Upgrade of JMA's Global Ensemble Prediction System

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1. Introduction

The Japan Meteorological Agency (JMA) upgraded its Global Ensemble Prediction System (Global EPS) on March 24 2020 to incorporate recent developments in the Global Spectral Model (GSM), a two-tiered sea surface temperature (SST) approach and a direct application of initial perturbations from JMA's new hybrid data assimilation system.

2. Major updates

(1) Incorporation of recent GSM developments

The forecast model for the Global EPS was upgraded to a low-resolution version of the newly revised Global Spectral Model (GSM; Yonehara et al. 2020). Sharing the same version of the forecast model with GSM enabled updating with the latest developments made since the introduction of the Global EPS in 2017.

(2) Two-tiered SST approach

SST as a lower-boundary condition for the forecast model with a lead time of 12 days was improved by adopting a two-tiered SST approach (Takakura and Komori 2020), while the SST within lead times of 11 days was prescribed as a persisting anomaly from the climatological SST as per the previous Global EPS.

(3) Changes in initial perturbations

The initial perturbations from the Local Ensemble Transform Kalman Filter (LETKF) are directly produced from JMA's new hybrid data assimilation (Kadowaki et al., 2020), instead of the independent LETKF cycle of the previous Global EPS. The amplitude of singular vector (SV)-based initial perturbations targeted in the high- and mid-latitudes of both hemispheres was reduced by 8.7% to mitigate over-dispersiveness in 500 hPa geopotential height forecasts with lead times of up to four days. SVs calculated over desert areas in low latitudes, resulting in irrational humidity perturbations over climatologically dry areas, are removed when such SVs are composed to form initial perturbations.

3. Verification results

To verify the performance of the new system for medium-range forecasting with lead times of up to 11 days, retrospective experiments covering periods exceeding three months in summer 2018 and winter 2017/18 were conducted. The results showed improvements in the RMSEs of ensemble mean forecasts for several elements, including 850 hPa temperature, 500 hPa geopotential height and 200 hPa winds, for both seasons. Figure 1 shows values for 500 hPa geopotential height in winter. Winter Brier skill scores for precipitation forecasts in Japan were also improved (not shown).

The hindcast experiments were also conducted for the 30-year period from 1981 to 2010 with data

from the Japanese 55-year Reanalysis (JRA-55; Kobayashi et al. 2015) as atmospheric initial conditions. Mean forecast errors were reduced over the Tropics (20°S – 20°N) in particular. For anomaly correlation coefficients of velocity potential at 200 hPa over the Tropics, the new Global EPS demonstrates improved forecast skill for most lead times and seasons (Figure 2). MJO forecast skill in areas such as correlation was also improved on sub-seasonal to seasonal timescales, benefiting from the two-tiered SST approach (not shown).

References

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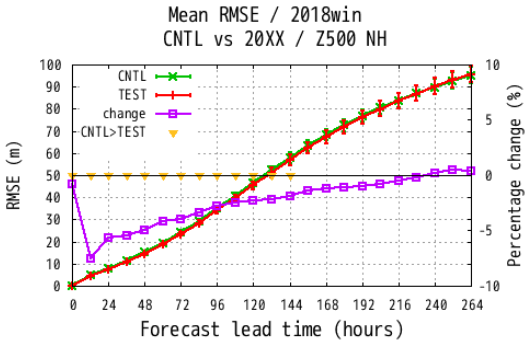

Figure 1: RMSEs of ensemble mean forecasts for 500 hPa geopotential height in the Northern Hemisphere (20°N – 90°N) during winter 2017/18 as a function of forecast lead times up to 264 hours. The red and green lines represent verification results for the new (TEST) and previous (CNTL) Global EPS (left axis; unit: m), and the purple line represents rates of change in scores ([TEST – CNTL]/CNTL, right axis; unit: %). Error bars indicate two-sided 95% confidence levels, and triangles indicate a statistically significant difference of 0.05.

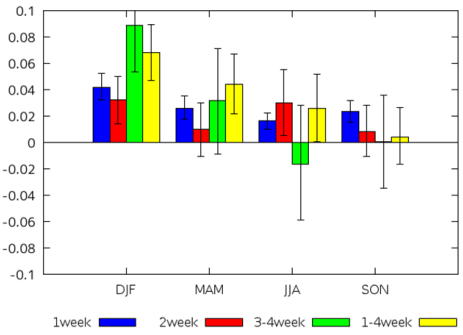

Figure 2: Differences in anomaly correlation coefficients for velocity potential at 200 hPa in the Tropics (20°S – 20°N) for all seasons. Positive values represent Global EPS anomaly correlation coefficients exceeding those of the previous Global EPS. Error bars indicate two-sided 95% confidence levels.