Monitoring statistics of the ERS-2 scatterometer for ESA

CYCLE 73

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

During cycle 73, data was received between 21:04 UTC 8 April 2002 and 20:59 UTC May 2002. No data was received within the 6-hourly cycles from 18 UTC 9 April 2002 to 00 UTC 10 April 2002, 00 UTC 12 April 2002, from 00 UTC 13 April 2002 to 18 UTC 13 April 2002, from 00 UTC 20 April 2002 to 06 UTC 20 April 2002, 18 UTC 21 April 2002, from 00 UTC 27 April 2002 to 12 UTC 27 April 2002, and 12 UTC 9 May 2002.

The quality of the data received during cycle 73 was slightly higher than the average performance of the data received during cycle 72. However, the quality was lower than for the data received during the last week of cycle 72, i.e., between 1 and 8 April 2002.

During cycle 73, there was no clear signature found of data that was degraded due to enhanced solar activity.

A new cycle of the ECMWF assimilation system was introduced on 9 April 2002. Since this date, water-vapour radiances from Meteosat 7, ozone data from SBUV and GOME, and European wind profilers are assimilated into the ECMWF model. On 17 April 2002, a global quality control on instrument performance for QuikSCAT scatterometer data was introduced.

2 ERS-2 statistics from 9 April to 13 May 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 73 as compared to the corresponding levels averaged over cycle 72, showed the following evolution. For lower incidence angles, the bias of the descending for and aft beam have become slightly more negative (around 0.1 dB). For the descending beams, biases have been slightly reduced at medium and high incidence angles (0.2 for the aft, 0.1 dB for the mid and aft beam).

The overall behaviour is similar to the situation for cycle 72: 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. However, with the exception of the aft beam at high incidence angles, the distribution of all three beams are flatter than they were for cycle 72.

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 appear just before or after 6-hourly cycles in which no data was received (see section 1). They are likely to be the result of insufficient statistics. There are two peaks (for 12 UTC - 18 UTC 17 April 2002 and for 18 UTC 11 May 2002) that are not connected to low data volumes. They are not profound in the cone history for lower nodes. For these two periods, the number of rejections on the basis of the ESA flag and/or problems with the CMOD4 inversion are larger than normal as well. However, these peaks are present for all nodes. For 00 UTC 16 April 2002, there is a peak in the number of rejections as well. It is present for node 1-14. This peak, and the two peaks in the distance history that were not connected to low data volume, correspond to negative peaks in the UWI wind bias histogram (next subsection).

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

2.3 UWI minus First-Guess history

Apart from the peaks connected to low data volume, there were three peaks in the UWI minus ECMWF first-guess wind history plots (Figure 3). Two of these peaks correspond to the peaks in the cone histogram for the higher nodes (i.e, for 12 UTC - 18 UTC 17 April 2002 and for 18 UTC 11 May 2002, see section 2.2). The peaks in the winds, however, are present for all nodes. The negative wind bias increases from -1 m/s to below -2 m/s. Standard deviations are larger than normal as well. The third peak coincides with the peak in the number of rejections histogram (i.e., for 00 UTC 16 April 2002, see section 2.2). The peak appears mainly for the lower nodes. The UWI bias is more negative than normal, but it is especially the standard deviation that is anomalously large (around 3 m/s).

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 73 was slightly higher w.r.t. data received during cycle 72. Only bias levels for UWI winds of the lowest nodes were a little bit worse. The biases for the other nodes, and the standard deviations for all nodes were better. The UWI winds now have an average bias of -1.06 m/s, which was -1.07 m/s for cycle 72. The bias is -1.18 m/s for nodes 1-2 (was -1.14 m/s) and -1.22 m/s for nodes 15-19 (was -1.23 m/s). Biases are smallest for nodes 8-10 (-0.88 m/s, was -0.92 m/s). The standard deviation is on average 1.72 m/s (was 1.77 m/s), and increases from 1.63 m/s (was 1.68 m/s) for nodes 1-2, to 1.78 m/s for nodes 15-19 (was 1.84 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 53.0 degrees, was 53.4) and between 15 and 25 degrees (average value 20.5, was 21.0) 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 basically the same bias (-1.06 m/s) compared to the plot from cycle 72 (-1.07 m/s). The standard deviation is smaller (1.73 m/s, was 1.86 m/s). Note that there is an amount of low wind data with collocated first-guess winds that are much stronger. The amount seems somewhat lower than for cycle 72, however, higher than for the last week of cycle 72 (i.e., 1-8 April 2002).

The direction scatter plot (Figure 8) looks similar to the results from cycle 72 (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 a prototype of CMOD5 (the version developed by Stoffelen and de Haan, 2001) versus ECMWF first-guess winds. The scatter plots are presented in Figures 9 and 10. The prototype CMOD5 winds perform better than the CMOD4 winds, especially at high wind speeds. The bias is much smaller (-0.78 m/s; -1.09 m/s for the de-aliased CMOD4 winds). The standard deviation, however, is almost equal (1.72 m/s; 1.71 m/s for the de-aliased CMOD4 winds). The remaining bias for the prototype 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 marginally better (bias 1.2 degrees for CMOD5 versus 1.6 degrees for CMOD4; standard deviation 19 degrees for CMOD5 versus 21 degrees for CMOD4).

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.

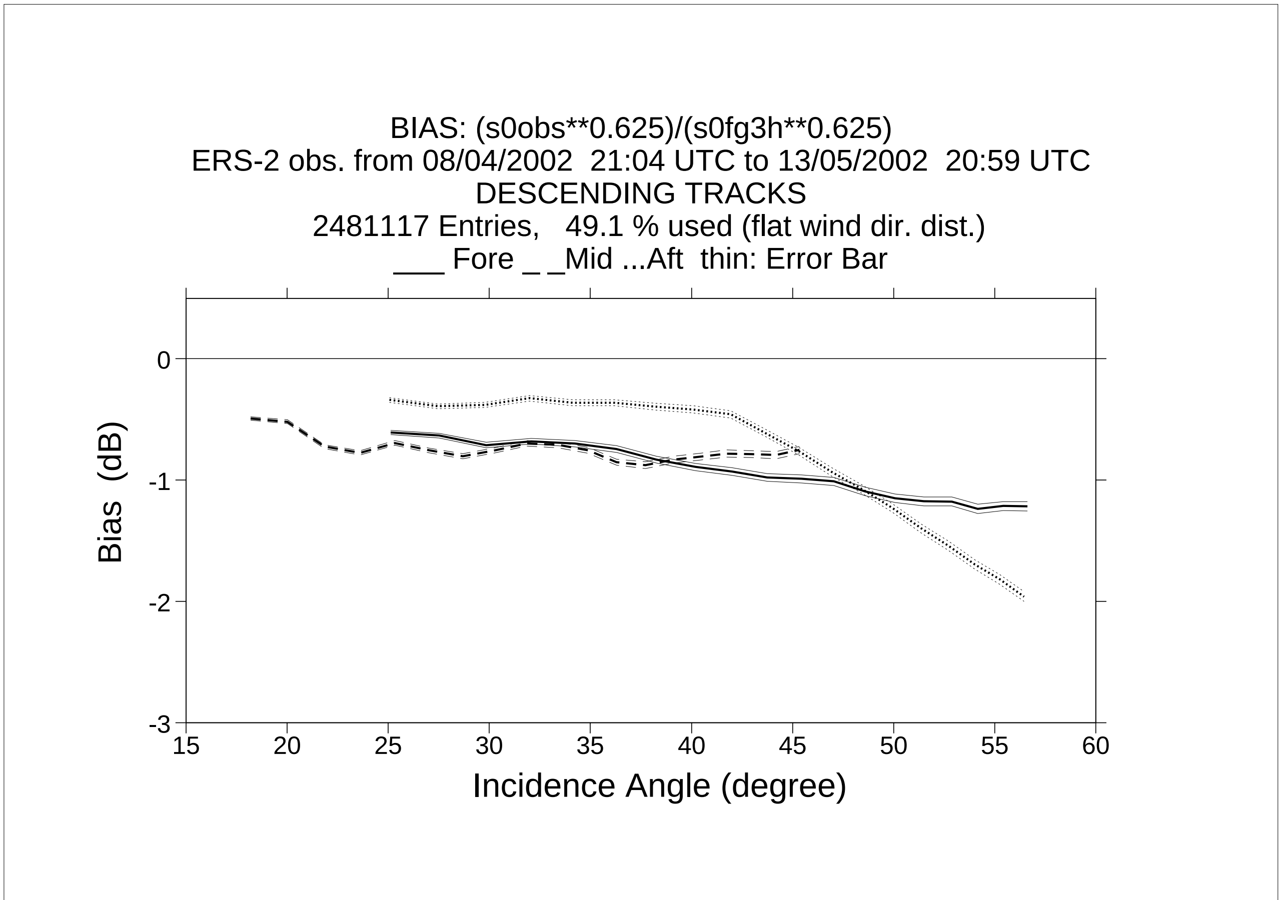
Figure 4: Same as Fig. 3, but for the wind direction difference. Statistics are computed only for wind speeds higher than 4 m/s.

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 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 08/04/2002 21:04 UTC to 13/05/2002 20:59 UTC
DESCENDING TRACKS
2481117 Entries, 49.1 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
Incidence Angle (degree)

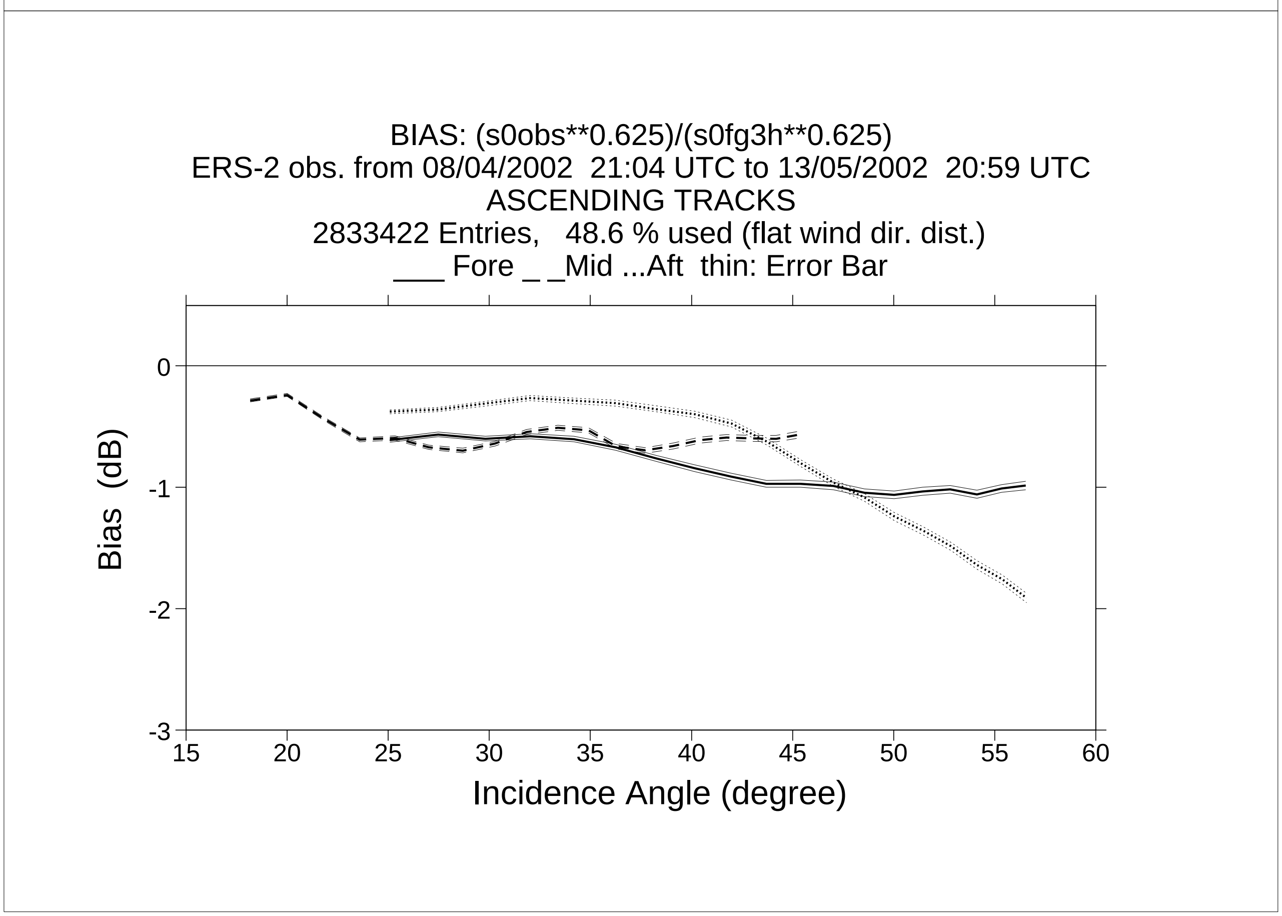

BIAS: (s0obs**0.625)/(s0fg3h**0.625)
ERS-2 obs. from 08/04/2002 21:04 UTC to 13/05/2002 20:59 UTC
ASCENDING TRACKS
2833422 Entries, 48.6 % used (flat wind dir. dist.)
___ Fore _ _Mid ...Aft thin: Error Bar
Bias (dB)
Incidence Angle (degree)

Figure 1

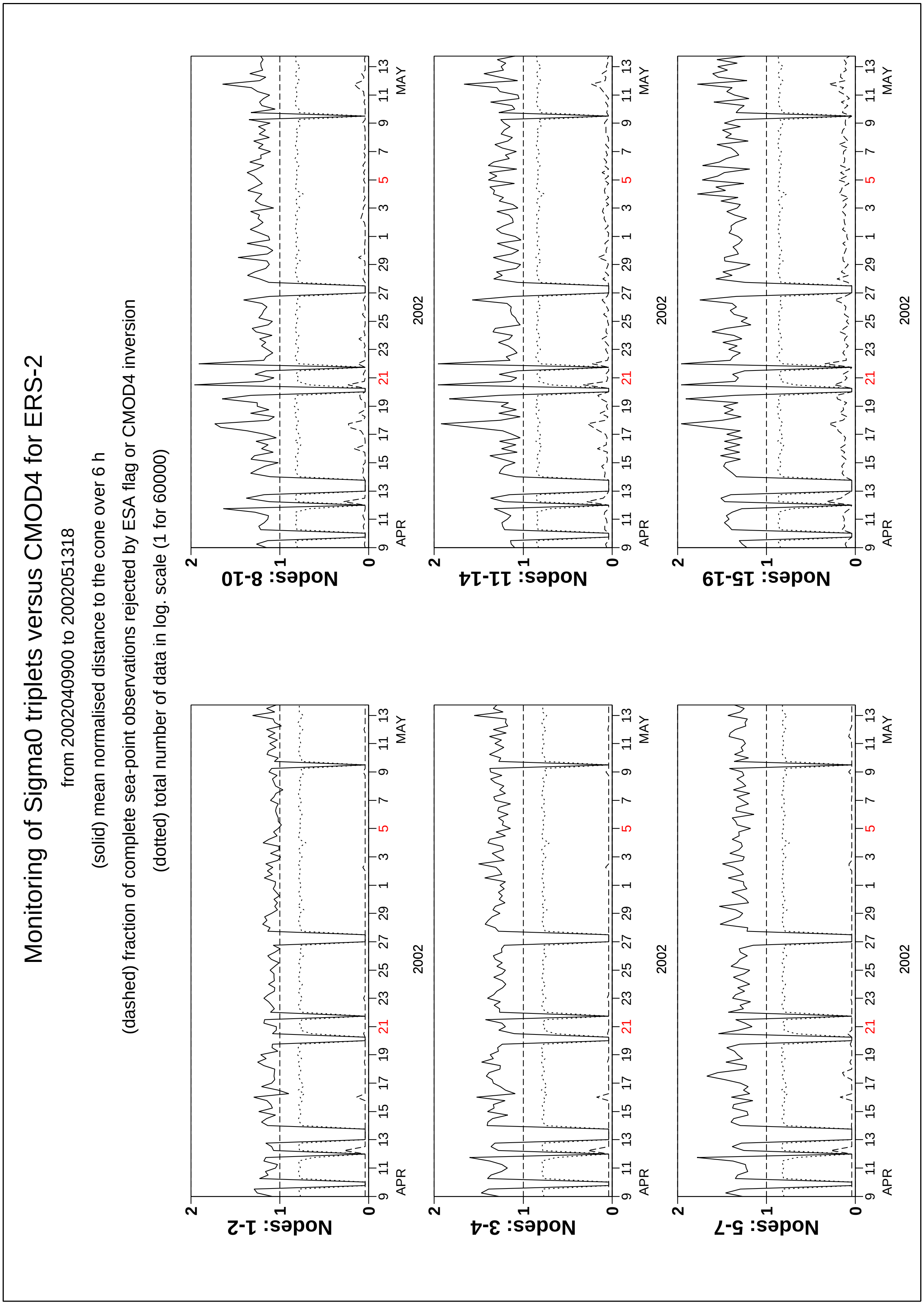
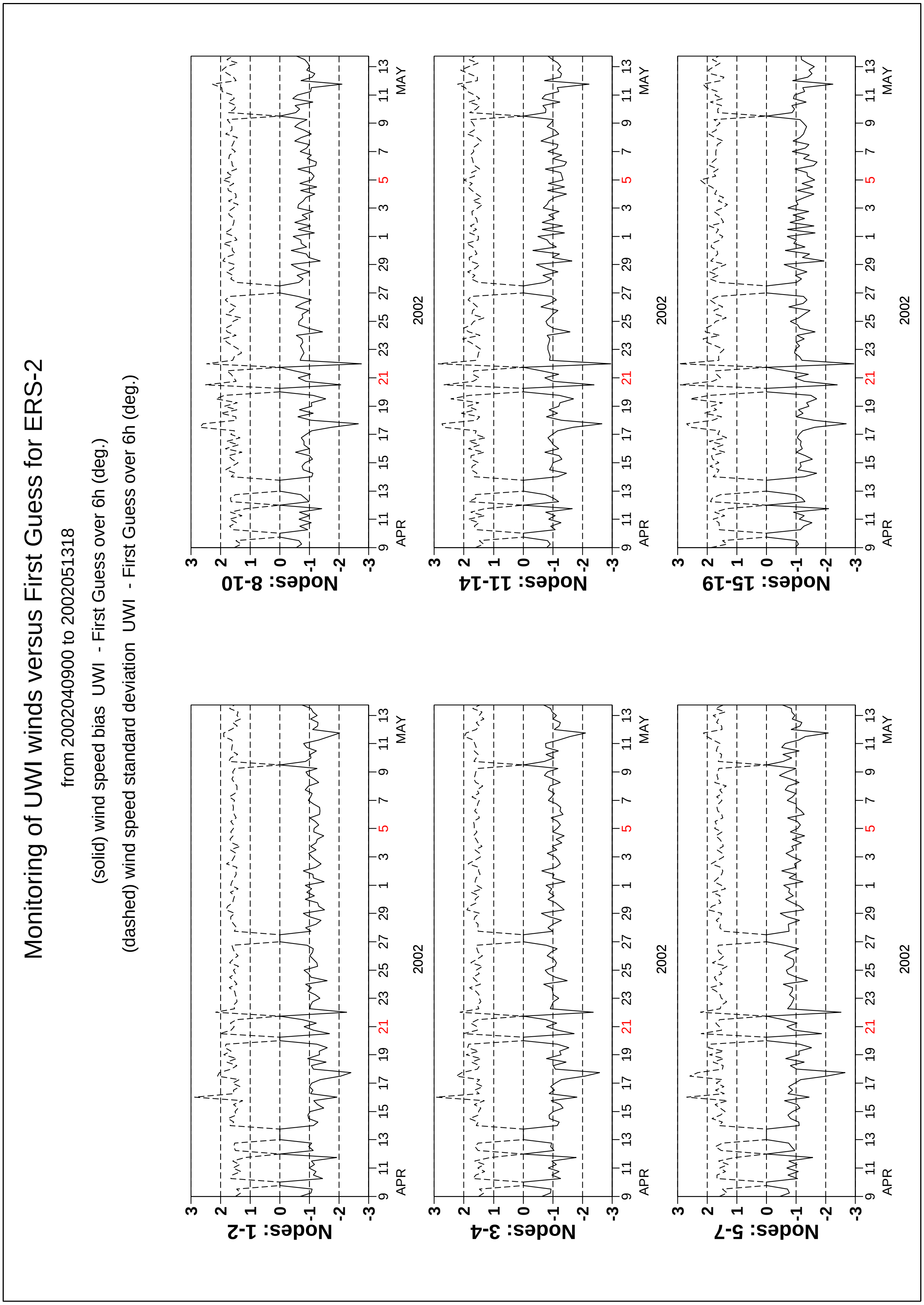

Monitoring of Sigma0 triplets versus CMOD4 for ERS-2
from 2002040900 to 2002051318
(solid) mean normalised distance to the cone over 6 h
(dashed) fraction of complete sea-point observations rejected by ESA flag or CMOD4 inversion
(dotted) total number of data in log. scale (1 for 60000)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
APR
MAY
2002

Figure 2



Monitoring of UWI winds versus First Guess for ERS-2
from 2002040900 to 2002051318
(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
APR
MAY
2002

Figure 3

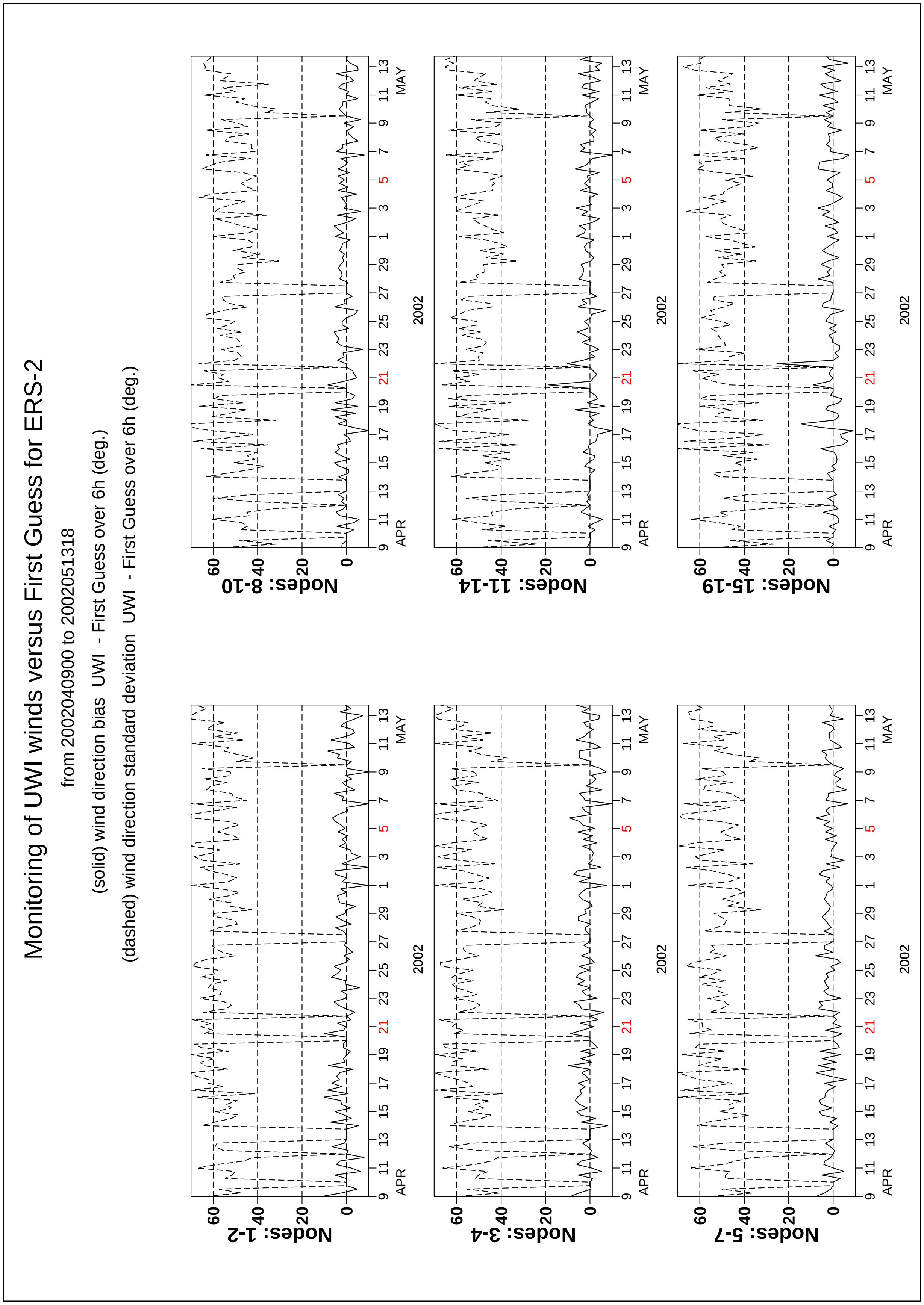

Monitoring of UWI winds versus First Guess for ERS-2
from 2002040900 to 2002051318
(solid) wind direction bias UWI - First Guess over 6h (deg.)
(dashed) wind direction standard deviation UWI - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
APR
MAY
2002

Figure 4

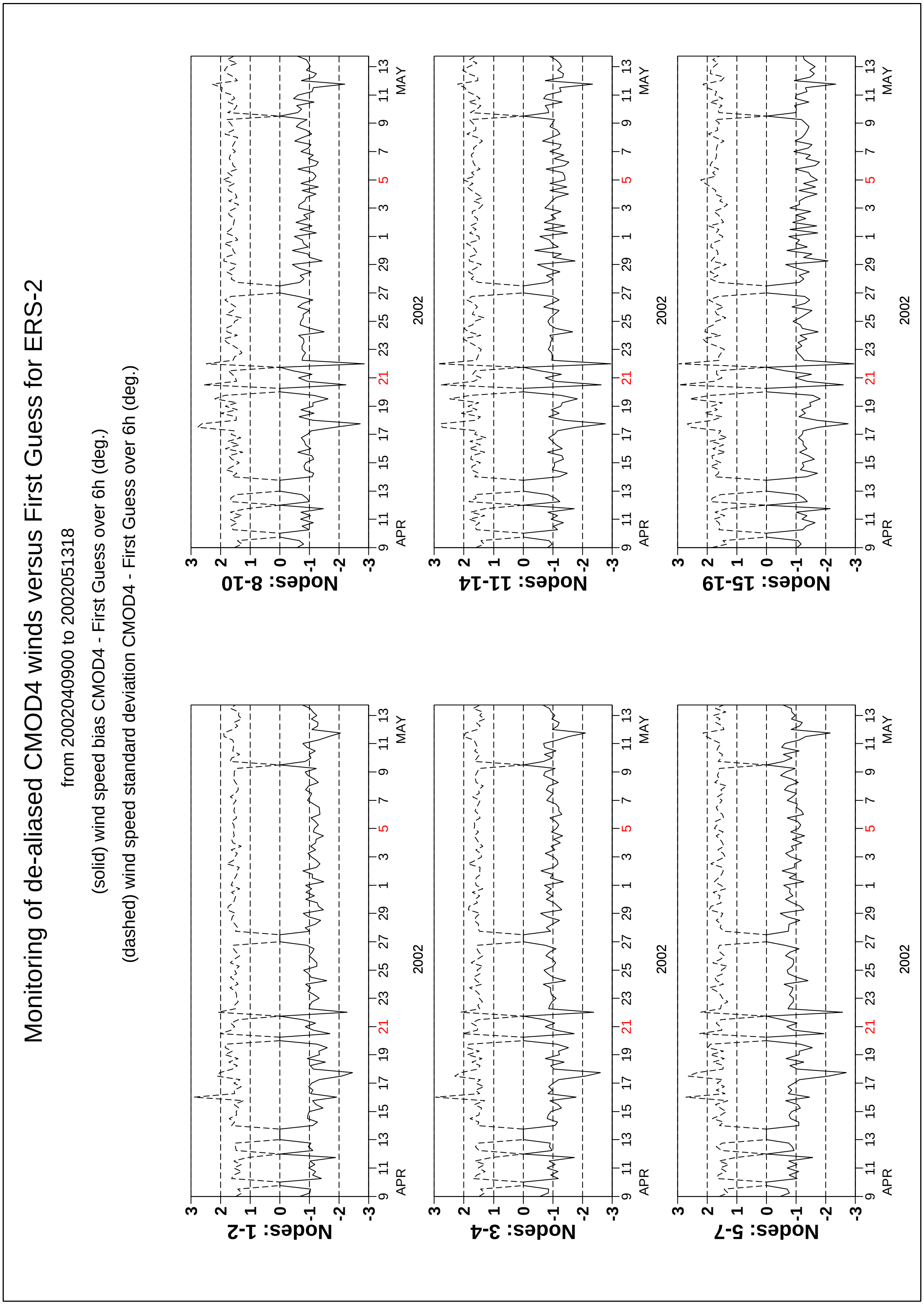
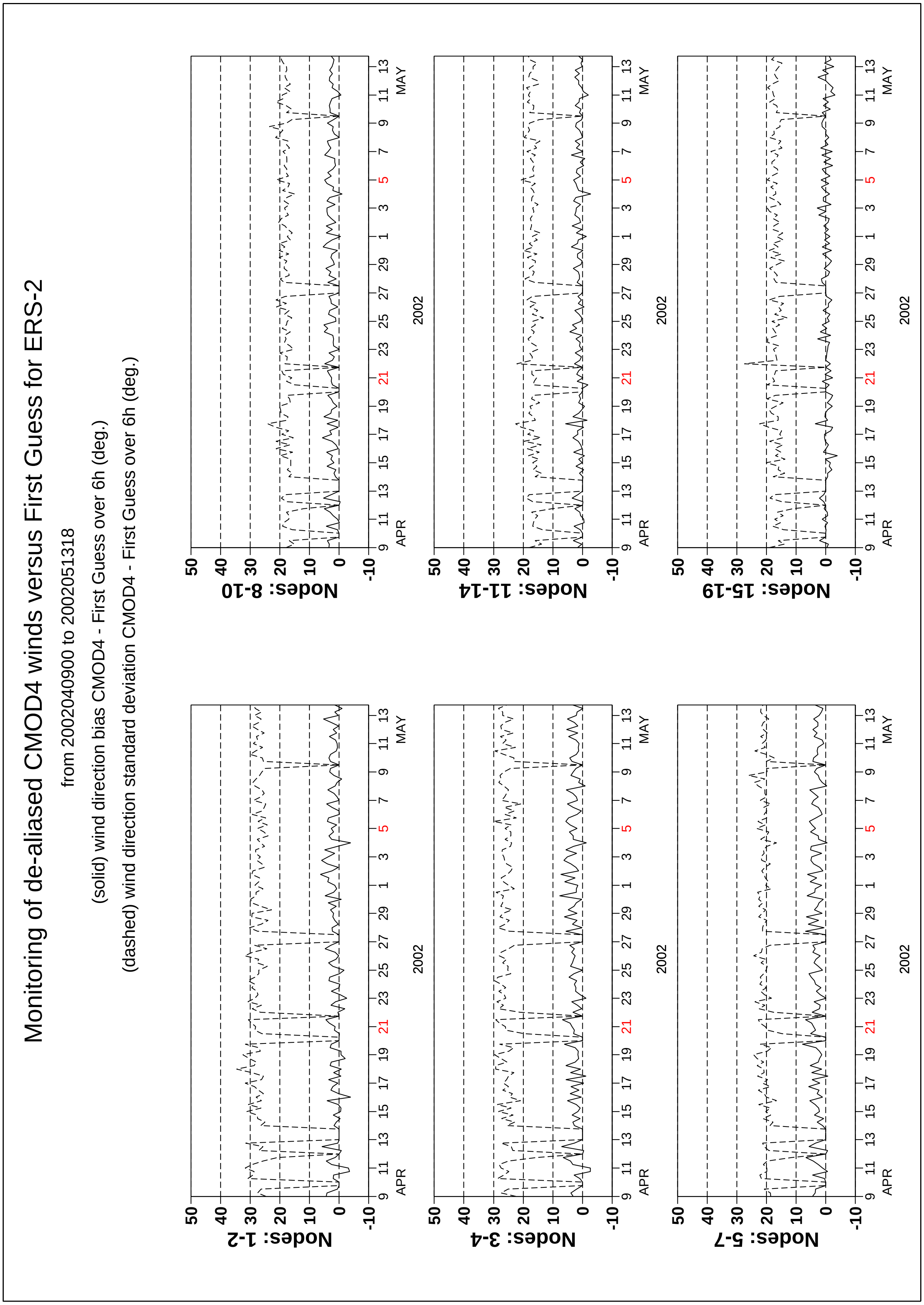

Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002040900 to 2002051318
(solid) wind speed bias CMOD4 - First Guess over 6h (deg.)
(dashed) wind speed standard deviation CMOD4 - First Guess over 6h (deg.)
Nodes: 1-2
Nodes: 3-4
Nodes: 5-7
Nodes: 8-10
Nodes: 11-14
Nodes: 15-19
APR
MAY
2002

Figure 5



Monitoring of de-aliased CMOD4 winds versus First Guess for ERS-2
from 2002040900 to 2002051318
(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
APR
MAY
2002

Figure 6

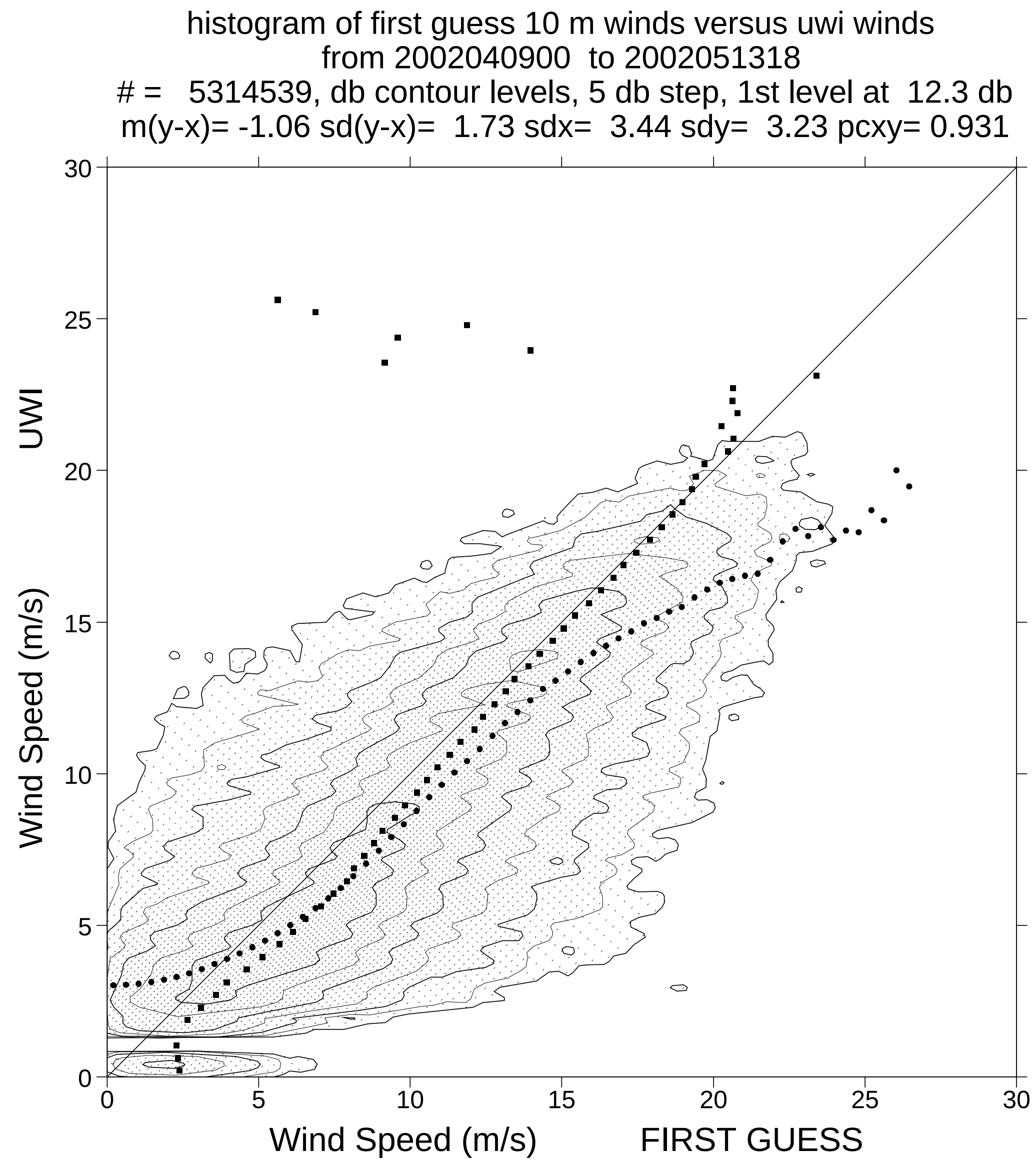
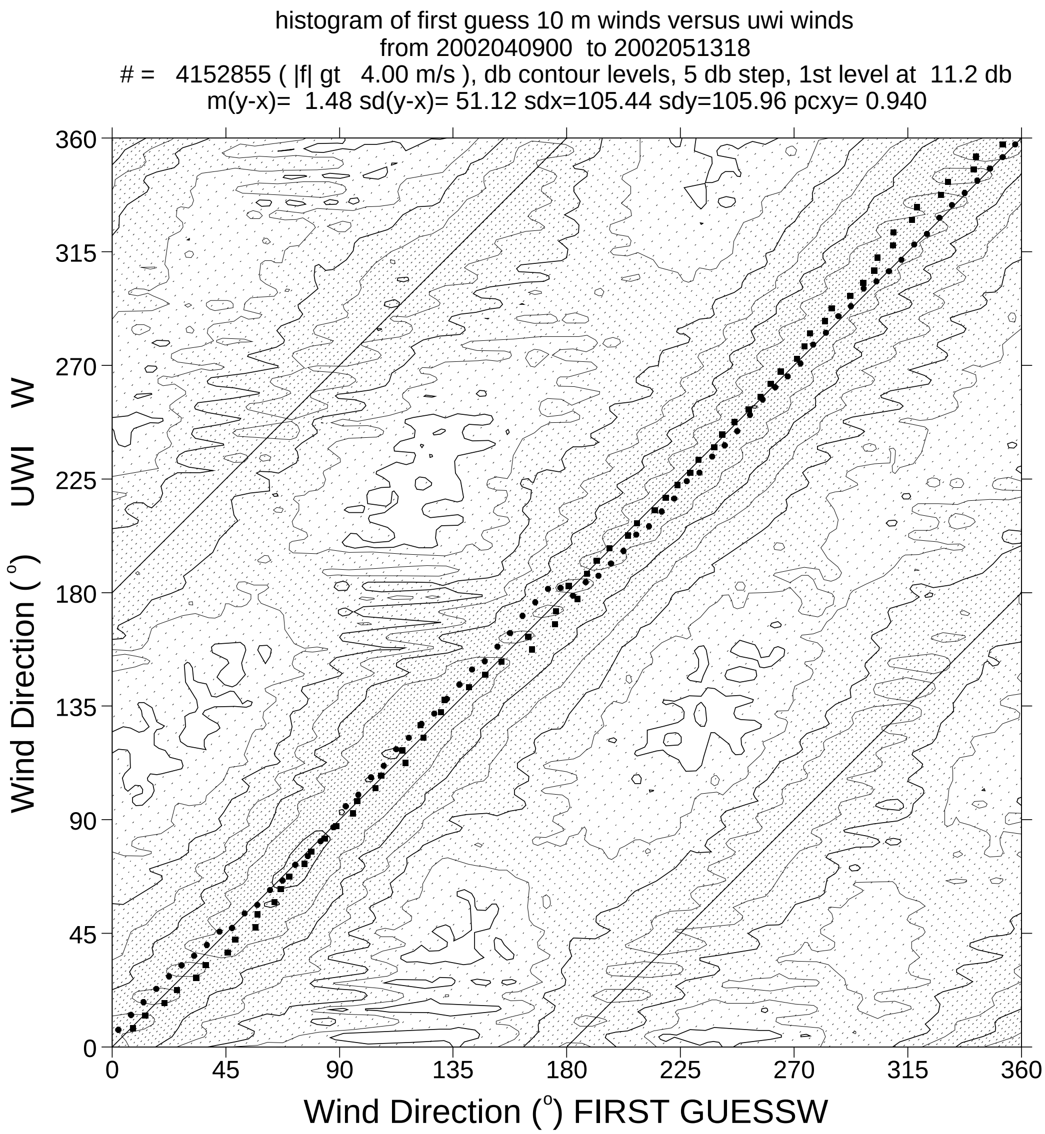

histogram of first guess 10 m winds versus uwi winds
from 2002040900 to 2002051318
= 5314539, db contour levels, 5 db step, 1st level at 12.3 db
m(y-x)= -1.06 sd(y-x)= 1.73 sdx= 3.44 sdy= 3.23 pcxy= 0.931
UWI
Wind Speed (m/s)
Wind Speed (m/s) FIRST GUESS
0
5
10
15
20
25
30

Figure 7



histogram of first guess 10 m winds versus uwi winds
from 2002040900 to 2002051318
= 4152855 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 11.2 db
m(y-x)= 1.48 sd(y-x)= 51.12 sdx=105.44 sdy=105.96 pcxy= 0.940
Wind Direction (o) UWI W
Wind Direction (o) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 8

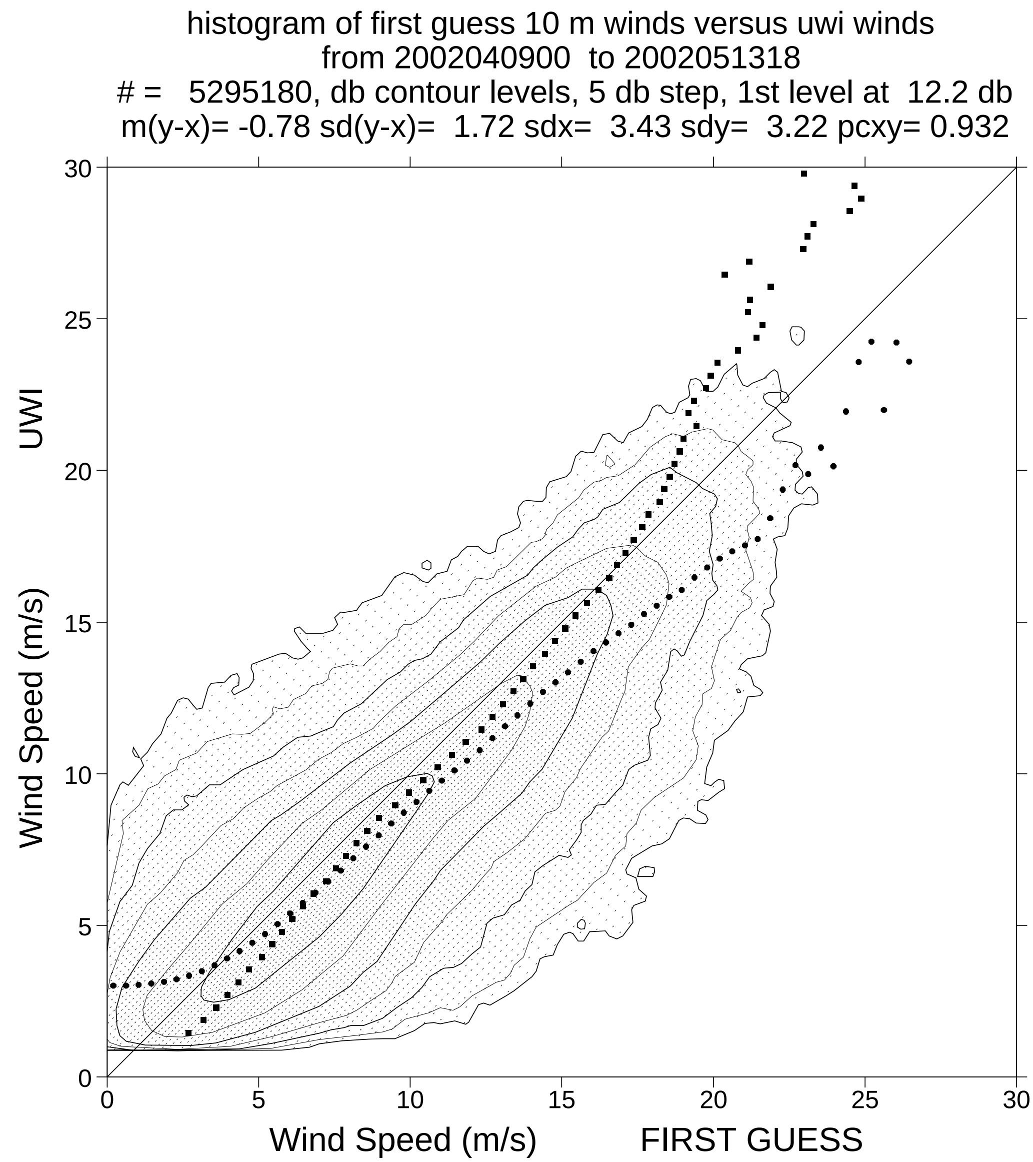

histogram of first guess 10 m winds versus uwi winds
from 2002040900 to 2002051318
= 5295180, db contour levels, 5 db step, 1st level at 12.2 db
m(y-x)= -0.78 sd(y-x)= 1.72 sdx= 3.43 sdy= 3.22 pcxy= 0.932
UWI
Wind Speed (m/s)
0
5
10
15
20
25
30
Wind Speed (m/s)
FIRST GUESS

Figure 9

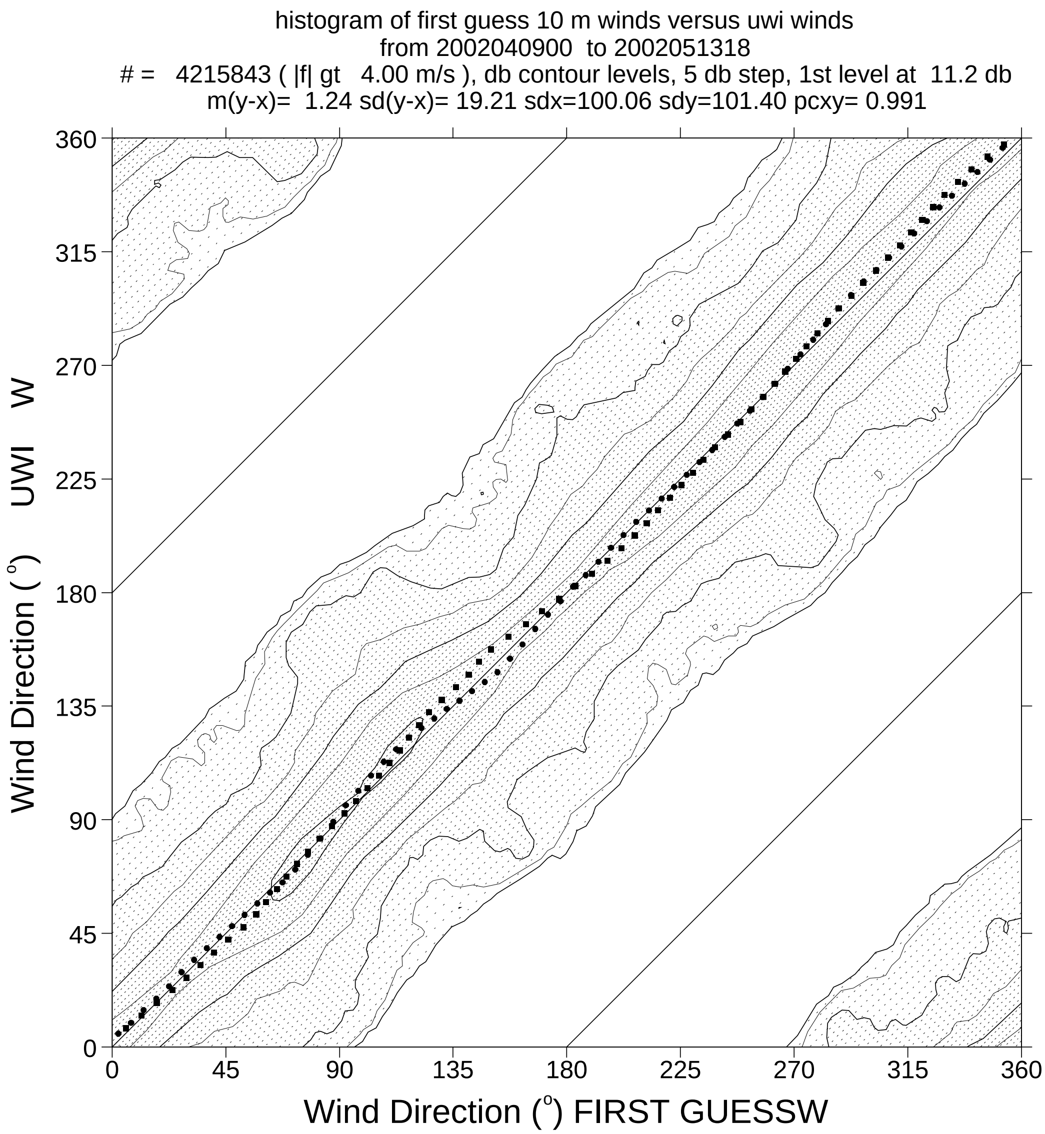

histogram of first guess 10 m winds versus uwi winds
from 2002040900 to 2002051318
= 4215843 (|f| gt 4.00 m/s), db contour levels, 5 db step, 1st level at 11.2 db
m(y-x)= 1.24 sd(y-x)= 19.21 sdx=100.06 sdy=101.40 pcxy= 0.991
Wind Direction (°) UWI W
Wind Direction (°) FIRST GUESSW
0
45
90
135
180
225
270
315
360

Figure 10