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 14 2023 to incorporate recent Global Spectral Model (GSM) developments and revised sea surface temperature (SST) boundary conditions.

2. Major Updates

(1) Incorporation of recent GSM developments

The forecast model was upgraded to a low-resolution version of the newly revised Global Spectral Model (GSM; Yonehara et al. 2023). Some of the upgrades were already applied in the Global EPS on March 2022 (Yamaguchi et al. 2022) in advance of application to the deterministic high-resolution model.

(2) Revised SST boundary conditions

SST boundary conditions are given via an approach combining SSTs prescribed as persisting anomalies from climatological values and other data operationally precomputed using JMA's atmosphere-ocean coupled Seasonal EPS model (JMA/MRI-CPS3; Hirahara et al. 2023). The area of application for the bias-corrected ensemble mean SST from Seasonal EPS, which was mainly used for the tropics and sub-tropics in the previous system, was expanded to the whole globe to improve temperature prediction for the mid-latitude lower troposphere. The period for which SST is linearly relaxed from climatological extrapolation to the bias-corrected ensemble mean SST from the Seasonal EPS is 6 – 11 days, as in the previous system.

3. Verification Results

To verify system performance for medium-range forecasts with lead times of up to 11 days, retrospective experiments covering periods of three months or more in summer 2021 and winter 2021/22 were conducted. The results showed improved continuous ranked probability score (CRPS) for several elements, including 500 hPa geopotential height (Z500) and 850 hPa temperature (T850) in the extra-tropics. Figure 1 shows CRPSs of Z500 and T850 for the Northern Hemisphere in winter and summer. The RMSE of ensemble mean two-meter temperature (T2m) over the mid-latitude ocean for the summer hemisphere is also improved after lead times of six days when the SST begins to relax toward the seasonal EPS. Figure 2 shows normalized differences of RMSEs for T2m between the new and previous systems. Brier skill scores for precipitation forecasts in Japan were also improved in winter (not shown). Performance for forecasts beyond 11 days was also verified, as reported by Yamaguchi et al. (2023).

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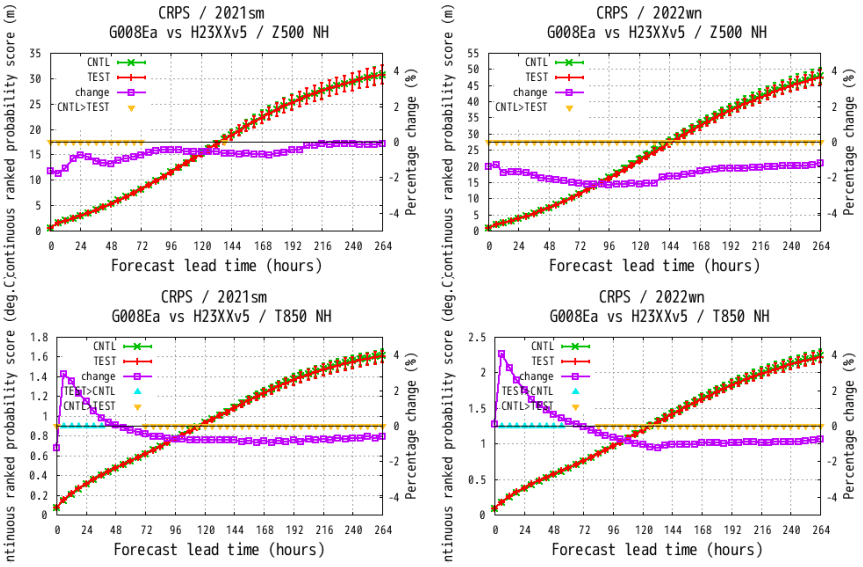

Figure 1: CRPSs of 500 hPa geopotential height (upper; unit: m) and 850 hPa temperature (lower; unit: K) forecasts against analysis for the Northern Hemisphere (20 – 90°N) during 2021 summer (left) and 2021/22 winter (right) as a function of forecast lead times up to 264 hours. The red and green lines represent verification results for the new (TEST) and previous (CNTL) Global EPS (left axis), and the purple line represents ratios of change in scores ([TEST-CNTL]/CNTL, right axis; unit: %). Error bars indicate two-sided 95% confidence levels, and triangles (TEST < CNTL or CNTL < TEST) indicate a statistically significant difference of 0.05.

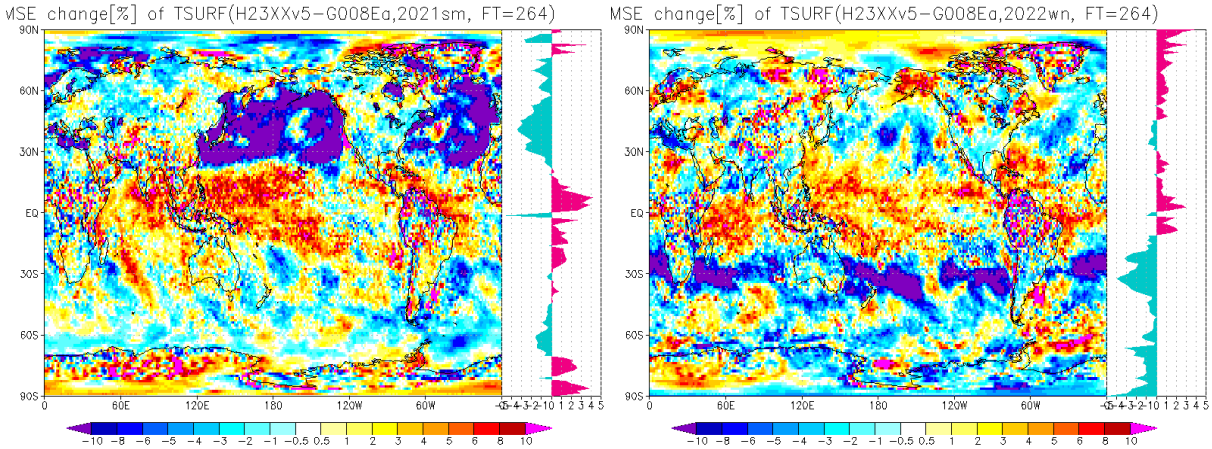

Figure 2: Ratios of change in RMSEs ([TEST-CNTL]/CNTL; unit: %) of two-meter temperature for forecast lead times of 264 hours in summer (left) and winter (right). The graph on the right represents zonal means.