

■ ECMWF Report on ENVISAT RA-2 for December 2011 ■

Report on ENVISAT Radar Altimeter - 2 (RA-2) Wind/Wave Product with Height Information (RA2 WWV 2P)

By: Saleh Abdalla

Date: 24 January 2012

Overview:

Based on the data received during this month, on average, 18964 observations arrived at ECMWF every 6-hour window of which an average of 10041 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 58.6% of the remaining part passed the quality control. **Most of the data between the 14:43 UTC on 20th and 18:05 UTC on the 27th of December were rejected due to the degradation of RA-2 production due to an anomalous MWR Level 0 data generation (ESA News of 02 January 2012).** As can be seen in Figure 1, there was no data gaps in terms of the 6-hour time window centred at major synoptic UTC times for this month. However, 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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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 rain flag should be ignored since then. The quality of the data is nominal after the change of orbit at end of October 2010.

Backscatter:

- ENVISAT Ku-band $\langle \sigma^0 \rangle = 10.87$ 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	+0.36	14.0	+0.29	15.3
Northern Hemisphere	+0.63	14.6	+0.38	15.4
Tropics	+0.30	14.1	-0.01	13.5
Southern Hemisphere	+0.25	13.1	----	----

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

	RA2 (Ku) - WAM		RA2 (Ku) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	-0.03	10.4	-0.01	12.4
Northern Hemisphere	-0.00	10.8	-0.01	12.5
Tropics	-0.05	9.7	-0.02	10.0
Southern Hemisphere	-0.02	10.1	----	----

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	-0.013	9.8	-0.71	8.0
Northern Hemisphere	-0.010	12.9	-0.63	11.3
Tropics	-0.016	7.3	-0.47	5.7
Southern Hemisphere	-0.013	11.3	-0.91	9.5

Remarks:

- **Most of the data between the 14:43 UTC on 20th and 18:05 UTC on the 27th of December were rejected due to the degradation of RA-2 production due to an anomalous MWR Level 0 data generation (ESA News of 02 January 2012).**
- The orbit of ENVISAT was reduced by about 17 km between the 22nd and the 27th of October 2010. 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.



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- The rain flag should not be used after the loss of the S-Band on 17 January 2008.
- 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 36 cm/s **higher** than the model for this month. Furthermore, it is about 29 cm/s **higher** than the buoy measurements for this month.
- The Ku-band significant wave heights are almost **unbiased** (lower by ~ 3 cm) when compared to WAM model results (unbiased in the NH, 1.5% 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 0.3% **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.
- However, in the ENVISAT final report (Abdalla, 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.

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- **There is a secondary cloud of outliers started to appear in the WTC scatter plots following the implementation of IPF 6.02L04 (since the 2nd of February 2010) as can be seen in Figures 38-41. Those outliers can occur almost anywhere and could not be associated with any specific condition or geographical location.**
- 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.
- **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.**
- ERS-2 satellite was permanently switched-off in July 2011.
- The ECMWF models were not changed during the last month. The current operational IFS cycle is CY37R3 (since the 15th of November 2011).

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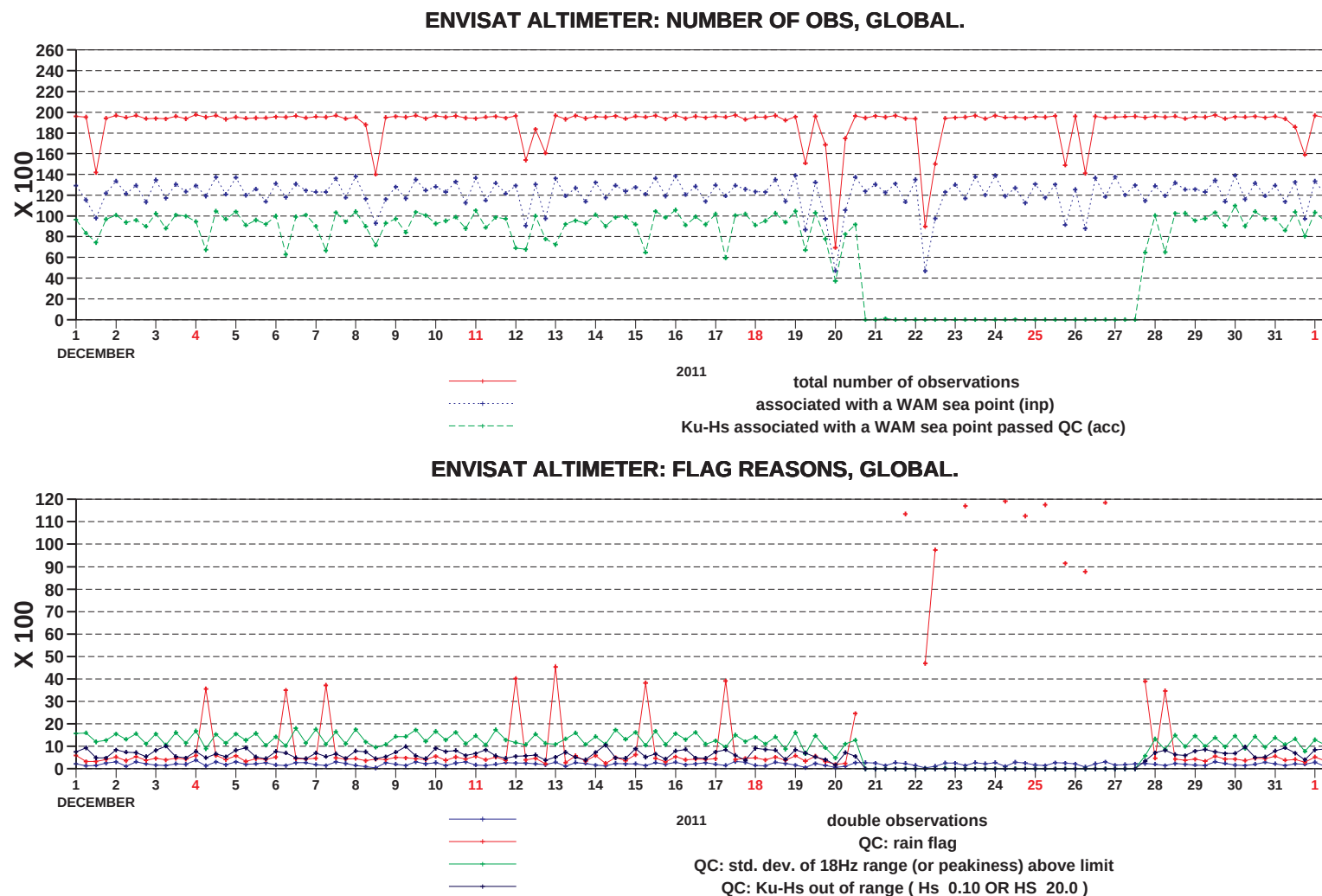


Figure 1: Time series of data reception for ENVISAT Altimeter data for December 2011

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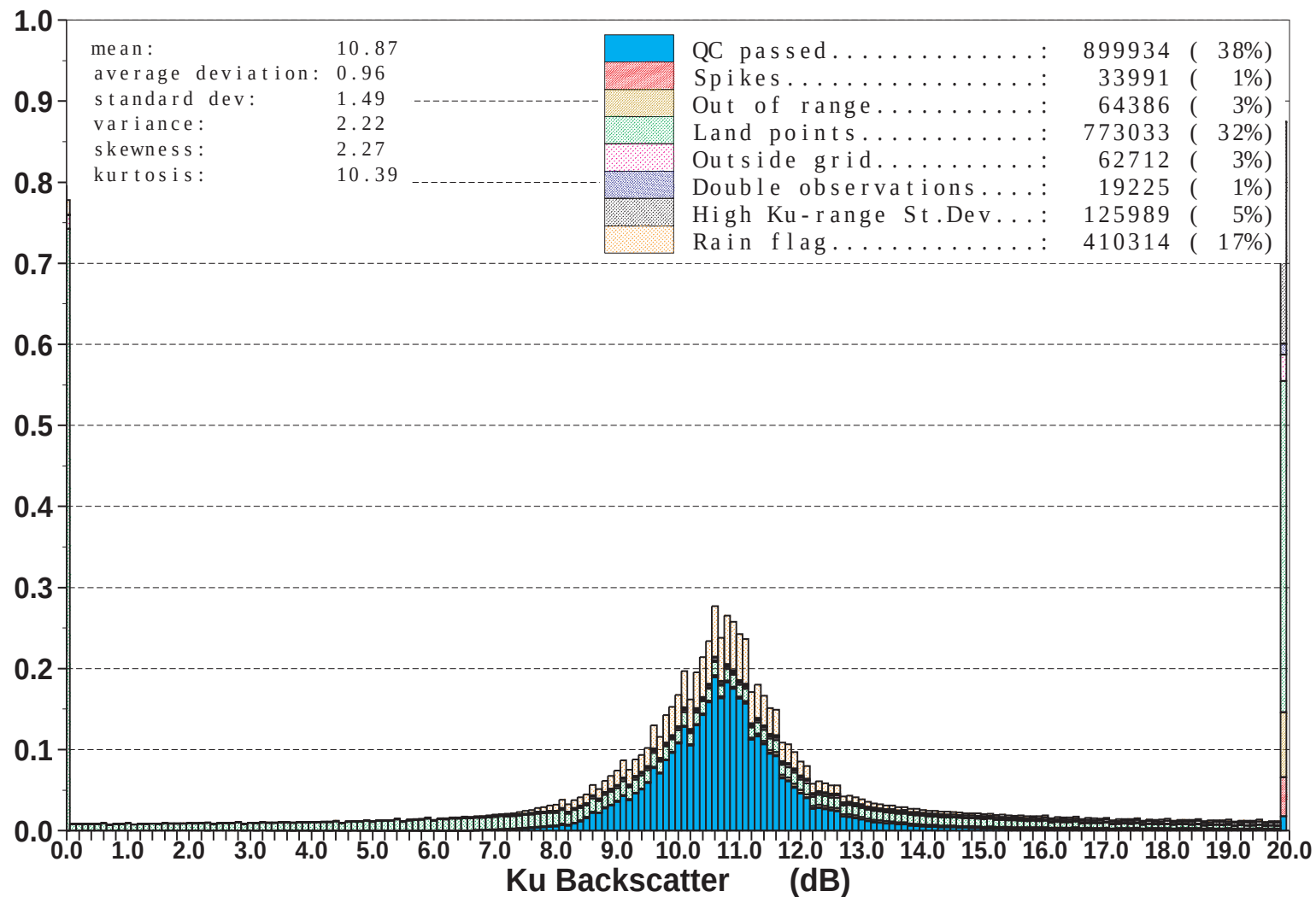


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for December 2011

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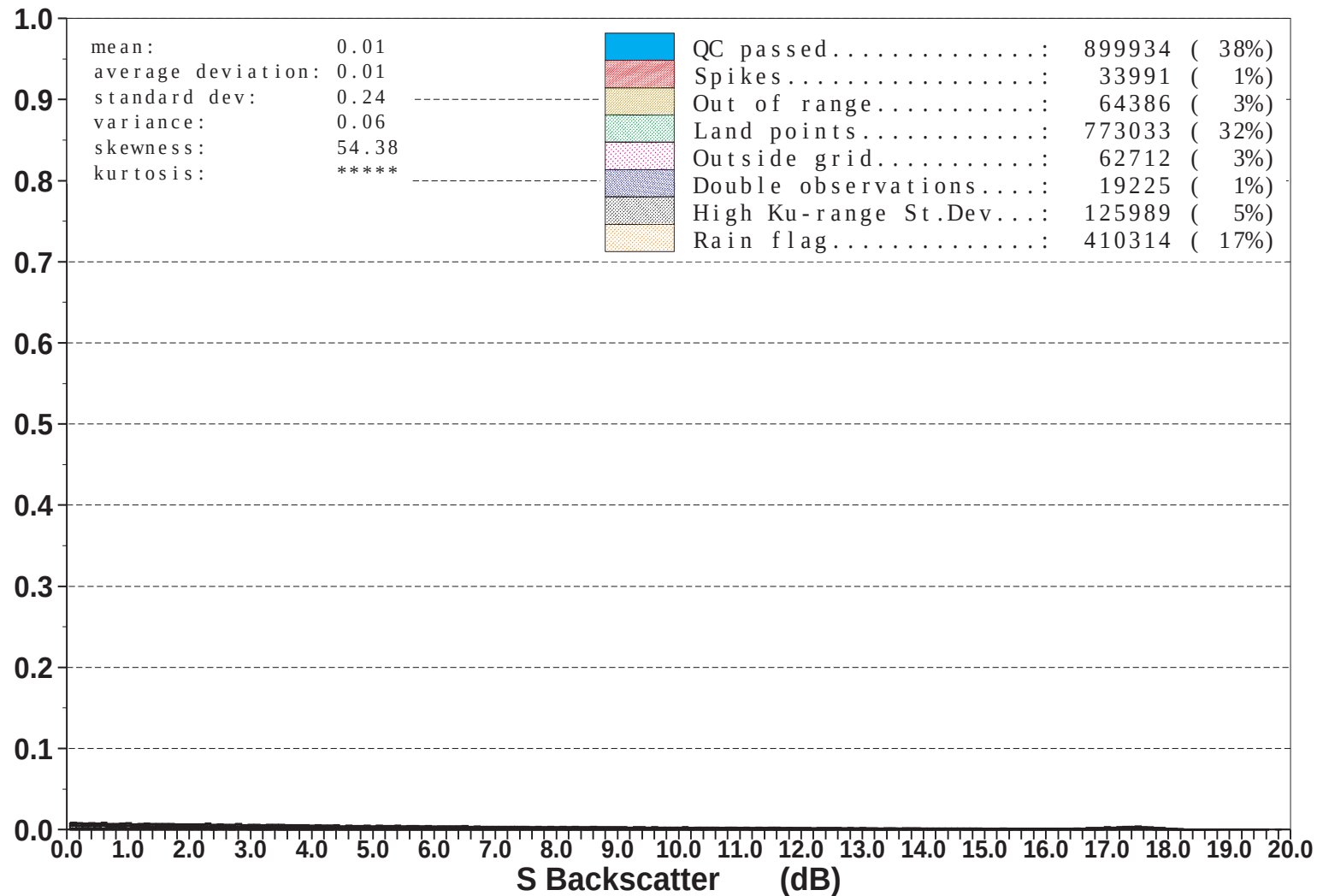


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for December 2011

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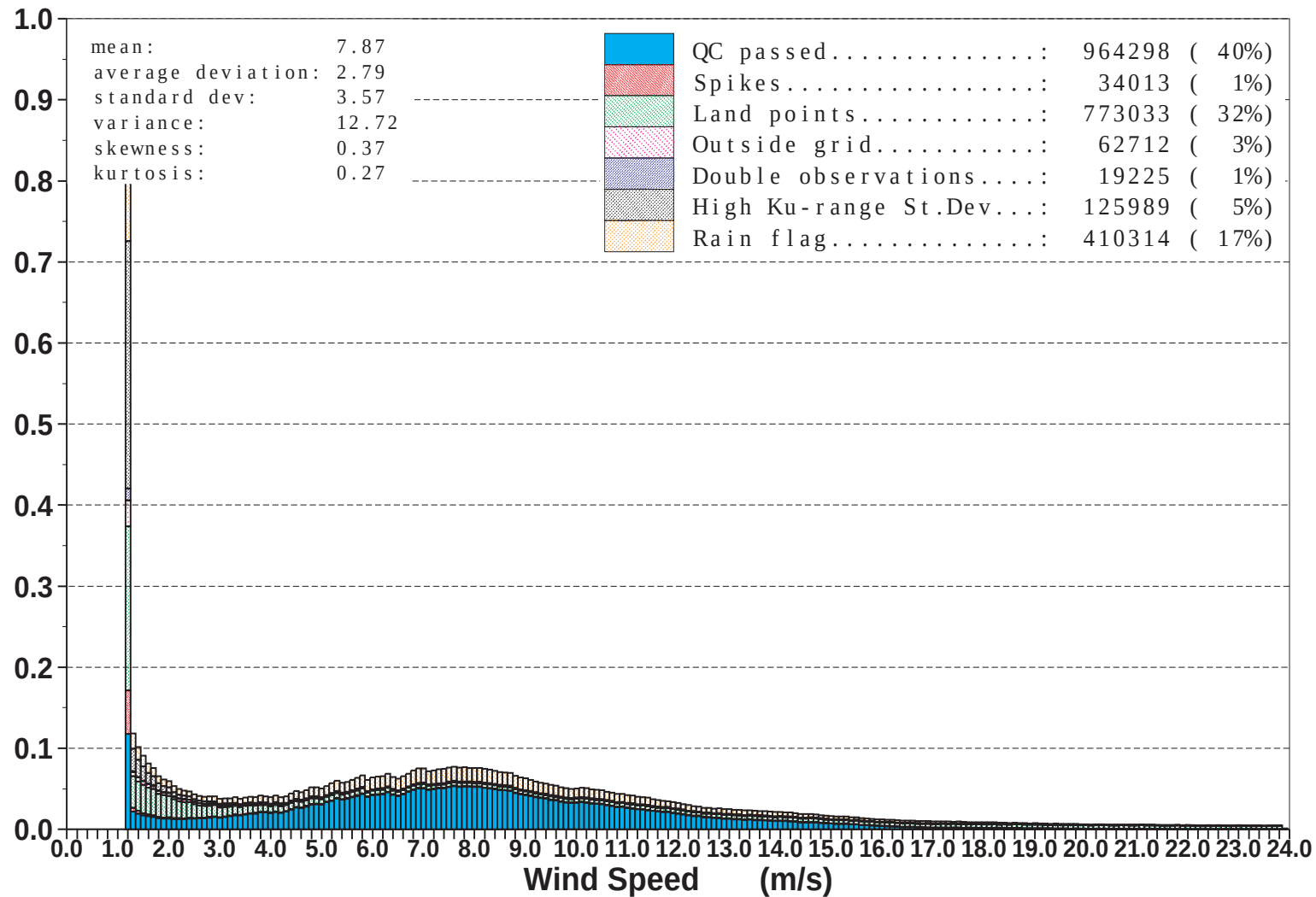


Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for December 2011

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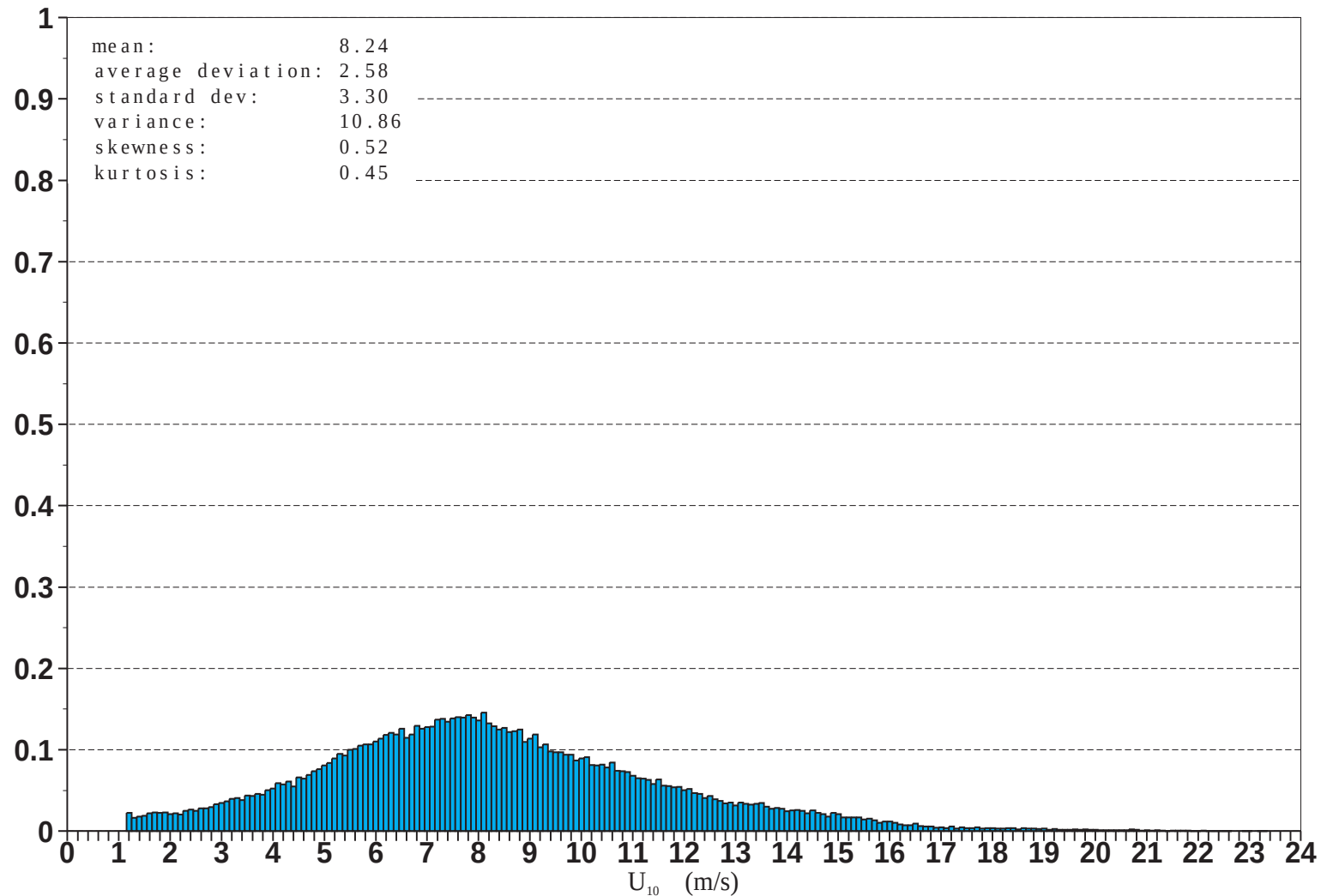


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for December 2011

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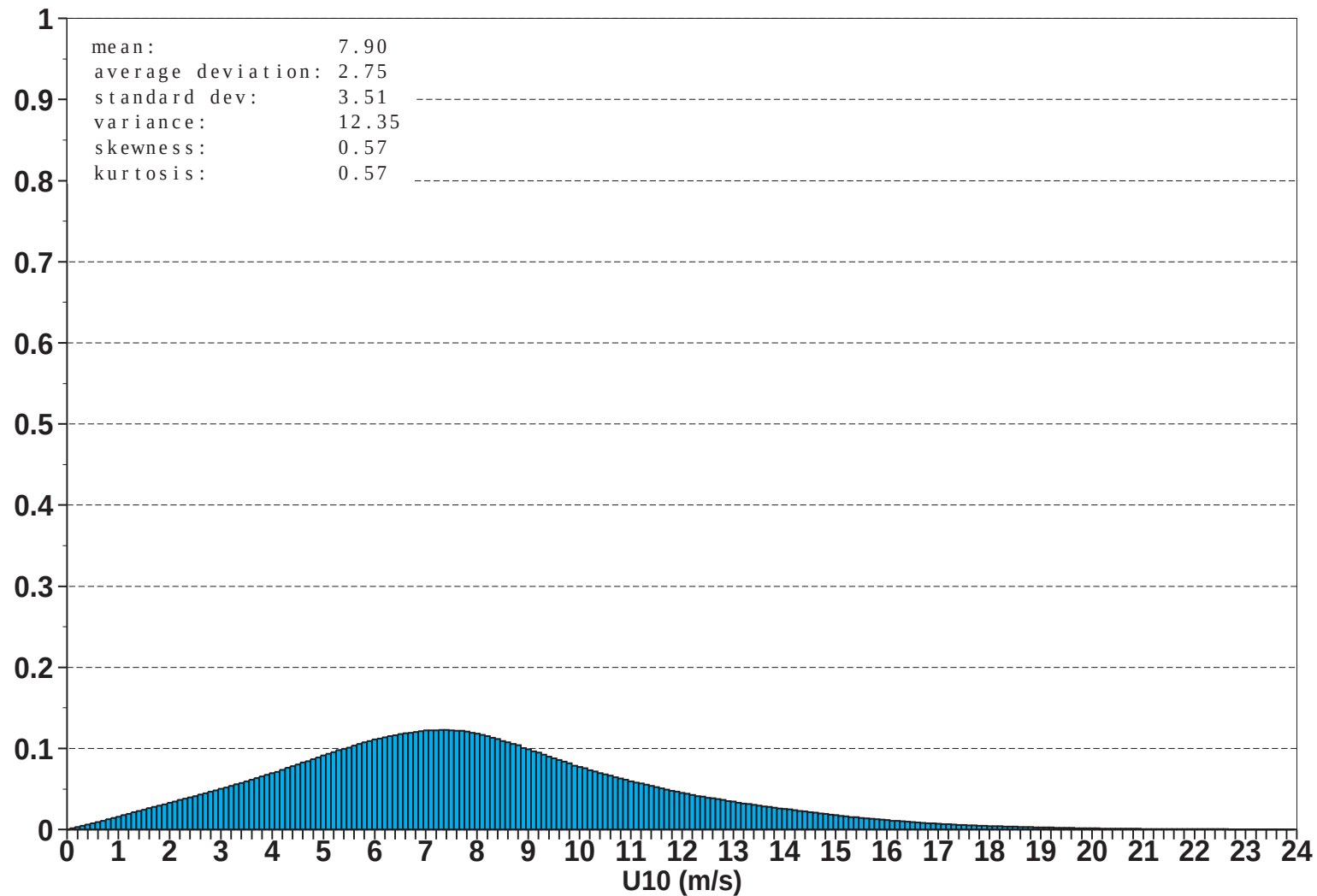


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for December 2011

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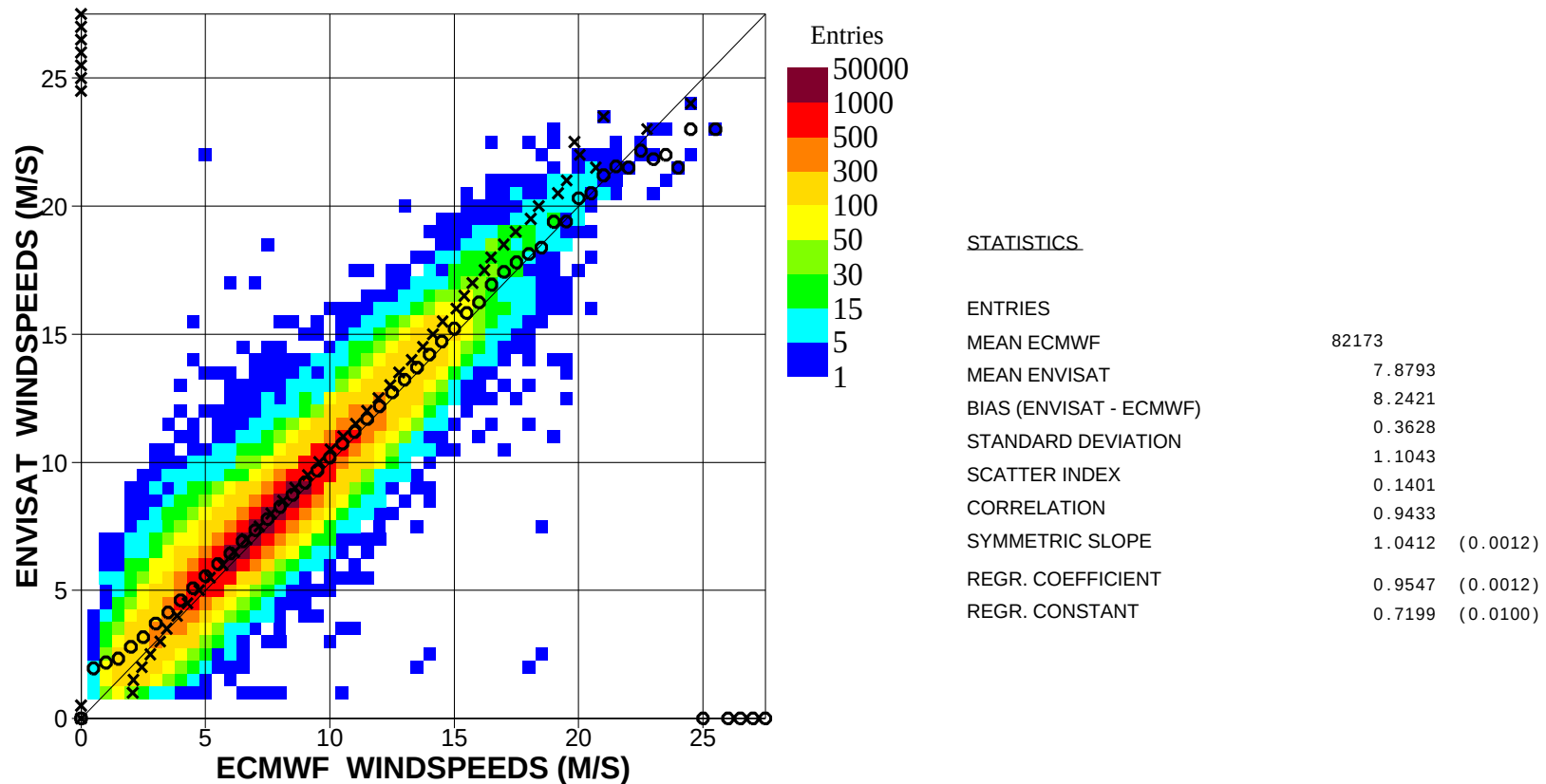


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for December 2011 (Global)

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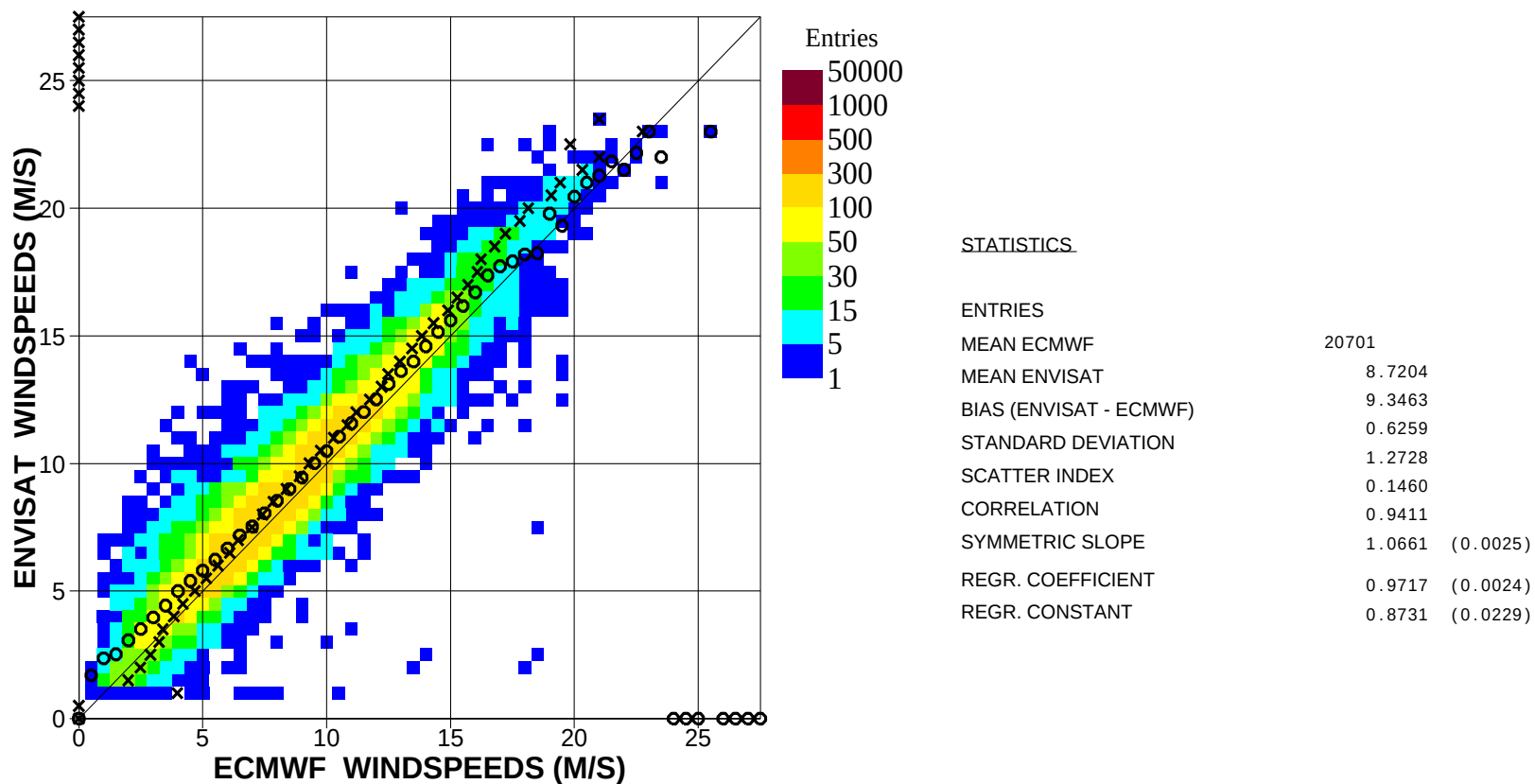


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for December 2011 (N.Hem.)

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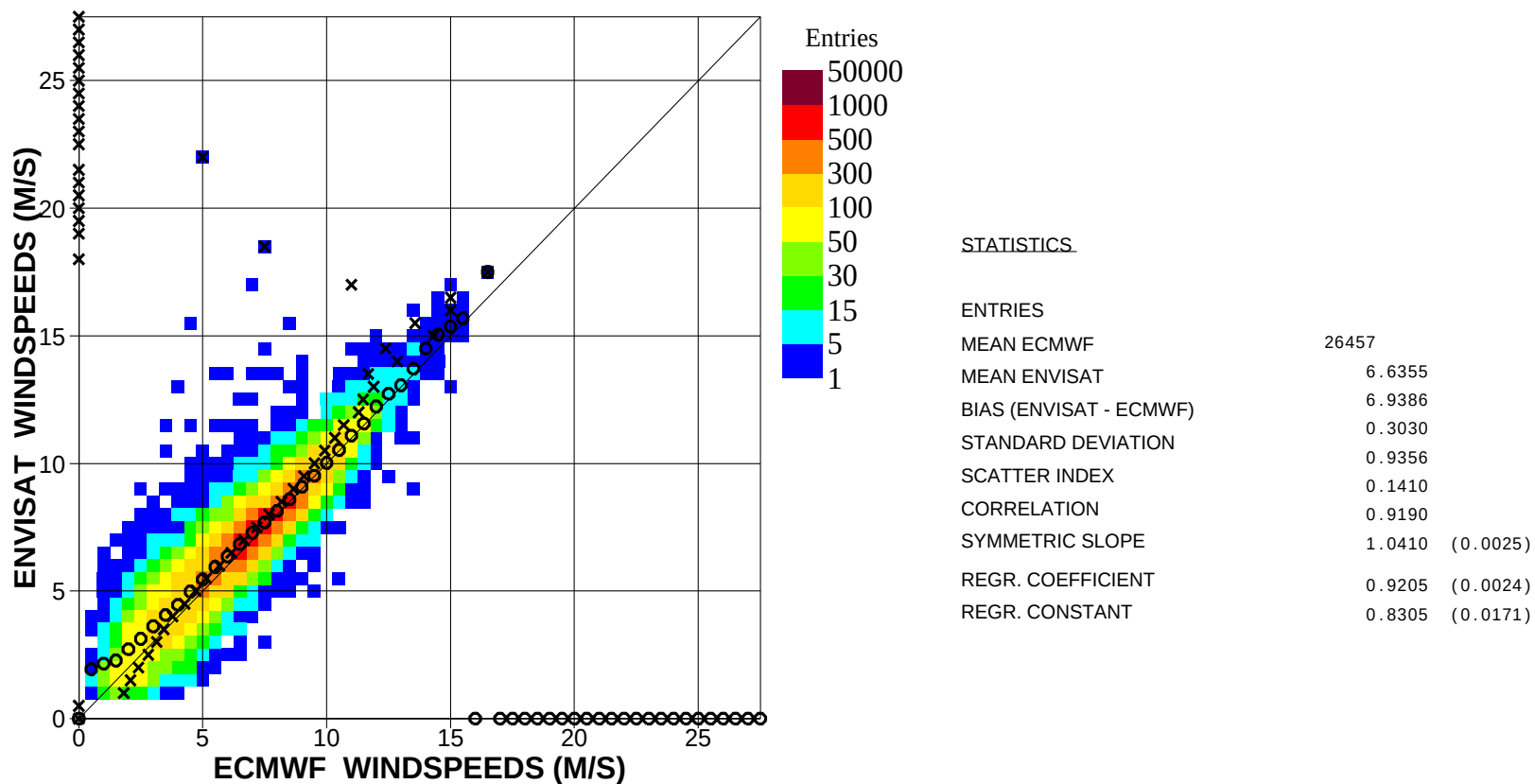


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for December 2011 (Tropics)

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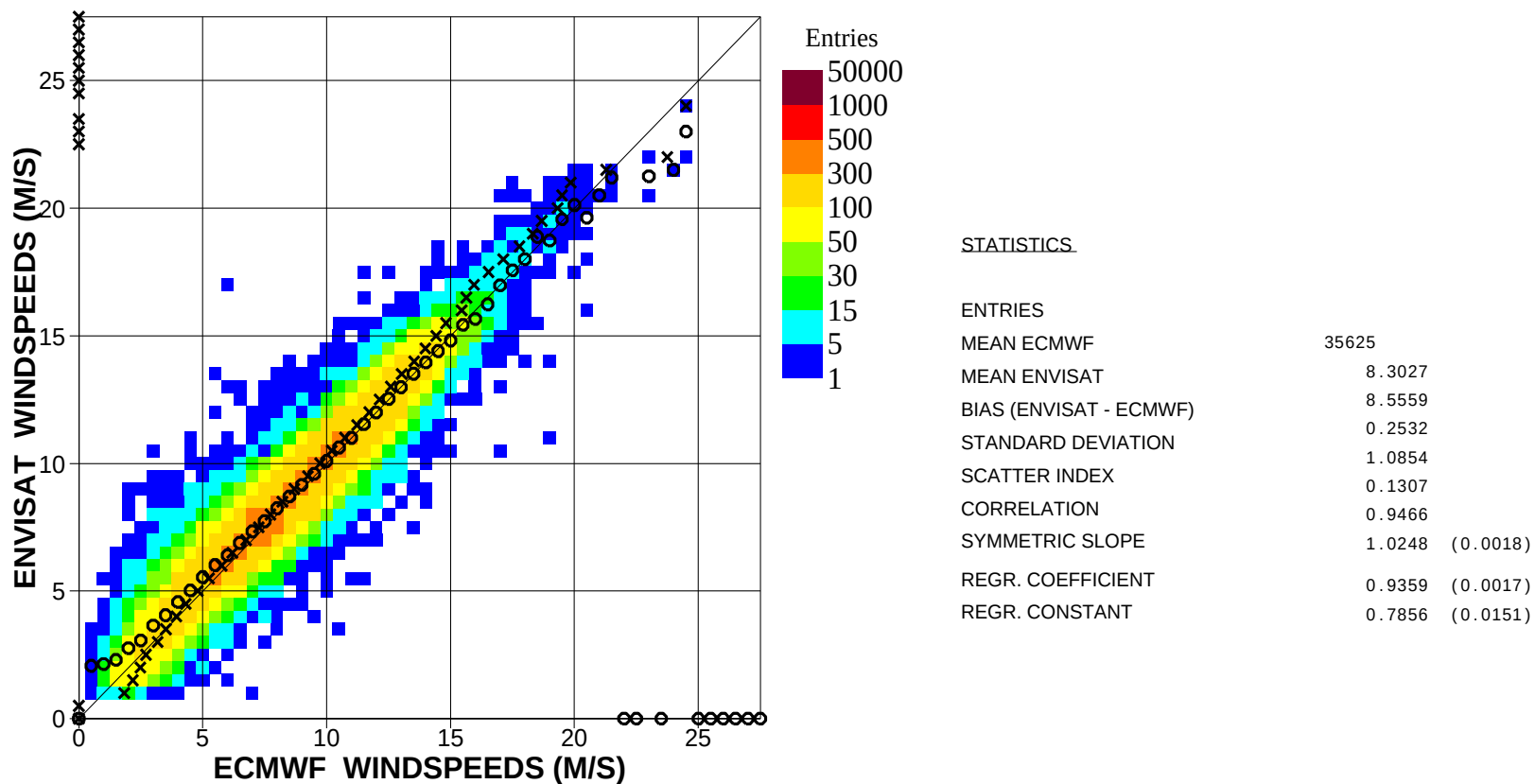


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for December 2011 (S.Hem.)

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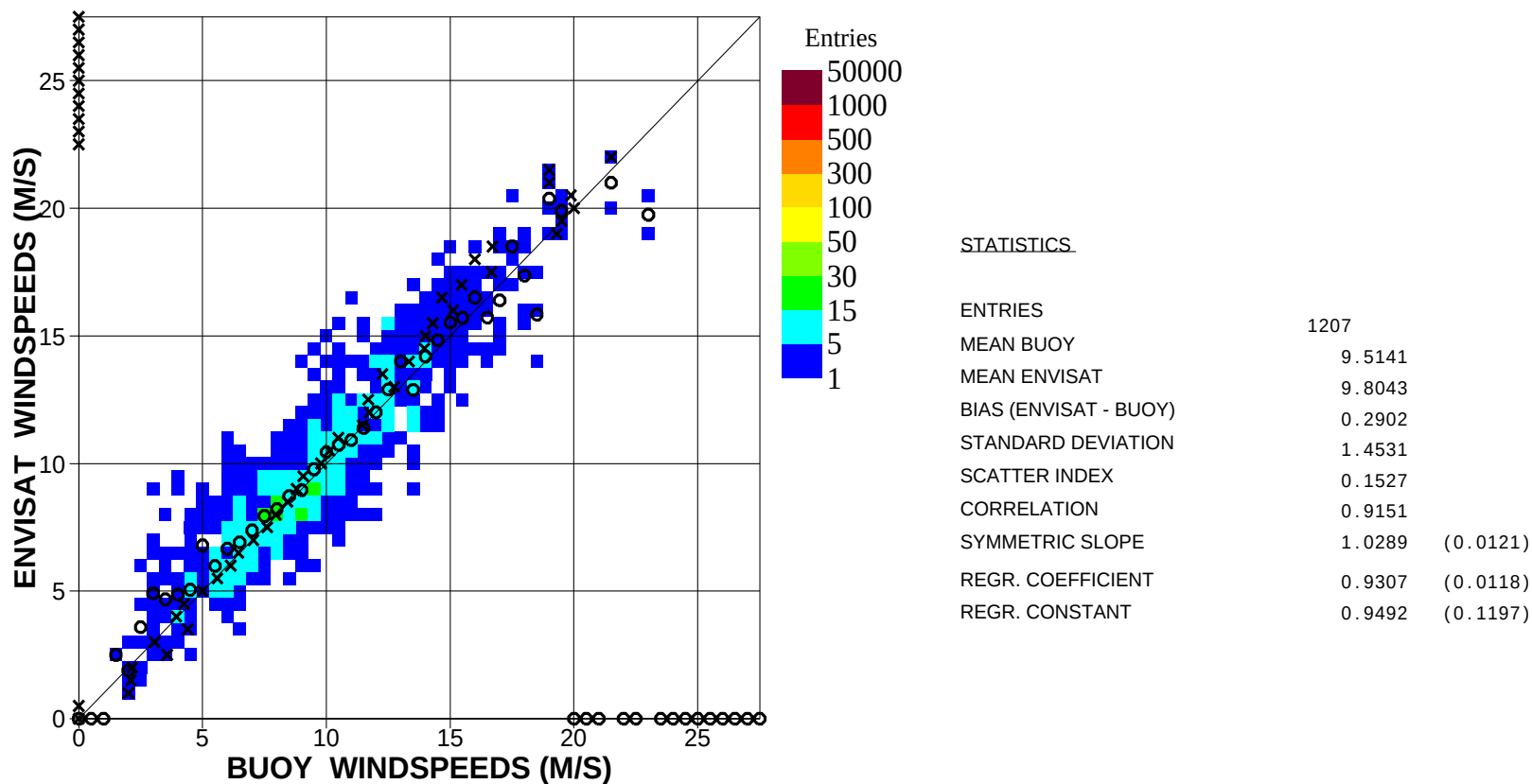


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for December 2011 (Global)

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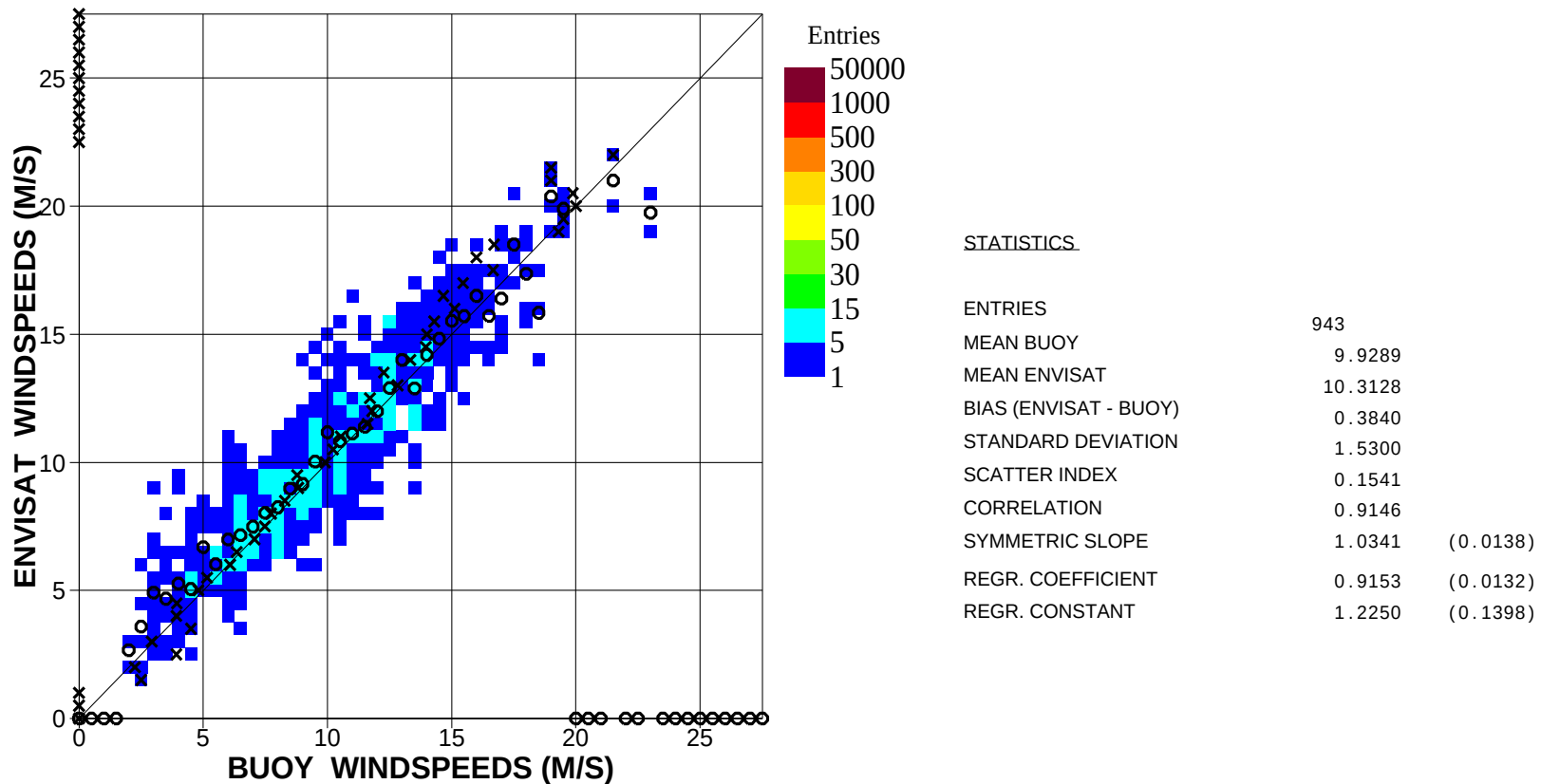


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for December 2011 (N.Hem.)

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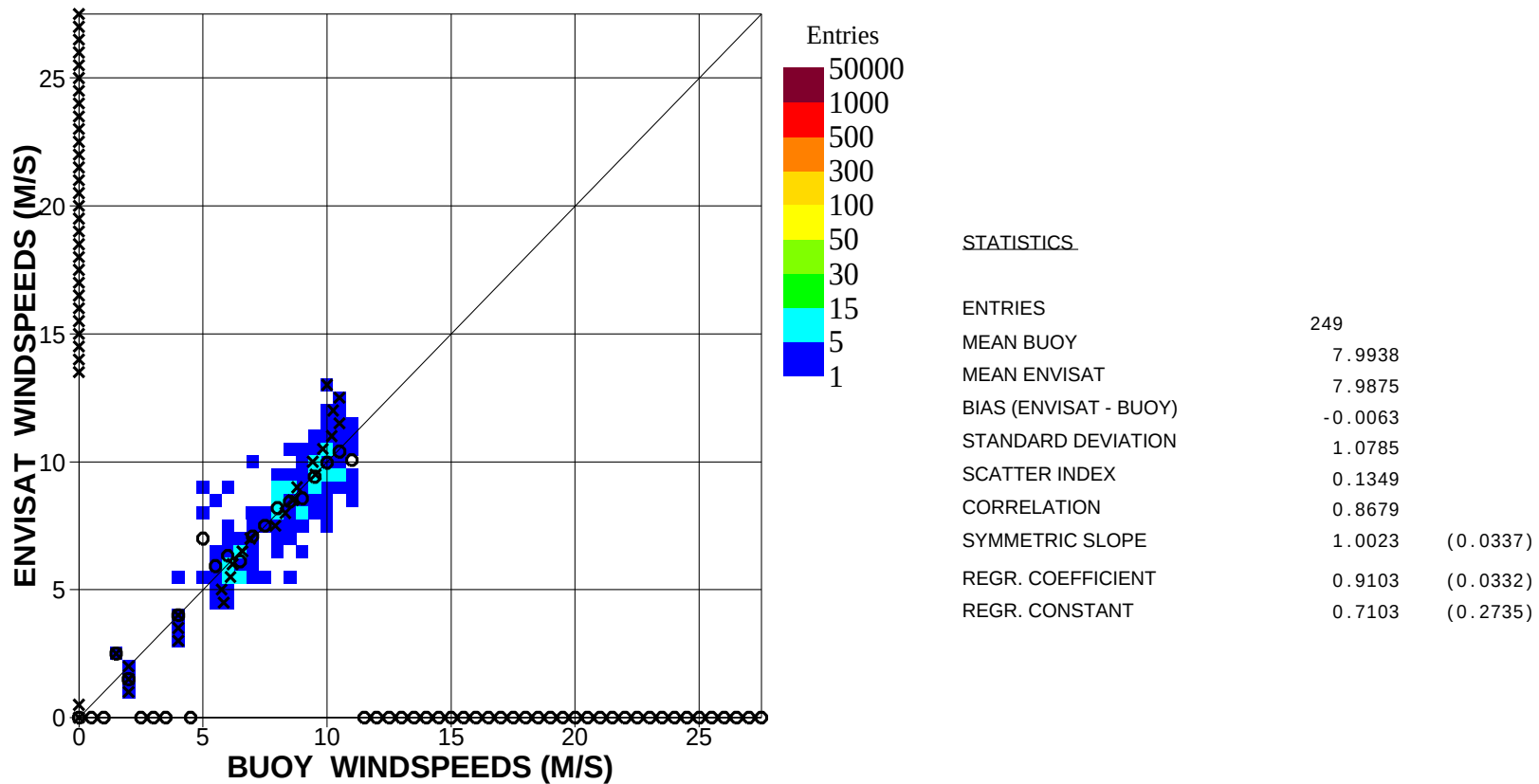


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for December 2011 (Tropics)

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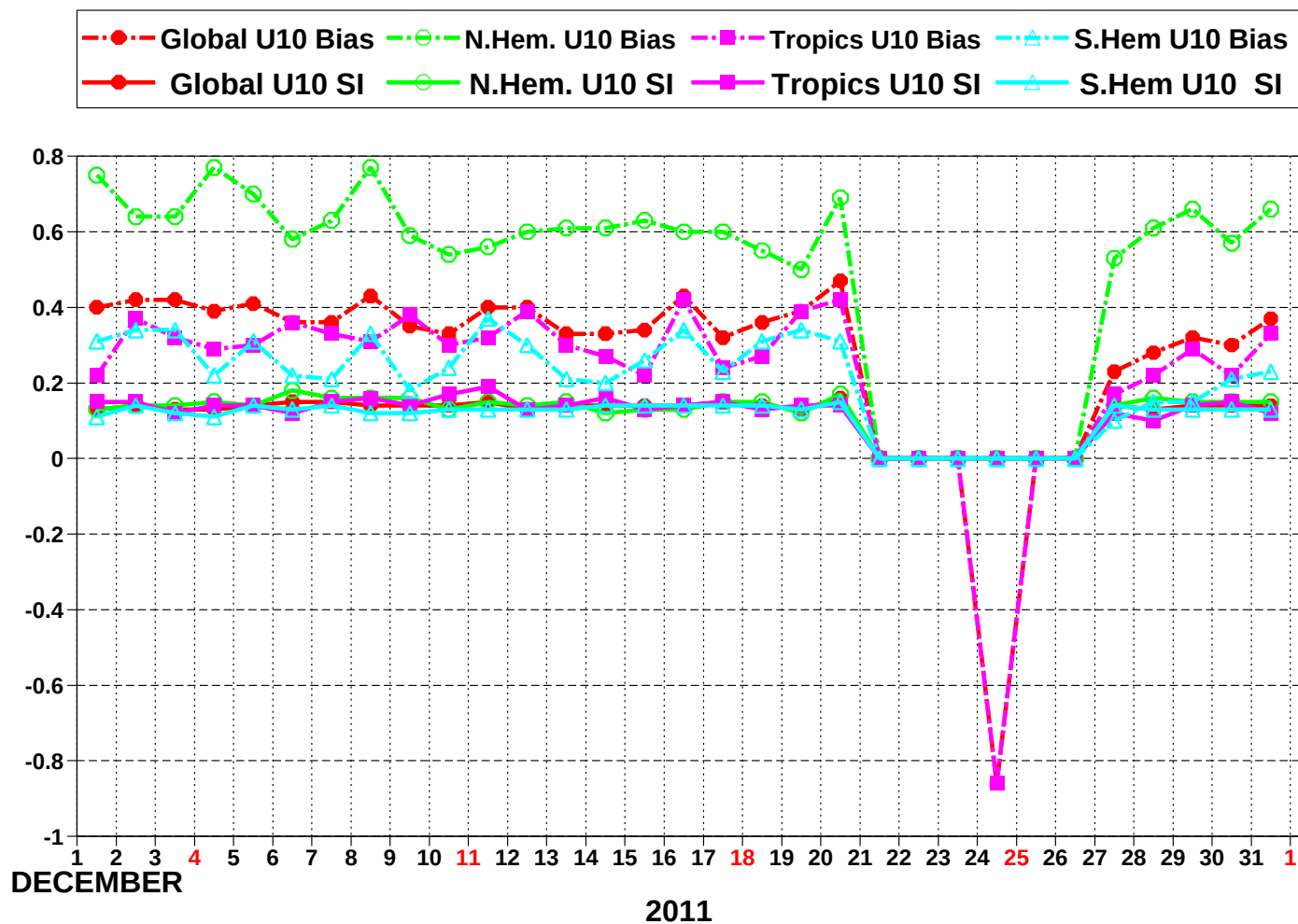


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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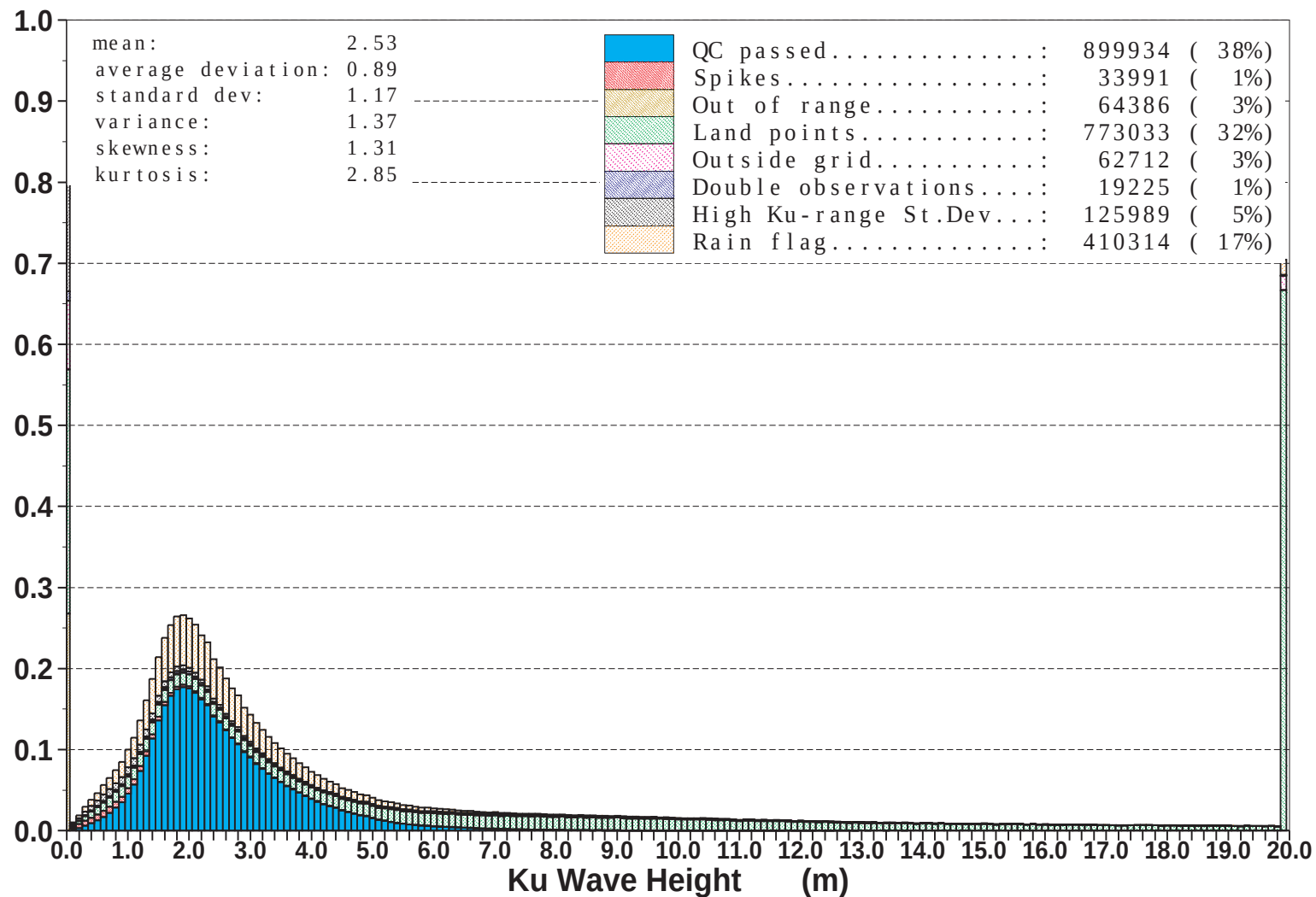


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for December 2011

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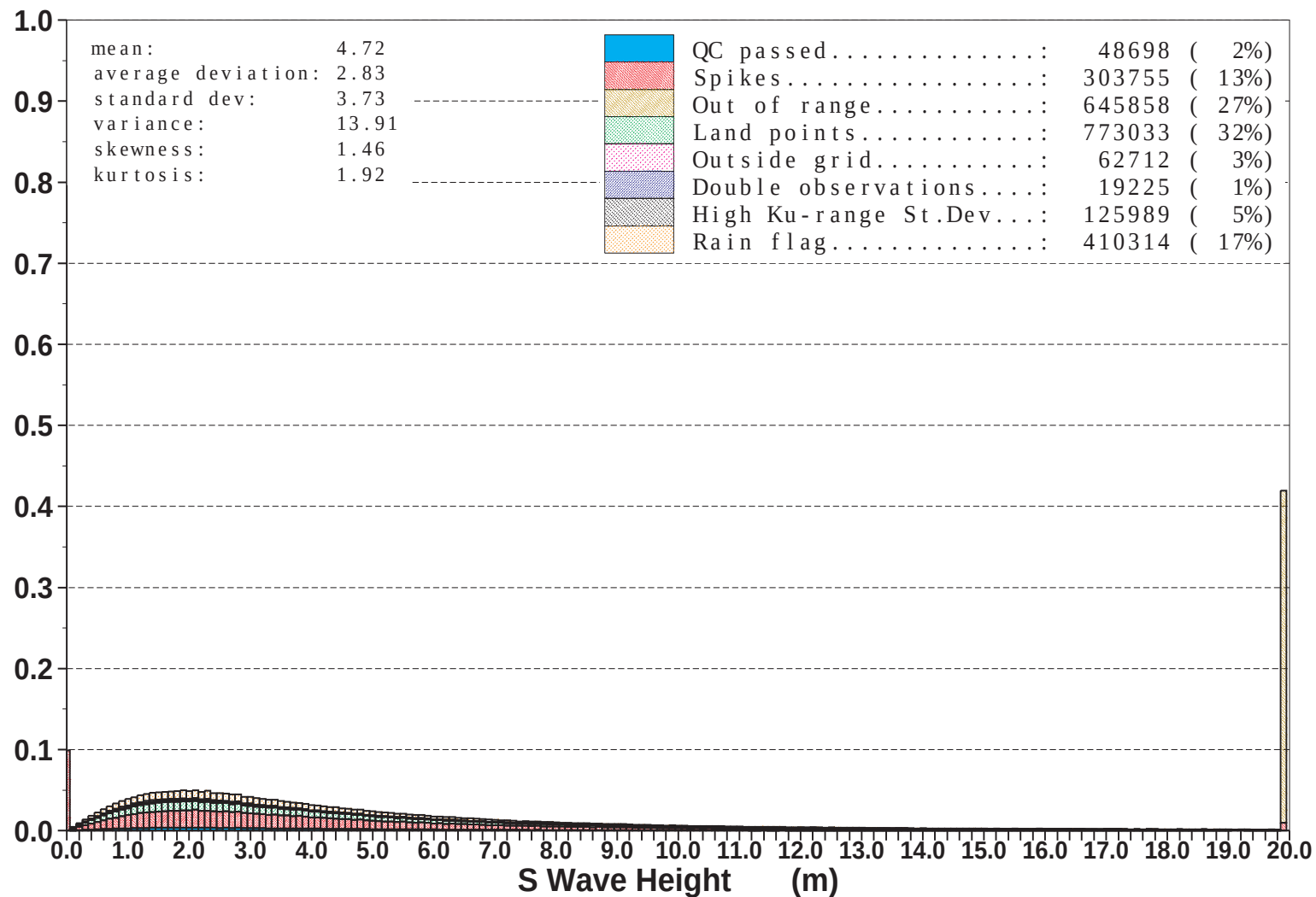


Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for December 2011

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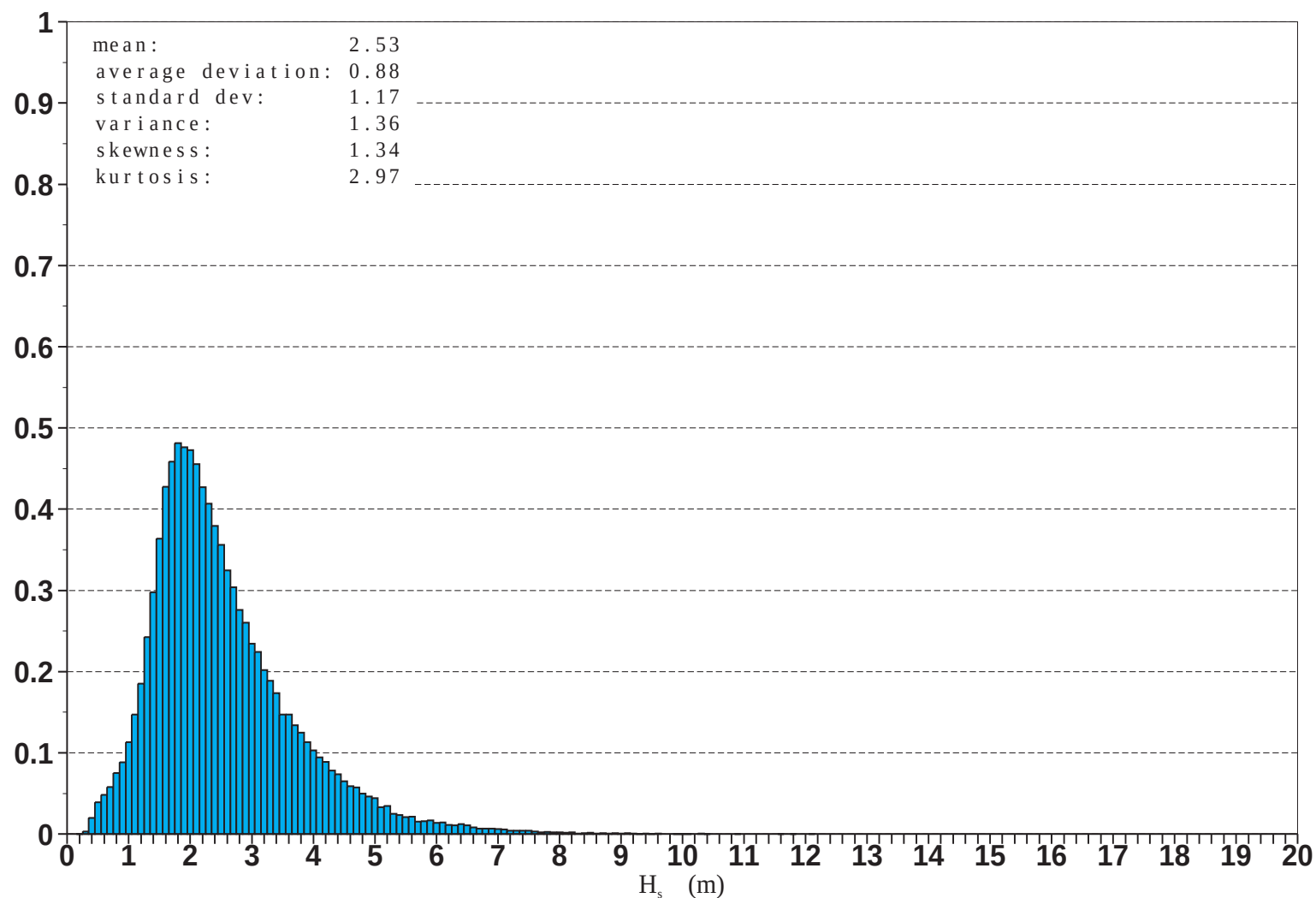


Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for December 2011

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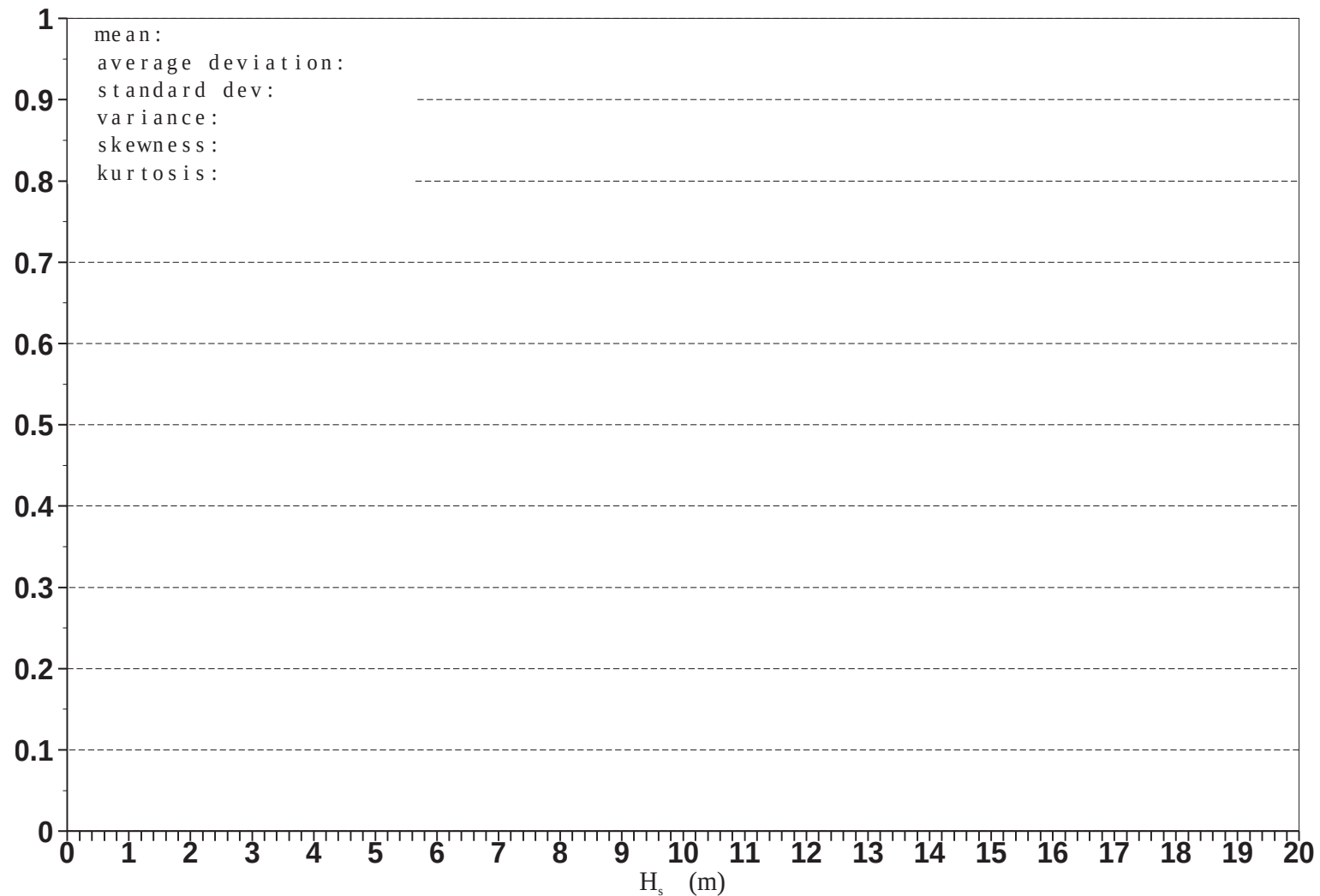


Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for December 2011

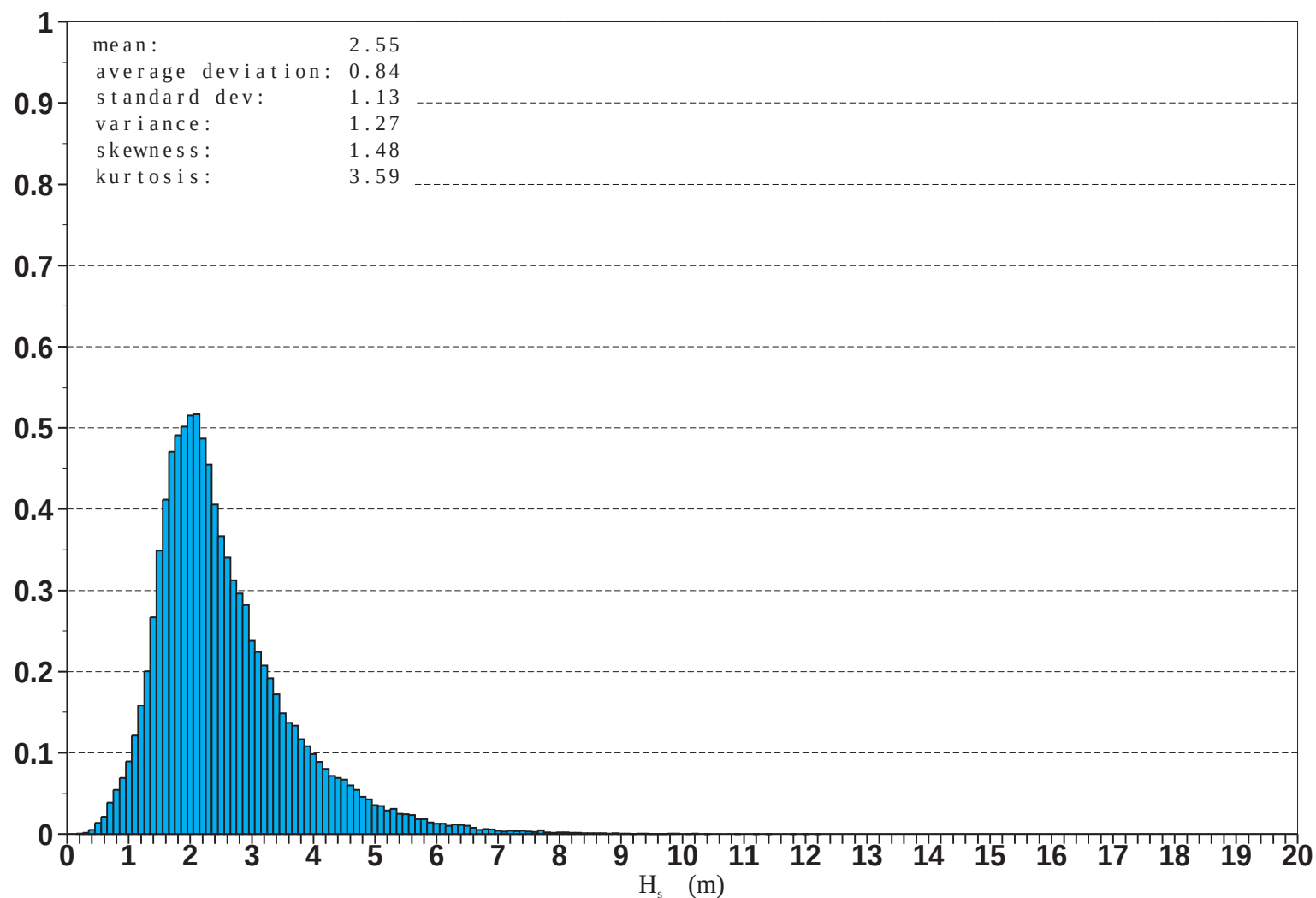
Plot not available.

ERS-2 was switched-off in July 2011.

Figure 19: Distribution of the ERS-2 Altimeter wave heights after along track averaging for December 2011.



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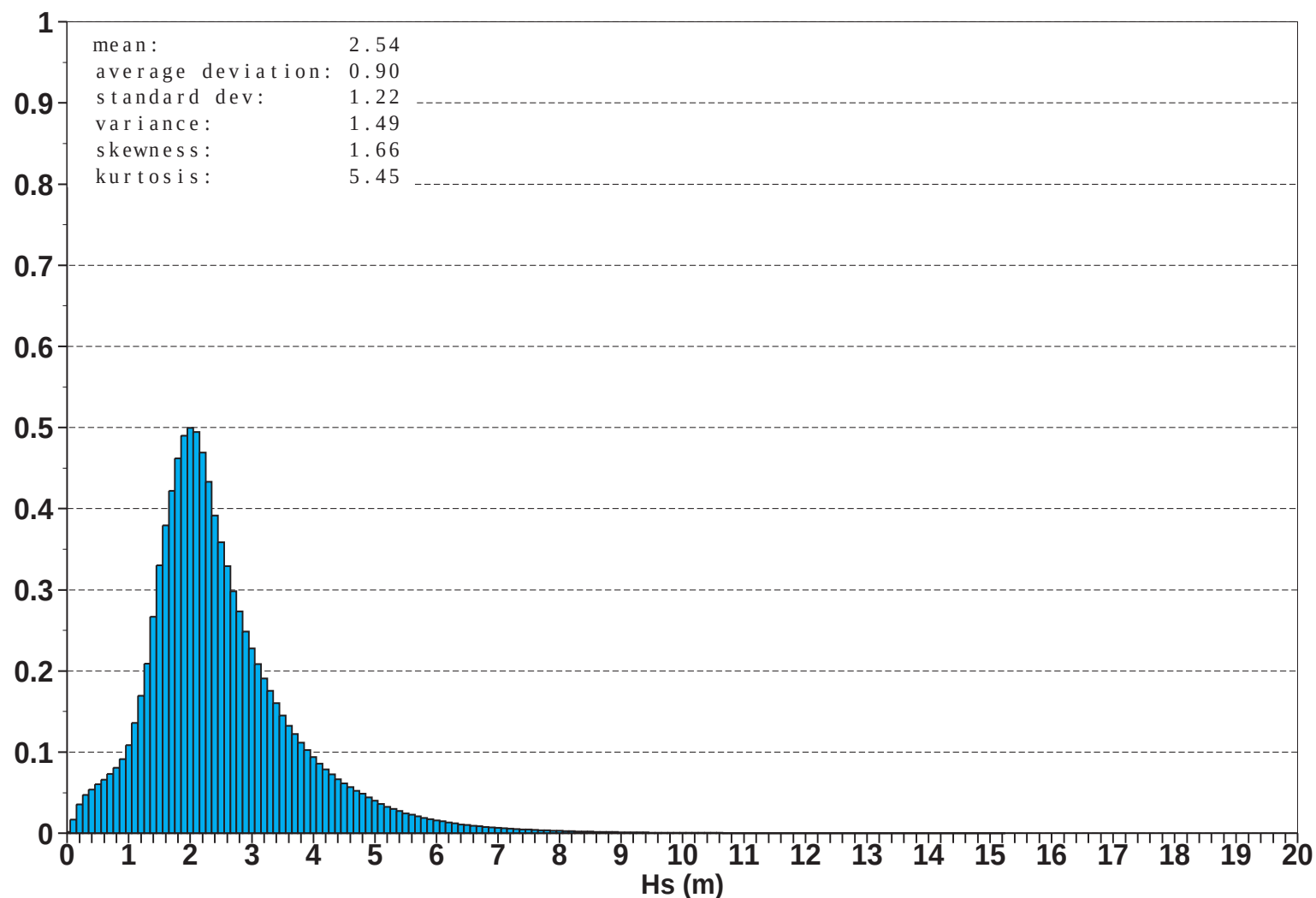


Figure 20: Global distribution of ECMWF First-Guess wave heights for December 2011

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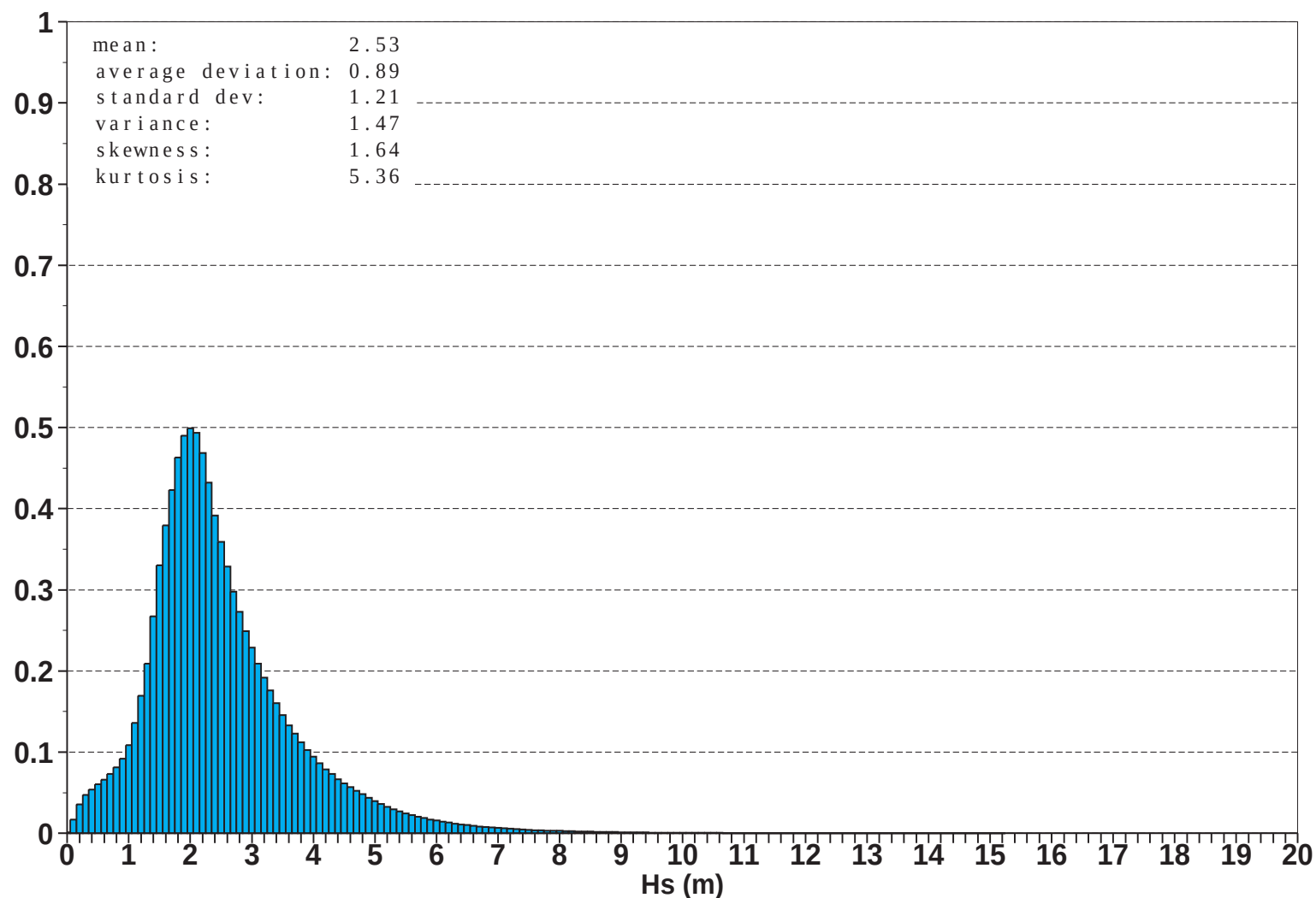


Figure 21: Global distribution of ECMWF Analysis wave heights for December 2011

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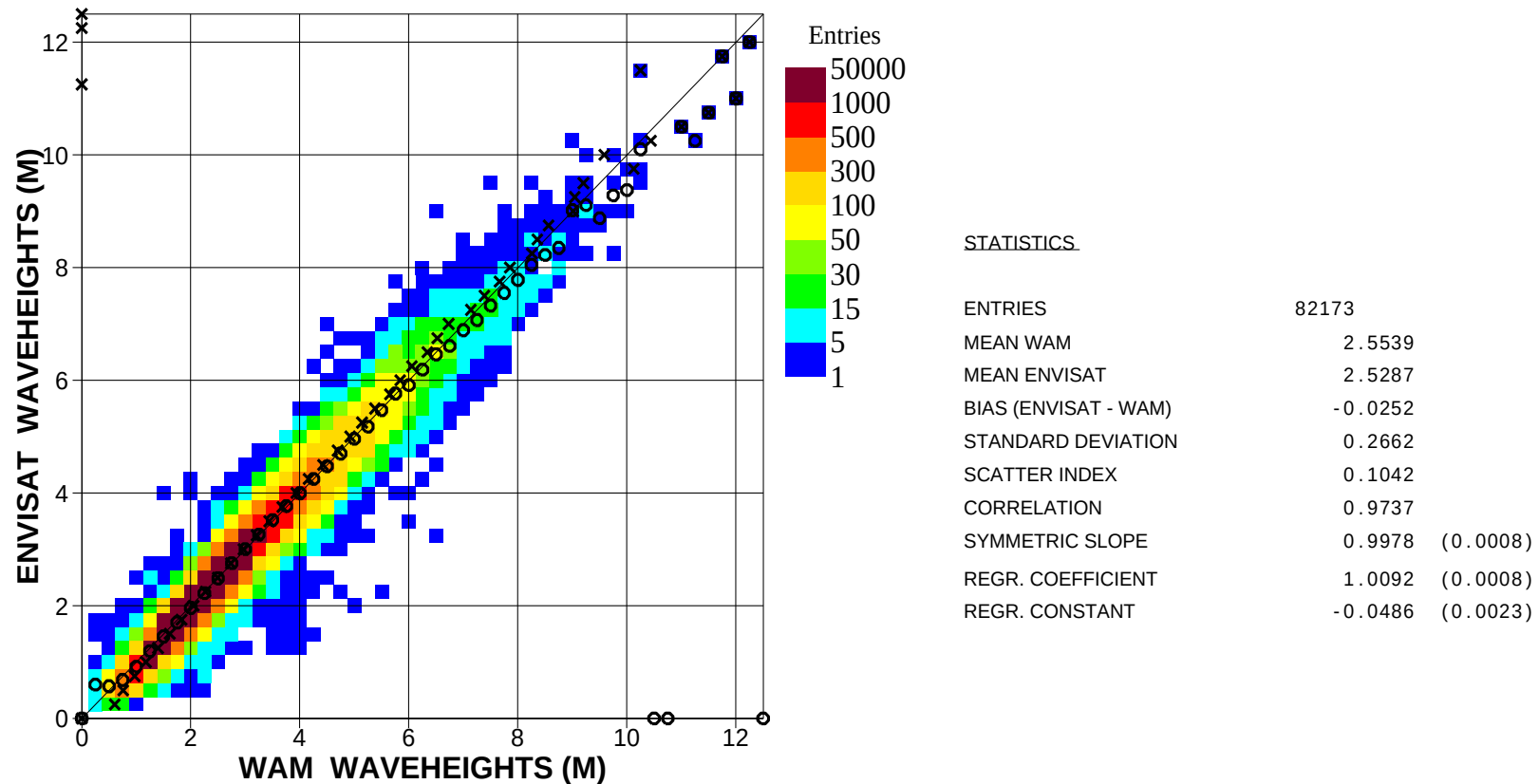


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for December 2011 (Global)

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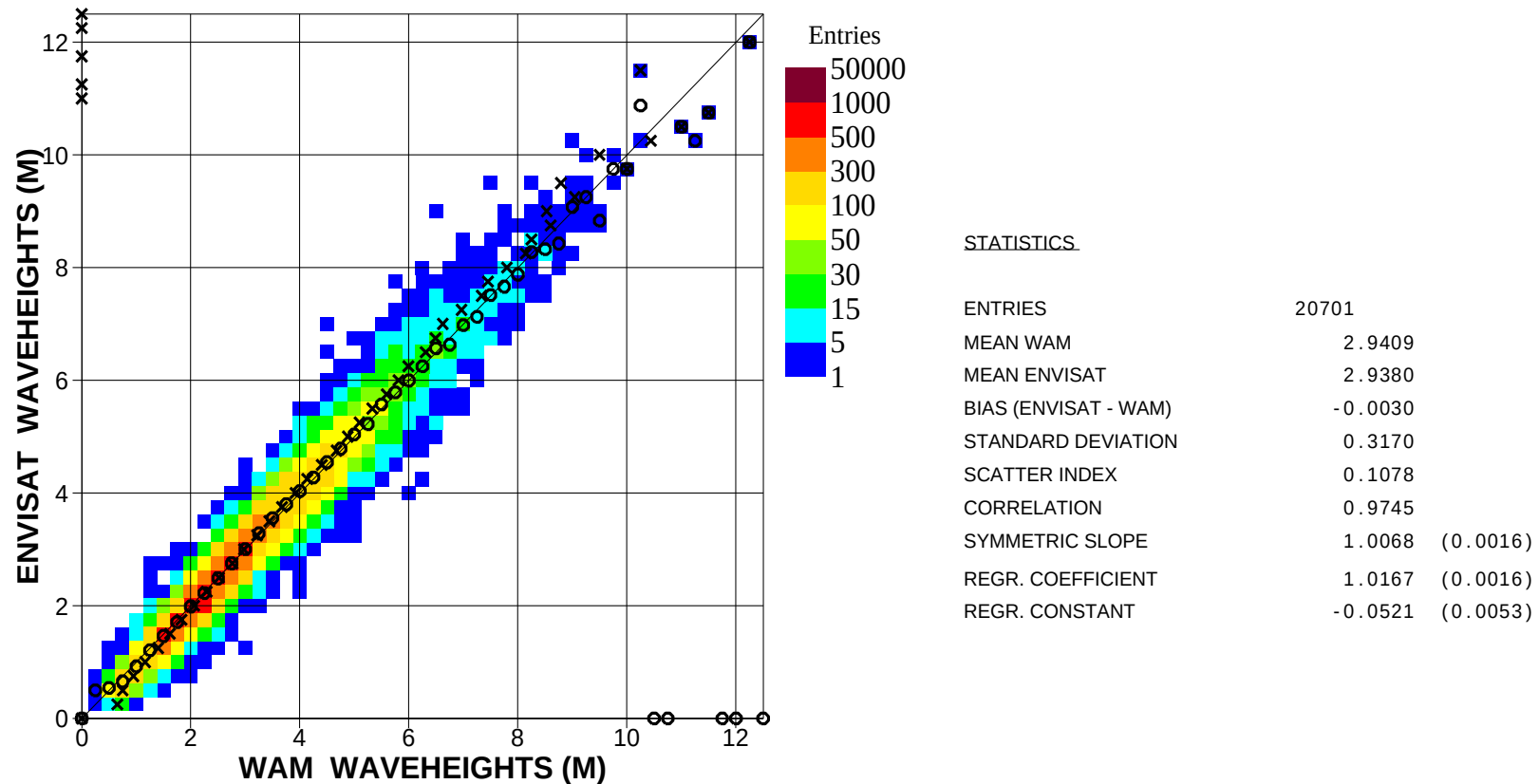


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for December 2011 (N.Hem.)

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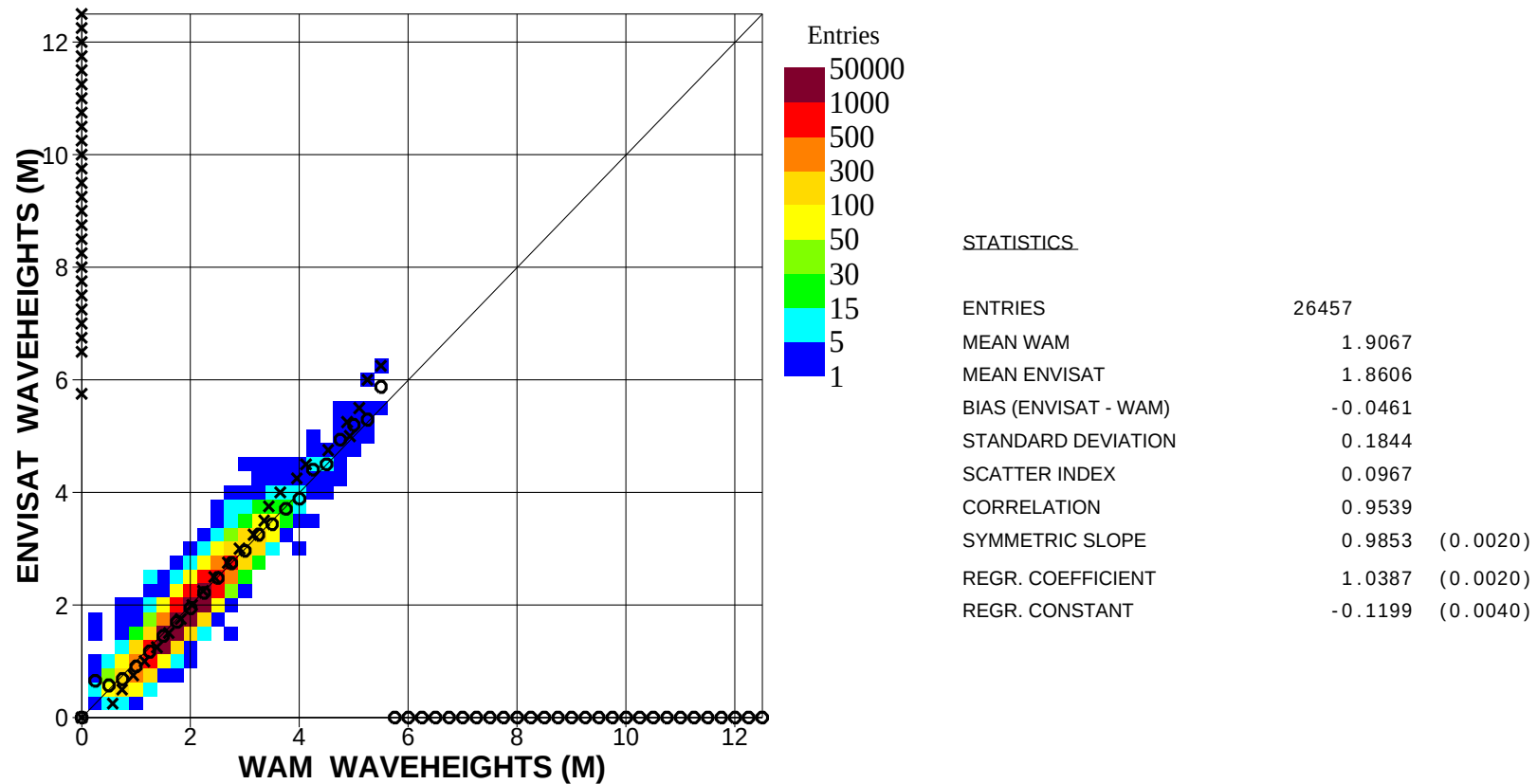


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for December 2011 (Tropics)

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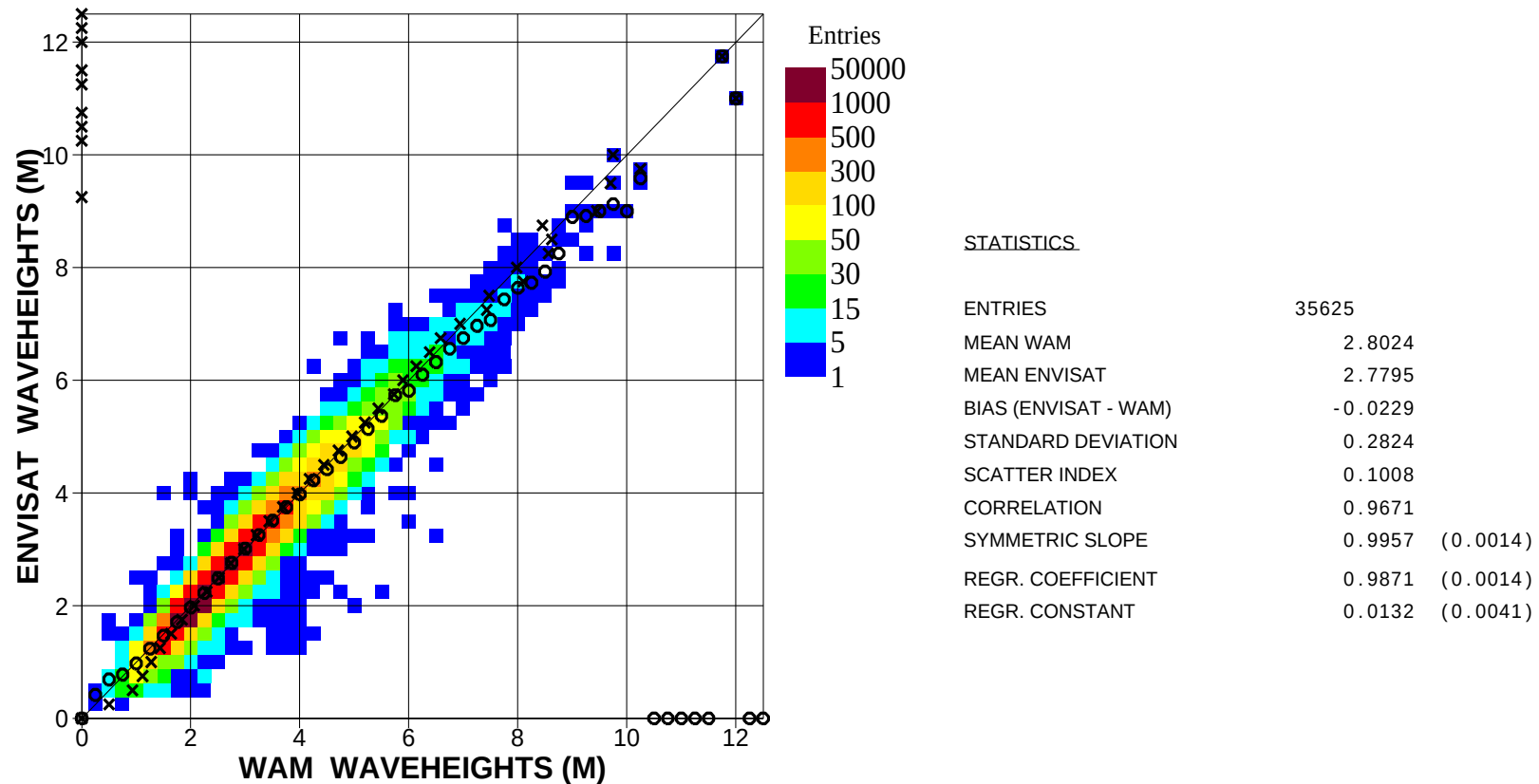


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for December 2011 (S.Hem.)

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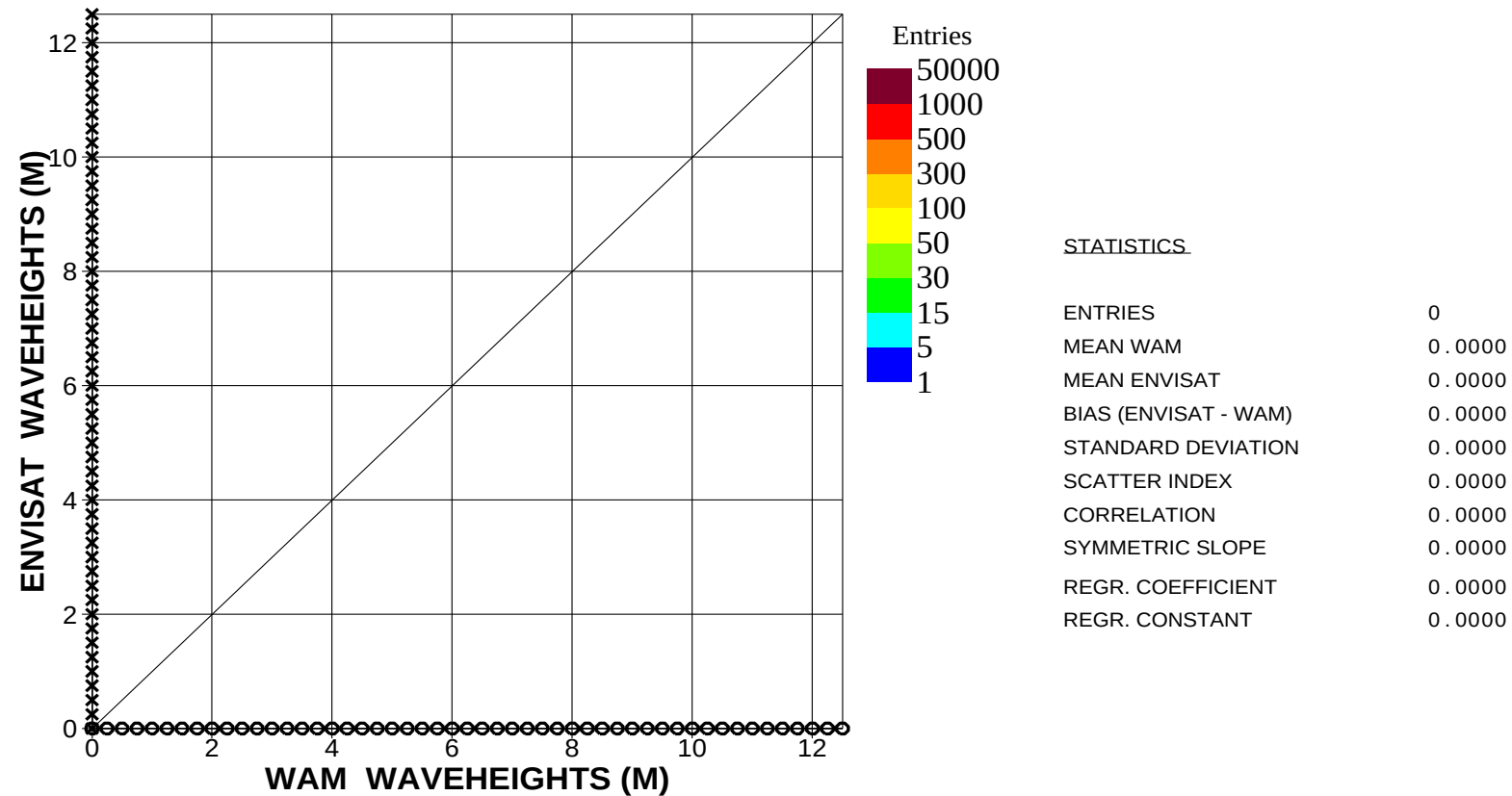


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for December 2011 (Global)

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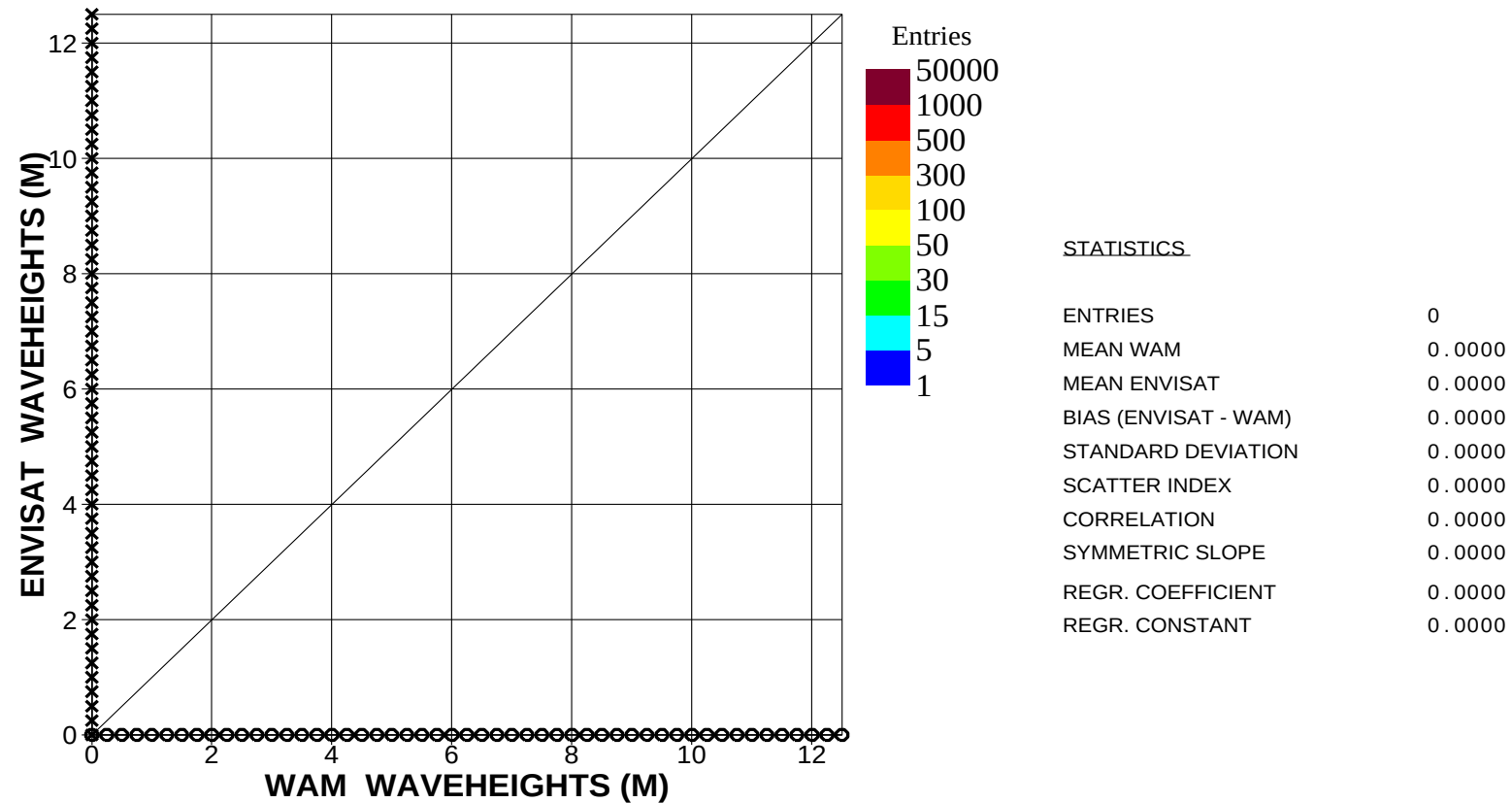


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for December 2011 (N.Hem.)

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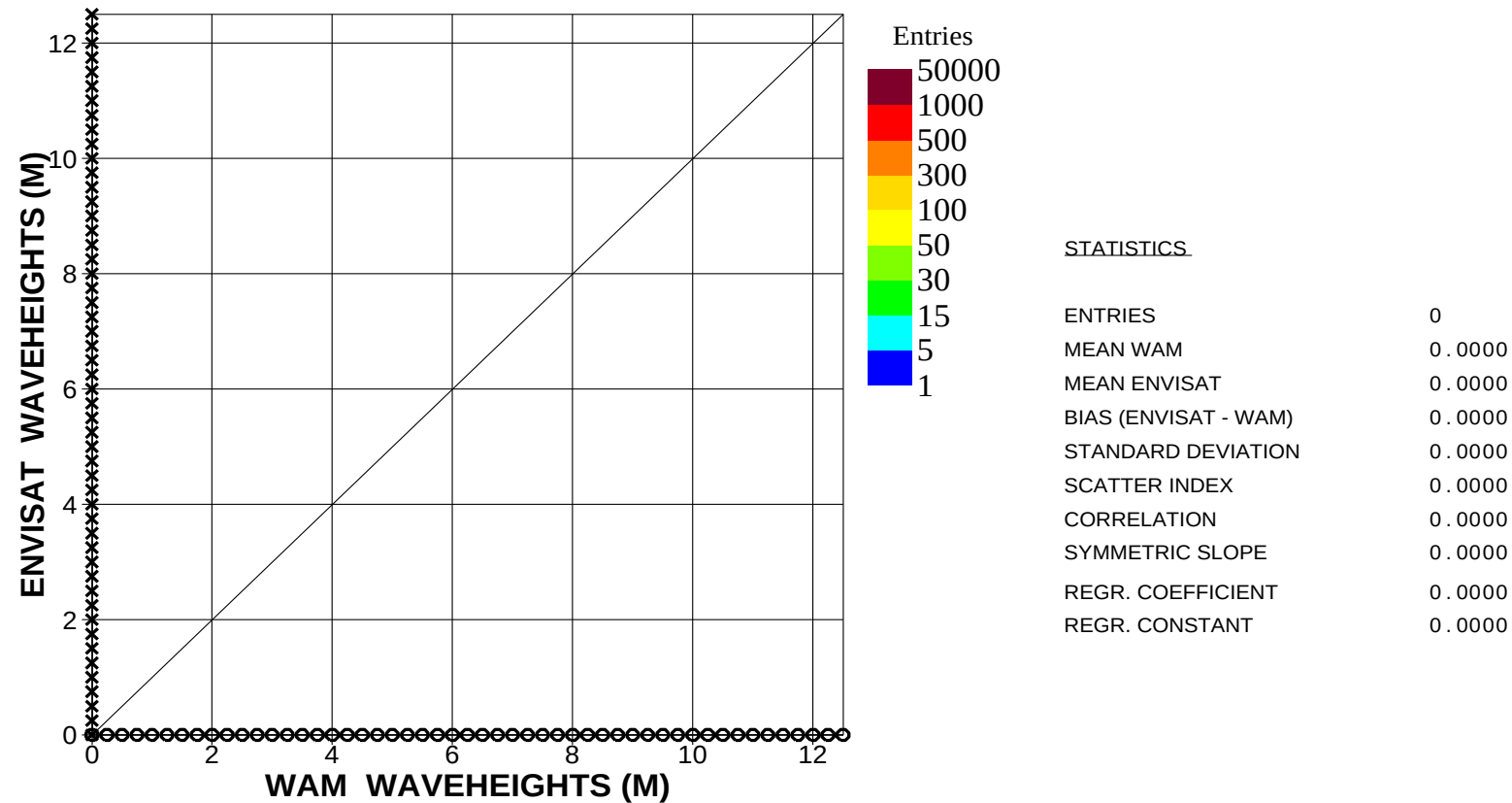


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for December 2011 (Tropics)

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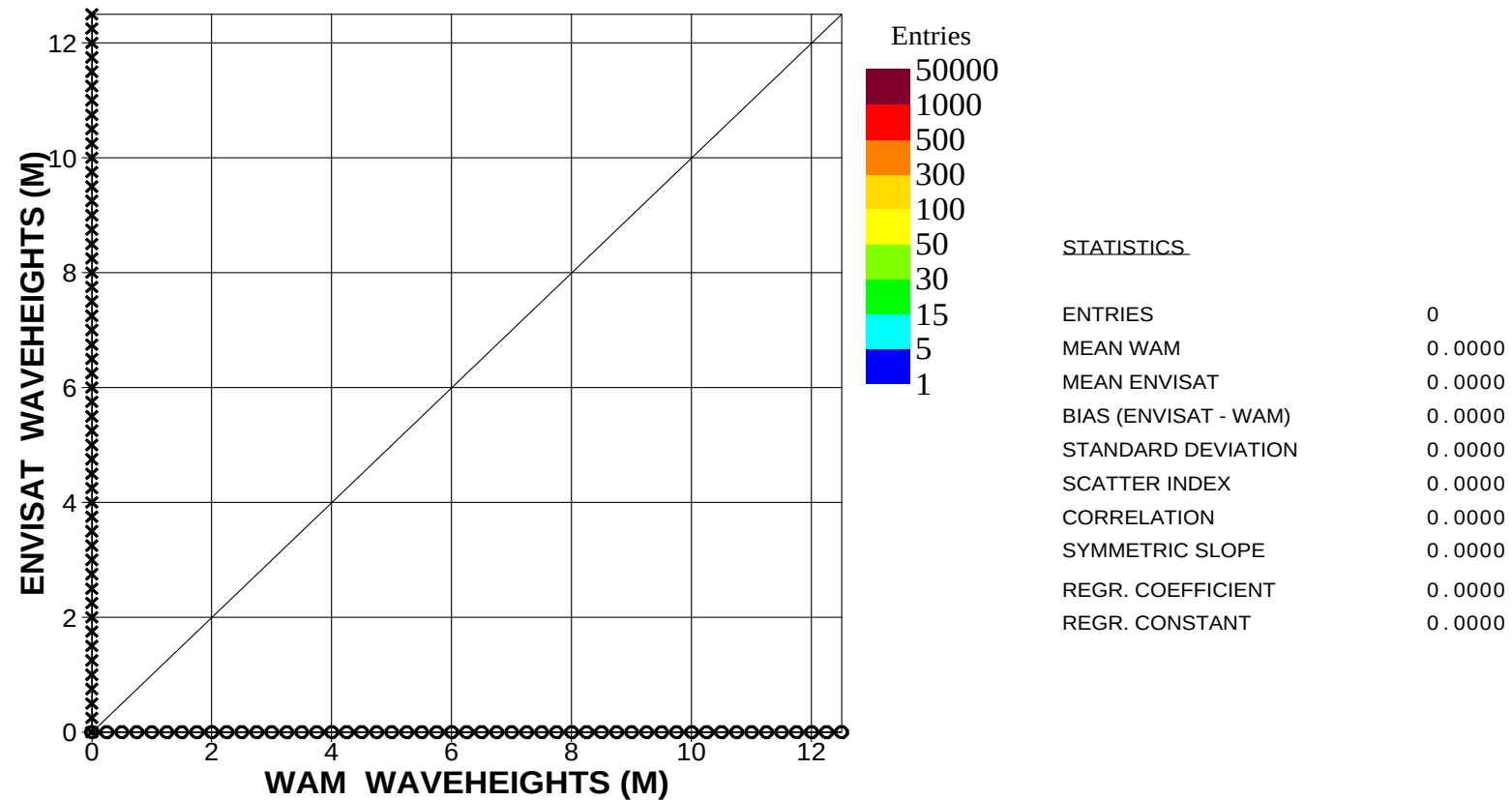


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for December 2011 (S.Hem.)

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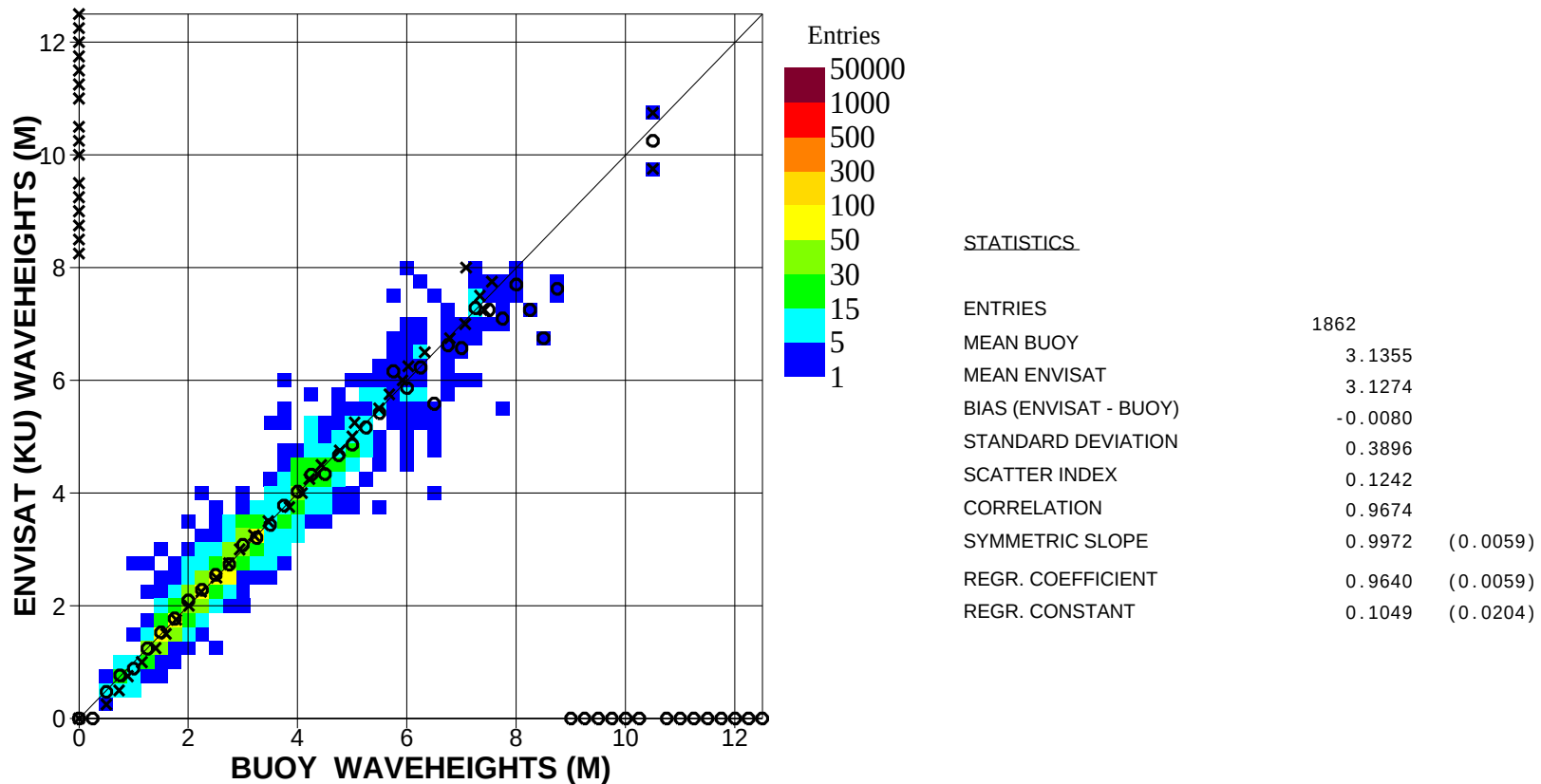


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for December 2011 (Global)

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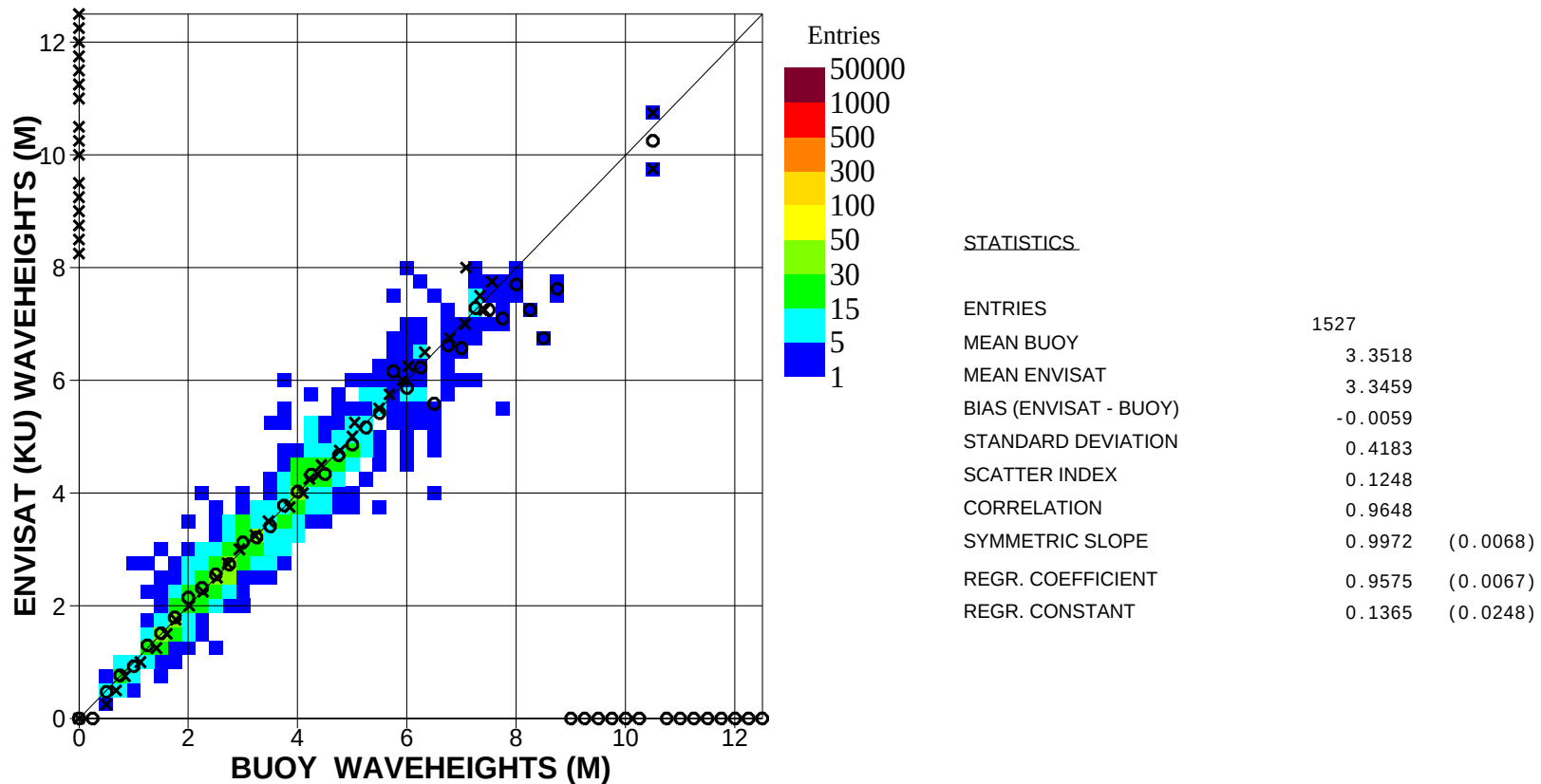


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for December 2011 (N.Hem.)

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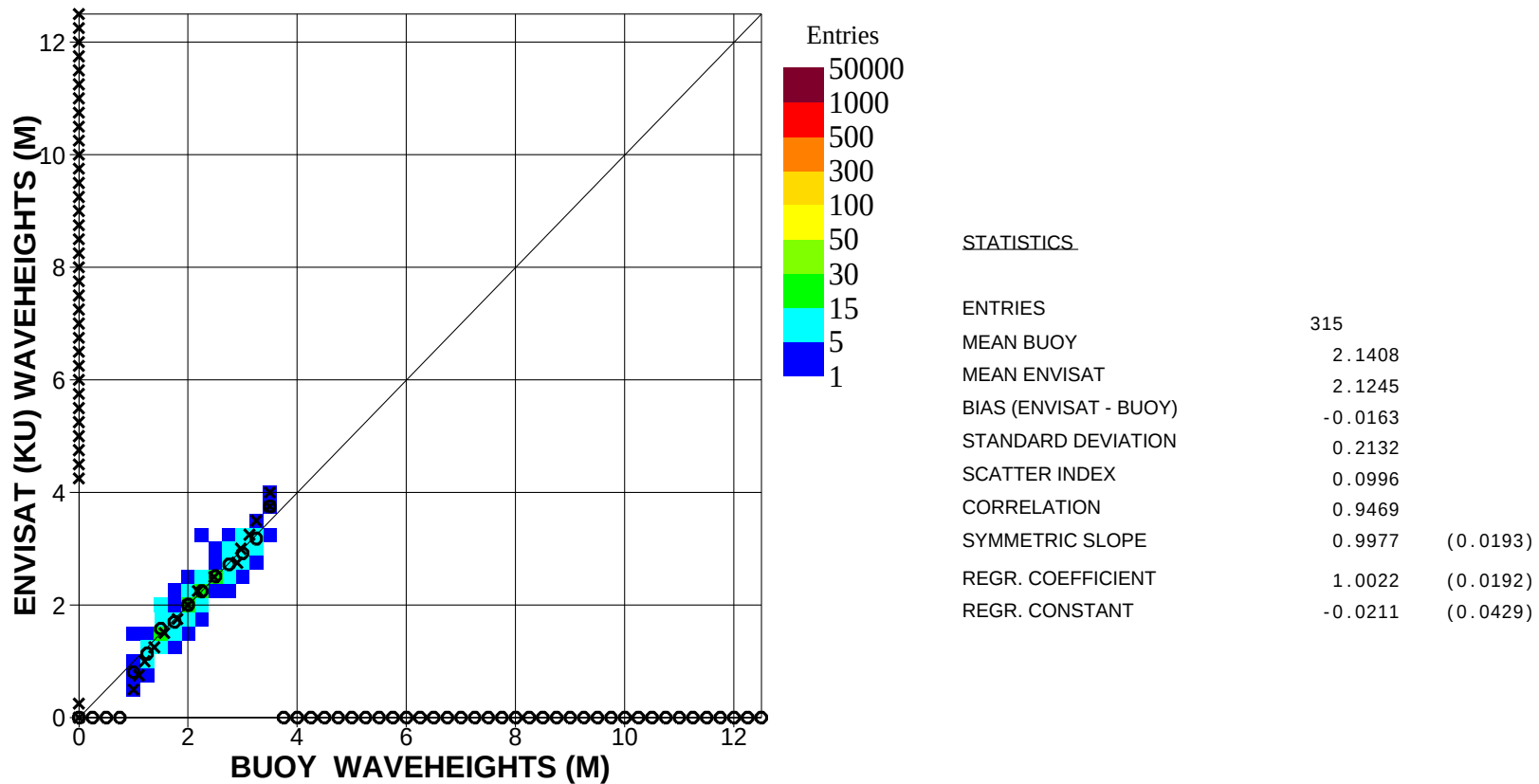


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for December 2011 (Tropics)

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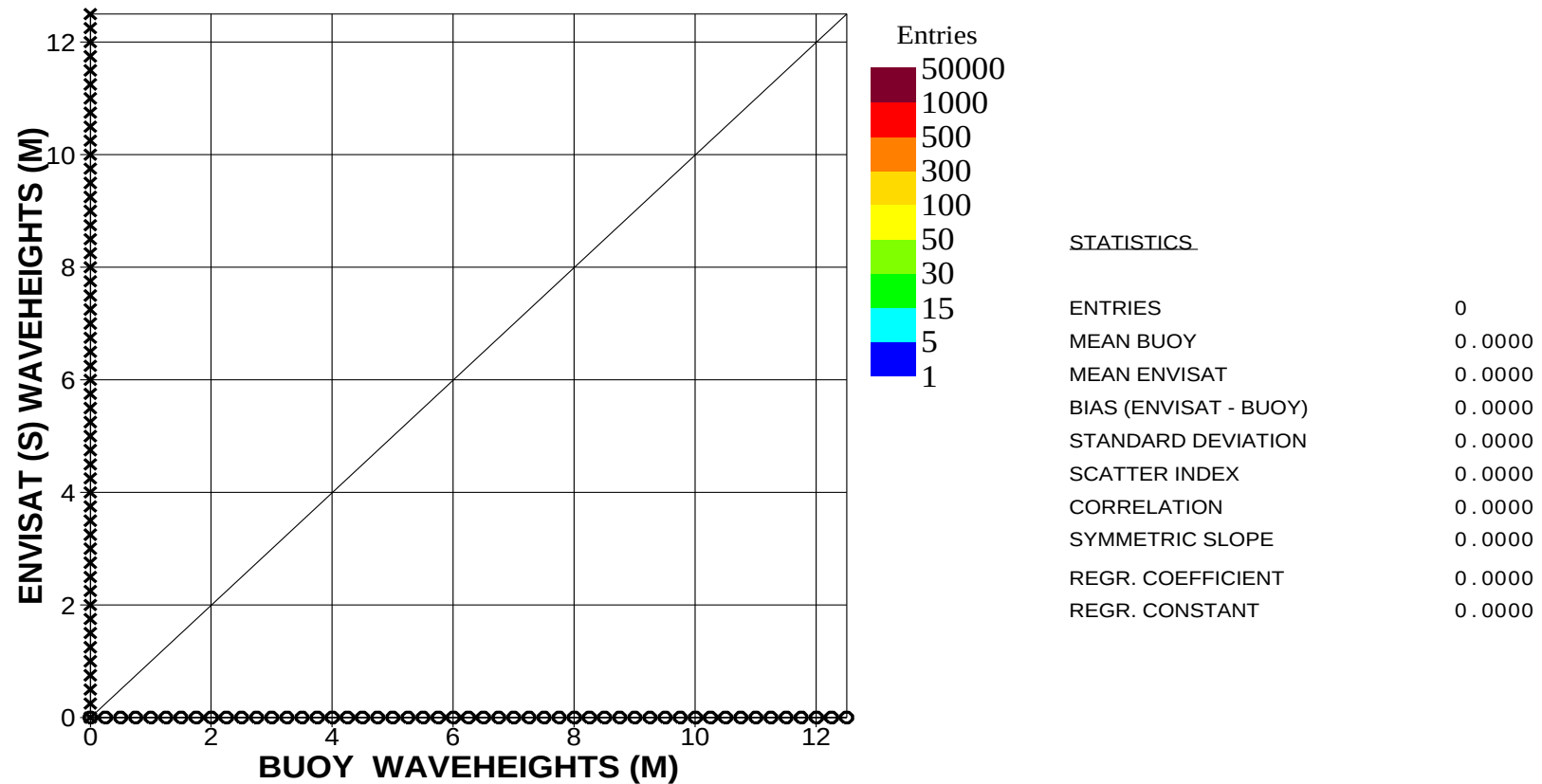


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for December 2011 (Global)

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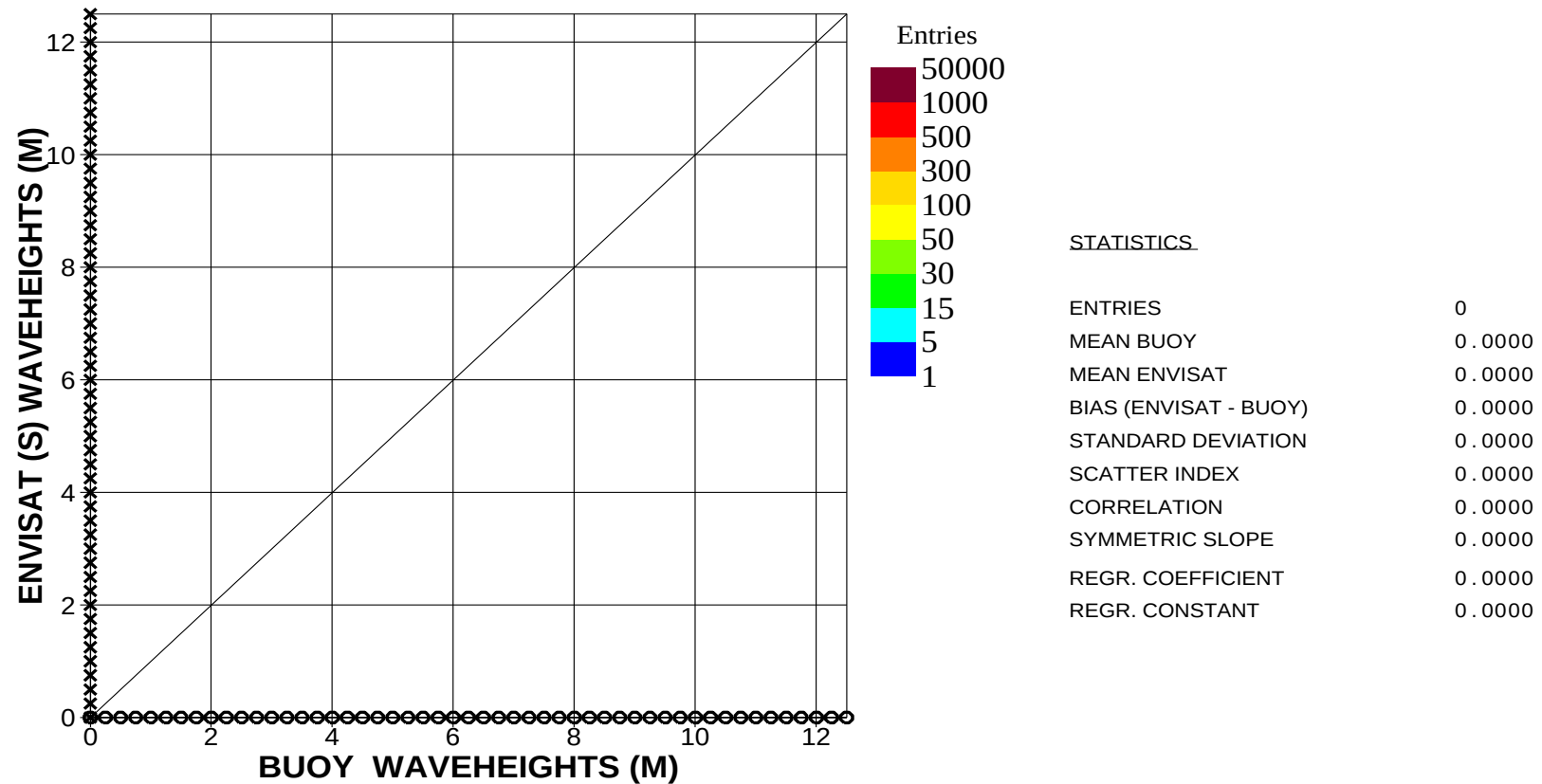


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for December 2011 (N.Hem.)

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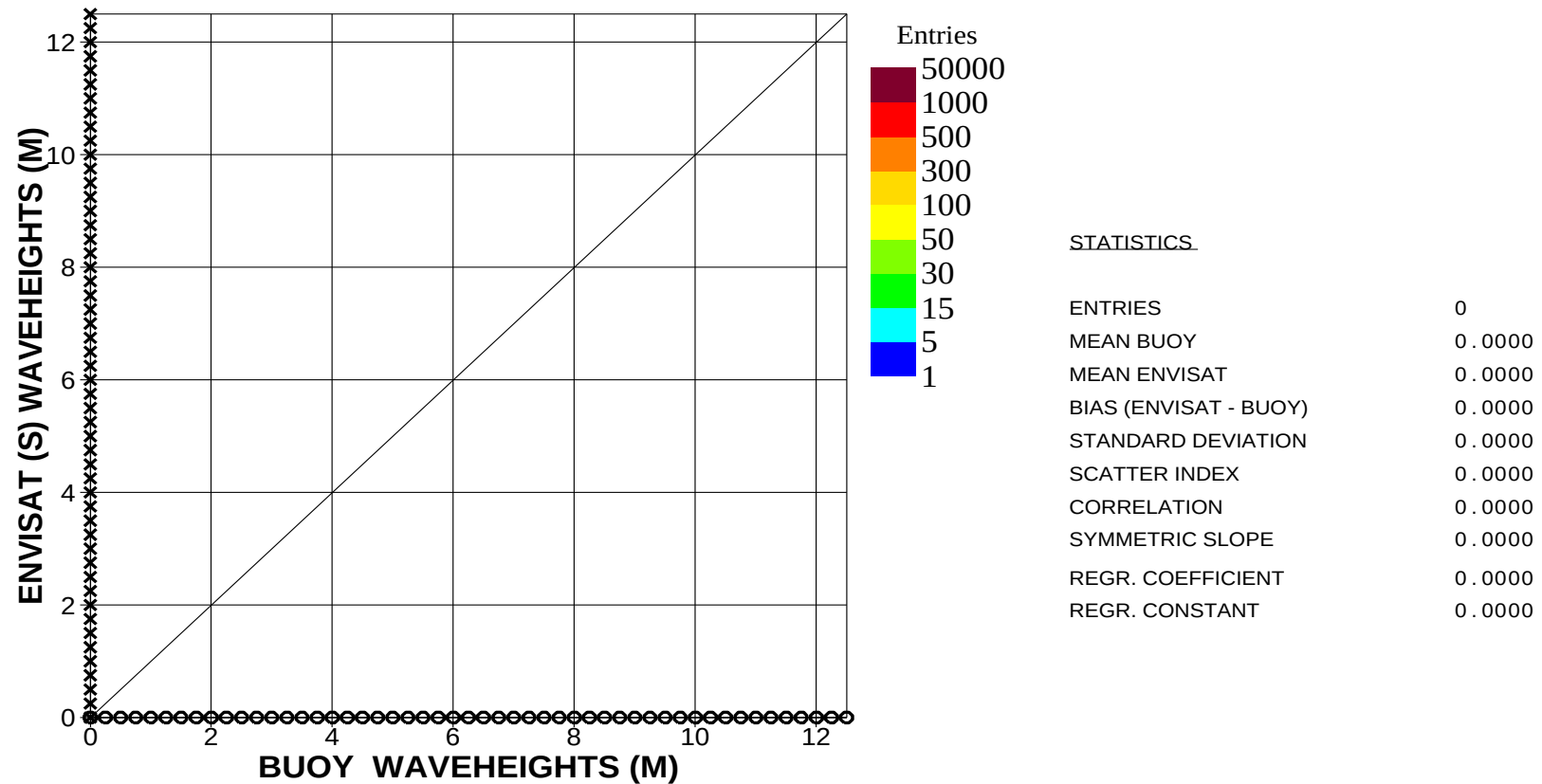


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for December 2011 (Tropics)

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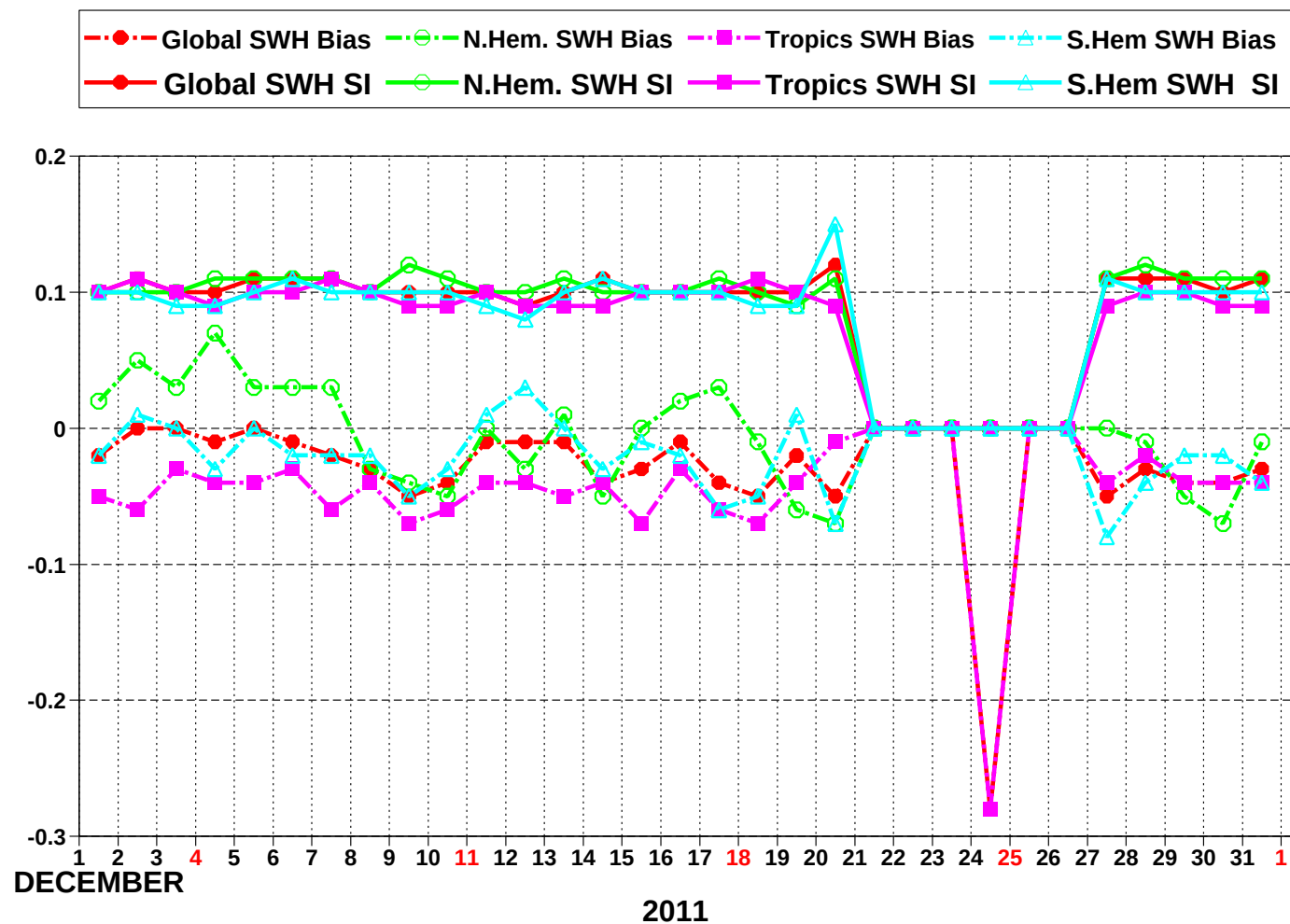


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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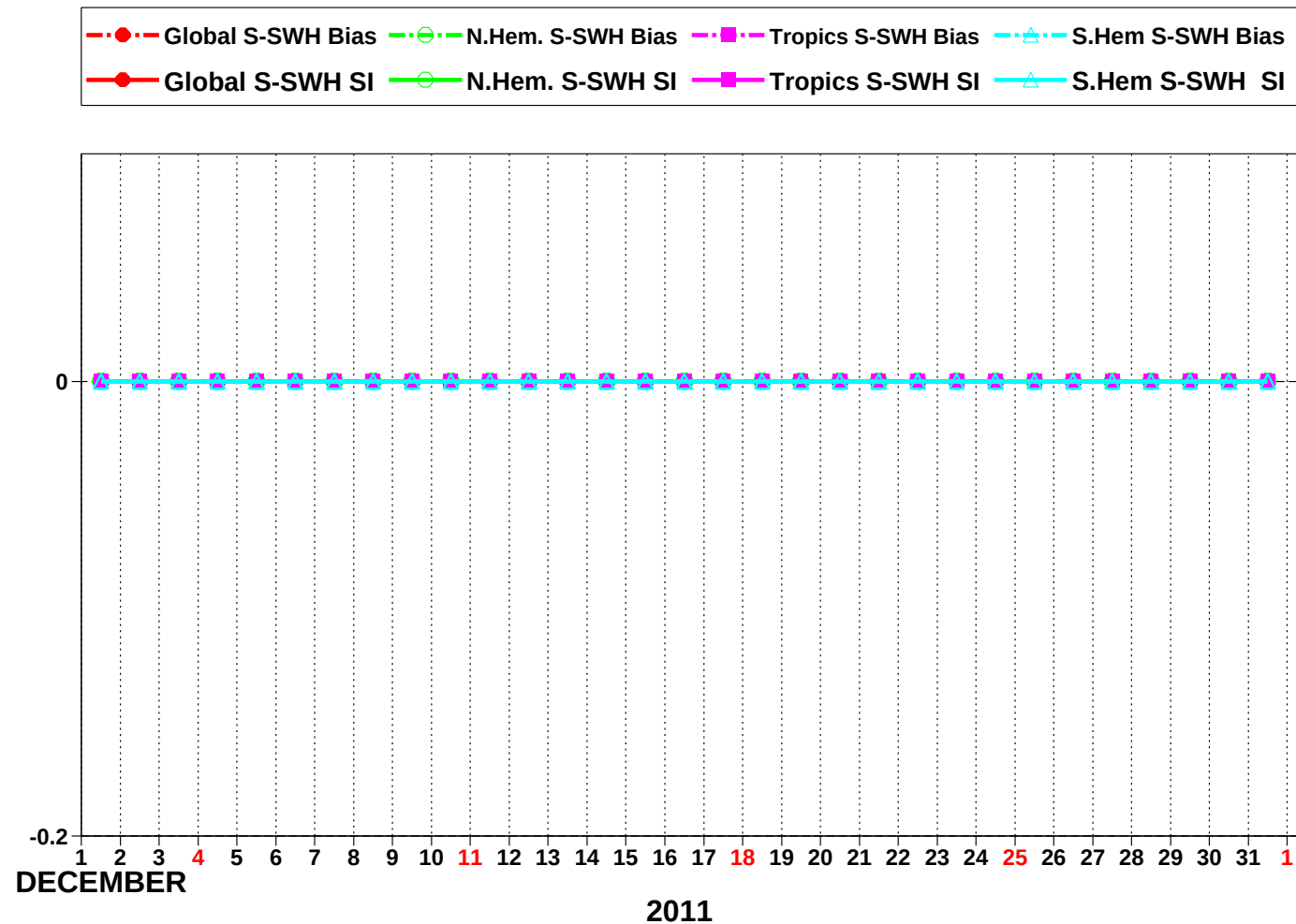


Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)



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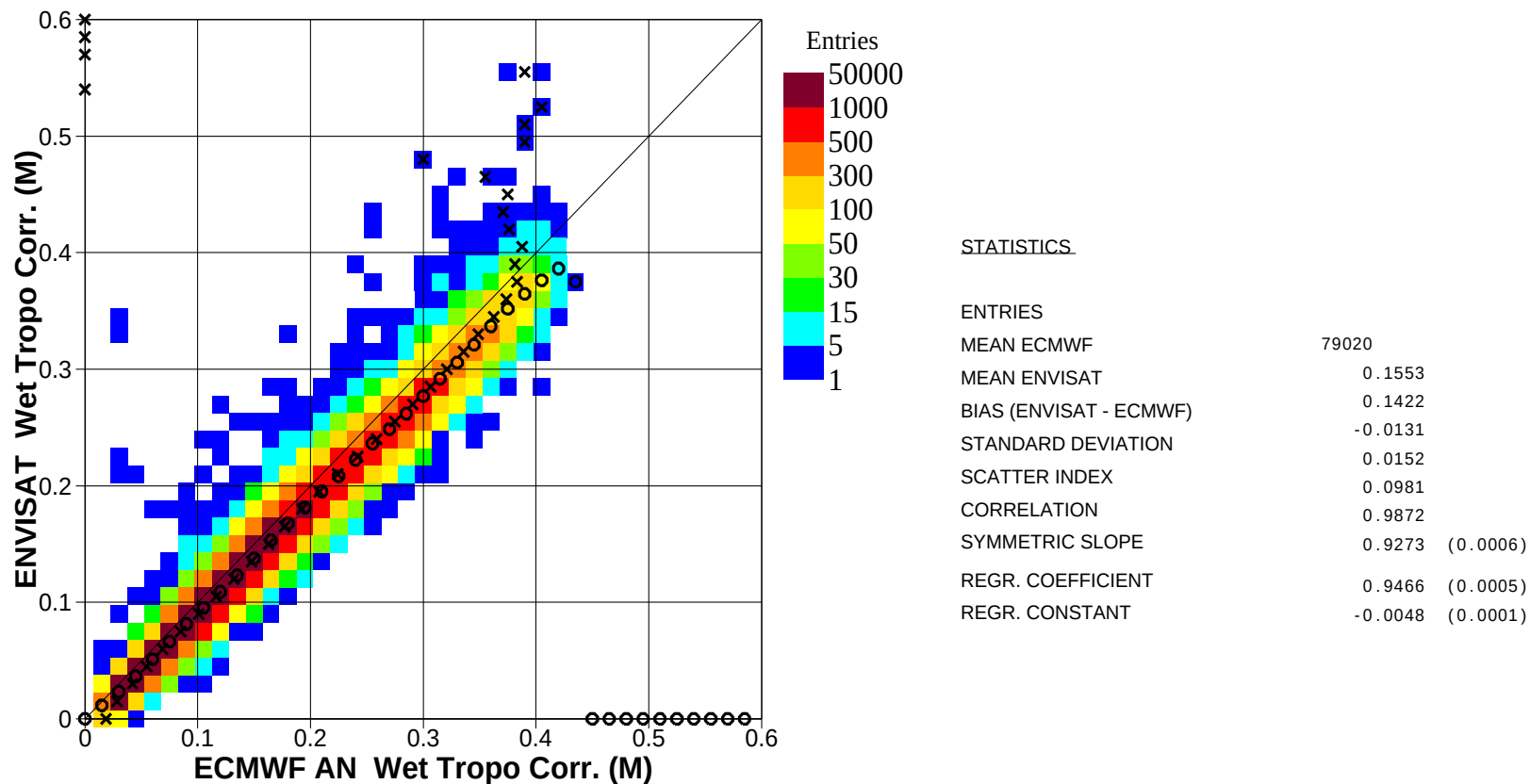


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for December 2011 (Global)

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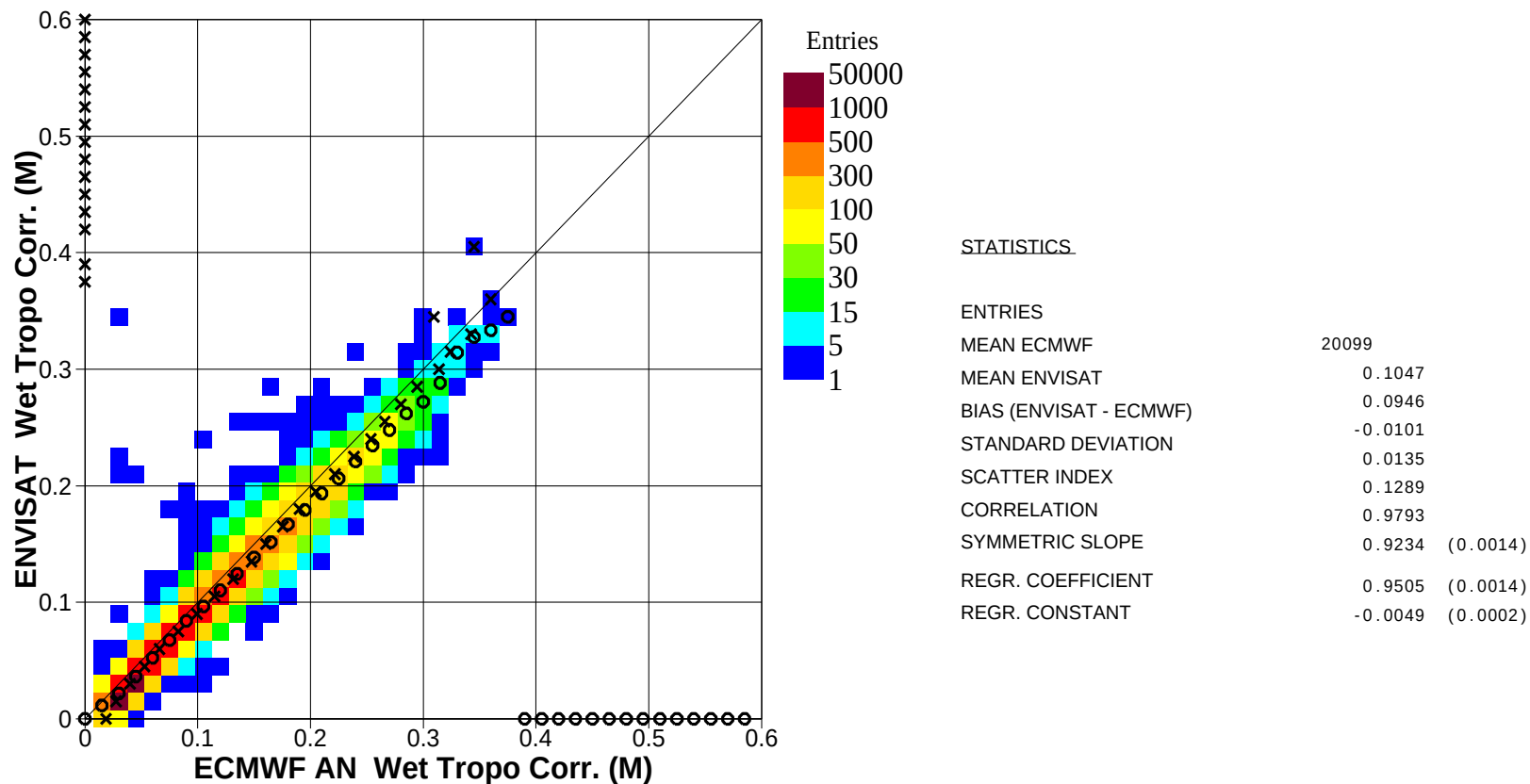


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for December 2011 (N.Hem.)

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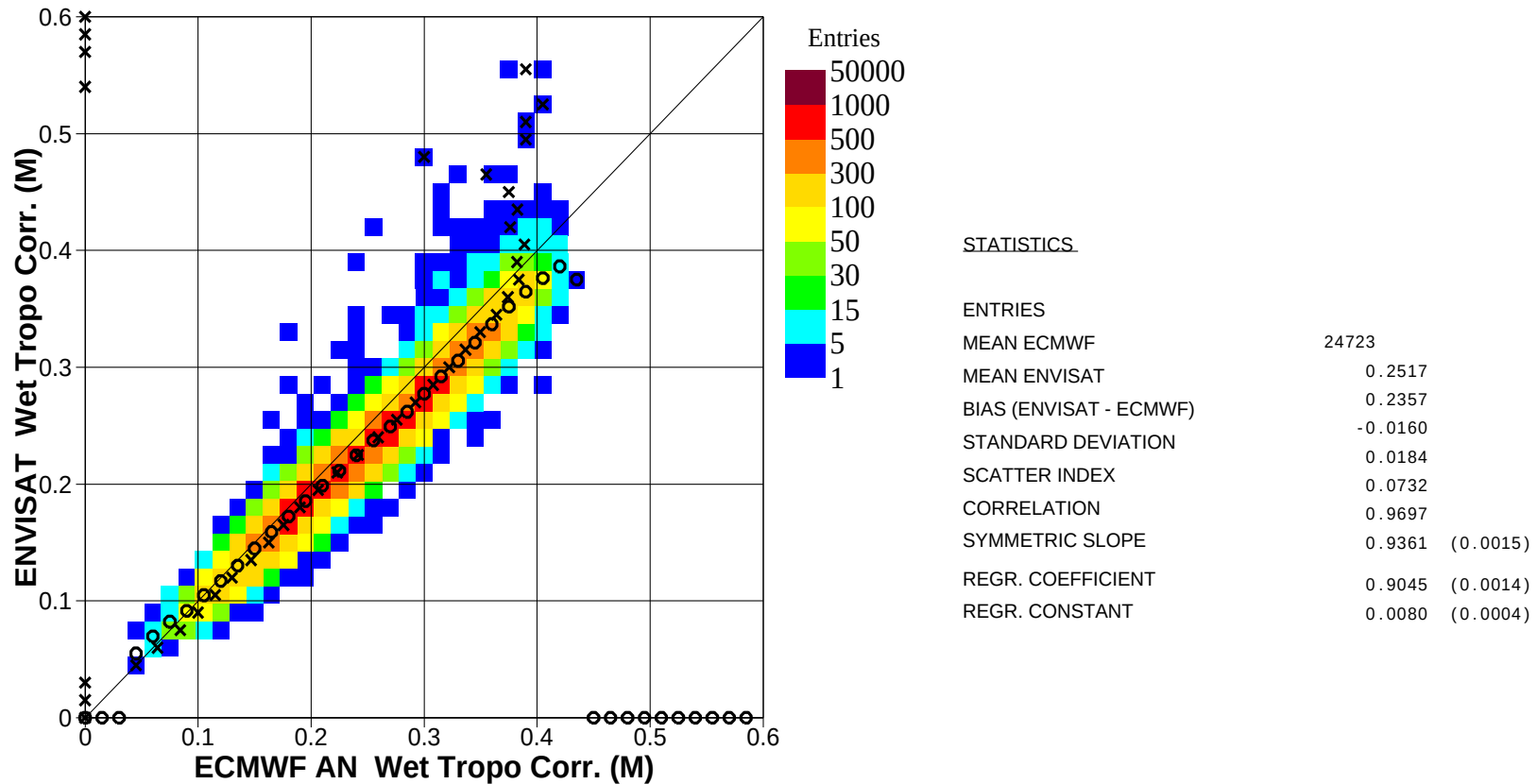


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for December 2011 (Tropics)

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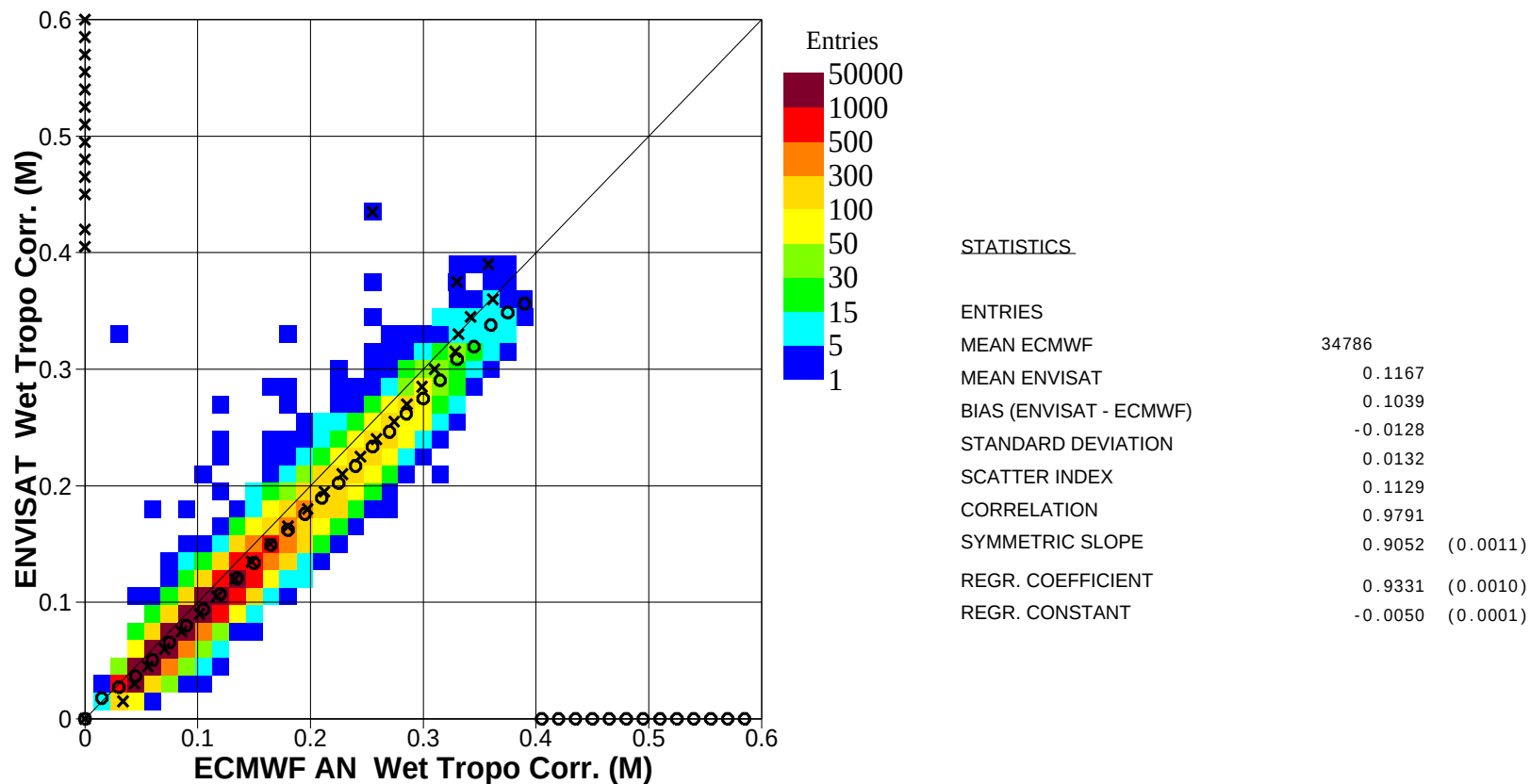


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for December 2011 (S.Hem.)

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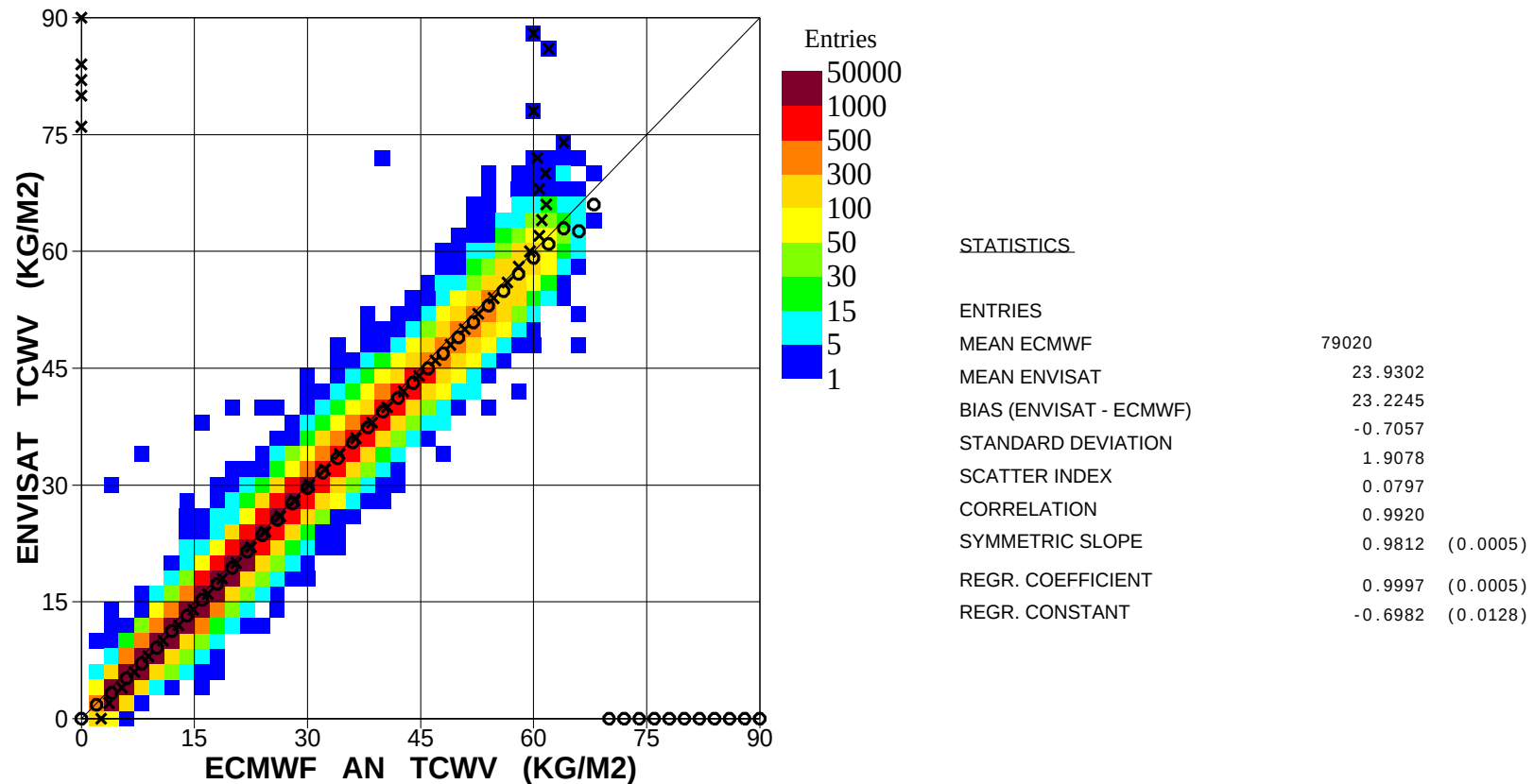


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for December 2011 (Global)

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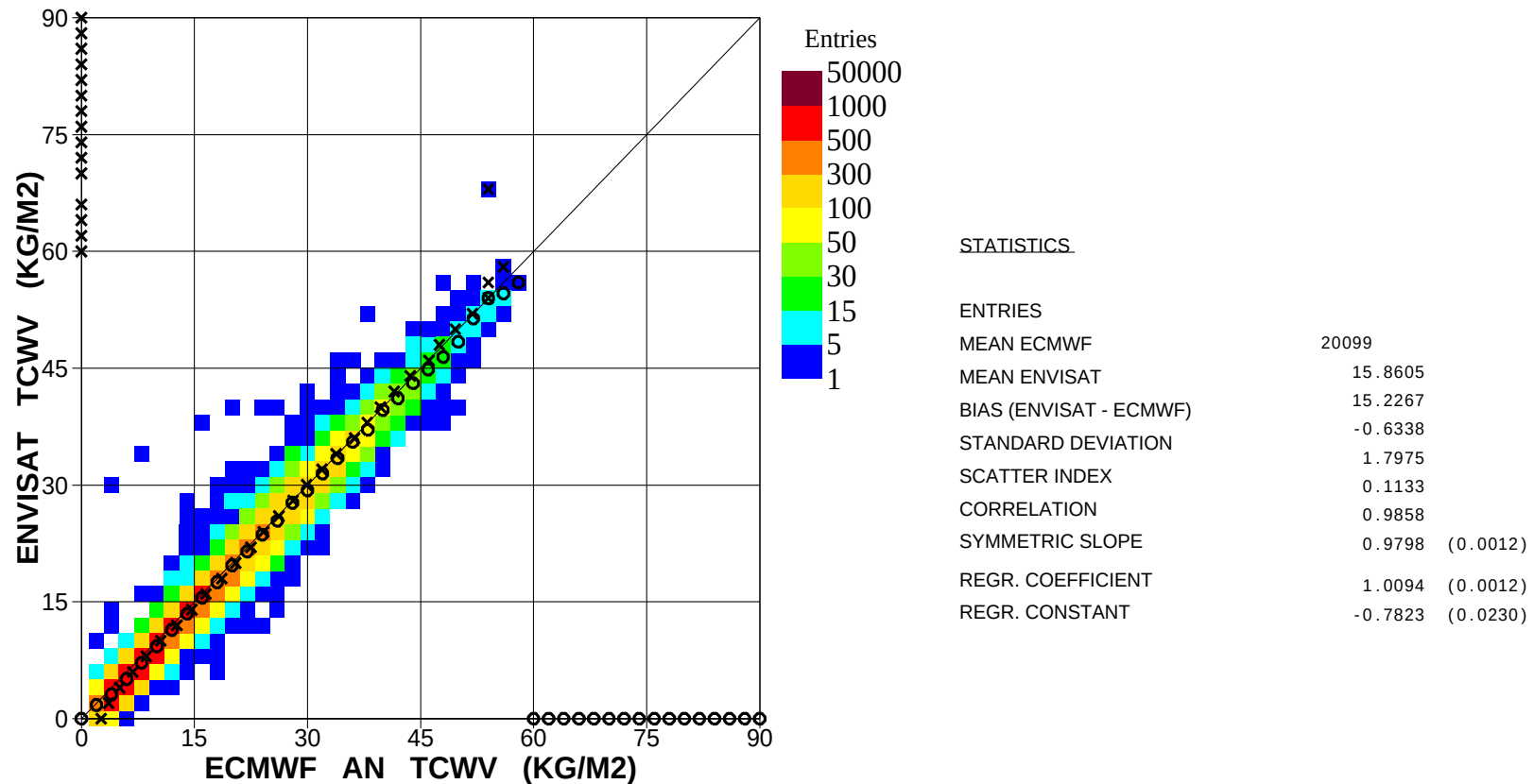


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for December 2011 (N.Hem.)

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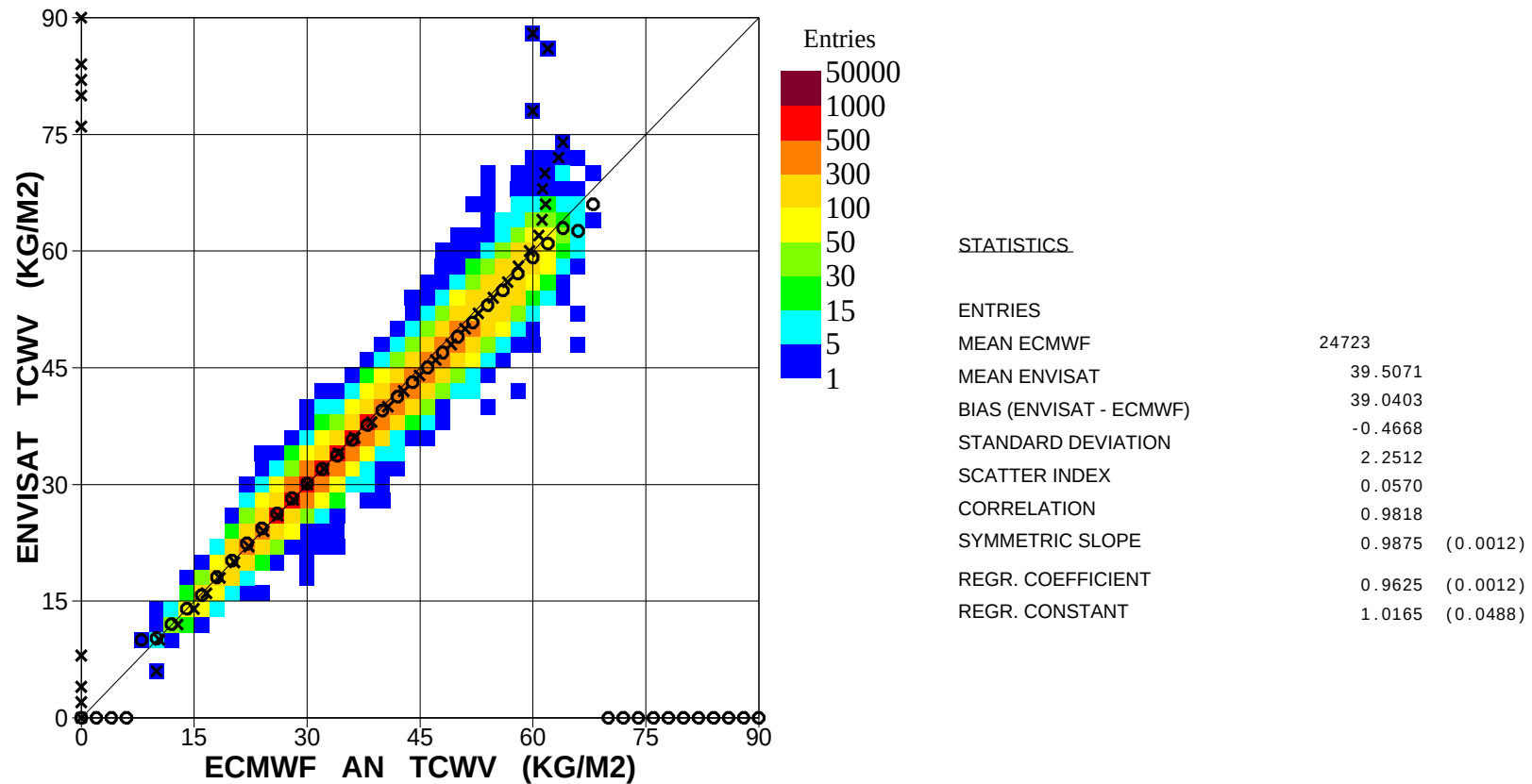


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for December 2011 (Tropics)

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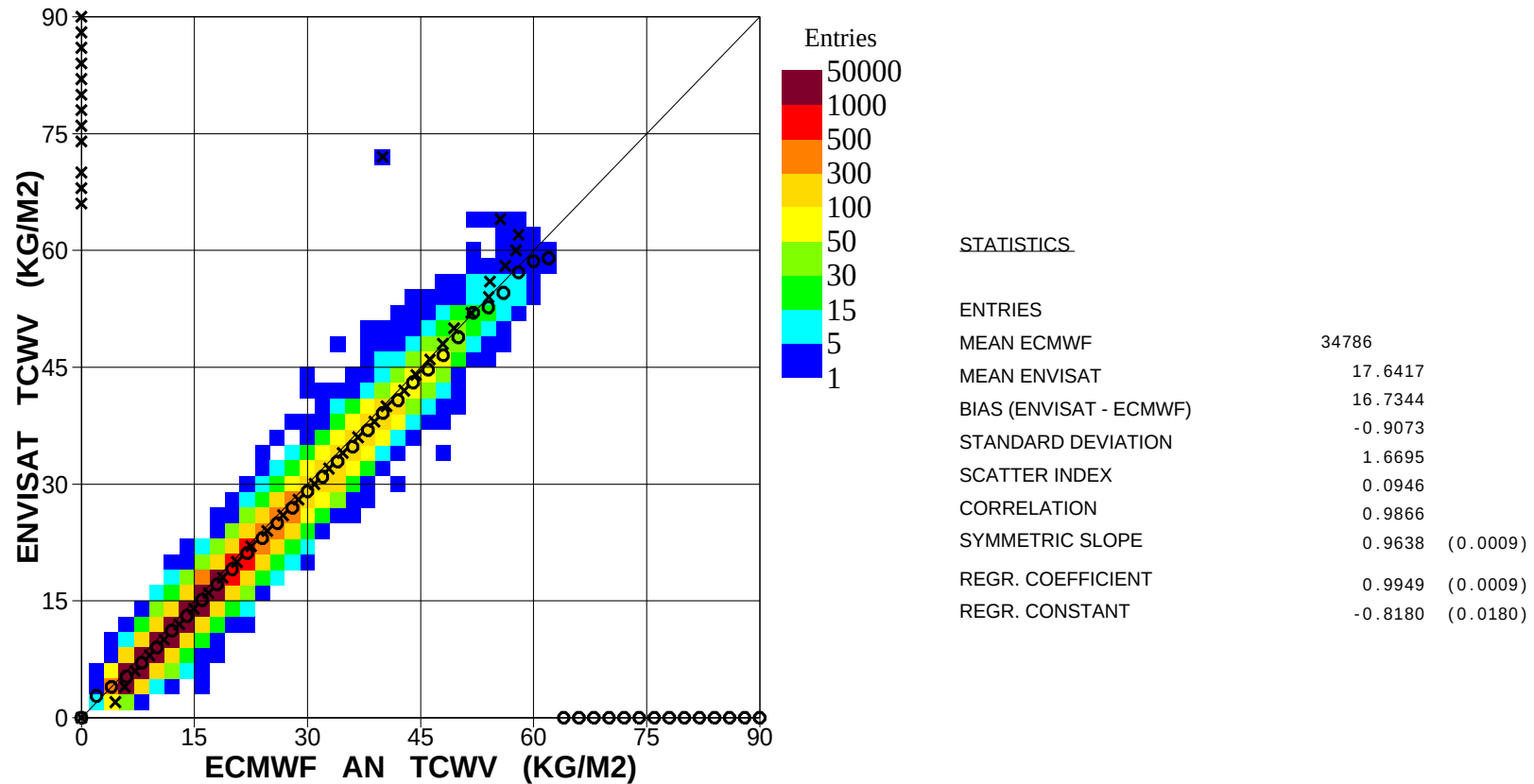


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for December 2011 (S.Hem.)

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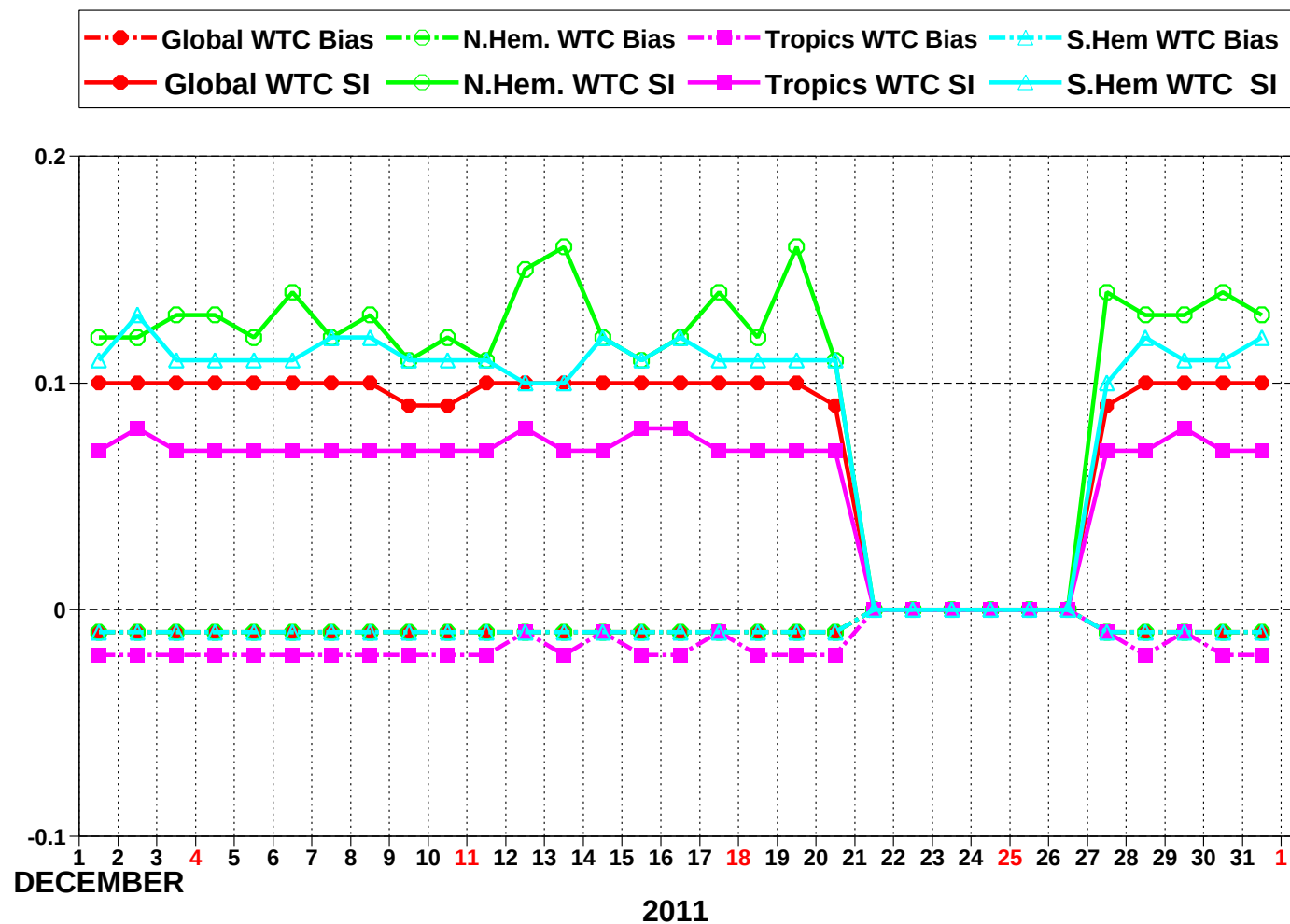


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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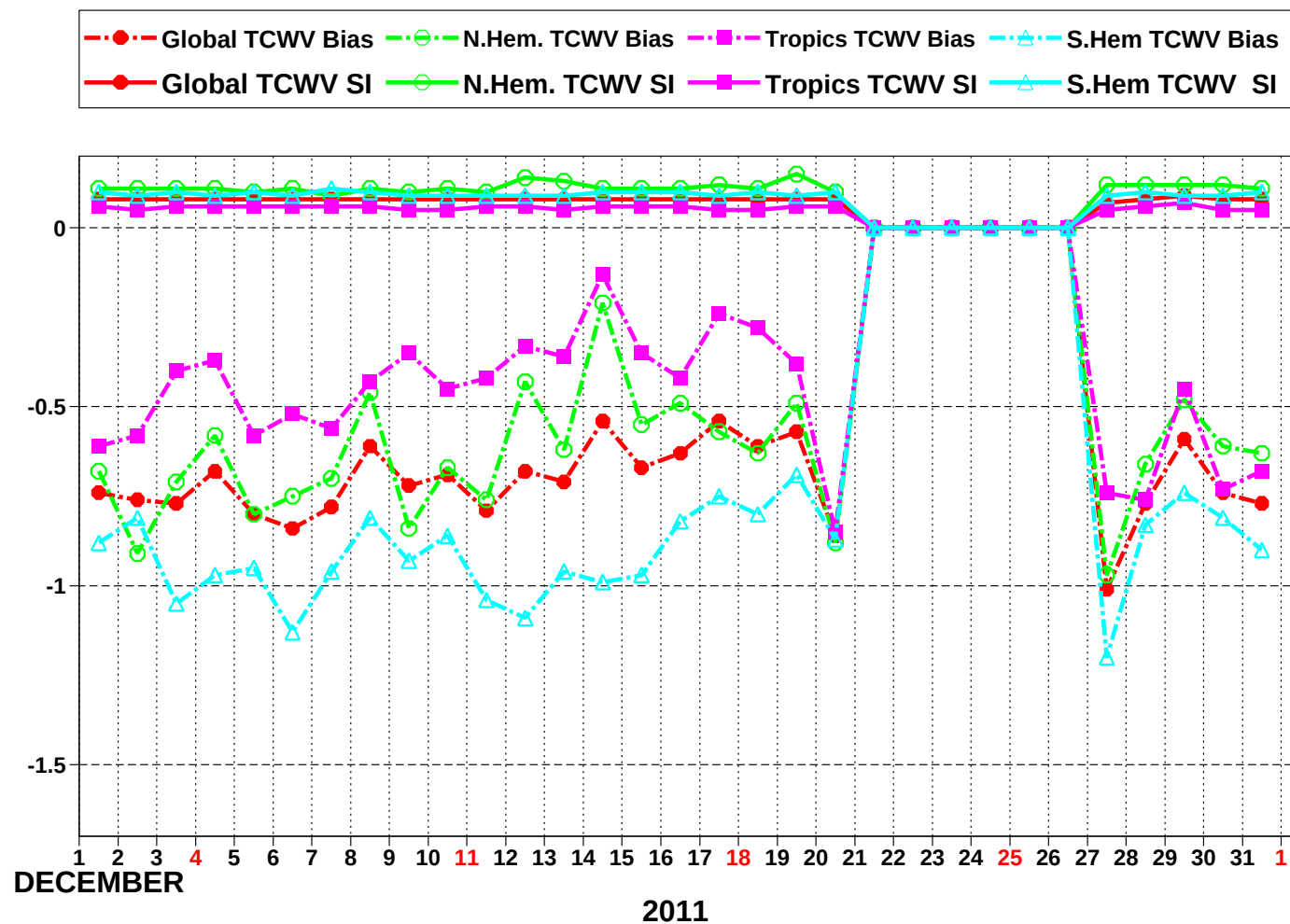


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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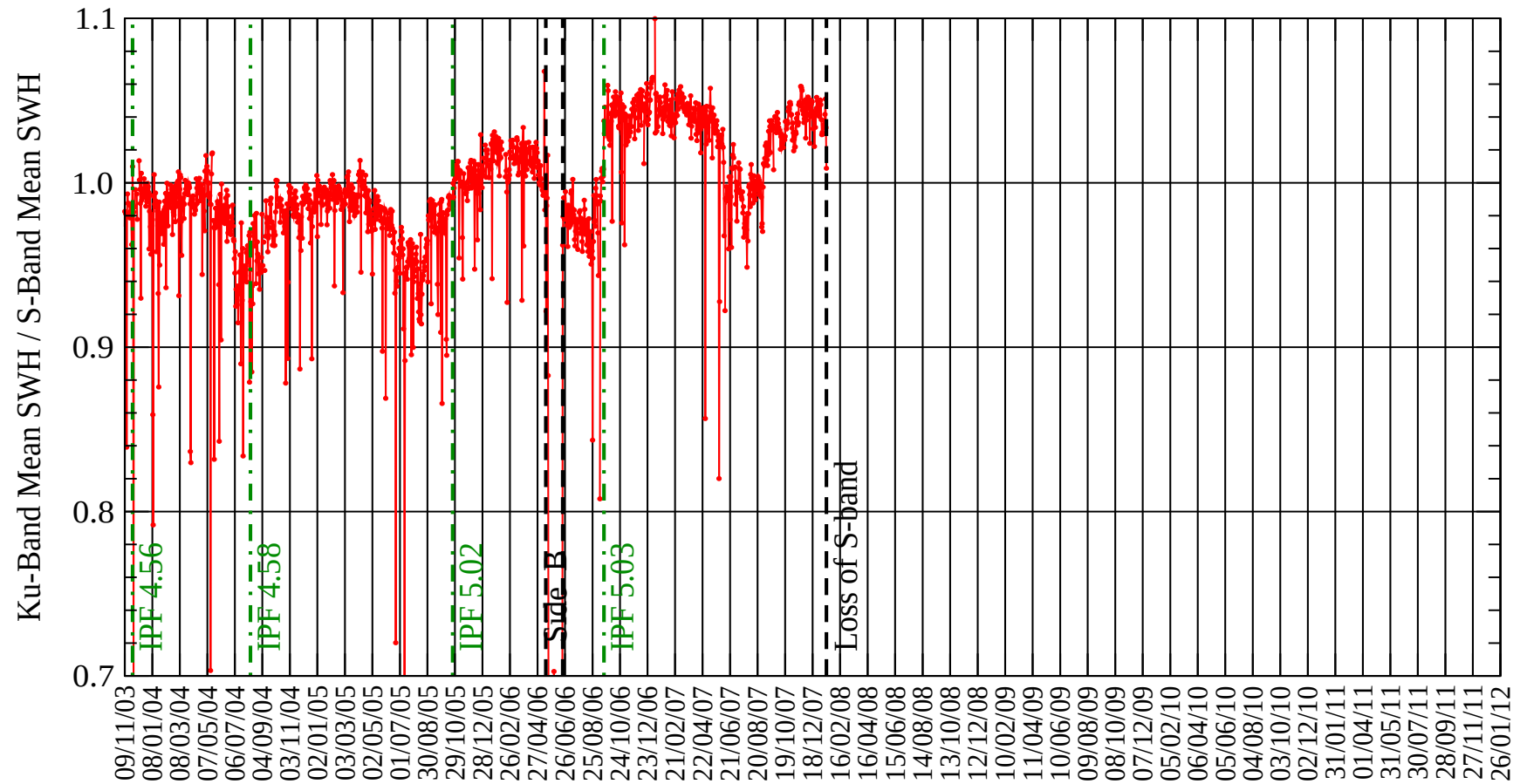


Figure 48: Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights.