GEOSTROPHIC TRANSPORT CALCULATIONS IN THE CENTRAL PACIFIC BASED ON THE SHIP-OF-OPPORTUNITY XBT LINES

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Since 1979 a joint U.S.-France program has deployed XBT's from ships-of-opportunity in the tropical Pacific. For this presentation data has been used from the central Pacific from an area bounded by 15°S to 20°N and 150°W to 170°W for the period February 1982 through May 1983.

The data were processed by averaging each month of data into blocks 2° of latitude by 20° of longitude and 10 m depth. An average of 2.6 casts went into each block. Eleven out of the total of 218 blocks are composed entirely of interpolated data. The most data-sparse region was south of 6°S.

The mean T-S relationship from the pre-FGGE Shuttle was used to get salinities for these initial dynamic computations. Later analyses will look more carefully into alternate relationships. Dynamic heights, zonal geostrophic velocities, and transports were computed. The effects of non-zonality and the fact that the ship tracks were not meridional were neglected. The mean dynamic topography between February 1982 and May 1983 is shown in Figure 1. Shown are the latitudes of the well-known ridges and troughs and the mean meridional pressure gradients that balance the zonal currents.

The monthly variation of dynamic height at these ridges and troughs is shown in Figure 2. The north equatorial ridge (NER) showed little or no seasonal or El Nino variation. The variance of the height of the ridge is about 1.7 times that observed during FGGE, but consists of short events with no trends. The climatological signal also shows small seasonal variance. Climatological dynamic height values tend to be slightly higher during the second half of the year, which is what was also observed in 1982-1983.

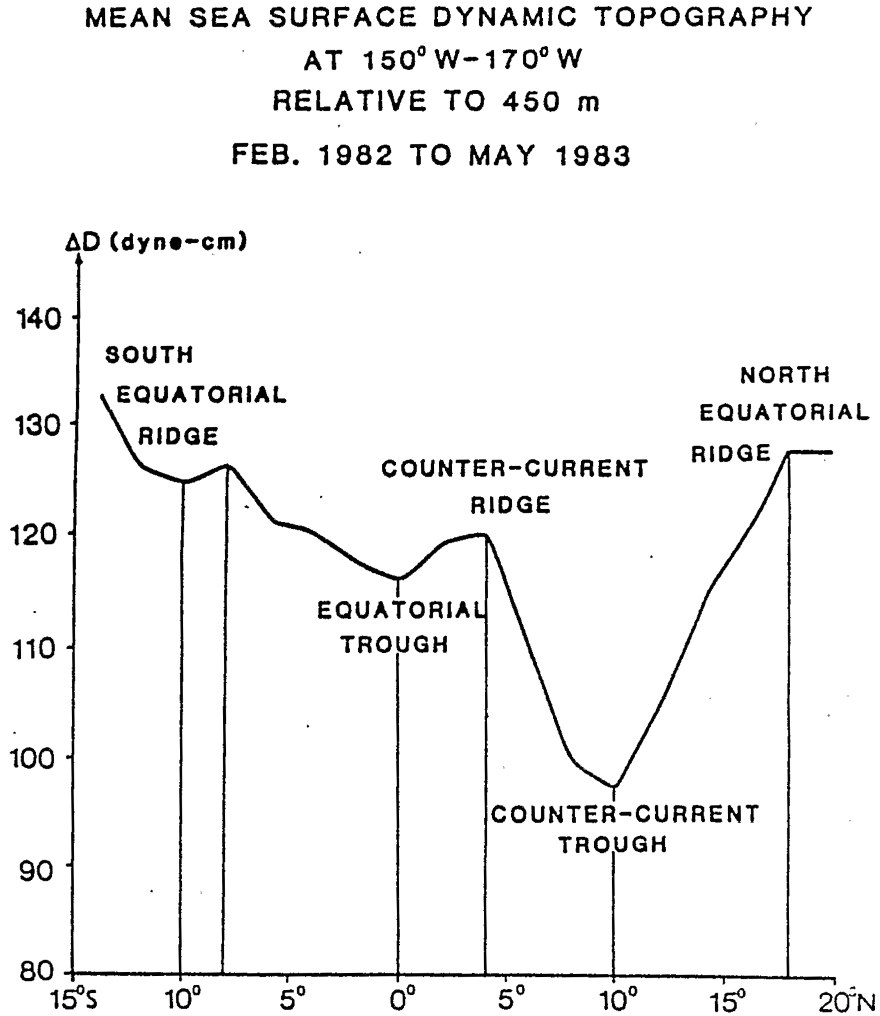

Figure 1

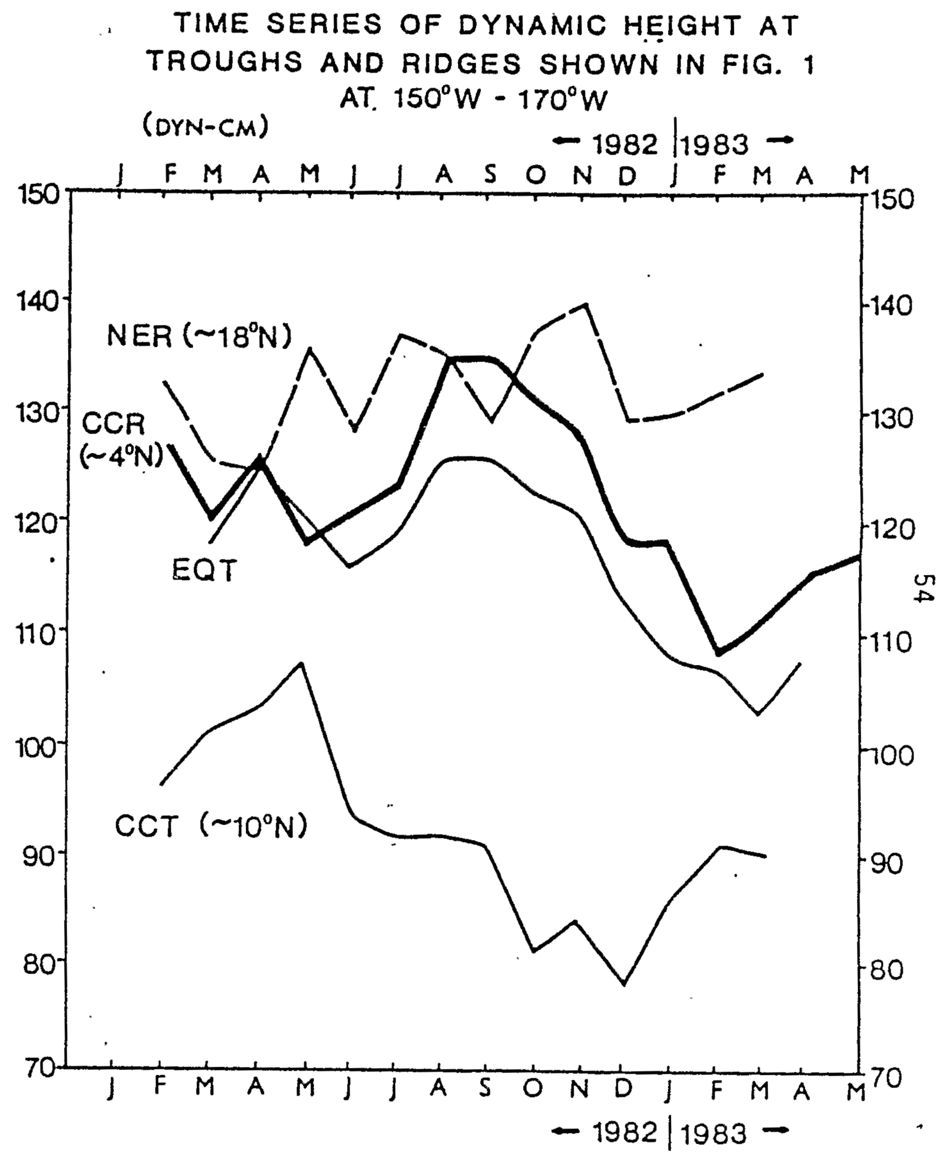

Figure 2

As contrasted with the NER, the other ridges and troughs show strong El Nino related signals. The counter-current trough (CCT) at about 10°N drops strongly first in May 1982 and then again in September, falling a total of 30 dyn-cm. Climatologically the seasonal signal is strong with an amplitude of about 12 dyn-cm. The seasonal fall occurs in August-September. During the FGGE Shuttle in 1979 the range of variation was 20 dyn-cm and the fall occurred between May and September. Thus the 1982-1983 pattern looks like an exaggerated normal cycle. In early 1983 the CCT recovered to a more normal height. The effect of the two drops in the CCT was to increase the volume transport of the NEC by about 13 x $10^6 m^3/s$, to a high of 25 Sv in November 1982 (1 Sv = $10^6 m^3/s$).

The countercurrent ridge (CCR) and the equatorial trough (EQT) show similar variability. A strong rise of 10-15 dyn-cm in August-September and a 25 dyn-cm fall after November 1982 to February 1983. The correlation coefficient between dynamic heights of these two features is 0.9. Similar high correlations are found between these two features climatologically and during the FGGE Shuttle. However, the variance of ridge height during the Shuttle was only 40% as great as for the '82-'83 period. Between June and September, the rise in CCR, coupled with a constant CCT, results in a doubling of the geostrophic transport of the North Equatorial Current (NECC) to a high 9f 44 Sv. As the CCT recovers and CCR continues to drop, the NECC transport falls to a low of 5 Sv in April 1983.

Scaling these CCR-CCT height differences by 10/f allows an intercomparison to be made with Wyrtki's climatology and with the Shuttle results for a pseudo-transport of the NECC [this quantity needs to be multiplied by a depth to get to transport numbers (Figure 3)]. All three curves look similar.

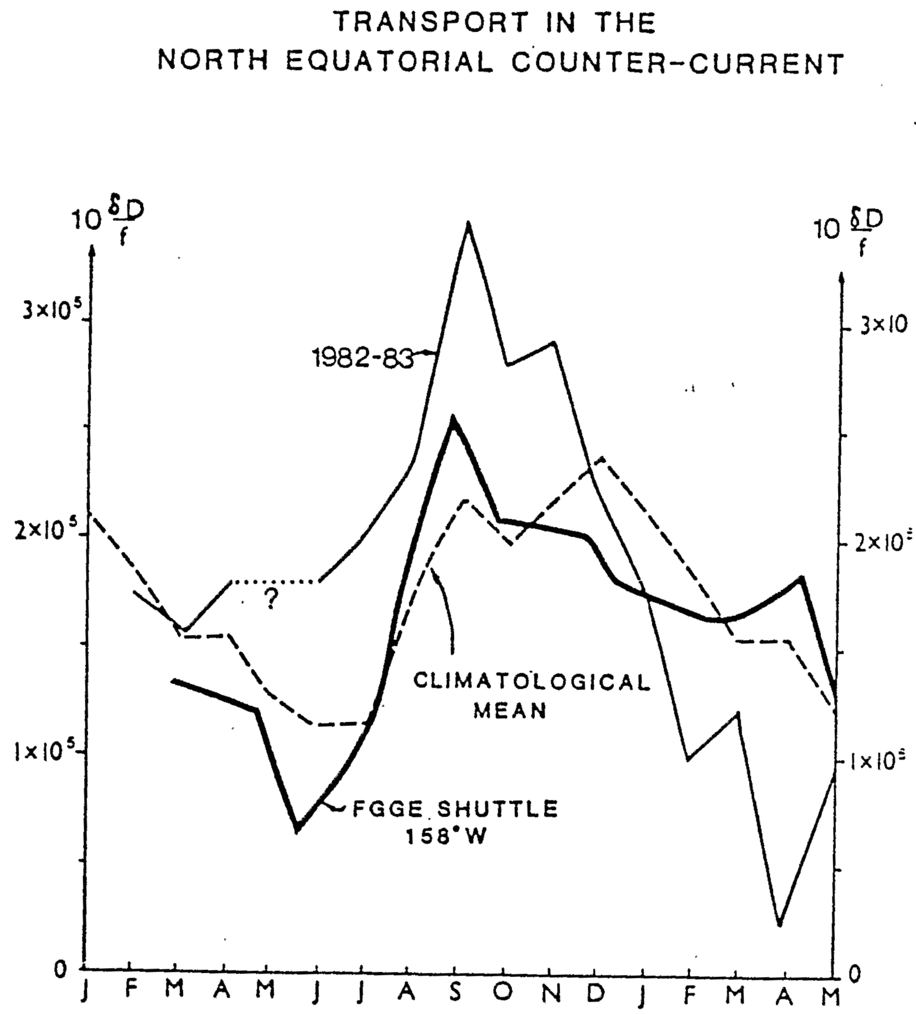

Figure 3 CLIMATOLOGY FROM WYRTKI (1974)

During the Shuttle the NECC transport never got above 33 Sv so that the peak 1982 value of 44 Sv was about 30% higher than during FGGE which was similar in pattern and magnitude to climatology. The 1982-1983 peak seems to be narrower than these other records.

An empirical orthogonal function decomposition of the meridional dynamic height variability shows the large-scale patterns of variation and their time variability (Figure 4). The first EOF represents 54% of the total variance and shows that the field from 6°S to 4°N fluctuates in concert. This EOF accounts for only about 10% of the variance at 10°-12°N in the CCT region, but 80% or more south of 4°N. The time variation of its amplitude shows the positive pulse starting in August and the turn towards negative in November. The second EOF, by contrast, accounts for 31% of the total variance. It shows less than 20% of the variance in the near-equatorial region, but about 80% at 10°-12°N at the CCT. The time variation of this EOF might be interpreted as the annual signal. Also it is similar to that for EOF1 lagged by four months. The rise at the CCT as shown by EOF2 occurs in May-June or before that close to the equator (EOF1) which occurs in July-August.

The last item I will mention is the mixed-layer temperature field observed at 150°-170°W during the Shuttle and in 1982-1983. During the Shuttle, warmer water than 28°C was almost always found a couple of degrees off the equator. In Figure 5 is shown the depth of the 28°C isotherm during 1982-1983. In contrast to the measurements in 1979-1980, during 1982-1983, 28°C water stretched across the equator. The temperature rose first (as indicated by its volume) in April and then again in July. The rise in April is one of the earliest indicators that something unusual was about to happen.

Reference

Wyrtki, K. (1974): The dynamic topography of the Pacific Ocean and its fluctuations. Hawaii Inst. of Geophysics, 1416-74-5, 19 pp. + 37 figures.

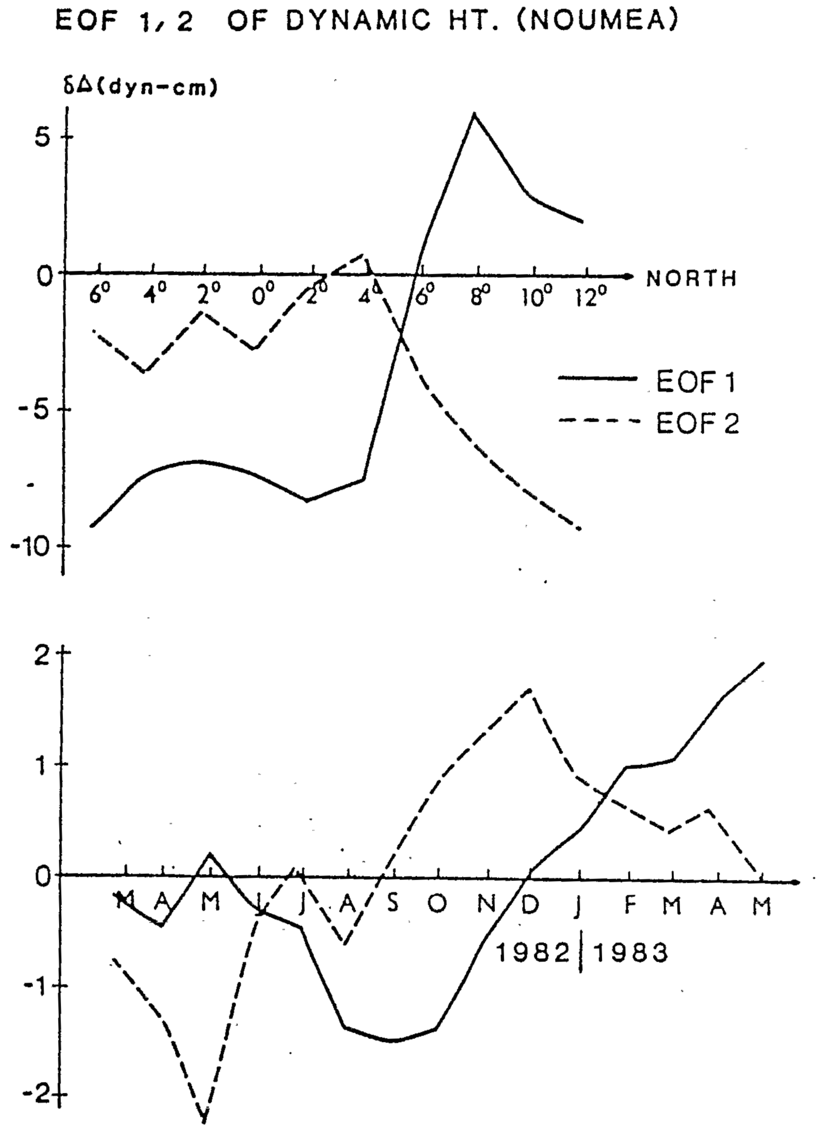

Figure 4

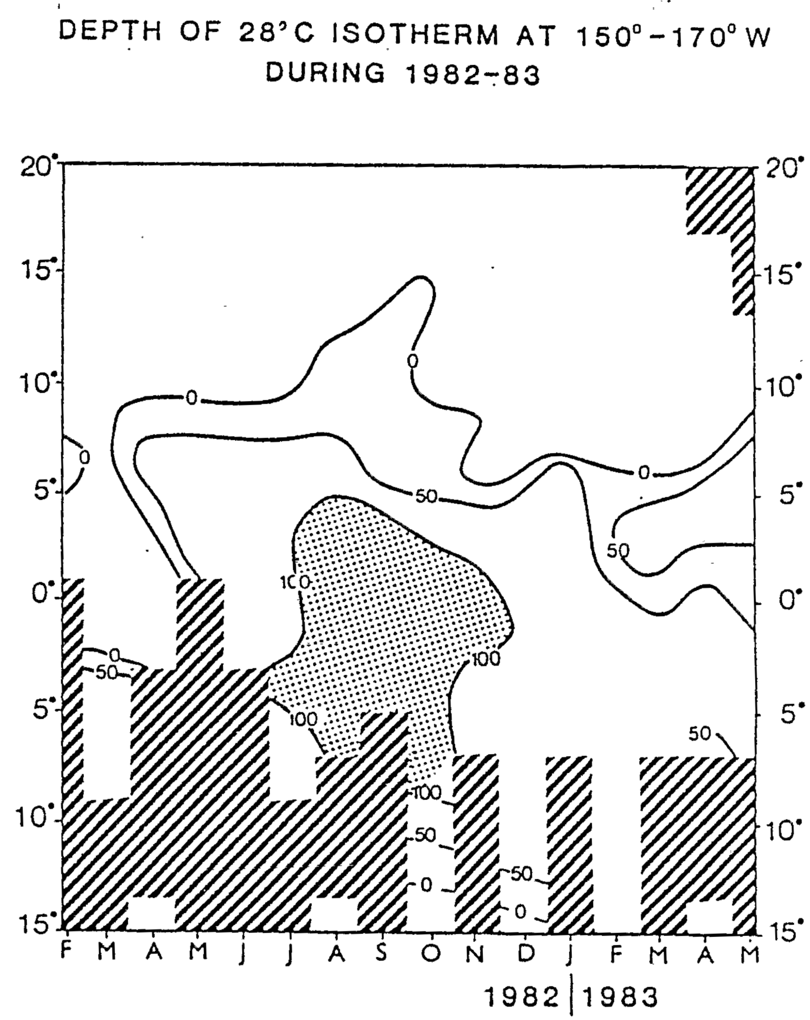

Figure 5

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(ABSTRACT)

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From ship-of-opportunity XBT data in the Central Pacific, dynamic calculations have been made. Dynamic height at troughs and ridges have been considered mainly during the 1982-83 EL-Nino. The North Equatorial Counter Current transport get a peak value in September 1982 (44 Sverdrup). Comparison of the ship of opportunity data is made with the climatological mean and the FGGE shuttle ones.

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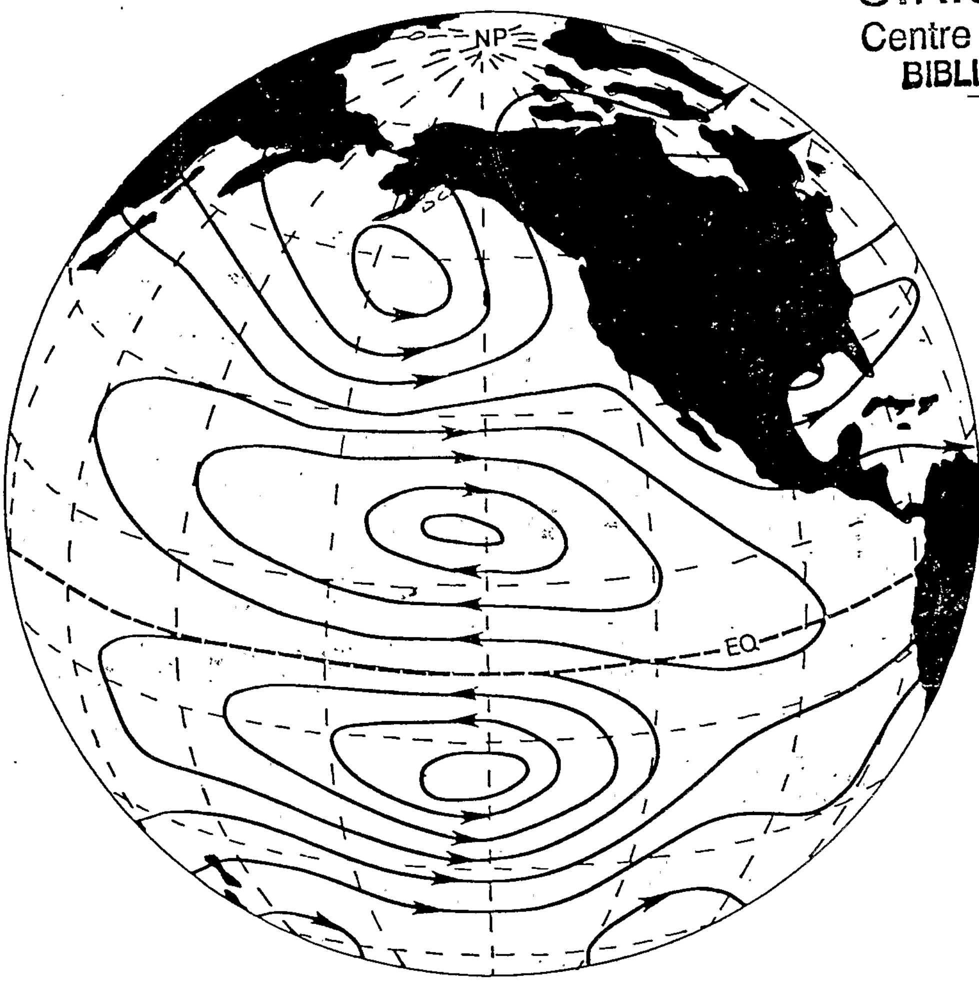

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