Monitoring statistics of the ERS-2 scatterometer for ESA

CYCLE 76

(Project Ref. 15988/02/I-LG)

Hans Hersbach
European Centre for Medium-Range Weather Forecasts,
Shinfield Park, Reading, RG2 9AX, England
Tel: (+44 118) 9499476, e-mail: dal@ecmwf.int

September 15, 2002

1 Introduction

From 12 December 2001 onwards, ESRIN redistributes ERS-2 scatterometer data to a selected group of users. The quality of this experimental gyroless product was monitored at ECMWF for cycle 76. The gyroless ERS-2 scatterometer data was not used in the 4D-Var data assimilation system at ECMWF.

During cycle 76, data was received between 21:01 UTC 22 July 2002 and 20:57 UTC 26 August 2002. Data was received for all 6-hourly cycles. However, less than 10% of the usual amounts was received for: 00 UTC 25 July 2002 and 00 UTC 24 August 2002.

The average quality of the data for cycle 76 was slightly higher than the average performance of the data received during cycle 75. However, it was somewhat worse than the performance during the last week of cycle 75.

The situation during cycle 76 was very stable. Time series of the normalised distance to the cone and of UWI winds minus ECMWF first-guess winds did not show high peaks. Such a stable situation for the gyroless data has not been observed since the start of its monitoring in December 2001.

During cycle 76, there was no clear signature found for data that was degraded by solar activity.

The ECMWF assimilation system was not modified during cycle 76.

2 ERS-2 statistics from 23 July 2002 to 26 August 2002

2.1 Sigma0 bias levels

The average sigma0 bias levels (compared to simulated sigma0's based on ECMWF model first-guess winds, see Figure 1) for cycle 76 as compared to the corresponding levels averaged over cycle 75, showed the following evolution. At high incidence angles the bias level of the descending fore beam and the ascending aft beam have become somewhat less negative (0.3 dB, resp. 0.2 dB). At low incidence angles the bias of the ascending mid beam is 0.1 dB less negative. All other bias levels remained more or less unchanged. The general picture has improved w.r.t. the situation of cycle 75. Bias levels are on average 0.6 dB too low, and for small and medium incidence angles the three beams agree. They show little dependency on incidence angle. At high incidence angles, the bias level of the ascending aft beam is more constant than it was for cycle 75. As a result, the incidence-angle dependency of bias levels slowly improves from cycle to cycle. Maximum negative biases are now above -1.5 dB, which allows for plotting scales as they were used during the nominal situation.

2.2 Distance to cone history

The distance to the cone history is shown in Figure 2. The situation is less volatile than it was for previous cycles. There are several peaks, though less pronounced as usual. The highest peak, i.e., for 00 UTC 24 August at high nodes, is caused by a small data volume. Other peaks occur for three 6-hourly periods between 3 and 5 August 2002 and for two periods around 18 August 2002. As mentioned already, they are not very pronounced.

For the first nodes, distances are precisely on their normalized levels. Toward higher nodes distances are somewhat too large, but the situation has improved considerably since December 2001.

2.3 UWI minus First-Guess history

In Figure 3, the UWI minus ECMWF first-guess wind history is plotted. The situation looks quite stable; there are no real peaks. Only for the cycles 00 UTC 5 August 2002 and 00 UTC 24 August 2002 the standard deviation is larger than average. The peak for the second date is induced by a small data volume. The bias levels are for these two cycles also somewhat more negative than average, but not dramatically (in the past, peaks of biases of more than -3 m/s were not uncommon). The peaks in the wind history are accompanied by peaks in the cone-distance time series (see Figure 2).

There is a trend that wind biases are slowly reduced. This is true for all nodes and a small jump in performance might be detected around 20 August 2002.

The quality of the UWI winds received during cycle 76 was slightly higher w.r.t. data received during cycle 75. The UWI winds now have an average bias of -1.07

m/s, which was -1.10 m/s for cycle 75. The bias is -1.38 m/s for nodes 1-2 (was -1.37 m/s) and -1.05 m/s for nodes 15-19 (was -1.12 m/s). Biases are smallest for nodes 8-10 (-0.94 m/s, unchanged). The standard deviation is on average 1.62 m/s (unchanged), and increases from 1.58 m/s (unchanged) for nodes 1-2, to 1.69 m/s for nodes 15-19 (was 1.67 m/s). Very similar results apply to the de-aliased CMOD4 winds.

The (scatterometer - model) direction standard deviations (Figure 4) were ranging between 40 and 60 degrees for the UWI data (average value 50.5 degrees, was 54.0) and between 15 and 25 degrees (average value 18.8, was 19.2) for their de-aliased counterparts (Figure 6). The directional bias is close to zero for both UWI and de-aliased CMOD4 products. Therefore, the skill in wind direction has improved somewhat.

2.4 Scatter plots

The scatter plot of model 10 m first-guess wind speeds versus UWI wind speeds (Figure 7) shows a slightly less negative bias (-1.07 m/s) compared to the plot from cycle 75 (-1.10 m/s). The standard deviation is marginally smaller (1.63 m/s, was 1.64 m/s). The amount of low wind data with collocated first-guess winds that are much stronger is comparable to the situation during cycle 75. Such data points are likely to be identified with situations in which inaccurate knowledge of yaw attitude leads to a partial destruction of backscatter and, therefore, inversion results into too low winds.

The direction scatter plot (Figure 8) looks similar to the results from cycle 75 (bias from 1.4 to -0.6 degrees, and standard deviation from 48 to 52 degrees).

In Figure 9, scatter plots for (de-aliased) winds inverted on the basis of the new CMOD5 formulation (developed at ECMWF in 2002) are presented These winds have w.r.t. the ECMWF first-guess winds a lower bias (-0.81 m/s) and a smaller standard deviation as well (1.61 m/s) than the CMOD4 winds have. In the high wind-speed sector these CMOD5 winds are more realistic than their CMOD4 counterparts. The negative bias of the CMOD5 winds is induced by the negative biases in the sigma0 levels (see Figure 1).

Figure Captions

Figure 1: Ratio of $< \sigma_0^{0.625} > / <$ CMOD4(FirstGuess)$^{0.625} >$ converted in dB for the for beam (solid line), mid beam (dashed line) and aft beam (dotted line), as a function of incidence angle for descending and ascending tracks. The thin lines indicate the error bars on the estimated mean. First-guess winds are based on the in time closest (+3h, +6h, +9h, or +12h) T511 forecast field, and are bilinearly interpolated in space.

Figure 2: Mean normalised distance to the cone computed every 6 hours for nodes 1-2, 3-4, 5-7, 8-10, 11-14 and 15-19 (solid curve close to 1 when no instrumental problems are present). The dotted curve shows the number of incoming triplets in logarithmic scale (1 corresponds to 60,000 triplets) and the dashed one indicates the fraction of complete sea-located triplets rejected by the ESA flag, or by the wind inversion algorithm (0: all data kept, 1: no data kept).

Figure 3: Mean (solid line) and standard deviation (dashed line) of the wind speed difference UWI - first guess for the data retained by the quality control.

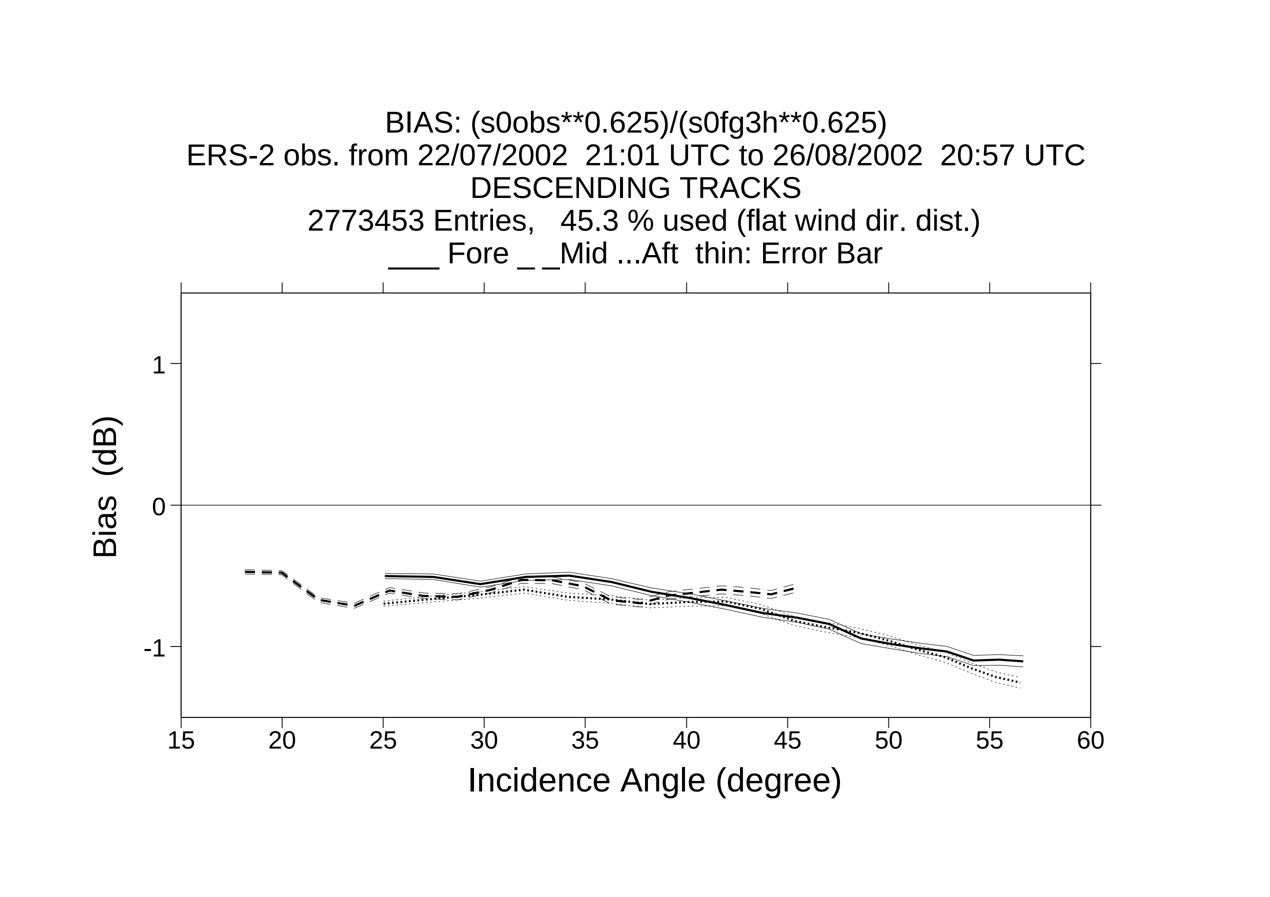
Figure 4: Same as Fig. 3, but for the wind direction difference. Statistics are computed only for wind speeds higher than 4 m/s.

Figures 5 and 6: Same as Fig. 3 and 4 respectively, but for the de-aliased CMOD4 data.

Figure 7: Two-dimensional histogram of first guess and UWI wind speeds, for the data kept by the quality control. Circles denote the mean values in the y-direction, and squares those in the x-direction.

Figure 8: Same as Fig. 7, but for wind direction. Only wind speeds higher than 4m/s are taken into account.

Figures 9: Same as Fig. 7, but for de-aliased CMOD5 winds instead of UWI wind speeds.


BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 22/07/2002 21:01 UTC to 26/08/2002 20:57 UTC
DESCENDING TRACKS
2773453 Entries, 45.3 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
1
0
-1
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)

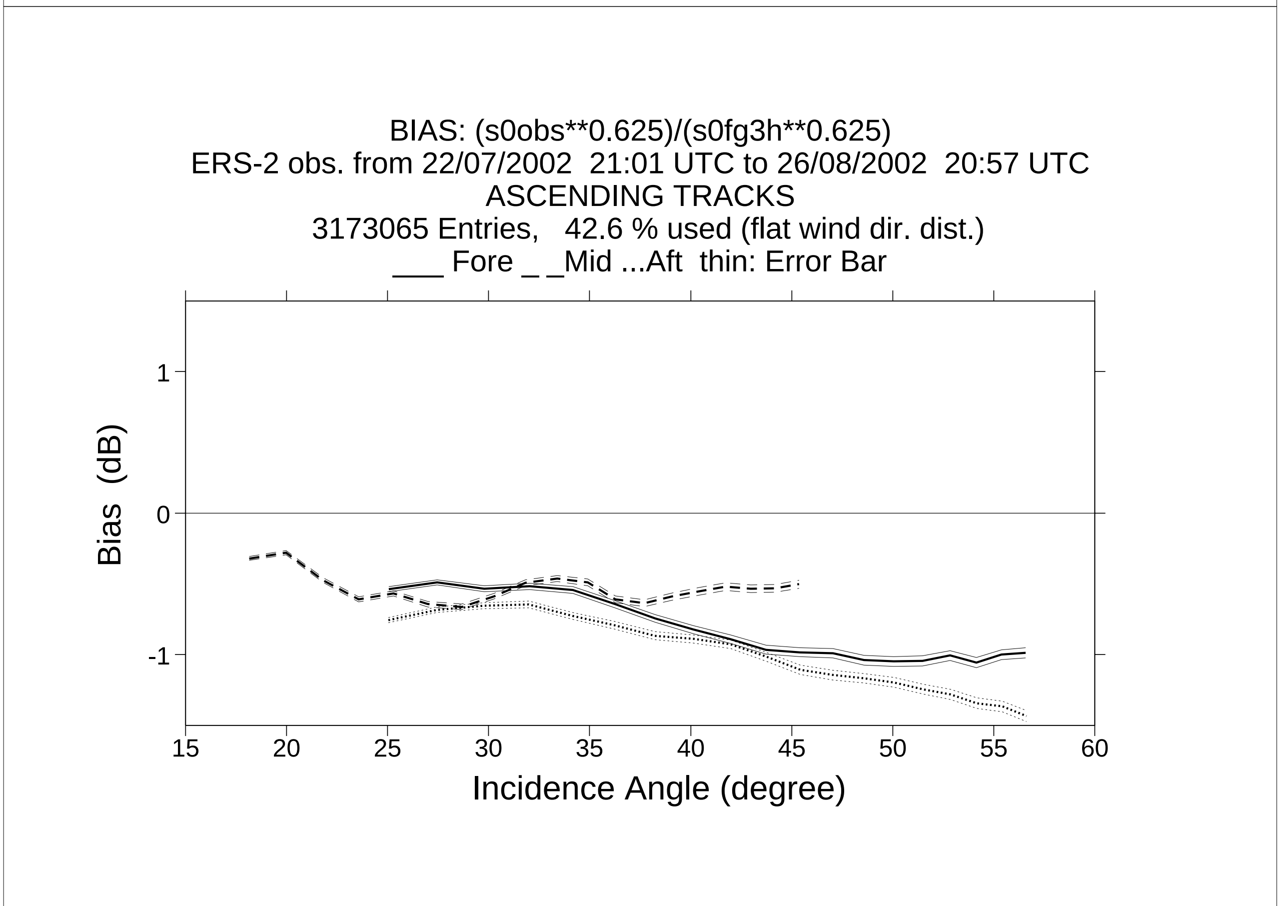
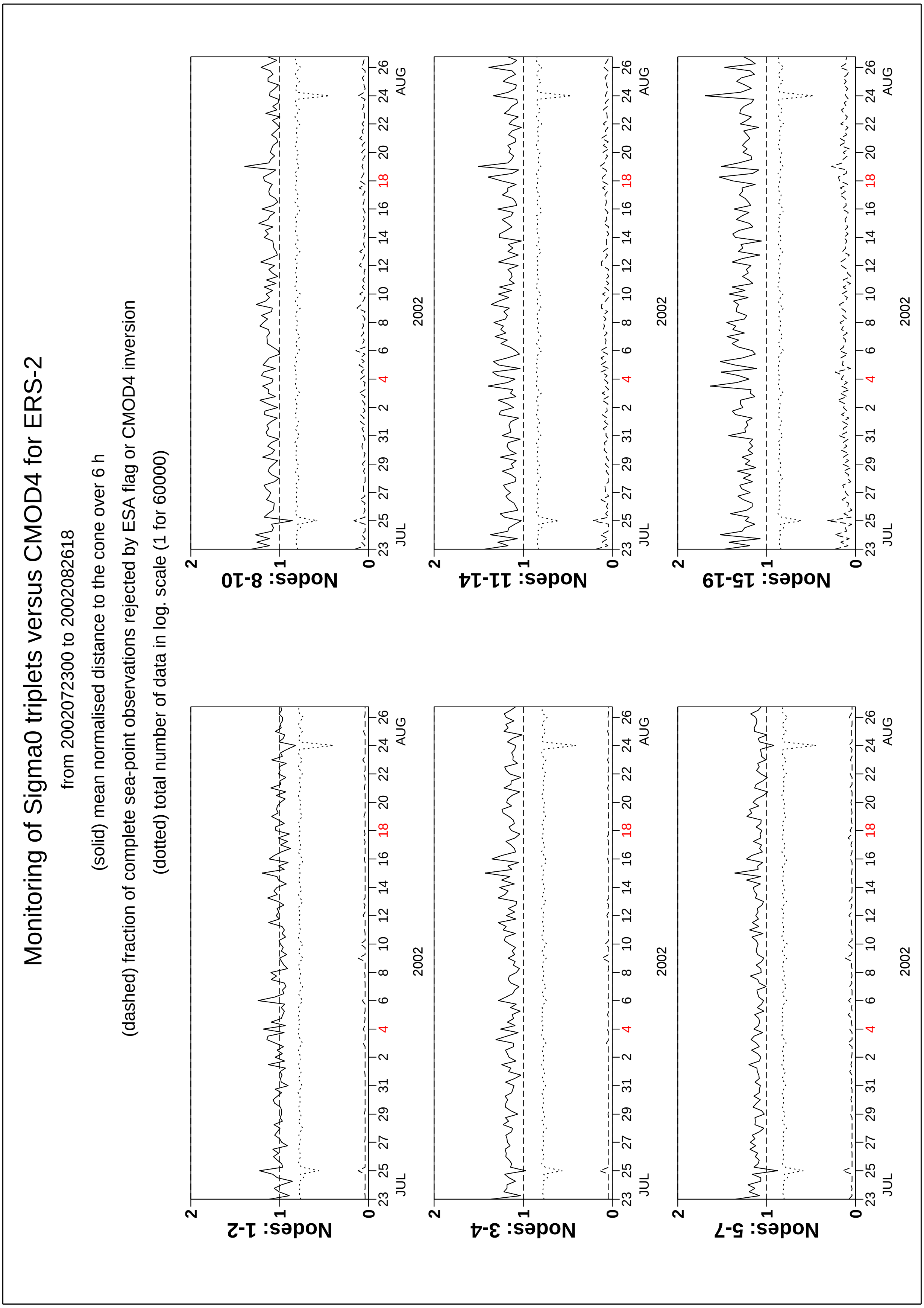

BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 22/07/2002 21:01 UTC to 26/08/2002 20:57 UTC
ASCENDING TRACKS
3173065 Entries, 42.6 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
1
0
-1
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)

Figure 1



Monitoring of Sigma0 triplets versus CMOD4 for ERS-2
from 2002072300 to 2002082618
(solid) mean normalised distance to the cone over 6 h
(dashed) fraction of complete sea-point observations rejected by ESA flag or CMOD4 inversion
(dotted) total number of data in log. scale (1 for 60000)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
JUL
AUG
2002

Figure 2

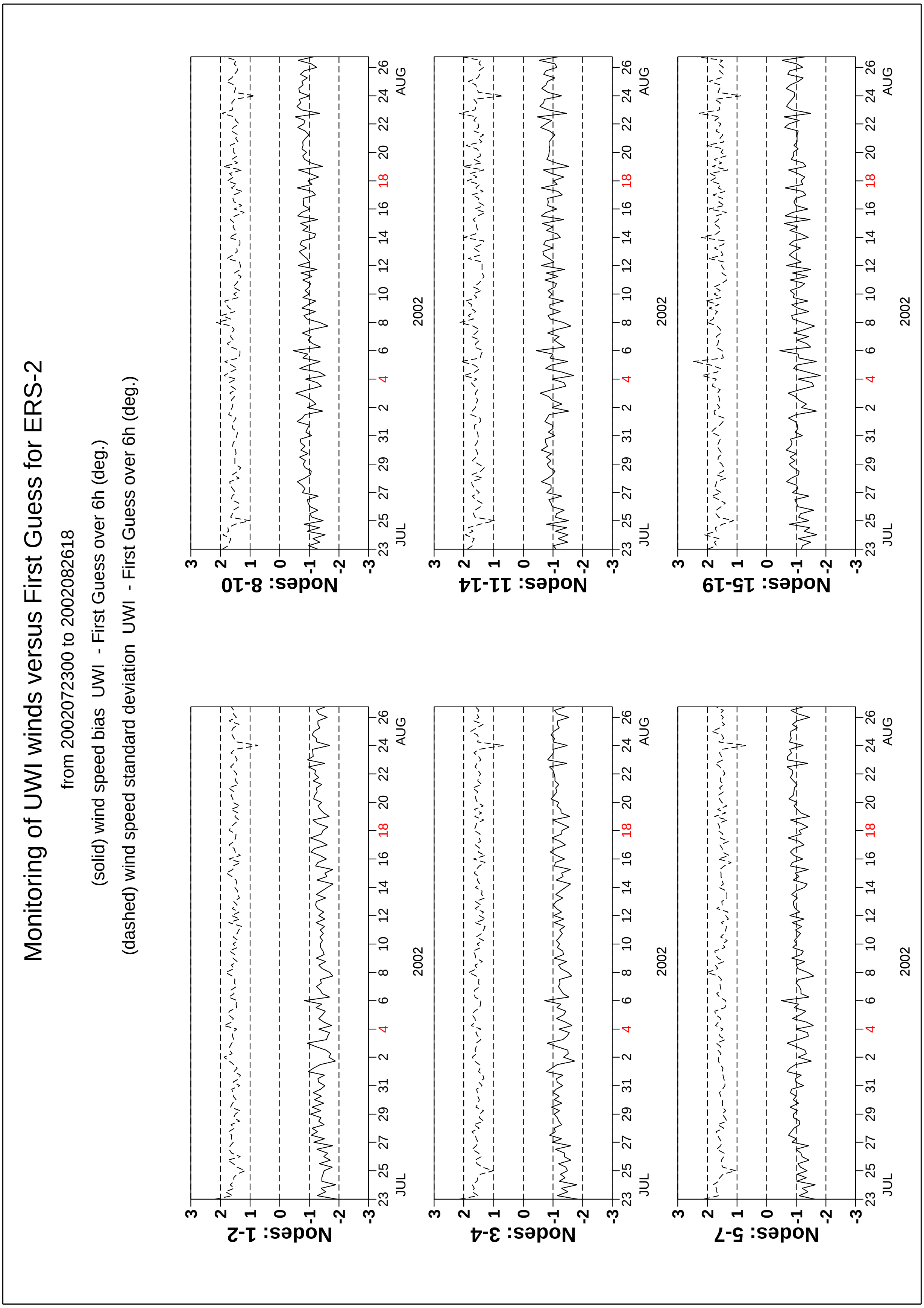
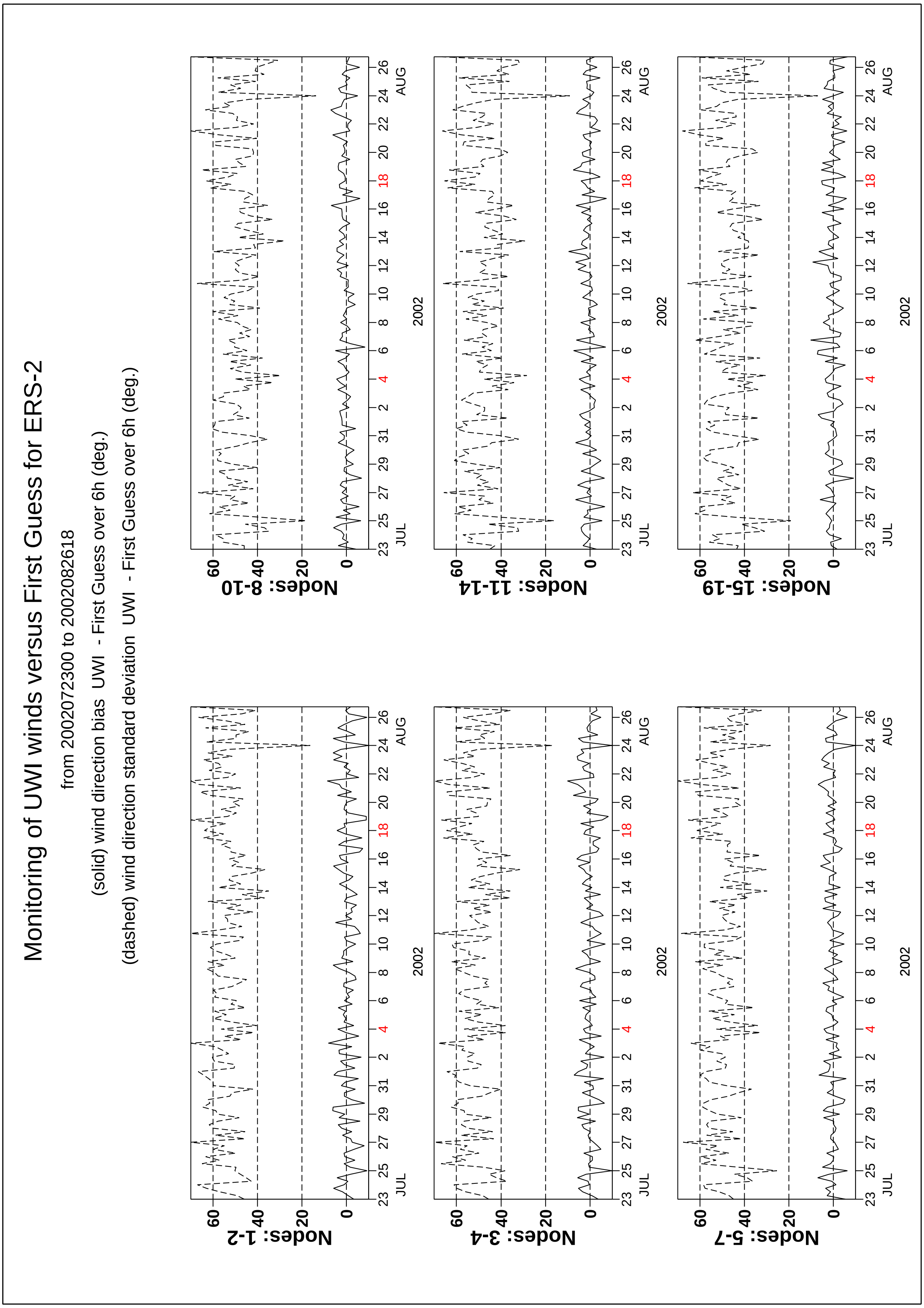

Monitoring of UWI winds versus First Guess for ERS-2
from 2002072300 to 2002082618
(solid) wind speed bias UWI - First Guess over 6h (deg.)
(dashed) wind speed standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
JUL
AUG
2002

Figure 3



Monitoring of UWI winds versus First Guess for ERS-2
from 2002072300 to 2002082618
(solid) wind direction bias UWI - First Guess over 6h (deg.)
(dashed) wind direction standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
JUL
AUG
2002

Figure 4

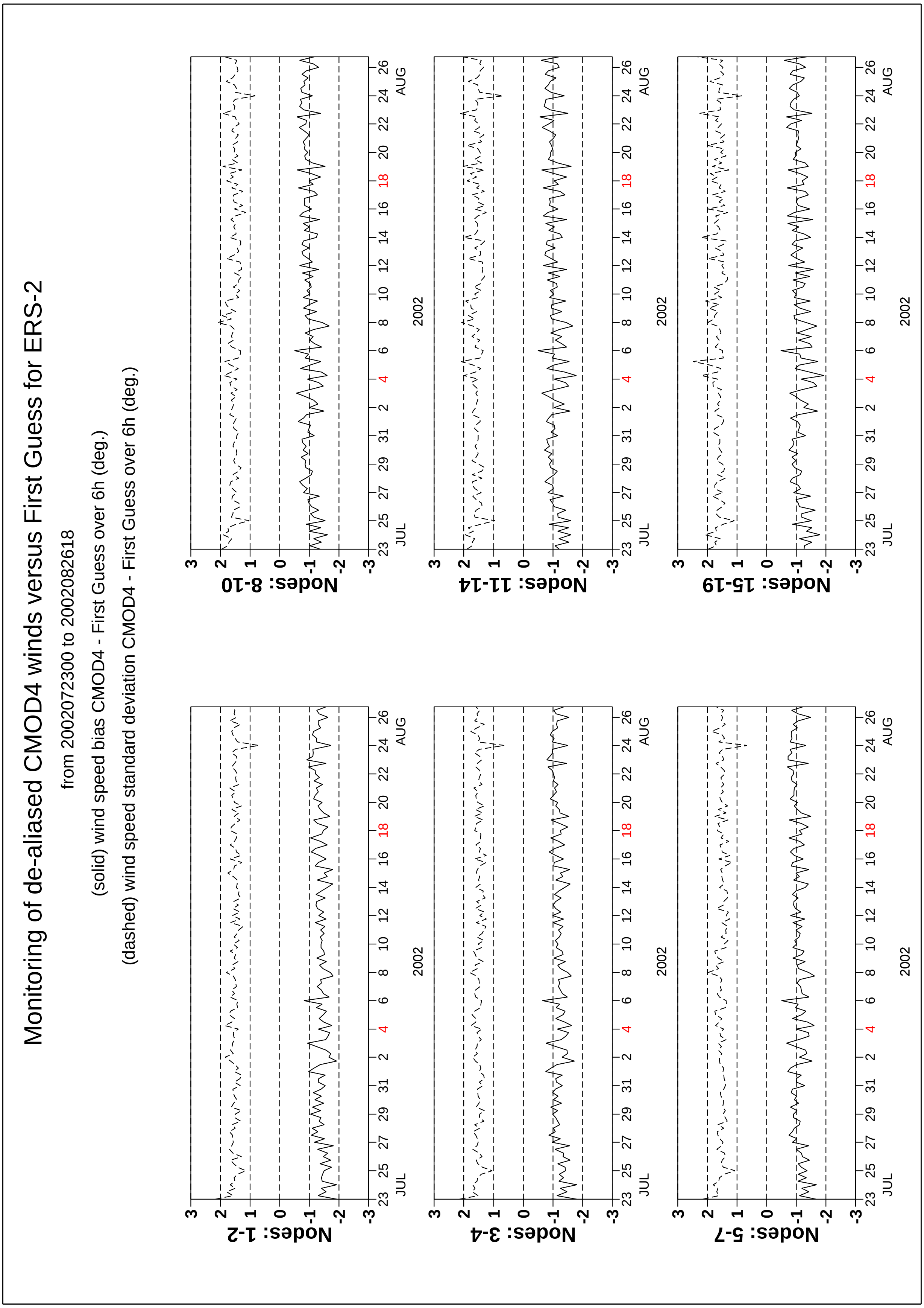

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002072300 to 2002082618
(solid) wind speed bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind speed standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
JUL
AUG
2002

Figure 5

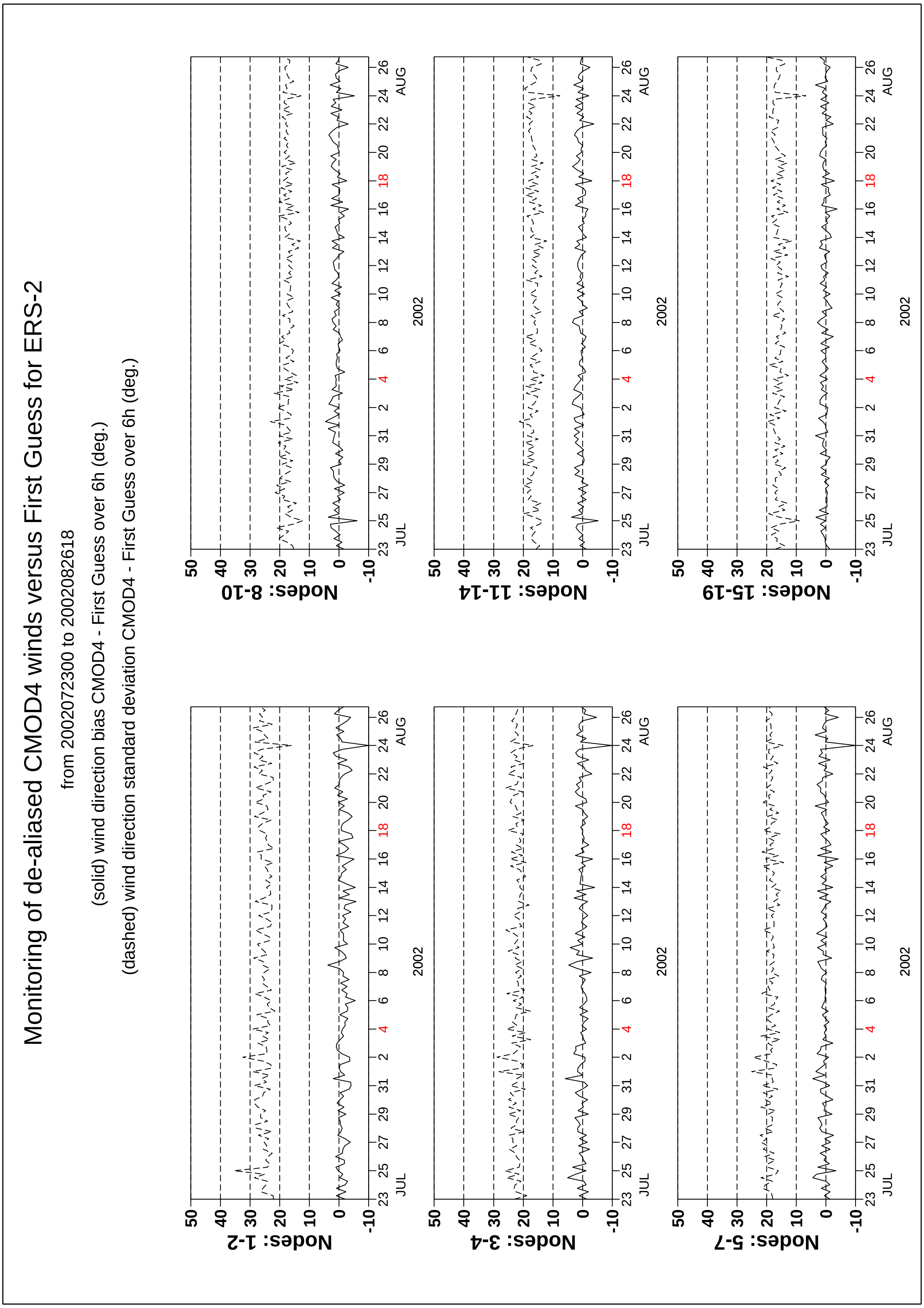

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002072300 to 2002082618
(solid) wind direction bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind direction standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
JUL
AUG
2002

Figure 6

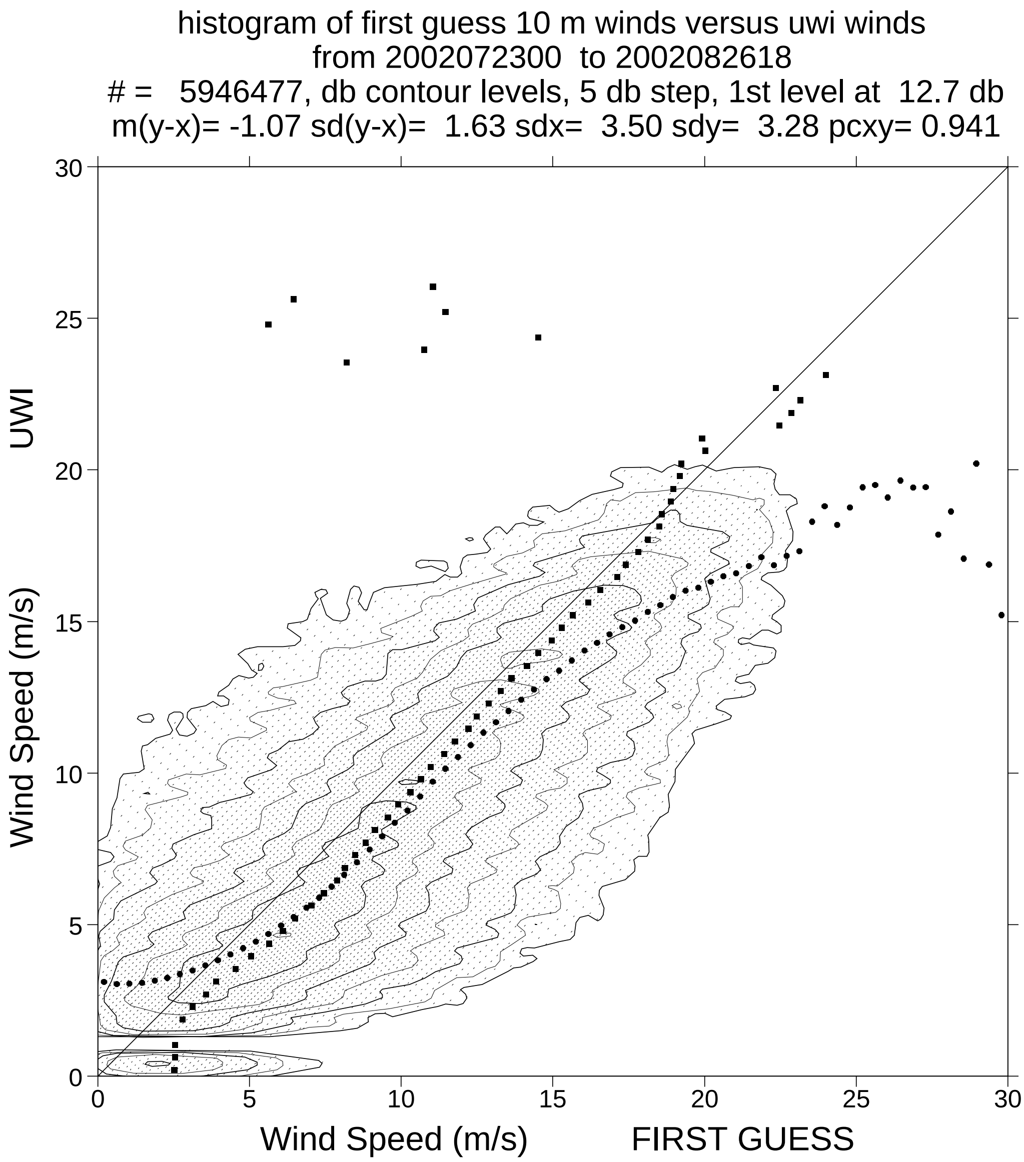

histogram of first guess 10 m winds versus uwi winds
from 2002072300 to 2002082618
= 5946477, db contour levels, 5 db step, 1st level at 12.7 db
m(y-x)= -1.07 sd(y-x)= 1.63 sdx= 3.50 sdy= 3.28 pcxy= 0.941
UWI
Wind Speed (m/s)
Wind Speed (m/s)
FIRST GUESS
0
5
10
15
20
25
30

Figure 7

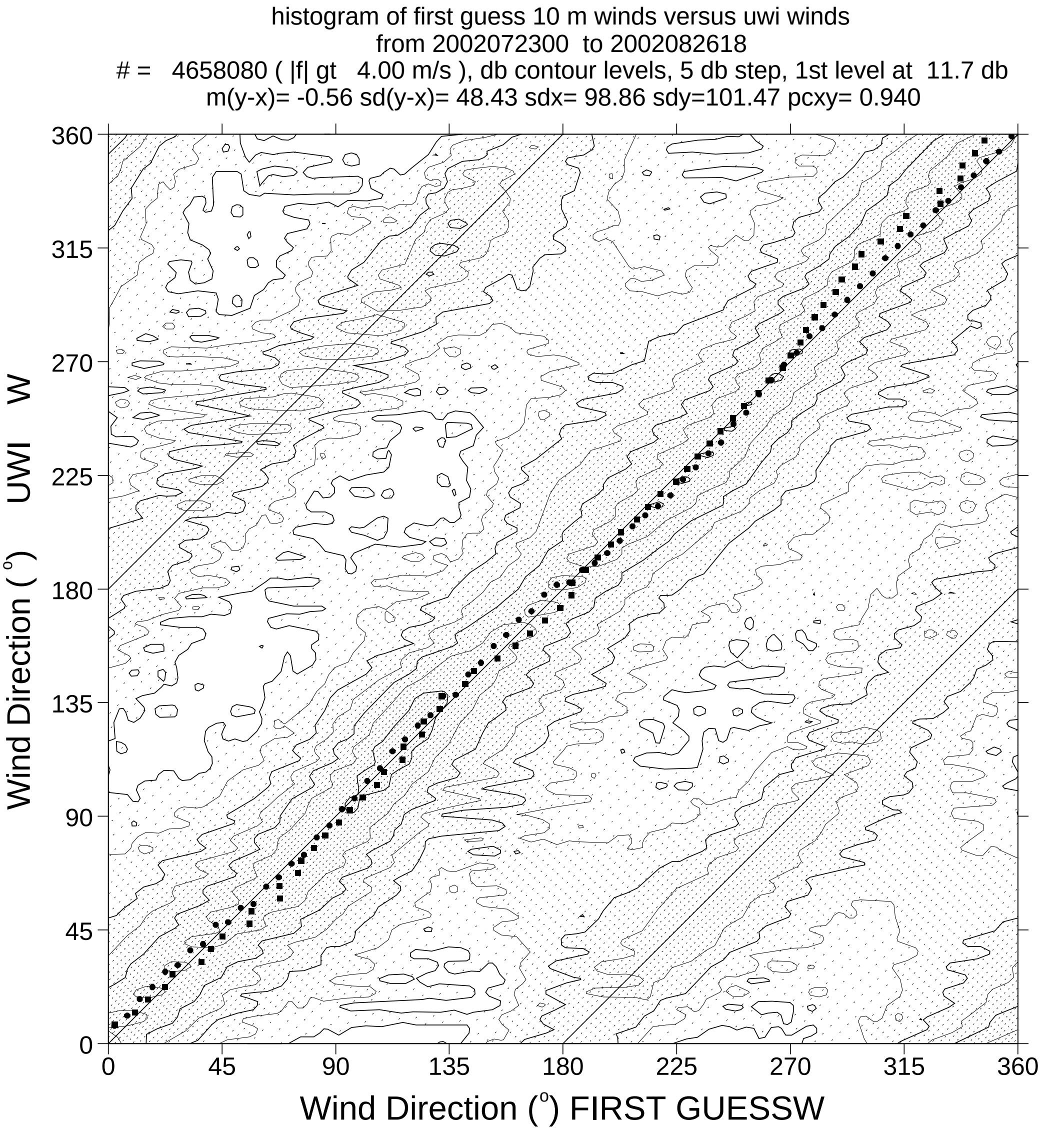

histogram of first guess 10 m winds versus uwi winds
from 2002072300 to 2002082618
= 4658080 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 11.7 db
m(y-x)= -0.56 sd(y-x)= 48.43 sdx= 98.86 sdy=101.47 pcxy= 0.940
Wind Direction (°) UWI W
Wind Direction (°) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 8

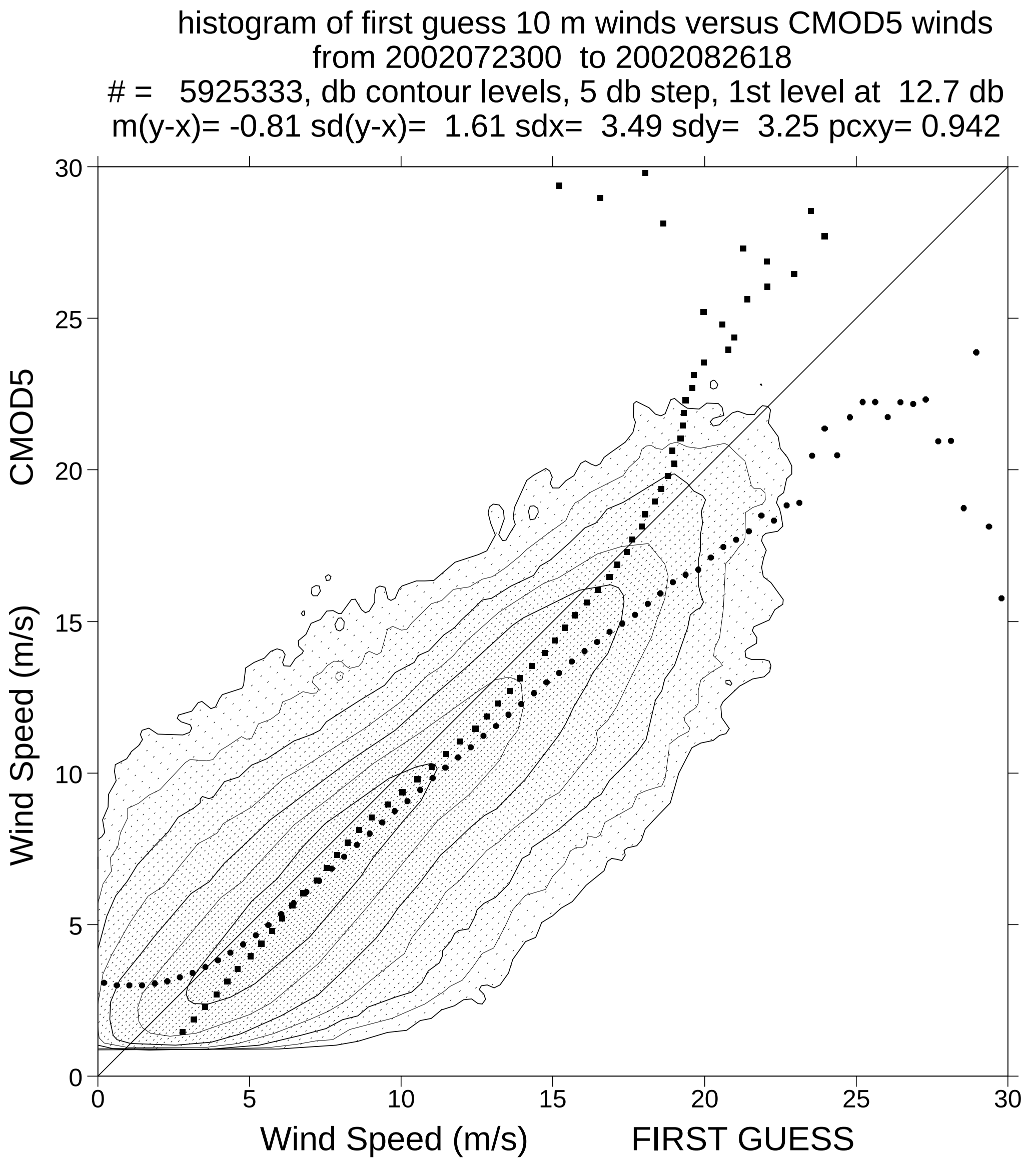

histogram of first guess 10 m winds versus CMOD5 winds
from 2002072300 to 2002082618
= 5925333, db contour levels, 5 db step, 1st level at 12.7 db
m(y-x)= -0.81 sd(y-x)= 1.61 sdx= 3.49 sdy= 3.25 pcxy= 0.942
CMOD5
Wind Speed (m/s)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Wind Speed (m/s)
FIRST GUESS

Figure 9