16B.1 ON THE DYNAMICS OF TWO DAY EQUATORIAL DISTURBANCES

Patrick T. Haertel
University of North Dakota, Grand Forks, ND

George N. Kiladis
NOAA Aeronomy Laboratory, Boulder, CO

1. Introduction

Two day disturbances are equatorially-trapped waves that propagate westward around 15 m/s, effectively modulating convection over the western Pacific warm pool (e.g. Haertel and Johnson 1998). In this study we test the ability of two idealized dynamical systems to capture the basic dynamics of these disturbances. The first is the primitive equations linearized about a basic state of rest (hereafter PE). The second system includes just two vertical modes for an atmosphere having a rigid upper boundary at the tropopause (hereafter 2M). Both of these systems have been used as the basis for theories that explain the observed dispersion diagrams of convectively coupled equatorial waves (Wheeler and Kiladis 1999; Mapes 2000; Lindzen 2003). Because of space limitations, we only present results for the 2M system in this extended abstract.

2. Data and Methods

Our approach is to use observations to construct a heating function for a composite two day disturbance, to apply this heating in the dynamical system to be tested, and to compare the simulated wind and temperature perturbations to those observed. The composite disturbance is constructed using gridded sounding data from TOGA COARE (Ciesielski et al. 2003) and GMS brightness temperature measurements. The compositing technique is outlined in detail in Wheeler et al. (2000). In that study a given convectively coupled equatorial disturbance is isolated through appropriate space-time filtering. In the present case it is only necessary to temporally filter the average brightness temperature retaining fluctuations between 1.5 and 3 days in order to effectively isolate two day disturbances (Haertel and Johnson 1998).

Corresponding author address: Patrick Haertel, Dept. of Atmospheric Sciences, Box 9006, University of North Dakota, Grand Forks, ND 58202; e-mail: haertel@aero.und.edu

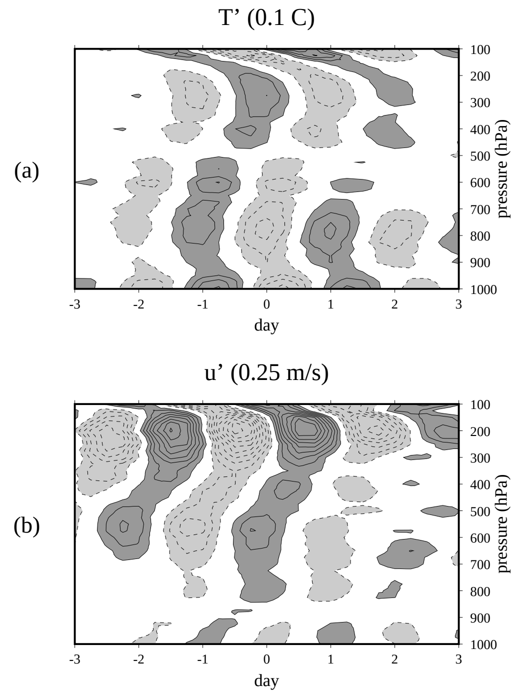

Figure 1. Time pressure series of perturbation temperature (a) and zonal wind (b) for the composite two day disturbance. Regions with amplitudes greater than the contour interval (given at the top of each plot) are shaded, dark for positive and light for negative.

3. Composite Observations

Negative near-surface and lower tropospheric temperature anomalies accompany the passage of the composite two day disturbance (Fig. 1a). Upper troposphere temperature perturbations are roughly out of phase with lower tropospheric perturbations. Above the boundary layer temperature perturbations propagate upward over time (tilt eastward with height) in most of the troposphere, and descend over time (tilt westward with height) above 300 hPa.

The zonal-wind time-series exhibits a similar structure (Fig. 1b). Below 200 hPa wind anomalies propagate upward over time (tilt eastward with height), and the anomalies propagate downward over time (tilt westward with height) above 200 hPa (Fig. 1a).

4. The 2M Simulation

The simulated temperature profile (Fig. 2a) shows most of the structure that appears in the composite temperature analysis (Fig. 1a); lower-tropospheric temperature perturbations are out of phase with upper-tropospheric temperature perturbations, amplitudes are a few tenths-of-a-degree C, and oscillations are weak or absent around 200, 500, and 900 *hPa*. There are two noticeable differences, however. First, near-surface temperature perturbations are not present in the two mode simulation. Second, the two mode system is unable to represent the vertical wave propagation near the tropopause. Nevertheless, considering the simplicity of the two mode system, the degree of similarity between the observed and simulated temperature perturbations is remarkable.

The simulated vertical profile of zonal-wind (Fig. 2b) also exhibits most of the structure that appears in the composite zonal-wind analysis (Fig. 1b); each field contains perturbations having an eastward tilt with height through the troposphere. For both cases the oscillations have local amplitude maxima near the surface, between 400 and 600 hPa, and near 200 hPa. Of course, the two mode system is unable to represent the reverse in tilt that occurs above 200 hPa that is associated with vertical wave propagation.

5. Discussion

Both the PE and 2M systems adequately represent the circulations and temperature perturbations associated with two day disturbances. The results of the present study are particularly useful for clarifying the 2M interpretation of equatorial waves, a point on which we will elaborate during the oral presentation.

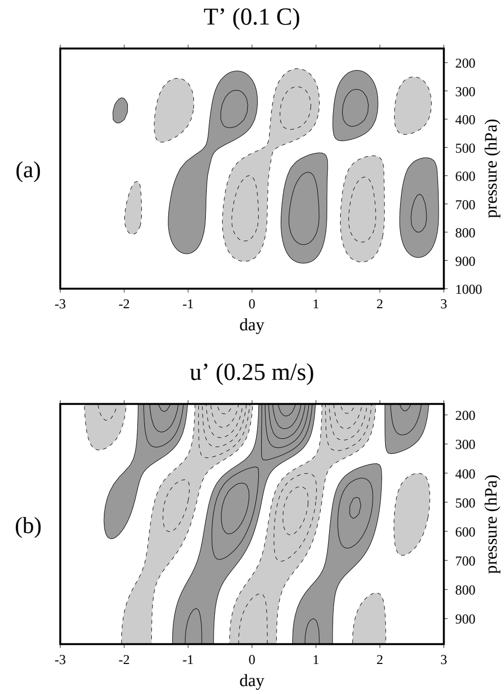

Figure 2. Time pressure series of perturbation temperature (a) and zonal wind (b) for the 2M simulation. Contoured as in Fig. 1.

6. References

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