Recent OSEs with Atmospheric Motion Vector wind data in the DMI-HIRLAM 3D-Var data analysis system

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Abstract

Meteosat-8 AMV[1] data became operational in the DMI-HIRLAM system in late May 2005, after tests with the old operational DMI-HIRLAM system and pre-operational testing. Here results of OSEs[2] with the present system are presented. The OSEs include tests with usage of Meteosat-8 AMV over land and a test with GOES-12 AMV data. The impact is essentially neutral, but the comparisons of the data with the forecast model first guess fields show similar 'performance' as for similar comparisons of radiosonde winds.

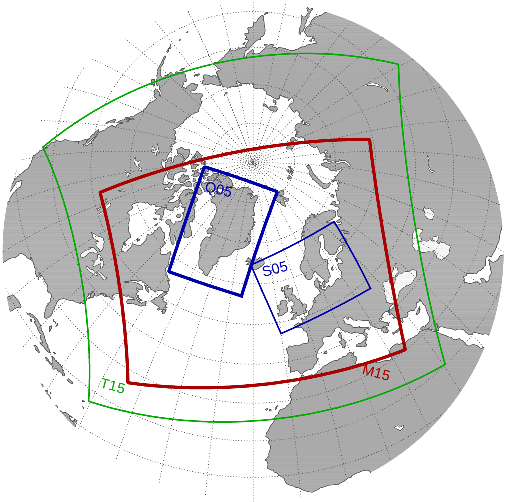
Introduction

For many years impact studies of SATOB data in the Optimum Interpolation analysis system in the operational DMI-HIRLAM analysis and forecasting system gave unacceptable negative impacts (unpublished results). At some point it was therefore decided to wait for the launch of the first Meteosat Second Generation (now named Meteosat-8) satellite. Then, in 2004 new impact studies were done with the operational at the time DMI-HIRLAM system giving some positive results (Guerrero and Amstrup, 2005). Based on these results and inclusion in a pre-operational set-up, use of Meteosat-8 AMV data (except for data over land north of 30°N) became operational May 31, 2005. However, still many things were not investigated, such as: What are the proper limits for the QI (quality indicator) supplied with the data for acceptance into the analysis system, should there be additional thinning of the data, and should some kind of bias correction be applied? Here, some results are given for a limited set of OSEs.

Set-up of the experiments

In this study a local version of the HIRLAM reference data analysis and forecasting system (Undén et al., 2003; Yang et al., 2005) has been used. The analysis system is a 3D-Var analysis, based on version 6.3.6 and using RTTOV8[3] as the radiative transfer model to calculate model derived brightness temperatures (Matricardi et al., 2004; Amstrup, 2005). The FGAT[4] option

[1] Atmospheric Motion Vectors
[2] Observing System Experiments
[3] Radiative Transfer model for TOVS, release 8; provided via EUMETSATs NWP SAF
[4] First-Guess at the Appropriate Time



Model Identification	M15	T15
grid points (mlon)	390	610
grid points (mlat)	448	568
No. of vertical levels	40	40
horizontal resolution	0.15°	0.15°

UTC	M15
1:37	M00+48 h
ECMWF 00 UTC	
7:00	M_E00+09 h
7:37	M06+48 h
ECMWF 06 UTC	
11:45	M_E06+09 h
13:37	M12+48 h
ECMWF 12 UTC	
19:00	M_E12+09 h
19:37	M18+48 h
ECMWF 18 UTC	
23:55	M_E18+09 h

Figure 1: Operational model areas (T15, G05, S05) and the reduced area (M15) for test runs (upper left). The schedule used for the OSEs is given on the right hand side. The number of grid points in the M15 and T15 model areas is given in the table below the figure.

is used. Figure 1 shows the operational model areas (T15, S05 and G05), as well as a medium-sized model area (M15) that is used to do experiments instead of the larger T15 model area. It is computationally too expensive to run extensive experiments using the T15 model area on the DMI NEC SX-6 super computer. The schedule is also given in Figure 1. The four rows with ECMWF denotes the arrival times of the lateral boundaries that are supplied by ECMWF[5]. The observational data used here are archived data corresponding to these cutoff times (except for GOES-12 which are used as if they were available). The run scheduled for 07 UTC is denoted M_E00+09 h and should be understood in the following way: the M15 model is restarted via blending (see Yang (2005) for further details) from the ECMWF analysis valid at 00 UTC, together with a new analysis that is done using data available at 07 UTC for the 00 UTC analysis, and a 9 h forecast is run to produce an 'up-to-date' status of the atmosphere to be used for the subsequent analysis.

Results from five runs are shown here: 1) M1C, the control using only conventional data; 2) M1D, additional Meteosat-8 AMV data with limits on the QI smaller than the data distributed by EUMETSAT in January 2006 and no data over land north of 30°N; 3) M1E, as M1D but with limits on QI of 60 %; 4) M1F, as M1E but usage of data over land for pressures less than 600 hPa; and 5) M1G, as M1C with additional GOES-12 AMV data with QI higher than 60. No thinning of AMV data is done in any of the experiments. The period used here is a one month period starting 00 UTC December 31, 2005 and ending with a long forecast 12 UTC January 28, 2006. Figure 2 shows the number of used AMV data in the four experiments using AMV data. It can be seen that Meteosat-8 data are missing in the period 10-13 January and GOES-12 data (extracted from the ECMWF mars archive) is missing for one day. Also, the number of data used in the M1E run are somewhat smaller than the number of data used in the M1D run.

[5]European Centre for Medium-Range Weather Forecasts

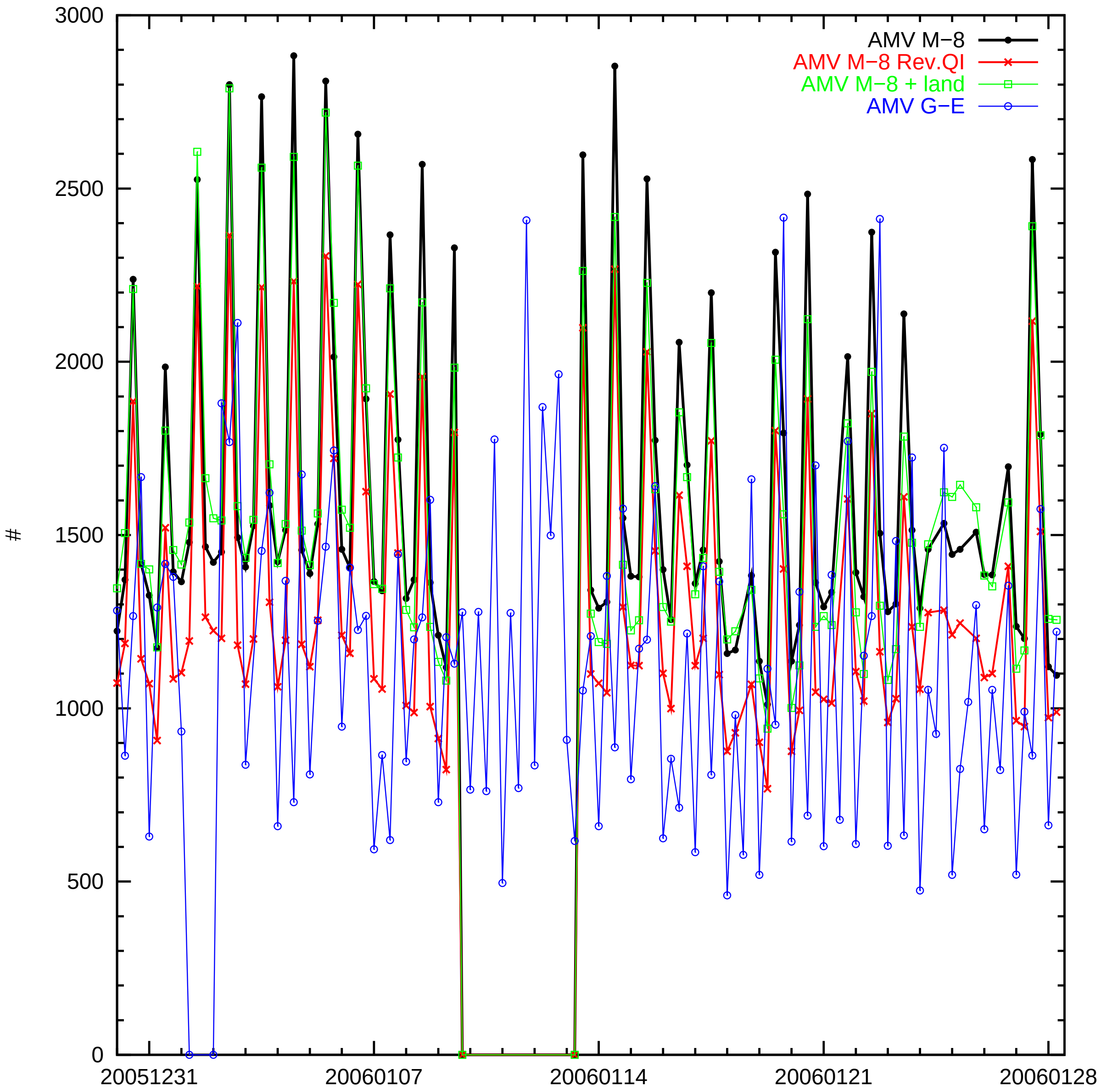


Figure 2: Number of AMV data used in the cycles for the different experiments: M1D (black), M1E (red), M1F (green) and M1G (blue). (Meteosat-8 data used in M1D/M1E/M1F and GOES-12 data used in M1G).

Results and conclusions

The results from the OSEs are given in terms of standard observation verification, where forecast results are compared to standard SYNOP and radiosonde observations using an EWGLAM[6] station list and a Danish station list. Figure 3 shows bias and root mean square (rms) errors for the surface variables 10 m wind, mslp (mean sea level pressure) and 2 m temperature; for the upper level variables temperature, wind speed and geopotential height at 850 hPa, 500 hPa and 250 hPa as function of forecast length for the 3 experiments using Meteosat-8 AMV data and the control run using only conventional data. For most parameters the impact on the obs. verification scores from adding AMV data are neutral or very marginal positive. For a few parameters, such as the 500 hPa temperature and 250 hPa wind, there is a small positive impact on the rms scores by adding AMV data to the system. There is also a positive impact on the

[6] European Working Group on Limited Area Model

mslp scores when using only Danish stations in the verification. The difference between scores for the M1D and M1E experiments are negligible, and it does not seem to be important to have a higher limit of the QI indicators for screening the data. The same is the case when adding Meteosat-8 data over land. The impact (not shown) from adding GOES-12 AMV data is also neutral.

Figures 4-6 show the statistics of the AMV data when comparing with the first guess fields or the analysis fields. When applying observational data in an analysis system such as 3D-Var it is implicitly assumed that the observations are bias free and that the observation errors have a Gaussian distribution. Bearing in mind that the first guess fields also have errors, it can be seen from Figure 4 that the assumption on a Gaussian error distribution seems reasonable for both Meteosat-8 and GOES-12. Radiosonde and aircraft wind data have similar distributions. However from Figure 5 it is seen that the assumption on bias free observations is not completely fulfilled. Accordingly, some tests with bias corrections may be useful.

Considerable more data would be used in the operational T15 area, since it extends both southwards and westwards compared to the M15 area. Furthermore, some of the data would also be further away from the boundary zone and the impact may therefore be larger for the T15 model. Additional tests should therefore be made with this model area.

It should also be noted that recent OSEs with the DMI-HIRLAM system (Amstrup, 2006) have shown that the impact from radiosonde wind data is somewhat smaller than the impact from radiosonde wind **and** temperature data. Therefore, a combination of AMV data and atmospheric temperature sounding data may benefit the impact from AMV data.

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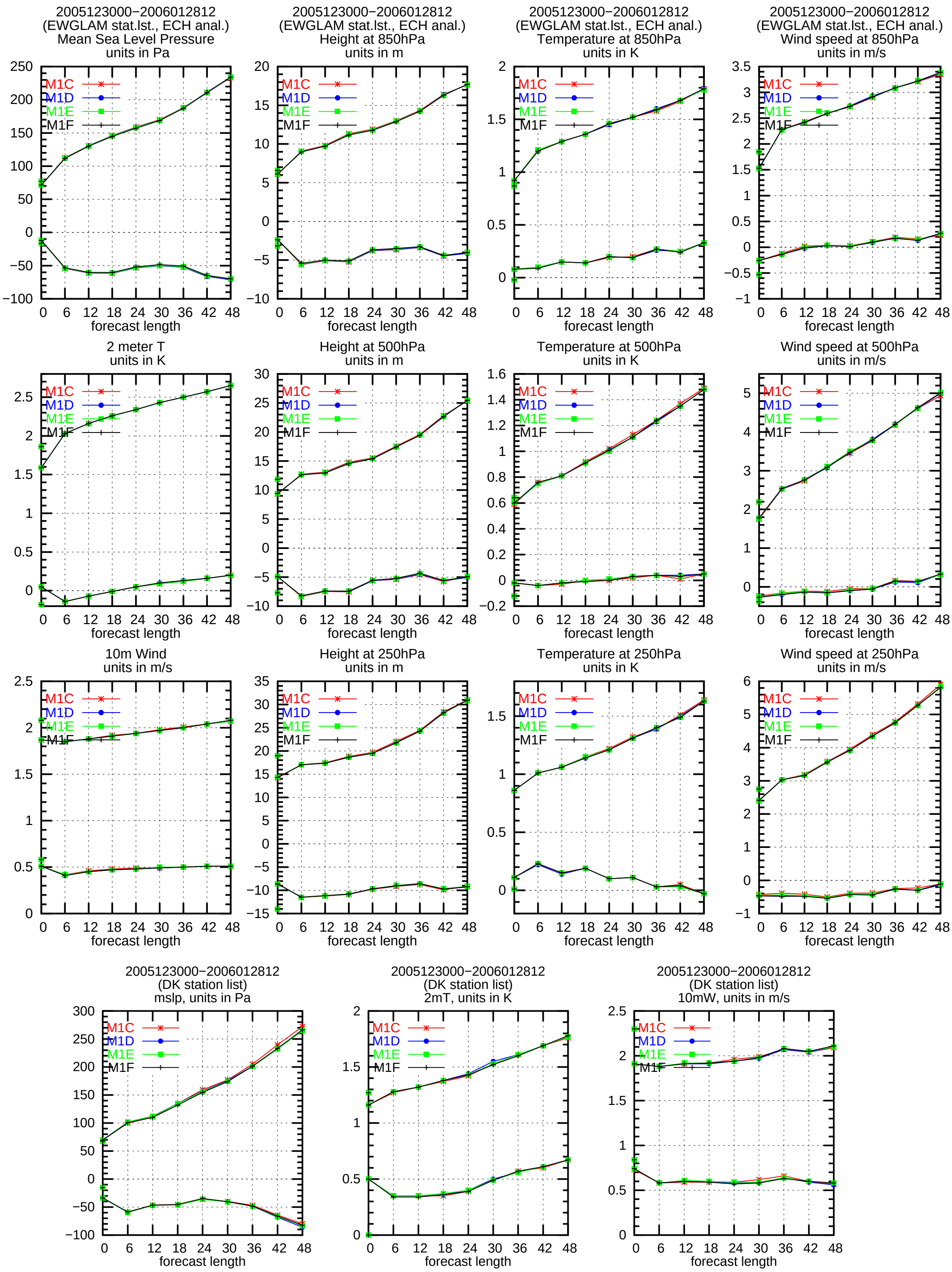

Figure 3: Observation verification against EWGLAM stations (upper 3 rows) and Danish (DK) stations (lower row) for parameters specified in the plot.

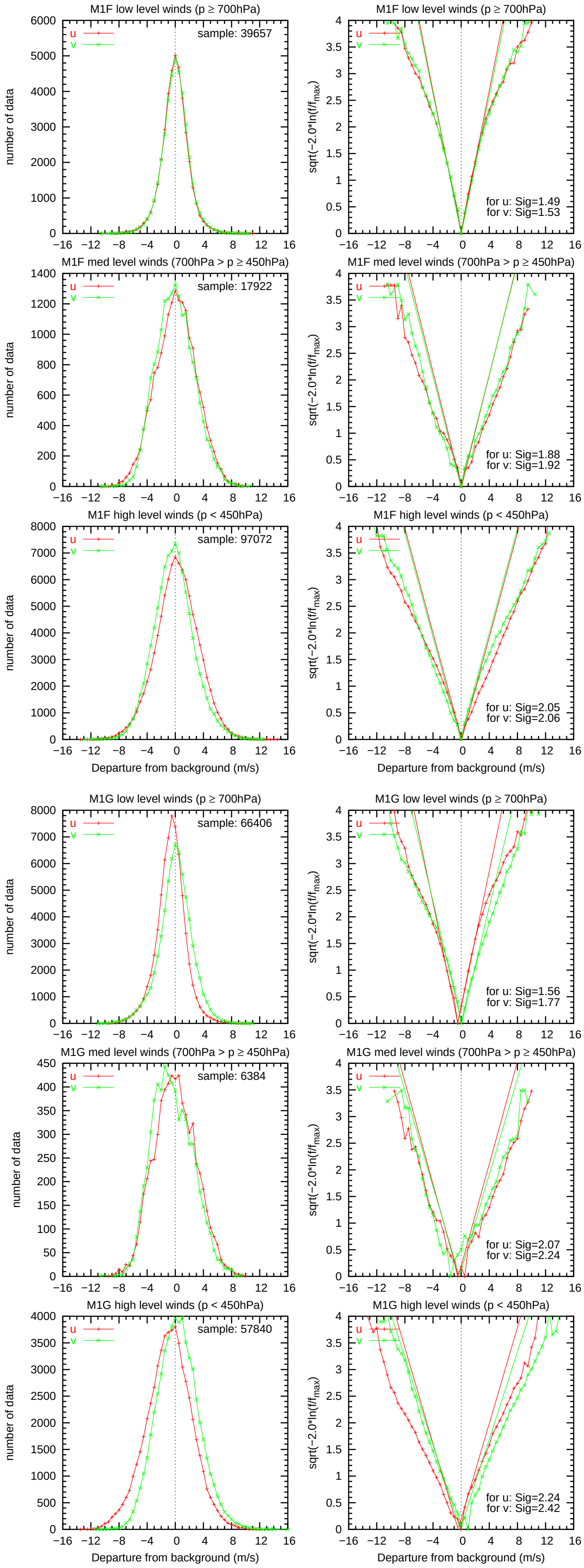

Figure 4: Statistics of Meteosat-8 AMV versus first guess fields for for the run with higher limits on QI and usage of data over land (M1F, upper) and for the run with GOES-12 AMV data (M1G, lower). The transformation $-2\ln(f/f_{\max})$ make a Gaussian distribution linear on each side of 0.

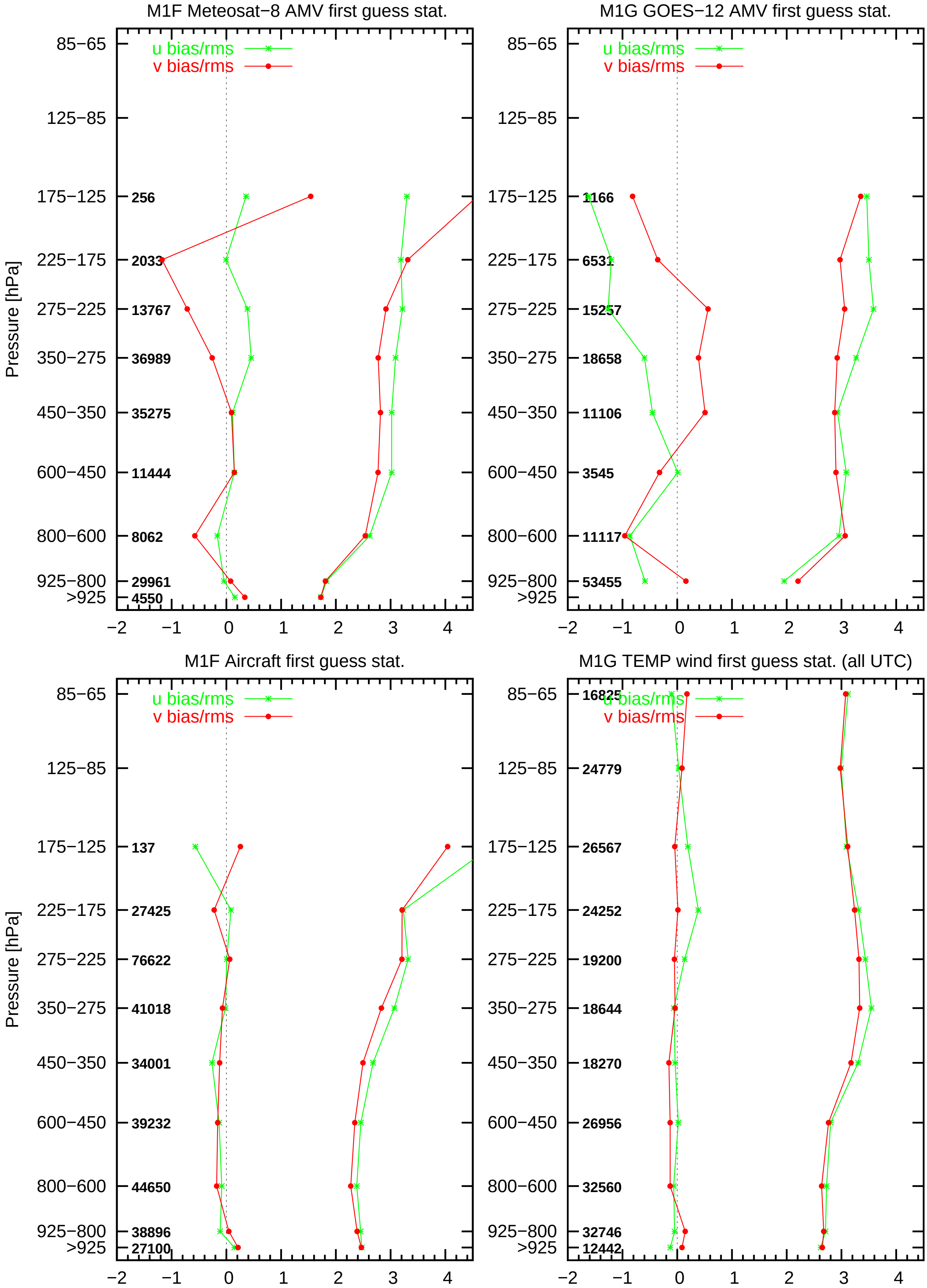

Figure 5: Statistics of used wind observations against model first guess fields. Upper left is for Meteosat-8 AMV data (M1F run including data over land), upper right is for GOES-12 AMV data, lower left is for aircraft data, and lower right is for radiosonde data.

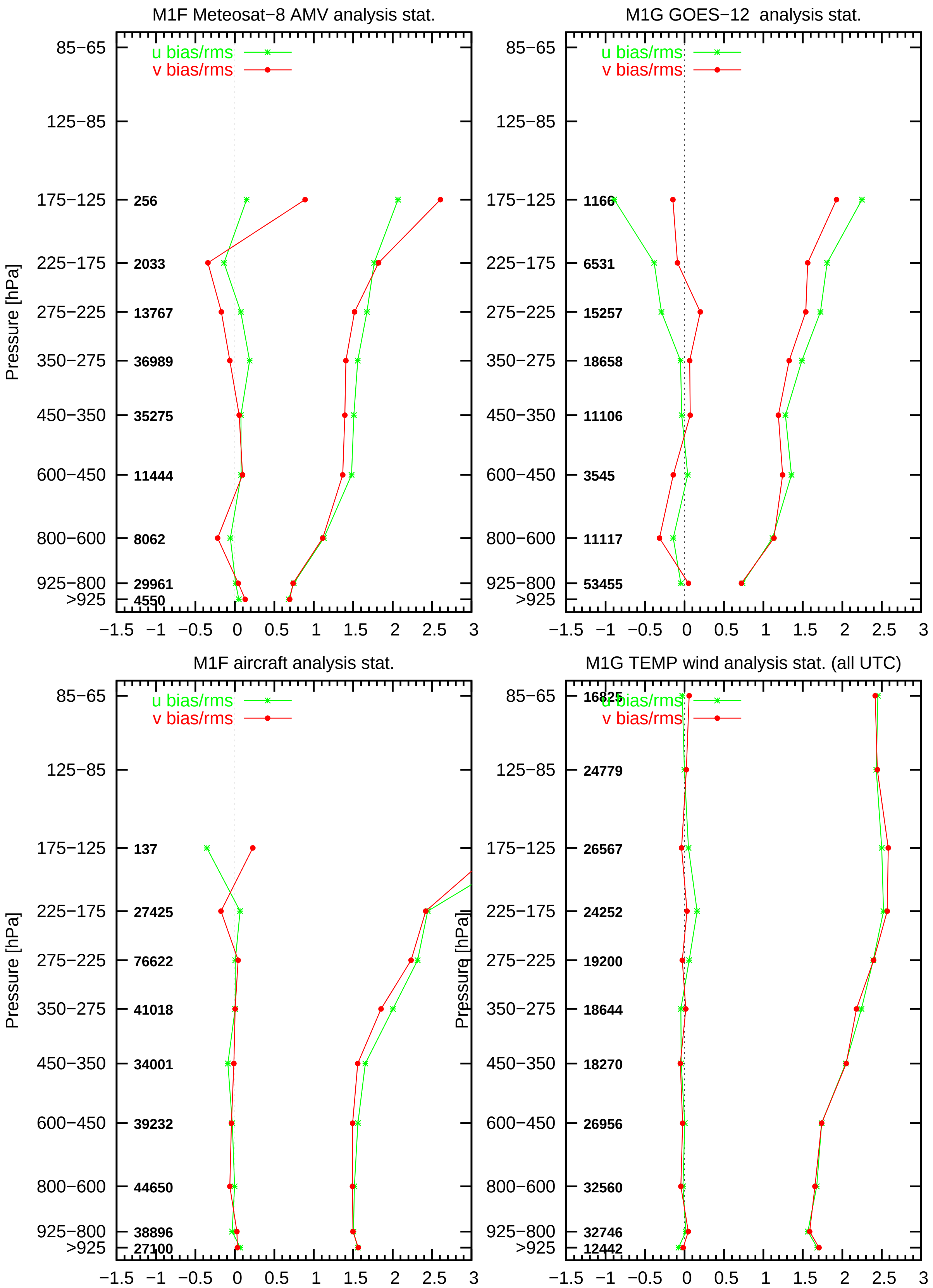

Figure 6: Statistics of used wind observations against model analyses fields. Upper left is for Meteosat-8 AMV data (M1F run including data over land), upper right is for GOES-12 AMV data, lower left is for aircraft data, and lower right is for radiosonde data.