RESULTS OF A METEOSAT-GOES WIND INTERCOMPARISON CAMPAIGN IN AUGUST 1990

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ABSTRACT

A wind intercomparison campaign was carried out by NOAA, ESA and EUMETSAT in August 1990, addressed to operational cloud motion winds from GOES and METEOSAT.

The paper analyses the performance of the two satellite wind data sets on the basis of comparison data provided by ECMWF. There is evidence that GOES winds at high speed have a stronger negative speed bias than METEOSAT. Collocated wind vectors from both satellites were too few to significantly contribute to te results of the study.

Recommendations are made for the planning of follow-on campaigns.

1 INTRODUCTION

The campaign was committed to operational cloud motion winds from the geostationary meteorological satellites METEOSAT and GOES, as extracted by ESA (under agreement with EUMETSAT) and NOAA, respectively. Verification data were provided by the European Centre for Medium Range Weather Forecast (ECMWF). The test period was selected from the 6 - 31th August 1990.

The test area of the campaign was selected in the overlap over the Atlantic between the two wind extraction areas, which are defined as circles around the subsatellite points at zero and 98 West degrees longitude with a radius of 55 and 60 degrees, for METEOSAT and GOES, respectively (Fig. 1).

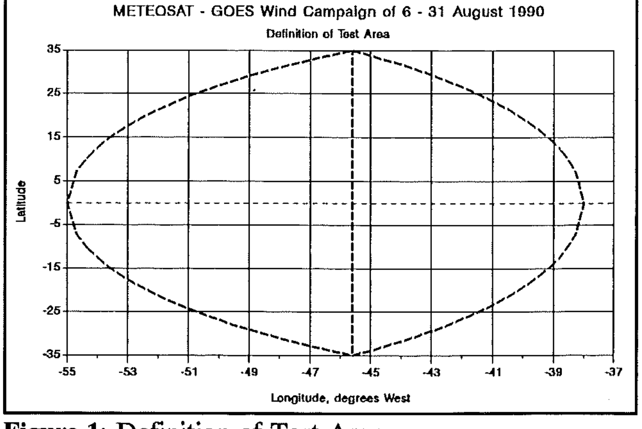

Figure 1: Definition of Test Area

Wind vectors were based on image triplets centred around the following observation times: for METEOSAT, at 05.00, 11.00, 17.00 and 23.00 UTC (however, on some days, triplets of 18.00 UTC were used instead of 17.00); for GOES, at 04, 10, 16 and 22 UTC (these times are reported in the operational messages, actual image times may differ by up to 1/2 hour).

The First Guess (FG) wind field of the operational ECMWF analysis scheme was taken as the reference to verify the satellite winds, because there are only few radiosonde stations over the test area. The FG wind field is based on the ECMWF numerical forecast scheme and relies on all observational data from previous observation times but does not make use of actual satellite wind data.

For horizontal and vertical collocation of satellite and FG winds, the FG wind field was interpolated at the location and height reported with the satellite wind. As regards observation time, the FG winds were taken at the closest nominal synoptic time 00.00, 06.00, 12.00 or 18.00 hours UTC (personal communication, A. Thoss).

The resulting data set of wind vectors and their differences to collocated FG wind were provided by ECMWF to EUMETSAT who put the data sets forward to the other participants. The results presented in this paper are those obtained at EUMETSAT.

The paper analyses the performance of the two satellite wind data sets and looks for systematic differences of their speed bias. In a first step, the evaluation uses the full data set of 3709 wind vectors obtained during the campaign. In a second step, only collocated wind vectors from both satellites are considered in order to assess whether "identical" conditions give rise to additional results.

Finally, the results are discussed under the aspect of how representative they are for the two wind extraction schemes in general. This is necessary because the test area and period are limited and the data are expected to be representative mainly for the tropical latitude and cases of low wind speed.

Evaluation areas:

- North = North of 20 degrees North
- Tropical Area from 20 degrees North to 20 degrees South.
- South = South of 20 degrees South

Height Level classification of Wind Vectors

100 - 400 hPa = High
401 - 700 hPa = Medium
701 - 999 hPa = Low

Table 1: Definition of evaluation area and height levels.

2 Full Data Set

For statistical analysis, differences between reported wind vectors and the ECMWF FG wind field were grouped according to satellite, area and height level, as shown in Table 1.

The following parameters were calculated for each of the groups: Number of wind vectors, ECMWF FG wind speed, speed bias, RMS vector difference. The results are summarized in Table 2. The number of wind vectors was 1112 for GOES and 2597 for METEOSAT, the total number from the whole campaign was 3709.

According to Table 2, speed bias between cloud motion winds and FG winds for most of the data groups are larger for GOES than for METEOSAT. Three possible reasons are discussed:

1. The ECMWF FG wind field is biased by preferential treatment of METEOSAT winds (Eriksson, 1990) in the quality control scheme at ECMWF.

2. The differences are in line with the well known bias/speed dependency and are explained by the greater FG wind speed seen with the GOES winds.

3. The differences are caused by the time difference between the wind vectors and the ECMWF FG field which is greater for GOES than for METEOSAT.

The first assumption is discussed in more detail in Section 4, which will show that the effect of this will be the same for verification of GOES and of METEOSAT winds.

GOES/METEOSAT wind campaign 6-31 AUGUST 1990

COMPARISON AGAINST FIRST GUESS (OBS-FG) IN THE OVERLAP AREA

All wind vectors

SATELLITE	AREA	LEVEL	RMS Vector Difference m/s	Speed Bias m/s	FG Speed m/s	Number
GOES	North	High Level	7.6	-0.3	13.7	91
METEOSAT	North	High Level	6.2	0.4	12.6	62
GOES	South	High Level	13.4	-5.4	35.5	75
METEOSAT	South	High Level	10.0	-2.0	34.3	290
GOES	Tropics	High Level	7.4	0.4	15.6	540
METEOSAT	Tropics	High Level	6.5	1.8	13.9	902
GOES	North	Medium Level	7.5	1.8	5.2	29
METEOSAT	North	Medium Level	5.0	2.4	5.6	53
GOES	South	Medium Level	4.5	-3.2	20.6	3
METEOSAT	South	Medium Level	5.6	-0.7	15.7	62
GOES	Tropics	Medium Level	5.3	0.7	7.4	70
METEOSAT	Tropics	Medium Level	3.6	0.3	7.9	554
GOES	North	Low Level	4.2	-1.0	7.0	41
METEOSAT	North	Low Level	2.4	0.0	7.8	112
GOES	South	Low Level	3.5	-1.0	8.4	50
METEOSAT	South	Low Level	3.8	0.7	8.4	140
GOES	Tropics	Low Level	4.2	-1.0	8.9	213
METEOSAT	Tropics	Low Level	2.7	0.3	8.8	422

Table 2: Summary of wind vectors according to satellite, area and height level.

The second hypothesis can be tested using scatter diagrams between FG speed the speed bias for all high level wind vectors of METEOSAT (Fig. 2) and GOES (Fig. 3). These diagrams show that the scatter of high level wind vectors at high speed is much larger for GOES than for METEOSAT.

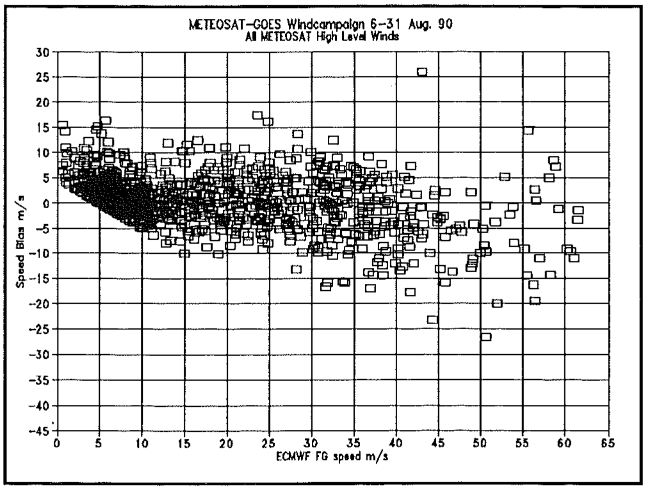

Figure 2: Speed Bias versus FG speed of all High Level Winds of METEOSAT.

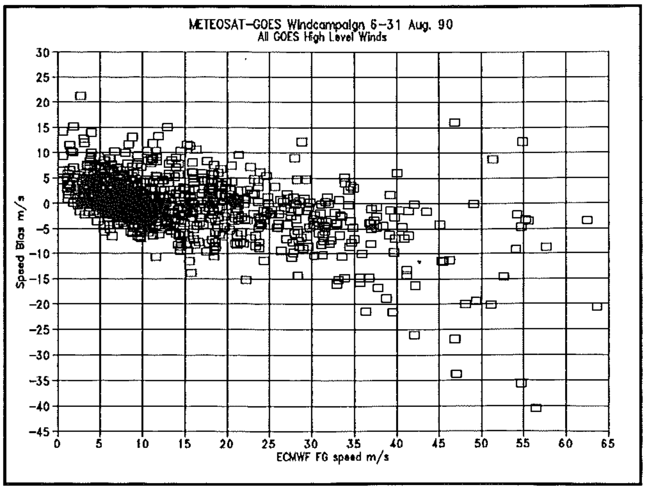

Figure 3: Speed Bias versus FG speed of all High Level Winds of GOES.

This can be explored further by looking at the bias/speed dependency of either wind data set in quantitative terms. Following the presentation scheme of ECMWF (Eriksson, 1990), Figure 4 shows the average speed bias for wind data from METEOSAT and GOES, respectively, at all height levels, grouped into speed classes of 10 m/s width. The diagram confirms the negative speed bias of GOES winds at all higher speed classes, whereas at lower speed, bias of METEOSAT and GOES winds are approximately equal. This explains the differences of the overall speed bias from Table 2.

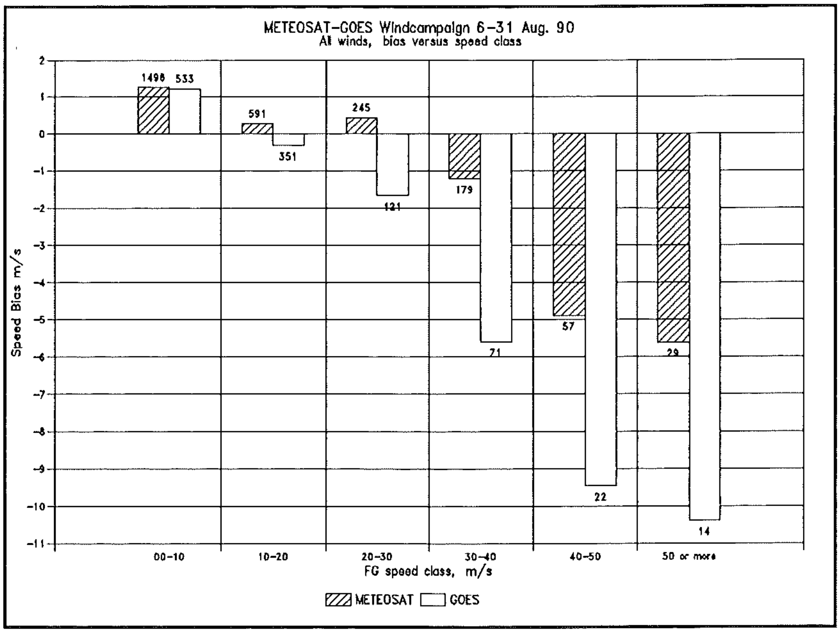

Figure 4: Bias versus speed for all METEOSAT and GOES winds, grouped in speed classes, with number of vectors in each class.

As an experiment to test the impact of time differences, Fig. 5 shows the distribution of bias of METEOSAT wind vectors separately for each observation time. Surprisingly, the performance of wind vectors of 18.00 UTC is much worse than of 17.00 UTC. However, the number of samples is small. Further studies on the basis of larger data sets may assess whether this variation of wind quality with day time is caused by variable quality either of the ECMWF FG wind field or of the wind extraction scheme, or whether this effect is not real at all.

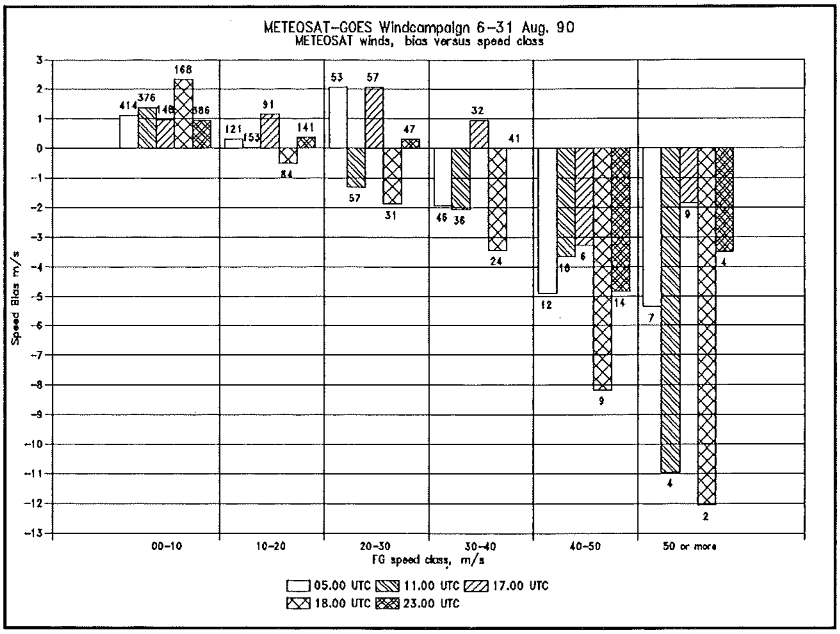

Figure 5: Bias versus speed for all METEOSAT winds, grouped in speed classes and actual observation times.

3 Collocated Winds

Collocated wind vectors of METEOSAT and GOES were considered within a distance of +/- 1.4 degrees latitude and longitude. The total number of vectors in this range was 338 for each of the two wind data sets.

The bias/speed dependency of collocated wind vectors is shown in Fig. 6. It is equivalent to Fig. 4 and shows similar systematic differences between METEOSAT and GOES wind characteristics. However, the number of cases is very small, in particular for wind speed greater than 50 m/s.

Although one would expect that the number of winds per class is equal for both satellite data sets, this is not the case because collocation differences lead to slight differences of FG speed because of the spatial interpolation, so that the allocation to speed classes may be different for pairs of "collocated" wind vectors.

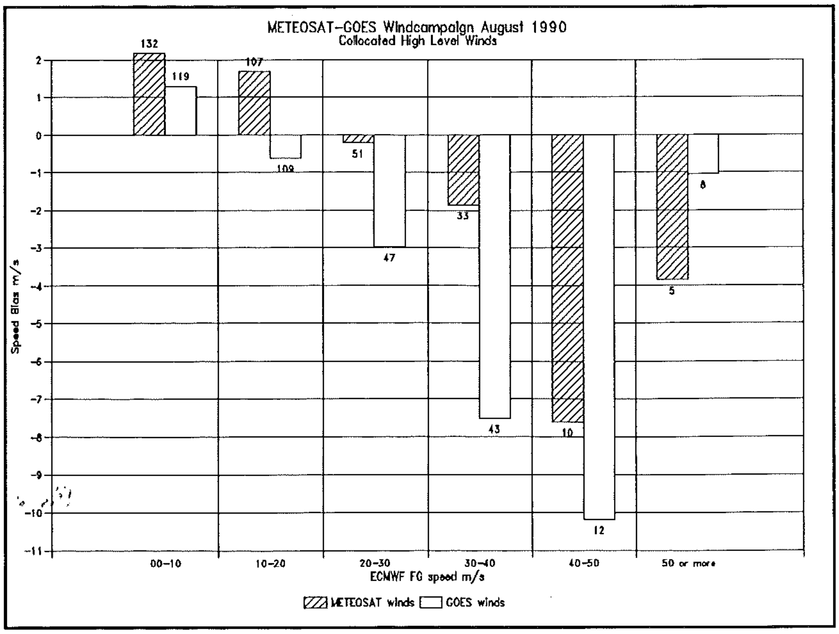

Figure 6: Bias versus speed for collocated METEOSAT and GOES winds, grouped in speed classes. Collocations within 1.4 degrees latitude/longitude.

4 Discussion

For interpretation of the results obtained so far, the following aspects have to be considered for the comparability of wind vectors from METEOSAT and GOES, and for the applicability of ECMWF FG wind data as a reference:

- GOES winds are extracted manually, whereas METEOSAT winds are merely an average over a METEOSAT image segment of 32x32 infrared pixels. Therefore, wind vectors will differ even with a perfect collocation of winds in space and time.

- METEOSAT and GOES winds are extracted from ig'mages of different observation times, as outlined in Section 1. However, the advantage of better coincidence with time of the 18.00 UTC winds of METEOSAT cannot be demonstrated with the small number of samples available from this campaign.

- The ECMWF FG wind field has a negative speed bias in the tropical and southern latitudes (Eriksson, 1990, Thoss, 1991). The negative speed bias of satellite winds may have contributed to this effect, in particular METEOSAT winds accepted by the quality control at ECMWF with some preference over other satellite winds. This, however, does not explain the greater negative speed bias of GOES winds. We should, instead, assume that with an unbiased FG field, speed bias would turn out greater for both, METEOSAT and GOES, respectively.

- The campaign was carried out during the month of August which is correlated normally with low wind speed over the northern hemisphere. Hence, high wind speeds are found mainly over the southern (extratropical) part of the test area. Since the ECMWF FG wind field is biased negative in this area, the "real" speed bias of METEOSAT and GOES winds is probably larger than the figures resulting from this campaign.

5 Conclusion

There is strong evidence that GOES winds have a stronger negative speed bias than those of METEOSAT.

It is evident from the scatter diagrams in Figures 2 and 3 that the number of wind vectors with very large differences from the FG is greater for GOES than for METEOSAT, in particular at moderate and high wind speed. It is assumed that a more stringent quality control would improve both, the scatter and the overall speed bias.

The small number of vectors available and the limitations discussed above, do not permit further substantial conclusions but justify further detailed investigations into some of the effects observed, in particular the daytime dependency of verification results.

For future campaigns, the following recommendations are made:

- to make operational characteristics of wind extraction schemes more comparable. At least, the image times used for wind extraction should be harmonized.

- select cases with high wind speed over the northern hemisphere where more radiosonde observations are available. From the meteorological point of view, the period most likely to offer such conditions are the months December and January.

- calibrate future comparison methods by verifying satellite winds with radiosonde data, and ensure that results are commensurate with those obtained with comparison with the FG wind field of a numerical model.

6 REFERENCES

EUMETSAT 1988: Report of the 17th meeting of the Co-ordination Group for Meteorological Satellites, CGMS XVII, Darmstadt, Federal Republic of Germany, 3-7 October 1988.

ERIKSSON, A., 1990: *Use of Cloud Motion Winds at ECMWF*, 8th METEOSAT Scientific Users Meeting, Norrköping, Sweden, 28th-31st August 1990, EUM P08.

THOSS, A., 1991: *Cloud Motion Wind Validation and Impact on Numerical Forecasts*, this volume.