

■ ECMWF Report on ENVISAT RA-2 for August 2005 ■

Report on ENVISAT Radar Altimeter - 2 (RA-2) Wind/Wave Product with Height Information (RA2_WWV_2P)

By: *Saleh Abdalla*

Date: *23 September 2005*

Overview:

Based on the data received during this month, on average, 15527 observations arrived at ECMWF every 6-hour window of which an average of 6187 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 79.75% 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 window centred at 00:00 on the 7th. of the month.
- Time window centred at 12:00 on the 12th. of the month.
- Time windows centred at 12:00 and 18:00 on the 13th. of the month.
- Time windows centred at 00:00, 06:00, 12:00 and 18:00 on the 15th. of the month.
- Time windows centred at 06:00 and 12:00 on the 16th. of the month.



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

- Time windows centred at 00:00 on: the 6th., the 8th., the 9th., the 10th., the 14th. and the 16th. of the month.
- Time windows centred at 06:00 on: the 7th., the 8th., the 12th. and the 18th. of the month.
- Time windows centred at 18:00 on: the 12th., the 16th. and the 30th. 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 $\langle \sigma_0 \rangle = 11.19$ dB (with a main peak at 11.1 dB with a tendency to have several secondary peaks).
- ENVISAT RA-2 S-Band $\langle \sigma_0 \rangle = 11.45$ dB (with a 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	- 0.28	17.3	- 1.10	18.8
Northern Hemisphere	- 0.76	19.9	- 1.08	19.8
Tropics	- 0.44	16.9	- 1.18	13.7
Southern Hemisphere	+ 0.18	14.5	----	----

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

	RA2 (Ku) - WAM		RA2 (Ku) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.13	11.3	0.13	16.8
Northern Hemisphere	0.13	15.4	0.13	17.1
Tropics	0.09	10.8	0.13	14.2
Southern Hemisphere	0.15	9.7	----	----



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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	19.4	0.29	35.1
Northern Hemisphere	0.31	35.3	0.30	35.8
Tropics	0.12	21.6	0.22	27.8
Southern Hemisphere	- 0.03	12.1	----	----

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	- 0.011	14.6	- 0.35	16.8
Northern Hemisphere	- 0.010	18.8	- 0.30	22.2
Tropics	- 0.012	6.2	+ 0.56	6.0
Southern Hemisphere	- 0.012	24.5	- 1.11	28.0



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Remarks:

- There was no related ECMWF model changes this month (current operational cycle is CY29R2 since 28 June 2005).
- 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 4% of the data this month. There were two major events of over-active rain flagging on the 18th.-19th. and on the 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 overestimated by about 5% when compared to WAM results (8% in the NH, 5% in Tropics and 4.5% in SH). 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 4.5-5.5% higher than buoy wave heights as can be seen in Figures 30-32 (Ku-band - buoy comparison).
- There is a couple of outliers in Figures 22 and 25 with Ku-band wave heights are much higher than the model values. Those outliers are within the ice region at the edge of the Antarctica.
- 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



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those outliers occurred on the 18th. and the 31st. of the month (Figure 37) coinciding with the significant over-active rain flagging events. It should be noted that the number of outliers is much less than the last month.

- The S-band wave height product is better than last month as compared with the model.
- The ratio between Ku-band and S-band wave heights this month changed between 0.92 and 0.98 with a couple of dips coinciding with the extreme RA-2 S-band anomaly events as can be seen in Figure 48. Furthermore, there is an apparent seasonal variation for this ratio as lower values (~ 0.92 - 0.94) reached during June, July and August (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 more 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.
- Note that the high bias in all time series plots on the 15th. of the month is due to the limited number of observations received during 15th.-16th. of the month.
- 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.



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- 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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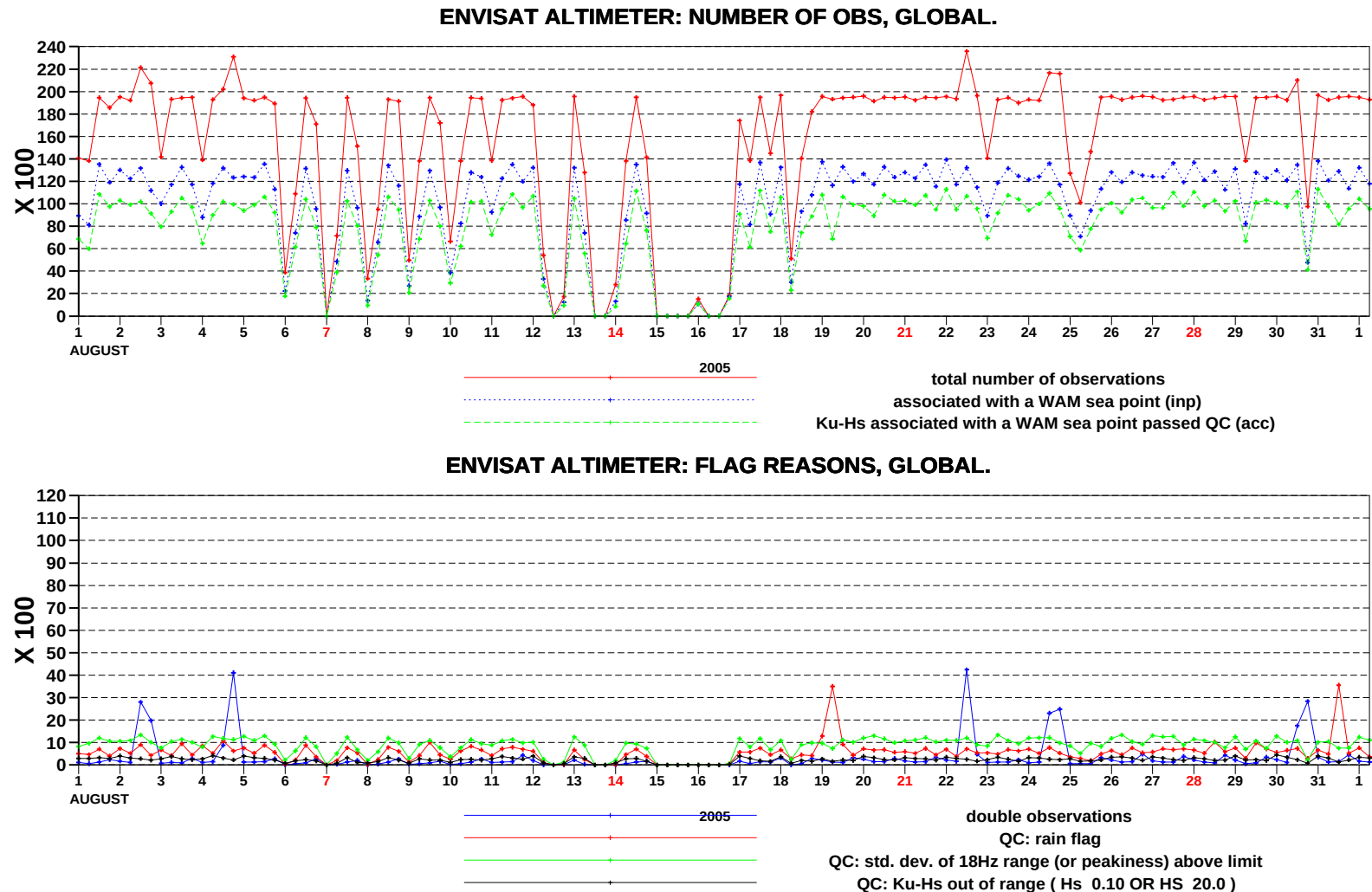


Figure 1: Time series of data reception for ENVISAT Altimeter data for August 2005

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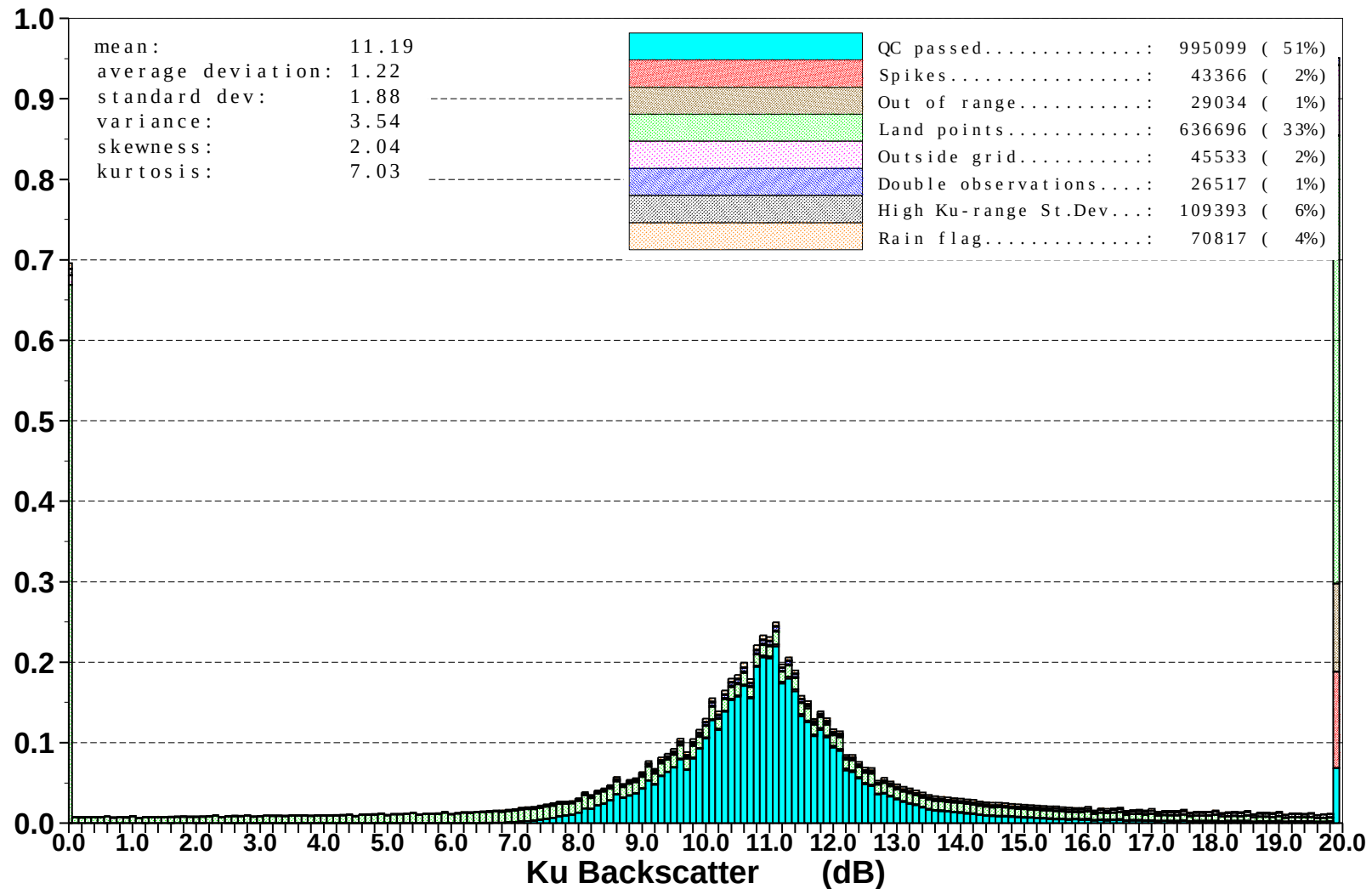


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for August 2005



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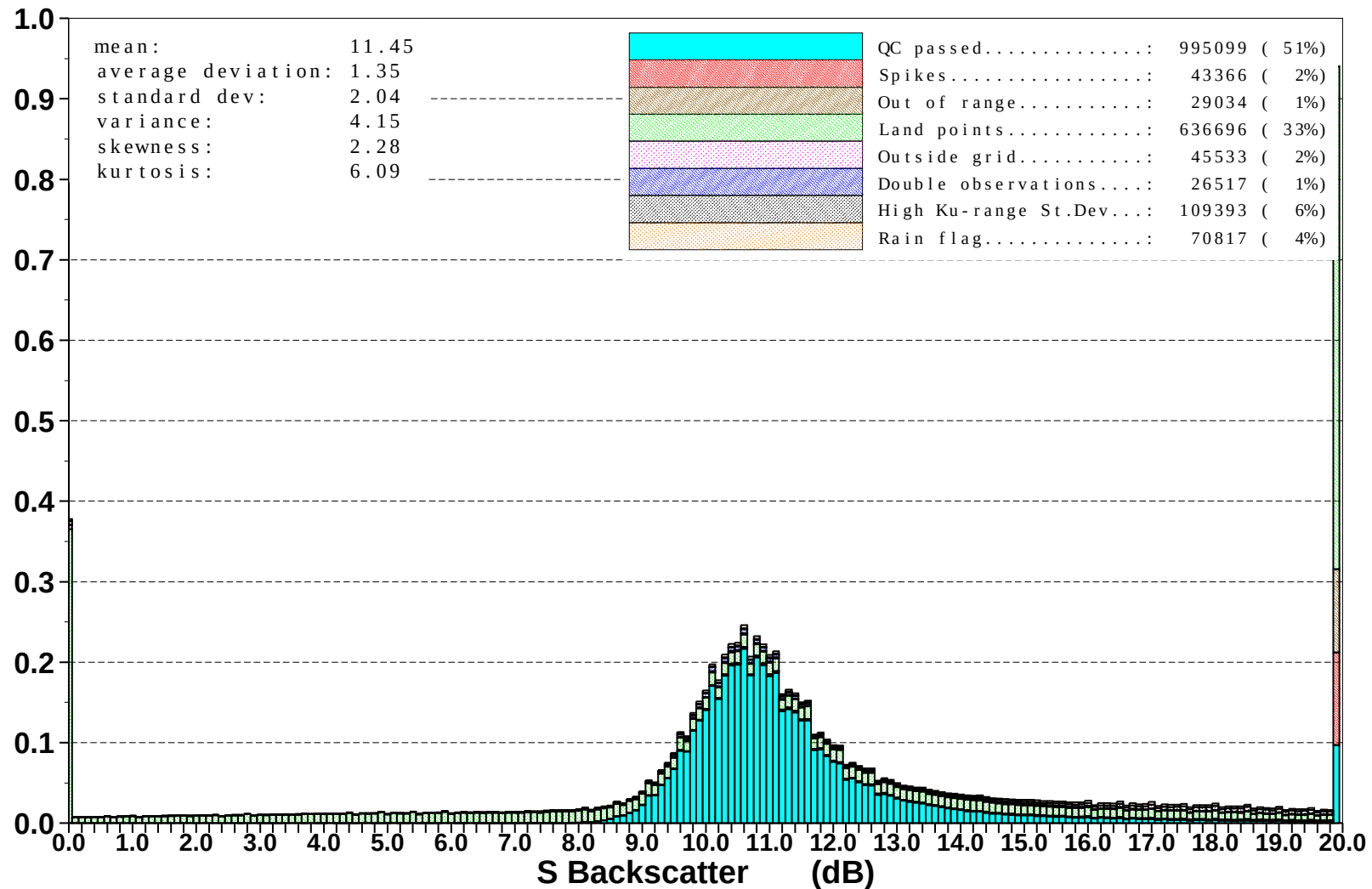


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for August 2005



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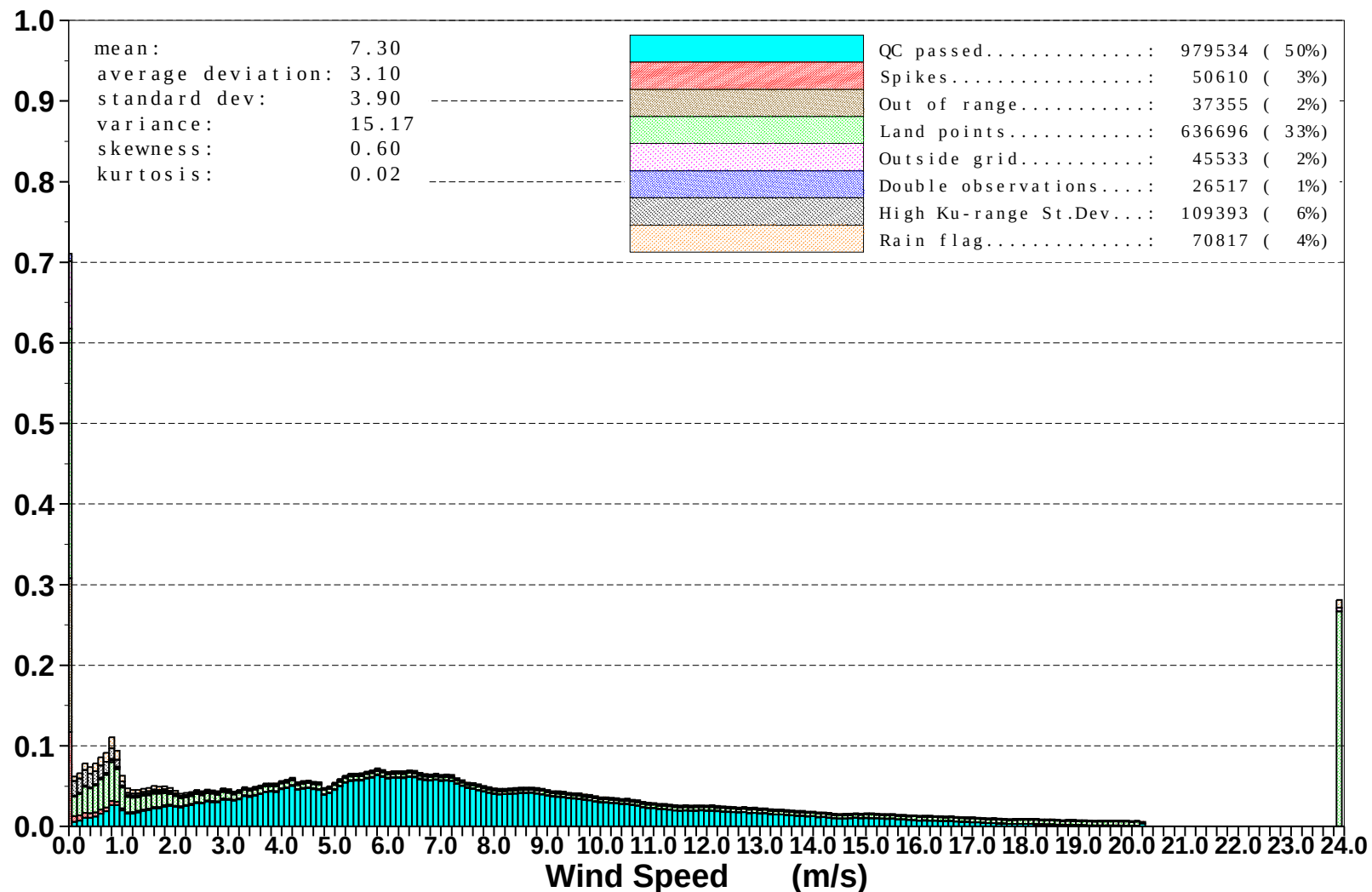


Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for August 2005



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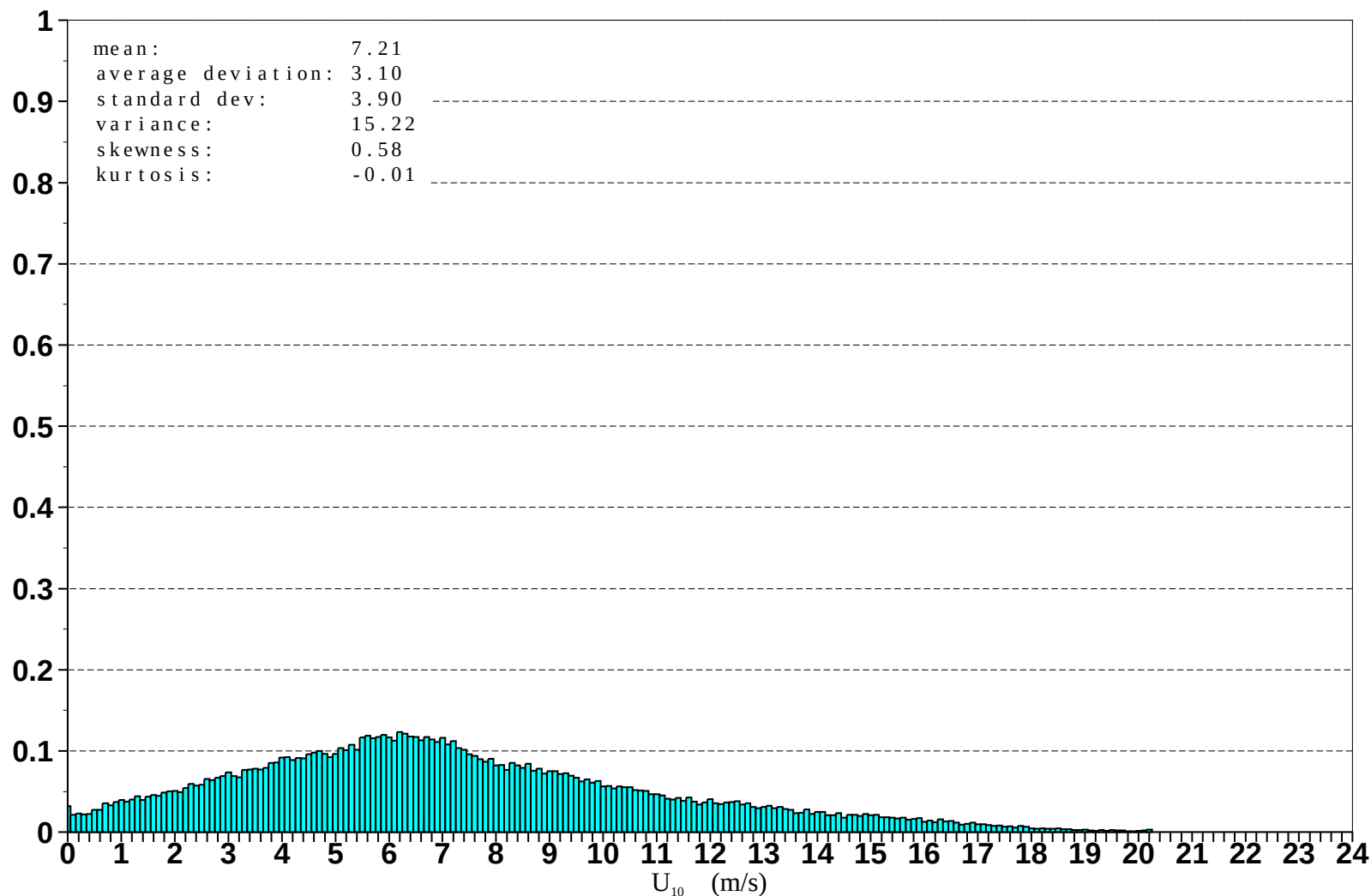


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for August 2005



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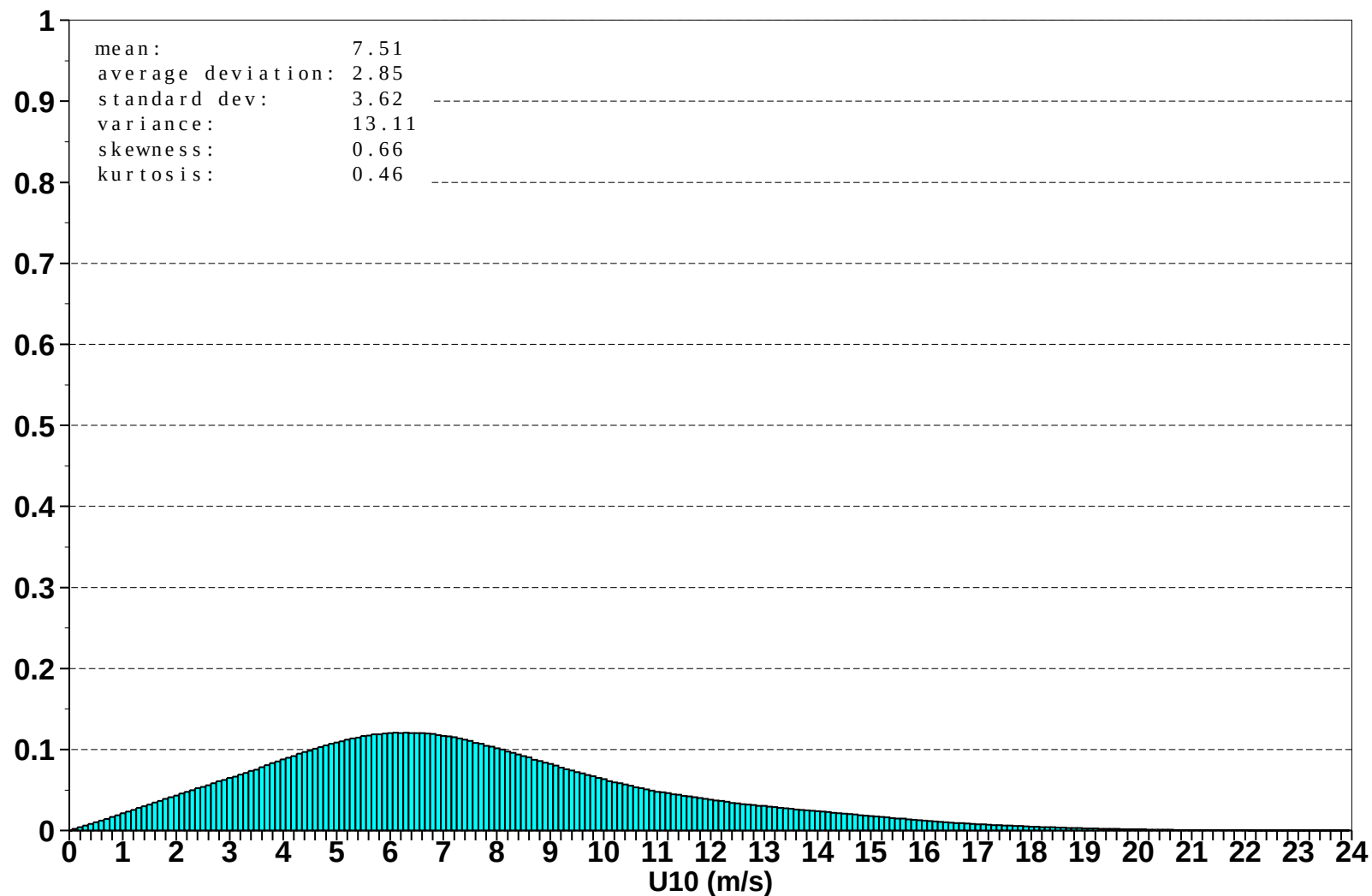


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for August 2005



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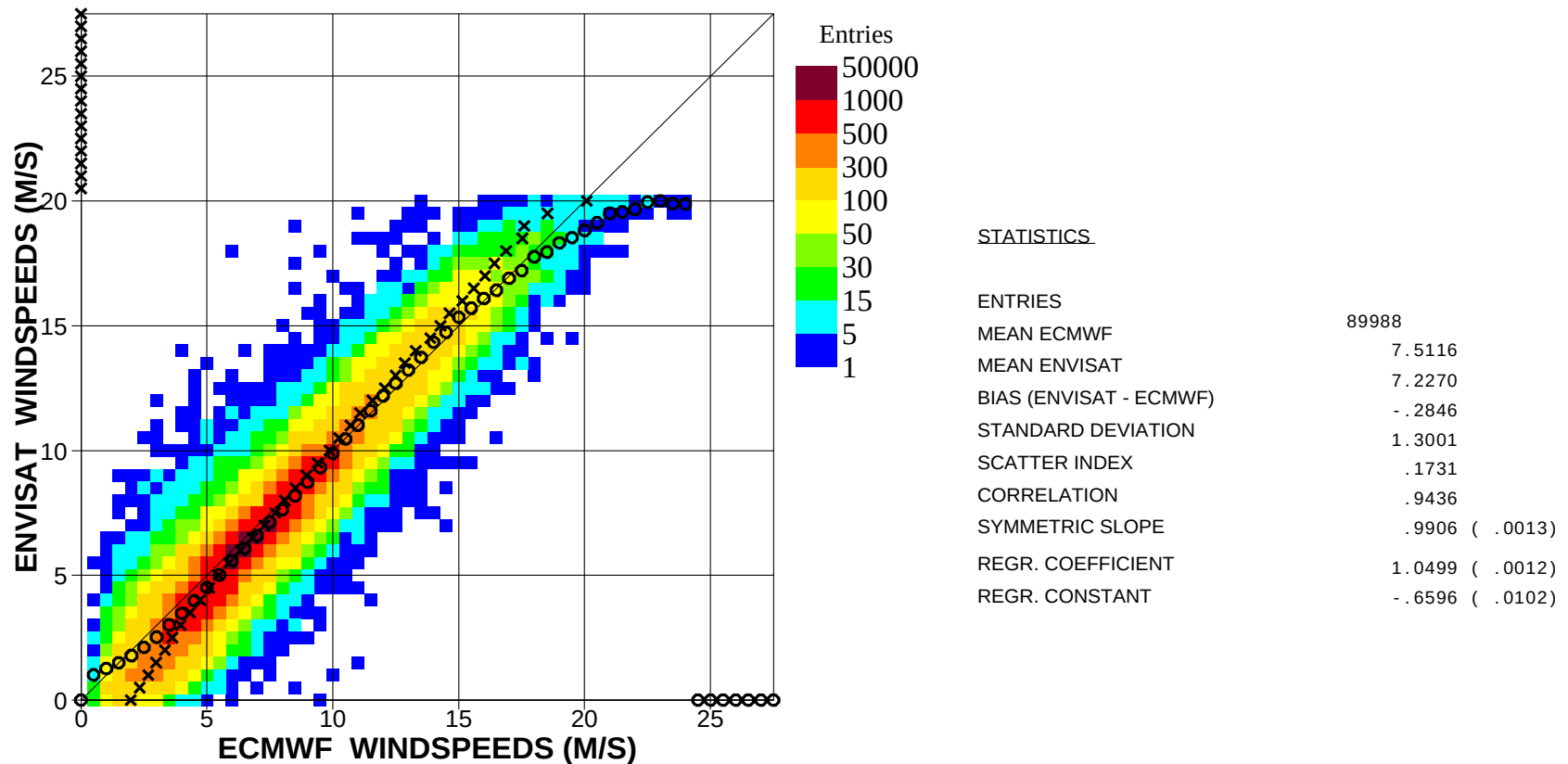


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for August 2005 (Global)

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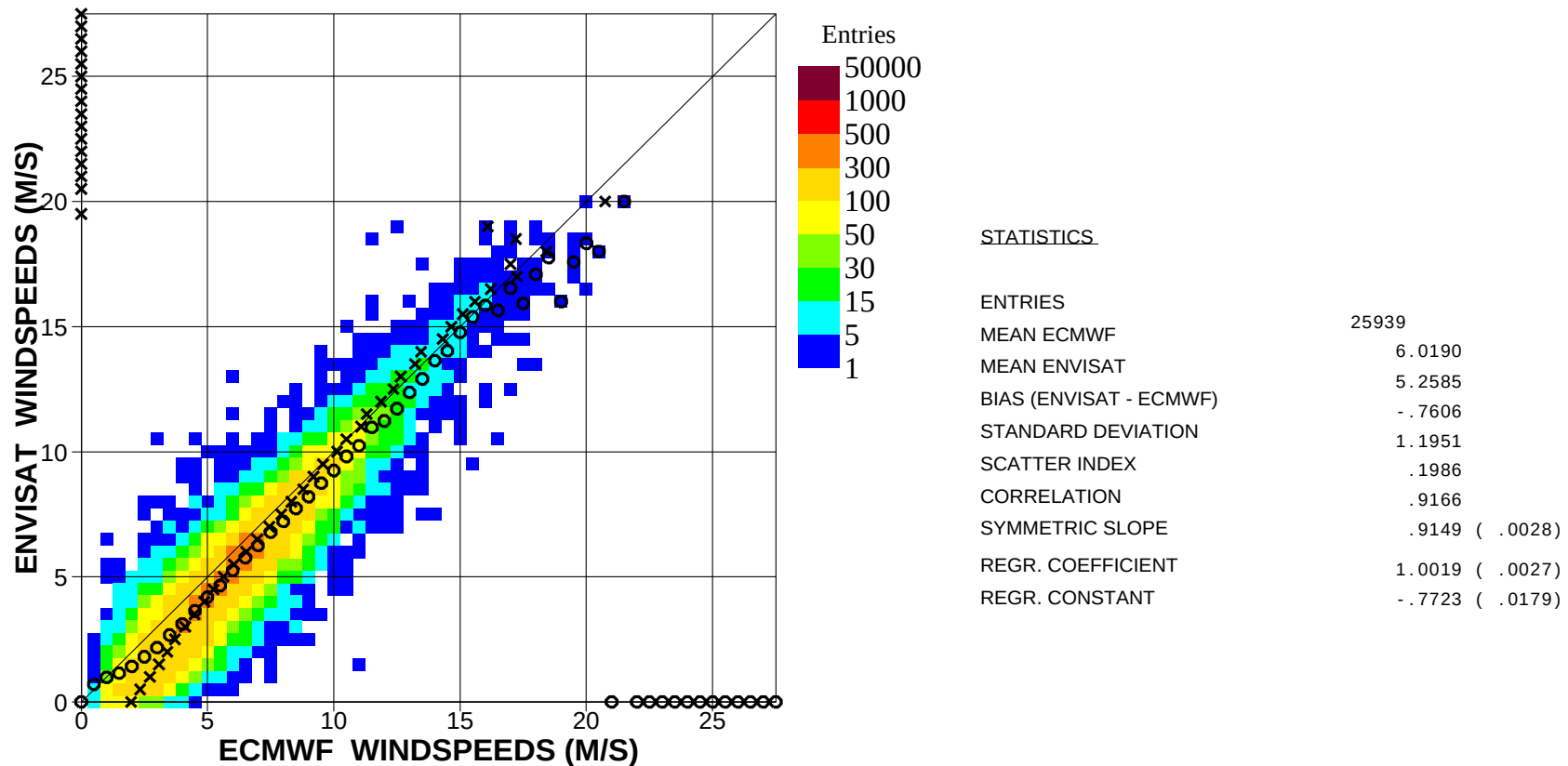


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for August 2005 (N.Hem.)

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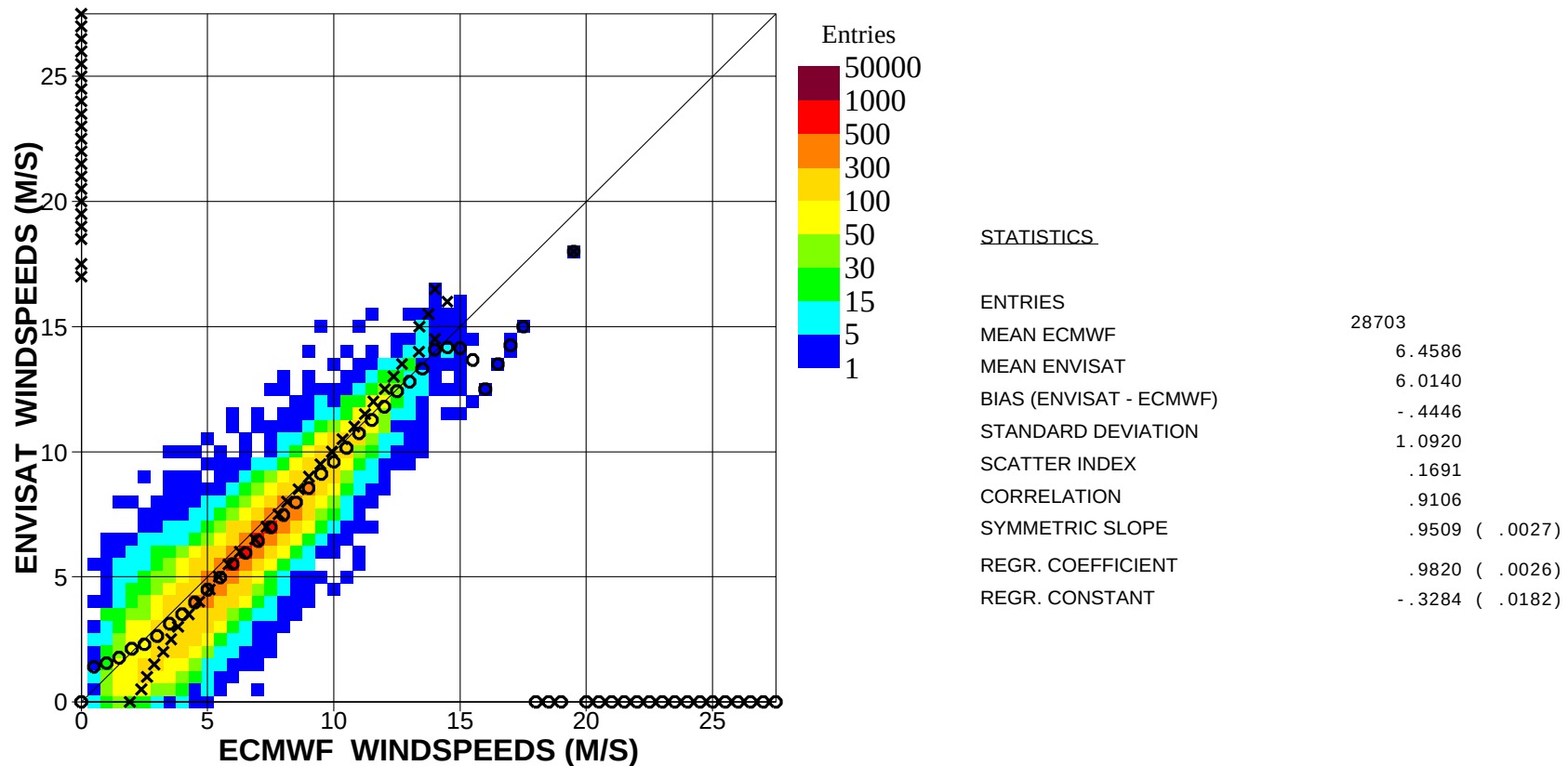


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for August 2005 (Tropics)

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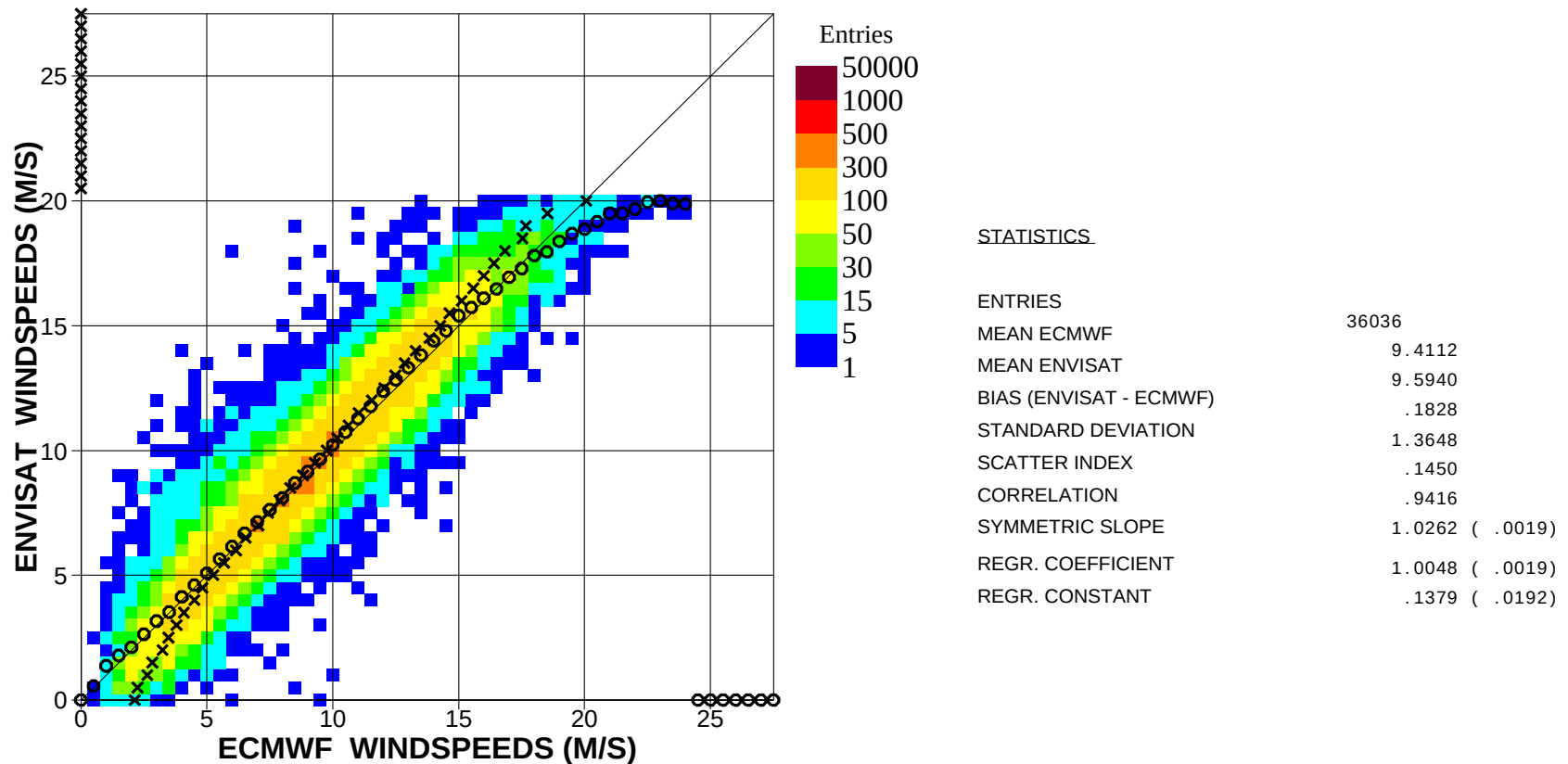


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for August 2005 (S.Hem.)



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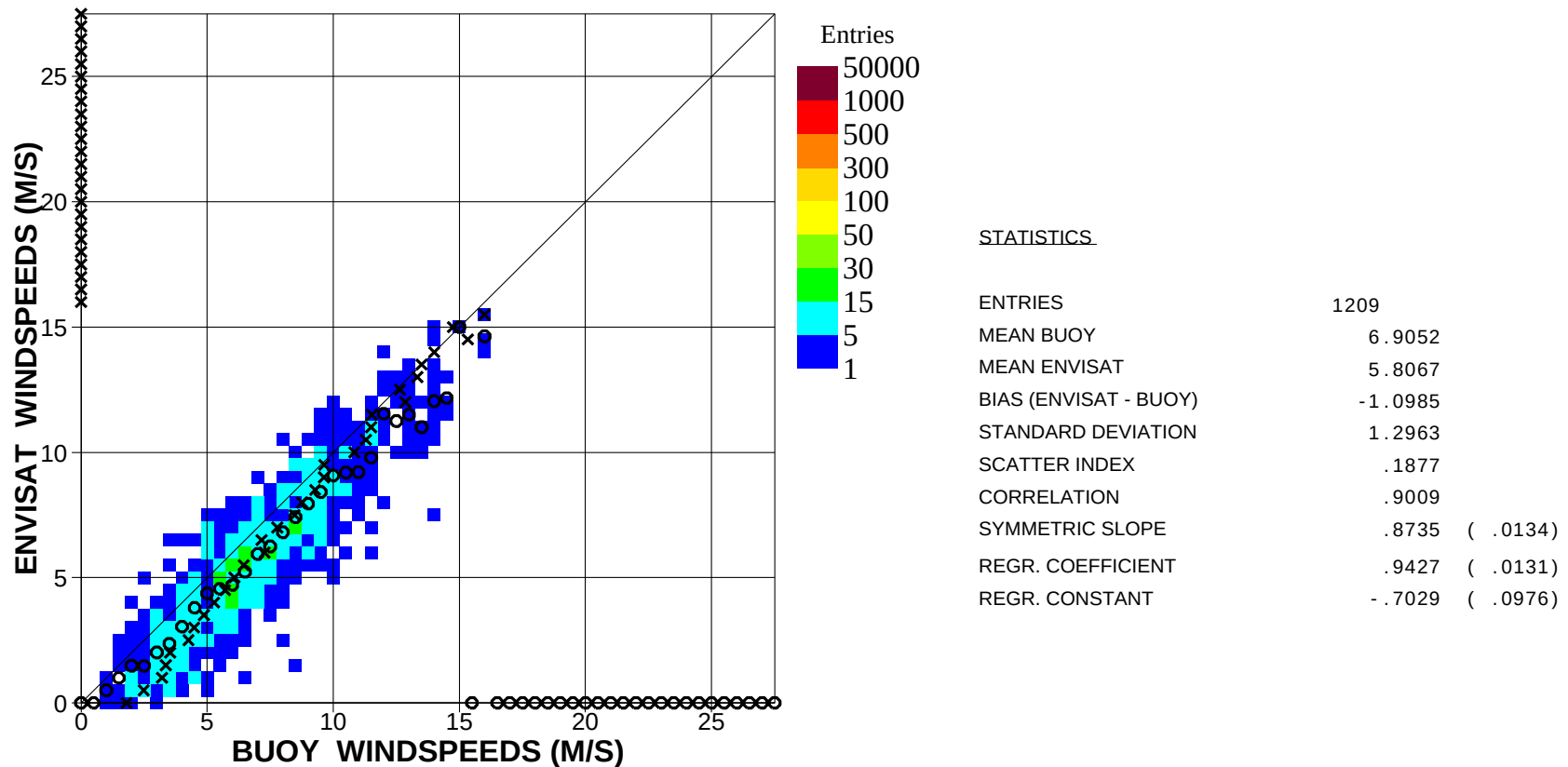


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for August 2005 (Global)



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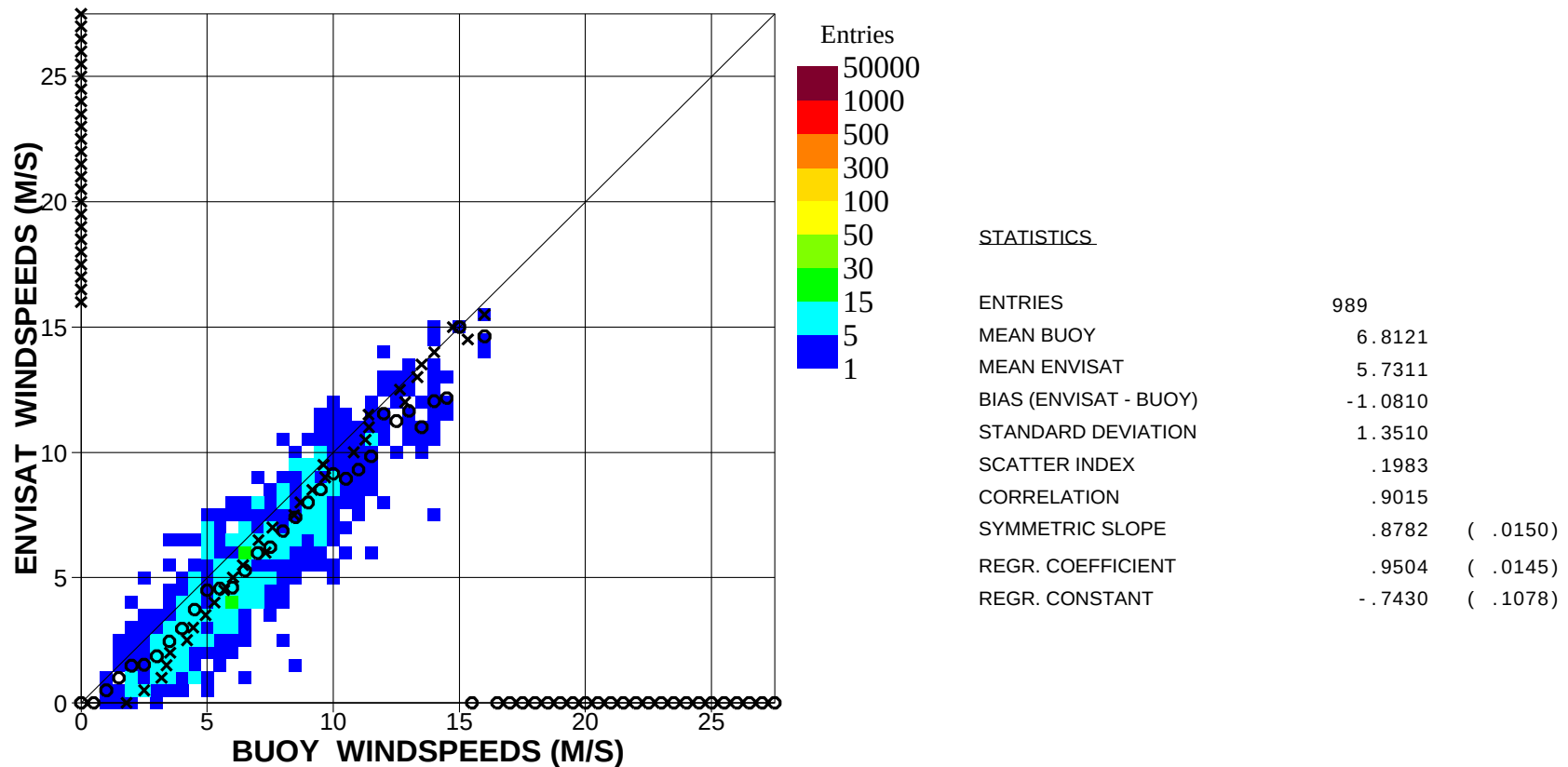


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for August 2005 (N.Hem.)

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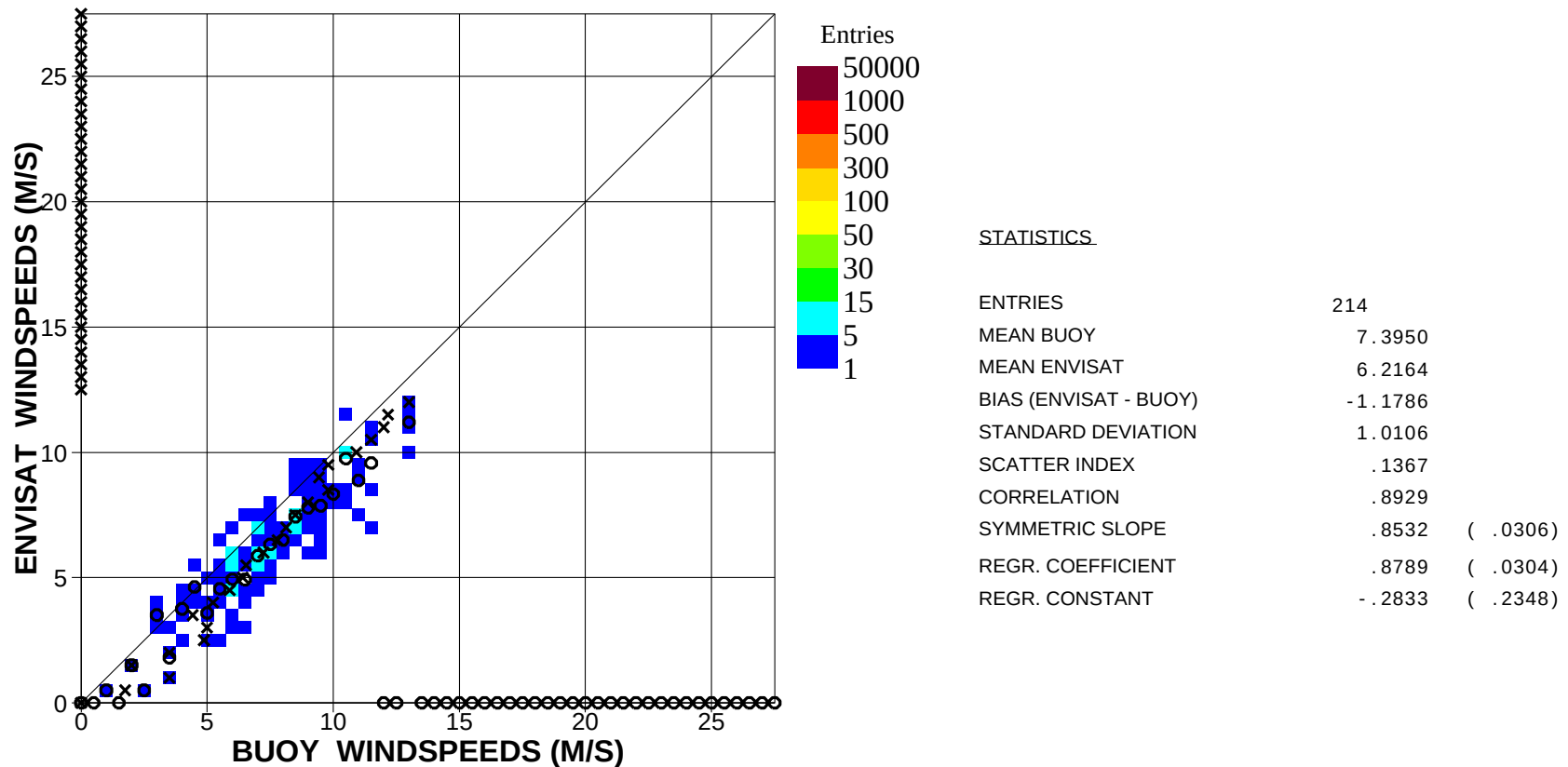


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for August 2005 (Tropics)



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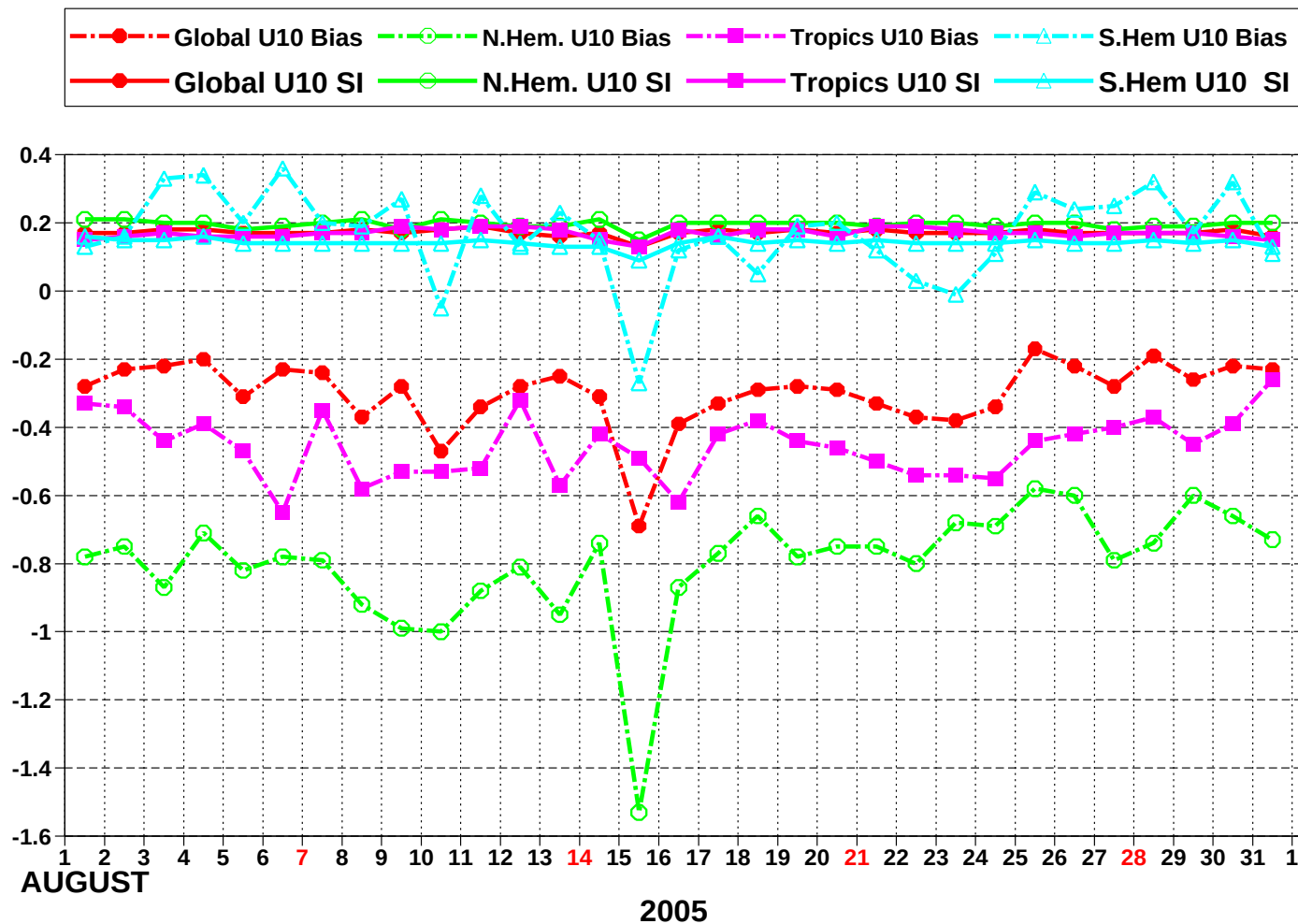


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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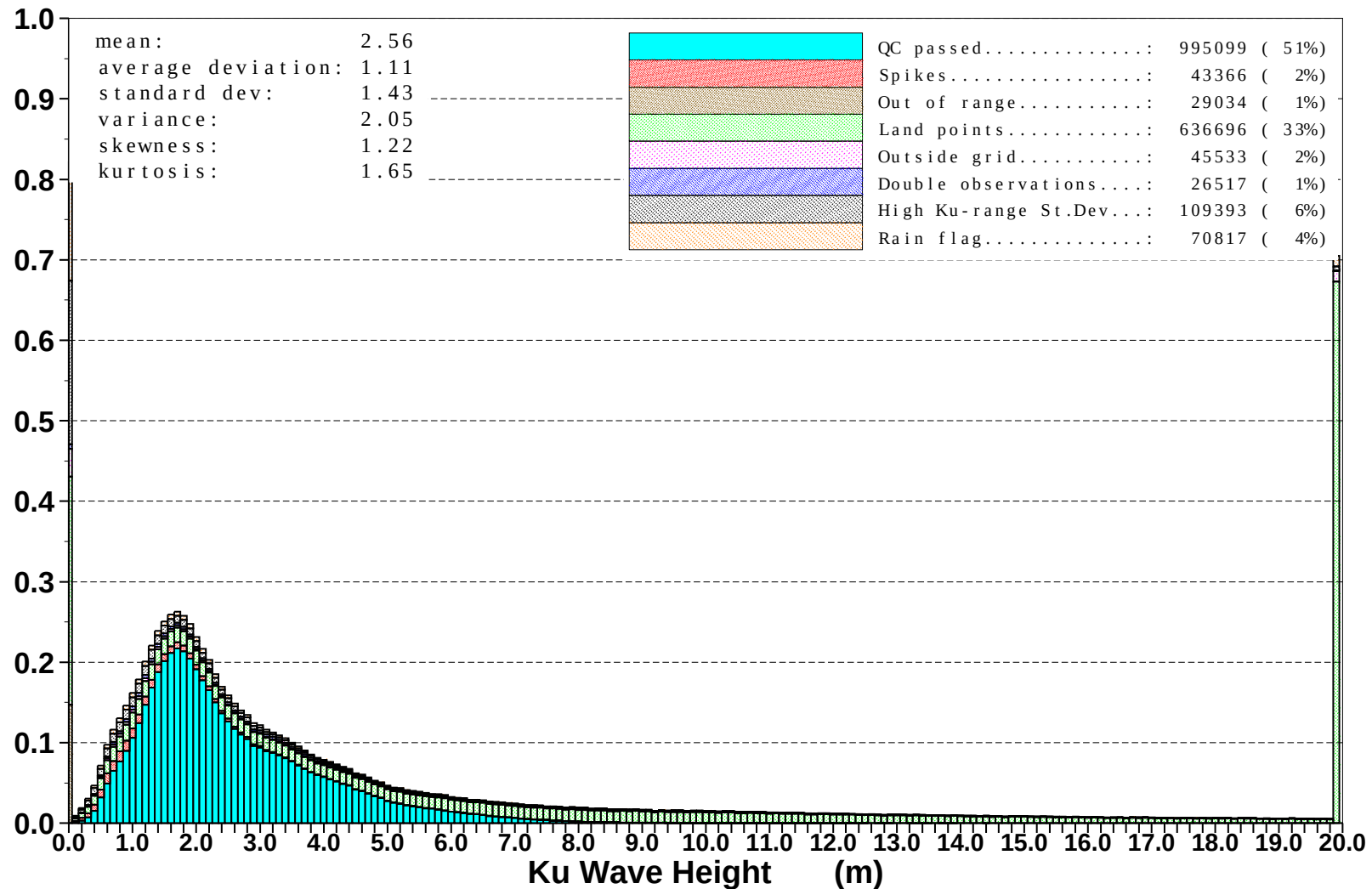


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for August 2005

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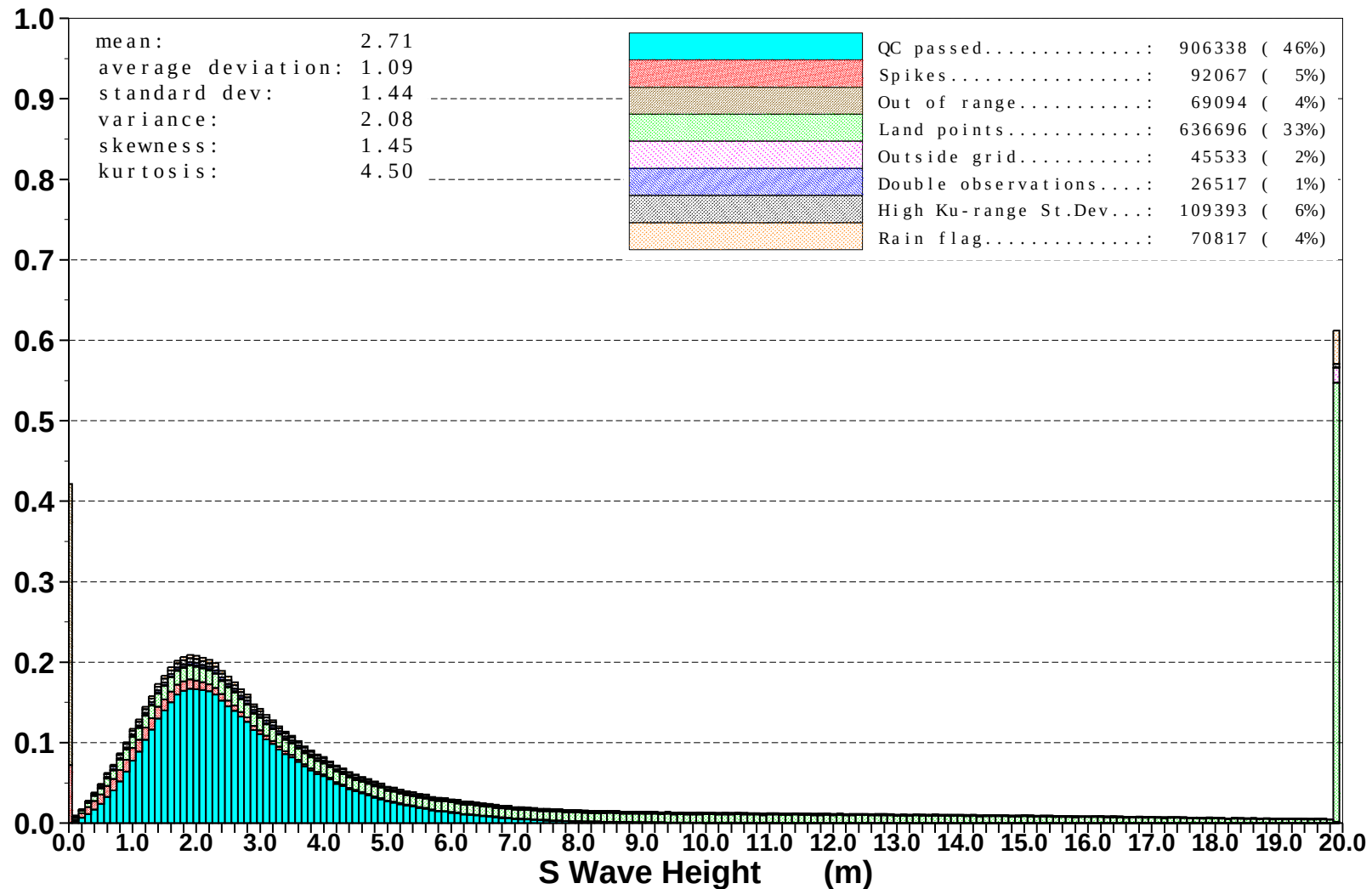


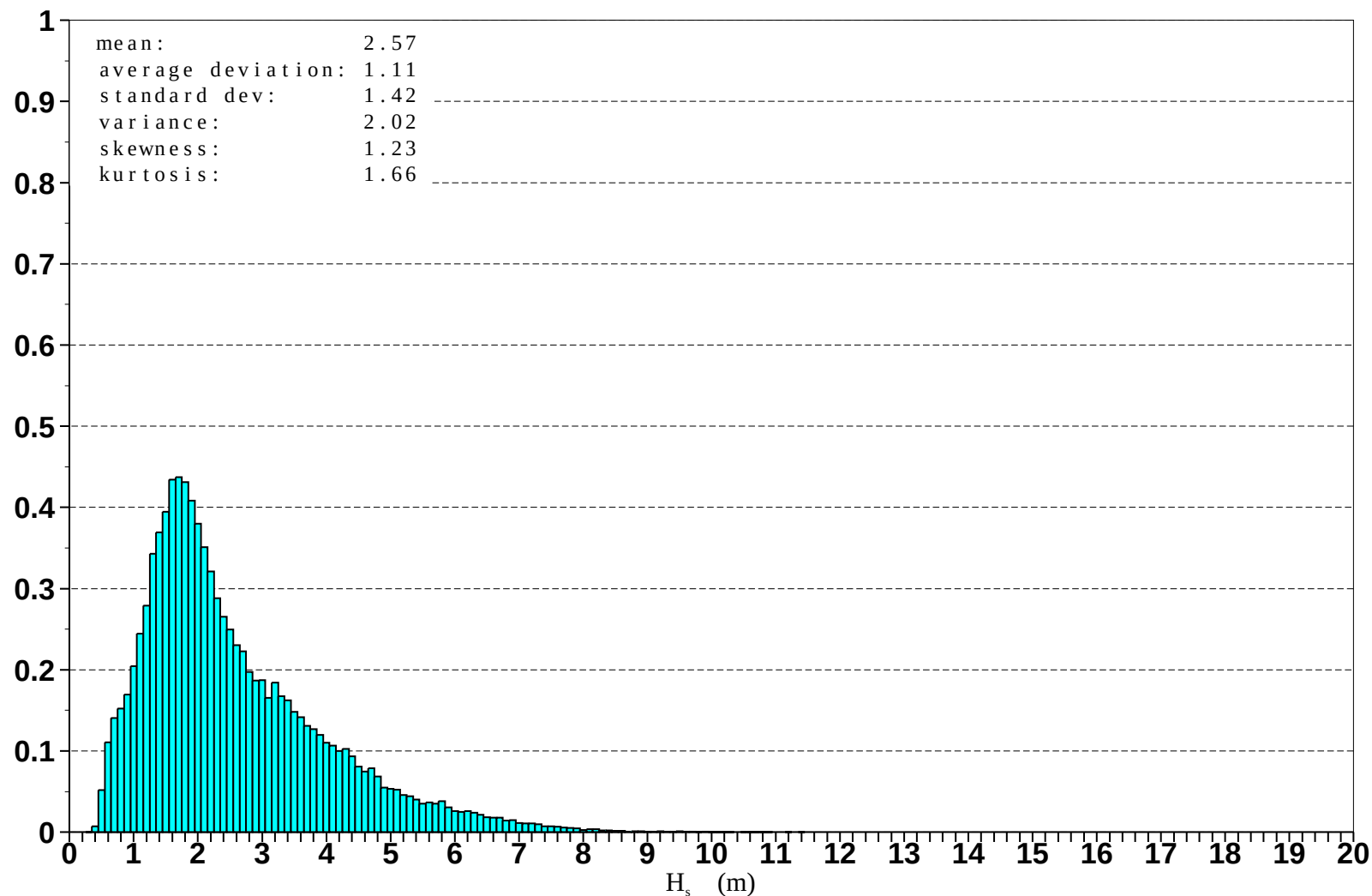
Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for August 2005



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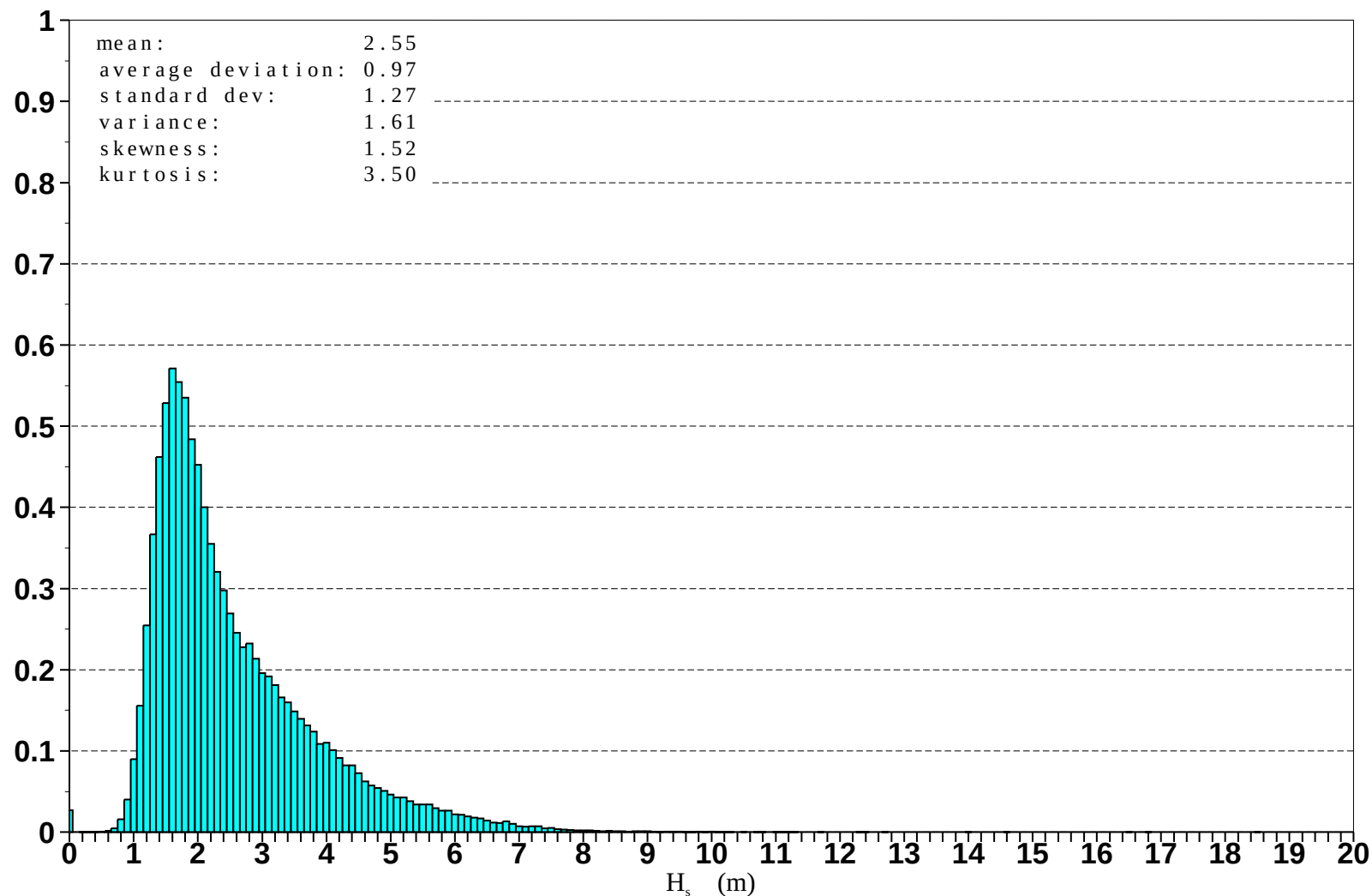


Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for August 2005



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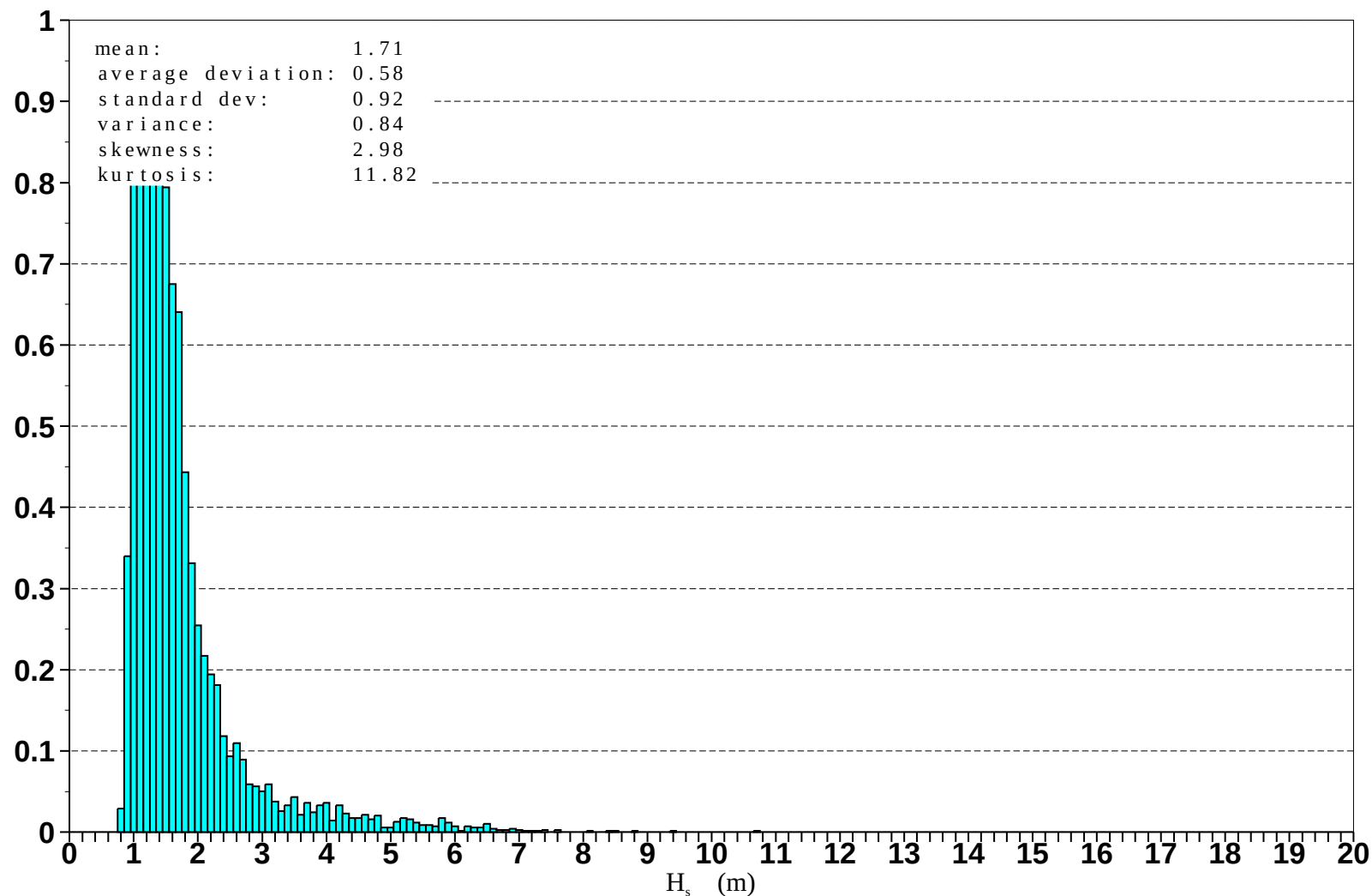


Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for August 2005

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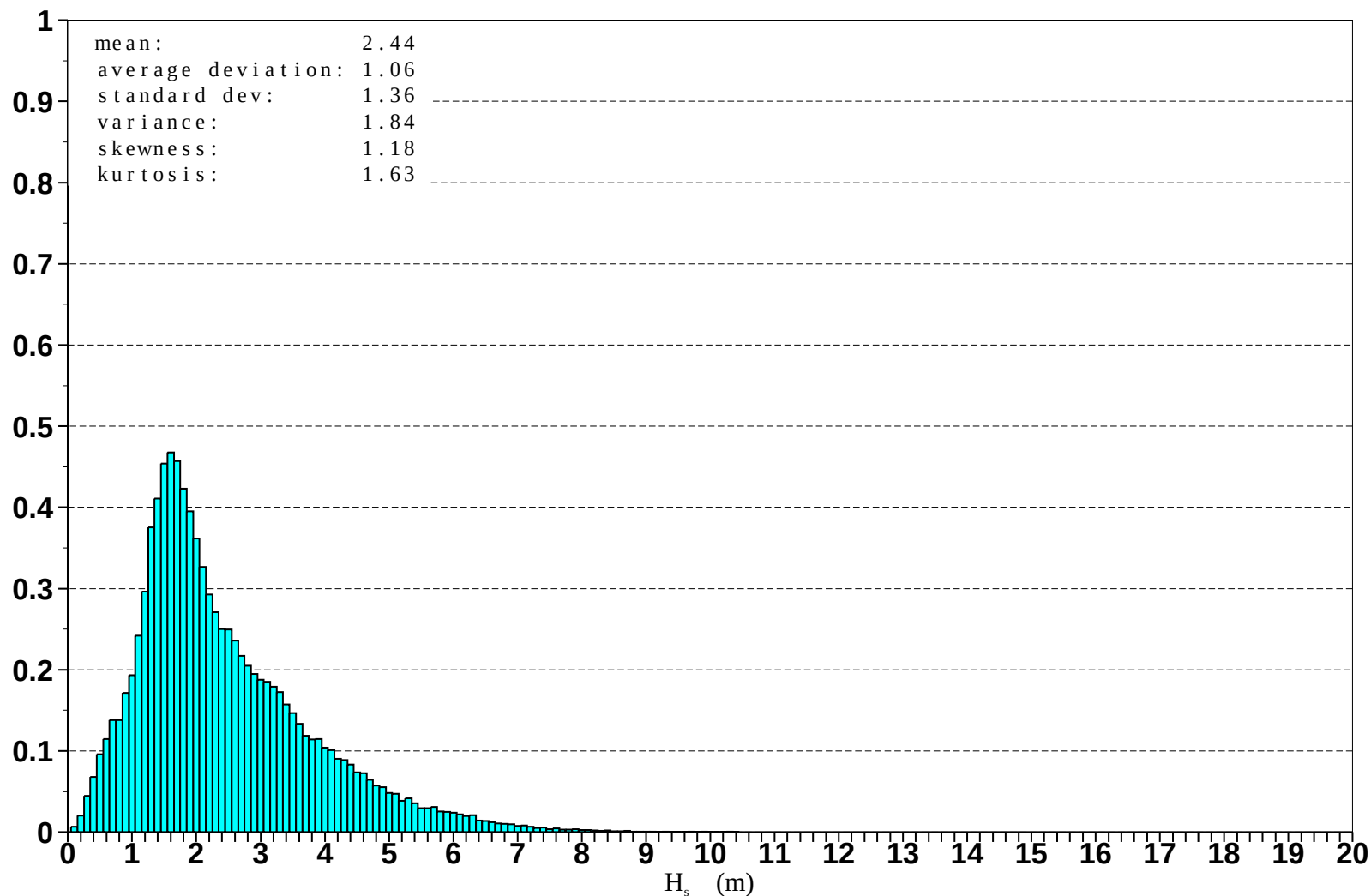


Figure 19b: Distribution of WAM 4V Wave Height (Collocated with ENVISAT) for August 2005



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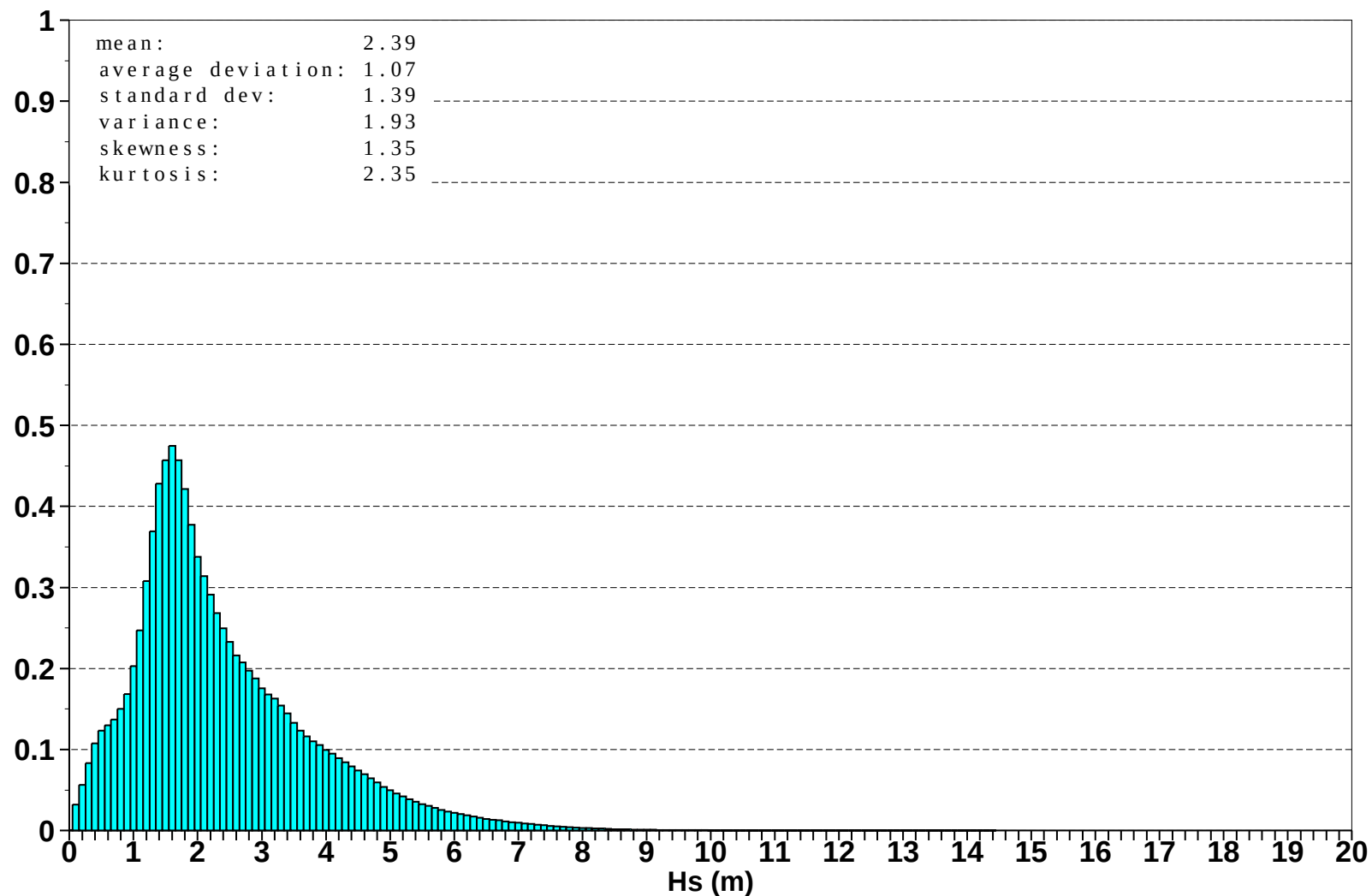


Figure 20: Global distribution of ECMWF First-Guess wave heights for August 2005



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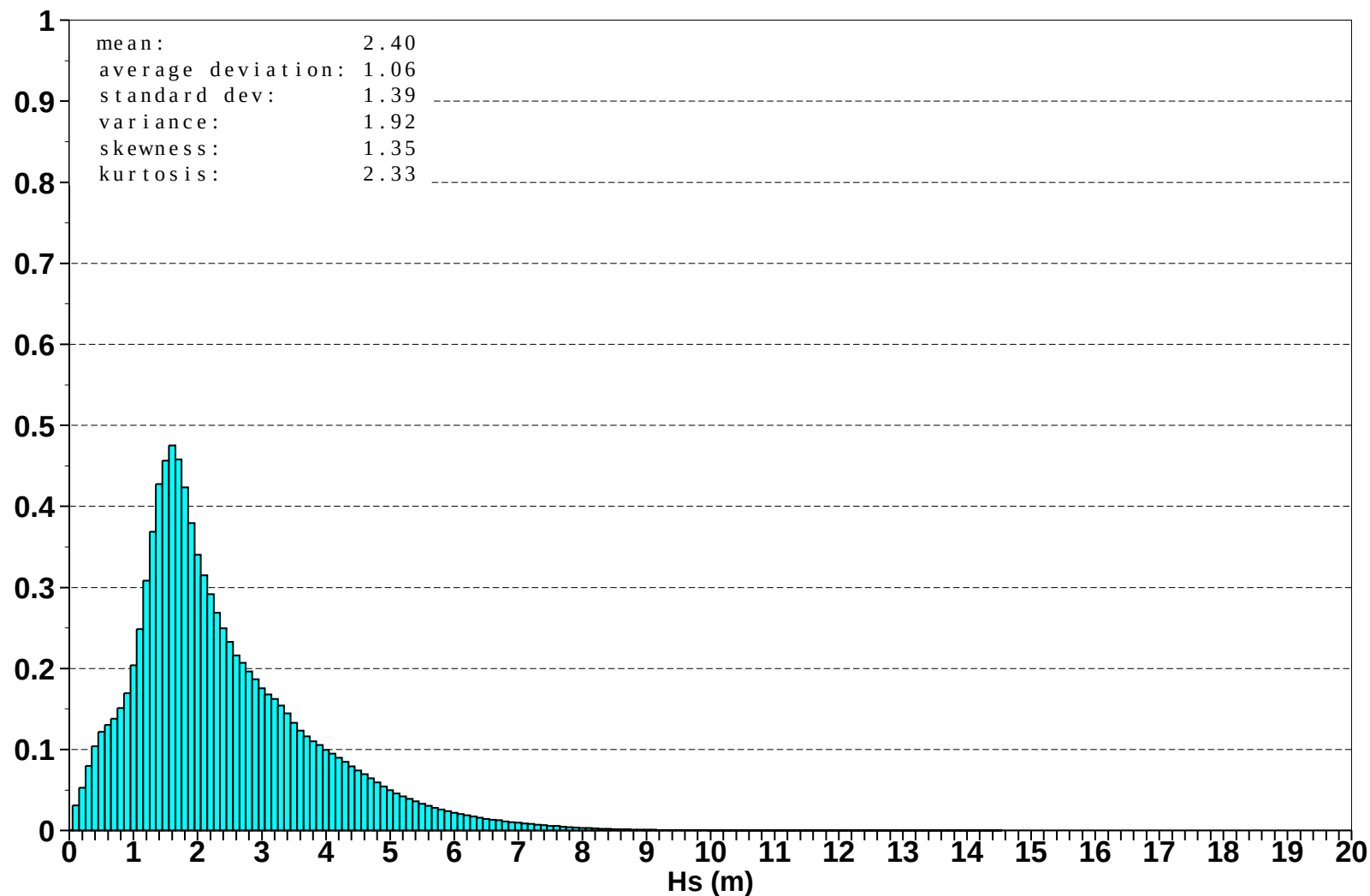


Figure 21: Global distribution of ECMWF Analysis wave heights for August 2005



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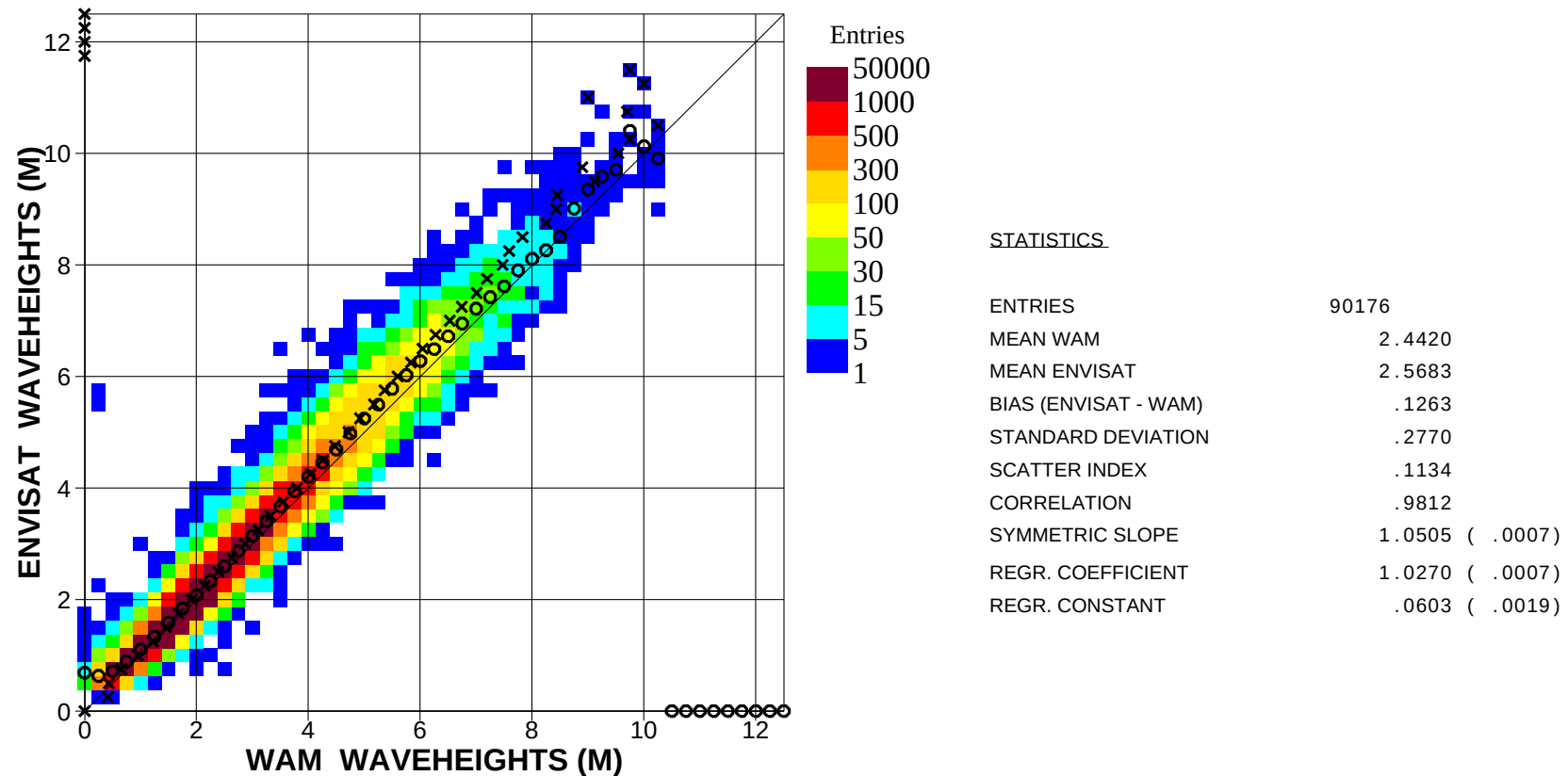


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for August 2005 (Global)

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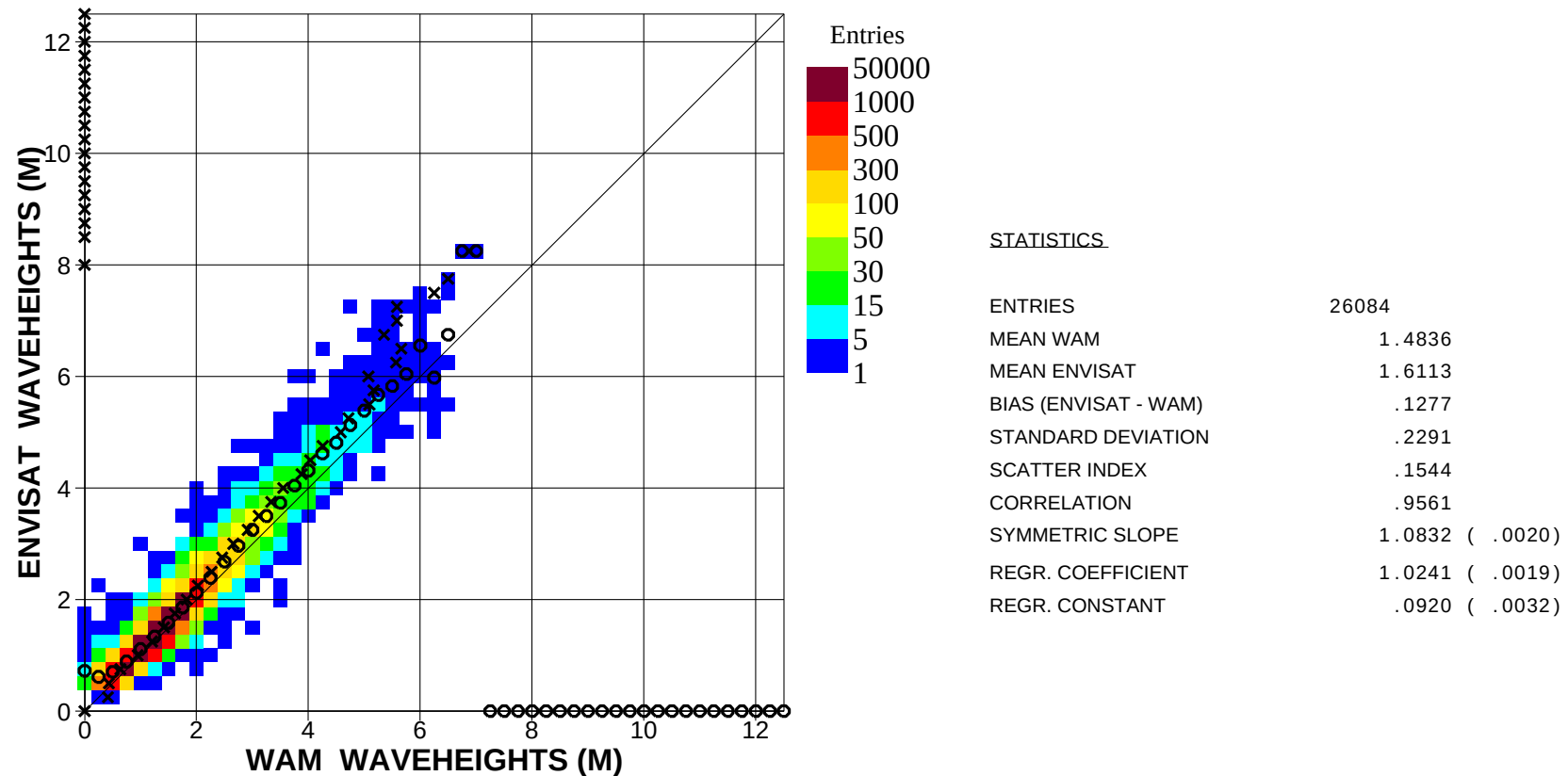


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for August 2005 (N.Hem.)

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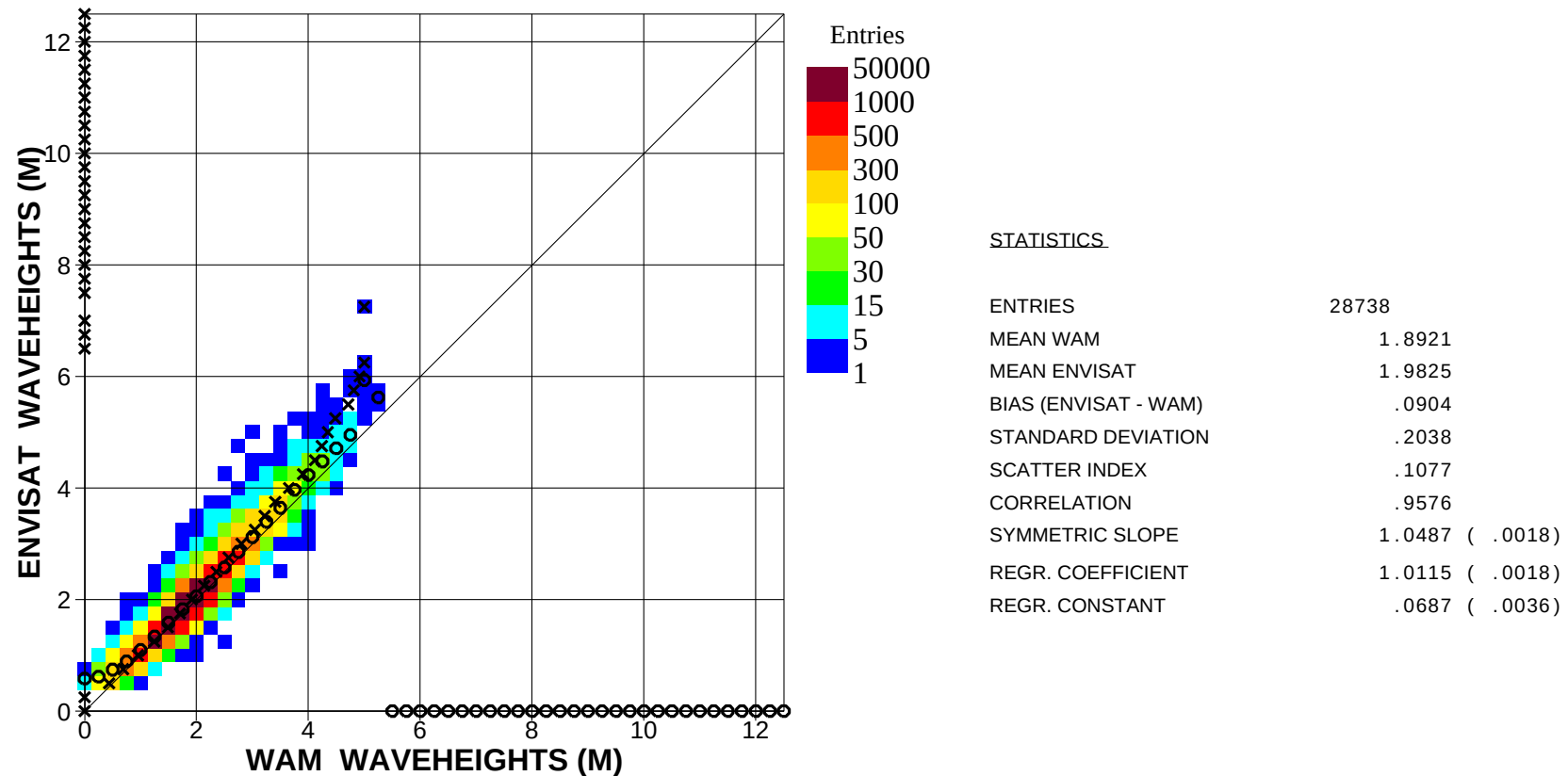


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for August 2005 (Tropics)

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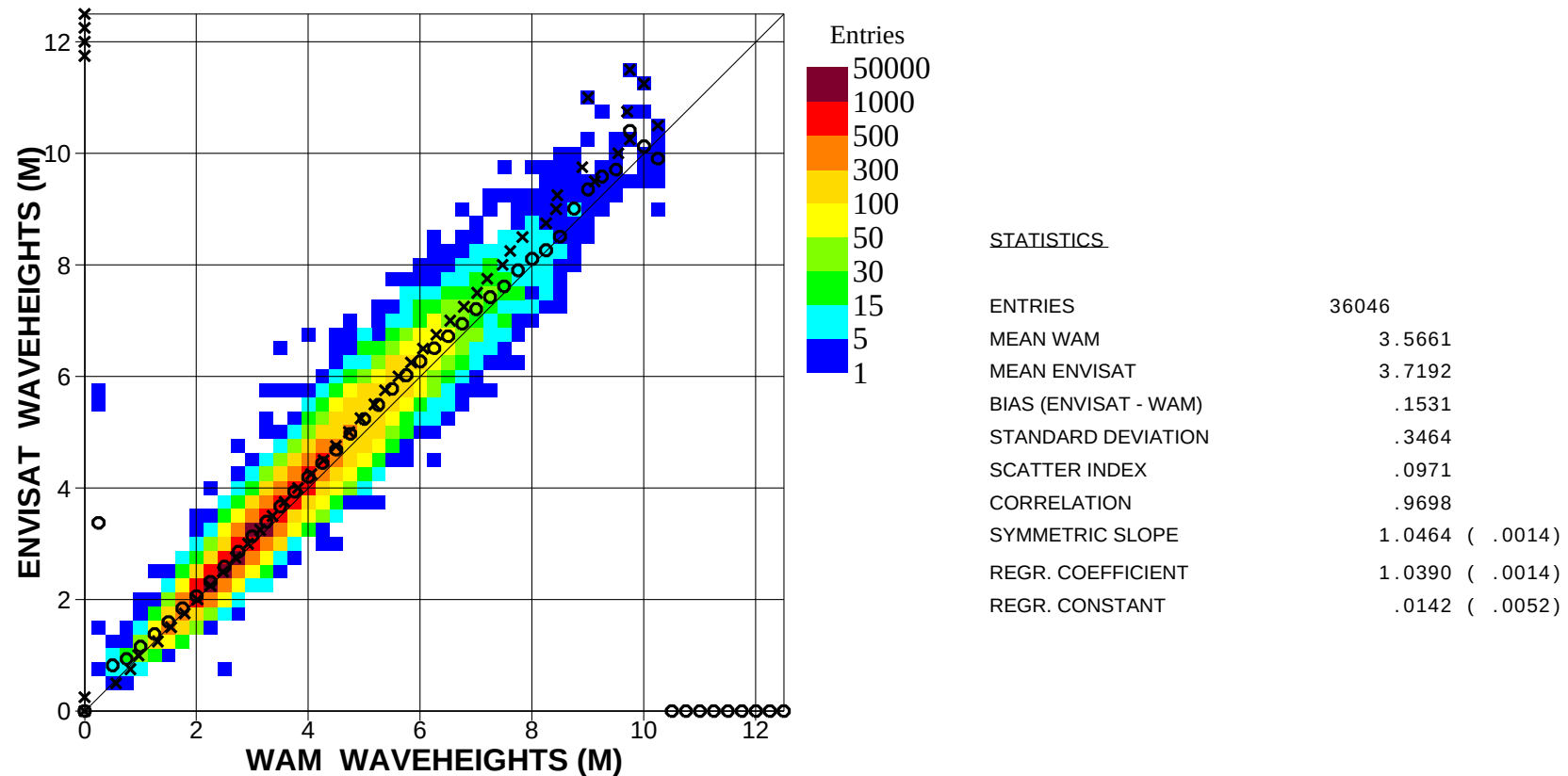


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for August 2005 (S.Hem.)

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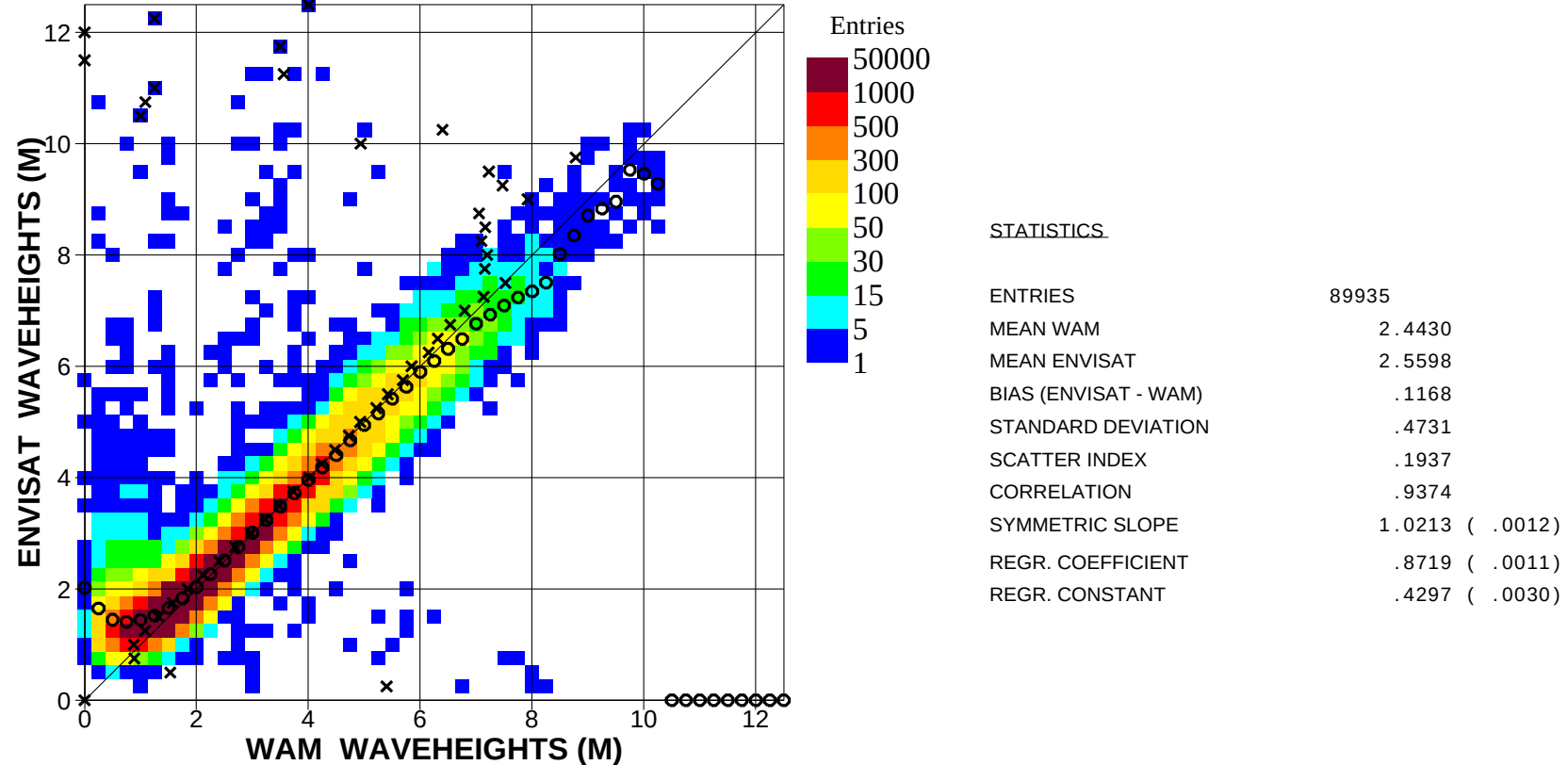


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for August 2005 (Global)

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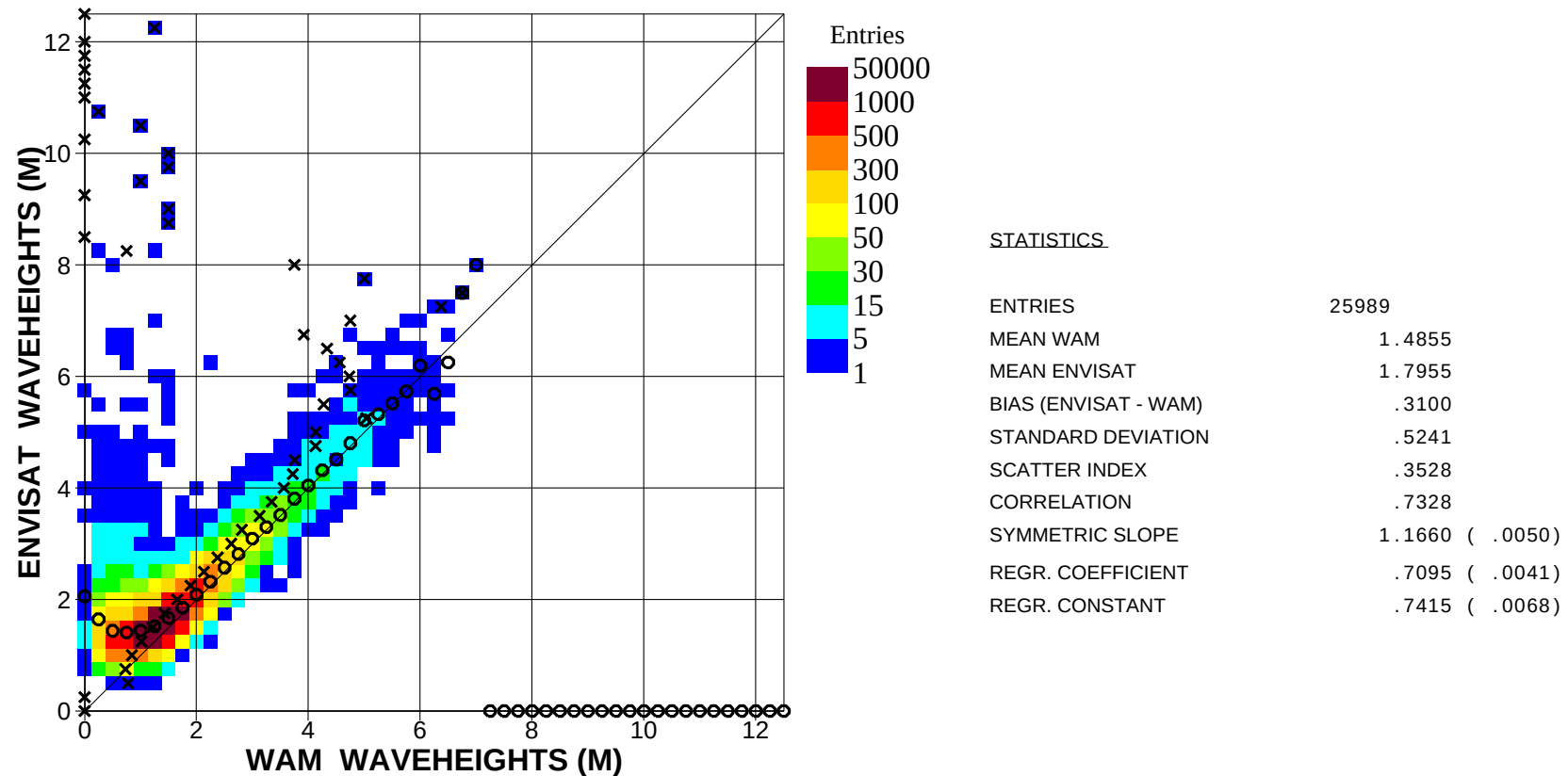


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for August 2005 (N.Hem.)

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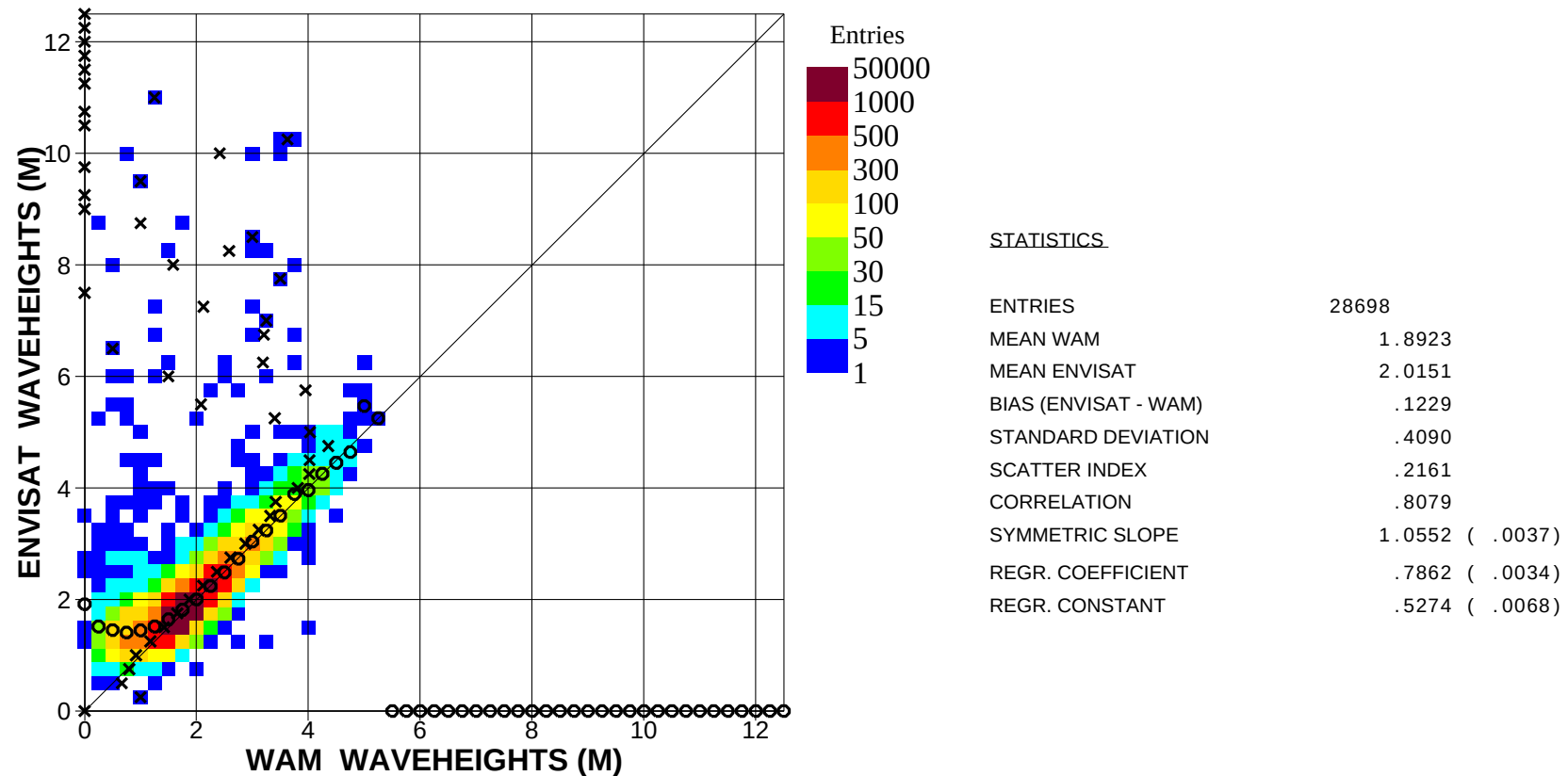


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for August 2005 (Tropics)

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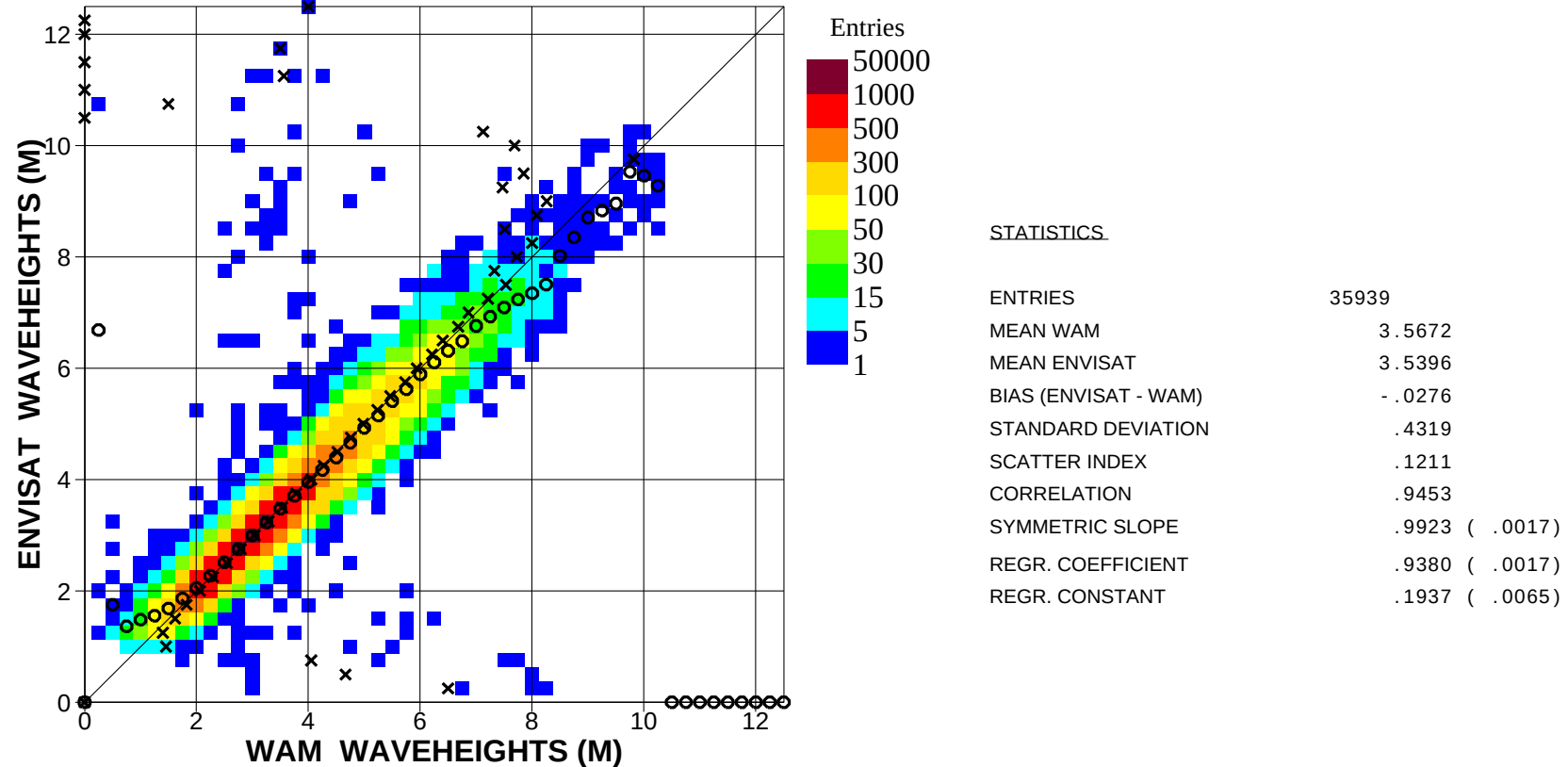


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for August 2005 (S.Hem.)

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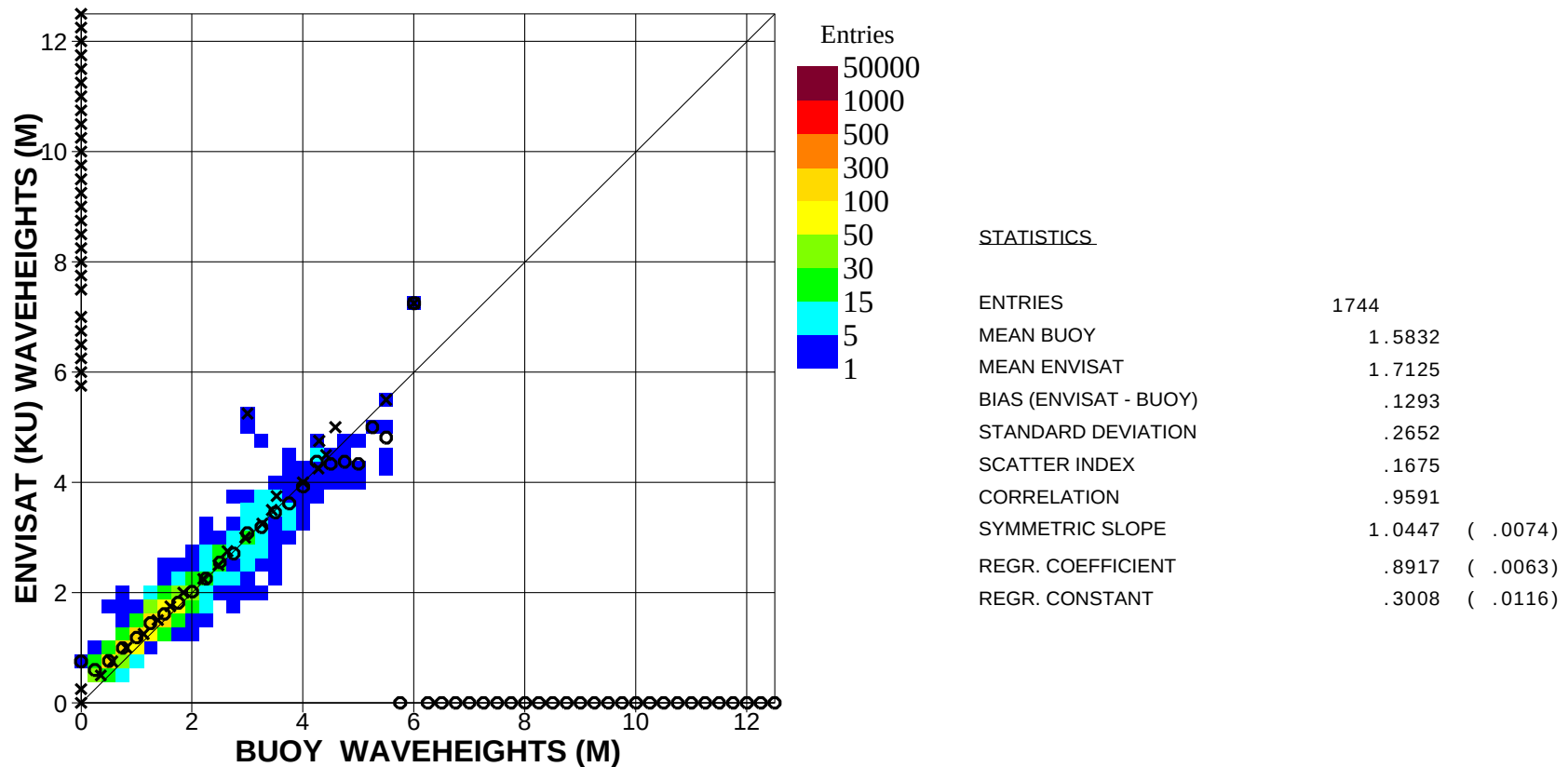


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for August 2005 (Global)

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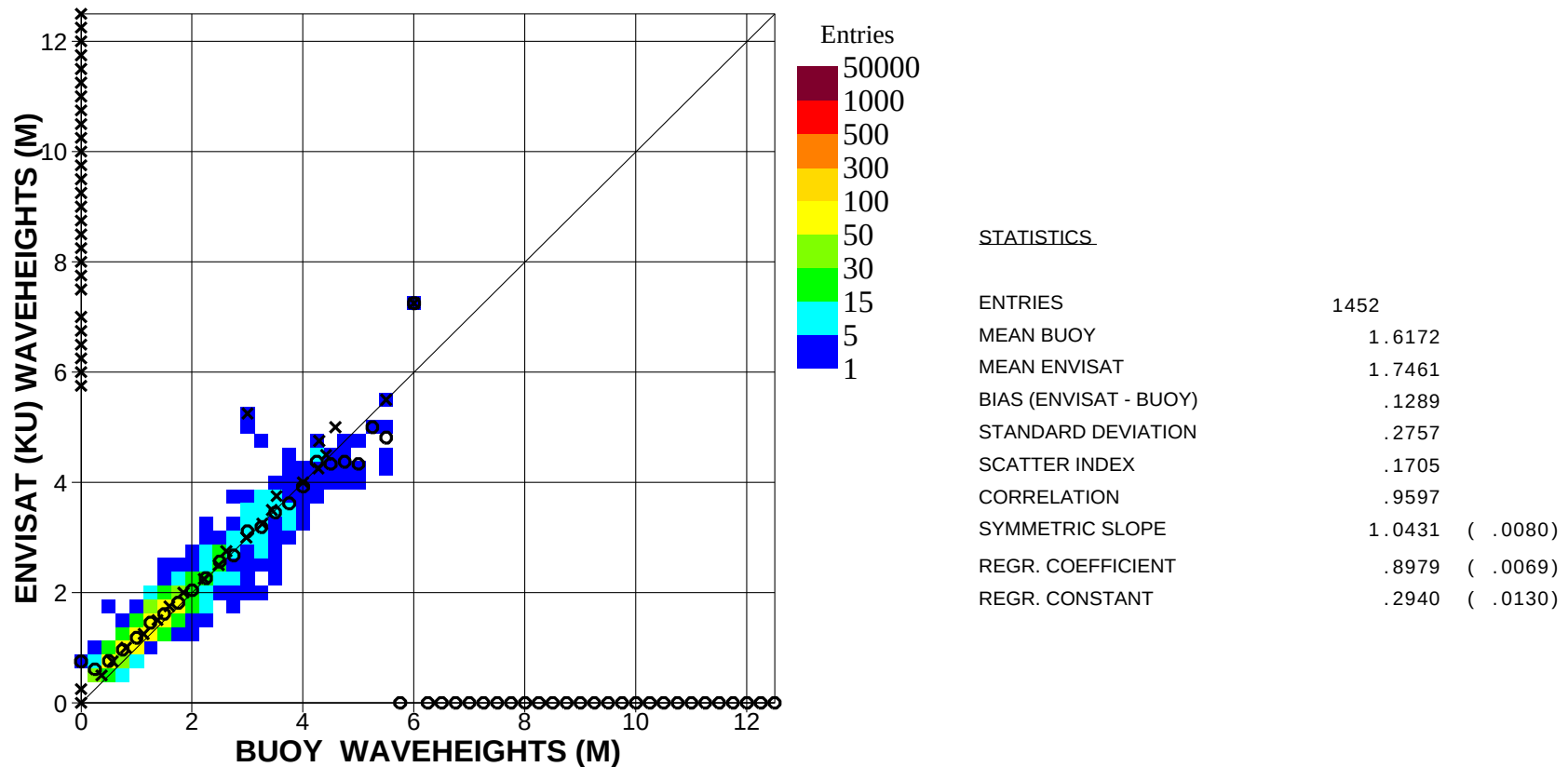


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for August 2005 (N.Hem.)

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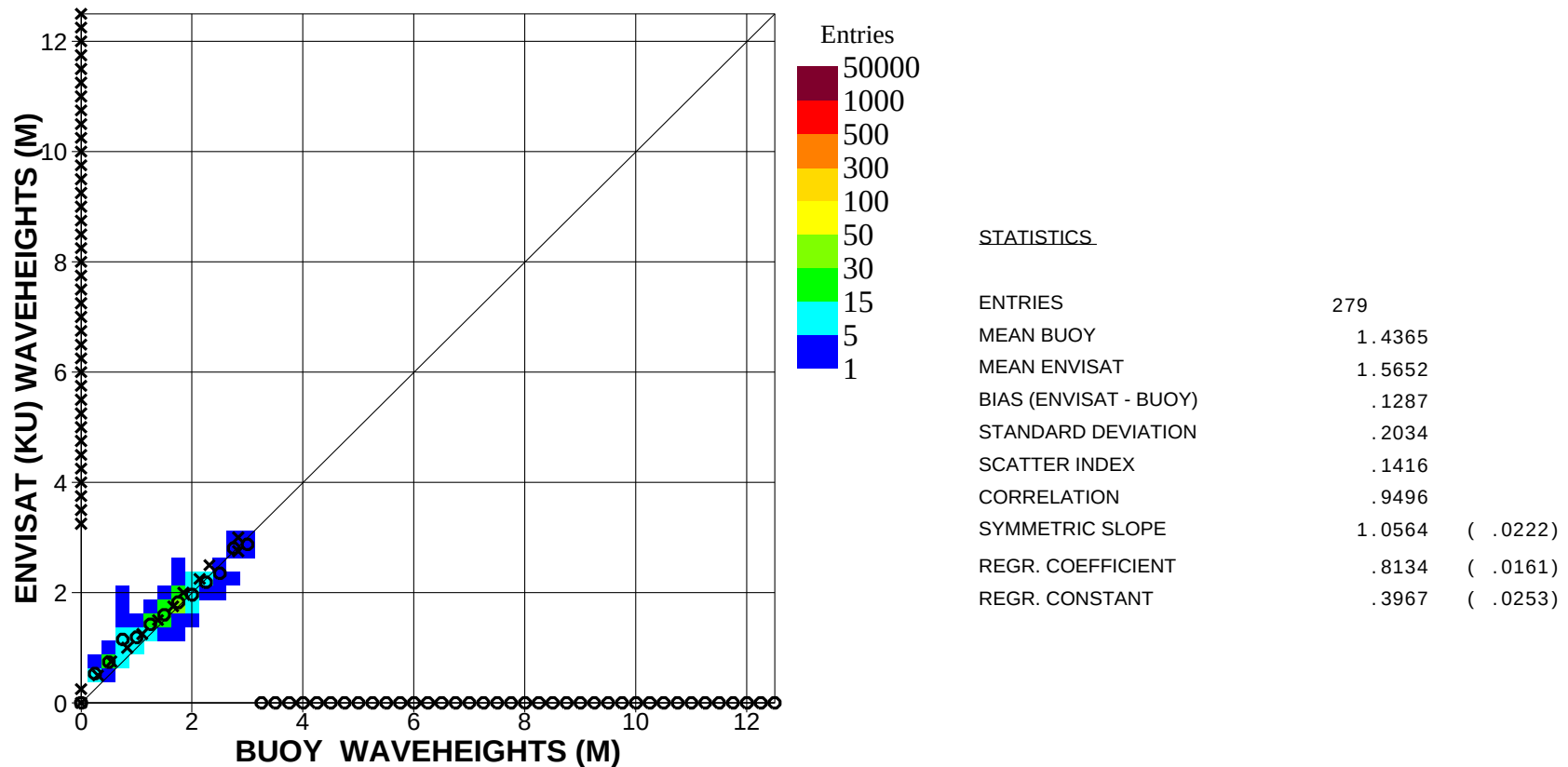


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for August 2005 (Tropics)



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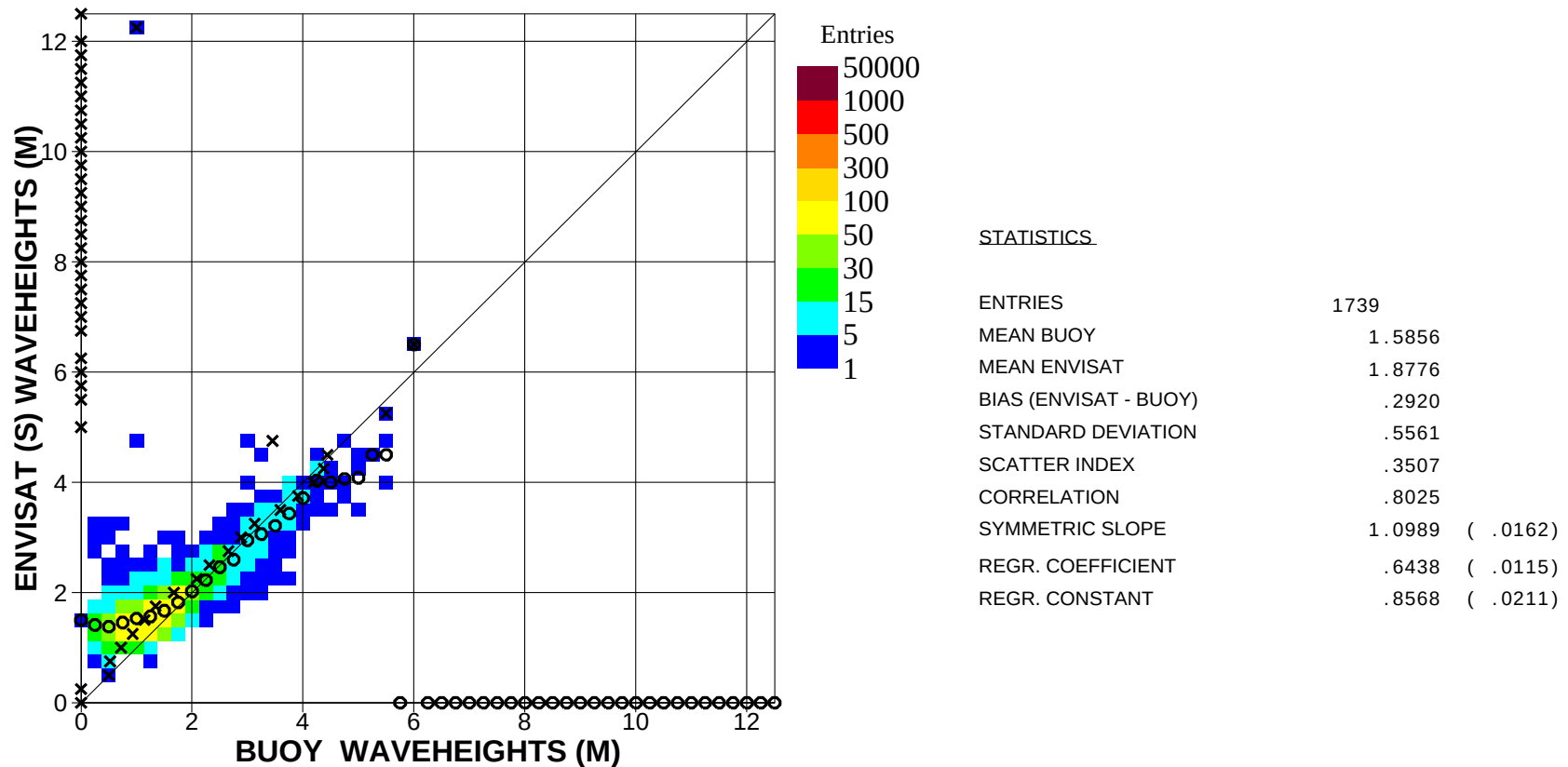


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for August 2005 (Global)

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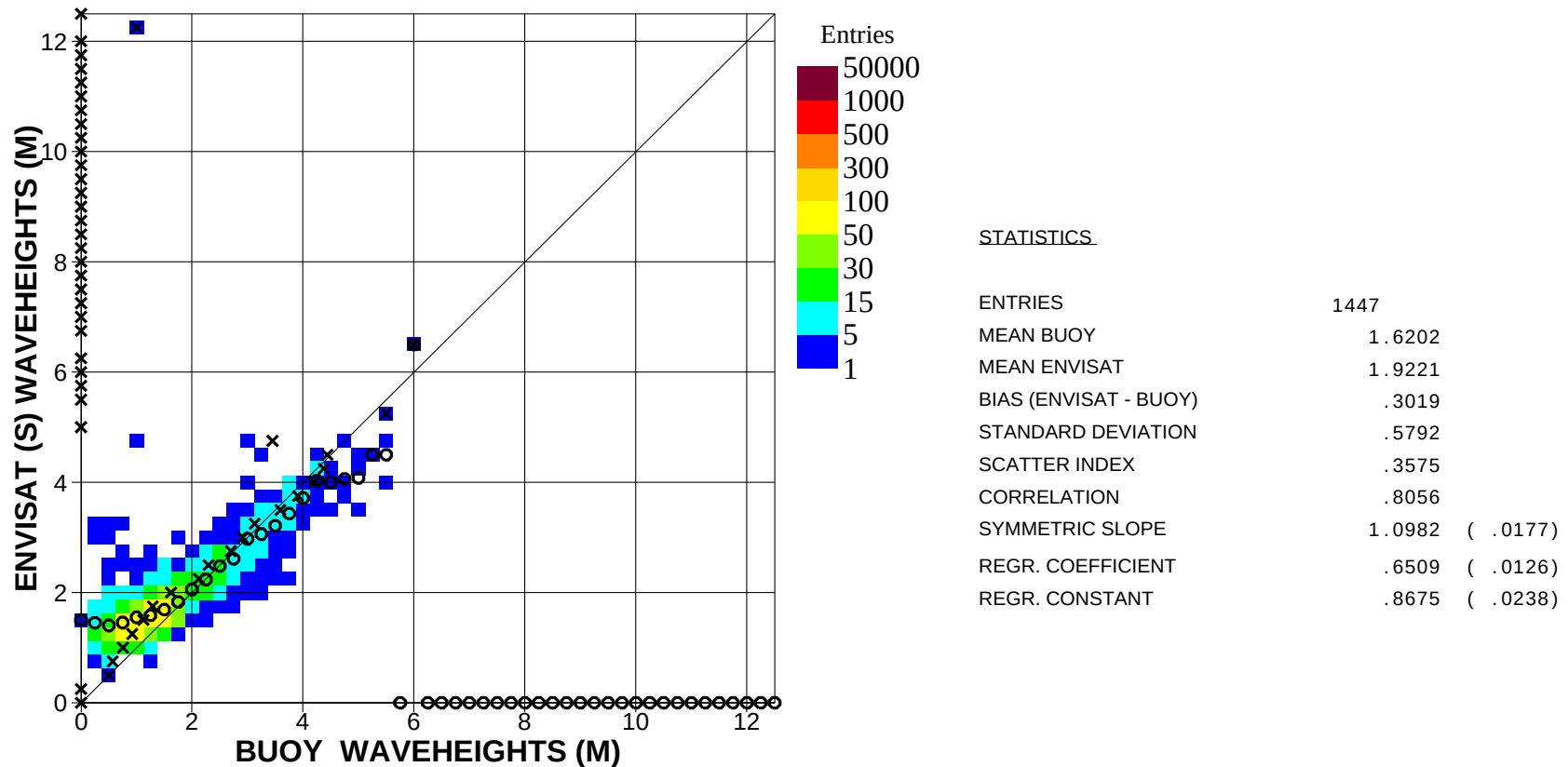


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for August 2005 (N.Hem.)

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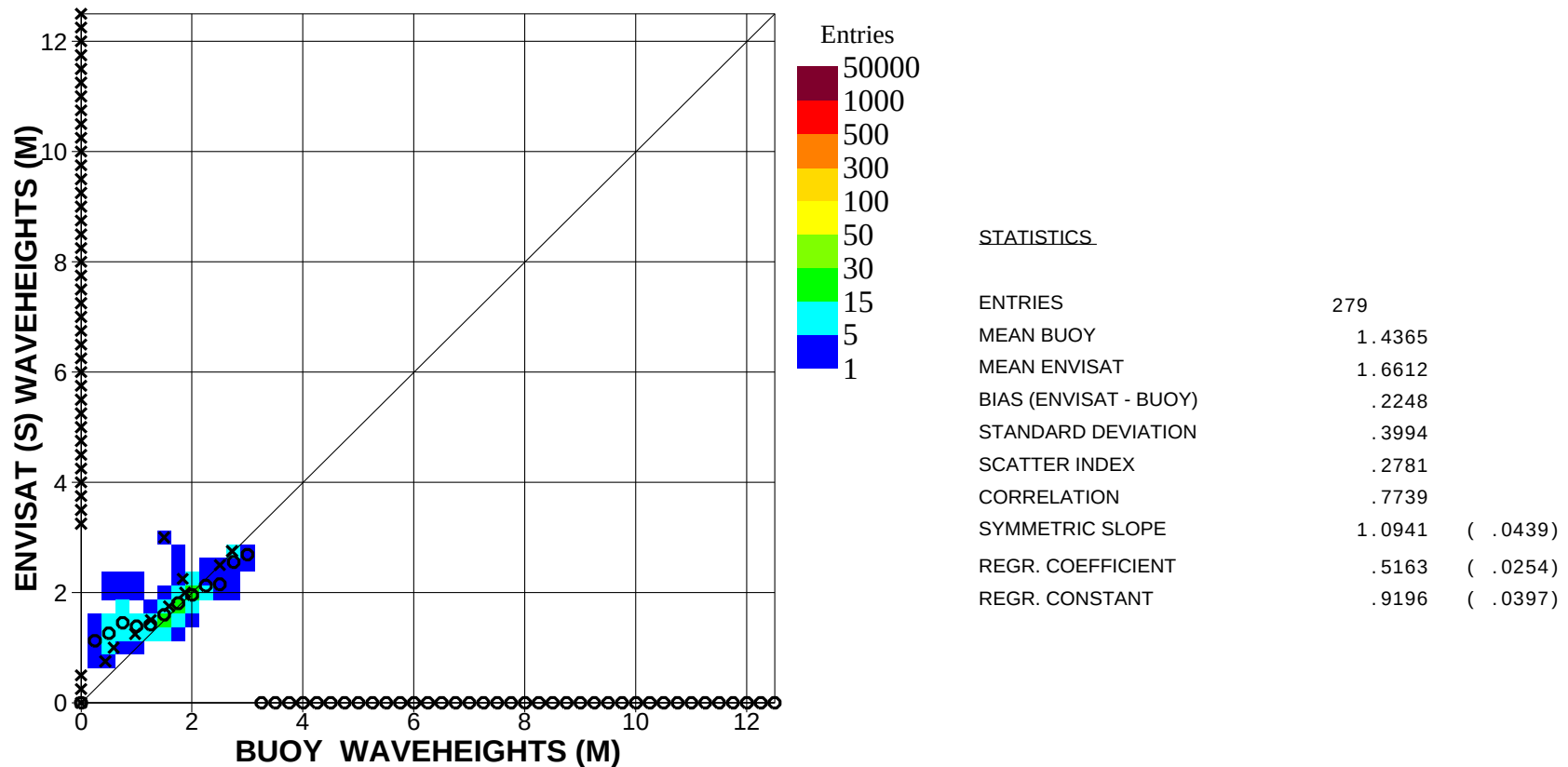


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for August 2005 (Tropics)

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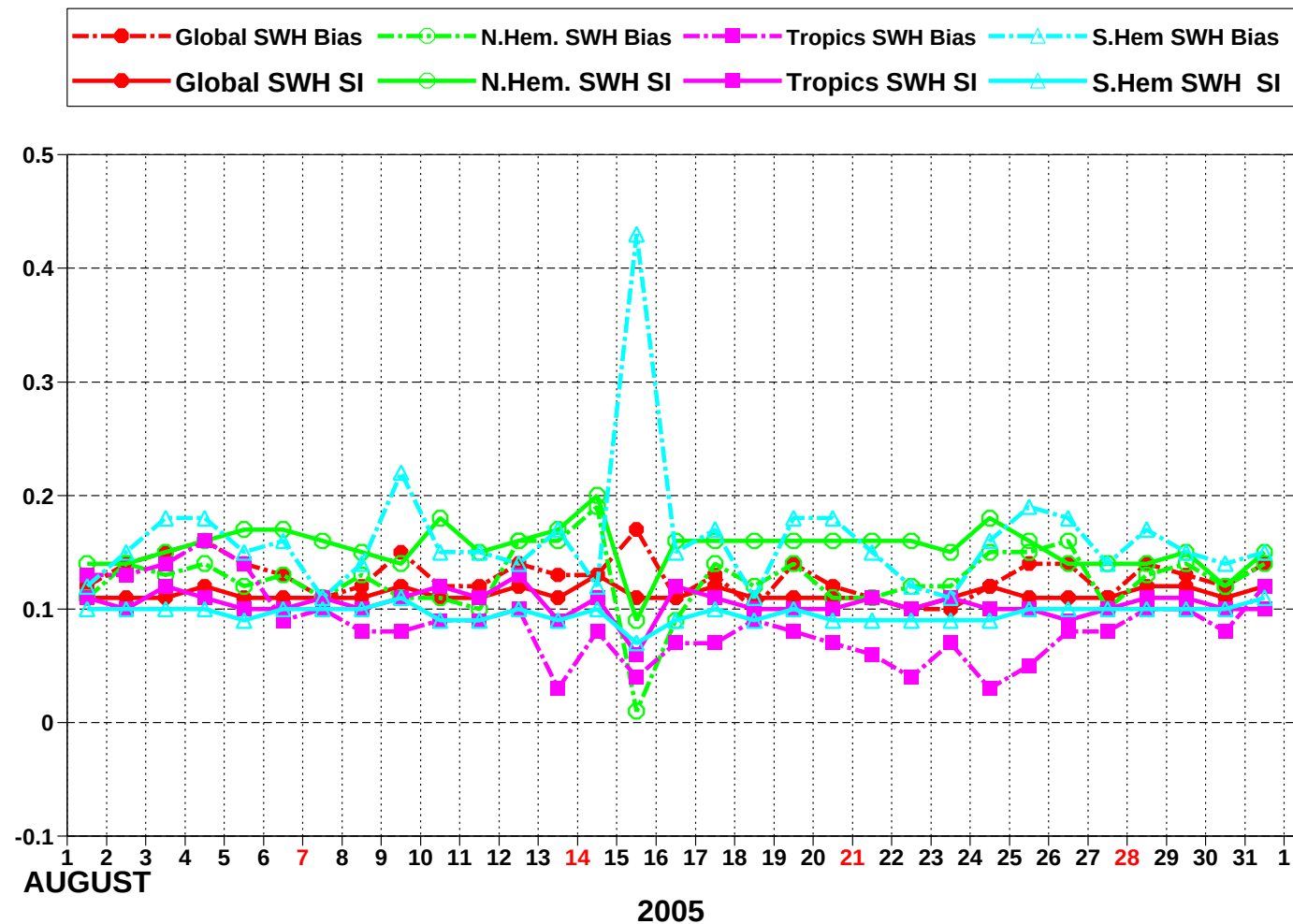


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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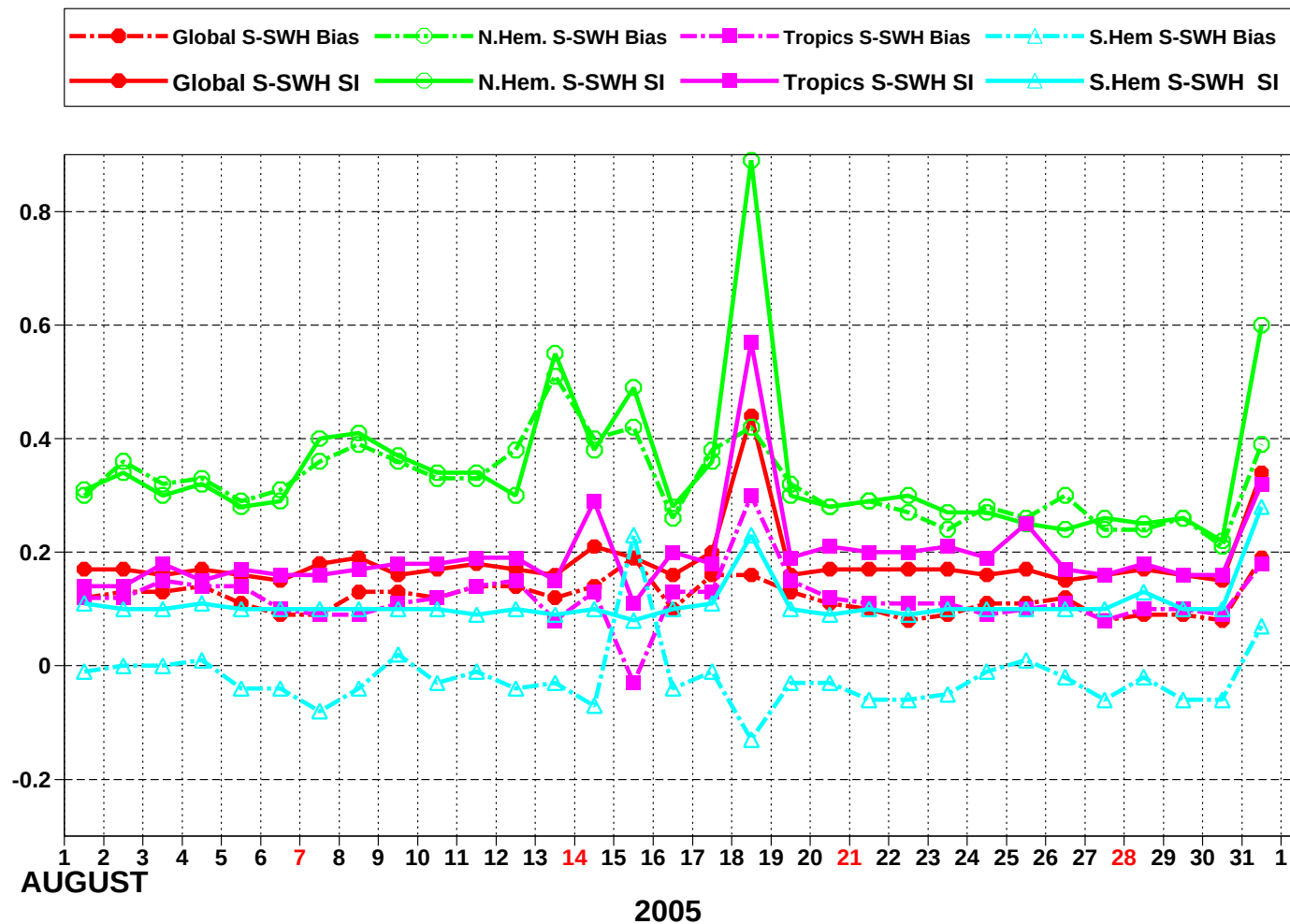


Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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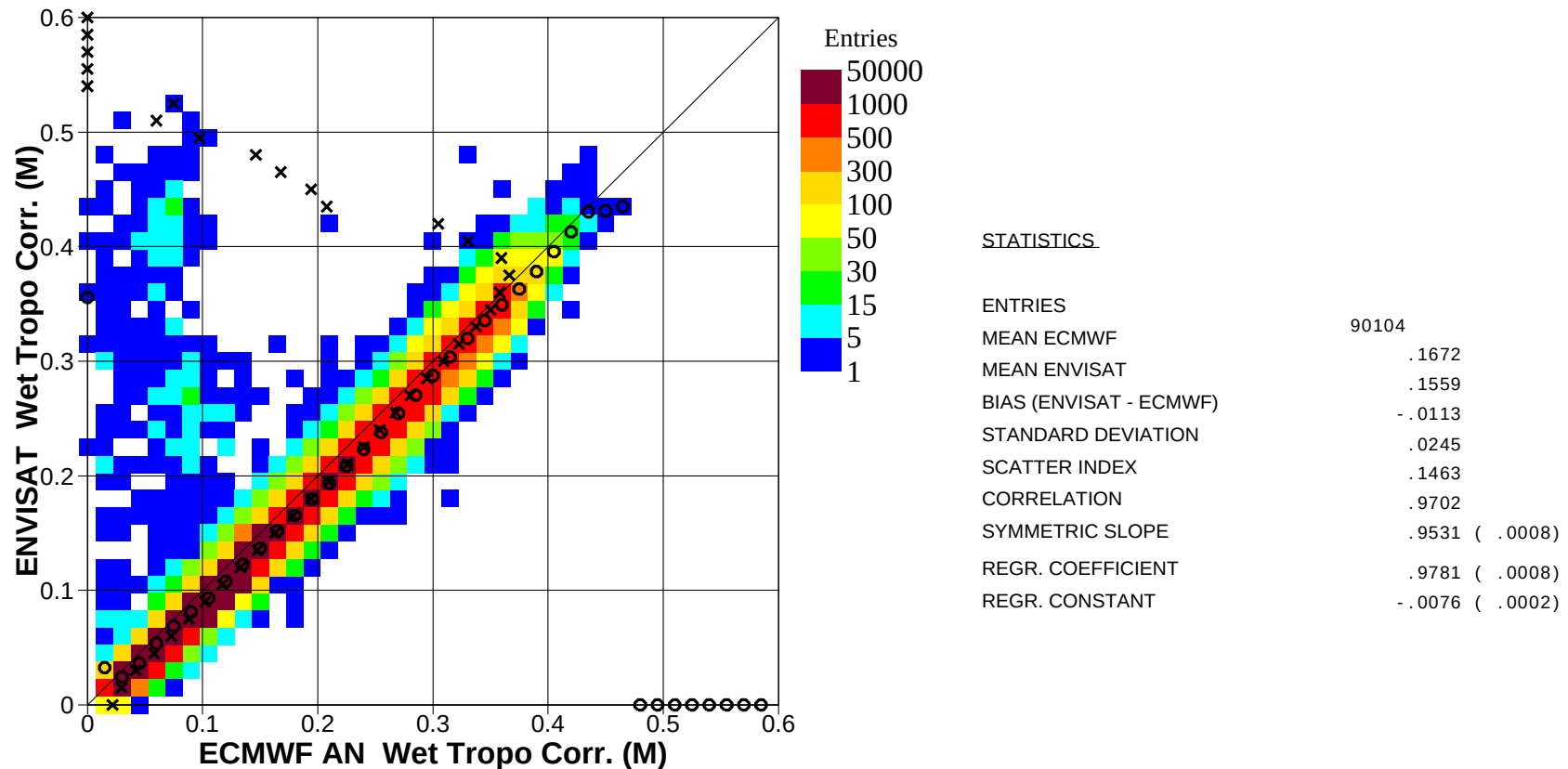


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for August 2005 (Global)



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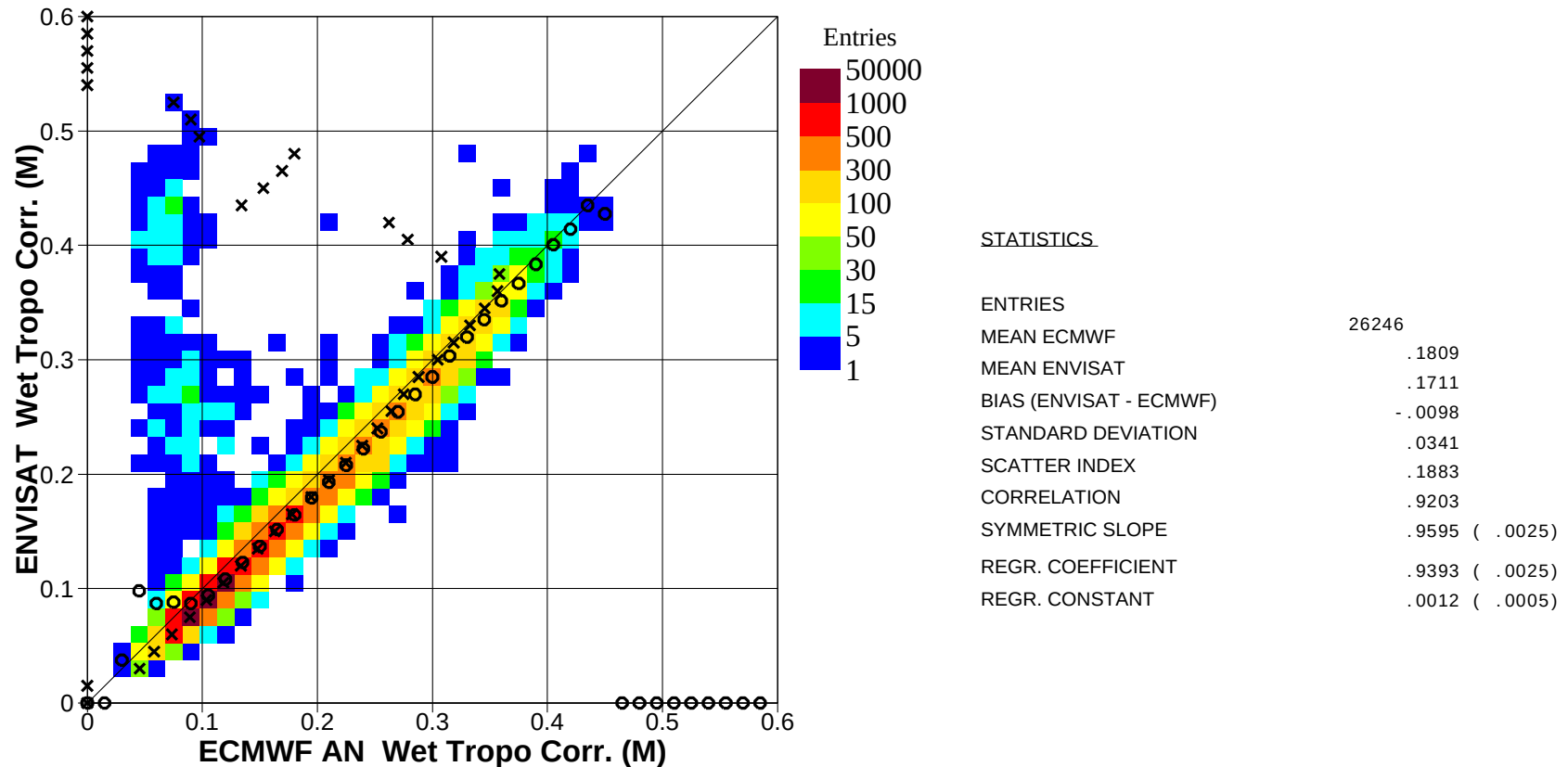


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for August 2005 (N.Hem.)

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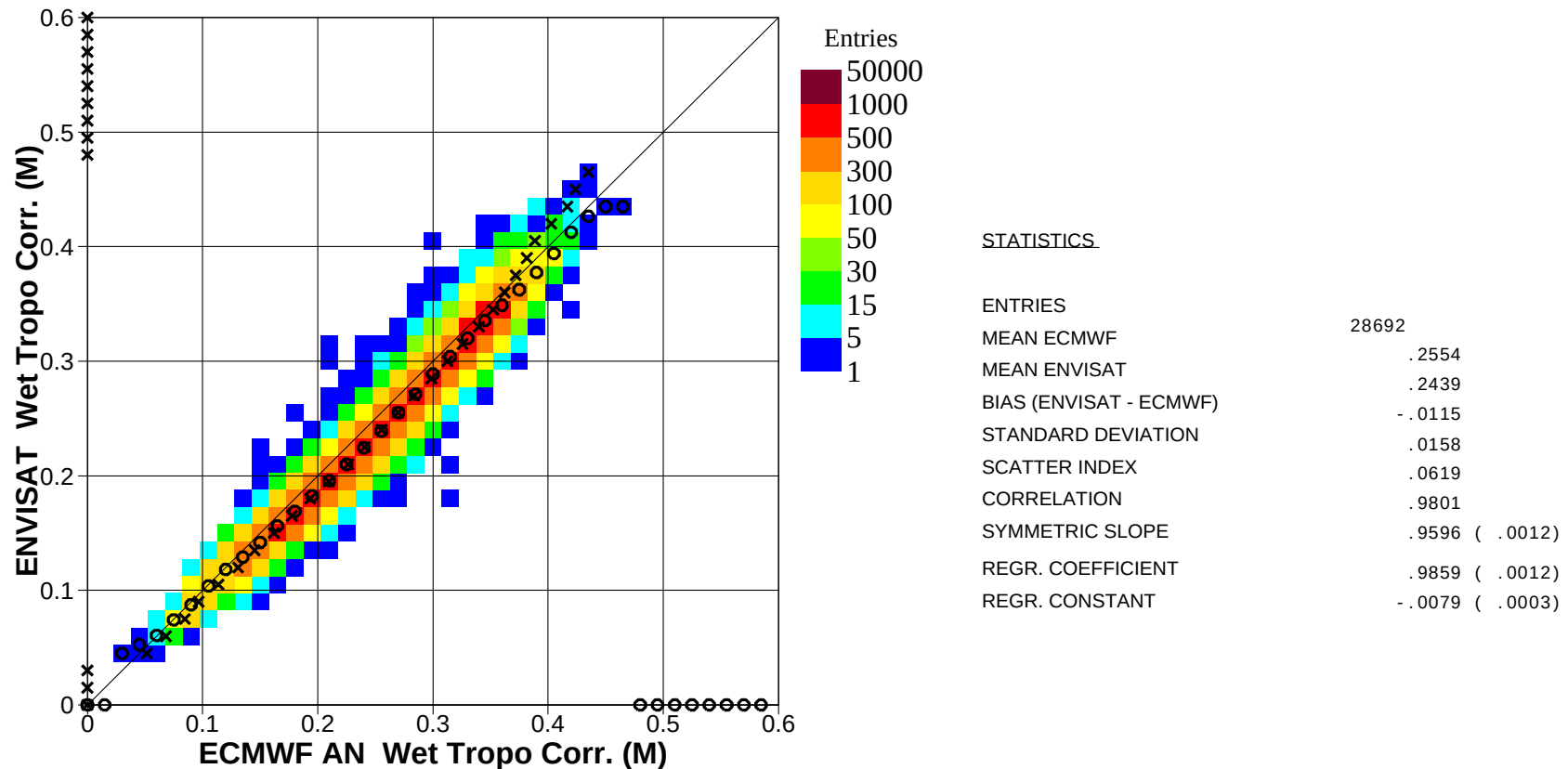


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for August 2005 (Tropics)

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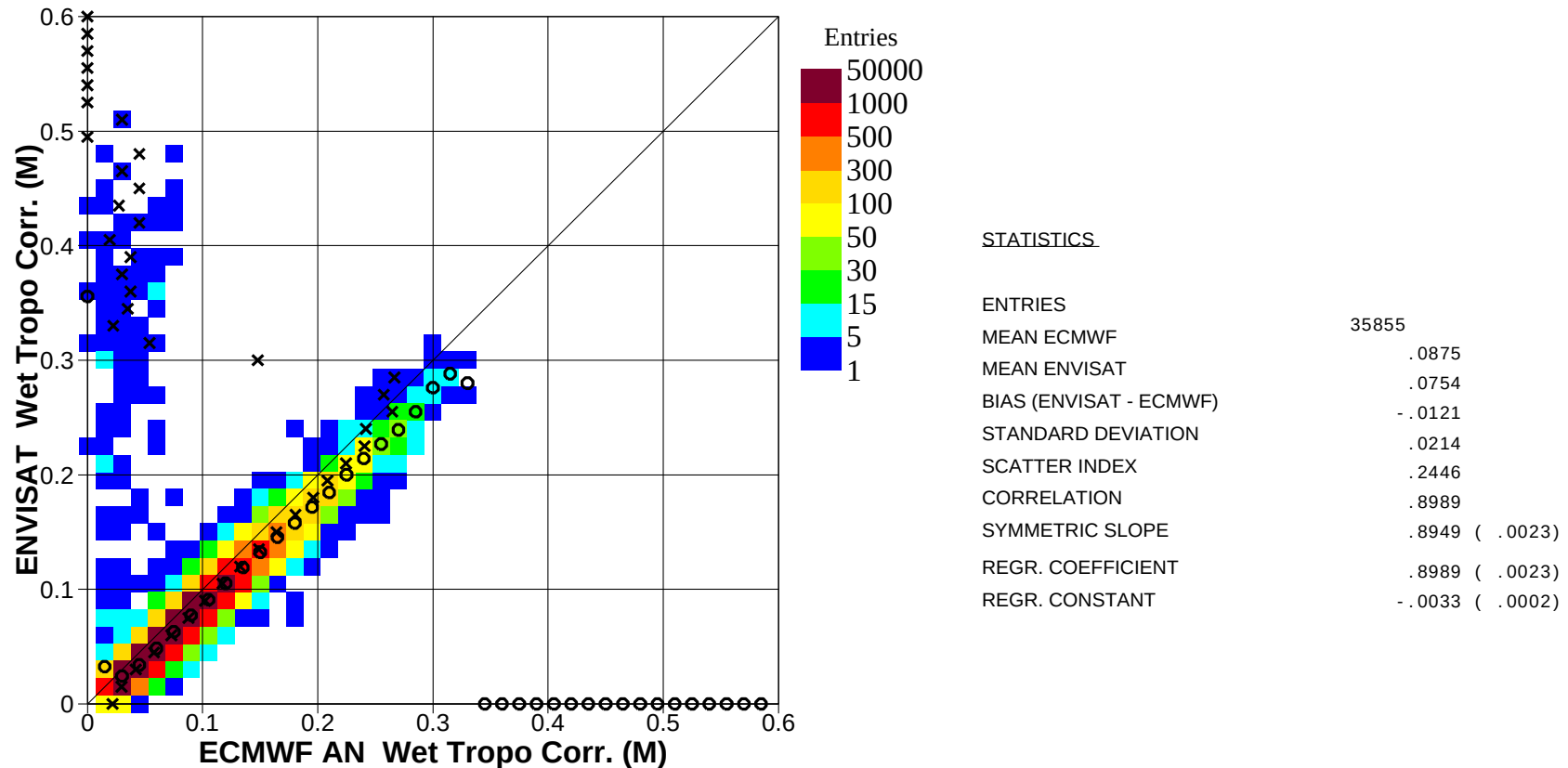


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for August 2005 (S.Hem.)

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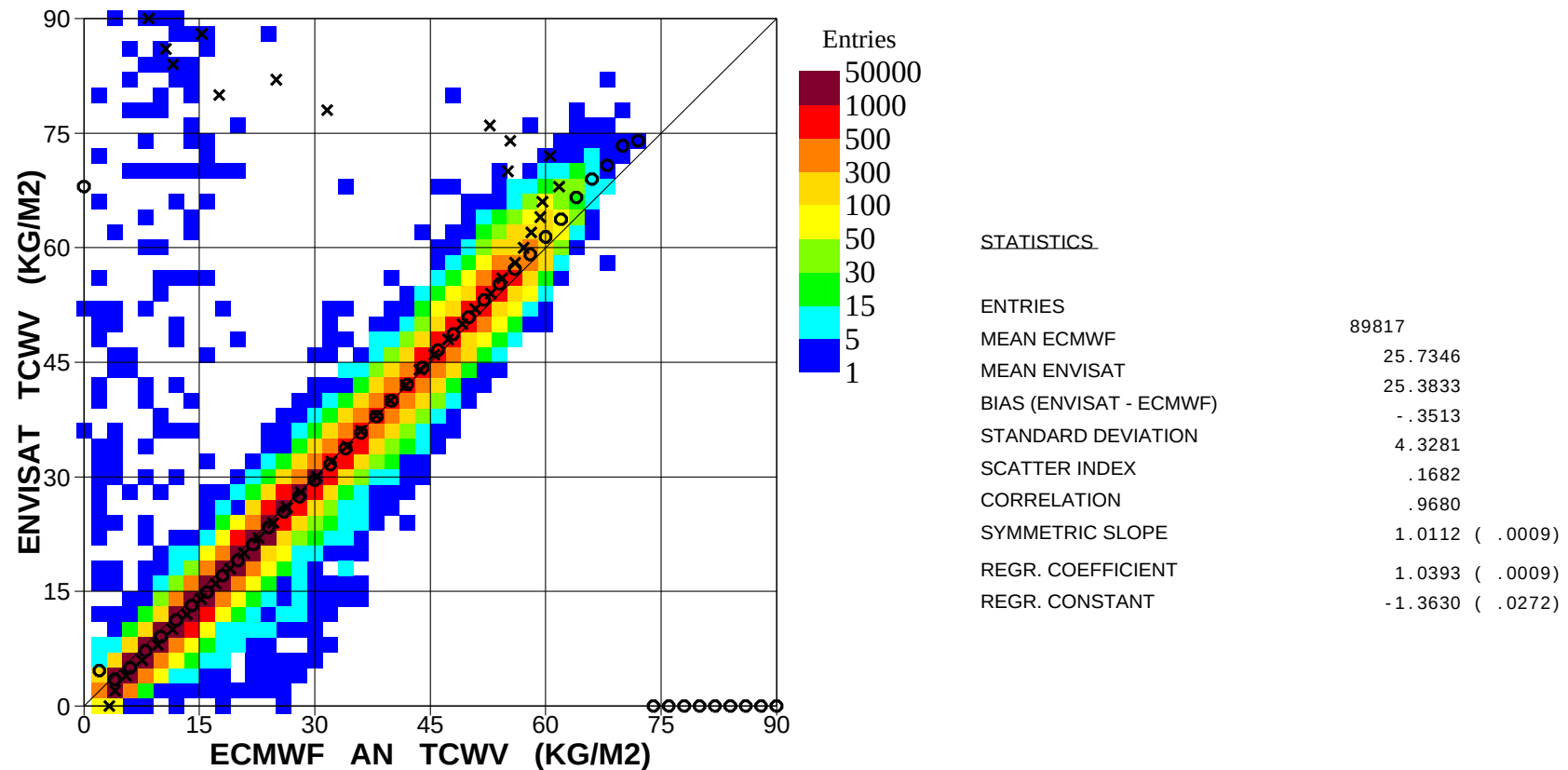


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for August 2005 (Global)

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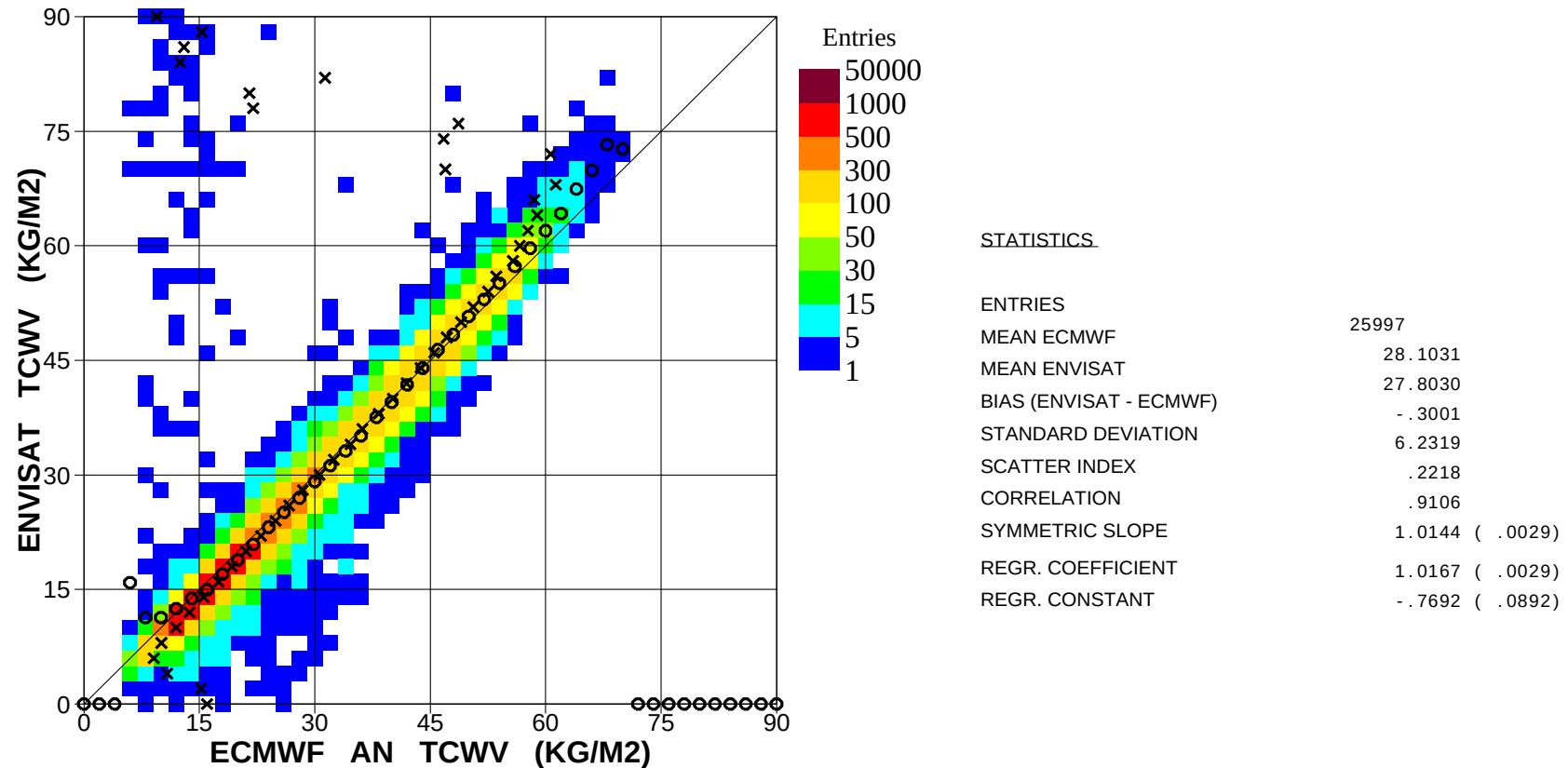


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for August 2005 (N.Hem.)



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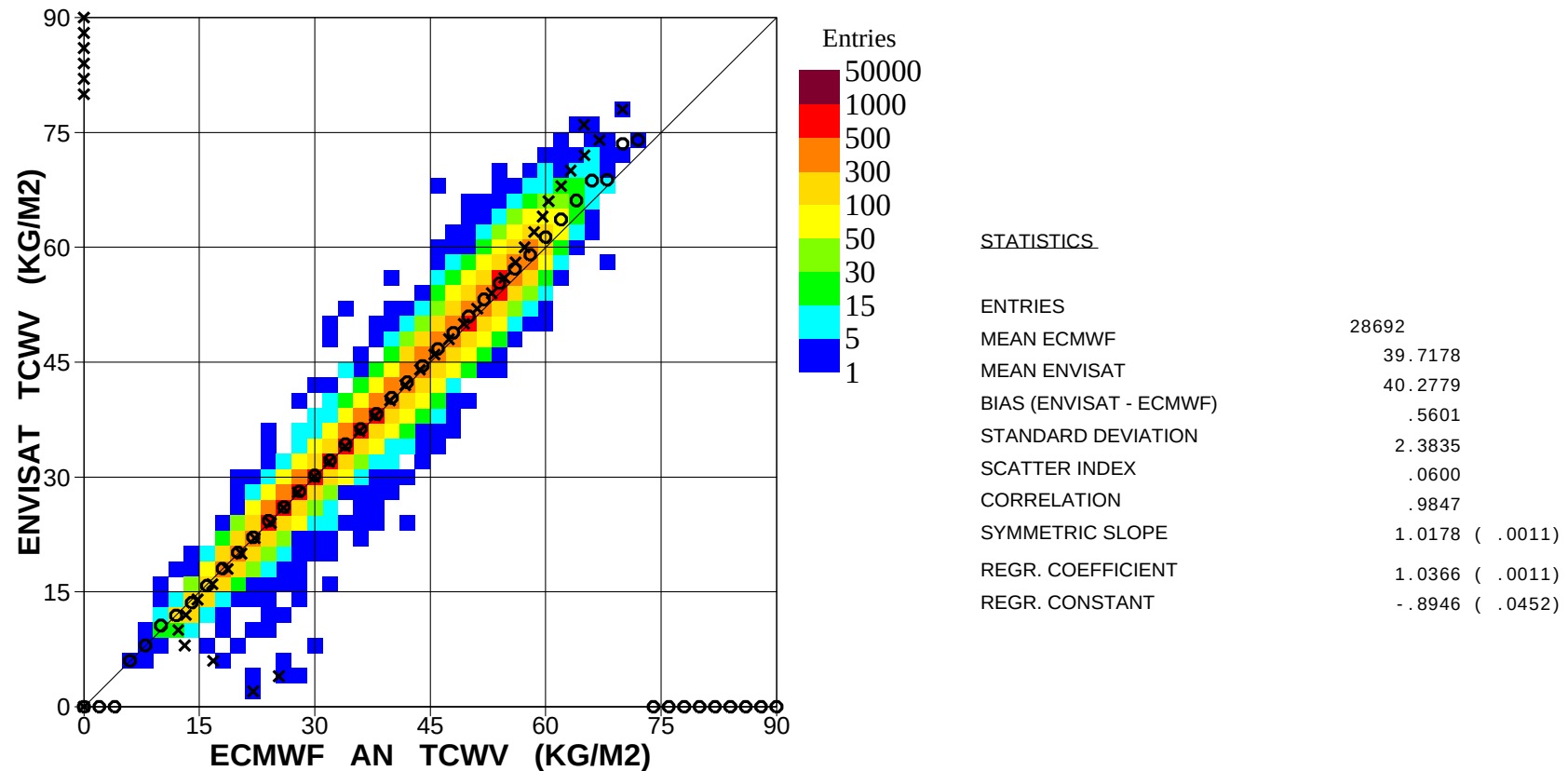


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for August 2005 (Tropics)



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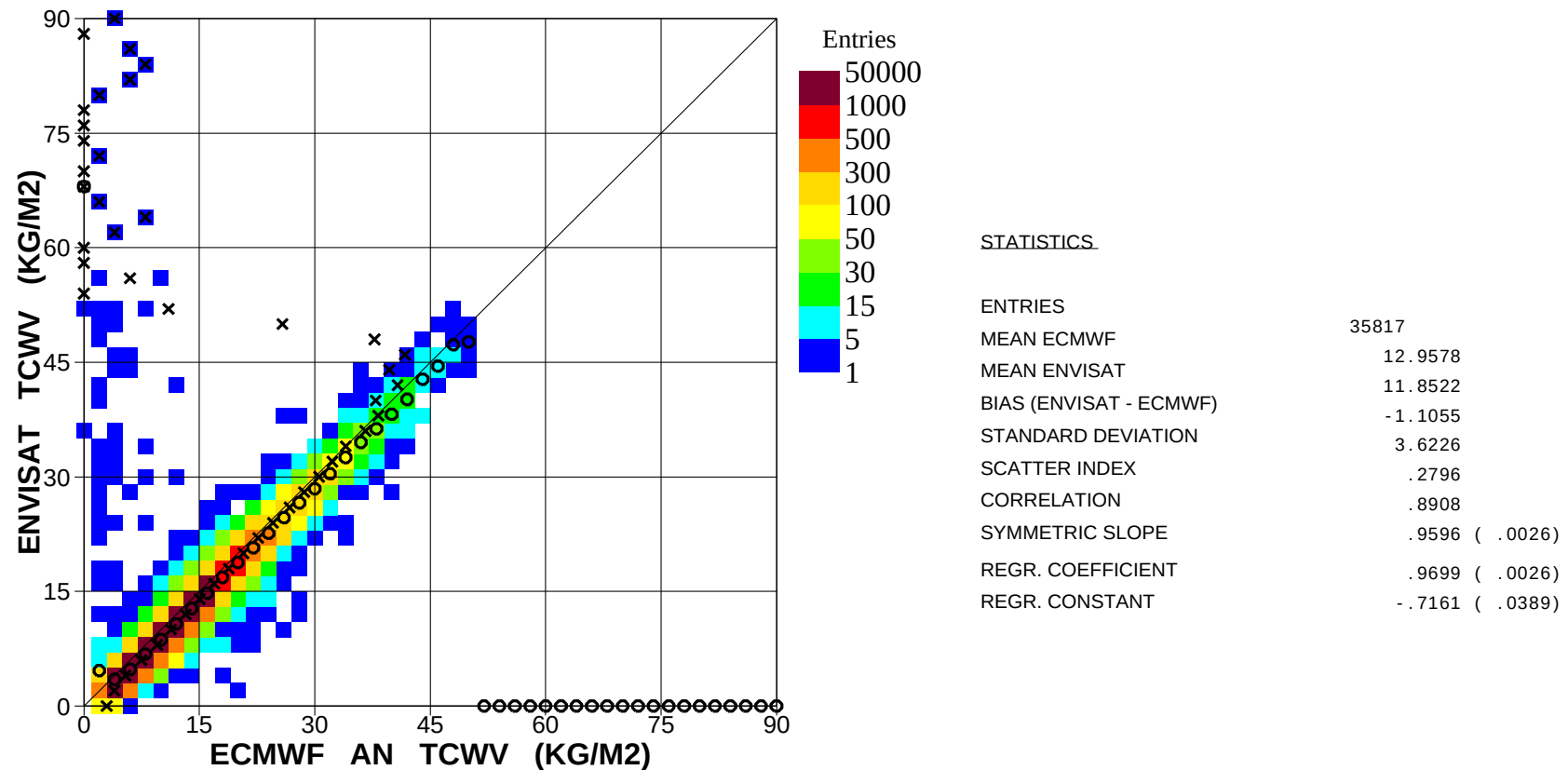


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for August 2005 (S.Hem.)



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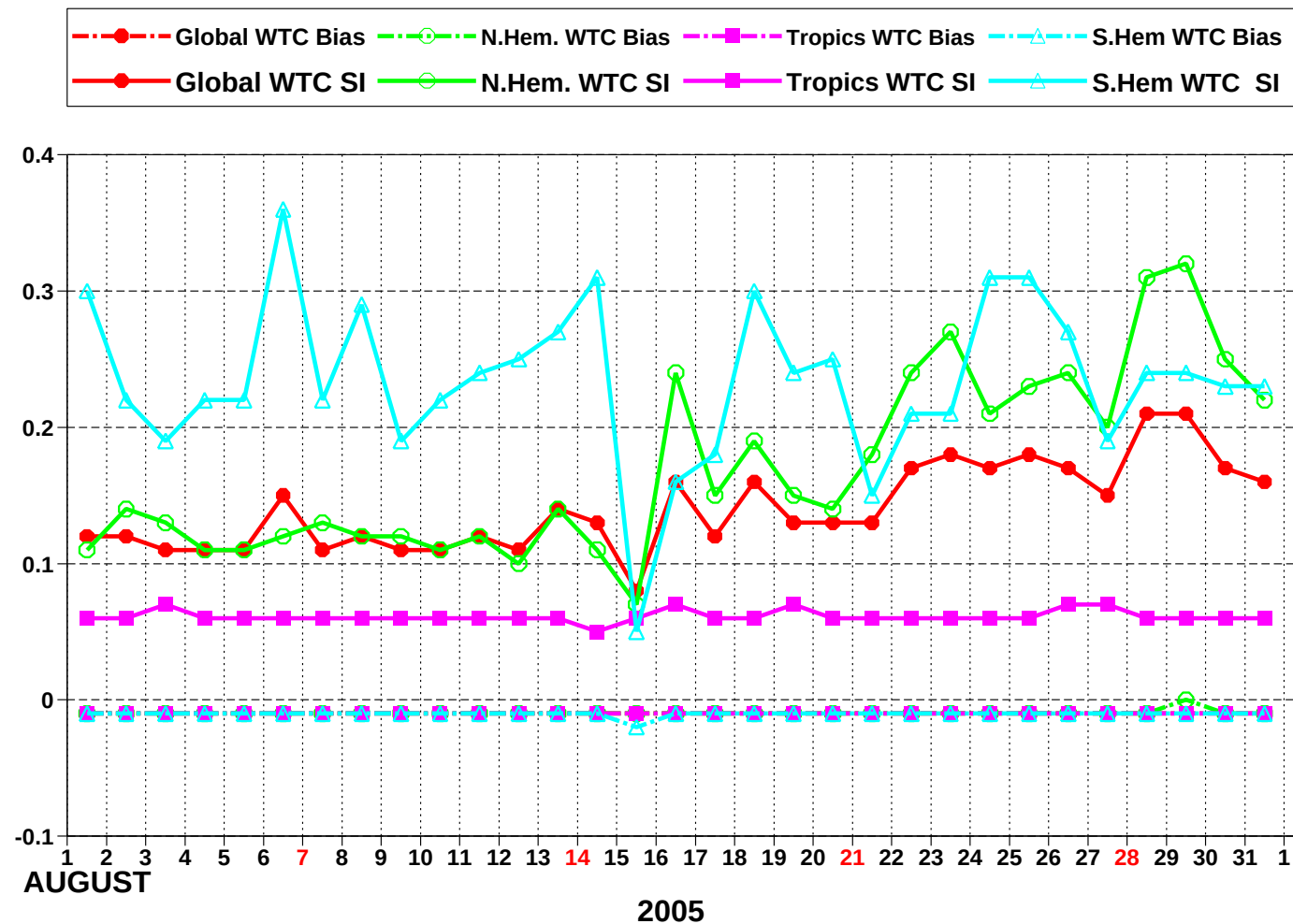


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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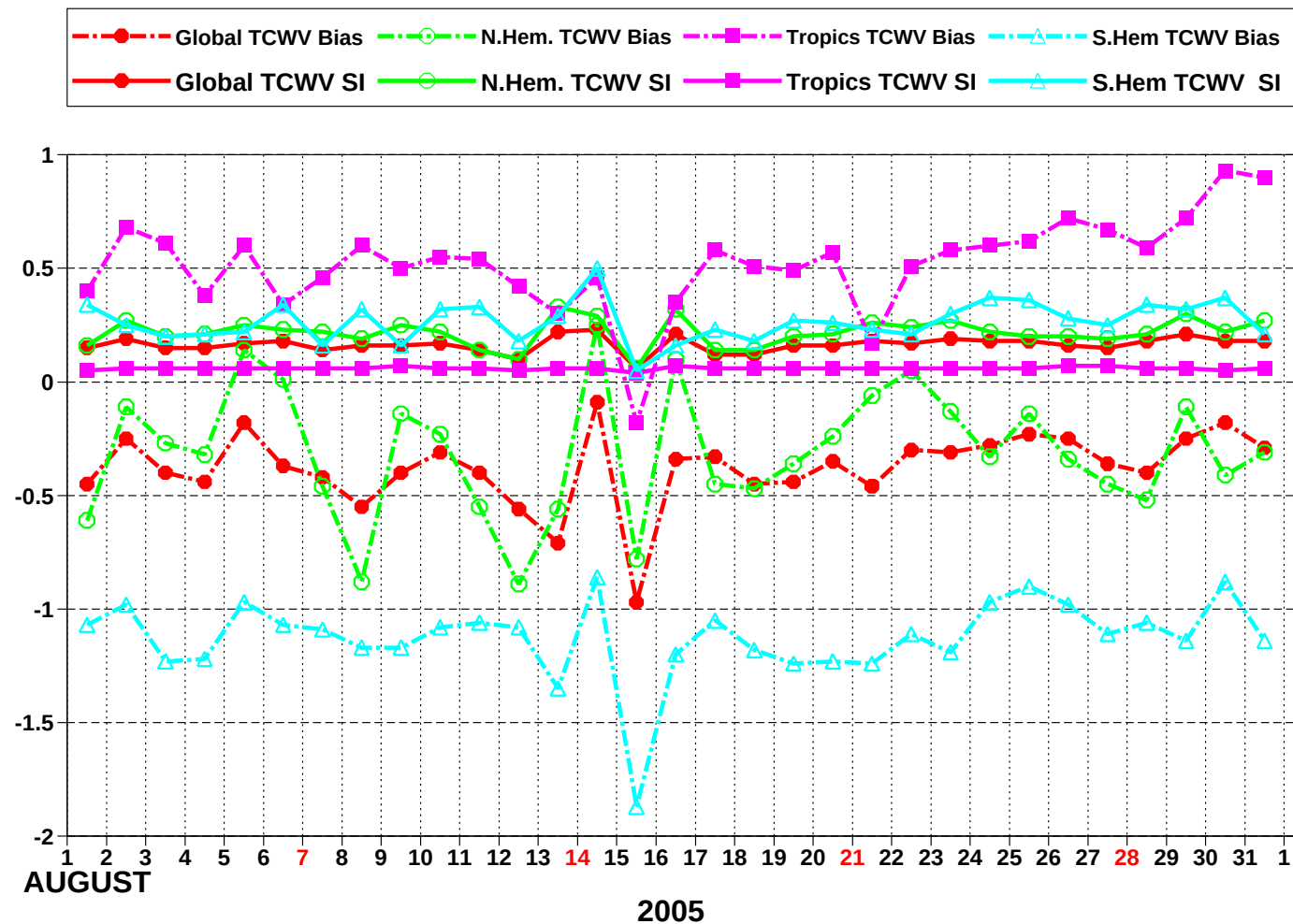


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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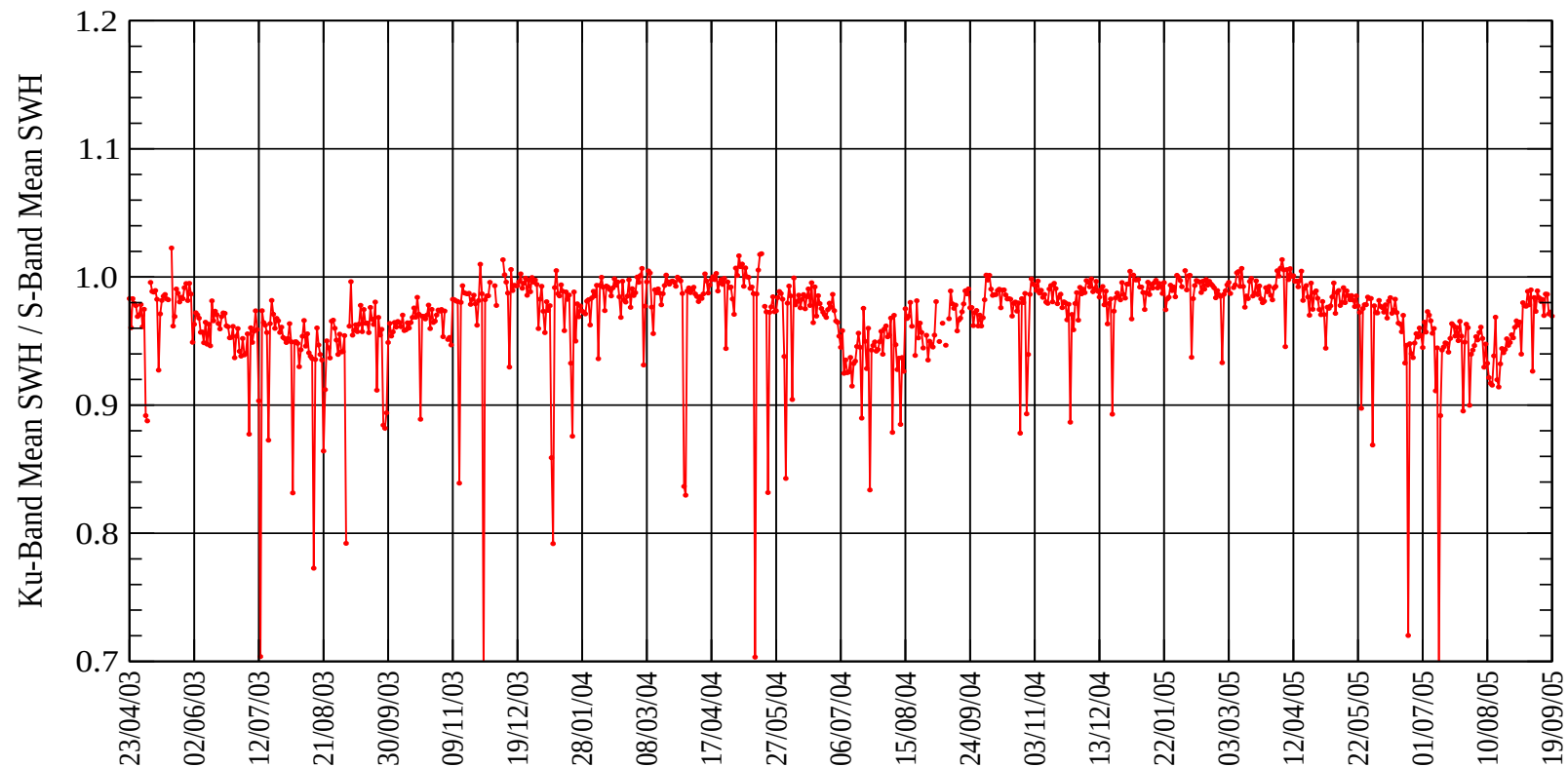


Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 23rd. of April 2003.

