QUALITY ASSESSMENT OF OPERATIONAL CLOUD-MOTION WIND DATA

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ABSTRACT

Up-to-date evaluation of the quality of the cloud-motion wind data received from the four 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 3 to 9 hour forecasts (first-guess fields). Collocation statistics between the cloud-motion winds and wind observations from other observing systems are also shown. Data from all satellites have a negative speed bias, slightly worse for GOES than for METEOSAT and GMS. GOES data have the smallest random errors. INSAT data have considerably improved but some problems remain.

1. INTRODUCTION

Monitoring of Cloud Motion Wind data from operational meteorological satellites is part of the ECMWF operational data monitoring system. The main aim is to provide guidance on the best use of the observations in the data assimilation system, but equally important is the use of the monitoring results to provide feed-back to the data producers. This provision of feed-back has been increasing continuously over the past few years, and for some observation types it has now reached operational status (in particular for surface marine data and for upper-air data).

2. MONITORING PROCEDURES

The assessment of the quality of the observations is based primarily on systematic comparisons between the observed values and the values predicted by the 3 to 9 hour forecast (first-guess field) and analysis (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 observation. 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 (particularly true in the tropics, mid-latitudes in the southern hemisphere and Antarctica). It also depends on possible systematic errors in the forecast model (particularly true in the tropics). To tackle this problem, the comparisons between observations and first-guess are cross-checked to the extent possible with collocations between observations of different types, for example aircraft data vs. SATOB data.

Statistics on SATOB data were presented at the first Wind workshop (Strauss, 1991). A set of significant results for the four operational satellites, including first-guess comparisons and collocations with aircraft and sonde observations, is put together in a quarterly report available from ECMWF on request.

3. OVERALL STATISTICS

3.1 Collocations with observations

Although conventional observations are potentially the safest data to be used for quality monitoring, their use is hampered by two problems: their limited availability and the presence of poor quality observations in the data sets. On the chart of the TEMP and PILOT data available for collocation with SATOB data in the period July to October 1993 shown in figure 1, it can be seen that the coverage is acceptable only over land in the northern extra-tropics and parts of Australia. Therefore, SATOB statistics will be heavily biased towards these areas. An additional problem is the quality of the TEMP data themselves. For example, it should be borne in mind that in the latitude band from 40S to 20N, 22 stations were listed in the WMO consolidated list of suspect stations for the period January-June 1993. For the statistics presented here, radiosonde data are pre-selected in two steps: stations with suspected quality problems are excluded a priori, and, in addition, single observations which fail certain criteria are also rejected.

Figure 2 shows speed collocations TEMP/PILOT vs. SATOB for the three satellites METEOSAT, GOES and GMS, for data above 400 hPa. The main feature is the negative bias, increasing with the observed speed. The comparison of the 3 satellites shows that the data from GOES have a larger bias but a smaller standard deviation, i.e. a smaller level of random errors, compared to METEOSAT and GMS.

The significance of collocations with aircraft data has increased significantly over the recent period, as the coverage has been improved by the introduction of automatic reporting systems (figure 3). However, results are obviously limited to the flight levels. Figure 4 shows collocations with aircraft as figure 2 for TEMP. The sample for METEOSAT is small, but the plots for GOES and GMS confirm what was seen with TEMP collocations.

3.2 First-guess comparisons

Figure 5 shows global collocations for the four satellites in three layers (note that the overall values of the biases are affected by the way of treating low speeds. METEOSAT, GMS and INSAT exclude speeds of less than 5 m/s). The main problem of the cloud motion wind data continue to be the negative speed bias oberved at high speed (to what extent this is due to height assignment is not discussed here). The comparisons with first-guess confirm what was seen on collocations with sondes and aircrafts, namely, that the bias is larger and the standard deviation smaller for GOES compared to METEOSAT and GMS.

Figure 6 shows the evolution of these biases since 1989 for four different classes of speed. METEOSAT and GMS present a similar pattern in 1993, while GOES has a negative bias even in the range 10-20 m/s (it should be noted that the first-guess has a tendency to be slightly too slow, as seen on comparisons with aircraft and radiosonde data).

4. METEOSAT WATER VAPOUR WINDS

Wind data from the IR and WV channels of METEOSAT are compared on figure 7. The quality of the WV is high, with a bias smaller than the bias of the IR data. However, they have a larger number of outliers, which is reflected in the overall standard deviation values, slightly worse for the WV data. This is confirmed by statistics on the rejections of data in the data assimilation. The percentage of data flagged by the first-guess check is typically around 8% for the WV data, against 4% for the IR data.

5. INSAT

Both the availability and the quality of the observations from INSAT-2A have considerably improved compared to the INSAT-1 satellites. Data are received for 00 and 12 UTC, instead of only 06 UTC before, and the numbers are large.

Table 1 gives the values of the RMS vector difference to first-guess in the Tropics for three layers since March 1993.

Table 1: RMS vector difference obs-FG, INSAT, 20S-20N (m/s)

	Mar-May 93	Jun-Aug 93	Sep-Nov 93
400-100 hPa	8.5	9.2	8.0
700-401 hPa	9.2	9.6	8.6
1000-701 hPa	6.5	7.0	6.8

Values of more than 10 m/s were not exceptional with INSAT-1. However, the corresponding values for the three other satellites are around 3 m/s at low levels, 5 m/s at medium levels and 7 m/s at high level. Very few conventional observations are available to check the statistics based on first-guess comparison, but the examination of individual charts shows that the relatively high RMS values are partly related to occasional inconsistencies in the height assignment, and also to an erroneously high frequency of zonal data.

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

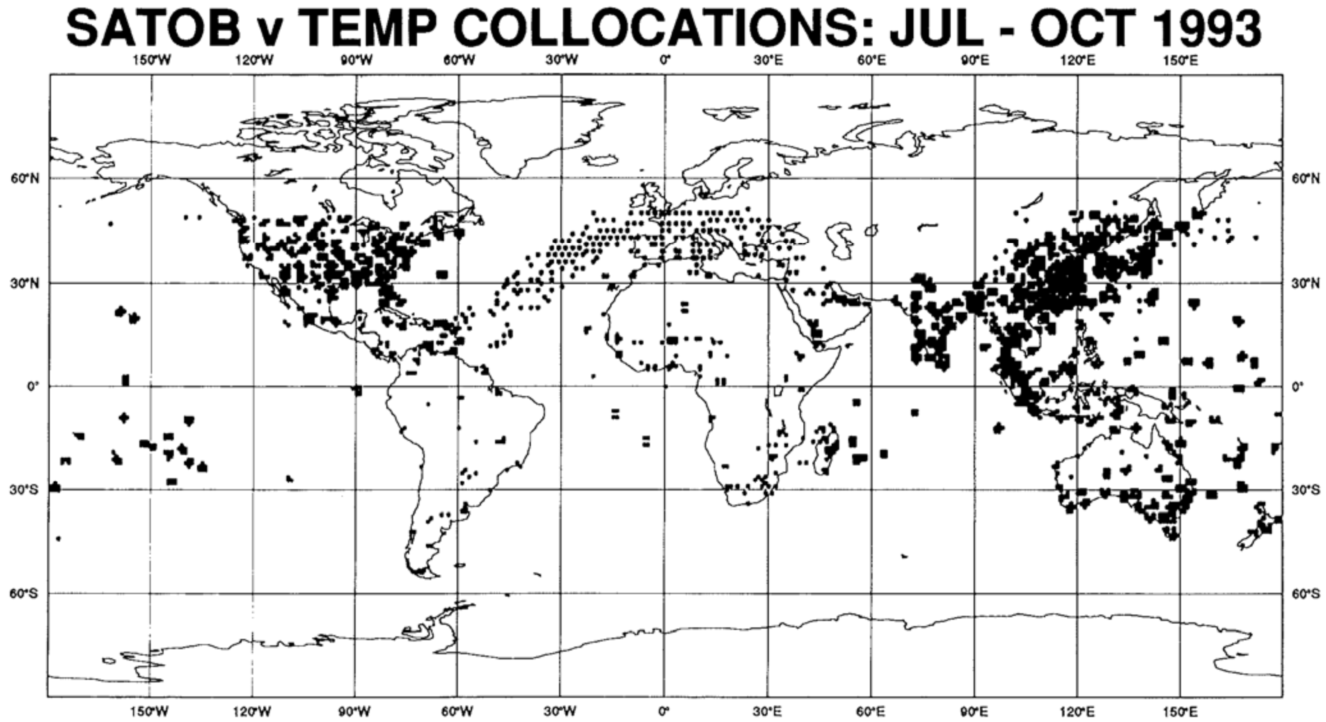

Figure 1: TEMP and PILOT observations collocated with SATOB observations, July-October 1993

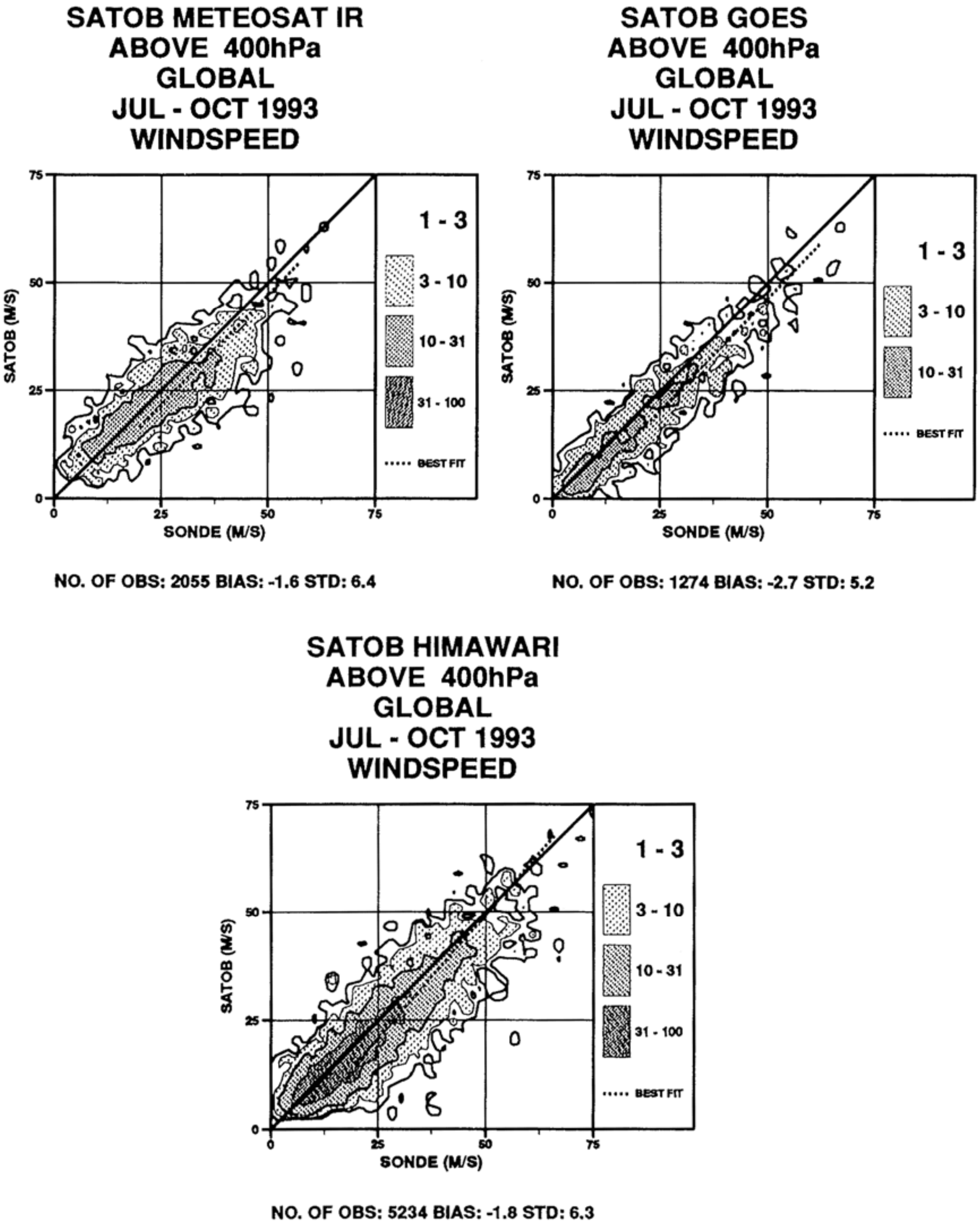

Figure 2: Comparison of wind speed data, SATOB vs. TEMP/PILOT

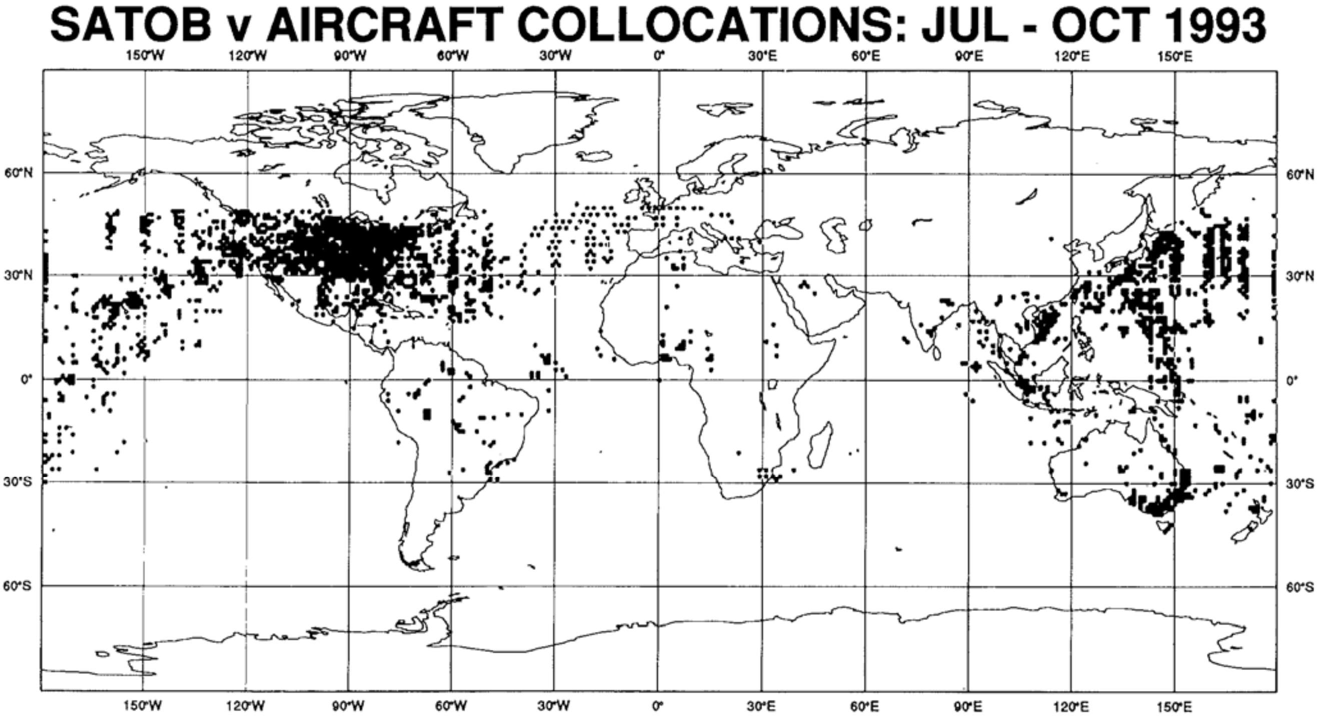

Figure 3: Aircraft observations collocated with SATOB observations, July-October 1993

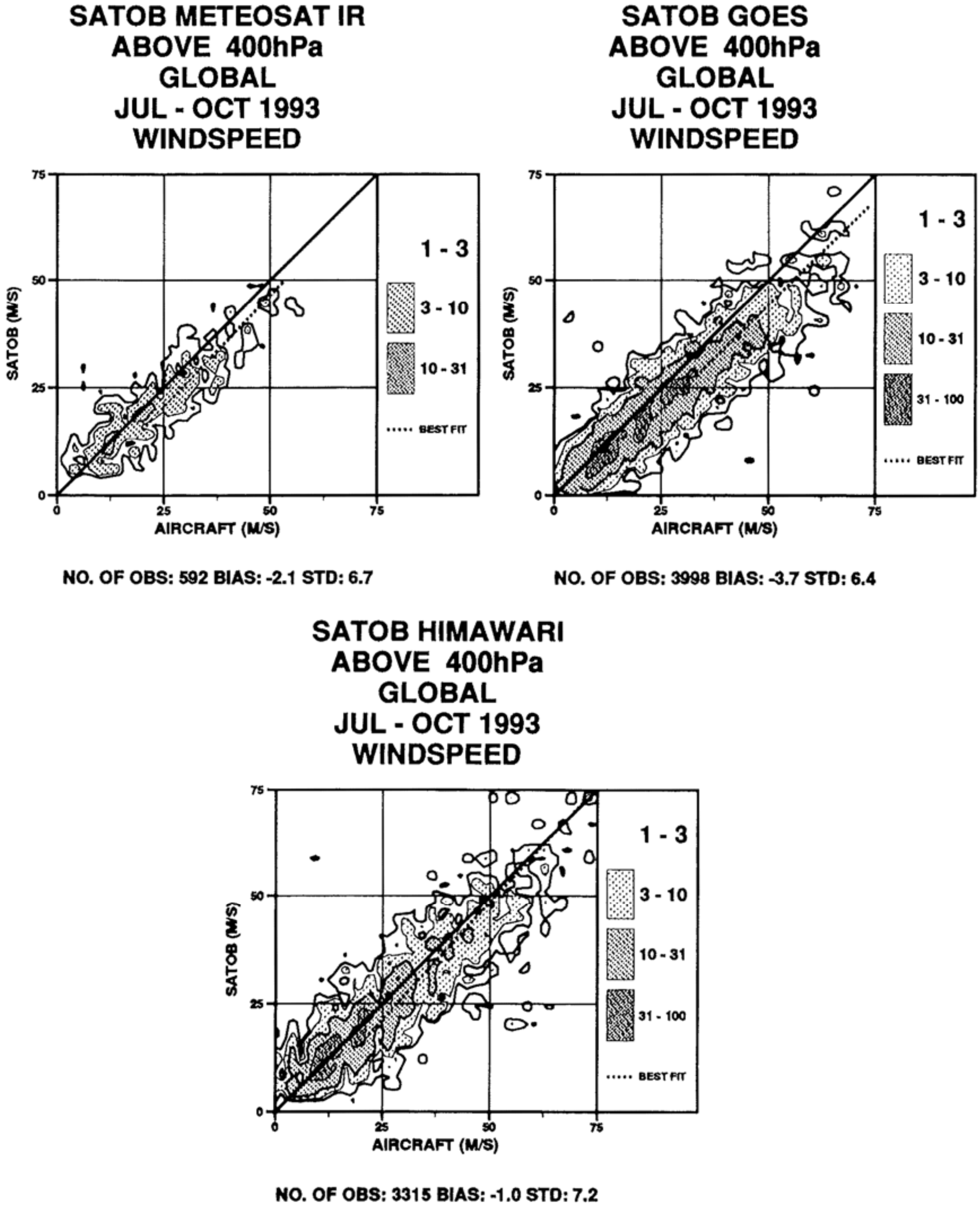

Figure 4: Comparison of wind speed data, SATOB vs. aircraft observations

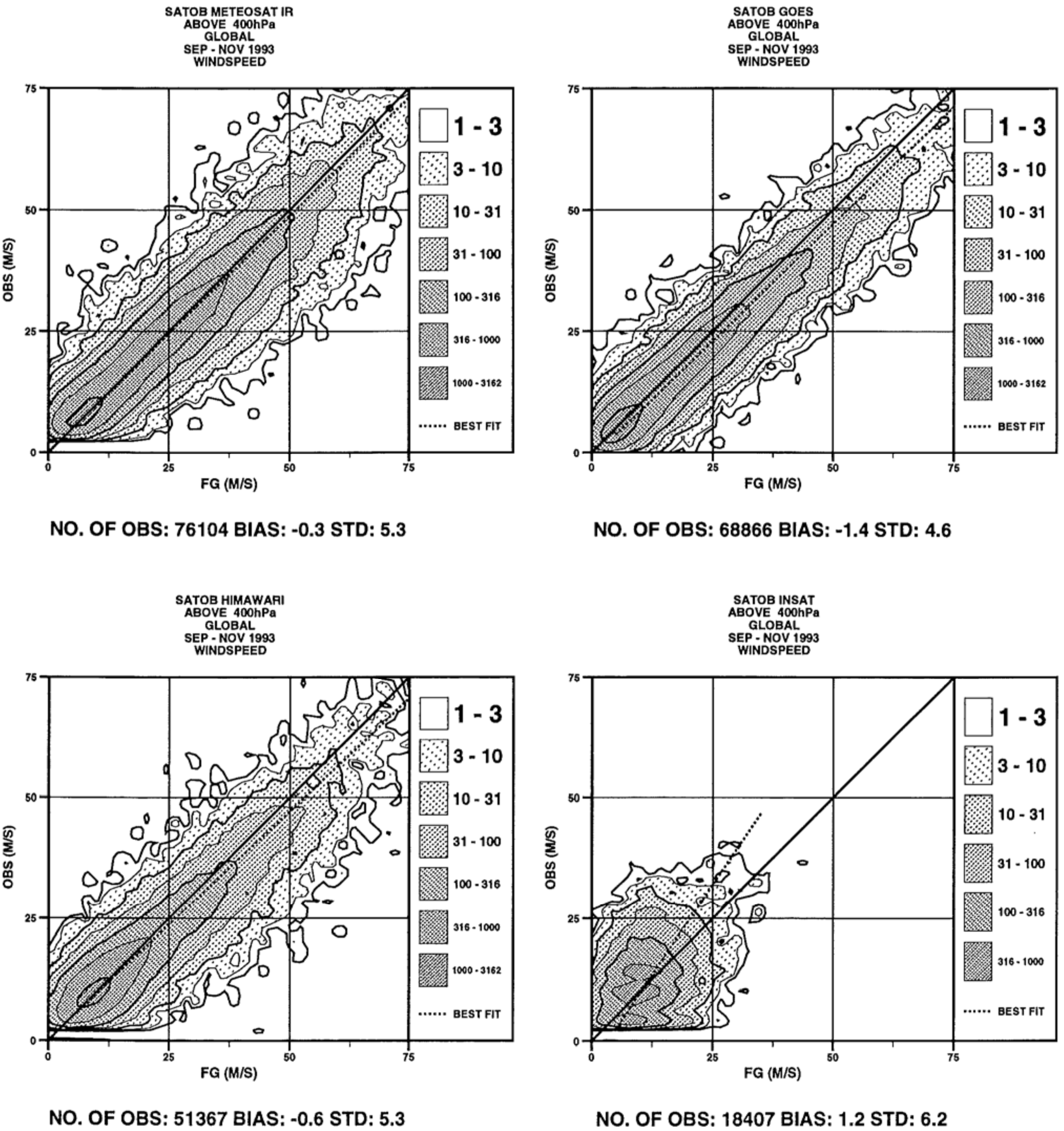

Figure 5: Comparison of wind speed data, SATOB vs. ECMWF first-guess fields

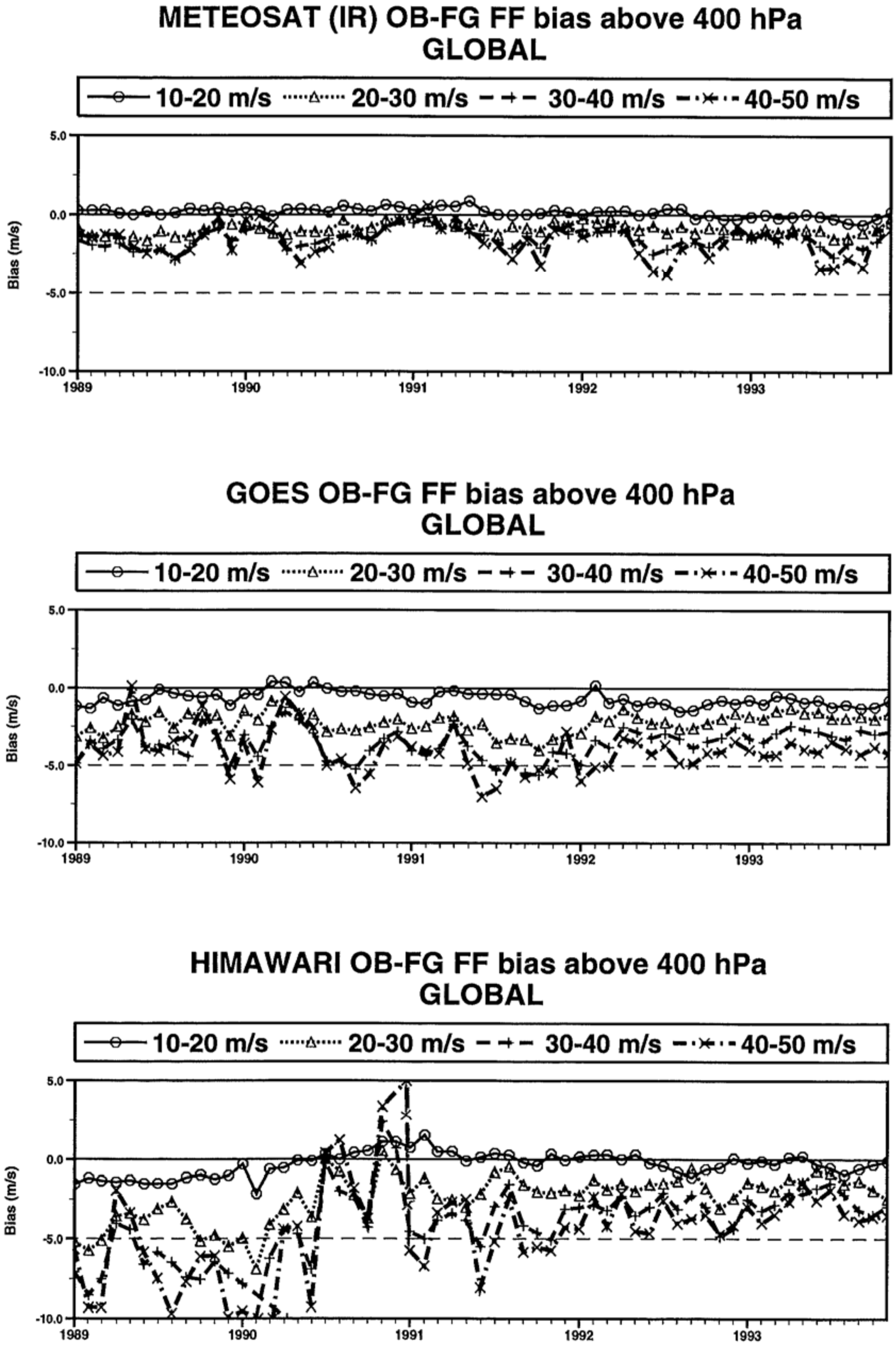

Figure 6: Speed bias for 4 classes of speed since 1989. The speed class is determined by the mean of the predicted and observed speed

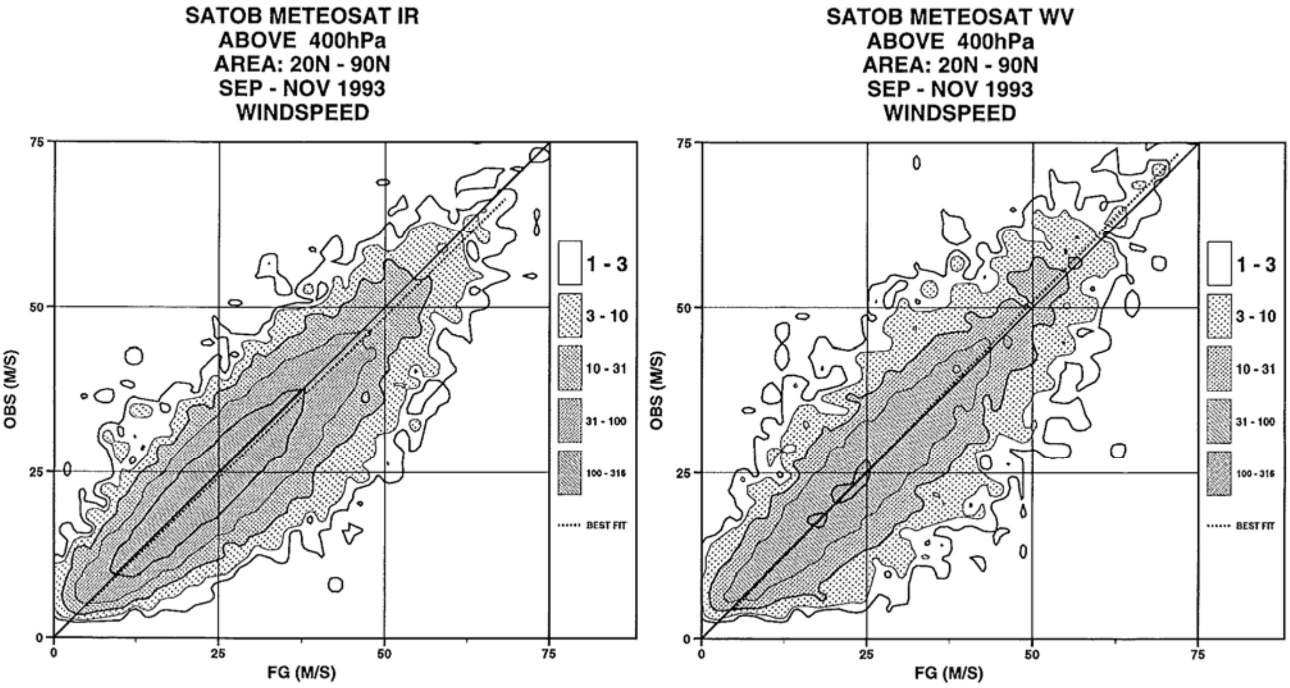

Figure 7: Comparison of METEOSAT infra-red and water vapour winds for speed