Current status of AMV system at KMA

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Abstract

Atmospheric Motion Vector (AMV) is one of important meteorological products derived from satellite data and is known that it has a positive or neutral impact on global or middle scale numerical forecast's results. Korea Meteorological Administration (KMA) had produced operationally AMV from GMS-5, GOES-9. Since 1, July, 2005, AMV from MTSAT-1R have been estimated by its own developed S/W modules. Currently, AMV at KMA is operationally produced over eastern Asian region and its spatial and temporal resolution is 50 km and one hour, respectively. To correct height of semitransparent cloud, the IR/WV intercept method is used and to evaluate the quality of AMV, EUMETSAT Quality Indicator (QI) is introduced in scheme. Result of validation for all-level vectors using radiosonde data shows that Root Mean Square Error (RMSE) and bias range from 8 to 13 m/s and from 0.9 to 4 m/s, respectively. AMV scheme of KMA has been currently developed as one of baseline products supported by data processing system development of Communication, Ocean and Meteorological Satellite (COMS).

1. INTRODUCTION

KMA started to produce AMV from three consecutive GMS-5 infrared and water vapor images with time interval of 30 minutes over full disk area 4 times a day in April, 2002. And high density low level wind around typhoon was produced once a day using visible images with the interval time of 15 minutes only when the typhoon exists and applied for typhoon analysis. With the replacement of GMS-5 by GOES-9, AMV from GOES-9 was produced. However because AMV from GMS-5 and GOES-9 was estimated by library function command developed by Sea Space, U.S.A. there were limitations to upgrade and modify AMV scheme. Development of data processing system for the meteorological application in COMS project which KMA is responsible for has supported AMV prototype S/W module development and KMA has been currently produced hourly AMV from MTSAT-1R from 1. July, 2005 by its own developed S/W modules. The most important alteration of currently developed process is usage of QI developed by

EUMETSAT, while the previous scheme utilized the threshold values to remove unreliable vectors. This paper explains AMV scheme of KMA, especially, comparison of two different height assignment techniques for semitransparent clouds, validation of height using lidar data and quality assessment of AMV. Finally, future works about AMV scheme development of KMA are concluded.

2. Current AMV system of KMA

AMV system of KMA is composed of four parts, vector tracking, height assignment, quality control and validation. As preprocessing procedure for AMV estimation, each channel brightness temperature calculated by Radiative Transfer Model (RTM) and Numerical Weather Prediction (NWP) wind profile data are required as ancillary data. Main points of AMV system of KMA will be summarized briefly in followings.

2.1 Tracking

We are estimating two vectors from three consecutive images with interval time of 30 minutes by cross-correlation method. Locations of target center are selected by equidistant grid, about 10 by 10 pixels. Target area size is 32 by 32 pixels and search area size is 64 by 64 pixels. Final vectors of target are derived by averaging two vectors. Currently, fixed search area size is utilized in our scheme, which is able to bring about vectors with less speed than real winds by finding location with maximum correlation within the given search area. Search area size makes an important role to determine the maximum wind speed of vectors. Therefore, fixed search area size can result in wrong vectors especially in the region of jet stream occurrence whose location and intensity have seasonal variation. We will apply the flexible search area size using NWP wind data corresponding to height assigned to each target and compare with previously used fixed search area size.

2.2 Height assignment

It has been known that height of AMV make a very important role in determining the accuracy of AMV. Image instrument onboard most of geo-stationary satellite lacks the CO_2 channel and thus the height assignment for semi-transparent cloud is dependent on the water vapor channel combination method, so called, IR/WV intercept method. In our scheme, EBBT method is basically applied for all of targets and IR/WV intercept method is introduced to correct height for semi-transparency case. IR/WV intercept method can be used only in case that the several restrictions are satisfactory.

Figure 1 shows the concept of IR/WV intercept method which is based on that single layer cloud with different cloud amount has a linear relationship between observed Infrared and water vapor brightness temperature. The height of AMV is assigned from cloud top temperature at the intersection point between the calculated curve line and observed regression line.

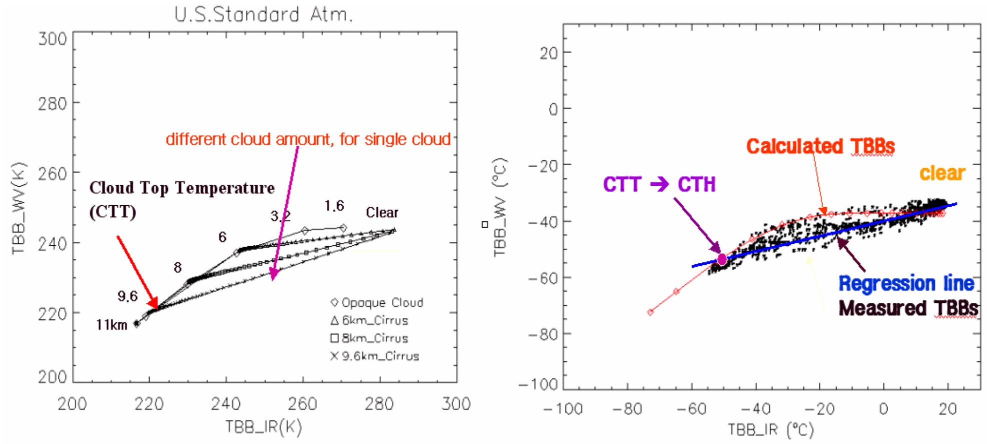

Figure 1: **Conceptual diagrams for IR/WV intercept method.**

The performance of AMV heights estimated by EBBT method and IR/WV intercept method was evaluated using the ground based lidar observation data (Figure 2). Ground based lidar data and AMV heights are collocated for only target that IR/WV intercept method is applied. Both heights of EBBT and IR/WV intercept method were compared by lidar heights. As shown in figure 2, lidar heights have better agreement with IR/WV intercept method heights than EBBT method heights, The statistical results show that for IR/WV intercept method RMSE and bias are 0.99 and 0.37 km, respectively and for EBBT method RMSE and bias are 1.43 and –1.16 km respectively. We can see from these results that IR/WV intercept method is more effective for semi- transparency case.

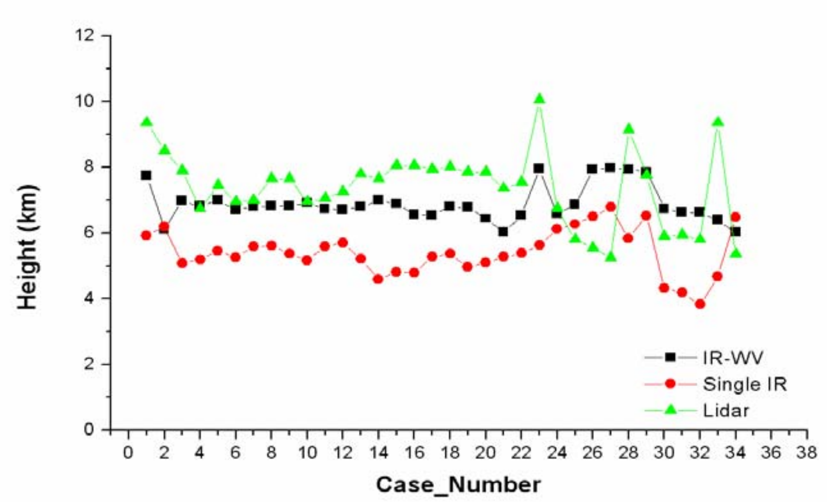

Figure 2: **Comparison of heights estimated from IR/WV intercept method and EBBT method (Single IR method) and lidar heights.**

2.3 Quality control

It is imperative to employ some internal quality control at the processing stage to remove poor vectors which do not represent the Instantaneous atmospheric flow. While the previous AMV scheme used simply threshold values to remove the poor data, in current AMV scheme we used Quality indicator (QI) developed by EUMETSAT as the quality estimates. It can be employed user community to select the part of the vector field. We also anticipate that it can be utilized to evaluate the performances of several schemes such as height assignment and target searching method. Figure 3 shows frequency of AMV versus QI classes for different consistency checks, direction, speed, vector, spatial coherence and comparison with forecast model. Comparing final QI not including forecast model QI check and final QI including forecast model QI, frequency of final QI depends greatly on model consistency. Final QI including forecast model QI has just 26% frequency of AMV with QI larger than 0.8. There is large difference between AMV and NWP vector at the level corresponding to height of AMV in term of wind direction and wind speed, especially, in case of cyclonic flow. We also calculated Normalized RMS (NRMS) in order to evaluate whether QI is good estimator of quality of AMV or not. Figure 4 shows that in case of high level winds from IR and WV, as QI increases, NRMS decreases and approaches to 0.4 while in case of middle and low level wind, NRMS is not largely improved as QI reaches to 1.

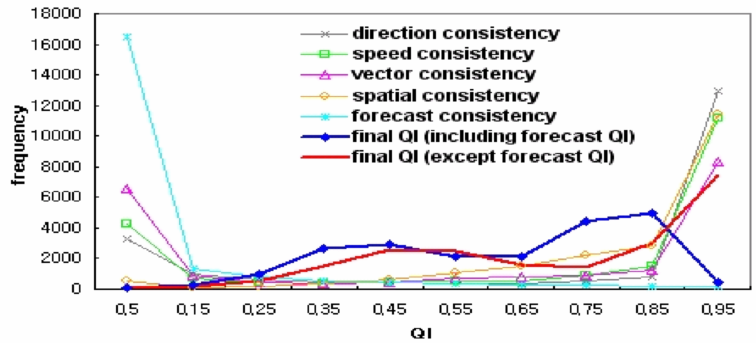

Figure 3: **Frequency versus QI classes.**

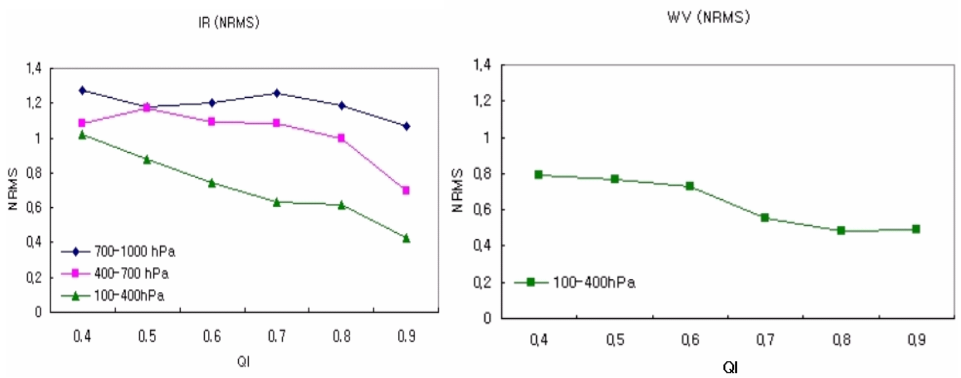

Figure 4: **Normalized RMS versus QI classes (left: IR_AMV, right: WV_AMV)**

2.4 Validation

Table 1 shows statistical accuracy of MTSAT-1R AMV with QI greater than 0.3. In case of MTSAT-1R AMV, averages of wind speed for low, middle and high level are 8.3, 14.7 and 22.7 m/s respectively, while in case of radiosonde wind data, 6.3, 11.1 and 20.8 m/s respectively. And RMSE between AMV and radisonde wind ranges from 10 to about 13 m/s.

	AMV vs. Radiosonde wind			AMV		Radiosonde		Num
Level	MVD	Bias	RMSE	Mean	STD	Mean	STD	
Low	8.3	1.9	10.9	8.3	7.2	6.3	4.5	16637
Mid	9.4	3.6	11.7	14.7	8.5	11.1	6.2	11806
High	10.8	1.8	12.8	22.7	10.1	20.8	7.7	7544

Table 1: **Validation results of AMV using rawinsonde data.**

3. Conclusions

AMV estimation scheme of KMA is currently in developing and still requires partly the improvement in its sub-schemes. Detailed future works of AMV scheme at KMA are as followings.

o. To apply flexible search area by using NWP wind data at the level corresponding to AMV height

o. To analyze the relationship between displacement with the maximum correlation and its height assigned to vector.

o. To provide user with reliable QI with meaningful statistics.

o. Finally, to compare our AMV with AMV from JMA, CMA.

As well as AMV of KMA will be applied as a variable of 3-D analysis system for weather monitoring at KMA.

4. References

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