Abstract View

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On Equatorial Waves and El Niño. II: Effects of Air-Sea Thermal Coupling

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ABSTRACT

Dynamics readjustment of a stratified ocean model to wind perturbations leads to variations in sea surface temperature (SST) related to the early phases of the observed interannual warming of the tropical Pacific known as El Niño. The role that the atmosphere plays in determining the extent and strength of the SST warming is examined through numerical experiments with varying parameterizations for the atmospheric thermal response to SST anomalies.

A prior specification of the atmospheric temperature (even as a function of space and time) amounts to assuming infinite heat capacity for the atmosphere. A zero-heat capacity atmospheric model is constructed, in which the surface air temperature is balanced between the SST and a radiative equilibrium temperature. In the latter model, SST perturbations are damped through radiative relaxation from the atmosphere, rather than through direct cooling to the atmosphere. This greatly increases the lifetime of SST anomalies and increases their areal extent.

The effect that the atmospheric parameterization has on an upper ocean model for El Niño is examined. The model tests are conducted by imposing wind perturbation on simple mean states driven by constant winds. Westerly wind perturbations in the western part of the model basin excite Kelvin waves that propagate to the east. Under southerly mean winds, this Kelvin wave propagates to the east without any signal in the SST, but large SST anomalies are generated upon reflection of the Rossby waves. Much weaker changes in the southerly winds near the eastern coast produce SST anomalies that mimic those generated by the westerly wind changes. Such a counter-example to remotely forced Kelvin wave theories for El Niño also arises when the southerly stress anomaly is held off the coast by 200 km. Sea-level changes associated with the westerly and southerly wind perturbations are markedly different. The rapid adjustment of the atmosphere to the ocean appears to be a necessary conditions for successful simulations of the El Niño warming.

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