P1.25 THE GLOBAL 3DVAR SYSTEM OF KOREA METEOROLOGICAL ADMINISTRATION

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1. INTRODUCTION

Many operational centers adapt variational method as a numerical weather prediction (NWP) analysis scheme. The variational analysis method is global minimization and can get more balanced analysis than the traditional optimal interpolation method, which is local minimization in getting the analysis. Another advantage of the variational analysis is that it can assimilate asynoptic data such as satellite radiation effectively by using observation operator, while the traditional optimal interpolation is difficult to assimilate asynoptic data (Courtier et al., 1998; Derber and Bouttier, 1999; Lorenc et al., 2000; Rabier et al., 1998). The Korean Meteorological Administration (KMA) has replaced the traditional statistical interpolation method at the end of 2003 in order to get a better analysis over the ocean by assimilating satellite data effectively.

In general, the summer weather in the East Asia is largely affected by the location and intensity of the Northern Pacific High (NPH). And the satellite data in NWP analysis over the western Pacific Ocean is important to improve prediction of the location of the NPH. However, it is not easy to use the satellite data optimally because of its peculiar error characteristics and sensitivity to the surface and cloud condition. Therefore in order to get useful information of satellite, it is important to extract and use the satellite information properly.

In this study, the 3DVAR is used to assimilate ATOVS data. The satellite observation error is calculated depending on the innovation and background error in the radiance space. As the ATOVS data is used only over the ocean, background error is sampled over the ocean and converted into radiance space reference to the TIGR profile. The forecast results with the 3DVAR are compared with that of the operational one at KMA for the summer 2003 and the preliminary results of the 3DVAR is shown.

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2. THE 3DVAR SYSTEM AT KMA

The 3dimentional data assimilation method is originated from the Japan Meteorological Agency (Takeuchi and Tsuyuki, 2001). The analysis variables are vorticity, unbalanced divergence, unbalanced surface pressure and temperature, and logarithm of specific humidity of hybrid sigma level and spectral space. The incremental method is adapted with the resolution of inner loop of T63 and outer loop of T213.

The background error covariance is block diagonal. It is assumed that the horizontal error correlation is uncorrelated by using the spectral coefficient under the condition with the homogeneity and isotropic condition. As well, we considered that error correlation between variables is removed by using the unbalanced variables. The linear balance equation is used to remove the balance component between mass and wind field and the constraints of the balance vary depending on the latitude (Daley, 1996). However the vertical correlation is not diagonal and the correlation is explicitly considered to make the background error covariance block-diagonal. The latitudinal dependency of the vertical error correlation is considered.

For operational use, the typhoon bogus

technique is applied on the background before the analysis depending on the Fujita formulation (Fujita, 1952). The global model at KMA is spectral model of which truncation is T213 and therefore the background of the analysis is spectral coefficient and the analysis increment in spectral space is directly used as a initial filed of the global model.

For the satellite data assimilation, the 1DVAR technique is used. The 1DVAR is a retrieval technique but it can be used as an observation operator for the 3DVAR. The 1DVAR used the calculated observation error by using the relationship between innovation and background error in the radiance space. This method can help to get the objective value of the observation error and can directly related to the current situation of the weather. The details are in Joo and Lee (2002).

3. RESULTS

3.1 Error tuning

In order to improve the 3DVAR results the error variances are tuned. The error correlation is calculated directly by the NMC method (24/48hour forecast difference). The observation cost function is calculated for each observation type and divided by the number of observation to verify if the current observation error is well tuned. The modification on the ratio of error variance is done by using Equation 1 which shows the cost function for each observation type if the background is the same as the analysis.

$$\langle J \rangle = \frac{1}{2}\left(\left(\frac{\sigma_o}{\sigma_b}\right)^{-2} + 1\right) \quad \cdots\cdots\cdots\cdots \quad (1)$$

Here, J is the cost function σ_o and σ_b is observation and background error respectively.

The effect of the error tuning is shown in Fig. 1. The tuning reduces bias but it has no much

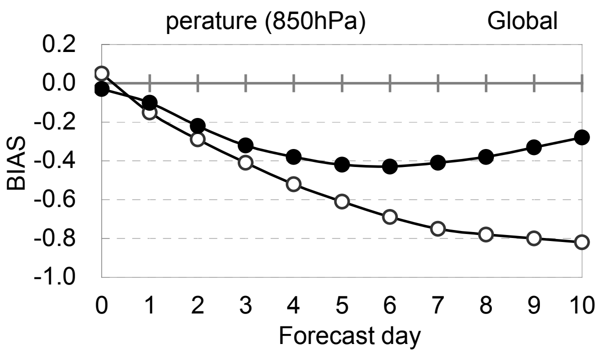

Fig. 1. Averaged 850hPa temperature bias of global prediction for September 2003. The solid line with closed circle and open circle indicate for the results of 3DVAR with the tuning and without the tuning, respectively.

3.2 Typhoon track forecast

The typhoon track is highly influenced by the NPH near the Korean peninsula. In order to verify the performance of the 3DVAR over the ocean, the typhoon track forecast is compared. The typhoon named “MAEMI” is selected. The “MAEMI” recorded high wind speed of 60m/s when it launched to the southern part of the Korean peninsula and causes lots of property loss over the area. Table 1 shows the track error averaged for the cases of which “MAEMI” approached near the Korean peninsula. IN this table, the typhoon track due to 3DVAR is better simulated than the operation.

Table 1. Typhoon track error in distance (km).

Expr. / Fcst	Operation	3DVAR
24 hour	129	132
48 hour	239	149
72 hour	372	157
96 hour	734	283

3.3 Statistical verification

The 3DVAR forecast results are compared with that of operation. The 3DVAR is performed with the same observation data. For the adjustment, the 3DVAR has started one month prior to the verification period. The verification period is September 2003 and the result of anomaly correlation of 500hPa geopotential height is shown in Fig. 2.

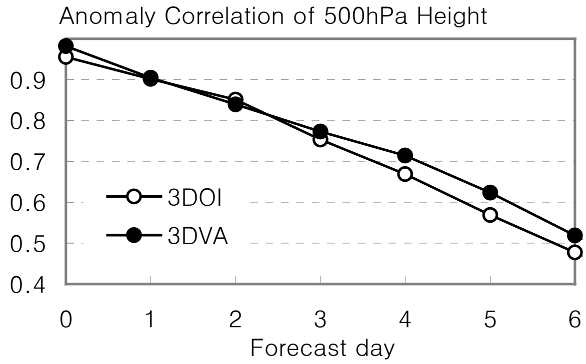

Fig. 2. Averaged anomaly correlation of 500hPa geopotential height for September 2003. The "3DOI" and "3DVA" indicate the results of operation and 3DVAR, respectively.

Figure 2 shows that the general performance of the 3DVAR is better than the operation all the forecast period. Other field shows similar results with Fig.2 and both bias and RMSE show better performance also. However the RAOB fits show no improvement in the 3DVAR (now shown here). However, far less number of satellite data is rejected in 3DVAR during the quality control over the oceans, and it is assumed that the background of the 3DVAR is closer to the satellite observation over the ocean where synoptic data is sparse. We can infer from this that the 3DVAR modulate the observation well over the ocean even the fit to the RAOB is not improved in the 3DVAR results.

4. FUTURE PLANS

The satellite data is not directly used yet in the 3DVAR and the 1DVAR retrieval algorithm is used to put the satellite information. However, the direct assimilation is important to improve the performance of the 3DVAR and will be implement. Even after the direct assimilation is installed, the 1DVAR will be used as a quality control for the radiance data and only the satellite data passed the 1DVAR will be used in the 3DVAR.

The FGAT technique will be implemented in order to lessen the error caused by the time difference between the satellite observation and first guess. It will be a simpler way of the time interpolation and will improve the 3DVAR results before we move to the 4DVAR.

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