Verification of JMA's new GEPS for one-month prediction

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1. Introduction

The Japan Meteorological Agency (JMA) replaced its previous One-month Ensemble Prediction System (EPS) (Hirai et al. 2014) with the Global EPS (GEPS) in March 2017 (Yamaguchi et al. 2018). The GEPS is an integrated system supporting JMA's issuance of typhoon forecasts, one-week forecasts, early warnings for extreme weather and one-month forecasts. This change includes major updates for the atmospheric forecast model and the method of generating initial and boundary perturbations (for details, see Yamaguchi et al. 2018). This paper outlines the performance of the GEPS verified in terms of one-month prediction via 30-year hindcast experiments.

2. Hindcast experiments

As specified in Table 1, the experiments were conducted for the 30-year period from 1981 to 2010 with atmospheric initial conditions produced from the Japanese 55-year Reanalysis (JRA-55; Kobayashi et al. 2015). Initial perturbations were created from a combination of initial singular vectors (SVs) and evolved SVs calculated using the SV method, while initial perturbations for the real-time system were produced by combining perturbations from the SV method and the Local Ensemble Transform Kalman Filter (LETKF) method (Yamaguchi et al. 2018). In these experiments, perturbations from the LETKF method were not adopted due to the high computational cost involved.

3. Verification results

With the weaker biases of velocity potential at 200 hPa over the Asian monsoon region in boreal summer, forecast mean errors of the GEPS are smaller than those of the previous One-month EPS (Figure 1). The four-week mean forecast fields of the GEPS also show smaller southward position biases for the sub-tropical jet stream than those of the previous One-month EPS (not shown).

For the anomaly correlation coefficients of geopotential height at 500 hPa over the Northern Hemisphere (20 – 90°N), the GEPS demonstrates improved forecast skill for most lead times and seasons (Figure 2).

Prediction skill for the Madden-Julian oscillation (MJO) is evaluated using the method described by Matsueda and Takaya (2012). As shown in Figure 3, the MJO amplitude of the GEPS is larger than that of the previous One-month EPS, but still smaller than that of analysis. Other MJO forecast skills (i.e., RMSE and correlation) of the GEPS are generally comparable to those of the previous One-month EPS (not shown).

Representation of quasi-biennial oscillation (QBO) is verified from the time series of equatorial zonal wind at 30 hPa (Figure 4). There is a large difference between the analysis (black line) and the forecast of the previous One-month EPS (blue lines), while the variation of zonal wind is better captured by the GEPS (red lines).

4. Summary

In this work, the one-month prediction performance of the GEPS was verified via hindcast experiments. Some of the major model biases seen in the previous One-month EPS were reduced, and the forecast skill of the GEPS was superior for most lead times and seasons. MJO amplitude and QBO representation were also improved.

Table 1 Hindcast experiment details

	Global EPS (GEPS)	Previous One-month EPS
Atmospheric forecast model	GSM1603 (Yonehara et al. 2017) with additional improvement of physical processes	GSM1304
Resolution (model top)	TL479L100 (0.01hPa) up to 18 days TL319L100 (0.01hPa) afterwards	TL319L60 (0.1hPa)
Period (initial date)	1981－2010 (10th, 20th, end of month)	
Ensemble size	5	
Initial perturbation method	Singular Vector (SV) method	Breeding of Growing Modes (BGM) method
Initial condition (atmosphere)	JRA-55	
Initial condition (land)	Calculated in advance using the land-surface model in the GEPS and atmospheric forcing from JRA-55	JRA-55
Verification data	JRA-55	

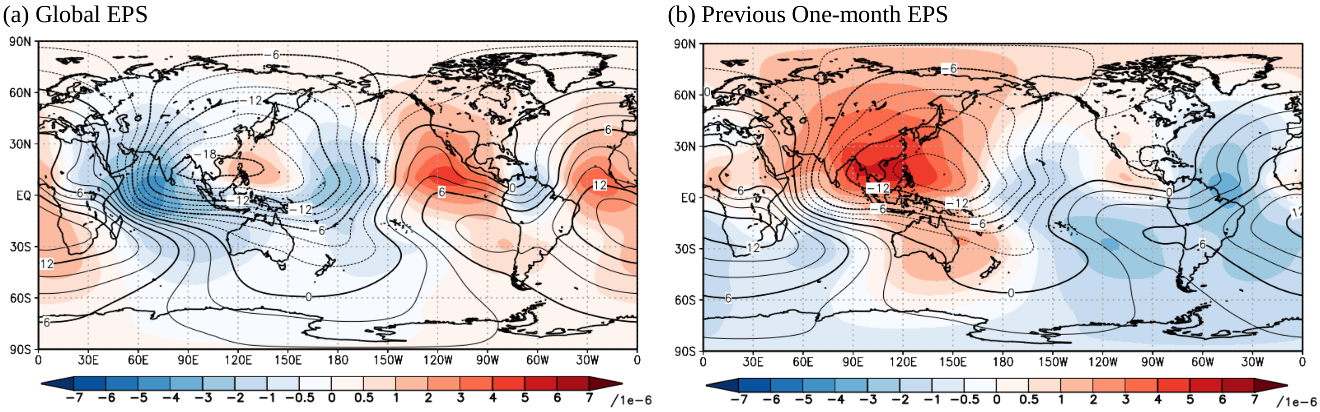

Figure 1 Climatological mean fields for 4-week mean (day 3 – day 30) velocity potential at 200 hPa (contours) and related mean errors (shading) for boreal summer with (a) the Global EPS (GEPS) and (b) the previous One-month EPS

The contour interval is 2×10^6 m^2/s.

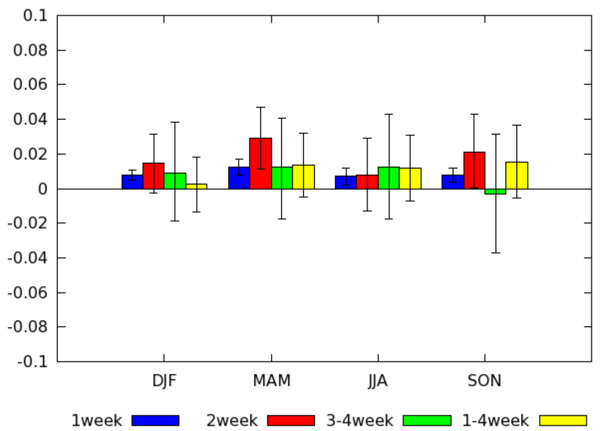

Figure 2 Differences in anomaly correlation coefficients for geopotential height at 500 hPa in the Northern Hemisphere (20 – 90°N) for all seasons

Positive values mean that anomaly correlation coefficients of the GEPS are larger than those of the previous One-month EPS. Error bars indicate the two-sided 95% confidence level.

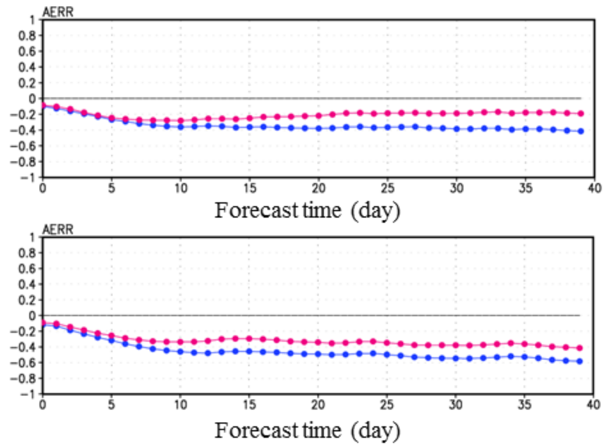

Figure 3 Mean MJO amplitude error for (top) boreal summer and (bottom) boreal winter

Positive (negative) values mean that the predicted MJO amplitudes are larger (smaller) than those of analysis. Blue and red lines represent results for the previous One-month EPS and the GEPS, respectively.

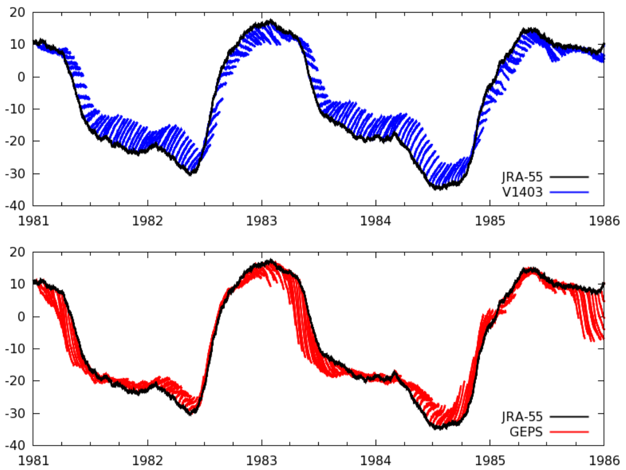

Figure 4 Time-series representation of equatorial (5°S – 5°N) zonal wind at 30 hPa (1981 – 1985)

Black lines represent analysis (JRA-55). Blue and red lines represent forecasts of the previous One-month EPS and the GEPS, respectively.

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