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Review of Hydrographic Conditions in Some Areas of the Northwest Atlantic, 1990

I. K. Sigaev

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO)
5, Dm. Donskoy Str., Kaliningrad, 236000, USSR

ABSTRACT

The 1990 hydrographic conditions in the Labrador Sea, Grand Banks off Newfoundland and Scotian Shelf were analysed against the background of the interannual variations observed during the last five years. For some characteristics 14-year period data were taken. Sea surface temperature (SST), surface boundary location and temperatures for the various depth layers were included into the analysis. Interannual variations show the decrease of temperature in 1990. In some periods of 1990 temperature anomalies attained their lowest values reported for the last five years.

The main reason for the decrease of temperature is considered to be the stronger cooling of the surface layer in the West Labrador Sea in winter 1990 as compared to the previous 4-year period. Spring transport of these waters by the Labrador Current further to the south, apparently, promoted the decrease of temperature in the Scotian Shelf water column, primarily in its eastern portion.

INTRODUCTION

The objective of the present review is to analyse the 1990 temperature conditions in the Labrador Sea, Grand Banks of Newfoundland and Scotian Shelf against the background of the interannual variations presented as time series data for 1986-1990 and 1977-1990. These data as well as other characteristics can be used to evaluate in details interannual variation of physical environment and to estimate the 1990 conditions. It is the second objective to determine reasons or environmental factors influencing the Scotian Shelf silver hake distribution and maturation during spring-summer

1990. The hypothesis was assumed that the surface temperature variation in the Labrador Current Area(western Labrador Sea) in some time results in the variation of temperature and volume of water in the Scotian Shelf intermediate cold layer because of the continuous water transport by the Labrador Current from north to south. Winter and spring environmental conditions are of great importance for the subsequent temperature regime of the intermediate layer in the south.

MATERIAL AND METHODS

To analyse SST its monthly means for 1986-1990 were obtained from the charts issued by the Hydrometeocenter of the USSR. Temperature values correspond to the crossing points of the 5-degree grid and centres of the 5-degree trapeziums covering all the North Atlantic region. Six points from the northwestern portion of the grid were chosen to demonstrate SST seasonal and interannual variations in the Labrador Sea, Grand Banks and Scotian Shelf (Fig. 1). To calculate SST anomalies the means for 1977-1982 were used. Further, the means for 15-year period (1977-1991) are supposed to be used.

Monthly means of the surface boundary location in the Scotian Shelf between 59°W and 65°W and to the south of it were analysed as well. Distances in tens of miles between 37°N and position of boundaries for cold shelf waters, slope waters and the northern edge of the Gulf Stream were used as indicators of boundaries. Distances were obtained from the Canadian facsimile charts (Ocean Feature Analysis) for each meridian between 59°W and 65°W and then averaged within the area by month (Sigaev, 1986). Anomalies for these distances were calculated with respect to the monthly means for 1978-1987. Gaps in data were available for 1986-1989 (winter months and April) due to lack of the facsimile charts.

Data of bathythermographic observations for 1978-1990 collected in autumn during the annual Canada-USSR Scotian Shelf surveys on juvenile hake abundance and distribution were summarized. Method of square by square data analysis was used including calculations of temperature means for the whole area and groups of squares covering spawning grounds and slope region. As previously data for 0, 50, 75 m and bottom were averaged. Plots of interannual anomaly variations with respect to the means for 1962-1986 are presented.

To estimate the Scotian Shelf environmental conditions in spring-summer 1990 STD and data from the bathymetric stations were used collected by the R/V EVRIKA in May-July 1990 within the framework of the joint Canada-USSR silver hake surveys. Using these data the means of temperature 0-30, 50-100, 150-200 m and different shelf portions were calculated and compared with the means for 1951-1980 (Drinkwater and Trites, Technical Report No. 1539, 1987). The means for a layer were calculated by averaging values for the depths included into the layer.

RESULTS

Sea surface temperature

Six groups of plots for the 1986-1990 surface temperature anomalies containing monthly means are presented in Fig. 2. As it was mentioned above these plots correspond to the points disposed in three areas (two points per area). Comparing plots for two Labrador Sea sites we can see the differences between 1990 and the previous 4-year period. Plots of the first and second groups prove winter and spring conditions in 1990 to be the most severe ones observed during the last 5-year period, i.e. ice cover in the areas mentioned was observed beyond the usual terms. If to compare the 1990 plots with the rest ones we can see that for the first and second points the 1990 monthly means of anomalies are very similar to those observed during relatively cold 1987 and 1986, respectively. But also winter and spring conditions at the second point are highly similar to those observed in 1987.

The plots for the 1990 SST anomalies in the Grand Banks (see the 3-rd and 4-th points) differ from those constructed for the previous years, namely negative values prevail during the first half of the year. This situation is very similar to that registered in 1986. In other cases either positive or close to normal values markedly prevailed.

Summarizing results of SST analysis in the Labrador Current we can, possibly, refer 1990 to the group of cold years with an abnormal decrease of temperature during the first half of the year.

The last two points are disposed in the Scotian Shelf where the surface temperature is mainly influenced by local environment. Differences are clearly seen between the plots of annual anomalies. This can be explained by the fact that one of the points is disposed in the shelf itself and the other one off the slope. In the northern point temperature is mainly influenced by the seasonal processes; in the southern point strong interdependence between temperature and advection of the warm slope water can be observed. Lower values of SST anomalies were recorded during the first half of 1990 (see Fig. 2, point 5). Between January and June only in February weak positive anomaly occurred. Then between July and late 1990, inclusive , it was negative, November excluding when it kept close to normal. Between 1987 and 1989 positive anomalies prevailed. In 1986 weak negative values predominated. In the shelf (see point 6) annual SST anomalies for the years discussed were characterized by the decrease of temperature in spring-summer and its increase in autumn. In separate years a specific temporal shift occurred. This trend can be seen for 1990 as well, but almost all the monthly means of anomalies being negative. Judging by the character of the annual anomalies 1990 is very similar to 1988 which is considered to be the coldest year during the last five years.

Water boundaries

The plots of annual anomalies concerning boundary positions for cold shelf and slope waters and the northern edge of the Gulf Stream front are presented in Fig. 3. The boundary positions reflect interannual variations extending from north to south. Specific peculiarities of the 1990 boundary dynamics can be seen in spite of the gaps in data happened mainly for the winter months. Fig. 3 displays negative anomalies in the shelf waters between May and late 1990, inclusive. It means that due to the decrease of temperature boundary shift to the south occurred. The decrease of temperature most likely resulted from intensification of the cold water advection from the north. Summer peak in the plot, possibly, demonstrates the seasonal warming of the layer which, however, didn't result in the normal boundary location. As to intraannual variations of boundary location the situation observed in 1990 was the most similar to that observed in 1988, when from May to December boundary for the cold shelf waters shifted more to the south as compared to its mean multiannual position. Two years, namely 1989 and especially 1986 should be referred to as the "warm" ones due to the cold water boundary displacement to the north. It should be noted that in 1990 boundary displacement (i.e. the decrease of temperature in the shelf region) occurred two months earlier as compared to that observed in 1989.

As to the slope water boundary its spring-summer shift to the south and autumn shift to the north were available. These are shown in plots for 1987-1989. In 1986 the peculiarity mentioned was not found as that year proved to be abnormally "warm" one. The southward shift was clearly distinct in June 1990. The northward shift occurred from July to September and then from October to December a strong southward boundary shift could be observed. Thus, the general trend for variation of the slope water boundary position in 1990 was supported by its southward shift. In 1990 the variation of the boundary position for the cold shelf water was noticeably similar to that of the slope waters. The boundary location of the northern edge of the Gulf Stream front changed according to the same intraannual scheme: the northward shift in winter and spring was followed by the southern shift in summer and then in autumn the boundary re-shifted to the north. In autumn 1990 unlike the previous years no shift of the northern edge of the Gulf Stream front to the north was observed (see plots). Between February and late 1990, inclusive, the Gulf Stream front shifted to the south indicating that the surface layer temperature was decreasing.

Water temperature anomalies in the Scotian Shelf in spring-summer 1990

After the monthly means of temperature and salinity for the Scotian Shelf region had been published (Drinkwater and Trites, 1987) we could compare the results of our current observations with the former ones. The table attached contains data on temperature anomalies by layer and shelf site and is based on the comparison of temperatures obtained by R/V EVRIKA in 1990. It can be seen from the Table that negative anomalies prevailed at 0-30 m over the most shelf portions. In the intermediate cold layer (50-100m) negative anomalies occurred east of the Emerald Bank (the Western Bank, shoals off Sable Island and Banquereau). It should be noted that the first two areas are spawning grounds for silver hake. In the 150-200 m layer occupied by the warm shelf waters negative temperature anomalies occurred only in the Western Bank and Banquereau. Thus, it can be concluded that decrease of temperature from May to July 1990 was demonstrated more clearly at 0-30 m over the whole shelf area, at 50-100 m in the spawning grounds and within the whole depth range in Banquereau. The decrease of temperature is mostly related to intensification of the cold water advection under the influence of the Labrador Current.

Water temperature anomalies in the Scotian Shelf in autumn 1977-1990

Analysis of the interannual variation of the autumn temperatures in the Scotian Shelf is based on the bathythermographic data collected during the USSR-Canada surveys on silver hake 0-group abundance. The surveys have been conducted since 1977. Method of square by square treatment of data was used. Fig. 4 displays the interannual variations of temperature in autumn 1975-1990 at 0, 50, 75 m and at the bottom. Data are presented for the whole shelf region, spawning site and slope area. As we can see the surface layer temperature steadily decreased since 1980-1981. In 1990 a negative anomaly occurred but its absolute value was lower as compared to that observed in 1988. We assume that boundary of the seasonal thermocline and core of the intermediate cold layer correspond to the 50 and 75-m depths, respectively. Bottom temperature demonstrates the impact of the warm slope water advection. Within the deeper layers temperature increased in 1979-1981 and 1984-1986 and decreased in 1982-1984 and from 1987 on. The second period of the temperature decrease has not yet finished and the 1990 temperatures for the depths mentioned prove this being the lowest ones since 1987. Thus, the Scotian Shelf temperature in autumn 1990 showed the process of decrease to occur not only in the surface layer but in the deeper as well.

Summarizing results of the temperature analysis in the Scotian Shelf region we can conclude that in 1990 the temperature decrease occurred in the surface layer during the largest period of the year, in the eastern intermediate cold layer from May to July and over the Shelf region within the water column in autumn.

DISCUSSION

The decrease of temperature in the Scotian Shelf from spring to summer, inclusive, possibly, influenced the seasons of maturation mass spawning for silver hake in 1991. From May to July 1991 the R/V EVRIKA made regular observations for silver hake distribution and biological state. According to data collected the mass spawning (the first batch of eggs release) occurred in early July, i.e. one month later than in 1989. Mass concentrations of spawning silver hake were found only on July 9 in the Sable Island shoal though separate specimens of the spawning females had been encountered in the catches since May 22 (cruise report by R/V EVRIKA, 1990).

The results of the autumn survey conducted by the R/V MALTSEVO demonstrated that water temperature continued to decrease during October-November as well (Fig. 4). Analysis of the temperature conditions given in this review should not be considered as an exhaustive one. The results obtained can be used as additional ones to the similar overview made for 1990 and the previous years. For example, sea surface temperatures reported by Drinkwater and Trites (1990) for some sites along the eastern coast and in the Scotian Shelf agree with SST values presented in this review. It can be concluded on the base of these two reviews that sea surface temperature was decreasing in 1988 and increasing in 1989. The anomalies described, apparently, reflect the natural tendency in temperature variations for the Northwest Atlantic through some mean values are needed to be re-calculated. Annual means of surface temperature for 1977-1982 used here will be re-calculated for the 15-year period as soon as data for 1991 are obtained.

The monthly means of temperature and salinity for the Scotian Shelf region presented by Drinkwater and Trites (Technical Report No. 1539) can be used only in the cases when the monthly means are based on sufficient numbers of observations made per month. In this report no sufficient observations are available for the winter months below 100 m. Thus, the temperature anomalies reported for 150-200 m should be considered only as approximate ones.

REFERENCES

1. Drinkwater K. F. and R. W. Tritos. 1987. Monthly means of temperature and salinity in the Scotian Shelf region. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1539. 101pp.

2. Drinkwater K. F. and Trites R. W. 1990. Overview of environmental conditions in the Northwest Atlantic in 1989. NAFO SCR Doc. 90/83, Serial No. N1806, 19 pp.

3. Sigaev I. K. 1986. Synoptical variability of hydrological front localization in energy active Gulf Stream zone in 1984. In book: Fisheries-oceanological research in the Atlantic Ocean and South-Eastern Pacific. Coll. of scientific papers of the Atlantic Scientific Research Institute of Marine Fisheries and Oceanography. Kaliningrad. p. 4-13.

Table Temperature anomalies in the Scotian Shelf, May-July 1990

Layer	Brouns Bank	Banquereau		Lahave Bank			Lahave Basin	Emerald Basin
	VI	VI	VII	V	VI	VII	VI	VI
0-30 m	1.2	-0.6	-0.1	1.9	0.1	-1.6	-0.4	-1.4
50-100 m	-0.2	0.1	1.0	3.2	1.5	2.1	2.1	0.6
150-200m	-	-	-	1.7	-	-	2.0	0.5

Table (continued)

Layer	Saddle			Emerald Bank			Western Bank			Sable Island	
	V	VI	VII	V	VI	VII	V	VI	VII	V	VI
0-30 m	1.3	-1.0	-0.5	0.0	-1.4	0.0	0.1	-1.7	-3.2	0.3	-2.5
50-100 m	4.2	1.4	0.8	2.9	0.3	2.7	2.7	-0.3	-2.2	-0.5	-2.6
150-200m	-	1.4	0.8	-	0.7	1.0	-	-	-0.8	-	2.8

Table (continued)

Layer	Banquereau	
	V	VII
0-30 m	-0.6	-3.2
50-100 m	-1.7	-1.5
150-200 m	-1.8	-4.4

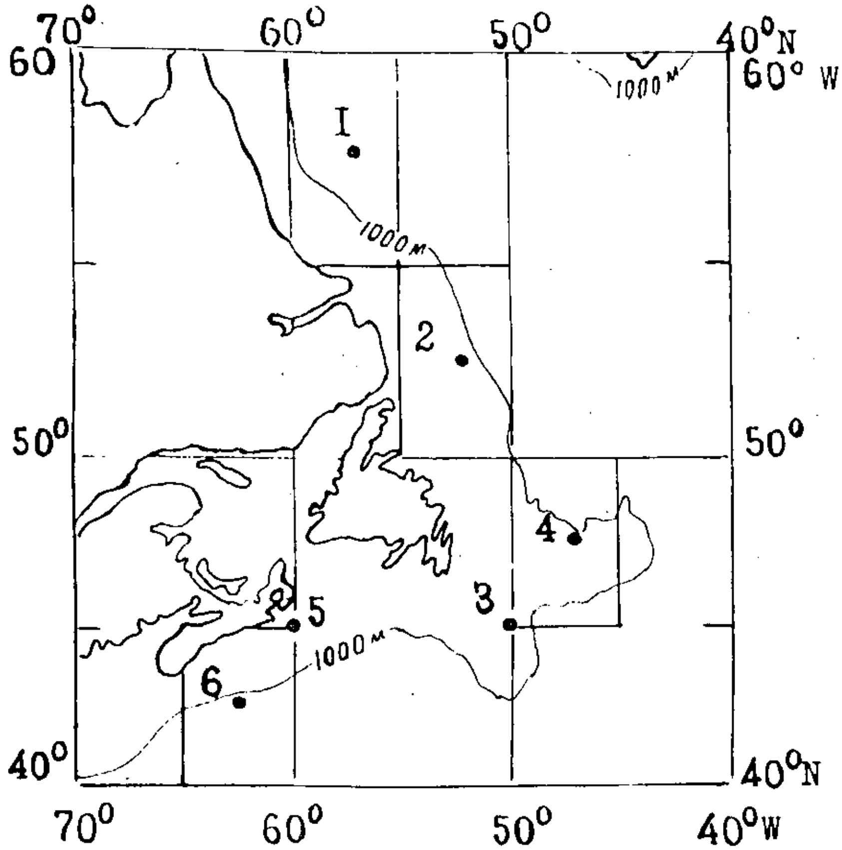

Fig. 1. Distribution of points where surface temperatures were easured and analysed.

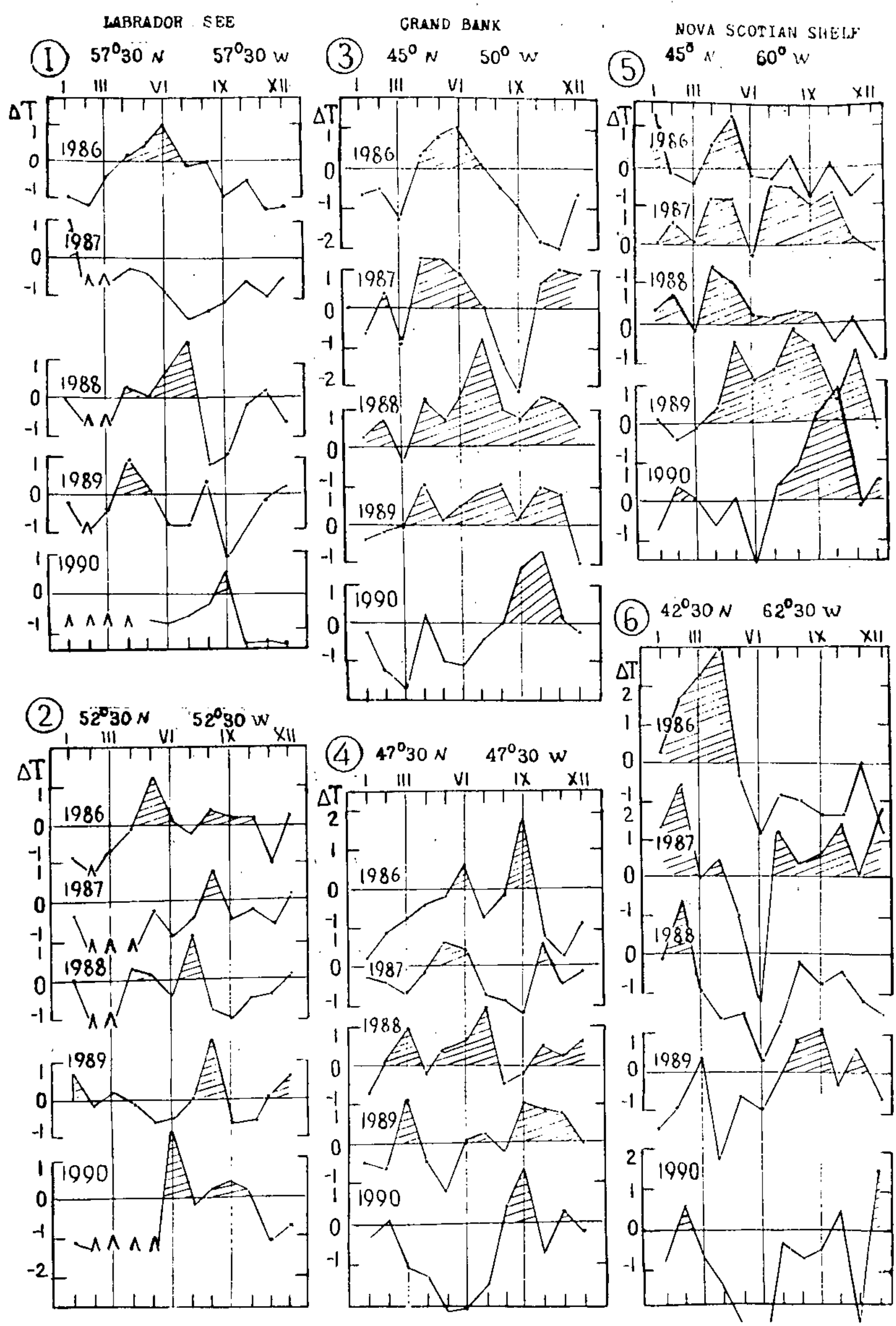

Fig. 2. Monthly means of surface temperature anomalies in the Labrador Sea, Grand Banks of Newfoundland and Scotian Shelf between 1986 and 1990.

"⋀" - sea surface covered with ice.

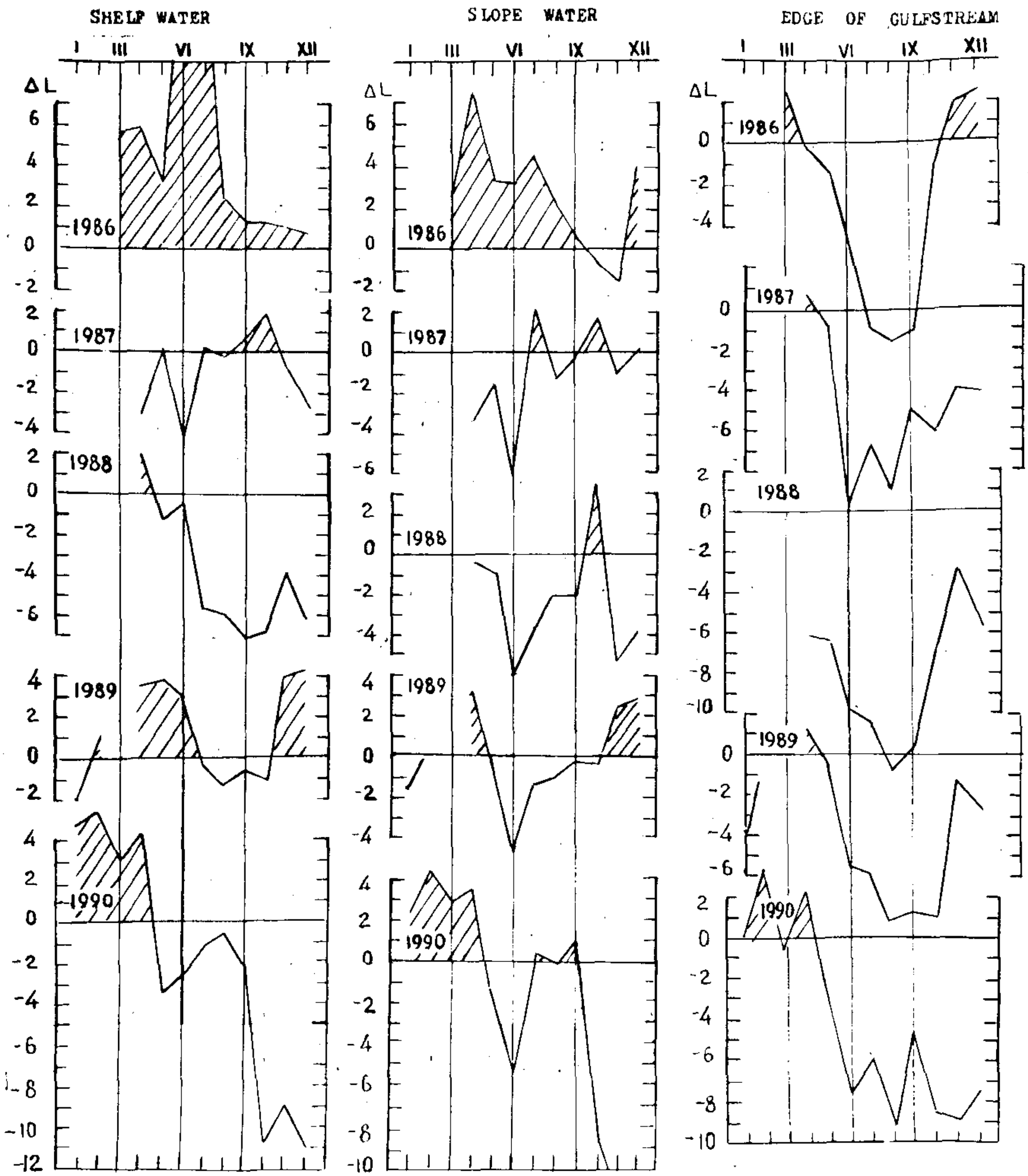

Fig. 3. Monthly mean anomalies of boundary location for the shelf and slope waters and northern edge of the Gulf Stream from 1986 to 1990 between 59°W and 65°W.

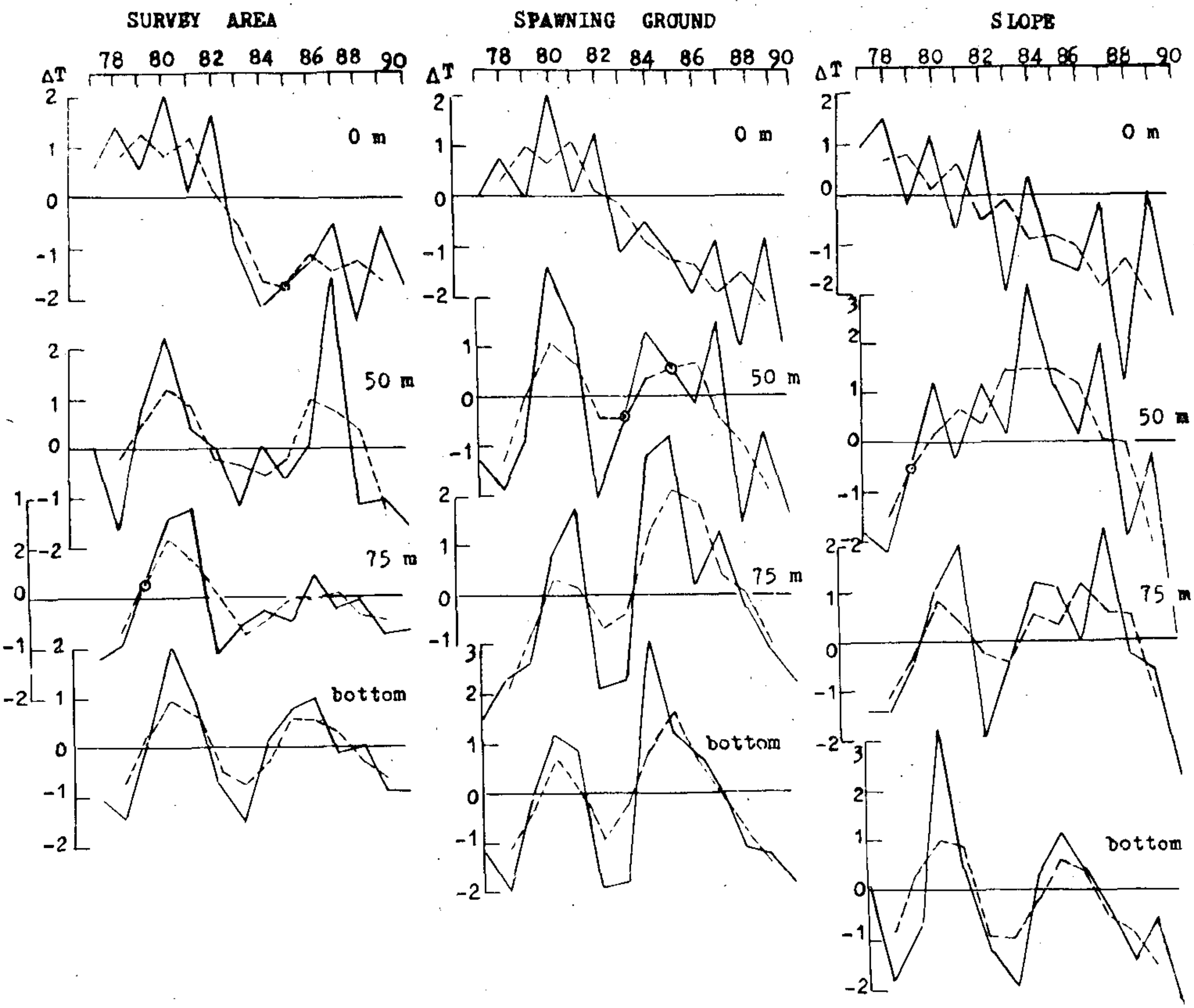

Fig. 4. Temperature anomalies in the Scotian Shelf region in autumn 1977-1990.

Dotted lines mean smoothed temperature values.