MONITORING OF CLOUD-MOTION WIND DATA IN NUMERICAL WEATHER PREDICTION

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ABSTRACT

Up-to-date evaluation of the quality of the cloud-motion wind data received from the five geostationary satellites currently in operation is presented. The evaluation is based on statistics of the departures between the reported wind and the wind predicted by the ECMWF six-hour forecasts (background fields).

The evaluation focuses on the performance of the various new data streams implemented over the recent period.

1. INTRODUCTION

Cloud Motion Wind data (CMW) are a well established component of the Global Observing System providing substantial input to data assimilation for NWP, especially over tropical and oceanic regions where few conventional observations are available. Water vapour data (WVMW) providing a significant additional coverage are also becoming available. This paper presents an up-to-date evaluation of the quality of these data received over the GTS, with special attention given to the new data streams implemented over the past year: new GOES and GMS satellites, new ground segment for the METEOSAT satellite.

The evaluation deals with availability of data first, to assess the geographical coverage of the information provided. Then a quality assessment is presented, based on systematic comparisons between the observed values and the values predicted by the ECMWF 6 hour forecast (first-guess field - detailed information on this technique can be found in Hollingsworth et al., 1986). The quality of the first-guess fields is generally high enough to ensure that a systematic deviation between the observed and the predicted data reflects a problem with the data. However, it has to be taken into account that the quality of the first-guess depends on the density and quality of data available to the preceding analyses, which can be critical in the tropics, Indian ocean, and mid-latitudes in the southern hemisphere. It also depends on possible systematic errors in the forecast model (particularly true in the tropics).

Similar evaluations were presented at the first two Wind workshops (Strauss, 1991 and 1993).

2. DATA AVAILABILITY

The rate of availability of the CMW and WVMW can be measured in different ways. Here we choose to monitor two quantities: the total number of observations produced, and the overall

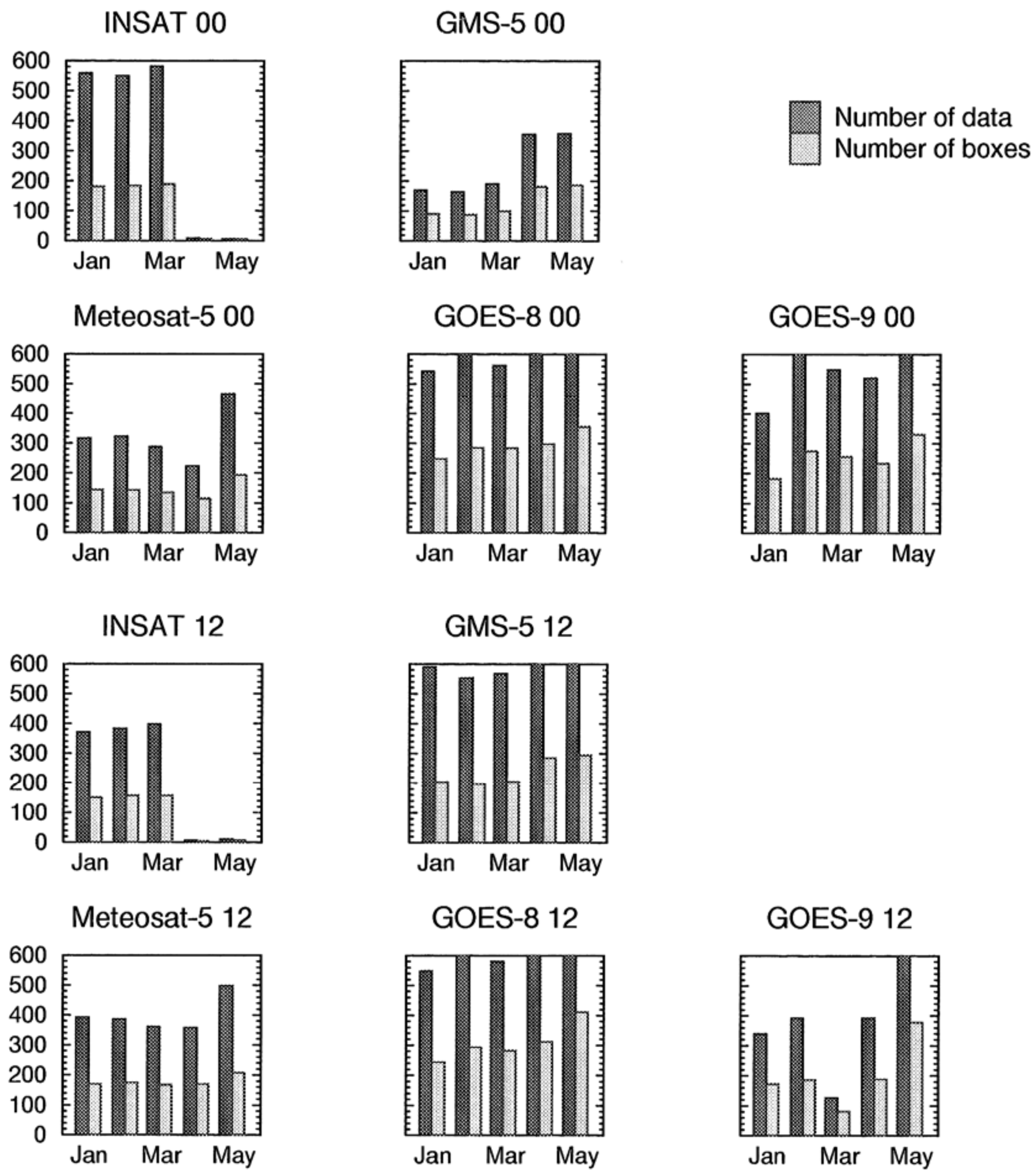

Figure 1 : Availability of data from the five operational satellites in 1996, for 00 and 12 UTC separately. The bars indicate the mean number of data (resp. grid boxes) produced per analysis time, for all levels and all channels.

number of boxes containing at least one observation. The size of the boxes is 5°x5°, for three layers separately. The boxes are counted between 50N and 50S, so the maximum number of boxes possible is 400 for one layer, or 1200 over the three layers corresponding to low, medium and high levels. The box count gives a useful indication of the geographical extent of the coverage, which is relevant for global NWP.

For each of these quantities, we compute the average over all the analysis times for which data were actually received, so that the results show the number of data or boxes normally produced for a typical analysis. This avoids an artificial reduction of the statistics because of missing data due to occasional production or telecommunication problems. The frequency of occurrence of such problems is also relevant and should be monitored, but in this paper we concentrate on the performance of the systems when they operate as expected.

Figure 1 shows the overall results at 00 and 12 UTC, for the months January to May 1996, with the five satellites currently in operations: Meteosat-5 (data from EUMETSAT/MPEF), Goes-8 and 9, GMS-5 and INSAT-2. Similar results are shown in figure 2 for February to May 1995, with Meteosat-5 (data processed by ESOC/MIEC), GOES-7 and GMS-4. The reception of INSAT data practi-

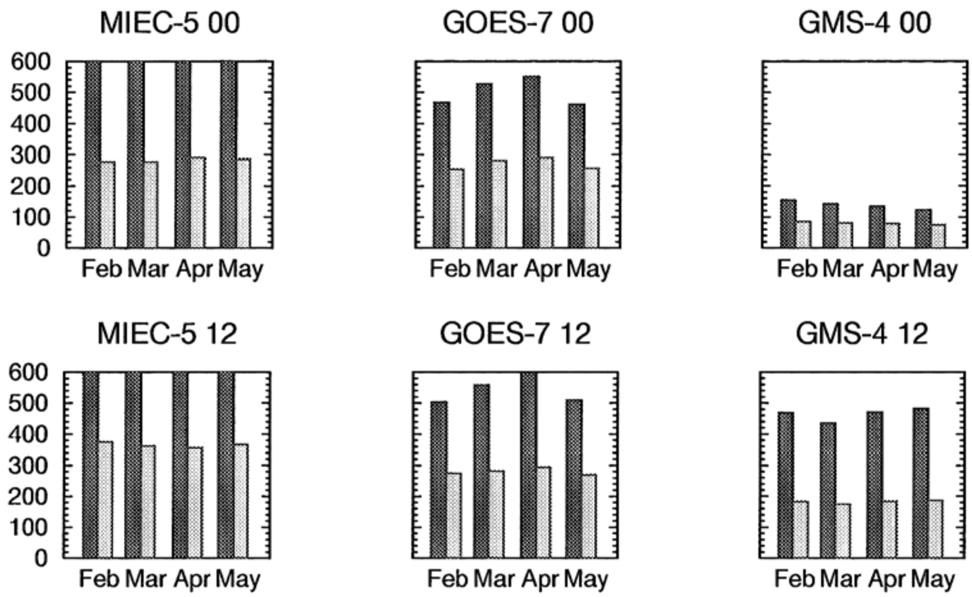

Figure 2 : same as figure 1 for February-May 1995 (MIEC-5: Meteosat data processed by ESA/MIEC)

cally stopped at the end of March 1996. Only very few observations have been received since then, mainly at 500 hPa in the northern hemisphere. For the GOES and GMS satellites, the increase over the period is due to the new dissemination of water vapour data, in April for GMS, in May for the two GOES. These data provide a significant additional coverage, both in terms of number of data and of area. The Meteosat coverage also increased at the end of the period, due to the change in quality control implemented at the end of April.

A straight comparison of the data volumes produced by the various systems is difficult because of the differences in local times and in proportion of land areas. However, it can be seen that Meteosat (and INSAT until the end of March) provide significantly less data than the other systems. The Meteosat coverage did improve at the end of April, but is still relatively low.

The comparison with the same period in 1995 shows that the new processing of Meteosat data is not as efficient as the previous one, while both GMS-5 and GOES-8 and 9 have improved over the previous GMS-4 and GOES-7.

Details of the distribution of Meteosat data are shown in figure 3 for the Tropics. A reduction in

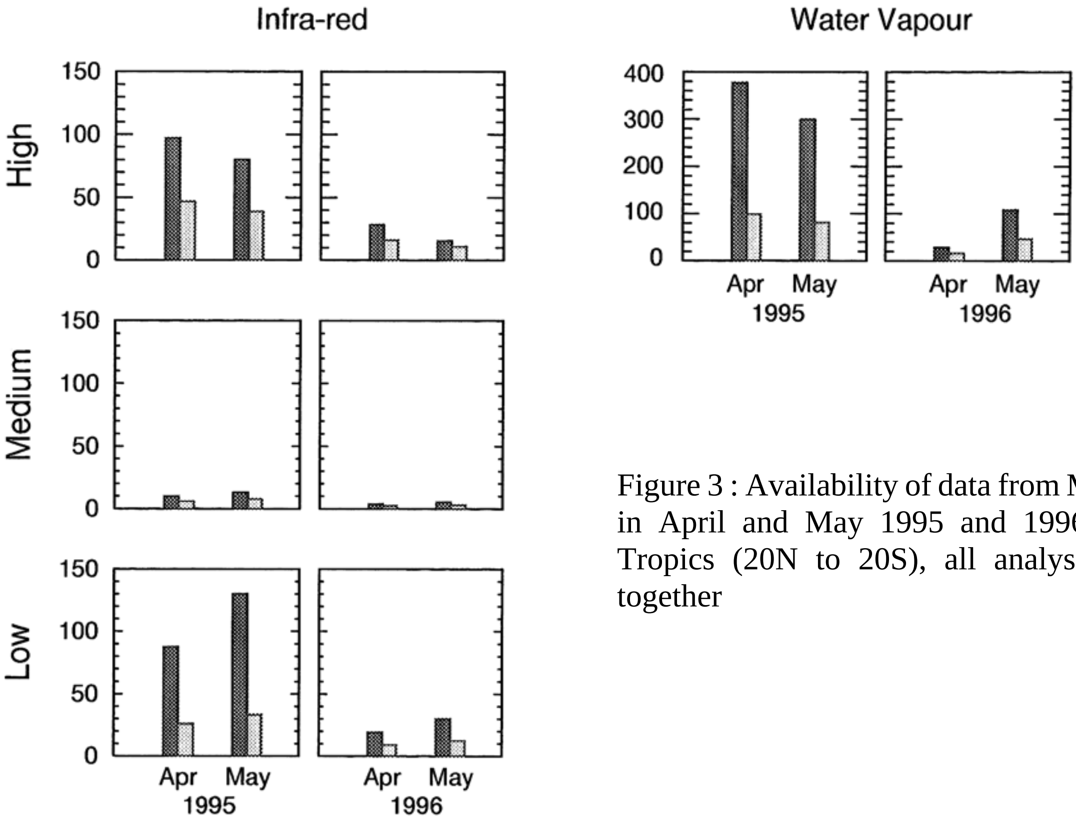

Figure 3 : Availability of data from Meteosat in April and May 1995 and 1996 in the Tropics (20N to 20S), all analysis times together

coverage from 1995 to 1996 is clearly seen, even after the change of quality control at the end of April 1996.

3. DATA QUALITY

Comprehensive statistics on the quality of CMW and WVWM are published every quarter in the ECMWF SATOB Data Monitoring Report. They include comparisons with the ECMWF first--guess fields and with all available conventional observations: TEMP and PILO data, aircraft data. The conventional observations are selected depending on the results of various quality checks: a priori quality control, and analysis checks performed within the data assimilation. These statistics show that the overall quality of the SATOB data has significantly improved since the early 1990’s.

The main characteristics of the CMW data compared to conventional in-situ measurements is still the tendency to underestimate the wind speed in high speed areas. Figure 4 shows the distribution of wind speed departures from first-guess for the observations where the mean speed is between 30 and 40 m/s, above 400 hPa. The differences between the departure distributions for the infra-red data from Meteosat, GOES and GMS are typical of what has been observed over the past few years. The speed bias of the water vapour data is generally smaller than the bias of the infra-red data.

Another critical issue for the use of the data in NWP is the quality control. While too tight rejection criteria may lead to the loss of useful information, an excessive number of outliers can damage the

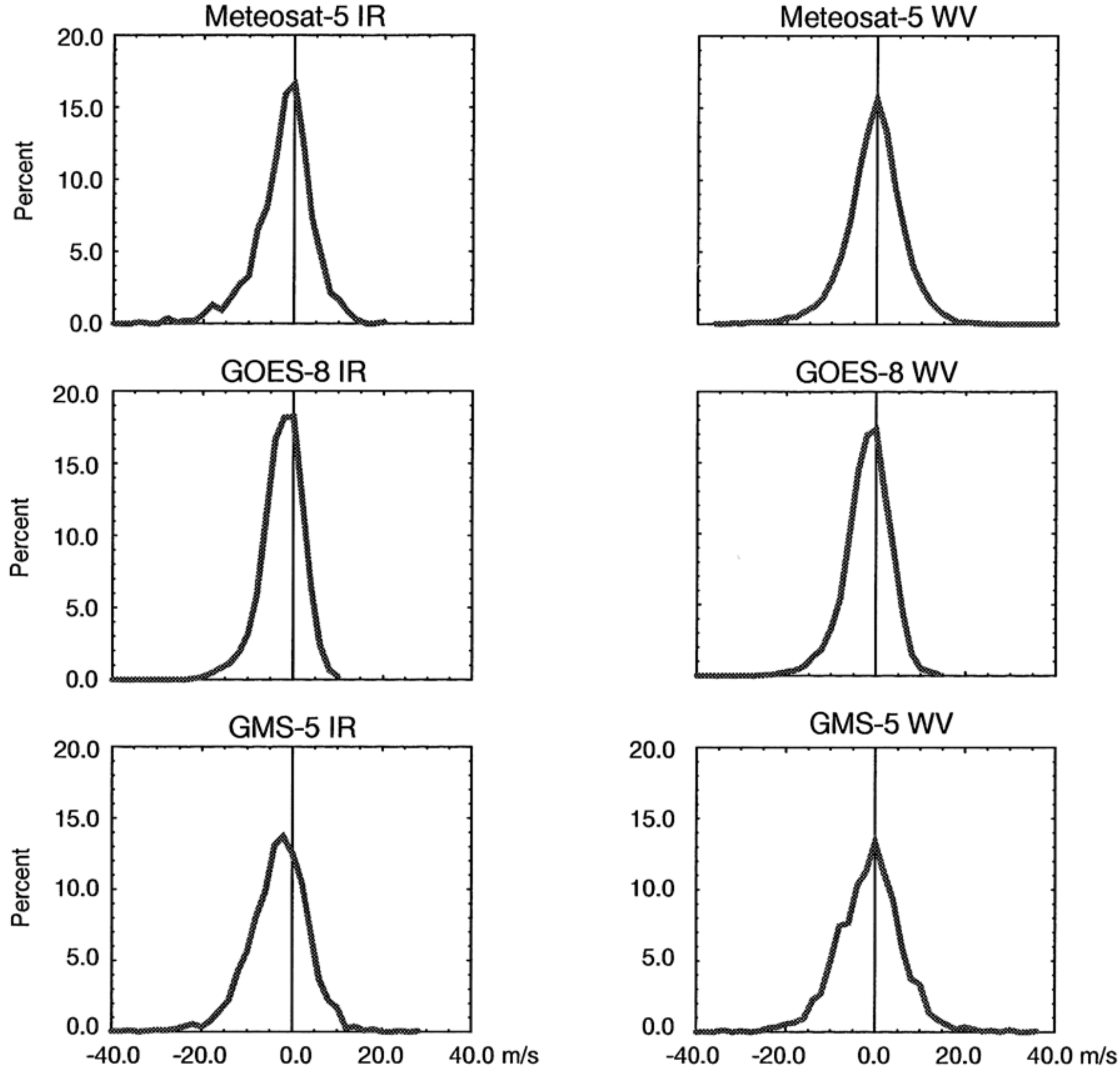

Figure 4 : Distributions of the speed departures from first-guess, May 1996, high levels (above 400 hPa), for the cases of mean speed between 30 and 40 m/s

quality of the analysis. The tails of the distributions in figure 4 show that outliers are indeed a problem.

CMW data from the INSAT satellite are potentially extremely valuable for data assimilation in the Indian ocean area, as very few conventional observations of any type are available in that region. However, there are indications that the quality of the data may be uncertain. This is seen for example in figure 5 where the distributions of the reported wind direction and speed are compared

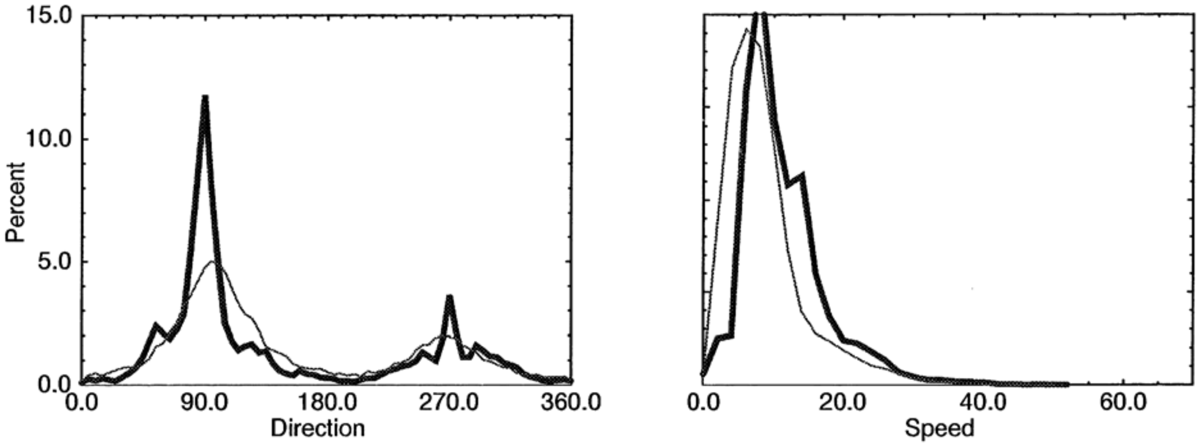

Figure 5 : Distributions of wind direction and speed as reported by INSAT (thick line) and predicted by the first-guess (thin line), March 1996

to the distributions of the same quantities predicted by the first guess. The direction distribution shows an excess of purely zonal winds which is not realistic, while the speed distribution is more noisy than expected. Another question which arises concerns the high frequency of data reported at 500 hPa, while all other systems tend to report mainly at high levels.

4. CONCLUSION

The overall quality of the Infra-Red cloud motion wind data from geostationary satellites available over the GTS has undoubtedly improved over the past ten years. In addition, water vapour data of at least as good quality have become available, enhancing the overall value of this observing system. Ways forward for further long term improvements are discussed elsewhere in these proceedings, however, for the shorter term it should be noted that the reliability of the operational procedures attached to motion wind data has sometimes not been as high as expected, for example through lack of GTS notification of operational changes. Significant gaps in coverage have been experienced, hampering to some extent the considerable benefit otherwise drawn from the system.

REFERENCES:

Hollingsworth, A., Shaw, D.B., Lönnberg, P. Illari, L., Arpe, K. and Simmons, A.J. (1986): Monitoring of observation and analysis quality by a data assimilation system. Mon. Wea. Rev. (114) pp 861-879

Strauss, B. (1991): Monitoring of cloud-motion winds at ECMWF. EUMETSAT/NOAA/WMO Workshop on Wind extraction from operational meteorological satellite data, pp 151-157

Strauss, B. and McGrath, R. (1993): Quality assessment of operational cloud-motion wind data. EUMETSAT/JMA/WMO/NOAA Second International Wind Workshop, pp 175-184