THERMAL AND CURRENT VARIABILITIES DURING 1979-85 IN THE WESTERN AND CENTRAL TROPICAL PACIFIC DEDUCED FROM XBT DATA

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INTRODUCTION

Since its beginning in mid 1979, the tropical Pacific XBT Ship of Opportunity network, maintained by ORSTOM and Scripps Institution of Oceanography, has been used intensively, either for descriptive, model validation, model data assimilation or satellite validation studies. However, sampling gaps in space and time so far prevented to built accurate space/time series with such data set. Over the January 1979-December 1985 period, we have been able to extend the original XBT data set from 15,683 to 45,118 temperature profiles, thanks to additional hydrocasts, CTD and many XBT data kindly provided by Japanese, Australian, U.S. and French agencies. With this updated data set, two complementary studies, focused on the 1982-83 El Nino, have been carried out by the ORSTOM-Nouméa SURTROPAC group in regions where the data density is by far the greatest. Delcroix and Henin (1989) have investigated the thermo-haline variabilities in the south western tropical Pacific (SWTP). Picaut and Tournier (1989) have estimated the geostrophic zonal current variabilities along the major western Pacific (WP) New Caledonia-Japan and central Pacific (CP) Fiji-Hawaii mean shipping tracks, which are nearly north-south oriented.

DATA PROCESSING AND VALIDATION

All the temperature profiles are submitted to a series of very effective quality control tests, at first over the whole tropical Pacific, then over the SWTP region and WP and CP mean transects. A four dimensional grid over the SWTP region (160°E-140°W, 24°S-10°S) and three dimensional grids over the WP and CP transects (20°N-20°S) are built using specific objective analyses and Fourier filtering techniques. Dynamic height relative to 400db are then calculated from the mean T-S Levitus (1982) Atlas file. Along the two mean transects the zonal geostrophic currents are calculated, off the equator with the classical first derivative equation of the meridional pressure field, and right at the equator with the second derivative (Tsuchiya, 1955). Due to the frequent presence of a cross-equatorial pressure field which destroys the geostrophic balance very close to the equator, a specific technique is designed in order to ensure the continuity between the first and second derivative current results in the vicinity and at the equator. The validity and adjustment of the geostrophic currents obtained over the 1979-84 period (1985 is omitted because of data gaps) are positively tested through intercomparisons with direct current measured in the western Pacific taken during the TOGA-SURTROPAC experiment (Delcroix et al., 1987) and in the central Pacific during the Hawaii-Tahiti Shuttle experiment (Wyrtki et al., 1981) and the LIPP-PEQUOD experiment (Firing, 1987).

THERMAL AND GEOSTROPHIC CURRENT STRUCTURE VARIATIONS

The variability associated with the seasonal cycle and the 1982-83 El Nino, is restricted to a relatively large 15°N-15°S area for the thermal structure, whereas it is mostly confined to the 3°N-3°S equatorial band for the geostrophic current structure. A good part of the extra equatorial thermal variability is induced by local Ekman pumping. Out of the SWTP region and of the WP and CP transects, the most important thermocline displacement occurs during El Nino in the south western Pacific around 5°S-12°S with a maximum vertical movement of 90m. In their SWTP study, Delcroix and Henin (1989) have clearly showed that such El Nino thermal displacement is due to the wind stress curl associated with the equatorial wind reversal in early 1983. In the SWTP region the normal seasonal thermocline cycle displacement is mostly due to the change of wind stress curl associated with the seasonal migration of the South Pacific Convergence Zone. Most of the extra equatorial thermocline displacements induce relatively important seasonal and El Nino variations in the South Equatorial Countercurrent and in the North Equatorial Countercurrent. However, the largest geostrophic current variations are equatorially trapped. Along the CP transect, such equatorially trapped structure is mostly due to the vertical displacement of the Equatorial Undercurrent core. Over the WP track, this trapped structure is also associated with the variability of currents in the surface layer.

GEOSTROPHIC AND EKMAN CURRENT TRANSPORT VARIATIONS

Variations and their possible mechanisms of zonal, meridional geostrophic and Ekman current transports, between the central and western tropical Pacific, is discussed through a box model study. The box is defined between the WP and CP tracks, two northern and southern boundaries and the pycnocline depth. It appears that the volume transport within this box is dominated by zonal geostrophic transport in the western equatorial Pacific. Such box study evidences the compensation between an Ekman divergence and geostrophic convergence during the non El Nino period. During the second half of 1982, the normal east-west surface slope along the equator reverses and induces a geostrophic divergence compensated by an Ekman convergence. This Ekman convergence is due to the appearance of strong westerly winds along the equator, which initiate that way the 1982-83 El Nino. The reversal of the zonal surface slope extends down to the Equatorial Undercurrent and explains its simultaneous disappearance, in Fall 1982, in the western and central Pacific. More generally, over the 1979-84 period, the zonal pressure gradient between WP and CP explains about half the average Equatorial Undercurrent geostrophic transport variations along WP and CP. This observational study supports the Equatorial Undercurrent zonal pressure mechanism proposed first by Veronis (1960).

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