

Observation of Mixed Rossby-Gravity Waves in the Western Equatorial Pacific

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During the IOP (Intensive Observation Period) of TOGA/COARE (Tropical Ocean and Global Atmosphere/Coupled Ocean Atmosphere Response Experiment) from December 1992 to February 1993, four Japanese moored ADCPs (Acoustic Doppler Current Profilers) measured vertical profiles of three-component velocities at the stations 2S (2°S, 156°E), 2N (2°N, 156°E), 154E (0°N, 154°E) and 147E (0°N, 147°E). Power spectra of the surface current showed a pronounced peak having a period of around 14 days for both the zonal and meridional velocities at the stations 2S and 2N near the equator, and for only the meridional velocity at the equator. This 14-day phenomenon is considered to be a kind of equatorial wave of the first baroclinic mode, from a comparison of the result of the vertical mode analysis and the vertical distribution of the standard deviation of band-pass filtered velocity fluctuations. A dispersion relationship obtained from the horizontal mode analysis of this wave confirmed that the 14-day phenomenon is a mixed Rossby-gravity wave with the westward propagating phase speed and eastward propagating group velocity. From the cross-spectral analysis of velocity data, the average phase speed and wavelength of the wave were estimated as 3.64 m s⁻¹ and 3939 km, respectively, for station pair 2S-147E. These values were in good agreement with the average phase speed and wavelength of 3.58 m s⁻¹ and 3836 km estimated from the dispersion curve and the observed period. A northerly wind burst blew over all the mooring sites during the middle of the observation period. The mixed Rossby-gravity wave, which is anti-symmetric for the zonal velocity about the equator, is likely to be forced by this northerly wind burst crossing the equator. Generation of the oceanic mixed Rossby-gravity wave of the first baroclinic mode is discussed in association with the atmospheric Rossby wave having the same period.

Keywords:

· Mixed Rossby
· gravity waves,
· equatorial Pacific,
· TOGA/COARE,
· moored ADCPs.

1. Introduction

In equatorial oceans there are several kinds of equatorial waves which may trigger El Niño events. In contrast to the Rossby and Kelvin waves generated in response to the zonal winds such as the Trades, the mixed Rossby-gravity wave with anti-symmetric characteristics about the equator has been less frequently investigated (Suarez and Schopf, 1989; Philander, 1990). This is partly because the Trades usually dominate over the central and eastern equatorial Pacific, and partly because the study of equatorial waves in the western equatorial Pacific has developed only recently. Meridional winds occasionally prevail in association with westerly bursts over the western equatorial Pacific (McPhaden *et al.*, 1988). It is worthwhile to know how the mixed Rossby-gravity wave is related to meridional winds and how it

modulates the initiation phase of El Niño.

The theoretical solution of the mixed Rossby-gravity wave in the equatorial region was first found by Matsuno (1966). Evidence for the mixed Rossby-gravity wave has often been found with relatively weak signal strengths in the sea-level data at island stations near the equator (Wunsch and Gill, 1976; Ripa and Hayes, 1981). A mixed Rossby-gravity wave with a period of about one month was well observed by moored current meters in a triangular arrangement in the Gulf of Guinea in the Atlantic Ocean (Weisberg *et al.*, 1979). Although this wave is well identified as an equatorially trapped wave through dynamic analyses, the effects of the wave on the overall equatorial ocean and its forcing mechanism are not discussed. During the period of the 1982-1983 El Niño, mixed Rossby-gravity waves with