Products of the JMA Ensemble Prediction System for one-month forecast

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Abstract

For forecasters who issue official one-month forecasts, it is important to understand how atmospheric phenomena related to one-month forecasts are predicted in the ensemble prediction system (EPS). In the report, operational forecast charts that are used for the purpose in JMA are introduced with an actual prediction case. In the case, a blocking over the North Atlantic decayed due to Rossby wave radiation along the Asian jet, and then indirectly affected sub-monthly climate variation in East Asia. Overall, the EPS could predict these processes with considerable spread among ensemble members.

1 Introduction

JMA has been operating the EPS for one-month forecast since 1996. The EPS is a simple extension of 9-day forecast conducted every day with 25 members prepared by the Breeding of Growing Mode (BGM) method. Thirteen members out of 25 are extended from 1200 UTC initial fields on Wednesday and other 13 members from 1200 UTC on Thursday. Then, the 26 members in total are used for the one-month forecast issued every week. As a post-processing of the EPS, several forecast materials, such as ensemble mean maps, spread maps, time sequences figures, are produced. Objective guidance products of official forecast elements are also derived from the EPS.

In JMA, it is considered that the forecast charts to monitor predicted Low Frequency Variability (LFV) in the atmosphere, such as Intra-Seasonal Oscillation (ISO) in the tropics, blockings, stationary Rossby waves, the Arctic Oscillation, and so on, are one of the most important materials for operational forecasters. In this ten years, our knowledge on the predictability of these phenomena has been deepening by many studies and an accumulation of operational forecasts cases. Making use of these progresses, many forecast charts to monitor predicted LFV have been developed. In the report, firstly, a typical case of forecast of LFV is shown. Then, some forecast charts are introduced.

2 Case study

The subtropical jet stream which flows along the southern part of the Eurasia continent, i.e. the Asian jet stream, works as a stationary Rossby wave guide (*Hoskins and Ambrizzi*, 1993). Thus, stationary Rossby waves excited by some processes tend to propagate along the jet stream, and sometimes cause severe sub-monthly climate variation in East Asia (*Sato et al.*, 2005). So far, several excitation mechanism of stationary Rossby waves which propagate along the jet stream are advocated (e.g. *Enomoto et al*, 2003). Some of them are related to LFV over the North Atlantic and Europe. *Sato et al*. (2005) insist that stationary Rossby waves which propagated southeastward from these regions, refracted in the entrance of the Asian jet, and propagate eastward along the Asian jet.

In January and February 2005, a stationary Rossby wave with large amplitude propagated along the Asian jet, and caused several severe cold days in Japan. The source of the wave seems to be a blocking anti-cyclone over the North Atlantic. Figure 1 shows observed consecutive pentad mean stream function anomalies and wave activity fluxes of stationary Rossby waves (*Takaya and Nakamura*, 2001). At first, an anti-cyclonic blocking was observed over the North Atlantic in 5th pentad 2005. Then, the shape of the blocking gradually changed with time, and when the main axis of the blocking became south-west to north-east direction, strong divergence of stationary Rossby wave-activity fluxes to southeastward was observed, then a strong anti-cyclonic circulation was generated in the Middle East. After that, wave activity fluxes were refracted to zonal direction, then a wave train along the Asian jet was built up. Meanwhile, the blocking in the North Pacific gradually decayed. The decay of the blocking and propagation of the stationary Rosbby wave can be seen in a time cross section (figure 2b) along the red line in figure 2a. Apparently there are two characteristic time scales which are defined by the group velocity of the Rossby wave and the decay rate of the blocking. These processes can be summarized as "gradual decay of the blocking over the North Atlantic due to Rosbby wave radiation along the Asian jet".

How were these processes predicted by the EPS of JMA? Figure 3 is the same as figure 2b except for the ensemble mean prediction from 20th and 26th January 2005. The time evolution of the wave train was not well predicted from 20th January. Since the blocking did not sufficiently grow and decayed too fast, persistency of the wave train was too short. On the other hand, decay of the blocking and the Rossby wave train were well predicted from 26thJanuary. Figure 4 shows time evolutions of the blocking over the North Atlantic predicted by each member. Most members from 20th January could not predict growth of the blocking sufficiently, but most members from 26th January could predict gradually decay of the blocking. Spread among members from 20th January is larger than that from 26th January. Corresponding to the prediction of the blocking, the forecast scores in East Asia from 26th January were better than that from 20th January.

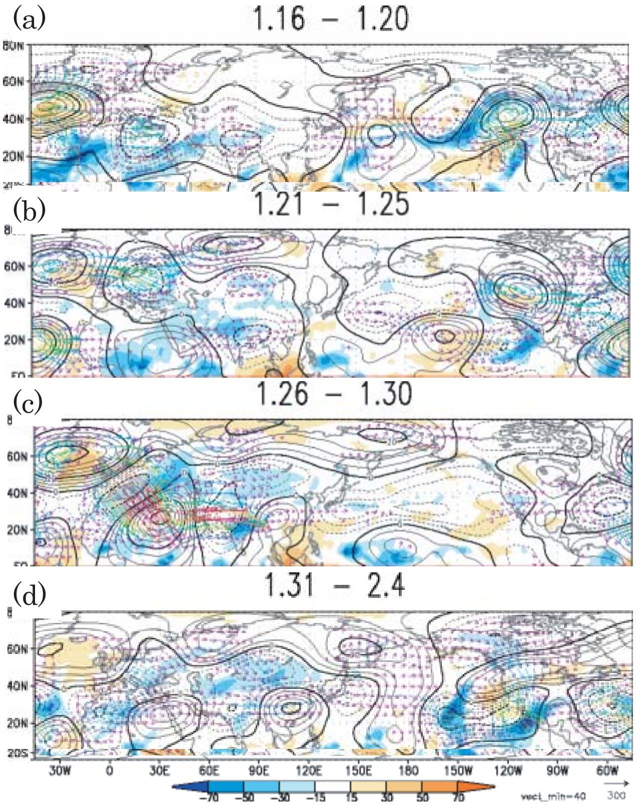

Fig. 1 Observed pentad mean stream function anomalies (contours) and wave-activity fluxes (arrows) at 200hPa, and OLR anomalies (shades) for (a)4th pentad (1/16-20), (b)5th pentad (1/21-25), (c)6th pentad(1/26-30), and (d) 7th pentad(1/31-2/4) in 2005. Contour interval is $5*10^6 m^2/s$. Arrows in the right bottom corner correspond to $300 m^2/s^2$.

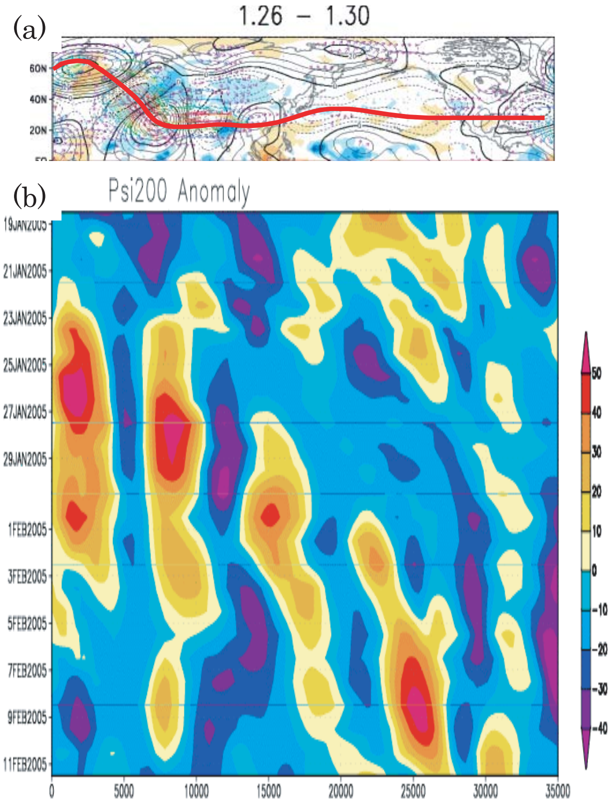

Fig. 2 (a) Same as fig.1(c). (b) Observed time cross section of stream function anomalies at 200hPa along the red line on (a) from 19th January to 11th February 2005. Unit of the color bar is $10^6 m^2/s$. Abscissa is distance (10^3m) from a base point (60W,60N).

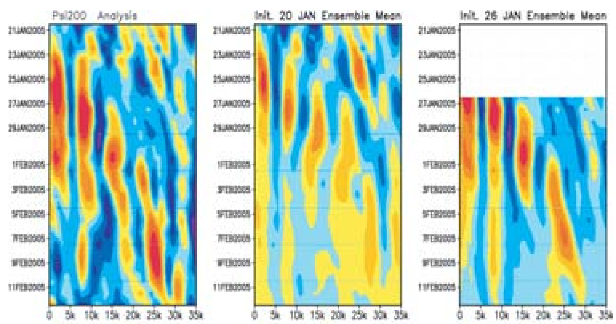

Fig. 3 Same as fig. 2(b) except for (left) observation, (middle) ensemble mean from 20th January, (right) ensemble mean from 26th January 2005.

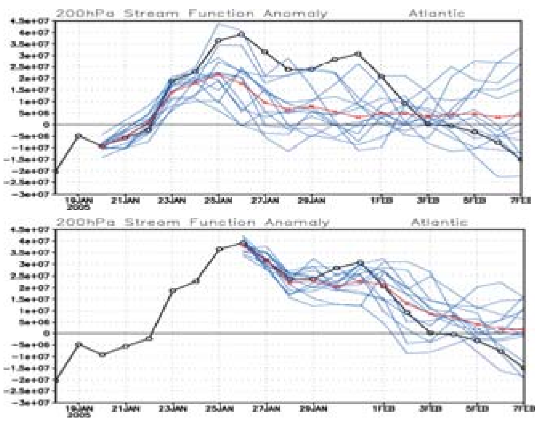

Fig. 4 Time series of area (60W-2.5E, 54N-60N) averaged stream function anomalies at 200hPa^h from 18th January to 7th February 2005 for (black) observation, (red) ensemble mean, and (blue) each member. Unit is m^2/s. Upper panel is for prediction from 20th January, and lower panel is for prediction fron 26th January 2005.

3 Forecast charts to understand predicted LFVs

In order to monitor predicted LFV in the atmosphere, such as the blocking and the stationary Rossby waves which were shown in the previous section, many kinds of forecast charts are provided. Some of forecast charts that are used for the purpose at operational forecast meetings are summarized in table 1.

Kinds of charts	Areas	Meteorological Elements	Main targets
Ensemble mean and stamp map	Tropics and extra-tropics	Stream function, anomalies, and wave activity fluxes at 200hPa	Stationary Rossby waves which propagate trapped by the sub-tropical jet, variation of the sub-tropical jet, and impacts of MJO
		Stream function and anomalies at 850hPa	The Asian monsoon, the sub-tropical anti-cyclone, and impacts of MJO
		Velocity potential and anomalies at 200hPa	Convective activities in the tropics, MJO, and the Asian monsoon
		Water vapour flux at 850hPa, precipitation ratio and anomalies	Convective activities in the tropics ,MJO, and the Asian monsoon
	Northern hemisphere	Geo-potential height and anomalies at 500 hPa	LFVs in the mid-high latitudes such as blocking, the AO, Rossby wave braking,variation of the polar front jet
		Sea level pressure and anomalies	The AO, the Aleutian low, the Siberian high, and the Okhotsk high
Cross sections and time series	Longitude-time cross section	Velocity potentialanomalies at 200hPa averaged in the equatorial region	MJO
	Time series of circulation indices	Scores of EOF1 of Z500 in the Northern Hemisphere	The AO
		Zonal index	Variation of westerlies

Table 1 Forecast charts mainly used to monitor predicted LFV in JMA

4 Remarks

In order to make official one-month forecast, it is important to understand how atmospheric phenomena related to one-month forecast are predicted in the EPS. In the report, the operational forecast charts that are used for the purpose are introduced with an actual prediction case.

Some of these forecast charts are available at the Tokyo Climate Center website (http://cpd2.kishou.go.jp/tcc/products/model/index.html). Verification charts and scores are also available.

References

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