ECMWF Report on ERS-2 RA for December 2001

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

By: *Saleh Abdalla*

Date: *8 January 2002*

Overview:

Based on the data received during the full month, on average, 16739 observations arrived at ECMWF every 6 hours of which 79.6% passed the quality control. Apart from the first two days of the month when there was no data, the data coverage was very good as can be seen in Figure 1. Note that we are talking about the raw data which have arrived at ECMWF before they were processed. The quality of the received data is as good as usual (see remarks below).

Backscatter:

ESR-2 $<\sigma_0>$ = 10.99 dB (with a main peak at 11.1 dB and a secondary peak at 10.6 dB)

Wind Speed Comparison with ECMWF wind speeds (bias):

ERS-2 global: 0.097 m/s

ERS-2 northern hemisphere: 0.408 m/s

ERS-2 tropics: 0.006 m/s

ERS-2 southern hemisphere: -0.014 m/s

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Wind Speed Comparison with buoy wind speeds (bias):

ERS-2 global: -0.017 m/s

ERS-2 northern hemisphere: 0.033 m/s

ERS-2 tropics: -0.650 m/s

Wave Height Comparison with ECMWF wave heights (bias):

ERS-2 global: -0.034 m (lowest waves measured: 0.6m)

ERS-2 northern hemisphere: 0.084 m

ERS-2 tropics: -0.040 m

ERS-2 southern hemisphere: -0.096 m

Wave Height Comparison with buoy wave heights (bias):

ERS-2 global: -0.184 m

ERS-2 northern hemisphere: -0.175 m

ERS-2 tropics: -0.358 m

Remarks:

- Again there are several outliers (RA values higher than model) in the scatter plot for the wind speed in the Southern Hemisphere (Figure 9) for this month as well. As has been pointed out in the previous reports, most of the outliers can

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be attributed to the DES Sun- Blinding phenomenon due to high solar activity on the 3rd., 12th., 21st.-22nd., and 24th.-28th. of the month.

- A significant outlier in the wind speed occurred on Dec. 7. The mismatch occurred during a descending pass and the following ascending pass between 16:48 and 18:25 UTC. Annalisa Martini pointed out that this outlier can be attributed to a problem in the ground Station signal reception with many small gaps in the raw data and many blank products in the fast delivery data.
- Other than the above mentioned outliers, the quality of Altimeter data is as it used to be.

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 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.

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Figure captions:

Figure 1: Time series of data reception for ERS-2 Altimeter data for December 2001.

Figure 2: Distribution of the ERS-2 Altimeter Backscatter after QC for December 2001.

Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2001.

Figure 4: Distribution of the ERS-2 Altimeter wind speeds after along track averaging for December 2001.

Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2001.

Figure 6: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2001 (global).

Figure 7: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2001 (northern hemisphere)

Figure 8: Comparison of ECMWF wind speed results with ERS-2 Altimeter wind speed data for December 2001 (tropics)

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Figure 10: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2001 (global).

Figure 11: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2001 (northern hemisphere).

Figure 12: Comparison of buoy wind speed observations with ERS-2 Altimeter wind speed data for December 2001 (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 2001.

Figure 15: Distribution of the ERS-2 Altimeter wave heights after along track averaging for December 2001.

Figure 16: Global distribution of ECMWF wave heights for December 2001.

Figure 17: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2001 (global).

Figure 18: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2001 (northern hemisphere)

Figure 19: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2001 (tropics)

Figure 20: Comparison of ECMWF wave height results with ERS-2 Altimeter wave height data for December 2001 (southern hemisphere)

Figure 21: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2001 (global).

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Figure 22: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2001 (northern hemisphere).

Figure 23: Comparison of buoy wave height observations with ERS-2 Altimeter wave height data for December 2001 (tropics).

Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) for December 2001.

Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2001

Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI) from December 1996 to December 2001

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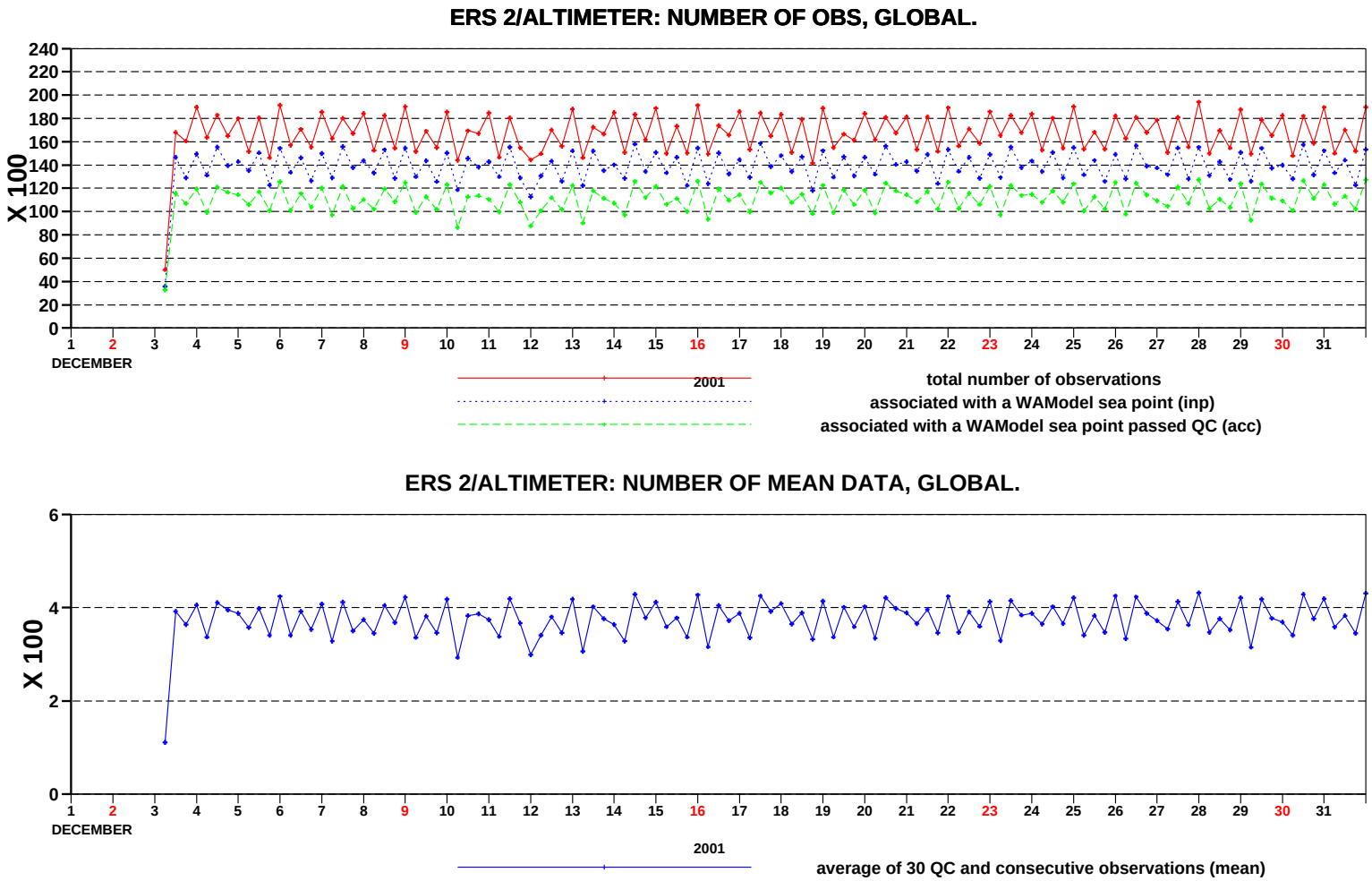


Figure 1: Time series of data reception for ERS-2 Altimeter data for December 2001

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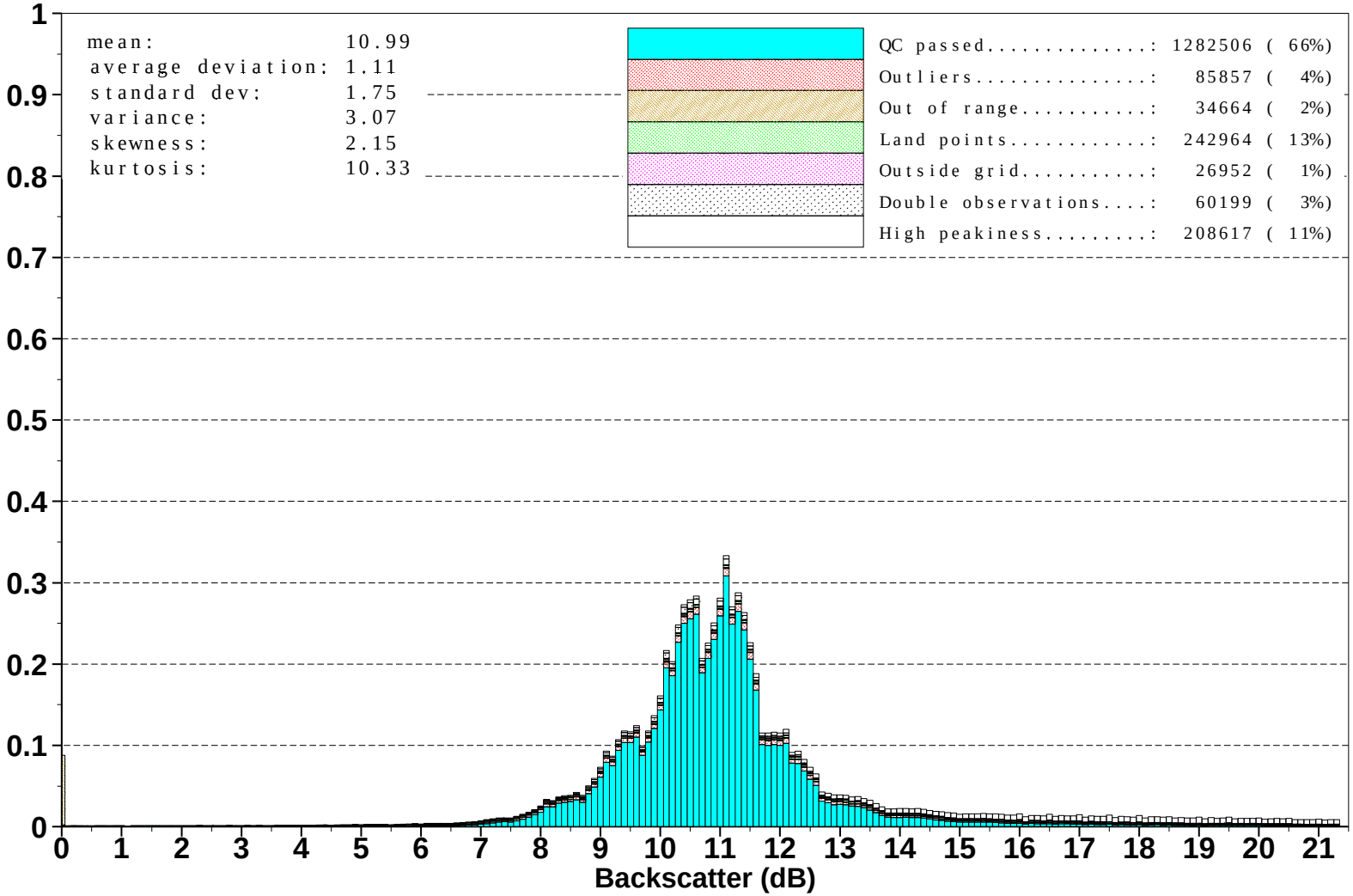


Figure 2: Distribution of the ERS-2 Altimeter backscatter after QC for December 2001

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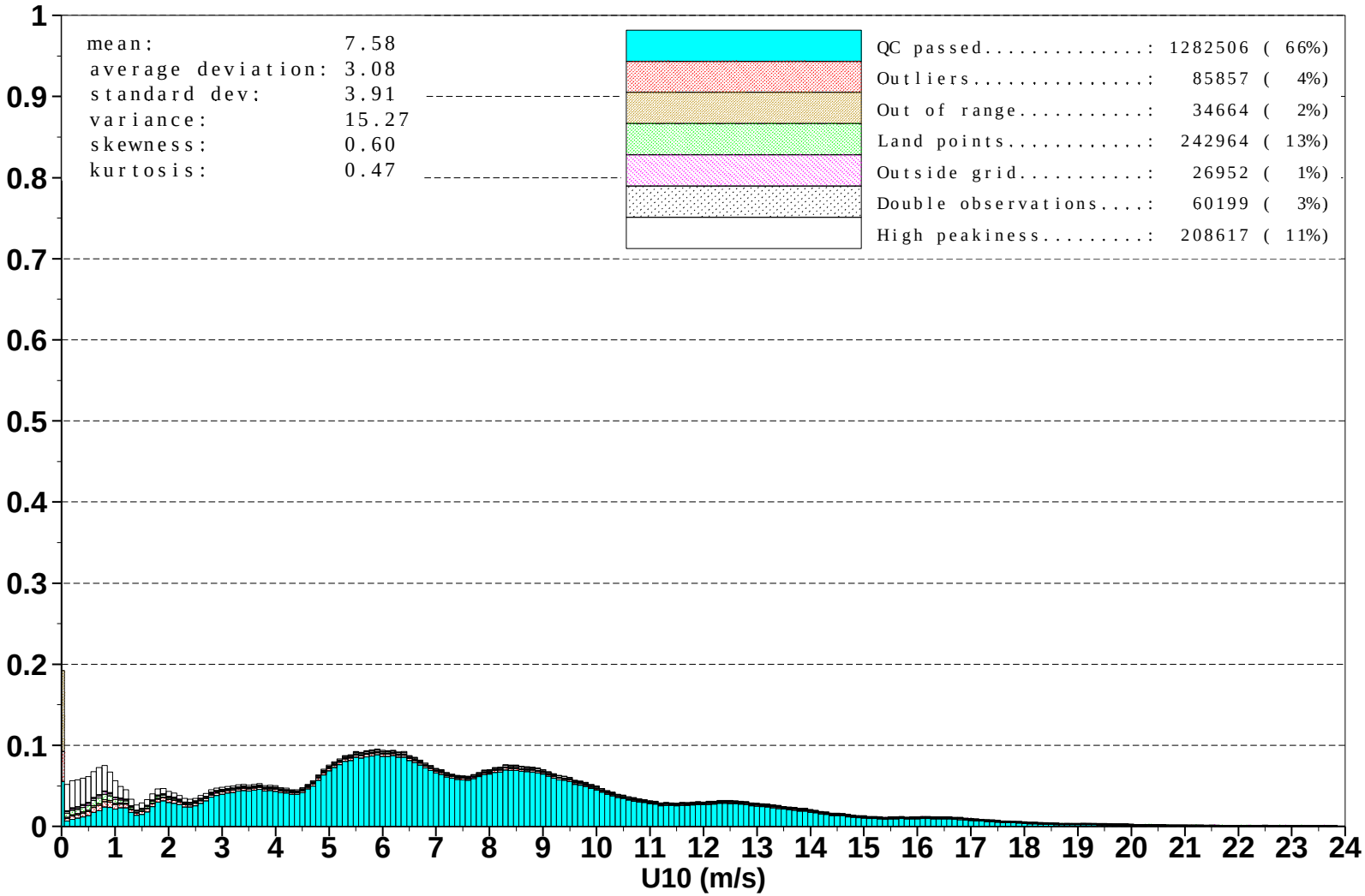


Figure 3: Distribution of the ERS-2 Altimeter wind speeds after QC for December 2001

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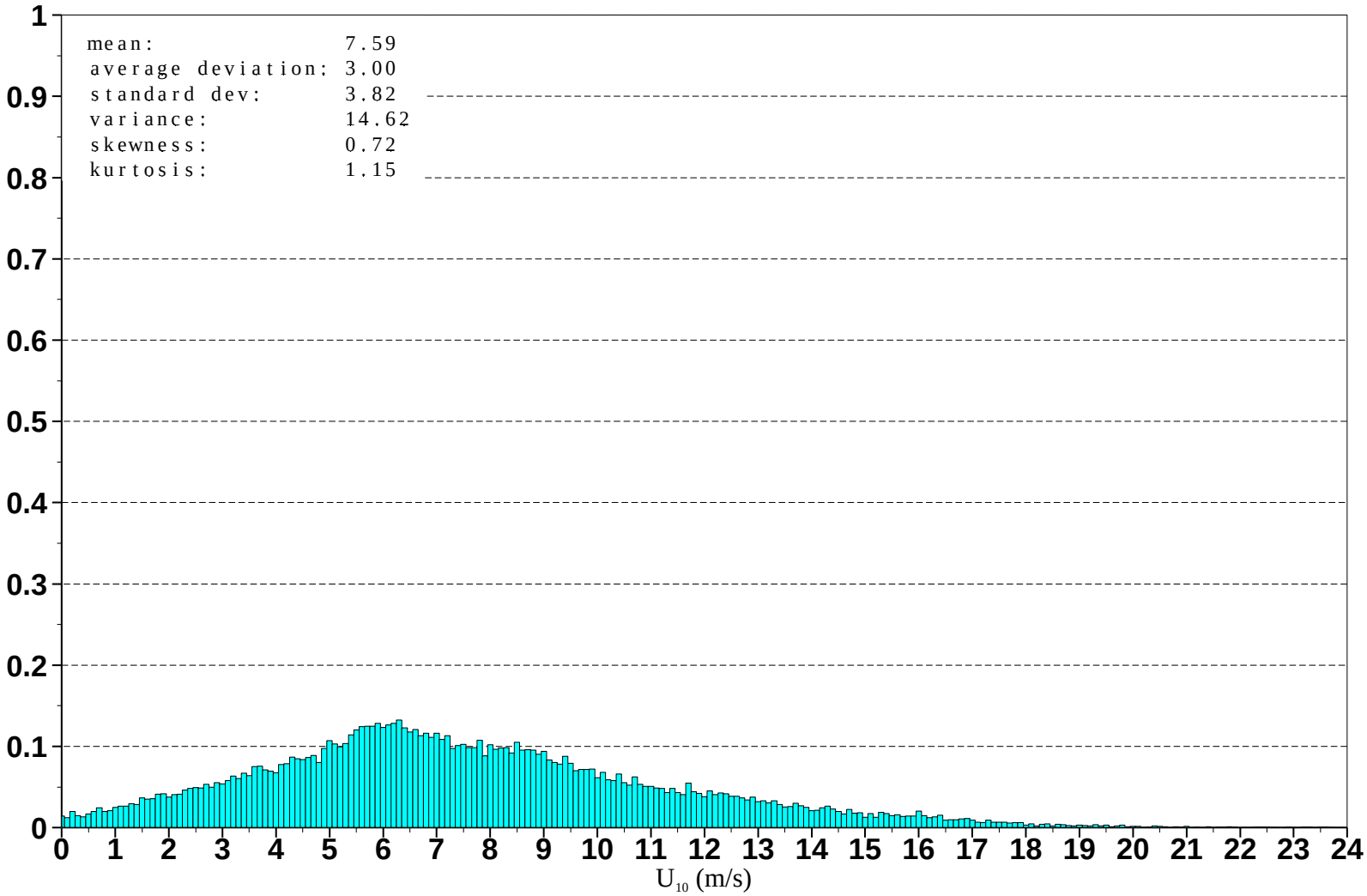


Figure 4: Distribution of ERS-2 Altimeter wind speeds after along track averaging for December 2001

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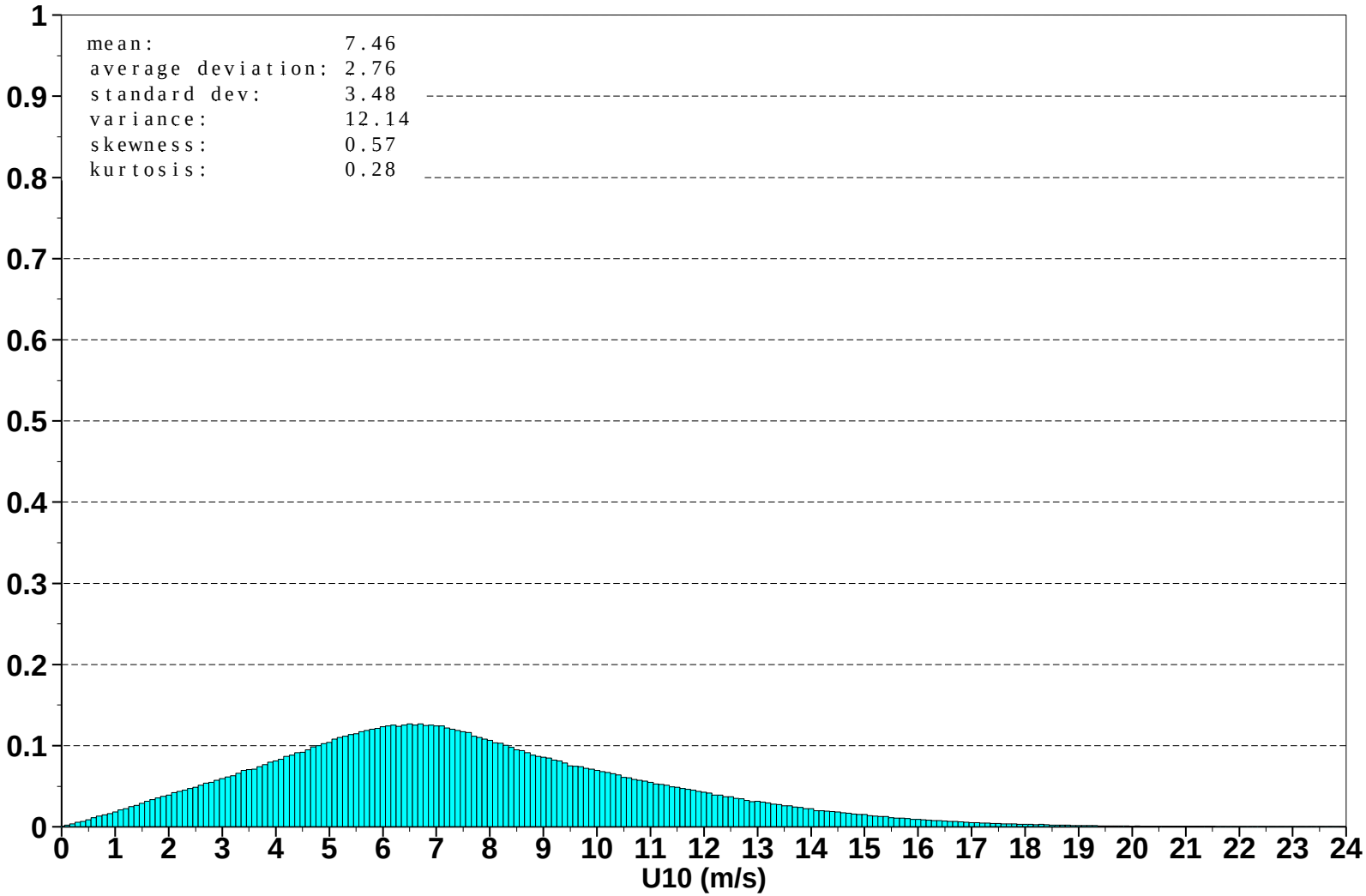
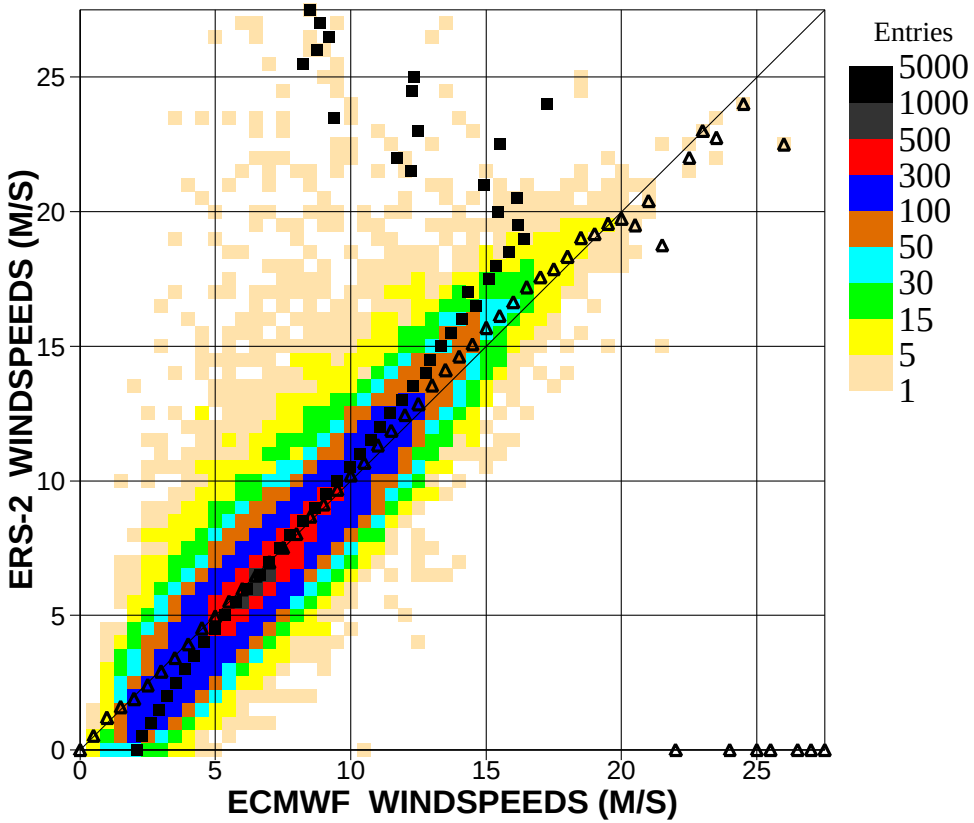


Figure 5: Global distribution of ECMWF ocean surface wind speeds for December 2001

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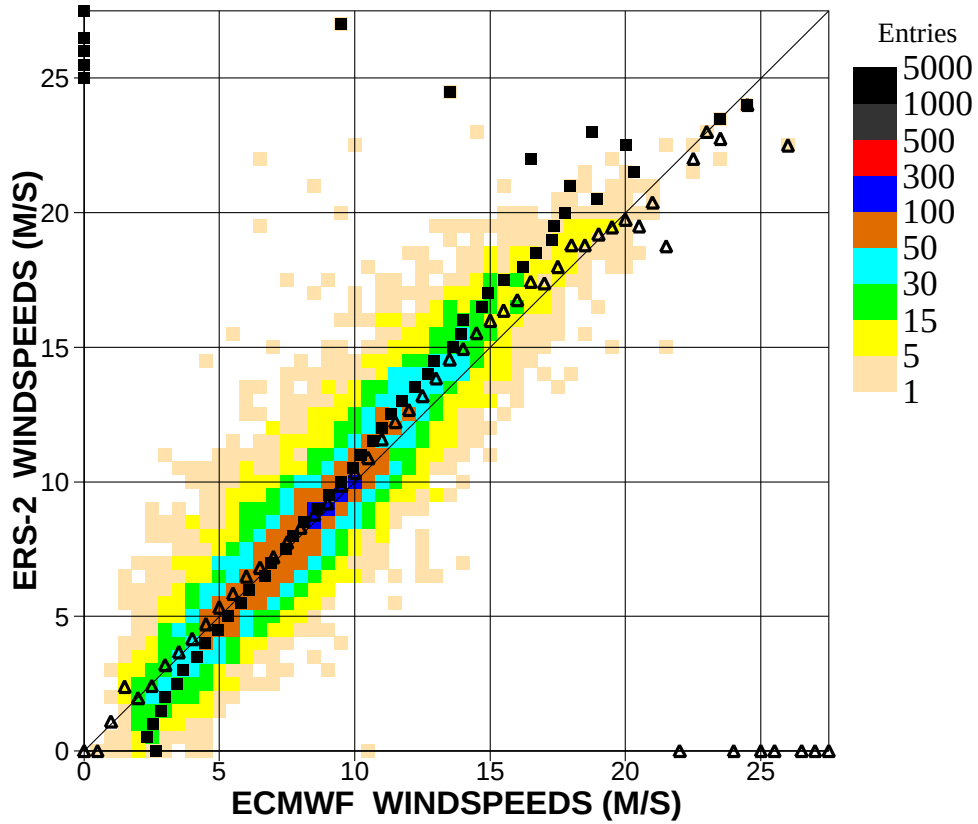
STATISTICS

ENTRIES	43268
MEAN ECMWF	7.4927
MEAN ERS-2	7.5893
BIAS (ERS-2 - ECMWF)	0.0966
STANDARD DEVIATION	1.7269
SCATTER INDEX	0.2305
CORRELATION	0.8933
SYMMETRIC SLOPE	1.0406(0.0026)
REGR. COEFFICIENT	1.0517(0.0025)
REGR. CONSTANT	-0.2906(0.0208)

Figure 6. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2001 (global)

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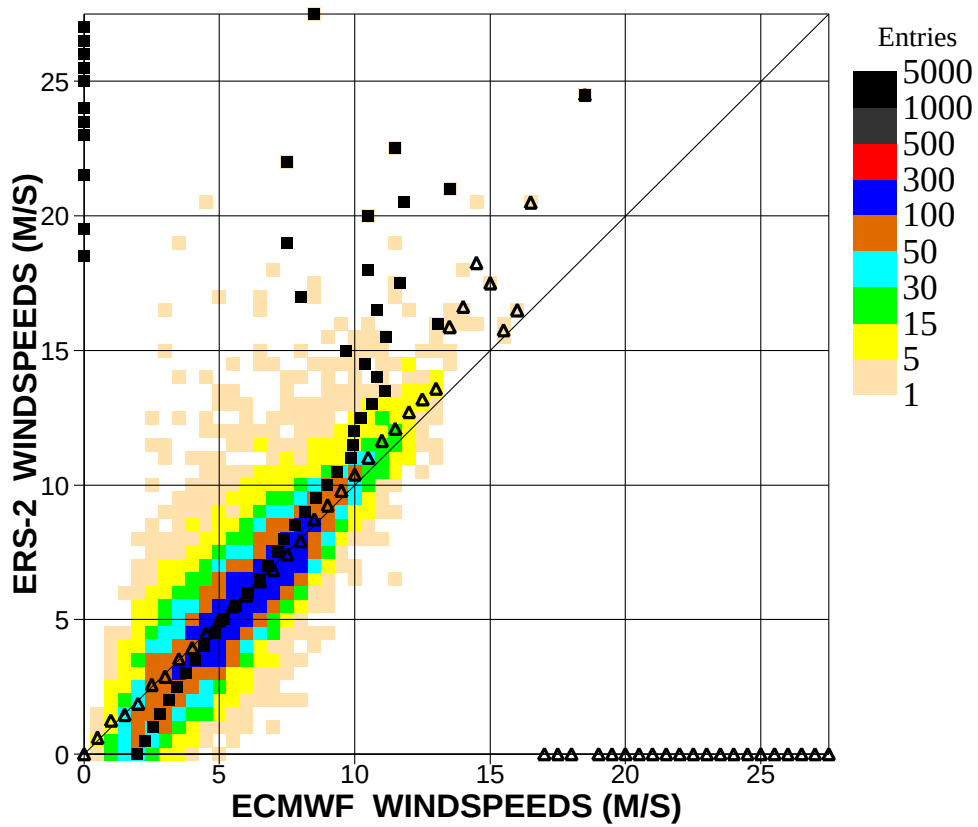
STATISTICS

ENTRIES	10767
MEAN ECMWF	8.7210
MEAN ERS-2	9.1284
BIAS (ERS-2 - ECMWF)	0.4075
STANDARD DEVIATION	1.5904
SCATTER INDEX	0.1824
CORRELATION	0.9206
SYMMETRIC SLOPE	1.0607(0.0043)
REGR. COEFFICIENT	1.0507(0.0043)
REGR. CONSTANT	-0.0348(0.0404)

Figure 7. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2001 (n.hem.)

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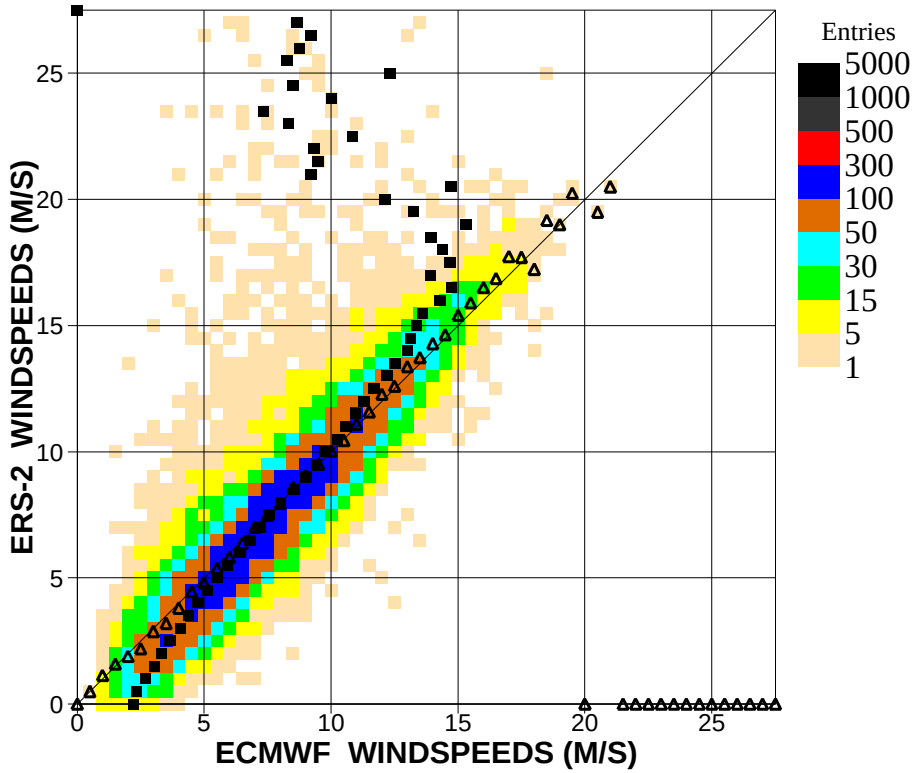


STATISTICS

ENTRIES	13845
MEAN ECMWF	5.9602
MEAN ERS-2	5.9664
BIAS (ERS-2 - ECMWF)	0.0062
STANDARD DEVIATION	1.5051
SCATTER INDEX	0.2525
CORRELATION	0.8420
SYMMETRIC SLOPE	1.0340(0.0057)
REGR. COEFFICIENT	1.0464(0.0057)
REGR. CONSTANT	-0.2702(0.0363)

Figure 8. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2001 (tropics)

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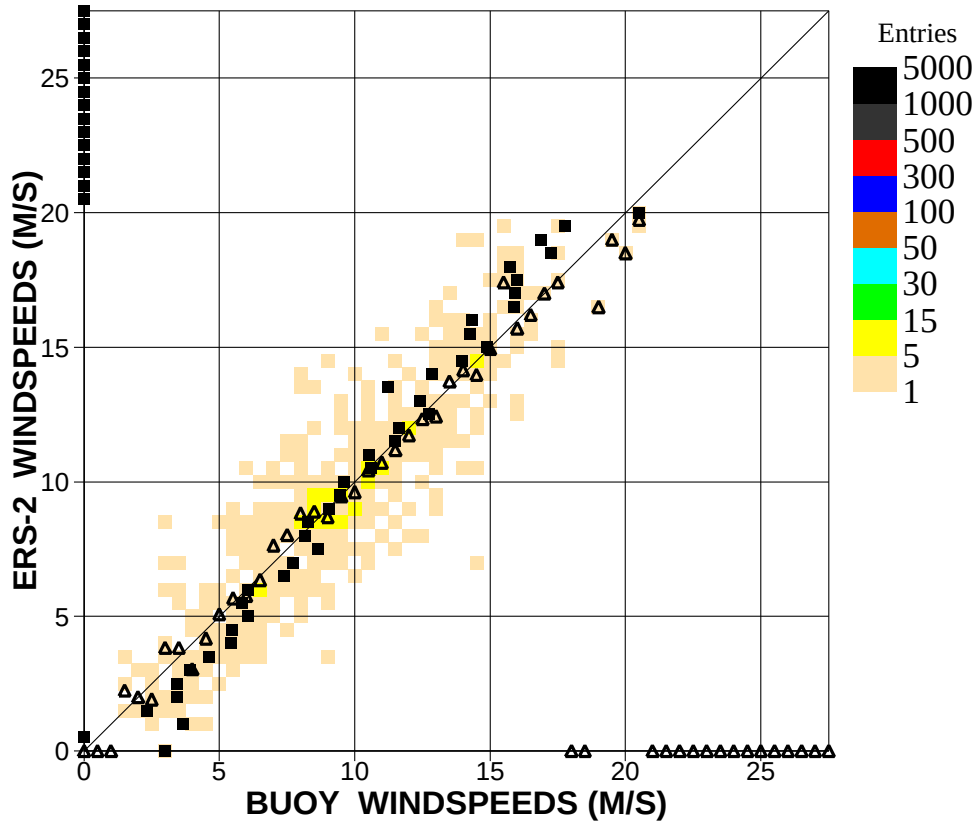


STATISTICS

ENTRIES	19011
MEAN ECMWF	7.8935
MEAN ERS-2	7.8792
BIAS (ERS-2 - ECMWF)	-0.0143
STANDARD DEVIATION	1.9227
SCATTER INDEX	0.2436
CORRELATION	0.8709
SYMMETRIC SLOPE	1.0294(0.0043)
REGR. COEFFICIENT	1.0418(0.0043)
REGR. CONSTANT	-0.3440(0.0364)

Figure 9. Comparison of ECMWF wind speed results with ERS2 Altimeter wind speed data for December 2001 (s.hem.)

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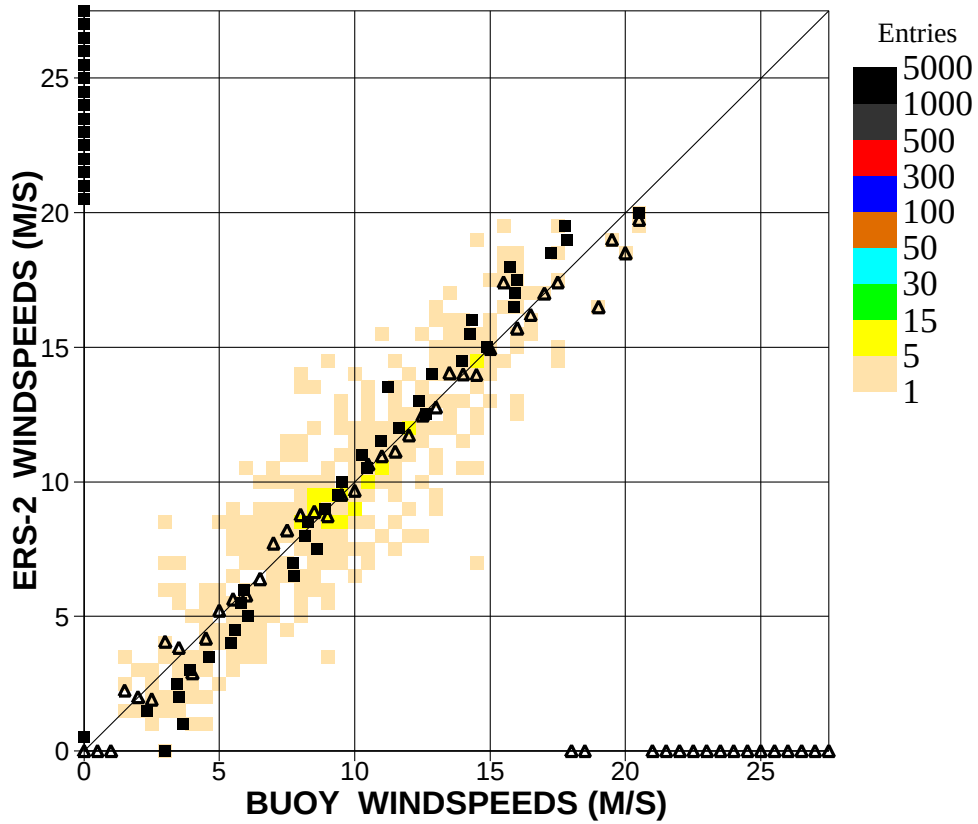


STATISTICS

ENTRIES	548	
MEAN BUOY	9.4473	
MEAN ERS-2	9.4308	
BIAS (ERS-2 - BUOY)	-0.0165	
STANDARD DEVIATION	1.7582	
SCATTER INDEX	0.1861	
CORRELATION	0.8986	
SYMMETRIC SLOPE	1.0099	(0.0204)
REGR. COEFFICIENT	0.9734	(0.0203)
REGR. CONSTANT	0.2346	(0.2063)

Figure 10. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2001 (global)

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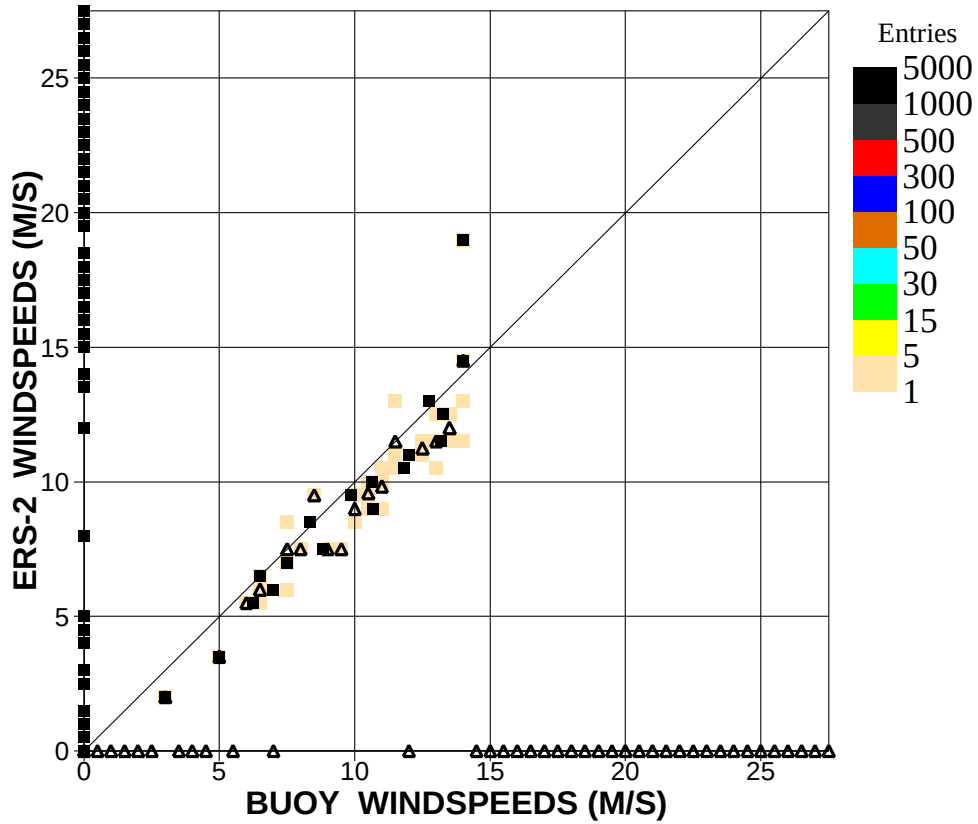


STATISTICS

ENTRIES	491	
MEAN BUOY	9.4118	
MEAN ERS-2	9.4448	
BIAS (ERS-2 - BUOY)	0.0330	
STANDARD DEVIATION	1.8028	
SCATTER INDEX	0.1915	
CORRELATION	0.8992	
SYMMETRIC SLOPE	1.0154	(0.0216)
REGR. COEFFICIENT	0.9766	(0.0215)
REGR. CONSTANT	0.2533	(0.2180)

Figure 11. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2001 (n.hem.)

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STATISTICS

ENTRIES	41	
MEAN BUOY	10.1984	
MEAN ERS-2	9.5488	
BIAS (ERS-2 - BUOY)	-0.6496	
STANDARD DEVIATION	1.2578	
SCATTER INDEX	0.1233	
CORRELATION	0.9126	
SYMMETRIC SLOPE	0.9495	(0.0747)
REGR. COEFFICIENT	1.0226	(0.0734)
REGR. CONSTANT	-0.8804	(0.7742)

Figure 12. Comparison of buoy wind speed observations with ERS2 Altimeter wind speed data for December 2001 (hawaii)

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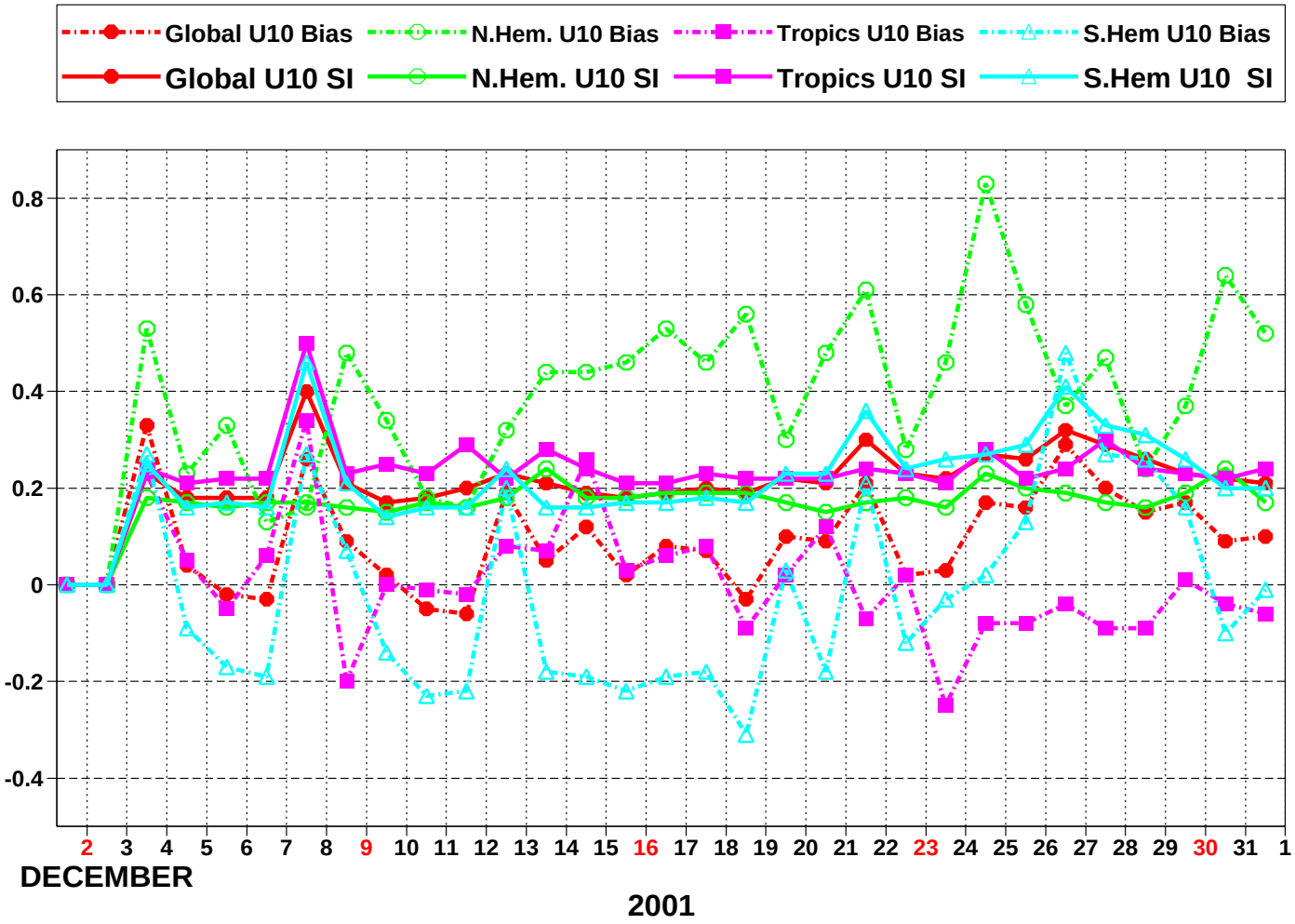


Figure 13: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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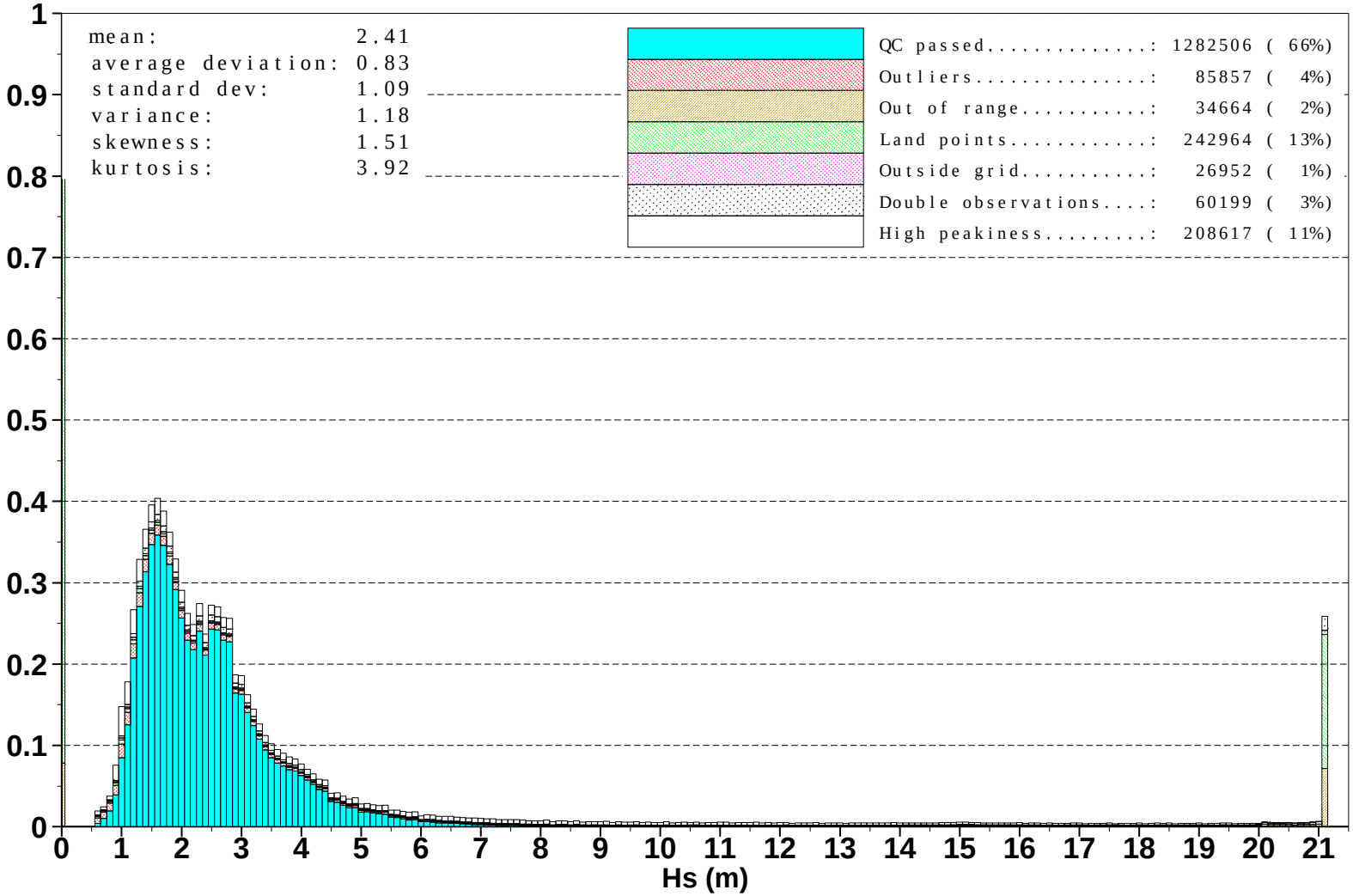


Figure 14: Distribution of the ERS-2 Altimeter wave heights after QC for December 2001

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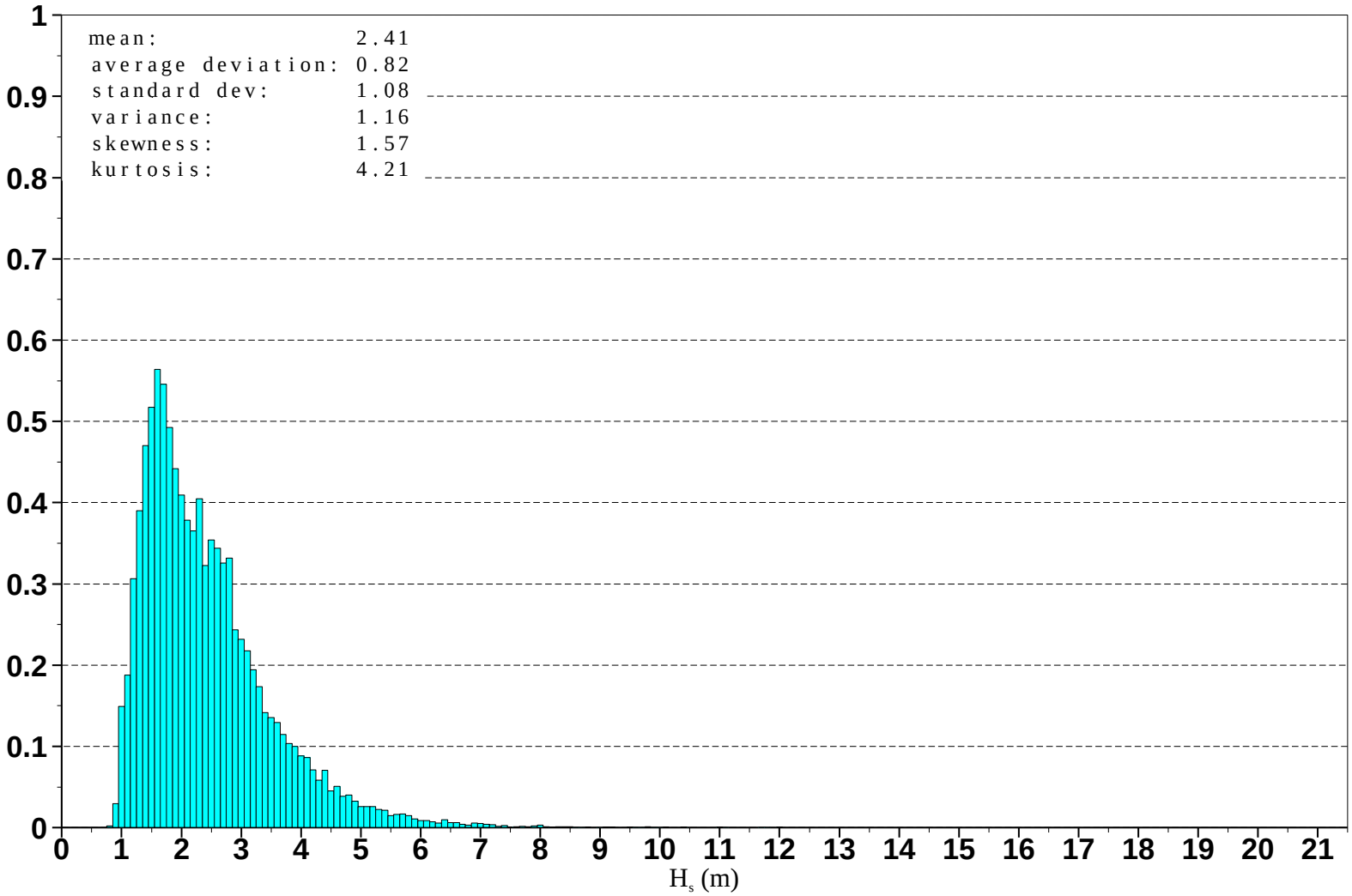


Figure 15: Distribution of ERS-2 Altimeter wave heights after along track averaging for December 2001

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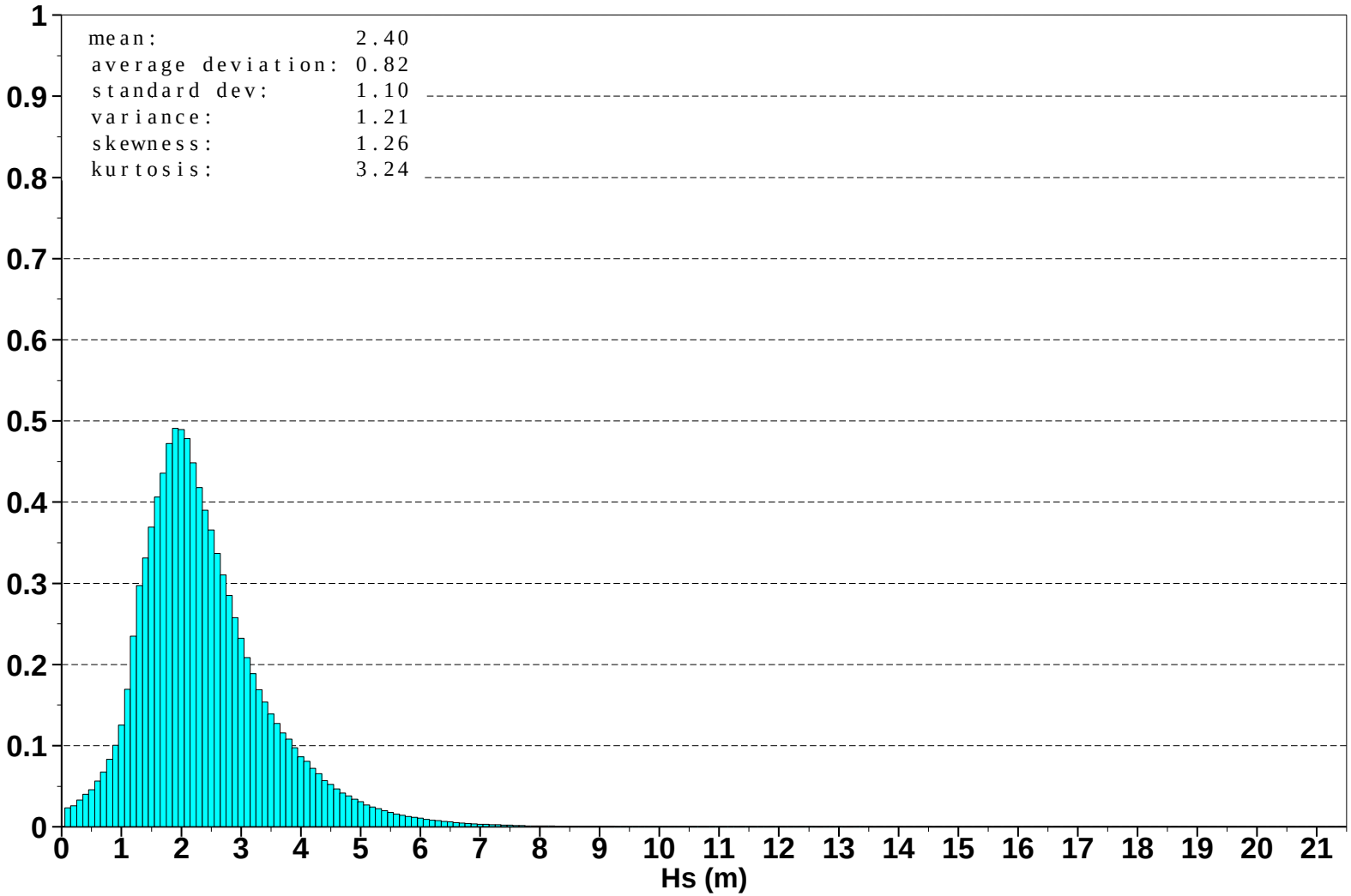
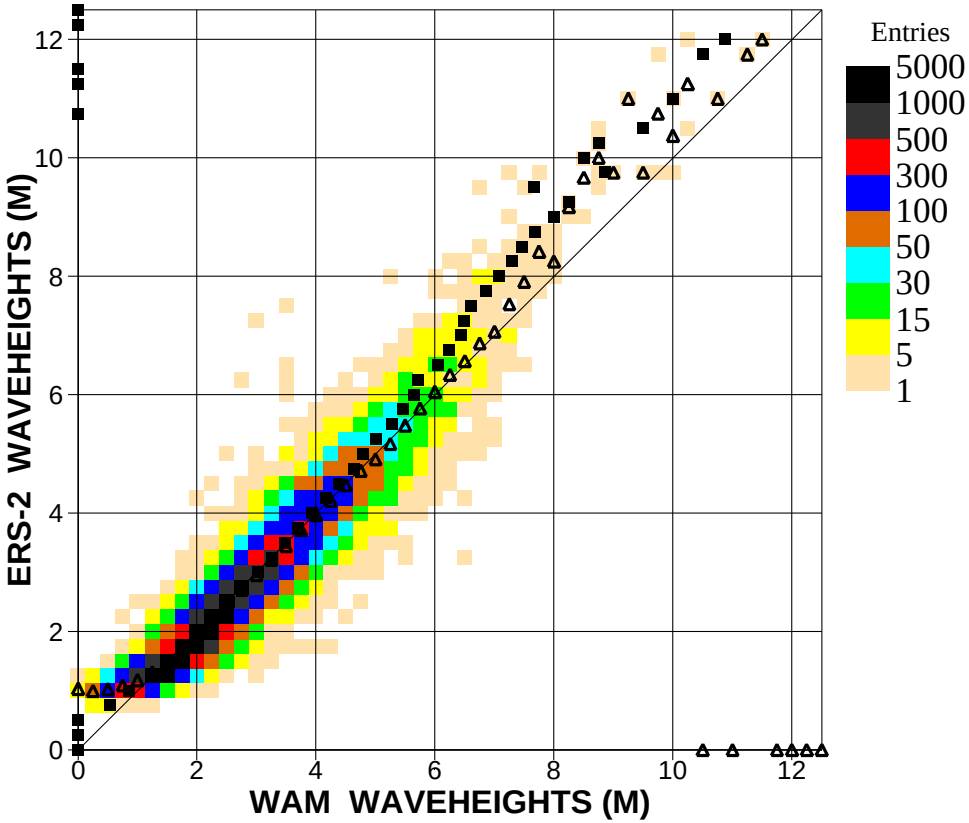


Figure 16: Global distribution of ECMWF wave heights for December 2001

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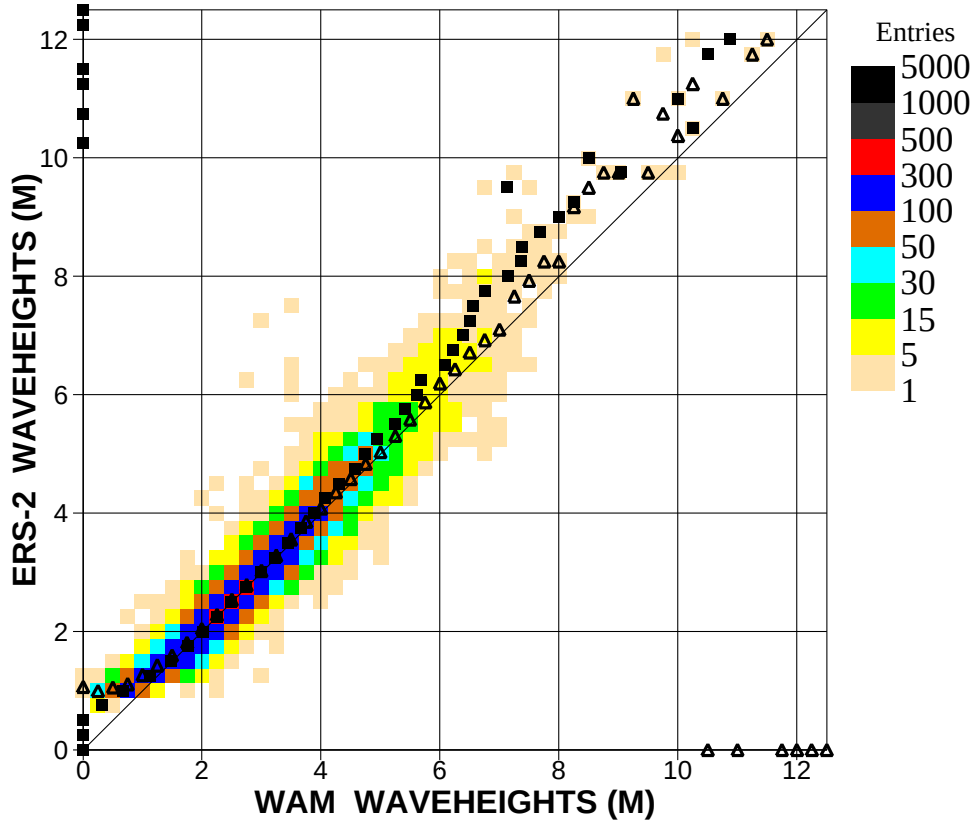


STATISTICS

ENTRIES	43268
MEAN WAM	2.4480
MEAN ERS-2	2.4140
BIAS (ERS-2 - WAM)	-0.0340
STANDARD DEVIATION	0.3087
SCATTER INDEX	0.1261
CORRELATION	0.9580
SYMMETRIC SLOPE	0.9929(0.0014)
REGR. COEFFICIENT	0.9863(0.0014)
REGR. CONSTANT	-0.0005(0.0038)

Figure 17. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2001 (global)

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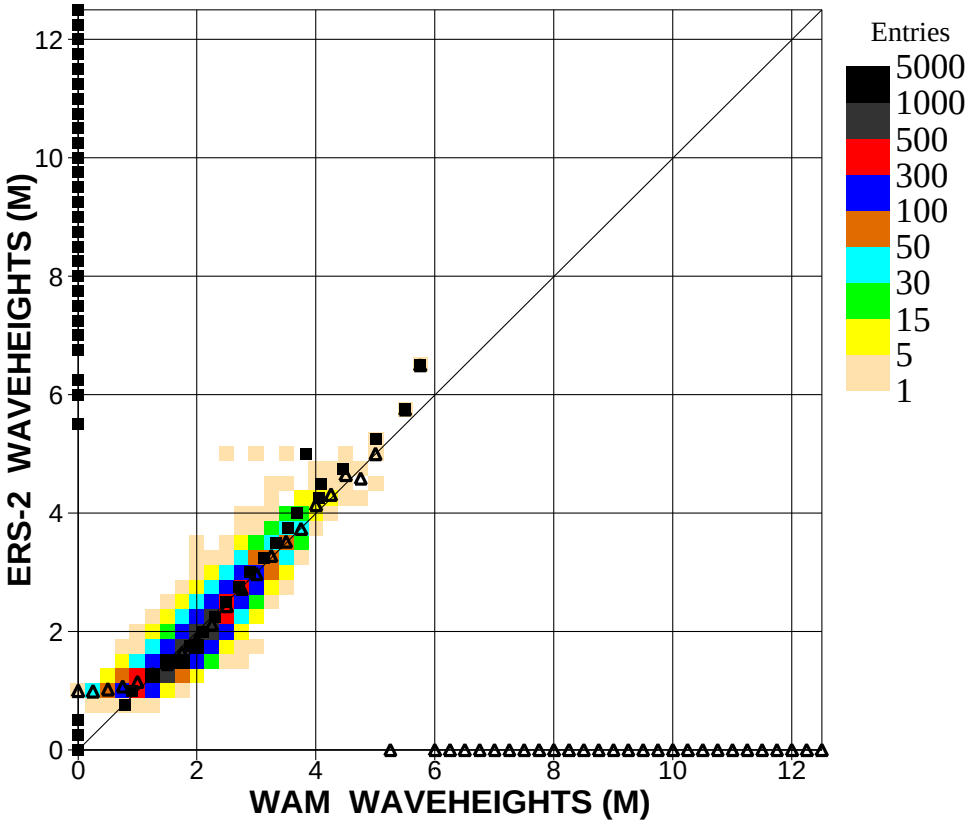


STATISTICS

ENTRIES	10767
MEAN WAM	2.9195
MEAN ERS-2	3.0032
BIAS (ERS-2 - WAM)	0.0837
STANDARD DEVIATION	0.3721
SCATTER INDEX	0.1275
CORRELATION	0.9604
SYMMETRIC SLOPE	1.0293(0.0028)
REGR. COEFFICIENT	0.9914(0.0028)
REGR. CONSTANT	0.1088(0.0089)

Figure 18. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2001 (n.hem.)

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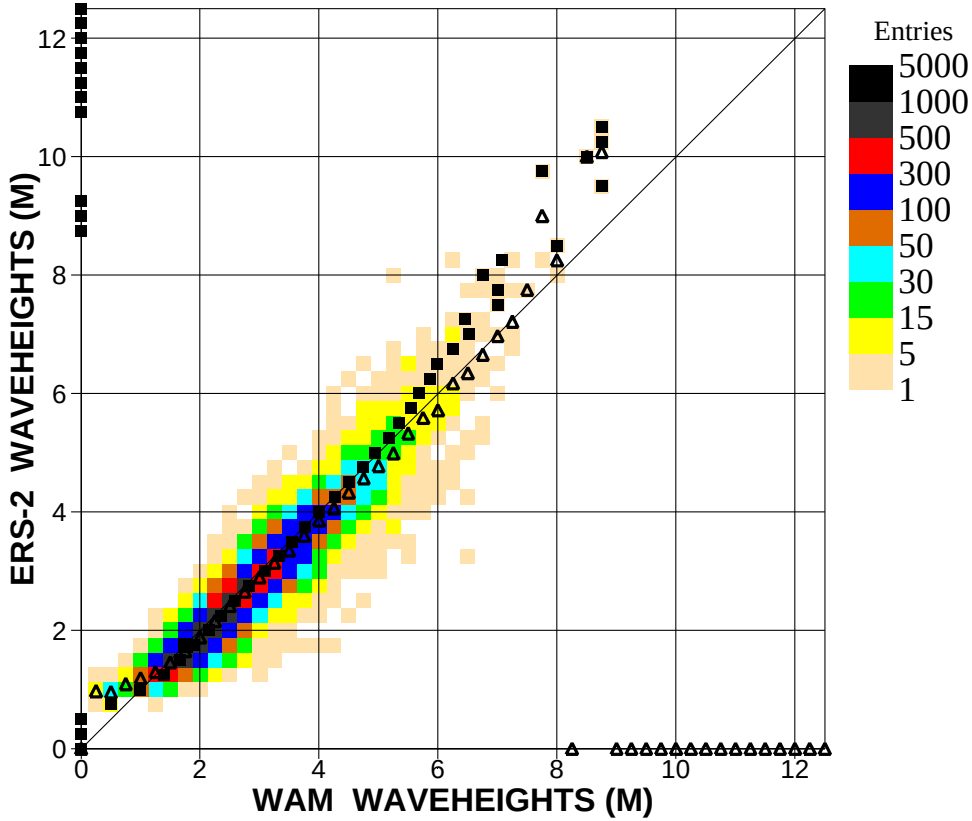


STATISTICS

ENTRIES	13845
MEAN WAM	1.9198
MEAN ERS-2	1.8796
BIAS (ERS-2 - WAM)	-0.0401
STANDARD DEVIATION	0.2246
SCATTER INDEX	0.1170
CORRELATION	0.9374
SYMMETRIC SLOPE	0.9802(0.0030)
REGR. COEFFICIENT	0.9283(0.0029)
REGR. CONSTANT	0.0975(0.0059)

Figure 19. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2001 (tropics)

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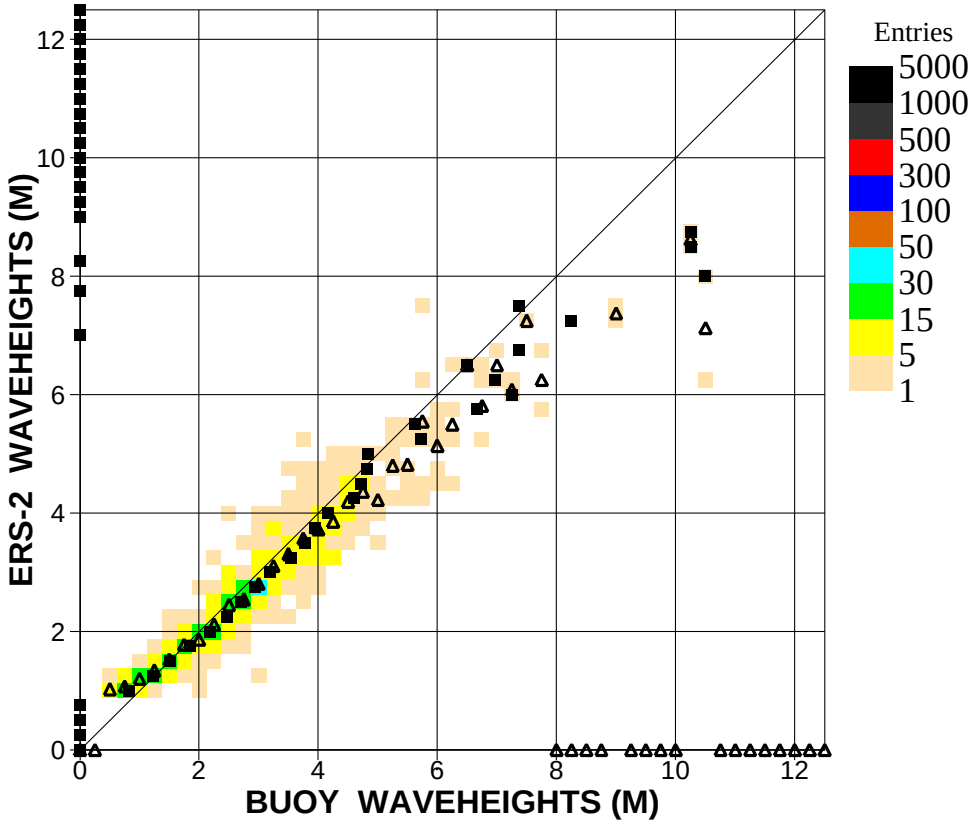


STATISTICS

ENTRIES	19011
MEAN WAM	2.5585
MEAN ERS-2	2.4624
BIAS (ERS-2 - WAM)	-0.0961
STANDARD DEVIATION	0.3019
SCATTER INDEX	0.1180
CORRELATION	0.9510
SYMMETRIC SLOPE	0.9690(0.0023)
REGR. COEFFICIENT	0.9652(0.0023)
REGR. CONSTANT	-0.0070(0.0062)

Figure 20. Comparison of ECMWF wave height results with ERS2 Altimeter wave height data for December 2001 (s.hem.)

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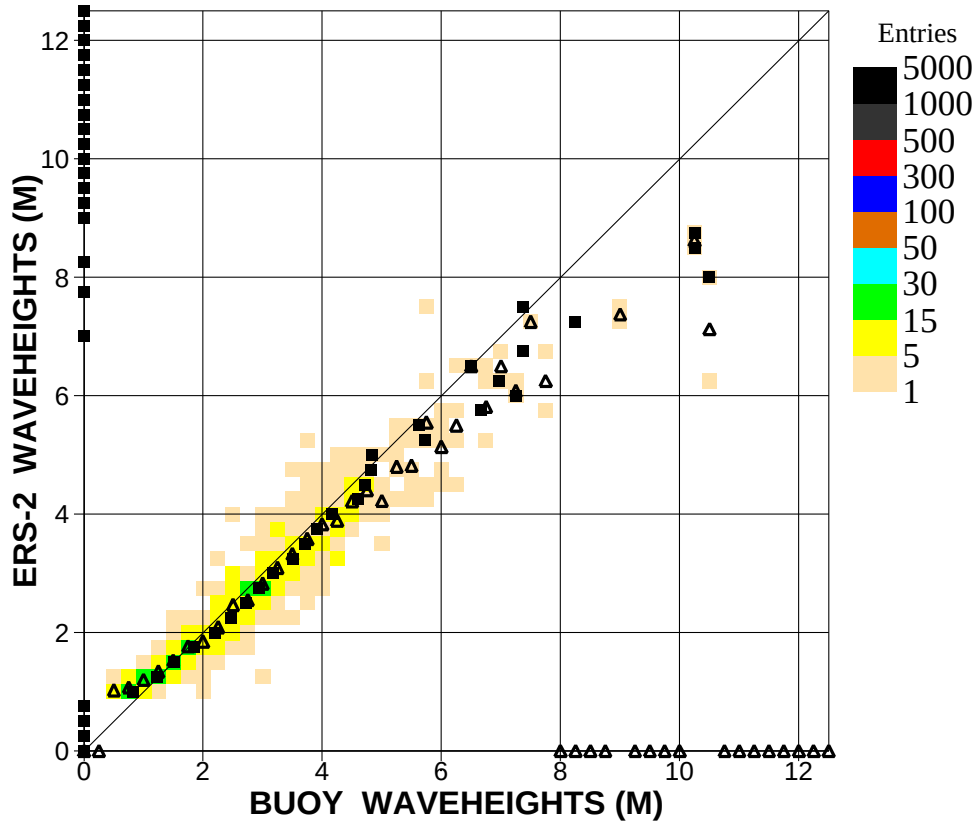


STATISTICS

ENTRIES	753	
MEAN BUOY	3.0475	
MEAN ERS-2	2.8640	
BIAS (ERS-2 - BUOY)	-0.1835	
STANDARD DEVIATION	0.4802	
SCATTER INDEX	0.1576	
CORRELATION	0.9529	
SYMMETRIC SLOPE	0.9250	(0.0103)
REGR. COEFFICIENT	0.8222	(0.0095)
REGR. CONSTANT	0.3583	(0.0325)

Figure 21. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2001 (global)

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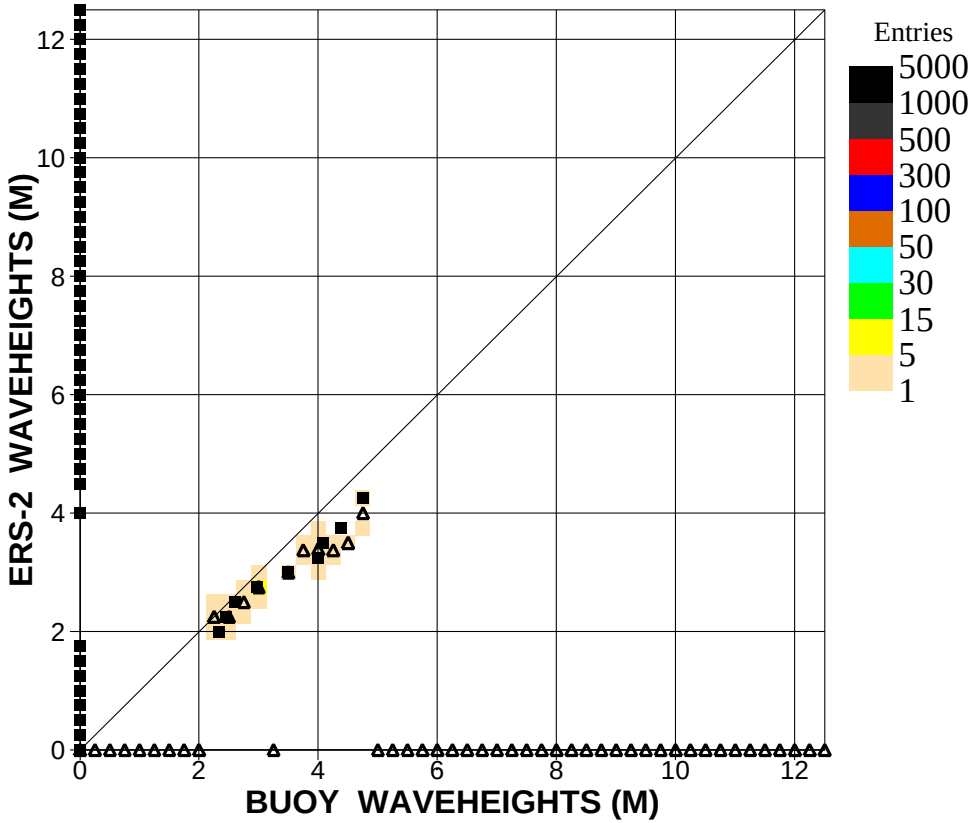


STATISTICS

ENTRIES	688	
MEAN BUOY	3.0475	
MEAN ERS-2	2.8721	
BIAS (ERS-2 - BUOY)	-0.1754	
STANDARD DEVIATION	0.4934	
SCATTER INDEX	0.1619	
CORRELATION	0.9535	
SYMMETRIC SLOPE	0.9268	(0.0108)
REGR. COEFFICIENT	0.8248	(0.0100)
REGR. CONSTANT	0.3586	(0.0341)

Figure 22. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2001 (n.hem.)

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STATISTICS

ENTRIES	48	
MEAN BUOY	3.2157	
MEAN ERS-2	2.8573	
BIAS (ERS-2 - BUOY)	-0.3584	
STANDARD DEVIATION	0.2780	
SCATTER INDEX	0.0865	
CORRELATION	0.9455	
SYMMETRIC SLOPE	0.8819	(0.0454)
REGR. COEFFICIENT	0.6876	(0.0349)
REGR. CONSTANT	0.6461	(0.1150)

Figure 23. Comparison of buoy wave height observations with ERS2 Altimeter wave height data for December 2001 (hawaii)

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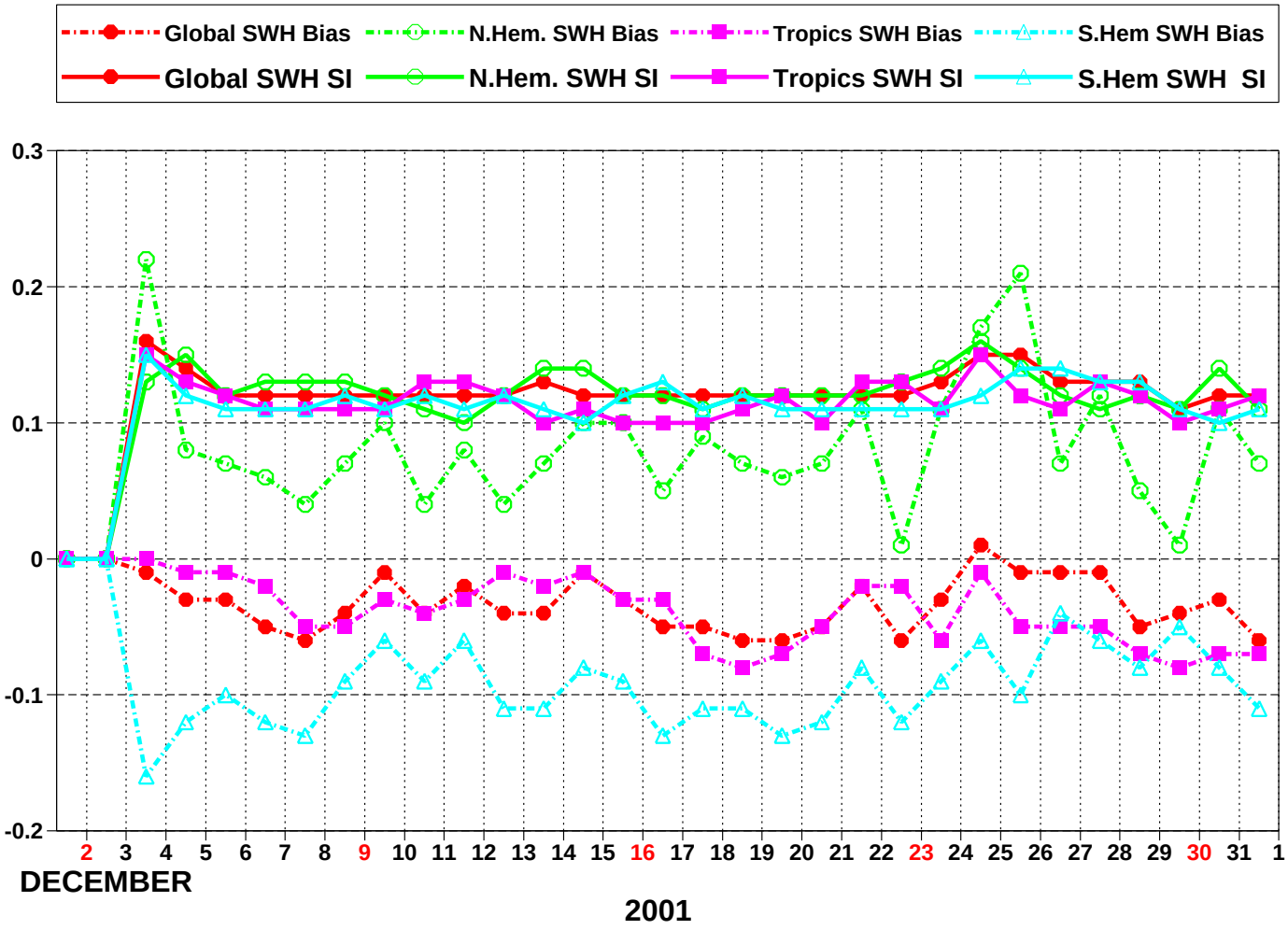


Figure 24: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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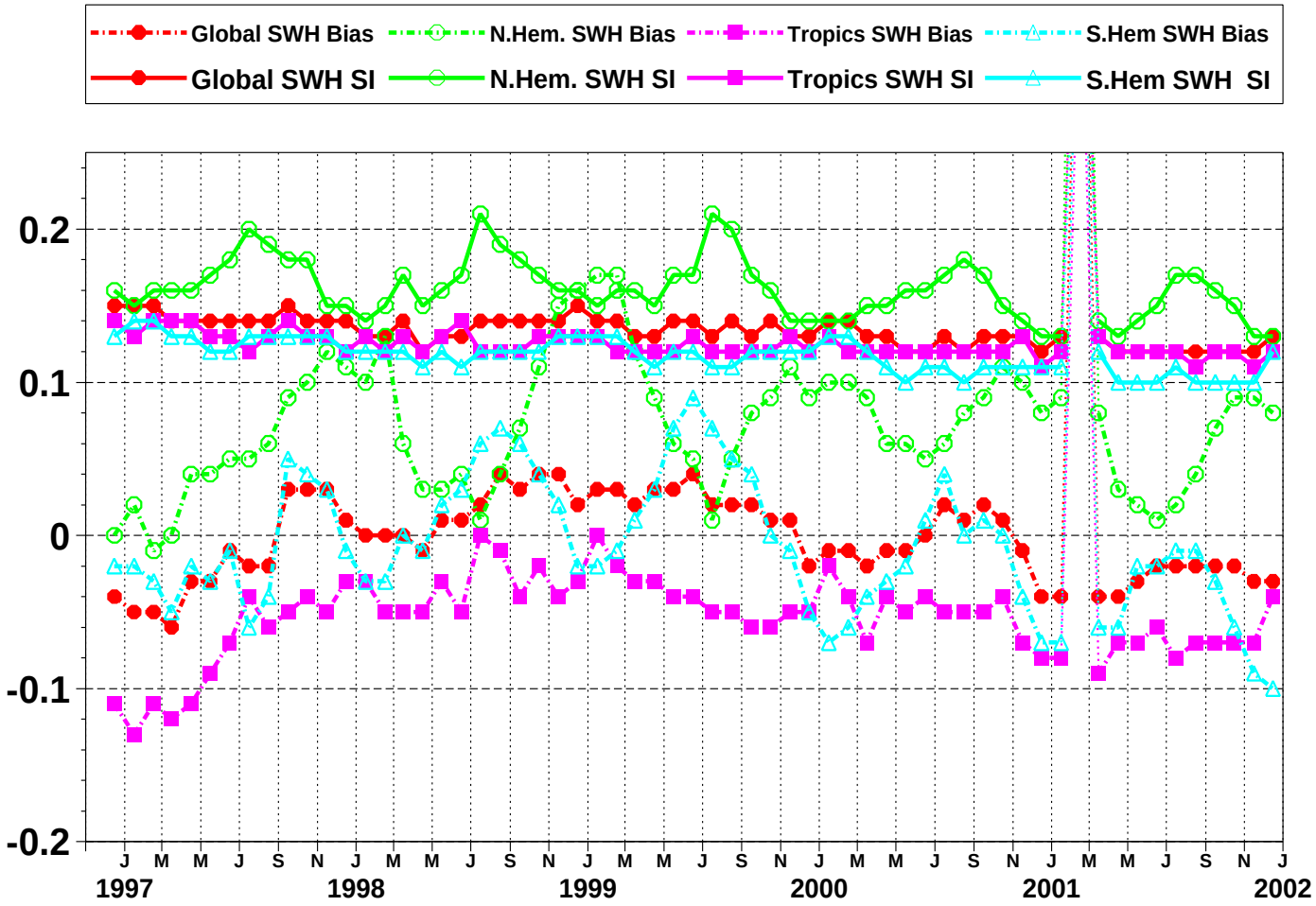


Figure 25: ERS-2 Altimeter wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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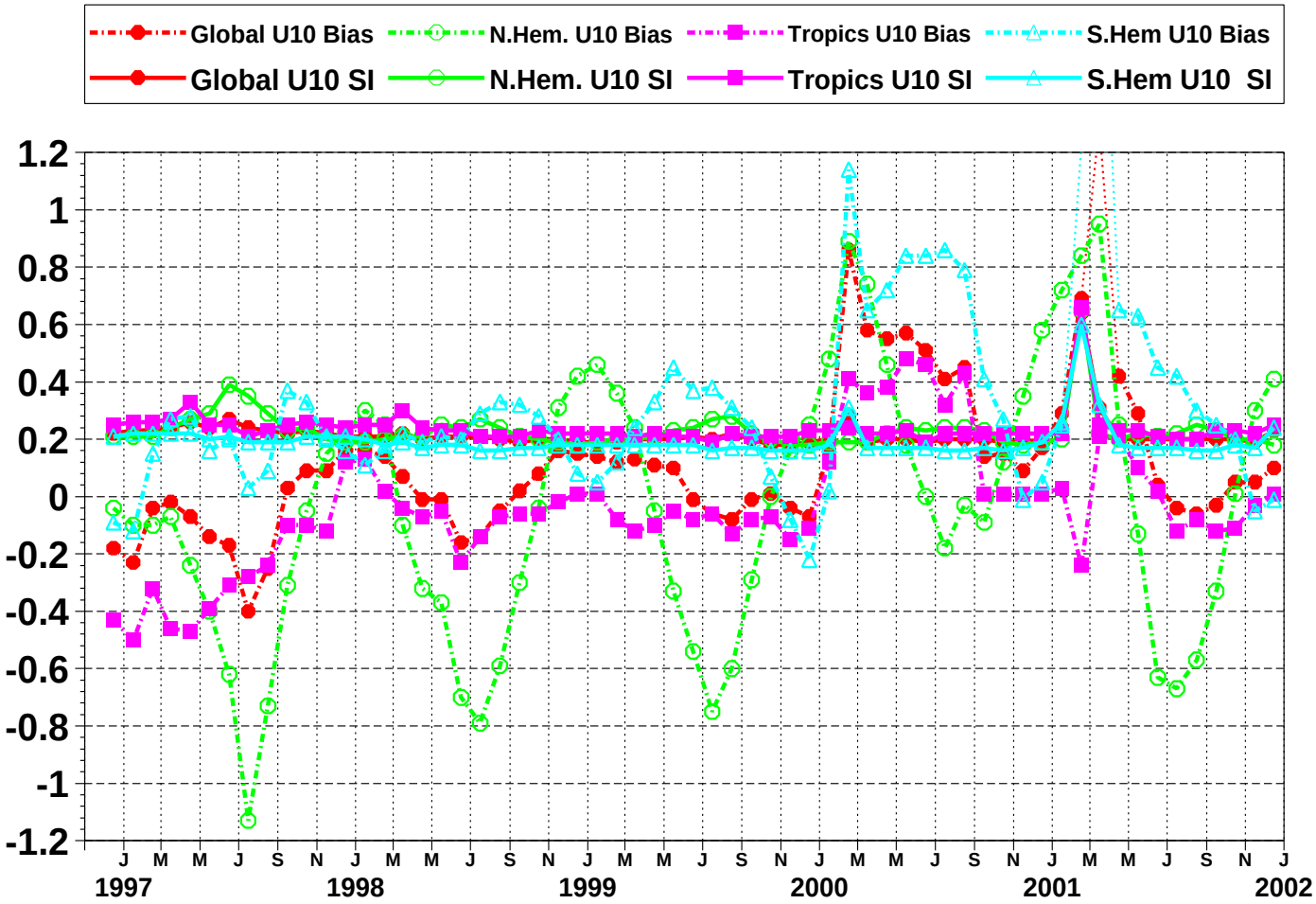


Figure 26: ERS-2 Altimeter wind speeds: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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