Sea Level Variations in the Gulf of Guinea

Daily sea surface temperatures (SST) measurements and continuous sea level data have been recorded since 1963 at Tema (6°N, 0°) by Ghana's Fishery Research Unit (F.R.U.) and Hydrographic Service. For nearly 15 years the Abidjan-based Office de le Recherche Scientifique et Technique Outre-Mer (ORSTOM) has measured the vertical distribution of temperature and salinity twice a week in water 30 m deep 4 km west of Abidjan (5°15'N, 4°W).

Time series of SST (Figure 1) contained evidence of two events occurring each year: (1) between November and February the temperature decreased by about 2°C (locally called the "little cold season") and (2) from mid-June to mid-October the SST decreased by about 5°C, indicating the presence of seasonal coastal upwelling in the eastern equatorial Atlantic. Monthly mean sea level data (Figure 1) showed the same features found in the SST record. Sea level dropped 5 cm in winter and 10-15 cm in summer. Daily mean sea level values indicated that the summertime decrease in sea level occurred rapidly at the beginning of June, and the minimum sea level occurred between late July and early August.

Figure 1 shows that the monthly sea level and SST variations correlated very well, and the variations of SST lagged behind sea level fluctuations by about one month. Bakun (1978) provided evidence of a similar lag between the acceleration of the Guinea Current in June-July and the minimum SST in August-September. Thus, the simultaneity of Guinea Current acceleration and coastal sea level fluctuations suggested that the depth of the thermocline decreased when sea level dropped. Because the Guinea Current is in geostrophic balance (Philander, 1979), an intensification of the current and a rapid drop in sea level at its northern edge implies that lower temperatures occur earlier in the deeper water than near the surface. The definite upwarping of the isotherms and isopycnals observed at the onset of the upwelling over the shelf near Ghana and the Ivory Coast is another test proving that the sea level changes are predominantly steric in origin in this area (*e.g.*, Houghton, 1976).

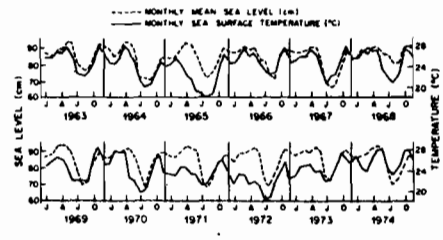

FIGURE 1 *(Verstraete)*
Monthly mean sea level and sea surface temperature observed at Tema from 1963 to 1974.

Monthly variations of the anomalies of surface dynamic height (referenced to 60 db), which were computed from hydrographic observations made over the shelf off Grand-Bassam 18 km east of Abidjan, were similar each year during the 1966-1970 period (Figure 2). They were similar to the fluctuations in surface dynamic height relative to 500 db that Merle (1978) found for the 0°-10°W, 4°-5°N area, and they correlated with monthly sea level values (Figure 1). The magnitude of the decrease in dynamic heights was about the same in August 1967, when upwelling was intense and SST reached a minimum of 19.8°C, as in August 1968, when upwelling was absent and the SST was 24.8°C. The fact that coastal meteorological conditions were not significantly different in 1967 than in 1968 is further substantiation that coastal upwelling is not locally forced.

To examine the low-frequency variability, the 1963-1978 monthly mean sea level at Tema was Fourier-analyzed. No significant fluctuations occurred at interannual time

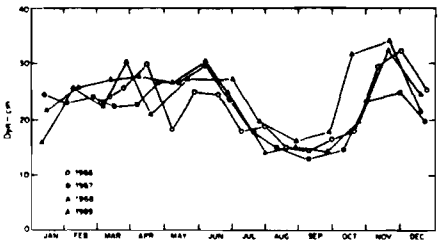

FIGURE 2 *(Verstraete)*
Variations of the surface dynamic height (referenced to 60 db) observed at one station in water ~ 90 m deep of the Grand-Bassam hydrographic section from 1966 to 1969.

scales. Significant spectral peaks at periods of 1-year and 6-months had amplitudes of 5.50 cm and 4.73 cm, respectively, and the phase angle was nearly the same at three different sites along the zonally oriented coast. Since the equilibrium adjustment time of the equatorial Atlantic Ocean is estimated to be 150 days (Philander, 1981), the semiannual variability of the ocean along the zonally eastern coast is probably in equilibrium with the seasonal cycle of the Guinea Current.

References

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Jean-Marc Verstraete
Office de la Recherche Scientifique
et Technique Outre-Mer
B.P.V. 18
Abidjan
Ivory Coast

Verstraete Jean-Marc. (1982).

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