Monitoring statistics of the ERS-2 scatterometer for ESA

CYCLE 78

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

During cycle 78, data was received between 22:52 UTC 30 September 2002 and 20:57 UTC 4 November 2002. No data was received for the 6-hourly periods of 00 UTC 06 October 2002, 00 UTC 07 October 2002, 12 UTC and 18 UTC 16 October 2002 and 00 UTC 28 October 2002.

The average quality of the data for cycle 78 was somewhat lower than the average performance of the data received during cycle 77. Scatterplots showed the reappearance of a number of light UWI winds collocated with much stronger ECMWF first-guess winds.

The situation during cycle 78 was less stable than it was for the previous two cycles. Time series of the normalised distance to the cone and of UWI winds minus ECMWF first-guess winds showed several peaks that were not related to low-data volumes. Some of these peaks were associated with large negative wind biases, which are an indication of yaw attitude errors of larger than 2 degrees.

The ECMWF assimilation system was not modified during cycle 78.

2 ERS-2 statistics from 31 September 2002 to 4 November 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 78 were within 0.1 dB from the corresponding levels averaged over cycle 77. For medium incidence angles, bias levels of the ascending fore and aft beam were reduced by 0.1 dB. At the highest incidence angles, however, the bias level of the ascending aft beam became ~ 0.1 dB more negative.

Bias levels are between 0.3 and 1.5 dB too low, and for descending tracks, bias levels of the three beams agree quite well for all incidence angles. For the ascending tracks, the differences are larger, and compared to cycle 77, differences between the fore and aft beam did increase. This trend was also present for the comparison between cycles 77 and 76 (see monitoring report for cycle 77). The bias level of the ascending fore and aft beam are for incidence angles up to 50 degrees within 0.3 dB and differ 0.5 dB for the highest incidence angle. The ascending mid beam is in between the bias levels of the fore and aft beam. The dependence of bias levels on incidence angles is reasonably mild, though slightly less satisfactory to that of the situation of cycle 77.

2.2 Distance to cone history

The distance to the cone history is shown in Figure 2. The situation is less optimal than it was for cycles 75 and 76. Several peaks are present that are not related to low data volumes. Usually peaks are more prominent towards higher nodes. Within the first 5 days of cycle 78, several peaks are visible, the largest occurring for 06 UTC 03 October 2002. Prior to (18 UTC 15 October 2002) and after (00 UTC 17 October 2002) the two 6-hourly periods for which no data was received (12 UTC and 18 UTC 16 October 2002), the cone history shows sharp peaks. Data volumes were normal for these periods. Finally, for the two 6-hourly periods 06 UTC and 12 UTC 30 October 2002, a large peak is observed as well. Smaller peaks (in the highest nodes only) are observed for 00 UTC 13 October 2002, 00 UTC 19 October 2002, 00 UTC 26 October 2002, and 00 UTC 04 November 2002. For all of these 6-hourly periods, the received data volume was in the order of 30% lower than average.

Like for cycle 77, the average level of the distance to the cone is close to the normalized value. Deviations are largest for nodes 3 to 7.

2.3 UWI minus First-Guess wind history

In Figure 3, the UWI minus ECMWF first-guess wind history is plotted. The situation looks less stable than for the period of cycle 77.

The peaks in the cone history for some 6-hourly periods at the start of cycle 78, 18 UTC 15 October 2002, 00 UTC 17 October 2002 and 06 UTC to 12 UTC 30 October 2002, are accompanied with negative peaks in the wind-bias history.

The most negative peak occurs for 00 UTC 17 October 2002. During that 6-hourly period, UWI winds are on average more than 2 m/s lower than their collocated ECMWF winds. In addition, for these situations, the standard deviation between the UWI and ECMWF winds is larger than normal. The large negative peaks in bias levels indicate possible inaccuracies in the yaw attitude control.

As mentioned above, the quality of the UWI winds for cycle 78 was somewhat lower than that of the winds received during cycle 77. The UWI winds now have an average bias of -0.95 m/s, which was -0.92 m/s for cycle 77. The bias is -1.25 m/s for nodes 1-2 (was -1.23 m/s) and -0.96 m/s for nodes 15-19 (was -0.90 m/s). Biases are smallest for nodes 8-10 (-0.81, was -0.78 m/s). The standard deviation is on average 1.63 m/s (was 1.59 m/s), and increases from 1.58 m/s (was 1.57 m/s) for nodes 1-2, to 1.69 m/s for nodes 15-19 (was 1.65 m/s). Therefore, the decrease in quality is strongest towards higher nodes. 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 49.9) and between 15 and 25 degrees (average value 19.5, was 19.3) 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 similar to that of cycle 77.

2.4 Scatter plots

The scatter plot of model 10 m first-guess wind speeds versus UWI wind speeds (Figure 7) shows a slightly more negative bias (-0.95 m/s) compared to the plot from cycle 77 (-0.92 m/s). The standard deviation is somewhat worse (1.64 m/s, was 1.61 m/s) as well. Unfortunately an amount of low UWI winds collocated with high ECMWF winds has reappeared. The situation is far more better than it was for the first cycles of monitored gyroless data (cycles 69 and 70). However, these undesired collocations were absent for cycles 76 and 77. Its re-appearance may be responsible for the increase of the bias level and standard deviation between the UWI and ECMWF winds.

The direction scatter plot (Figure 8) looks similar to the results from cycle 77 (bias from -0.1 to 0.45 degrees, and standard deviation from 47.6 to 48.2 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 77, both bias levels (from -0.64 to -0.69 m/s) and standard deviations (from 1.59 to 1.61 m/s) became higher. These winds have w.r.t. the ECMWF first-guess winds a lower bias and a smaller standard deviation than the CMOD4 winds have. In the high wind-speed sector the 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 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.

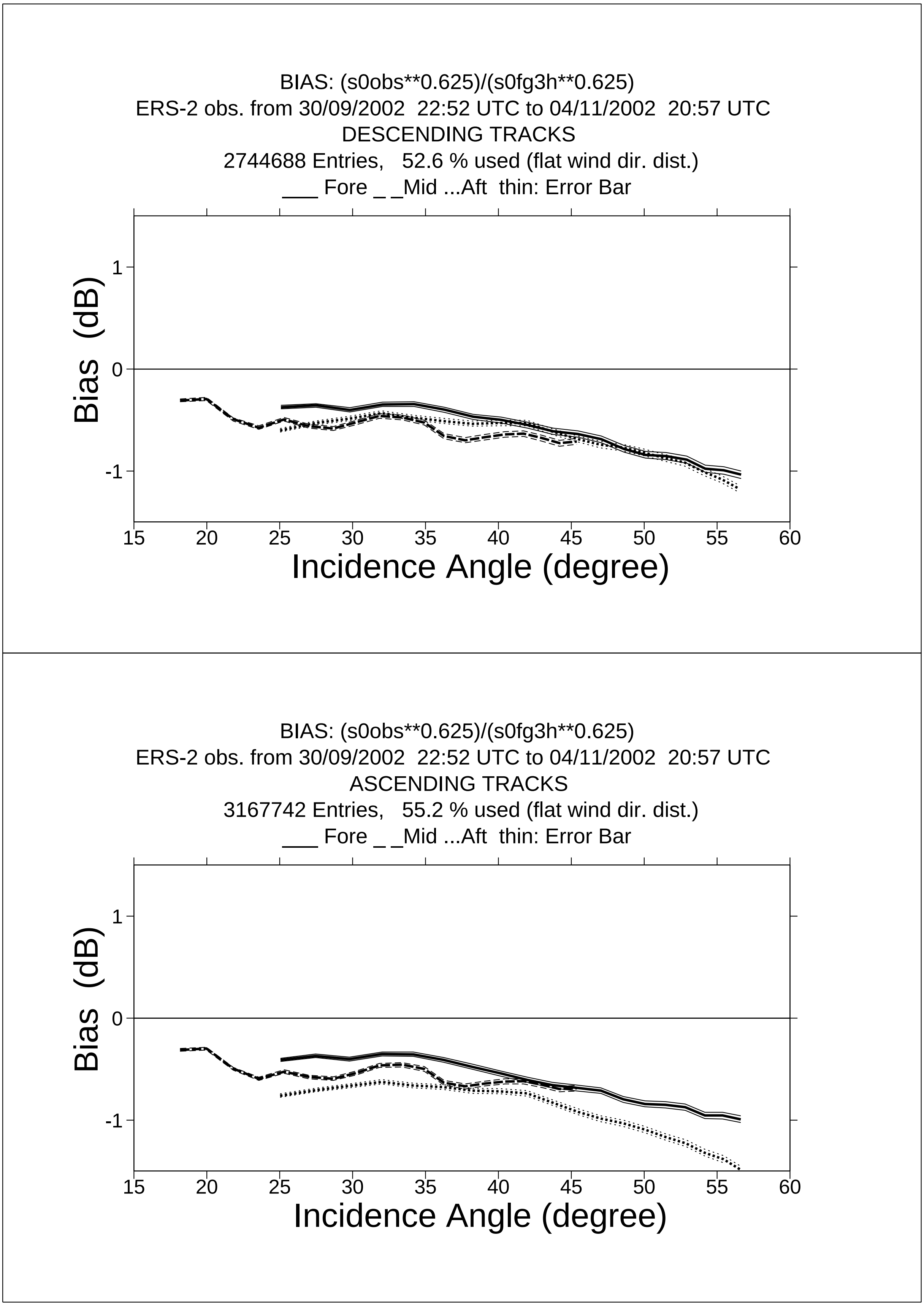

BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 30/09/2002 22:52 UTC to 04/11/2002 20:57 UTC
DESCENDING TRACKS
2744688 Entries, 52.6 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
1
0
-1
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)
BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 30/09/2002 22:52 UTC to 04/11/2002 20:57 UTC
ASCENDING TRACKS
3167742 Entries, 55.2 % 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

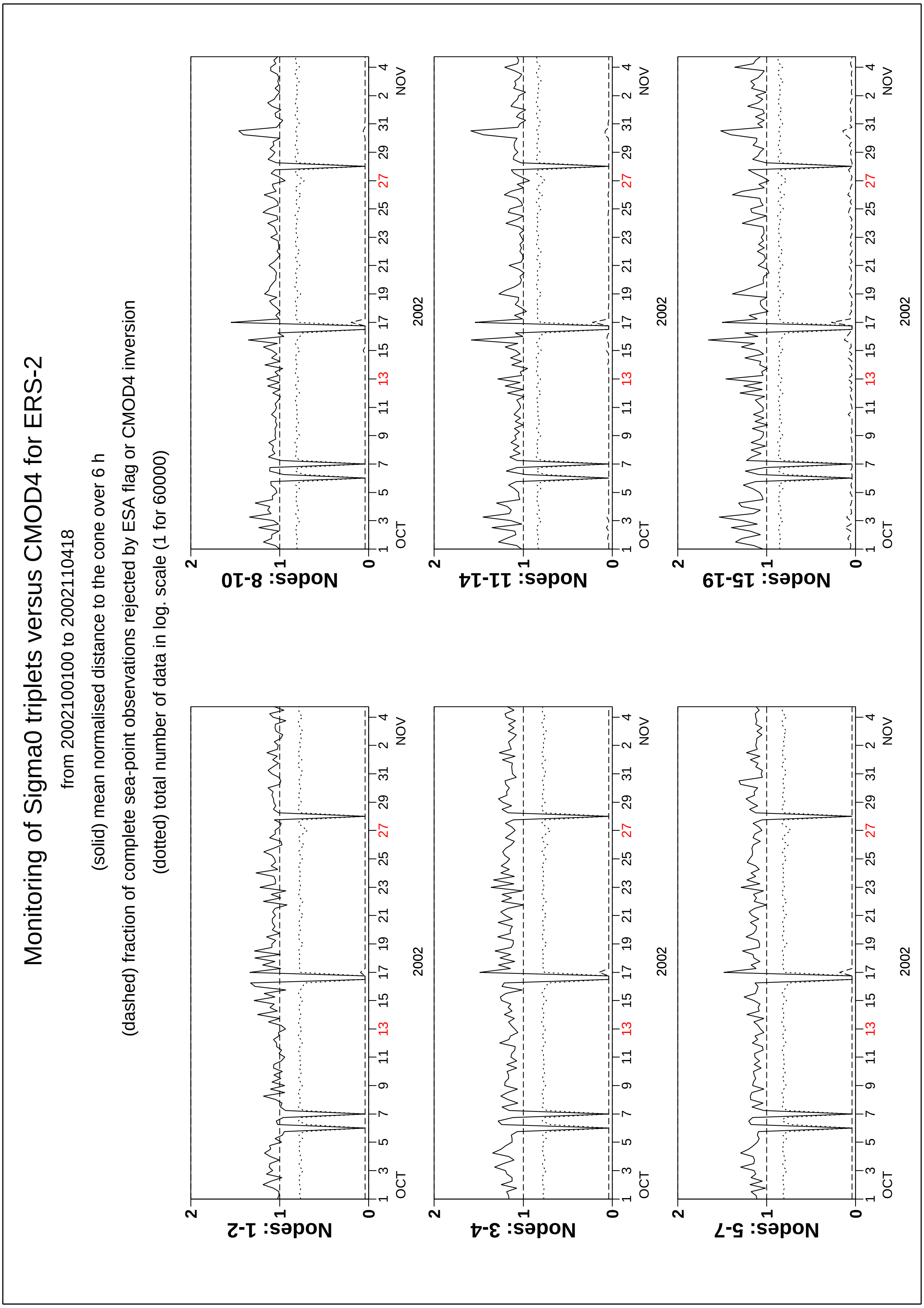

Monitoring of Sigma0 triplets versus CMOD4 for ERS-2
from 2002100100 to 2002110418
(solid) mean normalised distance to the cone over 6 h
(dashed) fraction of complete sea-point observations rejected by ESA flag or CMOD4 inversion
(dotted) total number of data in log. scale (1 for 60000)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
OCT
NOV
2002

Figure 2

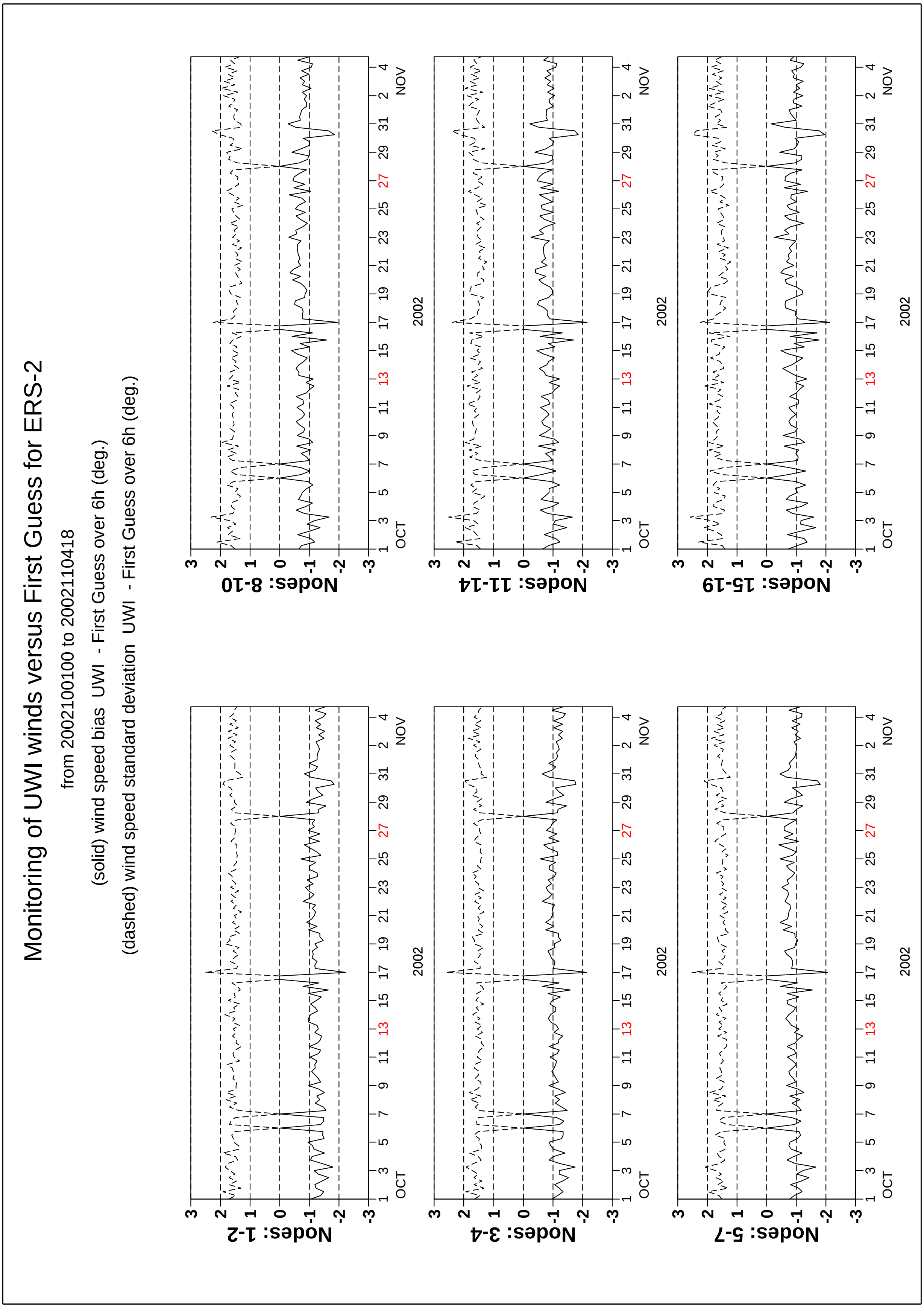

Monitoring of UWI winds versus First Guess for ERS-2
from 2002100100 to 2002110418
(solid) wind speed bias UWI - First Guess over 6h (deg.)
(dashed) wind speed standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
OCT
NOV
2002

Figure 3

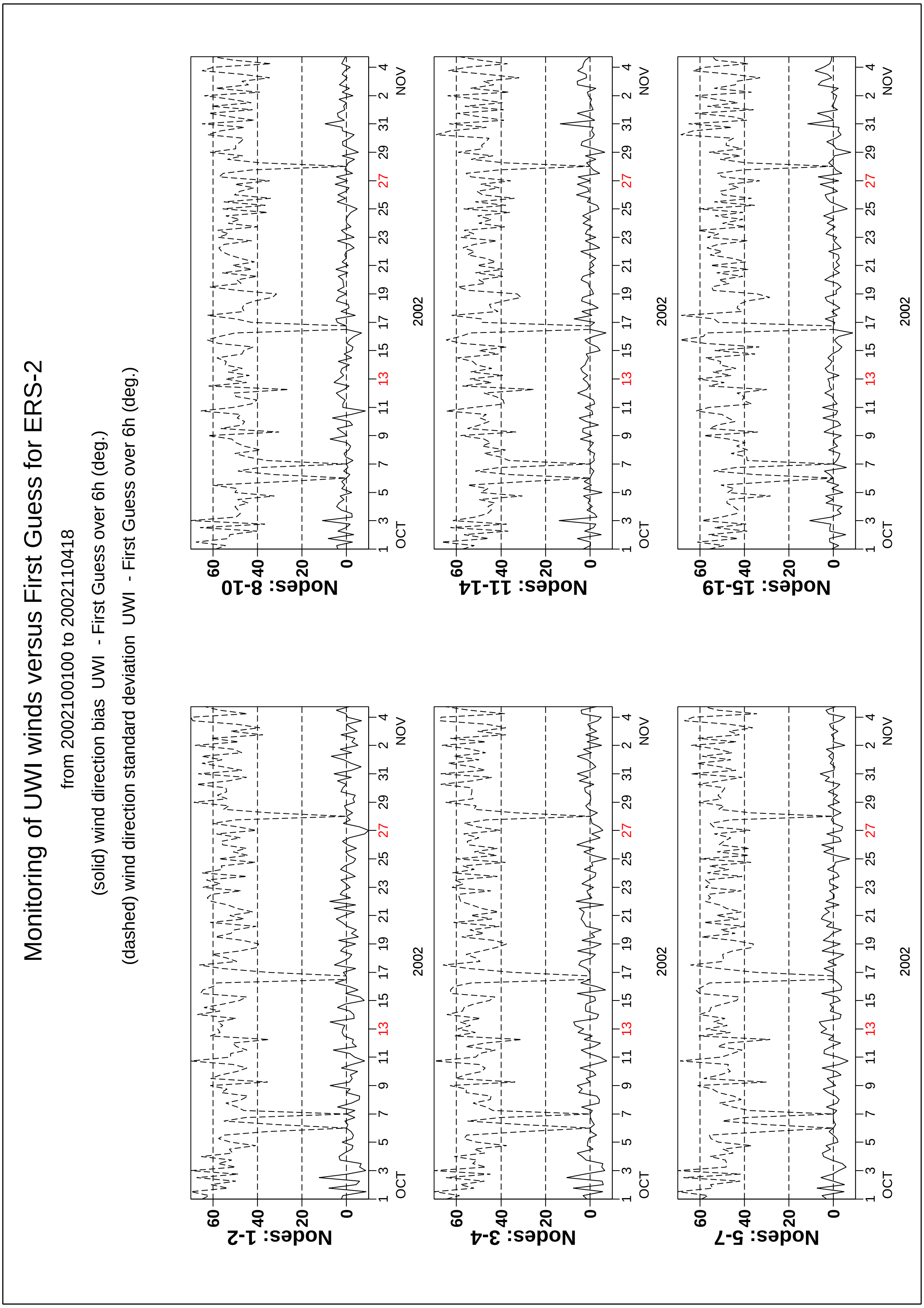

Monitoring of UWI winds versus First Guess for ERS-2
from 2002100100 to 2002110418
(solid) wind direction bias UWI - First Guess over 6h (deg.)
(dashed) wind direction standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
OCT
NOV
2002

Figure 4

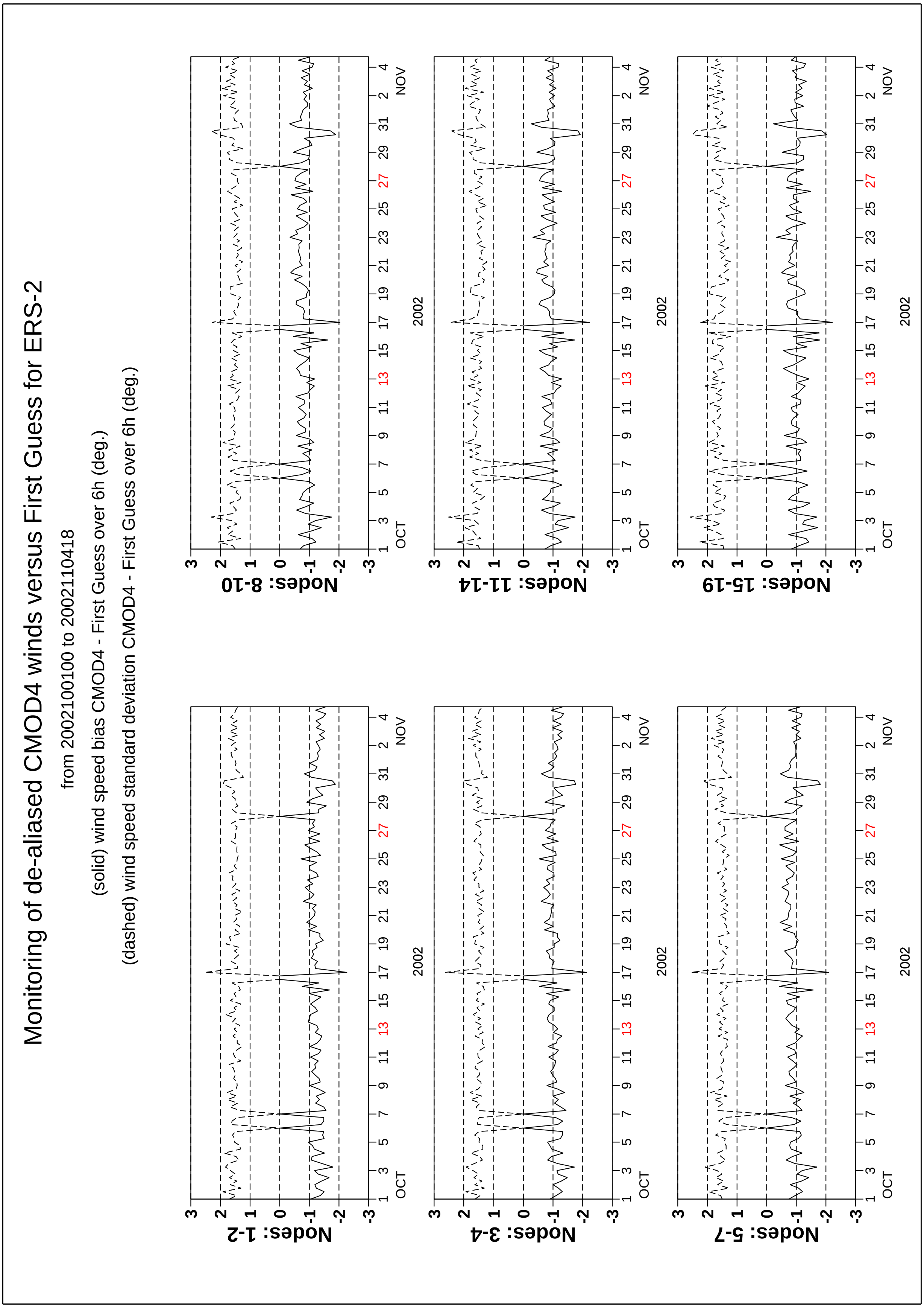

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002100100 to 2002110418
(solid) wind speed bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind speed standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
OCT
NOV
2002

Figure 5

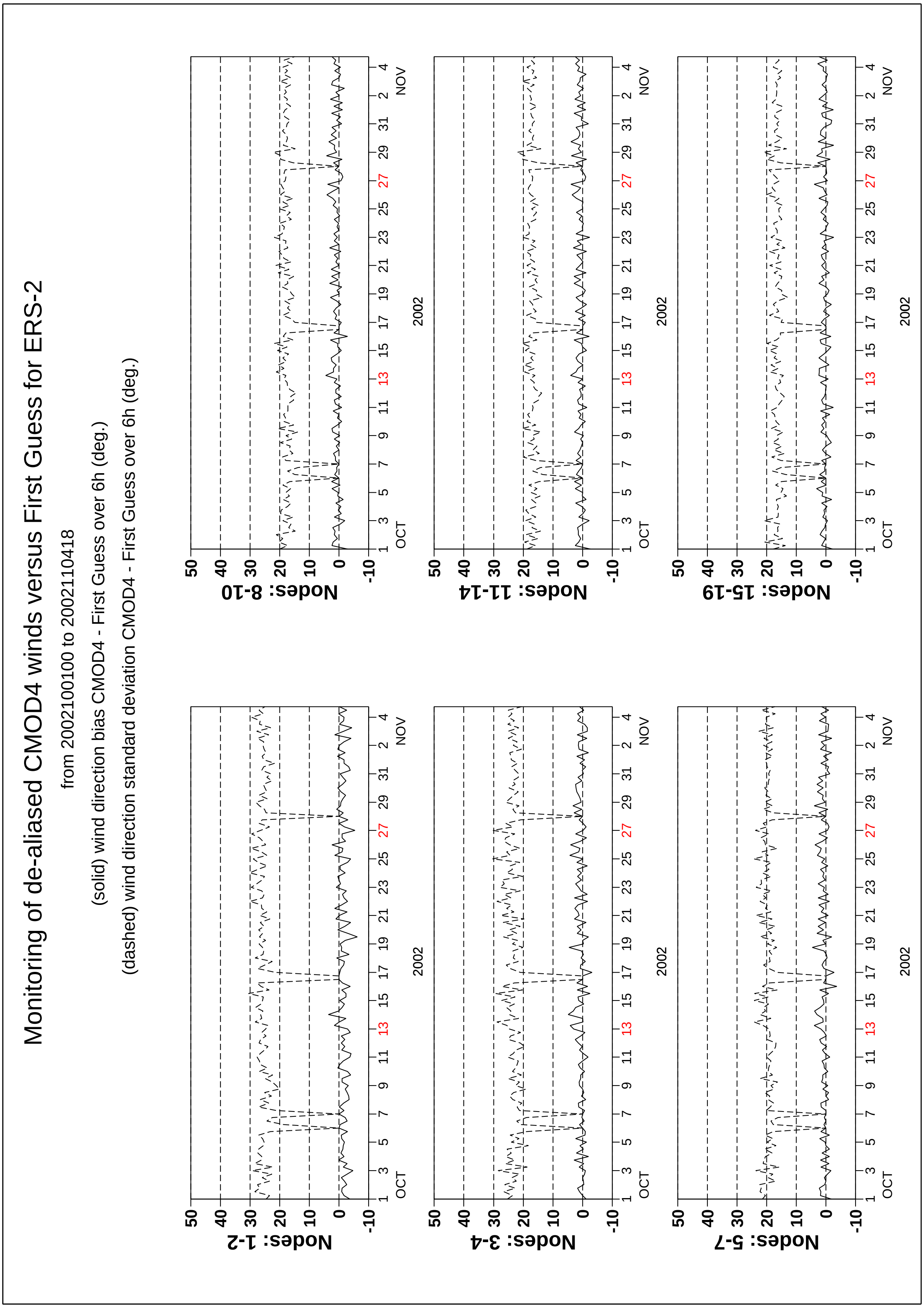

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002100100 to 2002110418
(solid) wind direction bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind direction standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
OCT
NOV
2002

Figure 6

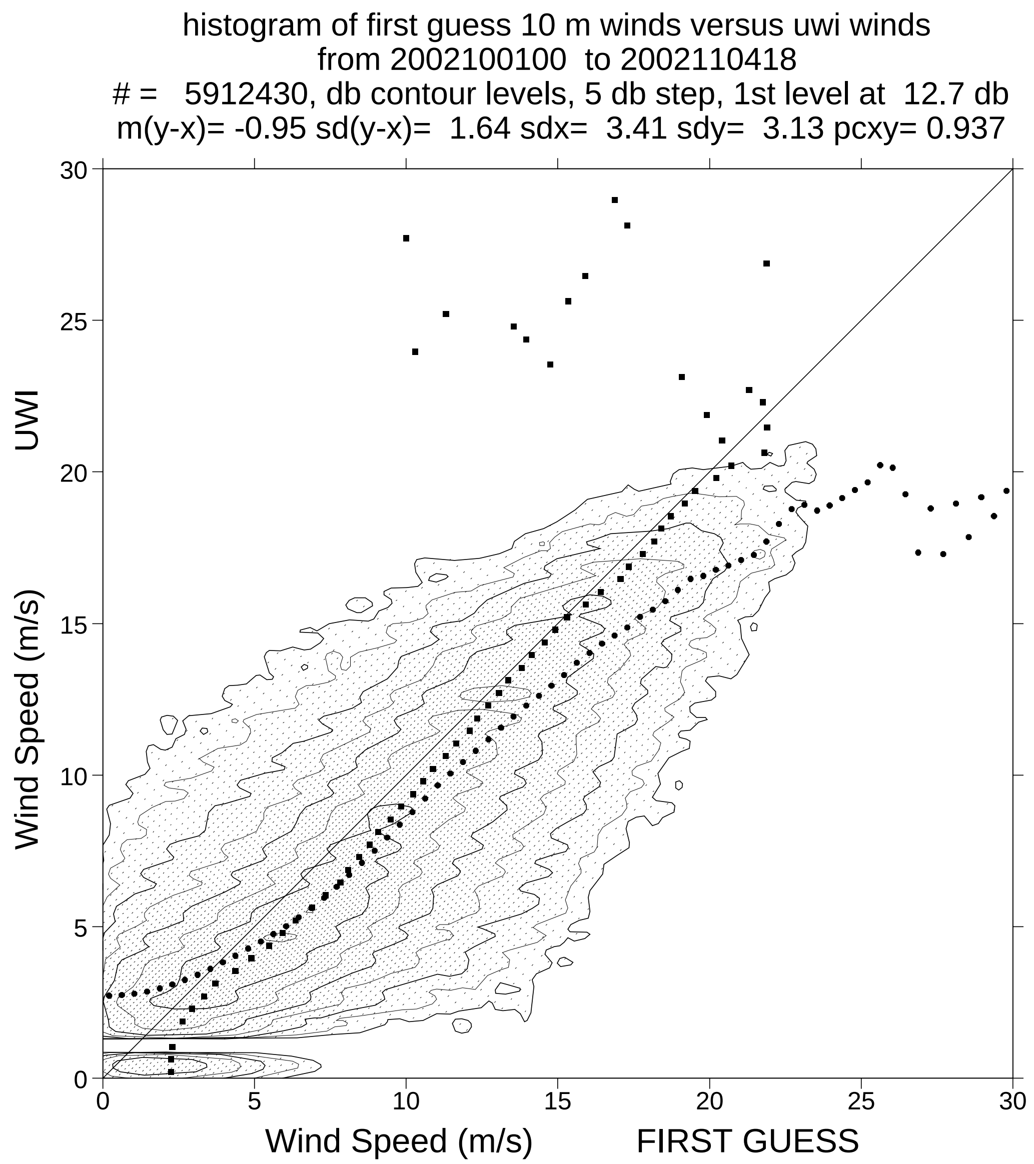

histogram of first guess 10 m winds versus uwi winds
from 2002100100 to 2002110418
= 5912430, db contour levels, 5 db step, 1st level at 12.7 db
m(y-x)= -0.95 sd(y-x)= 1.64 sdx= 3.41 sdy= 3.13 pcxy= 0.937
UWI
Wind Speed (m/s)
Wind Speed (m/s)
FIRST GUESS
0
5
10
15
20
25
30

Figure 7

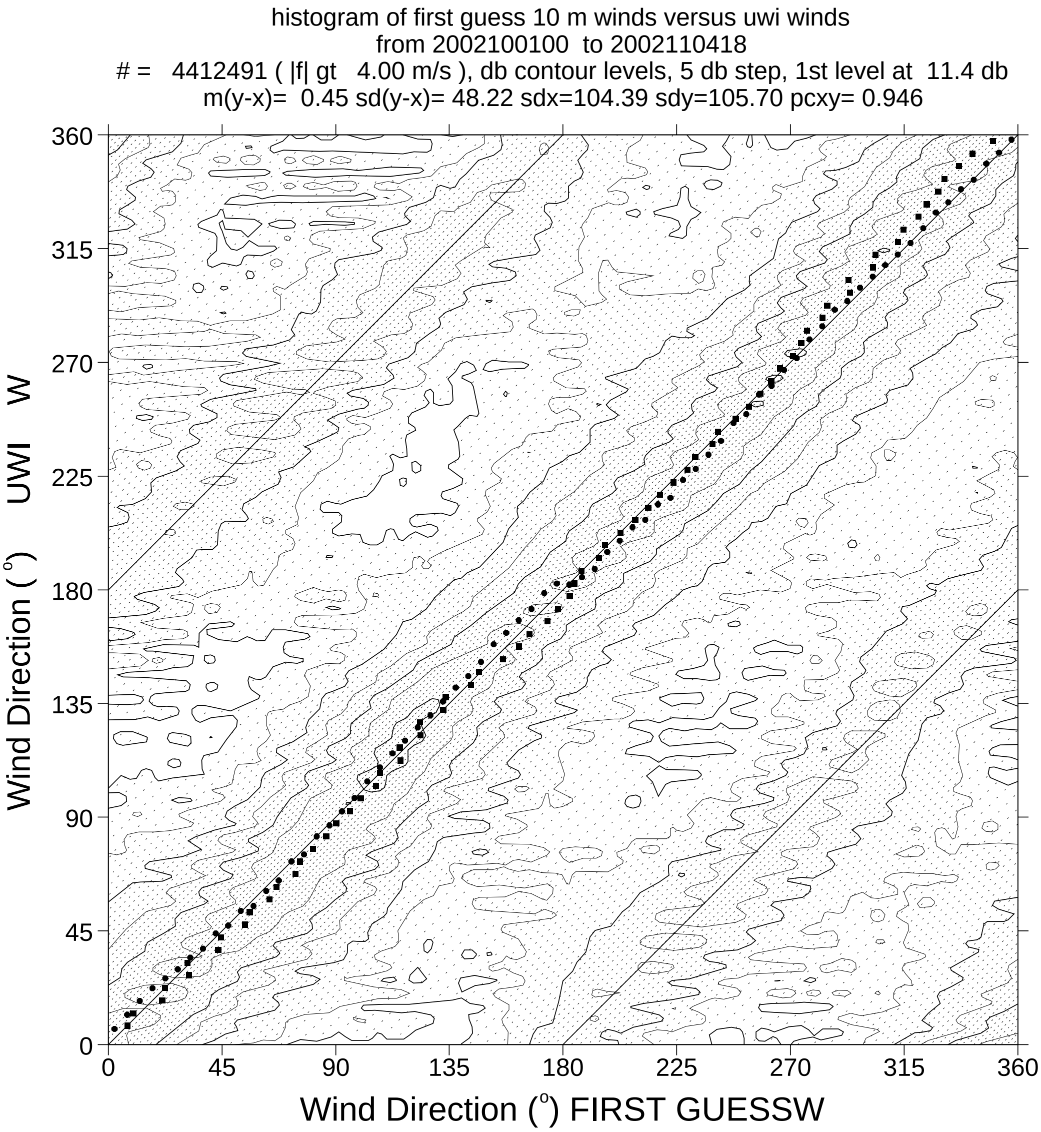
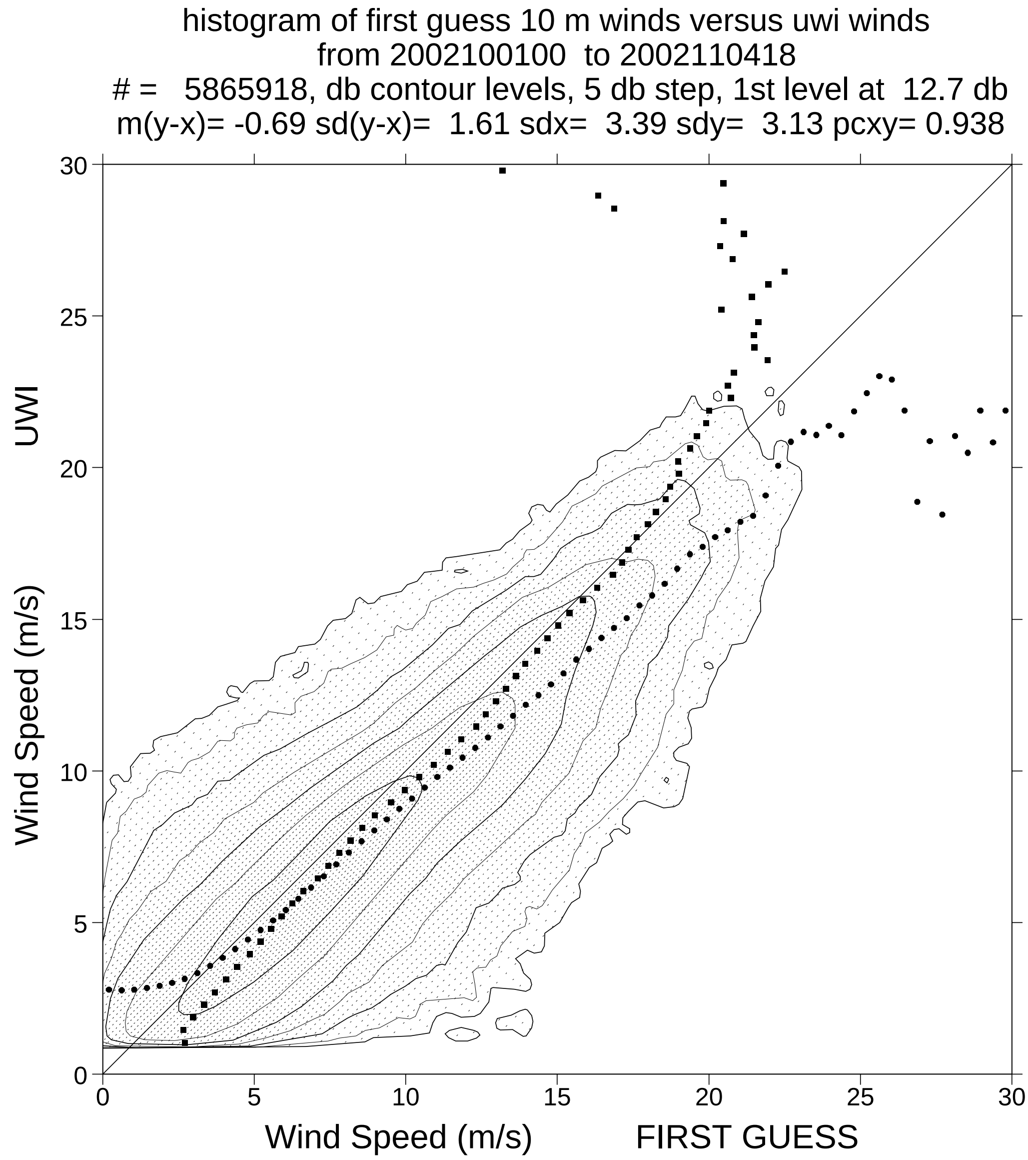

histogram of first guess 10 m winds versus uwi winds
from 2002100100 to 2002110418
= 4412491 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 11.4 db
m(y-x)= 0.45 sd(y-x)= 48.22 sdx=104.39 sdy=105.70 pcxy= 0.946
Wind Direction (o) UWI W
Wind Direction (o) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 8



histogram of first guess 10 m winds versus uwi winds
from 2002100100 to 2002110418
= 5865918, db contour levels, 5 db step, 1st level at 12.7 db
m(y-x)= -0.69 sd(y-x)= 1.61 sdx= 3.39 sdy= 3.13 pcxy= 0.938
UWI
Wind Speed (m/s)
0
5
10
15
20
25
30
0
5
10
15
20
25
30
Wind Speed (m/s)
FIRST GUESS

Figure 9