

■ ECMWF Report on ENVISAT RA-2 for January 2004 ■

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

By: Saleh Abdalla

Date: 13 February 2004

Overview:

Based on the data received during this month, on average, 11185 observations arrived at ECMWF every 6-hour window of which an average of 4784 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 79.13% 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.
- Starting from the beginning of the year till 00:00 on the 7th. of January there was no data except for windows of 06:00 due to missing BUFR files on the near-real time server (<ftp-ops.pdk.envisat.esa.int>).
- Time window 12:00 on the 28th. 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. RA-2 and MWR Instrument Processing Chain (IPF) V4.56 was operational at the ESA ENVISAT PDS processing centres at 07:31:27 UTC on Wednesday 26 November 2003.



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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 S-band wave height observations show a number of outliers. The quality of wind speed observations is better than usual. Apart from the few outliers, MWR products are generally fine and in good agreement with the model (they still somewhat drier than the model). Apparently, the MWR products became better since the implementation of the processing chain (V4.56) on the 26th. of November 2003.

Backscatter:

- ENVISAT RA-2 Ku-Band $\langle\sigma_0\rangle = 11.15$ dB (with a single peak at ~ 11.1 dB).
- ENVISAT RA-2 S-Band $\langle\sigma_0\rangle = 11.50$ dB (with a single rather broad 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	-0.17	16.7	-0.30	16.3
Northern Hemisphere	0.13	17.2	-0.24	16.1
Tropics	-0.33	18.5	-1.14	15.0
Southern Hemisphere	-0.19	15.2	----	----



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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	0.06	12.9	0.10	13.0
Northern Hemisphere	0.22	13.0	0.10	13.1
Tropics	-0.04	11.9	0.05	10.1
Southern Hemisphere	0.05	11.8	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.08	30.7	0.03	23.1
Northern Hemisphere	0.15	25.0	0.03	22.6
Tropics	0.09	46.5	0.01	29.3
Southern Hemisphere	0.04	25.0	----	----



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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	-0.013	13.0	-0.51	14.1
Northern Hemisphere	-0.011	27.0	-0.89	27.4
Tropics	-0.009	6.9	+0.93	7.0
Southern Hemisphere	-0.015	15.4	-1.29	17.3

Remarks:

- According to the used land sea mask (which is used for the operational WAM run at ECMWF), more than one third (33% 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 6% of the data this month, it was responsible for rejection of most of the data on the 9th., the 10th., the 17th., the 22nd. and the 24th. 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).



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- 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.
- There is a trend for Ku-band wave heights to be slightly overestimated especially when compared to WAM results by about 4%. 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). On the other hand, the RA-2 Ku-band wave heights are higher than buoy wave heights by about 2%.
- The bulk of S-band wave heights are in good agreement with both the WAM and the buoy data apart from 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 number of outliers is much larger than the previous month. Most of those outliers occurred on the 9th., the 10th., the 17th., the 21st., the 22nd. and the 24th. of the month (Figure 37) when there was over-active rain flagging. Figure 49 shows the difference between S-band and WAM model wave heights on the 10th. of the month. It is clearly seen that almost full tracks of S-band overestimation occur causing the large number of outliers.
- The ratio between Ku-band and S-band wave heights was rather stable (~ 0.98) over the whole month as can be 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). However, the number of those outliers is lower than they used to be before the introduction of the processing chain (V4.56) on the 26th. of November 2003. As in the previous month, 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) does not exist any more.
- While the MWR derived TCWV is now in good agreement with the model counterpart, the MWR WTC is still smaller (drier) than the model 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.
- RA-2 and MWR Instrument Processing Chain (IPF) V4.56 was operational at the ESA ENVISAT PDS processing centres at 07:31:27 UTC on Wednesday 26 November 2003.
- 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 following the failure of the ERS-2 tape recorders in June 2003. Also note that Figure 19 only represents the histogram for the covered area only.

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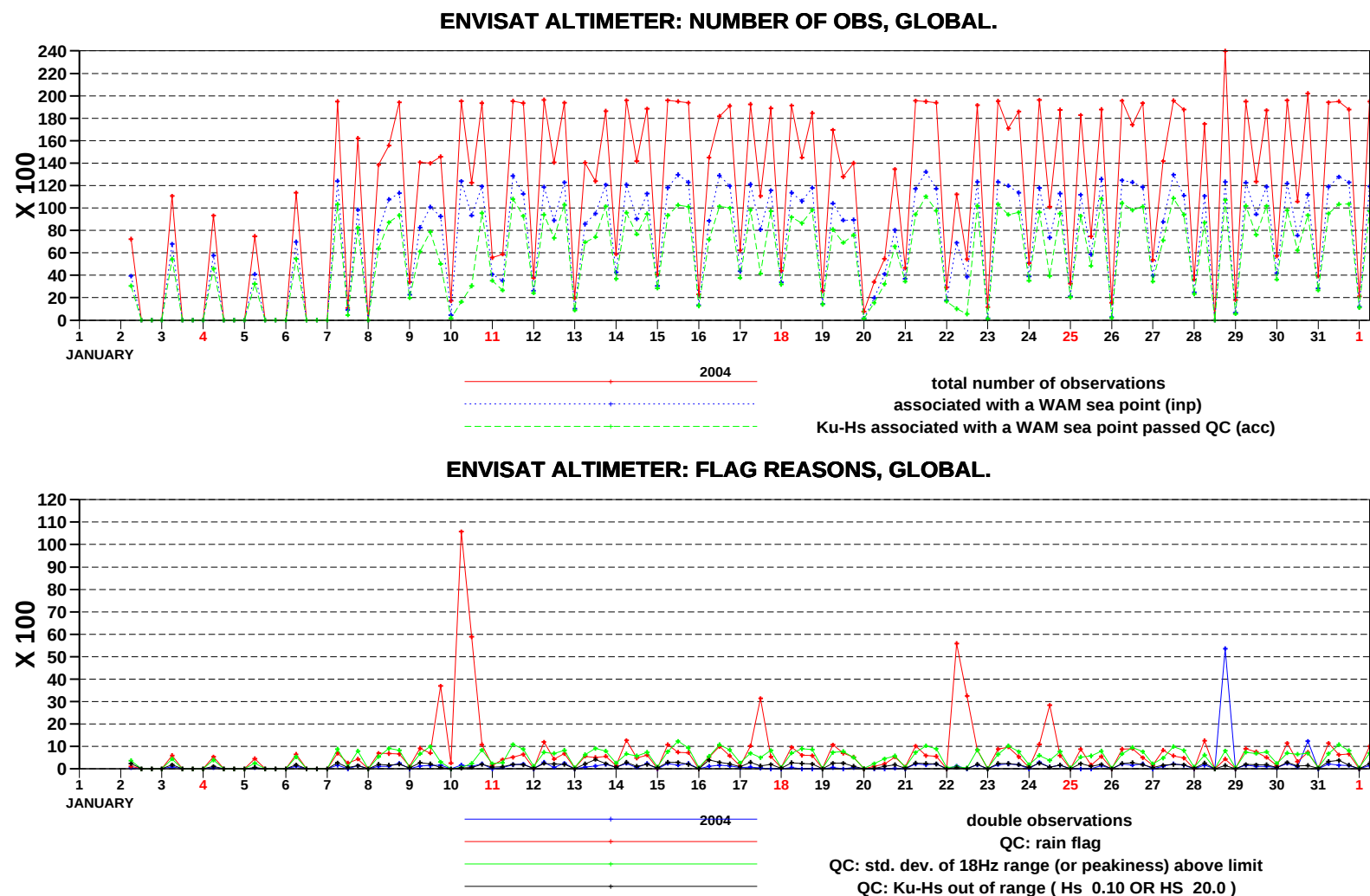


Figure 1: Time series of data reception for ENVISAT Altimeter data for January 2004

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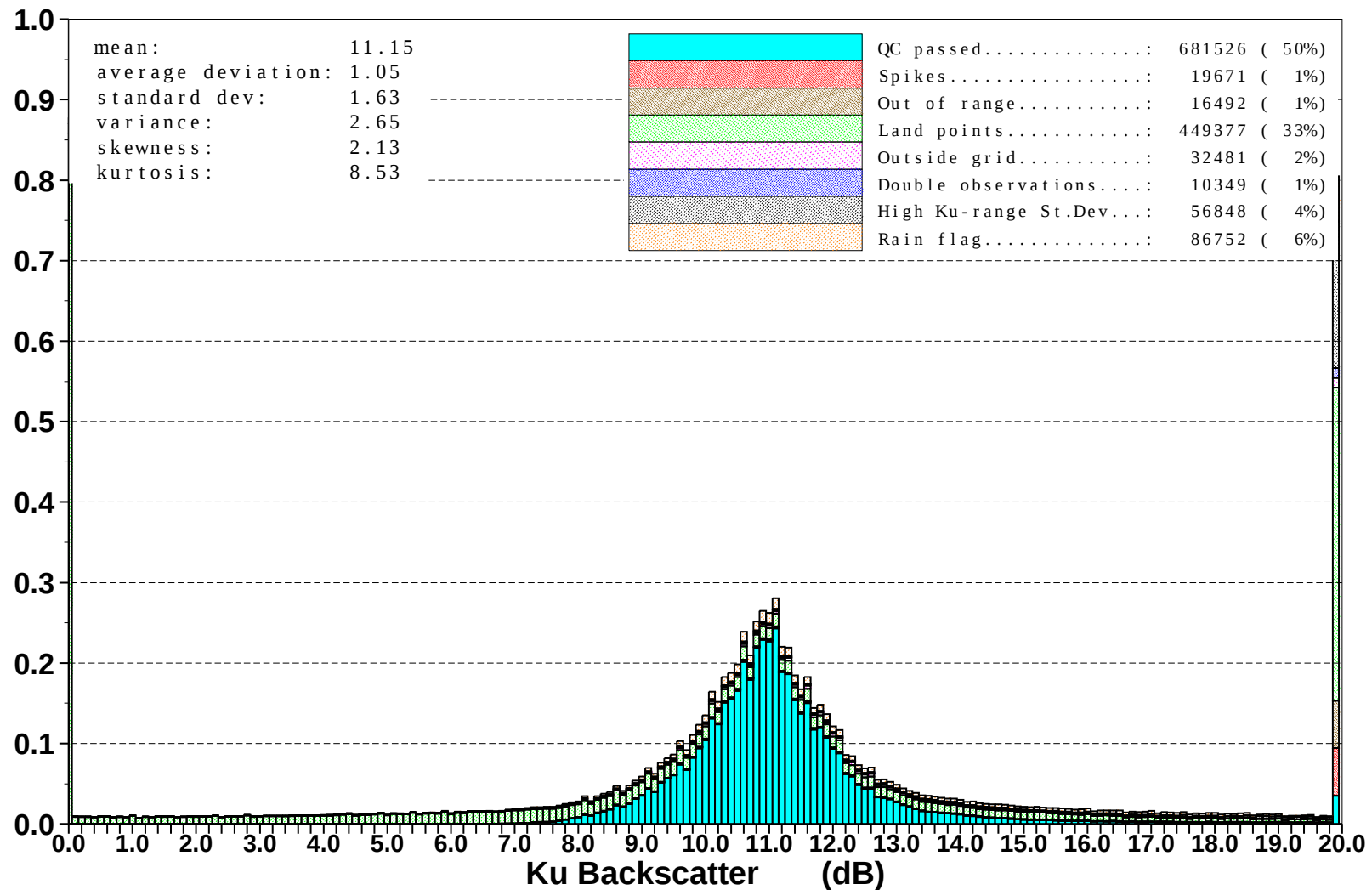


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for January 2004

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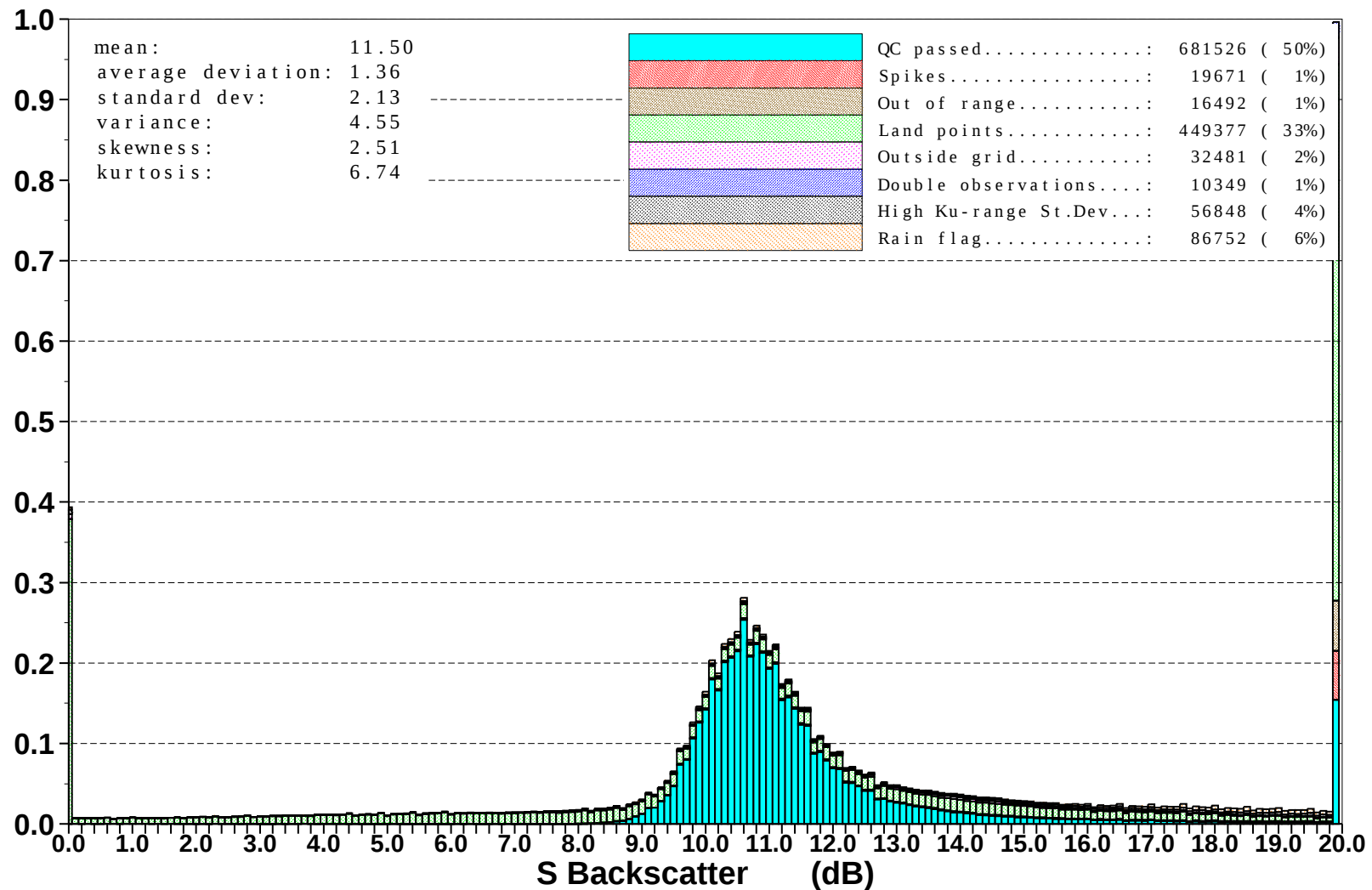
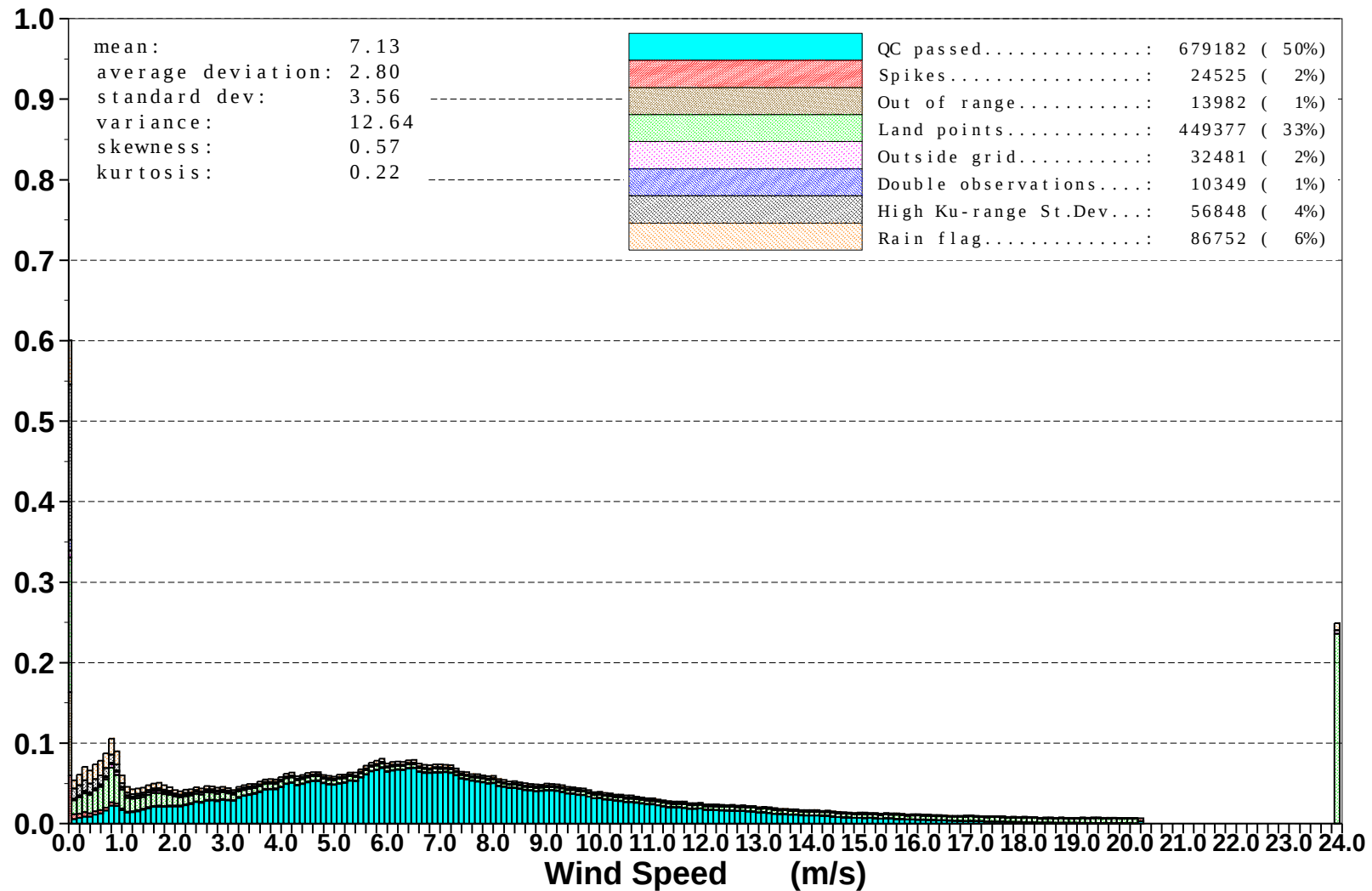


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for January 2004

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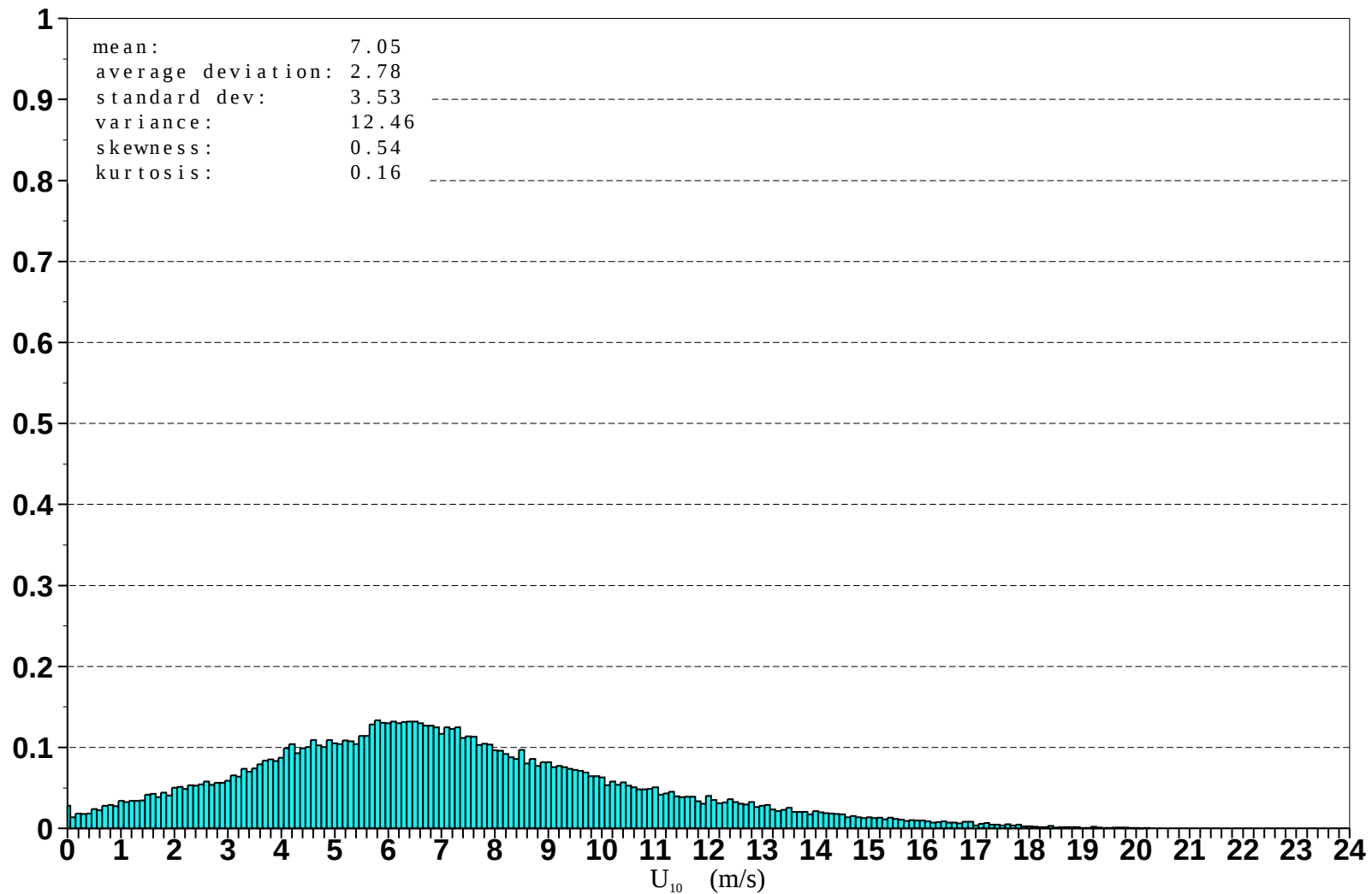


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for January 2004



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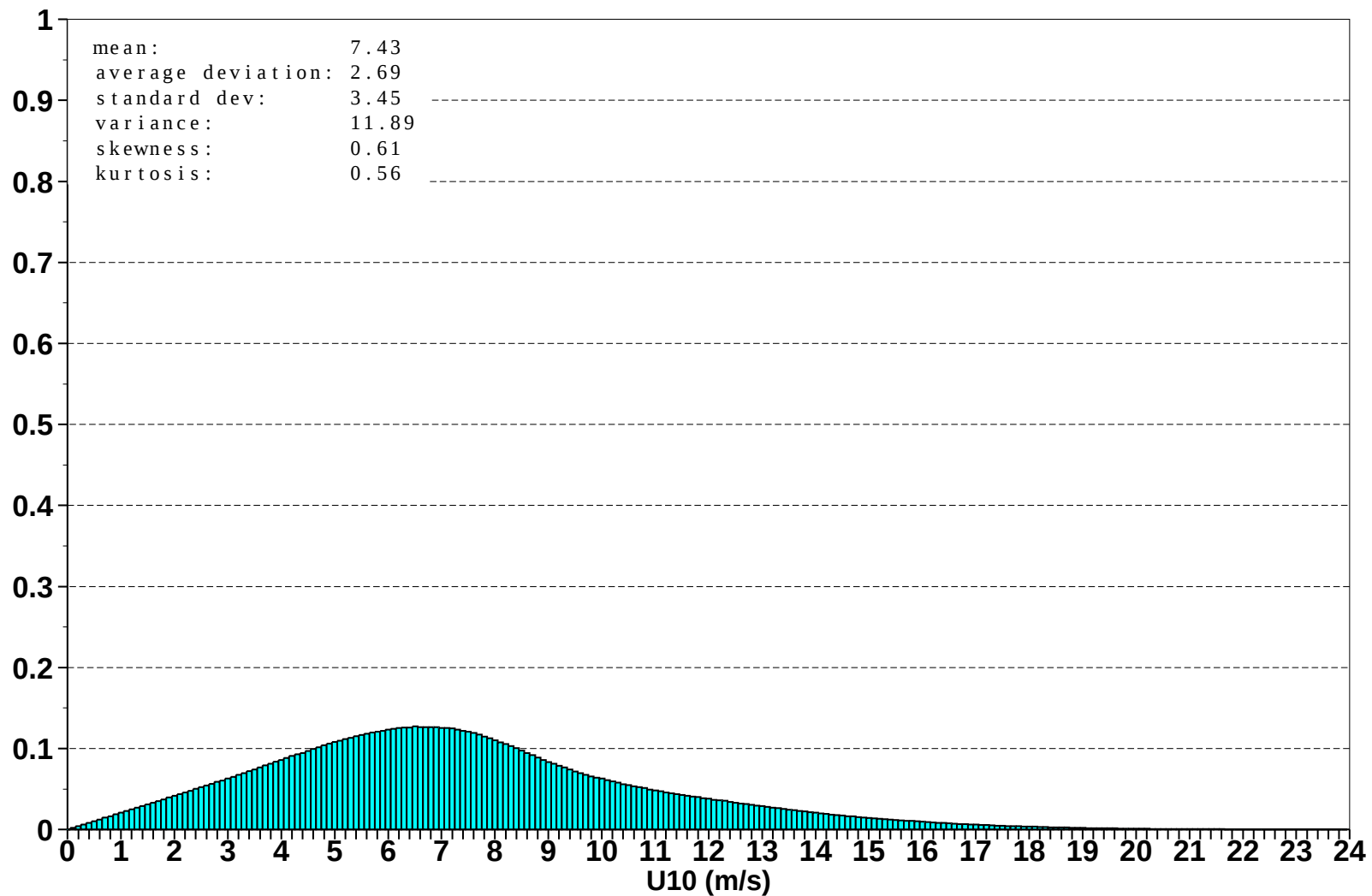


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for January 2004



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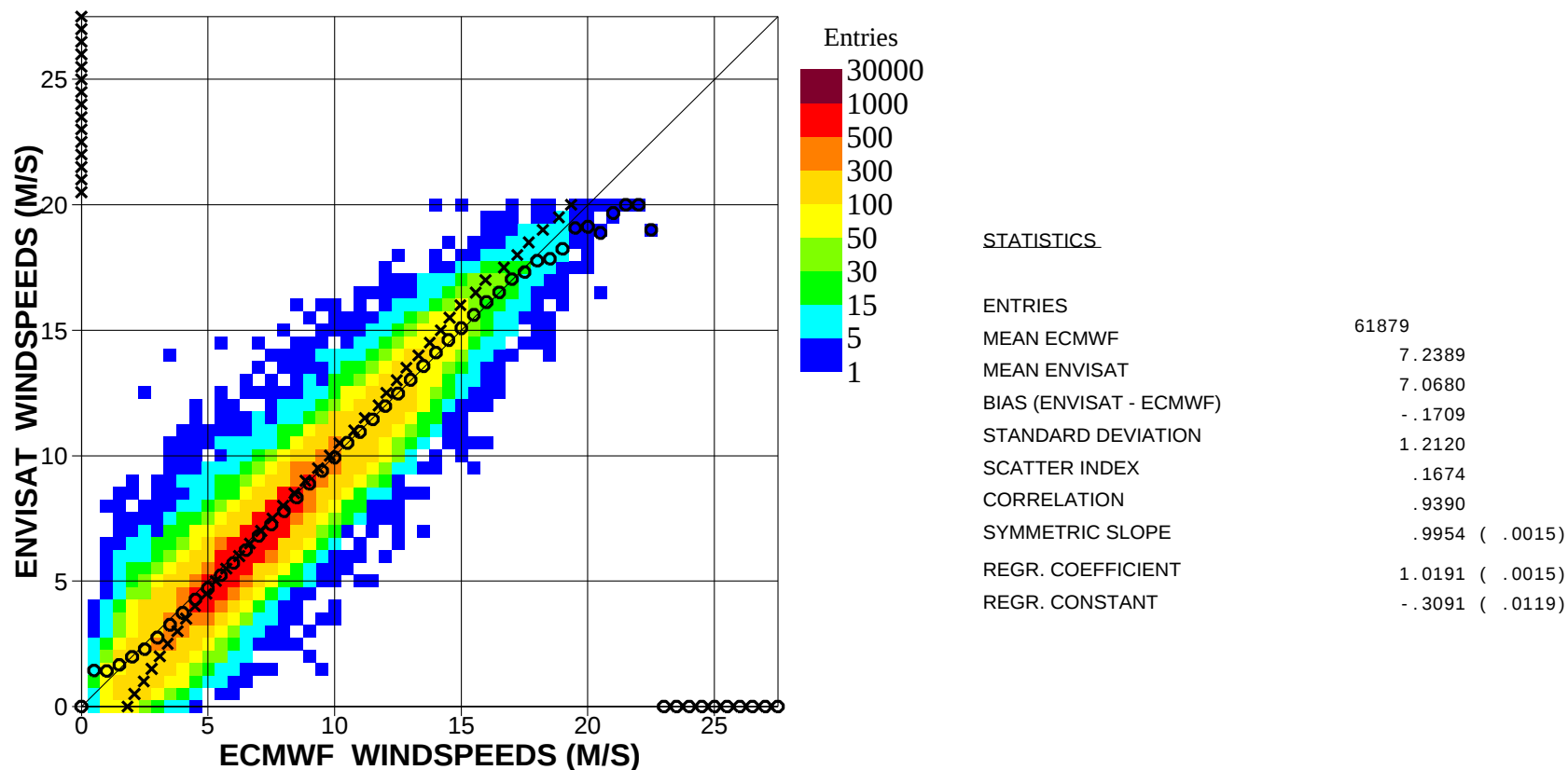


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for January 2004 (Global)

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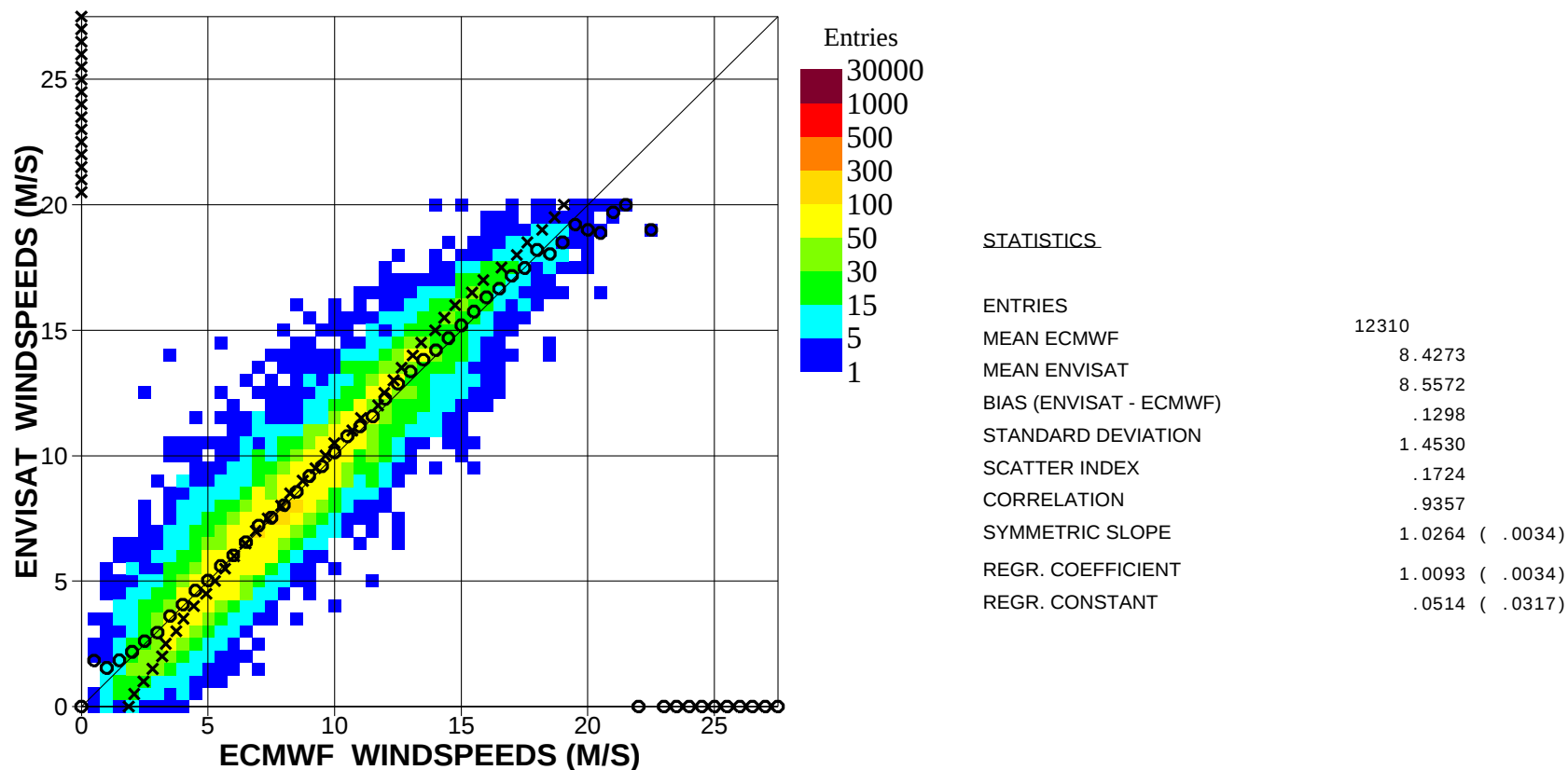


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for January 2004 (N.Hem.)

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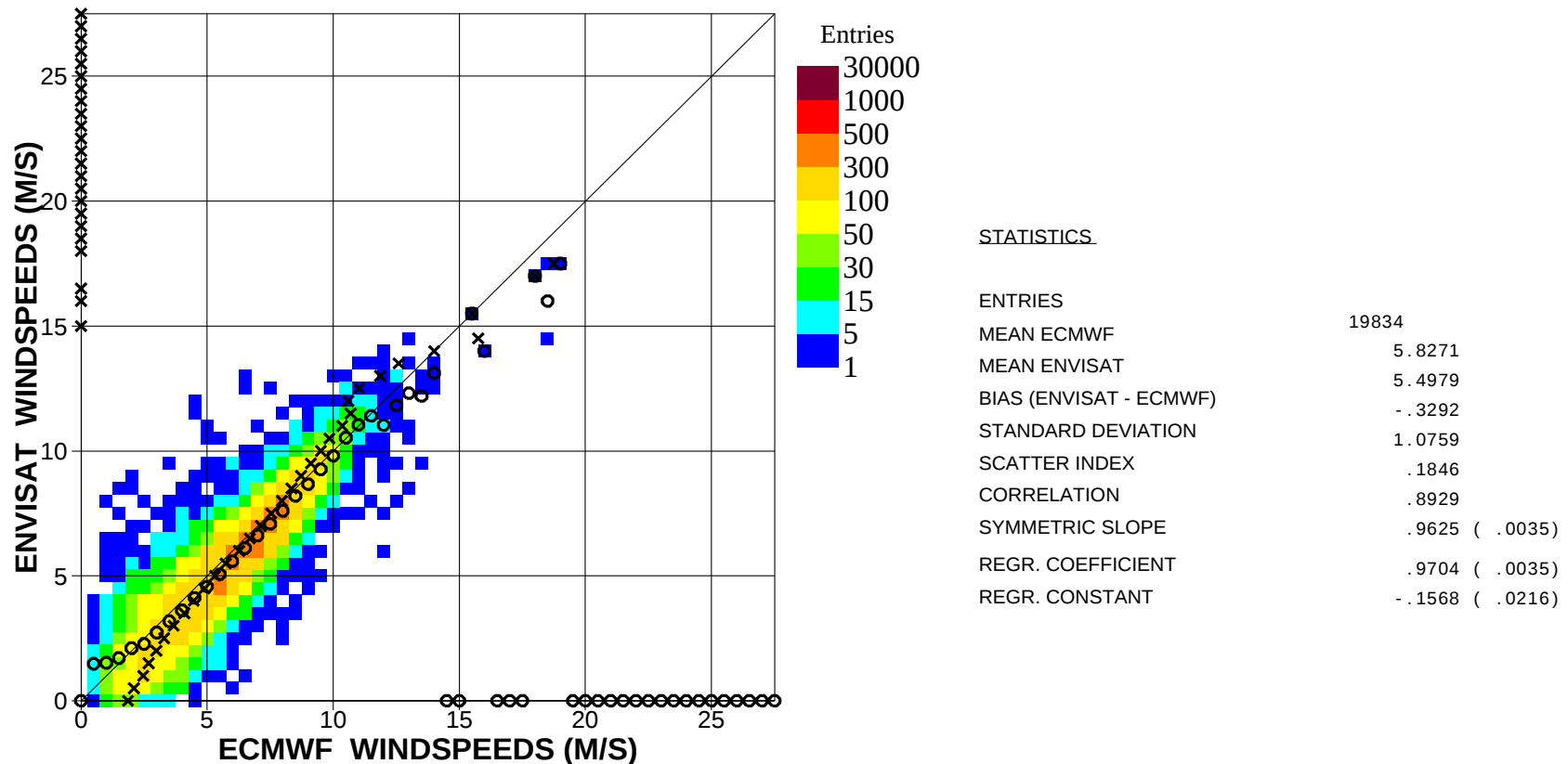


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for January 2004 (Tropics)

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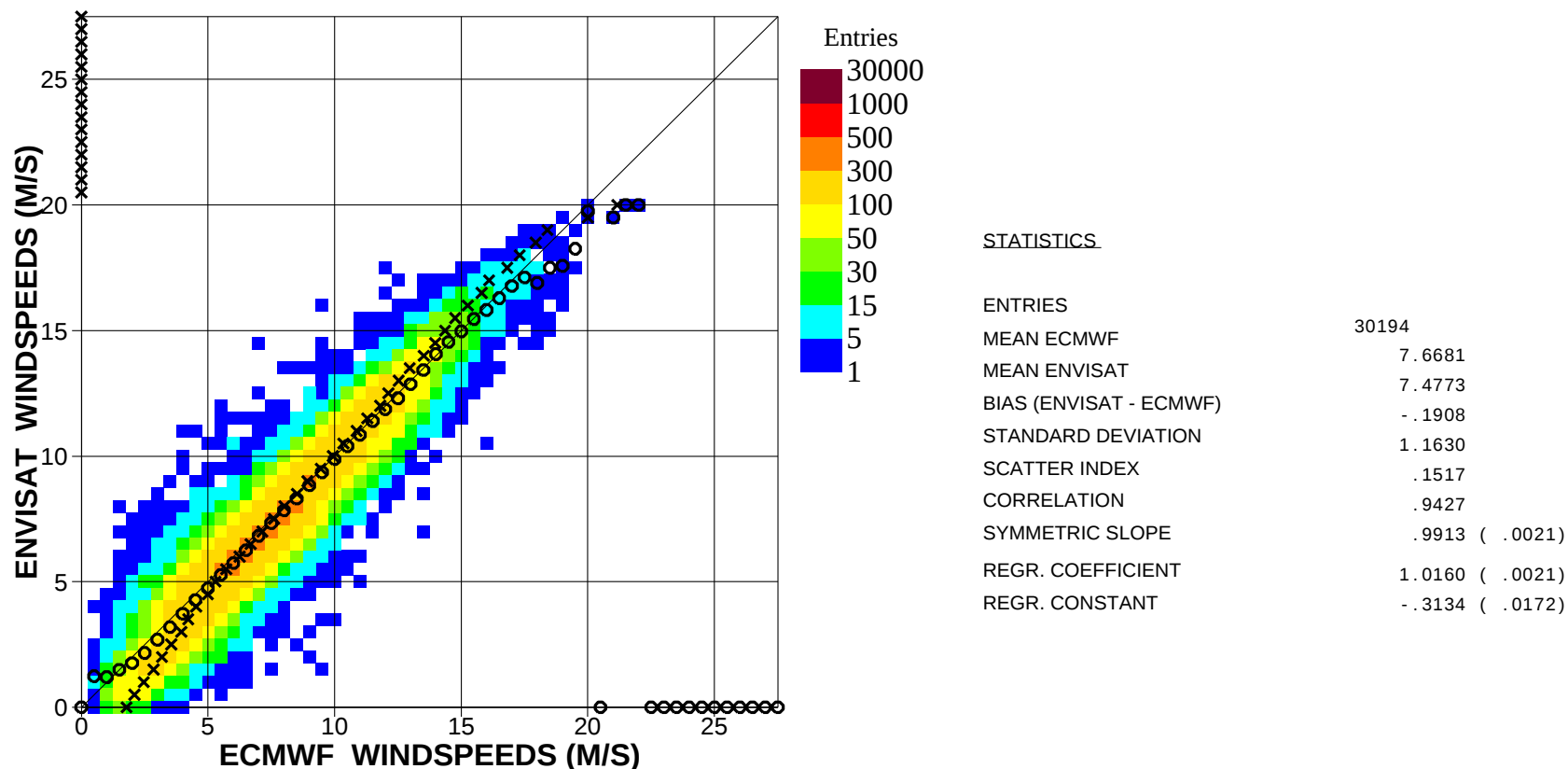


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for January 2004 (S.Hem.)

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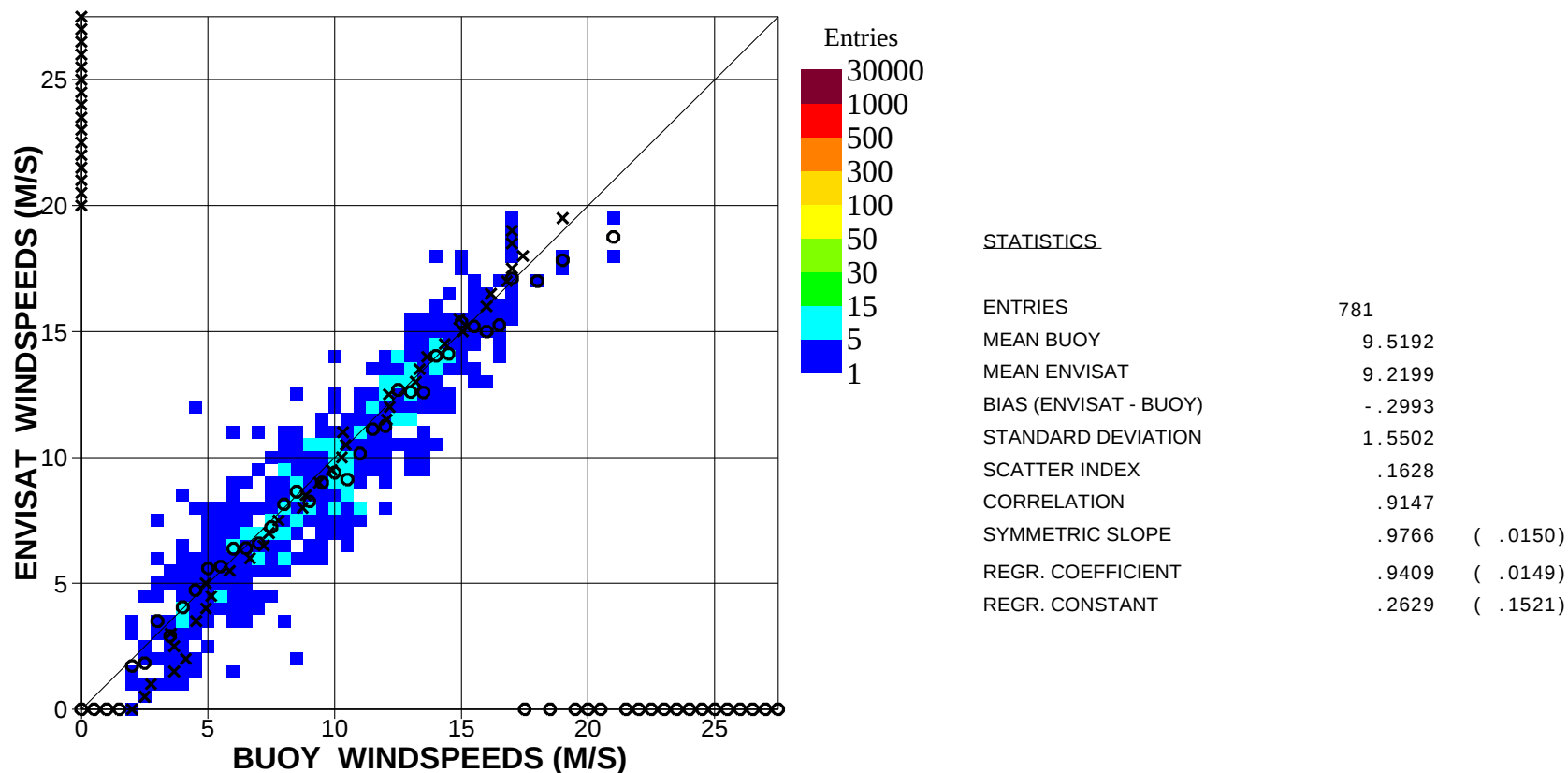


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for January 2004 (Global)

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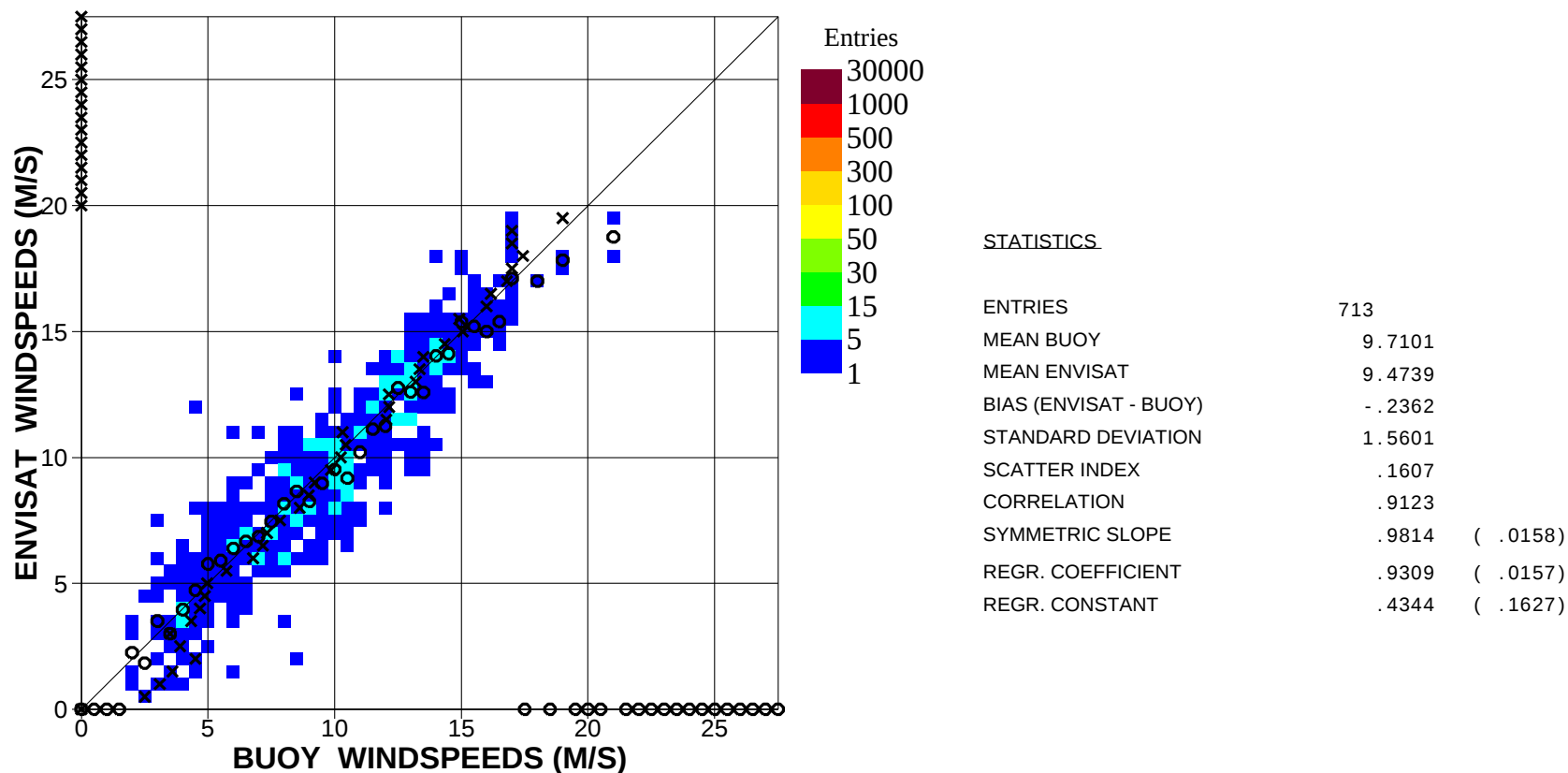


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for January 2004 (N.Hem.)

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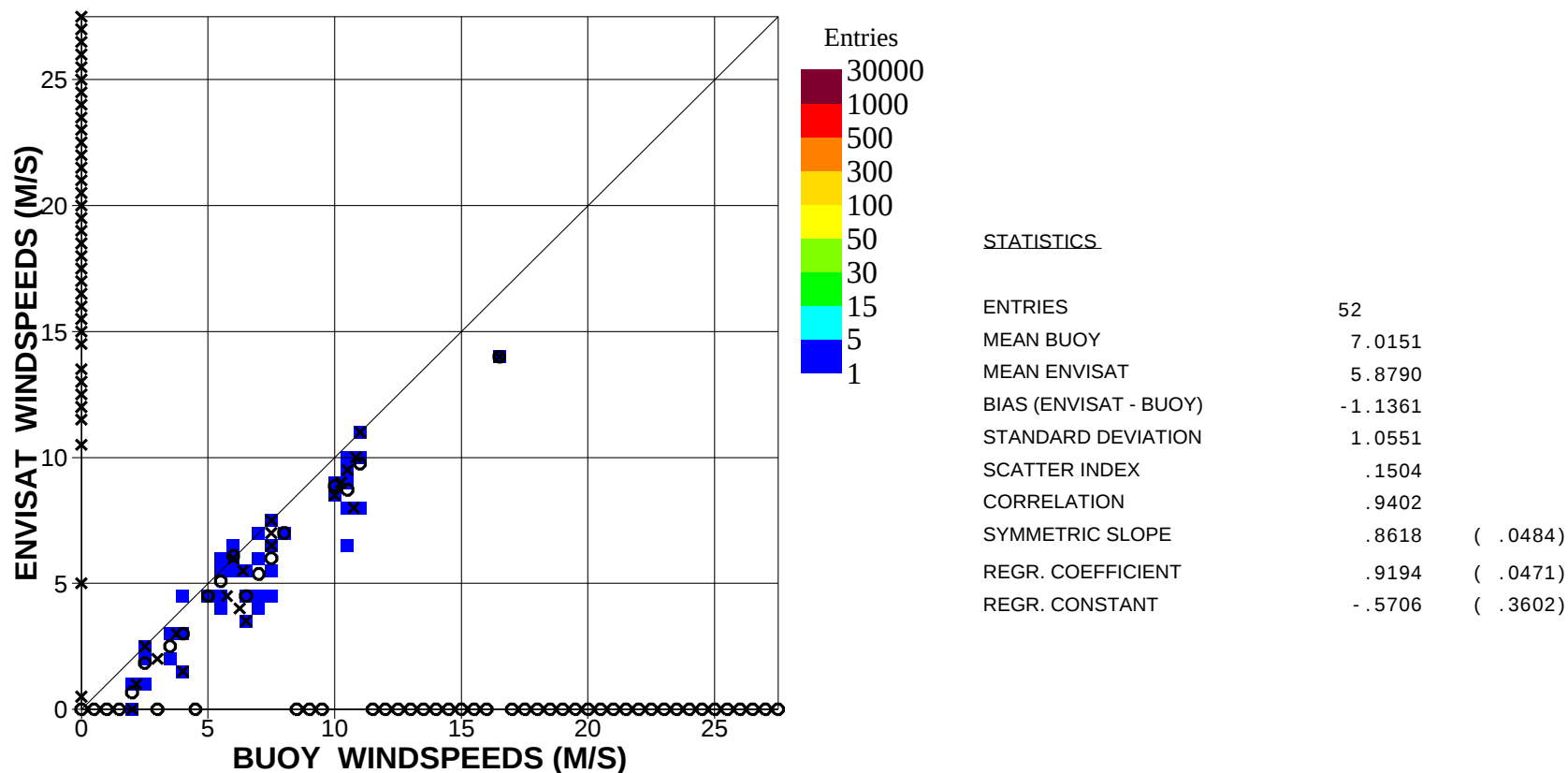


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for January 2004 (Tropics)

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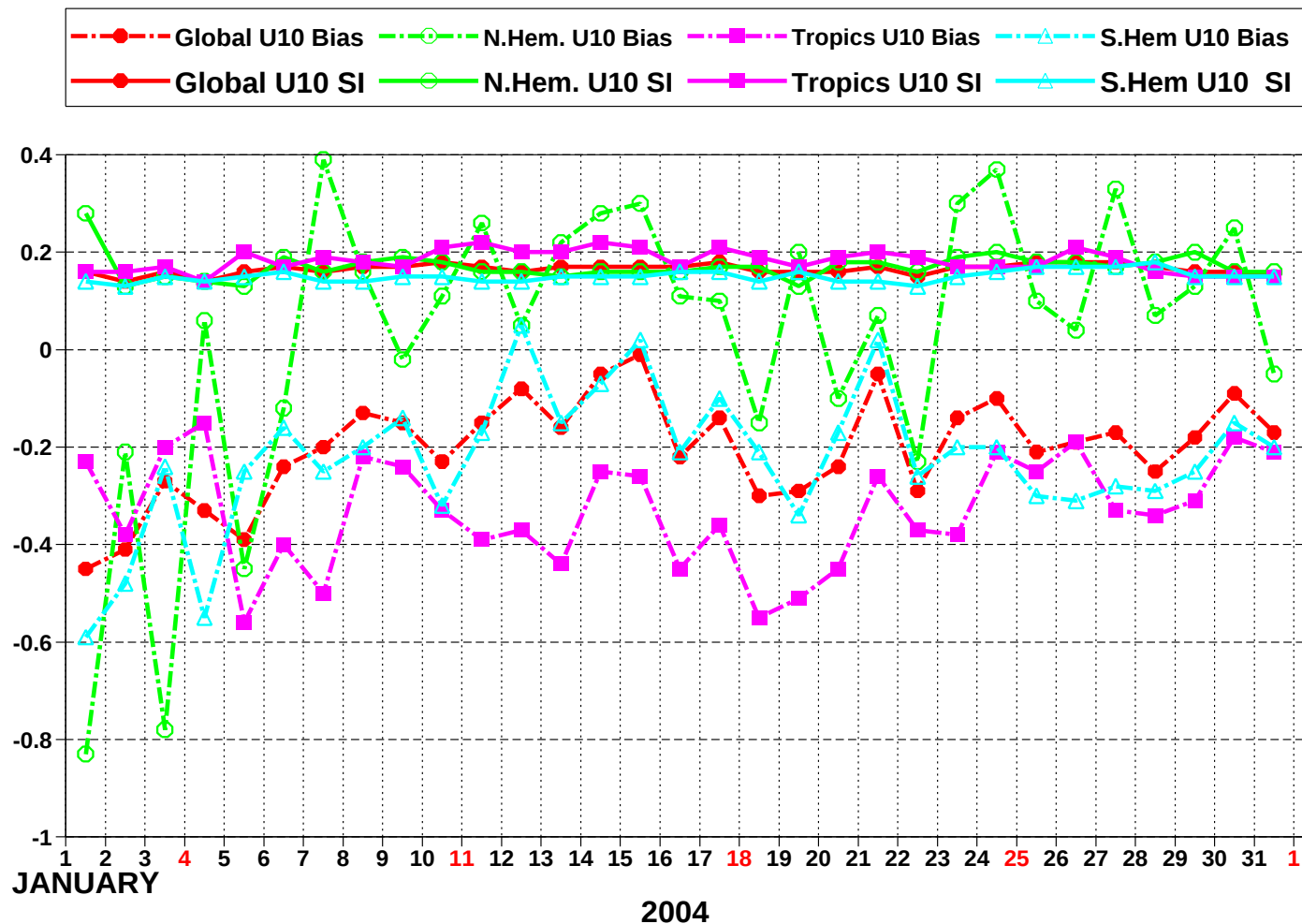


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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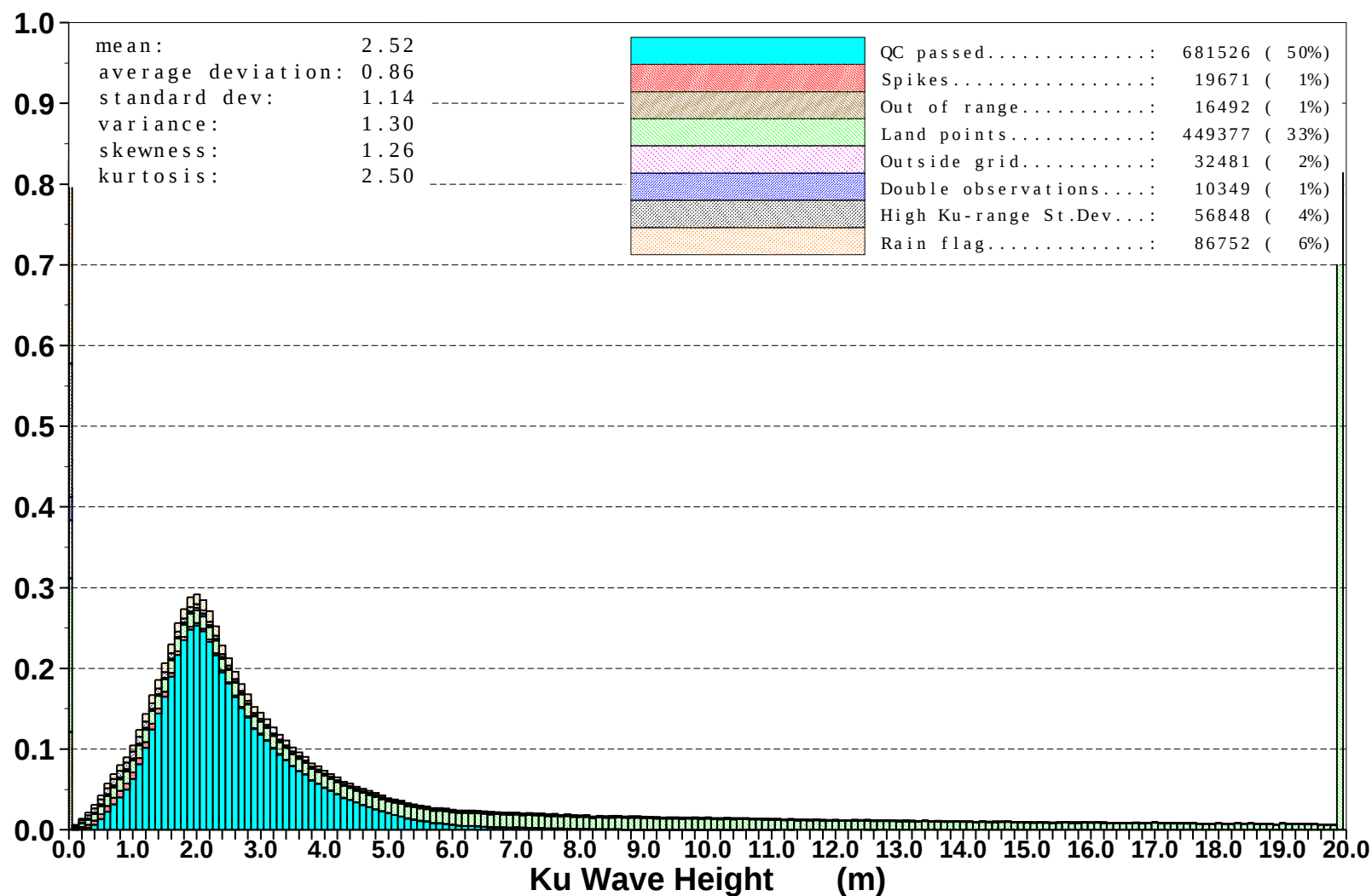


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for January 2004

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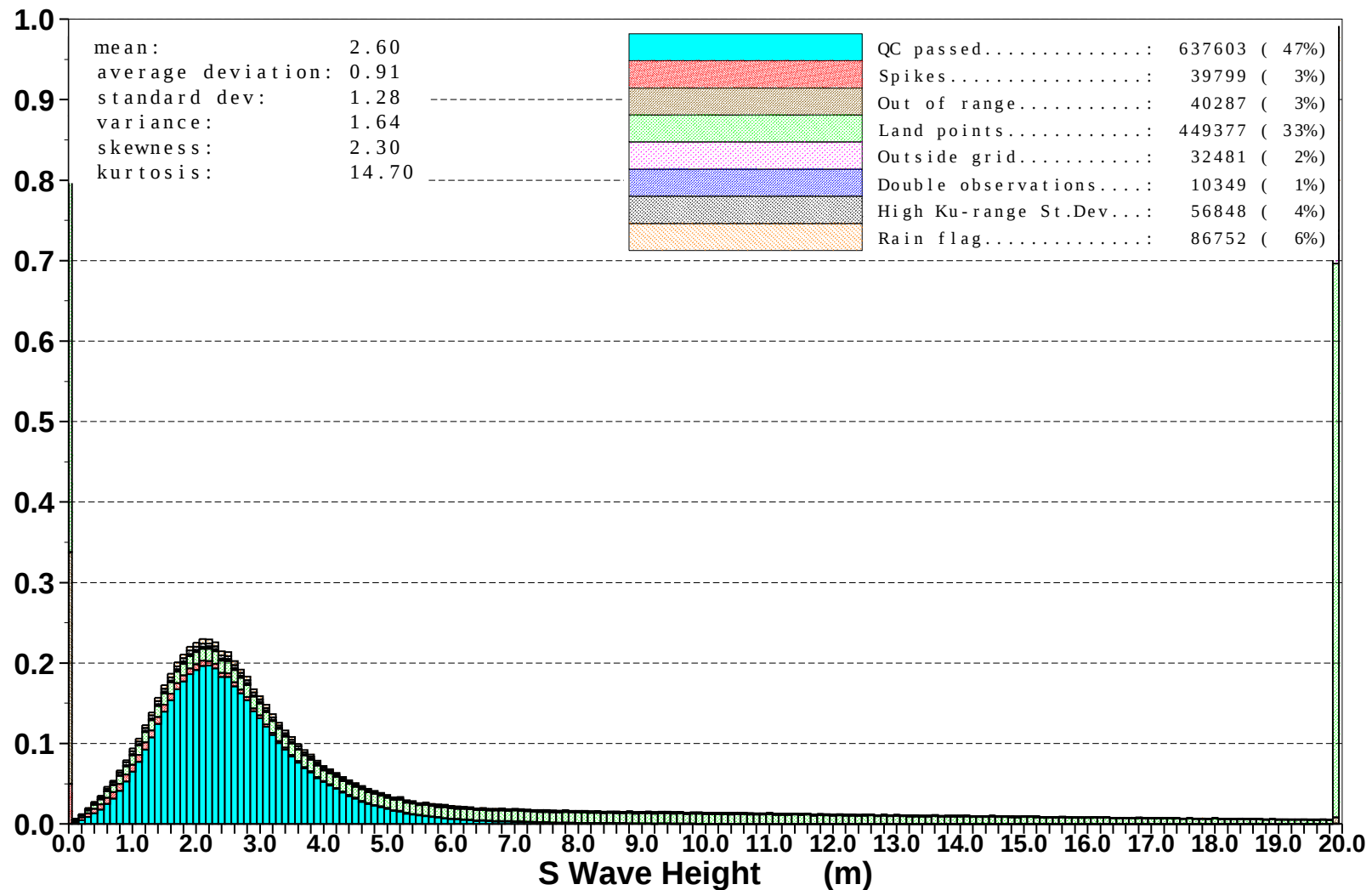


Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for January 2004

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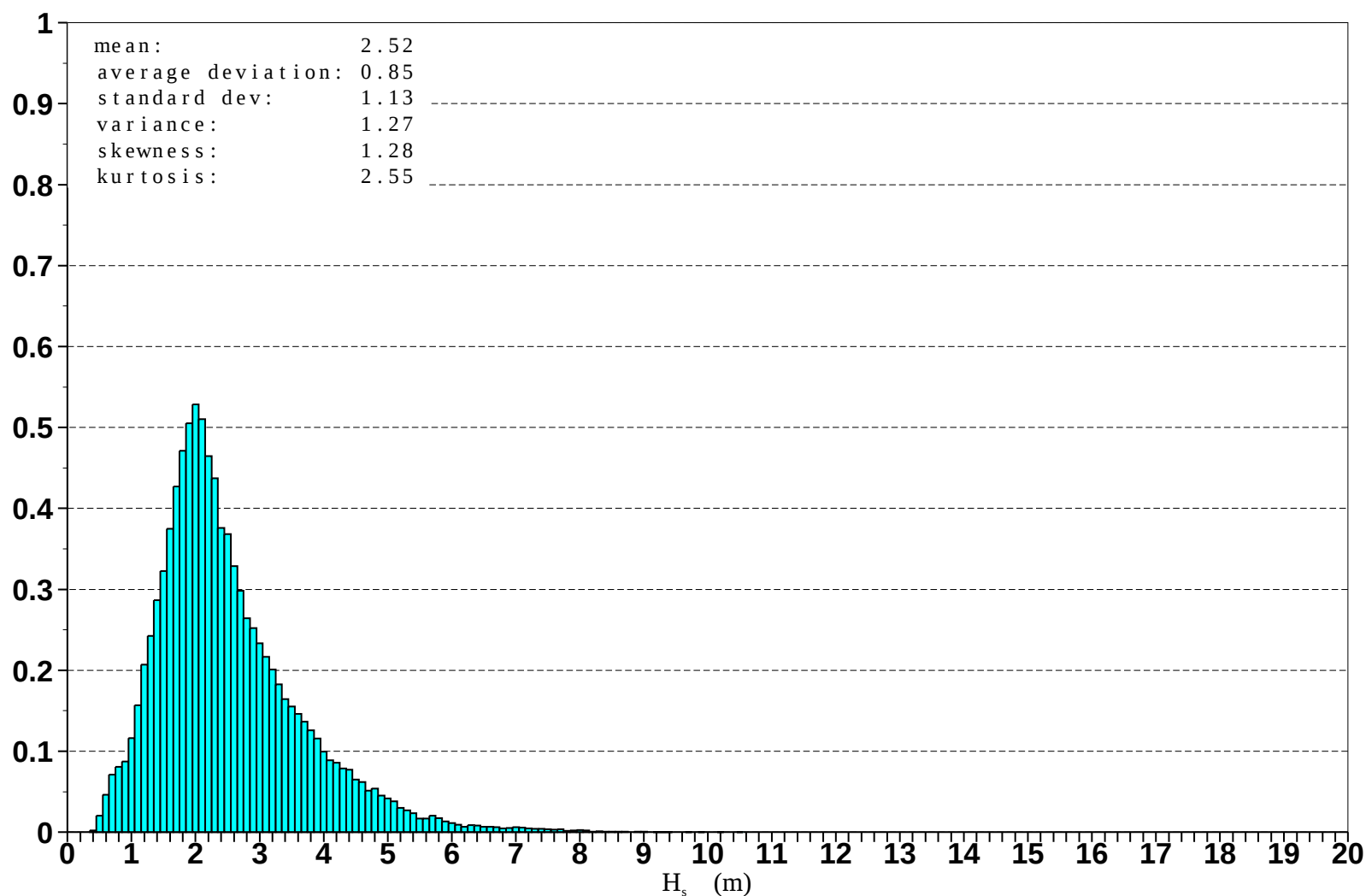


Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for January 2004



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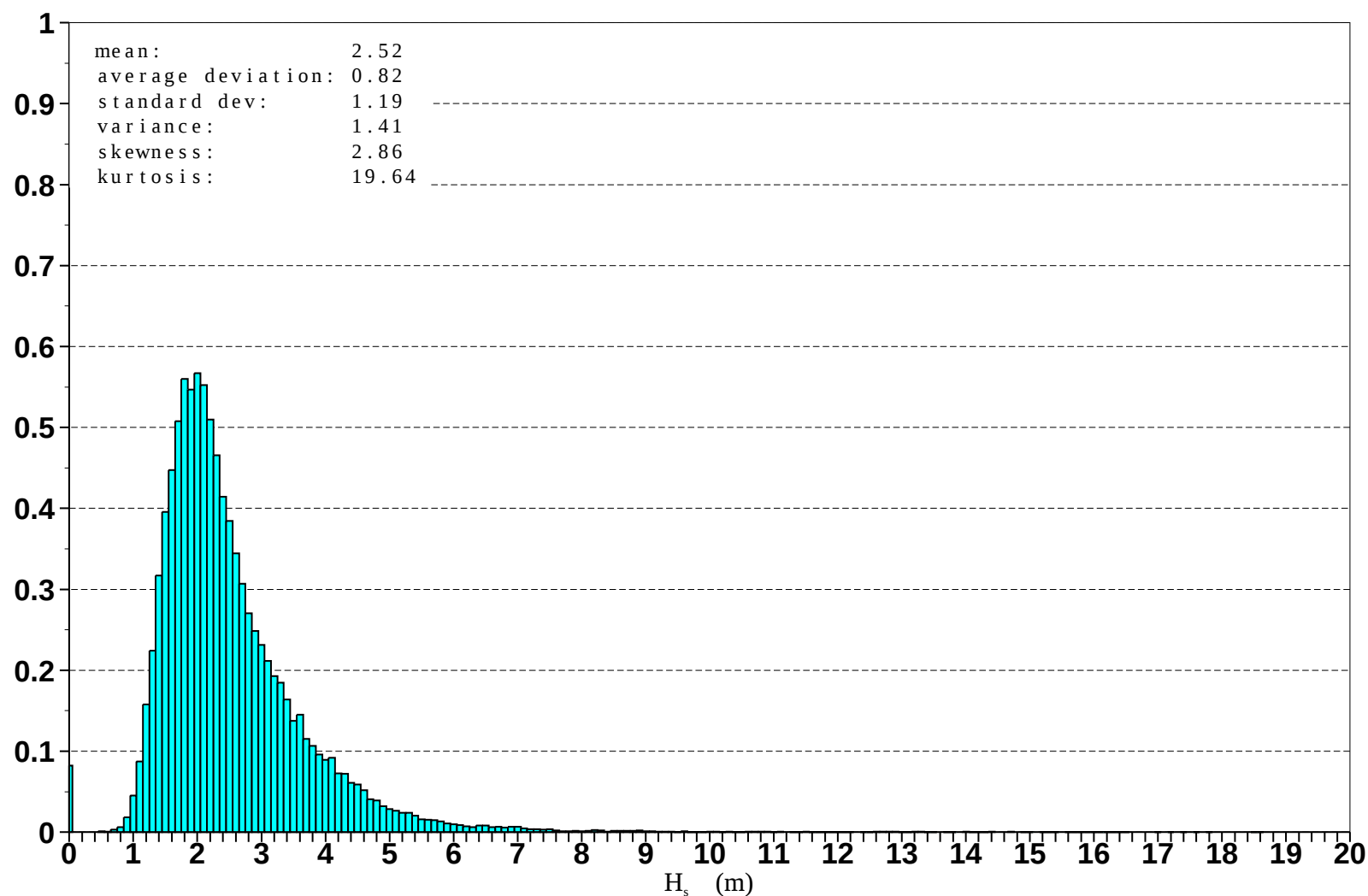


Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for January 2004



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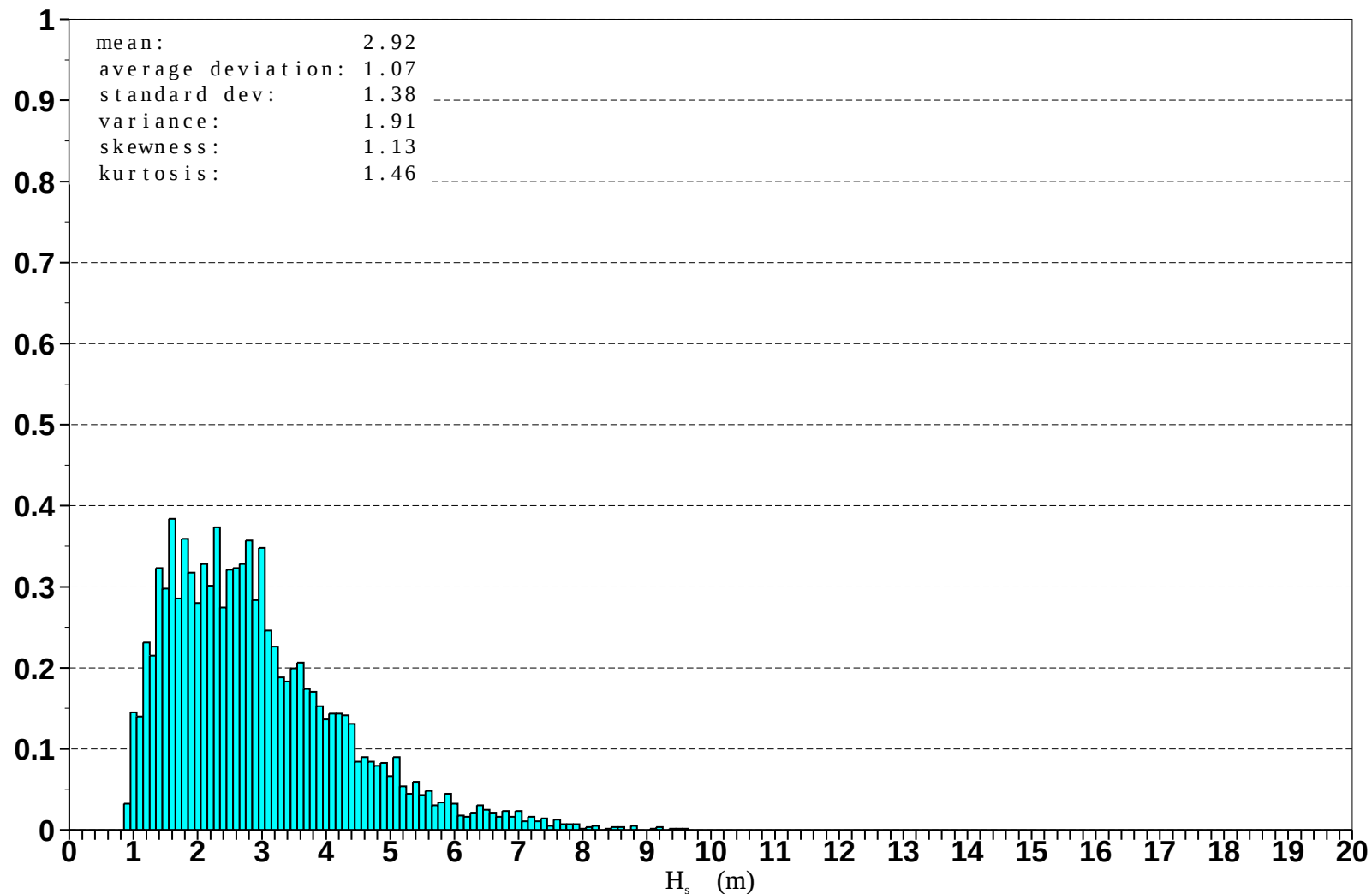


Figure 19: Distribution of ERS-2 Altimeter Wave Heights after Along-Track Averaging for January 2004



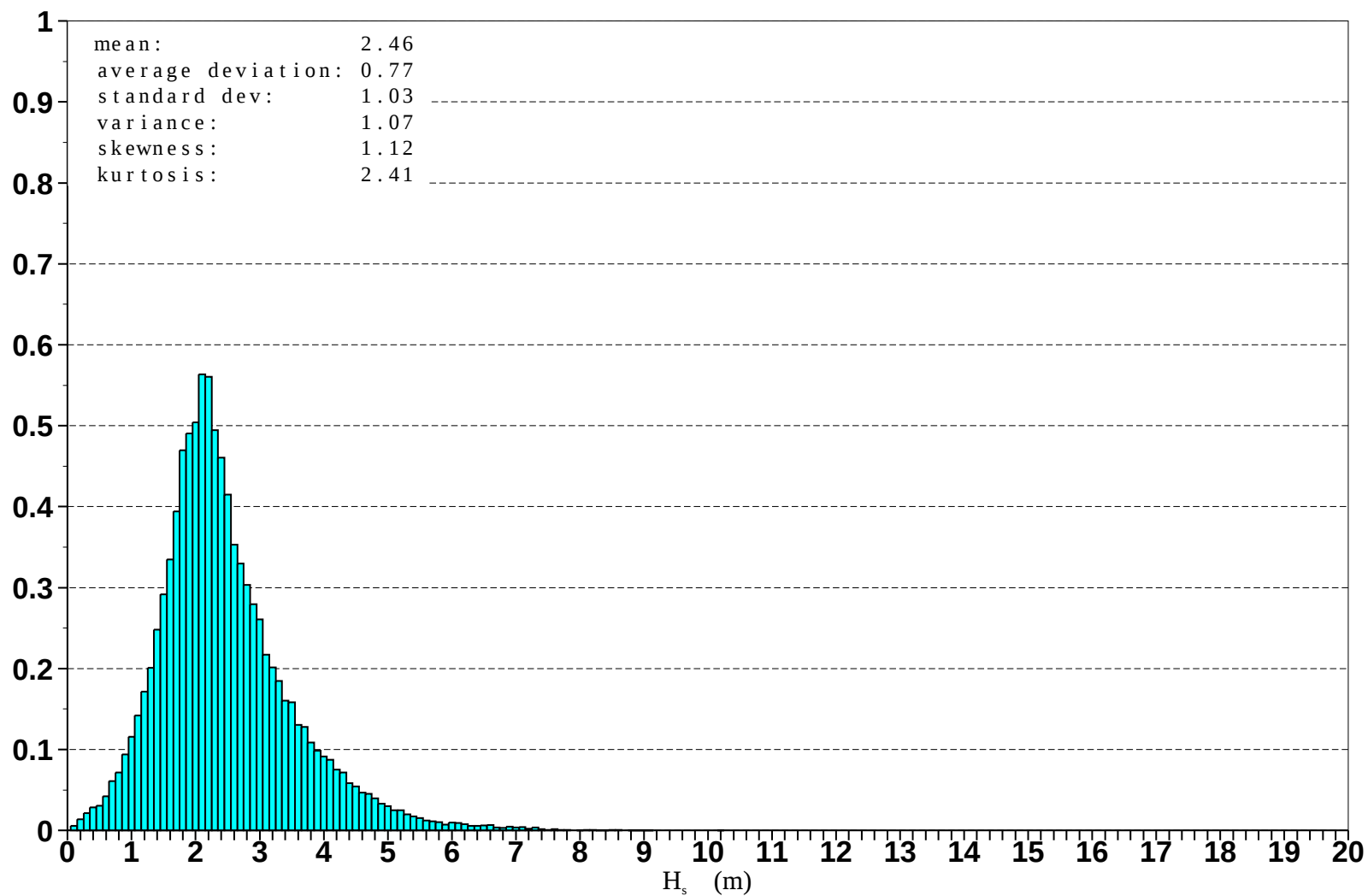
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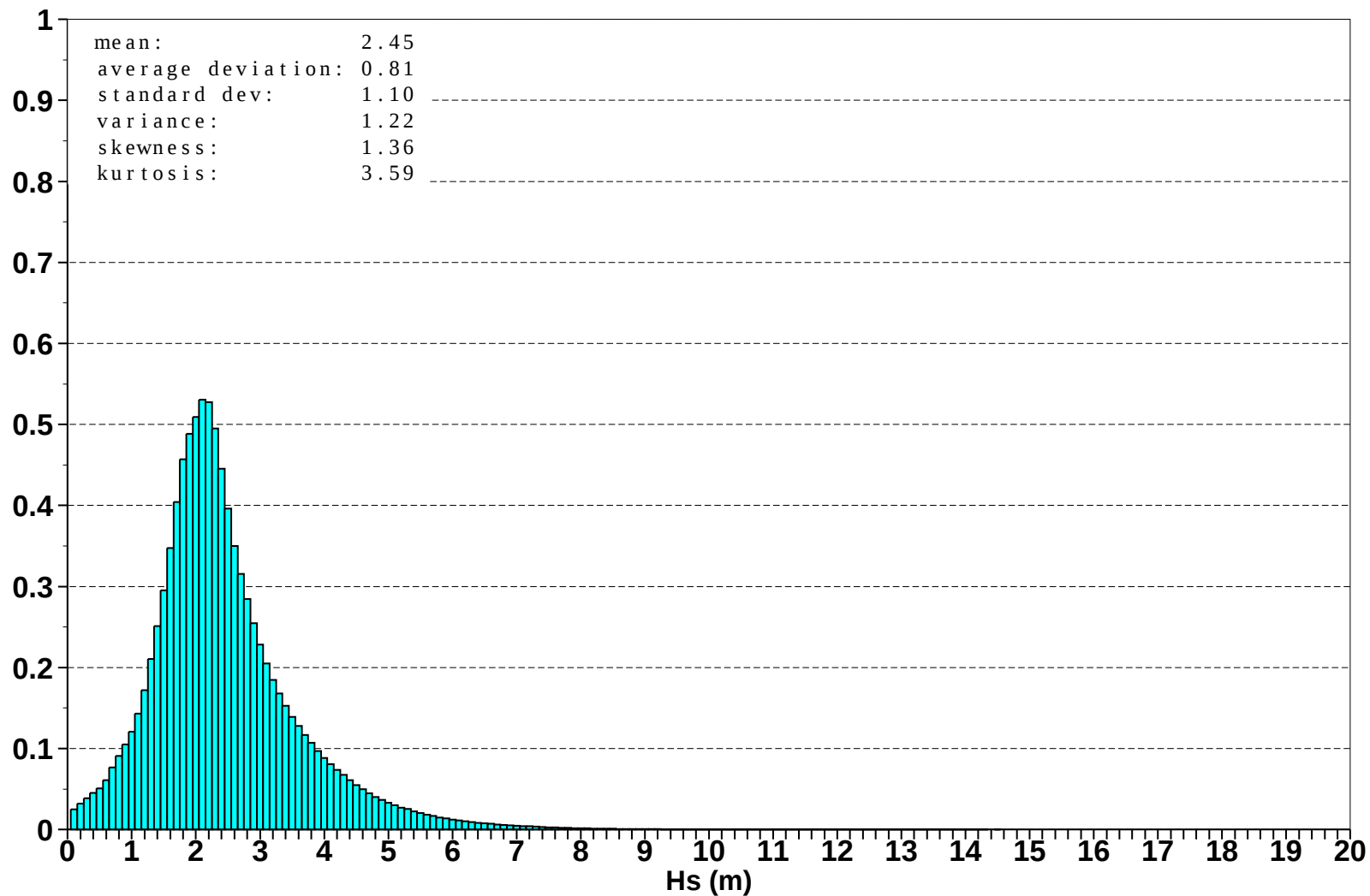


Figure 20: Global distribution of ECMWF First-Guess wave heights for January 2004



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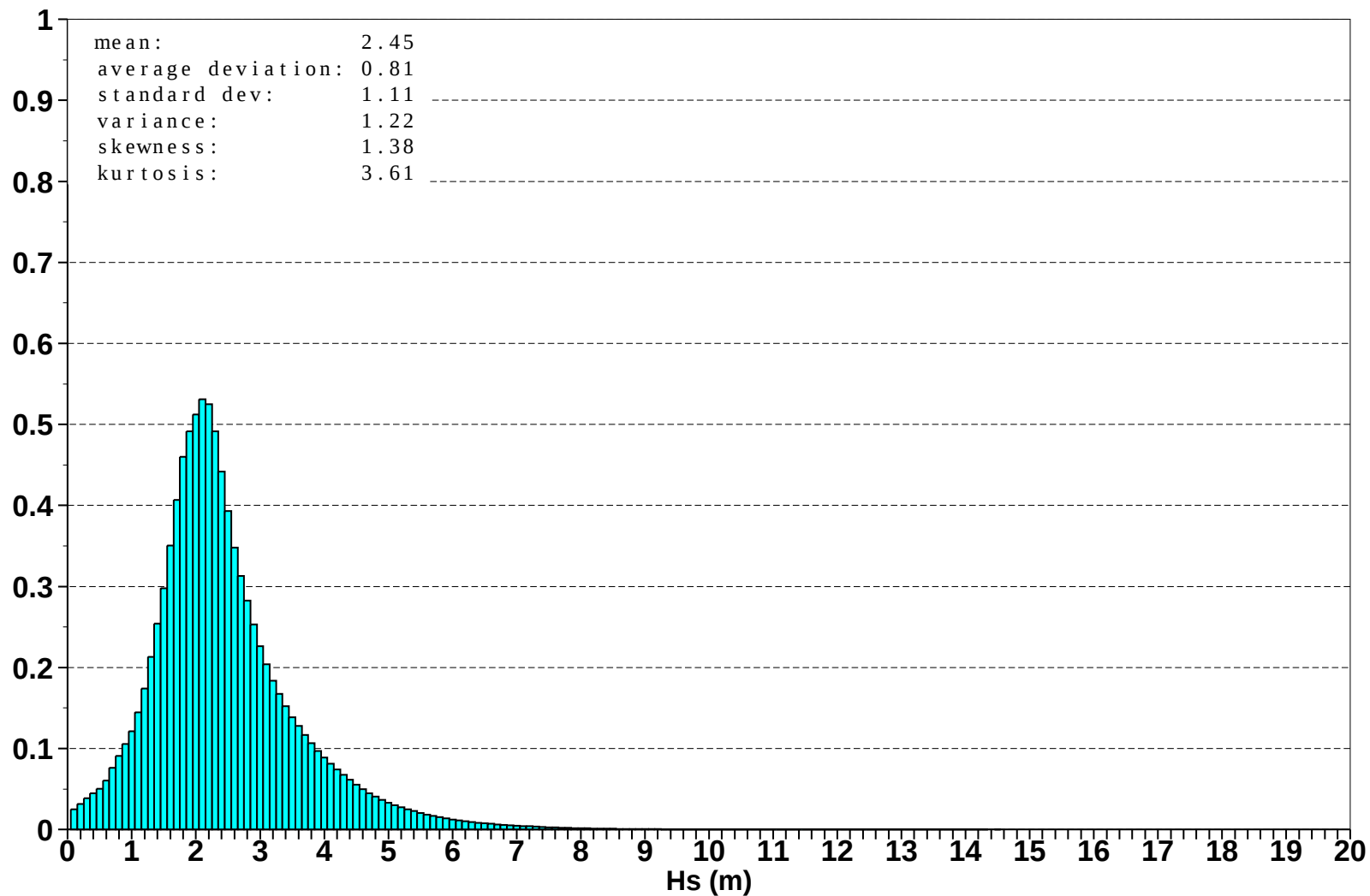


Figure 21: Global distribution of ECMWF Analysis (using ERS-2 data) wave heights for January 2004



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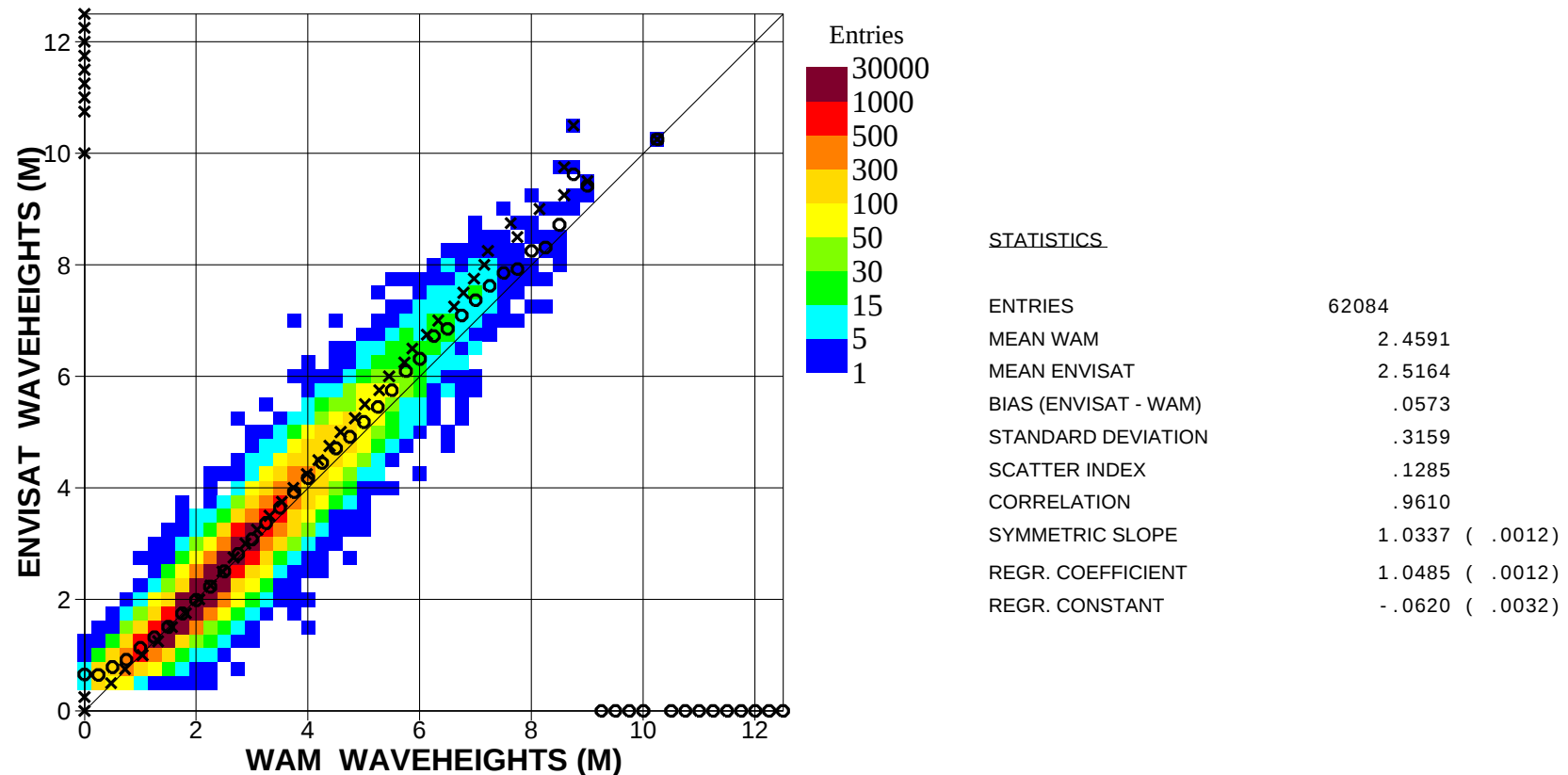


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for January 2004 (Global)

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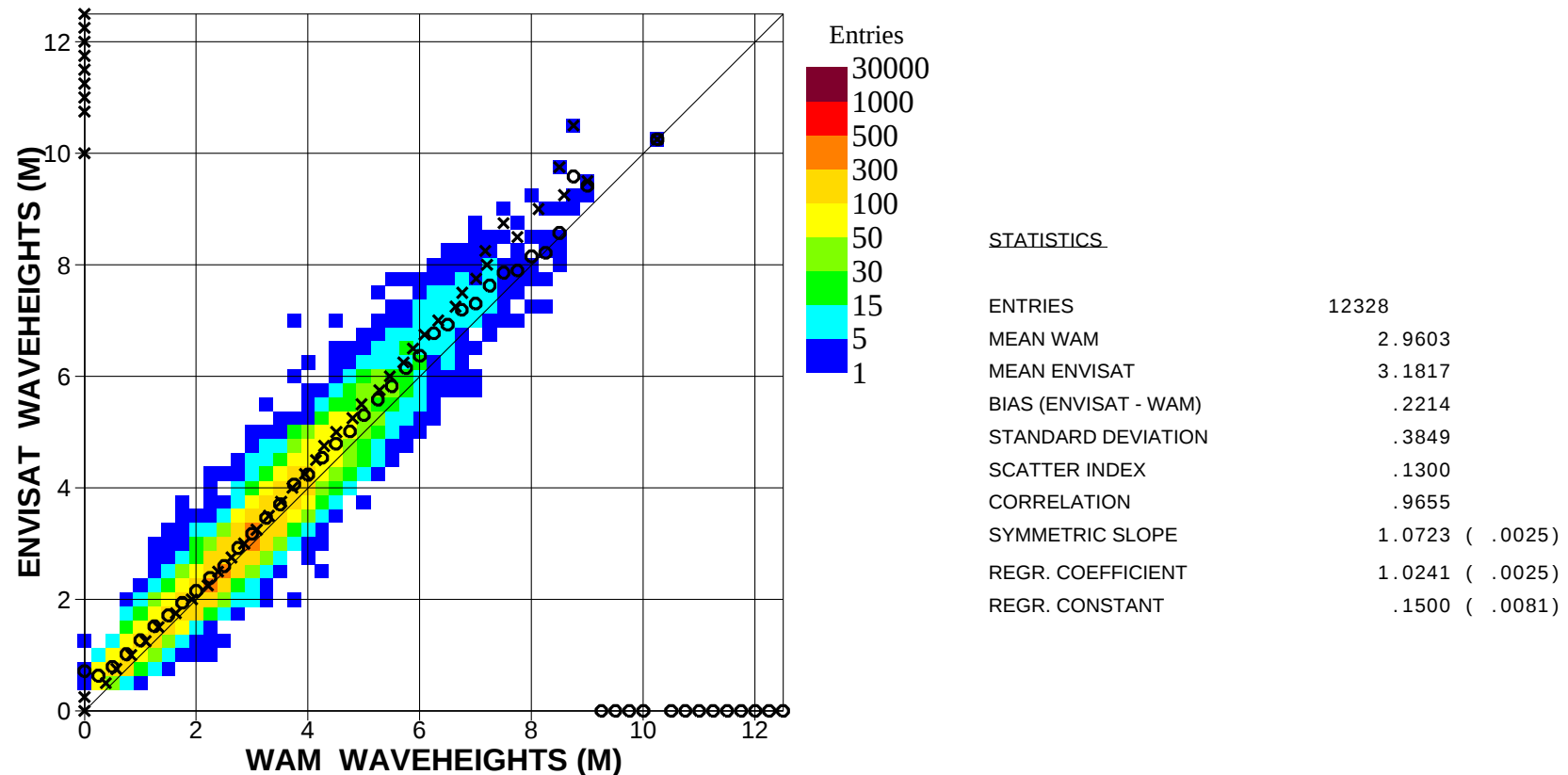


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for January 2004 (N.Hem.)

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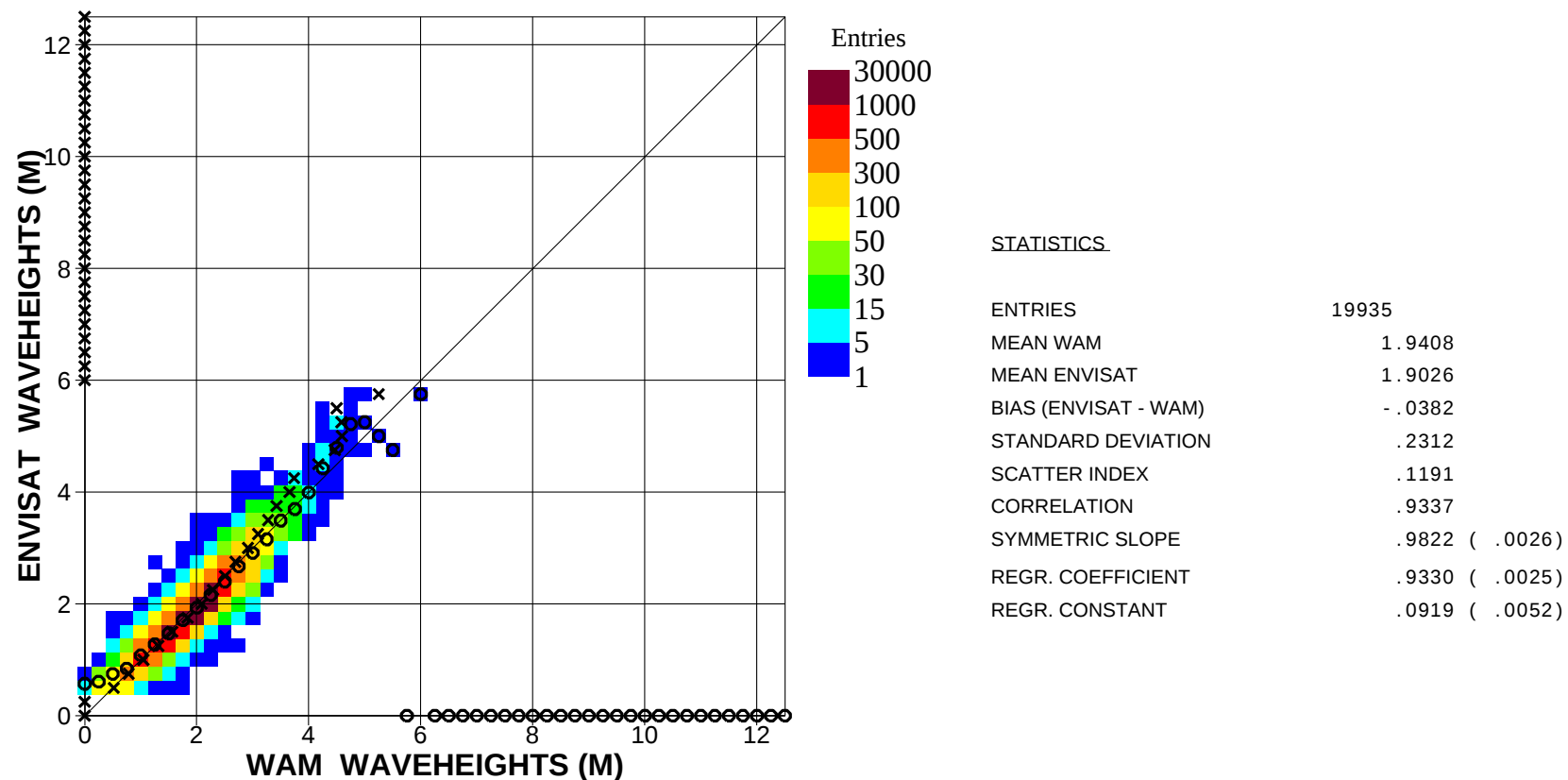


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for January 2004 (Tropics)



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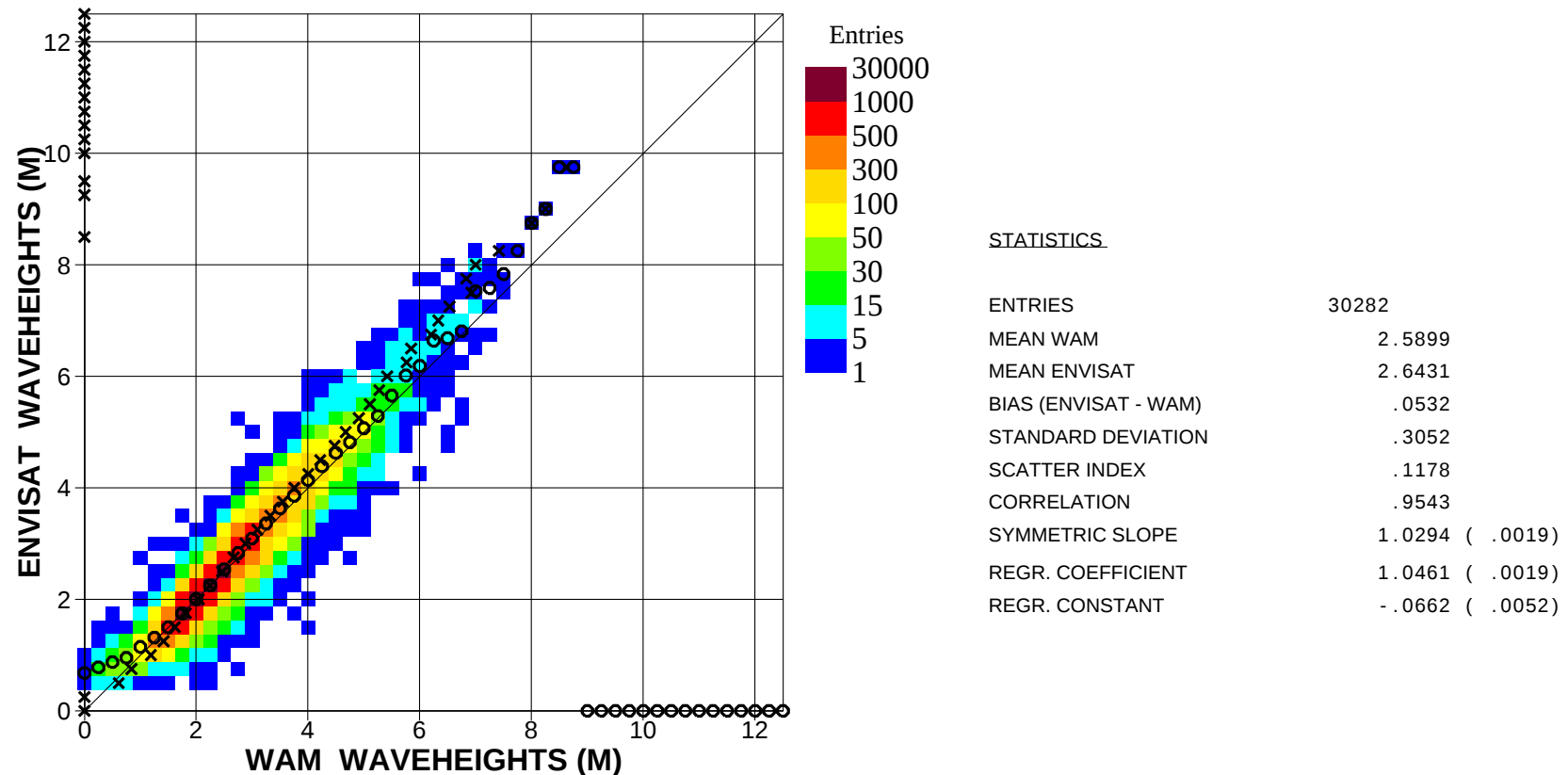


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for January 2004 (S.Hem.)

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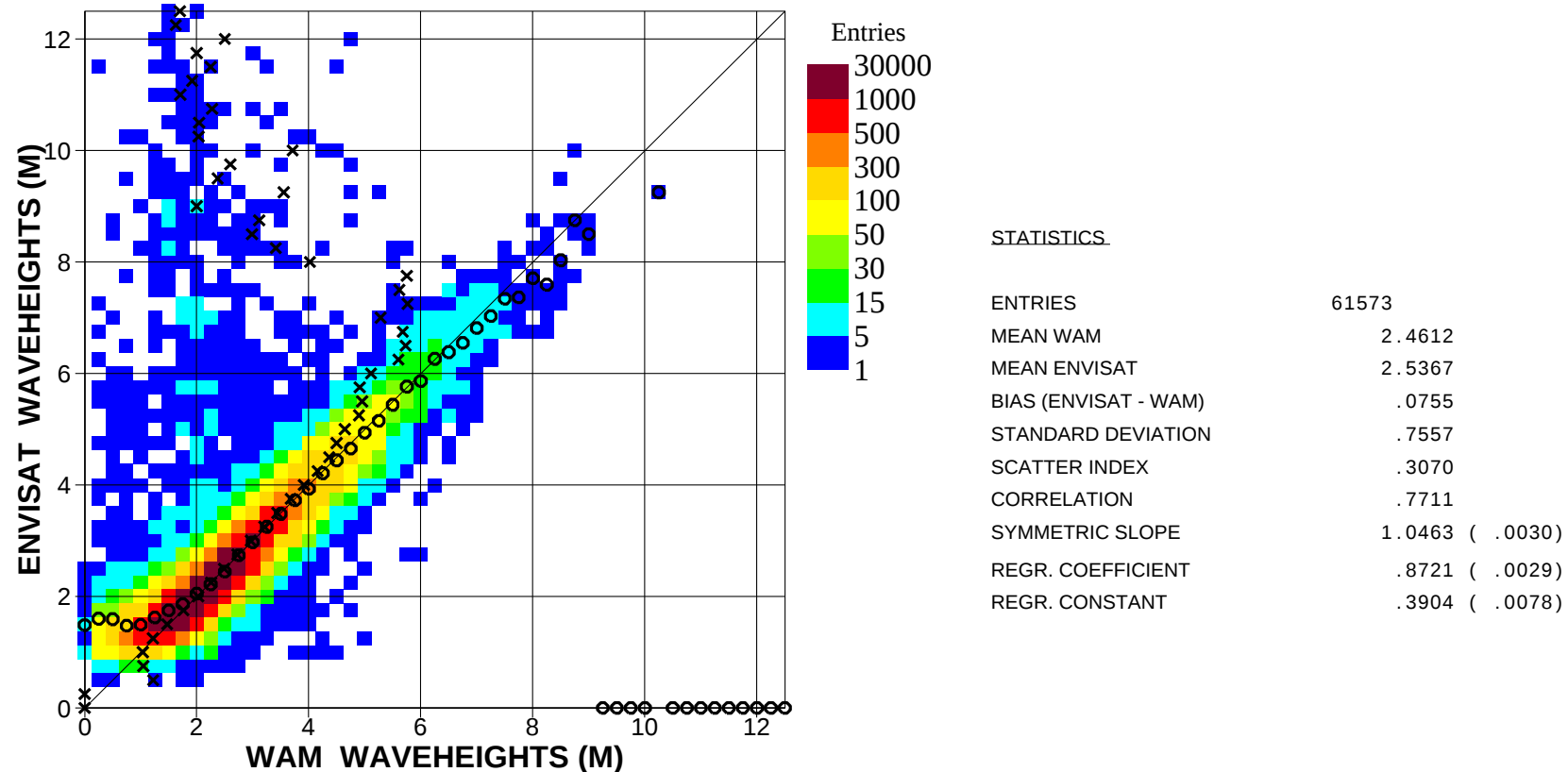


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for January 2004 (Global)

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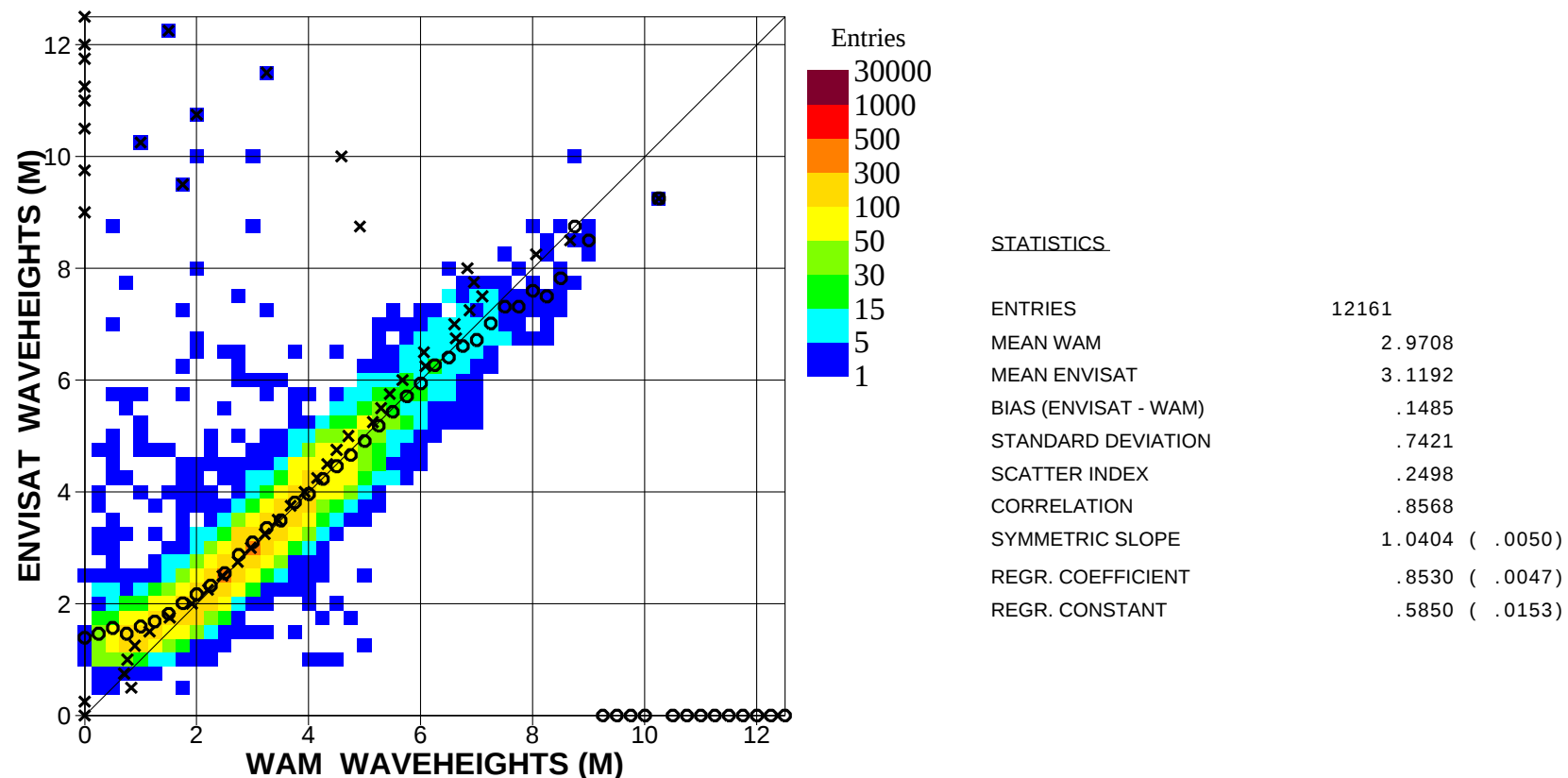


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for January 2004 (N.Hem.)

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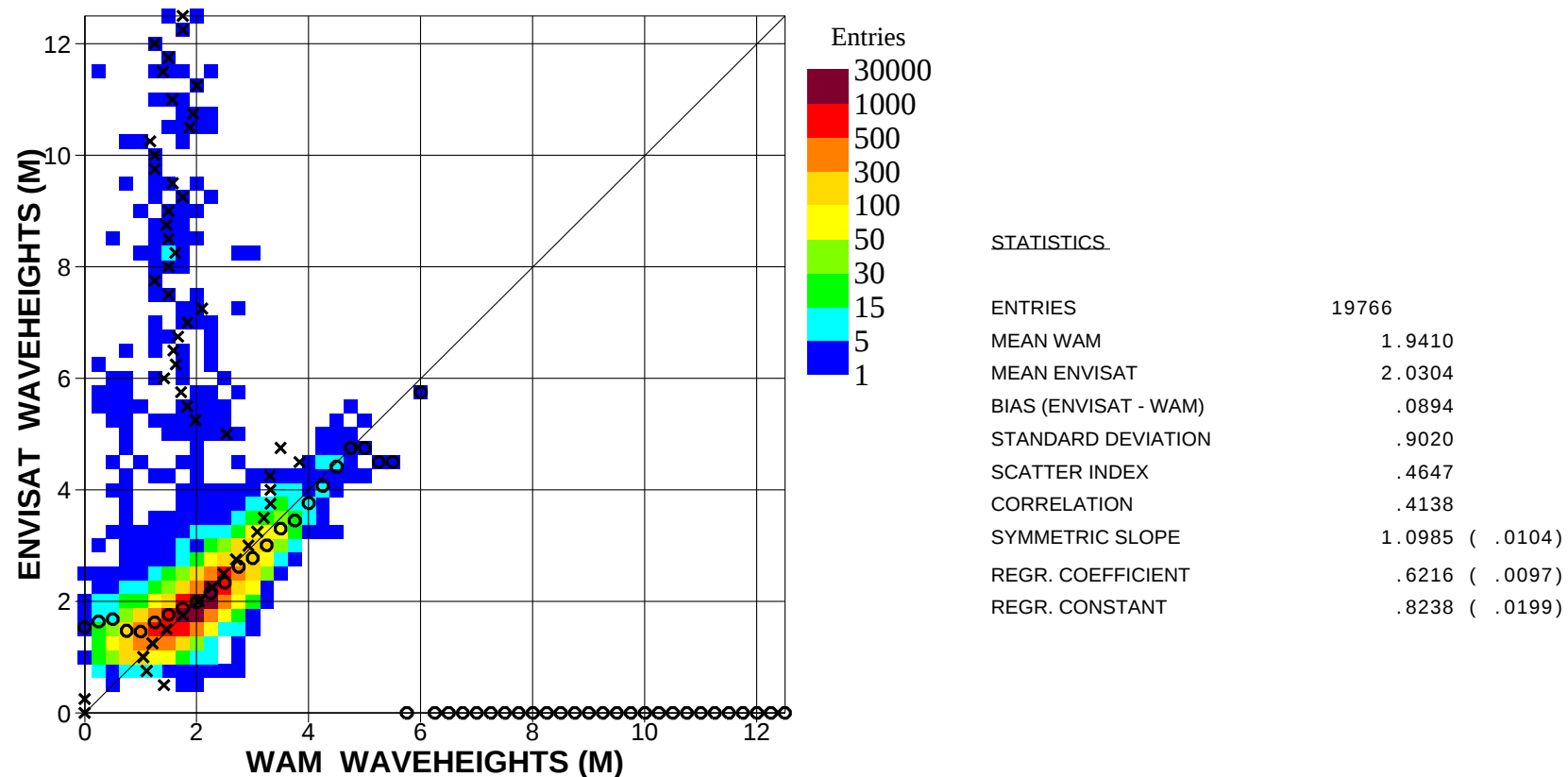


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for January 2004 (Tropics)

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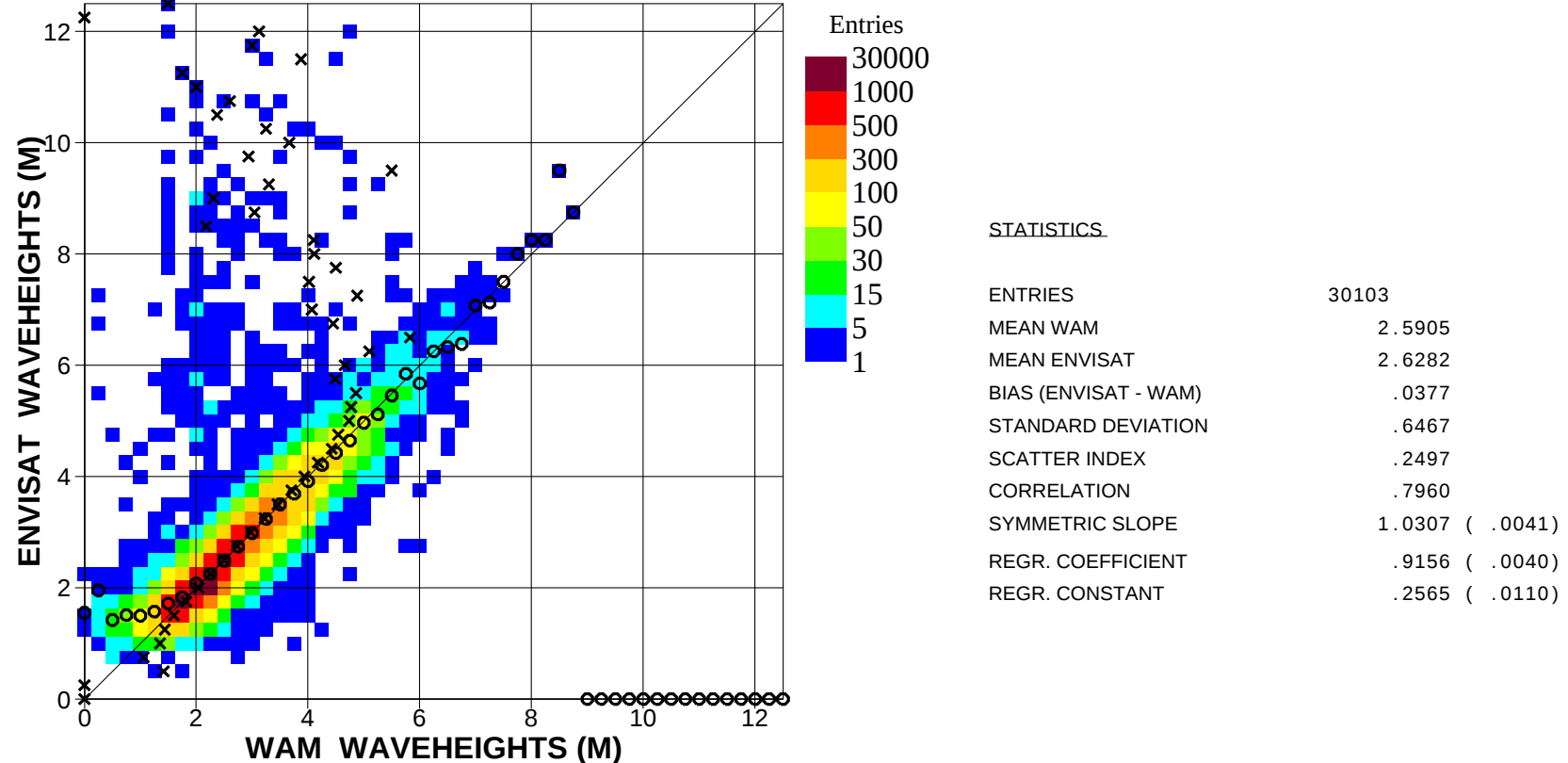


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for January 2004 (S.Hem.)

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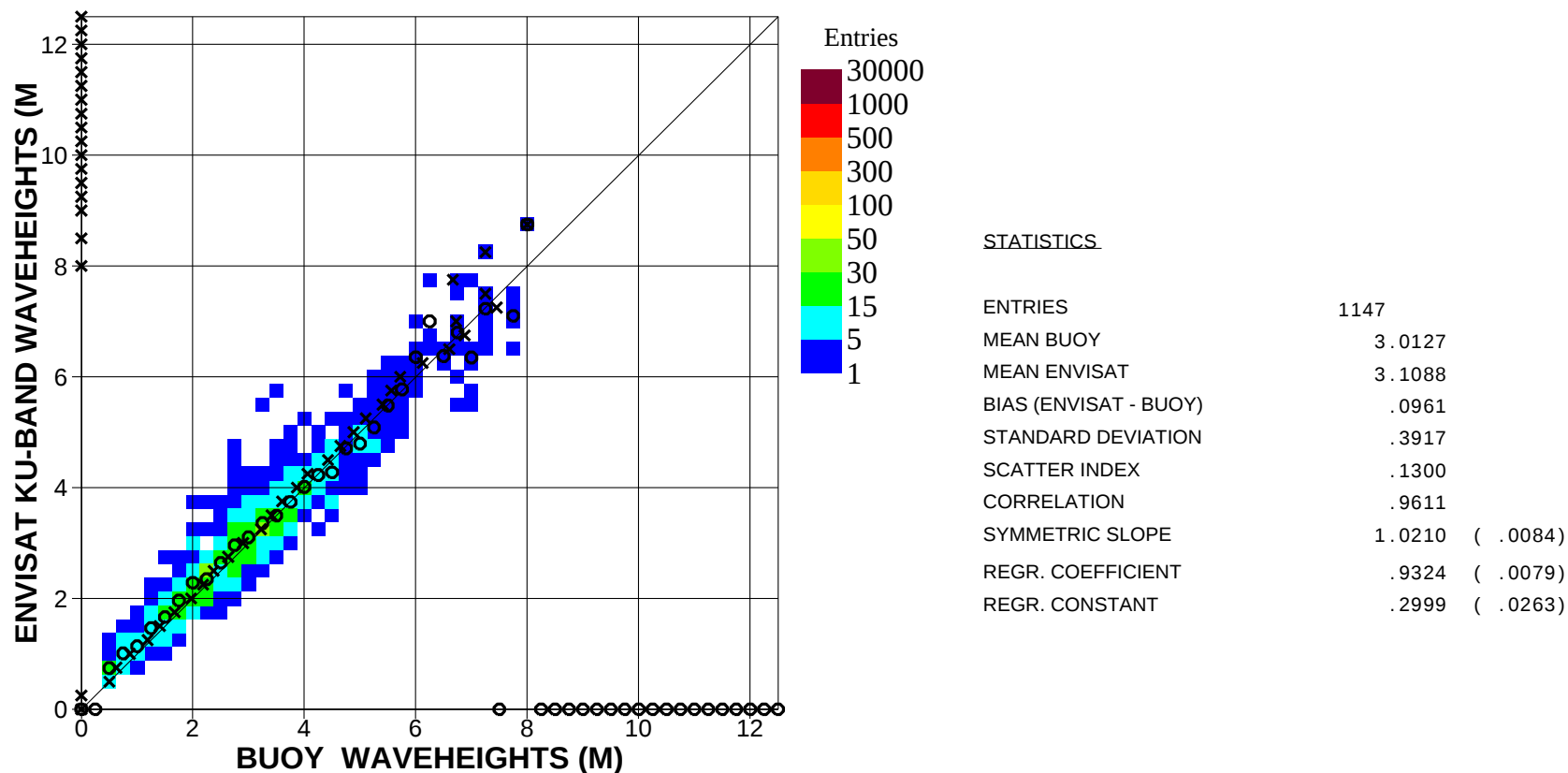


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for January 2004 (Global)

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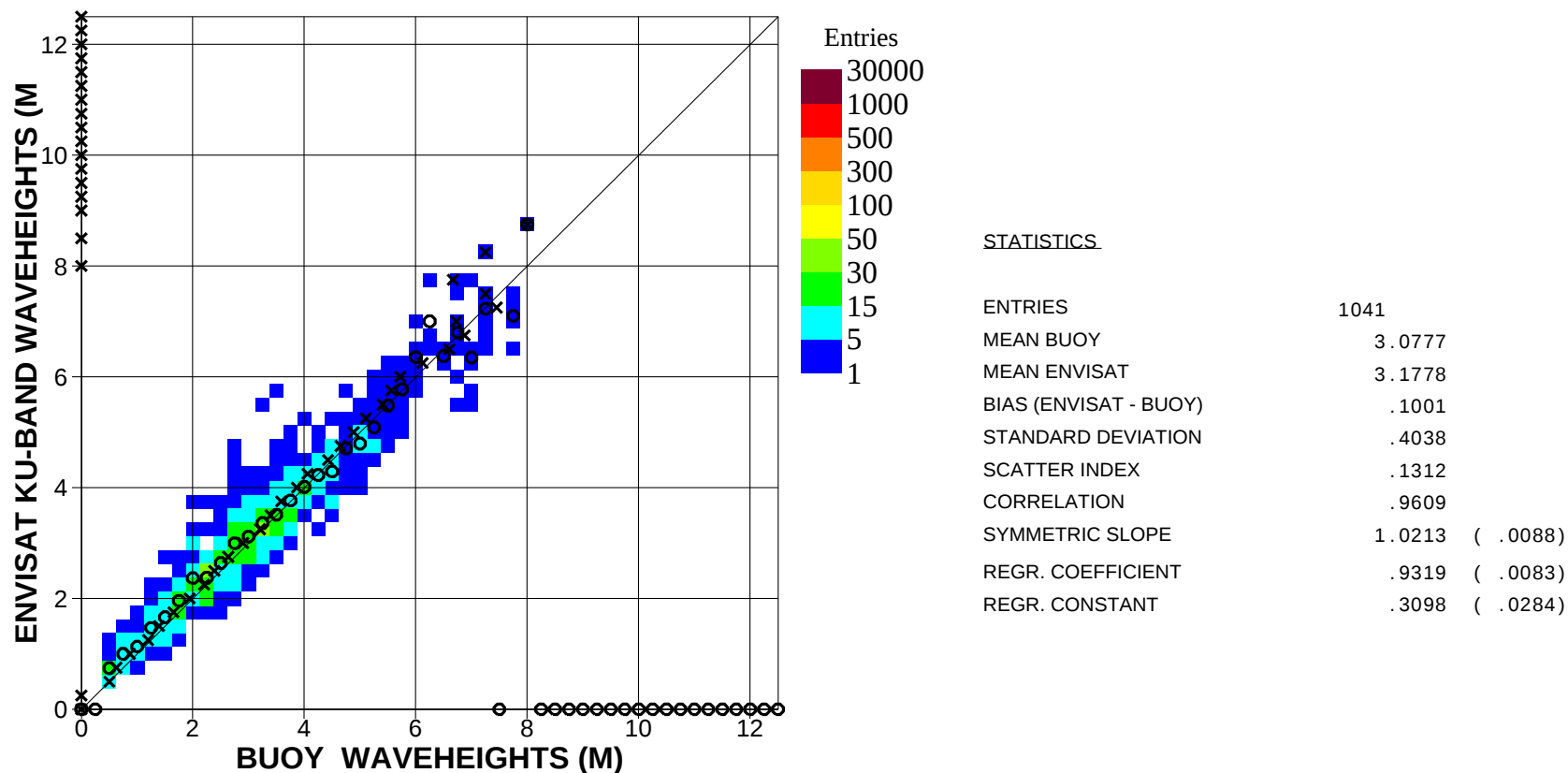


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for January 2004 (N.Hem.)



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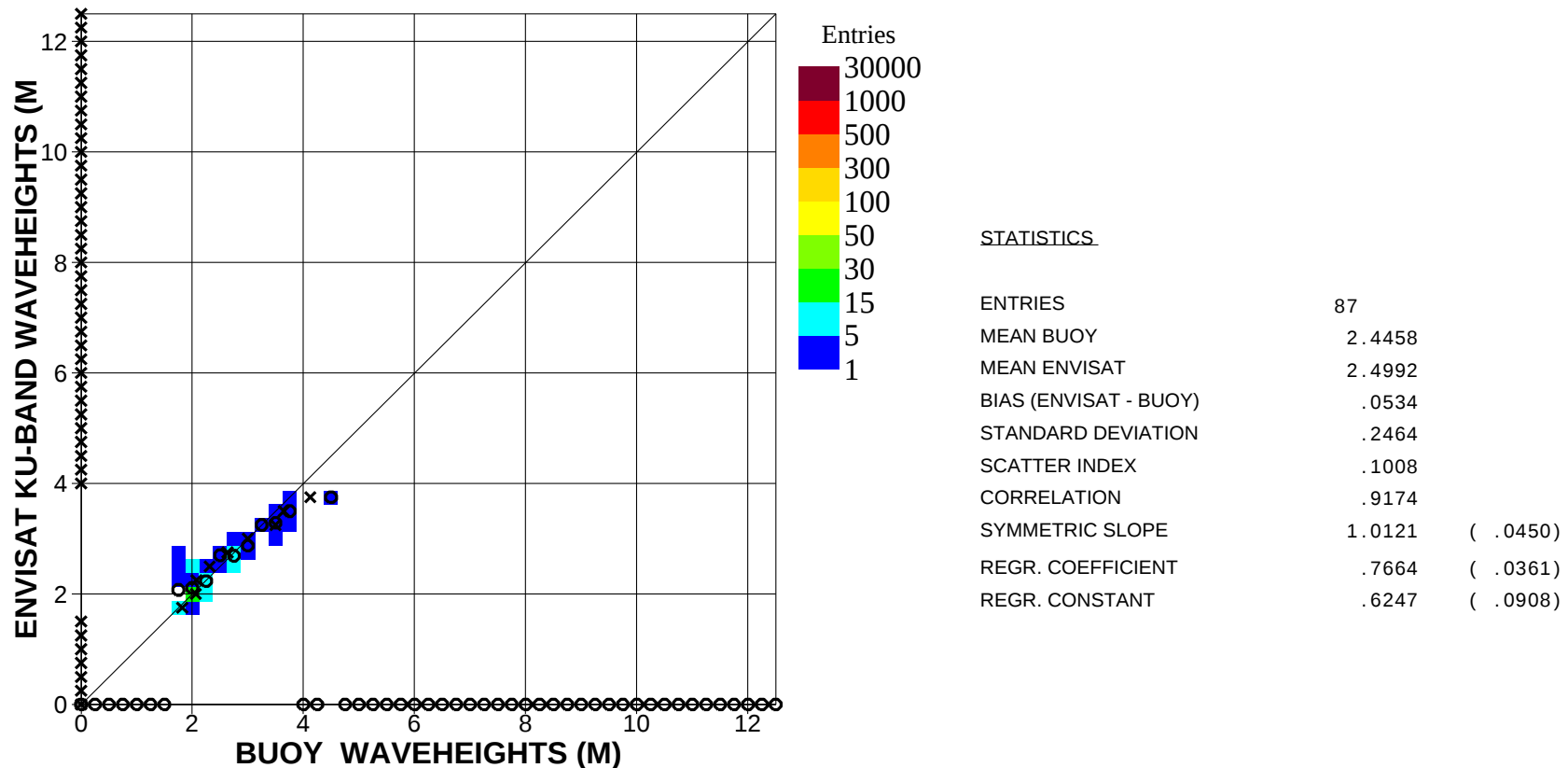


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for January 2004 (Tropics)

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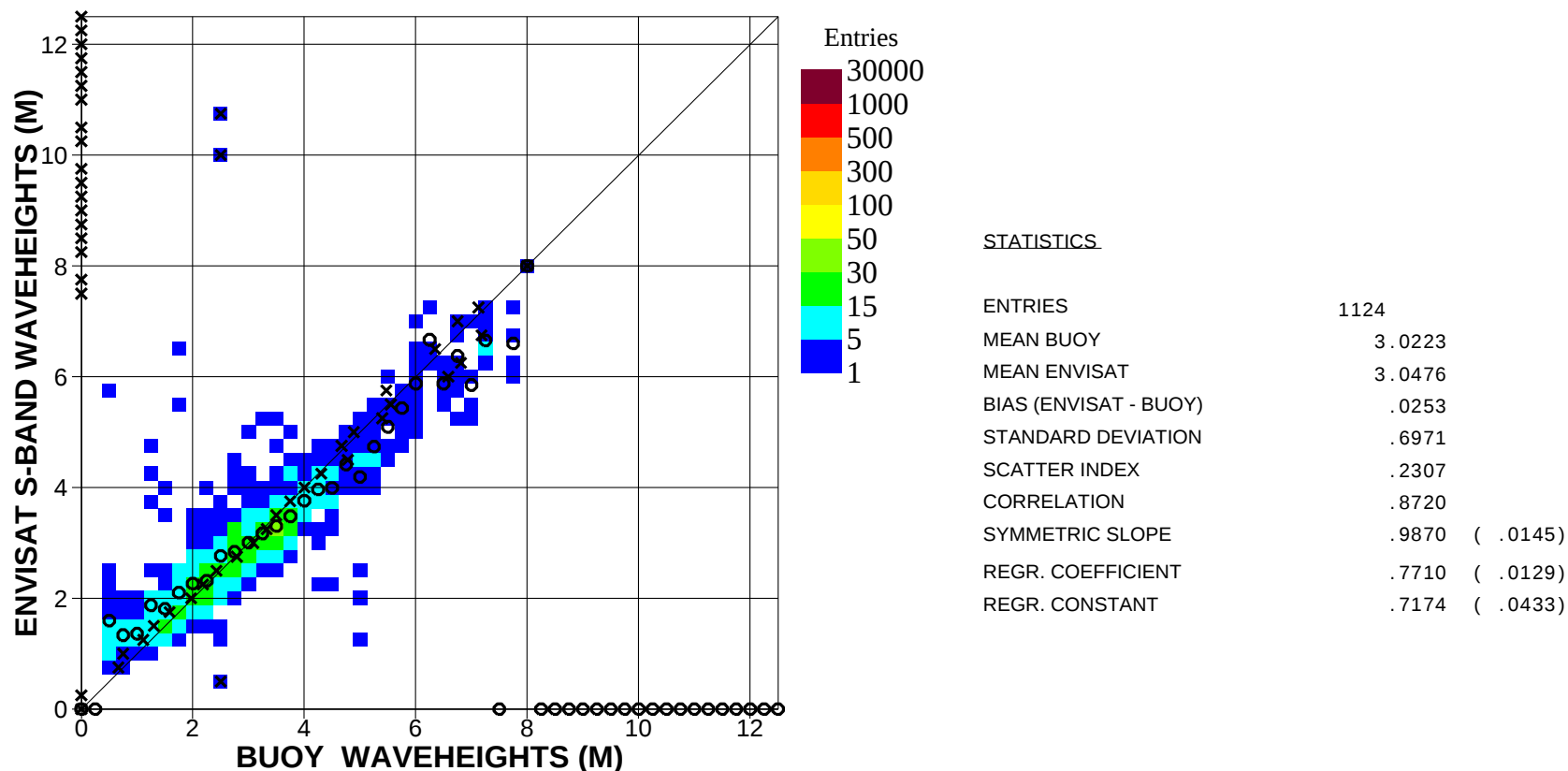


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for January 2004 (Global)



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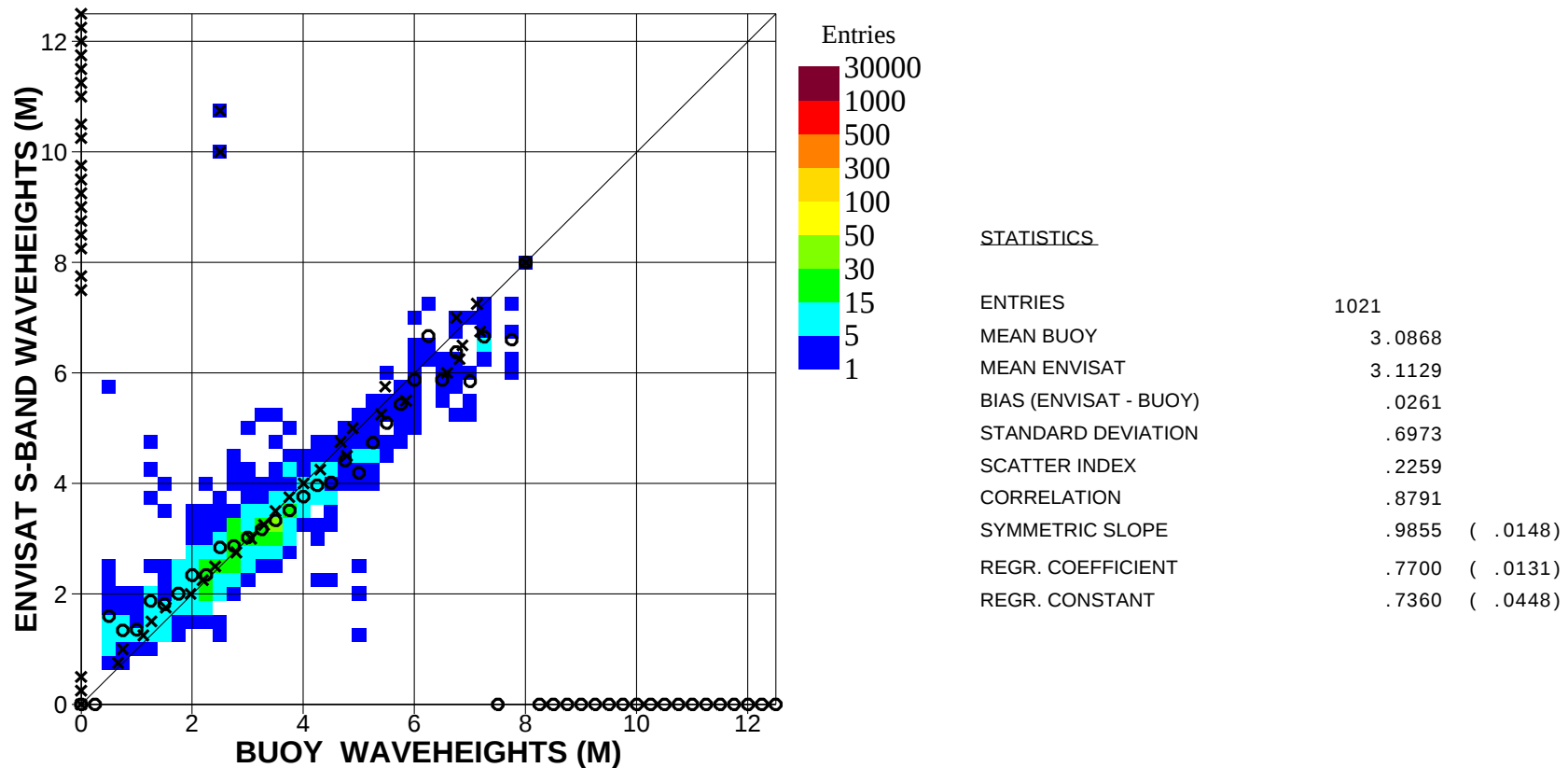


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for January 2004 (N.Hem.)

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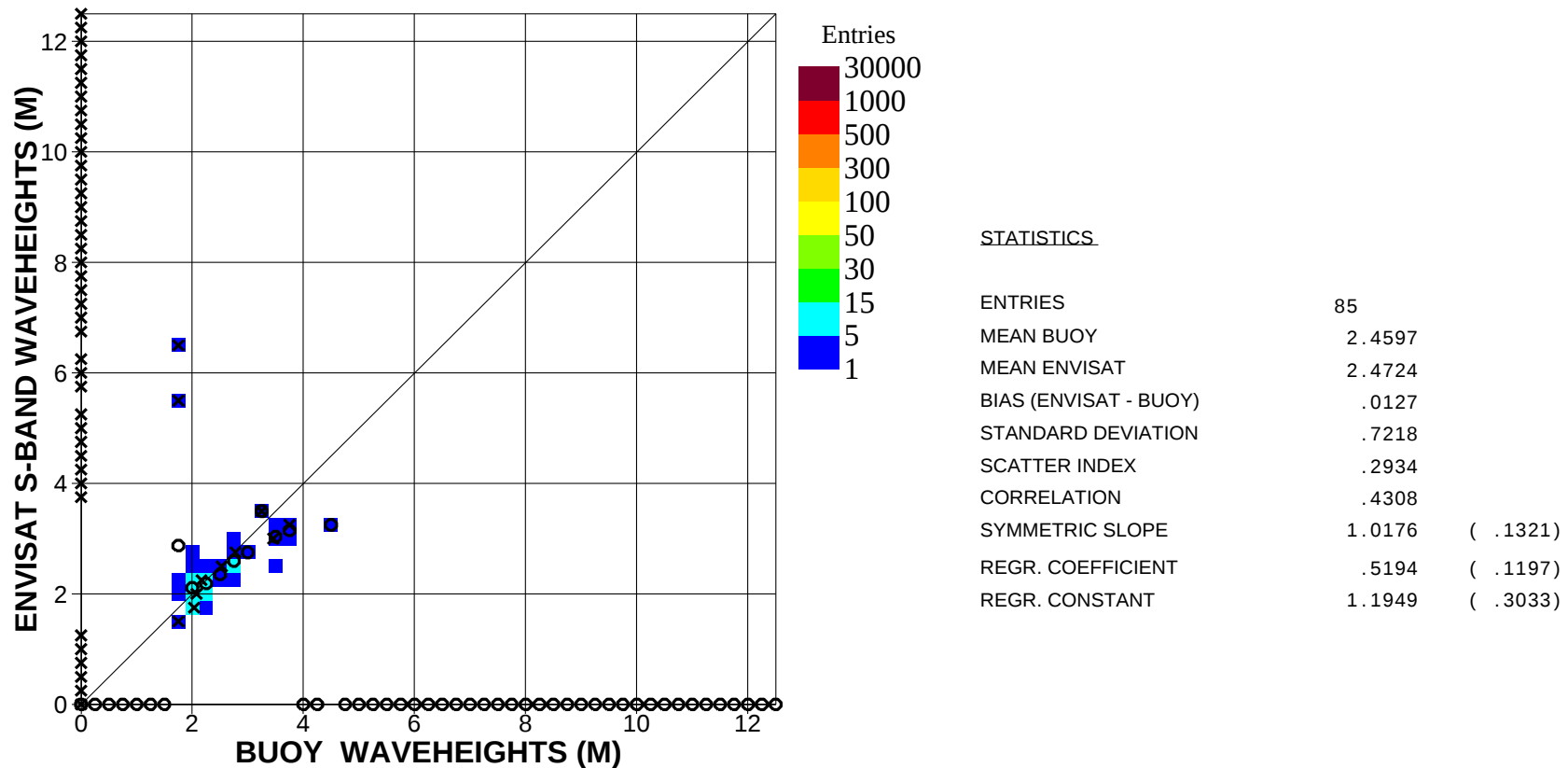


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for January 2004 (Tropics)

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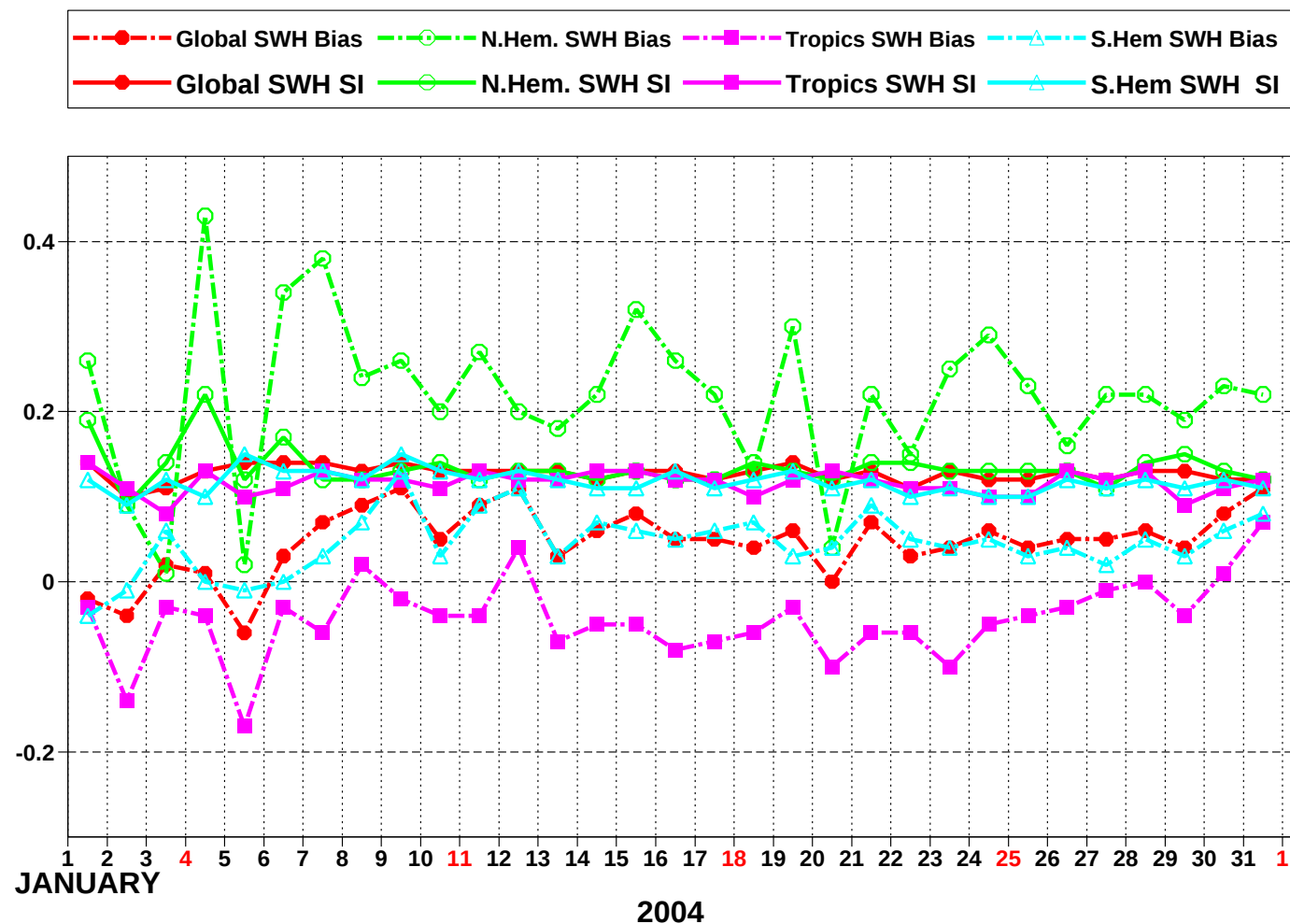


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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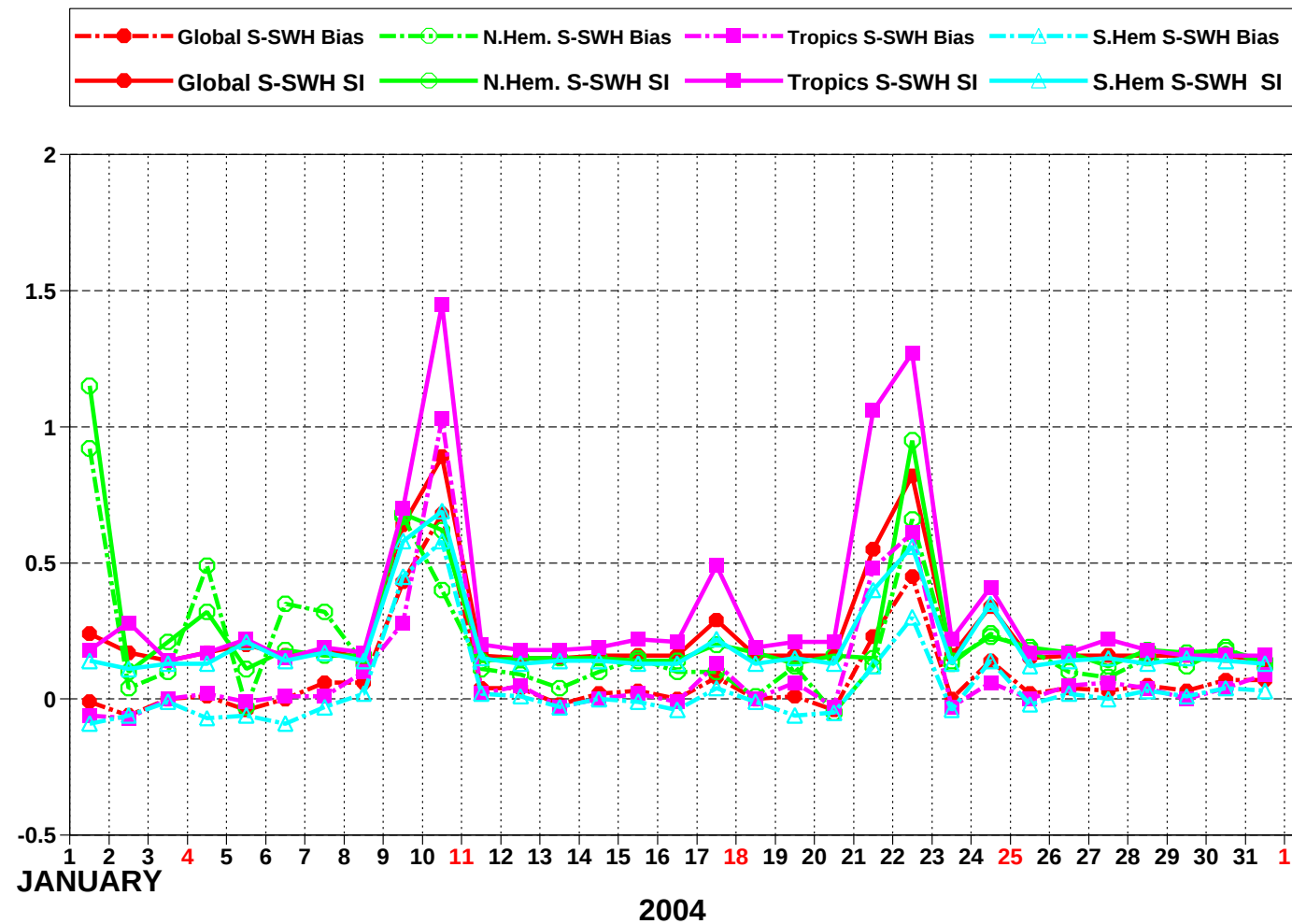


Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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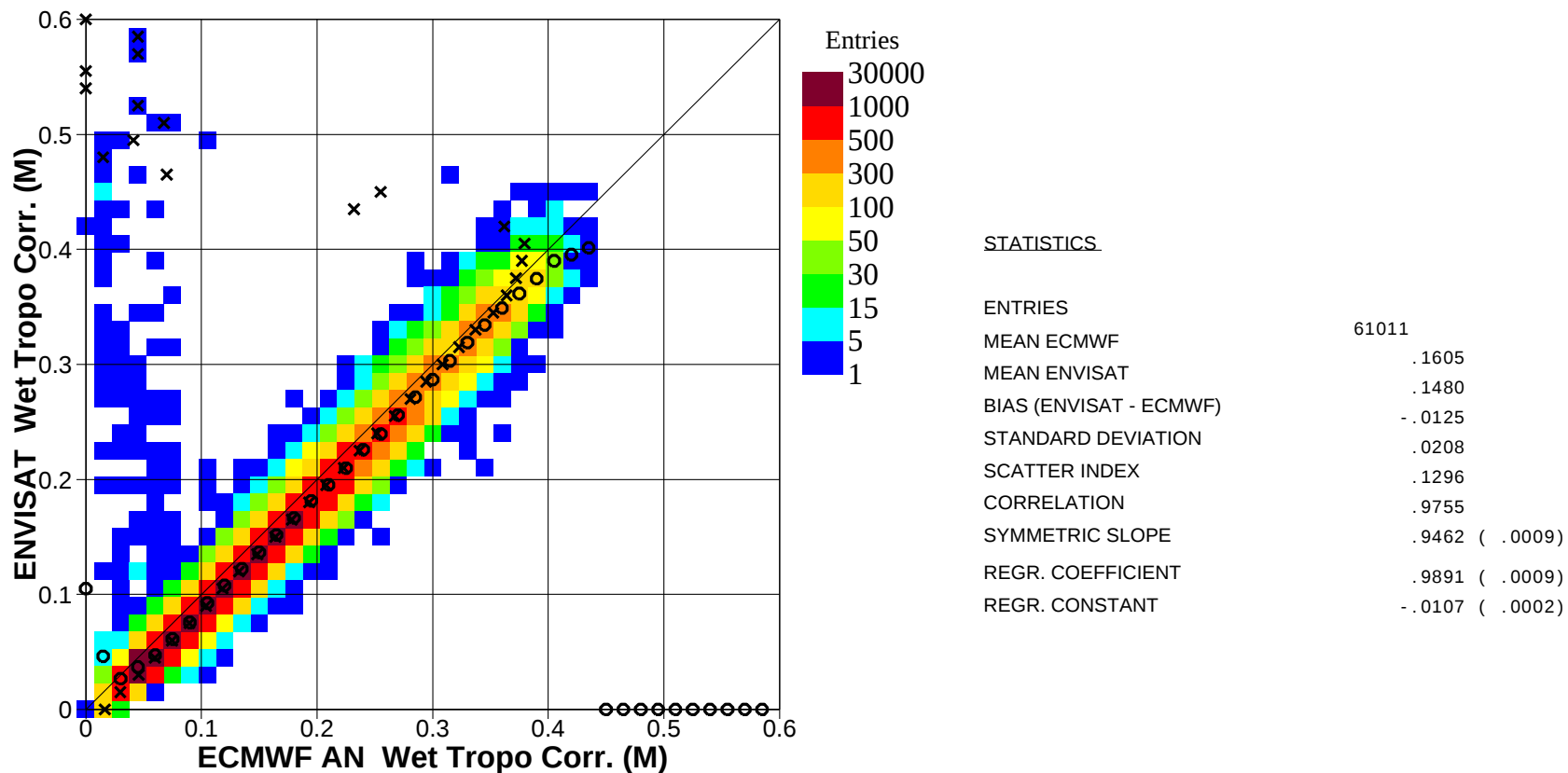


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for January 2004 (Global)

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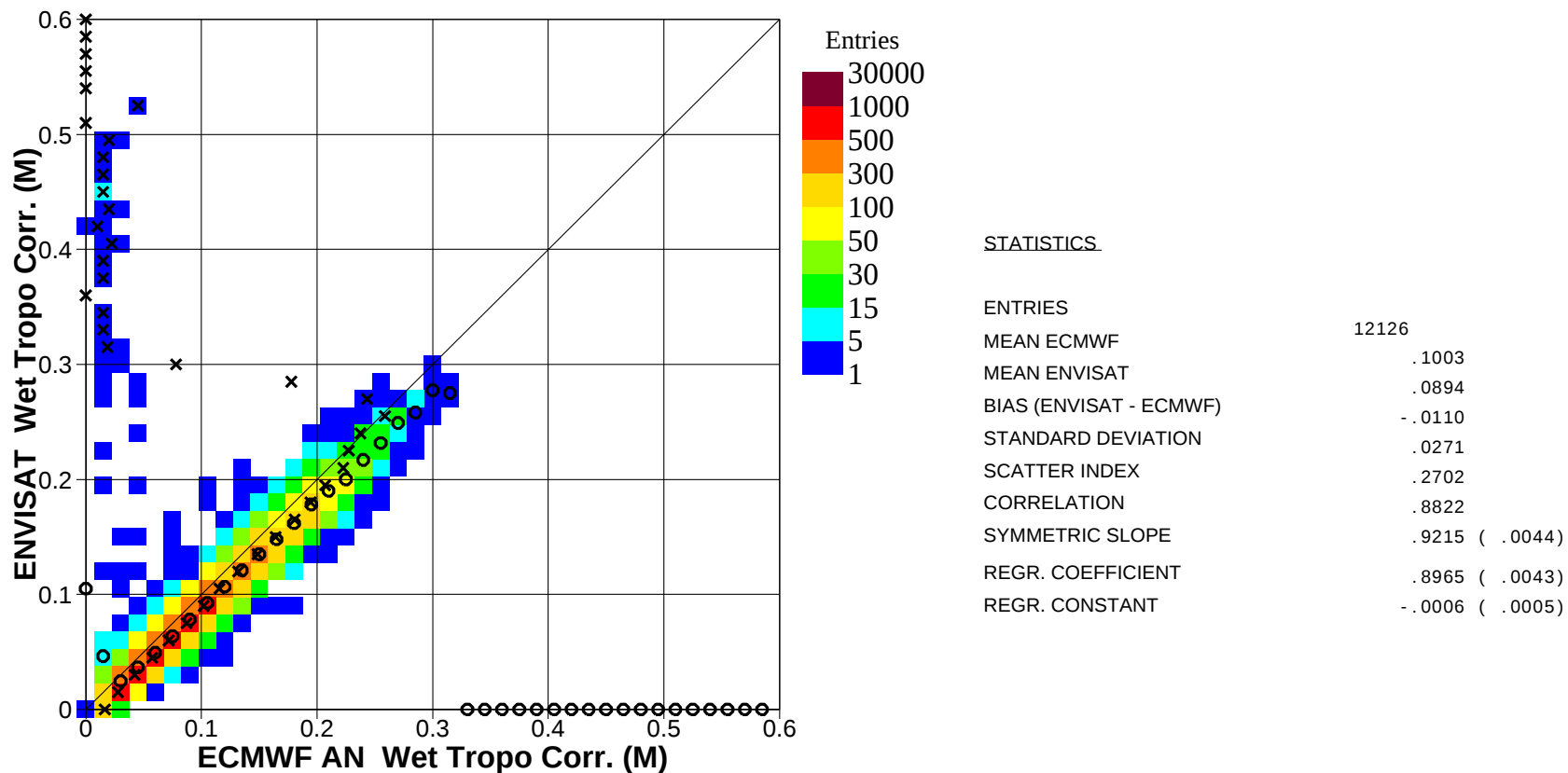


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for January 2004 (N.Hem.)

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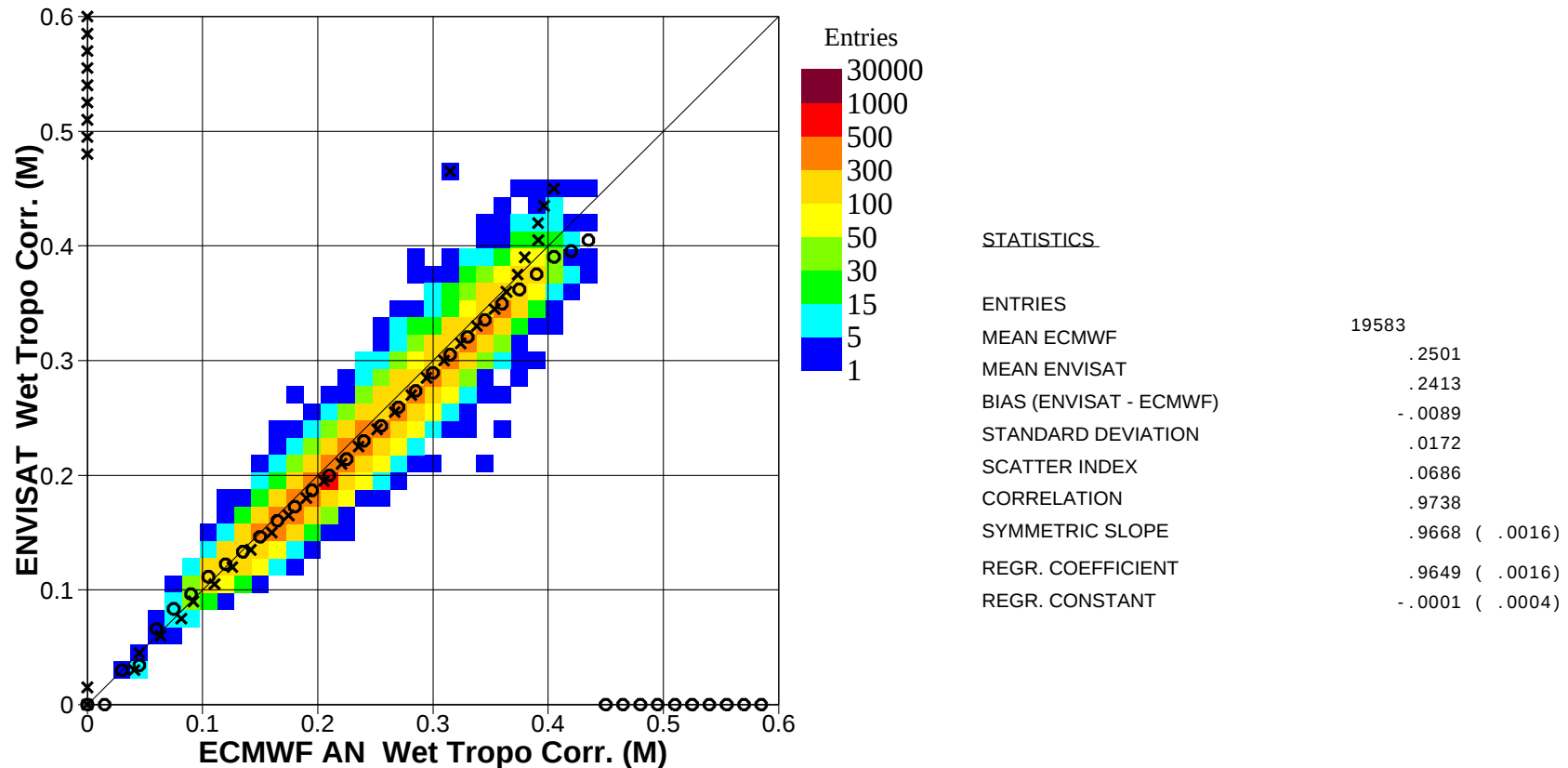


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for January 2004 (Tropics)

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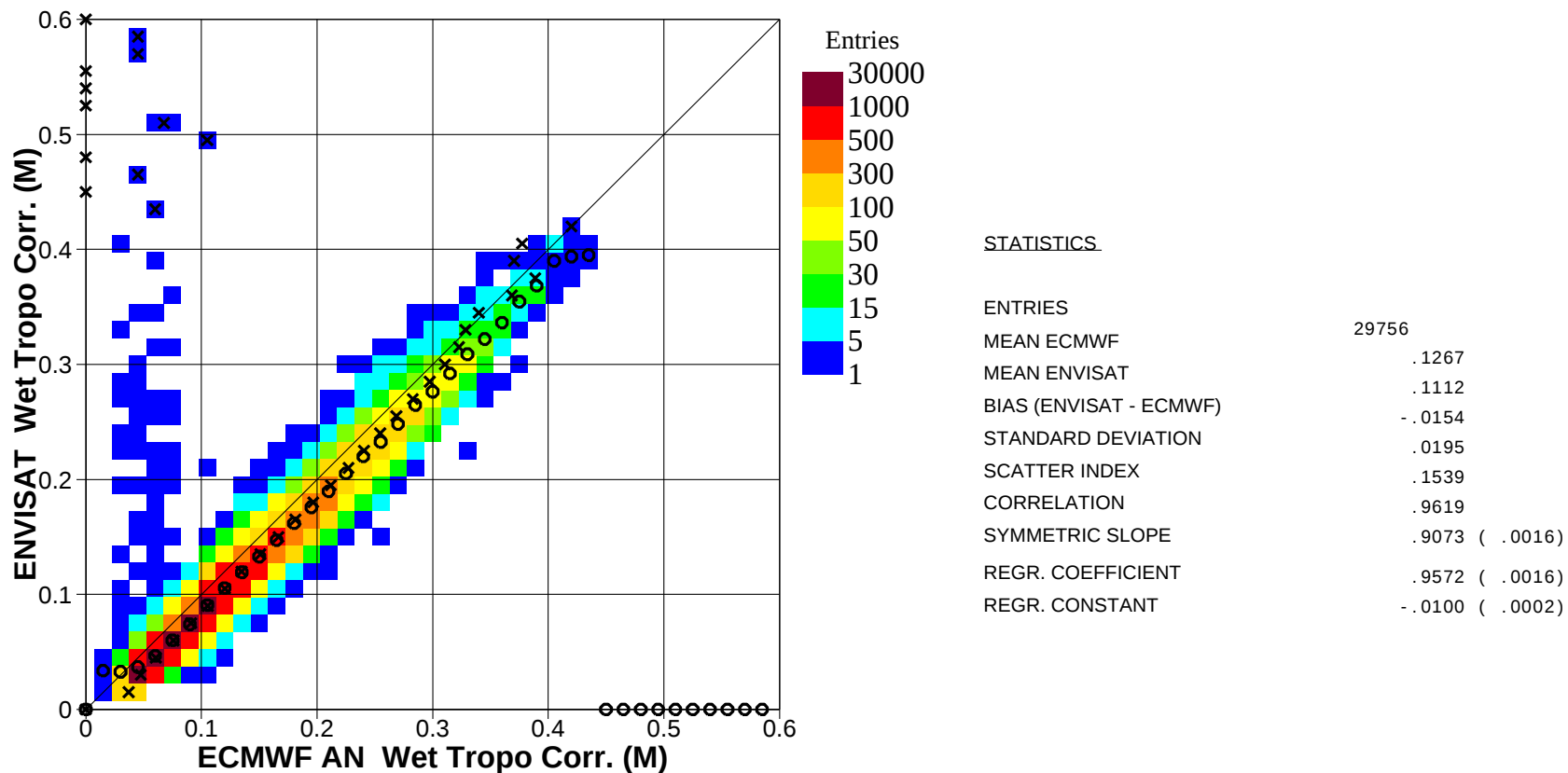


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for January 2004 (S.Hem.)

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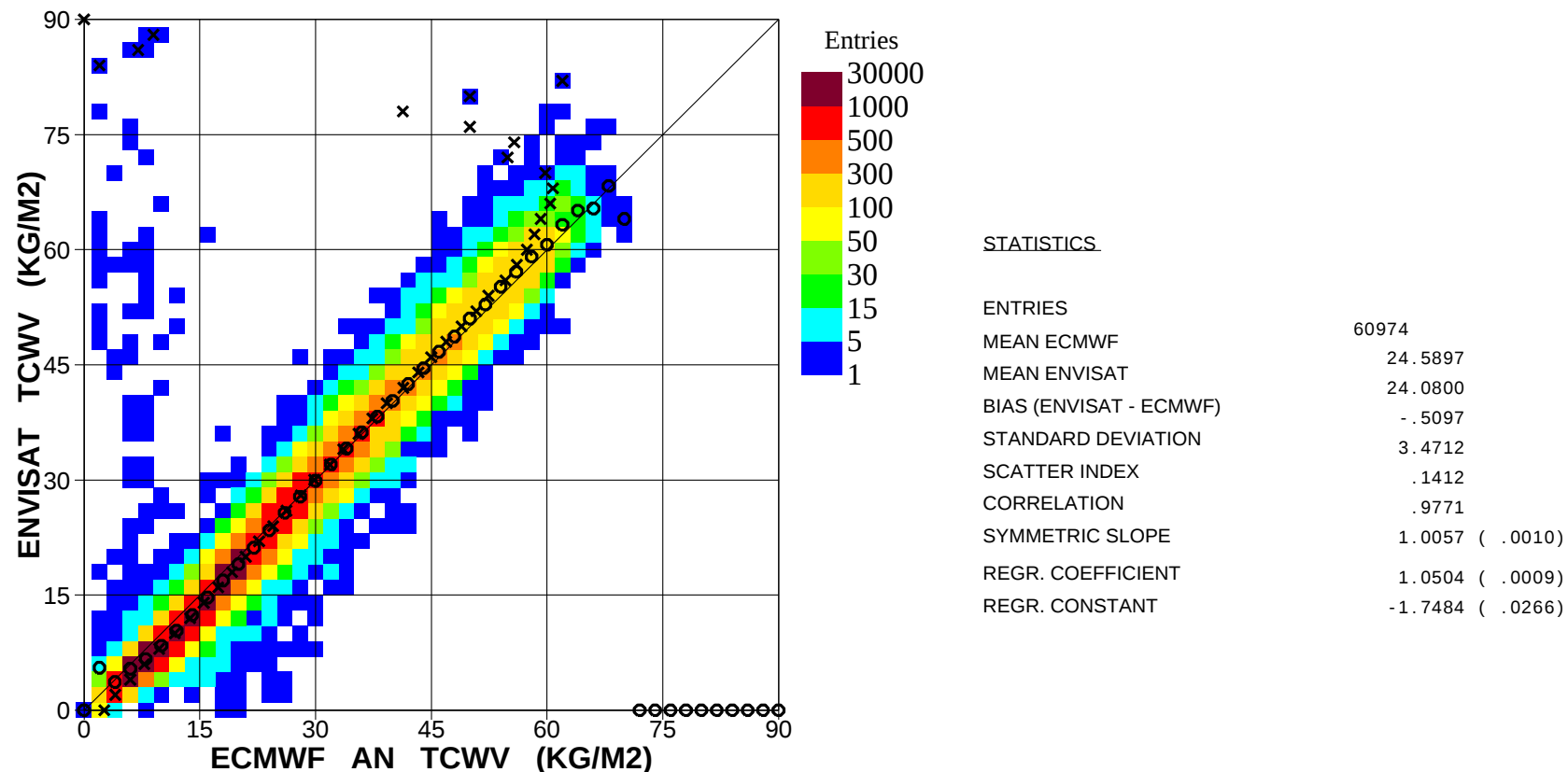


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for January 2004 (Global)



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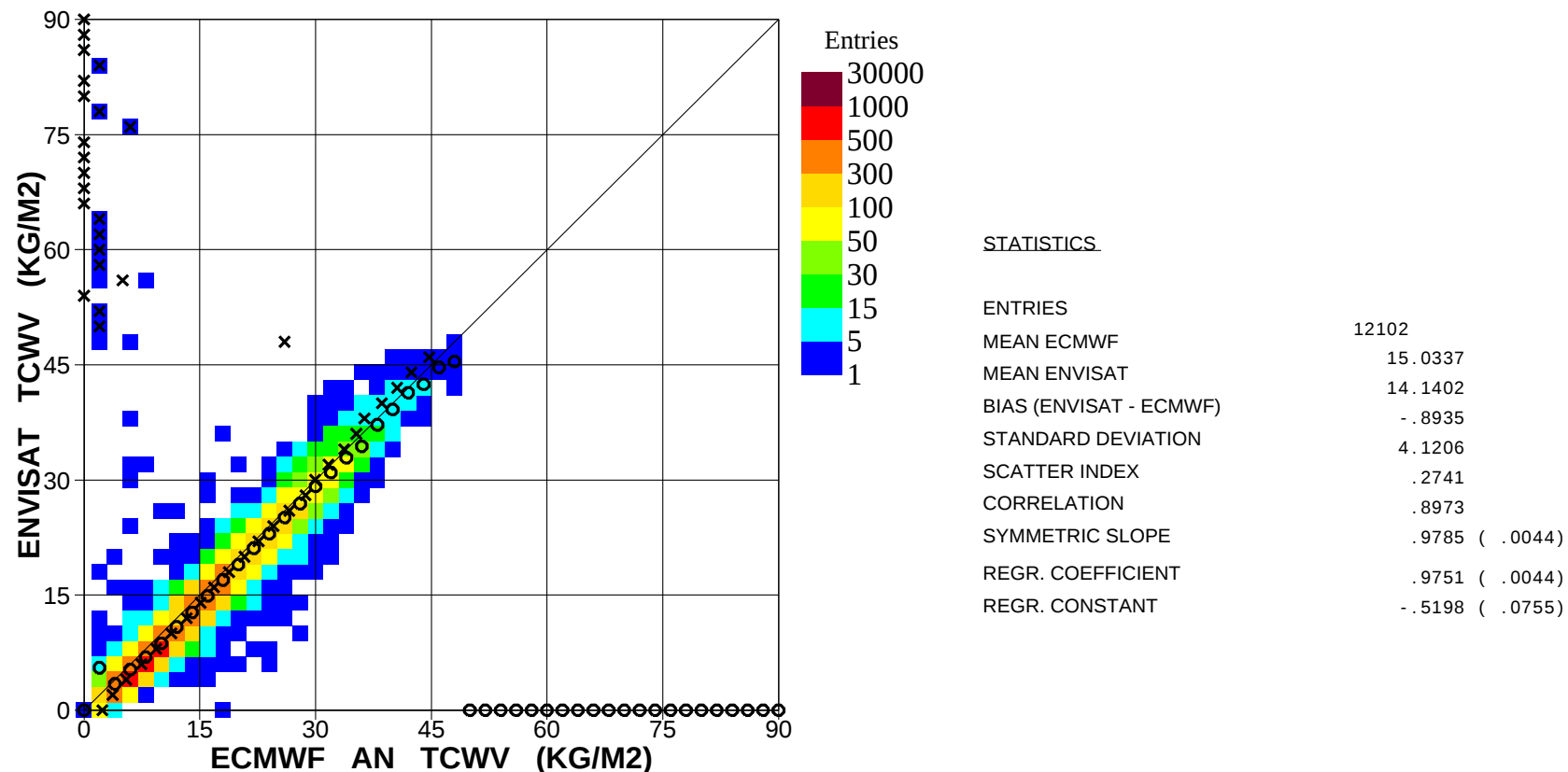


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for January 2004 (N.Hem.)



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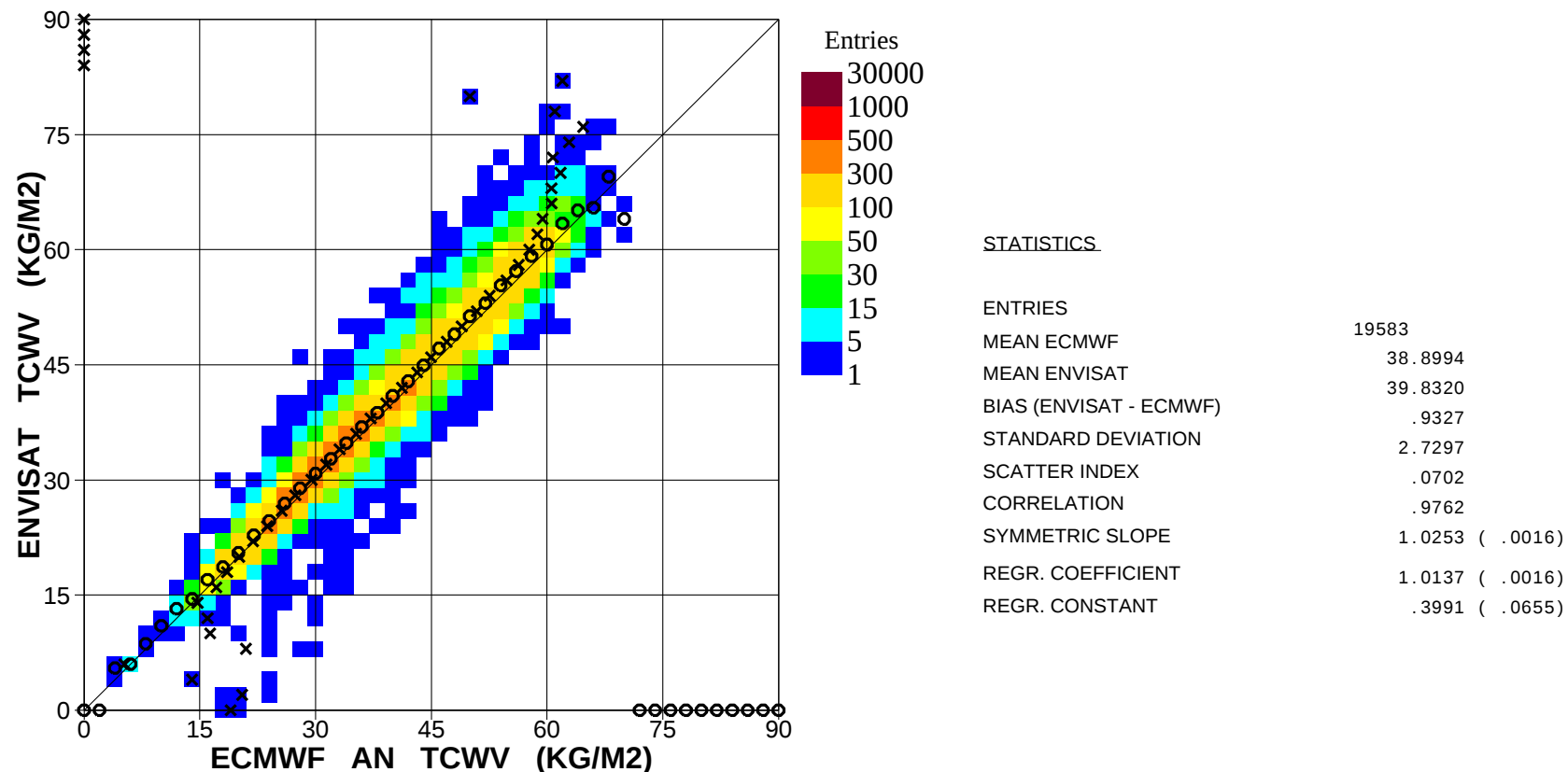


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for January 2004 (Tropics)

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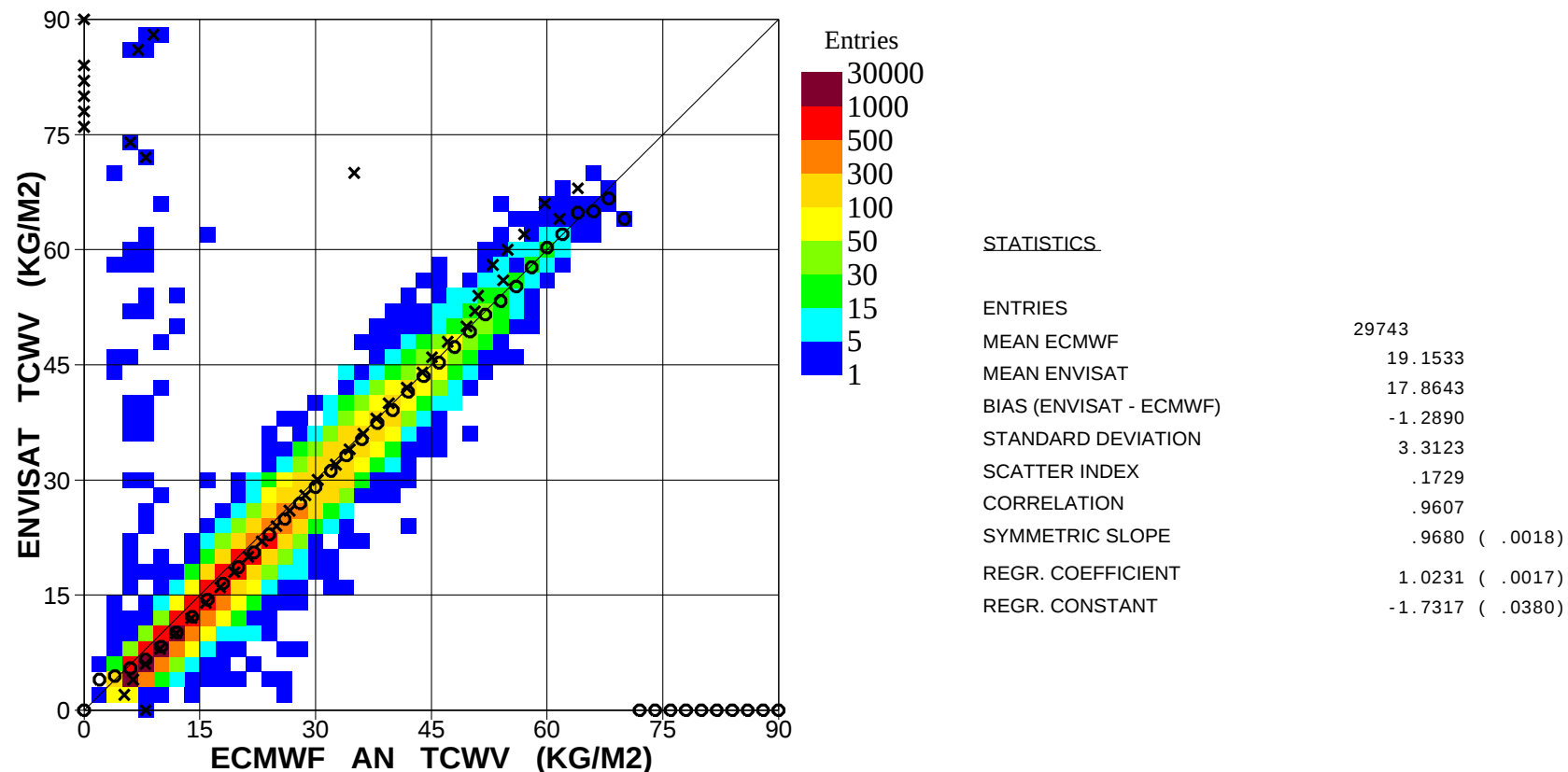


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for January 2004 (S.Hem.)



■ ECMWF Report on ENVISAT RA-2 for January 2004 ■

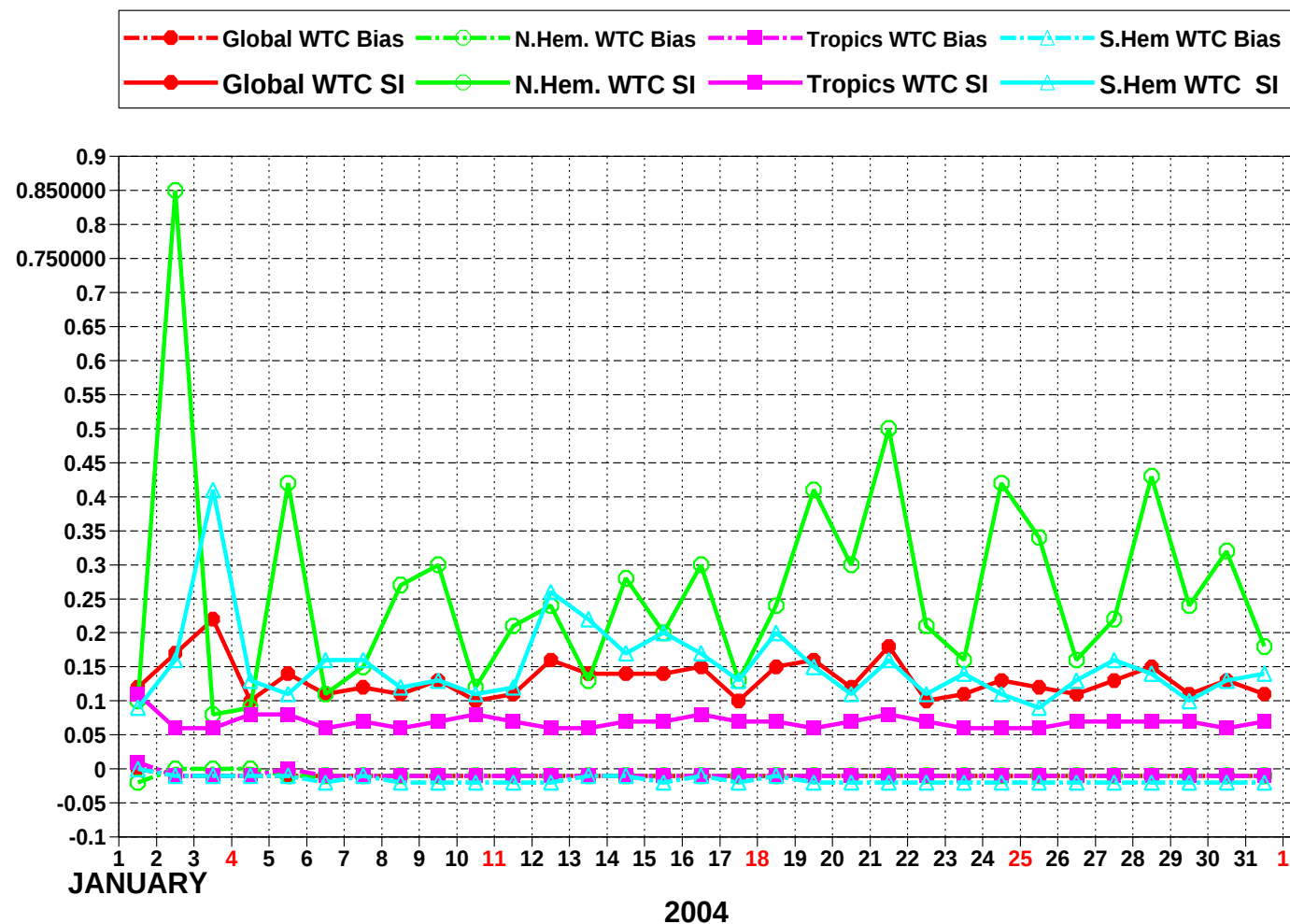


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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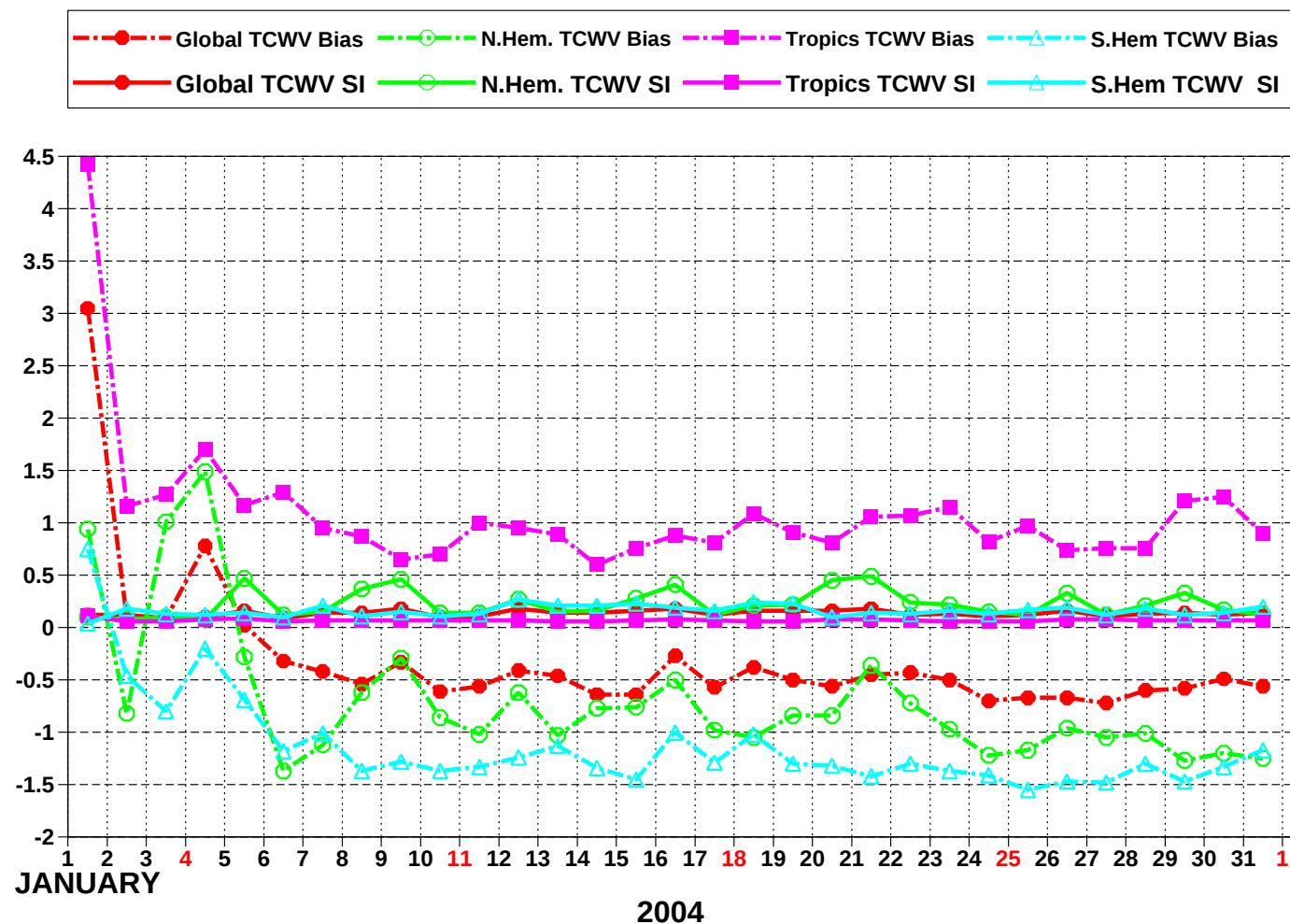


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

■ ECMWF Report on ENVISAT RA-2 for January 2004 ■

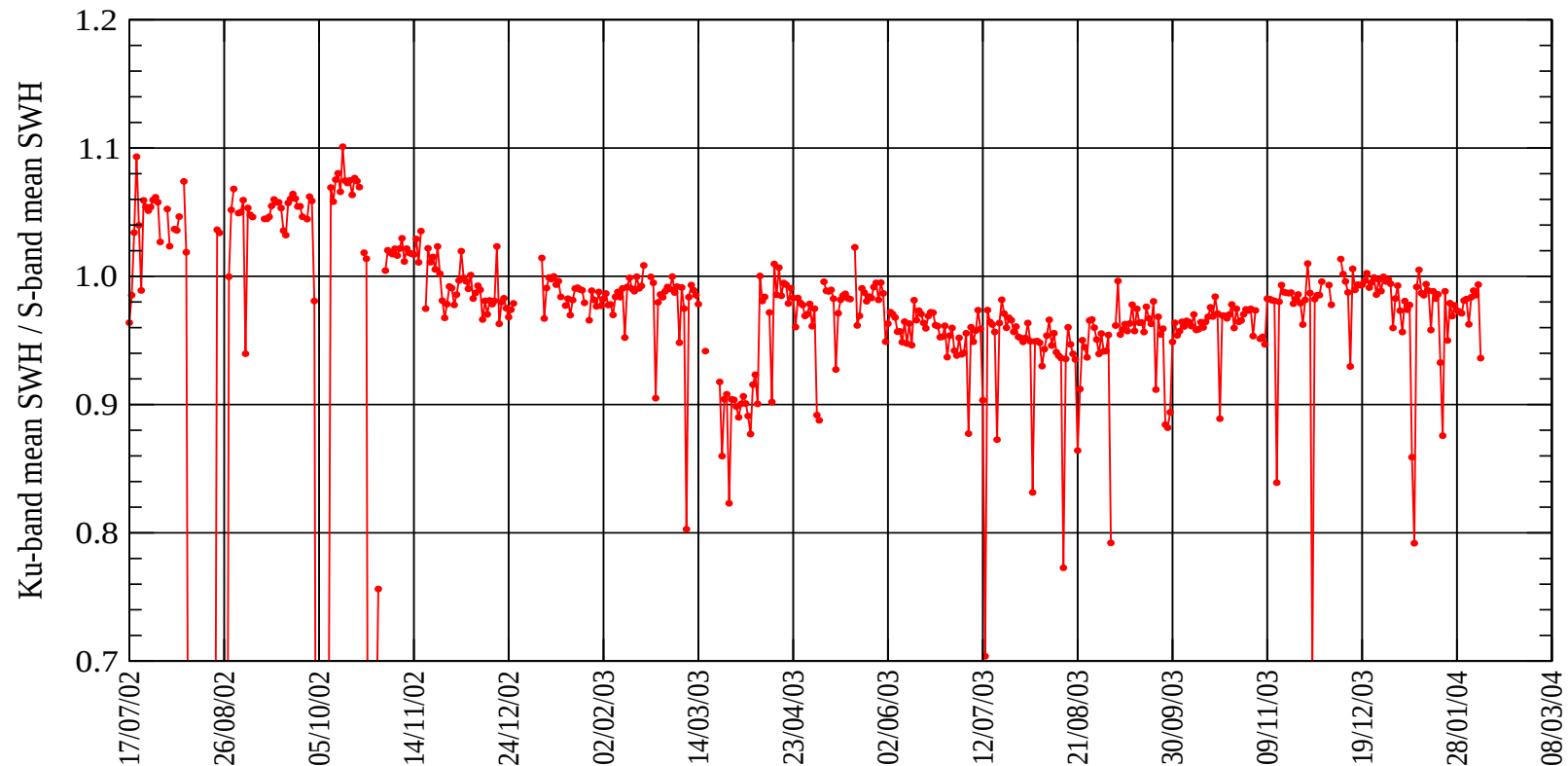


Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 18th. of July 2002.

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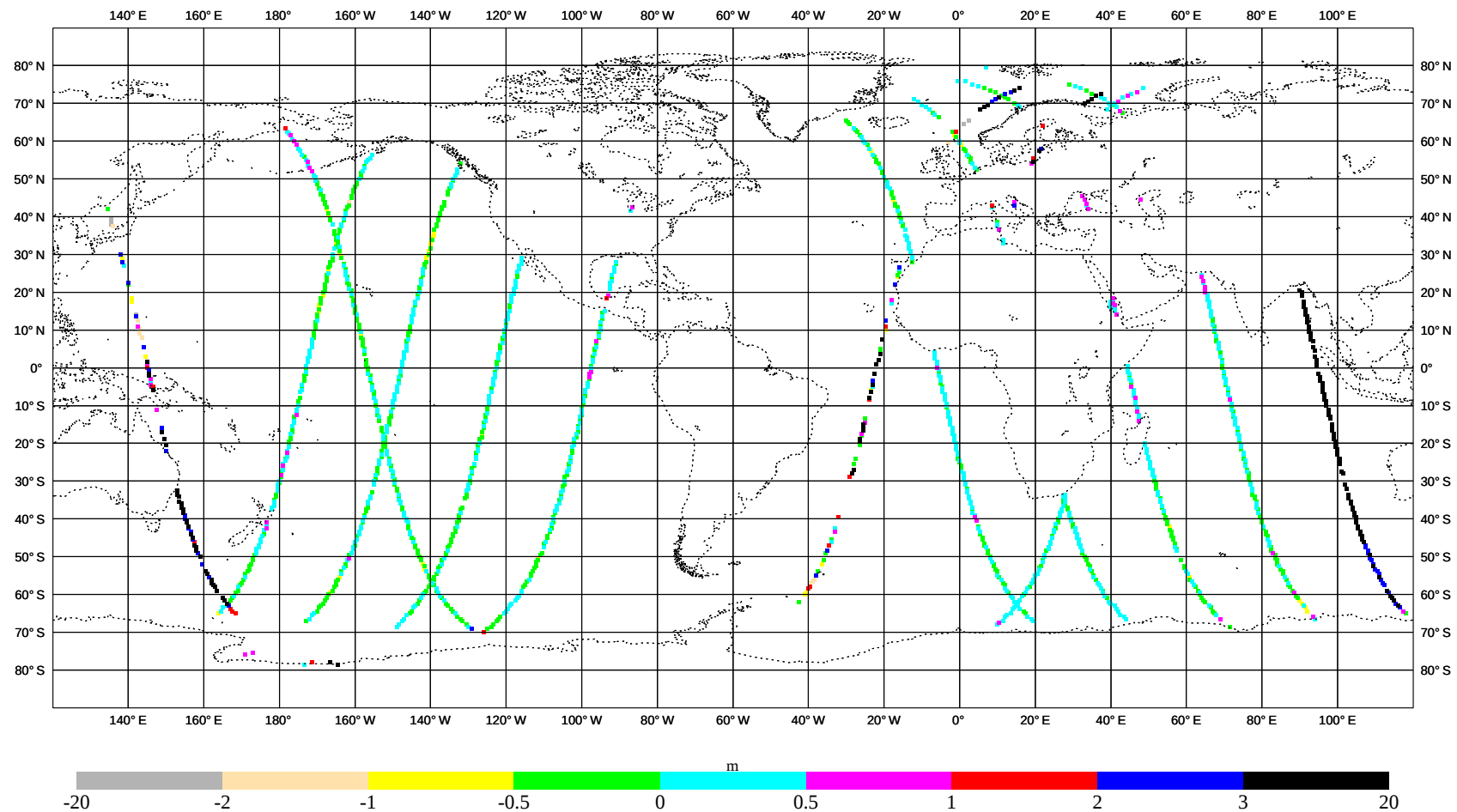


Figure 49: Significant wave height: Difference between S-Band altimeter and WAM model data for 10 January 2004