ECMWF Report on ERS-2 SAR for June 2002

Title: Report on ERS-2 SAR wave height data.

By: *Saleh Abdalla*

Date: *5 July 2002*

Overview:

On average, about 371 SAR wave mode spectra arrived at ECMWF every 6 hours of which 17.5% have been rejected. Data coverage, which was rather good, can be seen in Figure 1. There was significant reduction in data reception on the first 5 days of the month. The ESA Earth Observation Missions Helpdesk Team announced the suspension of data transfer to the Gatineau receiving station during the period 31 May till 3 June (e-mail messages of the ESA Earth Observation Missions Helpdesk Team on June 3 and 13, 2002). However, the most significant reductions were on the 4th. and the 5th. of the month! Furthermore, data reception was significantly reduced at time slots centred at 00:00 and 06:00 on the 10th., at 06:00 on the 12th., at 18:00 on the 14th., at 12:00 on the 22nd. and at 00:00 on the 26th. of the month.

In general, the SAR data are in good agreement with the model except for a slight negative bias as can be seen in Figures 11 and 12.

Wave Height Comparison (bias):

ERS-2 global: -0.026 m

ERS-2 northern hemisphere: 0.080 m

ERS-2 tropics: 0.012 m

ERS-2 southern hemisphere: -0.108 m

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Remarks:

- As it was stated in the last few reports, the SAR data quality has been improved relative to that during the year 2001. Even further improvement was experienced recently just after the recovery from the anomaly of March 2002 (on March 21). Apparently, this can be attributed to the ERS- 2 yaw control system which makes use of some of the data coming from SAR imagette processing. This yaw control system was implemented on March 4, 2002. The impact of this system on the SAR data quality was not felt earlier because of the anomaly which lasted about 2 weeks.

Definitions:

Four new integrated parameters are used to compare the SAR and the model spectra. These parameters are:

1. The mean wave period based on the '-1*th.*' moment (m_{-1}) defined as:

   $T_{-1} = m_{-1} / m_0$

   where m_0 and m_{-1} are the zeroth and the '-1*th.*' moments of the wave spectrum with the *n-th*. moment, in general, is defined as:

   $$m_n = \int d\theta \int df \cdot f^n \cdot F(f, \theta)$$

   F is the wave spectrum in frequency, f, - direction space. The comparison between ECMWF model and SAR mean wave periods for the whole month is given in Figure 7.

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2. The wave directional spread defined as:

$$\sigma = \sqrt{2[1 - r_1(f)]}$$

$$r_1(f) = \int df \int d\theta \cdot F(f,\theta) \cdot \cos[\theta - \varphi(f)]$$

$$\varphi(f) = \text{atan}\left\{ [\int d\theta \cdot F(f,\theta) \cdot \sin(\theta)] / [\int d\theta \cdot F(f,\theta) \cdot \cos(\theta)] \right\}$$

The comparison between ECMWF model and SAR wave directional spread values for the whole month is given in Figure 8.

3. The mean wave propagation direction defined as:

$$\varphi = \text{atan}\left\{ [\int df \int d\theta \cdot F(f,\theta) \cdot \sin(\theta)] / [\int df \int d\theta \cdot F(f,\theta) \cdot \cos(\theta)] \right\}$$

The comparison between ECMWF model and SAR mean wave propagation directions for the whole month is given in Figure 9.

4. The spectral peakedness parameter of Goda (Q_p) defined as:

$$Q_p = 2m_0^{-2} \int d\theta \int df \cdot f \cdot F^2(f,\theta)$$

The comparison between ECMWF model and SAR spectral peakedness (or roughly, spectral narrowness) values for the whole month is given in Figure 10.

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Figure captions:

Figure 1: Time series of data reception for ERS-2 Altimeter data for June 2002.

Figure 2: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for June 2002 (global).

Figure 3: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for June 2002 (northern hemisphere)

Figure 4: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for June 2002 (tropics)

Figure 5: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for June 2002 (southern hemisphere)

Figure 6: ERS-2 SAR wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI).

Figure 7: Comparison of ECMWF mean wave periods with ERS-2 SAR mean wave periods for June 2002 (global).

Figure 8: Comparison of ECMWF wave directional spread with that of ERS-2 SAR for June 2002 (global).

Figure 9: Comparison of ECMWF mean wave directions with those of ERS-2 SAR for June 2002 (global).

Figure 10: Comparison of ECMWF wave peakedness factor with that of ERS-2 SAR for June 2002 (global).

Figure 11: ERS-2 SAR wave heights: Timeseries of daily bias (ERS-2 - model) for the past year.

Figure 12: ERS-2 SAR wave heights: Timeseries of daily root mean square difference (RMSE) for the past year.

Figure 13: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for June 2002 (global).

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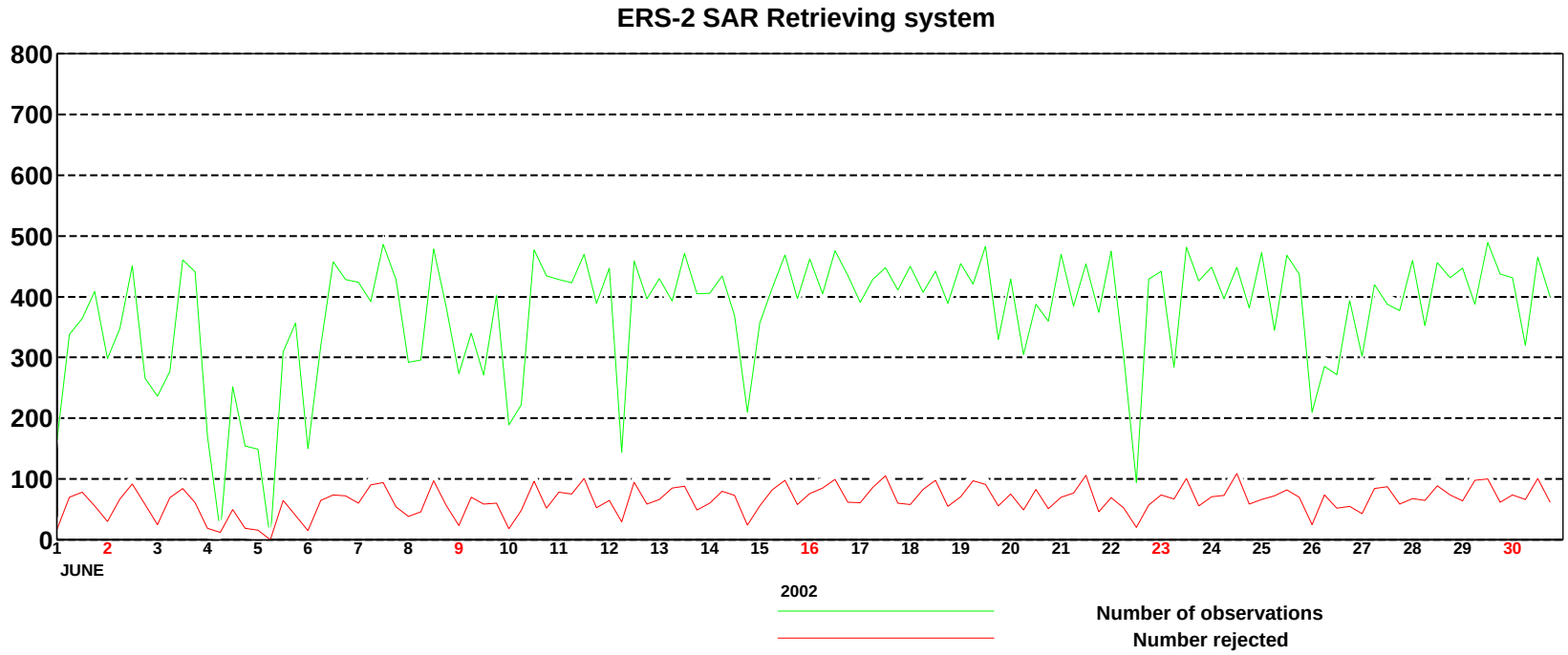

Figure 1: Time series of data reception for ERS-2 SAR wave mode spectra for June 2002

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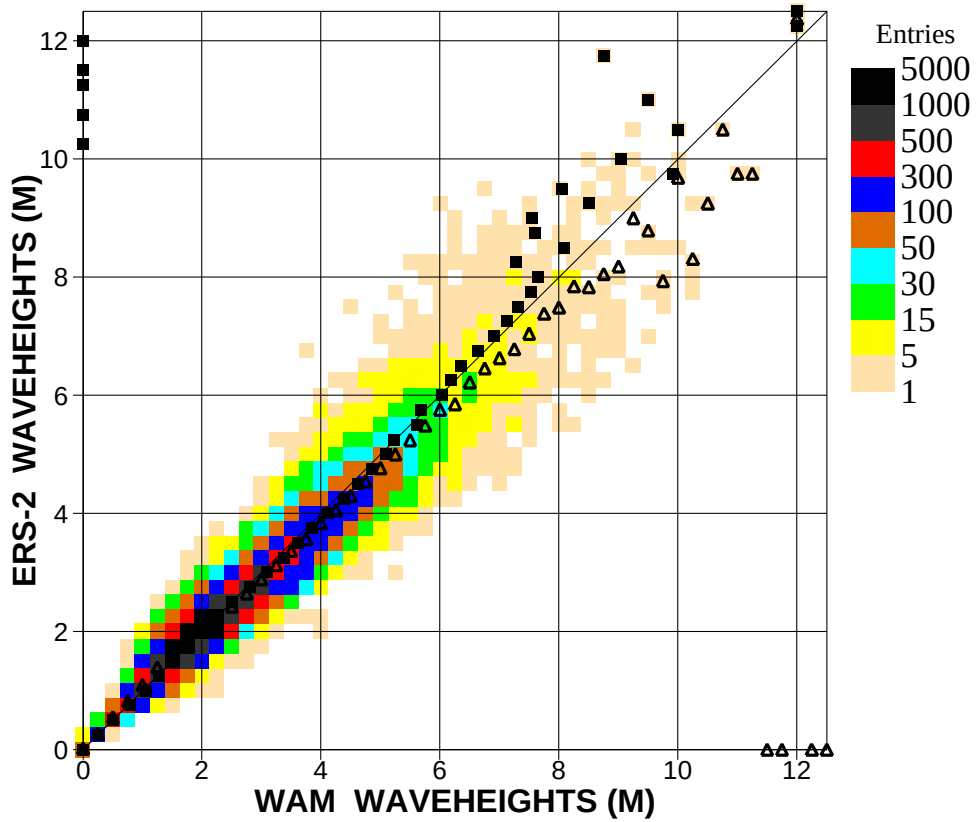

STATISTICS

ENTRIES	37010
MEAN WAM	2.5019
MEAN ERS-2	2.4755
BIAS (ERS-2 - WAM)	-0.0264
STANDARD DEVIATION	0.3615
SCATTER INDEX	0.1445
CORRELATION	0.9587
SYMMETRIC SLOPE	0.9813(0.0015)
REGR. COEFFICIENT	0.9096(0.0014)
REGR. CONSTANT	0.1998(0.0039)

Figure 2: Comparison of ECMWF wave height results with ERS2 SAR wave height data for June 2002 (global)

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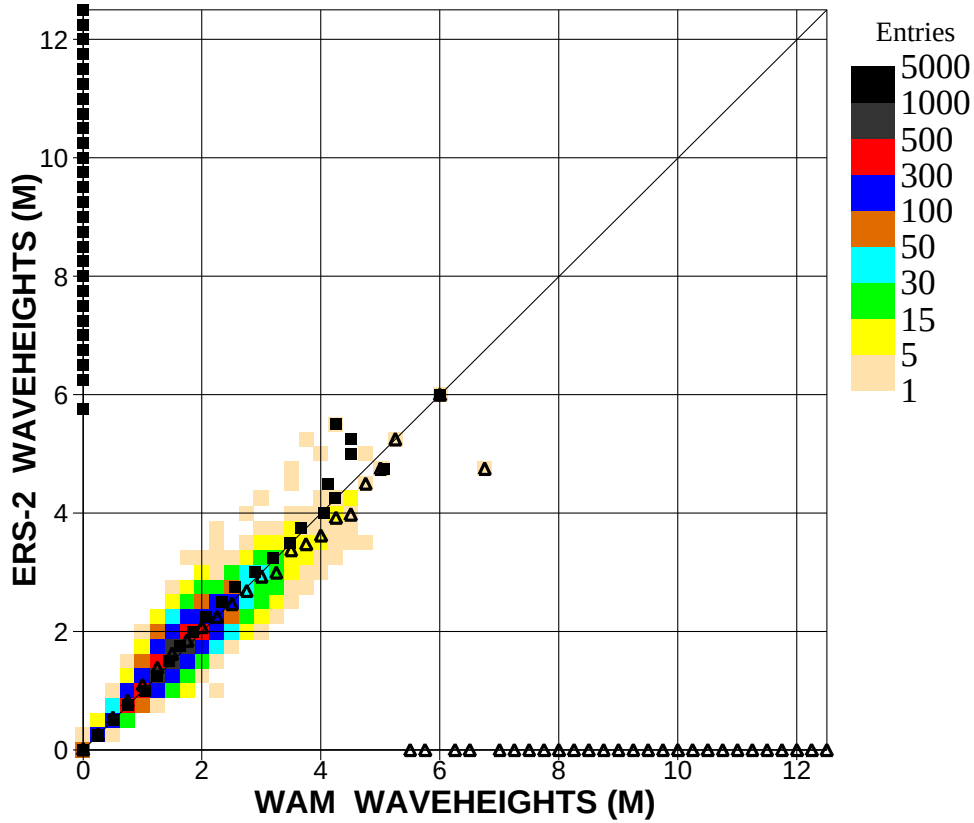

STATISTICS

ENTRIES	8625
MEAN WAM	1.5656
MEAN ERS-2	1.6457
BIAS (ERS-2 - WAM)	0.0801
STANDARD DEVIATION	0.2419
SCATTER INDEX	0.1545
CORRELATION	0.9298
SYMMETRIC SLOPE	1.0450 (0.0042)
REGR. COEFFICIENT	0.9372 (0.0040)
REGR. CONSTANT	0.1784 (0.0068)

Figure 3: Comparison of ECMWF wave height results with ERS2 SAR wave height data for June 2002 (n.hem.)

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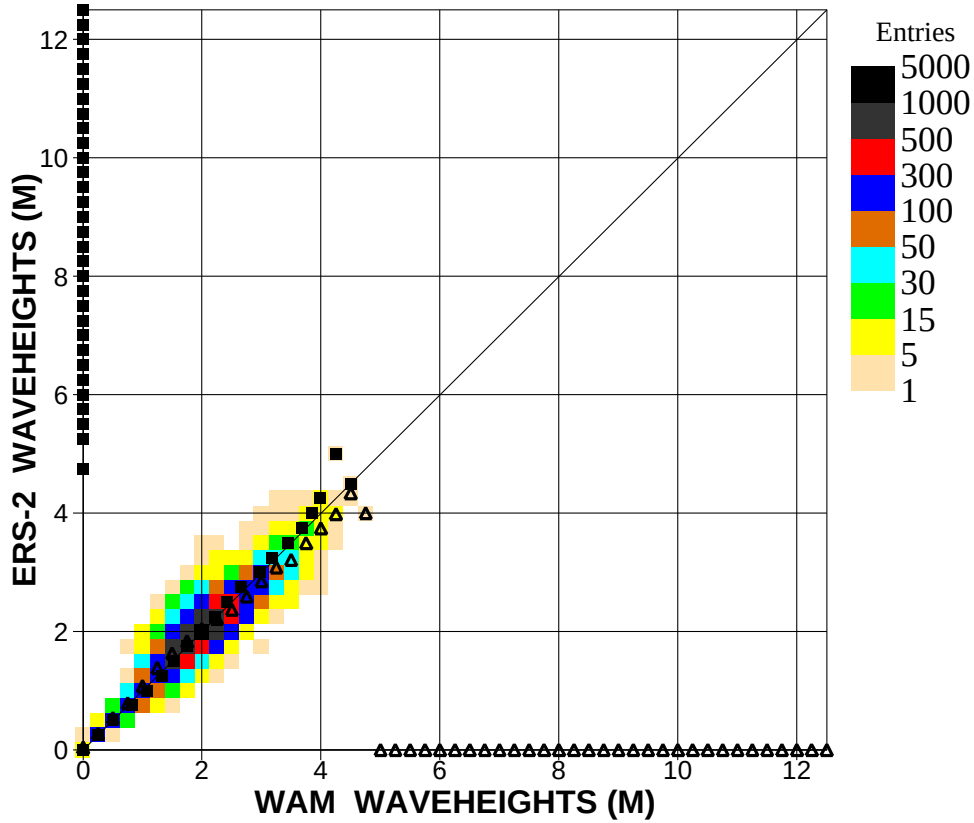

STATISTICS

ENTRIES	11746
MEAN WAM	1.9681
MEAN ERS-2	1.9804
BIAS (ERS-2 - WAM)	0.0123
STANDARD DEVIATION	0.2589
SCATTER INDEX	0.1315
CORRELATION	0.9046
SYMMETRIC SLOPE	1.0020(0.0040)
REGR. COEFFICIENT	0.8652(0.0038)
REGR. CONSTANT	0.2776(0.0077)

Figure 4: Comparison of ECMWF wave height results with ERS2 SAR wave height data for June 2002 (tropics)

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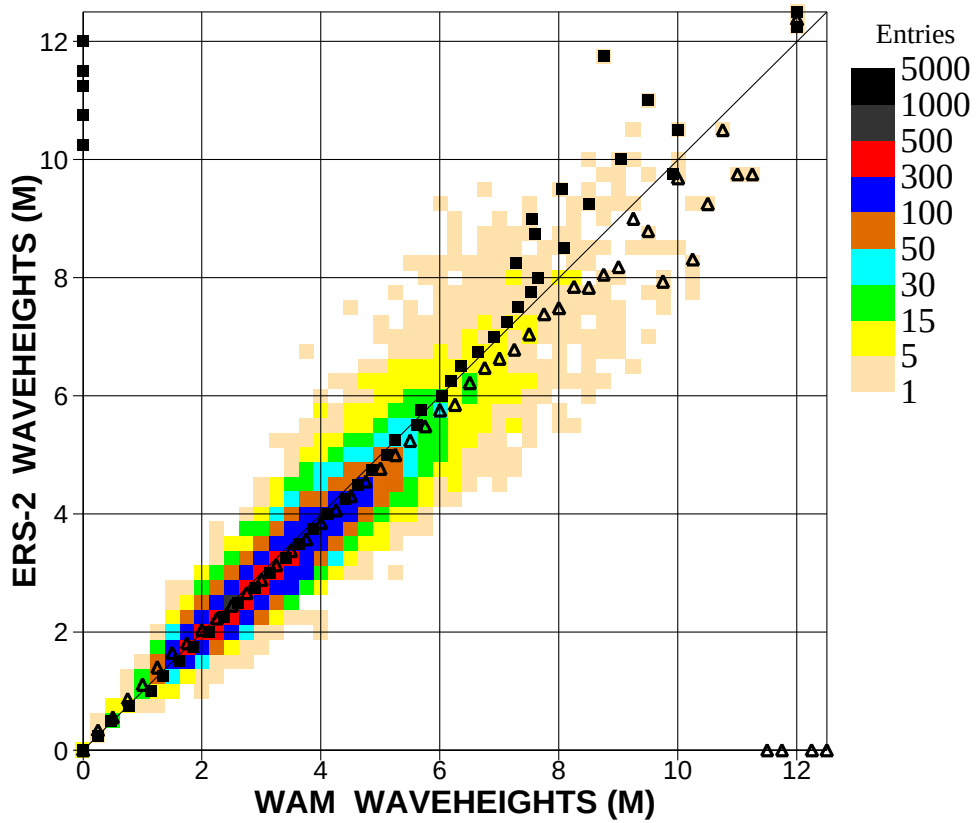

STATISTICS

ENTRIES	16896
MEAN WAM	3.3459
MEAN ERS-2	3.2380
BIAS (ERS-2 - WAM)	-0.1079
STANDARD DEVIATION	0.4445
SCATTER INDEX	0.1328
CORRELATION	0.9415
SYMMETRIC SLOPE	0.9689(0.0026)
REGR. COEFFICIENT	0.9190(0.0025)
REGR. CONSTANT	0.1631(0.0091)

Figure 5: Comparison of ECMWF wave height results with ERS2 SAR wave height data for June 2002 (s.hem.)

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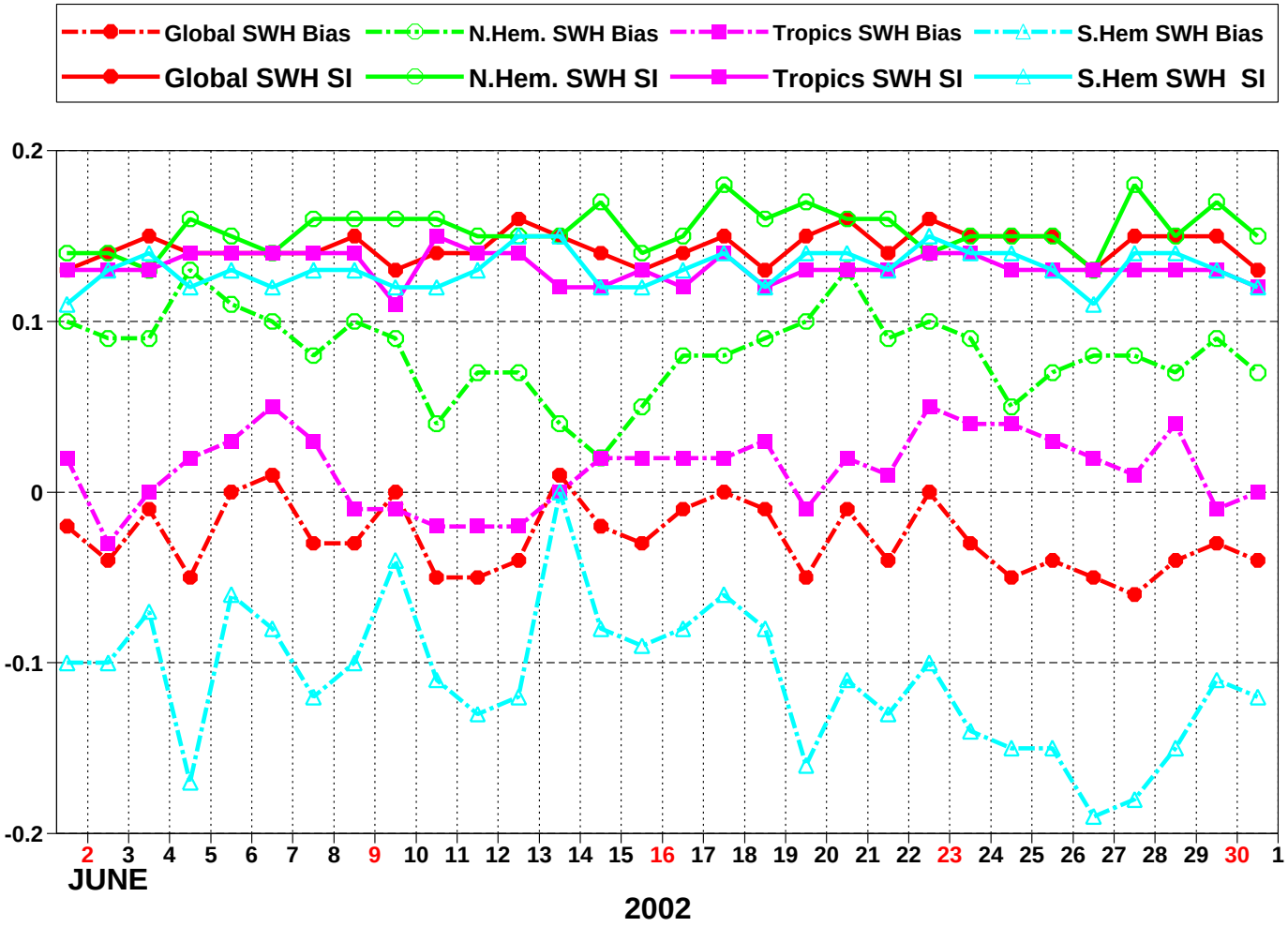

Figure 6: ERS-2 SAR wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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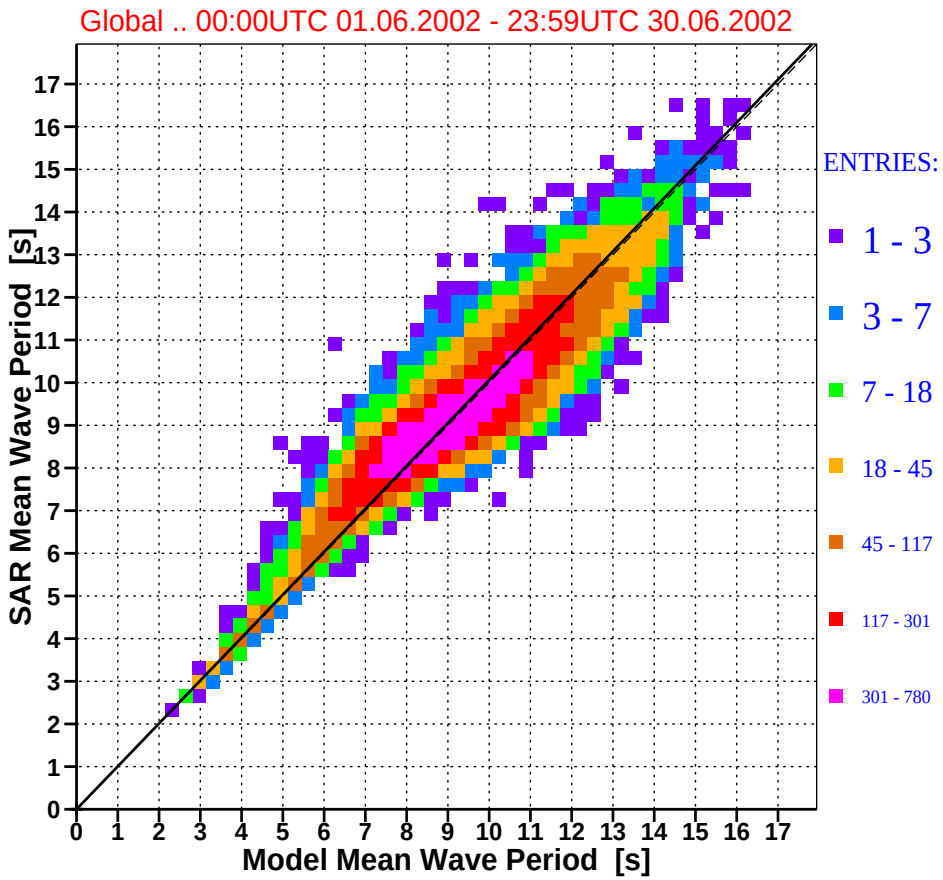

Entries = 36829
SAR mean = 9.40 ; stdev = 1.622
Model mean = 9.30 ; stdev = 1.814
LSQ fit: slope = 0.821 ; intr = 1.764
R.M.S.E. = 0.727 ; bias = 0.094
corr. coef. = 0.918 ; S.I. = 0.077
Symmetric slope = 1.006

Figure 7: Comparison of ECMWF mean wave periods with ERS-2 SAR mean wave periods for June 2002 (global).

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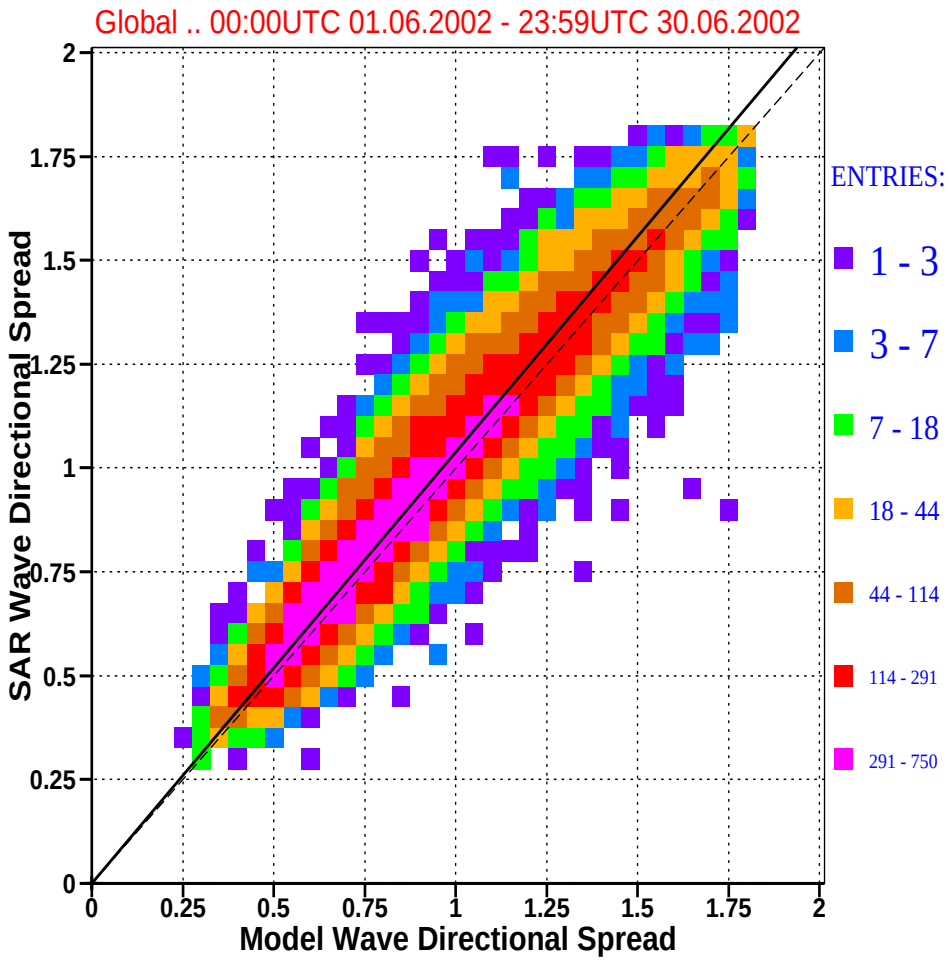

Entries = 36829
SAR mean = 0.95 ; stdev = 0.309
Model mean = 0.91 ; stdev = 0.308
LSQ fit: slope = 0.958 ; intr = 0.078
R.M.S.E. = 0.101 ; bias = 0.039
corr. coef. = 0.954 ; S.I. = 0.102
Symmetric slope = 1.039

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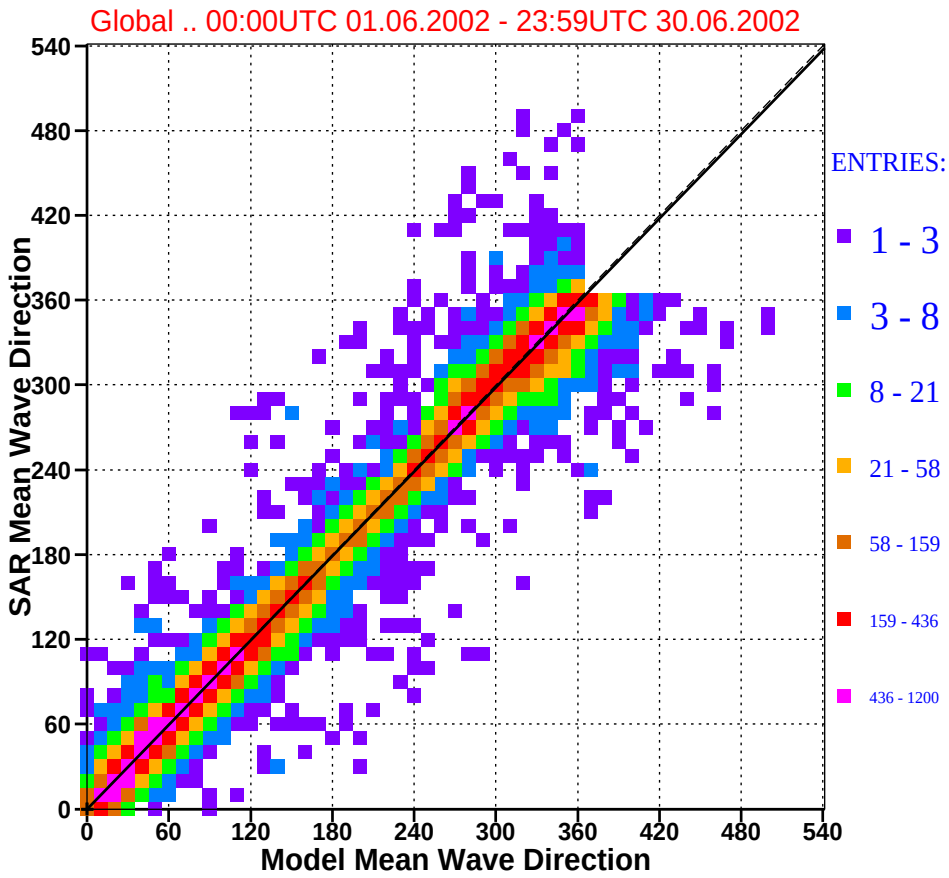

Entries = 36829
SAR mean = 158.7 ; stdev = 121.66
Model mean = 159.9 ; stdev = 121.91
LSQ fit: slope = 0.992 ; intr = 0.18
R.M.S.E. = 13.85 ; bias = -1.18
corr. coef. = 0.994 ; S.I. = 0.086
Symmetric slope = 0.995

Figure 9: Comparison of ECMWF mean wave directions with those of ERS-2 SAR for June 2002 (global).

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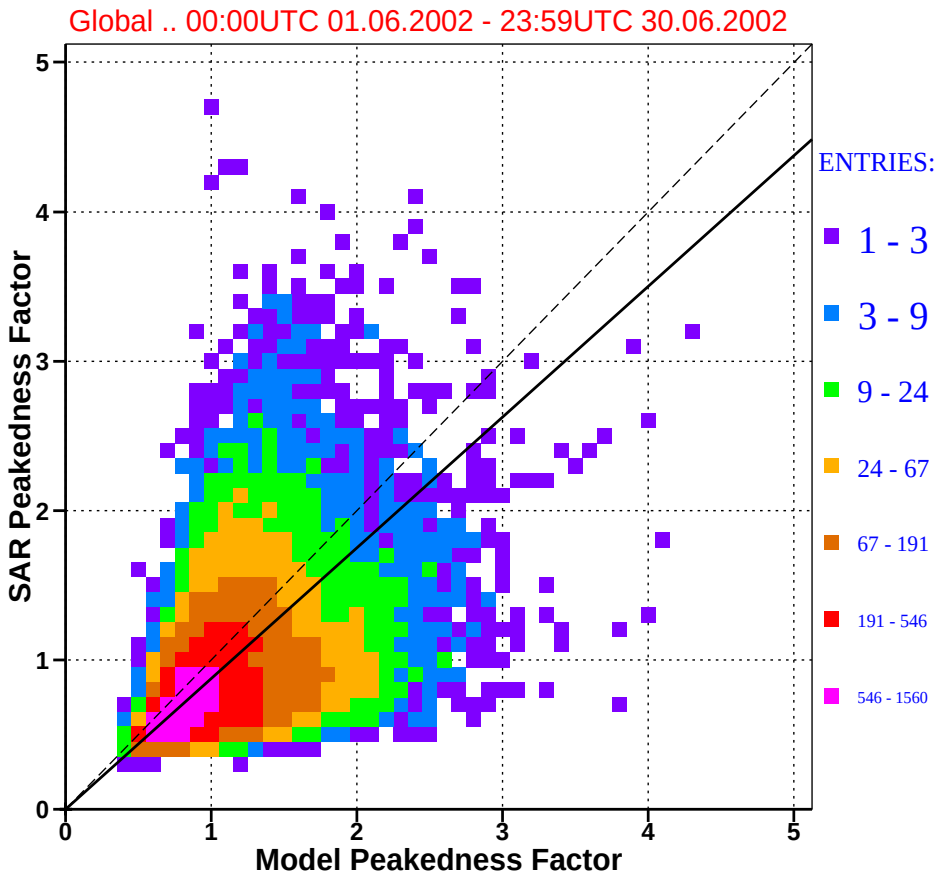

Entries = 36829
SAR mean = 0.90 ; stdev = 0.402
Model mean = 1.07 ; stdev = 0.378
LSQ fit: slope = 0.512 ; intr = 0.359
R.M.S.E. = 0.430 ; bias = -0.161
corr. coef. = 0.481 ; S.I. = 0.374
Symmetric slope = 0.875

Figure 10: Comparison of ECMWF wave peakedness factor with that of ERS-2 SAR for June 2002 (global).

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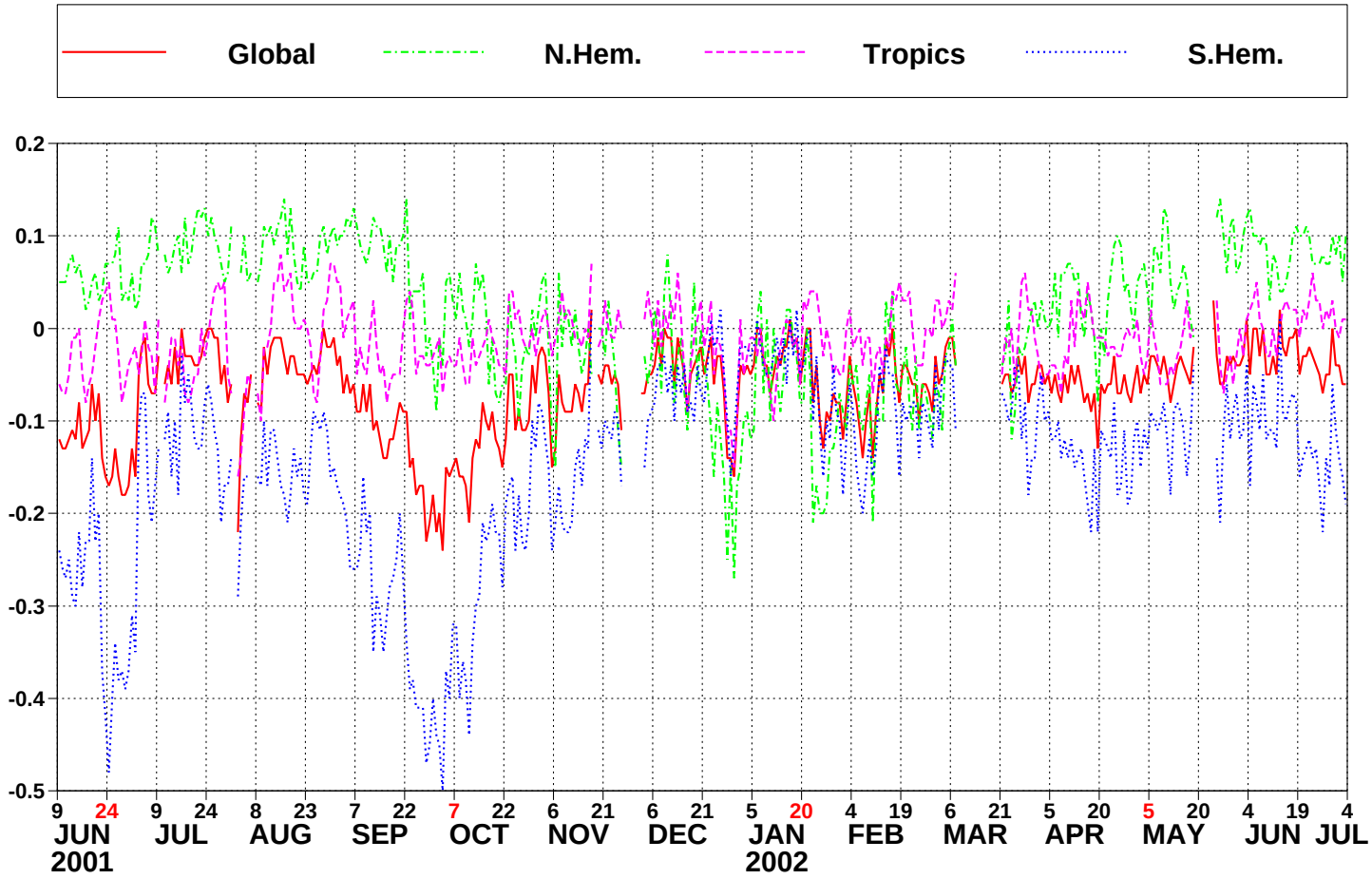

Figure 11: ERS-2 SAR wave heights: Timeseries of daily bias (ERS-2 - model) for the past year.

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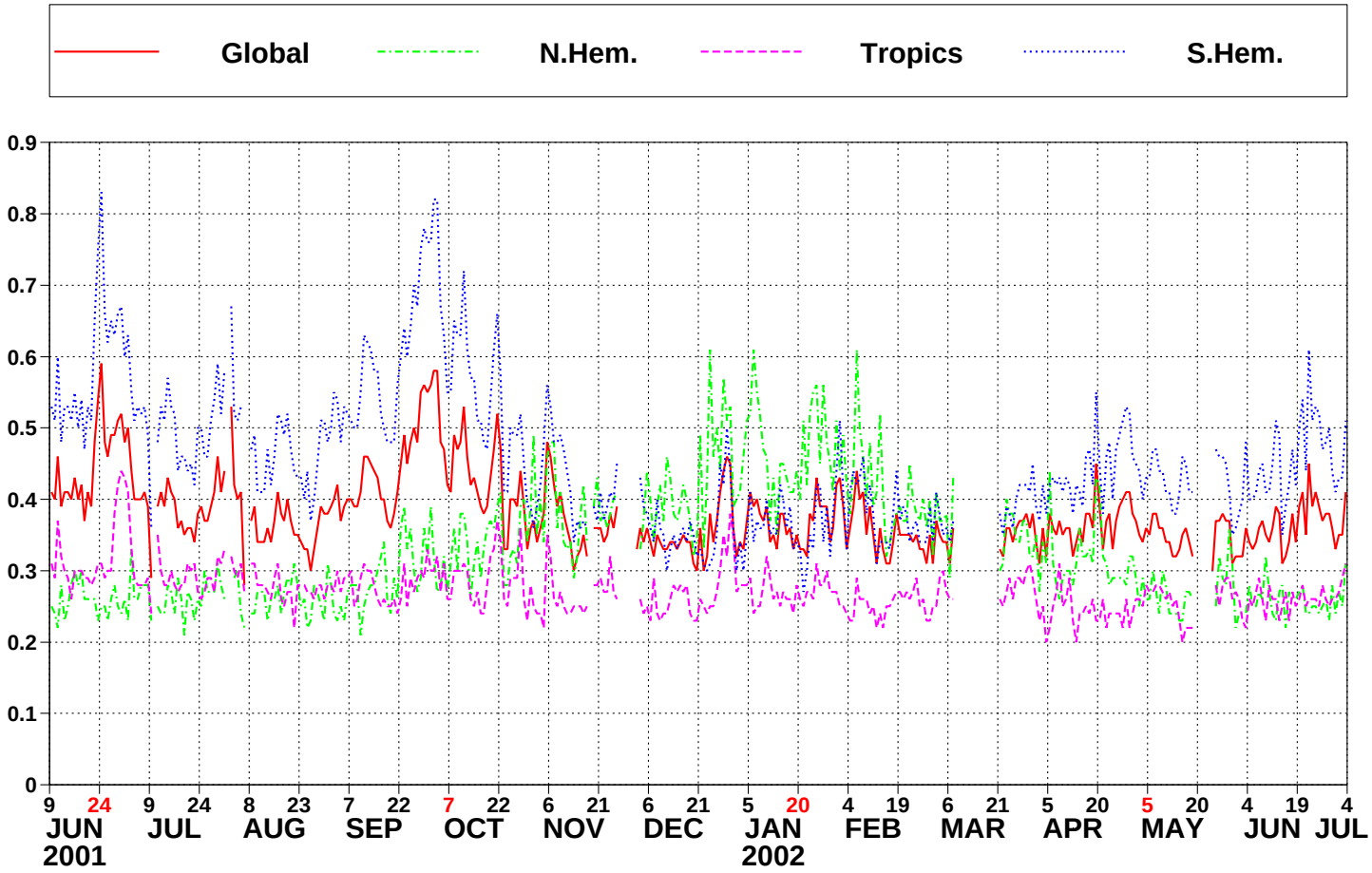

Figure 12: ERS-2 SAR wave heights: Timeseries of daily root mean square difference (RMSE) for the past year.

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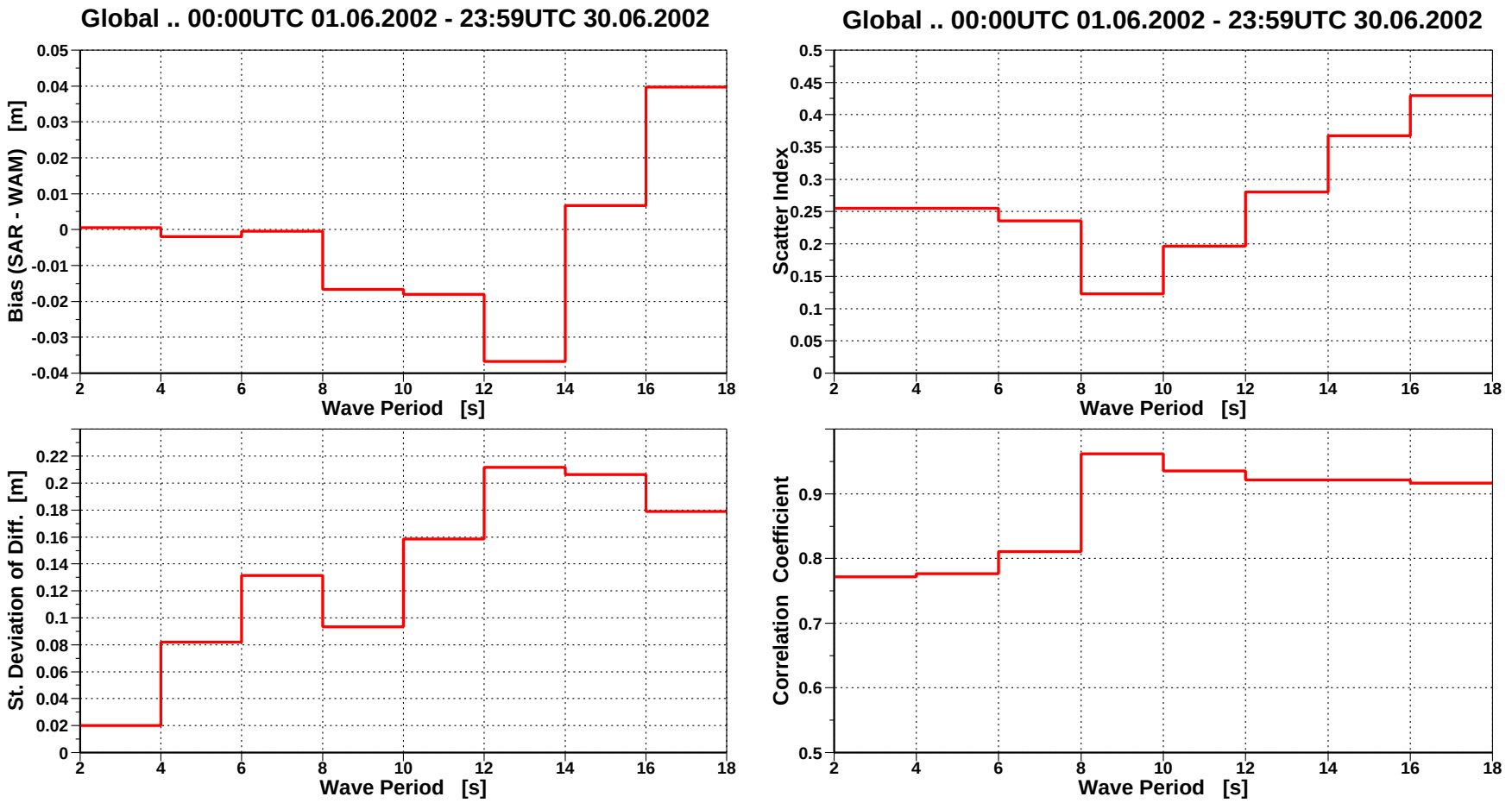

Figure 13: Comparison between SAR and ECMWF "2-second wave-period interval equivalent wave heights" for June 2002 (global).

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