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

Wind/Wave Product with Height Information (RA2_WWV_2P)

By: *Saleh Abdalla*

Date: *6 May 2011*

Overview:

Based on the data received during this month, on average, 16845 observations arrived at ECMWF every 6-hour window of which an average of 6553 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 78.0% of the remaining part passed the quality control. As can be seen in Figure 1, there was no data during the 6-hour time windows centred at major synoptic UTC times of 06:00 on the 1st, 00:00 to 18:00 on the 4th, and 18:00 on the 8th of the month. Furthermore, there was some significant reduction in data volume during several 6-hour 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 2011

Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of very 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 altimeter has been out of order since 18 January 2008. **The quality of the data is nominal after the change of orbit at end of October 2010**.

Backscatter:

- ENVISAT Ku-band $<\sigma^0>$ = 10.96 dB (with main peaks at 10.6 and 10.8 dB).
- ENVISAT S-band: ***Not available since 18 January 2008.***

Comparison Summary:

Table 1: Comparison of Surface Wind Speeds:

	RA2 - ECMWF		RA2 - Buoy	
	Bias (m/s)	SI (%)	Bias (m/s)	SI (%)
Global	+0.34	14.8	-0.18	19.4
Northern Hemisphere	+0.23	14.8	-0.19	20.1
Tropics	+0.20	15.2	-0.09	16.5
Southern Hemisphere	+0.48	14.2	----	----

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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	-0.05	10.1	-0.04	14.3
Northern Hemisphere	-0.03	10.9	-0.04	14.8
Tropics	-0.08	9.0	-0.04	10.8
Southern Hemisphere	-0.03	9.6	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	----	----	----	----
Northern Hemisphere	----	----	----	----
Tropics	----	----	----	----
Southern Hemisphere	----	----	----	----

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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	-0.011	9.9	-0.43	7.9
Northern Hemisphere	-0.012	11.6	-0.94	9.6
Tropics	-0.013	7.3	-0.07	5.1
Southern Hemisphere	-0.009	12.3	-0.39	10.9

Remarks:

- The orbit of ENVISAT was reduced by about 17 km between the 22nd and the 27th of October 2010. It was confirmed that this change has no impact on the RA-2 wind and wave data.
- "Envisat RA-2 (A-Side) S-band transmission power suddenly dropped at 23:23:40 UTC on 17 January 2008". All S-band parameters are no longer valid since then.
- 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 about **3.0%** of the data this month. **An investigation regarding the reason behind the increase in the rain flagging since the implementation of IPF 6.02L04 in early February 2010**

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(see Figure 49) was carried out. It turned out that the mismatch between the definition of the rain flag in the PDS (WWV) product and the BUFR template. In PDS it has 3 active bits while in BUFR only 2 bits are defined (complying with an earlier definition of the flag in PDS). Therefore, when the rain flag is set in the PDS to the status "evaluation not possible (101)", it is interpreted in the BUFR format as "rain status (01)" (see ECMWF presentation at the forthcoming QWG#16). This impact started to appear after the proper implementation of the "rain flagging algorithm" in the NRT IPF 6.02L04 processing chain (D. Cotton, 2010; personal communication). In fact, after the loss of S-band, the rain flag has no significance (it is active only when S-band altimeter gives reasonable data). Therefore, a change in the BUFR template is not necessary.

- 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.
- 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 globally about 34 cm/s **higher** than the model for this month. On the other hand, it is about 18 cm/s **lower** than the buoy measurements for this month.
- The Ku-band significant wave heights are almost **unbiased** (lower by ~ 5 cm) when compared to WAM model results (0.5% lower in the NH, 3.2% lower in the Tropics and 0.4% lower in the 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 1.0% **lower** compared to the buoy wave heights for this month as can be seen in Figures 30-32 (Ku-band - buoy comparison). This low bias is due to the implementation of IPF 6.02L04.

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- **However, in the ENVISAT final report (published in March 2011), it was shown that the bias for given SWH bin can be rather large. The bias is negative for lower wave heights and vice versa for higher waves. This results in low overall bias.**
- Note that all S-band observations are not valid after the 17th. of January 2008. Therefore, all plots related to S-band should be ignored for this month (although there appears a handful of observations passed the quality control during some months).
- While the MWR derived TCWV is in good agreement with the model counterpart (MWR TCWV is slightly dryer than the model especially in the Extra Tropics), the MWR WTC is still consistently smaller (drier) than the model values.
- There used to be a small cloud (few outliers this month) of TCWV scatter plot outliers hanging below the main cloud at model values between 20 and 30 kg/m^2 (see Figures 42-45 of monthly reports before February 2010). It used to occur almost anywhere. This group of outliers used to be very clear in the long-period scatter plots. No specific condition or geographical location could be associated with this behaviour. Long-term scatter plots produced (not shown here) for the 9-month period after the implementation of IPF 6.02L04 (since the 2nd of February 2010), as well as the scatter plots for this month show no trace of this issue any more. **On the other hand, a secondary cloud of outliers started to appear in the WTC scatter plots.**
- It is important to stress that one needs to keep in mind when making the comparison between the results presented here for the 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-1 (blacklisted since the 1st of April 2010) and Jason-2 altimeter significant wave height data are assimilated in the ECMWF wave model.

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- **ENVISAT RA-2 ASAR Wave Mode Level 1b product has been, temporarily, disallowed from being assimilated in the ECMWF wave model since the late hours of the 21st of October 2010. This was a precautionary measure to ensure that the data quality after the orbit shift is as good as before. Despite the fact that the orbit change did not downgrade the ASAR WM products, Level 1b is still not assimilated due to the planned changes in ASAR configuration.**
- The ECMWF models were not changed during this month. The current operational IFS cycle is CY36R4 (since the 9th of November 2010).

List of Figures:

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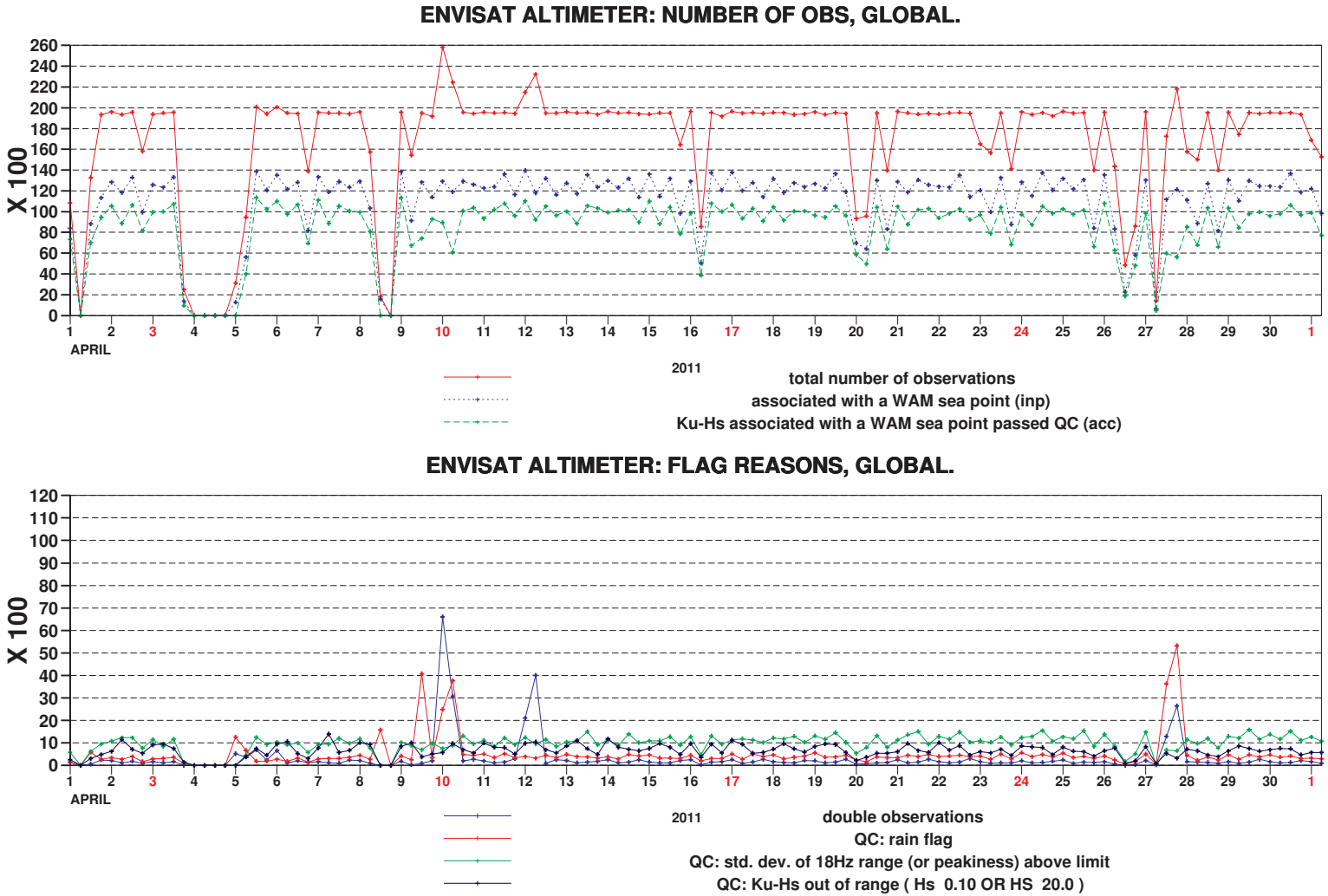

Figure 1: Time series of data reception for ENVISAT Altimeter data for April 2011

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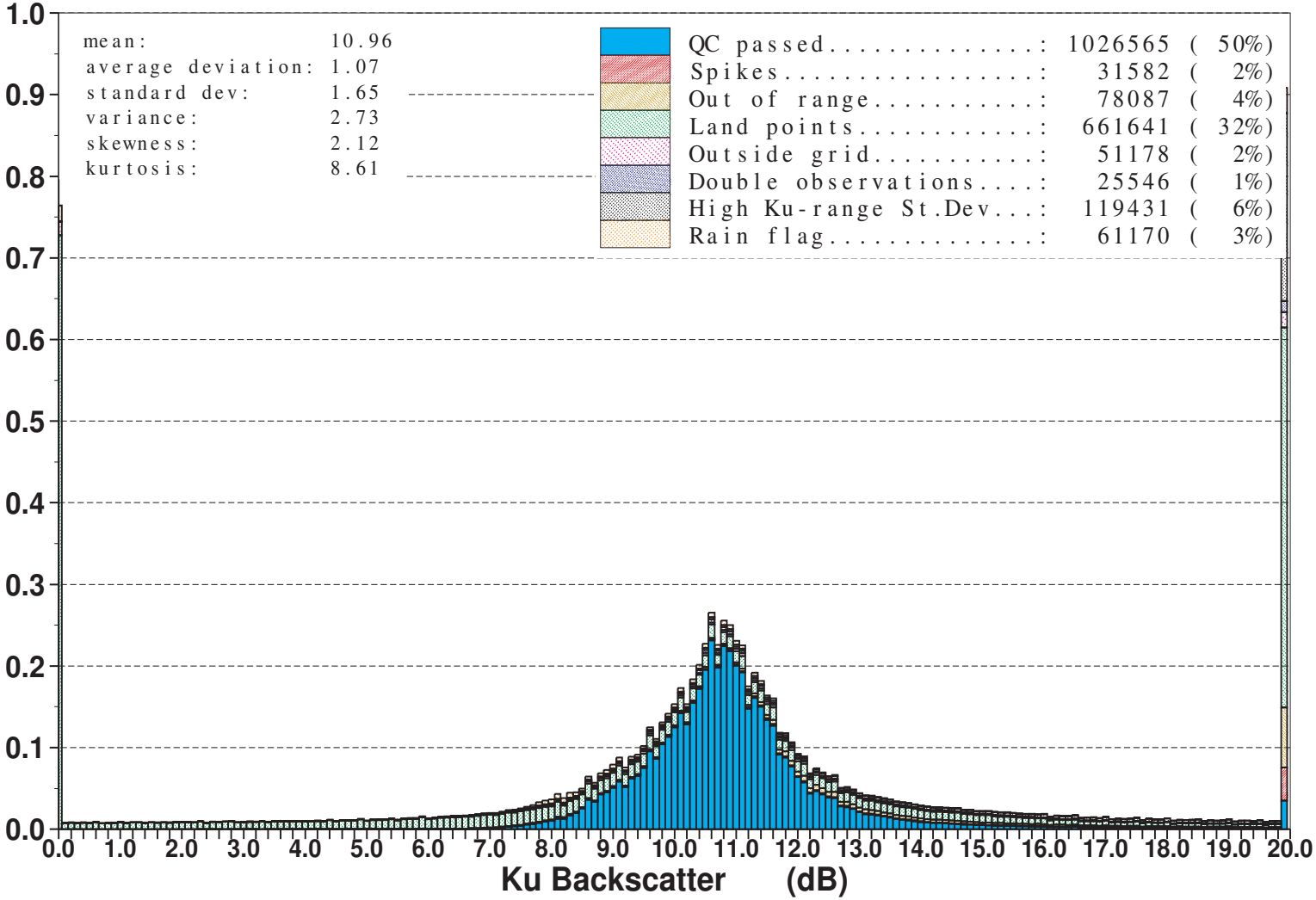

Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for April 2011

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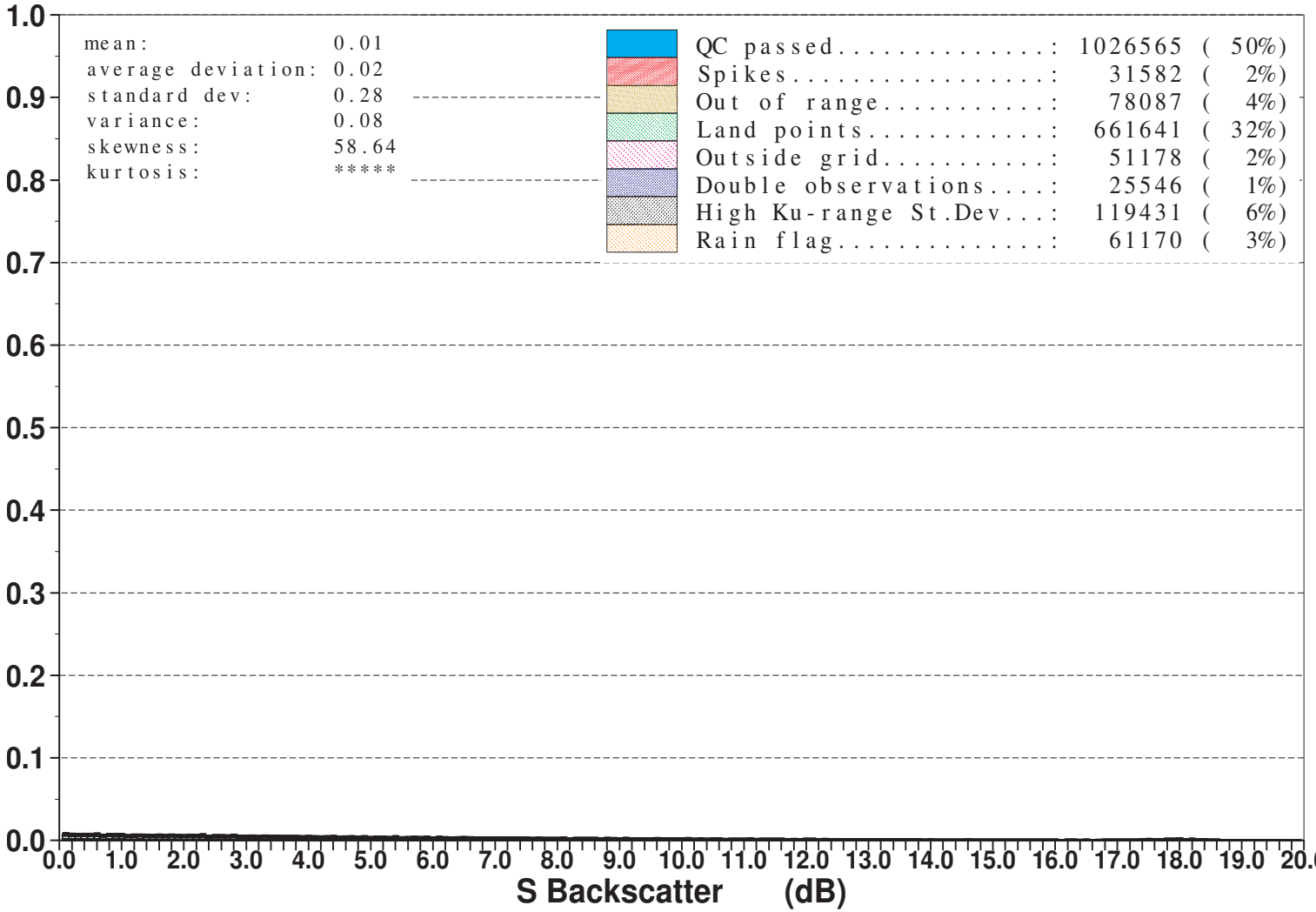

Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for April 2011

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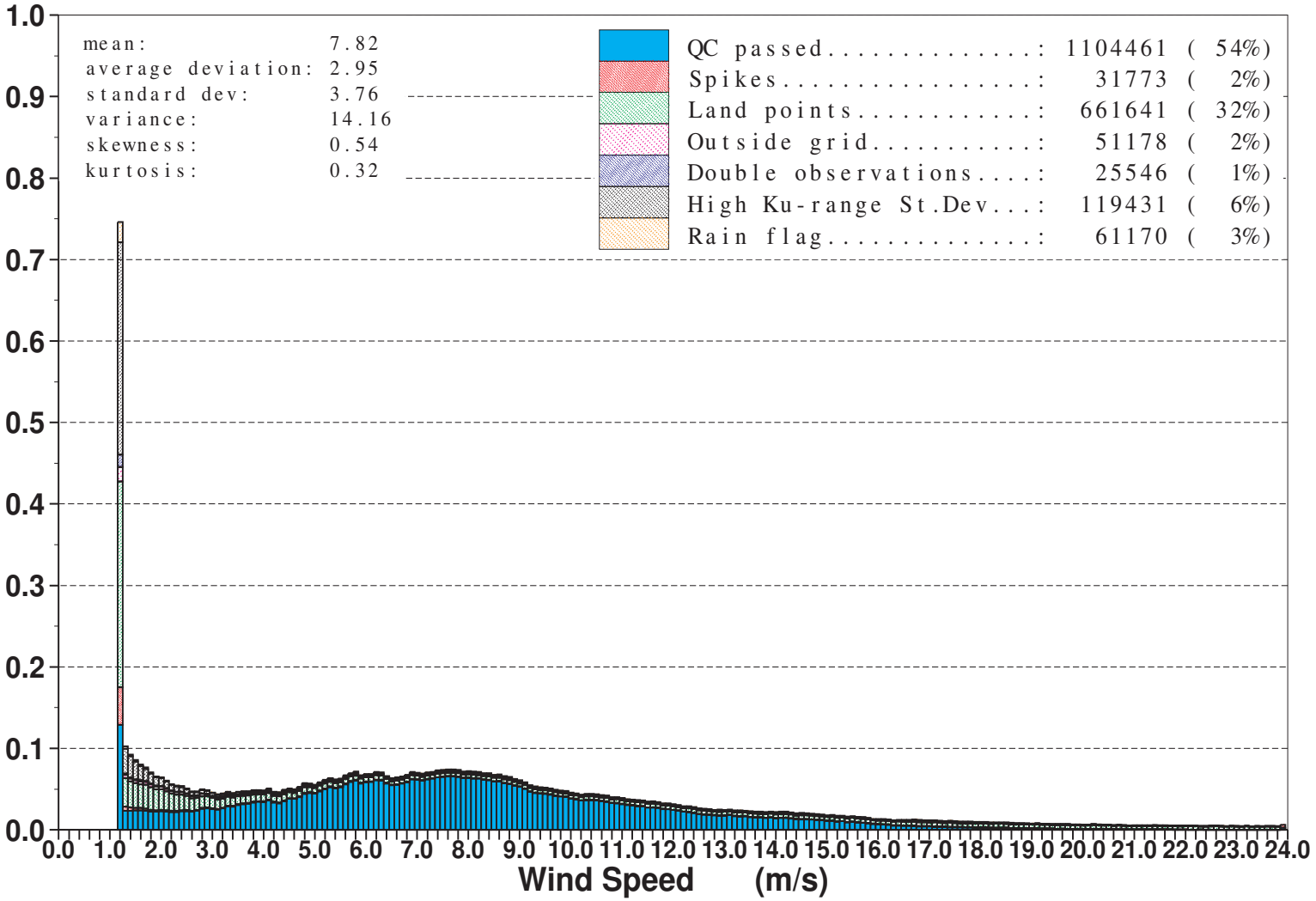

Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for April 2011

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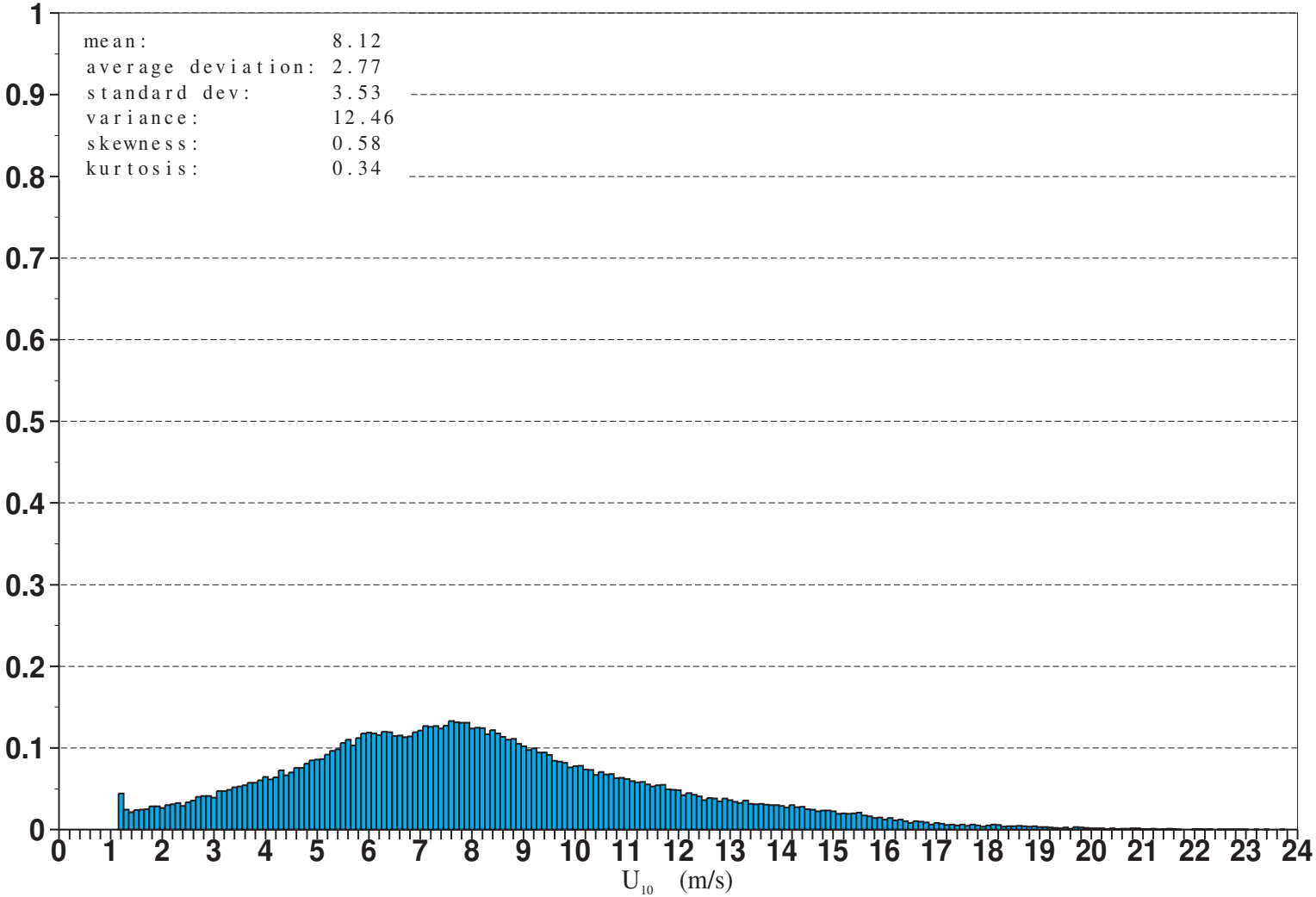

Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for April 2011

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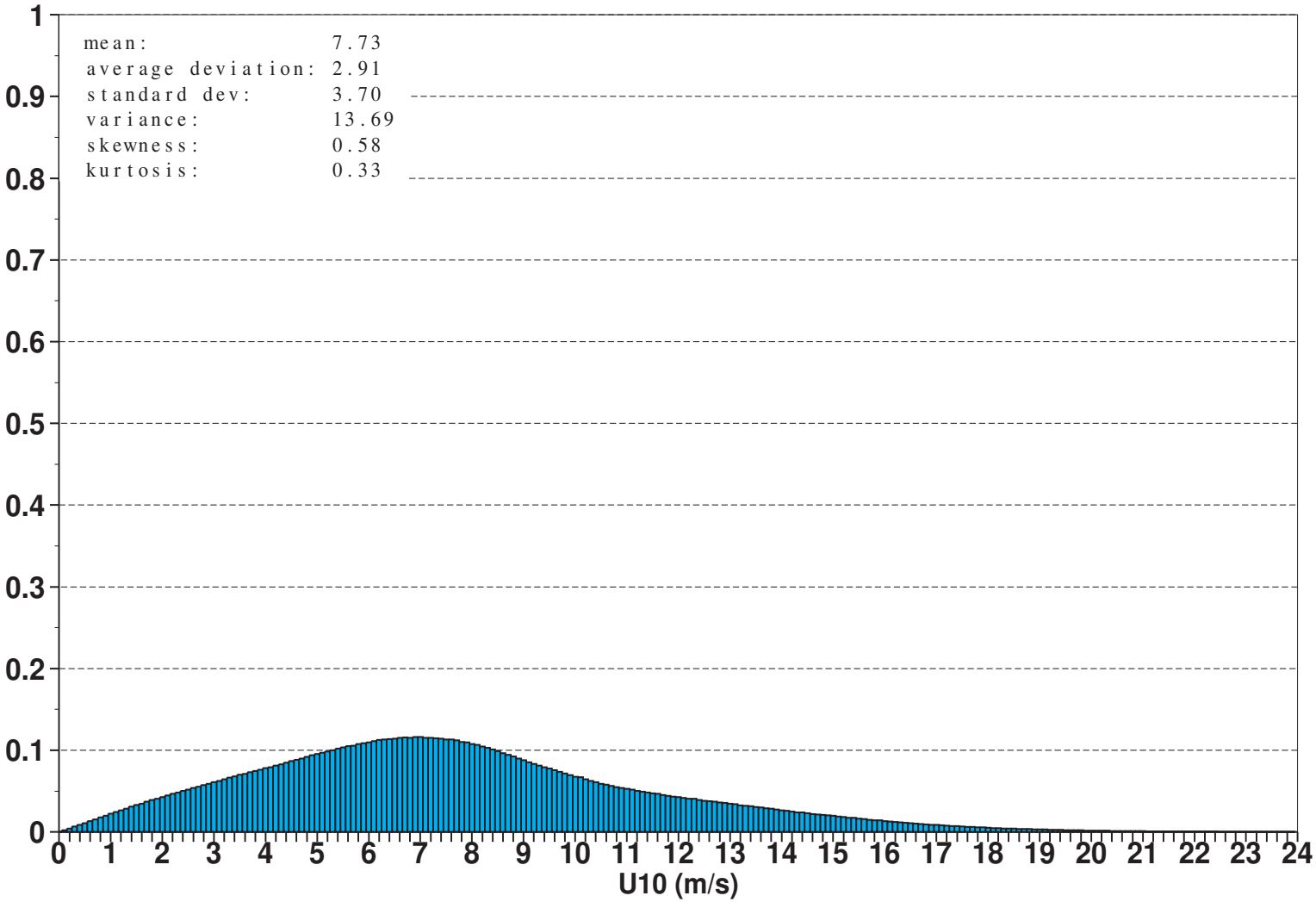

Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for April 2011

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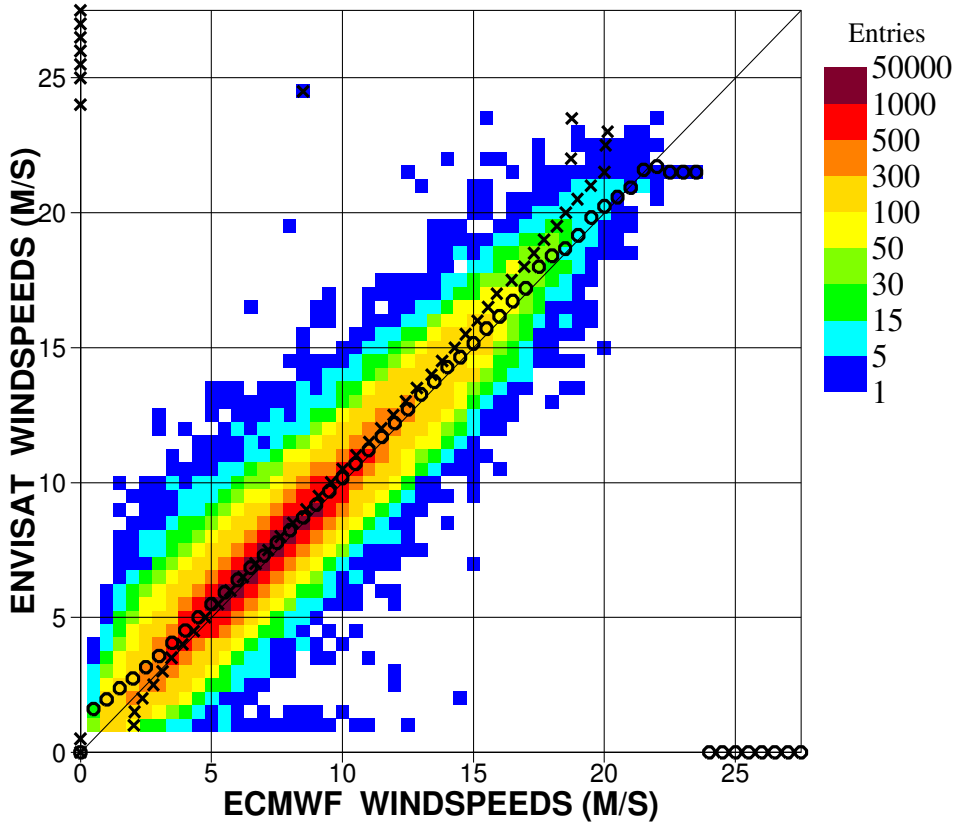

STATISTICS

ENTRIES	93645
MEAN ECMWF	7.7854
MEAN ENVISAT	8.1219
BIAS (ENVISAT - ECMWF)	0.3365
STANDARD DEVIATION	1.1502
SCATTER INDEX	0.1477
CORRELATION	0.9461
SYMMETRIC SLOPE	1.0391 (0.0011)
REGR. COEFFICIENT	0.9633 (0.0011)
REGR. CONSTANT	0.6220 (0.0092)

Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2011 (Global)

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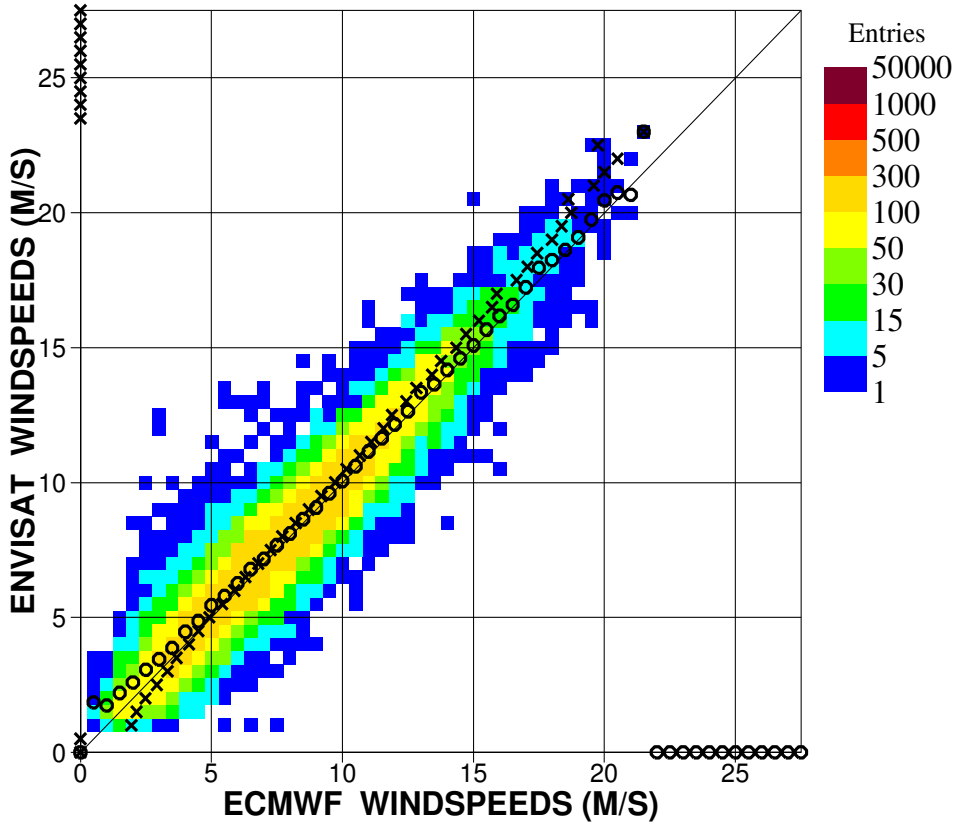

STATISTICS

ENTRIES	22518	
MEAN ECMWF	7.9755	
MEAN ENVISAT	8.2103	
BIAS (ENVISAT - ECMWF)	0.2349	
STANDARD DEVIATION	1.1784	
SCATTER INDEX	0.1477	
CORRELATION	0.9427	
SYMMETRIC SLOPE	1.0294	(0.0023)
REGR. COEFFICIENT	0.9704	(0.0023)
REGR. CONSTANT	0.4711	(0.0199)

Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2011 (N.Hem.)

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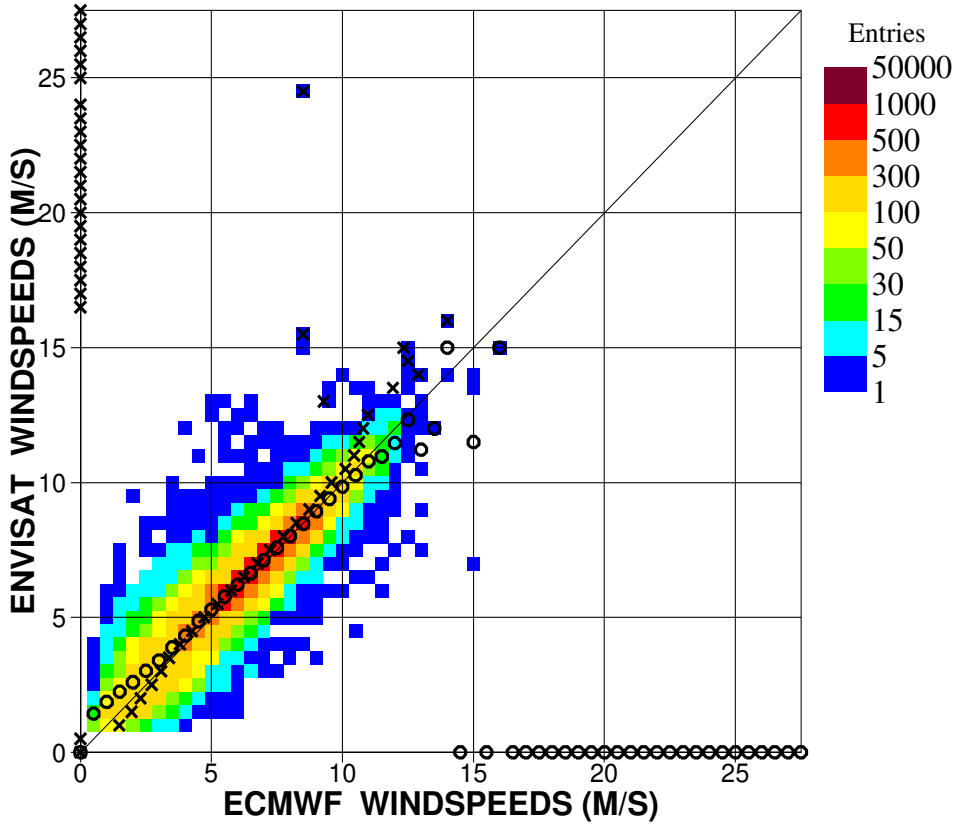

STATISTICS

ENTRIES	28810	
MEAN ECMWF	5.9900	
MEAN ENVISAT	6.1940	
BIAS (ENVISAT - ECMWF)	0.2040	
STANDARD DEVIATION	0.9076	
SCATTER INDEX	0.1515	
CORRELATION	0.9211	
SYMMETRIC SLOPE	1.0281	(0.0024)
REGR. COEFFICIENT	0.9089	(0.0023)
REGR. CONSTANT	0.7495	(0.0145)

Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2011 (Tropics)

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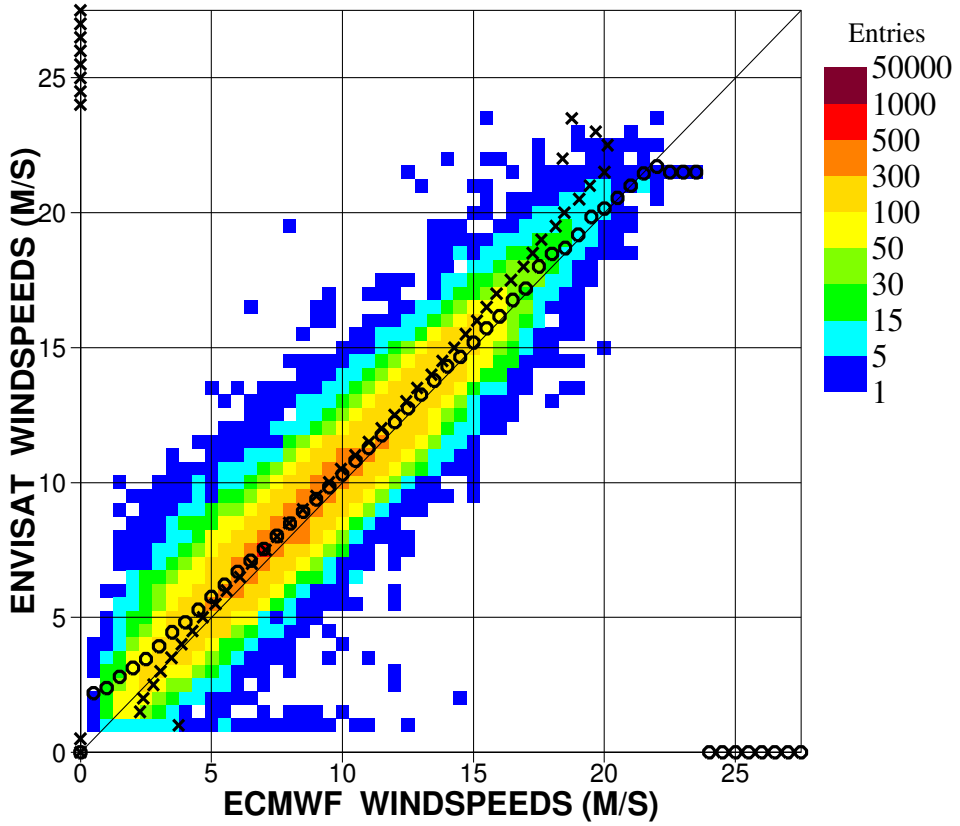

STATISTICS

ENTRIES	42987	
MEAN ECMWF	8.8740	
MEAN ENVISAT	9.3505	
BIAS (ENVISAT - ECMWF)	0.4765	
STANDARD DEVIATION	1.2565	
SCATTER INDEX	0.1416	
CORRELATION	0.9406	
SYMMETRIC SLOPE	1.0464	(0.0017)
REGR. COEFFICIENT	0.9424	(0.0016)
REGR. CONSTANT	0.9874	(0.0157)

Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2011 (S.Hem.)

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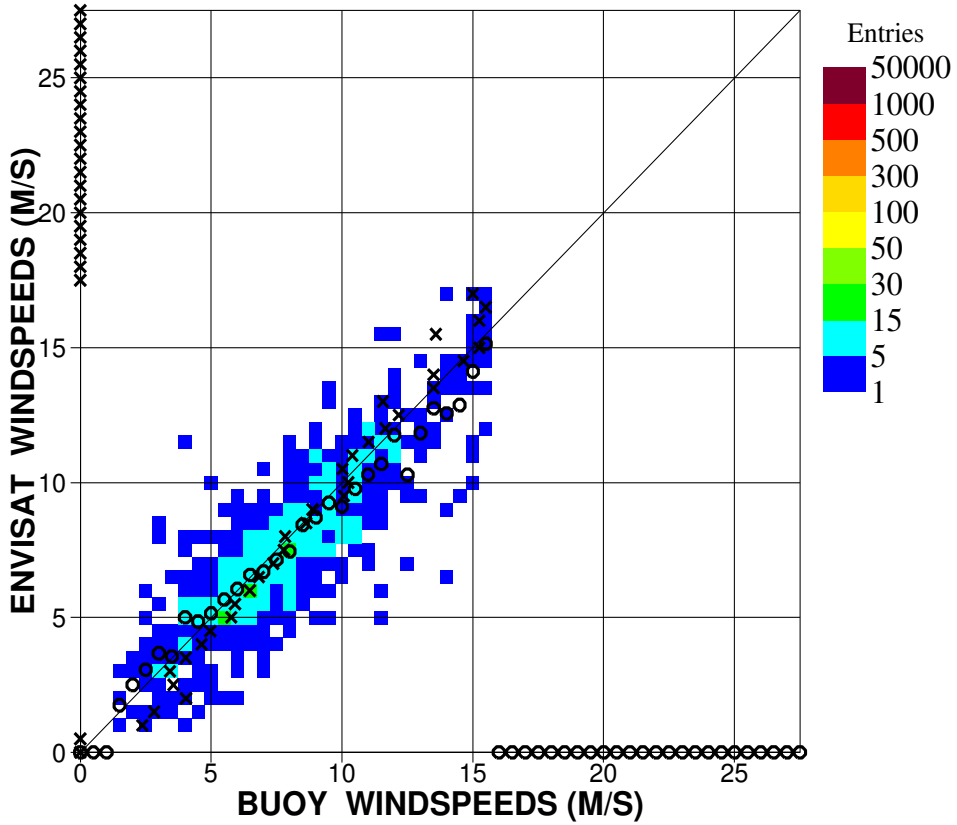

STATISTICS

ENTRIES	967	
MEAN BUOY	7.8068	
MEAN ENVISAT	7.6307	
BIAS (ENVISAT - BUOY)	-0.1762	
STANDARD DEVIATION	1.5170	
SCATTER INDEX	0.1943	
CORRELATION	0.8580	
SYMMETRIC SLOPE	0.9807	(0.0171)
REGR. COEFFICIENT	0.8623	(0.0166)
REGR. CONSTANT	0.8985	(0.1381)

Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2011 (Global)

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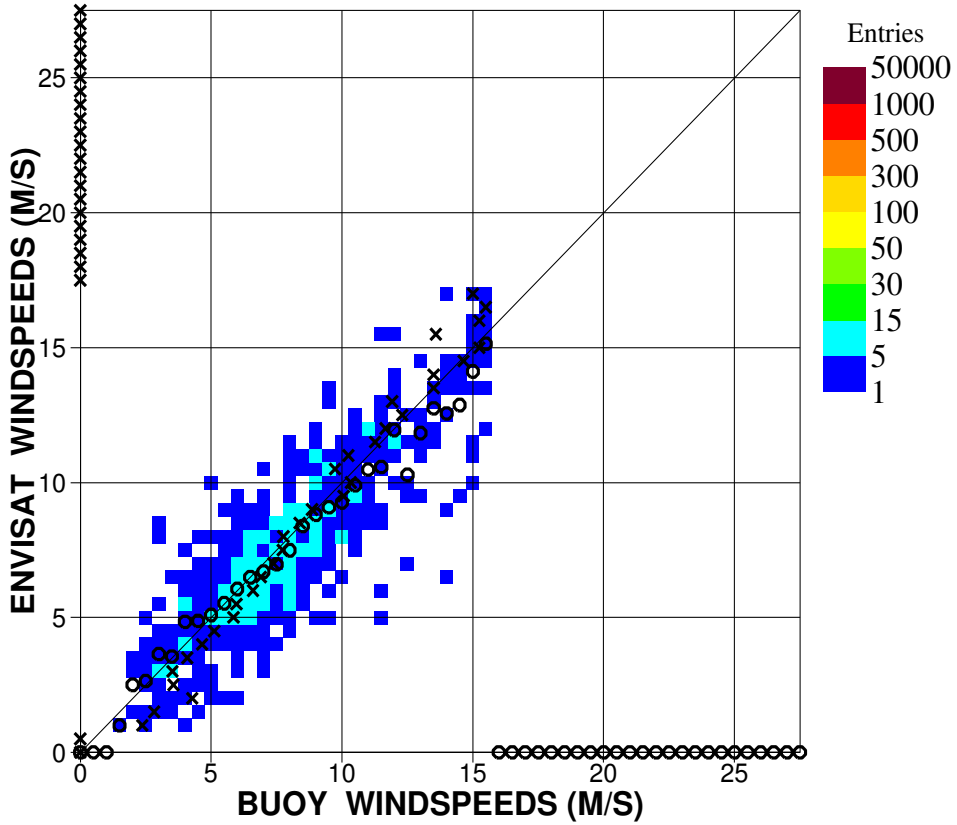

STATISTICS

ENTRIES	782	
MEAN BUOY	7.7532	
MEAN ENVISAT	7.5588	
BIAS (ENVISAT - BUOY)	-0.1944	
STANDARD DEVIATION	1.5606	
SCATTER INDEX	0.2013	
CORRELATION	0.8631	
SYMMETRIC SLOPE	0.9811	(0.0188)
REGR. COEFFICIENT	0.8826	(0.0185)
REGR. CONSTANT	0.7155	(0.1534)

Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2011 (N.Hem.)

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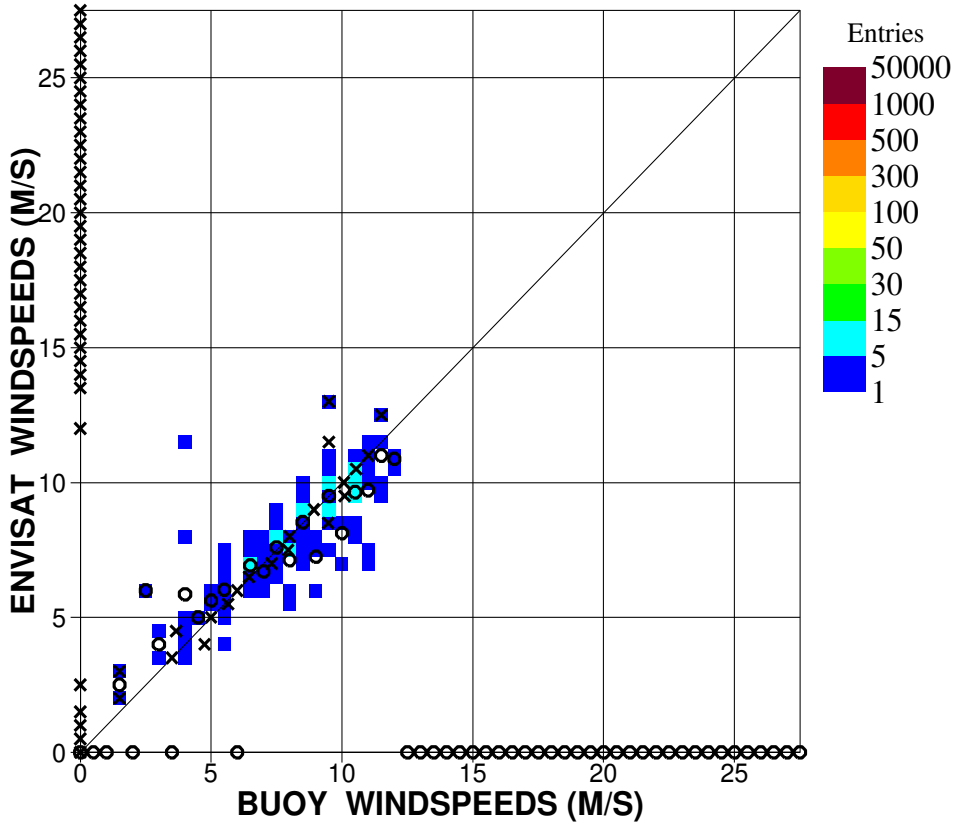

STATISTICS

ENTRIES	179	
MEAN BUOY	8.0737	
MEAN ENVISAT	7.9795	
BIAS (ENVISAT - BUOY)	-0.0942	
STANDARD DEVIATION	1.3336	
SCATTER INDEX	0.1652	
CORRELATION	0.8147	
SYMMETRIC SLOPE	0.9794	(0.0430)
REGR. COEFFICIENT	0.7011	(0.0375)
REGR. CONSTANT	2.3187	(0.3148)

Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2011 (Tropics)

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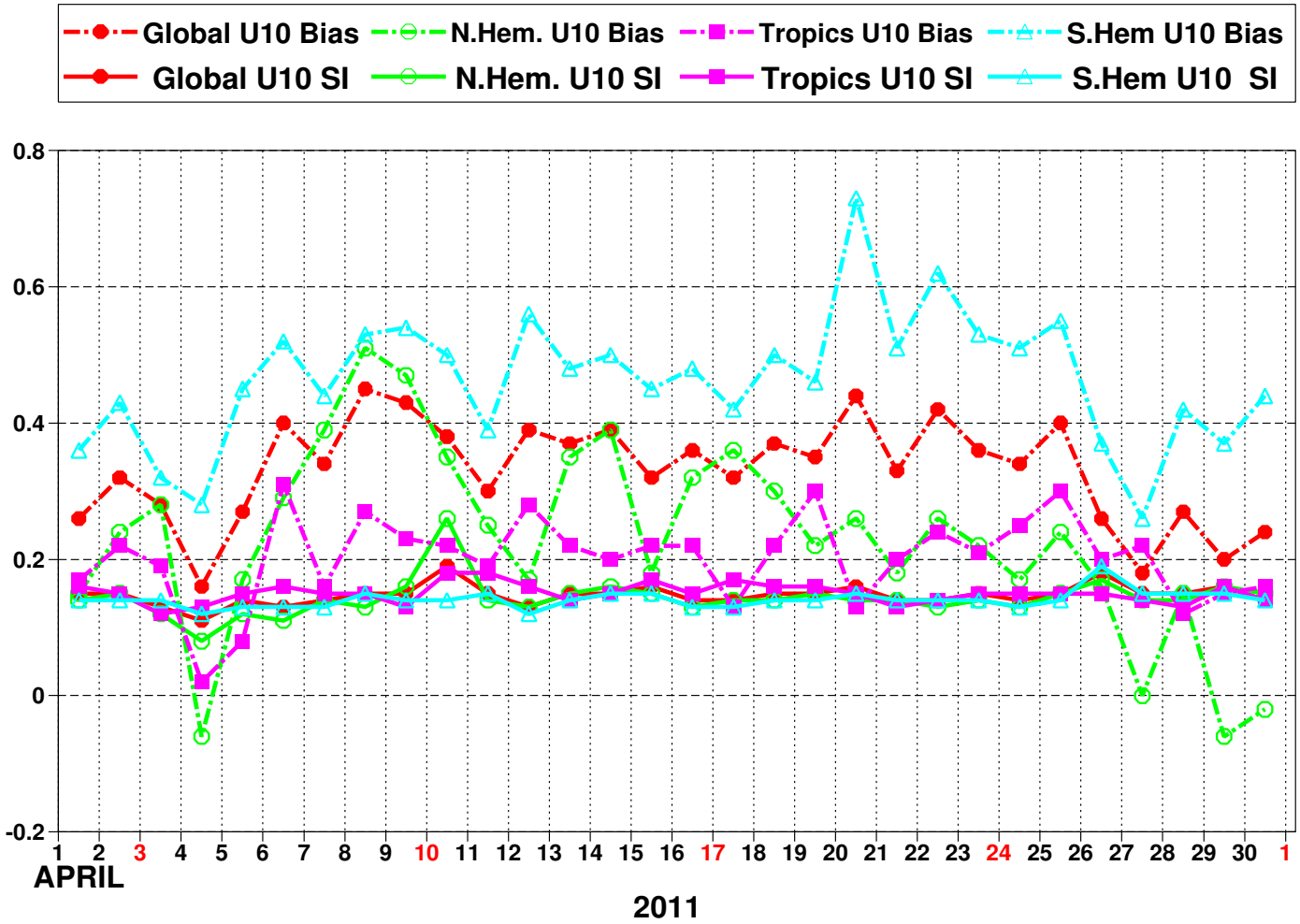

Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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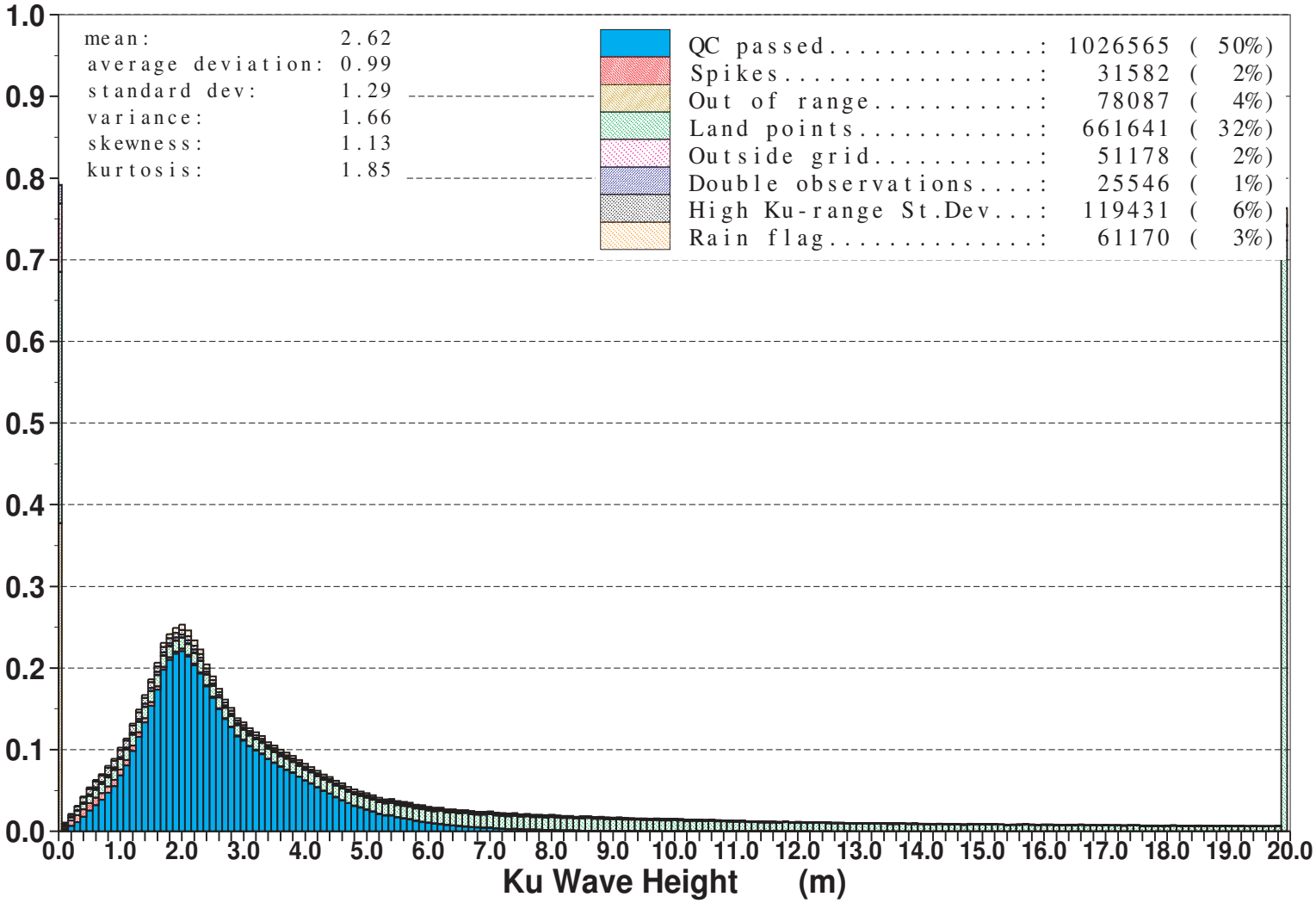

Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for April 2011

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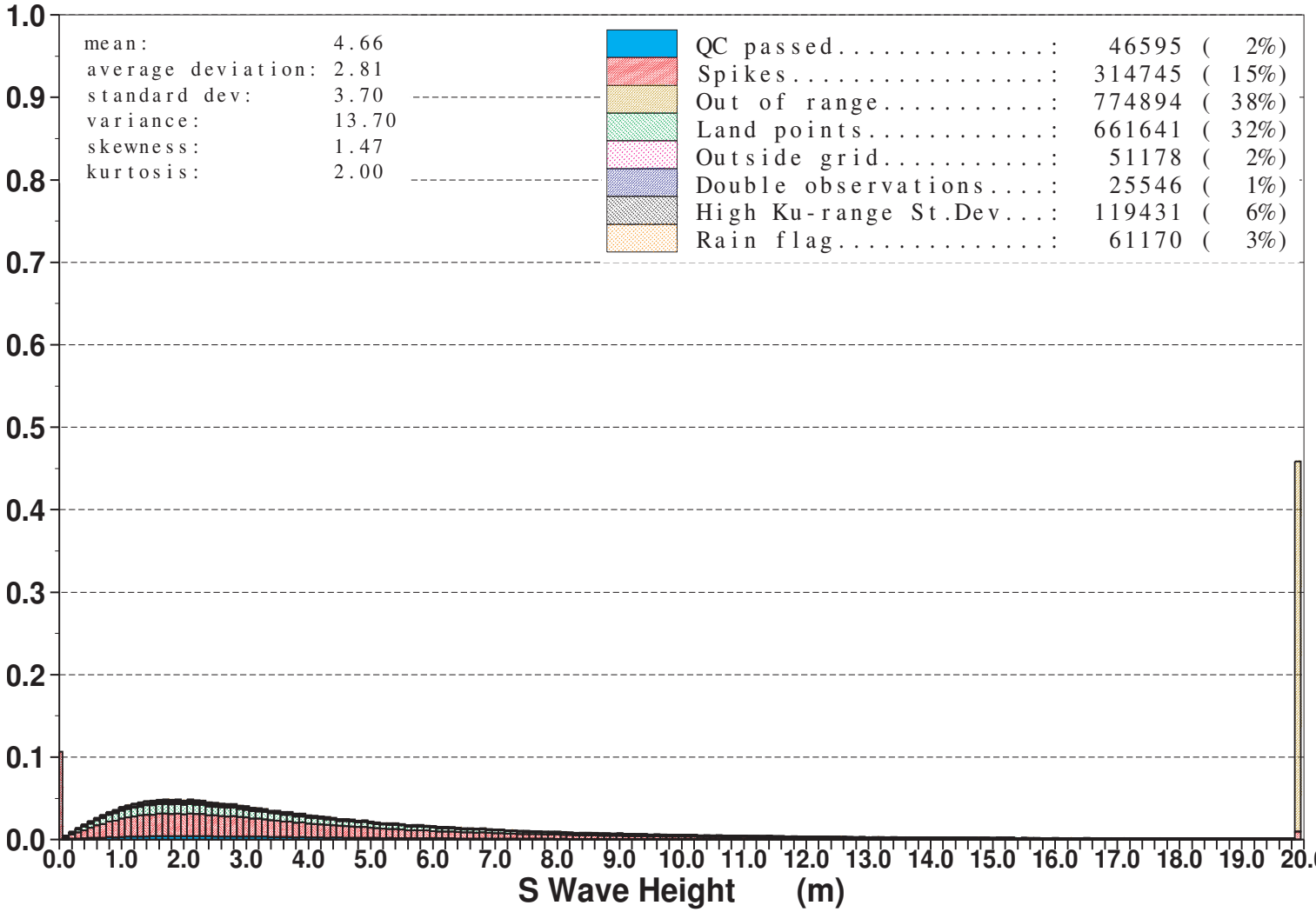

Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for April 2011

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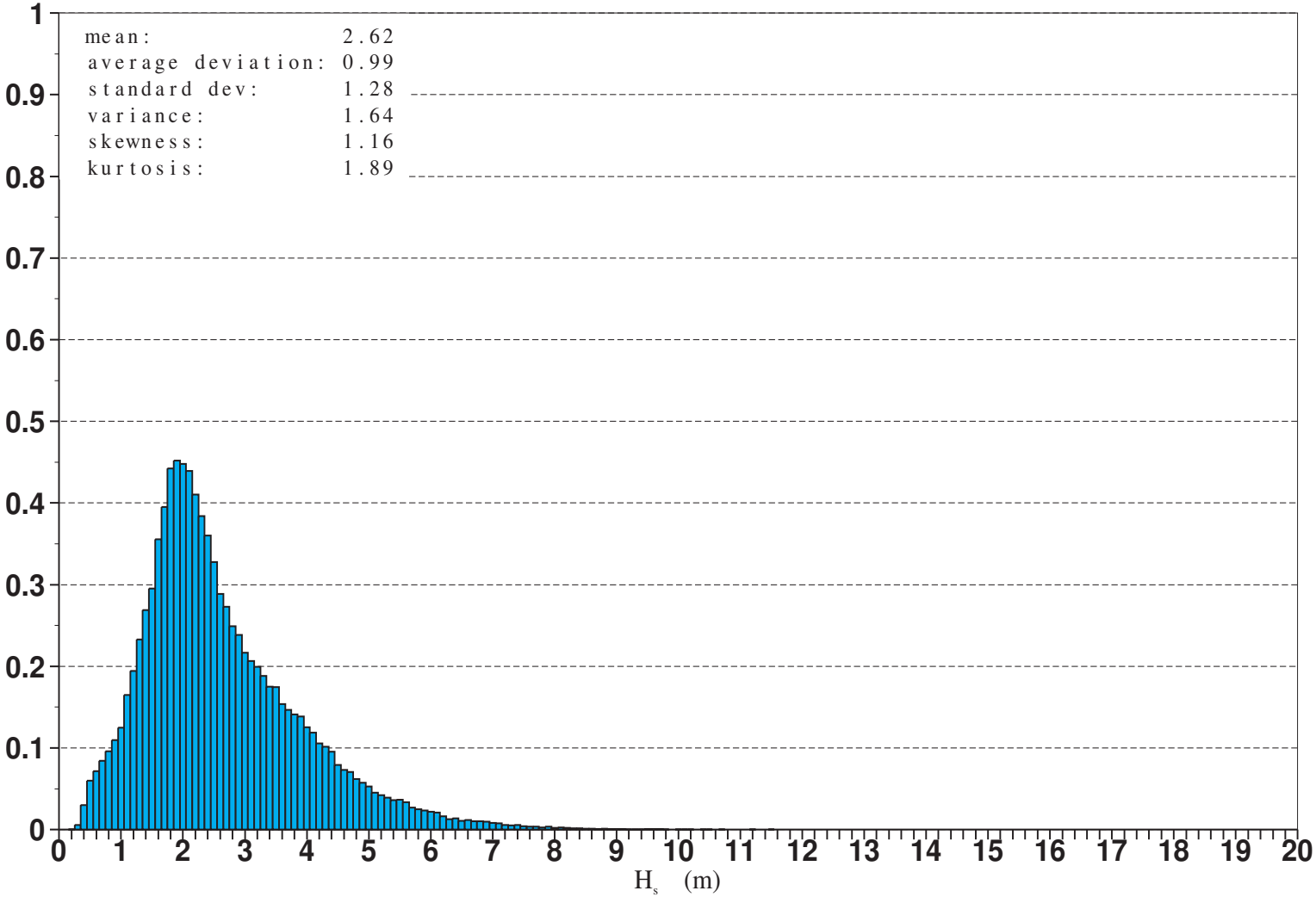

Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for April 2011

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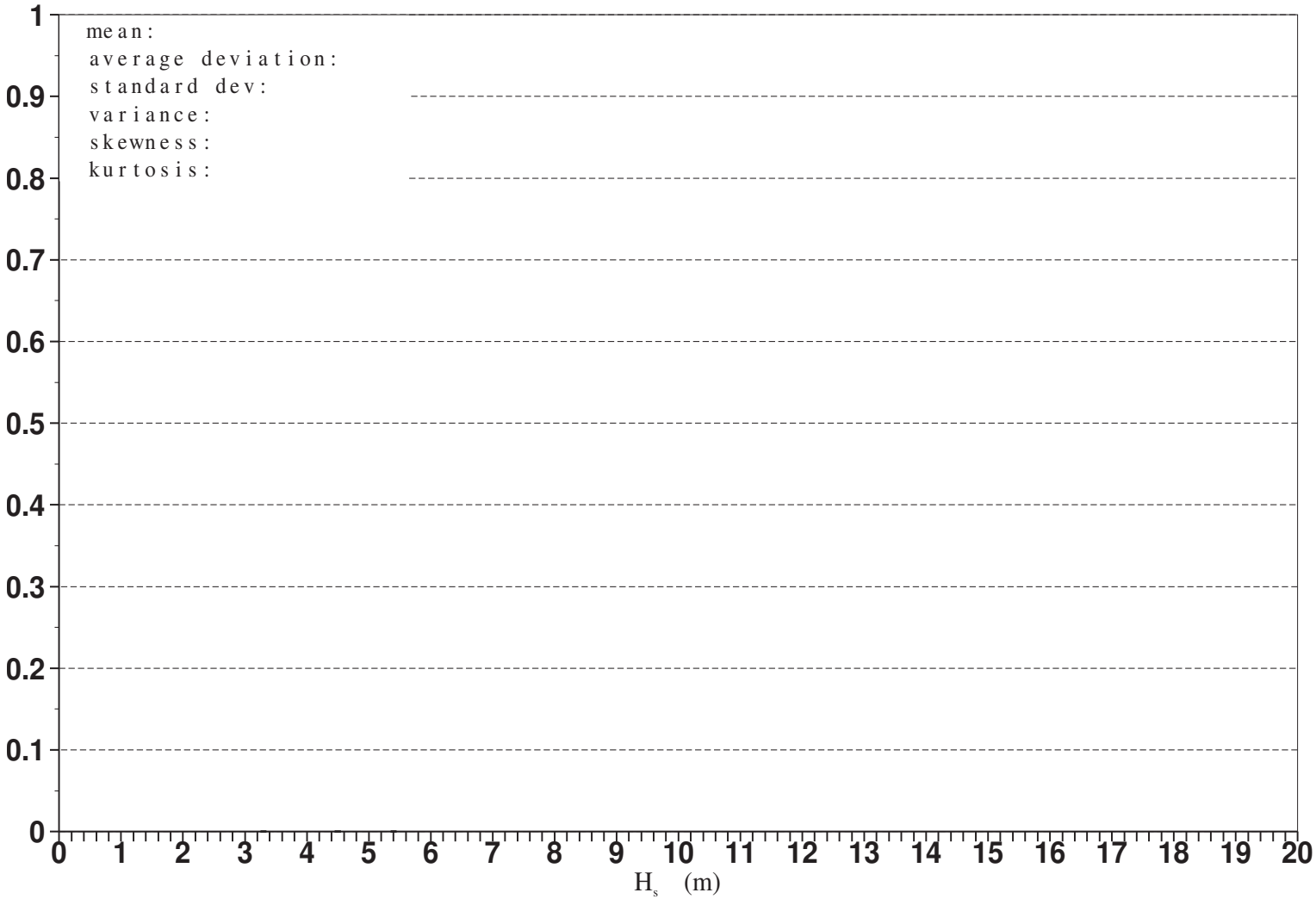

Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for April 2011

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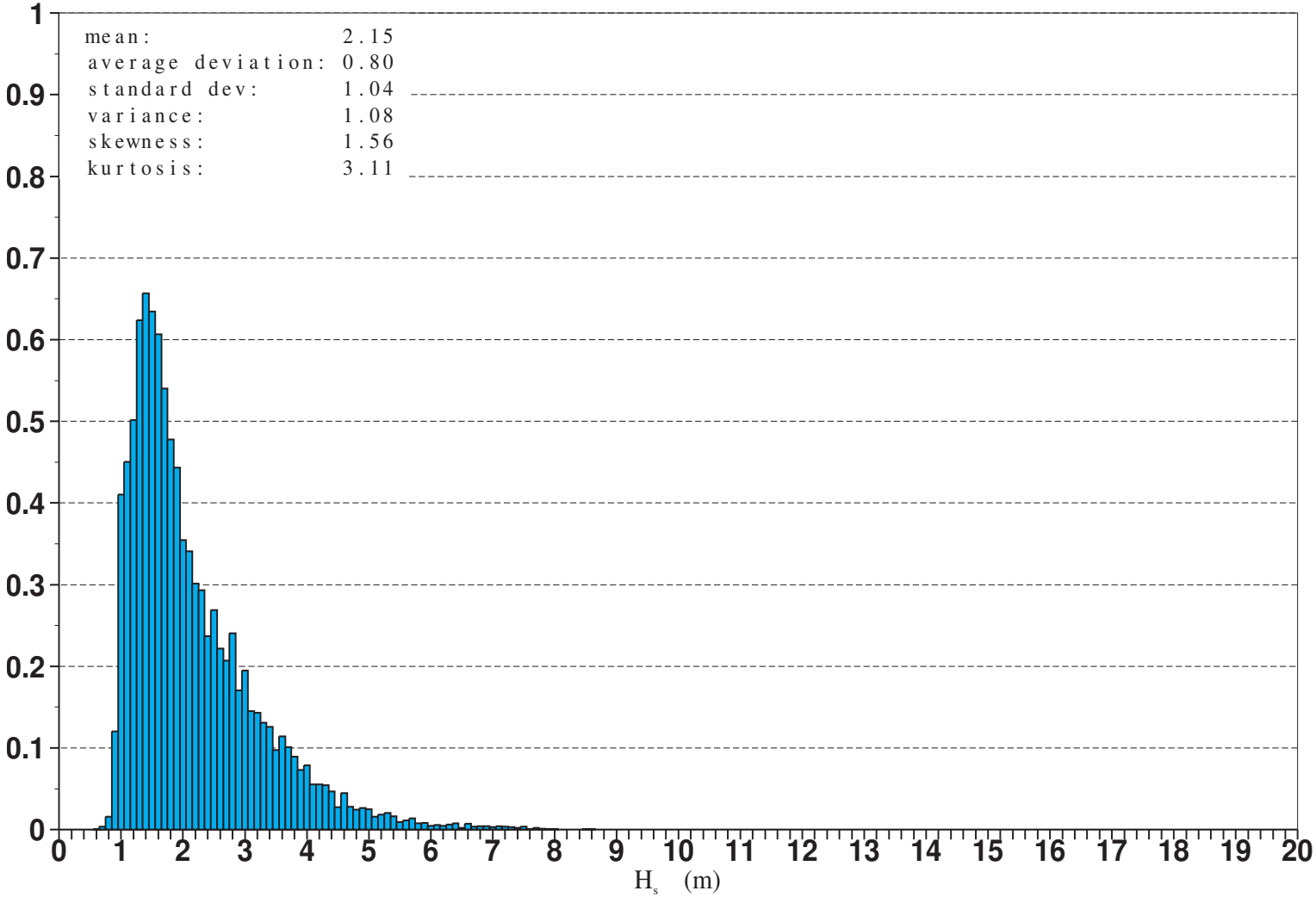

Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for April 2011

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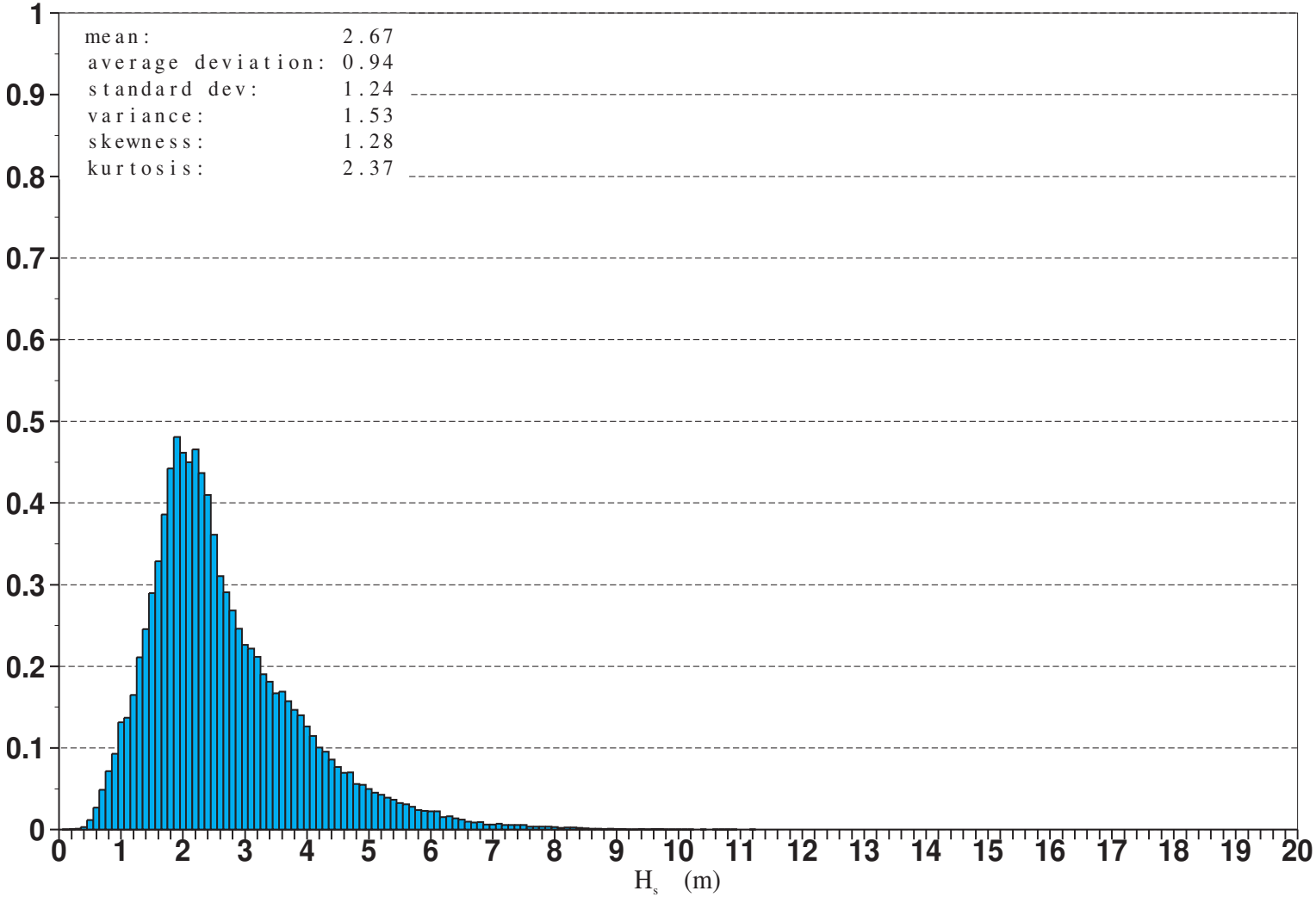

Figure 19b: Distribution of WAM 4V Wave Height (Collocated with ENVISAT) for April 2011

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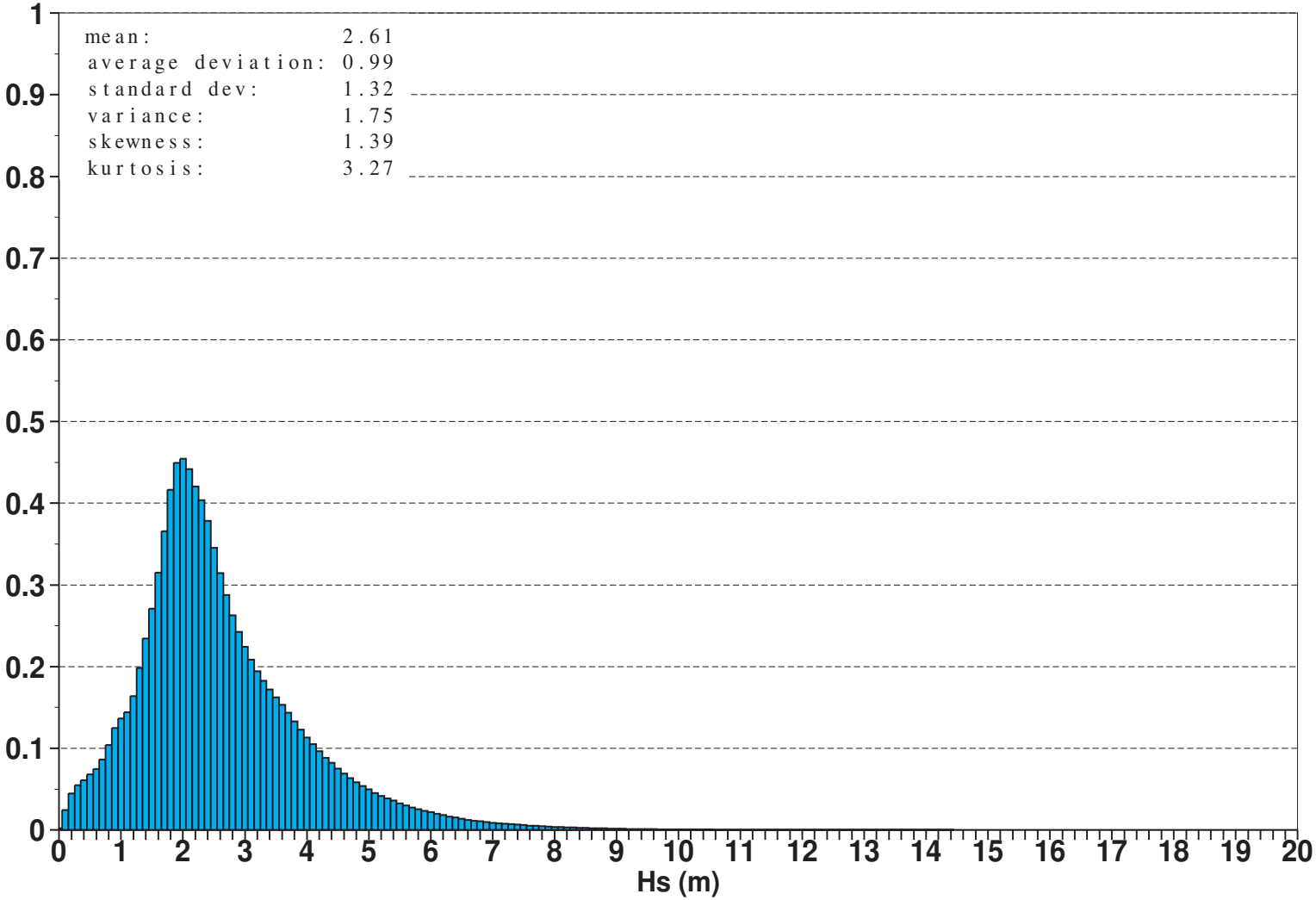

Figure 20: Global distribution of ECMWF First-Guess wave heights for April 2011

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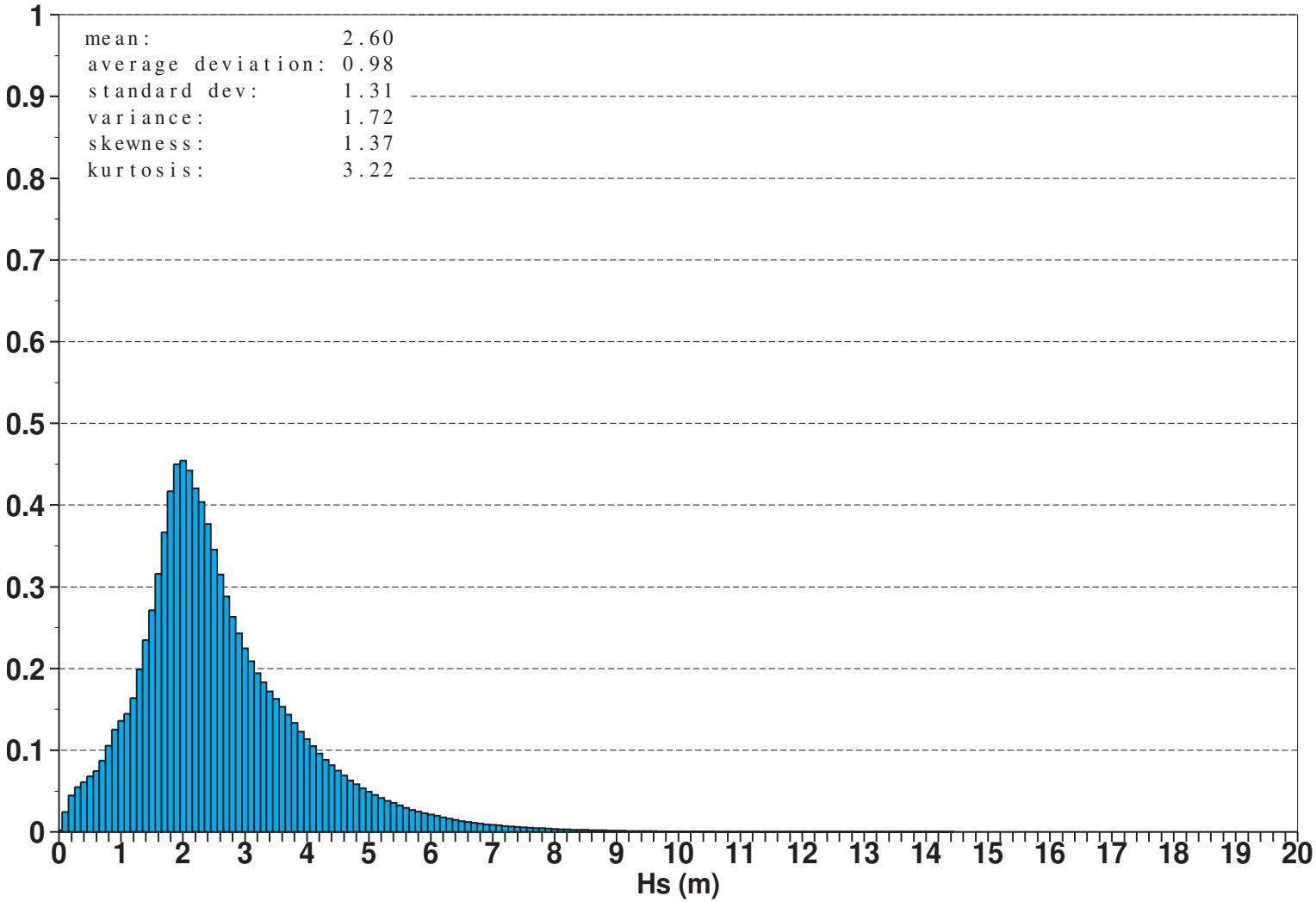

Figure 21: Global distribution of ECMWF Analysis wave heights for April 2011

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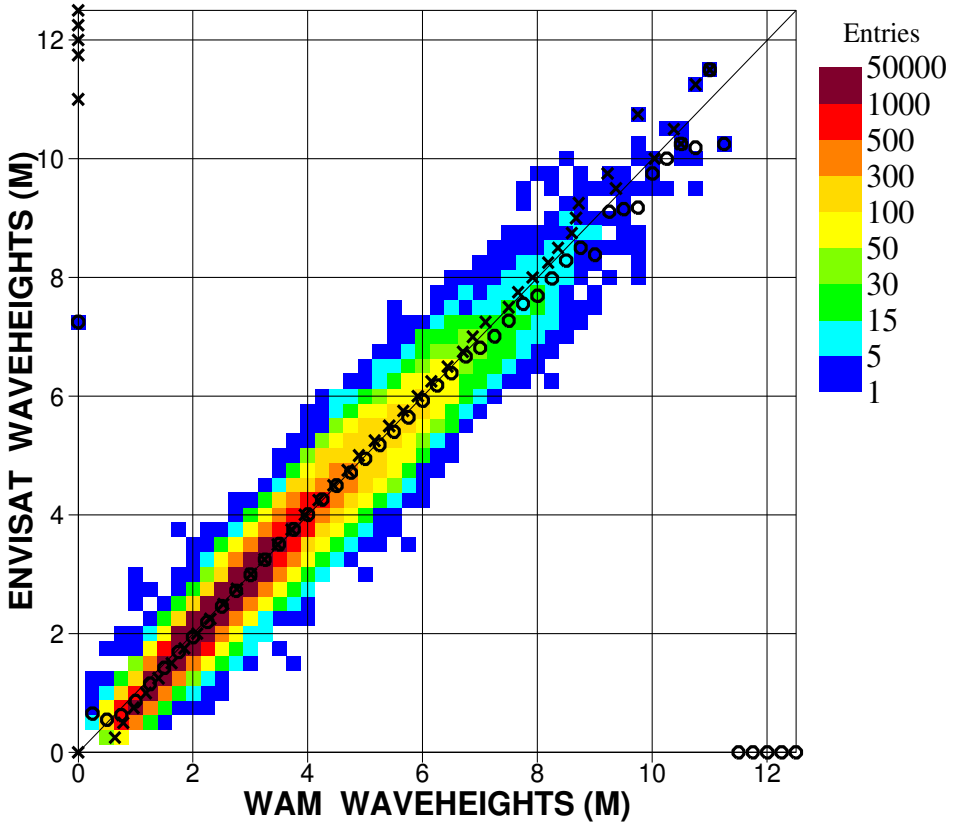

STATISTICS

ENTRIES	93645	
MEAN WAM	2.6698	
MEAN ENVISAT	2.6236	
BIAS (ENVISAT - WAM)	-0.0463	
STANDARD DEVIATION	0.2697	
SCATTER INDEX	0.1010	
CORRELATION	0.9776	
SYMMETRIC SLOPE	0.9921	(0.0007)
REGR. COEFFICIENT	1.0118	(0.0007)
REGR. CONSTANT	-0.0777	(0.0021)

Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2011 (Global)

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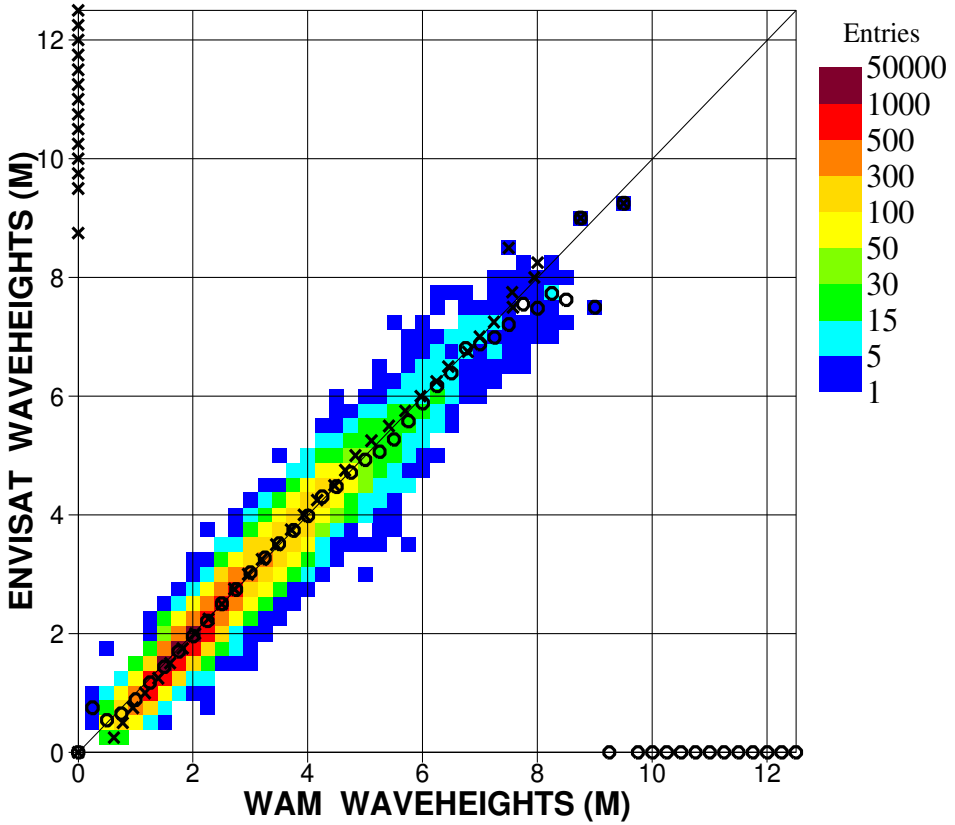

STATISTICS

ENTRIES	22518	
MEAN WAM	2.4434	
MEAN ENVISAT	2.4089	
BIAS (ENVISAT - WAM)	-0.0345	
STANDARD DEVIATION	0.2655	
SCATTER INDEX	0.1087	
CORRELATION	0.9744	
SYMMETRIC SLOPE	0.9951	(0.0016)
REGR. COEFFICIENT	1.0102	(0.0016)
REGR. CONSTANT	-0.0593	(0.0042)

Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2011 (N.Hem.)

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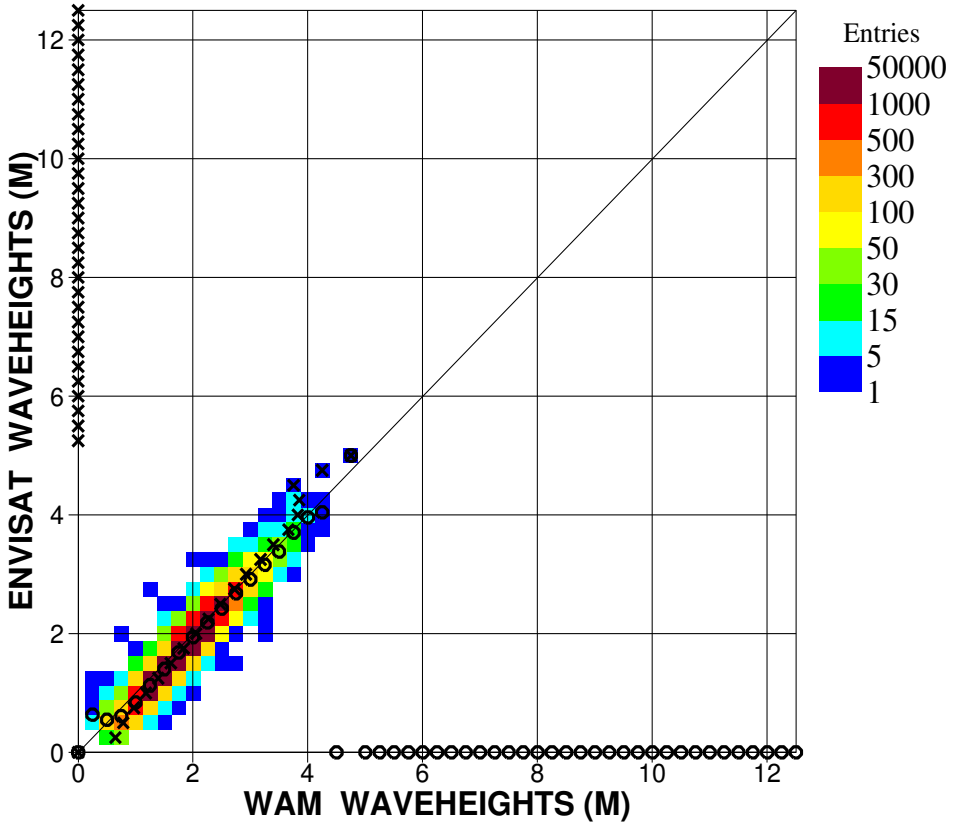

STATISTICS

ENTRIES	28810	
MEAN WAM	1.8679	
MEAN ENVISAT	1.7861	
BIAS (ENVISAT - WAM)	-0.0819	
STANDARD DEVIATION	0.1672	
SCATTER INDEX	0.0895	
CORRELATION	0.9615	
SYMMETRIC SLOPE	0.9676	(0.0018)
REGR. COEFFICIENT	1.0486	(0.0018)
REGR. CONSTANT	-0.1726	(0.0034)

Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2011 (Tropics)

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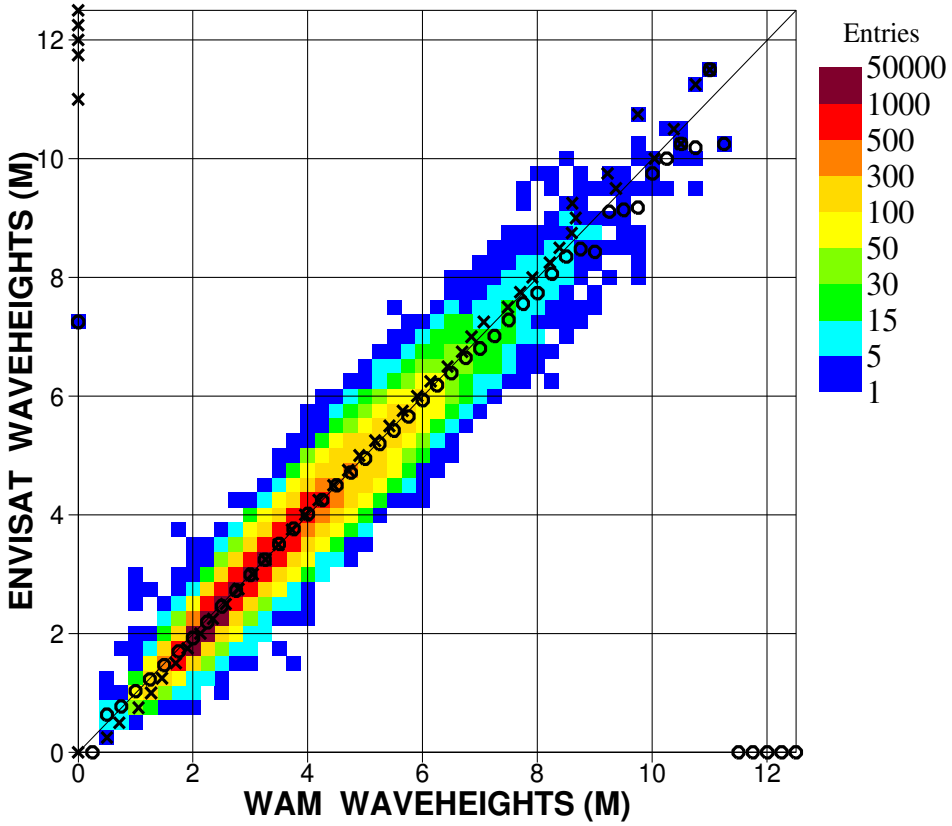

STATISTICS

ENTRIES	42987	
MEAN WAM	3.3170	
MEAN ENVISAT	3.2880	
BIAS (ENVISAT - WAM)	-0.0289	
STANDARD DEVIATION	0.3196	
SCATTER INDEX	0.0964	
CORRELATION	0.9690	
SYMMETRIC SLOPE	0.9960	(0.0012)
REGR. COEFFICIENT	0.9960	(0.0012)
REGR. CONSTANT	-0.0158	(0.0043)

Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2011 (S.Hem.)

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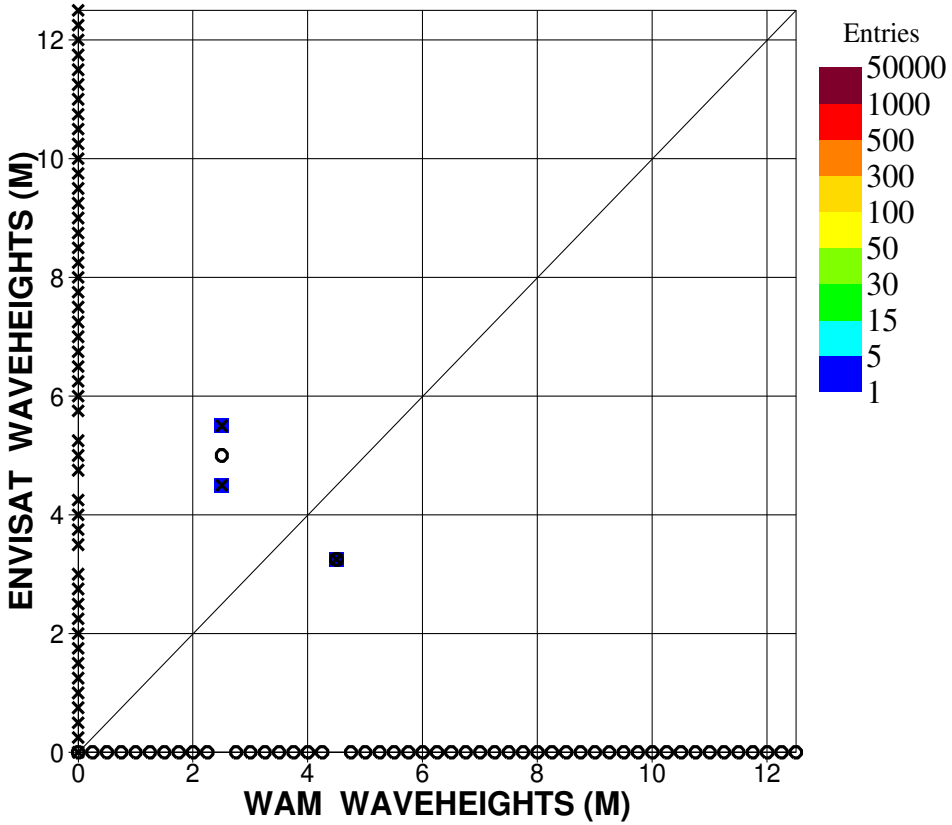

STATISTICS

ENTRIES	3	
MEAN WAM	3.1878	
MEAN ENVISAT	4.4011	
BIAS (ENVISAT - WAM)	1.2132	
STANDARD DEVIATION	2.0270	
SCATTER INDEX	0.6359	
CORRELATION	-.8770	
SYMMETRIC SLOPE	1.3571	(2.6600)
REGR. COEFFICIENT	-.8607	(0.5517)
REGR. CONSTANT	7.1448	(1.8221)

Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2011 (Global)

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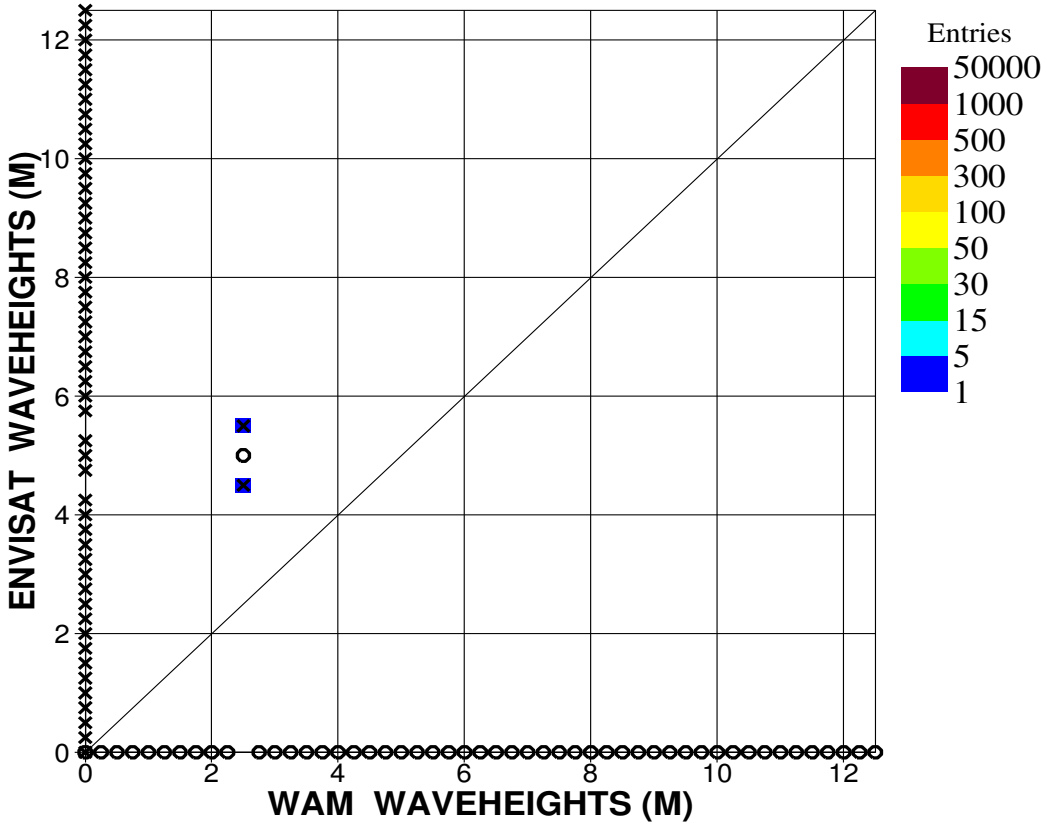

STATISTICS

ENTRIES	2
MEAN WAM	2.5787
MEAN ENVISAT	4.9375
BIAS (ENVISAT - WAM)	2.3588
STANDARD DEVIATION	0.5860
SCATTER INDEX	0.2272
CORRELATION	0.9998
SYMMETRIC SLOPE	1.9227
REGR. COEFFICIENT	10.2729
REGR. CONSTANT	-21.5531

Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2011 (N.Hem.)

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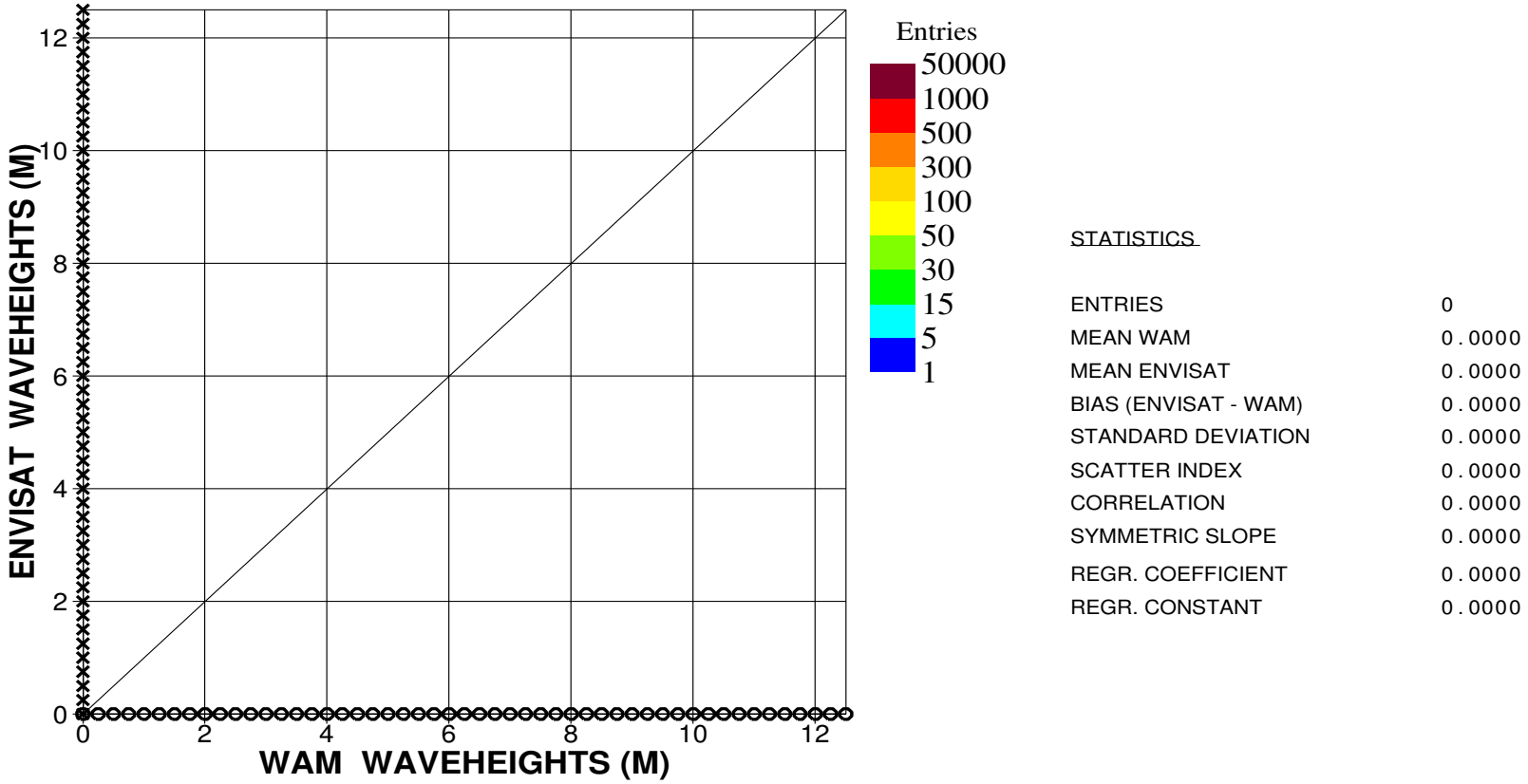

Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2011 (Tropics)

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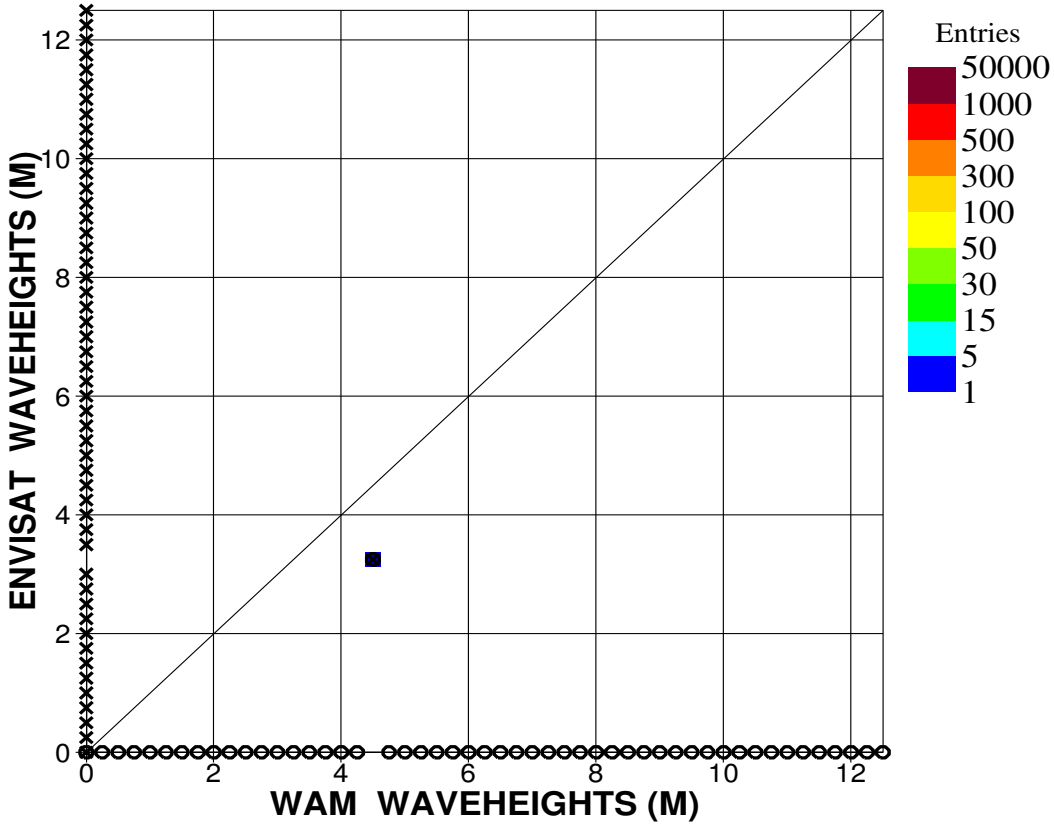

STATISTICS

ENTRIES	1
MEAN WAM	4.4061
MEAN ENVISAT	3.3282
BIAS (ENVISAT - WAM)	-1.0779
STANDARD DEVIATION	0.0000
SCATTER INDEX	0.0000
CORRELATION	0.0000
SYMMETRIC SLOPE	0.0000
REGR. COEFFICIENT	0.0000
REGR. CONSTANT	0.0000

Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2011 (S.Hem.)

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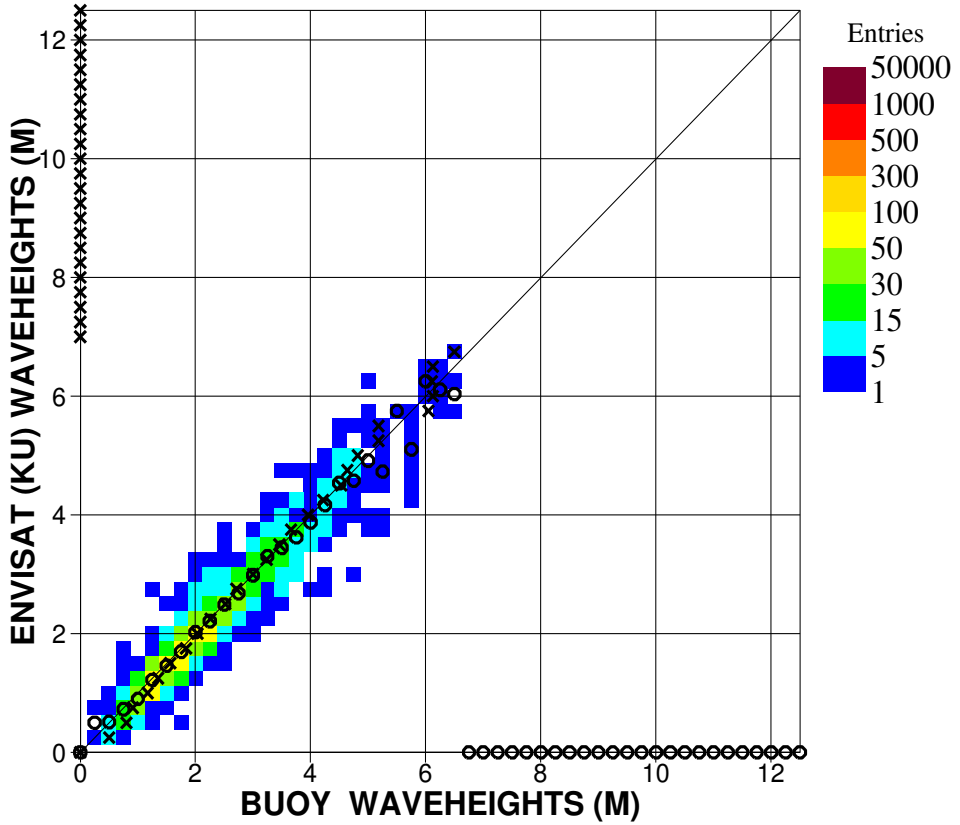

STATISTICS

ENTRIES	1754	
MEAN BUOY	2.3126	
MEAN ENVISAT	2.2723	
BIAS (ENVISAT - BUOY)	-0.0402	
STANDARD DEVIATION	0.3316	
SCATTER INDEX	0.1434	
CORRELATION	0.9581	
SYMMETRIC SLOPE	0.9899	(0.0070)
REGR. COEFFICIENT	0.9771	(0.0070)
REGR. CONSTANT	0.0126	(0.0180)

Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2011 (Global)

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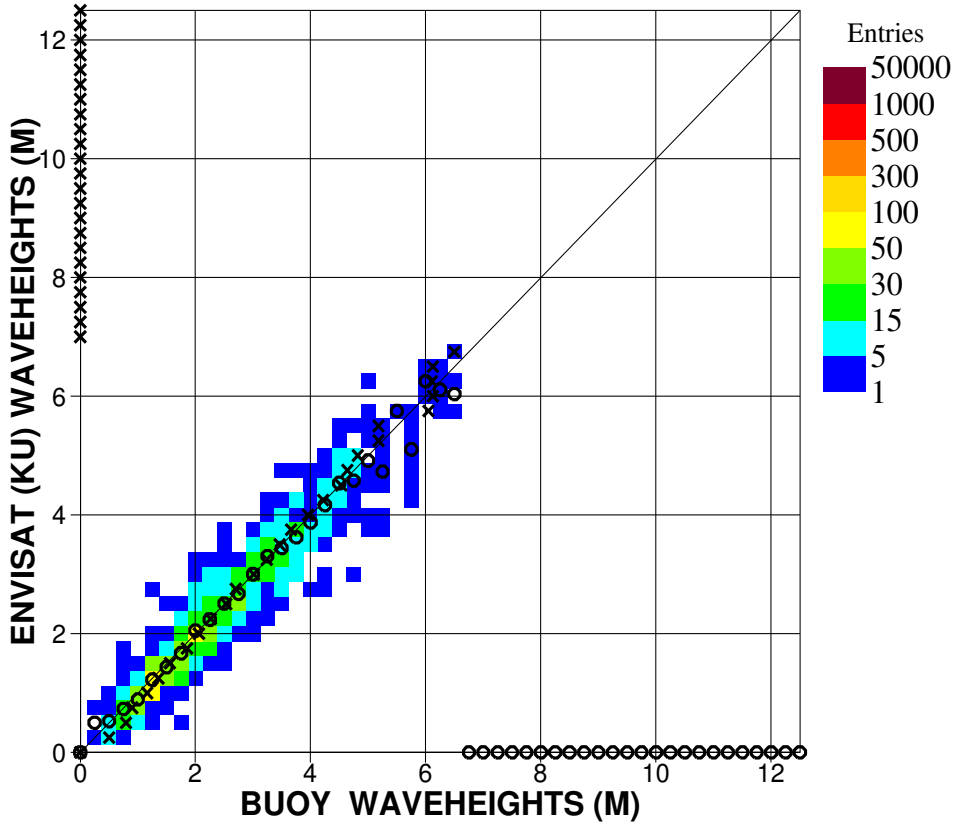

STATISTICS

ENTRIES	1427	
MEAN BUOY	2.4028	
MEAN ENVISAT	2.3626	
BIAS (ENVISAT - BUOY)	-0.0402	
STANDARD DEVIATION	0.3545	
SCATTER INDEX	0.1475	
CORRELATION	0.9580	
SYMMETRIC SLOPE	0.9906	(0.0078)
REGR. COEFFICIENT	0.9762	(0.0077)
REGR. CONSTANT	0.0169	(0.0208)

Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2011 (N.Hem.)

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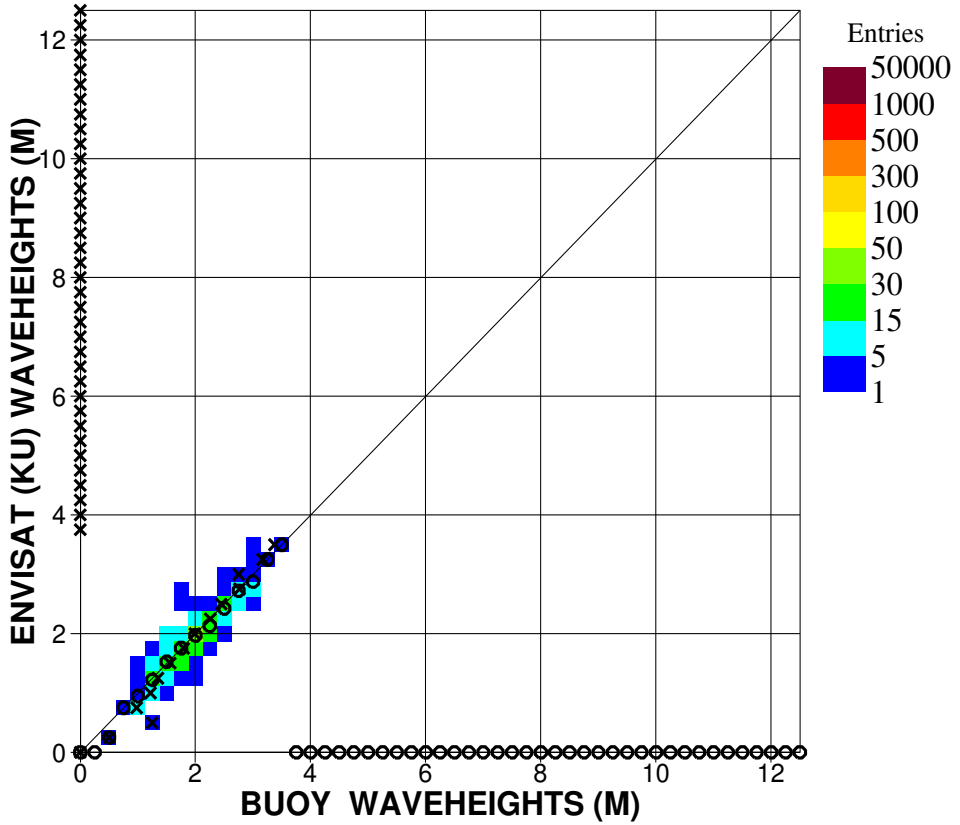

STATISTICS

ENTRIES	316	
MEAN BUOY	1.9193	
MEAN ENVISAT	1.8801	
BIAS (ENVISAT - BUOY)	-0.0392	
STANDARD DEVIATION	0.2062	
SCATTER INDEX	0.1074	
CORRELATION	0.9325	
SYMMETRIC SLOPE	0.9848	(0.0214)
REGR. COEFFICIENT	0.9774	(0.0214)
REGR. CONSTANT	0.0043	(0.0426)

Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2011 (Tropics)

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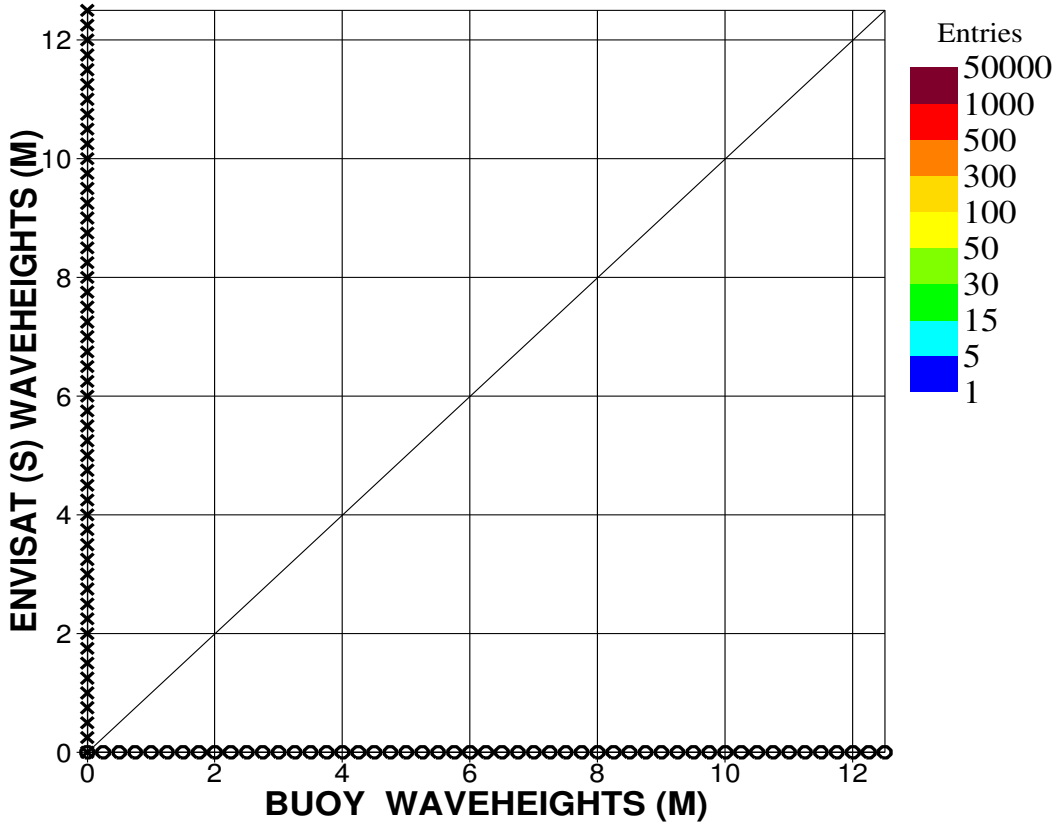

STATISTICS

ENTRIES	0
MEAN BUOY	0.0000
MEAN ENVISAT	0.0000
BIAS (ENVISAT - BUOY)	0.0000
STANDARD DEVIATION	0.0000
SCATTER INDEX	0.0000
CORRELATION	0.0000
SYMMETRIC SLOPE	0.0000
REGR. COEFFICIENT	0.0000
REGR. CONSTANT	0.0000

Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2011 (Global)

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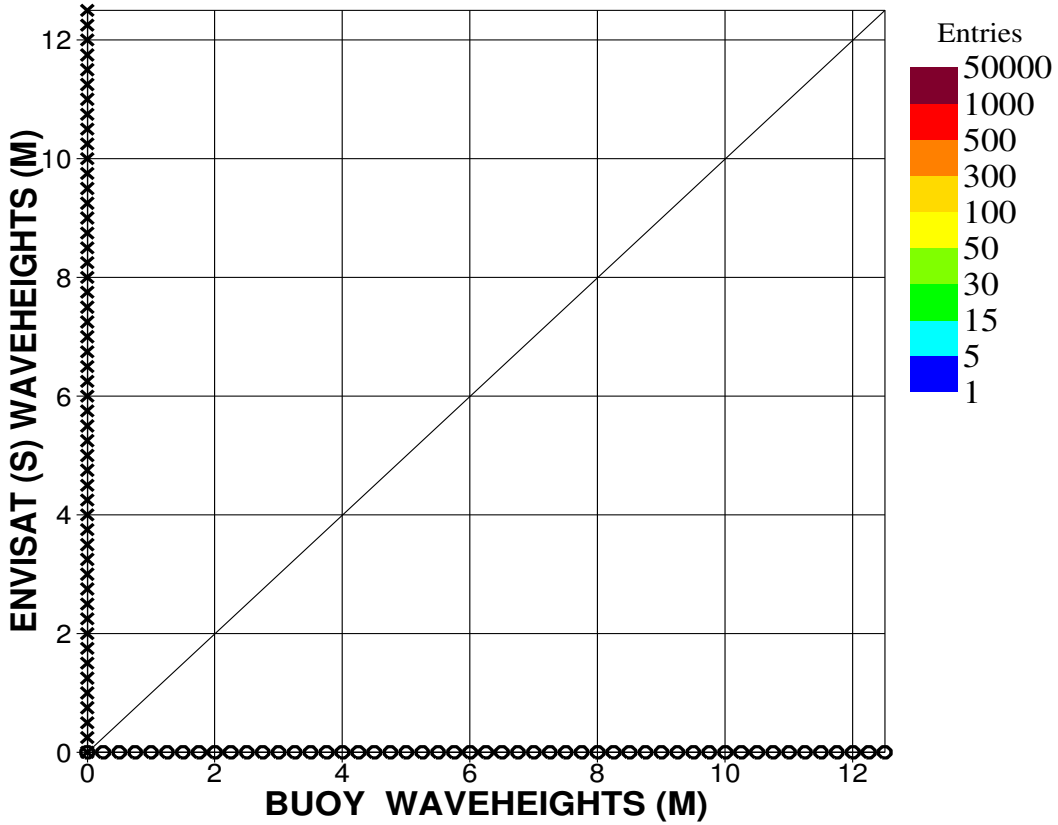

STATISTICS

ENTRIES	0
MEAN BUOY	0.0000
MEAN ENVISAT	0.0000
BIAS (ENVISAT - BUOY)	0.0000
STANDARD DEVIATION	0.0000
SCATTER INDEX	0.0000
CORRELATION	0.0000
SYMMETRIC SLOPE	0.0000
REGR. COEFFICIENT	0.0000
REGR. CONSTANT	0.0000

Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2011 (N.Hem.)

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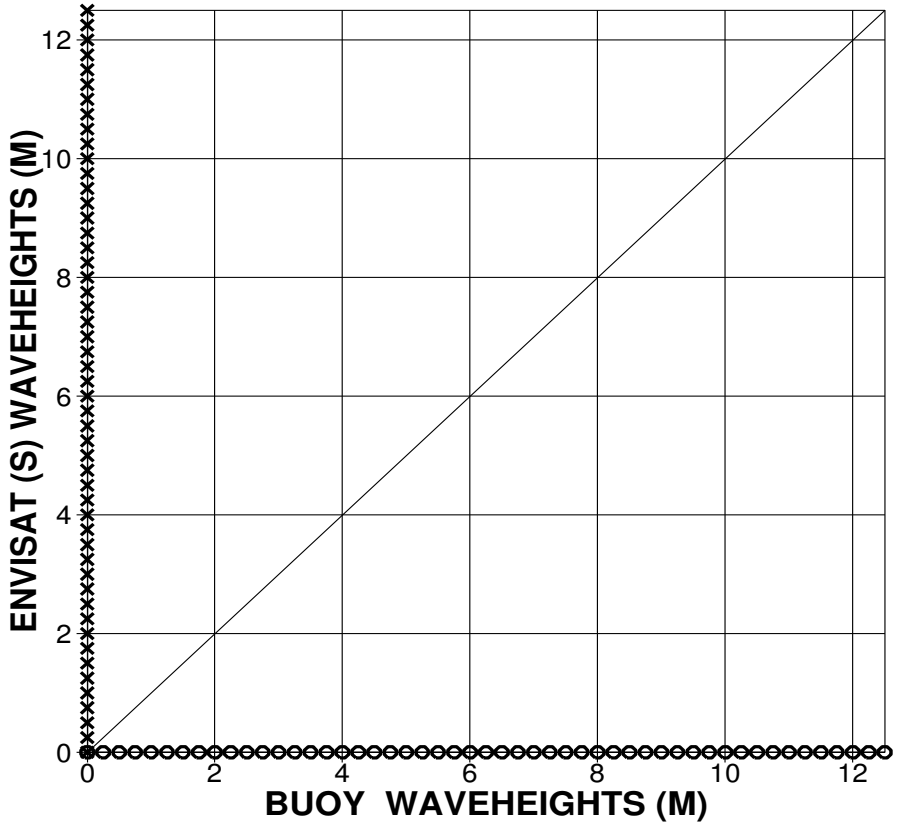

STATISTICS

ENTRIES	0
MEAN BUOY	0.0000
MEAN ENVISAT	0.0000
BIAS (ENVISAT - BUOY)	0.0000
STANDARD DEVIATION	0.0000
SCATTER INDEX	0.0000
CORRELATION	0.0000
SYMMETRIC SLOPE	0.0000
REGR. COEFFICIENT	0.0000
REGR. CONSTANT	0.0000

Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2011 (Tropics)

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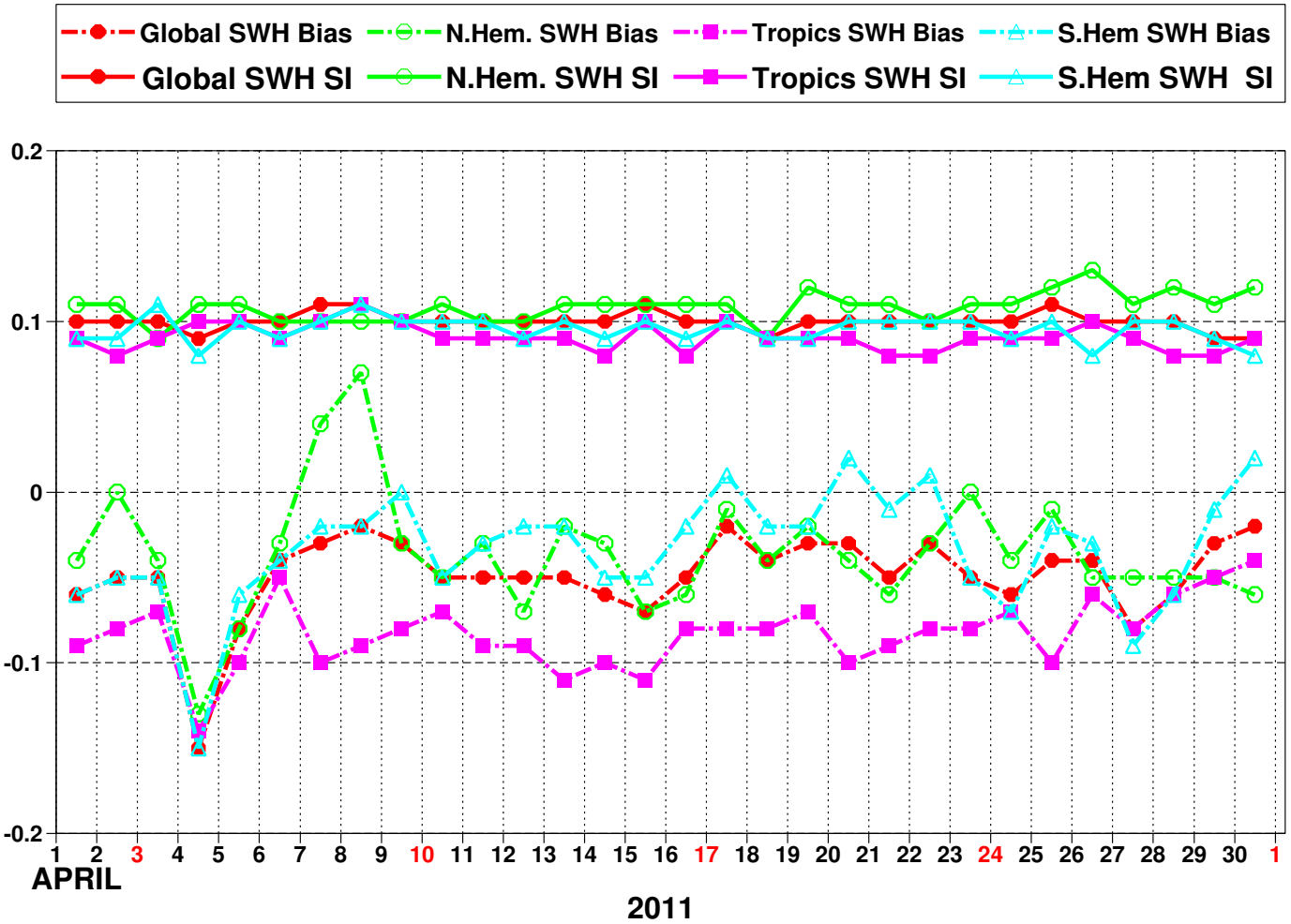

Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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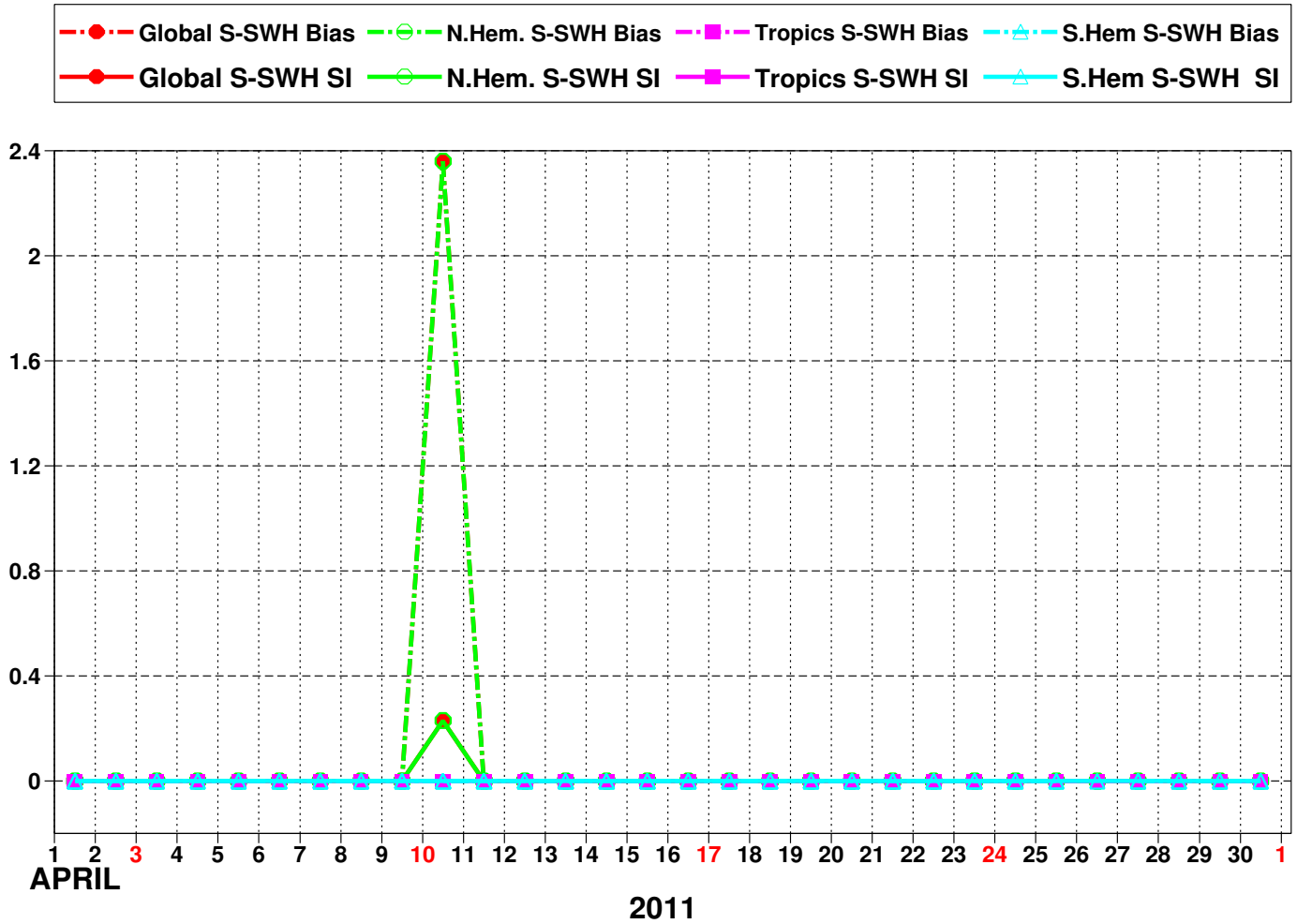

Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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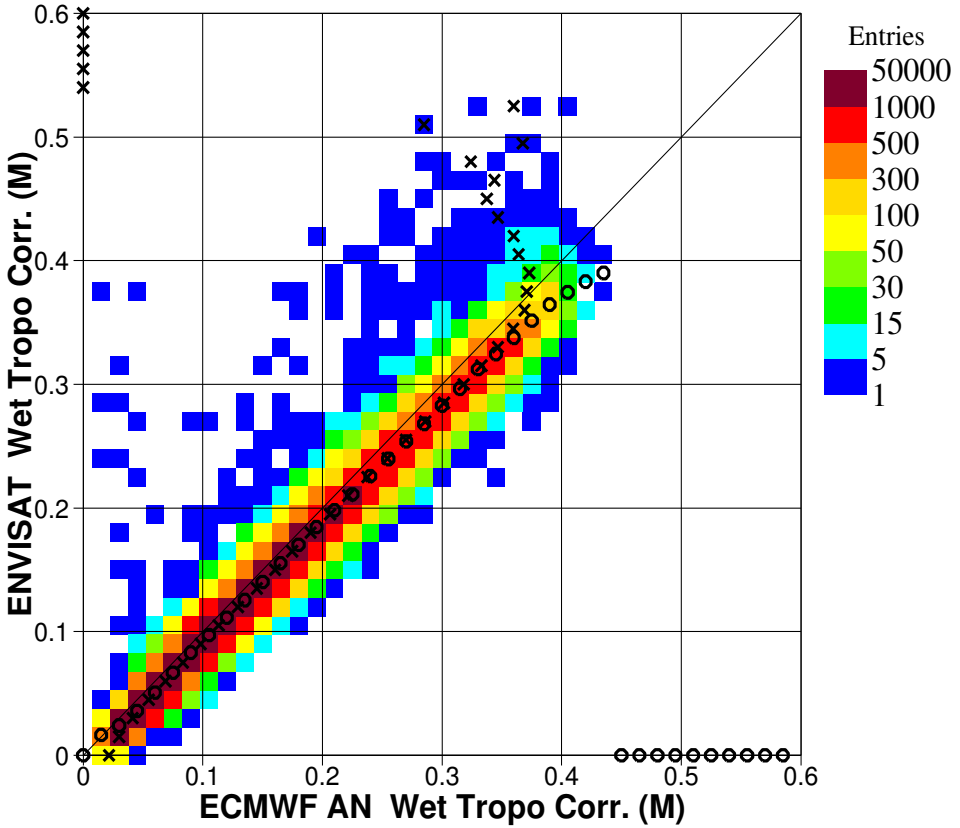

STATISTICS

ENTRIES	90107	
MEAN ECMWF	0.1544	
MEAN ENVISAT	0.1434	
BIAS (ENVISAT - ECMWF)	-0.0110	
STANDARD DEVIATION	0.0153	
SCATTER INDEX	0.0991	
CORRELATION	0.9876	
SYMMETRIC SLOPE	0.9413	(0.0005)
REGR. COEFFICIENT	0.9607	(0.0005)
REGR. CONSTANT	-0.0050	(0.0001)

Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2011 (Global)

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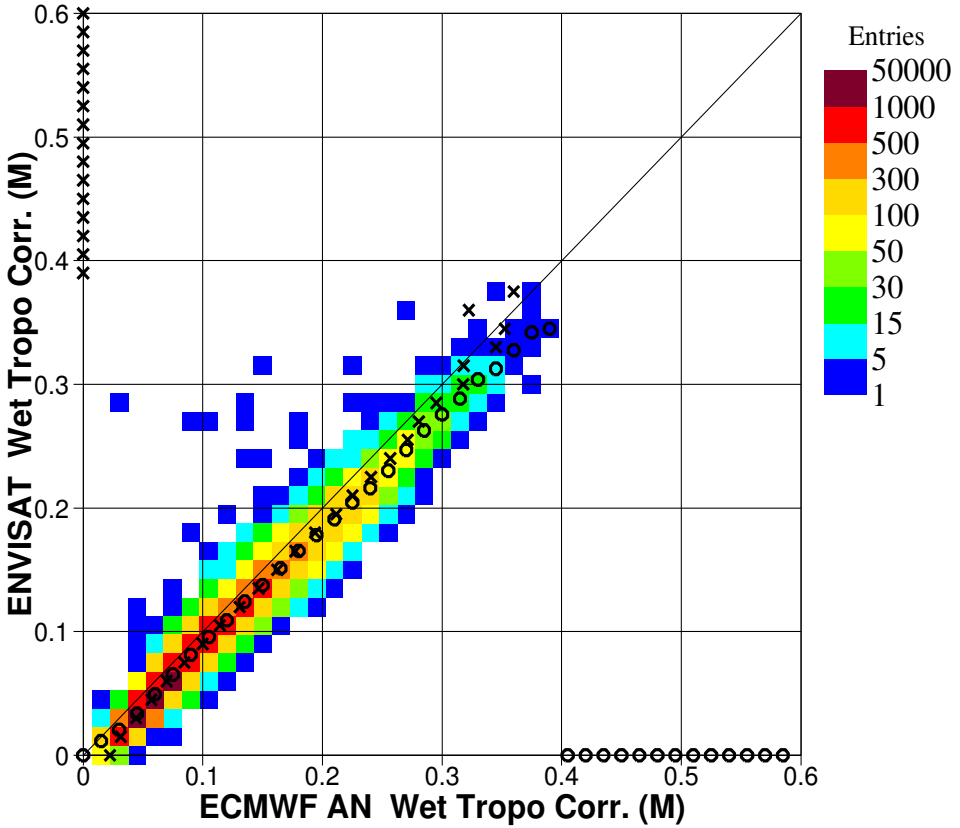

STATISTICS

ENTRIES	21997	
MEAN ECMWF	0.1105	
MEAN ENVISAT	0.0984	
BIAS (ENVISAT - ECMWF)	-0.0121	
STANDARD DEVIATION	0.0128	
SCATTER INDEX	0.1162	
CORRELATION	0.9791	
SYMMETRIC SLOPE	0.9116	(0.0014)
REGR. COEFFICIENT	0.9521	(0.0013)
REGR. CONSTANT	-0.0068	(0.0002)

Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2011 (N.Hem.)

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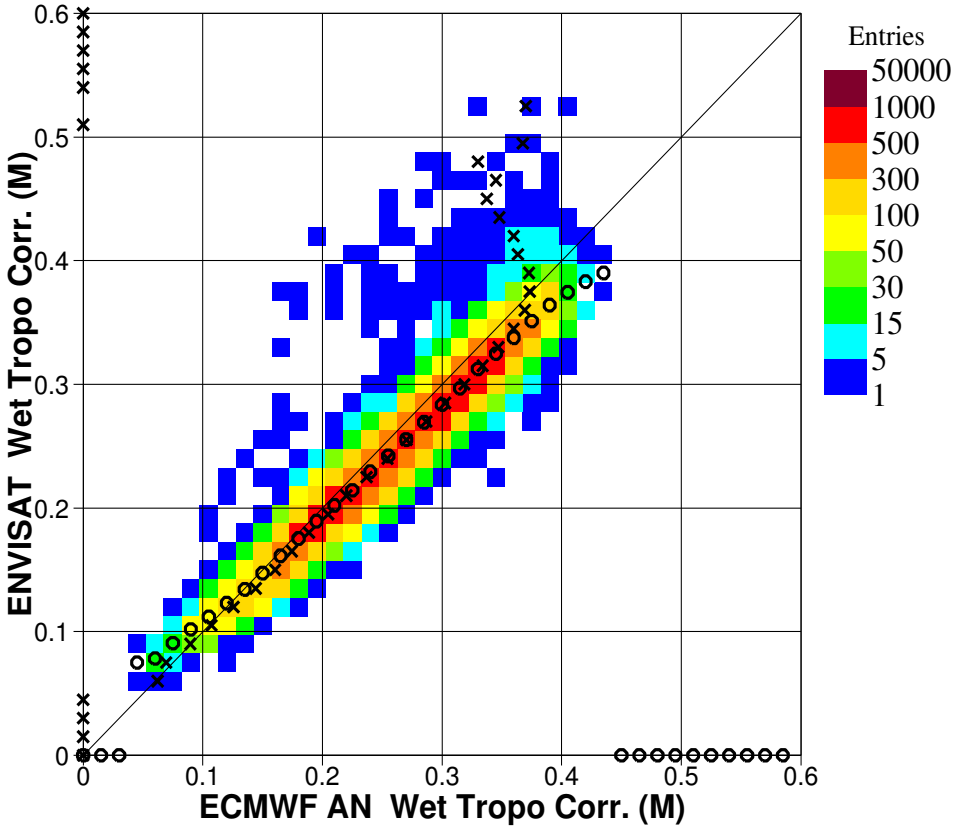

STATISTICS

ENTRIES	26898	
MEAN ECMWF	0.2633	
MEAN ENVISAT	0.2503	
BIAS (ENVISAT - ECMWF)	-0.0130	
STANDARD DEVIATION	0.0193	
SCATTER INDEX	0.0732	
CORRELATION	0.9625	
SYMMETRIC SLOPE	0.9499	(0.0016)
REGR. COEFFICIENT	0.9033	(0.0016)
REGR. CONSTANT	0.0125	(0.0004)

Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2011 (Tropics)

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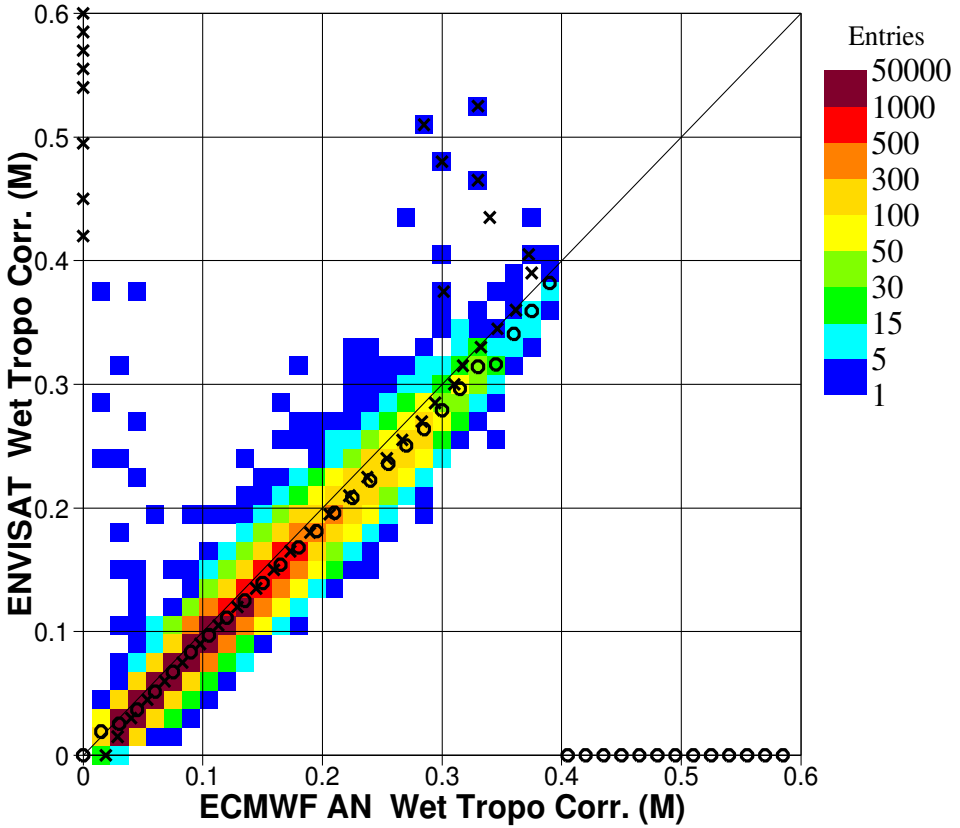

STATISTICS

ENTRIES	41857	
MEAN ECMWF	0.1083	
MEAN ENVISAT	0.0991	
BIAS (ENVISAT - ECMWF)	-0.0092	
STANDARD DEVIATION	0.0133	
SCATTER INDEX	0.1230	
CORRELATION	0.9793	
SYMMETRIC SLOPE	0.9313	(0.0010)
REGR. COEFFICIENT	0.9545	(0.0010)
REGR. CONSTANT	-0.0043	(0.0001)

Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2011 (S.Hem.)

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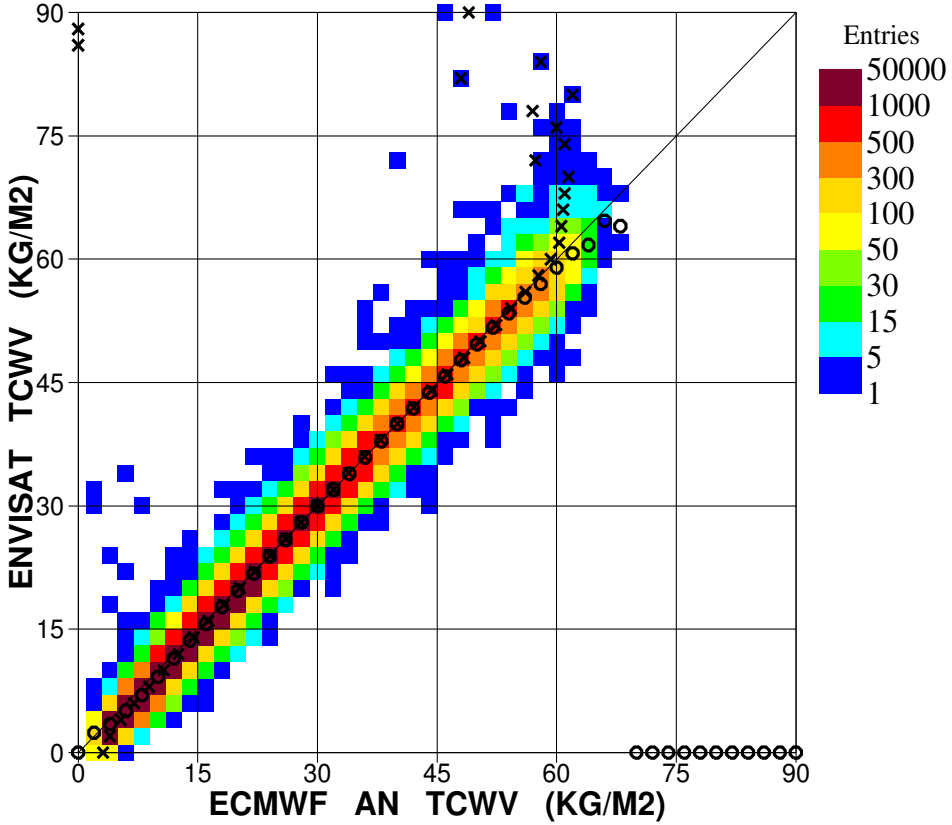

STATISTICS

ENTRIES	90107	
MEAN ECMWF	23.8537	
MEAN ENVISAT	23.4192	
BIAS (ENVISAT - ECMWF)	-0.4345	
STANDARD DEVIATION	1.8762	
SCATTER INDEX	0.0787	
CORRELATION	0.9930	
SYMMETRIC SLOPE	0.9924	(0.0004)
REGR. COEFFICIENT	1.0099	(0.0004)
REGR. CONSTANT	-0.6701	(0.0114)

Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2011 (Global)

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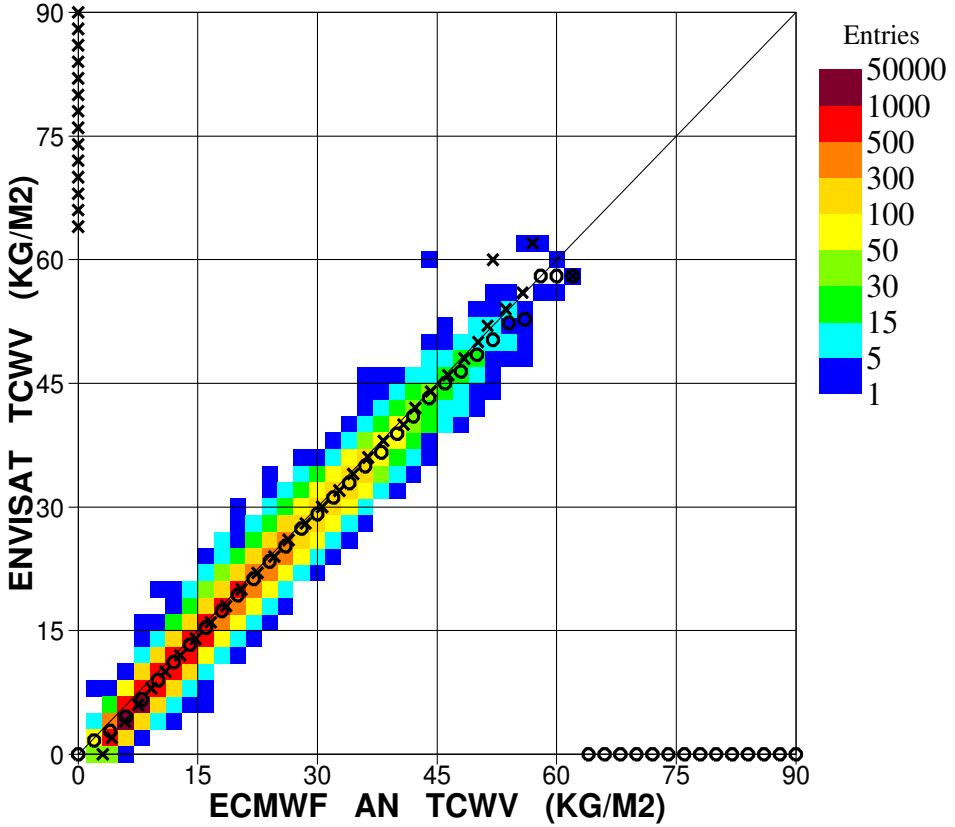

STATISTICS

ENTRIES	21997	
MEAN ECMWF	16.7791	
MEAN ENVISAT	15.8368	
BIAS (ENVISAT - ECMWF)	-0.9423	
STANDARD DEVIATION	1.6177	
SCATTER INDEX	0.0964	
CORRELATION	0.9874	
SYMMETRIC SLOPE	0.9662	(0.0012)
REGR. COEFFICIENT	1.0143	(0.0011)
REGR. CONSTANT	-1.1820	(0.0213)

Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2011 (N.Hem.)

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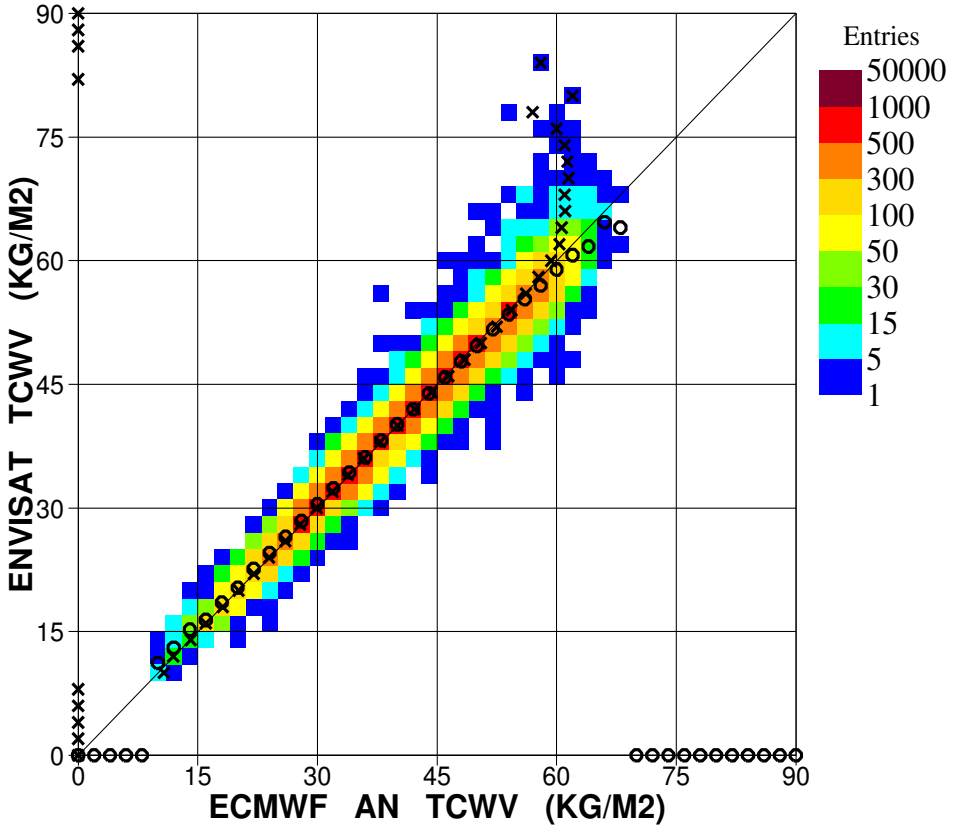

STATISTICS

ENTRIES	26898	
MEAN ECMWF	41.5286	
MEAN ENVISAT	41.4609	
BIAS (ENVISAT - ECMWF)	-0.0677	
STANDARD DEVIATION	2.1241	
SCATTER INDEX	0.0511	
CORRELATION	0.9819	
SYMMETRIC SLOPE	0.9972	(0.0012)
REGR. COEFFICIENT	0.9630	(0.0011)
REGR. CONSTANT	1.4686	(0.0487)

Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2011 (Tropics)

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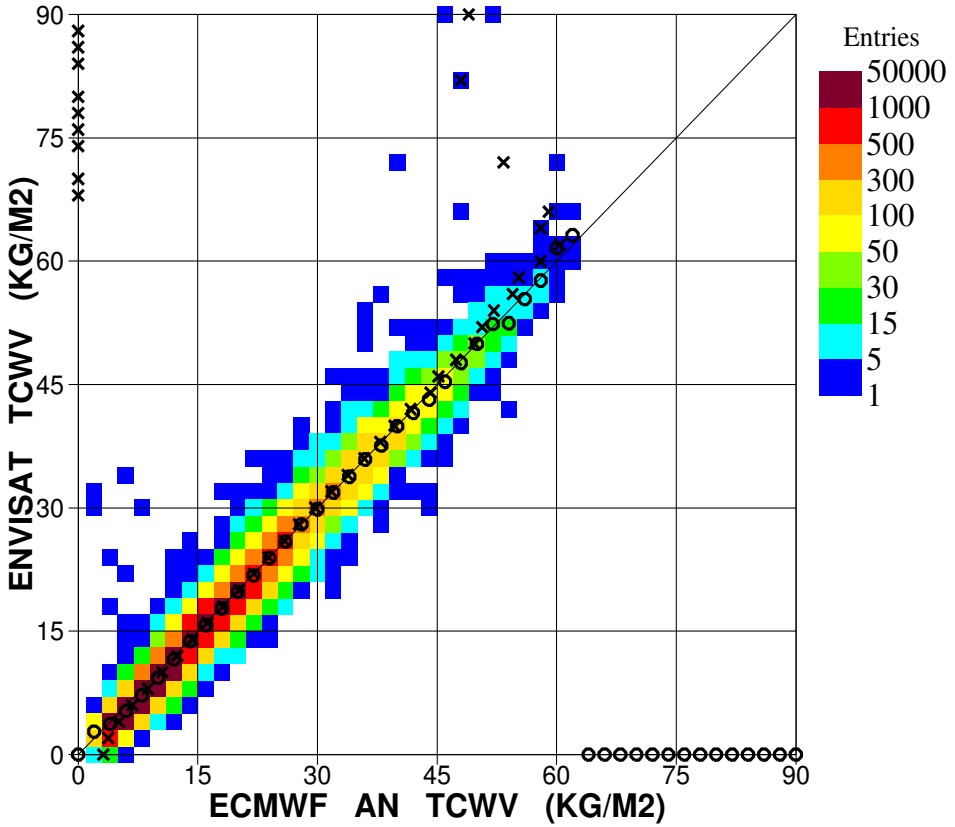

STATISTICS

ENTRIES	41857	
MEAN ECMWF	16.3281	
MEAN ENVISAT	15.9346	
BIAS (ENVISAT - ECMWF)	-0.3935	
STANDARD DEVIATION	1.7738	
SCATTER INDEX	0.1086	
CORRELATION	0.9862	
SYMMETRIC SLOPE	0.9917	(0.0009)
REGR. COEFFICIENT	1.0157	(0.0008)
REGR. CONSTANT	-0.6504	(0.0161)

Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2011 (S.Hem.)

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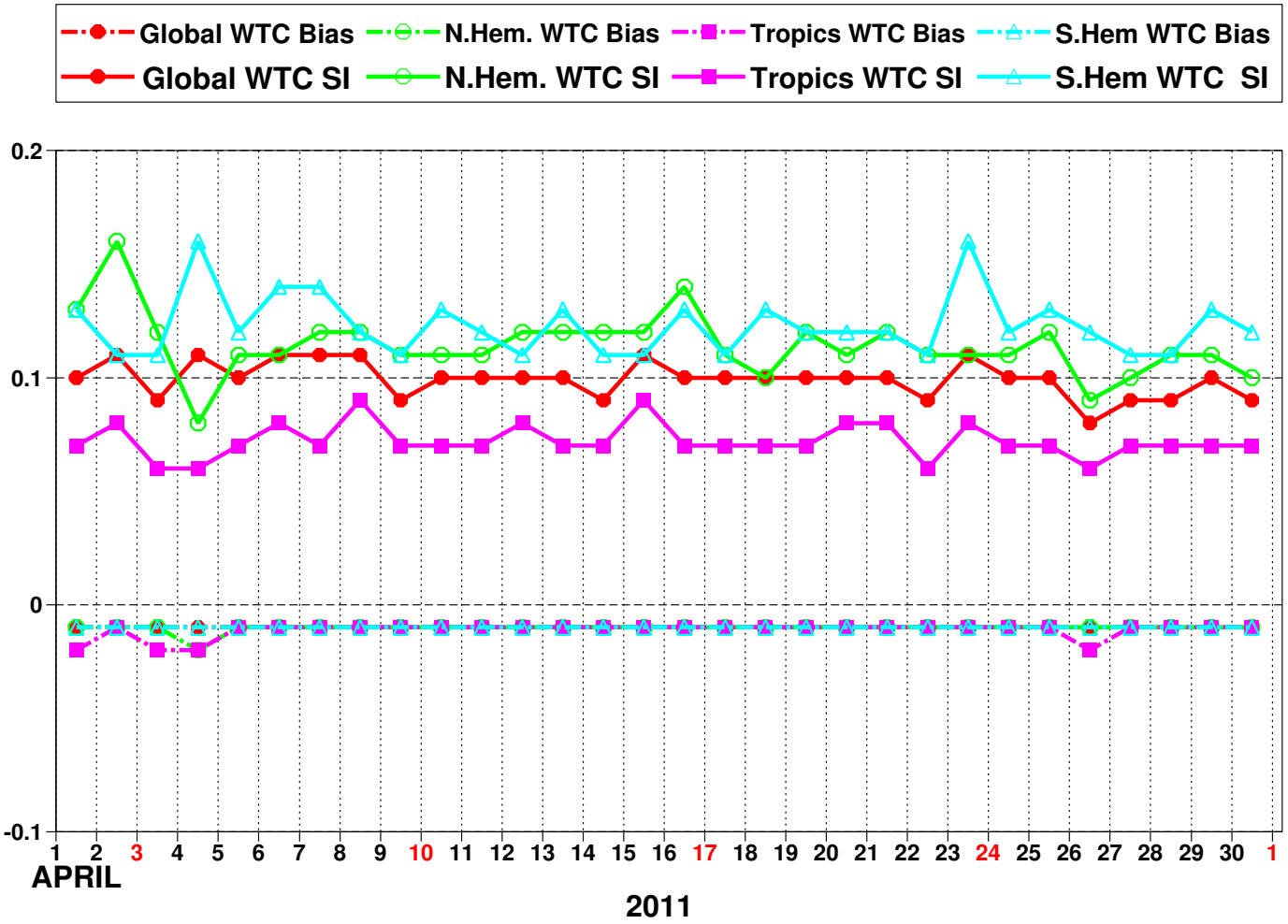

Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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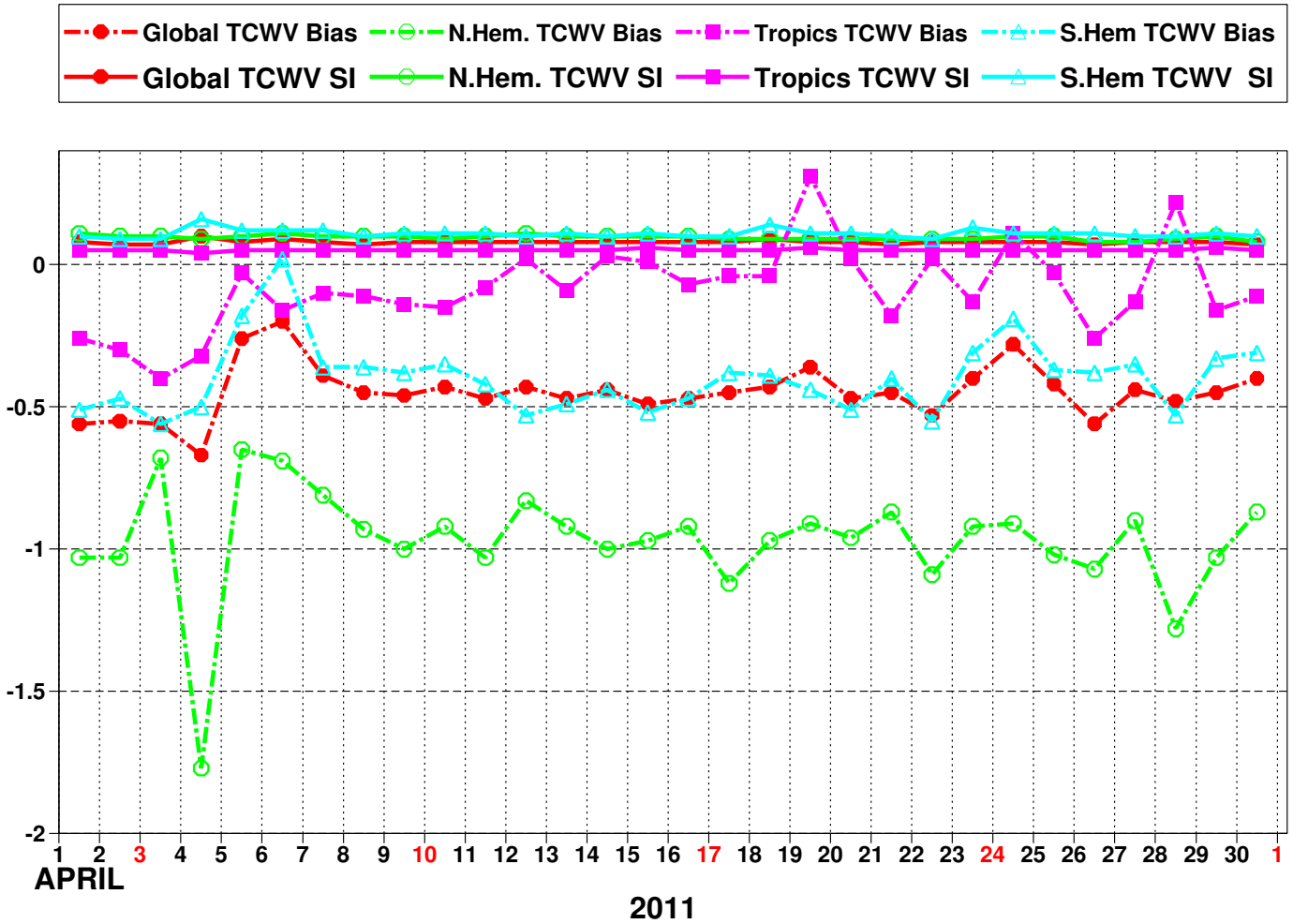

Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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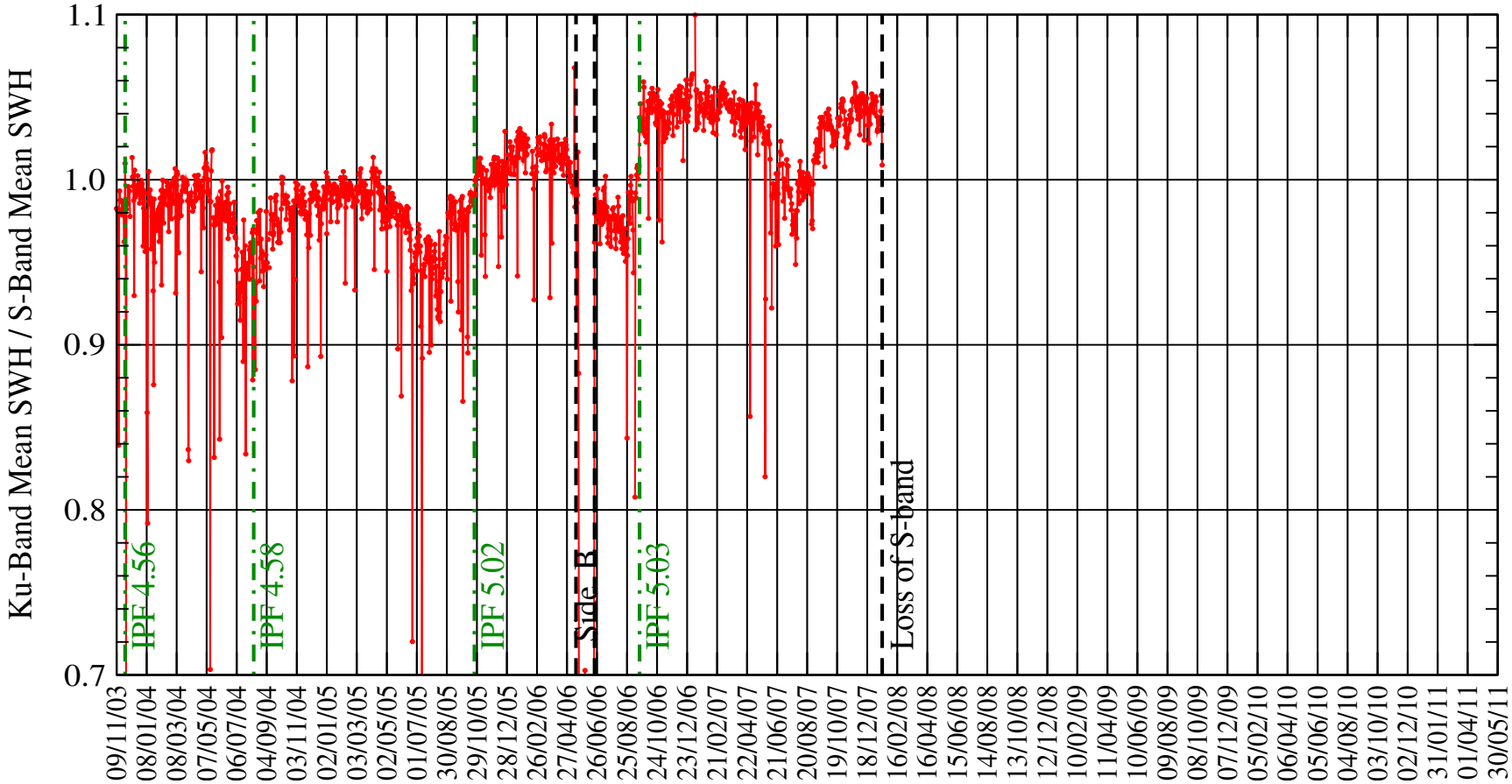

Figure 48: Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 13th. of May 2003.

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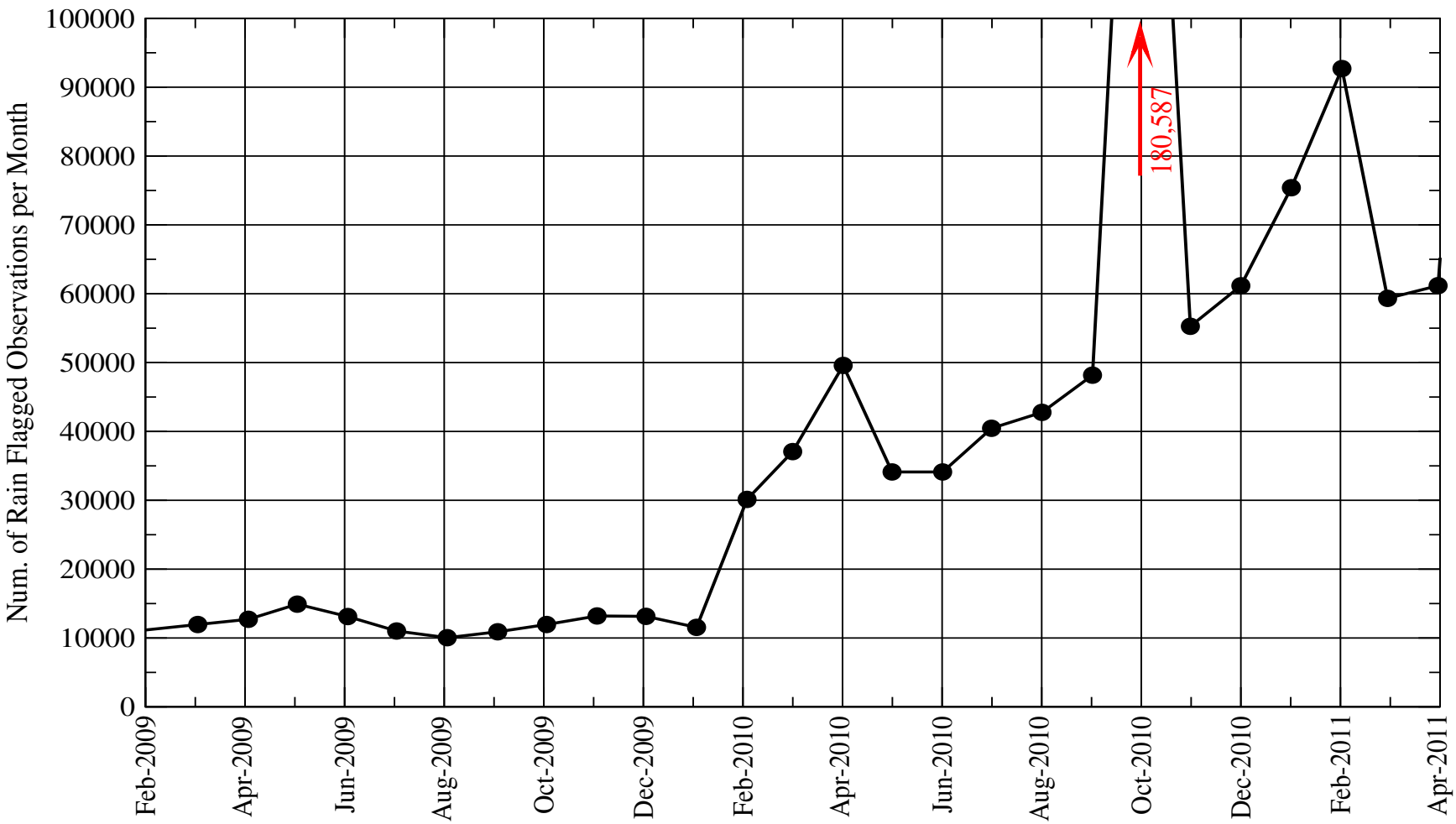

Figure 49: Timeseries of monthly global amount of products flagged due to the rain (i.e. rain flag was set).

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