ENSO RESPONSE TO ALTERED CLIMATES

Andrew Thorne Wittenberg

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Abstract

Observed secular changes in the El Niño / Southern Oscillation (ENSO) phenomenon are not well understood; nor are the major differences in ENSO simulations found among state-of-the-art general circulation models of the tropical Pacific. To address these issues, this study advances an efficient numerical model of the ocean-atmosphere system and then uses it to explore the sensitivity of ENSO to changes in the climatological background. The model includes dynamical, statistical, and stochastic components and provides a reasonably good simulation of the observed climatology and interannual variability of the tropical Pacific.

A series of idealized experiments reveals how changes in equatorial and off-equatorial zonal wind stresses, meridional stresses, and radiative forcings affect the tropical climatology. Because coupled feedbacks dominate the time-mean response, perturbed climatologies tend to resemble either an El Niño (with warm sea surface temperatures in the eastern equatorial Pacific, weakened trade winds and flattened thermocline) or a La Niña (with cool sea surface temperatures, enhanced trades and steeper-sloping thermocline).

The study then shows how these altered climates impact the behavior of ENSO, including its amplitude, frequency, spatial structure, mechanism, sensitivity to transient disturbances, and predictability. An analysis of the oceanic mixed layer thermodynamics provides a physical basis for understanding these changes. Results from a more sophisticated ocean-atmosphere model are also presented, and the problem of detecting climate-induced ENSO changes in short stochastic timeseries is discussed.

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