ECMWF Report on ERS-2 RA for October 2004

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

By: *Saleh Abdalla*

Date: *15 November 2004*

Overview:

Based on the data received during the whole month, on average, 3641 observations arrived at ECMWF every 6 hours of which 74.37% passed the quality control. The data coverage has been significantly reduced to around 15% of the nominal data reception following the failure of the ERS-2 tape recorders. As can be seen in Figure 1, there was no time windows with missing data (apart from significant reduction of data at few time windows). Note that we are talking about the raw data which have arrived at ECMWF before they were processed. The quality of the received data, which are now limited to the **North Atlantic and the western coast of North America**, is as good as usual.

Backscatter:

ESR-2 $<\sigma_0>$ = 11.18 dB (with two main peaks at ~10.6 dB and at 11.3 and other minor peaks).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: +0.070 m/s

ERS-2 northern hemisphere: +0.086 m/s

ERS-2 tropics: -0.148 m/s

ERS-2 southern hemisphere: *missing*

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ECMWF Report on ERS-2 RA for October 2004

Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: -0.409 m/s

ERS-2 northern hemisphere: -0.408 m/s

ERS-2 tropics: *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: 0.043 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: 0.057 m

ERS-2 tropics: -0.130 m

ERS-2 southern hemisphere: *missing*

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.130 m

ERS-2 northern hemisphere: -0.133 m

ERS-2 tropics: *missing*

Remarks:

- The quality of Altimeter data, both wind speed and significant wave height, is as good as it used to be.
- 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

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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. ESA has the intention to extend the coverage of the Real Time Low Rate acquisition over the North Atlantic in the near future.

- Assimilation of ERS-2 RA wave heights into ECMWF wave model was stopped on 21st. of October 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 if they were not so close).
- ENVISAT Ku-Band wave height data and ERS-2 SAR wave data are assimilated in the ECMWF wave model.
- There was no ECMWF model changes this month (latest change was to CY28R3 on the 28th. of September 2004).

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 October 2004.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for October 2004.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for October 2004.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for October 2004.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for October 2004.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for October 2004 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for October 2004 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for October 2004 (tropics)

Figure 9: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for October 2004 (southern hemisphere)

Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for October 2004 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for October 2004 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for October 2004 (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 October 2004.

Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for October 2004.

Figure 16: Global distribution of ECMWF wave heights for October 2004.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for October 2004 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for October 2004 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for October 2004 (tropics)

Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for October 2004 (southern hemisphere)

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Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for October 2004 (global).
Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for October 2004 (northern hemisphere).
Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for October 2004 (tropics).
Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for October 2004.
Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to October 2004
Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to October 2004

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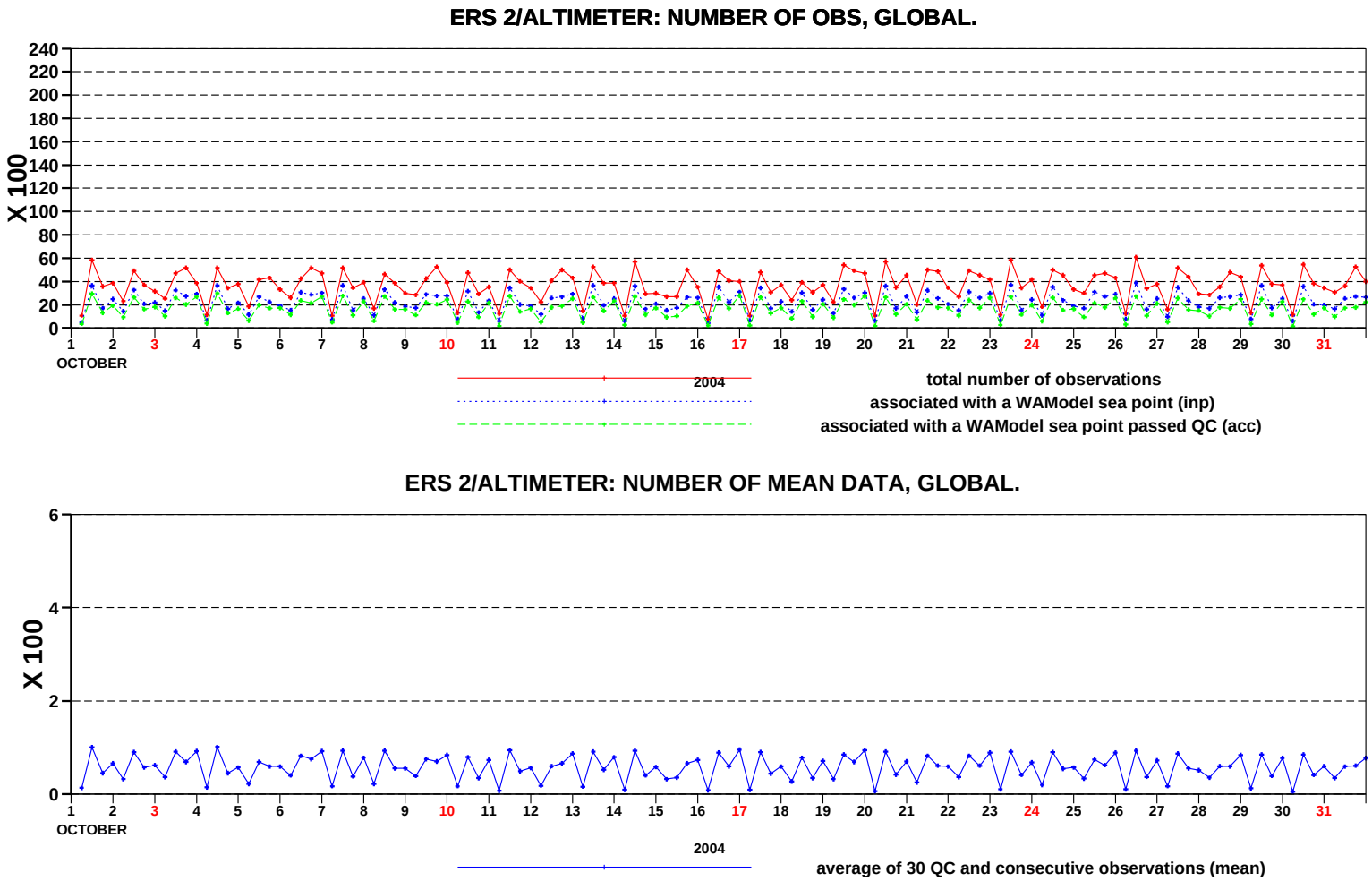


Figure 1: Time series of data reception for ERS-2 Altimeter data for October 2004

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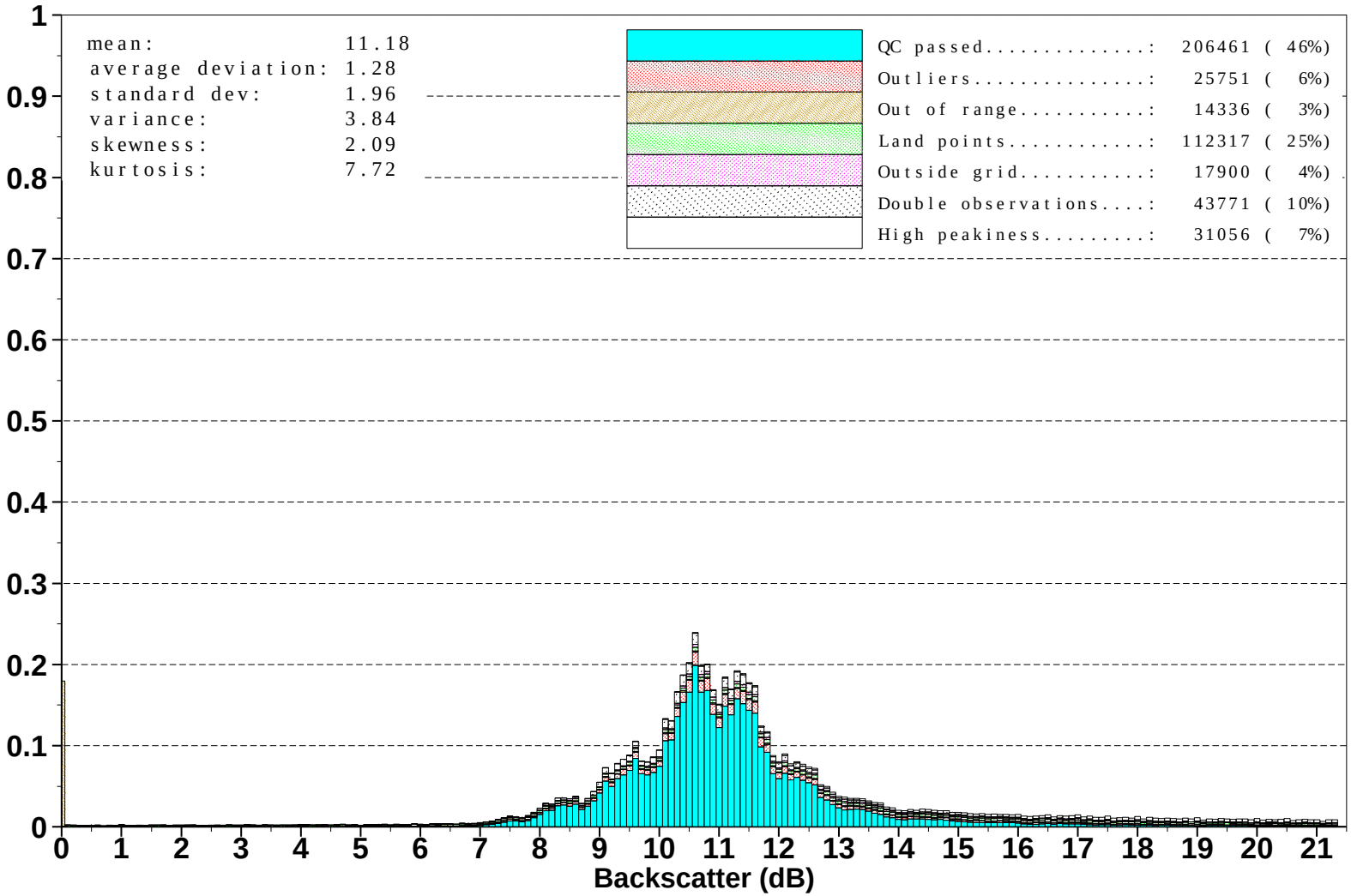


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for October 2004

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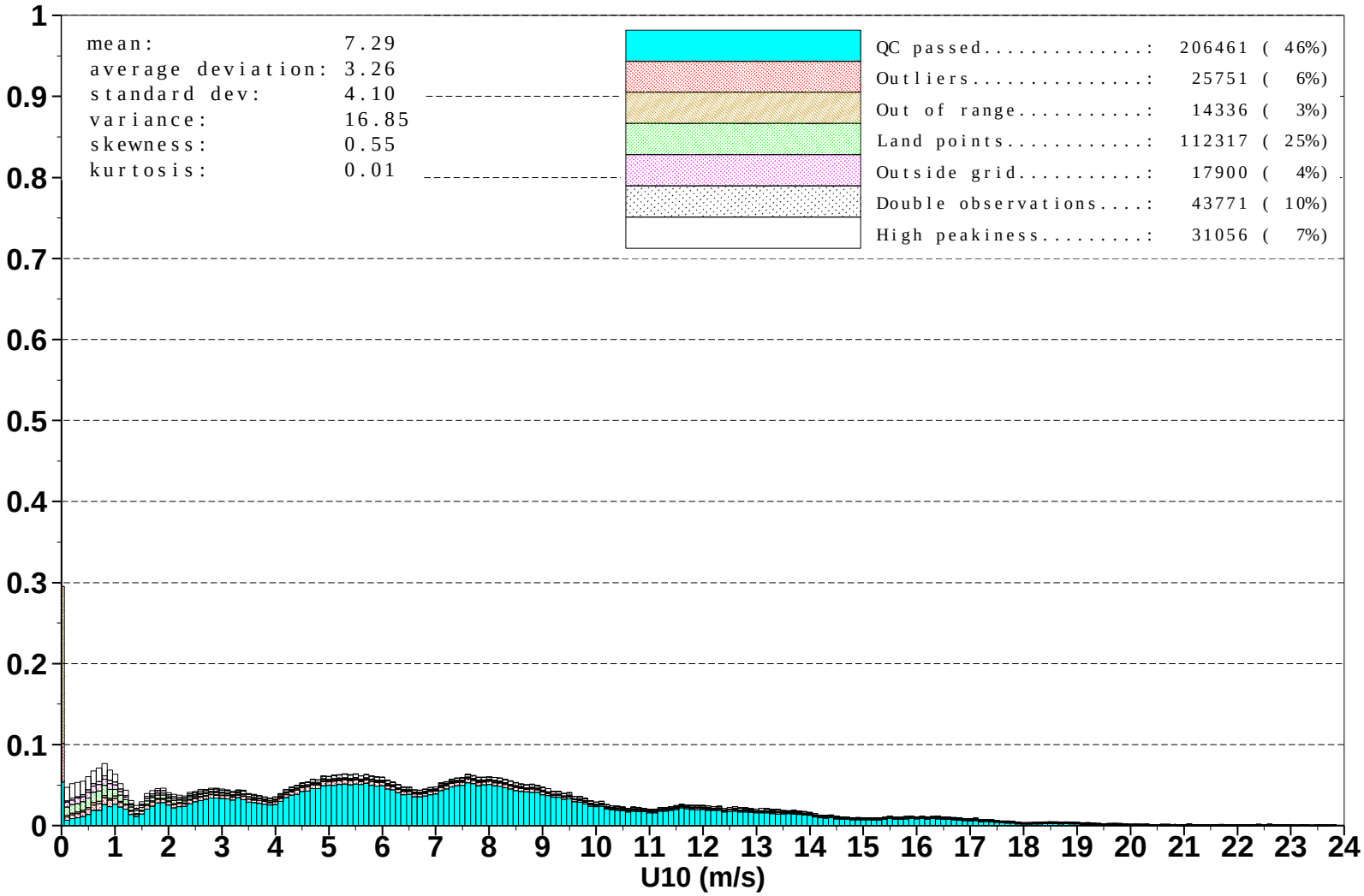


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for October 2004

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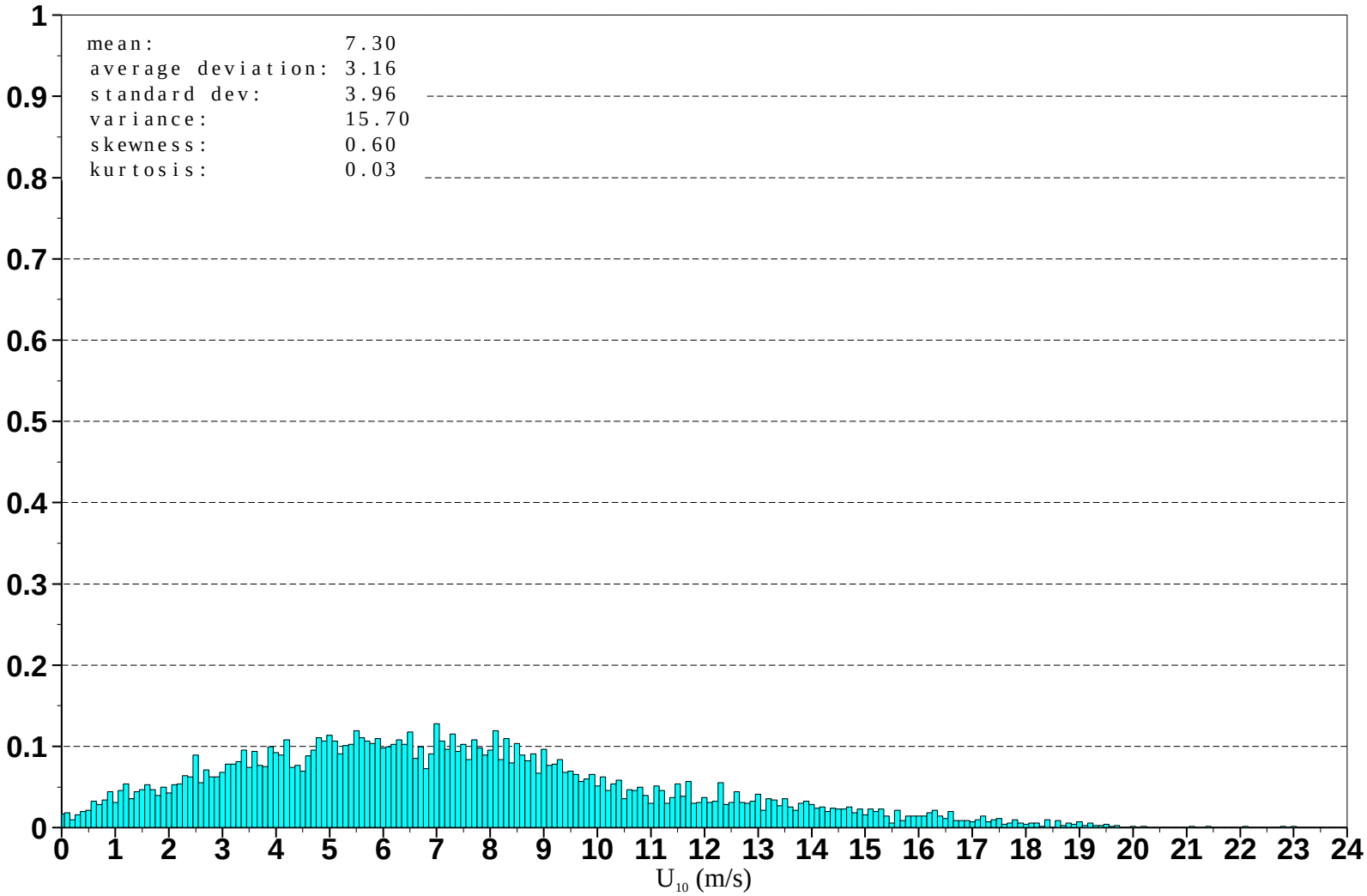


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for October 2004

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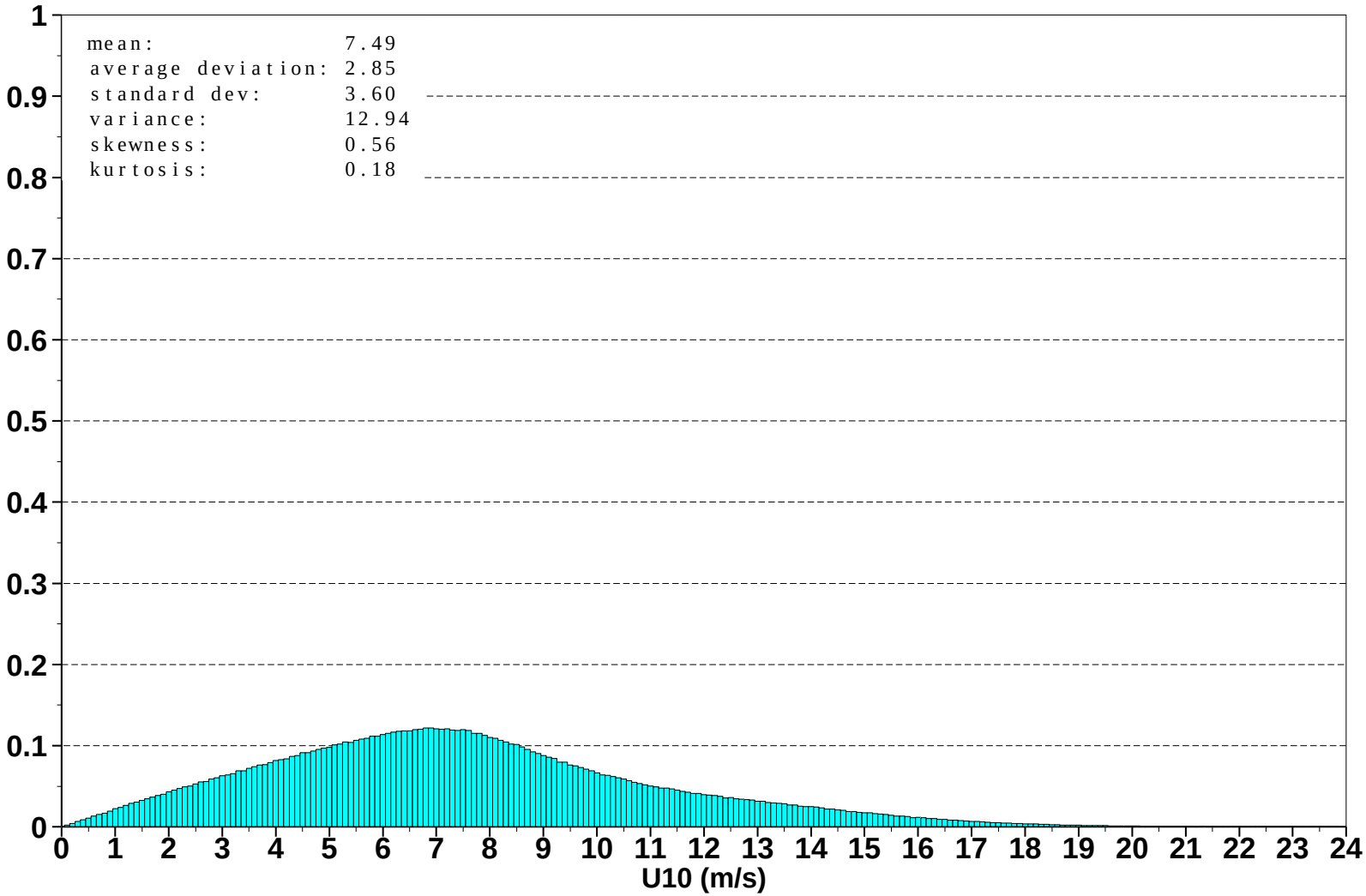
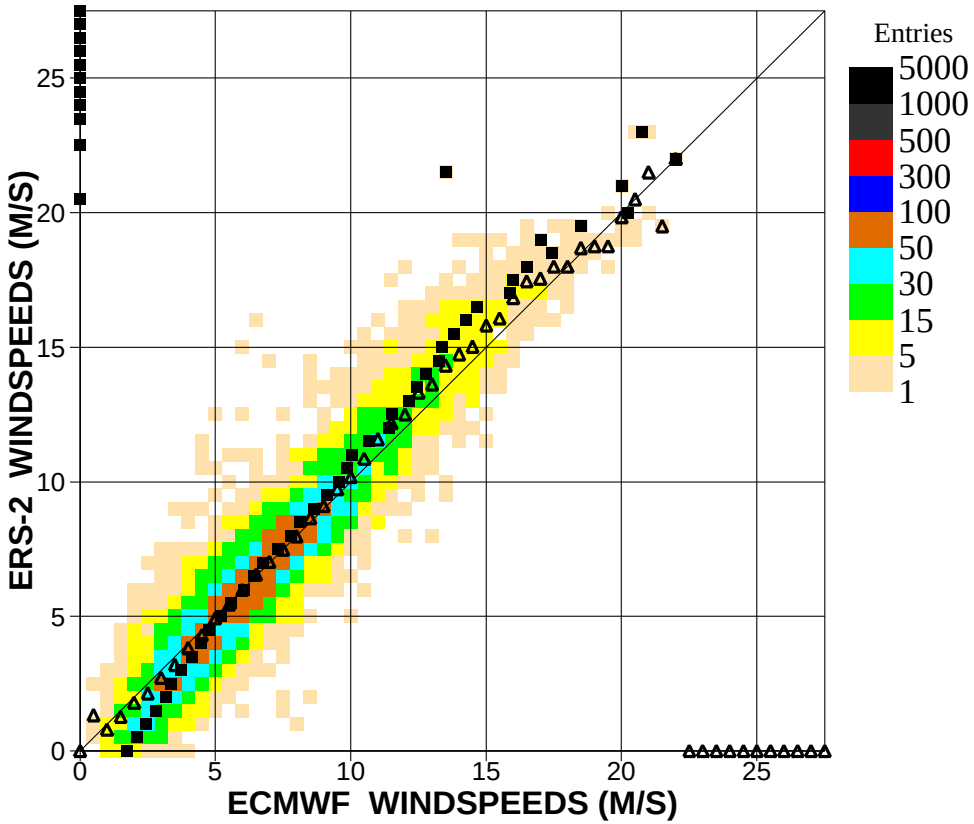


Figure 5: Global distribution of ECMWF ocean surface wind speeds for October 2004

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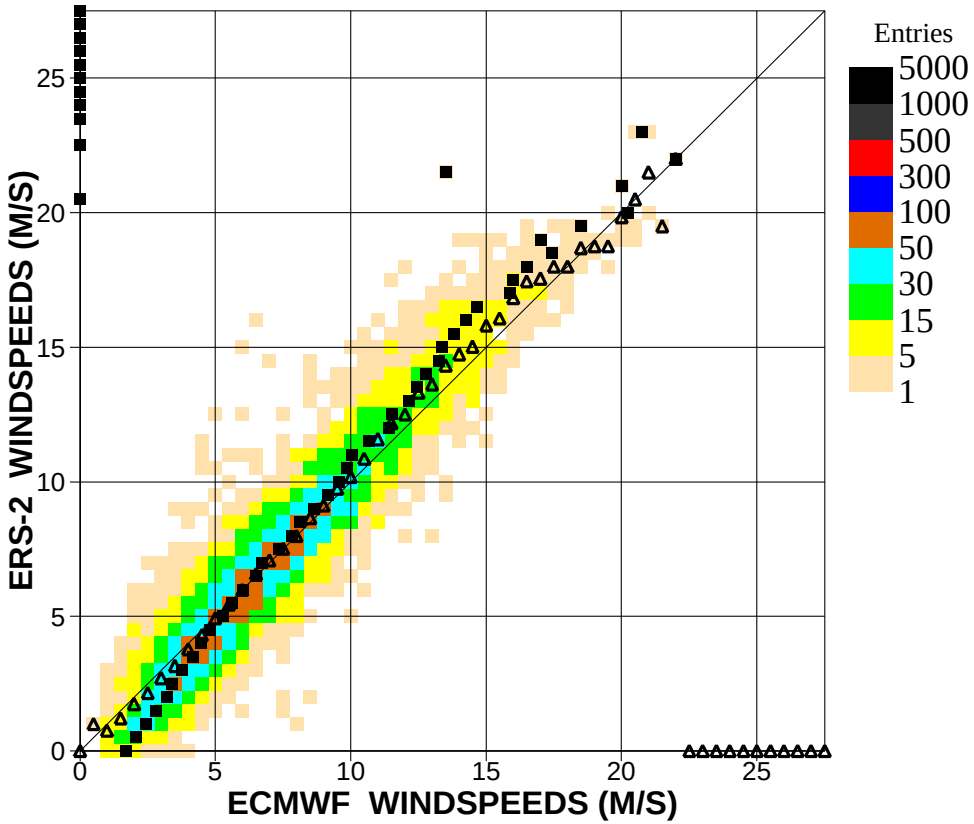


STATISTICS

ENTRIES	7034	
MEAN ECMWF	7.2257	
MEAN ERS-2	7.2954	
BIAS (ERS-2 - ECMWF)	0.0697	
STANDARD DEVIATION	1.3474	
SCATTER INDEX	0.1865	
CORRELATION	0.9430	
SYMMETRIC SLOPE	1.0363	(0.0046)
REGR. COEFFICIENT	1.0800	(0.0045)
REGR. CONSTANT	-0.5084	(0.0364)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for October 2004 (global)

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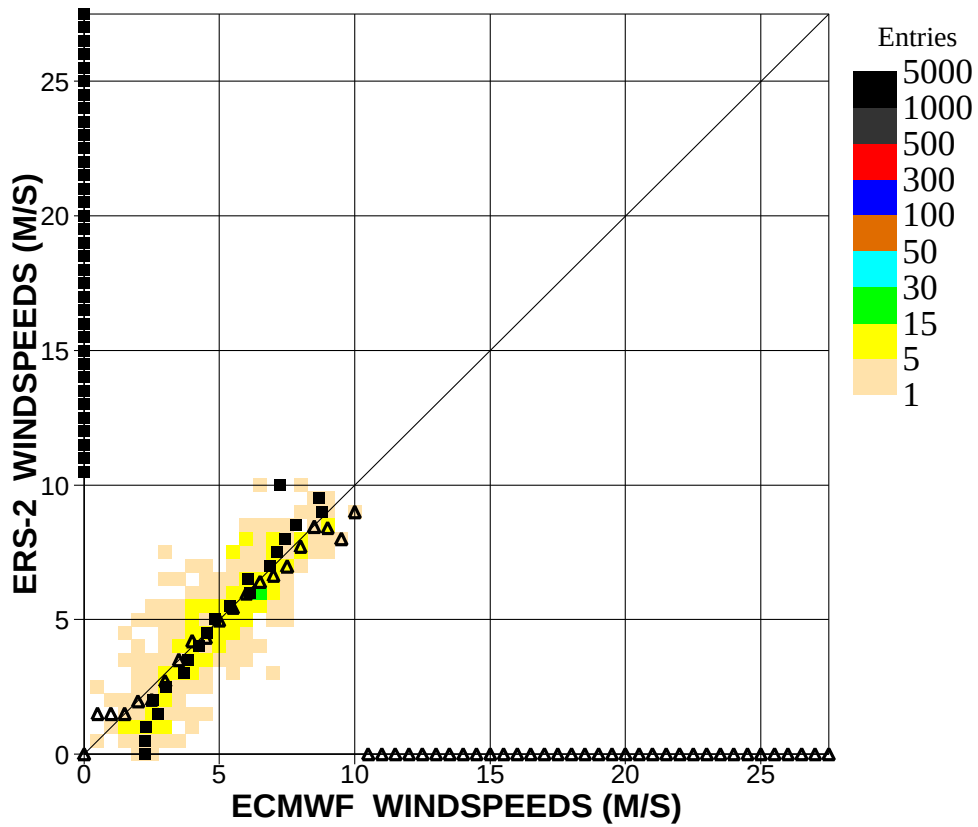


STATISTICS

ENTRIES	6521	
MEAN ECMWF	7.3969	
MEAN ERS-2	7.4826	
BIAS (ERS-2 - ECMWF)	0.0857	
STANDARD DEVIATION	1.3579	
SCATTER INDEX	0.1836	
CORRELATION	0.9437	
SYMMETRIC SLOPE	1.0377	(0.0048)
REGR. COEFFICIENT	1.0825	(0.0047)
REGR. CONSTANT	-0.5247	(0.0385)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for October 2004 (n.hem.)

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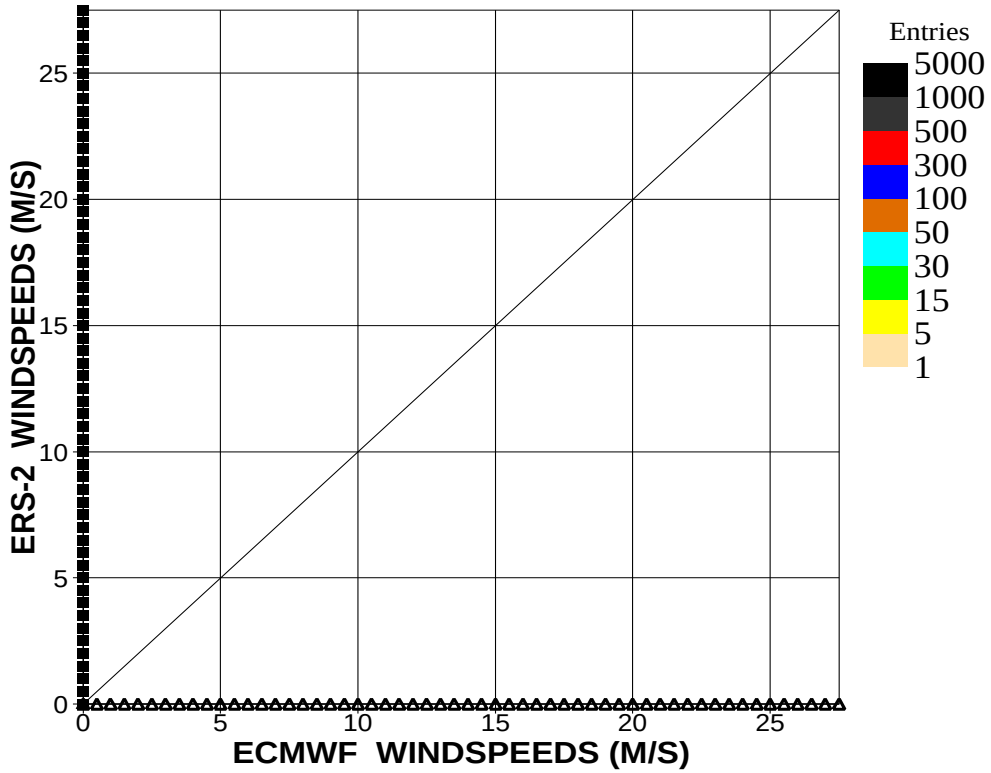


STATISTICS

ENTRIES	542	
MEAN ECMWF	5.0817	
MEAN ERS-2	4.9334	
BIAS (ERS-2 - ECMWF)	-0.1483	
STANDARD DEVIATION	1.1737	
SCATTER INDEX	0.2310	
CORRELATION	0.8454	
SYMMETRIC SLOPE	0.9928	(0.0262)
REGR. COEFFICIENT	0.9578	(0.0260)
REGR. CONSTANT	0.0662	(0.1416)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for October 2004 (tropics)

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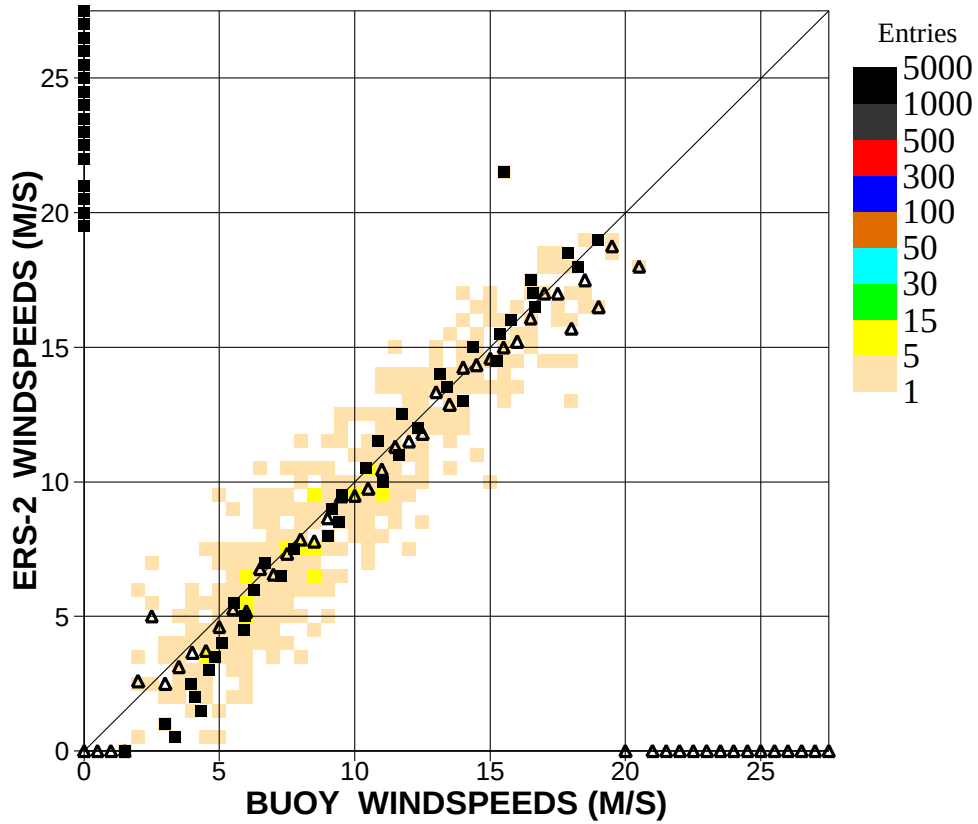


STATISTICS

ENTRIES	0
MEAN ECMWF	0.0000
MEAN ERS-2	0.0000
BIAS (ERS-2 - ECMWF)	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 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for October 2004 (s.hem.)

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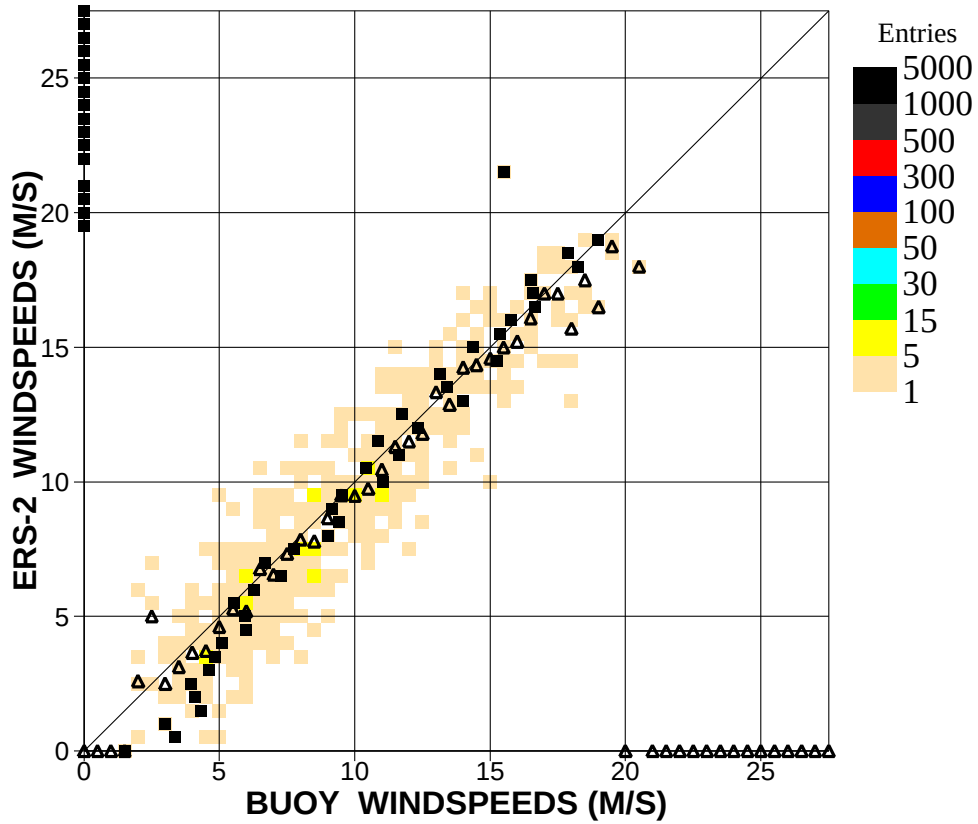


STATISTICS

ENTRIES	509	
MEAN BUOY	9.5733	
MEAN ERS-2	9.1644	
BIAS (ERS-2 - BUOY)	-0.4089	
STANDARD DEVIATION	1.6276	
SCATTER INDEX	0.1700	
CORRELATION	0.9210	
SYMMETRIC SLOPE	0.9729	(0.0184)
REGR. COEFFICIENT	0.9771	(0.0184)
REGR. CONSTANT	-0.1896	(0.1900)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for October 2004 (global)

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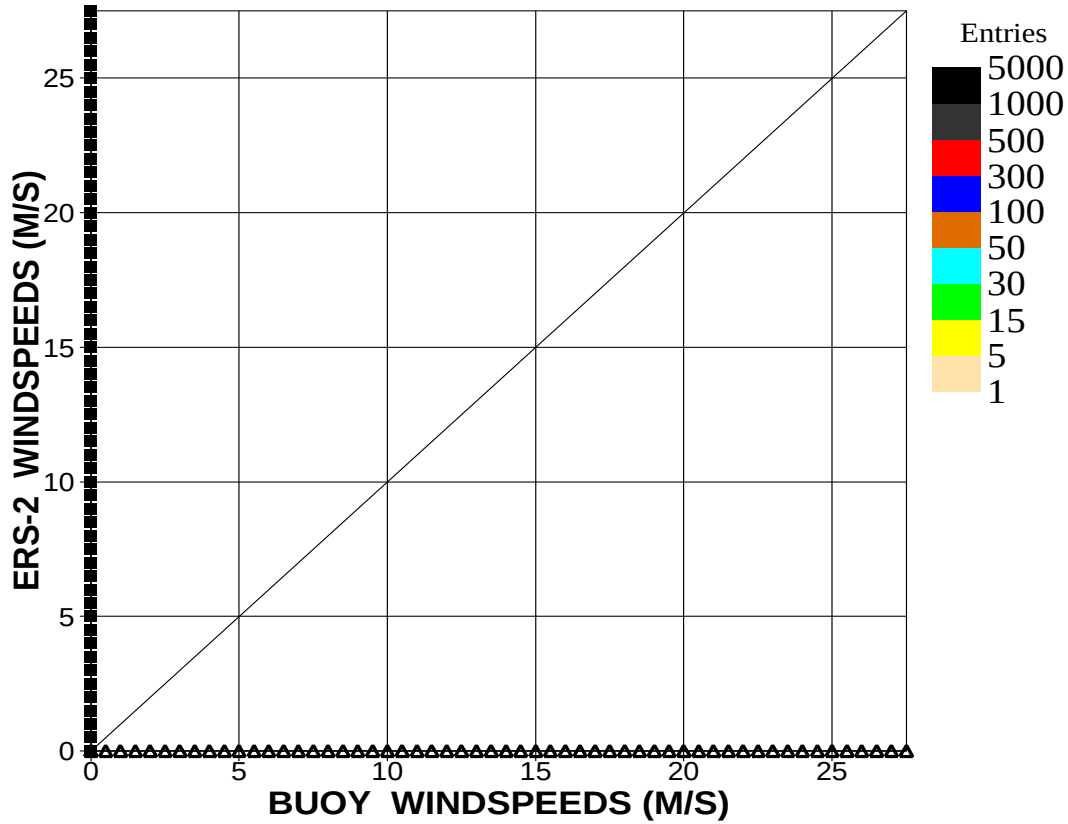


STATISTICS

ENTRIES	505	
MEAN BUOY	9.5937	
MEAN ERS-2	9.1855	
BIAS (ERS-2 - BUOY)	-0.4081	
STANDARD DEVIATION	1.6338	
SCATTER INDEX	0.1703	
CORRELATION	0.9206	
SYMMETRIC SLOPE	0.9730	(0.0186)
REGR. COEFFICIENT	0.9768	(0.0185)
REGR. CONSTANT	-0.1855	(0.1916)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for October 2004 (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 October 2004 (hawaii)

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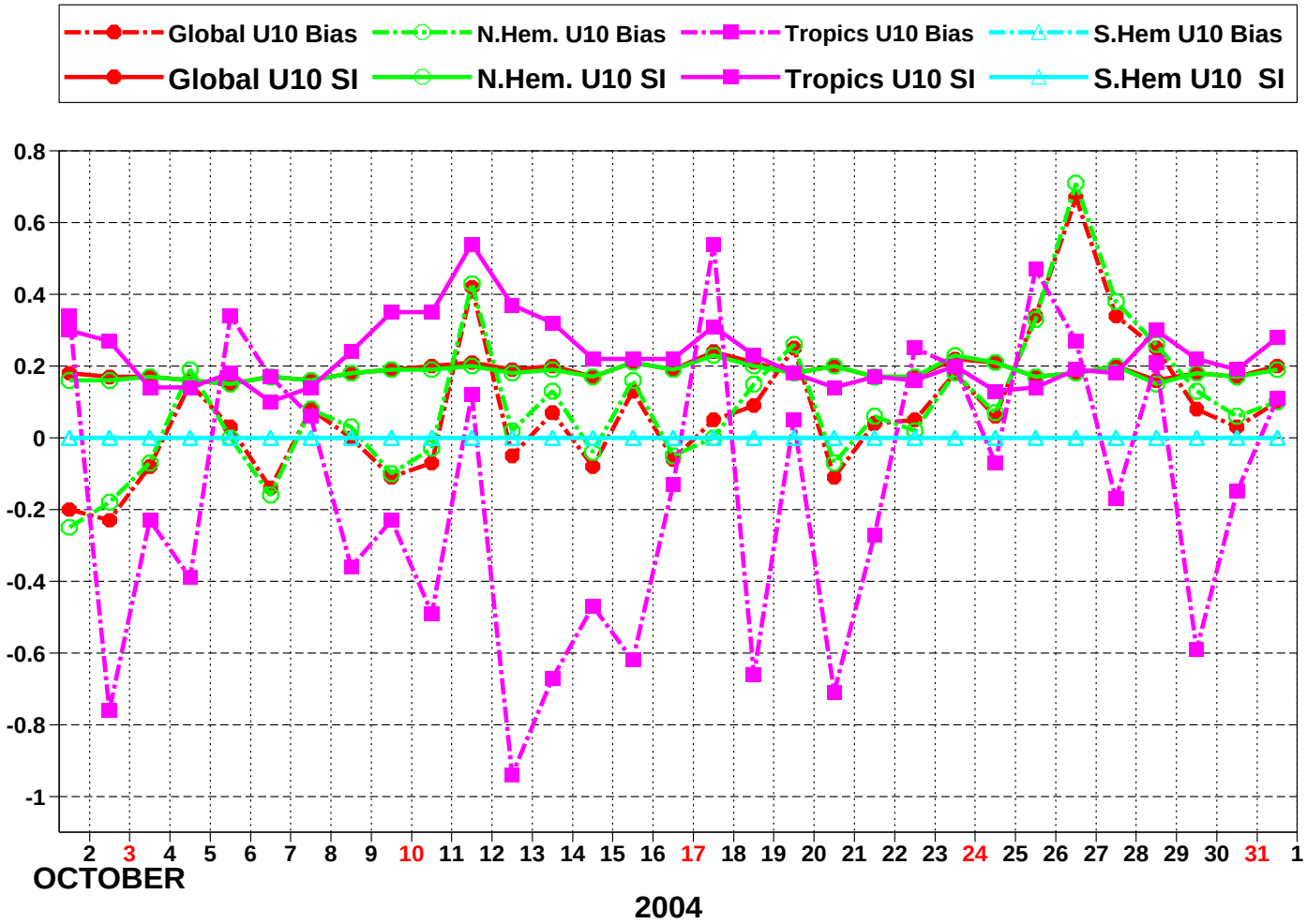


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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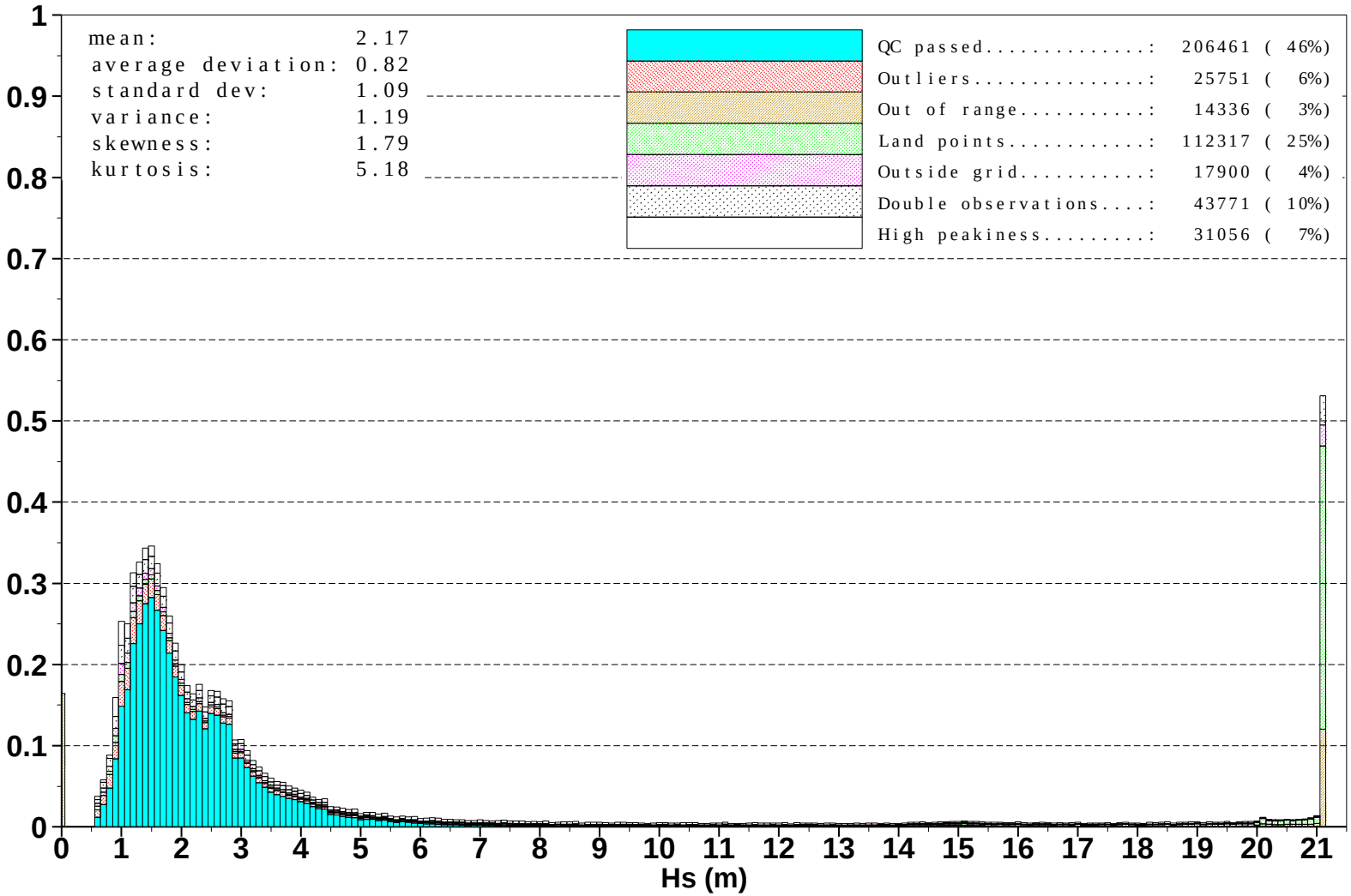


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for October 2004

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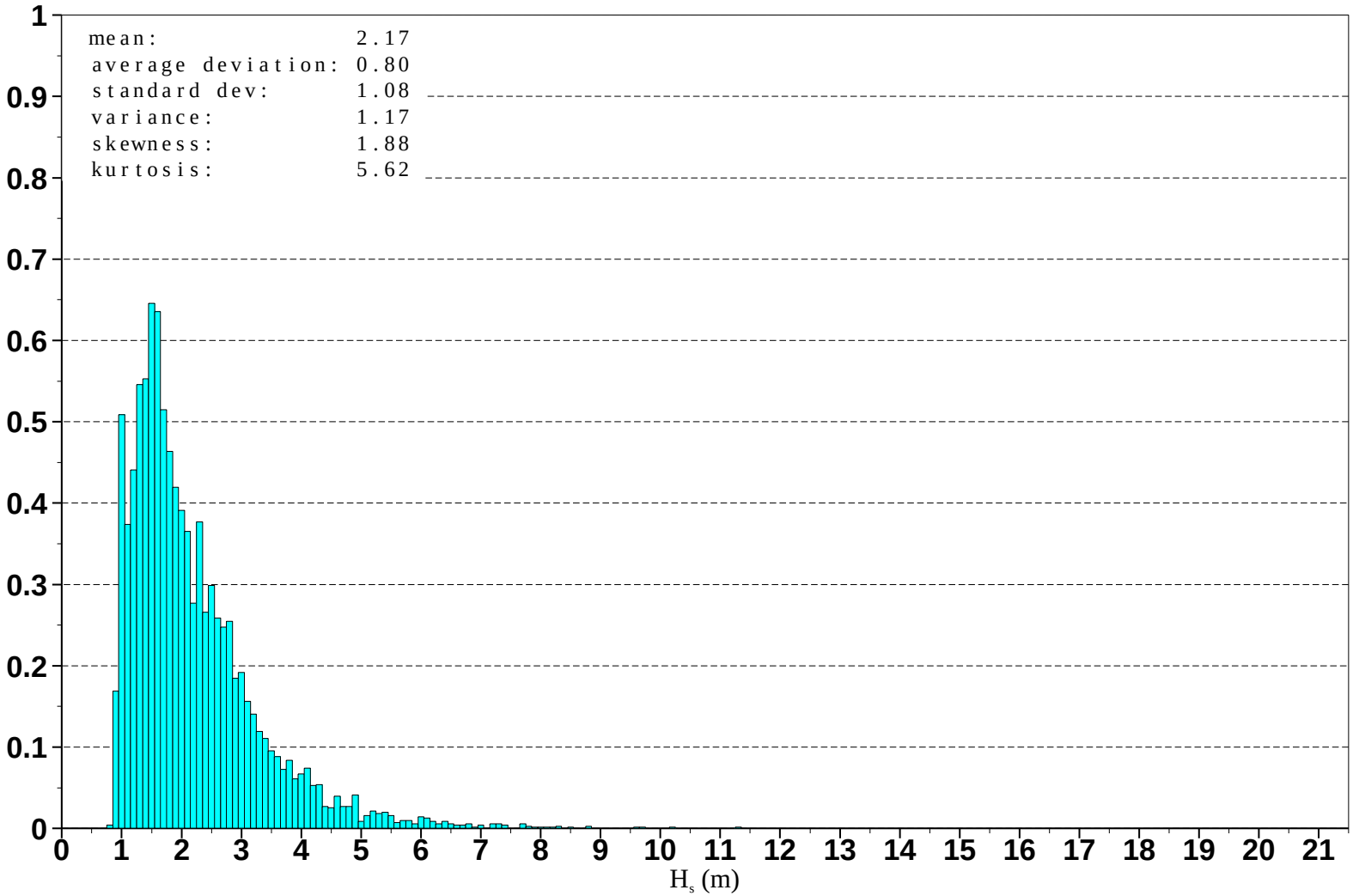


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for October 2004

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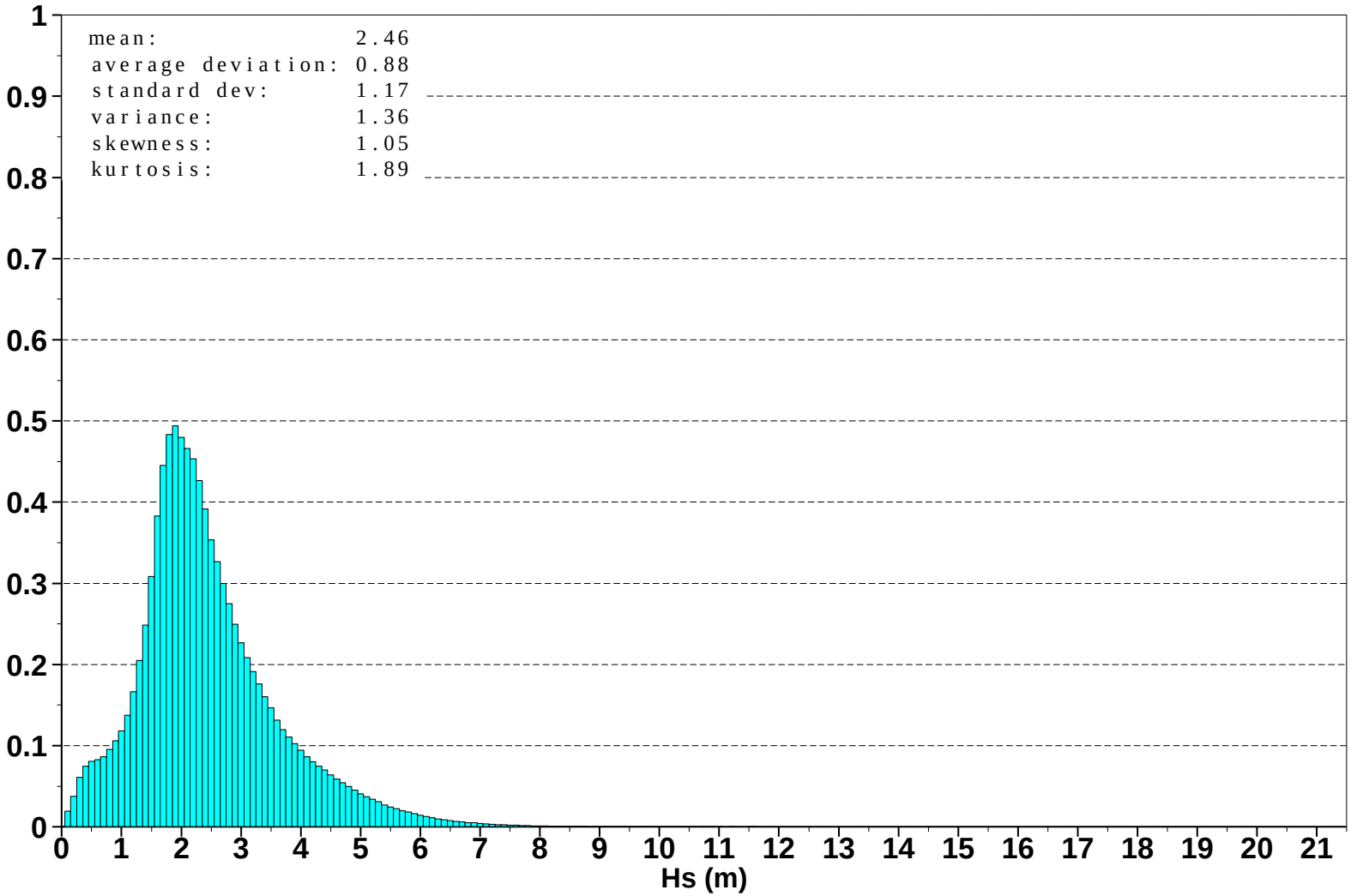
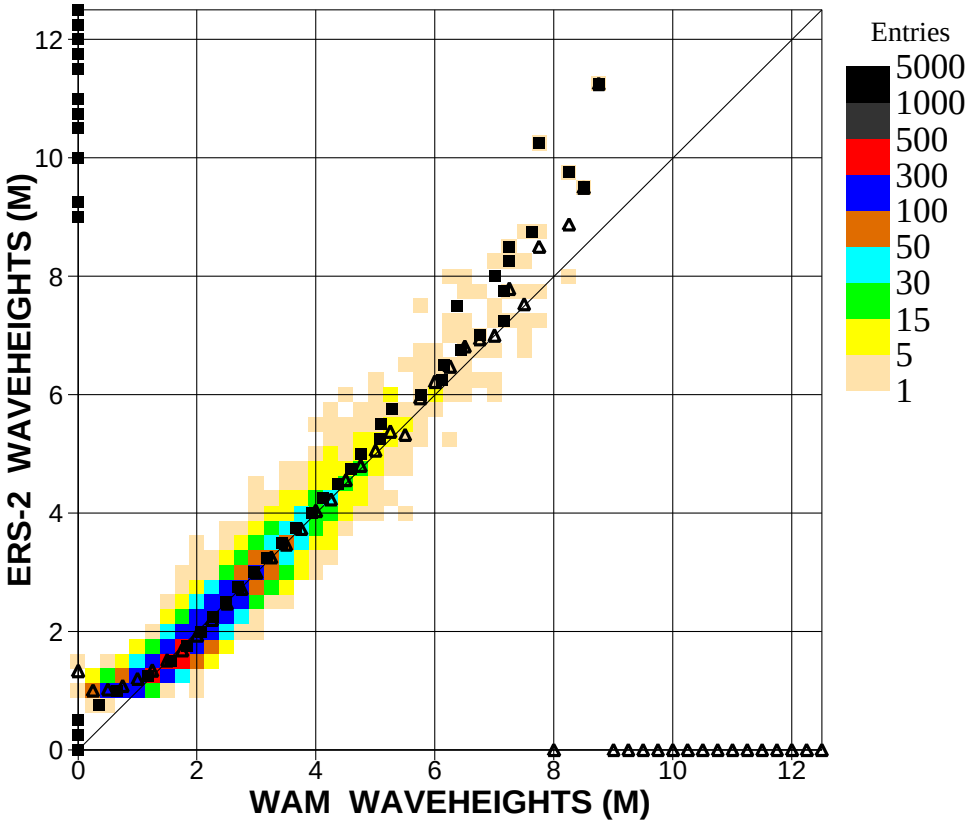


Figure 16: Global distribution of ECMWF wave heights for October 2004

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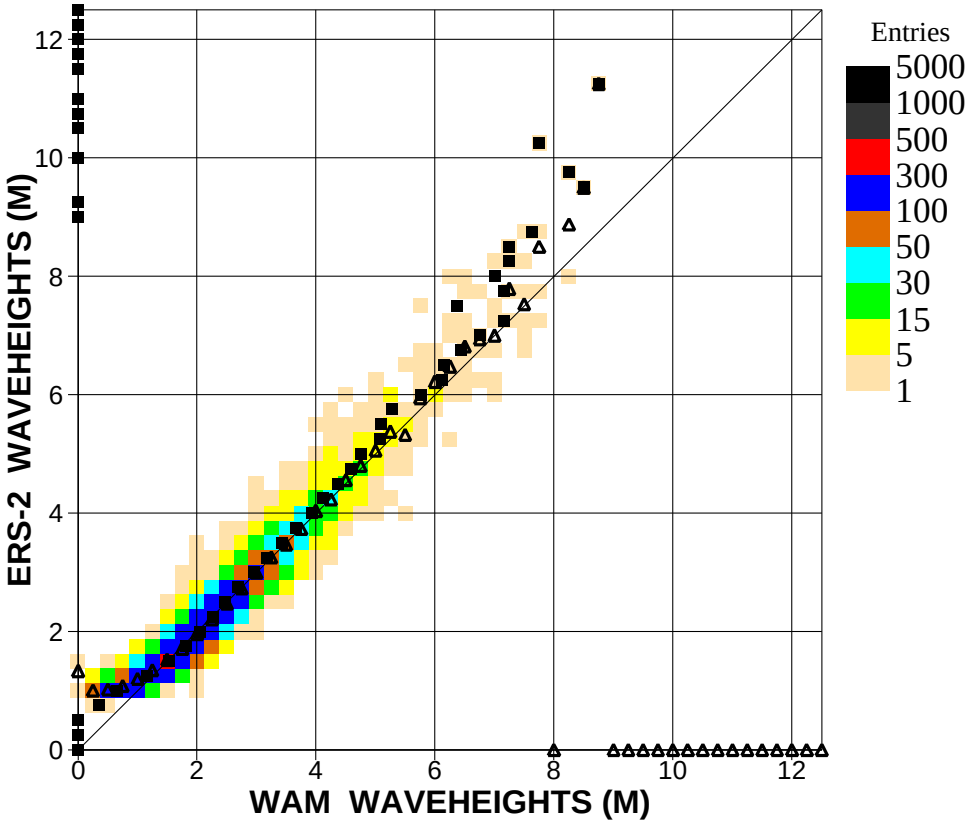


STATISTICS

ENTRIES	7034	
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MEAN ERS-2	2.1734	
BIAS (ERS-2 - WAM)	0.0428	
STANDARD DEVIATION	0.3030	
SCATTER INDEX	0.1422	
CORRELATION	0.9614	
SYMMETRIC SLOPE	1.0125	(0.0033)
REGR. COEFFICIENT	0.9456	(0.0032)
REGR. CONSTANT	0.1588	(0.0077)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for October 2004 (global)

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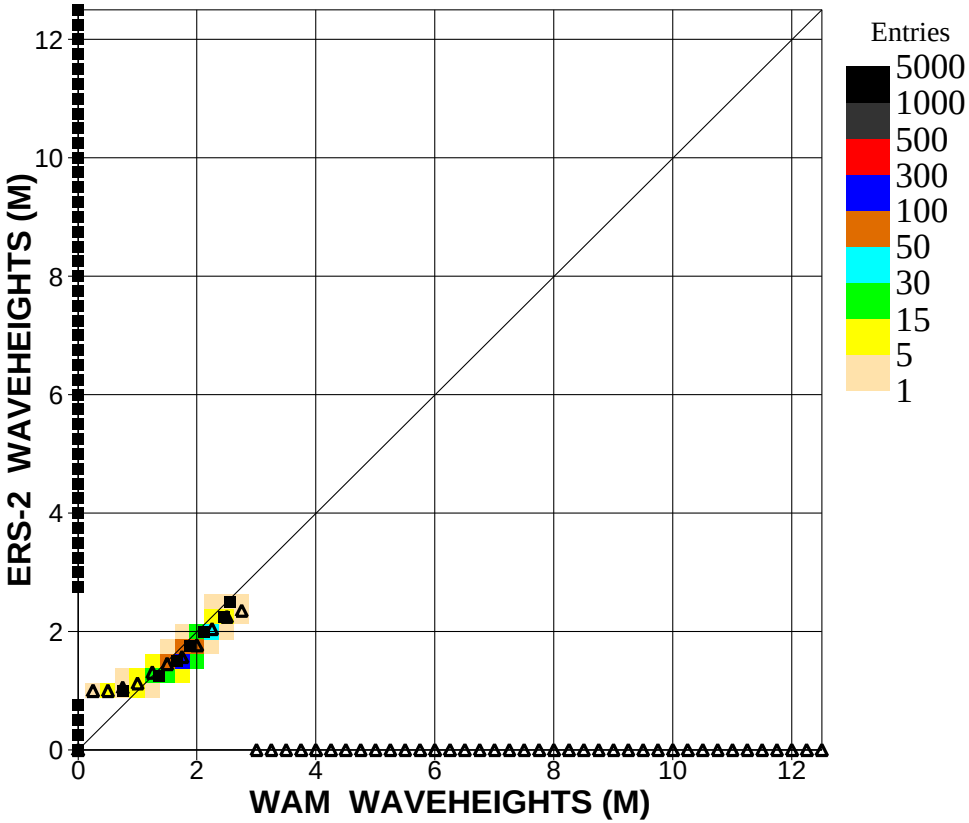


STATISTICS

ENTRIES	6521	
MEAN WAM	2.1607	
MEAN ERS-2	2.2172	
BIAS (ERS-2 - WAM)	0.0565	
STANDARD DEVIATION	0.3074	
SCATTER INDEX	0.1423	
CORRELATION	0.9625	
SYMMETRIC SLOPE	1.0162	(0.0034)
REGR. COEFFICIENT	0.9423	(0.0033)
REGR. CONSTANT	0.1812	(0.0080)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for October 2004 (n.hem.)

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STATISTICS

ENTRIES	542	
MEAN WAM	1.7434	
MEAN ERS-2	1.6132	
BIAS (ERS-2 - WAM)	-0.1302	
STANDARD DEVIATION	0.1601	
SCATTER INDEX	0.0918	
CORRELATION	0.8910	
SYMMETRIC SLOPE	0.9202	(0.0181)
REGR. COEFFICIENT	0.6908	(0.0151)
REGR. CONSTANT	0.4088	(0.0269)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for October 2004 (tropics)

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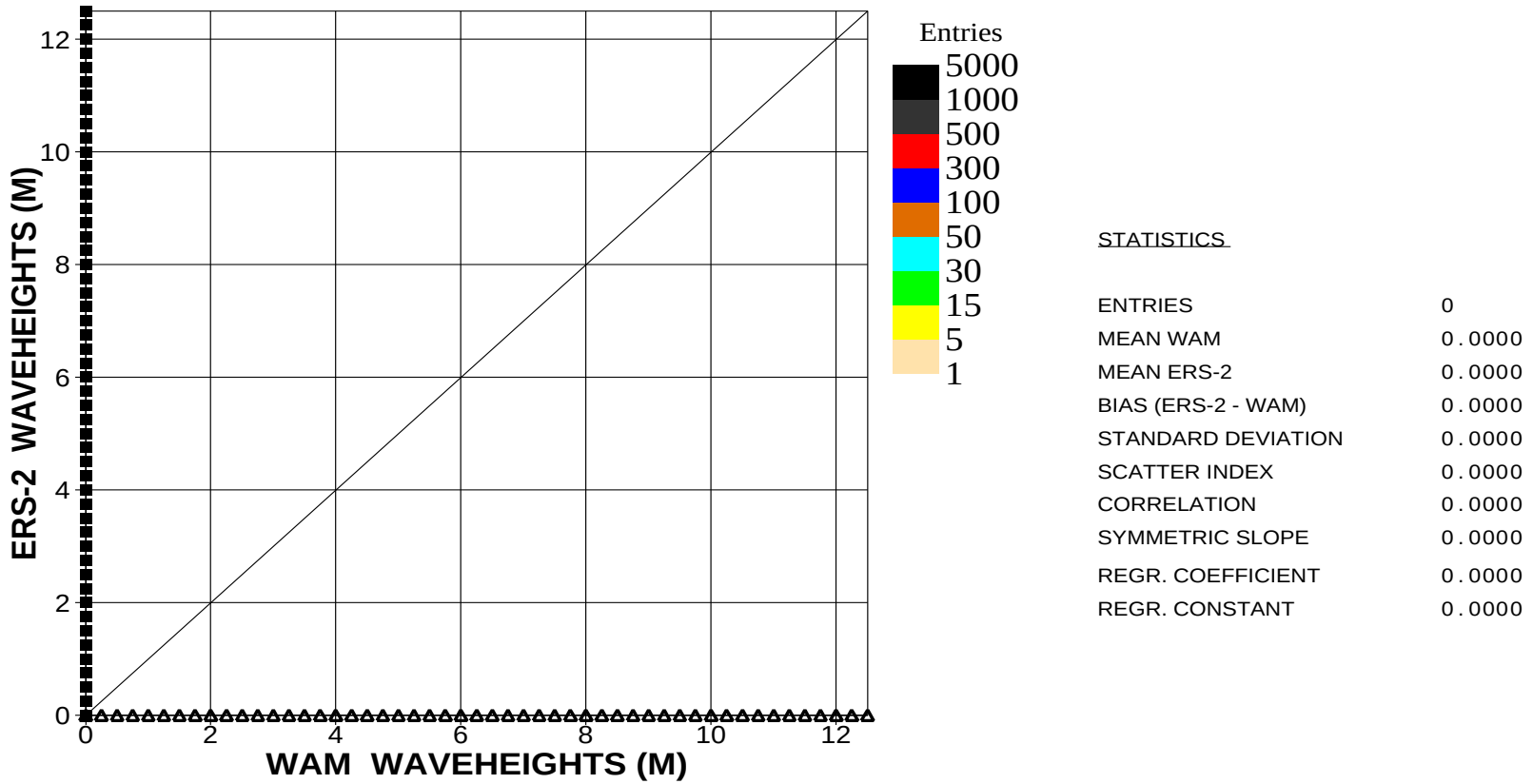
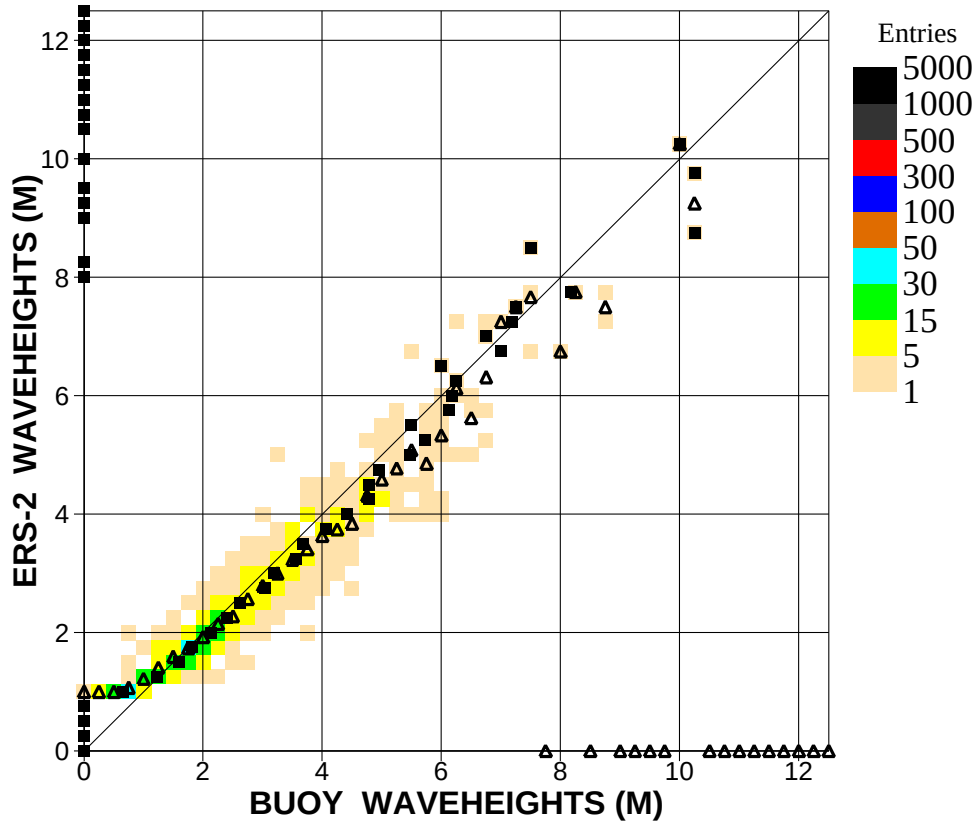


Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for October 2004 (s.hem.)

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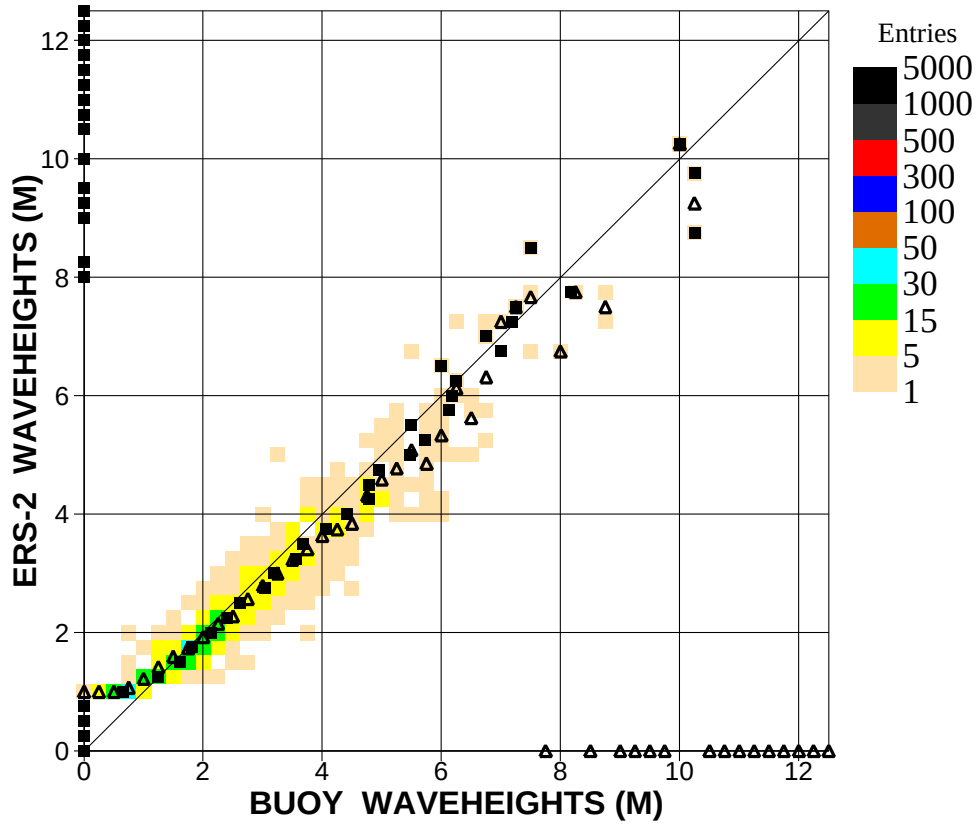


STATISTICS

ENTRIES	740	
MEAN BUOY	2.7506	
MEAN ERS-2	2.6204	
BIAS (ERS-2 - BUOY)	-0.1302	
STANDARD DEVIATION	0.4684	
SCATTER INDEX	0.1703	
CORRELATION	0.9592	
SYMMETRIC SLOPE	0.9346	(0.0098)
REGR. COEFFICIENT	0.8426	(0.0091)
REGR. CONSTANT	0.3028	(0.0291)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for October 2004 (global)

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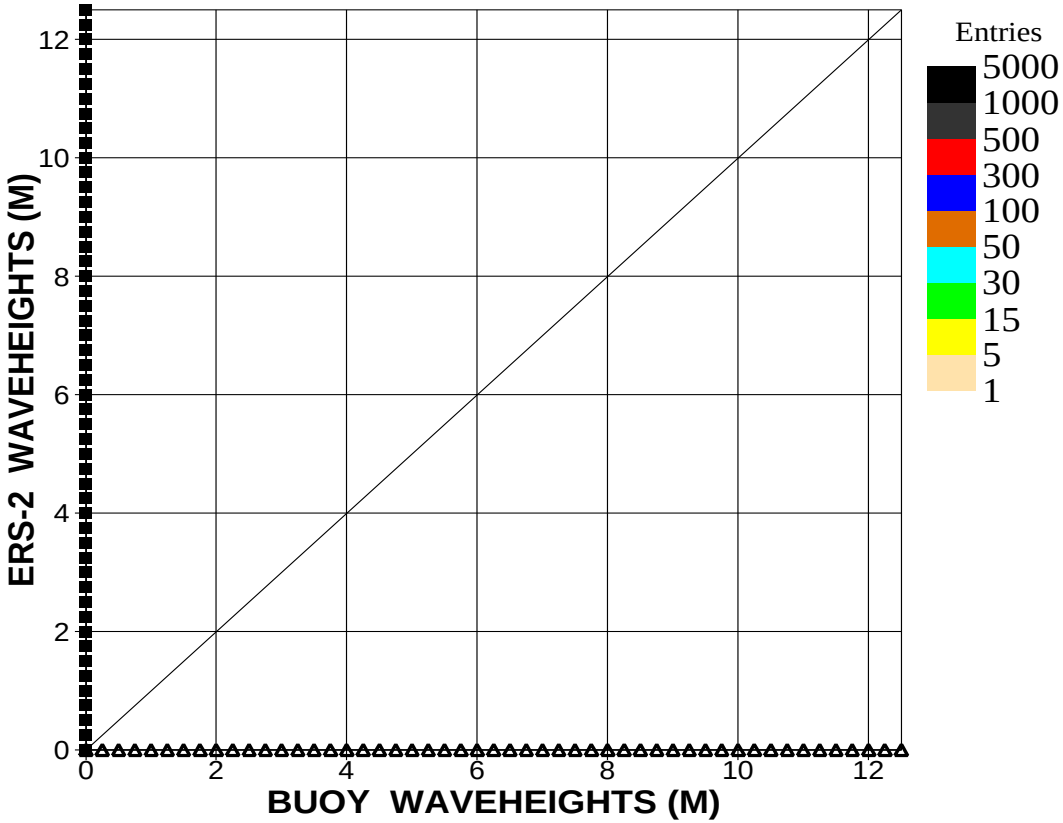


STATISTICS

ENTRIES	735	
MEAN BUOY	2.7628	
MEAN ERS-2	2.6300	
BIAS (ERS-2 - BUOY)	-0.1328	
STANDARD DEVIATION	0.4682	
SCATTER INDEX	0.1695	
CORRELATION	0.9590	
SYMMETRIC SLOPE	0.9344	(0.0099)
REGR. COEFFICIENT	0.8433	(0.0092)
REGR. CONSTANT	0.3000	(0.0294)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for October 2004 (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 October 2004 (hawaii)

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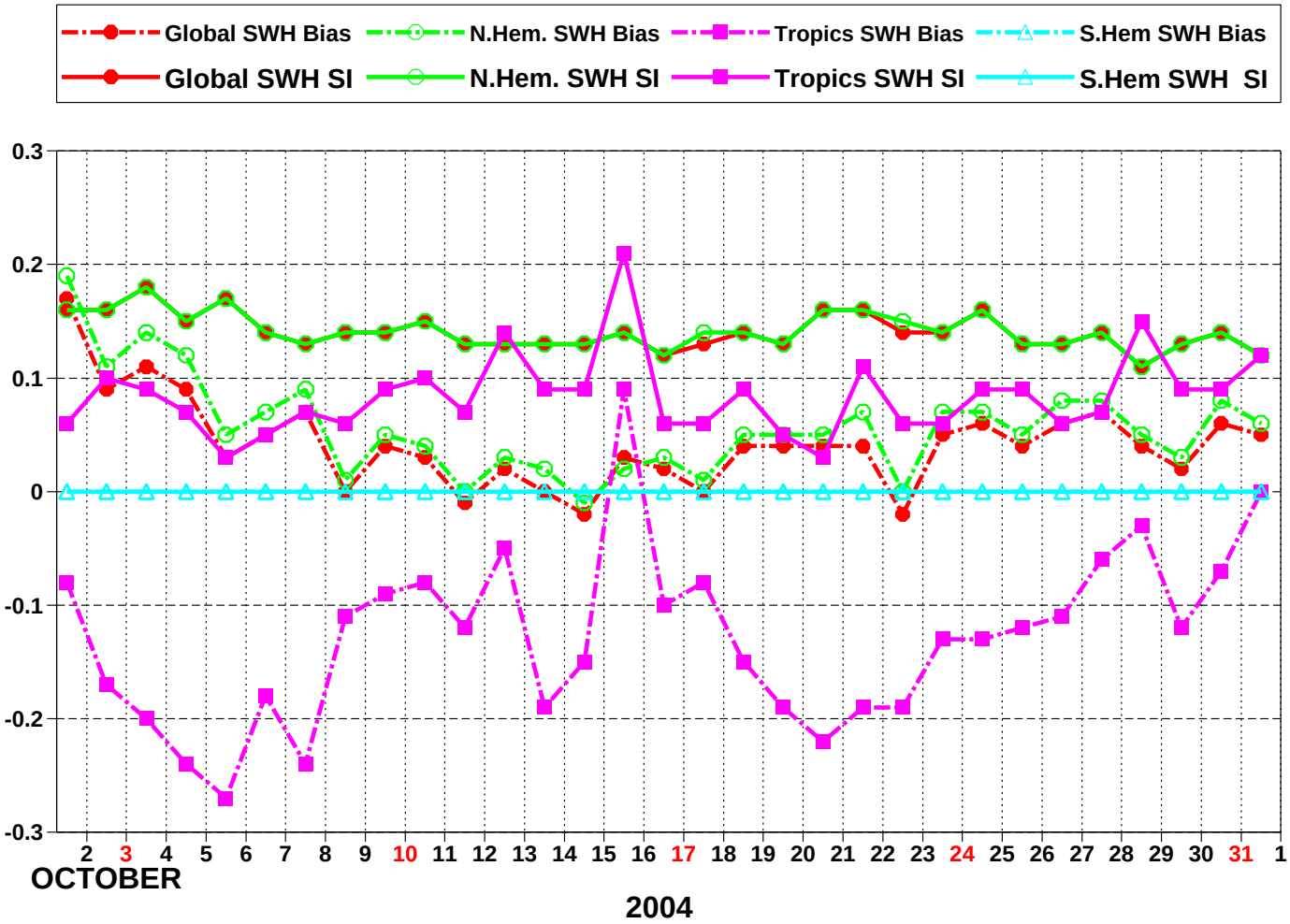


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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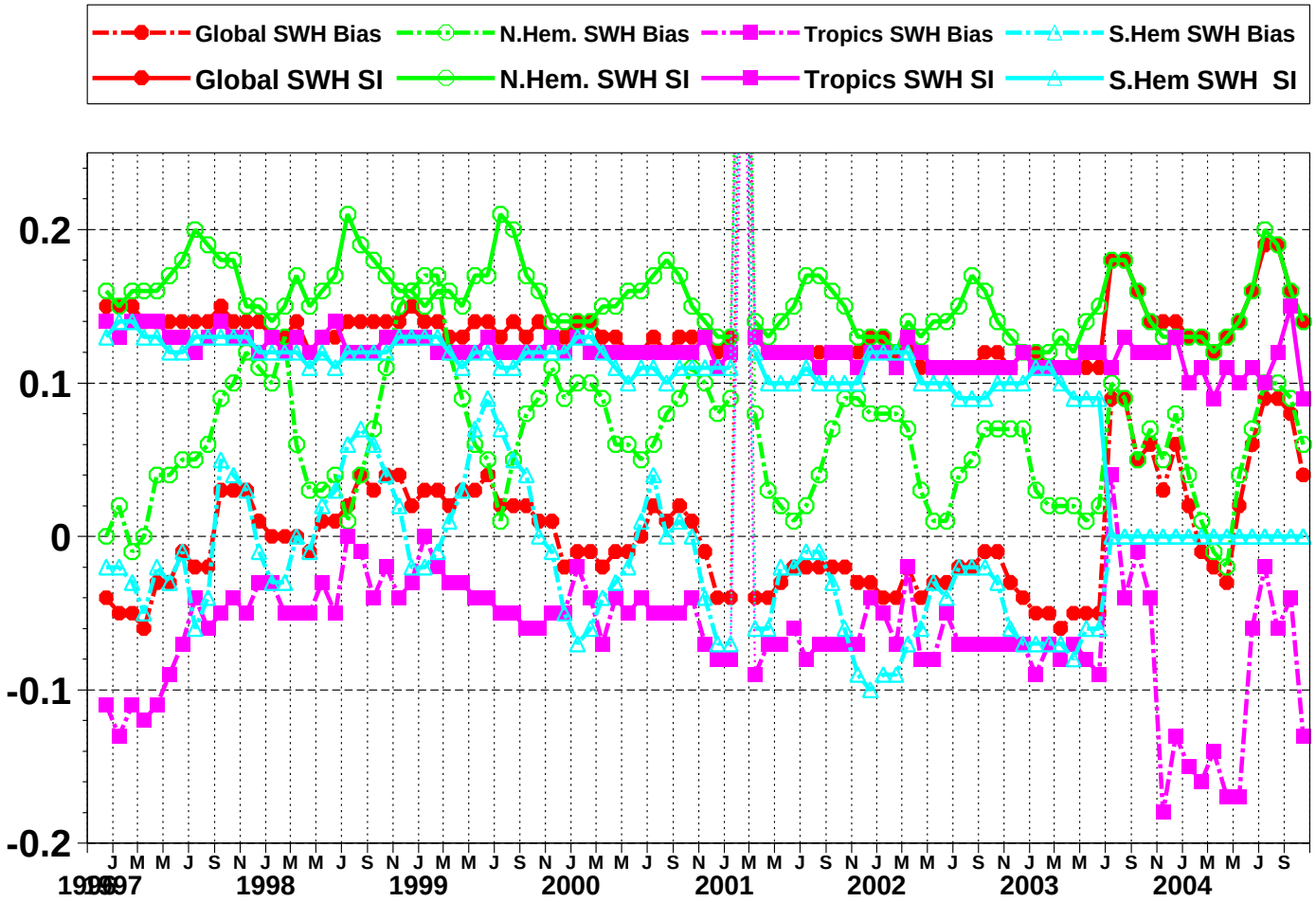


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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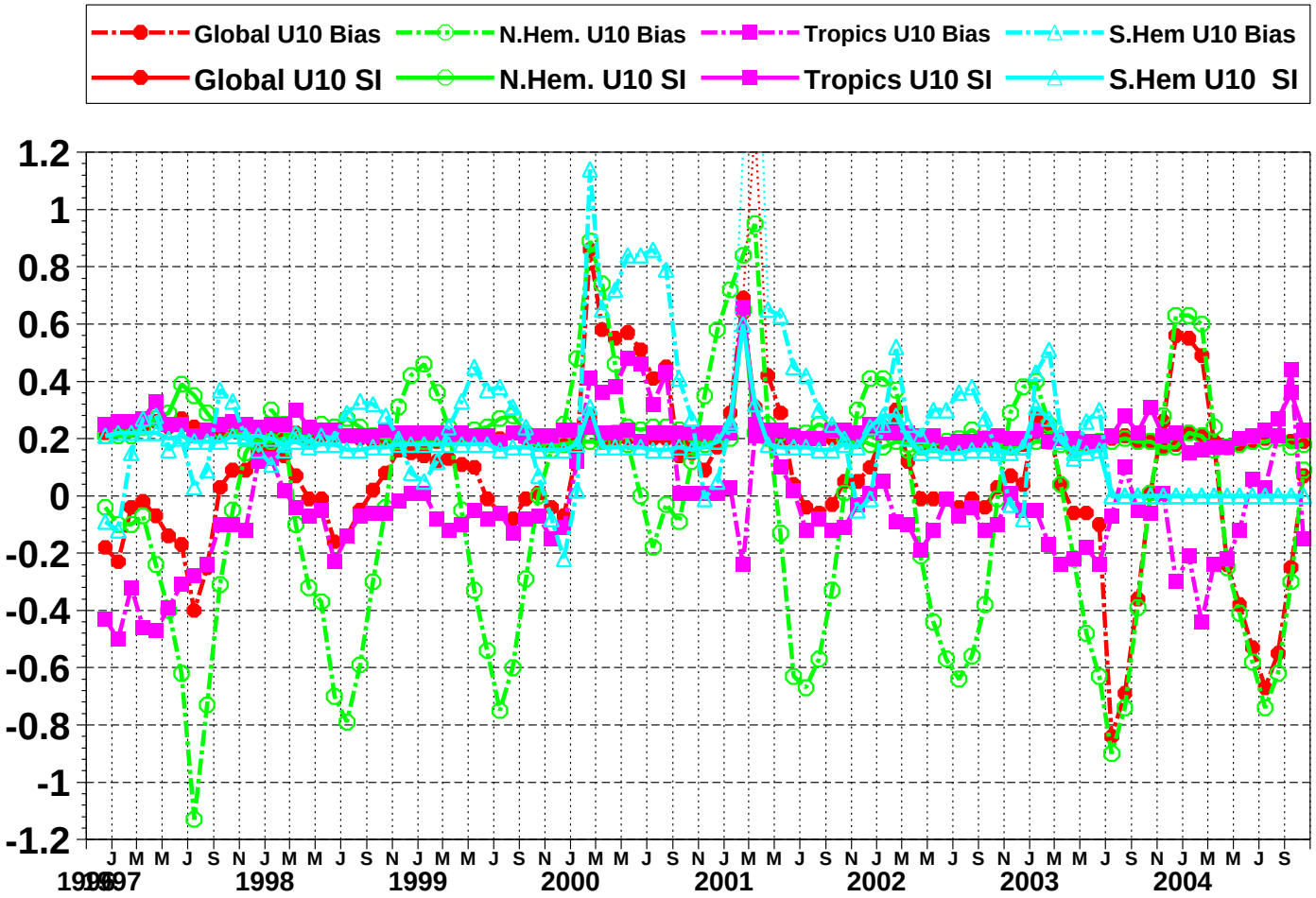


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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