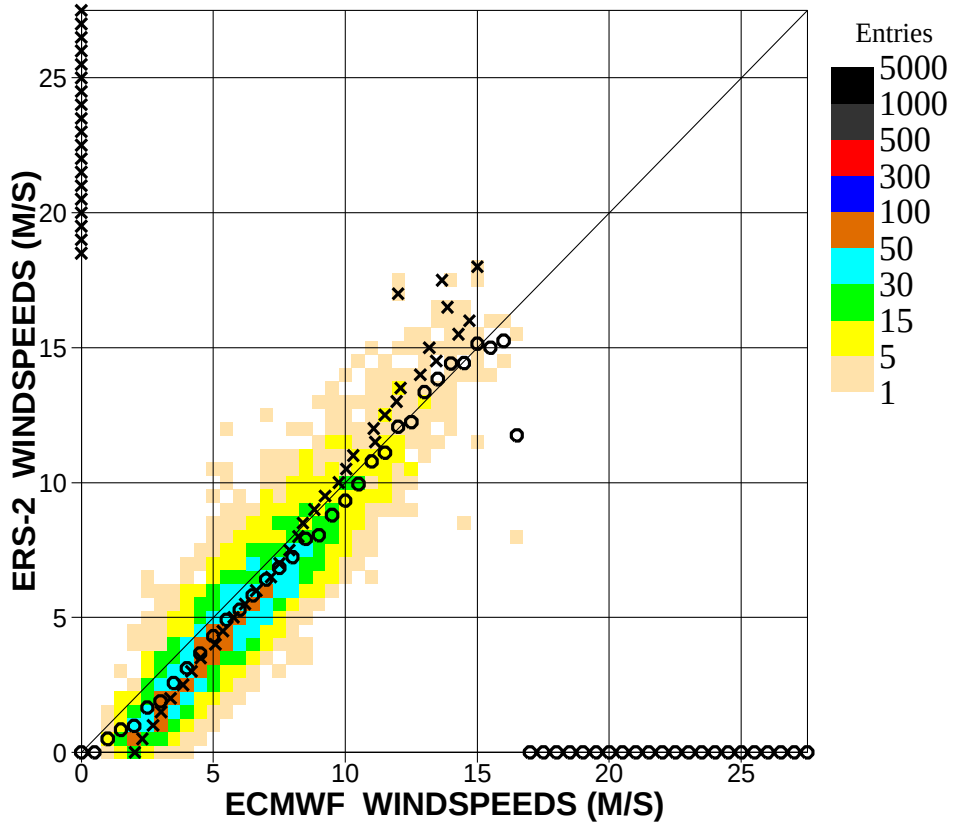
STATISTICS

ENTRIES	6540	
MEAN ECMWF	6.1147	
MEAN ERS-2	5.6178	
BIAS (ERS-2 - ECMWF)	-0.4969	
STANDARD DEVIATION	1.4254	
SCATTER INDEX	0.2331	
CORRELATION	0.8975	
SYMMETRIC SLOPE	0.9678	(0.0067)
REGR. COEFFICIENT	1.0668	(0.0065)
REGR. CONSTANT	-0.9056	(0.0433)

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

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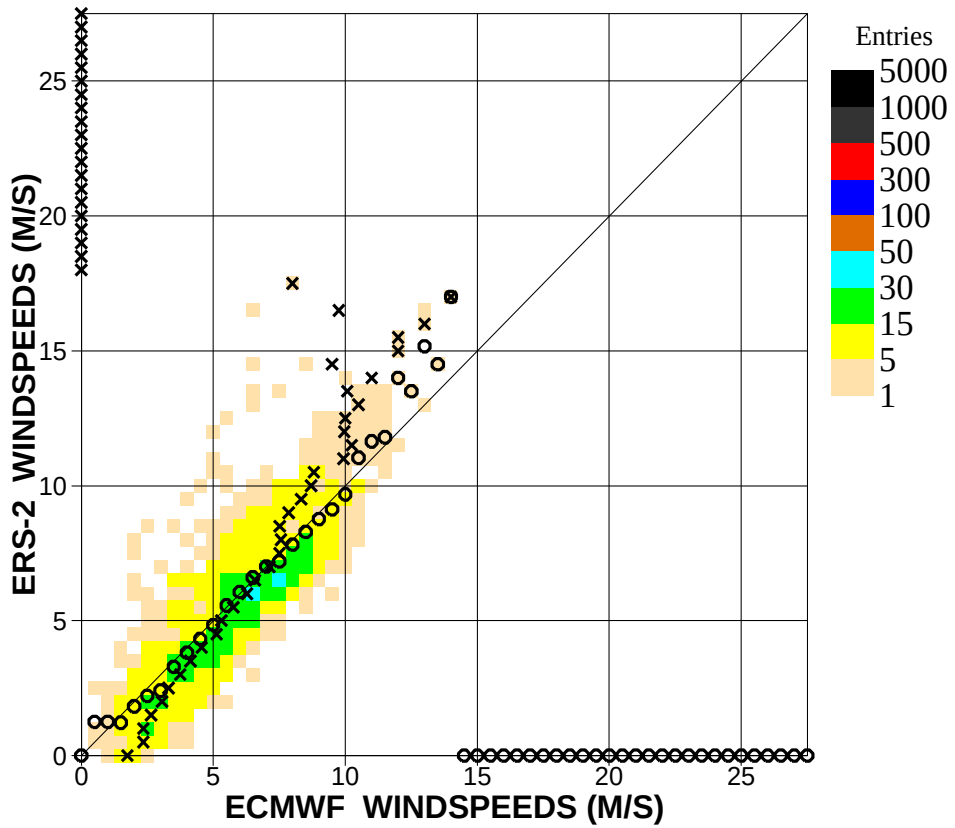


STATISTICS

ENTRIES	4409	
MEAN ECMWF	6.0715	
MEAN ERS-2	5.3485	
BIAS (ERS-2 - ECMWF)	-0.7231	
STANDARD DEVIATION	1.3056	
SCATTER INDEX	0.2150	
CORRELATION	0.9095	
SYMMETRIC SLOPE	0.9334	(0.0078)
REGR. COEFFICIENT	1.0630	(0.0073)
REGR. CONSTANT	-1.1057	(0.0485)

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

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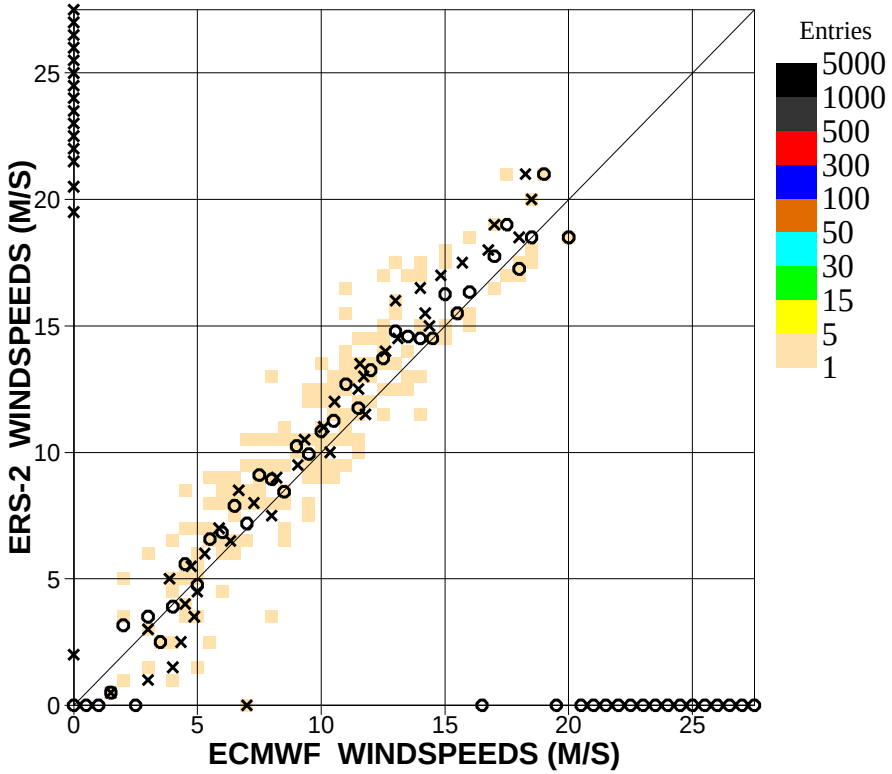
STATISTICS

ENTRIES	1988	
MEAN ECMWF	5.8571	
MEAN ERS-2	5.7363	
BIAS (ERS-2 - ECMWF)	-0.1209	
STANDARD DEVIATION	1.4895	
SCATTER INDEX	0.2543	
CORRELATION	0.8523	
SYMMETRIC SLOPE	1.0153	(0.0144)
REGR. COEFFICIENT	1.0378	(0.0143)
REGR. CONSTANT	-0.3422	(0.0901)

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

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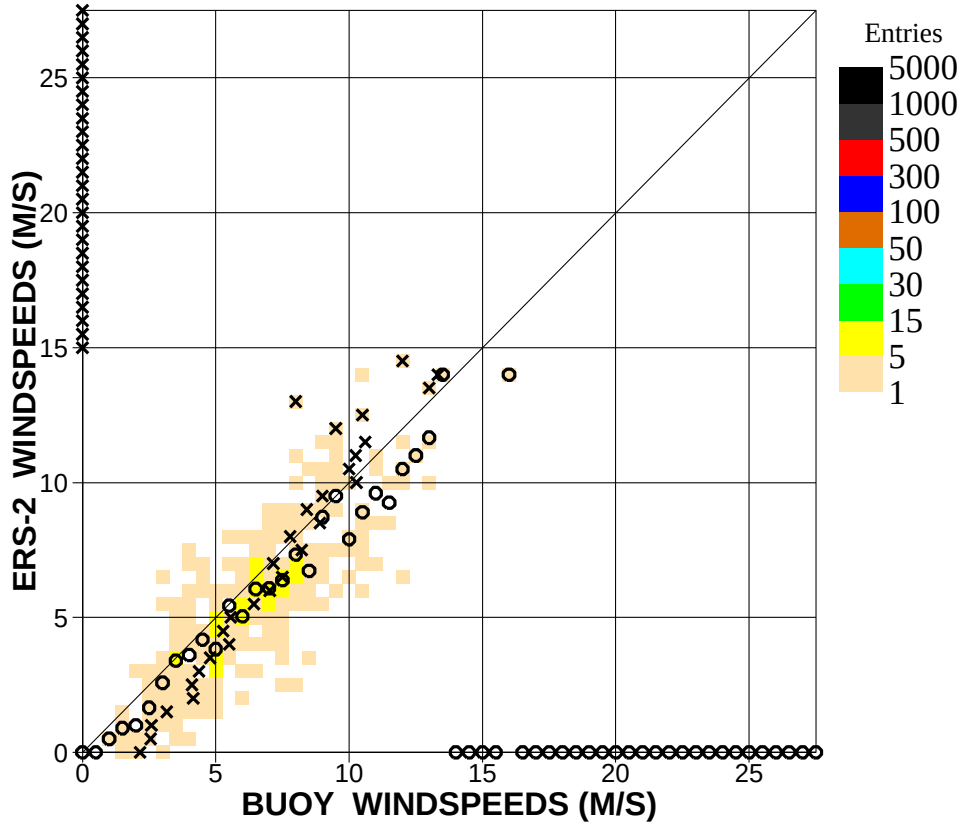
STATISTICS

ENTRIES	197	
MEAN ECMWF	9.7514	
MEAN ERS-2	10.5218	
BIAS (ERS-2 - ECMWF)	0.7705	
STANDARD DEVIATION	1.7802	
SCATTER INDEX	0.1826	
CORRELATION	0.9093	
SYMMETRIC SLOPE	1.0839	(0.0336)
REGR. COEFFICIENT	1.0142	(0.0332)
REGR. CONSTANT	0.6316	(0.3481)

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

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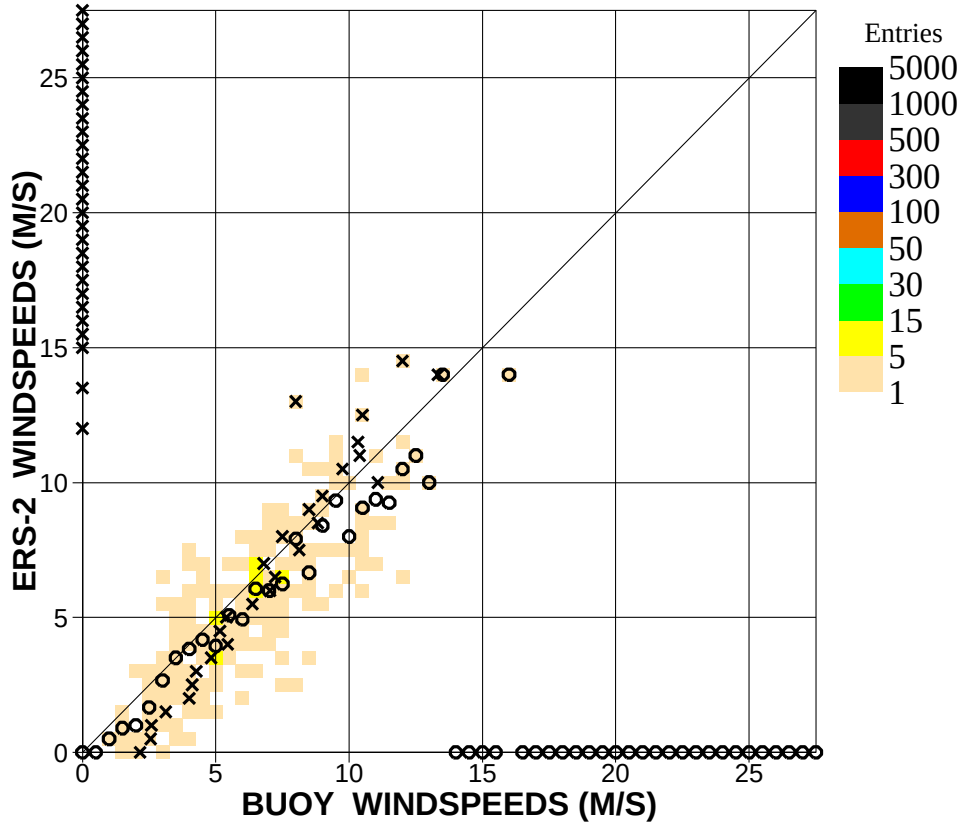


STATISTICS

ENTRIES	379	
MEAN BUOY	6.4713	
MEAN ERS-2	5.6974	
BIAS (ERS-2 - BUOY)	-0.7739	
STANDARD DEVIATION	1.5846	
SCATTER INDEX	0.2449	
CORRELATION	0.8255	
SYMMETRIC SLOPE	0.9147	(0.0329)
REGR. COEFFICIENT	0.9240	(0.0325)
REGR. CONSTANT	-0.2819	(0.2256)

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

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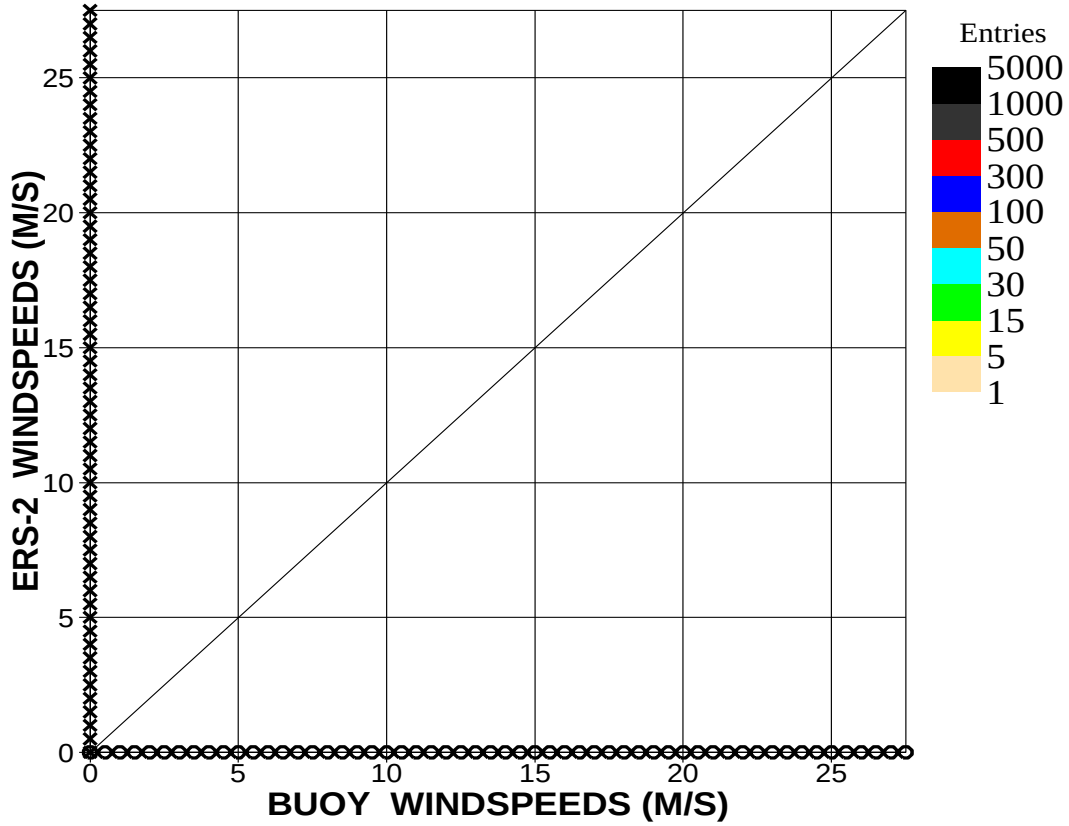


STATISTICS

ENTRIES	282	
MEAN BUOY	6.1904	
MEAN ERS-2	5.4181	
BIAS (ERS-2 - BUOY)	-0.7723	
STANDARD DEVIATION	1.6757	
SCATTER INDEX	0.2707	
CORRELATION	0.8130	
SYMMETRIC SLOPE	0.9113	(0.0385)
REGR. COEFFICIENT	0.8906	(0.0381)
REGR. CONSTANT	-0.0951	(0.2557)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for June 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 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for June 2009 (hawaii)

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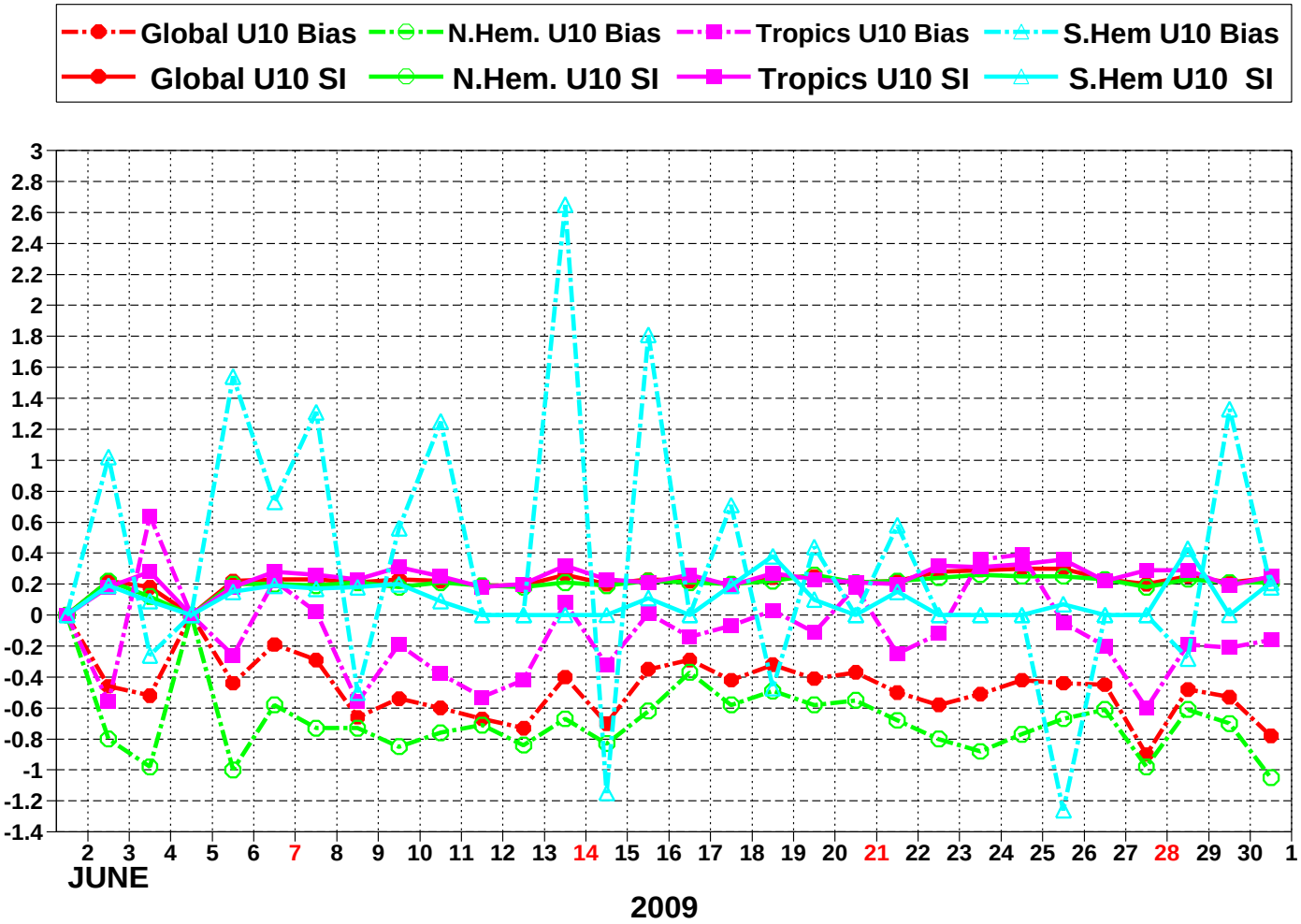


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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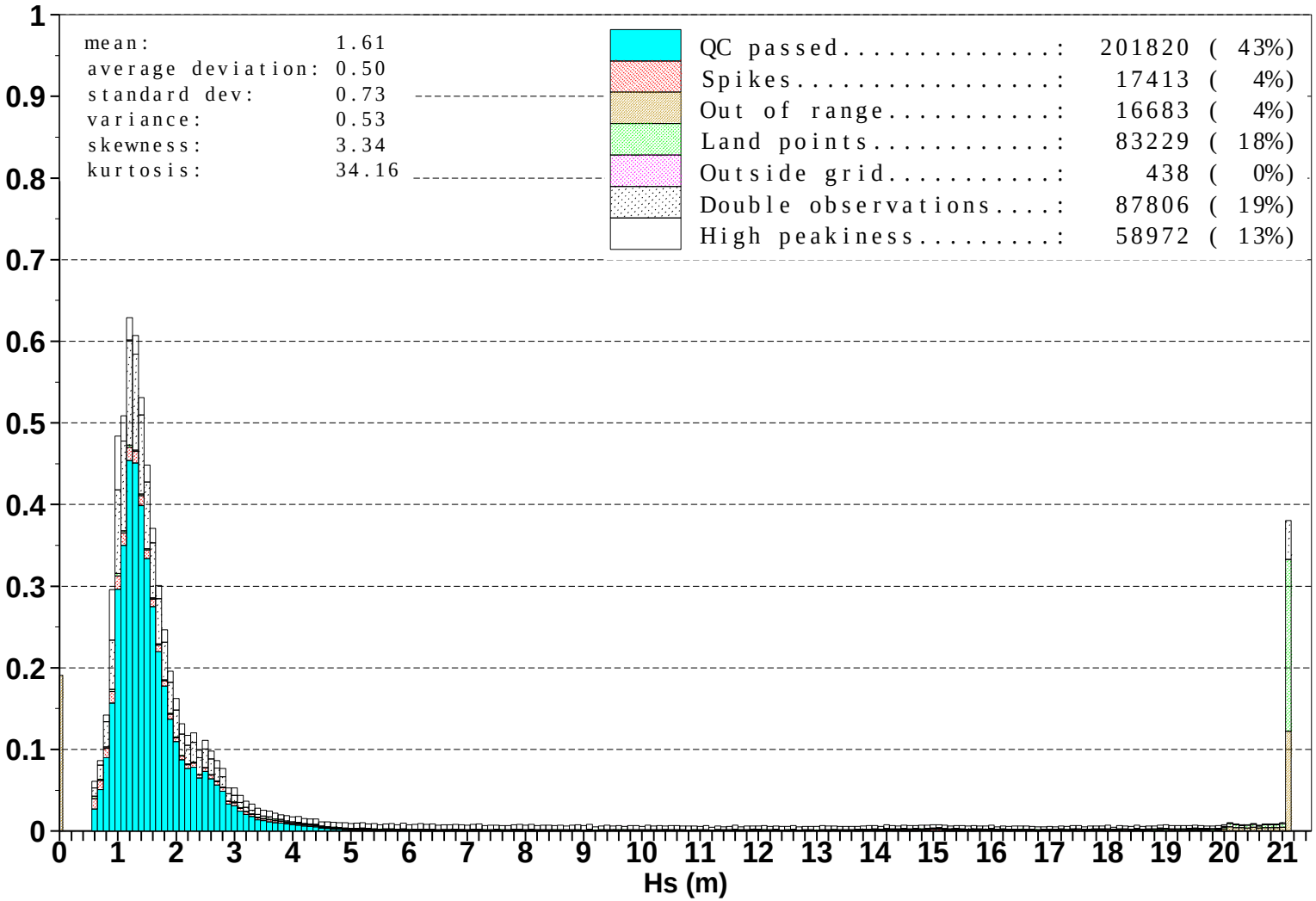


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for June 2009

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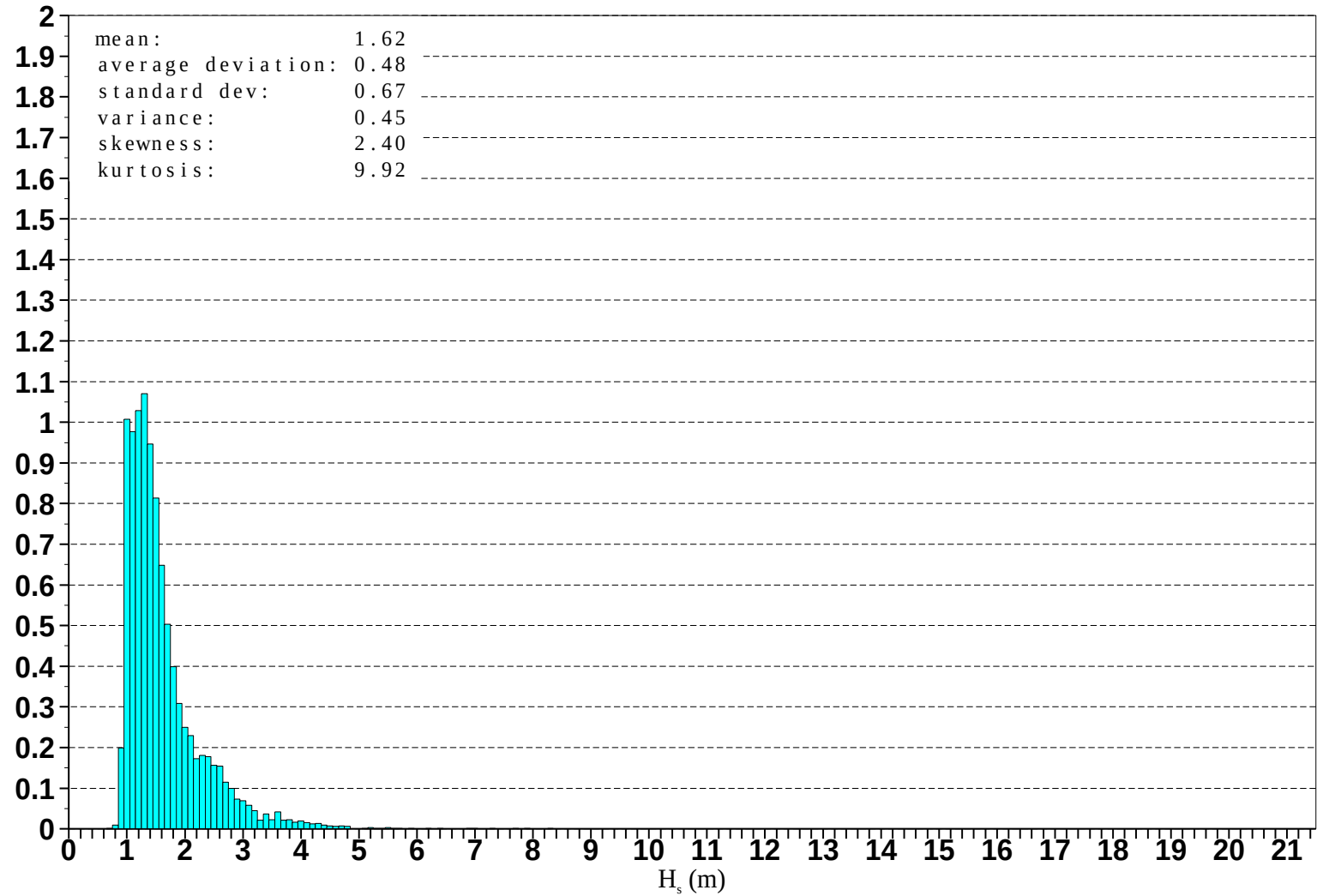


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for June 2009

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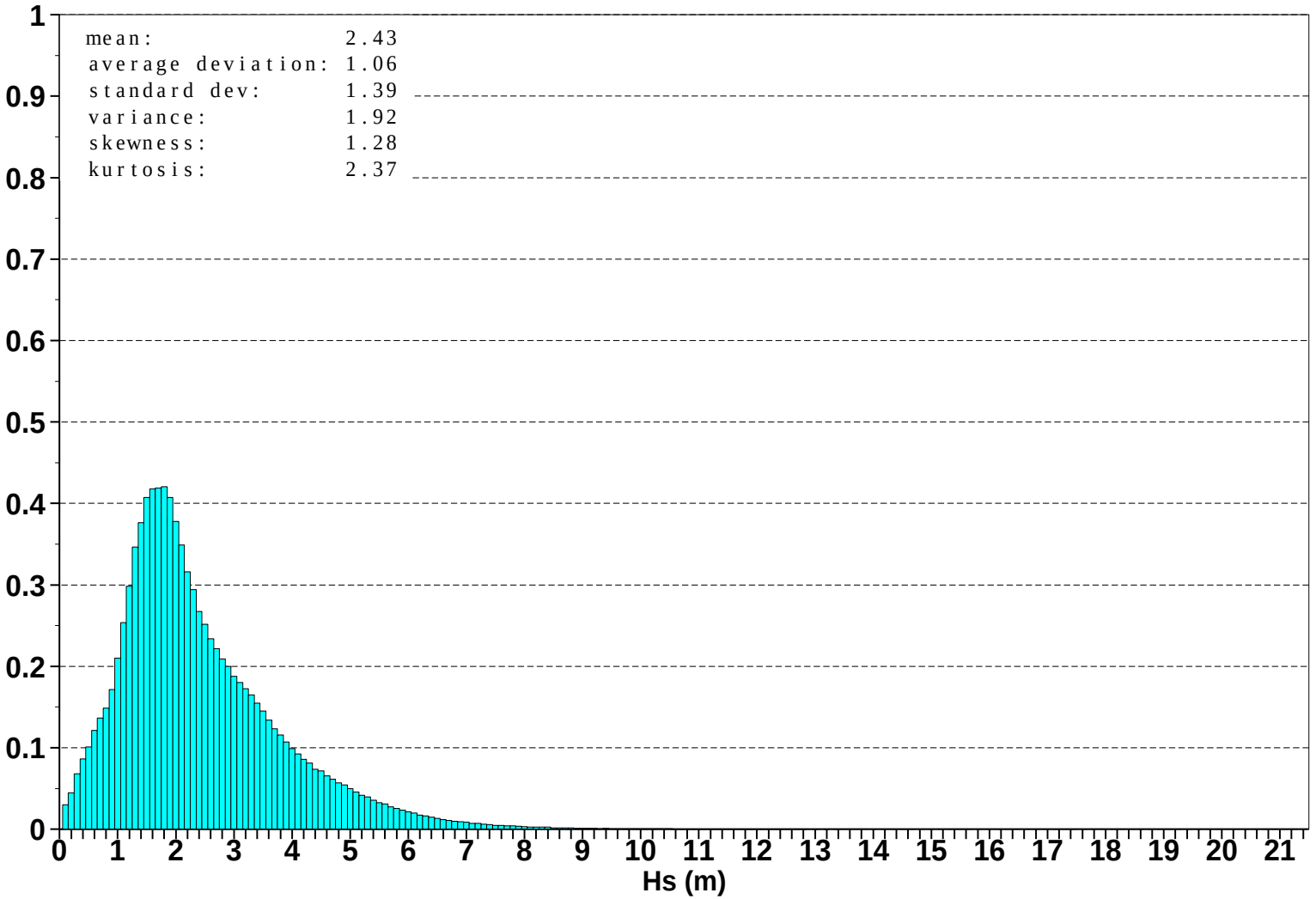
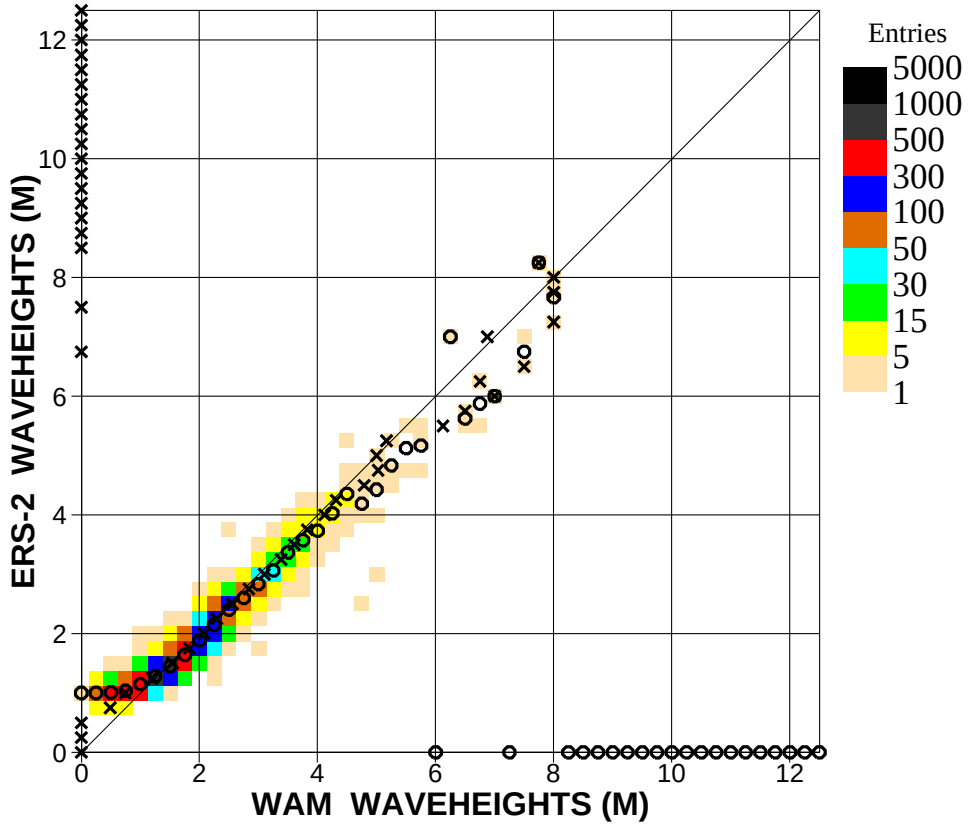


Figure 16: Global distribution of ECMWF wave heights for June 2009

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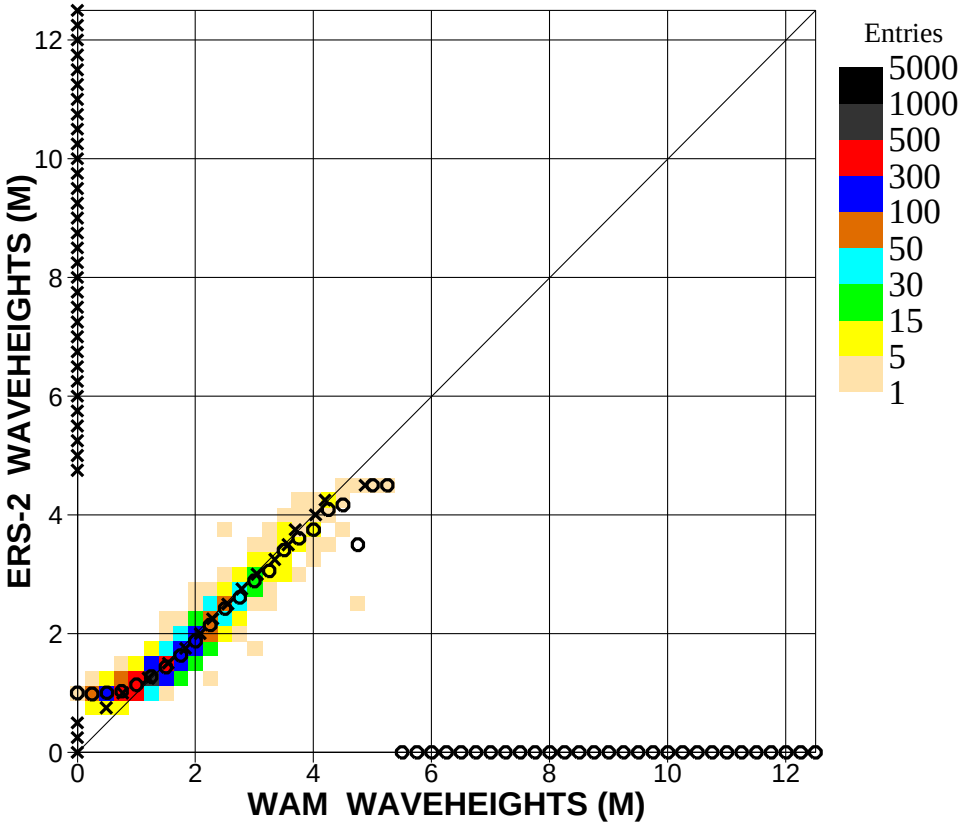


STATISTICS

ENTRIES	6540	
MEAN WAM	1.5871	
MEAN ERS-2	1.6173	
BIAS (ERS-2 - WAM)	0.0302	
STANDARD DEVIATION	0.2375	
SCATTER INDEX	0.1496	
CORRELATION	0.9628	
SYMMETRIC SLOPE	0.9854	(0.0036)
REGR. COEFFICIENT	0.8094	(0.0028)
REGR. CONSTANT	0.3327	(0.0050)

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

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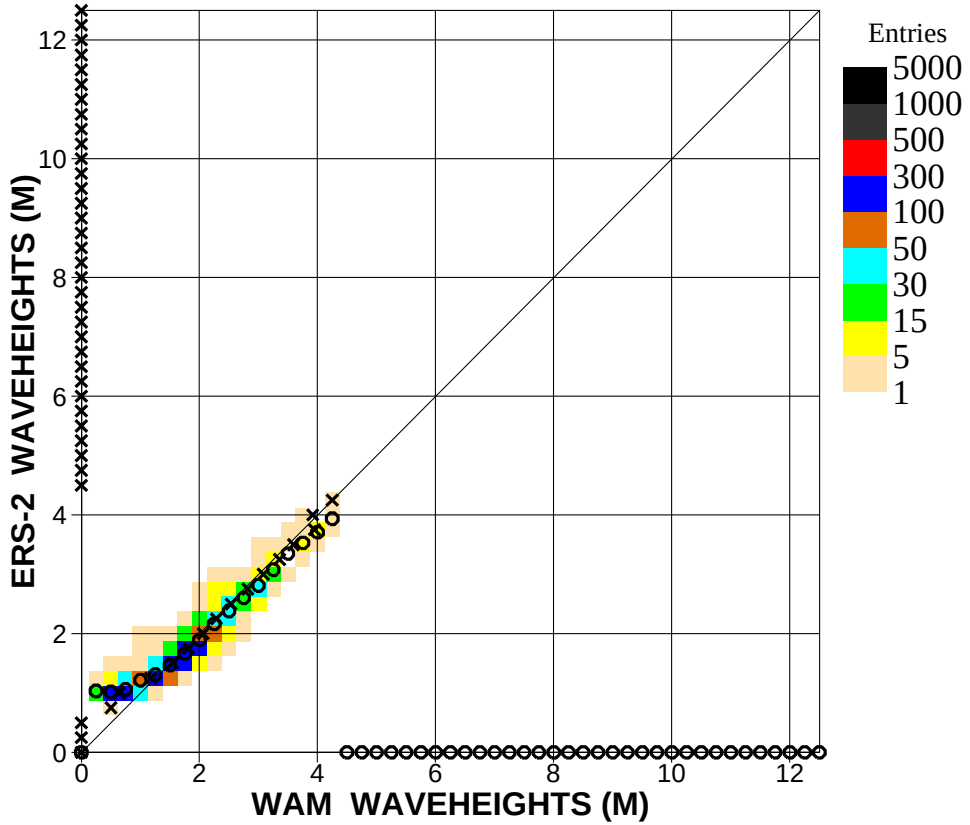


STATISTICS

ENTRIES	4409	
MEAN WAM	1.4643	
MEAN ERS-2	1.5083	
BIAS (ERS-2 - WAM)	0.0440	
STANDARD DEVIATION	0.2205	
SCATTER INDEX	0.1506	
CORRELATION	0.9525	
SYMMETRIC SLOPE	0.9976	(0.0051)
REGR. COEFFICIENT	0.7841	(0.0038)
REGR. CONSTANT	0.3601	(0.0061)

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

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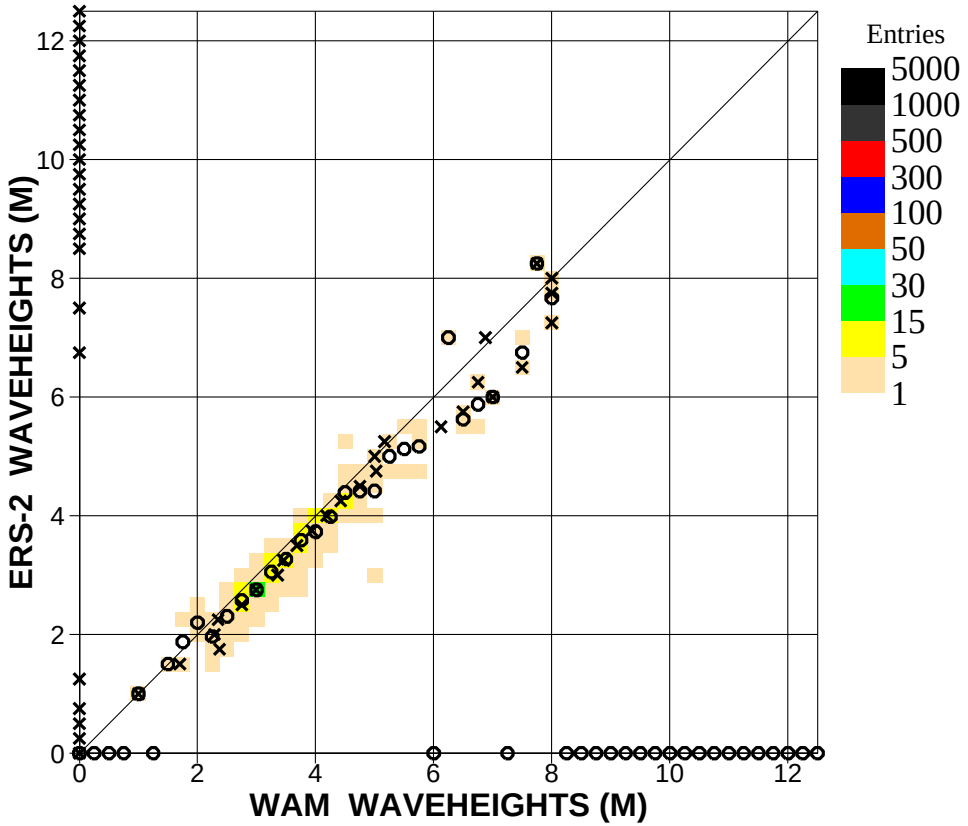


STATISTICS

ENTRIES	1988	
MEAN WAM	1.6472	
MEAN ERS-2	1.6739	
BIAS (ERS-2 - WAM)	0.0267	
STANDARD DEVIATION	0.2453	
SCATTER INDEX	0.1489	
CORRELATION	0.9477	
SYMMETRIC SLOPE	0.9865	(0.0078)
REGR. COEFFICIENT	0.7590	(0.0057)
REGR. CONSTANT	0.4236	(0.0103)

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

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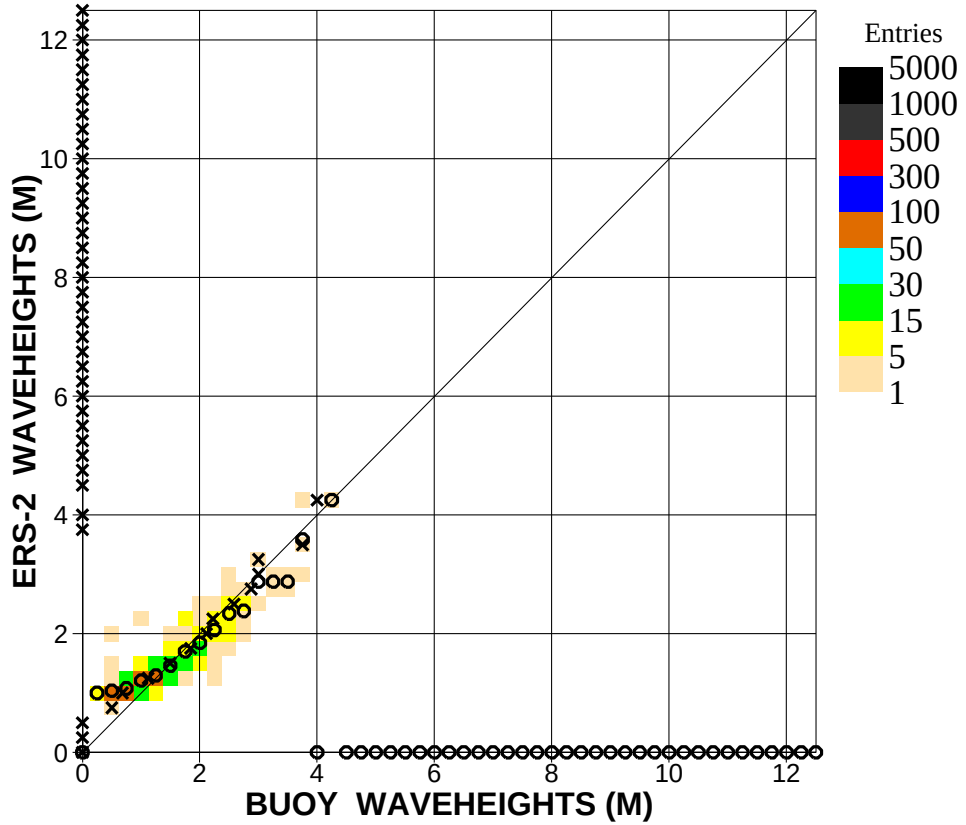


STATISTICS

ENTRIES	197	
MEAN WAM	3.7353	
MEAN ERS-2	3.4896	
BIAS (ERS-2 - WAM)	-0.2457	
STANDARD DEVIATION	0.3279	
SCATTER INDEX	0.0878	
CORRELATION	0.9666	
SYMMETRIC SLOPE	0.9362	(0.0175)
REGR. COEFFICIENT	0.9209	(0.0175)
REGR. CONSTANT	0.0497	(0.0690)

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

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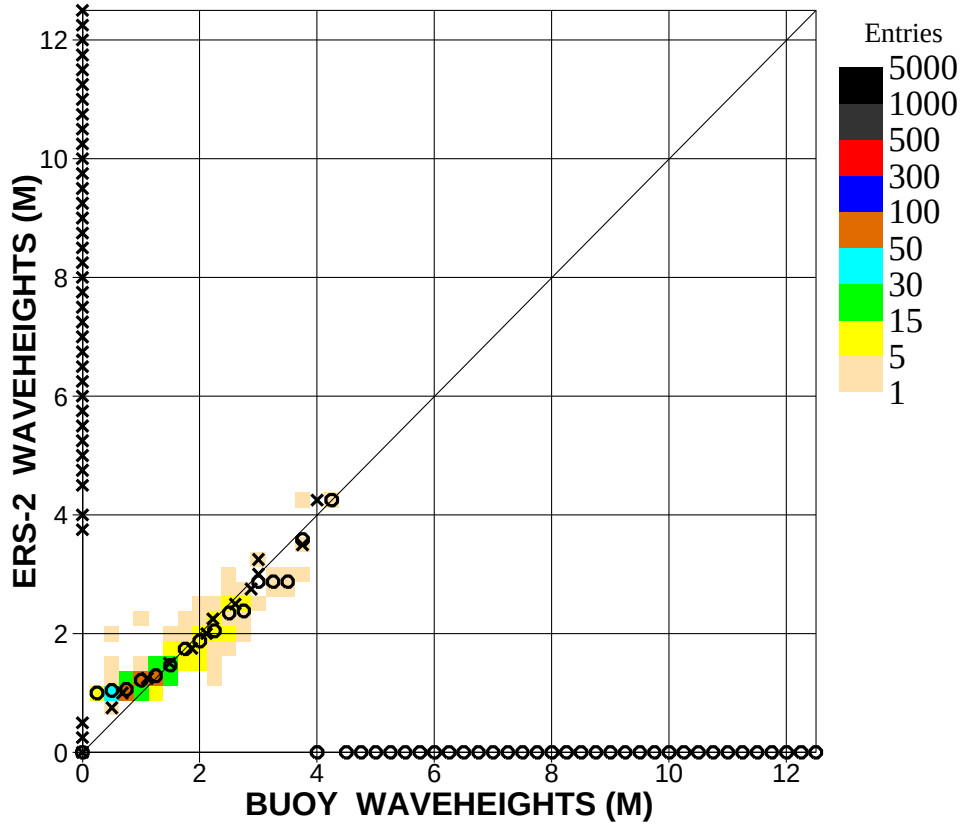


STATISTICS

ENTRIES	592	
MEAN BUOY	1.3344	
MEAN ERS-2	1.4500	
BIAS (ERS-2 - BUOY)	0.1156	
STANDARD DEVIATION	0.3098	
SCATTER INDEX	0.2322	
CORRELATION	0.9039	
SYMMETRIC SLOPE	1.0245	(0.0205)
REGR. COEFFICIENT	0.6563	(0.0128)
REGR. CONSTANT	0.5743	(0.0191)

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

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STATISTICS

ENTRIES	479	
MEAN BUOY	1.3485	
MEAN ERS-2	1.4683	
BIAS (ERS-2 - BUOY)	0.1198	
STANDARD DEVIATION	0.3167	
SCATTER INDEX	0.2349	
CORRELATION	0.9099	
SYMMETRIC SLOPE	1.0237	(0.0221)
REGR. COEFFICIENT	0.6706	(0.0140)
REGR. CONSTANT	0.5640	(0.0213)

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

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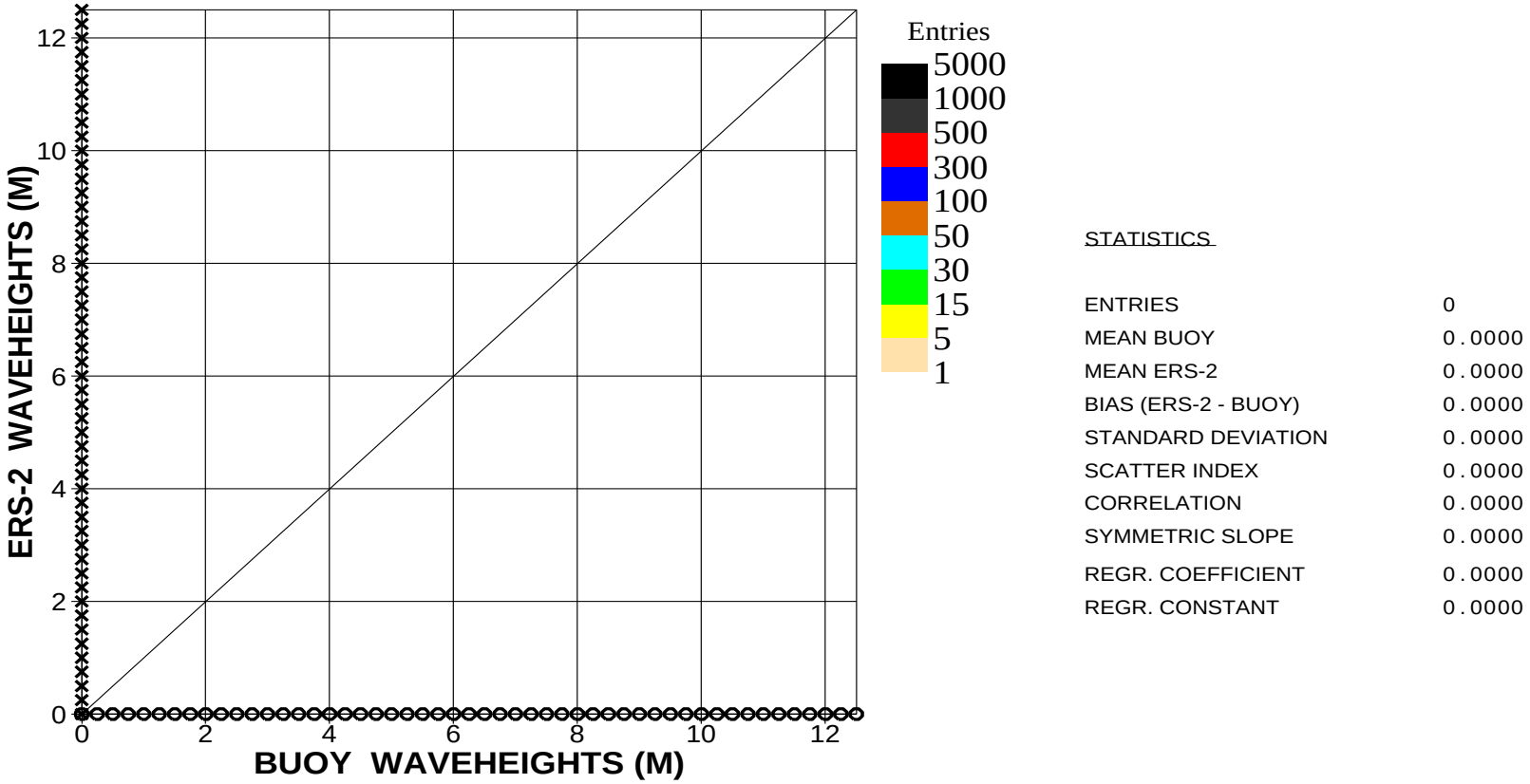


Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for June 2009 (hawaii)

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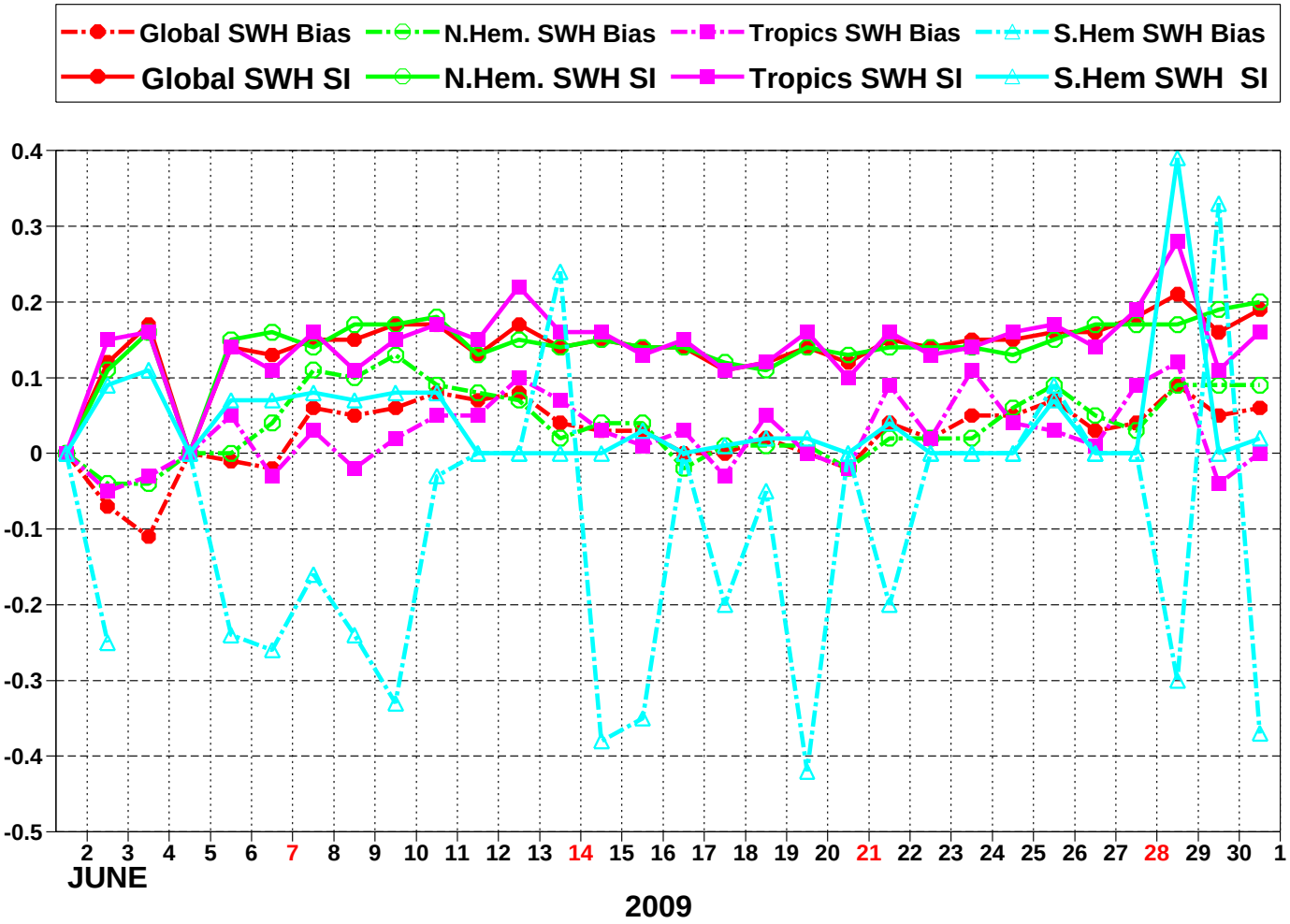


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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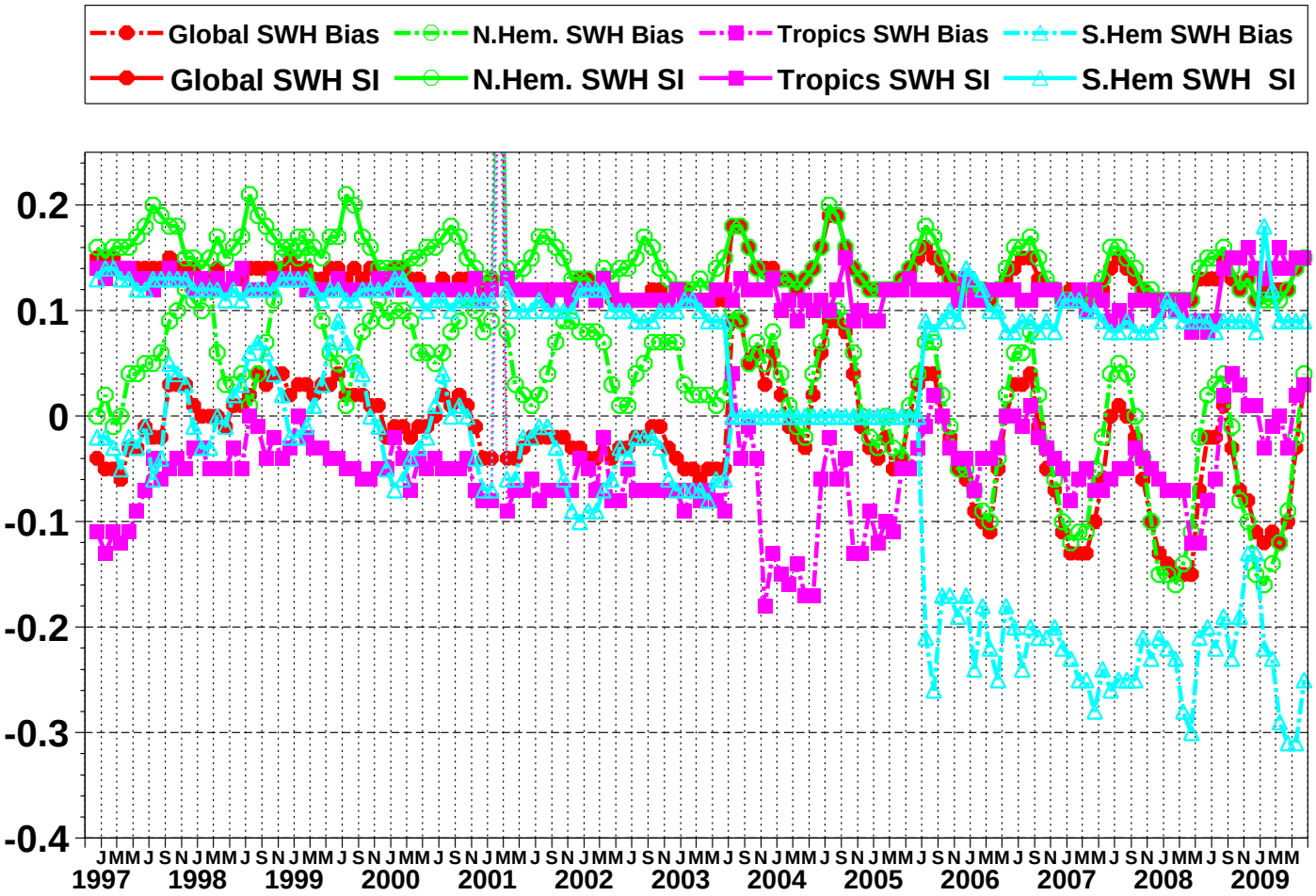


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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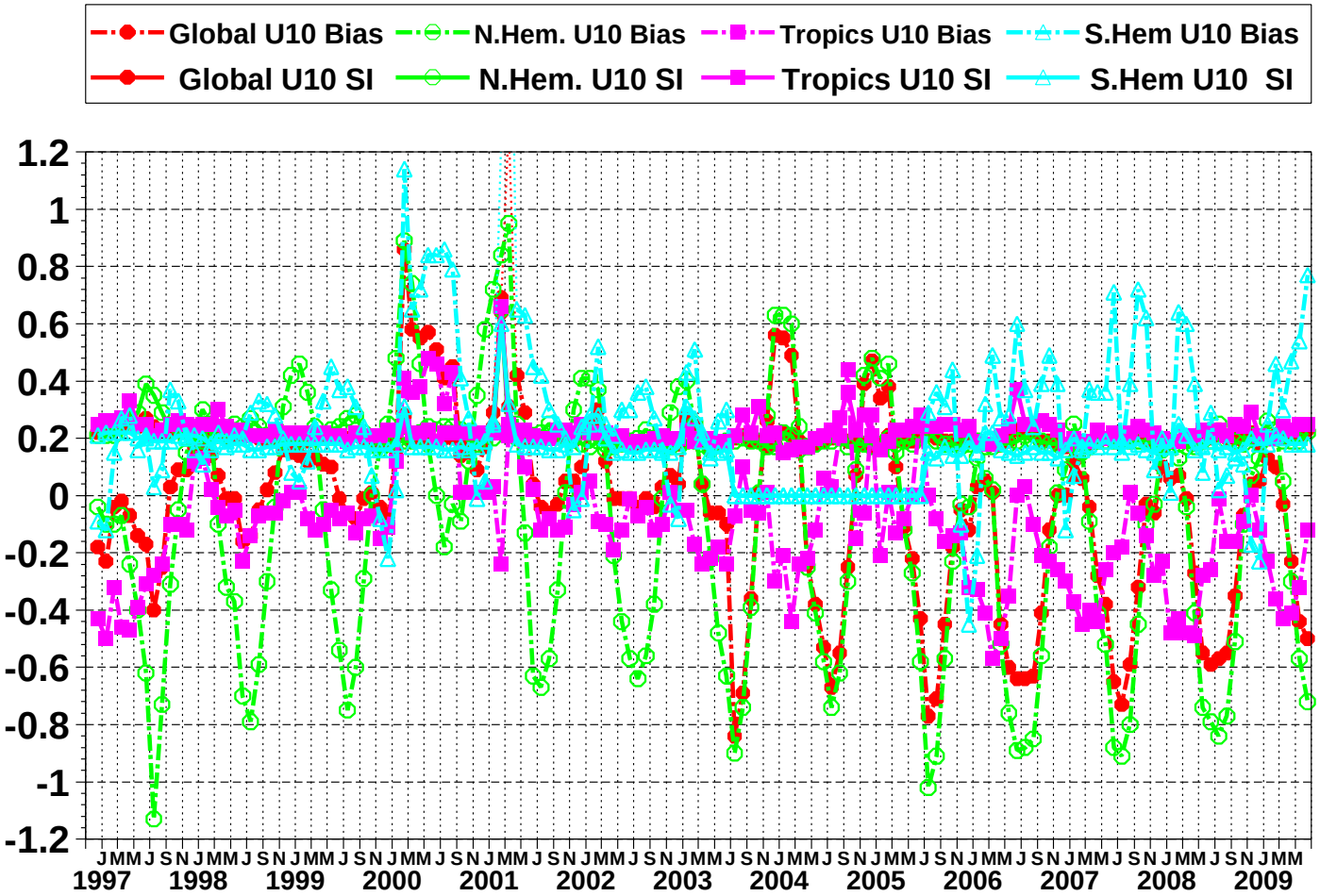


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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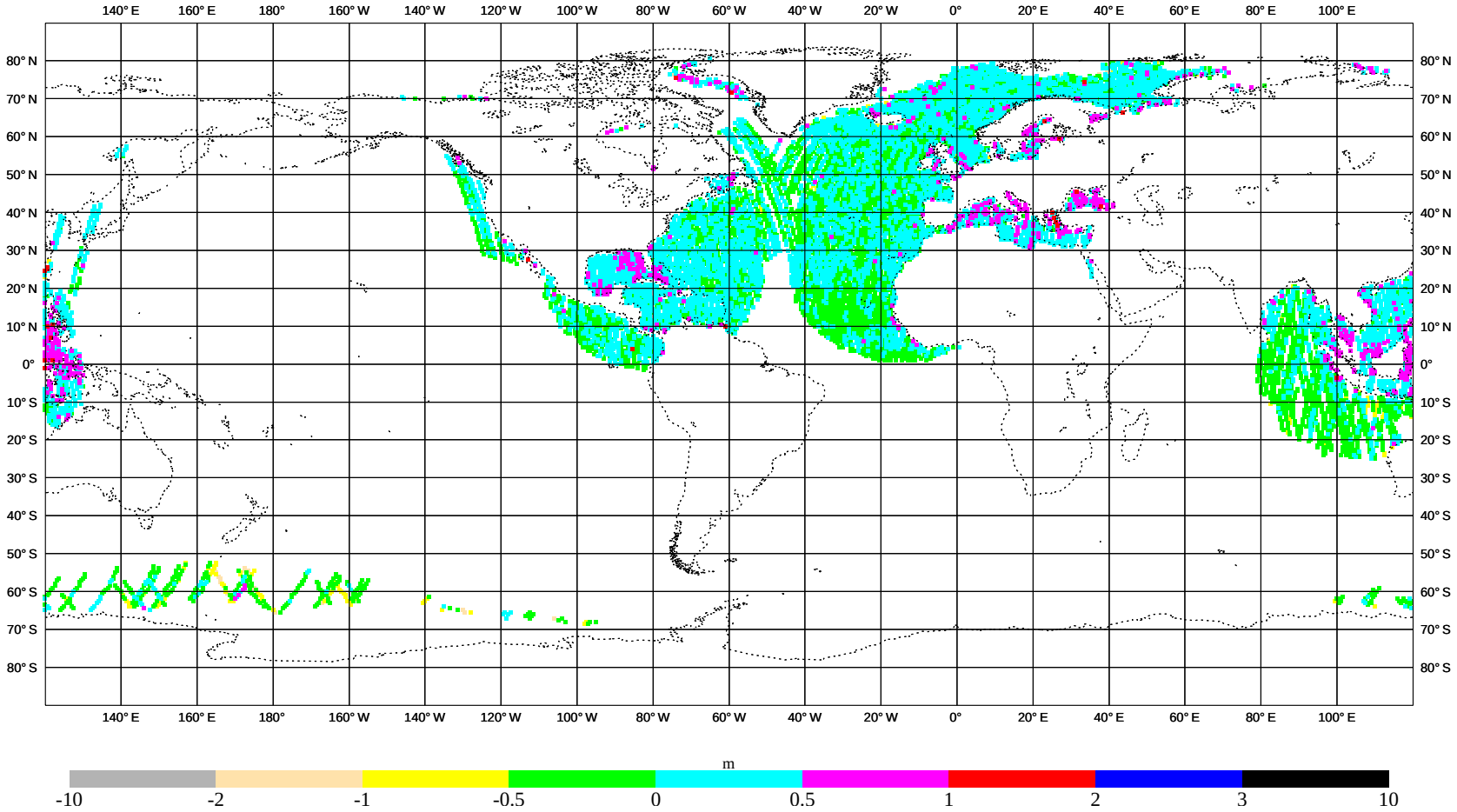


Figure 27: Significant wave height: Monthly mean difference of ERS-2 altimeter data minus wave model results for June 2009.

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