Expendable Bathythermograph Sections, 1972-79

Temperature profiles are made at irregular intervals of time throughout the Pacific Ocean along standard ship routes using expendable bathythermographs (XBT) deployed from ships-of-opportunity. Since 1972 NOAA's Pacific Environmental Group (PEG) has processed and archived these data. The data, initially received in analog trace form, are digitized and processed utilizing the Navy's Fleet Numerical Oceanography Center's (FNOC) computer facilities. Various computer products utilizing these data are available to interested scientists including tape copies of the digitized measurements. Data recorded from 1972 to 1979 between about 20°N and the equator between 140°W and 180° (Figure 1) will be used to describe the time-variations of the transport of the North Equatorial Current (NEC) between ~ 11°N and 20°N and the transport of the North Equatorial Countercurrent (NECC) (usually found between 4°N and 11°N). These data provide a continuation of the Wyrtki *et al.* (1977) measurements.

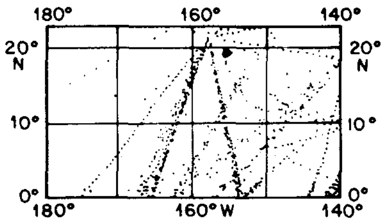

FIGURE 1 *(McLain & Favorite)*
Location of XBT data.

Because of the intense thermocline in the equatorial waters, the ocean can be approximated as a 2-layer system with the lower layer at rest. Wyrtki and Kendall (1967) showed that for such a simplified case, it is possible to estimate the transports of the currents using only the depths of selected isotherms in the thermocline near the northern and southern edges of each current and the density difference between the upper and lower layers. The equation contains two terms: the depth difference of the isotherm across the current (related to the slope of the thermocline), and the mean depth of the isotherm (related to the thickness of the surface layer). Time variations of the transport computed from each individual XBT section are shown in Figure 2. The mean annual cycles of the transports were computed from an average of the monthly values shown in Figure 2.

The mean depth of the 14°C isotherm in the NEC varied from 153 m in August to 209 m in January, the mean depth difference (slope of the isotherm) varied from 103 m in July to 176 m in January, and the resulting monthly mean transport varied from 11.4 Sv (1 Sv = 1 x 10^6 m^3 s^{-1}) in July to 24.2 SV in January (Figure 2A). This compared with a range of individual transports of 13.8 Sv to 19.1 Sv found by Wyrtki *et al.* (1977). The greater range found in this study may be due to the increased number of XBT sections now available.

The mean depth of the 20°C isotherm in the NECC was relatively constant, varying from 99 m in April to 123 m in January, the mean depth difference (slope) varied from 43 m in July to 111 m in November, and the mean transport varied from 11.2 Sv in July to a peak of 32.5 Sv in November (Figure 2B).

We believe that these data adequately re-

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Low Frequency Variability in the Atlantic

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and $\left\{\partial\sigma/=(gh)^{1/2}\right\}$ and $\left\{\partial\sigma/\partial m=\sigma(gh)^{1/2}/N\right\}$, for Kelvin waves, where σ is wave frequency, k is horizontal wavenumber, m is vertical wavenumber and N is buoyancy frequency. Using the scales from Figure 3, Table 1 gives component estimates, travel times to the observational depth, and zonal distance traversed.

TABLE 1 *(Weisberg & Horigan)*

Group velocity component estimates for long and short Rossby waves and for a Kelvin wave (using values from Figure 3), the associated travel times for energy to propagate 1000 m vertically with N = 0.002 s^{-1}, and the corresponding zonal distance traversed during this time.

	$\frac{\partial\sigma}{\partial k}$ cm s^{-1}	$\frac{\partial\sigma}{\partial m}$ cm s^{-1}	ΔT (1000 m) days	ΔX km
Long	− 3.0	-2.2×10^{-3}	526	− 1390
Short	+ 0.5	-3.6×10^{-4}	3215	1360
Kelvin	+ 14.0	-2.5×10^{-3}	463	5600

Kelvin waves, if generated near the surface in the western Atlantic, travel sufficiently fast to reflect off an eastern boundary becoming long Rossby waves before reaching the observational depth. Therefore, a predominance of linear Kelvin waves seems unlikely. Long and short Rossby waves have oppositely directed zonal group speeds. For a given vertical distance they traverse similar zonal distances with the longer waves moving much faster. Short Rossby waves arriving at the observational site would be generated in the central portion of the Atlantic since their energy flux is eastward.

An interesting finding is the relatively narrow vertical wavenumber bandwidth. Generation of narrow band waves by reflection is not expected, whereas generation by wave drag or instability would be expected to produce narrow band packets. Short Rossby waves are consistent with this type of generation since the eastward directed Equatorial Undercurrent is the principal momentum source on the equator.

Regardless of the above conjectures, a significant problem exists. The maximum zonal phase speeds for Kelvin and long Rossby waves are $(gh)^{1/2}$ and $(gh/3)^{1/2}$ respectively. Short Rossby waves are slower. Given the small observed vertical scales, with $(gh)^{1/2}$ = 14 cm s^{-1}, relative to the observed u component amplitudes, it appears that the low frequency zonal oscillations are intrinsically nonlinear (also suggested by Eriksen, 1980).

In summary, statistically and physically distinct low frequency v and u component behavior has been observed. The v component oscillations appear as linear, seasonally modulated expressions of nonlinearly induced waves. The u component oscillations appear as nonlinear features of unknown origin. Zonal scale information as well as theoretical guidance is needed.

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SST Fronts and Eddies

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PAX drifting buoys were deployed in the central Pacific (Patzert and McNally, see *TO-AN No. 3*, July 1980) some of which drifted along with the NECC. All buoys displayed wave-like trajectories except buoy 2807 which became trapped in an eddy-like clockwise circulation for approximately 45 days. Our SST analysis shows an anomalous high in the same region at the same time, suggesting the existence of a gyre. Figure 3 shows the station data (dots), SST contours (solid lines), and part of the buoy tracks (dashed lines). Unfortunately, there is not enough data in hand to explain convincingly the coincidence between the SST-anomalies and the eddy-like buoy tracks, but the data suggest the existence of eddies in the region between the SEC and the NECC.

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Index

An index of the contents and contributors to the first year's editions of the newsletter follows on page 15. The January issue of TO-AN will regularly feature an index of the previous year's manuscripts and authors.

The Editors

Expendable Bathythermographs

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solve the mean annual cycle of the transports of the NEC and the NECC. Sampling density is insufficient, however, to adequately resolve interannual fluctuations such as the effects of the El Niño phenomena. Sampling for several years at the rate obtained in 1979 would probably be necessary to resolve such interannual fluctuations.

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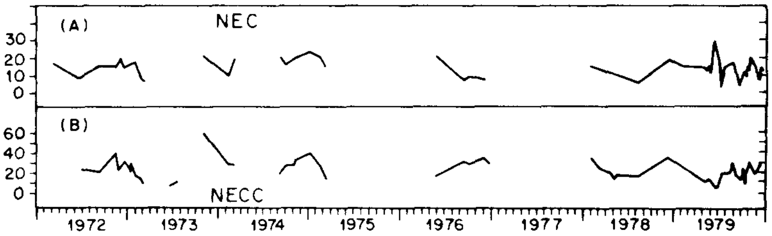

FIGURE 2 (*McLain & Favorite*)
Transports of the (A) North Equatorial Current and the (B) North Equatorial Countercurrent.

MEETINGS

EPOCS Meeting, 3-5 February 1981, Boulder Colorado

The third annual meeting of the EPOCS Co-Principal Investigators, 3-4 February, and the fourth annual meeting of the EPOCS Advisory Panel, 5 February, will be held in Boulder. Contact: Dr. Kent L. Groninger, Office of Programs, Environmental Research Laboratories, NOAA, Boulder, Colorado 80303 (tel: 303-449-1000-ext 6212).

SCOR WG 47, FGGE Oceanography, 27-30 April 1981, Venice, Italy

Reseachers will report oceanographic results found in the equatorial Atlantic, Indian and Pacific Oceans during the Global Weather Experiment. Similarities and differences of the equatorial regions will be highlighted. Contact: Dr. Jay McCreary, Nova University Ocean Sciences Center, 8000 North Ocean Drive, Dania, Florida 33004 (tel: 305-475-7487).

SCOR WG 56, Equatorial Upwelling Processes, 5-7 May 1981, Paris, France

The second combined meeting of the Biological and Physical Panels will be held 5-7 May 1981 in Paris, France. Contact: Dr. Henri Rotschi, Centre de Recherches Oceanographiques, ORSTOM, 29 Rue des Pecheurs, B.P.V. 18, Abidjan, Ivory Coast (tel: 35-50-14).

Notices

A bibliography of research on the phenomenon of upwelling has been prepared by Dr. A.F. Anto and Dr. V.V.R. Varadachari. This bibliography contains most of the publications on physical, chemical, biological and geological aspects of upwelling published between 1890 and 1977. Please send requests to Dr. A.F. Anto, National Intstitute of Oceanography, Dona Paula, 403 004 Goa, India.

A bibliography of research on the physical processes in the equatorial regions of the oceans has been compiled by Ms. Janet Witte. Please send requests to Ms. Janet Witte, Nova University Ocean Sciences Center, 8000 North Ocean Drive, Dania, Florida 33004.

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