

Long-Term Changes in the Equatorial Pacific Trade Winds

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Abstract

Past work (Cane and Sarachik 1977; Li and Clarke 1994) has shown that surface zonal equatorial wind stress, zonally integrated from one side of the Pacific to the other, is the key variable for estimating long-term El Niño behavior in the eastern Pacific. The long-term behavior of this key variable is difficult to determine directly, because of the paucity of equatorial wind observations and because of false trends in the wind data introduced by gradual changes in measurement methods. However, surface pressure data generally do not suffer from these false trends, and theory suggests that this key wind variable is linearly related to the difference (Δp) of surface atmospheric pressure between the eastern and western equatorial Pacific. We used detrended COADS pressure in the eastern and western equatorial Pacific and post-1960 detrended Florida State University equatorial wind stress zonally averaged across the Pacific to verify this relationship. Pressure difference and zonally averaged equatorial zonal wind stress (τ) were highly correlated ($r = -0.85$), and the regression also showed that advection of zonal momentum contributes substantially to the momentum balance in the equatorial atmospheric boundary layer. Further, hindcasts of eastern equatorial Pacific sea surface temperature suggested that τ from Δp was more accurate than τ from winds even since 1960, when wind data are more plentiful.

Using the Δp time series as a proxy for zonally integrated wind stress suggests that the equatorial trades strengthened during the 1920s and 1930s, weakened from the mid-1940s to late 1950s, strengthened during the 1960s, and have weakened rapidly since. This pattern is qualitatively consistent with the long record of sea surface temperature measurements at Puerto Chicama (Peru). The more recent rapid weakening is consistent with trends in several physical variables reported previously by others. The long-term changes affect El Niño/La Niña intensity and contribute significantly to sea level change on the western coast of the Americas. A proxy record of eastern Pacific sea surface temperature from coral (Dunbar *et al* 1994) suggests that such long-term (decade and longer) weakening and strengthening of the Pacific equatorial trades has occurred before major anthropogenic greenhouse gas release and at least back to 1600 AD.

References

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