

# Development of Extreme Weather Warning Products with JMA One-month Ensemble Prediction System

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## 1. Introduction

The Climate Prediction Division of the Japan Meteorological Agency (CPD/JMA) is currently developing a number of extreme weather warning products based on the operational one-month ensemble prediction system (EPS). For these products, the Extreme Forecast Index (EFI) developed at ECMWF (Lalauette, 2002; 2003) is adopted to indicate how and where EPS forecasts differ from the climatological probability distribution. In this short report, we briefly describe the data and method used for the EFI, and present examples of EFI products.

## 2. Data and method

The EFI is a measure of the difference between the probability distribution of a real-time forecast and the climatological probability distribution (Lalauette, 2003). It is a signed index with values ranging from -1 (all forecast members below the 0<sup>th</sup> percentile of the climatology) to +1 (all forecast members above the 100<sup>th</sup> percentile). We adopt a revised version of the EFI that adds weight to the tails of probability distributions (Zsótér, 2006).

The probability distribution of real-time forecasts is obtained from JMA one-month EPS values. The EPS consists of 25 members, and prediction is performed every Wednesday and Thursday. The reference climatological probability distribution (hereafter referred to as the model climate) is estimated based on five-member hindcasts (re-forecasts) starting on the nearest two initial dates during the period from 1981 to 2010. The initial dates of the hindcast are the 10<sup>th</sup>, 20<sup>th</sup> and last days of each month.

## 3. Examples of EFI products

In this section, we present examples of EFI products. First, Figure 1 shows a horizontal map of the EFI for the seven-day averaged temperature at 850 hPa based on EPS starting on October 27, 2011. The red (blue) regions indicate a high probability of extremely high (low) temperatures. As the EFI is a signed index, the probabilities of both high and low outliers can be summarized in one simple figure.

Second, Figure 2 shows an extreme weather warning map based on the EFI (Zsótér, 2006; Matsueda and Nakazawa, 2010). Here, extreme (abnormal) weather areas are defined as those where absolute EFI values exceed 0.8 (0.5). For example, areas where the EFI of temperature at 850 hPa exceeds 0.8 are identified as extremely warm. The product provides useful information for decision making by EPS users by combining multiple parameters.

The last product is the EFI meteogram (Figure 3) – a well-known meteorological product that displays time series representations of the EPS probability distribution and the EFI at individual points. Although the EFI's chief benefit is that it summarizes probability information simply in one index, it is also important for weather forecasters to directly understand the details of probability distributions. In this respect, the EFI meteogram is a supplement to the other two products.

## 4. Summary and future work

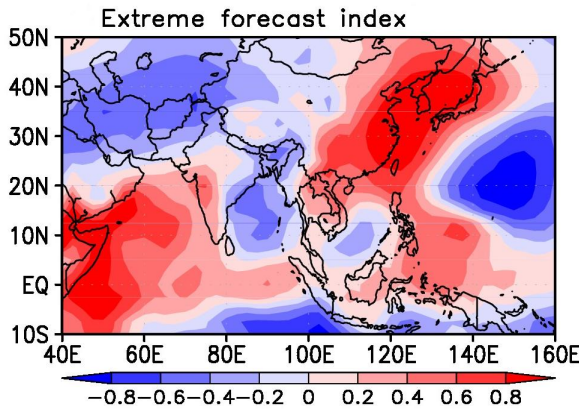
In this report, we have presented examples of the EFI-based products currently being developed by CPD/JMA. Future plans to improve the products include:

- (1) Investigation of the relationship between the EFI and other indices for extreme weather forecasting (Nakazawa and Matsueda, 2010; Zsótér, 2006)

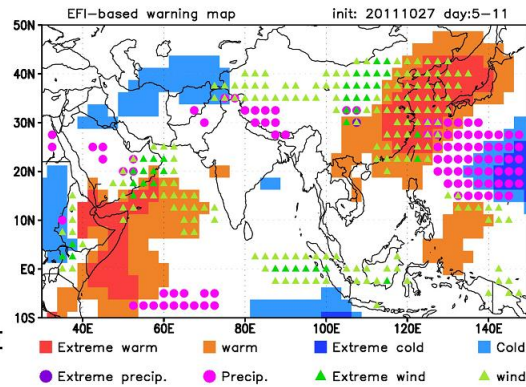
- (2) Experimental use of the EFI in operational forecasting
- (3) Verification of extreme event prediction based on the EFI

**References**

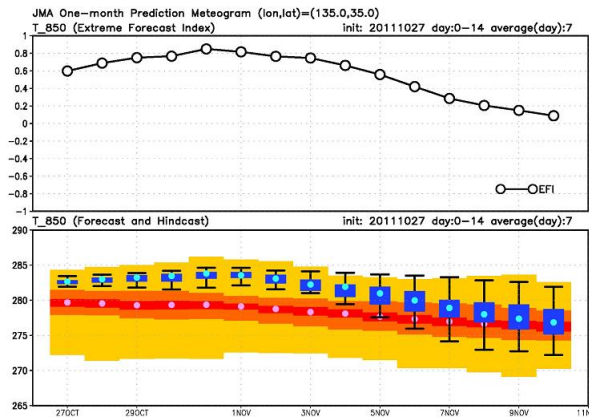
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**Figure 1.** EFI map of temperature at 850 hPa from 1 to 7 November, 2011, obtained from JMA one-month prediction starting on 27 October, 2011. The red (blue) regions indicate a high probability of extremely high (low) temperatures.



**Figure 2.** Extreme weather warning map based on EFI values. Extreme (abnormal) weather areas are defined as those where the absolute EFI value exceeds 0.8 (0.5). The period and the initial date of the forecast are the same as those for Fig. 1.



**Figure 3.** EFI meteogram for the seven-day averaged temperature at Kobe, Japan (135°E, 35°N). (top) Time series of EFI values. (bottom) Time series of the EPS forecast (cold color) and the model climate (warm color). The EPS forecast distribution is represented by box-whisker plots with the median (light-blue circles), the 20<sup>th</sup>/80<sup>th</sup> percentiles (blue boxes) and the minimum and maximum values (vertical lines). The model climate distribution is represented by box plots with the median (pink circles), the 10<sup>th</sup>/90<sup>th</sup> percentiles (red boxes), the 20<sup>th</sup>/80<sup>th</sup> percentiles (orange boxes) and the minimum and maximum values (yellow boxes).