RESEARCH DEPARTMENT MEMORANDUM

To:	DR, HMD, RD division and Section Heads	
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From:	Giovanna De Chiara, Patricia de Rosnay, Ioannis Mallas	
Date:	17 August 2011	File: R60.9/GDC/11101
Subject:	**Use of ASCAT wind: update of the sigma nought bias correction in IFS cycle 37r2**	

In May 2011 EUMETSAT worked on an updated version of the ASCAT (Advanced SCATterometer) Level 1 (backscatter) processor which involved, among the others modification, also a change of the instrument calibration. The new ASCAT L1 processor is planned to be put into operation on 18th August 2011. On the same date also a new configuration of the ASCAT Level 2 Soil Moisture processor will be introduced. Both updates result in an improvement in terms of both backscattering (and therefore wind) and soil moisture parameters.

At ECMWF ASCAT products are assimilated in IFS for both wind analysis and soil moisture monitoring. Since February 2011 the ASCAT L2 (ALWS) multi parameter products (backscattering coefficient, wind and soil moisture) are operationally used at ECMWF (de Rosnay 2011a).

ASCAT winds are not extracted directly from the Level 2 products. Winds are, instead, retrieved inside IFS from the available backscatter measurements stored in the Level 2 products on the basis of the CMOD5.N geophysical model function. A sigma nought bias correction is operationally applied to the ASCAT sigma nought measurements and has to be modified accordingly to any changes performed to the instrument calibration.

The aim of this memorandum is to show the results of the computation of the new sigma nought bias correction file that will replace, from 18 August 2011, the one used currently in operations. Data assimilation experiments were run to verify the impact of the new ASCAT products generated with the updated processor and the use of the new bias correction file in the wind retrieval procedure.

1. Eumetsat processor update

In May 2011 EUMETSAT updated the ASCAT L1 processor (new version PPF7.4) including the following modifications:

a) update of the instrument calibration, based on an analysis of the transponder external calibration campaign performed in 2010. This update:

- corrects the mid left beam backscatter increase of 0.1db observed in September 2009;
- corrects the calibration oscillations along incidence angle;
- decreases the backscatter by 0.1 dB on average for all beams, according to the results of the transponder campaign.

b) introduction of the revised Kp algorithm;

c) correction of the Hamming window width for the 12.5 km product (the node or WVC order was applied in reverse from near to far swath in both swaths).

To validate the new processor, on 24 May 2011 EUMETSAT delivered a test dataset in native eps format for both 25 and 12.5 km grid spacing products. The dataset includes ASCAT L1 products generated with the old (PPF 7.3) and the new (PPF 7.4) processors for the same orbits. The dataset covers the period from 26 March 2011 to 21 April 2011 (orbits 23002-23365).

2. Sigma Nought bias computation

The ECMWF in-house wind inversion is applied to Level 1 ASCAT backscatter triplets in order to obtain wind speed and direction. A bias correction is applied to ASCAT measurements both in terms of backscatter (before wind inversion) and wind speed (after inversion) mostly to compensate for any change in the instrument calibration and to ensure consistency between the retrieved and model winds. The bias correction files have to be updated for every change in the ASCAT calibration made by EUMETSAT.

Following the modifications to the ASCAT processor, an analysis has been carried out to compute the new sigma nought bias correction to be applied to ASCAT backscatter measurements. Due to the small level of the calibration change, only the sigma nought bias correction has to be updated.

The ASCAT L1 products generated with both the current (PPF7.3) and the new (PPF7.4) processor, respectively named *eps_o* and *eps_t*, have been analyzed in order to compute the new sigma nought bias. The sigma nougth extracted from the products (both eps_o and eps_t datasets) have been compared with the sigma nought obtained from the ECWMF FG winds by performing an inversion using the CMOD5.4 GMF.

In Figure 1, the bias between the ASCAT and the inverted ECMWF sigma nought values as function of the wind vector cells is plotted for the three beams. In blue is the bias computed w.r.t. the currently operational ASCAT sigma nought measurements (PPF 7.3). In red the bias computed w.r.t. the test dataset (PPF 7.4). The sigma nought bias correction currently applied in the operational processing is shown in black. In Figure 2 the same bias is plotted as function of the incidence angle. Figure 1 and Figure 2 show a reduction of the sigma nought bias relative to the ECMWF winds for the new configuration products. Also the major reduction of the bias for the left mid beam is noticed, as expected, as correction for the backscatter increase observed since September 2009.

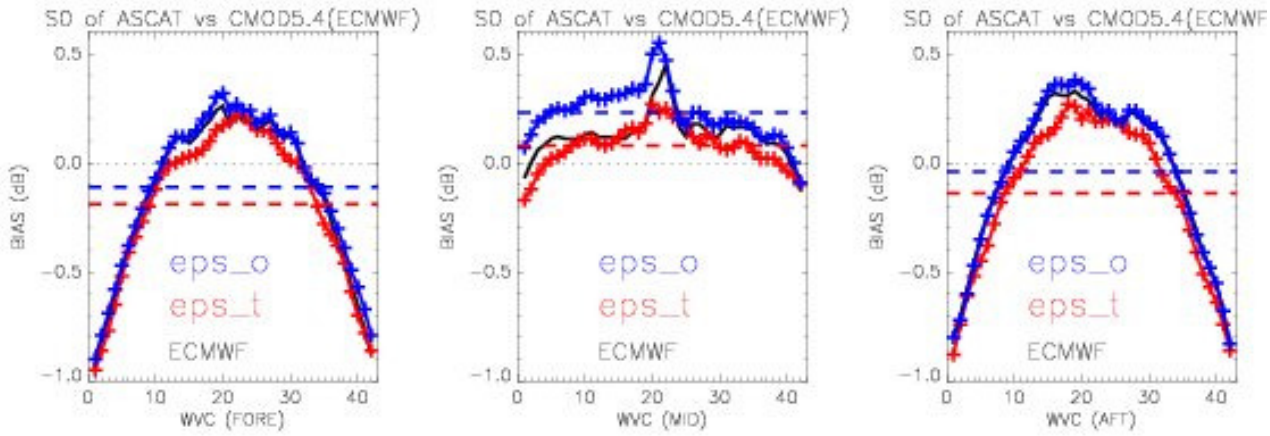

Figure 1: Backscatter (σ^0) bias for the three antennas (fore, mid, aft), as function of Wind Vector Cells (WVC), between the ASCAT L1 sigma nought measurements and the sigma nought obtained from the ECWMF FG winds by performing an inversion using the CMOD5.4 GMF. Node numbers range from 0 in the far left swath to 42 in the far right swath.

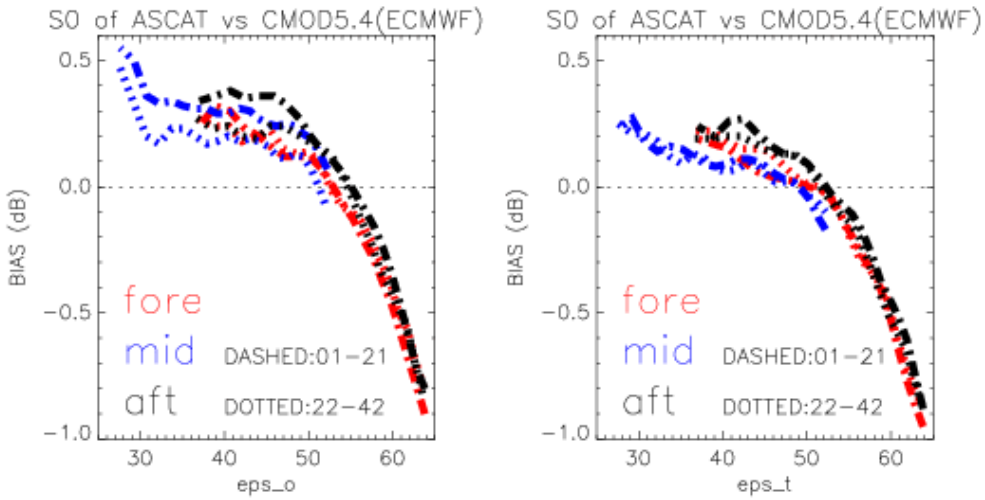

Figure 2: Backscatter (σ^0) bias as in Figure 1 but as function of the incidence angle.

In Figure 3 the difference in the ASCAT sigma nought (as function of the incidence angle) between the new (PPF7.4) and old (PPF7.3) processor configuration.

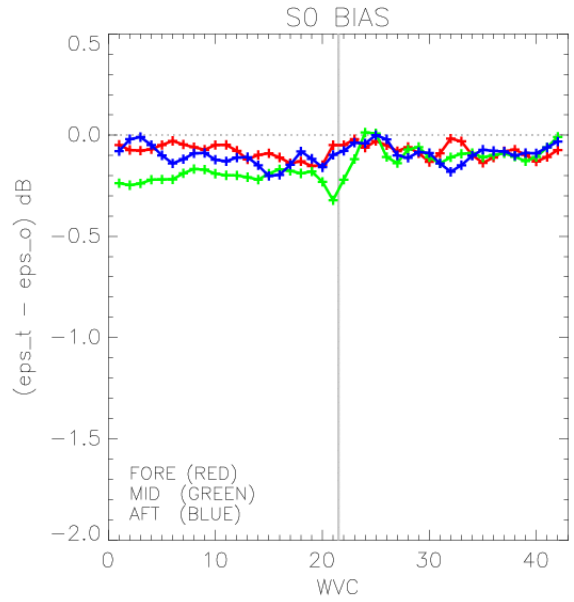

Figure 3: Differences in the ASCAT backscatter (σ^0) between the new (PPF7.4-eps_t) and the current (PPF7.3-eps_o) processor configuration.

From the above analysis, the new sigma nought bias correction file to be used in operation after the processor update, starting from the 18th August 2011, have been computed.

3. Numerical Experiments

On 8 July 2011 EUMETSAT delivered a test dataset of the improved ASCAT L2 multi parameter (backscattering coefficient, wind and soil moisture) products in BUFR format generated with the new configuration (new L1 processor and new L2 soil moisture processor).

Some experiments have been run based on the ASCAT L2 test products to verify the improvement expected and the new sigma nought bias correction computed.

The analysis experiment **fk6b** uses the DCDA ASCAT L2 multiparameter (ALWS) operational products (control experiment). For the experiment **fk6c** the fetchobs script has been modified in order to use the new (test dataset) ALWS products from ECFS. For both experiments the use of the ASCAT EARS (Advanced Retrasmission Service) stream data has been switched off as the test dataset was not available. Furthermore, both experiments use the ASCAT sigma nought bias correction file computed in 2008 and currently used in operation. More details about these experiments can be found in the Memorandum by de Rosnay (R43.8/PdR/11100).

Another analysis experiment, **fk9t**, was run at T255 from 27 March 2011 to 20 April 2011. It uses the new ALWS products from ECFS and the new sigma nought bias correction file computed as described in Par. 2.

Wind speed and direction retrieved from ASCAT sigma noughts measurements, as assimilated in the experiments fk6b (current operational configuration) and fk9t (new products configuration and new bias correction file) have been then compared to the ECMWF First-Guess winds.

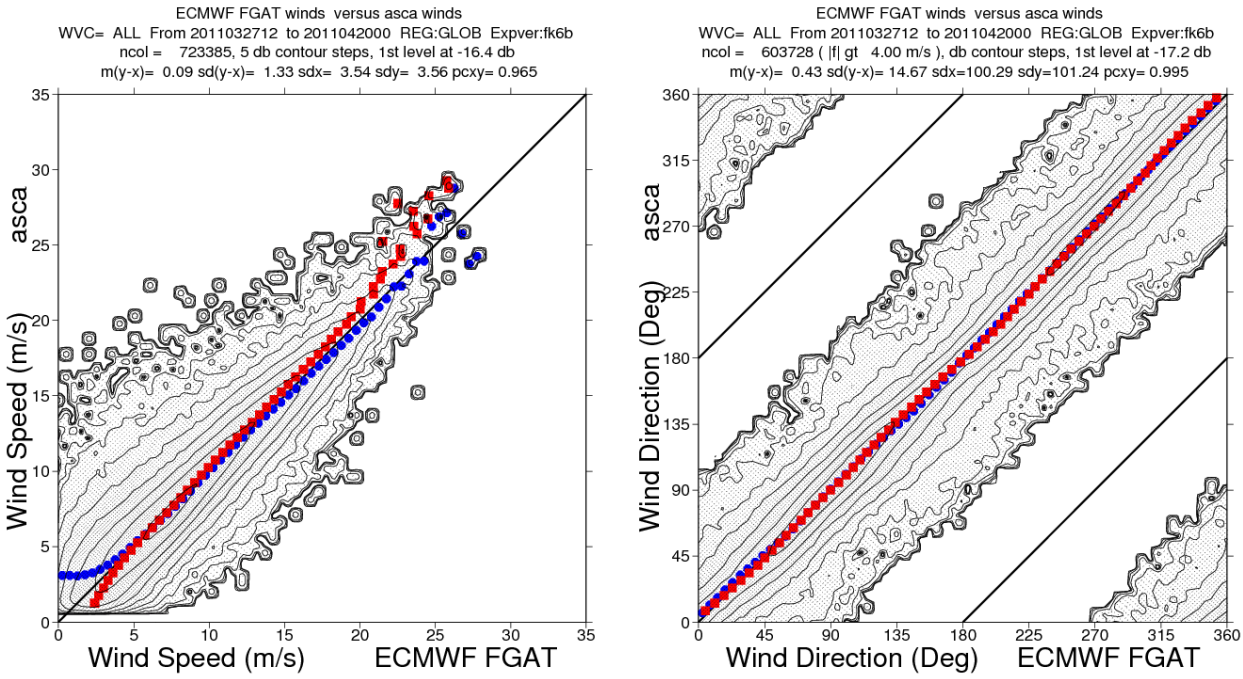

Figure 4: Two dimensional histogram of ASCAT (operational products-SW v.7.3) relative to ECMWF FG wind speed (left-hand panel) and wind direction (right-hand panel). Blue circles denote averages in the x-direction, red squares averages in the y-direction.

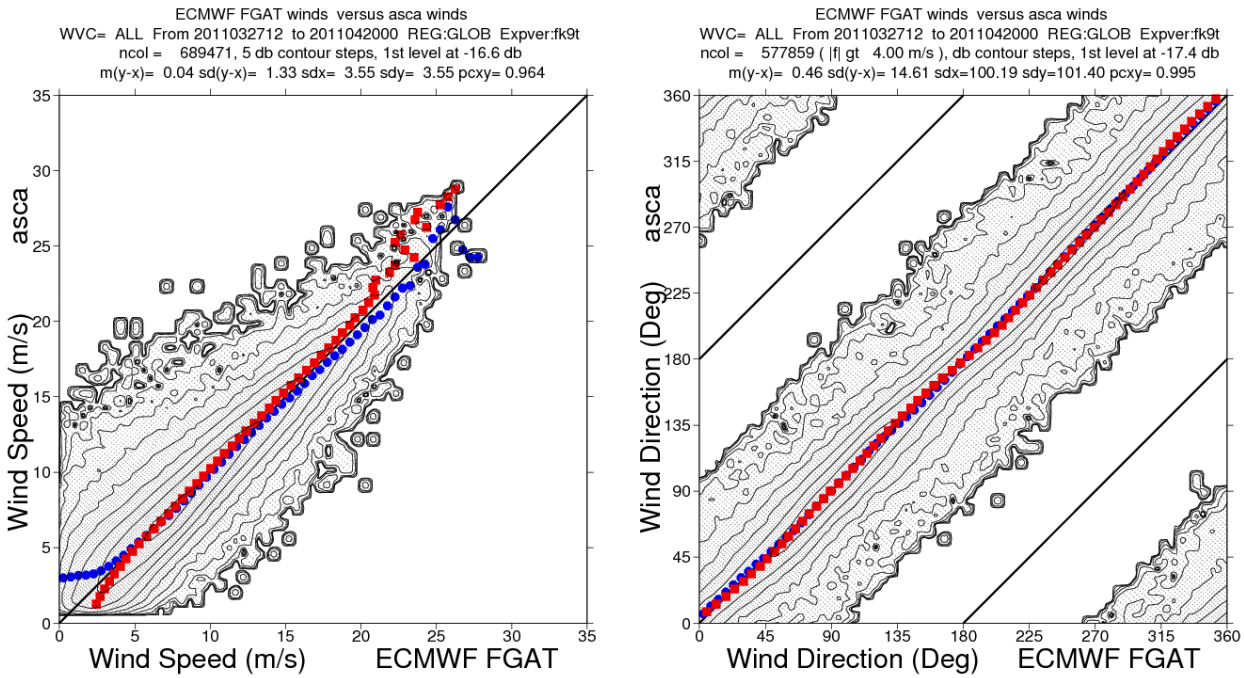

Figure 5: Two dimensional histogram of ASCAT (new test dataset SW v.7.4) relative to ECMWF FG wind speed (left-hand panel) and wind direction (right-hand panel). Blue circles denote averages in the x-direction, red squares averages in the y-direction.

As shown in Figure 4 and Figure 5, applying the updated sigma nought bias correction to the new products the quality of the wind retrieved is stable. The wind speed bias is slightly improved (is 0.04 m/s, was 0.09 m/s) while the wind speed standard deviation is stable (1.33 m/s). The quality of the wind retrieved is stable also in terms of wind direction: the bias is 0.46 deg (was 0.43 deg) while the standard deviation is 14.61 deg (was 14.67 deg). These results confirm a consistency in the ASCAT wind fields before and after the calibration change.

The impact of the new products processed with the new sigma nought bias correction file on ECMWF forecast system has been also evaluated. Figure 6 shows the anomaly correlation forecast at 500 hPa from 27 March 2011 to 20 April 2011 for the experimets fk9t (new ASCAT products and new bias correction file) and fk6c (new ASCAT products with old bias correction file). It shows that the use of the new sigma nought bias correction file to process the new ASCAT products has a slightly positive impact, except in North America and North Atlantic. However the test dataset analyzed is quite short to have reliable score results and a longer time span would be helpful to better assess the impact of the new data.

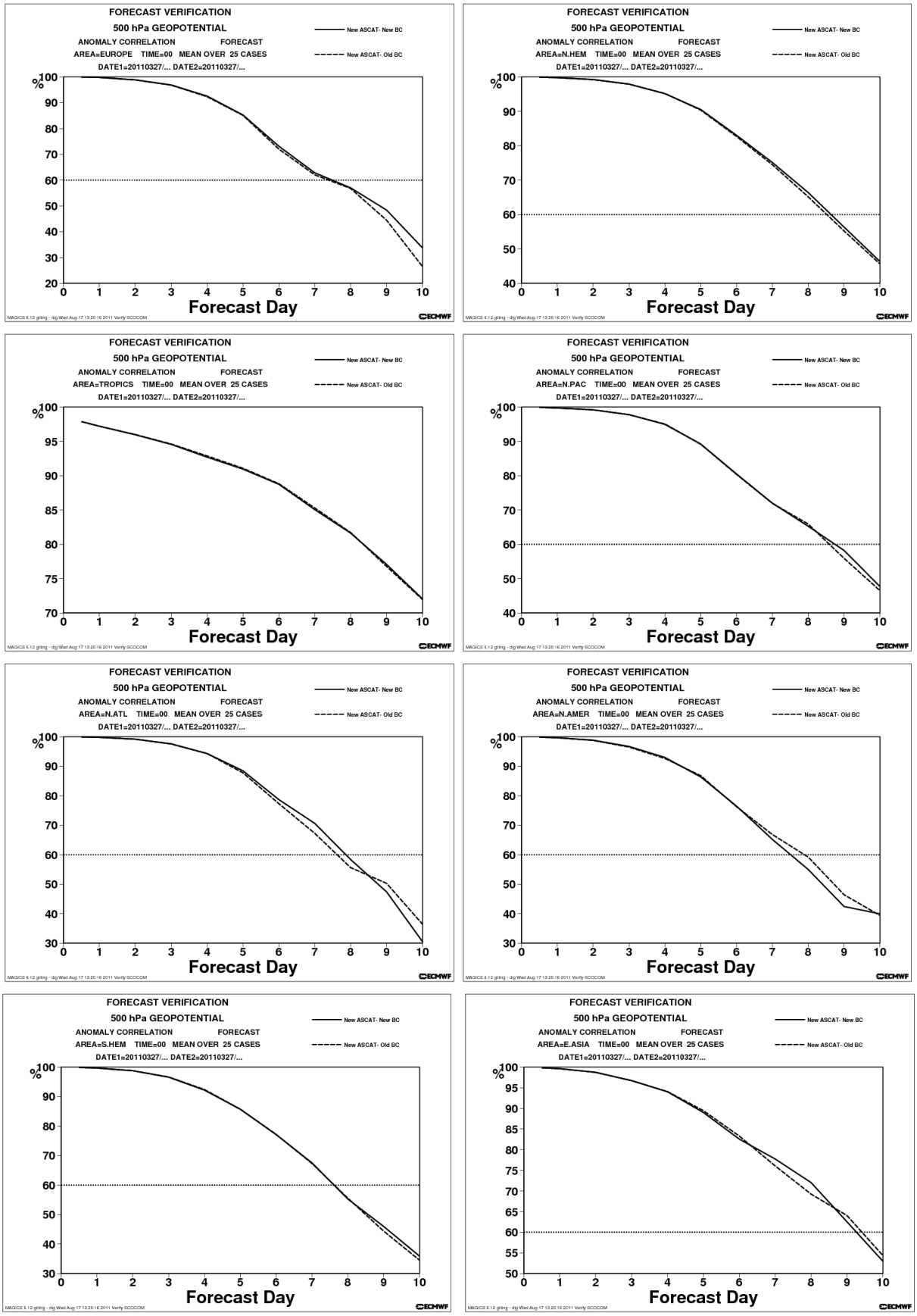

Figure 6: Impact of the new bias correction file on the anomaly correlation forecasts (at 500 hPa geopotential) from 27 March 2011 to 20 April 2011: new ASCAT products with the updated sigma nought bias correction (exp fk9t) versus new ASCAT products processed with the current bias correction file (exp fk6c).

4. Conclusions

EUMETSAT updated the ASCAT L1 (backscatter) processor and the ASCAT L2 Soil moisture processor. Both changes are planned to be put in operation on 18th August 2011. New improved ASCAT products will therefore replacing the current operational products received. Among the modifications to the ASCAT L1 processor, also un update of the instrument calibration has been performed.

Following the change of the instrument calibration, a new ASCAT sigma nought bias correction to be applied to the backscattering measurements during the wind inversion procedure has been computed. It has been obtained by analyzing an ASCAT L1 test dataset provided by EUMETSAT and generated with the new processor.

Some experiments were run to verify the new ASCAT L2 products and the use of the new sigma nought bias correction file in order to garantee a consistency in the quality of the wind fields before and after the processor update. Results show that the quality of the new ASCAT products processed with the new sigma nought bias correction is comparable with the ASCAT products currently used in operation. The wind speed and wind direction are stable in terms of both bias and standard deviation.

Also the importance to compute the new bias correction file has been evaluated. The use of the new bias correction file in the wind retrieval procedure from the new ASCAT products showed a slightly positive impact on the main regions on the 500 hPa geopotential forecast. Only a negative impact has been shown on North Atlantic and North America.

Based on the experiments described above, we can conclude that the new ASCAT ALWS files and the new sigma nought bias correction file can be safely implemented in operations.

Acknowledgements

Thanks to Hans Hersbach for the useful information and discussion regarding the bias computation.

References

de Rosnay P., 2011: Use of ASCAT Level 2 Multi-parameter BUFR product in operations in IFS cycle 36r4, *ECMWF Research department Memorandum, February 2011.*

de Rosnay P., G. De Chiara, I. Mallas, 2011: Use of ASCAT soil moisture: revised bias correction and test of improved ASCAT product in IFS cycle 37r2, *ECMWF Research department Memorandum, August 2011.*

Hersbach H., P. Janssen, 2007: Preparation for assimilation of surface-wind data from ASCAT at ECMWF, *ECMWF Research department Memorandum, June 2007.*