15B.1 WAVE-CONVECTION-RADIATION FEEDBACK IN MADDEN-JULIAN OSCILLATION

Jialin Lin* , Minghua Zhang, Taotao Qian and Robert D. Cess
State University of New York, Stony Brook, NY

Brian Mapes and Matts Newman
NOAA-CIRES Climate Diagnostics Center, Boulder, CO 80305

1. Introduction

One key question for the MJO study is: *What is the driving mechanism of the MJO?* The focus of current study is on the wave-convection-radiation instability theories, in which the MJO mode becomes unstable due to the positive feedback between the wave and the diabatic heating. Whether the parameterized heating amplify the MJO wave depends on if the heating is positively correlated with the temperature.

In most of the previous wave-convection-radiation instability theories, the wave structure along the equator is similar to that of the moist Kelvin wave. The schematics is shown in Fig. 1. The five components of the diabatic heating, namely, the free troposphere moisture convergence, the boundary layer moisture convergence, the surface heat flux, the local change of moisture, and the radiative heating, have been emphasized by wave-CISK, frictional wave-CISK, WISHE, charge-discharge, and cloud-radiation interaction mechanisms, respectively.

The purpose of this study is to test these mechanisms using the observational data.

2. Data and Method

The TOGA COARE datasets includes (1) the heat and moisture budgets calculated from the sounding array during TOGA COARE using the constrained variational analysis method (Zhang and Lin 1997), and (2) the longwave and shortwave radiative heating profiles calculated by Qian and Cess (2002, manuscript in preparation) using realistic cloud profiles and the CCM3 column radiation model.

The long-term datasets include: (1) the CPC Merged Analysis of Precipitation from 1979-1999, (2) the NCEP operational upper air sounding data from 1979-1999. (3) the NCEP/NCAR reanalysis from 1979-1999 with the vertical motion and diabatic heating calculated using the chi method (Sardeshmukh et al. 1999), (4) the ISCCP D1 cloud data from 1986-1993, (5) the NASA Water Vapor Project (NVAP) data from 1988-1995, and (6) the oceanic boundary layer states and surface fluxes calcualted from the Tropical Atmosphere Ocean (TAO) moored buoy array and the NCEP Real-time Marine data using the TOGA COARE algorithm (Fairall et al. 1996).

All the datasets are bandpass filtered to the 30-70 day frequency band. Composite structure of the MJO is constructed using the linear correlation and linear regression method.

3. Wave-convection-radiation feedback in the MJO

Fig. 2 shows the schematics of the observed wave-convection-radiation feedback in the MJO. First, the observed wave structure *along the equator* is different from the moist Kelvin wave. The Rossby component contributes significantly to the wave structure along the equator and makes the 200 mb geopotential height lag the zonal wind by a quarter cycle. This wave structure is associated with a top-heavy diabatic heating profile and a large contribution from stratiform precipitation (not shown).

Among the five heating components, the free troposphere moisture convergence, the boundary layer moisture convergence and the surface latent heat flux are positively correlated with the upper troposphere temperature, suggesting that they amplify the MJO wave. The local change of moisture and the upper troposphere radiative heating lag the upper troposphere temperature by nearly a quarter cycle, suggesting that they neither amplify nor damp the MJO wave.

REFERENCES

Fairall, C. W., E. F. Bradley, D. P. Rogers, J. B. Edson, and G. S. Young, 1996: Bulk parameterization of air-sea fluxes for TOGA COARE. *J. Geophys. Res.*, **101**, 3747-3764.

Zhang, M. H., and J. L. Lin, 1997: Constrained variational analysis of sounding data based on column-integrated budgets of mass, heat, moisture, and momentum: Approach and application to ARM measurements. *J. Atmos. Sci.*, **54**, 1503-1524.

*Corresponding author: Jialin Lin, NOAA-CIRES Climate Diagnostics Center, Boulder, CO 80305

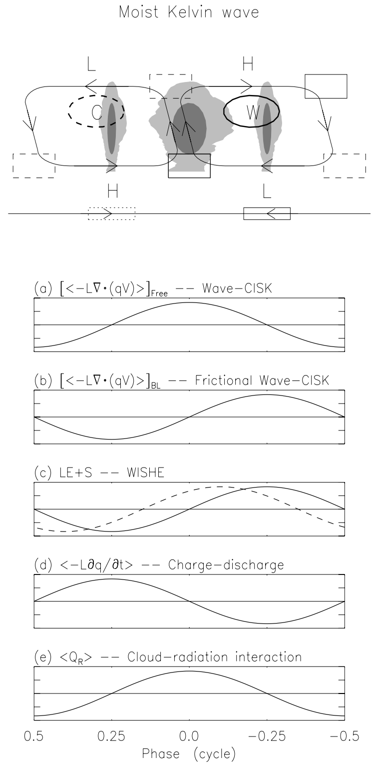

Figure 1: Schematics of the wave-convection-radiation feedback for the moist Kelvin wave.

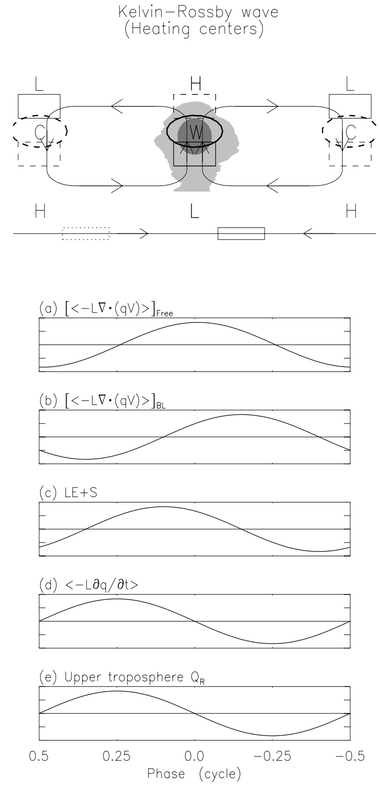

Figure 2: Schematics of the observed wave-convection-radiation feedback for the Kelvin-Rossby wave associated with the MJO.