CGMS-36 JMA-WP-06

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STATUS AND RECENT ACTIVITIES ON ATMOSPHERIC MOTION VECTORS AT JMA

In response to CGMS Recommendation 35.07

This paper reports on the status of MTSAT-1R AMVs and recent JMA's activities on it.

JMA terminated SATOB report at 06 UTC on 1 April 2008. JMA's AMV is currently available in BUFR report. The qualities of IR AMVs and cloudy-region WV AMVs have been improved since June 2007 when JMA updated the height assignment scheme. The distinct improvement is recognized in winter AMVs over the Southern Hemisphere.

For further AMV improvement, JMA is developing a new height assignment scheme for IR AMVs, and seeking the best size of image segment for tracking target. JMA plans to introduce the new algorithm by March 2009.

In the T-PARC study in 2008, JMA conducted Rapid Scan observations using MTSAT-2. JMA generated AMVs from Rapid Scan observations with appropriate parameters such as image segment for tracking target.

In response to Recommendation 35.07, JMA submitted AMVs computed from METEOSAT-8 and ECMWF forecast field using JMA's AMV algorithms.

JMA plans to start reprocessing AMVs from GMS, GOES-9 and MTSAT-1R images using available best algorithms to contribute to future reanalysis projects by the end of 2008.

STATUS AND RECENT ACTIVITIES ON ATMOSPHERIC MOTION VECTORS AT JMA

1 INTRODUCTION

The Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) produces Atmospheric Motion Vectors (AMVs) using MTSAT-1R images. This working paper reports on AMVs generated by JMA: the status of AMV production and dissemination in section 2, the recent AMV quality in section 3, recent JMA's activities on AMVs in section 4, and JMA's response to Recommendation 35.07 in section 5.

2 STATUS OF AMV PRODUCTION AND DISSEMINATION

Table 1 shows an outline of MTSAT-1R AMVs. JMA generates four types of AMVs from the MTSAT-1R images of Infrared (IR: 10.8 micrometer), Water Vapour (WV: 6.8 micrometer), Visible (VIS: 0.63 micrometer) and short-wave Infrared (IR4: 3.8 micrometer) (referred to below as IR AMV, WV AMV, VIS AMV and IR4 AMV, respectively).

JMA generates AMVs for full disk every six hours at 00, 06, 12 and 18 UTC from three successive images with an interval of 15 minutes, and delivers them via the Global Telecommunication System (GTS) in Binary Universal Form for data Representation (BUFR) format (six-hourly AMVs). SATOB report was terminated at 06 UTC on 1 April 2008. In addition, JMA generates AMVs over the Northern Hemisphere every hour between the six-hourly AMVs from images with an interval of 30 or 60 minutes (hourly AMVs)

In order to compensate the VIS AMVs at nighttime, JMA newly started to generate IR4 AMVs operationally on 25 March 2008, which is used in the JMA NWP system.

In addition to six-hourly AMVs, JMA plans to start distributing AMVs at 03, 09, 15 and 21 UTC in 2009.

Table 1 MTSAT-1R Atmospheric Motion Vector products generated by JMA

Kind of AMVs	Level of height	Time (UTC)	Image sector	Image interval (minutes)	Distribution
Infrared: IR (10.8 micrometer)	Upper, middle, lower	00, 06, 12, 18	Full Disk	15	BUFR via GTS
	Upper, middle, lower	02-05, 08-11, 14-17, 20-23	Northern Hemisphere	30	Internal use only
	Upper, middle, lower	01, 07, 13, 19	Northern Hemisphere	60	Internal use only
Water Vapor: WV (6.8 micrometer)	Upper, middle	00, 06, 12, 18	Full Disk	15	BUFR via GTS
	Upper, middle	02-05, 08-11, 14-17, 20-23	Northern Hemisphere	30	Internal use only
	Upper, middle	01, 07, 13, 19	Northern Hemisphere	60	Internal use only
Visible: VIS (0.63 micrometer)	Lower	00, 06	Full Disk	15	BUFR via GTS
	Lower	02-05, 08, 09 21-23	Northern Hemisphere	30	Internal use only
	Lower	01, 07	Northern Hemisphere	60	Internal use only
Short-wave Infrared: IR4 (3.8 micrometer) *1	Lower	12, 18	Full Disk	15	Internal use only
	Lower	08-11, 14-17, 20-23	Northern Hemisphere	30	Internal use only
	Lower	07, 13, 19	Northern Hemisphere	60	Internal use only

*1 JMA started to generate IR4 AMVs operationally on 25 March 2008.

3 RECENT QUALITY OF AMV

This section describes the monthly quality of the six-hourly IR and WV AMVs since July 2005 based on the standard CGMS AMV statistics. To evaluate the quality of the AMVs, they are compared with radiosonde observations. As reported at CGMS35 JMA-WP-06, the operational height assignment scheme was revised on 30 May 2007.

IR AMVs

Figure 1 shows a time series of the monthly statistics ((a) Root Mean Square Vector Difference (RMSVD), wind speed bias (BIAS) and (b) number) for the upper-level (above 400 hPa) IR AMVs. In the statistics, AMVs with Quality Indicator (QI) above 0.85 are used. In accordance with the radiosonde observation time, AMVs at 00 and 12 UTC are used. Figure 1 (a) shows that RMSVDs and BIASes of upper height level IR AMVs increase in winter for both the Northern and the Southern Hemispheres. However, the increase after June 2007 (shown by the vertical arrow), when the new height assignment scheme was introduced, is less than that in pervious years, particularly for the AMVs over the Southern Hemisphere in winter. The number of the upper-level IR AMVs (QI>0.85) AMVs in all regions increased slightly after June, 2007 (Figure 1 (b)).

(a)

(b)

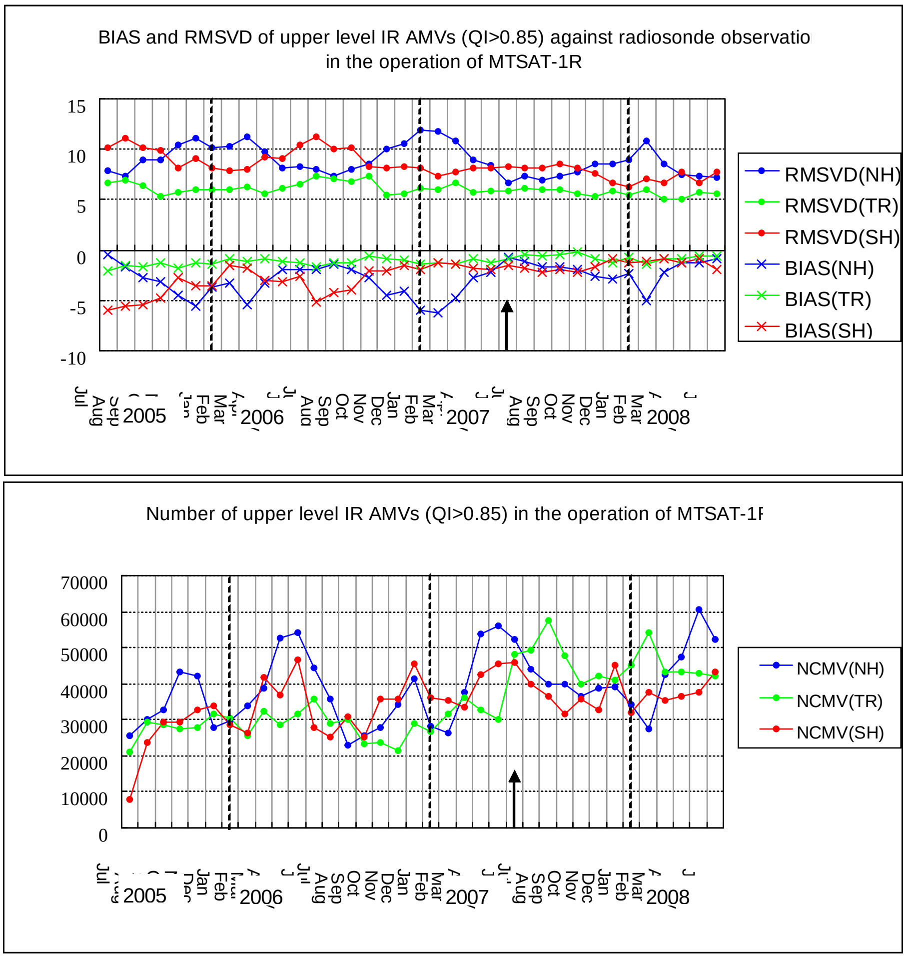

Figure 1 Long-term time series of (a) RMSVDs and BIAS es and (b) the number for upper-level IR AMVs (QI>0.85) over the Northern Hemisphere (between 20N and 50N), the Southern Hemisphere (between 50S and 20S) and the Tropics (between 20 S and 20N). The blue, red, and green lines stand for the Northern Hemisphere, the Southern Hemisphere and the Tropics, respectively. The black arrows in (a) and (b) denote the month when the current height assignment scheme was introduced in operation.

WV AMVs

Figure 2 (a) and (b) are similar to Figure 1 (a) and (b), but for the WV AMVs computed above 400 hPa over cloudy region. For the statistics, AMVs with Quality Indicator (QI) above 0.85 are used. Figure 2 (a) shows that the winter slow BIASes of WV AMVs are smaller than those of the IR AMVs in Figure 1 (a), while small fast BIASes are recognized in the summer hemisphere (Figure 2 (a)). The change in accuracy of the WV AMVs is not clear between before and after the improvement of the height assignment scheme. However, Figure 2 (b) shows that the numbers of the WV AMVs significantly increase after the improvement.

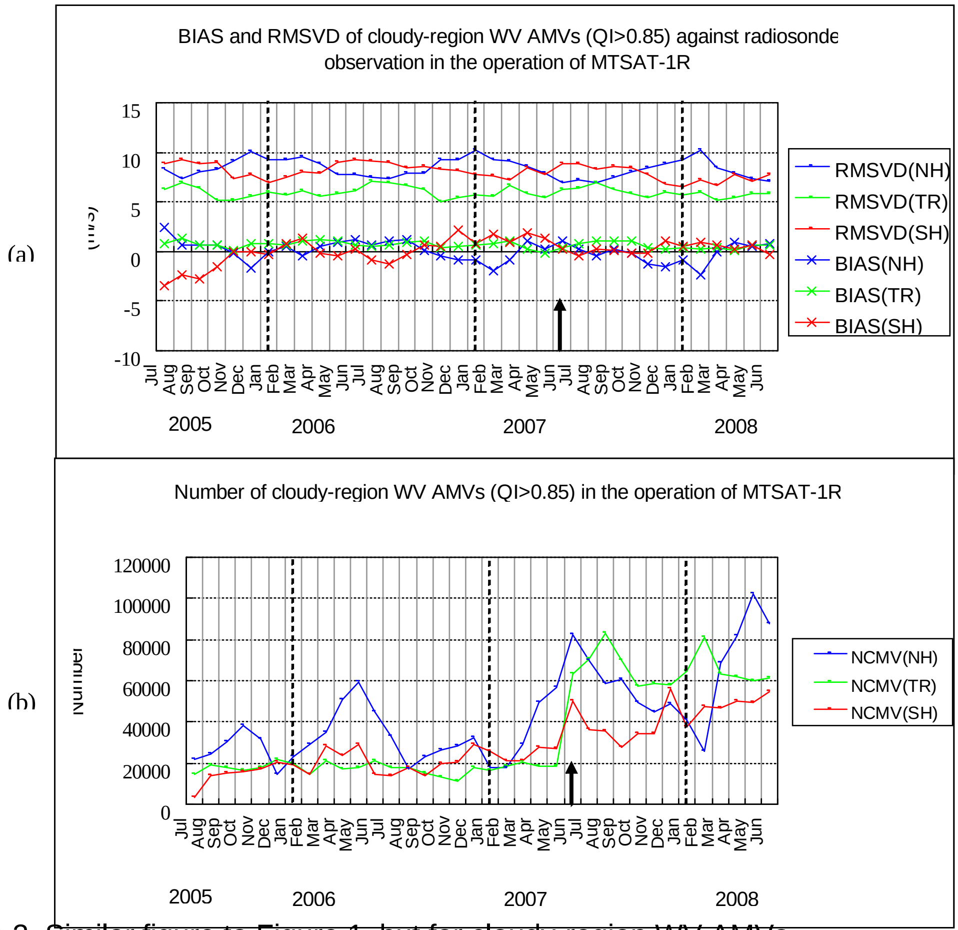

Figure 2 Similar figure to Figure 1, but for cloudy-region WV AMVs.

4 RECENT ACTIVITIES ON AMV

4.1 DEVELOPMENTS TO IMPROVE AMV QUALITY

Two developments on AMVs are underway. One is another new height assignment scheme (referred to below as *follow-on height assignment scheme*), and the other is modification of the size of image segment (referred to below as *template image*) for tracing targets.

(a) Follow-on height assignment scheme

This scheme selects the image pixels contributing to feature tracking and uses them for computing AMV height more correctly. It computes the contribution rates to feature tracking for pixels within the template image and uses the rates to select pixels for the height assignment. This scheme is applied to the height assignment of IR AMVs above 700 hPa.

Figure 3 shows the BIASes against JMA's NWP forecast fields and the numbers of IR AMVs (QI>0.85) computed using the current height assignment scheme (i.e. current AMVs) and those by the follow-on scheme (referred to below as *new AMVs*). As seen in Figure 3 (a) left, fast BIAS is observed in the current AMVs which are derived between 600 and 700 hPa. This fast BIAS problem was arisen by the implementation of the current height assignment scheme on 30 May 2007, while the significant slow BIAS for AMVs above 400 hPa was reduced as discussed in Section 3. Figure 3 (a) right shows the slow BIASes in new AMVs are still remaining at the same degree as those of the current AMVs. However, the fast BIAS problem is clearly resolved in the new AMVs. Figure 3 (b) shows that the numbers of the new AMVs are slightly larger than those of the current AMVs.

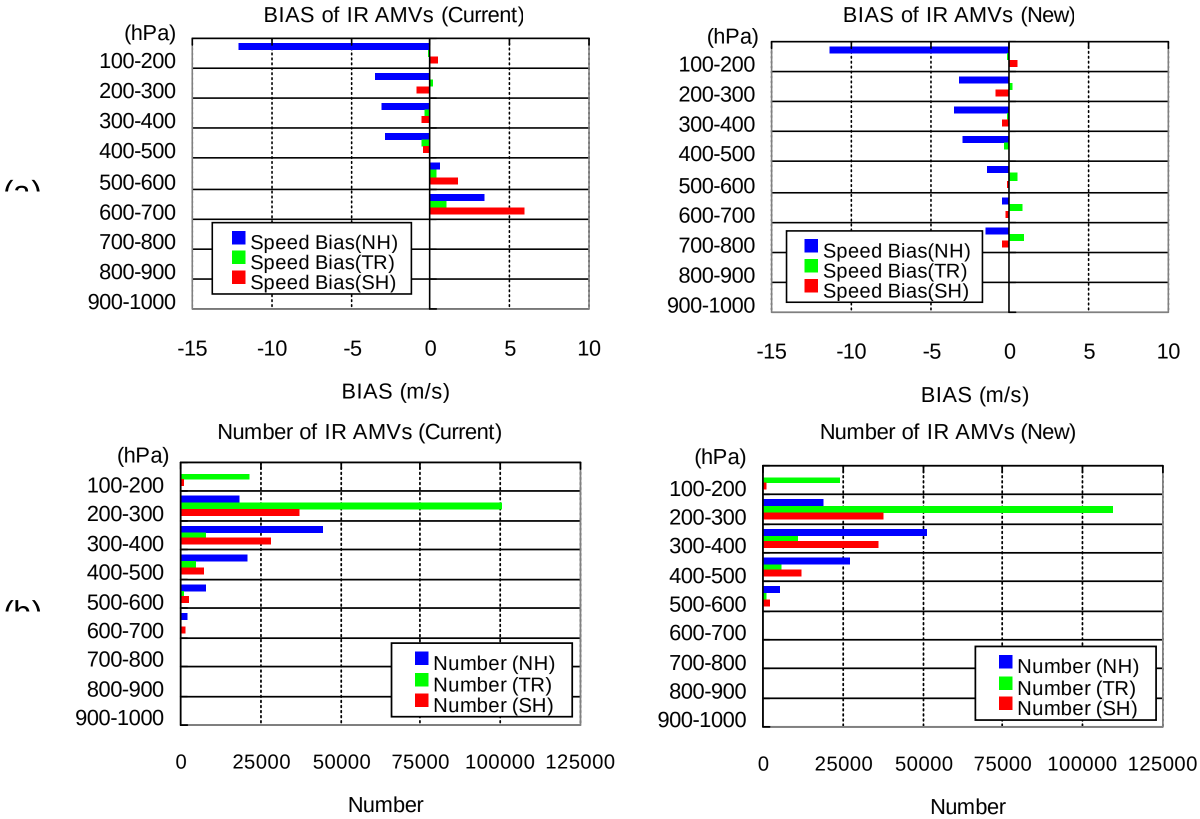

Figure 3 (a) BIASes against JMA's NWP first guess and (b) numbers of current (left) and new (right) IR AMVs at each height level for March 2007. NH, TR and SH stand for Northern Hemisphere (between 20N and 50N), Tropics (between 20S and 20N) and Southern Hemisphere (between 50S and 20S), respectively.

(b) Evaluation of template size

The size of template image (referred to below as *template size*) is an important parameter for the AMV computation, because it is related to the spatial scale of tracing target, whose movement is expected to be associated with wind vectors. Currently, the template size of 32 pixels is used for MTSAT-1R IR AMVs. The size is the same as that for GMS AMVs. However, the image intervals are different (15 minutes for the MTSAT-1R AMVs and 30 minutes for the GMS AMVs). In addition, the spatial resolution of recent NWP fields is higher than that before. Using smaller template size enables to capture respective air-parcel movements on streamlines properly even in flows with large curvatures. Moreover, the smaller template image leads to the higher accuracy of height assignment, since probability for single-layer cloud to dominate the template image is increased.

Figure 4 shows a time series of monthly BIASes, RMSVDs and numbers of IR AMVs (QI>0.85) computed by using template sizes of 32 and 16 pixels (referred to below as *T32-AMVs* and *T16-AMVs*, respectively). The follow-on height assignment scheme described above is employed for the study. Six-month statistics in 2007 is presented. It is recognized that both BIASes and RMSVDs of T16-AMVs are smaller than those of T32-AMVs, while the numbers of T16-AMVs are smaller than those of T32-AMVs. The decrease of numbers is mainly due to the diminution of nominated cloud targets. These characteristics are consistently seen for all months.

Figure 5 is the same figure as Figure 4, but for WV AMVs (QI>0.85) over cloudy region. The RMSVDs of T32-AMVs and T16-AMVs are almost the same. The BIASes of T16-AMVs are slightly positive, while those of T32-AMVs are slightly negative. The numbers of T16-AMVs for the six months are smaller than those of T32-AMVs respectively as seen for IR AMVs. However, the difference between the numbers of the two AMVs is smaller than that recognized for IR AMVs.

JMA will continue to review the template size issue, and plans to introduce the follow-on height assignment scheme with the best template size for the IR AMVs above 700 hPa by March 2009.

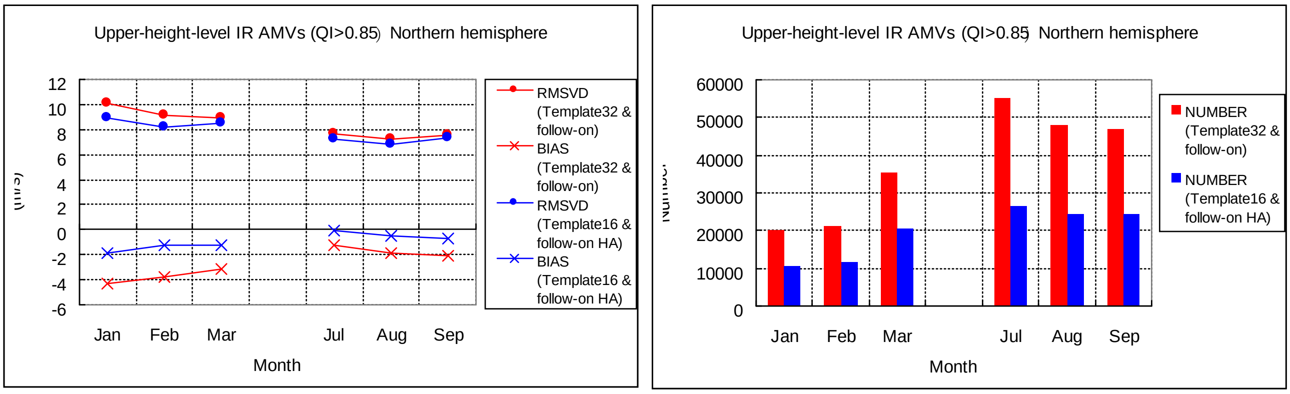

Figure 4 Monthly BIASes and RMSVDs against sonde observation (left) and number (right) for upper-height-level IR AMVs (QI>0.85) over the Northern Hemisphere. Red lines and bars mean IR AMVs computed by using the template size of 32. Blue ones mean IR AMVs computed by using the template size of 16. In the AMV computations, follow-on height assignment scheme, which is described in Section 4.1, is used.

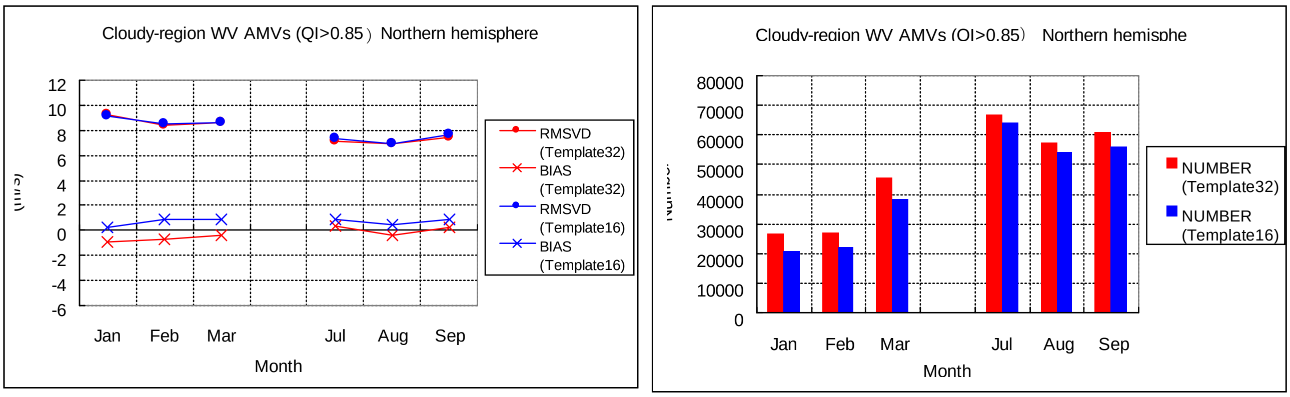

Figure 5 Monthly BIASes and RMSVDs against sonde observation (left) and number (right) for cloudy-region WV AMVs (QI>0.85) over the Northern Hemisphere. Red lines and bars mean IR AMVs computed by using the template size of 32. Blue ones mean IR AMVs computed by using the template size of 16.

4.2 AMV COMPUTATIONS FOR T-PARC STUDY

To contribute to the T-PARC (THORPEX (The Observing system Research and Predictability EXperiment) - Pacific Asian Regional Campaign) study from August through September in 2008, JMA conducted the Rapid Scan observations using MTSAT-2 to capture images with an interval of 15, 7, and 4 minutes. The images were captured from 10 September to 13 September, from 17 September to 18 September, and from 27 September to 28 September. These images are used to compute AMVs (referred to below as *15-min AMVs, 7-min AMVs,* and *4-min AMVs*, respectively).

15-min AMVs are computed hourly using two template sizes, 32 and 16 pixels respectively. The data were delivered to the users in near real time. The effectiveness of the data will be investigated by assimilating the data in the experimental JMA's NWP system.

7-min AMVs and 4-min AMVs are computed to capture meteorological phenomena with shorter lifetime. For the computation of the AMVs, template size is reduced to 16 pixels, and horizontal resolution is higher.

4.3 AMV FROM PAST SATELLITE IMAGES

JMA had reprocessed spatially high-density AMVs with QI from the images of GMS-3, 4 and 5 obtained between March 1987 and May 2003. The reprocessed AMVs were used in the 25-year Japanese long-term Reanalysis project (JRA-25) that was conducted from 2001 to 2005.

Following this work, JMA plans to reprocess AMVs from GMS, GOES-9, and MTSAT-1R images using the best available AMV algorithms, the new height assignment scheme and the new template size presented in Section 4.1. In addition, the AMV computation region will be extended from 50S-50N to 60S-60N. The reprocess computation will be started by the end of 2008.

5 RESPONSE TO RECOMMENDATION 35.07

Following a preceding study for the Recommendation 35.07 on the comparison of operational AMV height assignment algorithms, which was discussed in the Ninth International Winds Workshop in April 2008, JMA computed IR AMVs from METEOSAT-8 IR (10.8 µm) and WV (6.2 µm) images at 1200, 1215 and 1230 UTC on 18 August 2006 and ECMWF forecast fields using the JMA's AMV algorithms. Only template size was changed to 24 pixels from 32 pixels used in the operational system. The AMV data were sent to the CGMS study coordination team on 1 July 2008 to be evaluated by comparing with cloud LIDAR observations.