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Near-Bottom Temperatures on Sydney Bight and the Northeastern Scotian Shelf During 1995

by

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ABSTRACT

Near-bottom temperatures during 1995 in Sydney Bight and the northeastern Scotian Shelf are described from hydrographic surveys in January, July, and September. Also monthly mean temperature profiles in 1995 and temperature time series for Sydney Bight and Misaine Bank on the Scotian Shelf are presented. On Sydney Bight temperatures near bottom have generally been below the long-term mean (1961-90) during the past 10 years although in 1995 temperatures fluctuated near the mean indicating conditions appear to be moderating. In contrast, on the northeastern Scotian Shelf the cold conditions of the past decade show no signs of moderating with the temperature anomalies in 1995 being -1 to -1.5°C near bottom over much of the region

RÉSUMÉ

On décrit les températures près du fond dans la baie Sydney et le secteur nord-est du plateau néo-écossais à partir de données de levés hydrographiques effectués en janvier, juillet et septembre 1995. Sont aussi présentés des profils de la température moyenne mensuelle en 1995 et des séries chronologiques de données sur la température de l'eau de la baie Sydney et du banc Misaine, situé sur le plateau. Dans la baie Sydney, les températures près du fond se situaient généralement sous la moyenne à long terme (1961-1990) des dix dernières années, bien qu'elles s'approchaient de cette dernière, indiquant que les conditions semblent se stabiliser. Par contre, dans le nord-est du plateau néo-écossais, le froid qui a sévit au cours de la dernière décennie ne montre aucun signe de s'atténuer, les anomalies de température en 1995 se situant entre -1 °C et -1,5 °C près du fond dans presque toute la région.

Introduction

An important and active snow crab fishery operates off Cape Breton Island. To aid in the understanding of possible changes in the distribution and abundance of snow crab in Sydney Bight and on the northeastern Scotian Shelf, we provide an analysis of bottom temperatures during 1995. In this paper we discuss the available data, the methods used to generate bottom temperatures and temperature anomaly maps and describe the results. The anomalies are defined as deviations from their long-term (1961-90) average values. Monthly profiles of the mean temperature anomaly during 1995 for the two areas are also presented.

Data

Three extensive hydrographic surveys were undertaken in the area of interest: in January a cruise conducted by DFO Moncton to Cabot Strait that extended seaward to the northeastern tip of the Scotian Shelf (Fig. 1a); in July, as part of the annual Scotian Shelf groundfish survey (Fig. 1b); and in September to Sydney Bight as part of the southern Gulf of St. Lawrence groundfish survey (Fig. 1c). All data were collected with CTDs. Bottle data were also collected during the July survey but as these were only duplicates of the CTD data, they were not included in the analyses. Additional temperature data for 1995 were obtained from the Marine Environmental Data Service (MEDS) in Ottawa. The long-term means from which the anomalies were derived were estimated from data contained within the historical temperature, salinity (AFAP) database maintained at BIO. This database is derived from the MEDS holdings but the data have undergone further editing and processing. The MEDS data are derived from fisheries surveys, oceanographic studies and ships-of-opportunity.

Methods

Near-bottom temperatures for each of the hydrographic surveys were interpolated onto a specified grid using an objective analysis procedure known as optimal estimation. This is similar to other objective techniques such as kriging but offers the advantage that interpolation is 4-dimensional; the two horizontal dimensions, depth and time. For our purposes we did not interpolate in time, instead treating the surveys as synoptic. The interpolation used the 15 nearest neighbours within a radius of up to 30 km in the horizontal and in the vertical within ±15 m of the bottom between 0-50 m and ±25 m at > 50 m. The maximum profile depth for each station was assumed to be the bottom depth. The maximum profile depth was taken as the bottom depth. The temperature grid we choose had a horizontal spacing of 0.2x0.2° latitude-longitude and the grid boundaries were selected to match the survey areas. The data were then smoothed before the bottom temperatures contoured.

Monthly climatological means of the near-bottom temperatures were estimated at each grid point based upon optimal estimations using all available data in the AFAP database for the years 1961-1990. The climatological means were subtracted from the 1995 survey data to produce temperature anomalies.

In addition to the optimal estimated bottom temperatures, monthly mean temperature profiles were estimated within two areas defined by Drinkwater and Trites (1987). The areas shown in Fig. 2 are Sydney Bight (area 1) and Misaine Bank on the northeastern Scotian Shelf (area 5). All data within each area were averaged at standard depths by month to obtain a monthly mean profile.

Results

Near-Bottom Temperatures

Near-bottom temperatures in January ranged between 1.5 to 5 °C (Fig. 3). The warmest waters were found in the Laurentian Channel while large portions of Sydney Bight and Banquereau Bank were less than 2°C. This near-bottom temperature pattern reflects, in large part, the bottom topography with temperature generally decreasing with depth at this time of the year. These temperatures resulted in anomalies within 1°C of their climatological means (Fig. 3). The largest negative anomalies (colder than -1°C) were near Banquereau and the highest positive anomalies (warmer than 1°C) off Ingonish, Cape Breton, and in the Laurentian Channel off Scatari.

In July, near-bottom temperatures were estimated for the entire northeastern Scotian Shelf, as well as Sydney Bight. Values ranged from <1°C to over 8°C (Fig. 4). The warmest temperatures lay along the continental slope off Banquereau and on Sable Island Bank and reflect the influence of the offshore "slope waters" and the shallow depths around Sable Island, respectively. On Sydney Bight warm temperatures off Scatari indicate shallow depths but in the deeper sections of the Bight, temperatures were typically <2°C. The coolest temperatures (<1°C) lay over the deeper sections of the northeastern Scotian Shelf. Over Sydney Bight and the deep sections of the Scotian Shelf bottom temperature anomalies were negative (typically -1°C to -1.5°C) while positive anomalies covered the outer banks and the outer continental slope (Fig. 4).

By September, bottom temperatures had increased, up to 8°C in the shallow waters off Scatari and to 2°-3°C over much of Sydney Bight (Fig. 5). On the northeastern Scotian Shelf bottom temperatures rose by approximately 0.5° to 1°C. Temperature anomalies around Scatari were positive and reached upwards of 3°C above normal (Fig. 5). Over the rest of Sydney Bight anomalies were also positive in contrast to those during July. Anomalies over the Scotian Shelf remained below normal with the coldest values being approximately -1°C .

Monthly Mean Temperature Anomaly Profiles

Monthly mean temperature anomalies for Sydney Bight (area 1 in Fig. 2) tended to oscillate between above and below normal during 1995 (Fig. 6). Colder-than-normal temperatures dominated throughout the water column in July and August, and warmer-than-normal in January, September and October. In November, temperature anomalies were mostly positive except in the

60 to 100 m depth range. A time series of the monthly anomalies for 100 m shows colder-than-normal water during the past decade although relatively few data were collected during this period (Fig. 7). Temperatures appeared to be approaching near normal in 1995, however. The absolute temperatures at 100 m range from approximately 1-2°C, depending upon the month. Note, that although in January and September positive values dominated the mean anomaly profiles, at 100 m temperatures were near normal (Fig. 6).

In contrast, at Misaine Bank (area 5), negative temperature anomalies (0° to -2°C) predominated throughout the year (Fig. 8). The only significant positive anomaly was in the top 30 m in November. The time series of the 100 temperature anomalies shows that at Misaine Bank negative values have persisted for the past decade (Fig. 9). Recent years have seen the coldest or near coldest temperature anomalies since the 1950s. The pattern at 100 m is representative of the entire deep water layer within area 5. For reference, the absolute temperatures at 100 m are approximately 1-2.5°C, depending upon the month of the year.

Summary

Near-bottom temperatures observed during January, July and September 1995 over Sydney Bight show that conditions fluctuated about the long-term mean. This is in contrast to the deeper regions of the northeastern Scotian Shelf where near-bottom temperatures were consistently colder-than-normal, conditions that have persisted for the past 10 years. Similar colder-than-normal waters appear to have covered Sydney Bight during this 10 y period although they warmed towards more normal conditions in 1995. The cold waters during these past 10 y are consistent with similar cold conditions in the cold intermediate layer (CIL) in the Gulf of St. Lawrence (Gilbert and Pettigrew 1997). The CIL waters in the Gulf are thought to be a major contributor to the near-bottom waters on Sydney Bight and on the northeastern Scotian Shelf.

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Gilbert, D. and B. Pettigrew. 1997. Interannual variability (1948-1994) of the CIL core temperature in the Gulf of St. Lawrence. Can. Spec. Pub. Fish. Aquat. Sci. (in press).

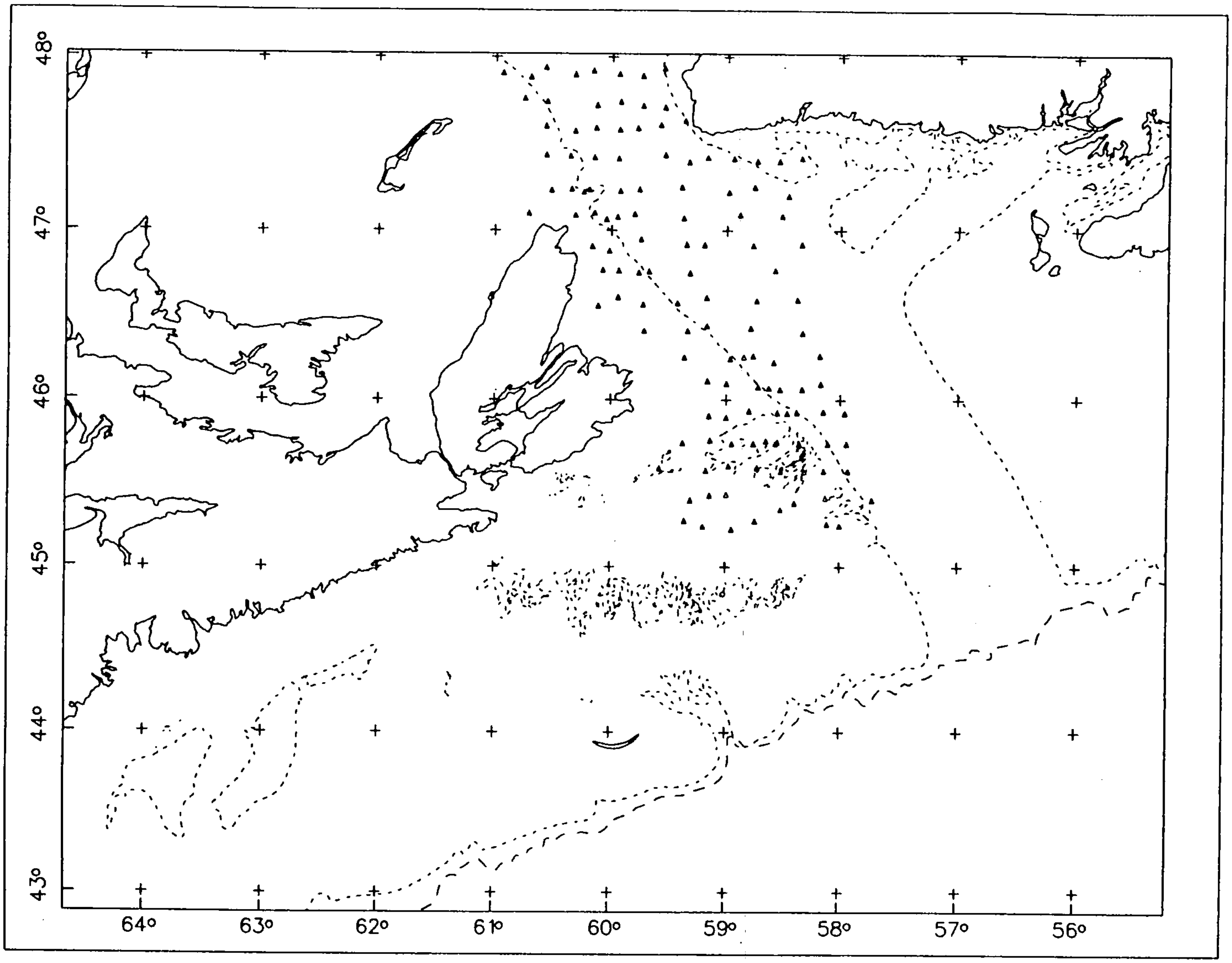


Fig. 1a. The CTD stations for the January survey.

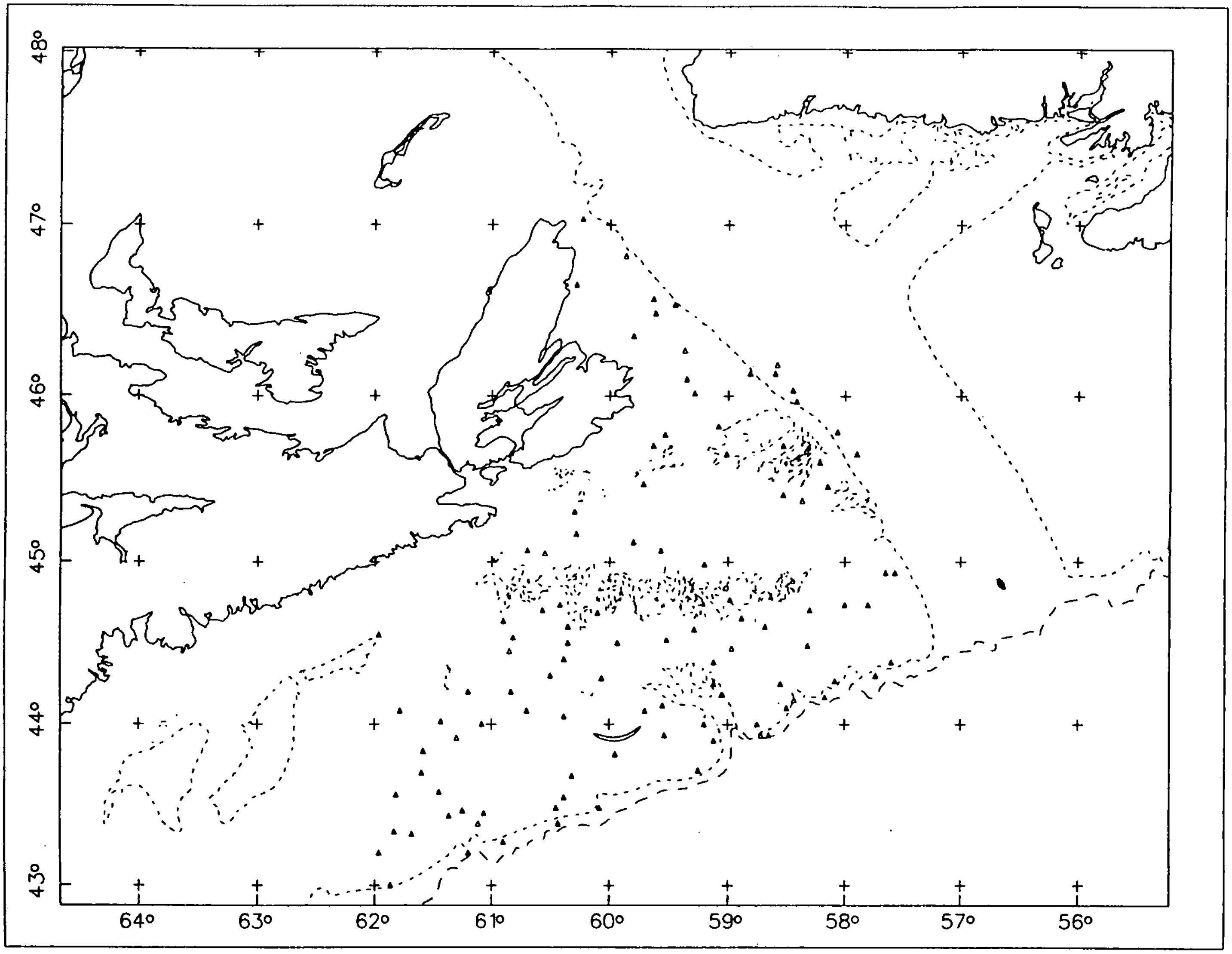


Fig. 1b. The CTD stations for the July survey.

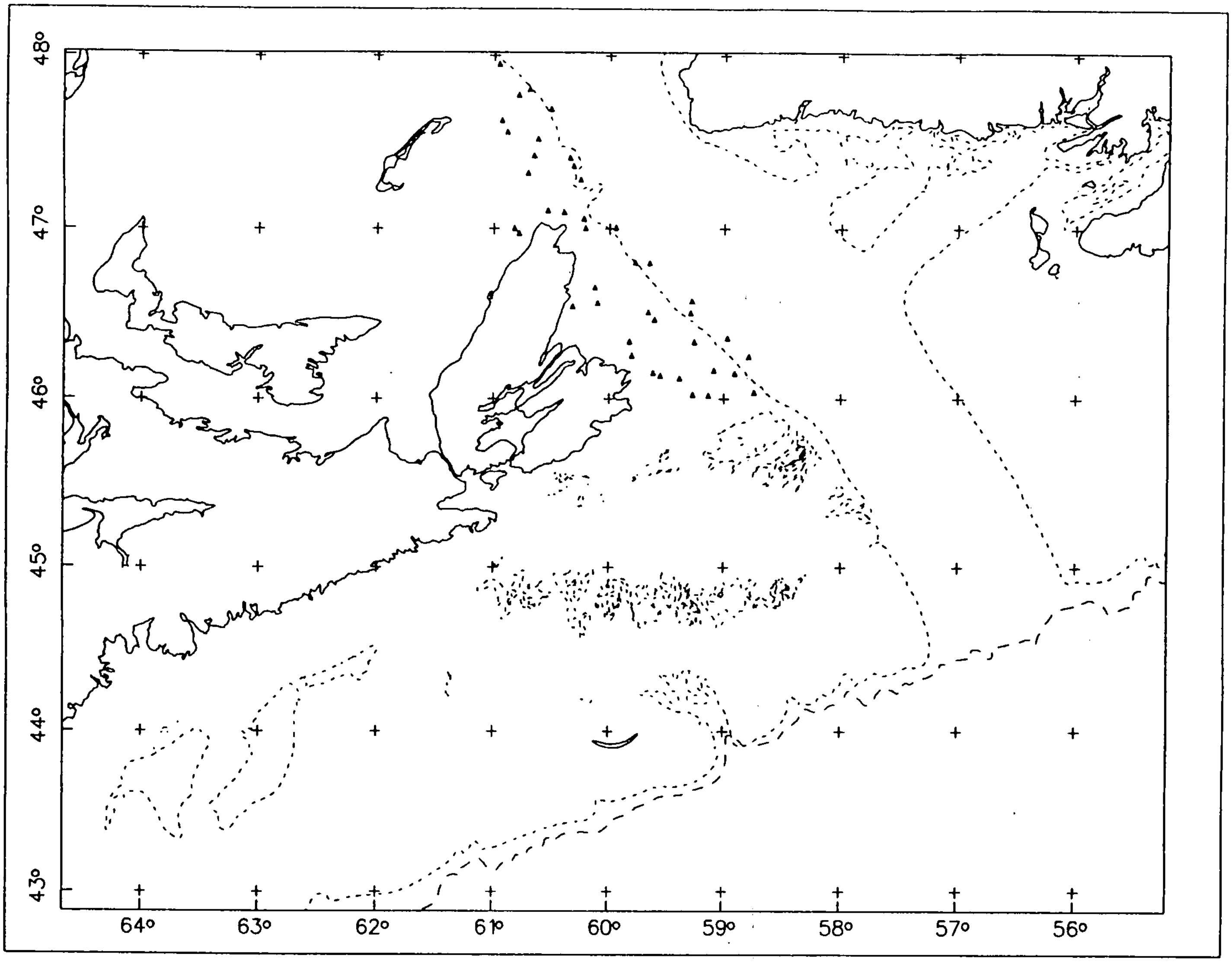
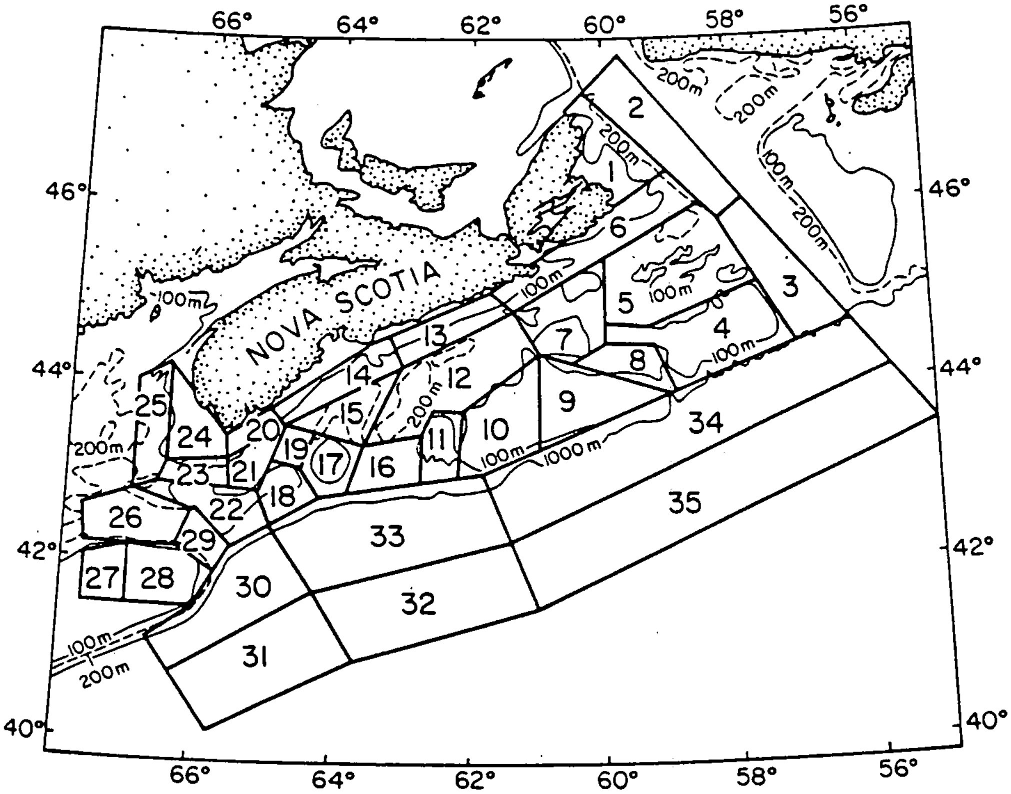


Fig. 1c. The CTD stations for the September survey.



1. SYDNEY BIGHT
2. N. LAURENTIAN CHANNEL
3. S. LAURENTIAN CHANNEL
4. BANQUEREAU
5. MISAINE BANK
6. CANSO
7. MIDDLE BANK
8. THE GULLY
9. SABLE ISLAND
10. WESTERN BANK
11. EMERALD BANK
12. EMERALD BASIN
13. EASTERN SHORE
14. SOUTH SHORE
15. LAHAVE BASIN
16. SADDLE
17. LAHAVE BANK
18. BACCARO BANK
19. ROSEWAY BANK
20. SHELBURNE
21. ROSEWAY BASIN
22. BROWNS BANK
23. ROSEWAY CHANNEL
24. LURCHER SHOALS
25. E. GULF OF MAINE
26. GEORGES BASIN
27. GEORGES SHOAL
28. E. GEORGES BANK
29. N.E. CHANNEL
30. SOUTHERN SLOPE
31. SOUTHERN OFFSHORE
32. CENTRAL OFFSHORE
33. CENTRAL SLOPE
34. NORTHERN SLOPE
35. NORTHERN OFFSHORE

Fig. 2. The areas defined by Drinkwater and Trites (1987).

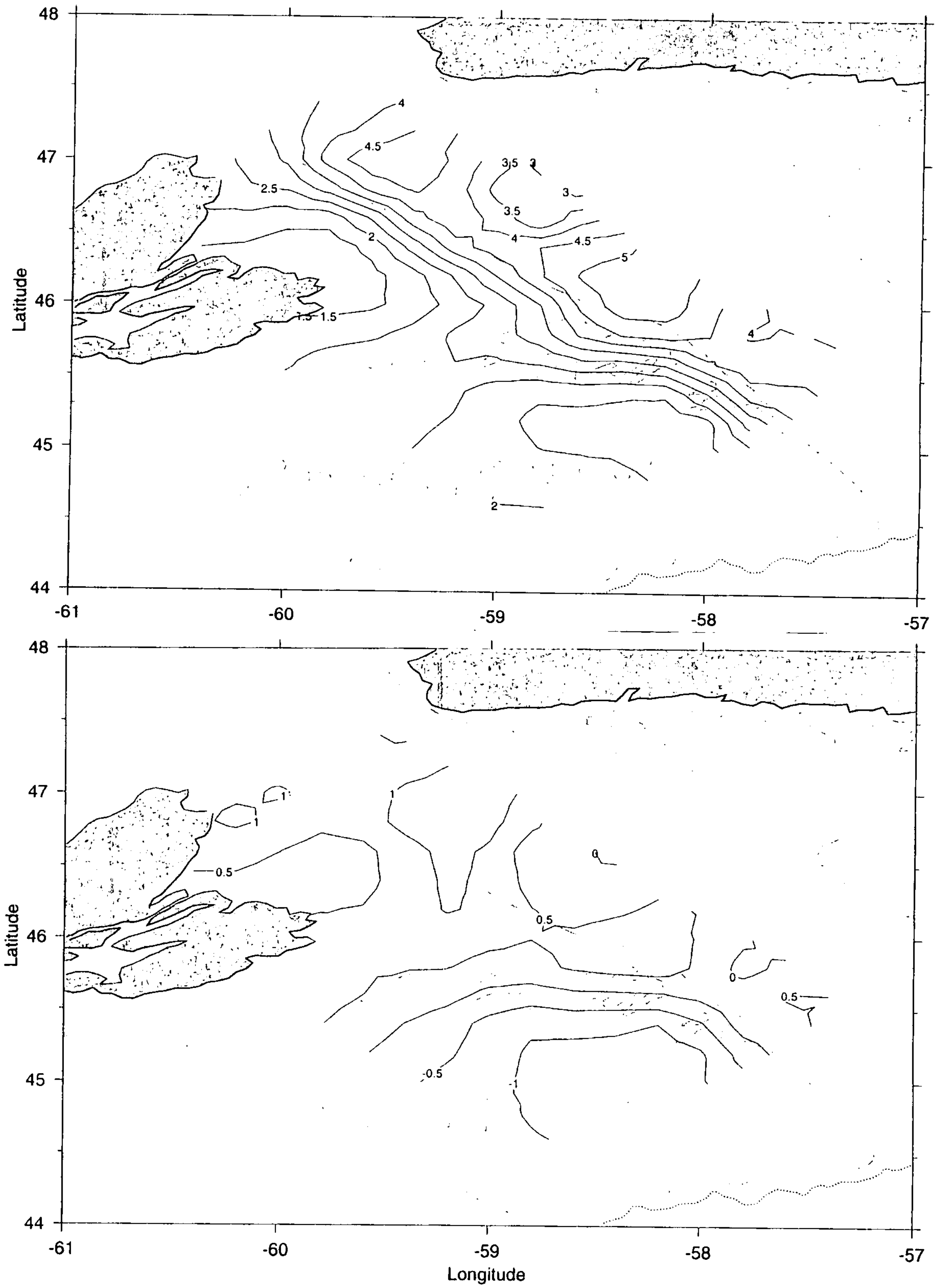


Fig. 3. The optimally-estimated near-bottom temperatures (top) and temperature anomalies (bottom) during the January survey.

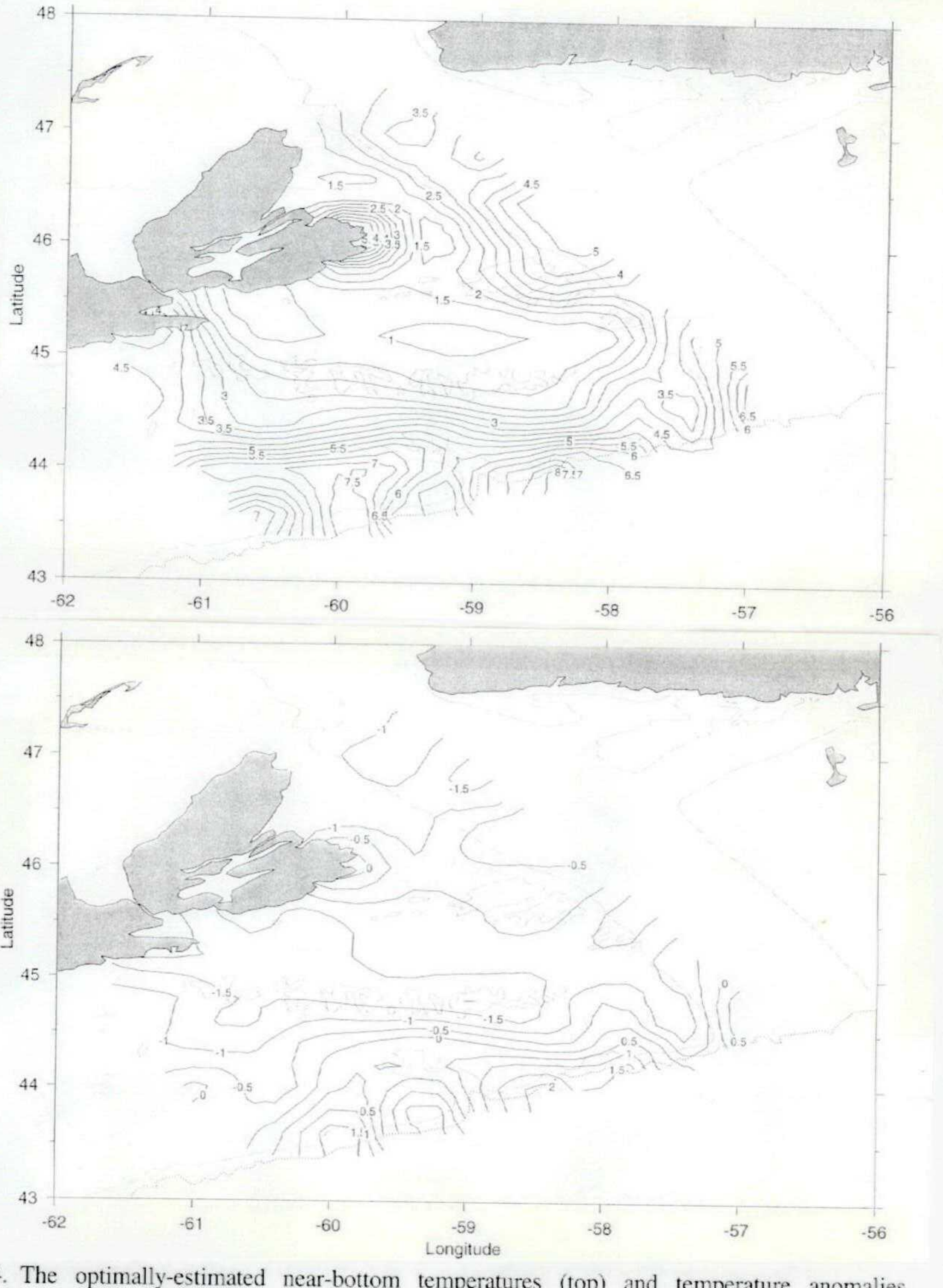


Fig. 4. The optimally-estimated near-bottom temperatures (top) and temperature anomalies (bottom) during the July survey.

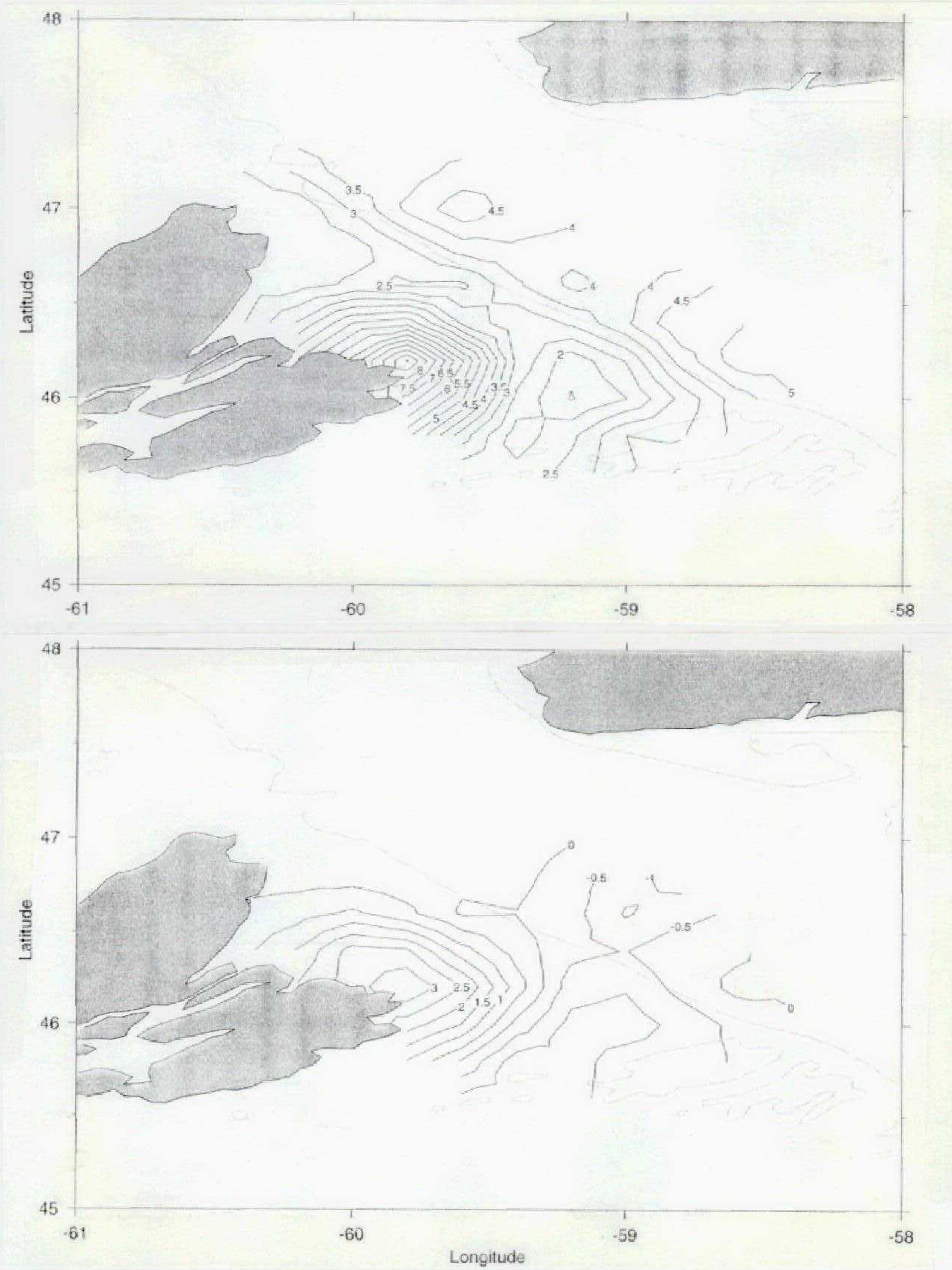


Fig. 5. The optimally-estimated near-bottom temperatures (top) and temperature anomalies (bottom) during the September survey.

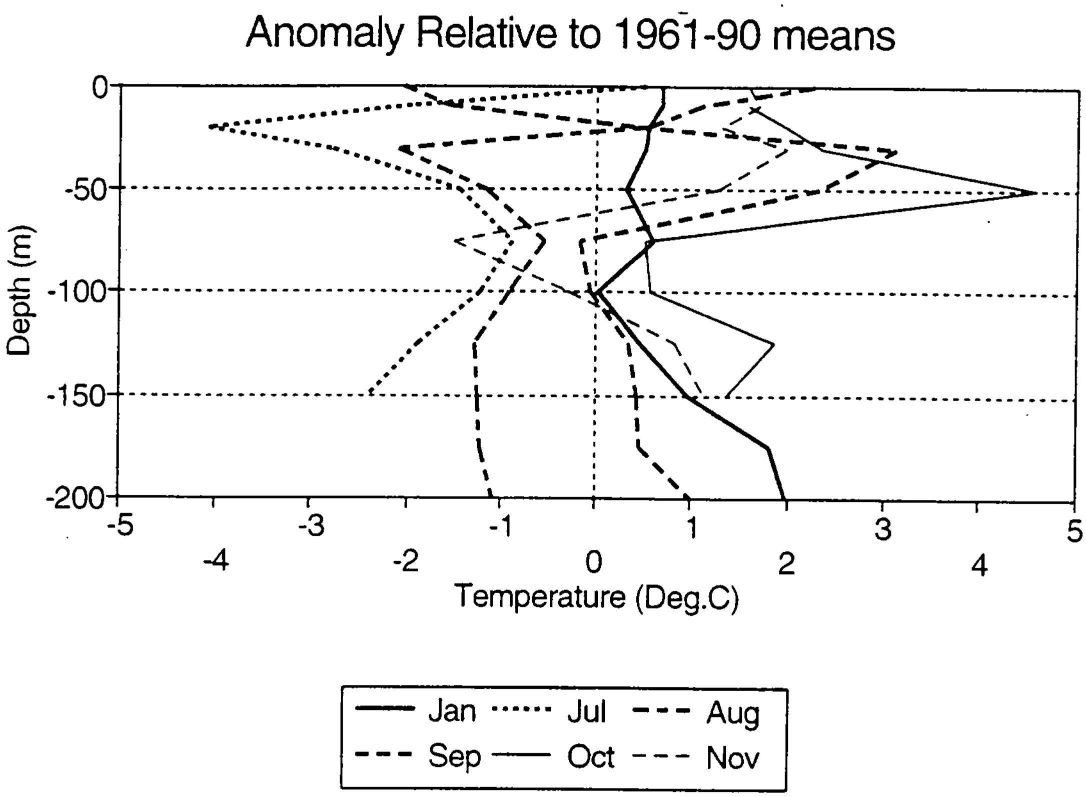


Fig. 6. Monthly mean temperature anomaly profiles for Sydney Bight (area 1 in Fig. 2).

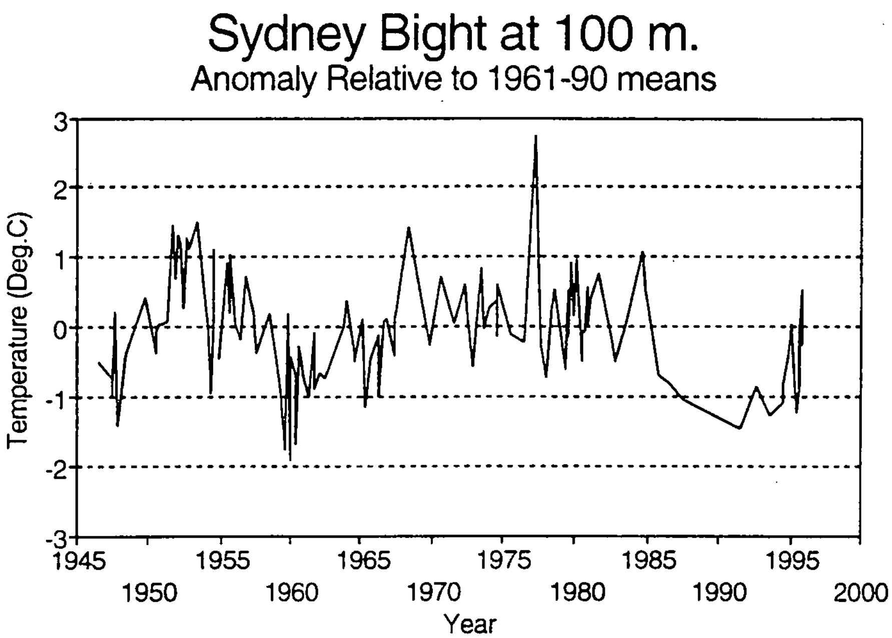


Fig. 7. Time series of monthly mean temperature anomalies at 100 m for Sydney Bight (area 1 in Fig. 2).

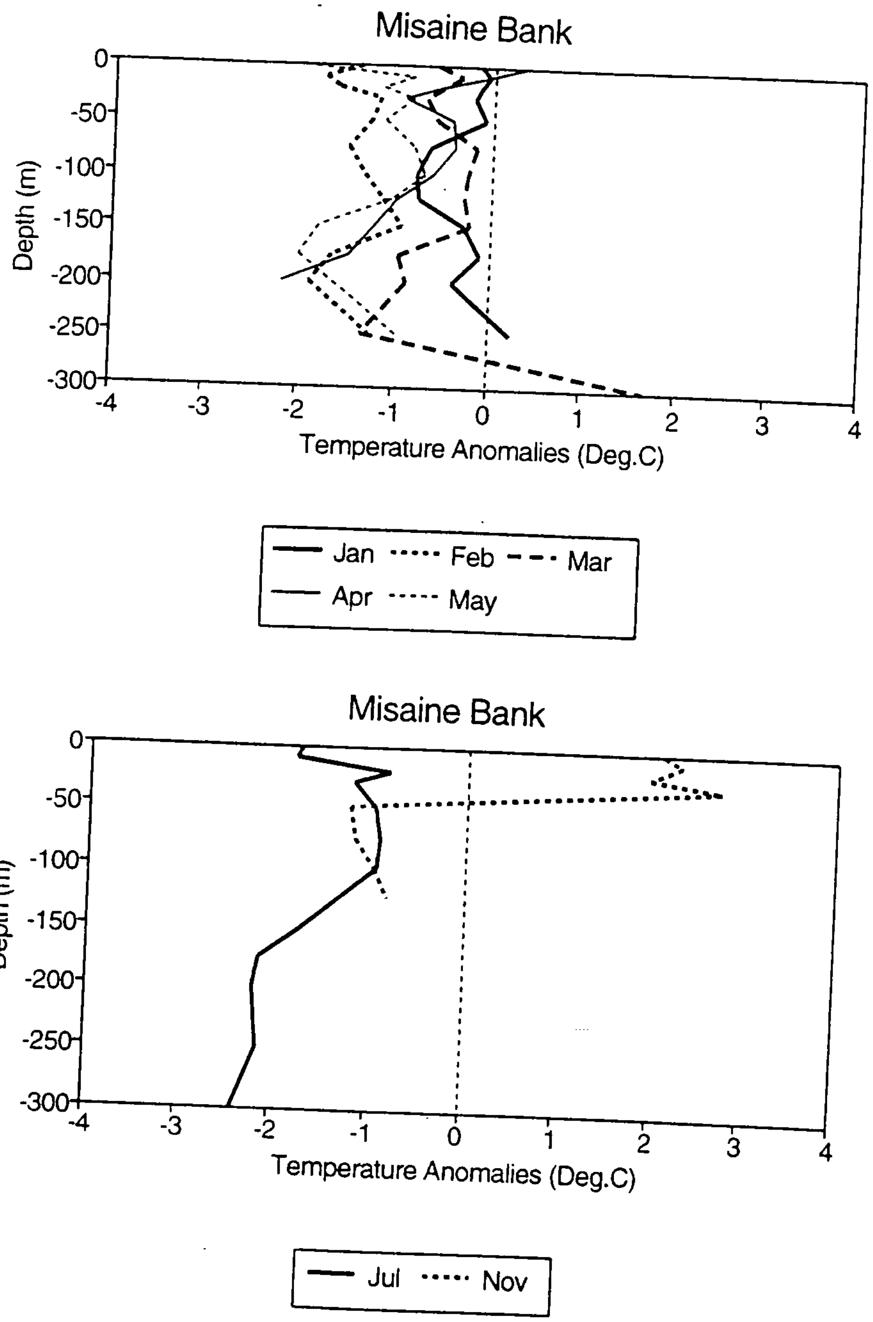


Fig. 8. Monthly mean temperature anomaly profiles for Misaine Bank (area 5 in Fig. 2).

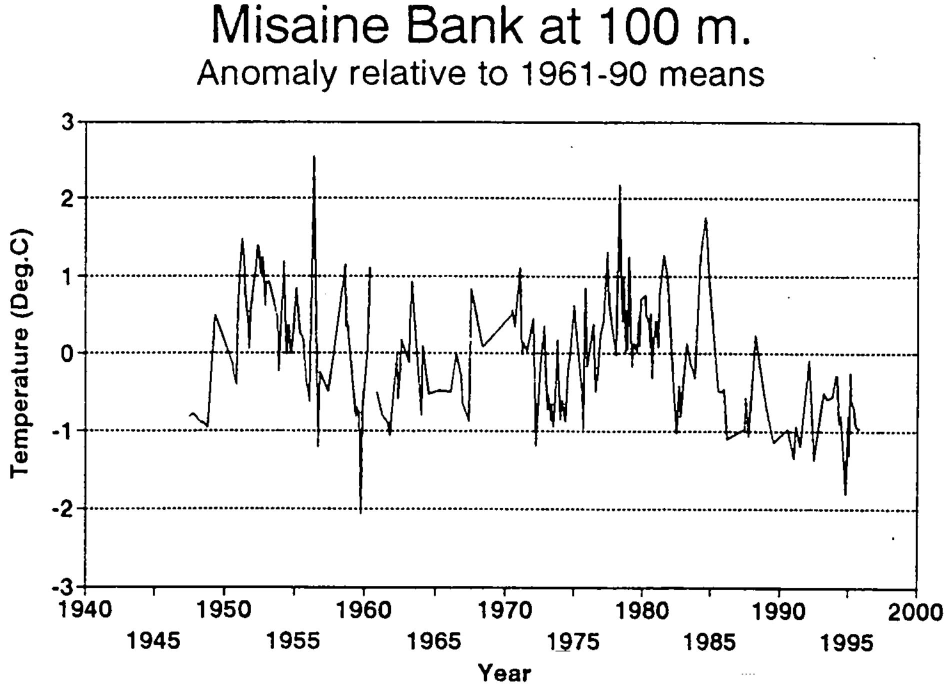


Fig. 9. Time series of monthly mean temperature anomalies at 100 m for Misaine Bank (area 5 in Fig. 2.)