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

Wind/Wave Product with Height Information (RA2_WWV_2P)

By: *Saleh Abdalla*

Date: *18 August 2005*

Overview:

Based on the data received during this month, on average, 16239 observations arrived at ECMWF every 6-hour window of which an average of 6710 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 76.31% of the remaining part passed the quality control. There was no data during the following periods (in terms of 6-hour time-windows; all times are in UTC) as can be seen in Figure 1:

- Time windows centred at 00:00 and 06:00 on the 4th. of the month.
- Time windows centred at 06:00, 12:00 and 18:00 on the 10th. of the month.
- Time windows centred at 06:00 on the 29th. of the month.

On the other hand, there was significant reduction in data volume during the following periods:

- Time window centred at 00:00 on: the 10th. of the month.
- Time windows centred at 06:00 on: the 3rd., the 6th., the 11th., the 12th., the 13th. and the 16th. of the month.

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- Time windows centred at 12:00 on: the 4th. and the 27th. of the month.
- Time windows centred at 18:00 on: the 3rd., the 9th., the 16th., the 17th. and the 27th. of the month.

Note that we are talking about the raw data which we downloaded in “bufr” format before they were processed.

It is worthwhile mentioning that most of the data gaps/reductions during the day (especially at time window 06:00 UTC) are due to the unavailability of the ftp server at Kiruna. Sometimes the server is unavailable for extended periods that the “delay cut-off” operational suite (more than 12-hour delay) is not able to receive the data in time for processing.

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 small number of outliers. The quality of wind speed observations is good. Apart from a number of outliers (which seem to be due ice contamination and should be rejected), the 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 $<\sigma_0>$ = 11.17 dB (with one main peak at 11.1 dB with a tendency to have several secondary peaks).
- ENVISAT RA-2 S-Band $<\sigma_0>$ = 11.51 dB (with a single main peak at ~ 10.6 dB with a tendency to have several secondary peaks).

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Comparison Summary:

Table 1: Comparison of Surface Wind Speeds:

	RA2 - ECMWF		RA2 - Buoy	
	Bias (m/s)	SI (%)	Bias (m/s)	SI (%)
Global	- 0.30	17.0	- 1.15	18.6
Northern Hemisphere	- 0.86	19.1	- 1.18	20.5
Tropics	- 0.39	15.8	- 1.04	12.6
Southern Hemisphere	+ 0.15	14.8	----	----

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

	RA2 (Ku) - WAM		RA2 (Ku) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.11	10.9	0.12	16.7
Northern Hemisphere	0.10	14.3	0.13	18.1
Tropics	0.09	10.2	0.07	9.7
Southern Hemisphere	0.13	9.6	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.12	30.2	0.30	35.0
Northern Hemisphere	0.32	51.9	0.33	35.9
Tropics	0.13	37.9	0.12	27.5
Southern Hemisphere	- 0.02	20.1	----	----

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	- 0.013	12.4	- 0.48	15.1
Northern Hemisphere	- 0.013	13.0	- 0.63	17.5
Tropics	- 0.013	6.1	+ 0.45	6.0
Southern Hemisphere	- 0.012	25.4	- 1.10	30.1

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ECMWF Report on ENVISAT RA-2 for July 2005

Remarks:

- There was no related ECMWF model changes this month (current operational cycle is CY29R2 since 28 June 2005).
- **It is worthwhile mentioning that most of the data gaps during the day are due to unavailability of the ftp server at Kiruna.**
- According to the used land sea mask (which is used for the operational WAM run at ECMWF), about one third of all processed data have been collected over land. This value is too large and is caused by not filtering the land records.
- The rain flag is only responsible for the rejection of 6% of the data this month. There were three major events of over-active rain flagging on the 11th.-12th., on the 26th.-27th. and on the 30th.-31st. 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), as usual.
- 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. Furthermore, the wind speed histogram of Figure 4 indicates that wind speeds around and below 1 m/s may not be optimal.
- 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. On the other hand, the RA-2 Ku-band wave heights are about 5.5% higher than buoy wave heights as can be seen in Figures 30-32 (Ku-band - buoy comparison).
- 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 well-known *RA-2 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). Most of those outliers occurred on the 11th.-12th., the 26th. and the 30th. of the month (Figure 37) coinciding with the significant over-active rain flagging events.

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- The S-band wave height product is worse than last month as compared with the model. However, it is better when compared with the wave buoy.
- The ratio between Ku-band and S-band wave heights this month changed between 0.92 and 0.98 with three dips coinciding with the extreme RA-2 S-band anomaly events as can be seen in Figure 48. Furthermore, there is a tendency for a seasonal variation for this ratio as lower values (~0.92-0.94) reached during June and July (similar to what happened during the same period in the last two years). The general reduction of the ratio during late April to late September of last two years seems to be repeated this year.
- 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). The number of outliers is less than last month. It seems that these outliers are due to sea-ice contamination. This issue will be treated soon.
- While the MWR derived TCWV is now in good agreement with the model counterpart (MWR TCWV is slightly smaller than the model), 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 RA-2 Ku-band wave height data and ERS-2 SAR wave data are assimilated in the ECMWF wave model.
- 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 (in addition to the eastern coast of China since late June 2005 and the Southern Ocean since early July 2005) 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.

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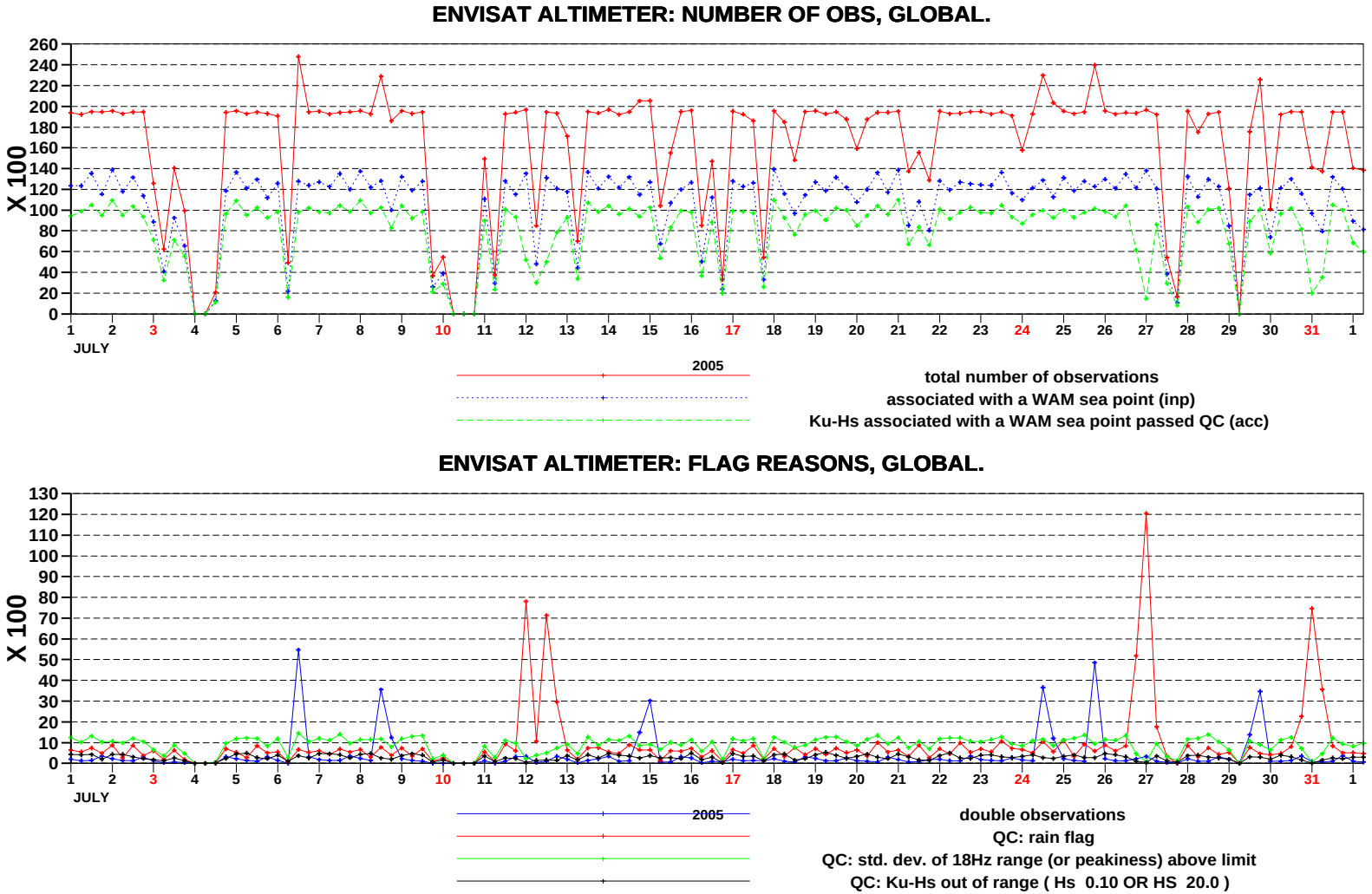

Figure 1: Time series of data reception for ENVISAT Altimeter data for July 2005

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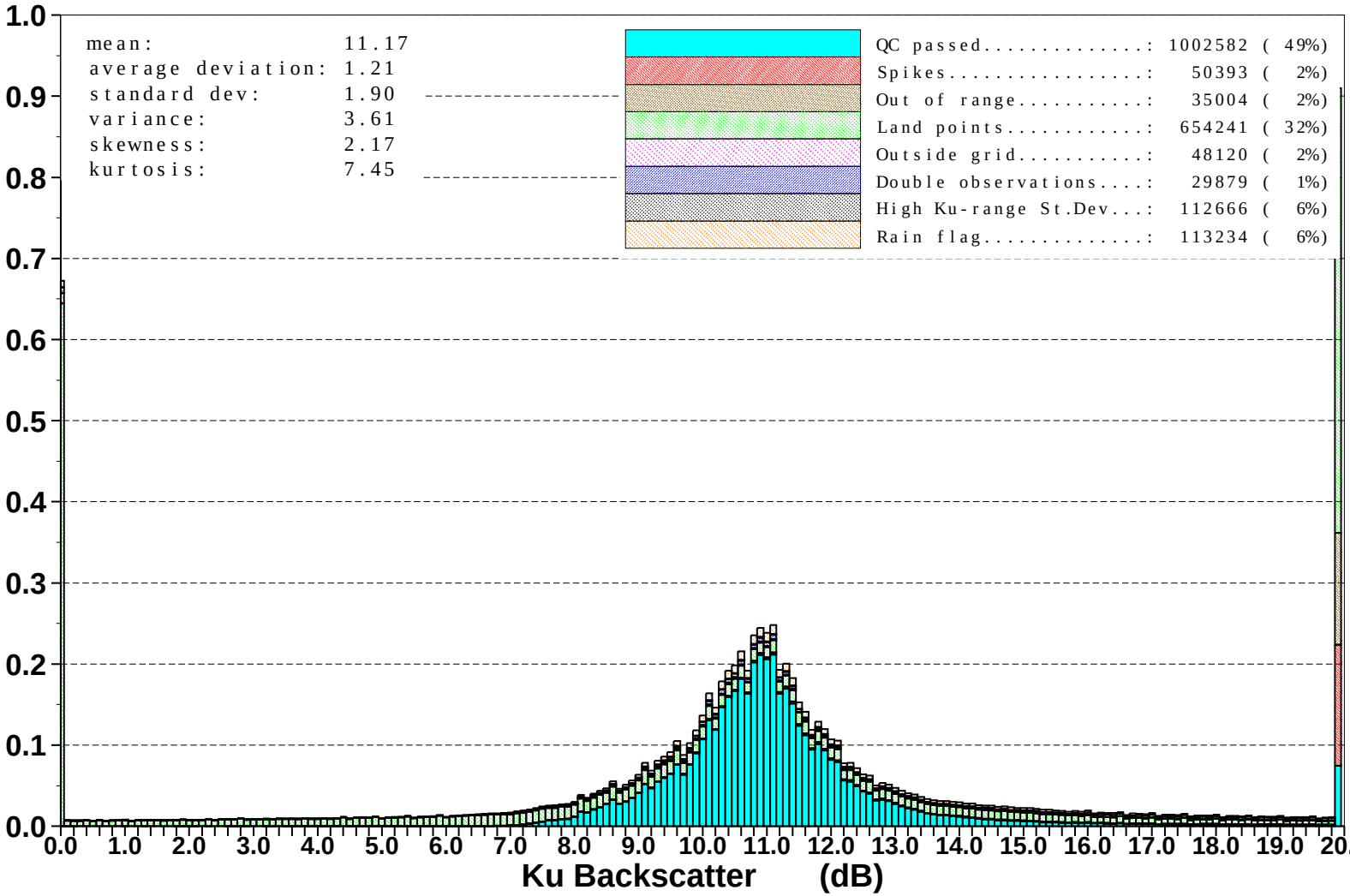

Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for July 2005

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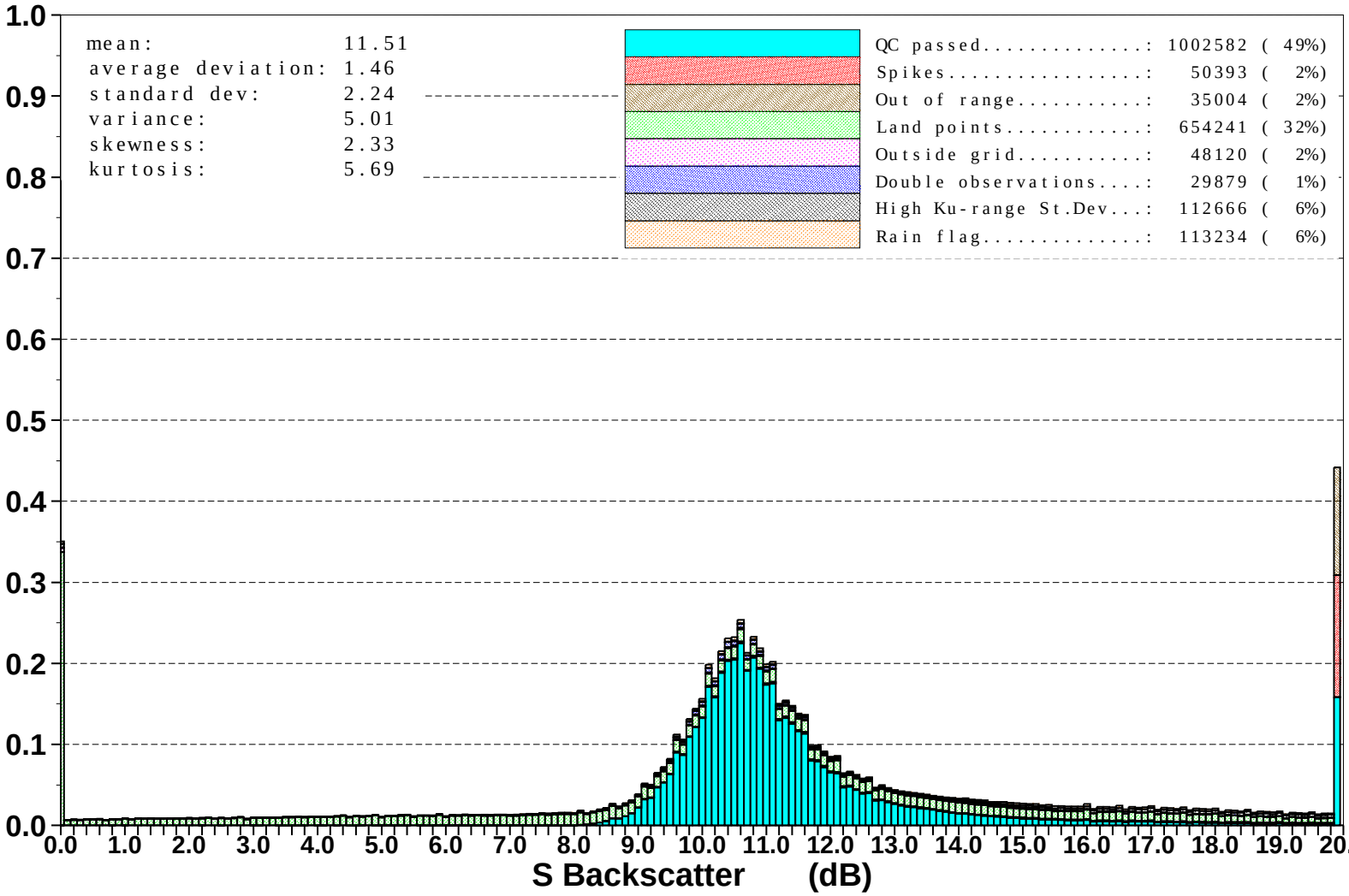

Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for July 2005

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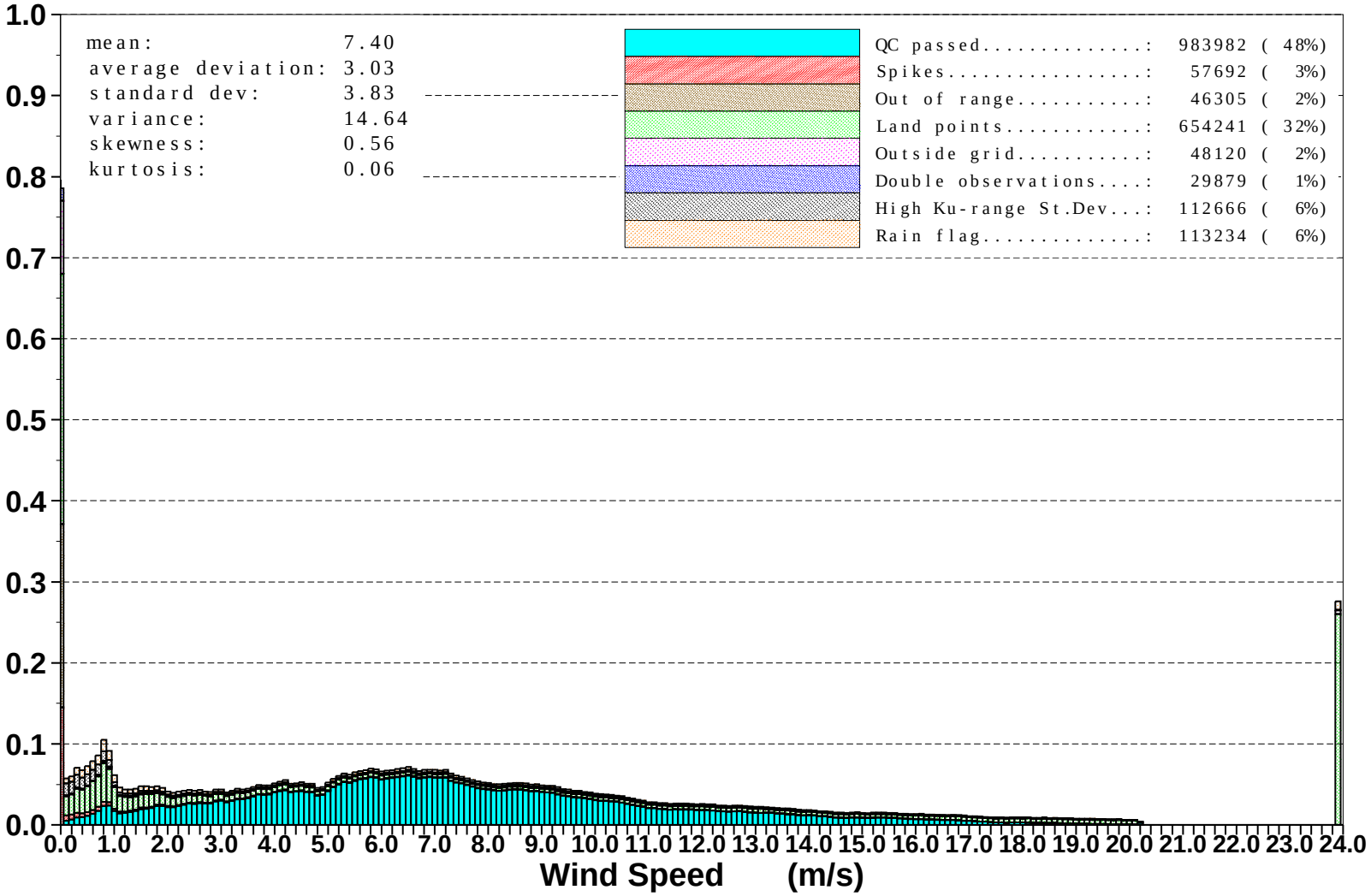

Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for July 2005

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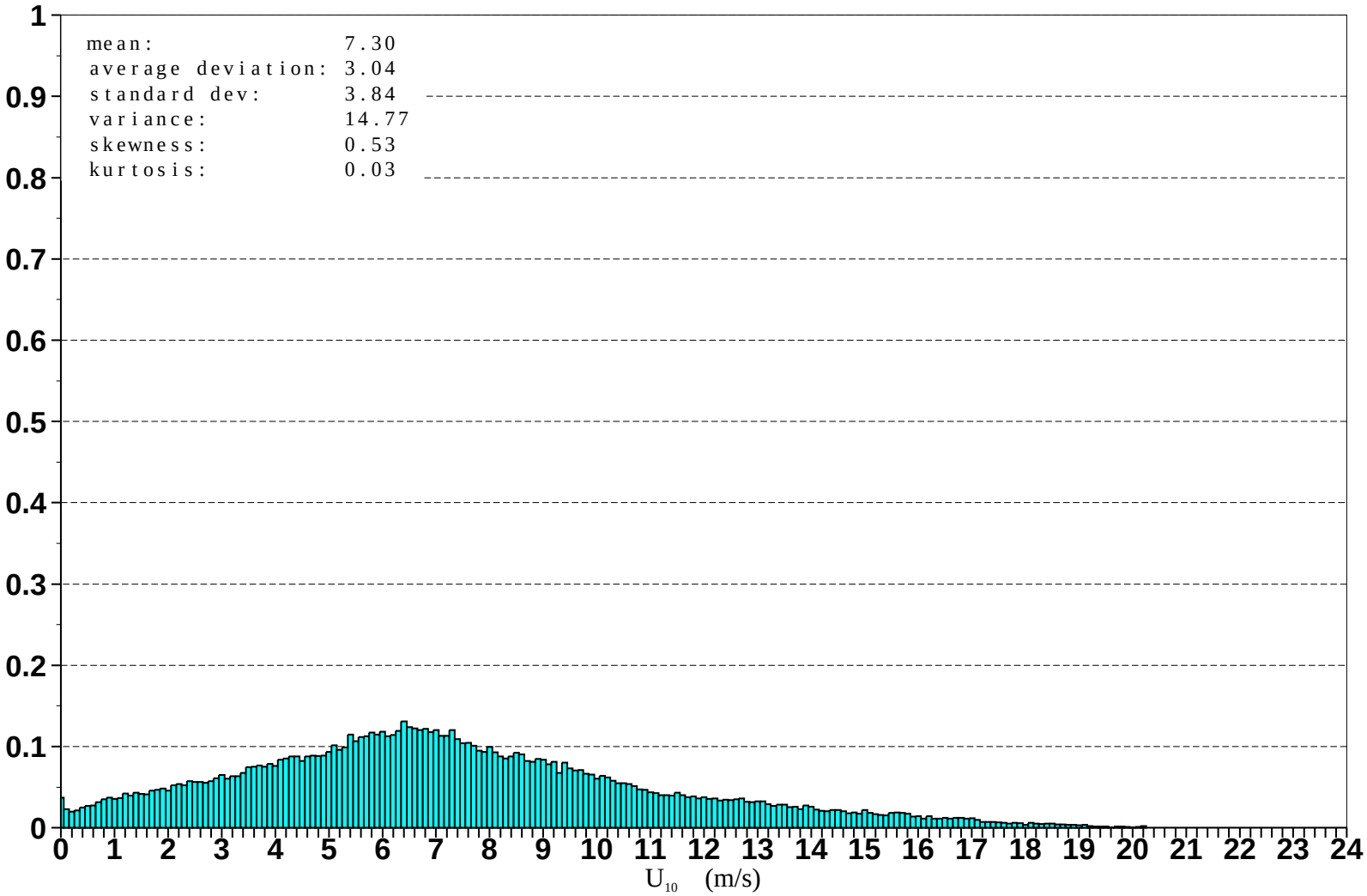

Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for July 2005

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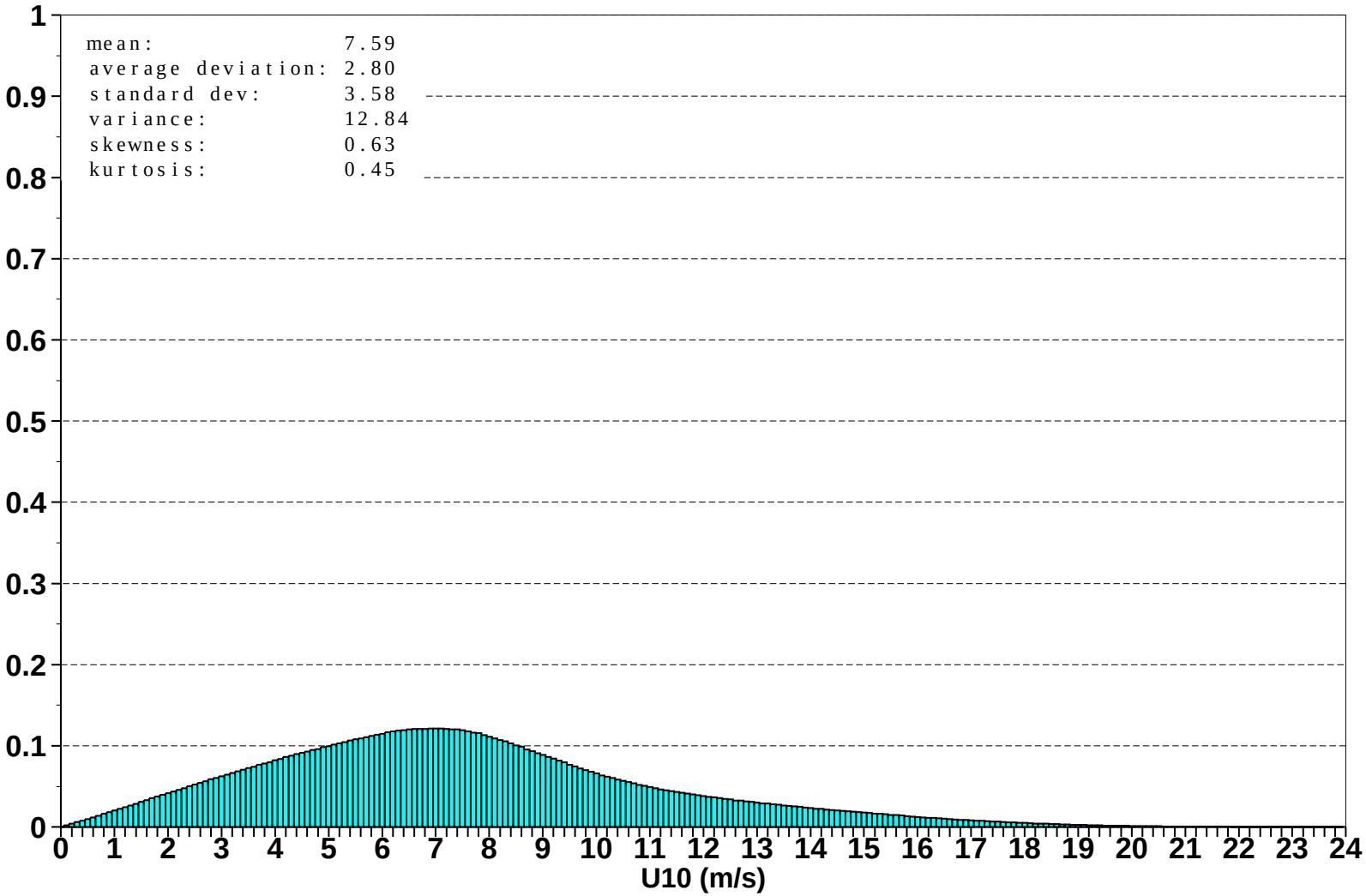

Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for July 2005

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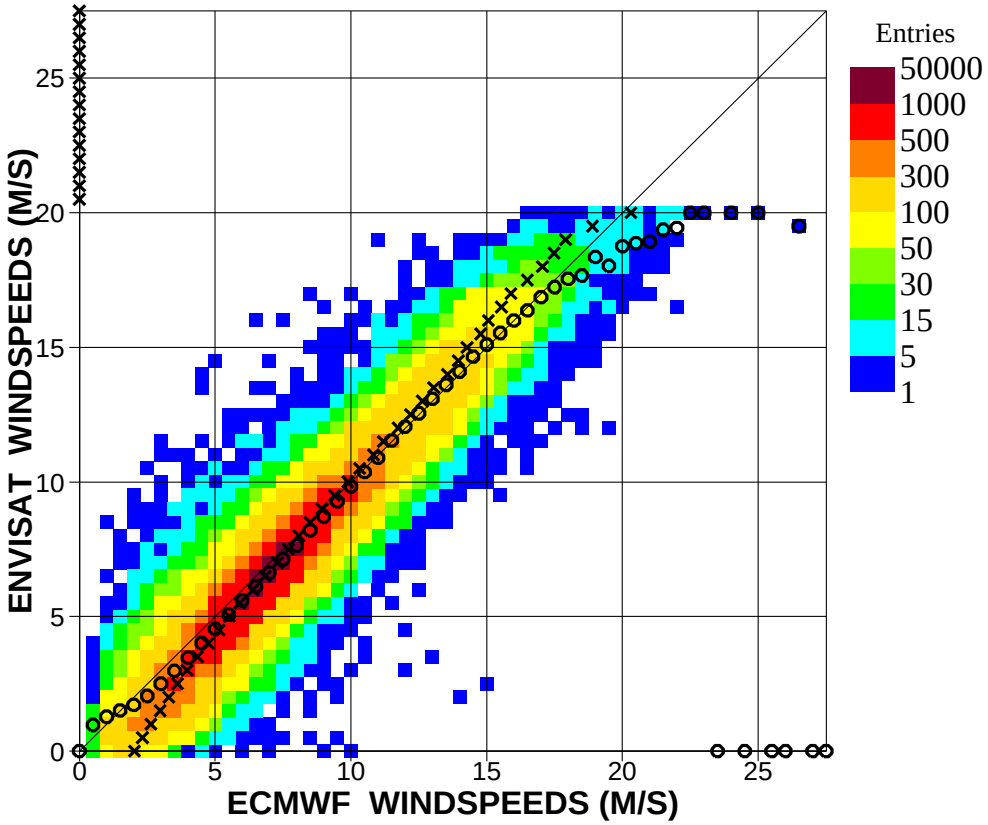

STATISTICS

ENTRIES	90492
MEAN ECMWF	7.6180
MEAN ENVISAT	7.3183
BIAS (ENVISAT - ECMWF)	-.2997
STANDARD DEVIATION	1.2973
SCATTER INDEX	.1703
CORRELATION	.9415
SYMMETRIC SLOPE	.9865 (.0013)
REGR. COEFFICIENT	1.0377 (.0012)
REGR. CONSTANT	-.5870 (.0103)

Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2005 (Global)

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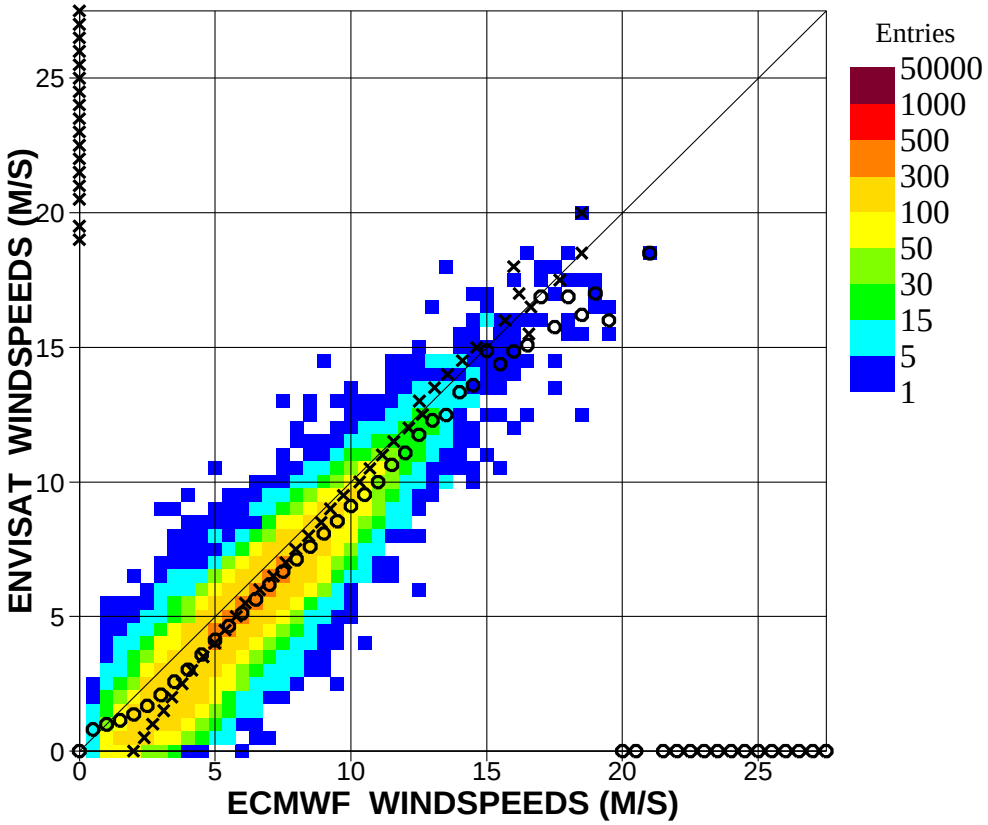

STATISTICS

ENTRIES	24995
MEAN ECMWF	6.0353
MEAN ENVISAT	5.1721
BIAS (ENVISAT - ECMWF)	-.8632
STANDARD DEVIATION	1.1538
SCATTER INDEX	.1912
CORRELATION	.9109
SYMMETRIC SLOPE	.8951 (.0029)
REGR. COEFFICIENT	.9830 (.0028)
REGR. CONSTANT	-.7606 (.0185)

Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2005 (N.Hem.)

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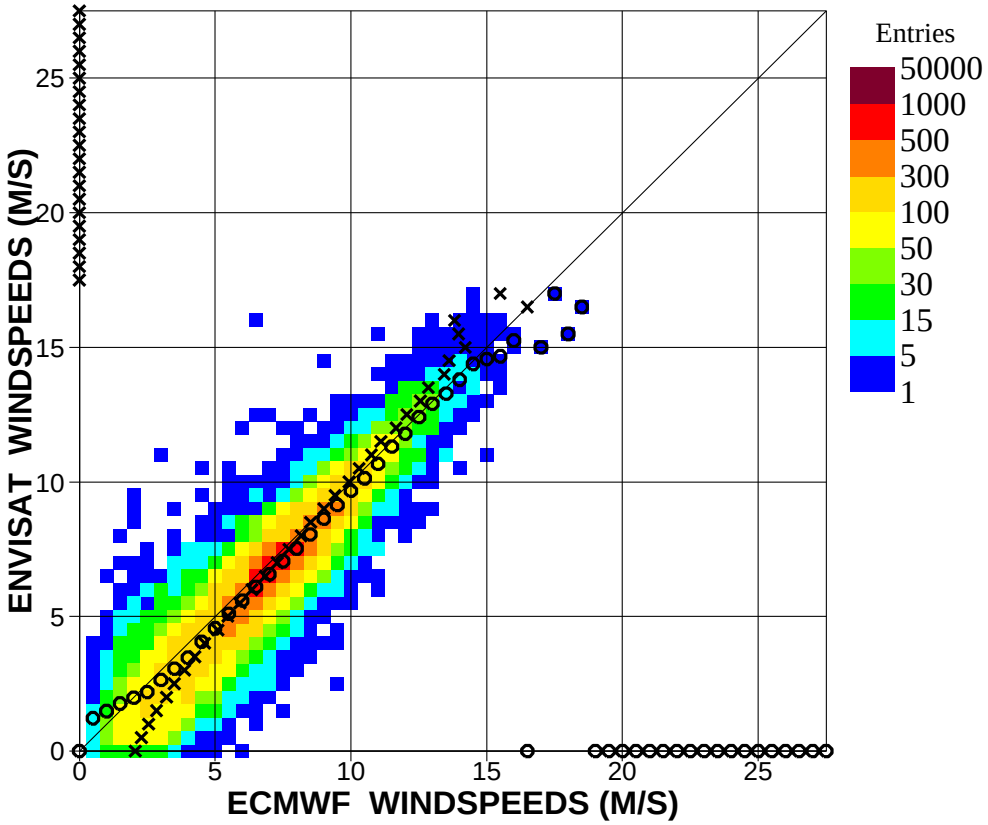

STATISTICS

ENTRIES	28921
MEAN ECMWF	6.7034
MEAN ENVISAT	6.3166
BIAS (ENVISAT - ECMWF)	-.3868
STANDARD DEVIATION	1.0578
SCATTER INDEX	.1578
CORRELATION	.9162
SYMMETRIC SLOPE	.9600 (.0026)
REGR. COEFFICIENT	.9943 (.0026)
REGR. CONSTANT	-.3485 (.0182)

Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2005 (Tropics)

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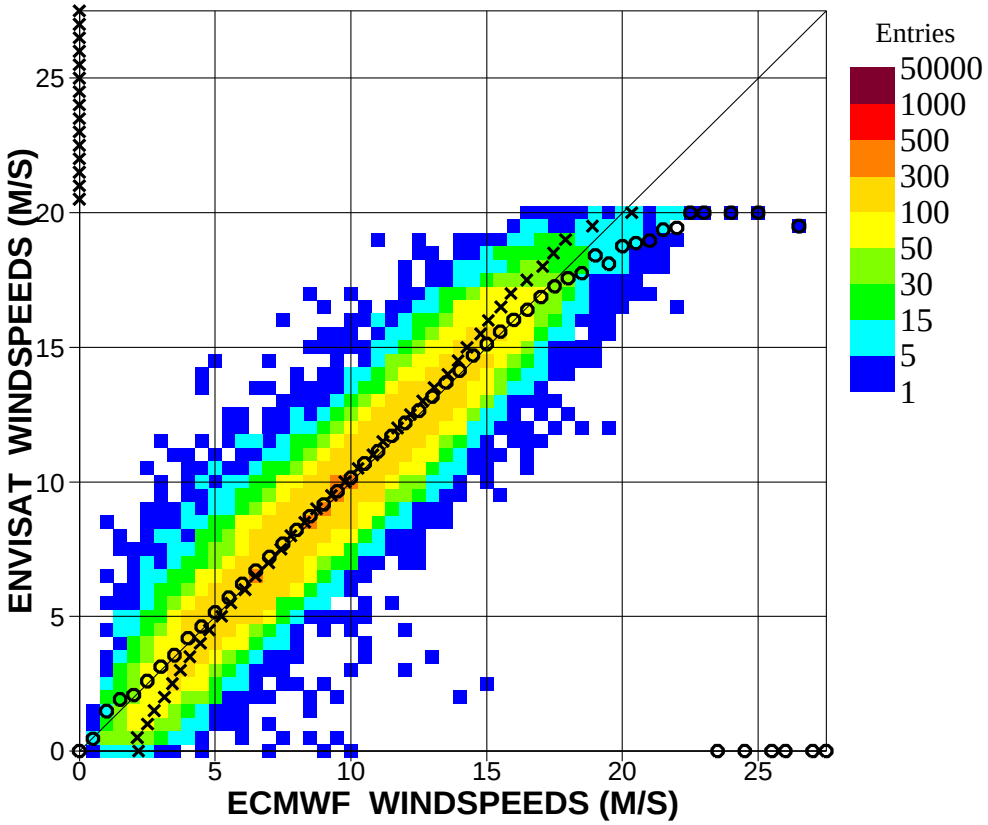

STATISTICS

ENTRIES	37284
MEAN ECMWF	9.3723
MEAN ENVISAT	9.5183
BIAS (ENVISAT - ECMWF)	.1459
STANDARD DEVIATION	1.3891
SCATTER INDEX	.1482
CORRELATION	.9396
SYMMETRIC SLOPE	1.0203 (.0019)
REGR. COEFFICIENT	.9846 (.0019)
REGR. CONSTANT	.2899 (.0188)

Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2005 (S.Hem.)

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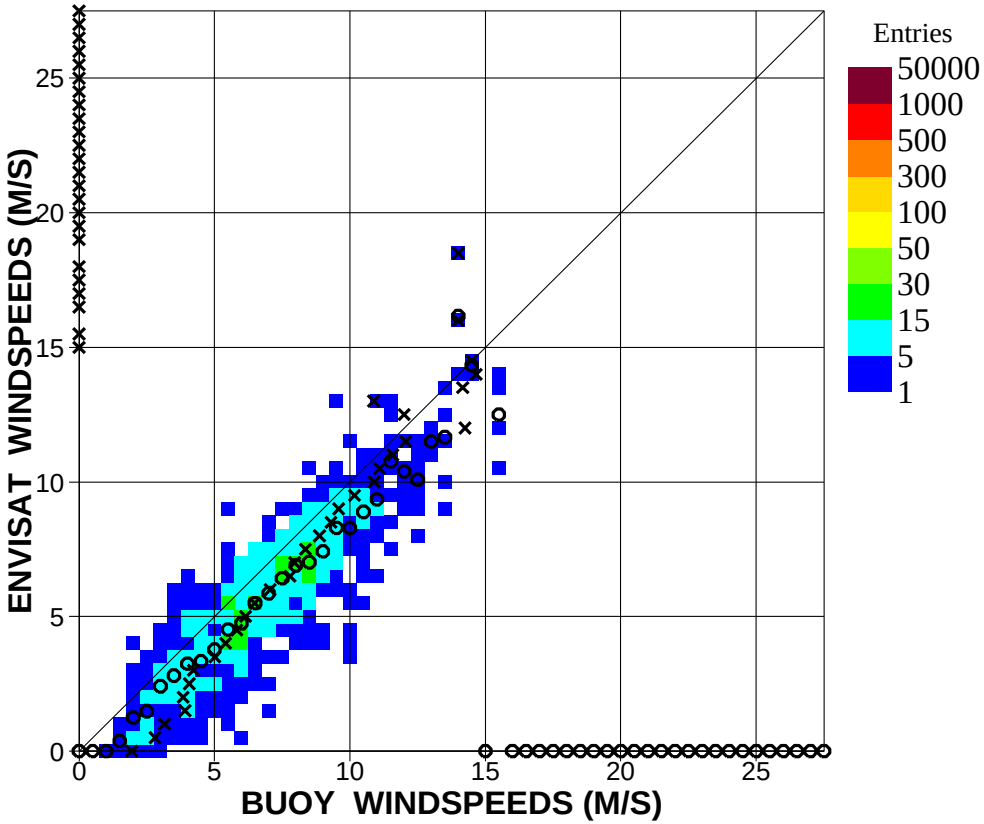

STATISTICS

ENTRIES	1223
MEAN BUOY	6.9105
MEAN ENVISAT	5.7615
BIAS (ENVISAT - BUOY)	-1.1490
STANDARD DEVIATION	1.2877
SCATTER INDEX	.1863
CORRELATION	.8802
SYMMETRIC SLOPE	.8623 (.0145)
REGR. COEFFICIENT	.9223 (.0142)
REGR. CONSTANT	-.6120 (.1049)

Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2005 (Global)

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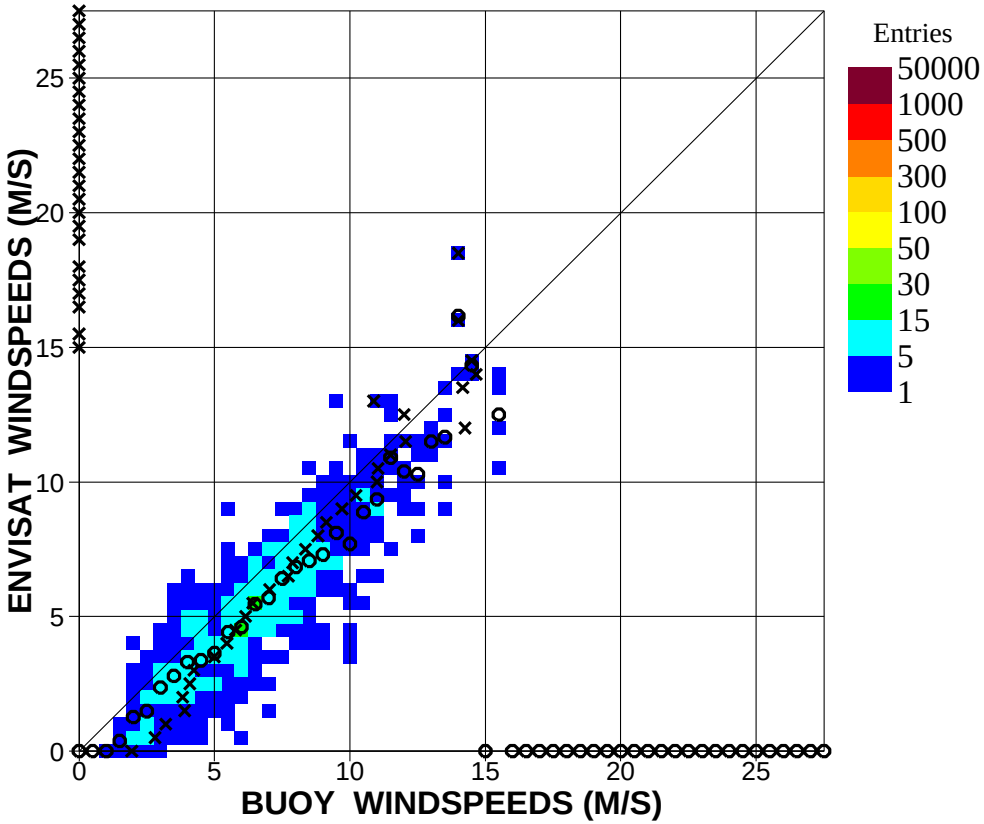

STATISTICS

ENTRIES	951	
MEAN BUOY	6.6483	
MEAN ENVISAT	5.4671	
BIAS (ENVISAT - BUOY)	-1.1812	
STANDARD DEVIATION	1.3593	
SCATTER INDEX	.2045	
CORRELATION	.8761	
SYMMETRIC SLOPE	.8568	(.0167)
REGR. COEFFICIENT	.9178	(.0164)
REGR. CONSTANT	-.6346	(.1174)

Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2005 (N.Hem.)

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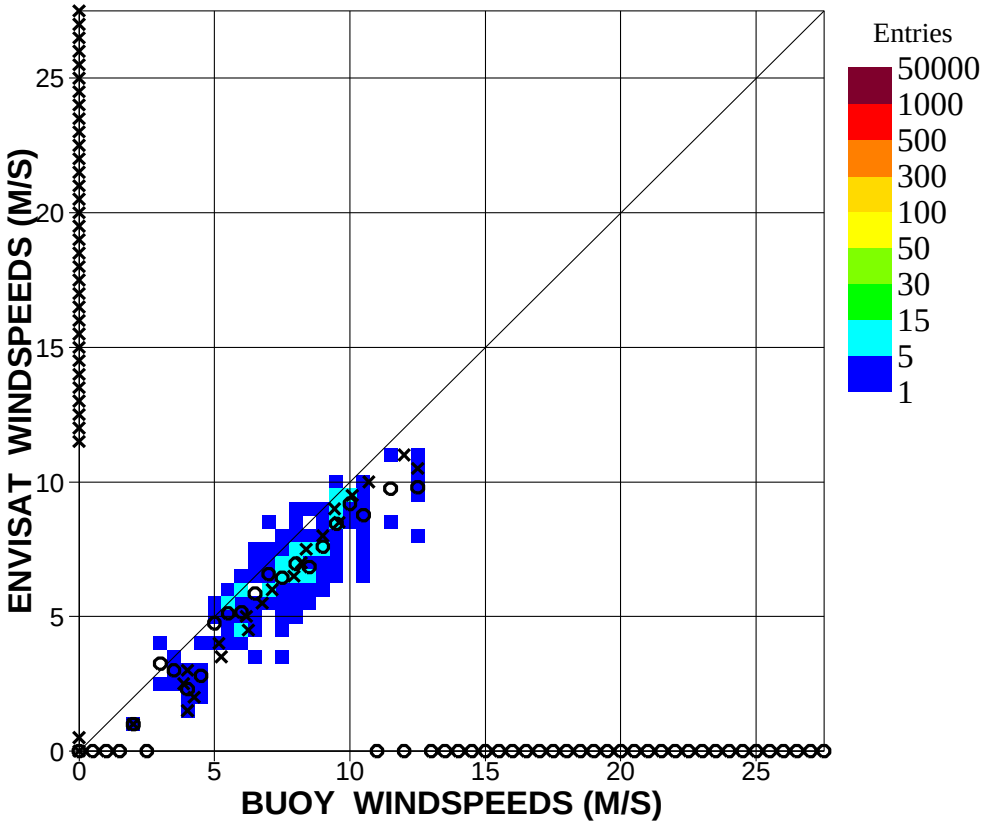

STATISTICS

ENTRIES	261	
MEAN BUOY	7.8527	
MEAN ENVISAT	6.8079	
BIAS (ENVISAT - BUOY)	-1.0448	
STANDARD DEVIATION	.9921	
SCATTER INDEX	.1263	
CORRELATION	.8659	
SYMMETRIC SLOPE	.8761	(.0318)
REGR. COEFFICIENT	.8837	(.0317)
REGR. CONSTANT	-.1312	(.2563)

Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2005 (Tropics)

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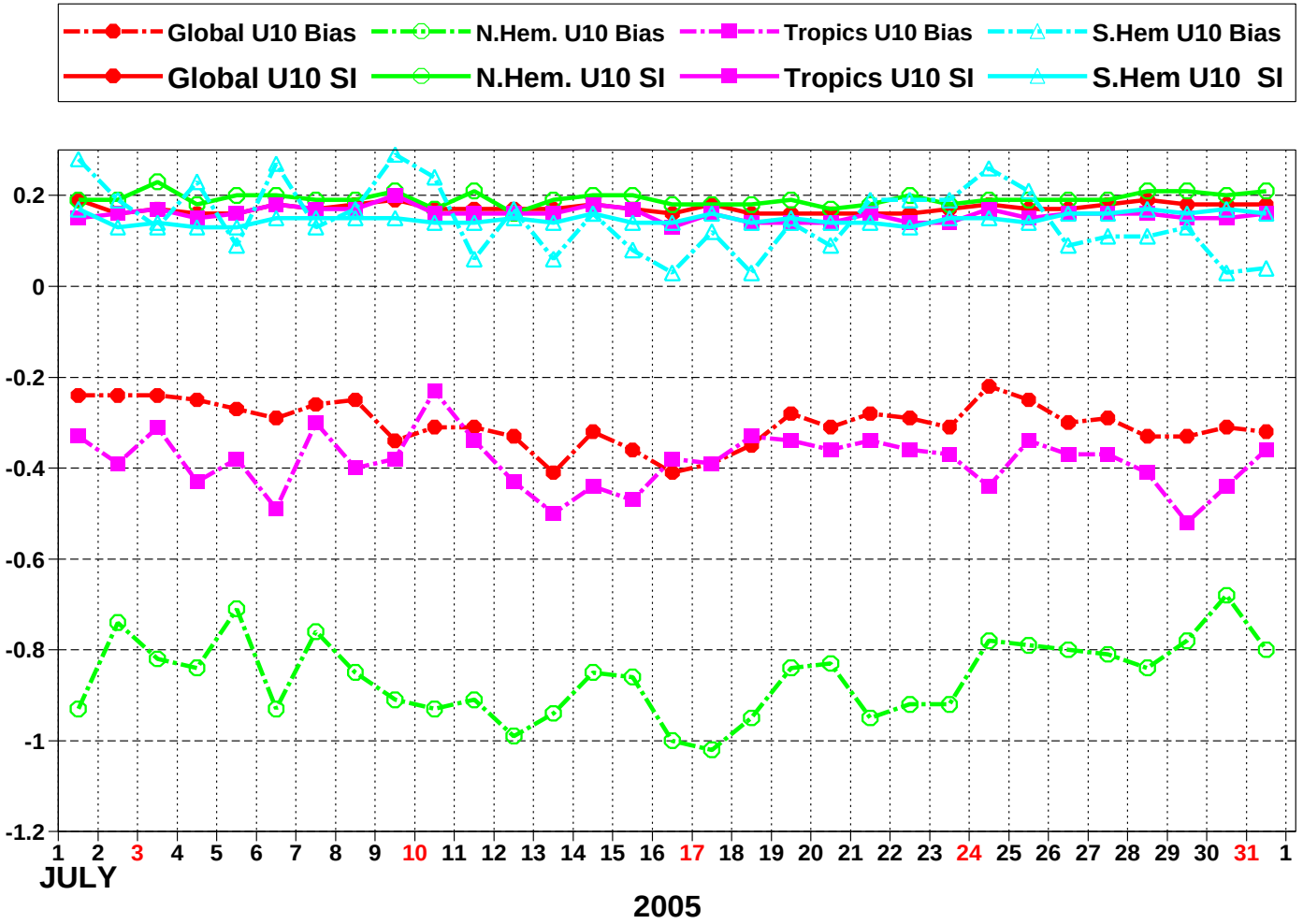

Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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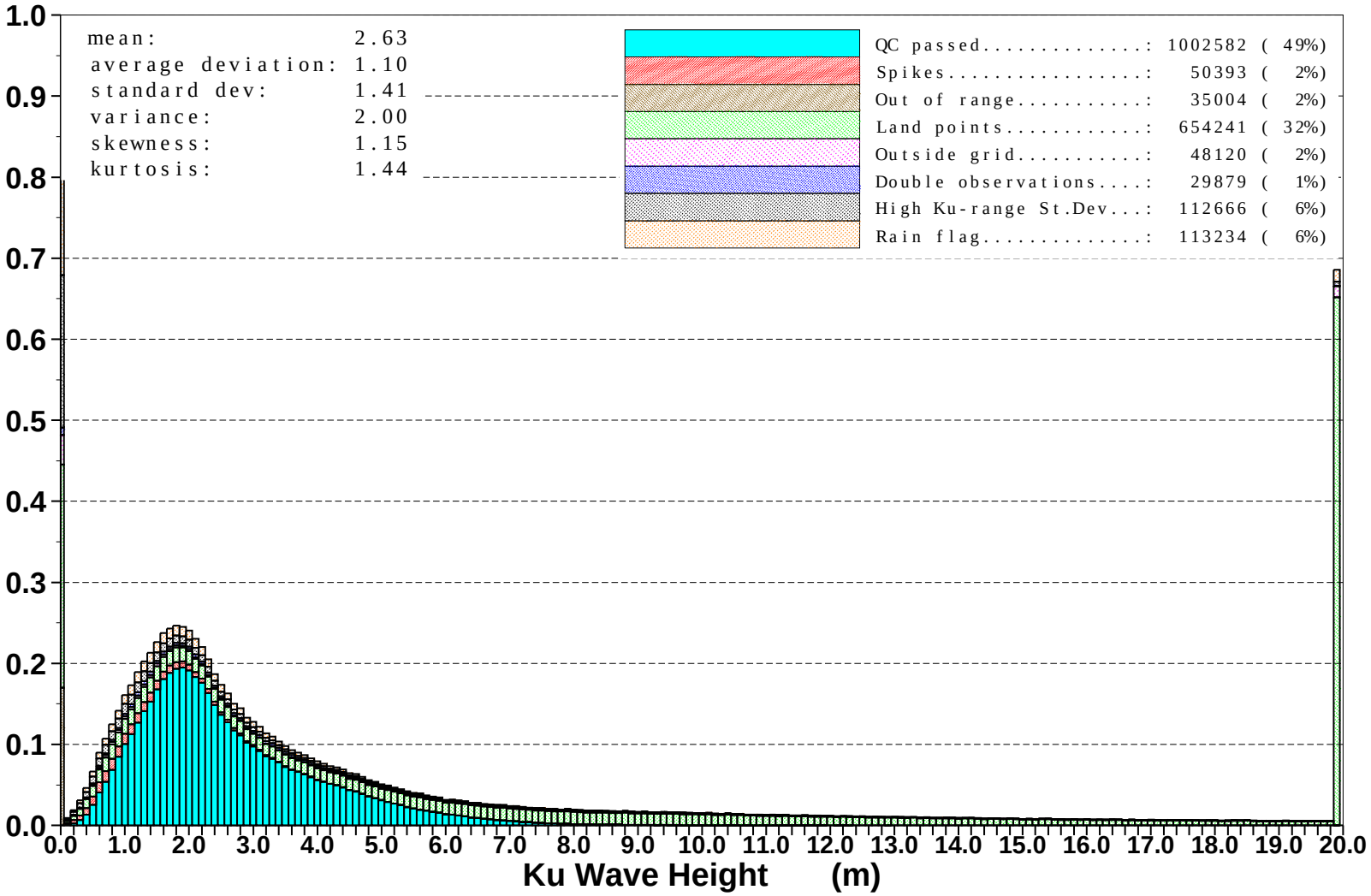

Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for July 2005

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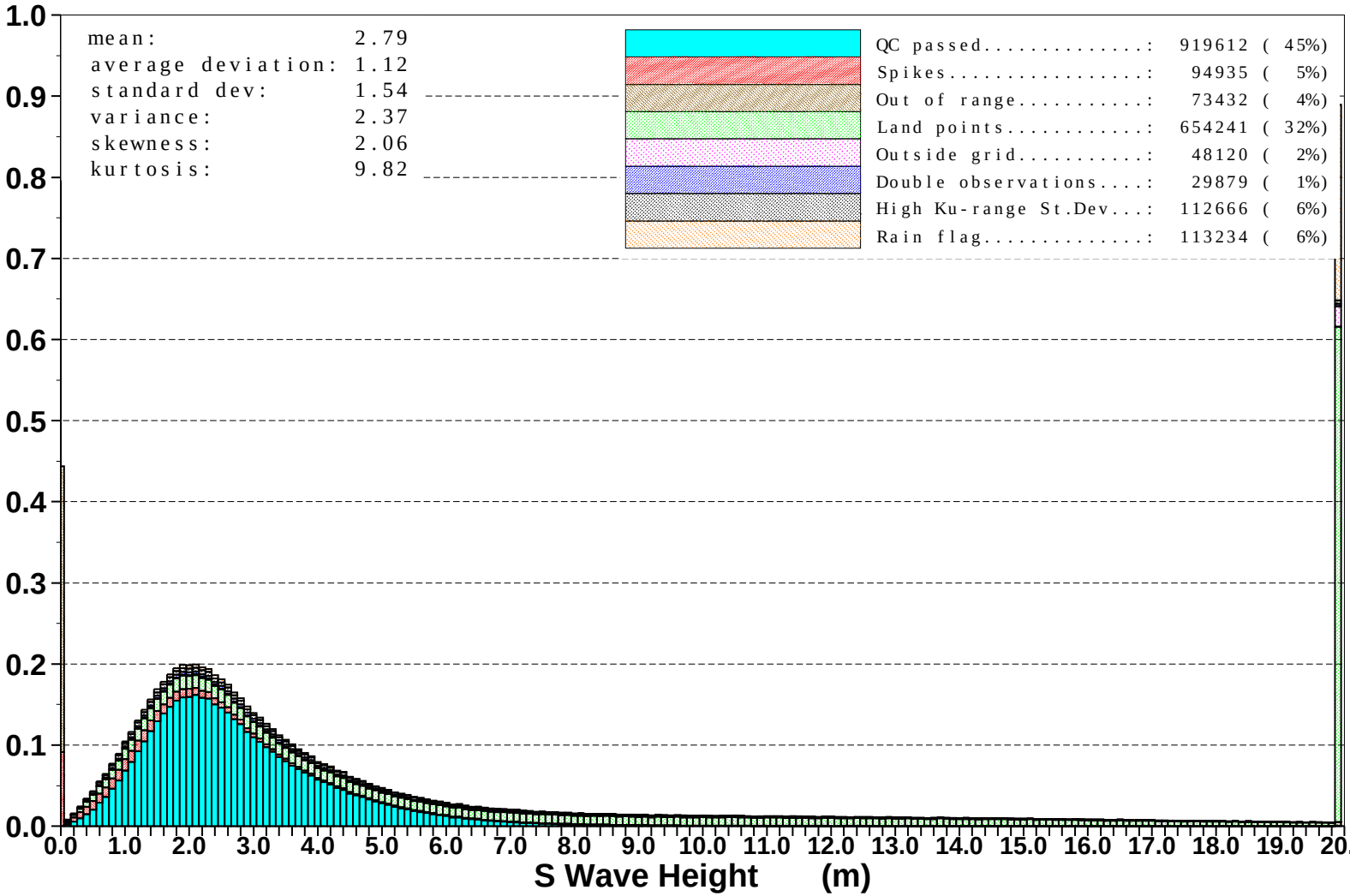

Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for July 2005

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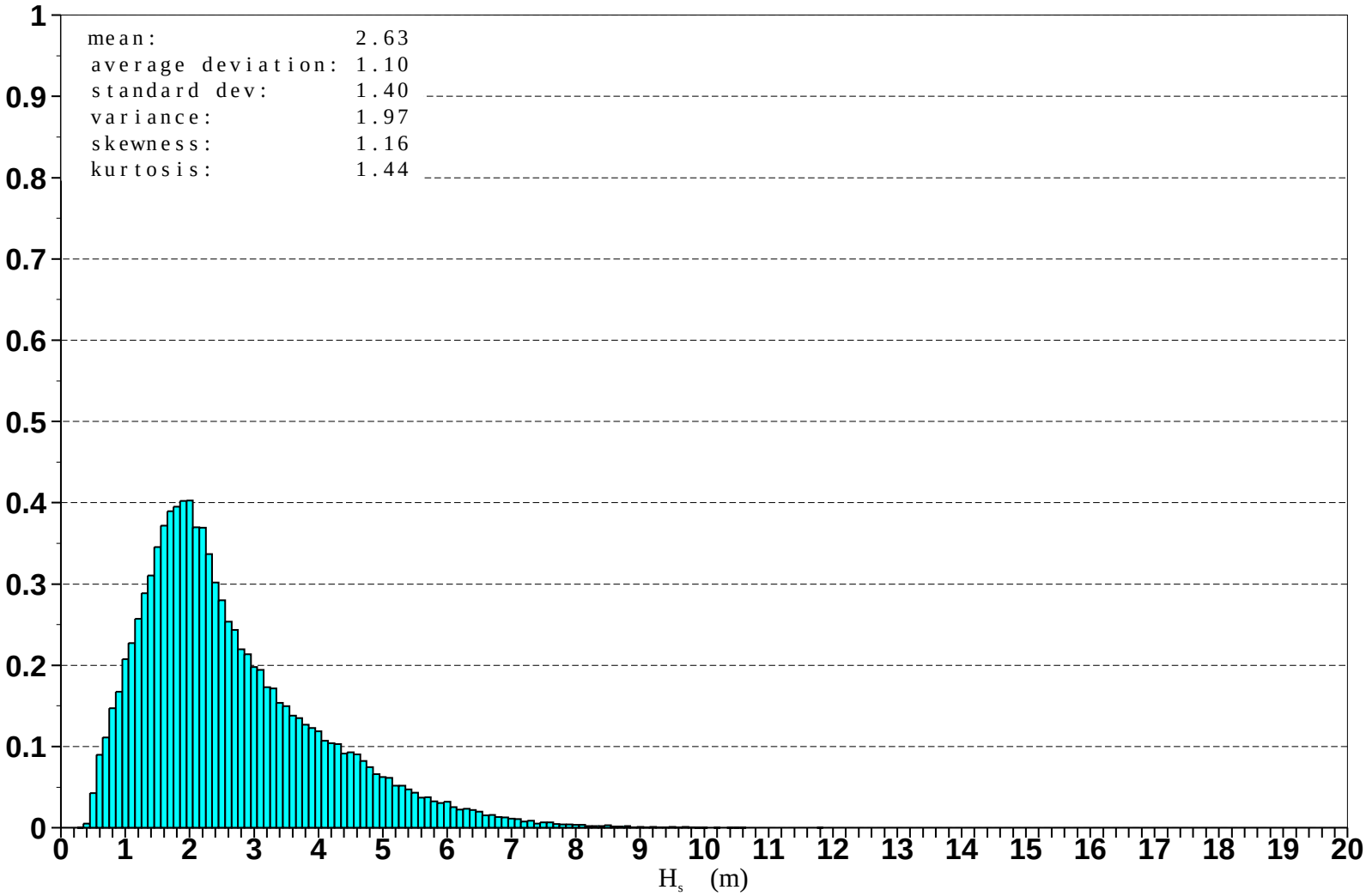

Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for July 2005

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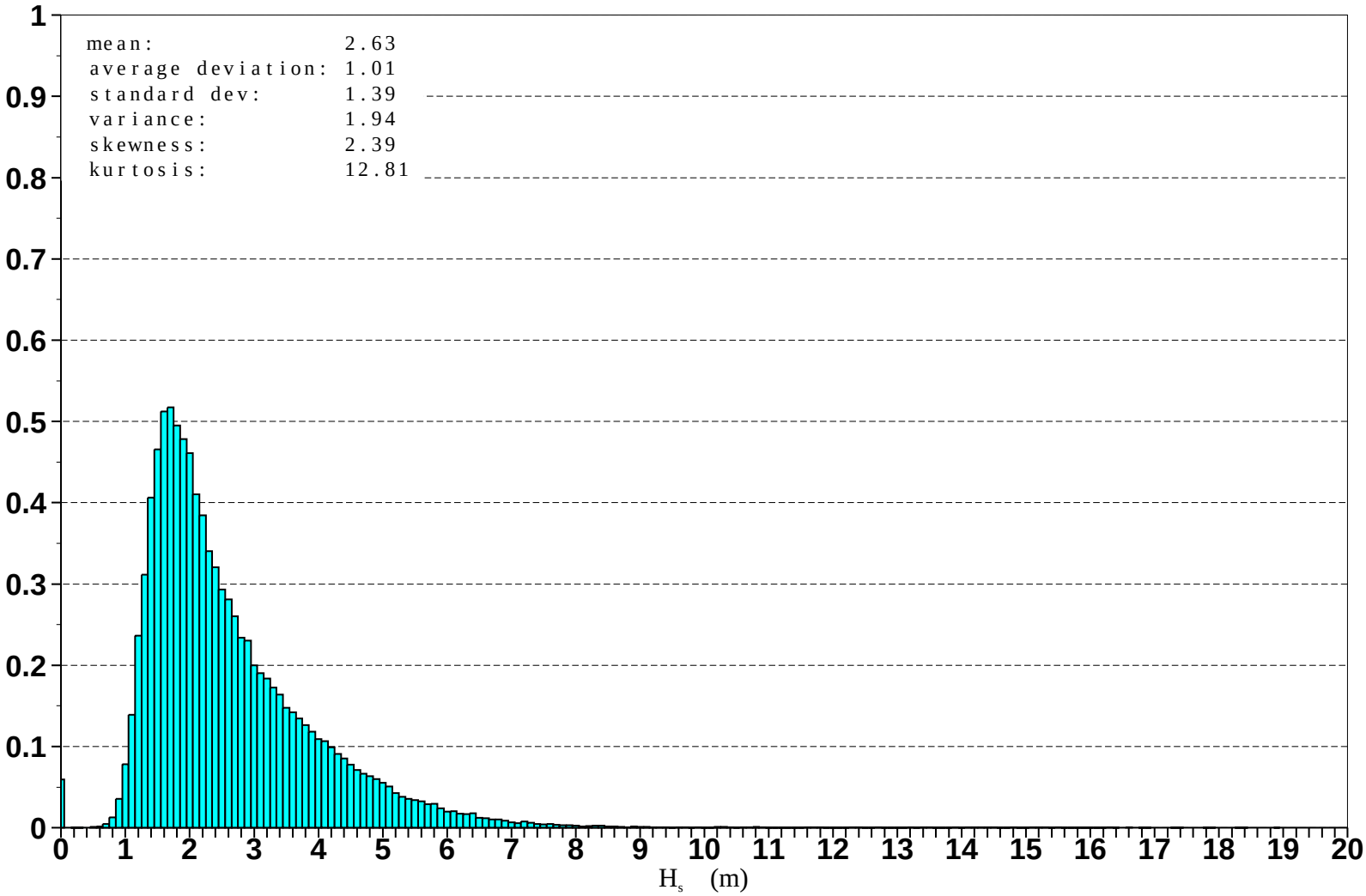

Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for July 2005

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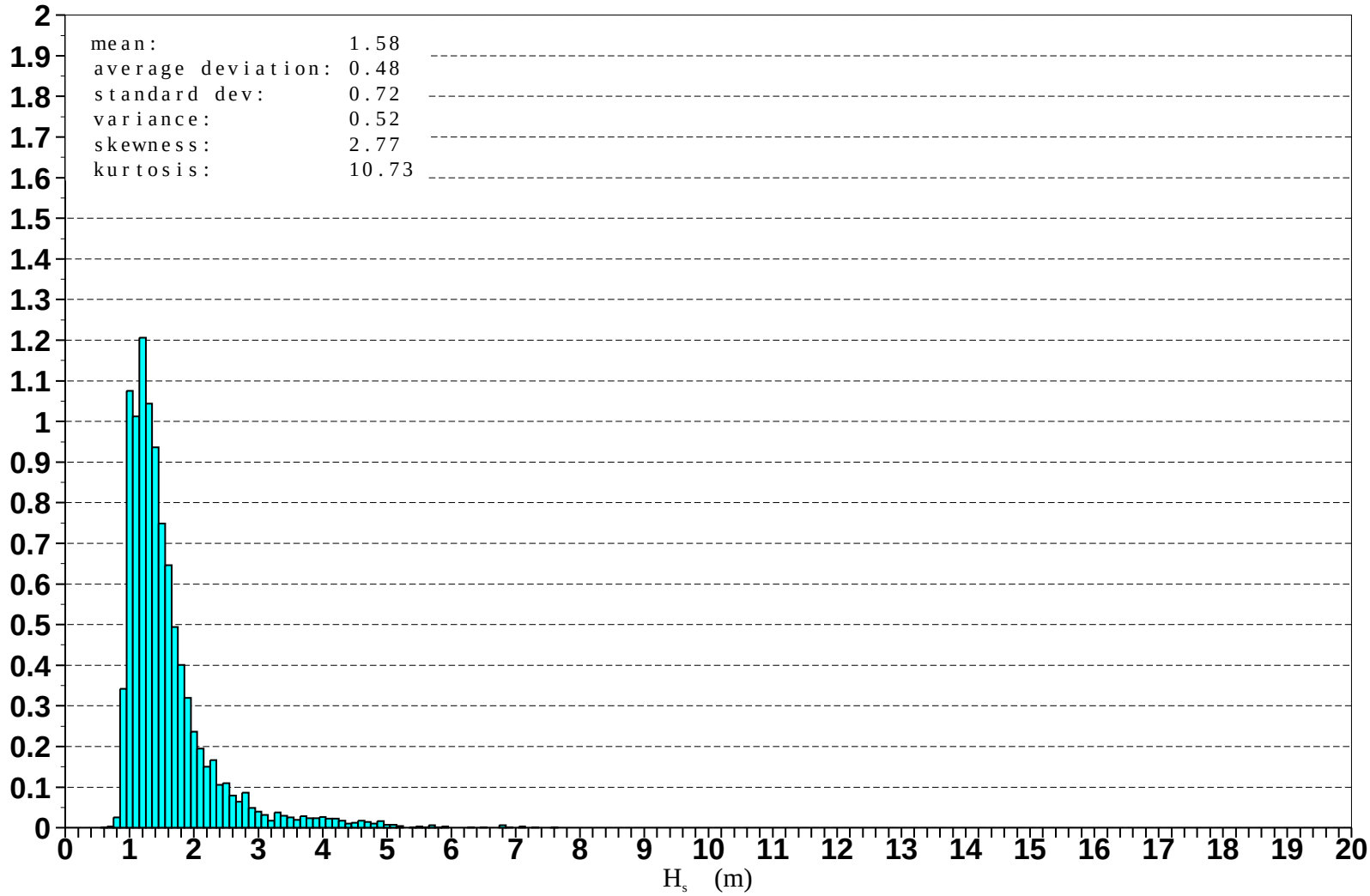

Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for July 2005

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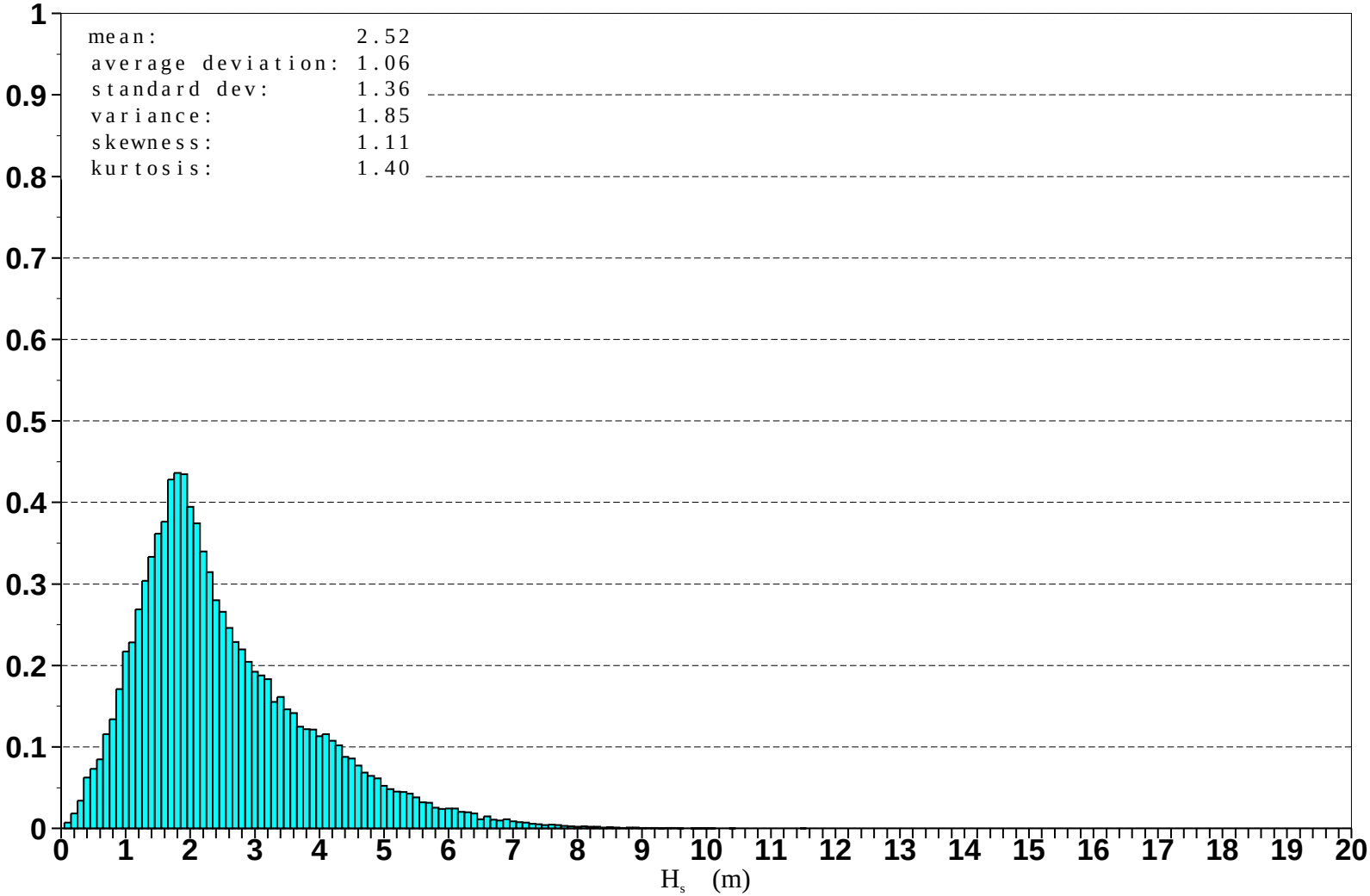

Figure 19b: Distribution of WAM 4V Wave Height (Collocated with ENVISAT) for July 2005

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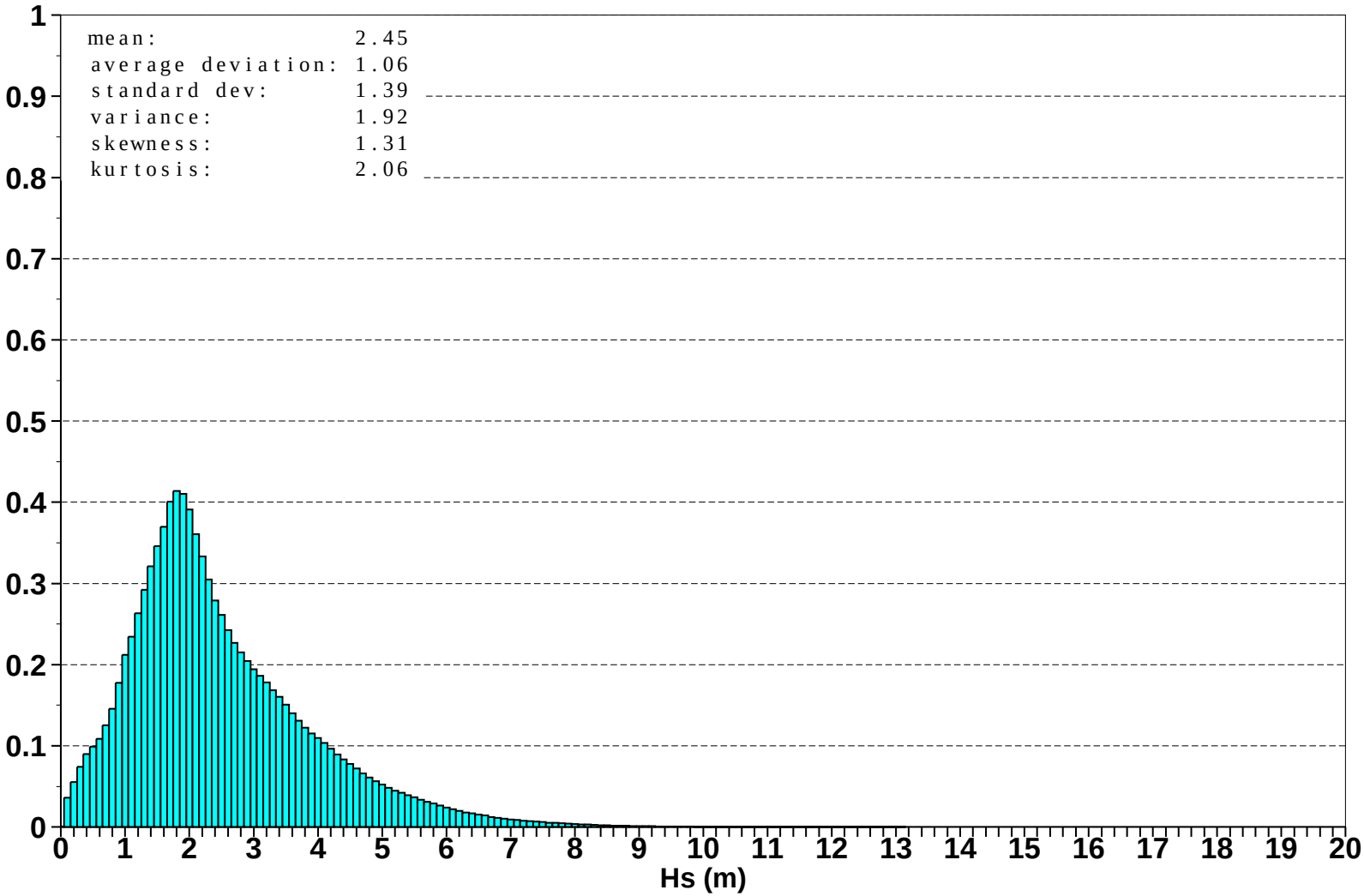

Figure 20: Global distribution of ECMWF First-Guess wave heights for July 2005

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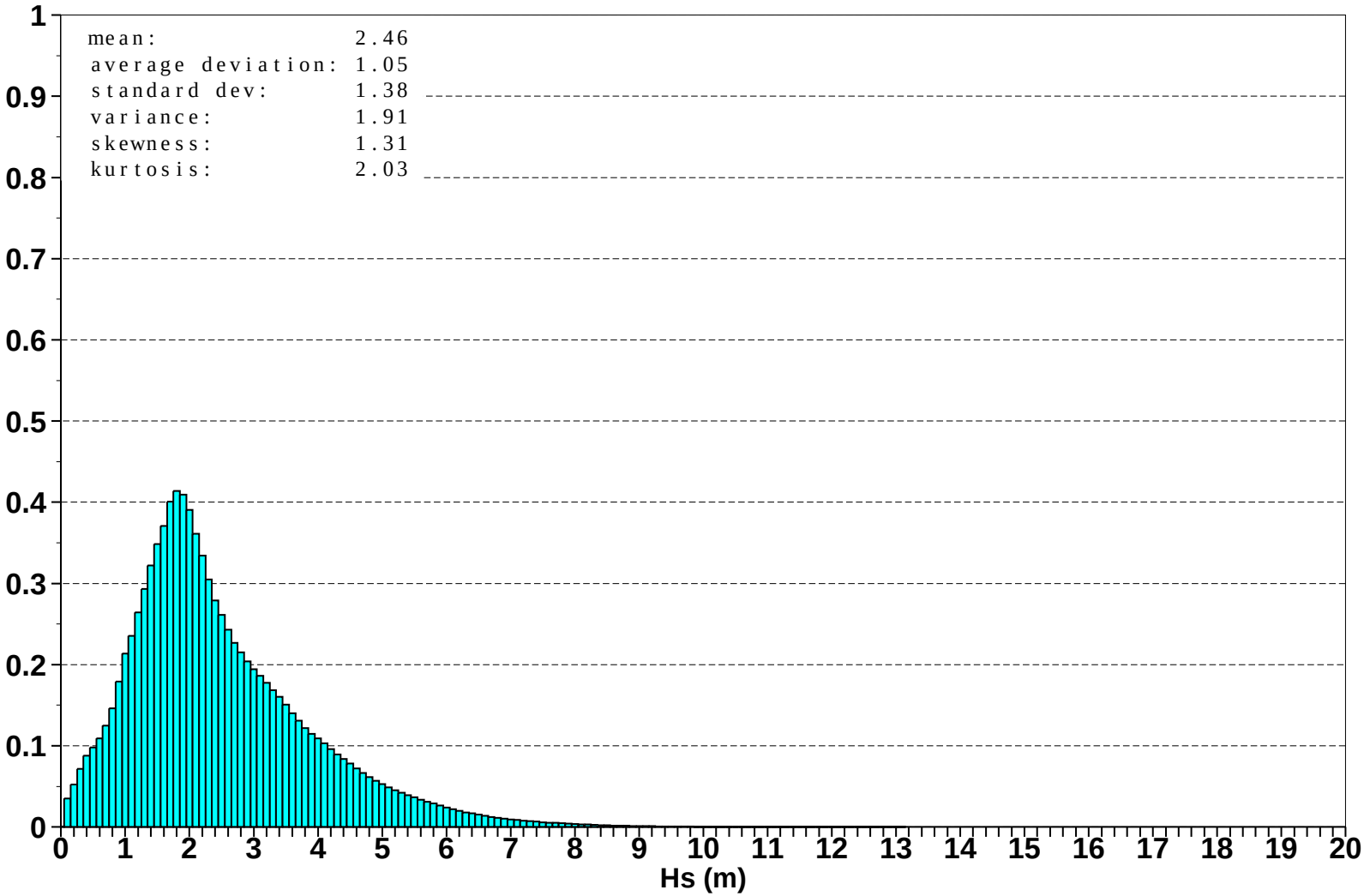

Figure 21: Global distribution of ECMWF Analysis wave heights for July 2005

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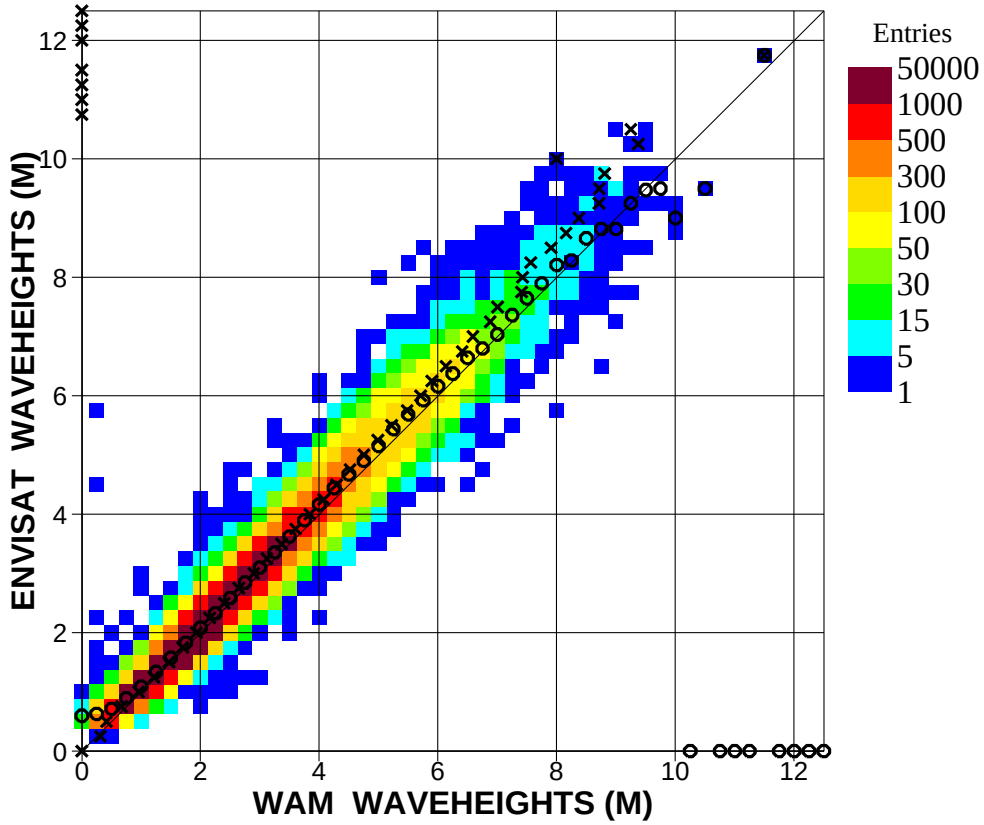

STATISTICS

ENTRIES	90717
MEAN WAM	2.5244
MEAN ENVISAT	2.6326
BIAS (ENVISAT - WAM)	.1082
STANDARD DEVIATION	.2751
SCATTER INDEX	.1090
CORRELATION	.9807
SYMMETRIC SLOPE	1.0406 (.0007)
REGR. COEFFICIENT	1.0129 (.0007)
REGR. CONSTANT	.0757 (.0019)

Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2005 (Global)

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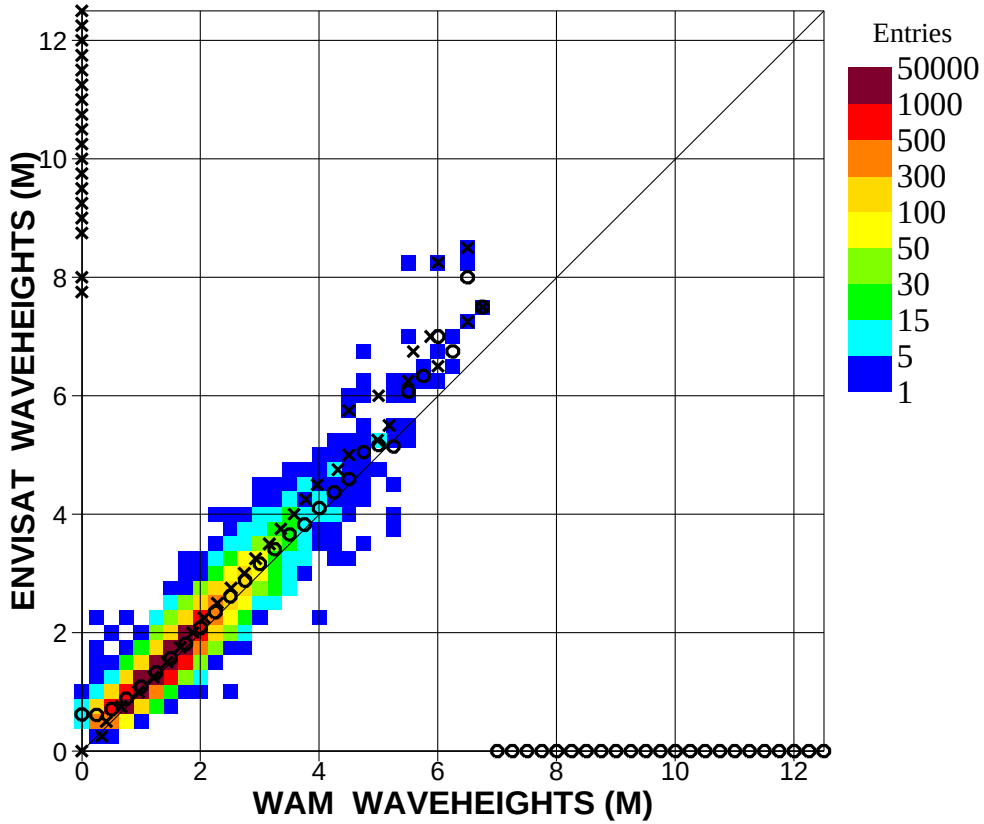

STATISTICS

ENTRIES	25119
MEAN WAM	1.4628
MEAN ENVISAT	1.5616
BIAS (ENVISAT - WAM)	.0988
STANDARD DEVIATION	.2091
SCATTER INDEX	.1429
CORRELATION	.9491
SYMMETRIC SLOPE	1.0633 (.0021)
REGR. COEFFICIENT	.9880 (.0021)
REGR. CONSTANT	.1163 (.0033)

Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2005 (N.Hem.)

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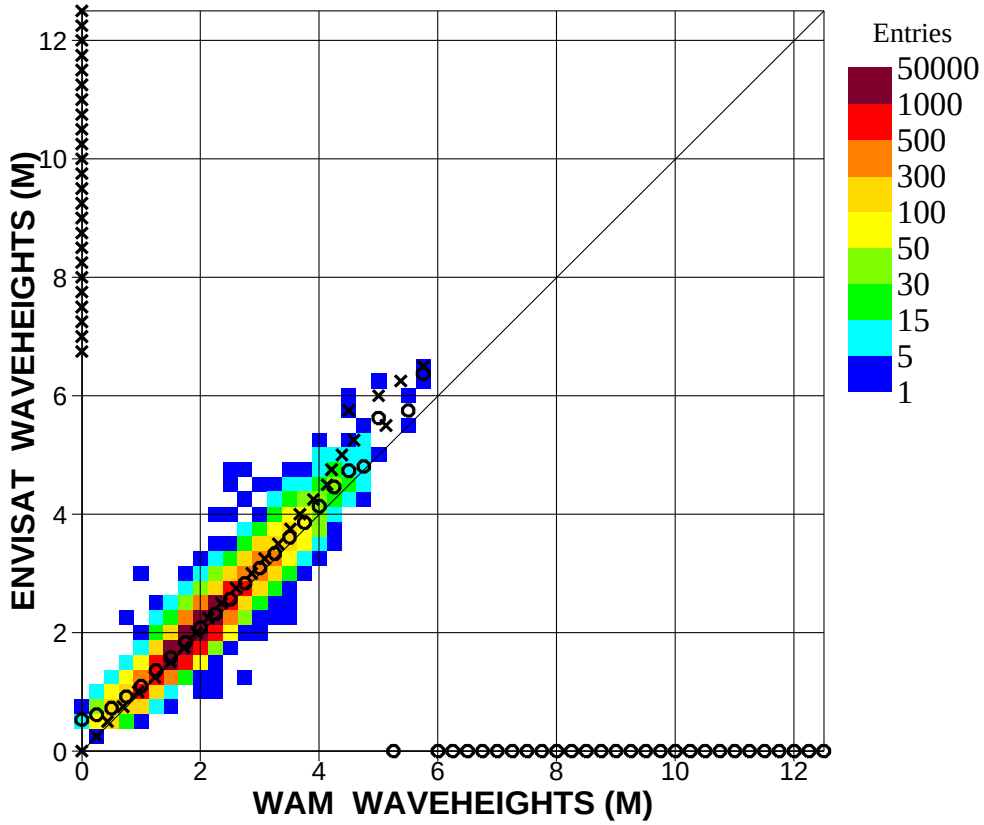

STATISTICS

ENTRIES	28979
MEAN WAM	2.0187
MEAN ENVISAT	2.1094
BIAS (ENVISAT - WAM)	.0907
STANDARD DEVIATION	.2066
SCATTER INDEX	.1024
CORRELATION	.9570
SYMMETRIC SLOPE	1.0443 (.0018)
REGR. COEFFICIENT	.9939 (.0018)
REGR. CONSTANT	.1031 (.0038)

Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2005 (Tropics)

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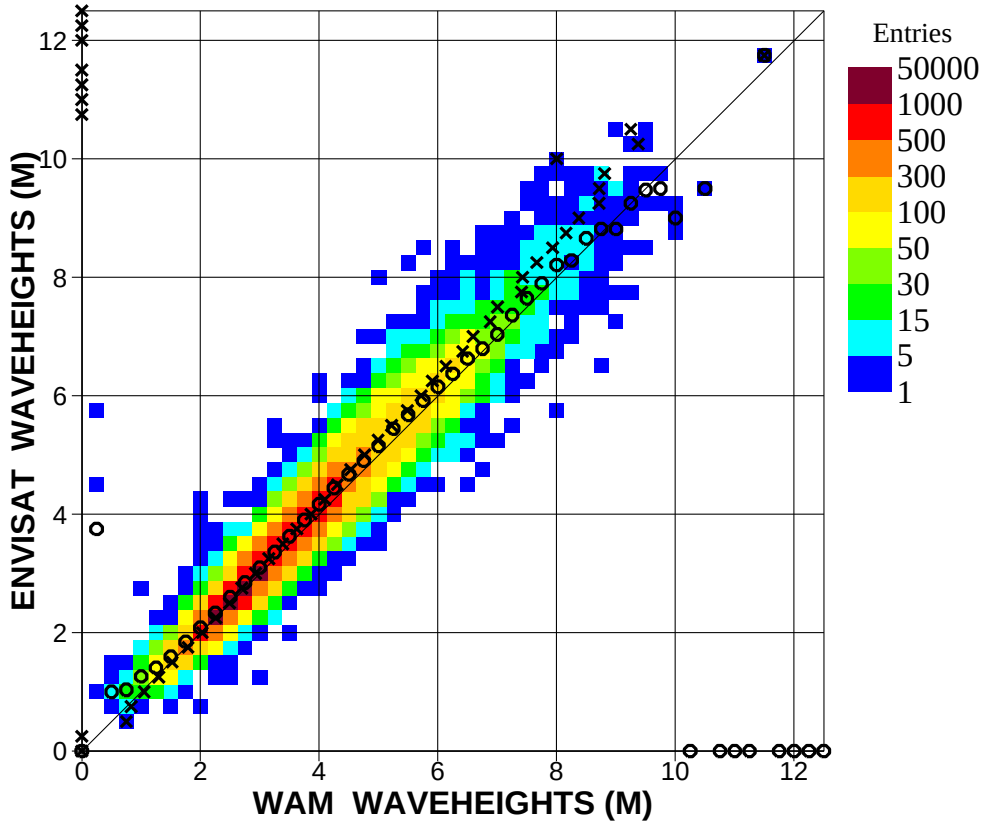

STATISTICS

ENTRIES	37328
MEAN WAM	3.6245
MEAN ENVISAT	3.7521
BIAS (ENVISAT - WAM)	.1276
STANDARD DEVIATION	.3488
SCATTER INDEX	.0962
CORRELATION	.9672
SYMMETRIC SLOPE	1.0371 (.0014)
REGR. COEFFICIENT	1.0168 (.0014)
REGR. CONSTANT	.0666 (.0053)

Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2005 (S.Hem.)

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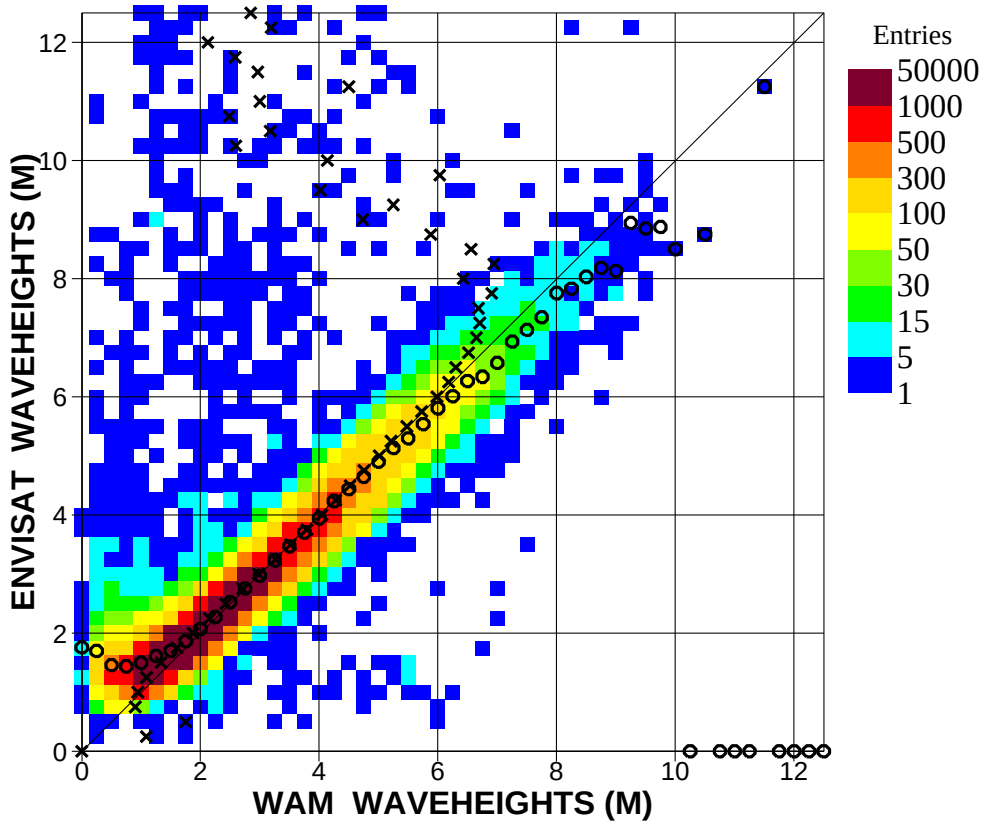

STATISTICS

ENTRIES	90178
MEAN WAM	2.5272
MEAN ENVISAT	2.6458
BIAS (ENVISAT - WAM)	.1186
STANDARD DEVIATION	.7622
SCATTER INDEX	.3016
CORRELATION	.8455
SYMMETRIC SLOPE	1.0398 (.0019)
REGR. COEFFICIENT	.8582 (.0018)
REGR. CONSTANT	.4769 (.0052)

Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2005 (Global)

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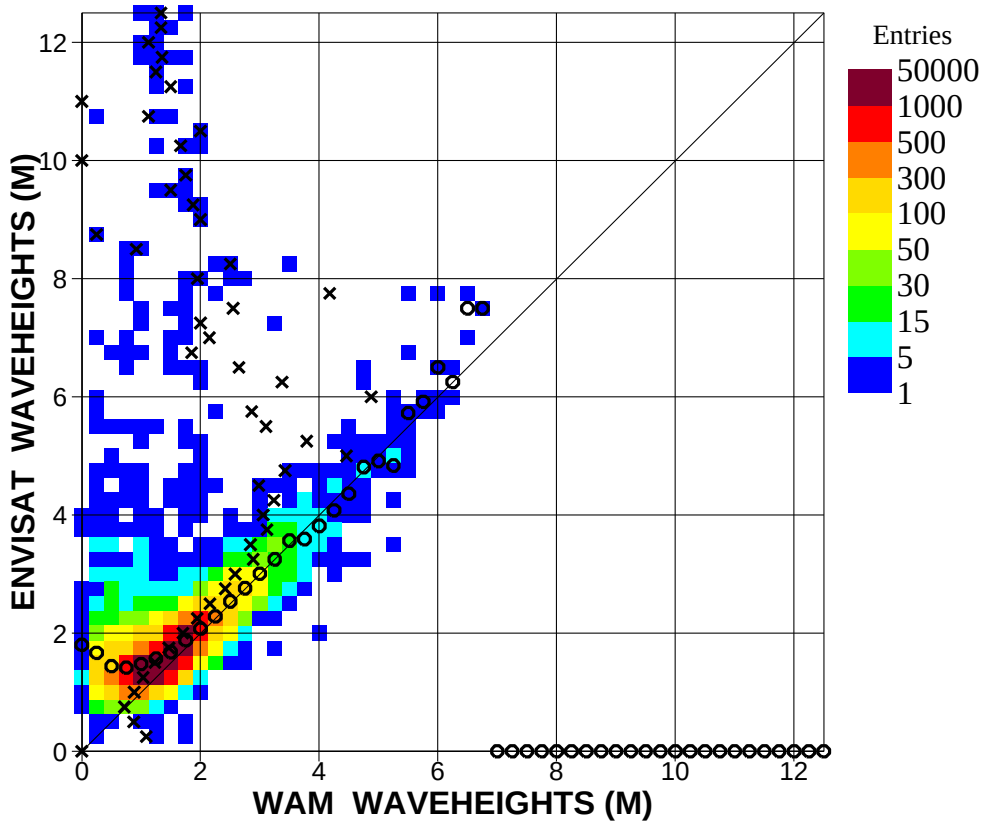

STATISTICS

ENTRIES	24975
MEAN WAM	1.4647
MEAN ENVISAT	1.7805
BIAS (ENVISAT - WAM)	.3158
STANDARD DEVIATION	.7595
SCATTER INDEX	.5185
CORRELATION	.4869
SYMMETRIC SLOPE	1.2292 (.0081)
REGR. COEFFICIENT	.6323 (.0072)
REGR. CONSTANT	.8544 (.0115)

Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2005 (N.Hem.)

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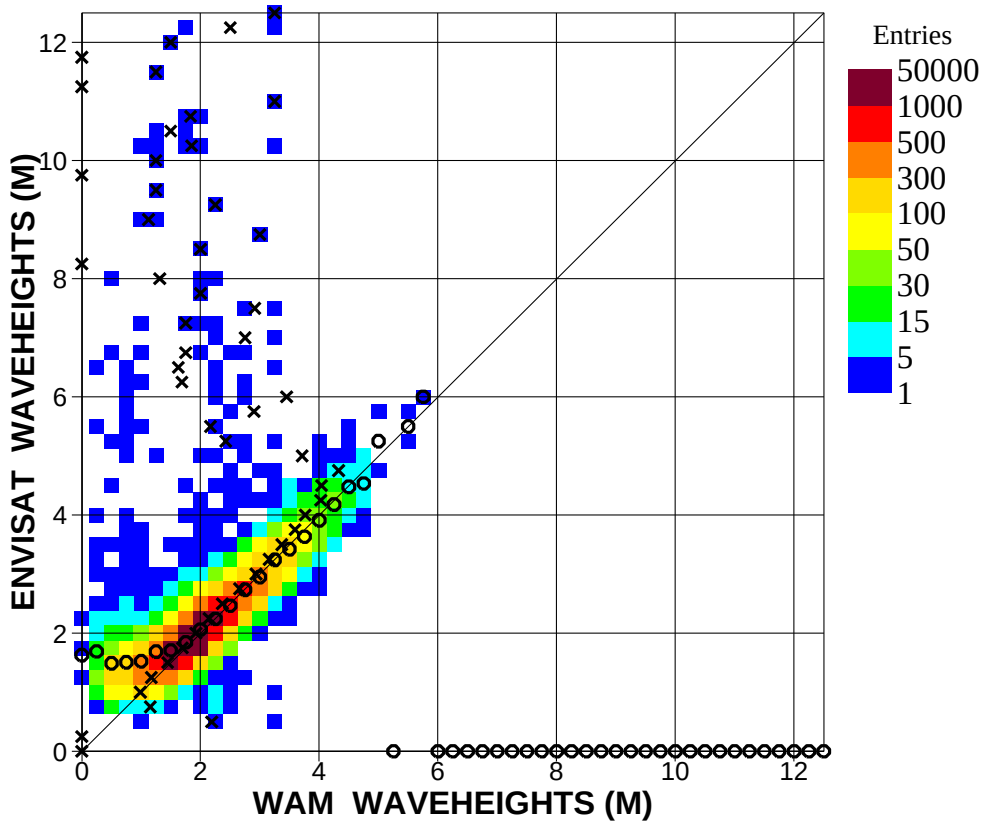

STATISTICS

ENTRIES	28778
MEAN WAM	2.0204
MEAN ENVISAT	2.1469
BIAS (ENVISAT - WAM)	.1264
STANDARD DEVIATION	.7664
SCATTER INDEX	.3793
CORRELATION	.5662
SYMMETRIC SLOPE	1.0920 (.0068)
REGR. COEFFICIENT	.7477 (.0064)
REGR. CONSTANT	.6362 (.0137)

Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2005 (Tropics)

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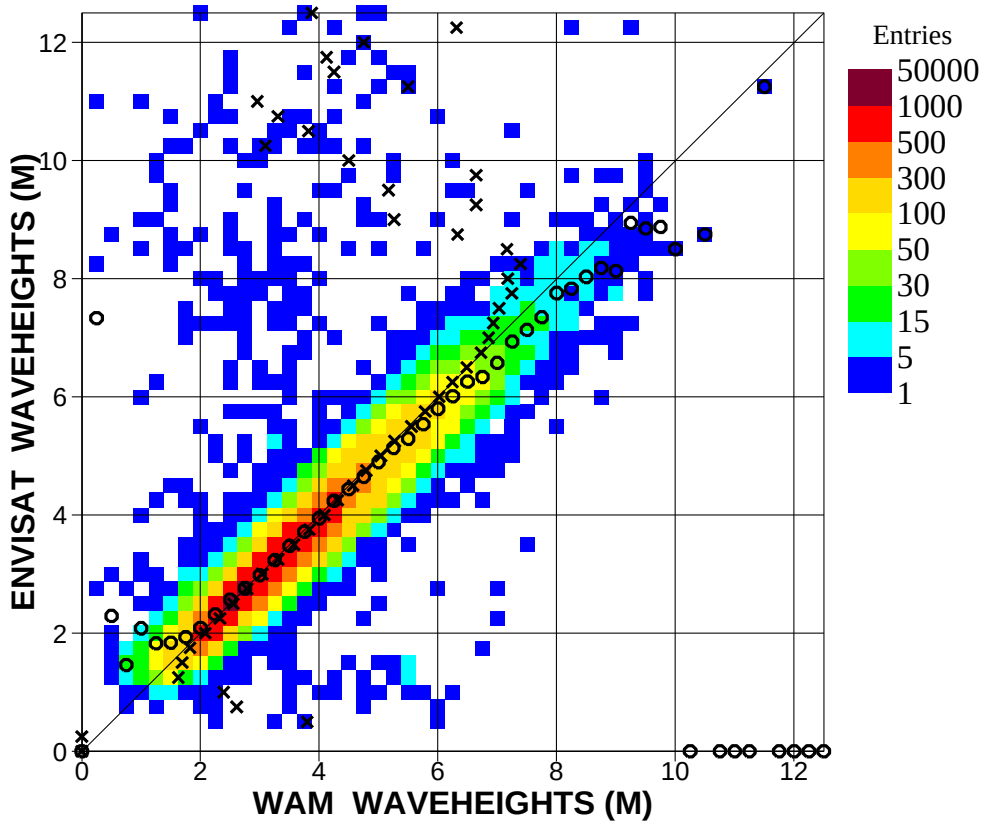

STATISTICS

ENTRIES	37131
MEAN WAM	3.6277
MEAN ENVISAT	3.6069
BIAS (ENVISAT - WAM)	-.0208
STANDARD DEVIATION	.7274
SCATTER INDEX	.2005
CORRELATION	.8562
SYMMETRIC SLOPE	1.0027 (.0029)
REGR. COEFFICIENT	.9122 (.0029)
REGR. CONSTANT	.2976 (.0110)

Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2005 (S.Hem.)

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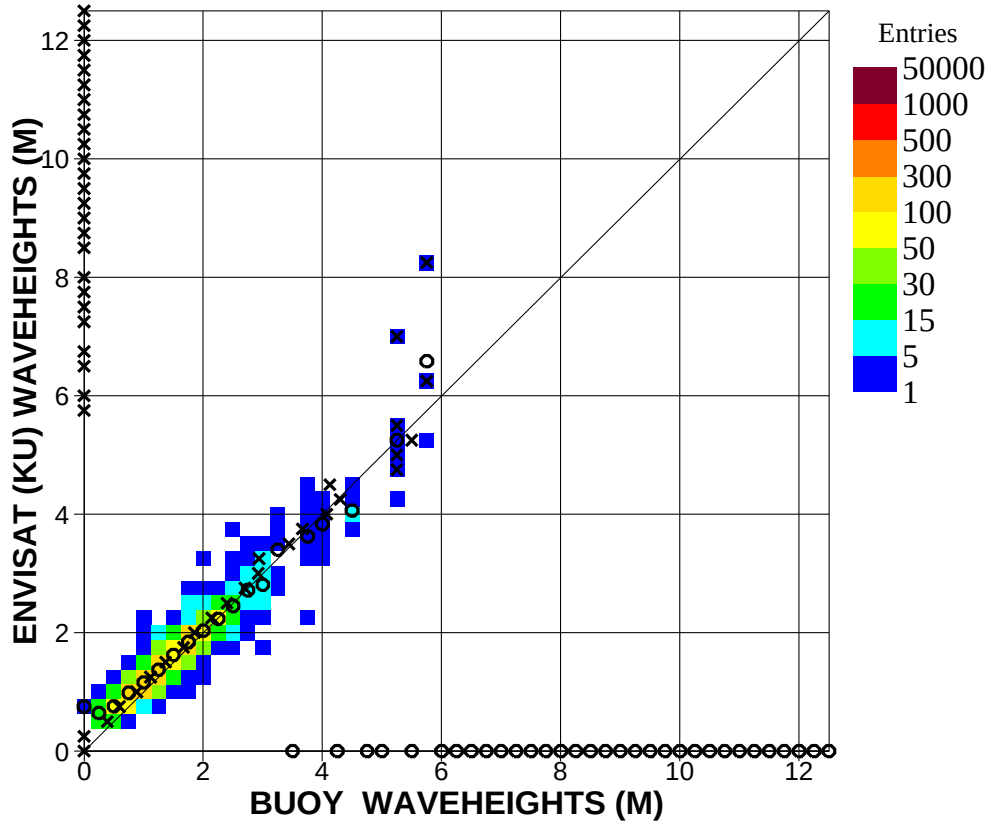

STATISTICS

ENTRIES	1913	
MEAN BUOY	1.4654	
MEAN ENVISAT	1.5865	
BIAS (ENVISAT - BUOY)	.1210	
STANDARD DEVIATION	.2446	
SCATTER INDEX	.1669	
CORRELATION	.9445	
SYMMETRIC SLOPE	1.0549	(.0081)
REGR. COEFFICIENT	.8877	(.0071)
REGR. CONSTANT	.2856	(.0116)

Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2005 (Global)

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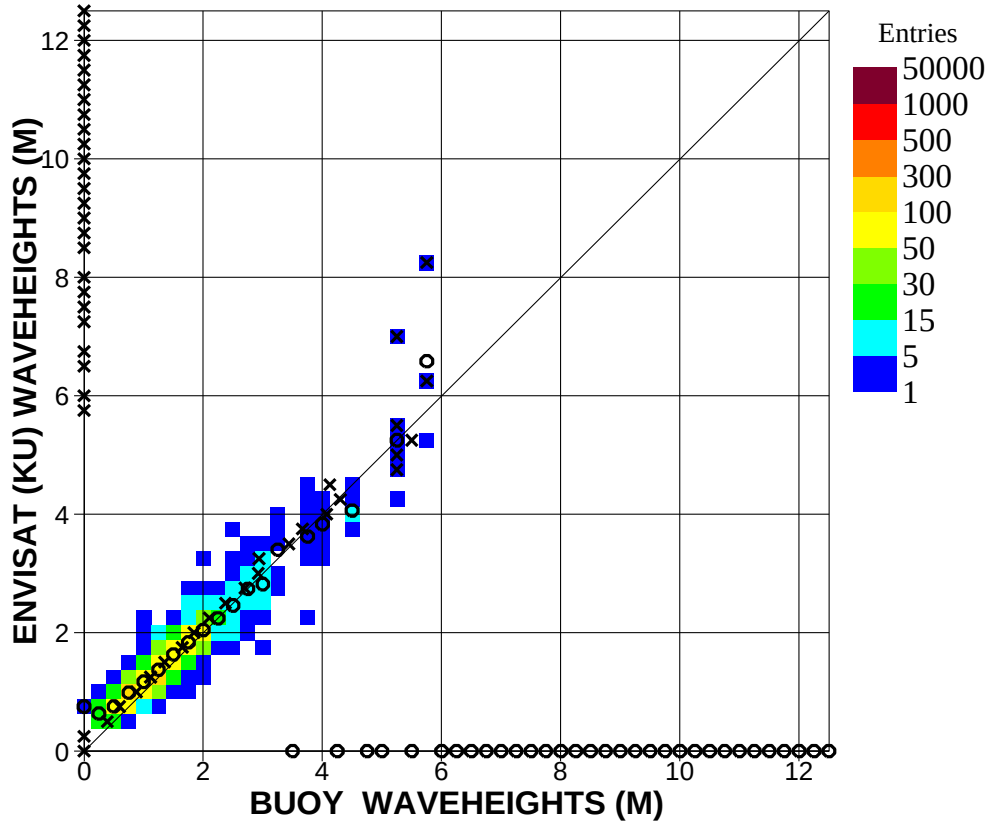

STATISTICS

ENTRIES	1570	
MEAN BUOY	1.4217	
MEAN ENVISAT	1.5524	
BIAS (ENVISAT - BUOY)	.1307	
STANDARD DEVIATION	.2578	
SCATTER INDEX	.1813	
CORRELATION	.9436	
SYMMETRIC SLOPE	1.0596	(.0091)
REGR. COEFFICIENT	.8907	(.0079)
REGR. CONSTANT	.2862	(.0128)

Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2005 (N.Hem.)

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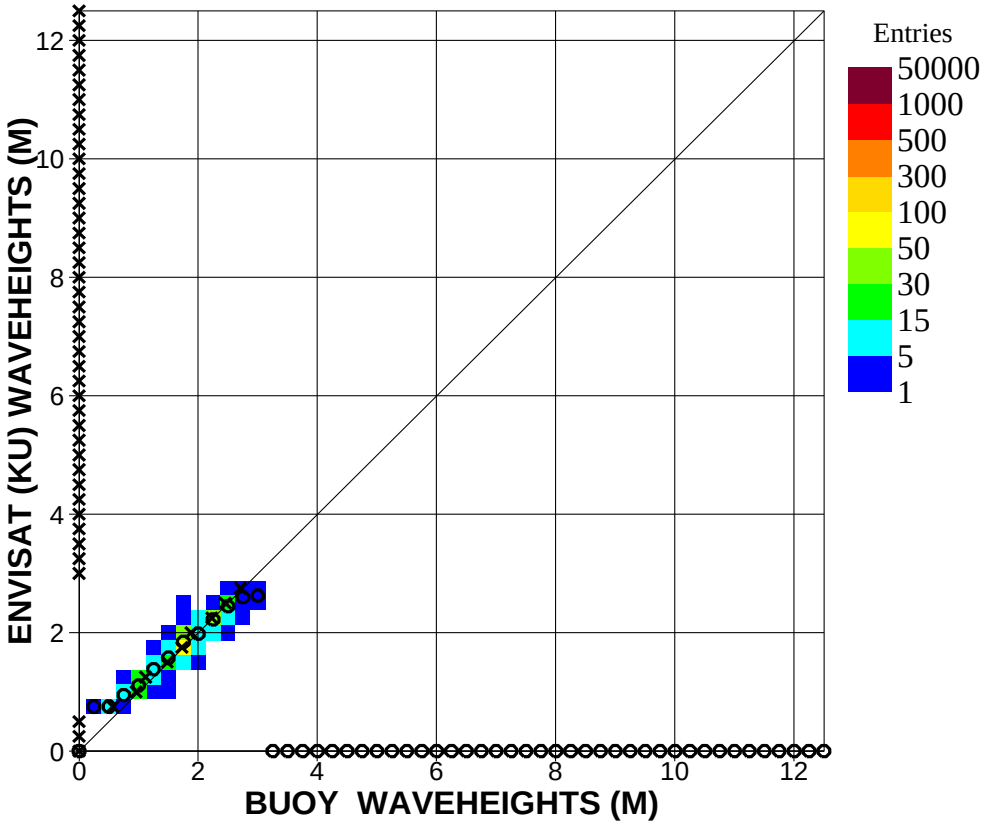

STATISTICS

ENTRIES	331	
MEAN BUOY	1.6793	
MEAN ENVISAT	1.7528	
BIAS (ENVISAT - BUOY)	.0734	
STANDARD DEVIATION	.1623	
SCATTER INDEX	.0966	
CORRELATION	.9476	
SYMMETRIC SLOPE	1.0349	(.0185)
REGR. COEFFICIENT	.8834	(.0164)
REGR. CONSTANT	.2692	(.0288)

Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2005 (Tropics)

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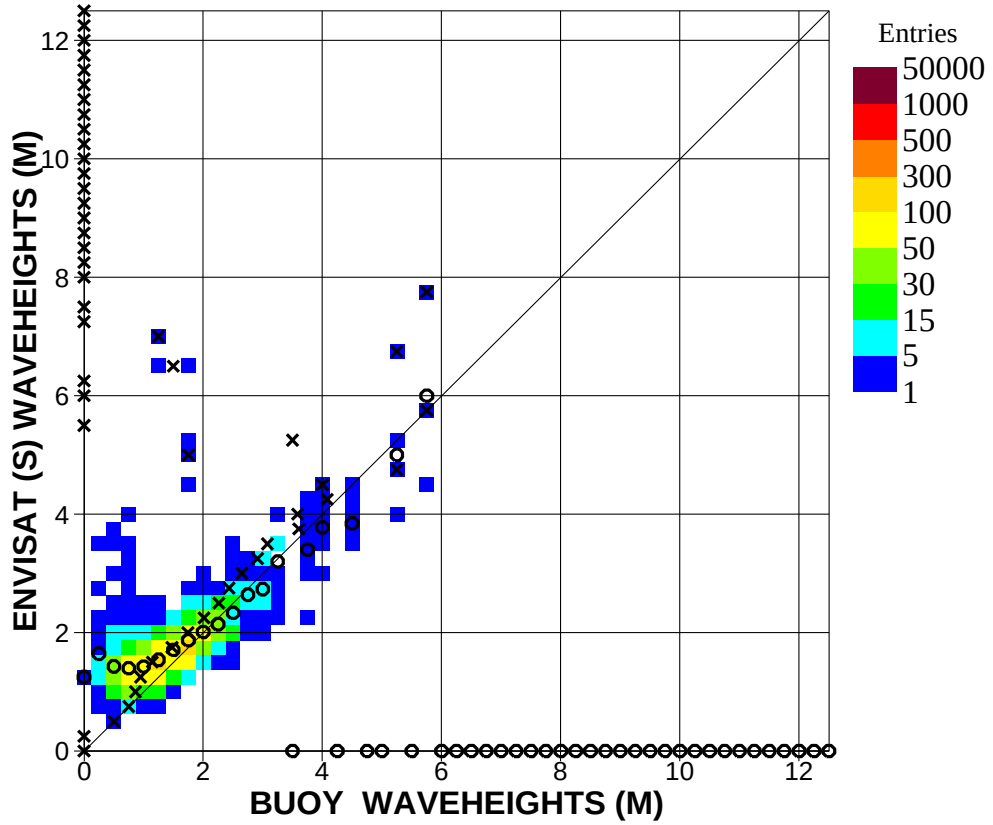

STATISTICS

ENTRIES	1899	
MEAN BUOY	1.4707	
MEAN ENVISAT	1.7677	
BIAS (ENVISAT - BUOY)	.2970	
STANDARD DEVIATION	.5149	
SCATTER INDEX	.3501	
CORRELATION	.7306	
SYMMETRIC SLOPE	1.1380	(.0181)
REGR. COEFFICIENT	.6156	(.0132)
REGR. CONSTANT	.8624	(.0218)

Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2005 (Global)

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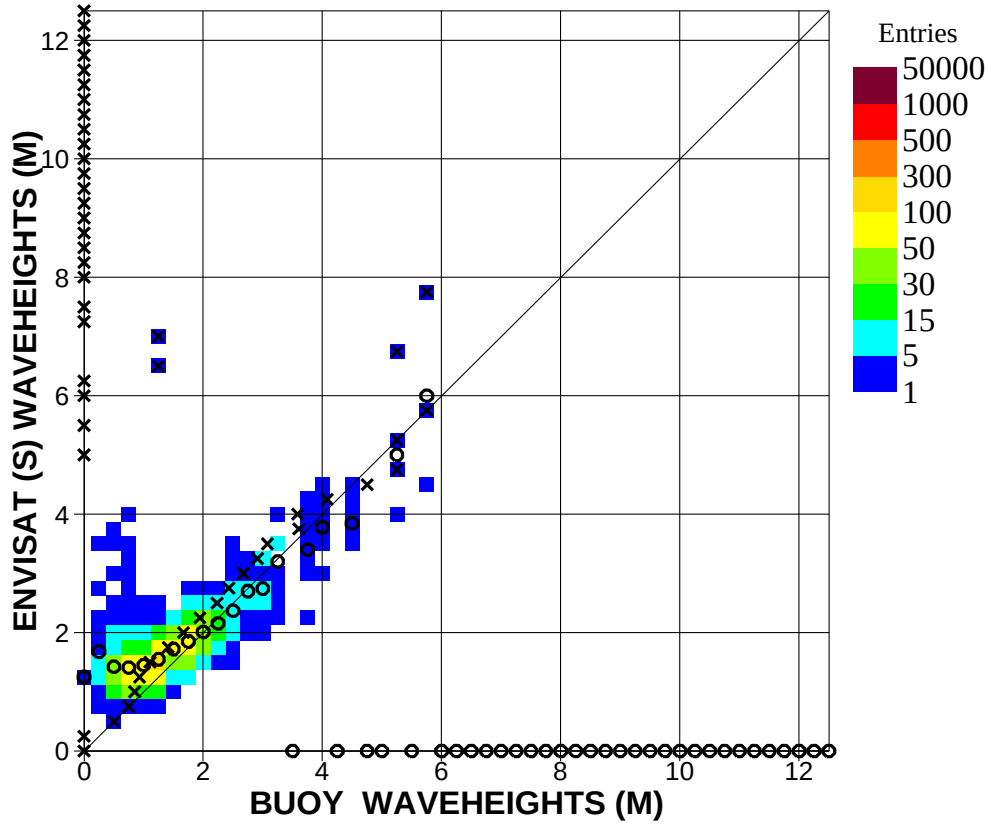

STATISTICS

ENTRIES	1556	
MEAN BUOY	1.4277	
MEAN ENVISAT	1.7587	
BIAS (ENVISAT - BUOY)	.3310	
STANDARD DEVIATION	.5122	
SCATTER INDEX	.3588	
CORRELATION	.7563	
SYMMETRIC SLOPE	1.1511	(.0195)
REGR. COEFFICIENT	.6227	(.0137)
REGR. CONSTANT	.8697	(.0222)

Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2005 (N.Hem.)

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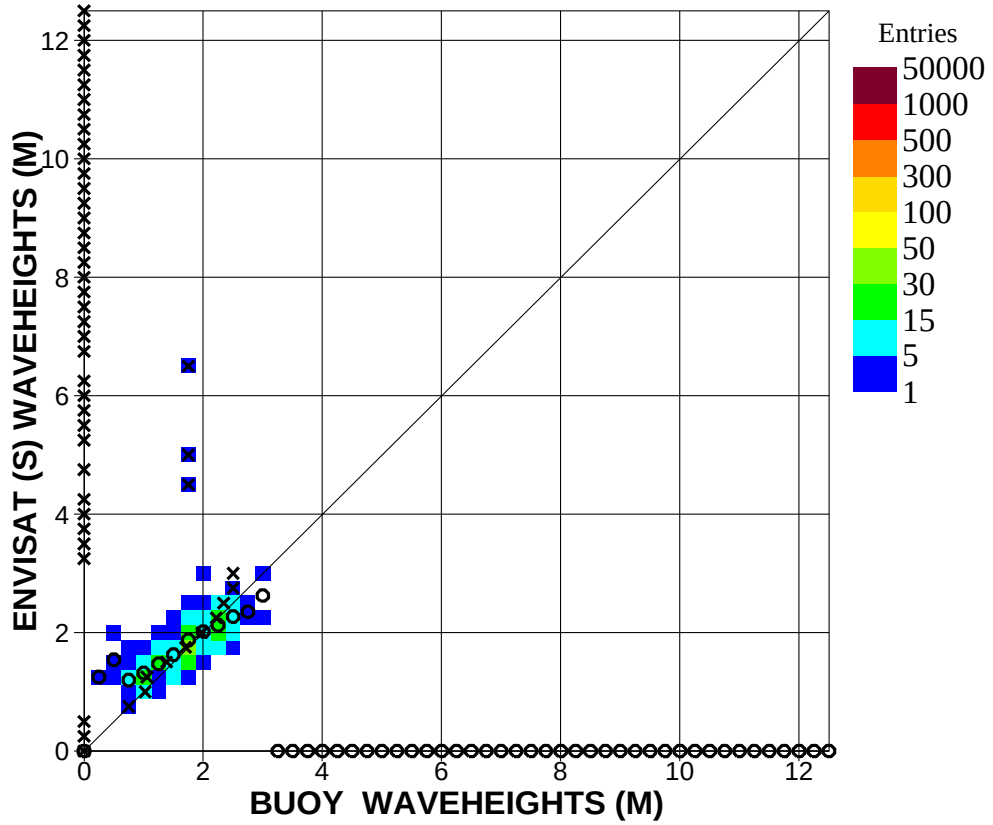

STATISTICS

ENTRIES	331	
MEAN BUOY	1.6793	
MEAN ENVISAT	1.8040	
BIAS (ENVISAT - BUOY)	.1247	
STANDARD DEVIATION	.4614	
SCATTER INDEX	.2748	
CORRELATION	.6018	
SYMMETRIC SLOPE	1.0712	(.0519)
REGR. COEFFICIENT	.6244	(.0457)
REGR. CONSTANT	.7553	(.0801)

Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2005 (Tropics)

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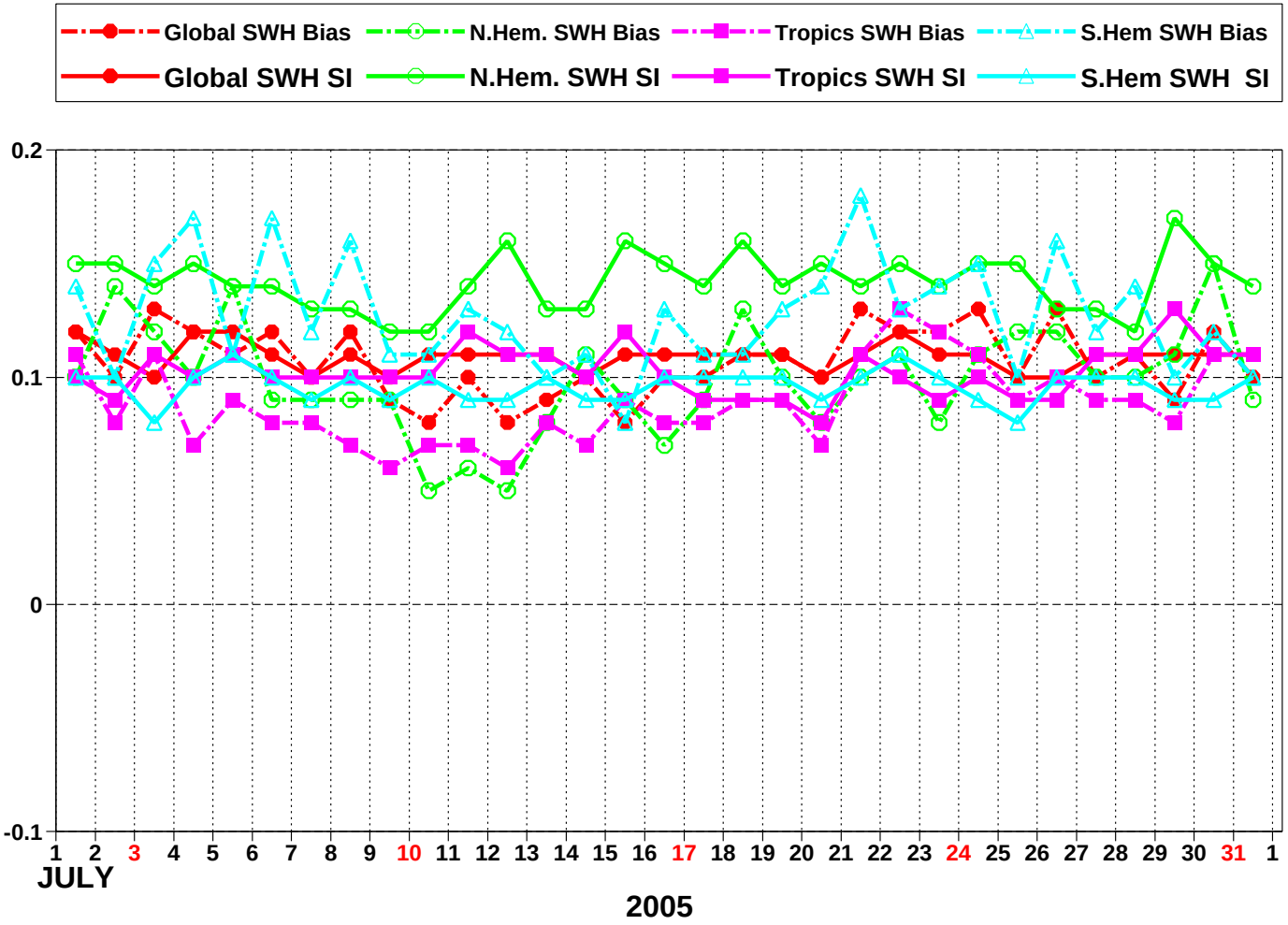

Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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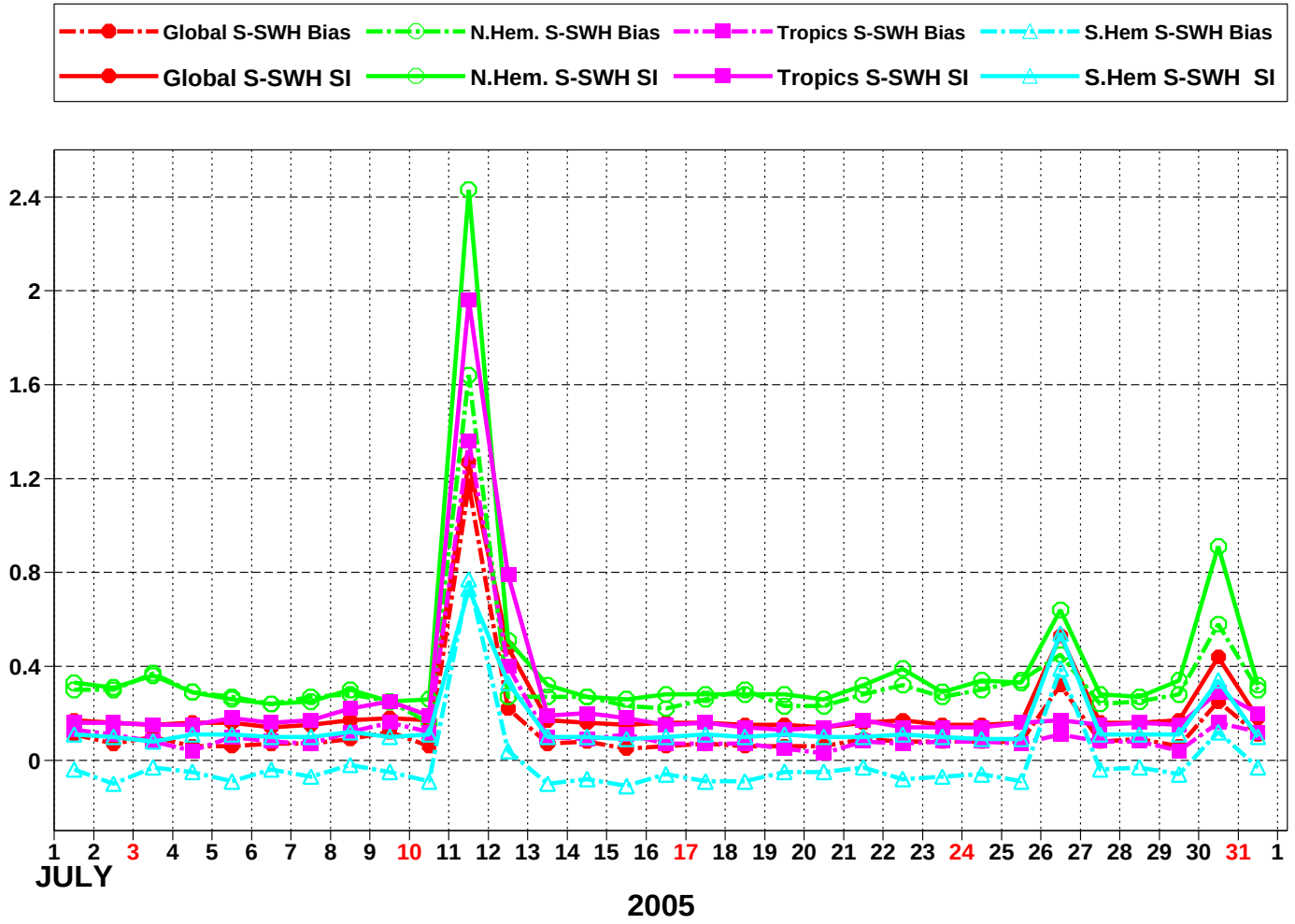

Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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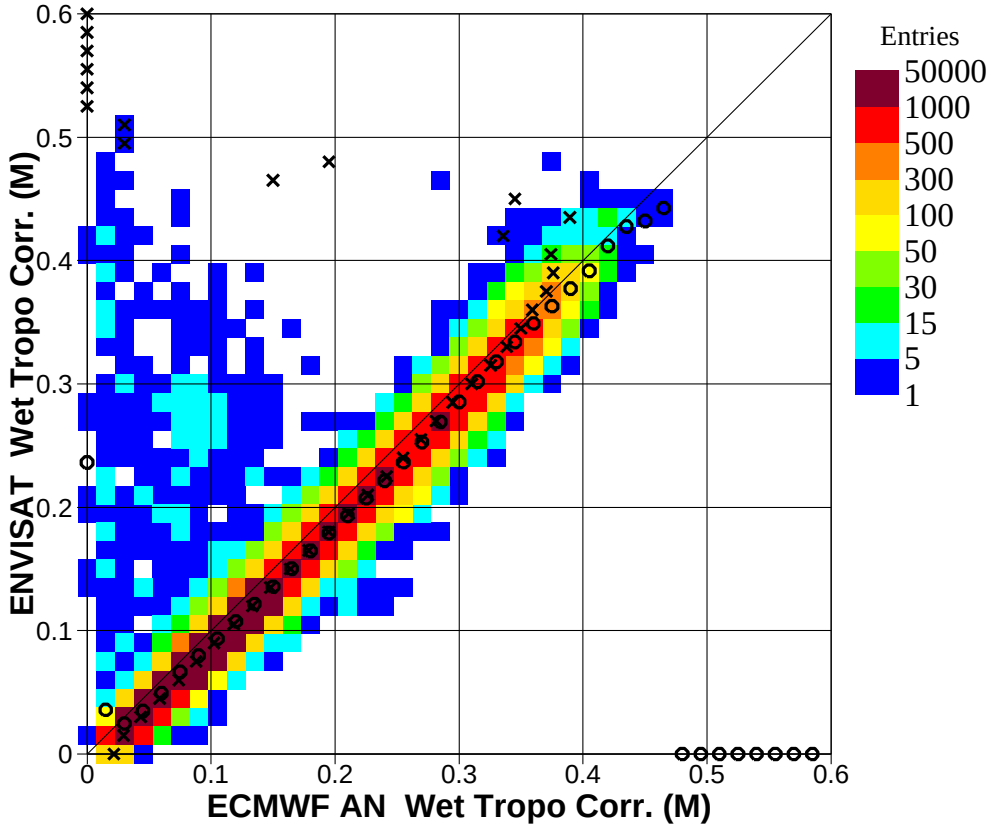

STATISTICS

ENTRIES	90785
MEAN ECMWF	.1696
MEAN ENVISAT	.1570
BIAS (ENVISAT - ECMWF)	-.0126
STANDARD DEVIATION	.0211
SCATTER INDEX	.1242
CORRELATION	.9775
SYMMETRIC SLOPE	.9455 (.0007)
REGR. COEFFICIENT	.9779 (.0007)
REGR. CONSTANT	-.0088 (.0001)

Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2005 (Global)

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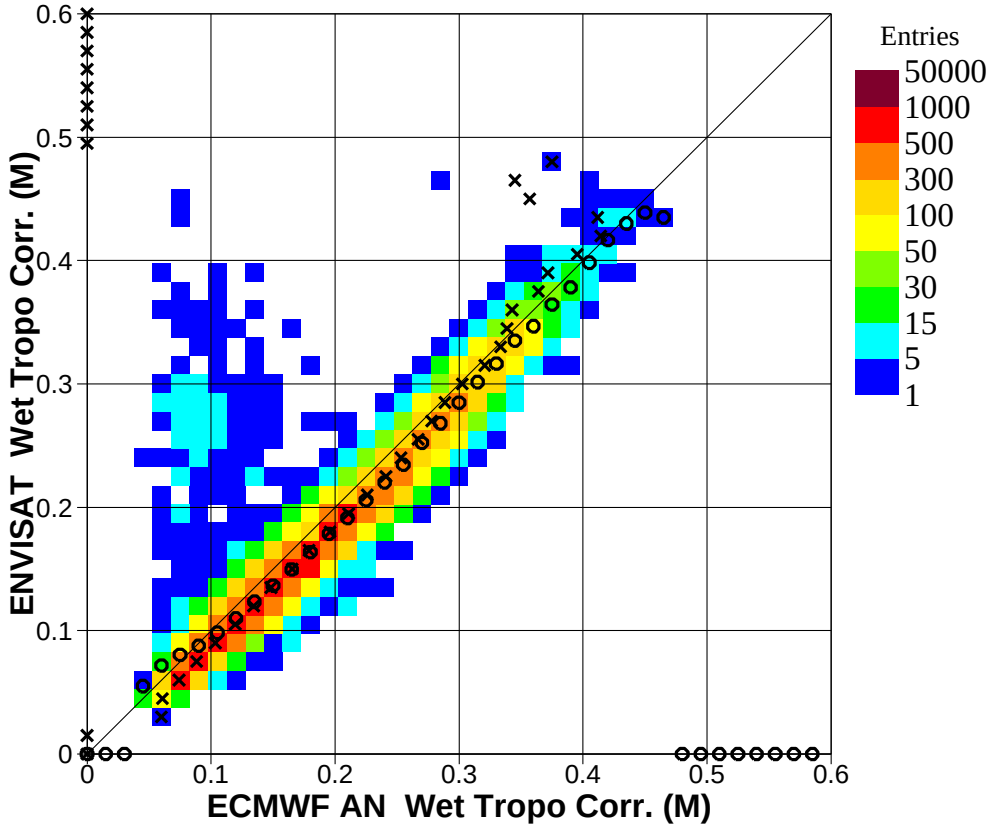

STATISTICS

ENTRIES	25289
MEAN ECMWF	.1862
MEAN ENVISAT	.1736
BIAS (ENVISAT - ECMWF)	-.0127
STANDARD DEVIATION	.0241
SCATTER INDEX	.1297
CORRELATION	.9511
SYMMETRIC SLOPE	.9416 (.0019)
REGR. COEFFICIENT	.9463 (.0019)
REGR. CONSTANT	-.0026 (.0004)

Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2005 (N.Hem.)

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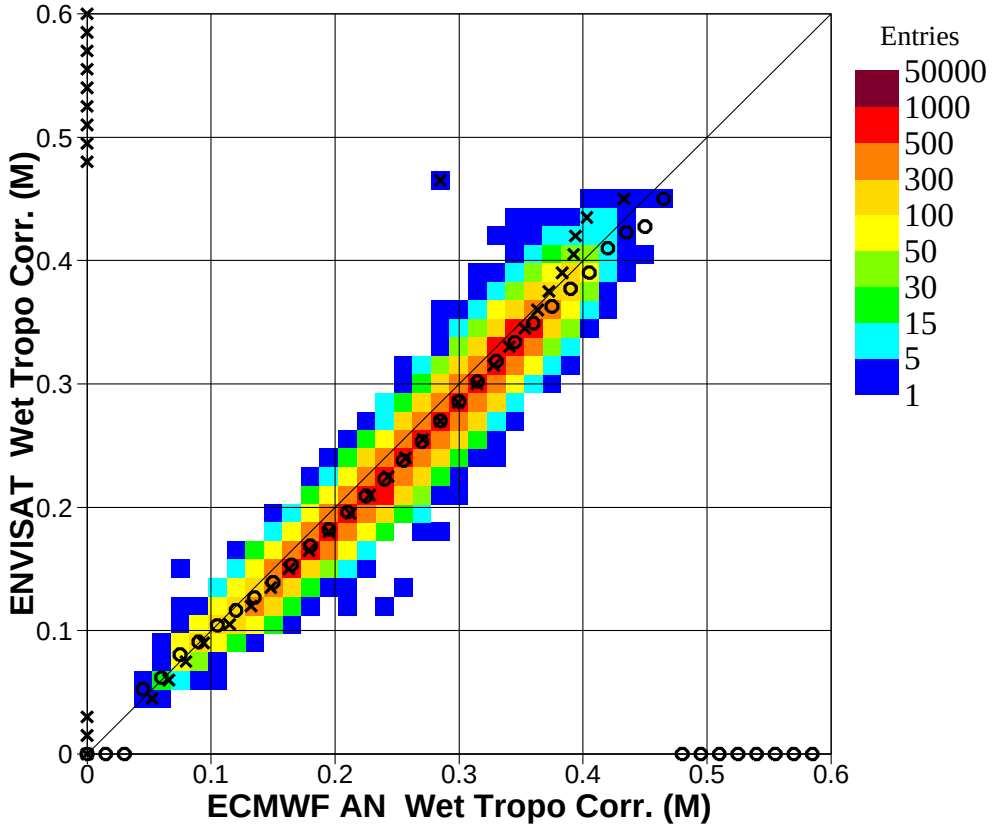

STATISTICS

ENTRIES	29002
MEAN ECMWF	.2612
MEAN ENVISAT	.2483
BIAS (ENVISAT - ECMWF)	-.0128
STANDARD DEVIATION	.0159
SCATTER INDEX	.0610
CORRELATION	.9787
SYMMETRIC SLOPE	.9557 (.0012)
REGR. COEFFICIENT	.9885 (.0012)
REGR. CONSTANT	-.0098 (.0003)

Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2005 (Tropics)

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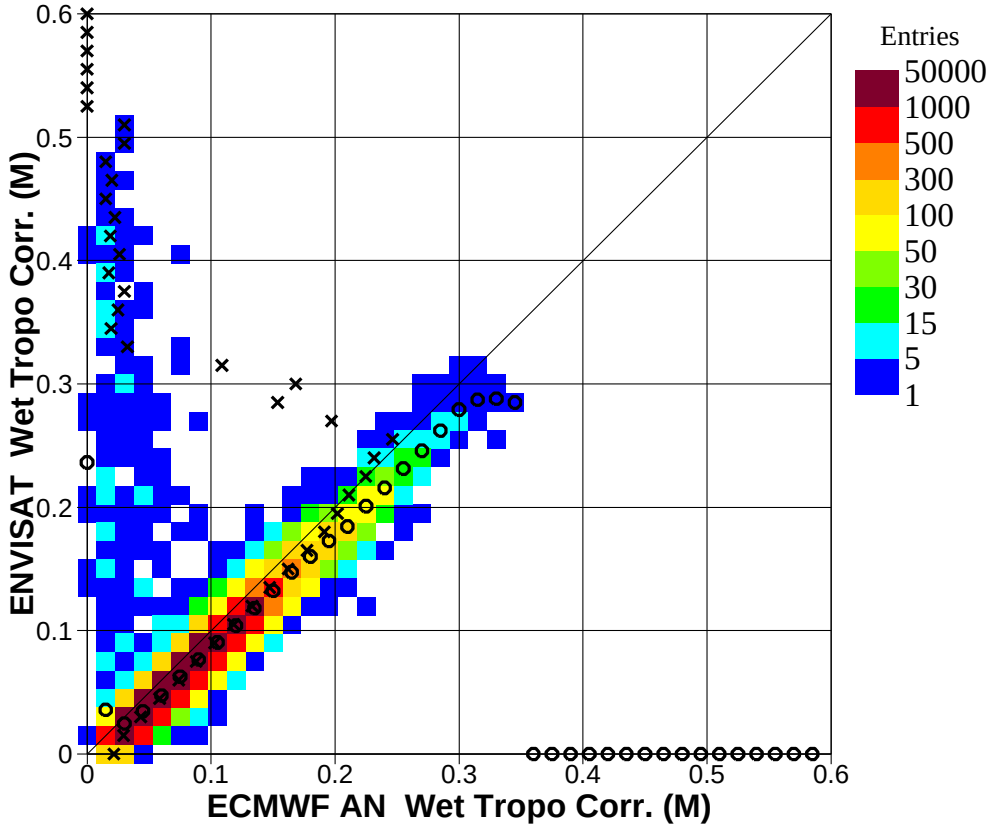

STATISTICS

ENTRIES	37202
MEAN ECMWF	.0876
MEAN ENVISAT	.0753
BIAS (ENVISAT - ECMWF)	-.0123
STANDARD DEVIATION	.0222
SCATTER INDEX	.2538
CORRELATION	.8833
SYMMETRIC SLOPE	.8950 (.0025)
REGR. COEFFICIENT	.8962 (.0025)
REGR. CONSTANT	-.0032 (.0002)

Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2005 (S.Hem.)

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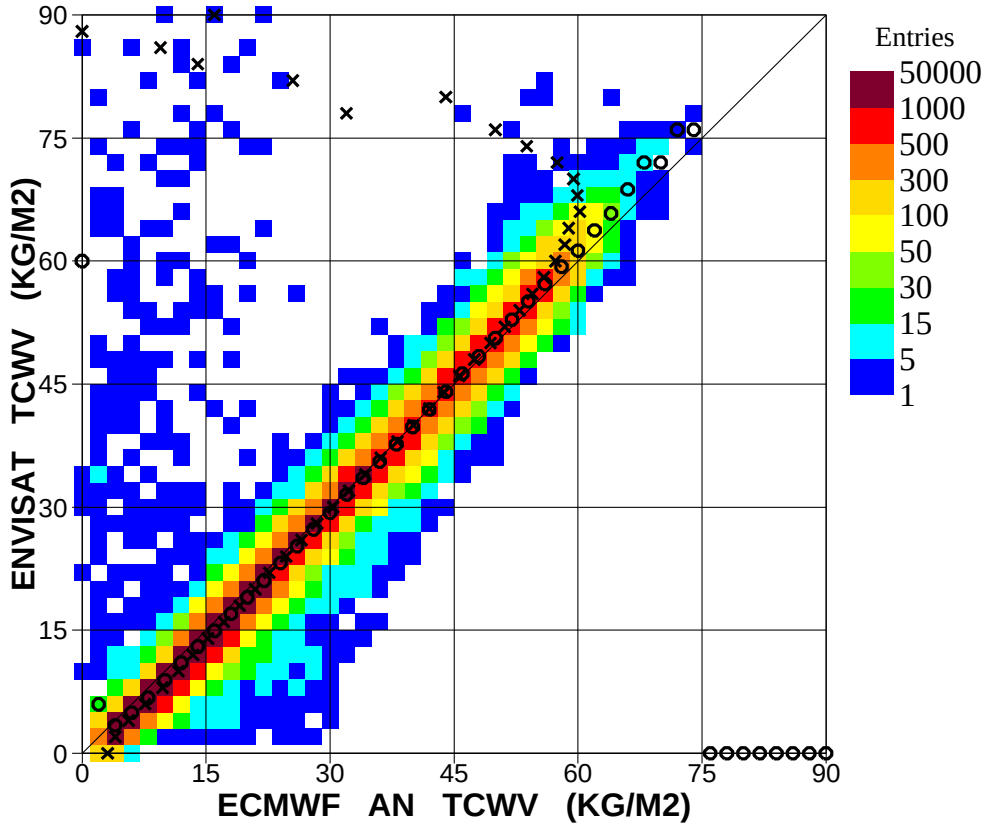

STATISTICS

ENTRIES	90572
MEAN ECMWF	26.0728
MEAN ENVISAT	25.5894
BIAS (ENVISAT - ECMWF)	-.4834
STANDARD DEVIATION	3.9433
SCATTER INDEX	.1512
CORRELATION	.9730
SYMMETRIC SLOPE	1.0048 (.0008)
REGR. COEFFICIENT	1.0367 (.0008)
REGR. CONSTANT	-1.4406 (.0249)

Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2005 (Global)

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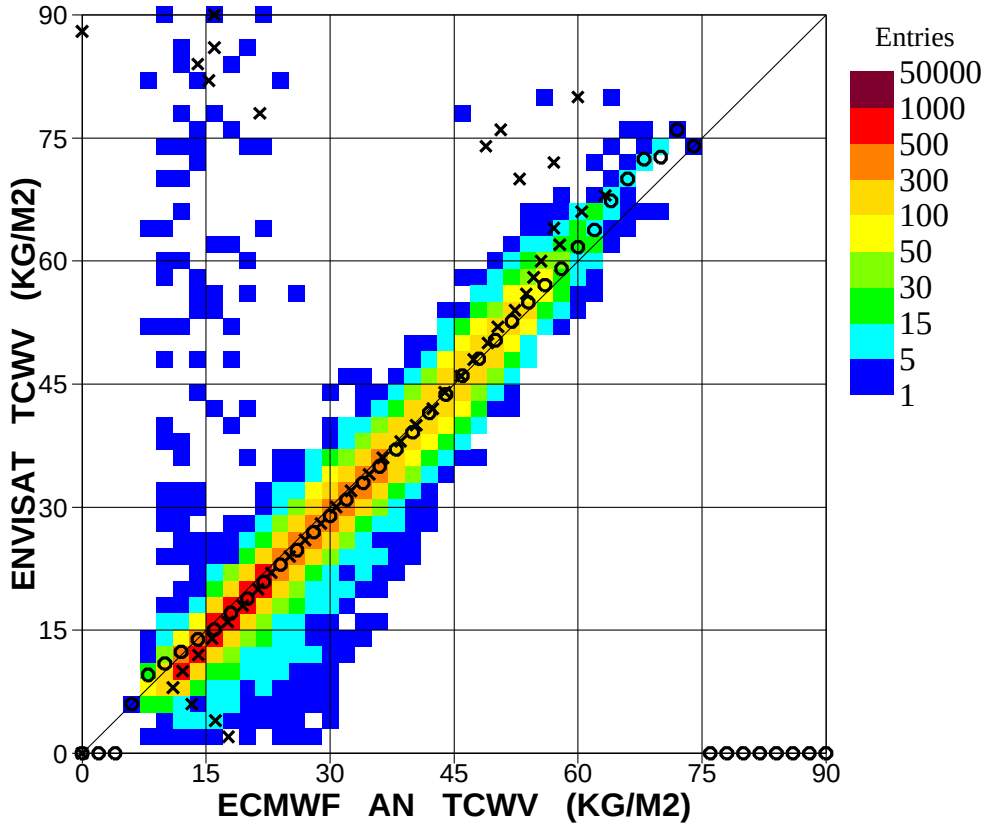

STATISTICS

ENTRIES	25109
MEAN ECMWF	28.9148
MEAN ENVISAT	28.2850
BIAS (ENVISAT - ECMWF)	-.6299
STANDARD DEVIATION	5.0478
SCATTER INDEX	.1746
CORRELATION	.9283
SYMMETRIC SLOPE	.9975 (.0026)
REGR. COEFFICIENT	1.0182 (.0026)
REGR. CONSTANT	-1.1550 (.0809)

Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2005 (N.Hem.)

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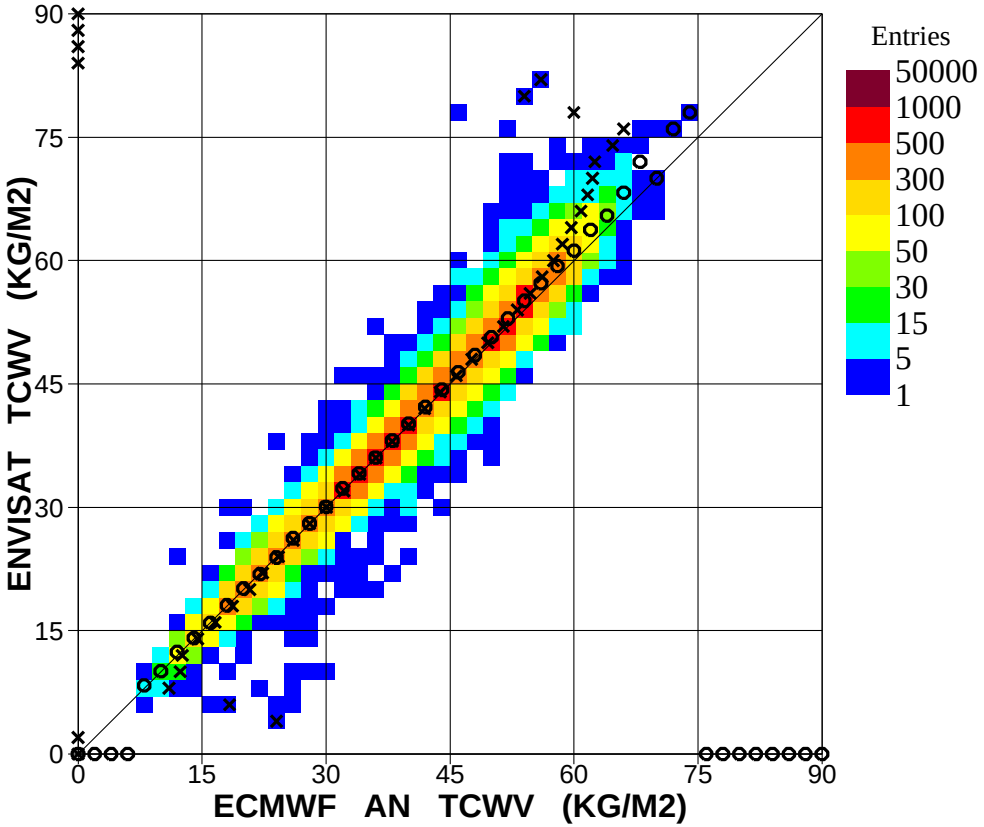

STATISTICS

ENTRIES	29002
MEAN ECMWF	40.5997
MEAN ENVISAT	41.0447
BIAS (ENVISAT - ECMWF)	.4450
STANDARD DEVIATION	2.4261
SCATTER INDEX	.0598
CORRELATION	.9832
SYMMETRIC SLOPE	1.0147 (.0011)
REGR. COEFFICIENT	1.0356 (.0011)
REGR. CONSTANT	-.9992 (.0478)

Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2005 (Tropics)

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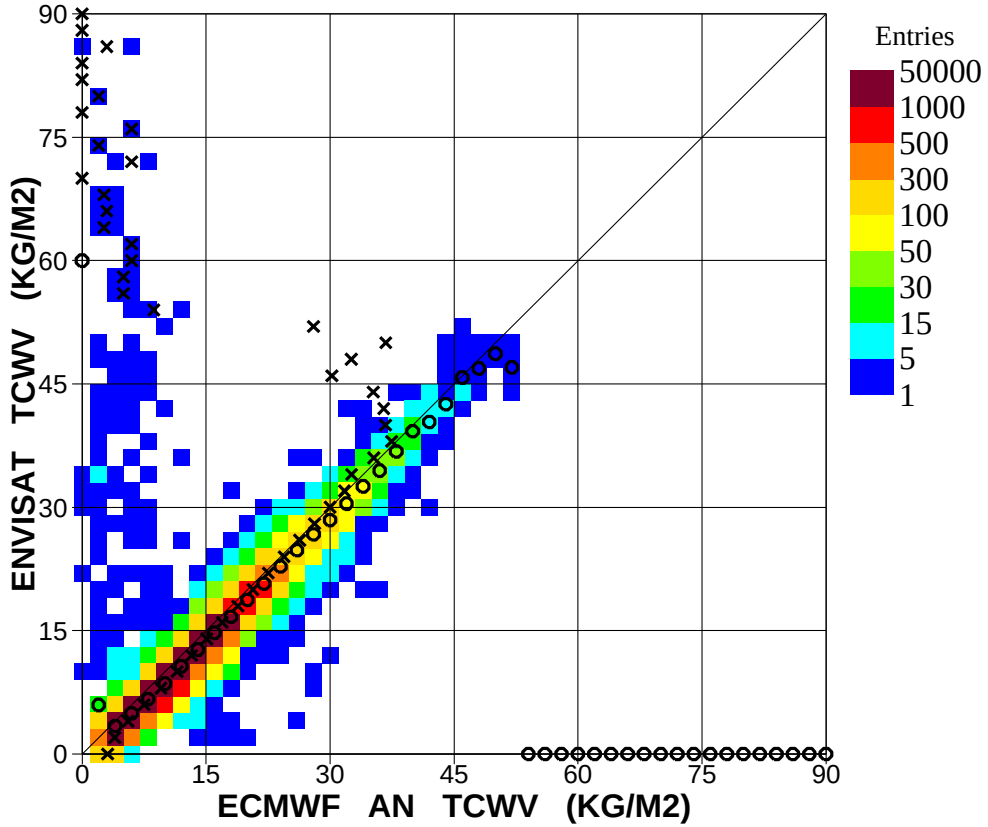

STATISTICS

ENTRIES	37169
MEAN ECMWF	12.9281
MEAN ENVISAT	11.8288
BIAS (ENVISAT - ECMWF)	-1.0993
STANDARD DEVIATION	3.8926
SCATTER INDEX	.3011
CORRELATION	.8668
SYMMETRIC SLOPE	.9630 (.0029)
REGR. COEFFICIENT	.9629 (.0029)
REGR. CONSTANT	-.6194 (.0423)

Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2005 (S.Hem.)

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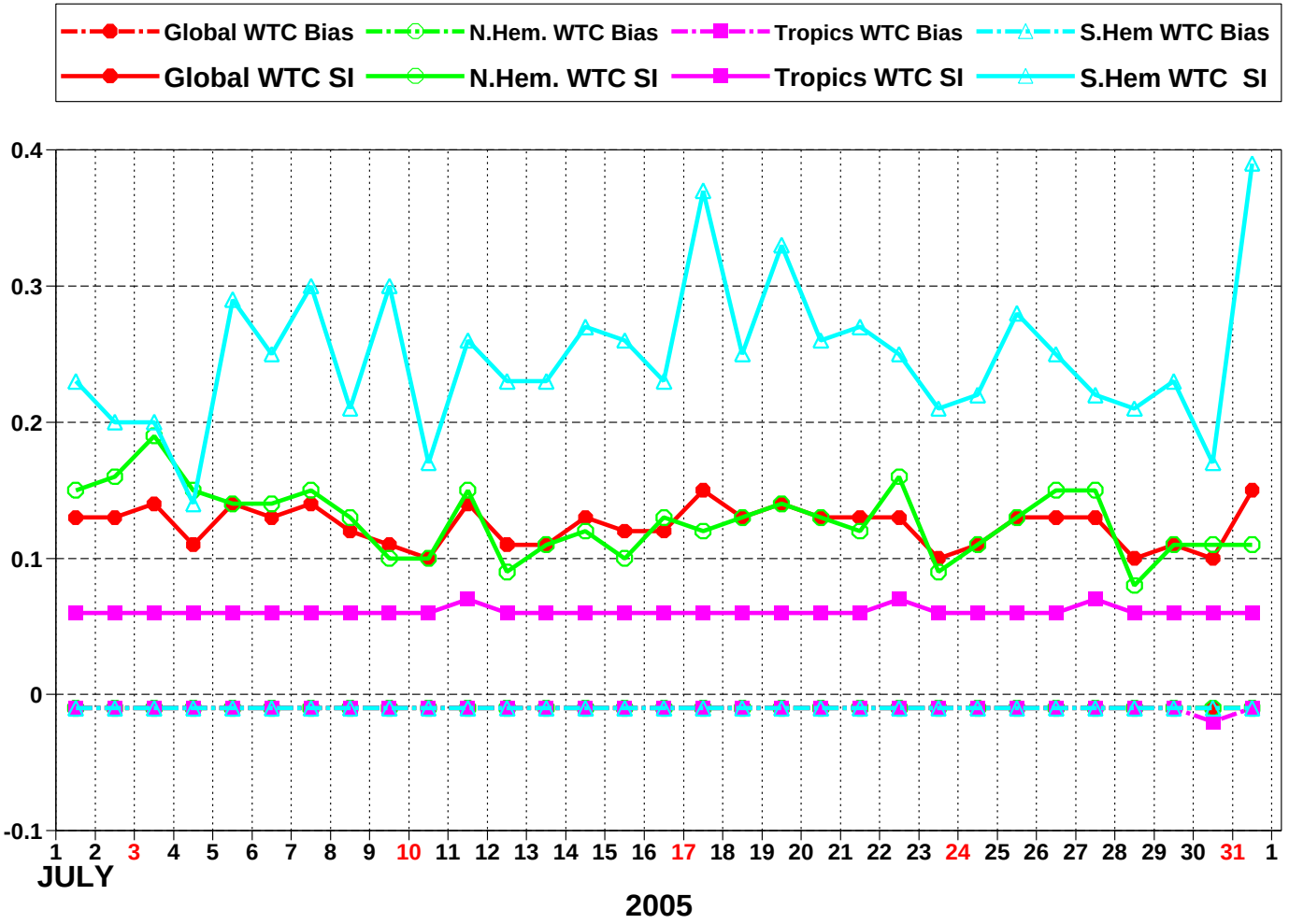

Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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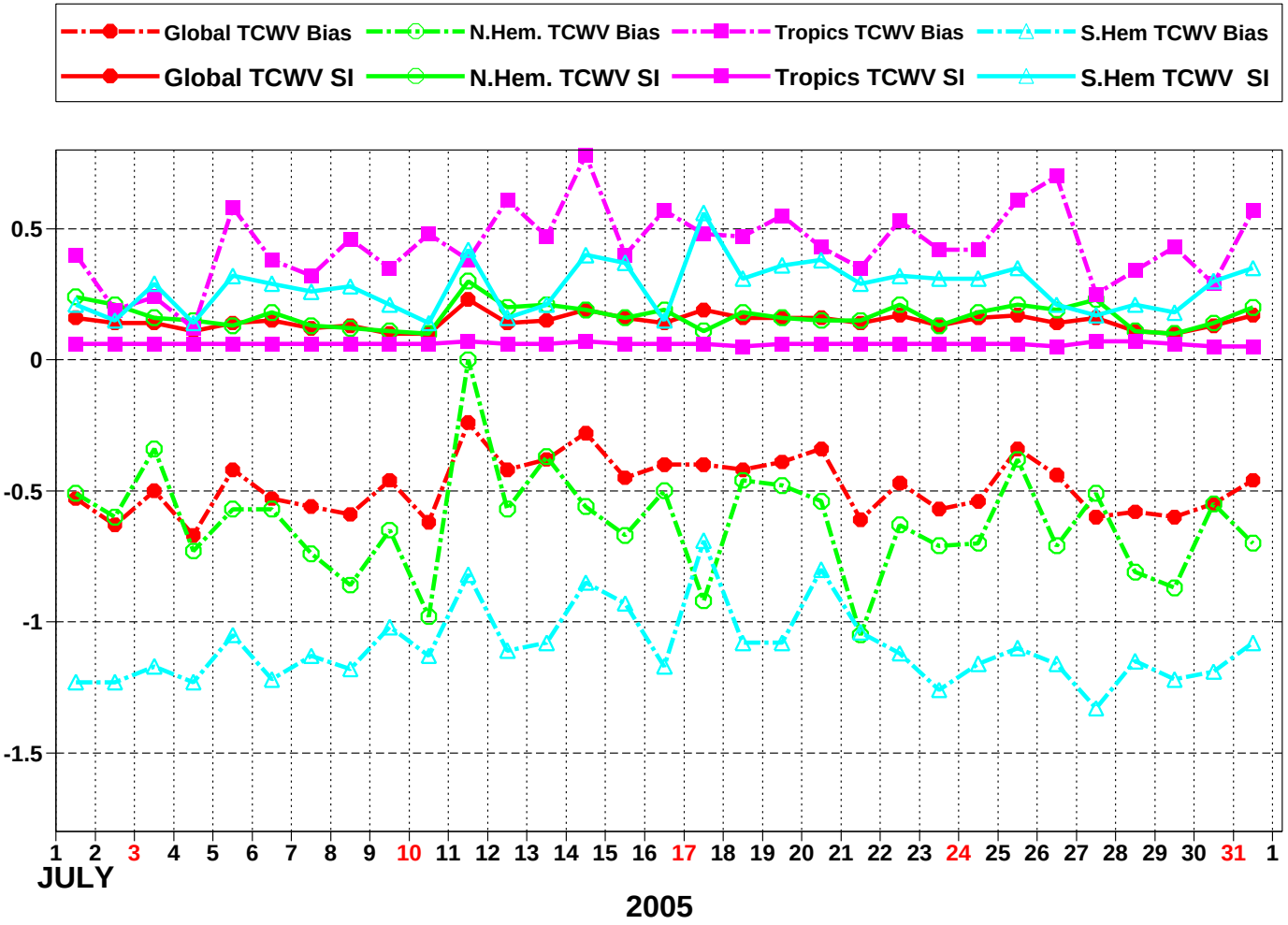

Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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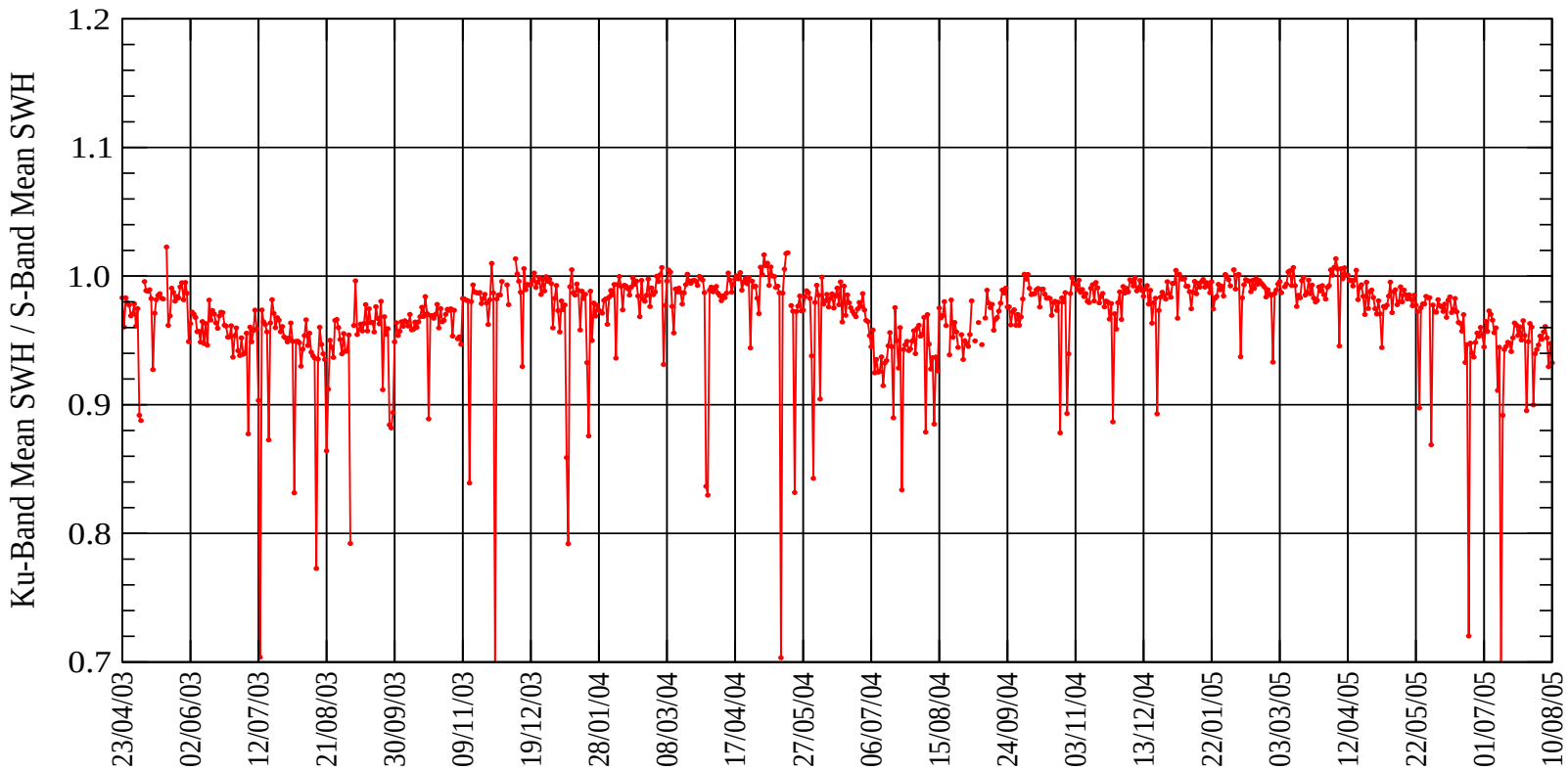

Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 23rd. of April 2003.

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