The Effect Of An Anomalously High Warm-pool SST On The Magnitude Of El Niño Warming

De-Zheng Sun,
NOAA-CIRES/Climate Diagnostics Center,
Boulder, Colorado
email:ds@cdc.noaa.gov,
Tel: 303 497 6272,
Fax: 303 497 6449

El Niño warming corresponds to an eastward extension of the western Pacific warm-pool; one thus naturally wonders whether an increase in the warm-pool SST will result in stronger El Niños. This question, though elementary, has not drawn much attention. The observation that the two strongest El Niños in the instrumental record occurred during the last two decades when the warm-pool SST was anomalously high, however, has added some urgency to answering this question. Here we show observational and numerical results which support a positive answer to this question.

The observational results come from an analysis of the heat balance of the tropical Pacific over the period of 1980-1999. The analysis confirms that El Niño acts as a major mechanism by which the tropical Pacific transports heat poleward-the poleward heat transport is achieved episodically and those episodes correspond well with the occurrence of El Niños. Moreover, the analysis shows that El Niño is a regulator of the heat content in the western Pacific: the higher the heat content, the stronger the subsequent El Niño warming, which transports more heat poleward, and results in a larger drop in the heat content in the western Pacific. These empirical results suggest that a higher warm-pool SST may result in stronger El Niño events. Specifically, raising the tropical maximum SST through an increase in the radiative heating across the equatorial Pacific initially increases the zonal SST contrast. A stronger zonal SST contrast then strengthens the surface winds and helps to store more heat to the subsurface ocean. Because of the stronger winds and the resulting steeper tilt of the equatorial thermocline, the coupled system is potentially unstable and is poised to release its energy through a stronger El Niño warming. A stronger El Niño then pushes the accumulated heat poleward and prevents heat buildup in the western Pacific, and thereby stabilizes the coupled system. Numerical experiments with a coupled model in which the ocean component is a

primitive equation model (the NCAR Pacific basin model) and therefore explicitly calculates the heat budget of the entire equatorial upper ocean, support this suggestion. The numerical experiments further suggest that in the presence of El Niños, the time-mean zonal SST contrast may not be sensitive to increases in the surface heating because the resulting stronger El Niños cool the western Pacific and warm the eastern Pacific.

The results suggest an important factor that may have contributed to the observed variability of ENSO amplitude on decadal and longer time-scales: variability in the warm-pool SST on these time-scales. The results also suggest that El Niño may be a mechanism that prevents the time-mean state of the coupled system--the climatological state--from becoming substantially unstable.