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VERIFICATION OF METEOSAT CLOUD MOTION WINDS WITH RADIOSONDE DATA

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ABSTRACT

The paper assesses the effects of recent changes to the METEOSAT wind extraction scheme on the basis of monthly verification data of cloud motion winds with collocated radiosonde wind measurements. Such verification data are available as monthly averages and are regularly distributed to CGMS members.

Further improvement of the operational wind extraction scheme from METEOSAT data has been demonstrated at all three height levels, i.e. high, medium and low level winds.

GMS winds have undergone considerable improvement since April 1990 for both, high and low level winds.

1. INTRODUCTION

There were several changes to the operational METEOSAT cloud-motion wind extraction scheme from 1984 to 1990 which either had a noticeable effect or were intended to do so (Schmetz et. al., 1993). Further changes after 1990 were documented in regular quarterly operations reports by ESA. An overall summary is given in Table 1.

Woick (1991) estimated the effects of those changes in quantitative terms. He used the empirical correlation between speed bias and reference wind speed as a tool to make the resulting performance changes visible, in particular those starting with February 1991 and November 1991. He showed that the well-known correlation with the speed bias also applies to the RMS vector difference. Since this parameter reflects the quality aspect more closely than the speed bias, this paper considers only the RMS vector differences between the satellite- derived and the radiosonde winds.

This paper provides an updated verification overview including high, medium and low-level winds. The two last changes of December 1992 and October 1993 are discussed on the basis of monthly averages and a long term summary review is given for all periods listed in Table 1.

Date	Change
Nov 84	Major revision of the methods for automatic and manual quality control.
Mar 87	Extraction of high level winds after windowing of IR radiances to suppress radiances from lower levels.
Sep 87	New WV channel calibration scheme.
Apr 89	Introduction of ECMWF first guess wind data to initialize the search algorithm for peaks in the correlation surface for high level winds.
Mar 90	Spatial coherence information used as an additional criterion for tracer test and height assignment.
Feb 91	Automatic Quality Control using horizontal wind gradients.
Nov 91	Using VIS data at 7 bits resolution for histogram processing.
Dec 92	Change of image filtering method
Oct 93	Image rectification by cubic spline interpolation

Table 1 Summary of changes to the METEOSAT cloud motion wind extraction scheme since 1984.

The paper also considers GMS data since October 1989 and compares their performance with METEOSAT winds.

2. METEOSAT HIGH LEVEL WINDS

Scatter diagrams of monthly averages of high-level wind RMS vector difference between METEOSAT derived and radiosonde winds are drawn in Fig. 1 for the period from December 1992 to December 1993. It is noted that values are well aligned along a linear regression line except for the two months of February and March 1993 where the RMS vector difference was about 1 m/s greater than expected.

There are two possible reasons which need to be explored further. First, there was a particularly strong radiometer anomaly "fish" observed during the month of February 1993. Second, it seems that there was a meteorological anomaly during these two months whereby the number of satellite derived months was particularly low over the European area - hence, the radiosonde data used for verification were dominated by non-European stations, and in particular by stations over North Africa. It remains to be tested whether wind measurements from these stations are of lower quality than those over Europe and whether this explains the greater differences between the satellite and radiosonde data.

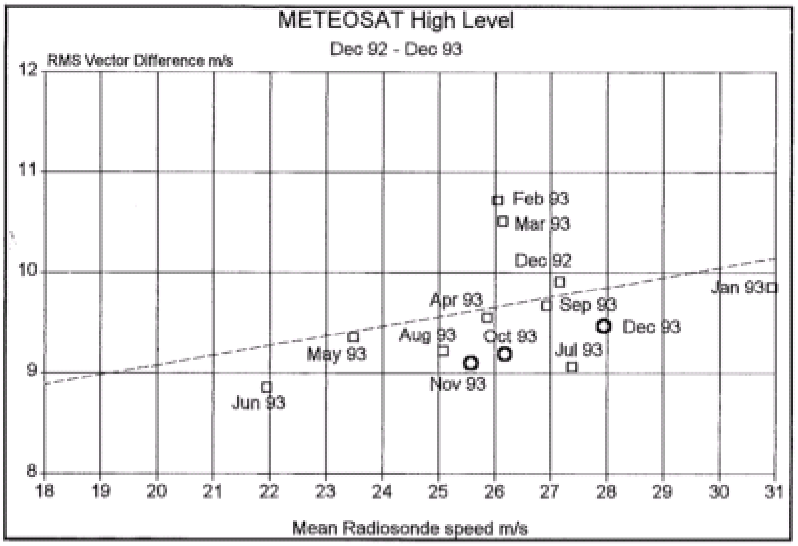

Figure 1: METEOSAT high level winds, scatter diagram of monthly averages of RMS vector difference with radiosonde data. Dashed regression line.

The regression line in Fig. 1 corresponds to the period of December 1992-September 1993 during which the wind extraction scheme was practically unchanged. If these two months were removed from the data set, the RMS vector difference of this period would be smaller by 0.24 m/s. The values of the last three months (from October to December 1993) are shown as circles, and show smaller RMS vector differences than the previous period. The improvement relative to the previous period (including the two suspect months) is estimated at about 0.4 m/s.

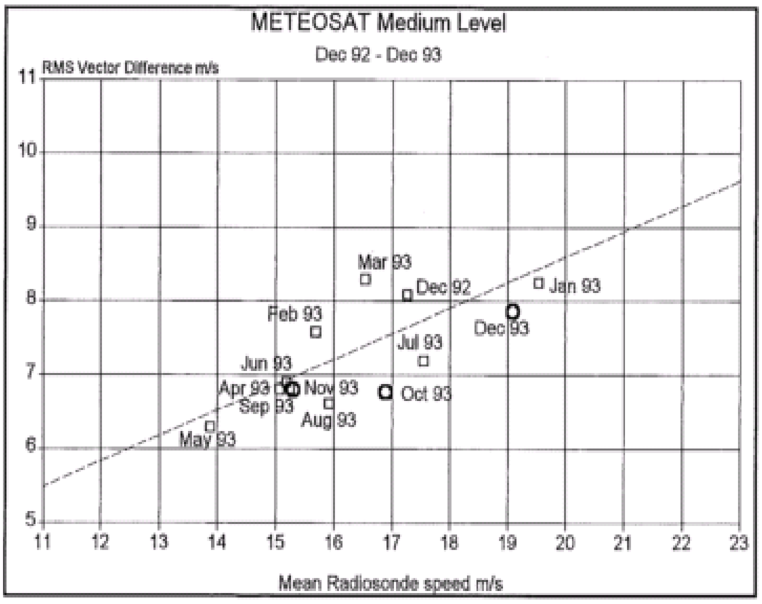

Figure 2: METEOSAT medium level winds, scatter diagram of monthly averages of RMS vector difference with radiosonde data. Dashed: regression line.

3. MEDIUM AND LOW LEVEL

Medium-level wind verification data reveal also a negative anomaly for the months of February and March 1993 of the order of almost 1 m/s. If these data did not exist, the RMS vector difference for the whole period would be 0.14 m/s less. In this case, we might conclude that Fig. 2 shows no improvement for the period from October to December 1993.

However, these months have a higher average wind speed so that there is indeed an improvement. It can be seen more clearly in Fig. 4.

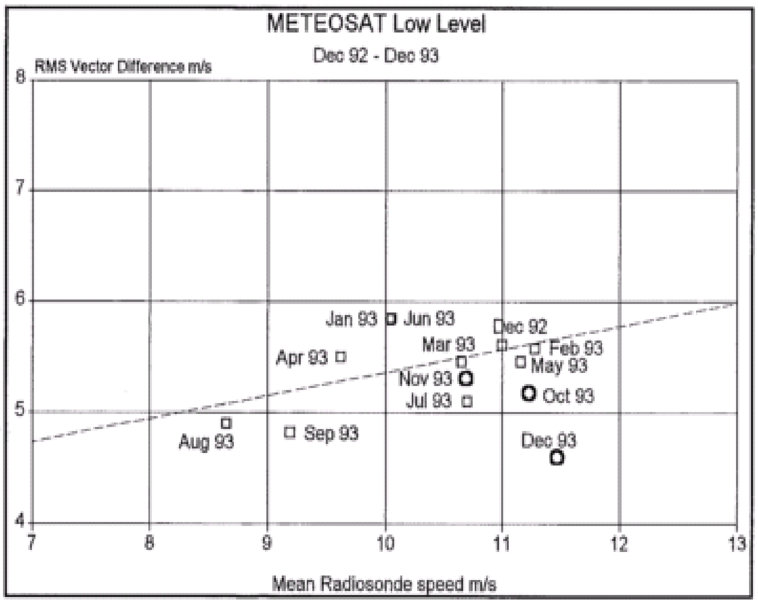

Figure 3: METEOSAT low level winds, scatter diagram of monthly averages of RMS vector difference with radiosonde data. Dashed: regression line.

In the low-level wind statistics (see Fig. 3) the months of February and March 1993 show no anomalies. Furthermore, there is a clear improvement for the period from October to December 1993. The reduction of RMS vector difference is estimated at the order of about 0.3-0.4 m/s. This confirms the positive effect of the change of the image rectification method introduced in October 1993 for low-level winds.

4. LONG-TERM EVOLUTION – METEOSAT

Long term validation results are shown in Figures 4-6 for high, medium and low level, respectively. GMS wind verification data are merged into the diagrams for comparison purpose.

Considering the apparent correlation between average radiosonde speed and the RMS vector difference, it is taken that the wind extraction method has improved if the vector of the performance change points across the regression lines in the diagrams. For example, the changes between February 1991 and September 1993 correspond to the empirical regression lines and are therefore explained by seasonal meteorological factors. A significant change is apparent only from October 1993 onwards.

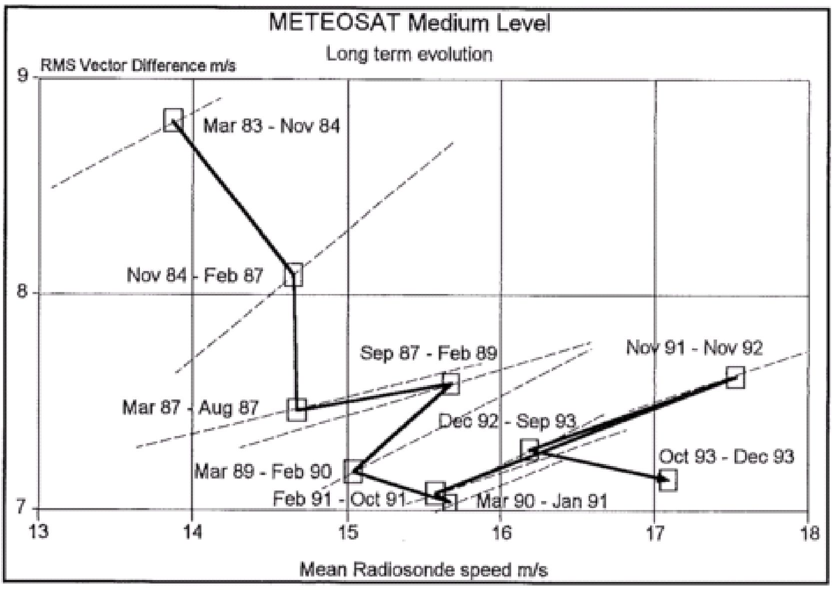

Figure 4: METEOSAT medium level winds, scatter diagram of monthly averages of RMS vector difference with radiosonde data. Dashed: regression lines within individual periods.

5. LONG TERM EVOLUTION – GMS

The same analysis as for METEOSAT winds was carried out for monthly verification data of GMS winds. Such data have been made available through CGMS since October 1989. Changes of the GMS operational wind extraction scheme have recently been described by Takata (1993):

Date	Change
Apr 90	Major revision of the statistical height assignment table for high level winds
Apr 91	Intensive manual quality control of high level winds and manual height reassignment
Apr 92	Further revision of manual quality control of high level winds
Apr 93	Further revision of the statistical height assignment table for high level winds

Table 2: Summary of changes to the GMS high level cloud motion wind extraction scheme (Takata, 1993).

Monthly verification for GMS high and low-level winds were grouped into periods analogous to those of METEOSAT and following those shown in Table 2. For comparison with METEOSAT, verification data of winds from both satellites were integrated into the same diagrams separately for the high and low level, respectively (there are no operational medium level winds from GMS). Figures 5 and 6 show that recent improvements were greater for GMS than for METEOSAT winds.

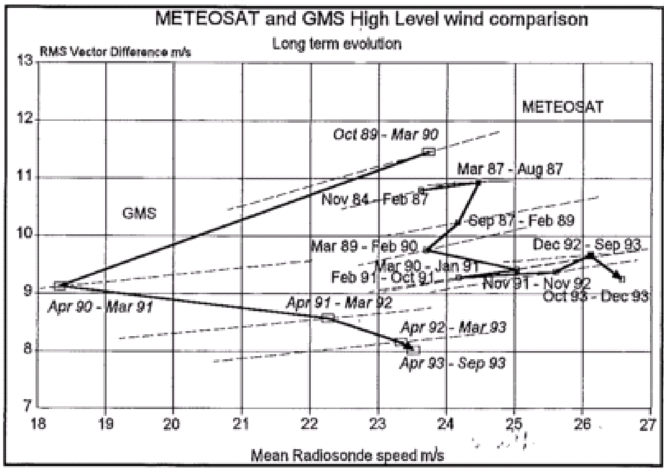

Figure 5: METEOSAT and GMS long term evolution of high level winds. Dashed: regression lines within individual periods.

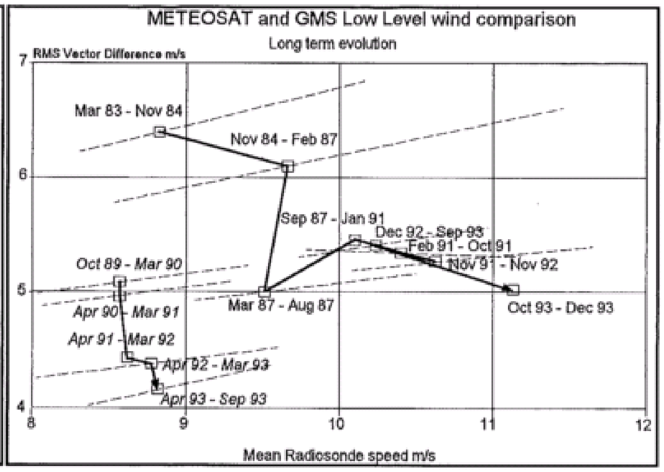

Figure 6: METEOSAT and GMS long term evolution of low level winds.

6. CONCLUSION

Further improvement of the operational wind extraction scheme from METEOSAT data has been demonstrated at all three height levels, i.e. high, medium and low-level winds. The introduction of the cubic spline rectification method had a positive effect. Since only three months of data have been available since the introduction of this method, and since there was a strong anomaly of wind verification data in early 1993, it is not advisable at this time to estimate the effect in quantitative terms.

GMS winds made remarkable progress since April 1990 for both, high and low level winds. This is largely due to refinement of the statistical and manual height assignment method and improved manual quality control.

7. REFERENCES

Schmetz, J., Holmlund, K., Hoffman, J., Strauss, B., Mason, B., Gaertner, V., Koch, A., Van de Berg, L.: Operational Cloud-Motion Winds from METEOSAT infrared images; *J. Appl. Met,* Vol. 32, No. 7, July 1993.

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