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Recent trends in temperature variations in ICNAF Subarea 4

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Introduction

A review of previous studies of fluctuations of marine climate in the N.W. Atlantic was presented at the Environmental Symposium in 1964. The long-term temperature variations, for Subarea 4, were based on observations from the twenties to 1962 (Lauzier, 1965a). A subsequent study (Lauzier and Marcotte, 1965) of the marine climate in the southwestern Gulf of St. Lawrence (4T) was also based on observations up to 1962. The year 1964 has been reported as "another cold year" (Lauzier, 1965b).

Here it is our intention to emphasize the temperature fluctuations during the past 17 years, 1951-1966, in the Subarea 4. This means an overlap from the previous studies (to 1962), but a necessary one to assure continuity and to cover the entire recent cooling period. The cooling period is also given its proper perspective with respect to the previous fluctuations.

Data

Recent data used here have been collected by all agencies in the oceanographic community of eastern Canada. Shore establishments were responsible for some of the monitor stations and the observations at depths were carried out from CSS Hudson, CSS Baffin, CNAV Sackville, CGS A.T. Cameron, Gambro L.V., Lurcher L.V. and M.V. Mallotus. Location of monitor stations and sections are shown in Fig. 1.

Surface temperature - air temperature

Trends of surface temperature at St. Andrews, N.B. are representative of the surface temperature variations over a large segment of the continental shelf. The St. Andrews series is represented in Fig. 2 along with longer air temperature series from Sable Island and Halifax, N.S. The close relationship between the three curves has been discussed previously (Lauzier, 1965a). The similarity in the recent cooling trends of the three series is a continuing feature.

Various trends in surface temperature were observed in the southwestern Gulf of St. Lawrence. As seen in Fig. 3, the temperature trends at Grande-Rivière are closely related to those of St. Andrews but the trends around the Magdalen Islands, at Entry Island, indicate a prolonged warming period followed by a short cooling period. Figures 2 and 3 show some of the changes in the marine climate as indicated by temperature fluctuations over the years. The recent cooling period, during the last 15-16 years, will be shown in more details as observed in bottom temperature variations.

Bottom temperatures

Three sectors in Subarea 4 have been monitored. The bottom temperature series are, to a large extent, discontinuous. The data are shown either as mean seasonal anomalies for layers where seasonal variations are significant or as mean seasonal temperatures for layers not affected by seasonal changes.

In the Bay of Fundy—Gulf of Maine, bottom temperature anomalies, at 90 metres, are represented in Fig. 4 and compared with the surface temperature series for St. Andrews. Temperature trends of bottom temperatures at Prince 5 Station and at Lurcher L.V. are very similar to the

surface temperature trend at St. Andrews. The temperature range is greater at Lurcher and less at St. Andrews than at Prince 5. The short term variations or year-to-year variations at these three stations are generally related to each other.

It would be premature to say that 1966 is the beginning of a warming or indicate some relaxation from the cooling as it would have been the case of 1961 and 1962. These two years were followed by cold years. The coldest year in the last 22 years was in fact 1965.

On the Central Scotian Shelf and Halifax area the bottom temperature trends are related to those of the Bay of Fundy—Gulf of Maine area. The year-to-year variations are also generally related to the previous group but the range of temperature is greater mainly on Emerald Bank (Fig. 5). The bottom temperatures anomalies on Emerald Bank are more variable than at Sambro, Lurcher or Prince 5 Station. Such variability has the disadvantage of either masking the general temperature trend or decreasing the significance of the trend. Greater variability of bottom temperature is observed as we approach the edge of the Continental Shelf. At Sambro L.V. and at Lurcher L.V., the rate of cooling is of the same order of magnitude, 0.20°C/year and 0.21°C/year respectively. On Emerald Bank, however, the cooling appears to be accentuated with 0.25°C/year.

Quarterly averages of the maximum temperatures within warm deep layers are represented in Fig. 6. These layers are not subjected to seasonal variations. In Emerald Basin (formerly known as Scotian Gulf) the range of temperature

variation is nearly equal to the range of temperature anomalies at Sambro L.V. and Lurcher L.V. In Cabot Strait, the maximum temperature variations at the core of the warm deep layer indicate a definite cooling starting only in the late fifties, as compared to early fifties for other bottom temperature series. Observations in Cabot Strait are less frequent than at other stations and the range of temperature variations appears to be half of the range in Emerald Basin.

Discussion

The cooling trend experienced in Subarea 4, from the early fifties, is still continuing in the middle sixties. The average rate of cooling during the last 15 or 16 years is of the order of 0.19°C/year. The St. Andrews surface temperature variations are representative of bottom temperature variation over a large segment of the Scotian Shelf.

At the time of the previous warming period, for most of the 1930's and 1940's, the temperature increase was greatest during the winter months. Now, for the recent cooling period, the temperature decrease is greatest during the summer and autumn months in the Bay of Fundy area, St. Andrews and Lurcher L.V., and during the winter months in Halifax area, Sambro L.V.

References

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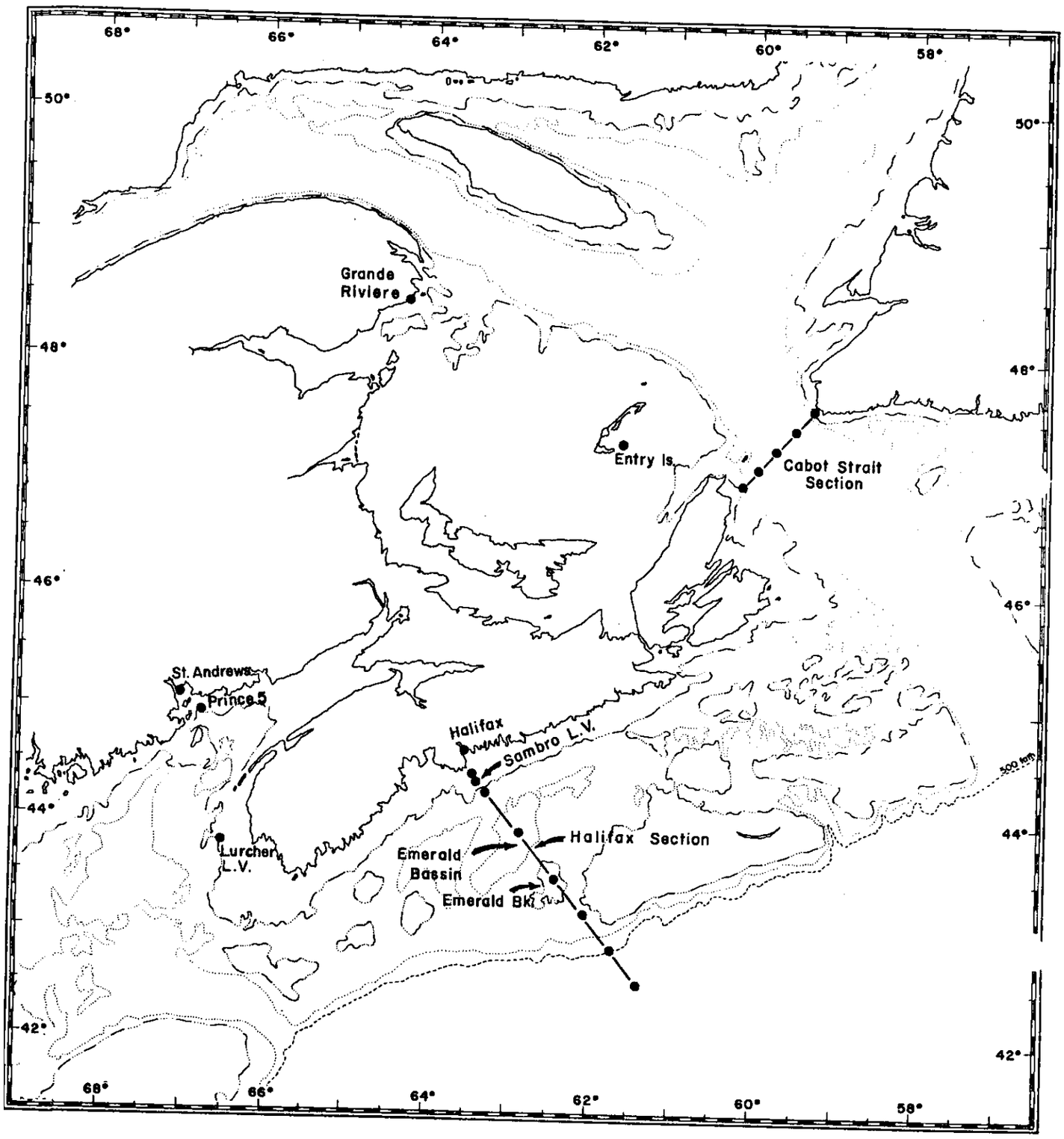

Fig. 1. Location of stations and sections.

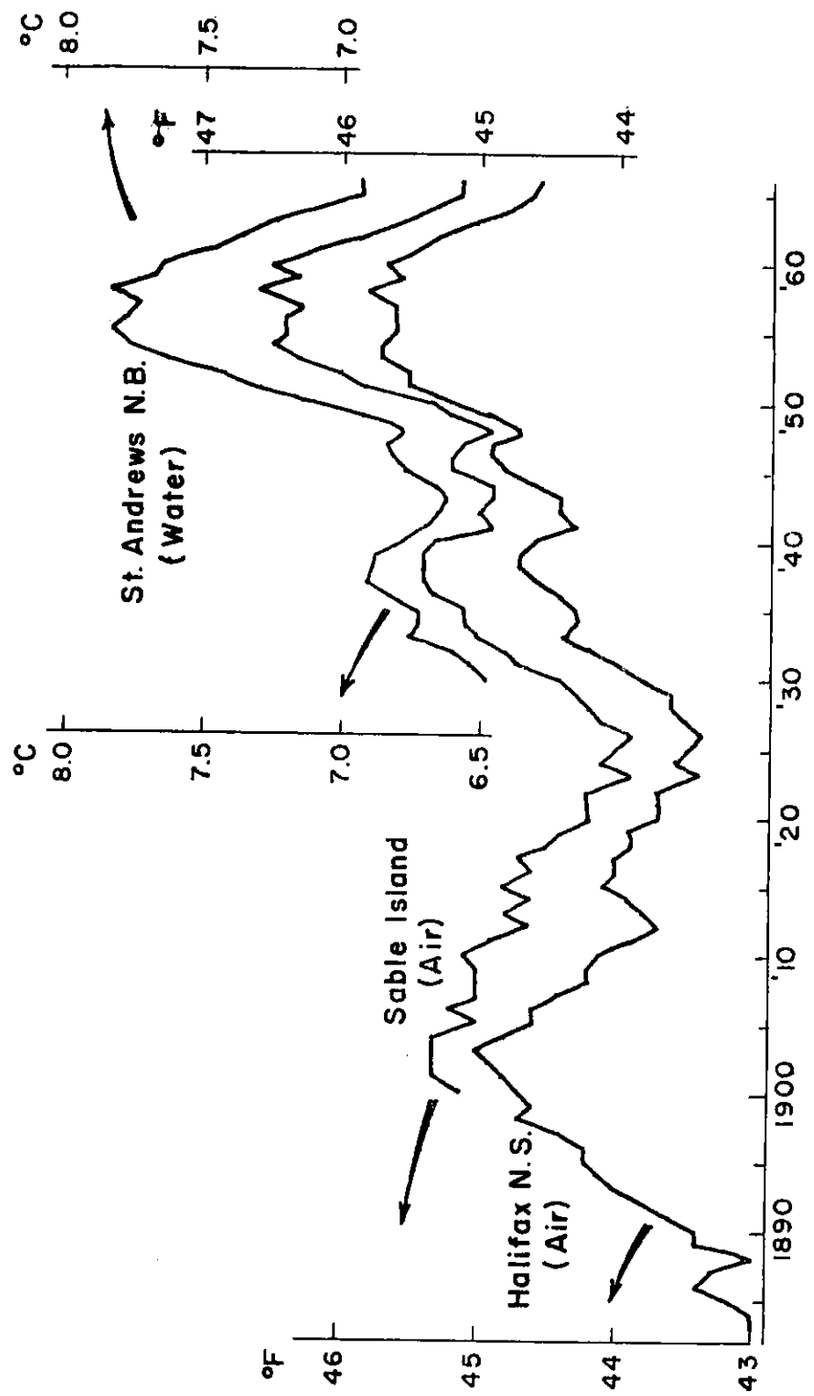

Fig. 2. Surface water temperatures at St. Andrews, N.B. Air temperatures at Sable Is. and Halifax, N.S. Ten-year moving averages of annual means credited to the last year of the period.

Fig. 3. Surface water temperatures (May - August) at Entry Is., St. Andrews and Grande-Rivière. Ten-year moving averages credited to the last year of the period.

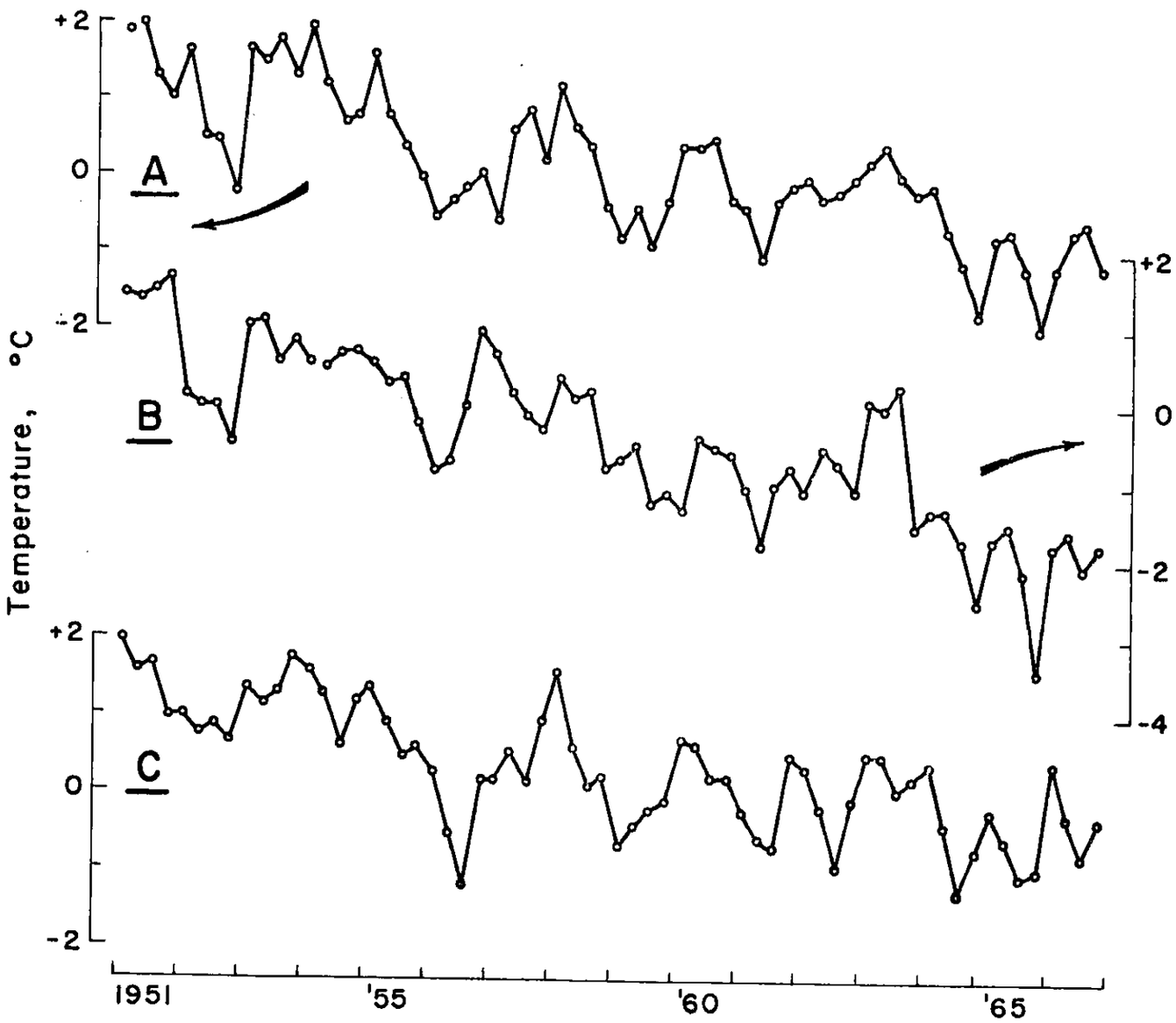

Fig. 4. Quarterly deviations of the water temperatures: (A) Prince 5 Station, bottom temperatures, average 1924-1960; (B) Lurcher L.V., bottom temperatures, average 1950-1959; (C) St. Andrews, surface temperatures, average 1921-1960. The dash lines represent temperature trends.

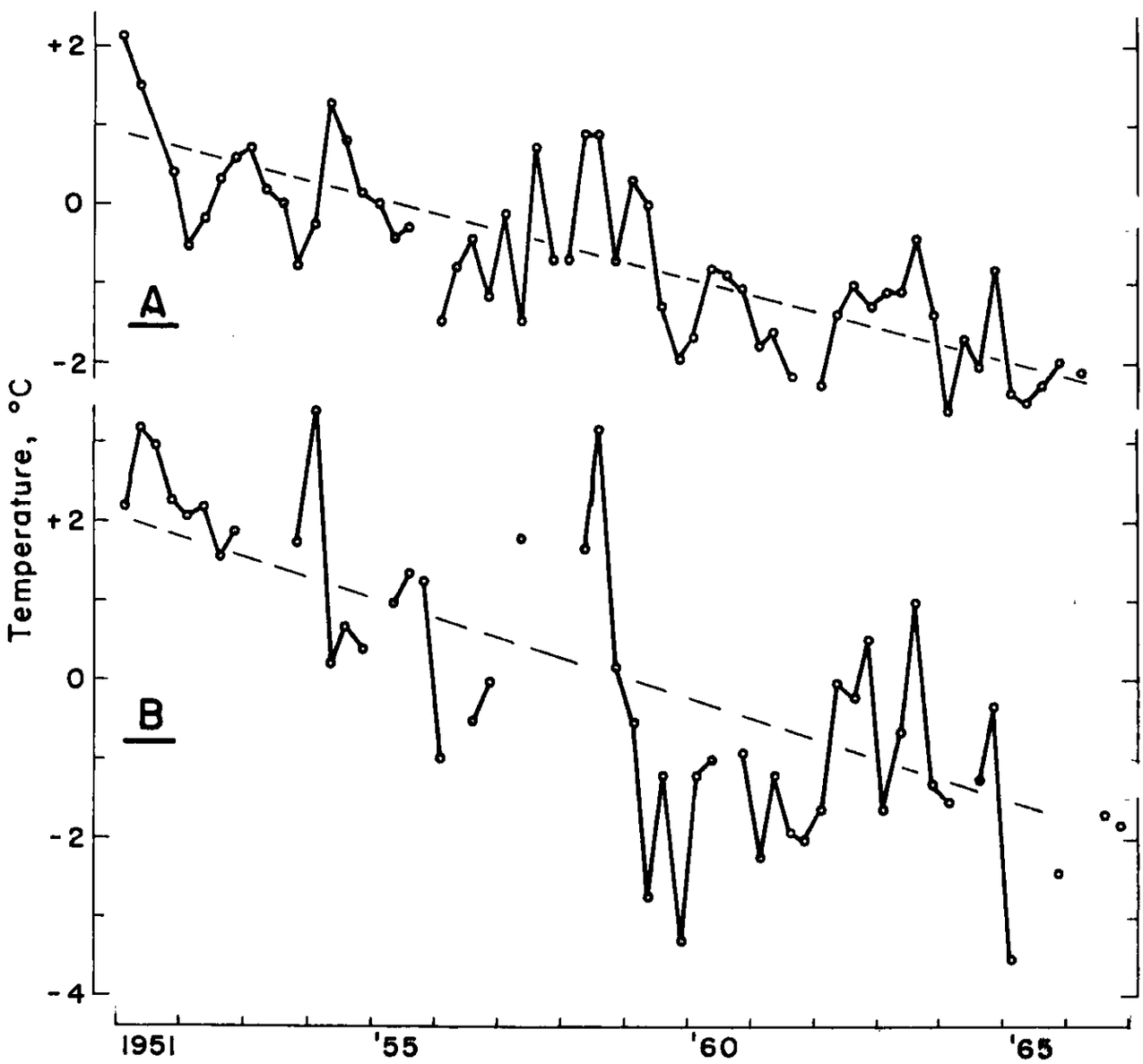

Fig. 5. Quarterly deviations of water temperatures: (A) Sambro L.V., bottom temperatures, average 1949-1959; (B) Emerald Bank, bottom temperatures, average 1950-1964. The dash lines represent temperature trends.

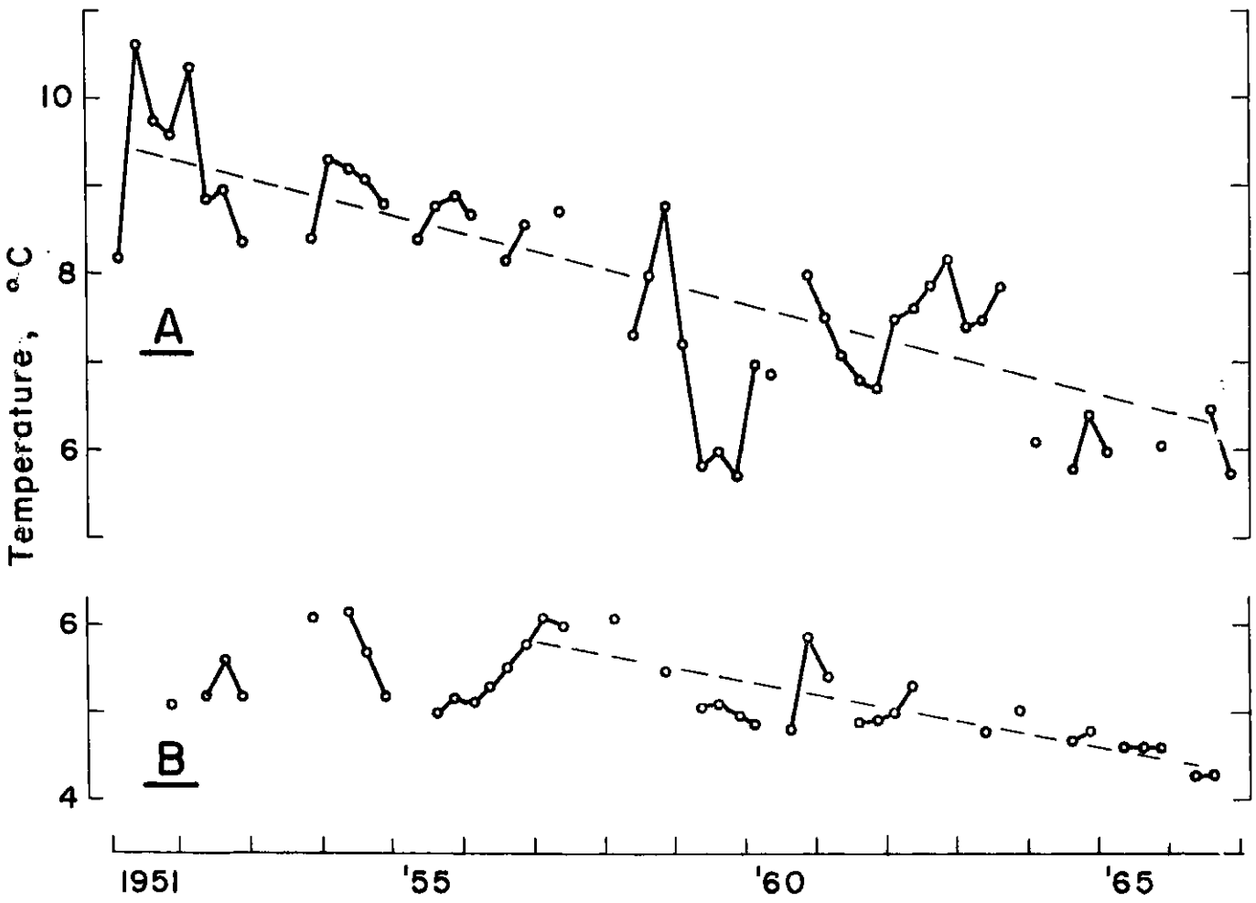

Fig. 6. Quarterly averages of water temperatures: (A) Maximum temperature within bottom layer of Emerald Basin; (B) Maximum temperature at the core of warm deep layer in Cabot Strait. Dash lines represent temperature trends.