"Course on Ocean-Atmosphere Interaction in the Tropics"
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"ENSO Observations: Tropics"

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Please note: These notes are intended for internal distribution only
1. ENSO OCCURS AT TIMES OF LOW SST
   
   $\text{SST} = \text{DARWIN} - \text{TAHITI}$

   
   a. FIRST PEAKED AT S.A. COAST & LATER PROPAGATED INTO CENTRAL PACIFIC
      REACHING PEAK IN DEC. OF YEAR.

   b. WIND WESTERLY ANOMALY TO WEST OF SST ANOMALIES.

   c. SST ANOMALIES PROPAGATE WESTWARD.

   d. NO HUMID AIR DATA.

3. WARM EVENT OF 1982-3

   a. SST ANOMALY GROWS IN PLACE WITHOUT PROPAGATION. (MEAN PROPAGATES EASTWARD)

   b. SEA-LEVEL $\Rightarrow$ HEAT FLOWS EASTWARD

   c. REGION OF PERSISTENT PRECIPITATION MOVES EASTWARD AWAY FROM AUSTRALIA AND INTO CENTRAL PACIFIC

   d. SST ANOMALIES FIRST GROW IN CENTRAL PACIFIC (PEAK IN DECEMBER) THEN PEAK
      AT COAST FOLLOWING APRIL-MAY,

   e. UPPER LEVEL ANTICICLOONES N-S OF WARM WATER.
Fig. 2.1 Time series of anomalies in sea level pressures at Darwin (solid) and Tahiti (dashed) from 1950 to 1988 smoothed with an 11-point filter designed to remove fluctuations of period less than about a year (Trenberth, 1984).

Fig. 2.2 Composite of the correlations ($\times 10$) of annual mean sea level pressures with Darwin (from Trenberth and Shea, 1987).
Fig. 17. Antecedent conditions anomaly composite (averages for August-October of the year preceding El Niño). (a) SST (°C), (b) wind anomaly (m s⁻¹), (c) velocity divergence (10⁻⁹ s⁻¹). The normal positions of the axes of convergence associated with the SPCZ and ITCZ are indicated on the convergence composite. Areas in which the number of observations averages less than 10 in a two-degree square are shaded on the wind composite.
Fig. 18. Onset Phase anomaly composite. (Averages for November-January prior to maximum positive SST anomalies on Ecuador-Peru coast.) Units and shading are as in Fig. 17.
Islands, the precipitation anomalies peaked near the time of maximum SST anomalies, and have now diminished to small positive values.

4) The SST and wind anomaly fields in the southwest Pacific clearly reflect a northeast displacement of the SPCZ. Cyclonic anomalous flow appears over
Fig. 20. Transition Phase anomaly composite (Averages for August-October of El Niño year). Units and shading are as in Fig. 17.
general vicinity of the equator. Within this area, our analyses clearly show a phase difference between the variations east and west of 170°W. These two separate areas appear to correspond to the $\delta U'$ and $\delta U''$ maxima of Barnett's Pacific tradewind EOF's (Barnett, 1977b). East of 170°W, the relaxation of the
negative anomalies are approaching the dateline, the anomalies west of 150°E change to small positive values.

Although there is a general tendency for westerlies to the west, and weaker easterlies to the east of the positive SST anomaly along the equator, the phase relationship between the wind and SST anomaly fields appears to change during the warm episode. In the broadest sense, as the area of strongest positive SST anomalies shifts westward, the area of westerly wind anomalies extends eastward. The model results of Gill (1980) are similar in some respects to the anomaly patterns during the Transition and Mature Stages.

The westerly anomalies along the equator reach their maximum eastward extent after the peak SST anomalies, around January(-1). Even then, they extend only to ~130°W. The difference in the phase relationship between SST and $U$ on the three eastern and three western ship tracks, which was discussed in Section 4 and summarized in Table 2, is clearly evident in Fig. 22.

c. Central and eastern Pacific precipitation anomalies

The data indicate large variations in the strength and evolution of the precipitation anomaly pattern from one warm event to another. Thus, the following discussion should be viewed as describing only broadscale mean conditions.

Prior to September(-1), precipitation is below normal over the central equatorial Pacific. A sharp change toward more positive anomalies takes place west of the dateline (Ocean–Nauru Precipitation Index, Fig. 16) during November(-1)–December(-1).

Fig. 23. SST anomaly composite for May–July of year following El Niño.
Fig. 1. Time-longitude section of SST. The section follows the equator to 95°W, then follows the climatological cold axis to its intersection with the South American coast at 8°S (15). (A) Mean climatology (4). The interval from 24° to 27°C is shaded to show the annual warm tongue. (B) Composite El Niño anomalies (15). El Niño year is year 0. (C) Anomalies from 1981 to 1983. Note the larger contour interval.

Fig. 5. Sea-surface temperature patterns (contour interval, 1 K). (A) December 1982 to February 1983. (B) December-February climatology. The heaviest shading corresponds to SST's > 29°C. (C) Anomalies for December 1982 to February 1983. The heaviest shading denotes anomalies > 3 K.
Fig. 4 (A to C) Anomalies in satellite-sensed outgoing longwave radiation (OLR) (contours) and wind at 850 mbar (arrows) for three seasons during the 1982–1983 episode. Negative anomalies in OLR, indicated by the solid contours and labeled W for "wet," correspond to regions of enhanced precipitation, and vice versa (D, "dry"). Contour interval, 20 W/m² (where contours correspond to ±10, ±30, and so forth). The longest arrows correspond to wind anomalies on the order of 10 m/sec.

Fig. 6 (left). Sea level time series at selected tropical Pacific stations (46). Rabaul is typical of the western Pacific; Fanning of the central Pacific, and Callao of the South American coast. Note that sea level falls in the west and rises in the east. The changes progress eastward with time. Fig. 7 (right). Temperature sections (°C) along 85°W (47). Sections for 1981 and March 1982 illustrate normal conditions.
over the relatively cold waters of the eastern equatorial Pacific, the major atmospheric effects are associated with eastward and equatorward shifts of the convective regions located on the climatologically warm fringes of the anomaly area.

The pattern of interannual SST variability in the equatorial Pacific and its relationship to the annual cycle is illustrated in Fig. 4, which shows an SST time section spanning the

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Fig. 5. SST anomaly time sections (along the equator from 120°E to 95°W, then southeastward, to the South American coast at 8°S. Upper: Composite for 1957, 1965, 1972 episodes; lower: 1982/83 episode. Contour interval 0.5°C × 10.
Fig. 8. Same for March–May 1983.