MONITORING OF CLOUD-MOTION WINDS AT ECMWF

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ABSTRACT

An evaluation of the quality of Cloud Motion Wind data is presented, including trends in performance since 1988, based on comparison with the ECMWF 6-hour forecasts. All satellites exhibit a slow bias at levels above 400 hPa, for wind speeds above 20 m/s. In the range 30 to 50 m/s the value of this bias is currently around -2.5 m/s for METEOSAT and -5 m/s for GOES. For GMS, the bias varies more from month to month, in the range -1 to -6 m/s.

1. INTRODUCTION

Monitoring of Cloud Motion Wind data from operational meteorological satellites, in both real-time and delayed mode, is performed operationally within the ECMWF global data monitoring system. The assessment of the quality of the observations is based on systematic comparisons between the observed values and the values predicted by the 6-hour forecast (first-guess field). Detailed information on this technique can be found in Hollingsworth et al., 1986. Specific results relating to SATOB data monitoring are given in Radford, 1989. In the following, we concentrate mainly on mean differences from the first-guess, although RMS departures are also routinely computed.

2. MONTHLY RESULTS

Figure 1 is a chart of the monthly mean vector departures in May 1991, for upper levels (above 350 hPa), displayed in boxes of 5° x 5°. Numbers are plotted for boxes with at least 10 observations. It can be seen that in southern mid-latitudes most of the biases are against the mean flow. Also noticeable is a change of pattern between the East Atlantic and the North Atlantic north of 25°N, showing departures in the GOES area to be larger than in the METEOSAT area, whereas the quality of the first-guess is homogeneous over the whole of the North Atlantic.

In the Southern Hemisphere mid-latitudes, there are also striking differences between the three available satellites, in the order of 2 to 4 m/s on average. In this case the quality of the first-guess varies from one area to another, and certainly accounts for part of these differences; however, comparisons with radiosonde observations have shown that, on average, the spatial variations of first-guess quality are smaller than these differences (Radford, 1987).

Figure 2 is the same plot for levels below 700 hPa. Except for INSAT data, bias values at these levels are generally very small. INSAT data also show internal inconsistencies which are reflected on the chart by the irregular variations of the arrows from box to box. This confirms previous results about the inadequate quality of these data for use in assimilation.

3. TREND SINCE 1988

Wind speed and wind direction biases have been computed monthly since January 1988 for each satellite. The data are stratified by mean speed class, i.e. by the average of the observed and predicted wind speeds. Also the data are stratified in three layers: above 400 hPa, from 700 to 400 hPa, and below 700 hPa.

Figure 3 shows the speed biases for METEOSAT, GOES and GMS data, for four different speed classes, for levels above 400 hPa. It is clear that in these statistics, the quality of the first-guess must have an impact, particularly in the Tropics where it is more variable than in the mid-latitudes (note that over the period 1988 - 1990, the main changes to the ECMWF model took place in May 1989 and May and June 1990). However, care is needed when interpreting the results to compare the quality of these three satellites. In addition to the impact of irregular first-guess quality, a serious difficulty arises from the fact that the selection of targets with respect to the synoptic situation is different from one satellite to another, therefore leading to inhomogeneous data sampling.

For all three satellites, data at low speed are virtually unbiased, but a negative bias is found at higher speeds; no such bias is observed in the lower levels (not shown). For METEOSAT, significant reduction of the bias has been achieved since 1988; for speeds higher than 20 m/s, the current value of the bias is around -2 to -3 m/s. The corresponding value for GOES data ranges from -2 to -5 m/s. For GMS the change of height assignment technique in April 1990 lead to a large reduction of the bias, however, there is still a large variation from month to month, with bias values ranging from -1 to -6 m/s.

With regard to the wind direction, the bias of METEOSAT data is shown separately for three sub-areas: north of 20°N, 20°N to 20°S, south of 20°S, for levels above 400 hPa (figure 4). A small but consistent bias can be seen, which is positive in the Northern Hemisphere and negative in the Southern Hemisphere. This is observed only at high levels; a possible explanation may be the preferred location of the suitable targets in jet areas. A similar signal is found for GOES and GMS data.

4. CONCLUSION

Cloud Motion Wind data constitute an essential component of the Global Observing System. For numerical weather prediction, their impact is quite beneficial (cf paper by Kelly, these proceedings), provided a suitable quality control is applied. Significant improvements have been achieved over the last few years, but it is clear that much still needs to be done to bring all producers to a similar level as far as data quality is concerned, and also, in the case of the application to NWP, to enhance the way in which this information can be used.

Acknowledgement

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References

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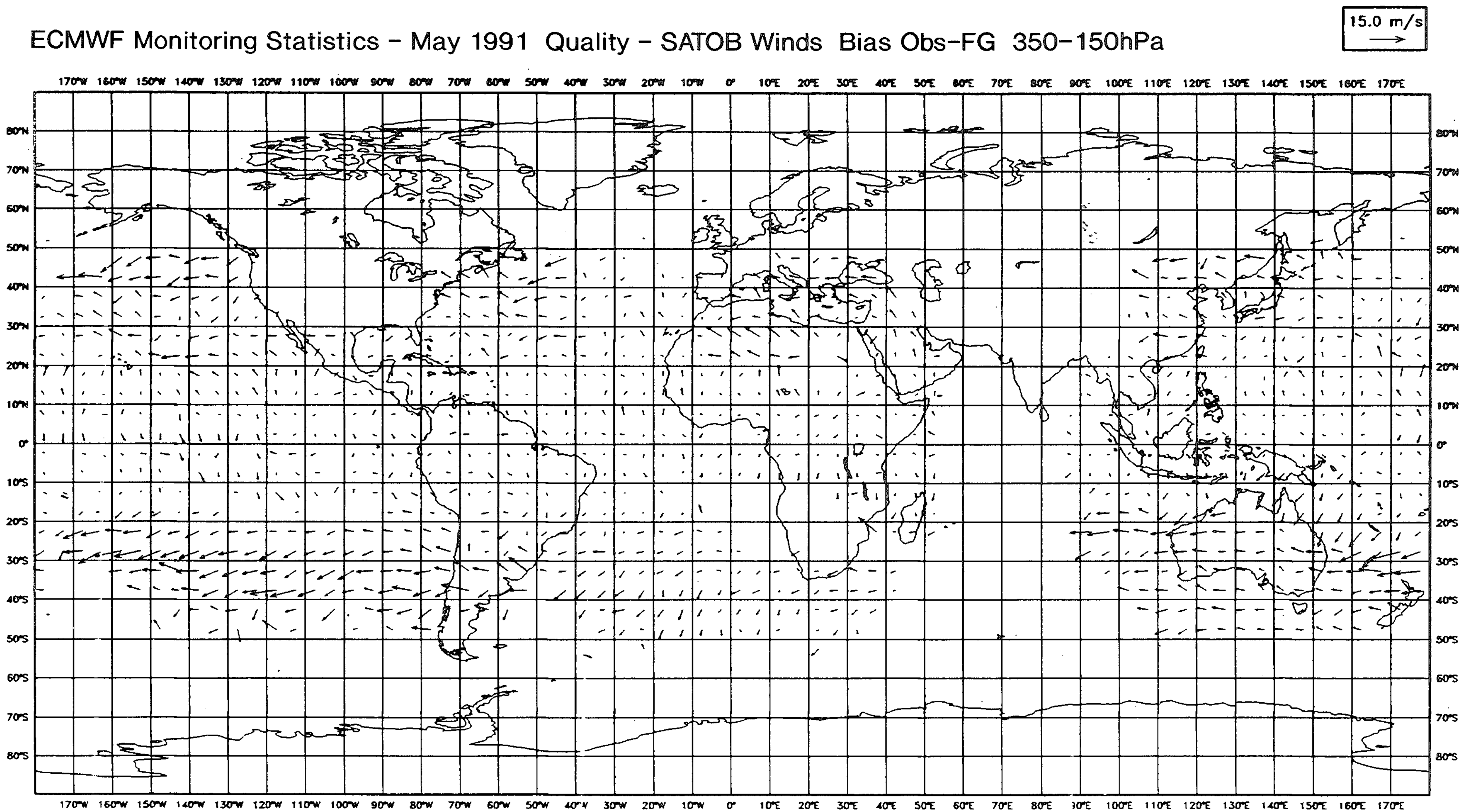

Fig. 1 Mean vector of cloud-motion wind observations minus first-guess wind for May 1991 in the layer 350-150 hPa, averaged over boxes of 5° x 5°

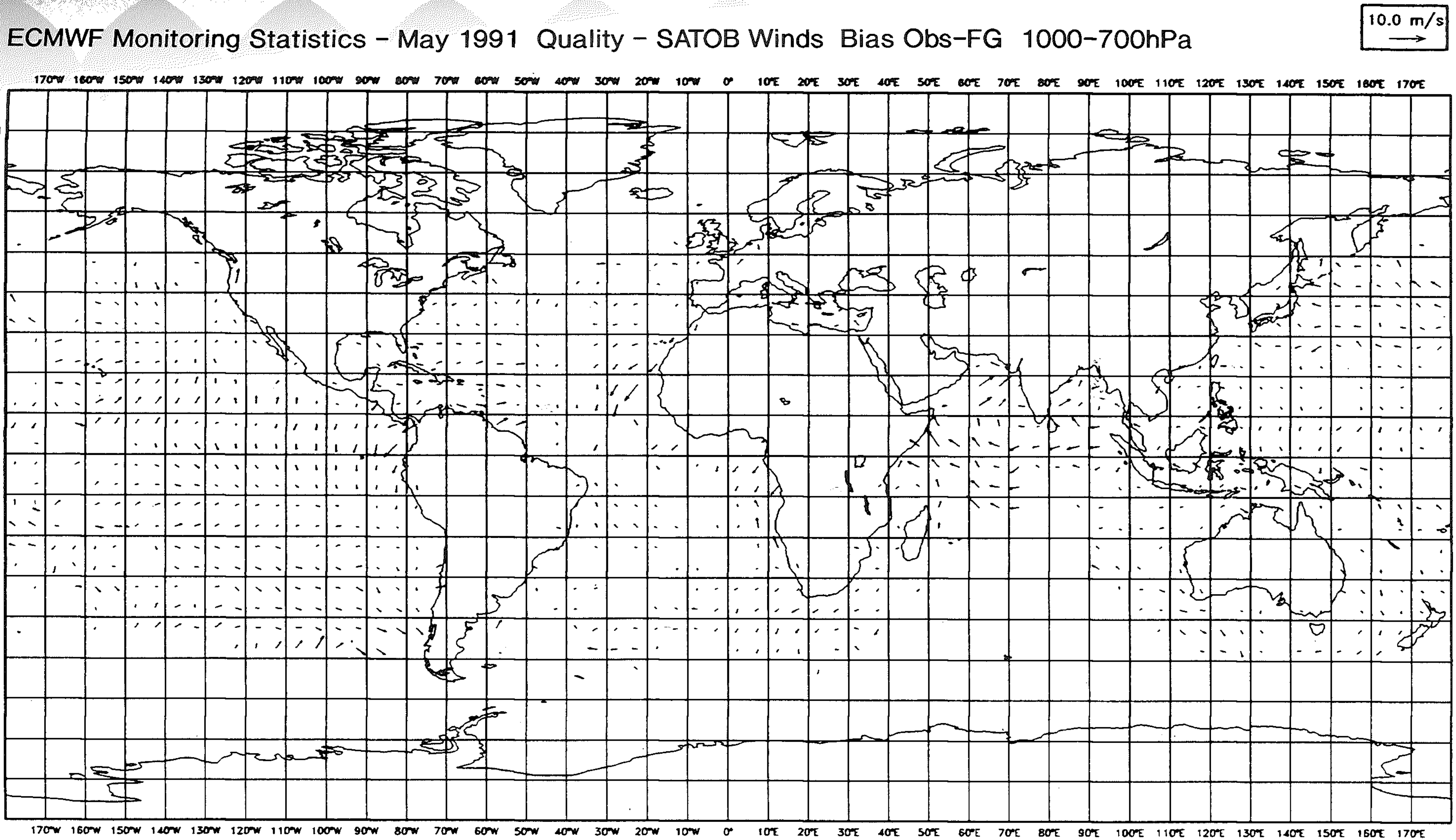

Fig. 2 Same as Fig. 1 for the layer 1000-700 hPa

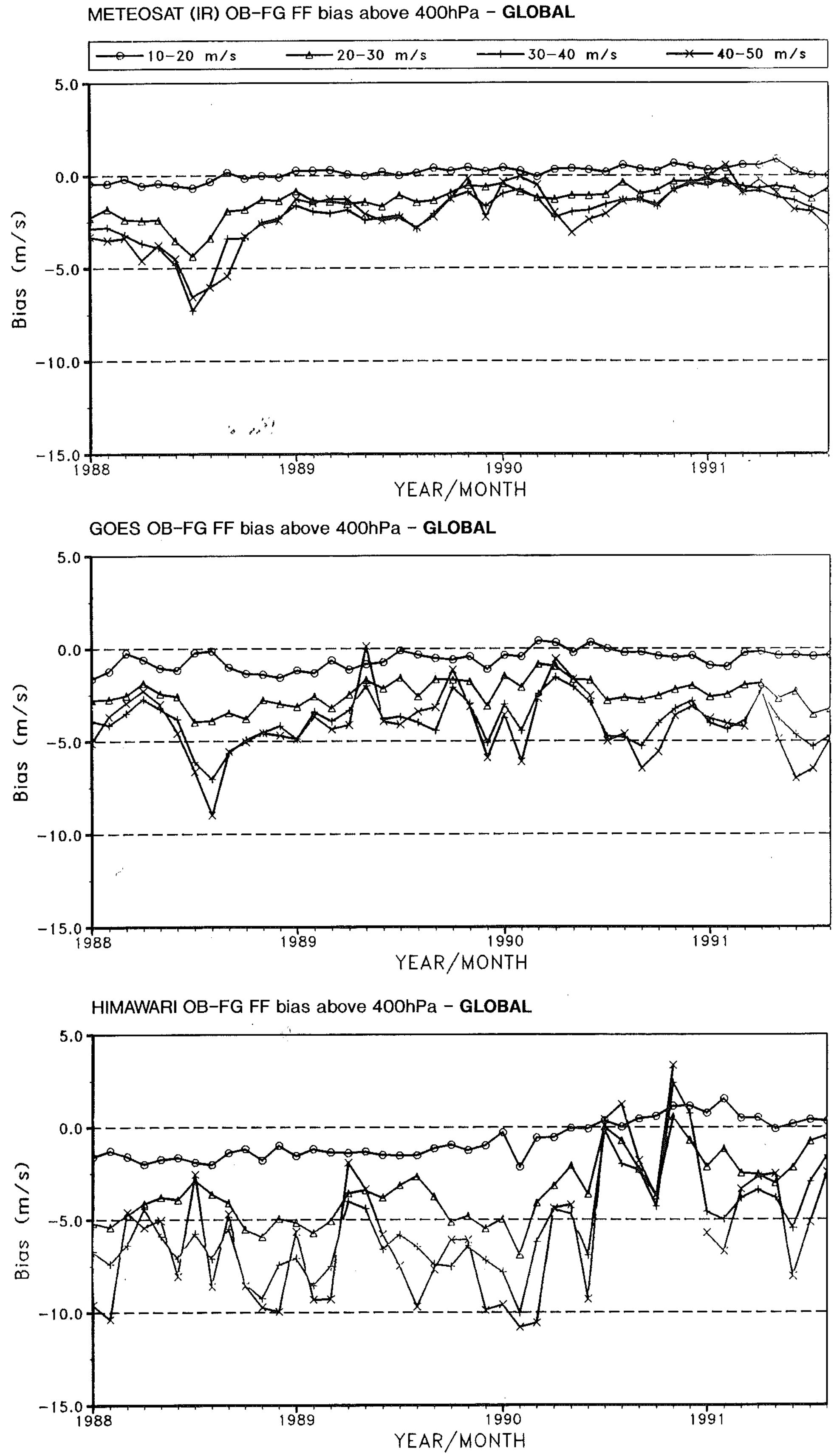

Fig. 3 a) Graph of the evolution between January 1988 and August 1991 of the upper-level wind speed bias of METEOSAT observations. Graphs are shown for four classes of averaged wind speed (average of the predicted and observed speeds): 10-20 m/s, 20-30 m/s, 30-40 m/s and 40-50 m/s.
b) Same as a) for GOES.
c) Same as a) for HIMAWARI.

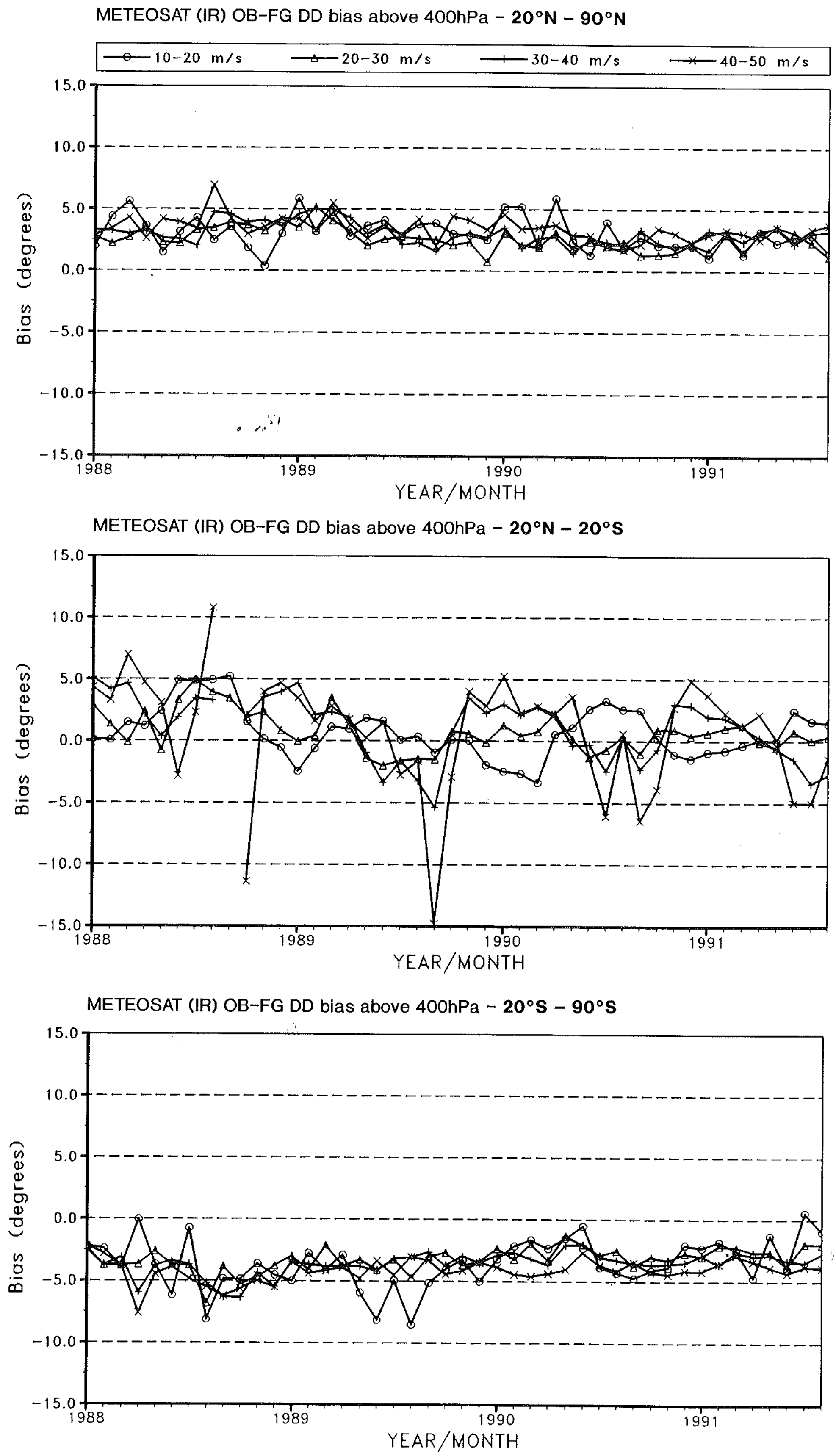

Fig. 4 a) As fig. 3a) but for the wind direction bias in the Northern Hemisphere extra-Tropics (North to 20°N).
b) Same as a) for the equatorial belt (20N to 20S).
c) Same as a) for the Southern Hemisphere (South to 20S).