Eddy Structure in the Central South Pacific Ocean

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ABSTRACT

Two west-to-east temperature sections (~2500 km in length) have been constructed from closely spaced (~37 km) XBT measurements in the central South Pacific collected during Legs J and K of the Pacific GEOSECS Expedition. For those portions of track passing through the islands of the Tuamotu Archipelago, the main thermocline exhibited 50 m station-to-station variability on a scale too short to be resolved. In the open ocean away from these islands, the variability was smaller, 10–20 m, with only one 200 km scale eddy spatially resolved.

1. Measurements

There was an opportunity to utilize some ship time for simple underway data collection on Legs J and K of the GEOSECS Pacific Expedition, aboard the R/V *Melville* in April and May, 1974. The cruise tracks included two lines running eastward for 6 days from PaPeete, Tahiti (18°S, 150°W) to near 126°W, a distance of approximately 2500 km (Figs. 1a and 1b). Arrangements were made for one of the authors (W.C.P.) to be aboard on Leg J during April 1974 to conduct an intensive sampling program consisting of soundings using expendable bathythermographs (Sippican T-7 XBT probes) to 750 m and the gathering of surface temperatures and salinities during the 6-day run (Figs. 1e and 1f). One month later, during May 1974, the same program was repeated along the eastward track of Leg K (Figs. 1c and 1d). The XBT probes were launched at 2 h intervals which translated to approximately 37 km spacing. Our results are worthy of reporting in that the low costs and simple techniques used here have yielded new information that could easily be repeated elsewhere.

Unlike many locations in the world's oceans the central South Pacific might be expected to be comparatively simple in structure. The mean flow is thought to be a slow westward flow under the influence of the steady southeast trade winds. The literature contains very little information about the variations in the upper layer structure in this region. As can be seen in Fig. 1a, the two cruise tracks were located near the center of the South Pacific anticyclonic gyre, in a region of weak westerly flow. Here the water masses are horizontally quite homogeneous. Vertically, the temperature within the main thermocline decreases almost linearly from below the mixed layer to almost 400 m. The objective of our experiment was to investigate the magnitude and scales of perturbations within this main thermocline.

2. Discussion

By inspection of Fig. 1, we note that both temperature sections have several characteristics in common. Both appear "noisier" in their western halves, downstream and within the low islands of the Tuamout Archipelago. In the main thermocline, station-to-station variations of approximately 50 m occur. Thus the islands may be generating this small-scale variability which is not well resolved by the 37 km sampling. A variety of atmospheric and oceanic mechanisms have been observed to induce oceanic disturbances near islands (Chopra, 1973). Another possibility is oceanic wakes generated by the mean flow past islands (Barkley, 1972), with eddy scales comparable to island dimensions. Station spacing and island sizes are similar (Fig. 1b).

In the eastern halves, on the other hand, both fields are considerably quieter. Station-to-station variations of 10–20 m are typical. Only a single significant disturbance occurs in each leg. In Leg K the disturbance at 133°W is well resolved (200 km scale), while in Leg J at 129°W it is not. The relative absence of eddy activity (away from island influences) should be contrasted with reports from other areas where the eddy field is more energetic (Hamon and Cresswell, 1972; Koshlyakov and Grachev, 1973; Bernstein and White, 1974; Robinson *et al.*, 1975). On the basis of our observations, it is likely that the wavelength and amplitude of the oceanic eddy field varies substantially in the world's oceans.

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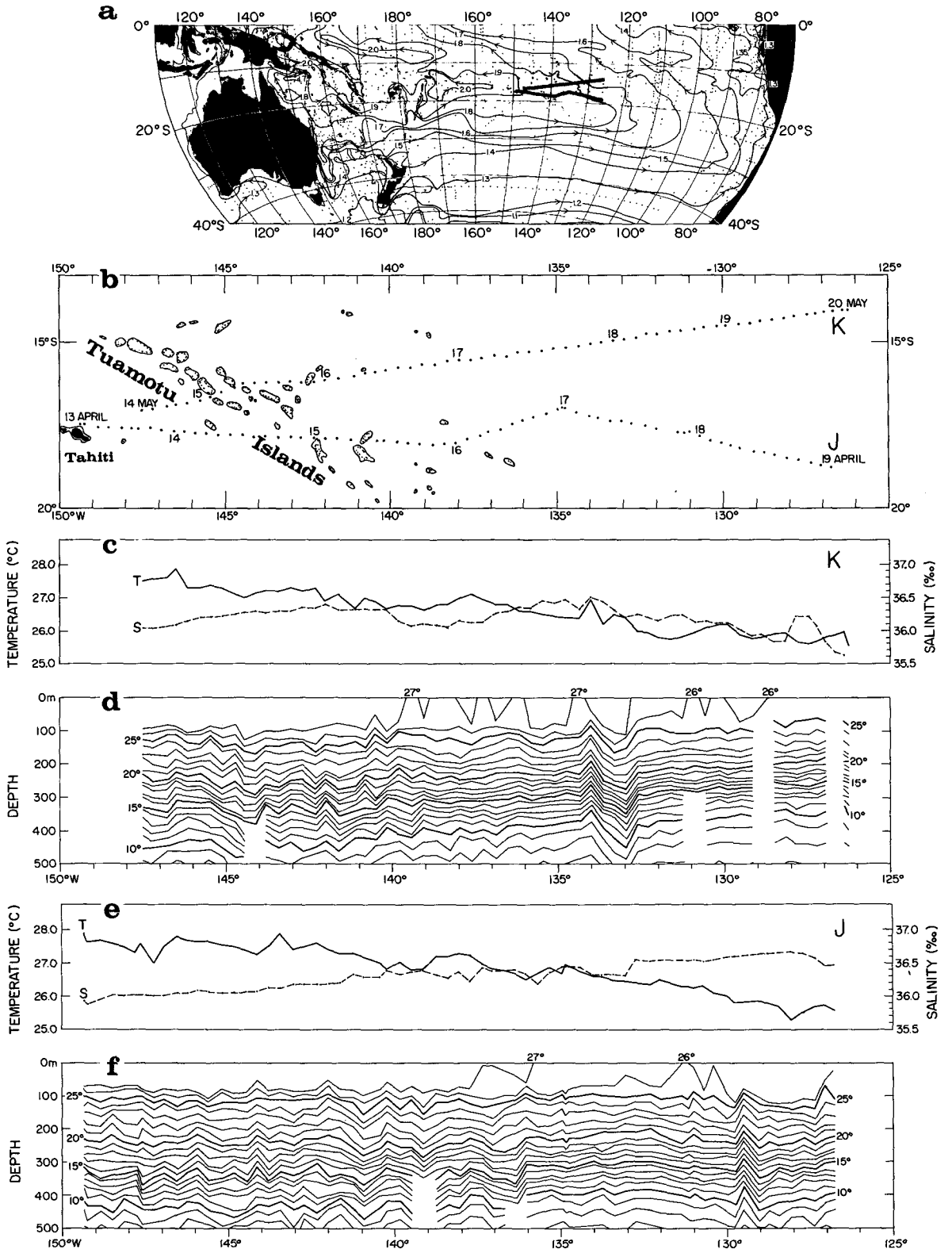

FIG. 1a. Geopotential anomaly 0/1000 db (contour intervals are 1.0 J kg^{-1}, 0.1 dynamic m) for northern winter from Reid and Arthur (1975) with cruise tracks of Legs J and K of GEOSECS Expedition indicated by heavy dashes.

FIG. 1b. Station locations of bucket samples and XBT launches along Legs J and K with islands and 1000 m depth contour included.

FIG. 1c. Surface temperatures and salinities measured from bucket samples along Leg K cruise track.

FIG. 1d. Temperature (°C) section as measured by 2 h XBT launches along Leg K cruise track (blank areas indicate XBT malfunction).

FIG. 1e. As in 1c except for Leg J.

FIG. 1f. As in 1d except for Leg J.

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