

# ■ ECMWF Report on ERS-2 SAR for March 2003 ■

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

**By:** *Saleh Abdalla*

**Date:** *7 April 2003*

## **Overview:**

On average, about 375 SAR wave mode spectra arrived at ECMWF every 6 hours of which 10.0% have been rejected. Data coverage, which was rather good, can be seen in Figure 1. There was no data reception during the time windows centred at 18:00 on the 19th., and at 00:00 and 12:00 on the 20th. of the month. Furthermore, there was significant reduction of data reception during the time windows centred at 00:00 on the 14th. and the 18th., at 06:00 on the 20th. and the 23rd. of the month (all times are in UTC).

In general, the SAR data are in good agreement with the model.

## **Wave Height Comparison (bias):**

ERS-2 global: -0.015 m

ERS-2 northern hemisphere: -0.011 m

ERS-2 tropics: 0.021 m

ERS-2 southern hemisphere: -0.038 m



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## Remarks:

- The SAR worked normally this month.

## 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 ‘-1th.’ moment ( $m_{-1}$ ) defined as:

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

where  $m_0$  and  $m_{-1}$  are the zeroth and the ‘-1th.’ 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.

2. The wave directional spread defined as:

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

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



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

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:

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

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 March 2003.

Figure 2: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for March 2003 (global).

Figure 3: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for March 2003 (northern hemisphere)

Figure 4: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for March 2003 (tropics)

Figure 5: Comparison of ECMWF wave height results with ERS-2 SAR wave height data for March 2003 (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 March 2003 (global).

Figure 8: Comparison of ECMWF wave directional spread with that of ERS-2 SAR for March 2003 (global).

Figure 9: Comparison of ECMWF mean wave directions with those of ERS-2 SAR for March 2003 (global).

Figure 10: Comparison of ECMWF wave peakedness factor with that of ERS-2 SAR for March 2003 (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 March 2003 (global).

Figure 14: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (n. hem.).

Figure 15: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (tropics).

Figure 14: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (s. hem.).

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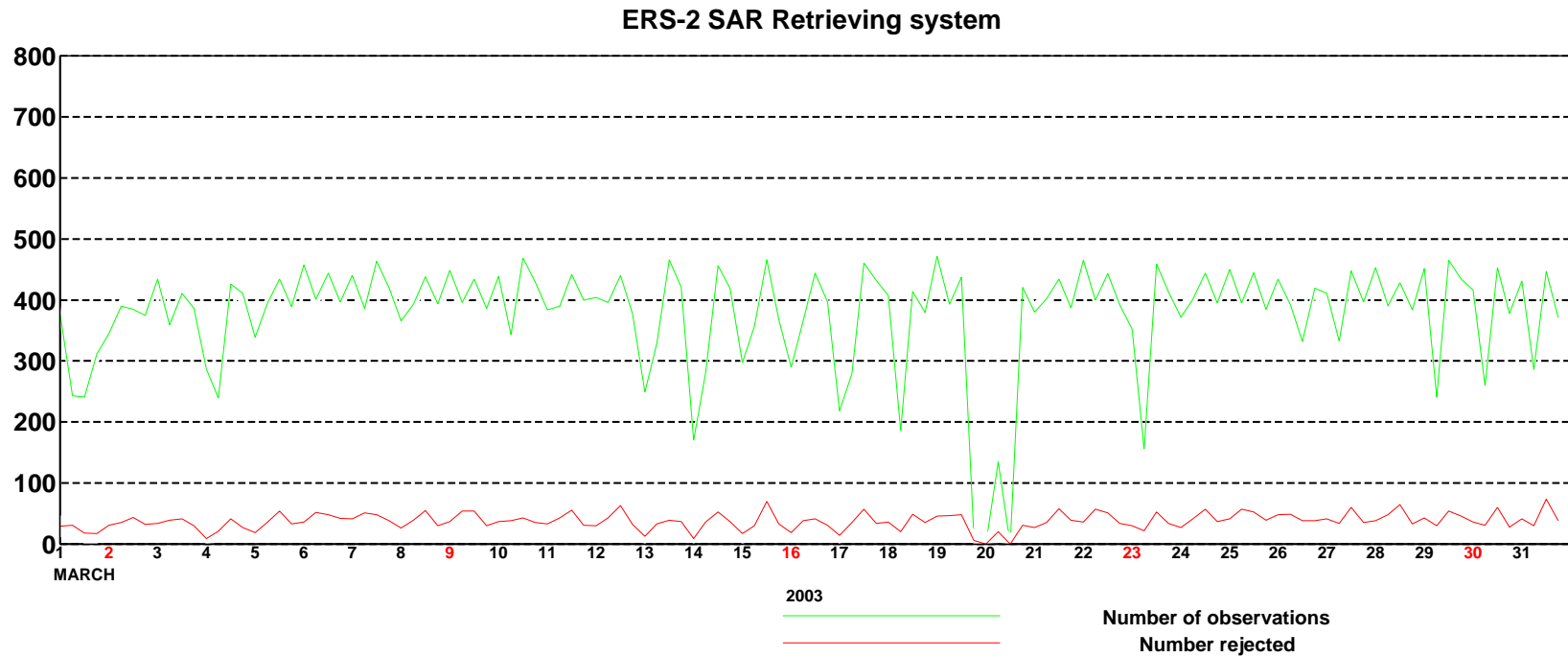


Figure 1: Time series of data reception for ERS-2 SAR wave mode spectra for March 2003

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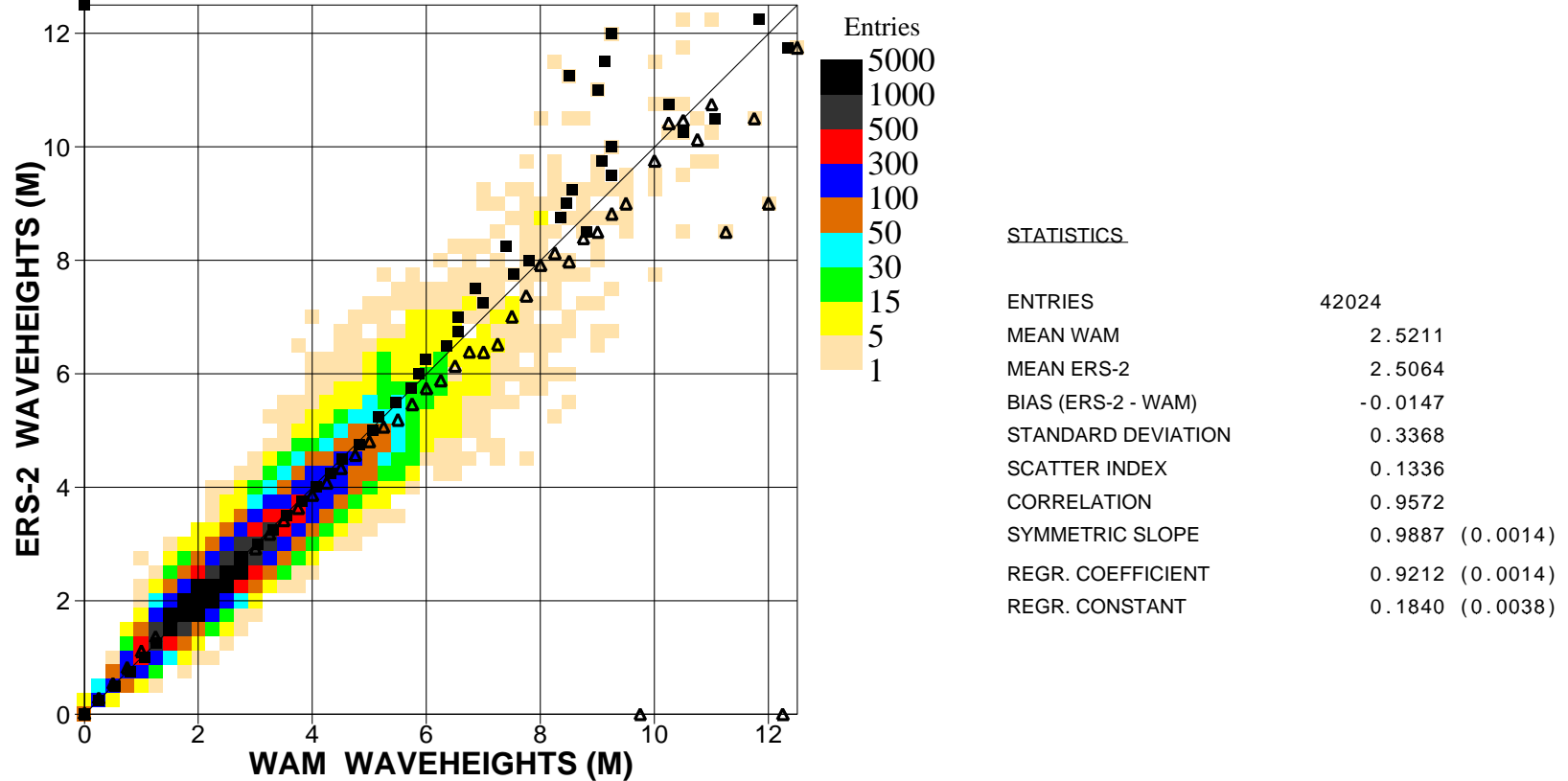


Figure 2: Comparison of ECMWF wave height results with ERS2 SAR wave height data for March 2003 (global)

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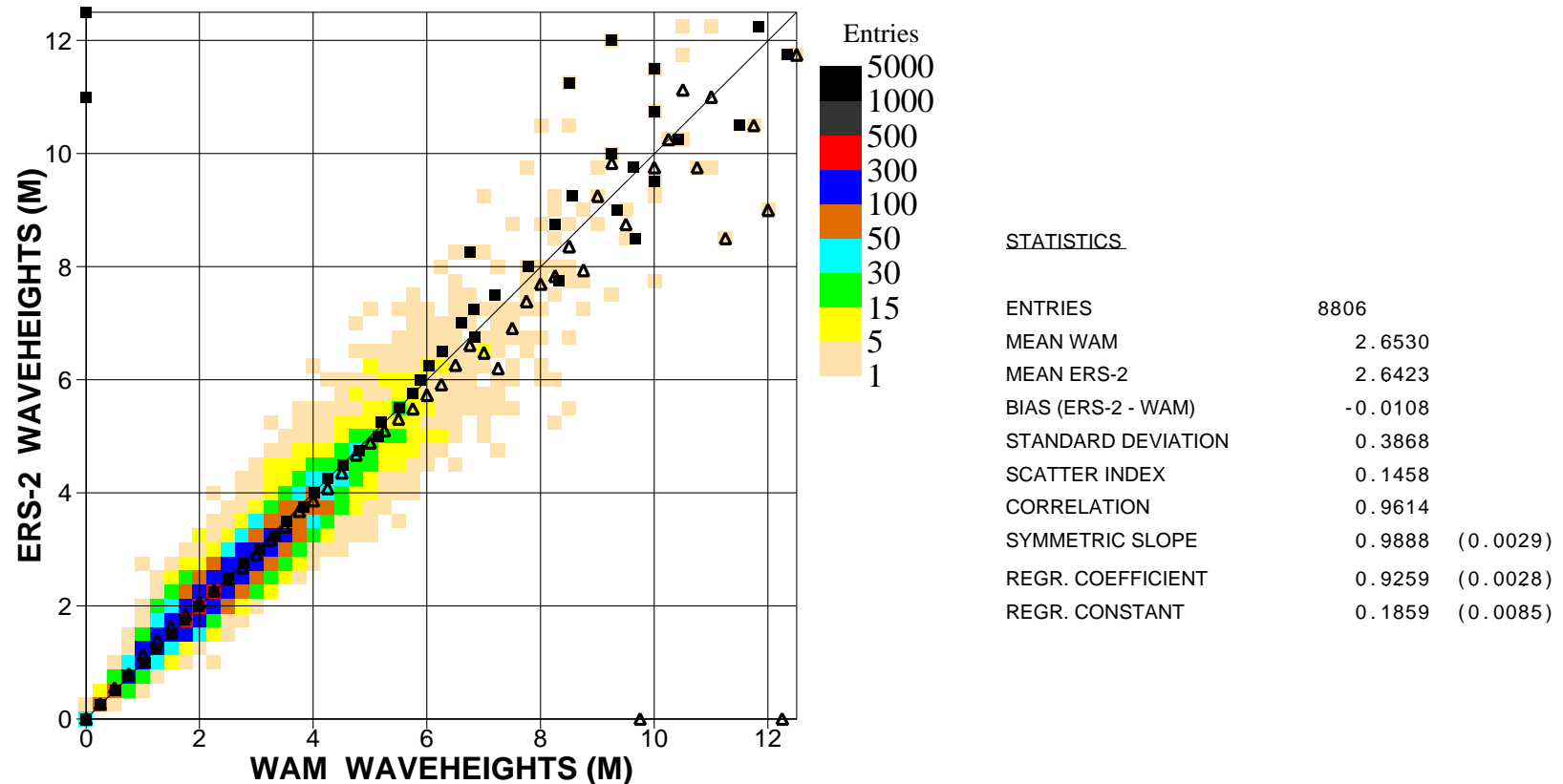


Figure 3: Comparison of ECMWF wave height results with ERS2 SAR wave height data for March 2003 (n.hem.)

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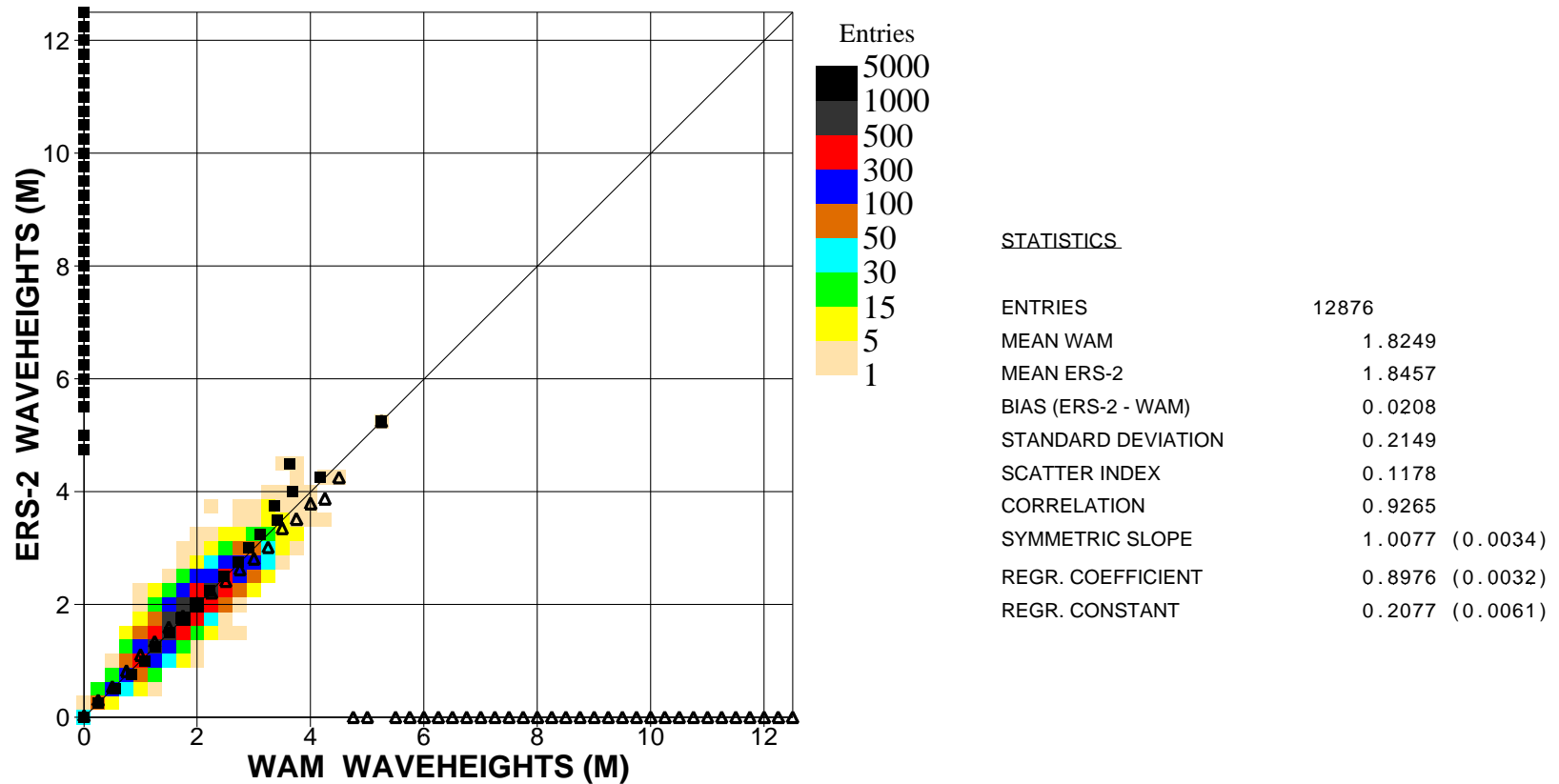


Figure 4: Comparison of ECMWF wave height results with ERS2 SAR wave height data for March 2003 (tropics)

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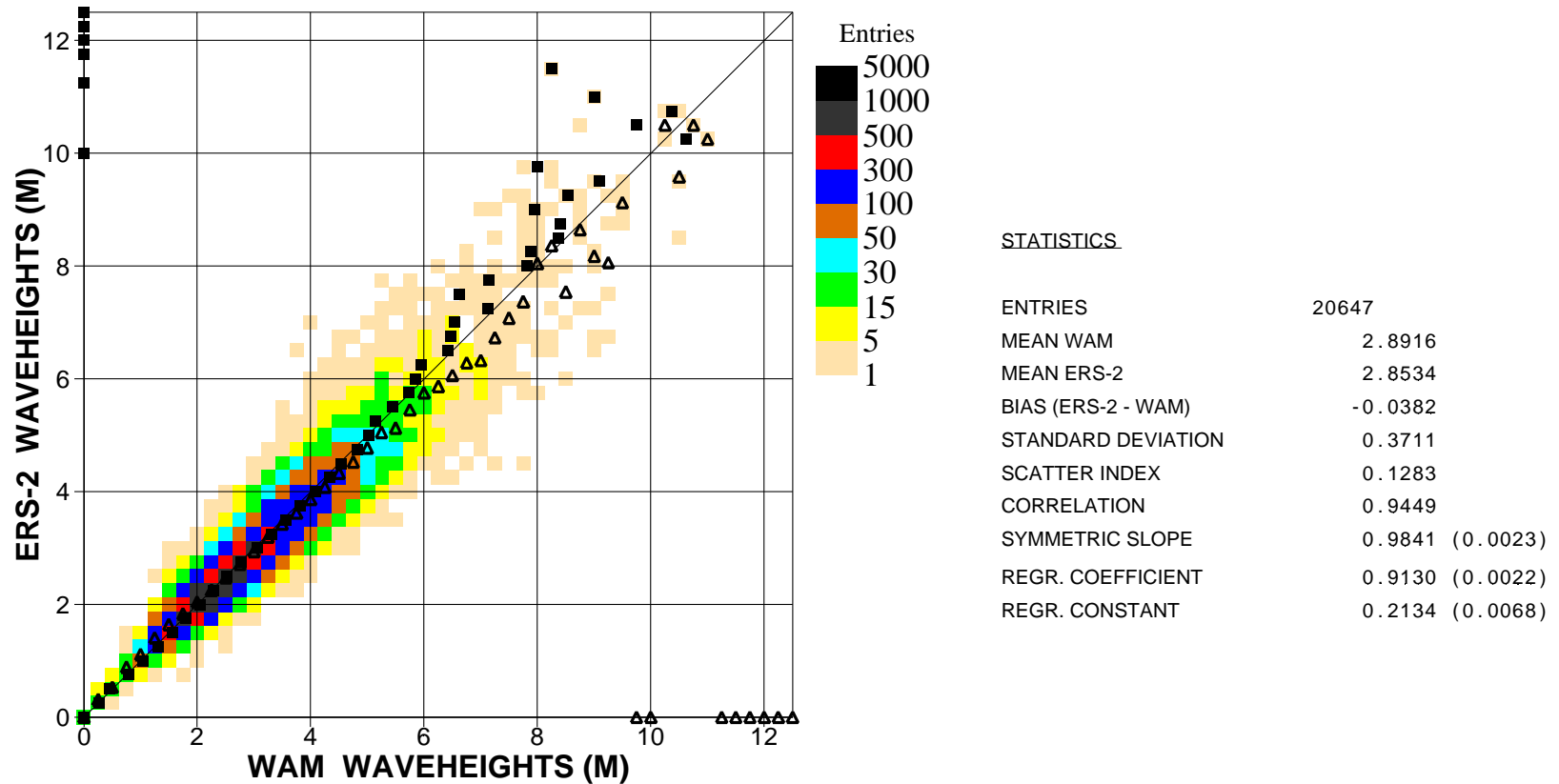


Figure 5: Comparison of ECMWF wave height results with ERS2 SAR wave height data for March 2003 (s.hem.)

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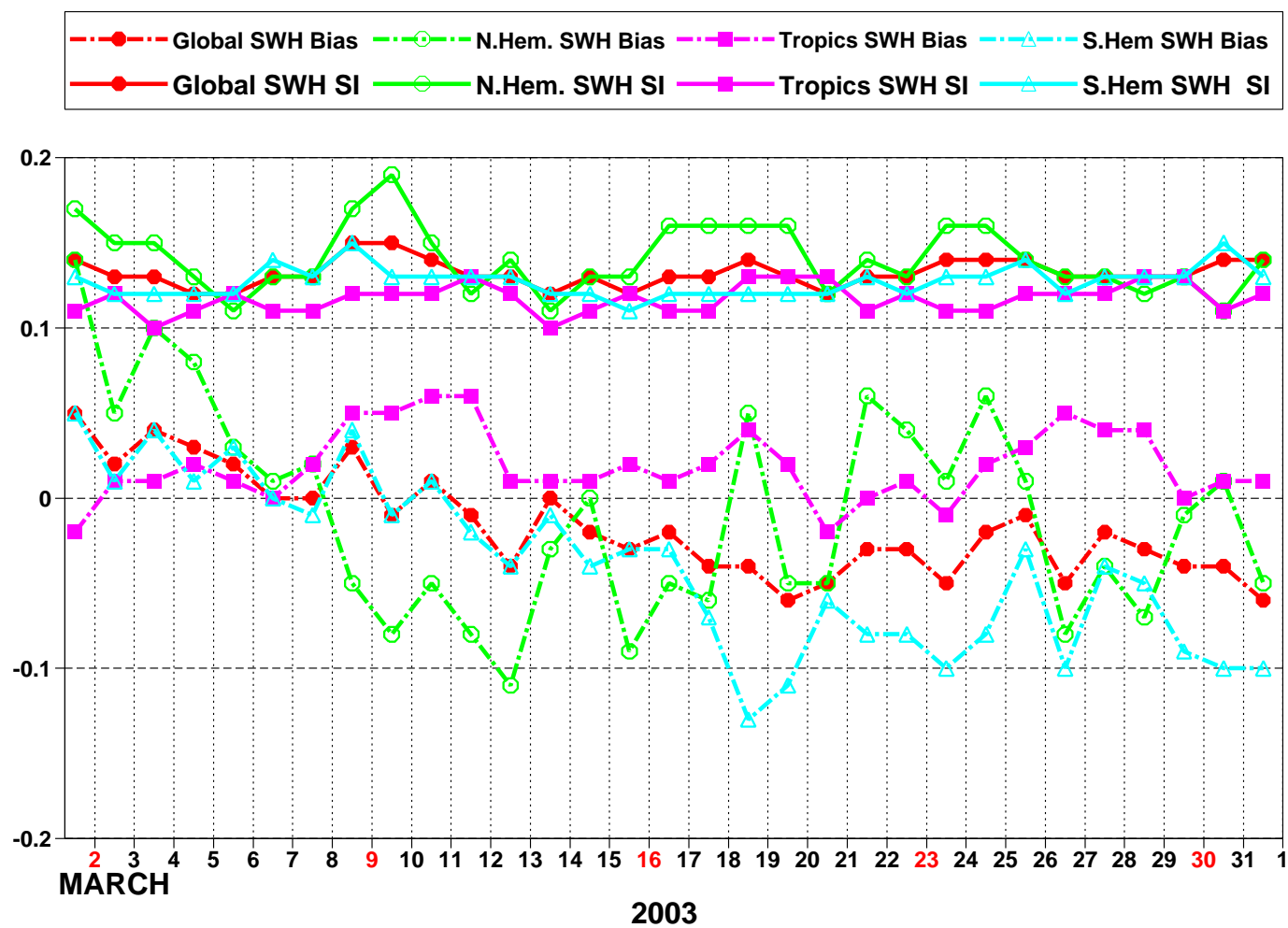


Figure 6: ERS-2 SAR wave heights: Timeseries of bias (ERS-2 - model) and scatter index (SI)

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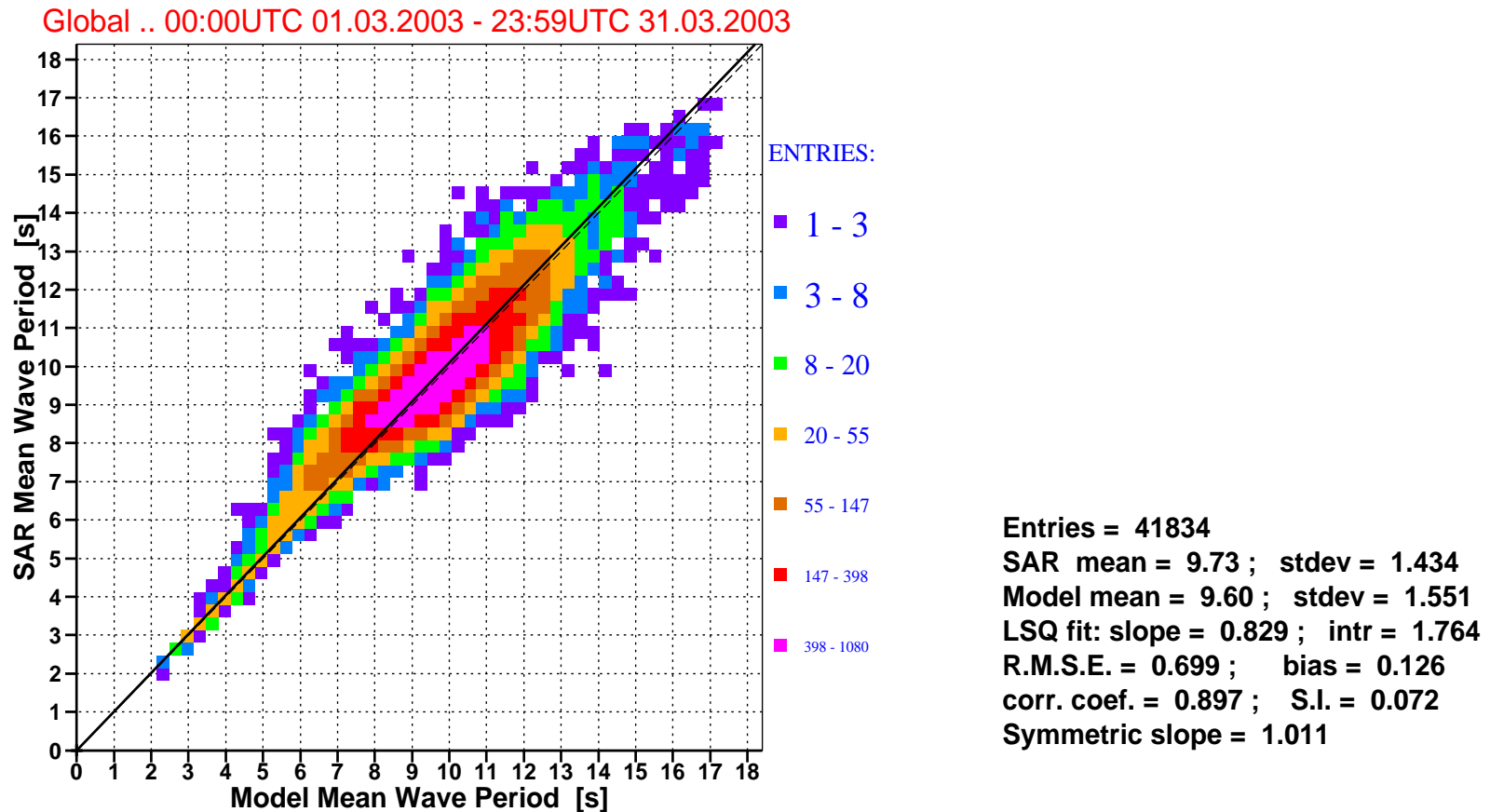


Figure 7: Comparison of ECMWF mean wave periods with ERS-2 SAR mean wave periods for march 2003 (global).

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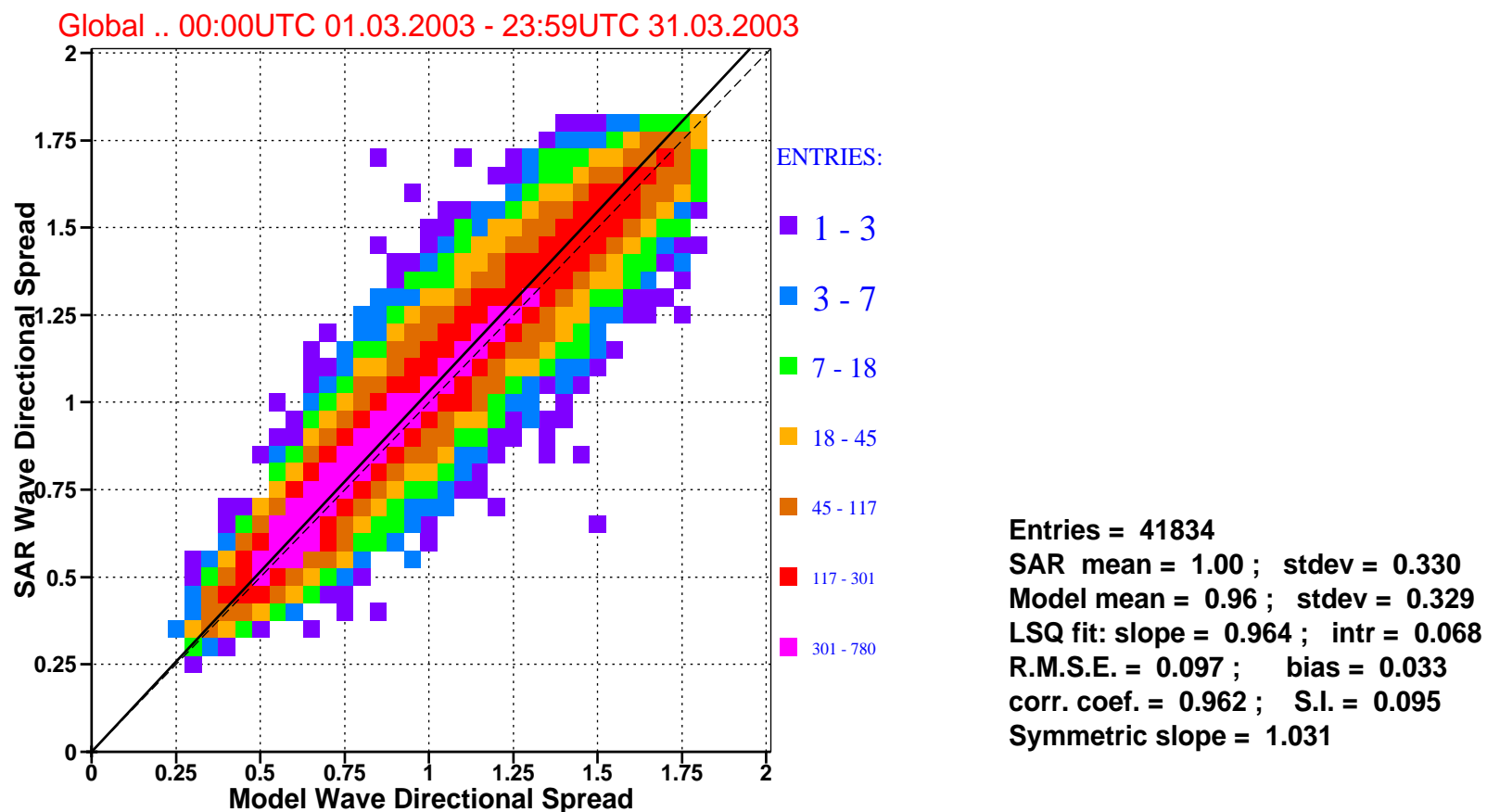


Figure 8: Comparison of ECMWF wave directional spread with that of ERS-2 SAR for march 2003 (global).

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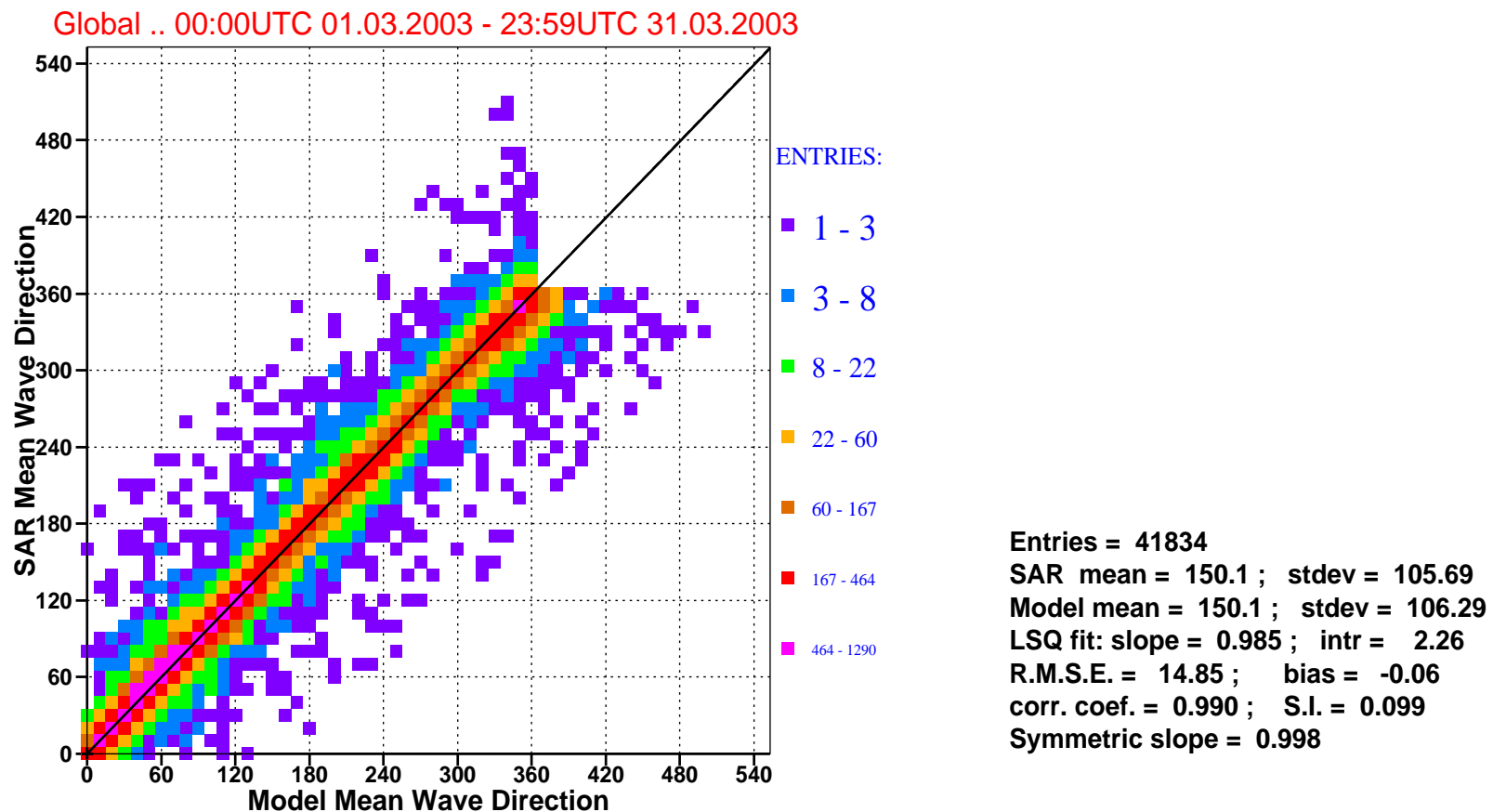


Figure 9: Comparison of ECMWF mean wave directions with that of ERS-2 SAR for march 2003 (global).

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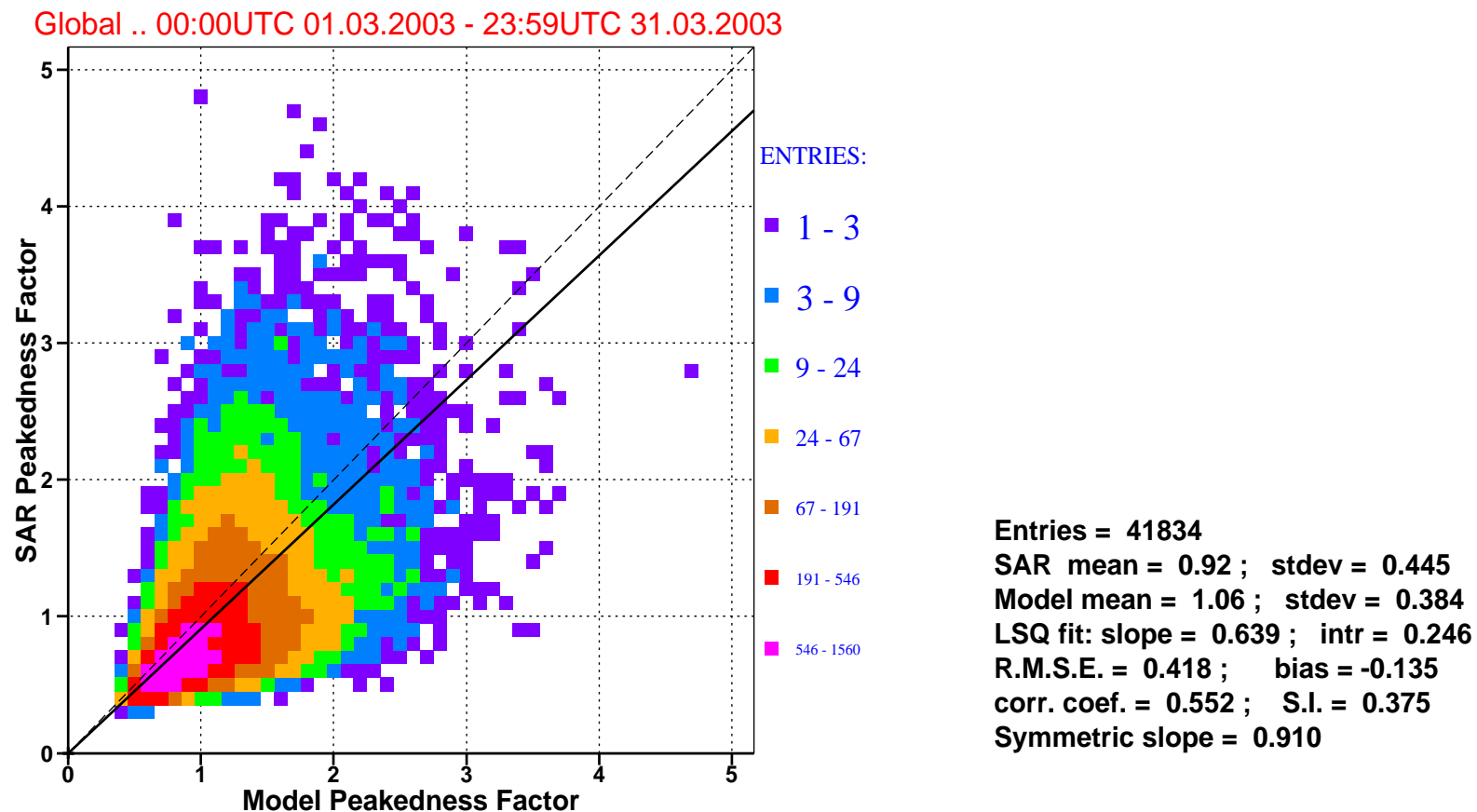


Figure 10: : Comparison of ECMWF wave peakedness factor with that of ERS-2 SAR for march 2003 (global).

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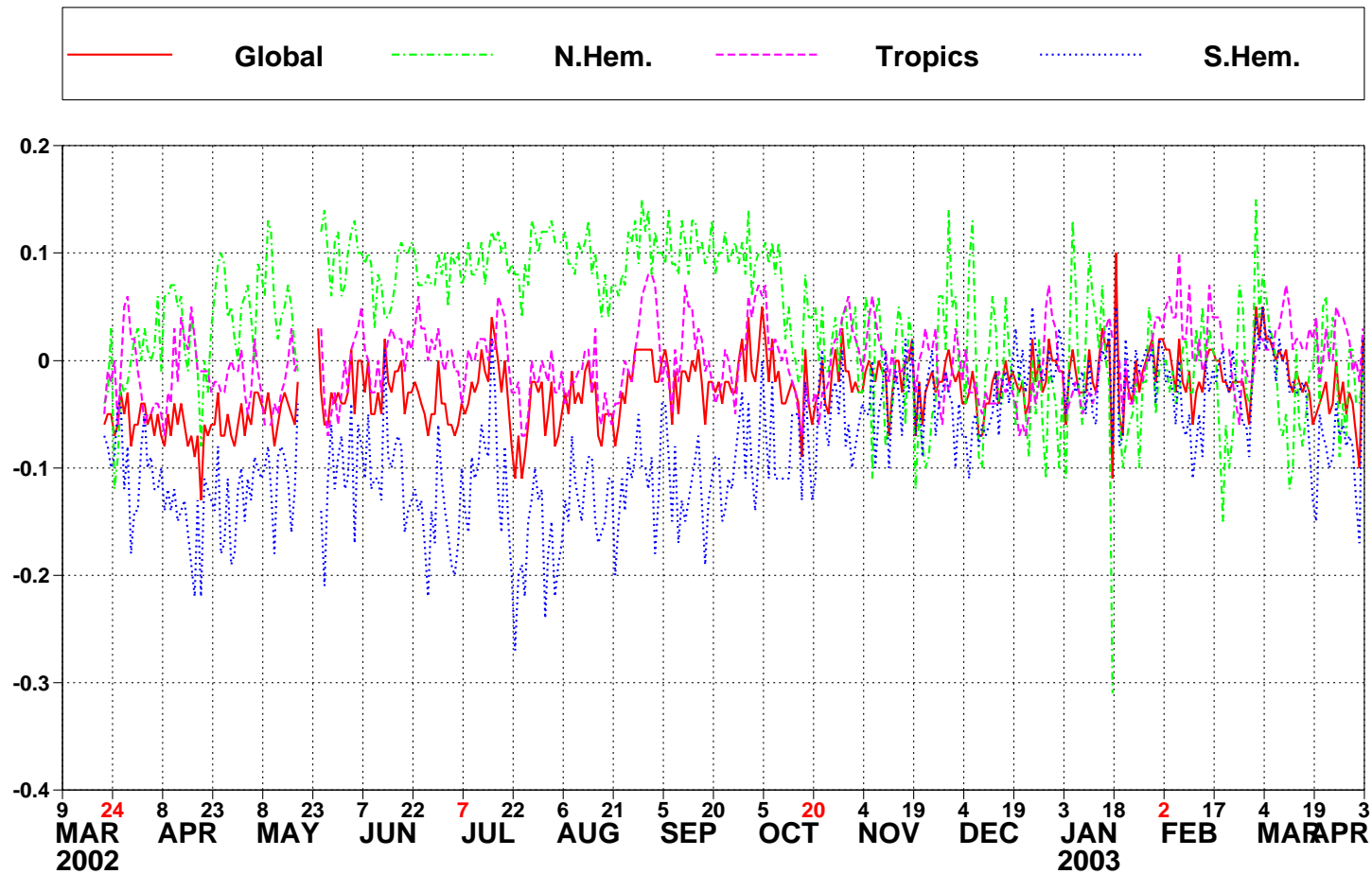


Figure 11: ERS-2 SAR wave heights: Timeseries of daily bias (ERS-2 - model) for the past year.



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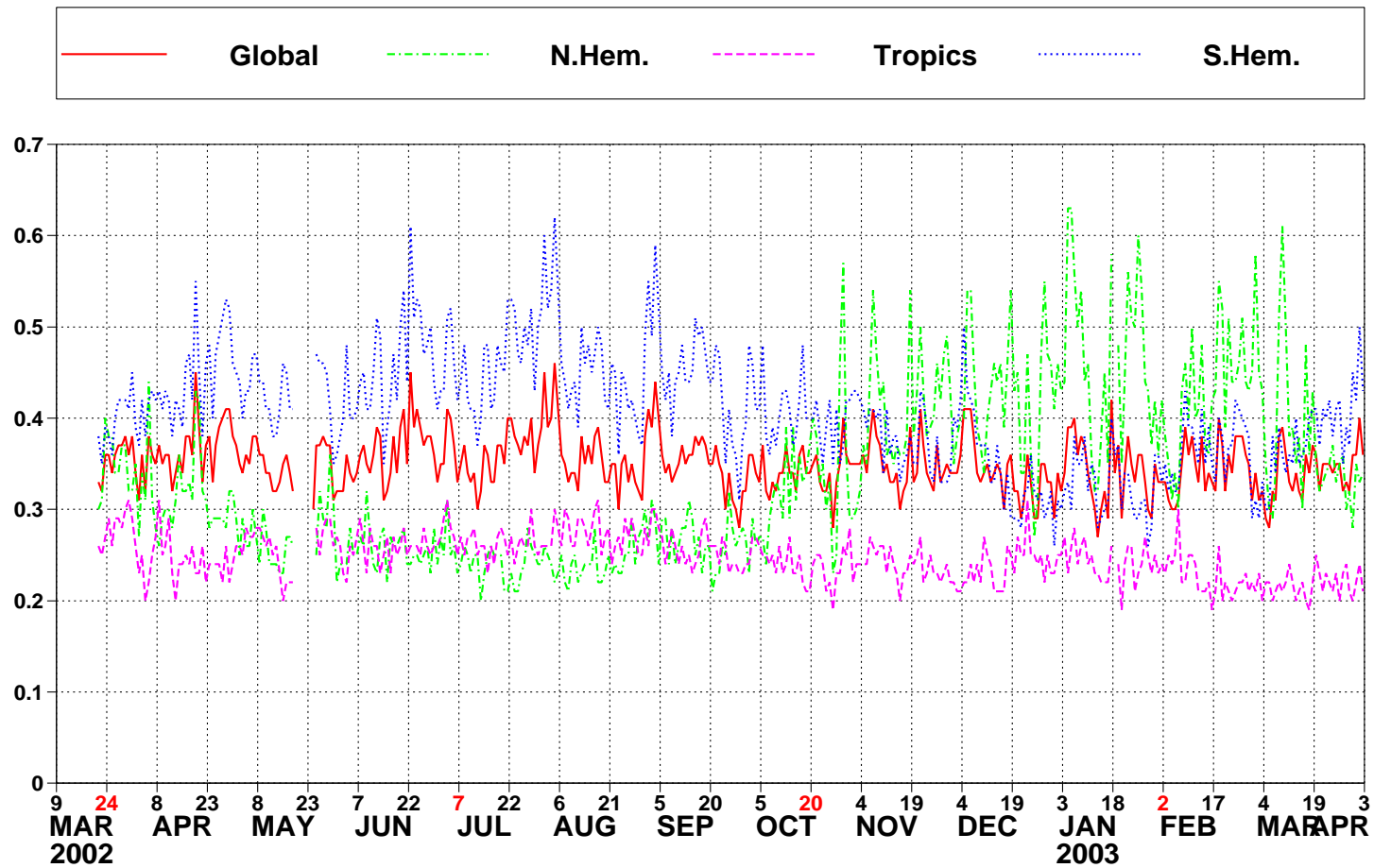


Figure 12: ERS-2 SAR wave heights: Timeseries of daily root mean square difference (RMSE) for the past year.





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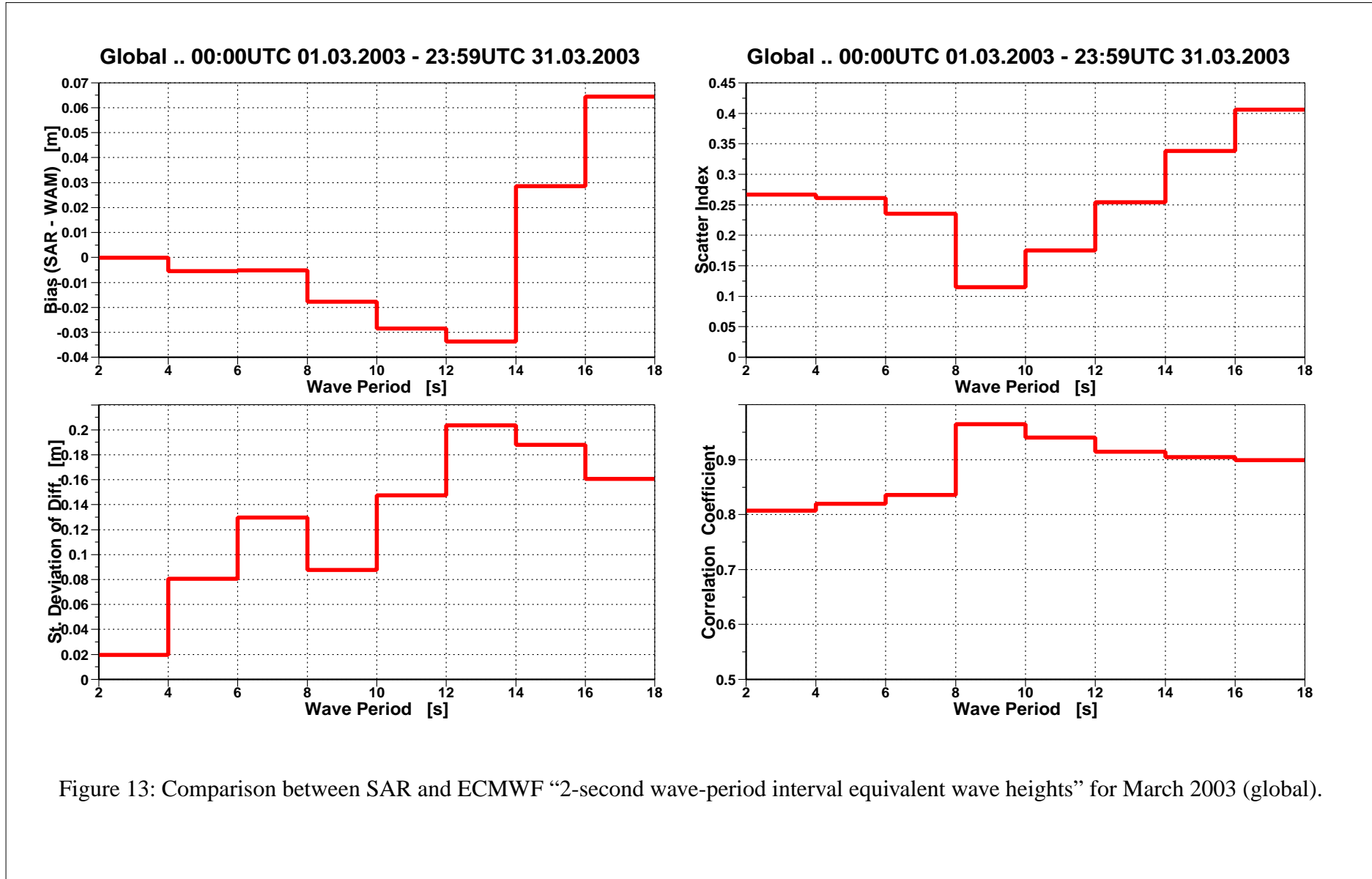


Figure 13: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (global).

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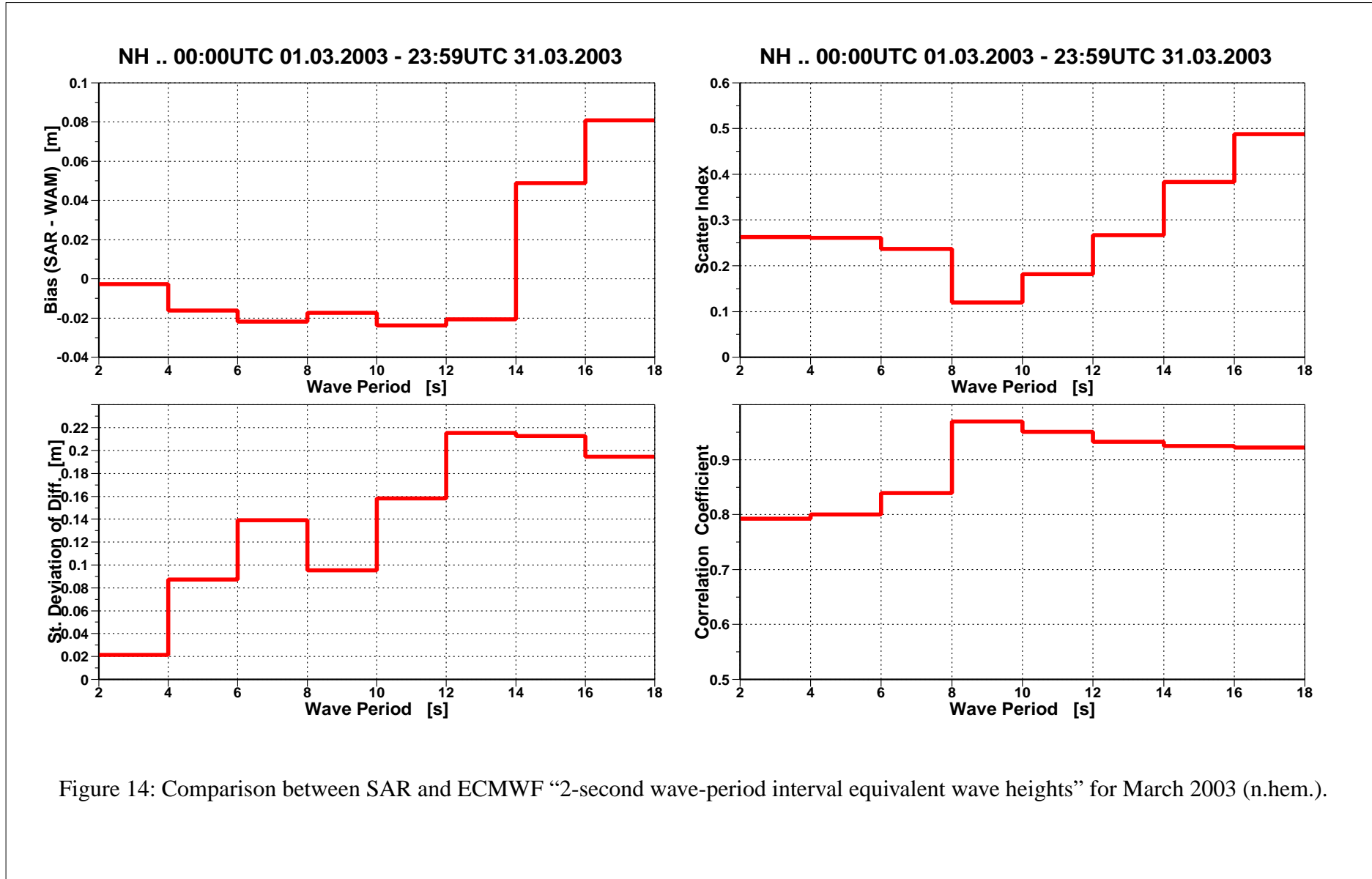


Figure 14: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (n.hem.).

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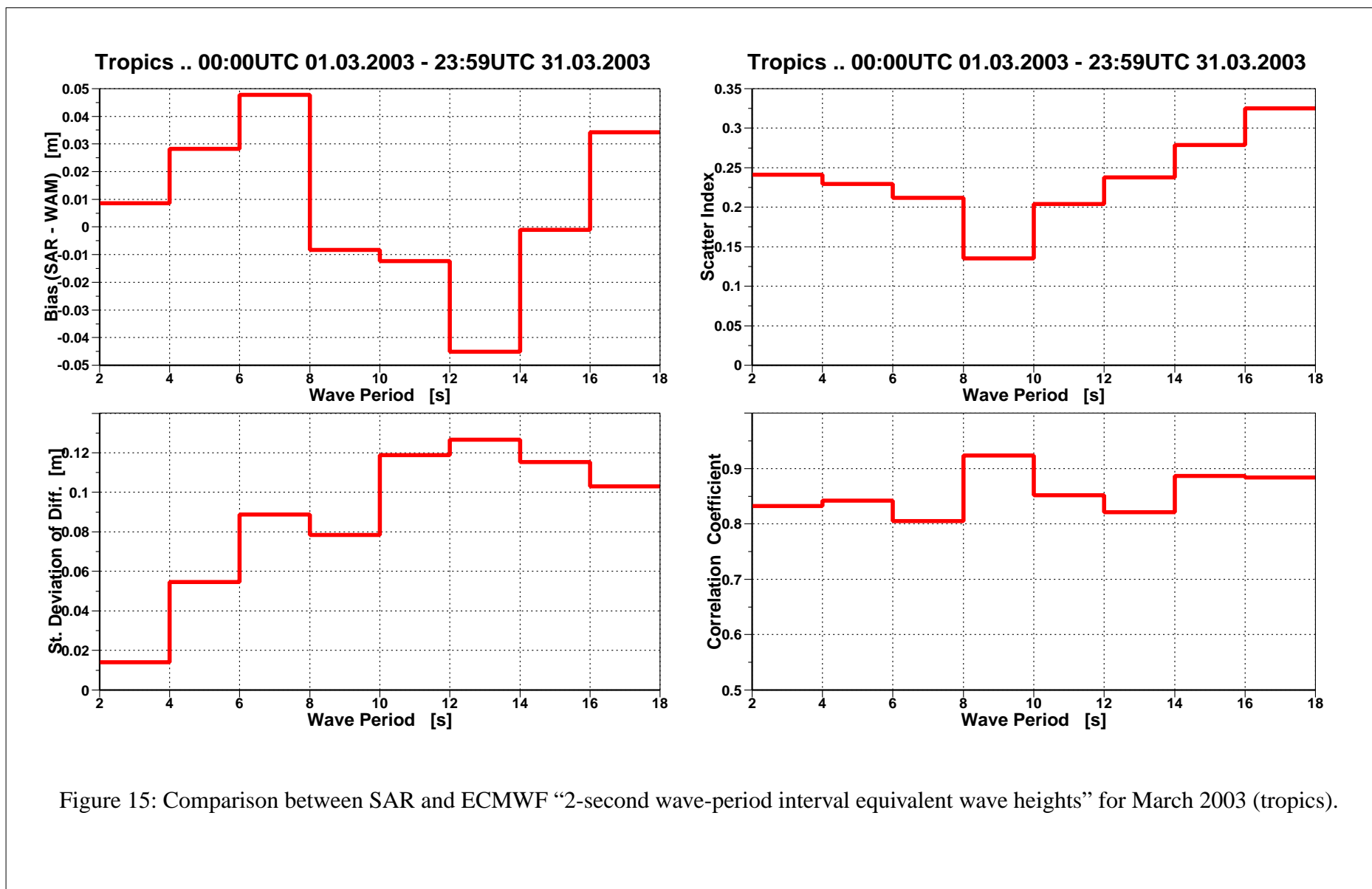


Figure 15: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (tropics).

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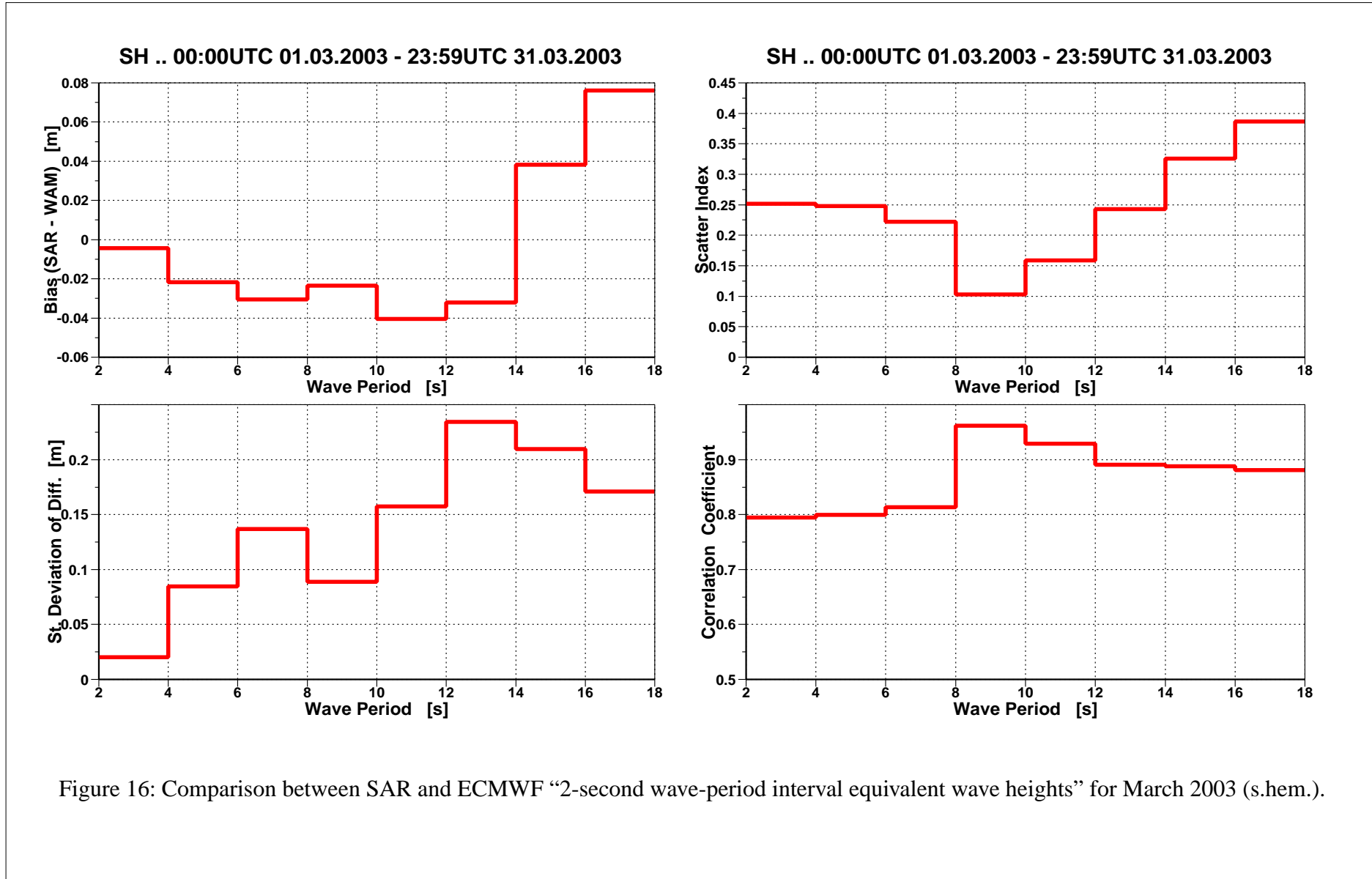


Figure 16: Comparison between SAR and ECMWF “2-second wave-period interval equivalent wave heights” for March 2003 (s.hem.).

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