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Seasonal and Interannual Fluctuations of the 30-50 Day Mode in the Zonal Mean Westerly Flow

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Abstract

Seasonal and interannual fluctuations of the 30-50 day mode zonal mean flow at 500mb were preliminarily investigated in the latitudinal-time sections for the 37 years from 1946 to 1982. It was manifested that the northward propagations from the subtropics to the pole are dominant particularly in the warmer seasons, whereas the southward propagations are more apparent in the colder seasons in most of the years.

1. Introduction

One of the major results of the FGGE in the tropics was the confirmation of the subseasonal low-frequency mode (with the time scale of 30-50 days) of the global east-west and the monsoon circulations, which were noticed by some earlier observations (Madden and Julian, 1971, 1972; Yasunari, 1979, 1980, 1981). The eastward propagation of the divergent circulation with the zonal-wavenumber one is a fundamental structure of this mode along the equatorial belt (Lorenc, 1983, Krishnamurti et al., 1985). Over the northern summer monsoon region, it appears as a northward propagation of the transient Hadley cell (Krishnamurti and Subrahmanyam, 1982). T. Murakami et al. (1984) postulated this mode as interactions among synoptics-scale disturbances, the local Hadley circulation and the zonal mean flow. Furthermore, Anderson and Rosen (1983) found that the same mode in this time scale dominantly exists in the zonal mean westerly angular momentum with the northward propagations from the equator toward the north pole. Recently, M. Murakami (1983) showed a clear correlation between the zonal mean westerly wind anomalies and the Indian summer monsoon fluctuation of this mode. These reconnaissance studies have suggested that this low-frequency mode is one of the basic subseasonal modes of the atmospheric general circulation which presumably originates in the tropics. However, the variability and persistence of this mode from season to season and from year to year is still unknown, which should naturally be connected with the dynamics of this mode.

The present study shows some observational results on the seasonal as well as the interannual variability particularly in the meridional direction of this low-frequency mode in the zonal mean westerly wind anomalies.

2. Data

Since the analyzed wind data is not available for a long-term period of more than 10 years, the 500mb pentad-mean geopotential height data compiled at Japan Meteorological Agency was used to compute the geostrophic zonal wind. The data covers the whole northern hemisphere north of 20N with 10° long. x 10° lat. grid points during the period of 37 years from 1946 to 1982. The geostrophic zonal wind was, therefore, obtained for every 10° latitude band. As the analy-

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sis area is limited to the north of the subtropics, the assumption of the geostrophic wind may have no problem on the accuracy to estimate the zonal wind.

To reduce the mean seasonal cycle, the normal-year pentad values were subtracted from the original pentad-mean values. The band-pass filtered data was then produced by operating 3-pentad moving average minus 11-pentad moving average, in order to get the maximum frequency response of 30-50 day period. The data was finally zonally averaged for each latitude band.

3. Results and discussions

The latitude-time sections of the filtered zonal-mean westerly wind were produced for the whole period to examine the meridional propagation. Fig. 1 shows a part of it for the period from 1977 to 1982, which includes the FGGE years. Although the anomaly patterns are still more or less contaminated with higher-frequency aliasing because of the equally-weighted moving averages, the overall features seem to show some systematic propagations in most of the period. Northward propagations of the anomalies through the whole latitudes (20N-80N) are more dominant especially in the warmer seasons than southward propagations. The predominancy of the northward propagation was also pointed out in the pioneer work of Riehl et al. (1950), by using a similar method of the present analysis. Interestingly, during the colder seasons of most years (1978, J, F, M, N; 1979, J, F, M, A; 1980, J, F; 1981, J, F, M, O, N, D; 1982, F, M, etc.), southward propagations are apparent. The phase speeds of both northward and southward propagations are in the range of 1° to 2° lat/day. This rate is a little bit larger than that in the tropical latitudes. The amplitudes of the anomalies are generally larger in the winter seasons than in the summer seasons. The results for the whole period (1946-82) have also proved to show that this seasonal tendency of the latitudinal propagations (Fig. 1) are nearly common features in most of the years though the year-to-year variability and persistence of the northward or southward propagation is quite large.

It may be suggested that the northward propagation of the zonal mean westerly wind is resulted from the modulation of the poleward transport of the relative angular momentum whose rate of production in the tropics may vary considerably associated with the planetary-scale divergent circulation of this mode. The mechanism of the southward propagation in the colder seasons is however, unresolved. Presumably, it may be associated with the planetary-scale movement of the cold polar vortex (e.g., the vascillation-type movement). Further results of analysis will be discussed elsewhere.

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Figure Caption

Fig. 1. Latitude-time section of filtered zonal mean westerly wind anomalies at 500mb for the period of 1977 through 1982. Units of contours are $1ms^{-1}$, and negative areas are shaded.