7D.7 A SIMPLE, VERTICALLY RESOLVED MODEL OF TROPICAL DISTURBANCES WITH A HUMIDITY CLOSURE

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1 INTRODUCTION

A simple linearized model for large-scale disturbances in the tropical non-rotating atmosphere with a humidity closure is presented. The model includes cloud-radiation interactions (CRI) and wind-induced surface heat exchange (WISHE), Fuchs and Raymond (2002, 2005).

The humidity closure parameterizes the precipitation rate as directly proportional to the precipitable water with a relaxation time chosen to be one day. The justification for the humidity closure is found in the work by Sobel et al. (2004) and Bretherton et al. (2004). Using the daily-mean sounding data averaged over the five KWAJEX (Kwajalein Experiment) locations, Sobel et al. show that the correlation between CAPE and precipitation is weak and negative while the correlation between the relative humidity and precipitation is positive. Bretherton et al. show a strong correlation and almost no phase lag between the actual precipitation and the precipitation predicted from the relative humidity. They suggest that the schemes such as that of Betts-Miller should use the moisture adjustment time of 12 h rather than $1-2$ h.

2 MODEL

The model is vertically resolved, with the single assumption that the fixed vertical profile of heating has the structure of the first baroclinic mode. The vertical profile of vertical velocity is calculated with a radiation boundary condition. The calculated vertical velocity consists of two sinusoidal components with different vertical wavelengths. One corresponds to the imposed heating profile or deep convection component and the other to a shallow mode component that comes from satisfying the boundary conditions and is the one that determines the phase speed of the convectively coupled gravity mode.

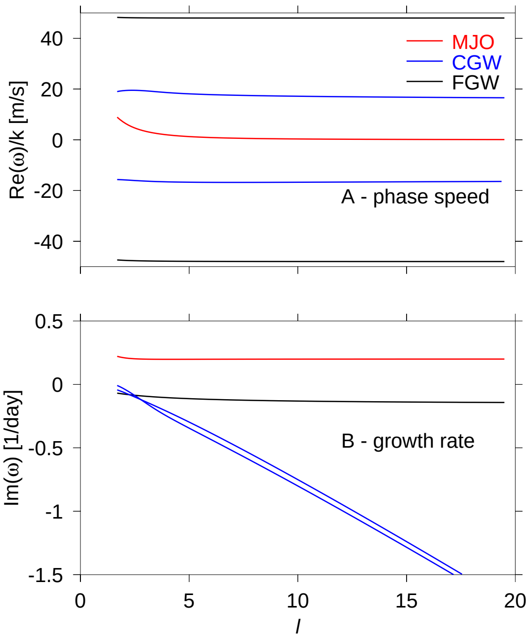

Figure 1: Dimensional dispersion curves as a function of the planetary wavenumber l.

3 RESULTS

The modeled modes are of three types, see figure 1: fast gravity waves (FGW) that resemble adiabatic modes with fundamental baroclinic vertical structure, convectively coupled gravity waves (CGW) and an unstable "moisture mode".

The CGW move with a phase speed of 17 m/s, a consequence of the dynamical structure of the model

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in which there are no a priori assumptions except the imposed vertical heating profile. The convectively coupled gravity mode maps to the Kelvin mode in the equatorial beta plane case, allowing us to compare it with the observed convectively coupled Kelvin waves that propagate with a phase speed of 17 m/s (Straub and Kiladis, 2002). However, the damping of the convectively coupled gravity wave is the biggest flaw of the model and is perhaps due to the absence of convective available potential energy (CAPE) or convective inhibition (CIN) in our convective closure.

4 CONCLUSIONS

We believe that the modeled "moisture mode" is related to the Madden-Julian oscillation (MJO). It is normally stationary, but propagates eastward under the influence of WISHE (Raymond 2001). This mode is unstable under the influence of CRI and gross moist instability.

For the first time we may have a simple analytical model that simultaneously captures the MJO and convectively coupled Kelvin waves. A simple idea that more moisture gives more precipitation leads to the governing mechanism of the MJO while the phase speed of the convectively coupled Kelvin waves is determined only by its dynamical structure. The CRI and gross moist instability destabilize the MJO while we still don't understand destabilization of the convectively coupled Kelvin waves.

5 REFERENCES

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