Monitoring statistics of the ERS-2 scatterometer for ESA

CYCLE 74

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

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

During cycle 74, data was received between 21:01 UTC 13 May 2002 and 20:57 UTC 17 June 2002. Due to an unavailability of the AMI instrument, no data was received within the 6-hourly cycles from 12 UTC 19 May 2002 to 18 UTC 25 May 2002 (with the exception of some data between 12 UTC - 18 UTC 24 May 2002). Also no data was received during the cycles: 18 UTC 29 May 2002, 00 UTC 31 May 2002, 00 UTC 1 June 2002, from 00 UTC 2 June 2002 to 12 UTC 02 June 2002, 00 UTC 4 June 2002, and 06 UTC 5 June 2002. Besides these cycles, there was a number of cycles for which the data volume was much lower than normal.

The quality of the data that was received during cycle 74 was higher than the average performance of the data received during cycle 73.

During cycle 74, there was no clear signature found for data that was degraded by solar activity.

The ECMWF assimilation system was not modified during cycle 74.

2 ERS-2 statistics from 14 May 2002 to 17 June 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 74 as compared to the corresponding levels averaged over cycle 73, showed the following evolution. For lower and mid incidence angles, the bias of the descending for and aft beam have become slightly more negative (around 0.1 dB). For the descending aft beam, the bias was slightly reduced at high incidence angles (around 0.2 dB).

The overall behaviour is very similar to the situation for cycle 73: a flat distribution for the mid beam, a gradual increase of negative bias for the for beam towards higher incidence angles, and a rapidly increasing negative bias for the aft beam for incidence angles larger than 42 degrees. The distribution of each beam is slightly flatter than it was for cycle 73.

2.2 Distance to cone history

For the higher nodes the distance to the cone history shows a number of peaks (Figure 2), most of them which are a result of low data volumes. An example of such a peak appeared at 06 UTC 26 May 2002. Only about ten percent of the usual volume was received. The peak in the cone history is most profound for the highest nodes. For this date, the UWI winds are more that 2 m/s lower than collocated ECMWF first-guess winds. The peak appears for all nodes. A second example of a low data-volume peak occurred at 00 UTC 10 June 2002. For this case, there was no sign of a degradation of UWI winds.

On average, normalised distances are larger than one, and are highest for the last five nodes.

2.3 UWI minus First-Guess history

There were many peaks in the UWI minus ECMWF first-guess wind history plots (Figure 3). Most of them (possibly all of them) are to be connected to low data volumes.

For the history plot of the de-aliased CMOD4 winds versus the ECMWF first-guess winds a very similar behaviour was observed (Figure 5).

The quality of the UWI winds received during cycle 74 was higher w.r.t. data received during cycle 73. The UWI winds now have an average bias of -1.00 m/s, which was -1.06 m/s for cycle 73. The bias is -1.14 m/s for nodes 1-2 (was -1.18 m/s) and -1.18 m/s for nodes 15-19 (was -1.22 m/s). Biases are smallest for nodes 8-10 (-0.82 m/s, was -0.88 m/s). The standard deviation is on average 1.65 m/s (was 1.72 m/s), and increases from 1.57 m/s (was 1.63 m/s) for nodes 1-2, to 1.72 m/s for nodes 15-19 (was 1.78 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 52.9 degrees, was 53.0) and between 15 and 25 degrees (average value 20.6, was 20.5) 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 hardly changed.

2.4 Scatter plots

The scatter plot of model 10 m first-guess wind speeds versus UWI wind speeds (Figure 7) shows a somewhat lower bias (-1.00 m/s) compared to the plot from cycle 73 (-1.06 m/s). The standard deviation is smaller (1.67 m/s, was 1.73 m/s). The amount of low wind data with collocated first-guess winds that are much stronger is less than it was for cycle 73. 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 situation has improved considerably since the restart of the distribution in December 2001.

The direction scatter plot (Figure 8) looks similar to the results from cycle 73 (bias from 1.7 to 1.1 degrees, and standard deviation from 52 to 51 degrees).

Finally, scatter plots were made for de-aliased winds inverted on the basis of the new CMOD5 formulation (developed at ECMWF in 2002) versus ECMWF first-guess winds. The scatter plots are presented in Figures 9 and 10. The CMOD5 winds perform better than the CMOD4 winds, especially at high wind speeds. The bias is smaller (-0.72 m/s; -1.00 m/s for the de-aliased CMOD4 winds). The standard deviation, is smaller as well (1.65 m/s; 1.67 m/s for the de-aliased CMOD4 winds). The remaining bias for the CMOD5 winds are likely to be induced by the negative bias levels of the sigma0's (see section 2.1). The statistics for the de-aliased wind directions is comparable for the two model functions (bias 1.6 degrees; standard deviation 9 degrees for CMOD5 versus 21 degrees for CMOD4).

Figure Captions

Figure 1: Ratio of $<\sigma_0^{0.625}>/<\mathrm{CMOD4(FirstGuess)}^{0.625}>$ 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.

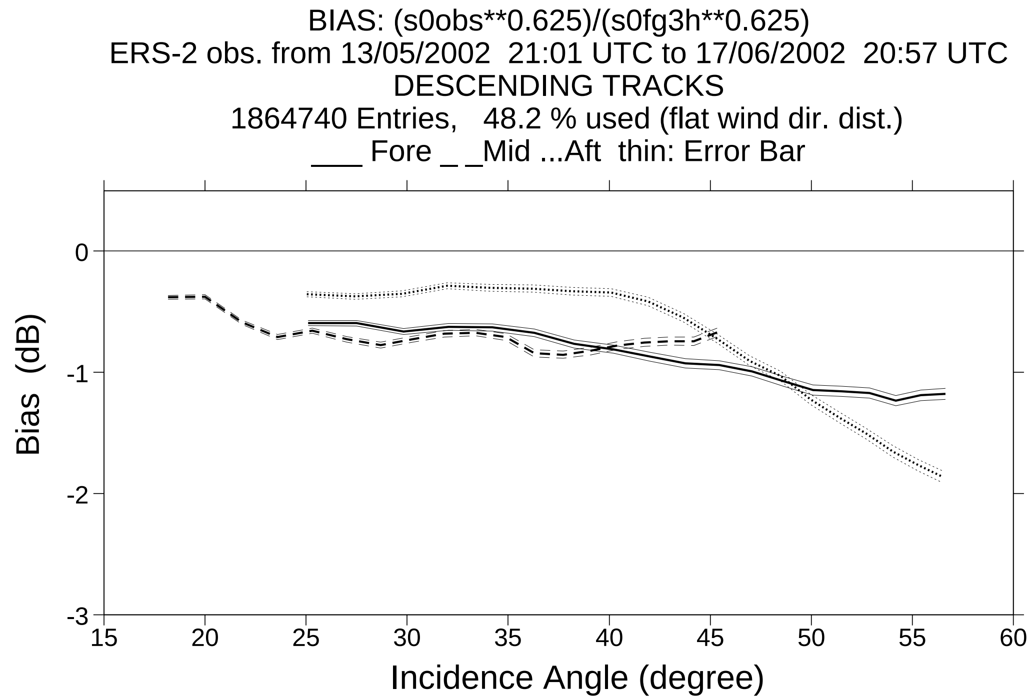
Figure 4: Same as Fig. 3, but for the wind direction difference. Statistics are computed only for wind speeds higher than 4 m/s.

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 and 10: Same as Fig. 7 and 8 respectively, but for de-aliased inverted winds based i on a prototype of the CMOD5 model function.


BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 13/05/2002 21:01 UTC to 17/06/2002 20:57 UTC
DESCENDING TRACKS
1864740 Entries, 48.2 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
0
-1
-2
-3
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)

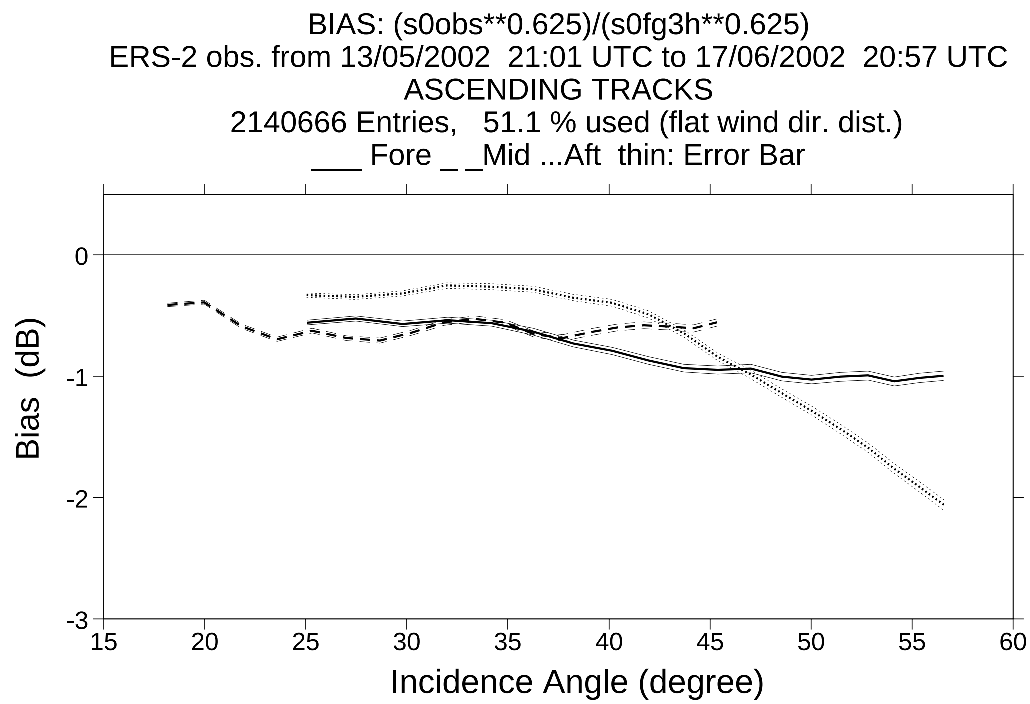

BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 13/05/2002 21:01 UTC to 17/06/2002 20:57 UTC
ASCENDING TRACKS
2140666 Entries, 51.1 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
0
-1
-2
-3
15
20
25
30
35
40
45
50
55
60
Incidence Angle (degree)

Figure 1

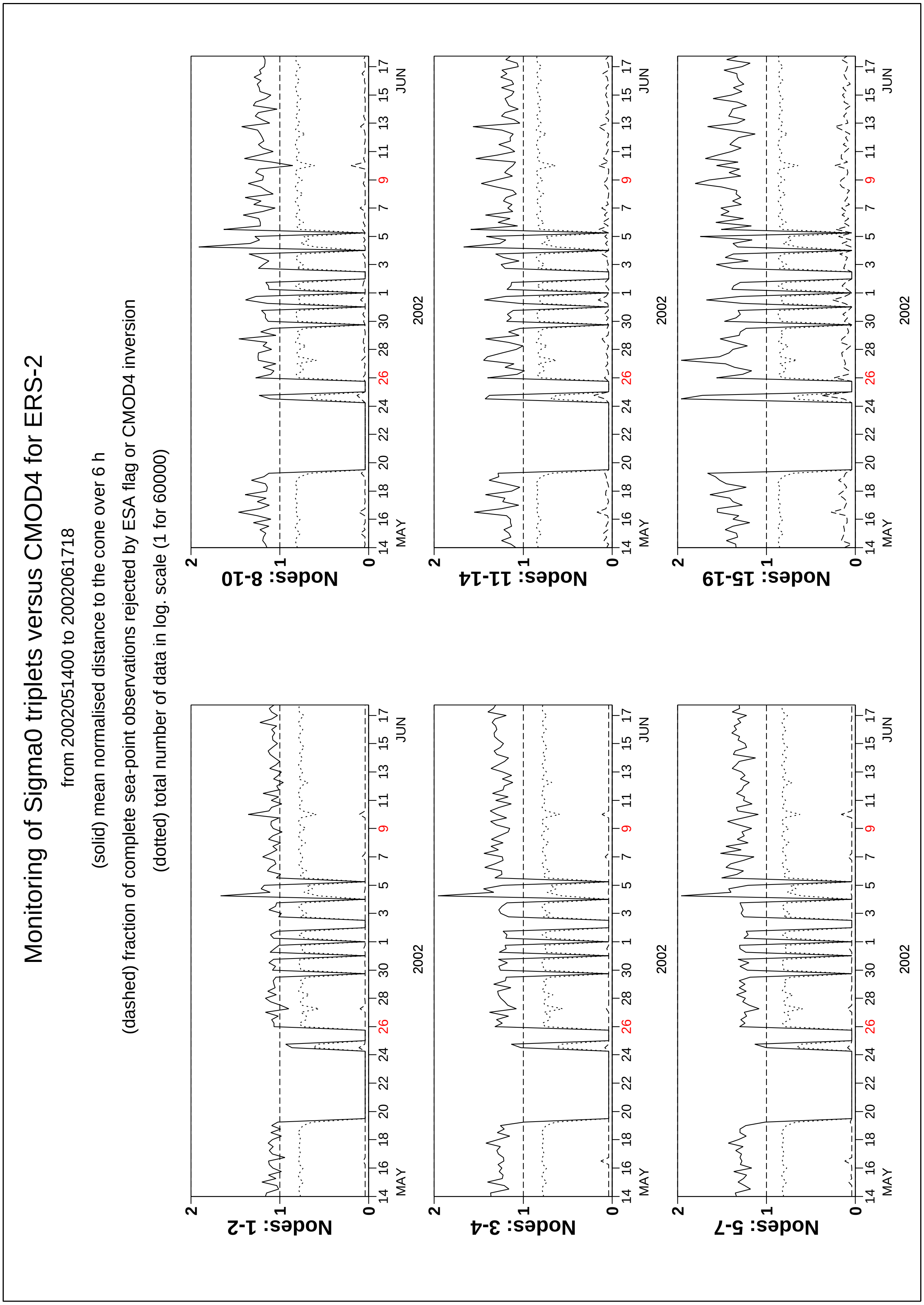

Monitoring of Sigma0 triplets versus CMOD4 for ERS-2
from 2002051400 to 2002061718
(solid) mean normalised distance to the cone over 6 h
(dashed) fraction of complete sea-point observations rejected by ESA flag or CMOD4 inversion
(dotted) total number of data in log. scale (1 for 60000)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
MAY
JUN
2002

Figure 2

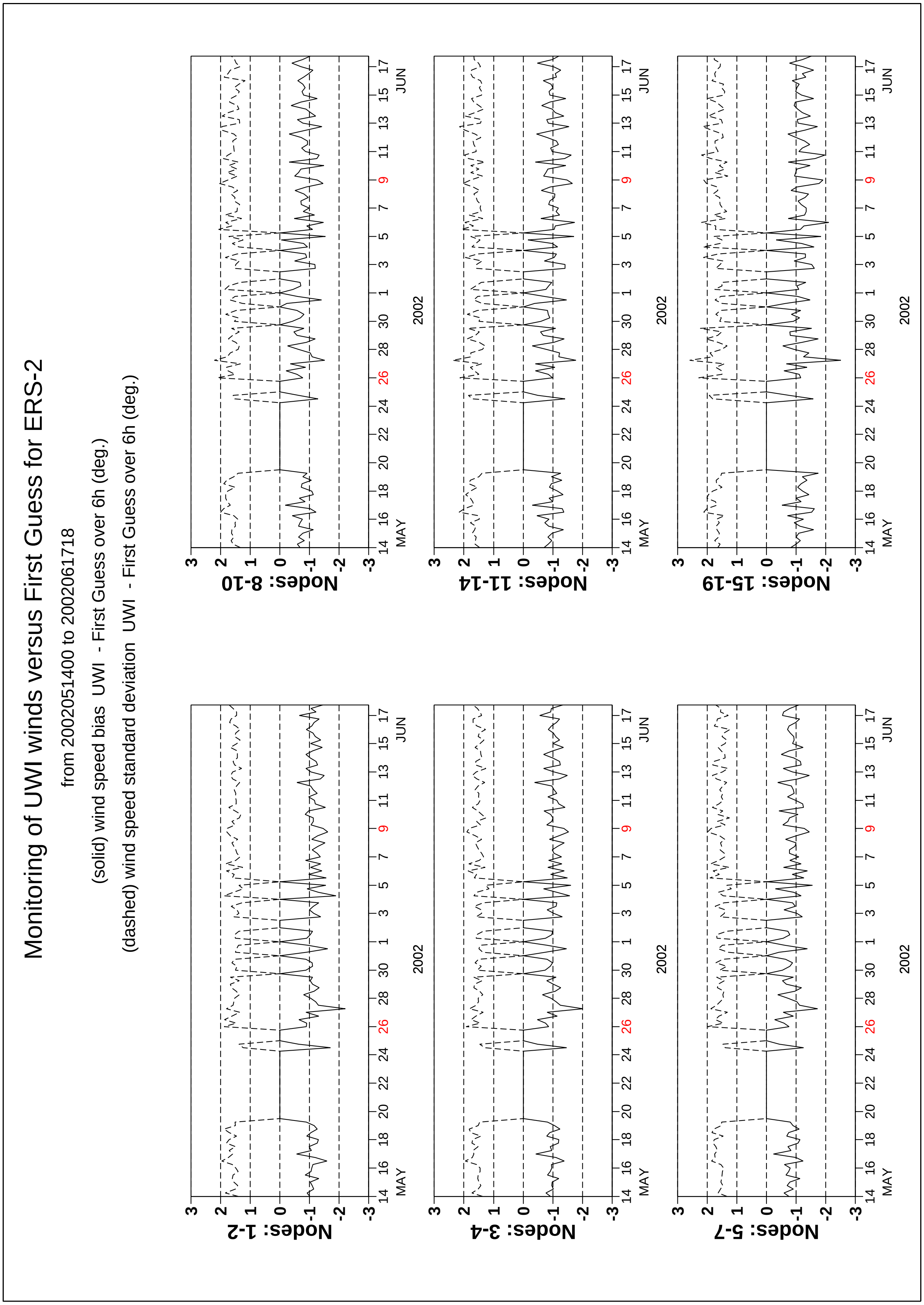

Monitoring of UWI winds versus First Guess for ERS-2
from 2002051400 to 2002061718
(solid) wind speed bias UWI - First Guess over 6h (deg.)
(dashed) wind speed standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
MAY
JUN
2002

Figure 3

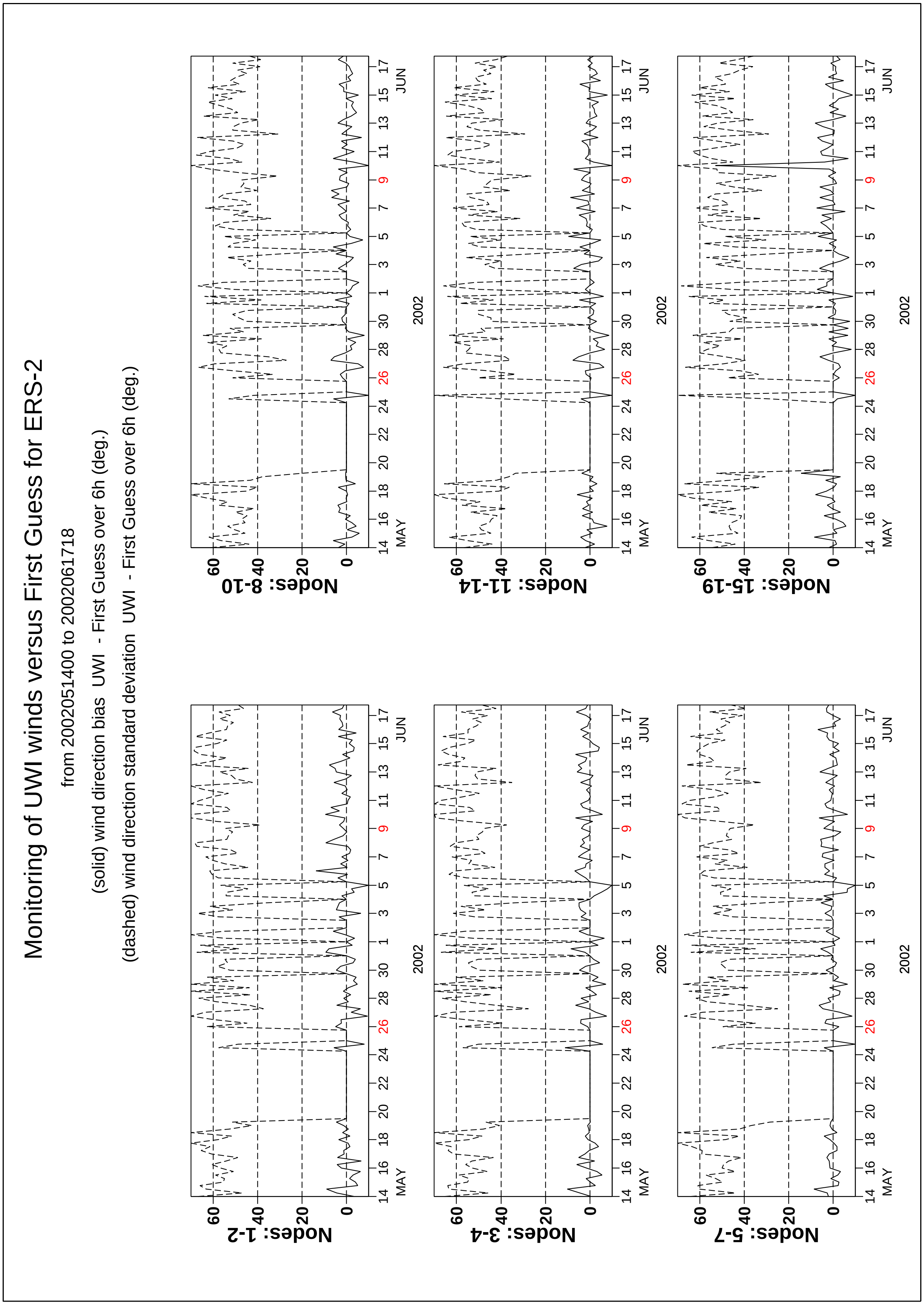

Monitoring of UWI winds versus First Guess for ERS-2
from 2002051400 to 2002061718
(solid) wind direction bias UWI - First Guess over 6h (deg.)
(dashed) wind direction standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
MAY
JUN
2002

Figure 4

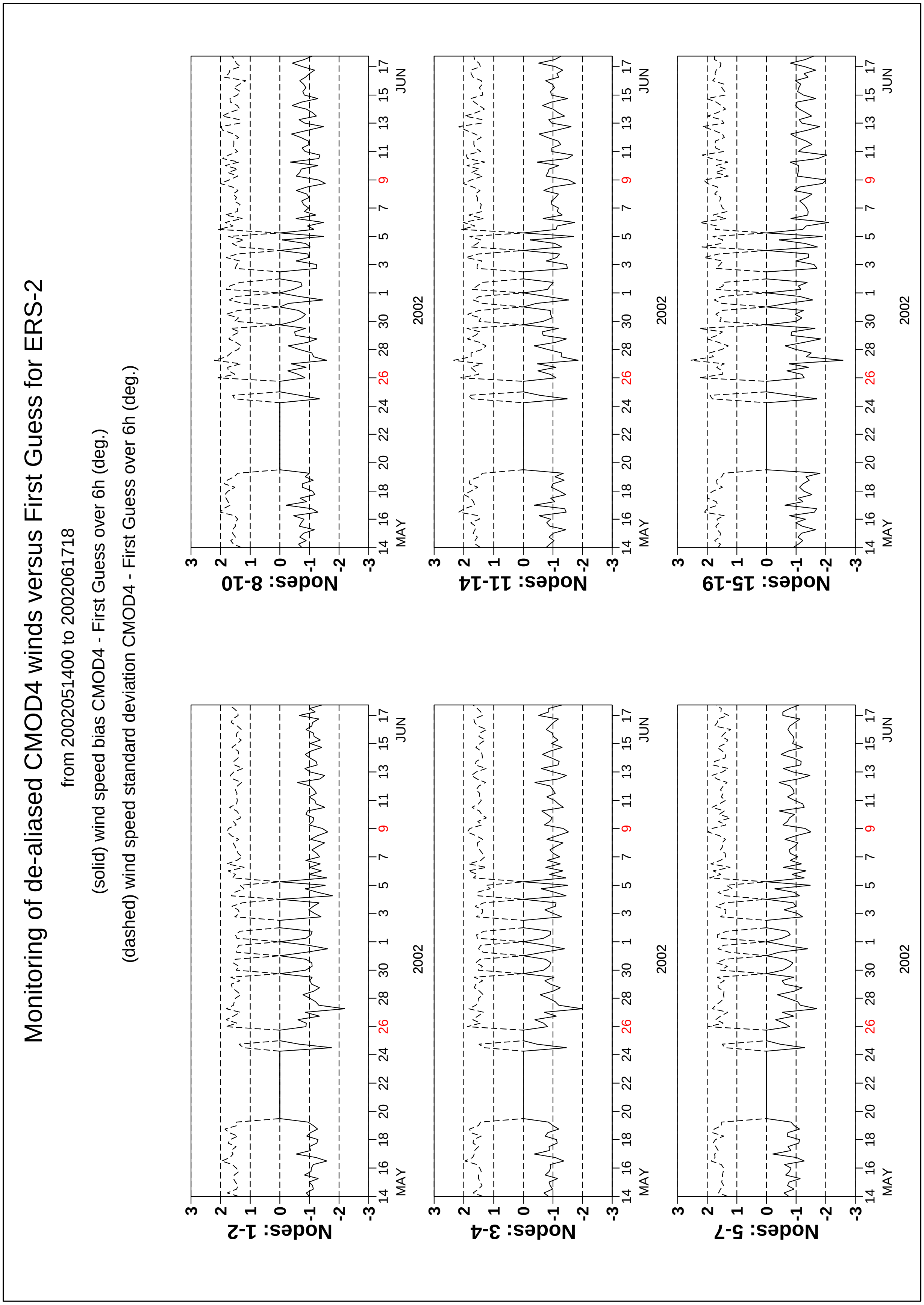

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002051400 to 2002061718
(solid) wind speed bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind speed standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
MAY
JUN
2002

Figure 5

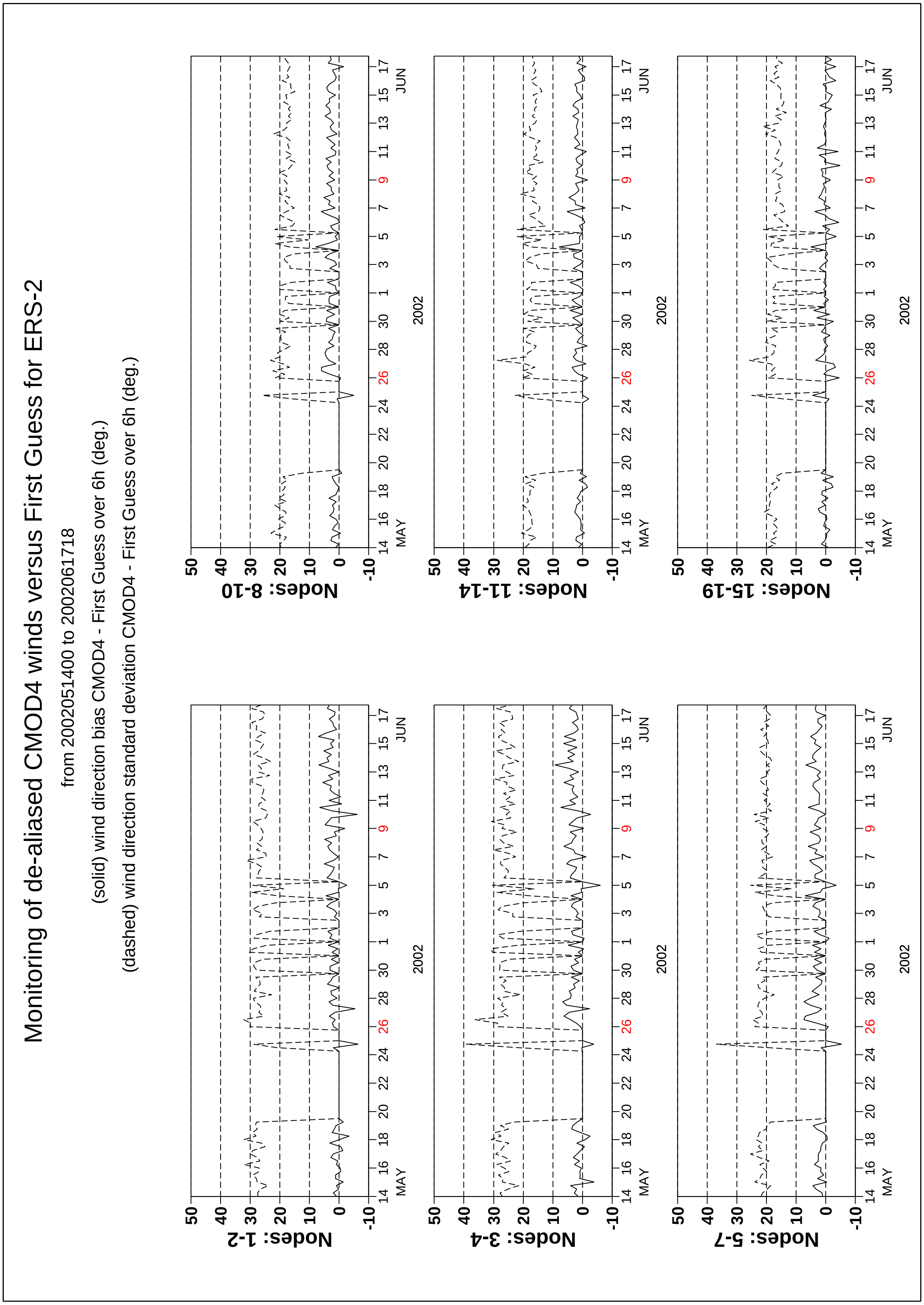

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002051400 to 2002061718
(solid) wind direction bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind direction standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
MAY
JUN
2002

Figure 6

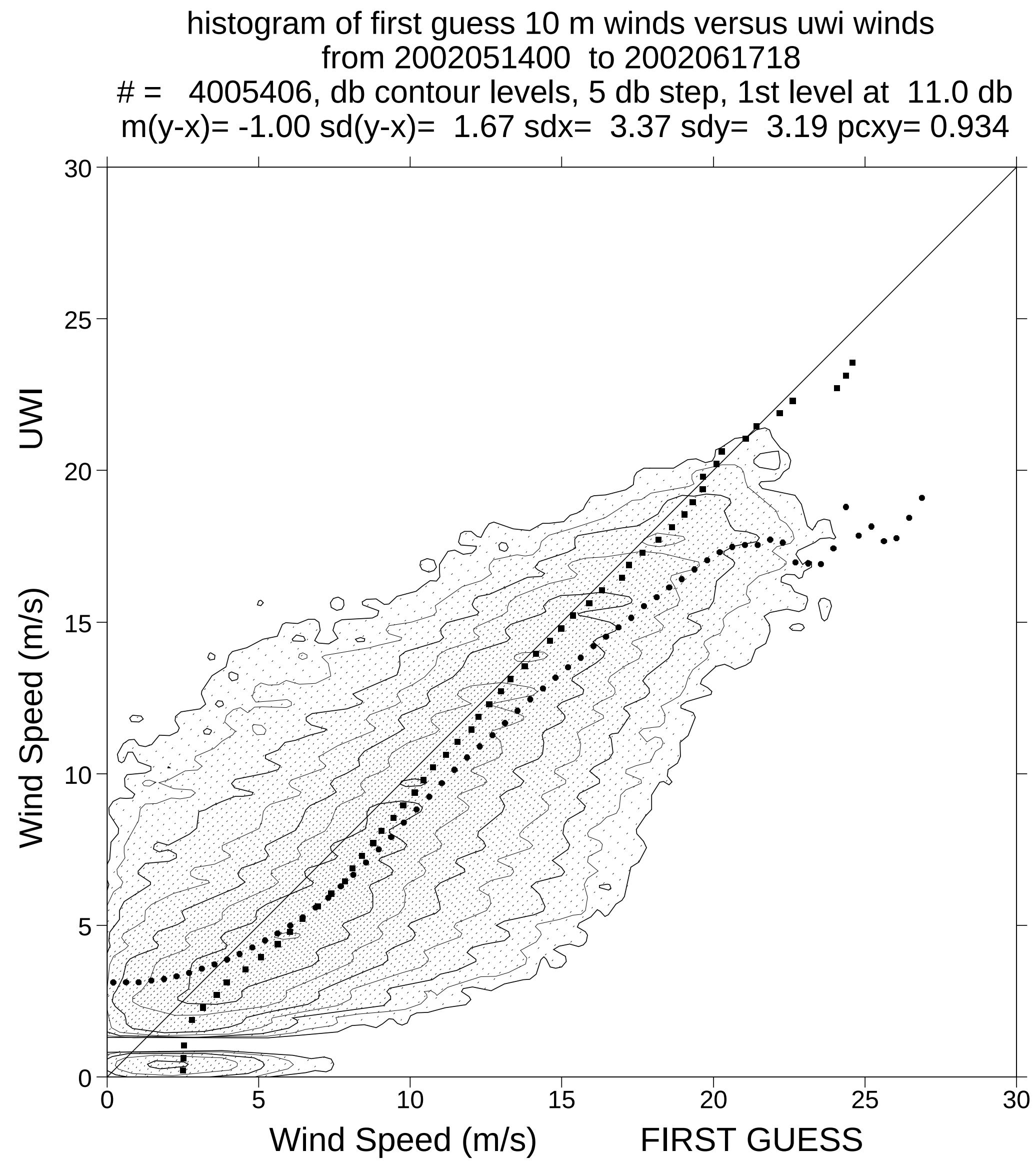

histogram of first guess 10 m winds versus uwi winds
from 2002051400 to 2002061718
= 4005406, db contour levels, 5 db step, 1st level at 11.0 db
m(y-x)= -1.00 sd(y-x)= 1.67 sdx= 3.37 sdy= 3.19 pcxy= 0.934
Wind Speed (m/s) UWI
Wind Speed (m/s) FIRST GUESS
0
5
10
15
20
25
30

Figure 7

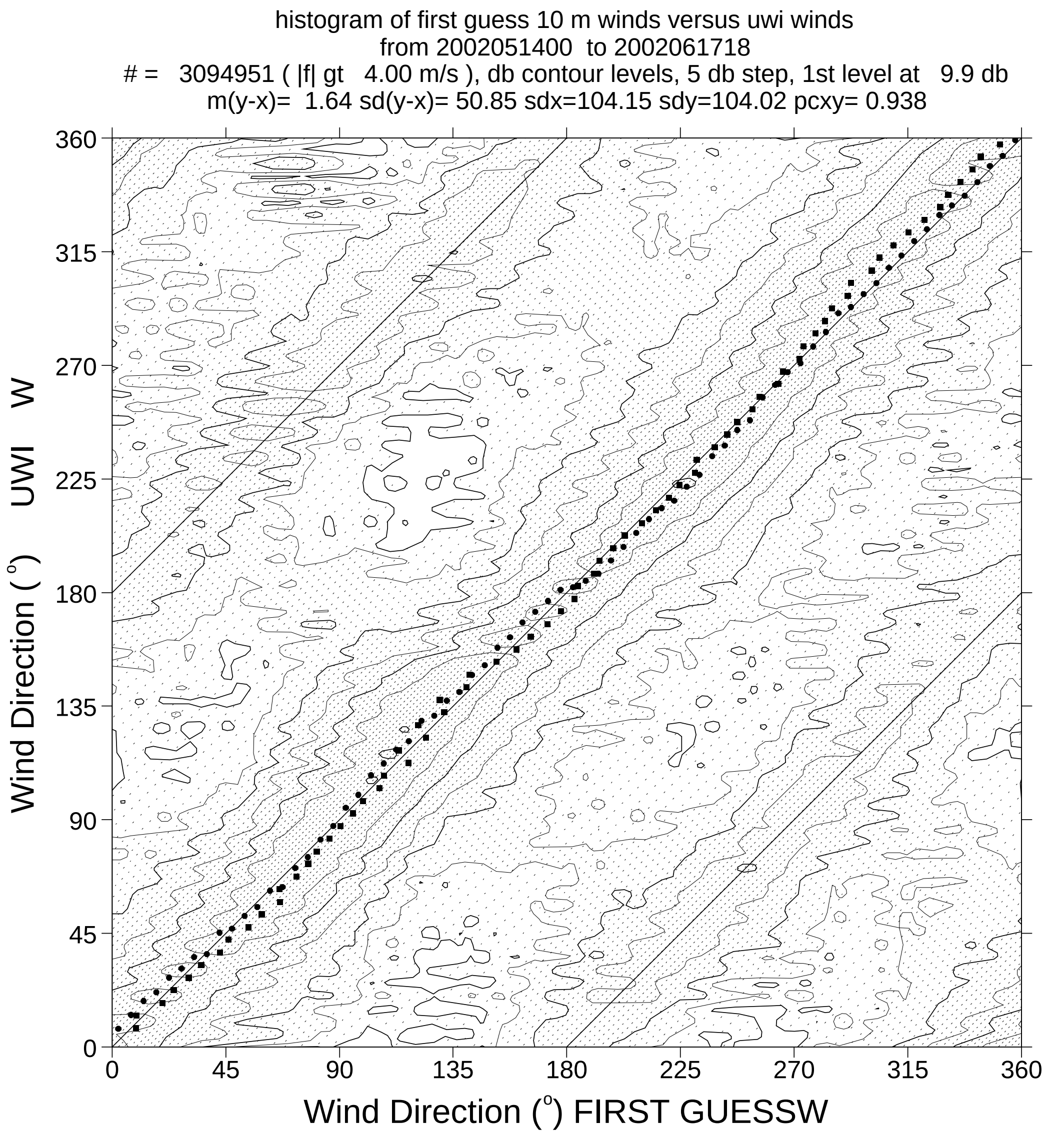

histogram of first guess 10 m winds versus uwi winds
from 2002051400 to 2002061718
= 3094951 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 9.9 db
m(y-x)= 1.64 sd(y-x)= 50.85 sdx=104.15 sdy=104.02 pcxy= 0.938
Wind Direction (°) UWI W
Wind Direction (°) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 8

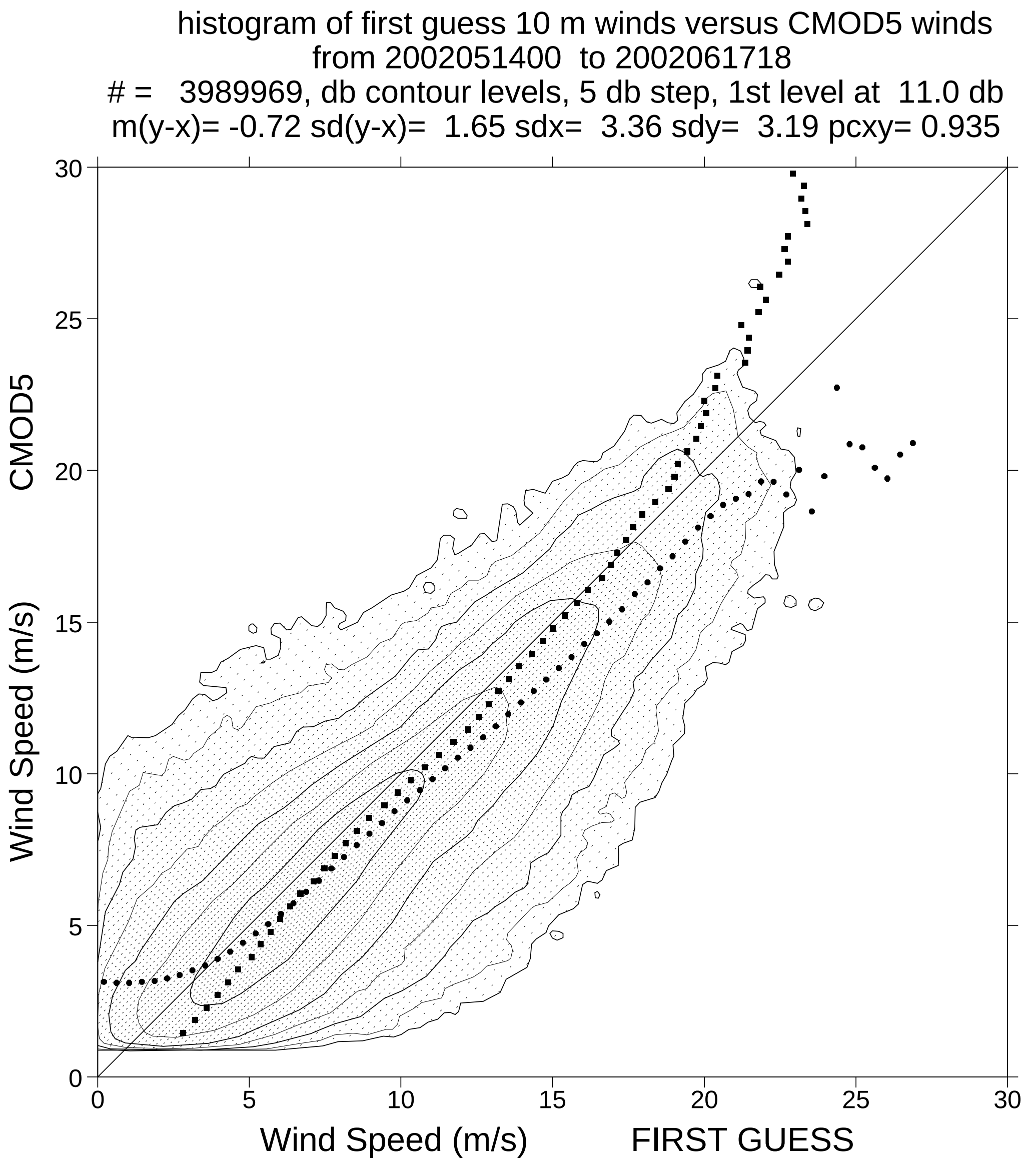

histogram of first guess 10 m winds versus CMOD5 winds
from 2002051400 to 2002061718
= 3989969, db contour levels, 5 db step, 1st level at 11.0 db
m(y-x)= -0.72 sd(y-x)= 1.65 sdx= 3.36 sdy= 3.19 pcxy= 0.935
CMOD5
Wind Speed (m/s)
Wind Speed (m/s)
FIRST GUESS
0
5
10
15
20
25
30

Figure 9

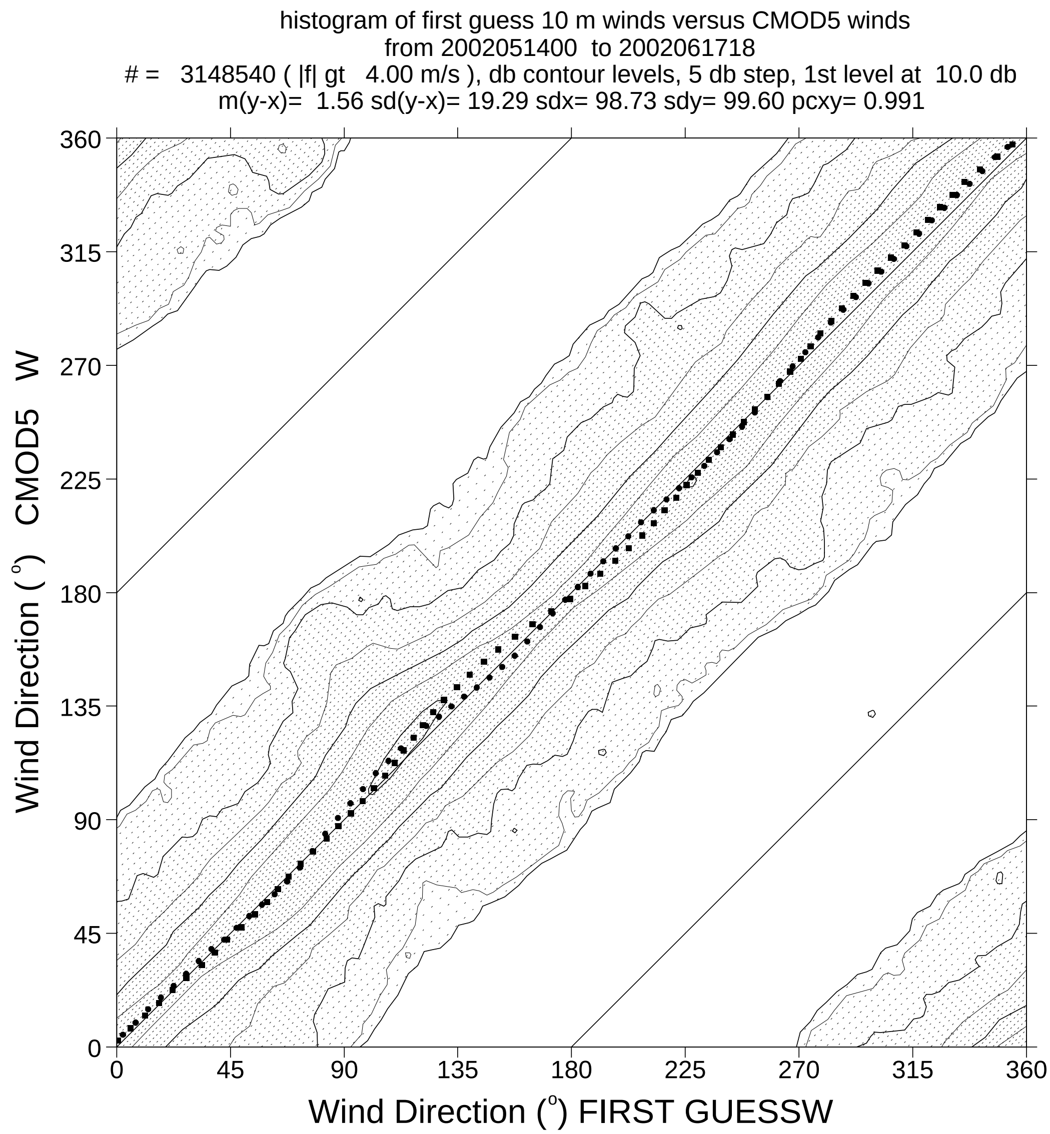

histogram of first guess 10 m winds versus CMOD5 winds
from 2002051400 to 2002061718
= 3148540 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 10.0 db
m(y-x)= 1.56 sd(y-x)= 19.29 sdx= 98.73 sdy= 99.60 pcxy= 0.991
Wind Direction (o) CMOD5 W
Wind Direction (o) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 10