Report on ENVISAT Radar Altimeter - 2 (RA-2)

Wind/Wave Product with Height Information (RA2_WWV_2P)

By: *Saleh Abdalla*

Date: *7 May 2004*

Overview:

Based on the data received during this month, on average, 14273 observations arrived at ECMWF every 6-hour window of which an average of 6048 observations were rejected initially because of one of the following reasons: being over land, being outside model domain, being a double observation or flagged for rain contamination. On average 78.96% of the remaining part passed the quality control. Data reception is significantly reduced at 6-hour window centred at UTC midnight everyday. There was no data during the following periods (in terms of 6-hour time-windows; all times are in UTC):

- Time window 00:00 on the 22nd. of the month.

The time series of the data coverage and some reasons of rejection can be seen in Figure 1. Note that we are talking about the raw data which we downloaded in “bufr” format before they were processed. RA-2 and MWR Instrument Processing Chain (IPF) V4.56 was operational at the ESA ENVISAT PDS processing centres at 07:31:27 UTC on Wednesday 26 November 2003.

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ECMWF Report on ENVISAT RA-2 for April 2004

Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of good quality. The S-band wave height observations show a number of outliers. The quality of wind speed observations is good. Apart from the few outliers, MWR products are generally fine and in good agreement with the model (wet tropo correction is somewhat smaller than the model).

Backscatter:

- ENVISAT RA-2 Ku-Band $<\sigma_0>$ = 11.06 dB (with a single rather broad peak at ~ 11.1 dB).
- ENVISAT RA-2 S-Band $<\sigma_0>$ = 11.34 dB (with a single rather broad peak at ~ 10.6 dB).

Comparison Summary:

Table 1: Comparison of Surface Wind Speeds:

	RA2 - ECMWF		RA2 - Buoy	
	Bias (m/s)	SI (%)	Bias (m/s)	SI (%)
Global	-0.13	17.5	-0.65	18.3
Northern Hemisphere	-0.33	17.8	-0.63	18.6
Tropics	-0.40	19.6	-0.74	13.7
Southern Hemisphere	0.15	15.7	----	----

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Table 2: Comparison of Ku-Band Significant Wave Heights:

	RA2 (Ku) - WAM		RA2 (Ku) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.10	11.3	0.10	13.4
Northern Hemisphere	0.15	13.3	0.10	13.7
Tropics	0.02	10.5	0.05	7.7
Southern Hemisphere	0.14	10.3	----	----

Table 3: Comparison of S-Band Significant Wave Heights:

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.07	23.4	0.11	24.6
Northern Hemisphere	0.15	23.1	0.12	25.2
Tropics	0.10	30.0	-0.03	10.8
Southern Hemisphere	0.01	20.5	----	----

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Table 4: Comparison of Wet Tropo Correction and Total Column Water Vapour Values:

	MWR WTC - ECMWF WTC		MWR TCWV - ECMWF TCWV	
	Bias (m)	SI (%)	Bias (kg/m^2)	SI (%)
Global	-0.012	14.1	-0.44	15.3
Northern Hemisphere	-0.011	28.6	-0.93	28.5
Tropics	-0.009	6.5	+0.91	6.8
Southern Hemisphere	-0.014	18.2	-1.10	20.9

Remarks:

- There was no changes in the ECMWF models during this reporting period.
- According to the used land sea mask (which is used for the operational WAM run at ECMWF), more than one third (33% to be exact) of all processed data have been collected over land. This value is too large and is due to not filtering the land records.
- Although the rain flag is only responsible for the rejection of 6% of the data this month, it was responsible for rejection of most of the data on the 1st. and the 27th. of the month (lower panel of Figure 1).
- The wind speed data are in good agreement with the wave model and buoy data except for very low wind speeds (below ~ 4 m/s) and for high wind speeds (20 m/s and above).

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- The wind speed algorithm needs some adjustments both in the low wind regime (below ~ 4 m/s) and more importantly for the very high wind regime (20 m/s and above) as can be concluded from the scatter plots in Figures 7-13 and from comparing the histograms in Figures 5 and 6.
- The time series of wind speed errors shown in Figure 14 suggests a kind of wind speed anomaly during the 24-hour period starting at 09:00 UTC on 13 April. This was reported to ESA and turned out according to Annalisa Martini that there was an OCM manoeuvre on 14 April 2004 staring at 02:45. This manoeuvre adversely affected the range measurements (SSH anomalies) producing a lot of out of range values until the end of the day. Most probably the wind speed, which is less sensitive to the attitude variations, was also adversely affected when the pointing was really bad.
- There is a trend for Ku-band wave heights to be slightly overestimated by about 4% when compared to WAM results. This is visually clear in the scatter plots in Figures 22-25 (Ku-band - WAM comparisons) and can be inferred from the symmetric slope values in same scatter plots as well as in Figures 30-32 (Ku-band - buoy comparison). On the other hand, the RA-2 Ku-band wave heights are higher than buoy wave heights by about 3%.
- The bulk of S-band wave heights are in good agreement with both the WAM and the buoy data apart from a number of outliers (due to the known S-band anomaly) when compared with the model (as can be seen in the scatter plots in Figures 26-29) and to less extent with the buoys (as can be seen in the scatter plots in Figures 33-34). The number of outliers is slightly more than the previous month. Most of those outliers occurred on the 1st. and the 26-27th. of the month (Figure 37) when there was over-active rain flagging.
- The ratio between Ku-band and S-band wave heights was rather stable (~0.98-1.00) over the whole month as can be seen in Figure 48.
- There is quite a number of outliers in the scatter plots comparing the MWR derived wet tropospheric correction (WTC) and total column water vapour (TCWV) against the ECMWF model in the Northern and Southern Hemisphere (Figures 39, 41, 43 and 45). However, the number of those outliers is lower than they used to be before the introduction of the processing chain (V4.56) on the 26th. of November 2003. As in the last few months, the tendency of the ECMWF

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model to have saturation values for both quantities (around 0.4 m for WTC and around 60 kg/m^2 for TCWV) does not exist any more.

- While the MWR derived TCWV is now in good agreement with the model counterpart, the MWR WTC is still consistently smaller (drier) than the model values.
- It is important to stress that one needs to keep in mind when making the comparison between the results presented here for the ENVISAT RA-2 and the results presented in the ERS-2 altimeter reports that the ERS-2 plots and statistics are done for super-observations composed of 30 individual observation, while the plots and statistics here are for super-observations with 11 individual observations. Therefore, it is natural for the RA-2 plots and statistics to show a bit more variability.
- ENVISAT Ku-band wave height data and ERS-2 SAR wave data are assimilated in the ECMWF wave model.
- RA-2 and MWR Instrument Processing Chain (IPF) V4.56 is operational at the ESA ENVISAT PDS processing centres (since 07:31:27 UTC on Wednesday 26 November 2003).
- The ERS-2 SAR wave data used for assimilation at ECMWF wave model are now limited to the North Atlantic and the western coast of North America following the failure of the ERS-2 tape recorders in June 2003. Also note that Figure 19 represents the histogram for the covered area only.

List of Figures:

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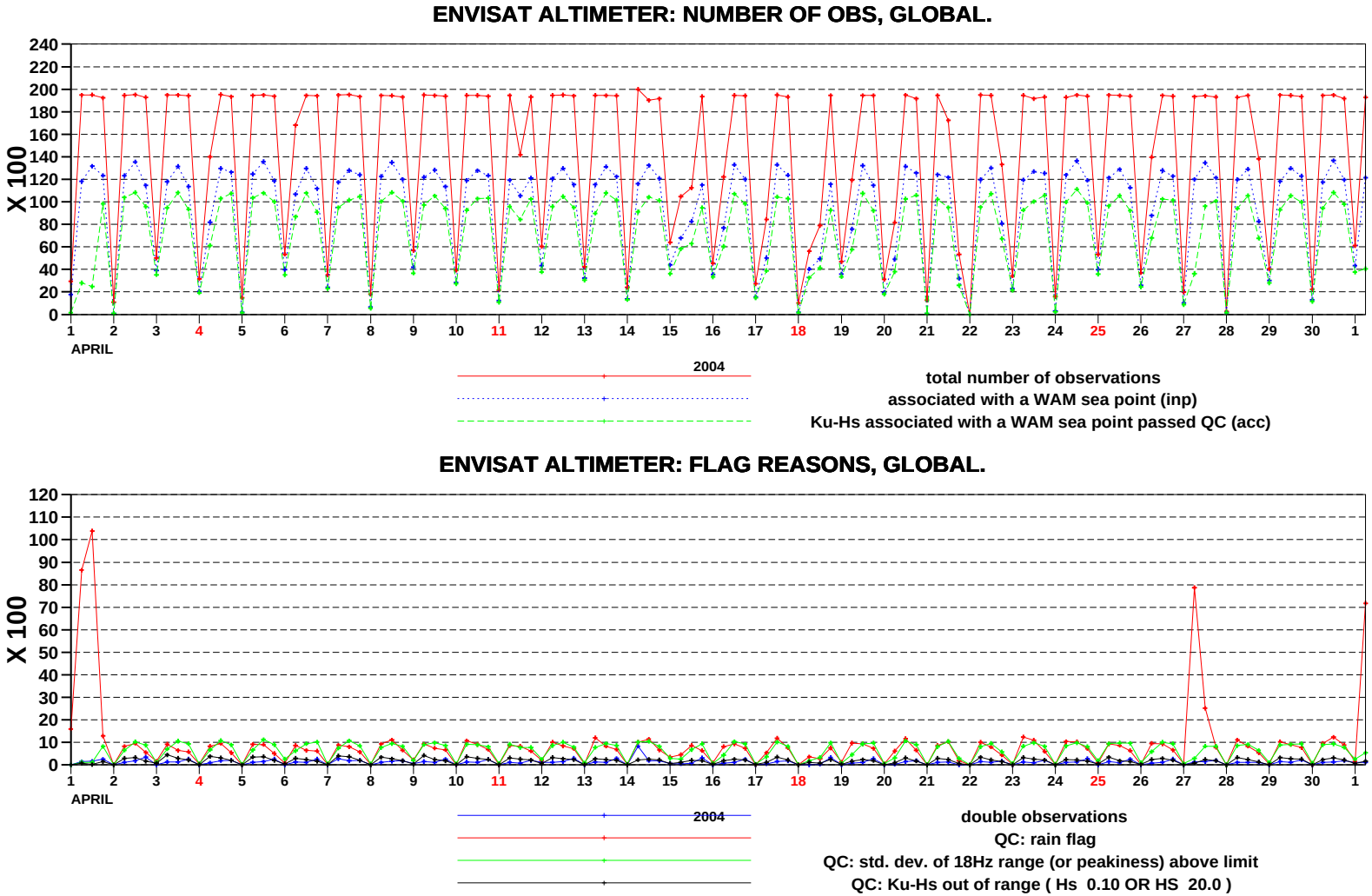

Figure 1:Time series of data reception for ENVISAT Altimeter data for April 2004

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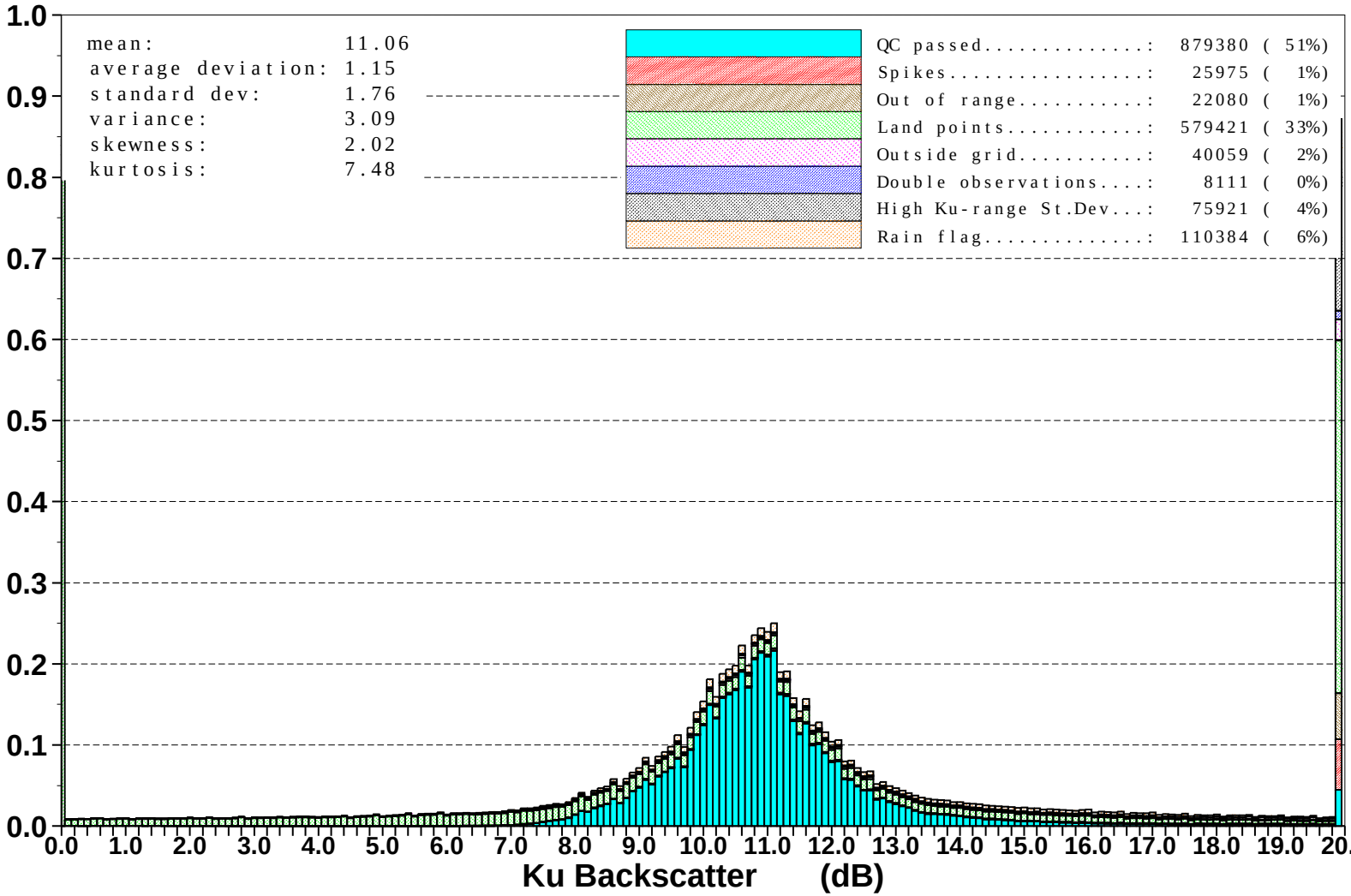

Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for April 2004

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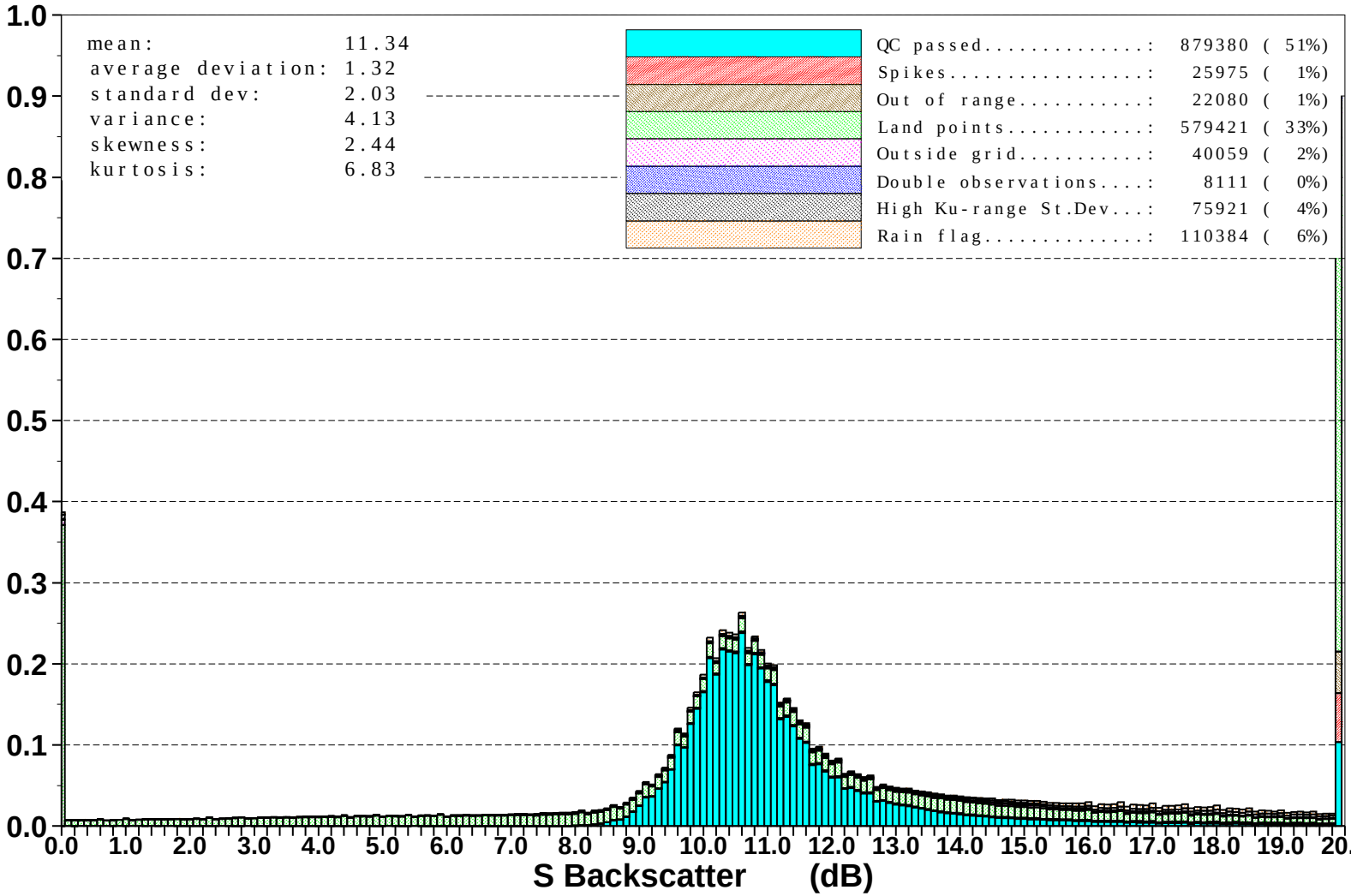

Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for April 2004

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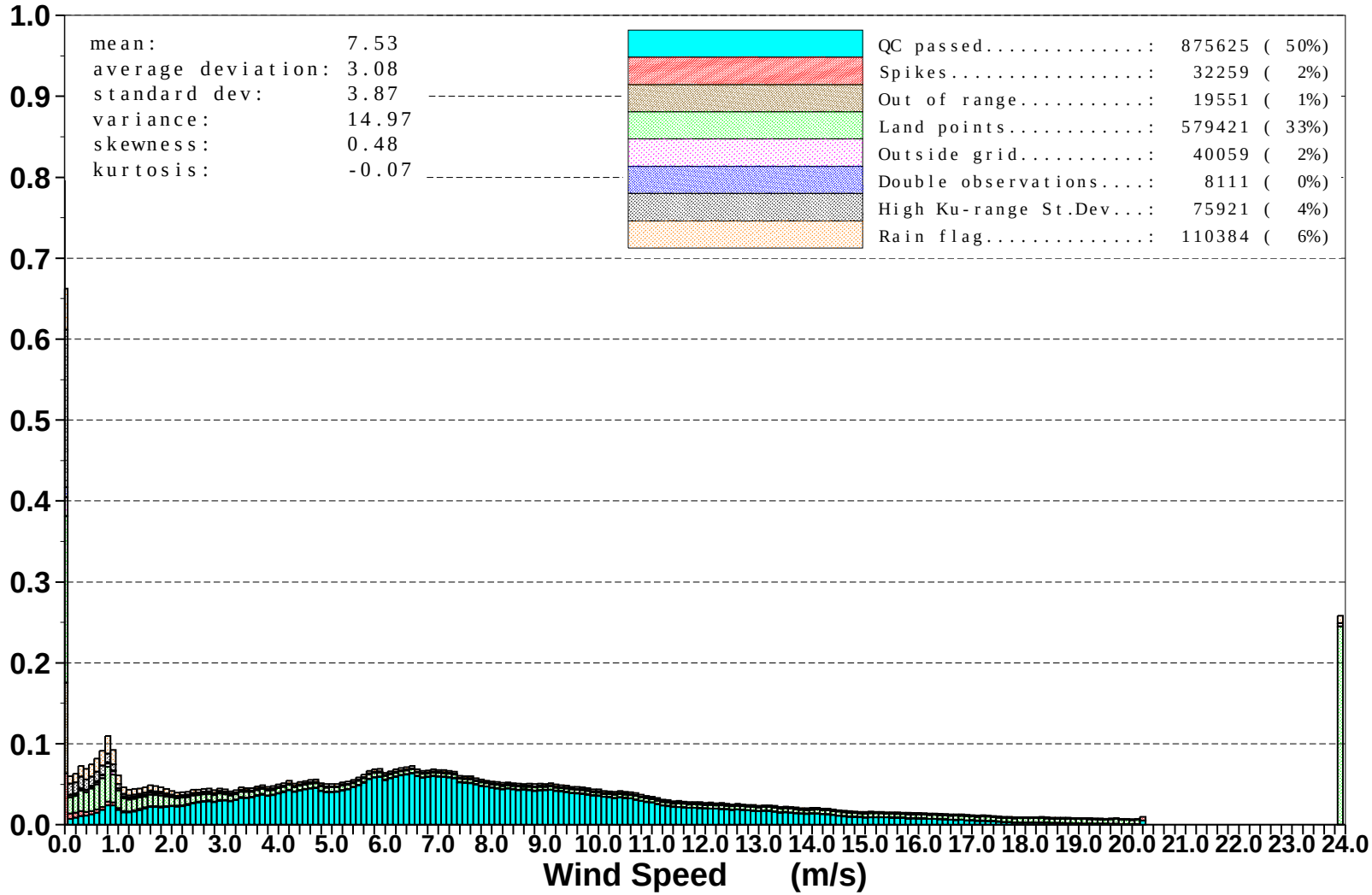

Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for April 2004

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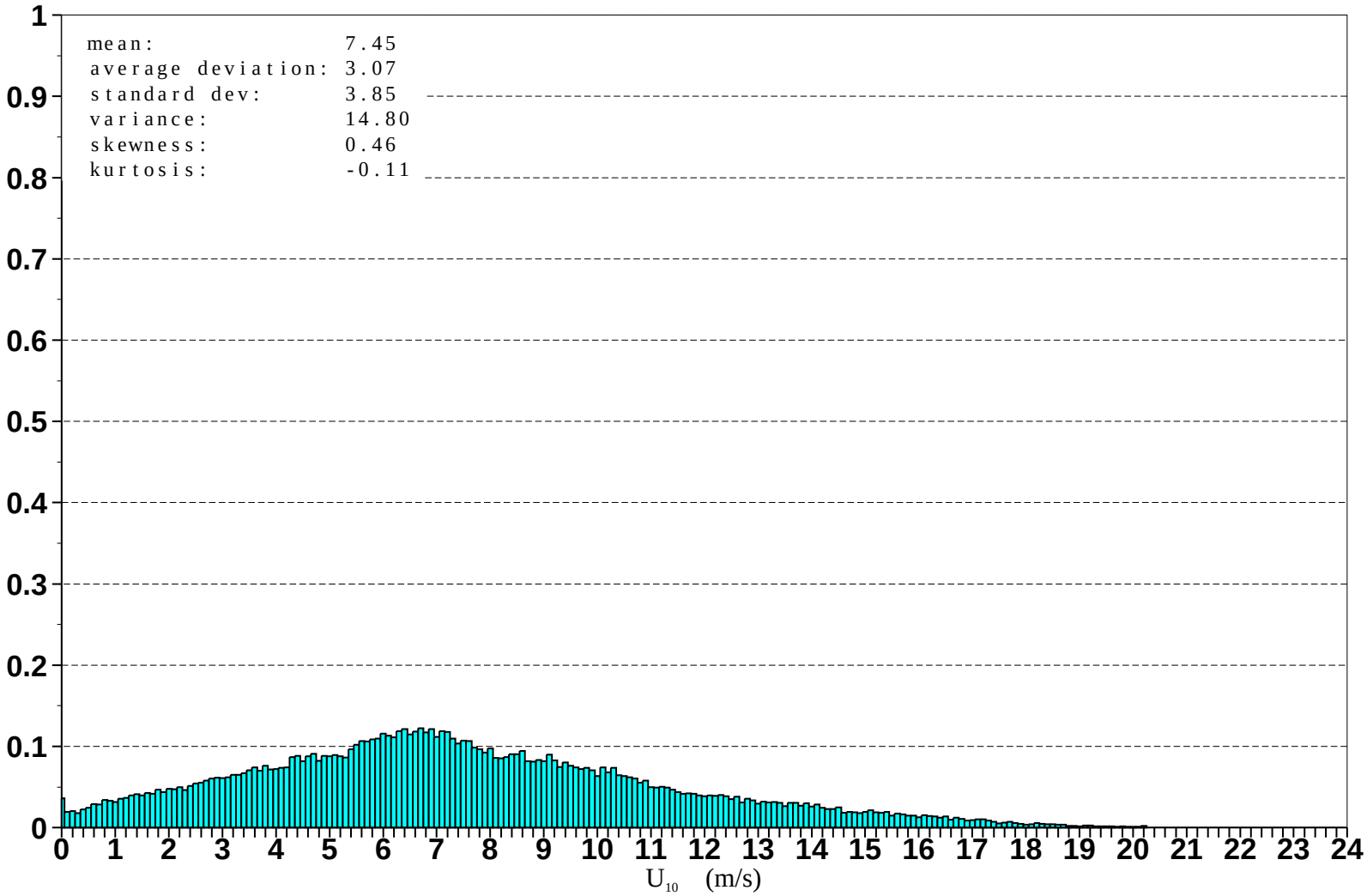

Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for April 2004

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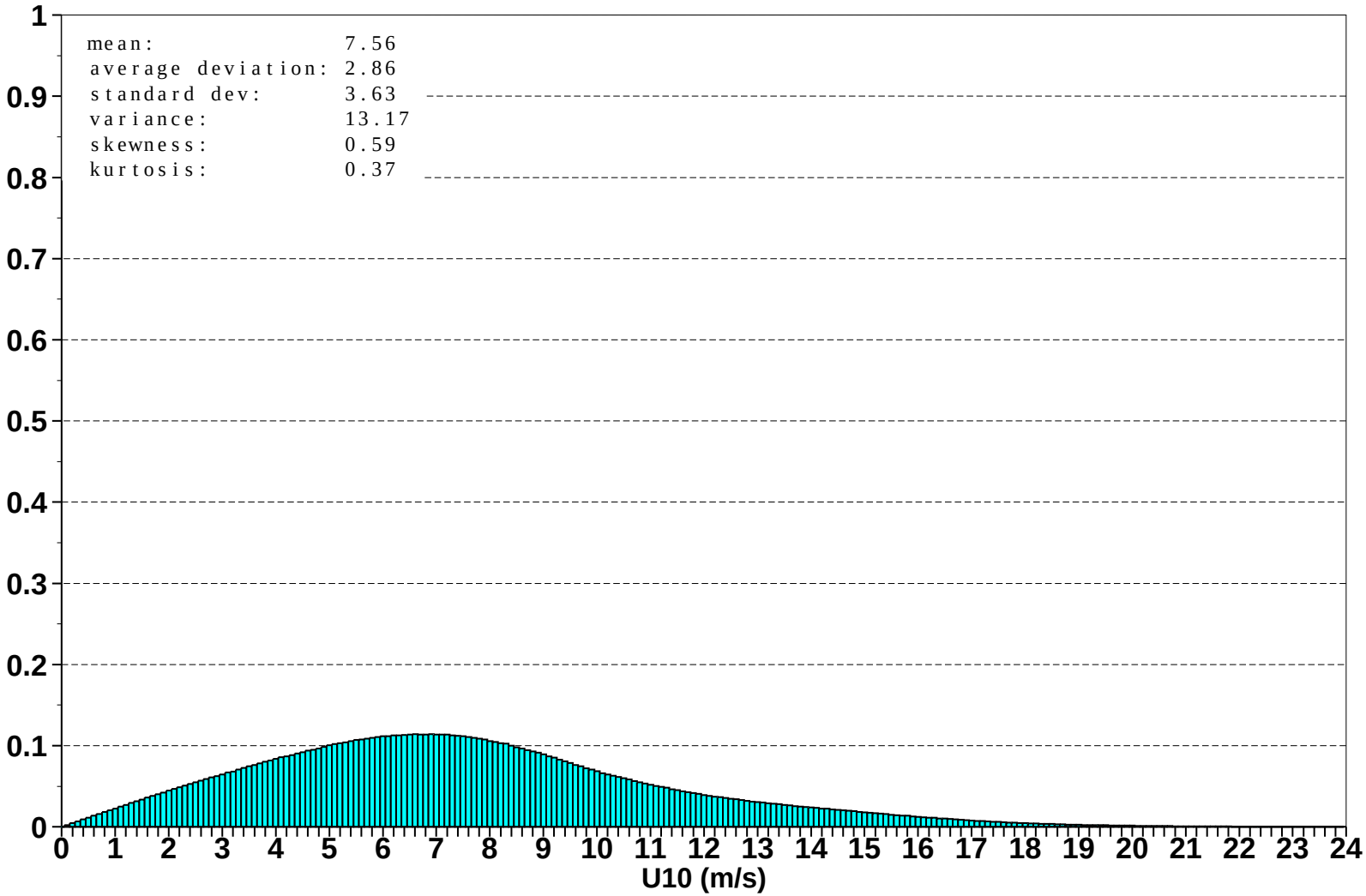

Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for April 2004

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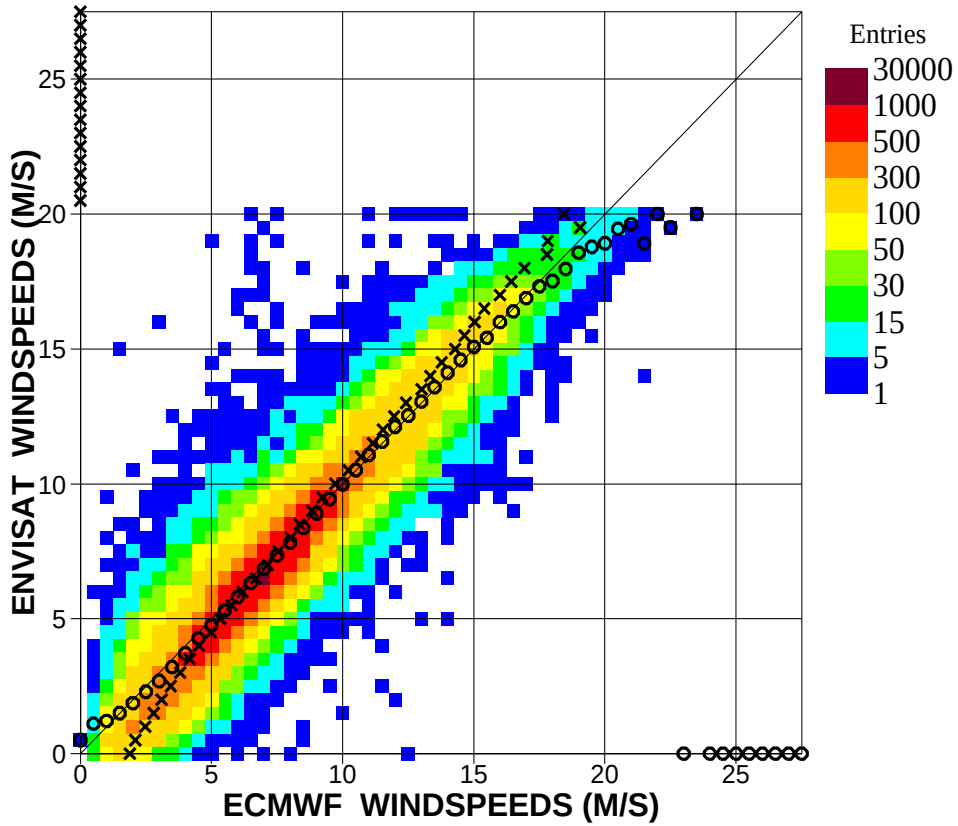

STATISTICS

ENTRIES	79837
MEAN ECMWF	7.6012
MEAN ENVISAT	7.4740
BIAS (ENVISAT - ECMWF)	-.1272
STANDARD DEVIATION	1.3288
SCATTER INDEX	.1748
CORRELATION	.9382
SYMMETRIC SLOPE	1.0029 (.0013)
REGR. COEFFICIENT	1.0227 (.0013)
REGR. CONSTANT	-.2998 (.0112)

Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2004 (Global)

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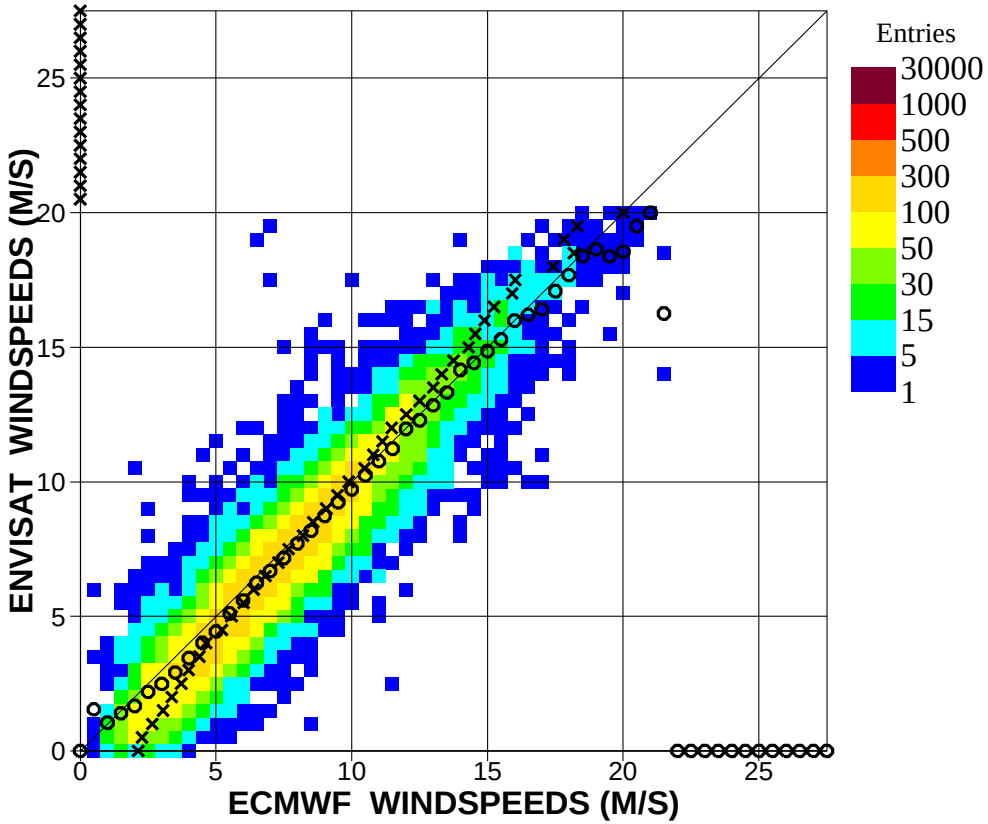

STATISTICS

ENTRIES	17840
MEAN ECMWF	7.5262
MEAN ENVISAT	7.1951
BIAS (ENVISAT - ECMWF)	-.3311
STANDARD DEVIATION	1.3425
SCATTER INDEX	.1784
CORRELATION	.9303
SYMMETRIC SLOPE	.9815 (.0031)
REGR. COEFFICIENT	1.0271 (.0030)
REGR. CONSTANT	-.5351 (.0249)

Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2004 (N.Hem.)

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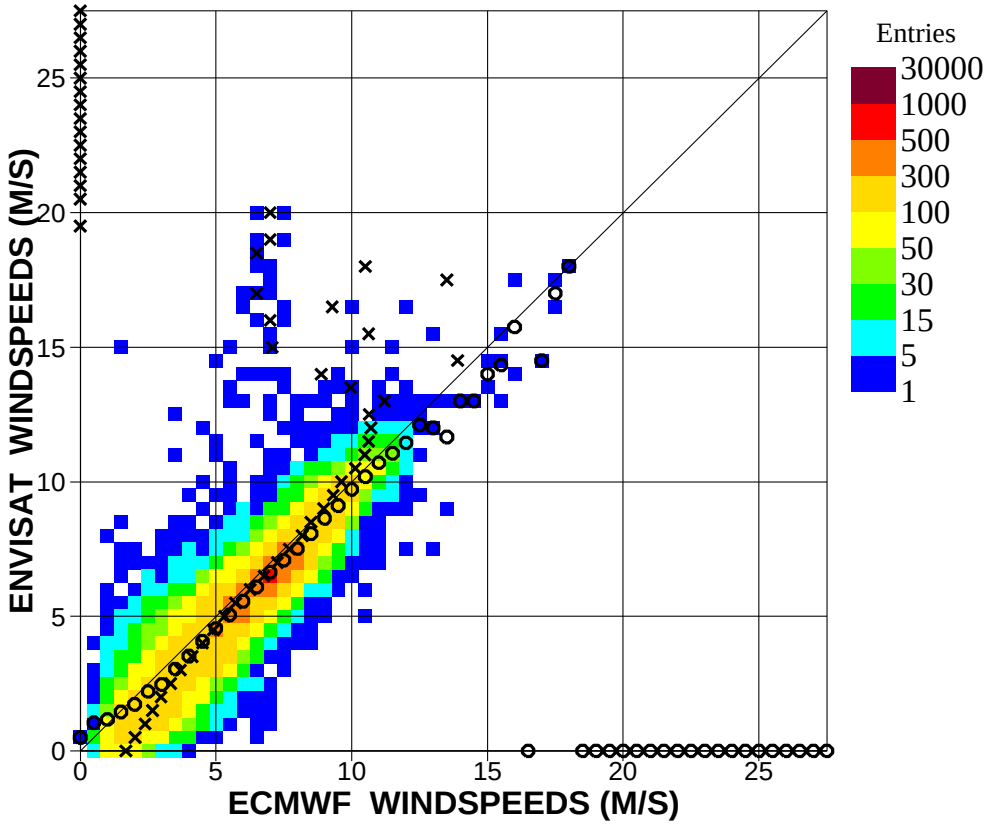

STATISTICS

ENTRIES	25056
MEAN ECMWF	5.8190
MEAN ENVISAT	5.4210
BIAS (ENVISAT - ECMWF)	-.3980
STANDARD DEVIATION	1.1404
SCATTER INDEX	.1960
CORRELATION	.9021
SYMMETRIC SLOPE	.9577 (.0030)
REGR. COEFFICIENT	.9902 (.0030)
REGR. CONSTANT	-.3410 (.0188)

Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2004 (Tropics)

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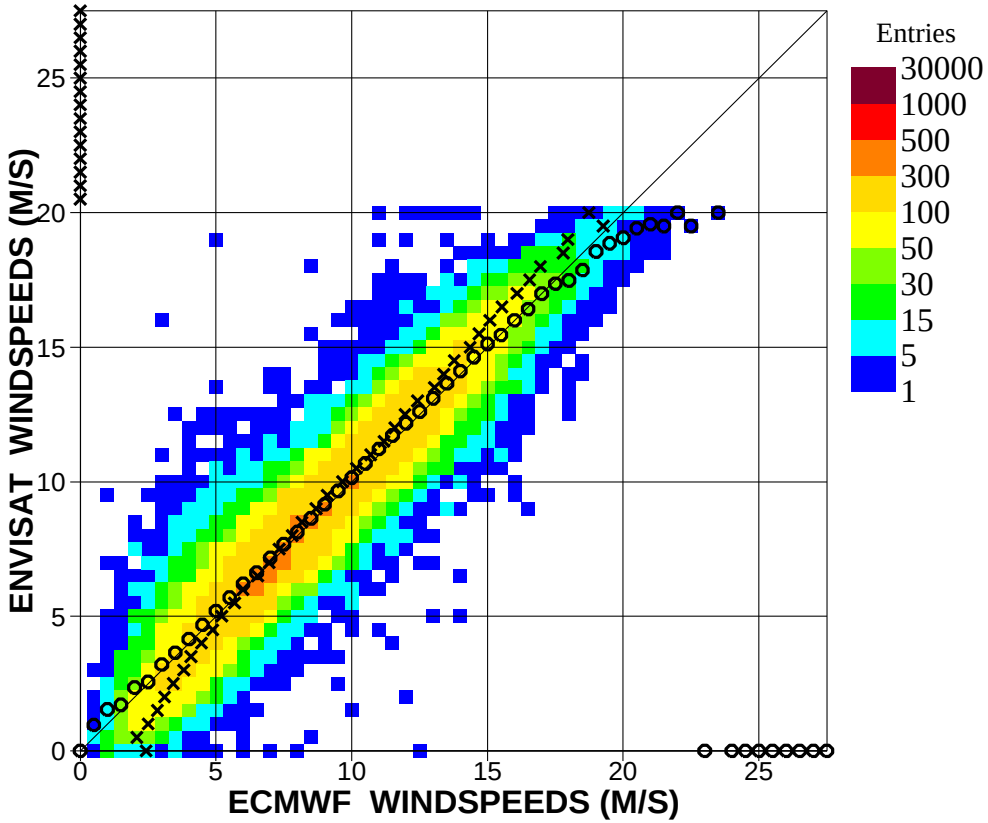

STATISTICS

ENTRIES	37532
MEAN ECMWF	8.8118
MEAN ENVISAT	8.9597
BIAS (ENVISAT - ECMWF)	.1479
STANDARD DEVIATION	1.3837
SCATTER INDEX	.1570
CORRELATION	.9356
SYMMETRIC SLOPE	1.0228 (.0019)
REGR. COEFFICIENT	.9882 (.0019)
REGR. CONSTANT	.2515 (.0184)

Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2004 (S.Hem.)

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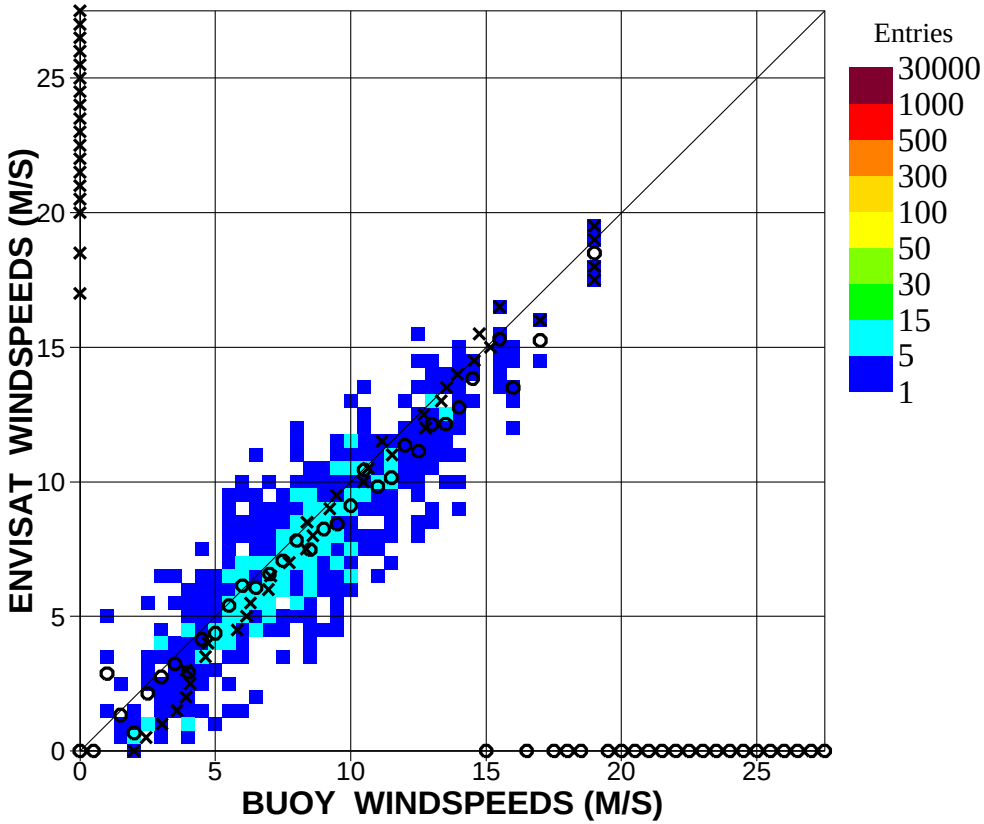

STATISTICS

ENTRIES	884	
MEAN BUOY	8.3146	
MEAN ENVISAT	7.6650	
BIAS (ENVISAT - BUOY)	-.6496	
STANDARD DEVIATION	1.5206	
SCATTER INDEX	.1829	
CORRELATION	.8887	
SYMMETRIC SLOPE	.9363	(.0160)
REGR. COEFFICIENT	.9155	(.0159)
REGR. CONSTANT	.0527	(.1415)

Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2004 (Global)

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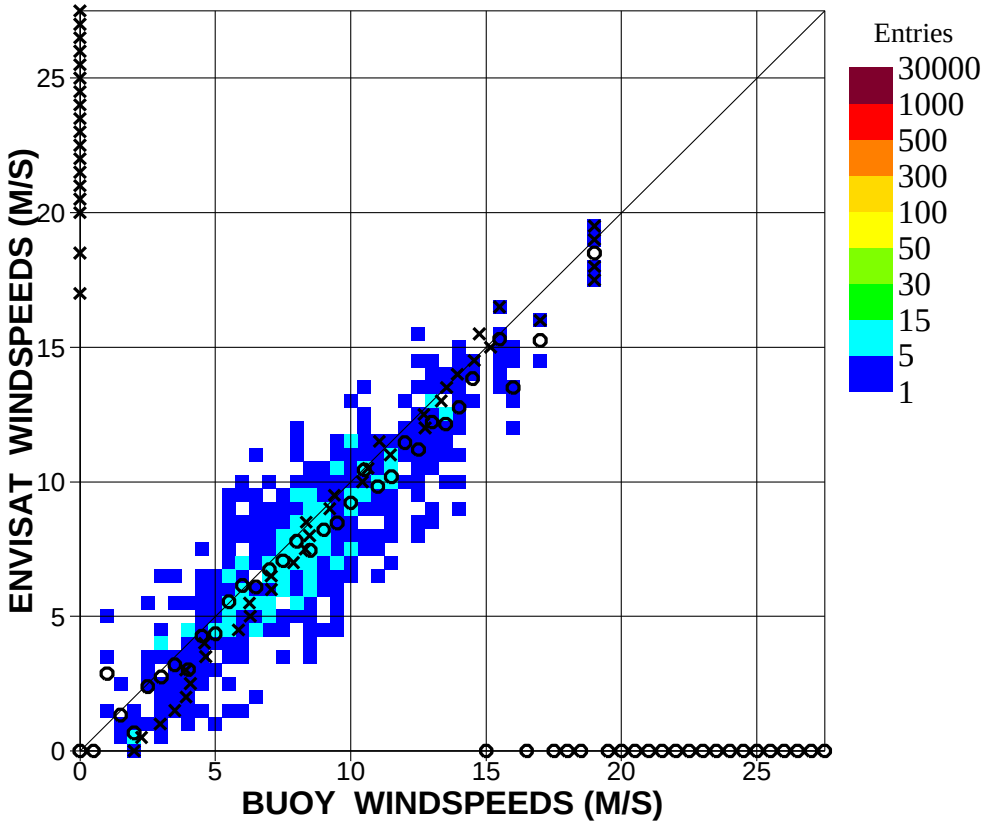

STATISTICS

ENTRIES	774	
MEAN BUOY	8.4694	
MEAN ENVISAT	7.8439	
BIAS (ENVISAT - BUOY)	-.6255	
STANDARD DEVIATION	1.5770	
SCATTER INDEX	.1862	
CORRELATION	.8848	
SYMMETRIC SLOPE	.9400	(.0174)
REGR. COEFFICIENT	.9116	(.0173)
REGR. CONSTANT	.1232	(.1566)

Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2004 (N.Hem.)

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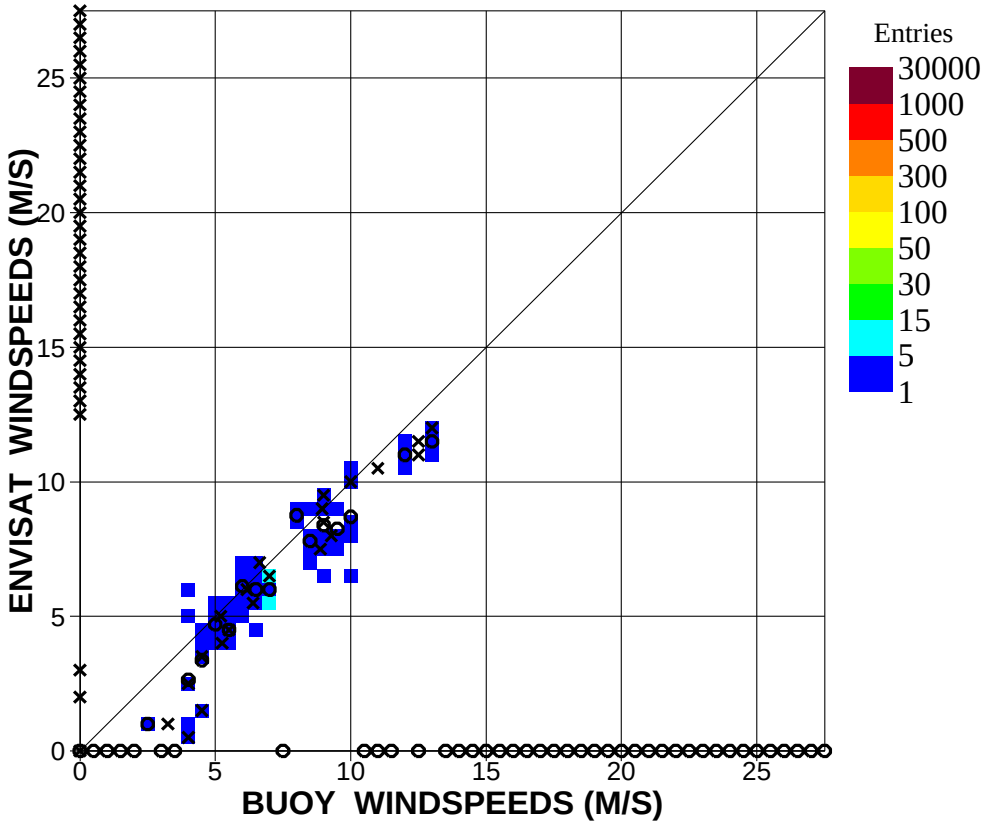

STATISTICS

ENTRIES	99	
MEAN BUOY	7.0855	
MEAN ENVISAT	6.3438	
BIAS (ENVISAT - BUOY)	-.7417	
STANDARD DEVIATION	.9672	
SCATTER INDEX	.1365	
CORRELATION	.9136	
SYMMETRIC SLOPE	.9109	(.0442)
REGR. COEFFICIENT	.9637	(.0436)
REGR. CONSTANT	-.4843	(.3236)

Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2004 (Tropics)

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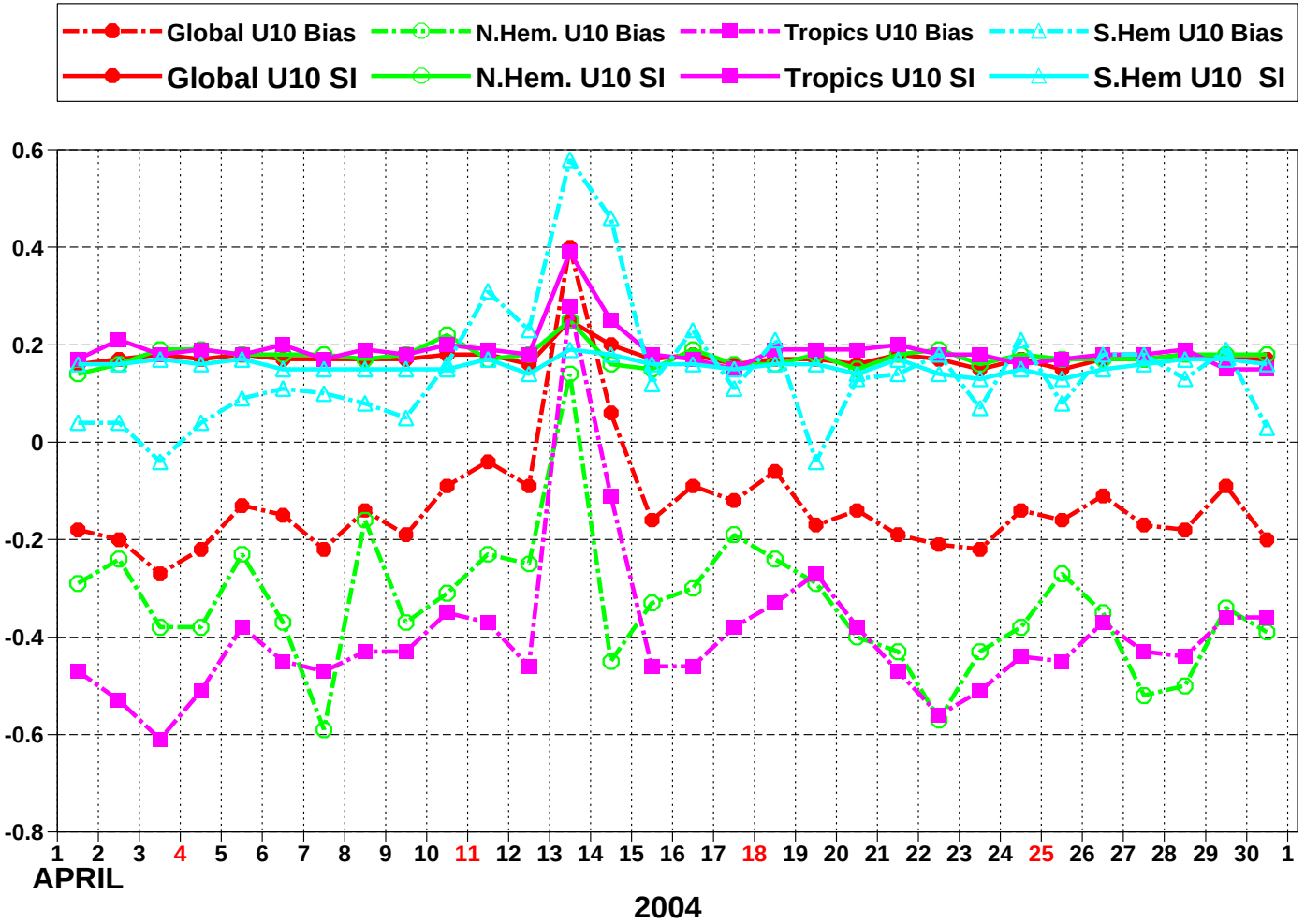

Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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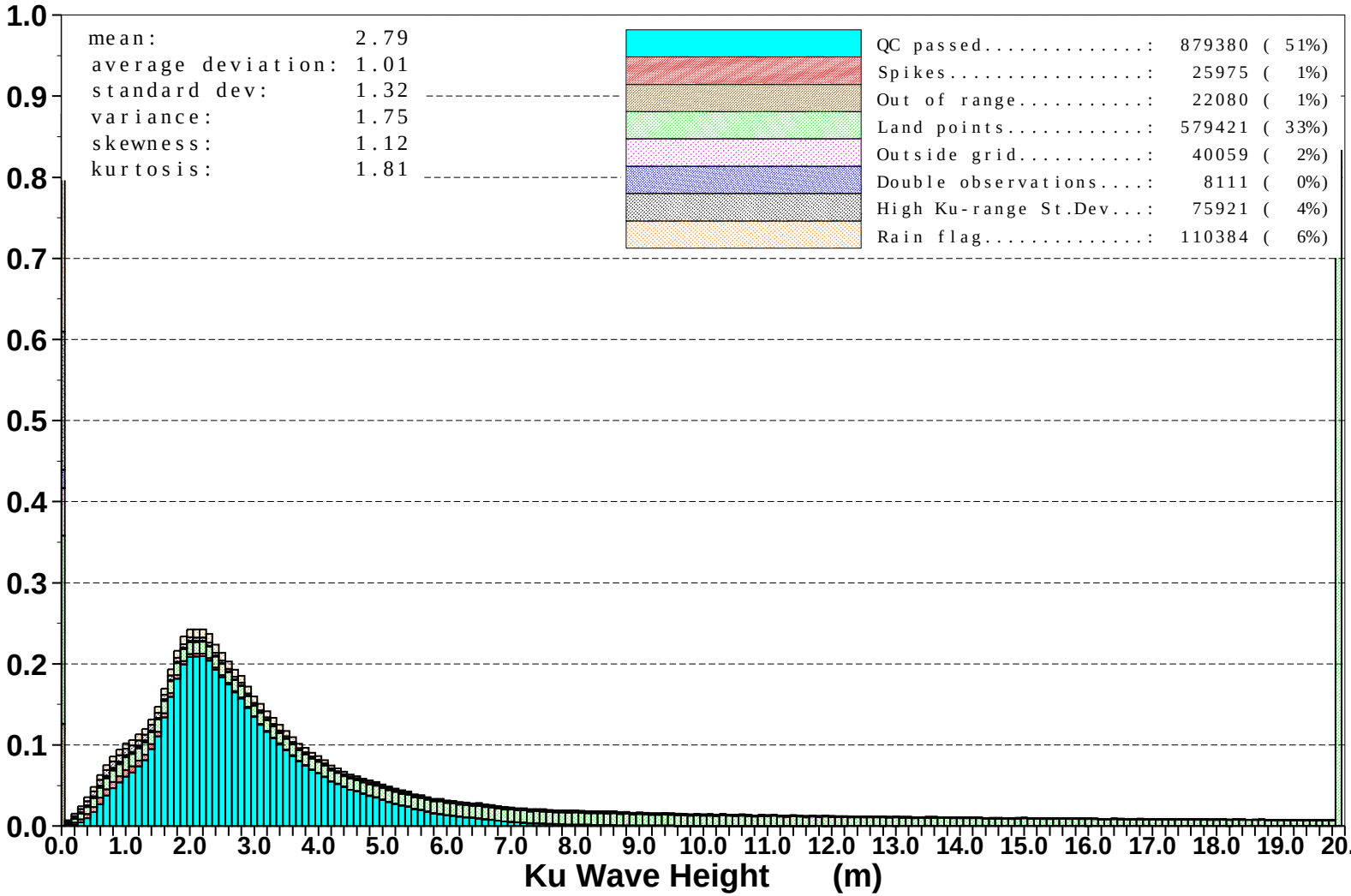

Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for April 2004

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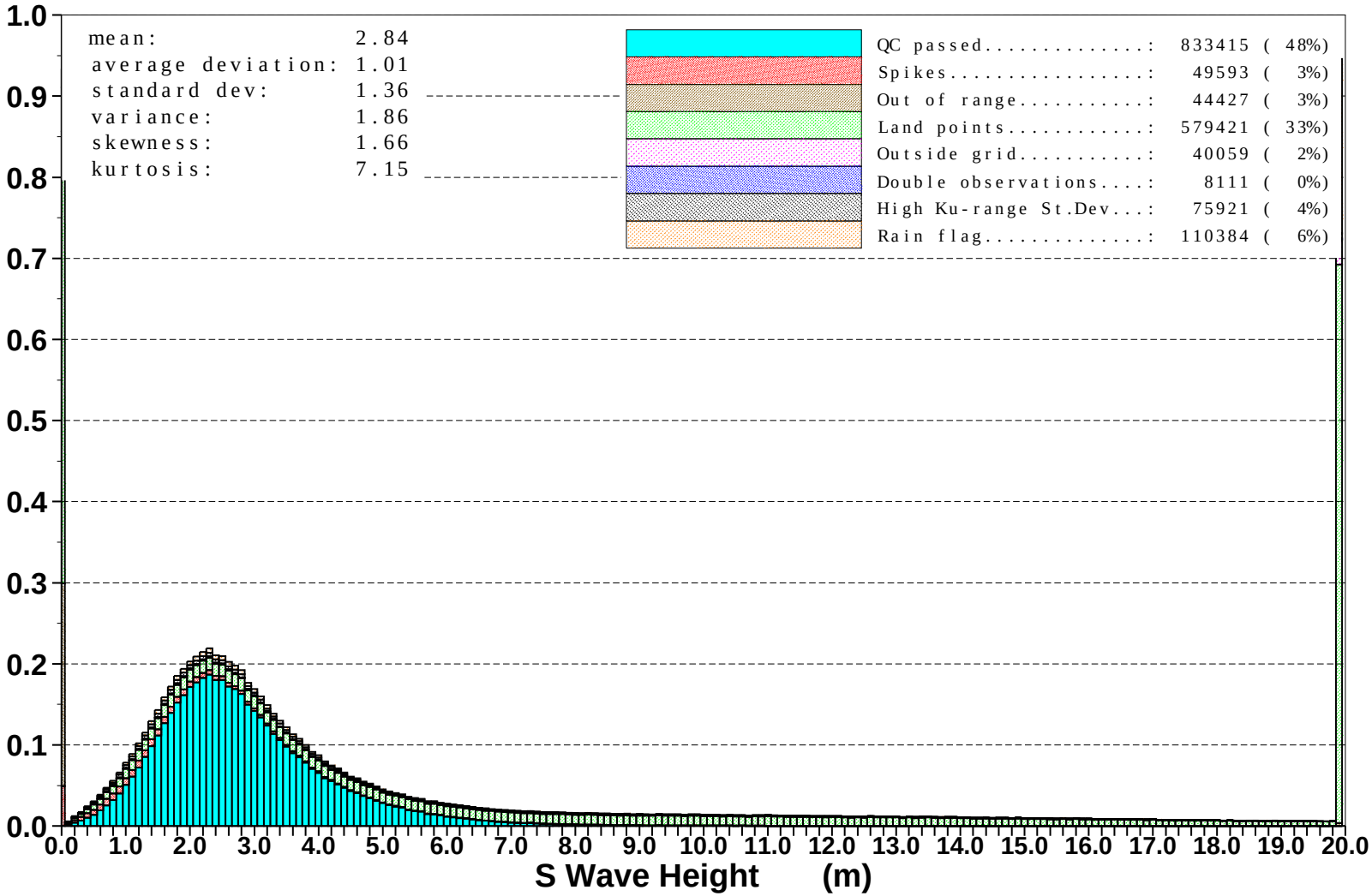

Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for April 2004

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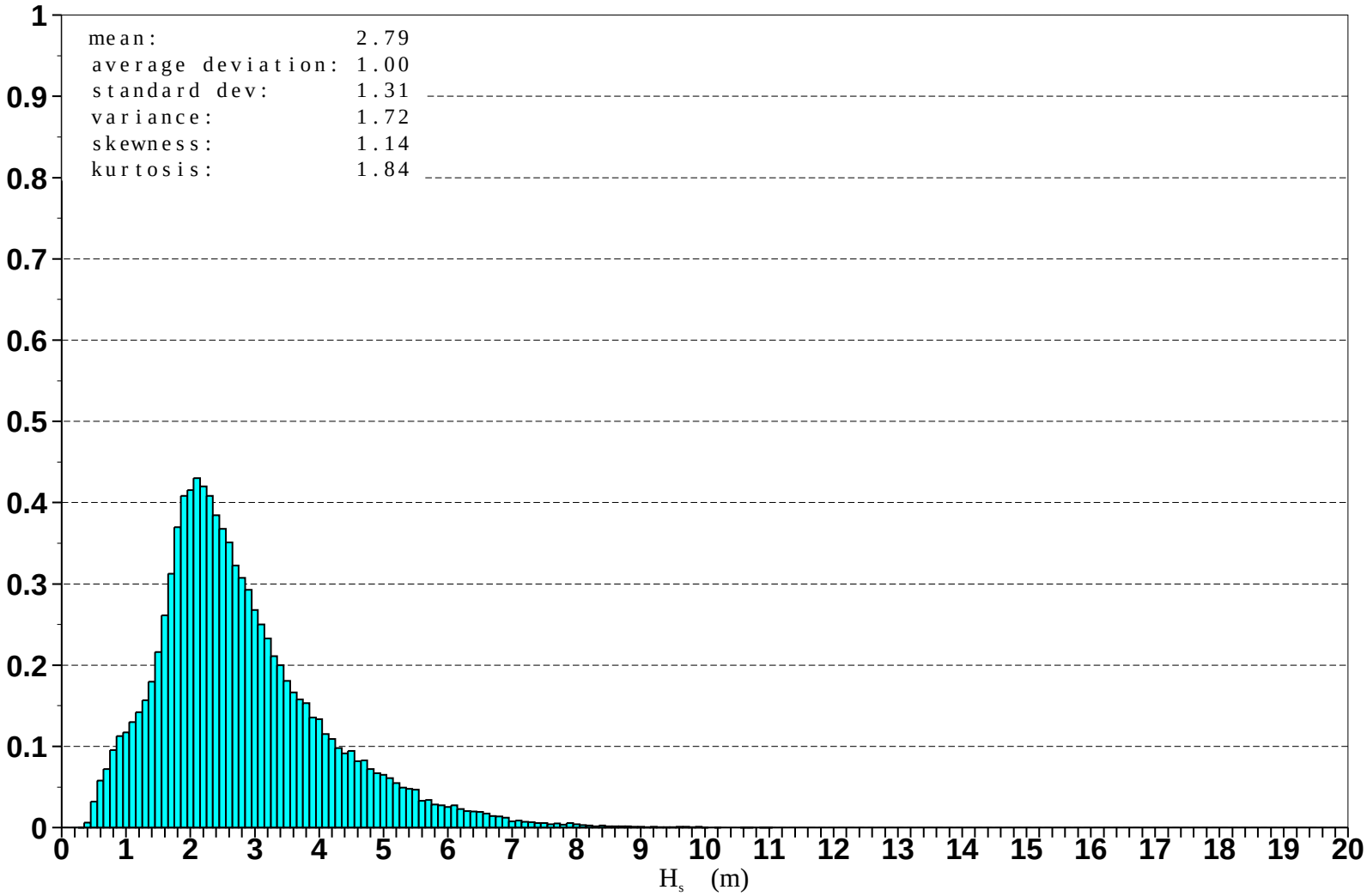

Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for April 2004

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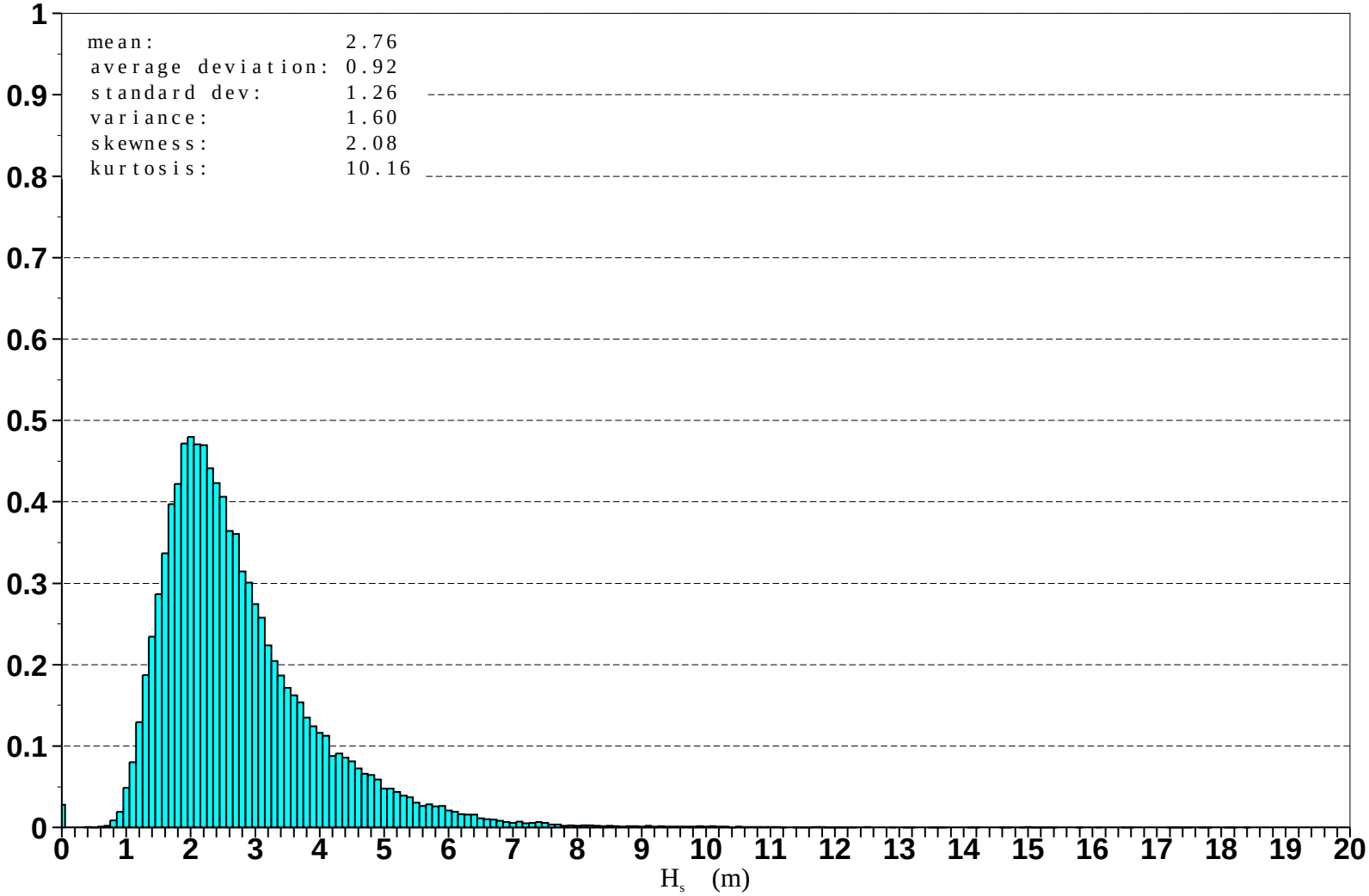

Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for April 2004

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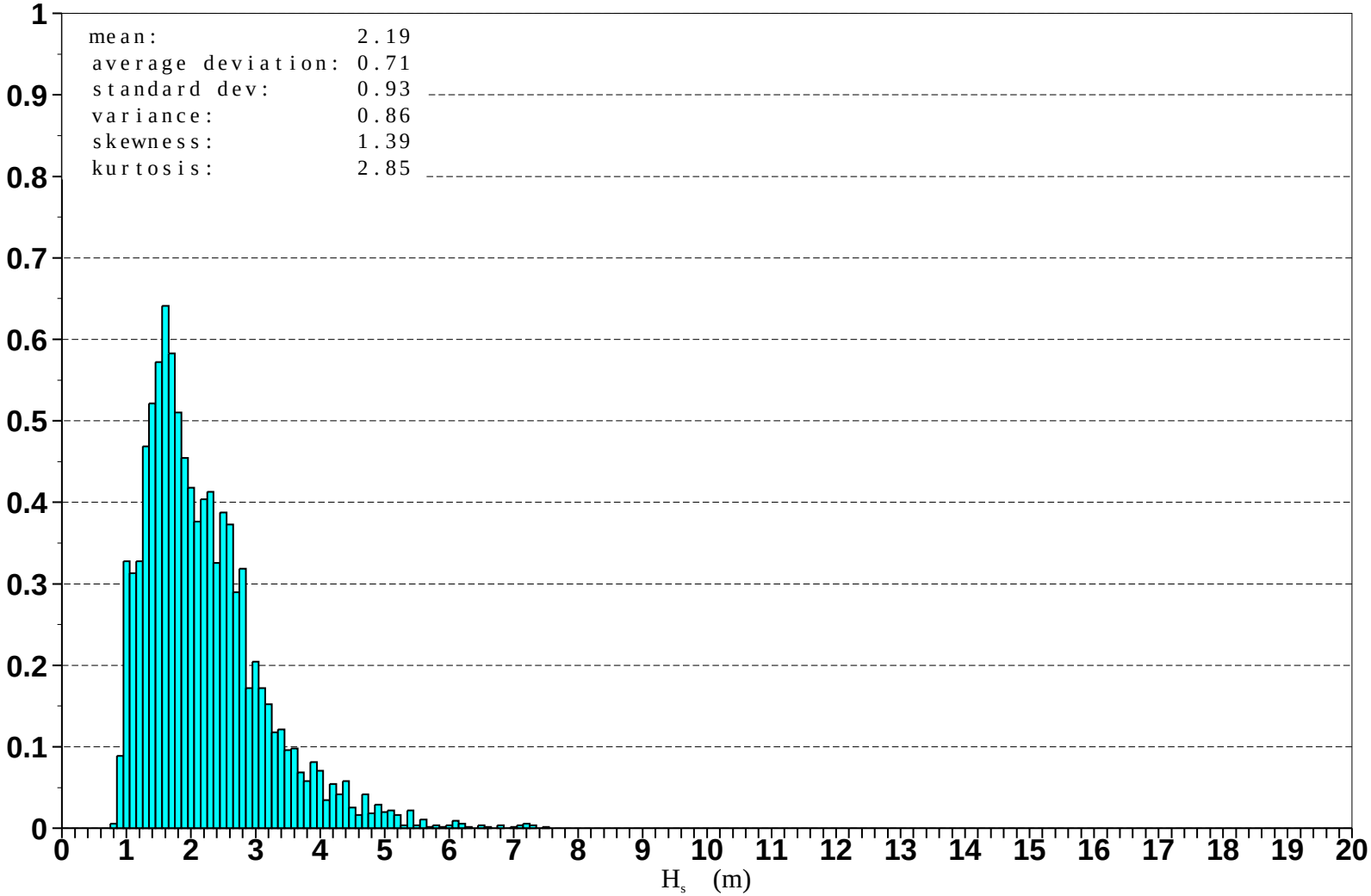

Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for April 2004

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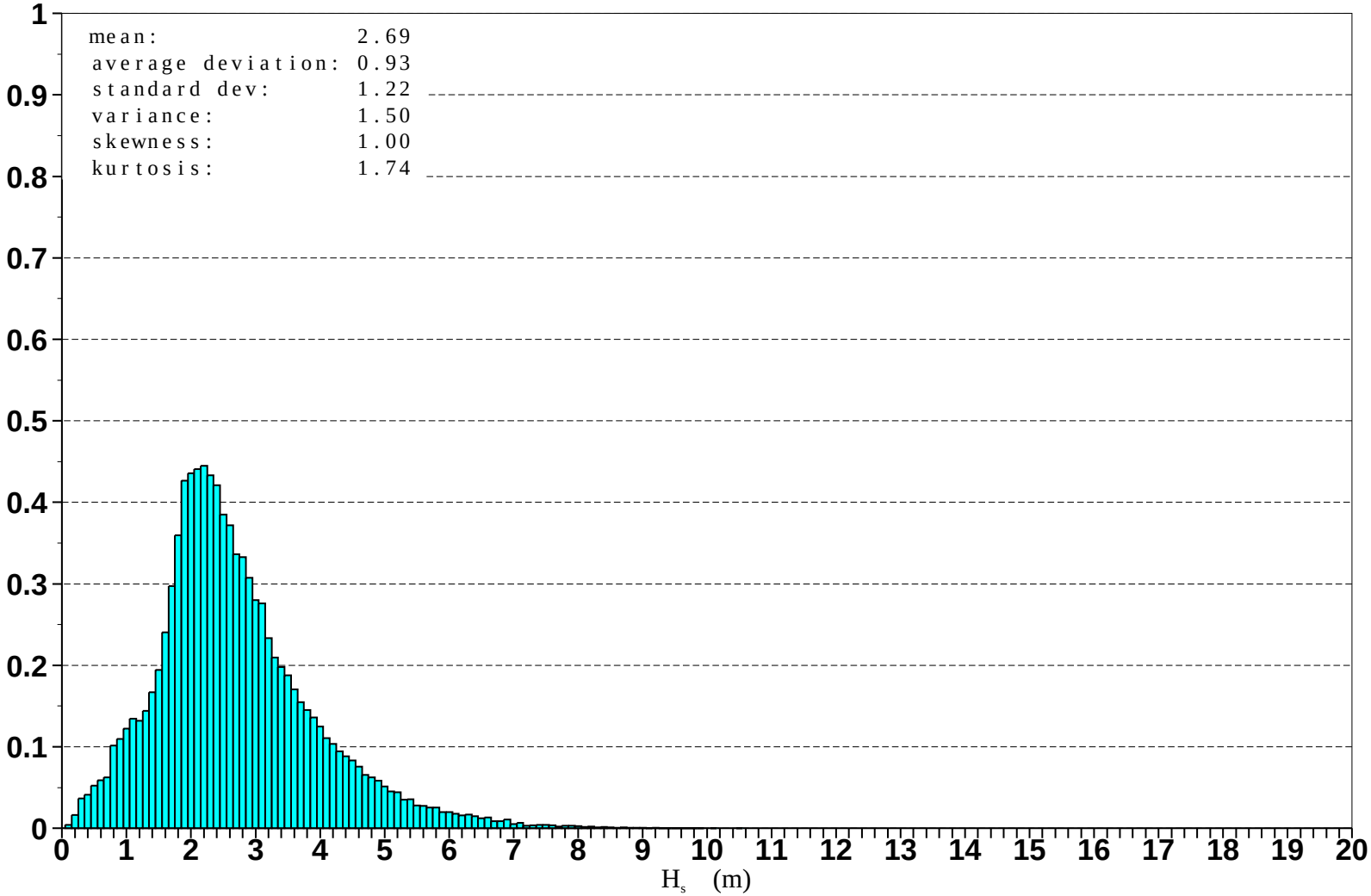

Figure 19b: Distribution of WAM 4V Wave Height (Collocated with ENVISAT) for April 2004

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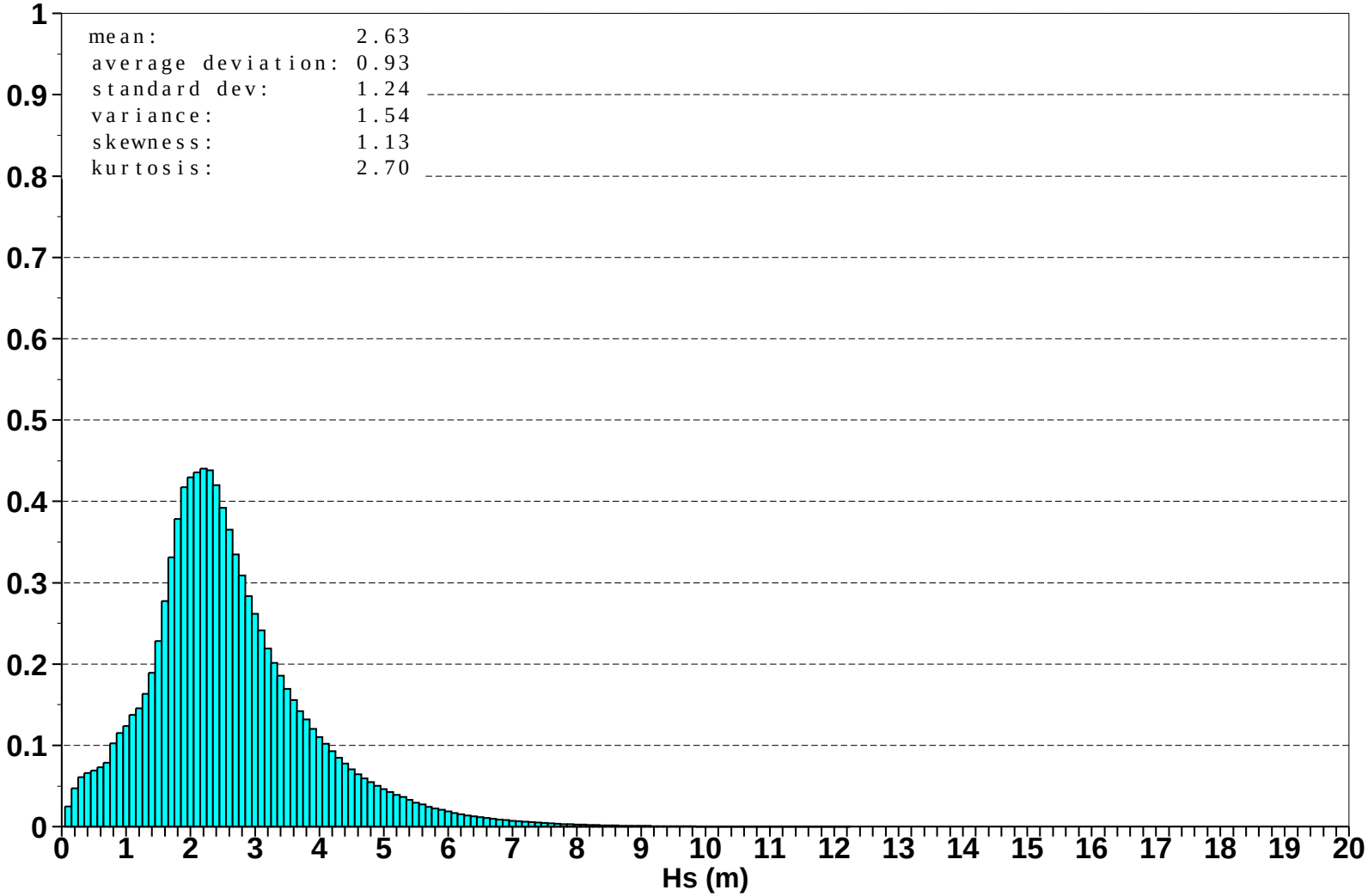

Figure 20: Global distribution of ECMWF First-Guess wave heights for April 2004

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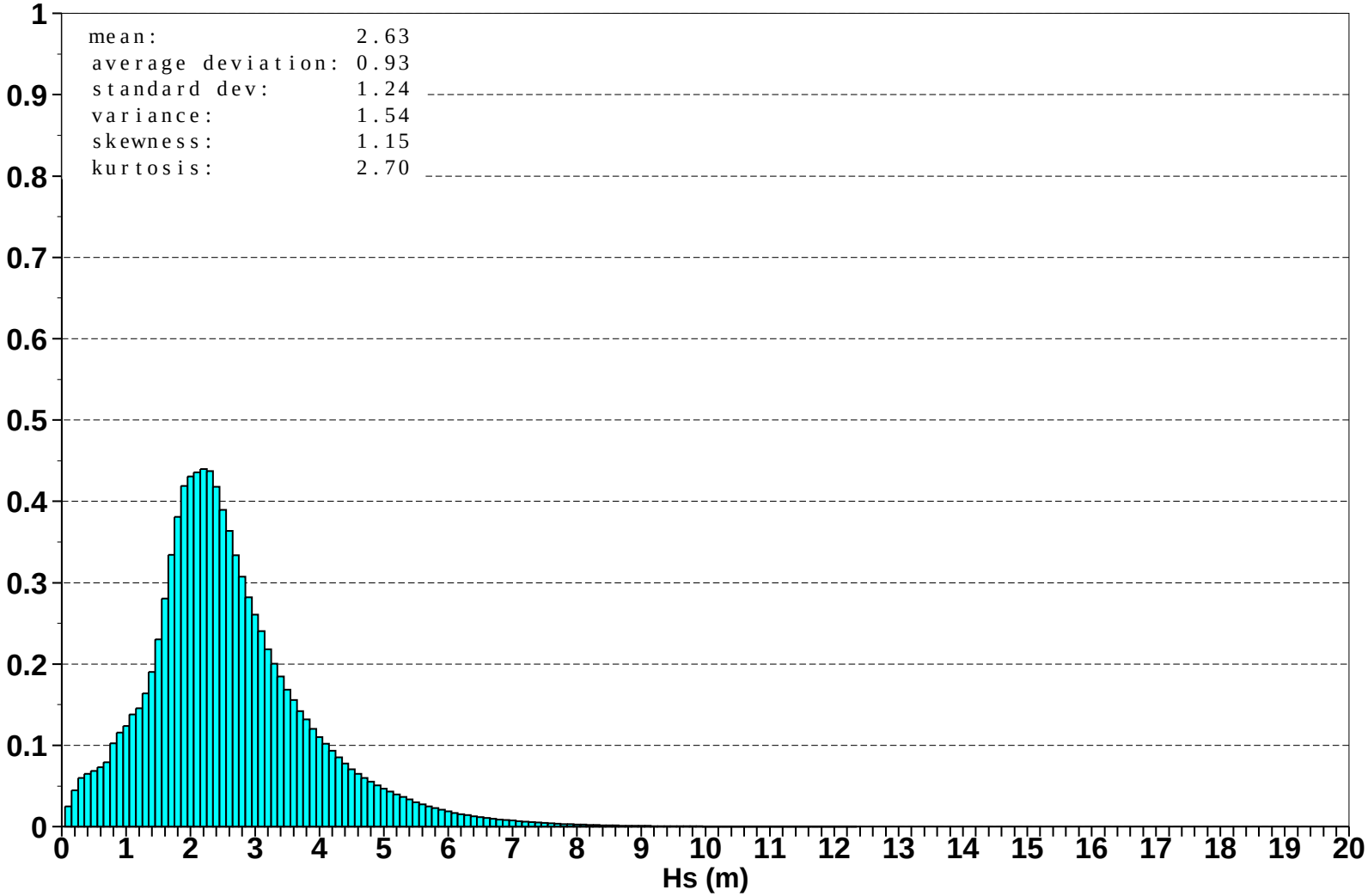

Figure 21: Global distribution of ECMWF Analysis (using ERS-2 data) wave heights for April 2004

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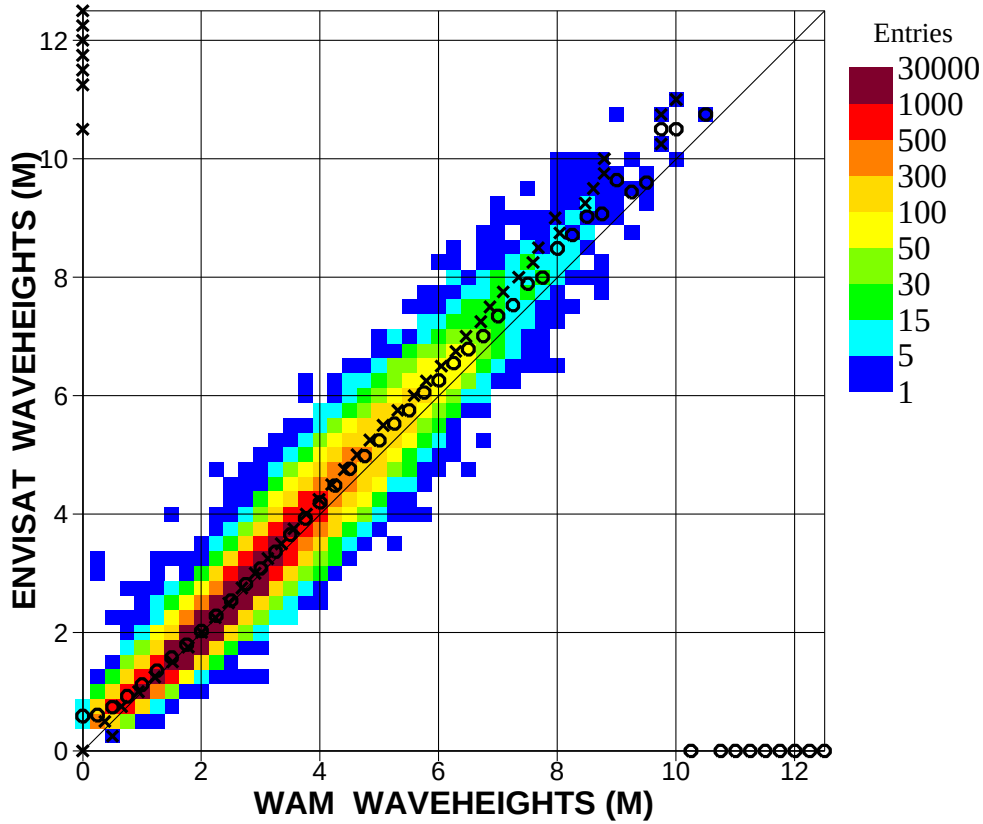

STATISTICS

ENTRIES	80041
MEAN WAM	2.6901
MEAN ENVISAT	2.7930
BIAS (ENVISAT - WAM)	.1028
STANDARD DEVIATION	.3039
SCATTER INDEX	.1130
CORRELATION	.9737
SYMMETRIC SLOPE	1.0441 (.0009)
REGR. COEFFICIENT	1.0439 (.0009)
REGR. CONSTANT	-.0154 (.0026)

Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2004 (Global)

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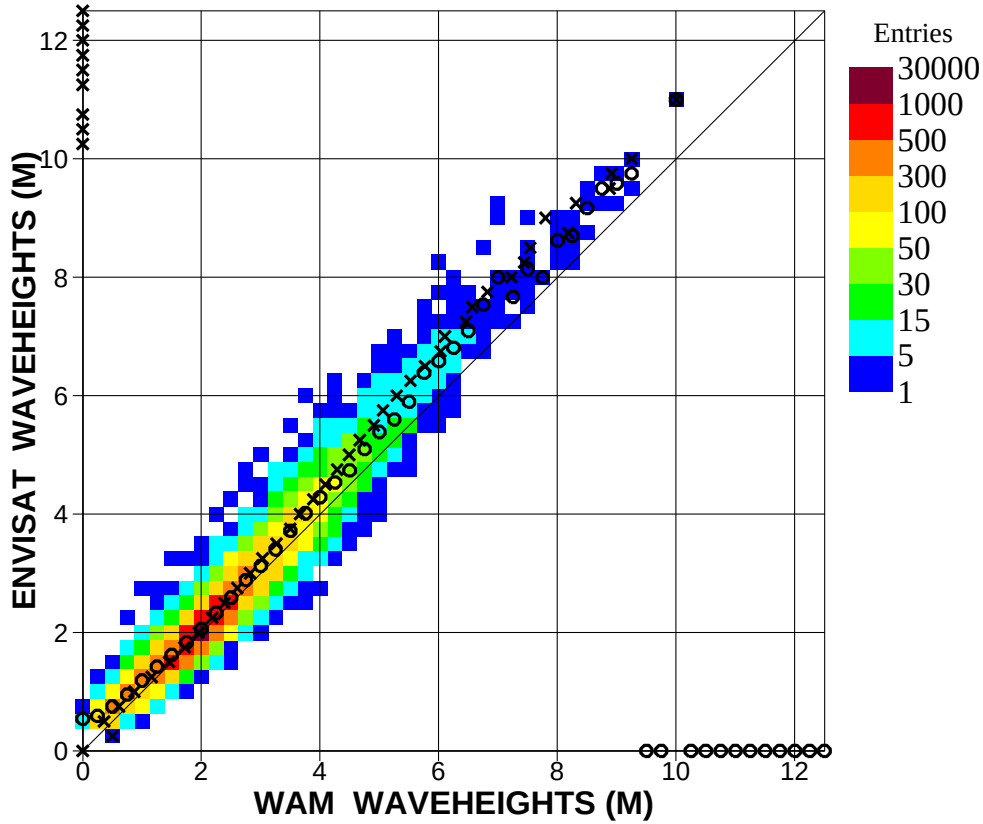

STATISTICS

ENTRIES	17872
MEAN WAM	2.2583
MEAN ENVISAT	2.4031
BIAS (ENVISAT - WAM)	.1448
STANDARD DEVIATION	.2998
SCATTER INDEX	.1328
CORRELATION	.9671
SYMMETRIC SLOPE	1.0655 (.0021)
REGR. COEFFICIENT	1.0362 (.0020)
REGR. CONSTANT	.0629 (.0051)

Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2004 (N.Hem.)

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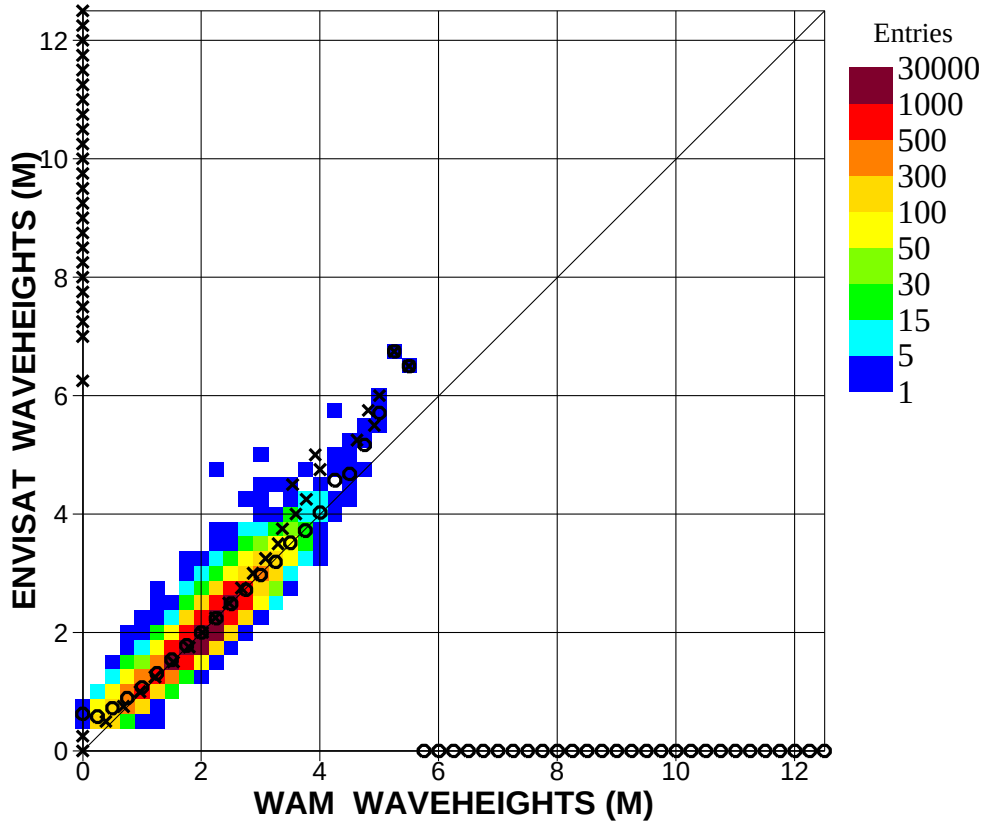

STATISTICS

ENTRIES	25187
MEAN WAM	1.9545
MEAN ENVISAT	1.9748
BIAS (ENVISAT - WAM)	.0203
STANDARD DEVIATION	.2044
SCATTER INDEX	.1046
CORRELATION	.9501
SYMMETRIC SLOPE	1.0080 (.0020)
REGR. COEFFICIENT	.9376 (.0019)
REGR. CONSTANT	.1422 (.0040)

Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2004 (Tropics)

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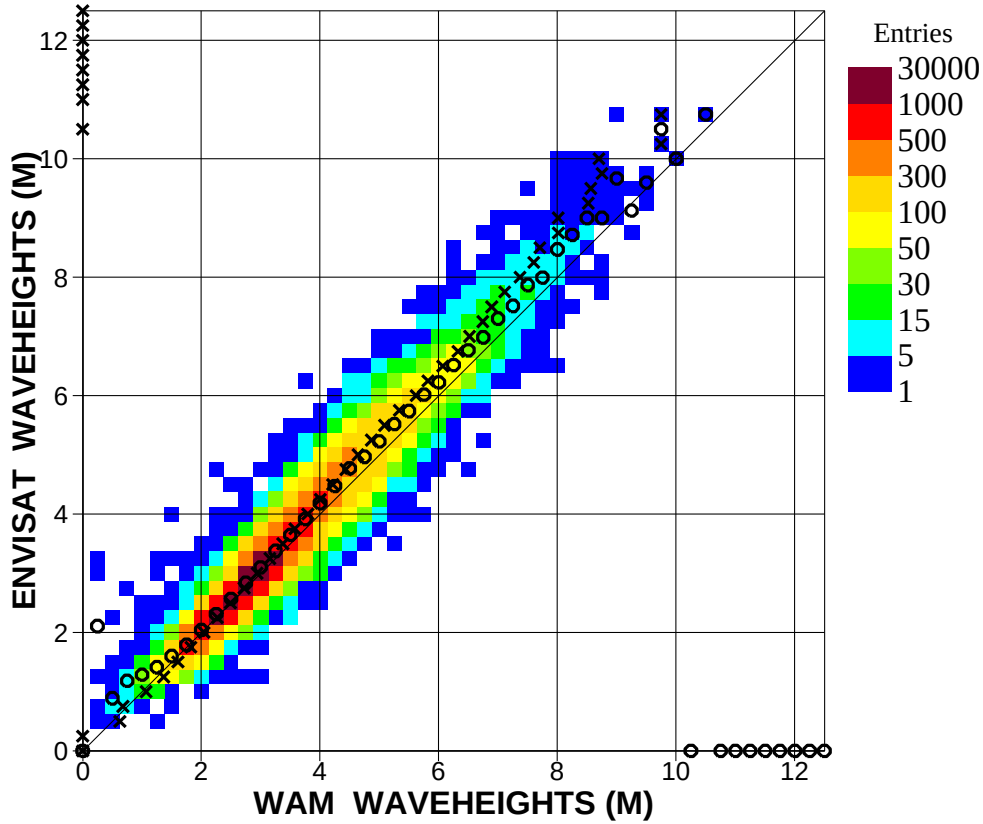

STATISTICS

ENTRIES	37574
MEAN WAM	3.3806
MEAN ENVISAT	3.5181
BIAS (ENVISAT - WAM)	.1375
STANDARD DEVIATION	.3469
SCATTER INDEX	.1026
CORRELATION	.9655
SYMMETRIC SLOPE	1.0468 (.0015)
REGR. COEFFICIENT	1.0570 (.0015)
REGR. CONSTANT	-.0553 (.0053)

Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2004 (S.Hem.)

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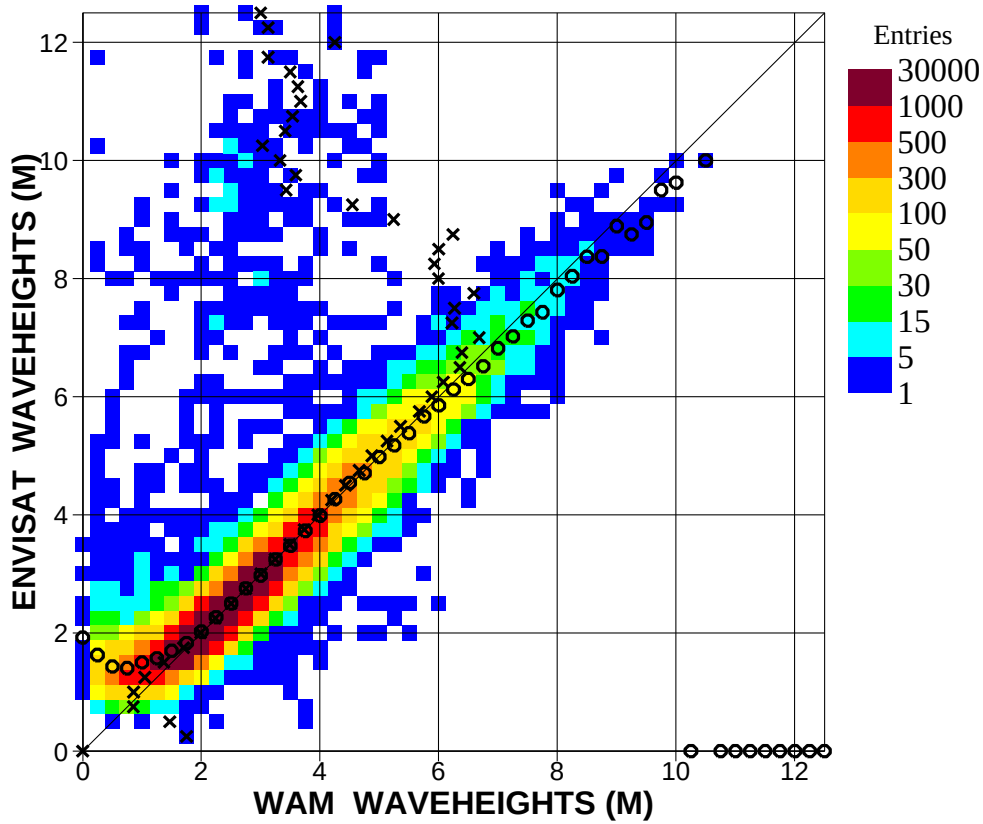

STATISTICS

ENTRIES	79815
MEAN WAM	2.6921
MEAN ENVISAT	2.7634
BIAS (ENVISAT - WAM)	.0713
STANDARD DEVIATION	.6290
SCATTER INDEX	.2337
CORRELATION	.8716
SYMMETRIC SLOPE	1.0267 (.0018)
REGR. COEFFICIENT	.8960 (.0018)
REGR. CONSTANT	.3514 (.0053)

Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2004 (Global)

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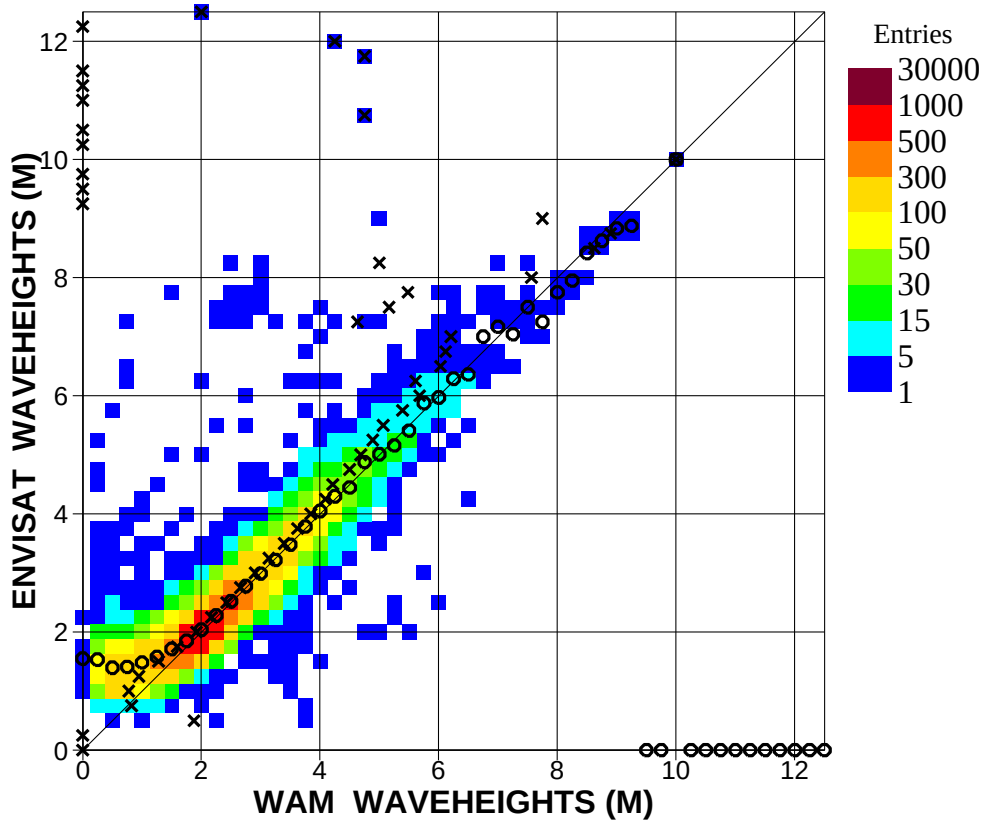

STATISTICS

ENTRIES	17797
MEAN WAM	2.2593
MEAN ENVISAT	2.4122
BIAS (ENVISAT - WAM)	.1529
STANDARD DEVIATION	.5211
SCATTER INDEX	.2306
CORRELATION	.8814
SYMMETRIC SLOPE	1.0472 (.0037)
REGR. COEFFICIENT	.8412 (.0034)
REGR. CONSTANT	.5118 (.0085)

Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2004 (N.Hem.)

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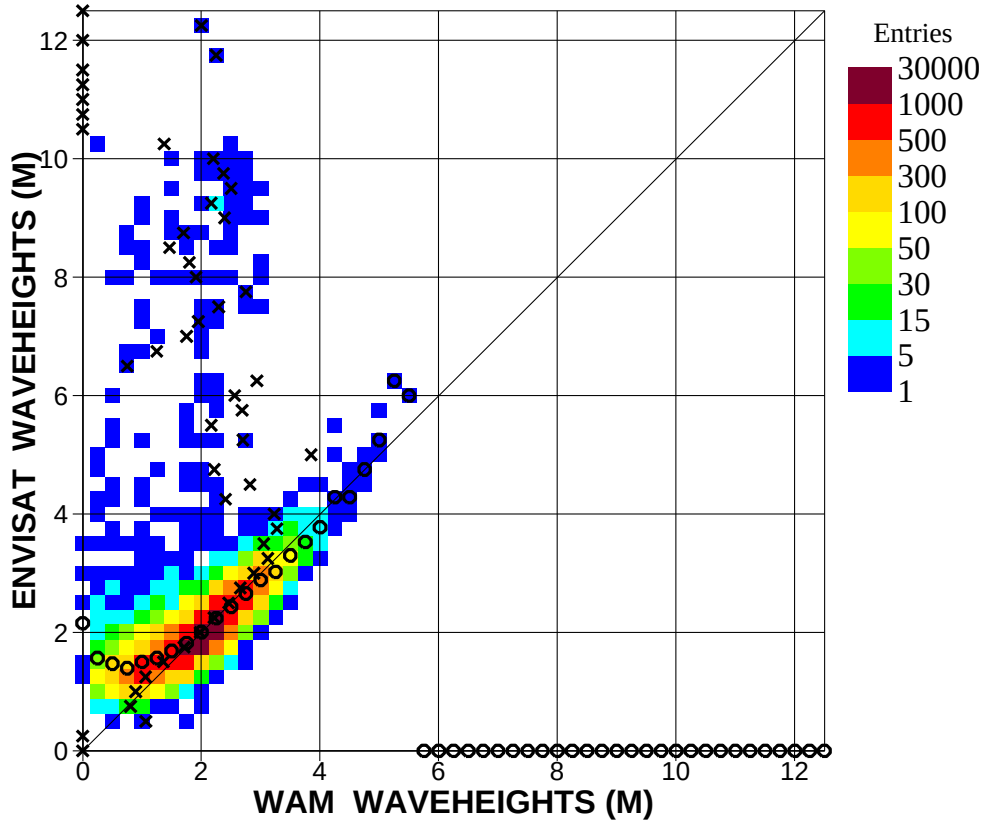

STATISTICS

ENTRIES	25095
MEAN WAM	1.9564
MEAN ENVISAT	2.0597
BIAS (ENVISAT - WAM)	.1033
STANDARD DEVIATION	.5863
SCATTER INDEX	.2997
CORRELATION	.6183
SYMMETRIC SLOPE	1.0535 (.0058)
REGR. COEFFICIENT	.6552 (.0053)
REGR. CONSTANT	.7779 (.0108)

Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2004 (Tropics)

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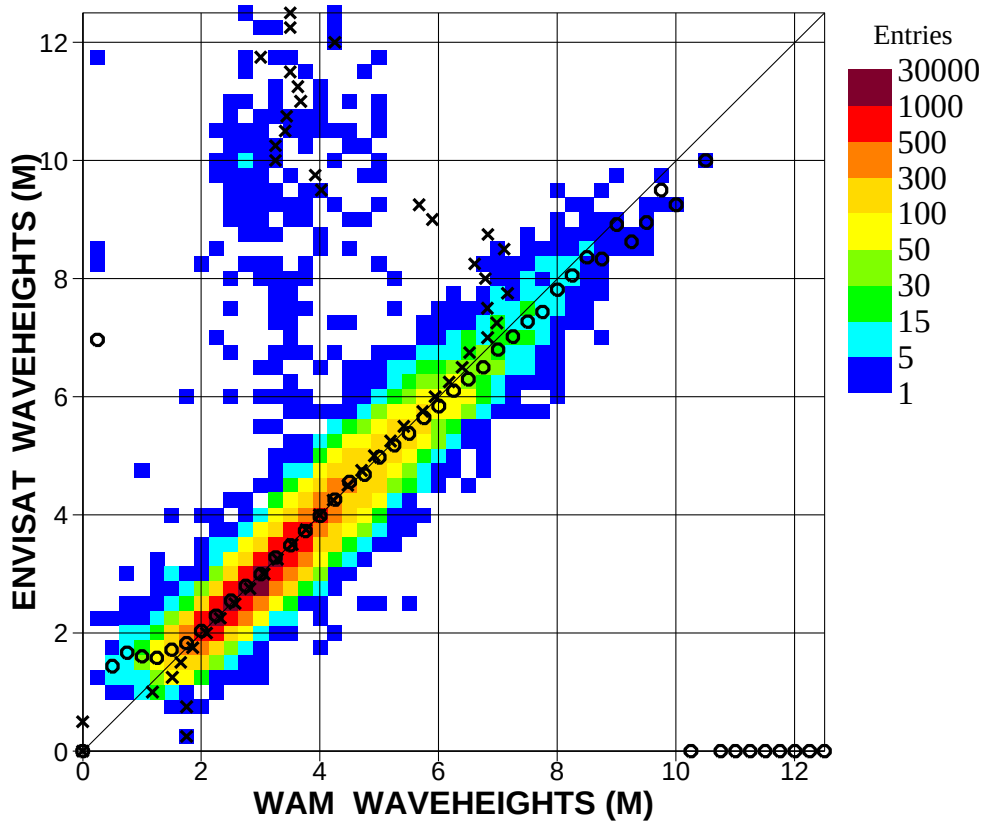

STATISTICS

ENTRIES	37513
MEAN WAM	3.3813
MEAN ENVISAT	3.3931
BIAS (ENVISAT - WAM)	.0117
STANDARD DEVIATION	.6942
SCATTER INDEX	.2053
CORRELATION	.8532
SYMMETRIC SLOPE	1.0160 (.0030)
REGR. COEFFICIENT	.9488 (.0030)
REGR. CONSTANT	.1850 (.0107)

Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2004 (S.Hem.)

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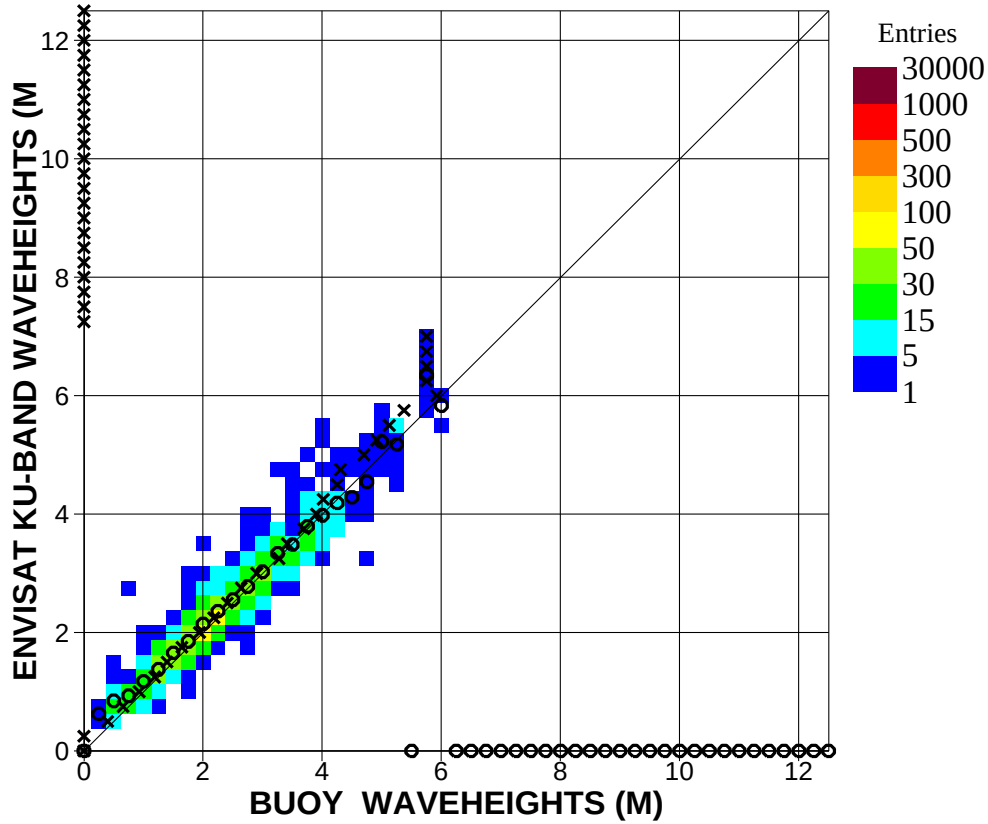

STATISTICS

ENTRIES	1343	
MEAN BUOY	2.3453	
MEAN ENVISAT	2.4454	
BIAS (ENVISAT - BUOY)	.1001	
STANDARD DEVIATION	.3131	
SCATTER INDEX	.1335	
CORRELATION	.9582	
SYMMETRIC SLOPE	1.0335	(.0081)
REGR. COEFFICIENT	.9481	(.0077)
REGR. CONSTANT	.2219	(.0200)

Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2004 (Global)

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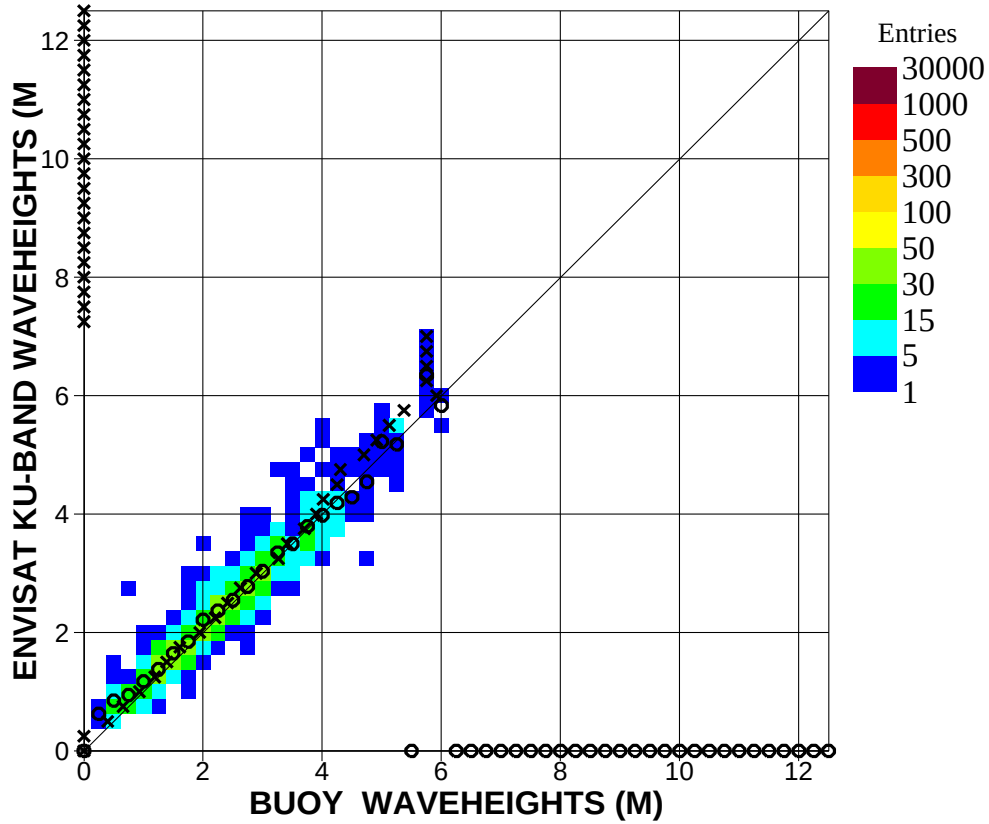

STATISTICS

ENTRIES	1213	
MEAN BUOY	2.3750	
MEAN ENVISAT	2.4796	
BIAS (ENVISAT - BUOY)	.1046	
STANDARD DEVIATION	.3241	
SCATTER INDEX	.1365	
CORRELATION	.9582	
SYMMETRIC SLOPE	1.0342	(.0085)
REGR. COEFFICIENT	.9477	(.0081)
REGR. CONSTANT	.2287	(.0214)

Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2004 (N.Hem.)

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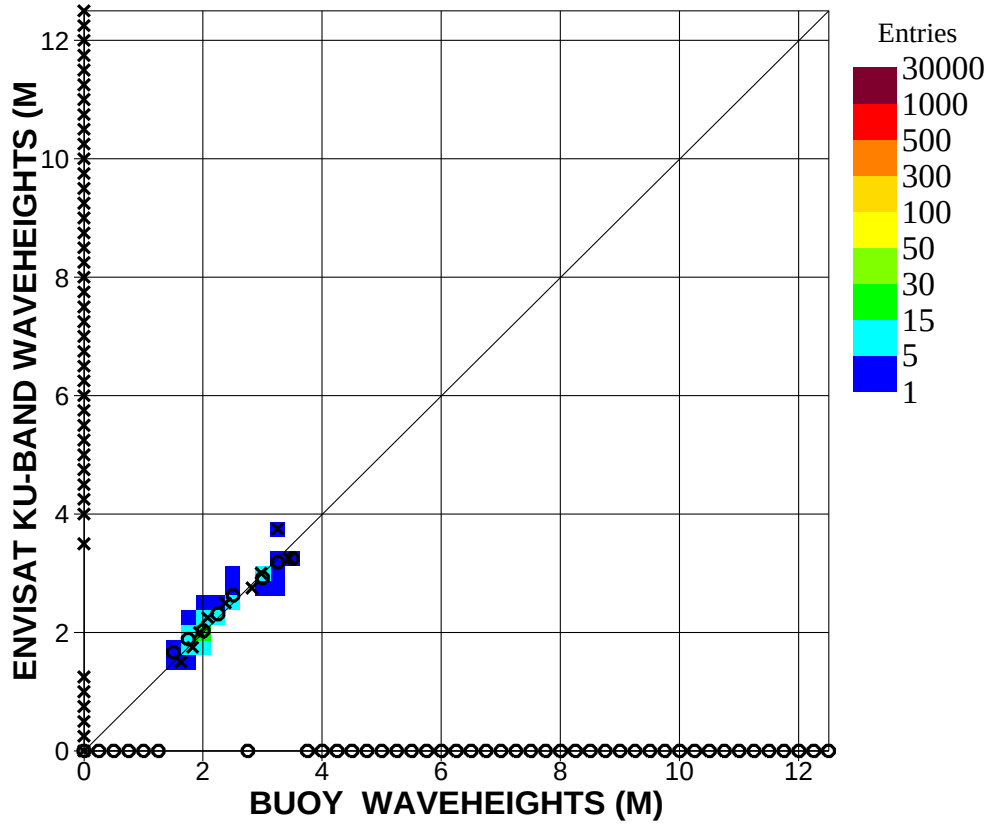

STATISTICS

ENTRIES	114	
MEAN BUOY	2.1744	
MEAN ENVISAT	2.2245	
BIAS (ENVISAT - BUOY)	.0501	
STANDARD DEVIATION	.1676	
SCATTER INDEX	.0771	
CORRELATION	.9302	
SYMMETRIC SLOPE	1.0200	(.0354)
REGR. COEFFICIENT	.8806	(.0328)
REGR. CONSTANT	.3097	(.0729)

Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2004 (Tropics)

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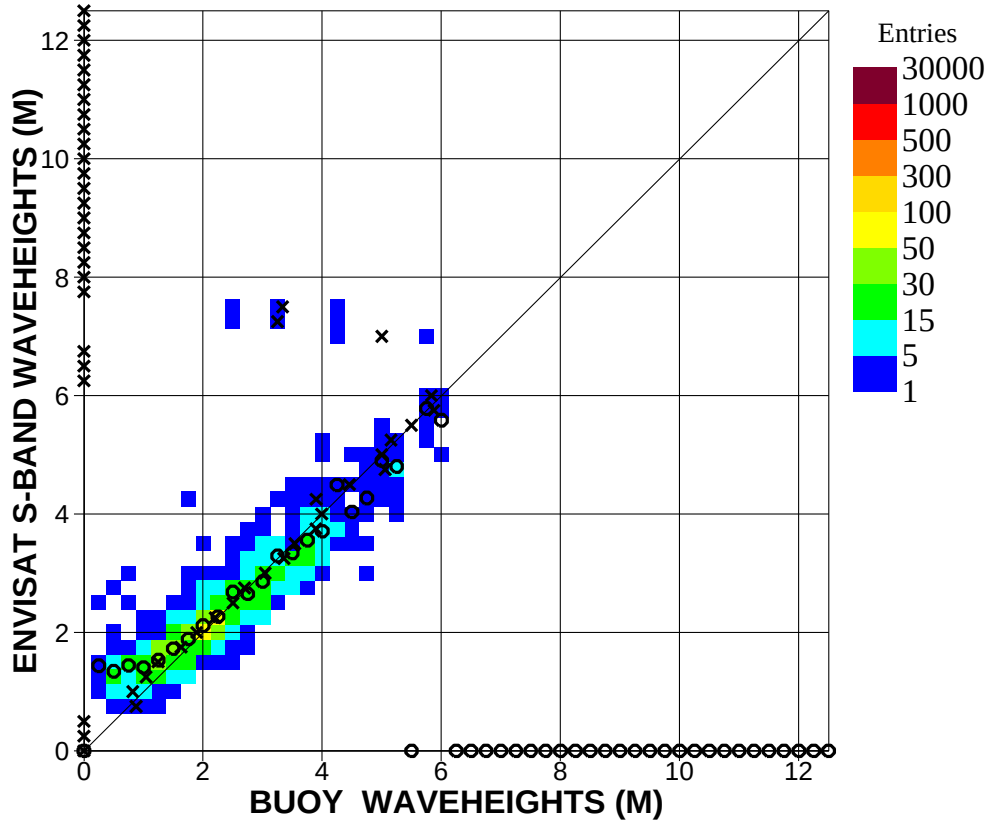

STATISTICS

ENTRIES	1336	
MEAN BUOY	2.3455	
MEAN ENVISAT	2.4521	
BIAS (ENVISAT - BUOY)	.1066	
STANDARD DEVIATION	.5764	
SCATTER INDEX	.2457	
CORRELATION	.8535	
SYMMETRIC SLOPE	1.0283	(.0148)
REGR. COEFFICIENT	.8061	(.0135)
REGR. CONSTANT	.5615	(.0348)

Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2004 (Global)

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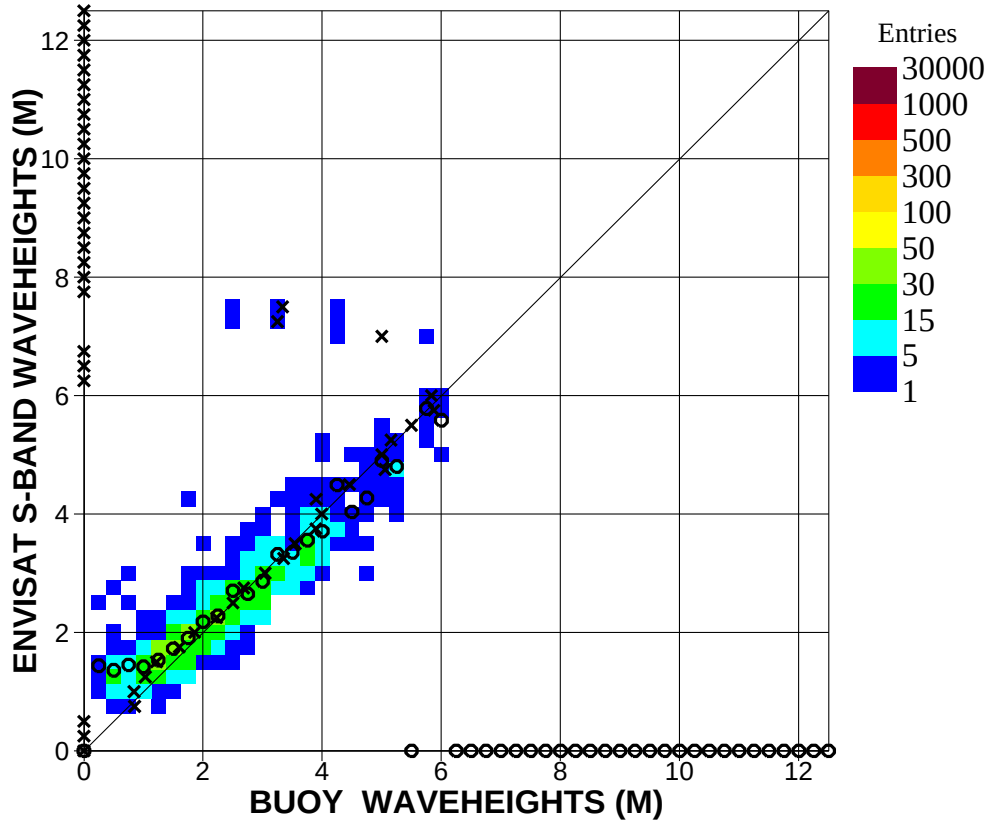

STATISTICS

ENTRIES	1206	
MEAN BUOY	2.3754	
MEAN ENVISAT	2.4921	
BIAS (ENVISAT - BUOY)	.1166	
STANDARD DEVIATION	.5992	
SCATTER INDEX	.2522	
CORRELATION	.8522	
SYMMETRIC SLOPE	1.0304	(.0157)
REGR. COEFFICIENT	.8036	(.0142)
REGR. CONSTANT	.5831	(.0374)

Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2004 (N.Hem.)

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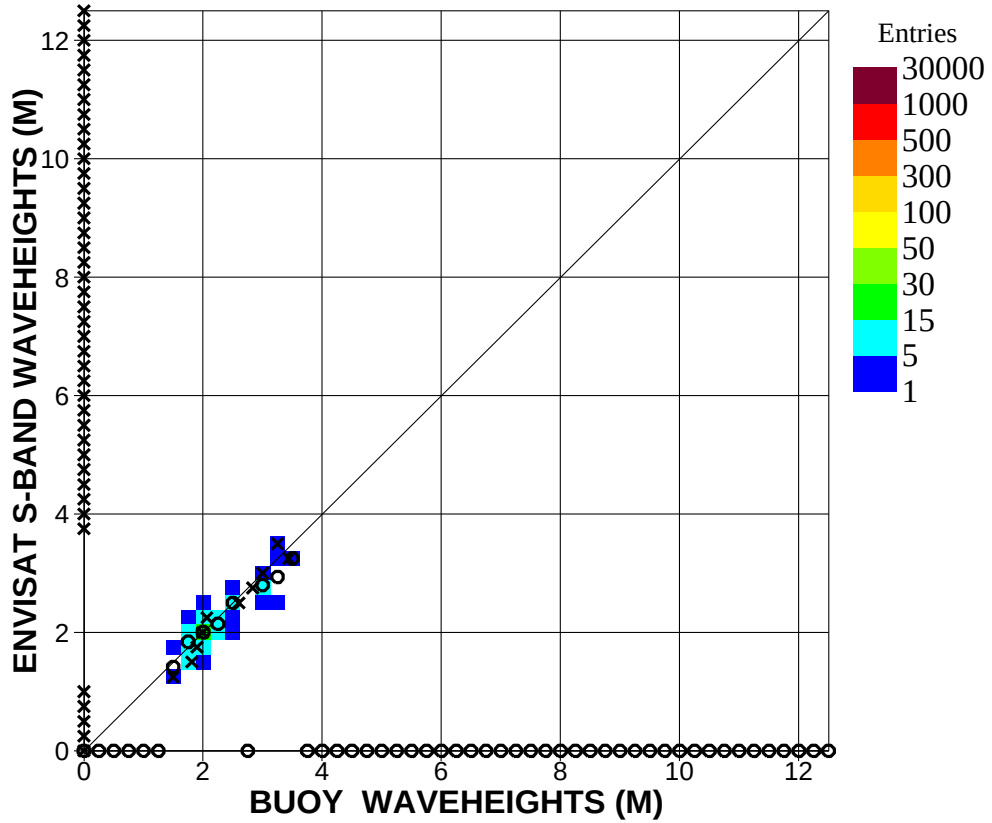

STATISTICS

ENTRIES	114	
MEAN BUOY	2.1744	
MEAN ENVISAT	2.1472	
BIAS (ENVISAT - BUOY)	-.0272	
STANDARD DEVIATION	.2343	
SCATTER INDEX	.1078	
CORRELATION	.8627	
SYMMETRIC SLOPE	.9861	(.0481)
REGR. COEFFICIENT	.8227	(.0456)
REGR. CONSTANT	.3583	(.1012)

Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2004 (Tropics)

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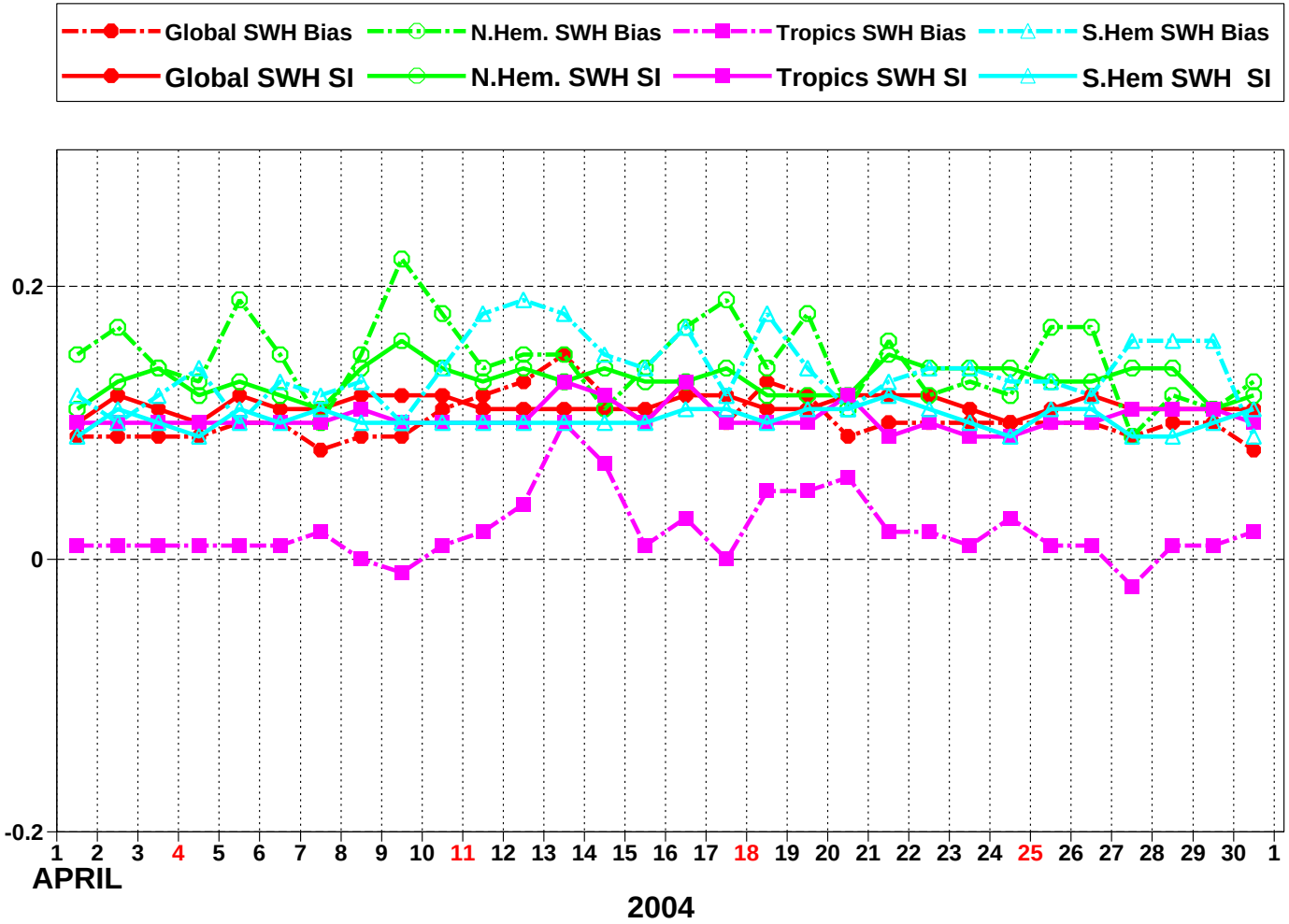

Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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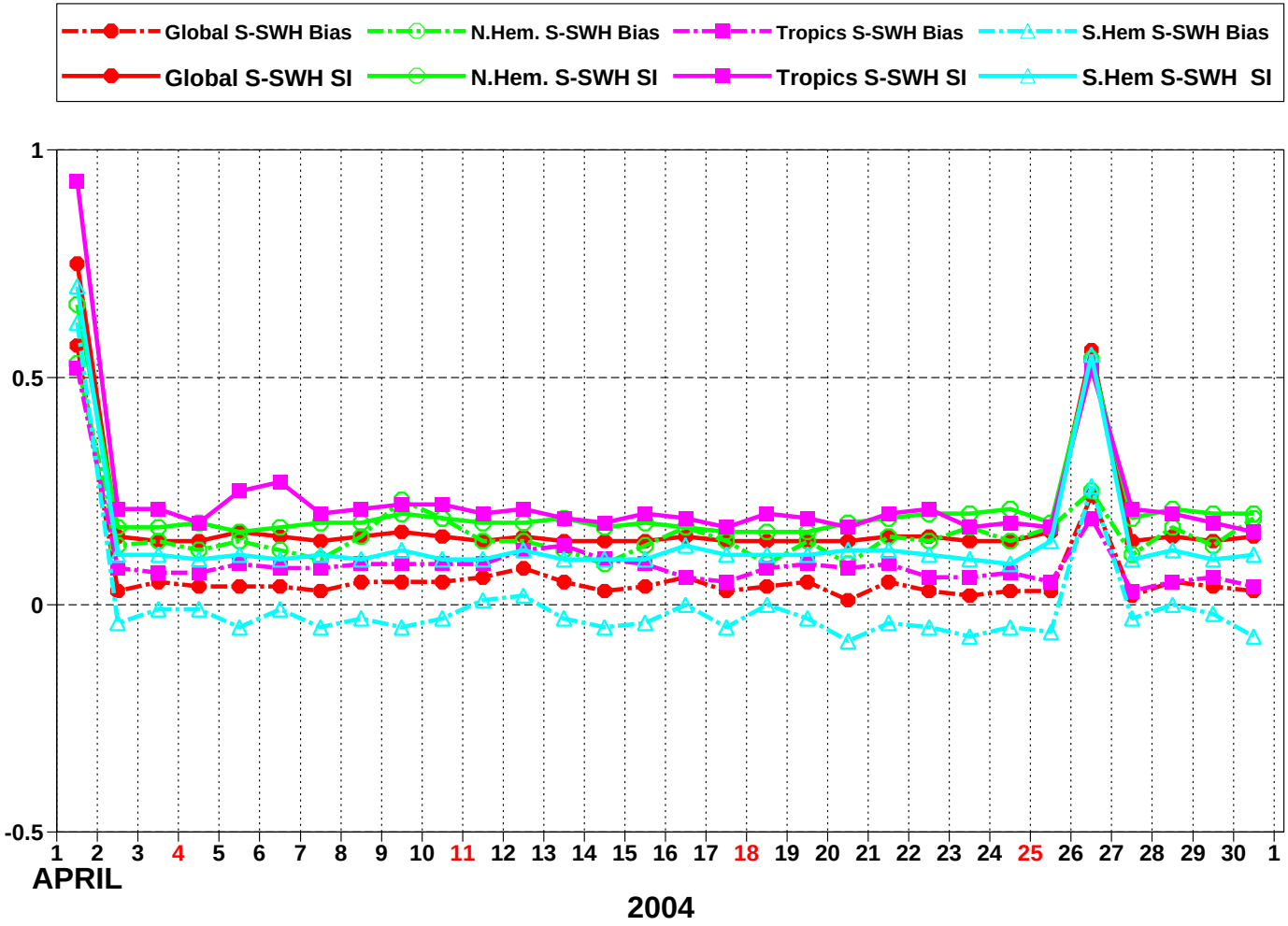

Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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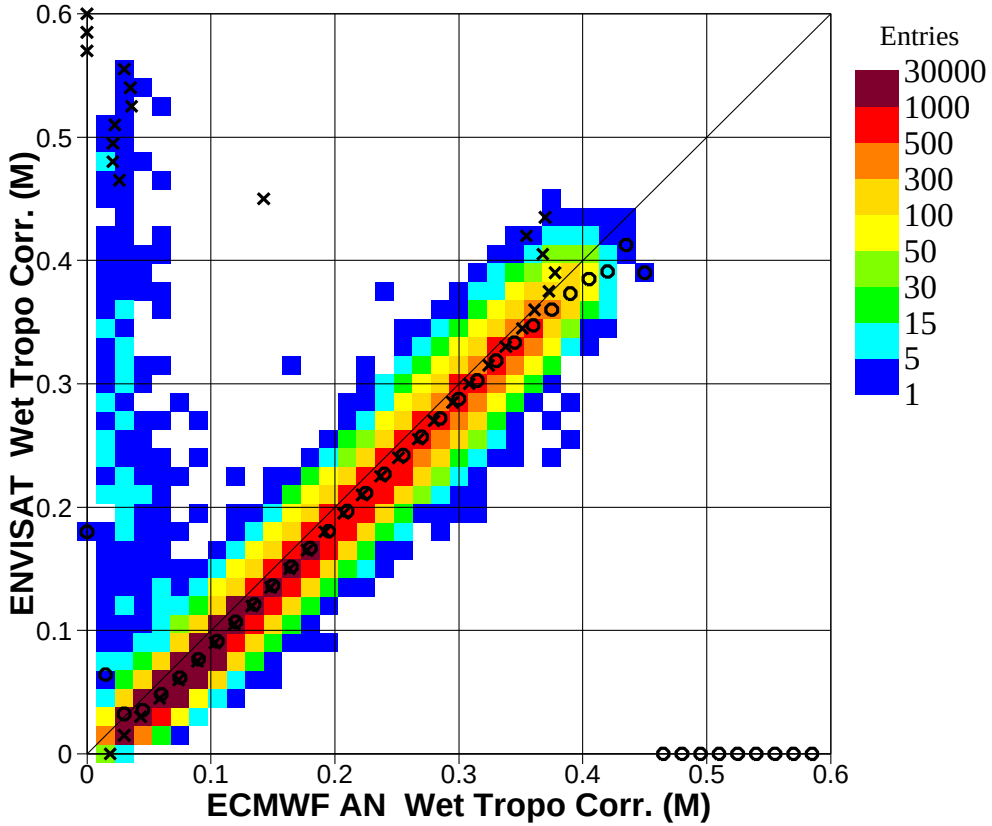

STATISTICS

ENTRIES	80318
MEAN ECMWF	.1619
MEAN ENVISAT	.1502
BIAS (ENVISAT - ECMWF)	-.0117
STANDARD DEVIATION	.0229
SCATTER INDEX	.1412
CORRELATION	.9740
SYMMETRIC SLOPE	.9506 (.0008)
REGR. COEFFICIENT	.9822 (.0008)
REGR. CONSTANT	-.0088 (.0002)

Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2004 (Global)

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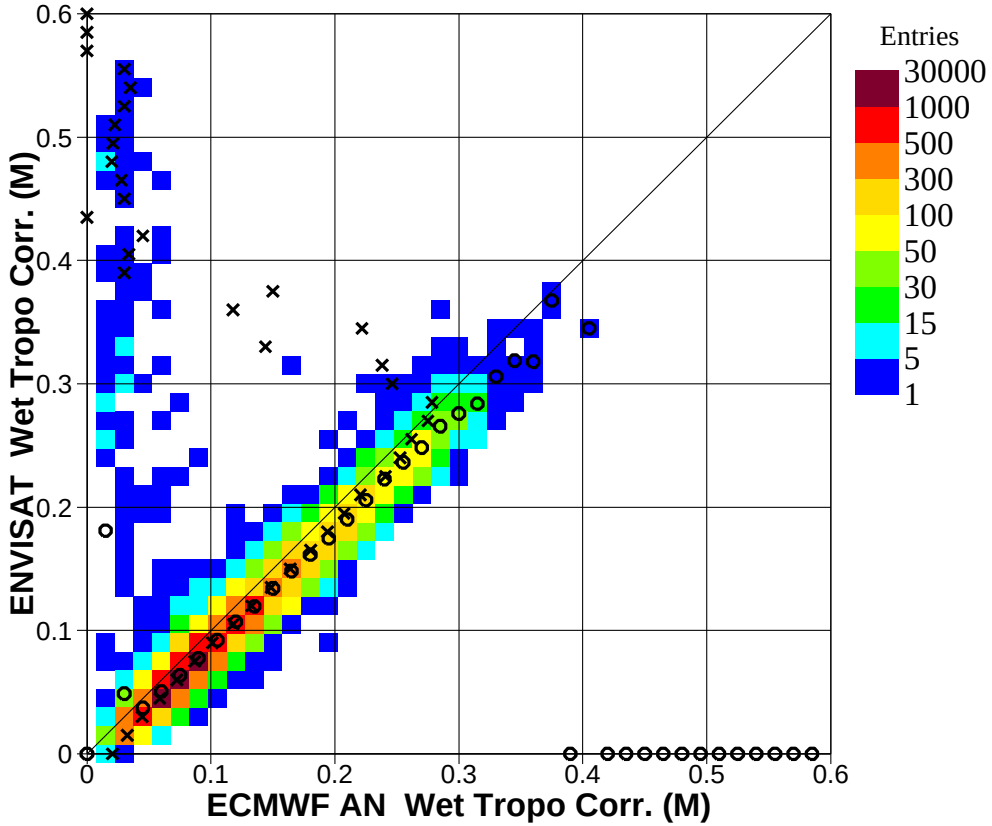

STATISTICS

ENTRIES	17971
MEAN ECMWF	.1110
MEAN ENVISAT	.0999
BIAS (ENVISAT - ECMWF)	-.0111
STANDARD DEVIATION	.0317
SCATTER INDEX	.2859
CORRELATION	.8640
SYMMETRIC SLOPE	.9317 (.0039)
REGR. COEFFICIENT	.8931 (.0039)
REGR. CONSTANT	.0008 (.0005)

Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2004 (N.Hem.)

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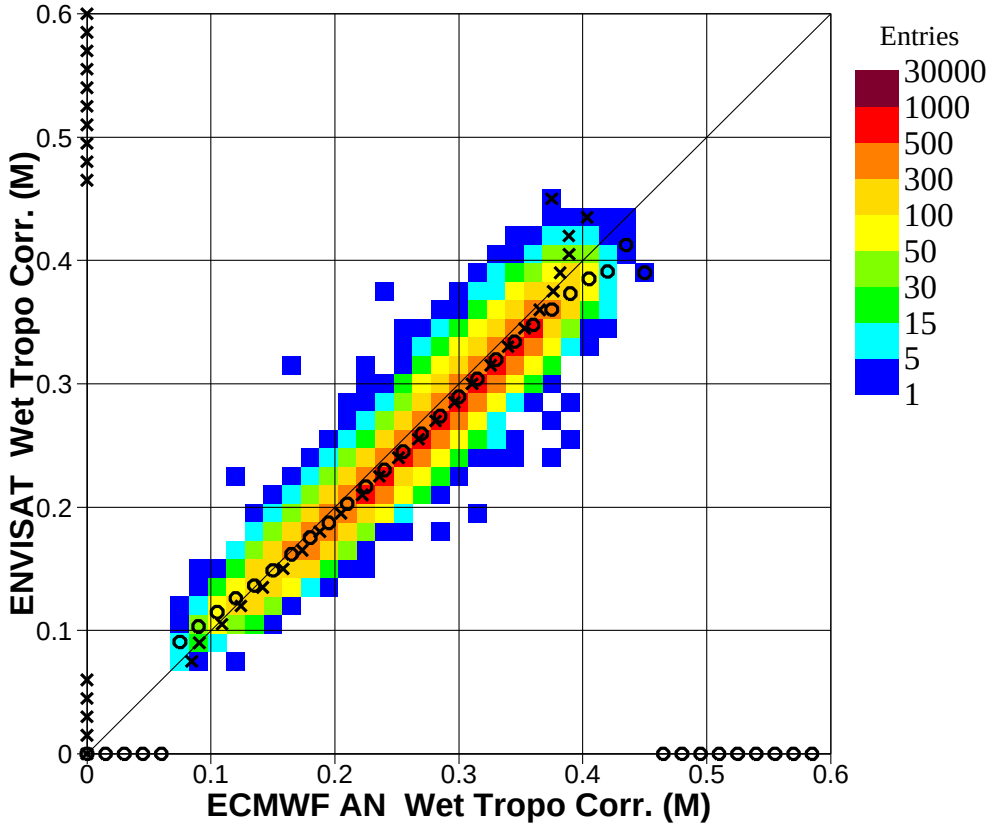

STATISTICS

ENTRIES	25229
MEAN ECMWF	.2715
MEAN ENVISAT	.2623
BIAS (ENVISAT - ECMWF)	-.0093
STANDARD DEVIATION	.0176
SCATTER INDEX	.0649
CORRELATION	.9684
SYMMETRIC SLOPE	.9667 (.0015)
REGR. COEFFICIENT	.9482 (.0015)
REGR. CONSTANT	.0048 (.0004)

Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2004 (Tropics)

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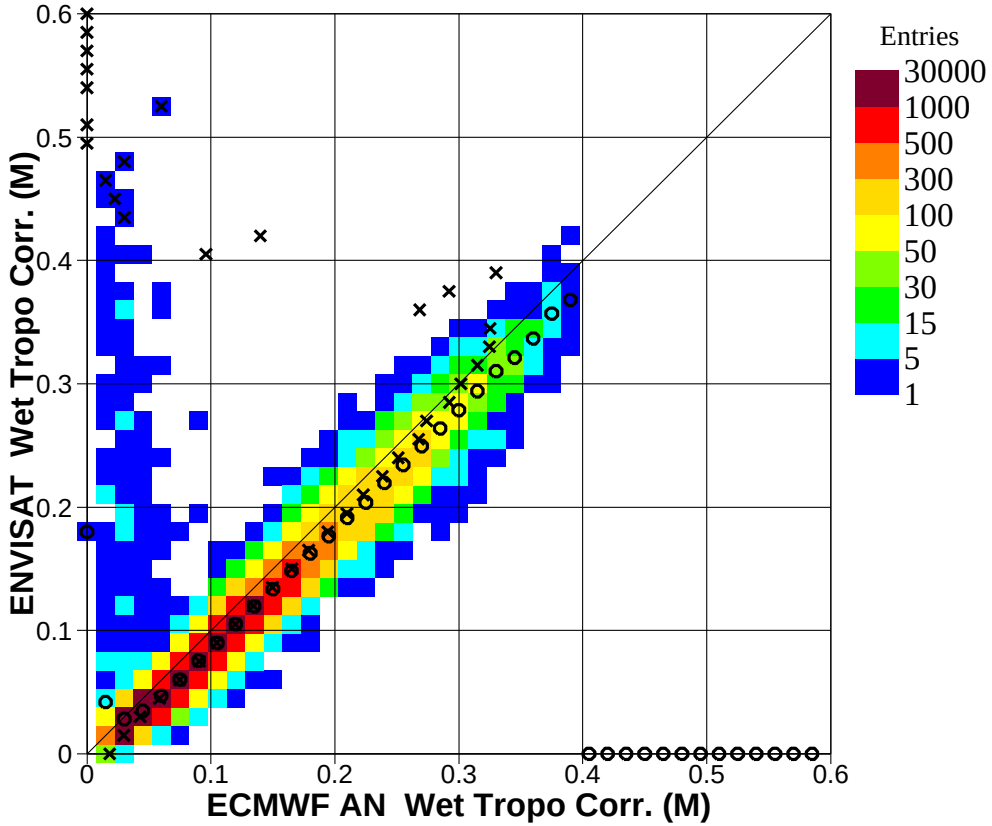

STATISTICS

ENTRIES	37712
MEAN ECMWF	.1135
MEAN ENVISAT	.0999
BIAS (ENVISAT - ECMWF)	-.0136
STANDARD DEVIATION	.0206
SCATTER INDEX	.1815
CORRELATION	.9542
SYMMETRIC SLOPE	.9092 (.0015)
REGR. COEFFICIENT	.9395 (.0015)
REGR. CONSTANT	-.0067 (.0002)

Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2004 (S.Hem.)

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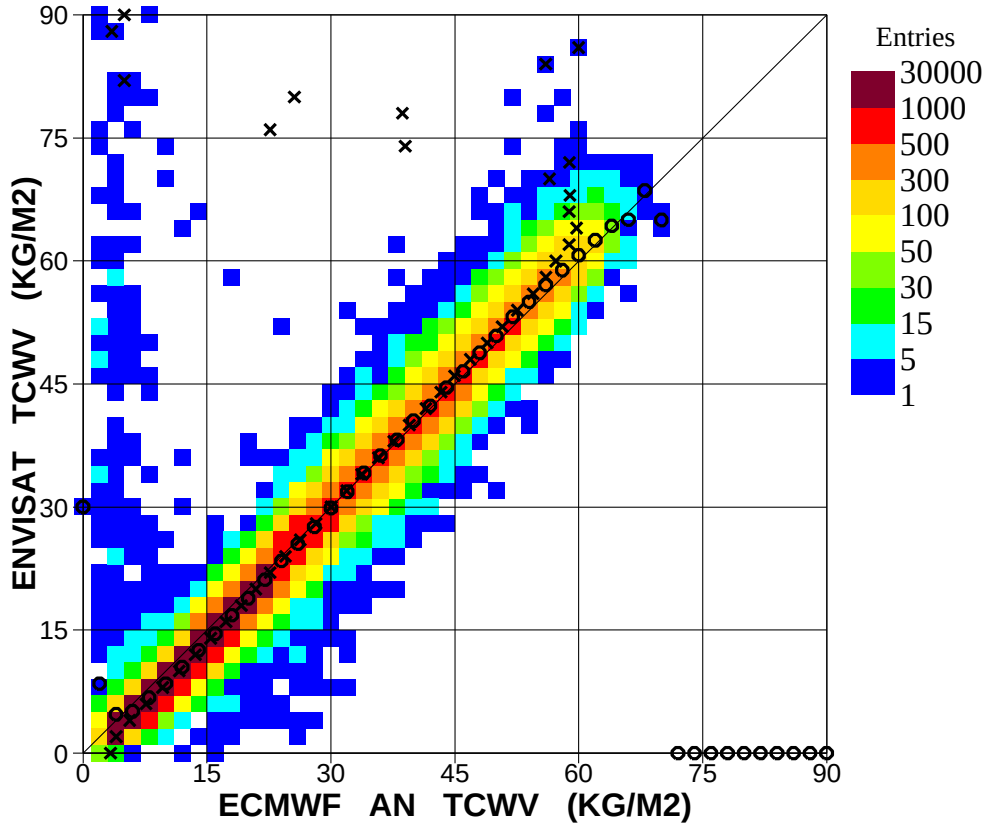

STATISTICS

ENTRIES	80251
MEAN ECMWF	24.8726
MEAN ENVISAT	24.4292
BIAS (ENVISAT - ECMWF)	-.4435
STANDARD DEVIATION	3.7947
SCATTER INDEX	.1526
CORRELATION	.9755
SYMMETRIC SLOPE	1.0079 (.0008)
REGR. COEFFICIENT	1.0419 (.0008)
REGR. CONSTANT	-1.4858 (.0245)

Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2004 (Global)

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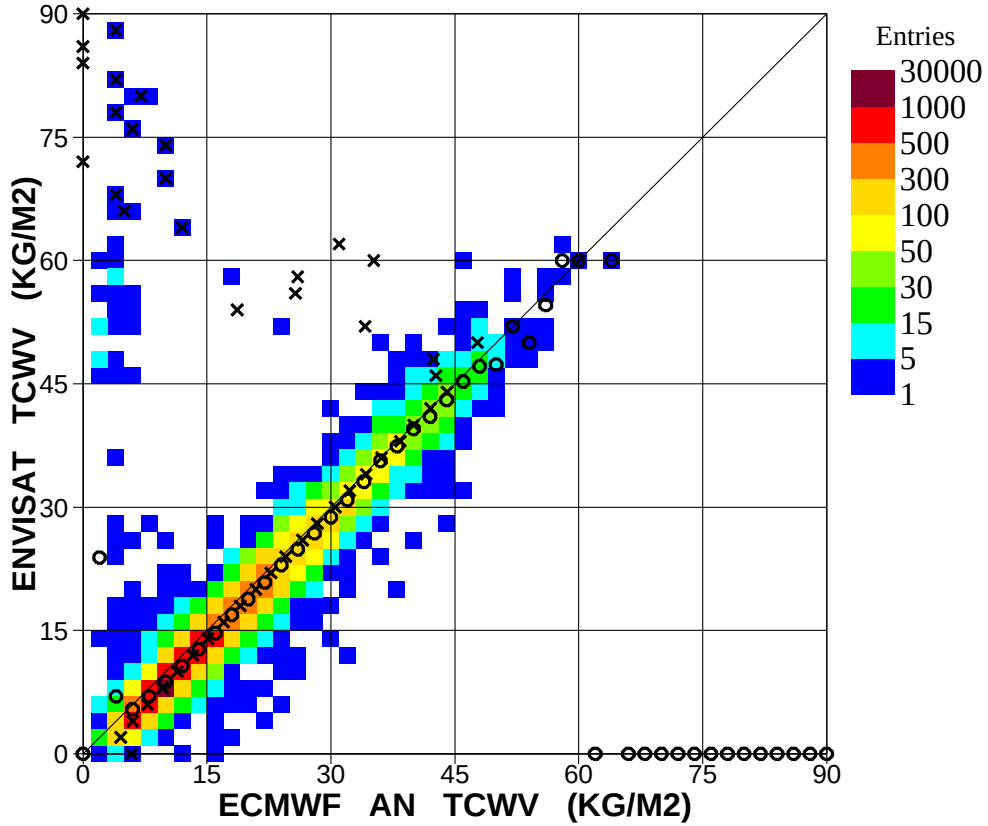

STATISTICS

ENTRIES	17923
MEAN ECMWF	16.7523
MEAN ENVISAT	15.8224
BIAS (ENVISAT - ECMWF)	-.9299
STANDARD DEVIATION	4.7667
SCATTER INDEX	.2845
CORRELATION	.8868
SYMMETRIC SLOPE	.9842 (.0038)
REGR. COEFFICIENT	.9771 (.0038)
REGR. CONSTANT	-.5469 (.0730)

Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2004 (N.Hem.)

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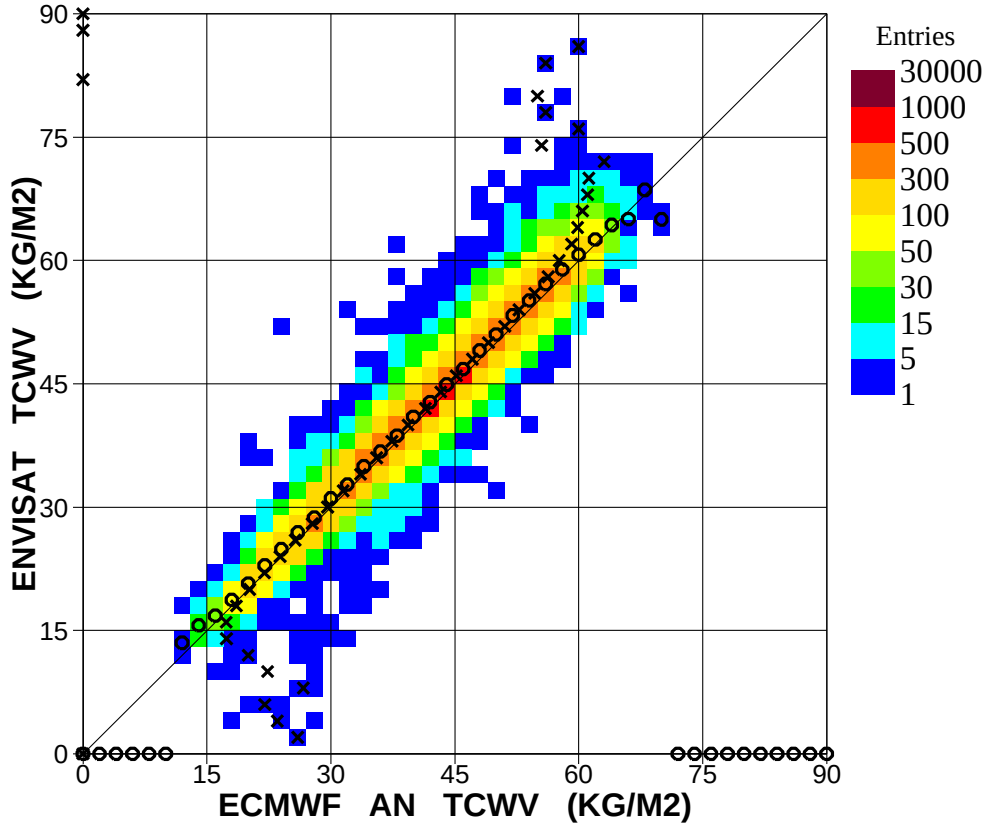

STATISTICS

ENTRIES	25229
MEAN ECMWF	42.4642
MEAN ENVISAT	43.3718
BIAS (ENVISAT - ECMWF)	.9076
STANDARD DEVIATION	2.8697
SCATTER INDEX	.0676
CORRELATION	.9696
SYMMETRIC SLOPE	1.0225 (.0016)
REGR. COEFFICIENT	1.0072 (.0016)
REGR. CONSTANT	.6036 (.0703)

Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2004 (Tropics)

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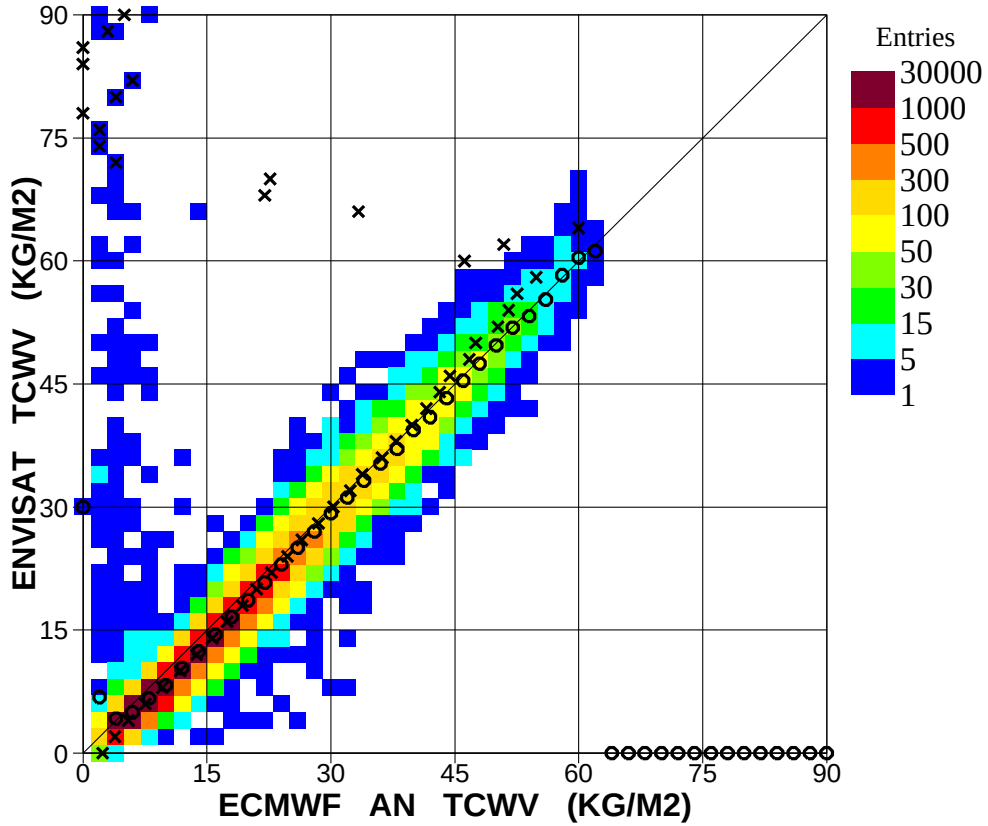

STATISTICS

ENTRIES	37693
MEAN ECMWF	17.0757
MEAN ENVISAT	15.9751
BIAS (ENVISAT - ECMWF)	-1.1006
STANDARD DEVIATION	3.5709
SCATTER INDEX	.2091
CORRELATION	.9492
SYMMETRIC SLOPE	.9709 (.0017)
REGR. COEFFICIENT	1.0013 (.0017)
REGR. CONSTANT	-1.1223 (.0345)

Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2004 (S.Hem.)

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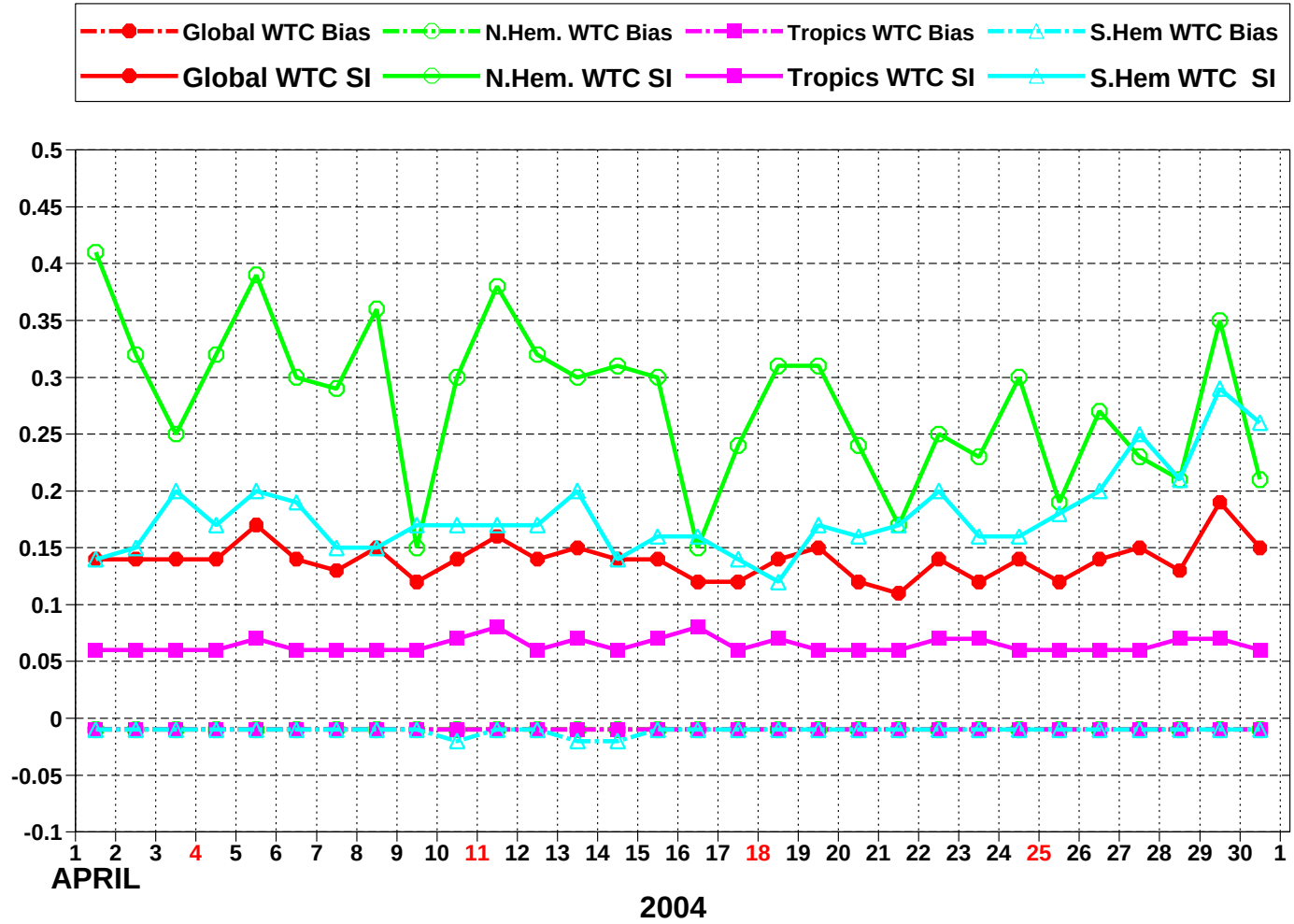

Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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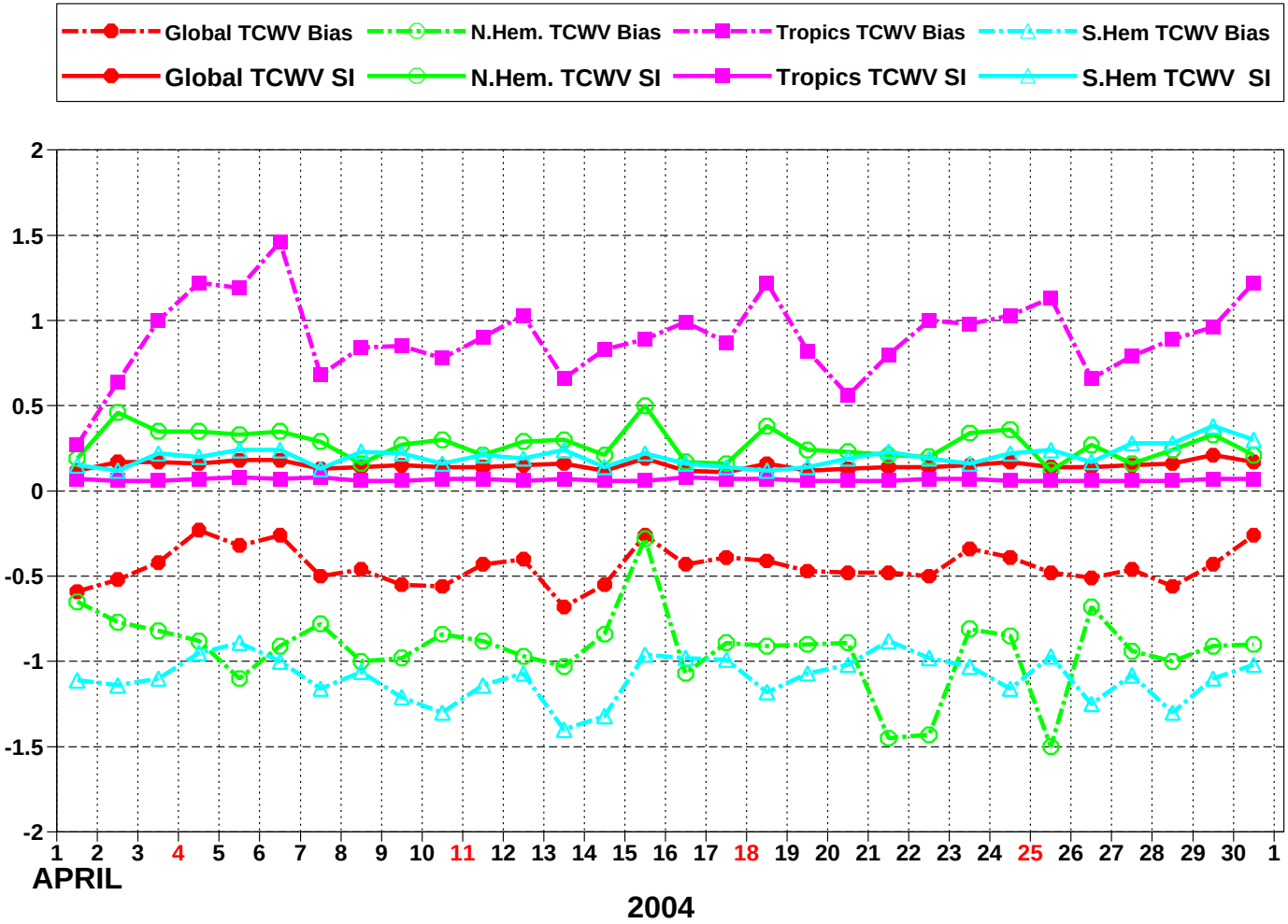

Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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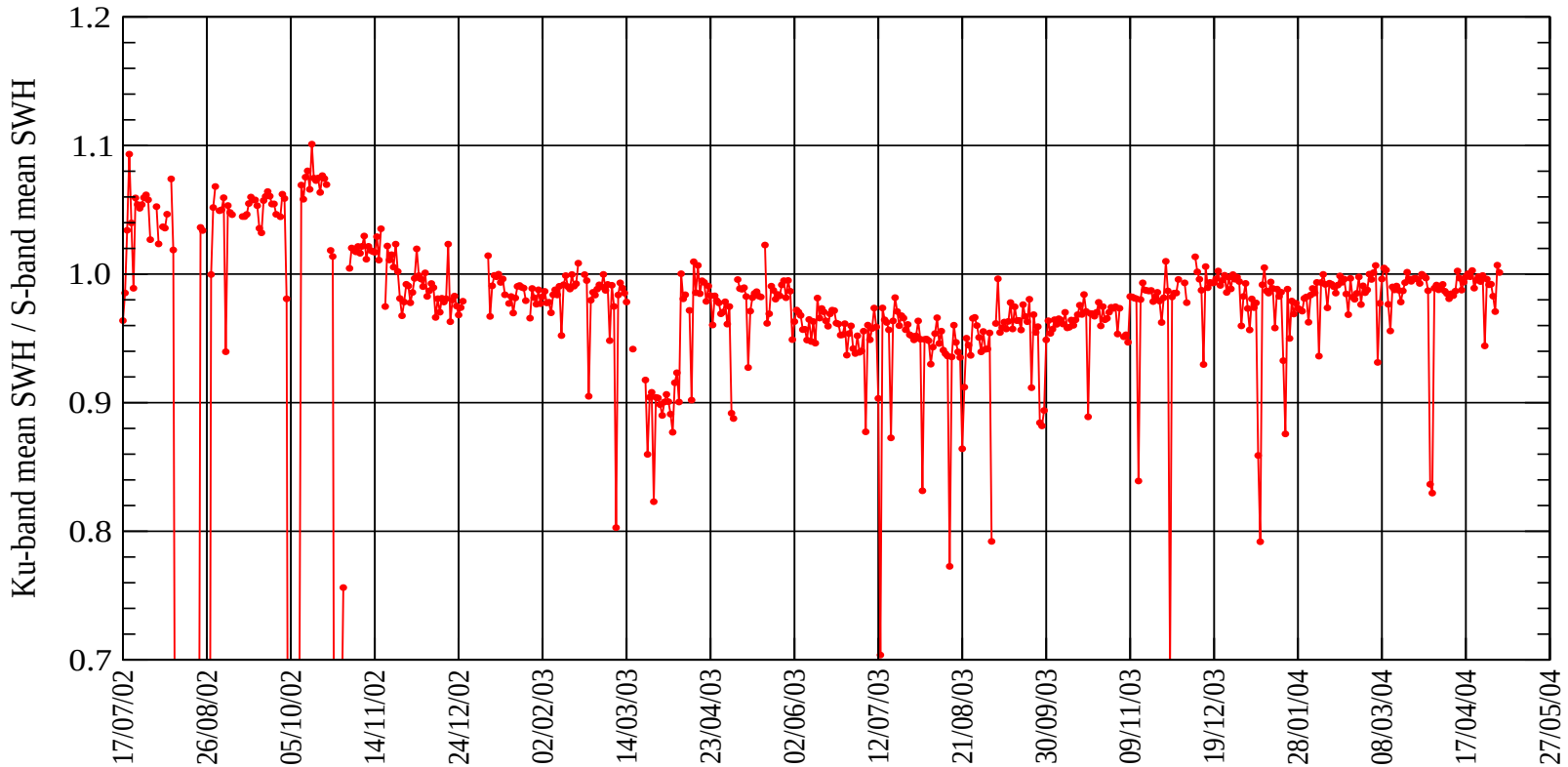

Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 18th. of July 2002.

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