Monitoring statistics of the ERS-2 scatterometer for ESA

CYCLE 77

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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 77. The gyroless ERS-2 scatterometer data was not used in the 4D-Var data assimilation system at ECMWF.

During cycle 77, data was received between 21:02 UTC 26 August 2002 and 19:32 UTC 30 September 2002. No data was received for the 6-hourly period of 00 UTC 14 September 2002, and less than 15% of the usual amount was received for 12 UTC 11 September 2002.

The average quality of the data for cycle 77 was higher than the average performance of the data received during cycle 76. The quality slowly becomes comparable to that of the nominal ERS-2 scatterometer data from before January 2001. Standard deviations w.r.t. collocated ECMWF first-guess winds are comparable to that of the nominal situation or even slightly better. The wind bias w.r.t. to first-guess winds is still somewhat more negative ($\sim$ -0.9 m/s compared to $\sim$ -0.7 m/s).

The situation during cycle 77 was reasonably stable. Time series of the normalized distance to the cone and of UWI winds minus ECMWF first-guess winds showed a few peaks only.

During cycle 77, there was no clear signature found for data that was degraded by solar activity.

The ECMWF assimilation system was not modified during cycle 77.

2 ERS-2 statistics from 27 August 2002 to 30 September 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 77 as compared to the corresponding levels averaged over cycle 76, showed the following evolution. The bias levels of most beams has reduced with amounts between 0.1 and 0.2 dB. This especially applies for the fore beam which shows an improvement of about 0.2 dB for all incidence angles and both the ascending and descending tracks. In general, bias levels are in the order of 0.4 to 0.8 dB too low. For descending tracks, bias levels of the three beams agree quite well for all incidence angles. For the ascending tracks, the difference between the fore and aft beam has widened, though. The bias level of the ascending fore beam is for most incidence angles about 0.3 dB less negative than that of the corresponding level of the aft beam. The ascending fore and mid beam agree quite well, even for high incidence angles. In that respect the aft beam is the outlier. The dependence of bias levels on incidence angles is mild, and similar to the situation of cycle 76.

2.2 Distance to cone history

The distance to the cone history is shown in Figure 2. The situation is like cycle 76, less volatile than it was for earlier cycles of gyroless data. The peaks for 12 UTC 11 September 2002 and 00 UTC 14 September 2002 are due to low data volumes. For the higher nodes there is a peak for the three 6-hourly periods between 18 UTC 18 September and 6 UTC 19 September 2002. The UWI winds are of lower quality for these three periods (see Figure 3). The standard deviation is higher, and for the higher nodes, wind biases are more negative than usual. This indicates an attitude problem, probably yaw related. For this date, no enhanced solar activity was observed. The attitude problem, therefore, must have had a different origin. For the lowest two nodes there is a peak in the distance to the cone history for 00 UTC 26 September 2002. It is accompanied by a somewhat higher standard deviation for the UWI winds; bias level are normal for this 6-hourly period.

For the lower nodes, distances are very close to their normalized levels, like for cycle 76. For the higher nodes, there is a transition at 18 UTC 04 September 2002. Since that date, distances for higher nodes have moved much closer to the normalized values. As a result, distance levels are not far from their normalized values for all nodes. The performance of the UWI winds at high nodes has improved as well since this date (see Figure 3).

2.3 UWI minus First-Guess history

In Figure 3, the UWI minus ECMWF first-guess wind history is plotted. The situation looks reasonably stable. For the three 6-hourly periods from 18 UTC 18 September to 6 UTC 19 September 2002, for the higher nodes wind biases are significantly more negative than normal. The amplitude of the peak (2 m/s) is smaller than that of peaks before cycle 77. There is also a small deterioration of the standard deviation for this period. For 00 UTC 20 September 2002, there is a smaller peak, again, only at the higher nodes. The peaks in the wind time series correspond to peaks in the distance to the cone history. However, for 00 UTC 20 September 2002 these peaks are not very pronounced.

For all nodes there is a trend that wind biases are slowly reducing. For higher nodes there is a drop in standard deviation at 18 UTC 04 September 2002. This transition towards improved performance is accompanied with lower average cone distances (see Figure 2).

The quality of the UWI winds received during cycle 77 was somewhat higher w.r.t. data received during cycle 76. The UWI winds now have an average bias of -0.92 m/s, which was -1.07 m/s for cycle 76. The bias is -1.23 m/s for nodes 1-2 (was -1.38 m/s) and -0.90 m/s for nodes 15-19 (was -1.05 m/s). Biases are smallest for nodes 8-10 (-0.78, was -0.94 m/s). The standard deviation is on average 1.59 m/s (was 1.62 m/s), and increases from 1.57 m/s (was 1.58 m/s) for nodes 1-2, to 1.65 m/s for nodes 15-19 (was 1.69 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 49.9 degrees, was 50.5) and between 15 and 25 degrees (average value 19.3, was 18.8) 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 is very similar to that of cycle 76.

2.4 Scatter plots

The scatter plot of model 10 m first-guess wind speeds versus UWI wind speeds (Figure 7) shows a less negative bias (-0.92 m/s) compared to the plot from cycle 76 (-1.07 m/s). The standard deviation is somewhat smaller (1.61 m/s, was 1.63 m/s) as well.

The direction scatter plot (Figure 8) looks similar to the results from cycle 76 (bias from -0.6 to -0.1 degrees, and standard deviation from 48.4 to 47.6 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. Compared to CMOD5 winds for cycle 76, both bias levels (from -0.81 to -0.64 m/s) and standard deviations (from 1.61 to 1.59 m/s) were reduced. These winds have w.r.t. the ECMWF first-guess winds a lower bias and a smaller standard deviation as well than the CMOD4 winds have. In the high wind-speed sector these CMOD5 winds are more realistic than their CMOD4 counterparts.

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 normalized 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.

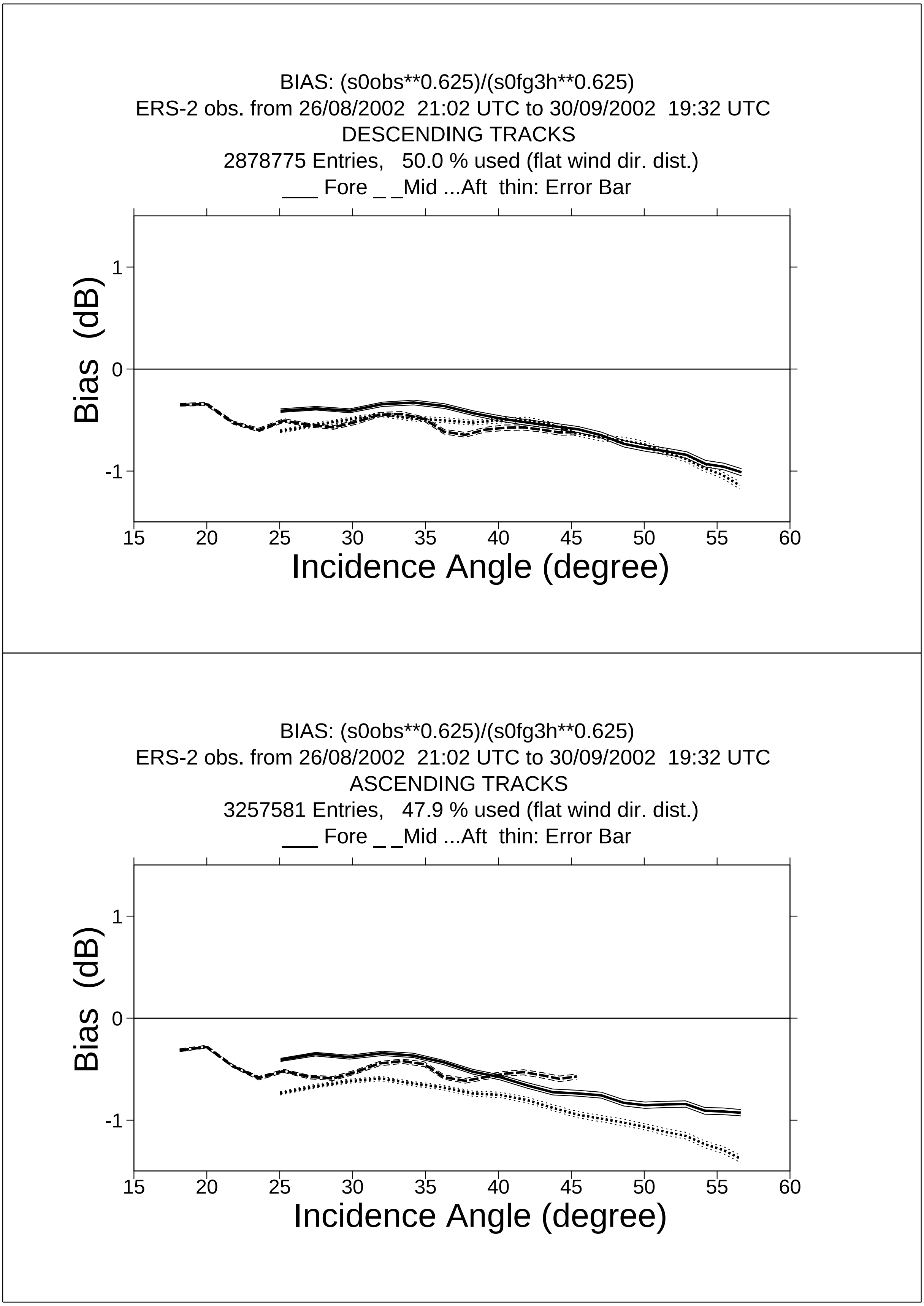
BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 26/08/2002 21:02 UTC to 30/09/2002 19:32 UTC
DESCENDING TRACKS
2878775 Entries, 50.0 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
1
0
-1
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)
BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 26/08/2002 21:02 UTC to 30/09/2002 19:32 UTC
ASCENDING TRACKS
3257581 Entries, 47.9 % 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

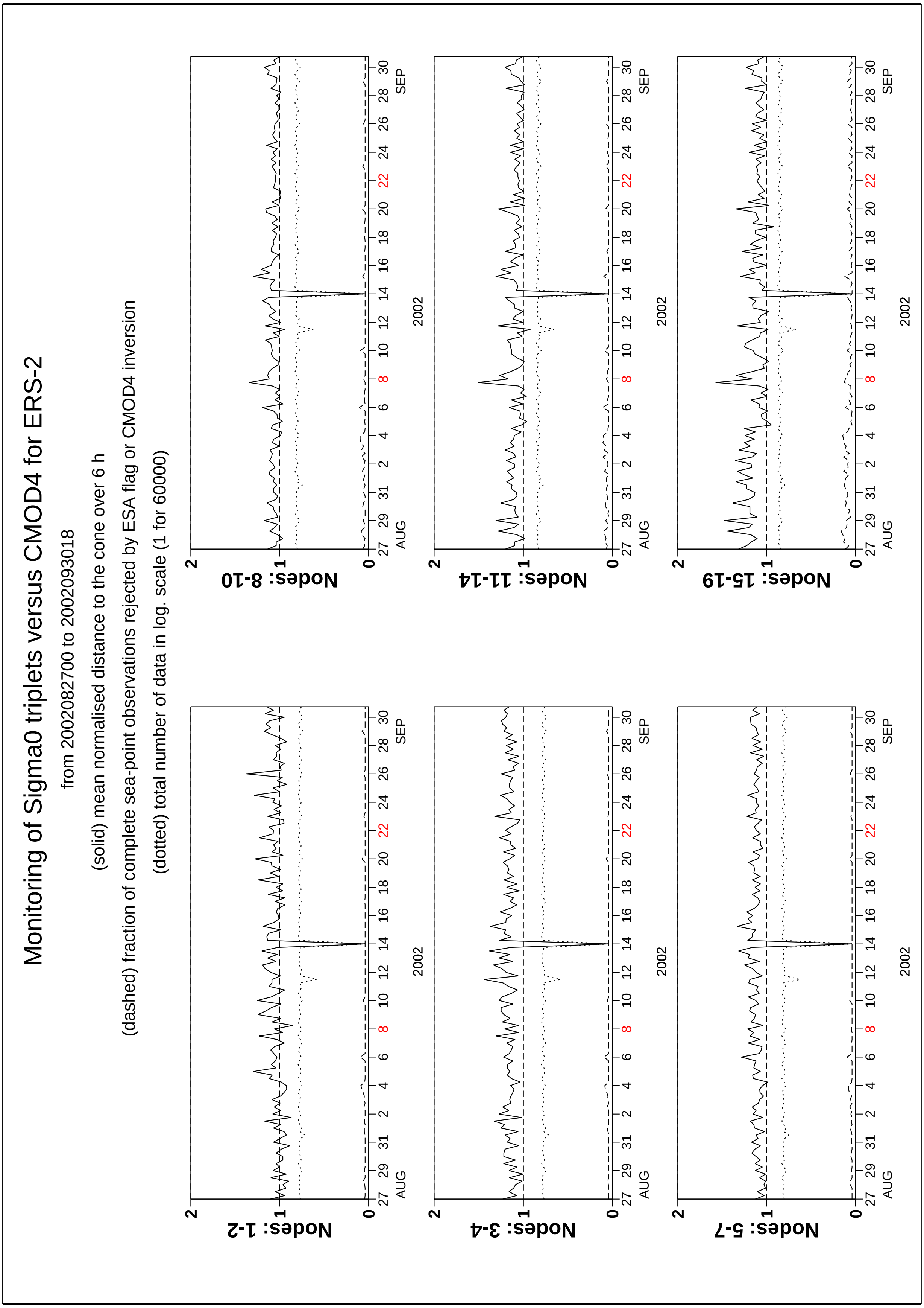
Monitoring of Sigma0 triplets versus CMOD4 for ERS-2
from 2002082700 to 2002093018
(solid) mean normalised distance to the cone over 6 h
(dashed) fraction of complete sea-point observations rejected by ESA flag or CMOD4 inversion
(dotted) total number of data in log. scale (1 for 60000)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
AUG
SEP
2002

Figure 2

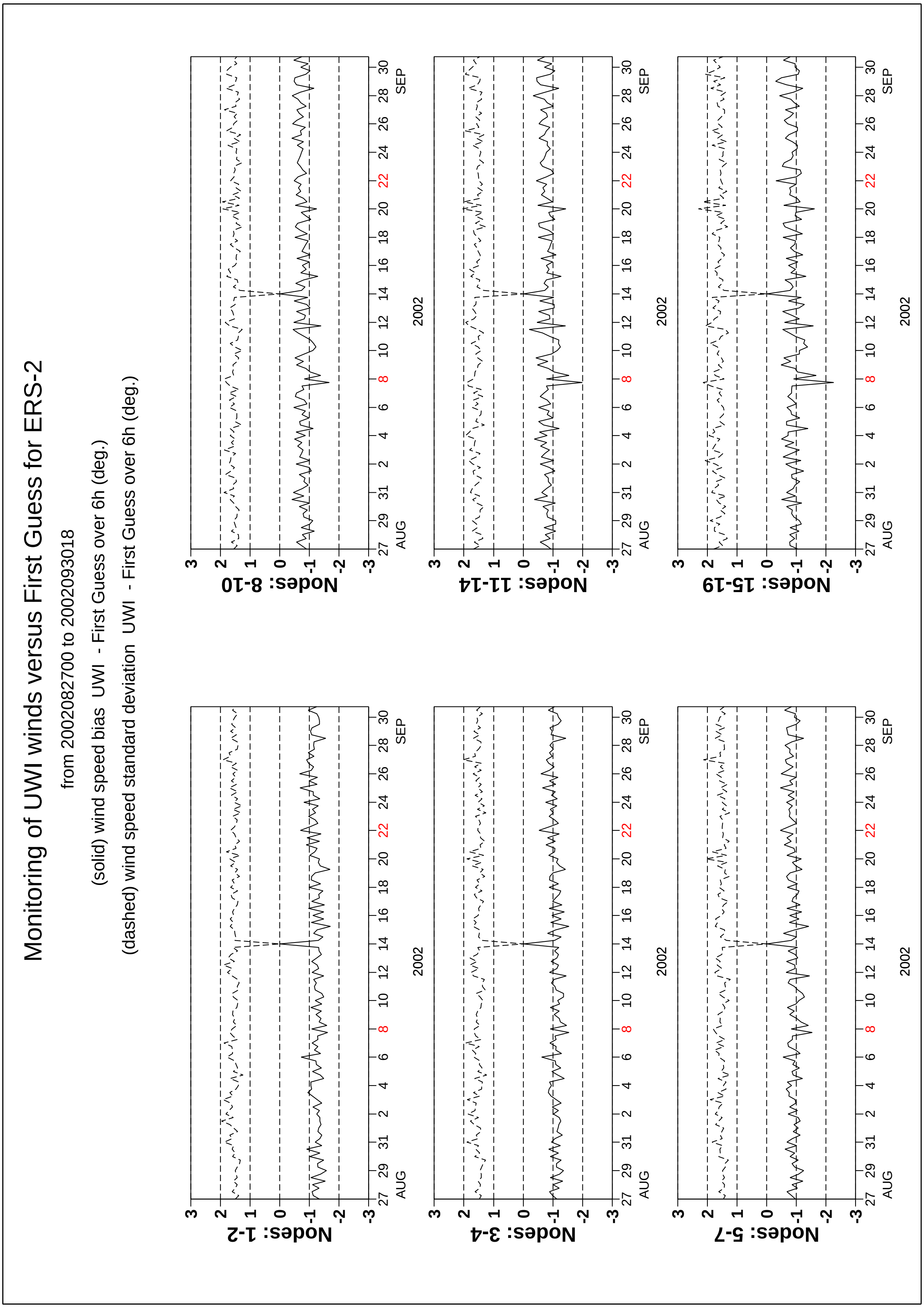
Monitoring of UWI winds versus First Guess for ERS-2
from 2002082700 to 2002093018
(solid) wind speed bias UWI - First Guess over 6h (deg.)
(dashed) wind speed standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
AUG
SEP
2002

Figure 3

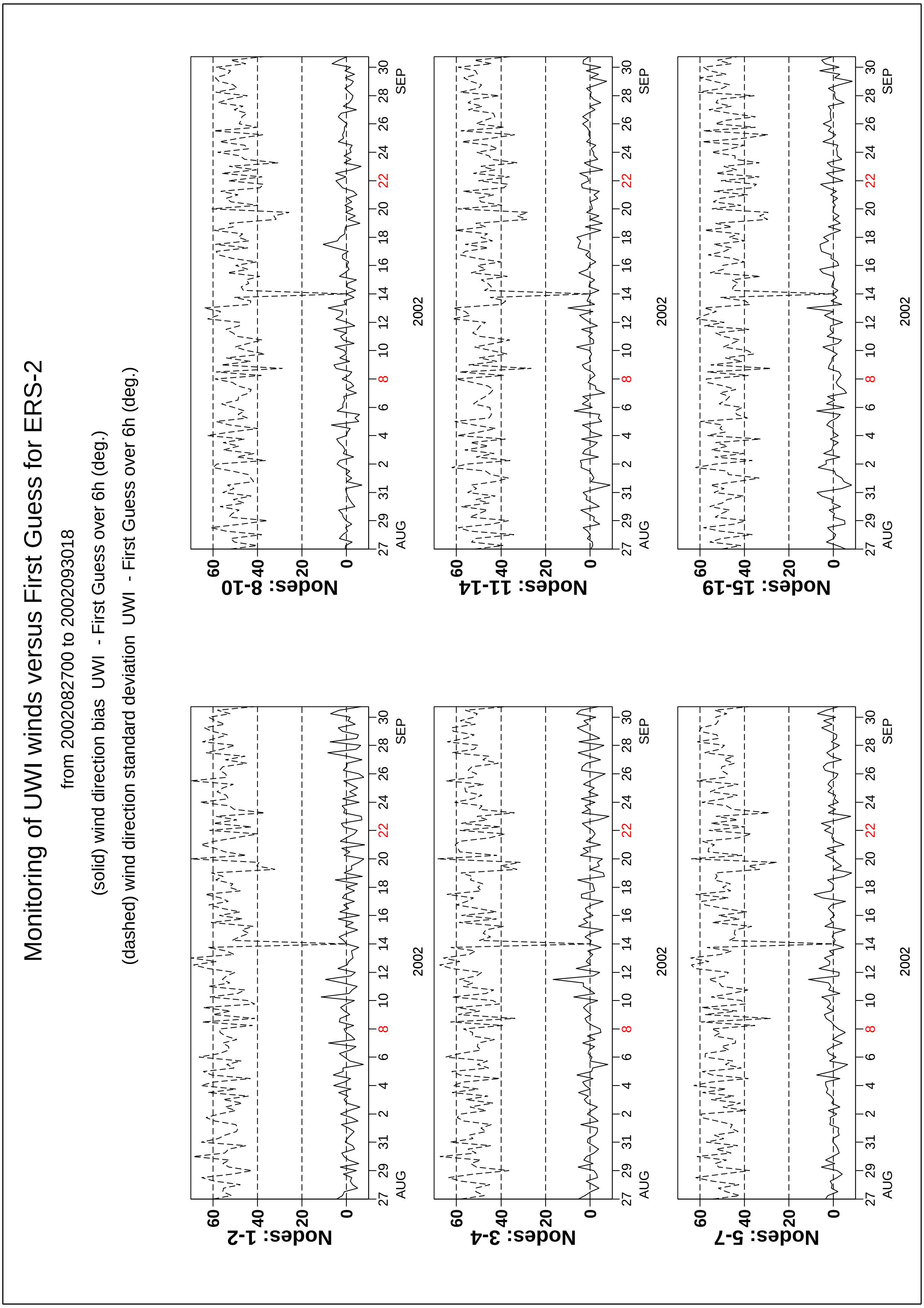
Monitoring of UWI winds versus First Guess for ERS-2
from 2002082700 to 2002093018
(solid) wind direction bias UWI - First Guess over 6h (deg.)
(dashed) wind direction standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
AUG
SEP
2002

Figure 4

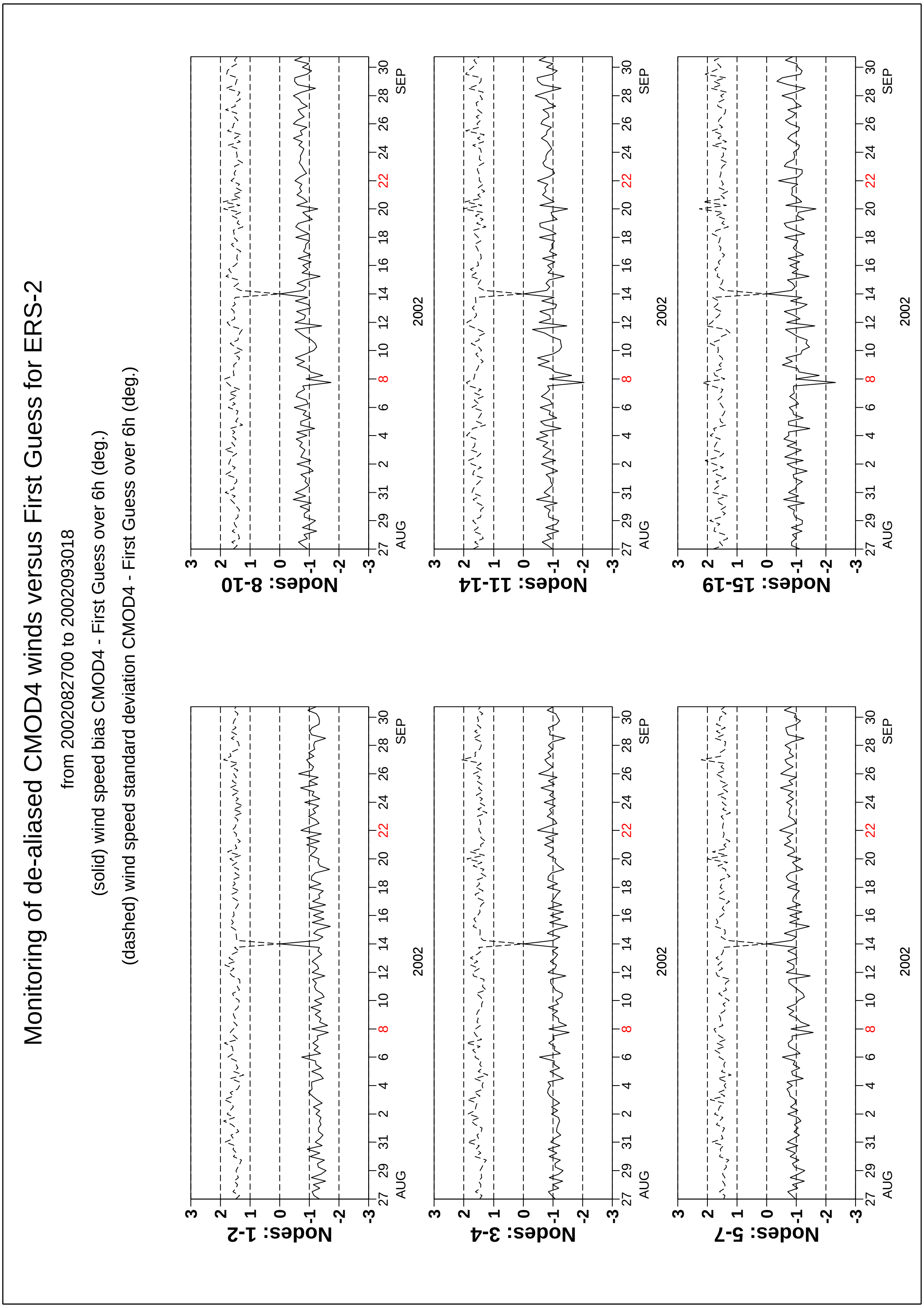
Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002082700 to 2002093018
(solid) wind speed bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind speed standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
AUG
SEP
2002

Figure 5

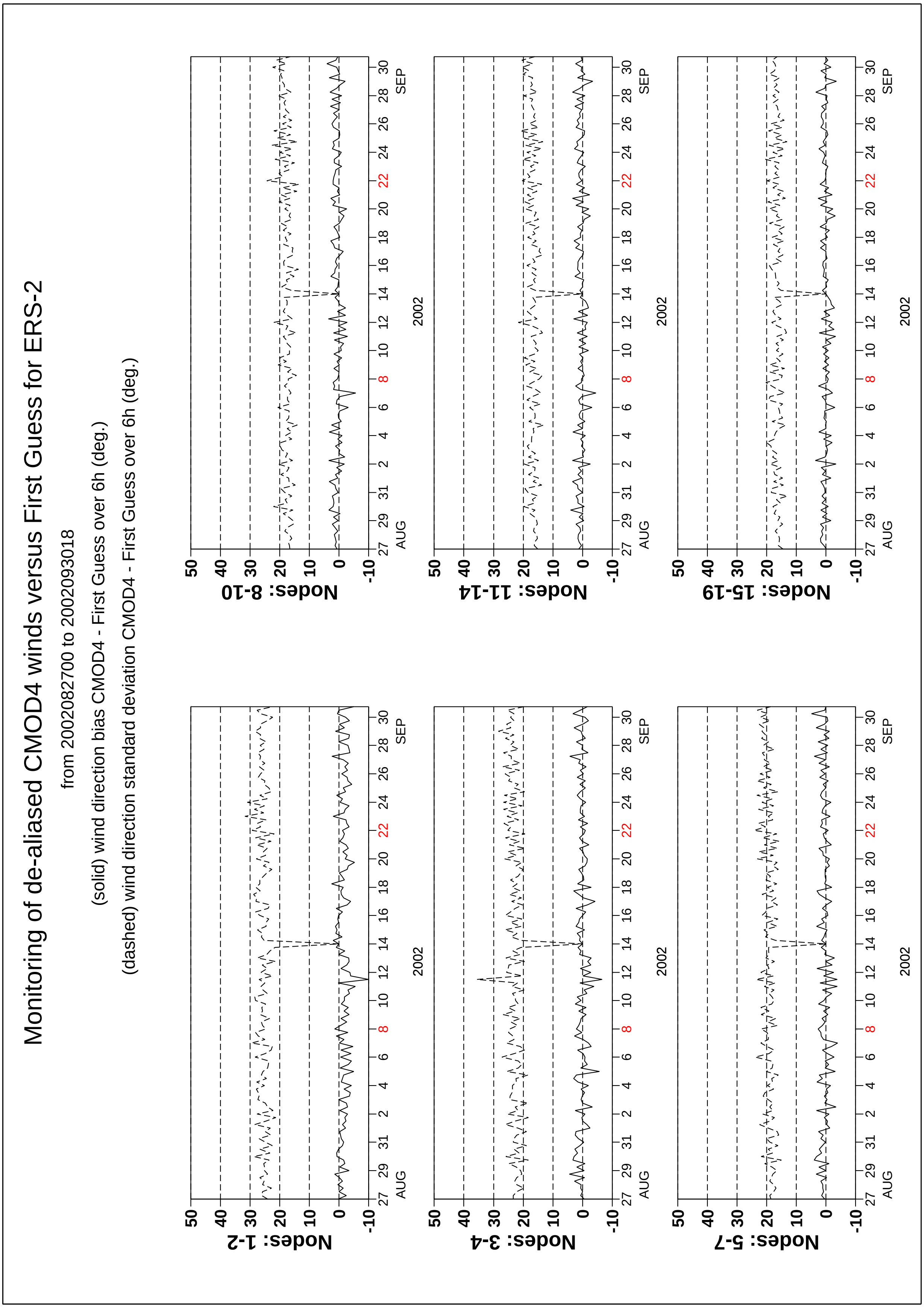
Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002082700 to 2002093018
(solid) wind direction bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind direction standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
AUG
SEP
2002

Figure 6

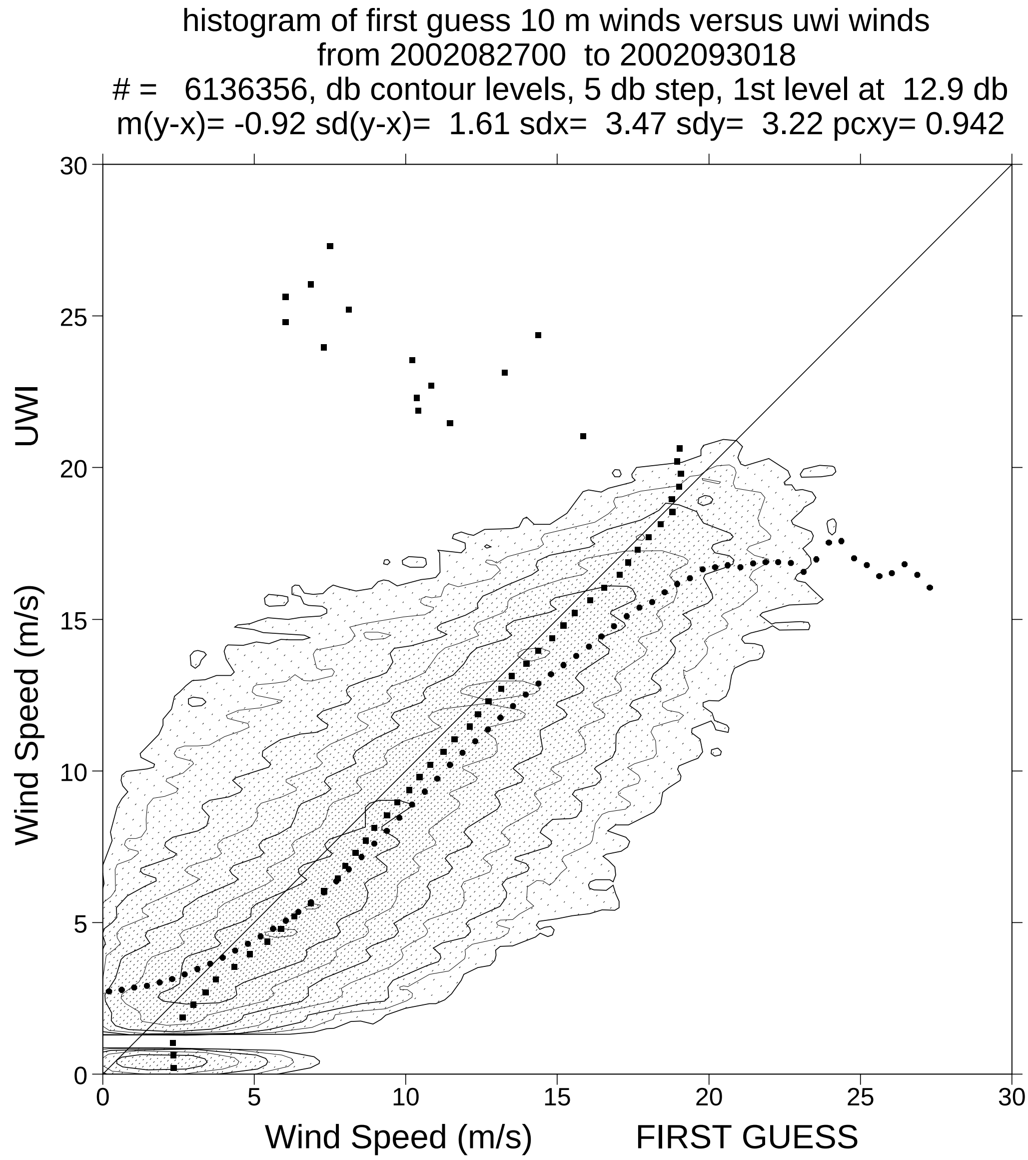
histogram of first guess 10 m winds versus uwi winds
from 2002082700 to 2002093018
= 6136356, db contour levels, 5 db step, 1st level at 12.9 db
m(y-x)= -0.92 sd(y-x)= 1.61 sdx= 3.47 sdy= 3.22 pcxy= 0.942
UWI
Wind Speed (m/s)
Wind Speed (m/s)
FIRST GUESS
0
5
10
15
20
25
30

Figure 7

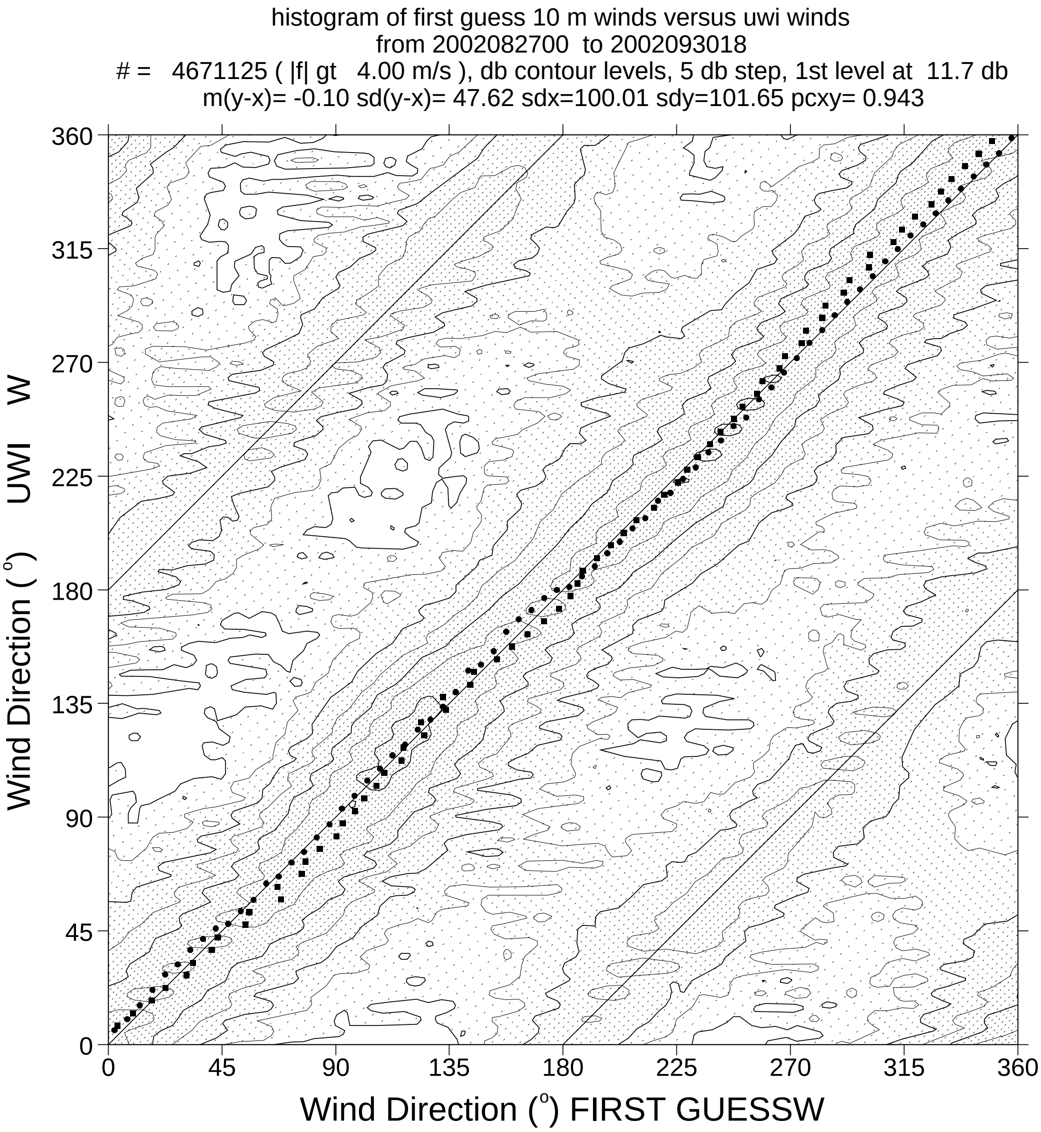
histogram of first guess 10 m winds versus uwi winds
from 2002082700 to 2002093018
= 4671125 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 11.7 db
m(y-x)= -0.10 sd(y-x)= 47.62 sdx=100.01 sdy=101.65 pcxy= 0.943
Wind Direction (o) UWI W
Wind Direction (o) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 8

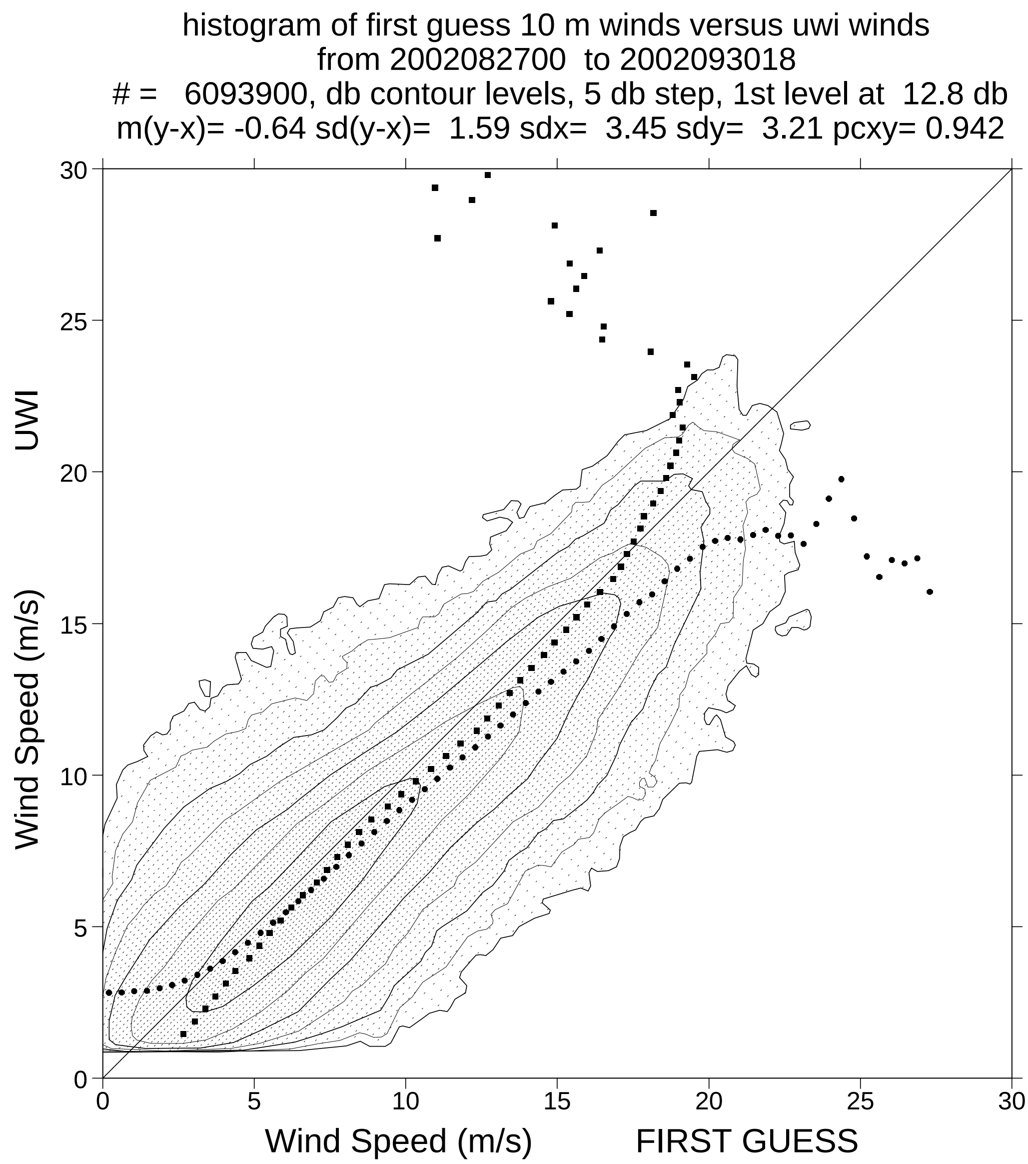
histogram of first guess 10 m winds versus uwi winds
from 2002082700 to 2002093018
= 6093900, db contour levels, 5 db step, 1st level at 12.8 db
m(y-x)= -0.64 sd(y-x)= 1.59 sdx= 3.45 sdy= 3.21 pcxy= 0.942
UWI
Wind Speed (m/s)
Wind Speed (m/s)
FIRST GUESS
0
5
10
15
20
25
30

Figure 9