

■ ECMWF Report on ENVISAT RA-2 for July 2003 ■

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

By: Saleh Abdalla

Date: 7 August 2003

Overview:

Based on the data received during this month, on average, 8998 (varies between 0 and 19376) observations arrived at ECMWF every 6-hour window of which an average of 3536 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 77.06% 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):

- Data either missing or significantly reduced at midnight everyday.
- Time windows 06:00 and 12:00 on the 2nd. of the month.
- Time windows 18:00 on the 16th., the 25th., the 27th., the 28th. and the 31st. of the month.

The time series of the data coverage and some reasons of rejection can be seen in Figure 1. Note that we are talking about the raw data which we downloaded in “bufr” format (since June 2003 bufr data as converted by ESA are used) before they were processed.



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Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of good quality. The quality of S-band wave height observations is slightly worse than last month. The S-band wave heights keep their trend to get higher than the Ku-band waves. The quality of wind speed observations is acceptable. Apart from the few outliers, MWR products are generally fine and in good agreement with the model (they still somewhat drier than the model).

Backscatter:

- ENVISAT RA-2 Ku-Band $\langle\sigma_0\rangle = 11.02$ dB (with a single rather broad peak at ~ 10.8 dB).
- ENVISAT RA-2 S-Band $\langle\sigma_0\rangle = 10.79$ dB (with a single rather broad peak at ~ 9.9 dB).

Comparison Summary:

Table 1: Comparison of Surface Wind Speeds:

	RA2 - ECMWF		RA2 - Buoy	
	Bias (m/s)	SI (%)	Bias (m/s)	SI (%)
Global	-0.04	17.7	-0.81	20.8
Northern Hemisphere	-0.65	20.5	-0.87	22.8
Tropics	-0.14	17.3	-0.57	11.3
Southern Hemisphere	0.43	14.8	----	----



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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	0.16	15.3	0.10	15.2
Northern Hemisphere	0.07	21.0	0.11	16.4
Tropics	0.04	14.7	0.02	8.4
Southern Hemisphere	0.31	12.3	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.17	26.6	0.24	27.2
Northern Hemisphere	0.30	51.3	0.28	29.0
Tropics	0.08	31.4	-0.07	11.2
Southern Hemisphere	0.15	17.6	----	----



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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	-0.018	22.9	-0.75	23.7
Northern Hemisphere	-0.013	30.4	-0.19	31.2
Tropics	-0.013	8.7	+0.51	8.9
Southern Hemisphere	-0.025	35.8	-2.19	37.7

Remarks:

- For the period covered, the RA-2 Ku-band wave height data are generally of good quality. The S-band wave height data are of acceptable quality (slightly worse than the previous month). The wind speed data are of acceptable quality. The MWR derived quantities are as usual with a number of outliers when compared against the model.
- According to the used land sea mask (which is used for the operational WAM run at ECMWF), more than one third (34% to be exact) of all processed data have been collected over land. This value is too large as the land records are not filtered out.
- Although the rain flag is only responsible for the rejection of 3% of the data this month, it was responsible for rejection of most of the data on the 13th. and the 18th. of the month (lower panel of Figure 1).



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- 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 (above 20 m/s).
- **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 (above ~ 20 m/s) as can be concluded from the scatter plots in Figures 7-13 and from comparing the histograms in Figures 5 and 6.**
- There is a trend for Ku-band wave heights to be slightly overestimated especially when compared to WAM results by about 6.5%. This is visually clear in the scatter plots in Figures 22-25 (Ku-band - WAM comparisons) and can be inferred from the symmetric slope values in same scatter plots as well as in Figures 30-32 (Ku-band - buoy comparison). It is worthwhile saying that the RA-2 Ku-band wave heights are higher than buoy wave heights by about 4%, while ERS-2 altimeter is lower by about 3.5% than the buoy observations.
- The S-band wave heights are slightly worse than the previous month when compared to both the WAM and the buoy data with quite a number of outliers when compared to the model (as can be seen in the scatter plots in Figures 26-29) and to the buoy (as can be seen in the scatter plots in Figures 33-34).
- **The S-band wave height values increased, thus the ratio between Ku-band and S-band wave heights decreased, over the period July 2002 to early April 2003 as can be seen in Figure 48. This behaviour was handled on the 9th of April bringing the wave heights from both sensors to a comparable level. However, this lasted for few days only. The S-band wave height keeps their tendency to increase and they are now about 5% higher than the Ku-band wave height as can be clearly seen in Figure 48.**
- There is quite a number of outliers in the scatter plots comparing the MWR derived wet tropospheric correction (WTC) and total column water vapour (TCWV) against the ECMWF model in the Northern and Southern Hemisphere (Figures 39, 41, 43 and 45). The tendency of the ECMWF model to have saturation values for both quantities (around 0.4 m for WTC and around 60 kg/m^2 for TCWV) is still existing. We stress that the model behaviour is theoretically more sound.
- The MWR derived WTC and TCWV tend to be smaller (drier) than ECMWF values for smaller values, then tend to converge towards the ECMWF values at high values.



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- 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.
- ERS-2 radar altimeter and SAR wave data were not available for assimilation at ECMWF wave model before the 16th. of July 2003 (except for about 24 hours on the 1st. - 2nd. of the month) following the failure of the ERS-2 tape recorders. The ERS-2 data are now limited to the North Atlantic and the western coast of North America. As a result, the difference statistics between ENVISAT RA-2 and first guess wave model wave heights are slightly higher than those from the previous months.

Comparison Method:

A brief description of RA-2 data processing and quality control process together with any special considerations, assumptions and/or data corrections needed while comparing various quantities will go here.



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

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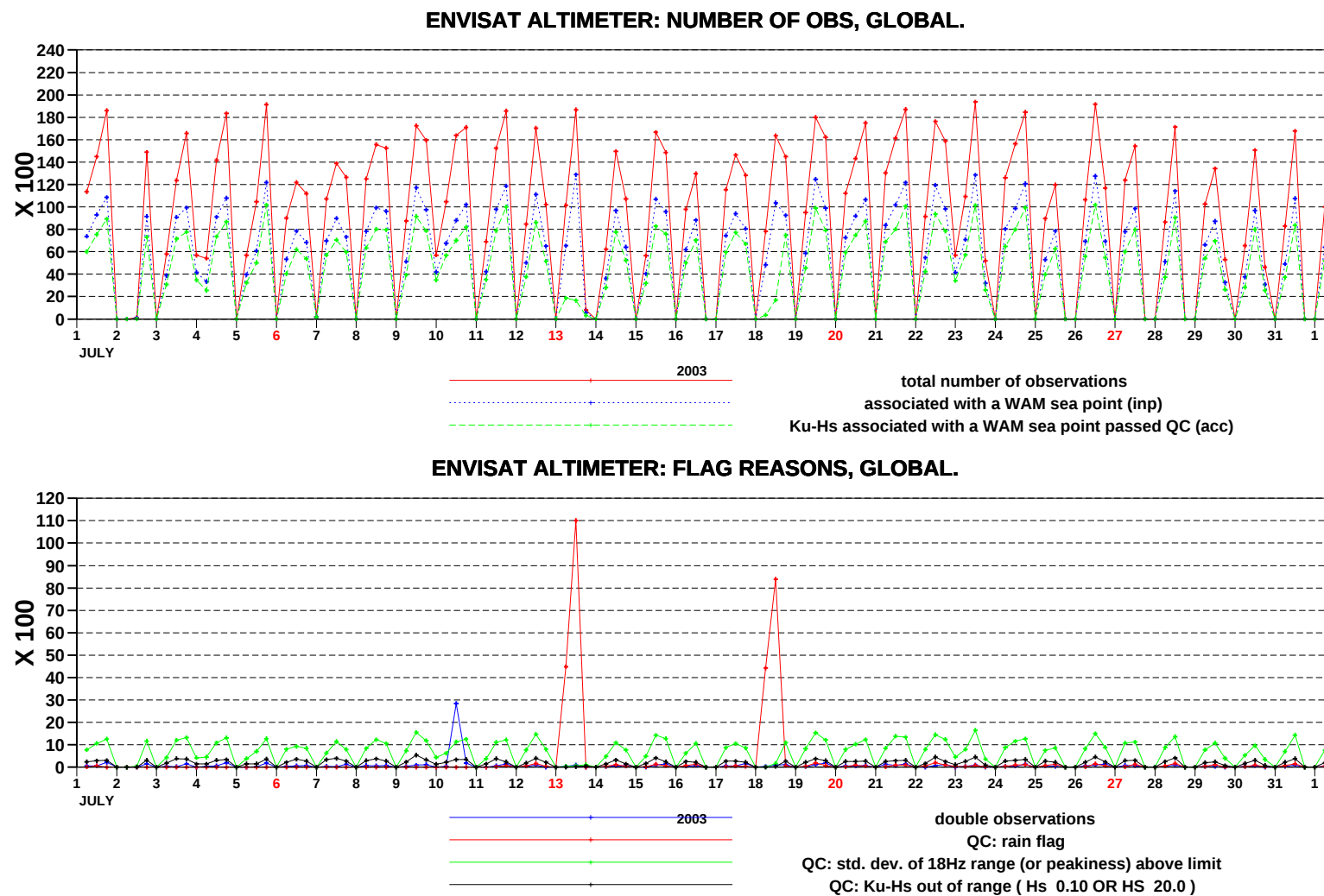


Figure 1: Time series of data reception for ENVISAT Altimeter data for July 2003

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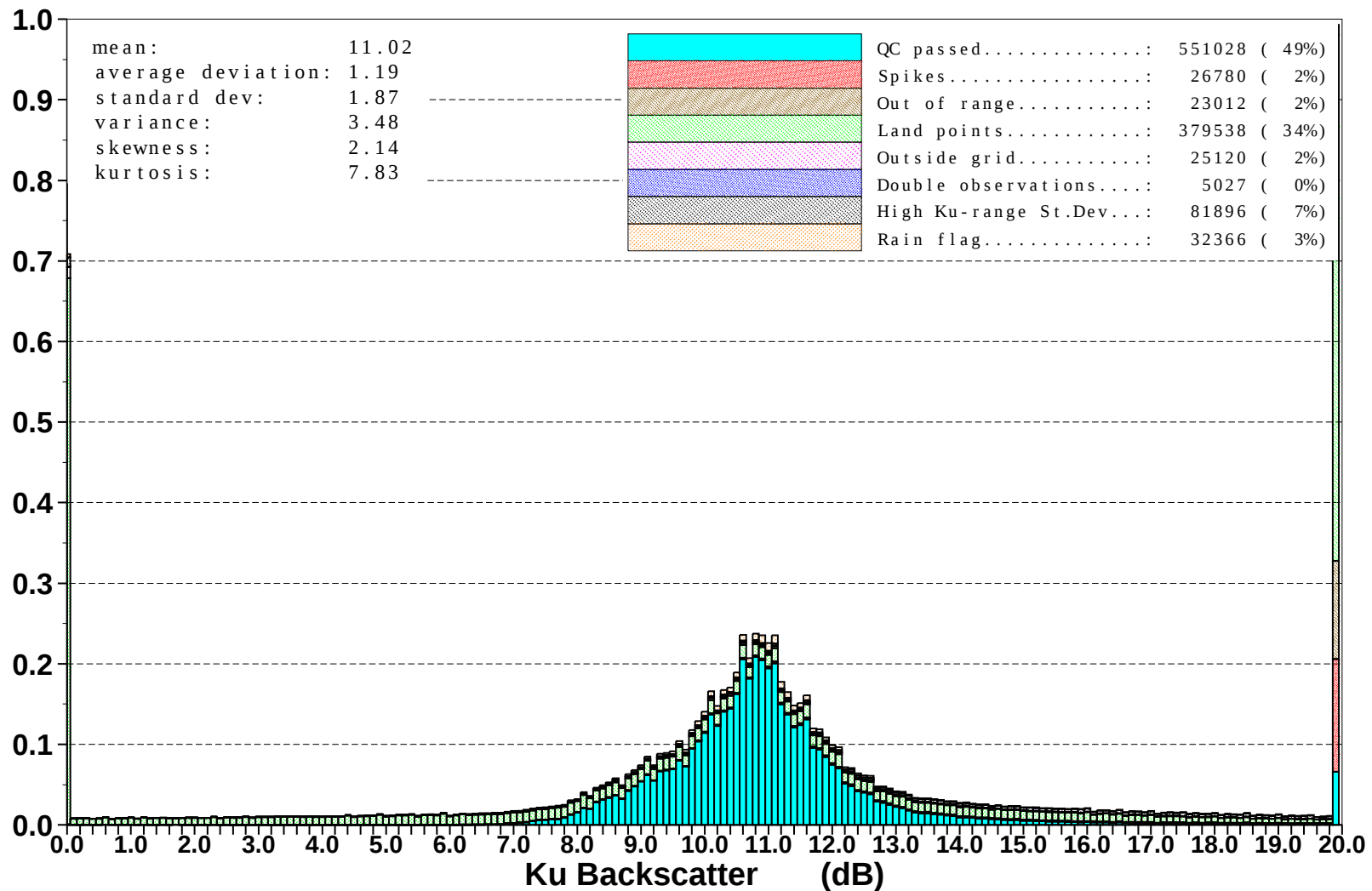


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for July 2003

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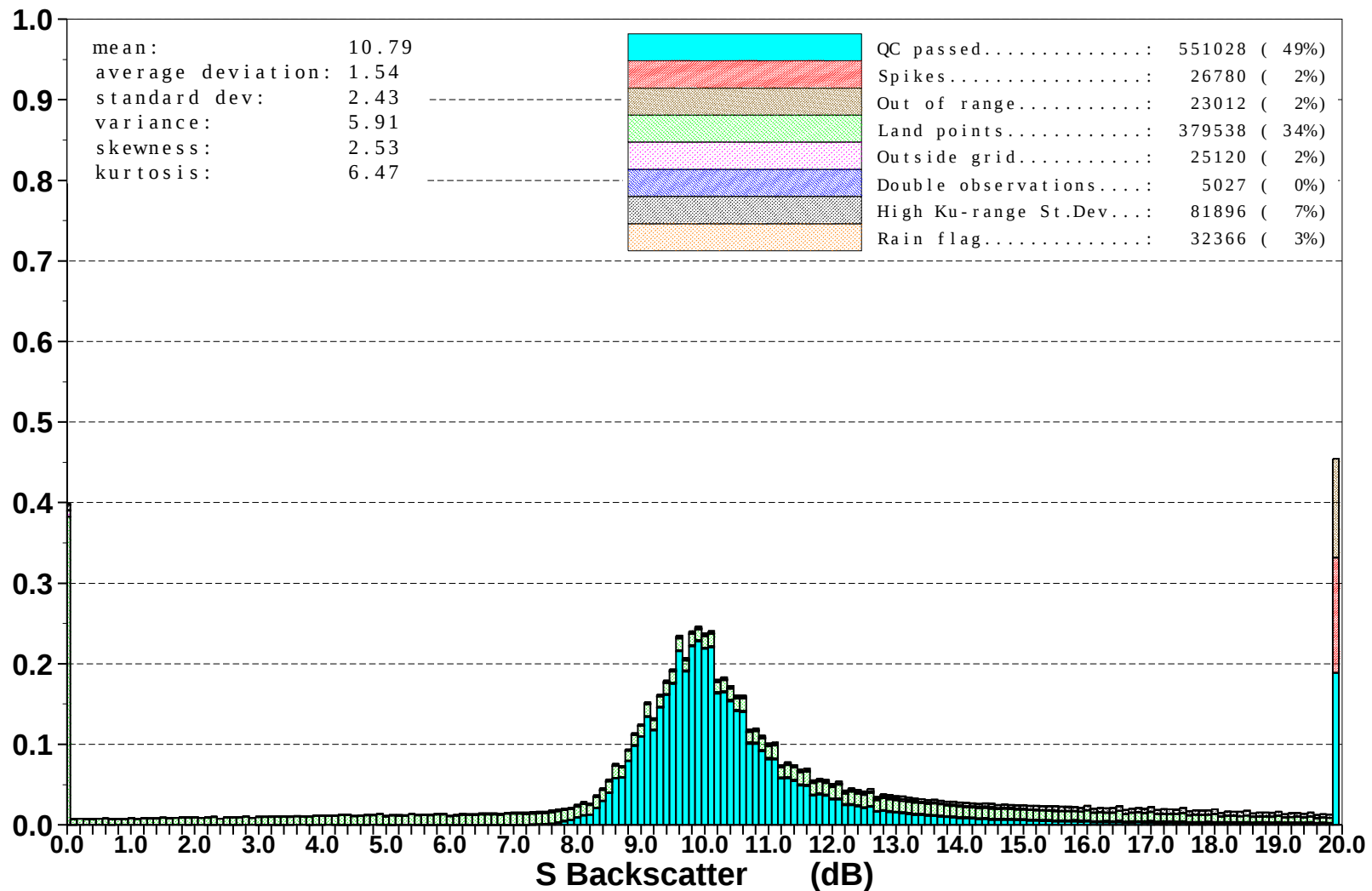


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for July 2003

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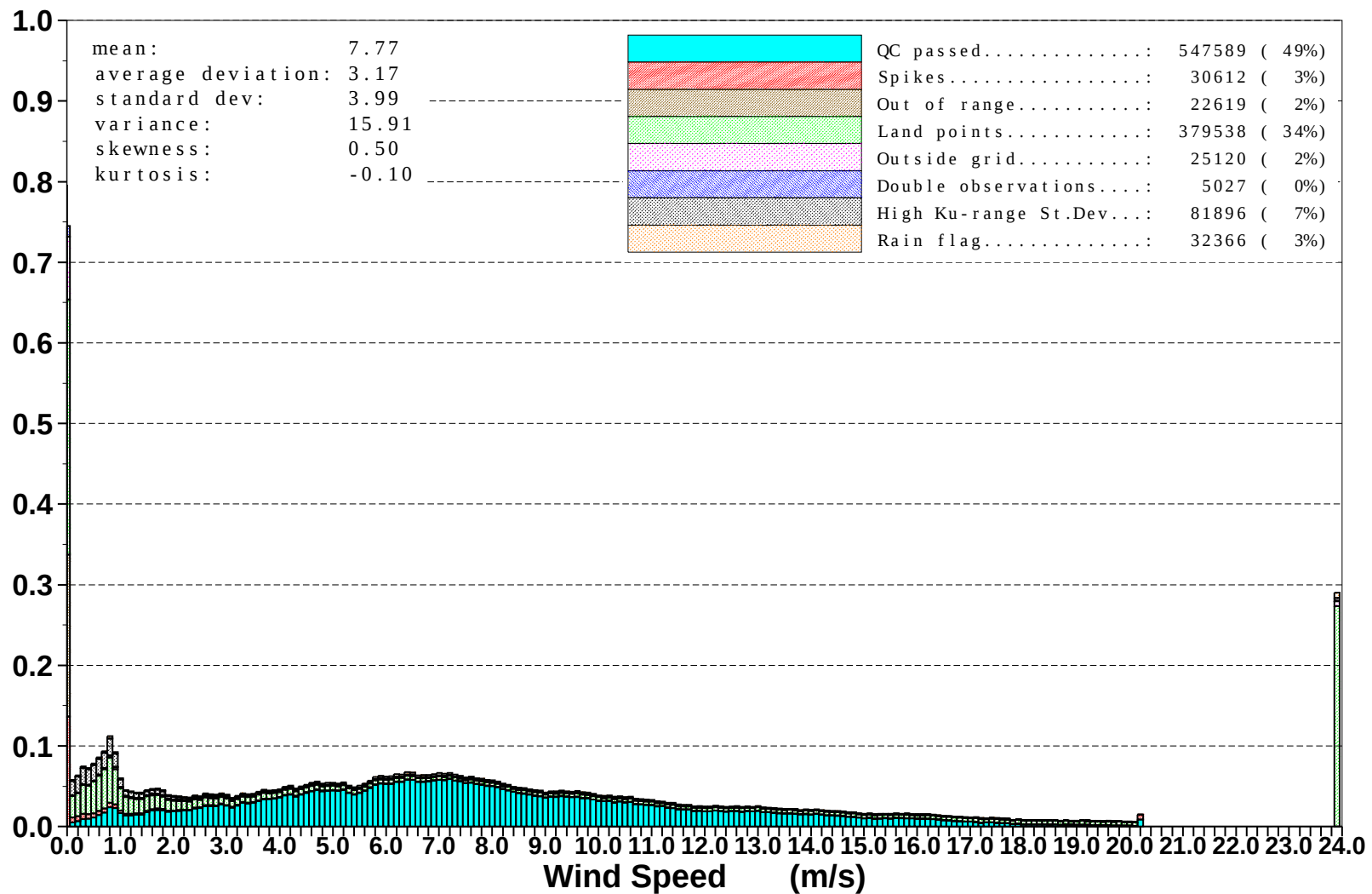


Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for July 2003

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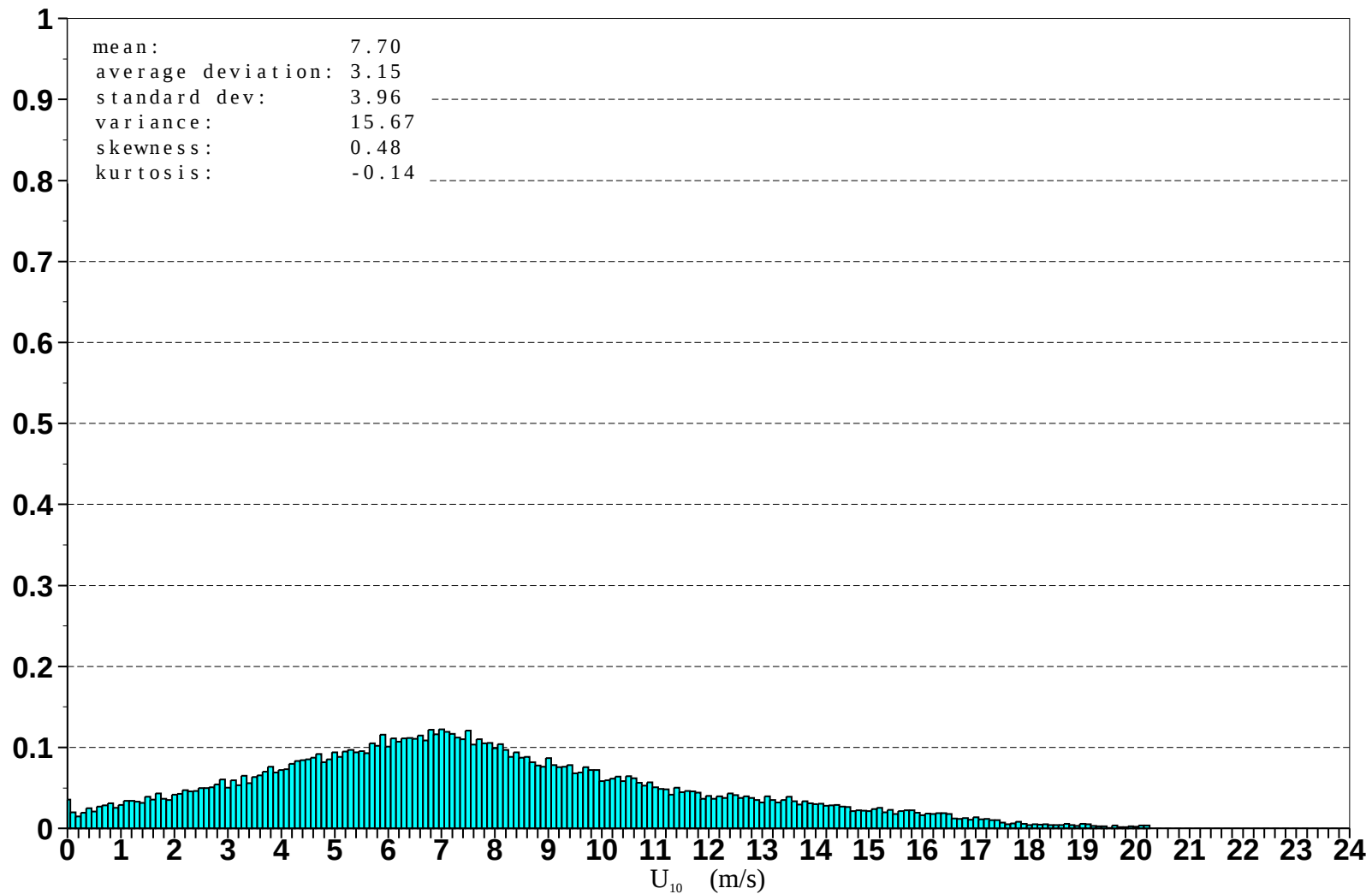


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for July 2003



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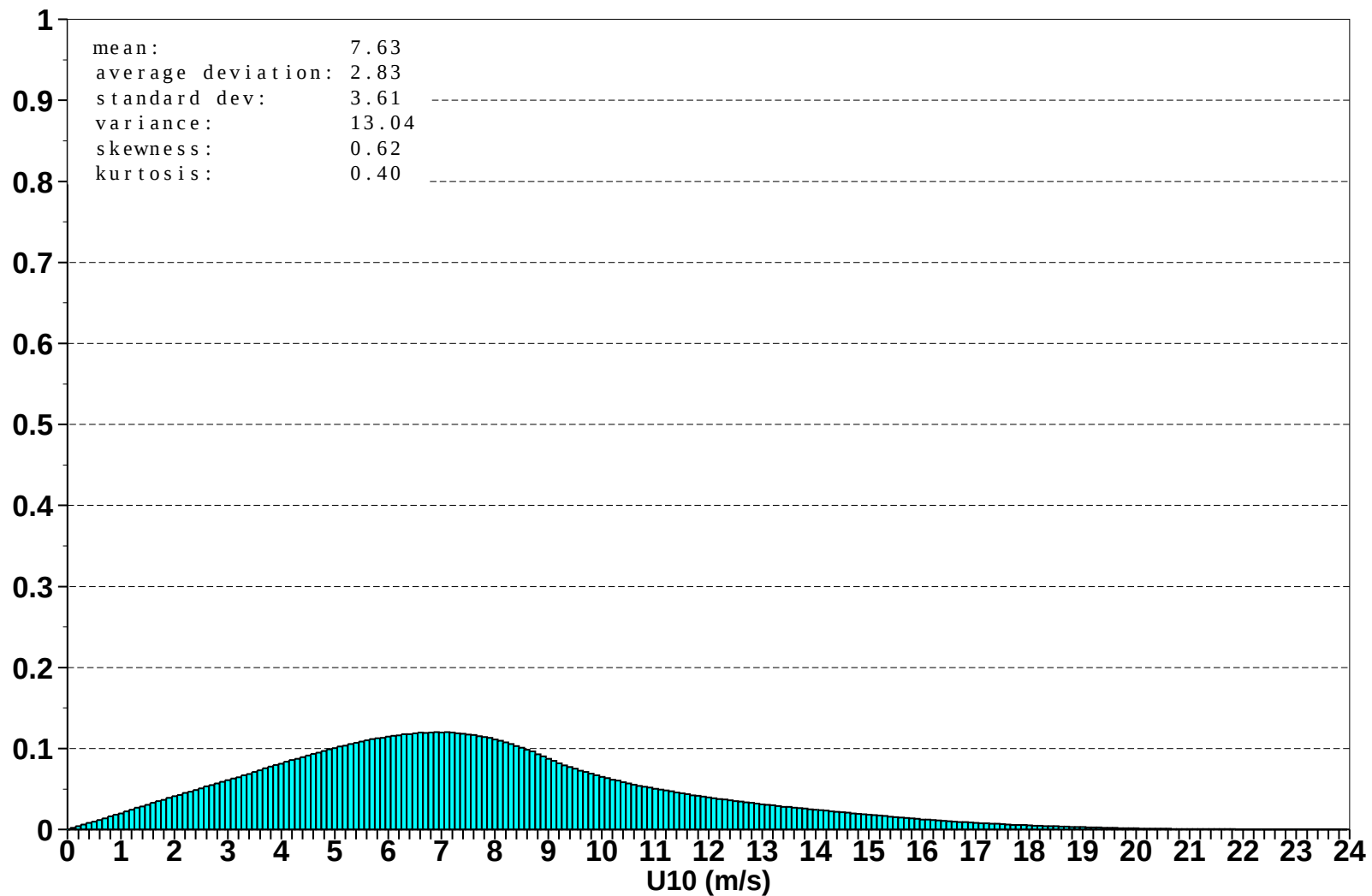


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for July 2003



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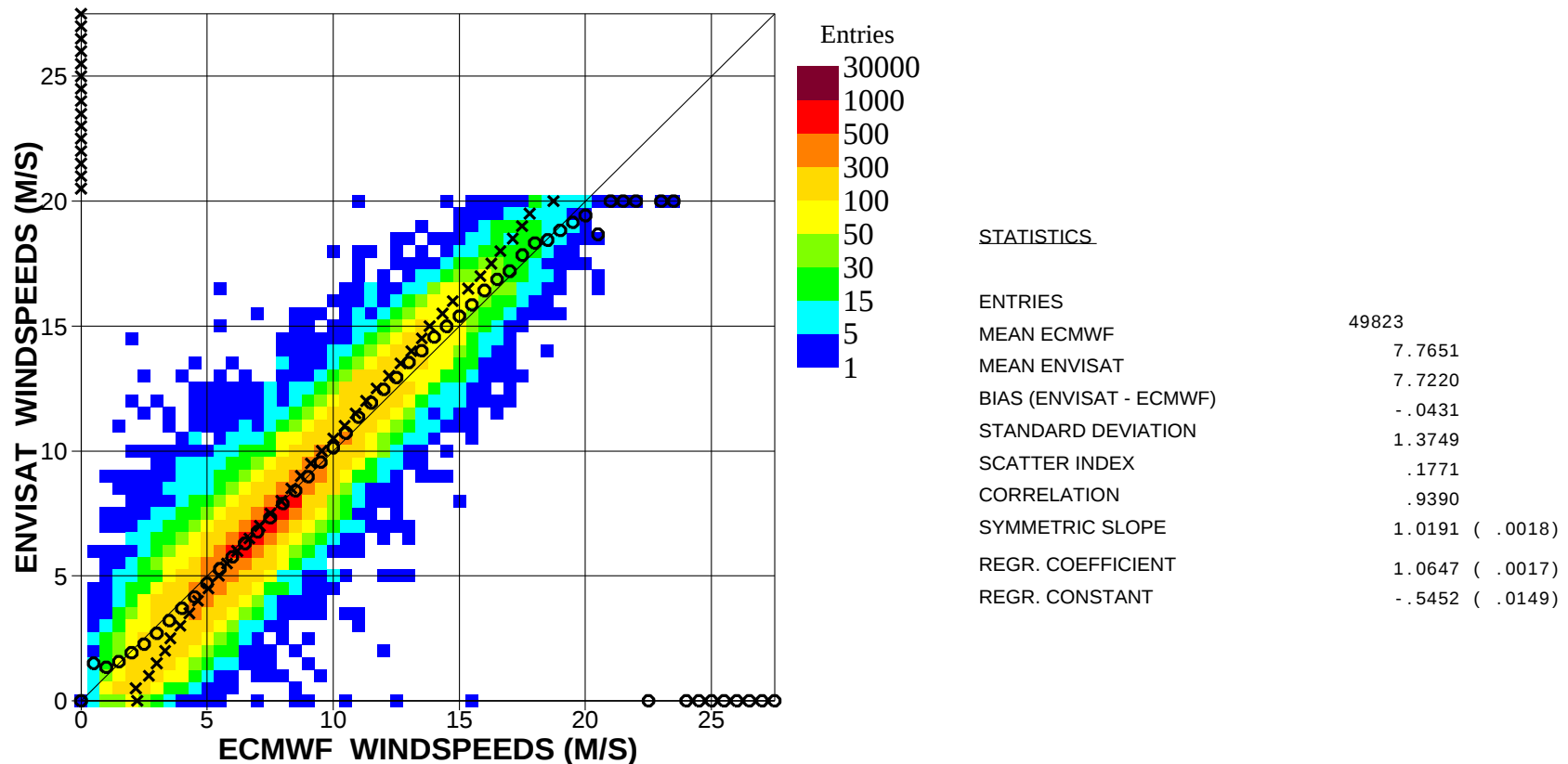


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2003 (Global)

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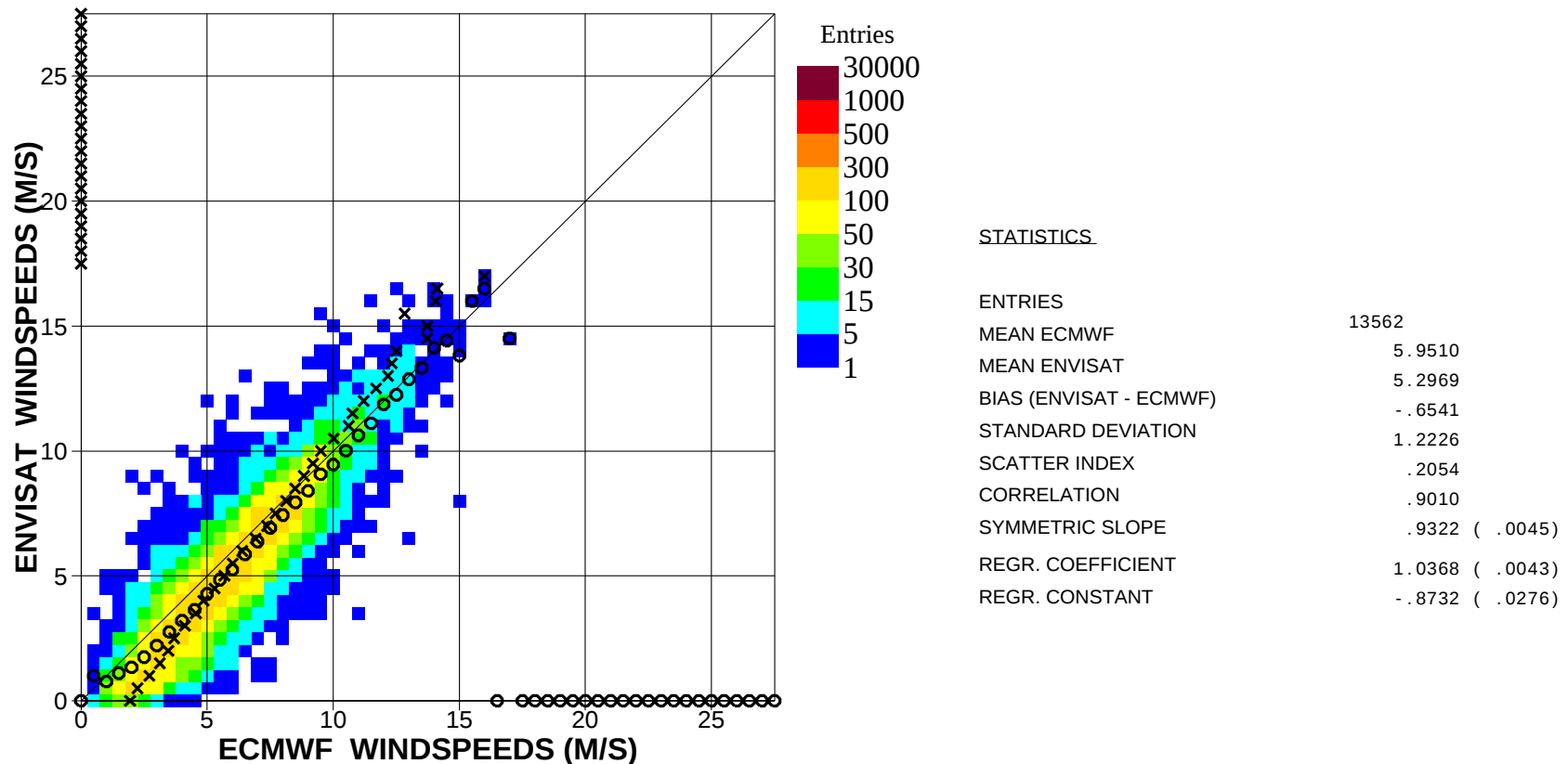


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2003 (N.Hem.)

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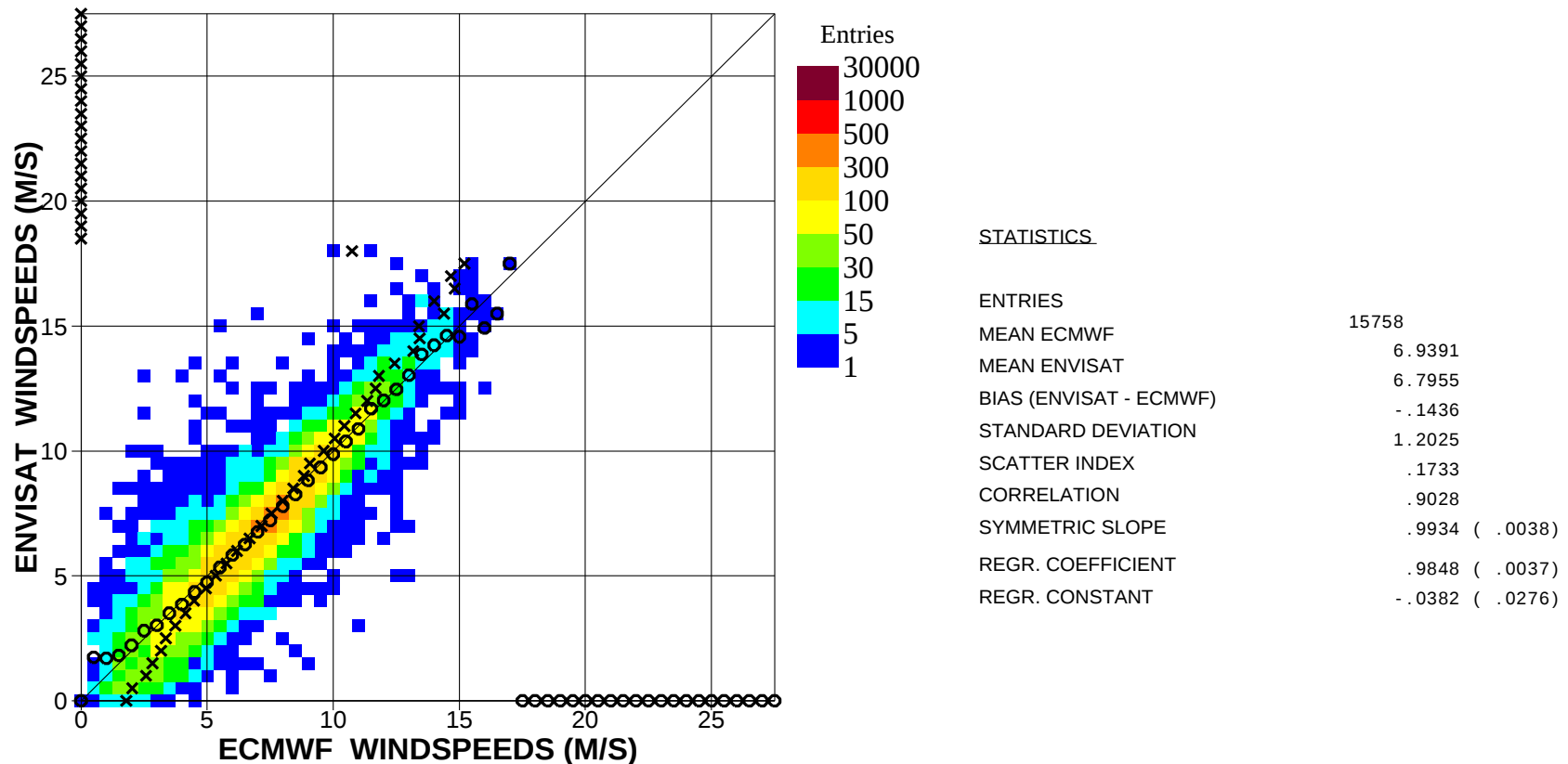


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2003 (Tropics)

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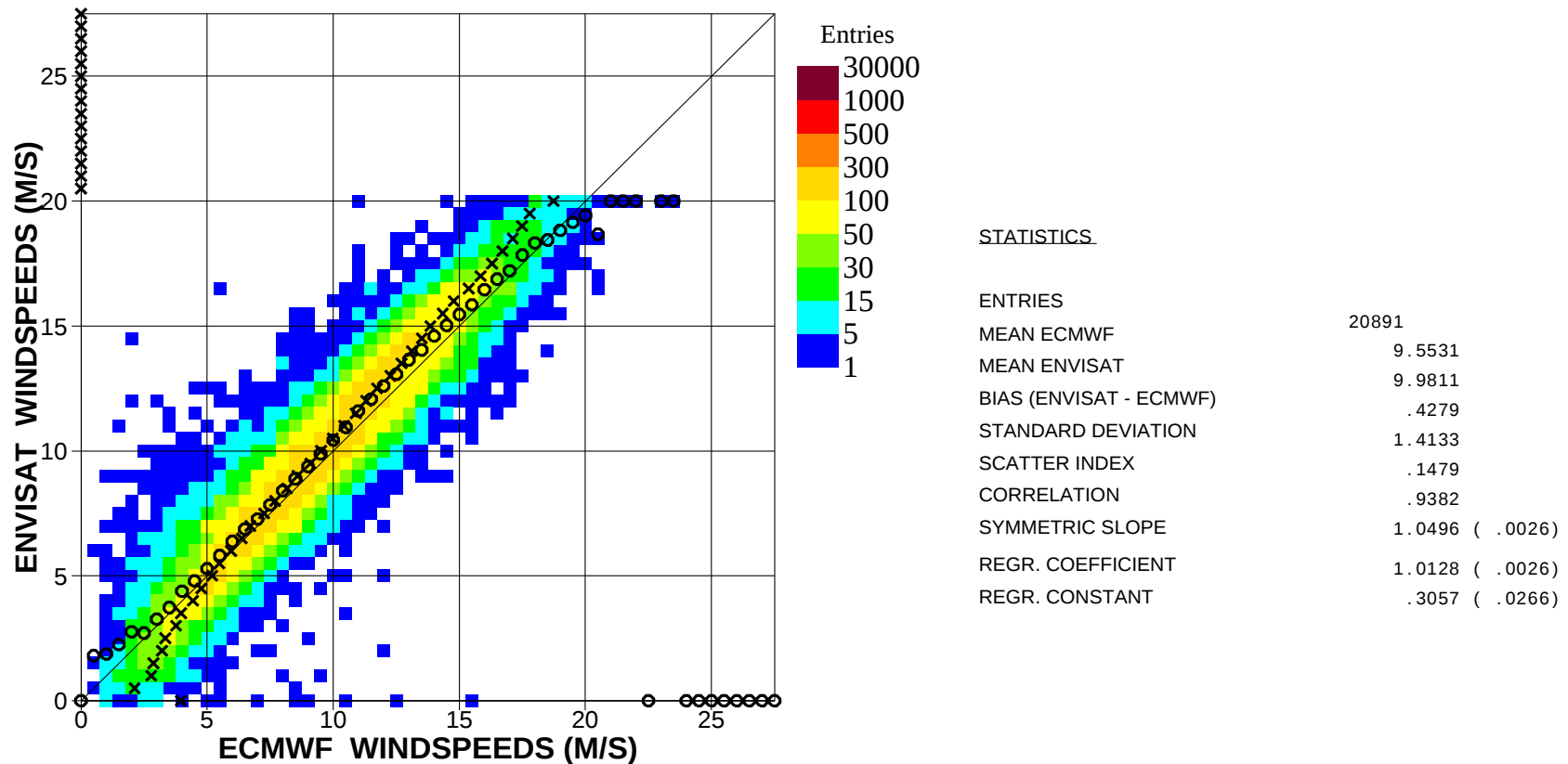


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for July 2003 (S.Hem.)

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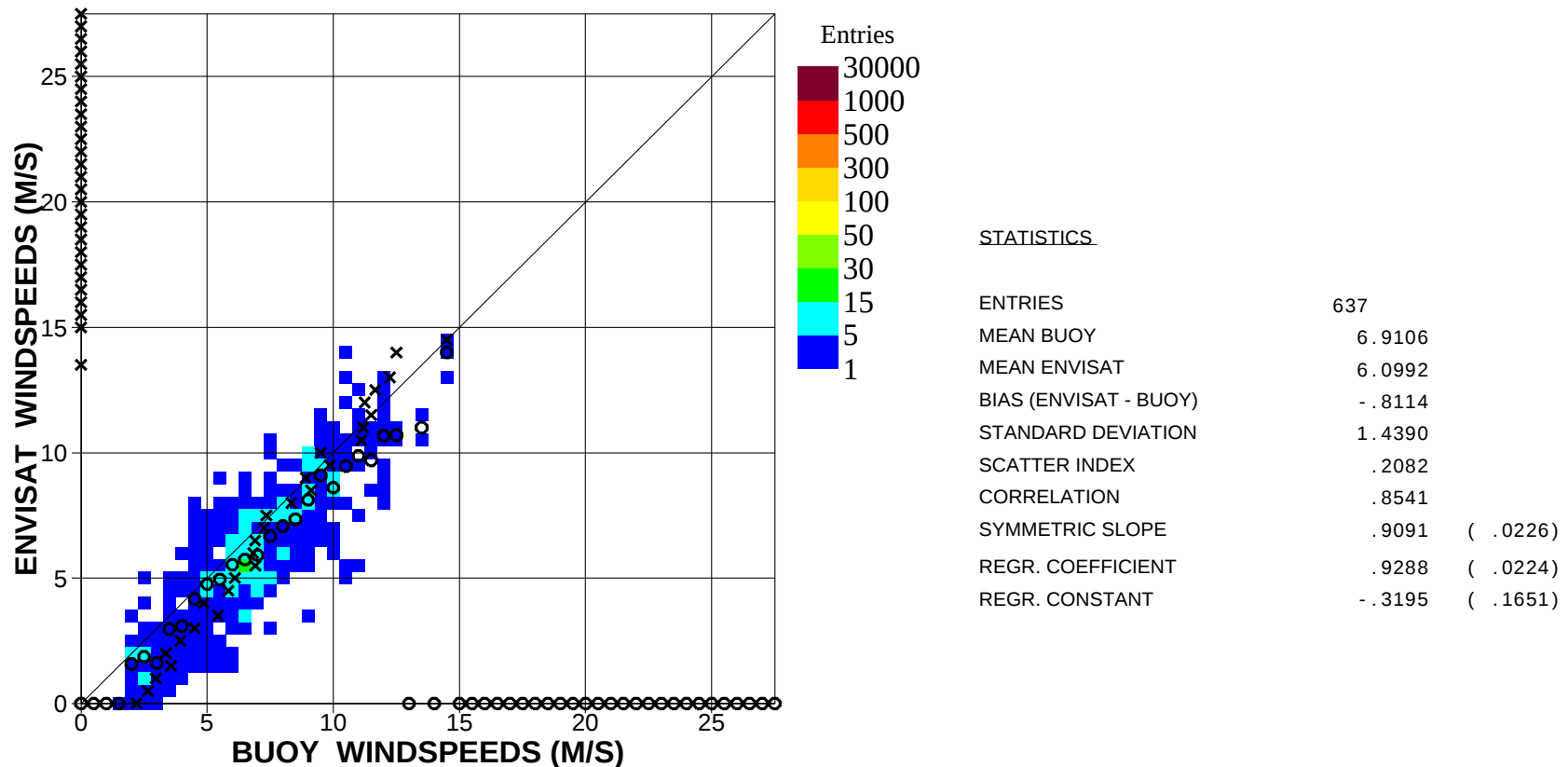


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2003 (Global)

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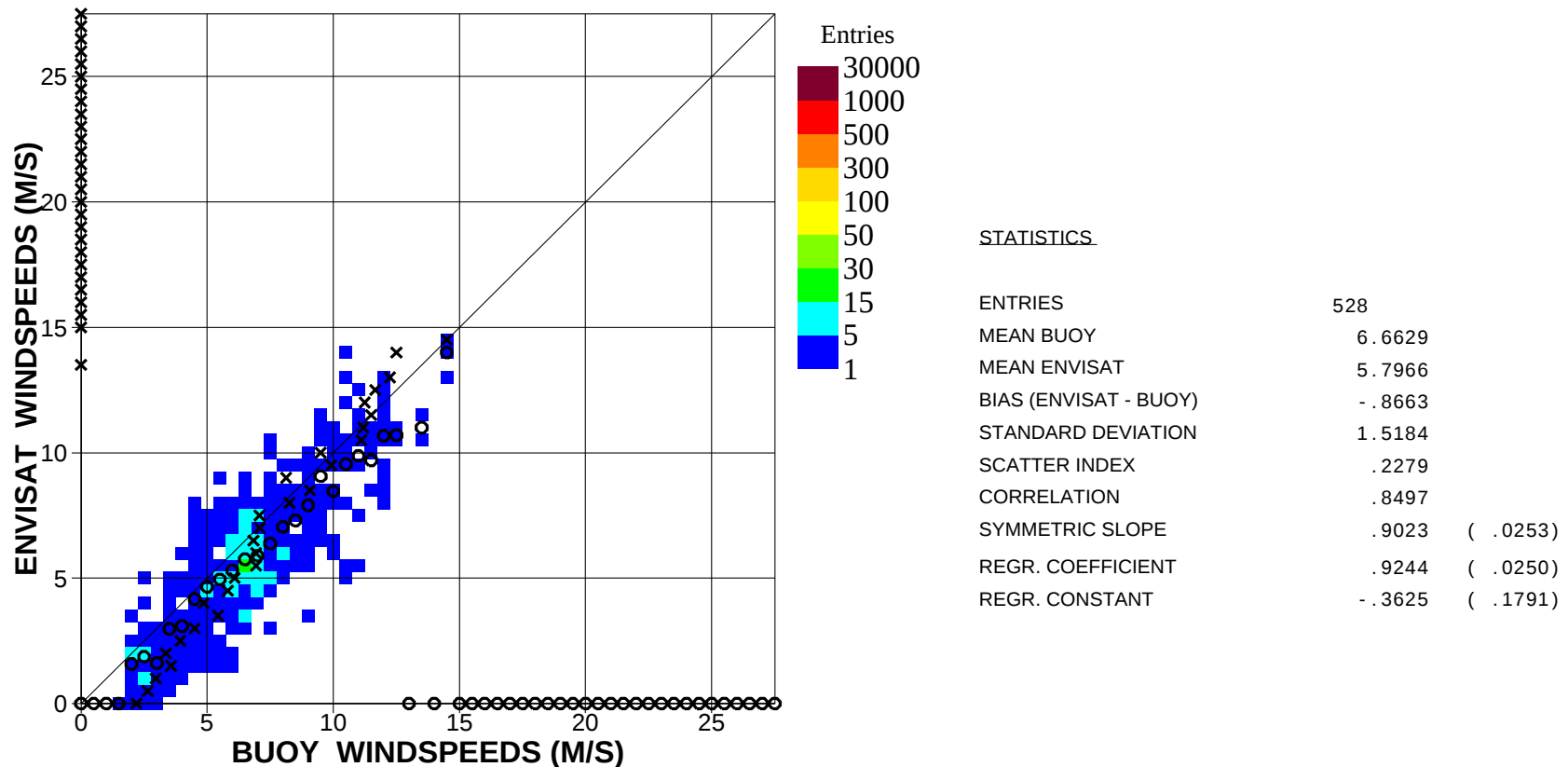


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2003 (N.Hem.)

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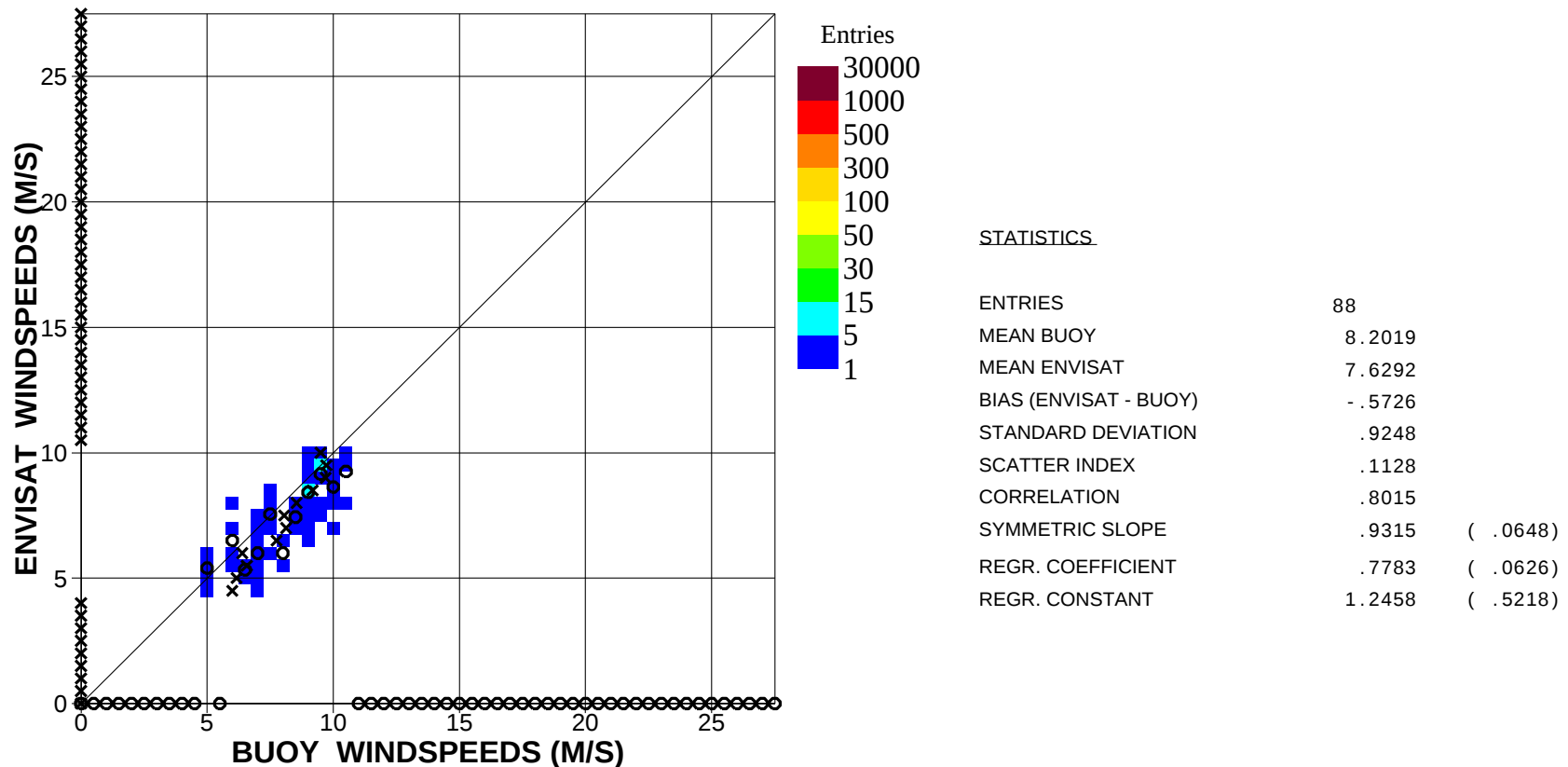


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for July 2003 (Tropics)

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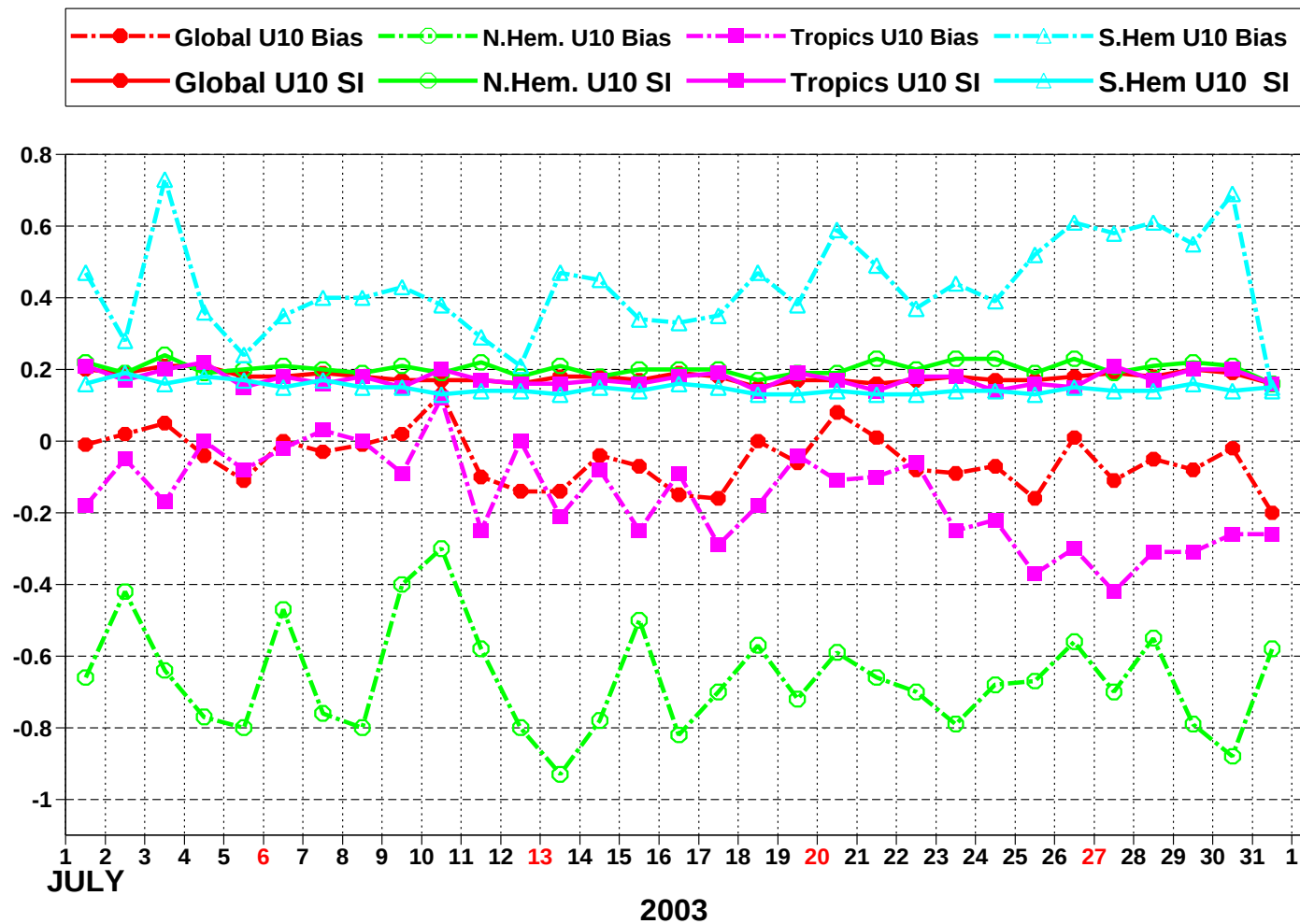


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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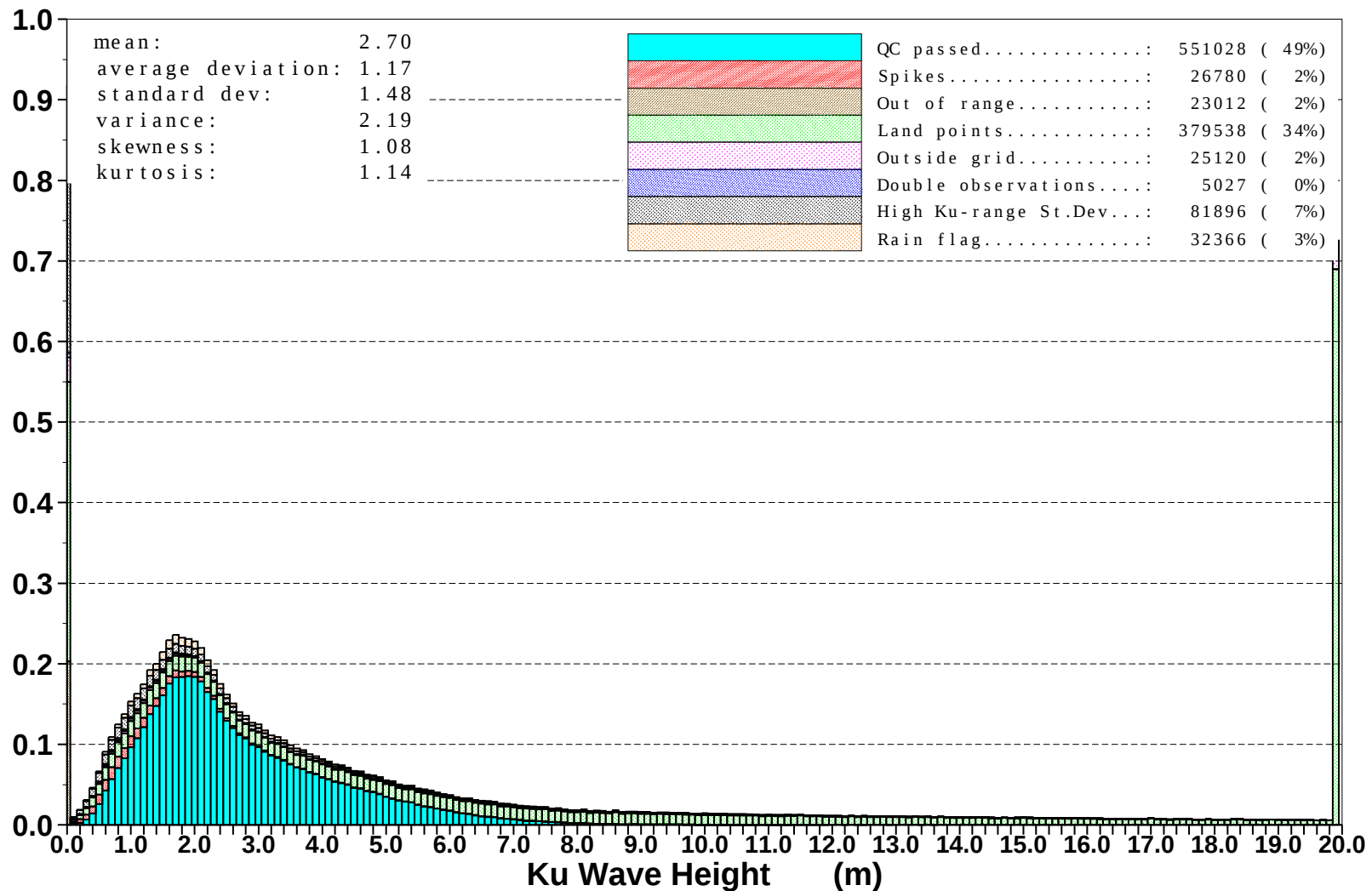


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for July 2003

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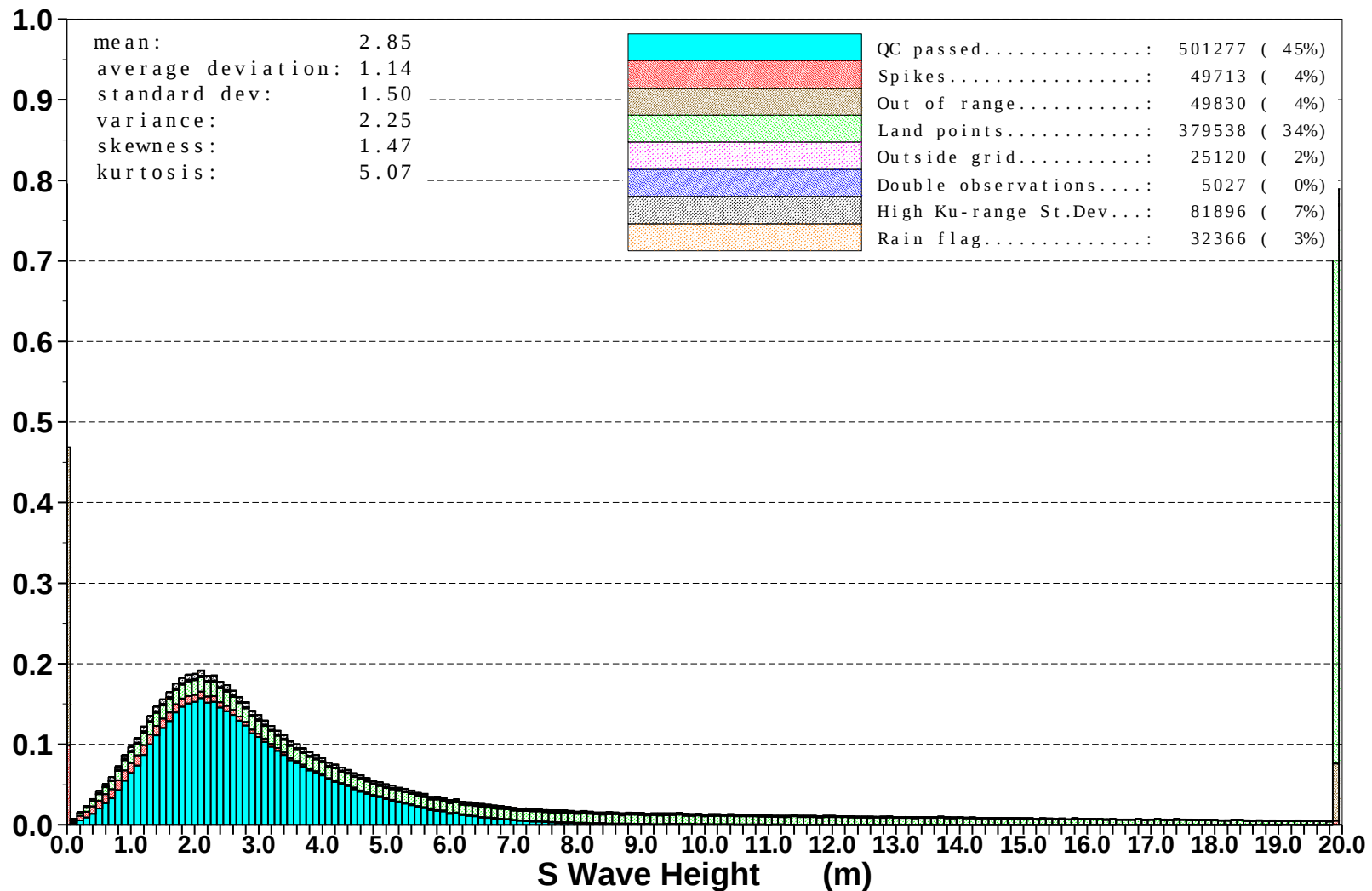
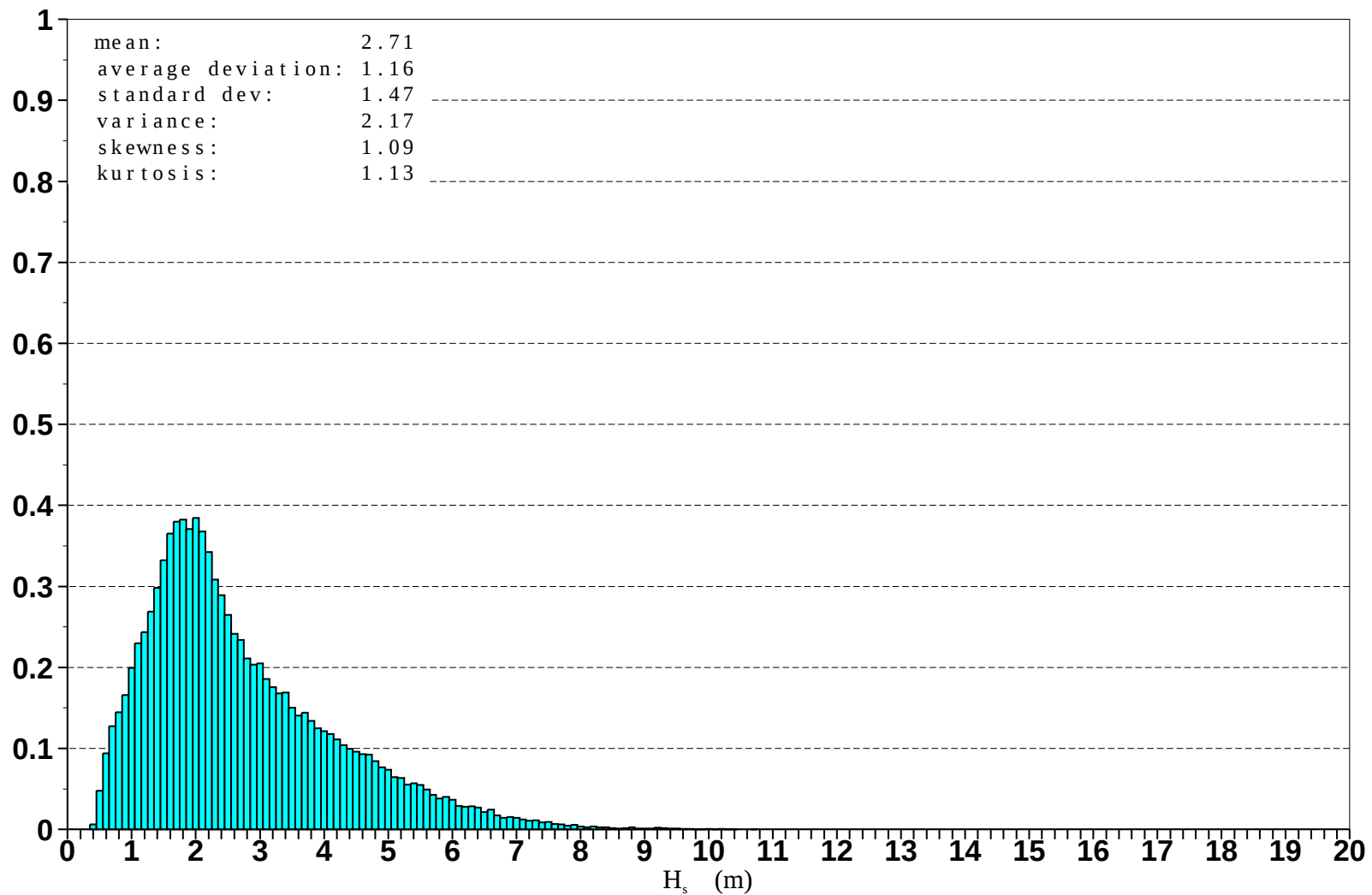


Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for July 2003



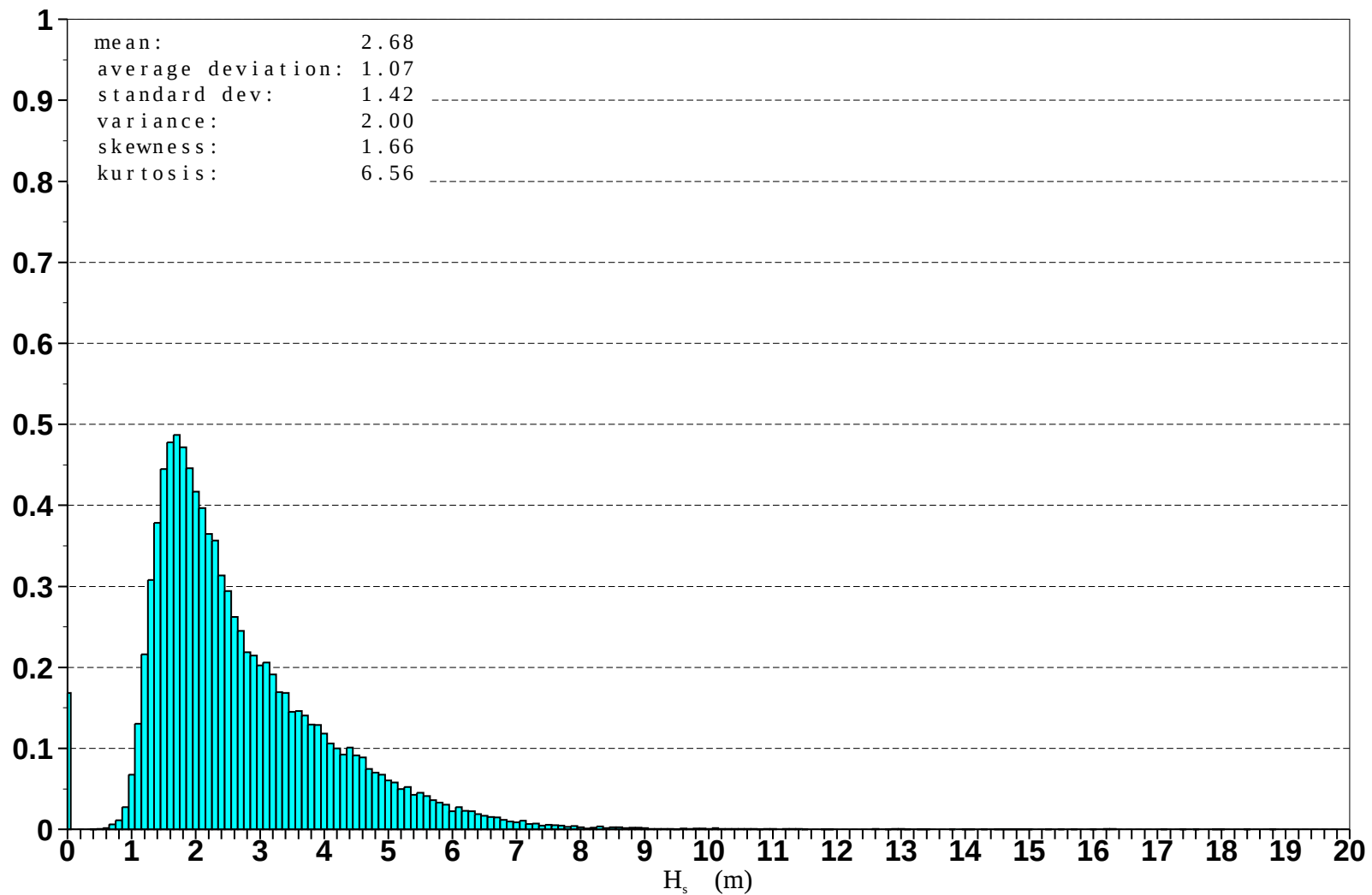
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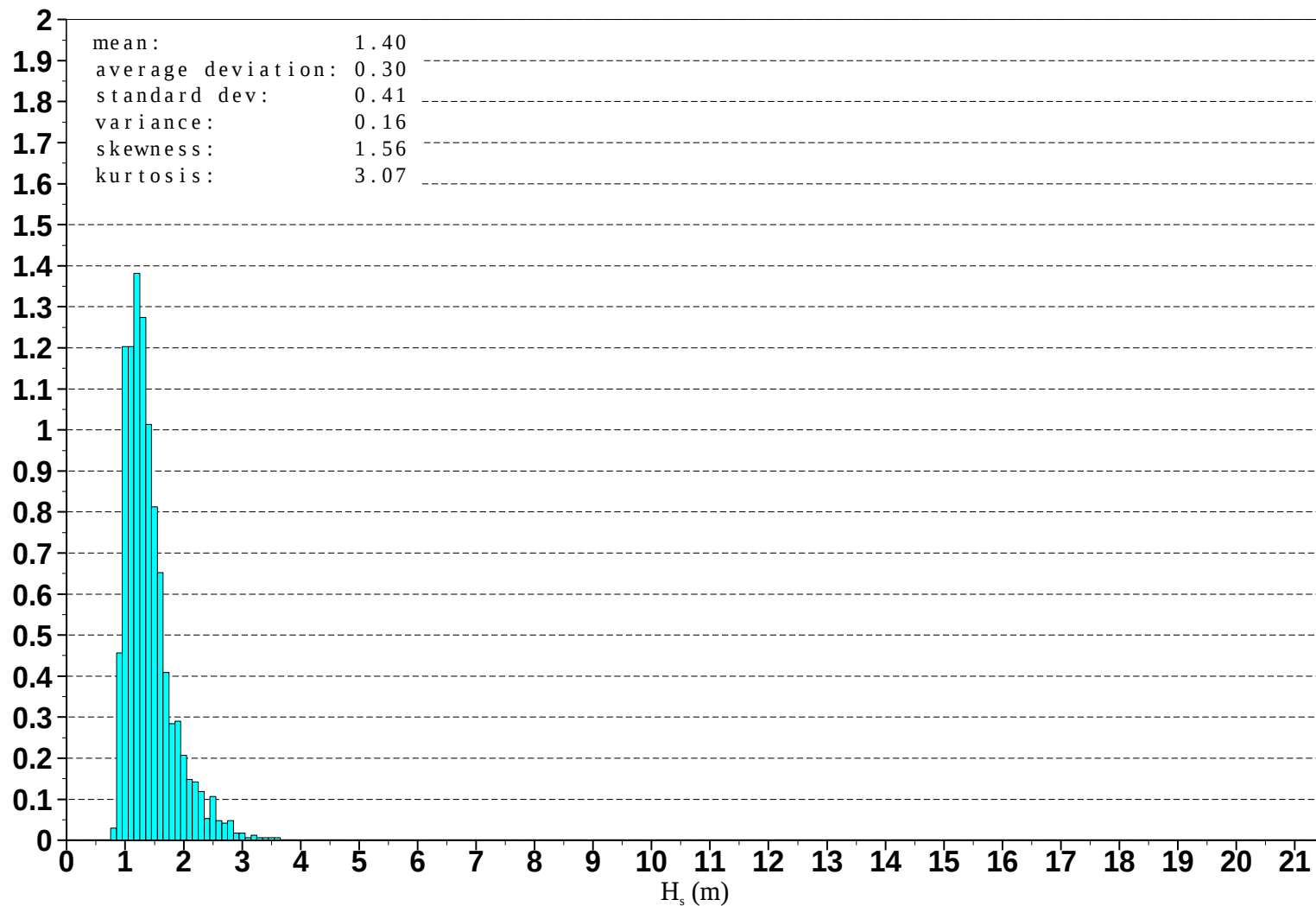
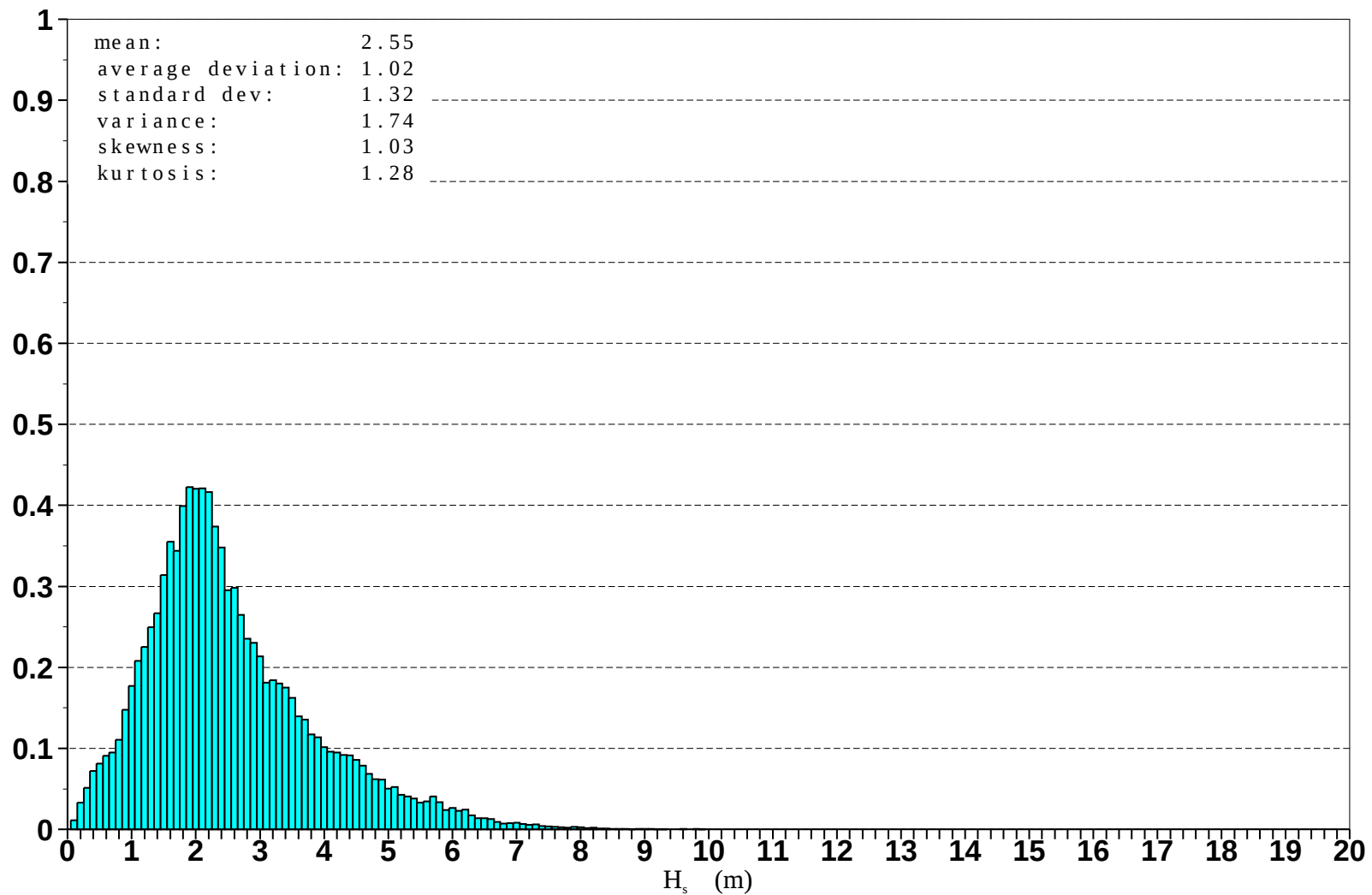


Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for July 2003

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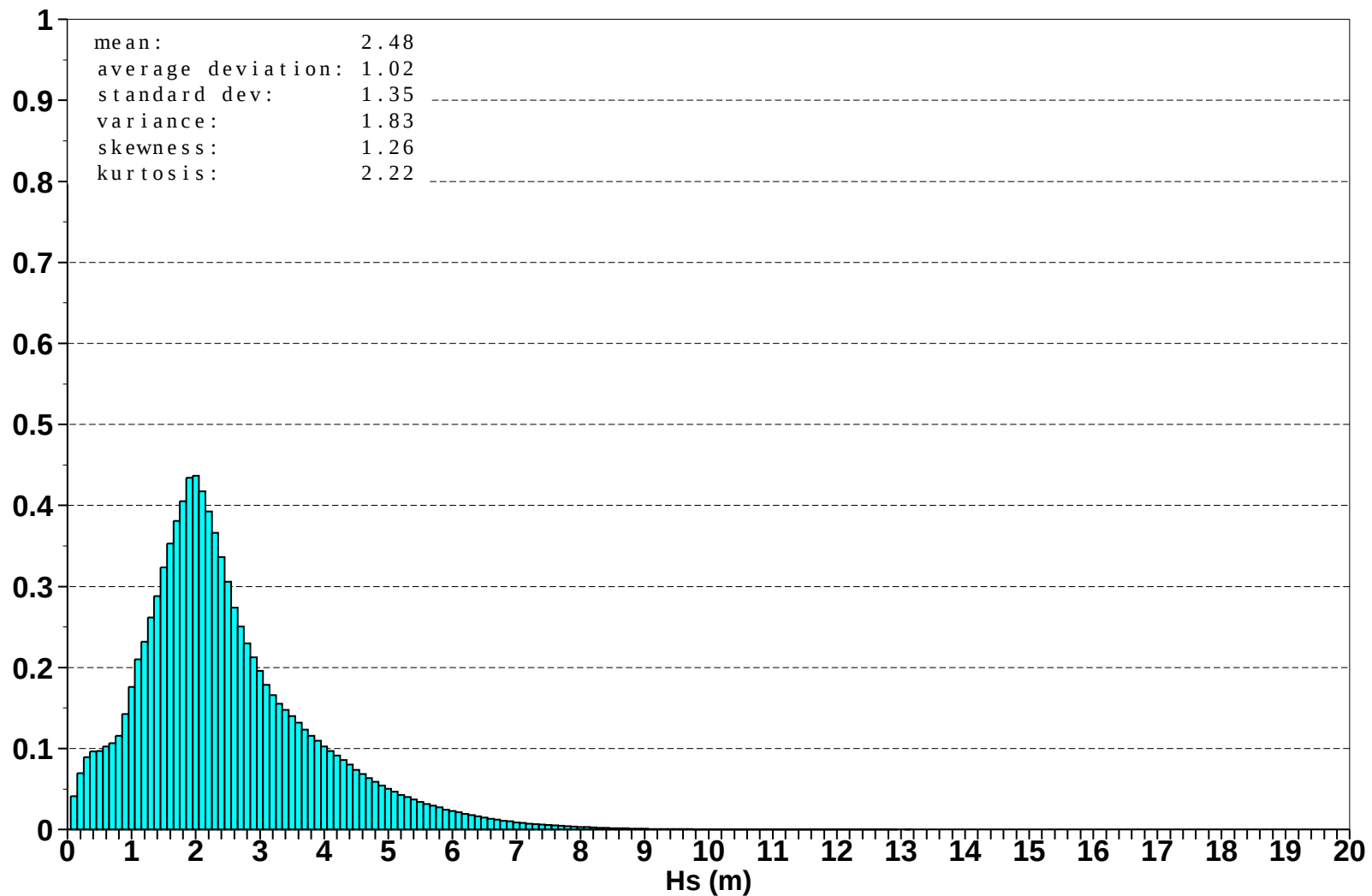


Figure 20: Global distribution of ECMWF First-Guess wave heights for July 2003



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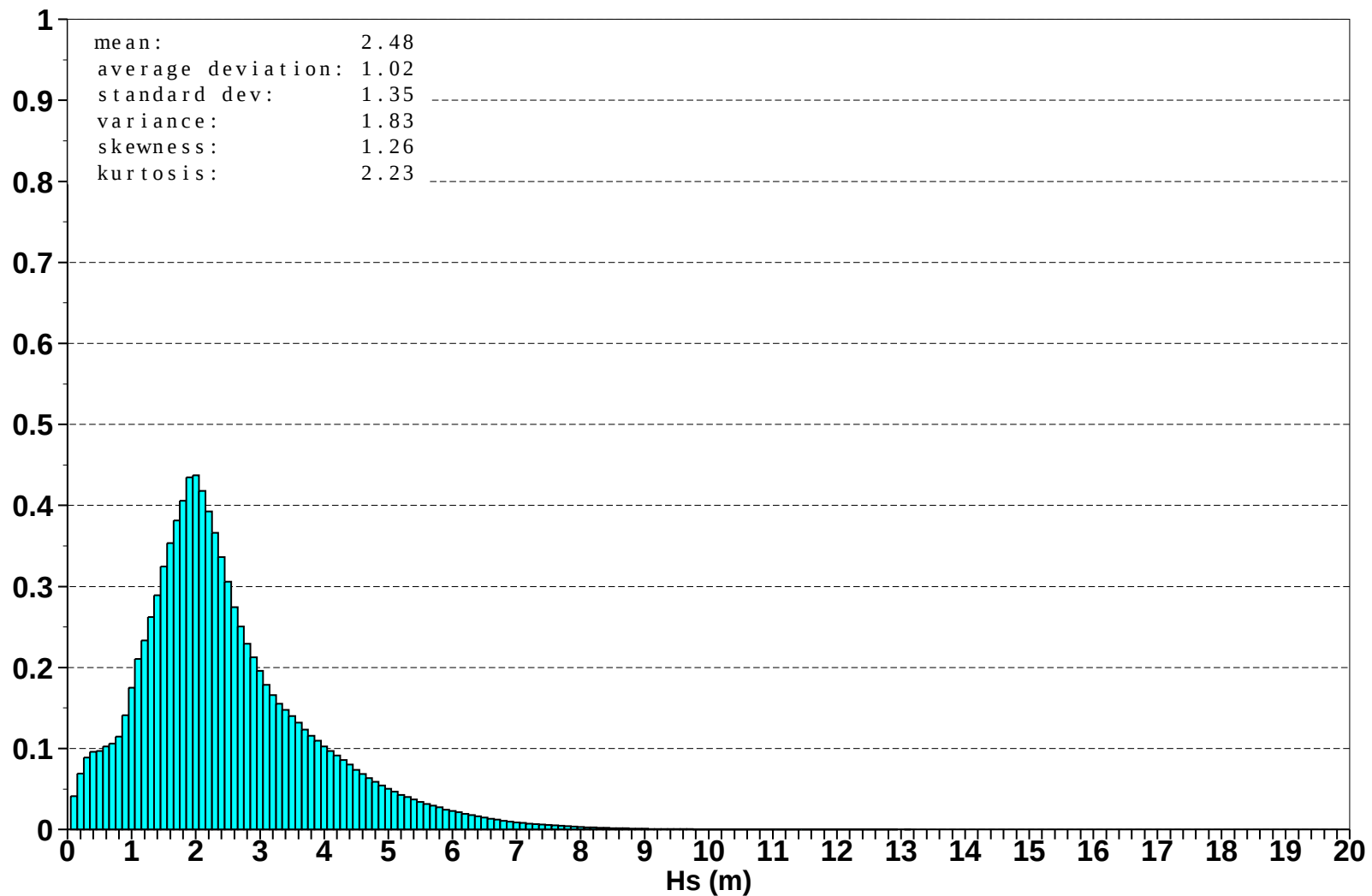


Figure 21: Global distribution of ECMWF Analysis (using ERS-2 data) wave heights for July 2003



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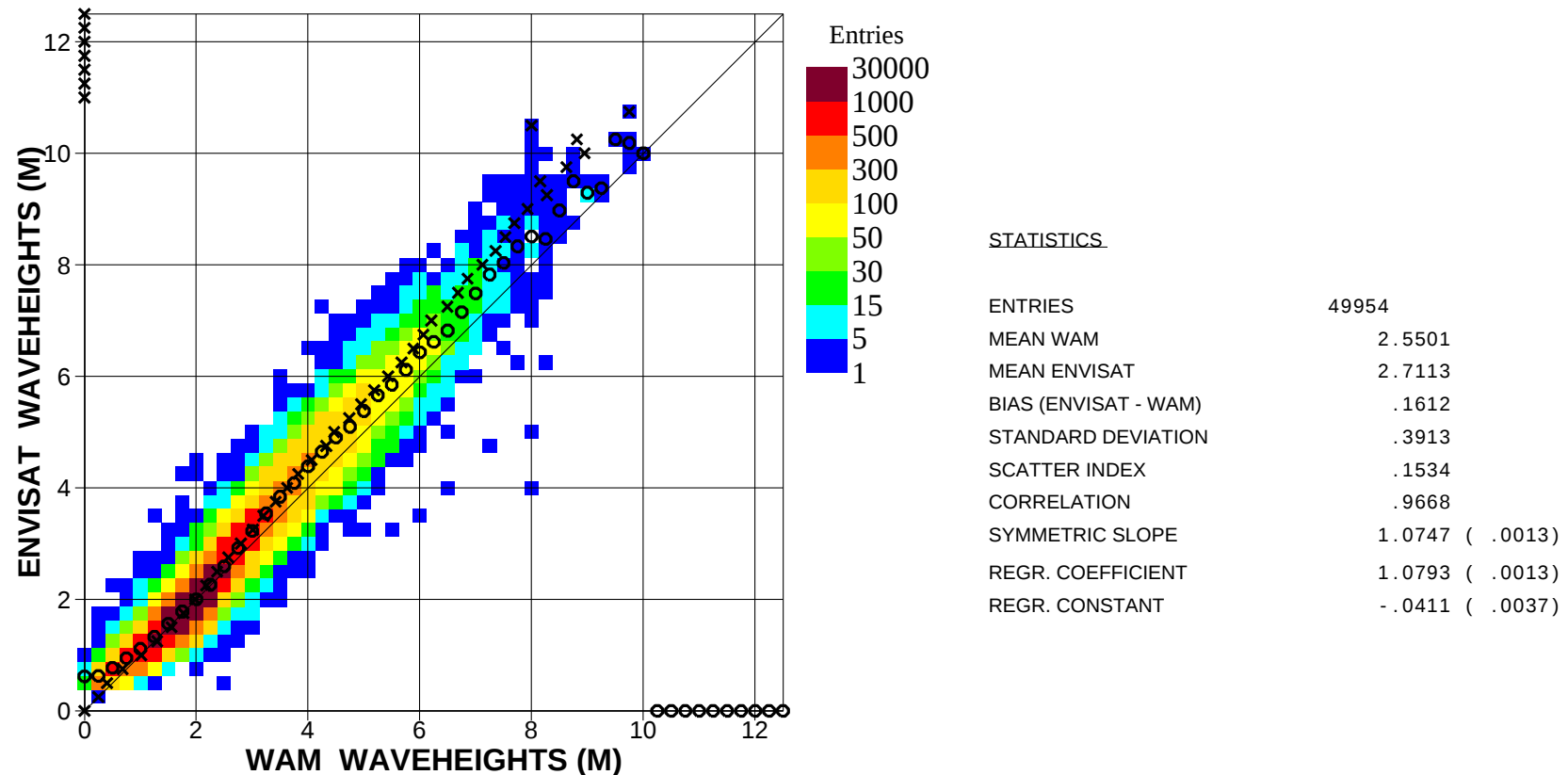


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2003 (Global)

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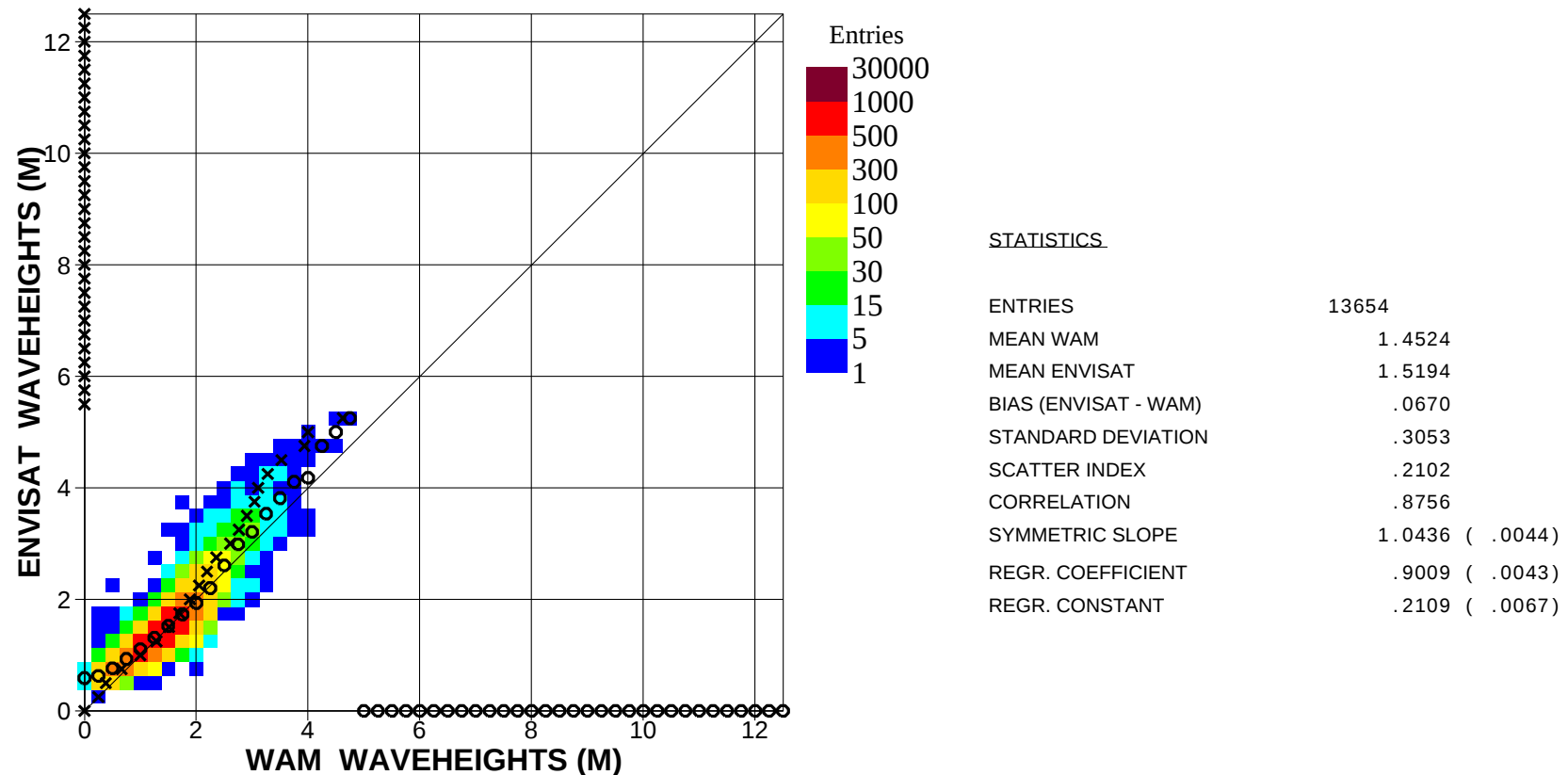


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2003 (N.Hem.)

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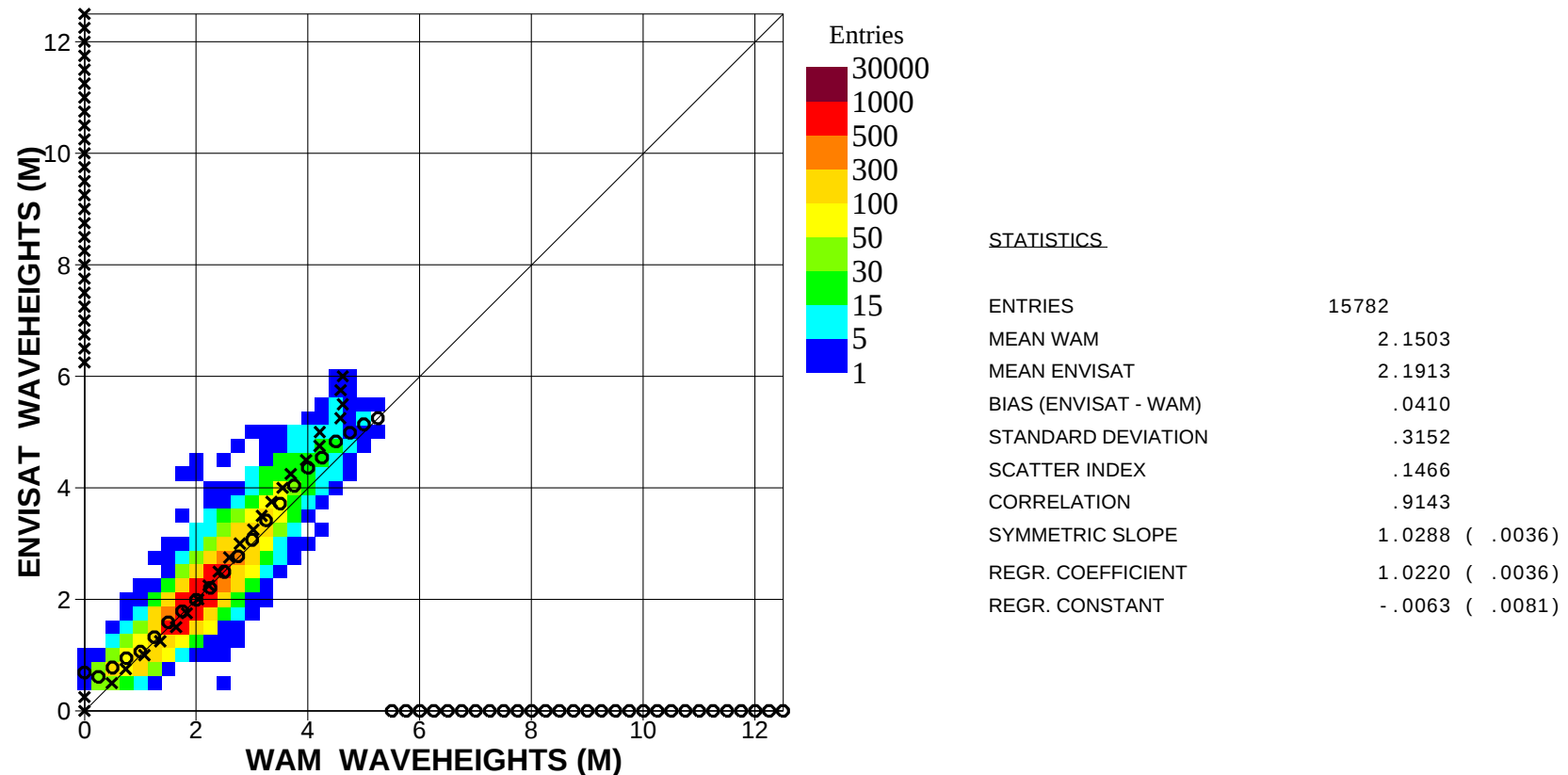


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2003 (Tropics)

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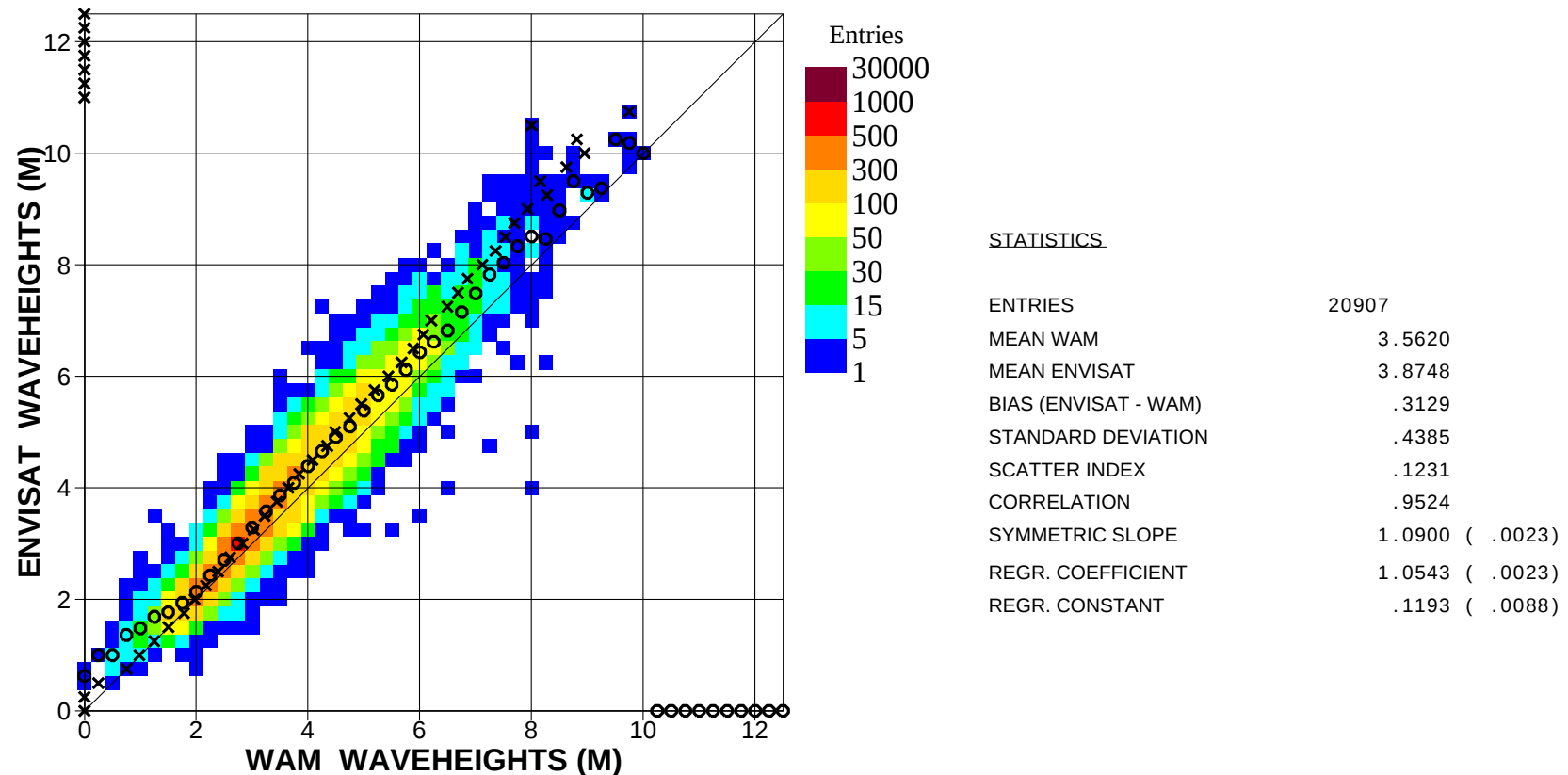


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for July 2003 (S.Hem.)

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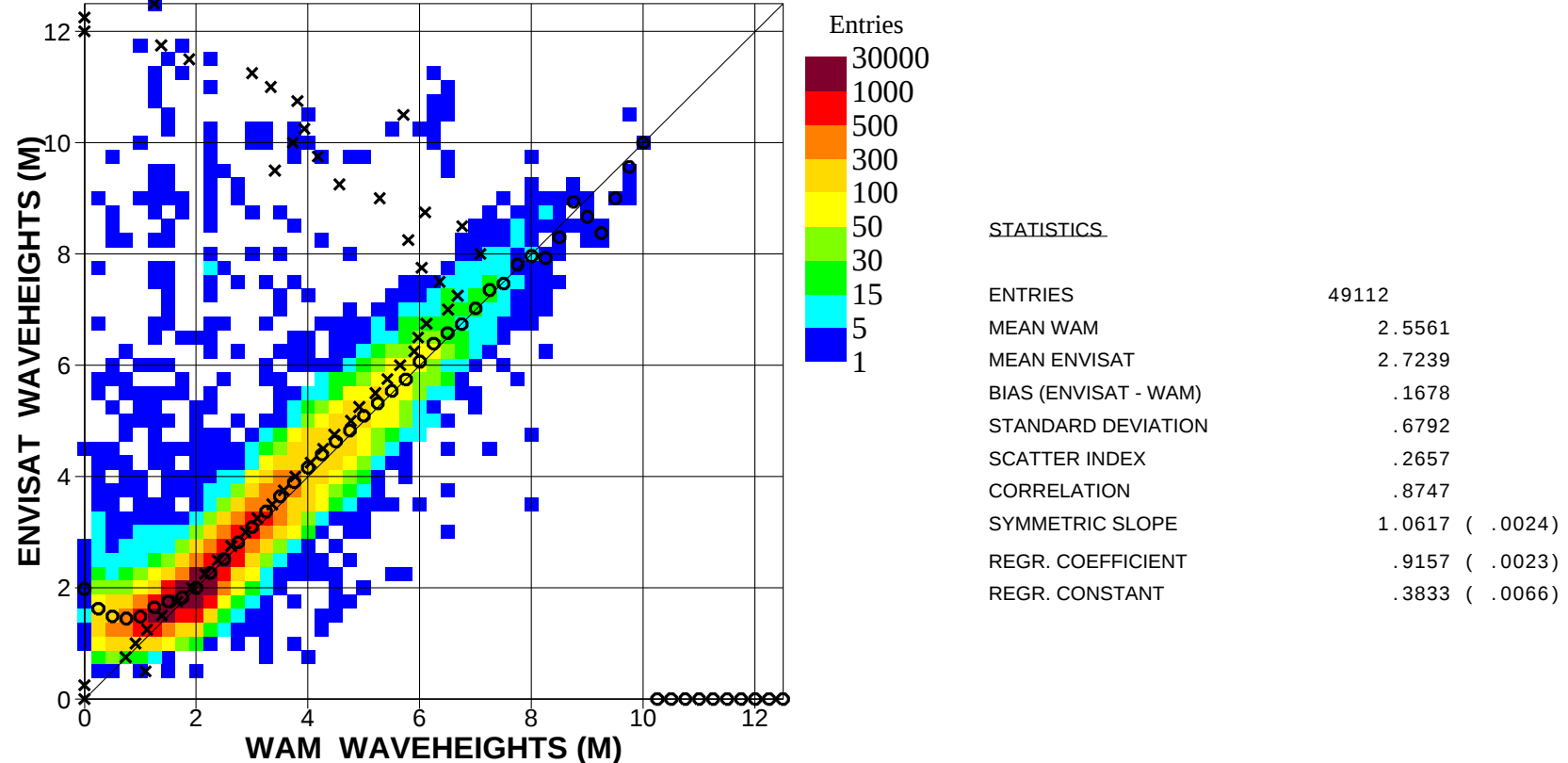


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2003 (Global)

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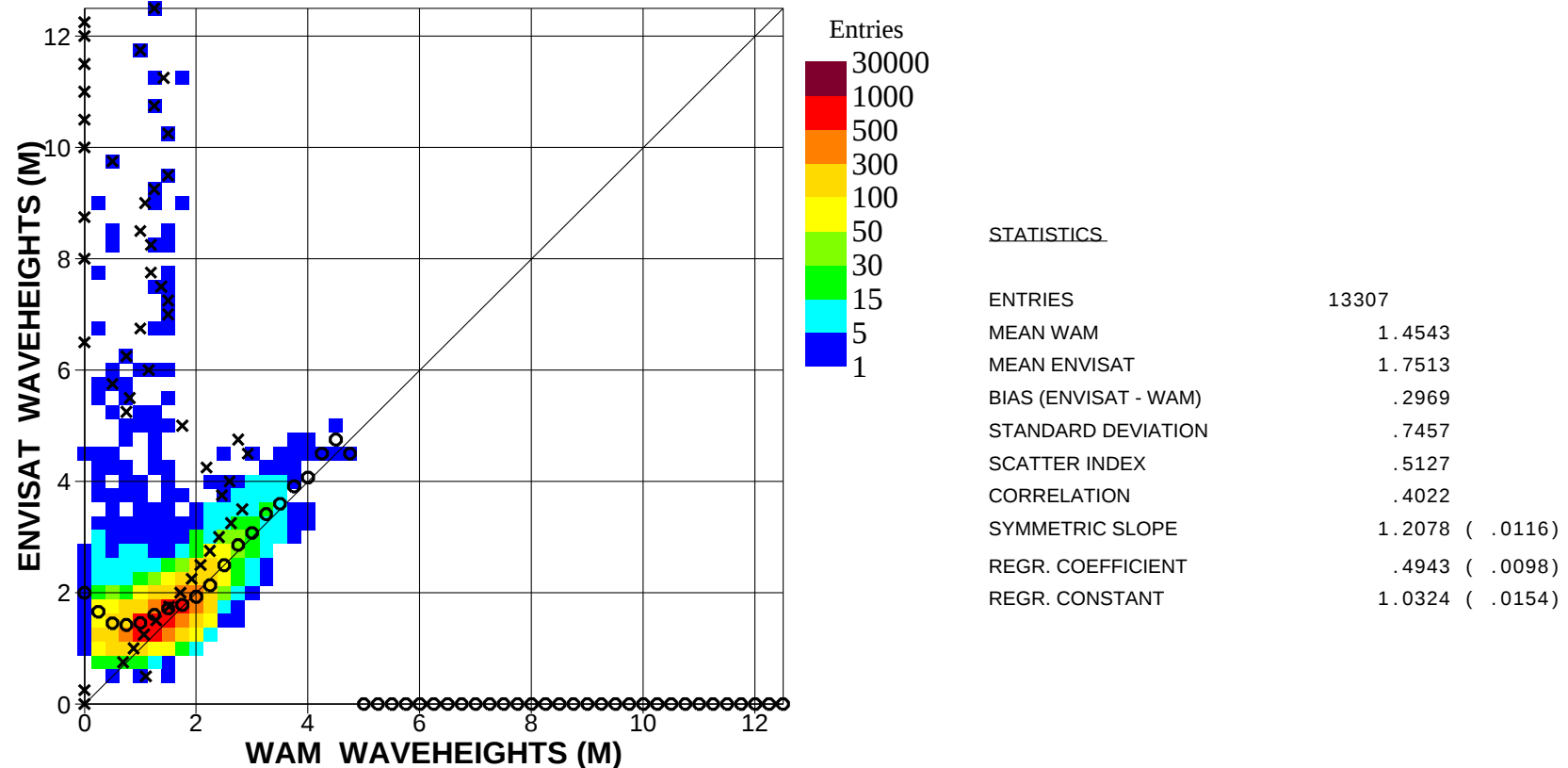


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2003 (N.Hem.)

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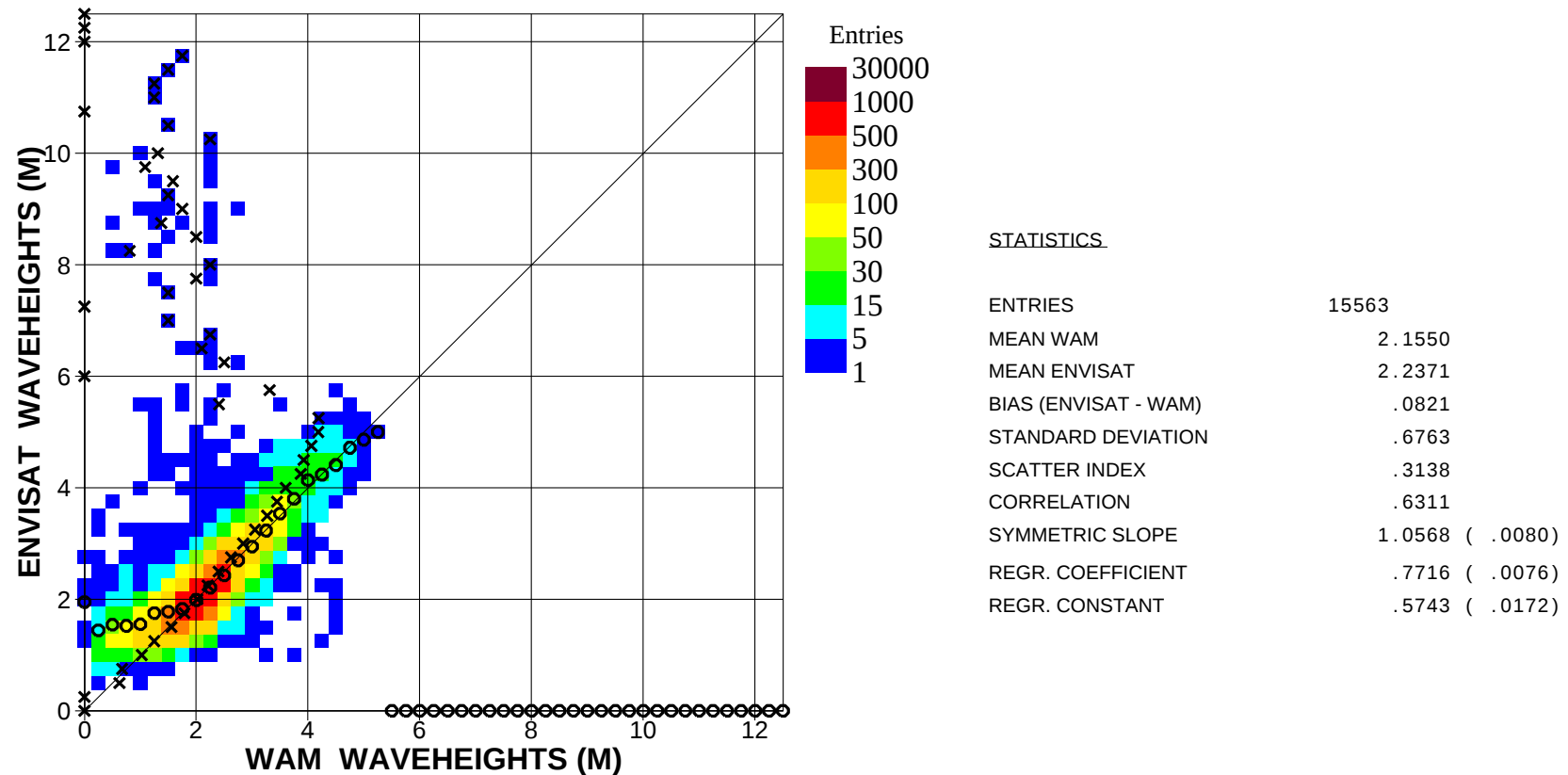


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2003 (Tropics)

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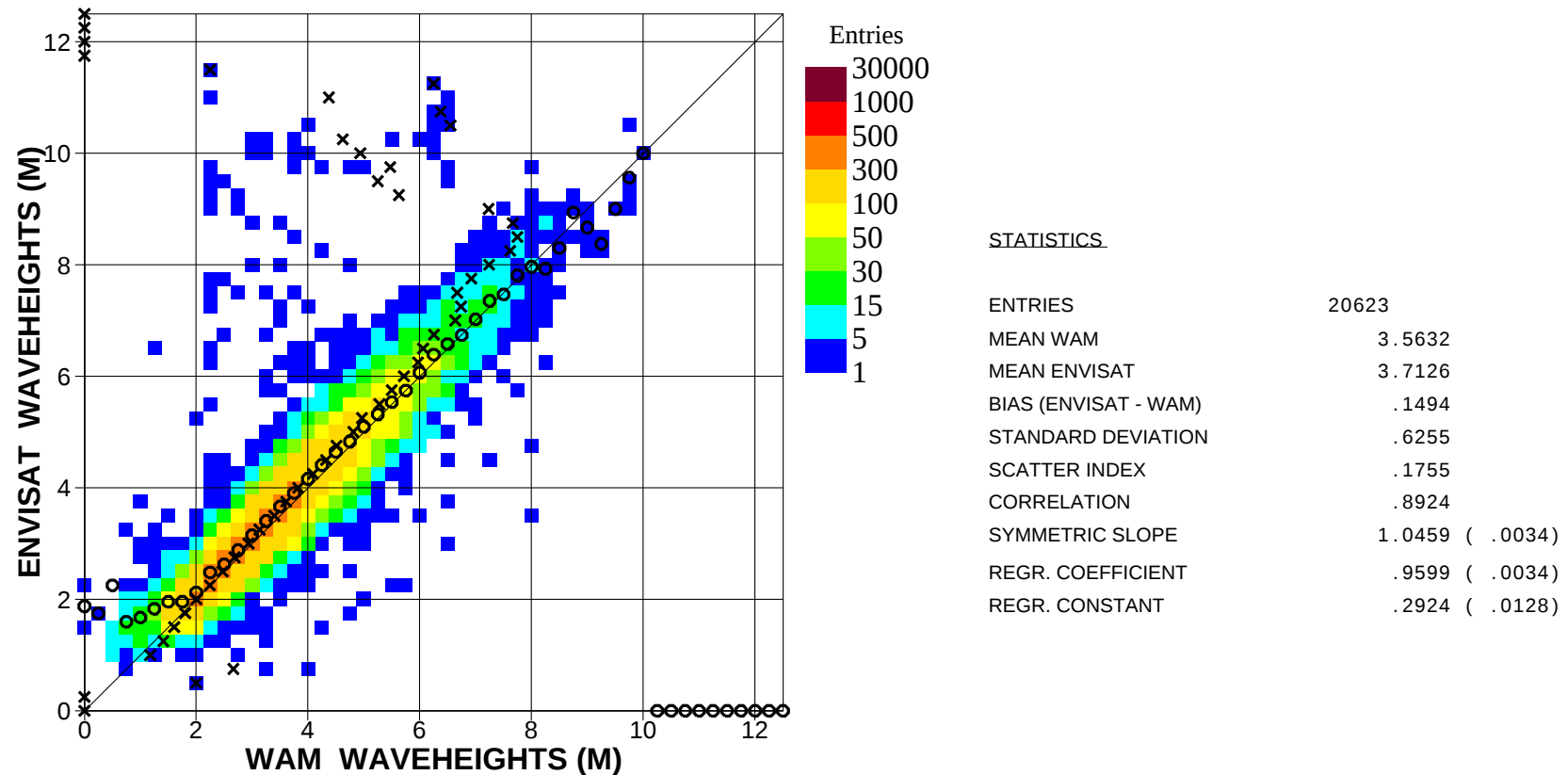


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for July 2003 (S.Hem.)

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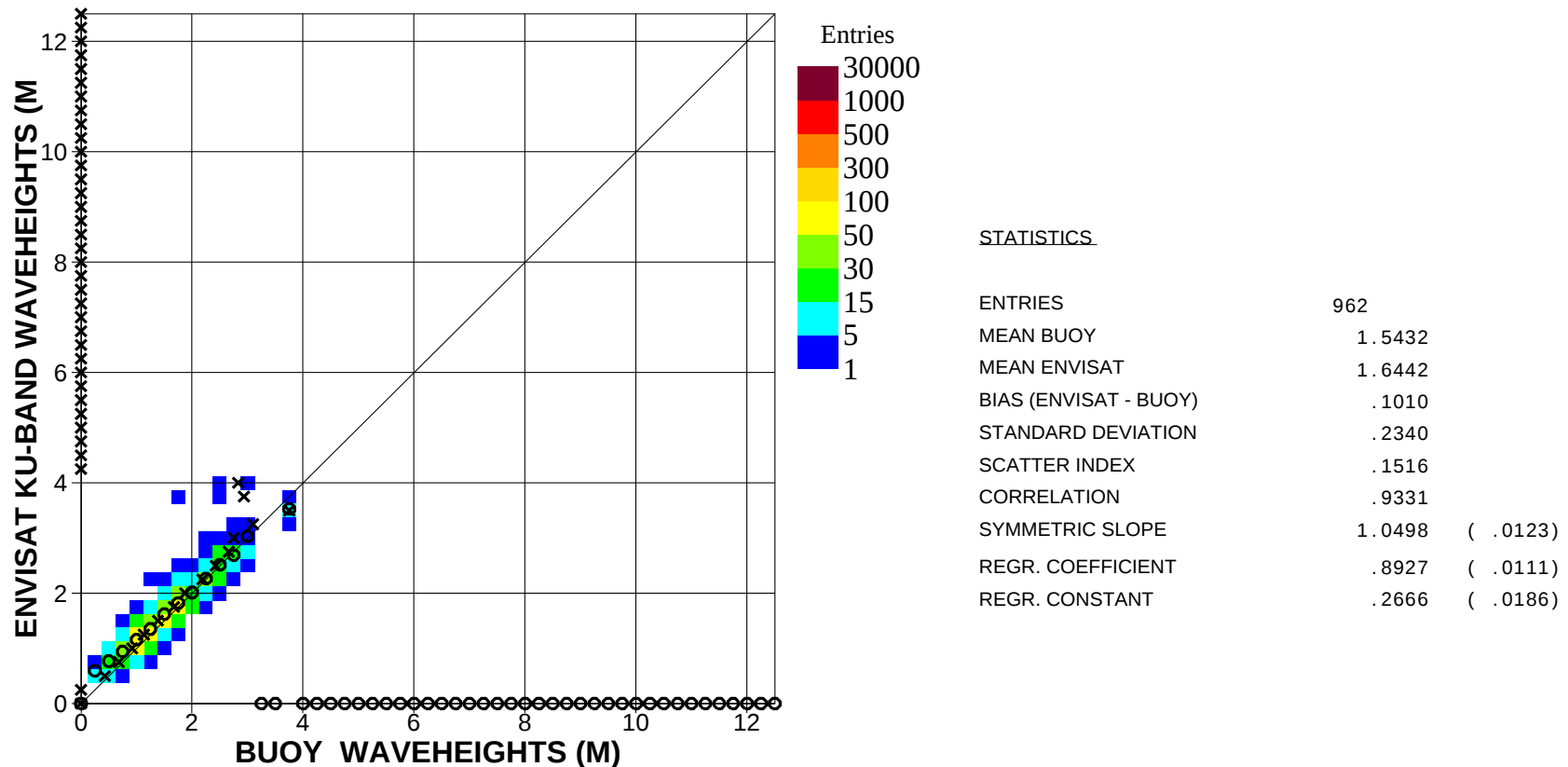


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2003 (Global)

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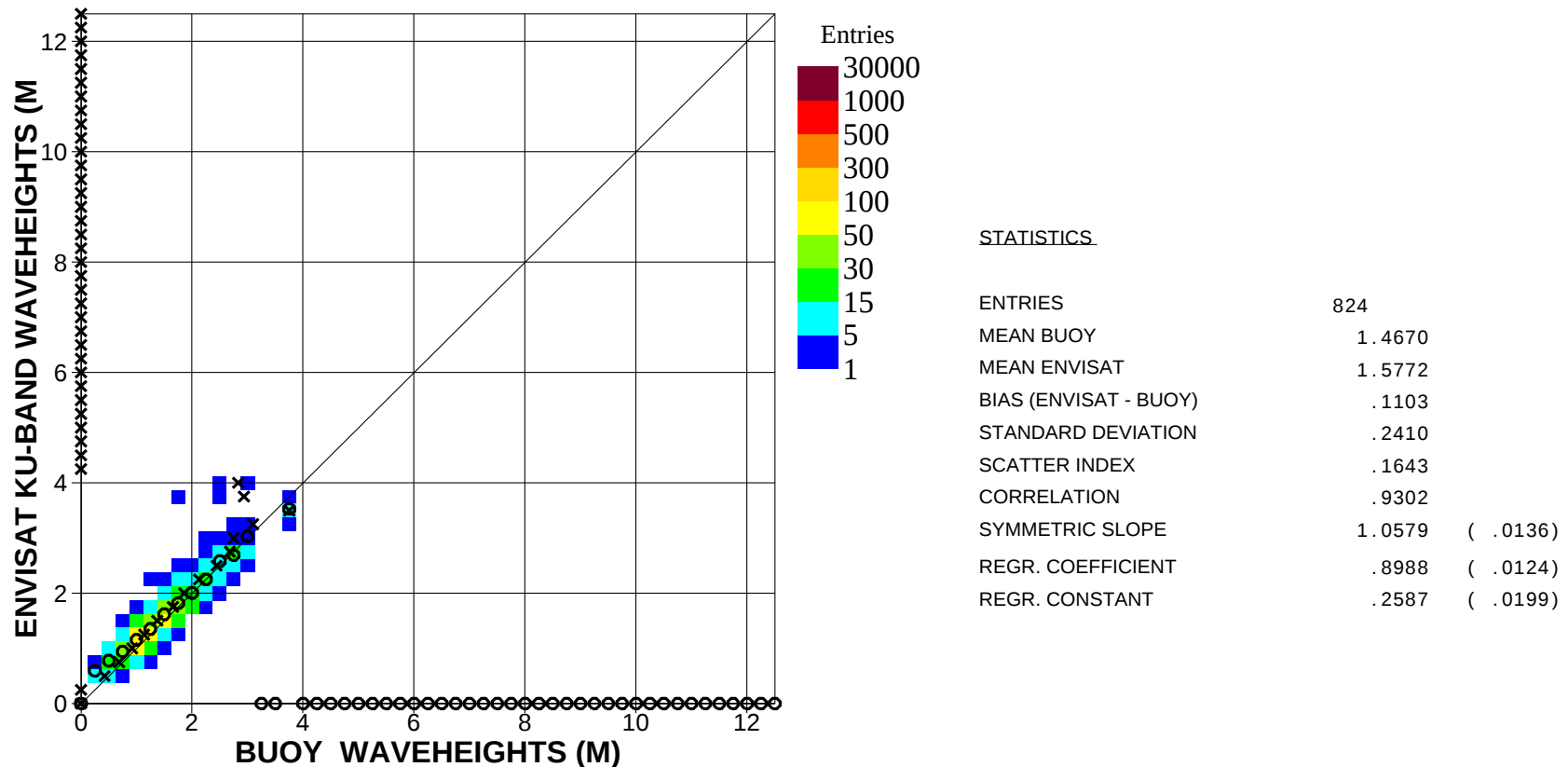


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2003 (N.Hem.)

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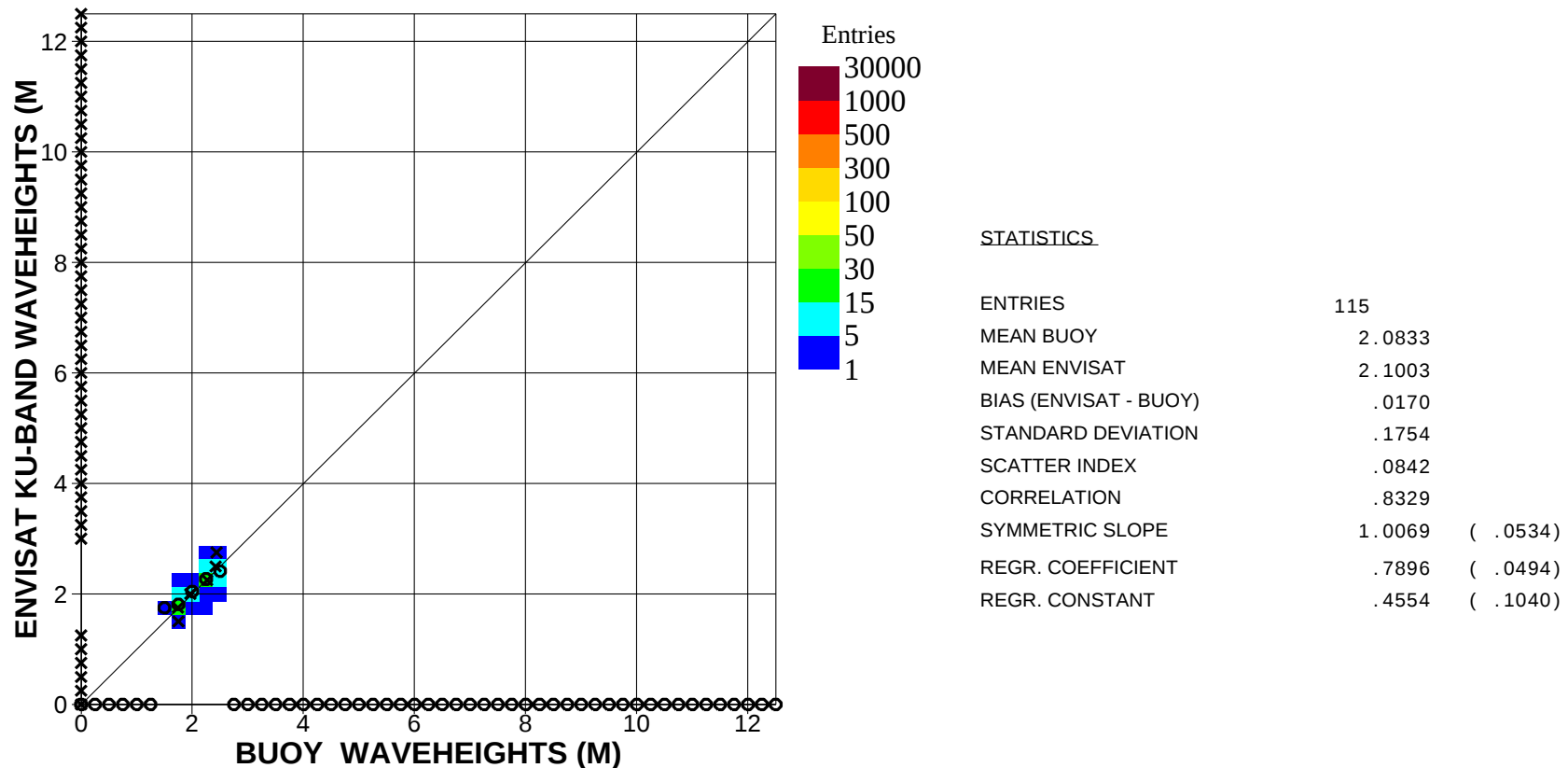


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for July 2003 (Tropics)

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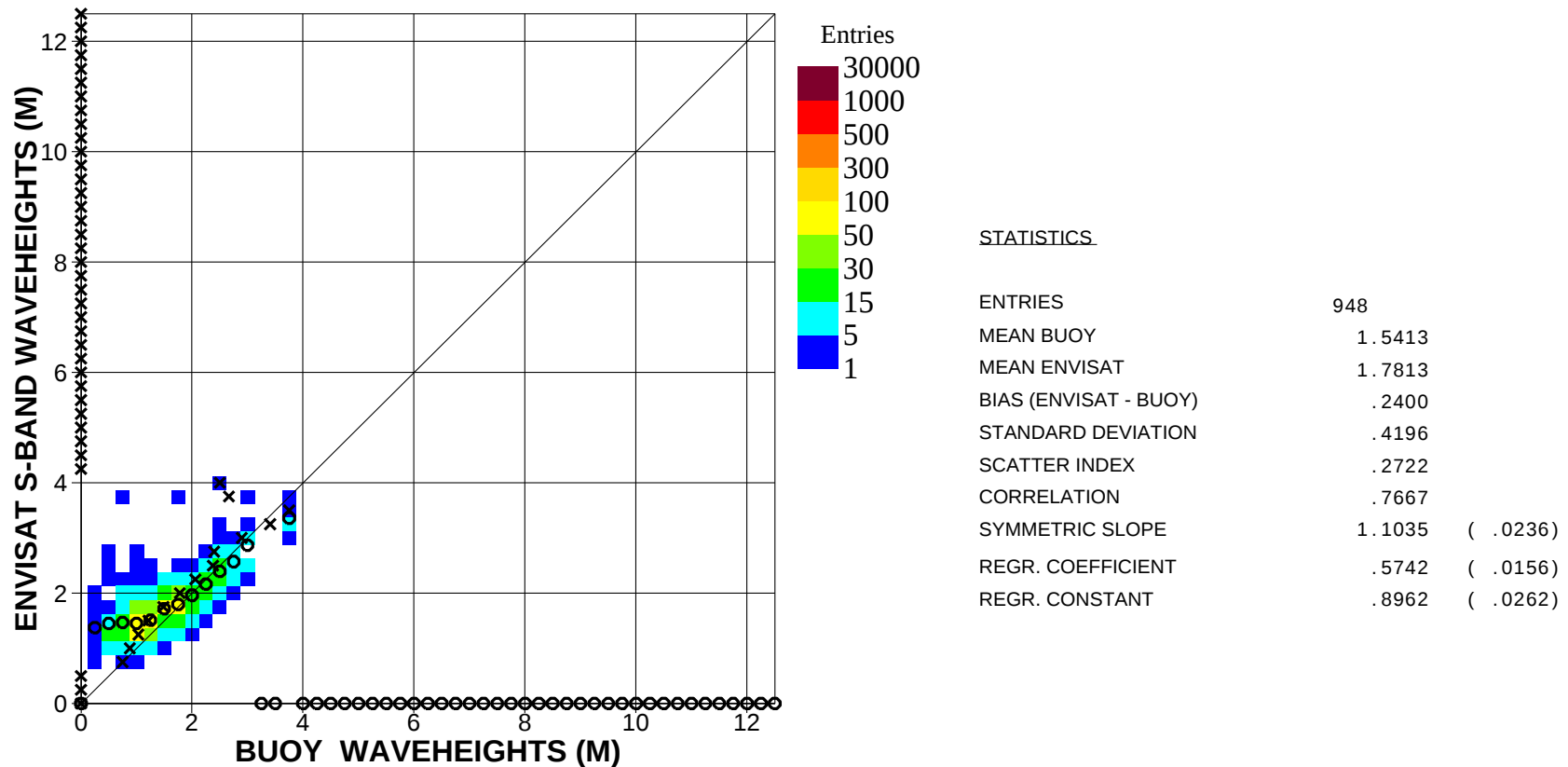


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2003 (Global)

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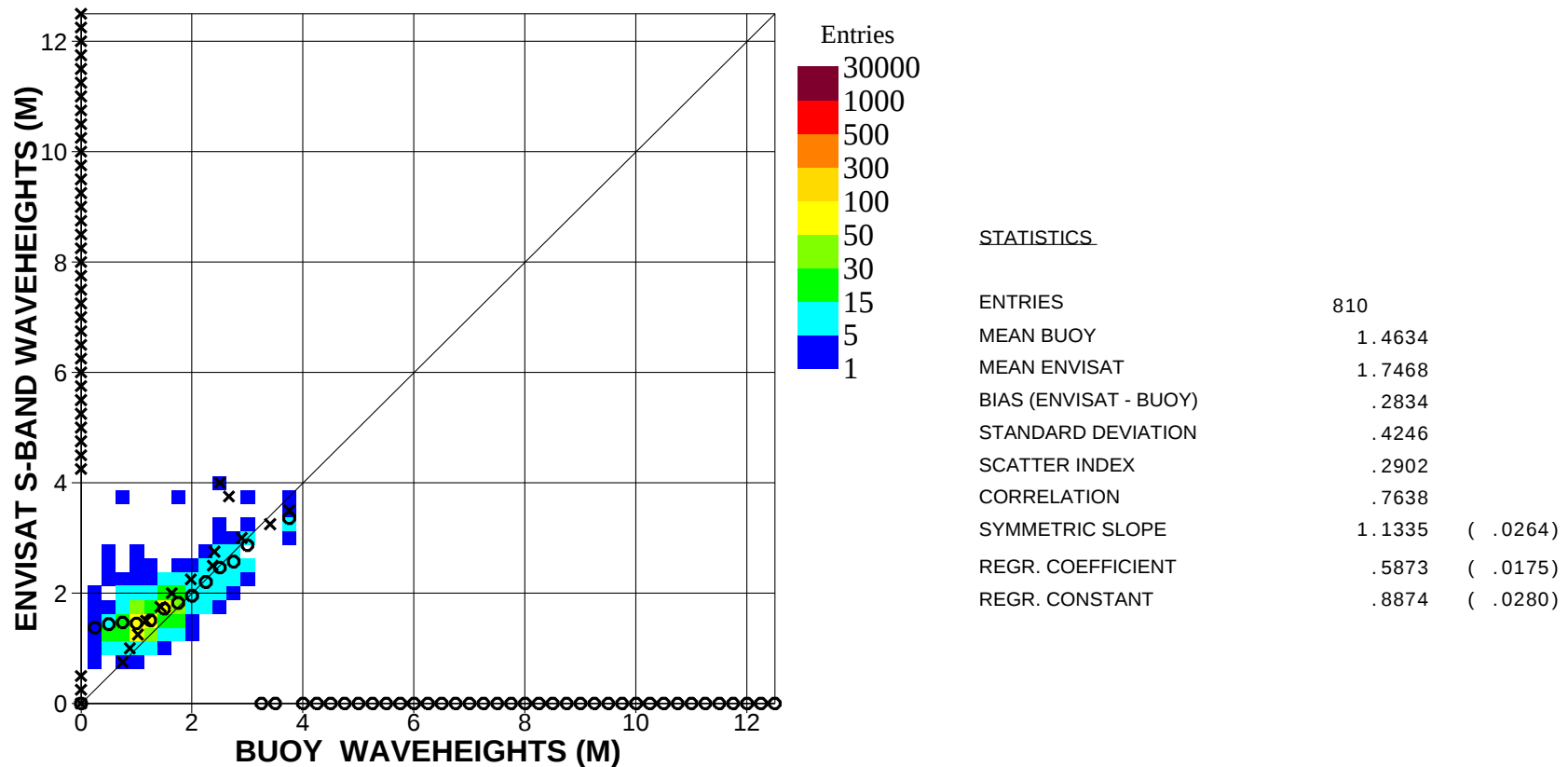


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2003 (N.Hem.)

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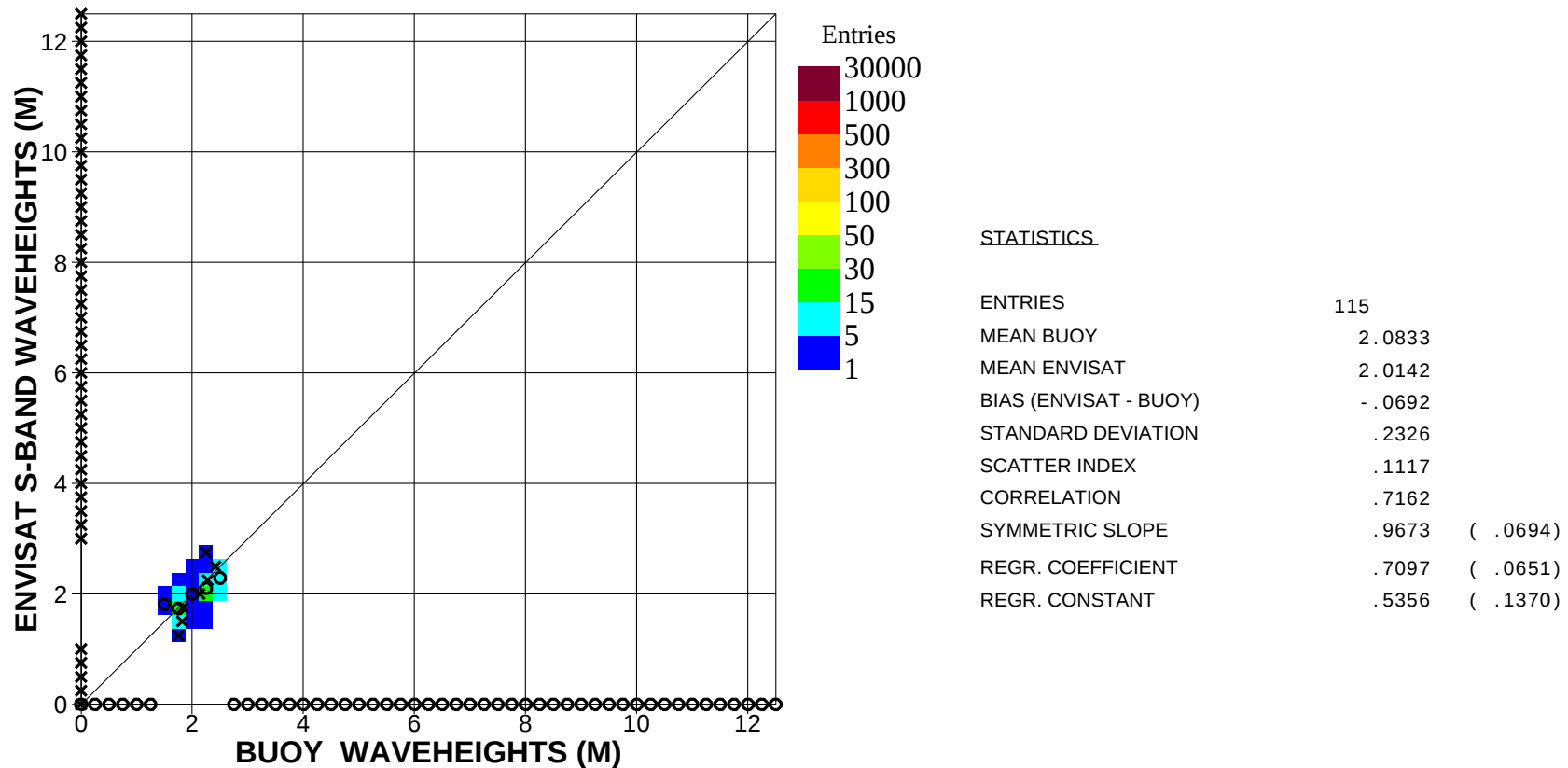


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for July 2003 (Tropics)



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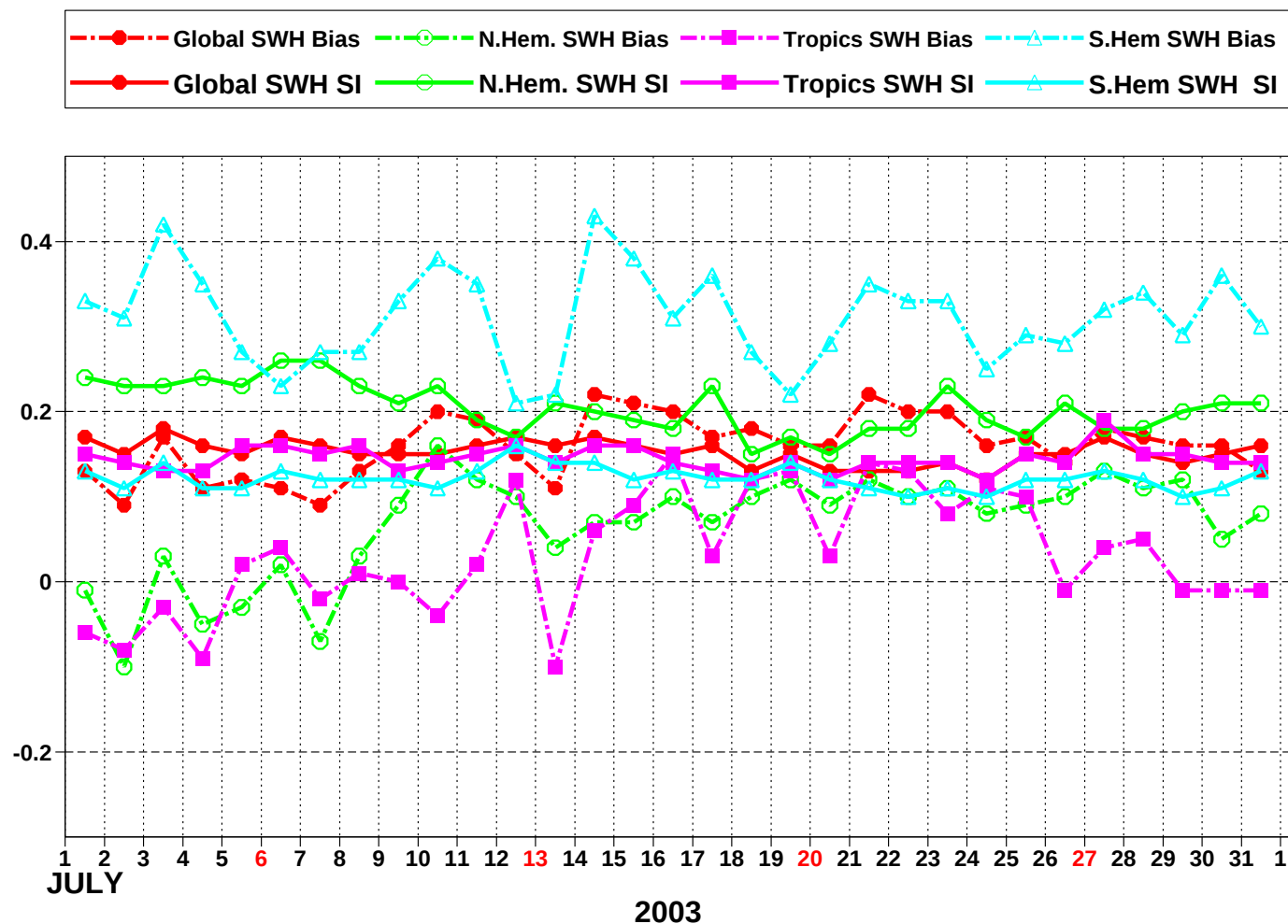


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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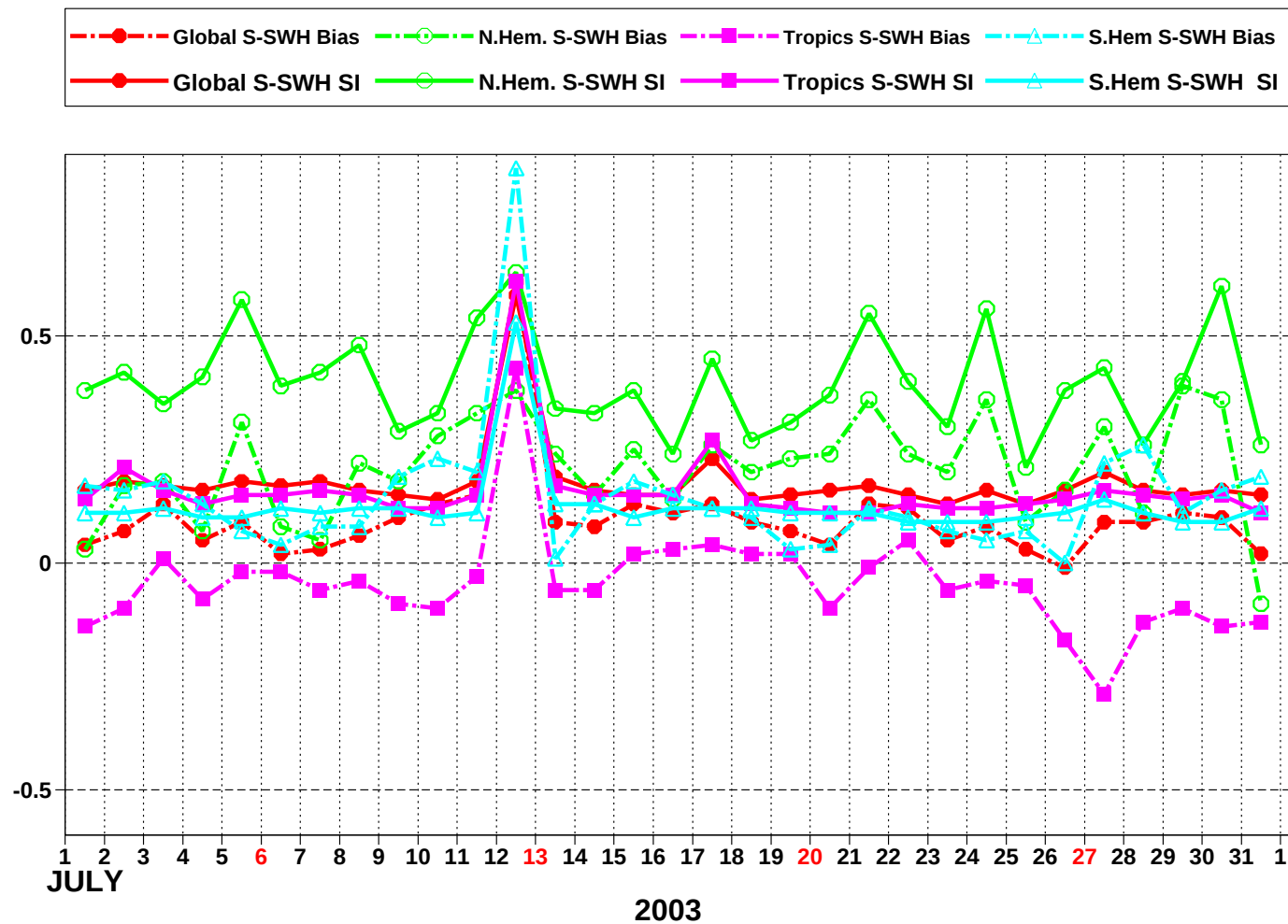


Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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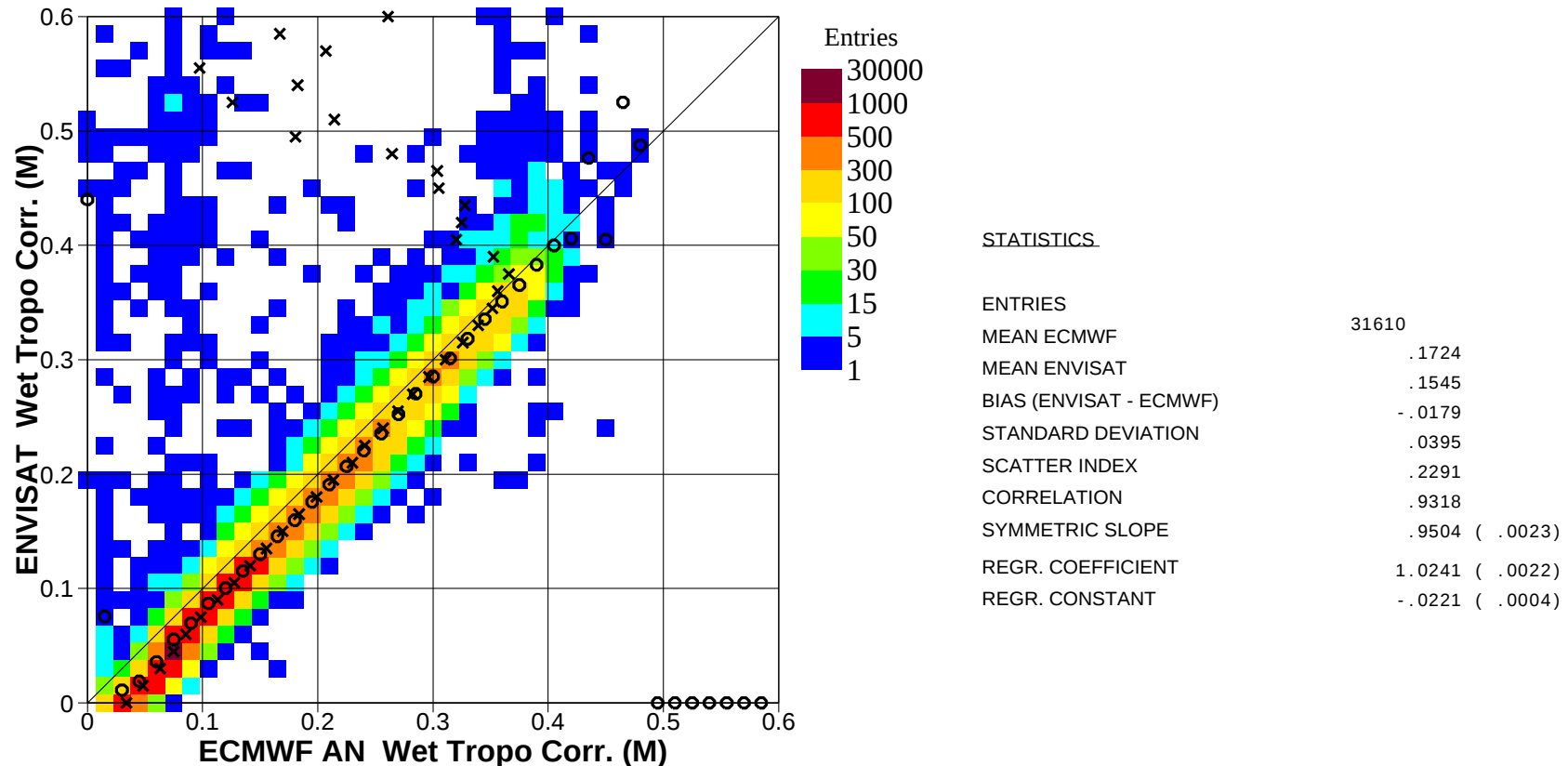


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2003 (Global)

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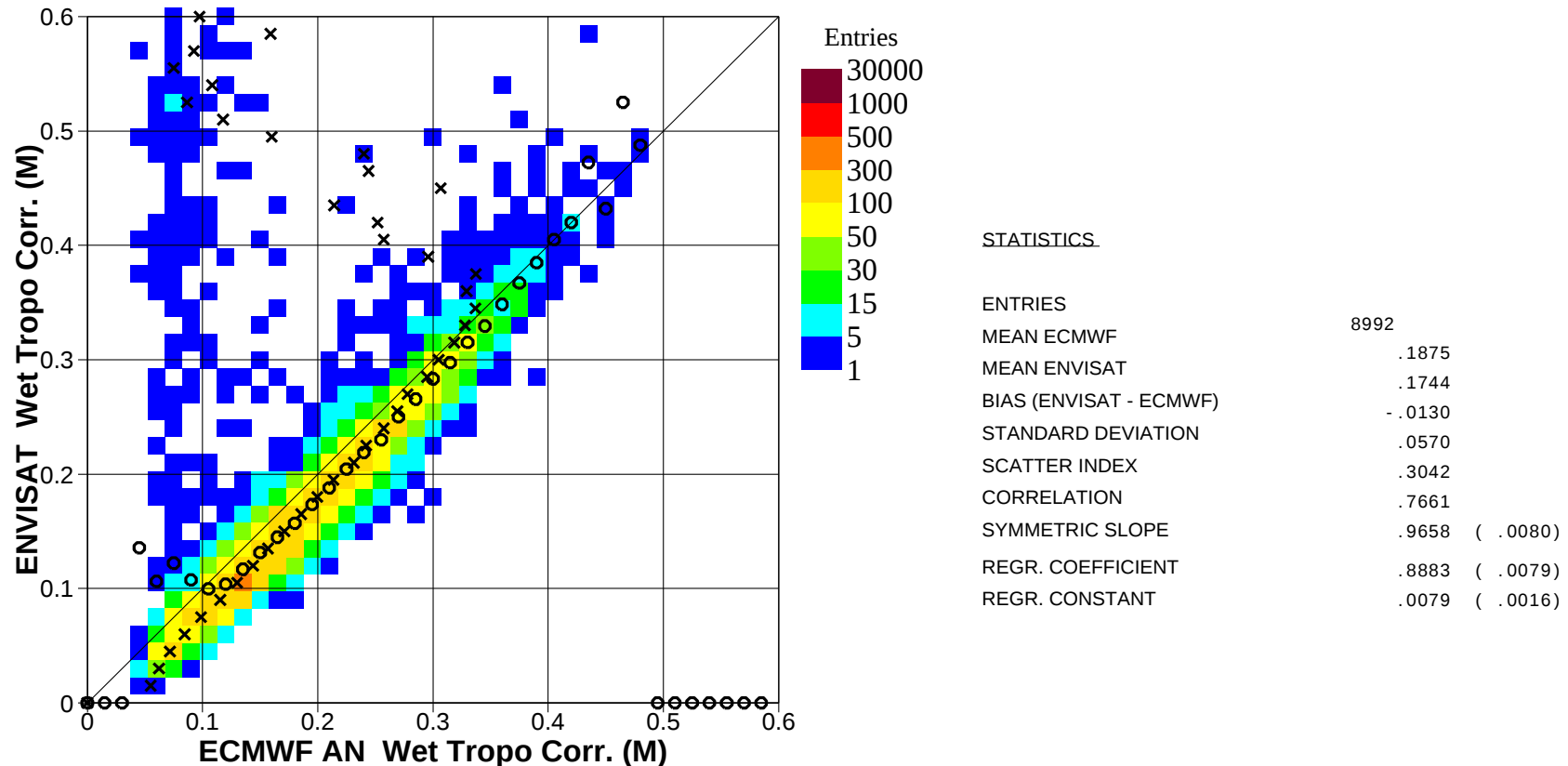


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2003 (N.Hem.)

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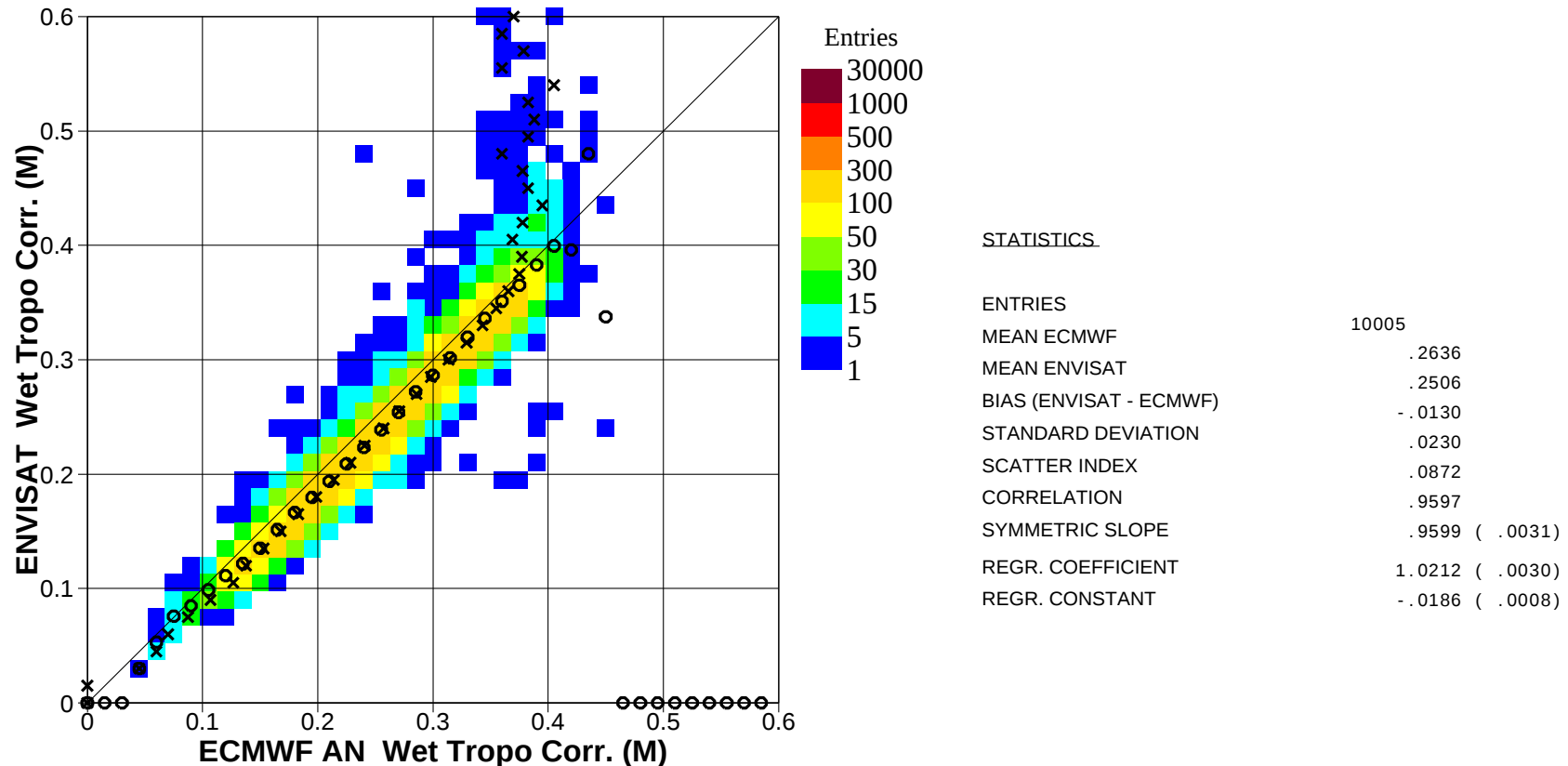


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2003 (Tropics)

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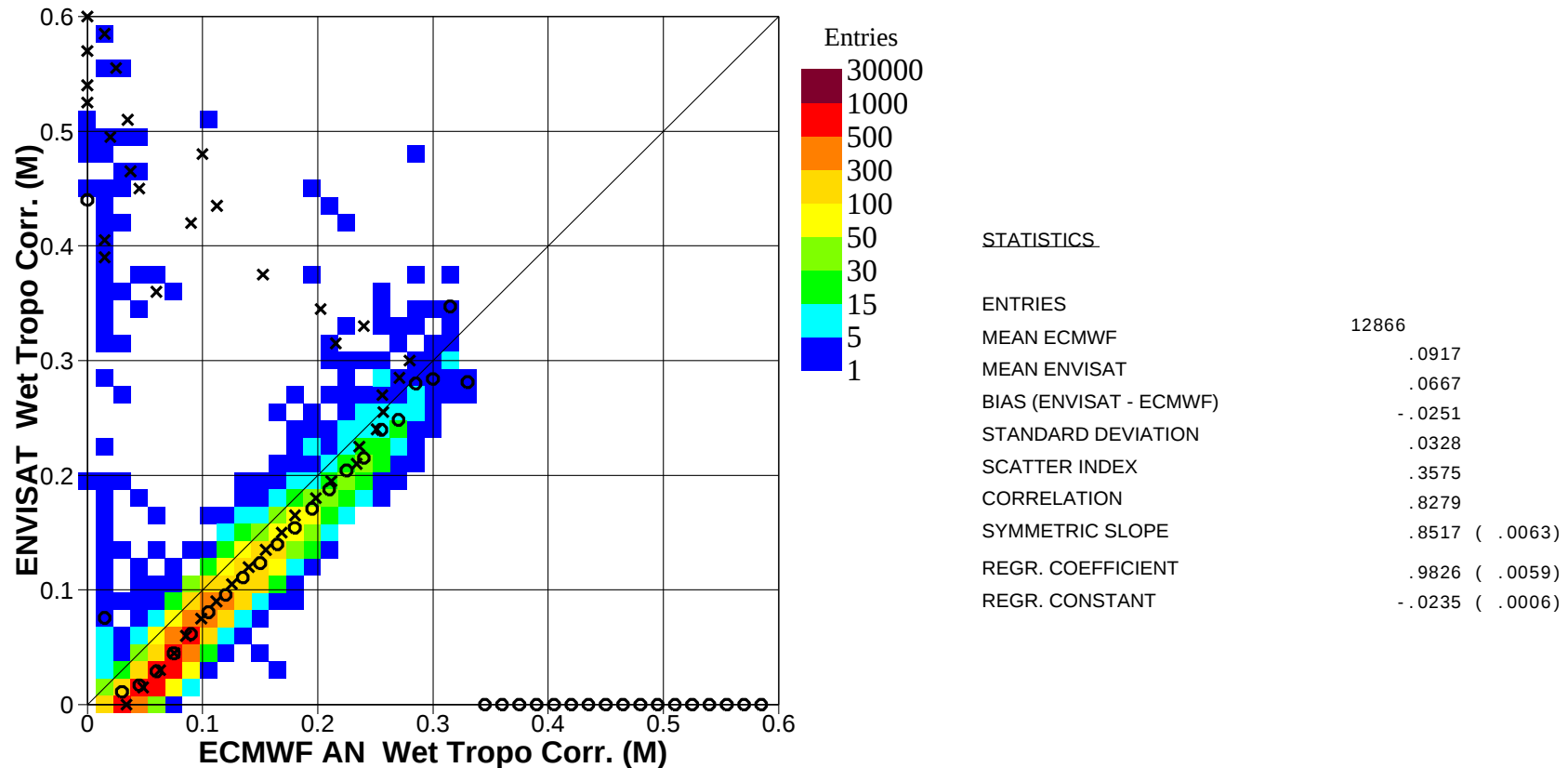


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for July 2003 (S.Hem.)

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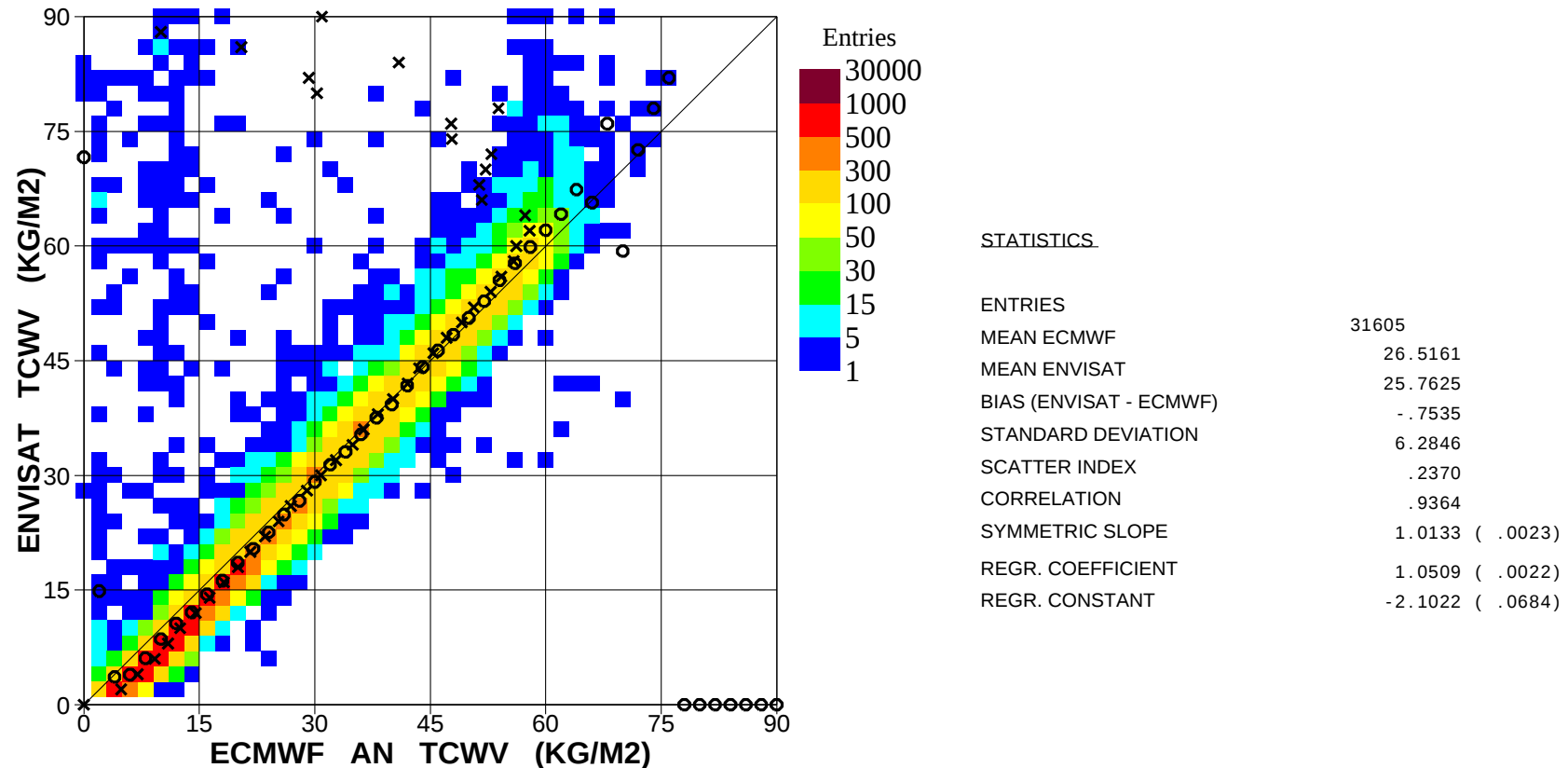


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2003 (Global)

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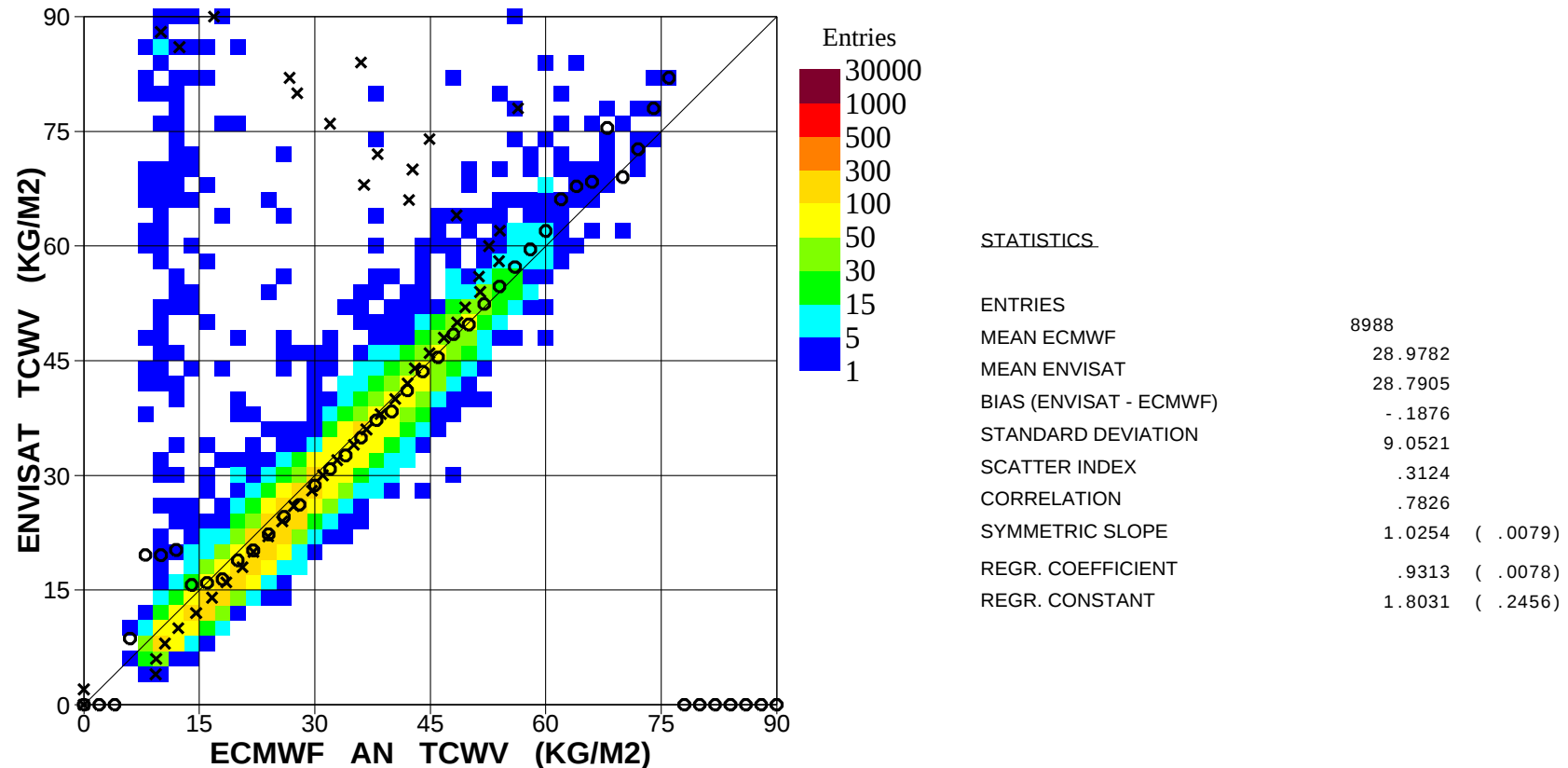


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2003 (N.Hem.)

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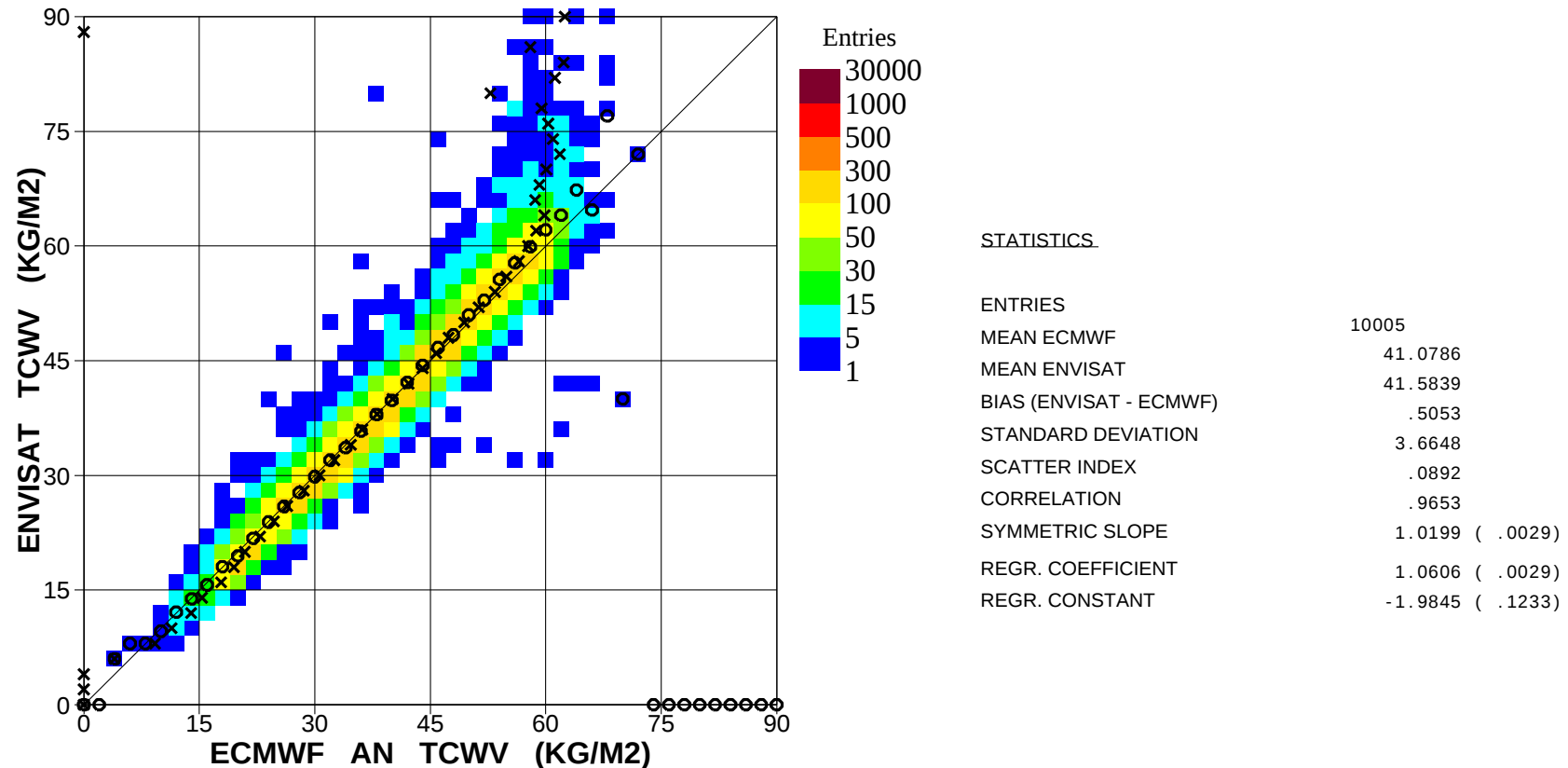


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2003 (Tropics)

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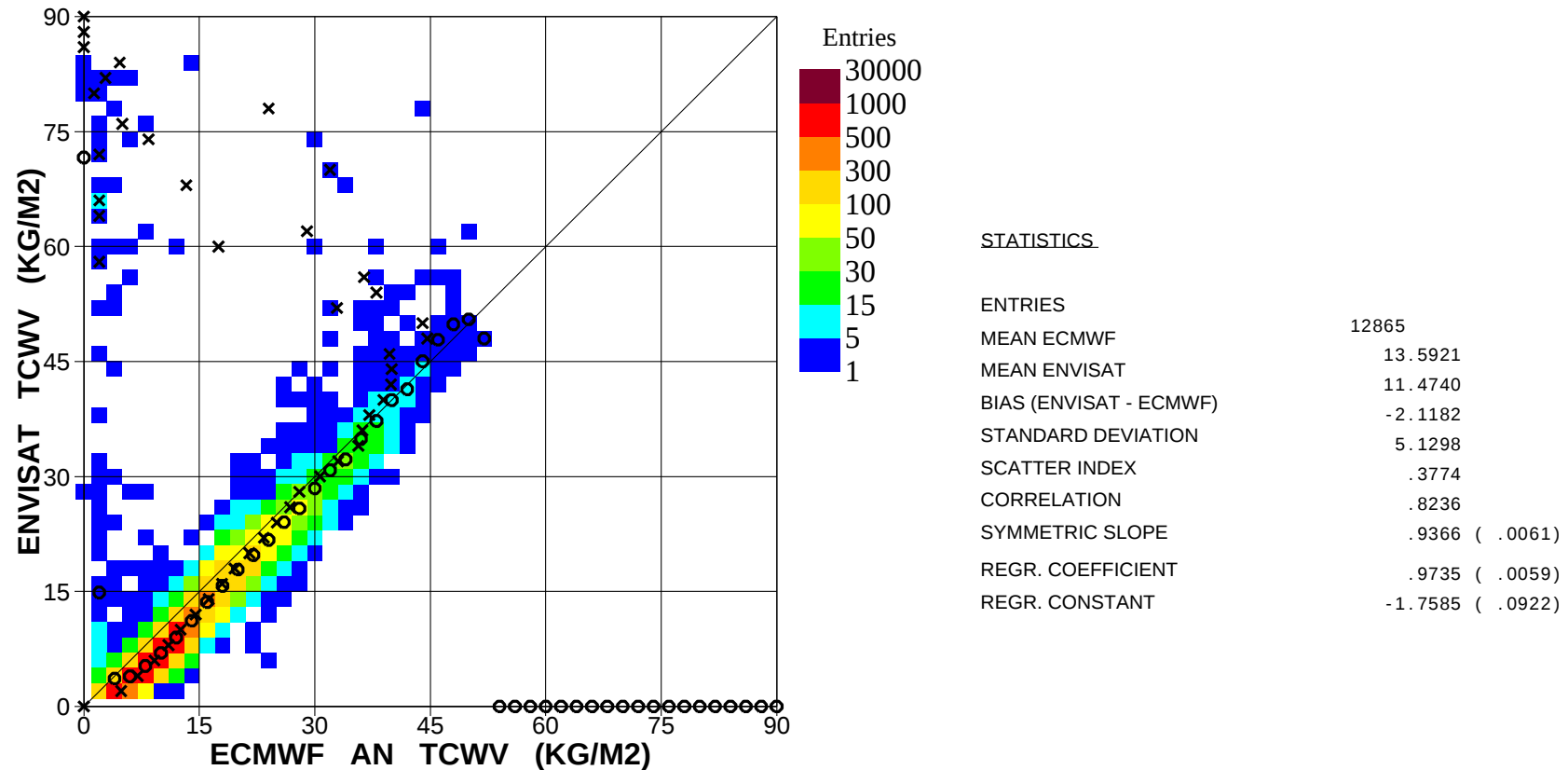


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for July 2003 (S.Hem.)

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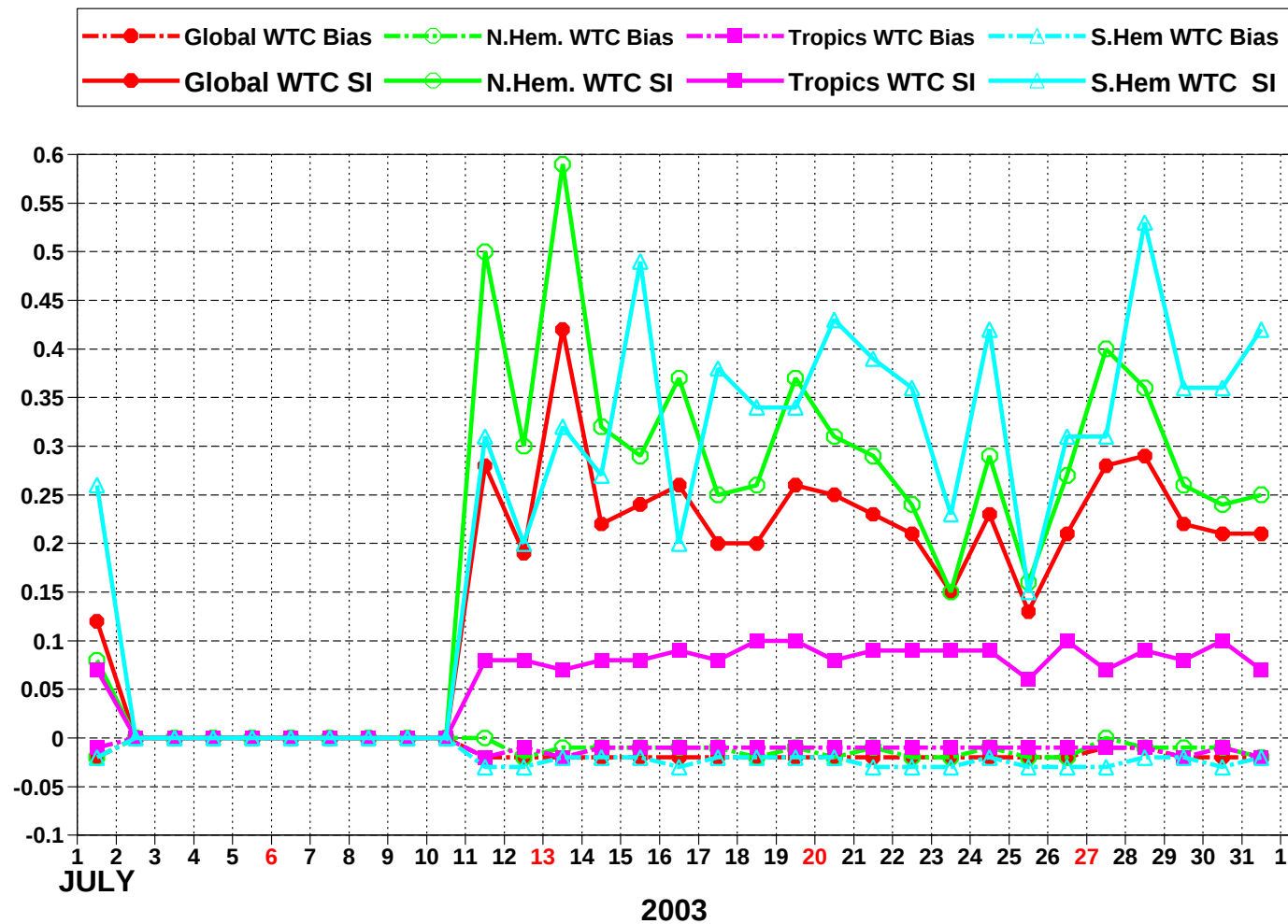


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)



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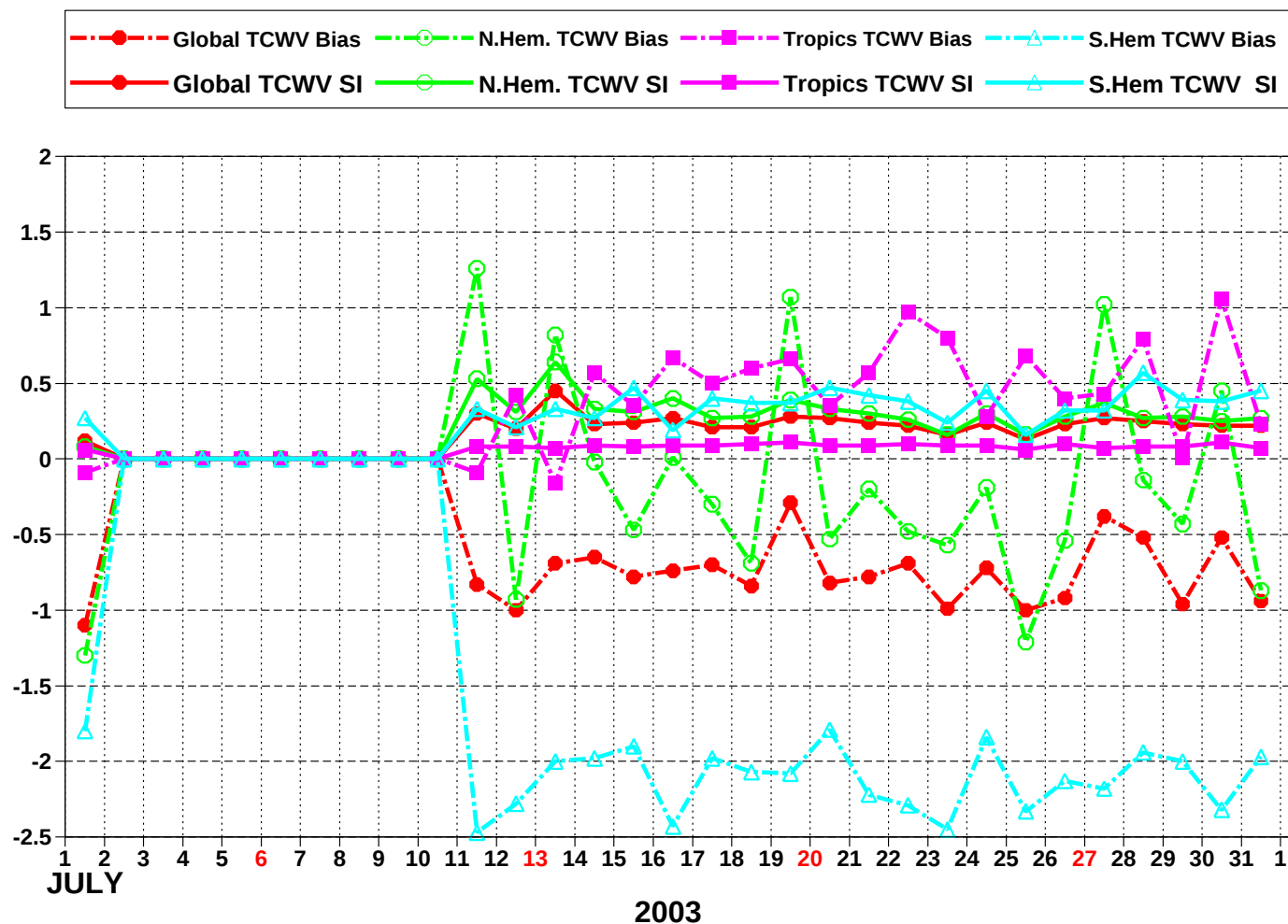


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)



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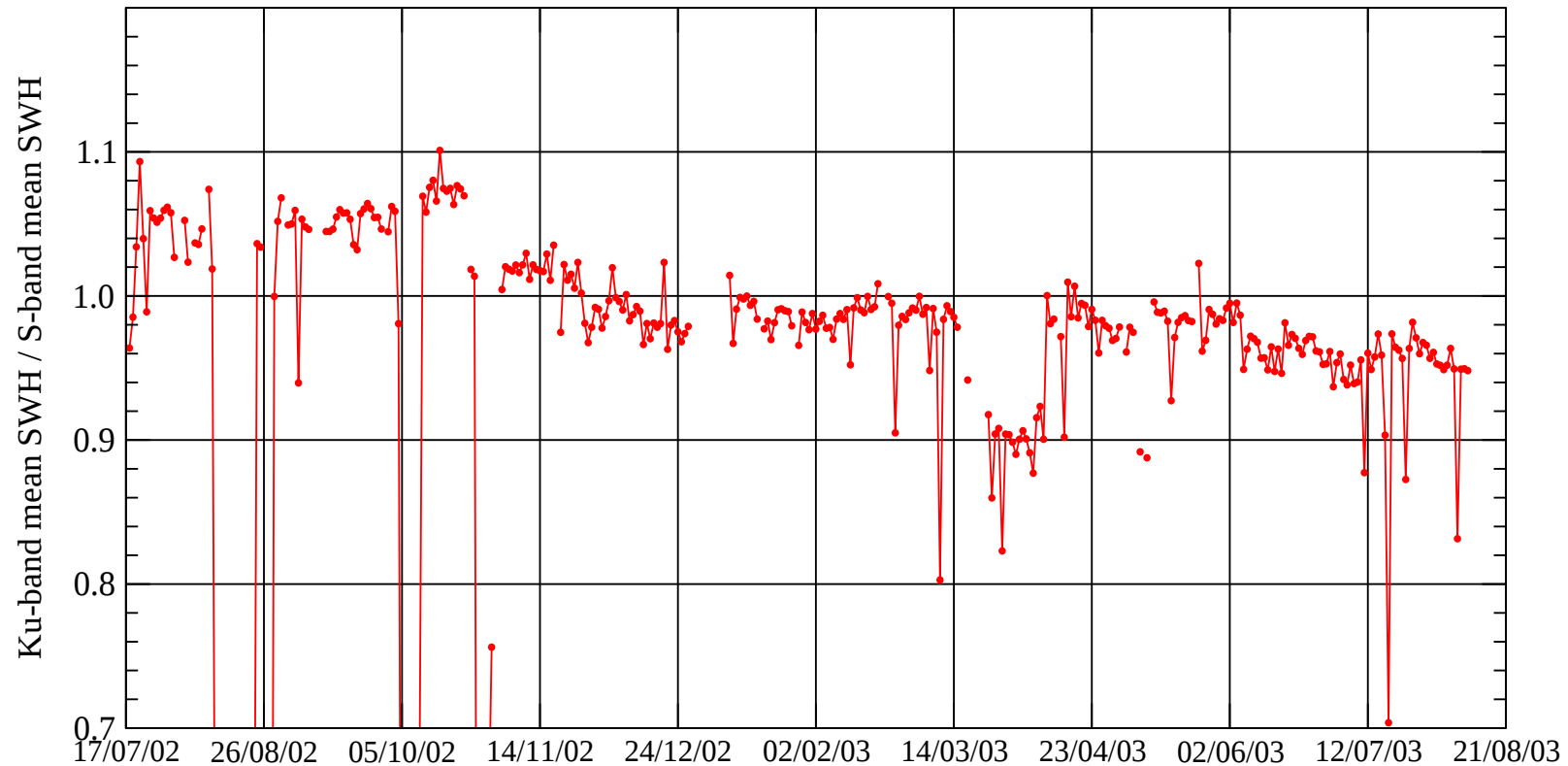


Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 18th. of July 2002.