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1982-83 El Niño in the Eastern Pacific Observed from Ships of Opportunity

Fortunately, during the 1982-83 El Niño, the equatorial eastern Pacific was covered by several experiments using research vessels, as for example EPOCS. The first results appeared in TO-AN in 1983-84 (Leetmaa *et al.*, 1983; Mangum and Hayes, 1983; and Halpern, 1984). There was also the monitoring by XBT and surface data (sea surface temperature [SST], sea surface salinity [SSS]) from ships of opportunity established by the Group SURTROPAC of the Centre ORSTOM de NOUMEA along the shipping route Tahiti or Mururoa (French Polynesia) -Panama, crossing the equator at 110° W.

To consider simultaneously the variability of the parameters with the time and space (*i.e.*, the latitude), space-time diagrams have been used with the time on the abscissa and the latitude on the ordinate. The units used are the month and one degree of latitude. The irregular distribution of the observations presents special difficulties for describing the variations with time and latitude. To obtain smoothed values of the parameters centered in each mesh which may be used for automatic contouring, a method of linear interpolation is used. This method, called Kriging, is founded on the theory of regionalized variables (Matheron 1965, 1970) and permits us to use a set of comparable situations.

At 110° W, the equatorial record of monthly mean profiles (Figure 1) shows, as already noticed by Halpern (1983), a tremendous 1982-83 anomaly in the vertical thermal structure. This anomaly was induced by the eastward propagation of several atmospheric and oceanographic variations with two groups of phase speed (Gill and Rasmusson, 1983; Donguy and Eldin, 1985) as follows:

1) sea-level and isotherm depth anomaly at 0.6-0.7 m/s;
2) westerly wind anomaly, SST, rainfall, and SSS at 0.3-0.4 m/s.

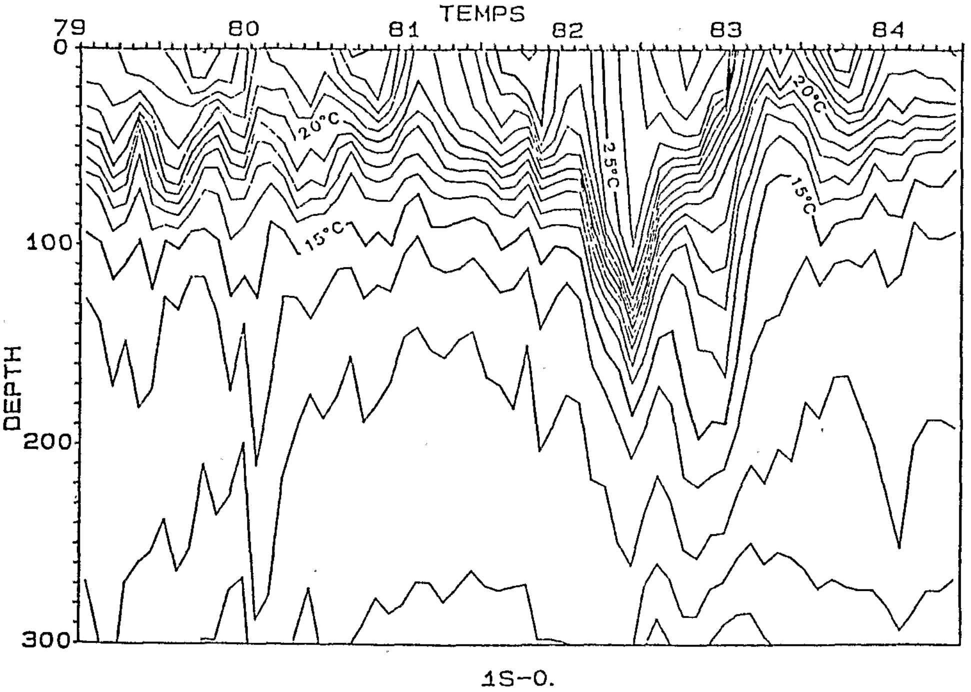

FIGURE 1 *(Donguy and Dessier)*
1979-84 isotherm fluctuations at the equator, 110° W between surface and 300m depth.

The arrival of the two waves is distinctly observed:

1) Maximum isotherm depth (Figure 1) and consequently the anomaly of mixed layer thickness (Figure 2) occurs from September to February 1983 and is also revealed at the surface by the SST anomaly centered in January 1983 (Figure 3).
2) The SSS anomaly occurs during the first half of 1983 (Figure 4) and is also associated with a second SST anomaly centered in April 1983 (Figure 3). A second isotherm depth maximum occurs also in April 1983 but appears only in isotherms colder than about 20° C (Figure 1).

Each wave is accompanied by eastward currents:

1) In December 1982 (Figure 5A), direct measurements and thermal pattern gave evidence of an eastward current at the equator from the surface to 250 m.
2) In April 1983 (Figure 5B), at the equator the current is eastward from the surface to 250 m.

The existence of two SST anomalies is consistent with results presented by Philander (1985). The deepening of isotherms observed in December, 1982, propagating across the equatorial Pacific at 0.6-0.7 m/s induces at the surface a SST positive anomaly reaching 4°C. This anomaly, in turn, increases local heating of the atmosphere and induces a westerly wind anomaly. This feature is observed in April, 1983, and causes in turn a new SST positive anomaly, accompanied by a SSS anomaly. This SSS anomaly may have a zonal origin as induced by rainfall, or a meridional origin as suggested by Figure 5 where there is a southward propagation of low SSS from the Gulf of Panama to the southern hemisphere. It is also possible that both mechanisms are working simultaneously.

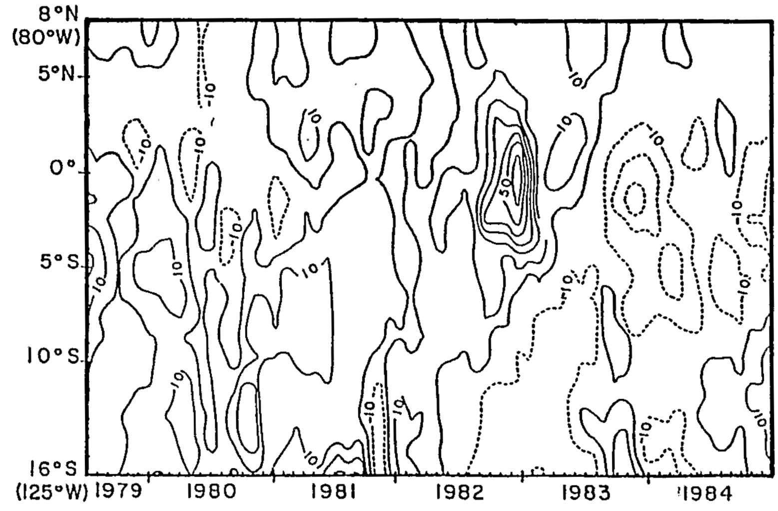

FIGURE 2 *(Donguy and Dessier)*
Anomaly of mixed layer thickness in meters along the shipping route.

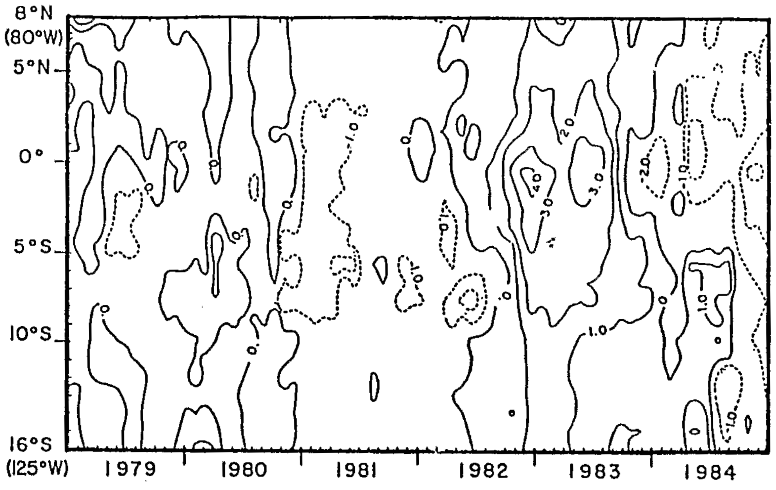

FIGURE 3 *(Donguy and Dessier)*
SST anomaly in ° C along the shipping route.

References

Donguy, J.R. and G. Eldin, 1985: Eastward propagation at the equator during the 1982-83 El Niño inferred from sea surface salinity. *Trop. Ocean-Atmos. Newslett.*, No. 32, 1-2.

Gill, A.E. and E.M. Rasmusson, 1983: The 1982-83 climate anomaly in the equatorial Pacific. *Nature*, 306 (5940), 229-234.

Halpern D., 1983: *Upper ocean current and temperature observations along the equator west of the Galápagos Islands before and during the 1982-83 ENSO event.* pp. 59-91. In Papers from the 1982-83 El Niño/Southern Oscillation Data Display Workshop, NOAA/AOML, Miami, Florida USA.

Halpern D., 1984: Upper ocean heat content in the eastern equatorial Pacific during the 1982-83 ENSO event. *Trop. Ocean-Atmos. Newslett.*, No. 24, 14-16.

Leetmaa, A., D. Behringer, J. Toole and R.L. Smith, 1983: Observations of the 1982-83 El Niño at 85° W. *Trop. Ocean-Atmos. Newslett.*, No. 21, 11-12.

Mangum, L. and S.P. Hayes, 1983: Spring 1983 profiling in the eastern Equatorial Pacific. *Trop. Ocean-Atmos. Newslett.*, No. 21, 12-13.

Matheron, G., 1965: *Les variables régionalisées et leur estimation.* Masson et Cie., 305 p.

Matheron, G., 1970: *La théorie des variables régionalisées et ses applications.* Les Cahiers du C.M.M., fasc. 5.

Philander, S.G.H., 1985: El Niño and La Niña. *J. Atmosph. Sci.*, 42(23), 2652-2662.

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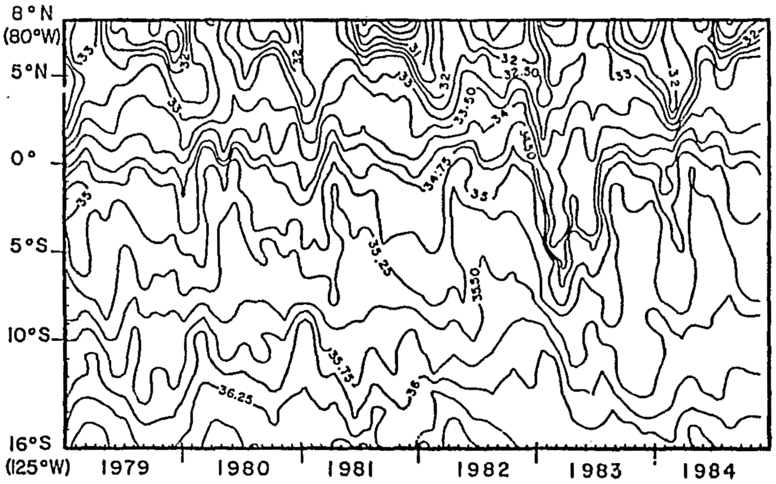
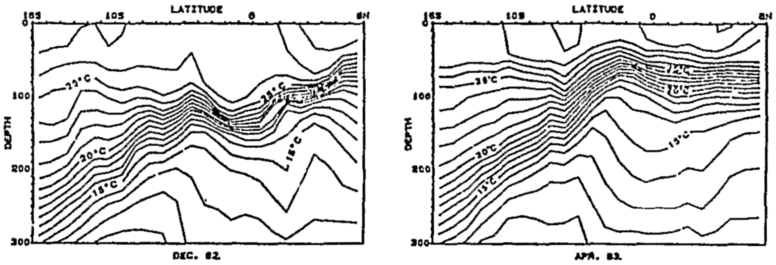


FIGURE 4 *(Donguy and Dessier)*
SSS along the shipping route.



A

B

FIGURE 5 *(Donguy and Dessier)*
Thermal structure 8° N–16° S, 80° W–135° W; (A) December 1982; (B) April 1983.

Indices of Equatorial Currents in the Central Pacific

Monitoring the variability in the strength of ocean circulation is one of the main tasks of synoptic oceanography. Because of geostrophy, flow in the ocean is intimately connected with the slope of the sea surface and, consequently, sea-level observations at given locations can be used to monitor the variable strength of the flow among such stations. A method to monitor the strength of equatorial currents in the Pacific by means of sea-level observations has been devised by Wyrtki (1974) and time-series for the period 1950 to 1970 have been published. A continuation of these time-series for the period 1970 to 1975 included the 1975 El Niño event (Wyrtki, 1977)

The method uses the mean north-south profile of dynamic height relative to 500 decibars between 140°W and 170°E in the central Pacific Ocean and disturbs it by monthly mean sea-level observed at islands. The disturbed profile is used to determine the position and dynamic height at five topographic ridges and troughs. The differences in height between successive ridges and troughs are interpreted as a measure of the strength of the respective four currents. I purposely use here the term "strength" of a current because I wish to imply that sea-level difference is an approximation not only for the geostrophic flow at the sea surface, but for transport as well. Because the entire surface layer above the thermocline is subject to the same pressure gradient, the slope of the sea surface is also a measure of the geostrophic transport in the surface layer and of its mean speed. The relations between surface slope, geostrophic transport, and thermocline slope have been investigated by Tang (1985), and high correlations have been found among these.

Kessler and Taft (1986) have also shown that volume transports, dynamic height differences, and sea-level differences are highly correlated in the equatorial Pacific. These authors concluded that indices based on XBT data are better approximations of the volume transports than are sea-level differences; XBT sections allow the de-