Quasi-two Weeks Oscillation in the Tropical Atmosphere

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With 10 Figures

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Summary

Based on analysis of ECMWF data (1981–1987) and numerical simulations using a general circulation model (GCM), a quasi-two-week (10–20 day) oscillation in the tropical atmosphere is studied in this paper. It is shown that the kinetic energy of the quasi-two-week oscillation is larger than that of the intraseasonal oscillation, and is another important low-frequency system in the tropical atmosphere. By comparing it with the intraseasonal oscillation, some obvious differences can be found. For example, the zonal scale of the quasi-two-week oscillation is dominated by perturbations with wavenumber 2–4; its vertical structure mainly shows barotropic features; the zonal propagation is basically westward; and its meridional and zonal components the same size.

1. Introduction

Intraseasonal (30–60 day) oscillations in the tropical atmosphere have been studied systematically since the 1980s (Krishnamurti and Subrahmanyan, 1982; Lan and Chan, 1985; Knutson and Weickmann, 1987; Li, 1991). This low-frequency system in the tropical atmosphere has been regarded as an important factor in short-term variation of climate. Its structure, activity and dynamical mechanism are well understood. In the summer monsoon area and in the tropical western Pacific region, the quasi-two-week (10–20 day) oscillation has also been exposed (Krishnamurti and Bholme, 1976; Chen, 1980). But the study of the 10–20 day oscillation in the tropical atmosphere is not sufficient, especially in terms of global climate.

In this paper, the structure and activities of the 10–20 day oscillation in the tropical atmosphere will be investigated using analyses of ECMWF data (1981–1988). In order to give prominence to the quasi-two-week oscillation, a 10–20 day filter is used in the analyses as well as using 30–60 day filter to study intraseasonal oscillation in the atmosphere. The simulated 10–20 day oscillation with a global general circulation model (GCM) in this paper is quite consistent with observations. The CSIRO GCM-4 used in this paper is a 4-level primitive equation general circulation model with a rhomboidal wavenumber 21 spectral representation. The numerical simulation results provide a deep understanding of the 10–20 day oscillation in the tropical atmosphere.

2. Global Distribution of Kinetic Energy

Intraseasonal oscillation has been regarded as a low-frequency oscillation in the tropical atmosphere. What is the 10–20 day oscillation in the tropics? We will discuss this question by comparing the kinetic energies of the intraseasonal oscillation and the 10–20 day oscillation and show the distribution of kinetic energy of the 10–20 day oscillation of the tropical atmosphere. Figure 1 shows the longitudinal distributions of kinetic energy at 200 hPa for the 10–20 day oscillation and the intraseasonal oscillation. It is very clear that in the tropical atmosphere the kinetic energy of the 10–20 day oscillation is always larger than
that of the intraseasonal oscillation either in winter or in summer. This means the 10–20 day oscillation is stronger than intraseasonal oscillation in the tropical atmosphere, and the 10–20 day oscillation can be regarded as a more important low-frequency oscillation in the tropical atmosphere.

In the lower troposphere (850 hPa), the 10–20 day oscillation is also stronger than the intraseasonal oscillation. The longitudinal distributions of kinetic energy of the intraseasonal oscillation in the upper and lower troposphere are however similar, whereas those for the 10–20 day oscillation at 200 hPa and 850 hPa are different (Fig. 2). In general, kinetic energies at 200 hPa in the western hemisphere are stronger than those in the eastern hemisphere, whereas those at 850 hPa in the eastern hemisphere are stronger than those in the western hemisphere.

The numerical simulation by the GCM also shows some features of the 10–20 day oscillation in the tropical atmosphere. These are quite consistent with the observations. The kinetic energy of the simulated 10–20 day oscillation at 200 hPa (stronger energy in the western hemisphere) has a different longitudinal distribution from that at 850 hPa (stronger energy in the eastern hemisphere), and is clearly larger than that of the simulated intraseasonal oscillation as shown in Table 1.

### Table 1. Zonal Averaged Kinetic Energies of the Simulated 10–20 day Oscillation and Intraseasonal Oscillation at the Upper Troposphere in the Tropical (11.1°S–11.1°N) Atmosphere

<table>
<thead>
<tr>
<th></th>
<th>July</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>10–20 day oscillation</td>
<td>5.69 m² s⁻²</td>
<td>1.85 m² s⁻²</td>
</tr>
<tr>
<td>30–60 day oscillation</td>
<td>1.32 m² s⁻²</td>
<td>1.74 m² s⁻²</td>
</tr>
</tbody>
</table>

### 3. Temporal Evolution

During 1981–1988, the globally averaged kinetic energies of 10–20 day oscillation at 200 hPa in the tropical atmosphere vary from year to year, but show a similar seasonal variation. As an example, Fig. 3 shows the temporal evolution of globally averaged kinetic energies of the 10–20 day oscillation at 200 hPa in the tropical atmosphere in 1983, 1984 and 1987. The annual variation shows that the kinetic energy is generally stronger during