CURRENT STATUS OF THE EUMETSAT METEOSAT-8 ATMOSPHERIC MOTION VECTOR QUALITY CONTROL SYSTEM

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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 in January 2004 as Meteosat-8. The new imager presents several improvements over the imager on the first generation satellites, e.g. higher temporal and spatial sampling and more spectral bands. The improvements enable several significant enhancements and improvements for the operational products already produced with data from 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 is in reality still ongoing. Significant improvements are expected in cloud classification, which inevitably will improve all products, and also for the AMV product a number of improvements are foreseen.

This paper will present the status of the Automatic Quality Control scheme currently applied on Atmospheric Motion Vectors derived by the Meteorological Product Extraction Facility with Meteosat-8 data at EUMETSAT. The presentation will highlight existing shortcomings of the present system and outline potential future improvement.

1. INTRODUCTION

The MSG AMV AQC system is essentially the same as for the MFG (Meteosat First Generation, Meteosat 1-7) satellites described at the Eumetsat web site (www.eumetsat.de) and will not be further described here. Even if the MSG AMV product provides many more variables suitable as input to the AQC, only the five “MFG like” tests were available at start of operations. New tests are under development and are described later in this paper.

The main difference between MFG and MSG AMV processing, concerning the AQC, is that in MFG only speed/direction from the two components and the height calculated from the middle image are used as input to the AQC. The final AMV is a vector average of the two components. In MSG is the final AMV based on three components (from four images) and all variables are available for all components, i.e every component has not only it’s own speed and direction, but also it’s own height and it’s own result from every AQC test. These are then averaged to form the final AMV.

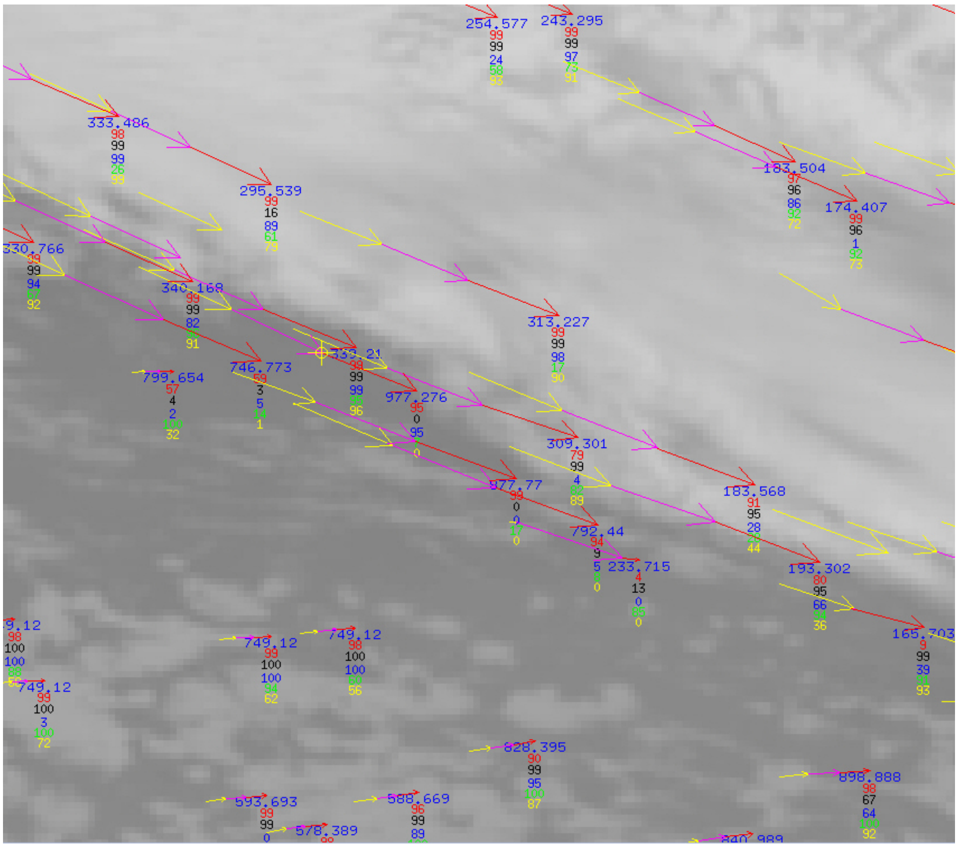


Figure 1. Three components, and for the last component (red) also the assigned pressure (with three decimals!), the quality indicator (red) and the returned values for some of the contributing AQC tests.

2. THE MSG AMV AQC

2.1 The temporal test problem

A basic assumption in the Eumetsat AMV AQC Scheme is that each test has to show continuos relation to quality in terms of rms difference against radiosonde observations. The continuity is important since when forming the final quality index (QI) the different tests are simply averaged. A special problem is then that the temporal tests for the first component has no preceding value to compare with. The present approach is to use the preceding final AMV for the comparison, which introduces some problems demonstrated in Figure 2 below.

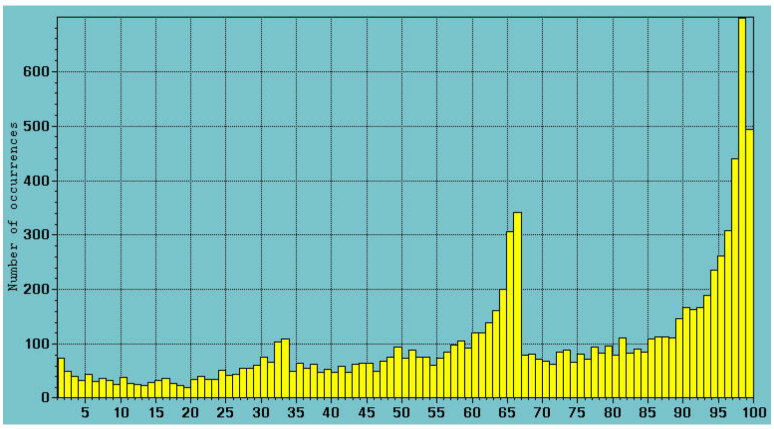


Figure 2. Final AMV Temporal Vector Test QI distribution, Channel 10.8, all levels.

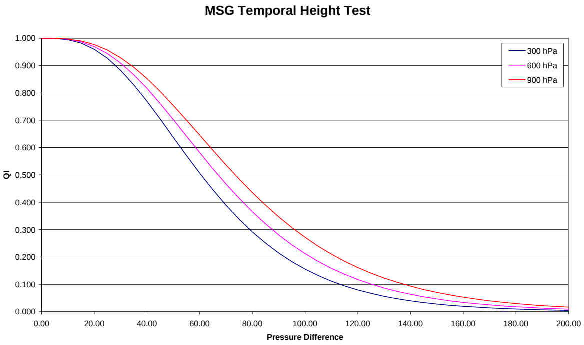
It's obvious from manual monitoring that the high frequency of QI's with 33% or 66% is caused by an increased amount of zero values in the first component, indicating that it was not possible to find any preceding Final AMV within the specified box to compare with. This in turn negatively impacts the necessary continuity mentioned above and thereby the functionality of the AQC, since quite a number of AMV's are getting a reduced QI only because the lack of preceding AMV. The chosen solution to the problem is to not use the first component in the averaging, i.e. use only the last two components. It's expected that this change will be in operation from September 2004.

2.2 New tests

It's a well known problem that the MTP AMV AQC scheme has limited ability to identify AMV's on wrong height. If the height error is consistent in an area there is no test able to identify this problem. With the increased amount of variables available to the AQC scheme, some new tests has been constructed.

2.2.1. Temporal height test

This new test works in the same way as the other temporal tests, i. .e. it compares the heights from the components and calculates a QI using a tanh function to return a normalised value. The behaviour of the test, and the distribution of the returned QI's (Channel 10.8, all levels) are demonstrated in Figures 3 and 4.



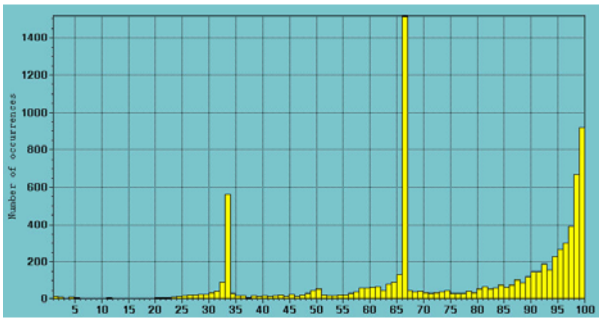
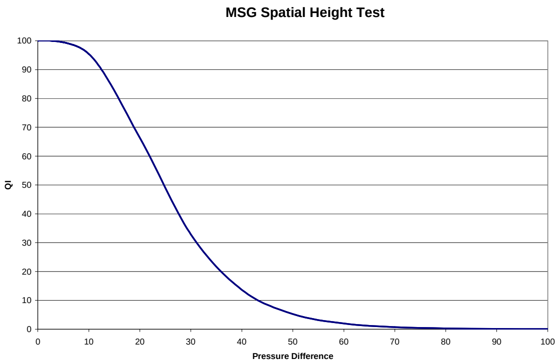


Figure 3. QI against pressure difference. **Figure 4. QI distribution, Channel 10.8, all levels.**

It's clear that the temporal height test is even more impacted by the "first component problem" mentioned above and an evaluation of this new test has therefore not yet been possible.

2.2.2. Spatial height test

This new test works the same way as the spatial vector test, but instead of the vector it compares the heights from the surrounding AMV's. See Figures 5 and 6.



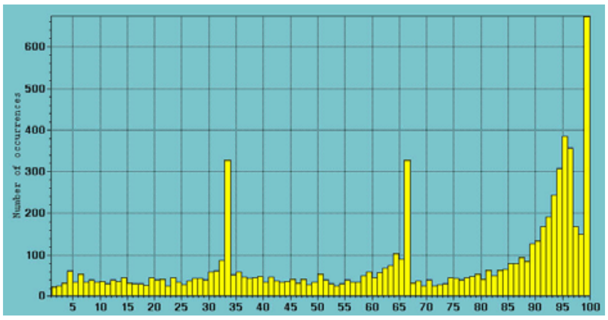


Figure 5. QI against height difference. **Figure 6. QI distribution, Channel 10.8, all levels.**

The test is tuned to return a value below 50% for a pressure difference above 25 hPa, and we can see that most AMV's get's a QI better than 90%. I.e. the spatial height consistency is in most cases very good.

2.2.3. Image correlation test

This test is based on the direct comparison of image data and using the 10.8 and 6.2 channels. It works on a 24 x 24 pixel area surrounding the AMV position, and calculates the correlation between the counts within that area. If the correlation is big (both images bright) it's assumed to be a high level AMV, if the correlation is small it's assumed to be a low level cloud. Values in-between are assumed to indicate uncertainty. To be able to handle the returned QI as all the other AQC tests, the AQC function is inversed for AMV's below 500 hPa, i.e. a high QI for this test should indicate a high cetainty for both high and low level clouds.

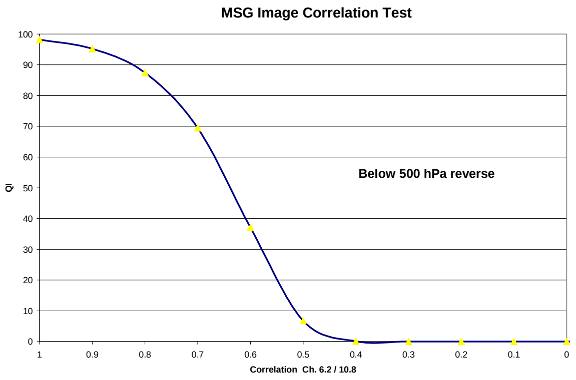


Figure 7. QI against pressure difference.

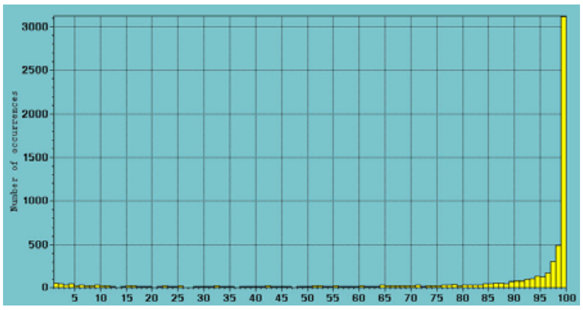


Figure 8. QI distribution, Channel 10.8, all levels.

From the QI distribution (Figure 8) it looks like we have a similar problem as for the temporal tests, high frequencies for values around 33% and 66% indicating that it's common that one or two of the components have a very low QI together with a very high QI for the other (s). The reason for this behaviour is under investigation.

2.2.4. Verification of new tests against radiosonde data

A very simple test, just adding the new tests with the same weight as the old tests, indicates that improvements are possible. For low level winds (Figure 9 below) the impact is obvious, the RMS error against radiosonde normalised with speed (red continuos curve) is 5-10% better for QI's above 50% than using old tests only.

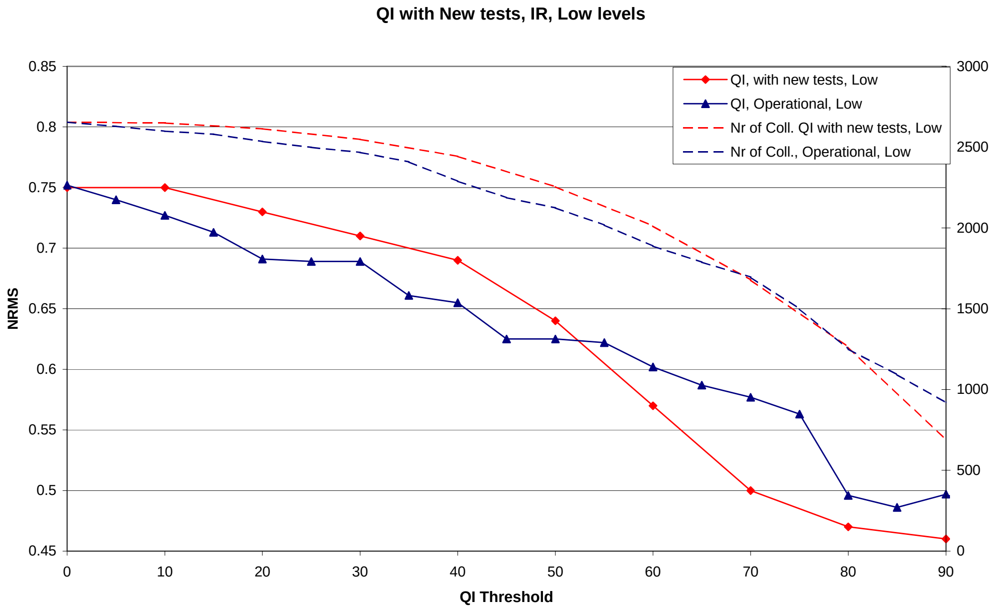


Figure 9.

3. HEIGHT ASSIGNMENT PROBLEMS IN MSG MPEF AMV PROCESSING

As mentioned above the Eumetsat AMV AQC has problems to evaluate AMV quality if the height assignment is consistently wrong for a whole area. Below are two examples on such situations.

3.1 The averaging problem

The MSG MPEF AMV processing works with several height assignments, and the present approach is to create the final height as an average of all available heights. This is not always the best method as shown in picture 10. The cloud top of the clouds seen in the underlying 10.8 image is obviously around 850 hPa, which is correctly assigned by the EBBT method (red). But the final height (top blue) is far higher than that, since the CO2 methods are included in the averaging. Another height assignment scheme without averaging is under development and will be tested in September 2004, and put into operation in November 2004.

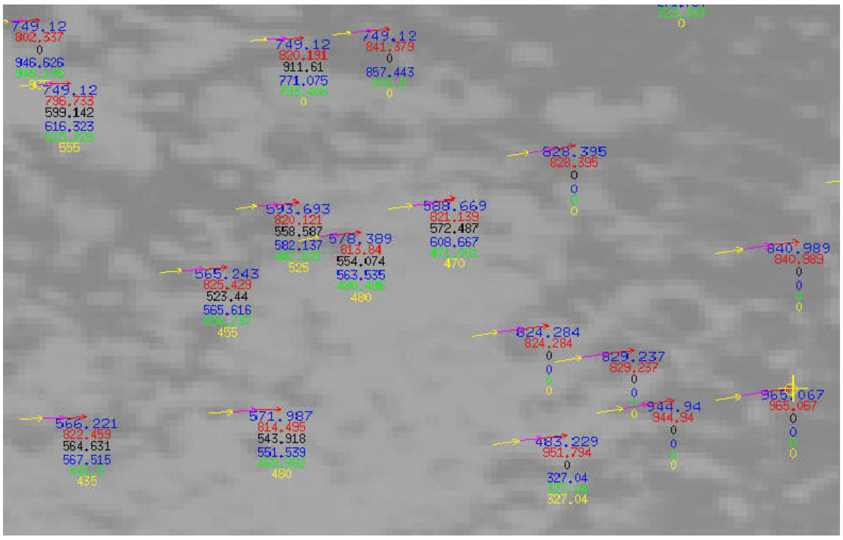
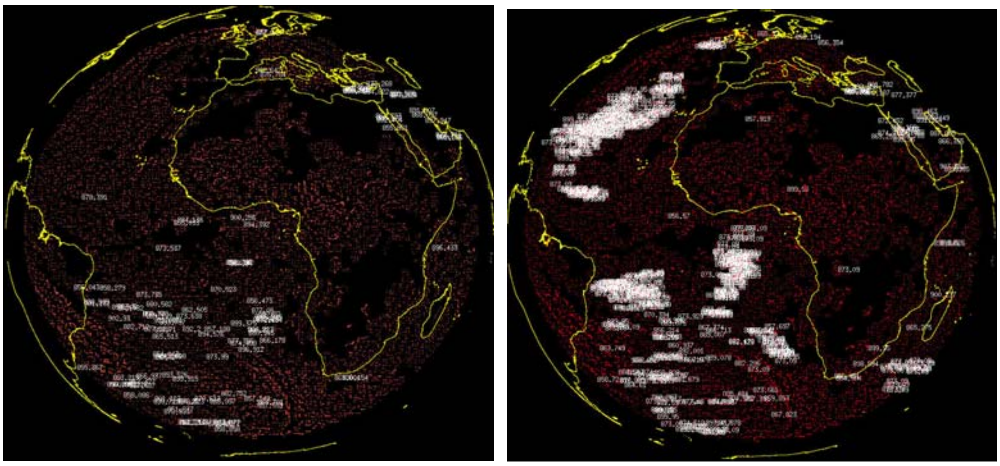


Figure 10.

3.2 The inversion height assignment

The inversion height assignment is described at the Eumetsat web site (www.eumetsat.de) and will not be further described in detail here. In short this scheme is reassigning all low-level clouds to the coldest level in the inversion, if an inversion has been identified in the forecast. Due to too few processing levels in the lower part of the troposphere very few inversions are identified in MSG MPEFand no height reassignment is applied. On test is another processing scheme with more levels, and it's expected that this will be put in operation in September 2004. The impact of this change is demonstrated below, the top picture shows clouds between 850 and 900 hPa (pressure with white figures) with the present system, the bottom picture the same product but now with the new processing scheme with more forecast levels. The difference is obvious.



Figures 11 and 12.

4. CONCLUSIONS AND FUTURE IMPROVEMENTS

During commissioning of MSG-1 the main objective of the product validation was to verify the existence of the algorithms and to ensure a stable environment. Bug fixing and further improvements of both systems and applications, especially cloud height assignment is now ongoing. The AMV Automatic Quality Control system is still under development in parallel with improvement in the product processing itself. Since the AQC is a tuned activity, a final implementation has to await the most impacting product changes, which are foreseen to be implemented during autumn 2004. The present plan is that an AMV product with a redesigned height assignment and a retuned AQC with several new tests should be operational before Christmas 2004.