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IMPACT STUDIES OF HIGHER RESOLUTION COMS AMV IN THE KMA NWP SYSTEM

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Abstract

A new algorithm to retrieve higher resolution AMV (the target size is about 64 km at nadir, and uses optimal target method for target selection) was developed by National Meteorological Satellite Center (NMSC) in Korea. Currently, the operational KMA global NWP system uses COMS AMV, whose target size is about 96 km at nadir, with other AMVs from Meteosat, GOES, MTSAT and polar orbit satellites. The higher resolution AMV data seem to have better quality compared with sonde observation relieving the slow bias in winter jet region. Also the number of data is increased four times as much as previous one. Assimilation of higher resolution COMS AMV made wind analysis fields stronger in winter jet region improving forecast verification score in winter hemisphere. However, the forecast impact wasn't good in summer hemisphere, and so detailed analysis on AMV error characteristics had been done for optimized use of the new data. In this study, newly developed AMV data were assimilated in the operational KMA global NWP system replacing previous COMS AMV data. Then, different strategies of blacklisting have been tested because the current blacklisting strategy is very strict, and so only small amount of AMV can be assimilated. It was shown that more data were assimilated and the forecasting impact was more positive when weaker blacklisting strategy was applied. Also, error profiles for each channel were calculated, and its impact was evaluated. The variation of spatial thinning strategy has been tested since the spatial resolution of AMV data changed. However, the thinning impact wasn't that good than we expected.

1. INTRODUCTION

COMS AMV data have been being assimilated in KMA NWP system since 2011. The forecasting error reduced especially in the Asian region where COMS AMVs were mainly assimilated (Lee et al., 2012). In the forecast sensitivity to observations (FSO) of KMA global system, it showed that COMS AMV contribute about 3 % among the all kinds of AMV used in the system. It is a quite small value when we think about the contribution of other AMVs such MTSAT (15 %), GOES (49 %) and MSG (24 %). Even though we take account of the spatial coverage of COMS AMV's, derived only extended northern hemisphere (above -10 degrees of latitude), 3 % is still too small. In order to maximize the impact of COMS AMV, a new AMV product (higher resolution AMV) has been developed by NMSC/KMA, and tested in the data assimilation system.

2. DATA AND PRELIMINERY RESULTS

The KMA's global NWP system is a N512/L70 unified model of the Met Office (~ 25 km / top = 80 km), and the assimilation system uses hybrid ensemble 4DVAR. The spatial resolution of the operational COMS AMV is about 96 km x 96 km at the nadir (the target size is 24 x 24, T24), and the three channel's AMV (infrared, water vapour and visible) data are assimilated with simple blacklisting and thinning strategies (2 degrees, 100 hPa and 1 hour). The new target size of the higher resolution AMV is 16 x 16 (about 64 km, T16), and the algorithm uses optimal target selection method. T16 algorithm produces about twice more data with less slow bias and RMSE than that of T24 (in the validation against sonde observation). Figure 1 shows the example of retrieved AMVs by both algorithm (T24 and T16), and the colours represent the height of the winds (red, green and blue indicate the wind in the levels of 1000 ~ 700 hPa, 700 ~ 400 hPa and above 400 hPa, respectively). For the all levels, more wind vectors are shown in the T16 algorithm (Figure 1. b).

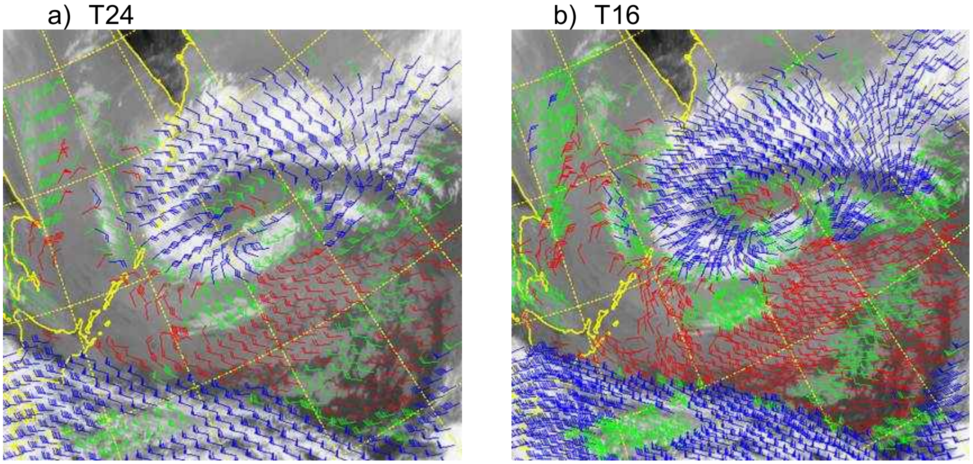


Figure 1: **Estimated AMVs by T24 and T16 algorithm. Red, green and blue indicate the wind assigned in the levels of 1000 ~ 700 hPa, 700 ~ 400 hPa and above 400 hPa, respectively.**

The new retrieved AMVs were tested in the NWP system without changes in blacklisting, thinning and observation error. The experimental periods were December 2013 (winter season) and July 2014 (summer season) for one month respectively. In the winter, the higher resolution AMV analyzed the wind field (mean analysis field) faster than that in operation. Usually AMV of COMS has slow bias in winter jet region, but by using smaller target size (T16), the slow biases were reduced, and it affected the wind field of analysis (Figure 2). Finally, the forecast errors were decreased both northern and southern hemisphere (up to 2 % in the geo-potential height at 500 hPa). However, forecast impacts in the summer season were somewhat negative except the southern hemisphere wind.

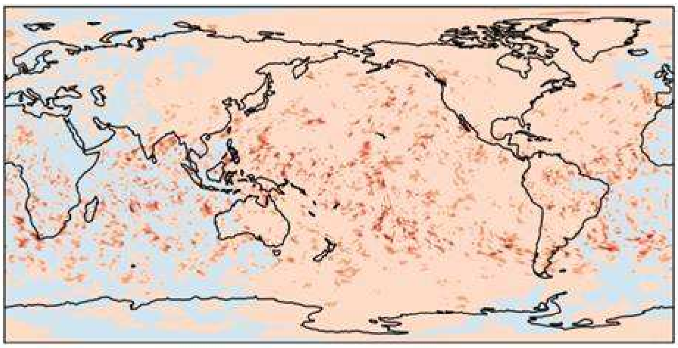
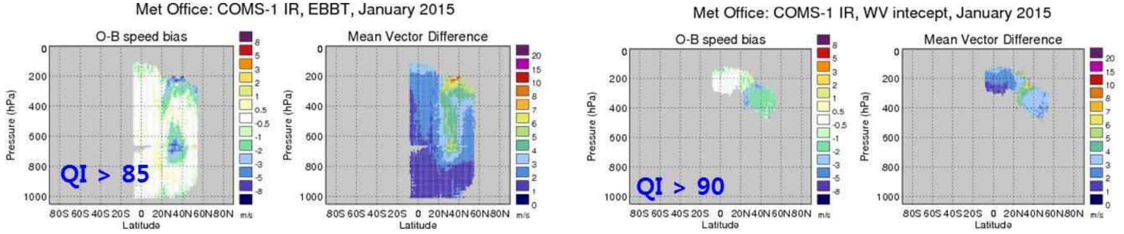


Figure 2: **Mean analysis difference (T16 - T24) of U at 200 hPa (m/s). Red colour means that the analysis wind is stronger when T16 data were assimilated.**

3. BLACKLISTING AND ERROR PROFILE

In order to optimize the use of higher resolution AMV in the data assimilation system, error statistics were newly calculated based on the relationship between observation and model background. From the errors, new blacklisting strategy and error profile were determined. To blacklist bad quality of data, very detailed reduction condition according to channel, QI, latitude and height was set. In fact, in the current operational setting, the elimination condition is somehow strict in some part, so too many data were deleted as well as bad data. Conversely, sometimes the condition is too loose; so many bad data were passed to the quality control process. Figure 3 shows how the detailed blacklisting strategy is applied. In the left panel of a (operation, for IR EBBT), all AMVs with the QI >85 were assimilated, but in the bottom, the condition is divided by QI again, and the regions where the error is large are blacklisted even though the QI is greater than 90. In the right panel (for IR WV intercept), only AMVs with the QI>90 were assimilated, but now more data whose QI is just greater than 85 can be assimilated in the region where the statistical error is smaller. There ways were applied to other channel. On the other hand, very weak blacklisting condition (QI > 80 for all AMVs), and new error profiles were also tested.

a) Operation



b) New blacklisting

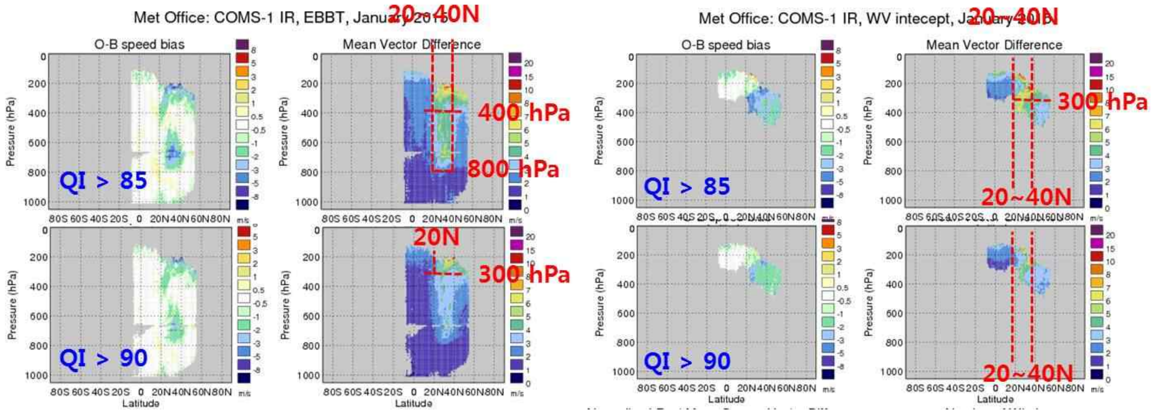


Figure 3: **Blacklisting strategies of operation (top) and detailed way (bottom).**

4. IMPACTS ON THE FORECASTS

Three more experiments were carried out with different blacklisting and errors from operational use (V1: very detailed blacklisting, V2: use all AMVs QI>80, V3: V1 + new error profile). As expected, the number of data passed the quality control process is highest in V2, and higher in V1 than the operation. V2, admitted to pass more data, unfortunately included many bad data, and it resulted in large difference with the operation in the mean analysis field especially over the region where AMVs are assimilated (Figure 4).

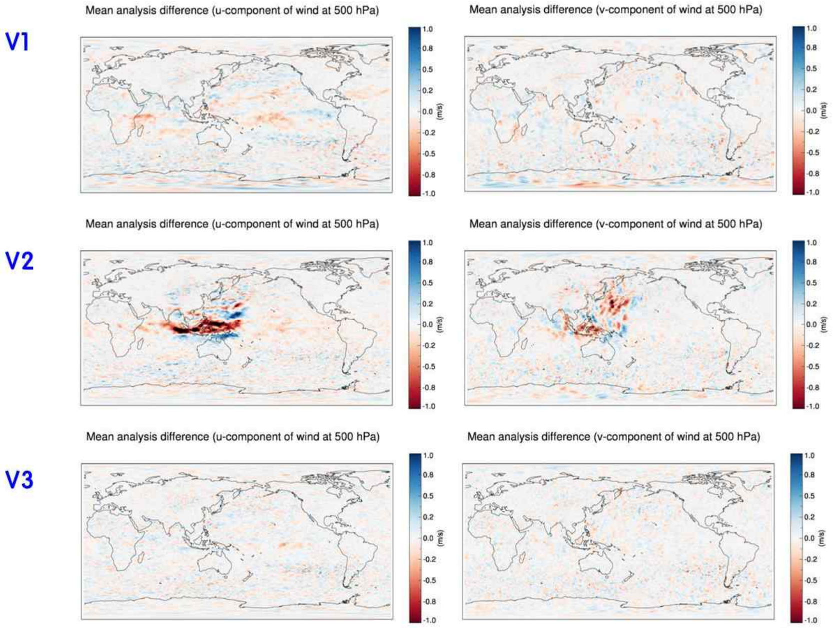


Figure 4: **Mean analysis difference of U (left), V (right).**

It is also shown in the background fit of other observation such as sonde and COMS CSR as well as AMV. In the figure 5, it is found that background fit in experiment V1 and V3 improved compare to the operation (positive value), but not in V2. Figure 6 shows the vertical background fit, and it represents the strong negative impacts of V2 on the analysis field especially in the mid-level of atmosphere. However, background fits of the experiment V1 and V3 shows the tendency of positive impact.

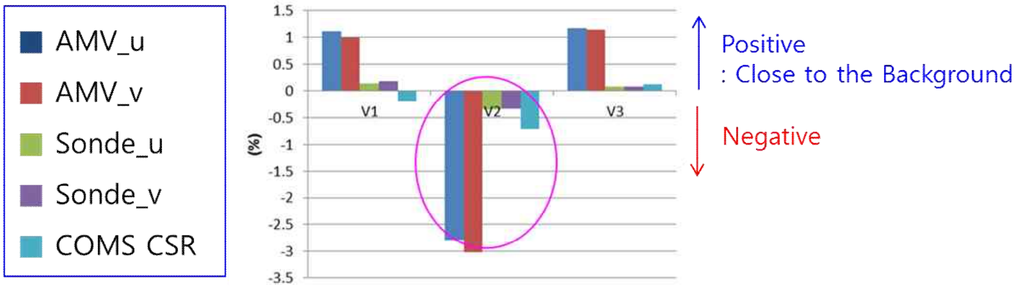


Figure 5: **Monthly mean background fits in the experiments.**

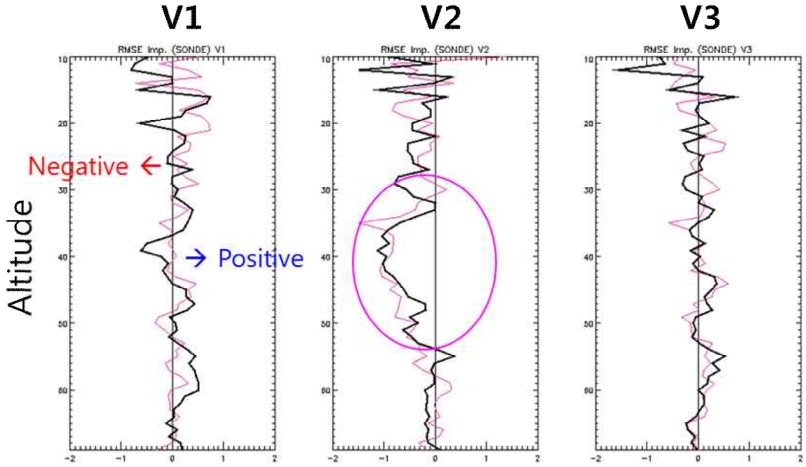


Figure 6: **Monthly mean vertical background fits in the experiments. Black and pink lines indicate U and V component of wind.**

The forecast fields of the experiments were verified against sonde and its own analysis fields, also, compared with the operation. Table 1 show the improvement rate (%) of RMSE against sonde observation (positive value means positive impact of the experiments). For all three experiments, mean improvement rates in the Asian region are evaluated as positive. In the experiment V1 (with very detailed blacklisting), global mean impact also shows positive.

Global (Asia)	T850	G500	W250	Mean
V1	0.18 (0.26)	0.62 (1.55)	-0.03 (0.02)	0.25 (0.61)
V2	-0.15 (0.32)	0.03 (-0.15)	-0.01 (0.07)	-0.05 (0.08)
V3	-0.24 (0.02)	0.10 (0.19)	0.06 (0.05)	-0.03 (0.12)

Table 1: **Improvement rate (%) of forecast RMSE verified against sonde observation. Positive values represent positive impacts of experiments.**

5. SUMMARY

In order to improve the impact of COMS AMV in the KMA global NWP system, higher resolution AMV is produced, and tested in the model. In the initial experiment which tested the higher resolution AMV with the same condition of quality control and the error profile, forecast error reduced by decreasing the slow bias of wind in winter season. However, the impact on summer season is somewhat negative, so new error statistics were estimate and applied. By applying detailed blacklisting strategy from the carefully analysed error, forecast error reduced compare to the operation. While, another experiment with just weak blacklisting (QI>80) influenced very negatively on the forecast showing the large difference between the observation and the background.

References

Lee, E., Kim, Y., Sohn, E., Cotton, J., Saunders, R., (2012) Application of hourly COMS AMVs in KMA operation, Proceedings of the 11th International Wind Workshop