

■ ECMWF Report on ENVISAT RA-2 for April 2009 ■

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

Wind/Wave Product with Height Information (RA2 WWV 2P)

By: *Saleh Abdalla*

Date: *26 May 2009*

Overview:

Based on the data received during this month, on average, 18090 observations arrived at ECMWF every 6-hour window of which an average of 6592 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 81.32% of the remaining part passed the quality control. As can be seen in Figure 1, there was no data during the 6-hour time windows centred at 12 UTC on the 1st, 18 UTC on the 28th and 00 and 06 on the 29th of the month. Furthermore, there was some reduction in data volume during few 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.

Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of very good quality. The S-band wave height observations are of good quality. The quality of wind speed observations is as good as usual. The MWR products, after



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England

Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703

Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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removing the ice contaminated observations, are generally in good agreement with the model (wet tropo correction is somewhat smaller than the model). S-band altimeter has been out of order since 18 January 2008.

Backscatter:

- ENVISAT Ku-band $\langle\sigma^0\rangle = 11.03$ 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	+ 0.28	14.7	- 0.19	18.1
Northern Hemisphere	+ 0.17	14.6	- 0.08	19.2
Tropics	+ 0.15	14.9	- 0.66	11.6
Southern Hemisphere	+ 0.43	13.8	----	----



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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	0.08	9.6	0.13	15.6
Northern Hemisphere	0.09	10.9	0.13	15.8
Tropics	0.08	8.4	0.10	13.8
Southern Hemisphere	0.08	9.0	----	----

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	-0.014	9.5	-0.90	8.9
Northern Hemisphere	-0.016	11.7	-1.55	11.1
Tropics	-0.016	7.1	-0.58	6.4
Southern Hemisphere	-0.011	11.4	-0.76	10.9

Remarks:

- “Envisat RA-2 (A-Side) S-band transmission power suddenly dropped at 23:23:40 UTC on 17 January 2008”. All S-band parameters are no longer valid since then.
- According to the used land sea mask (which is used for the operational WAM run at ECMWF), about one third of all processed data have been collected over land.
- The rain flag is responsible for the rejection of about 0.6% of the data this month.
- 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

■
Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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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 28 cm/s **higher** than the model for this month. On the other hand, it is about 19 cm/s **lower** than the buoy measurements for this month. The upper limit of the algorithm is 21.3 m/s.
- The Ku-band significant wave heights are higher by about 3.1% when compared to WAM model results (4.1% in the NH, 4.0% in Tropics and 2.7% in 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 4.6% higher than buoy wave heights for this month as can be seen in Figures 30-32 (Ku-band - buoy comparison).
- **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 are a handful of observations passed the quality control.**
- While the MWR derived TCWV is now in good agreement with the model counterpart (MWR TCWV is slightly dryer than the model especially in the Extra Tropics), the MWR WTC is still consistently smaller (drier) than the model values.
- **There is a small cloud (few outliers this month) of TCWV scatter plot outliers hanging below the main cloud at model values between 20 and 30 kg/m² as can be seen in Figures 42-45. It occurs almost anywhere. This group of outliers becomes very clear in the rather long-period scatter plots. No specific condition or geographical location could be associated with this behaviour. The additional quality control criteria mentioned above did not help much to eliminate this kind of outliers. This issue is still unresolved.**
- 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-



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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-2 altimeter significant wave height data are assimilated in the ECMWF wave model.
- ECMWF model was not changed during this month. The current operational IFS cycle is CY35R2 (since 10 March 2009).

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England

Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703

Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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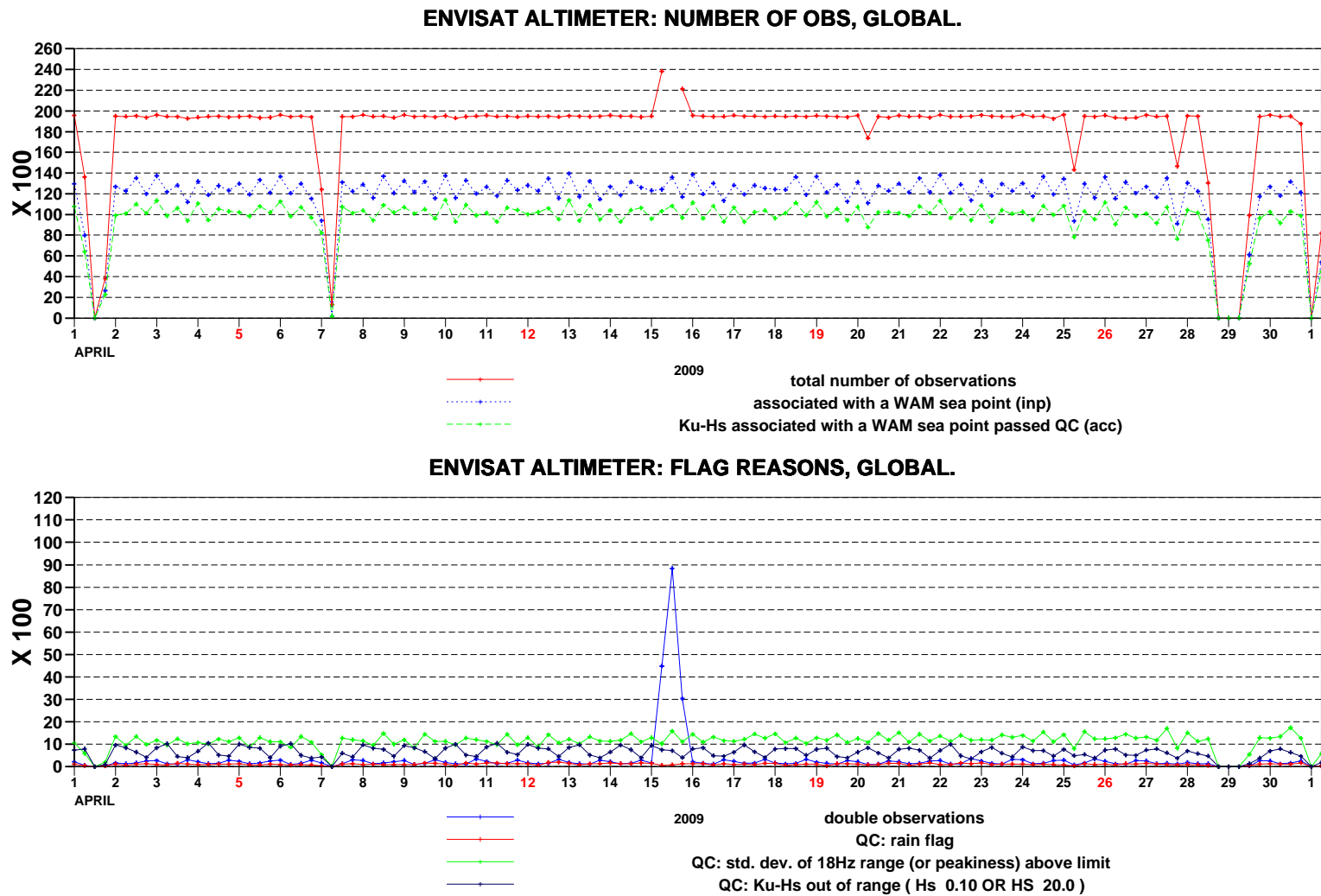


Figure 1: Time series of data reception for ENVISAT Altimeter data for April 2009

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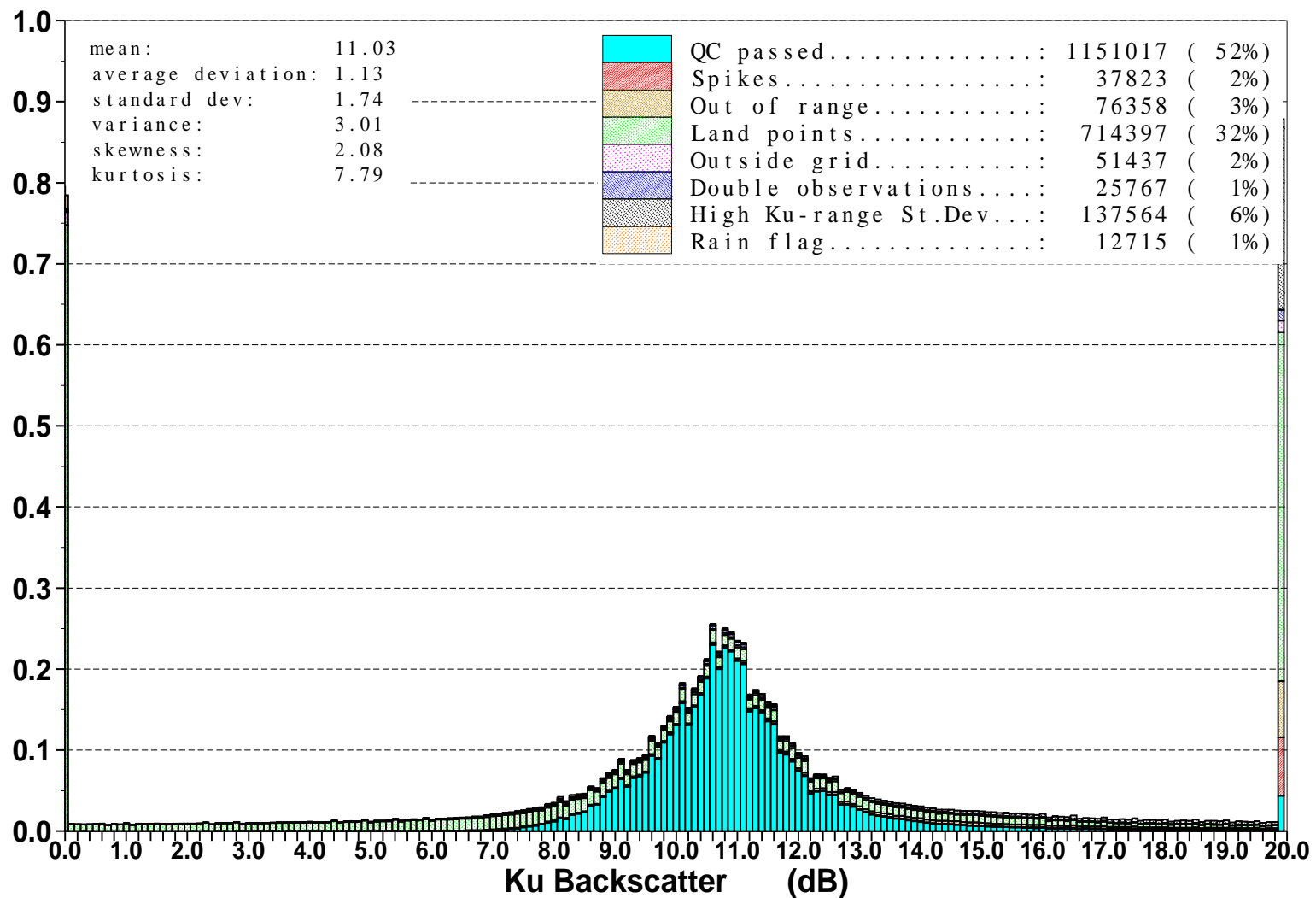


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for April 2009



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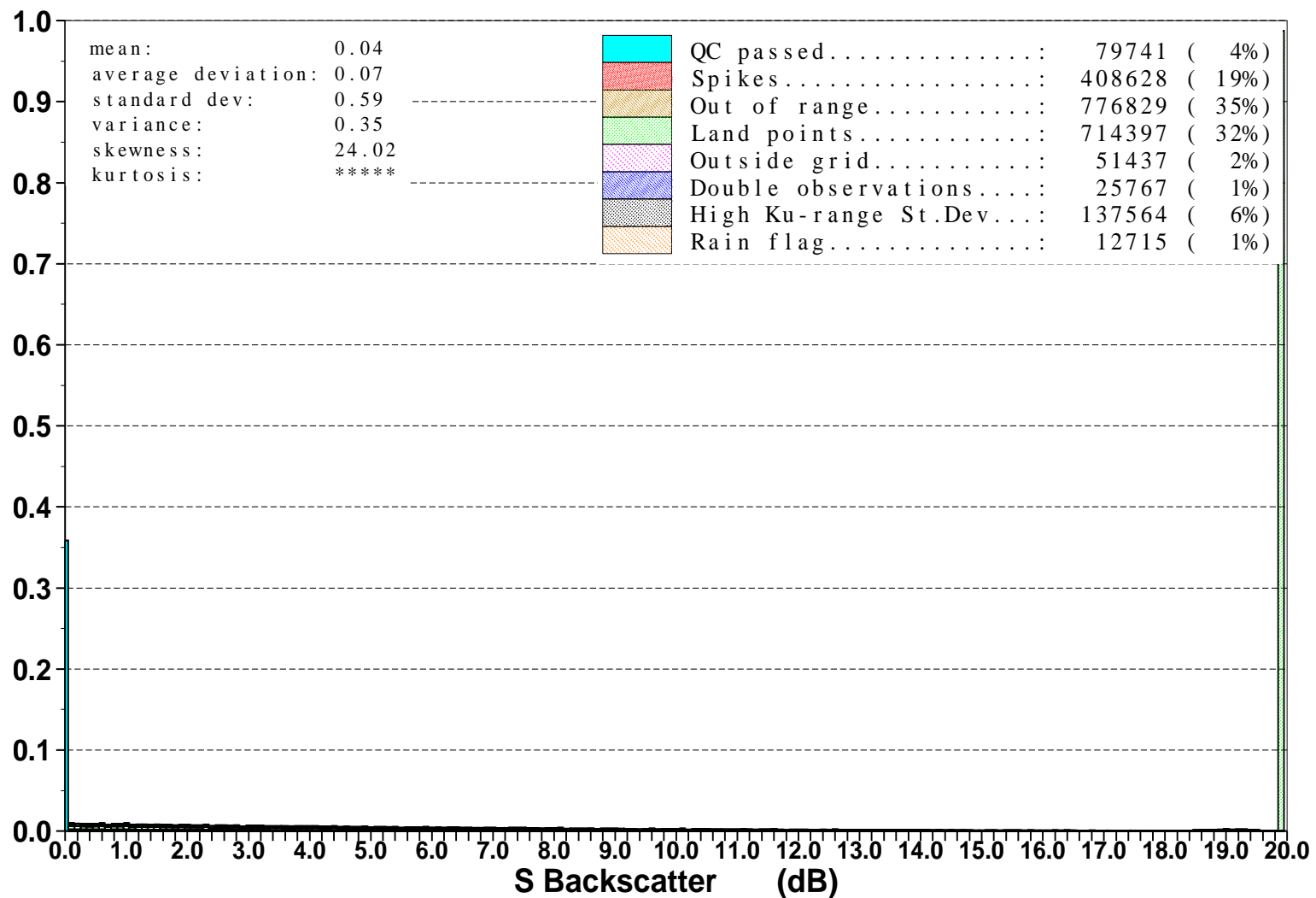


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for April 2009

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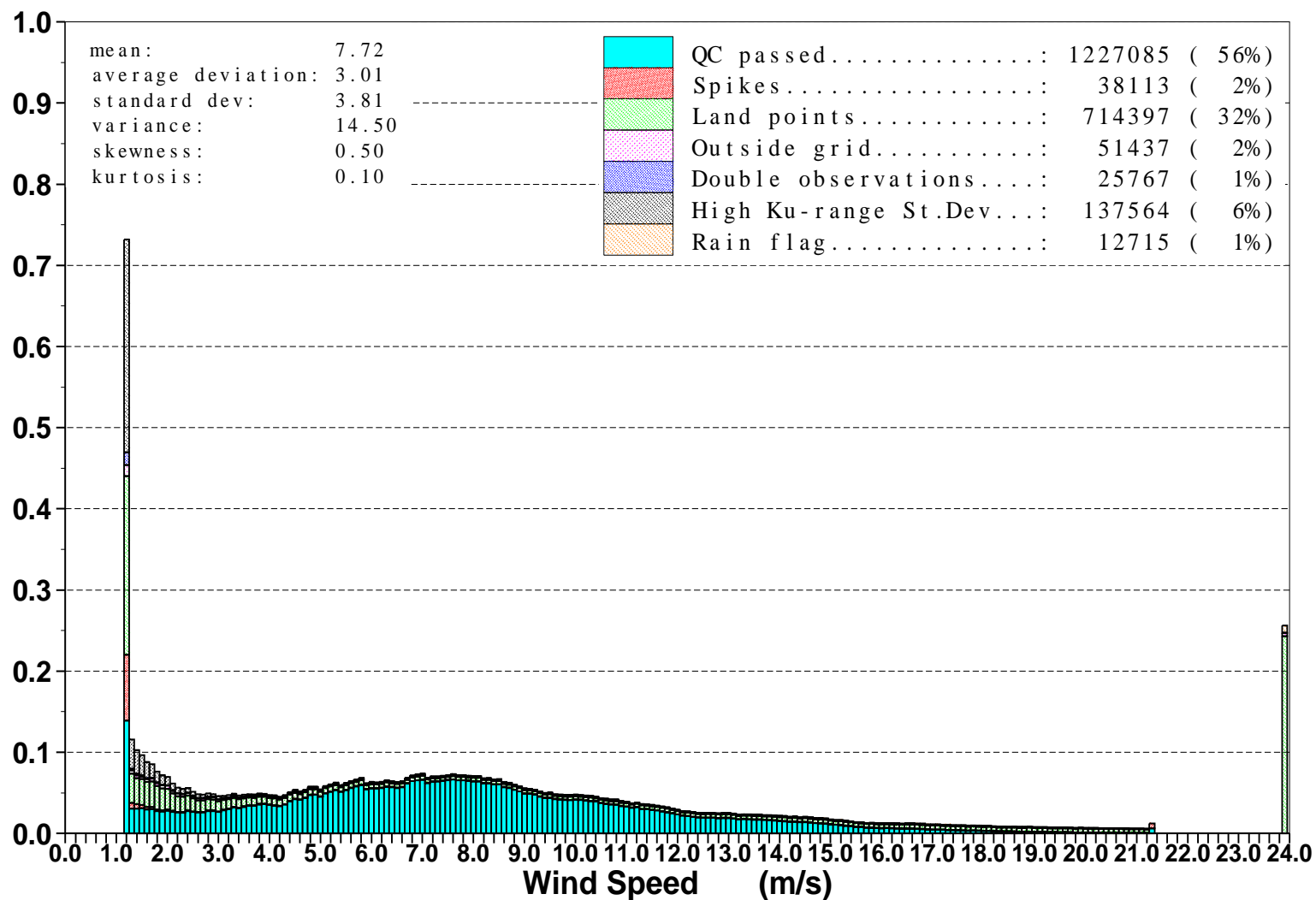


Figure 4: Distribution of the ENVISAT Altimeter Wind Speed after QC for April 2009

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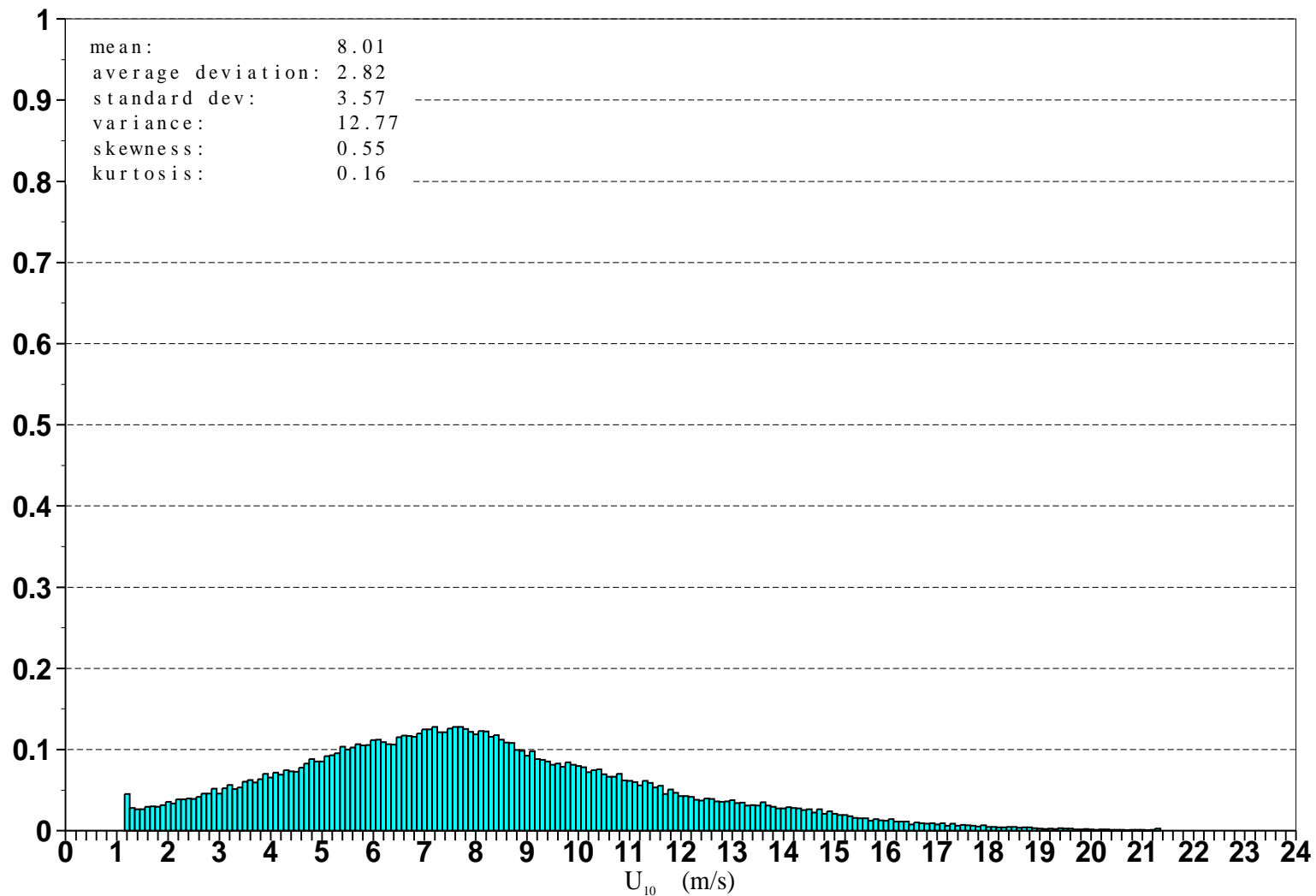


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for April 2009



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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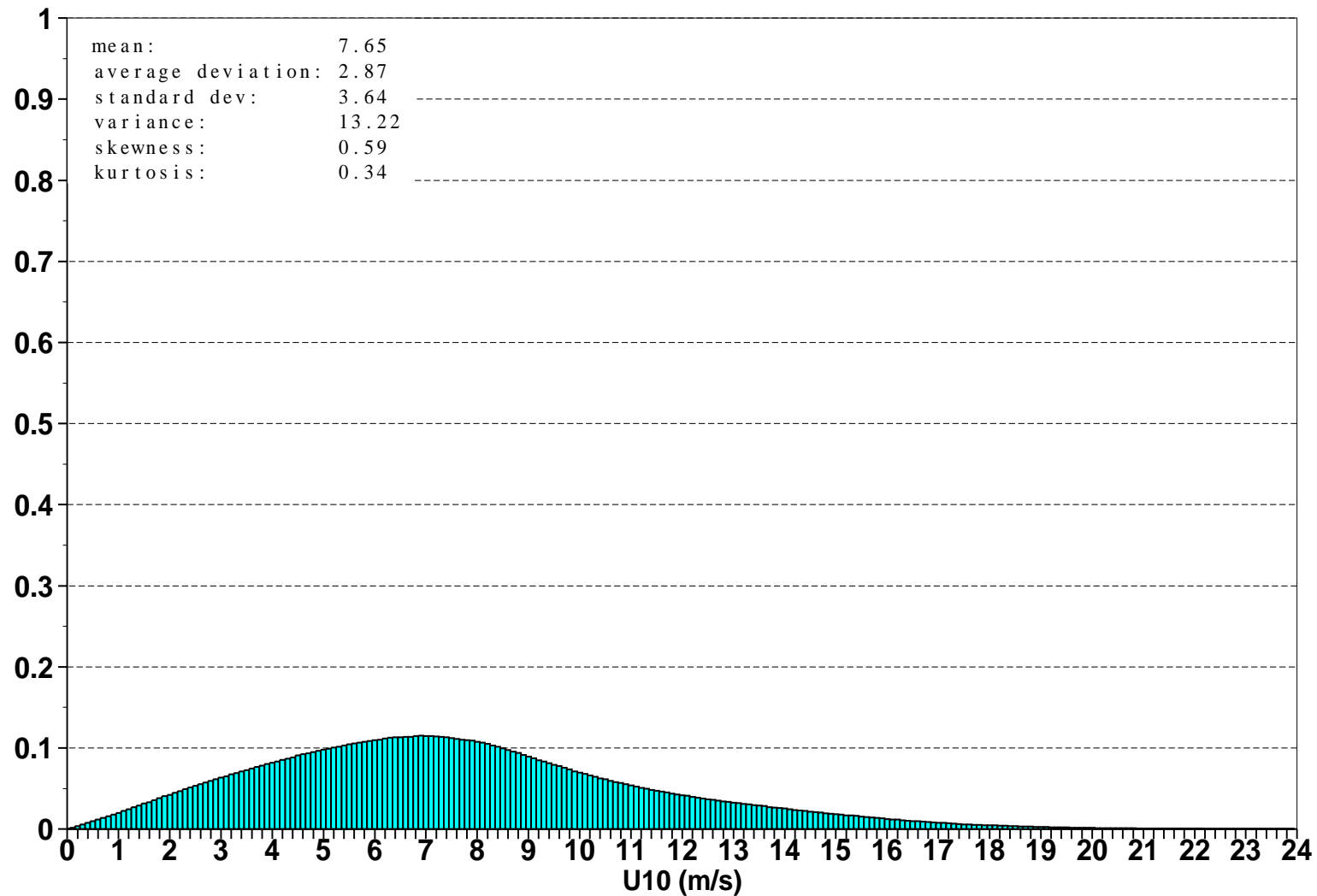


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for April 2009



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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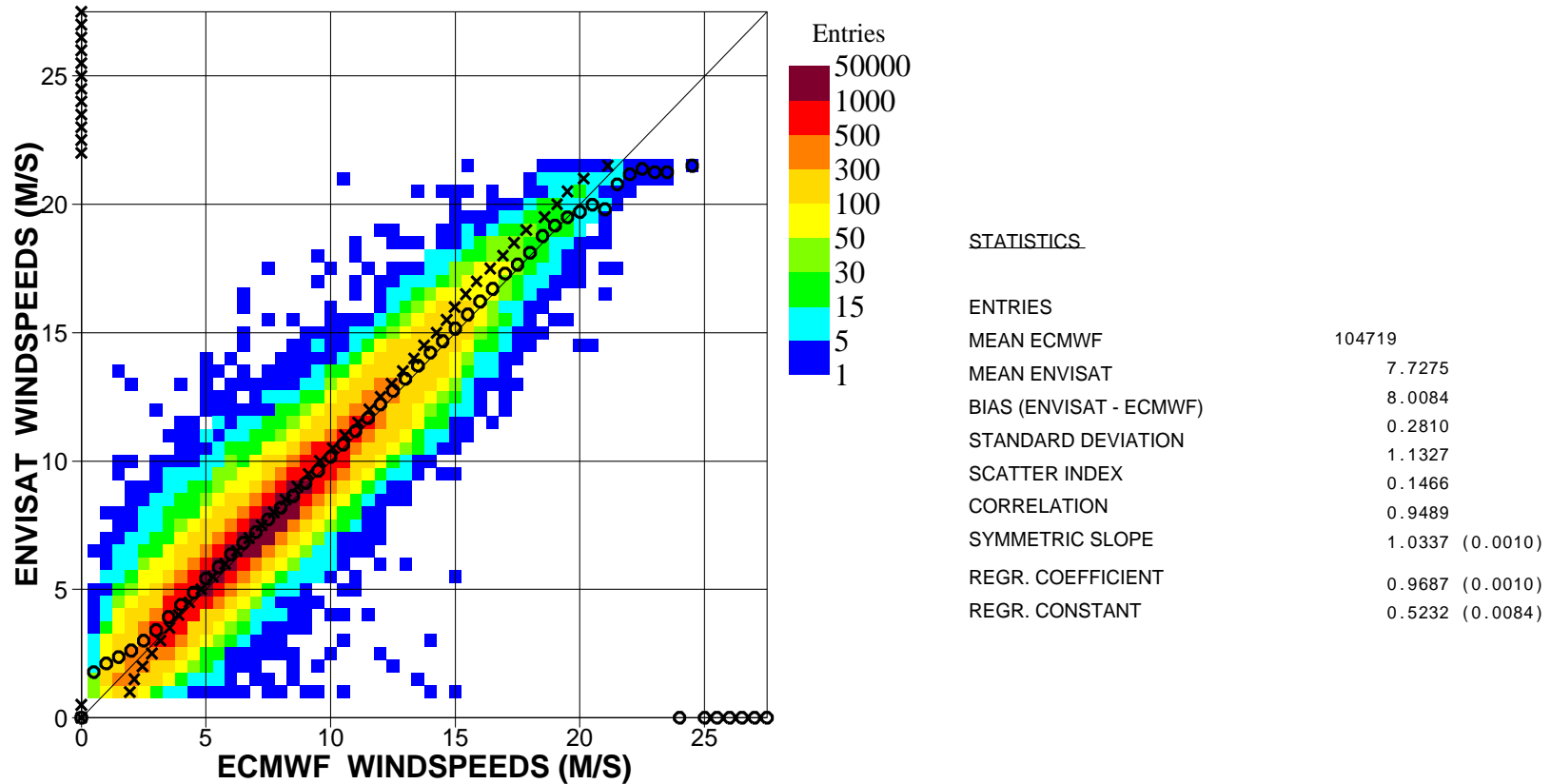


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2009 (Global)

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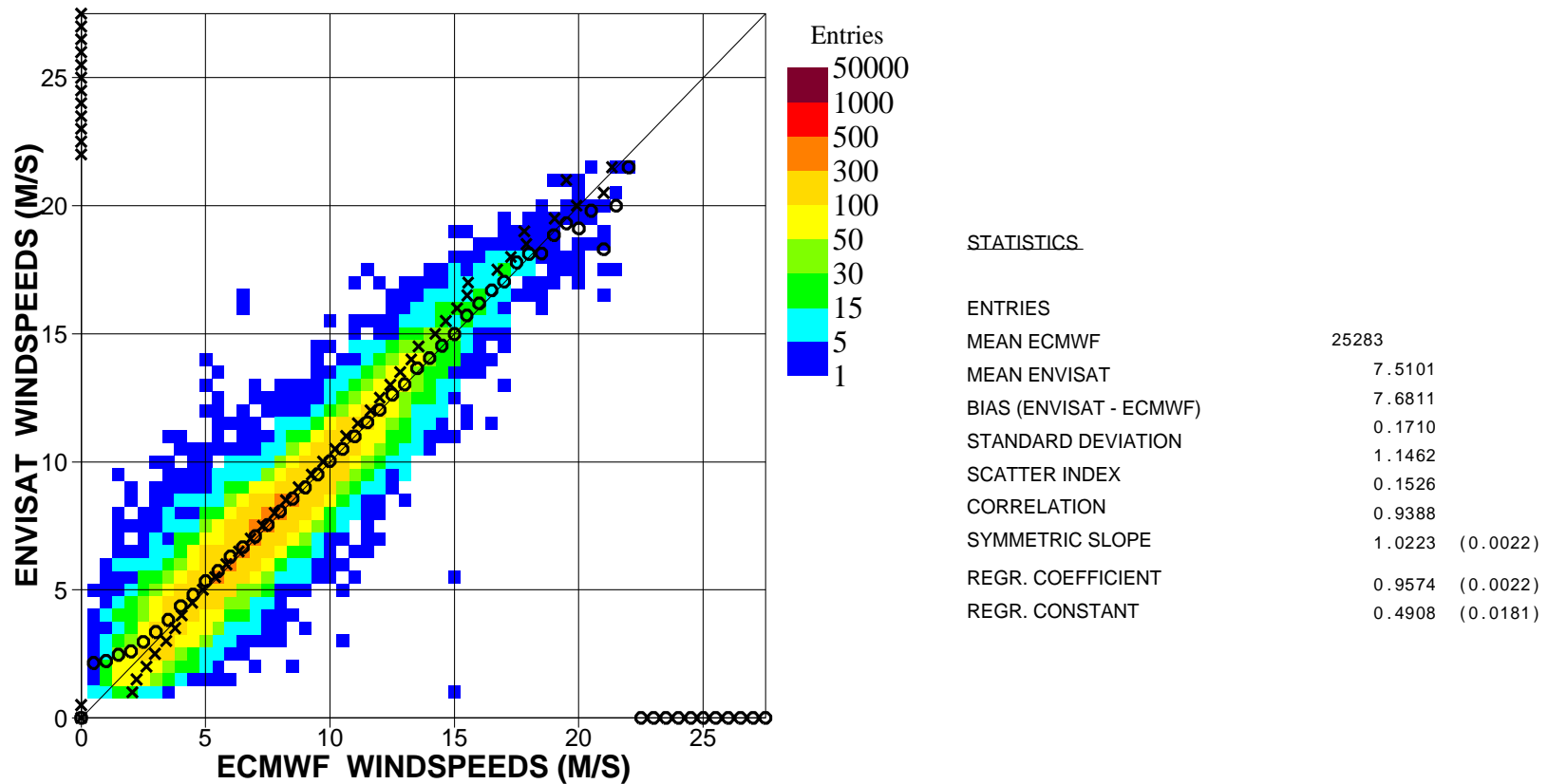


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2009 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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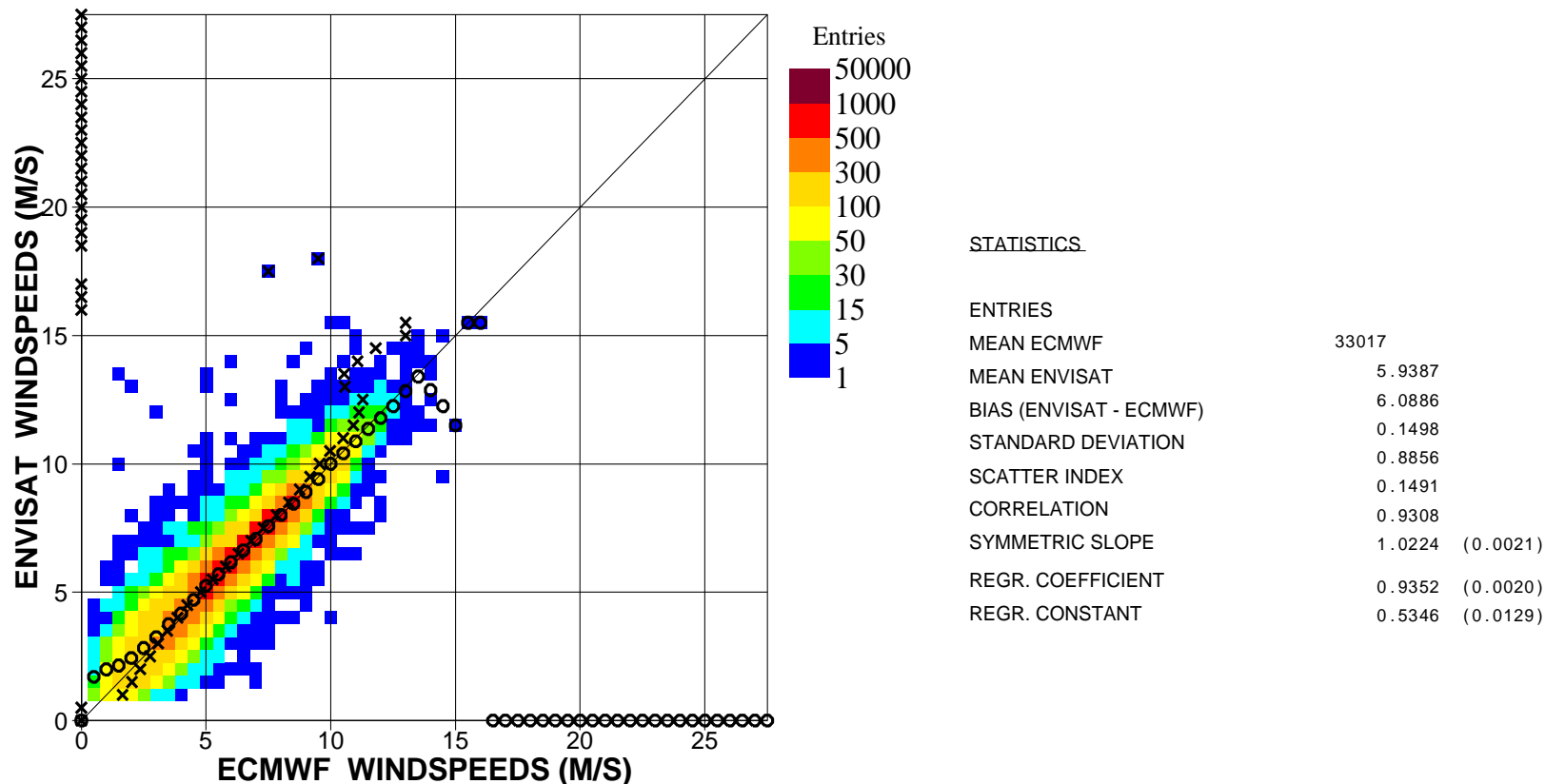


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2009 (Tropics)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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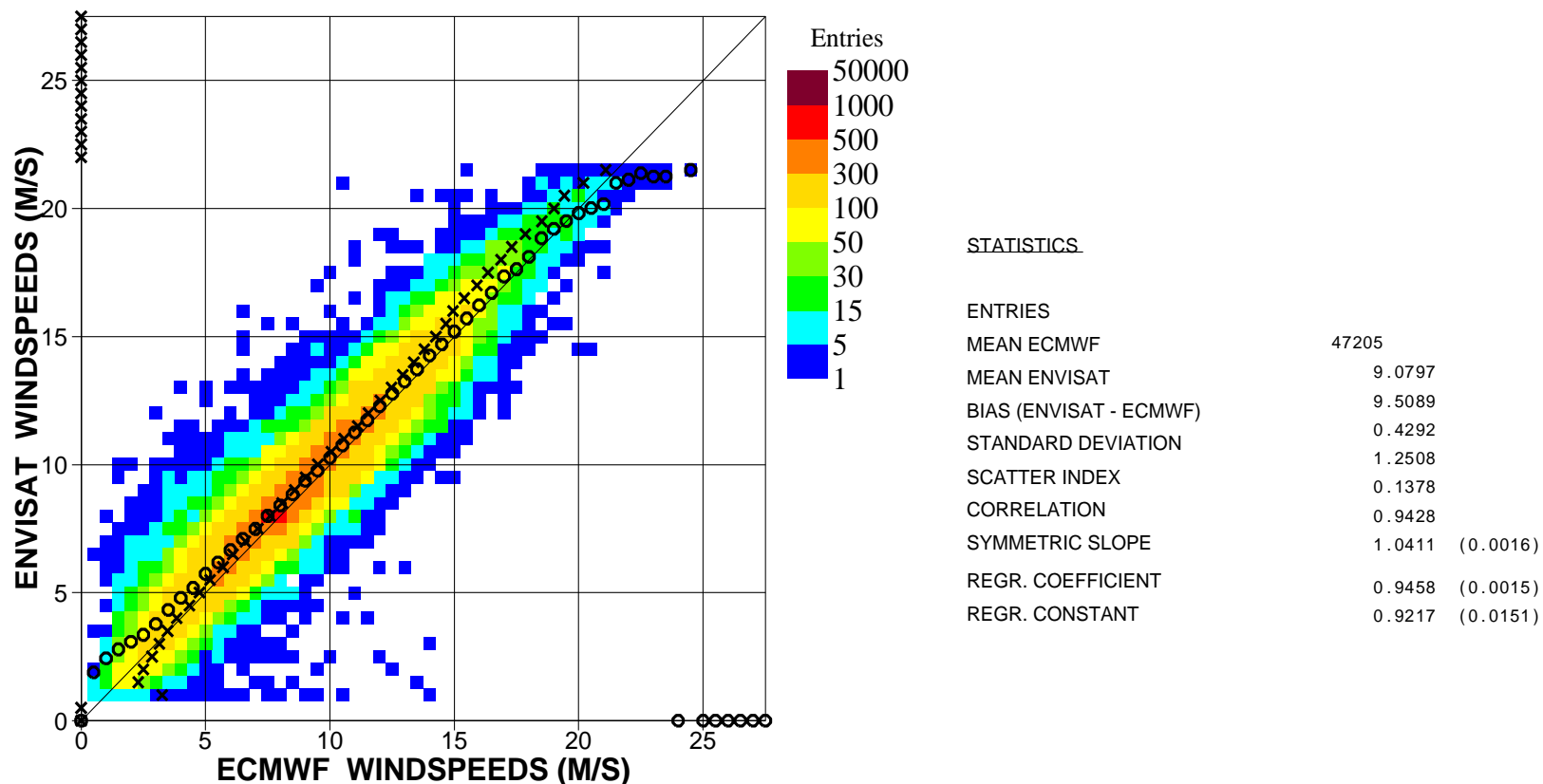


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2009 (S.Hem.)

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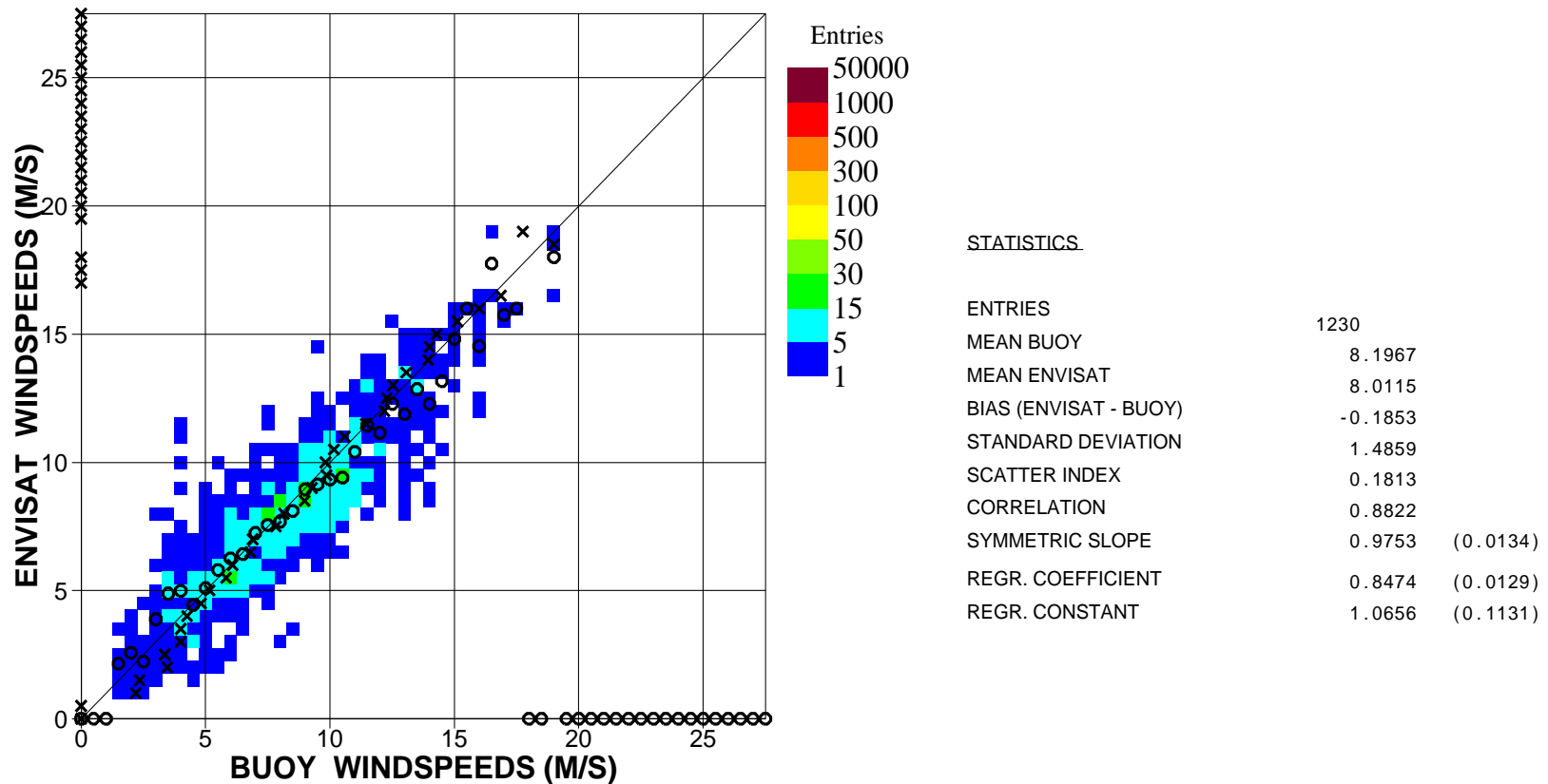


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2009 (Global)

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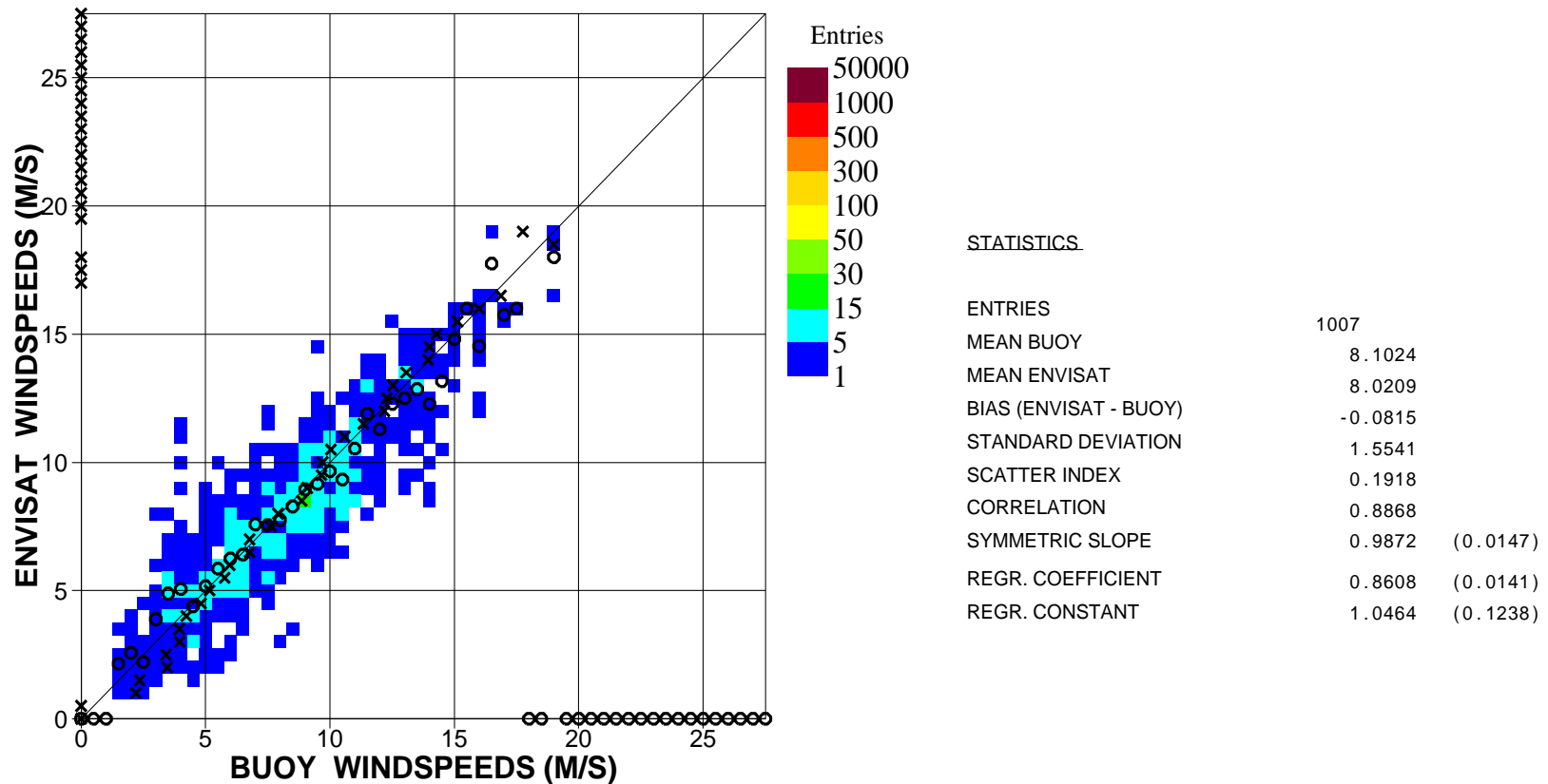


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2009 (N.Hem.)

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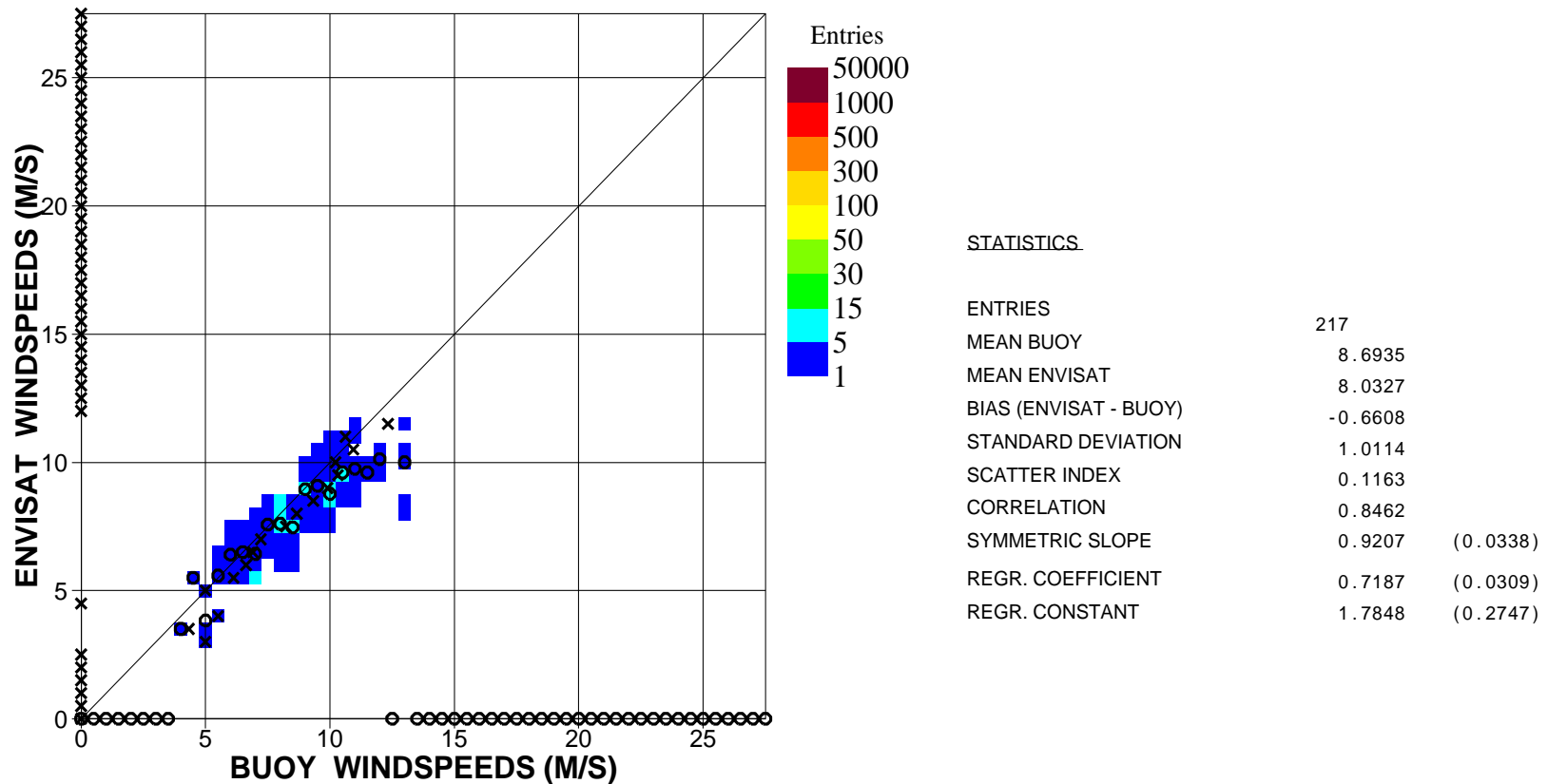


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2009 (Tropics)

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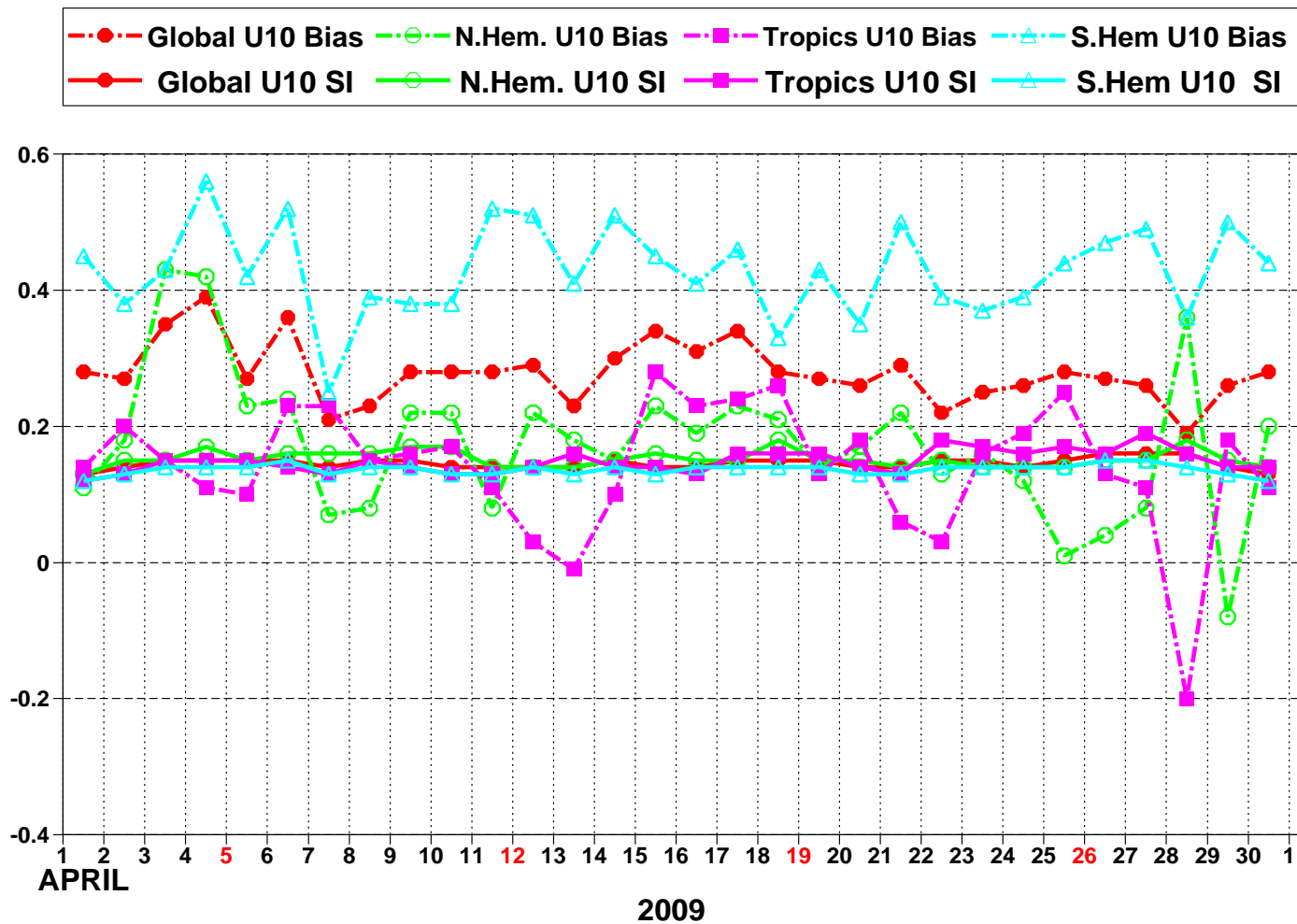


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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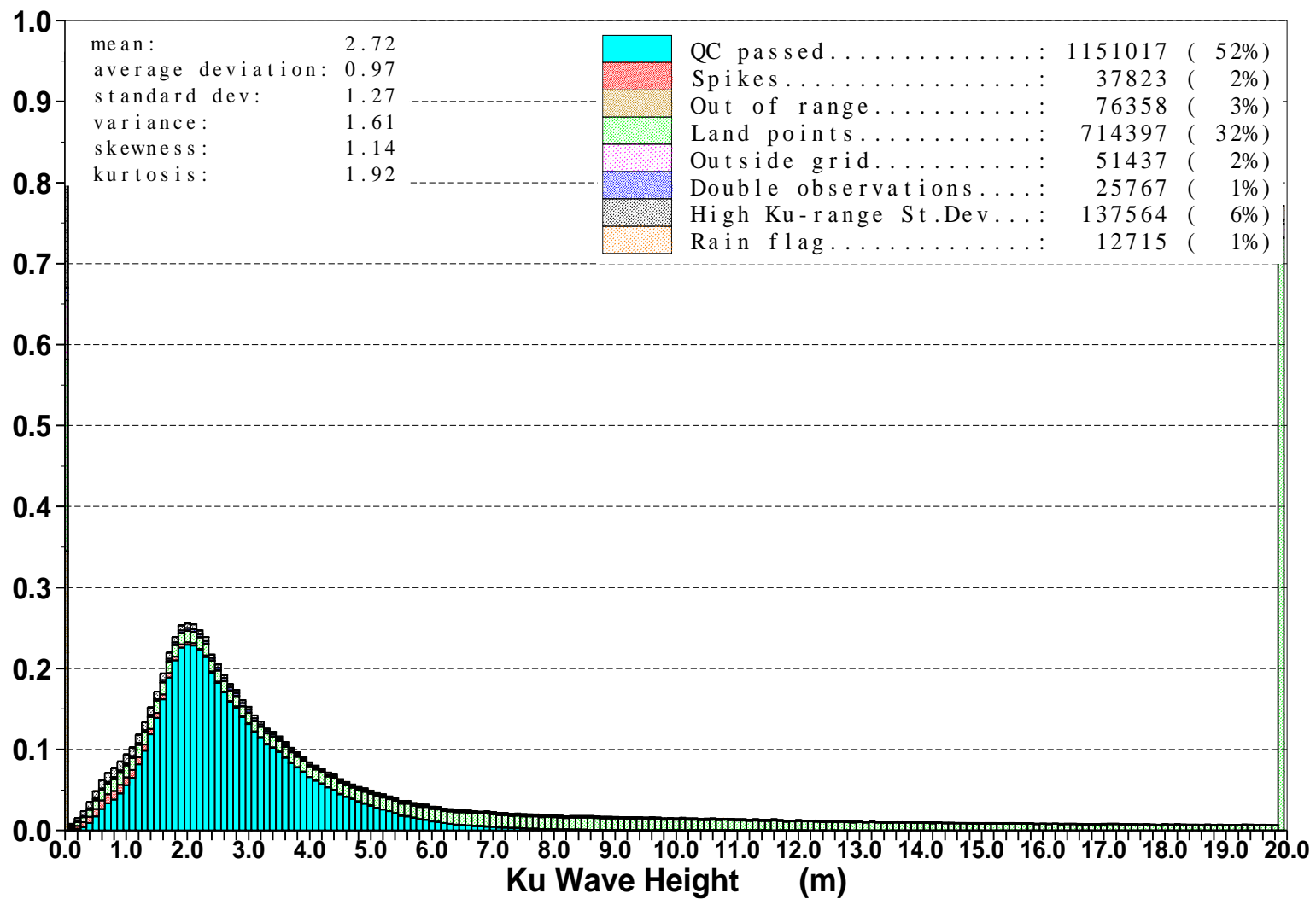


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for April 2009

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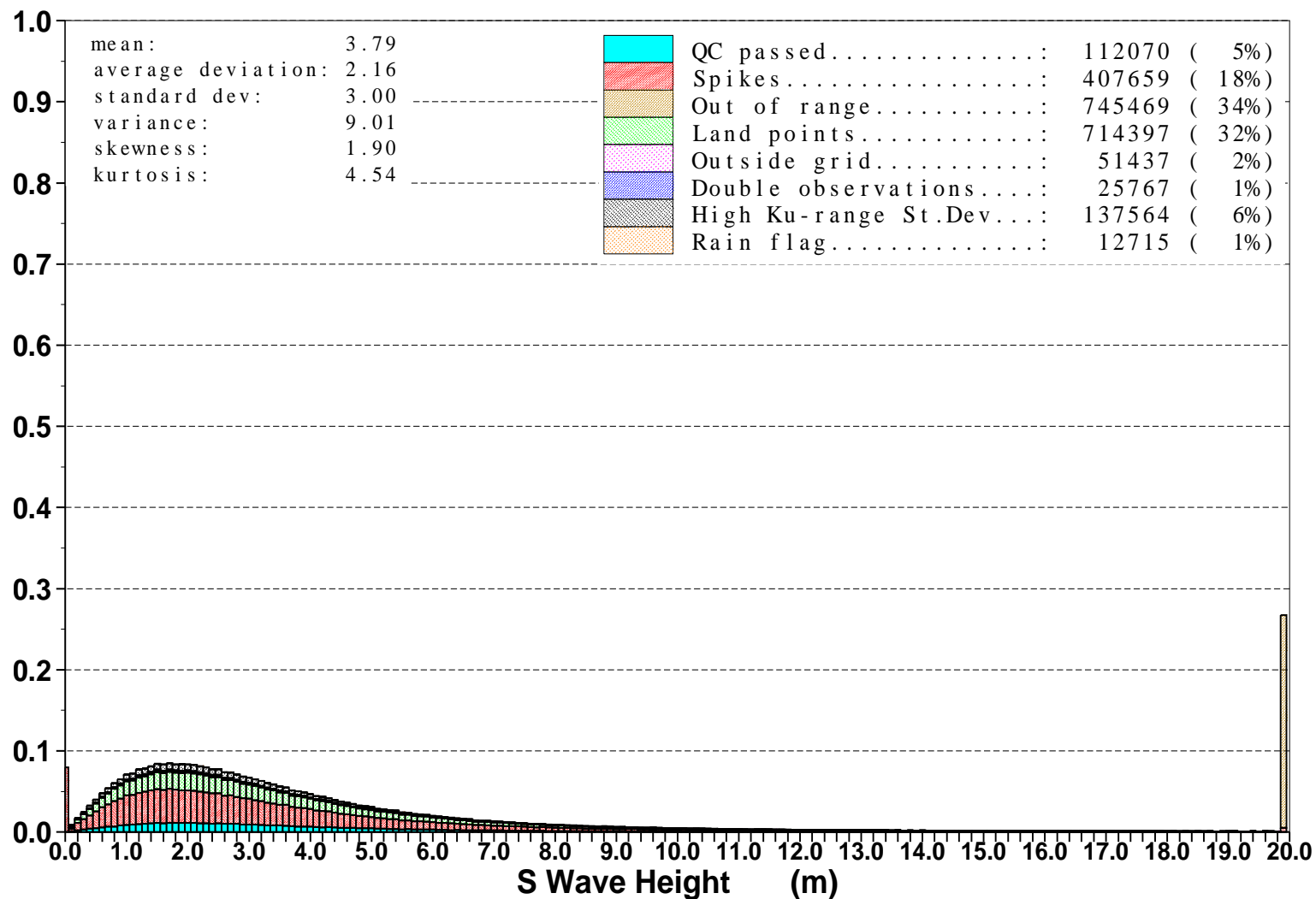


Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for April 2009

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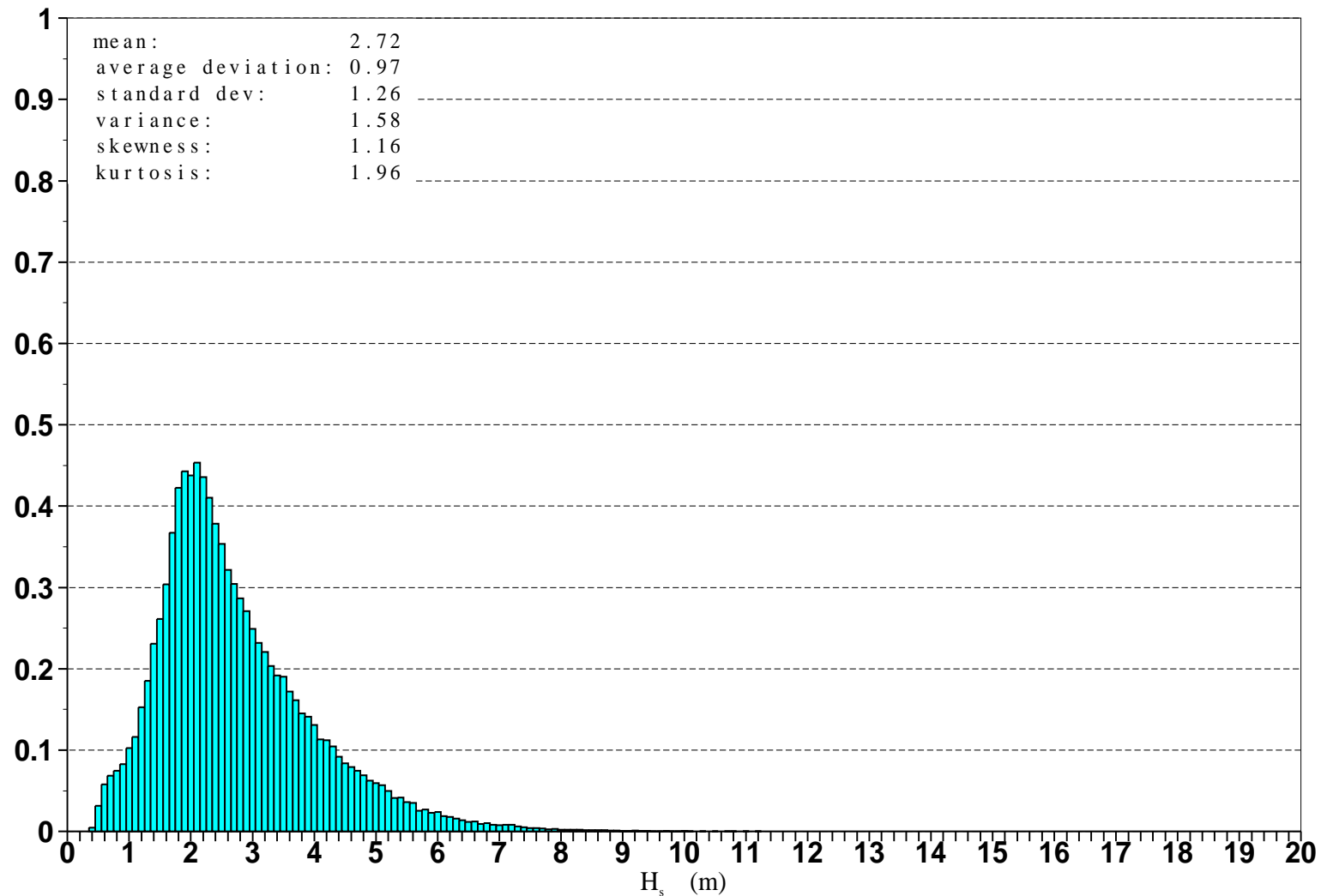


Figure 17: Distribution of ENVISAT Altimeter Ku-Band Wave Heights after Along-Track Averaging for April 2009

■
Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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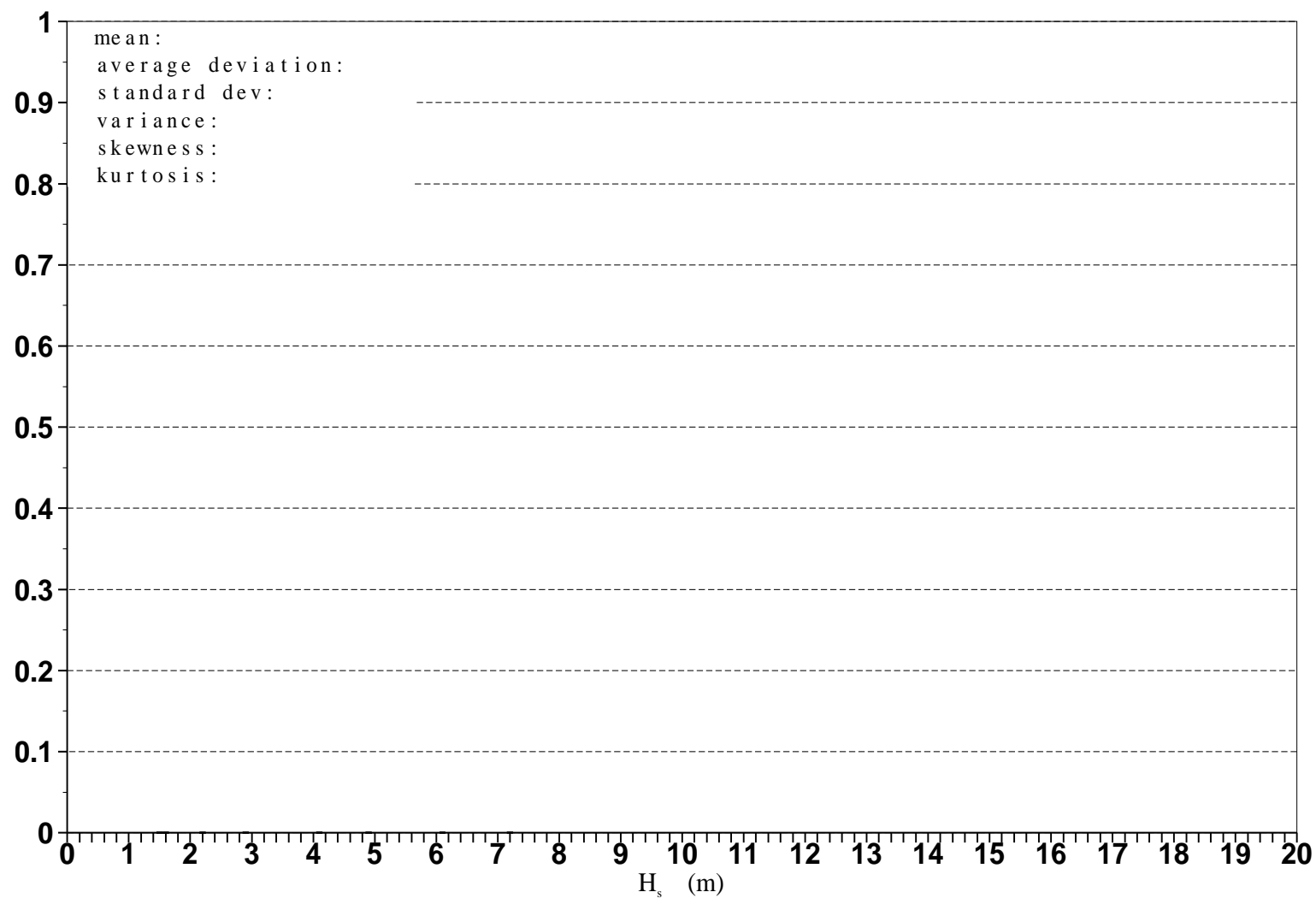


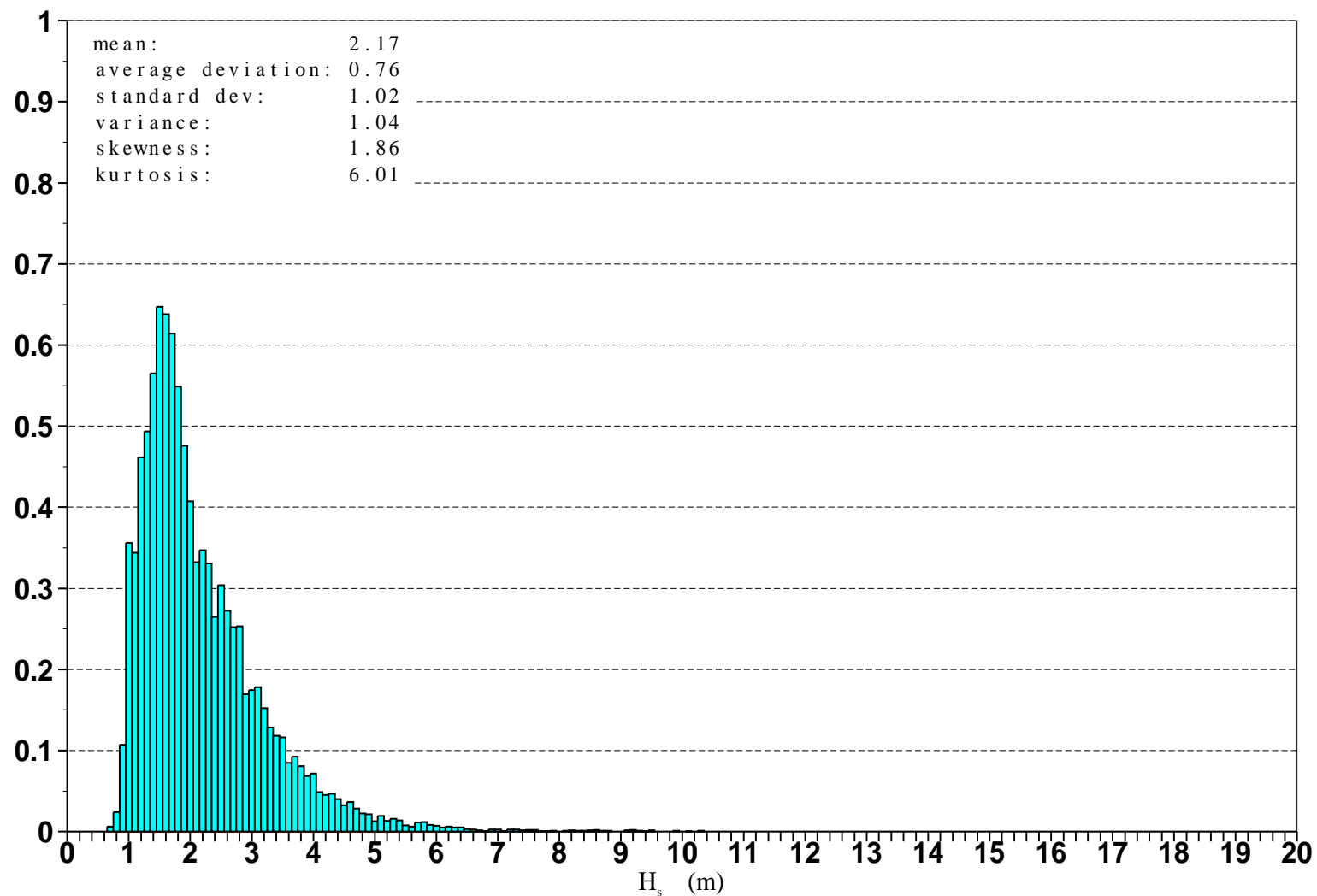
Figure 18: Distribution of ENVISAT Altimeter S-Band Wave Heights after Along-Track Averaging for April 2009



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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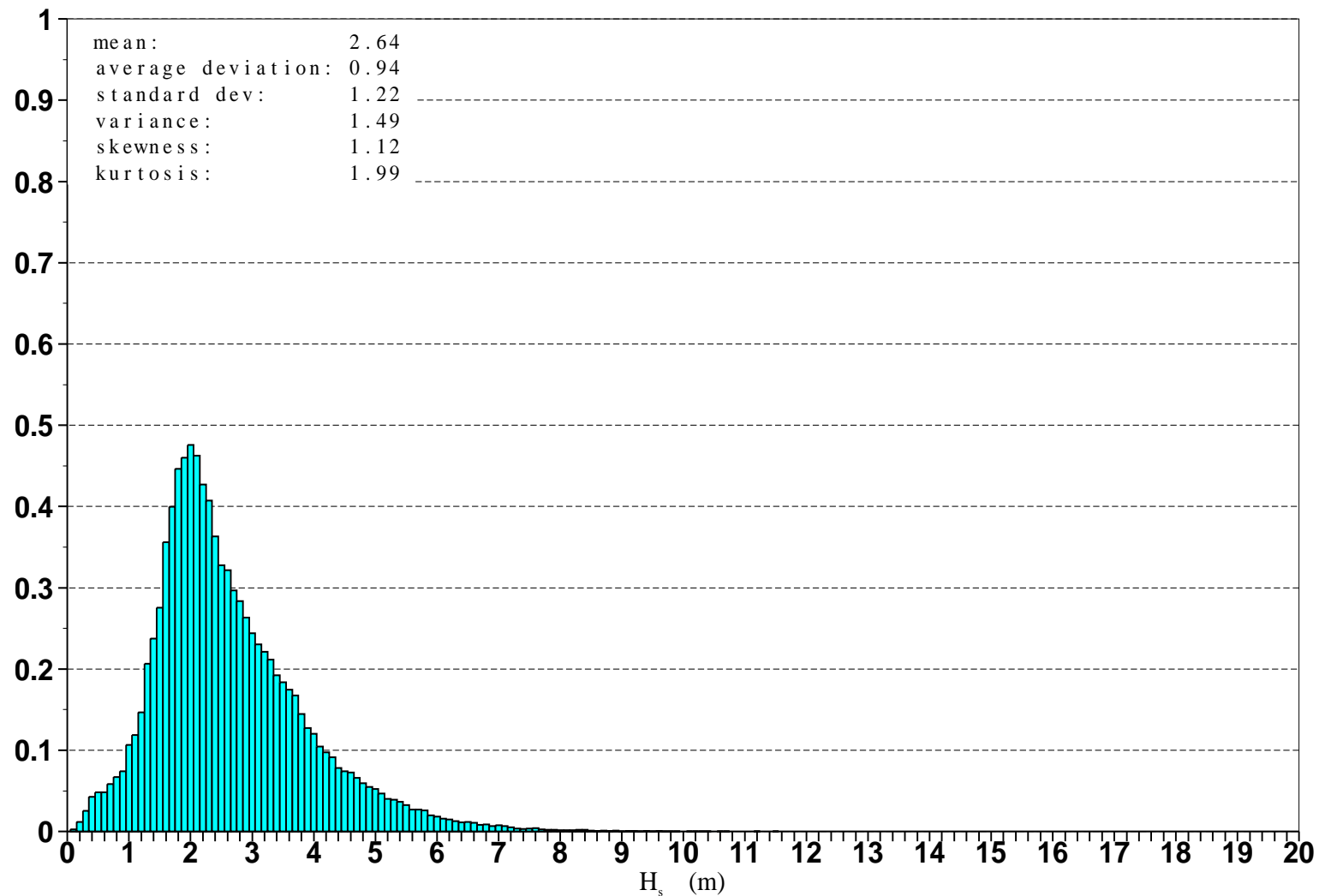
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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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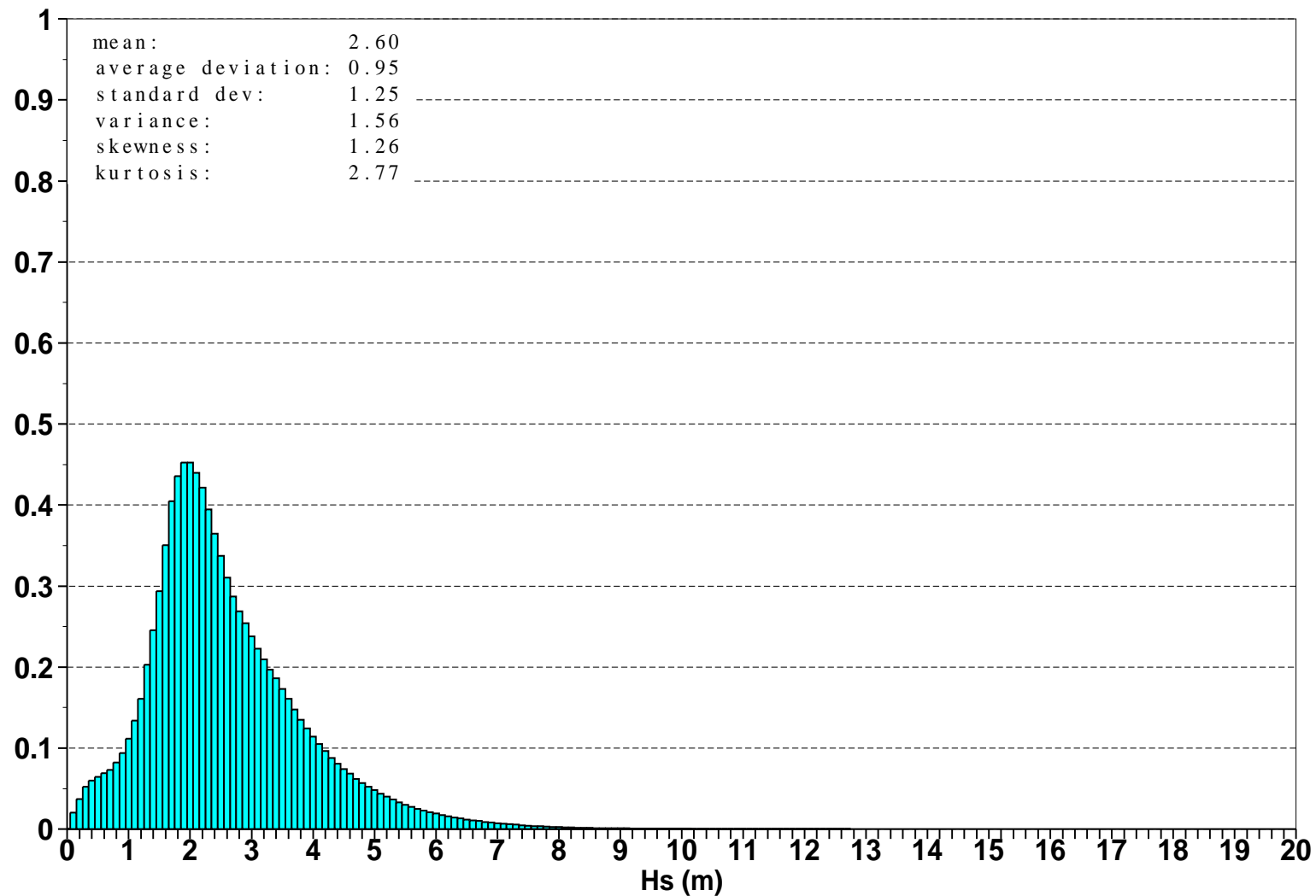


Figure 20: Global distribution of ECMWF First-Guess wave heights for April 2009



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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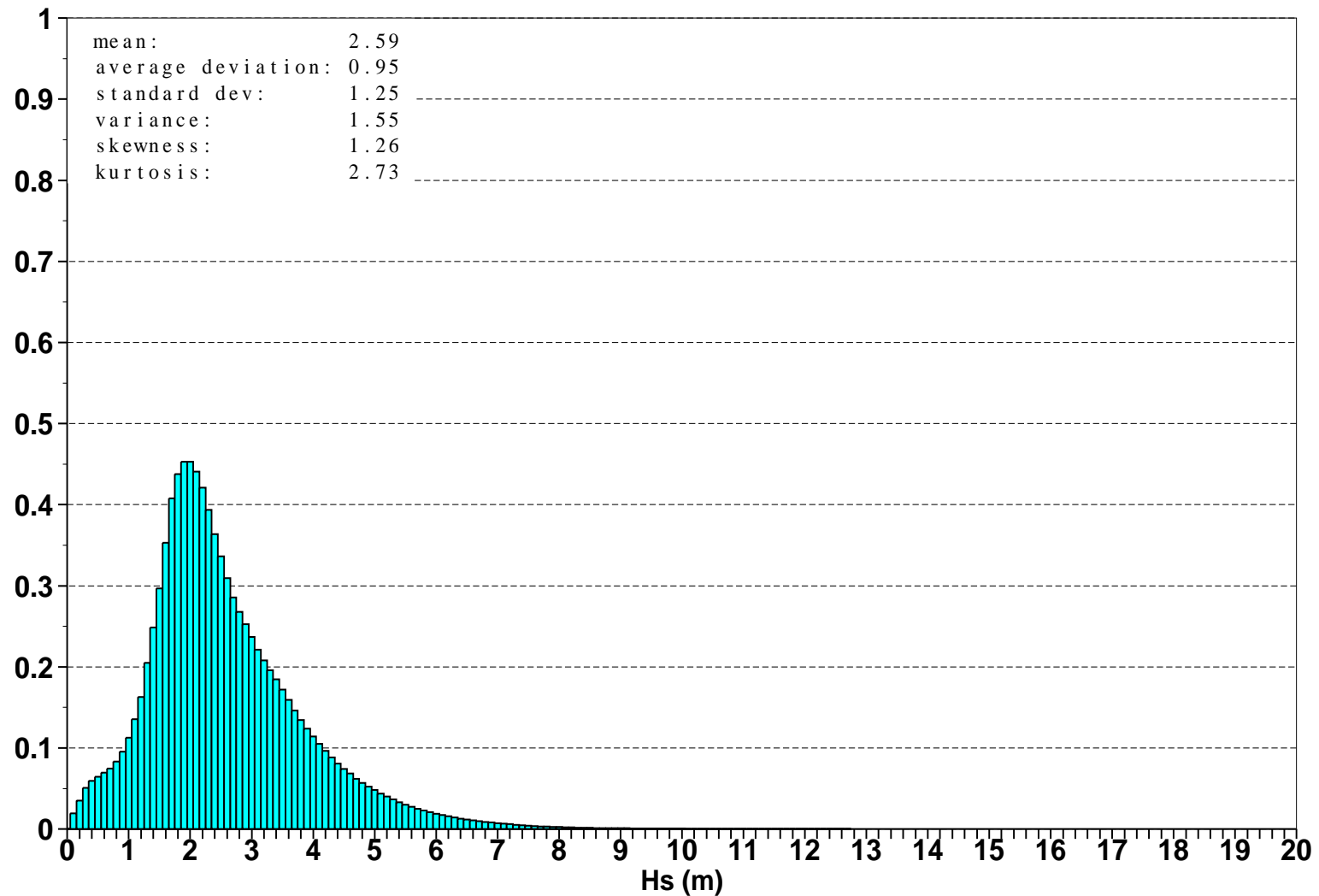


Figure 21: Global distribution of ECMWF Analysis wave heights for April 2009

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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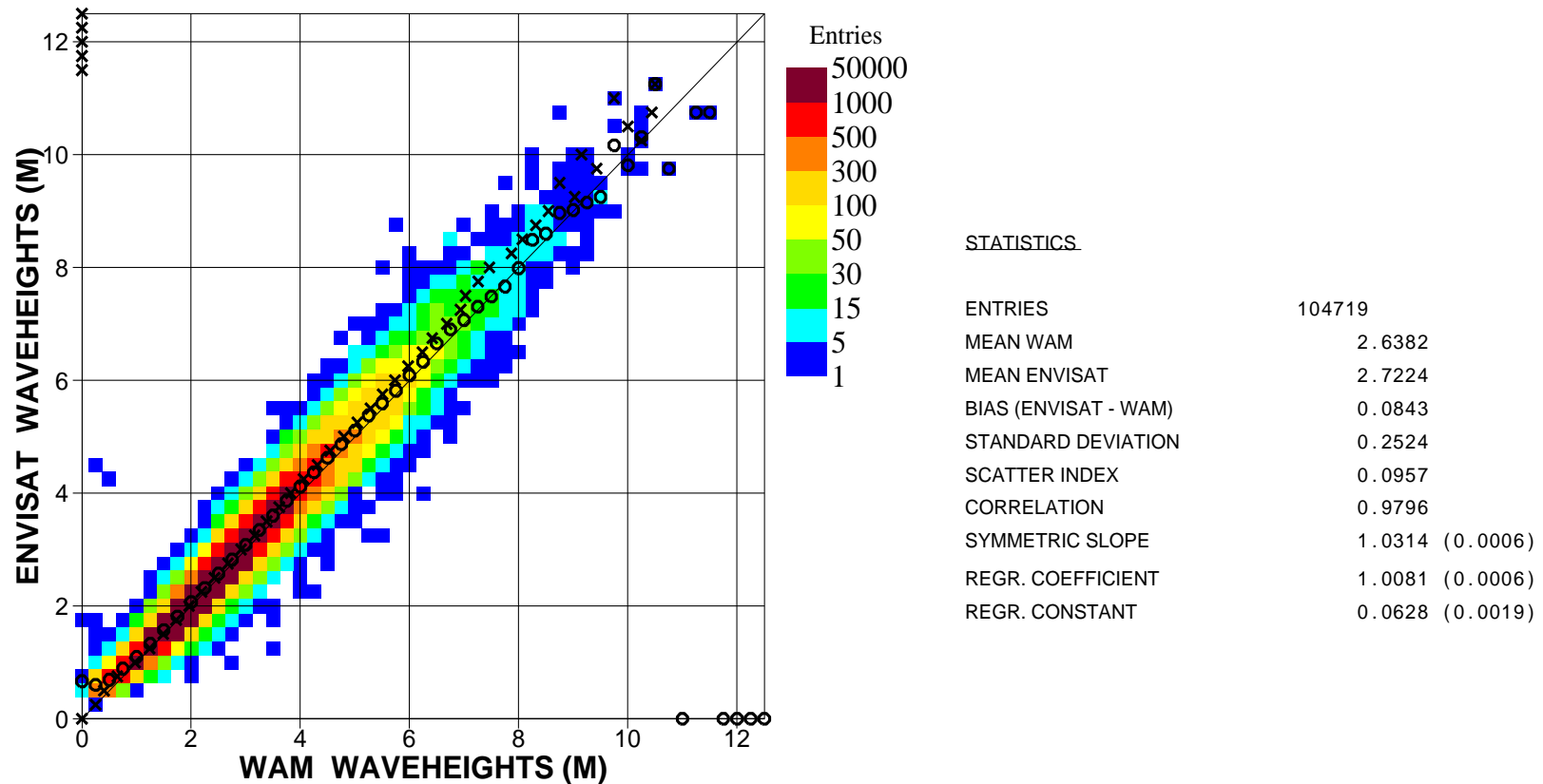


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2009 (Global)

Saleh Abdalla

European Centre for Medium Range Weather Forecasts
 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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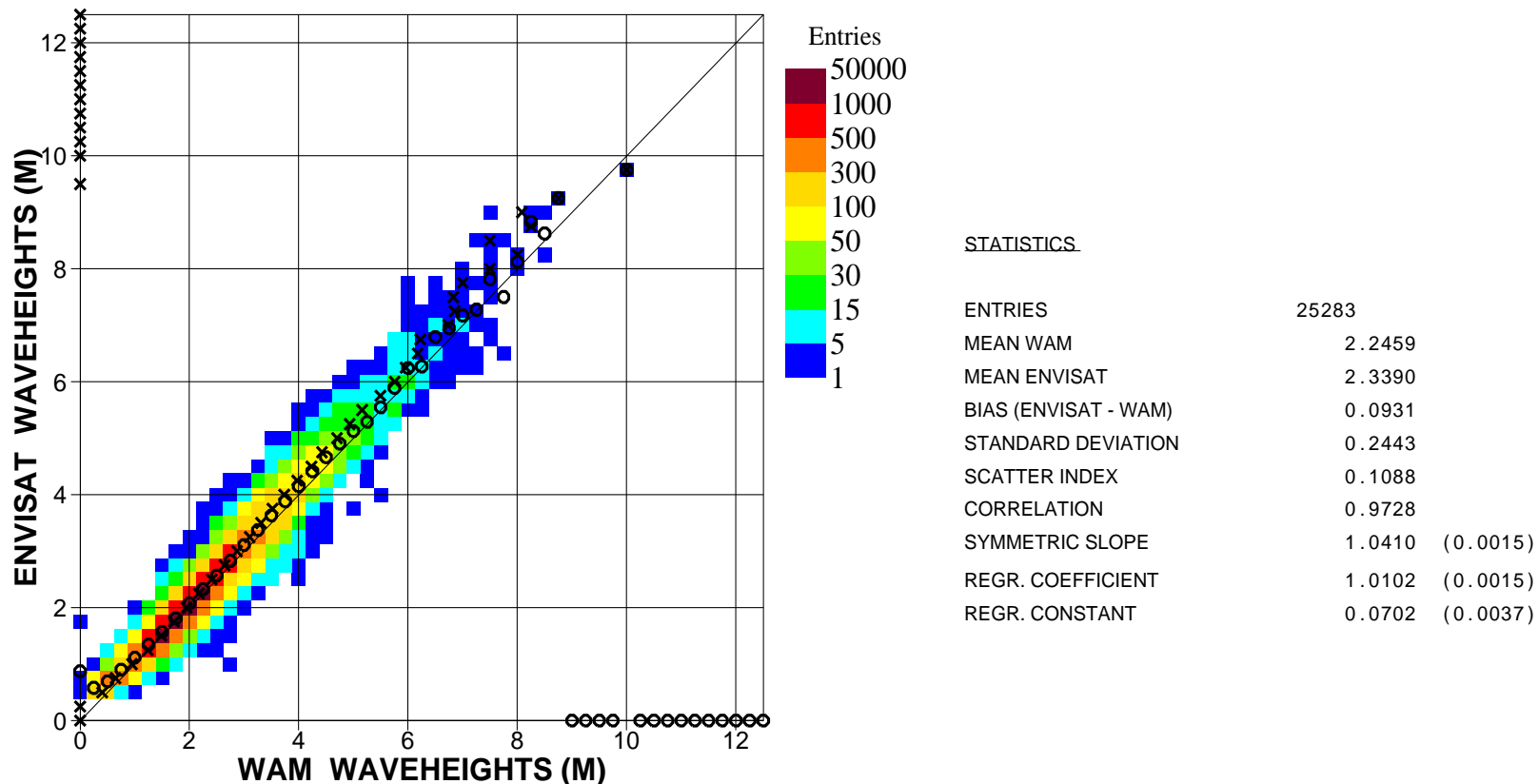


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2009 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
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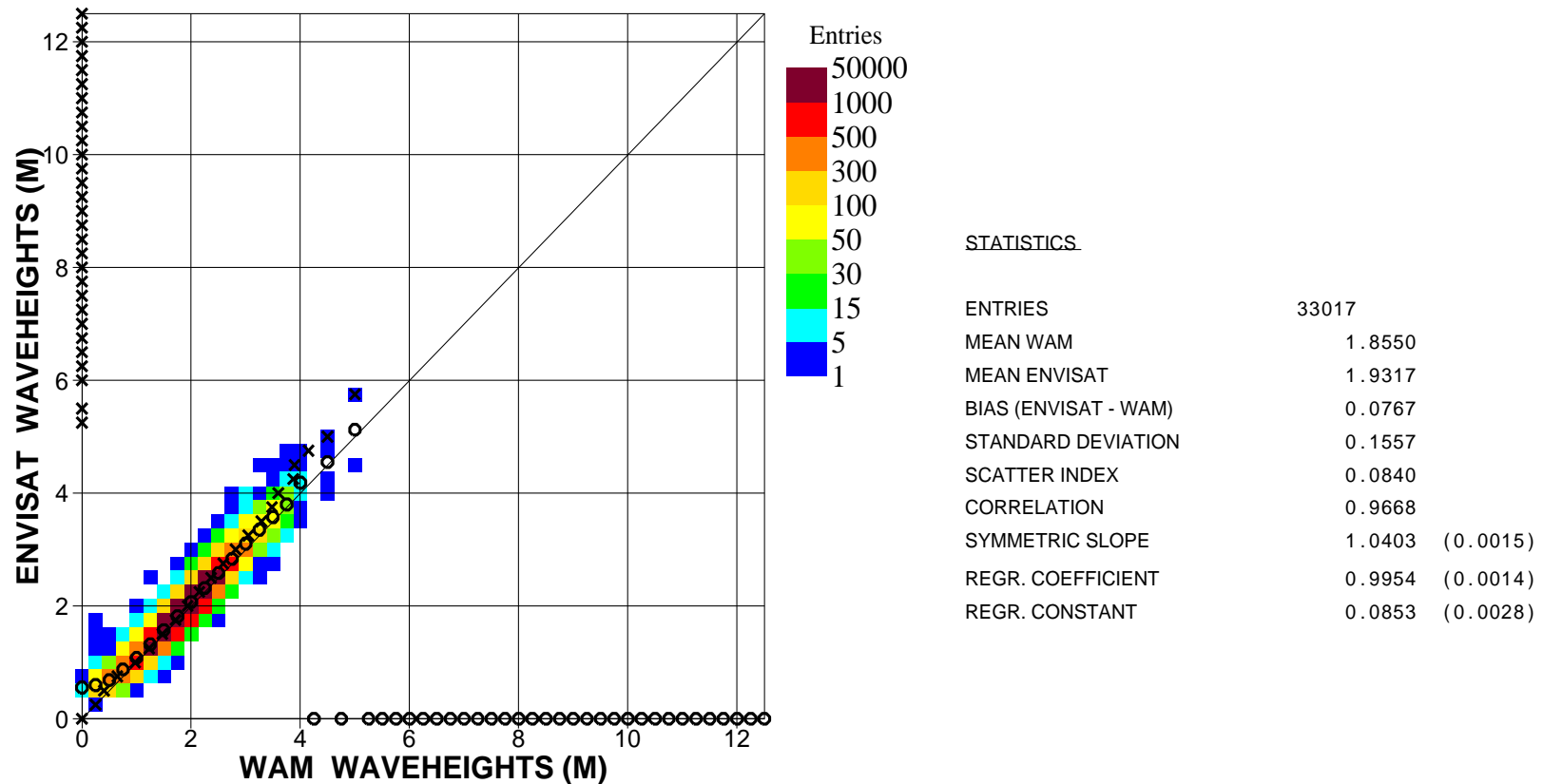


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2009 (Tropics)

Saleh Abdalla

European Centre for Medium Range Weather Forecasts
 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
 Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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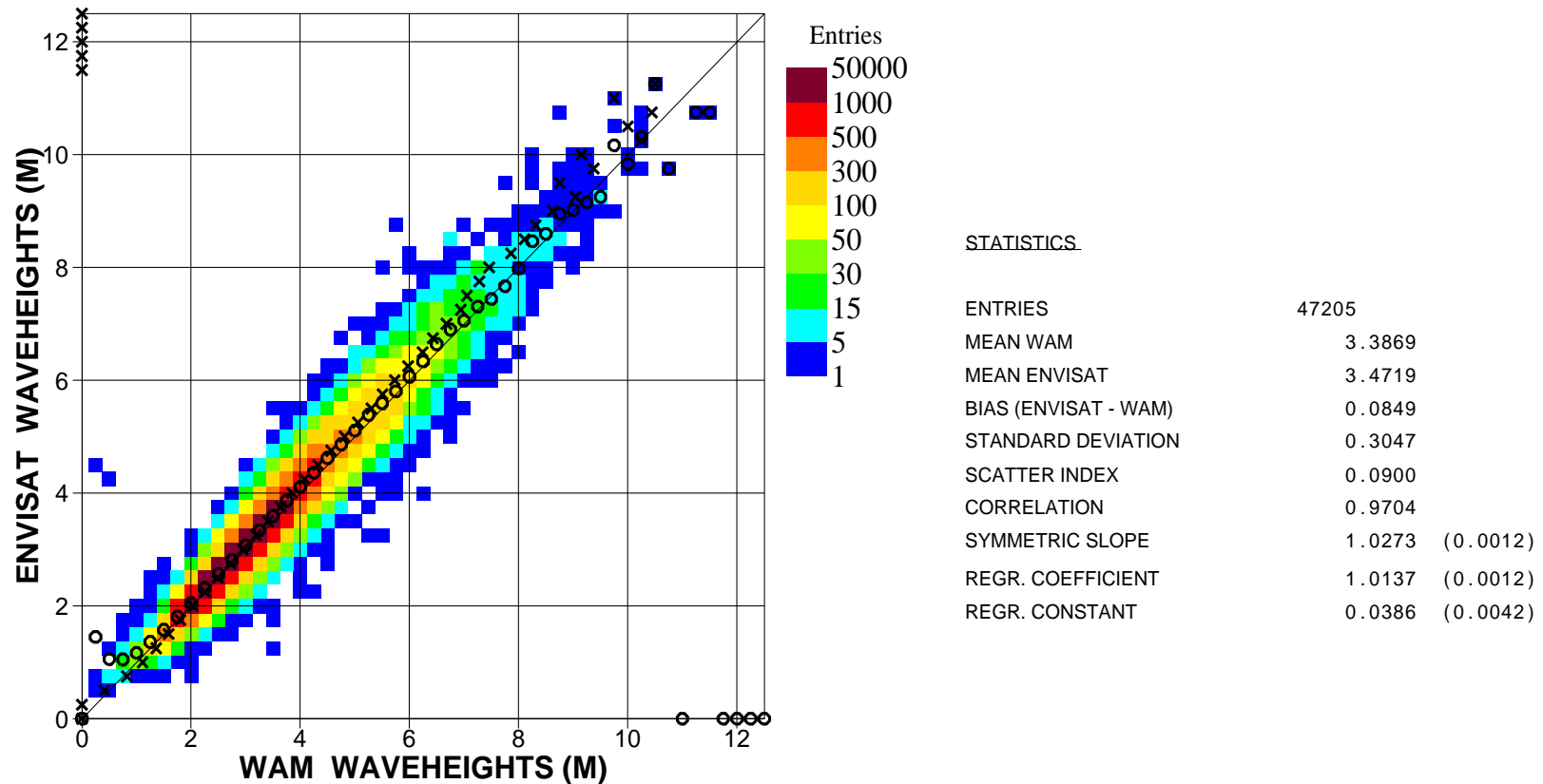


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2009 (S.Hem.)

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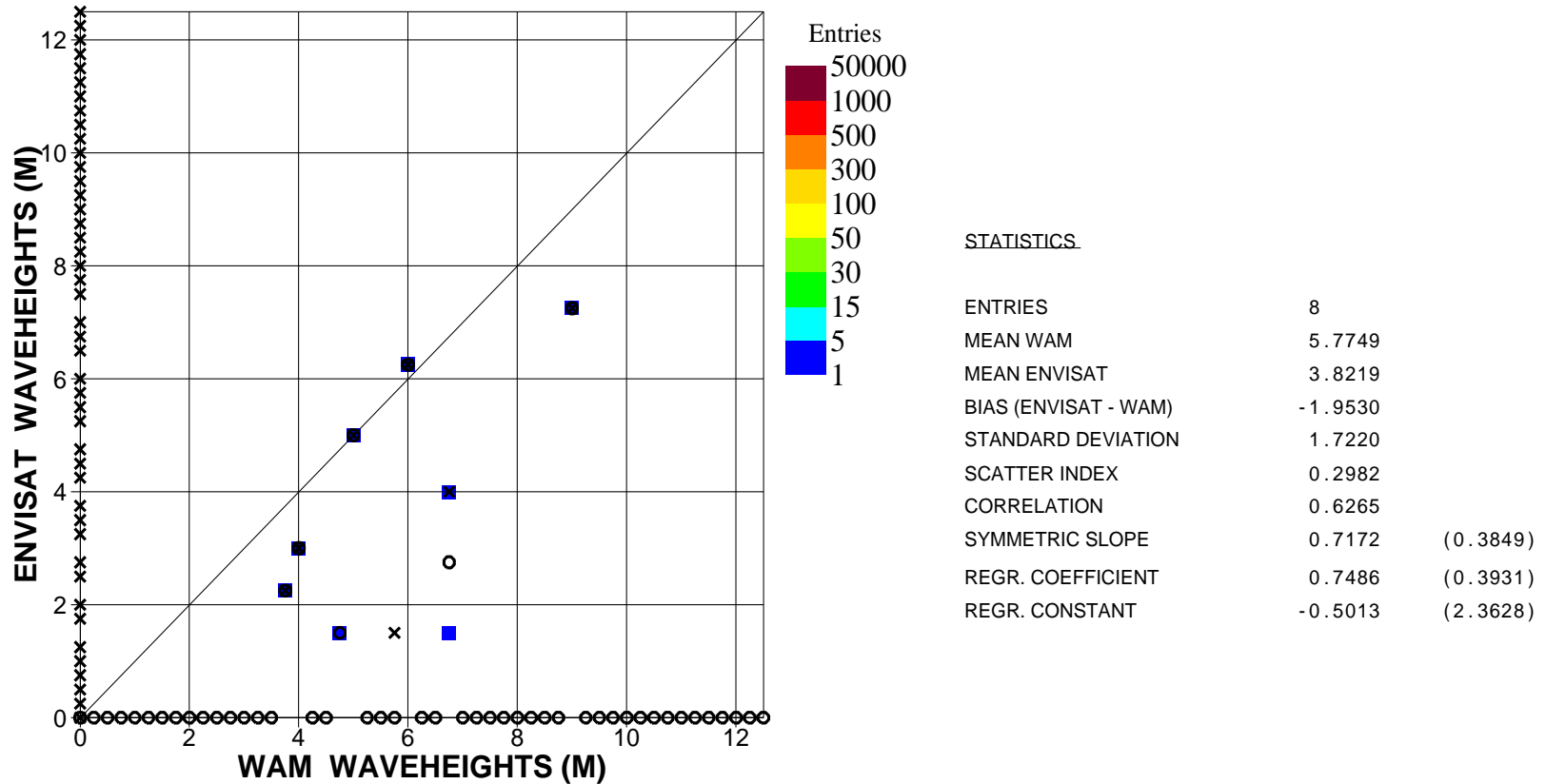


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2009 (Global)



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
 Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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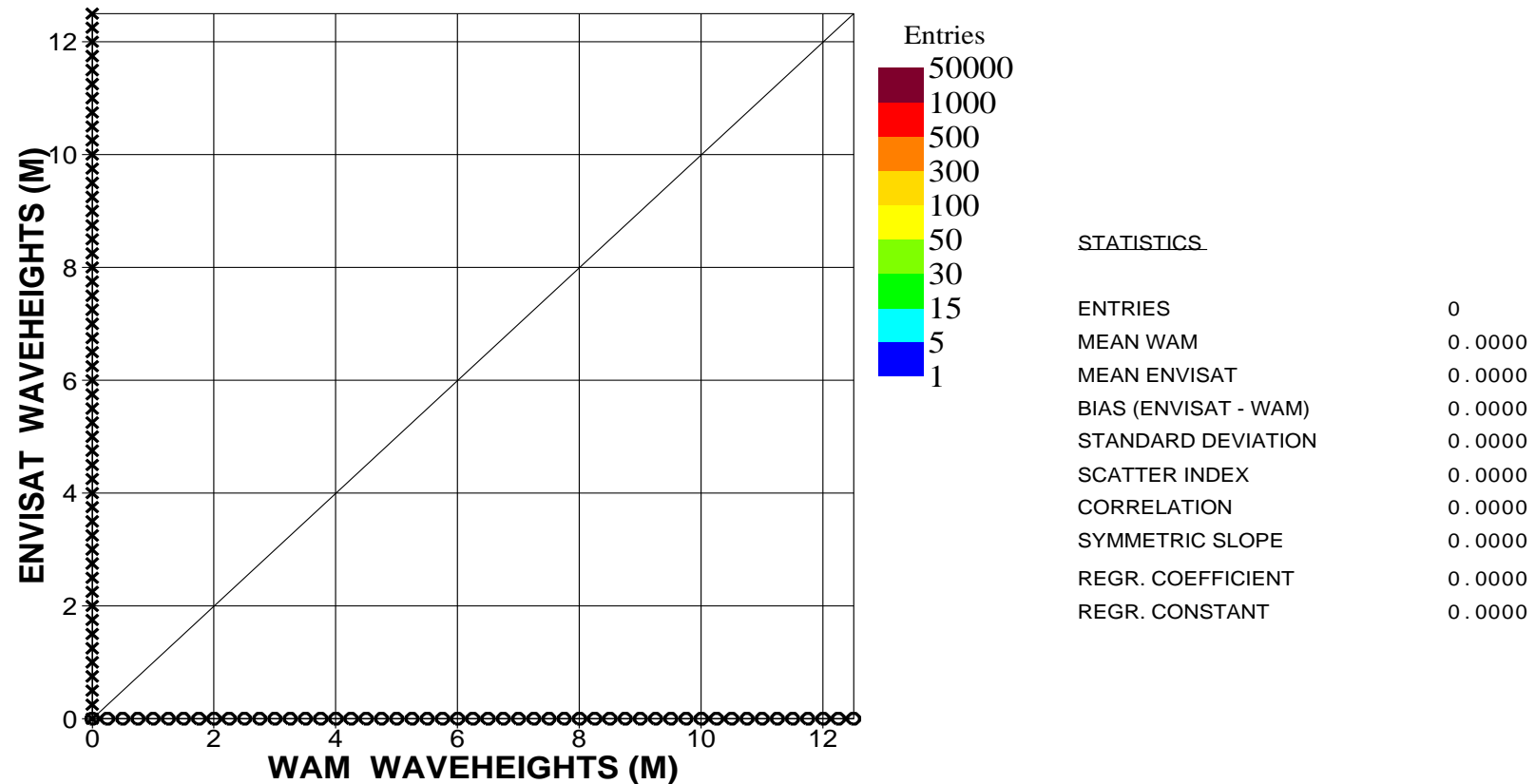


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2009 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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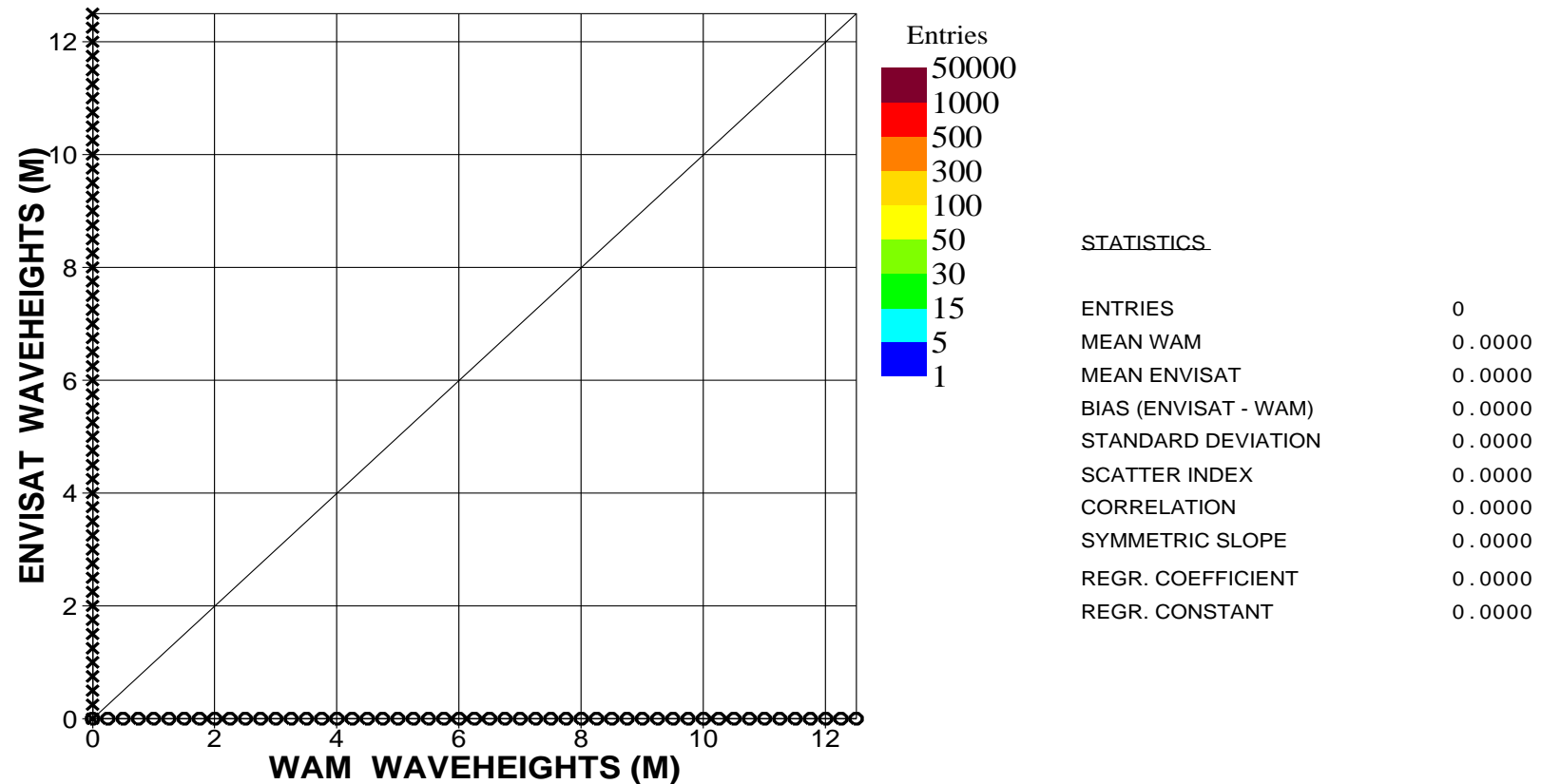


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2009 (Tropics)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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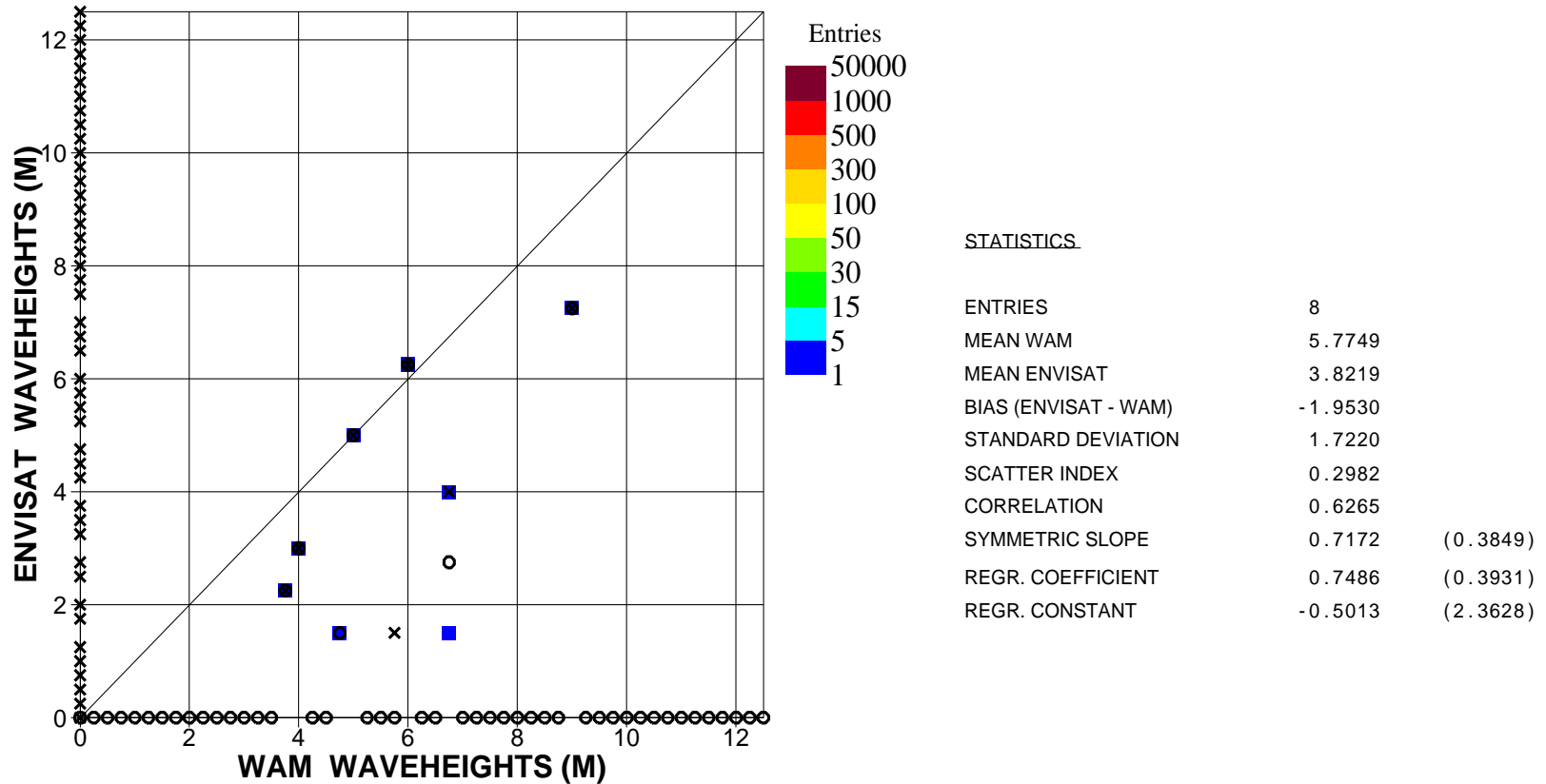


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2009 (S.Hem.)

Saleh Abdalla

European Centre for Medium Range Weather Forecasts
 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
 Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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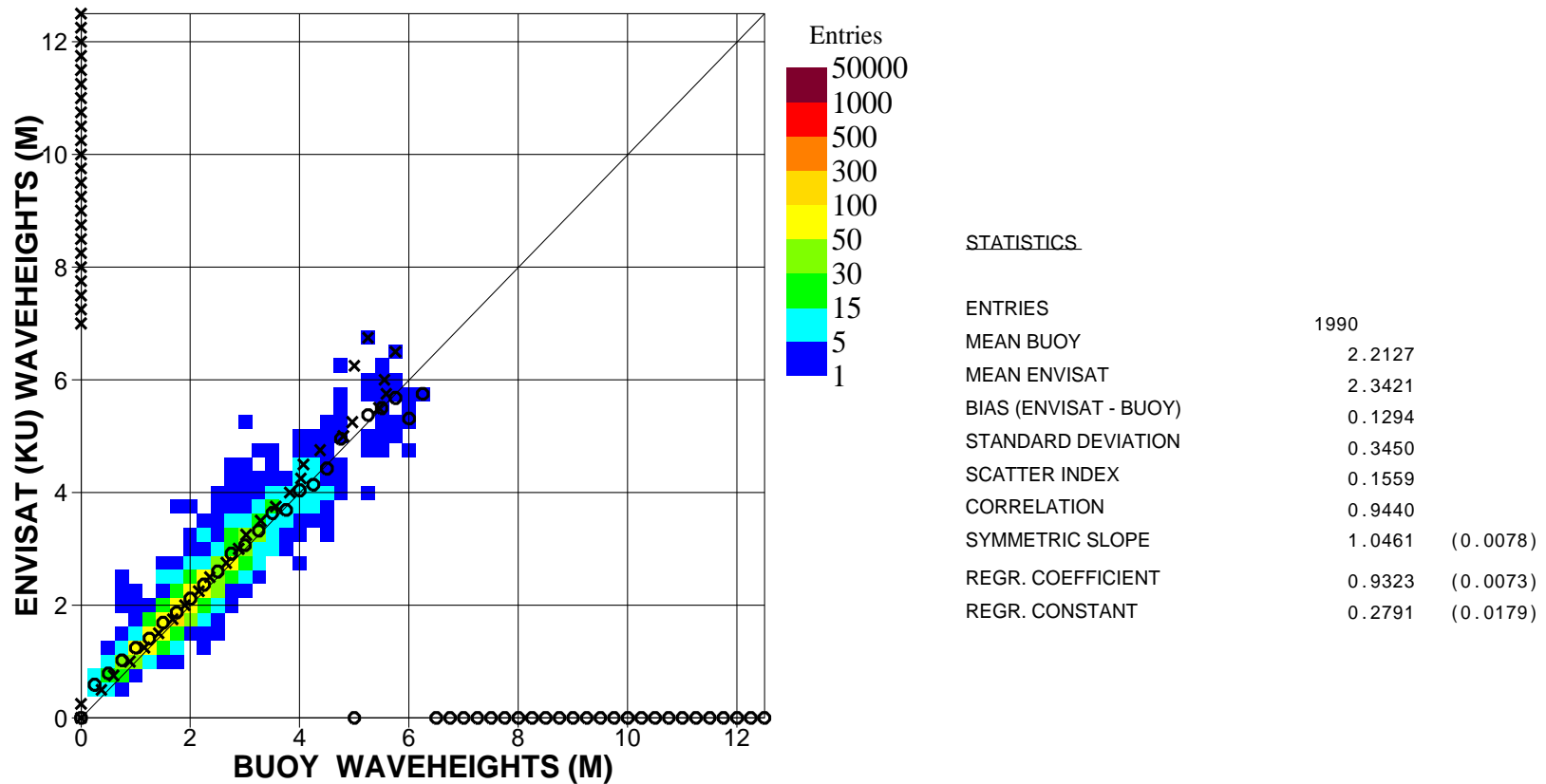


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2009 (Global)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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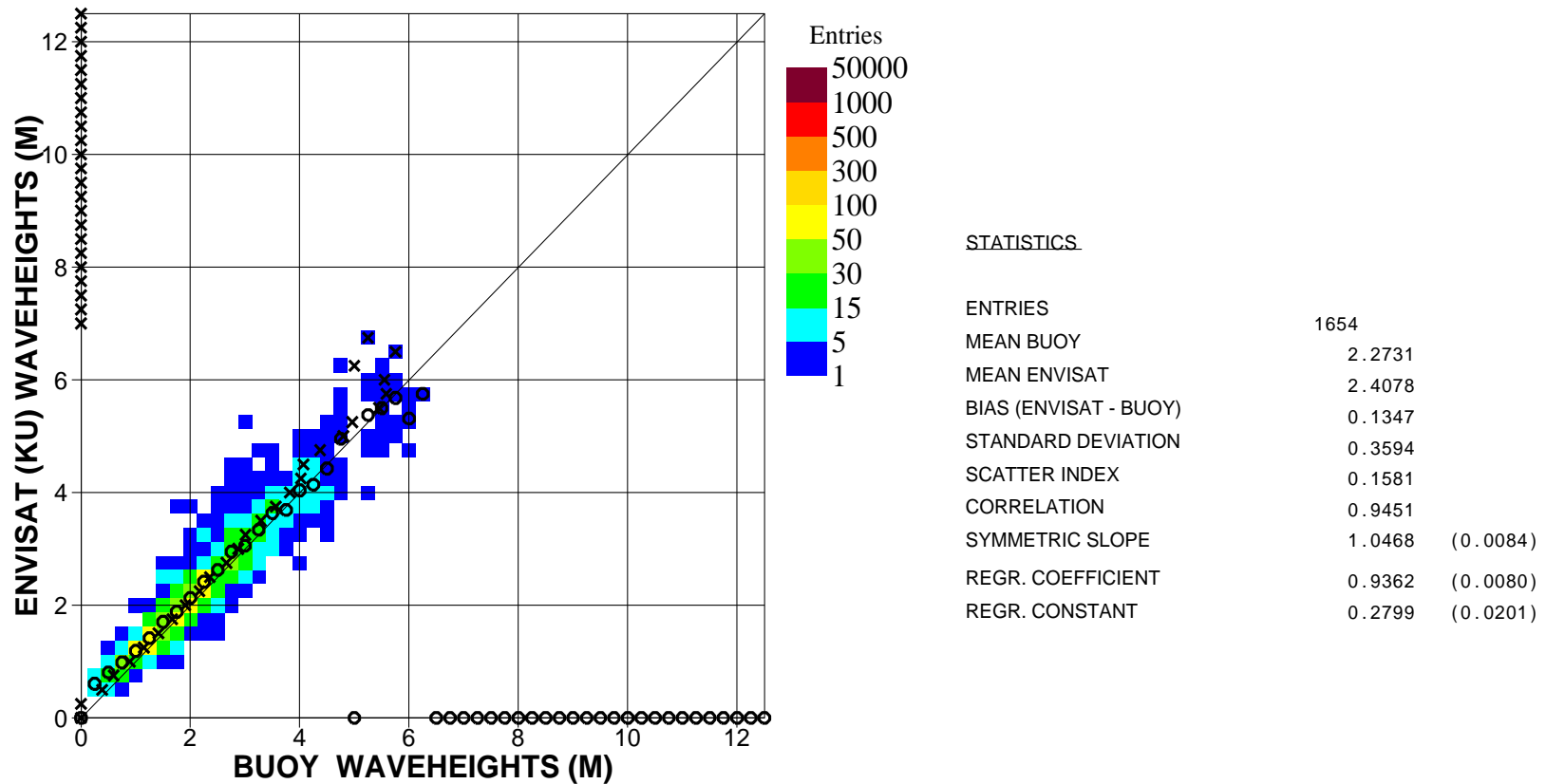


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2009 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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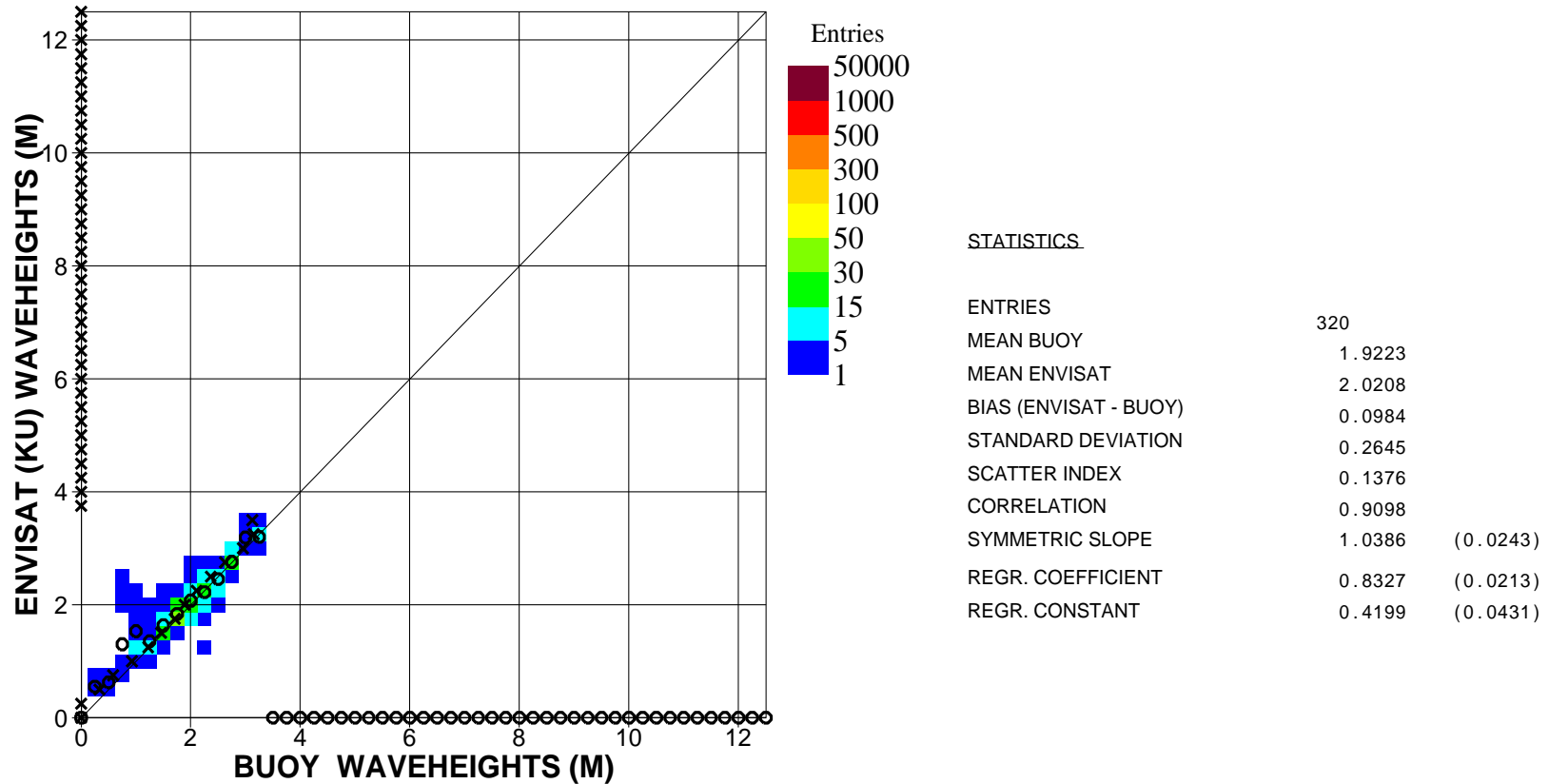


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2009 (Tropics)

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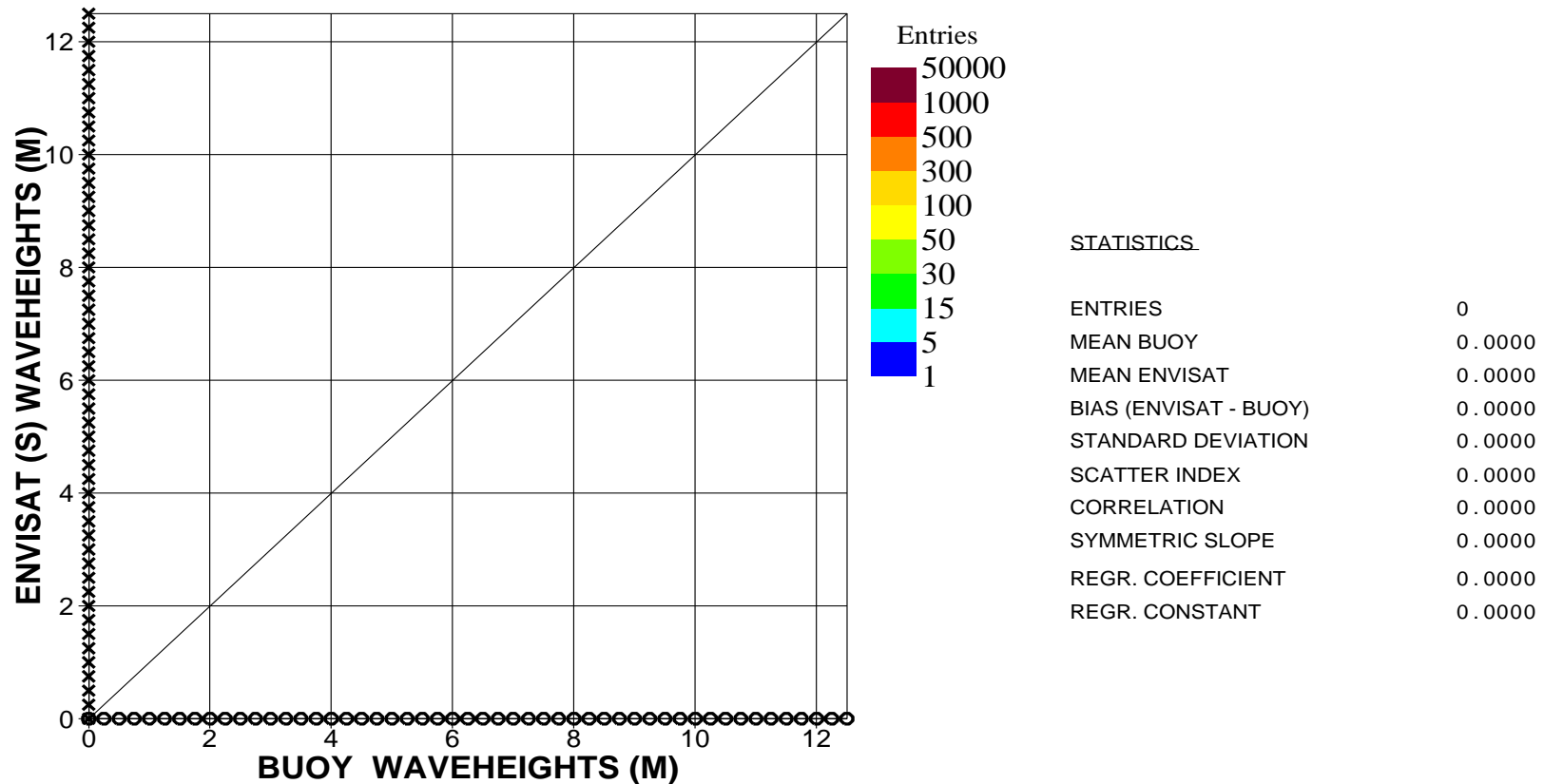


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2009 (Global)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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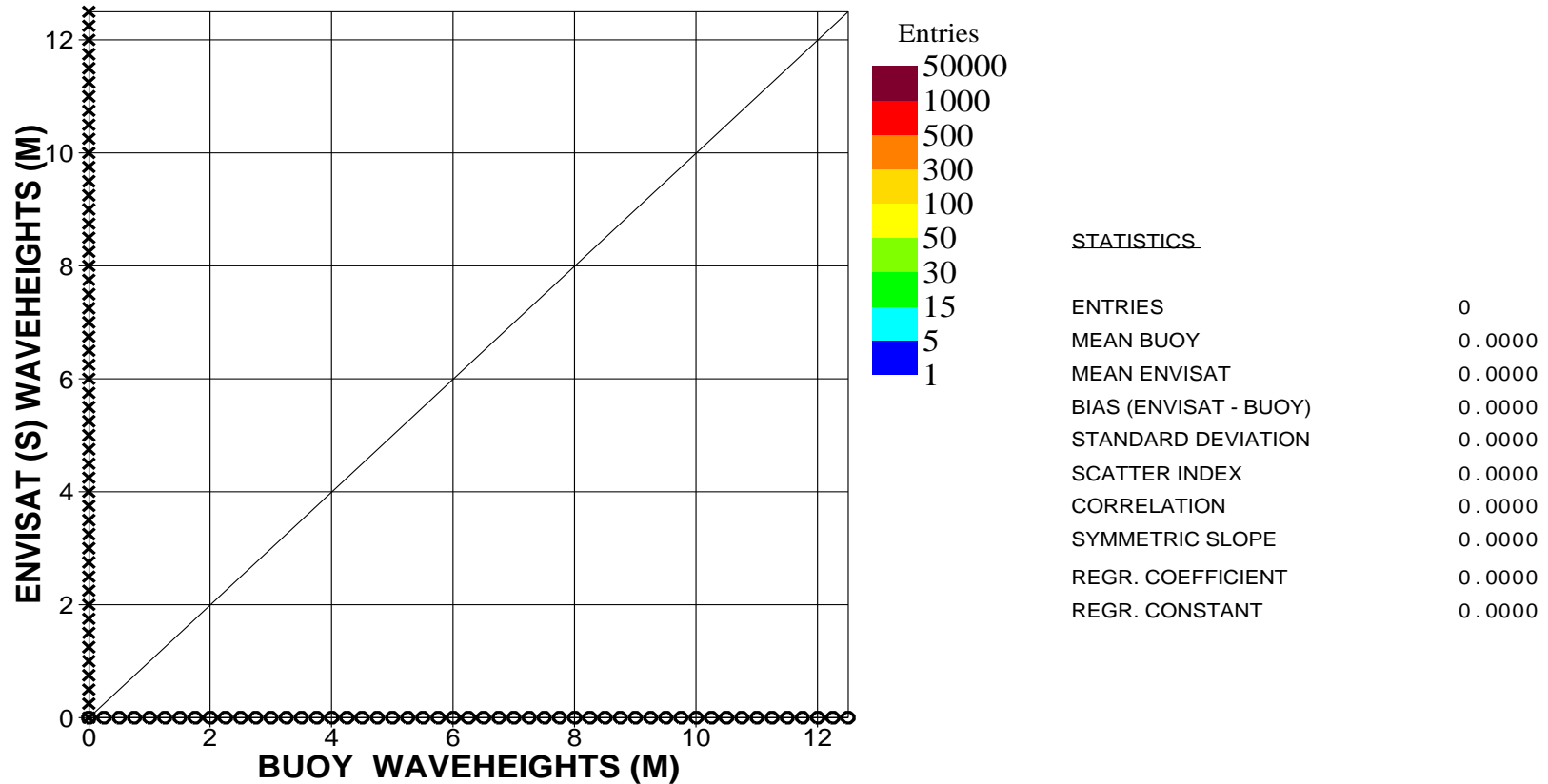


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2009 (N.Hem.)



Saleh Abdalla

European Centre for Medium Range Weather Forecasts

Shinfield Park, Reading, Berkshire RG2 9AX, England

Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703

Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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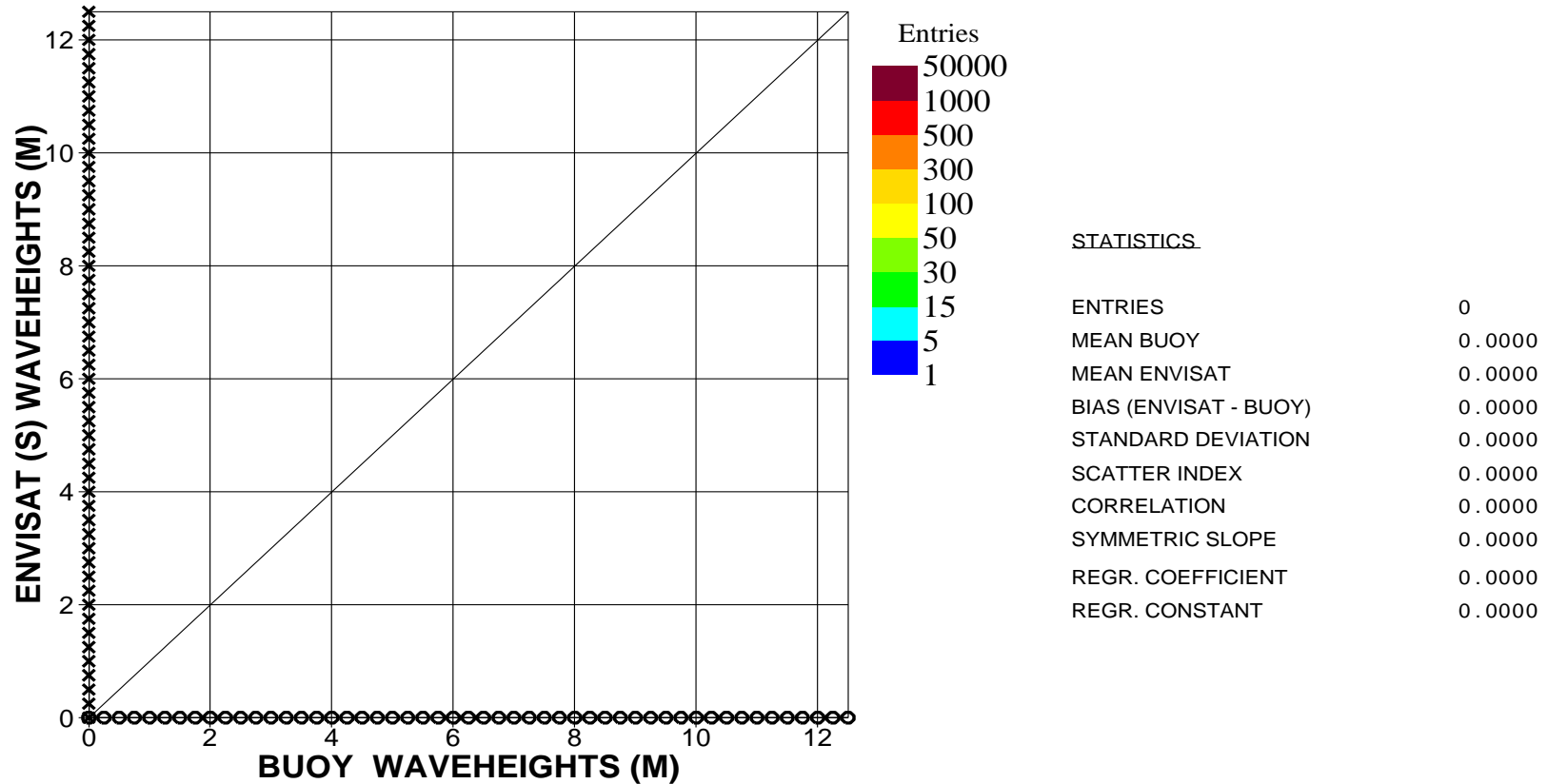


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2009 (Tropics)



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
 Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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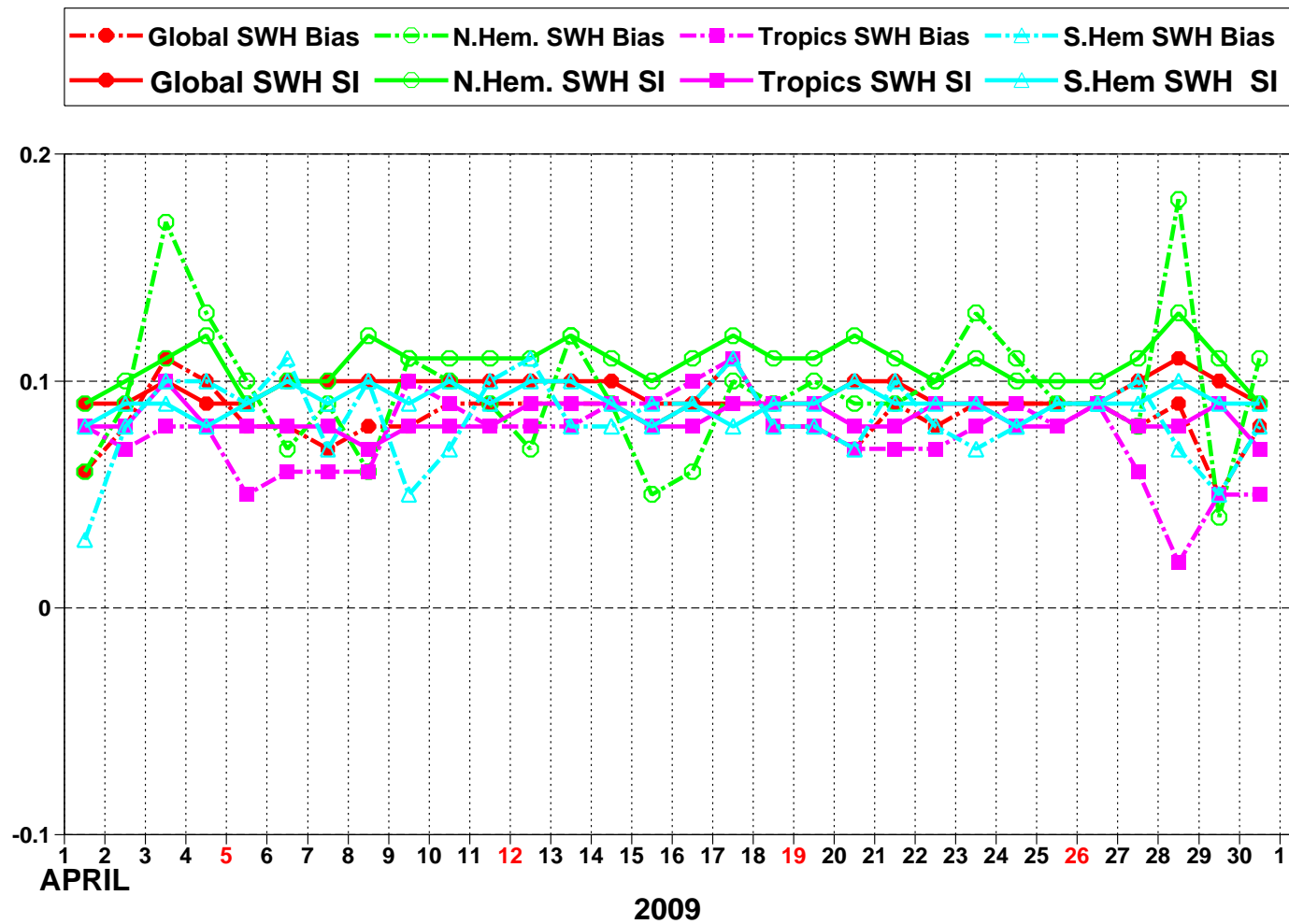


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)

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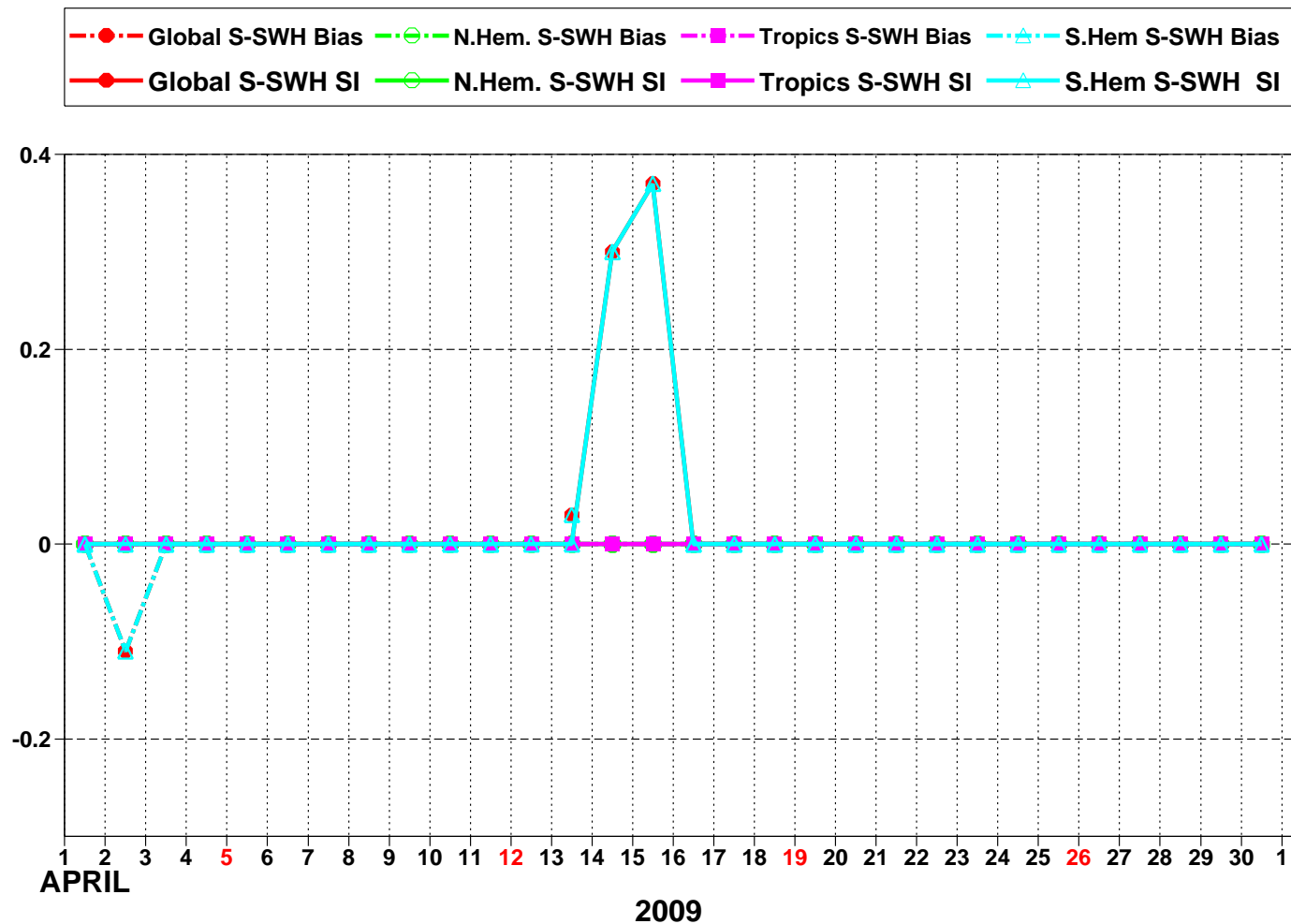


Figure 37: ENVISAT Altimeter S-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)



Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England

Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703

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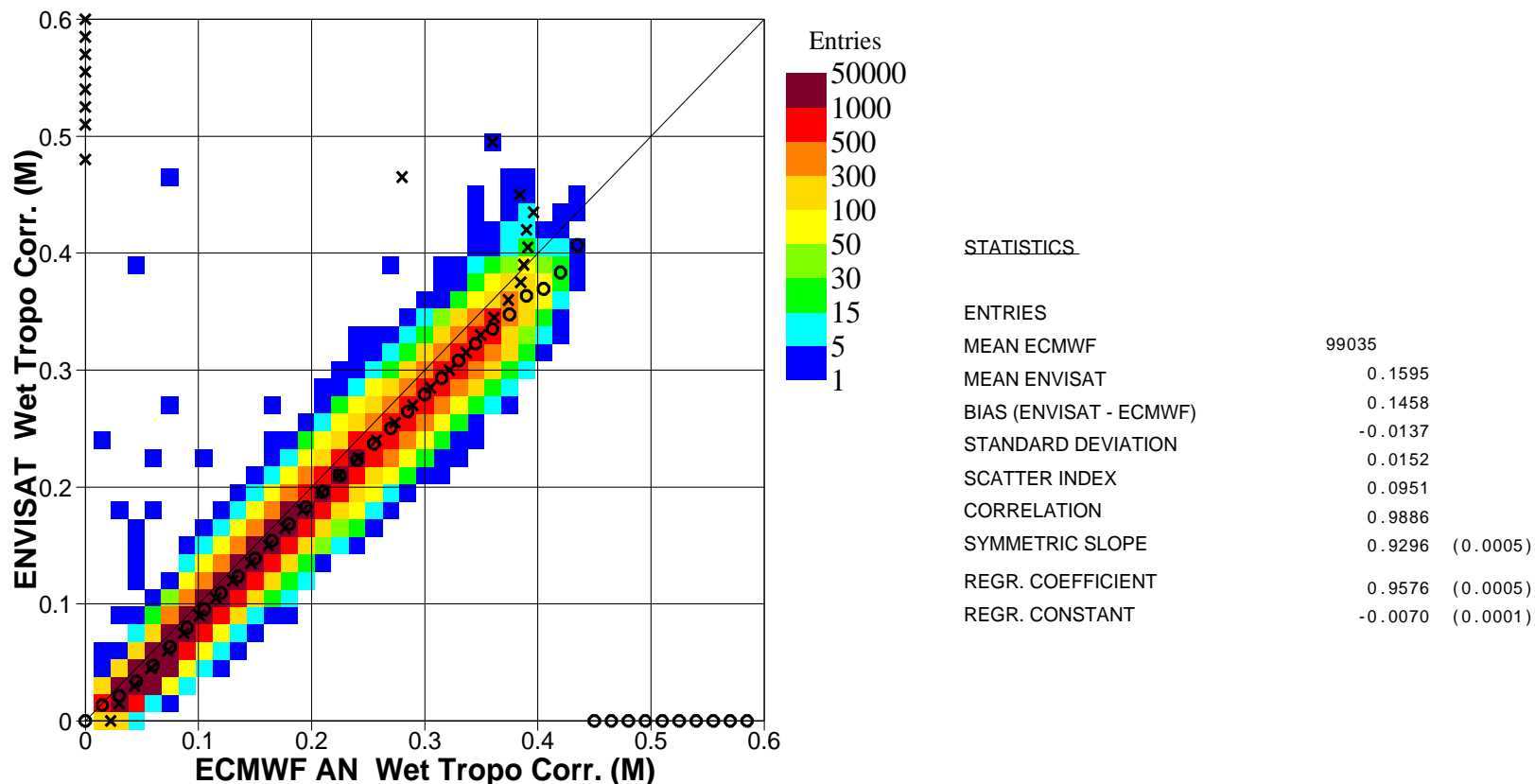


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2009 (Global)

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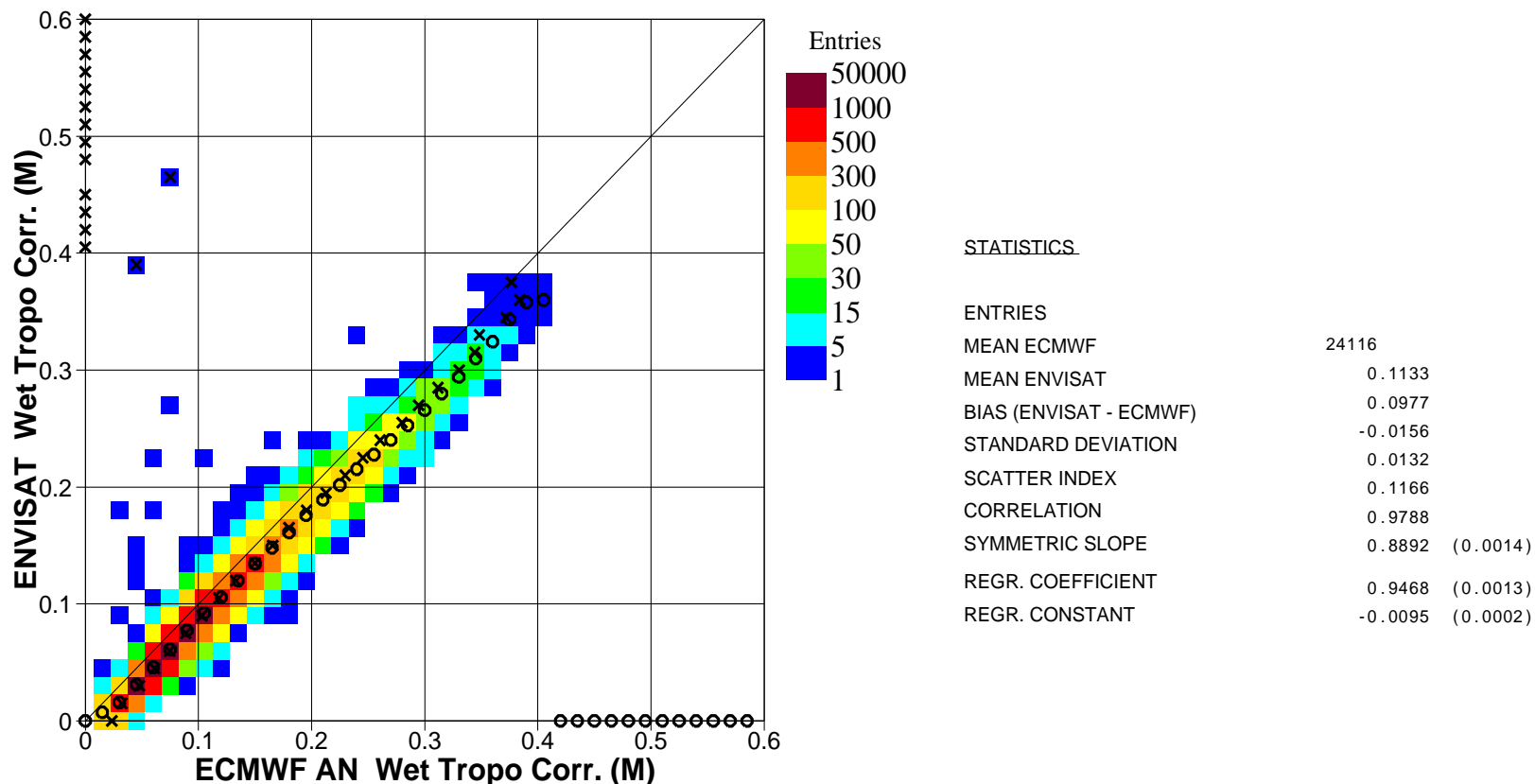


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2009 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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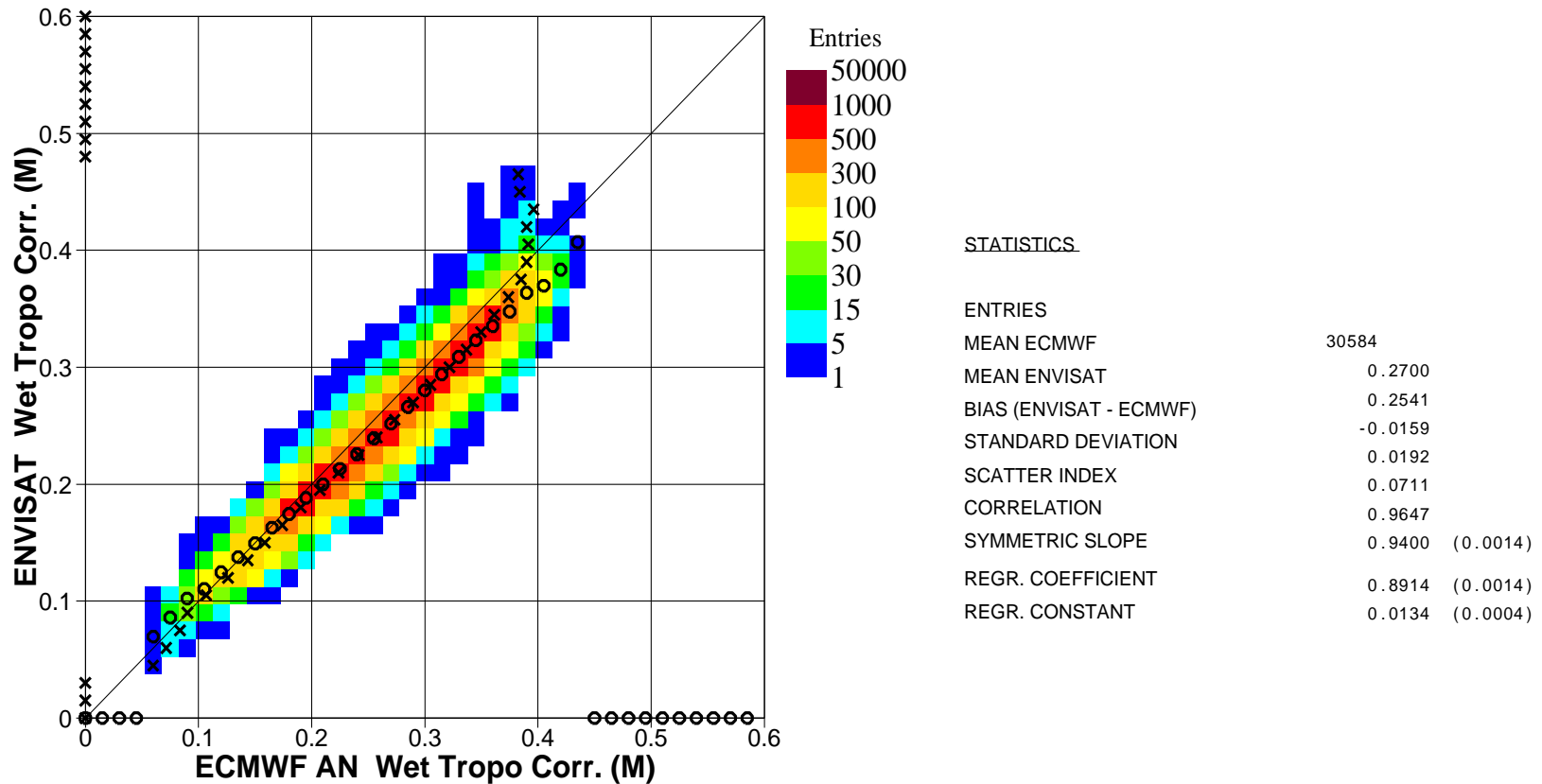


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2009 (Tropics)

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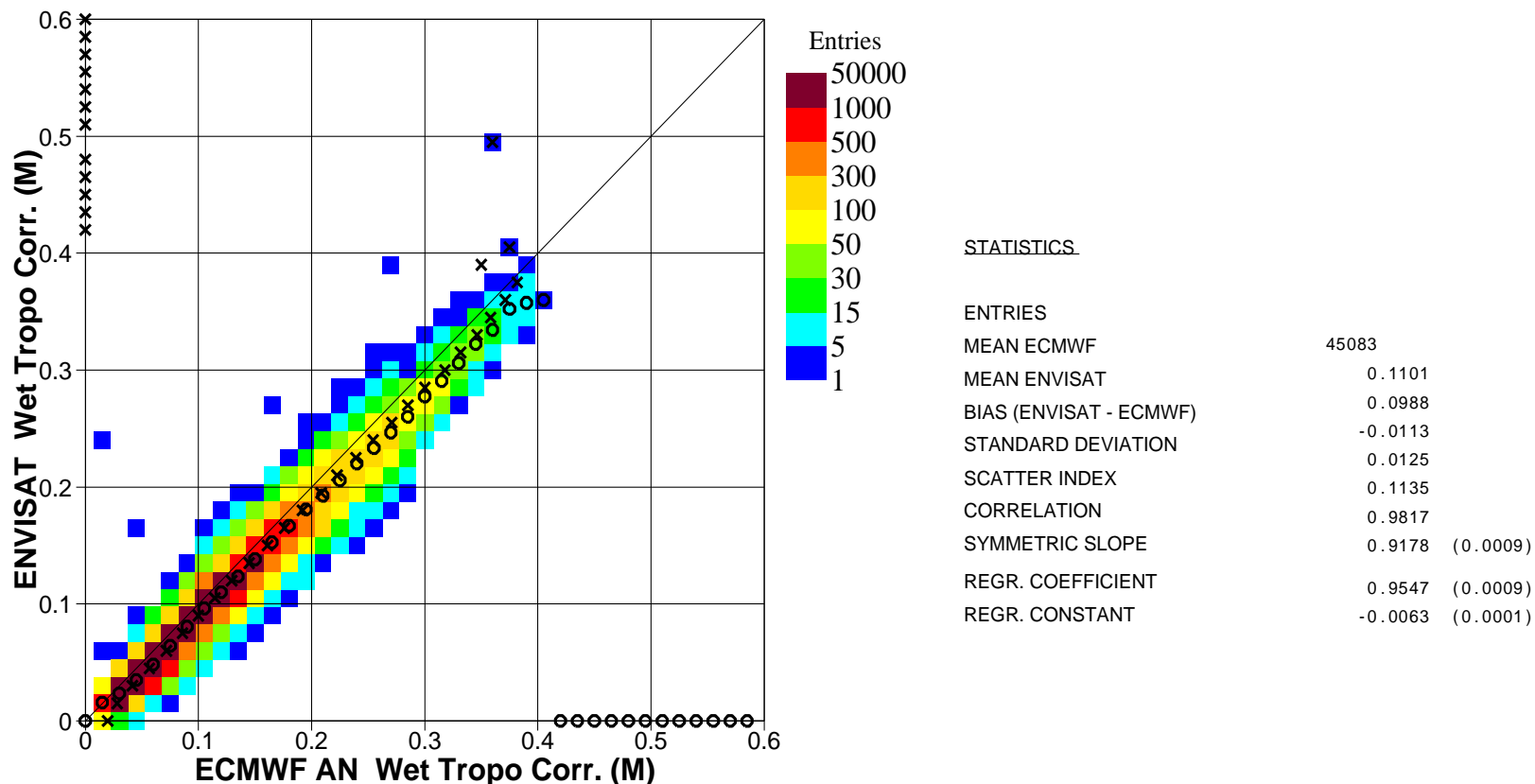


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2009 (S.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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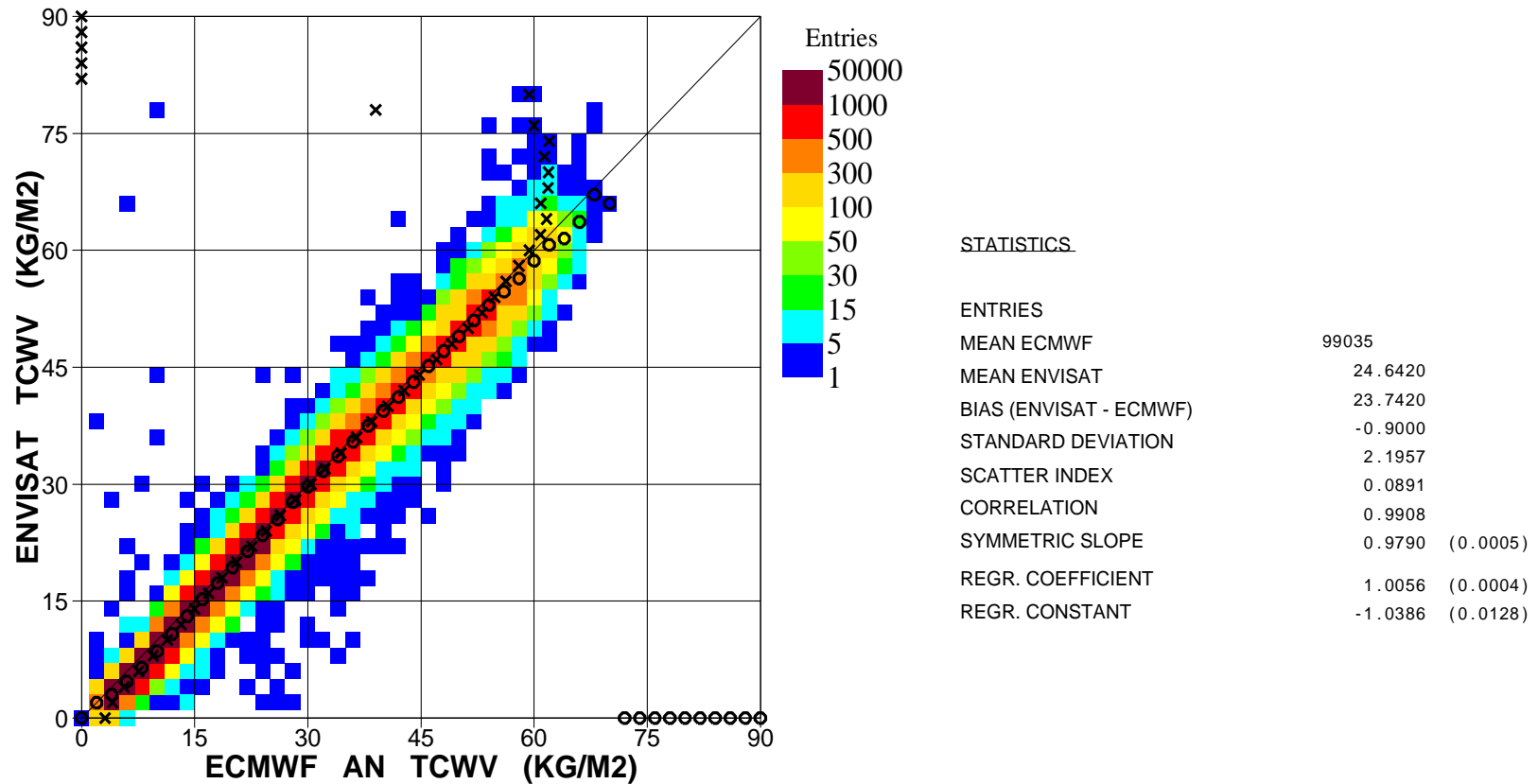


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2009 (Global)

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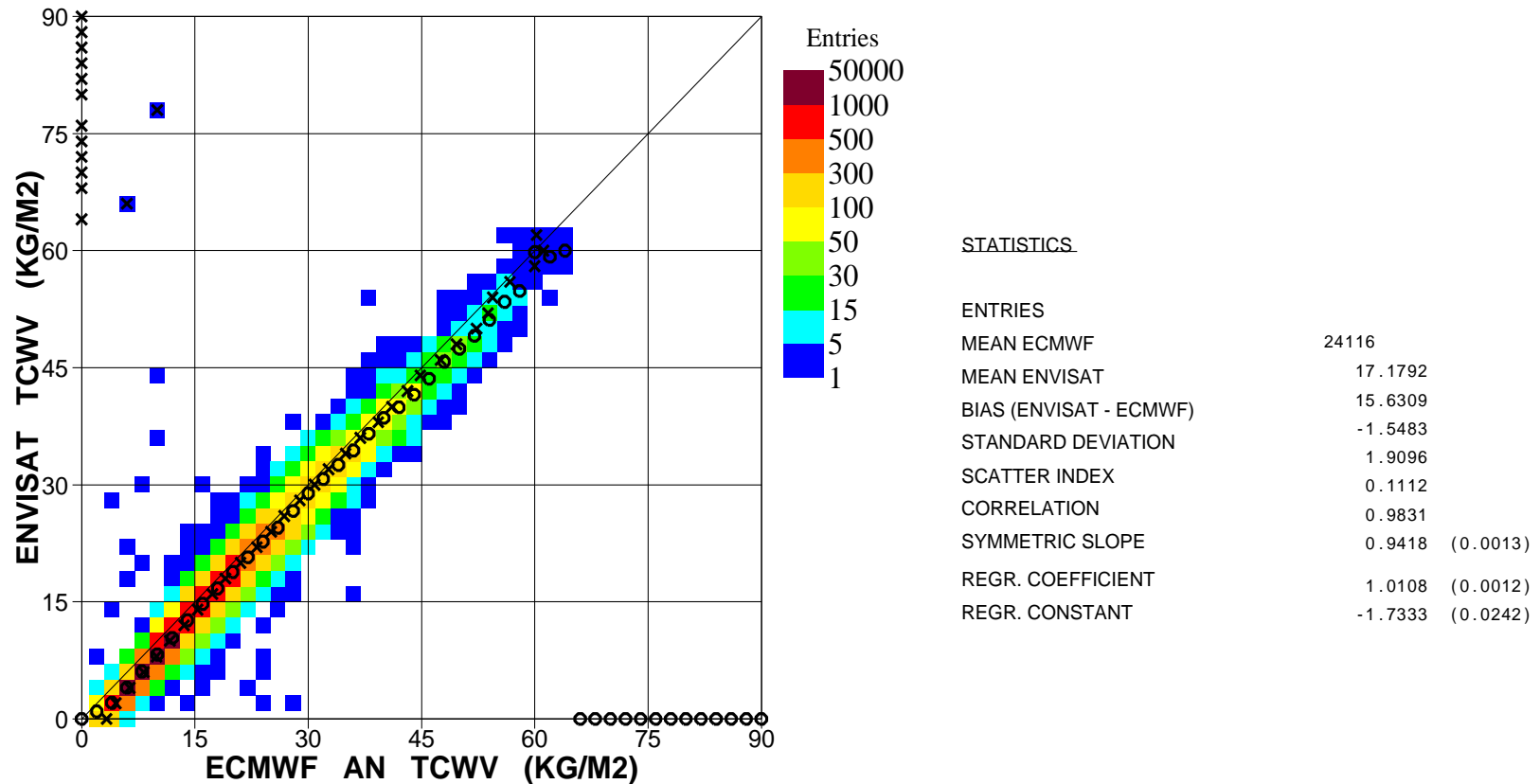


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2009 (N.Hem.)

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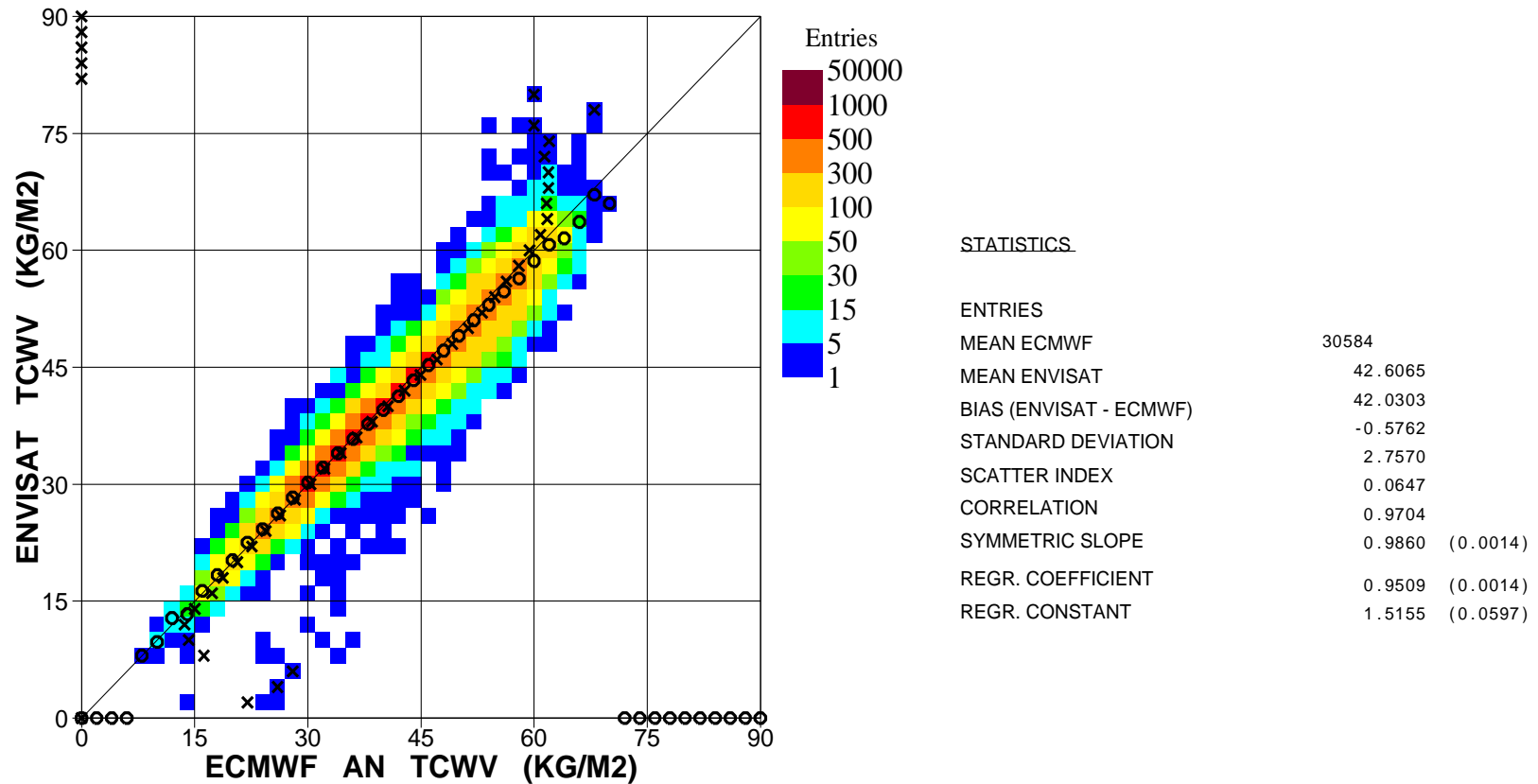


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2009 (Tropics)

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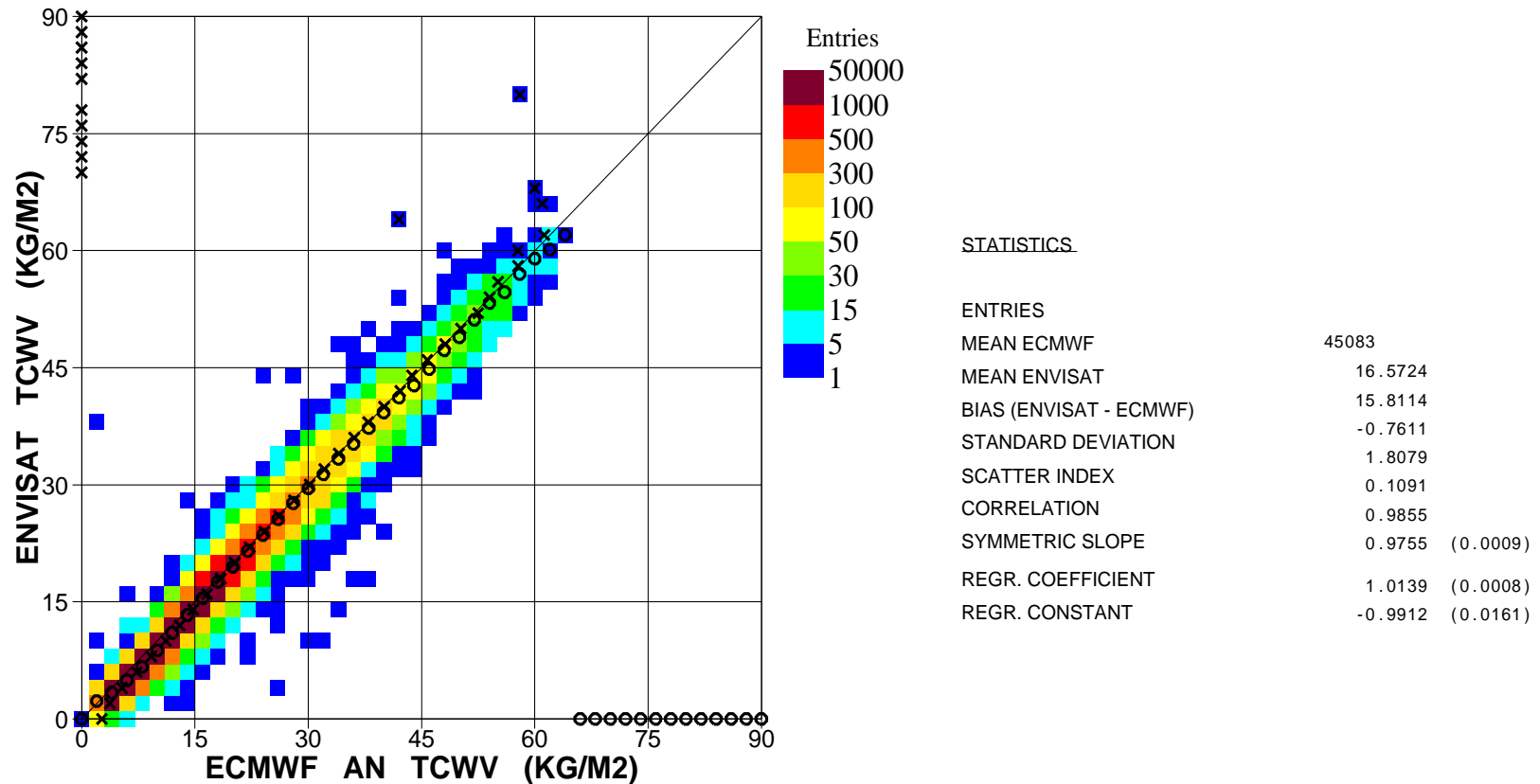


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2009 (S.Hem.)

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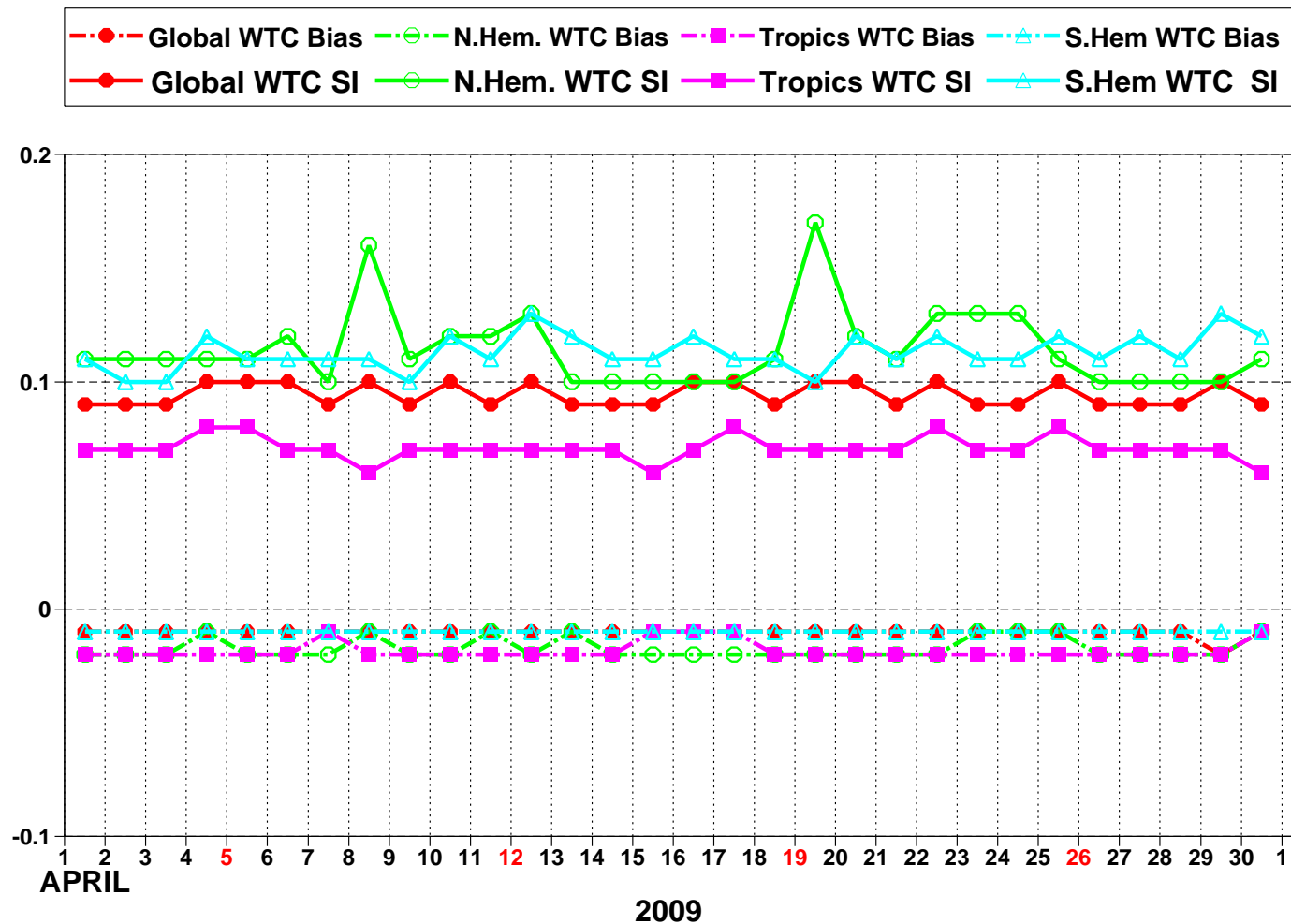


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)



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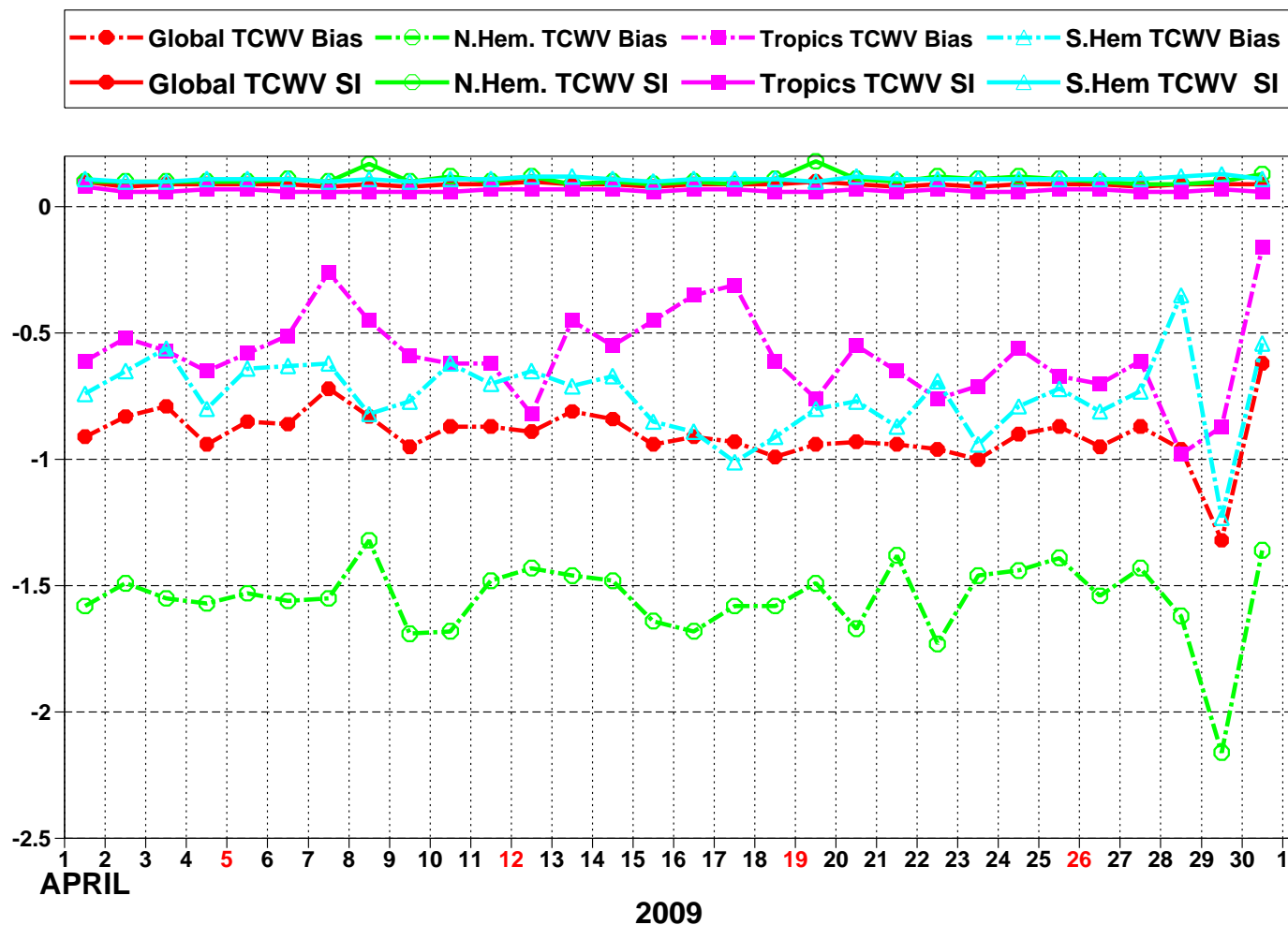


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)



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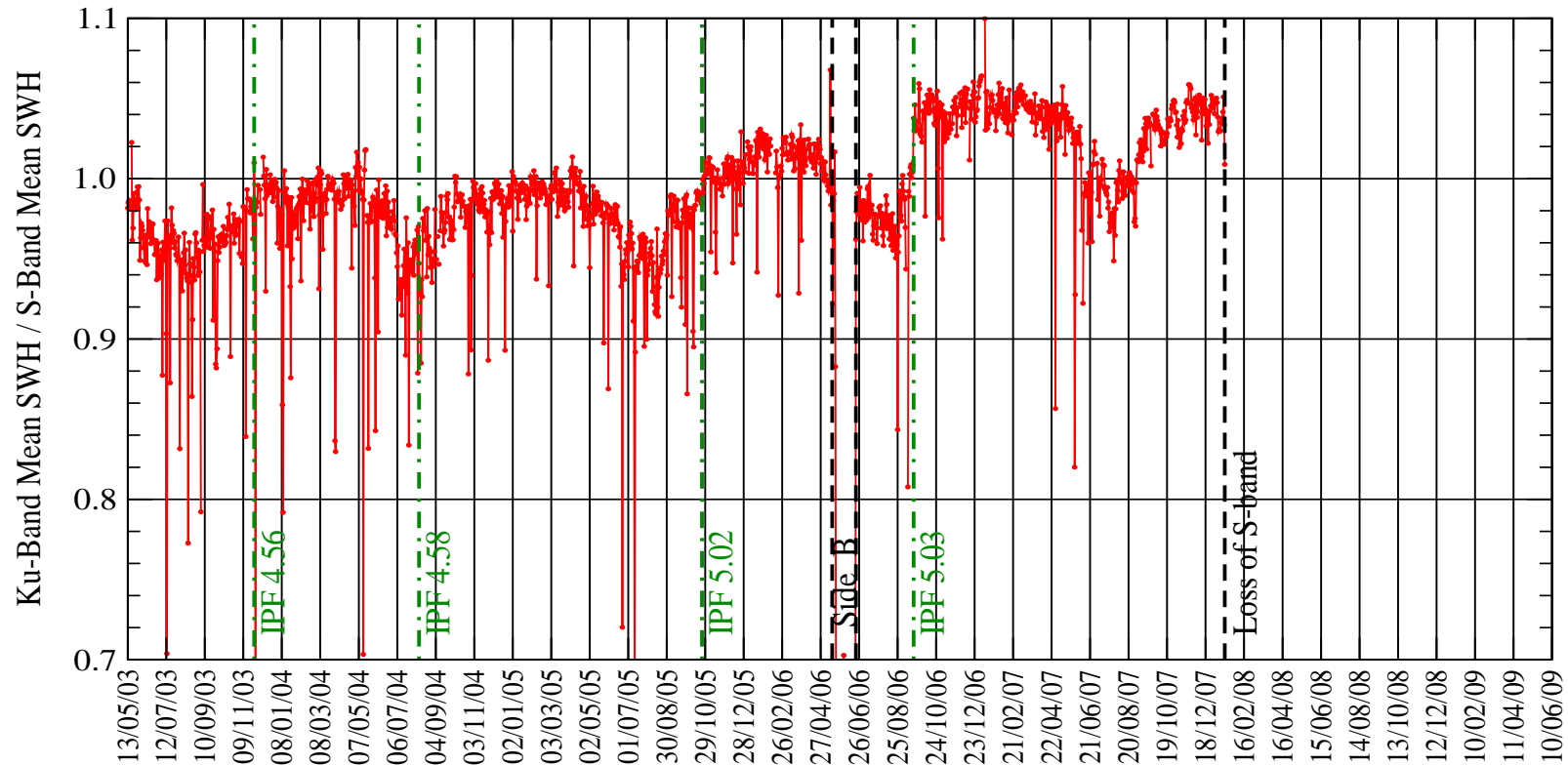


Figure 48: Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 13th. of May 2003.