STATUS OF ATMOSPHERIC MOTION VECTOR IN JMA

Takahito IMAI

Japan Meteorological Agency / Meteorological Satellite Center
3-235, Nakakiyoto Kiyose-shi, Tokyo 204-0012, Japan

ABSTRACT

The Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) started the calculation of the atmospheric motion vectors (AMVs) from MTSAT-1R images on 15 July 2005. With the change of earth observation schedule, the MTSAT-1R 6-hourly AMVs are calculated from 15 minutes interval images, whereas the GMS-5 ones from 30 minutes interval images. The schedule change also enables to calculate hourly AMVs in northern hemisphere.

The accuracy of the MTSAT-1R 6-hourly AMVs is studied. Comparison to GOES-9 AMVs shows that total number of calculated MTSAT-1R AMVs is increased but the number of upper level AMVs with QI greater than 0.85 is slightly decreased. The root mean square of wind vector difference (RMSVD) against Radio Sonde observations is increased. Statistics also shows that upper level infrared AMVs have slow wind speed differences (BIAS). Further study to eliminate the slow BIAS and tuning of parameters to calculate QI will be continued to improve quality of the AMVs in JMA.

1. INTRODUCTION

MTSAT-1R was launched on 26 Feb 2005 by H-IIA from the Tanegashima Space Flight Center. The satellite carries a new imager called JAMI (Japanese Advanced Meteorological Imager), whose specifications are shown in Table.1. JAMI has a new 3.8-micron channel (IR4), and higher spatial and quantized resolutions. In addition, its observation schedule is changed consisting half disk observations and full disk observations as shown in Figure 1.

Atmospheric motion vectors (AMVs) provide wide and homogeneous atmospheric observing information. Hence, they are important as data for generating initial condition of the Numerical Weather Prediction (NWP). The Meteorological Satellite Center (MSC) has been calculating AMVs from visible (VIS) and infrared (IR1) images since 1978 and water vapor (WV or IR3) images since 1995. The outline of the AMVs calculating system in MSC was reported at the 7th IWW (Kumabe, 2004). The calculating area is within 50N-50S and 90E-170W. The AMVs data are encoded into the WMO format (SATOB and BUFR), and transmitted to the NWP centers via GTS. MSC started the transmission of MTSAT-1R AMVs on 15 Jul 2005. This report describes the new features contained in the MTSAT-1R AMVs.

	Channel	Nadia spatial res.		Quantization		# of obs. Par day	
		VIS	IR	VIS	IR	Full disk	Half disk
MTSAT-1R	VIS, IR1,2,3,4	1 km	4 km	10 bits	10 bits	24	32
GMS-5	VIS, IR1,2,3	1.25 km	5 km	6 bits	8 bits	28	(NA)

Table.1: The specifications of MTSAT-1R/JAMI and GMS-5/VISSR.

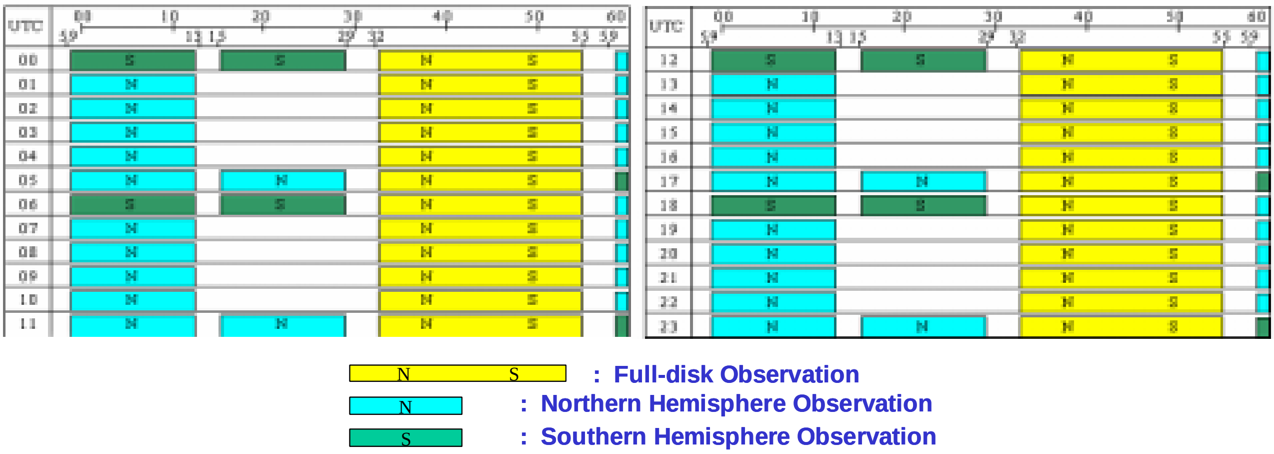

Figure1: Observation schedule of MTSAT-1R

2. FEATURES OF MTSAT-1R AMV

There are three major changes in AMVs by introducing MTSAT-1R observations. Two of them are related to the MTSAT-1R observing schedule, and the last one is to the upgrade of the imager specification.

First, the temporal interval of images used in the calculation of the 6-hourly AMVs (00, 06, 12, and 18 UTC) is shortened from 30 minutes to 15 minutes. Figure 2 (a) and (b) shows the usage of images for calculating the 6-hourly AMVs of “MTSAT-1R” and “GMS series and GOES-9”, respectively. The calculation of the MTSAT-1R AMVs uses five successive images with 15 minutes intervals consisting of four half disk and one full disk observations, whereas one of the GMS-5 AMVs uses three full disk images with 30 minutes intervals. Observation times assigned to the MTSAT-1R AMVs are around 30 minutes different between northern and southern hemisphere. By using 15 minutes interval images, it is expected that the number of the calculated AMVs increases (CGMS-XXVI, JMA WP-17) and the quality of the AMVs data becomes better (de Smet, 2002).

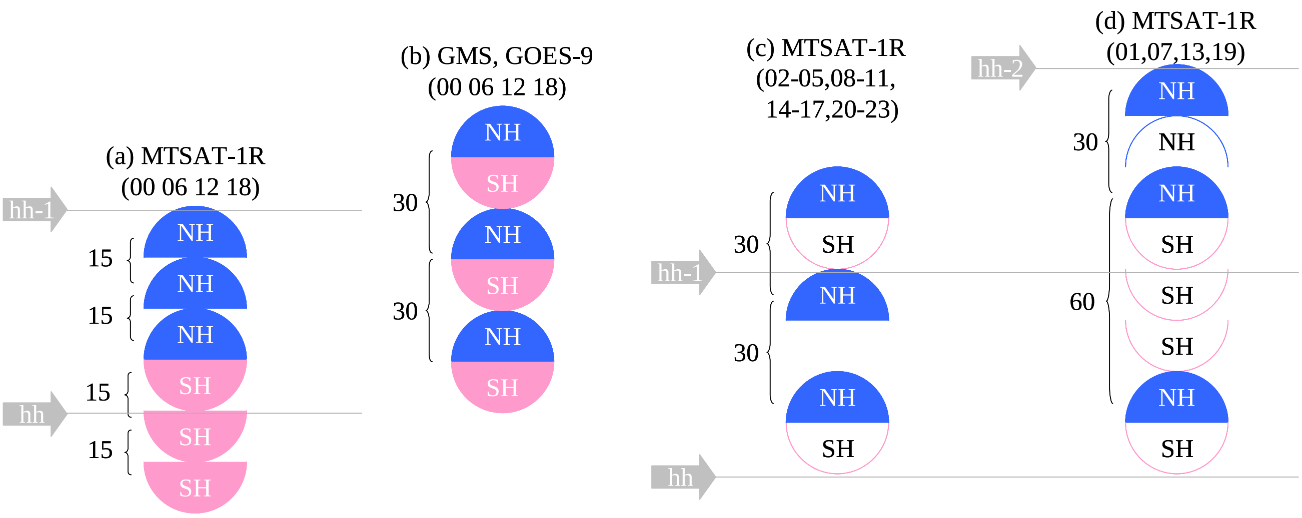

Figure 2: Usage of MTSAT-1R observing images to calculate (a) the 6-hourly AMVs of MTSAT-1R, (b) the 6-hourly AMVs of GMS series and GOES-9, (c) hourly AMVs at 02-05, 08-11, 14-17, and 20-23 UTC and (d) hourly AMVs at 01, 07, 13, and 19 UTC of MTSAT-1R. Full and half circles represent full and half disk observing images, respectively. NH and SH represent northern and southern hemisphere images, respectively. Shaded disks represent the images used to calculate AMVs. Numbers at the left of disks represent time interval, and the notes “hh” within arrows denote the official time of AMVs.

Second, a new product called “hourly AMVs" has been introduced since the beginning of MTSAT-1R. The calculation of the hourly AMVs uses northern hemisphere half disk images newly implemented in the MTSAT-1R’s observing schedule as shown in Figure 1. Therefore, the region of this product is limited over the northern hemisphere. As shown in Figure 2 (c), the 30 minutes interval images are used usually. But as illustrated in Figure 2 (d), the hourly AMVs next to 6-hourly ones at 01, 07, 13 and 19 UTC, use the 30 minutes and 60 minutes interval images, since there is no northern hemisphere half disk image scheduled between second and third images as shown in Figure 1. JMA plans to assimilate the hourly AMVs in the NWP models by the help of the 4D-VAR scheme. The investigation of the use of the hourly AMVs is reported in Yamashita, 2006.

Third, images of higher spatial and quantized resolutions are used to calculate AMVs. Using higher spatial resolution images, area of image clipped as target for pattern matching can be reduced without decreasing number of clipped pixels. This means that smaller phenomena can be treated without losing information for pattern matching. Moreover, using higher quantized resolution images increases the information for pattern matching.

3. STATUS OF AMV

Figure 3 shows the numbers of the 6-hourly AMVs per observation regarding MTSAT-1R and GOES-9. “All QI" represents the total numbers of AMVs calculated by tracing cloud (or water vapor) targets, and “QI>85" represents the number of qualified AMVs whose QIs are higher than 0.85. The operation of MTSAT-1R AMV started on 15 July 2006. Even after that day, MSC calculated GOES-9 AMVs in background process.

The total numbers of calculated AMVs for MTSAT-1R are around 1.3, 1.5 and 2 times larger than those for GOES-9, respectively. It denotes that the large benefit is obtained by using 15 minutes interval images as a substitute of 30 minutes ones. Other researches examined in MSC show that this improvement is originated from the smaller rotating of cloud targets, saving very fast moving targets, and the smaller change of target shapes by using 15 minutes interval images.

Even though the increase of the total numbers, the numbers of MTSAT-1R “QI>85” AMVs over upper level atmosphere are neutral or smaller than those of GOES-9 ones. It is considered that the problem of parameters used to compute QIs. QI is computed from 5 components, the direction consistency, the speed consistency, the vector consistency, the forecast consistency and the spatial consistency test. Almost half of QI components are concerned with acceleration of tracking target that depends on time intervals of the images, where MTSAT-1R 6-hourly AMV uses 15 minute interval images which is reduced. Further investigation is necessary.

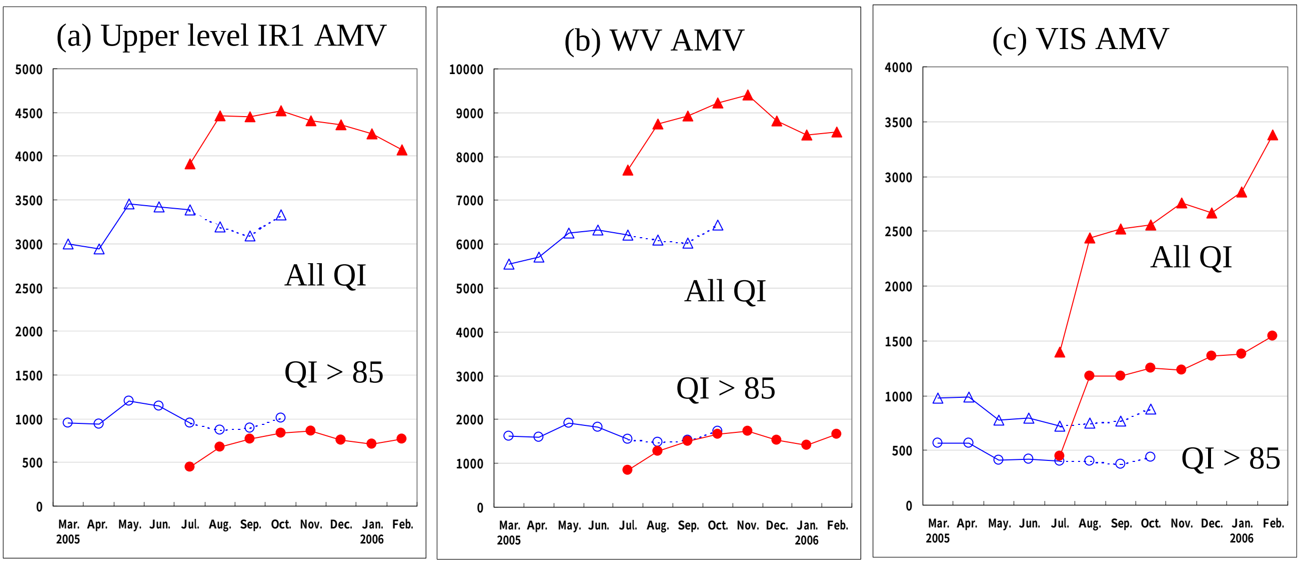

Figure 3: Time series of the numbers of (a) upper level infrared AMVs, (b) water vapor AMVs, and (c) visible AMVs per observation. “All QI” represents that the number of all AMVs calculated by tracing cloud or water vapor without quality control. “QI>85” represents the number of AMVs whose QIs are greater than 0.85. The red lines with filled points represent MTSAT-1R, and the blue lines with open points represent GOES-9. The operation of MTSAT-1R AMV started on 15 July 2006.

Figure 4 shows the time series of statistics regarding the 6-hourly AMVs of MTSAT-1R and GOES-9 with QI greater than 0.85, the average of the wind speed components of the AMVs, the root mean square of wind vector differences (RMSVDs) between the AMVs and Radio Sonde winds, and the average of the wind speed differences (BIAS). As seen in Figure (a) and (b), the averaged wind speeds of upper AMVs for MTSAT-1R are higher than those of GOES-9. It is originated from the benefit of using 15 minutes interval images saving very fast wind speed data. The RMSVDs of the upper level AMVs for MTSAT-1R are slightly larger than those for GOES-9. It is due to both the increase of higher wind speed data and the QI parameter problem. Large slow BIAS of the MTSAT-1R upper level infrared AMVs is remained as that of the GOES-9. Because slow BIAS is larger in middle latitude region of winter hemisphere especially at jet stream region where wind speed vertical sheer is strong, it is thought that height assignment is concern with slow BIAS problem. With respect to the MTSAT-1R lower level AMVs seen in Figure 4 (c) and (d), accuracy differences between MTSAT-1R and GOES-9 are small. Slightly degradation is seen in MTSAT-1R RMSVDs. Since the speeds of lower level winds are relatively smaller than those of upper level winds, the RMSVDs are expected to be improved by updating MTSAT-1R ground software to mitigate its navigation problem.

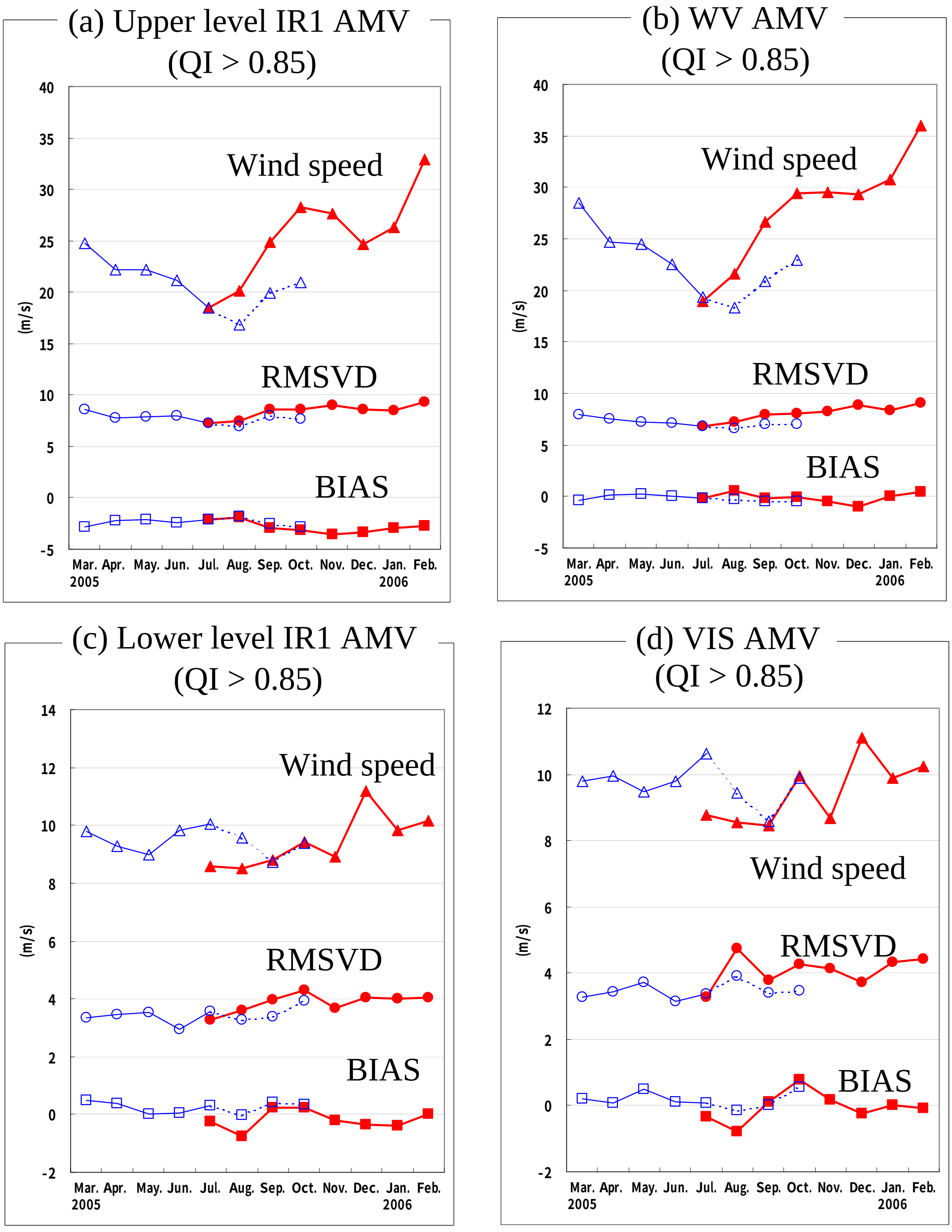

Figure 4: Time series of averaged wind speeds (Wind speed), root mean square vector difference between AMVs and radio sonde observed winds (RMSVD), and wind speed difference (BIAS) with respect to (a) upper level infrared winds, (b) water vapor winds, (c) lower level infrared winds, and (d) visible winds. Only the AMVs, whose QIs are higher than 0.85, are used. The red lines with filled points represent MTSAT-1R,

and the blue lines with open points represent GOES-9. The operation of MTSAT-1R AMV started on 15 July 2006.

4. SUMMARY AND FUTURE PLAN

The features and status of the MTSAT-1R AMVs are reported. The interval of successive images used for calculating 6-hourly AMVs is shortened from 30 to 15 minutes and hourly AMVs are started. For 6-hourly AMVs, comparison to GOES-9 AMVs which uses 30 minutes interval images shows that total number of calculated MTSAT-1R AMVs is increased by using 15 minutes interval images. On the contrary, the number of upper level AMVs with QI greater than 0.85 is slightly decreased and RMSVD against Radio Sonde observations is increased. Insufficient tuning of parameters to compute QI can be one of the causes of this result. Statistics also show that upper level infrared AMVs have slow BIAS. Therefore further study to eliminate the slow BIAS and tuning of parameters to compute QI are needed to improve quality of the AMVs in JMA.

Because slow BIAS is concern with height assignment, JMA plans modification of AMV height assignment. Use of higher resolution NWP models, introduction of a radiative transfer model to estimate radiation intensity absorbed by atmosphere which exist between observed point and satellite and review of pixel selection used for height assignment are candidates of modification. Recalculation of QI computing parameters is also planned.

5.REFFERENCE

Kumabe R., (2004) Renewal of operational AMV extraction system in JMA, Proceedings of 7th IWW, 71-77.

Yamashita K., (2006) Assimilation of Hourly MTSAT-1R AMV into JMA-MSM, Proceedings of 8th IWW

JMA, (1998) Satellite Wind Products for MTSAT, JMA working paper-17 of CGMS-XXVI Agenda item III/4

de Smet A., (2002) Operational AMV products derived with meteosat-6 rapid scan data, Proceedings of 6th IWW, 179-185.