VARIABILITY IN SOME OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS AROUND THE LAGOS HARBOUR ENTRANCE, NIGERIA. (1978 – 1987)

Oyewo E. O., Ajao E. A., Ibe A. C., Orekoya T., Jarikre, B. E., and Asante-Nimako A. M.*

Nigerian Institute for Oceanography and Marine Research, P.M.B. 12729, Lagos - Nigeria.

* Department of Meteorological Services, Federal Ministry Of Civil Aviation, Lagos – Nigeria.

ABSTRACT

Surface water temperatures and salinities at two stations around the Lagos Harbour entrance were measured from January 1978 to December 1987. Surface water dissolved oxygen (D.O) was also measured at one of the stations from January 1982 to December, 1987. This paper presents the findings for the period and the inter-relationship of the measured parameters with the prevailing hydrological and meteorological regimes.

The pattern of surface water temperatures at both stations in the study period showed a clearly defined mean maximum of 29.5^{0}C around April and an equally clearly defined mean minimum of 25.8^{0}C around August. Occasionally, there were also less clearly defined mean maximum and minimum temperatures in October/November and January respectively.

The salinity amplitude at both stations is influenced by rainfall especially at the Harbour stations and also possibly by local upwelling which couples both stations through tidal flushing. The mean minimum salinity at the Harbour station (12.29$\pm$ 6psu) was recorded in October while the highest mean maximum (13.23$\pm$1.7) at this station was in April. At the Beach station, mean maximum (32.3$\pm$1.3) and minimum (27.53$\pm$3.1) salinities were recorded in May and September respectively. It was observed that in most of the years of study, the rainfall pattern showed no break in the month of August.

Surface D.O values were generally greater than 4.50mg L^{-1}. There was a peak D.O period in July/August. The inter- and intra-annual variability in the D.O pattern is explicable in terms of the non-conservative nature of the gas, its involvement in the bio-geochemical cycle and the influence of physical process on its temporal and spatial concentration.

INTRODUCTION:

In November 1977, the Nigerian Institute for Oceanography and Marine Research (NIOMR) started a data acquisition programme which included the collection of surface water temperature, salinity and D.O data around the Lagos Harbour entrance. The main objective was an improvement of the understanding of the quality of the waters of the Harbour entrance area as a benchmark for evaluating past and future changes in the area.

This paper is a follow up of Oyewo et al (1982) on this subject. It is limited to the presentation of Beach and Harbour stations' surface water temperatures and salinities data over a ten-year period (1978-1987) as well as D.O data at the Harbour station only for the period 1982 – 1987. Some meteorological data are presented to explain observed variations.

MATERIALS AND METHODS

The sampling stations are marked H (Harbour station) and B (Beach station) on Figure 1. Surface water temperature was measured using the 'Bucket method' and mercury-in-glass water thermometers. Precautions against the heating and cooling effects of the sun, wind as well as parallax were taken. As much as possible, the daily temperature readings were made between 0730 and 0800 hours G.M.T. Air temperature measurement was made just before the reading of the surface water temperature.

Salinity measurements were carried out using an automatic Tsurumi Seiki laboratory, Salinometer and reported in practical salinity units.

Samples for D.O determination were fixed at the sampling stations and later treated in the laboratory following the standard winkler's titrimetric method.

Meterological observations were made daily at 0900 hours G.M.T. at NIOMR's roof top meterological observatory. Additional meterological data were obtained from the Federal Department of Meteorology where necessary. The incident radiation data are given only in terms of distillometer volumes because they were obtained from an uncallibrated Gunn-Bellani equipment.

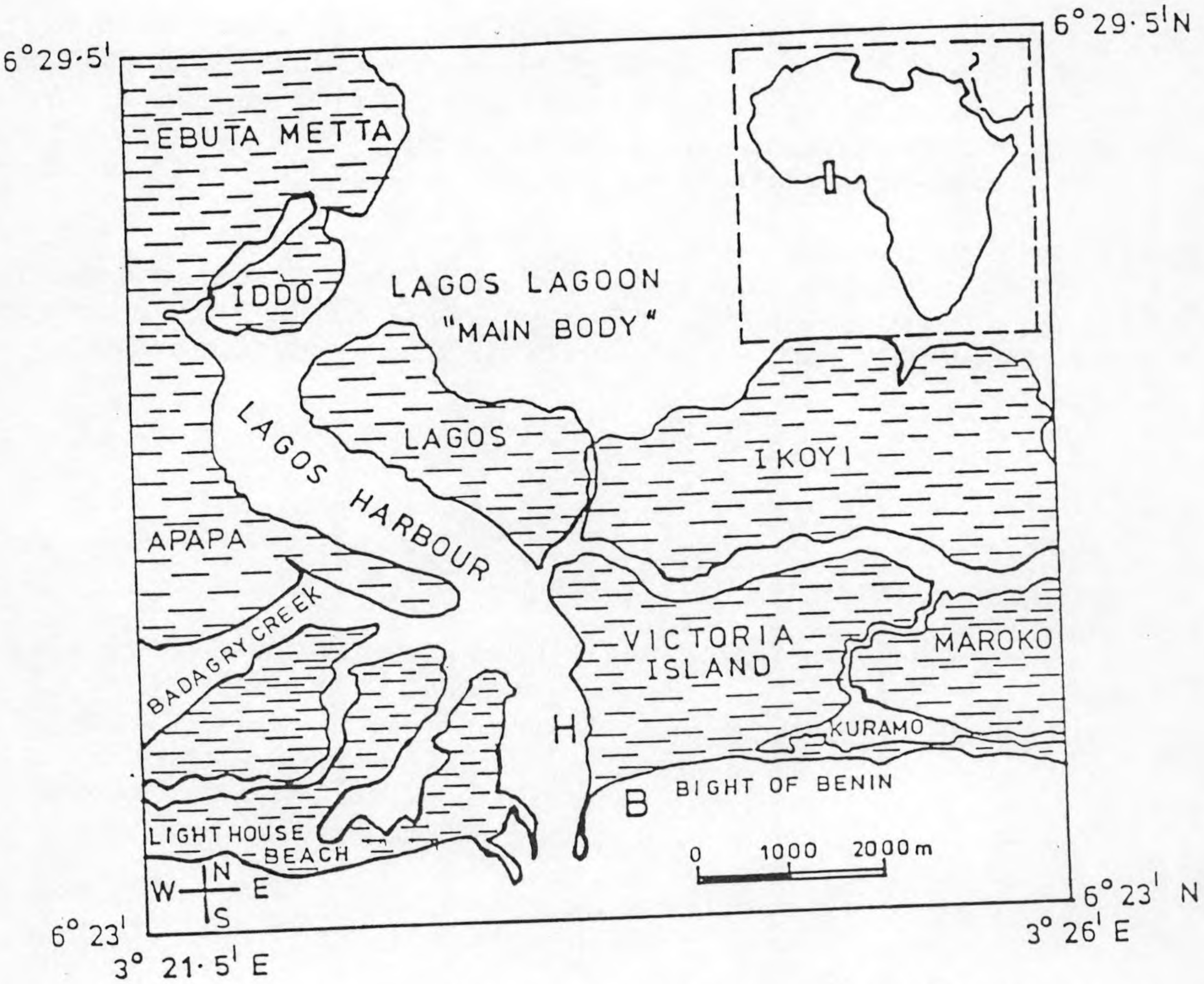

Fig. 1: Map of Lagos Harbour Entrance Showing sampling sites B (BEACH) and H (HARBOUR).

RESULTS AND DISCUSSION

Temperature

The pattern of daily variations at both stations is depicted in Figure 2. Since this pattern was similar for each of the ten years of study, varying inter-annually only in the finer details, only those for five years are presented. The diurnal fluctuations in temperature are sometimes large and rather complex. The monthly means for 1978 –87 (Figures 3 and 4) show the seasonal cycle and temporal variations. The complexity of the daily fluctuations is however masked in the monthly means. The apparent relative simplicity of the monthly means compared with the diurnal variations has been previously reported (Oyewo et al 1982). The overall temperature pattern at both stations shows a clearly defined mean maximum of about 29.5°C in April and an equally clearly defined mean minimum of about 25.8°C in August (Table 1). In most of the years of study, there was a second but less clearly defined maximum in the October/November period. In some years, there were second but less clearly defined minima around January (Figure 2). There was a regular temperature decline from April/May of each year reaching a minimum around August. There was also a regular rise in temperature from September to November. Olaniyan (1969) ascribed the maximum temperature period in the Lagos lagoon complex (including the Lagos Harbour) to the effect of insolation on a body of water that is largely static at this period of the year. He also explained the minimum temperature period in terms of the influx of cool freshwater into the lagoon complex at this period. Longhurst (1964) ascribed the warming up process around the Gulf of Guinea from September to November to the progressive downward migration of isotherms from the surface to become incorporated in the thermocline which consequently comes to include a progressively greater range of temperature. He also ascribed the temperature decline between April and August to the overall cooling of the Gulf of Guinea and the South Atlantic during this period of the year. At both stations however, there is evidence (Fig 3) that the influence of radiation parameter is very significant. Albeit, it is important to caution here on the danger of adducing radiation forcing functions alone to explain the observed variations:
Apart from radiation heating, ocean upwelling can affect the recorded values and may be coupled through the seasonal cycle that affects both wind and cloudiness. Although wind data for the study period are not sufficiently complete for any meaningful interpretation, there are indications that strong winds may be occurring during the low temperature season. Besides, if radiation were the primary influence on the temperature cycle, it should lead by a quarter cycle (Houghton, written communication). It is also important to mention that variations at station H can be affected by advection, tidal and other mixing processes in the Lagos lagoon complex. Stations H and B are themselves coupled through tidal flushing such that the relevant radiation and other influencing parameters may affect both stations simultaneously. This may explain the similarity in temperature patterns at both stations.

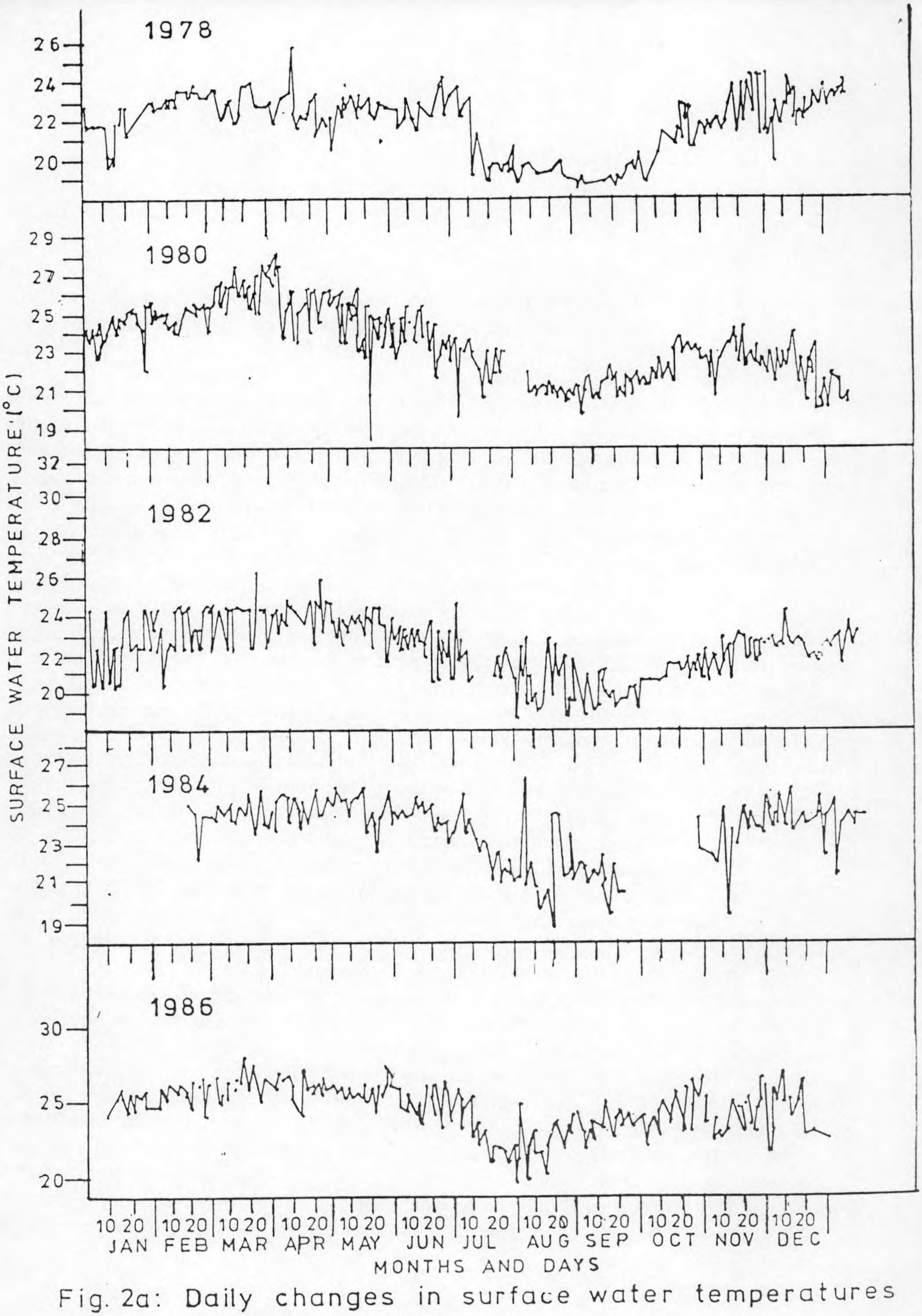

Fig. 2a: Daily changes in surface water temperatures at station B.

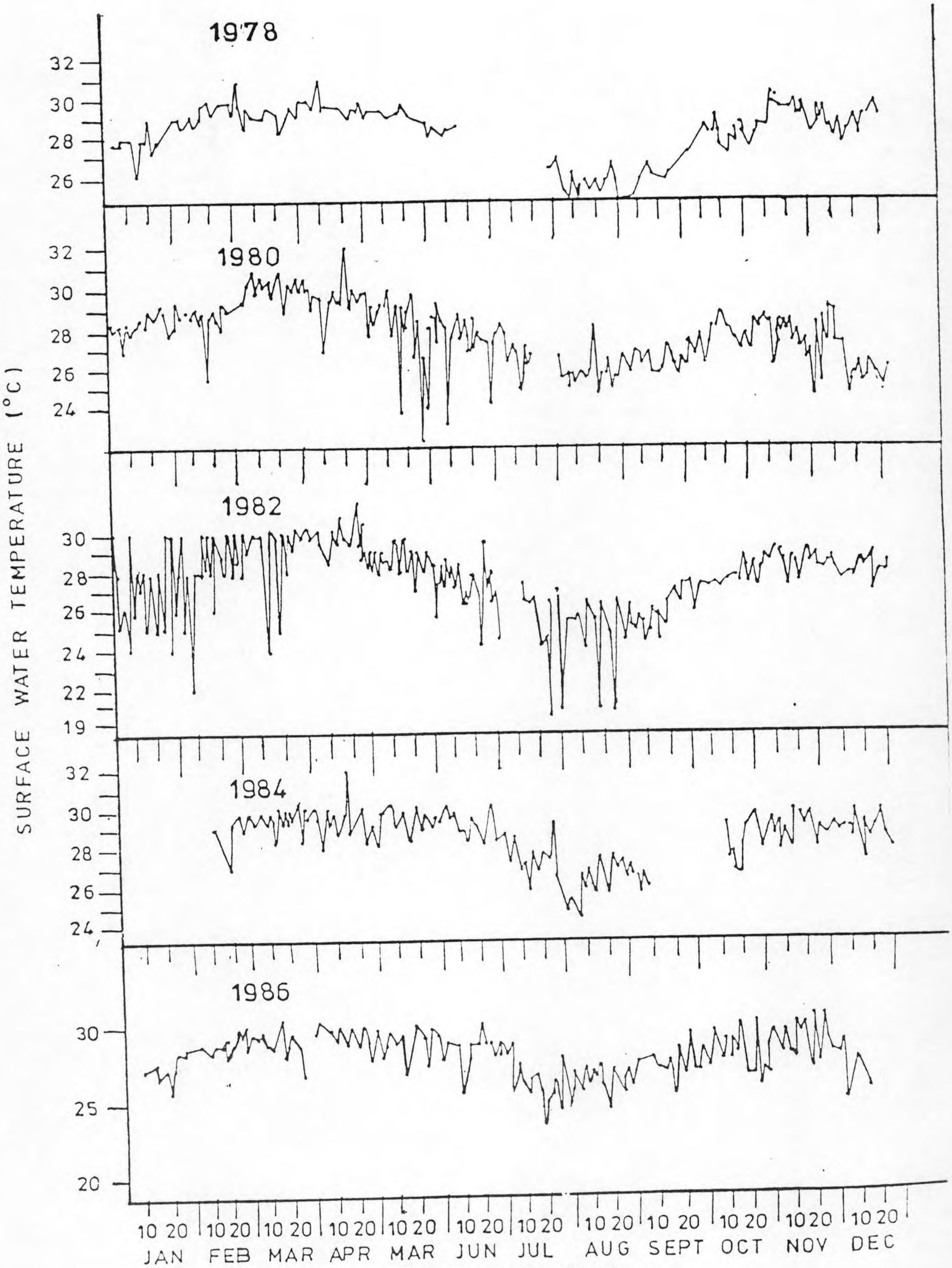

Fig. 2b: Daily changes in surface water temperatur at station H.

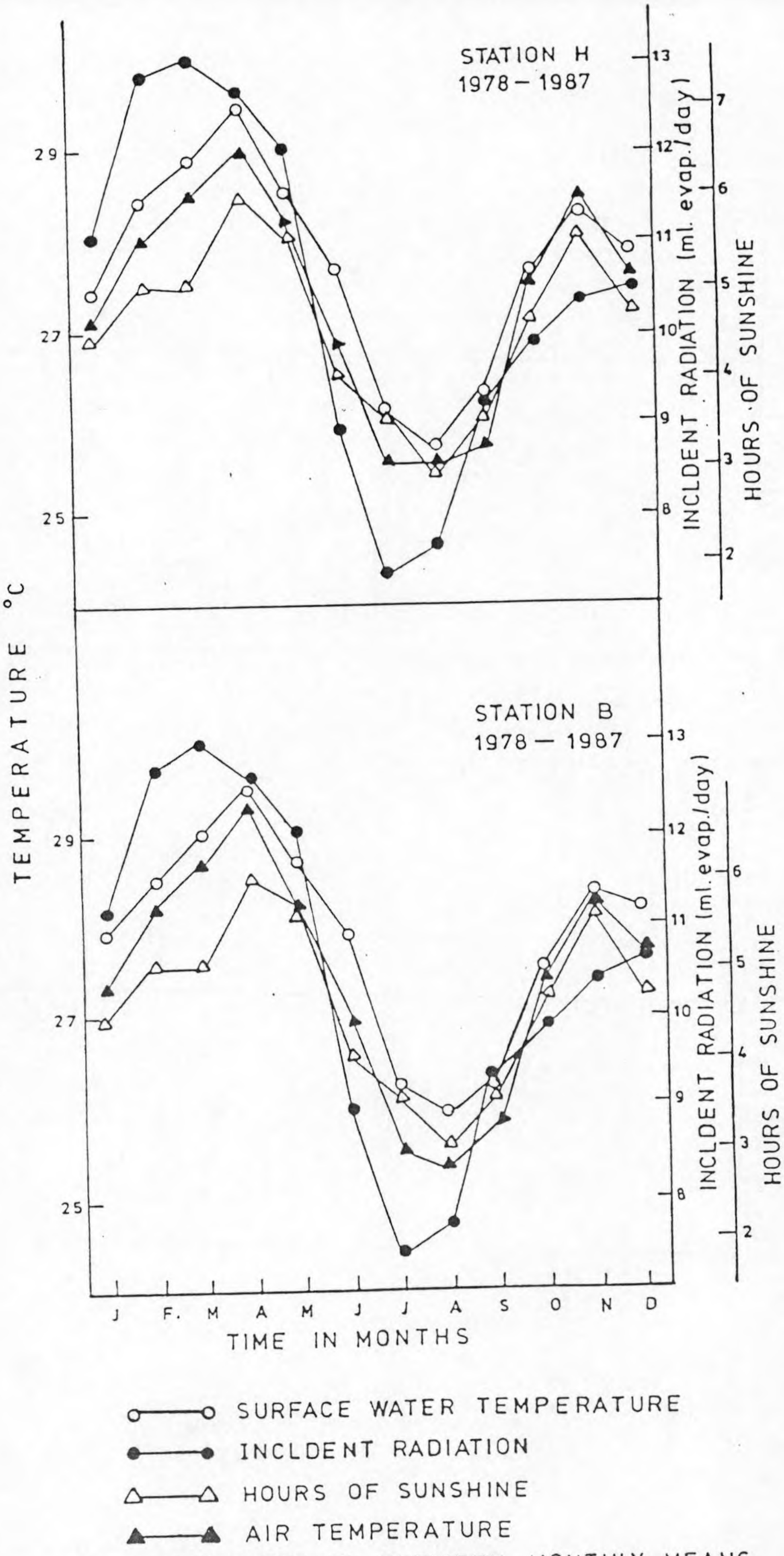

Fig. 3: RELATIONSHIP BETWEEN MONTHLY MEANS OF SURFACE WATER TEMPERATURE AND THREE CLIMATIC ELEMENTS.

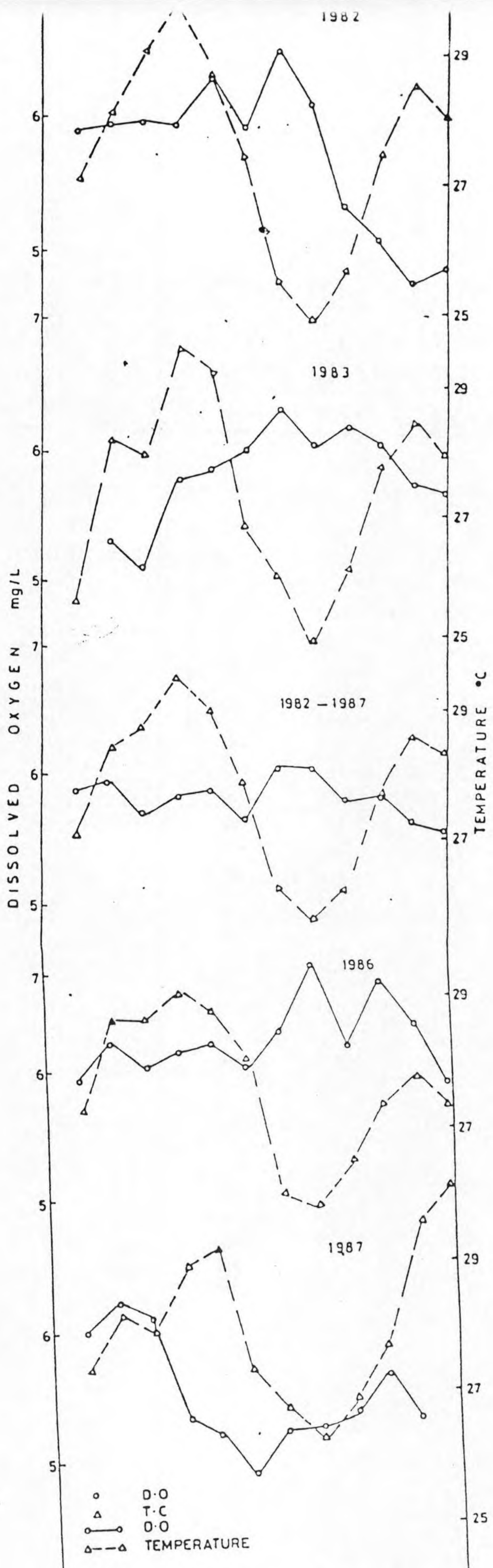

Fig. 4. MONTHLY MEANS OF SURFACE DISSOLVED OXYGEN AND TEMPERATURE — STATION H.

TABLE 1 :

MONTHLY MEANS OF SURFACE WATER TEMPERATURE ,RAINFALL, INCIDENT RADIATION, HOURS OF SUNSHINE IN STATIONS B. AND H. (1978 – 1987) STANDARD DEVIATIONS ARE IN PARENTHESES

Months	Station B Temp. (°C)	Station H Temp. (°C)	Air Temp Station B (°C)	Air Temp. Station H (°C)	Station B Salinity psu	Station H Salinity Psu	Mean Rainfall (mm)	Incident Radiation ml Evap/day	Hours Of Sun-Shine
Jan.	27.85 (1.15)	27.45 (0.980	27.15 (1.25)	27.15 (1.19)	31.88 (1.18)	29.15 (1.89)	5.5 (11.14)	11.10 (2.31)	4.42 (1.74)
Feb.	28.45 (0.98)	28.46 (0.48)	28.29 (1.31)	28.01 (1.33)	32.45 (1.47)	30.29 (2.36)	25.31 (36.88)	12.71 (1.59)	[illegible].08 (1.38)
March	29.09 (0.90)	28.92 (0.69)	28.66 (1.43)	28.53 (1.19)	31.70 (3.01)	30.15 (3.51)	68.89 (38.91)	13.02 (1.14)	5.05 (0.97)
April	29.54 (0.41)	29.45 (0.47)	29.32 (0.93)	29.07 (1.06)	32.55 (1.22)	31.23 (1.72)	114.29 (76.49)	12.66 (1.97)	6.02 (0.67)
May	28.65 (0.99)	28.56 (0.94	28.12 (1.32)	28.24 (1.39)	32.30 (1.32)	27.77 (4.7)	275.5 (132.5)	12.00 (1.09)	5.61 (0.73)
June	27.85 (1.03)	27.71 (0.73)	26.89 (1.09)	26.87 (0.95)	30.95 (3.82)	19.60 (5.79)	272.85 (121.76	8.91 (0.97)	4.06 (0.83)
July	26.16 (0.67)	26.22 (0.55)	25.45 (1.29)	25.55 (0.92)	31.49 (2.99)	15.10 (5.48)	189.62 (137.31	7.30 (2.39)	3.60 (0.62)
August	25.86 (0.41)	25.78 (0.46)	25.34 (0.91)	25.55 (0.48)	31.10 (3.25)	16.85 (7.88)	135.83 (140.53	7.66 (0.75)	2.99 (1.20)
Sept.	26.19 (0.68)	26.33 (0.44)	25.71 (0.85)	25.70 (0.58)	31.82 (3.25)	19.66 (10.36)	196.10 (122.96	9.26 (0.9)	3.50 (0.59)
Oct.	27.46 (0.88)	27.67 (0.56)	27.40 (0.77)	27.57 (0.49)	27.53 (3.12)	12.95 (5.59)	147.07 (749.1)	9.83 (2.19)	4.66 (0.58)
Nov.	28.29 (1.10)	28.35 (0.98)	28.29 (1.17)	28.49 (0.62)	28.11 (2.26)	18.18 (4.48)	60.38 (47.17)	10.34 (1.35)	5.58 (1.60)
Dec.	28.14 (1.43)	27.89 (1.27)	27.64 (1.39)	27.63 (1.04)	31.09 (1.09)	24.71 (2.98)	54.60 (8.79)	10.53 (2.22)	4.70 (1.40)
Overall mean	27.79 (1.18)	27.73 (1.13)	27.37 (1.30)	27.36 (1.22)	31.08 (1.62)	22.97 (6.62)	128.83 (90.85)	10.44 (1.44)	(4.61) (0.93)

It is also worthy of note, that the basic elements in the cycle just described are broadly repeated along the entire West African Coast (Longhurst, 1964; Oyewo at al 1982) where similar climatic regimes exist. Furthermore, the similarity in the temperature cycle between the Lagos Harbour entrance stations and three Ivorien stations are clear (Figures, 3, 4 and 5). The monthly means of the surface water temperature at both stations based on data for 10 years (Table 1) may be regarded as predictive and a basis for evaluating changes. Departures may only be expected in the event of a local or global climate change, upwelling around station B or in any other area under the influence of the same current system.

The unusual oceanographic and meteorological conditions reported by Philander (1986) were not reflected in the data for station B. Although the lowest total rainfall was recorded in 1984, no significant positive departures from the mean temperature was recorded in any of the years of study. A slight decrease in surface temperature was infact recorded in the initial period of 1983. The phenomenon reported by Philander (1986) may be truer of areas of the Atlantic closer to or south of the equator. It however raises the dire need to carry out investigations on whether or not events in the interior of the Gulf at any point in time are different from those occurring in coastal areas in the inner shelf.

Air temperature, incident radiation and hours of Sunshine

The inter-relationship between these elements and surface water temperature is depicted in Fig.3. The similarity in the patterns lends credence to previous suggestions (Longhurst 1964: Oyewo et al 1982) that a possible mechanism exists in the local radiation cycle to explain the observed temperature pattern at the two sampling stations and by implication, the entire West African Coast where similar climatic regimes prevail. However,, due cognizance should be taken of the earlier warning of the danger in attempting to explain the observed variation in terms of radiation forcing functions alone.

SALINITY CYCLE

The mean salinity values for the study period are shown in Fig. 6 which also shows the pattern for two of the years of study: 1979 – the year of heaviest rainfal (Total Rainfall- 2221.1mm) and 1984 – the year of lowest rainfall (Total rainfall – 1091.7mm). Details for the other years are in Table 1. The salinity amplitude appears to be rainfall dependent as previously suggested by Hill and Webb (1958) and Olaniyan (1969). It is however important to quickly point out that the situation at both stations is more complex than it would at first appear: Salinity at both stations could be influenced by local

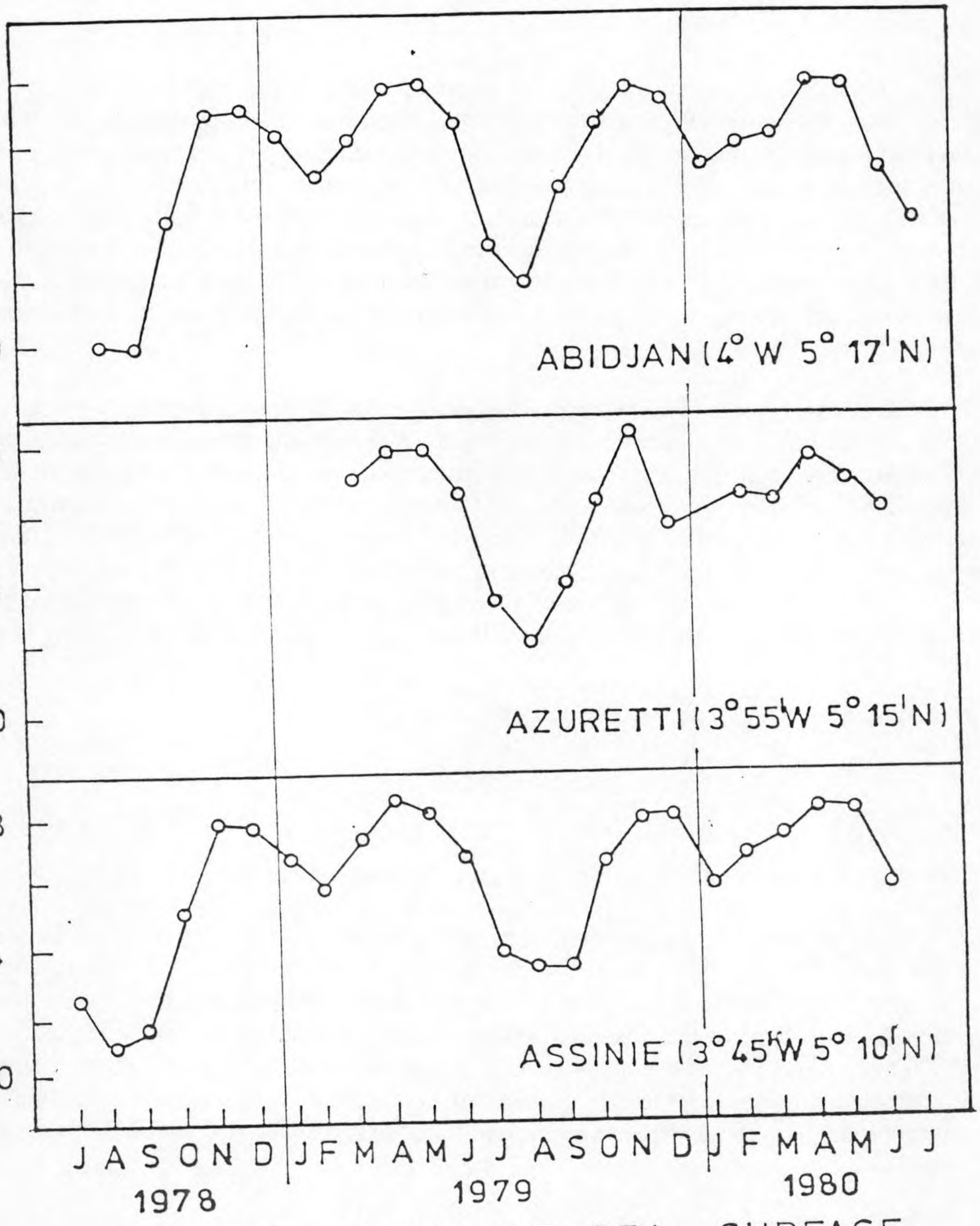

Fig. 5: MONTHLY MEANS OF SEA-SURFACE TEMPERATURES IN THE COASTAL WATERS OF THE IVORY COAST.

SOURCE: Centre de Recherches Oceanographiques, Abidjan — Ivory Coast.

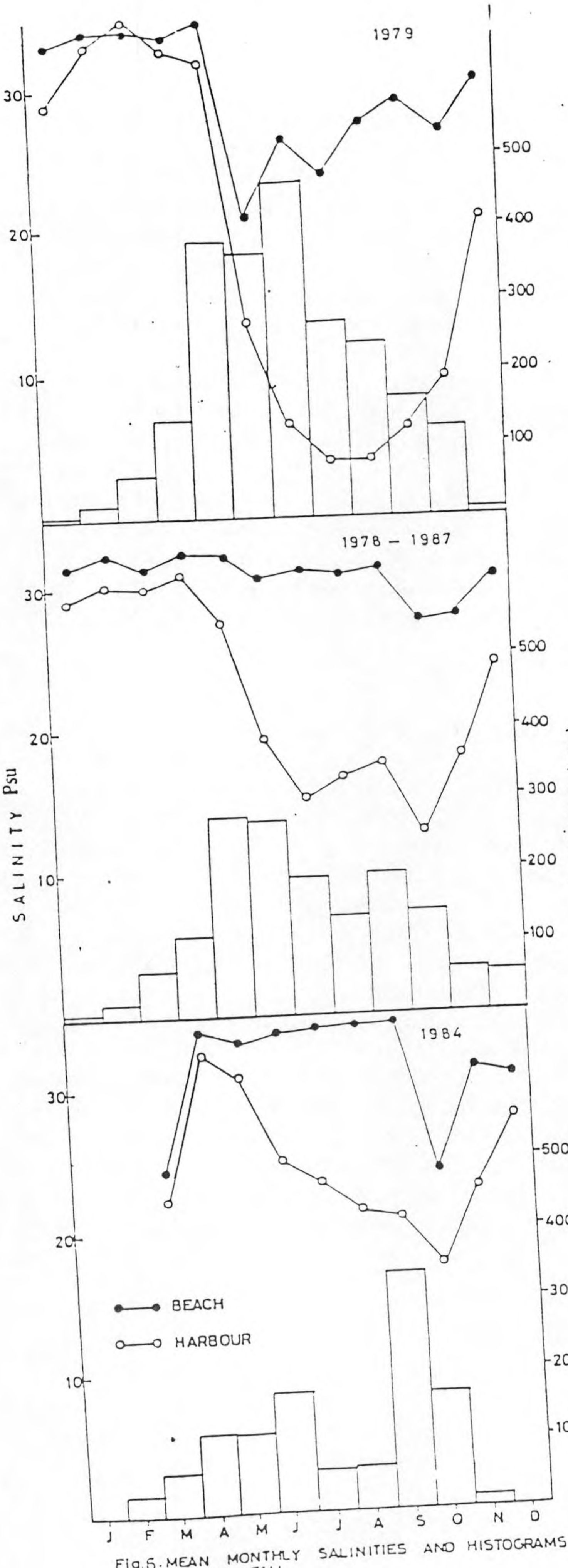

Fig.5. MEAN MONTHLY SALINITIES AND HISTOGRAMS OF RAIN FALL.

rainfall, distant rainfall as manifested river flow into the lagoon and ocean upwelling viz-a-viz coupling with tidal flushing and other lagoon mixing processes earlier alluded to. In this respect, the use of local rainfall alone is not satisfactory but had to be used in the absence of complete information on 'distant rainfall'' in all areas in the catchment areas of all drainage basins emptying into the Lagos lagoon complex. It is also worthy of note that station H being close to the sea had the highest salinity values in the Lagos lagoon complex with lower values in areas of the lagoon complex further "upstream" where the influence of freshwater is more pronounced (Oyewo, unpublished data).

It is interesting to note, from the climatological point of view, that in the past, the local rainfall pattern in the study area was such that there was a short, relatively rainless break within the March-October wet season. This was variously described as the little dry season or 'August Break' (Longhurst 1964; Hill and Webb, 1958). The data collected between 1978.and 1987 however suggest that the situation is changing. There were substantial rains in the July/August period of many of the years of study. Only 1982 recorded a clear "August Break" It is therefore imperative to be cautions in making generalisations about climate. Long term studies perhaps spanning several decades will give a clearer picture of the trend.

DISSOLVED OXYGEN (D.O) 1982 - 1987

The D.O. pattern for two of the years of observation are shown in Fig. 4. The mean D.O values are shown in Table 2. and are generally greater than 4.5mg L^{-1}. The mirror image between D.O and temperature which would have been expected if the former were solely dependent on the latter is imperfect in many respects. The inter-annual variation in D.O concentration and the absence of a clear trend unlike the temperature cycle is to be expected: Oxygen is non conservative and actively involved in the bio-geochemical cycle. Its concentration is affected by physical processes like turbulent mixing, diffusion and advection. Albeit, there appears to be a peak D.O period in July/August, which also corresponds to the period of influx of freshwater into the lagoon system sequel to the rains as well as that of low temperatures and salinity which will promote greater oxygen solubility. The influx of sediments, organic debris and nutrients with fresh water could lead to increased photosynthesis, plankton bloom and increased phtotosynthetic oxygen. This influx could however, also lead to oxygen depletion due to oxidative decomposition of dead bloom organisms. It is suggested that such depletion may be minimised at station H due to a swift transport out to sea of the organic load. It is also possible that any such load may be insufficient to depress D.O significantly.

TABLE 2:

STATION H MONTHLY MEANS OF DISSOLVED OXYGEN, AND SURFACE TEMPERATURE (1982 – 1987) (STANDARD DEVIATION VALUES ARE IN PARENTHESIS)

MONTH	TEMPERATURE °C	D. O. mg/L
January	27.11 (0.89)	5.95 (0.07)
February	28.44 (.0.3)	5.99 (0.64)
March	28.76 ((0.64)	5.72 (0.39)
April	29.59 (0.38)	5.84 (0.35)
May	29.04 (0.29)	5.91 (0.41)
June	27.81 (0.77)	5.64 (0.43)
July	26.27 (0.55)	6.09 (0.52)
August	25.75 (0.61)	6.09 (0.52)
September	26.33 (0.47)	5.82 (0.43)
October	27.76 (0.26)	5.89 (0.52)
November	28.65 (0.68)	5.63 (0.51)
December	28.38 (1.07)	5.58 (0.47)

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