Climatological wintertime blocking frequency for the Northern Hemisphere in JMA's new One-month Ensemble Prediction System

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1. Introduction

As atmospheric blocking (referred to here simply as *blocking*) has a significant impact on regional climatic conditions, the capacity for its representation in Numerical Weather Prediction (NWP) modeling is very important. I n thi s study, climatological wintertime blocking frequency for the Northern Hemisphere in the new Japan Meteorological Agency (JMA) One-month Ensemble Prediction System (EPS) was investigated based on related hindcast (re-forecast) experiments.

2. Data and method

JMA plans to upgrade its One-month EPS in March 2014 (Hirai et al. 2014). The new EPS (referred to here as V1403) has a horizontal resolution of TL319 (55km), which is higher than the TL159 (110km) specification of the old version (V1103) operated until February 2014. As a result, blocking frequency improvement is expected (e.g., Matsueda et al. 2009; Jung et al. 2012). Data sets from hindcast experiments for V1403 and V1103 are available for the 30-year period from 1981 to 2010 (Sato et al. 2014) and the Japanese 55-year Reanalysis (JRA-55; Ebita et al. 2011) is used for analysis data. In this study, blocking frequencies were investigated for 29 boreal winters (December, January, February, or DJF) in the period from 1981/1982 to 2009/2010 with five-member ensembles. Regarding the configuration of the hindcast experiments, predictions made during the period from 4 to 31 days ahead and started on ten initial dates between 10th November and 20th February (every ten days or so) were used.

Blocking was assessed using an index calculated from seven-day running means of daily 500hPa geopotential height (Z500) based on the method of Scherrer et al. (2006), which is an extension from the approach proposed by Tibaldi and Molteni (1990) (referred to here as TM90). A grid was considered to be blocking when the conditions below were satisfied with latitude ϕ and $\Delta\phi = 15\text{degs}$.

$$GHGS = [Z500(\phi) - Z500(\phi + \Delta\phi)]/\Delta\phi > 0$$

$$GHGN = [Z500(\phi - \Delta\phi) - Z500(\phi)]/\Delta\phi < -10[m/deg]$$

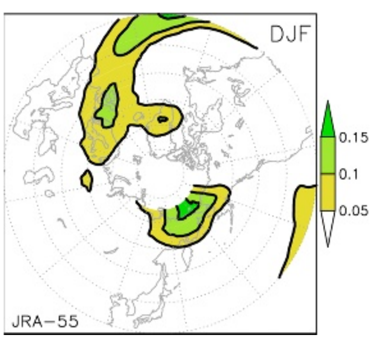

Figure 1 Climatological blocking frequency in analysis (JRA-55) in boreal winter (DJF)
Contour interval is 0.05 and the lowest contour is 0.05. Climatology is calculated from 29 years from 1981/1982 to 2009/2010.

3. Results

Figure 1 shows wintertime (DJF) blocking frequency derived with JRA-55 data used for the analysis fields. In the mid- and high-latitudes, two major peaks are present in the Euro-Atlantic and Pacific sectors, which is consistent with the outcomes of many previous studies (e.g., TM90; Scherrer et al. 2006). Figure 2 shows the predicted blocking frequencies of V1403 and V1103 and their differences from that of the analysis, and also indicates the difference between V1403 and V1103.

In the Euro-Atlantic sector, the blocking frequencies of V1403 and V1103 are both lower than that of the analysis. However, the blocking frequency deficiency in V1403 is smaller than that in V1103, which means the frequency is increased and improved in V1403. This is clearly seen in the longitudinal distribution of blocking frequency at 60˚N, which is consistent with TM90, except in the latitudinal band ranges 5˚ north and south of 60˚N (Figure 3).

In the Pacific sector, meanwhile, the blocking frequency deficiency in V1403 is stronger than that of V1103. Blocking frequency dependency on lead time in V1103 is stronger than that in V1403, and as a result, the blocking frequency in V1103 over the Pacific sector averaged for all lead times appears similar to that of the analysis (not shown). This weakening of lead time dependency in V1403 can be seen as an improvement, though a deficiency compared to the analysis remains.

4. Summary

In this study, climatological blocking frequencies in JMA's One-month EPS were investigated using data sets from related hindcast experiments and compared to analysis derived from JRA-55. It was found that the new EPS (V1403) shows improved climatological wintertime blocking frequency for the Northern Hemisphere. As V1403 has a higher horizontal resolution than the old version (V1103), this result is consistent with those of previous studies (e.g., Matsueda et al. 2009; Jung et al. 2012). However, blocking frequency in V1403 was still deficient in comparison to the analysis results, which is also consistent with the tendency seen in JMA's One-week EPS (Matsueda 2008). To clarify the model's capacity for blocking representation, more detailed investigation is needed such as the persistency of blocking and interannual variations of blocking frequency in the model.

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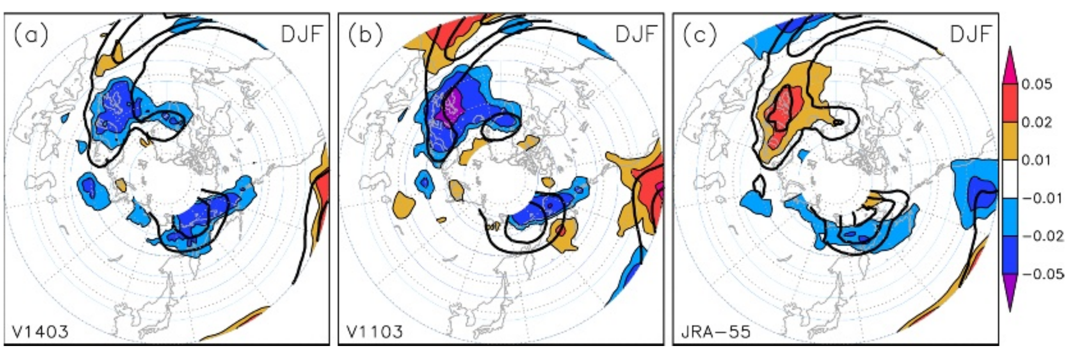

Figure 2 Climatological blocking frequency in JMA's One-month EPS in boreal winter (DJF)
(a) V1403 (contour) and related differences from the analysis (shaded). (b) As per (a), but for V1103. (c) Analysis (JRA-55; contours as per Figure 1) and differences between V1403 and V1103 (V1403 - V1103; shaded). The contour interval is 0.05 and the lowest contour is 0.05. Shading is as shown in the color bar index. The climatology is calculated for the 29-year period from 1981/1982 to 2009/2010.

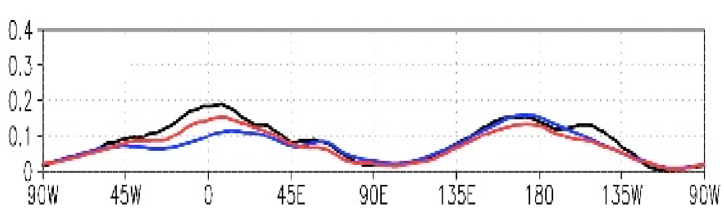

Figure 3 Longitudinal distribution of climatological blocking frequency in boreal winter (DJF) at 60˚N
Analysis (JRA-55; black), V1403 (red), and V1103 (blue).