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IMPROVEMENTS TO EUMETSAT AMVS AND PRELIMINARY IMPACT ON NWP

In response to CGMS action 36.19

Satellite operators deriving AMVs to summarise their methods and ways to characterise the AMV errors, with emphasis on the height assignment error.

This paper summarizes the main results of the operational tests done at EUMETSAT using the new pixel selection method proposed by Borde and Oyama (2008) at IWW9, which aims to better select the pixels used to estimate the AMV height. This method keeps a closer link between the tracking and the height assignment steps in the AMV extraction algorithm, using the Individual pixel contribution to the cross correlation coefficient, to select the pixels that contribute the most to the tracking, which then offers a suitable subset of image pixels for the height assignment. Results of operational tests show large improvements of the new scheme on the AMV product for both the Vis0.8, HRVis and IR10.8 channels, increasing the total amount of AMVs (QI>80) and also the amount of good AMV/radiosonde collocations. However, speed biases against radiosondes are generally a bit larger, especially the known slow biases observed at high levels for IR10.8 AMVs. The two period datasets have been then tested in the forecasting system at ECMWF, showing a general neutral to slightly positive impact on the forecast.

Recommendation proposed: It is recommended to discuss the new pixel selection method preceding the AMV height assignment in detail at the 10th International Winds Workshop and to consider similar changes by all satellite operators deriving AMVs.

Improvements to EUMETSAT AMVs and preliminary impact on NWP

1 INTRODUCTION

At IWW9 Borde and Oyama (2008) showed the importance of the pixel selection process applied to isolate the pixels used to set the AMV altitude. They described a new method that keeps a closer link between the tracking and the height assignment (HA) step in the AMV extraction algorithm proposing to use the Individual pixel contribution to the cross correlation coefficient, CCij, to select the pixels that contribute the most to the tracking, which then offers a suitable subset of image pixels for the height assignment. Since IWW9 this method has been tested on a parallel chain at EUMETSAT for two separated periods of one month. This paper summarizes the main results of these operational tests, showing the improvements of the new scheme on the AMV product and the preliminary impact on NWP. This last part has been estimated at ECMWF through an assimilation test done by I. Genkova (personal communication 2009) using the two period datasets.

2 RESULTS OF OPERATIONAL TESTS

Three different configurations have been tested operationally: 1) the current OPE algorithm (referred as OPE); 2) the current OPE algorithm without image enhancement (referred as OPE_noIE); 3) the new scheme that uses the CCij information to set the AMV height (referred as New). The OPE algorithm estimated AMV pressure using a pixel selection process based on the coldest peak of the Cloud Top Height parameter (referred as CLA-CTH) histogram within the 24x24 pixels target box. This CLA-CTH is calculated operationally for all cloudy pixels using a water vapour slicing method.

Two periods have been studied, the first one from 24 December 2008 00:00 UTC to 21 January 2009 00:00 UTC, and the second one from 22 January 2009 00:00 UTC to 18 February 2009 00:00 UTC. During the first period all the configurations used the CLA-CTH calculated operationally at EUMETSAT. During the second period another CLA-CTH parameter has been calculated using CO2 slicing method, and used to feed the tested configurations (OPE_noIE and New). Table 1 summarizes the main differences of these configuration tests.

Table1: Configuration tests

Test	Image Enhancement	Pixel selection scheme	CLA-CTH Parameter	
			Period 1	Period 2
OPE	On	Current	Current OPE	Current OPE
OPE_noIE	Off	Current	Current OPE	CO2 slicing
New	Off	New	Current OPE	CO2 slicing

In the framework of this short paper, the performances of the new scheme are compared only against the performances of the current AMV product extracted at EUMETSAT.

2.1 **AMVs with high Quality Index.**

The new scheme increases the internal consistency of AMV fields, and the amount of IR10.8 AMVs of a Quality Index QI>80, commonly referred as "excellent" AMVs, is increased by nearly 10% on average for the first period and 17% for the second period considering all pressure levels together. More detailed statistics are listed in Table 2. The calculation of the QI is based on the use of spatial consistency and temporal consistency tests. However, the current QI does not indicate whether this estimated altitude is correct or not.
Comparing the results of the two periods shows the overall importance of the actual cloud top height assignment method.

Table 2: Relative increase (in %) of the amount of excellent IR10.8 AMVs (QI>80) for the two periods.

Relative increase of good AMVs (QI>80) (New – OPE) / OPE (in %)		Period 1	Period 2
IR10.8	All levels	10	17
	High levels	-3	23
	Mid Levels	102	48
	Low levels	11	8
VIS 0.8		4	4
HRV		5	3

2.2 Comparison against Radiosonde observations.

The quality of the AMV product involves direct comparison of collocated computed AMVs and radiosonde (RS) observations. The following criteria are generally applied to filter only the "good collocations" in the statistic: Horizontal distance AMV/RS < 150 km; Vertical distance AMV/RS < 25 hPa ; AMV Quality Index>= 80 ; Speed difference AMV/RS < 30 m/s ; Direction difference AMV/RS < 60 deg ; AMV speed > 2.5 m/s.
Tables 3 and 4 present the relative increase of the amount of good AMVs/RS collocations (in %) and the AMVs/RS speed biases (in m/s) for the two periods. Results are given for low-levels VIS0.8 and HRV AMVs, and split in three different altitude levels for IR10.8 AMVs. Unfortunately, the geographical distribution of the statistics is not homogeneous, as the global statistics are mainly dominated by the northern hemisphere (more than 60% of the total amount for IR channels) where most radiosondes are launched. Therefore the results are also given according to geographical areas, i.e. global, Northern Hemisphere (NH), Southern Hemisphere (SH) and TRopics (TR).
According to the filtering criteria described above, an increase in the total amount of good AMVs/RS collocations in the statistics means that the new AMVs of QI>80 are more frequently in a fair agreement with the neighbouring radiosonde observations for the detected altitude, speed and direction.

In summary the new method largely increases the number of good AMVs/RS collocations nearly everywhere for IR10.8, VIS0.8 and HRV AMVs. The AMVs/RS speed biases are a bit larger using the new method, especially the well known slow bias observed for high levels IR10.8 AMVs. Results are slightly different for the two periods which again illustrates the importance of the method used to calculate the CLA-CTH parameter.

Table 3: Relative increase (in %) of the amount of good AMVs /RS collocations for the two periods.

Relative increase of the amount AMV/RS collocations: (New-OPE)/OPE (in %)		Period 1				Period 2			
		Global	NH	SH	TR	Global	NH	SH	TR
IR10.8	All levels	22	26	22	15	40	45	30	29
	High levels	7	6	14	8	48	59	31	33
	Mid Levels	58	47	109	205	41	65	19	-4
	Low levels	48	60	39	24	6	0	56	94
VIS 0.8		28	40	7	13	25	51	9	-7
HRV		32	34	30	6	44	47	25	-6

Table 4: AMV/RS speed biases (in m/s) for the two periods.

AMV/RS speed Bias New (OPE) (in m/s)		Period 1				Period 2			
		Global	NH	SH	TR	Global	NH	SH	TR
IR10.8	All levels	-1.3 (-1.2)	-1.6 (-1.8)	-1.7 (-1.5)	-0.4 (-0.1)	-2.6 (1.5)	-2.8 (-1.8)	-1.8 (-1.)	-2.0 (-0.7)
	High levels	-1.9 (-1.2)	-2.9 (-2.1)	-2.1 (-1.5)	-0.6 (0)	-3.3 (-1.7)	-3.9 (-2.3)	-2 (-0.9)	-2.3 (-0.7)
	Mid Levels	-1 (-2.2)	-1.4 (-2.4)	-0.9 (-1.5)	2.2 (-0.7)	-2.7 (-1.8)	-3 -1.9)	-1.7 (-1.1)	-0.4 (-0.3)
	Low levels	0.1 (-0.4)	0.5 (-0.2)	-0.5 (-1.2)	-0.9 (-0.8)	1. (0.)	1.6 (0.38)	-0.1 (-0.7)	-0.9 (-0.7)
VIS 0.8		-0.1 (-0.5)	-0.2 (-0.3)	-0.5 (-1.3)	-0.8 (-0.7)	0.4 (-0.3)	1. (0.1)	-0.2 (-0.5)	-0.8 (-0.8)
HRV		0.7 (0.1)	0.8 (0.1)	0.2 (0.5)	-0.8 (-0.9)	1.3 (0.3)	1.4 (0.4)	-0.9 (-1.5)	-0.6 (-1.1)

2.3 **Preliminary impact on NWP**

Assimilation tests have been done at ECMWF by I. Genkova using the two period datasets. Figure 1 presents the impact on the forecast at 4 different pressure levels (850, 500, 200 and 100hPa from the upper left to the bottom right for all groups of 4 graphs) for the northern hemisphere. The upper plots correspond to period 1 and lower plots to period 2. Positive difference corresponds to a positive impact. The general impact of the new scheme on the forecast is mainly neutral to slightly positive.

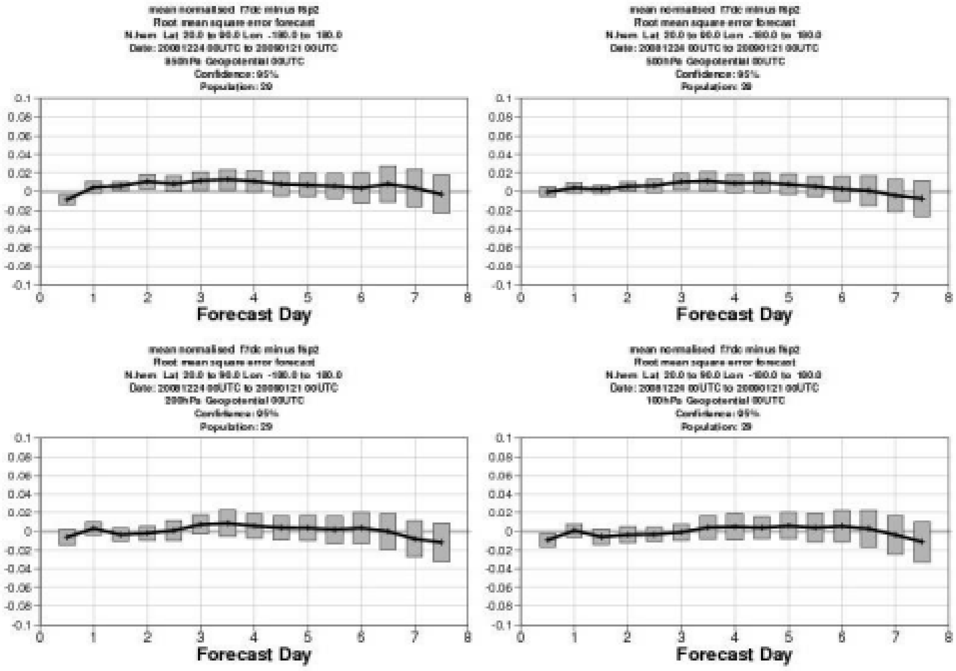
3 CONCLUSIONS

This paper is an answer to CGMS action 36.19. It summarizes the main results of the operational tests done at EUMETSAT using the new pixel selection method proposed by Borde and Oyama (2008). This new scheme provides a clearer and better physical relationship between the displacement vector and the radiances that are used to set the AMV height. Comparisons against operational product show large improvements of the new scheme on the AMV product for both the VIS0.8, HRV and IR10.8 channels, increasing the total amount of AMVs with QI>80, and also the amount of good AMVs/RS collocations. Speed biases against RS are generally a bit larger, especially the known slow bias at high levels for IR10.8 AMVs. These two period datasets have been tested in assimilation at ECMWF, preliminary results showing a generally neutral or even slightly positive impact on the forecast.

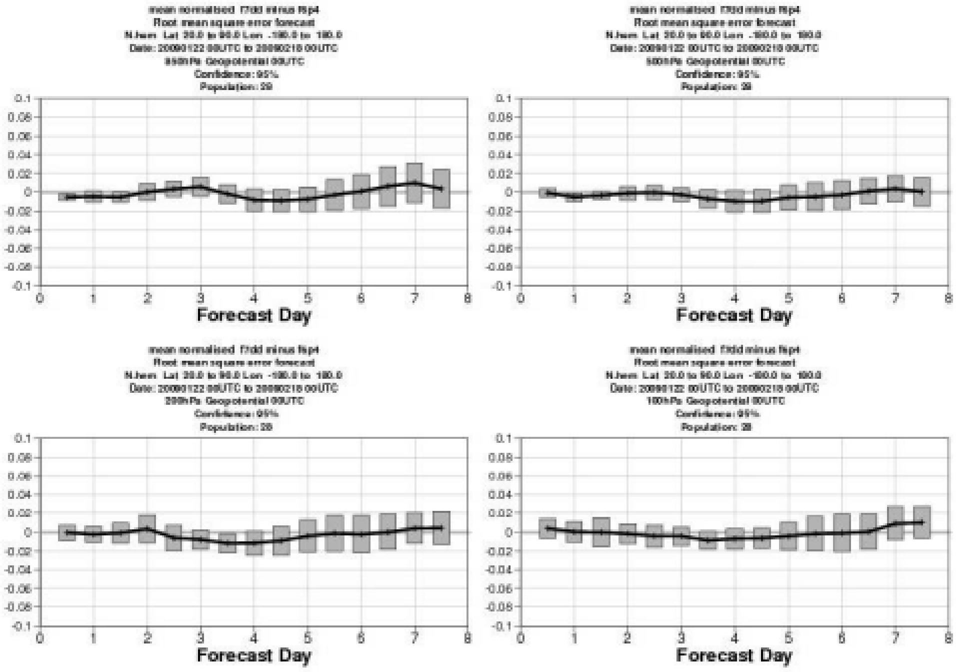
Based on a better physical concept, the new pixel selection method is also very simple and provides a high potential to easily integrate future improvements, like a better estimation of the cloud top heights for example. A part of the effects observed in the results above are probably due to the image enhancement process, which is not used with the new method. The impact on the forecast still needs to be further analysed and better understood. The next IWW10 shall be a good opportunity to discuss in details all these issues, including the advantages and caveats of the new pixel selection method, and to encourage all AMV providers to adopt a similar approach.

4 REFERENCES

Borde R., and R. Oyama, 2008, 'A Direct Link between Feature Tracking and Height Assignment of Operational Atmospheric Motion Vectors', Ninth Int. Winds Workshop, Annapolis, USA.



Period 1 Northern Hemisphere



Period 2 Northern Hemisphere

Figure 1: Impact on the forecast assimilating the two period datasets (upper panel: period 1, lower panel: period 2), by courtesy from I. Genkova (ECMWF). Results are presented at 4 different pressure levels (850, 500, 200 and 100hPa from the upper left to the bottom right for all groups of 4 graphs) for the northern hemisphere. Positive difference corresponds to a positive impact.