VERIFICATION OF METEOSAT WINDS FROM MPEF AND MIEC

Heinrich Woick

EUMETSAT, Am Kavalleriesand 31, 64295 Darmstadt, Germany

ABSTRACT

Operational production of wind data from METEOSAT was transferred from ESA's Meteorological Information Extraction Centre (MIEC) to EUMETSAT's Meteorological Products Extraction Facility (MPEF) in November 1995. The European Centre for Medium Range Weather Forecast (ECMWF) supported validation of MPEF winds by providing monthly statistics of differences between winds from MPEF and from conventional radiosonde observations.

Evaluation of MPEF data available from November 1995 to May 1996 shows that MPEF high level winds from the METEOSAT water vapour channel have reached a quality better than MIEC and nearly comparable quantity, whereas high level IR winds appear to be worse. MPEF medium and low level IR winds are better than MIEC but their number is much lower.

1. INTRODUCTION

The evolution of the METEOSAT wind extraction scheme has been documented by various authors, for example by Schmetz et. al. (1993). Quantitative estimates of performance improvements were performed by Woick (1993), using monthly verification data of METEOSAT winds versus radiosonde wind observations based on comparison with collocated radiosonde data. The technique used the well-known empirical correlation between speed difference and the measured radiosonde winds to compensate for the effect of seasonal variations of the performance parameters. The same method is used in this paper to study the relative performance of MPEF winds from November 1995 to May 1996 and MIEC winds from the last 15 months of operations.

2. MPEF AND MIEC WIND VALIDATION

Provision of validation data by MIEC was performed without major change since MIEC became operational until the end of November 1995. ECMWF validations started in October 1995, and MPEF operational wind extraction started in November 1995.

This resulted in a duplication of MIEC validation data for the month of October 1995, i.e. data were available from both, MIEC and ECMWF. This duplication is useful to assess the effect of systematic differences between the two validation schemes on the result of performance comparison between MIEC and MPEF winds.

ECMWF and MIEC validation procedures differed in two respects: first, the spatial collocation window used by ECMWF is narrower than the one used by MIEC. Second, ECMWF selected the radiosonde data according to an internal quality control scheme. Third, MIEC collocations were screened in order to remove gross errors in either the radiosondes or the satellite wind vectors, in cases when the vector difference exceeded 30 m/s or the direction difference exceeded 60 degrees. A summary of the differences is shown in Table 1.

	MIEC	**MPEF**
Period	early 1978 - Nov 95	Nov 95 - now
validation by	MIEC	ECMWF
exceptional validation by	ECMWF, for Oct 95 only	
Collocation time	1.5 h	1.5 h
Collocation vertical	25 hPa	25 hPa
Collocation horizontal	2x2 deg lat. - long.	150 km
Radiosonde selection	all available from GTS	selection by quality
Other screening	vector difference ≤30 m/s direction difference ≤ 60°	

Table 1: MIEC and MPEF verification method differences

As an immediate effect, the number of collocations between satellite winds and radiosonde winds in the ECMWF validation scheme was reduced to only one third of the number known from MIEC.

Another effect concerns the performance differences for this month and needs some discussion. Since the collocation window became more narrow and better radiosonde winds were selected for the comparison, it was expected that the ECMWF validation procedure would lead to smaller differences between satellite wind and radiosonde data. On the other hand, the screening of large deviations of vector and direction difference by MIEC could let the MIEC winds look slightly better.

Table 2 shows the performance differences found by the ECMWF and the MIEC validation schemes for October 1995, respectively, for the two main validation parameters, i.e. the RMS Vector Difference and the Speed Difference. Obviously, the table supports the contrary of what was expected because the ECMWF statistics shows larger values of negative speed difference and RMS vector difference than the MIEC statistics, except for the IR high level winds.

Wind Data Set of October 1995	ECMWF minus MIEC RMS Vector Difference	ECMWF minus MIEC Speed Difference	ECMWF minus MIEC mean Radiosonde Speed Difference
Water Vapour	0.9 m/s	-0,41 m/s	-1,43
IR high level	- 0.3 m/s	-0,90 m/s	-0,04
IR medium level	0.3 m/s	-0,60 m/s	-0,10
IR low level	0.5 m/s	-0,63 m/s	-0,21

Table 2: MIEC and MPEF validation differences for October 1995

Differences between ECMWF and MIEC validation data were largest for high level water vapour winds. For this data set, mean radiosonde speed in the ECMWF statistics was lower by 1.43 m/s, probably caused by different sets of radiosonde data used by ECMWF after quality screening.

This causes the ECMWF validation of MPEF WV winds to look slightly better than they would be at the same wind speed, because of the empirical correlation of speed bias and RMS vector difference with mean radiosonde speed. A correction can be made by estimating the relevant regression factors from the slopes of the two regression lines in Figure 1.

The resulting effect from the differences between validation schemes of ECMWF and MIEC on high level water vapour winds is such that MPEF speed bias appears 0.6 m/s more negative and RMS vector difference appears 1.2 m/s larger than for MIEC water vapour winds.

For the other height levels, radiosonde speed differences are smaller and such a correction is considered unnecessary.

The overall impression from Table 2 is that either, MIEC values were too optimistic or ECMWF validation is too pessimistic. There is no obvious argument to support either of these two possibilities.

These differences are based on one month of data only. However, since they look consistent amongst the different height levels, they are considered as relevant for comparison between MPEF and MIEC winds performance and are taken into account in the further discussion below.

3. MIEC VALIDATION RESULTS

The performance of MIEC winds during the period from September 1994 to November 1995 is illustrated in the following scatter diagrams of monthly average speed bias and RMS vector difference between METEOSAT and radiosonde observations. For comparison, the parallel validation results by ECMWF for October 1995 are included as bold squares.

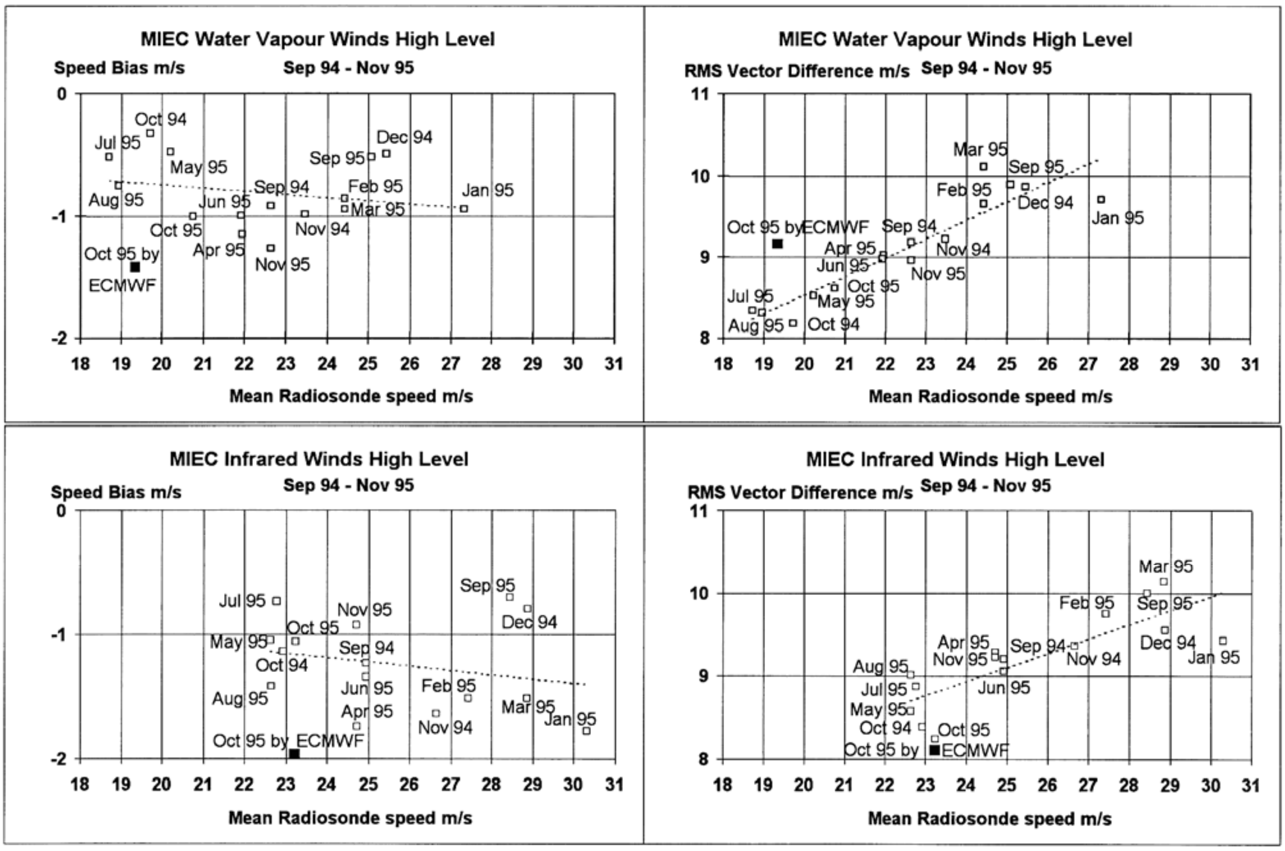

Figure 1: Scatter diagrams of monthly average speed bias (left panels) and RMS vector difference (right panels) of MIEC high level water vapour (upper panel) and IR winds (lower panel) versus radiosonde winds.

For high level winds, scatter patterns and regression lines look similar to previous periods of MIEC wind extraction schemes and validation data. There is also good similarity of patterns between high level IR and WV winds.

It is also apparent from the diagrams that the speed bias of WV winds was systematically less than for IR high level winds (about 0.4 m/s at equal wind speed). This has consistently been the case with MIEC WV winds since their operational production started in 1992.

RMS vector differences of WV winds were of the order of 0.6 m/s greater than for IR winds. This was assumed to be an effect of missing manual quality control .

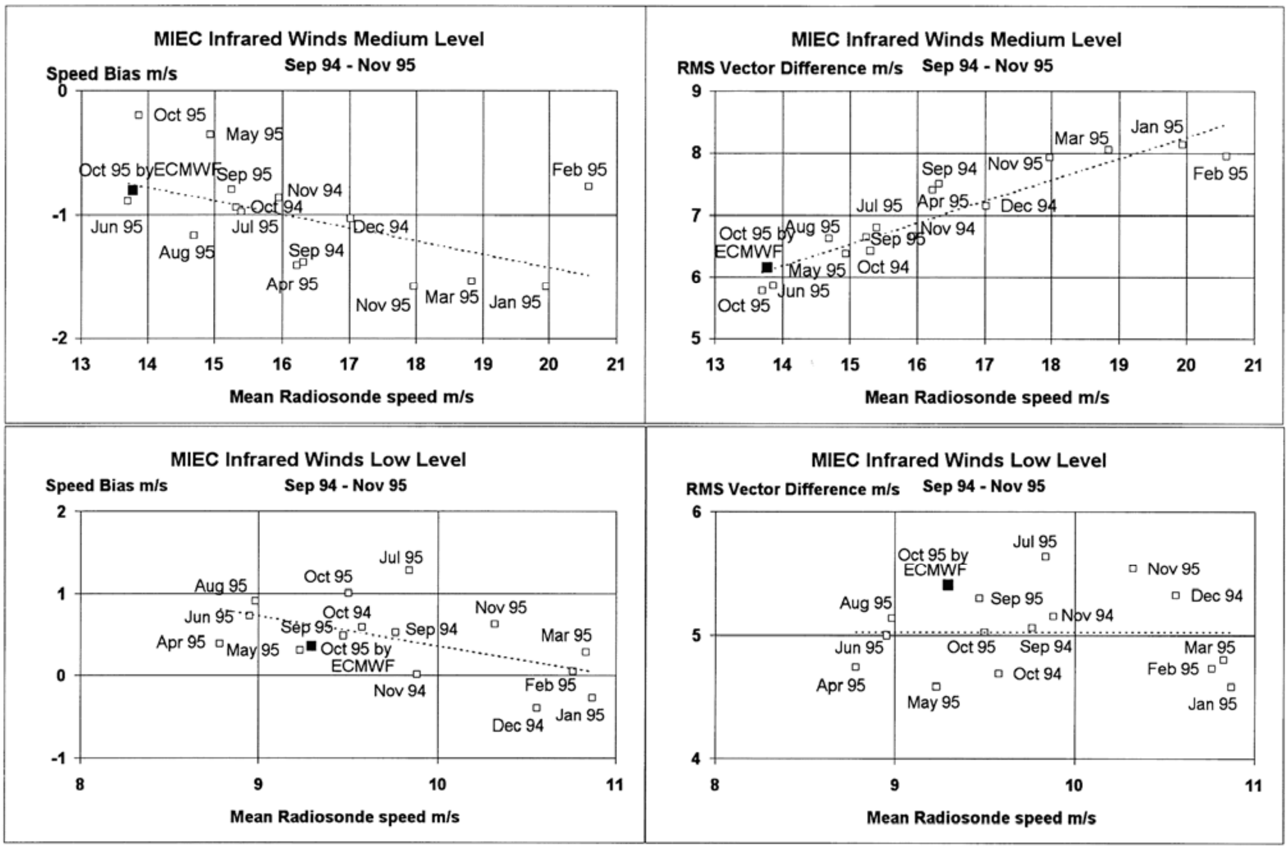

Figure 2: Scatter diagrams of monthly average speed bias (left panels) and RMS vector difference (right panels) of MIEC medium level (upper panel) and low level winds (lower panel) versus radiosonde winds.

Medium level winds show a pattern very similar to the high level winds, with a clear grouping around their regression line.

Correlation is much poorer for the RMS vector difference of low level winds because of some minor changes to the wind extraction scheme during the period. On the other hand, subdividing the period into smaller more homogeneous periods would reduce the number of data sets per period so far that conclusions would become speculative.

These diagrams represent the final performance level of the MIEC wind extraction scheme that has been reached after a long evolution since 1983.

4. MPEF VALIDATION

MPEF validation results are discussed below on the basis of scatter diagrams of monthly averages of speed bias and RMS vector difference between METEOSAT derived and radiosonde winds for the period from November 1995 to May 1996. It is noted that initial performance in November and December 1995 was quite poor, with subsequent improvement in the following months. Therefore, no regression lines were drawn from MPEF data because it is felt that the MPEF wind extraction scheme was not sufficiently homogeneous during this period. Instead, former MIEC regression lines are included in the diagrams for comparison and reference.

4.1 MPEF Water Vapour Winds

RMS vector difference of WV winds improved noticeably since November 1995, whereby the evolution from month to month was not steady.

At the end of April 1996, automatic quality control was tuned as described in detail by Rattenborg and Holmlund (1996). The effect was an increase by a factor of three of disseminated winds and a slight increase of RMS vector difference which can be seen from Figure 3.

The RMS vector difference of May 1996 appears about 1 m/s below the MIEC regression line (i.e. better) and the speed bias appears about 0.2 m/s below (i.e. slightly worse). In order to correct for the validation differences between ECMWF and MIEC, we apply a correction of 0.6 m/s for the speed bias and 1.2 m/s for the RMS vector difference as discussed in Chapter 2.

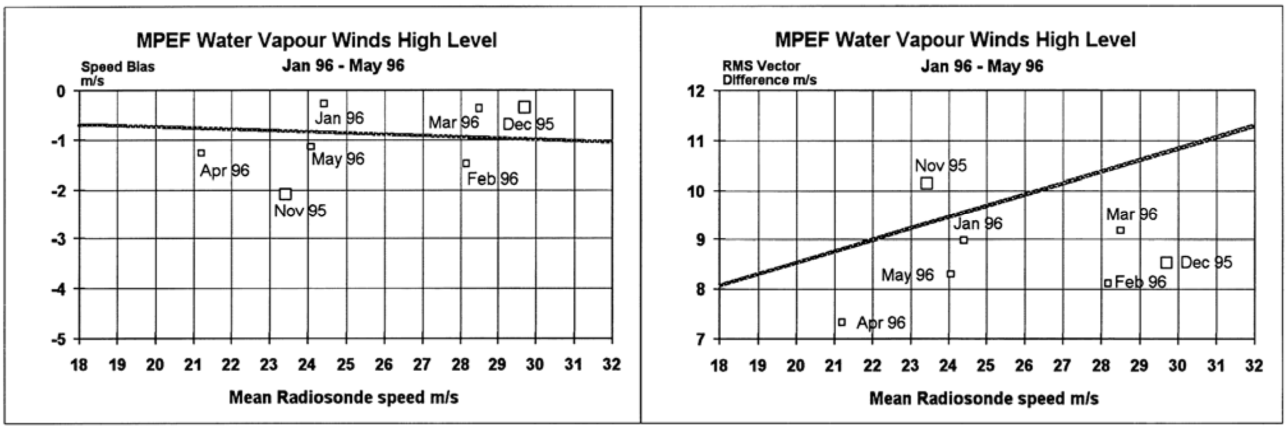

Figure 3: Scatter diagrams of monthly average speed bias (left panels) and RMS vector difference (right panels) of MPEF high level water vapour winds versus radiosonde winds.

It follows that WV winds in May 1996 have reached a significantly better quality level than the former MIEC, with differences estimated as 2.2 m/s for the RMS vector difference and ca. 0.8 m/s for the speed bias. This improvement is considerable. Its validity depends on the assumptions made about the validation differences between ECMWF and MIEC.

4.2 MPEF IR High Level Winds

The change of automatic quality control procedures at the end of April 1996 had a great impact on the selection of MPEF wind vectors from IR and WV channels for dissemination. MPEF operations foresee to disseminate only one high level wind per segment, whereby priority is given to WV winds in cases where both IR and WV wind vectors are available from the same segment. Since the number of WV winds was increased in May, there was a corresponding reduction of IR winds in areas where good WV winds were available. Unfortunately, IR high level winds are likely of good quality in the same areas, so that with May 1996, many IR winds of better quality were discarded by the selection process and more IR winds of inferior quality were left for dissemination. This caused also a strong reduction of the overall number of high level IR winds disseminated.

This procedure is different from the former MIEC who disseminated wind vectors from both channels independently in order to provide a maximum number of winds to the users.

The effect of the change on the performance of May 1996 can be seen in Figure 4 as a remarkable degradation of RMS vector difference against the previous months. Assuming that the slope of the MIEC regression line should also be applicable to MPEF winds, the conclusion is that disseminated MPEF IR high level winds were of lower quality than former MIEC winds: the RMS vector difference is greater than MIEC by ca. 0.3 m/s and the negative speed bias is greater than MIEC by about 0.9 m/s. Taking into account the differences of collocation criteria used by ECMWF and MIEC as listed in Table 2, the estimate is that for MPEF high level IR winds, RMS vector difference is greater by 1.2 m/s and speed bias is greater by -0.6 m/s as compared with MIEC.

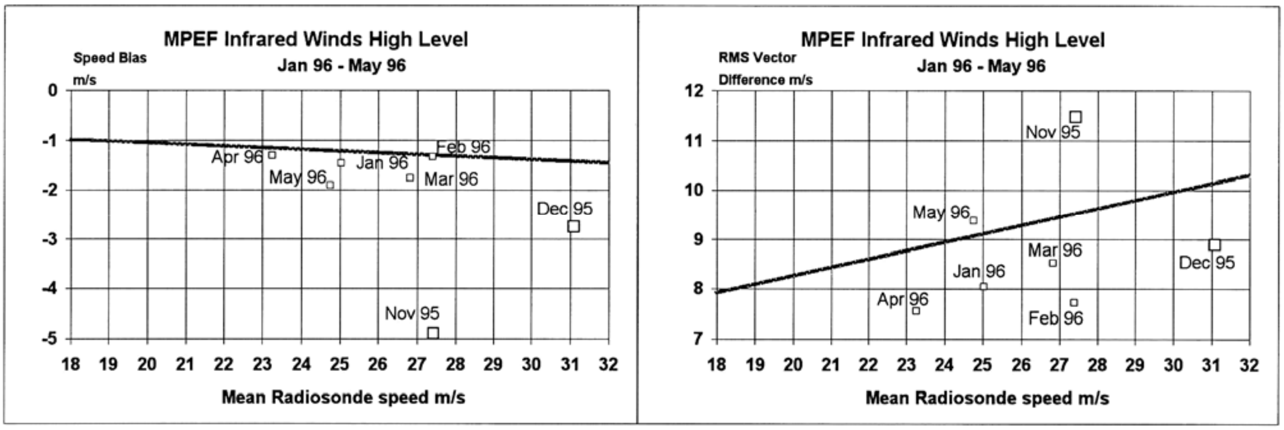

Figure 4: Scatter diagrams of monthly average speed bias (left panels) and RMS vector difference (right panels) of MPEF high level IR winds versus radiosonde winds.

4.3 MPEF IR Medium and Low Level Winds

Scatter diagrams for medium and low level wind verification data indicate slight improvement against former MIEC performance. This improvement is increased further when the validation differences as discussed in Chapter 2 are taken into account.

Medium level data for the months starting with January 1996 look more regular than for high level IR winds. This indicates that the wind extraction method remained relatively stable during this period.

Low level winds exhibit the same lack of correlation between RMS vector difference and speed bias as for MIEC winds, i.e. the wind extraction scheme was not stable throughout the period. For both height levels, the overall number of wind vectors produced was much smaller than known from the former MIEC.

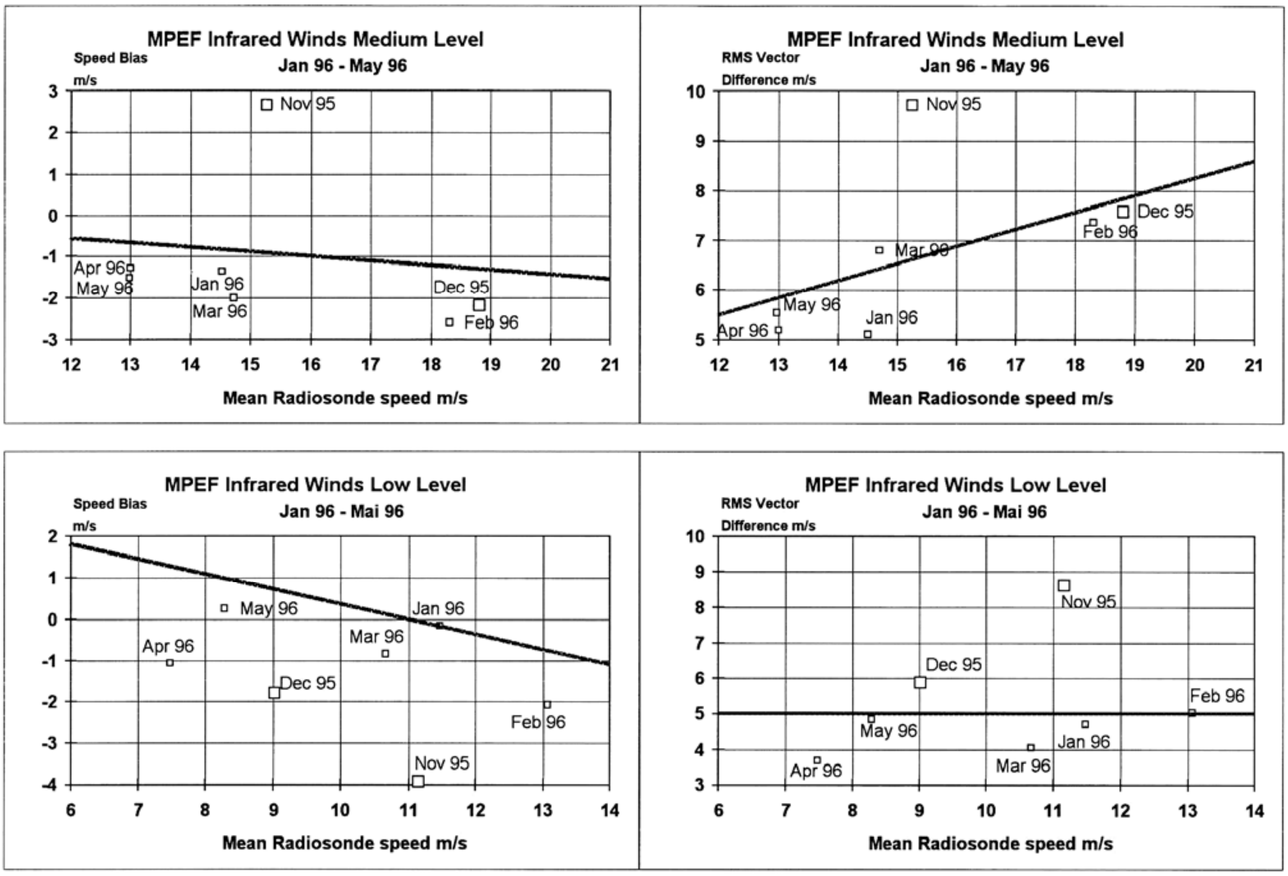

Figure 5: Scatter diagrams of monthly average speed bias (left panels) and RMS vector difference (right panels) of MPEF medium level (upper panel) and low level winds (lower panel) versus radiosonde winds.

4.4 OVERALL NUMBER

The overall number of winds disseminated by MPEF has been much lower than by MIEC. This is probably caused by restrictive quality control during the early life of MPEF. Fig 6 shows the overall number of winds disseminated, separately for IR and WV winds, respectively. Whereas the overall number of WV winds was greatly increased in May 1996, the number of IR winds was kept about the same throughout the period from January to May 1996.

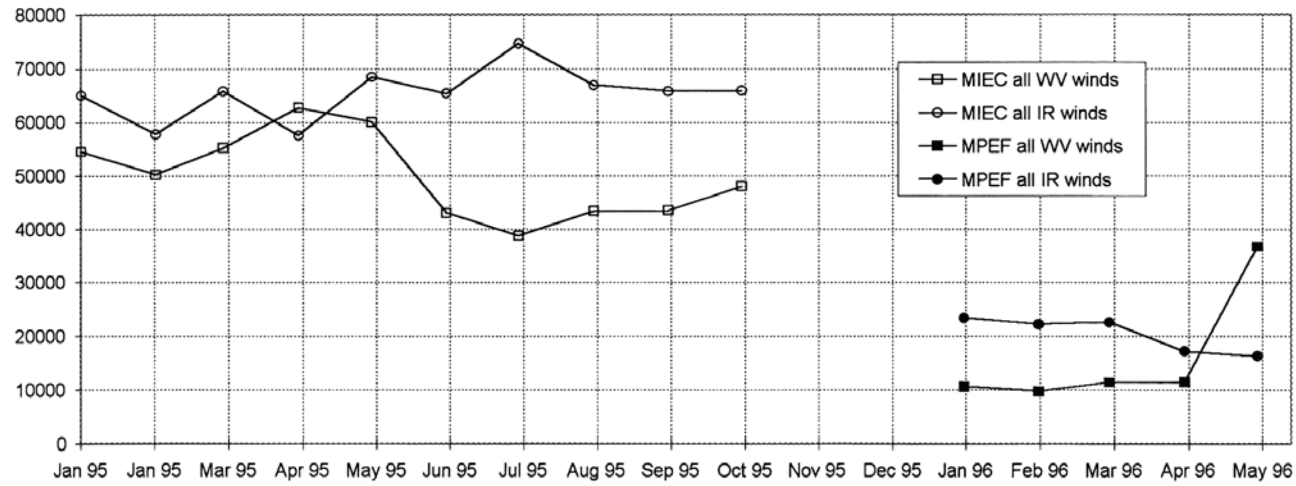

Figure 6: Overall Number of MIEC and MPEF winds disseminated.

Some more details of number and geographical coverage are discussed by Strauss et. al. (1996).

5. CONCLUSION

After poor quality at the beginning of MPEF operations, wind quality greatly improved during the following months at the expense of considerably reduced quantity.

In May 1996 high level water vapour winds reached a quality level much better than MIEC, and a quantity nearly comparable. However, high level IR winds quality was still poorer than MIEC.

For medium and lower level IR winds, the quality is better than MIEC but the overall number is still too small.

6. ACKNOWLEDGEMENT

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