Water Displacements and Trajectories in the Western Pacific Warm Pool Region during the 1982-83 El Niño

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Abstract

The Western Pacific warm pool is the origin of the basin-wide warm water redistribution during an El Niño. During the 1982-83 event, two prominent sea level depressions (signifying a large loss of warm water) formed in this region, offering the opportunity to document the associated warm water displacements.

This study attempts to identify the water trajectories and the dynamic processes associated with the development of the depressions based on the available wind and sea level observations. For this purpose, the circulation is diagnosed from these observations utilizing a simple least-squares formulation of a linear $1\frac{1}{2}$-layer reduced-gravity model. Trajectories are simulated from this circulation field to trace the horizontal fluxes associated with the upper layer volume fluctuations in the warm pool. The dynamics of the volume fluctuations and of the water trajectories are analyzed using the Eulerian and the Lagrangian forms of the vorticity equation, respectively.

The observations indicate that the 1982-83 El Niño can be differentiated into four phases. Two successive generations of equatorial Kelvin waves during the second and third phases were linked to the draining of warm water from the warm pool region forming the two large sea level depressions north and south of the equator. The southern depression was relatively larger than the northern depression because it extended to the equatorial region. Trajectories show that water displacements

were related to the variations of the equatorial currents and the meridional flows that connected these currents. For instance, two eastward volume surges with the North Equatorial Countercurrent were observed in connection with the formation of the depressions. The dynamical analyses show the relative importance of Ekman pumping and Rossby wave motion in the formation and recovery of the depressions. In particular, the Lagrangian analysis reveals the roles of the two components of Ekman pumping in forcing Rossby waves.