Upgrade of JMA's One-Week Ensemble Prediction System

Haruki Yamaguchi, Masakazu Higaki, Masayuki Kyouda
Numerical Prediction Division, Japan Meteorological Agency
e-mail: kyouda@naps.kishou.go.jp

1. Introduction

The Japan Meteorological Agency (JMA) has operated its One-Week Ensemble Prediction System (WEPS) since March 2001 (JMA 2013). A major upgrade implemented in February 2014 included enhancement of the forecast model's horizontal resolution from TL319 to TL479 and revision of its physical processes, such as the stratocumulus and radiation schemes. It also included increased frequency of operation from once a day to twice a day and an approximate halving of each ensemble size from 51 to 27 so that the total ensemble size is now 54/day as opposed to 51/day. The major differences between the previous and upgraded WEPSs are listed in Table 1. This upgrade has had a positive impact on forecast scores for both ensemble mean and probabilistic forecasts, and is expected to enhance forecasts of severe weather caused by tropical cyclones and local phenomena.

Table 1: Major upgrades applied to JMA's One-Week EPS in February 2014

	Previous system	Upgraded system
Forecast model version	GSM1011	GSM1304 - Upgraded stratocumulus scheme - Upgraded radiation scheme
Horizontal resolution	TL319 (approx. 55 km)	TL479 (approx. 40 km)
Time step	1,200 sec.	720 sec.
Forecast range (initial time)	264 hours (12 UTC)	264 hours (00, 12 UTC)
Ensemble size	51 (51/day)	27 (54/day)

2. Performance of the upgraded WEPS

An experiment was conducted for the periods from December 2011 to February 2012 and from July to September 2012 on the upgraded WEPS before it was put into operation. Figure 1 illustrates the anomaly correlation coefficients for the 500-hPa geopotential height of the ensemble mean forecast for the Northern Hemisphere extra-tropics, and shows that the upgraded WEPS is superior to the previous version for almost whole forecast range. However, a negative impact caused by ensemble size reduction partially offsets the positive impact of the model upgrade in the longer forecast range. For the upgraded WEPS, doubling the ensemble size by combining the latest and previous ensemble forecasts results in better verification scores for some probabilistic forecasts than using latest forecasts alone in the longer forecast range (not shown).

Figure 2 illustrates control member position errors in typhoon track forecasts derived from the previous and upgraded WEPSs. The errors of the upgraded version are smaller, indicating better forecasts. The higher-resolution model can make the central pressure of forecast tropical cyclones (TCs) lower and closer to that of analyses, while a high-pressure bias still remains. The TC forecast improvement also appears in ensemble mean forecasts. The benefit of increased horizontal resolution is also seen in orographic precipitation data. This results in improved verification scores in forecasting to determine the probability of precipitation over Japan in winter, when the winter monsoon tends to bring orographic precipitation to the upwind side of the Japanese Archipelago. Figure 3 shows Brier skill scores (BSSs) for probabilistic forecasts of 24-hour cumulative

precipitation exceeding 1 mm verified against rain gauge observations in Japan during the period from December 2011 to February 2012. The values for the upgraded WEPS are higher than those of the previous WEPS over the whole forecast range.

REFERENCE

Japan Meteorological Agency, 2013: Outline of the operational numerical weather prediction at the Japan Meteorological Agency (JMA). Appendix to the WMO Technical Progress Report on the Global Data-Processing and Forecasting System and Numerical Weather Prediction, JMA. 188pp.

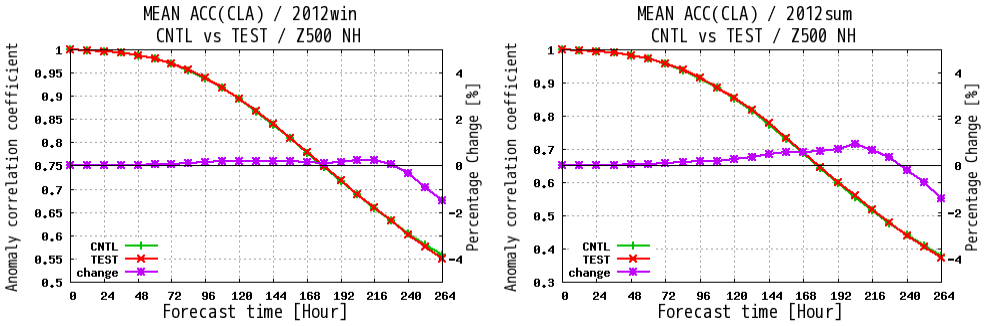

Figure 1: Anomaly correlation coefficients of 500-hPa geopotential height for ensemble mean forecasts from December 2011 to February 2012 (left) and from July to September 2012 (right). The horizontal axis shows the forecast range up to 264 hours ahead, and the green and red lines represent the results of verification for the previous and upgraded WEPSs, respectively. The purple line indicates the relative change (%) from the previous score to the upgraded score based on the vertical scale on the right; positive change means upgraded scores are higher than previous scores.

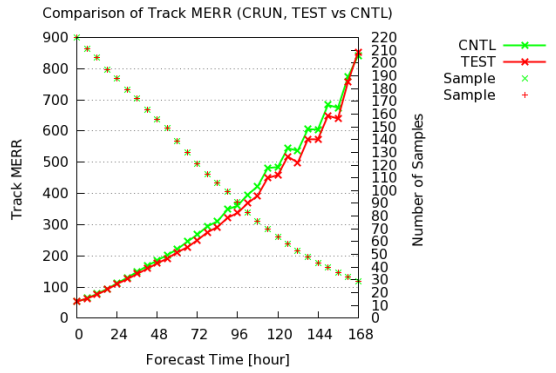

Figure 2: Mean position errors of control member TC tracks. Verified samples are all from TCs over the northwestern Pacific from July to September 2012. The horizontal axis shows the forecast range up to 168 hours ahead, and the green and red lines represent the results of verification for the previous and upgraded WEPSs, respectively. Plus marks indicate the numbers of verified samples based on the vertical scale on the right.

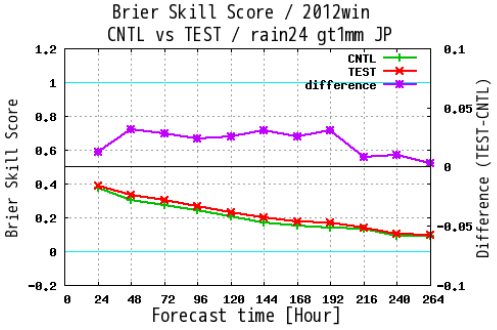

Figure 3: Brier skill scores for probabilistic forecasts of 24-hour cumulative precipitation exceeding 1 mm from December 2011 to February 2012 in Japan. The horizontal axis shows the forecast range up to 264 hours ahead, and the green and red lines represent the results of verification for the previous and upgraded WEPSs, respectively. The purple line indicates the difference calculated by subtracting the previous values from the upgraded values based on the vertical scale on the right.