Modification to Initial Perturbations of JMA's Typhoon Ensemble Prediction System

Yoichiro Ohta
Numerical Prediction Division, Japan Meteorological Agency
e-mail:ota@met.kishou.go.jp

Since February 2008, JMA has operated the Typhoon Ensemble Prediction System (TEPS) to contribute to operational five-day forecasts of tropical cyclones (TCs) at the RSMC Tokyo-Typhoon Center. The TEPS forecast model is a low-resolution version (TL319L60) of JMA's Global Spectral Model (GSM), and is operated four times a day when TCs are present or expected to appear in JMA's area of responsibility (0˚N – 60˚N, 100˚E – 180˚E). There are 11 TEPS members (1 control member + 10 perturbed members), and the forecast time is up to 132 hours. A detailed description of the TEPS is given by Yamaguchi and Komori (2009).

The initial perturbations of the TEPS are produced using the singular vector (SV) method (Buizza and Palmer 1995). Two spatial target areas to obtain SVs are defined to capture the uncertainty of TC track forecasts. One is the Northwestern Pacific (20°N – 60°N, 100˚E – 180˚E), and the other consists of a group of areas around the central positions of TC forecasts (three at maximum: TC target area). To improve the forecast skill of the TEPS, JMA introduced two revised methods for the production of initial perturbations in May 2010. First, the TC target areas are set as circular regions with a 750-km radius from the TC's central position, in contrast to the previous rectangular-area settings (10 degrees in the meridional direction and 20 degrees in the zonal direction). Figure 1 shows a comparison of the previous and new TC target areas centered on the position of 20°N and 140°E. Second, the amplitude of initial perturbations is normalized using a moist total energy (Ehrendorfer et al. 1999; Barkmeijer et al. 2001) value, in contrast to the previous normalization that used the maximum meridional or zonal wind speed.

Figure 2 shows ensemble mean track forecast errors classified according to reliability indices. A, B and C represent higher, middle and lower levels of forecast reliability, respectively. The indices are determined by six-hourly accumulated ensemble spreads at each forecast time. In the new system, the mean track forecast errors of A, B and C are maintained in the same order throughout the forecast time, unlike in the previous system. This indicates that the modifications implemented contribute to the appropriate distribution of initial perturbations. Consequently, the spread-skill relationship of TC track forecasts is improved, and the TEPS is able to provide more accurate information on operational TC forecasts.

References

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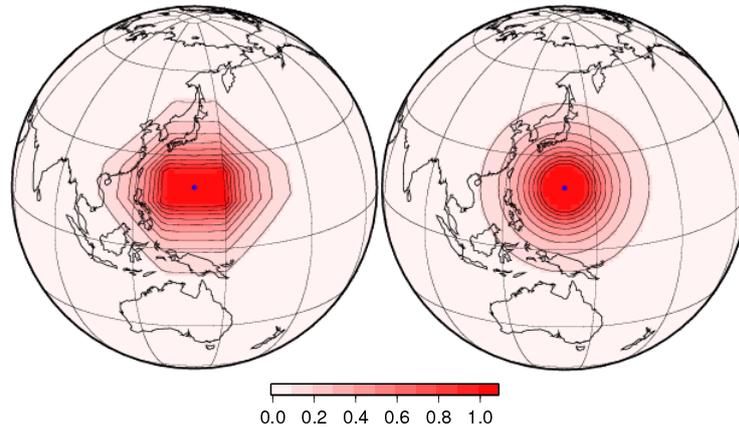
Figure 1 Comparison of the previous (left) and new (right) TC target areas. The central position of the targets is 20°N and 140°E. Colors with contours show projection operator values in the SV calculation.
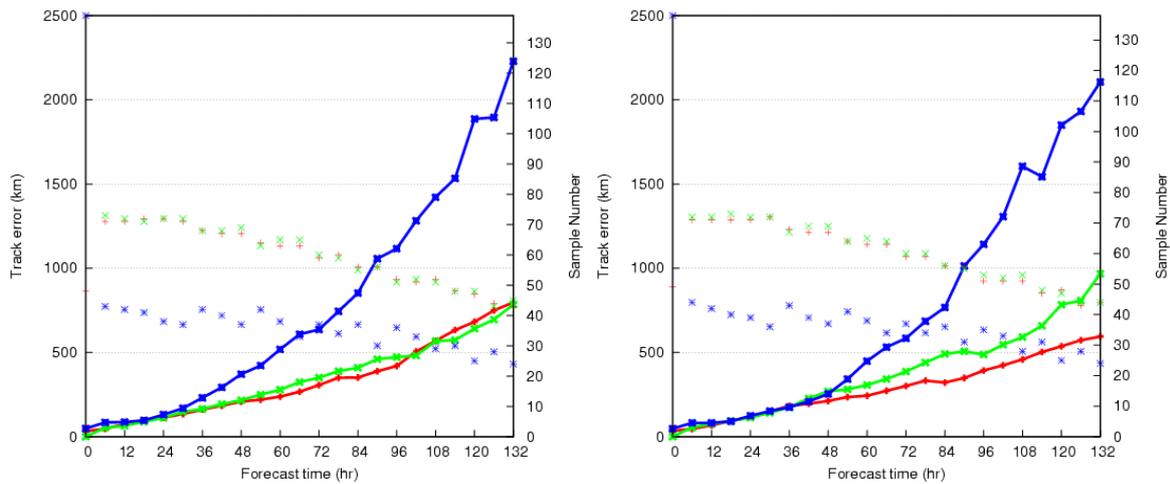

Figure 2 Ensemble mean track forecast errors for TCs in JMA's area of responsibility from 25 September to 25 October, 2009. The left and right panels are for the old and new systems, respectively. The red, green and blue lines show the mean track errors with reliability indices of A, B and C, respectively. The colored marks indicate the number of samples for each class.