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Environmental Conditions on the Newfoundland Shelf, Spring 1997 with Reference to the 1961-1990 Normal

by

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ABSTRACT

Oceanographic observations from the Grand Bank and the northeast Newfoundland Shelf during the spring of 1997 are presented and compared to historical (1961-1990) data from the area. In addition, ice cover data from the winter and spring are also presented. The analysis indicate that above normal air temperatures experienced in Atlantic Canada during late fall of 1996 and normal values during January of 1997 resulted in below normal ice cover extent and concentration during early winter of 1997 along the east coast of Newfoundland and Labrador. By February however, air temperatures were below normal resulting in above normal ice conditions in the inshore regions during mid-winter and into early spring. At Station 27 the warm conditions during 1996 continued into the early winter of 1997, however by April and into May temperatures dropped below normal in the upper water column by 0.5 to 1.0 °C but continued normal to above normal in deeper water. Salinities were slightly below normal at Station 27 during winter and early spring of 1997. Temperatures on the Grand Bank and along the east coast of Newfoundland were generally below normal (up to 1.0 °C) in the upper 100 m of the water column. The cold-intermediate-layer (CIL) was about normal on the Grand Bank and slightly below normal along the Bonavista transect. In general, meteorological and ice conditions during late fall of 1996 and early winter of 1997 resulted in a continuation of moderate oceanographic conditions during early winter of 1997. By mid-winter and into early spring air temperatures were below normal resulting in increased ice cover and colder that normal spring upper layer ocean temperatures, particularly in the inshore regions.

INTRODUCTION

This report updates environmental conditions in the Newfoundland region during the winter and spring of 1997, 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 and the NAFO Scientific Council. The 1997 observations were made during a spring oceanographic survey conducted by the Canadian Department of Fisheries and Oceans to the Grand Bank and along the east coast of Newfoundland from May 8 to May 19 aboard the CSS Parizeau. In addition, all Station 27 data collected since January of 1997 by fisheries research surveys are included in the analysis. The report also presents sea ice cover data for Atlantic Canada during the winter and spring of 1997.

During the spring 1997 survey oceanographic measurements were made along transects running from Cape Race to the southeast Grand Bank, along 47° N (Flemish Cap transect) and along the Bonavista transect (Fig. 1). The measurements were made along the transects from nearshore along the east coast of Newfoundland and offshore to the shelf edge in about 2000 m of water. Measurements 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.

ICE CONDITIONS

The maximum extent of the ice edge (defined by one-tenth coverage) during mid-January to late May of 1997 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 Figure 2. The monthly positions of the ice edge for 1997 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 1996 and early winter of 1997 water and air temperatures in many areas along the east coast of Newfoundland were above normal (eg. Goose Bay air temperatures were 4.0 °C above normal in December and 2 °C above normal in January, Monthly Meteorological Summaries, Atmospheric Environment Service) which resulted in below normal ice extent during January. By mid-February to mid-March the ice edge extended further south than normal, however the offshore extent was about normal. By mid-April the ice edge was still further south than normal in the inshore regions and had receded to about normal limits by early May. By late May the ice edge was located over Hamilton Bank, well north of the seasonal normal with only an isolated patch of pack ice on the northeast Newfoundland coast.

Shown in Figure 3 are the cumulative (January to June, except January to May for 1997) ice areas south of 55° N latitude along the east coast of Newfoundland and Labrador from 1969 to 1997 again as defined by the 1/10 ice edge. Similar to 1996, the 1997 total ice area on the Newfoundland Shelf was among the lowest in the time series. In general, the 1997 ice season along the east coast of Newfoundland was among the lightest on record in terms of ice cover extent and duration. However, the ice edge in the inshore areas was further south than normal from February to April reaching to about 47° N latitude during mid-March.

STATION 27 TEMPERATURE AND SALINITY

The Station 27 monthly temperature and salinity anomalies at standard depths of 0, 20, 30, 50, 75, 100, 150 and 175 m are shown in Figs. 4 and 5. These anomalies are based on a total of 15 profiles collected from January to May of 1997 and are referenced to a 1961 to 1990 normal. No data were available for February and March and the value for May is based on six observations from May 6 to May 22 and hence may be biased low.

The above normal temperatures experienced during 1996 continued into January of 1997 with values about 0.25 to 0.5 °C above normal. During April, surface temperatures were slightly below normal while bottom temperatures were slightly above normal, elsewhere they were near normal. Temperatures during May were more than 1.0 °C below normal at the surface and generally below normal in the upper 75 m of the water column. Below 100 m depth temperatures continued above normal by up to 0.5 °C at the bottom. Salinities were near to slightly below normal during the spring of 1997 over all depths, very similar to 1996 values (Colbourne 1997).

TEMPERATURE AND SALINITY TRANSECTS

Vertical distributions of the temperature and salinity fields together with the anomalies along the southeast Grand Bank transect, the standard Flemish Cap (47° N) transect and the Bonavista transect (Fig. 1) for the spring of 1997 are presented in Figs. 6 to 11. The anomalies were calculated from the mean of all available data for the transect from 1961 to 1990 during a time period of two weeks on either side of the 1997 survey.

The spring temperature along the southeast Grand Bank transect (Fig. 6) ranged from 0.5 to 1.0 °C near the surface and to 0.0 to -1.0 °C below 25 m in the Avalon Channel and at the edge of the continental shelf. Over the Grand Bank temperatures ranged from about 0.5 to 2.5 °C near bottom at about 80 m depth and from 1.0 to greater than 3.5 °C in the near surface layer. Beyond the shelf break, temperatures experienced considerable variability ranging from greater than 5.0 °C near the surface and between 2.0 to 4.0 °C below 60 m depth. Except for the deeper Avalon Channel, where temperatures were near normal, these temperatures were 1.0 to 2.0 °C below normal in the upper layer over the inshore portion of the Grand Bank and from about 0.5 to 1.0 °C below normal near the shelf edge in the offshore branch of the Labrador Current. Near the central portion of the bank temperatures were near normal at depth

and above normal near the surface. Beyond the shelf break outside the Labrador Current influence, temperatures were above normal, particularly in water depths below 200 m. Salinities along this transect (Fig. 7) ranged from 32.5 to 32.75 PSU over the bank and from 33.0 to 34.5 PSU offshore of the bank. There were no significant salinity anomalies over the Bank, however offshore of the bank below 150 m depth, salinities appear to be above normal by up to 0.4 PSU.

Spring temperatures along the Flemish Cap transect (Fig. 8) ranged from 0.5 to 1.0 °C near the surface and to 0.0 to -0.5 °C below 20 m depth in the Avalon Channel and below 50 m depth at the edge of the continental shelf. Over the outer Grand Bank temperatures were below -0.5 °C near bottom at about 80 m depth and from 1.0 to 1.5 °C in the near surface layer. Beyond the shelf break in the Flemish Pass temperatures ranged from 3.0 to 5.0 °C in the upper water column and from 3.0 to 3.5 °C below 100 m depth. East of the Flemish Cap temperatures ranged from 5.0 to 6.5 °C near the surface and between 4.0 to 6.0 °C below 100 m depth. These values were 0.5 to 1.0 °C below normal in the Avalon Channel and from 0.25 to 0.5 °C below normal over the outer Grand Bank in the upper layer. At the edge of the continental shelf out to the Flemish Cap temperatures ranged from about normal to 1.0 °C above normal. East of the Flemish Cap temperatures were below normal by about 0.5 °C. Salinities along the transect (Fig. 9) ranged from 32.5 to 33.0 PSU over the bank and from 33.0 to 34.5 PSU east of the Grand Bank in the upper 150 m of the water column and from 34.5 to 34.75 in deeper water. These values were about 0.2 to 0.4 below normal in the Avalon Channel, about normal over the Grand Bank, and above normal by 0.2 to 0.4 PSU east of the Flemish Cap.

Temperatures along the Bonavista transect (Fig. 10) in the upper 50 m of the water column ranged from -0.5 °C to 0.0 °C over most of the Newfoundland Shelf and to 0.5 to 3.0 °C over the outer most portion of the transect. In deeper water (50 m to the bottom) within 25 km of the coast, temperatures ranged from -1.5 °C to 0.0 °C in the cold intermediate layer (CIL) and to 0.0 °C to 3.0 °C along the bottom across the continental shelf and beyond. The corresponding temperature anomalies ranged from 0.25 to 1.0 °C below normal in the surface layer from the coast out to the shelf break. At mid-depth to the bottom over most of the shelf temperatures were from 0.25 to 1.5 °C above normal. Salinities along the transect (Fig. 11) ranged from 32.0 to 33.5 PSU over the shelf in the upper 50 m of the water column and from 33.0 to 34.5 PSU in deeper water over the shelf and generally greater than 34.5 PSU east of the shelf. These values were about 0.2 to 0.4 PSU below normal at mid-depth on the outer shelf, near normal over the remainder of the shelf and above normal by 0.2 to 0.3 PSU near the surface east of the shelf break.

THE COLD INTERMEDIATE LAYER (CIL)

As shown 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. This feature undergoes large seasonal variations with the cross-sectional area of water reaching its maximum in January (Fig. 12) as the upper layer cools. By spring the warming of the upper layer commences and the cross-sectional area of sub-zero °C water decreases and reaches its minimum by October along the Bonavista transect and by December along the Flemish Cap transect. The variation in the area of sub-zero °C water along the Flemish Cap transect (Grand Bank portion) is mainly influenced by the seasonally heated upper layer which undergoes a large change beginning in April. During winter and early spring the entire water column on the Grand Bank is below 0.0 °C with maximum cross-sectional area at about 45 km^2 after which it decreases to approximately 25 km^2 by May and remains nearly constant during the summer.

During the spring of 1997 the total area of sub-zero °C water was below the long-term normal along the Bonavista transect and slightly above normal along the Flemish Cap transect. During the period of 1990-1993 the total area of sub-zero °C water along the Bonavista transect was significantly above normal from spring to fall (Fig. 12). The recent observations indicate a continuation of normal to below normal CIL areas since the summer of 1995 when the CIL was the lowest in about 10 years along the Bonavista transect (Colbourne 1996).

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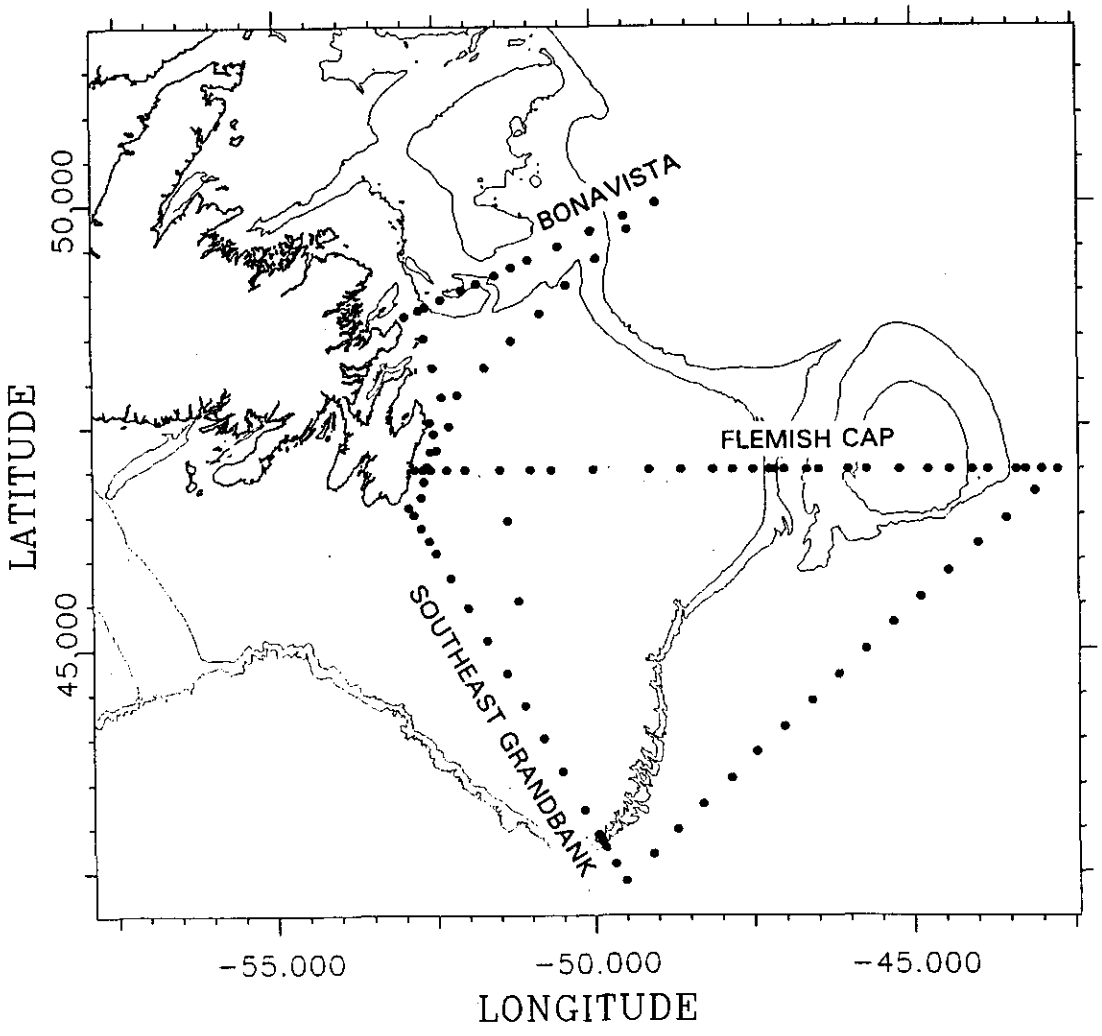

Fig. 1. Location map showing positions of the stations occupied during the spring 1997 oceanographic survey. The bathymetry lines are 300 and 1000 m.

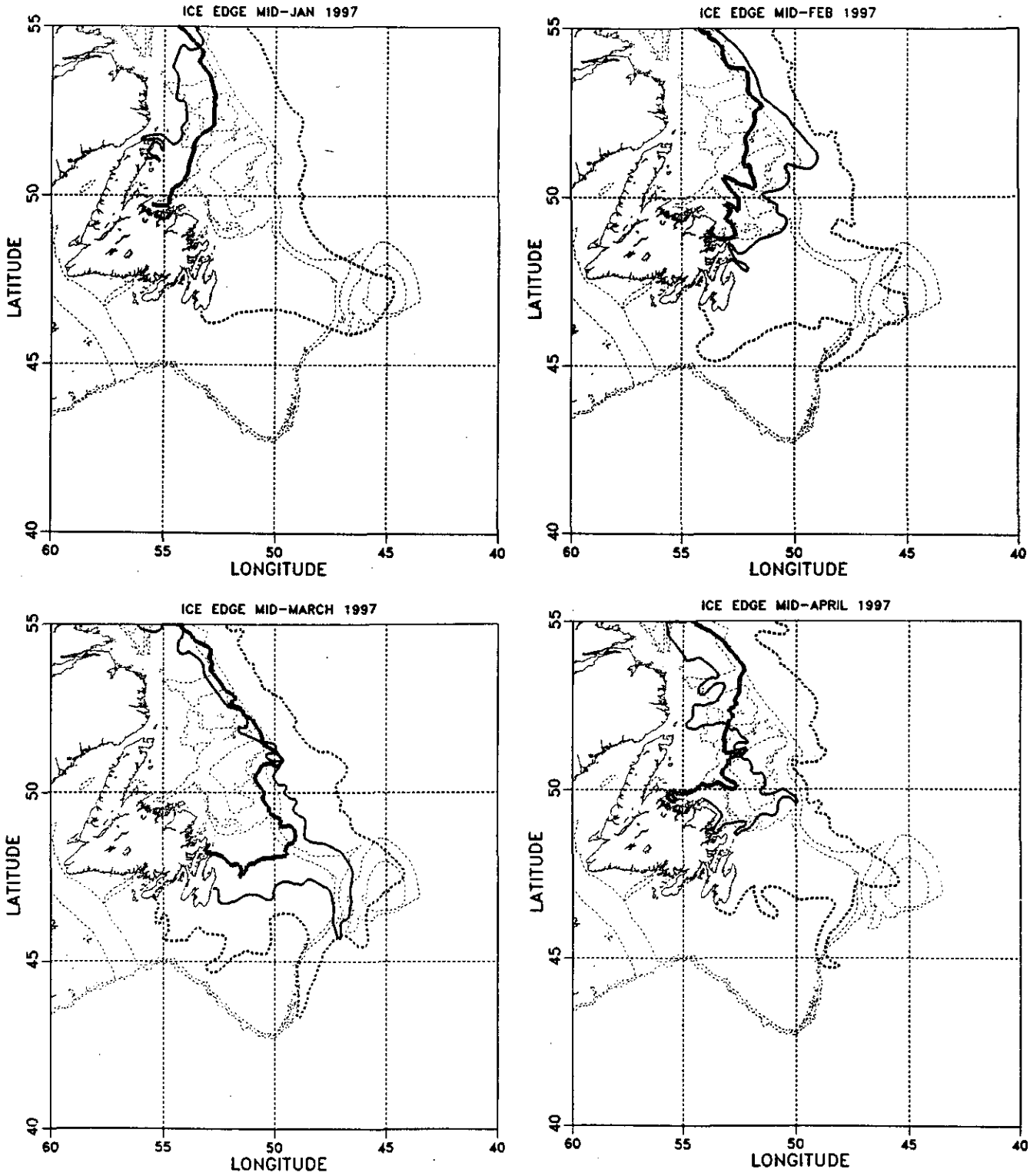

Fig. 2. Ice edge locations for mid-January to mid-April of 1997 (light solid lines). The dashed and heavy solid lines are locations for the maximum and median positions for the same time period based on historical data from 1962 to 1987. (from Cote, 1989)

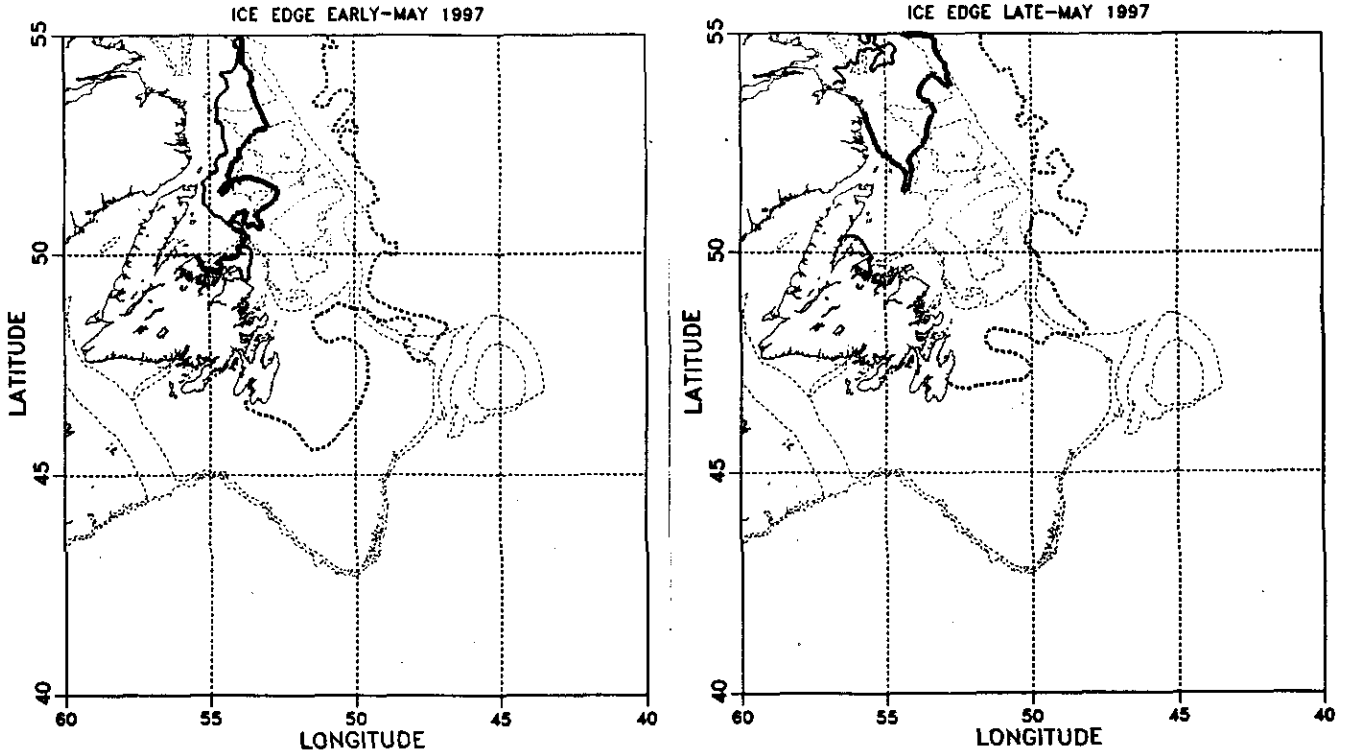

Fig. 2 (cont). Ice edge locations for early and late-May of 1997 (light solid lines). The dashed and heavy solid lines are locations for the maximum and median positions for the same time period based on historical data from 1962 to 1987. (from Cote, 1989)

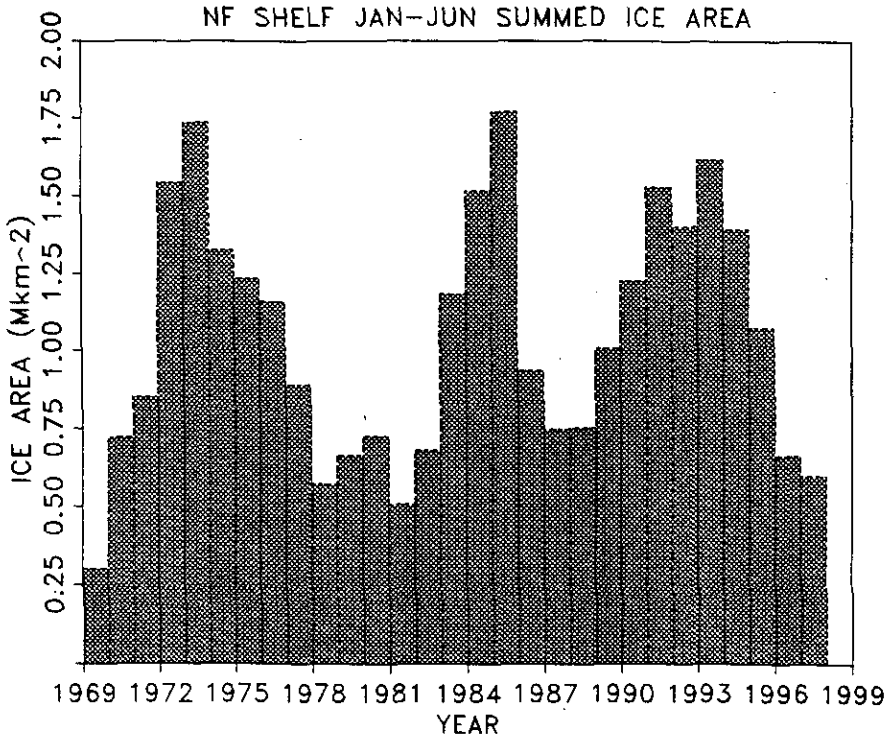

Fig. 3. Time series of the annual cumulative ice areas along the east coast of Newfoundland south of 55 °N latitude.

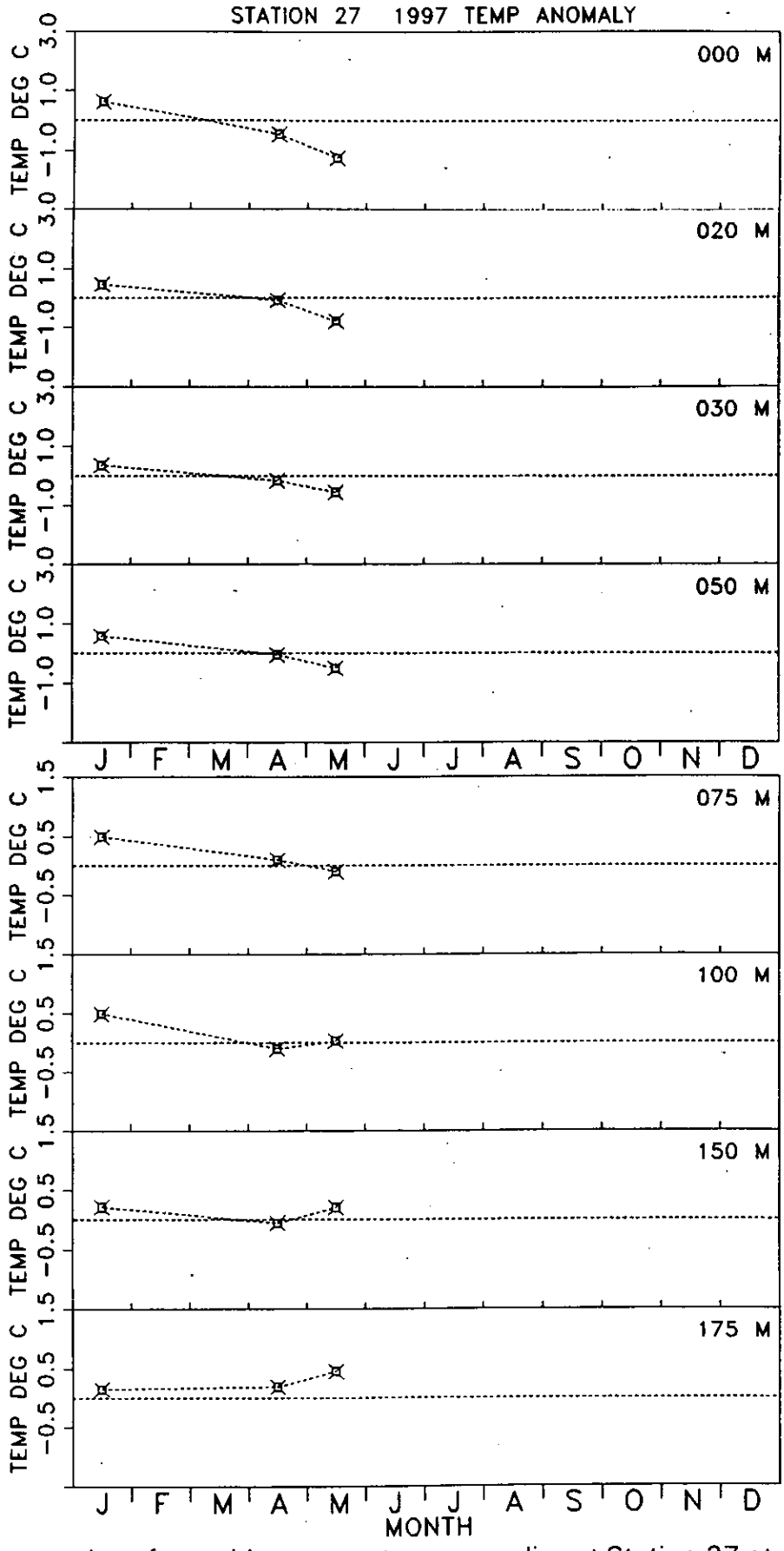

Fig. 4. Time series of monthly temperature anomalies at Station 27 at standard depths for January to May of 1997.

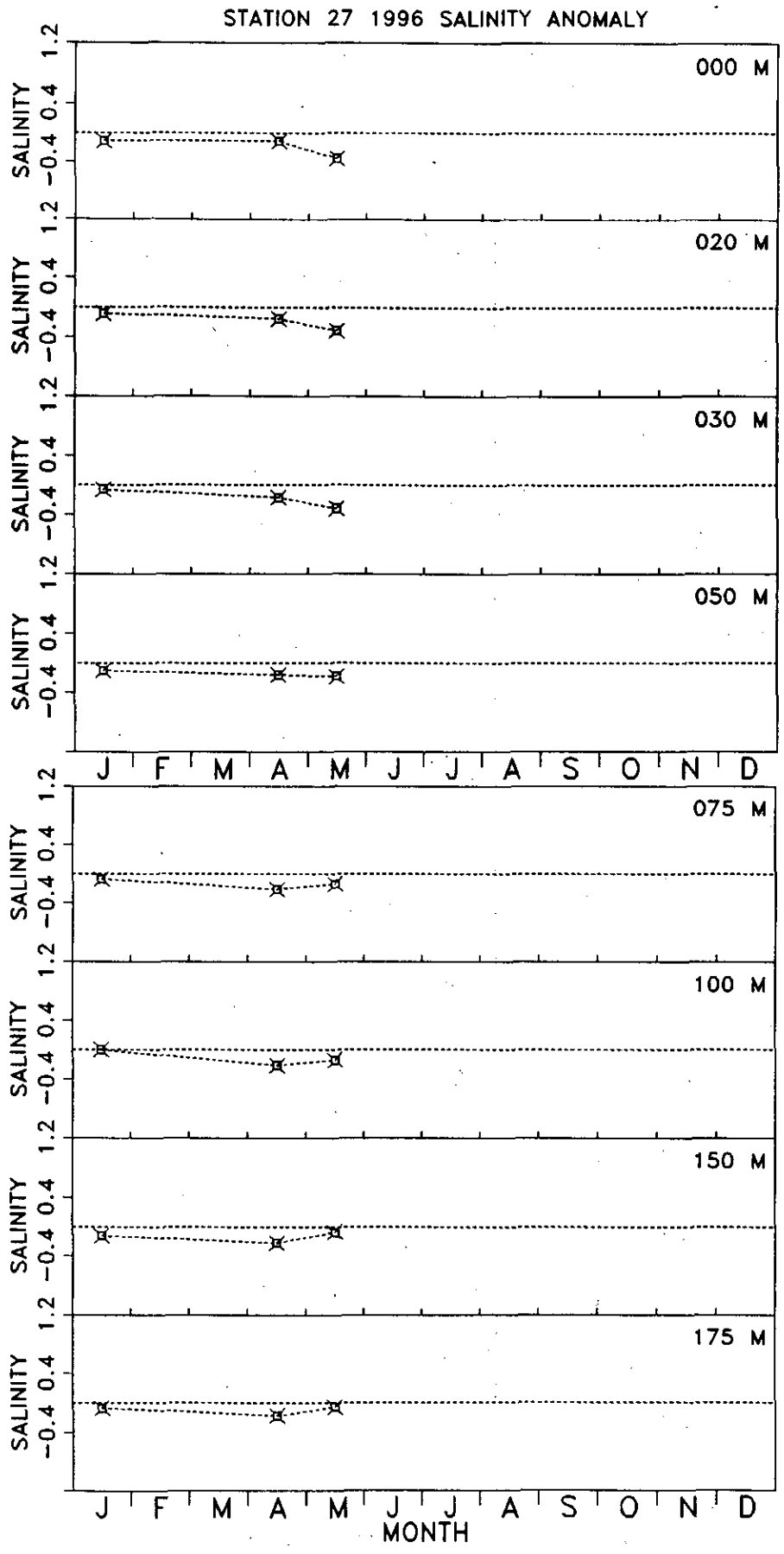

Fig. 5. Time series of monthly salinity anomalies at Station 27 at standard depths for January to May of 1997.

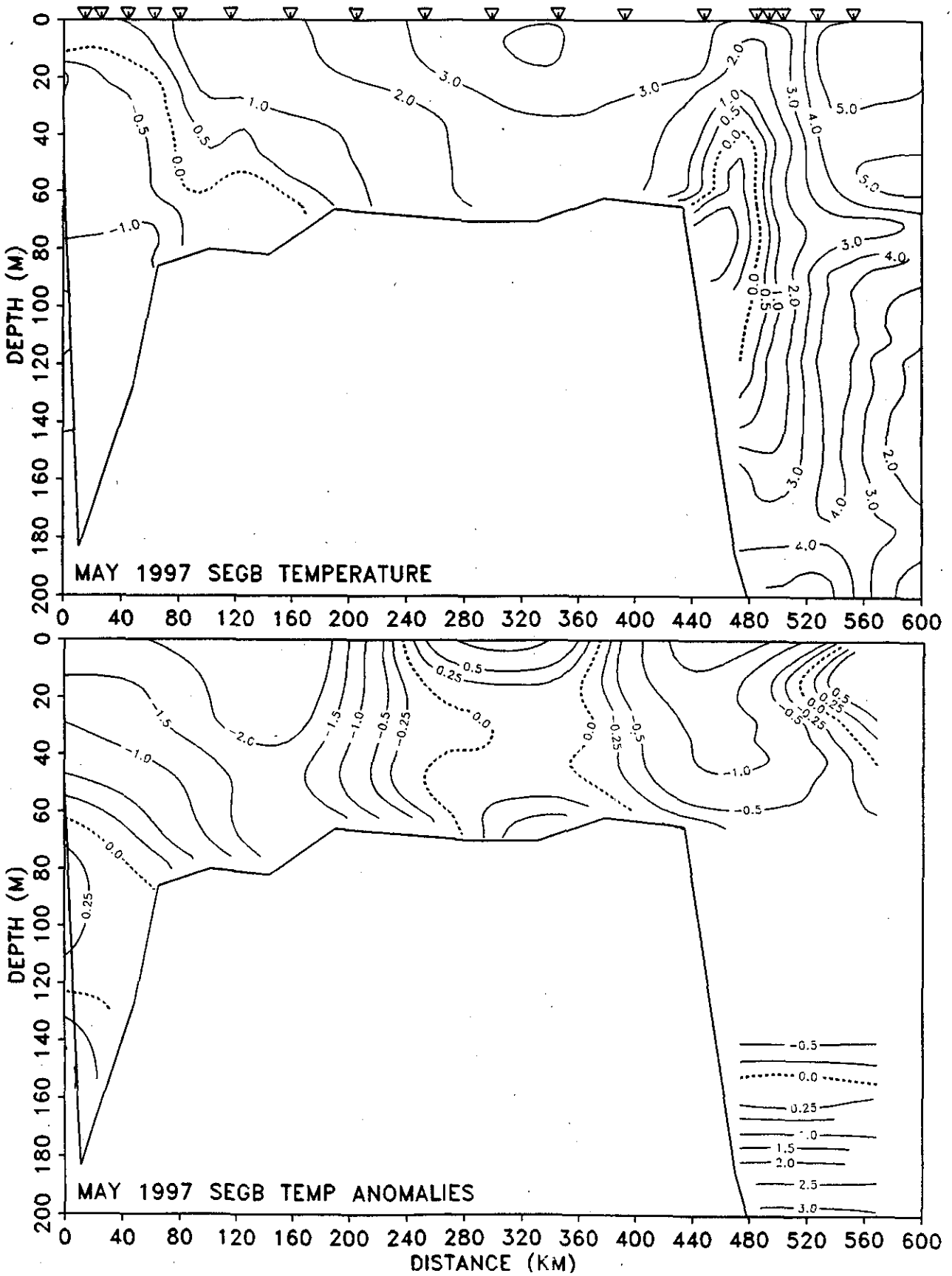

Fig. 6. The vertical distribution of temperature and temperature anomalies along the the southeast Grand Bank transect for early May 1997.

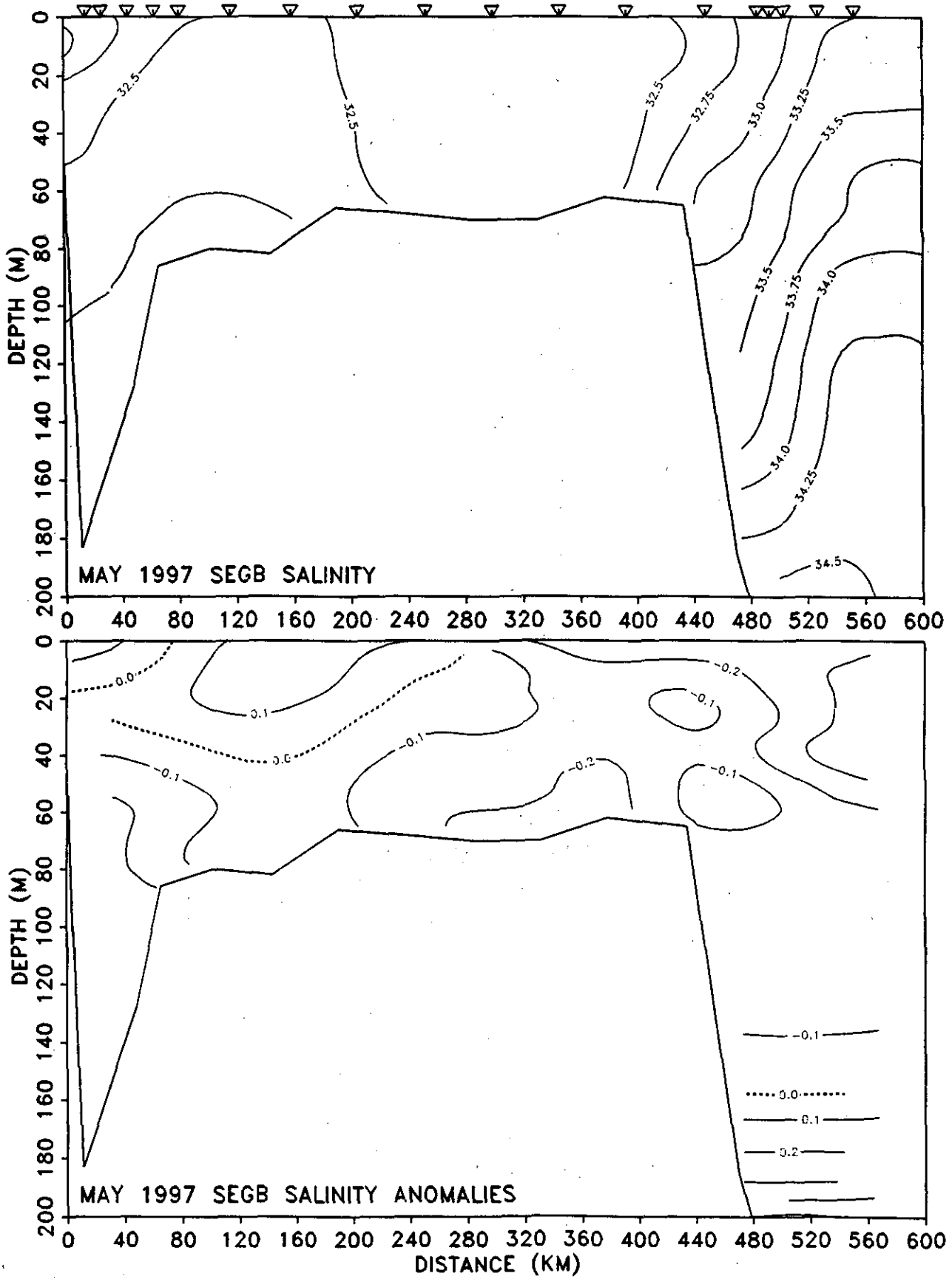

Fig. 7. The vertical distribution of salinity and salinity anomalies along the Southeast Grand Bank transect for early May 1997.

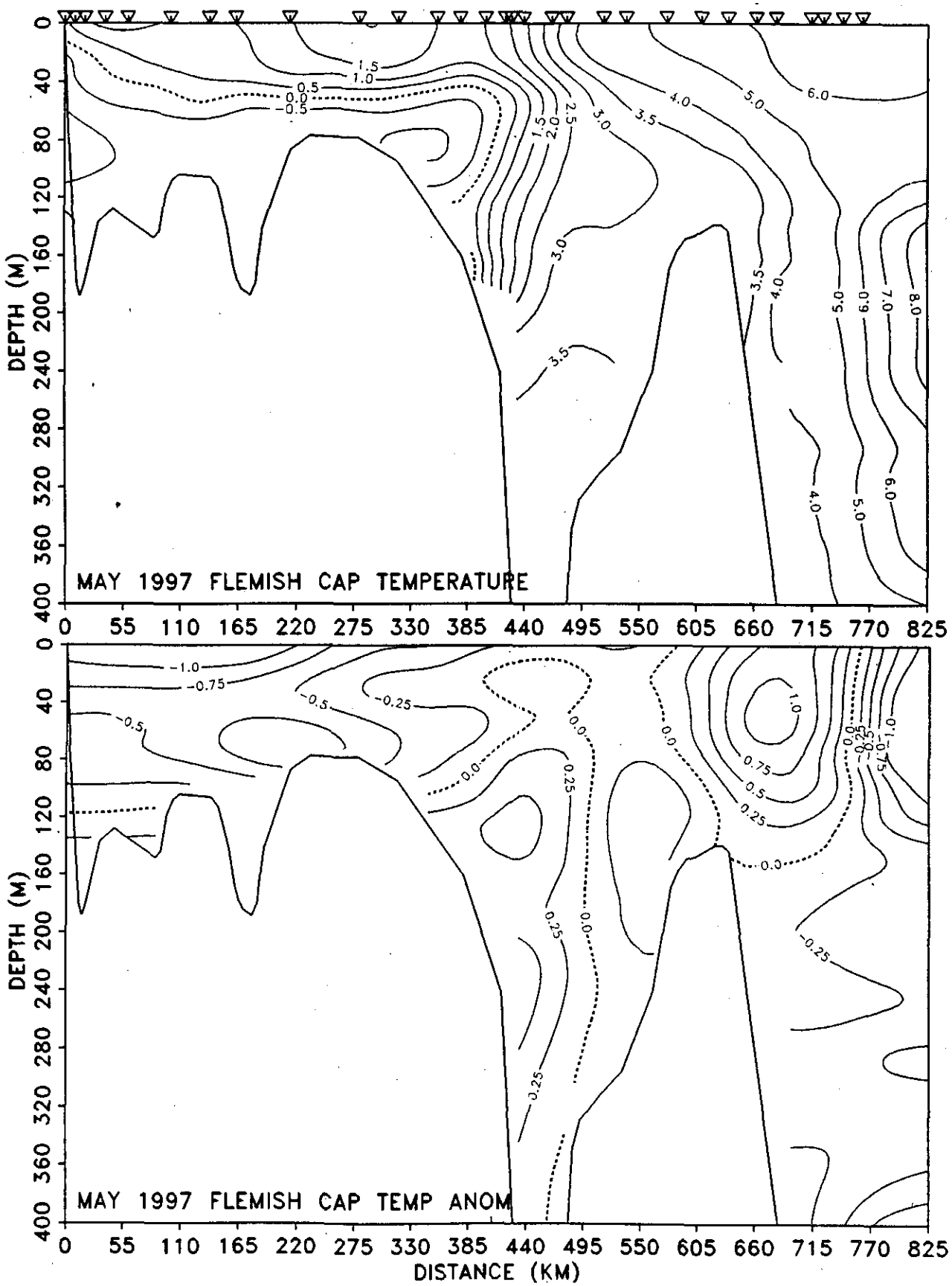

Fig. 8. The vertical distribution of temperature and temperature anomalies along the standard Flemish Cap transect for late April 1997.

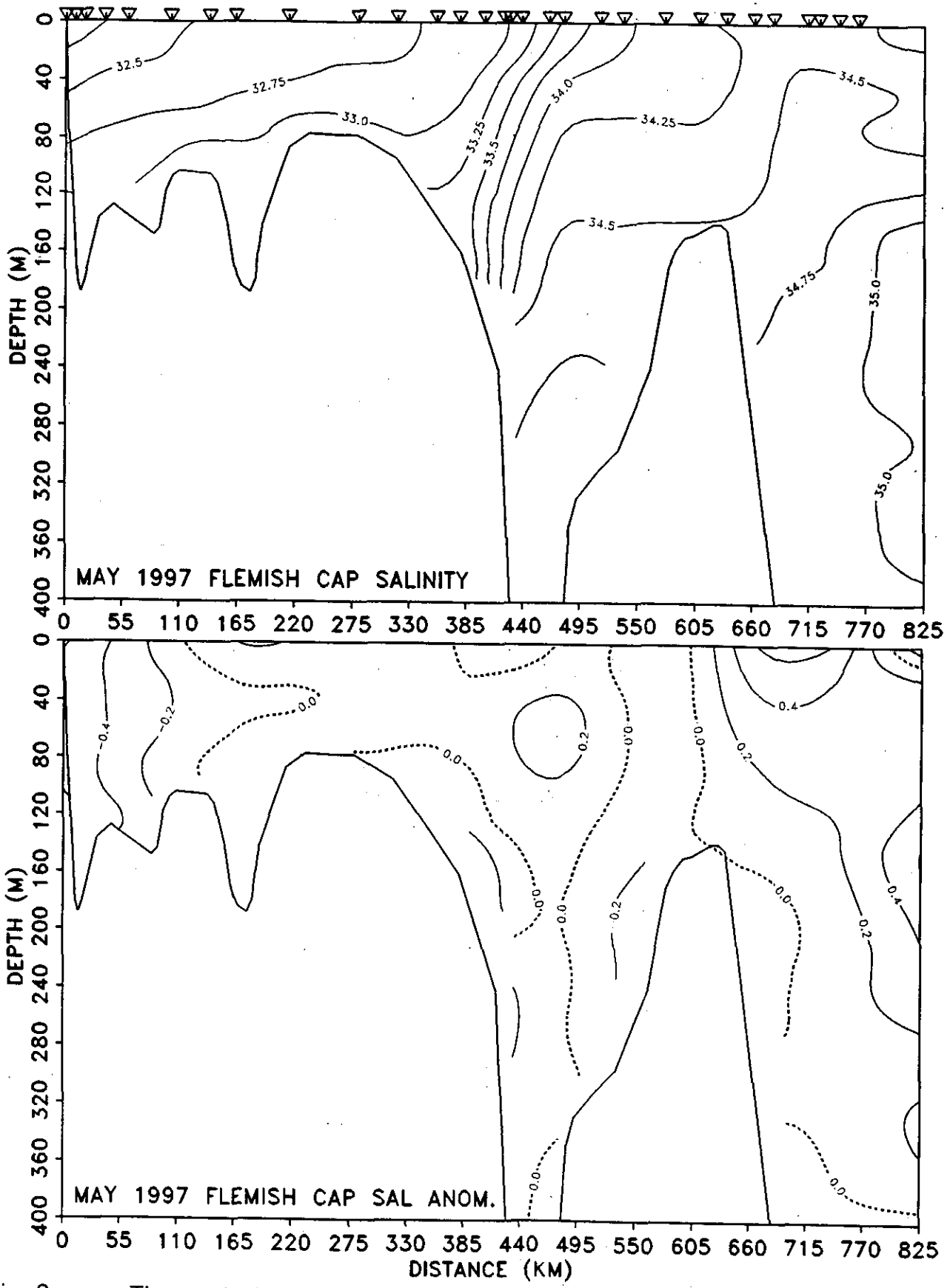

Fig. 9. The vertical distribution of salinity and salinity anomalies along the standard Flemish Cap transect for May 1997.

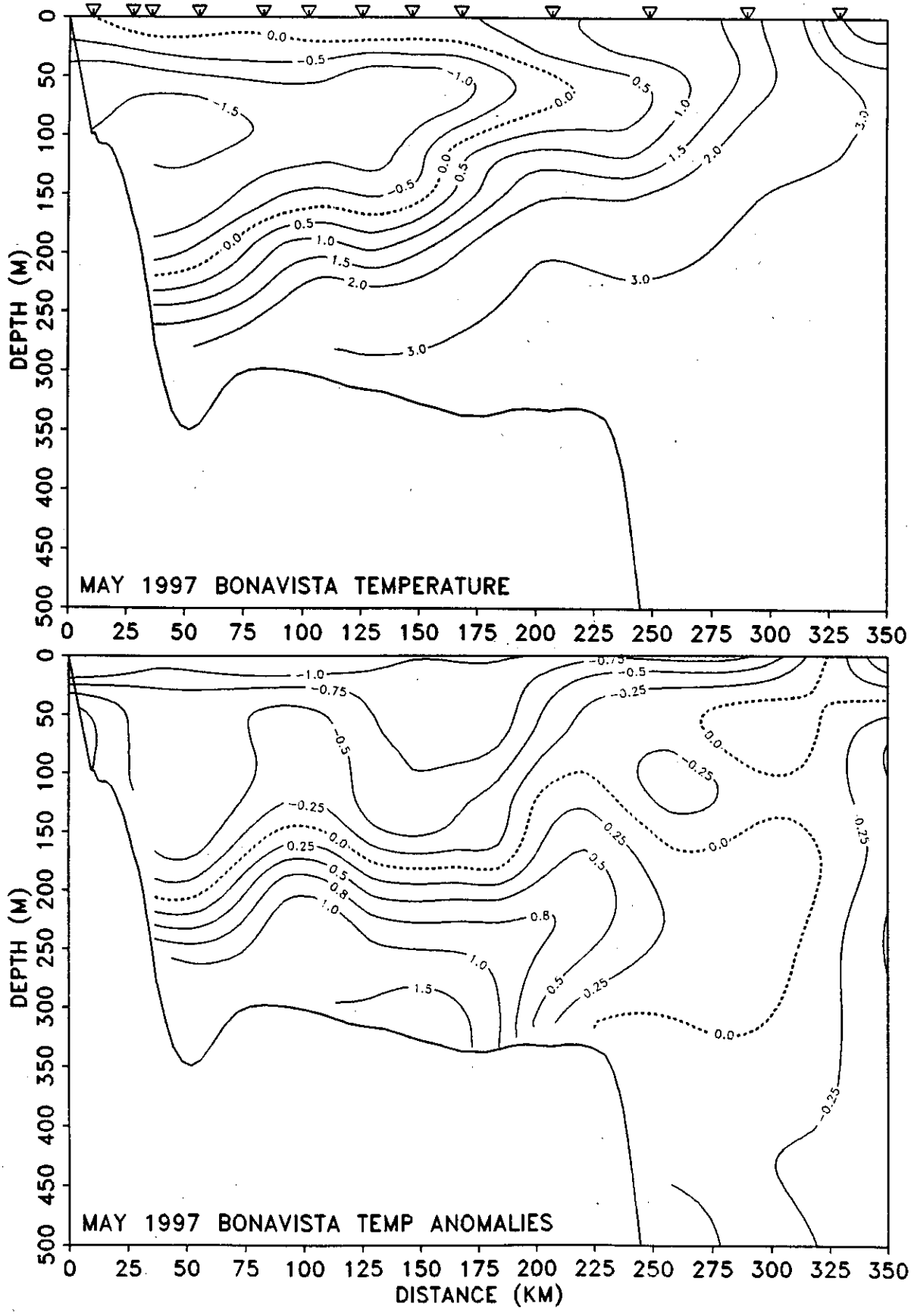

Fig. 10. The vertical distribution of temperature and temperature anomalies along the standard Bonavista transect for May 1997.

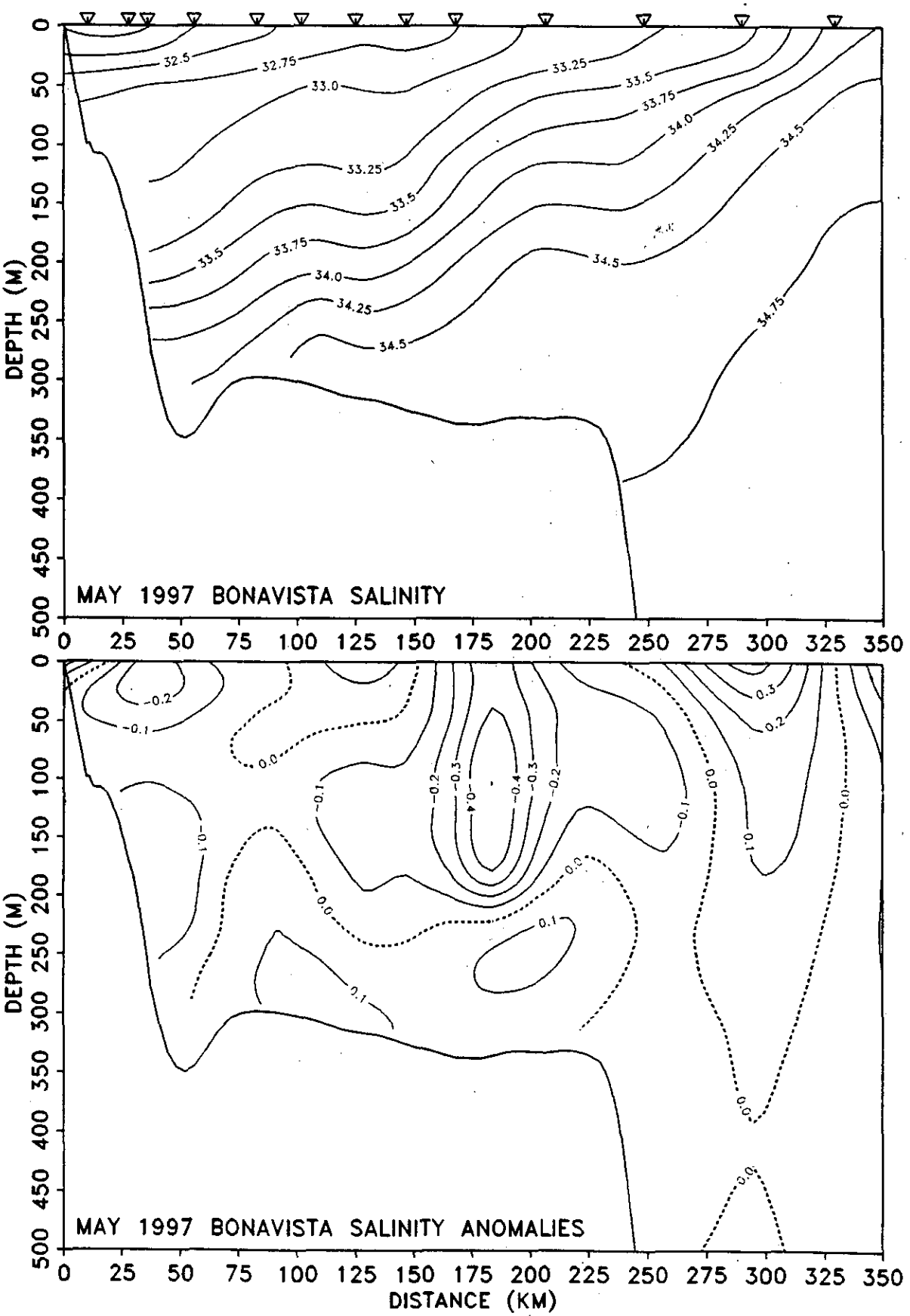

Fig. 11. The vertical distribution of salinity and salinity anomalies along the standard Bonavista transect for May 1997.

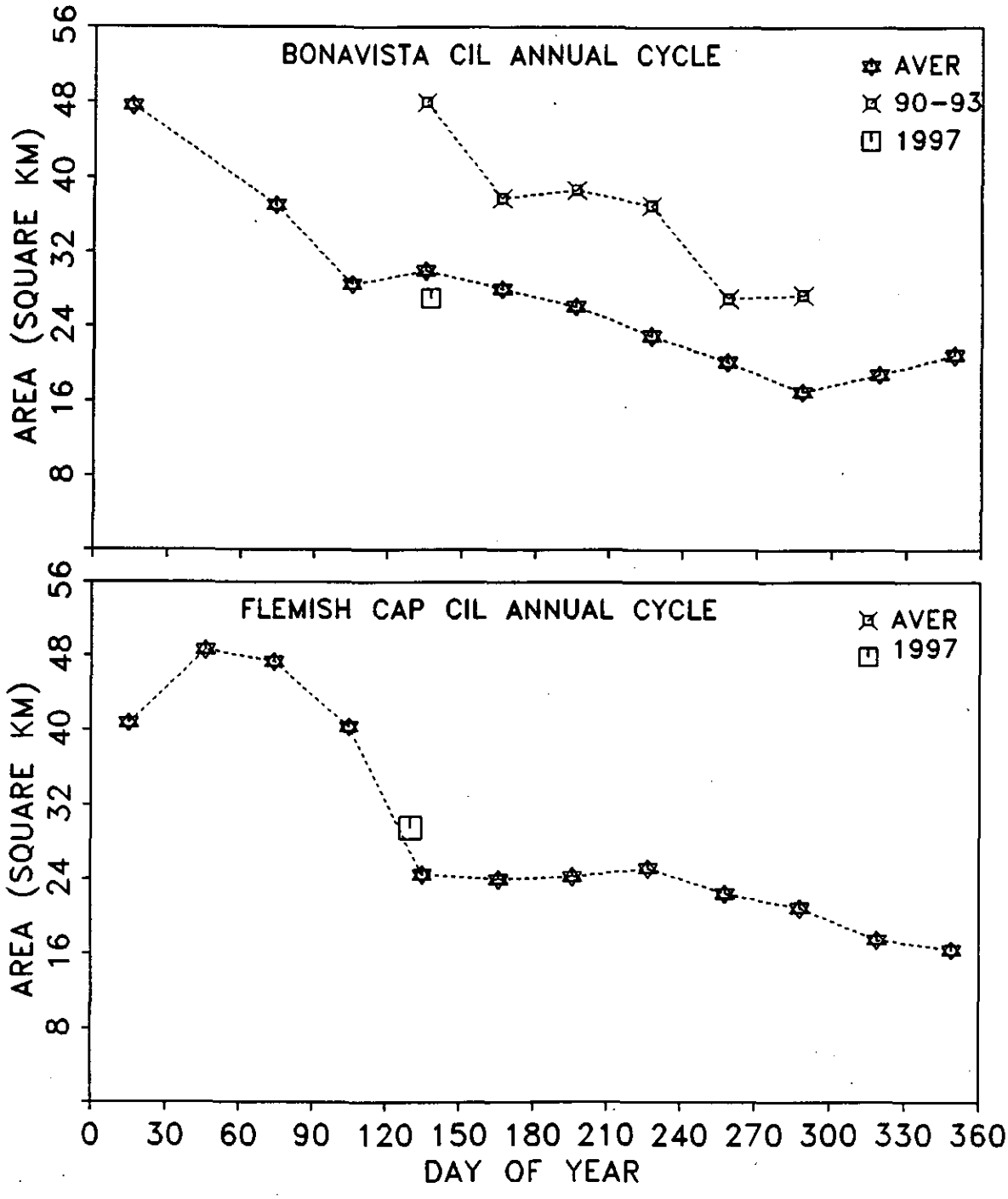

Fig. 12. The seasonal cycle of the CIL area along the Bonavista and Flemish Cap transects obtained from the monthly average of all temperature observations. along each transect (Colbourne and Senciall, 1993, 1996).