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The impact of ocean-modulated westerly wind bursts on ENSO prediction

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It has recently been suggested that equatorial Pacific westerly wind bursts (WWBs) are strongly modulated by sea surface temperature and hence by ENSO, rather than being an external stochastic forcing of the coupled system. Here, the dependence of WWBs on the large-scale SST is modeled via a novel statistical approach. A WWB model is developed by identifying WWB characteristics such as the probability of occurrence, wind strength, location, and fetch, in the observed winds of 1988–2005. A combined singular value decomposition (SVD) and linear regression method is then used to find the model which best reproduces the observed WWB characteristics from the large-scale SST. The WWB model is novel in two major aspects. (1) The singular value decomposition (SVD) is used to capture the linear relationship between the WWB characteristics and SST, instead of between the wind field itself and the SST. (2) The probability of WWB occurrence is explicitly predicted from the SST, such that the modeled WWBs are partially stochastic. The resulting WWB model reproduces the observed increased likelihood and eastward movement of WWBs as the Pacific warm pool extends.

The impacts on seasonal-to-interannual predictability are explored by adding the WWB model to a hybrid, coupled model. Specifically, the GFDL MOM4 ocean general circulation model is coupled to a linear statistical atmosphere and the explicit WWB model. Retrospective forecasts, i.e., "hindcasts," are used to investigate if the modeled WWBs may improve predictions of El Niño episodes over the last 25 years. Furthermore, the WWBs are decomposed into deterministic and stochastic parts, so that the competing impacts on ENSO prediction are quantified.