4C.5 Influence of Equatorial Rossby Waves on Tropical Cyclogenesis in the Western Pacific

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1. INTRODUCTION

In recent years, equatorial wave modes have been a topic of much research in the literature. Wheeler and Kiladis (1999) focused on the relationship between these types of disturbances and deep tropical convection. Their work revealed the presence of many statistically significant spectral peaks in outgoing longwave radiation (OLR) within the tropics, several of which corresponded well to the dispersion relations of equatorially trapped wave modes. This suggests that equatorial waves may govern much of the weather in the deep tropics.

Dickinson and Molinari (2002) employed a more synoptic approach to understanding the role of equatorial waves by investigating a case study of a mixed Rossby-gravity wave packet. For approximately one month, individual cyclonic and anticyclonic disturbances within the wave train cyclically developed and propagated westward. During its lifetime, the packet was associated with the sequential formation of three tropical cyclones.

Previous research suggests that convectively coupled equatorial wave modes substantially influence the weather in the tropics. Paralleling the method of Dickinson and Molinari (2002), this study will examine the synoptic evolution of an equatorial Rossby wave packet and the associated tropical cyclogenesis.

2. DATA AND METHODOLOGY

This research focuses on an equatorial Rossby wave packet present during the boreal summer of 1991 in the western Pacific. Twice daily European Centre for Medium-Range Forecasts (ECMWF) uninitialized gridded analyses available on a 1.125^{o} latitude-longitude grid have been utilized to examine this event. In addition, outgoing longwave radiation (OLR) will be used as a proxy for deep tropical convection. Twice daily OLR data are available on a 2.5^{o} latitude-longitude grid and follow the improved interpolation procedures for missing data by Liebmann and Smith (1996) and the time of day corrections of G. Kiladis (personal communication).

A 15-30-day band-pass filter has been applied to the data to isolate the equatorial Rossby waves from both the background state (Madden-Julian oscillation, monsoon trough) as well as other tropical disturbances with shorter temporal scales (mixed Rossby-gravity waves, westward inertial gravity waves, etc.).

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3. RESULTS

Figure 1 illustrates a Hovmoeller plot of 15-30-day meridional wind averaged over 5^{o}N-20^{o}N. What appears to be an equatorial Rossby wave packet is clearly visible beginning in mid-August and continues over a two-month period. Phase and group velocity calculations from the ER wave dispersion relation support this interpretation. The phase speed of the individual disturbances within the wave packet is approximately -1.8 m s^{-1}. Generally, it appears that the packet remains stationary throughout its lengthy existence, implying a group speed of zero.

To provide a better understanding of the structure of this wave train, horizontal maps of 15-30-day winds and OLR are presented in Fig. 2. On 910905, a broad cyclonic circulation associated with the ER wave is centered near 15^{o}N, 148^{o}E (Fig. 2a). A swath of enhanced convection extends from the eastern periphery clockwise around to the southern periphery of the cyclone. Its Southern Hemisphere counterpart, centered at 5^{o}S, 155^{o}E, is more compact and displaced eastward of the Northern Hemisphere cyclone. A region of enhanced convection resides in the center of the Southern Hemisphere circulation. A third feature of interest is a small anticyclone located at 25^{o}N, 130^{o}E. A nonconvective area is displaced to the southeast of its circulation center.

Eleven days later, the synoptic pattern appears completely reversed (Fig. 2b). Two anticyclones occupy a majority of the western Pacific, rather than two cyclones. One anticyclone exists near 10^{o}N, 145^{o}E with a region of suppressed convection extending though the northerlies and easterlies of the circulation. In the Southern Hemisphere, a smaller anticyclone is located at 5^{o}S, 145^{o}E, again shifted eastward of the Northern Hemisphere circulation feature. Farther north, a cyclone is present near 25^{o}N, 135^{o}E with enhanced convection displaced to the southeast of the center.

This cycle of alternating cyclonic and anticyclonic disturbances persists throughout the life of the ER wave train. Within these disturbances, 11 tropical cyclones develop in association with the wave packet. A detailed discussion of this evolution and the associated tropical cyclogenesis will be presented in the talk.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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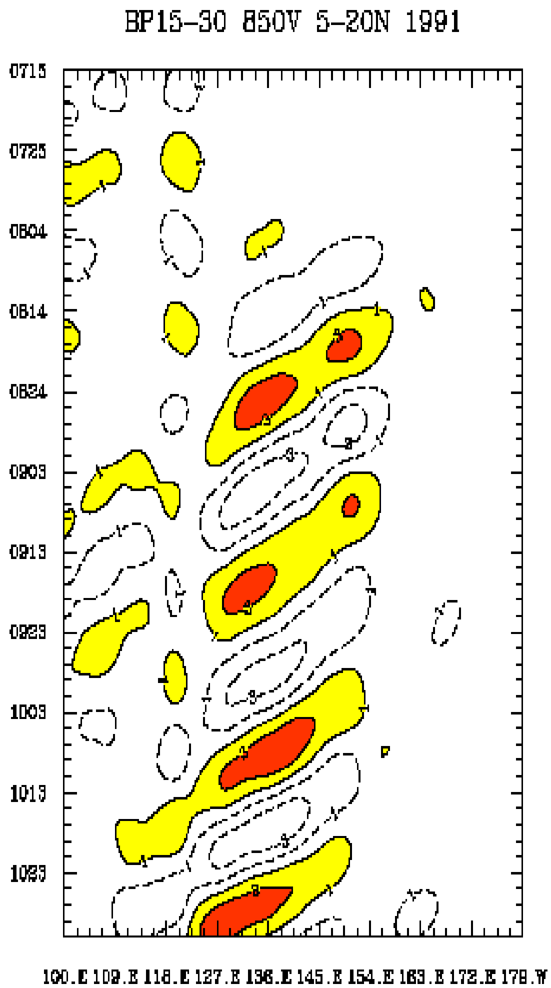

Figure 1

Figure 1: Hovmoeller plot of band-pass 15-30-day filtered meridional wind averaged over 5^{o}N-20^{o}N. Positive values are shaded.

Figure 2: (a) Band-pass 15-30-day filtered wind and OLR for 910905/0000. Negative values of OLR are shaded. (b) Same as in (a), but for 910916/0000.

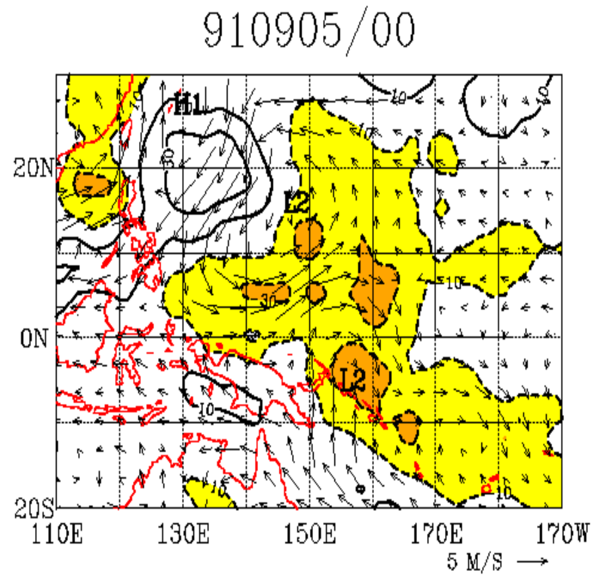

Figure 2a

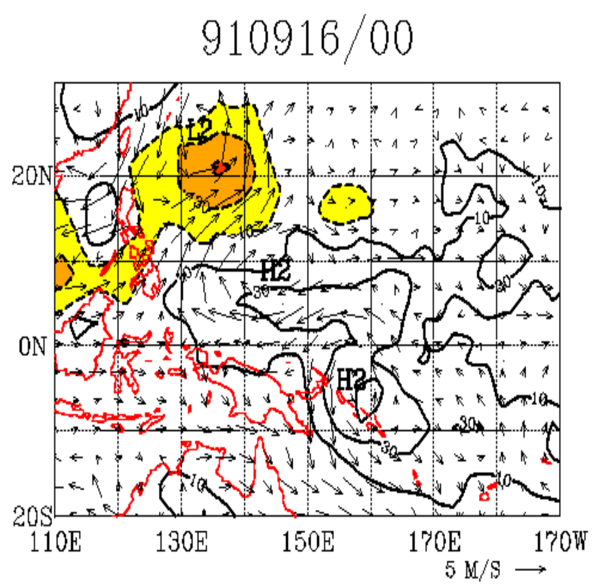

Figure 2b