MSG AMV PROCESSING

SOME VIEWS FROM EUMETSAT OPERATIONS

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ABSTRACT

In August 2002 as the first Meteosat Second Generation satellite was launched a new era started at EUMETSAT. The satellite was commissioned by the end of 2003 and started routine operations already in January 2004 as Meteosat-8. The new imager presents several improvements, but also challenges, compared to the imager on the first generation satellites. Due to significant delays in the MSG ground segment installation, the time for validation of the meteorological products became extremely short and several modifications has been implemented after start or operations. The 1st of December 2004 the AMV height assignment functionality was redesigned, in short the averaging of the various successful height methods was abandoned and the CO2 / IR 10.8 method was made the primary height assignment, with the uncorrected EBBT height used for low levels and if higher then the CO2 height. The 1st of December 2005 the height assignment was changed again, discussed below. There are still significant improvements to be expected in the MSG AMV processing.

This paper will present some views on the way changes to the operational products has been validated, a short discussion about MSG AMV features and errors. Some results from the MSG-2 commissioning are presented.

VERIFICATION AND VALIDATION

The basic method for validation of changes to the AMV products is collocations with radiosonde data. The availability of radiosonde observations is limited in space and time, for a reliable comparison a fairly long time series is necessary, but even with very long series certain areas / heights are not properly covered (Atlantic / low levels). The NWP model do not suffer from these limitations, but is on the other hand not the full "truth". As some NWP centers are applying bias corrections a validation against the model is also necessary, but due to lack of a parallel system within MPEF, it has not always been possible to provide external users with time series long enough for a proper validation of changes.

Change 1 Dec 2005: CO2 / IR 12.0 height method and adding of WV Atmospheric Absorption

Both manual inspection of AMV's and the MSG Height Assignment Study 2004/2005 indicated that the CO2 / IR 12.0 height assignment method provided better result then the initially used CO2 / IR 10.8 method, the study indicated that CO2 12.0 would on average be about 30 hPa lower. The Height Assignment Study was a pure statistical study, a physical description and a discussion about the limitations of the CO2 height assignment method was also presented at IWW-8 in Beijing 2006 by Arthur de Smet, Eumetsat.

Below are the radiosonde collocation tables for the validation of the CO2 height methods (High levels, QI > 80% only). The period is only two weeks in may, but it seems quite clear that the CO2 / IR 12.0 method provides better biases, for IR 10.8 AMV's the bias is less than half! A parallel validation at ECMWF indicated quite neutral impact, and the change was accepted.

Change to CO2 12.0 4 - 17 may 2005

Channel	HA Method	CO2 10.8 (OPER)			CO2 12.0		
	Area	NORTH	SOUTH	TROPICS	NORTH	SOUTH	TROPICS
WV 6.2							
Cloudy	RFS Speed	26.32	41.41	18.98	25.40	4[illegible].26	18.48
High level	MVD	6.48	9.49	5.70	6.08	8.80	5.59
QI > 80%	NRMS	0.30	0.29	0.37	0.29	0.27	0.37
	Nr. Coll.	3533	425	639	3617	404	696
	RMS	7.86	11.87	7.01	7.35	1[illegible].03	6.76
	Spd Bias	-2.61	-2.76	-0.99	-1.99	-2.72	-0.26
		Higher (more EBBT's). Some improvement in Bias. ECMWF: neutral					
IR 10.8							
High level	RFS Speed	26.49	38.64	19.50	25.25	36.29	19.54
QI > 80%	MVD	6.29	9.98	5.61	6.05	8.03	5.35
	NRMS	0.28	0.31	0.35	0.29	0.28	0.33
	Nr. Coll.	2069	281	406	1866	256	380
	RMS	7.55	12.17	6.82	7.29	9.99	6.44
	Spd Bias	-2.82	-4.16	-1.19	-1.12	-2.38	-0.27
		Lower. Great Improvement in Bias. ECMWF: Tropics worse, rest OK					

As mentioned above it was expected that the CO2 / IR 12.0 heights should be lower, surprisingly enough this seems not to happen for 6.2 AMV's. Investigations showed that the reason to this was the

lack of compensation for atmospheric absorption in the WV EBBT height assignment method, which is used if higher up in the atmosphere than the CO2 height. This was corrected and the validation was repeated, now for 10 days in November (Table 2 below).

Change to CO2 12.0 + Atm. Abs. 18 - 28 nov 2005

Channel	HA Method	CO2 10.8 (OPER)			CO2 12.0 + Atm. Abs.		
	Area	NORTH	SOUTH	TROPICS	NORTH	SOUTH	TROPICS
WV 6.2							
Cloudy	**R/S Speed**	32.24	30.43	18.15	30.60	29.25	17.29
High level	**MVD**	7.65	7.78	6.39	6.72	6.69	6.86
QI > 80%	**NRMS**	0.29	0.31	0.43	0.27	0.28	0.49
	Nr. Coll.	**2439**	**594**	**998**	**1781**	**540**	**860**
	RMS	9.26	9.57	7.83	8.21	8.12	8.51
	Spd Bias	**-3.04**	**-1.72**	**-1.21**	**-1.55**	**-0.71**	**0.07**
		Great improvement in Bias. NRMS better for NH and SH.					
IR 10.8							
High level	**R/S Speed**	31.16	32.72	18.40	30.34	29.78	17.91
QI > 80%	**MVD**	7.66	8.26	6.31	6.95	6.63	5.99
	NRMS	0.29	0.31	0.42	0.28	0.26	0.42
	Nr. Coll.	**1758**	**383**	**589**	**1441**	**378**	**516**
	RMS	9.07	10.22	7.77	8.34	7.84	7.45
	Spd Bias	**-3.61**	**-2.74**	**-1.31**	**-2.46**	**-1.50**	**-0.77**
		Small impact for atm. abs. expected					
		Applied from 1 Dec 2005					

With the compensation for atmospheric absorption applied also the 6.2 AMV's show a reduced number of high level winds and the bias is reduced with 50% as for the IR 10.8 AMV's in the May validation.

The validation period ended the 28th of November and for administrational reasons the change had to be applied from 1st of December, or not at all. Hence, there were no time for an external validation and as the result for the 6.2 AMV's were similar to the result for 10.8 AMV's in the May validation it was decided to go ahead with the change without further external validation.

Image Enhancement

The purpose with the Image Enhancement within the IR 10.8 AMV processing is to increase the contrast between the selected target and possible lower level surfaces. The image enhancement has been applied since start of MSG operations, no dedicated validation on MSG MPEF was performed, but some offline studies indicated and improved clustering. With the arrival of the LTV (MPEF Long Time Validation chains) at the end of December 2005 there was a possibility to have a parallel run without image enhancement. The resulting collocation tables (below) shows very small impact on quality in term of RMS error or bias, the main impact is less winds with high QI and a small increase in

background speed. The reason the reduced amount of AMV's with high QI's is that the Image Enhancement has a negative impact on tracking.

Also interesting is the huge difference between collocations against radiosondes and aircrafts, for the January period the difference in background speed is 10 m/s! Therefore the validation was repeated for 10 days in February with similar results, allthough the difference in background speed is now reduced to 4 m/s, which is also a lot! Further investigations has showed that the reason to these big differences is the different location of the observation, hence the answer is very depending of the used reference and comparable statistics can only be achieved by controlling the reference. At the moment we start with the AMV and search for an observation to compare with, to do the contrary would provide more comparable results.

Collocations NH, High, > 80%	24 - 30 Jan 2006				4 - 15 Feb 2006			
	Radiosonde		**Aircraft**		**Radiosonde**		**Aircraft**	
	Without	With	Without	With	Without	With	Without	With
R/S Speed	31.37	33.92	21.04	22.82	34.42	35.57	30.17	31.29
MVD	7.21	7.20	5.92	6.12	7.77	7.81	6.89	6.61
NRMS	0.29	0.27	0.35	0.33	0.27	0.26	0.27	0.25
Nr. Coll.	**1180**	**1047**	**1205**	**940**	**2006**	**1828**	**3370**	**2421**
RMS	9.10	9.09	7.29	7.62	9.34	9.41	8.08	7.84
Spd Bias	**-2.72**	**-2.07**	**-2.22**	**-2.33**	**-2.70**	**-2.43**	**-3.77**	**-2.84**

Increased mean speed
Bias improved, but only for RS
10-15% less > 80%

Increased mean speed
Bias improved, for Aircraft!
10-30% less !

Negatively impact on tracking, on weak winds. Better or worse?
Difference R/S - Acft due to different locations!

The conclusion of the tables above is that the Image Enhancement reduces the amount of AMV's with high quality index, together with a small improvement in RMS and Bias. As it is possible to reach the same result by simply increase the QI threshold it is far from sure that the Image enhancement actually improves the product, and the data was therefore sent to ECMWF for an evaluation against forecast data. An answer is not yet available.

Conclusions for AMV validation:

- The reference has to be controlled. Start with the observation instead of the AMV
- Collocations not enough due to limitations in coverage
- Quality improvement together with reduced amount does not necessarily indicate an improvement in total as the same can be achieved by raising the QI threshold.
- More user involvement in the validation process is needed as the model impact is the essential!
- More user involvement in the validation process is needed as the bias correction schemes needs tuning.
- The validation process should be formalised and technical resources available to provide parallel time series long enough for a sensible validation.

OBSERVATION ERRORS AND OTHER MSG AMV FEATURES

Observation Errors

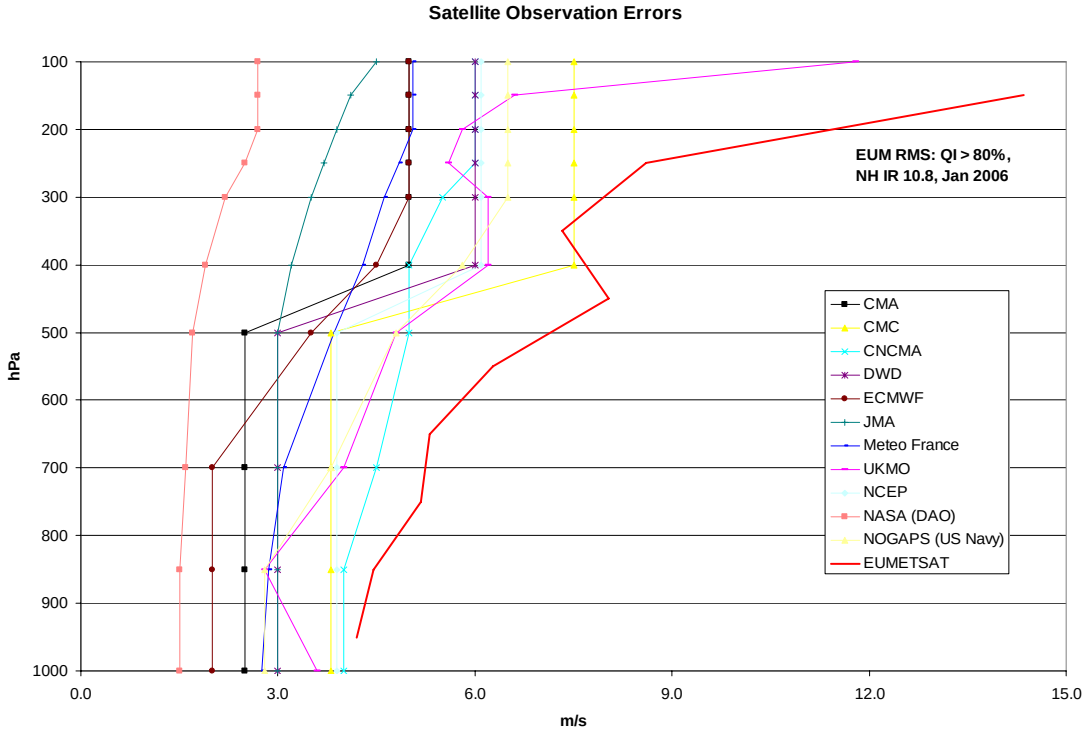
It has been requested by some users that the data providers (as Eumetsat) should provide a vector error together with the AMV. JMA had in CGMS 28 the task to collect information from the NWP centers about which observation errors were applied to AMV's (CGMS 28, JPN-WP-14). The result is shown in the picture below and the most interesting is the large differences between the NWP centers. The reason to the differences is best explained in the JMA paper:

"Since each NWP center uses different thinning, quality control, and assimilation methods, and different background error statistics, it is not surprising that the observation errors are different among centers."

As this paper is fairly old and based on MTP data available at that time, one can add that also the quality threshold used before presenting the AMV data to the model is important. In the BUFR era a user has the possibility to set his own quality threshold based on the Eumetsat QI or to use the autoedited AMV's based on RFF.

Conclusion for observation errors

The dataprovider has small possibilities to provide an error as he has no control of the handling of the AMV's in the assimilation scheme. What easily can be provided is the total error against radiosondes, but that is not very useful. To proceed with this the NWP centers has to define which error is requested with reference to collocation box size, QI threshold, RFF aso.



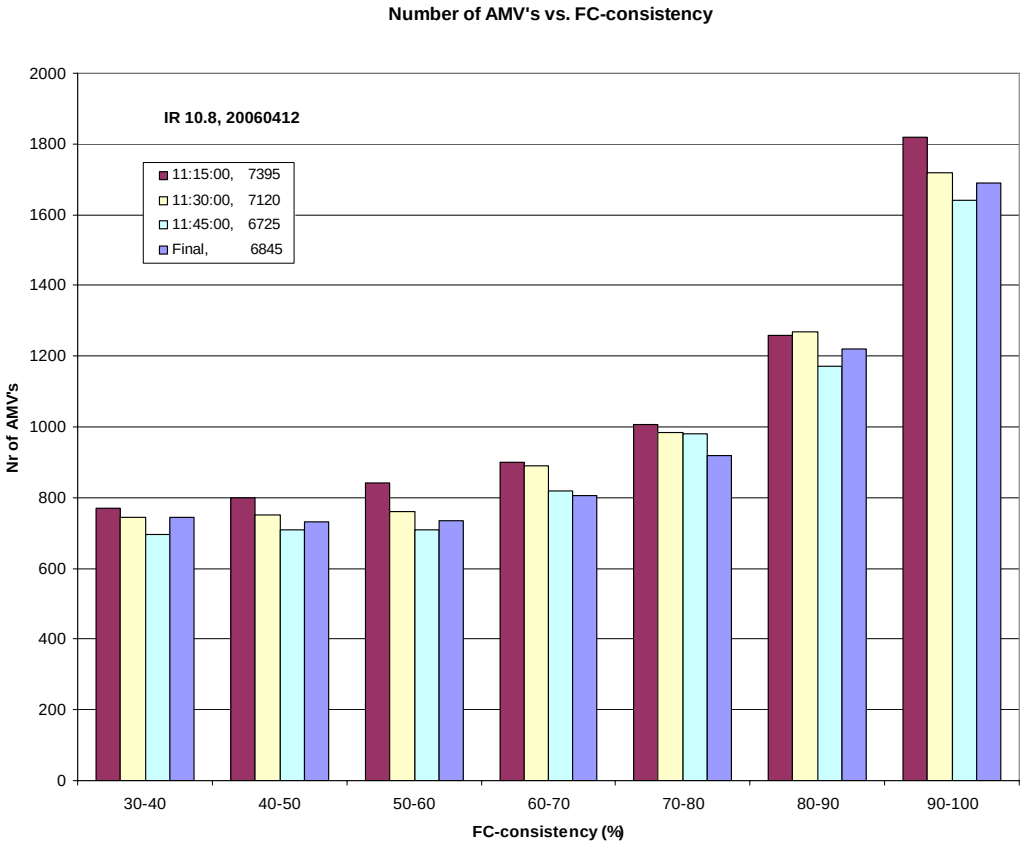
MSG AMV averaging

MSG AMV's are an average of three components, from four images for the following reasons:

- Improves stability, in case of data loss a Final AMV can be provide from two components
- Reduces impact from random image errors

But the effect of this is not always positive:

- Representativity in time is undefined, depending on which components were used for the averaging.
- When adding more height assignments (STC, IR/WV ratio) the averaging will be tricky as users has requested that different height assignment methods should not be mixed.
- It's far from sure that the end quality is improved. The picture below indicates in fact that in terms of average forecast consistency the first component is better than the Final AMV product.



Conclusion:

- It can be questioned if the hourly averaging has a positive impact on the final quality and if the advantages are bigger than the disadvantages.
- If the averaging is abandoned quarterly AMV's can easily be provided.

MSG-2 COMMISSIONING

The first experiences of MSG-2 has been made and the quality of the image data is in most cases comparable to Meteosat-8 (MSG-1).

The exception is the 6.2 channel where severe disturbances has been experienced. There are two problems:

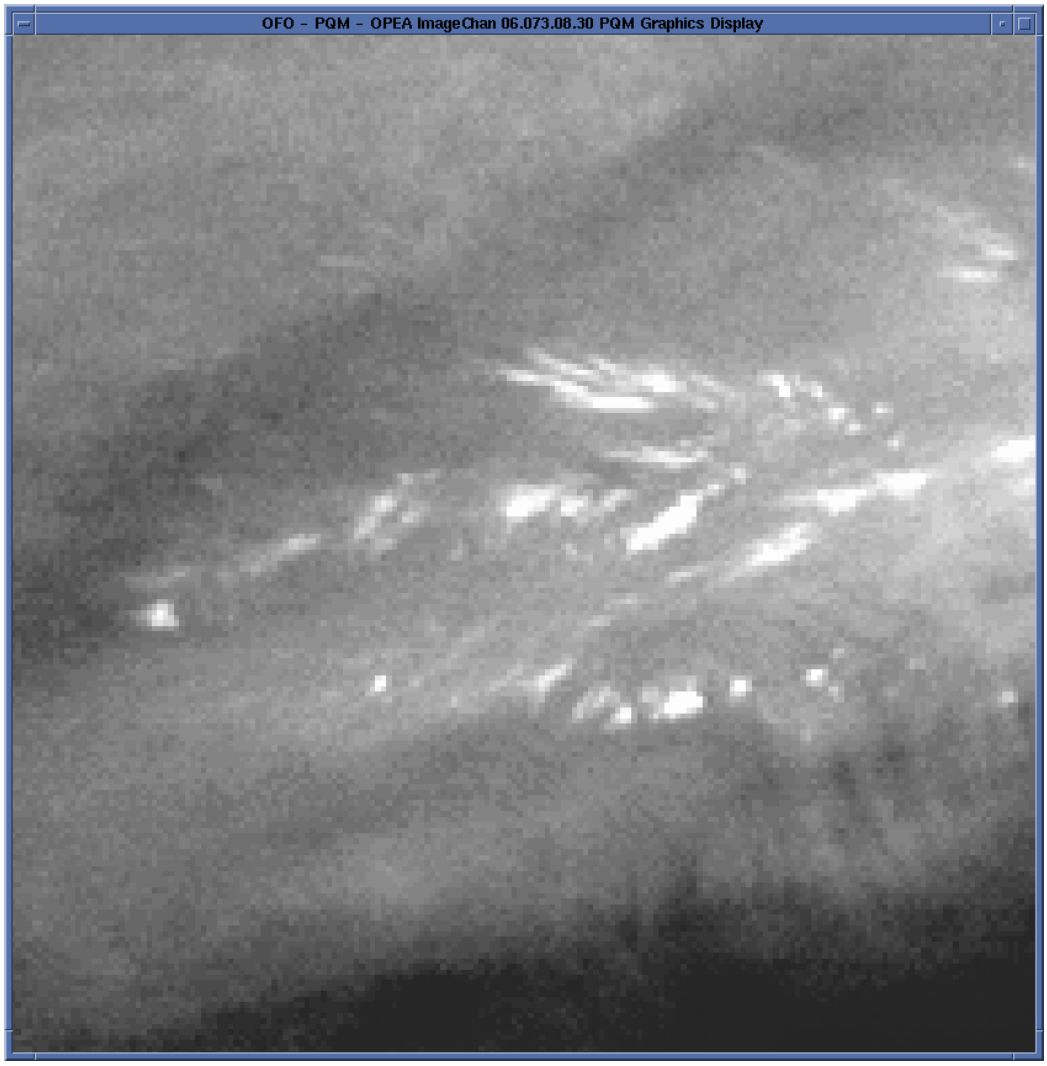
- Bright image lines, between 2 and 5 / image.
- Low level noise, frequent all over the image.

The problem has been identified to two of three 6.2 detectors having non optimal performance.

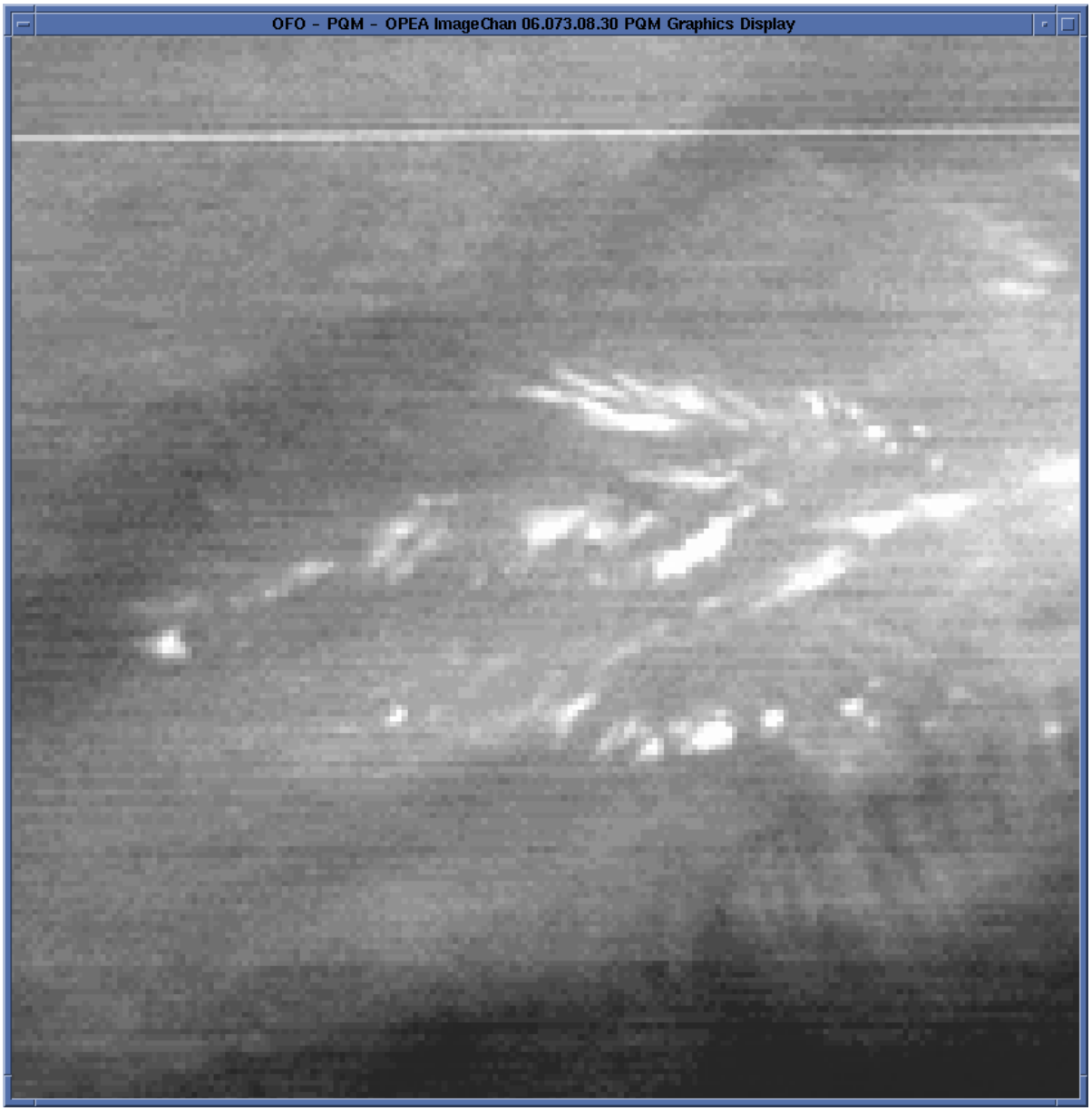
Impact on products

- Cloud detection is impacted
- 20% less 6.2 winds after AQC (>80%), tracking is negatively impacted.

There is work ongoing filter out the disturbances, any quantitative results are not foreseen before autumn 2006.



Meteosat-8, 6.2 image



MSG-2, 6.2 image