A new operational one-week Ensemble Prediction System at Japan Meteorological Agency

Ryota SAKAI*, Masayuki KYOUDA**, Munehiko YAMAGUCHI* and Takashi KADOWAKI*
*Numerical Prediction Division, Japan Meteorological Agency
** Climate Prediction Division, Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, JAPAN
(e-mail: ryouta.sakai-a@met.kishou.go.jp)

1. Introduction

Since 2001, Japan Meteorological Agency (JMA) has operated one-week Ensemble Prediction System (EPS). On November 21, 2007, JMA newly employed the Singular Vectors as an initial perturbation method, and improved the resolution of the one-week EPS. This paper reports on an outline and the performance of new one-week EPS.

2. Specifications of the new one-week EPS

The Singular Vectors (SVs) method (Buizza and Palmer, 1995) was introduced into the operational system in place of the Breeding of Growing Mode (BGM) method (Toth and Kalnay, 1993). Table 1 shows the specifications of the new initial perturbation method. A tangent linear and adjoint model used for the SVs calculation are the same as those used for the 4-dimensional variational data assimilation system (4D-VAR) in the JMA Global Spectral Model (GSM). The SVs are computed for the Northern Hemisphere (30N-90N) and the Tropics (20S-30N), separately. The moist total energy norm (Ehrendorfer, 1999) is employed for the metrics of perturbation growth. In addition to the initial SVs which are calculated from the present analysis field, the evolved SVs which are linearly integrated for optimization period up to the initial time have been also introduced into the initial perturbations. In order to construct initial perturbations with wide spatial distribution, 25 initial perturbations are obtained by combining the SVs in the respective targeted region (the Northern Hemisphere and the Tropics). After adjustment of initial perturbation amplitude using climatological variance, 50 perturbed ensemble initial fields are generated from 25 initial perturbations by adding each perturbation to analysis field positively and negatively. The analysis field for the one-week EPS (T_L319L60) is obtained by truncated from the high resolution Global Analysis field (T_L959L60).

Table 1 Specifications of new initial perturbation method.

	Northern Hemisphere	Tropics
Initial perturbation generator	Singular Vectors method	
Targeted region	30N - 90N	20S - 30N
Resolution of tangent-linear and adjoint model	T63L40 (1.875 deg.)	
Physical processes of inner model	* simplified-physics	** full-physics
Optimization time	48 hours	24 hours
Norm	Moist Total Energy	
Evolved SV	Used (48 hours integration)	Used (24 hours integration)
Sampling	Variance minimum method	
Amplitude of initial perturbation	12% of the climatological variance at 500hPa geopotential height	26% of the climatological variance at 850hPa temperature
Initial perturbation size	25	
Ensemble size	50 perturbed run + 1 control run = 51 ensemble members	

* simplified-physics: Initialization, horizontal diffusion, surface turbulent diffusion and vertical turbulent diffusion.
** full-physics: In addition to the simplified-physics processes, gravity wave drag, long-wave radiation, clouds and large scale convection and cumulus convection.

A forecast model used in the one-week EPS is the low-resolution version of the JMA GSM (Iwamura, 2008). Table 2 shows the specifications of the old and the new one-week EPS forecast model. The horizontal and vertical resolutions are enhanced to T_L319L60. In addition, the deep convection scheme has been improved (Nakagawa, 2008).

Table 2 Specifications of old and new forecast model.

	Old One-week EPS	New One-week EPS
Horizontal resolution	T_L159 (1.125 deg.)	T_L319 (0.5625 deg.)
Vertical resolution (Layer)	40 (surface - 0.4hPa)	60 (surface - 0.1hPa)
Forecast time (initial time)	216 hours (12UTC)	
Time integration	3 time-level scheme (1200s)	2 time-level scheme (1200s)
Initial field	Interpolated analysis field of T_L319L40 into T_L159L40	Truncated analysis field of T_L959L60 into T_L319L60

3. Performance of the new one-week EPS

Figure 1 shows the verification result of the preliminary experimentation over the Northern Hemisphere (20N-90N) in December 2005. The anomaly correlation of the geopotential height forecast field at 500 hPa (Z500) for

the new one-week EPS is similar to that of the old one (Figure 1a). The new one-week EPS improves the relationship between the Z500 Root Mean Square Error (RMSE) of the ensemble mean and the ensemble spread around the ensemble mean which should grow at the same magnitude (Figure 1b, 1c).

Figure 2 shows the brier skill score (BSS) for the probabilistic forecast that anomaly of temperature at 850 hPa in the Eastern Asia (30N-60N, 110E-150E) is larger than 1.5 climatological standard deviation and smaller than -1.5 climatological standard deviation. The verification period is the same as Figure 1. The BSSs of the new one-week EPS are superior to that of the old one.

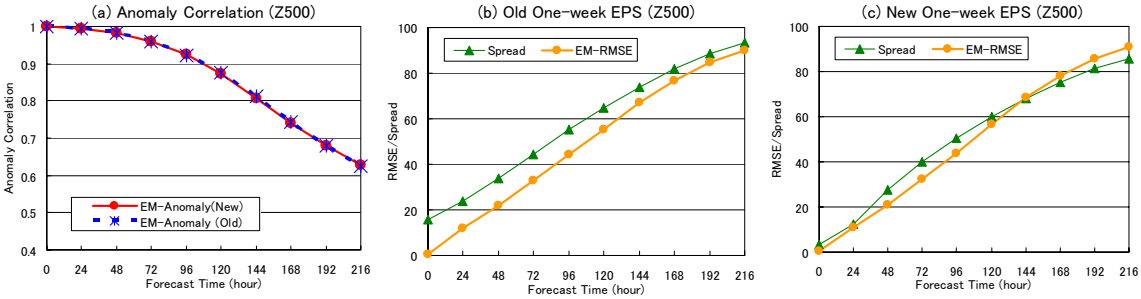

Figure 1 Verification result of the preliminary experimentation for Northern Hemisphere in December 2005. (a) Anomaly Correlation of Z500. The red line is the new EPS, the blue bashed line is the old EPS. (b) Relationship between the RMSE and the spread of Z500 for the old EPS. (c) Same as (b) but for the new EPS. In (b) and (c), the green line shows the spread around the ensemble mean, the orange line shows the ensemble mean RMSE of Z500.

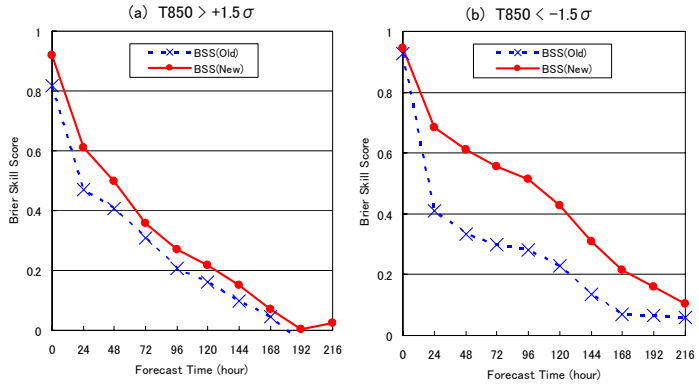

Figure 2 Probabilistic Verification of the preliminary experimentation for the East Asia in December 2005. Anomaly of T850 forecast is (a) larger than +1.5 climatological standard deviation and (b) smaller than -1.5 climatological standard deviation. The red line represents the new EPS and the blue dashed line does the old EPS.

References

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