Verification of Quantitative Precipitation Forecasts over Japan from Operational Numerical Weather Prediction Models

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1. Introduction

In 1995, the Working Group on Numerical Experimentation (WGNE) initiated a project for the verification and intercomparison of quantitative precipitation forecasts (QPFs) from operational NWP global models over different areas of the globe.

The Japan Meteorological Agency (JMA) has verified QPFs over Japan provided by operational NWP centers since 2002 (Hirai and Sakashita, 2004).

This paper briefly describes the verification results for 2007 and 2008.

2. QPF Data and Verification Method

(1) QPF Data

Table 1 shows the specifications of QPF data provided by operational NWP centers as of February 2009 and the methods of transforming QPF data.

The reference is taken from observational precipitation data derived from the surface rain gauge network over Japan that has been in operation since 1974. The density of the stations corresponds to a resolution of approximately 17×17 km.

(2) Verification Method

As the horizontal resolutions of QPF data differ among models, they must be transformed to a common verification grid system. In this activity, an 80-km mesh on a polar stereo projection is used as the verification grid system, and the two transformation methods outlined below are adopted.

1) **Interpolation**

This method is used to transform low-resolution QPF data from the original grid systems to the verification grid system. Each QPF value on a verification grid point is the interpolation of the raw QPF values on the four original grid points surrounding the verification grid point.

2) **Averaging**

This method is used to transform high-resolution QPF data from the original grid systems to the verification grid system. Each QPF value on a verification grid point is the average of the raw QPF values on the original grid points included in the verification grid point.

The methods used to transform QPF data are shown in Table 1. The observational data were transformed to the same verification grid system using the averaging method by regarding the stations as grid points.

Table 1 Specifications of QPF data provided by operational NWP centers as of February 2009, and the methods of transforming QPF data to the verification grid system.

NWP Center	Horizontal resolution (degrees)	Forecast time (hours)	Transformation method
BoM[1]	1.25×1.25	12, 24, 36, …, 120	Interpolation
DWD[2]	0.36×0.36	6, 12, 18, …, 174	Averaging
ECMWF[3]	0.50×0.50	6, 12, 18, …, 72	Averaging
NCEP[4]	1.00×1.00	6, 12, 18, …, 72	Interpolation
UKMO[5]	0.56×0.38	6, 12, 18, …, 96	Averaging
JMA[6]	0.25×0.25	6, 12, 18, …, 84	Averaging

3. Verification Results

(1) Time Series of Verification Results

Figure 1 shows a time series of the monthly bias score (BIAS) and equitable threat score (ETS) for precipitation exceeding 1 mm/24h for the Japan area (the forecast time is from 24 h to 48 h).

All models show seasonal variation in both BIAS and ETS. Concerning BIAS, there are peaks for summer in all models and for winter in some models. All models show poor ETS in summer.

(2) Six-hour Verification Results

Figures 2(1) and 2(2) show the frequency and ETS, respectively, of precipitation exceeding 1 mm/6h with respect to forecast time in summer 2007. Figure 3 shows the same data as Figure 2 for summer 2008.

From Figure 2(1), a clear tendency is seen for summer 2007: most models predicted precipitation the most frequently during the daytime and the least frequently at night. JMA predicted precipitation the most frequently in the evening though, and the frequency during the daytime is almost as high as that in the evening.

From Figure 3(1), a different tendency is found for summer 2008: JMA predicted precipitation the least frequently during the daytime, even though the other models predicted precipitation the most frequently during the daytime as with summer 2007.

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[1] Australian Bureau of Meteorology
[2] Deutscher Wetterdienst (Germany)
[3] European Centre for Medium-Range Weather Forecasts
[4] National Centers for Environmental Prediction (United States)
[5] United Kingdom Meteorological Office
[6] Japan Meteorological Agency

All models overestimated the frequency of precipitation exceeding 1 mm/6h during the day for both the summers of 2007 and 2008.

From Figures 2(2) and 3(2), a dependency on local time can be found for the ETS. Some models predict precipitation better in the morning than with other local times. The dependency can be seen more clearly in summer 2008 than that of 2007.

4. Discussion

ETSs in summer are smaller than in other seasons for all models, and the precipitation they predicted have different dependencies on local time from observational precipitation. These facts indicate that it is still difficult for models to accurately estimate areas or frequencies of precipitation in summer.

A unique feature was found in JMA's model for 2008 whereby the frequency of precipitation showed minimum values during the daytime in summer. This feature was not found in the other operational models or for summer 2007. In November 2007 and January 2008, the cumulus parameterization scheme in the JMA model (GSM) was revised (Iwamura and Kitagawa, 2008; Nakagawa, 2008). Since no other changes related to precipitation processes were implemented in the JMA model, this is presumed to be part of the cause of this feature.

References

Hirai, M. and T. Sakashita, 2004: Verification of Quantitative Precipitation Forecast from Operational Numerical Weather Prediction Models over Japan (WGNE precipitation intercomparison project). *CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling*, **34**, 6.01-6.02.

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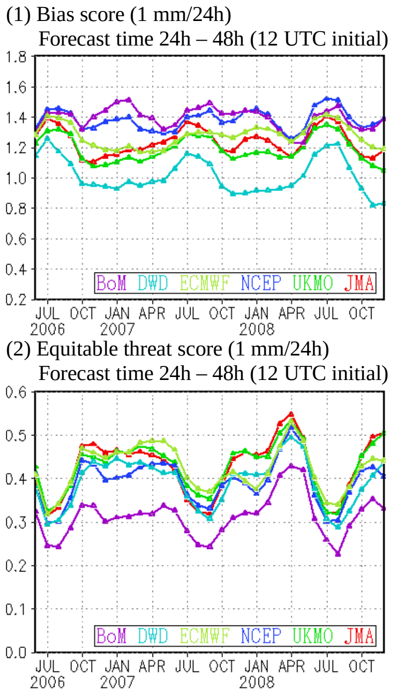

Figure 1 Time series of monthly bias scores (1) and equitable threat scores (2) for precipitation exceeding 1mm/24h for the Japan area from June 2006 to December 2008. The forecast time is from 24h to 48h (12 UTC initial). Scores are calculated for three consecutive months from the previous month to the next month.

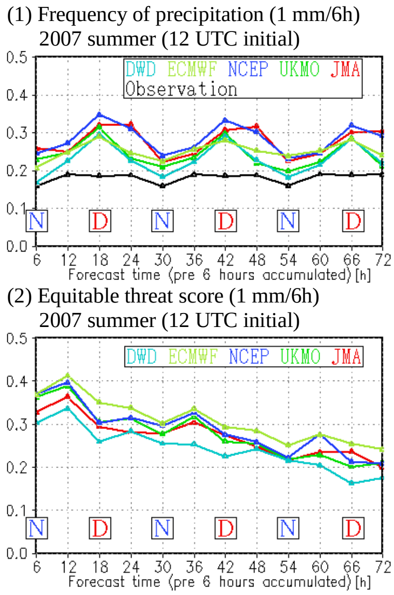

Figure 2 Frequency of predicted and observed precipitation (1) and equitable threat scores (2) for precipitation exceeding 1mm/6h (accumulated over the previous 6 hours) for the Japan area with respect to forecast time in summer 2007 (from June 2007 to August 2007). D and N correspond to local times of 09–15 (daytime) and 21–03 (night), respectively.

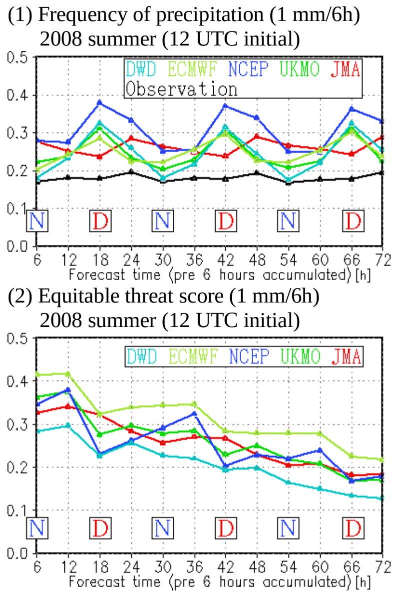

Figure 3 Frequency of predicted and observed precipitation (1) and equitable threat scores (2) for precipitation exceeding 1mm/6h (accumulated over the previous 6 hours) for the Japan area with respect to forecast time in summer 2008 (from June 2008 to August 2008). D and N are the same as in Figure 2.