Vertical Wind Shear Effects on Kelvin Wave-CISK Modes: Possible Relevance to 30 ~ 60 Day Oscillations

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ABSTRACT

Several numerical model simulations (Hayashi and Sumi, 1986; Lau and Peng, 1987) reported generation of eastward propagating equatorial disturbances which appear to be model analogs of the observed 30~60 day oscillations. Kelvin wave-CISK has been proposed as a possible mechanism for driving these simulated disturbances (Lau and Peng, 1987; Chang and Lim, 1988). However, model and theoretical wave-CISK disturbances all propagate faster than the observed oscillations. In this paper, we investigate whether the "Doppler shifting" effect by a mean wind may adequately slow down the wave-CISK modes. In addition, the effect of vertical mean wind shear on their stability is also studied. The model and solution methods of this paper is adopted from Lim *et al.* (1990). Mean winds with a linear shear in the pressure coordinate are considered. It is found that a westerly shear tends to stabilize the Kelvin wave-CISK modes while an easterly shear tends to enhance their instability. The wave-CISK modes are "Doppler shifted" by the mean winds, but to only about 60 ~ 70% of the vertical-averaged mean wind speed. Based on the climatological equatorial mean winds, growth rate and propagation speed of the Kelvin wave-CISK modes are estimated for various longitudes. With the mean wind effect, the Kelvin wave-CISK modes take about 35~40 days to travel around the equatorial belt. Their growth rate is largest over the Indian Ocean and western Pacific Ocean where increased activity of convective clouds associated with the oscillations are often reported.

1. INTRODUCTION

Many theories have been proposed for the 30 ~ 60 day oscillations first observed by Madden and Julian (1972). Chang (1977) interpreted the phenomena as a slow mode of forced Kelvin waves in which heating is balanced by dissipation. This mode of Kelvin waves, in contrast to the usual gravity-type of Kelvin wave, have a deep circulation trapped in the troposphere, and propagates with a phase speed of about 10 m/s. Later theories tended to explore

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