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Discussed in WG II

CURRENT STATUS OF AMV ESTIMATION AT KMA

This paper introduces the current status of AMV in operation at KMA including the accuracy of AMV compared with radiosonde observation data. And it describes on-going international collaborations in order to improve KMA AMV scheme: Global AMV inter-comparison study and the impact of target size on AMV estimation.

1. INTRODUCTION

KMA has been developing Communication Ocean Meteorological Satellite (COMS) Data Processing System (CMDPS) to prepare operational meteorological products after launch COMS.

As a part of CMDPS, Atmospheric Motion Vector (AMV) algorithm has been developed since 2002 in KMA (KMA AMV) and producing them from infrared (IR AMV) and water vapor (WV AMV) channel data of MTSAT-1R in operation of KMA since June 2005. In June 2008, AMV validation module was added to AMV system which made it possible to get monthly statistics and monitor the quality of KMA AMV.

In this report, we will introduce the current status of KMA AMV and describe some efforts to improve KMA AMV scheme through the international joint works on the International Wind Workshop as well as collaboration with EUMETSAT: Global AMV inter-comparison and the impact of target size on AMV estimation.

2. KMA OPERATION SATUS AND THE ACCURACY OF AMV

KMA has been producing two products: IR AMV and WV AMV, respectively using three consecutive infrared and water vapor image data with interval time of 30 minutes from MTSAT-1R over two areas: MTSAT-1R Full disk (FD) area and eastern Asia area (EA) as given in Table 1. AMV calculation area over Full disk is divided into 4 sub areas of NW, NE, SW, SE sectors and the calculations are done in parallel with 4 CPUs to reduce the processing time. AMV over FD area is calculated within less than 65 degrees of satellite zenith angle of MTSAT-1R four times a day at 00, 06, 12 and 18 UTC, and hourly AMV is also calculated over eastern Asian area according to MTSAT-1R observation schedule.

Table 1 KMA AMV products specifics

Satellite	AMV Product	Spatial resolution at Nadir	Image Sector	Product time	Image Interval(min)
MTSAT-1R	IR Cloud drift wind (IR AMV)	4km	EA	Hourly	30
	Water vapor wind (WV AMV)		FD	4 times a day (00,06,12,18UTC)	30

Table 2 shows the example of the monthly report of KMA AMV accuracy estimated during the period of August 2008. In case of IR AMV, The RMS error of Vector Difference (RMSVD) is range from 4 to 9 ms^{-1} and bias from -5 to 0 ms^{-1}. IR AMV has large negative bias of about -5 ms^{-1} in southern hemisphere with high level while it has large positive bias of about 5 ms^{-1} in middle level except for southern hemisphere. Such a large positive bias might be due to wrong height assignment for middle level which is likely to contain multi-layer clouds. The accuracy of WV AMV is given for only high level which ranges from -3 to 0 ms^{-1} in bias and from 6 to 8 ms^{-1} in RMSVD.

Table 2 Accuracy of IR AMV and WV AMV of Aug. 2008.

IR AMV	**All Regions**	**North (20N ~ 50N)**	**Tropics (20N ~ 20S)**	**South (20S ~ 50S)**
All Levels				
- # of AMV	11,950	7,582	3,461	907
- RMSVD (ms^{-1})	6.67	6.99	6.03	6.43
- bias (ms^{-1})	0.33	0.24	0.90	-1.10
Low Level (700hPa-1000hPa)				
- # of AMV	503	44	113	346
- RMSVD (ms^{-1})	4.95	10.06	5.67	4.06
- bias (ms^{-1})	1.67	6.35	2.91	0.67
Middle Level (400hPa-700hPa)				
- # of AMV	1,993	974	648	371
- RMSVD (ms^{-1})	8.02	8.31	8.05	7.22
- bias (ms^{-1})	3.85	4.87	4.89	-0.64
High Level (100hPa-400hPa)				
- # of AMV	9,454	6,564	2,700	190
- RMSVD (ms^{-1})	6.48	6.78	5.56	9.19
- bias (ms^{-1})	-0.48	-0.48	-0.14	-5.22
WV AMV	**All Regions**	**North (20N ~ 50N)**	**Tropics (20N ~ 20S)**	**South (20S ~ 50S)**
High Level (100hPa-400hPa)				
- # of AMV	10,634	6,703	3,541	390
- RMSVD (ms^{-1})	7.00	7.06	6.75	8.14
- bias (ms^{-1})	1.03	0.66	2.27	-3.96

3. CHANGES OF KMA AMV SCHEME FROM GLOBAL AMV INTER-COMPARISON STUDY

KMA reviewed over the reason why the difference of KMA AMV occurs based on the results of global AMV inter-comparison study formulated at the 8th international wind workshop (IWW8) (Iliana et al, 2008). KMA AMV was advised from results of this study as followed:

o. There are several vectors with large discrepancy in wind speed and wind direction among AMV producers in KMA AMVs.

o. There is relatively lower bias of AMV wind speed in high level than those of other center’s AMVs.

o. Low level broken clouds over ocean area which are assigned to high level bring strong disagreement among AMV producers as shown as the red circle with large X mark in the figure 1(a). Winds with large difference are shown as yellow colored spots on figure 1(b) (Iliana et al., 2008).

First of all, we looked over the reason why AMV of target with low level broken cloud was assigned to high level and found that it was due to applying height correction methods (STC & IRWV method). We modified the condition of correction scheme of height assignment (HA) to correct strictly only height of high-level cloud, which has higher threshold of correlation of 0.8 between infrared and water vapor brightness temperature within target area. KMA AMVs were calculated on grid of 0.5 x 0.5 degree of latitude and longitude from triplet MSG-SEVIRI satellite data and ECMWF 6hour forecast profiles provided from IWW8. Where, target box size of 24 x 24 pixels and search box size of 80 x 80 pixels were set and the modified HA scheme was applied. Figure 2 shows the distribution of AMV heights calculated with new HA scheme. In result, AMVs with wrong heights have proper low level heights as shown in Figure 2.

KMA AMVs were compared with JMA AMVs to find the difference of wind speed, wind direction and height. Both of them were re-sampled into the same map configuration. Figure 3 shows the scatter plot of (a) wind speed, (b) wind direction, (c) height between KMA and JMA. Overall, KMA AMV has a good agreement with JMA. However there are still vectors with large difference shown even though the locations of target of KMA AMV don't make a complete match with those of JMA AMV because of re-sampling. There are unexplained wind data on 90° or 180° wind directions, which is required to check about vector tracking method. JMA AMV scheme seems to fix the heights of low level AMVs to 850 hPa. Heights of AMV have a tendency to be lower than those of JMA in high level.

(a) (b)

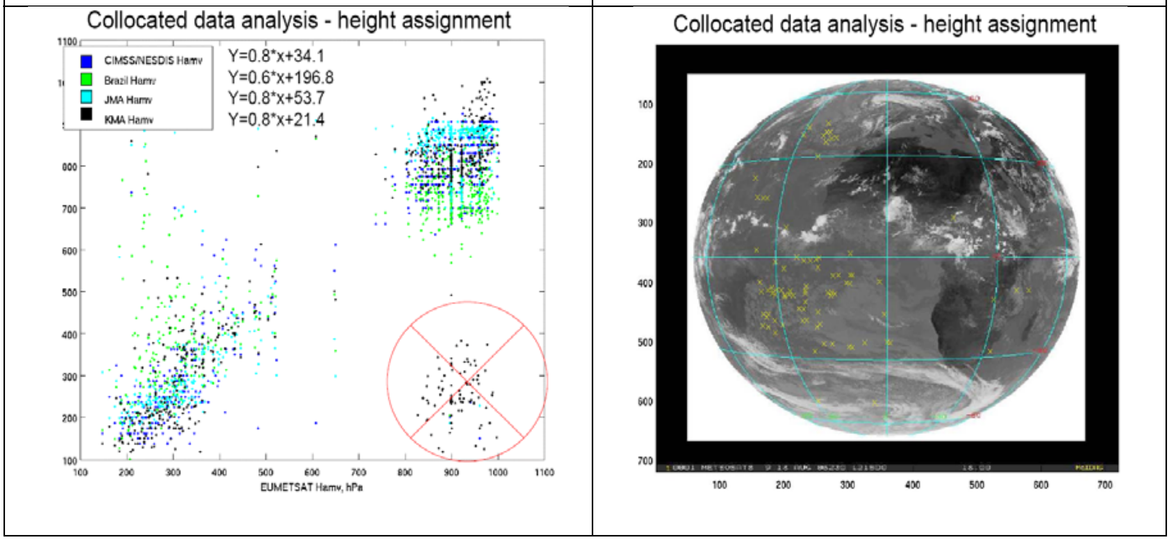

Fig 1. Global AMV height inter-comparison (Iliana et al, 2008). Red x with circle shown in figure (a) represents strong disagreement between KMA and other producers and yellow colored spots of figure (b) represent the locations of AMV with low bias of height from KMA.

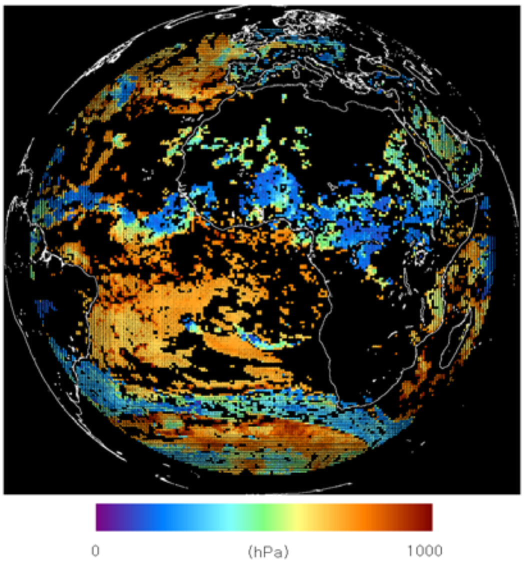

Fig 2 Distribution of AMV heights derived from modified HA scheme. AMVs with abnormal heights over ocean in Figure 1 is not shown any more in this figure after application of modified HA scheme.

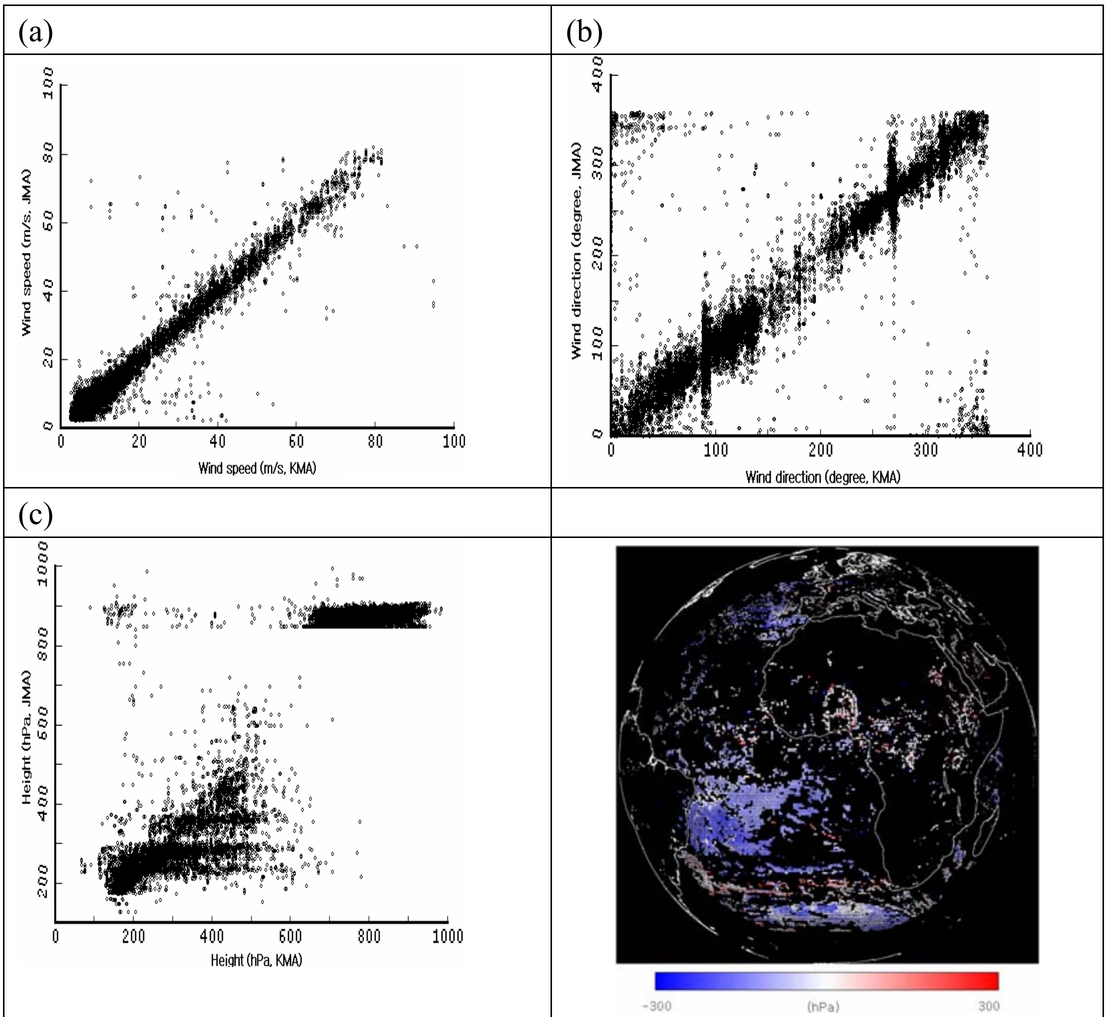

Fig 3 Scatter plots of (a) wind speed(ms^{-1}), (b) direction(degree) and (c) height(hPa) between KMA and JMA and (d) distribution of difference of AMV heights(hPa) between KMA and JMA.

4. THE IMPACT OF TARGET BOX SIZE ON WIND SPEED BIASES

Target size can have influences on some parts of current AMV scheme because target size determines the pixel number in vector tracking and height assignment. However most of AMV producers have been determining subjectively.

This study compared AMVs derived from different three target size in Table 3. AMV are derived from three MTSAT-1R infrared images with 30-minutes-interval by KMA AMV system. Figure 4 shows that with smaller target AMV, number of upper troposphere (100-400 hPa) vectors are reduced and number of middle and low level (400-1000 hPa) vectors are increased. It means that vectors are assigned to lower level than bigger-target AMVs. Because that smaller target relatively has more opportunities that include only middle and low level observation, number of low level vectors is increased. While small target AMV assigns more vectors to lower level, overall vector speed is increased (Figure 5). That confirms increase of faster vectors does not come from change of height distribution but from vector estimation itself.

Increase of wind speed at smaller target box size is directly reflected on the validation results (Figure 6). The statistics indicates that with 32 x 32 of target box size, wind speeds of AMVs are lower than observation especially (about -3.4 ms^{-1}, AMV quality > 0.3). And the wind speed biases of AMVs are reduced with smaller box size (16 x 16 pixels) to -1.5 ms^{-1}.

Table 3 AMVs with three different target sizes were experimented. Search sizes are set to guarantee same maximum displacement (about 75 ms-1 at nadir position)

	Target Box Size	**Search Area**
EXP A (KMA operational)	32x32 pixels (130 x 130 km^2)	80 x 80 pixels
EXP B	24x24 pixels (100 x 100 km^2)	72 x 72 pixels
EXP C	16x16 pixels (65 x 65 km^2)	64 x 64 pixels

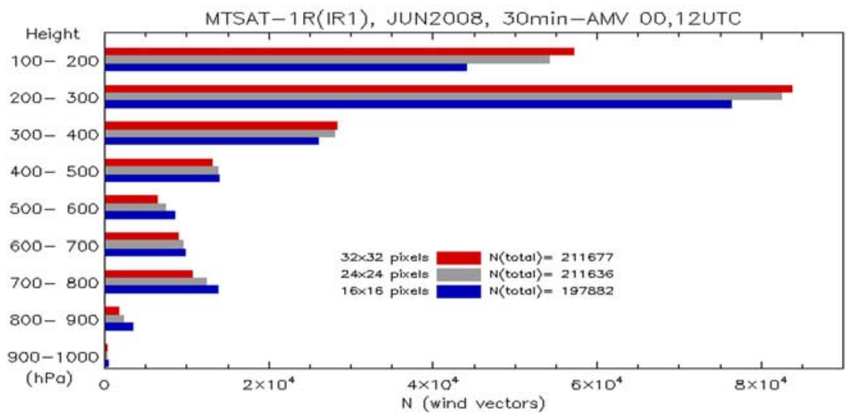

Fig 4 Histograms of AMV's height (hPa) during a month of June, 2008. Smaller target AMVs are assigned lower level than bigger ones.

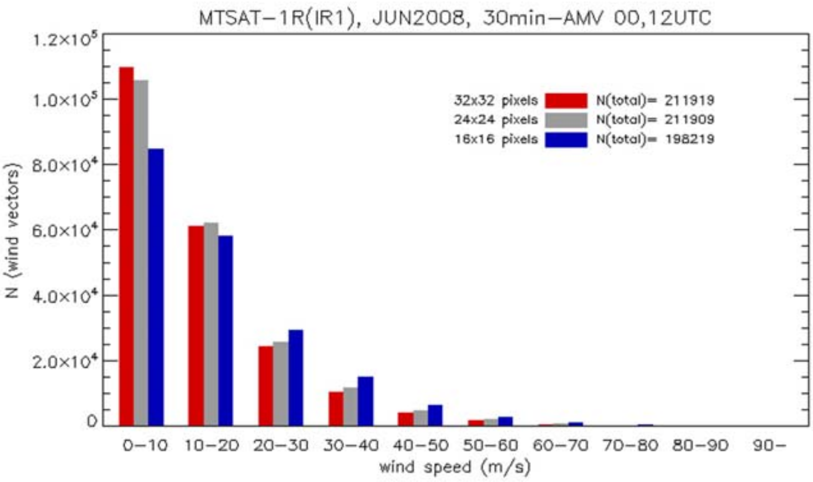

Fig 5 Histograms of AMV's wind speed (ms^{-1}) during a month of June, 2008. Smaller target AMVs are faster than bigger ones.

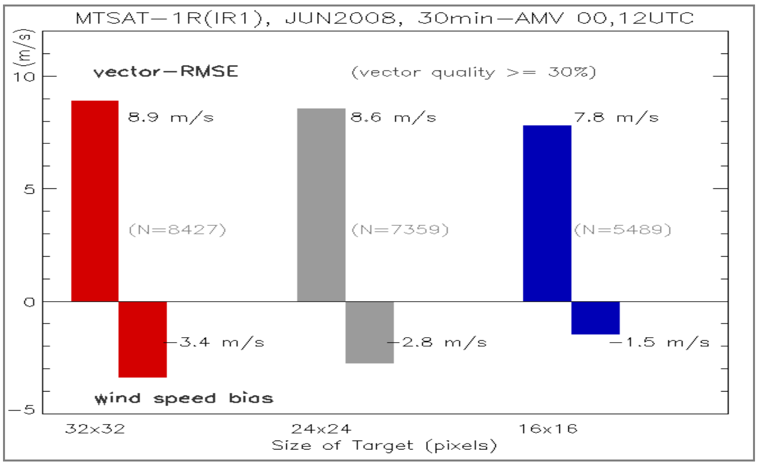

Fig 6 Validation of AMV's compared to radiosonde observation. RMSVD(ms^{-1}, left of each pair of colour bars) and wind speed bias (ms^{-1}, right of each pair of colour bars). Target box sizes are 32 x 32 (red), 24 x 24 (grey), and 16 x 16 (blue) pixels. Poor quality vectors that have less than 0.3 of QI are rejected for collocation.

5. SUMMARY AND FUTURE PLAN

Current bias and RMSVD of KMA AMV are about 1 ms^{-1} and 7 ms^{-1}, respectively for August of 2008. However the accuracy of KMA AMV should be improved by considering regional characteristics and AMV distribution in height . In the aspect of improvement of AMV, international joint works such as global AMV inter-comparison study (Iliana et al, 2008) are very useful. KMA will try to solve the problems revealed at Iliana et al (2008) such as low bias of wind speed in high level and occurrence of several abnormal vectors.

In addition, the study about the impact of target size on AMV extraction will be extended to the scene analysis within a target box for translating the characteristics of AMV according to different target sizes by collaborating with EUMETSAT. At first step, we have started case studies. Figure 7 shows the preliminary results indicating that a smaller target of 16x16 pixels might extract better vectors than large target with high possibility to contain multi-layer clouds.

(a) (b)

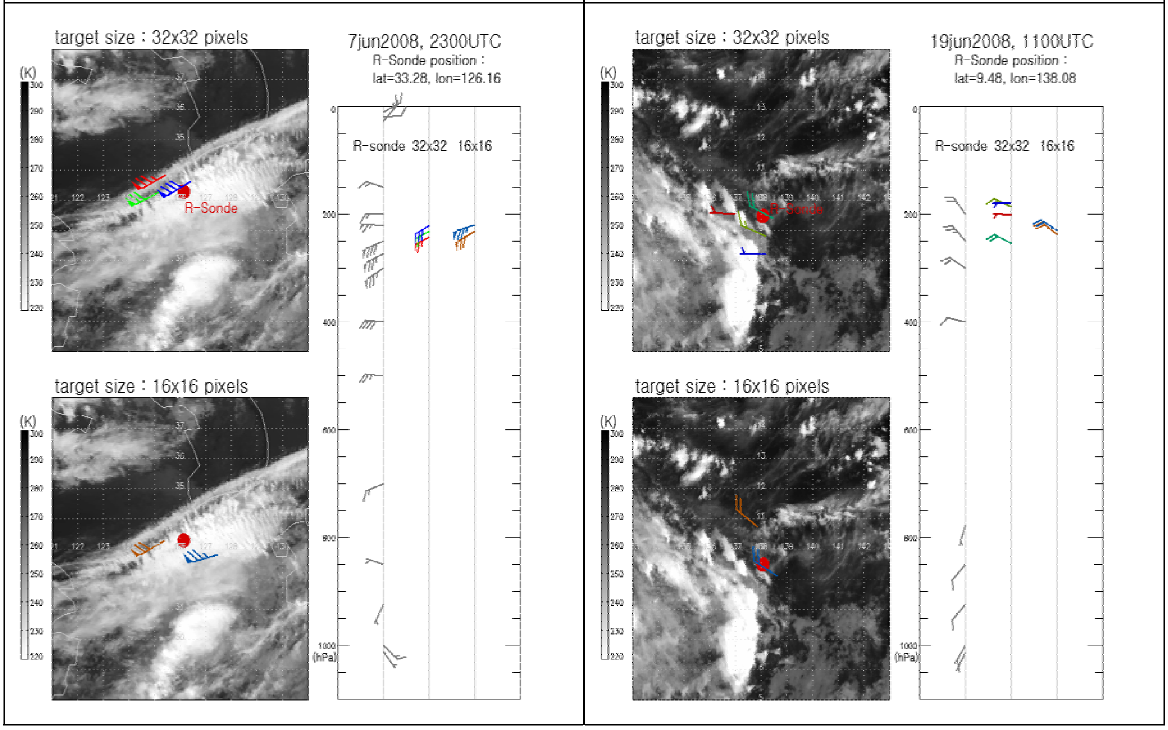

Fig 7 AMVs that collocated to single rawinsonde observation: (a) mid-latitude, synoptic scale, opaque cloud case, (b) tropical, multi-level cloud case accompanied wind shear. Colour of wind barbs is only for distinction. Grey barbs are rawinsonde observation. Erroneous slow vectors are assigned to high level for shear case of large target AMV.

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