MONITORING OF ATMOSPHERIC MOTION VECTORS AT ECMWF

G.A. van der Grijn and A. Garcia-Mendez

European Centre for Medium-Range Weather Forecasts, Shinfield Park, Reading RG2 9AX, U.K.

ABSTRACT

The status of operational use of AMVs at ECMWF is presented. In recent years, the operational use of satellite data, including AMVs, has increased considerably. Consequently, this has led to a growing importance of data monitoring. Examples of the tools used for data reception monitoring and quality control will be given, including a short overview of the AMV data monitoring plots that can be found on the recently extended ECMWF web pages. AMVs from METEOSAT-8 have been passively monitored shortly after it became operational in January 2004. Results will be shown.

1. INTRODUCTION

This paper will give an overview of the work done in data monitoring of atmospheric motion vectors (AMV) in the operations department at ECMWF. First a summary of AMV data that are actively assimilated at ECMWF will be given and a list of recent changes in the AMV data usage. The monitoring of satellite winds is done both in quasi real-time and a-posteriori mode. A description of these monitoring activities is given in section 3, including a short description of the recently extended satellite data monitoring pages on the ECMWF public web server. Finally, in section 4 some comments are made concerning the first results of the METEOSAT-8 monitoring.

2. AMV DATA USAGE

Below is an overview of important changes with respect to AMV usage at ECMWF since the 6th International Winds Workshop in May 2002.

- 11/12/02: Change to METEOSAT 80 km. water vapour winds. New thinning for high-resolution WV winds. (Dec. 2002)
- Introduction of MODIS winds (January 2003)
- Introduction of GOES-12 winds (October 2003)
- GOES BUFR winds introduced (January 2004)
- Passive monitoring of METEOSAT-8 winds (March 2004)

Figure 1a and 1b show the data coverage of all AMV data compared for the same day (20 May) in 2002 and 2004. In the past two years the amount of AMV data available for assimilation has risen by roughly a factor of 2. To a large extent this increase in data coverage can be ascribed to the increased resolution of METEOSAT winds, the presence of GOES-9 over the West-Pacific and the introduction of MODIS winds. Especially the latter have proved to be beneficial in the ECMWF model as they fill the large data sparse areas over the poles. (Bormann and Thépaut 2004)

The usage of data in a numerical weather prediction model is not only decided on the basis of its quality and availability but also on the basis of its expected benefit in the context of the existing global observing system and limited model resolution. As a result, the usage of AMV data at ECMWF is currently as summarized below.

- The platforms that are used are METEOSAT-5, METEOSAT-7, GOES-10, GOES-12 and TERRA
- From the geostationary platforms, infrared, visible and water vapour cloudy winds are used. Concerning the MODIS instrument on TERRA, infrared and both water vapour clear and water vapour cloudy winds are used.
- Geostationary AMV data are thinned in 200 km x 200 km boxes, for MODIS this is 140 km x 140 km.
- In addition to the background check, also an asymmetry check is performed on all AMVs to deal with the known slow bias in upper-level AMVs. This check gives a penalty to winds that under-report by more than 4 m/s compared to the background field (FG). The test gets increasingly tougher if the FG speed increases, up to 60 m/s when all AMVs under-reporting by more than 4m/s are rejected. The test is relaxed for low level winds and the tropics.
- AMV data over Europe and North-America is not used. Over other land areas, data is only used above the 500hPa level.

Contrary to Figure 1b, Figure 1c shows the data that was actually used by the assimilation to change the FG. A similar evaluation was done at the fourth International Winds Workshop in 1998 by Lalaurette *et al*.. It is interesting to note that despite the above restrictions, the number of used AMV data has also doubled over the last 6 years.

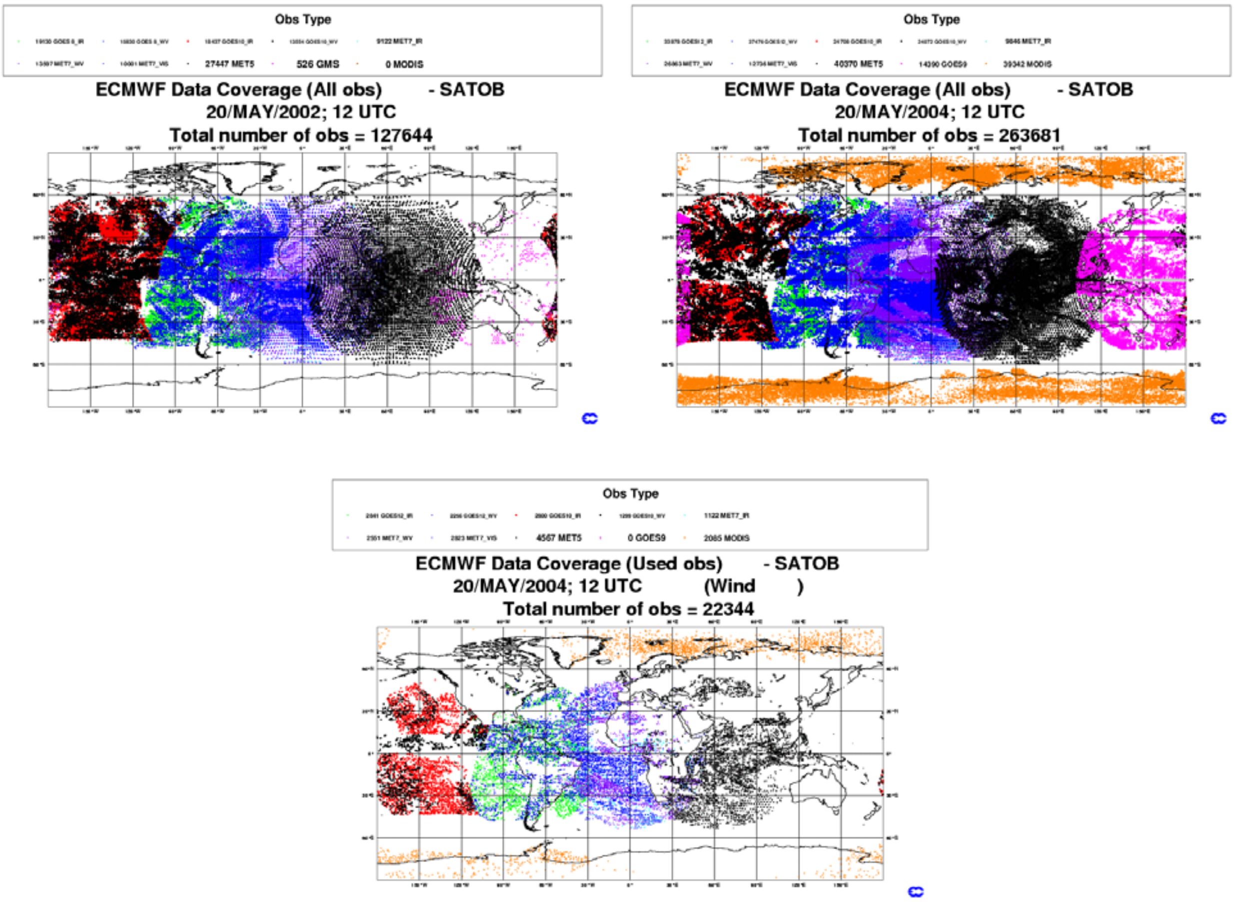

Figure 1: AMV data coverage map for all data on 20 May 2002 12UTC (top left, a), all data on 20 May 2004 12UTC (top right, b) and used data on 20 May 2004 12UTC (bottom, c).

3. MONITORING OF AMV AT ECMWF

The monitoring of AMV data at ECMWF is done on a daily (quasi real-time) and on a a-posteriori basis.

a) daily monitoring
The impact of the global observing system on the ECMWF forecast model is assessed daily. Maps as shown in Figure 1 point at problems in data availability. The forecast itself is closely monitored by comparison to previous or other NWP centres forecasts. Inconsistent and/or bad forecasts may be a result of large analysis

increments, i.e. differences between the analysis (AN) and the FG. If that is the case, an in-depth investigation is done by the analyst on duty to assess whether these large increments are due to bad data or a bad FG in that area. Figure 2 shows a case of large wind increments associated to an upper-level trough over the North-Pacific. The increments are a result of stronger wind speeds in the analysis than in the FG on the right-hand side of the trough. It can be seen in Figure 3 that in this area both AIRCRAFT and AMV are reporting higher wind speeds than the FG suggesting that the increments in this particular case were probably caused by model error rather than bad observations.

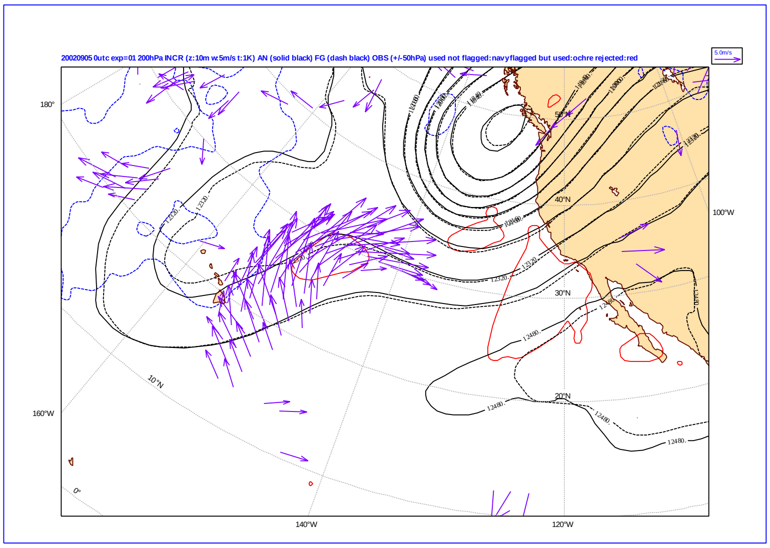

Figure 2: Analysis increment map for 200 hPa from 5 September 2002 at 00 UTC; Solid black is the analysis of 200 hPa geopotential height; Dashed black is the background (FG) field; Red and blue contours show the positive and negative difference between the analysis and FG (increments) in terms of geopotential; Purple arrows show the wind increments.

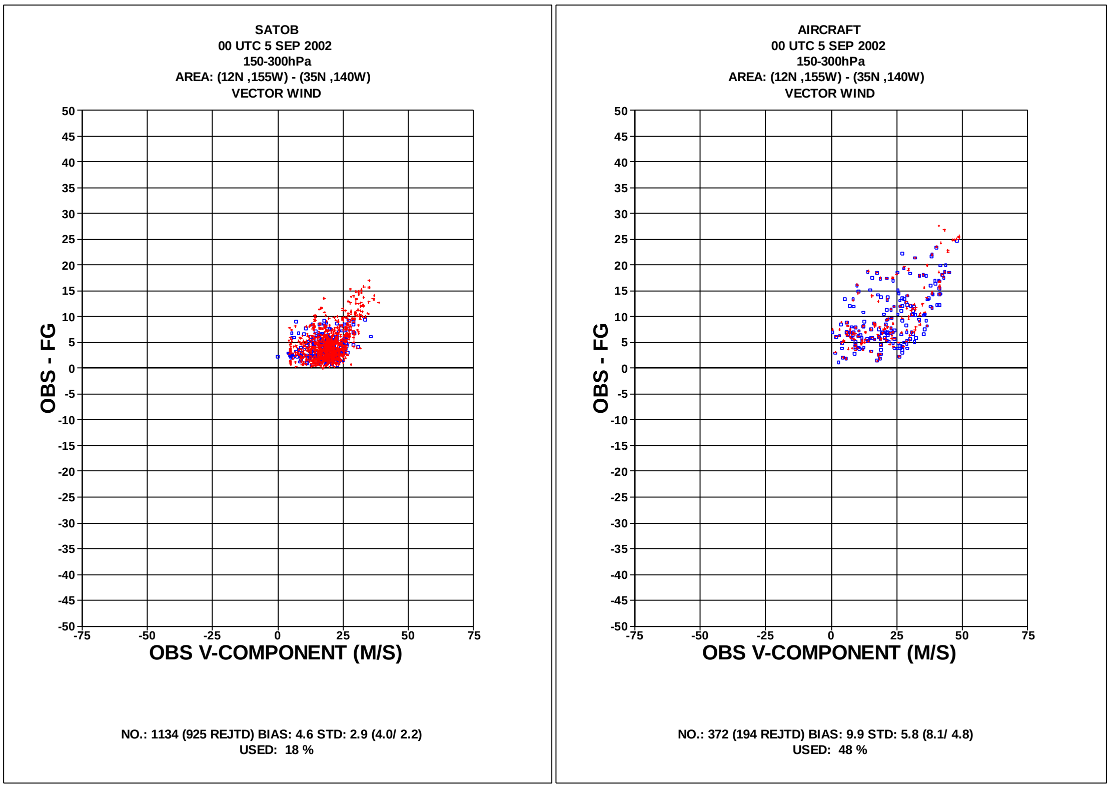

Figure 3: Scatter plot of FG departures against observed meridional wind in an area with large wind increments (see Figure 2) for AMV data (left) and AIRCRAFT (right). Red dots are for rejected data.

b) a-posteriori monitoring

In addition to the case-study type of monitoring that is described above, a more objective monitoring of AMV data is done on a monthly basis by comparison with short-range model forecasts. This type of monitoring gives a better understanding of observation biases or systematic model errors. Figure 4 shows monthly density plots of observed AMV from GOES-12 against FG. In general, the AMV data is in good agreement with the FG. However, a clear shift in the distribution can be seen for wind speeds larger than 60 m/s. This signature seems to be associated to the post-processing of GOES winds and does not appear in METEOSAT where no bias correction is applied.

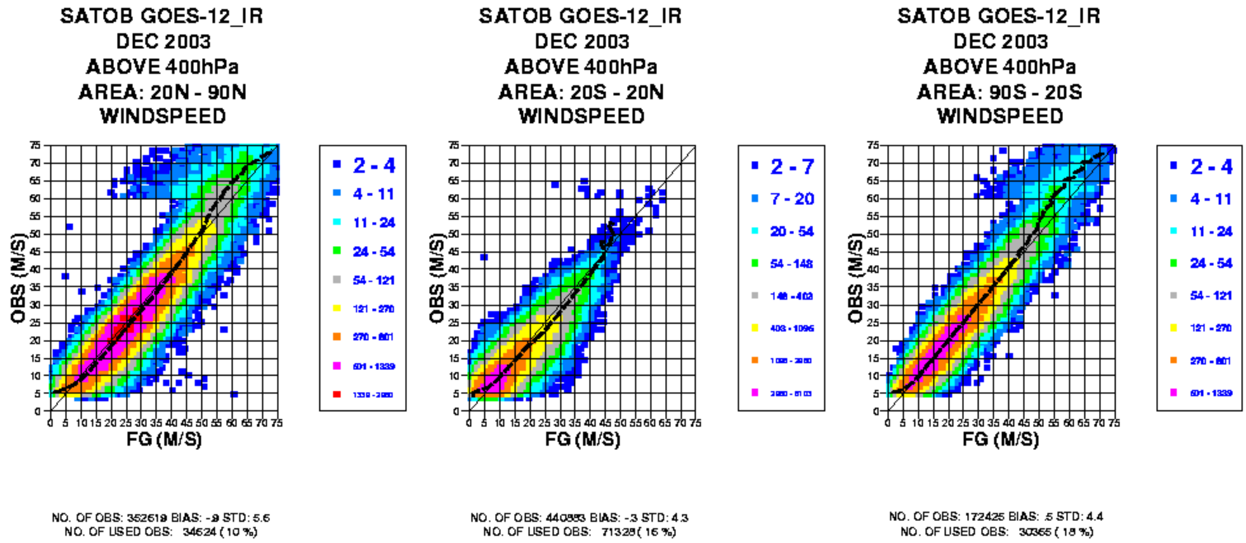

Figure 4: Density plots of observed AMV data from GOES-12 above 400 hPa against ECMWF model FG for northern hemisphere, tropics and southern hemisphere.

Statistics as plotted in Figure 4 compare observations with model data. However, neither the model nor the observations are without error and therefore both contribute to the analysis error. An attempt to gain more insight in the two contributions is done with the joint UKMO-ECMWF participation in NWP-SAF where these type of statistics can be compared for the UKMO and ECMWF model (see the Forsythe contribution in the same volume).

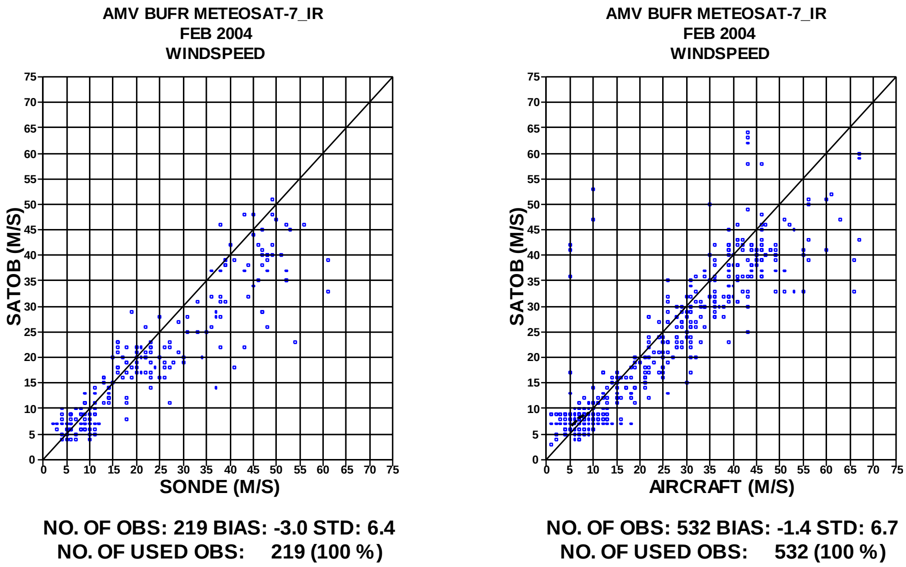

Figure 5: Scatter diagrams of satellite winds against collocated radiosonde (left) and aircraft observations (right).

The effect of model dependency is gone if one gathers statistics of AMV data collocated with other sources of observation. Such diagrams are shown in Figure 5. A clear under-estimation of the satellite derived winds can be seen, especially at higher wind speeds.

c) new monitoring products on the web

Since February 2004, new satellite data monitoring products have been put on the ECMWF public web server at the following address:

http://www.ecmwf.int/products/forecasts/d/charts/monitoring/satellite

In addition to data monitoring plots for AMV data that are actively assimilated, these pages also feature statistics for AMV data that are passively monitored. Figure 6 shows a screen shot of monitoring products available for METEOSAT-8. Apart from geographical plots of monthly means there are also time series of area averages and hovmoeller plots with zonal mean fields. The time series and hovmoeller plots are daily updated while the geographical plots are updated once a week.

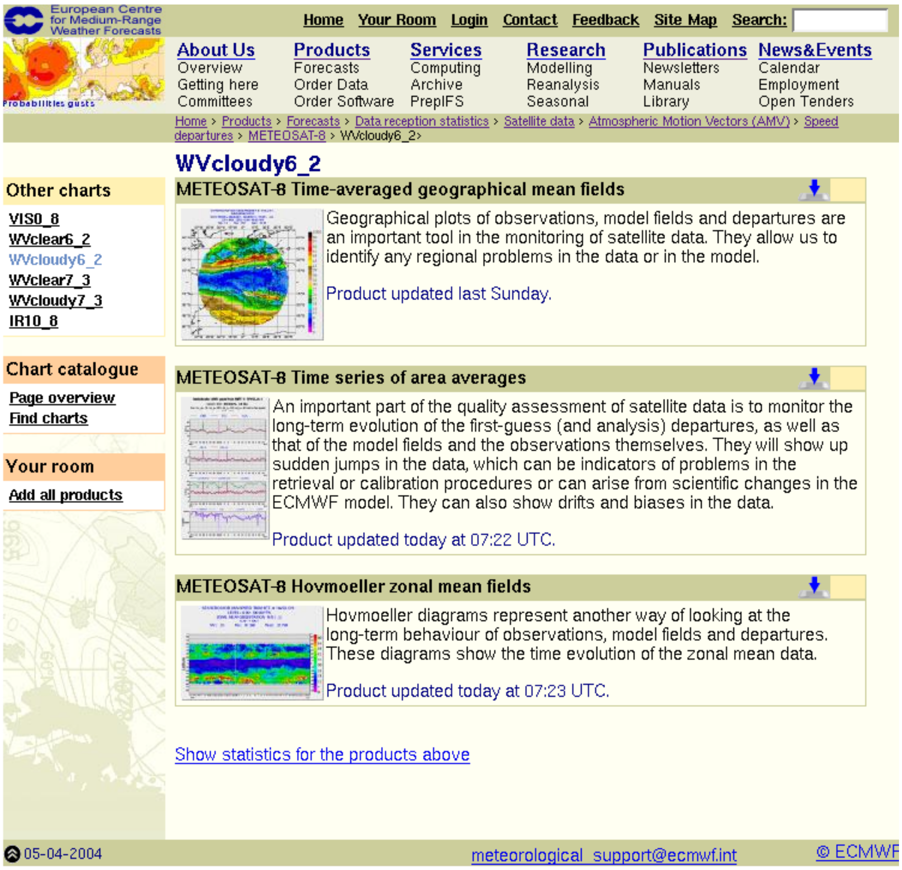

Figure 6: Screenshot of AMV data monitoring plots from METEOSAT-8 as available on the ECWMF public web pages.

4. PASSIVE MONITORING OF METEOSAT-8

Shortly after METEOSAT-8 went operational the data has been passively monitored at ECMWF. Figure 7 compares time series of wind speed departures from the ECMWF model for infrared winds from METEOSAT-7 and METEOSAT-8. The sample contains only data with a EUMETSAT quality index (QI) larger than 65. It can be seen the departures for both satellites are very similar. However, there is a slight indication that the satellite winds in the middle and lower levels are slightly stronger for METEOSAT-8 than for its predecessor.

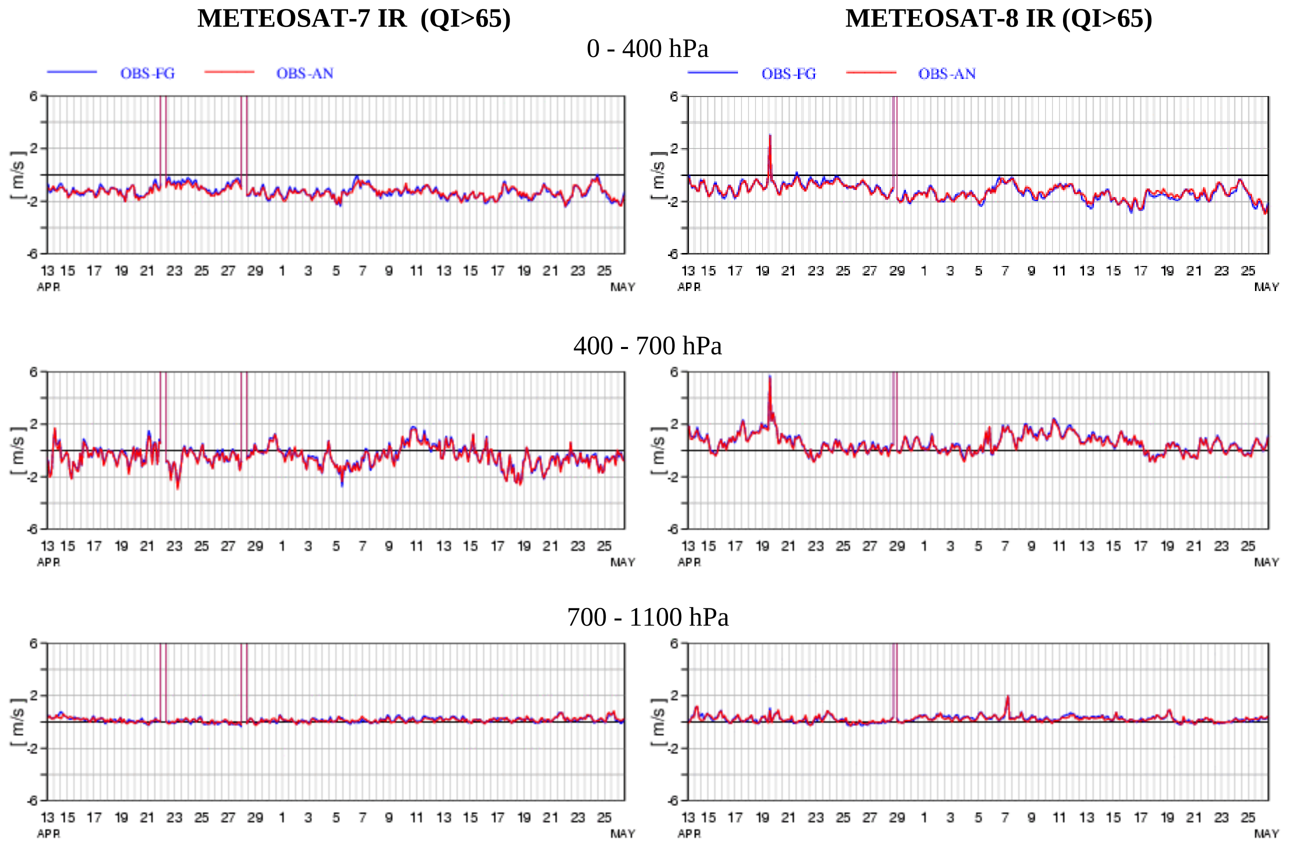

Figure 7: Time series of area averaged wind speed departures for three levels for METEOSAT-7 and METEOSAT-8. FG departues are in blue, AN departures are in red.

5. REFERENCES

Bormann, N. and J.-N. Thépaut (2004) Impact of MODIS Polar Winds in ECMWF's 4DVAR Data Assimilation System, *Monthly Weather Review*, **132**, 929-940.

Lalaurette, F., A. Garcia-Mendez and M. Rohn (1998) Monitoring of AMV at ECMWF. *Proc. 4th Int. Winds Workshop*, Saanenmöser, Switzerland, October 1998.