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Effects of westerly wind bursts on El Niño: a new perspective

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The relation of El Niño to the westerly wind bursts (WWBs) in the tropical western Pacific has been a hotly debated issue in recent years. Here we provide a new perspective on this problem based on observational data as well as model experiments. Daily observations during the past 50 years reveal that every El Niño event during this period is accompanied by frequent WWBs, suggesting a close relationship of these wind bursts with both "cold-tongue" and "warm-pool" El Niños. Basically, WWBs have two distinct effects on equatorial ocean dynamics: First, they cause surface water convergence and push down the equatorial thermocline, thus exciting eastward downwelling equatorial Kelvin waves; Second, they generate strong equatorial surface currents, which advect warm water toward the east, thus extending the eastern edge of the warm pool. Therefore, it is plausible that WWBs may enhance cold-tongue El Niño through combined effects of Kelvin wave and warm water advection, and may produce warm-pool El Niño by advection alone when the thermocline in the east is not shallow enough for El Niño to occur. In order to test this hypothesis, we add WWB-like stochastic noise to an intermediate coupled ocean-atmosphere model, which by itself is tuned to produce a damped regular oscillation with SST anomalies confined to the eastern Pacific. When the noise is added, the SST anomalies in the east are amplified and become irregular, while warm events start to occur in the vicinity of the dateline. Our model results indicate that WWBs are responsible for the existence of warm-pool El Niño, and also for the irregularity and extremes of cold-tongue El Niño.