

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

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

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

By: *Saleh Abdalla*

Date: *5 May 2005*

Overview:

Based on the data received during this month, on average, 15280 observations arrived at ECMWF every 6-hour window of which an average of 6174 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 80.29% of the remaining part passed the quality control. There was no data during the following periods (in terms of 6-hour time-windows; all times are in UTC) as can be seen in Figure 1:

- Time windows centred at 06:00 on the 20th. and the 23rd. of the month.
- Time windows centred at 00:00 and 06:00 on the 24th. of the month.

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

- Time window centred at 00:00 on: the 12th. and the 26th. of the month.
- Time windows centred at 06:00 on: the 3rd., the 5th., the 12th., the 13th., the 14th., the 18th., the 21st., the 22nd., the 26th., the 27th., the 28th., the 29th. and the 30th. of the month. (as well as the 1st. of May).
- Time windows centred at 12:00 on: the 21st. and the 24th. of the month.



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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- Time windows centred at 18:00 on: the 23rd., the 28th. and the 30th. of the month.

Note that we are talking about the raw data which we downloaded in “bufr” format before they were processed.

It is worthwhile mentioning that most of the data gaps during the day (especially at time window 06:00 UTC) are due to the unavailability of the ftp server at Kiruna. Sometimes the server is unavailable for extended periods that the “delay cut-off” operational suite is not able to receive the data in time for processing.

Quality of Received Data:

For the period covered, the RA-2 Ku-band wave height data are generally of good quality. The S-band wave height observations show a small number of outliers. The quality of wind speed observations is good. Apart from a number of outliers (which seem to be due ice contamination and should be rejected), the MWR products are generally fine and in good agreement with the model (wet tropo correction is somewhat smaller than the model).

Backscatter:

- ENVISAT RA-2 Ku-Band $\langle\sigma_0\rangle = 10.96$ dB (with two main peaks at 10.9 dB and the usual 11.1 dB with a tendency to have several secondary peaks especially at 10.6 dB, 10.1 dB and 11.3 dB).
- ENVISAT RA-2 S-Band $\langle\sigma_0\rangle = 11.21$ dB (with a single main peak at ~ 10.6 dB with a tendency to have several secondary peaks especially at 10.1 dB, 10.4 dB and 10.8 dB).



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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Comparison Summary:

Table 1: Comparison of Surface Wind Speeds:

	RA2 - ECMWF		RA2 - Buoy	
	Bias (m/s)	SI (%)	Bias (m/s)	SI (%)
Global	- 0.09	16.6	- 0.38	19.2
Northern Hemisphere	- 0.22	17.8	- 0.35	19.7
Tropics	- 0.37	17.1	- 0.72	12.8
Southern Hemisphere	+0.16	15.1	----	----

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

	RA2 (Ku) - WAM		RA2 (Ku) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.12	11.0	0.11	14.9
Northern Hemisphere	0.14	12.3	0.12	15.2
Tropics	0.08	10.5	0.05	10.3
Southern Hemisphere	0.13	10.2	----	----

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

	RA2 (S) - WAM		RA2 (S) - Buoy	
	Bias (m)	SI (%)	Bias (m)	SI (%)
Global	0.05	17.6	0.07	22.4
Northern Hemisphere	0.12	17.7	0.08	23.0
Tropics	0.12	21.4	- 0.03	12.5
Southern Hemisphere	-0.03	15.5	----	----

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	- 0.012	14.5	- 0.46	15.6
Northern Hemisphere	- 0.011	29.7	- 0.80	31.5
Tropics	- 0.010	6.4	+ 0.82	6.6
Southern Hemisphere	- 0.014	18.3	- 1.14	19.7

■
Saleh Abdalla

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

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Remarks:

- The ECMWF models changed on the 5th. of April 2005. A new treatment of wave breaking source function in the wave model was introduced (current operational cycle is CY29R1). This change is expected to have positive impact on wave predictions.
- **It is worthwhile mentioning that most of the data gaps during the day are due to unavailability of the ftp server at Kiruna.**
- According to the used land sea mask (which is used for the operational WAM run at ECMWF), about one third of all processed data have been collected over land. This value is too large and is caused by not filtering the land records.
- The rain flag is only responsible for the rejection of 5% of the data this month. There was one major event of over-active rain flagging on the 7th. of the month (lower panel of Figure 1).
- The wind speed data are in good agreement with the wave model and buoy data except for very low wind speeds (below ~ 4 m/s) and for high wind speeds (20 m/s and above), as usual.
- The wind speed algorithm needs some adjustments both in the low wind regime (below ~ 4 m/s) and more importantly for the very high wind regime (20 m/s and above) as can be concluded from the scatter plots in Figures 7-13 and from comparing the histograms in Figures 5 and 6. Furthermore, the wind speed histogram of Figure 4 indicates that wind speeds around and below 1 m/s may not be optimal.
- There is a trend for Ku-band wave heights to be slightly overestimated by about 5% when compared to WAM results. This is visually clear in the scatter plots in Figures 22-25 (Ku-band - WAM comparisons) and can be inferred from the symmetric slope values in same scatter plots. On the other hand, the RA-2 Ku-band wave heights are about 3% higher than buoy wave heights as can be seen in Figures 30-32 (Ku-band - buoy comparison).
- The bulk of S-band wave heights are in good agreement with both the WAM and the buoy data apart from a number of outliers (due to the well-known *RA-2 S-band anomaly*) when compared with the model (as can be seen in the scatter plots in Figures 26-29) and to less extent with the buoys (as can be seen in the scatter plots in Figures 33-34). Most of



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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those outliers occurred on the 7th. of the month (Figure 37) coinciding with the significant over-active rain flagging events.

- The ratio between Ku-band and S-band wave heights varied this month between ~ 0.98 to ~ 1.00 with a dip coinciding with the extreme RA-2 S-band anomaly events as can be seen in Figure 48. Furthermore, there is a tendency for the ratio to get smaller since the beginning of April.
- 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). It seems that these outliers are due to sea-ice contamination. This issue will be treated soon.
- While the MWR derived TCWV is now in good agreement with the model counterpart (MWR TCWV is slightly smaller than the model), the MWR WTC is still consistently smaller (drier) than the model values.
- It is important to stress that one needs to keep in mind when making the comparison between the results presented here for the ENVISAT RA-2 and the results presented in the ERS-2 altimeter reports that the ERS-2 plots and statistics are done for super-observations composed of 30 individual observation, while the plots and statistics here are for super-observations with 11 individual observations. Therefore, it is natural for the RA-2 plots and statistics to show a bit more variability.
- ENVISAT RA-2 Ku-band wave height data and ERS-2 SAR wave data are assimilated in the ECMWF wave model.
- 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 represents the histogram for the covered area only.

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Saleh Abdalla

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Saleh Abdalla

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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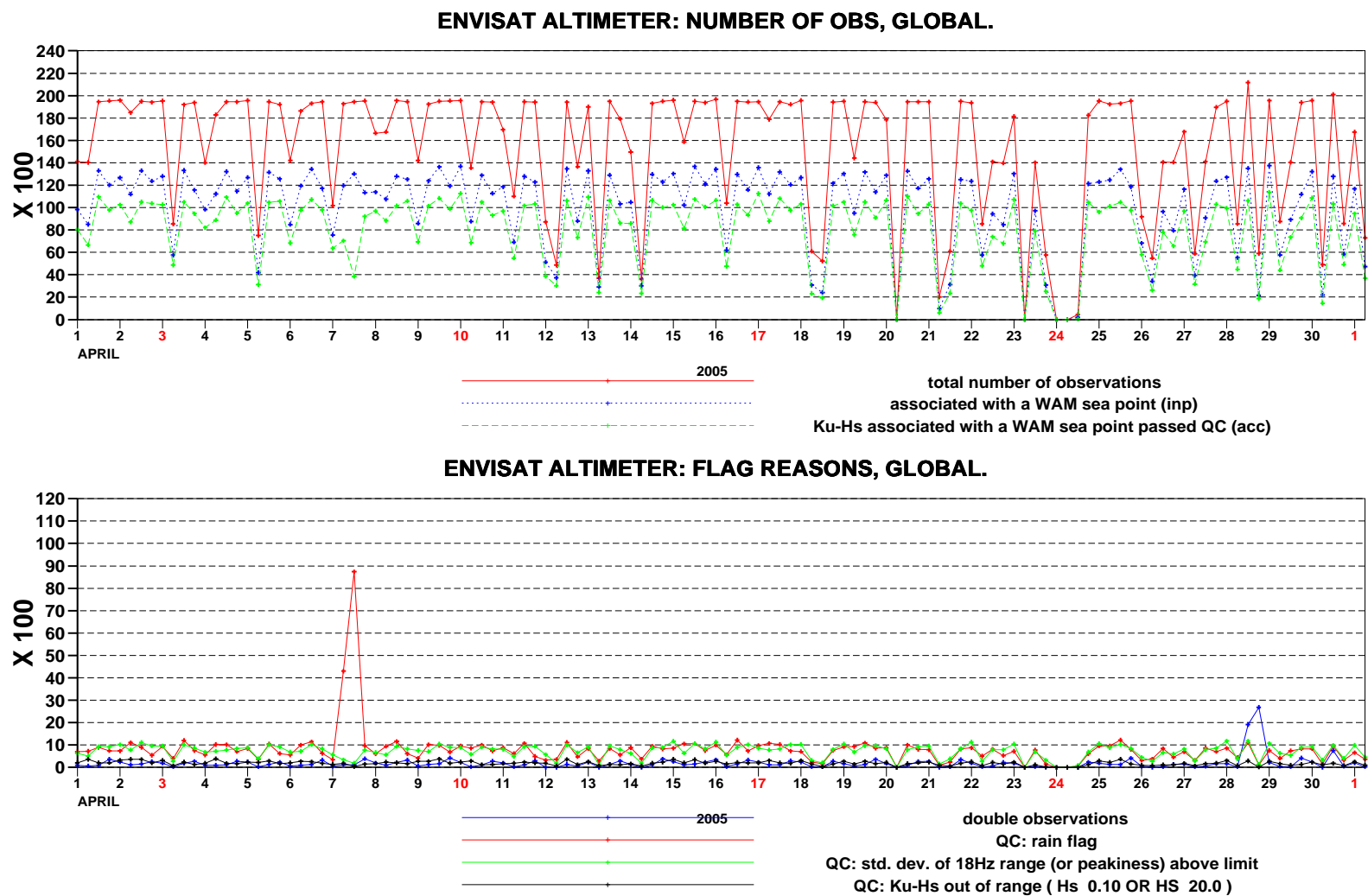


Figure 1: Time series of data reception for ENVISAT Altimeter data for April 2005

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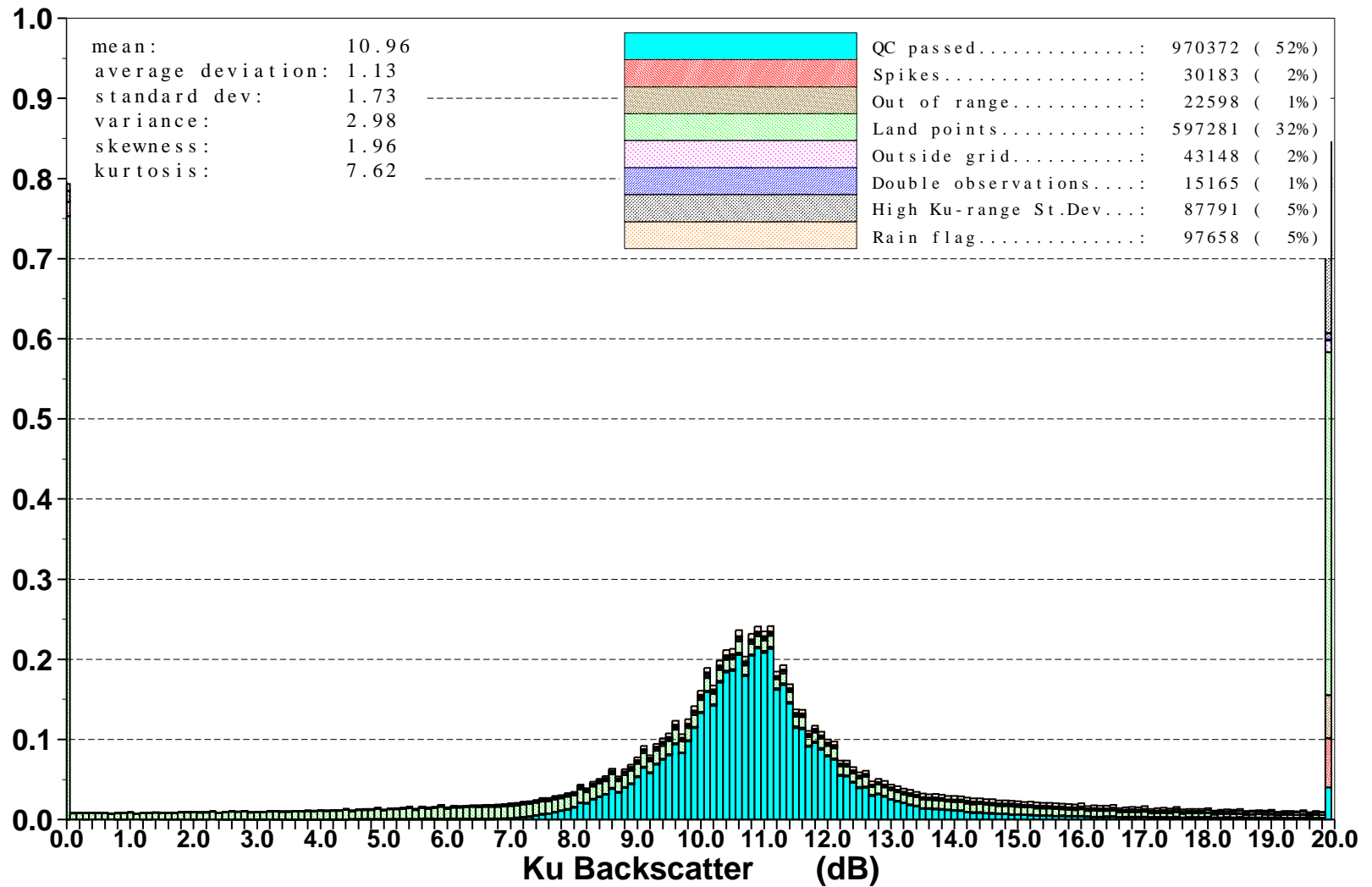


Figure 2: Distribution of the ENVISAT Altimeter Ku Backscatter after QC for April 2005

■
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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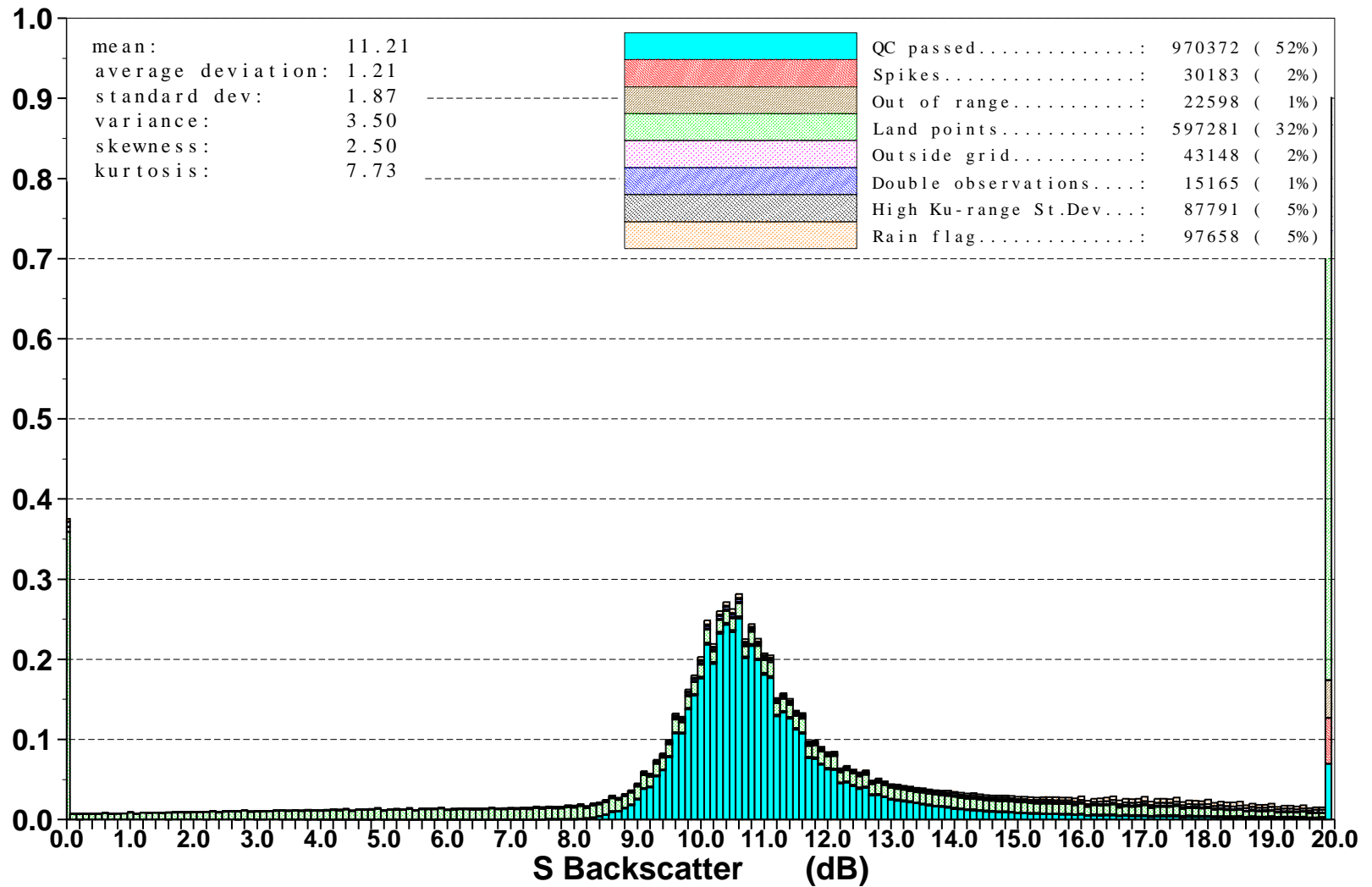


Figure 3: Distribution of the ENVISAT Altimeter S Backscatter after QC for April 2005



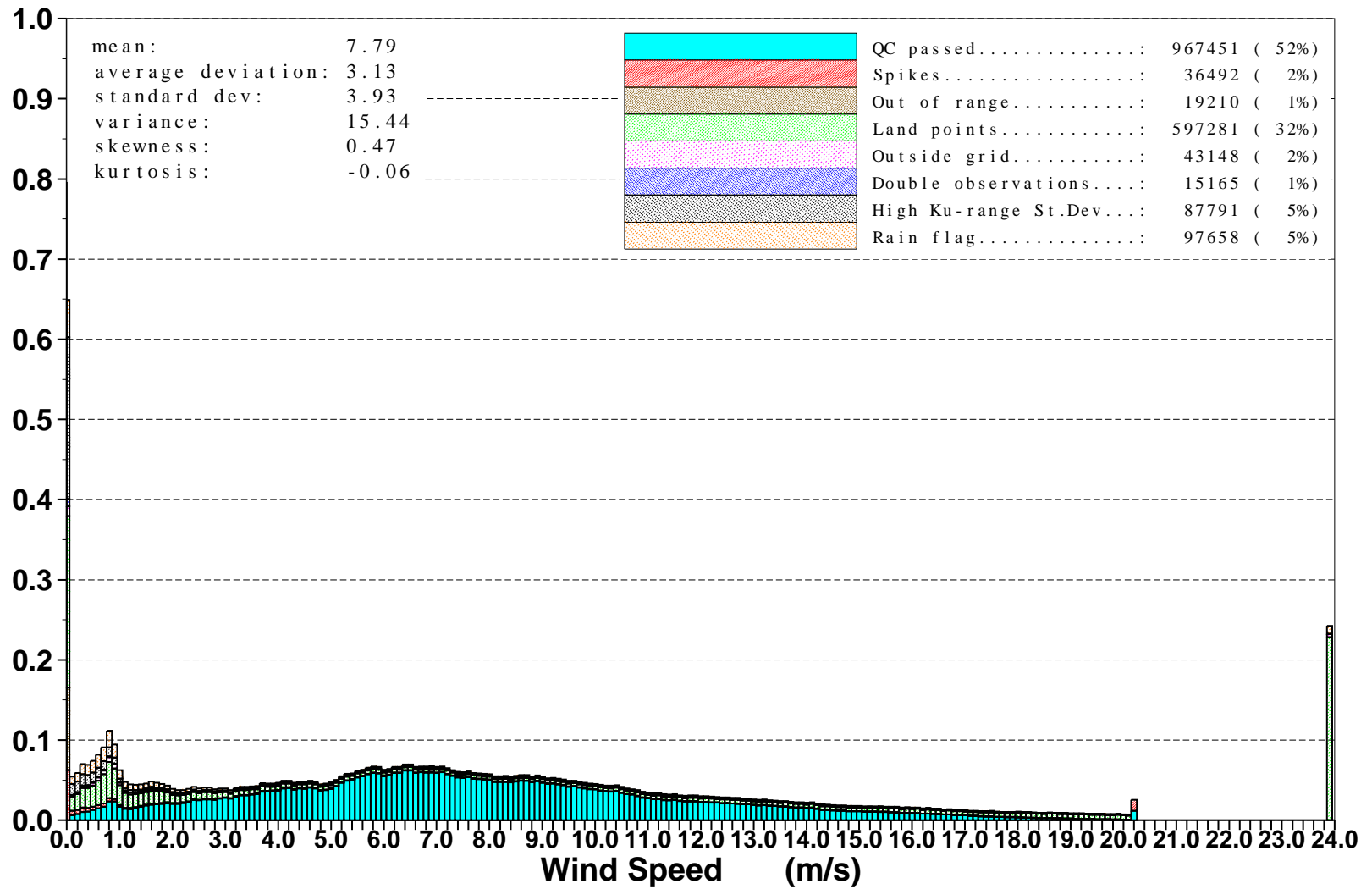
Saleh Abdalla

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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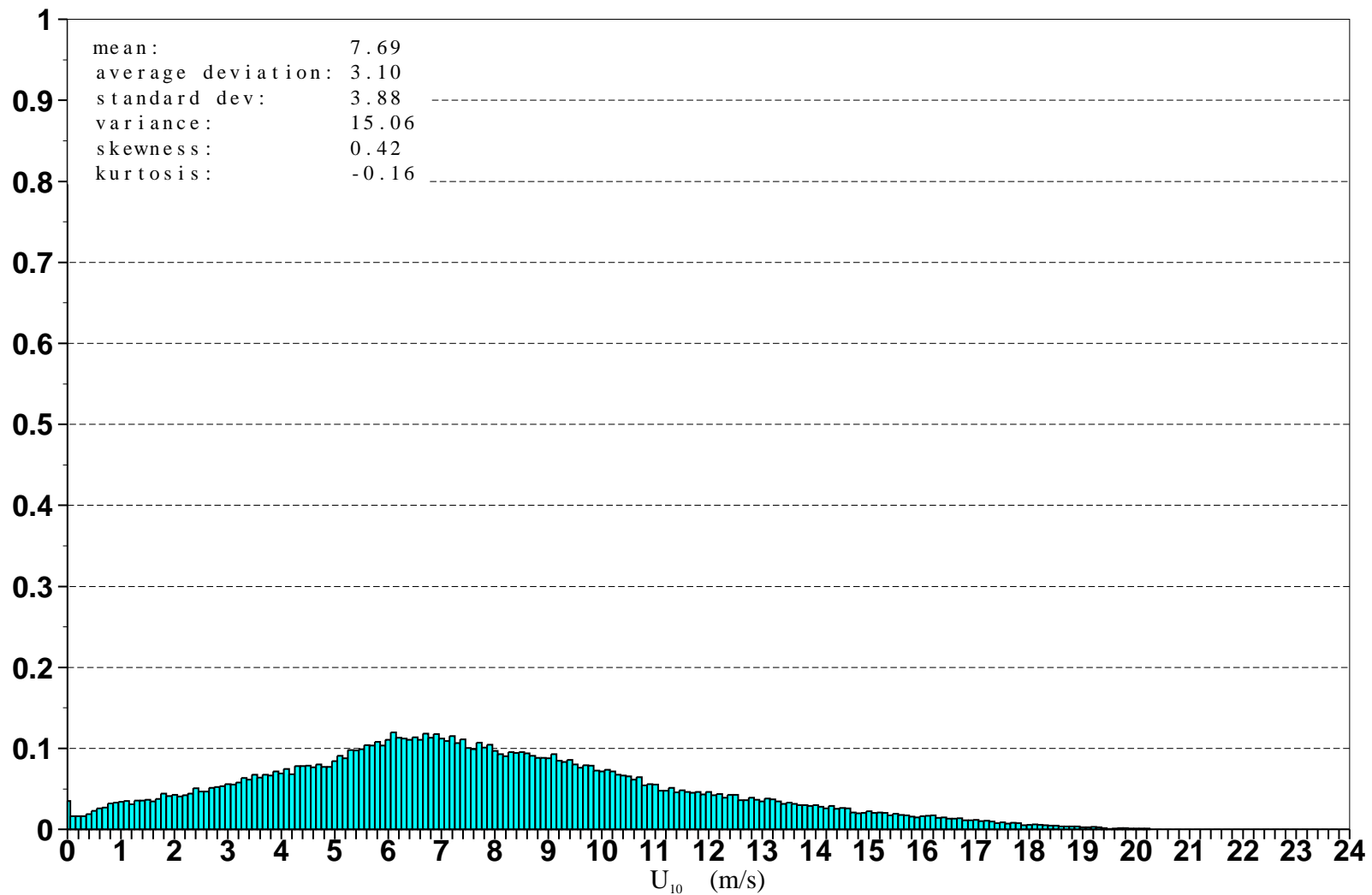


Figure 5: Distribution of ENVISAT Altimeter Wind Speeds after Along-Track Averaging for April 2005



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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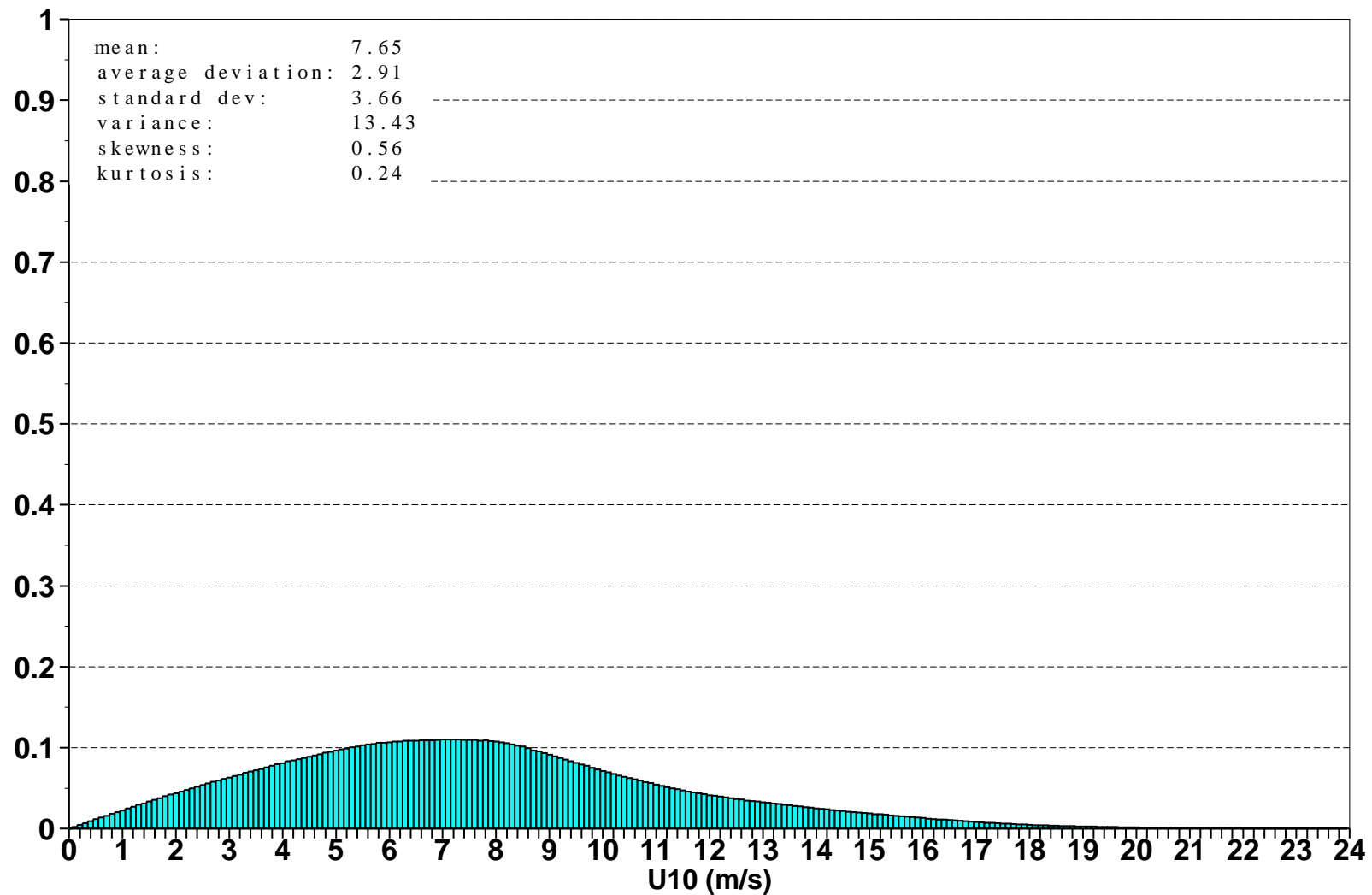


Figure 6: Global distribution of ECMWF Analysis ocean surface wind speeds for April 2005



Saleh Abdalla

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

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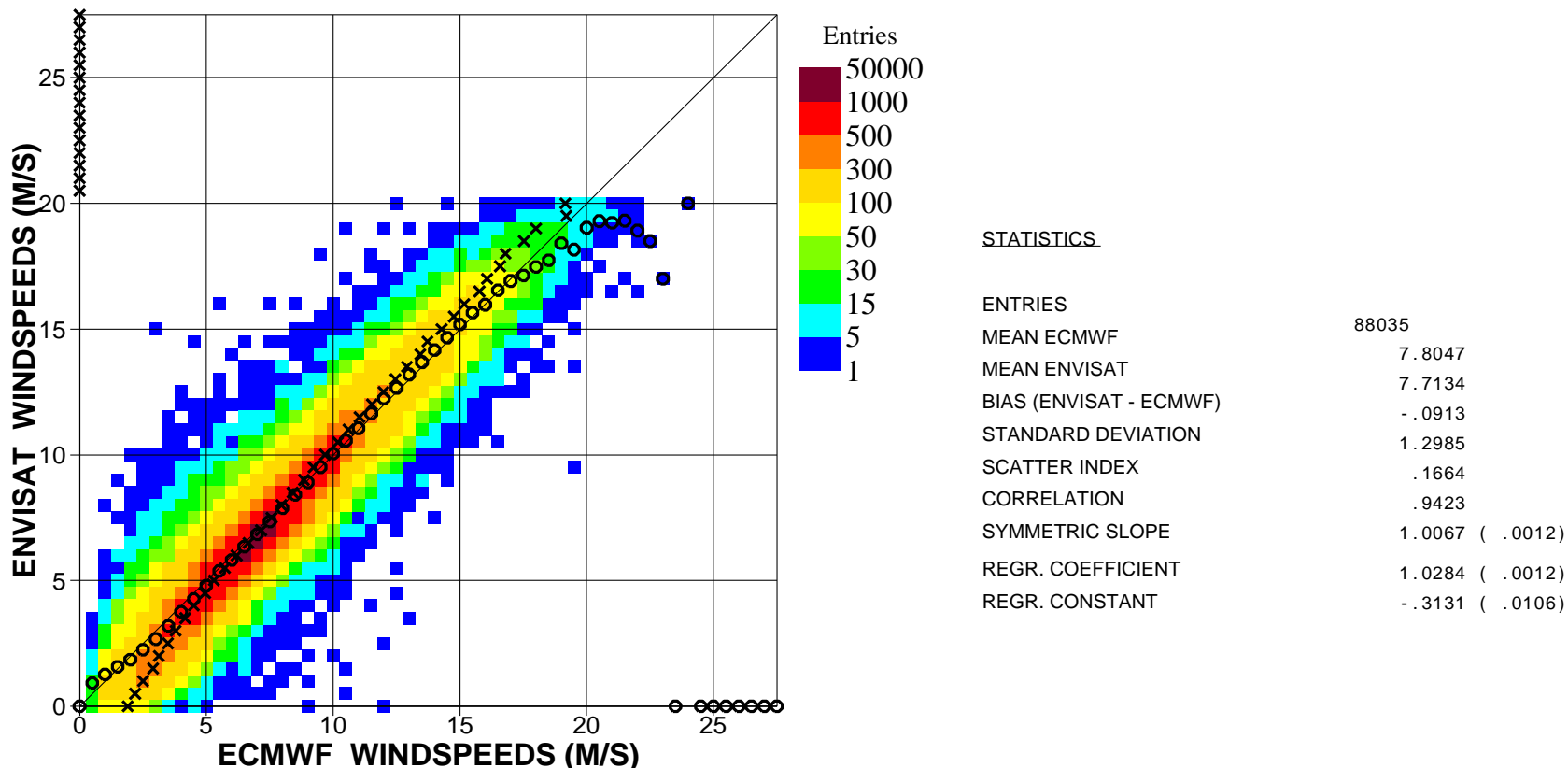


Figure 7. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2005 (Global)

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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
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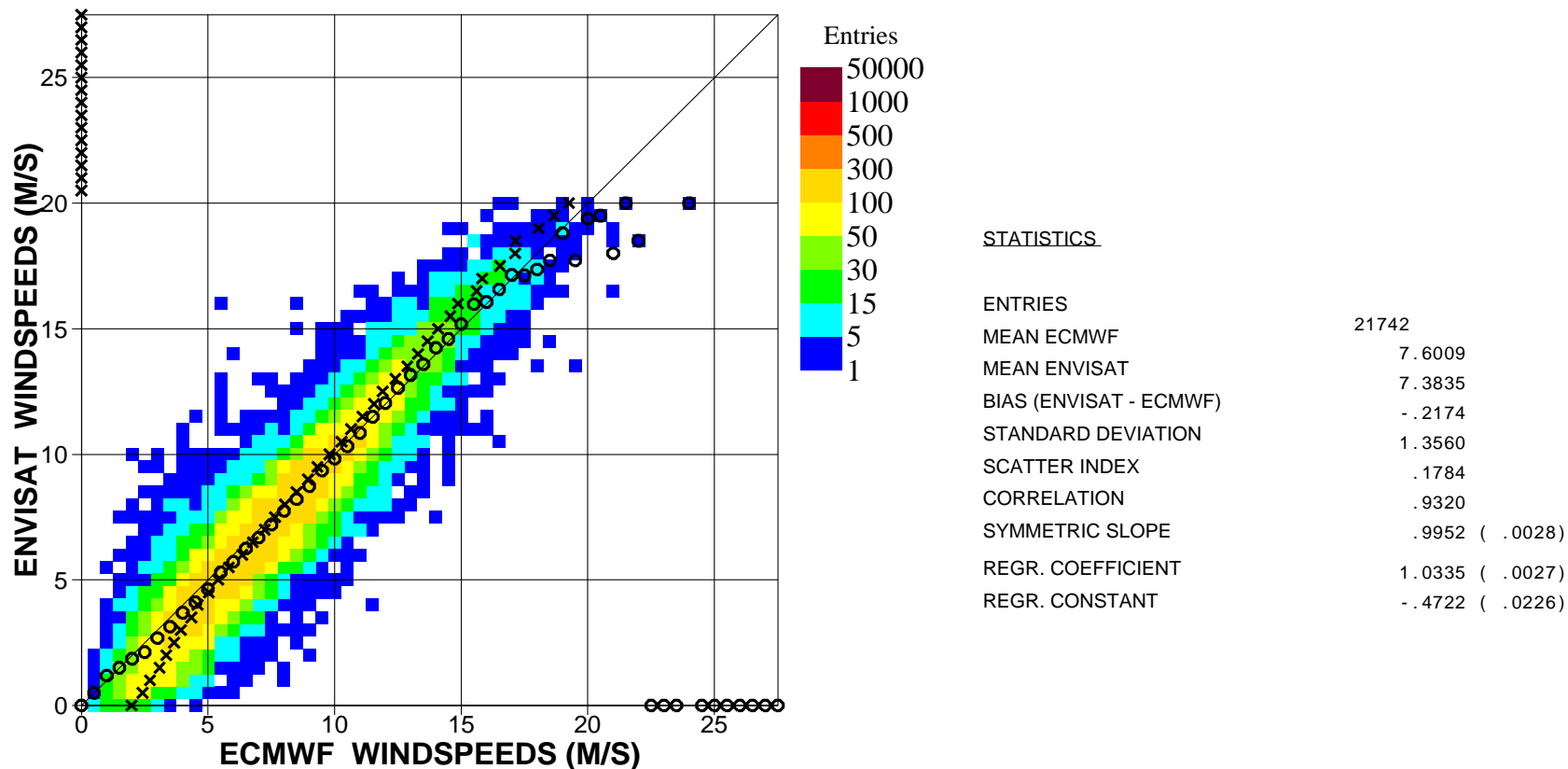


Figure 8. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2005 (N.Hem.)

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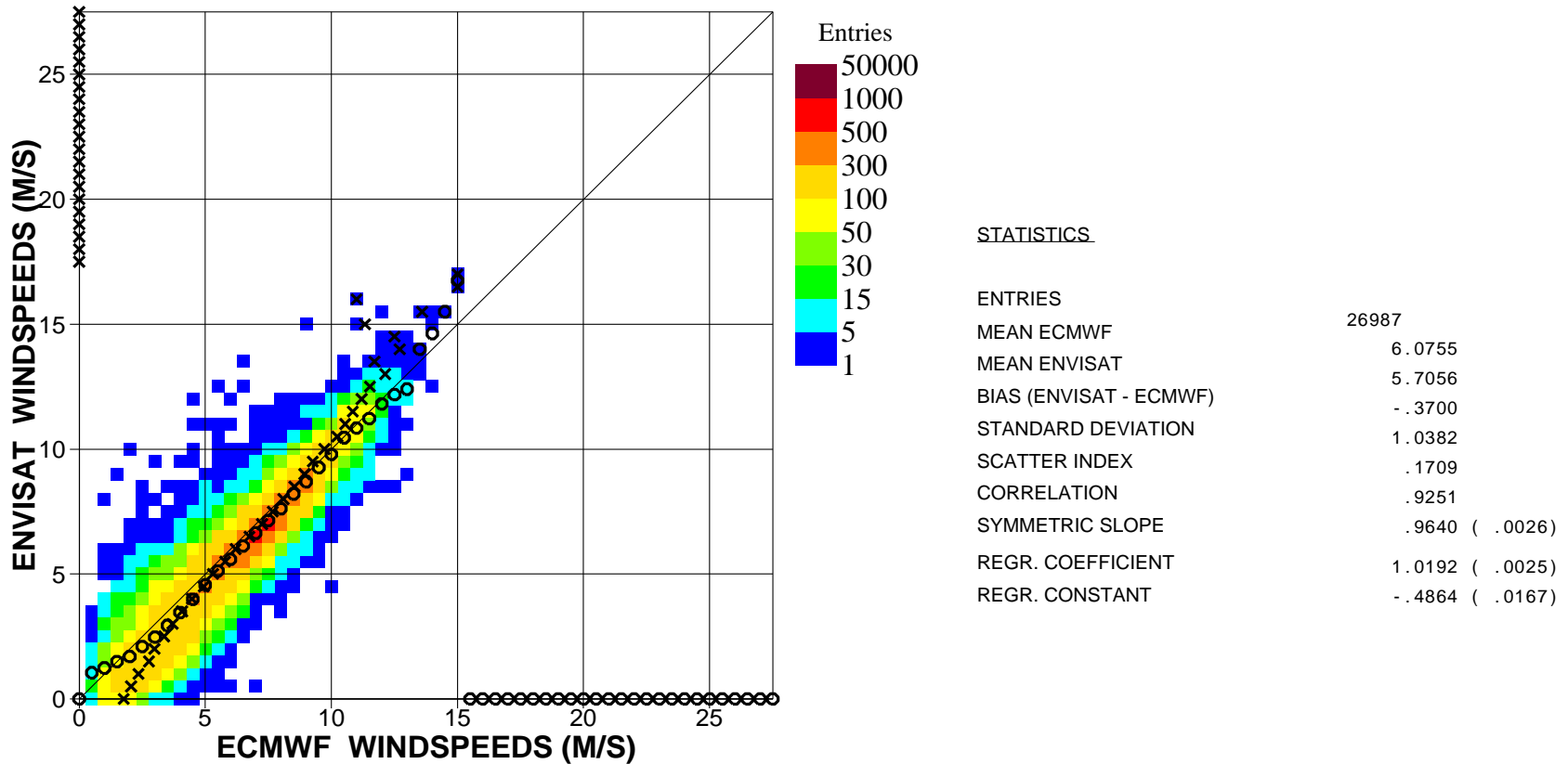


Figure 9. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2005 (Tropics)

■
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
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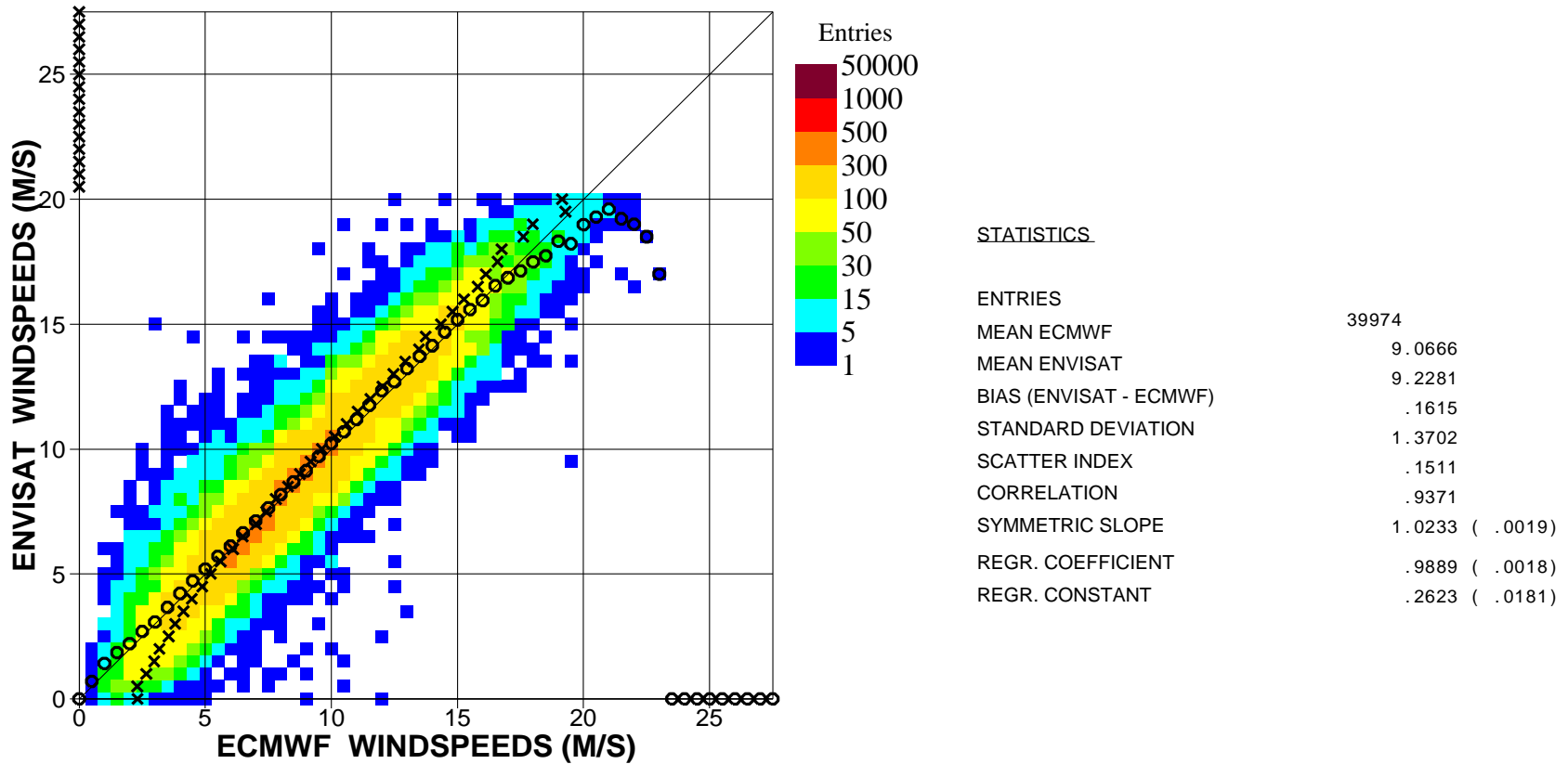


Figure 10. Comparison between ENVISAT Altimeter and ECMWF wind speeds for April 2005 (S.Hem.)

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Saleh Abdalla

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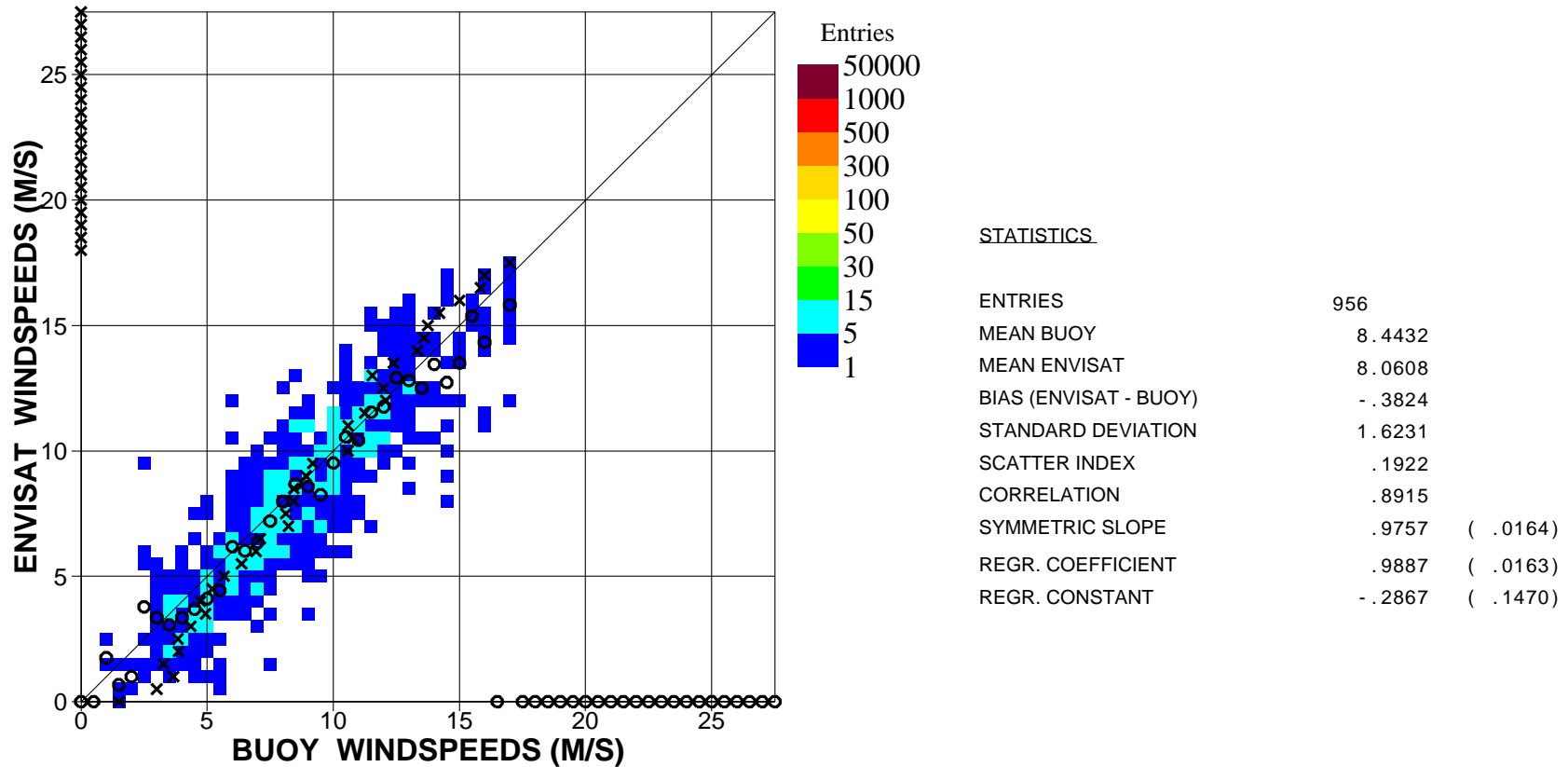


Figure 11. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2005 (Global)

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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
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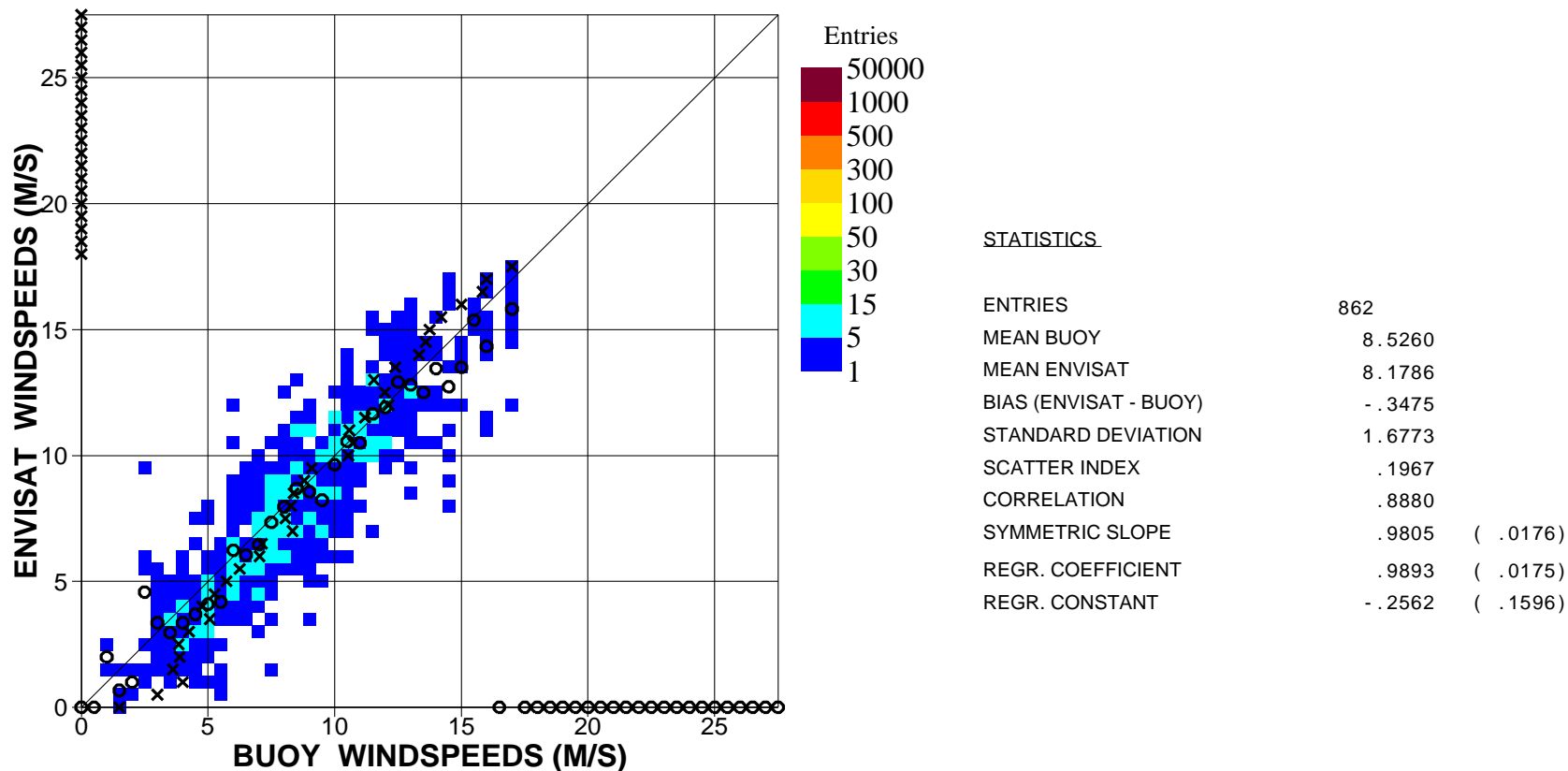


Figure 12. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2005 (N.Hem.)

■
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
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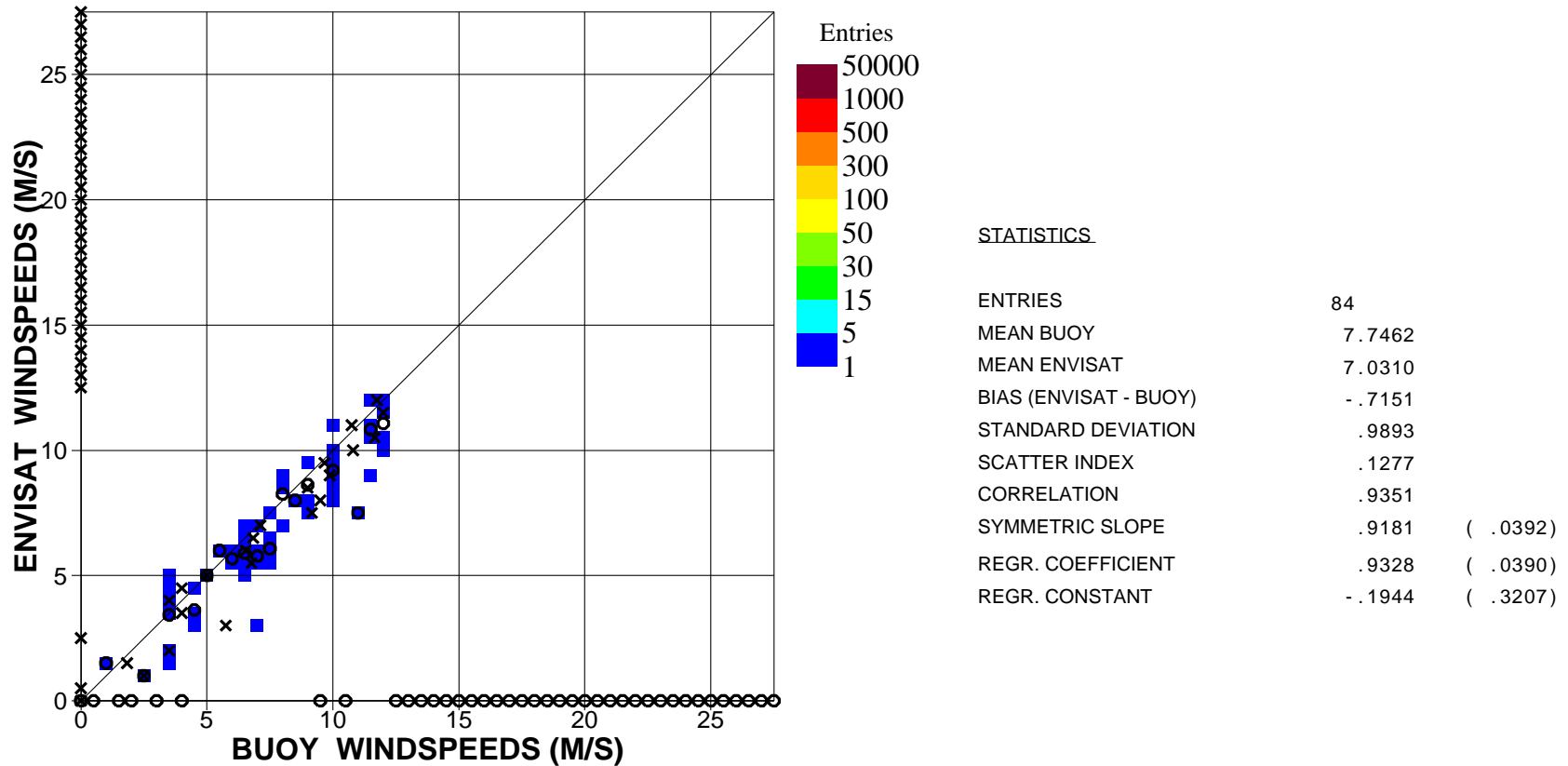


Figure 13. Comparison between ENVISAT Altimeter and buoy wind speeds for April 2005 (Tropics)

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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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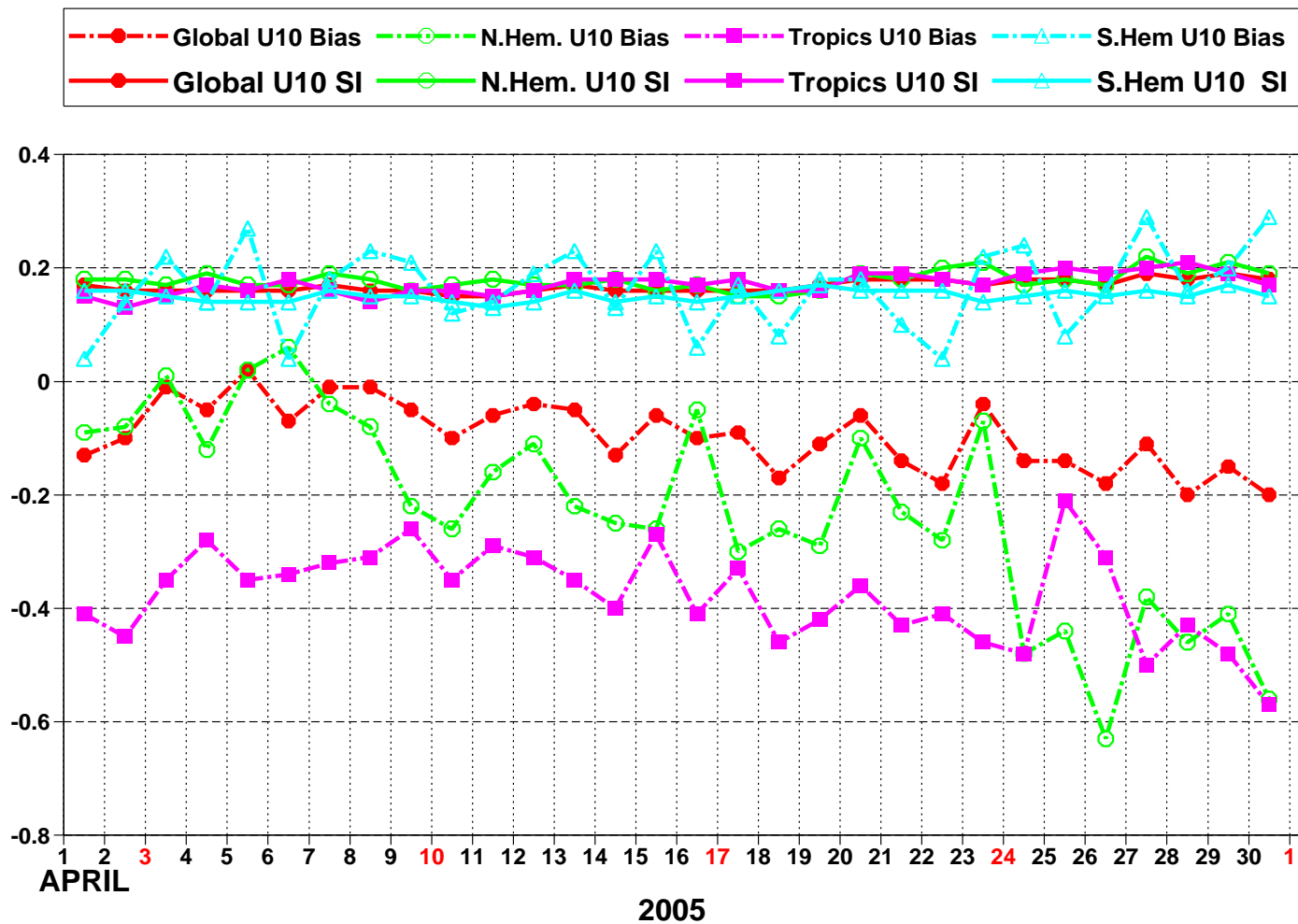


Figure 14: ENVISAT Altimeter wind speeds: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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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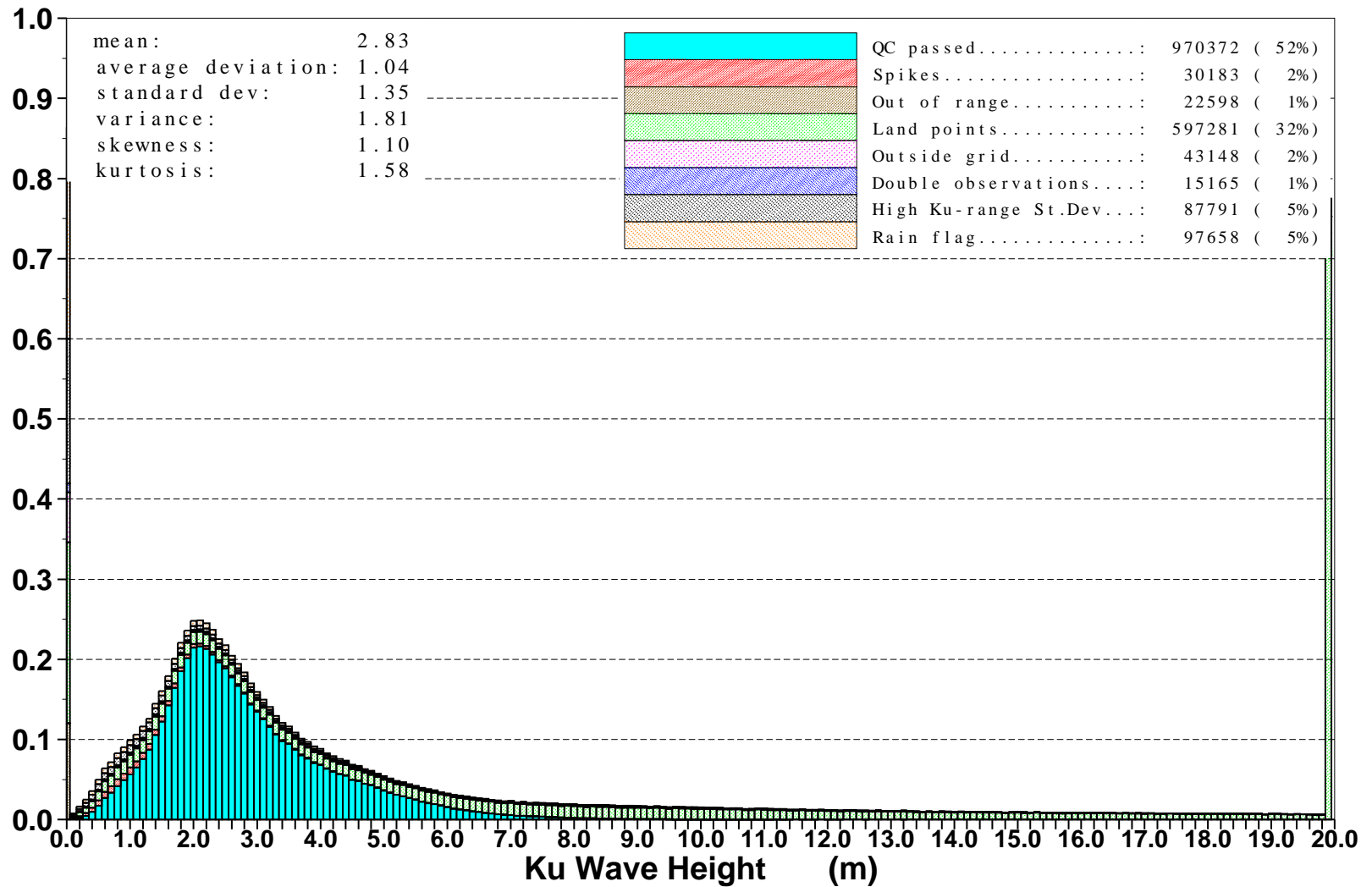


Figure 15: Distribution of the ENVISAT Altimeter Ku Wave Height after QC for April 2005

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Saleh Abdalla

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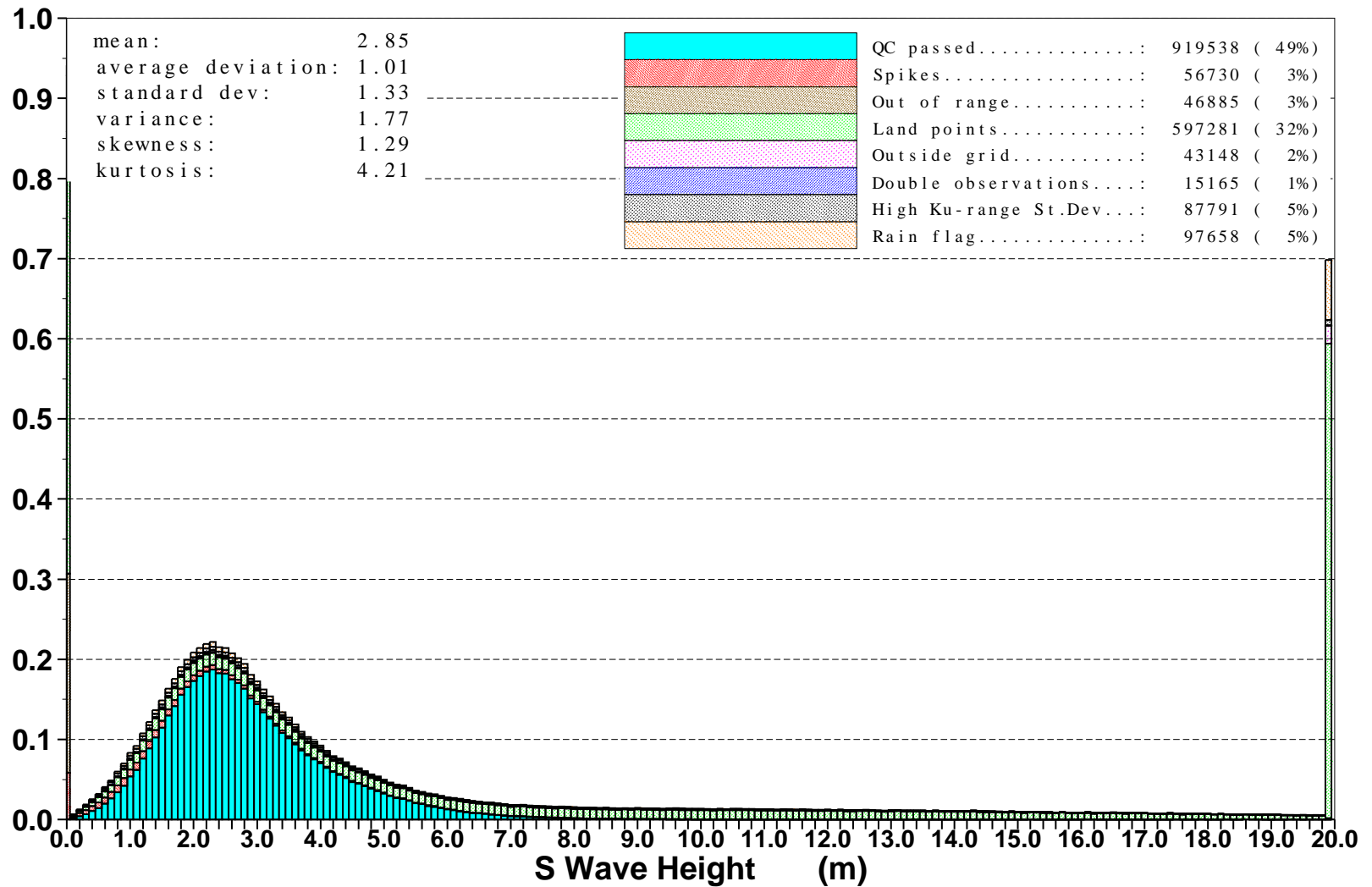
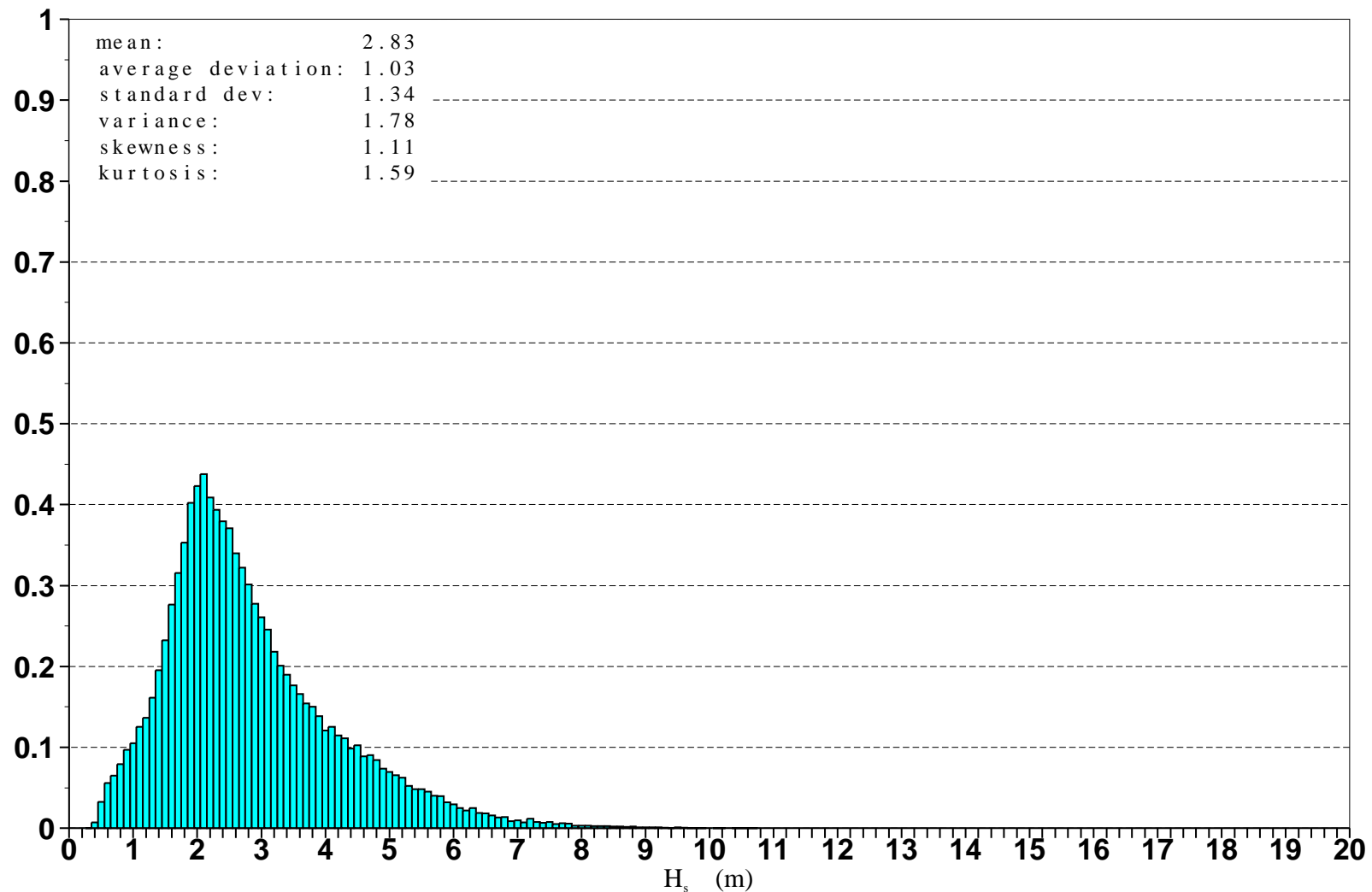


Figure 16: Distribution of the ENVISAT Altimeter S Wave Height after QC for April 2005

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Saleh Abdalla

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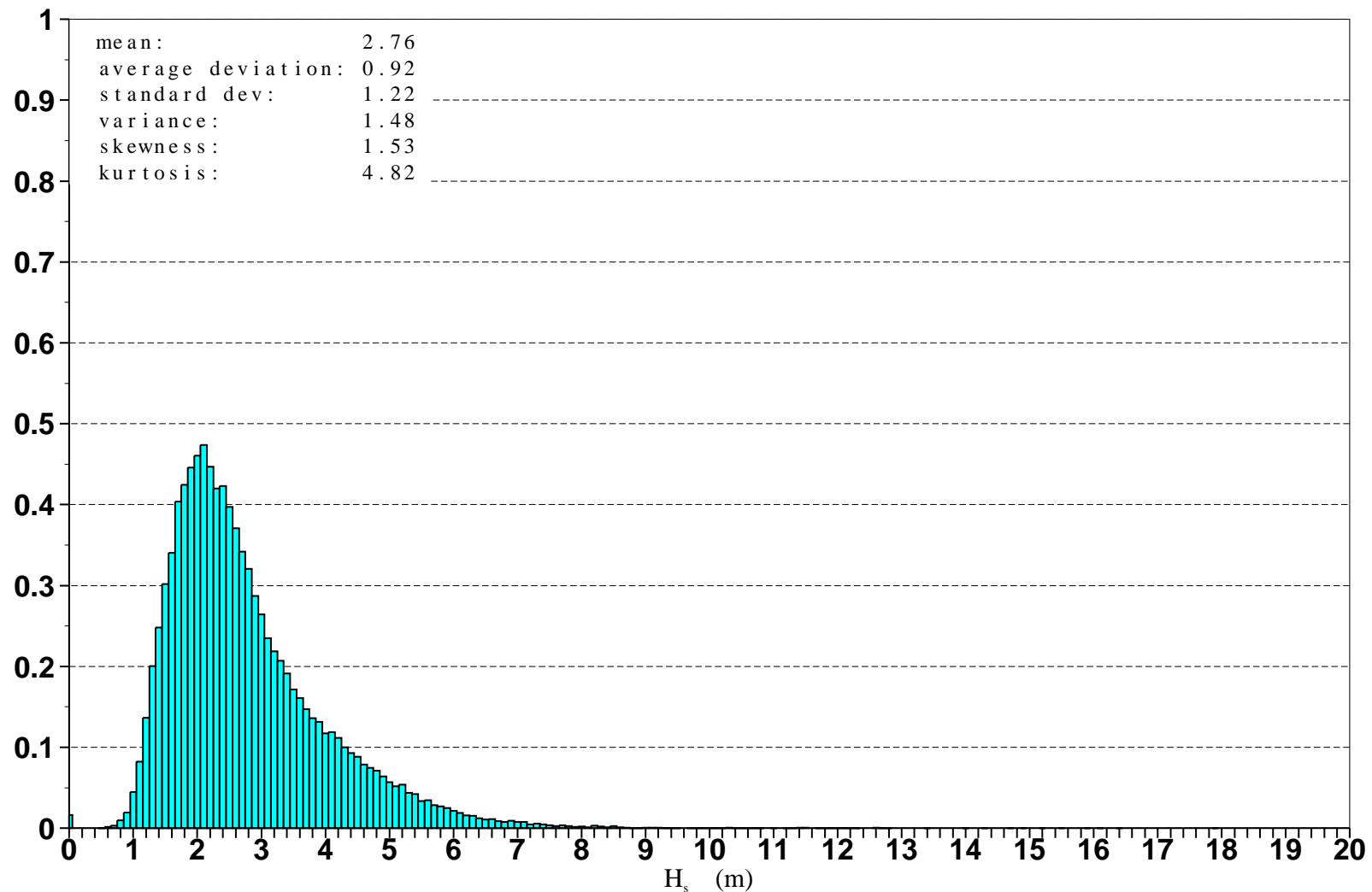
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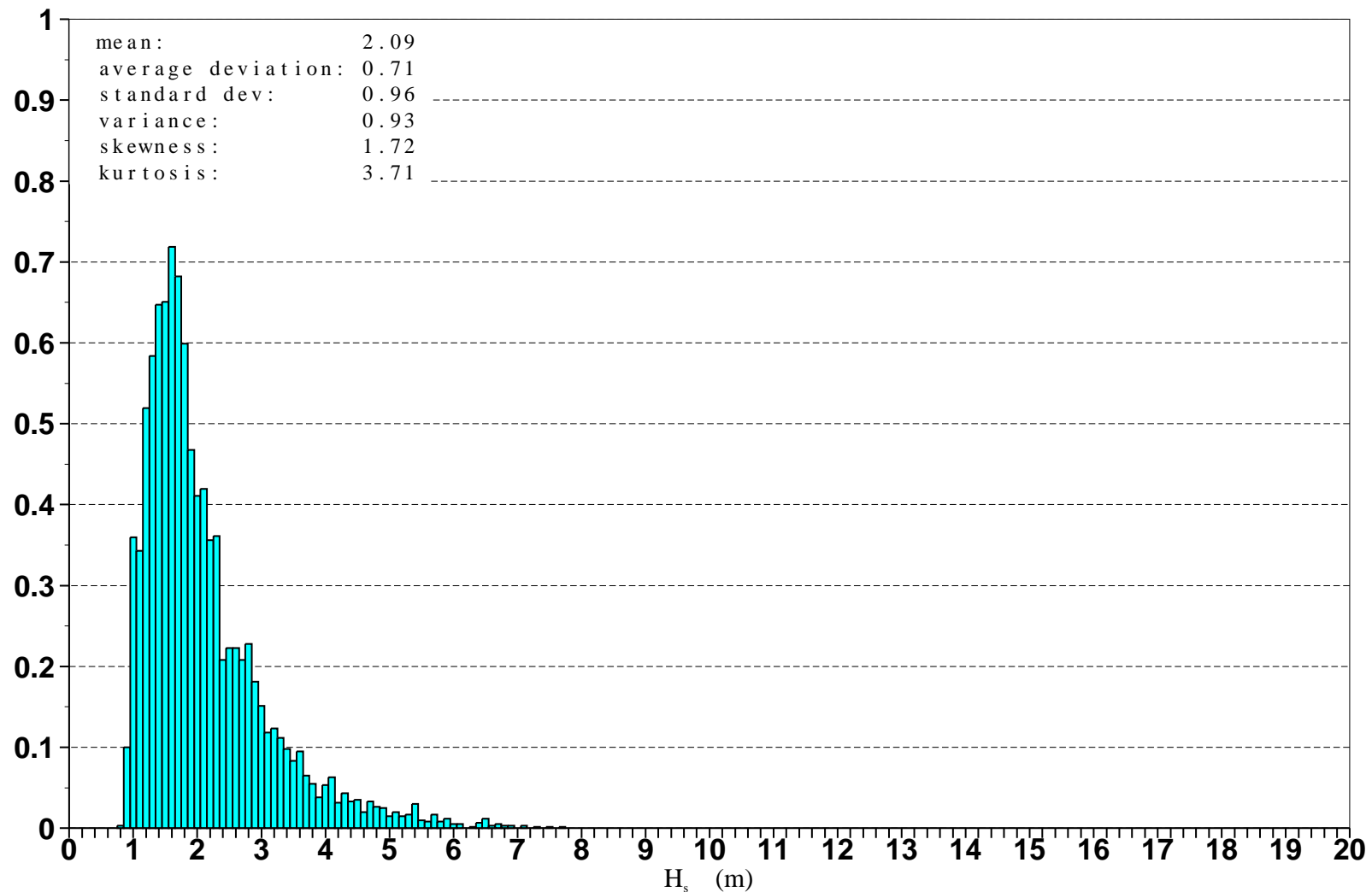
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Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

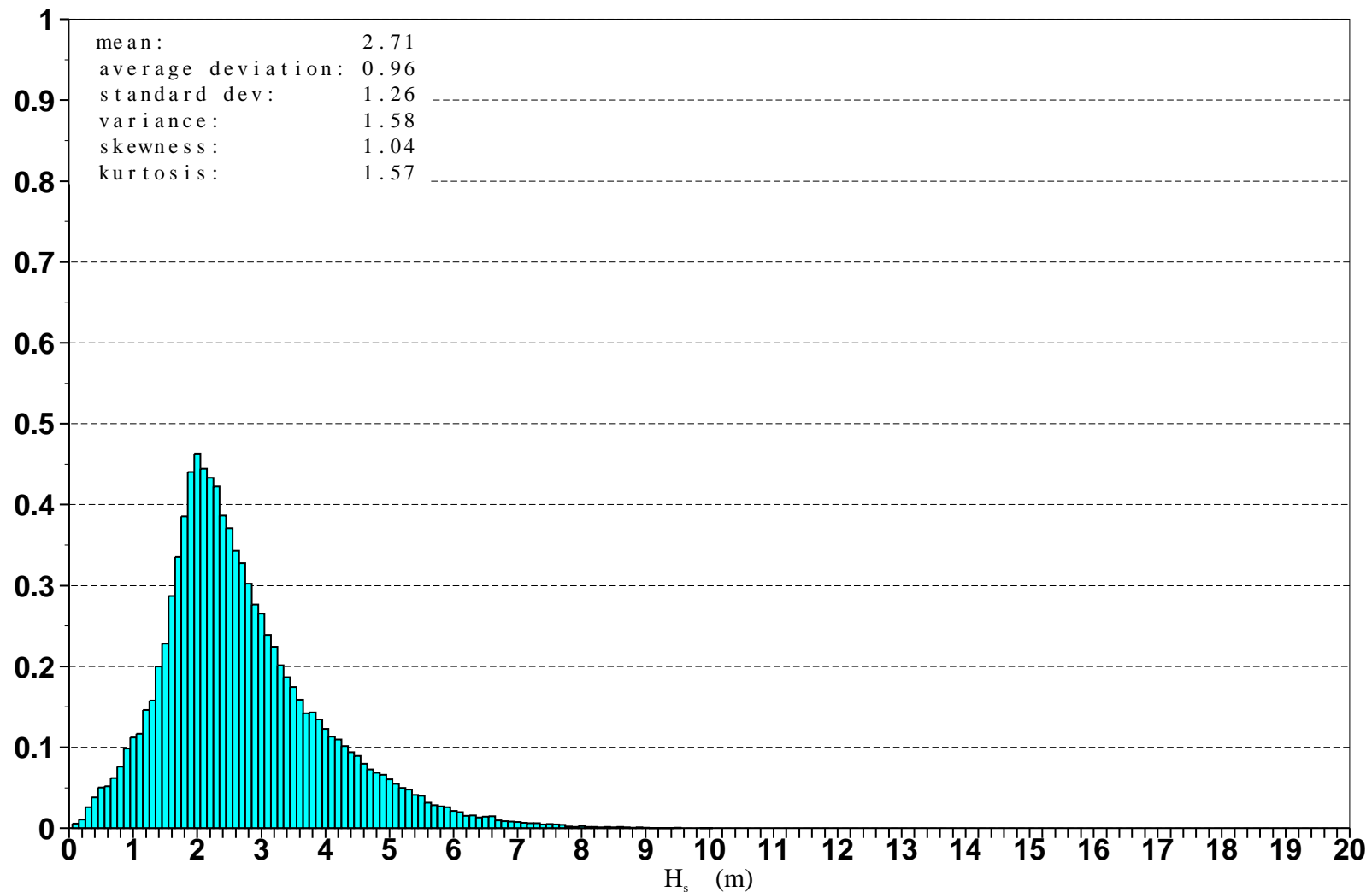
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Saleh Abdalla

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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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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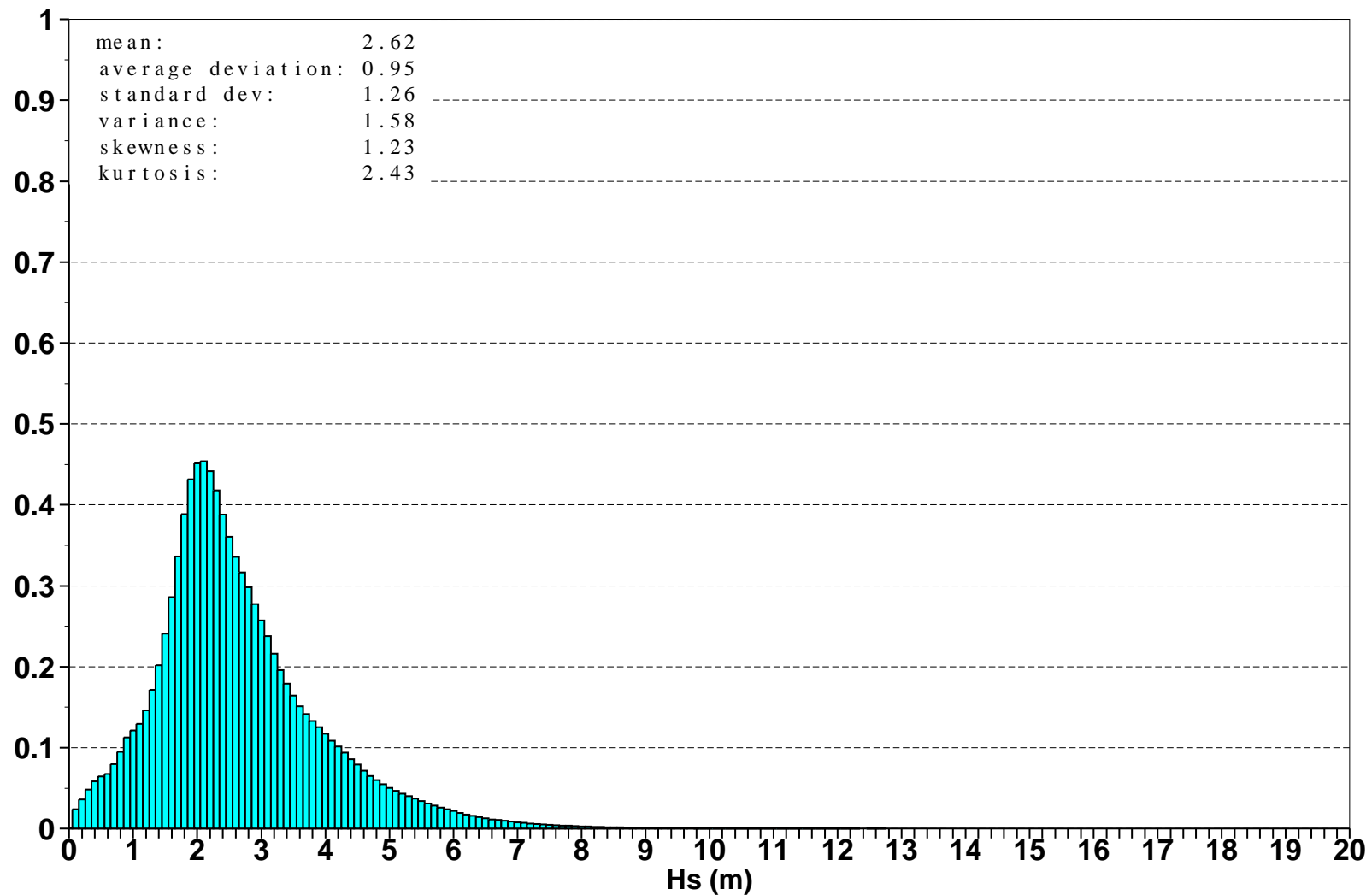


Figure 20: Global distribution of ECMWF First-Guess wave heights for April 2005



Saleh Abdalla

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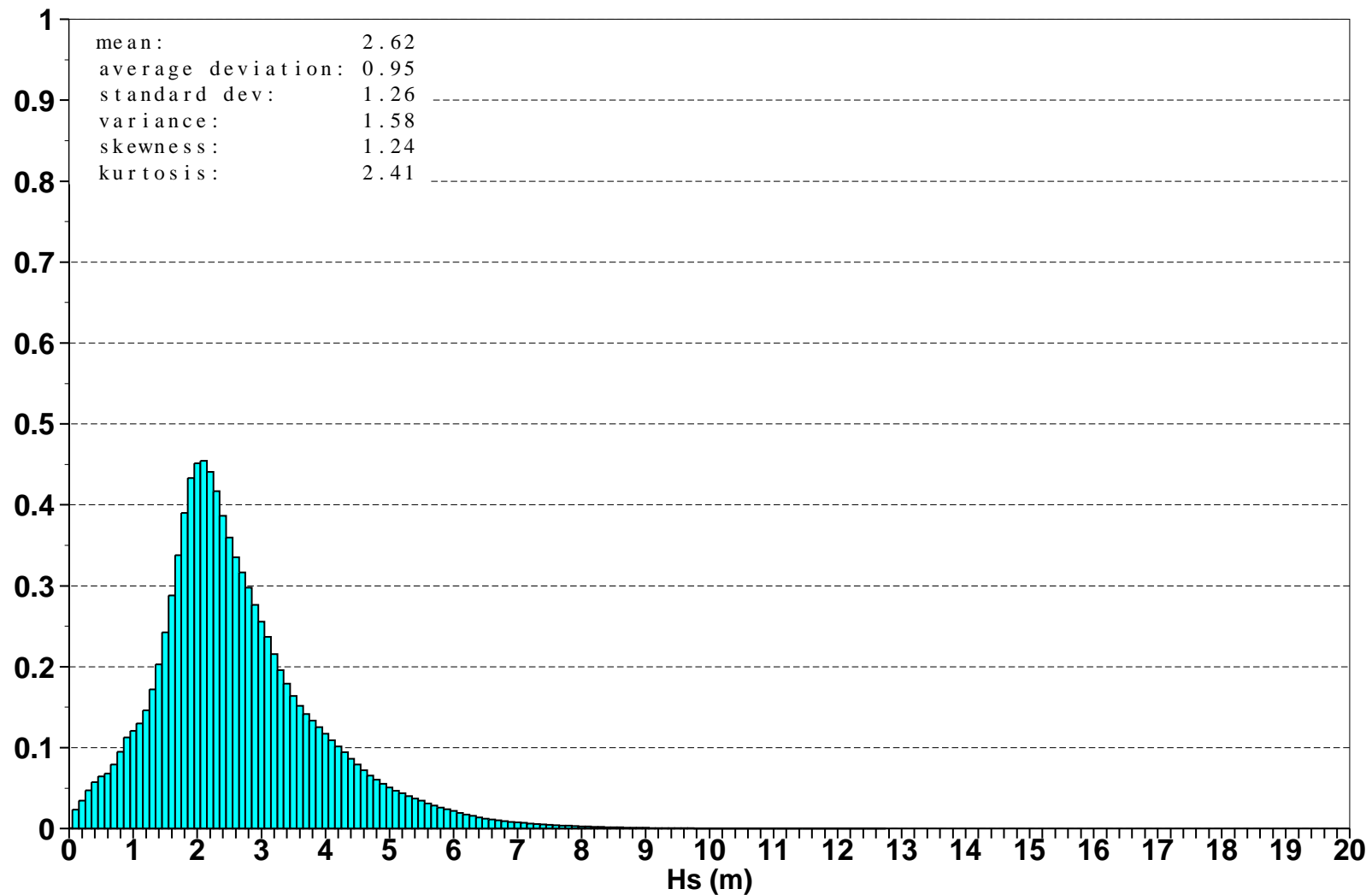


Figure 21: Global distribution of ECMWF Analysis wave heights for April 2005



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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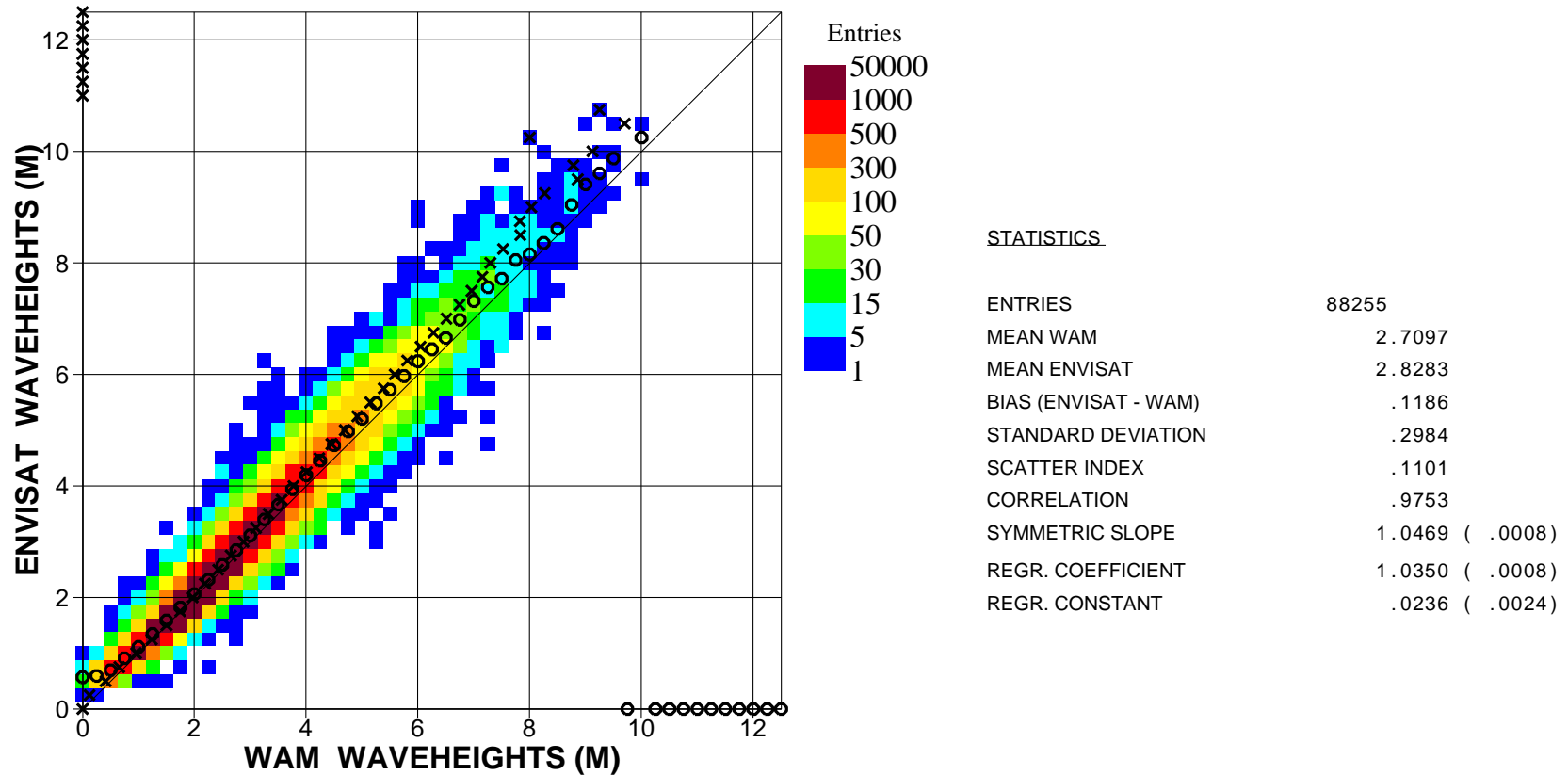


Figure 22. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2005 (Global)

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Saleh Abdalla

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Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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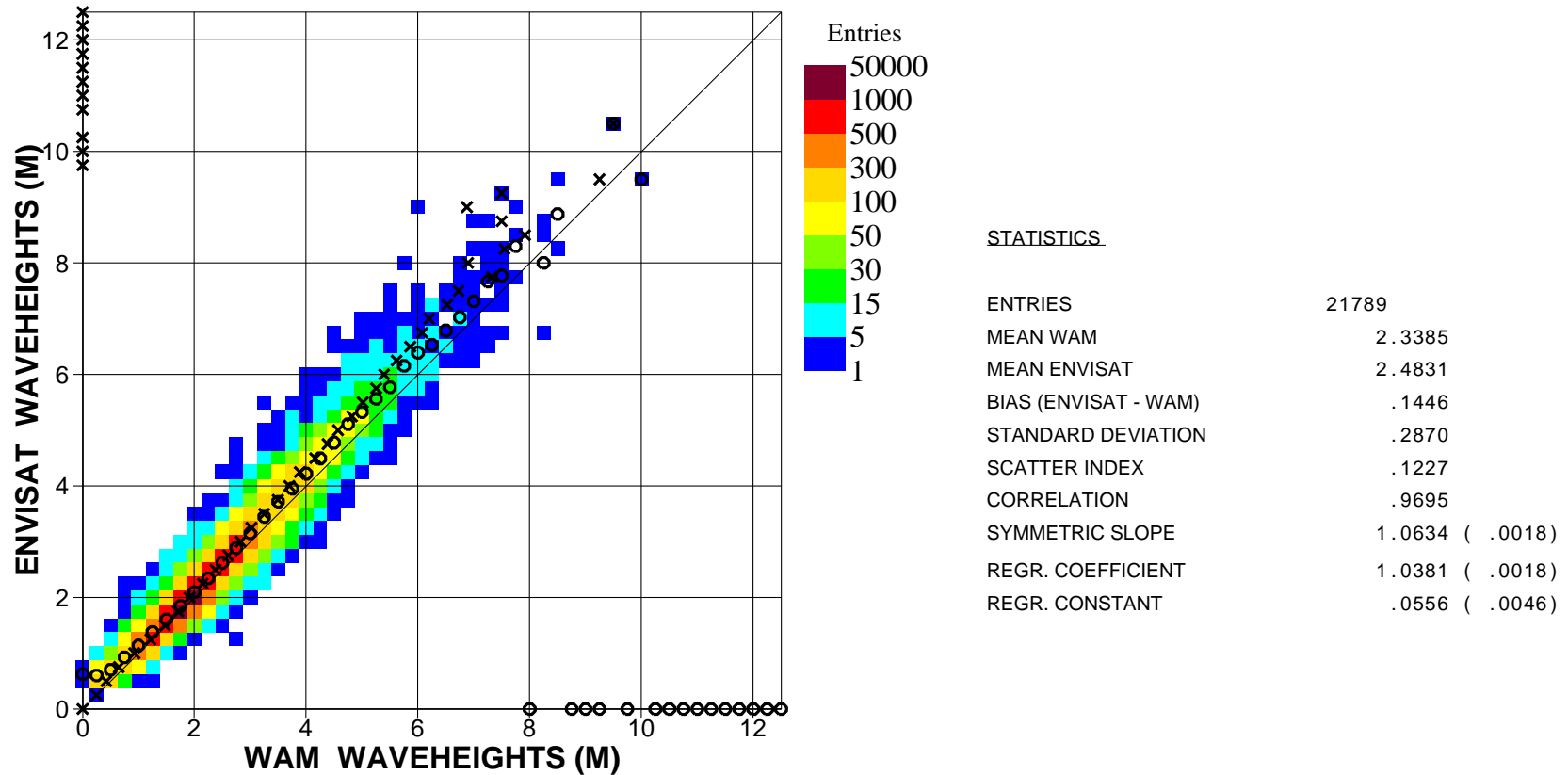


Figure 23. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2005 (N.Hem.)

Saleh Abdalla

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 Shinfield Park, Reading, Berkshire RG2 9AX, England
 Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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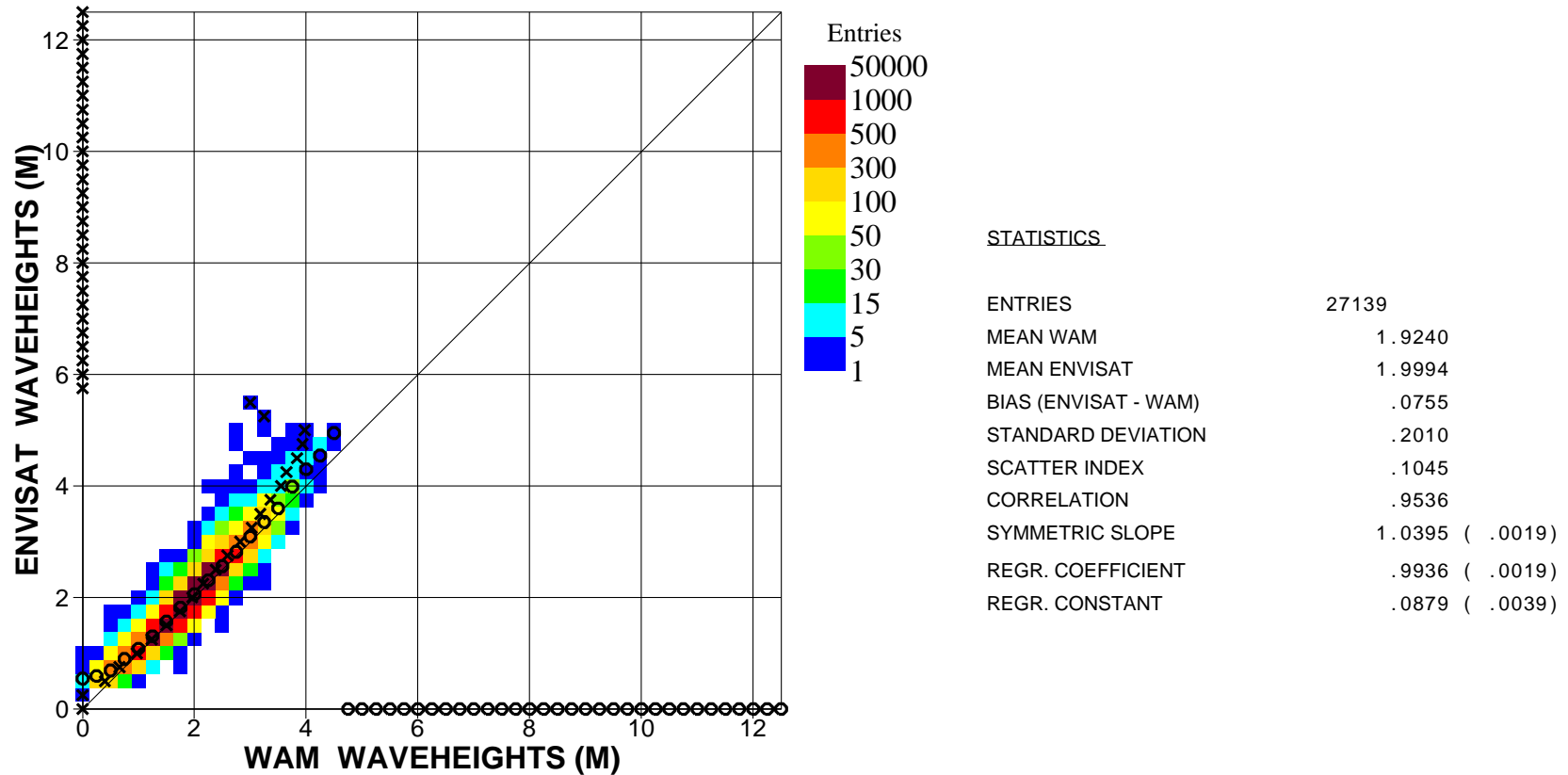


Figure 24. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2005 (Tropics)

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Saleh Abdalla

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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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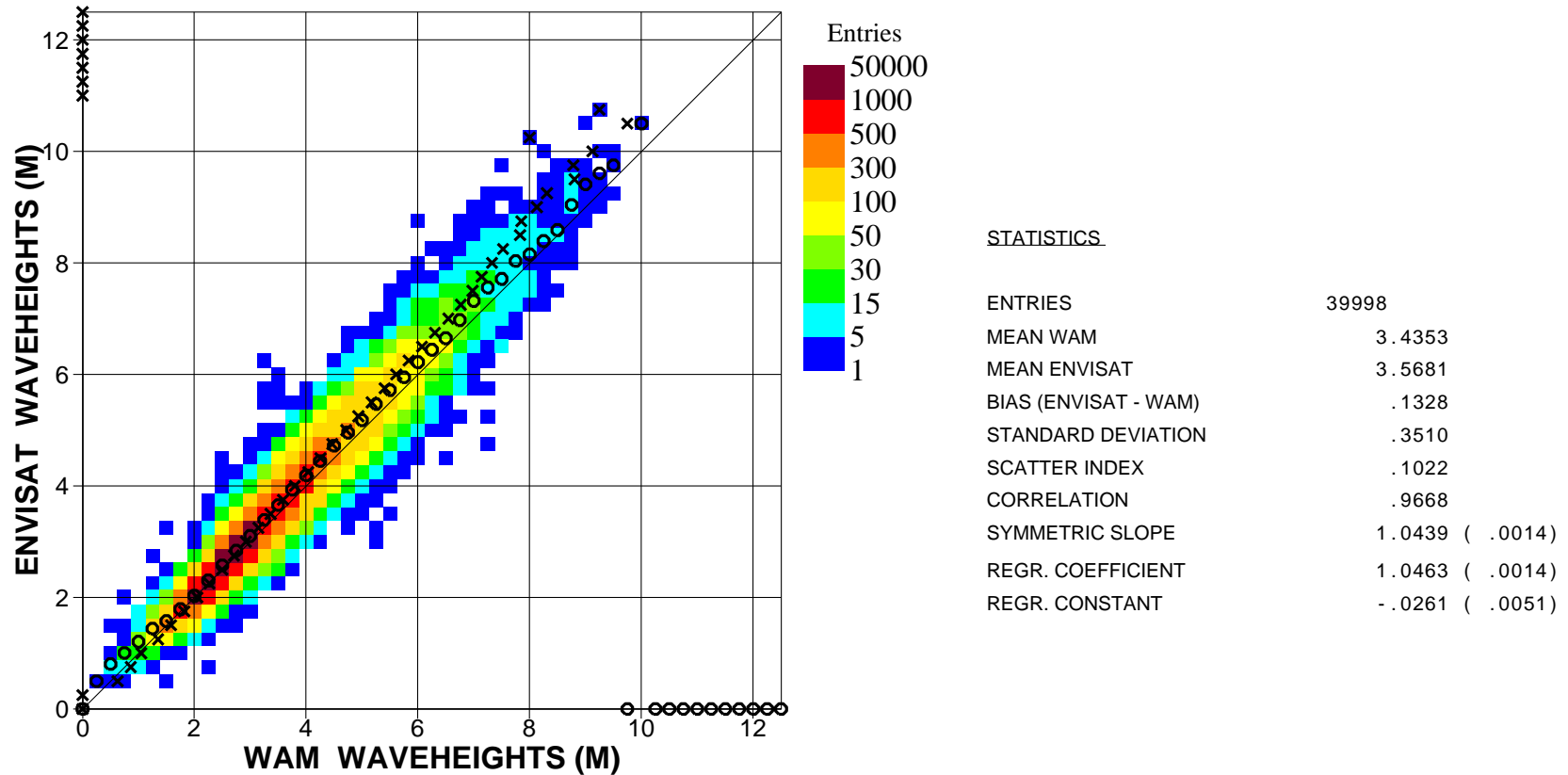


Figure 25. Comparison between ENVISAT Altimeter Ku-Band and WAM (first guess) significant wave heights for April 2005 (S.Hem.)

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Saleh Abdalla

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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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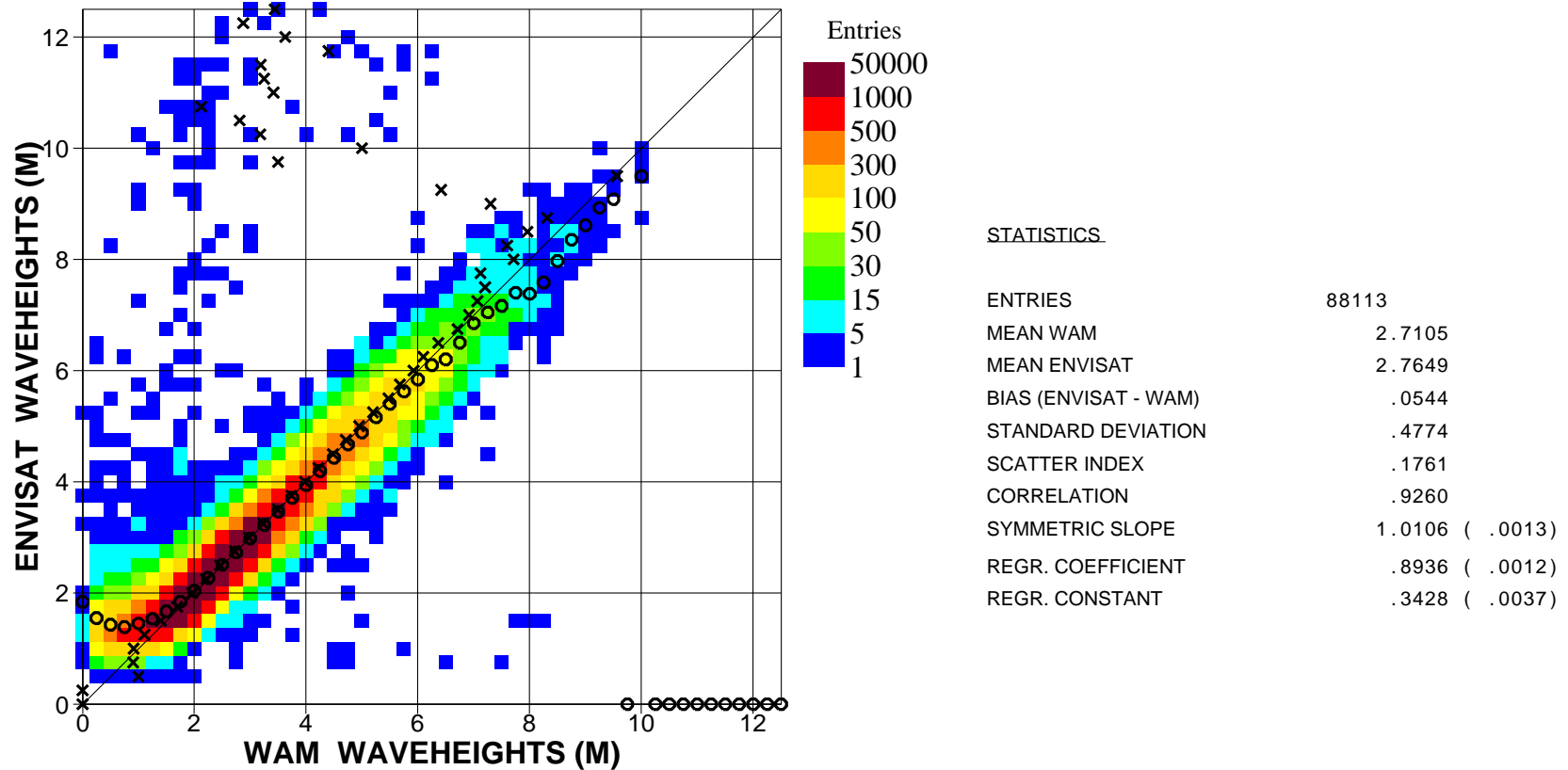


Figure 26. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2005 (Global)

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Saleh Abdalla

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Shinfield Park, Reading, Berkshire RG2 9AX, England
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Telex 984 7908 ECMWF G, Telefax (0118) 986 9450, e-mail abdalla@ecmwf.int

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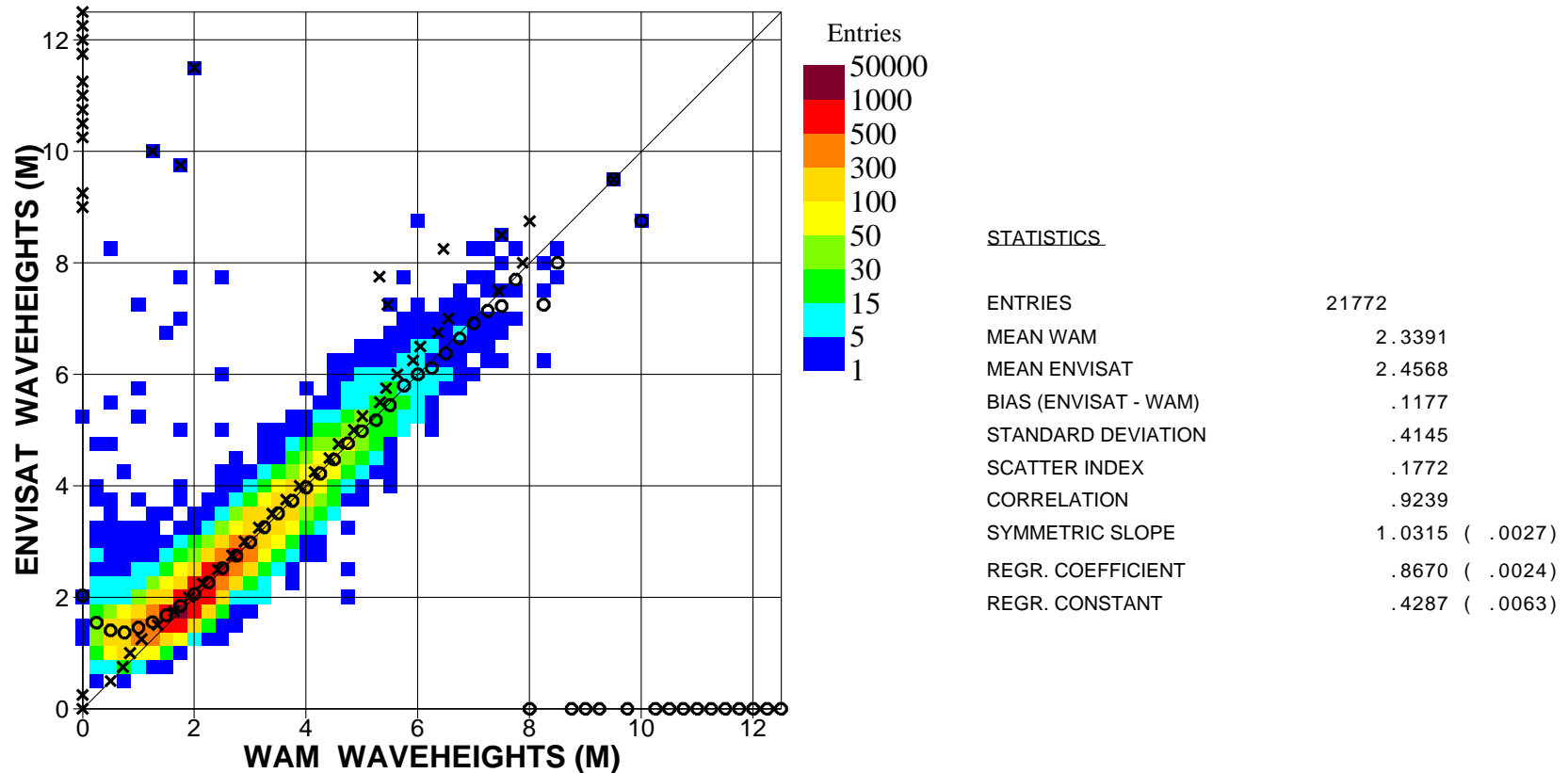


Figure 27. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2005 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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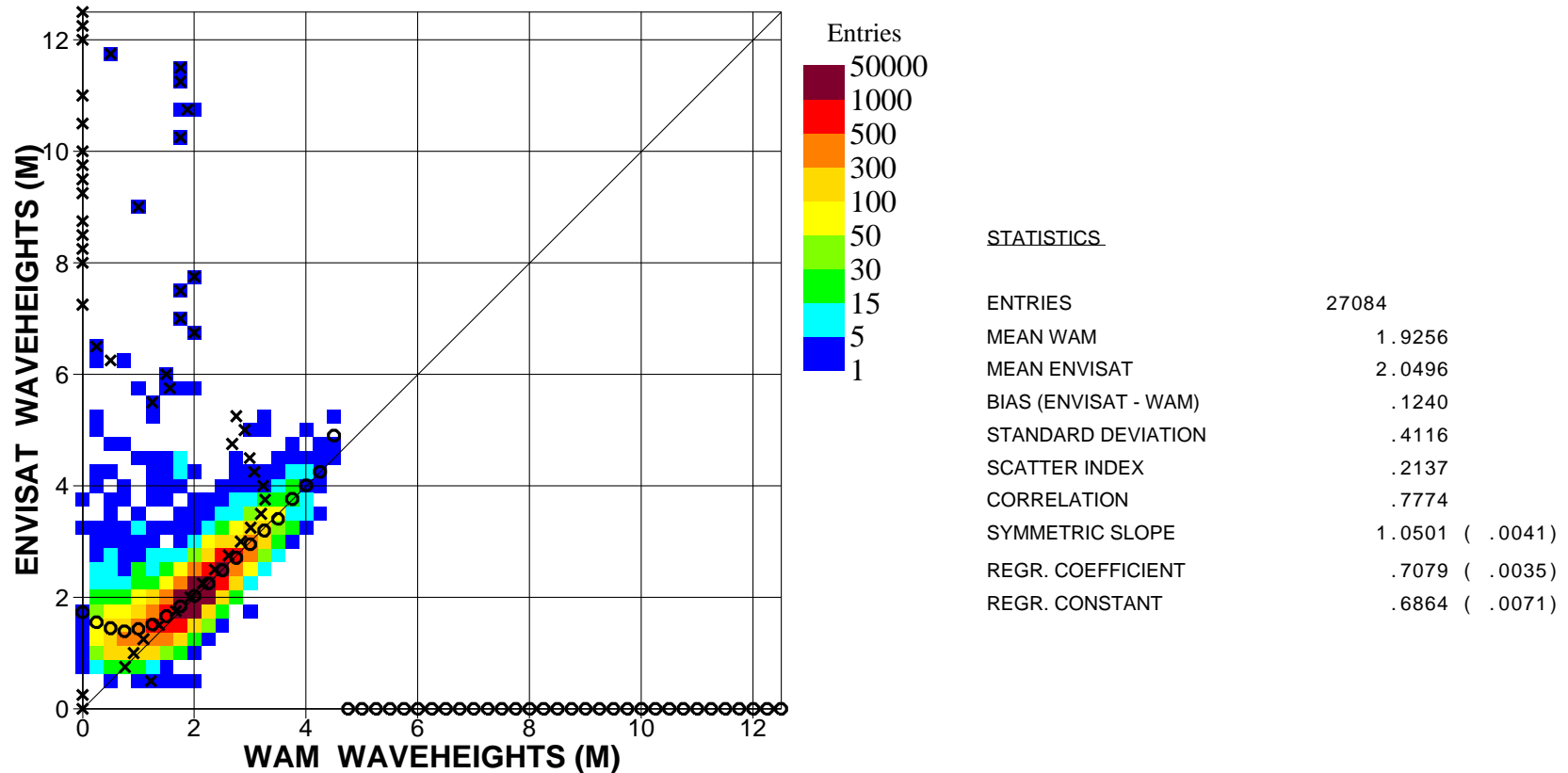


Figure 28. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2005 (Tropics)

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Saleh Abdalla

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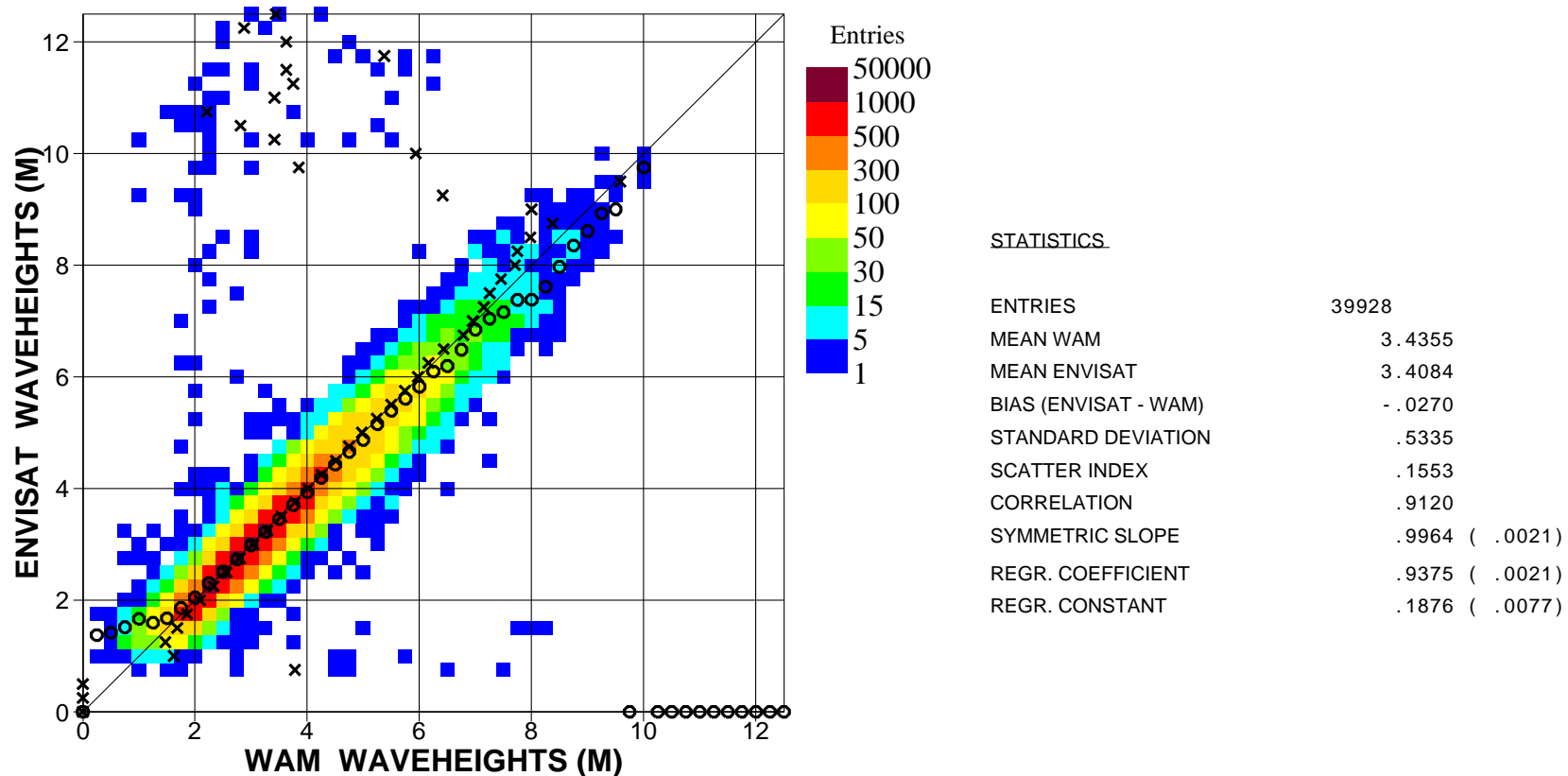


Figure 29. Comparison between ENVISAT Altimeter S-Band and WAM (first guess) significant wave heights for April 2005 (S.Hem.)

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Saleh Abdalla

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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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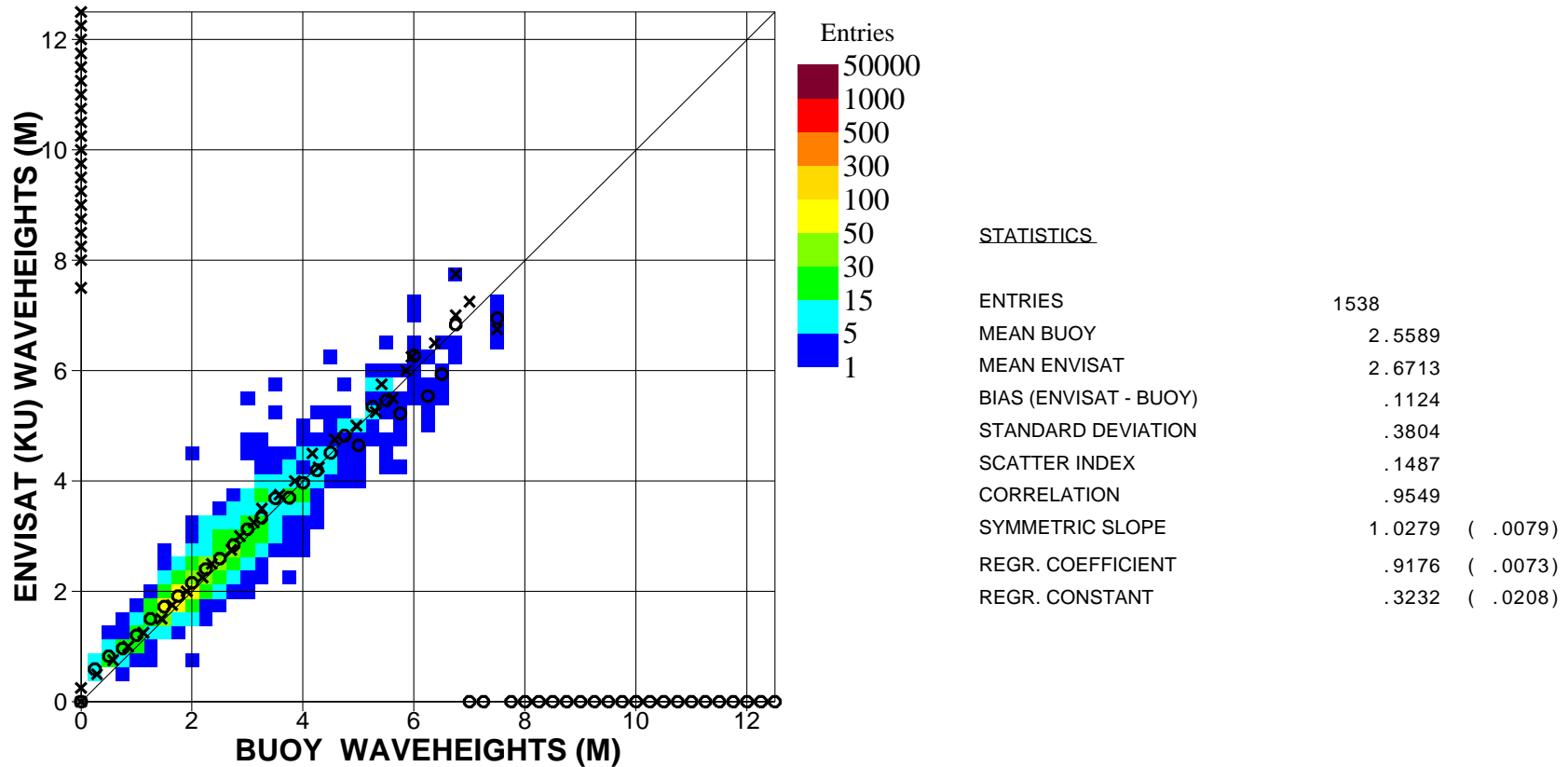


Figure 30. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2005 (Global)

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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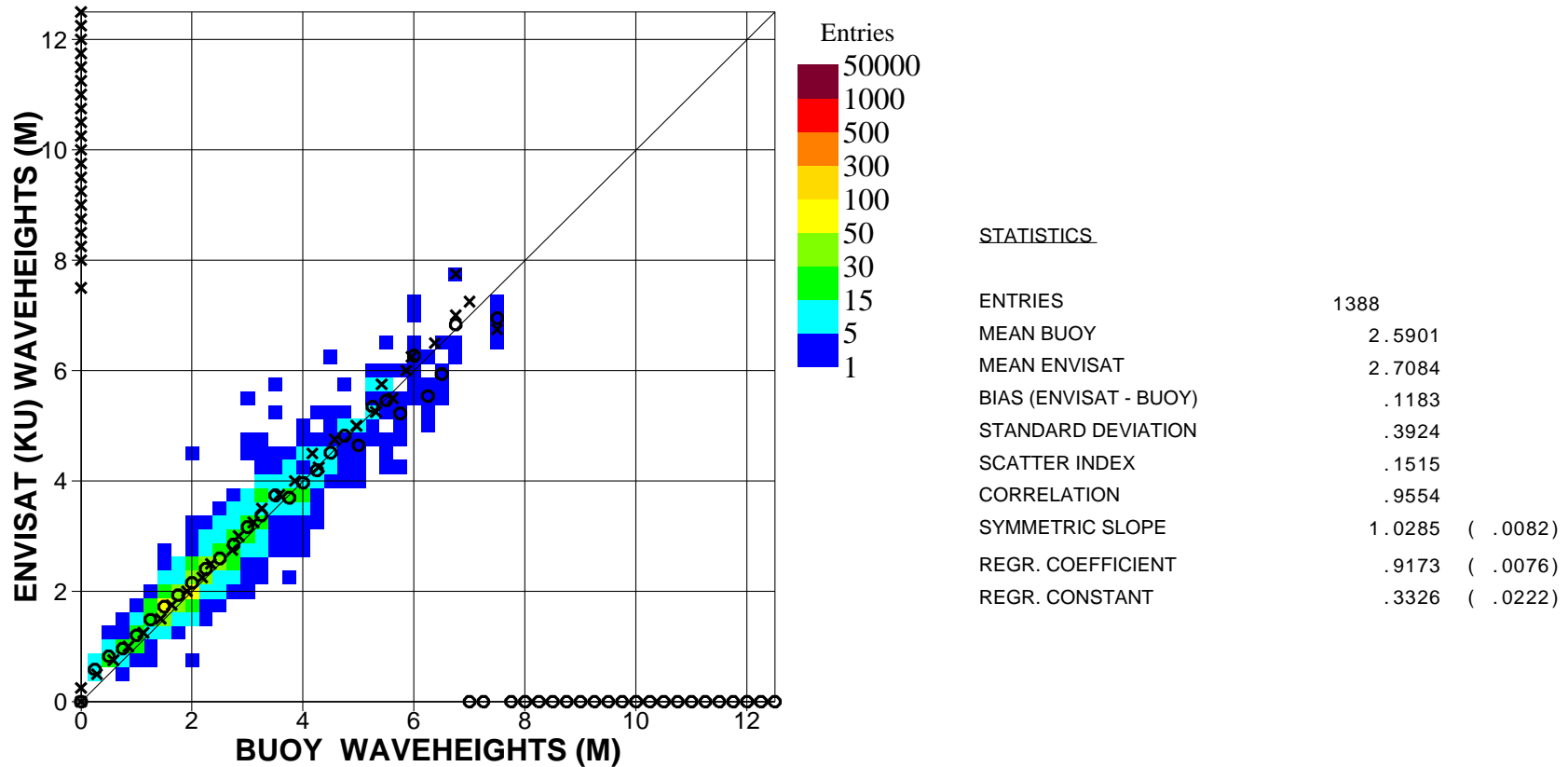


Figure 31. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2005 (N.Hem.)

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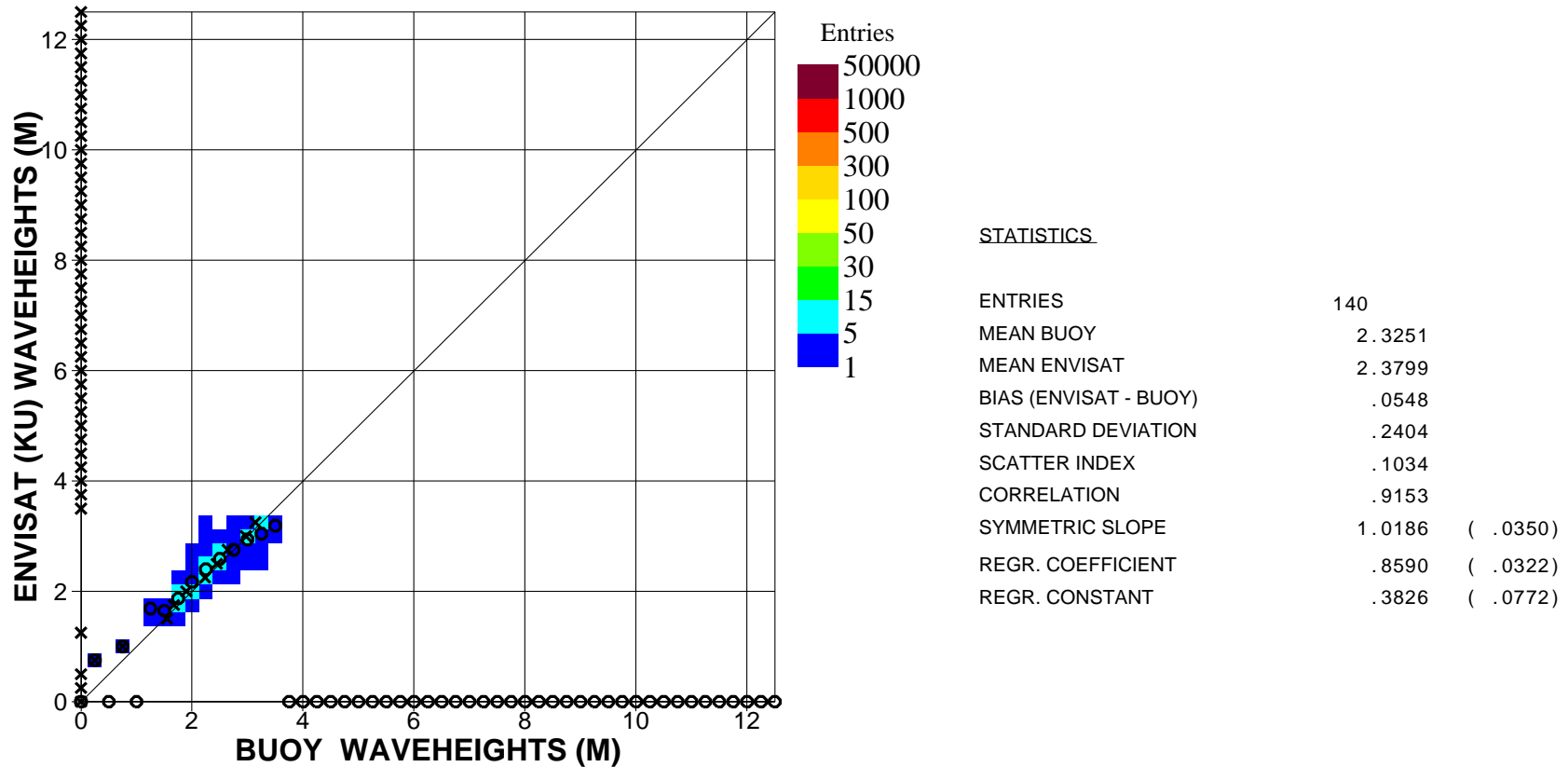


Figure 32. Comparison between ENVISAT Altimeter Ku-Band and buoy significant wave heights for April 2005 (Tropics)

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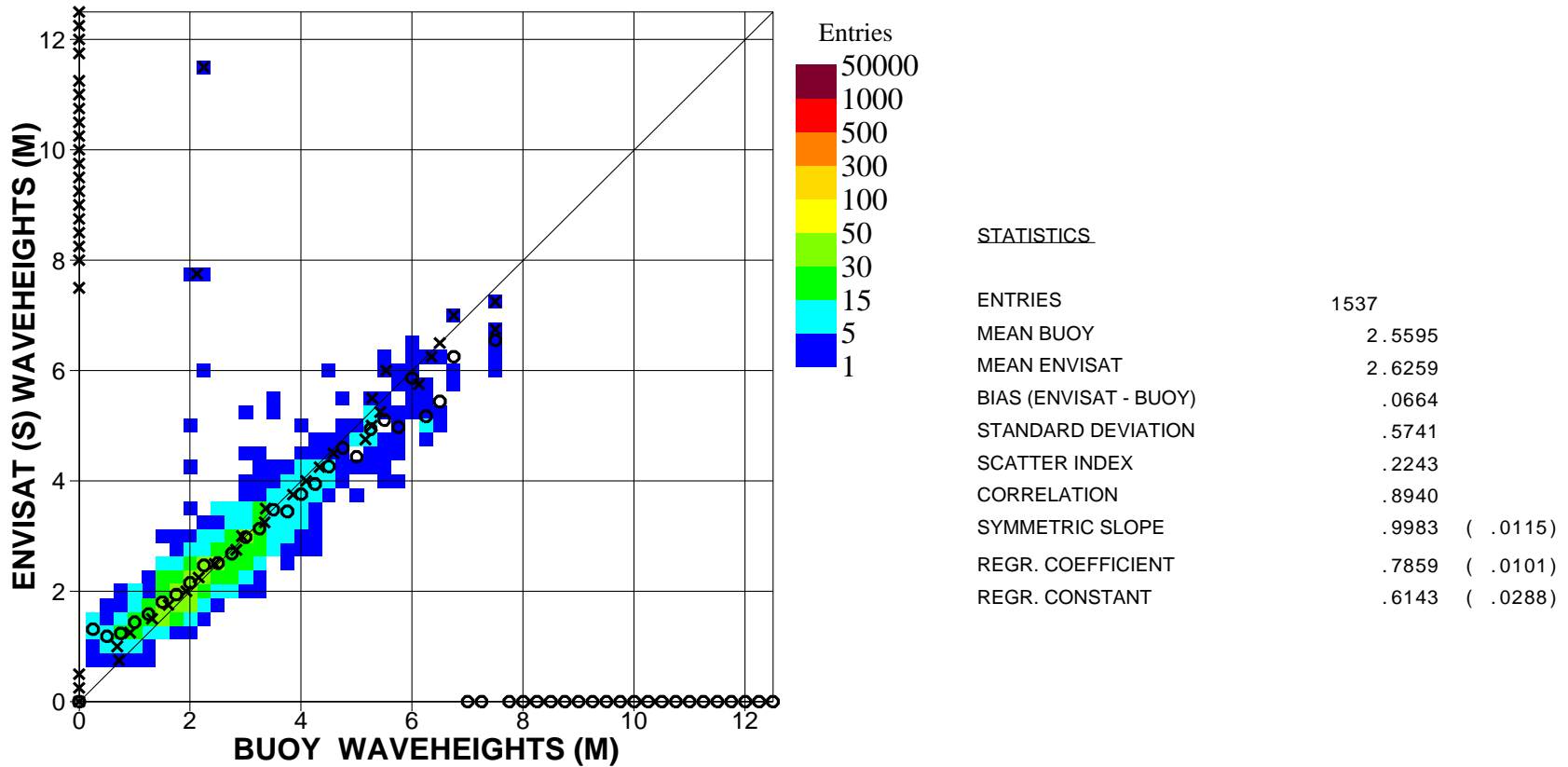


Figure 33. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2005 (Global)

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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
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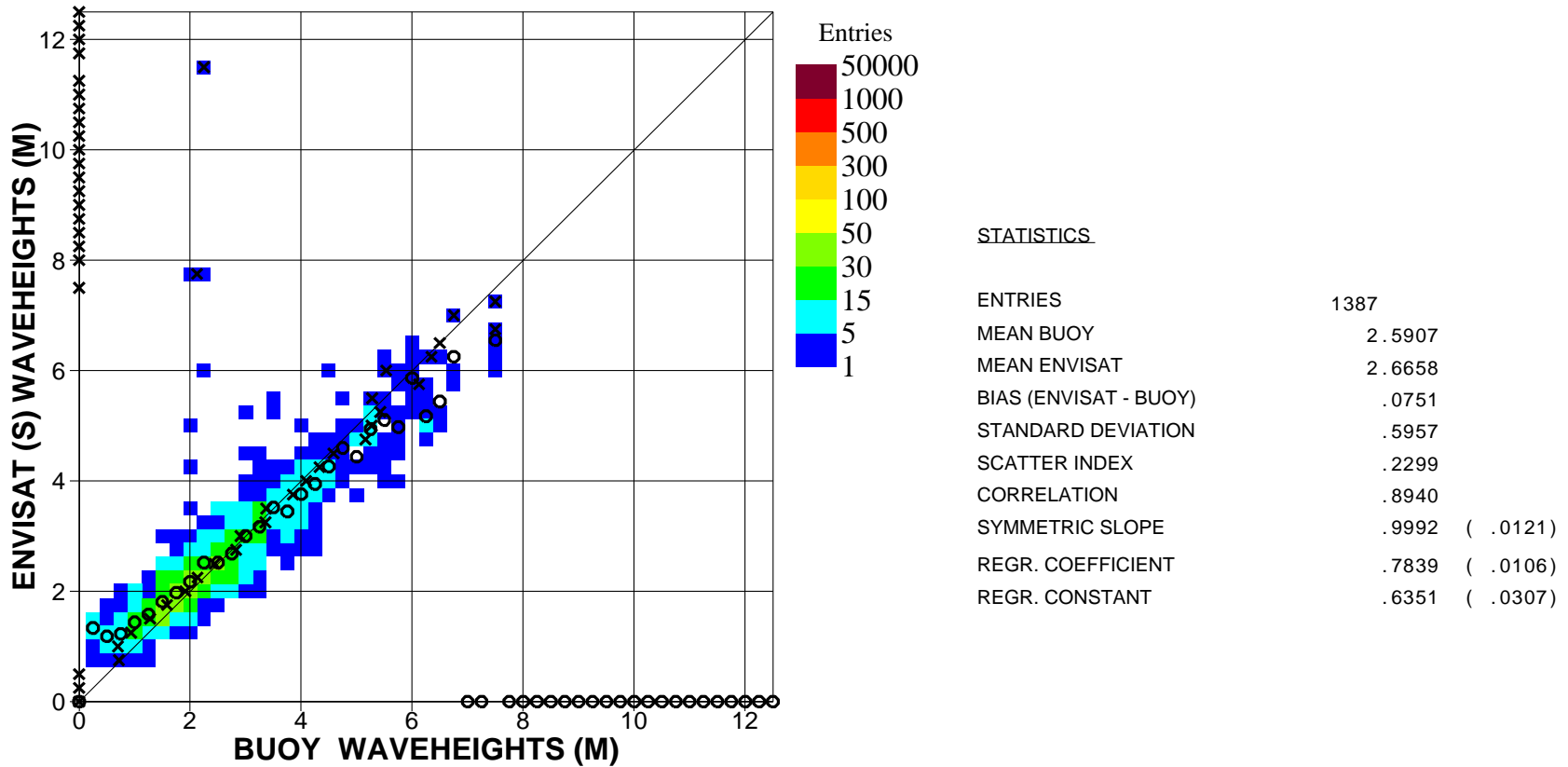


Figure 34. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2005 (N.Hem.)

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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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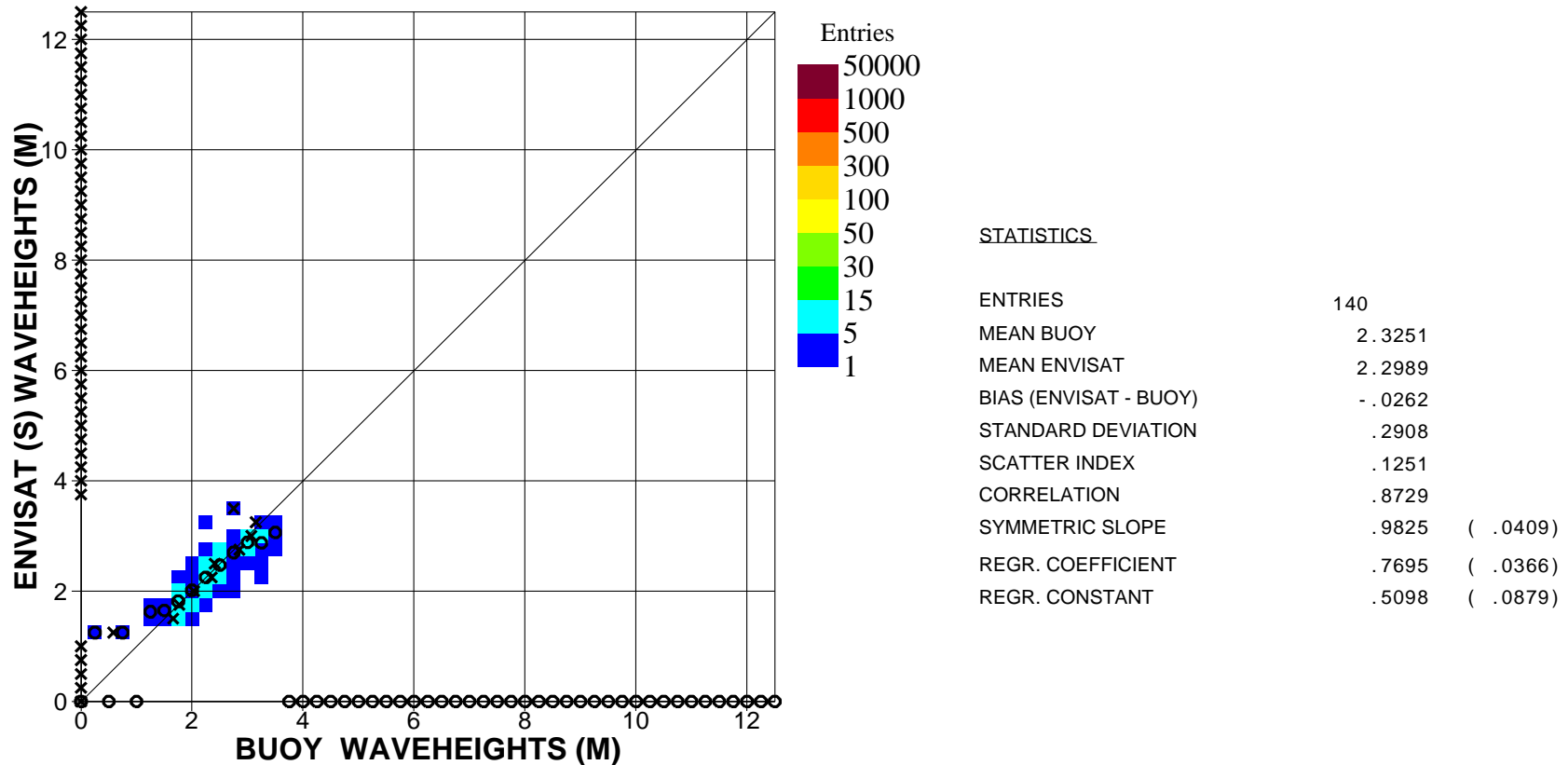


Figure 35. Comparison between ENVISAT Altimeter S-Band and buoy significant wave heights for April 2005 (Tropics)

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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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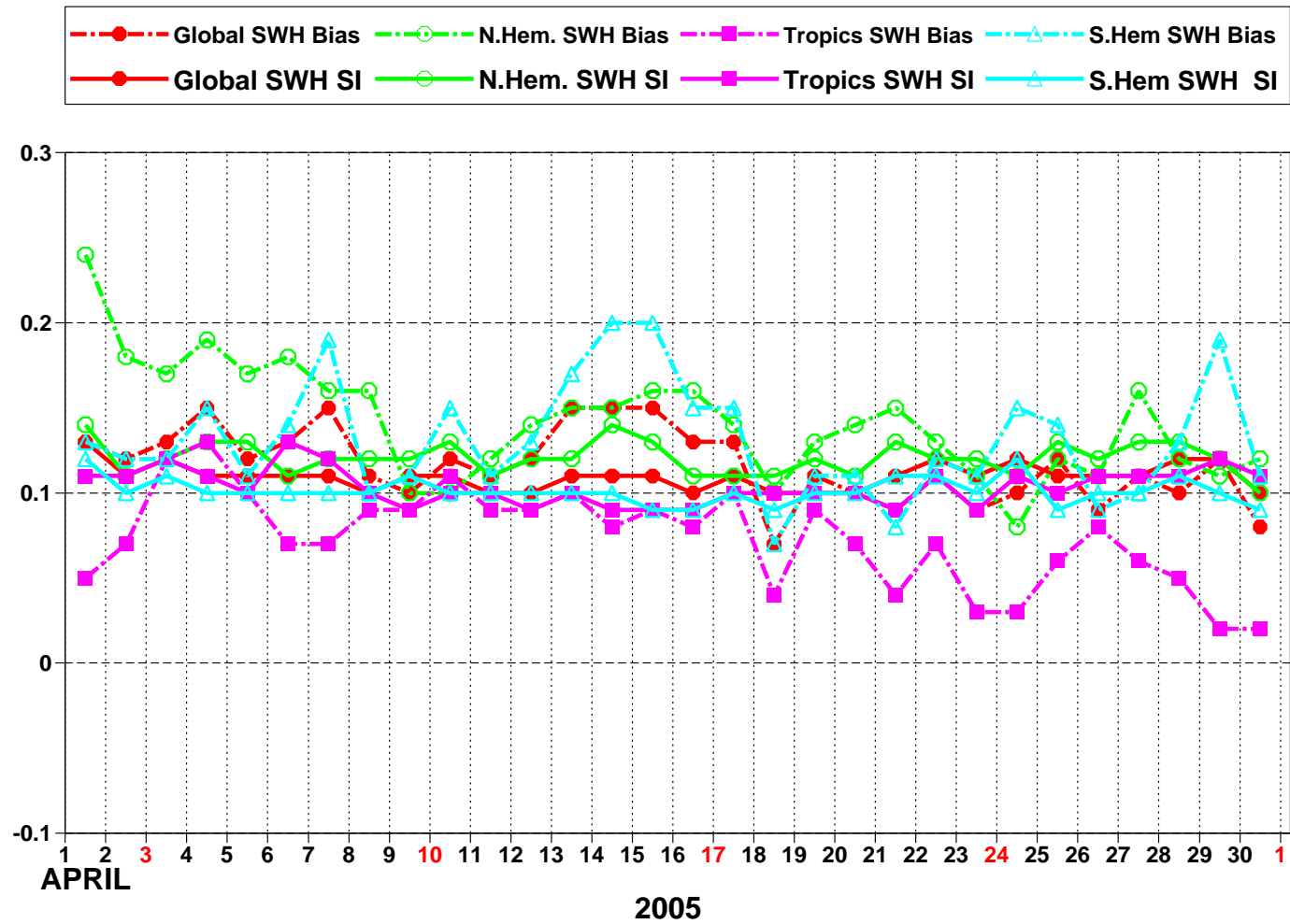


Figure 36: ENVISAT Altimeter Ku-band wave heights: Timeseries of bias (ENVISAT - WAM_FG) and scatter index (SI)



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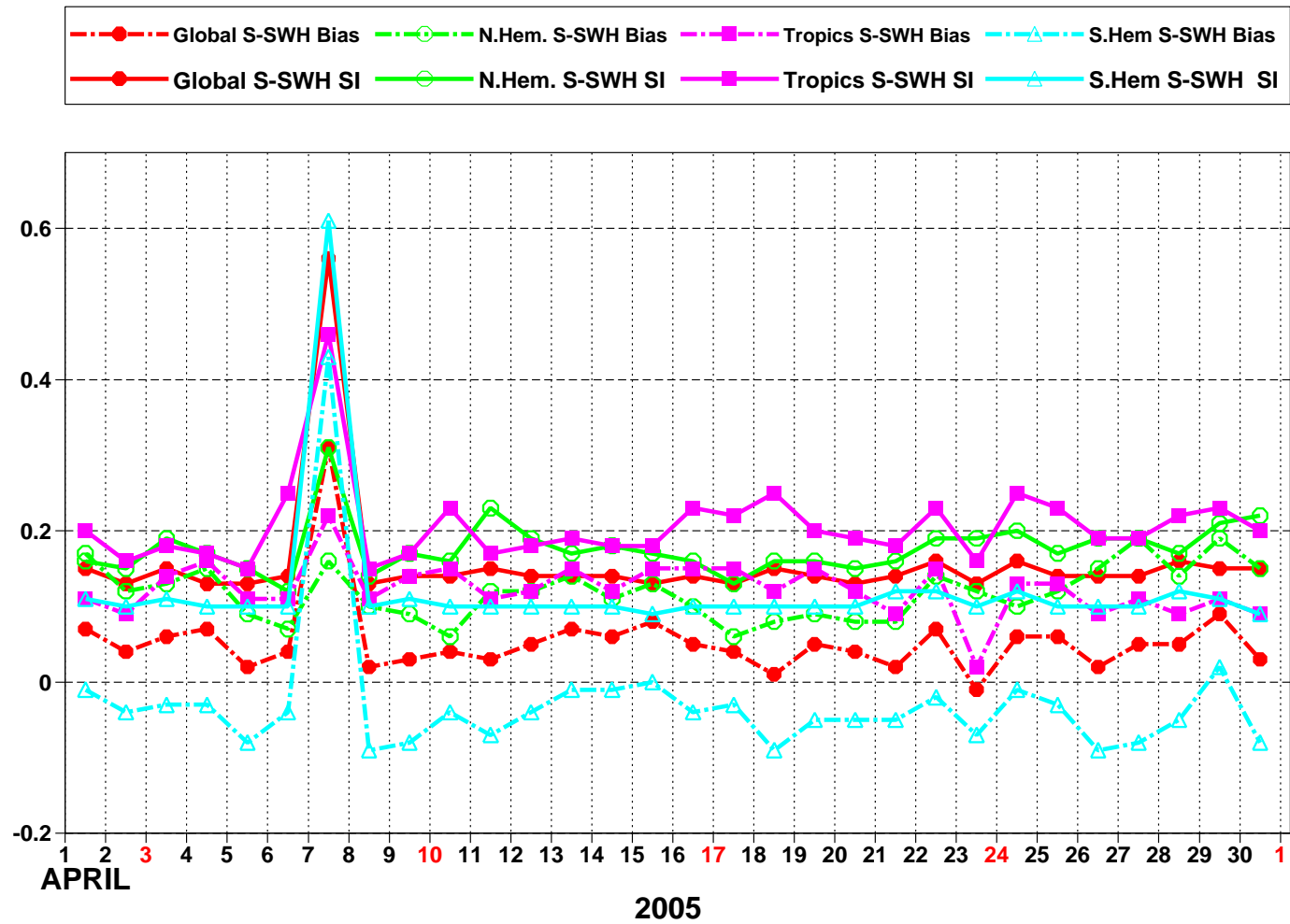


Figure 37: ENVIAT Altimeter S-band wave heights: Timeseries of bias (ENVIAT - WAM_FG) and scatter index (SI)

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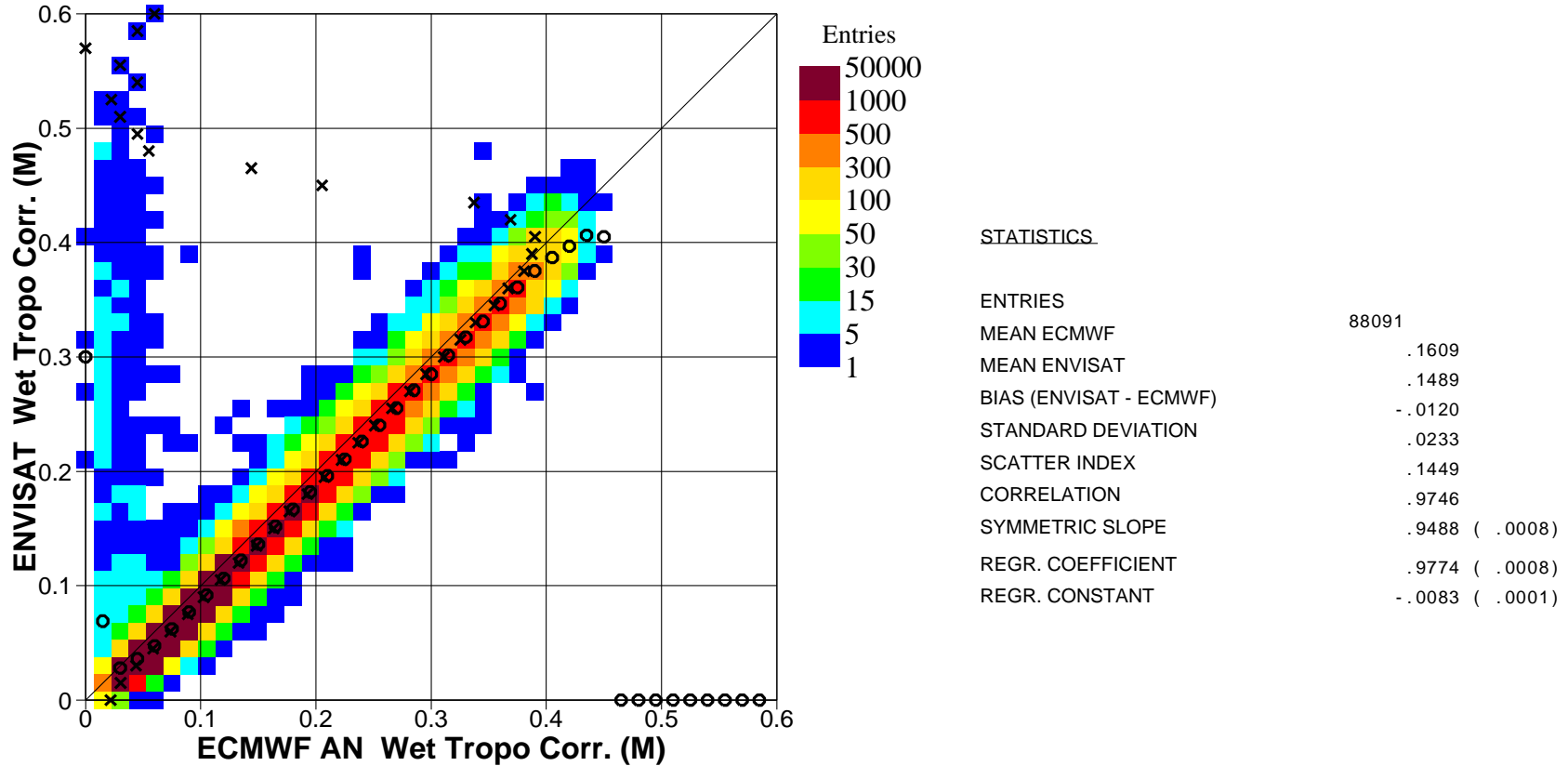


Figure 38. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2005 (Global)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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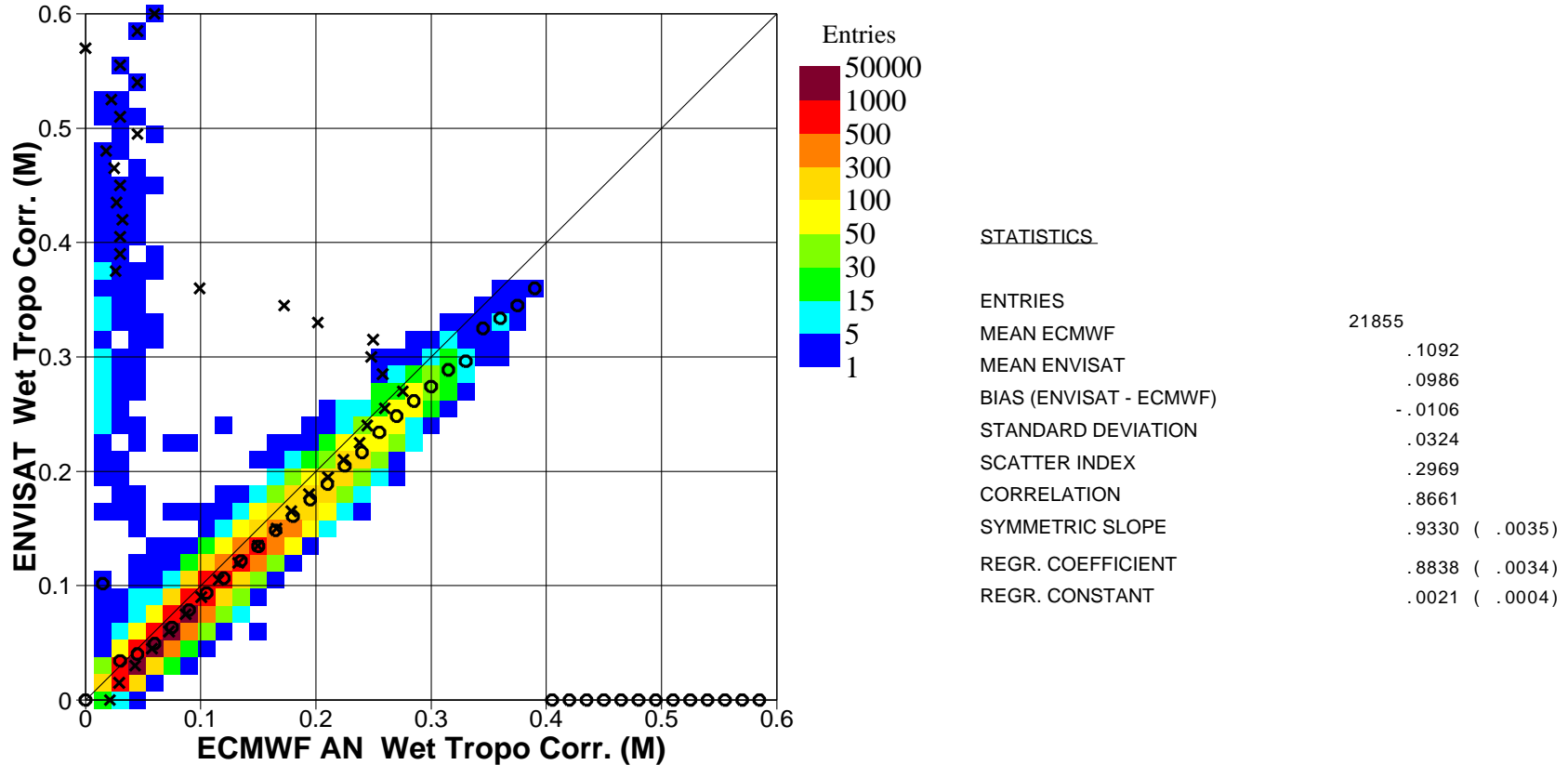


Figure 39. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2005 (N.Hem.)

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Saleh Abdalla

European Centre for Medium Range Weather Forecasts
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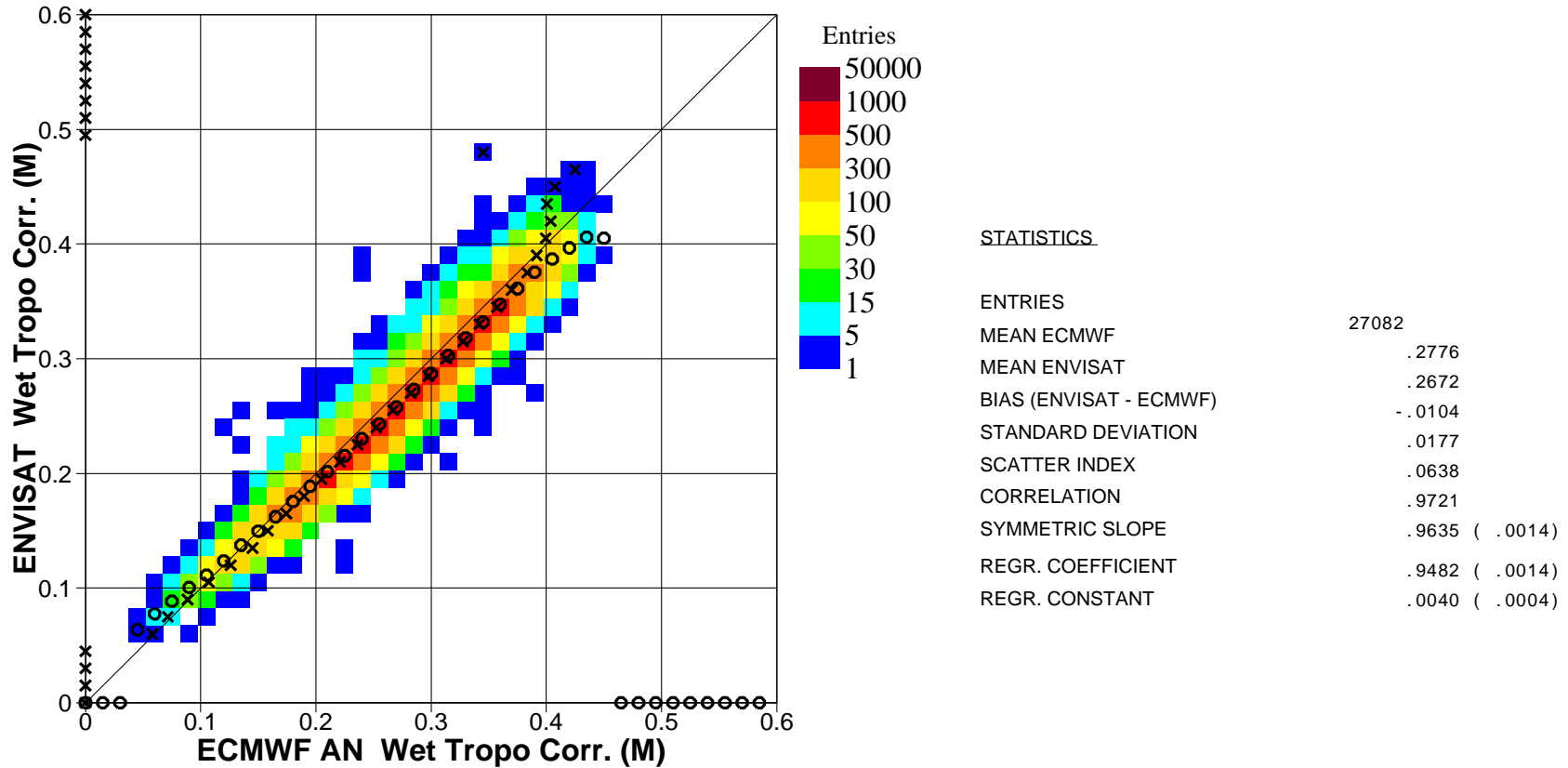


Figure 40. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2005 (Tropics)

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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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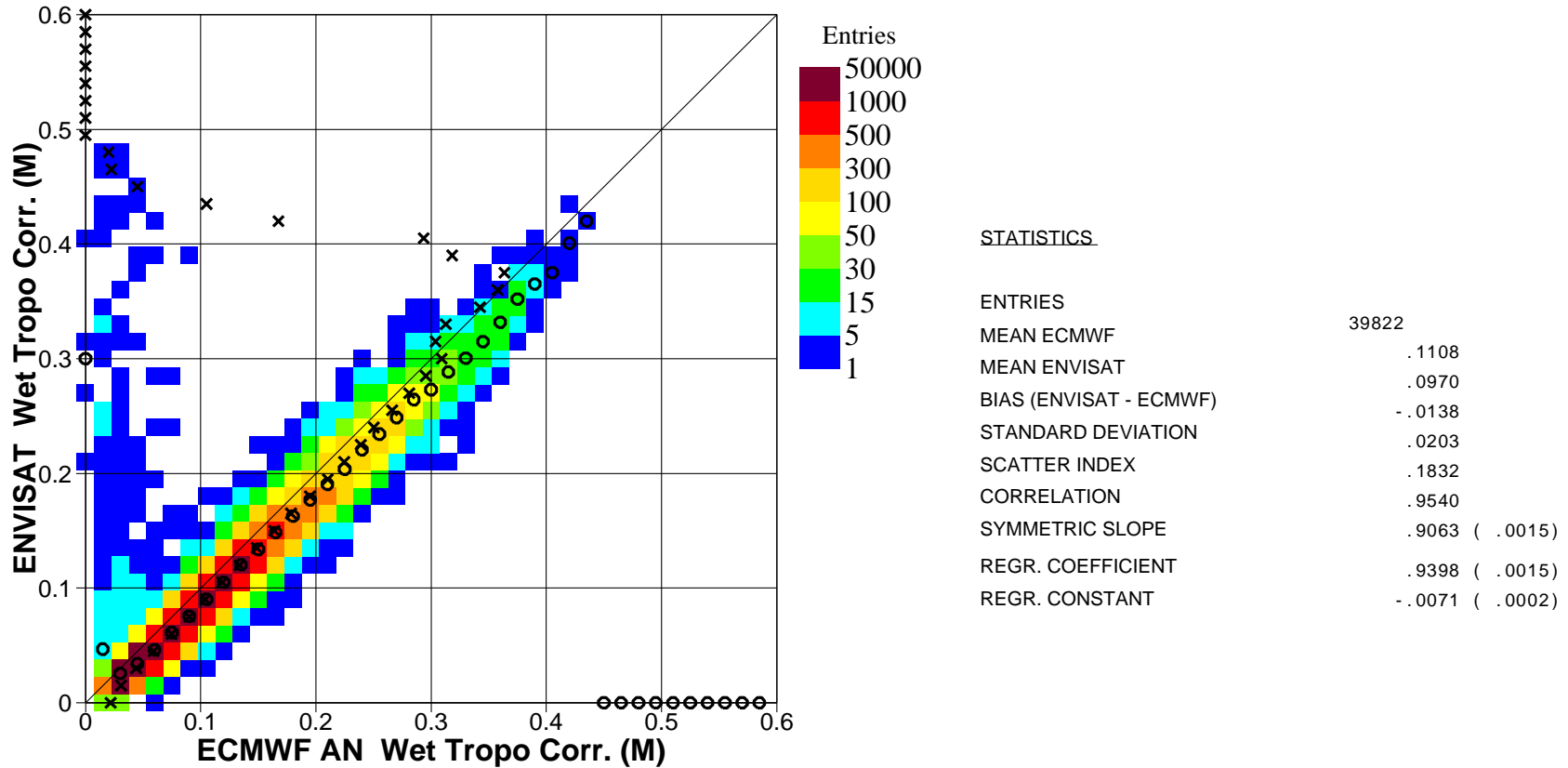


Figure 41. Comparison between ENVISAT MWR and ECMWF (analysis) wet tropo correction for April 2005 (S.Hem.)

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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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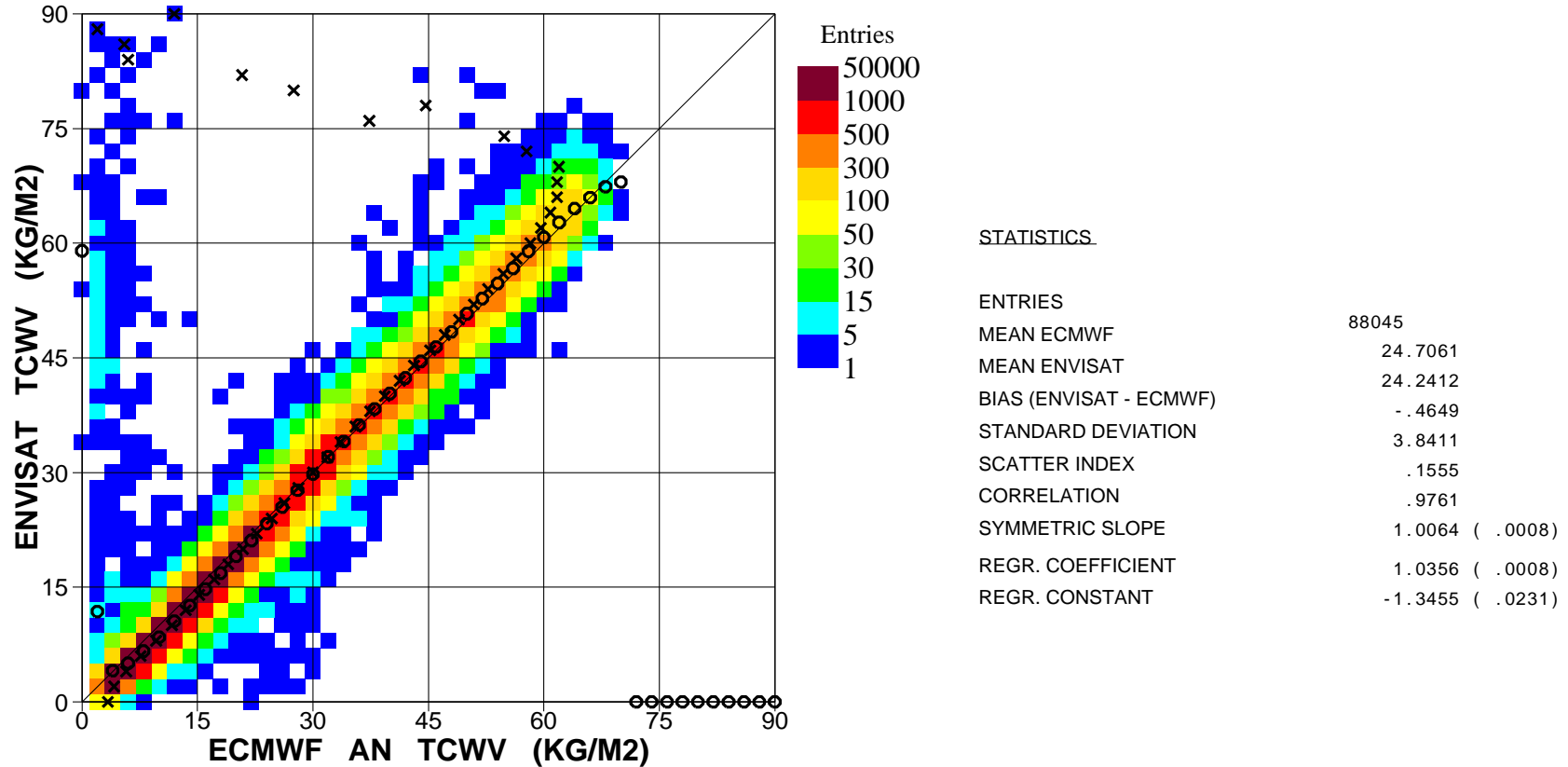


Figure 42. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2005 (Global)

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Saleh Abdalla

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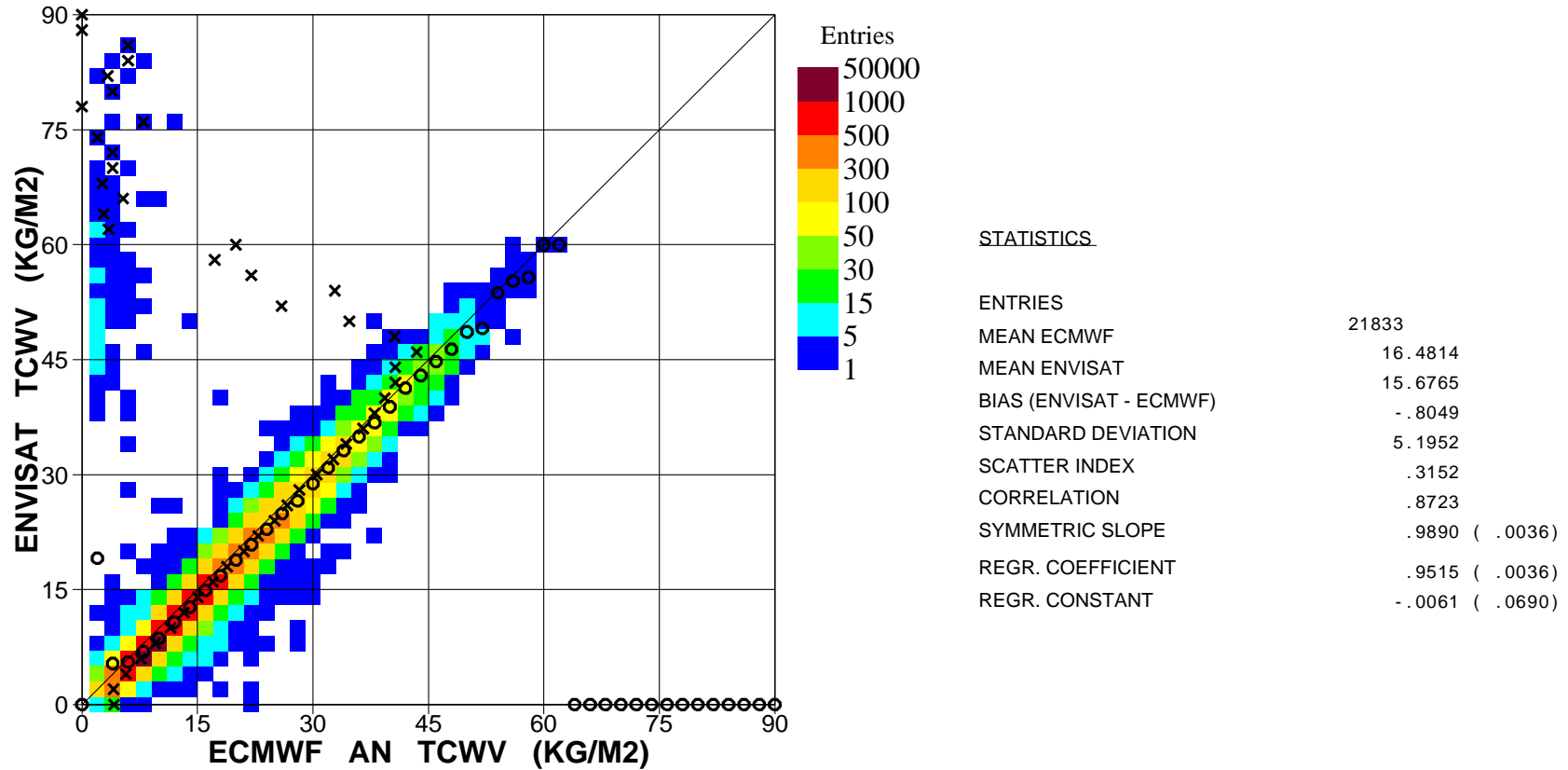


Figure 43. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2005 (N.Hem.)

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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
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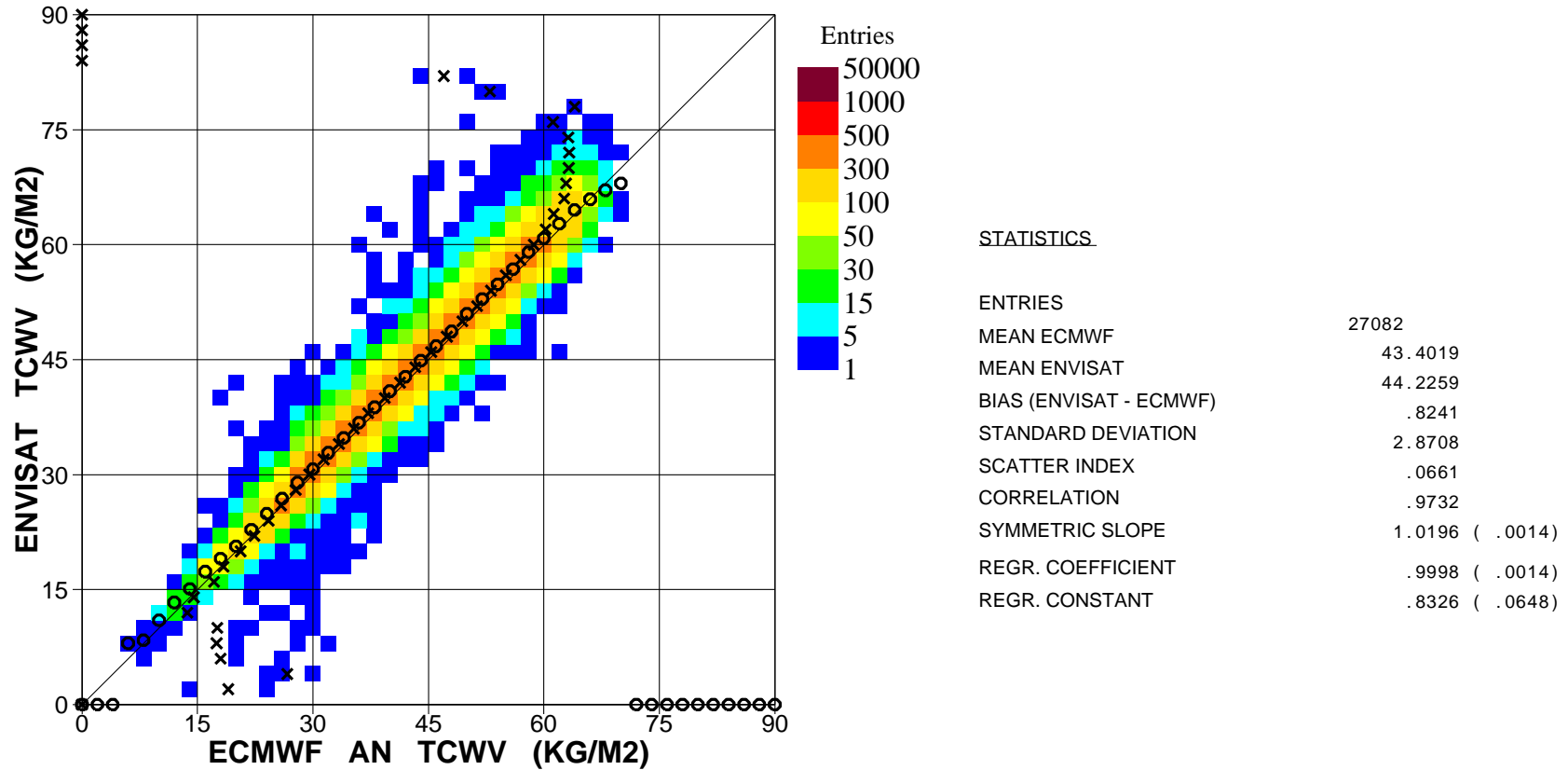


Figure 44. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2005 (Tropics)

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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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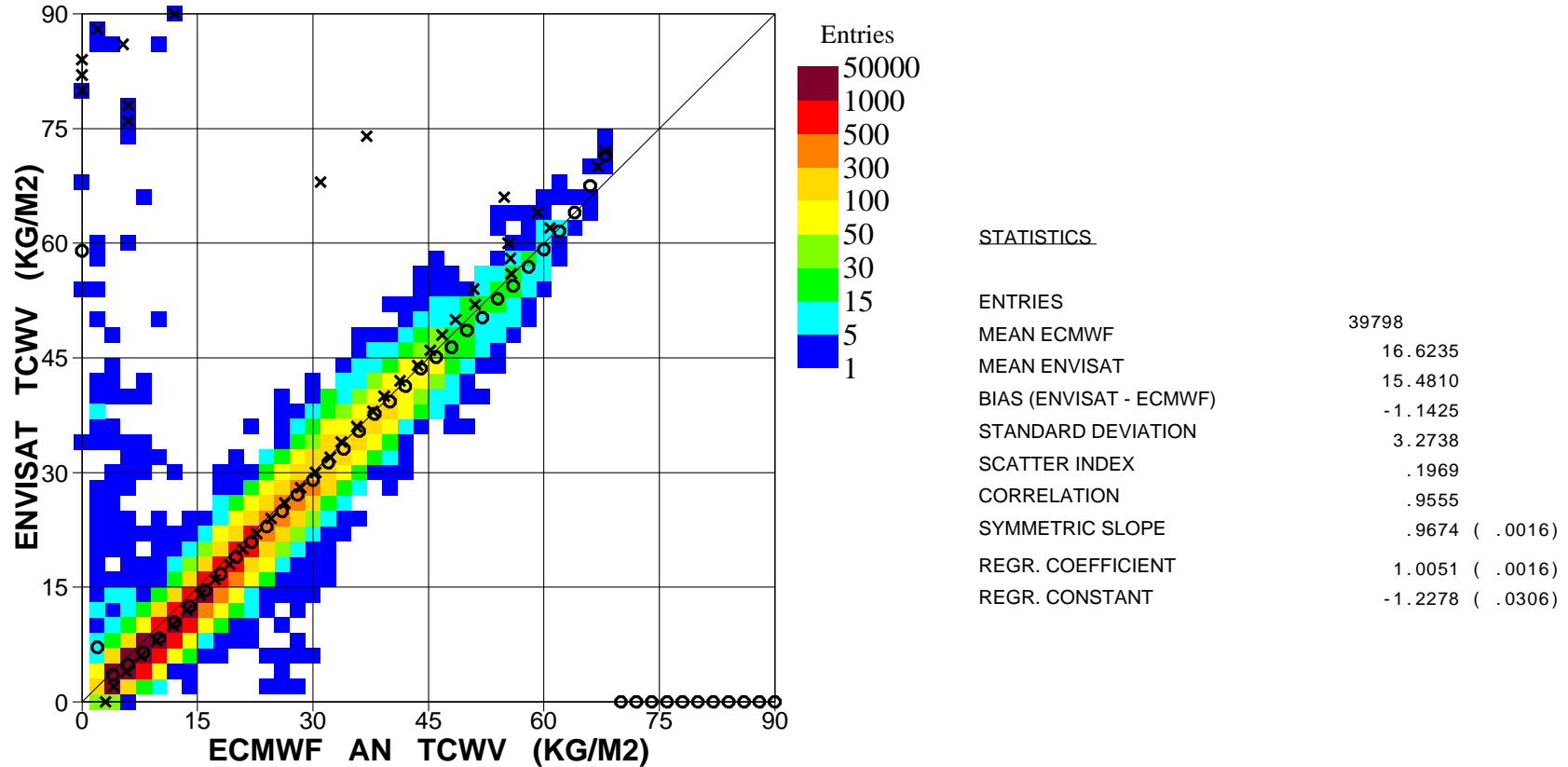


Figure 45. Comparison between ENVISAT MWR and ECMWF (analysis) total column water vapour for April 2005 (S.Hem.)

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Saleh Abdalla

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Shinfield Park, Reading, Berkshire RG2 9AX, England
Telephone: U.K. (0118) 949 9703, International (+44 118) 949 9703
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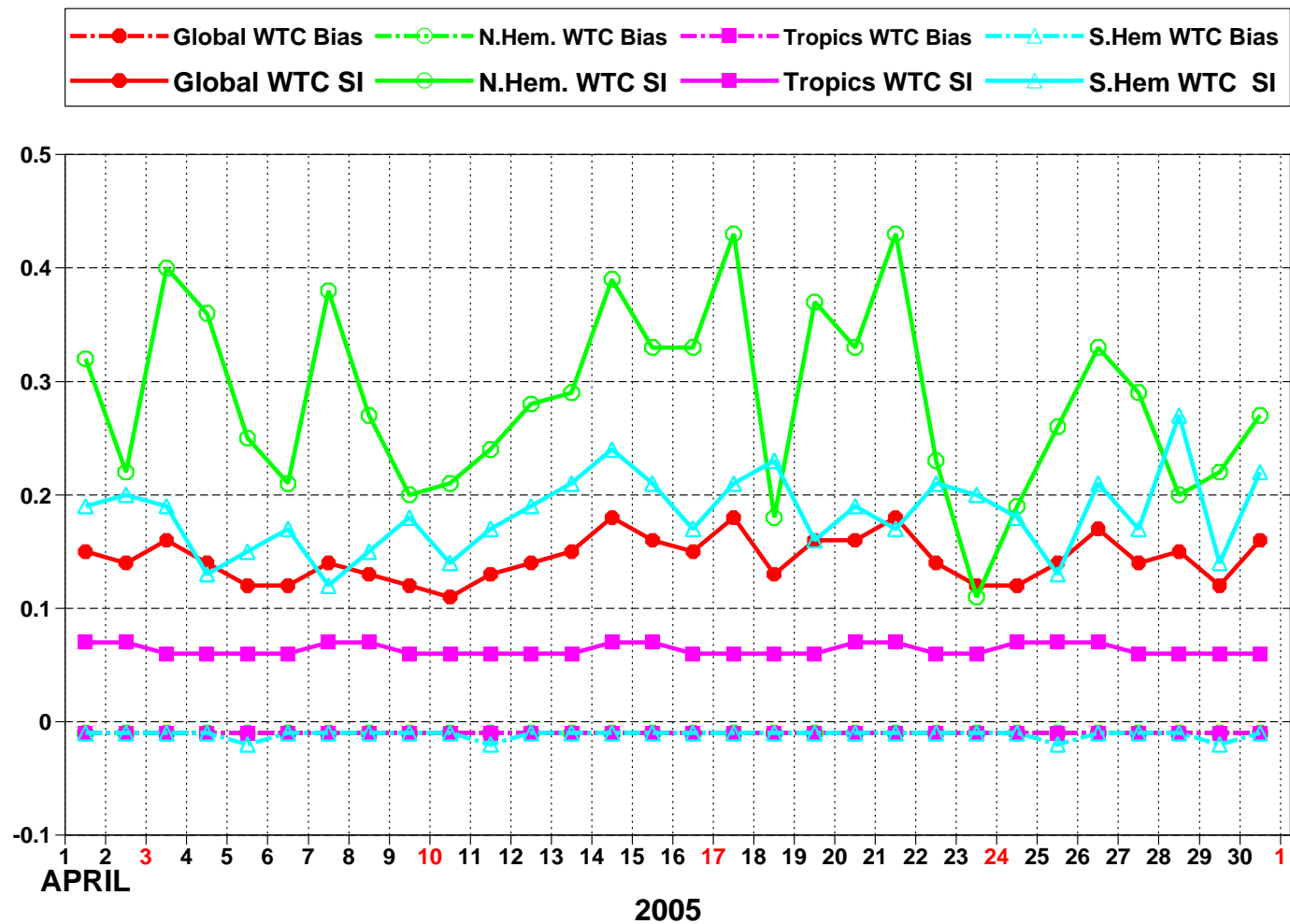


Figure 46: ENVISAT Altimeter wet tropo correction: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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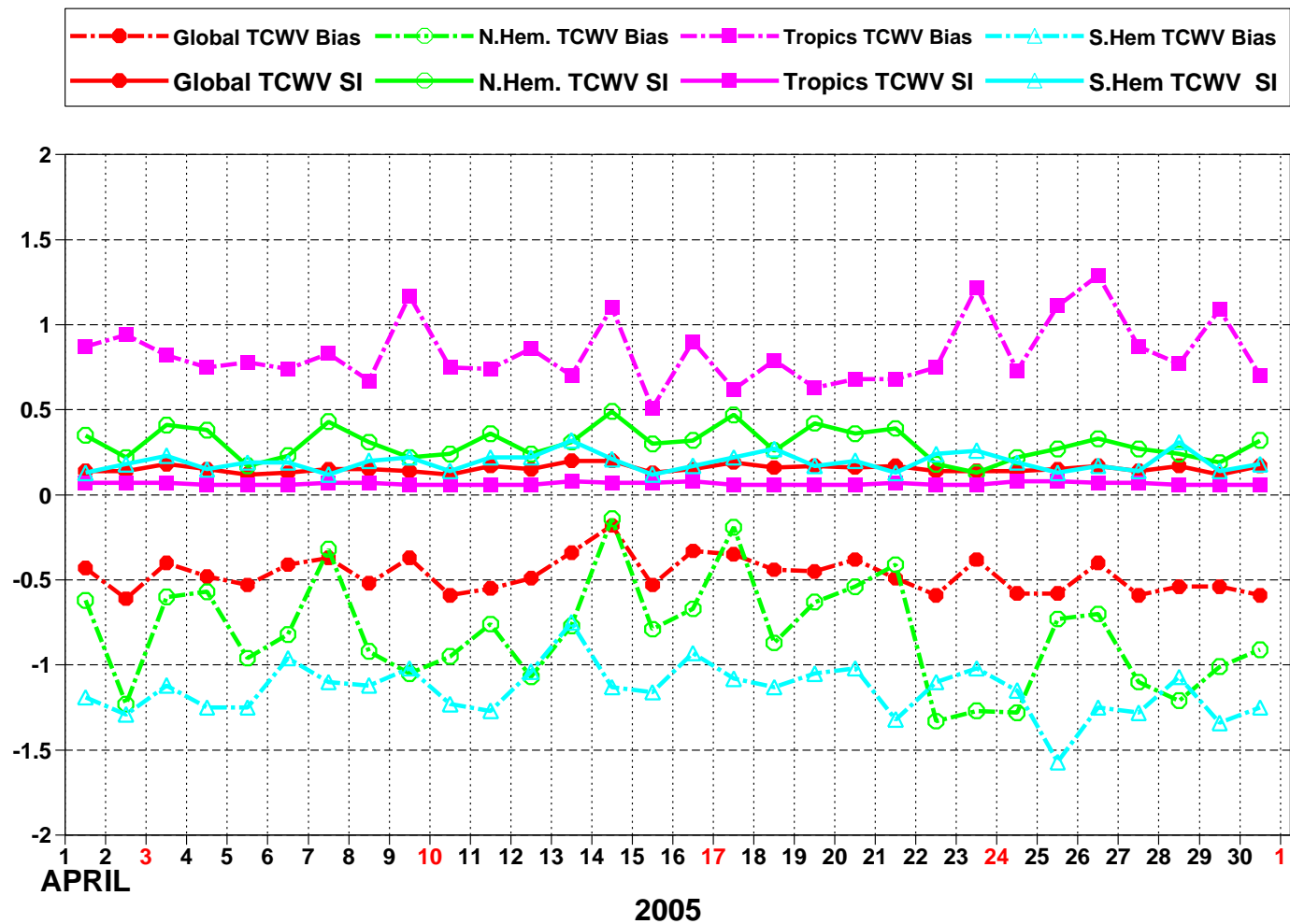


Figure 47: ENVISAT Altimeter total column water vapour: Timeseries of bias (ENVISAT - ECMWF) and scatter index (SI)

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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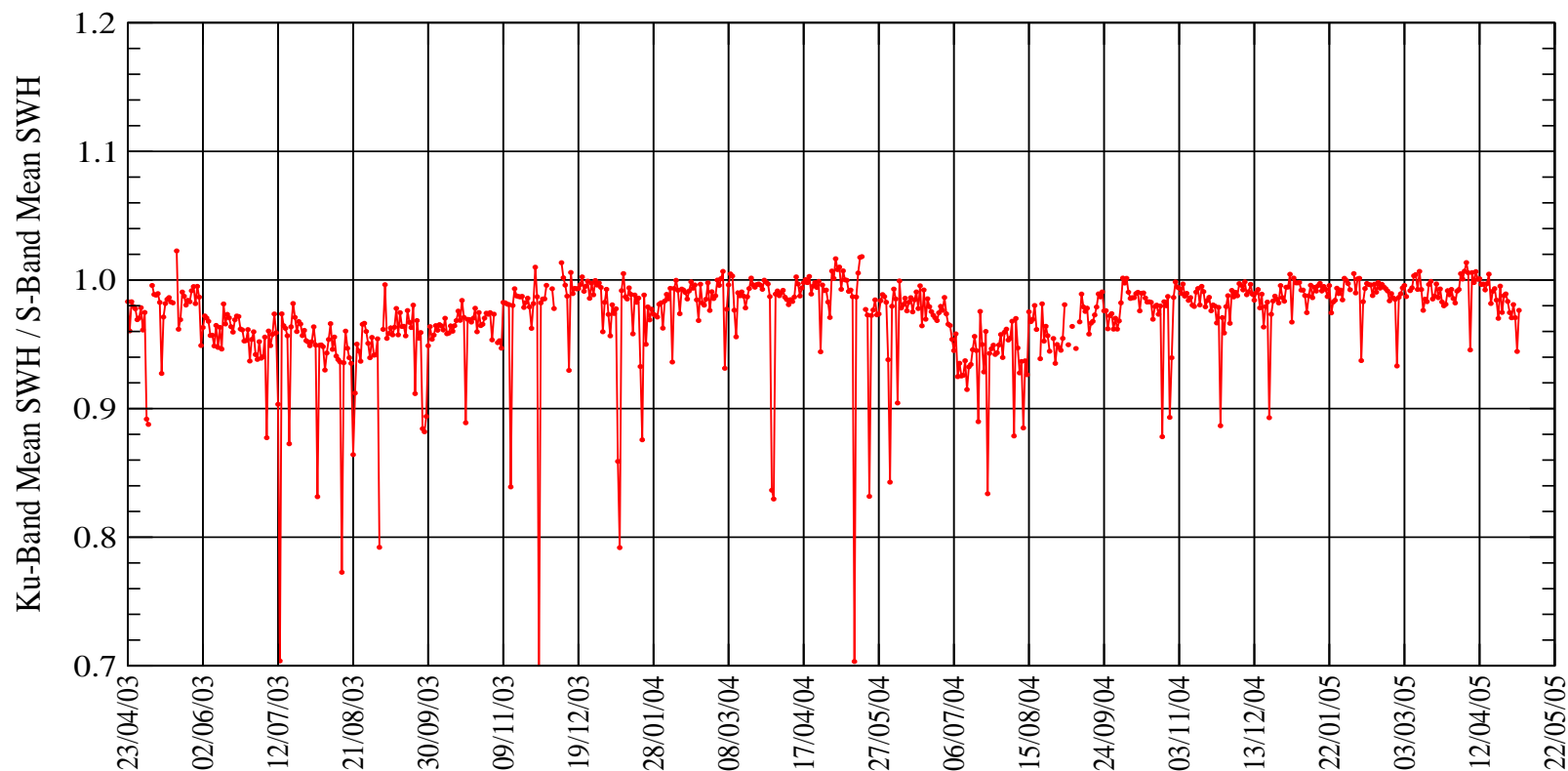


Figure 48. Timeseries of daily global ratio between mean Ku-Band to mean S-Band significant wave heights since the 23rd. of April 2003.

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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