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The 1978 Occurrence of High Sea Surface Salinity in the Eastern Coral Sea

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Long-term changes in sea surface salinity in the Coral Sea, including high salinity values occurring in the periods 1957-58 and 1972-73, have been described by Donguy and Henin (1975). These phenomena were related to the El Niño events along the western coast of South America (Donguy and Henin, 1981). During these periods the Intertropical Convergence Zone (ITCZ) was on the equator and the eastward flowing South Equatorial Countercurrent (SECC) was particularly noticeable north of 10°S. South of this latitude a strong westward current advected high salinity waters. At the same time, drastic drought conditions occurred in southwest Pacific countries.

During 1978, when high sea surface salinities were observed (Figure1) in the eastern Coral Sea, the El Niño phenomenon did not occur in the eastern Pacific Ocean. In this note an attempt is made to determine whether changes in the current system explain the salinity variation. Generally, in the southwest Pacific Ocean, eastward flows carry low salinity water and westward flows transport saltier water.

The mean height of the surface dynamic topography relative to 1000 decibars is quite variable in the Coral Sea. A zonal ridge is commonly observed near 15-18°S, inducing an eastward flow on the south side (the South Tropical Countercurrent, STCC), a westward flow on the north side (the South Equatorial Current, SEC) and the eastward flowing South Equatorial Countercurrent (SECC) which passes through the Solomon Archipelago.

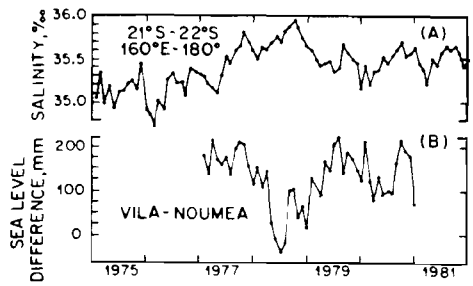

FIGURE 1 *(Henin)*

(A) Monthly mean sea surface salinities recorded 1975-81 by merchant ships between 21°S-22°S and 160°E-180°. (B) Monthly mean sea level differences between Vila (17°26.4'S, 168°11.4'E) and Noumea (22°10.8'S, 166°15.6'E) during 1977 to 1981.

Scarcity of hydrological casts in the Coral Sea prompted the development of data collection using XBT measurements from merchant ships. In this way, data have been collected routinely along shipping lanes between New Caledonia and Japan, New Guinea, Vanuatu and Fiji (Meyers and Donguy, 1980). However, the XBT program only became operational in 1979, so no data are available to infer the current system during 1978 when the high salinities were observed.

The relationship between monthly mean values of dynamic height and sea level in tropical areas (Wyrtki, 1980) was exploited to monitor the current system variations in the Coral Sea. Sea level data from three stations were used. Honiara (Solomon Islands) lies in the dynamic trough between the SECC and the SEC. Vila (Vanuatu) is located either on the ridge between SEC and STCC or on the north side of the eastward STCC. Noumea (New Caledonia) has always been observed to be in the STCC.

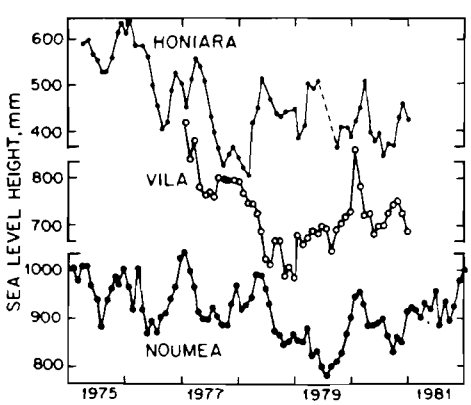

FIGURE 2 *(Henin)*

Monthly mean sea level values recorded at Honiara (9°15.6'S, 159°34.2'E), Vila (17°26.4'S, 168°11.4'E) and Noumea (22°10.8'S, 166°15.6'E).

Because of the uncertain location of the ridge between 15°S and 18°S, the sea level difference is significant only between Vila and Noumea, which are always in the south eastward flux. Available time series of mean sea levels for the 1975-81 period are shown in Figure 2. Using harmonic analysis, Wyrtki (1980) showed annual and semi-annual sea level variations at Honiara and Noumea. These variations are masked by a southward travelling low sea level disturbance which was recorded in late 1977 at Honiara, in late 1978 at Vila and in mid 1979 at Noumea. In order to eliminate the variations of periods shorter than one year, a twelve month running mean was used before computing cross-correlation coefficients between Honiara and Vila, Vila and Noumea, and Honiara and Noumea. The largest correlation coefficients were obtained at lags of 11 months for Honiara-Vila, 5 for Vila-Noumea and 16 for Honiara-Noumea, indicating a southward movement of the low sea level disturbance of about 4 cm s^{-1}.

The geostrophic flow between stations is related to the difference of dynamic heights at these locations, so the relationship between dynamic height and monthly mean sea level allows us to use the difference of monthly mean sea level between two islands to monitor the magnitude of the geostrophic transport. Thus, the southward travelling low sea level disturbance observed in the Coral Sea produces a change in the current strength.

The sea level difference between Vila and Noumea (Figure 1), which is representative of the magnitude of the eastward flowing STCC, shows a very well marked minimum in 1978, which coincides with the sea surface salinity maximum near 21°S-22°S. Normally the eastward STCC carries low salinity water and moves at an average speed of 25 cm s^{-1}. However, in 1978 the rate of flow was considerably weaker, about 5 cm s^{-1}. It therefore seems that the higher salinities observed are a consequence of the smaller volume of low salinity waters being carried to the Coral Sea. The origin of the southward moving low sea level disturbance has not yet been elucidated.

References

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Christian Henin
O.R.S.T.O.M.
B. P. A5
Noumea Cedex
New Caledonia