STATUS OF GMS-5 WIND PRODUCTS AND MTSAT WIND PRODUCTS PLANS AT MSC/JMA

Masami Tokuno

Meteorological Satellite Center, Japan Meteorological Agency
3-235, Nakakiyoto, Kiyose, Tokyo
Japan

ABSTRACT

The Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) has operationally produced Cloud Motion Winds and Water Vapor Motion Winds from GMS-5 images four times a day and High Resolution Low-level Cloud Motion Winds (HRLCMW) in the vicinity of the typhoon once a day in the daytime for only one typhoon. This paper presents the current status and quality of High level Cloud Motion Winds and Water Vapor Motion Winds in the last three years. In addition, we will describe some plans for the satellite wind products with MTSAT at MSC.

1. Introduction

Meteorological Satellite Center (MSC) has produced Cloud Motion Winds (CMWs) since 1982. The following improvements have been carried out up to now. The program of high-level CMWs (HCMWs) extraction has been changed, i.e., the revision of height assignment table (1990), the second revision of height assignment table (1993), the exclusion of the area containing cumulonimbus and the introduction of IR and WV intercept technique (1995)(Takata 1993; Tokuno 1996). The program of quality control has also been changed, the introduction of intensive manual quality control technique including reassignment of wind height assigned automatically (1991) and the employment of improved manual quality control software (1992) (Takata 1993). Low-level CMWs (LCMWs) extraction scheme has not been changed since the introduction of automatic wind extraction in 1982. LCMWs are derived through man-machine interactive process as same as HCMWs for quality control. In addition, MSC has produced Water Vapor Motion Winds (WVMWs) from GMS-5 image data since June 1995. IR-WV intercept technique is used to assign wind height automatically. WVMWs are derived through automatic objective quality control process (Tokuno 1996). Recently MSC has increased the number of derived WVMWs since July 31 1998.

This report firstly shows current operational wind products of MSC and the results of evaluation of HCMWs and WVMWs in the last three years. Then we compare the results of the accuracy of WVMWs before and after the introduction of increasing the number of derived WVMWs. Finally we show a future plan for satellite wind products.

2. Current Operational Wind Products

Current GMS-5 operational wind products are shown in Table-1. Both low and high level CMWs have been produced by using visible and infrared images. The techniques of target cloud selection and height assignment were modified in September 1995. In target selection, a new processing was introduced to exclude the areas containing cumulonimbus by using brightness temperature difference between IR and WV sensor. In the height assignment, an IR and WV intercept technique was newly introduced to correct brightness temperature of non-black body clouds.

WVMWs are derived a middle and high levels in the troposphere from WV images. The WVMW extraction scheme is basically the same as that of CMW. However, its quality check is applied only by the automatic procedure, in which homogeneity of the speed, direction and height are controlled. WVMWs have been operationally disseminated via GTS since 28 March 1996. Recently MSC has increased the number of derived WVMWs since July 31 1998.

High density low level visible winds were derived from time-sequential images at 15 minute intervals around 04 UTC in May 1988. Automatic quality control procedure was introduced in 1992. In this procedure, the weak wind whose speed is less than 5 m/s and the wind whose direction is anticyclonic in regard to typhoon center are excluded.

Table 1 Operational Wind Products of MSC

Type of Product	Region of Interest	Output Frequency
Cloud / Water Vapor Motion Winds	50°N – 50°S 90°E – 170°W	00UTC, 06UTC, 12UTC,18UTC 4 times / day
High Density Low Level Visible Winds Around Typhoon	20°lat. X 20°long. Centered on the typhoon Center	Once a day (04UTC) When a typhoon exists

3. Current Status of the Accuracy of GMS-5 Cloud Motion Winds

Monthly mean differences between CMWs or WVMWs and rewinsonde winds are calculated in accordance with the method specified in the international comparison of Atmospheric Motion Winds. Vector differences of CMWs and WVMWs from January 1997 through December 1999 are shown in Fig. 1 (a), and speed differences are shown in Fig. 1 (b), (c) and (d).

3.1 Low-level CMWs

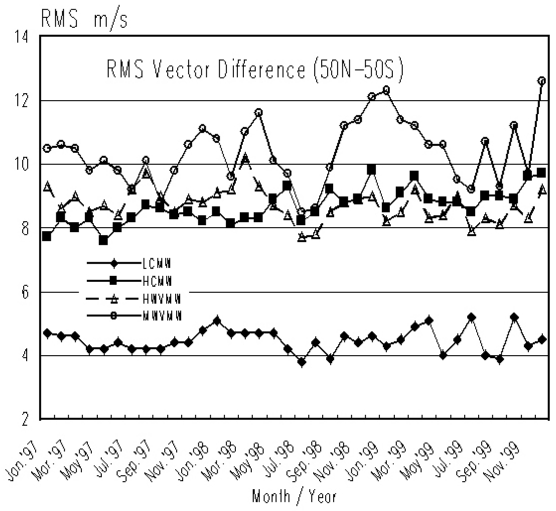
The root mean square (RMS) vector differences are 3.8~5.2 m/s and the fluctuation increases in 1999 (Fig. 1(a)). RMS speed differences are 2.7~4.5 m/s and the fluctuation increases in 1999 (Fig.1 (b)). Average speed differences (BIAS) are -0.7~0.7 m/s with a short term variation (Fig.1 (c)) and absolute value of the speed difference (ABS) is 1.9~2.6 m/s with a seasonal variation (Fig.1 (d)).

3.2 High-level CMWs

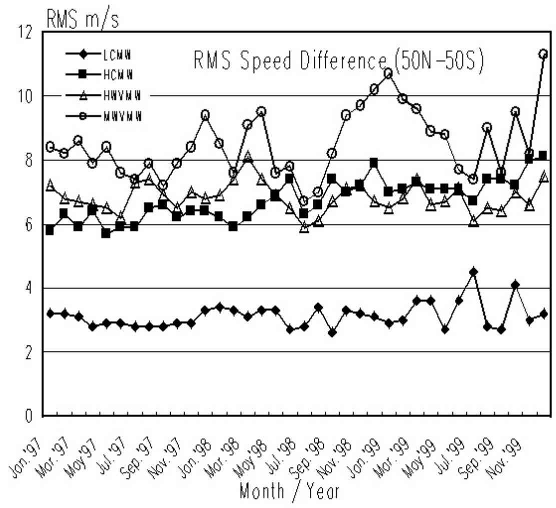
RMS vector differences are 7.6~9.8 m/s, which have an increasing tendency after the latter 1998 (Fig.1 (a)). RMS speed differences are 5.8~8.1 m/s (Fig.1 (b)) and ABS is 4.0~5.8 m/s (Fig.1 (d)). Both have an increasing tendency after the latter 1998. BIAS are -3.8~-0.8 m/s, which have an increasing tendency year by year (Fig.1 (c)).

3.3 High-level WVMWs

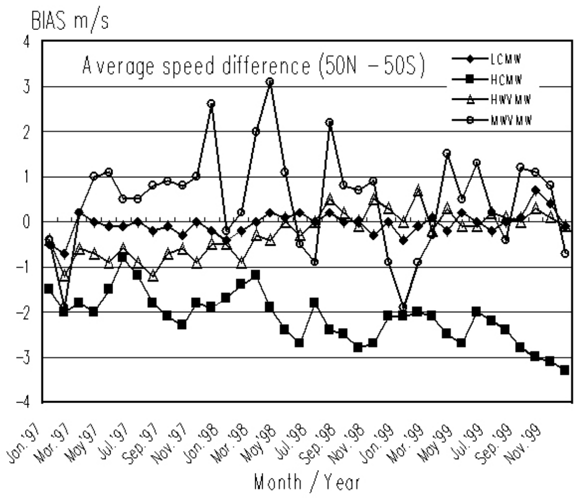
RMS vector differences before and after July 1998 are 7.7~10.2 m/s (means : 8.9 m/s) and 7.8~9.2 m/s (means : 6.9 m/s) (Fig.1 (a)). Those of RMS speed differences are 5.9~8.1 m/s (means : 6.9 m/s) and 6.1~7.5 m/s (means : 6.8 m/s) (Fig.1 (b)). Those of BIAS are –1.2~0.0 m/s (means : -0.6 m/s) and -0.2~0.7 m/s (means : 0.2 m/s) (Fig.1 (c)). Those of ABS are 4.4~5.8 m/s (means : 4.9 m/s) and 4.5~5.2 m/s (means : 4.8 m/s) (Fig.1 (d)). Thus the value of the later in all the cases above is a little smaller than that of the former. This result suggests that the amount of highly accurate HWVMWs increases as the total number of derived WVMWs increases.



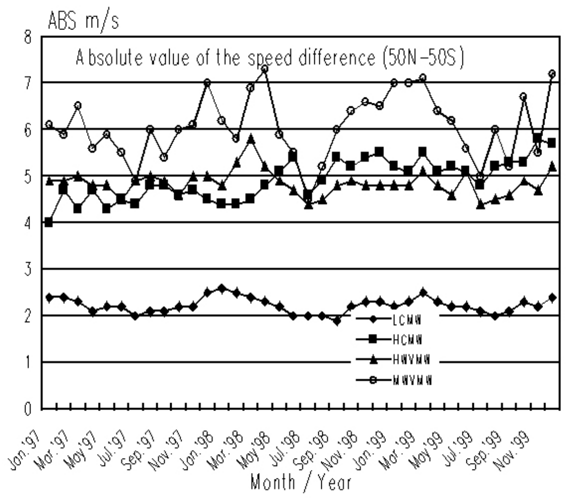
(a) RMS Vector Difference



(b) RMS Speed Difference



(c) Average Speed Difference



(d) Absolute Value of the Speed Difference

Figure 1. Monthly means of differences between GMS-5 CMWs or WVMWs and radiosonde wind from January 1997 through December 1999. LCMW : Low-level CMW, HCMW : High-level CMW, HWVMW : High-level WVMW, MWVMW : Middle-level WVMW

3.4 Middle-level WVMWs

RMS vector differences before and after July 1998 are 8.5~11.6 m/s (means : 10.1 m/s) and 8.6~12.6 m/s (means : 10.7 m/s) (Fig.1 (a)). Those of RMS speed differences are 6.7~9.5 m/s (means : 8.1 m/s) and 7.0~11.3 m/s (means : 9.0 m/s) (Fig.1 (b)). Those of BIAS are -1.9~3.1 m/s (means : 0.5 m/s) and -1.9~2.2 m/s (means : 0.4 m/s) (Fig.1 (c)). Those of ABS are 4.5~7.3 m/s (means : 5.9 m/s) and 5.0~7.2 m/s (means : 6.2 m/s)(Fig.1 (d)). Thus the value of the latter in above cases is a little larger than that of the former. This result suggests that the amount of inaccurate MWVMWs increases as the total number of derived WVMWs increases.

4. Comparison of High-level CMWs in 1997 with those in 1999

As shown in the session 3.2, the accuracy of HCMWs has a decreasing tendency since the latter 1998. Further investigation is carried out through the comparison of HCMWs in 1997 with those in 1999, dividing into two groups, in the summer (July and August) and the in the winter (December and next January).

Fig. 2 shows the distribution of total number of HCMWs per station used for comparison of HCMWs with rewinsode winds in the summer of 1997 and in the winter of 1997/1998. As expected, the total number of northern extra-tropical regions increases in the summer, while that of tropical regions decreases. In contrast, those of southern extra-tropical regions and tropical regions are increase in the winter. The distribution of total number of HCMWs 1999 is similar to that in 1997.

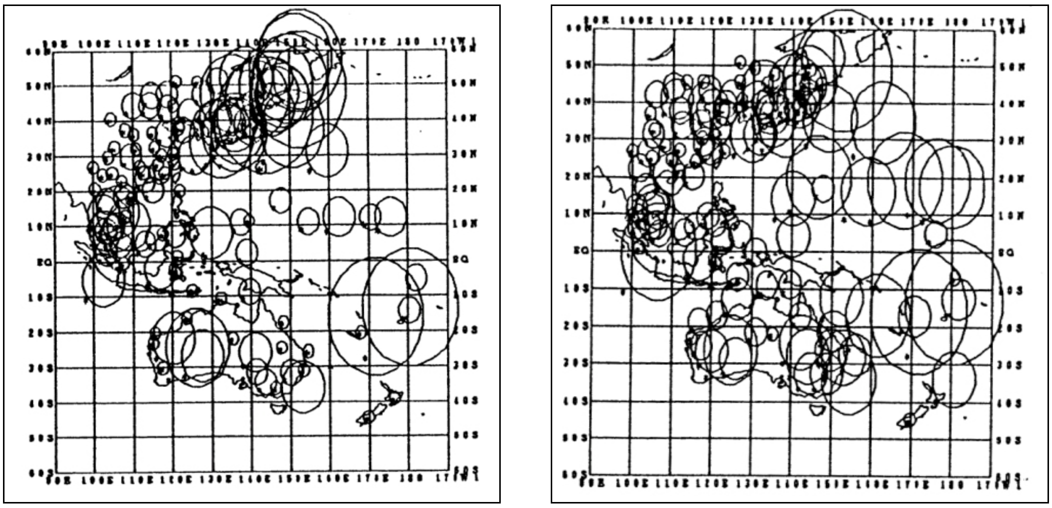
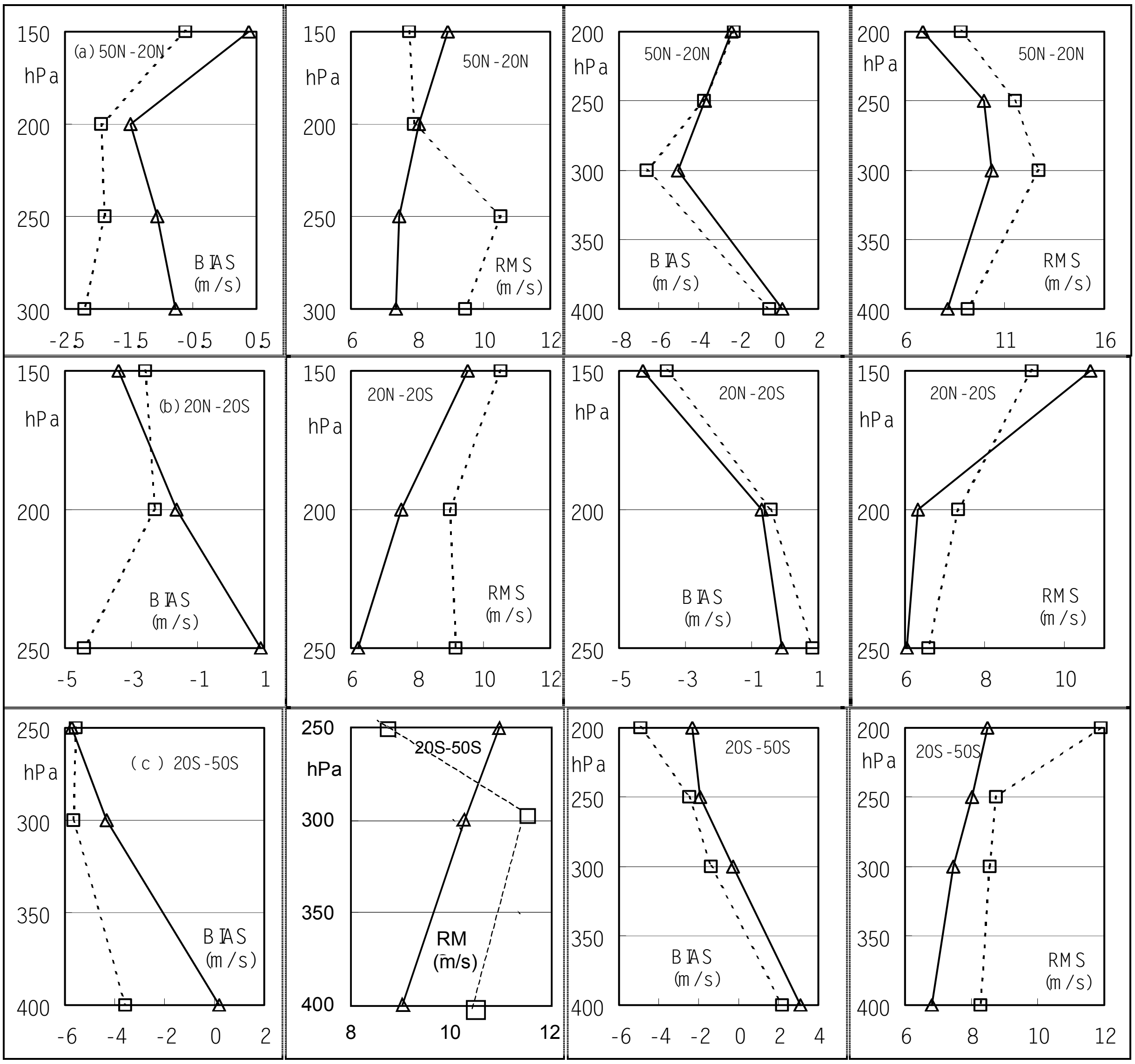


Figure 2. The distribution of total number of HCMWs per station used for the comparison.
Left HCMWs, July and August 1997. Right;HCMWs, December 1997 and January 1998

Fig. 3 shows the comparison of the vertical distribution of wind speed bias and RMS vector difference in the three latitude zones, i.e., northern extra-tropical regions (NH) (50N–20N), Tropical regions (TR) (20N–20S) and southern extra-tropical regions (SH) (20S–50S). The following features are outstanding. The negative speed bias of 1999 is apparently increased compared with that of 1997, exceptionally in both of Extra Hemisphere, that of 1999 is about 2 m/s larger than that of 1997. RMS Vector Difference in 1999 has the same tendency as that of speed bias as that of 1999 is about 2 m/s larger than that of 1997 in all regions. Thus the accuracy of HCMWs in 1999 significantly decreases compared with that of 1997, especially in the summer.



Wind Speed Bias RMS Vector Difference Wind Speed Bias RMS Vector Difference
HCMWs (Summer) Δ:1997 □:1999 HCMWs (Winter) Δ:1997/1998 □:1998/1999

Figure 3. The vertical distribution of wind speed bias and RMS vector difference in (a) NH (50N-20N), (b) TR (20N-20S), (c) SH (20S-20N) for HCMWs.

5. Comparison of WVMWs in 1997 with those in 1999

As shown in the session 3.3 and 3.4, accuracy of HWVMWs has a increasing tendency since August 1998 when the total number of WVMWs was increased. In contrast, the accuracy of MWVMWs has a decreasing tendency since August 1998. Further investigation is carried out through the comparison of WVMWs in 1997 with those in 1999 in the same way shown in the previous session.

Fig. 4 shows the distribution of total number of WVMWs per station used for comparison of WVMWs in the summer of 1999 and in the winter of 1998/1999 after the introduction of increasing the number of derived WVMWs. As expected, the total number of derived WVMWs in northern extra-tropical regions increases extremely in the summer. In contrast, that in southern extra-tropical regions and in tropical regions increases extremely in the winter.

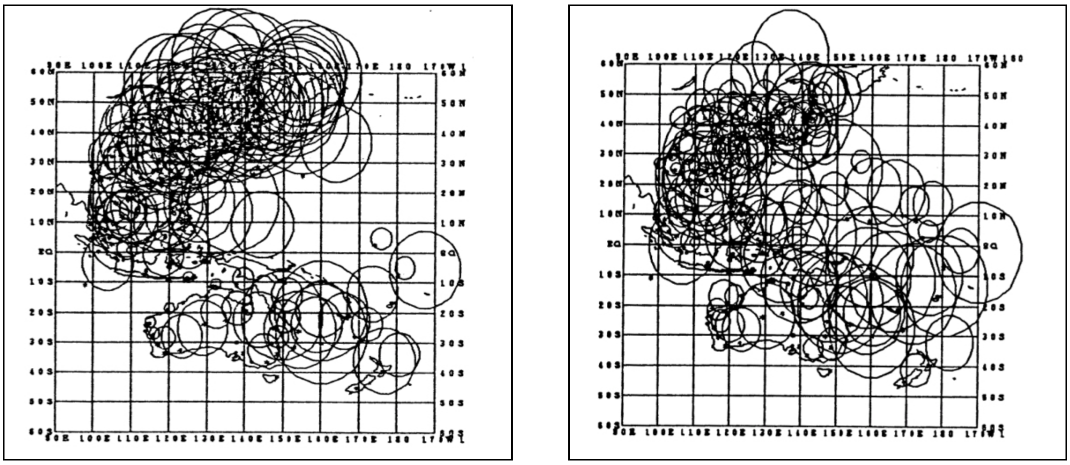
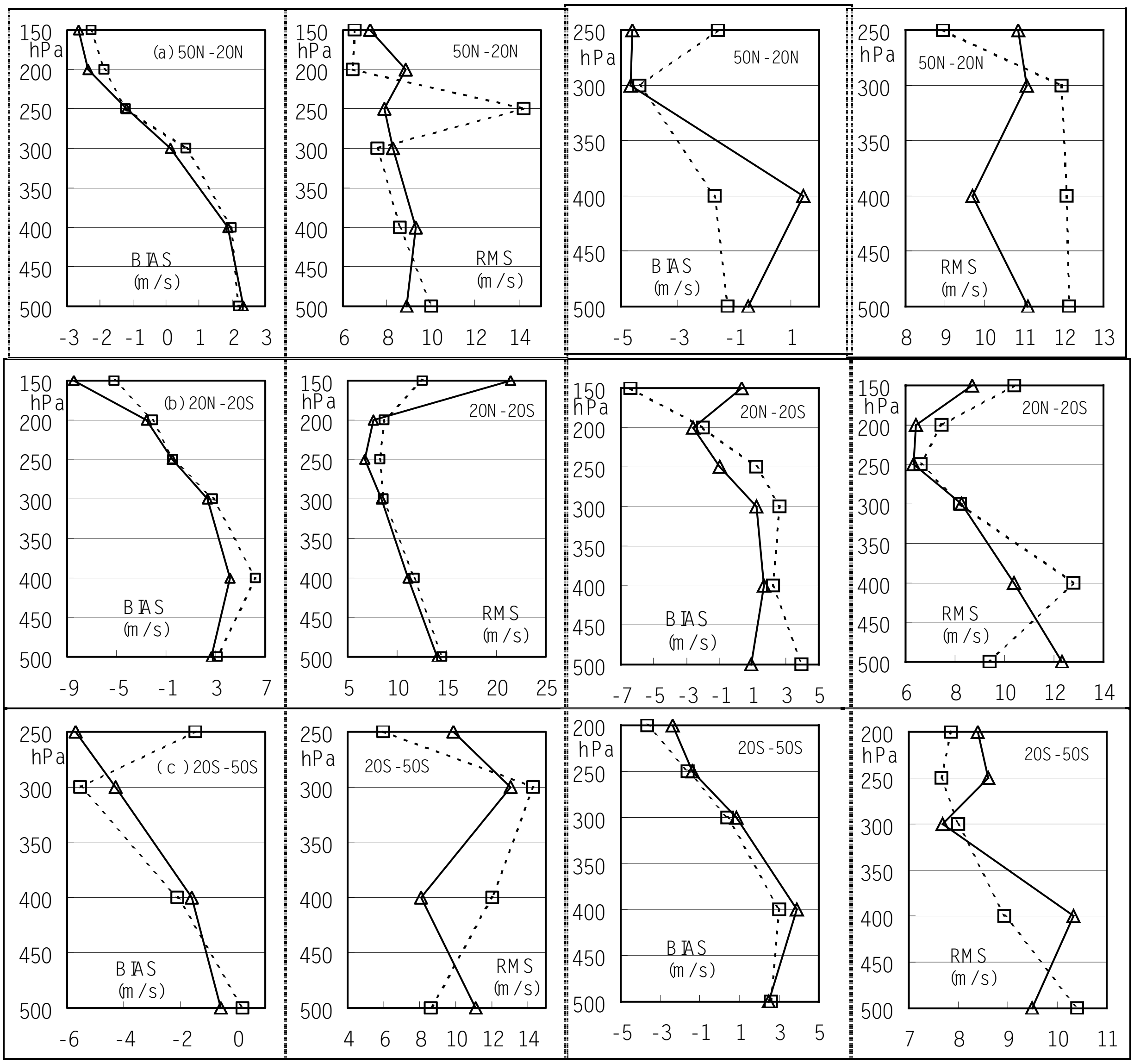


Figure 4. The distribution of total number of WVMWs per station used for the comparison.
Left; WVMWs, July and August 1999 right; WVMWs, December 1998 and January 1999.



Wind Speed Bias RMS Vector Difference Wind Speed Bias RMS Vector Difference
WVMWs (Summer) Δ:1997 □:1999 WVMWs(Winter) Δ:1997/1998 □:1998/1999
Figure 5. The same as Figure 3 for WVMWs

Fig. 5 shows the comparison of the vertical distribution of wind speed bias and RMS vector difference in the three latitude zones. The following features are outstanding. In the summer, there is no significant difference between 1997 and 1999 in wind speed bias. RMS vector difference at 250 hPa of 1999 in NH region is greatly larger than that of 1997. In addition, RMS vector difference in SH region in 1999 is about 2 m/s larger than that in 1997. In the winter, negative speed bias of 1998/1999 in NH region is larger than that of 1997/1998. In contrast, negative speed bias of 1998/1999 in TR region is smaller than that of 1997/1998. RMS vector difference of 1998/1999 is larger than that of 1997/1998 between 300 hPa and 500 hPa. Thus RMS vector difference of 1998/1999 has a increasing tendency compared with that of 1997/1998 in the winter of both NH and SH region.

6. Future plan

Although MTSAT's launch did not succeed due to trouble of the launch vehicle on November 15, we are planning to launch MTSAT-1R as a replacement of MTSAT in the end of FY 2002 and a follow-on MTSAT-2 in FY 2004. The operation of MTSAT-1R will begin in FY 2003. Functions of the meteorological mission of MTSAT-1R will be almost the same as the planed MTSAT.

MSC will partly change the way of producing satellite winds when MTSAT-1R is operated in FY 2003, shortening the interval between images for wind tracking from 30-minute to 15-minute. It is expected that this change will bring an increase of the number of infrared winds by about 20 % more than the present product (Tokuno 1997). Taking an advantage of images at 15-minute intervals, MSC will also produce HRLCMWs four times a day for all observed typhoons to support typhoon analysis at the Forecast Division of JMA headquarter. In addition, the information on the HRLCMWs will be transmitted on LRIT to national Met Services that may be affected by the typhoons.

MSC currently has medium-term targets of wind products: increase in the number of derived wind vectors, provision of high-density winds, improvement of the height assignment method, full automated quality control, adding quality information to each vectors, dissemination of products in the BUFR format and adaptation to data assimilation with 4D-Variation method in the numerical prediction model.

In order to achieve these goals, it is necessary to improve the efficiency of software development and computation performance. MSC has begun shifting the facility to produce satellite wind from mainframe computers to work stations. Hereafter, we will gradually develop and replace the algorithms and finally complete then in 2004, when 4D-Var methods is to be introduced into JMA numerical model.

MSC is planning to begin the operation of deriving high-density winds around up to five typhoons at the same time using 15-minute interval visible images by early 2000. High-density winds are presently derived for only one typhoon at a time (Fig. 6).

7. Conclusion

Forgoing analysis leads to the following conclusion. The accuracy of HCMWs in 1999 significantly decreases compared with that of 1997 in the last three years. The accuracy of WVMWs after the introduction of increasing the number of derived WVMWs also decreases in the winter of both NH and SH region although the accuracy of WVMWs does not decrease in other seasons and in TR region The cause is not yet cleared. Therefore the effort is inquired to clear up the cause.

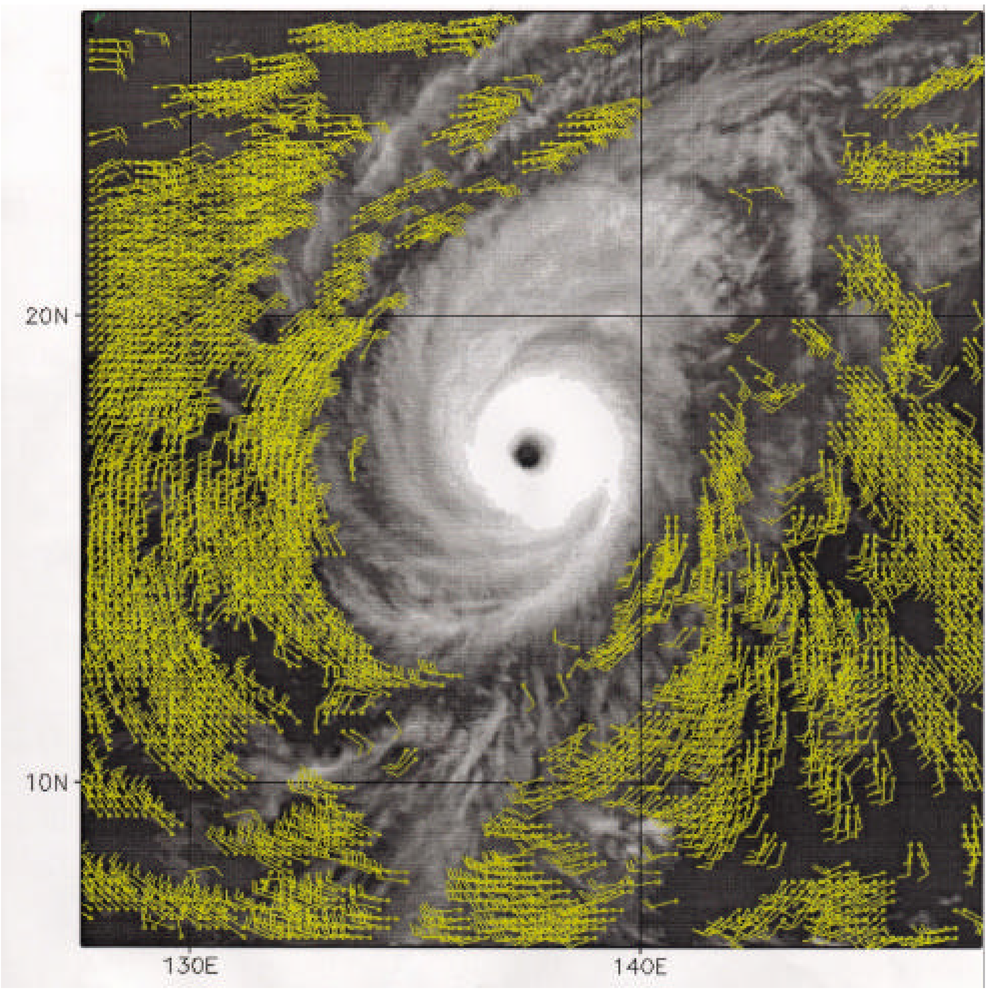


Figure 6. Illustration of the high density visible CMWs in typhoon vicinity at 04 UTC 20 Apr. 1997.

REFERENCES

Takata, S., 1993: Current status of GMS wind and operational low-level wind derivation in a typhoon vicinity from short-time interval images. *Proceedings of Second International Winds Workshop*, Tokyo, 17 – 15 Dec. 1993. EUMP14, 29-36.

Tokuno, M, 1996: Operational system for extracting cloud motion and water vapor motion winds from GMS-5 image data *Proceedings of Third International Winds Workshop*, ASCONA, SWITZERLAND, 10 –12 June 1996. EUMP18, 21-30.

Tokuno, M, 1997: Development of new products for MTSAT. *Proceedings of 1997 Meteorological satellite data users' conference*, Brussels, Belgium 29th September – 3rd October 1997.