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

Wind/Wave Product with Height Information (RA2_WWV_2P)

By: *Saleh Abdalla*

Date: *14 May 2007*

Overview:

Based on the data received during this month, on average, 16359 observations arrived at ECMWF every 6-hour window of which an average of 6545 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 80.05% of the remaining part passed the quality control. As can be seen in Figure 1, there was no data during the following periods (in terms of 6-hour time windows):

- time window centred at 18:00 UTC on the 9th. of the month,
- time windows centred at 12:00 UTC on the 10th., the 15th. and the 30th. of the month.

Furthermore, there was some reduction in data volume during several other time windows.

Note that we are talking about the raw data which we downloaded in "BUFR" format before they were processed. Some of the data losses was due to delays in the availability of data files on ESA ftp servers.

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ECMWF Report on ENVISAT RA-2 for April 2007

Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of very good quality. The S-band wave height observations, after removing the S-band anomaly related outliers, are of good quality. The quality of wind speed observations is as good as usual. The MWR products, after removing the ice contaminated observations, are generally in good agreement with the model (wet tropo correction is somewhat smaller than the model). **The S-band significant wave height is lower than usual after the implementation of the IPF 5.03.**

Backscatter:

- ENVISAT Ku-band $<\sigma^0>$ = 11.09 dB (with a main peak at 10.6 dB and a secondary peak at 11.1 dB).
- ENVISAT S-band $<\sigma^0>$ = 11.42 dB (with a main 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	+ 0.28	16.1	- 0.18	21.0
Northern Hemisphere	+ 0.20	16.5	- 0.11	21.8
Tropics	+ 0.14	16.9	- 0.65	10.9
Southern Hemisphere	+ 0.42	15.1	----	----

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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	0.09	10.4	0.14	14.9
Northern Hemisphere	0.13	11.7	0.15	14.9
Tropics	0.06	9.2	0.09	14.8
Southern Hemisphere	0.10	9.7	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	- 0.11	14.4	+ 0.01	20.7
Northern Hemisphere	- 0.03	16.8	+ 0.02	20.7
Tropics	- 0.02	19.0	- 0.06	20.8
Southern Hemisphere	- 0.22	10.8	----	----

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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	8.5	- 0.53	8.8
Northern Hemisphere	- 0.015	10.2	- 1.40	9.9
Tropics	- 0.012	6.2	+ 0.46	6.2
Southern Hemisphere	- 0.011	10.9	- 0.72	10.6

Remarks:

- 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.
- The rain flag is responsible for the rejection of 5% of the data this month.
- As a result of the implementation of the IPF version 5.02 processing chain, the wind speed product is now limited to a lower value of 1.18 m/s (Figures 4 and 5). This is an expected result as the algorithm was tailored to fit the model and the buoy wind speeds requiring this type of shift. Further adjustment was not found suitable below this value since there is some doubts about the capability of wind with lower speeds to generate any detectable surface water waves. Irrespective of this, the wind speed histogram of Figure 5 compares well with the model counterpart in Figure 6.

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- As can be seen in Table 1 and Figures 7-10, the wind speed data are in good agreement with the ECMWF model. ENVISAT wind speed product is now about 28 cm/s (20 cm/s in NH, 14 cm/s in Tropics, and 42 cm/s in SH) higher than the model for this month. On the other hand, it is about 18 cm/s **lower** than the buoy measurements. The upper limit of the algorithm is 21.3 m/s.
- The Ku-band significant wave heights are higher by about 3.6% when compared to WAM model results (5.3% in the NH, 3.0% in Tropics and 3.3% in SH) over the whole month. This is visually clear in the scatter plots of Figures 22-25 (Ku-band - WAM comparisons) and can be inferred from the symmetric slope values of same scatter plots. On the other hand, the RA-2 Ku-band wave heights are about 4.4% higher than buoy wave heights as can be seen in Figures 30-32 (Ku-band - buoy comparison).
- As a result of the additional quality control criteria of limiting the difference between the backscatter coefficient values from Ku- and S-band altimeters, most of the outliers (due to the well-known RA-2 S-band anomaly) in the scatter plots of S-band versus wave model significant wave height (Figures 26-29) were eliminated.
- The S-band overestimates significant wave heights at low sea states forming a tail in the scatter plots similar to the corresponding ERS altimeter plots (see Figures 26-29 and 33-35).
- The S-band significant wave height product is lower than the model except for conditions with low sea state dominance; i.e. the Northern Hemisphere during the summer and the Tropics.
- **The S-band significant wave height is about 3-4% (~10 cm) lower than usual following the operational implementation of the ENVISAT Altimetry Instrument Processing Facility (IPF) Version 5.03 on the 19th. of September 2006.**
- **As can be seen in Figure 48, the ratio between Ku-band and S-band wave heights this month was between 1.03 and 1.06 (following the IPF Ver. 5.03 processing chain on the 19th. of September 2006).**

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- It is important to notice the seasonal variation for the ratio between Ku- and S-band wave heights with low values of about 0.92-0.94 (0.96 in 2006) reached during June to August and high values around 1.0 (1.02 in 2005-2006) during December to April. This seasonal cycle seems to be related to the S-Band overestimation of low wave height (see Figures 26-29 and 33-35). **However, it seems that this picture has changed after the implementation of IPF 5.03.**
- Stricter quality control and the use of the model sea ice information eliminate most of the usual 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).
- **There is a small cloud of TCWV scatter plot outliers hanging below the main cloud at model values between 20 and 30 kg/m^2 as can be seen in Figures 42-45. It occurs almost anywhere. This group of outliers becomes very clear in the rather long-period scatter plots. No specific condition or geographical location could be associated with this behaviour. The additional quality control criteria mentioned above did not help much to eliminate this kind of outliers. This issue is still unresolved.**
- While the MWR derived TCWV is now in good agreement with the model counterpart (MWR TCWV is slightly smaller than the model in the Extra Tropics), 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 significant wave height and ASAR Wave Mode Level 1b data as well as Jason altimeter significant wave height data are assimilated in the ECMWF wave model. **Note, however, that the assimilation of ENVISAT ASAR Wave Mode wave heights has been halted since 18 January 2007.**

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- There was no ECMWF model change during this month. The current operational IFS cycle is CY31R1 (since 12 September 2006).

List of Figures:

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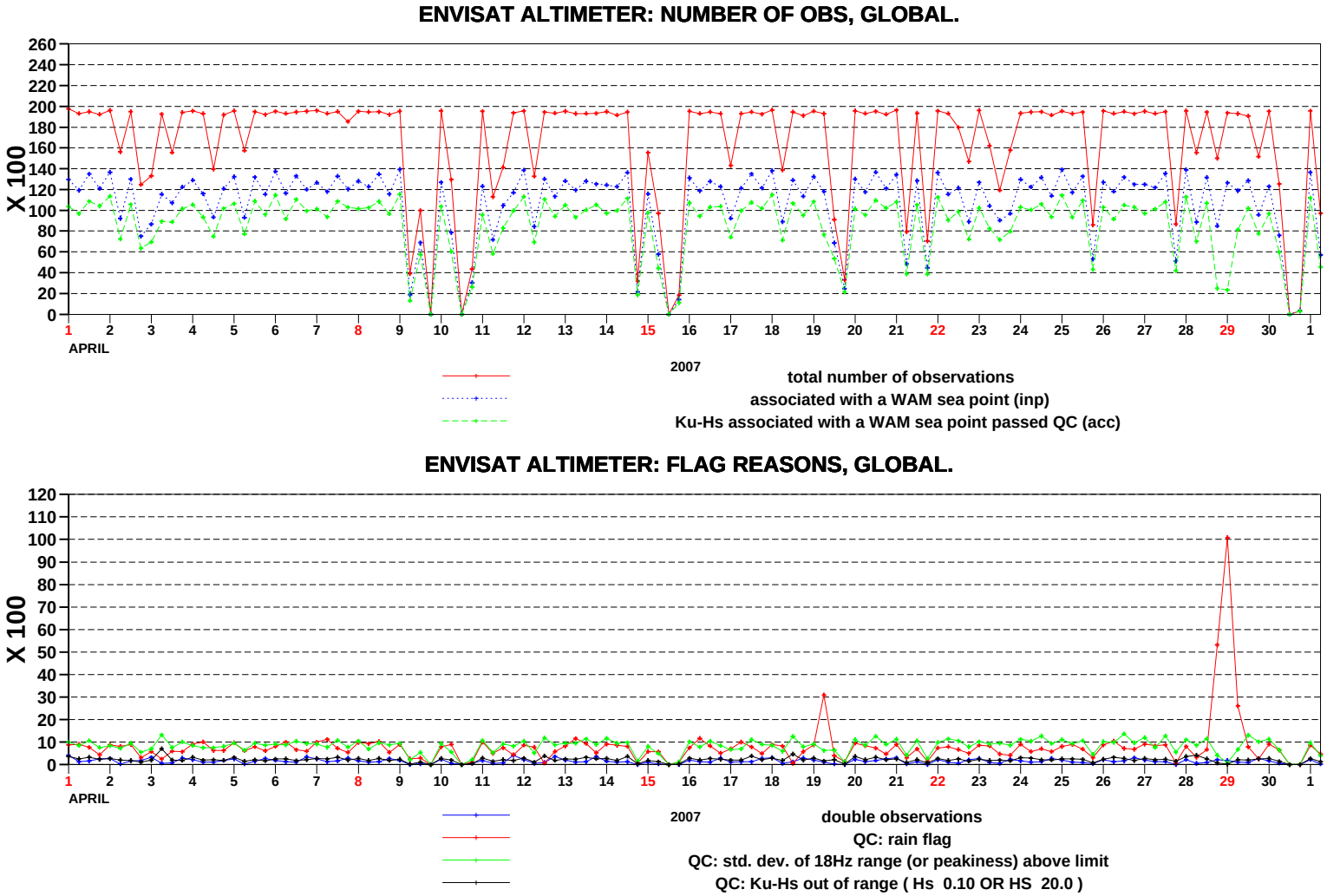

Figure 1:Time series of data reception for ENVISAT Altimeter data for April 2007

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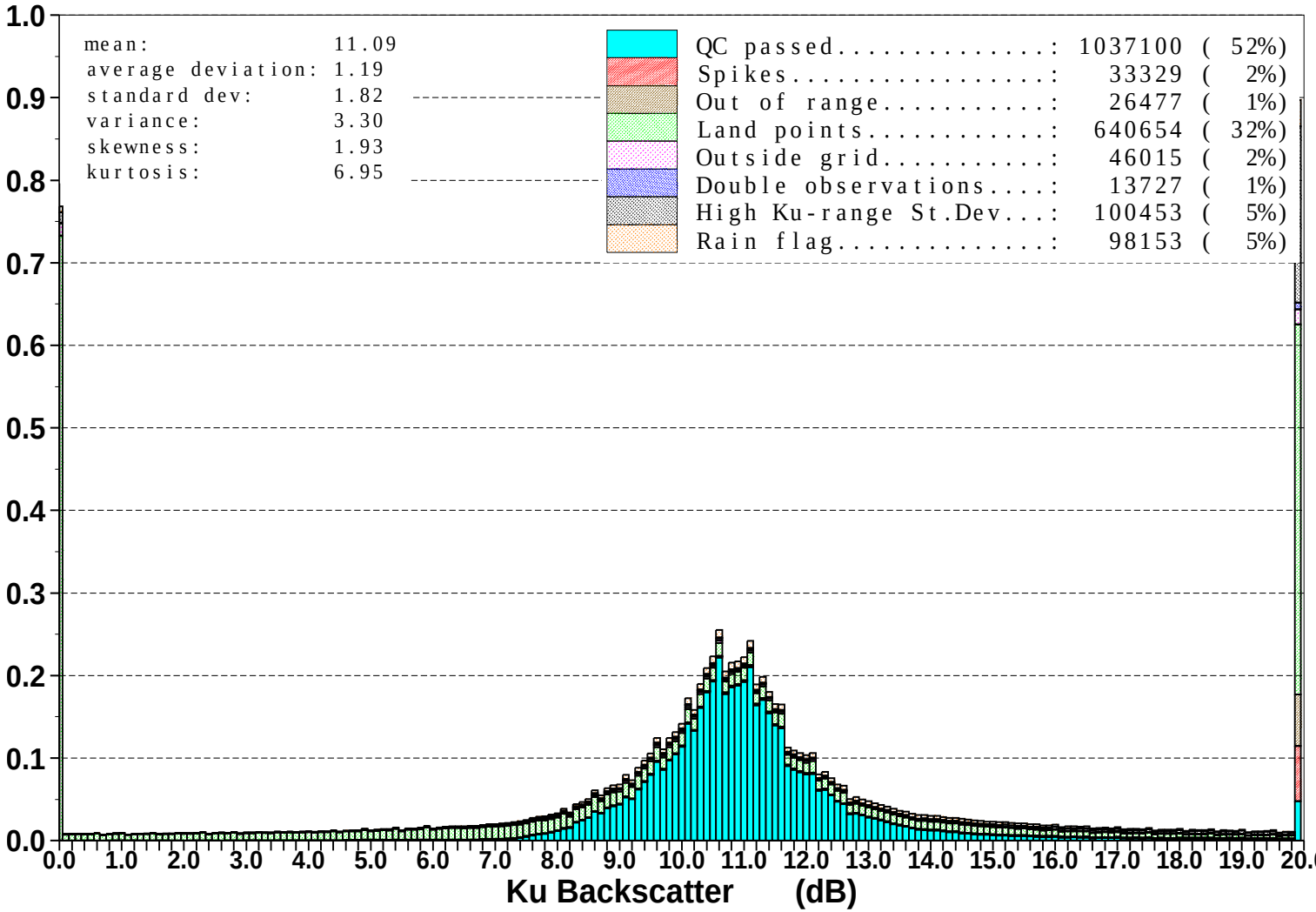

Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for April 2007

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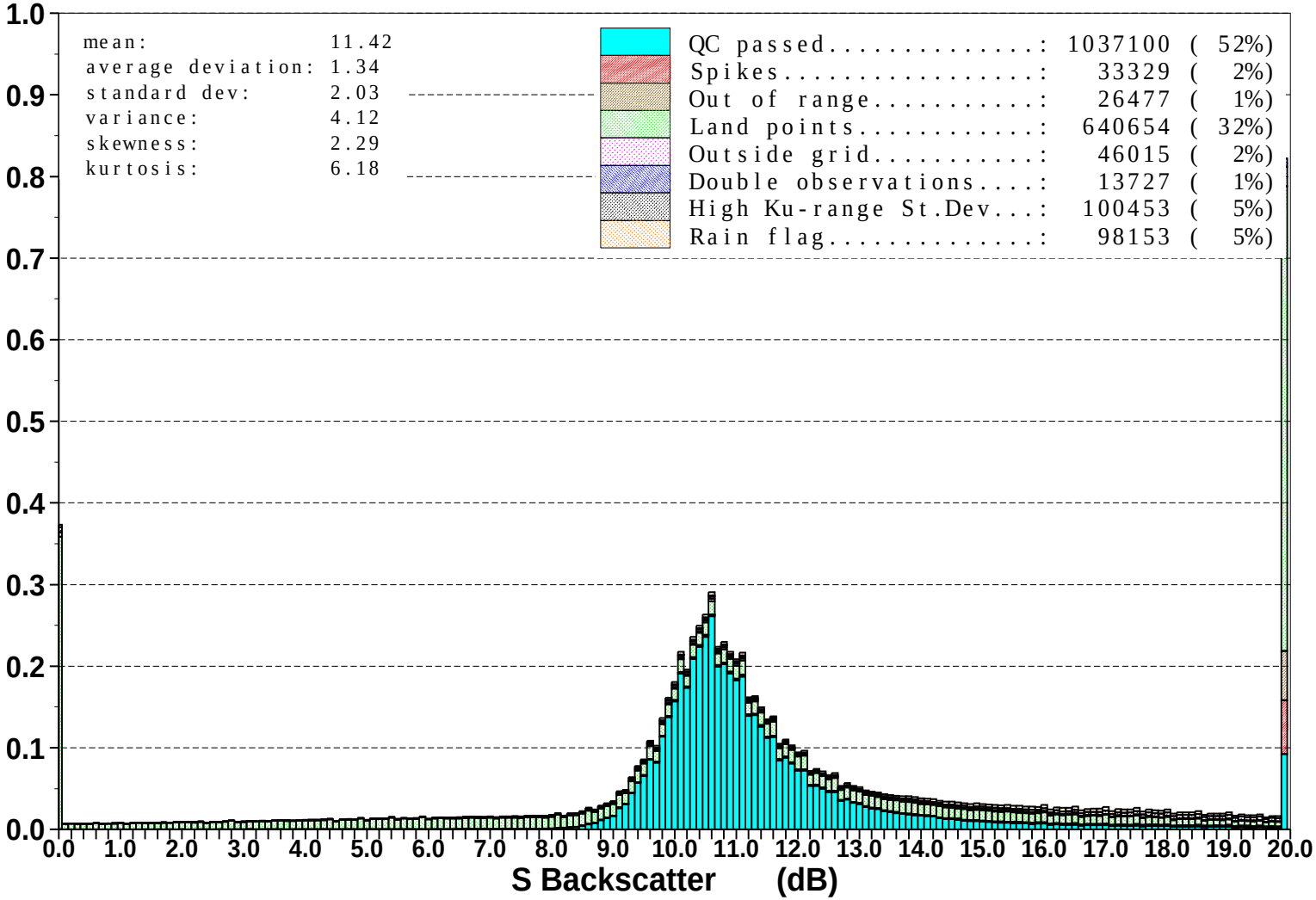

Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for April 2007

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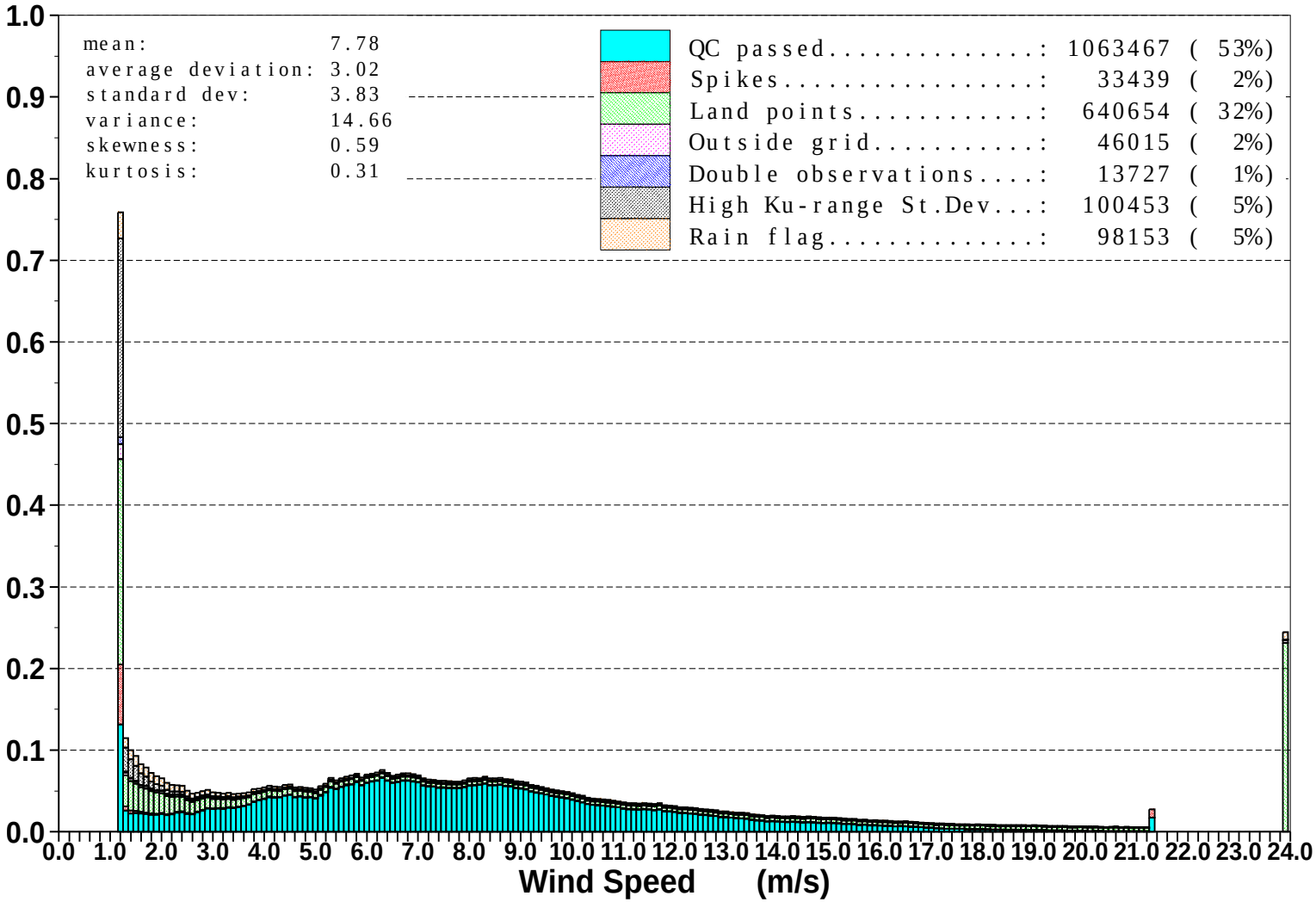

Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for April 2007

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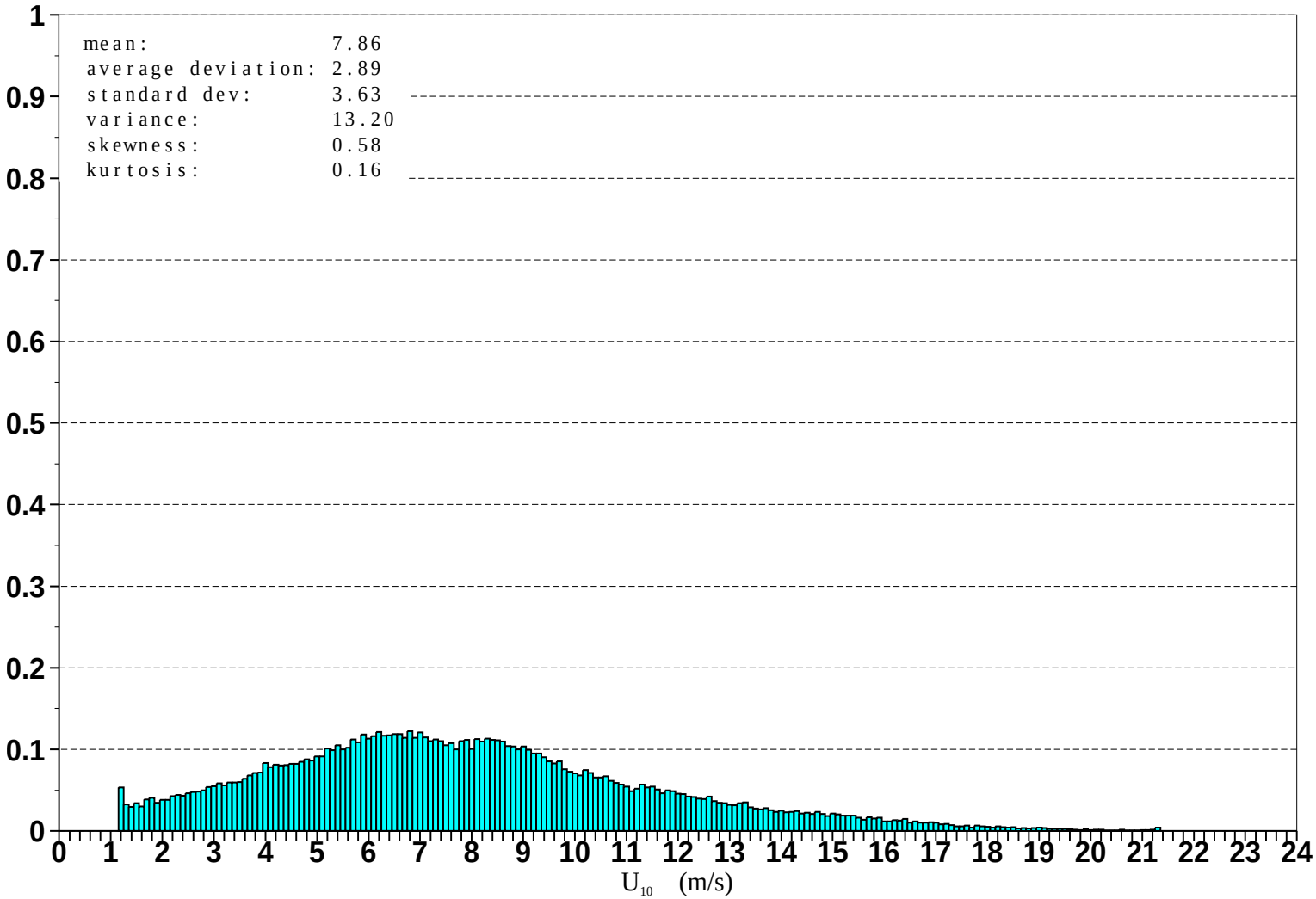

Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for April 2007

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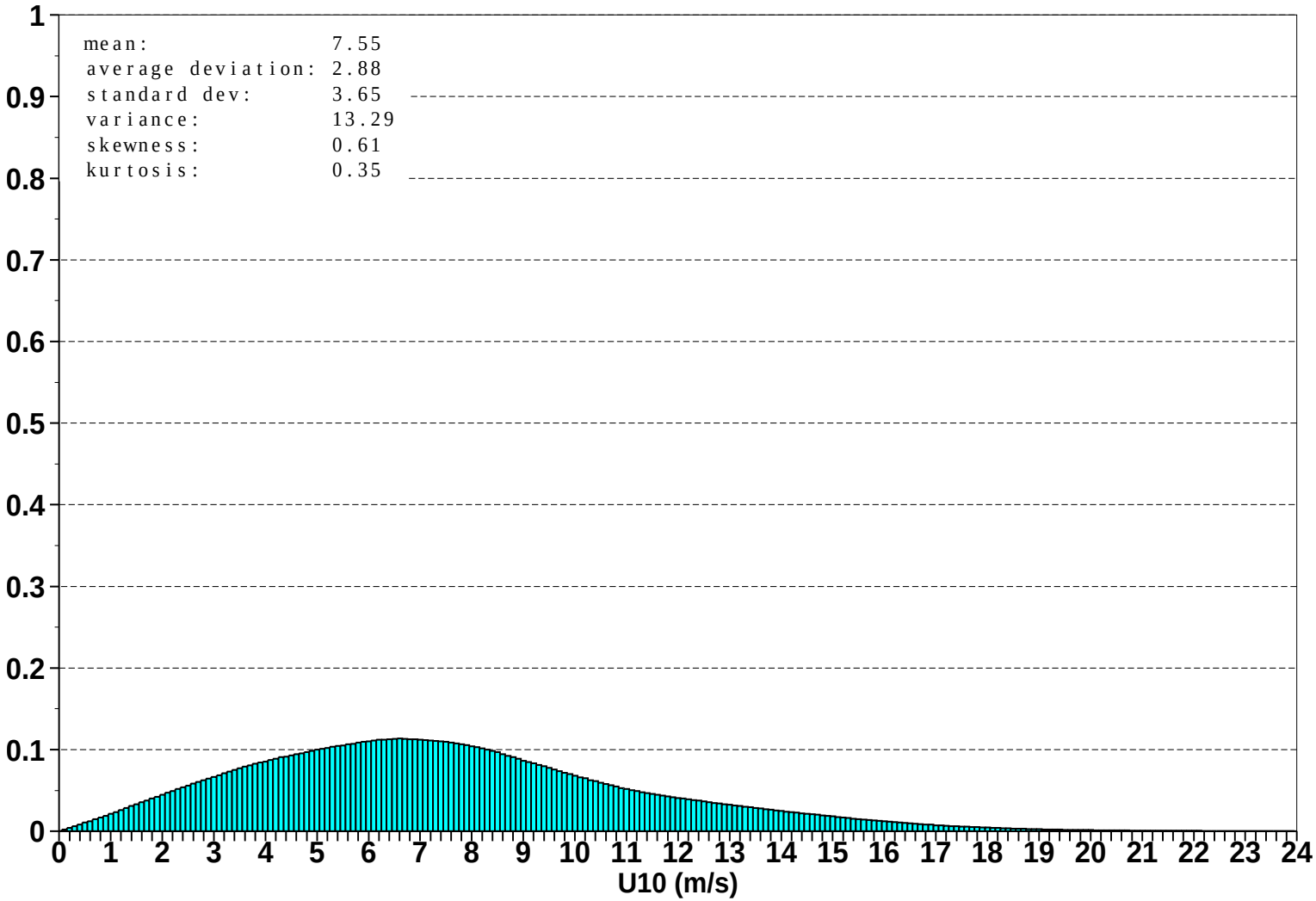

Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for April 2007

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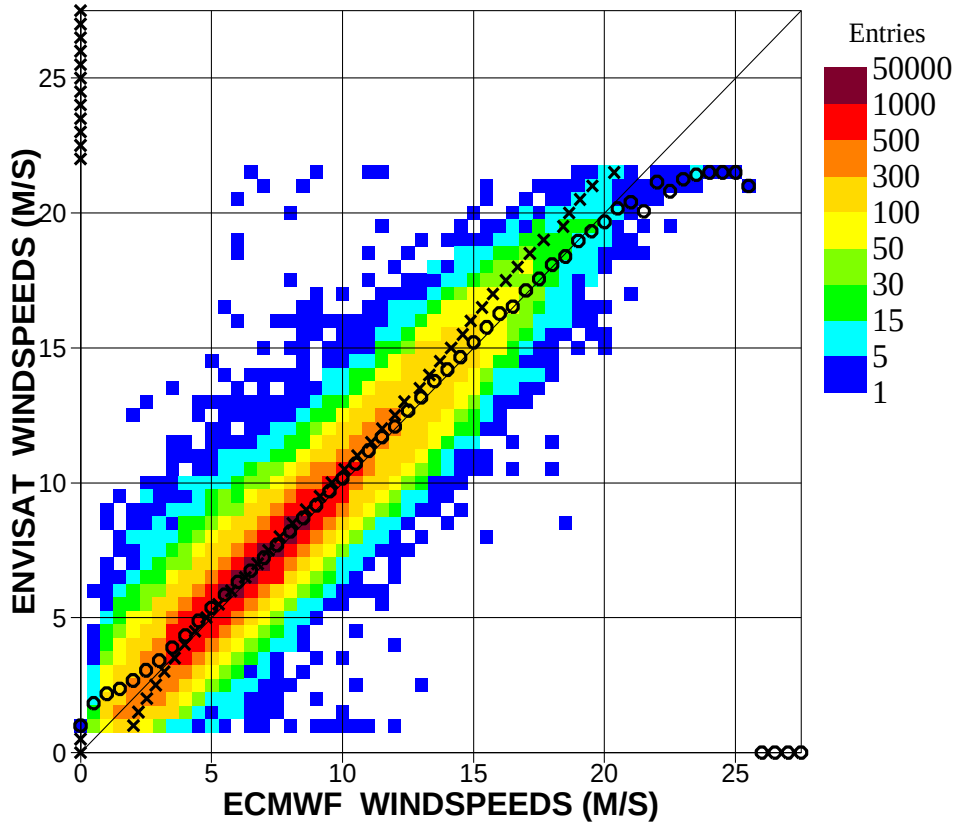

STATISTICS

ENTRIES	94247	
MEAN ECMWF	7.5827	
MEAN ENVISAT	7.8635	
BIAS (ENVISAT - ECMWF)	0.2808	
STANDARD DEVIATION	1.2199	
SCATTER INDEX	0.1609	
CORRELATION	0.9425	
SYMMETRIC SLOPE	1.0351	(0.0011)
REGR. COEFFICIENT	0.9673	(0.0011)
REGR. CONSTANT	0.5288	(0.0093)

Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2007 (Global)

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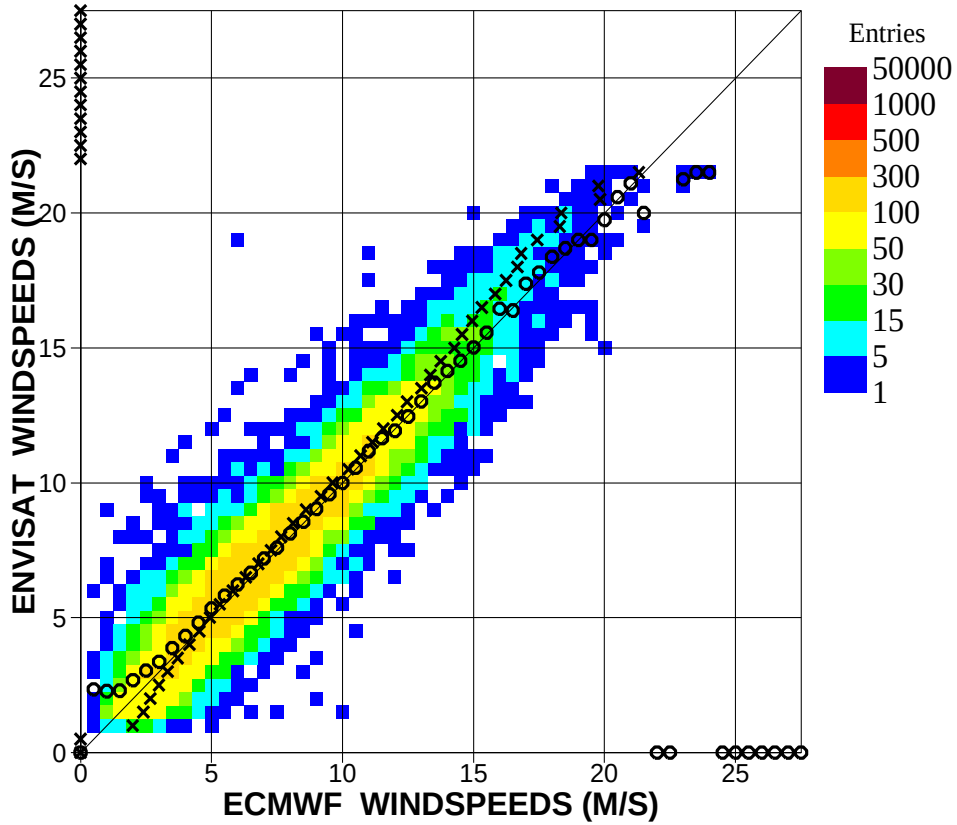

STATISTICS

ENTRIES	22781
MEAN ECMWF	7.5691
MEAN ENVISAT	7.7715
BIAS (ENVISAT - ECMWF)	0.2024
STANDARD DEVIATION	1.2470
SCATTER INDEX	0.1647
CORRELATION	0.9369
SYMMETRIC SLOPE	1.0268 (0.0024)
REGR. COEFFICIENT	0.9623 (0.0024)
REGR. CONSTANT	0.4875 (0.0198)

Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2007 (N.Hem.)

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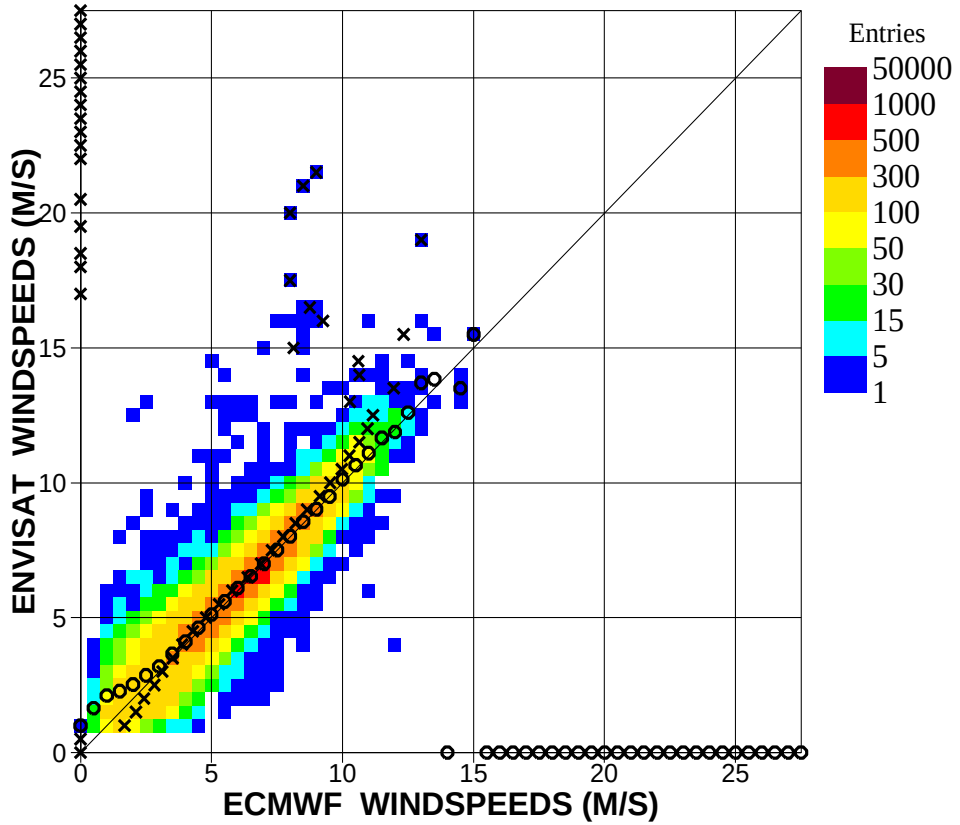

STATISTICS

ENTRIES	29327	
MEAN ECMWF	5.7969	
MEAN ENVISAT	5.9367	
BIAS (ENVISAT - ECMWF)	0.1398	
STANDARD DEVIATION	0.9779	
SCATTER INDEX	0.1687	
CORRELATION	0.9197	
SYMMETRIC SLOPE	1.0248	(0.0024)
REGR. COEFFICIENT	0.9461	(0.0024)
REGR. CONSTANT	0.4523	(0.0148)

Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2007 (Tropics)

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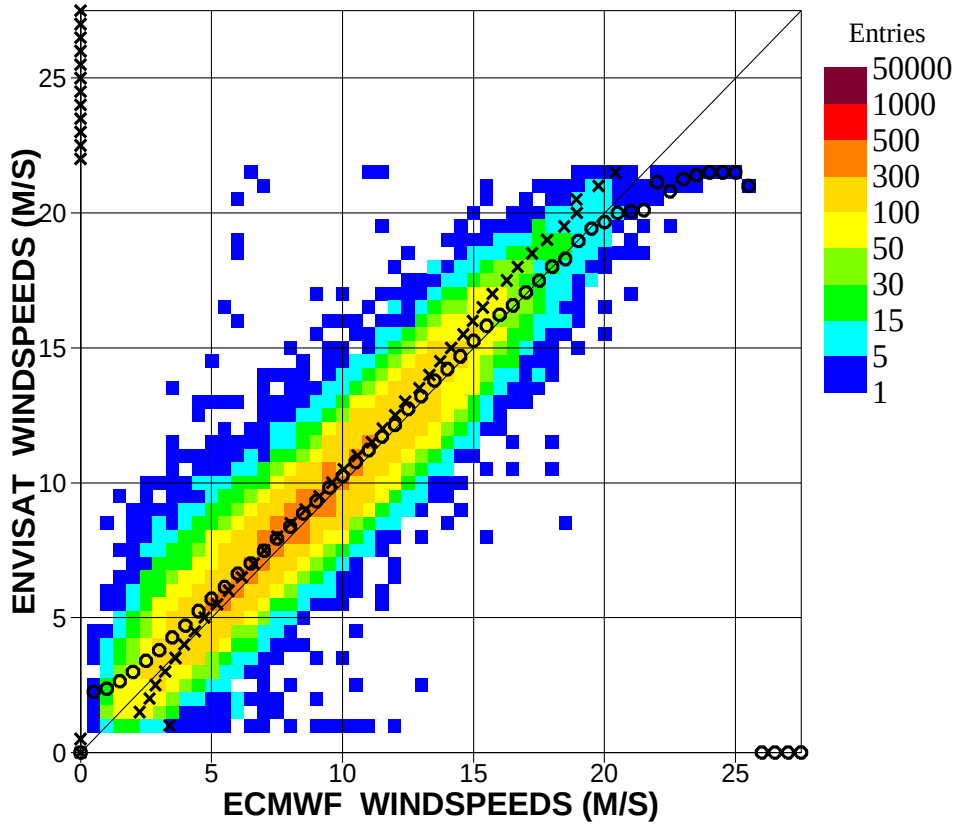

STATISTICS

ENTRIES	42827	
MEAN ECMWF	8.7949	
MEAN ENVISAT	9.2119	
BIAS (ENVISAT - ECMWF)	0.4170	
STANDARD DEVIATION	1.3313	
SCATTER INDEX	0.1514	
CORRELATION	0.9361	
SYMMETRIC SLOPE	1.0414	(0.0018)
REGR. COEFFICIENT	0.9426	(0.0017)
REGR. CONSTANT	0.9213	(0.0163)

Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2007 (S.Hem.)

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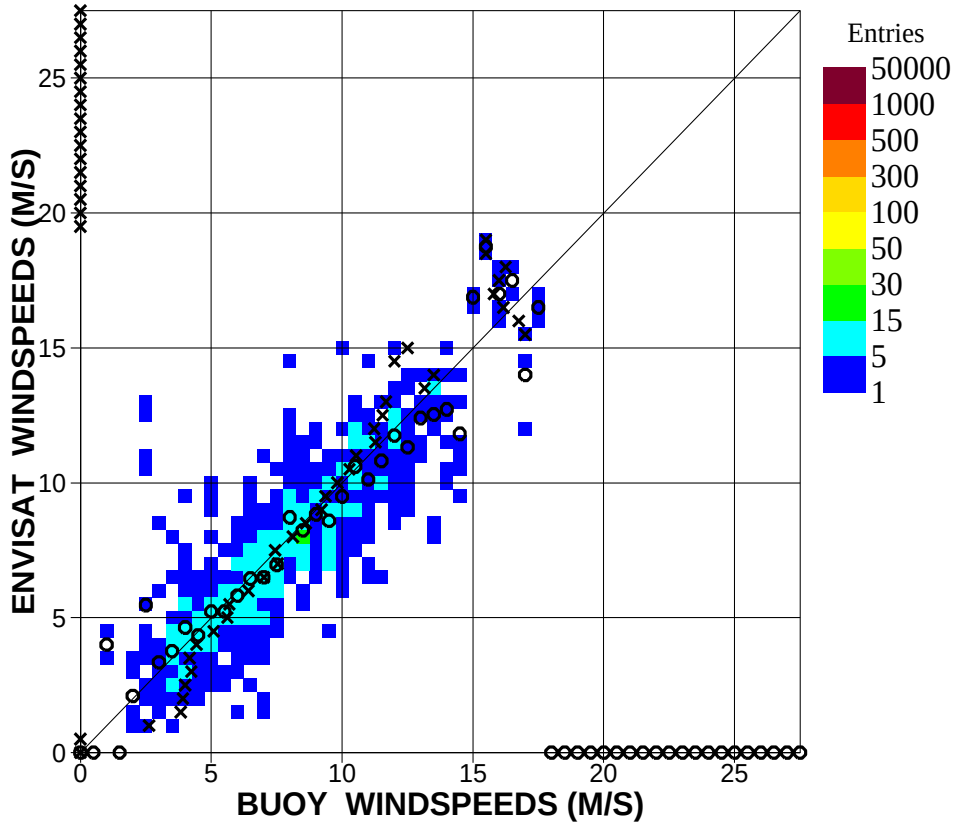

STATISTICS

ENTRIES	961	
MEAN BUOY	7.9135	
MEAN ENVISAT	7.7372	
BIAS (ENVISAT - BUOY)	-0.1763	
STANDARD DEVIATION	1.6605	
SCATTER INDEX	0.2098	
CORRELATION	0.8549	
SYMMETRIC SLOPE	0.9850	(0.0176)
REGR. COEFFICIENT	0.8834	(0.0173)
REGR. CONSTANT	0.7467	(0.1466)

Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2007 (Global)

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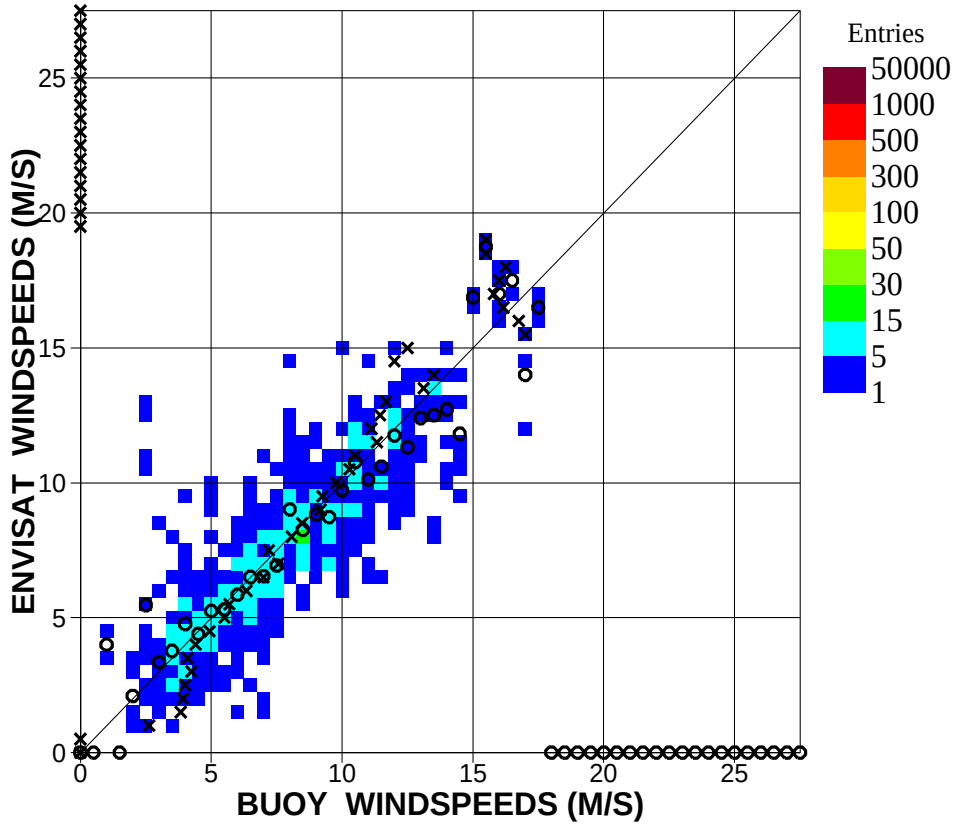

STATISTICS

ENTRIES	853	
MEAN BUOY	7.8937	
MEAN ENVISAT	7.7813	
BIAS (ENVISAT - BUOY)	-0.1124	
STANDARD DEVIATION	1.7217	
SCATTER INDEX	0.2181	
CORRELATION	0.8528	
SYMMETRIC SLOPE	0.9921	(0.0189)
REGR. COEFFICIENT	0.8797	(0.0185)
REGR. CONSTANT	0.8374	(0.1567)

Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2007 (N.Hem.)

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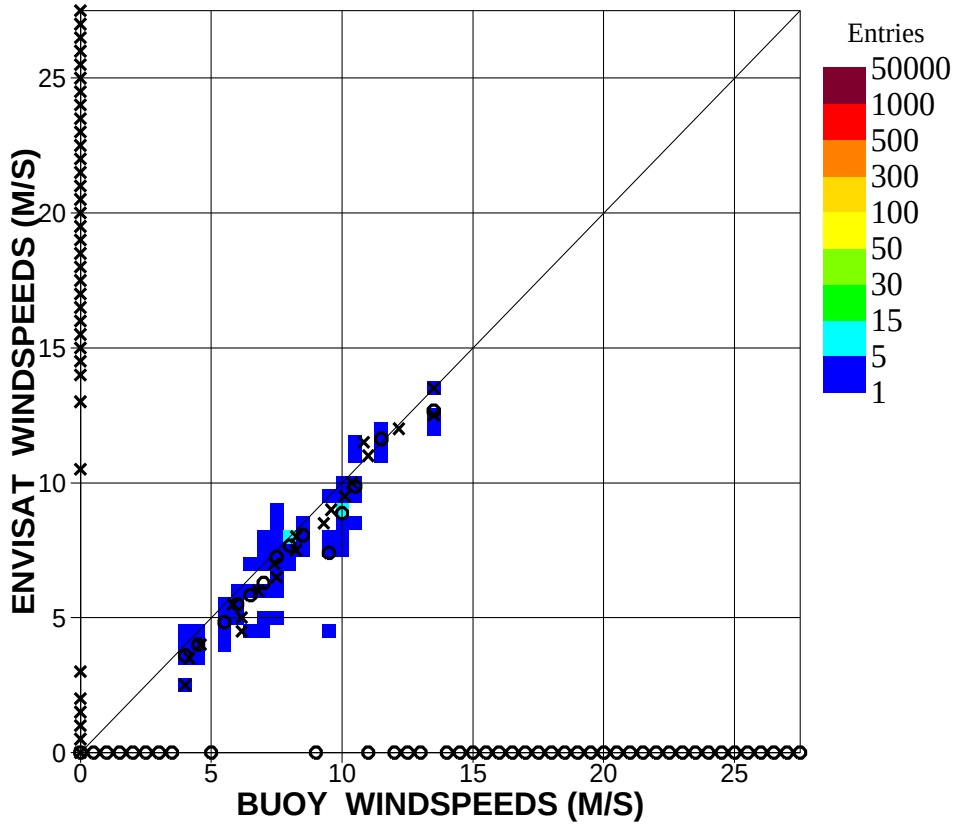

STATISTICS

ENTRIES	98	
MEAN BUOY	8.1835	
MEAN ENVISAT	7.5342	
BIAS (ENVISAT - BUOY)	-0.6493	
STANDARD DEVIATION	0.8940	
SCATTER INDEX	0.1092	
CORRELATION	0.9201	
SYMMETRIC SLOPE	0.9285	(0.0415)
REGR. COEFFICIENT	0.9505	(0.0413)
REGR. CONSTANT	-0.2439	(0.3498)

Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2007 (Tropics)

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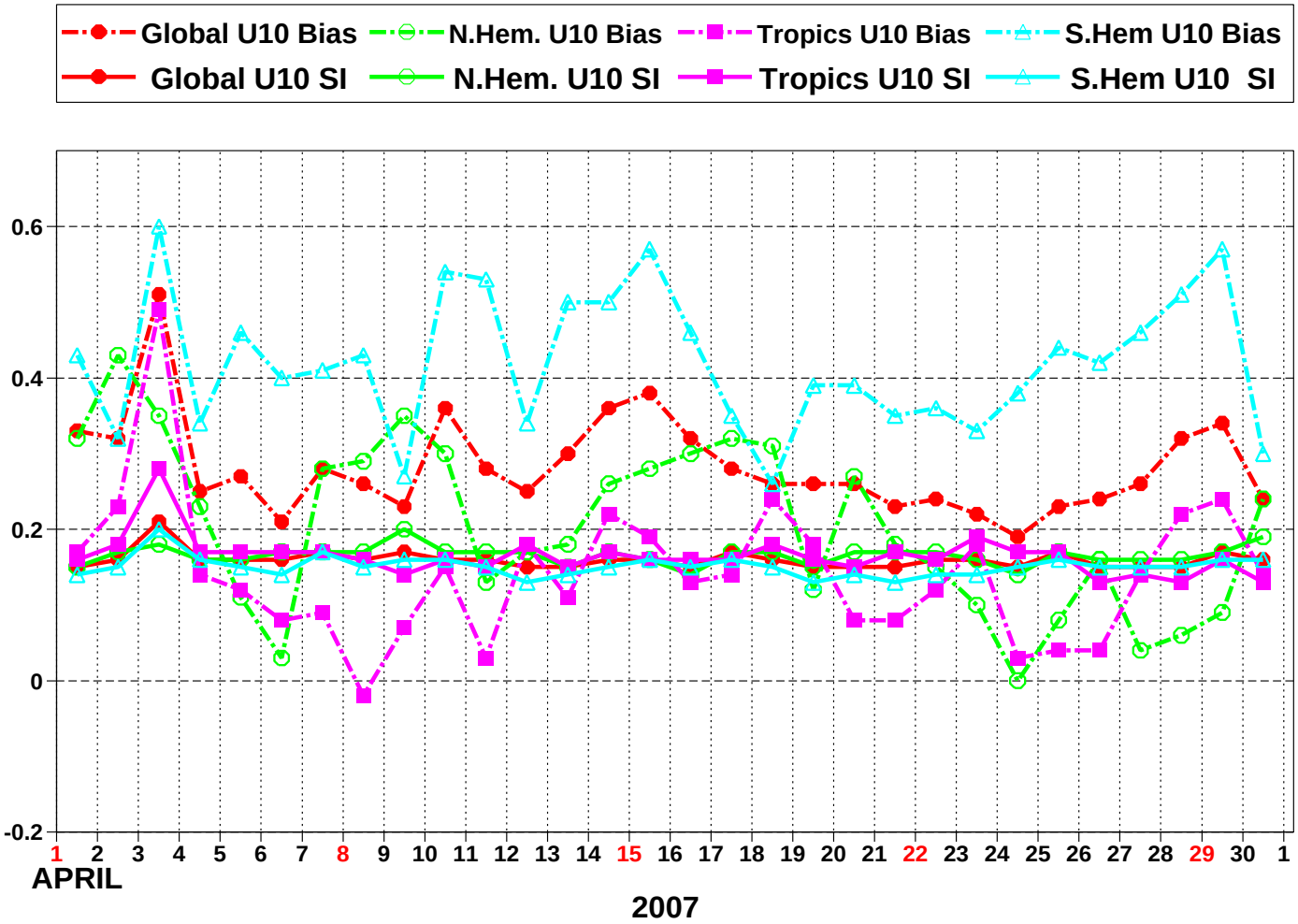

Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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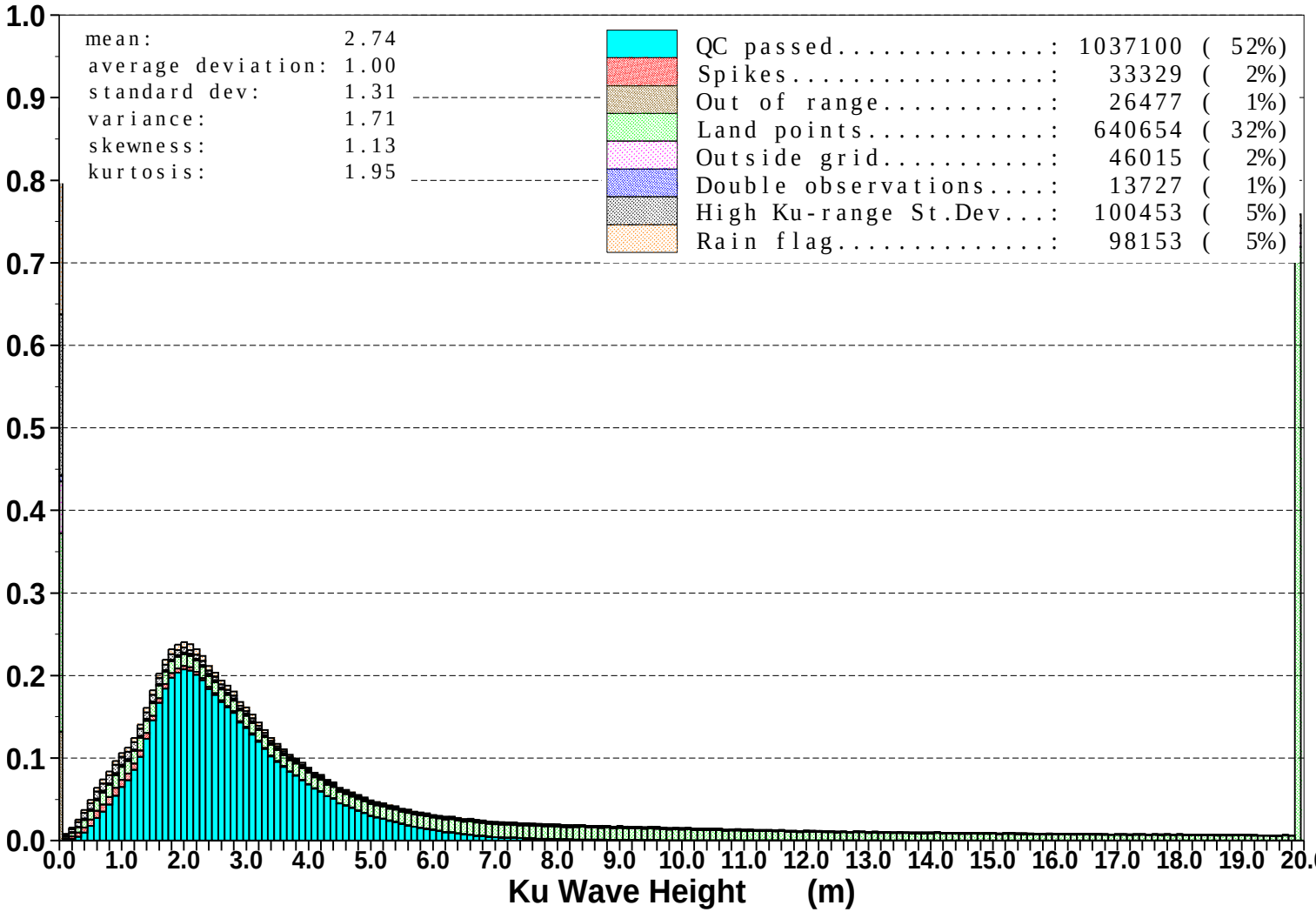

Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for April 2007

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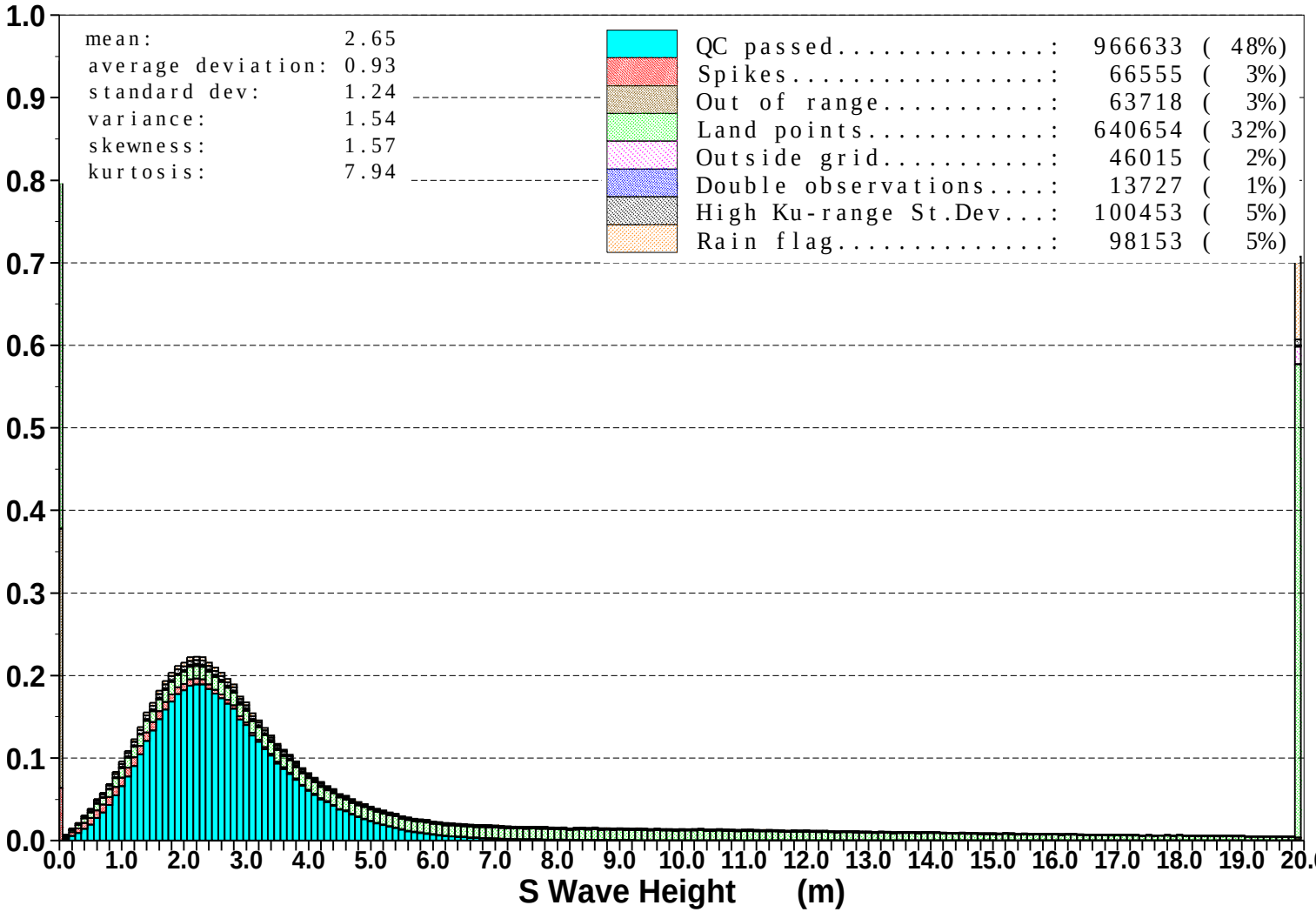

Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for April 2007

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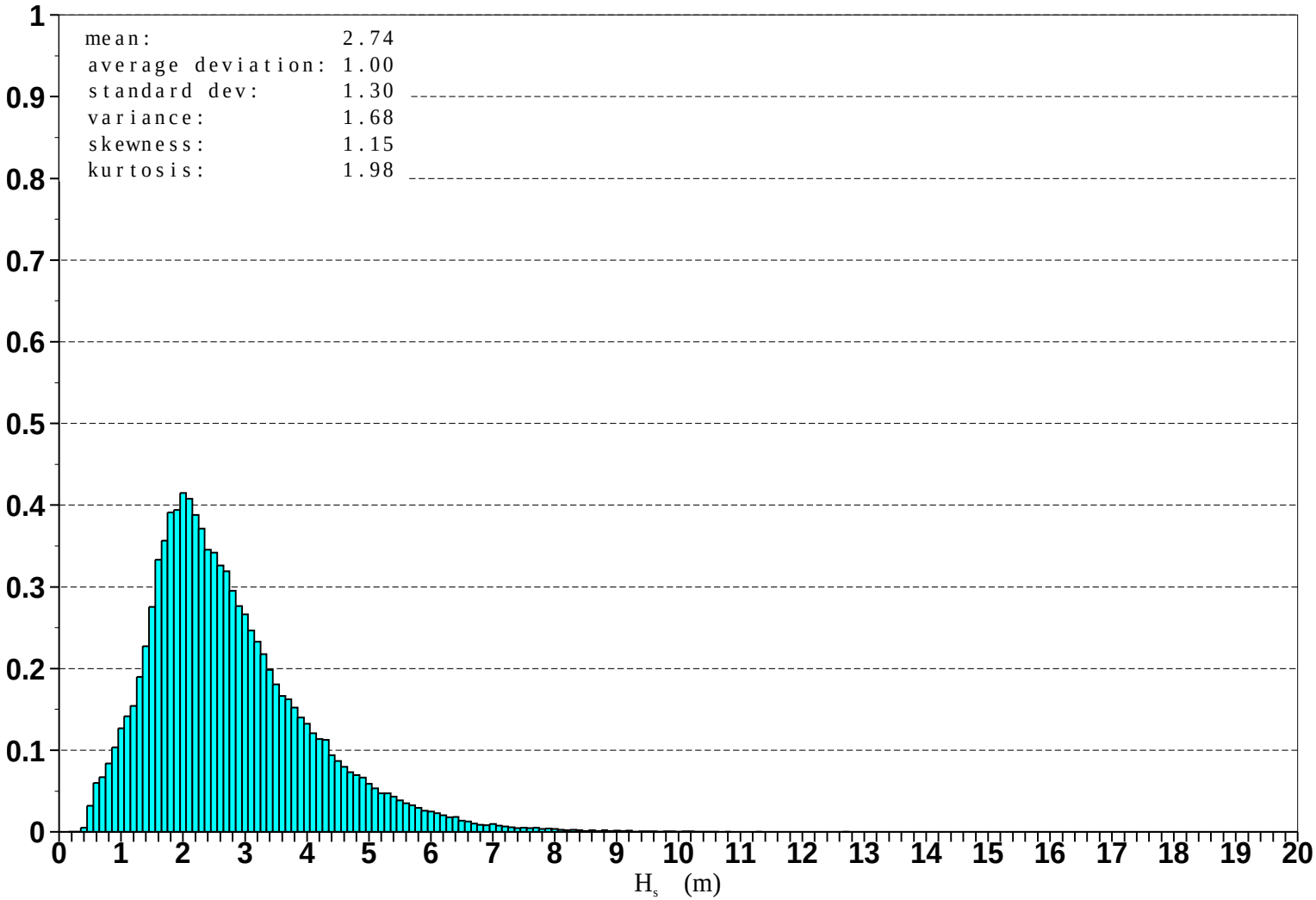

Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for April 2007

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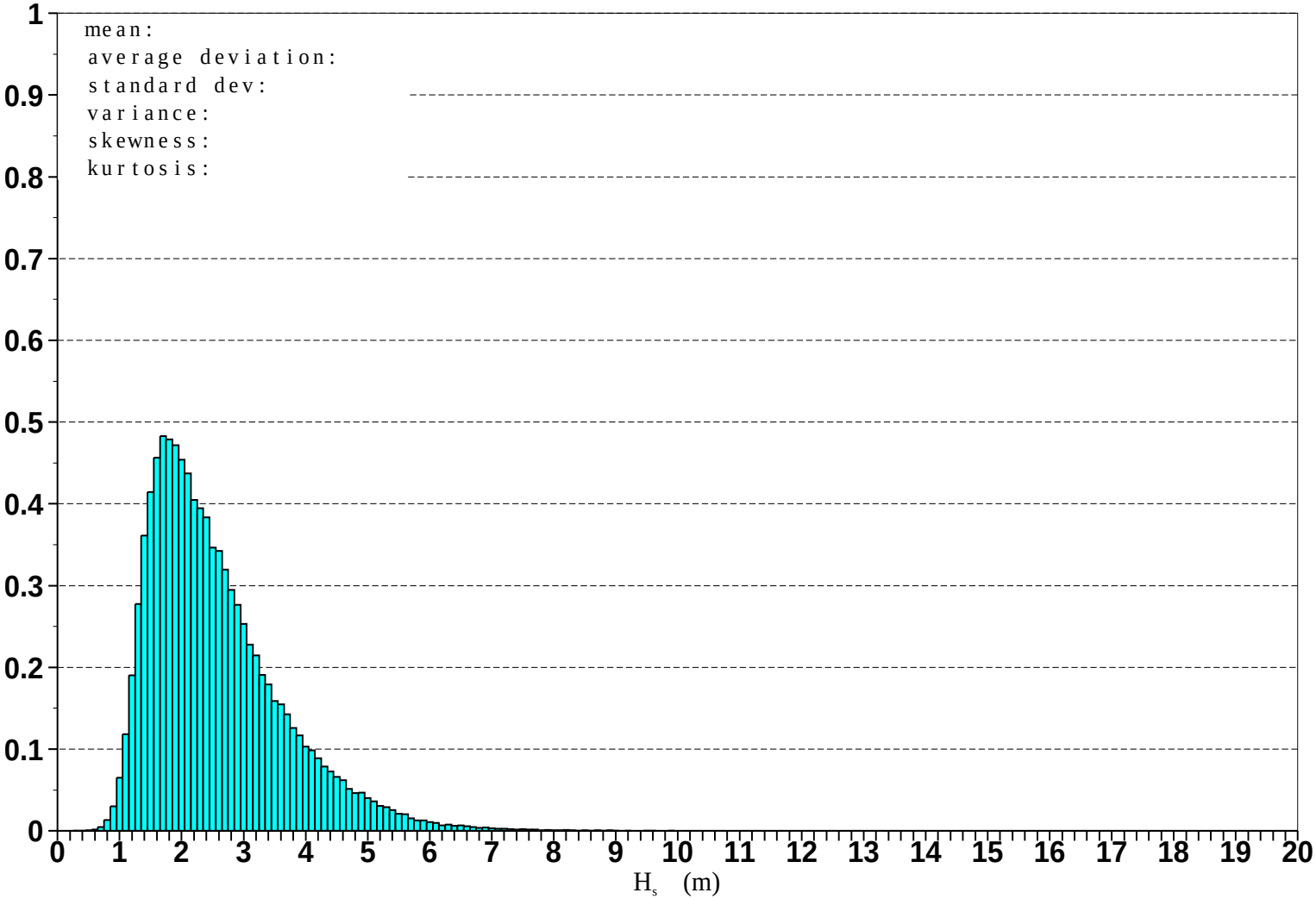

Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for April 2007

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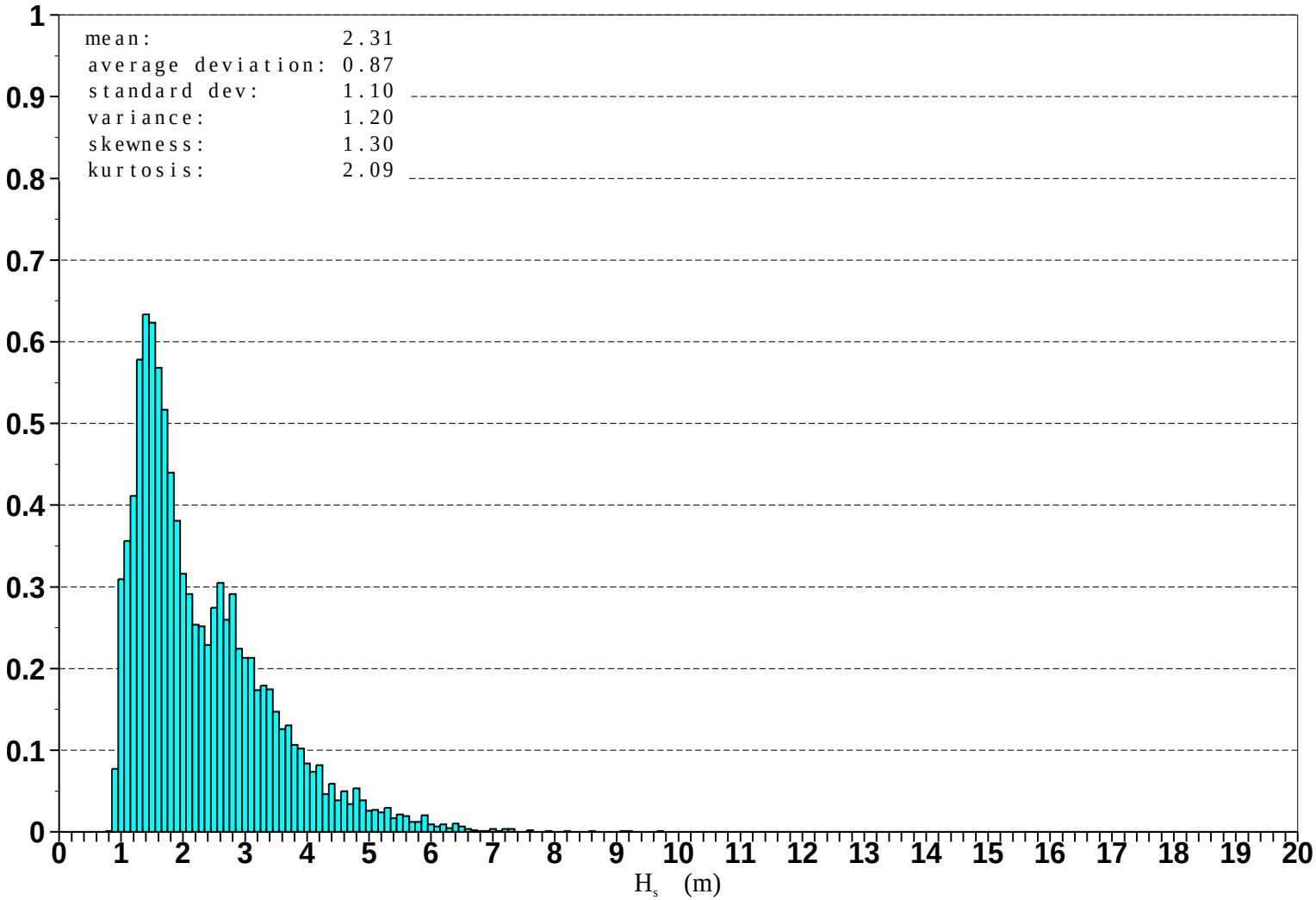

Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for April 2007

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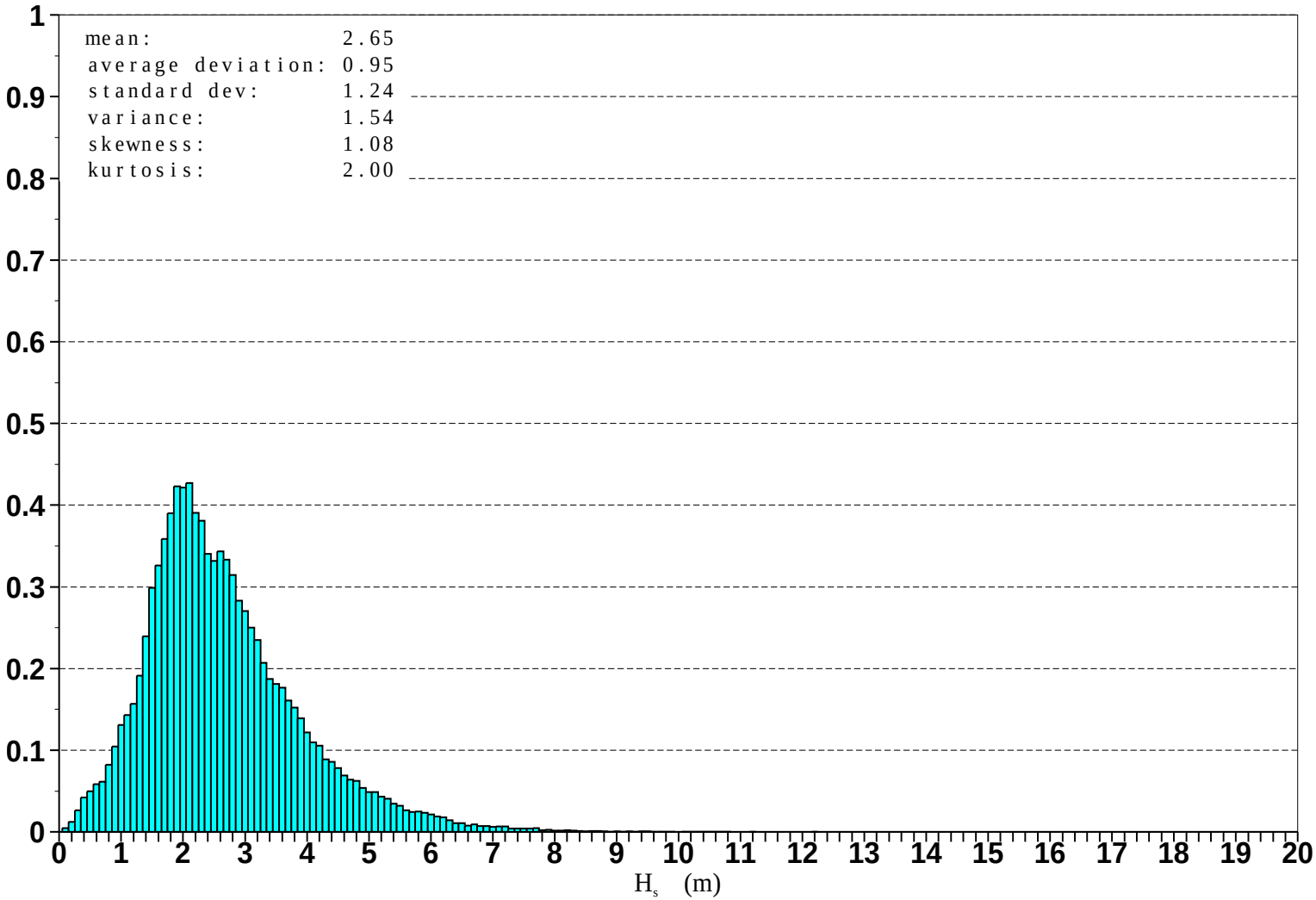

Figure 19b: Distribution of WAM 4V Wave Height (Collocated with ENVISAT) for April 2007

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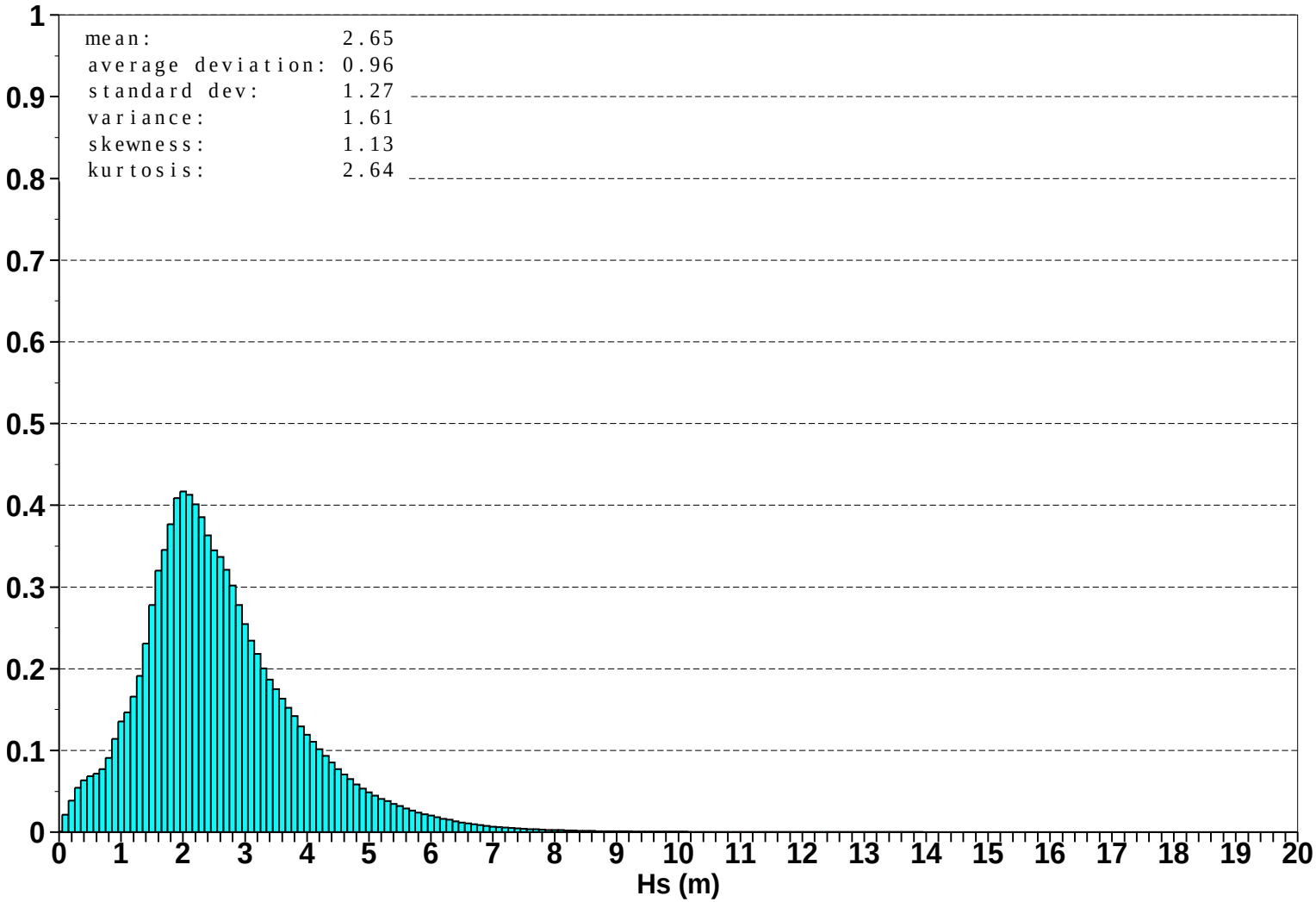

Figure 20: Global distribution of ECMWF First-Guess wave heights for April 2007

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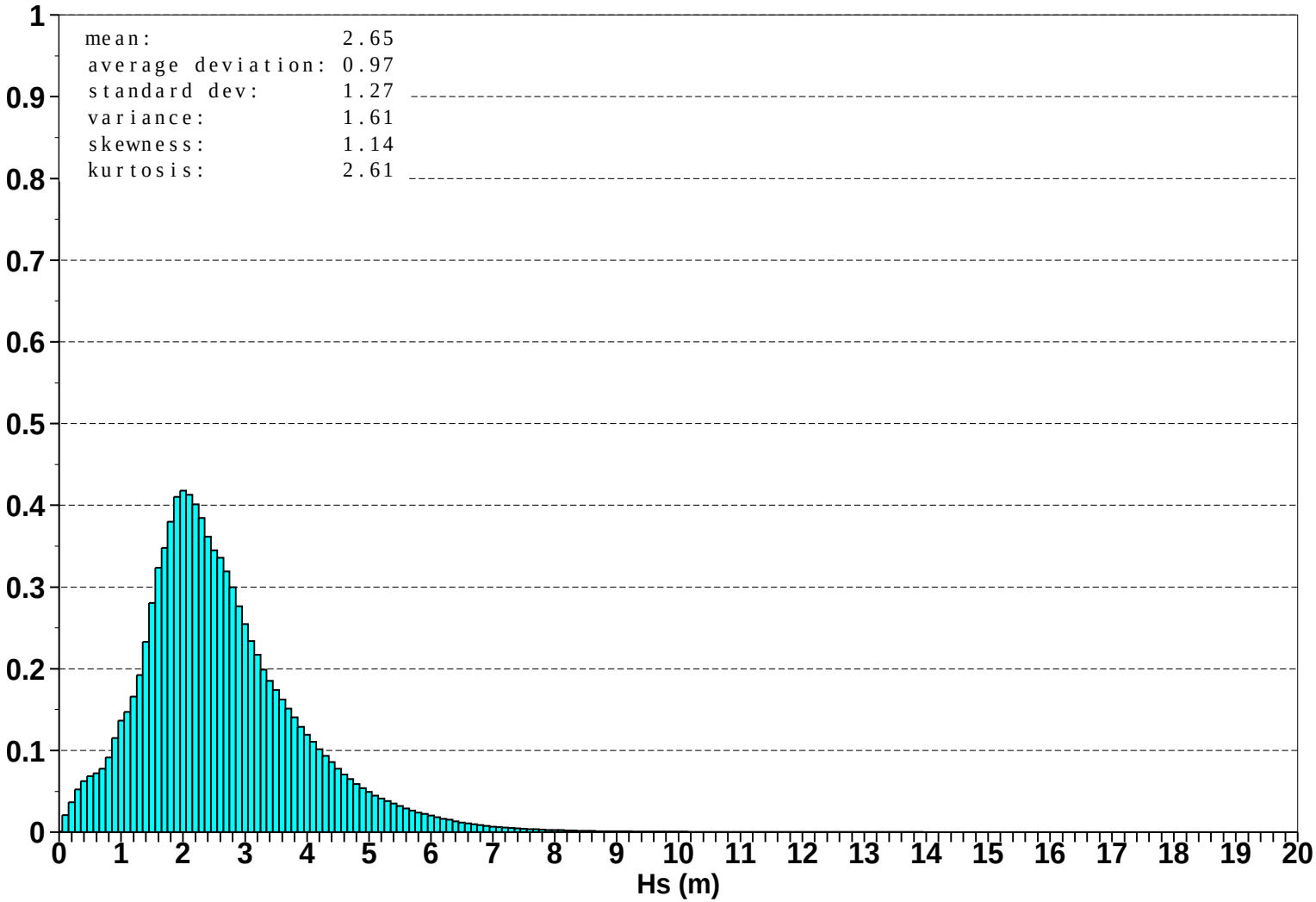

Figure 21: Global distribution of ECMWF Analysis wave heights for April 2007

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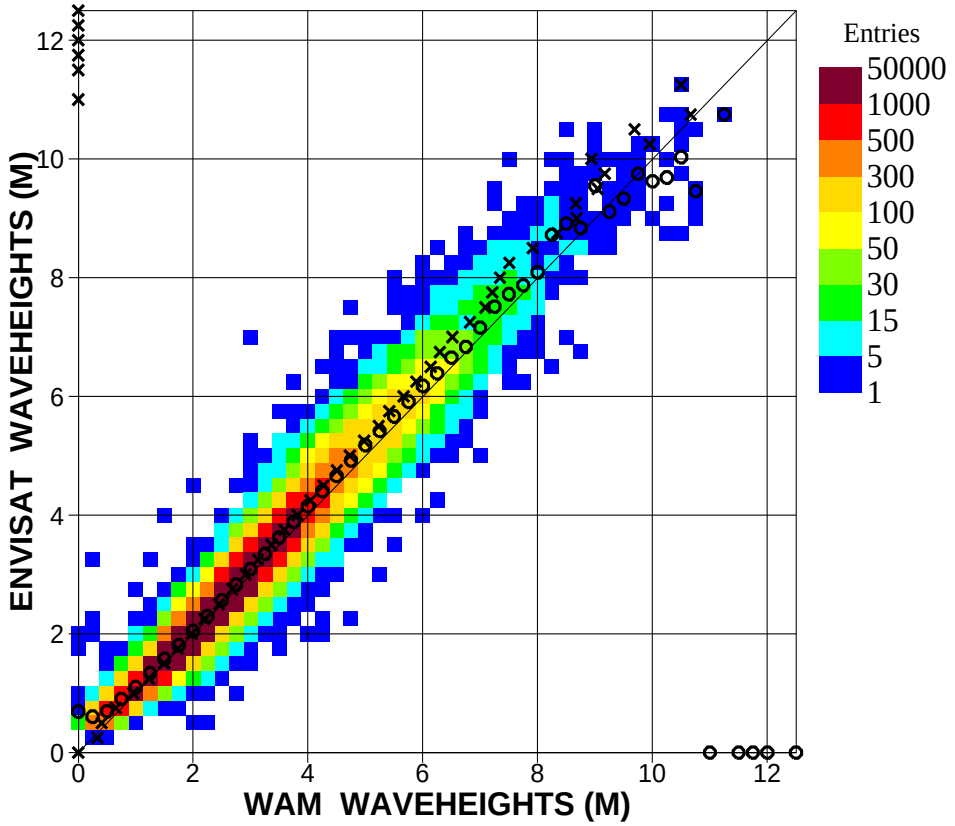

STATISTICS

ENTRIES	94247	
MEAN WAM	2.6518	
MEAN ENVISAT	2.7443	
BIAS (ENVISAT - WAM)	0.0926	
STANDARD DEVIATION	0.2749	
SCATTER INDEX	0.1037	
CORRELATION	0.9774	
SYMMETRIC SLOPE	1.0364	(0.0007)
REGR. COEFFICIENT	1.0197	(0.0007)
REGR. CONSTANT	0.0402	(0.0021)

Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2007 (Global)

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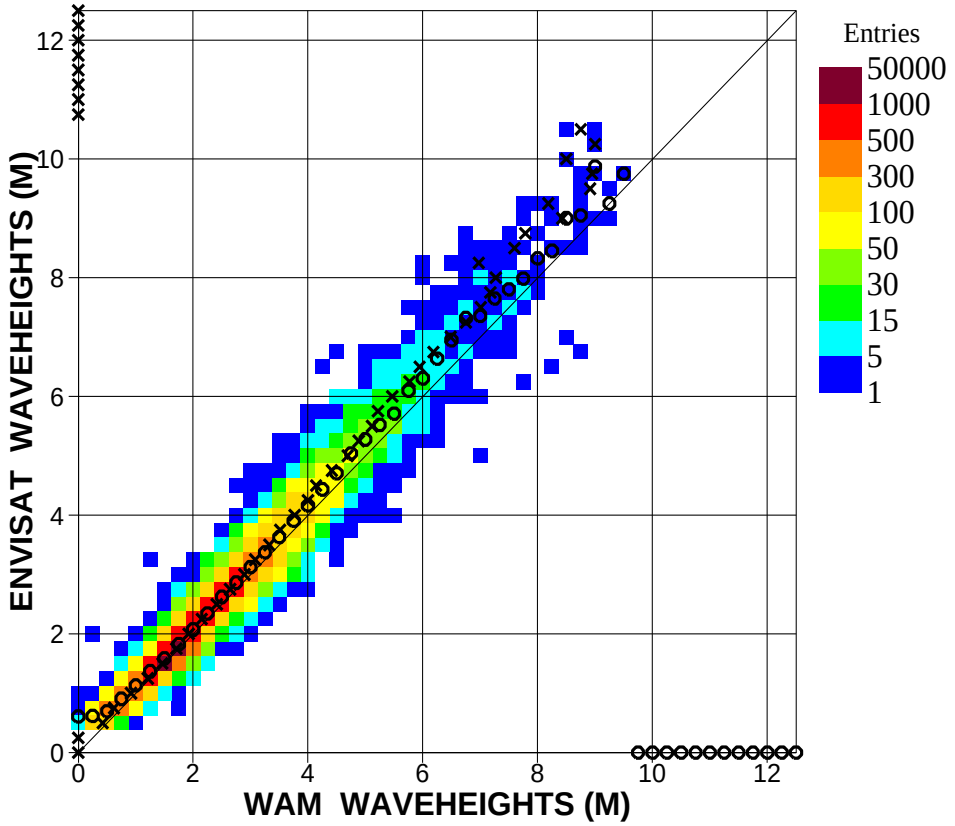

STATISTICS

ENTRIES	22781	
MEAN WAM	2.3888	
MEAN ENVISAT	2.5140	
BIAS (ENVISAT - WAM)	0.1251	
STANDARD DEVIATION	0.2783	
SCATTER INDEX	0.1165	
CORRELATION	0.9756	
SYMMETRIC SLOPE	1.0526	(0.0015)
REGR. COEFFICIENT	1.0277	(0.0015)
REGR. CONSTANT	0.0589	(0.0041)

Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2007 (N.Hem.)

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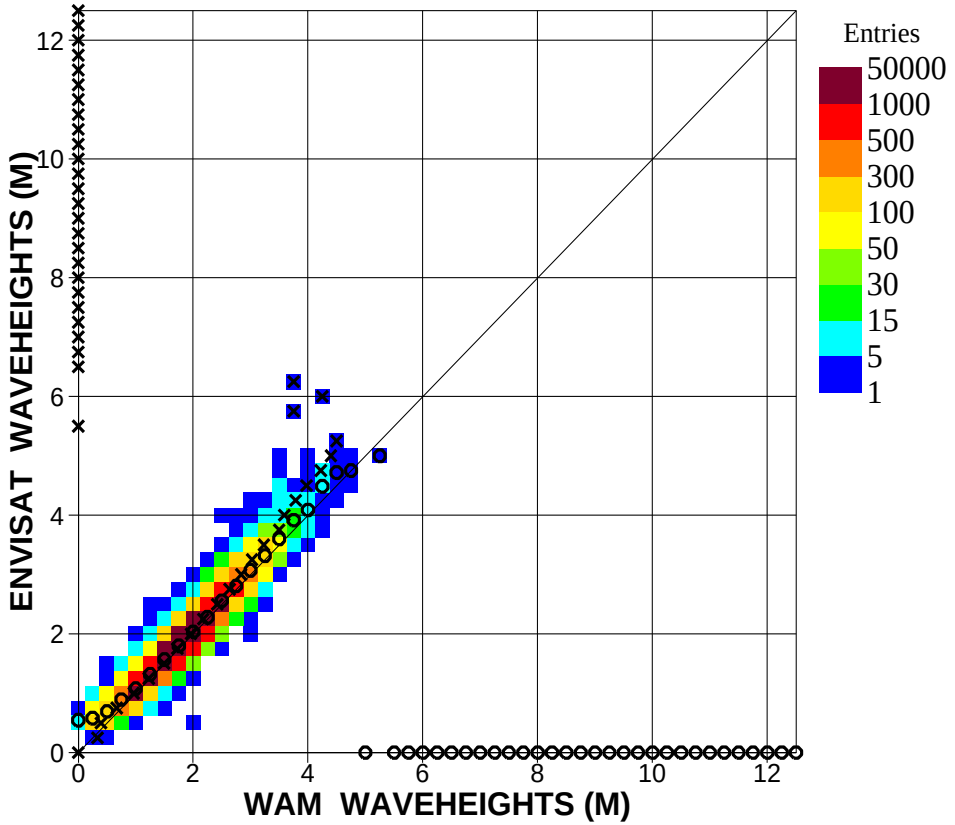

STATISTICS

ENTRIES	29327	
MEAN WAM	1.8706	
MEAN ENVISAT	1.9314	
BIAS (ENVISAT - WAM)	0.0608	
STANDARD DEVIATION	0.1724	
SCATTER INDEX	0.0922	
CORRELATION	0.9634	
SYMMETRIC SLOPE	1.0308	(0.0016)
REGR. COEFFICIENT	0.9788	(0.0016)
REGR. CONSTANT	0.1005	(0.0031)

Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2007 (Tropics)

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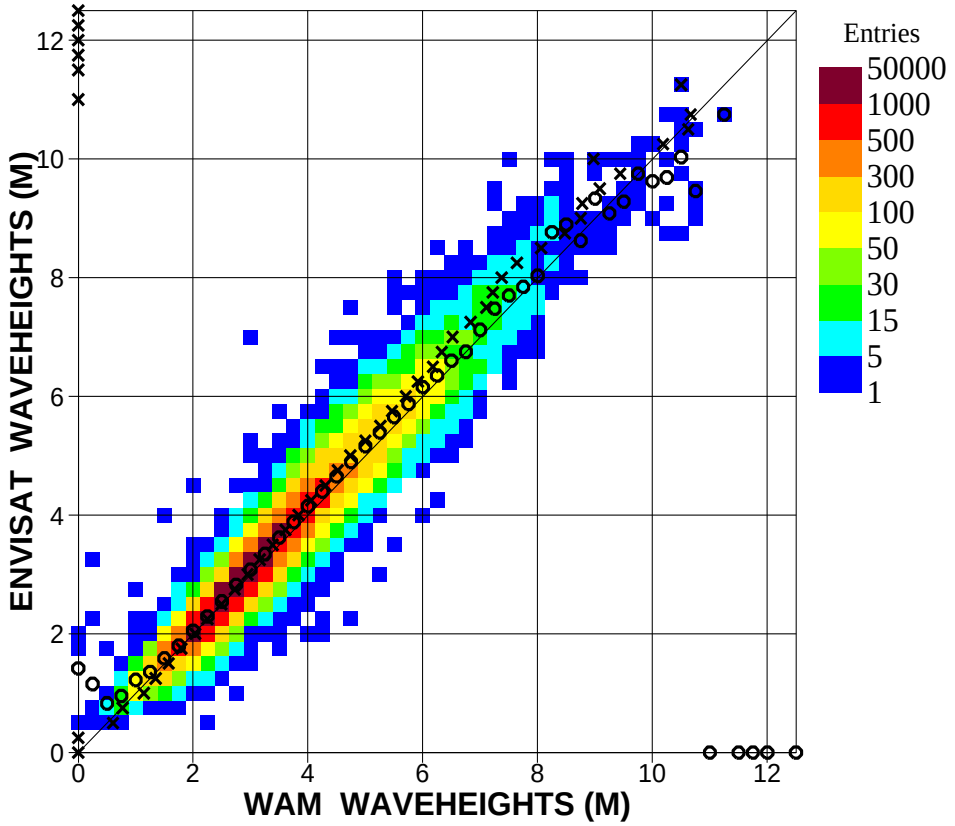

STATISTICS

ENTRIES	42827	
MEAN WAM	3.3179	
MEAN ENVISAT	3.4144	
BIAS (ENVISAT - WAM)	0.0965	
STANDARD DEVIATION	0.3227	
SCATTER INDEX	0.0973	
CORRELATION	0.9684	
SYMMETRIC SLOPE	1.0326	(0.0013)
REGR. COEFFICIENT	1.0251	(0.0013)
REGR. CONSTANT	0.0133	(0.0045)

Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2007 (S.Hem.)

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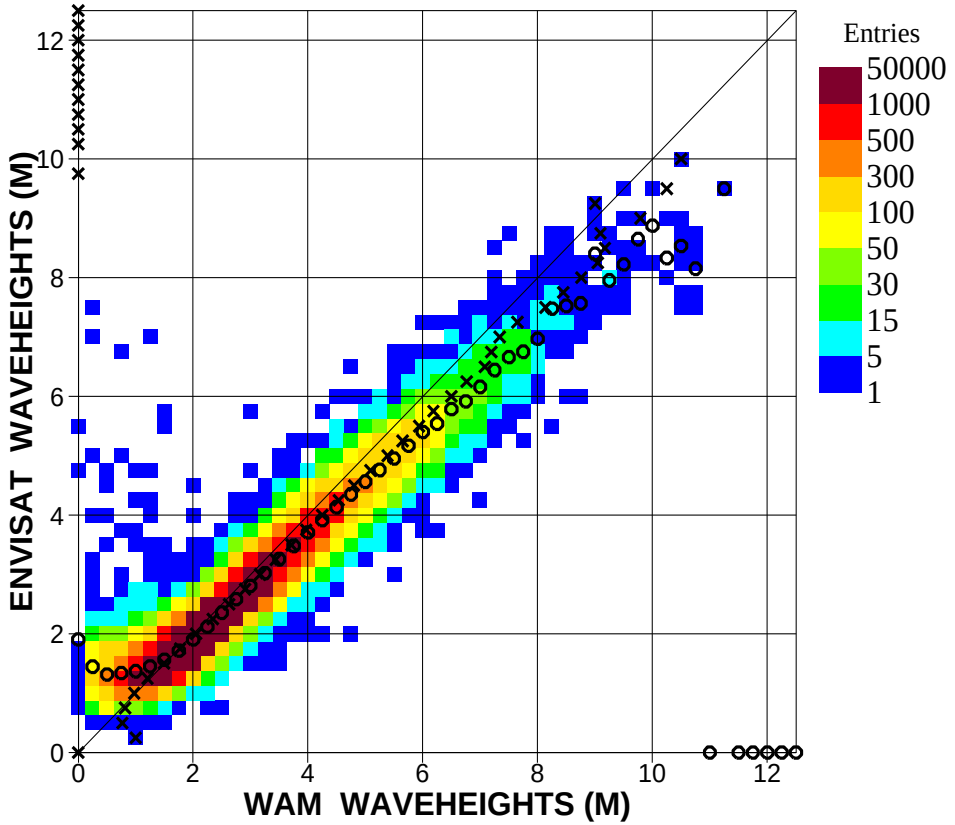

STATISTICS

ENTRIES	92661	
MEAN WAM	2.6616	
MEAN ENVISAT	2.5472	
BIAS (ENVISAT - WAM)	-0.1144	
STANDARD DEVIATION	0.3827	
SCATTER INDEX	0.1438	
CORRELATION	0.9557	
SYMMETRIC SLOPE	0.9407	(0.0009)
REGR. COEFFICIENT	0.8229	(0.0008)
REGR. CONSTANT	0.3568	(0.0025)

Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2007 (Global)

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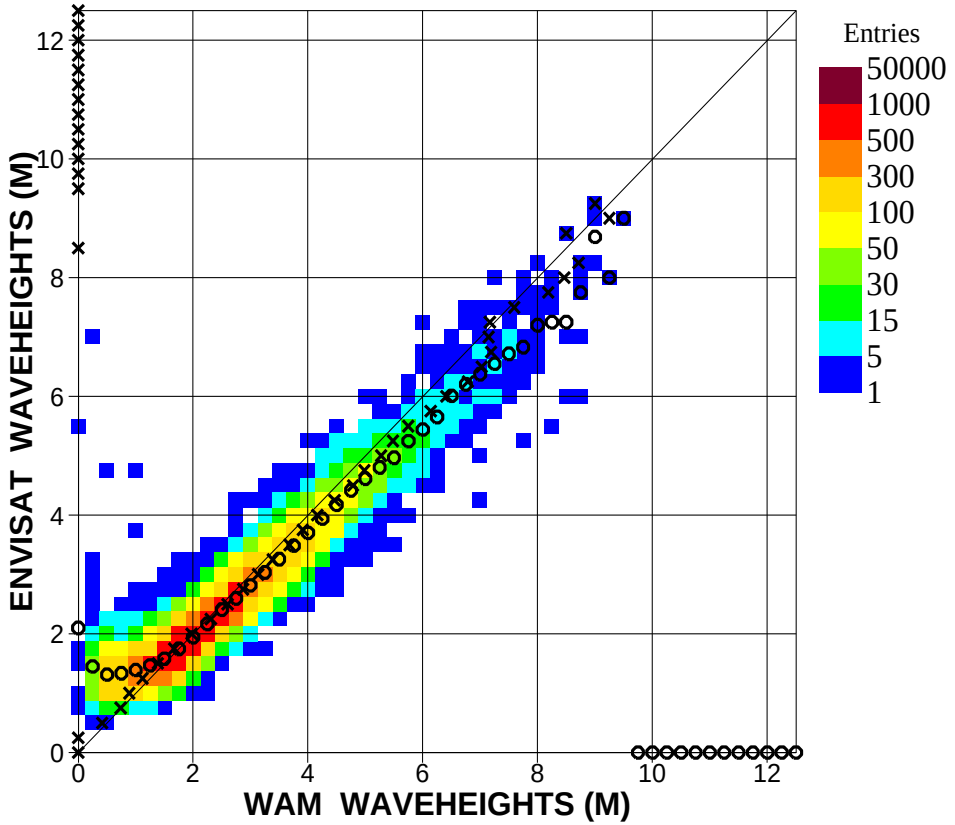

STATISTICS

ENTRIES	22451	
MEAN WAM	2.4010	
MEAN ENVISAT	2.3735	
BIAS (ENVISAT - WAM)	-0.0274	
STANDARD DEVIATION	0.4030	
SCATTER INDEX	0.1679	
CORRELATION	0.9463	
SYMMETRIC SLOPE	0.9622	(0.0022)
REGR. COEFFICIENT	0.8012	(0.0018)
REGR. CONSTANT	0.4498	(0.0049)

Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2007 (N.Hem.)

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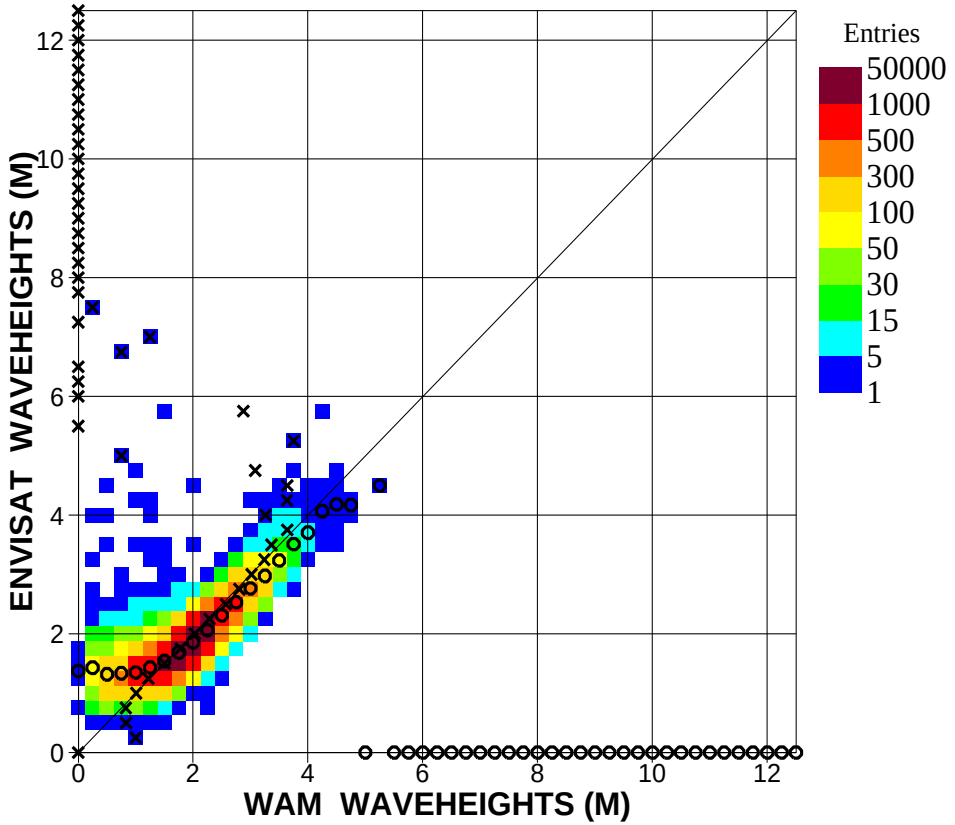

STATISTICS

ENTRIES	28627	
MEAN WAM	1.8794	
MEAN ENVISAT	1.8601	
BIAS (ENVISAT - WAM)	-0.0193	
STANDARD DEVIATION	0.3568	
SCATTER INDEX	0.1899	
CORRELATION	0.8199	
SYMMETRIC SLOPE	0.9730	(0.0033)
REGR. COEFFICIENT	0.6598	(0.0027)
REGR. CONSTANT	0.6200	(0.0054)

Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2007 (Tropics)

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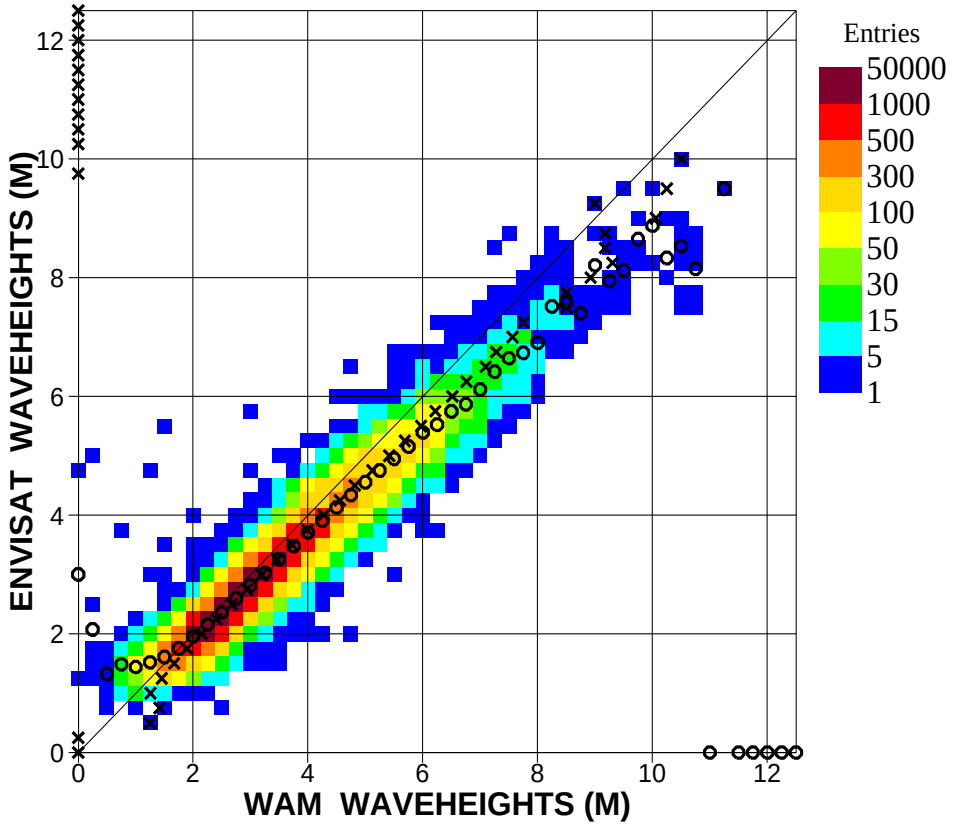

STATISTICS

ENTRIES	42259	
MEAN WAM	3.3211	
MEAN ENVISAT	3.0969	
BIAS (ENVISAT - WAM)	-0.2242	
STANDARD DEVIATION	0.3578	
SCATTER INDEX	0.1077	
CORRELATION	0.9582	
SYMMETRIC SLOPE	0.9271	(0.0013)
REGR. COEFFICIENT	0.8483	(0.0013)
REGR. CONSTANT	0.2798	(0.0044)

Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2007 (S.Hem.)

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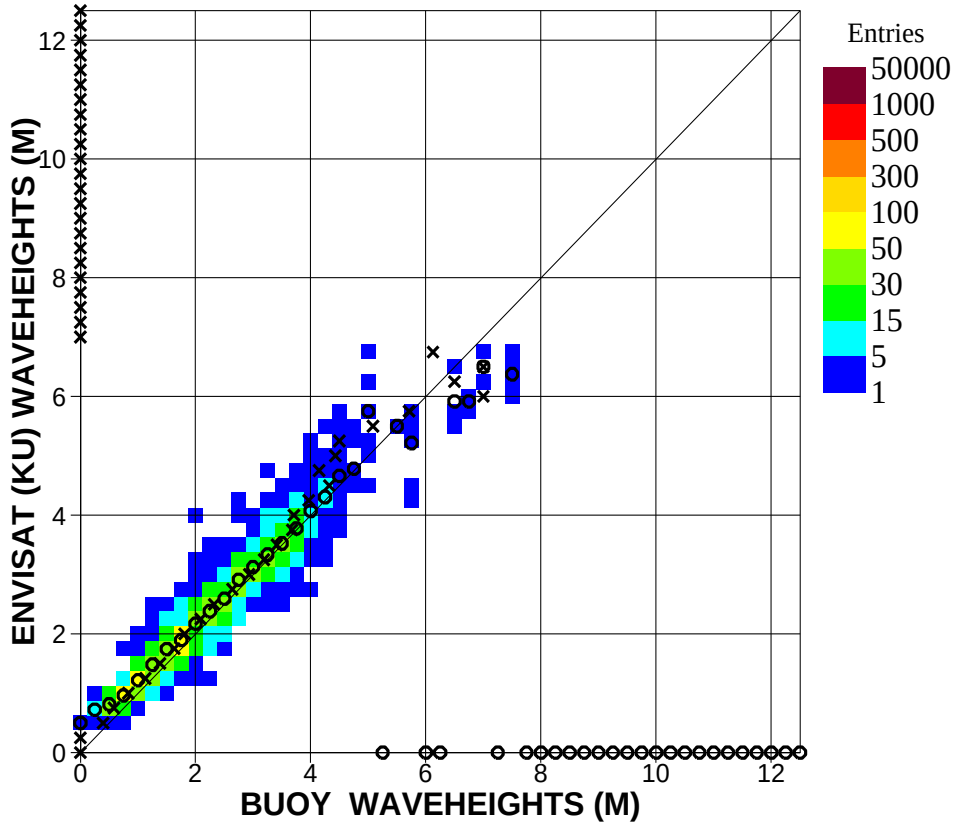

STATISTICS

ENTRIES	1600	
MEAN BUOY	2.3167	
MEAN ENVISAT	2.4611	
BIAS (ENVISAT - BUOY)	0.1444	
STANDARD DEVIATION	0.3451	
SCATTER INDEX	0.1489	
CORRELATION	0.9556	
SYMMETRIC SLOPE	1.0442	(0.0078)
REGR. COEFFICIENT	0.9269	(0.0071)
REGR. CONSTANT	0.3138	(0.0185)

Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2007 (Global)

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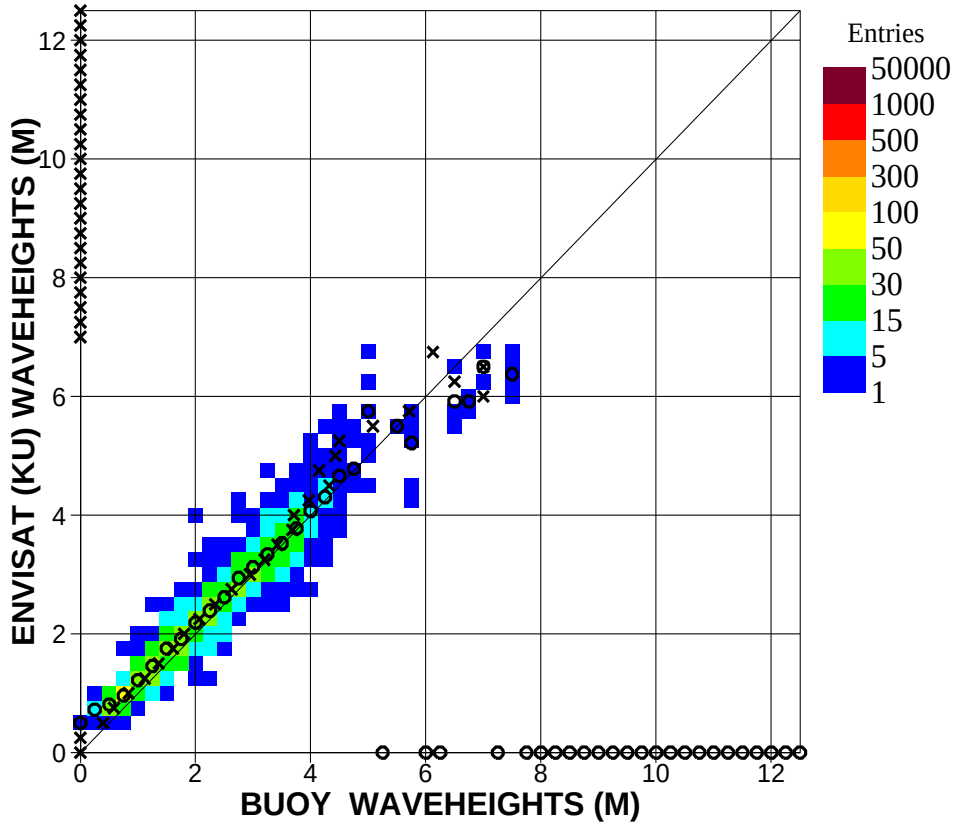

STATISTICS

ENTRIES	1444	
MEAN BUOY	2.3560	
MEAN ENVISAT	2.5062	
BIAS (ENVISAT - BUOY)	0.1502	
STANDARD DEVIATION	0.3501	
SCATTER INDEX	0.1486	
CORRELATION	0.9569	
SYMMETRIC SLOPE	1.0446	(0.0081)
REGR. COEFFICIENT	0.9261	(0.0074)
REGR. CONSTANT	0.3243	(0.0196)

Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2007 (N.Hem.)

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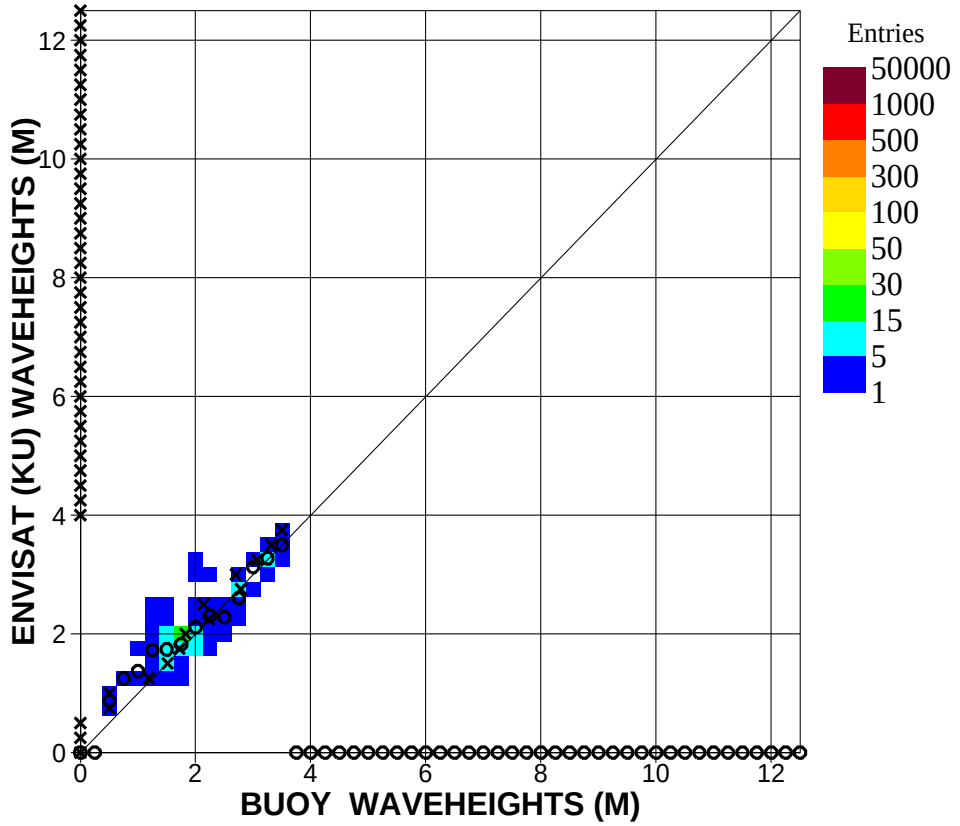

STATISTICS

ENTRIES	145	
MEAN BUOY	1.9887	
MEAN ENVISAT	2.0830	
BIAS (ENVISAT - BUOY)	0.0944	
STANDARD DEVIATION	0.2952	
SCATTER INDEX	0.1484	
CORRELATION	0.8929	
SYMMETRIC SLOPE	1.0383	(0.0392)
REGR. COEFFICIENT	0.8463	(0.0357)
REGR. CONSTANT	0.4001	(0.0747)

Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2007 (Tropics)

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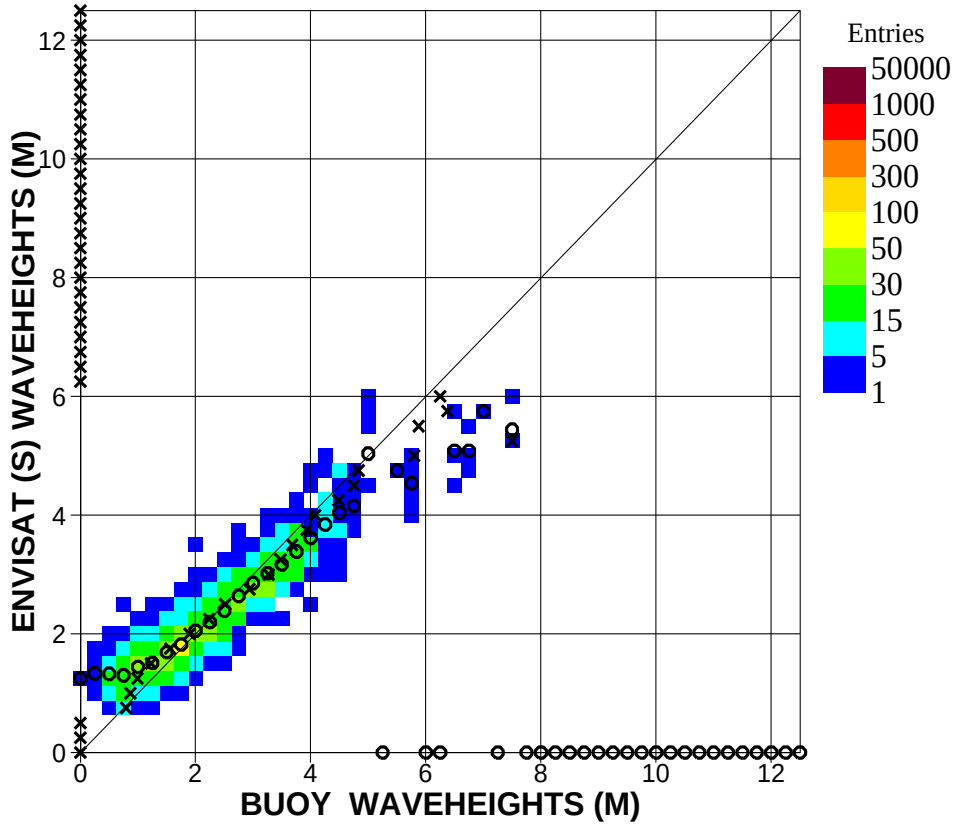

STATISTICS

ENTRIES	1560	
MEAN BUOY	2.3249	
MEAN ENVISAT	2.3398	
BIAS (ENVISAT - BUOY)	0.0149	
STANDARD DEVIATION	0.4815	
SCATTER INDEX	0.2071	
CORRELATION	0.9261	
SYMMETRIC SLOPE	0.9625	(0.0099)
REGR. COEFFICIENT	0.7107	(0.0073)
REGR. CONSTANT	0.6875	(0.0191)

Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2007 (Global)

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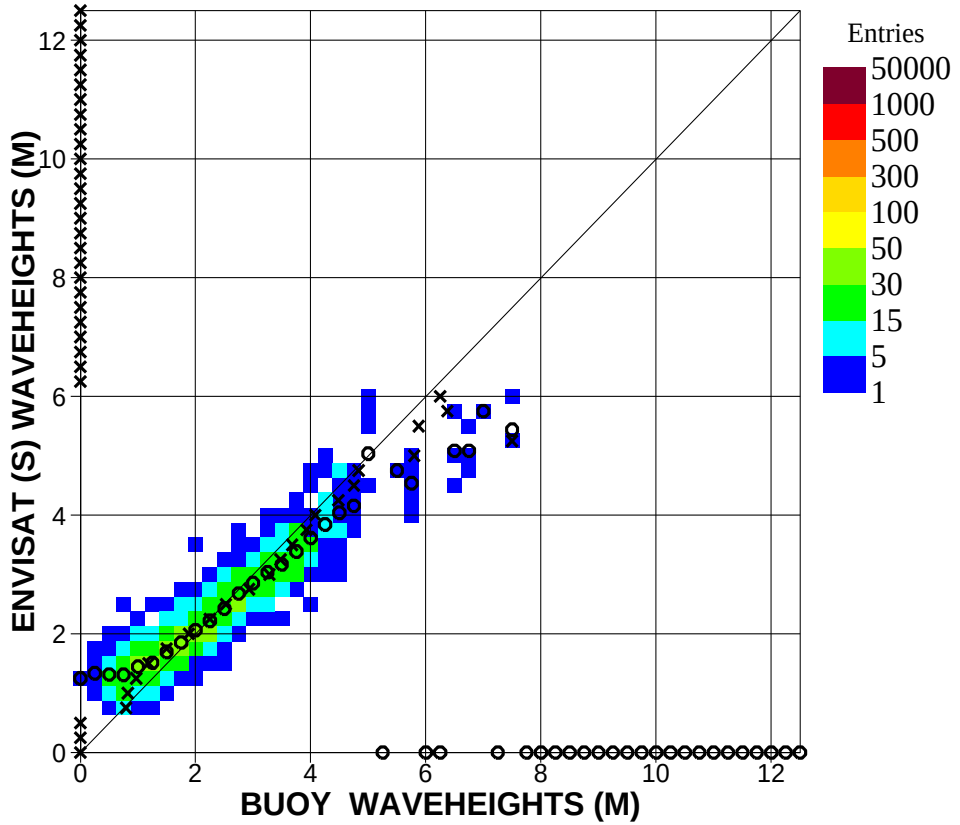

STATISTICS

ENTRIES	1414	
MEAN BUOY	2.3620	
MEAN ENVISAT	2.3832	
BIAS (ENVISAT - BUOY)	0.0212	
STANDARD DEVIATION	0.4878	
SCATTER INDEX	0.2065	
CORRELATION	0.9305	
SYMMETRIC SLOPE	0.9629	(0.0103)
REGR. COEFFICIENT	0.7089	(0.0074)
REGR. CONSTANT	0.7087	(0.0197)

Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2007 (N.Hem.)

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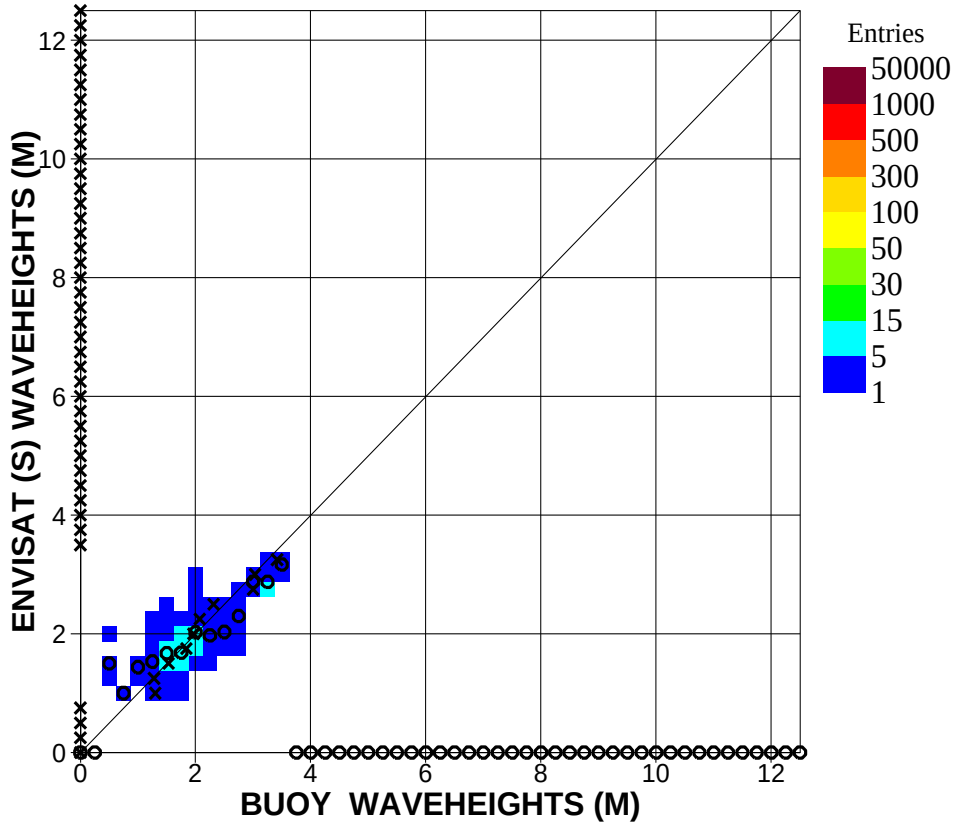

STATISTICS

ENTRIES	135	
MEAN BUOY	2.0050	
MEAN ENVISAT	1.9439	
BIAS (ENVISAT - BUOY)	-0.0611	
STANDARD DEVIATION	0.4163	
SCATTER INDEX	0.2076	
CORRELATION	0.7814	
SYMMETRIC SLOPE	0.9533	(0.0519)
REGR. COEFFICIENT	0.6175	(0.0428)
REGR. CONSTANT	0.7058	(0.0903)

Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2007 (Tropics)

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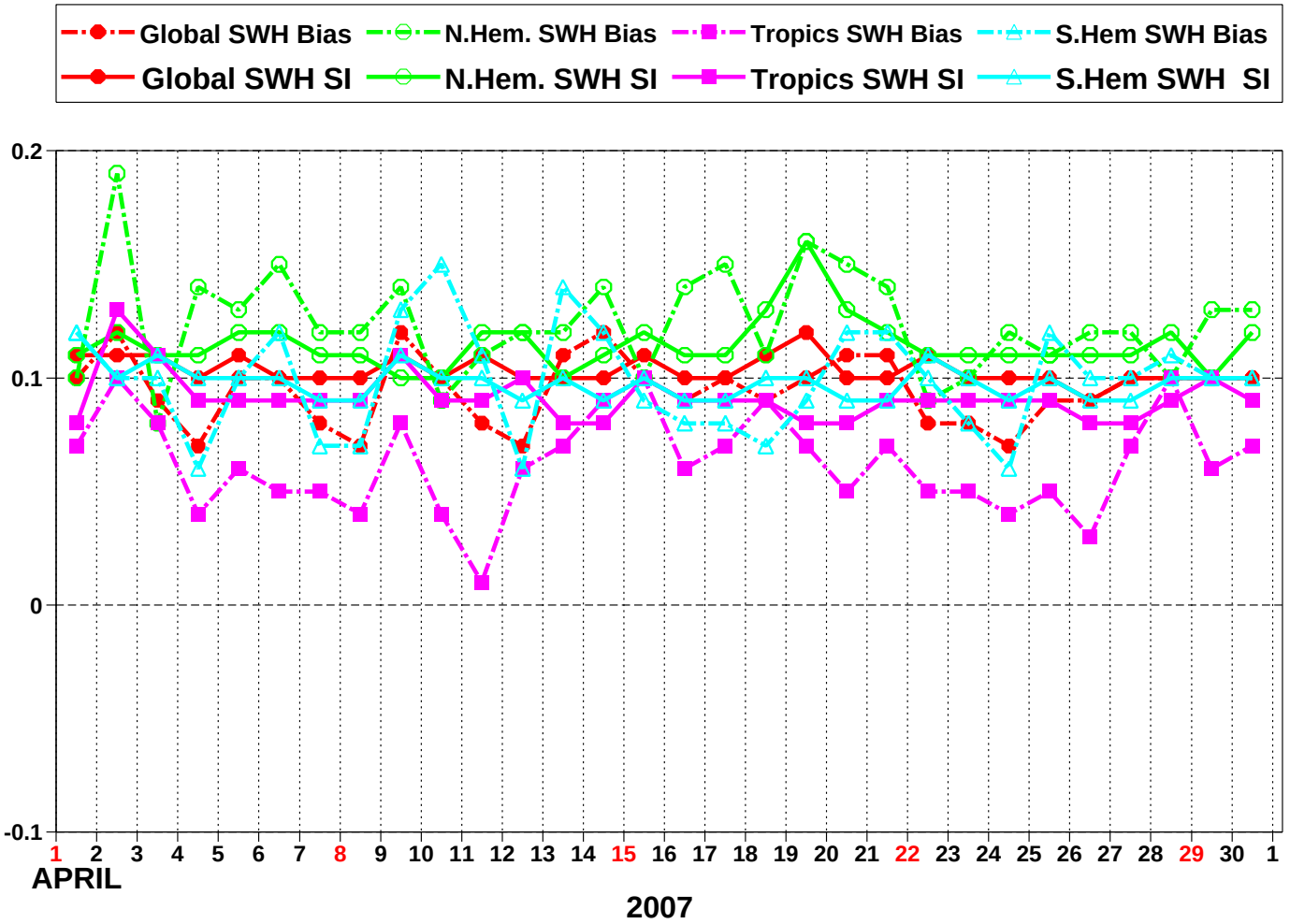

Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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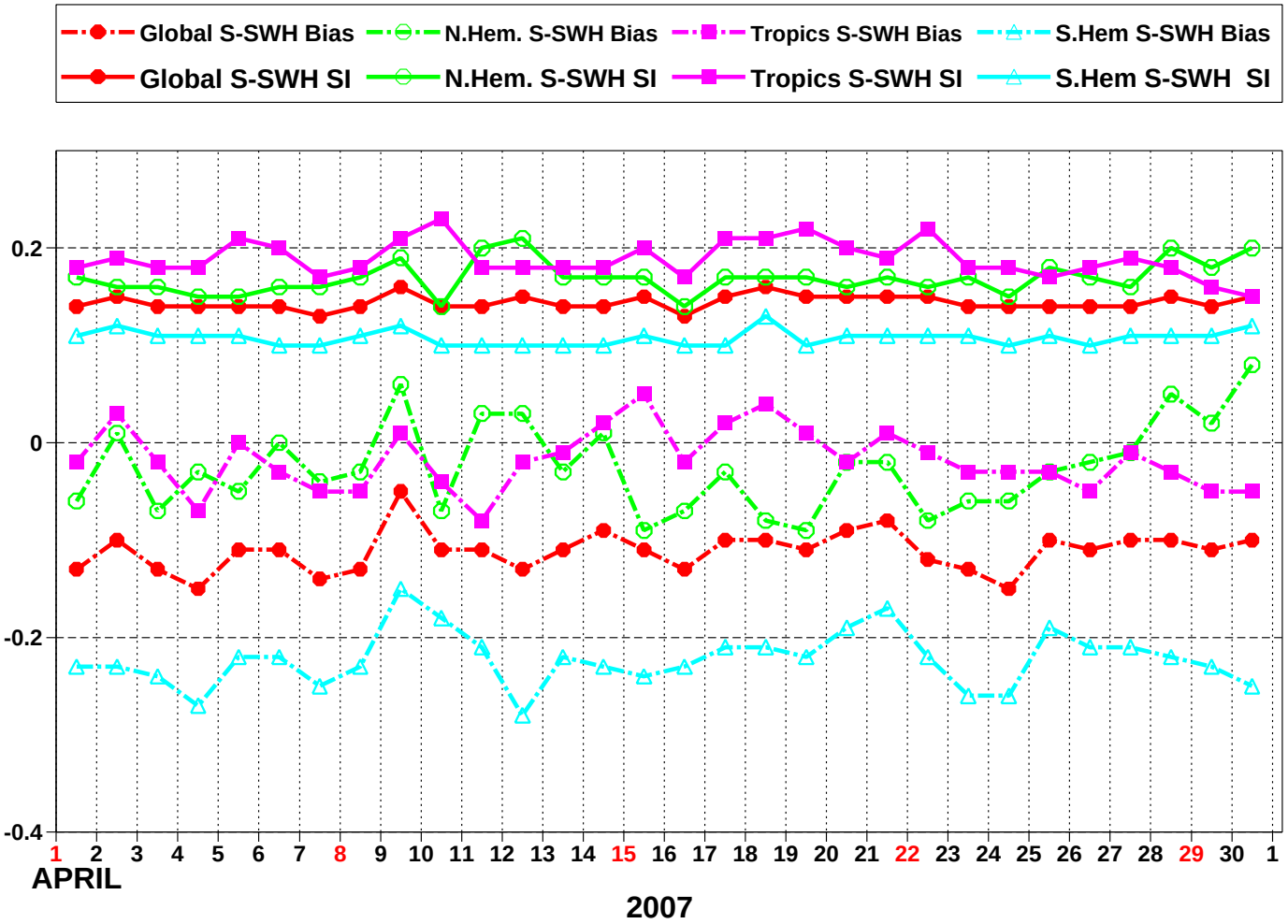

Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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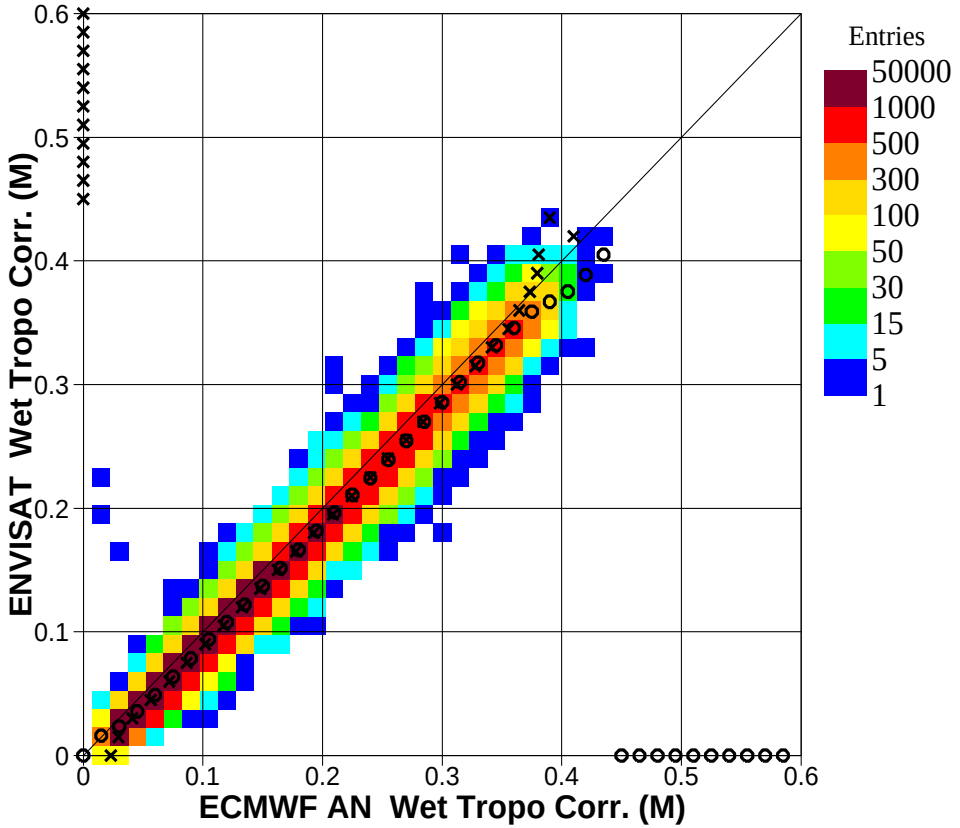

STATISTICS

ENTRIES	87361	
MEAN ECMWF	0.1577	
MEAN ENVISAT	0.1454	
BIAS (ENVISAT - ECMWF)	-0.0123	
STANDARD DEVIATION	0.0134	
SCATTER INDEX	0.0852	
CORRELATION	0.9907	
SYMMETRIC SLOPE	0.9418	(0.0005)
REGR. COEFFICIENT	0.9816	(0.0005)
REGR. CONSTANT	-0.0094	(0.0001)

Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2007 (Global)

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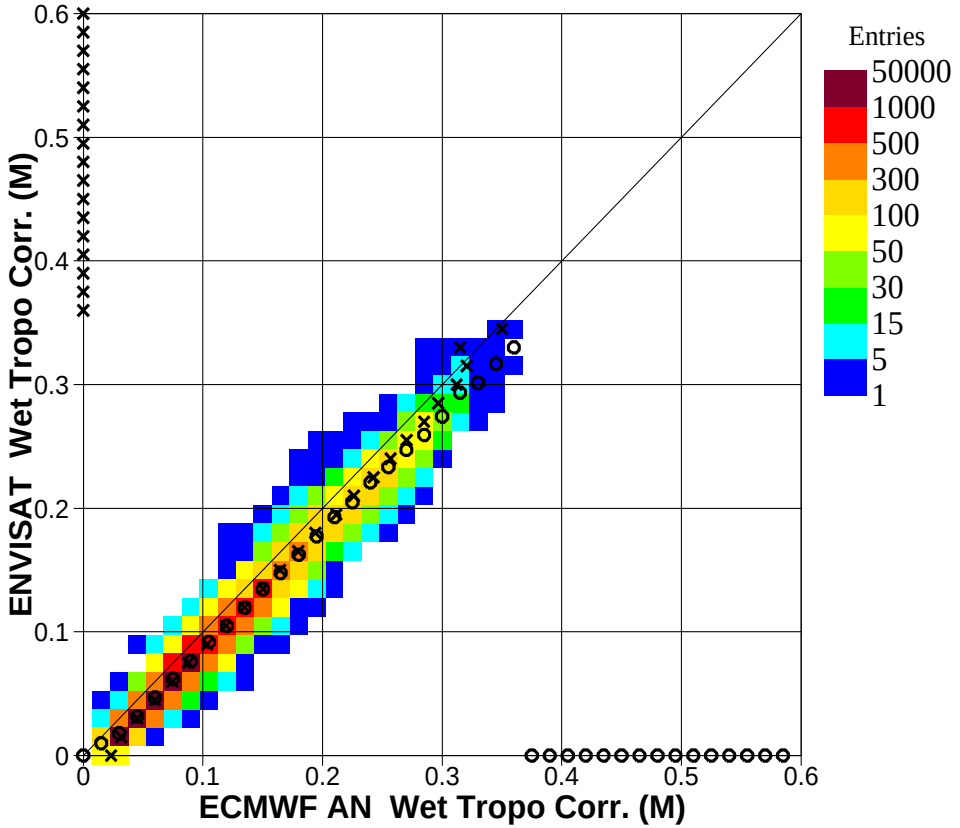

STATISTICS

ENTRIES	21441	
MEAN ECMWF	0.1119	
MEAN ENVISAT	0.0971	
BIAS (ENVISAT - ECMWF)	-0.0148	
STANDARD DEVIATION	0.0115	
SCATTER INDEX	0.1023	
CORRELATION	0.9837	
SYMMETRIC SLOPE	0.8960	(0.0013)
REGR. COEFFICIENT	0.9623	(0.0012)
REGR. CONSTANT	-0.0106	(0.0002)

Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2007 (N.Hem.)

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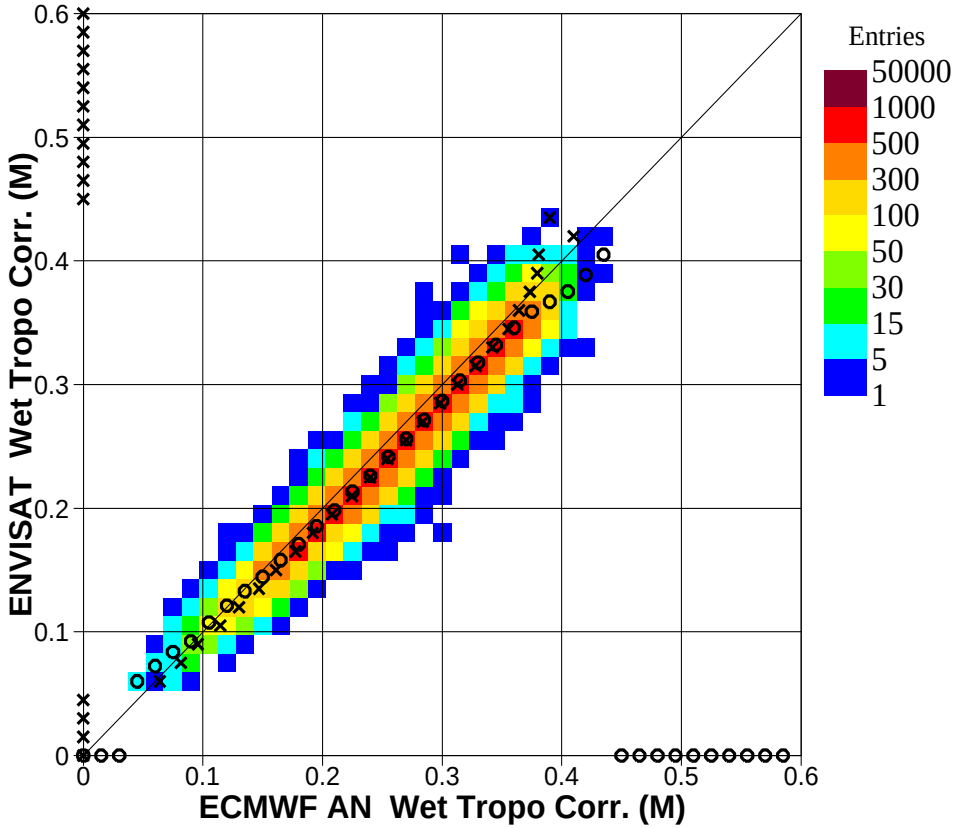

STATISTICS

ENTRIES	26614	
MEAN ECMWF	0.2681	
MEAN ENVISAT	0.2561	
BIAS (ENVISAT - ECMWF)	-0.0120	
STANDARD DEVIATION	0.0165	
SCATTER INDEX	0.0617	
CORRELATION	0.9723	
SYMMETRIC SLOPE	0.9576	(0.0014)
REGR. COEFFICIENT	0.9621	(0.0014)
REGR. CONSTANT	-0.0018	(0.0004)

Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2007 (Tropics)

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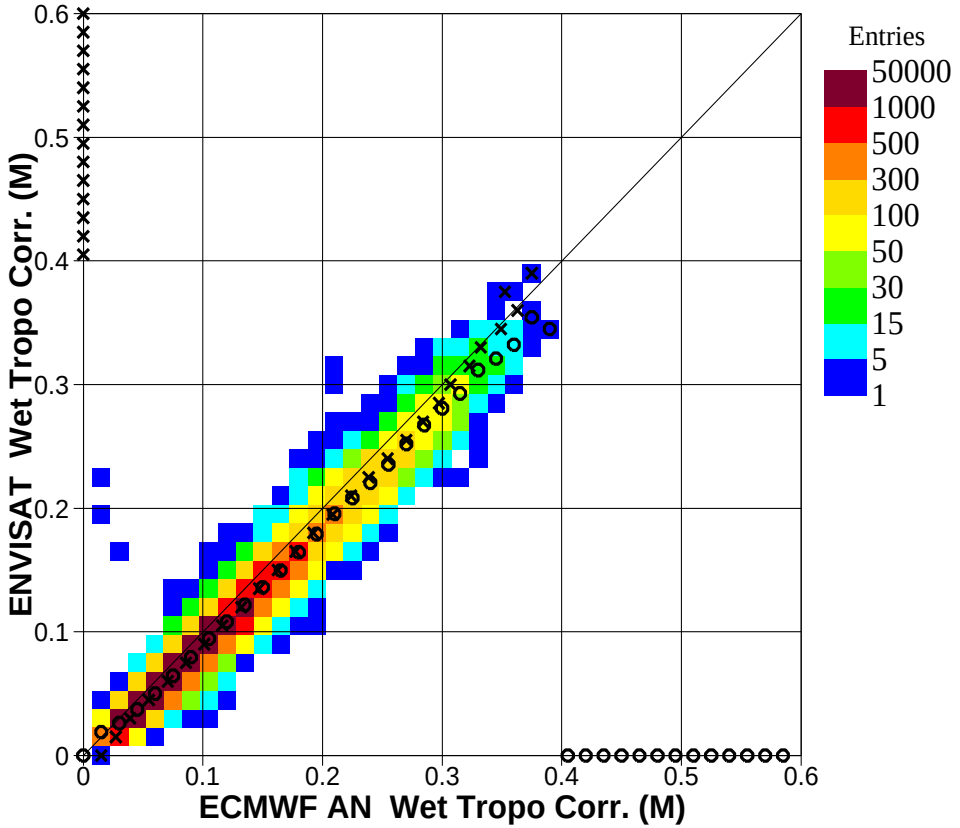

STATISTICS

ENTRIES	39930	
MEAN ECMWF	0.1093	
MEAN ENVISAT	0.0981	
BIAS (ENVISAT - ECMWF)	-0.0112	
STANDARD DEVIATION	0.0119	
SCATTER INDEX	0.1087	
CORRELATION	0.9833	
SYMMETRIC SLOPE	0.9156	(0.0009)
REGR. COEFFICIENT	0.9482	(0.0009)
REGR. CONSTANT	-0.0055	(0.0001)

Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2007 (S.Hem.)

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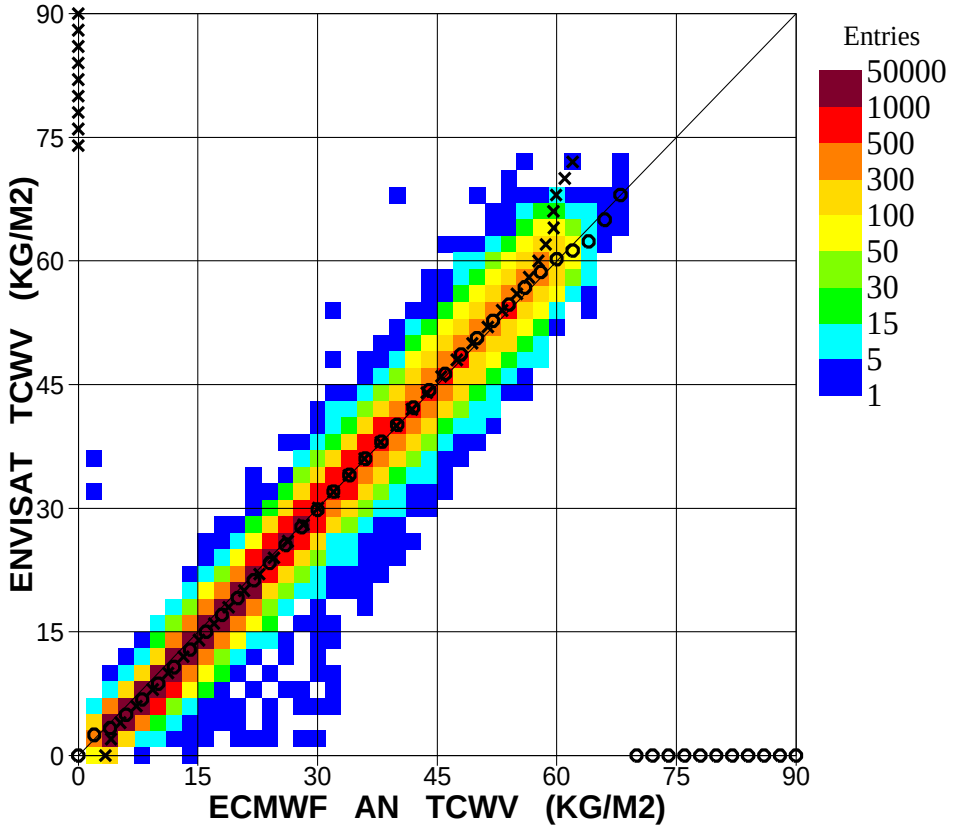

STATISTICS

ENTRIES	87361	
MEAN ECMWF	24.1888	
MEAN ENVISAT	23.6583	
BIAS (ENVISAT - ECMWF)	-0.5305	
STANDARD DEVIATION	2.1357	
SCATTER INDEX	0.0883	
CORRELATION	0.9922	
SYMMETRIC SLOPE	0.9991	(0.0005)
REGR. COEFFICIENT	1.0392	(0.0004)
REGR. CONSTANT	-1.4783	(0.0127)

Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2007 (Global)

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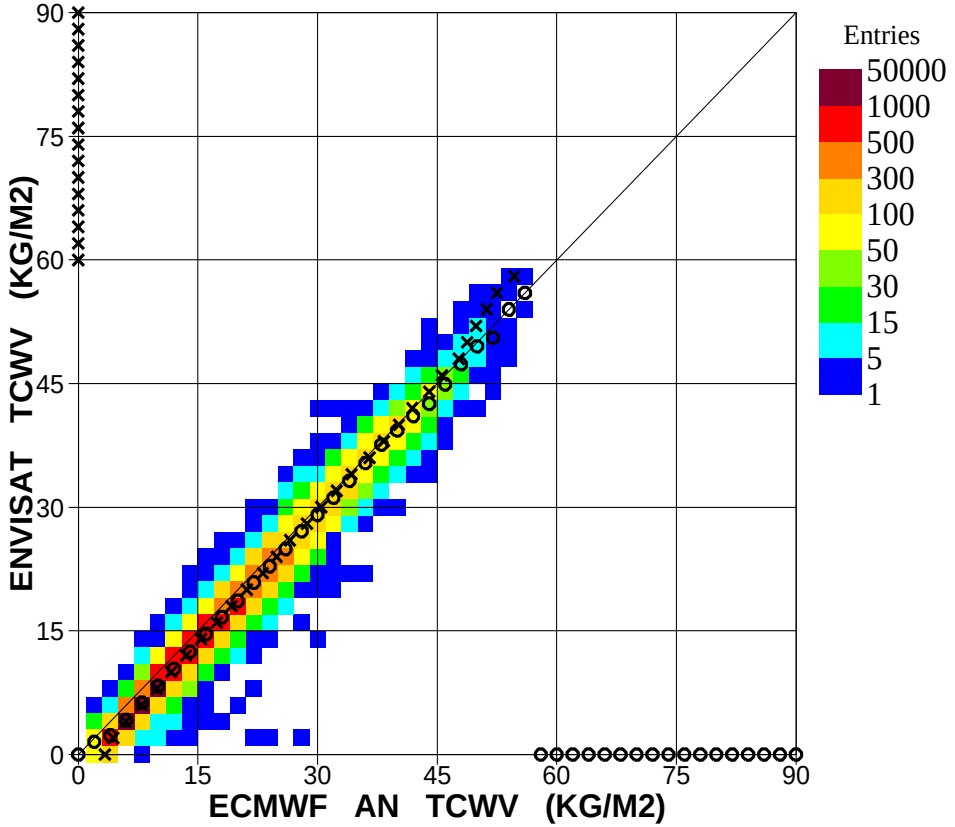

STATISTICS

ENTRIES	21441	
MEAN ECMWF	16.9213	
MEAN ENVISAT	15.5243	
BIAS (ENVISAT - ECMWF)	-1.3970	
STANDARD DEVIATION	1.6814	
SCATTER INDEX	0.0994	
CORRELATION	0.9874	
SYMMETRIC SLOPE	0.9524	(0.0013)
REGR. COEFFICIENT	1.0333	(0.0011)
REGR. CONSTANT	-1.9605	(0.0222)

Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2007 (N.Hem.)

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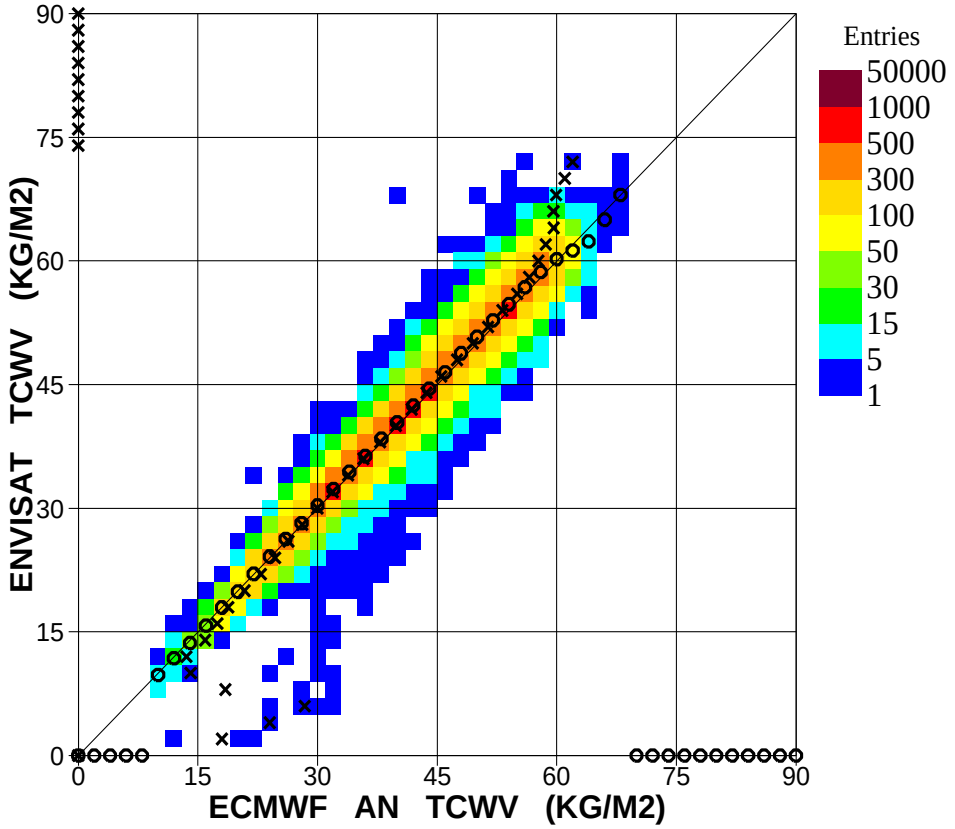

STATISTICS

ENTRIES	26614	
MEAN ECMWF	41.8736	
MEAN ENVISAT	42.3367	
BIAS (ENVISAT - ECMWF)	0.4631	
STANDARD DEVIATION	2.5777	
SCATTER INDEX	0.0616	
CORRELATION	0.9758	
SYMMETRIC SLOPE	1.0132	(0.0014)
REGR. COEFFICIENT	1.0177	(0.0014)
REGR. CONSTANT	-0.2790	(0.0606)

Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2007 (Tropics)

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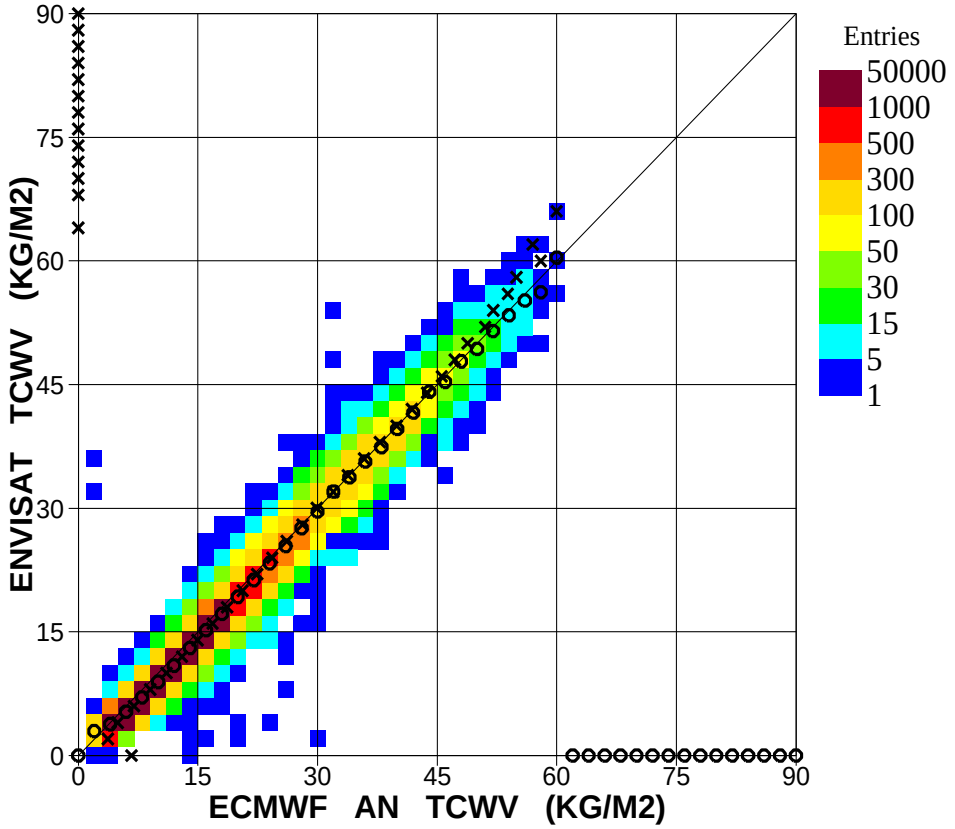

STATISTICS

ENTRIES	39930	
MEAN ECMWF	16.4124	
MEAN ENVISAT	15.6930	
BIAS (ENVISAT - ECMWF)	-0.7195	
STANDARD DEVIATION	1.7369	
SCATTER INDEX	0.1058	
CORRELATION	0.9863	
SYMMETRIC SLOPE	0.9763	(0.0009)
REGR. COEFFICIENT	1.0122	(0.0008)
REGR. CONSTANT	-0.9204	(0.0164)

Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2007 (S.Hem.)

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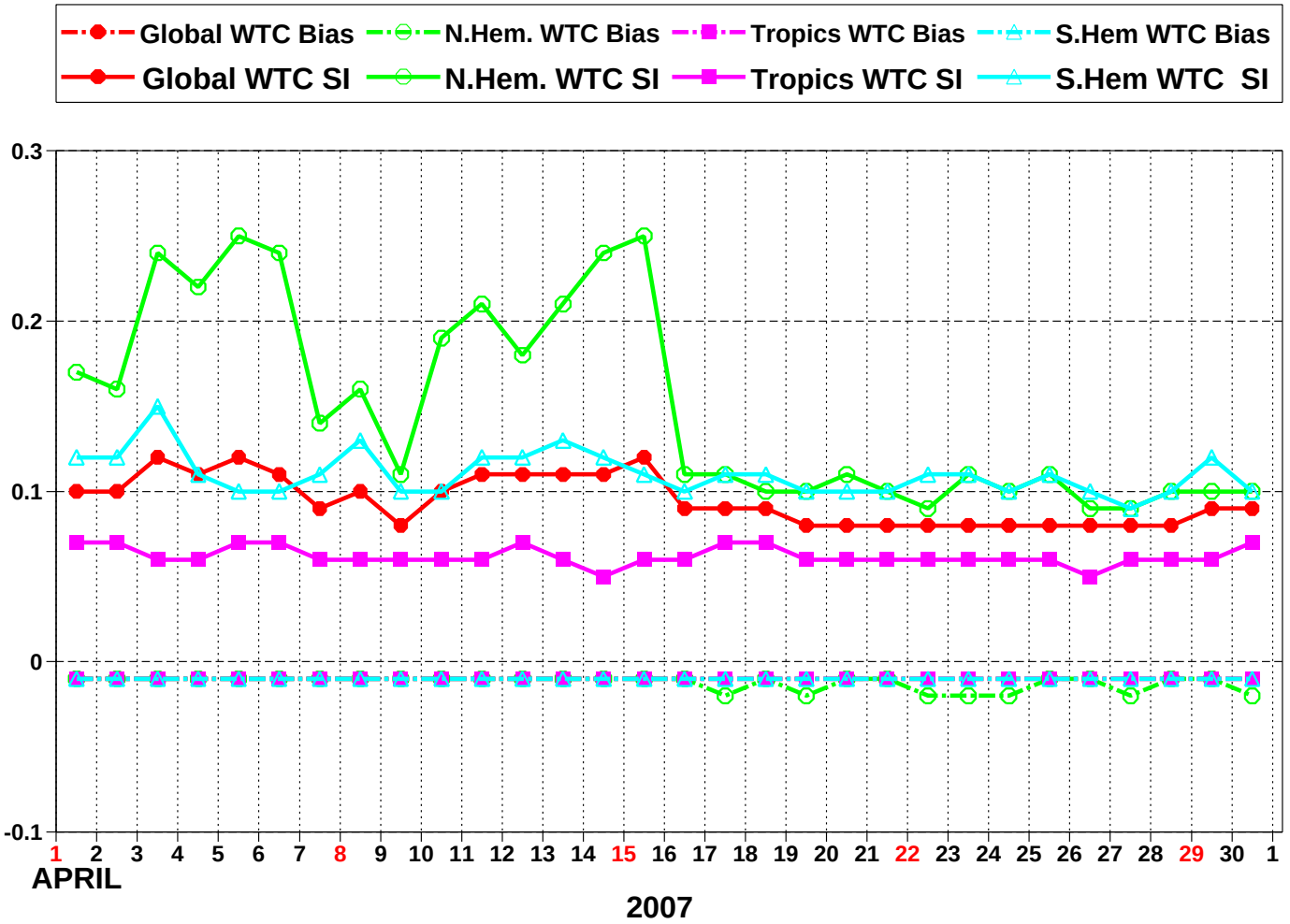

Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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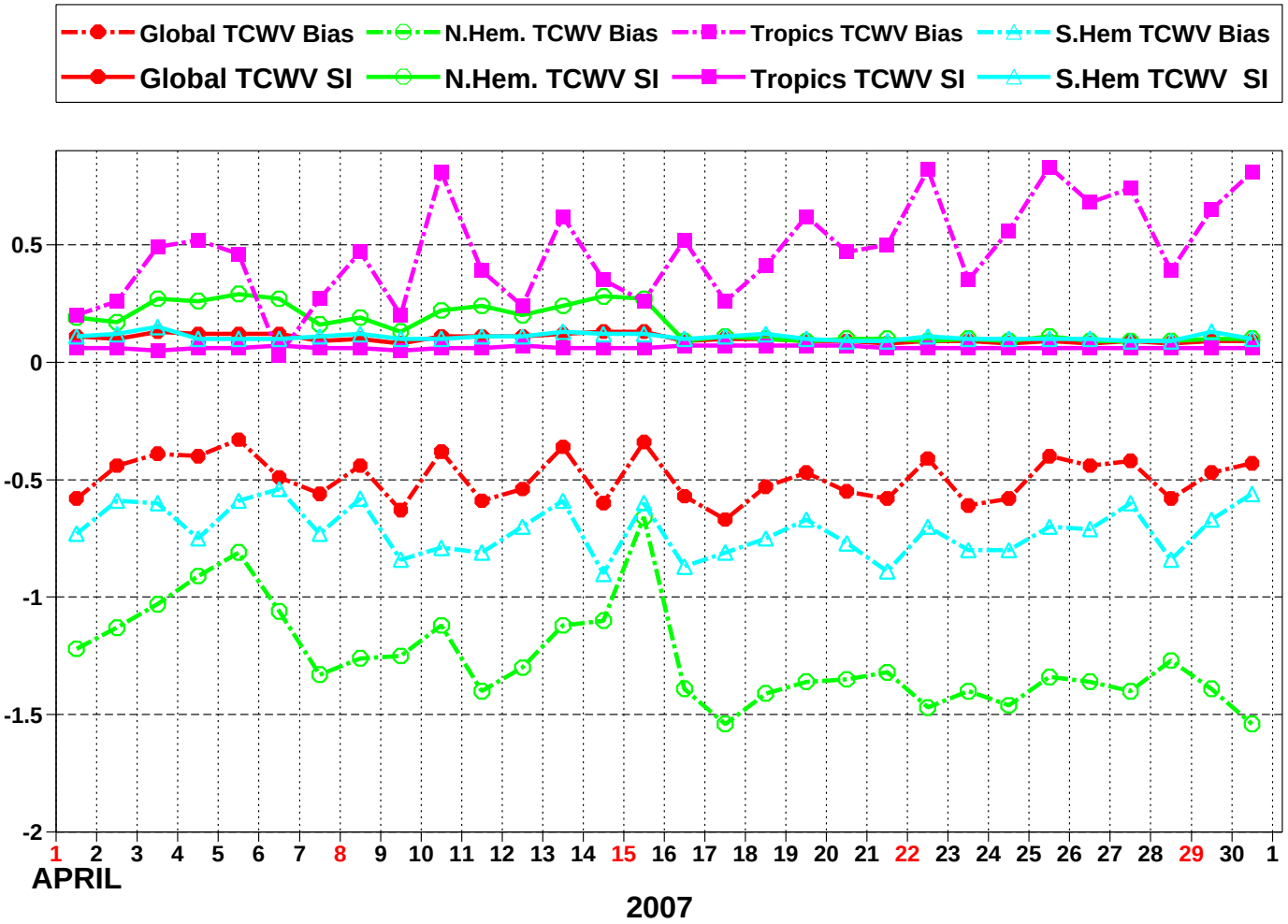

Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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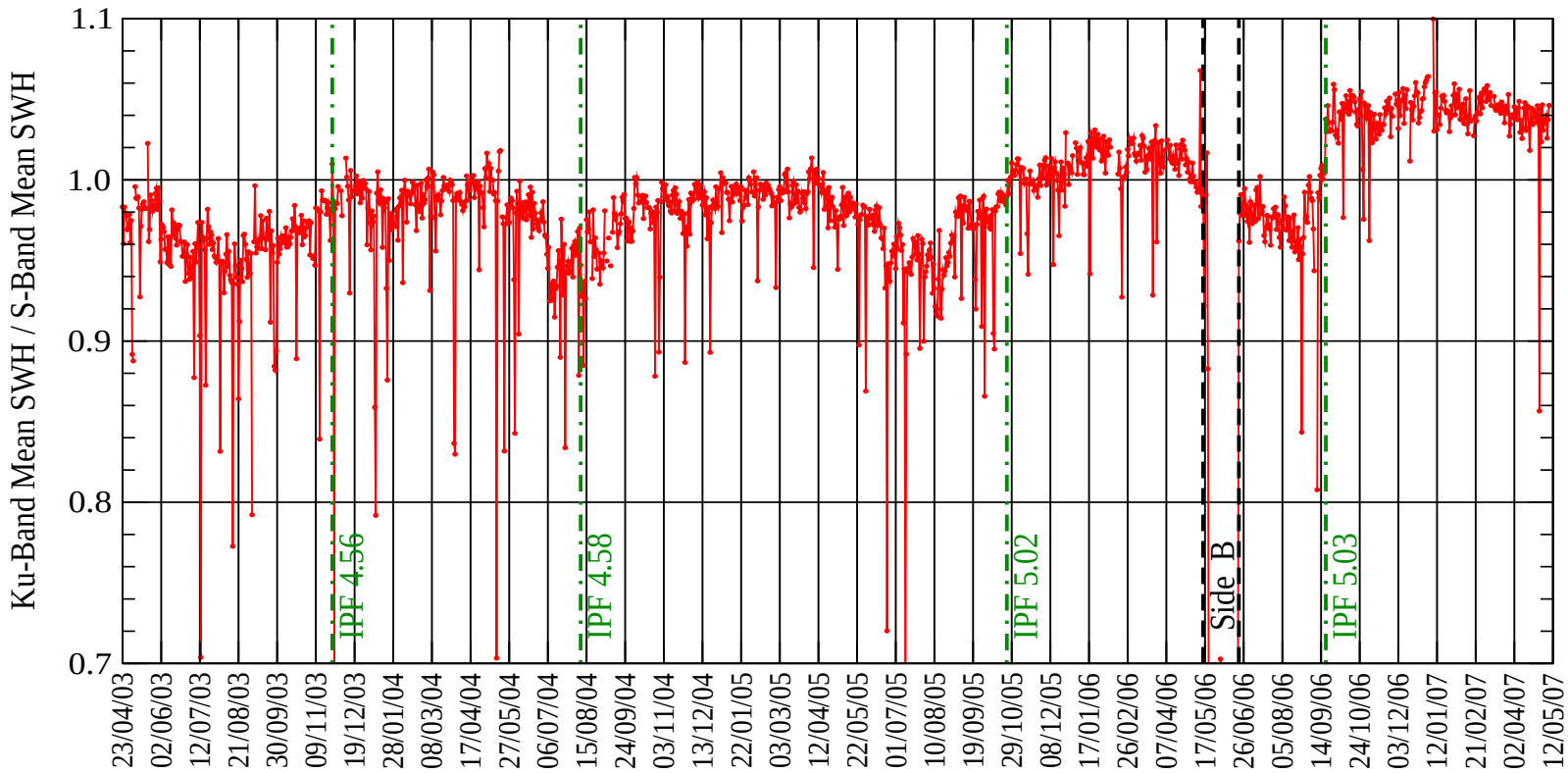

Figure 48: Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 23rd. of April 2003.

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