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Discussed in WG II

COMPARISON OF ATMOSPHERIC MOTION VECTOR HEIGHTS ASSIGNED BY ECMWF AND KMA NWP PROFILES

This document is in response to CGMS Recommendation 34.14 and 34.15.
This paper reports on difference of AMV height assignment between ECMWF and KMA NWP models under the same KMA AMV height assignment scheme.

1. INTRODUCTION

Most of the countries that possess geostationary meteorological satellites have produced Atmospheric Motion Vector (AMV). The accuracy of AMV is important to improve the performance of Numerical Weather Prediction (NWP) model. The assigned height is known the primary error factor to estimate the AMV. The main error factors of Height Assignment (HA) schemes are schematic error from the algorithm, input data of NWP, and the calculated values from Radiative Transfer Model (RTM). This report presents the impact of NWP profiles using the Korea Meteorological Administration (KMA) HA algorithm.

This study has been carried out as a part of the 34th CGMS Recommendations 34.14 and 34.15.

2. OVERVIEW ON KMA AMV HA ALGORITHM

KMA HA algorithm has been applied by Equivalent Black Body Temperature (EBBT) method, H_2O intercept method, and Semi-Transparent Correction (STC) method over the entire AMV targets. Height is assigned by cloud top temperature (CTT) which is determined by 15% of the coldest pixels of the target box and should be in the range between tropopause layer and surface inversion layer given by NWP forecast temperature profiles.

The EBBT method determines the height as the best fitting level of the observed CTT with infrared brightness temperature profile that is calculated by assuming opaque cloud, which exists at each level of NWP profile. H_2O intercept and STC methods are being used to correct CTT for height assignment of semi-transparent cloud, which is detected higher than real temperature due to the contamination of emission from surface or under cloud. The concept of these methods is based on the linearity of the brightness temperatures between infrared and water vapor channels over the cloud amounts. The successful chance of AMV HA through H_2O intercept and STC method is dependent on the slope and offset of regression line given by observed brightness temperatures of infrared and water vapor channels within the given target box.

The final AMV height is produced by taking the highest one out of three HA schemes for all AMV targets.

3. DATA

Three consecutive infrared SEVIRI satellite images on MSG at 1212, 1227, and 1242 UTC on August 18, 2006 were used to produce AMV. AMV heights are calculated with 1227 UTC data.

KMA NWP and ECMWF 6 hour forecast profiles were used as input data of RTTOV8 to calculate the layer to top brightness temperature. MODIS CTP data of 6 granules from 1205 to 1235 UTC on August 18, 2006 were adopted into independent data to compare with the produced AMV heights.

4. AMV HEIGHTS FROM ECMWF AND KMA NWP PROFILES

Fig. 1 shows the number density of the calculated layer to top Brightness Temperatures (BT) of infrared and water vapor channels of MSG simulated by RTTOV8 using ECMWF and KMA NWP profiles. Especially as shown in Fig. 1 (c) and (d), when calculated BT of infrared channel is less than 240K, the major concentration of the BT calculated from the ECMWF and KMA NWP profiles show considerable difference more than 30K in calculated BT of water vapor channel. It indicates that there exists difference in water vapor profiles of two models. Most of KMA NWP temperature profiles shown in Fig. 1 (b) represent the inversion layer with minimum temperature of 230K at stratosphere and this feature contrasting with ECMWF makes abnormal moisture distribution in the stratosphere and upper troposphere. It seems to raise the peak level of weight function of the water vapor channel, which is related to the temperature and the water vapor profiles in atmosphere and affect the brightness temperature of water vapor channel. Such a difference of calculated brightness temperature using two models could be a reason to generate the different heights of AMV.

Result of HA schemes by two different models is given in Table 1. Overall, most of AMV heights have been assigned through the EBBT method regardless of which model has been used. But the chance of final adjustment by H_2O intercept method is about 19% for ECMWF profile, 2 % for KMA profile, respectively.

Fig. 2 shows the histogram of the assigned AMV heights and target temperatures. There are primary peaks around 285 K of target temperature in both models, yet assigned as different levels, about 800 hPa for ECMWF and 700 hPa for KMA respectively. Also two models are disagreed around the target temperature less than 240 K. It is because ECMWF has more chance to be adjusted in HA than KMA due to characteristics of H_2O intercept method. For the KMA profiles, it seems to be difficult to make the intersection point between the calculated curve and observed line since most of calculated brightness temperature of water vapor channel is concentrated around 230K. H_2O intercept method has the tendency to have higher height compared to the EBBT method because the corrected CTT is mainly lower than CTT given by the EBBT method. Thus, relatively high frequency in high level occurs in ECMWF profile. Meanwhile, in case of KMA profile, there is an abnormal peak around 100 hPa which should be corrected by a quality check procedure.

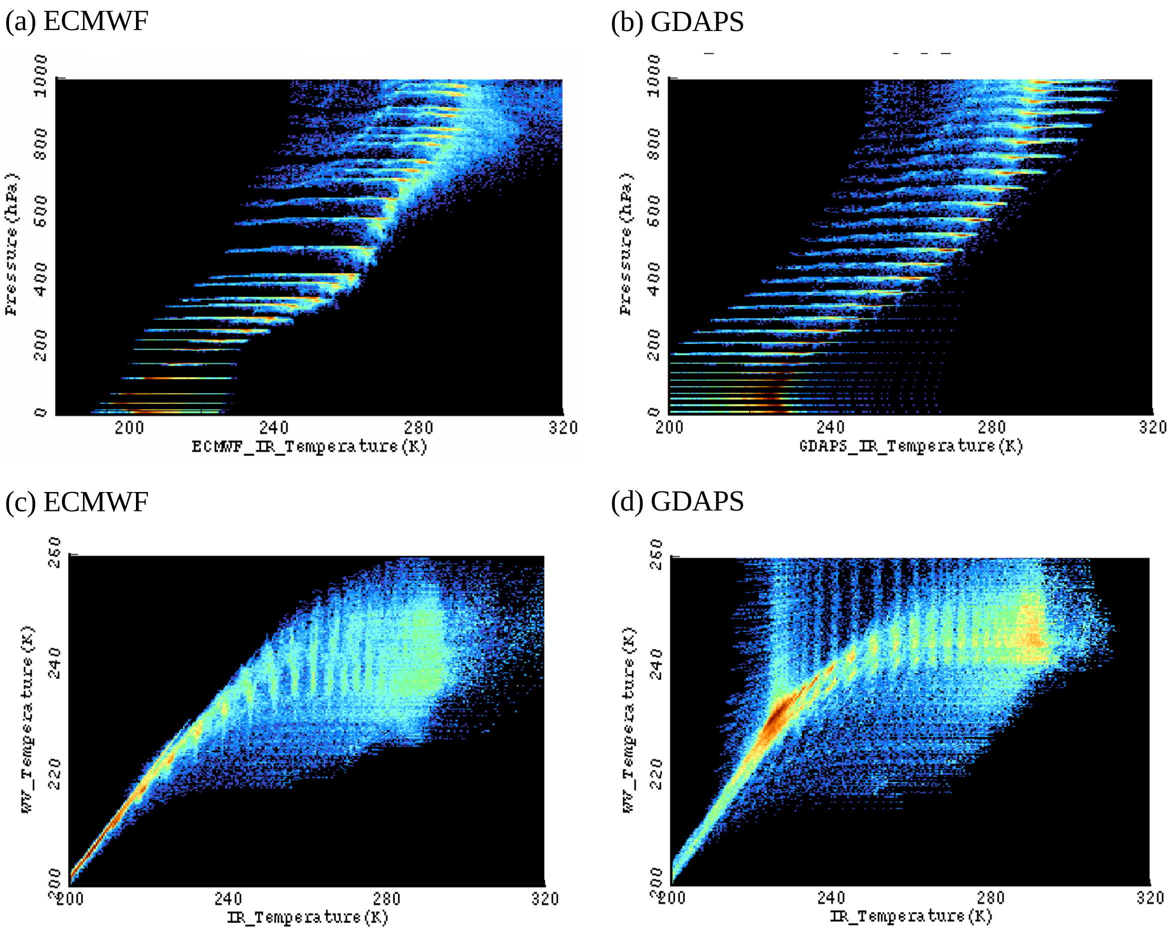

Fig. 1 Number density of calculated layer to top brightness temperature of infrared and water vapor channel of MSG-1 SEVIRI for AMV height assignment.

Table 1. Chances of final AMV height assignment according to various HA schemes of KMA The values in brackets mean percentage.

NWP (%)	Clear	Cloud	EBBT	H2O inercept	Other	Low level correction (cloud base)	Total Target No.
ECMWF	649	4703	3609(76.7)	895(19.0)	199(4.2)	2625(55.8)	4703(100)
KMA			4600(97.8)	99(2.1)	4(0.1)	2830(60.2)	4703(100)

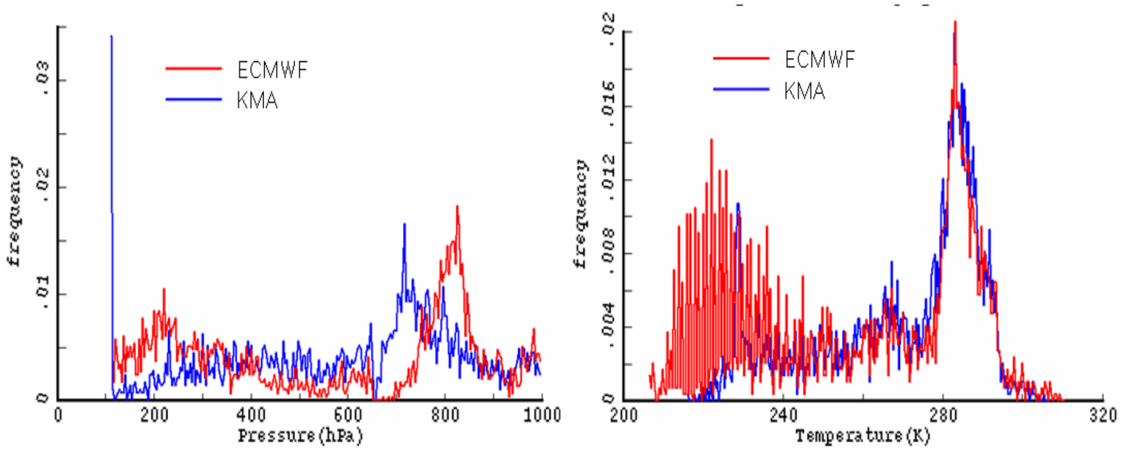

Fig. 2 Histograms of assigned AMV height (left) and target temperature (right)
Frequency in y-axis means the percentage.

5. COMPARISON WITH MODIS CTP

MODIS CTP is estimated by the ratio method with a variety of CO_2 channels or EBBT method. Estimated AMV heights from two models were compared with MODIS CTP as independent data set (Fig. 3). However, it is difficult to say that which one is more accurate between two products. As we can see in Fig. 4(a), MODIS CTP seems to be determined relatively low compared to the AMV heights for both models. Especially, two models have different frequencies in level higher than 250 hPa because of the characteristics of HA scheme as mentioned.

Comparison result was also shown differences according to the way to make collocation dataset with MODIS CTP. When MODIS CTPs at only target center and for all pixels within a target box were compared, MODIS CTP was mainly lower than the produced AMV heights (Fig. 4(c)). However, when MODIS CTPs averaged by 15% of the coldest pixels within a target box were used, it appears better agreement (Fig. 4(c)).

6. FUTURE WORKS

This study showed that AMV height is dependent on the NWP profiles and HA schemes. And such facts are expected to have an effect on the accuracy of AMV, which should be evaluated in future. Especially, when NWP data for AMV HA and background NWP data for data assimilation are different, the impact of estimated AMV on the performance of NWP data assimilation should be analyzed.

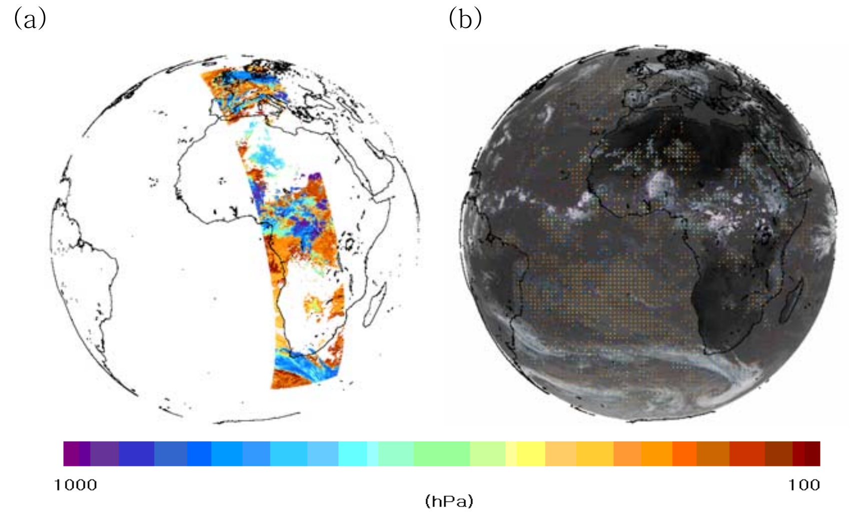

Fig. 3 (a) MODIS CTPs of 6 granules from 1205 to 1235UTC and (b) the assigned AMV height at 1227UTC on Aug. 18 2006.

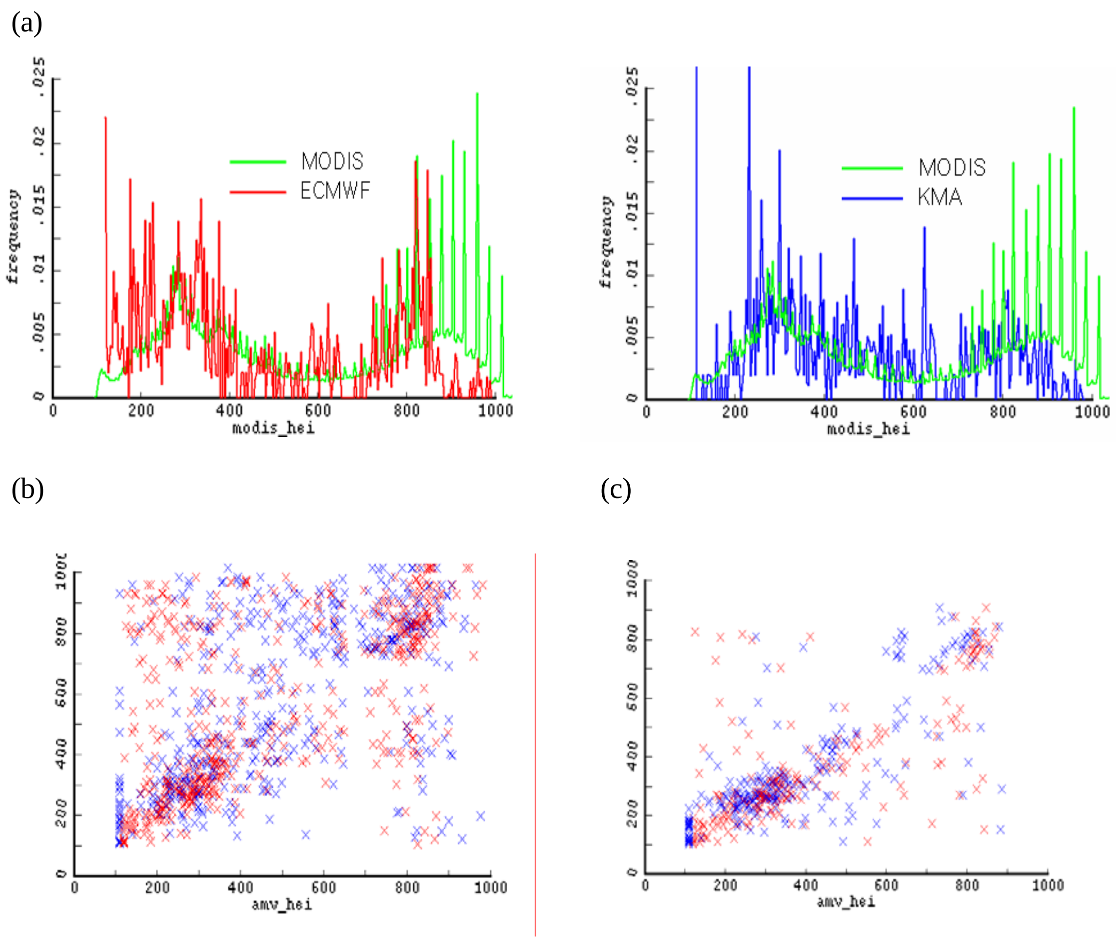

Fig. 4 (a) Histograms of all MODIS CTPs within a target box and AMV heights assigned by ECMWF and KMA profiles, (b) scatter plot between AMV heights and MODIS CTPs which is given at a target center, and (c) averaged value of the 15% coldest pixels within a target box. Red crosses are for EMCWF and blue for KMA NWP.