The effect of westerly wind bursts on ENSO: Why each El Niño event is unique

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Abstract

Episodic brief relaxations of easterly zonal winds in the vicinity of the Dateline in the equatorial Pacific are known as westerly wind bursts (WWB). In this study we reexamine the response of the coupled ocean-atmosphere system to WWBs in a comprehensive coupled model. Our approach follows that of Lengaigne et al. (2004) and involves adding the wind stress anomaly produced by a westerly wind burst (the one actually observed in March 1997, preceding the El Niño event of that year) to the experiments with the coupled model. Two sets of ensemble experiments are conducted. In the first set, the initial ocean heat content of the system is recharged (OHC is higher than normal), while in the second set it is neutral (OHC anomaly with respect to the model climatology is near zero). We study the differences between the two sets and, at the same time, differences between the members of each set. When looking at the ensemble means we find that, in the first set of experiments, the WWB leads to a strong Eastern Pacific El Niño (EP), while in the second set to a weak Central Pacific El Niño (CP). The particular response of the system to the perturbation is determined by the interplay between the warming of the eastern equatorial Pacific (initially caused by the wind-induced Kelvin wave), the weakening of the zonal equatorial currents, and the eastward shift of the warm pool. In addition to the differences between the two sets, we also find significant differences between ensembles members in each set of experiments. These latter differences are especially large within the second (neutral) set where SSTs can differ by ~5^{o}C between the end members of the ensemble. Even after the WWB, the system can potentially evolve into a broad range of states - from a weak La Niña to a CP El Niño or even an EP El Niño. This confirms that the predictability of El Niña and La Niña when the ocean heat content is near neutral can be inherently limited.