Verification of the new JMA's EPS for Long Range Forecasting based on SVS-LRF

Kohshiro Dehara[1], Hirotoshi Mori[1], Masayuki Hirai[1] Noriyuki Adachi[1]

[1] Climate Prediction Division, Japan Meteorological Agency, Tokyo, Japan
(E-mail: dehara@met.kishou.go.jp)

1. Introduction

The ensemble prediction system (EPS) for long range forecasting of JMA was replaced. This update is fundamental, because an atmospheric global circulation model (AGCM) is abandoned as a long range forecasting model and an atmosphere-ocean coupled global circulation model (CGCM) is introduced. The operational information of the seasonal prediction has been produced with the new system since February 2010.

We carried out the hindcast experiment based on the standardized verification system for long range forecasts (SVS-LRF; WMO 2006). This paper reports prediction skill of the new system comparing with the old one.

2. Design of the hindcast experiment

Table 1 shows specifications of the hindcast experiment. The major changes of the prediction system between the new system (CGCM) and the conventional one (AGCM) are as follows

* The forecasting model is replaced from AGCM to CGCM, although the atmospheric component of CGCM is basically same as AGCM.
* Ensemble method is changed. CGCM adopts the combination of initial perturbation method and the lagged average forecasting (LAF) method, while AGCM treats only initial perturbations.

Verification data are referred to COBE-SST (Ishii et al. 2005) for SSTs, JRA-25/JCDAS (Onogi et al. 2007) for atmosphere, and GPCP (Adler et al. 2003) for precipitations.

3. Verification results

(1) Prediction skill of Sea surface temperatures

Prediction skill of CGCM is compared with the persistence forecasting (PERSISTENCE). Figure 1 shows anomaly correlation coefficient (ACC) of NINO3.4SSTs (170°E-120°W, 5°S-5°N). A remarkable persistency barrier is found in spring. In contrast, ACC of CGCM is much higher than that of PERSISTENCE. However, prediction skill is relatively insufficient from spring to summer as the other numerical and statistical models (Jin et al. 2008).

(2) Prediction skill of atmosphere

Prediction skill of atmosphere for summer (JJA) with the initial month of February is compared. Figure 2 shows the reliability diagrams of sea-level pressure at tropics (20°S-20°N) for upper tercile events. Reliability of CGCM is nearer the diagonal, so it is better than that of AGCM. Brier Skill Score (BSS) of CGCM is larger than that of AGCM. ACC of stream function at 850hPa of CGCM is larger than that of AGCM in large parts of the Pacific, especially from Southeast Asia to the northwest part of the Pacific and in the northeast part of the Pacific. This indicates that CGCM improves prediction skill of large scale atmospheric circulations in the tropics. This may relate to refinement of prediction of tropical precipitation. CGCM improves prediction skill of precipitation over the Western North Pacific Monsoon (WNPM) region (10°N-20°N, 110°E-160°E) (Figure 4). The cause of this may be that air-sea interaction, such as negative correlation between SSTs anomaly and precipitation in the WNPM region, is considered properly by CGCM comparing with AGCM.

References

Adler, R.F., G.J. Huffman, A. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, P. Arkin, E. Nelkin, 2003: The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979-Present). *J. Hydrometeor.*, **4**, 1147-1167.

Ishii, M., A. Shouji, S. Sugimoto, and T. Matsumoto, 2005: Objective Analyses of Sea-Surface Temperature and Marine Meteorological Variables for the 20th Century using ICOADS and the Kobe Collection. Int. *J. Climatol.*, **25**, 865-879.

Jin E. K., James L. Kinter III, B. Wang, C.-K. Park, I.-S. Kang, B. P. Kirtman, J.-S. Kug, A. Kumar, J.-J. Luo, J. Schemm, J. Shukla and T. Yamagata, 2008: Current status of ENSO prediction skill in coupled ocean–atmosphere

Onogi, K., J. Tsutsui, H. Koide, M. Sakamoto, S. Kobayashi, H. Hatsushika, T. Matsumoto, N. Yamazaki, H. Kamahori, K. Takahashi, S. Kadokura, K. Wada, K. Kato, R. Oyama, T. Ose, N. Mannoji, and R. Taira, 2007: The JRA-25 Reanalysis. *J. Meteor. Soc. Japan*, **85**, 369-432.

WMO, 2006: Standardised Verification System (SVS) for Long-Range Forecasts (LRF), New Attachment II-8 to the Manual on the GDPFS (WMO-No. 485), Volume I, 28pp.

Table 1 Specifications of the conventional and the new system for long range forecasting

		Old system (AGCM)	New system (CGCM)
Outline of the system		AGCM with two-tier method	CGCM (one-tier method + flux adjustment)
Model	Atmospheric component	JMA-GSM (TL95 (~1.125°), 40 levels (up to 0.4 hPa))	
	Oceanic component	---	MRI.COM (1.0° in longitude, 0.3°~1.0° in latitude, up to 50 levels, 75°N-75°S)
Initial condition	Atmosphere	JRA-25/JCDAS	
	Ocean	---	MOVE/MRI.COM-G
Boundary condition	Land surface	numerical prediction initialized from climatology	
	SST	two-tiered method (persisted anomaly + statistical prediction)	numerical prediction with flux adjustment climatology out of the oceanic model domain (polar region)
	Sea ice	climatology	
Parameter	CO_2	constant	trend
Ensemble method	Ensemble size	11	10 (5 BGMs and 15-day LAF)
	Perturbation method	singular vector (SV) method	combination of initial perturbation (atmospheric breeding growing mode (BGM) method and oceanic initial perturbation) and lagged average forecast (LAF) method
Hindcast	Target period	1984~2005	1979~2008
	Initial dates	10th of the every month	the beginning of month and the middle of the preceding month

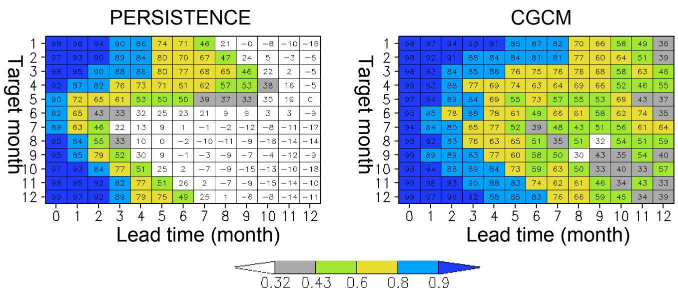

Figure 1 Anomaly correlation coefficient (ACC) of NINO.3.4 (170°E-120°W, 5°S-5°N) SSTs during 1979-2007 with respect to target month (vertical) and leadtime (horizontal) by persistence (left) and CGCM (right). The two-digit number denotes 100 times ACC. 0.32 and 0.43 of ACC are equivalent to 5% and 1% significant level of one-side t-test, respectively.

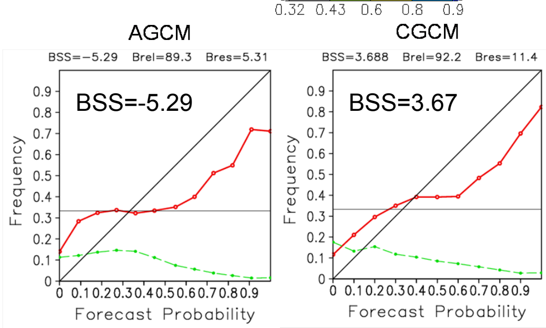

Figure 2 Reliability Diagrams of sea-level pressure for summer (JJA) with the initial month of February at tropics (20°S-20°N) for upper tercile events.
Full(Red) : Reliability, Dash(green) : Forecast Frequency, BSS: Brier Skill Scores x 100

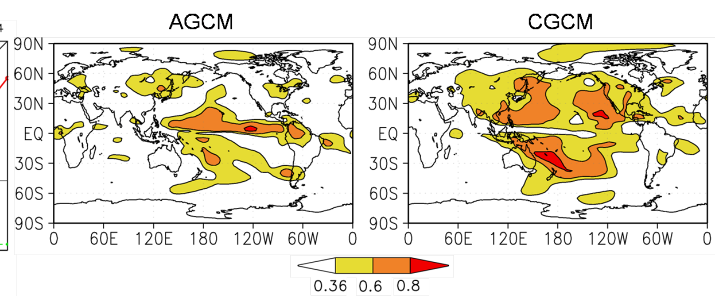

Figure 3 Anomaly correlation coefficient of stream function at 850hPa for summer (JJA) with the initial month of February by AGCM (left) and CGCM (right). Target period is 1984~2005. 0.36 of ACC is equivalent to 5% significant level of one-side t-test.

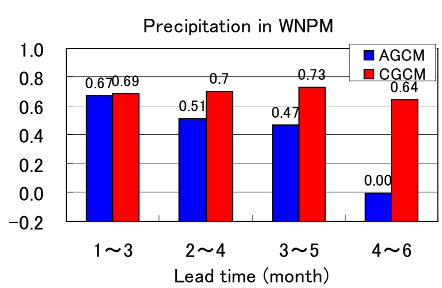

Figure 4 Anomaly correlation coefficient of 3-month mean of precipitation for summer (JJA) with the initial month of February over Western North Pacific Monsoon region (110°E-160°E, 10°N-20°N) with respect to lead time by AGCM (Blue) and CGCM (Red). Target period is 1984~2005.