Interactions between the 30–60 Day Oscillation, the Walker Circulation and the Convective Activities in the Tropical Western Pacific and Their Relations to the Interannual Oscillation

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ABSTRACT

In this paper, interactions between the 30–60 day oscillation, the Walker circulation and the convective activities in the tropical western Pacific during the Northern Hemisphere summer are analyzed by using the observed data of wind fields and high-cloud amounts for the period from 1980 to 1989.

The analyzed results show that the 30–60 day oscillation (hereafter called LFO) may be largely affected by the convective activities in the tropical western Pacific. The LFO in the tropical western Pacific during the strong convective activities around the Philippines is generally stronger than those during the weak convective activities around the Philippines. Moreover, in the case of strong convective activities around the Philippines, the LFO in the tropical western Pacific and tropical eastern Indian Ocean generally propagates westward, and it is intensified by the LFO with a westward propagating center of maximum oscillation from the east to 140°E. However, in the case of weak convective activities around the Philippines, the LFO gradually becomes stronger with a eastward propagating center of maximum oscillation from the eastern Indian Ocean to the tropical western Pacific.

Corresponding to the 30–60 day oscillation, the Walker circulation is also in oscillation over the tropical Pacific and its circulation cell seems to shift gradually westward from the tropical western Pacific to the tropical eastern Indian Ocean with strong convective activities around the Philippines. This may maintain the intensification of convective activities there. However, during the weak convective activities around the Philippines, the Walker circulation gradually moves eastward and an ascending flow may appear in the equatorial central Pacific. This may cause convective activities to be intensified over the equatorial central Pacific.

The analyzed results also show that the LFO in the tropical western Pacific and East Asia may be associated with the interannual oscillation of the SST anomaly in the tropical western Pacific.

Key words: The low–frequency oscillation, The Walker circulation, The convective activities

I. INTRODUCTION

The 30–60 day oscillation in the tropical atmosphere first found by Madden and Julian (1971, 1972) may be considered as a trigger for recent studies on the role of convective activities in the tropical atmospheric motion. Many researchers have investigated on the characteristics, structure and cause of this oscillation. Chen and Lau (1980), Sumi and Murakami (1984), Quah (1984), Lau and Chan (1985) discussed the characteristic features of the 30–60 day oscillation in the tropical atmosphere during the Northern Hemisphere winter. Yasunari (1979, 1981), Murakami et al. (1984) investigated the quasi–40 day oscillation of cloudiness in the Indian monsoon during the Northern Hemisphere summer.

The 30–60 day oscillation is closely associated with convective activities. Nakazawa (1986a, 1986b) found that an obvious region of the 30–60 day oscillation of OLR is in the eastern Indian Ocean and tropical western Pacific. Weickmann et al. (1985), Knutson and
Weickmann (1986) also proposed that an obvious region of the 30–60 day oscillation is in the region of strong convective activities.

The 30–60 day oscillation is also associated with the Walker circulation, as shown by Madden and Julian (1972). Murakami (1985) pointed out that the 30–60 day oscillation is associated with the variability of the Walker circulation.

Murakami, Chen and Xie (1986) discussed the correlations between the LFO, the shorter time scale oscillations and the longer time scale oscillations. Their studies showed that the different time scale oscillation can interact each other. However, they did not discuss the interaction between the LFO and the interannual oscillations. Lau and Chan (1988) discussed the possibility of their interaction. Therefore, with the LFO being studied, the interaction between the LFO and the interannual oscillations becomes an interesting topic more and more.

Recently, many investigations and observational facts have shown that the tropical western Pacific is a region of the highest SST in the global sea surface temperature field. This region is called as the western Pacific warm pool. The air–sea interaction is very strong there. Moreover, since the ascending branch of the Walker circulation is over this region, the convergence of air and moisture leads to form strong convective activities in this region. Therefore, the 30–60 day oscillation may be very pronounced in this region. Nitta (1986, 1987), Huang and Li (1987), Kurihara (1989), Huang and Sun (1992) pointed out that the interannual variability of the convective activities is very dominant in the tropical western Pacific and showed that this variability is closely associated with the interannual oscillation of the SST in the western Pacific warm pool. Thus, it may be a significant research topic to study on the interactions between the 30–60 day oscillation, the Walker circulation and the convective activities in the tropical western Pacific in the interannual time scale.

In this paper, the interactions between the convective activities, the Walker circulation and the 30–60 day oscillation in the tropical western Pacific are analyzed by using the observed data of wind fields and high–cloud amounts for 10 summers from 1980 to 1989. In Section II of this paper, the interannual variability of the convective activities in the tropical Pacific is simply described. In Section III, the characteristic features of the 30–60 day oscillation in the different cases of the convective activities are examined. The intraseasonal variations of the Walker circulation in the different cases of the convective activities are presented in Section IV.

II. INTERANNUAL VARIABILITY OF THE CONVECTIVE ACTIVITIES IN THE TROPICAL PACIFIC

The high–cloud amounts observed from GMS satellite for 12 summers from 1978 to 1989 are used to analyze the interannual variability of the convective activities over the tropical Pacific. Figures 1a and 1b indicate interannual variations of 3–month running mean normalized anomalies of high–cloud amounts averaged for the area of 110°E–140°E, 10°N–20°N and for the area of 170°E–170°W, 5°N–5°S, respectively. It may be clearly seen from Fig. 1a that in the summers of 1978, 1981, 1984, 1985 and 1988, the convective activities were active in the tropical western Pacific. However, the convective activities were less active over the tropical western Pacific and were intensified over the equatorial central Pacific in the summers of 1980, 1982, 1983 and 1987, as shown in Fig. 1b. These results indicate that the interannual variability of the convective activities is considerably obvious in the tropical Pacific during the Northern Hemisphere summer. Moreover, it is shown that there is an oscillation between the convective activities in the tropical western Pacific and those in the equatorial central Pacific. This oscillation may be closely associated with the ENSO cycle. Therefore, we may divide this variability into two categories: one is that convective activities