Not to be cited without
permission of the authors[1]

DFO Atlantic Fisheries
Research Document 95/98

Ne pas citer sans
autorisation des auteurs[1]

MPO Pêches de l'Atlantique
Document de recherche 95/ 98

ENVIRONMENTAL CONDITIONS IN ATLANTIC CANADA, SUMMER 1995 WITH COMPARISONS TO THE 1961-1990 AVERAGE

by

E. Colbourne

Department of Fisheries and Oceans
P. O. Box 5667
St. John's Newfoundland, Canada A1C 5X1

[1]This series documents the scientific basis for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the secretariat.

[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

ABSTRACT

Oceanographic observations from the Grand Bank, northeast Newfoundland and southern Labrador Shelves during the summer (July) of 1995 are presented and compared to historical (1961-1990) data from the area. In addition, meteorological and ice cover data from the winter and spring are also presented. The analysis indicates that the colder than normal air temperatures experienced in Atlantic Canada during the winter and early spring had moderated to near normal conditions by the spring of 1995. The above normal ice coverage during winter and early spring along the east coast of Newfoundland and Labrador had returned to near normal conditions by mid-May except for some isolated patches in the inshore regions. At Station 27 water temperatures were normal during the winter months but had cooled to 0.5-1.0 °C below normal during the spring and early summer of 1995, except in the depth range of 15-70 m in July when temperatures were up to 1.0 °C above normal. Salinities were near normal during early winter and from January to July near the bottom but up to 1.0 psu fresher than normal in the upper water column during spring and early summer. The cold-intermediate-layer (CIL) was above normal along the Flemish Cap transect (20 %) and up to 28 % below normal along the Bonavista transect and 32 % below normal along the Seal Island transect. The cross-sectional area of sub-zero °C water on the Northeast Newfoundland and southern Labrador Shelves was the lowest in about 10 years. Minimum CIL core temperatures were above normal along the Seal Island transect, about normal along the Bonavista transect but still slightly below normal on the Grand Bank along the Flemish Cap transect.

RÉSUMÉ

On présente ici des observations océanographiques concemant les Grands Bancs de Terre-Neuve ainsi que les plates-formes du nord-est de Terre-Neuve et du sud du Labrador au cours de l'été (juillet) 1995 et on les compare aux données historiques (1961-1990) pour la région. On présente également des données sur la météorologie et la couverture de glace en hiver et au printemps. L'analyse révèle que les températures de l'air inférieures à la normale qu'a connues le Canada atlantique durant l'hiver et le début du printemps se sont ultérieurement modérées et qu'elles avaient atteint un niveau proche de la normale au printemps de 1995. Quant à la couverture de glace, qui était supérieure à la normale le long de la côte est de Terre-Neuve et du Labrador en hiver et au début du printemps, elle était pratiquement revenue à la normale à la mi-mai, sauf en ce qui conceme quelques bancs de glace dans les régions côtières. À la station 27, les températures de l'eau, normales durant l'hiver, étaient tombées de 0,5 à 1 °C sous la normale au printemps et au début de l'été 1995, sauf aux profondeurs de 15 à 70 mètres en juillet, où elles étaient supérieures de 1 °C à la normale. Les salinités étaient proches de la normale au début de l'hiver et de janvier à juillet à proximité du fond, mais supérieures de 1,0 unité pratique de salinité à la normale dans la partie supérieure de la colonne d'eau au printemps et au début de l'été. La couche froide intermédiaire (CFI) se situait au-dessus de la normale le long du transect du Bonnet flamand (20 %) et jusqu'à 28 % et 32 % en dessous d'elle le long des transects de Bonavista et de l'île Seal, respectivement. L'aire transversale d'eau de température inférieure à O °C sur les plates-formes du nord-est de Terre-Neuve et du sud du Labrador était à son plus bas niveau en 10 ans environ. Les températures intemes minimales de la CFI étaient supérieures à la normale le long du transect de l'île Seal, proches de la normale le long du transect de Bonavista, mais restaient inférieures à la normale sur les Grands Bancs de Terre-Neuve, le long du transect du Bonnet flamand.

INTRODUCTION

This report presents an overview of environmental conditions in Atlantic Canada during the first half of 1995, with a comparison to the average conditions based on historical data from the period 1961-1990 in accordance with the convention of the World Meteorological Organization. The 1995 observations were made during an annual oceanographic survey in July aboard the CSS Parizeau, conducted by the Department of Fisheries and Oceans in St. John's Newfoundland. In addition, all Station 27 data collected since January of 1995 by fisheries research surveys are included in the analysis. The report also presents meteorological and ice cover data for Atlantic Canada during the winter and spring of 1995.

During the July 1995 survey oceanographic measurements were made along 9 transects running from the inshore areas along the east coast of Newfoundland and Labrador and offshore to the shelf edge across most major Banks (Fig. 1). Measurements along the transects included vertical profiles of currents, temperature, salinity, chlorophyll and dissolved oxygen. In addition, water and plankton samples were collected at some stations for salinity, chlorophyll, oxygen and biological analysis.

METEOROLOGICAL CONDITIONS

The mean air temperature and anomalies over Canada from January to May of 1995 are shown in Fig. 2, the shaded areas indicate a positive anomaly. This data is published by the Atmospheric Environment Service of Canada in the Monthly Supplement to Climate Perspectives (Saulesleja and Berry, 1995).

During the winter of 1994-1995 (Dec. to Jan.) a ridge of high pressure over western Canada coupled with a more northerly displaced jet stream resulted in generally above normal temperatures across western and central Canada and allowed milder air to penetrate to eastern Canada and into the Arctic (Saulesleja and Berry, 1995). The exception being northern Newfoundland and Labrador which remained colder than normal.

In January air temperature anomalies ranged from 2.0 °C below normal over northern Newfoundland and Labrador and intensified to between -2.0 to -4.0 °C by February and warmed to 0.0 to -2.0 °C by March of 1995. By April of 1995 the air temperatures had moderated to about 2.0 °C above normal over northern regions and to 0.0 over southern areas, a trend that continued into May (Fig 2 and Fig 3).

The recent negative air temperature anomalies experienced this past winter, although not as severe as in the past few years, are a continuation of a cold trend that began during the late 1980s (Findlay and Deptuch-Stapf, 1991). In contrast to the colder than normal conditions in Atlantic Canada in the past several years western and most of central Canada have experienced above normal air temperatures, indicated by the shaded areas in Fig. 2.

ICE CONDITIONS

The maximum extent of the ice edge (defined by one-tenth total coverage) during mid-January to mid-June of 1995 together with the median and maximum positions of the ice edge for the period 1962 to 1987 along the coast of Newfoundland are shown in Fig. 4. The mid-monthly positions of the ice edge for 1995 were digitized from the daily ice charts published by Ice Central of Environment Canada in Ottawa, the median and maximum positions of the ice edge were published by Cote (1989).

During the fall of 1994 near surface water temperatures along the east coast of Newfoundland were somewhat warmer than normal (Colbourne, 1995) this together with weaker negative air temperature anomalies experienced during early winter of 1994-1995 resulted in only slightly above normal ice coverage during January and February (Fig. 4). By mid-March however, the ice edge had reached near maximum extent in the inshore regions along the east coast of Newfoundland but remained below normal in the offshore areas. By mid-April the ice cover had receded to about 48° N latitude still further south than normal but the offshore extent had receded to below normal conditions over much of the northeast Newfoundland and Labrador Shelves. By mid-May and into June, except in the some extreme inshore regions, the ice edge had receded to about normal limits along the coast of northern Newfoundland and southern Labrador.

In general, ice conditions along the east coast during the winter and early spring of 1995 were above normal (in terms of total ice coverage), but not as severe as in the previous few years. The exception to this was the above normal duration of ice that became locked into the bays along the east coast of Newfoundland due to persistent onshore winds.

STATION 27 TEMPERATURE AND SALINITY TIME SERIES

Depth versus time distribution of temperature and salinity (top panels) and anomalies (bottom panels) based on all XBT and CTD data collected at station 27 from January to the end of July, a total of 41 profiles, are plotted in Figure 5. The anomalies were calculated from the mean of all data collected on the station from 1961-1990.

The cold isothermal water column during the winter months has temperatures ranging from 0.0 °C to -1.5 °C from the surface to bottom and throughout the whole time period at depths below 85 m. The time series (top panel) shows upper layer (generally the 0 to 50 m depth range) temperatures decreasing from 1.0 °C in early January to -1.5 °C by the end of February, and remaining at that value until early April, when the surface warming commenced. By early May the upper layer temperature had again warmed to above 0.0 °C and to 10 °C by late July.

Figure 5a (bottom panel) shows that the normal temperatures experienced in January decreased to -0.25 to -0.5 °C below normal by early March and to -0.75 °C below normal in the upper layer by April. By late June and into July temperatures had warmed to 0.0 to 1.0 °C above normal in the depth range of 10 to 60 m but remained below normal at the surface and at depths from 60 m to the bottom. Figure 5b shows near normal salinities between 32.6 to 33.0 psu in the lower half of the water column and values ranging from 31.0 to 32.4 from the surface to about 75 m depth, up to 1.0 psu fresher than normal during spring and early summer.

The monthly temperature and salinity anomalies at Station 27 from January to July of 1995 at standard depths again referenced to a 1961 to 1990 average, are shown in Fig. 6. The normal temperatures experienced during the winter of 1995 over the entire water column have decreased to below normal values by spring. Temperatures during July of 1995 ranged from normal values at 20 m depth to 1.0 °C above normal at 50 m depth. Salinities have decreased from near normal values in February to 1.0 psu below normal by the spring in the upper layer.

The time series of monthly temperature and salinity anomalies at Station 27 from January 1, 1988 to July 31, 1995 at standard depths of 0, 30, 100 and 175 m, again referenced to a 1961 to 1990 mean, are shown in Fig. 7. The high frequency seasonal variations in the anomalies have been filtered out. At the surface the above normal temperatures experienced during the latter half of 1994 have again decreased to below normal values by the summer of 1995 but were above normal in July of 1995 at 30 m depth. At the deeper depths of 100 and 175 m temperatures have increased slightly during the last year but are still below normal. These negative anomalies have persisted since 1983 with a few periods of positive anomalies during the mid to late 1980s.

The time series of salinity anomalies (Fig. 7, bottom 4 panels) at the surface and at 30 m depth shows that the large fresher than normal anomaly that began in early 1991 had returned to near normal conditions by 1994 but have decreased to below normal values by the summer of 1995. Salinities in the deeper water (100-175 m) had returned to near normal conditions in early 1993 but returned to fresher conditions by the summer of 1994 and again by the summer of 1995. Other periods with colder and fresher than normal salinities particularly in the early 1970s and mid 1980s are associated with colder than normal air temperatures, heavy ice conditions and larger than normal summer cold-intermediate-layer (CIL) areas on the continental shelf (Drinkwater, 1993, Colbourne et al. 1994).

VERTICAL TEMPERATURE, SALINITY AND OXYGEN DISTRIBUTION

The vertical distribution of the temperature and salinity fields together with the anomalies along the standard Flemish Cap, Bonavista and Seal Island transects for the summer of 1995 are presented in Fig. 8 to 14. The anomalies were calculated from the mean of all available data for the transect from 1961 to 1990 during the time period of the 1995 survey.

The summer temperature along the Flemish Cap transect (Fig. 8) ranged from 10 °C near the surface to -1.0 °C below 75 m across the Grand Bank and about 3.0 °C over the Flemish Cap in the depth range from 80 m to the bottom. These temperatures were more than 1.0 °C below normal in the upper layer over the Grand Bank and about 0.5 °C below normal near bottom over the Grand Bank and Flemish Cap. Upper layer salinities (Fig. 9) were slightly fresher than normal over the Grand Bank to slightly saltier than normal over the Flemish Pass and Cap, while deeper (below 150 m) water salinities were normal.

Temperatures along the Bonavista transect (Fig. 10) in the upper 50 m of the water column ranged from 0.0 °C to 8.0 °C near the coast and to 4.0 to 6.0 °C over most of the continental shelf. In deeper water (50 m to the bottom) temperatures ranged from -1.0 °C to -1.5 °C near the coast and to 0.0 °C to 3.0 °C further offshore near the edge of the continental shelf and beyond. The corresponding temperature anomalies ranged from 0.0 to -1.0 °C in the surface layer over the continental shelf and to 0.0 to 1.0 °C above normal over the water column from 50 m to the bottom across the shelf. Bonavista salinities (Fig. 11) ranged from 31.0 psu near the surface to 33.5 psu near the bottom over the inshore portion of the transect to 34.75 psu at about 325 m depth near the shelf edge. The corresponding salinity anomalies show fresher than normal conditions ranging from 0.1 to 0.9 psu below normal in the upper water column in the inshore region and from 0.1 to 0.6 psu above normal in the surface layers over the edge of the continental shelf and in the depth range of 100-300 m over the shelf.

The average dissolved oxygen distribution across the northeast Newfoundland shelf along the Bonavista transect (Fig. 12) shows saturations ranging form 90 to 100 % in the surface layers to about 80 to 85 % over the shelf in the CIL and about 90 % in deeper water on the continental slope areas. During the summer of 1995 saturation levels ranged from 90 to 100 % from the surface to about 100 m depth over the shelf and to bottom near the shelf edge. Over the inshore portion of the shelf values ranged from 85 to 90 % from 100 m to the bottom. These values are very similar to 1994 during the same time period and show no evidence of oxygen depletion.

Temperatures along the Seal Island transect (Fig. 13) ranged from 2 to 6.0 °C in the upper layer and from -0.5 to 0.0 °C over most of the shelf below 50 m depth and about 3.0 °C beyond the shelf edge. Temperature anomalies along the Seal Island transect ranged from 0.0 to 1.0 °C above normal over the shelf and about 0.0 to -1.0 °C below normal in the offshore region beyond the shelf edge. Salinities along the Seal Island transect (Fig. 14) were generally 0.1 psu to 0.8 psu above normal over most of the shelf and normal in deep water at the shelf edge.

THE COLD INTERMEDIATE LAYER (CIL)

As shown earlier in Fig. 10 the vertical temperature structure on the Newfoundland continental shelf is dominated by a cold layer of water, commonly referred to as the CIL (Petrie et al., 1988), trapped between the seasonally heated upper layer and warmer slope water near the bottom. For example, along the Bonavista transect during 1995 this cold layer extended offshore to about 200 km, with a maximum thickness of about 190 m corresponding to a cross-sectional area of about 19.7 km^2 compared to the 1961-90 average of 26.8 km^2. The core of the CIL (temperatures less than -1.5 °C) was very small along the Bonavista transect at about only 2 km^2 compared to an average of about 9 km^2 and non-existent along the Seal Island transect.

Figure 15 shows a time series of the CIL cross-sectional area for the Seal Island, Bonavista and Flemish Cap transects. In 1995 the CIL area off Bonavista was about 30 % below normal compared to about 7 % above normal in 1994, 28 % in 1993 and up to 68 % in 1991. The CIL area along the Seal Island transect was also well below normal (32%) during 1995 with a cross-sectional area of 19.2 km^2 compared to the 1961-90 average of 28.3 km^2. Along the

Flemish Cap transect the CIL remained above normal during the summer of 1995 at about 18 % compared to 12 % in 1994 and to 48 % during 1991. In general, the total cross-sectional area of sub-zero °C water, except for the Flemish Cap transect, was the lowest in about 10 years.

The intensity or minimum core temperatures of the CIL for all three transects from 1948 to 1995 are shown in Fig. 16. The minimum temperature observed in the core of the CIL along the Seal Island transect was about -1.17 °C well above the normal of -1.57 °C. Core temperatures along the Bonavista transect were about normal at -1.63 °C and slightly below normal along the Flemish Cap transect at about -1.62 °C compared to the normal of -1.52 °C.

HORIZONTAL TEMPERATURE AND SALINITY FIELD

Figure 17 and 18 shows horizontal maps of the average and the July 1995 near surface (10 m) and 75 m depth temperature and salinity fields in Atlantic Canada from all available data from July 15 to 31, 1961-90 and for 1995. These contours were derived from unweighted averages (ie. data for the entire time period are assumed synoptic) of all data in a square grid of 0.25 degrees. The normal sea surface temperature for this time period ranged from 12.0 °C over the Grand Bank to 5.0 °C off southern Labrador on Hamilton Bank. The surface temperatures during July 1995 ranged from 9.5 °C over the Grand Bank to about 4.5 to 5.0 °C on Hamilton Bank. In general the surface temperature over most of the surveyed area was up to 1.0 to 2.0 °C below the long-term average. Surface salinities show slightly fresher than normal conditions particularly along the coastal regions.

At 75 m depth, close to the bottom over most of the Grand Bank and about at the center of the CIL over most of the northeast Newfoundland Shelf, the average temperature ranged from 0.0 °C over the Grand Bank to about 3.0 °C along the continental slope and less than -1.0 °C over parts of the northeast Newfoundland and Labrador Shelves. The temperatures over the surveyed area in July 1995 ranged from -1.25 °C along the northeast Newfoundland coast to 3.0 °C at the shelf edge and from -1.0 to -1.25 °C over the Grand Bank. Except for the Grand Bank temperatures at 75 m depth were generally warmer than the long-term average. Salinities at 75 m depth were slightly saltier than normal in most areas.

ACKNOWLEDGEMENTS

I thank the technical staff of the oceanography section at NAFC for the professional job done in data collection and processing and for the computer software support. I also thank the many scientists at the NAFC for collecting and providing much of the data contained in this analysis and to the Marine Environmental Data Service in Ottawa for providing most of the historical data. I would also like to thank the captain and crew of the CSS Parizeau.

REFERENCES

Colbourne, E. B., S. Narayanan, and S. Prinsenberg. 1994. Climatic Change and Environmental Conditions in the Northwest Atlantic during the period 1970-1993. ICES mar. Sci. Symp., 198:311-322.

Colbourne, E. 1995. Oceanographic conditions and Climate Change in the Newfoundland Region During 1994. DFO AFRD. 95/3.

Cote, P. W. 1989. Ice limits eastern Canadian seaboard. Environment Canada, Ottawa. 39 p.

Drinkwater, K. F. 1994. Overview of Environmental Conditions in the Northwest Atlantic in 1993. NAFO SCR Doc. 94/20, Ser. No. N2385. 61p.

Findlay, B.F., and Deptuch-Stapf, A. 1991. Colder than normal temperatures over northeastern Canada during the 1980s. Climate Perspectives, April Monthly Review, 13:9-12.

Petrie, B., S. Akenhead, J. Lazier and J. Loder. 1988. The Cold Intermediate Layer on the Labrador and Northeast Newfoundland Shelves, 1978-1986. NAFO Sci. Coun. Stu. 12: 57-69.

Saulesleja, A. and M. Berry., 1995. Climate Perspectives, Monthly and Seasonal Reviews. Vol 17.

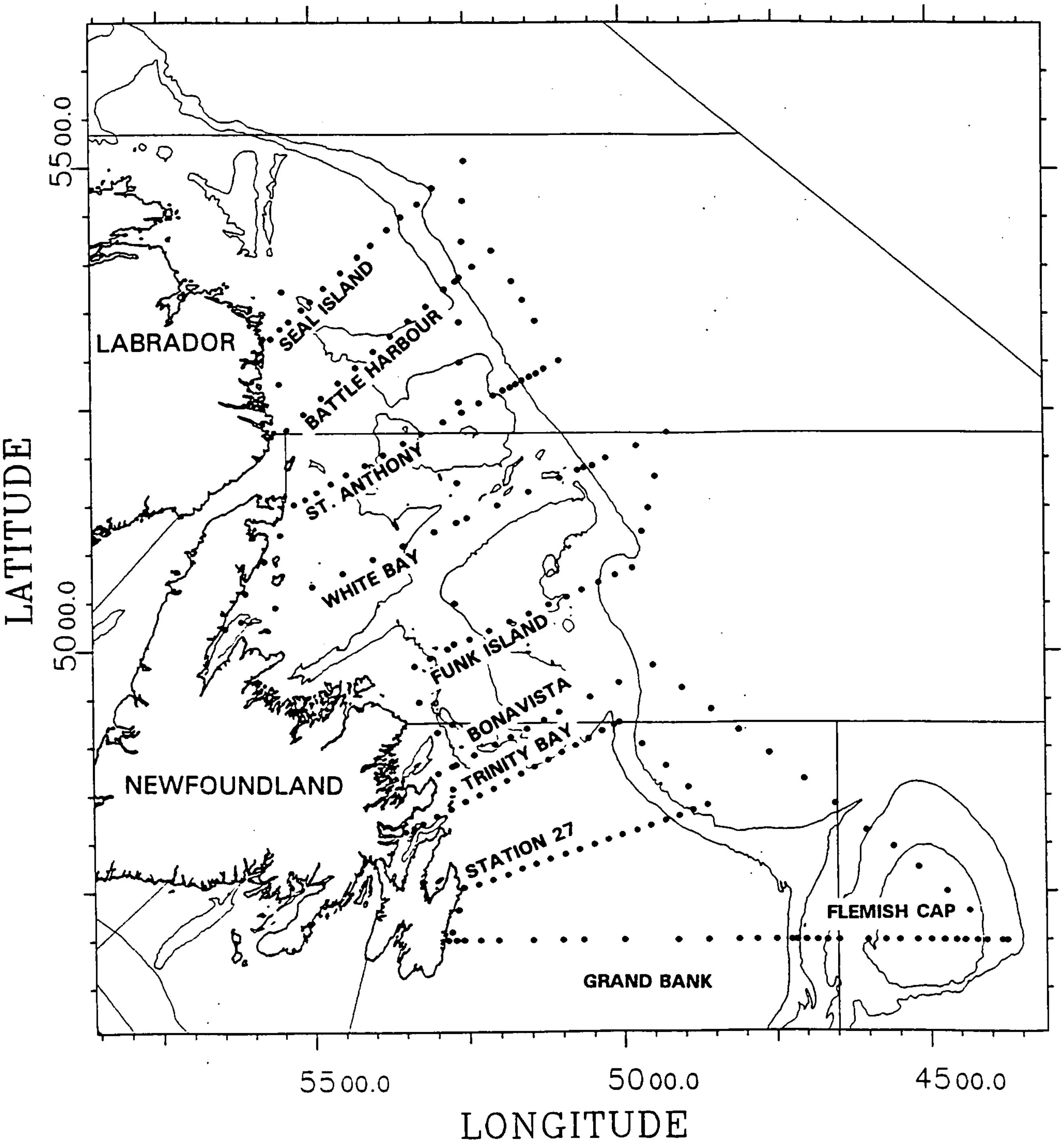


Fig. 1. Location map showing positions of the stations occupied during the annual oceanographic survey in July 1995. The bathymetry lines are 300 and 1000 m.

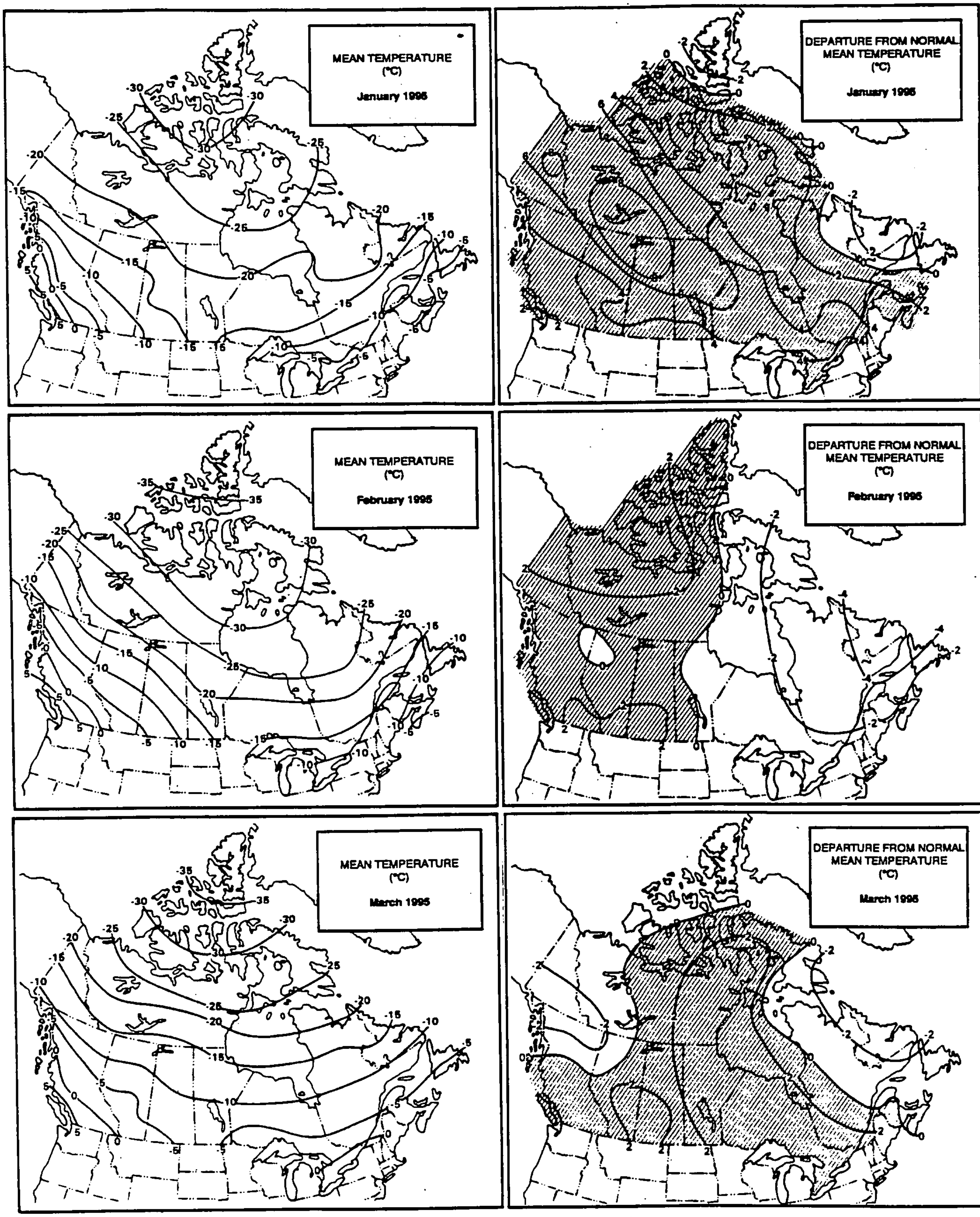


Fig. 2. The mean monthly air temperature and anomalies over Canada for January to March of 1995 (From Climatic Perspectives, Vol. 17, 1995).

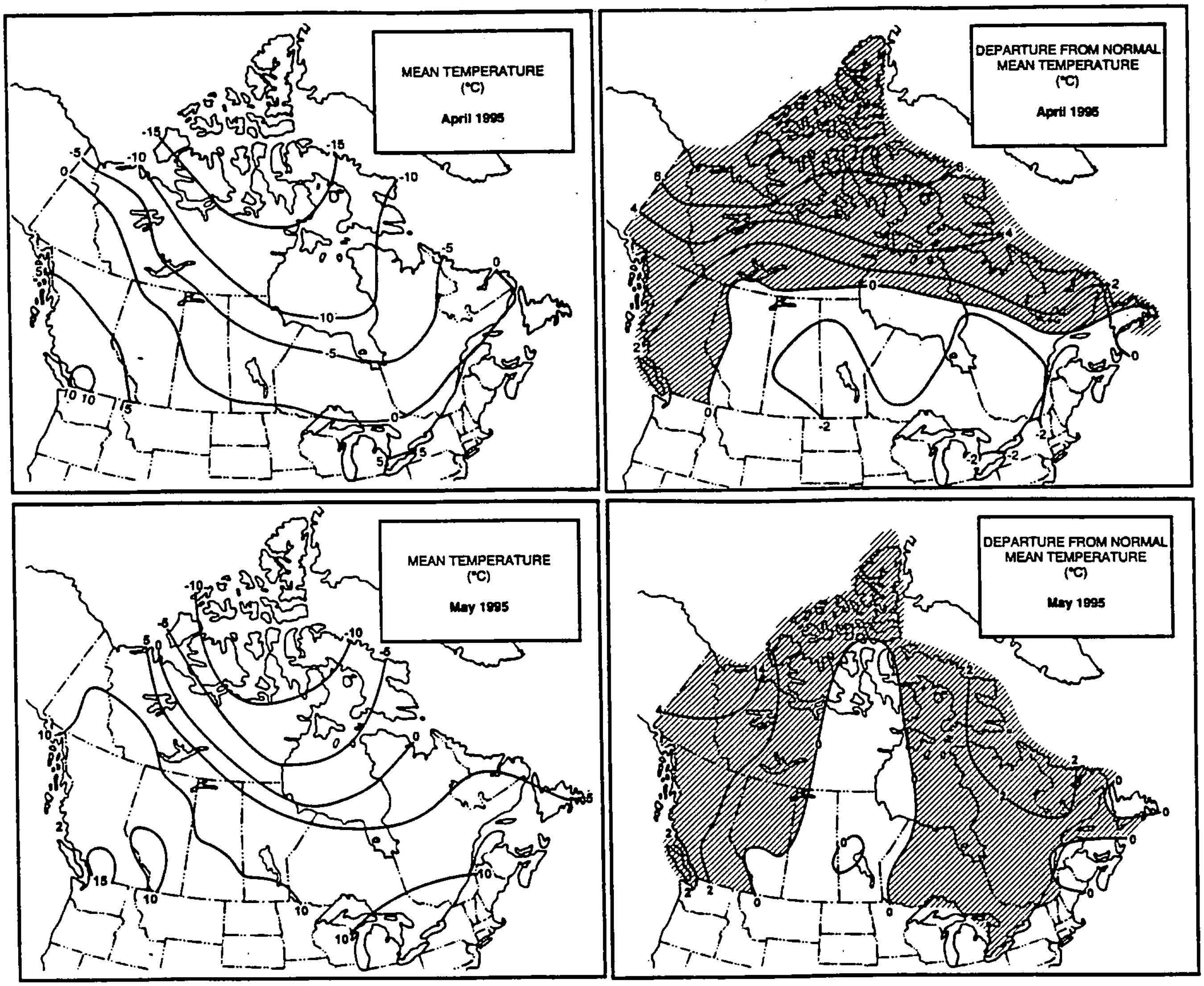
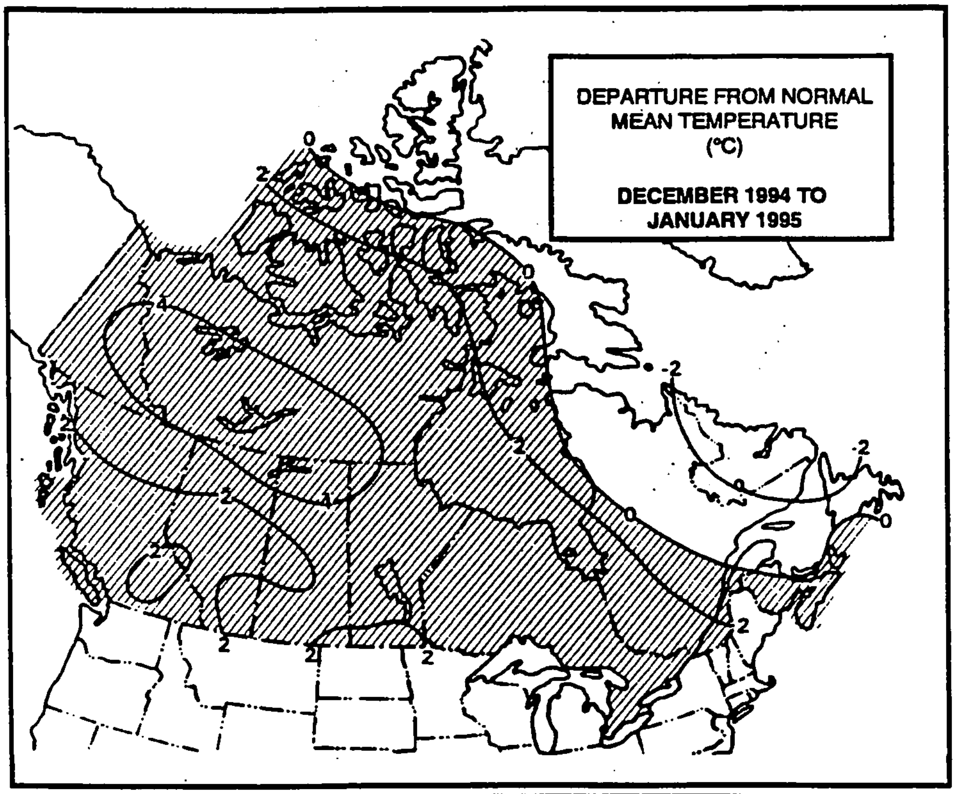


Fig. 2 (cont).The mean monthly air temperature and anomalies over Canada for April and May of 1995 (From Climatic Perspectives, Vol. 17, 1995).



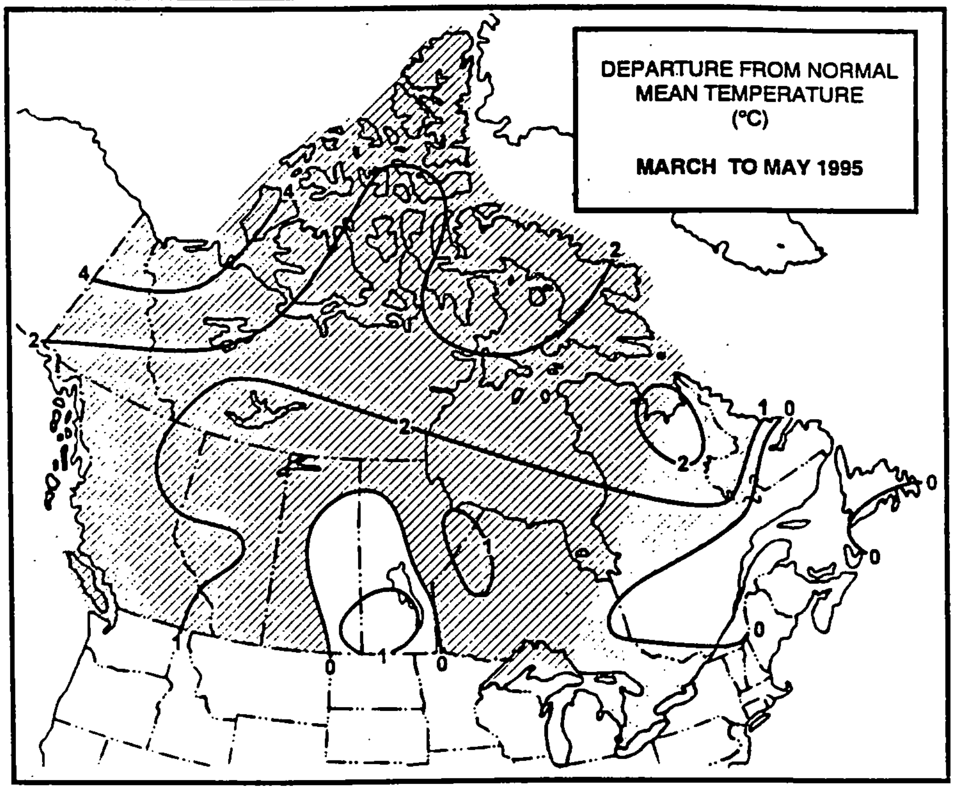


Fig. 2 (cont).Monthly air temperature anomalies over Canada for the winter and spring of 1995 (From Climatic Perspectives, Vol. 17, 1995).

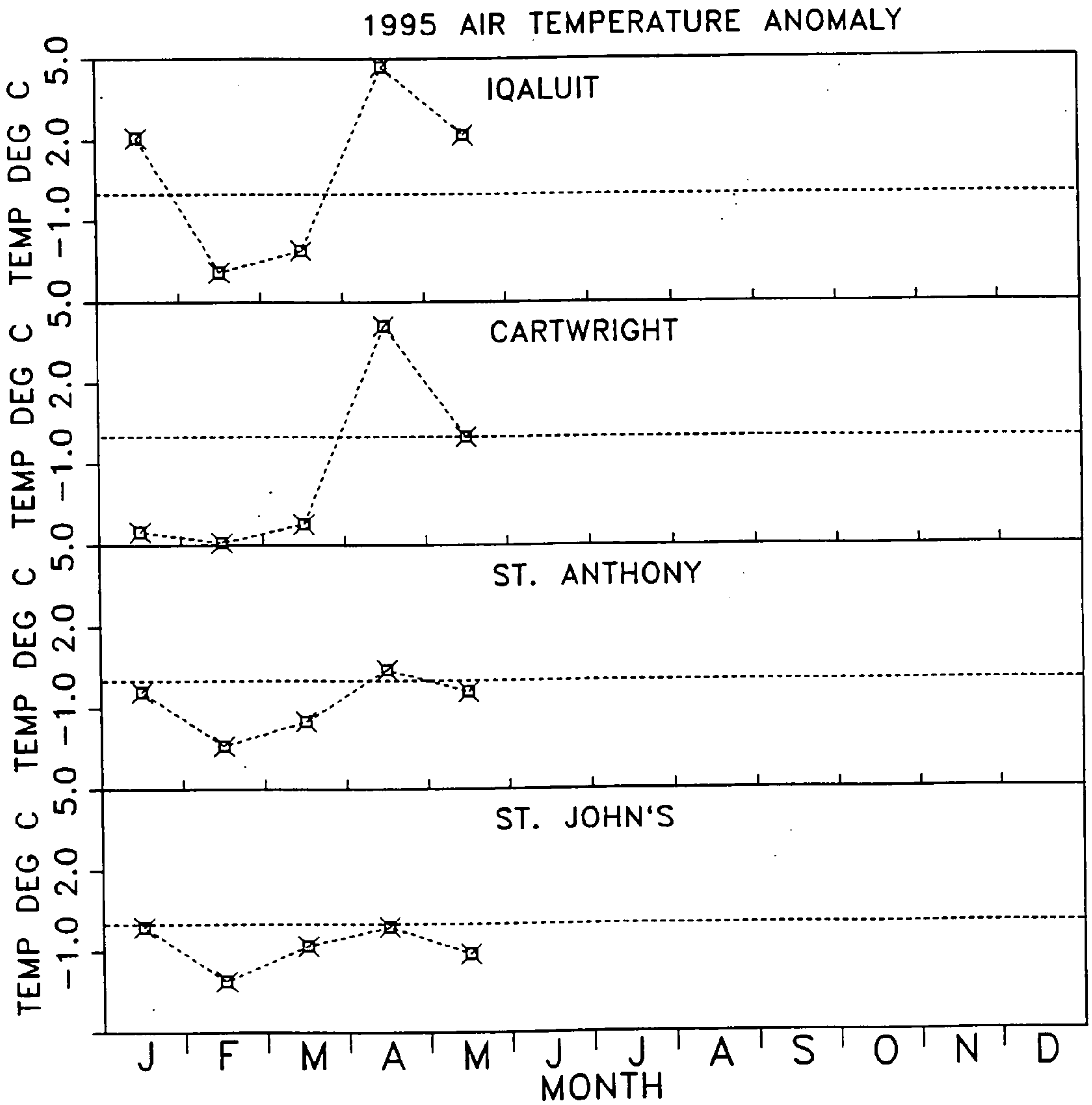


Fig. 3. The mean monthly air temperature anomalies at selected coastal sites for January to May of 1995 (From Climatic Perspectives, Vol. 17, 1995).

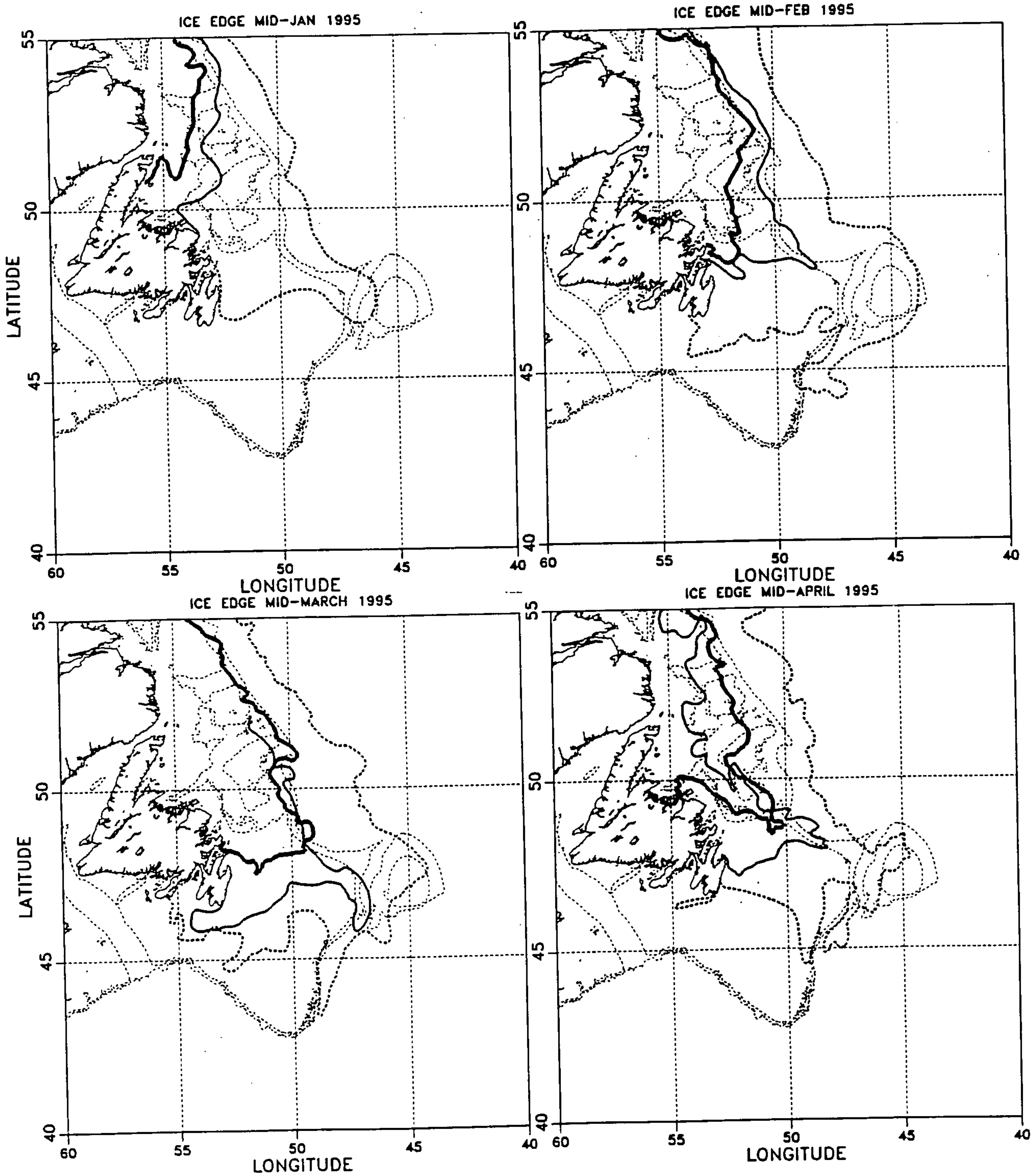


Fig. 4. Ice edge locations for mid-January to mid-April of 1995 (light solid lines). The dashed and heavy solid lines are locations for the maximum and median positions for the same time period based on historical data from 1962 to 1987. (from Cote, 1989)

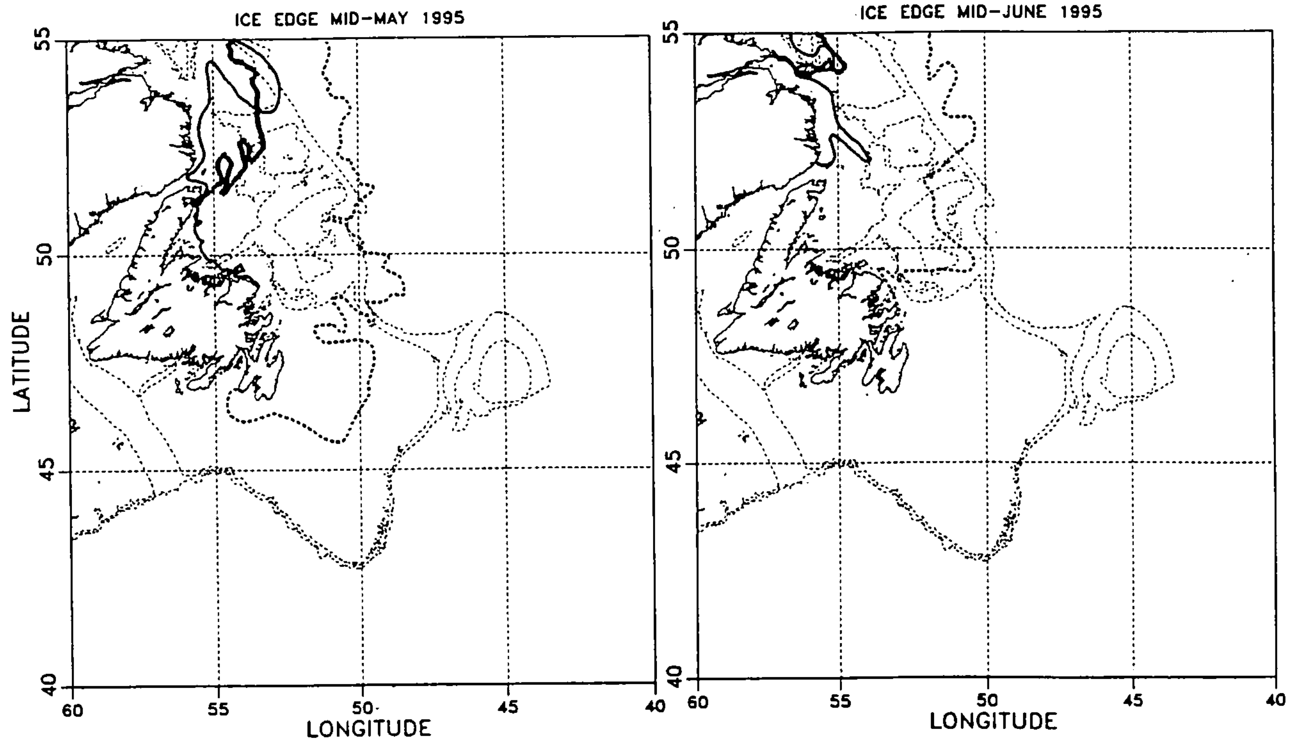


Fig. 4 (cont).Ice edge locations for mid-May and mid-June of 1995 (light solid lines). The dashed and heavy solid lines are locations for the maximum and median positions for the same time period based on historical data from 1962 to 1987. (from Cote, 1989)

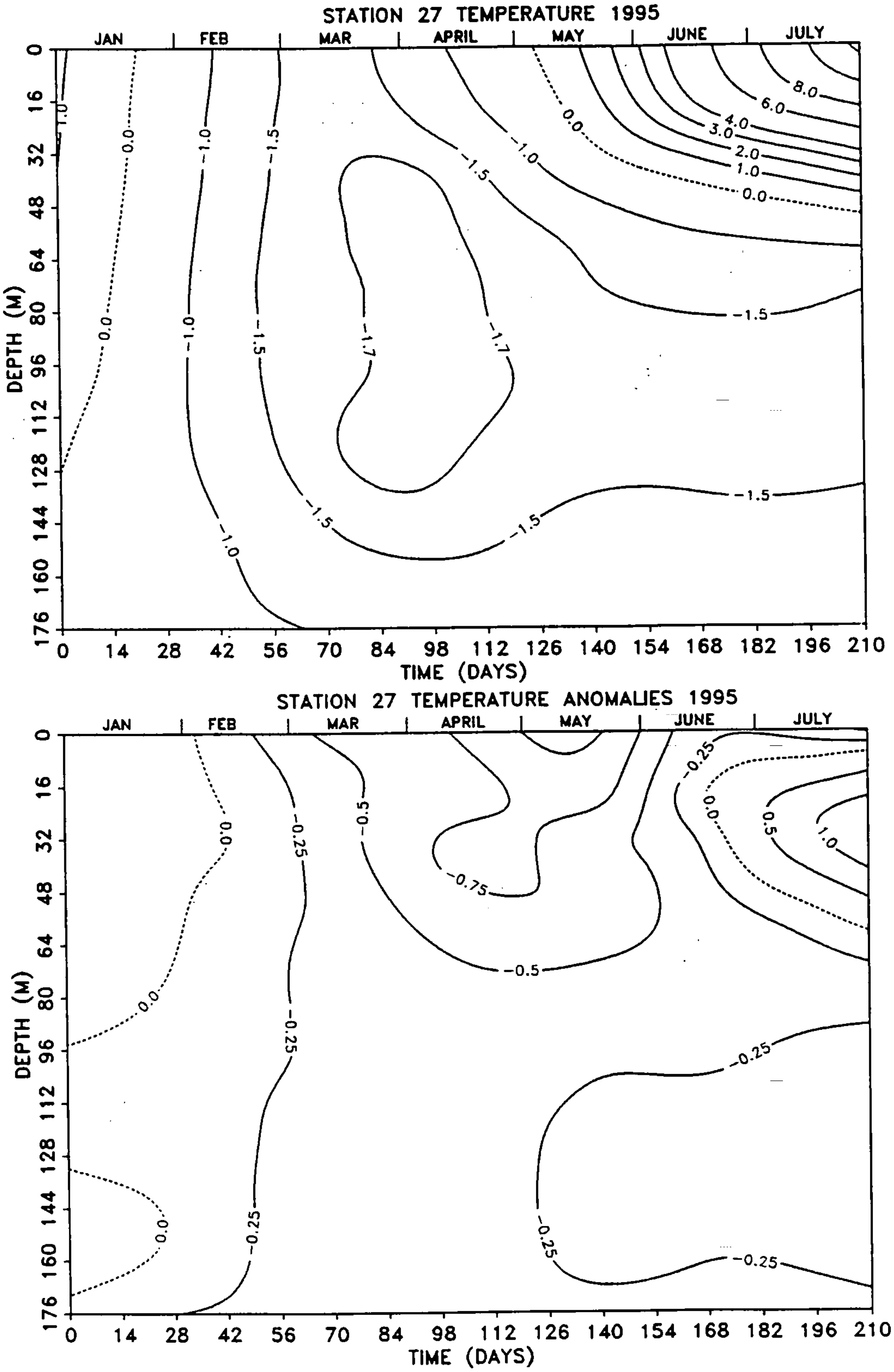


Fig. 5a. Depth versus time contour plots of temperatures and anomalies at Station 27 from January 1 to July 31, 1995.

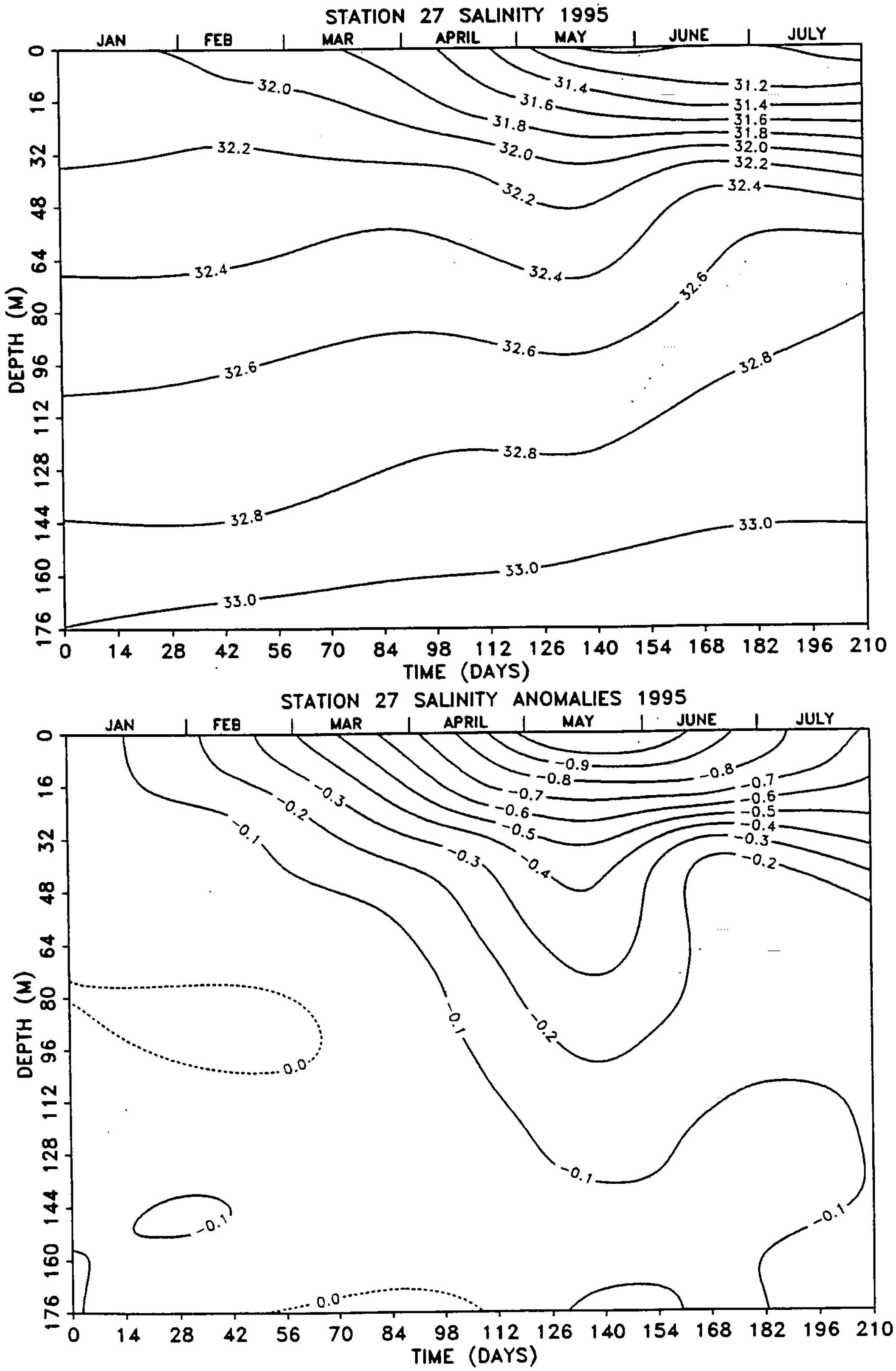


Fig. 5b. Depth versus time contour plots of salinity and anomalies at Station 27 from January 1 to July 31, 1995.

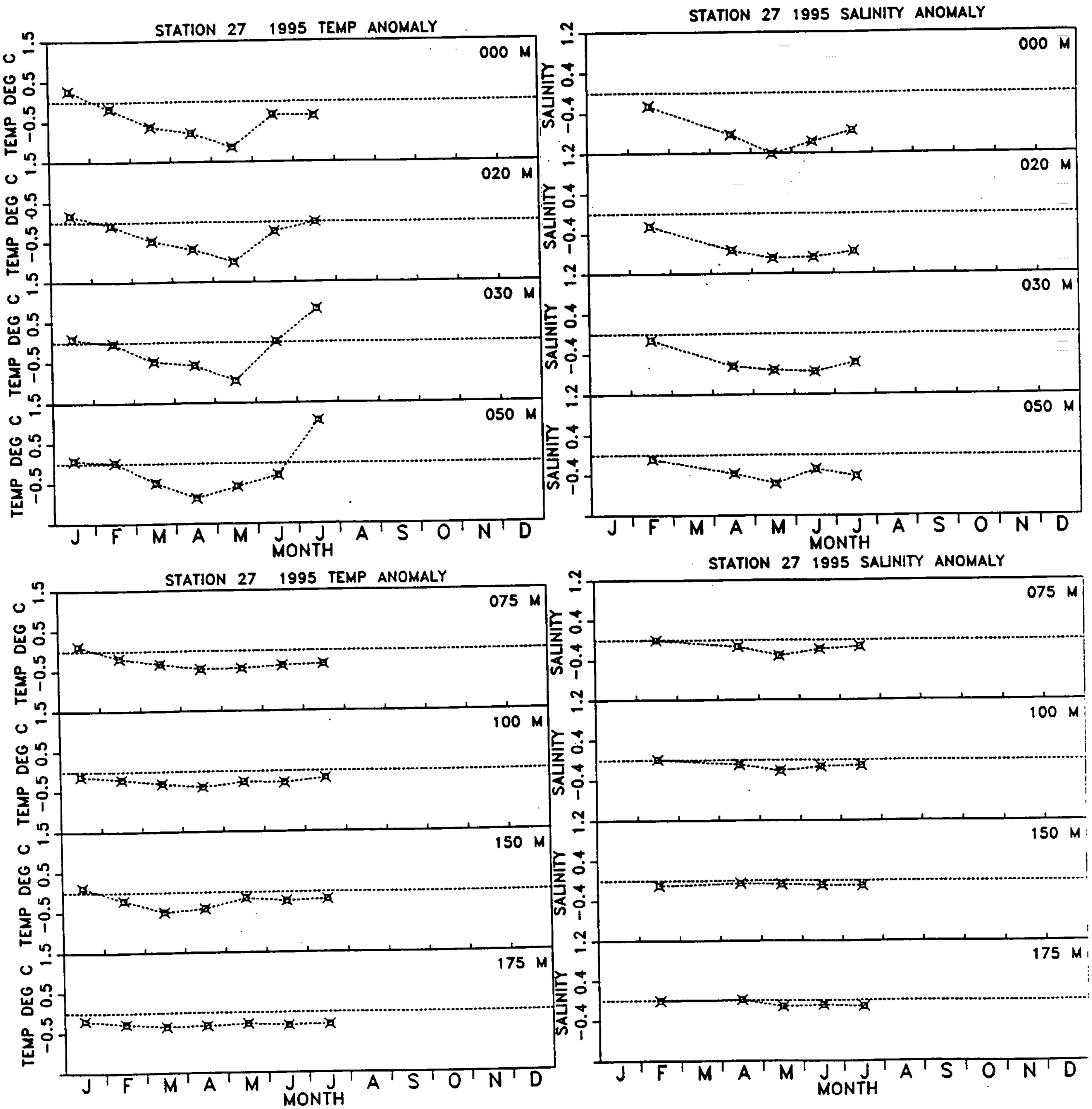
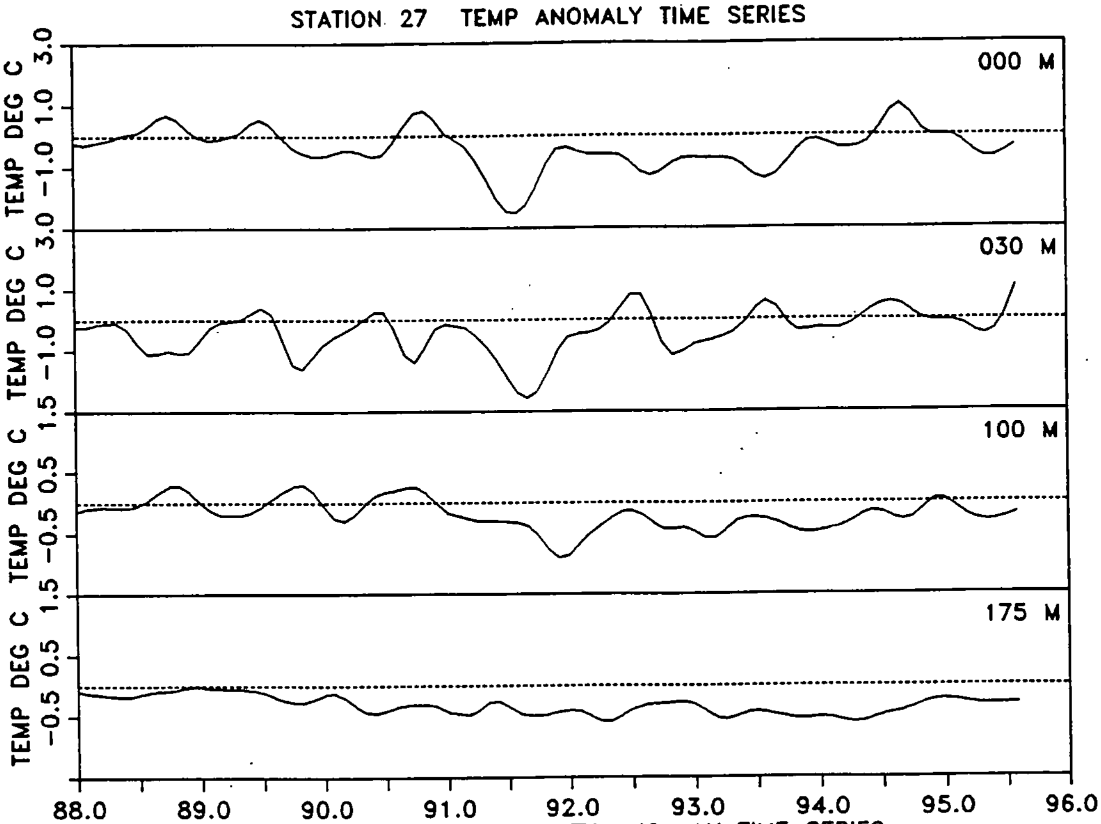


Fig. 6. Time series of monthly temperature and salinity anomalies at Station 27 at standard depths for January to July 1995.



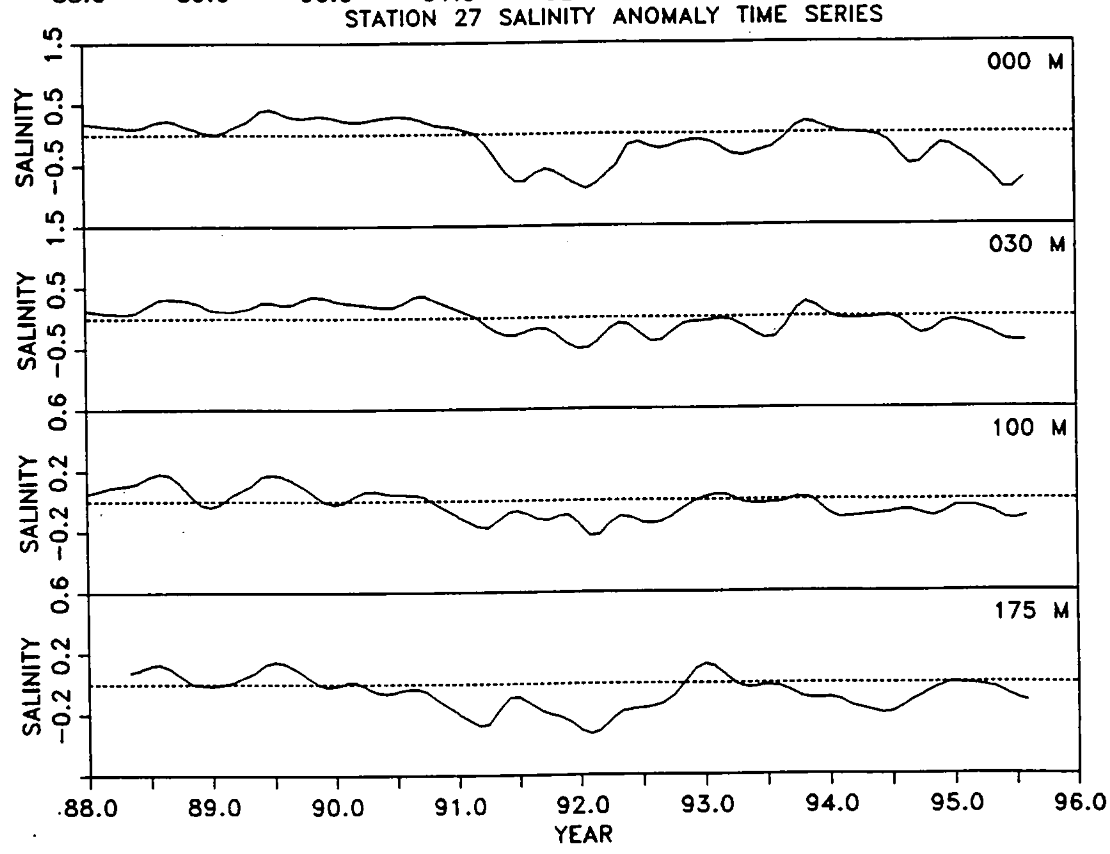


Fig. 7. Low passed filtered time series of monthly temperature and salinity anomalies at Station 27 at standard depths (0,30,100 and 175) from January 1, 1988 to July 31, 1995.

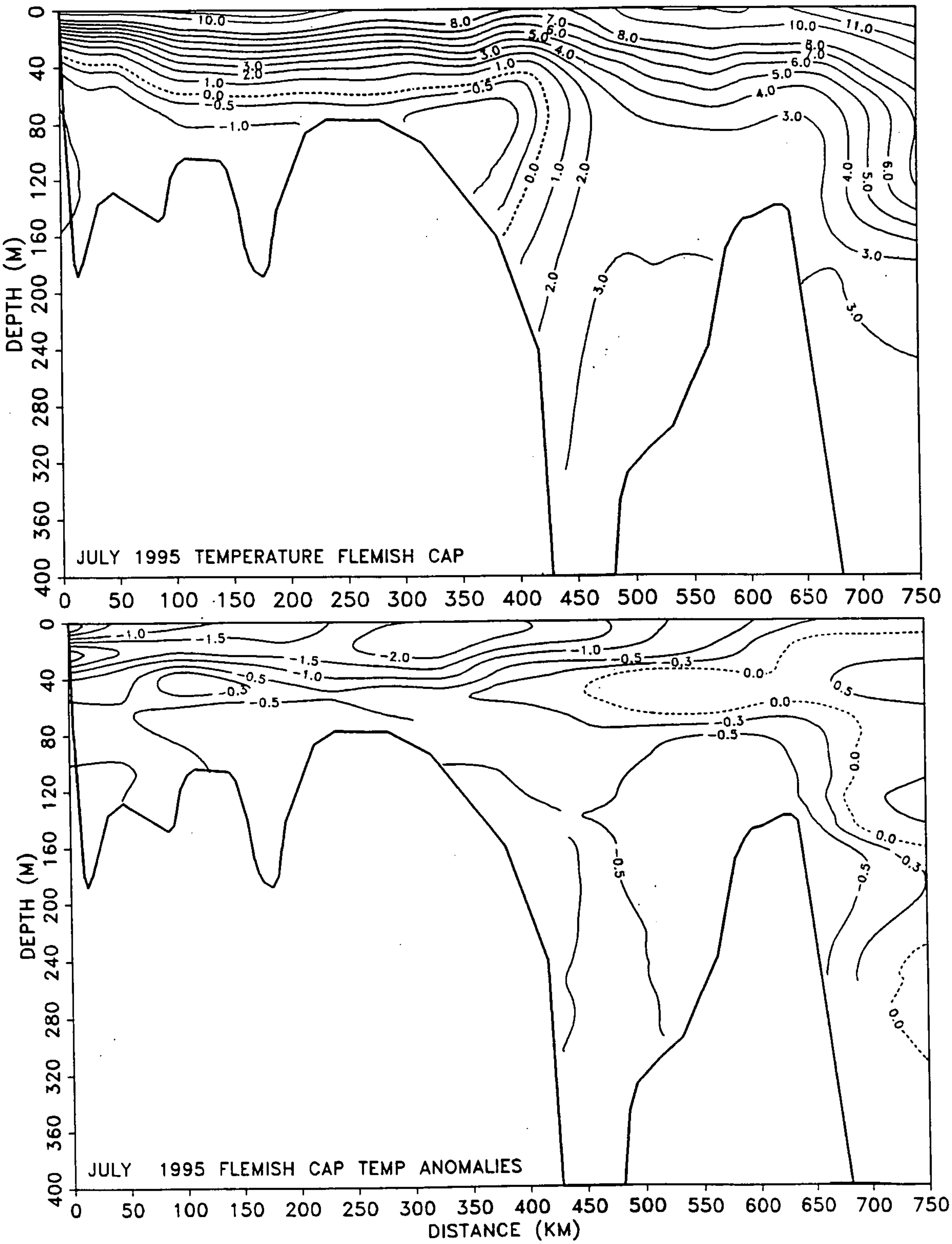


Fig. 8. The vertical distribution of temperature and temperature anomalies along the standard Flemish Cap transect for July 1995.

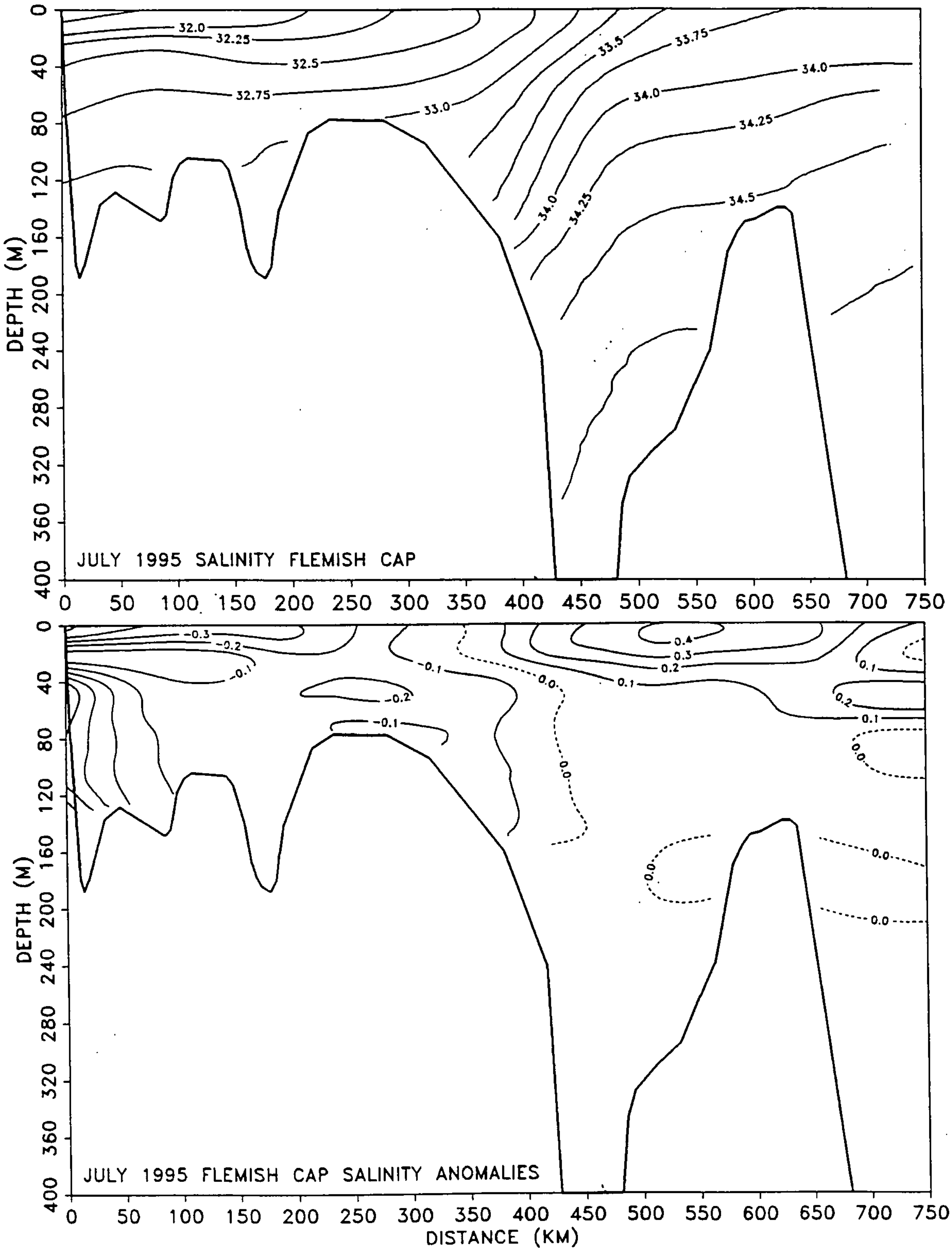


Fig. 9. The vertical distribution of salinity and salinity anomalies along the standar Flemish Cap transect for July 1995.

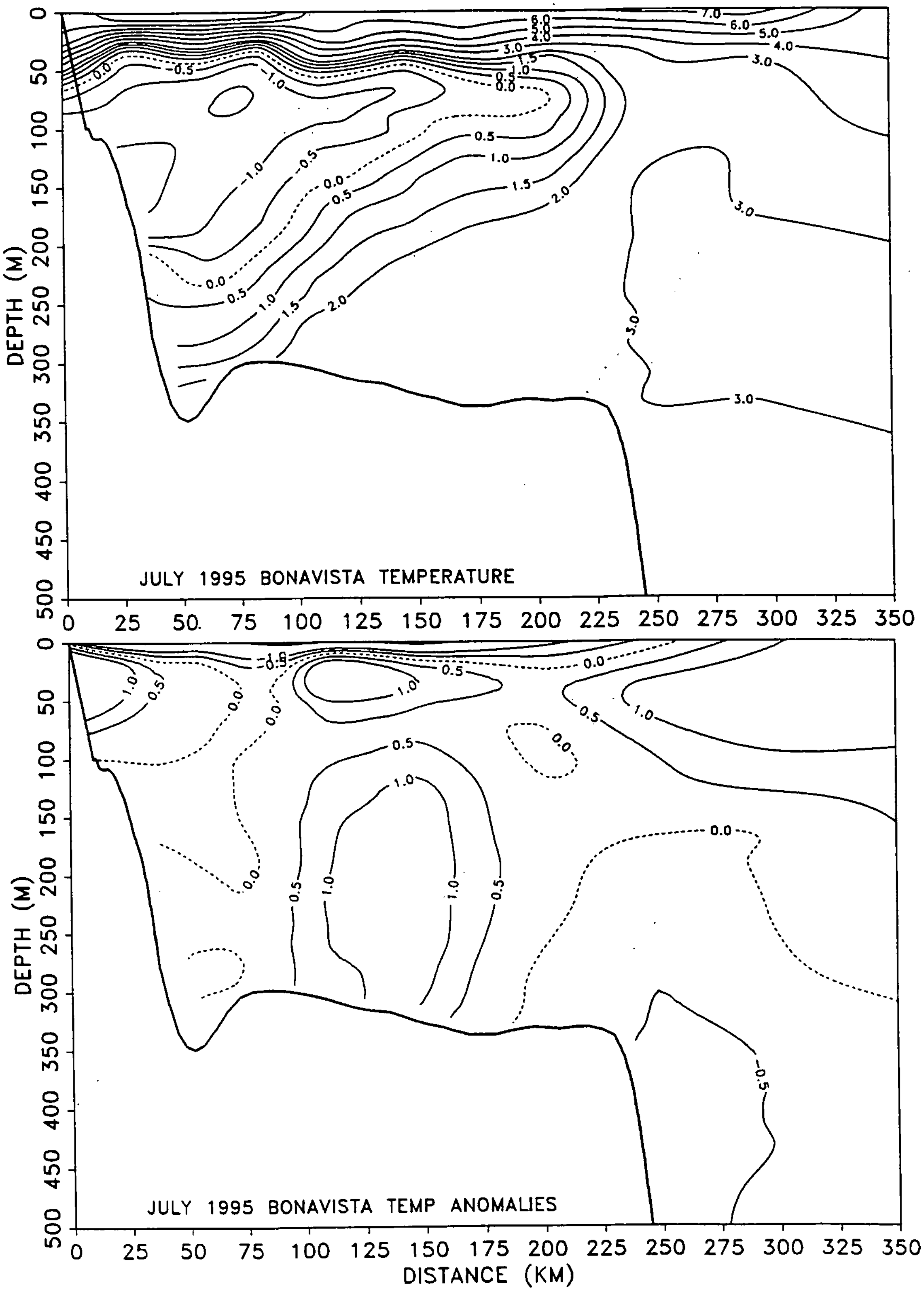


Fig. 10. The vertical distribution of temperature and temperature anomalies along the standard Bonavista transect for July 1995.

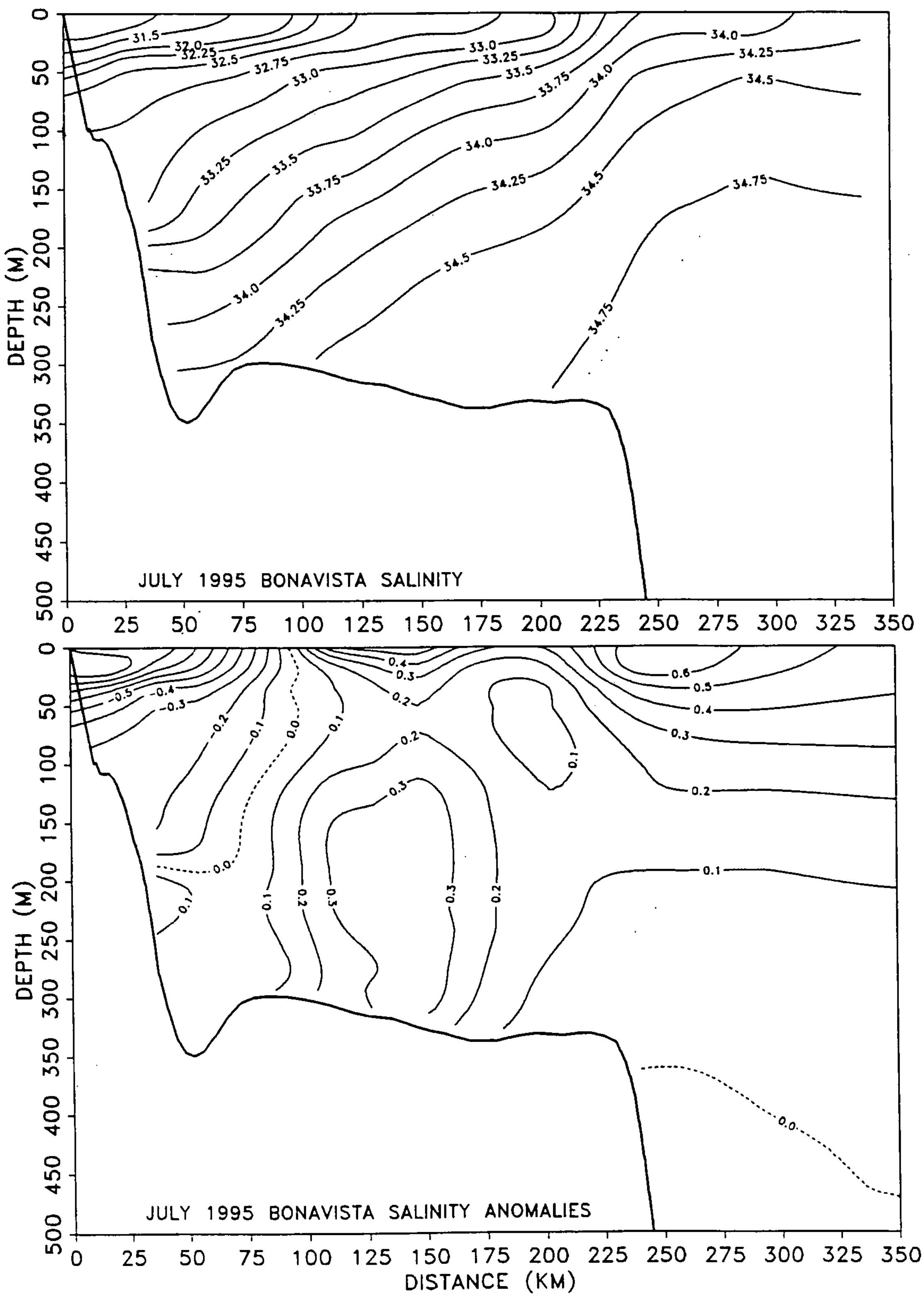


Fig. 11. The vertical distribution of salinity and salinity anomalies along the standard Bonavista transect for July 1995.

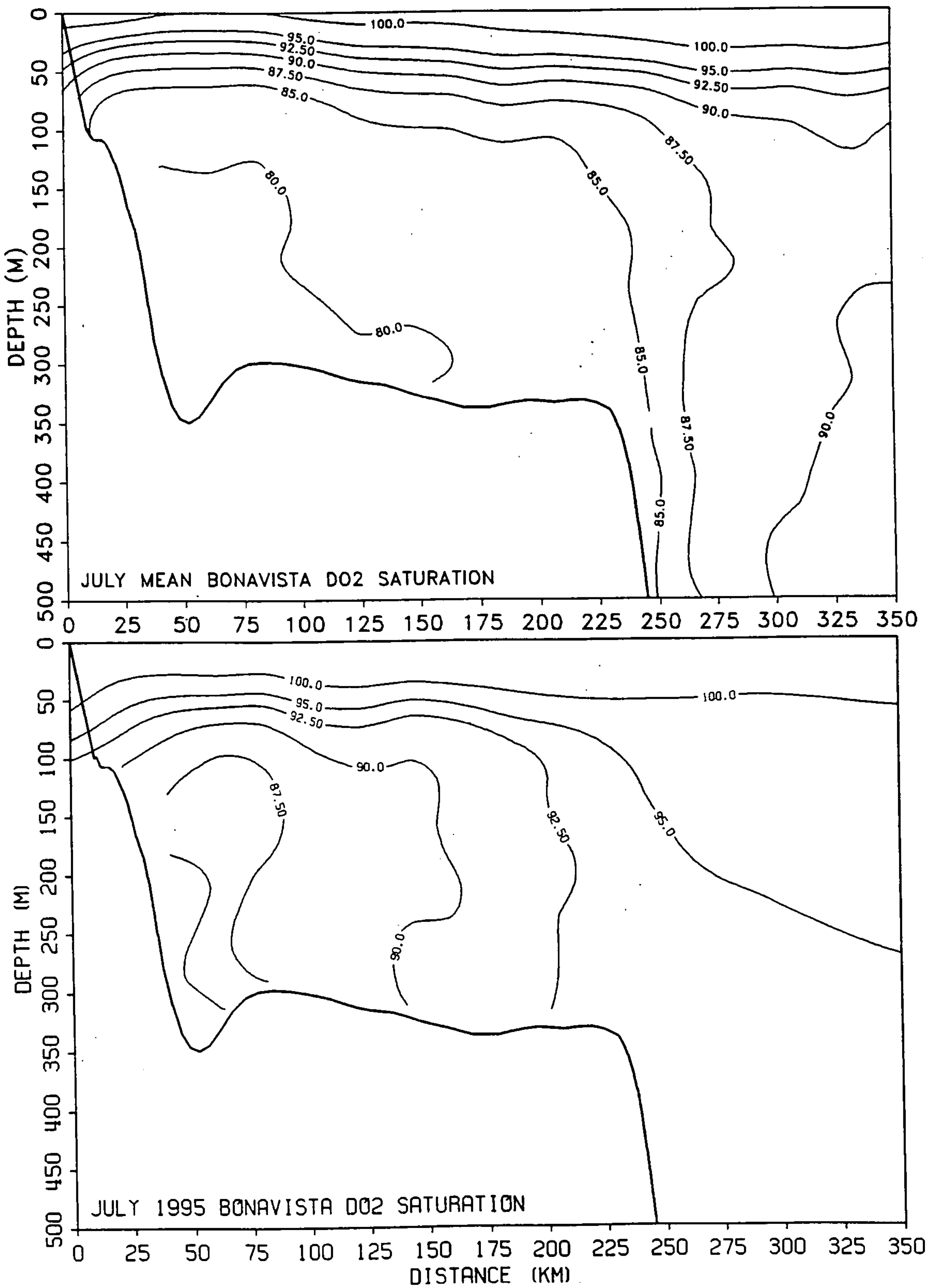


Fig. 12. The vertical distribution of dissolved oxygen saturation along the standard Bonavista transect for the average of historical data (top panel) and for July, 1995 (bottom panel).

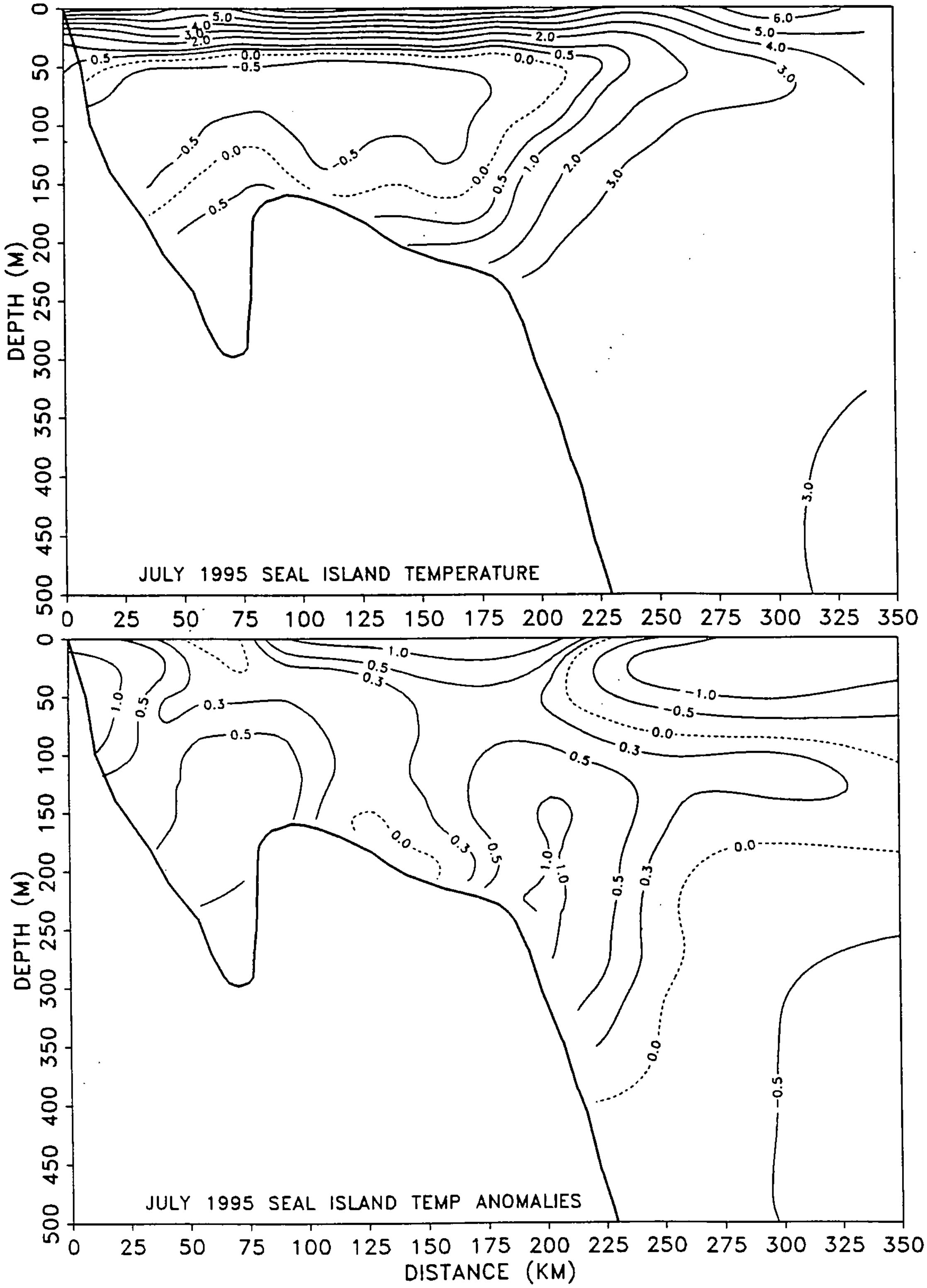


Fig. 13. The vertical distribution of temperature and temperature anomalies along the standard Seal Island transect for July 1995.

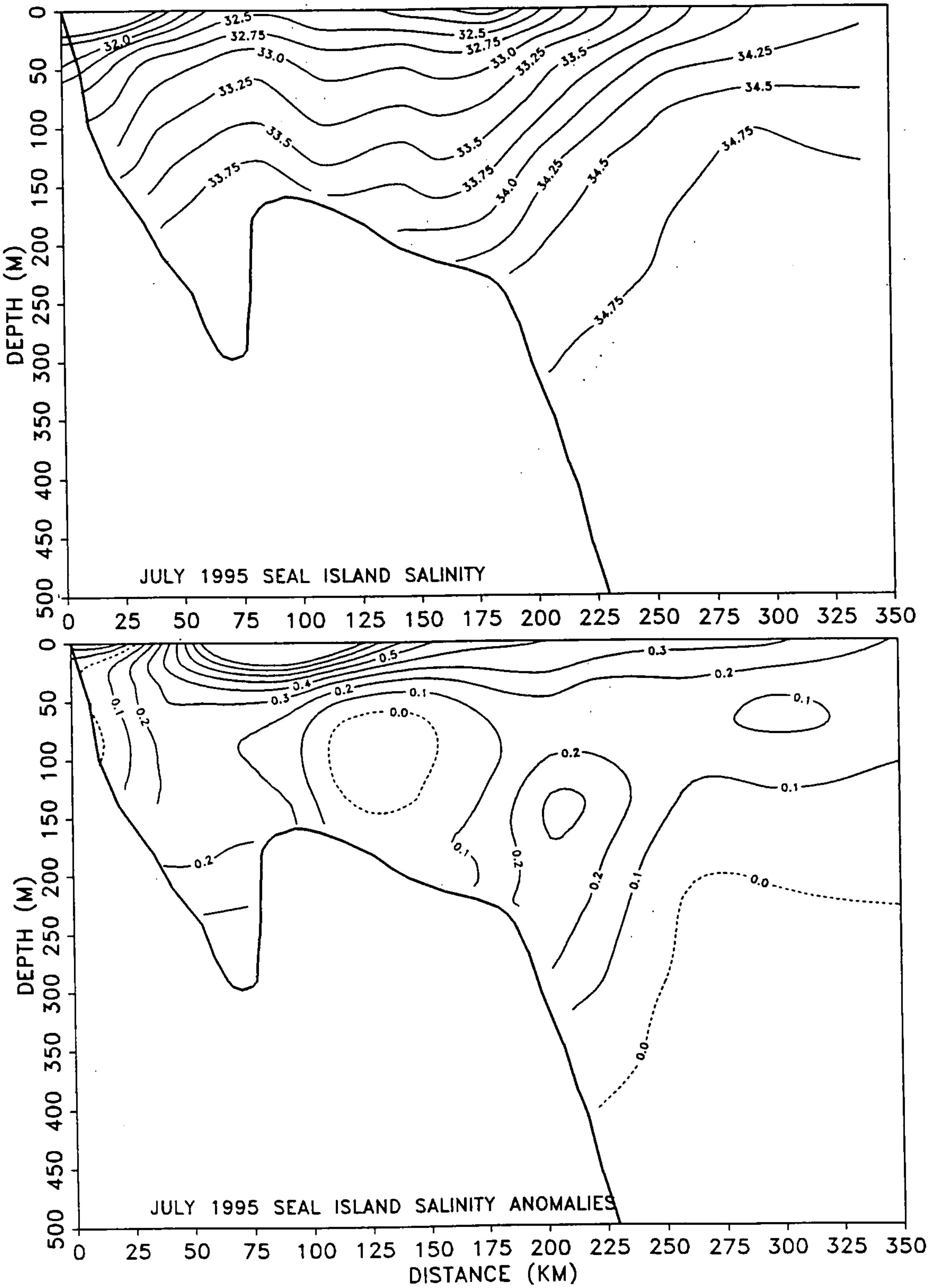


Fig. 14. The vertical distribution of salinity and salinity anomalies along the standard Seal Island transect for July 1995.

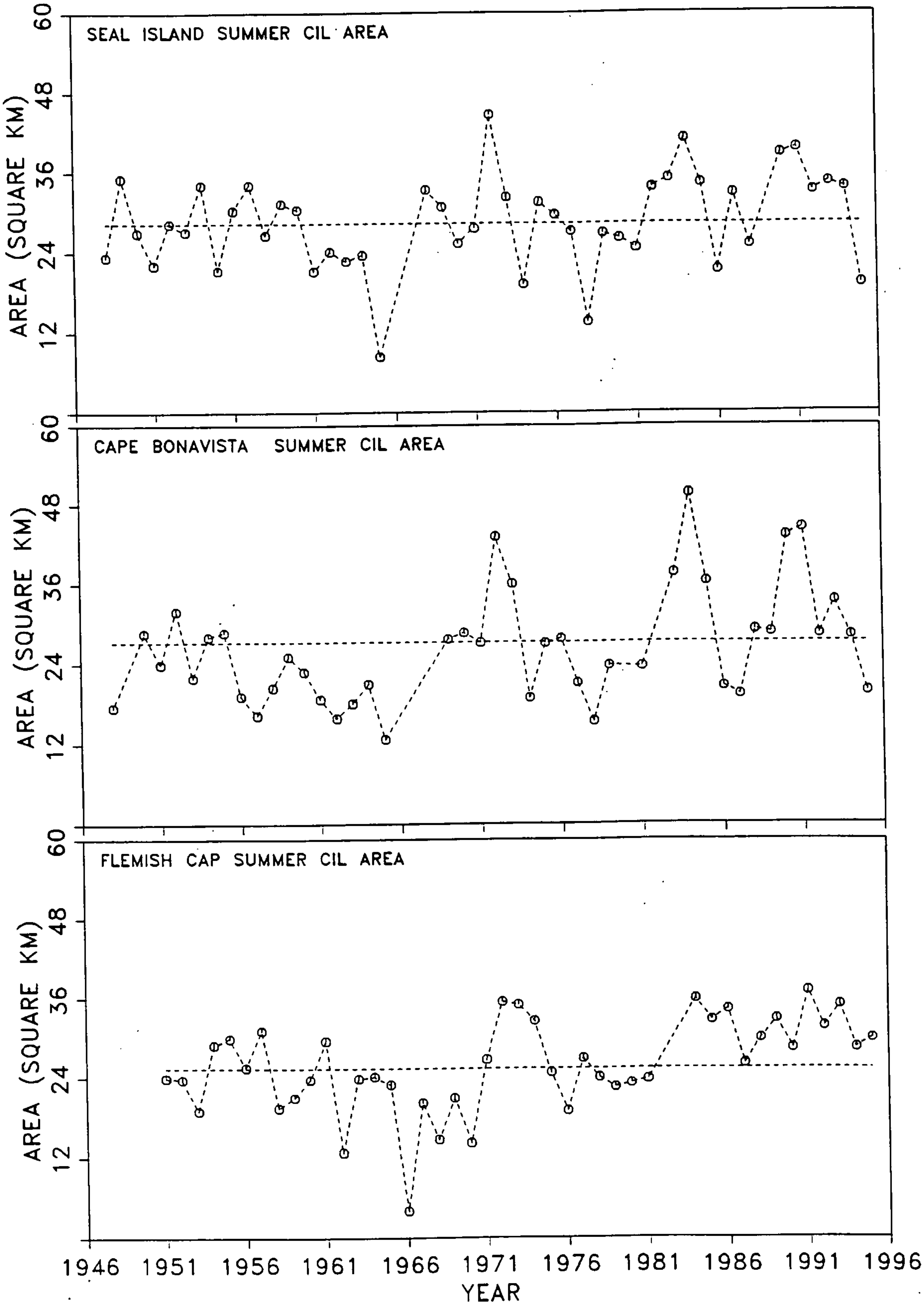


Fig. 15. Time series of CIL area along the Seal Island, Bonavista and Flemish Cap transects. The dashed line represents the 1961-90 average.

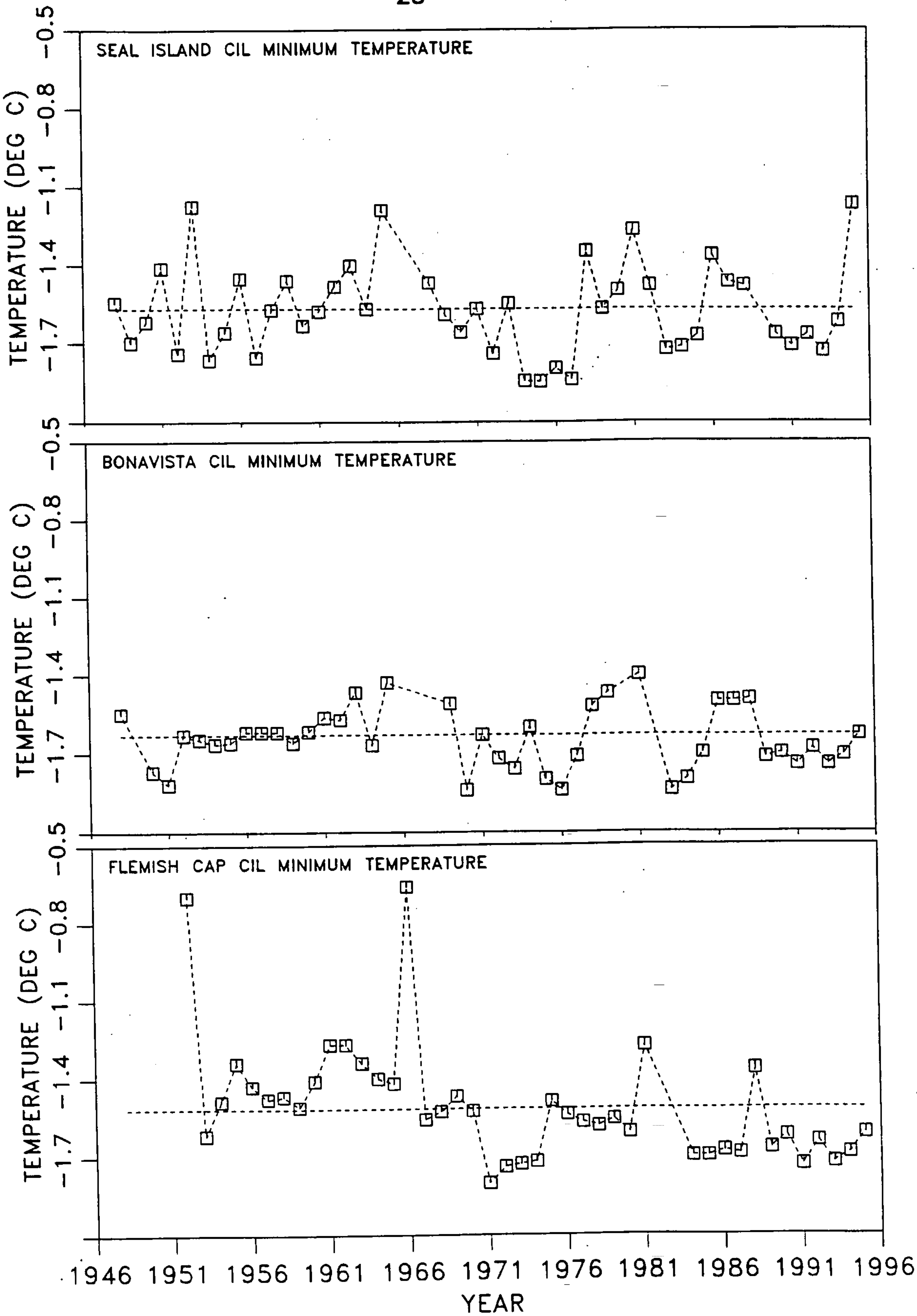


Fig. 16. Time series of CIL minimum temperature along the Seal Island, Bonavista and Flemish Cap transects. The dashed line represents the average.

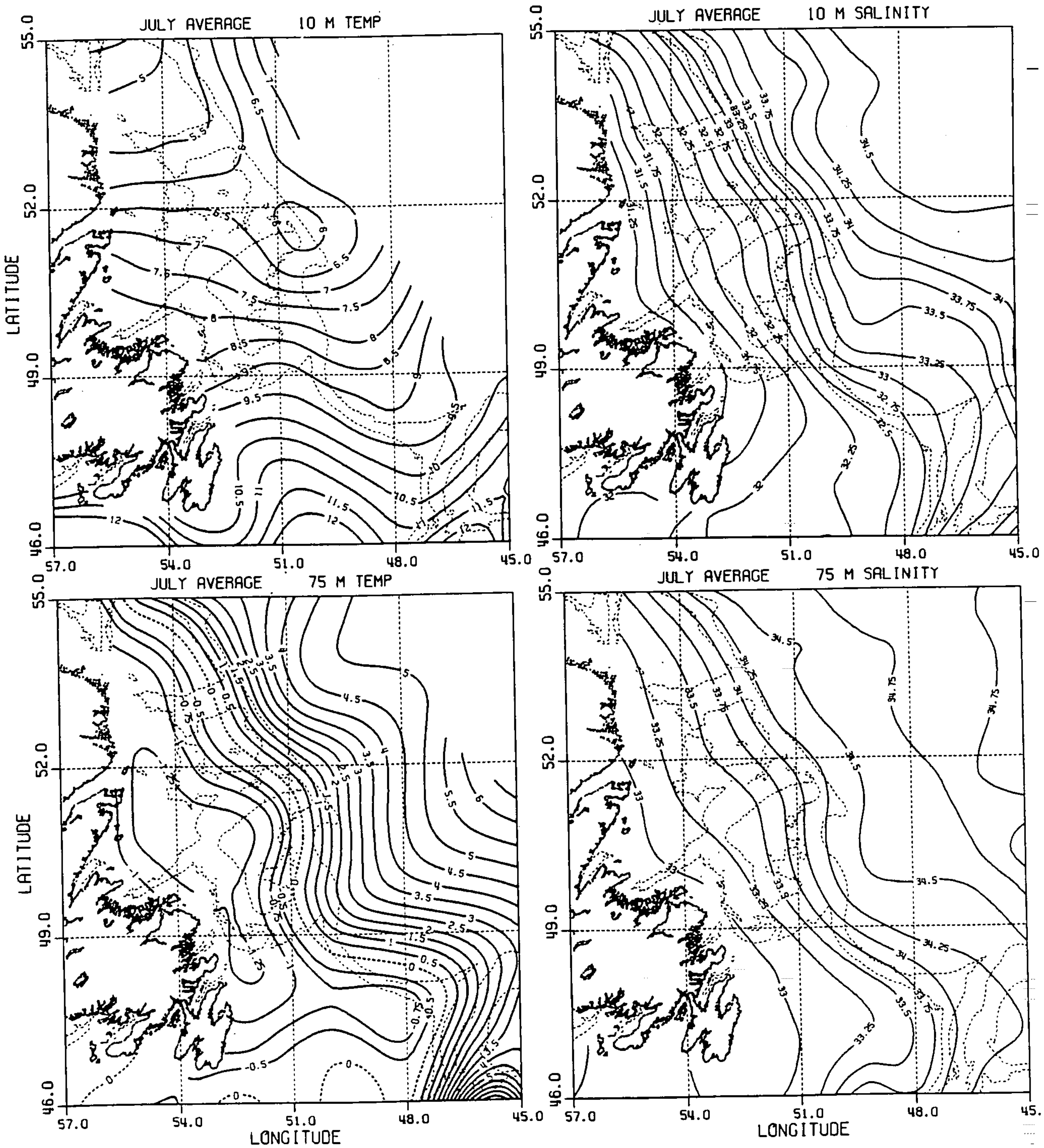


Fig. 17. The July 15-31 1961-1990 average surface (10 m) and 75 m horizontal temperature and salinity maps for the Newfoundland continental shelf region.

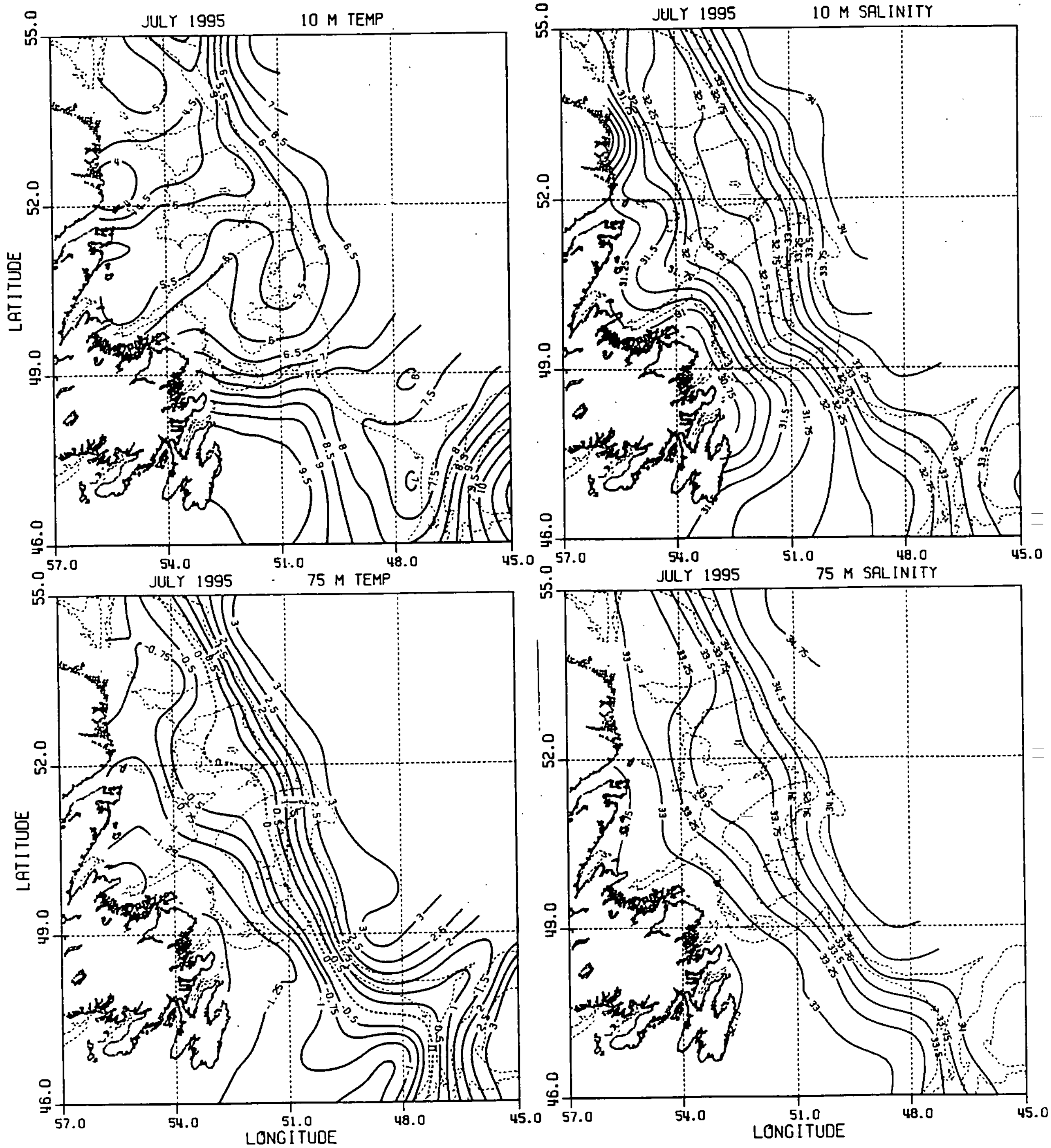


Fig. 18. The July 15-31 1995 surface (10 m) and 75 m horizontal temperature and salinity maps for the Newfoundland continental shelf region.