ECMWF Report on ERS-2 RA for December 2004

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

By: *Saleh Abdalla*

Date: *11 January 2005*

Overview:

Based on the data received during the whole month, on average, 3382 observations arrived at ECMWF every 6 hours of which 65.59% 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 data from time window centred at 06:00 UTC on the 26th. to 06:00 UTC on the 28th. of the month, inclusive, and at 18:00 UTC on the 28th. of the month. There was 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 $<\sigma_0>$ = 10.47 dB (with a main peak at ~10.6 dB and two secondary peaks at 9.6 dB and ~11.1 dB).

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: +0.465 m/s

ERS-2 northern hemisphere: +0.484 m/s

ERS-2 tropics: +0.177 m/s

ERS-2 southern hemisphere: *missing*

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Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: +0.136 m/s

ERS-2 northern hemisphere: +0.151 m/s

ERS-2 tropics: *missing*

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: -0.029 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: -0.023 m

ERS-2 tropics: -0.087 m

ERS-2 southern hemisphere: *missing*

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.162 m

ERS-2 northern hemisphere: -0.163 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 related ECMWF model changes this month (current operational cycle is CY28R4).

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 December 2004.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2004 (global).

Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2004 (northern hemisphere).

Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2004 (tropics).

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for December 2004.

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2004

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2004

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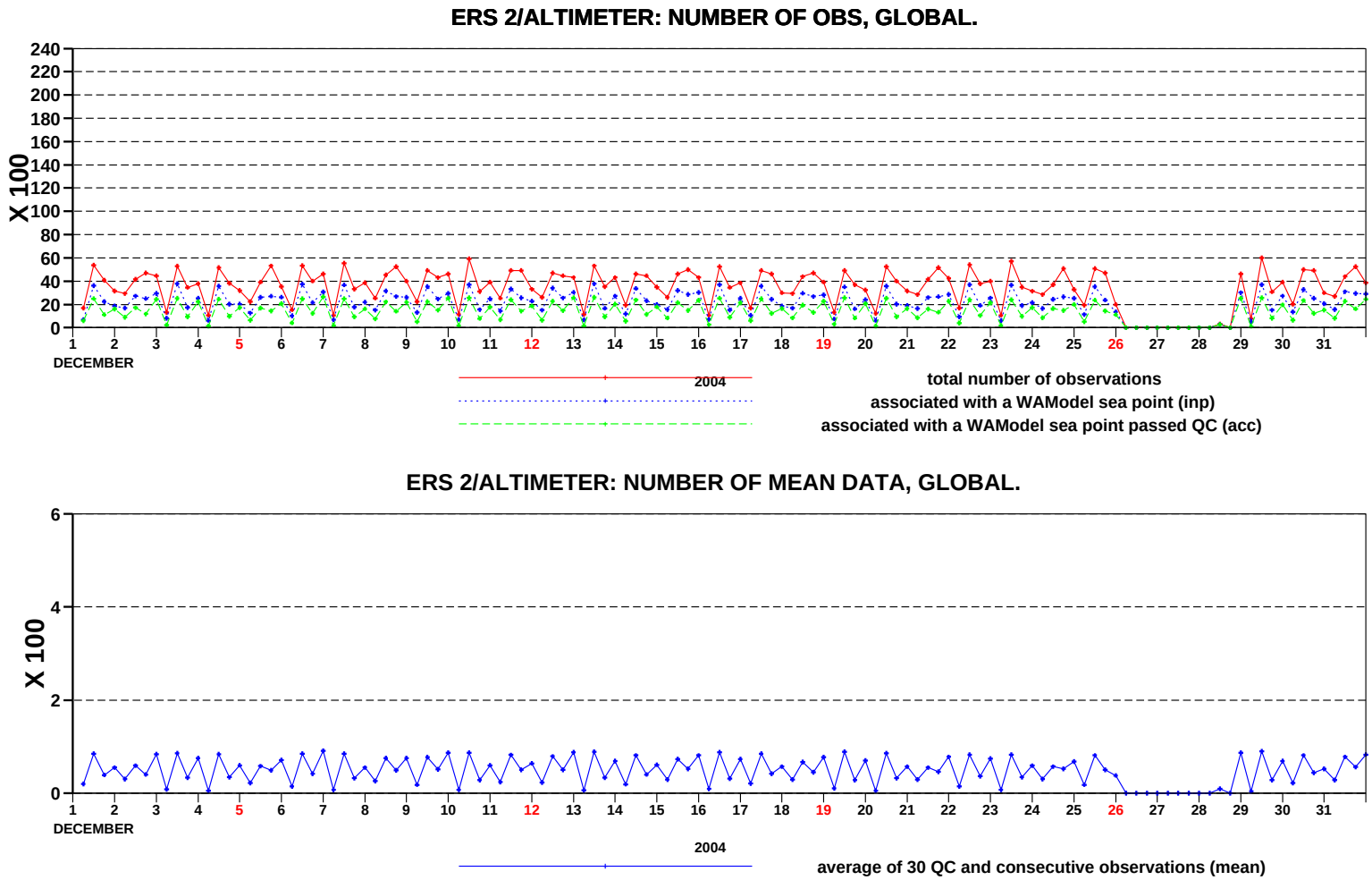


Figure 1:Time series of data reception for ERS-2 Altimeter data for December 2004

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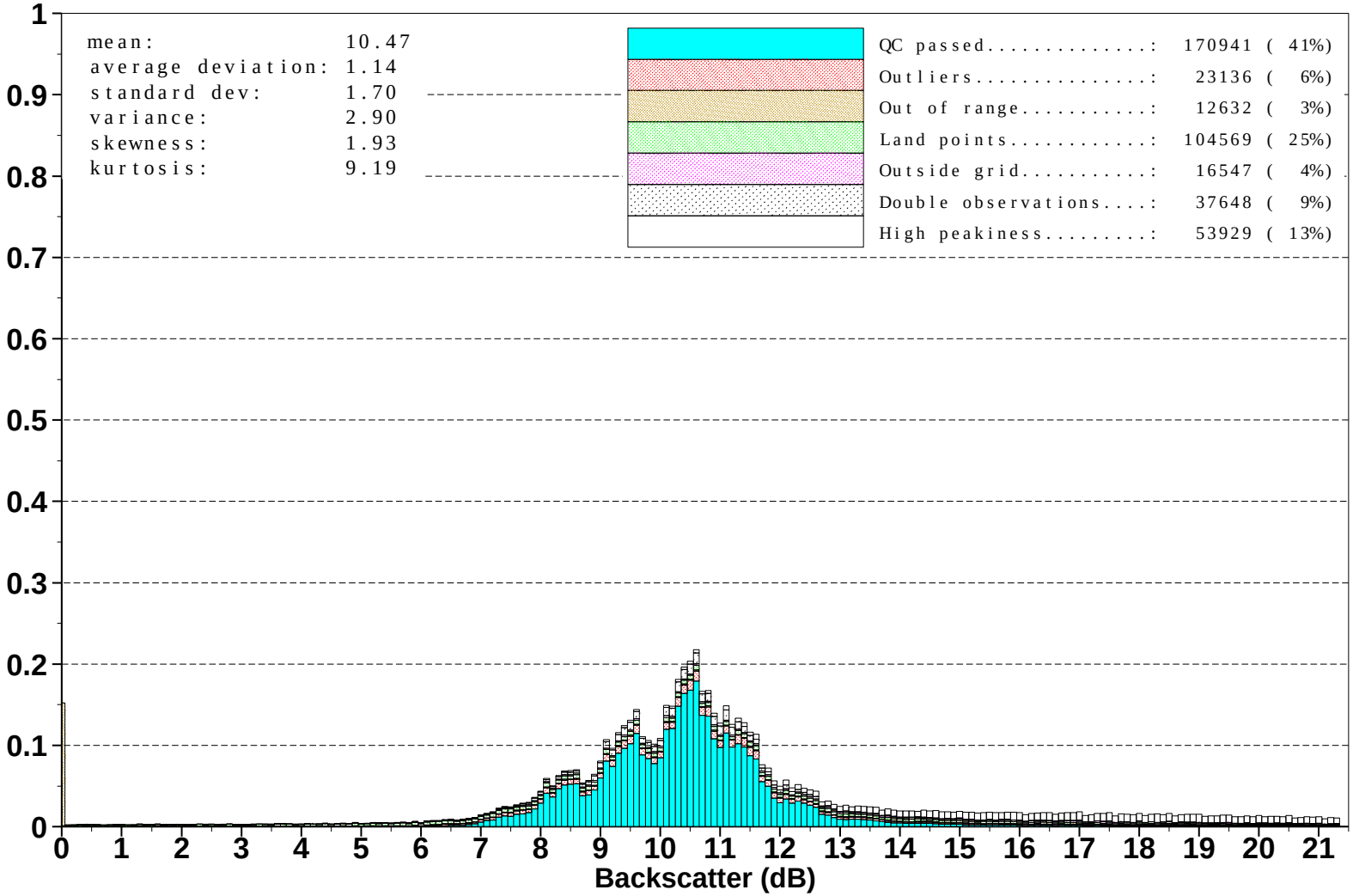


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for December 2004

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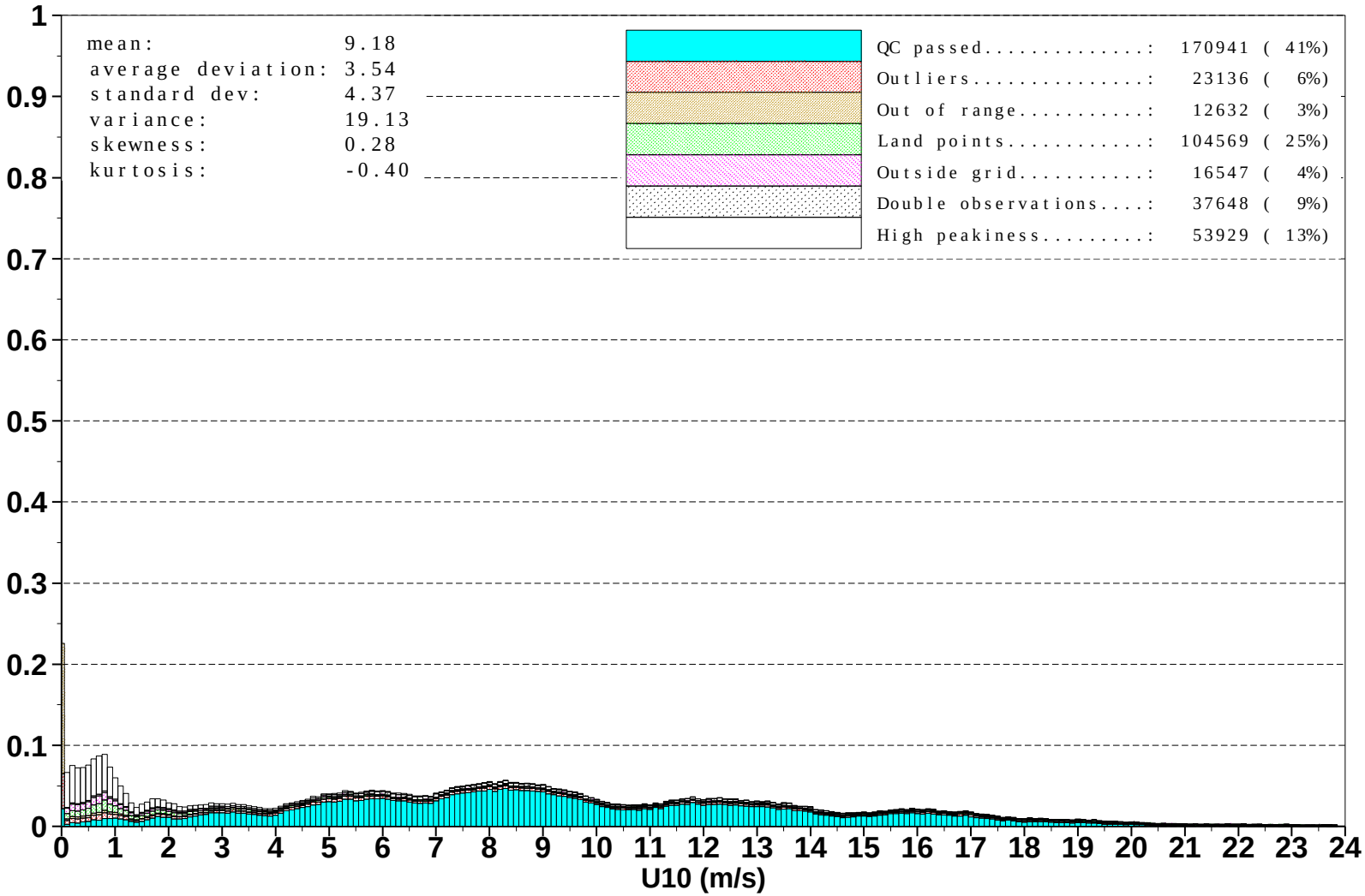


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2004

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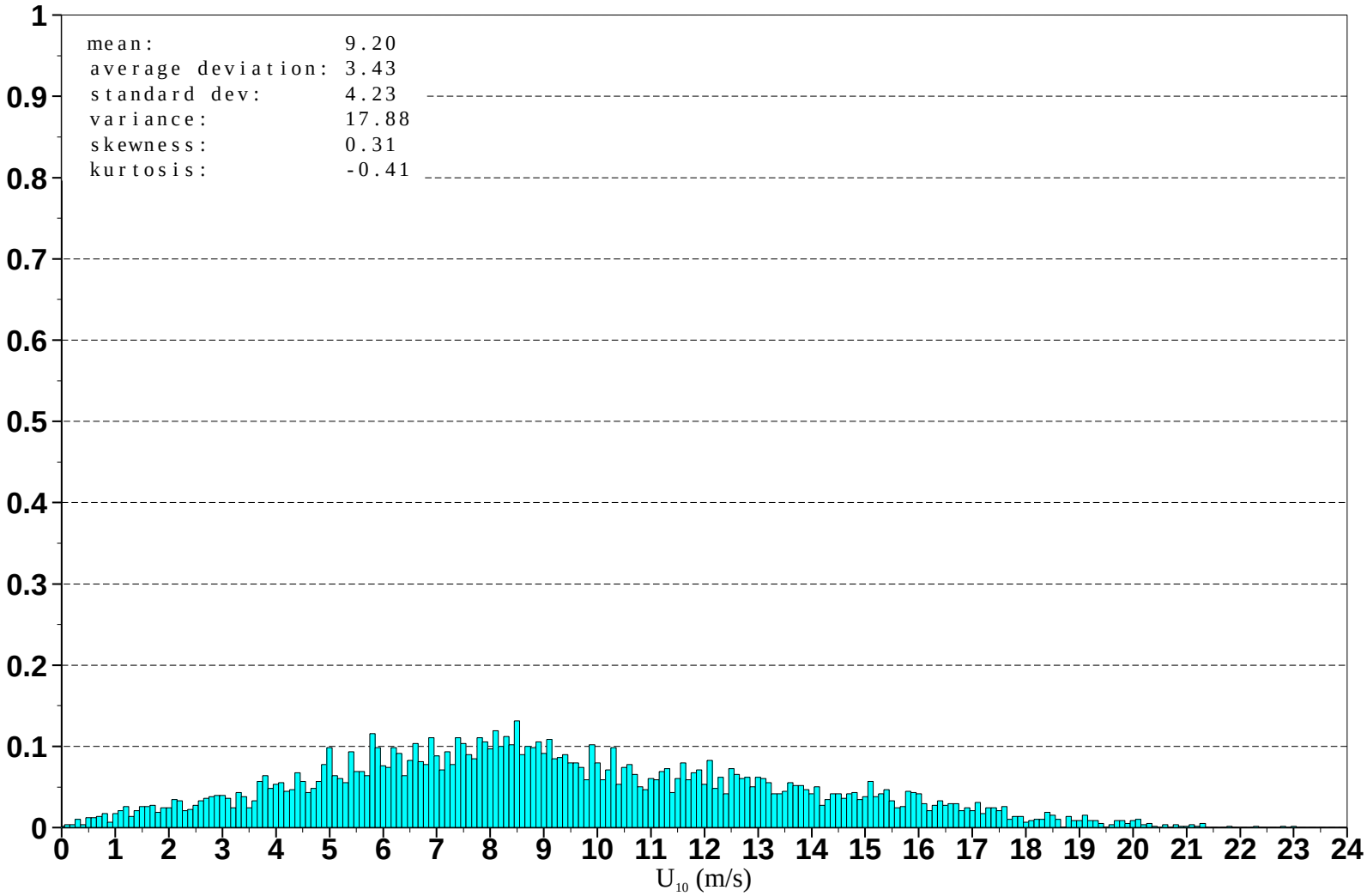


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for December 2004

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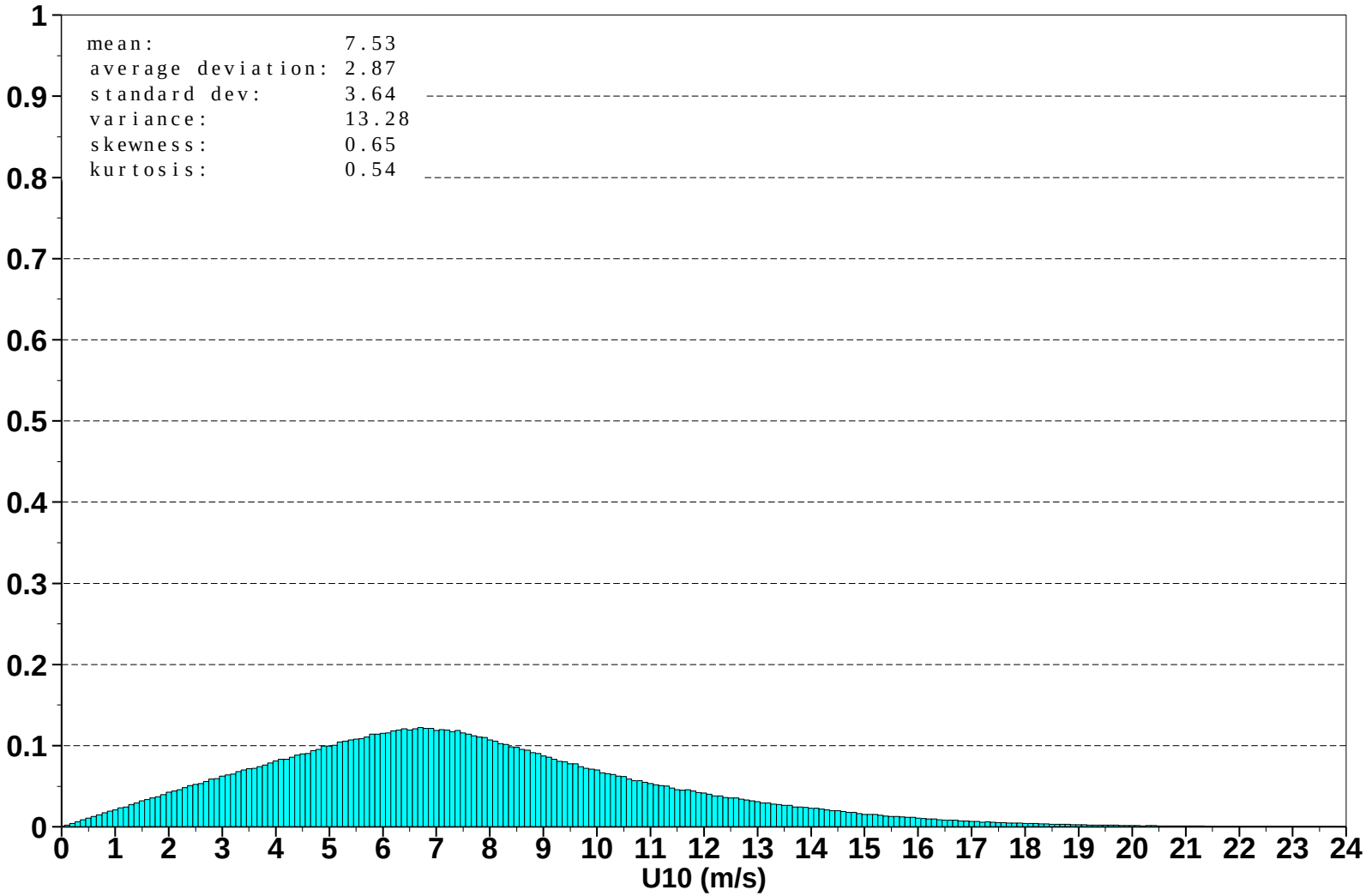
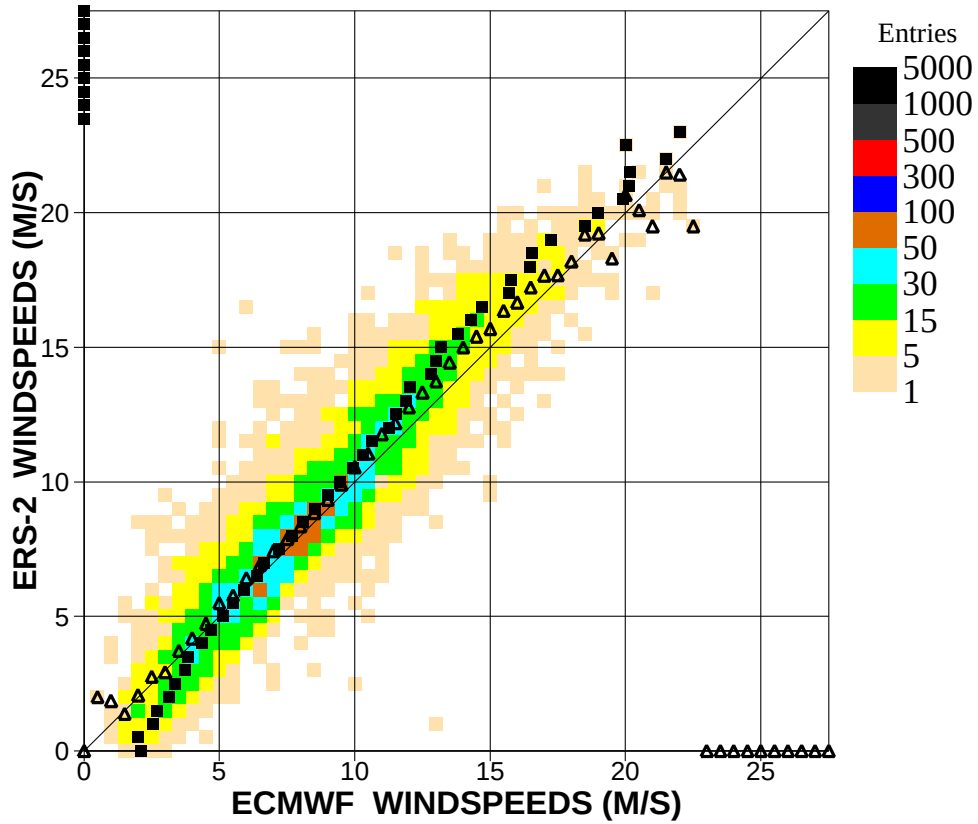


Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2004

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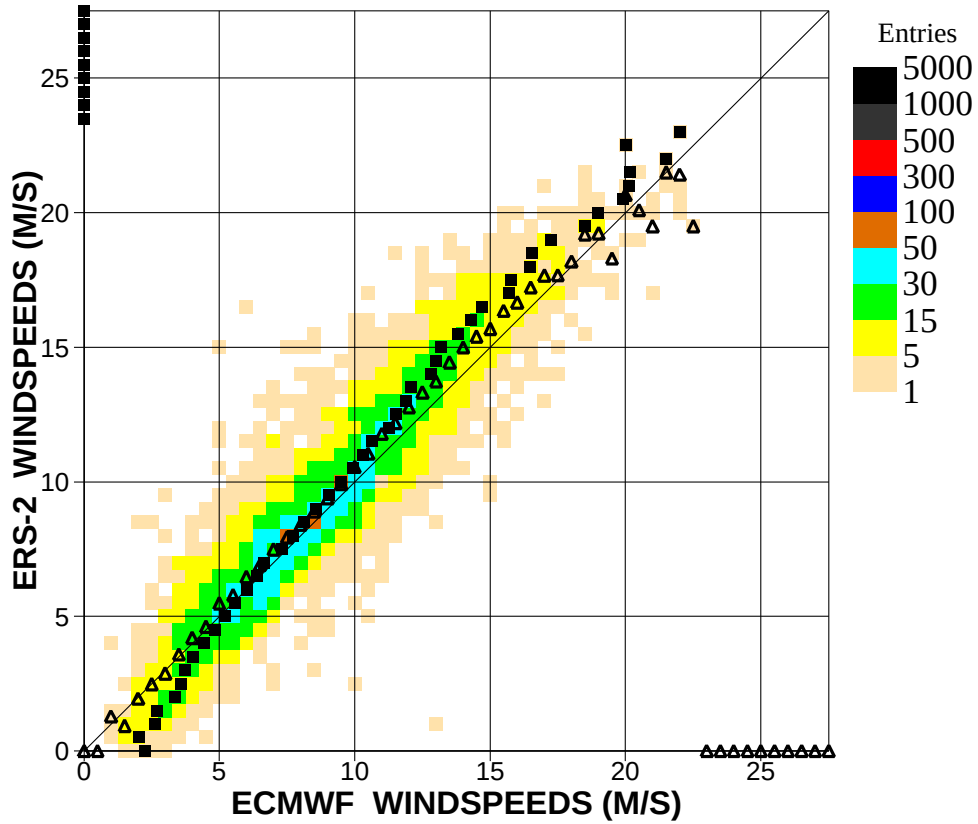
STATISTICS

ENTRIES	5787	
MEAN ECMWF	8.7340	
MEAN ERS-2	9.1992	
BIAS (ERS-2 - ECMWF)	0.4653	
STANDARD DEVIATION	1.4995	
SCATTER INDEX	0.1717	
CORRELATION	0.9358	
SYMMETRIC SLOPE	1.0631	(0.0052)
REGR. COEFFICIENT	1.0419	(0.0052)
REGR. CONSTANT	0.0989	(0.0492)

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

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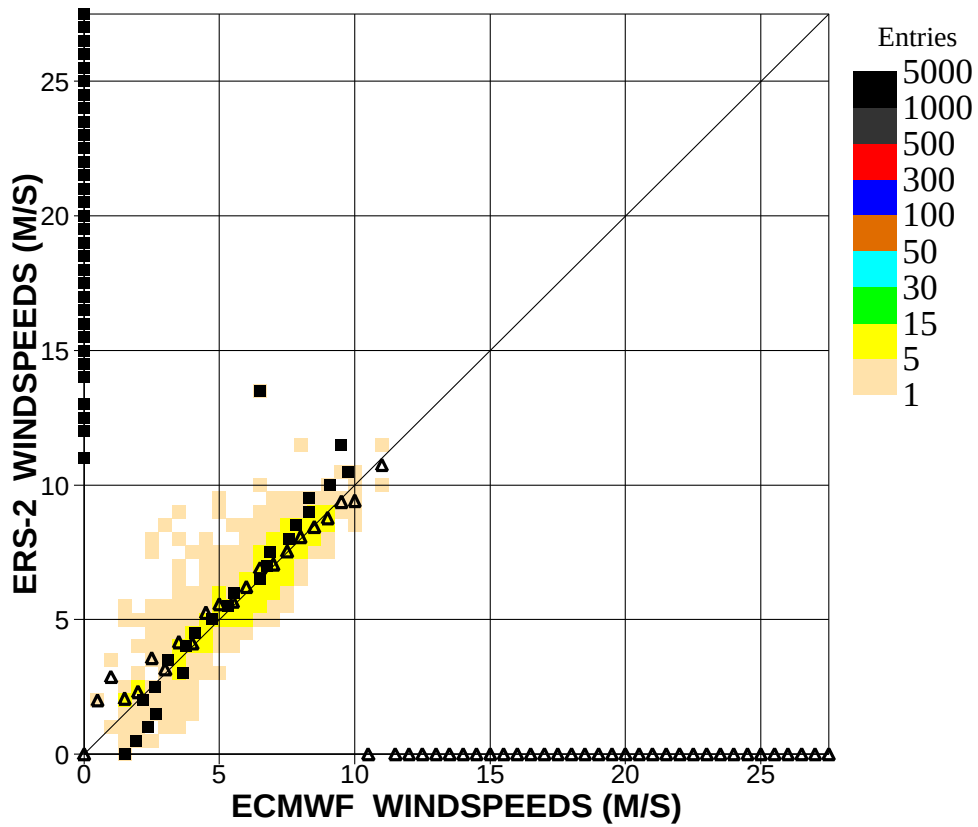
STATISTICS

ENTRIES	5240	
MEAN ECMWF	9.0507	
MEAN ERS-2	9.5346	
BIAS (ERS-2 - ECMWF)	0.4839	
STANDARD DEVIATION	1.5232	
SCATTER INDEX	0.1683	
CORRELATION	0.9343	
SYMMETRIC SLOPE	1.0636	(0.0055)
REGR. COEFFICIENT	1.0458	(0.0055)
REGR. CONSTANT	0.0690	(0.0541)

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

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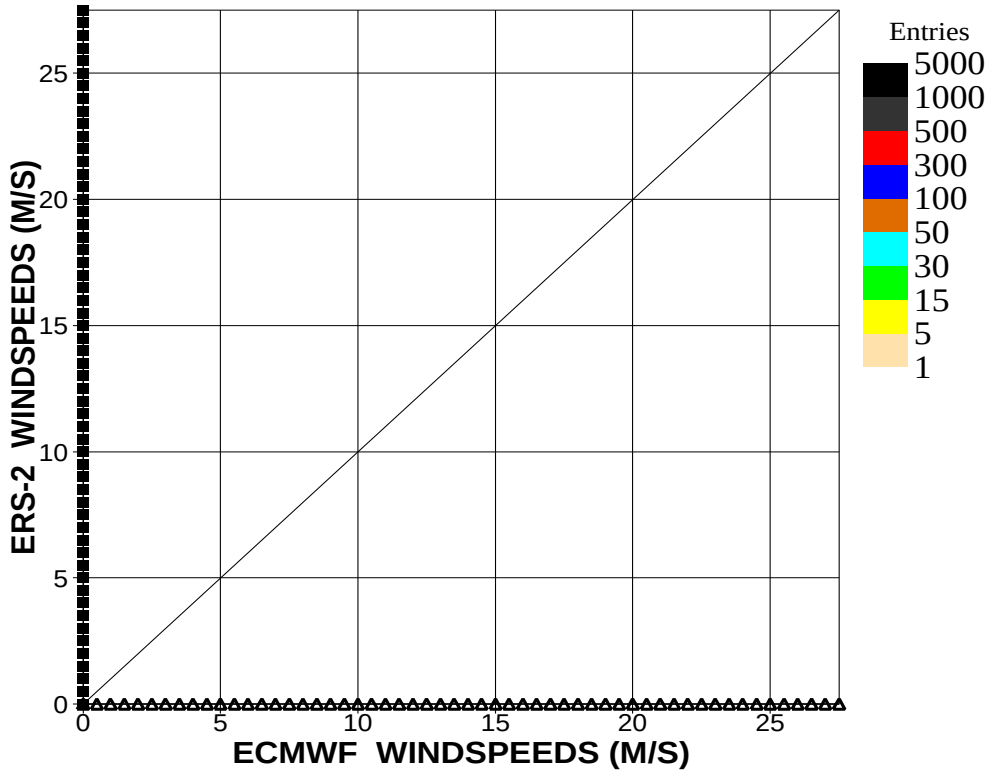


STATISTICS

ENTRIES	572	
MEAN ECMWF	5.7618	
MEAN ERS-2	6.0385	
BIAS (ERS-2 - ECMWF)	0.2766	
STANDARD DEVIATION	1.2187	
SCATTER INDEX	0.2115	
CORRELATION	0.8509	
SYMMETRIC SLOPE	1.0477	(0.0239)
REGR. COEFFICIENT	0.8897	(0.0230)
REGR. CONSTANT	0.9121	(0.1417)

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

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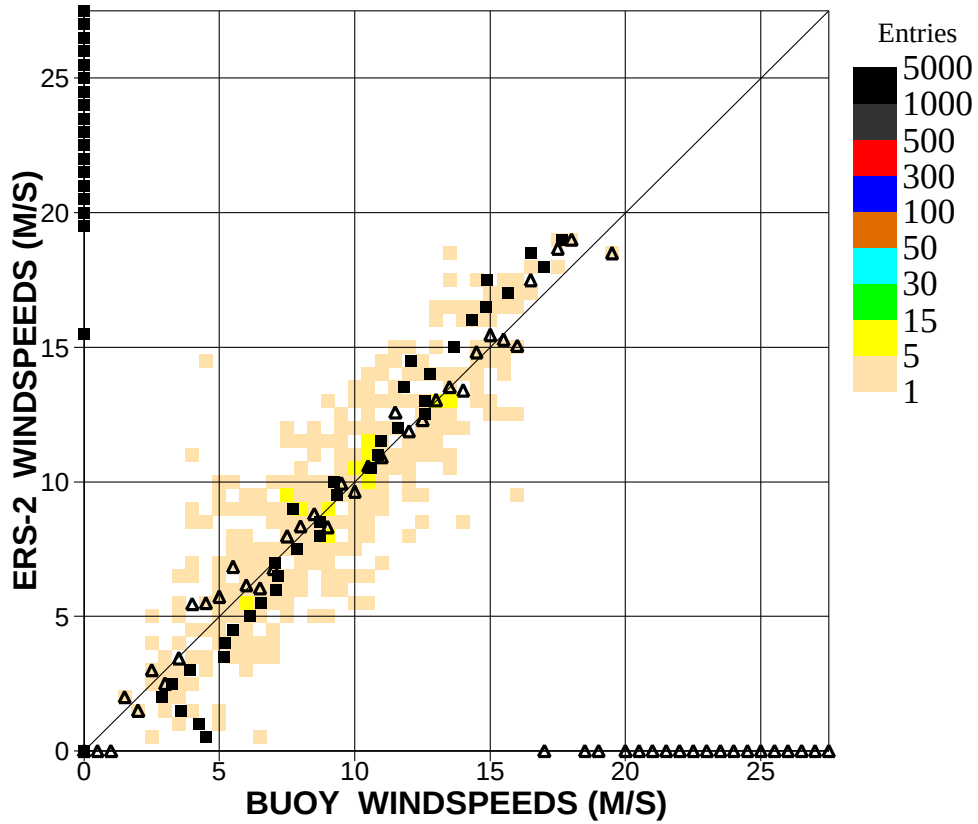
STATISTICS

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 December 2004 (s.hem.)

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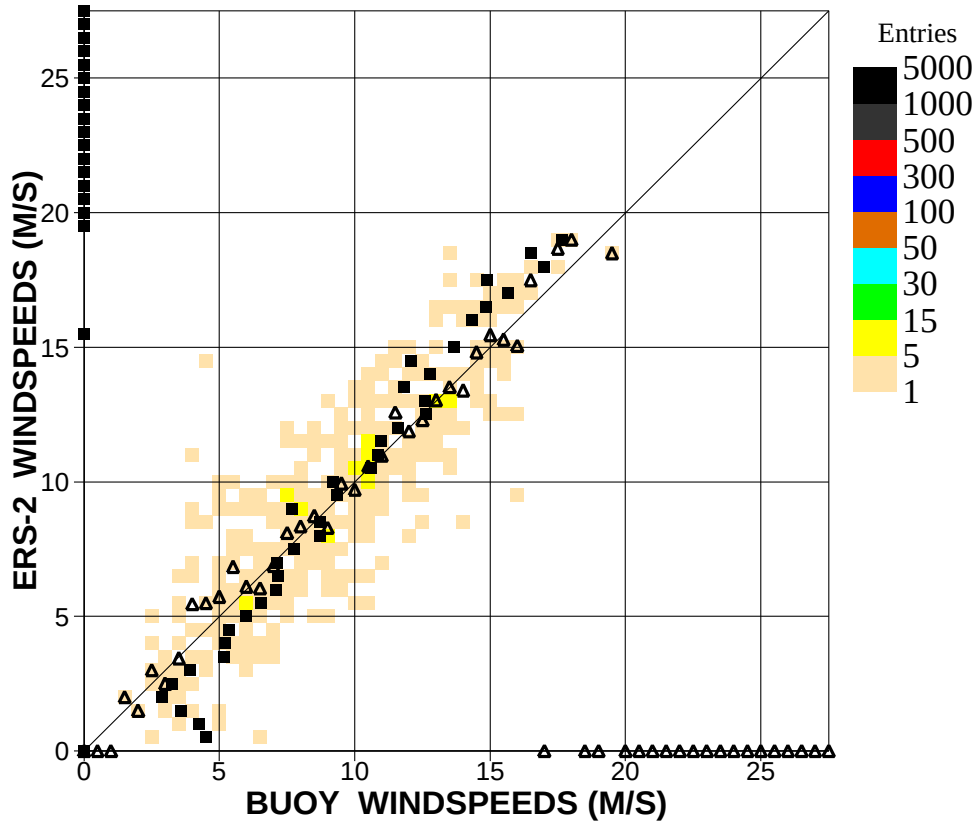


STATISTICS

ENTRIES	497	
MEAN BUOY	9.5143	
MEAN ERS-2	9.6501	
BIAS (ERS-2 - BUOY)	0.1358	
STANDARD DEVIATION	1.9461	
SCATTER INDEX	0.2045	
CORRELATION	0.8591	
SYMMETRIC SLOPE	1.0248	(0.0256)
REGR. COEFFICIENT	0.9471	(0.0254)
REGR. CONSTANT	0.6391	(0.2565)

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

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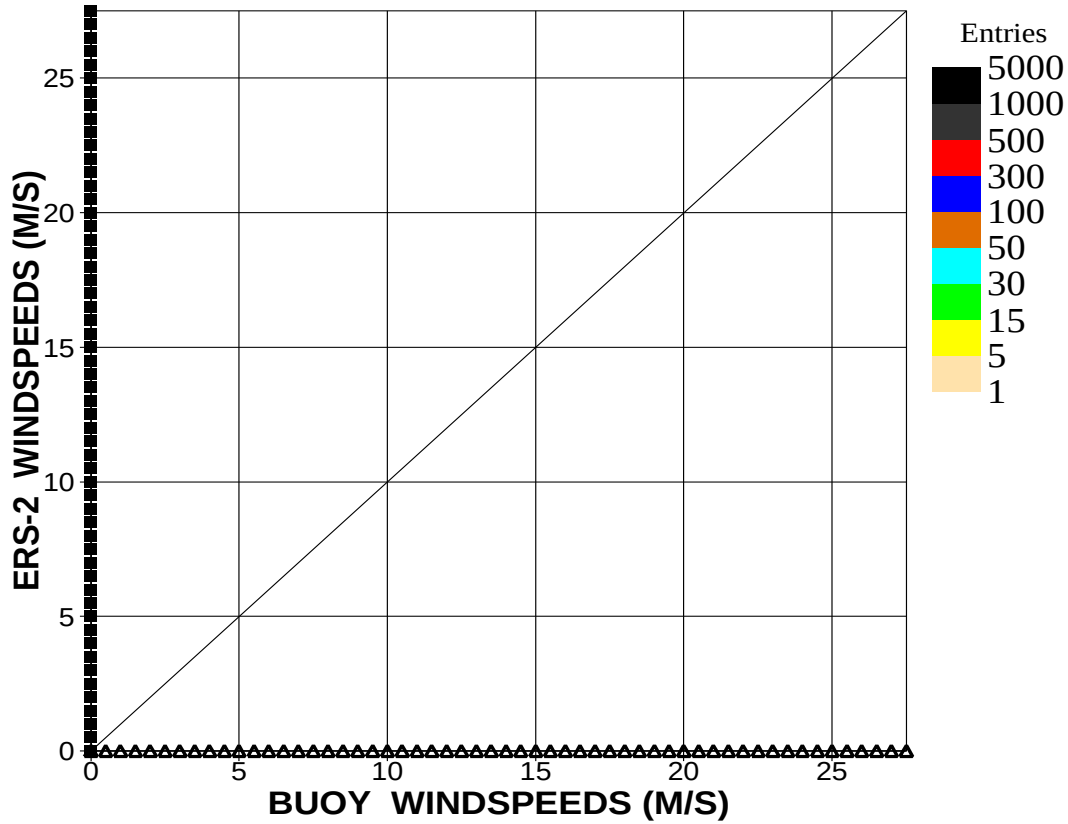


STATISTICS

ENTRIES	489	
MEAN BUOY	9.5230	
MEAN ERS-2	9.6740	
BIAS (ERS-2 - BUOY)	0.1510	
STANDARD DEVIATION	1.9495	
SCATTER INDEX	0.2047	
CORRELATION	0.8597	
SYMMETRIC SLOPE	1.0260	(0.0258)
REGR. COEFFICIENT	0.9459	(0.0255)
REGR. CONSTANT	0.6663	(0.2580)

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

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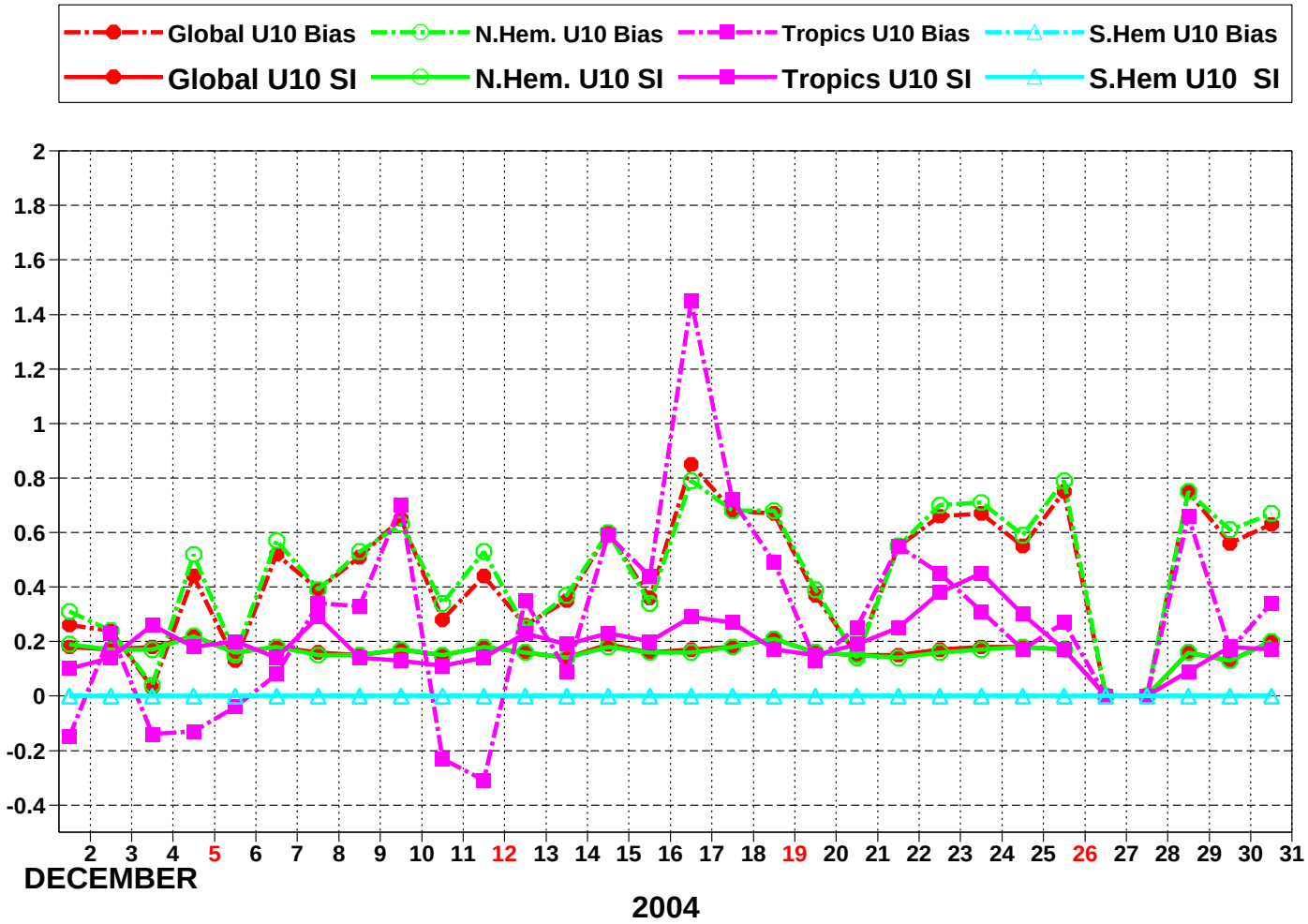


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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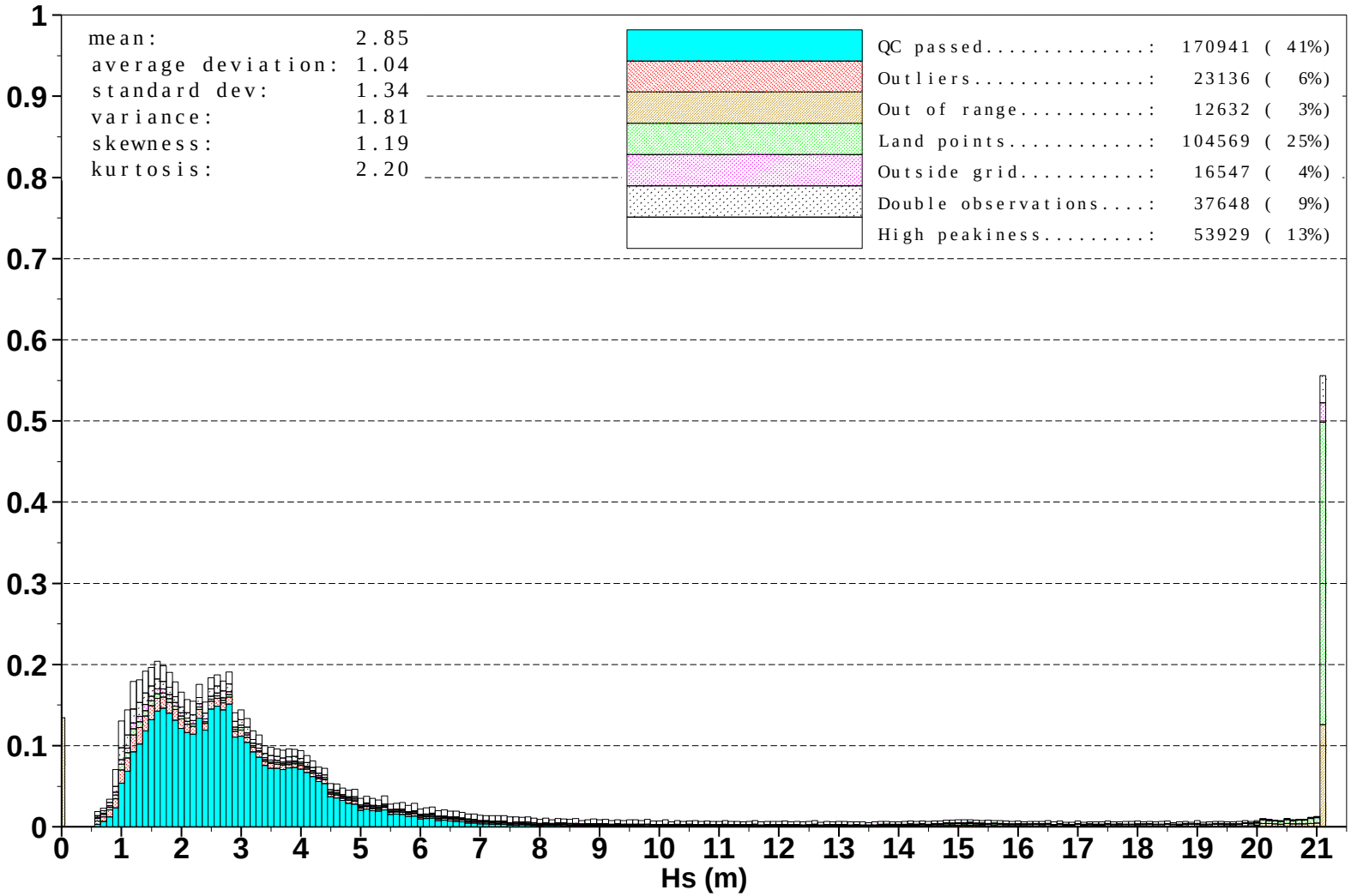


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for December 2004

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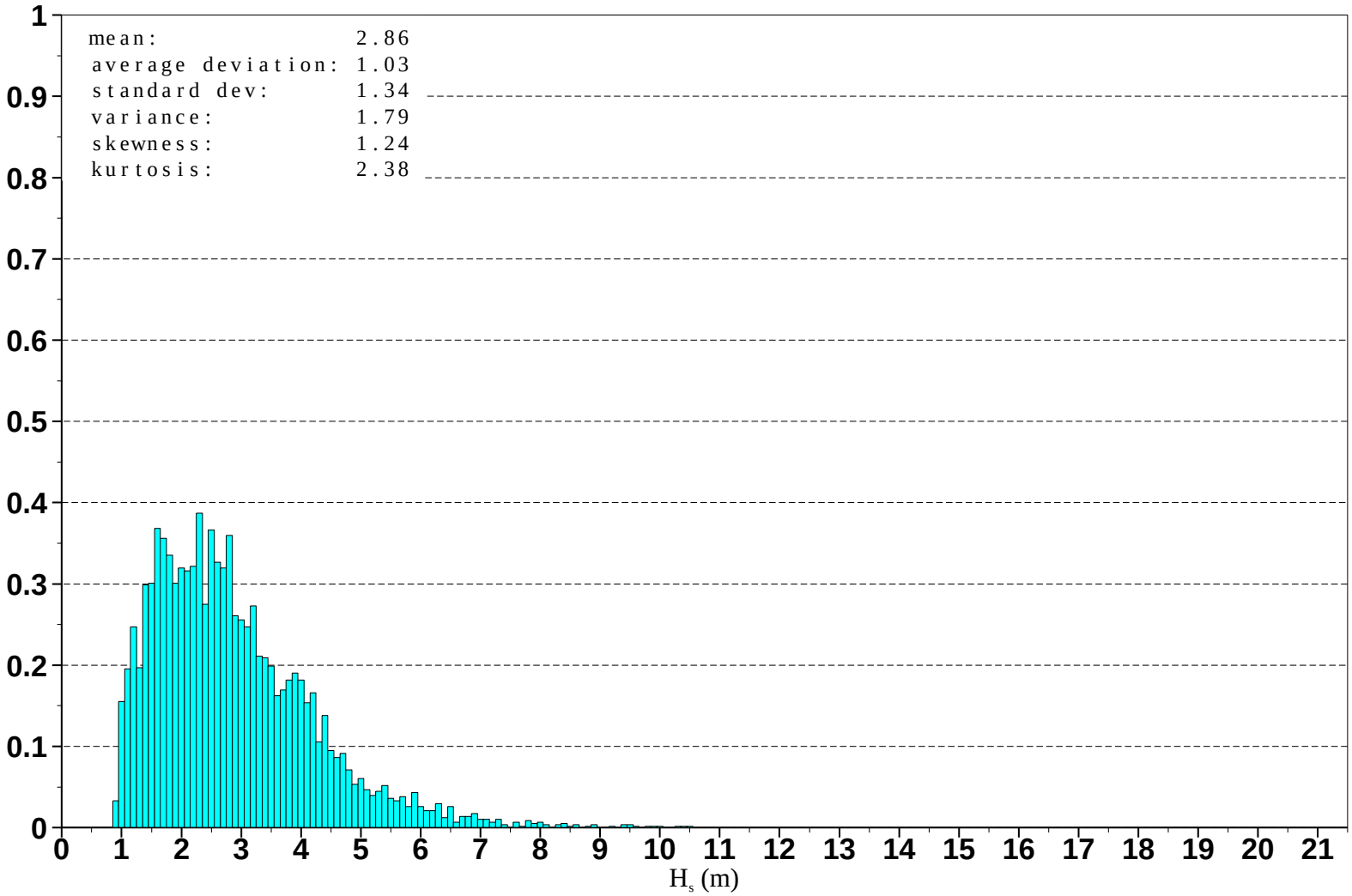


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for December 2004

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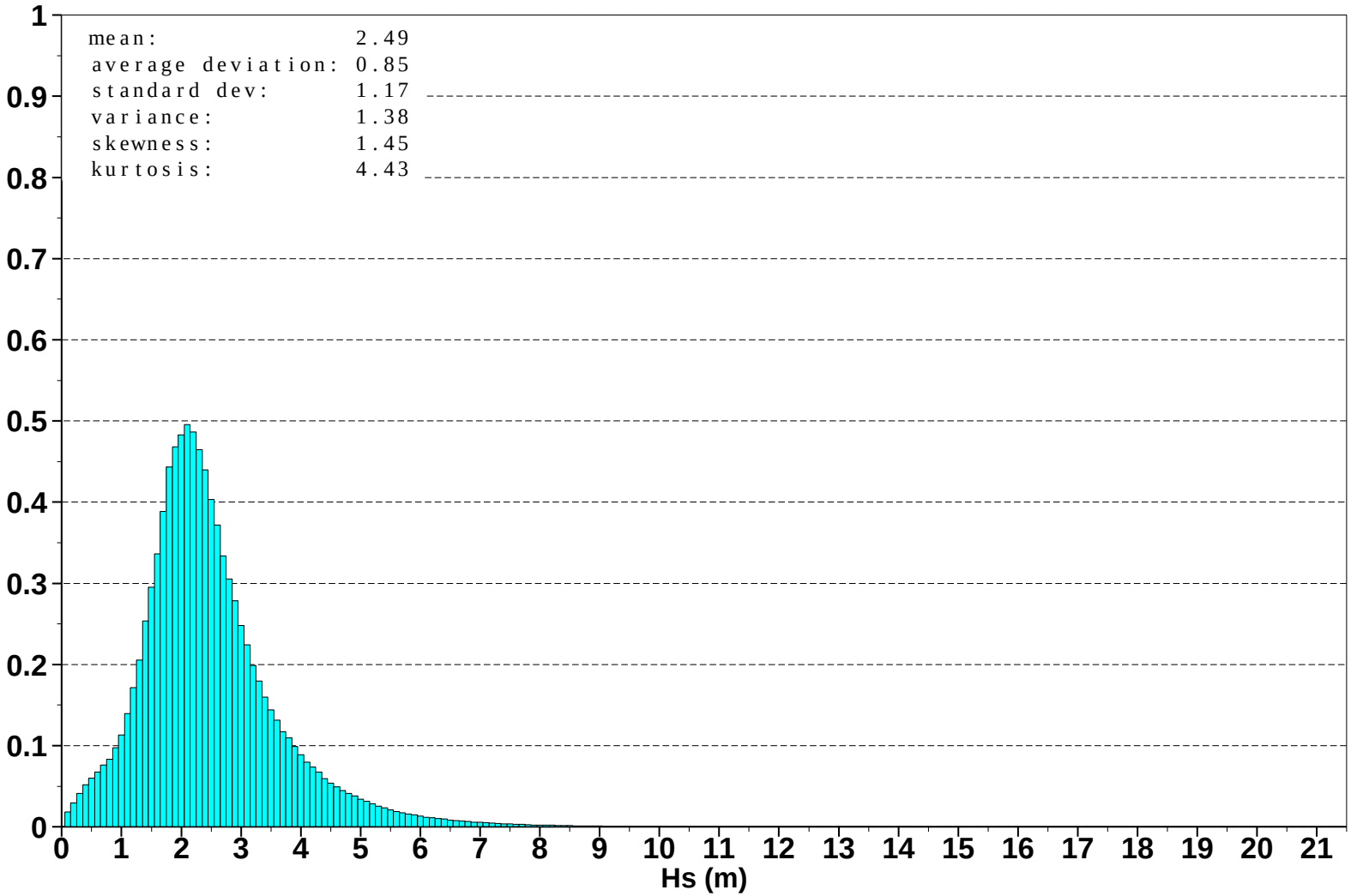
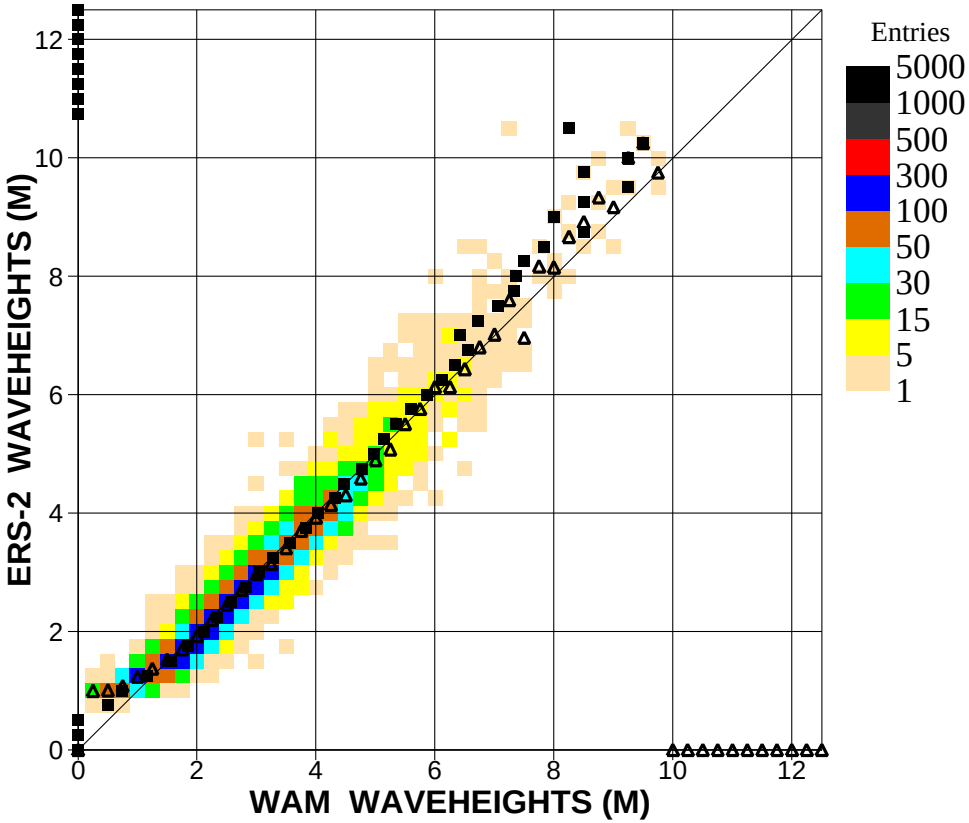


Figure 16: Global distribution of ECMWF wave heights for December 2004

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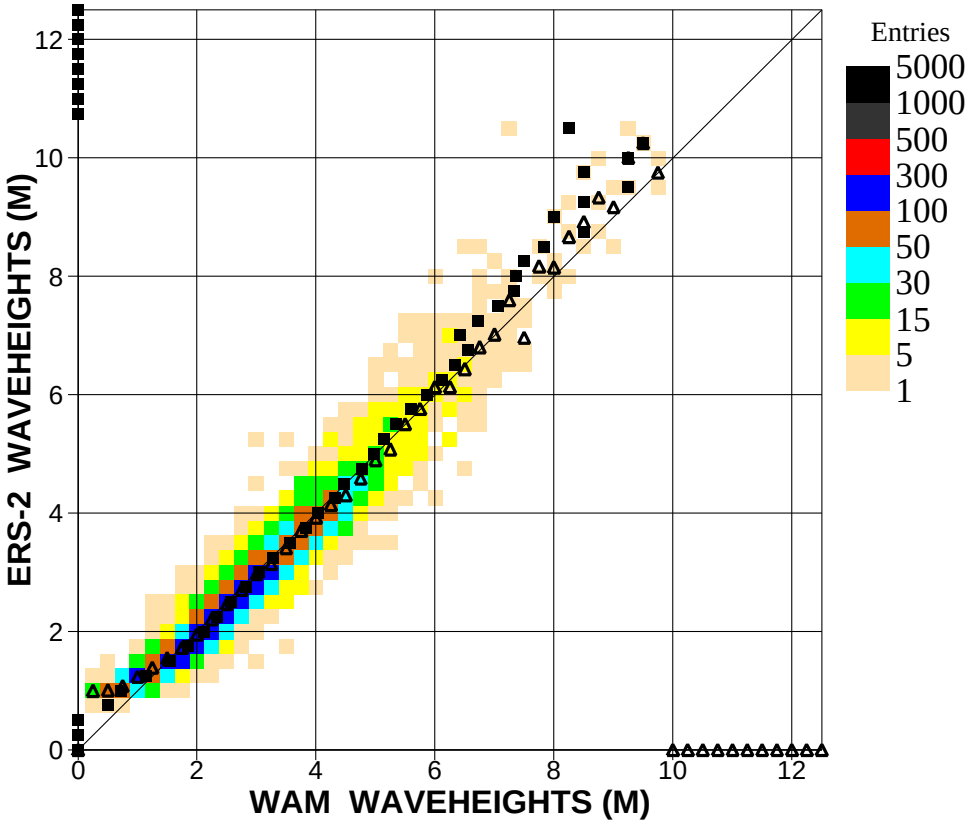


STATISTICS

ENTRIES	5787	
MEAN WAM	2.8907	
MEAN ERS-2	2.8613	
BIAS (ERS-2 - WAM)	-0.0293	
STANDARD DEVIATION	0.3450	
SCATTER INDEX	0.1194	
CORRELATION	0.9668	
SYMMETRIC SLOPE	0.9913	(0.0034)
REGR. COEFFICIENT	0.9647	(0.0034)
REGR. CONSTANT	0.0726	(0.0107)

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

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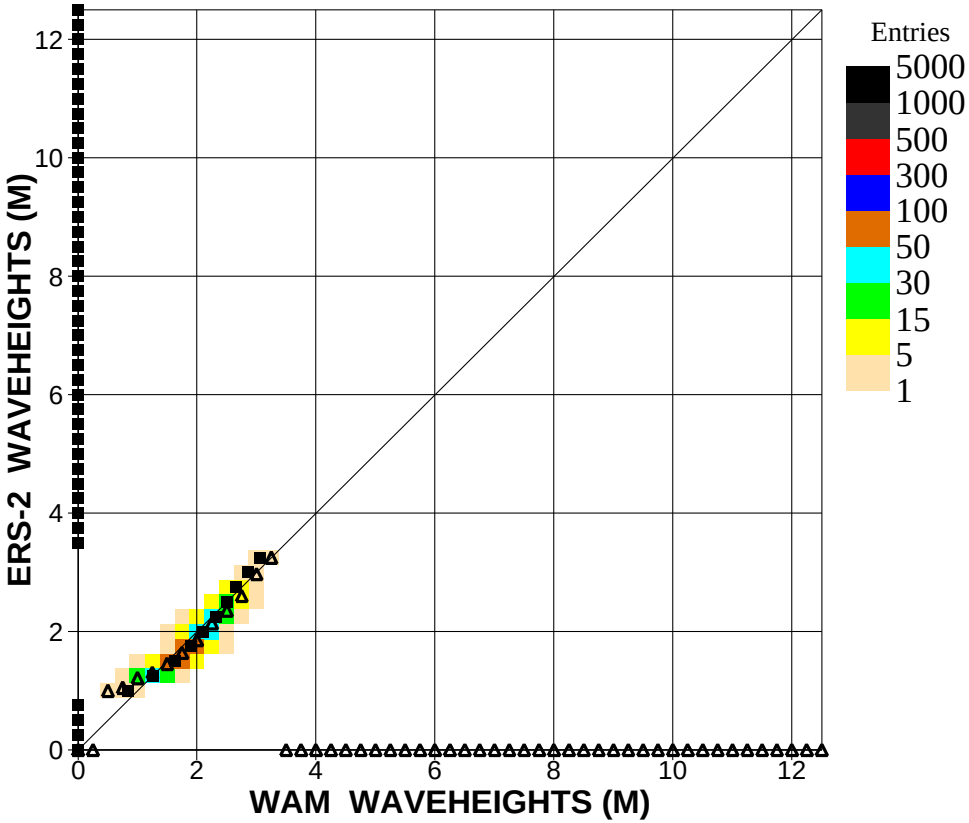


STATISTICS

ENTRIES	5240	
MEAN WAM	2.9938	
MEAN ERS-2	2.9706	
BIAS (ERS-2 - WAM)	-0.0231	
STANDARD DEVIATION	0.3579	
SCATTER INDEX	0.1195	
CORRELATION	0.9653	
SYMMETRIC SLOPE	0.9927	(0.0036)
REGR. COEFFICIENT	0.9600	(0.0036)
REGR. CONSTANT	0.0965	(0.0118)

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

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STATISTICS

ENTRIES	572	
MEAN WAM	1.9092	
MEAN ERS-2	1.8224	
BIAS (ERS-2 - WAM)	-0.0868	
STANDARD DEVIATION	0.1704	
SCATTER INDEX	0.0892	
CORRELATION	0.9261	
SYMMETRIC SLOPE	0.9535	(0.0152)
REGR. COEFFICIENT	0.8663	(0.0148)
REGR. CONSTANT	0.1685	(0.0290)

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

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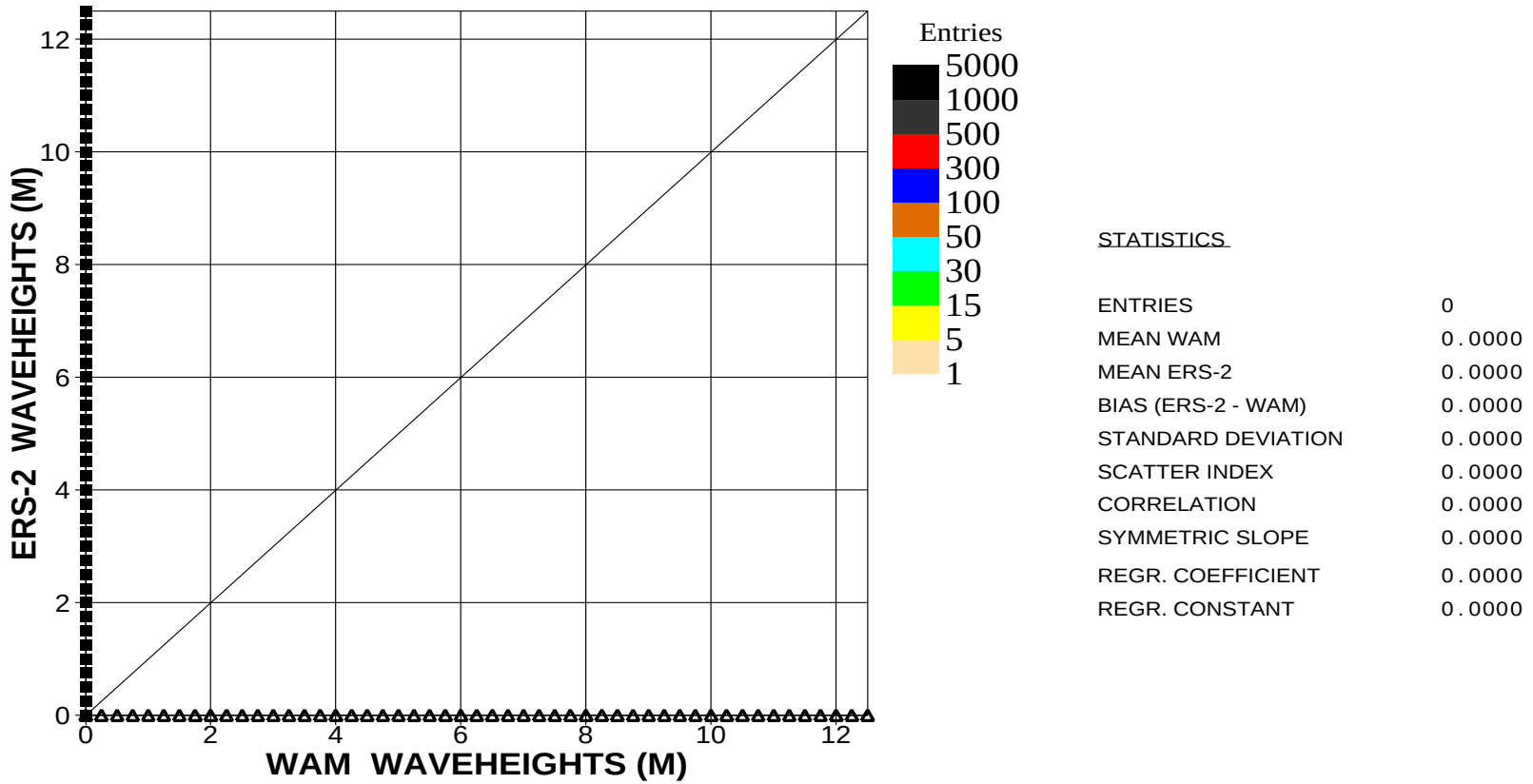
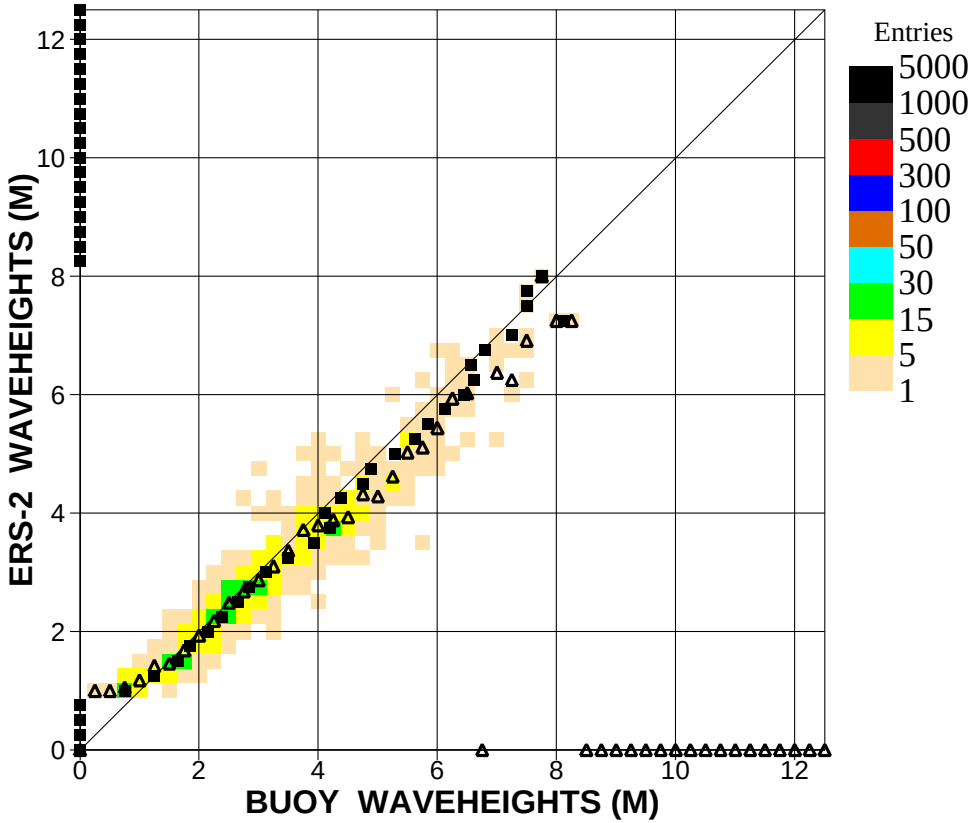


Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2004 (s.hem.)

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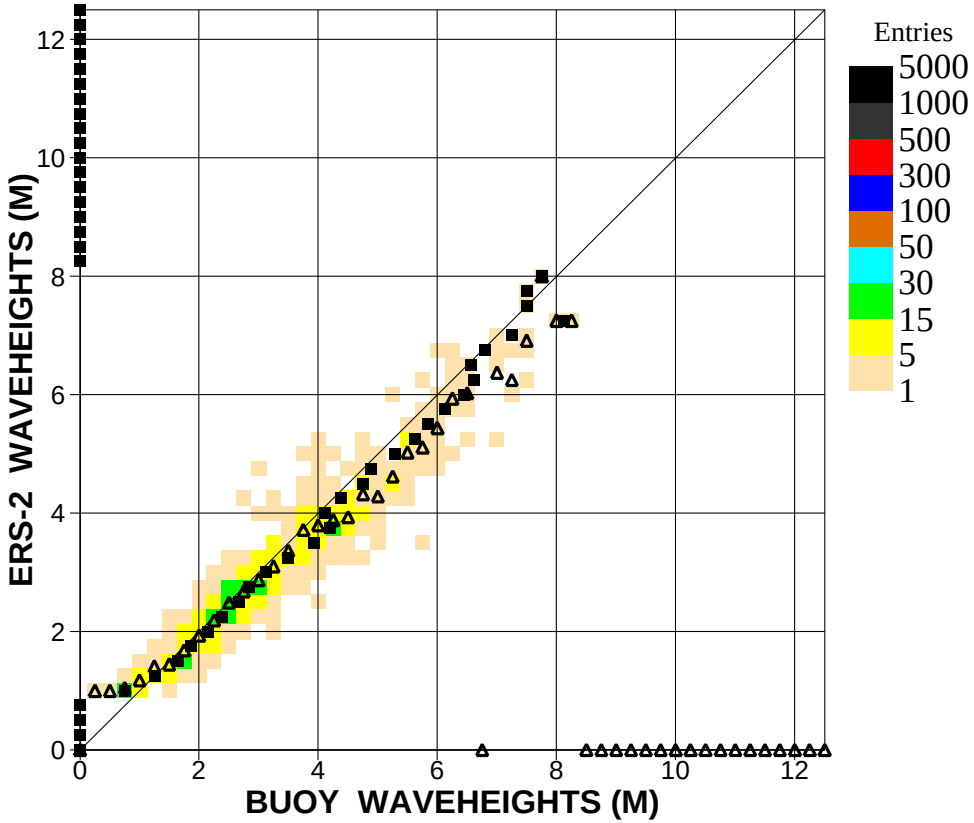
STATISTICS

ENTRIES	731	
MEAN BUOY	3.2085	
MEAN ERS-2	3.0469	
BIAS (ERS-2 - BUOY)	-0.1616	
STANDARD DEVIATION	0.4456	
SCATTER INDEX	0.1389	
CORRELATION	0.9573	
SYMMETRIC SLOPE	0.9399	(0.0101)
REGR. COEFFICIENT	0.8561	(0.0096)
REGR. CONSTANT	0.3002	(0.0339)

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

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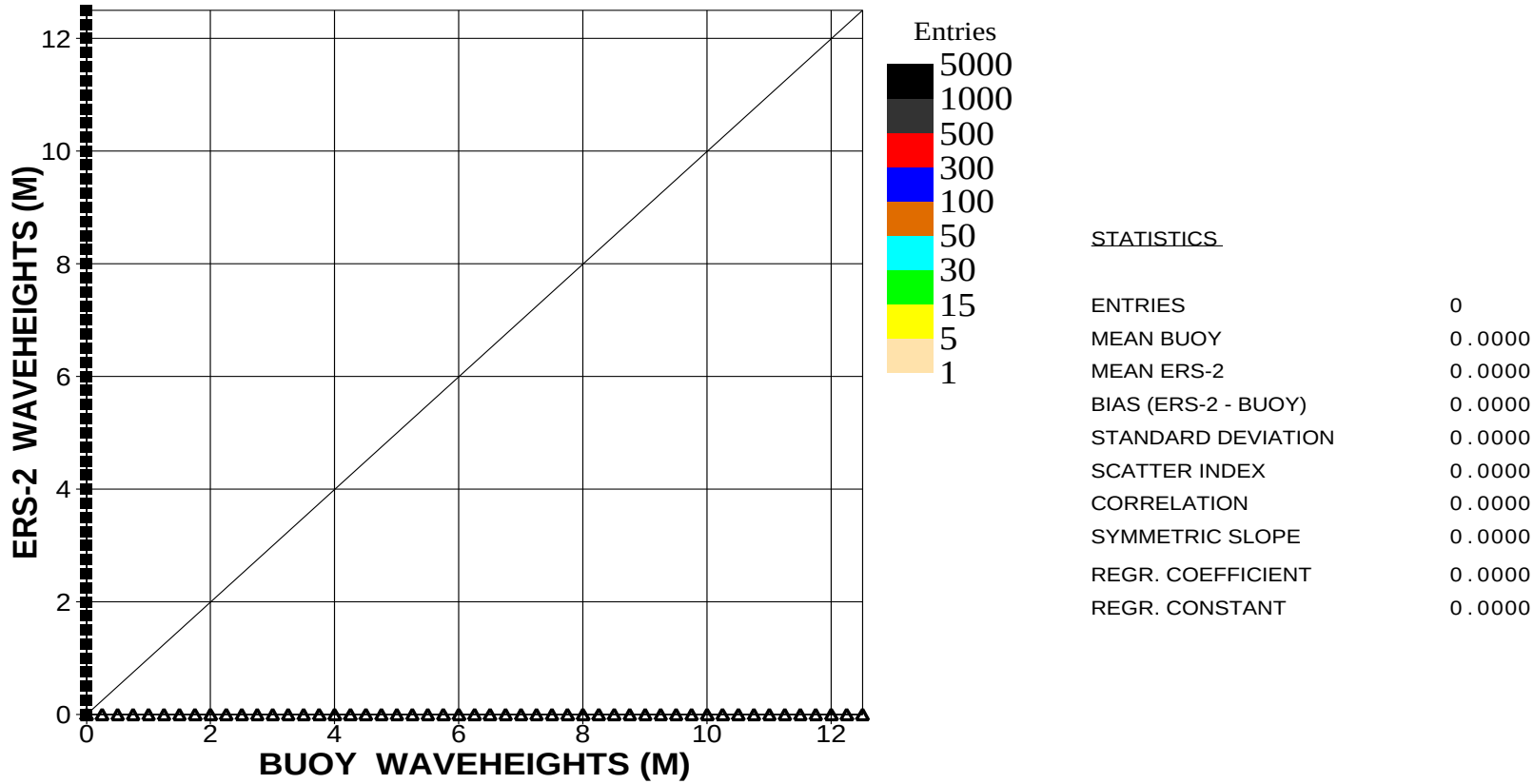


STATISTICS

ENTRIES	723	
MEAN BUOY	3.2262	
MEAN ERS-2	3.0628	
BIAS (ERS-2 - BUOY)	-0.1634	
STANDARD DEVIATION	0.4468	
SCATTER INDEX	0.1385	
CORRELATION	0.9569	
SYMMETRIC SLOPE	0.9398	(0.0102)
REGR. COEFFICIENT	0.8558	(0.0097)
REGR. CONSTANT	0.3018	(0.0344)

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

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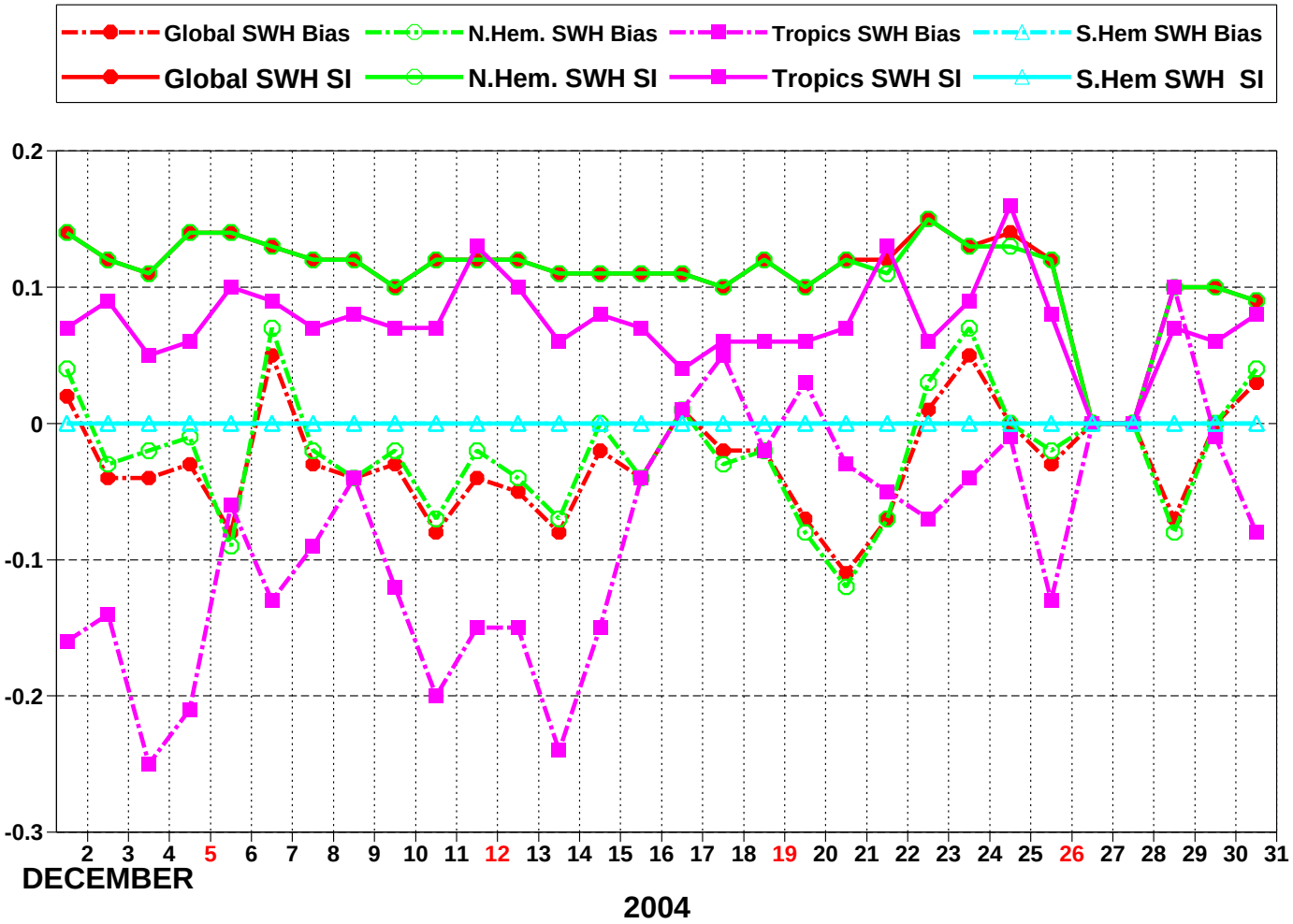


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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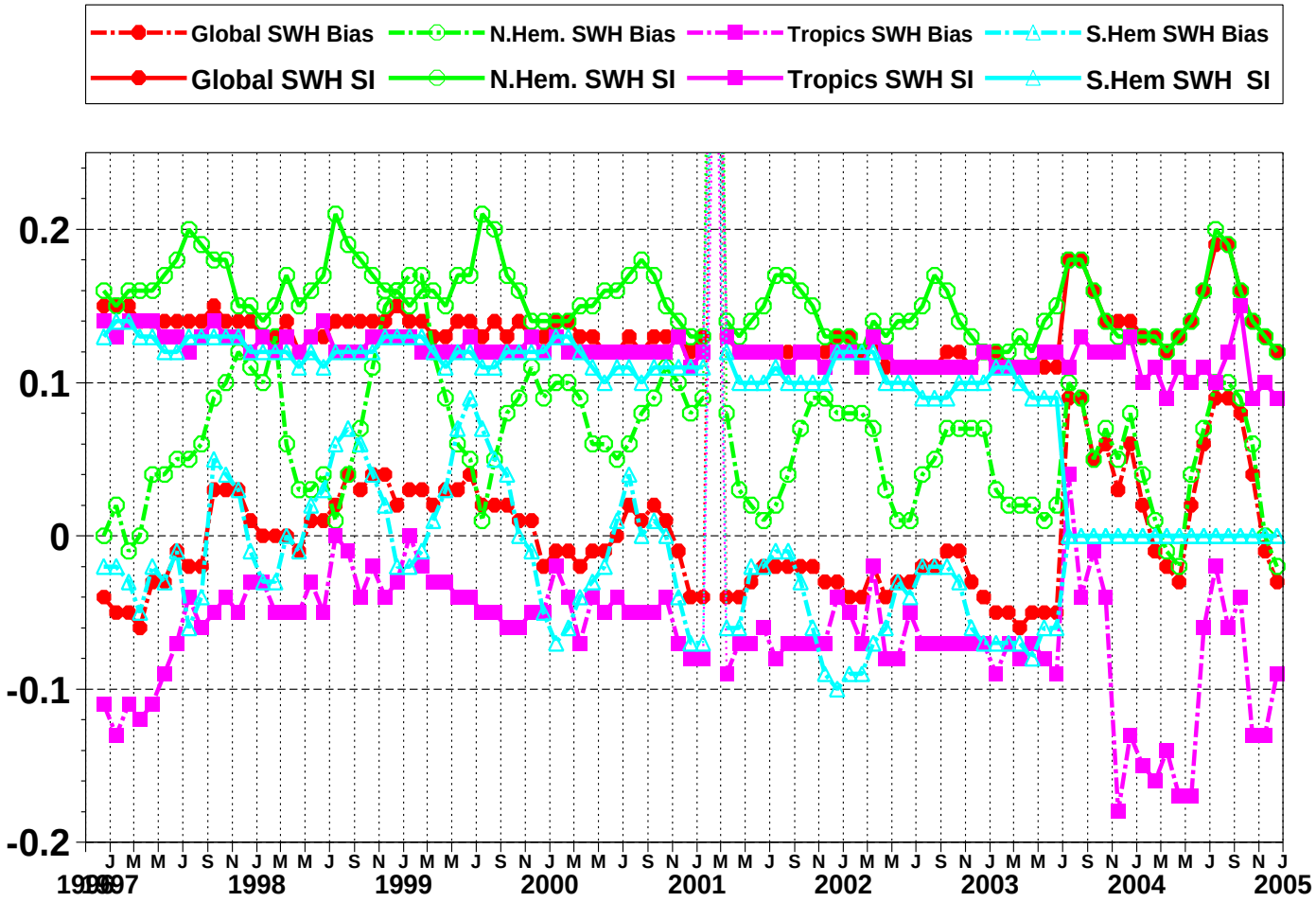


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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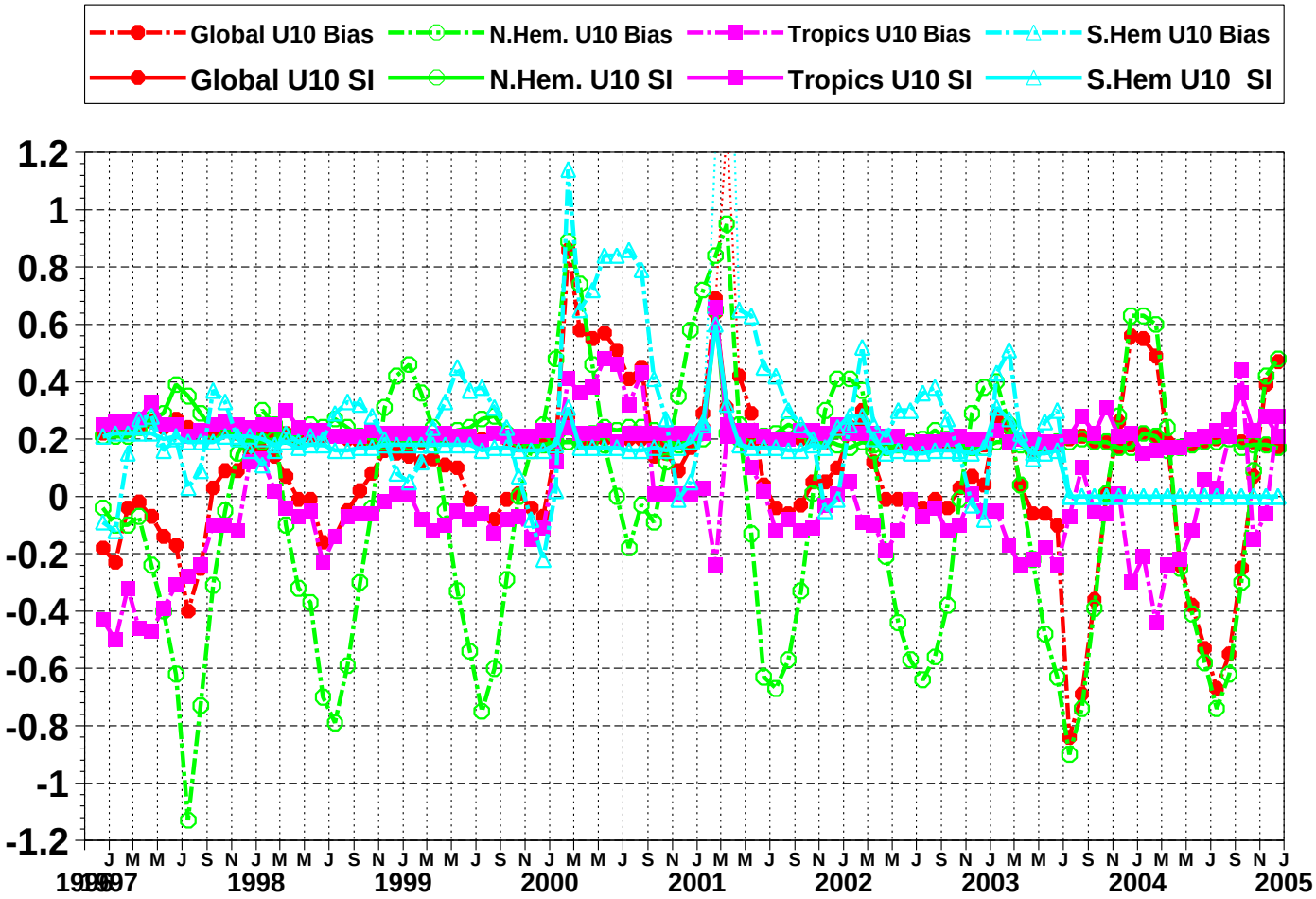


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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