Abstract View

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Eastern Tropical Ocean Response to Changing Wind Systems: with Application to El Niño

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ABSTRACT

El Niño is an anomalous condition that historically has been studied in the coastal region of the eastern tropical South Pacific. The phenomenon is commonly characterized there by the rapid appearance of anomalously high sea level and sea surface temperatures, and southward transport of the warmer, fresher equatorial waters. Observational evidence also suggests that El Niño is associated with a large-scale weakening of the equatorial wind systems over a large extent of the ocean interior. The problem investigated here is whether these ocean and atmosphere events are dynamically connected.

A model is used to follow the initial baroclinic response of the eastern Pacific Ocean to different distributions of interior wind stress change. Model results suggest the following conclusions. Changes in the meridional wind field cannot cause an El Niño event. Changes in the zonal wind field outside of the equatorial band (roughly ±5° of latitude) are not important in generating El Niño. A symmetric weakening of the equatorial zonal wind field can cause rapid lowering of the thermocline in the eastern Pacific; moreover, this lowering spreads all along the eastern boundary well out of the region of direct forcing and at higher latitudes is associated with poleward quasi-geostrophic coastal jets. An anti-symmetric change of the equatorial zonal wind field forces cross-equatorial transport; in this case, the anomaly fields do not spread along the eastern boundary but remain confined to the equatorial region. An asymmetric change of the equatorial zonal wind field has commonly observed aspects of El Niño; this response is defined to be a “model” El Niño event.

The model is of interest in itself. It is simple and analytic, and therefore its response can be understood in terms of familiar linear wave theory. After the swiftly propagating coastal Kelvin waves have passed through the model, the solution in the eastern Pacific can be viewed as a superposition of three parts: 1) a locally forced response, 2) packets of nondispersive Rossby waves excited at the eastern boundary, and 3) packets of equatorially trapped Kelvin waves arriving from the western boundary.

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