Update of the JMA's El Niño Prediction System in February 2009

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1. Introduction

In February 2009, JMA updated the El Niño prediction system, which consists of a global ocean data assimilation system (MOVE/MRI.COM-G; Usui et al. 2006) and a coupled atmosphere-ocean global circulation model (JMA/MRI-CGCM; Takaya et al. 2007).. The operational information, such as the El Niño outlook[1] and monitoring of global oceanic condition[2], has been produced with the new system since March 2009. This paper reports the overview of the update and the prediction skill by the hindcast experiments.

2. Outline of the JMA's El Niño prediction system

Specifications of the JMA/MRI-CGCM are shown in Table 1. The atmospheric component is a lower-resolution version of the global spectral model (GSM0603) used by JMA for operational numerical weather prediction (JMA. 2007). The atmospheric initial conditions are referred to the climate data assimilation system in JMA (JCDAS). The oceanic initial conditions are provided by the ocean data assimilation system (MOVE/MRI.COM-G), which adopts multivariate three dimensional variational (3D-VAR) method with vertical coupled Temperature-Salinity (T-S) Empirical Orthogonal Function (EOF) modes. Coupling of heat, momentum and fresh water flux between the oceanic and atmospheric components takes every one-hour. In order to mitigate climate drift, flux adjustment of both heat and momentum flux are given during time integration.

3. Major changes of this update

The oceanic perturbation has been newly implemented in the new system. The oceanic perturbed initial members are estimated through the ocean data assimilation system forced with the perturbed surface wind stress fields, which are produced by the atmosphere breeding method. Therefore, the ensemble method has been improved as follows (Figure 1);

- (Old) Lagged Average Forecasting (LAF) ensemble (one member with twelve initial dates)
- (New) Combination of perturbations and LAF ensemble (five members with six initial dates)

Accordingly, ensemble size has been increased from 12 to 30 and the lag period has been shortened from 55 to 25 days.

In addition, some statistics, such as the T-S EOF modes for MOVE/MRI.COM-G, flux adjustment and bias correction of SSTs for JMA/MRI-CGCM have been replaced according to the improvement of the MOVE/MRI.COM-G.

4. Performance

To examine the impacts of refining the ensemble method, the performances of the following two ensemble methods were compared in a hindcast experiment (Figure 2);

- ***LAF5***: A 10-day LAF ensemble consisting of five members
- ***PTB10***: A combination of the 25-day LAF ensemble and perturbations consisting of 10 members

Four initial dates per year were set for the experiment (31 January, 1 May, 30 July and 28 October) for the period from spring 1996 to spring 2006 (10 years). The ensemble size of ***PTB10*** was larger than that of ***LAF5***, and the lag period for ***PTB10*** was shorter than that of LAF5. It can be estimated that the difference in performance of both methods corresponds approximately to the improvement in forecast skills brought about by this upgrade.

It is found that ***PTB10*** improves on the prediction of SSTs over the western tropical Pacific and the Indian Ocean (Figure 3). This improvement can mainly be attributed to the increased ensemble size compared with the result of other methods in aggregating ensemble members (not shown). Perturbations used in the new ensemble method are important to increase ensemble size within a limited time.

References

Yasuda, T., Y. Takaya, C. Kobayashi, M. Kamachi, H. Kamahori, and T. Ose, 2007: Asian monsoon predictability in JMA/MRI seasonal forecast system. CLIVAR Exchange, 43, 18-24.

Usui, N., S. Ishizaki, Y. Fujii, H. Tsujino, T. Yasuda and M. Kamachi, 2006: Meteorological Research Institute multivariate ocean variational estimation (MOVE) system. Advances in Space Research, 37, 806-822.

Takaya, Y., T. Yasuda, S. Matsumoto, T. Nakaegawa and T. Ose, 2007: Seasonal Prediction Skill in the New ENSO Forecast System at Japan Meteorological Agency. WCRP Workshop on Seasonal Prediction, Barcelona Spain June 4-7, 2007.

[1] http://ds.data.jma.go.jp/tcc/tcc/products/elnino/index.html
[2] http://ds.data.jma.go.jp/tcc/tcc/products/clisys/index.html

Table 1 Specifications of the El Niño prediction model (JMA/MRI-CGCM)

Atmospheric component	Domain	Global
	Resolution	TL95, 40 vertical levels
Oceanic component	Domain	Global except the Arctic Ocean (75°S-75°N)
	Resolution	1.0° (long.) x 1.0° (lat.), (1.0° (long.) x 0.3° (lat.) near equator) 50 vertical levels
Coupling	Frequency	Every one-hour
	Flux adjustment	heat and momentum fluxes

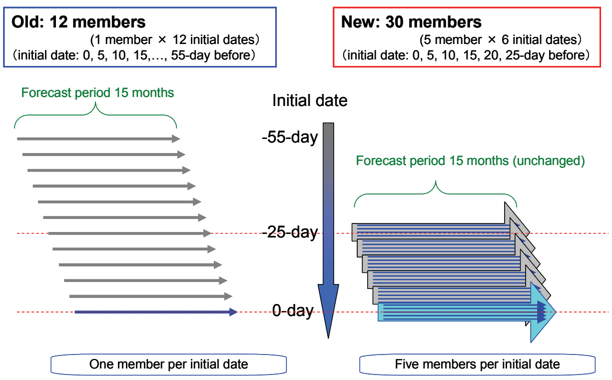

Figure 1 Schema of the aggregation of ensemble members in the old (left) and new (right) El Niño prediction system.

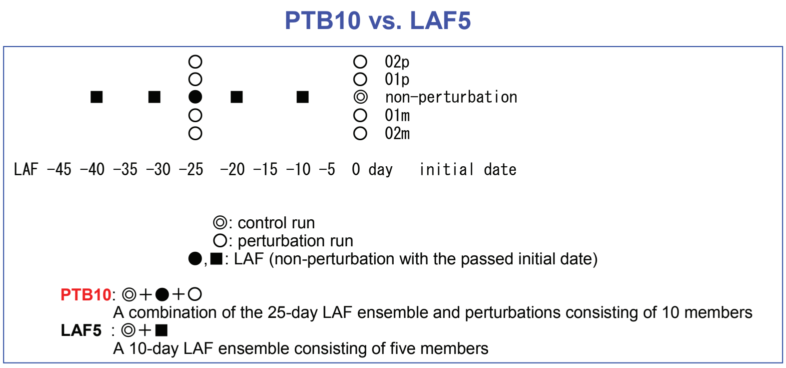

Figure 2 Schema of two ensemble methods (PTB10 and LAF5) in the hindcast experiment.

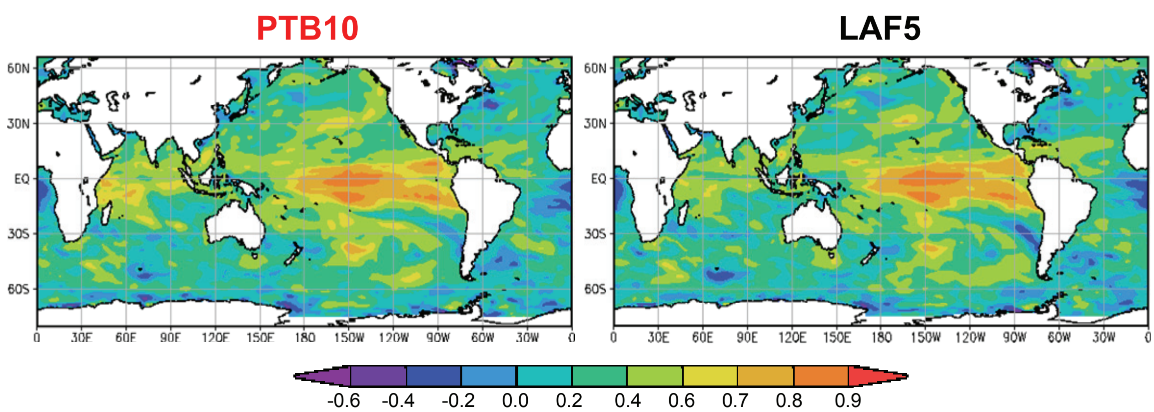

Figure 3 Anomaly correlation coefficient of SST prediction by PTB10 (left) and LAF5 (right) Lead time is six months.