Sea-surface Temperature Variability around Cape Recife, South Africa

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Sea-surface temperature measurements taken during the course of biological research along the coast of the eastern Cape Province have revealed that, on occasion, large temperature differences occur in the waters around prominent coastal headlands. As such occurrences can have significant biological implications, sea-surface temperatures on either side of Cape-Recife (Fig. 1) were monitored to determine the nature and frequency of this temperature variability and are reported here.

In temperate latitudes the vertical sea temperature distribution is typically characterized by an isothermal mixed upper layer over a thermocline layer in which temperature decreases rapidly with depth. Seasonal variations occur in this vertical distribution and, during summer, accumulation of heat in the upper layers causes a well developed thermocline off the southern Cape coast. When surface waters cool in autumn the thermocline begins to break down and in winter coastal waters are relatively isothermal. Vertical profiles of sea temperature with depth off the eastern Cape coast (Fig. 2) indicate the sharp thermocline below the warm surface layer in summer and the isothermal winter conditions. Besides seasonal variation in heat exchange between sea and atmosphere, changes in sea-surface temperatures can be ascribed to various factors such as mixing by wave action, convective stirring, advection by currents and wind stress. The wind induces the motion of a layer of surface water by means of friction. This motion is influenced by the Coriolis force, resulting in the net transport of surface water to the left of the direction of the wind in the southern hemisphere (Ekman drift). When surface water is forced offshore by wind it is replaced by vertical upward transport of subsurface water. This process is known as upwelling and is a particularly conspicuous phenomenon along the western coasts of continents where prevailing winds carry surface water away from the coast. Recent studies indicate that seasonal upwelling also occurs along the south coasts of Africa and Australia under certain wind conditions. When surface water is forced onshore by wind, downward vertical transport of surface water occurs at the coast and this process is known as downwelling.

Methods

Sea-surface temperature was measured from the Skoenmakerskop shore (34°03'S, 25°33'E) each morning from July 1980 to June 1981, using surface water collected in a 5-litre plastic bucket and a mercury thermometer accurate to 0.1°C. Records of sea-surface temperature (accurate to 1°C) measured each morning at Humewood Beach (33°59'S, 25°40'E) during the same period were made available by the Port Elizabeth Municipality beach office. Local wind conditions were obtained from recordings of the hourly means of wind direction and velocity taken at Port Elizabeth airport located between Skoenmakerskop and Humewood Beach (Fig. 1). It should be noted, however, that these recordings probably do not accurately reflect conditions at the two coastal sites. Progressive wind vectors, indicative of both wind direction and velocity, were computed for each month of the study period.

Results and discussion

Sea-surface temperatures around Cape Recife ranged from 12°C to 27°C over the study period; the mean annual temperature at Skoenmakerskop was 18.1°C and at Humewood Beach was 17.5°C. Large differences, particularly in the summer and autumn months, were evident between the two study areas. Sea-surface temperatures at Skoenmakerskop were generally higher than those at Humewood Beach during the summer months, whereas in winter they were similar. Fluctuations were more pronounced at Skoenmakerskop on the open coast than at Humewood Beach, which lies within the confines of the relatively shallow Algoa Bay. Figure 4 shows that mean monthly sea-surface temperatures followed a typical seasonal pattern, although ten-day running means for the two sites still highlight the sea-surface temperature fluctuations at Skoenmakerskop in the summer months.

Progressive wind vectors for each month of the study period are given in Fig. 5. South-westerly winds predominate throughout the year with an increased easterly component in the summer months. Maximum windflow occurs in the summer months. Correlation of wind and temperature data indicates that the often...
Fig. 3. Daily sea-surface temperatures at Skoemakerskop (---) and Humewood Beach (--) for the period July 1980 to June 1981.

Drastic temperature drops at Skoemakerskop during the summer and autumn months are associated with winds having an easterly component. As easterly winds generate an offshore flow of surface water west of Cape Recife, it appears that upwelling of cold subsurface water is responsible for these declines. For example, the 9°C temperature drop at Skoemakerskop during the period 25–28 December 1980, shown in Fig. 3, corresponds with the strong north-easterly wind on the 25th, which is shown in the shaded section of the December 1980 progressive wind vector (Fig. 5).

At Skoemakerskop, relaxation of upwelling and an increase in sea-surface temperature occurred with the south-westerly winds associated with the passing of coastal low pressure systems. These winds cause horizontal transport of warm surface water back towards the coast, leading to downwelling on convergence with the land. An anomalous situation developed towards the end of March 1981 when a sharp temperature decline was evident at Skoemakerskop (Fig. 3). During this period, severe storms with south-westerly winds gusting to 37 m s⁻¹, extensive flooding and a

Fig. 4. Monthly means (o - o) and ten-day running means (•-•) of sea-surface temperature at Skoemakerskop and Humewood Beach for the period July 1980 to June 1981.
fall in air temperature occurred along the eastern Cape coast. It is suggested that the exceptionally high wind and associated heavy seas caused turbulent mixing of the water column, thereby accounting for the drop in sea-surface temperature.

Temperature fluctuations at Humewood were not as marked as those at Skoenmakerskop and it would appear that the shallow waters around Humewood were generally well mixed. The only drastic temperature fluctuation during the study period was an 8°C drop which occurred in February 1981 when a period of easterlies preceded a south-west wind. Analysis of earlier records from Humewood Beach (1972 – 1980) shows that similar falls in temperature occur annually during February and March (Fig. 6). In February 1982 this phenomenon was again observed after a period of fresh easterlies and sea-surface temperatures taken at Sundays River Beach on the north side of Algoa Bay (Fig. 1) showed a marked drop from 21°C to 14°C prior to any decrease at Humewood Beach. It is thus suggested that, although the mechanism for the cold water phenomenon at Humewood Beach is probably complex, the origin of the cold water can be attributed to upwelling around Woody Cape in a manner similar to that described for the summer occurrence of cold water in False Bay near Cape Town.10

I thank the Port Elizabeth Municipality beach office and the Port Elizabeth airport meteorological office for permitting access to sea temperature and wind records, Mrs Neary of Skoenmakerskop for her kind assistance, Professor P. Warren (UPE) for help with computer analysis of wind data and Dr E. Schumann (NRIO), Professor G. Brundrit (UCT) and Mr V. Swart (NRIO) for useful discussions and comments on the manuscript.