ENSO Cycle: Recent Evolution, Current Status and Predictions

Vernon E. Kousky and R. Wayne Higgins
Climate Prediction Center / NCEP

1. Introduction

During 2004 positive SST anomalies persisted in the western equatorial and expanded eastward into the east-central and eastern equatorial Pacific. At the same time the basin-wide upper ocean heat content was greater than average. These features indicate a developing warm (El Niño) episode. The gradual evolution towards a warm episode was strongly modulated by Madden-Julian Oscillation (MJO) activity, which resulted in considerable intraseasonal variability in many tropical Pacific atmospheric and oceanic fields.

2. Recent evolution

Persistent positive SST anomalies have been observed over the western equatorial Pacific during late 2003-September 2004 (Fig. 1).

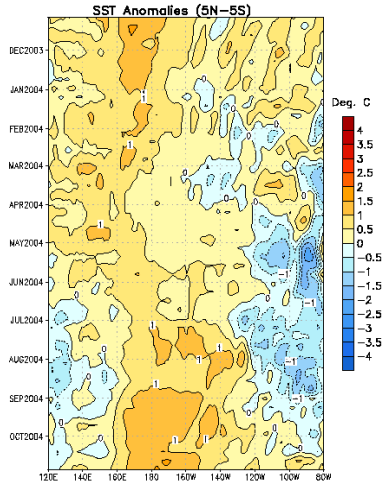

Fig. 1. Time-longitude section of SST anomalies averaged over the latitude band 5ºN-5ºS. Anomalies are departures from the 1971-2000 base period mean.

In July 2004 anomalies increased in the central equatorial Pacific and subsequently this anomalous warmth spread eastward into the eastern equatorial Pacific, resulting in increases in the SST indices in the Niño 3.4, Niño 3 and Niño 1+2 regions (Fig. 2).

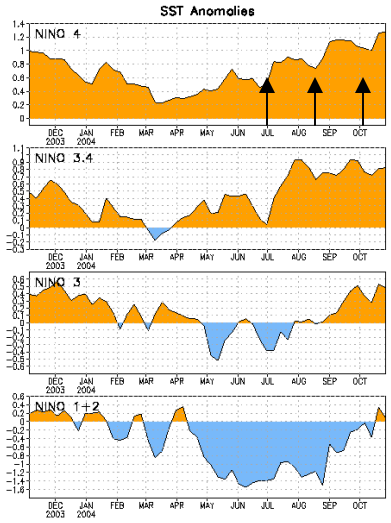

Fig.2. Time series of the weekly SST anomalies for the Niño regions.

These indices have been strongly modulated by MJO activity, which has produced periods of alternating weaker-than-average and stronger-than-average easterlies over the equatorial Pacific (arrows in Fig. 2 and dashed lines in Fig. 3)

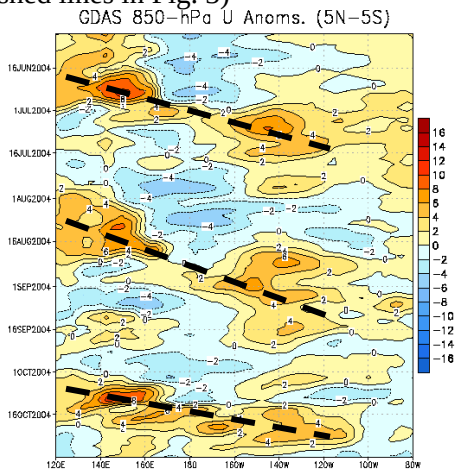

Fig. 3. Time-longitude section of 850-hPa zonal wind anomalies, computed with respect to the 1979-1995 base period. The heavy dashed lines indicate periods of westerly wind anomalies.

3. Current conditions (October 2004)

During October 2004 equatorial ocean surface temperatures were greater than +0.5°C above average at most locations between 160°E and 120°W (Fig. 4). Departures greater than +1°C were observed between 165°E and 130°W, and slightly cooler-than-average ocean surface temperatures were found near the South American coast, and in the region of Indonesia.

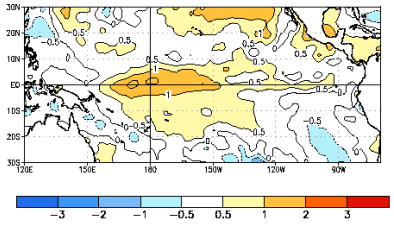

Fig. 4. Anomalous SST for 3-30 October 2004. Contour interval is 0.5°C.

During October 2004 positive SST anomalies persisted in the central and east-central equatorial Pacific, where departures greater than +1°C were observed. Negative anomalies decreased in areal extent and magnitude in the eastern equatorial Pacific. This pattern indicates the early stages of a warm (El Niño**)** episode.

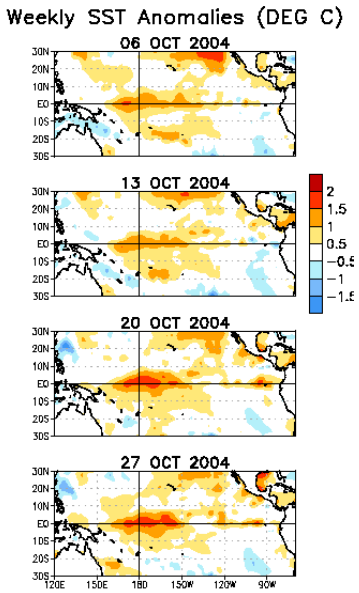

Fig. 5. Weekly SST anomaly patterns for October 2004.

The subsurface temperature anomalies in the equatorial Pacific during September-October 2004 (Fig. 6) indicate that the basin-wide upper-ocean heat content is greater than average, which is a feature usually found during the early stages of warm episodes.

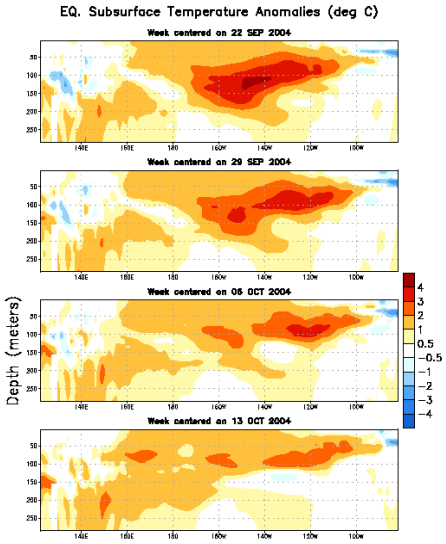

Fig. 6. Weekly equatorial depth-longitude sections of upper-ocean temperature anomalies for mid-September through mid-October 2004.

4. SST Predictions

The NCEP coupled forecast system (CFS) predictions for SST anomalies (Fig. 7) indicate that warm episode conditions should continue through Northern Hemisphere 2005.

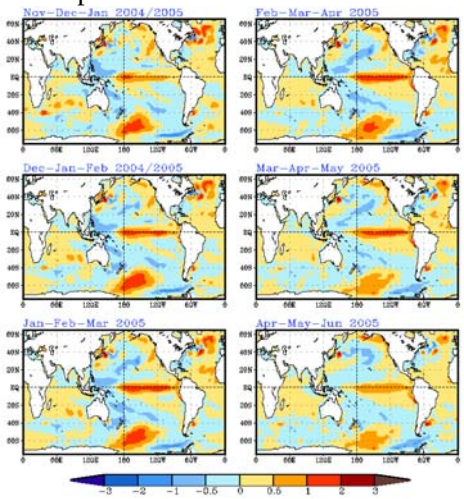

Fig. 7. CFS SST anomaly predictions.

Other forecasting techniques (Fig. 8), compiled by the IRI, are consistent in indicating a weak or moderate warm episode (Niño 3.4 SST anomalies greater than or equal to +0.5ºC and less than +1.5ºC) continuing through spring 2005.

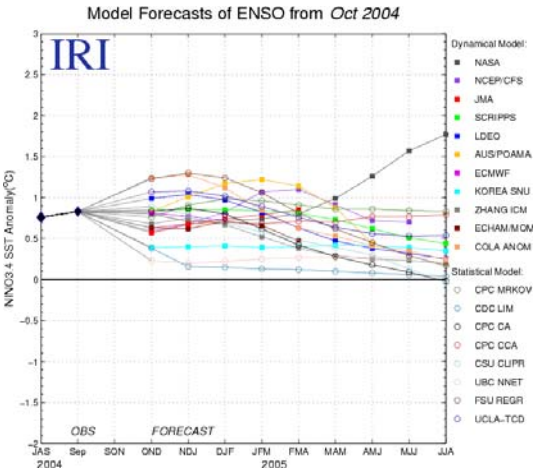

Fig. 8. Predicted Niño 3.4 SST anomalies form several different statistical and coupled model forecast systems..

5. U.S. winter 2004-05 predictions

Given the likelihood that a weak or moderate warm episode will continue through the Northern Hemisphere winter season, the official outlooks relied heavily on ENSO composites and long-term trends as tools for projecting anomalous temperature and precipitation patterns. Composite temperature and precipitation patterns for past warm episodes, having Niño 3.4 anomalies similar to those predicted for winter 2004-05 (Fig. 9), show that for weak or moderate warm episodes there is a strong indication of below-average temperatures in the Southeast and a somewhat weaker indication of above-average temperatures in the northern Plains and portions of the West.

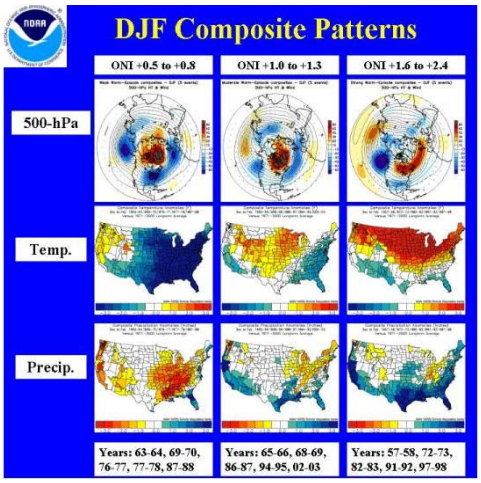

Fig. 9. Composite anomalous 500-hPa height (top panels), surface (2-m) temperature (middle panels), and precipitation (bottom panels) for different values of the Oceanic Niño Index (ONI, 3-month running mean of the Niño 3.4 SST anomaly).

There is also a strong indication for drier-than-average conditions over the Tennessee and Ohio Valleys, and a weaker tendency for wetter-than-average conditions over portions of the Southeast and along the immediate Gulf Coast. It is interesting to note that as the intensity of the warm episode increases, as measured by the ONI, the country becomes increasingly warmer and wetter than average. The composites for weak or moderate warm episodes are reflected in the official seasonal outlooks, which also reflect recent trends (warm in the West and wet in Texas) (Fig. 10).

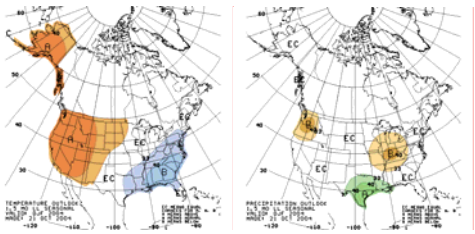

Fig. 10. DJF 2004-05 outlooks for temperature (left) and precipitation (right).