Westerly wind bursts revisited: Implications for central Pacific, eastern Pacific and extreme El Niño events

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Westerly wind bursts that sporadically occur in the western tropical Pacific (WWBs) are believed to play an important role in the evolution of El Niño events and the ENSO cycle in general. In particular, a succession of wind bursts preceding the 1997/1998 El Niño may have been responsible for the extraordinary amplitude of that event. It has been argued that the background conditions of the tropical ocean-atmosphere system determine whether a WWB would have a strong effect on ENSO or not. Here, we conduct a suite of ensemble experiments with a comprehensive coupled model in which we reexamine the response of the climate system to a WWB (following the study of Lengaigne et al. 2004, we add an actually observed wind burst to winds produced by the 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 the model climatology), while in the second set it is neutral (OHC is nearly normal). For the recharged state, in the absence of WWBs, a moderate central Pacific El Niño (CP) develops in about a year. In contrast, for the neutral state, there develops a weak La Niña event. However, when the WWB is imposed, the situation dramatically changes: the recharged state slides into an eastern Pacific El Niño (EP), while the neutral set shifts into a weak CP El Niño instead of the previously dominant La Niña conditions. The particular response of the system to the perturbation is determined by the background state of the ocean and the subsequent ocean-atmosphere interactions. The most relevant aspects of the background state are the temperature in the eastern equatorial Pacific, the position of the warm pool eastern edge, and the strength of the mean zonal currents. Further, we find that in the first set of experiments, after the WWB is imposed, several of the ensemble members develop extreme EP El Niño events resembling that of 1997/1998. The occurrence of these extreme events depends on how much the edge of the warm pool can shift eastward facilitating a strong Bjerknes feedback. Ultimately, our results indicate that (1) the occurrence of different types of El Niño can be accounted for in part by stochastic atmospheric processes including WWBs; and (2) extreme El Niño events can result from a rare combination of strong WWB activity and the appropriate background conditions of the coupled system.