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Year to Year Variations in Water Temperature in NAFO Subdivision 3Ps

by

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1. INTRODUCTION.

Since 1977 groundfish surveys are carried out each year on board the R/V Cryos in the NAFO Subdivision 3Ps, one in late winter, another in autumn until 1984.

By using hydrological observations made during these cruises we aim in this paper to provide informations on year to year variations in water temperature in the southern part of Saint-Pierre Bank.

2. MATERIAL AND METHODS.

The transect from southwestern slope of Saint-Pierre Bank to North of Green Bank previously described by FOREST et al (1981) has been selected.

From 1978 to 1984, the hydrographic section was made by using XBT cast made after trawlings the closest as possible to this transect and in a short time interval. Details on location of these stations are given table 1 and 4 and figures 1 to 6. Since 1985, 14 XBT stations are occupied each year on this transect. No data were available for the year 1980.

Temperatures were recorded for surface, 5 meters depth and for each ten meters depth interval down to the bottom.

For each year, average temperatures were calculated by depth level using all stations along the transect to obtain a mean vertical profile of temperature for the year considered.

A reference vertical distribution of temperature for the period studied was calculated by averaging the mean temperatures by depth obtained for each year. Then, yearly mean temperatures were compared by depth range to the average temperatures observed over the period studied (1978 to 1987 for the late winter and 1978 to 1984 for the autumn).

3. RESULTS AND DISCUSSION.

3.1. Year to year variations in late winter.

Over the period 1978-1987, the transect have been carried out between middle of February and middle of March (table 1).

The yearly mean vertical profiles of temperature obtained (fig. 4) can be classified in three groups depending on whether surface layer temperatures (0-100 m) are above (years 1981, 1983 and 1984), close (year 1978) or below (years 1979, 1982 and 1985 to 1987) 0° C.

The year 1978 with surface layer temperatures about 0° C appears to look like the mean temperature profile for the 1978-1987 base period (fig. 5).

Annual temperature anomalies, that is to say differences between yearly means and mean for the 1978-1987 base period are presented table 3 and fig. 6. Two years can be classified as warm winter : 1981 and 1984 with positive anomalies greater than 1° C, and the year 1987 as a very cold winter. Negative anomalies were observed during the three last years.

Anomalies analysis by 100 meters depth range (table 3 and fig. 7) shows that larger temperature fluctuations were generally found in the two upper depth ranges except for the year 1982.

The biggest anomalies were found in the 100-199 meters depth range in 1984 (+3.32° C) and 1987 (-2.47° C) and between 200 and 299 meters in 1982 (-2.82° C).

On the hydrological section for the cold winter 1985 (fig. 8), water masses with temperatures below -1° C extended from west upper slopes of Saint-Pierre Bank to Green Bank, with a small warm water mass near the bottom in the Halibut Channel. This is in accordance with results of DRINKWATER and al (1986) for the Station 27, which was dominated by below-normal temperatures.

For the warm winter 1984, hydrological section (fig. 9) shows that surface temperatures are positive and there are only two small water masses with temperature below 0° C near the Halibut Channel bottom.

3.2. Year to year variations in autumn.

From 1978 to 1984, XBT stations used were occupied in October (table 4).

The figure 10 shows that intermediate water layer temperatures were below 0° C in 1980, 1981 and 1984.

As for winter, an average temperature profile was derived for the 1978-1984 period (fig. 11).

Table 6 and fig. 12 show the annual temperature anomalies. A negative trend can be observed from 1978 to 1980 and year 1984 appears as a cold autumn with an anomalie of -1.65° C.

Like in winter, anomalies analysis by 100 meters depth range (table 6 and fig. 13) shows that larger temperature fluctuations generally occured in the 100-199 meters depth range.

4. CONCLUSION.

From this study, the 1981 and 1984 winters appear as warm winters while the three last winters (1985 to 1987) were cold. The series was too short in autumn to provide good information, but it seems that 1984 autumn was very cold.

Generally for both season, the larger temperature fluctuations occured in the 100-199 meters depth range, temperatures at these depthes being greatly influenced by the importance of the Labrador current cold waters.

References

DRINKWATER (K.F.), TRITES (R.W.), 1986.- Overview of Environmental Conditions in the Northwest Atlantic in 1985.- NAFO SCR Doc. 86/72.

FOREST (A.), POULARD (J.C.), 1981.- Water temperature distributions in NAFO Subdivision 3Ps in autumn 1980 and late winter 1981.- NAFO SCR Doc. 81/VI/45.

Years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Number of transect stations	8	8		13	10	9	14	14	14	11
Duration of transect in days	5	2		11	8	5	4	1	1	1
Date of beginning of transect	March 14	March 7		March 11	March 12	Febr. 26	March 15	March 13	Febr. 21	March 5
Date of end of transect	March 19	March 8		March 21	March 19	March 2	March 18	March 14	Febr. 22	March 6

Table 1.- Number of XBT stations in late winter.

Depth (m)		1978	1979	1981	1982	1983	1984	1985	1986	1987	Mean
0 to 99	Minimum	- 0.6	- 1.1	- 0.3	- 1.0	- 0.3	- 0.5	- 1.6	- 1.3	- 1.5	- 1.6
	Maximum	6.0	- 0.1	4.7	1.1	3.2	7.3	1.1	1.5	0.0	7.3
	Average	- 0.02	- 0.51	1.97	- 0.63	1.06	1.67	- 1.00	- 0.66	- 1.05	0.09
	St. dev.	1.18	0.78	3.14	0.97	1.85	2.74	1.50	1.03	1.52	1.49
100 to 199	Minimum	- 0.6	- 0.6	- 0.6	- 1.0	- 0.5	- 0.9	- 1.4	- 1.2	- 1.4	- 1.4
	Maximum	8.2	8.6	9.1	7.8	6.6	10.0	7.4	6.7	4.4	10.0
	Average	4.17	2.14	3.10	1.32	3.06	5.54	0.19	0.75	- 0.25	2.22
	St. dev.	6.97	4.68	5.64	3.56	5.12	8.80	2.26	2.23	1.13	4.56
200 to 299	Minimum	6.8	7.1	5.9	2.9	2.4	7.0	- 0.9	4.3	1.5	- 0.9
	Maximum	8.1	7.9	8.5	5.5	5.7	9.4	7.7	8.3	7.2	9.4
	Average	7.78	7.51	7.31	3.82	5.55	8.45	6.00	7.05	6.33	6.64
	St. dev.	11.56	11.48	10.60	5.56	8.24	12.22	8.96	10.16	9.23	9.49
300 to 399	Minimum	4.7		5.7	3.4		5.4	5.7	6.0	5.4	3.4
	Maximum	6.1		6.4	4.6		7.7	7.8	7.5	6.1	7.8
	Average	5.27		5.86	4.17		6.45	7.18	6.70	5.61	5.89
	St. dev.	8.07		8.61	6.23		9.49	10.42	9.70	8.26	8.79
0 to 399	Minimum	- 0.6	- 1.1	- 0.6	- 1.0	- 0.5	- 0.9	- 1.6	- 1.3	- 1.5	- 0.9
	Maximum	8.2	8.6	9.1	7.8	6.6	10.0	7.8	7.5	6.33	10.0
	Average	1.81	0.95	3.09	0.80	2.01	3.52	0.87	1.28	0.52	1.65
	St. dev.	15.77	12.65	13.41	9.12	9.87	14.29	11.42	19.31	11.57	17.07

Table 2.- Yearly temperatures observed in late winter (minimum, maximum, average and standard deviation).

Depth (m)	1978	1979	1981	1982	1983	1984	1985	1986	1987
0 to 99	- 0.11	- 0.60	+ 1.91	- 0.72	+ 0.97	+ 1.58	- 1.09	- 0.75	- 1.14
100 to 199	+ 2.09	- 0.08	+ 0.88	+ 1.24	+ 0.84	+ 3.32	- 2.03	- 1.47	- 2.47
200 to 299	+ 1.14	+ 0.99	+ 0.79	- 2.82	- 1.09	+ 1.94	- 0.64	+ 0.41	- 0.32
300 to 399	- 0.62		- 0.03	- 1.72		+ 0.56	+ 1.29	+ 0.81	- 0.28
0 to 399	- 0.16	- 0.70	1.44	- 0.85	+ 0.36	+ 1.87	- 0.78	- 0.37	-1.13

Table 3.- Yearly deviation to the mean by depth range in late winter.

Years	1978	1979	1980	1981	1982	1983	1984
Number of transect stations	10	8	7	13	13	13	12
Duration of transect in days	5	3	7	8	6	4	11
Date of beginning of transect	Oct. 15	Oct. 16	Oct. 4	Oct. 7	Oct. 14	Oct. 28	Oct. 25
Date of end of transect	Oct. 19	Oct. 18	Oct. 10	Oct. 14	Oct. 19	Nov. 1	Nov. 4

Table 4.- Number of XBT station in autumn.

Depth (m)		1978	1979	1980	1981	1982	1983	1984	Mean
	Minimum	- 1.0	- 1.1	- 1.2	- 1.2	- 1.1	- 1.4	- 1.4	- 1.4
0 to 99	Maximum	13.5	12.8	11.6	13.0	16.1	14.7	11.5	16.1
	Average	6.59	5.38	5.34	6.33	5.77	6.22	4.33	5.71
	St. dev.	10.49	9.16	9.28	10.65	9.85	9.91	7.50	9.56
	Minimum	- 1.4	- 1.3	- 1.2	- 1.1	- 1.1	- 1.5	- 1.4	- 1.5
100 to 199	Maximum	9.7	7.9	7.5	7.4	9.7	8.7	5.5	9.7
	Average	2.53	3.49	0.48	2.44	3.48	1.87	- 0.7	1.80
	St. dev.	5.44	6.33	2.76	4.86	6.53	4.56	1.52	4.56
	Minimum	7.0	6.4	6.4	6.3	4.9	6.9	2.1	2.1
200 to 299	Maximum	9.6	7.0	9.0	7.9	8.0	8.4	7.9	9.0
	Average	8.61	7.67	7.39	7.16	6.69	7.74	6.83	7.44
	St. dev.	12.61	10.08	10.90	10.40	9.74	11.71	10.87	10.38
	Minimum	6.8	5.7	6.6	5.0	4.4		7.4	4.4
300 to 399	Maximum	6.8	6.2	7.0	6.5	6.3		7.5	7.5
	Average	6.80	5.96	6.83	5.72	5.22		7.43	6.33
	St. dev.	0	9.42	11.83	8.39	7.69		12.09	8.40
	Minimum	- 1.4	- 1.3	- 1.2	- 1.2	- 1.1	- 1.5	- 1.4	- 1.5
0 to 399	Maximum	13.5	12.8	11.6	13.0	16.1	14.7	11.5	16.1
	Average	5.68	5.06	4.39	5.77	5.29	5.30	3.32	4.97
	St. dev.	13.74	11.27	14.19	7.83	8.57	12.66	15.96	17.04

Table 5.- Yearly temperatures observed in autumn (minimum, maximum, average and standard deviation).

Depth (m)	1978	1979	1980	1981	1982	1983	1984
0 to 99	+ 0.88	- 0.33	- 0.37	- 0.62	+ 0.06	+ 0.51	- 1.38
100 to 199	+ 0.73	+ 1.69	- 1.32	+ 0.64	+ 1.68	+ 0.03	- 2.50
200 to 299	+ 1.17	- 0.68	- 0.55	- 0.28	- 0.75	+ 0.30	- 0.61
300 to 399	+ 0.47	- 0.37	+ 0.50	- 0.61	- 1.11		+ 1.10
0 to 399	+ 0.71	+ 0.09	- 0.58	+ 0.80	+ 0.32	+ 0.33	- 1.65

Table 6.- Yearly deviation to the mean by depth range in autumn.

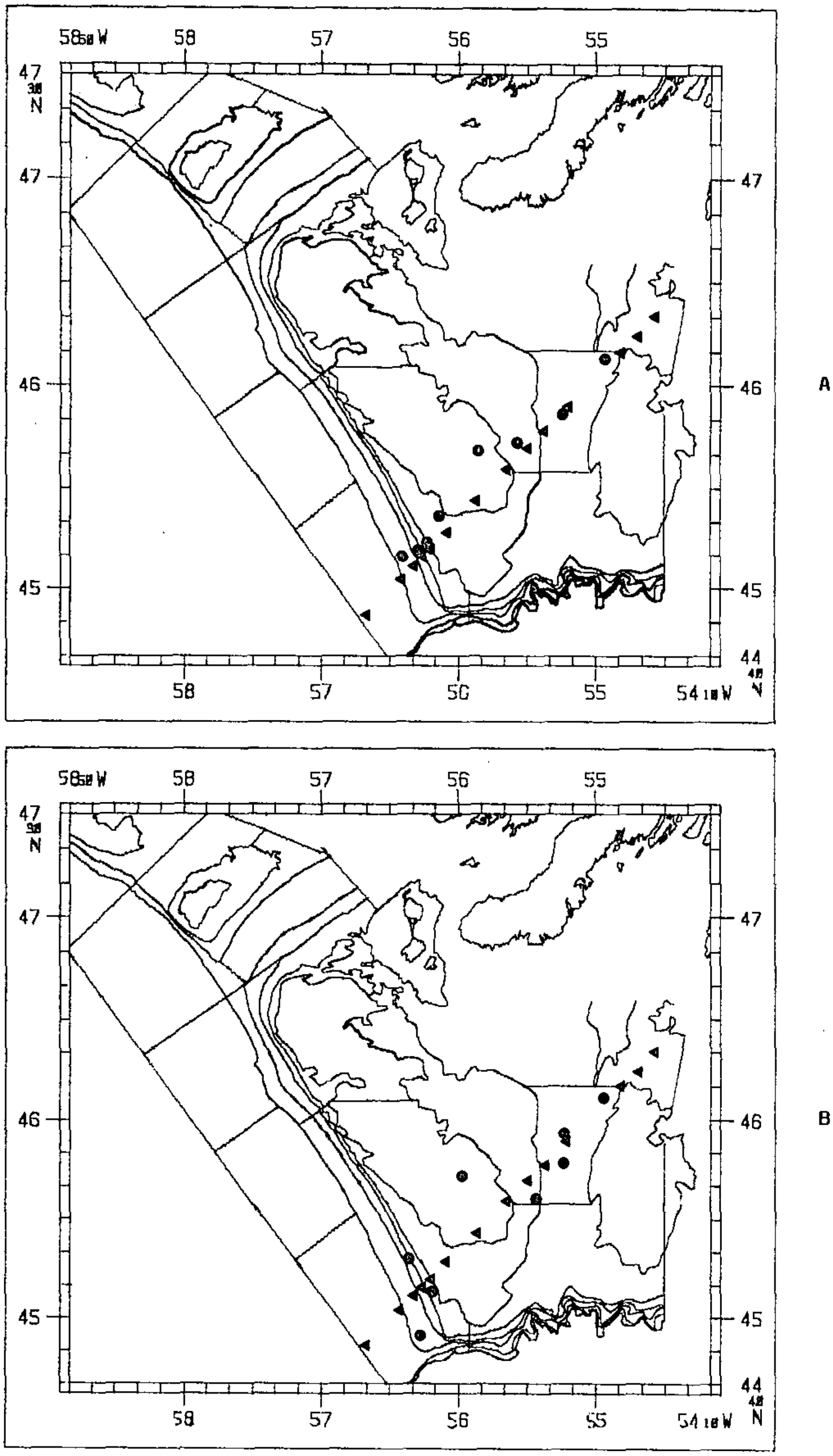
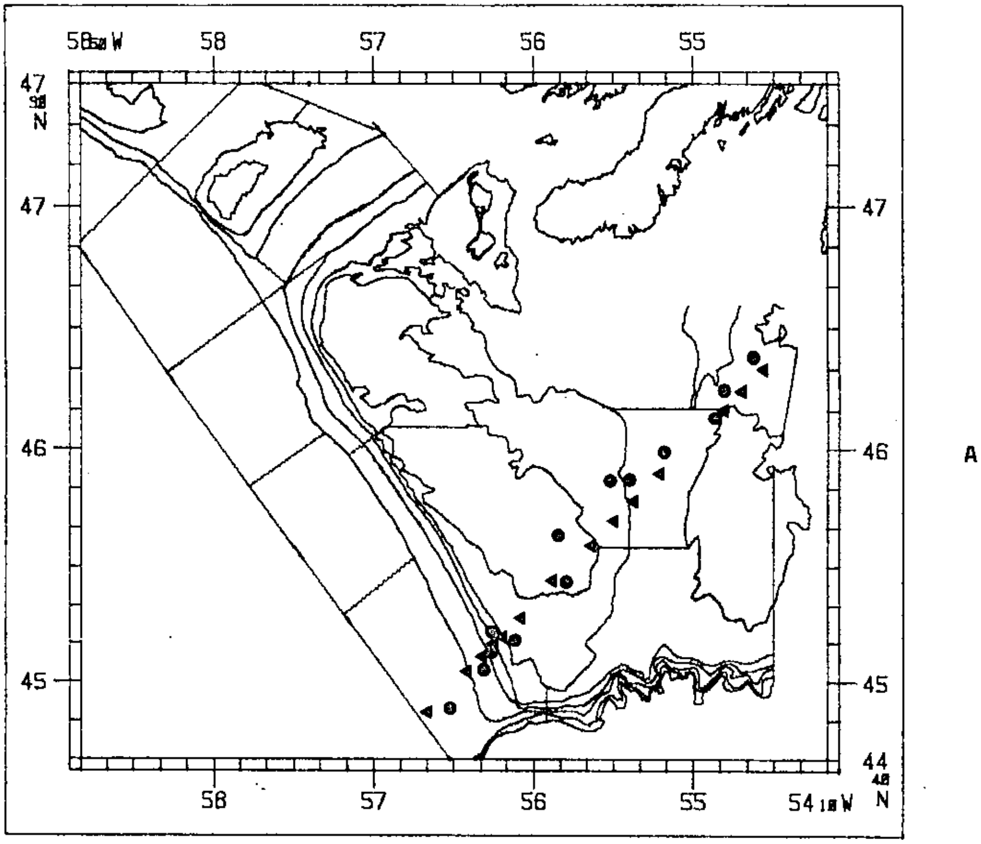


Fig. 1 : XBT station positions (●) used in late winter :
A = 1978, B = 1979
(◀) XBT station occupied since 1985.



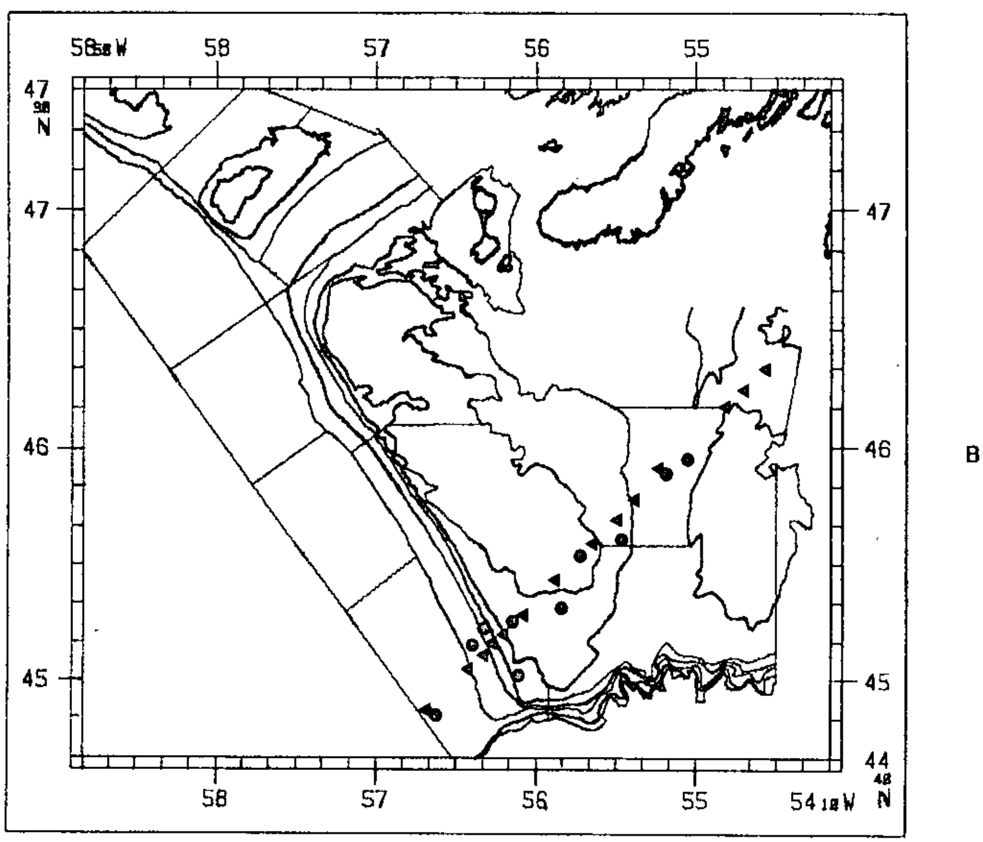
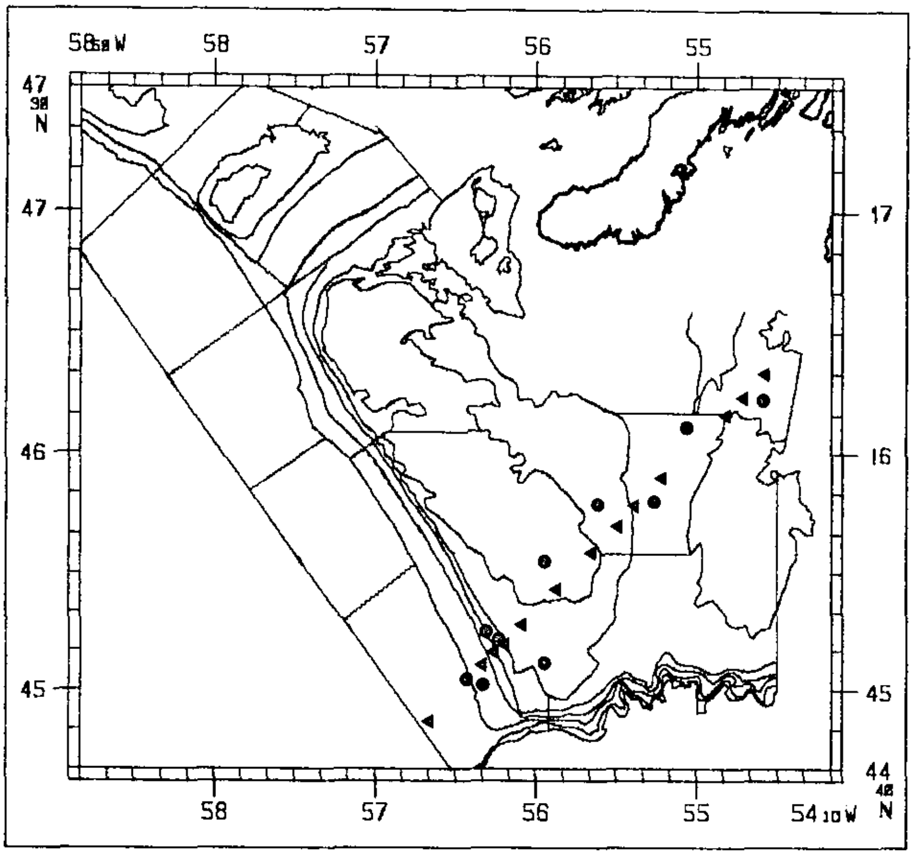
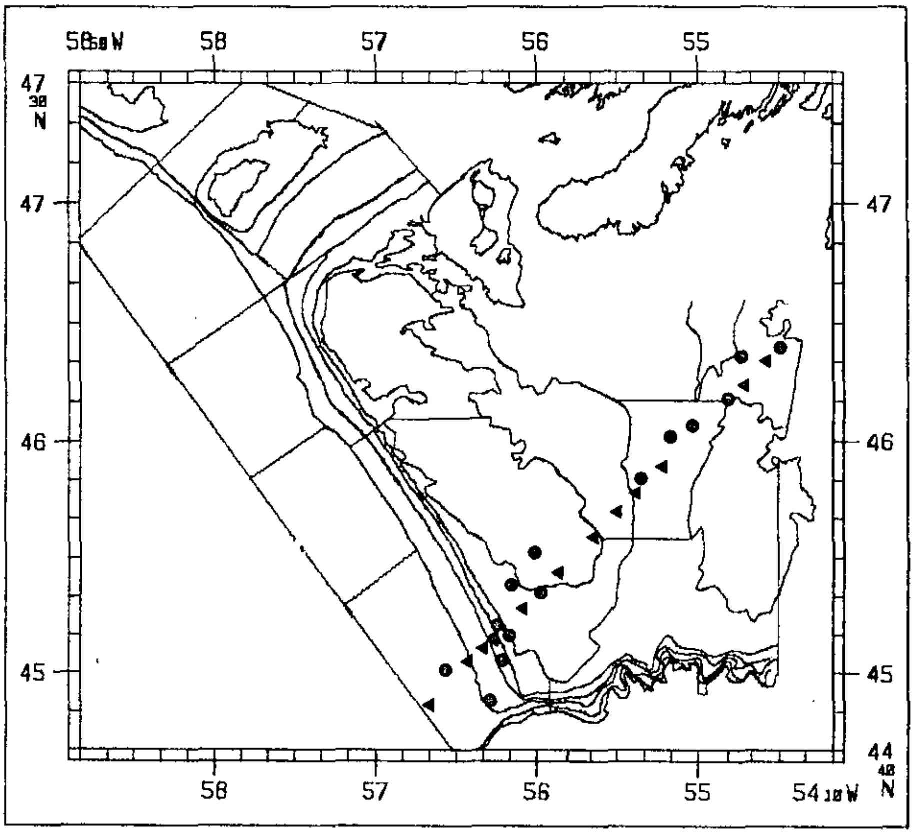


Fig. 2 : XBT station positions (●) used in late winter : A = 1981, B = 1982
(◄) XBT stations occupied since 1985.



A



B

Fig. 3 : XBT station positions (●) used in late winter :
A = 1983, B = 1984
(◄) XBT stations occupied since 1985.

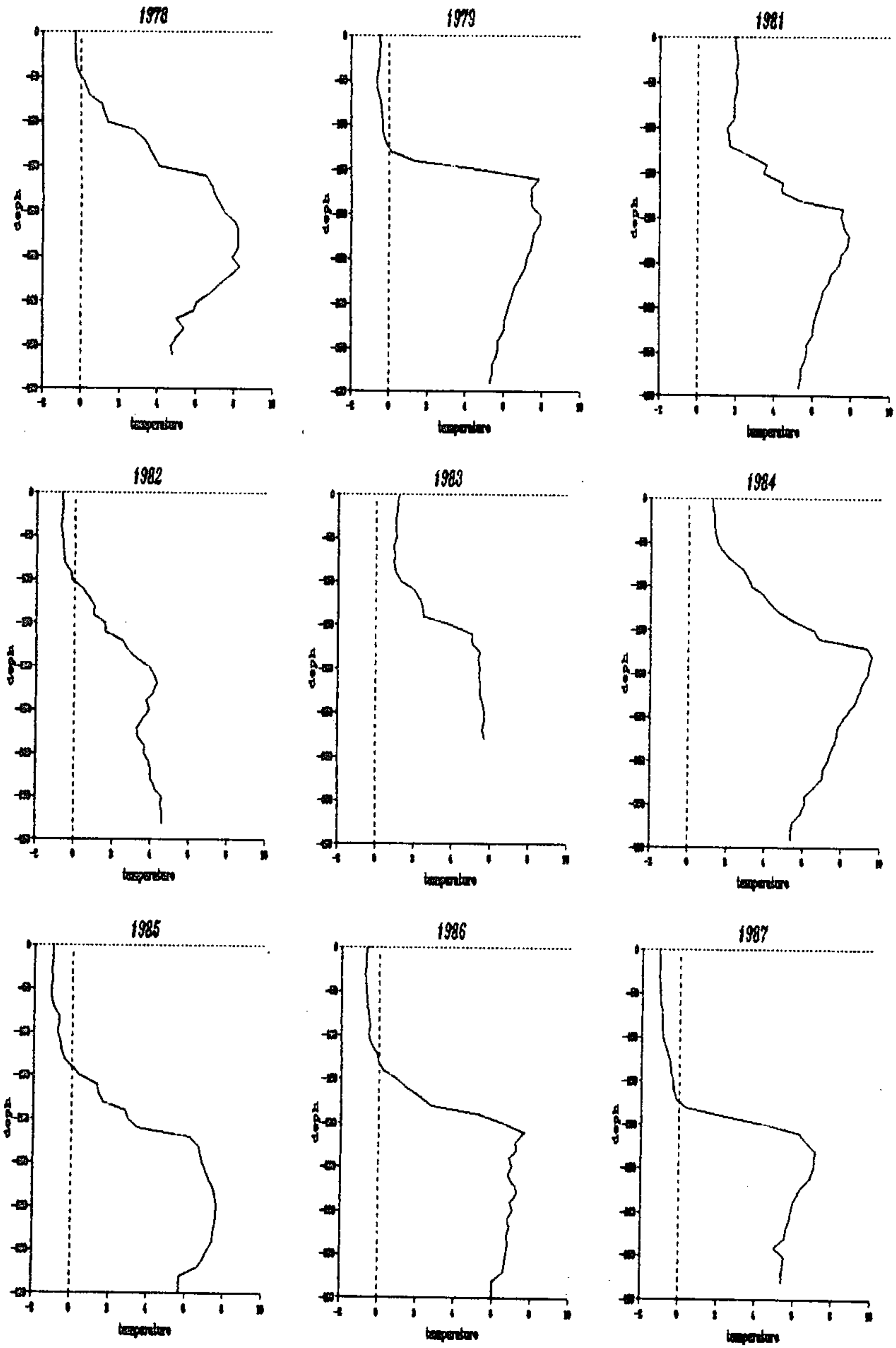


Fig. 4 : Yearly mean profile of temperature in late winter.

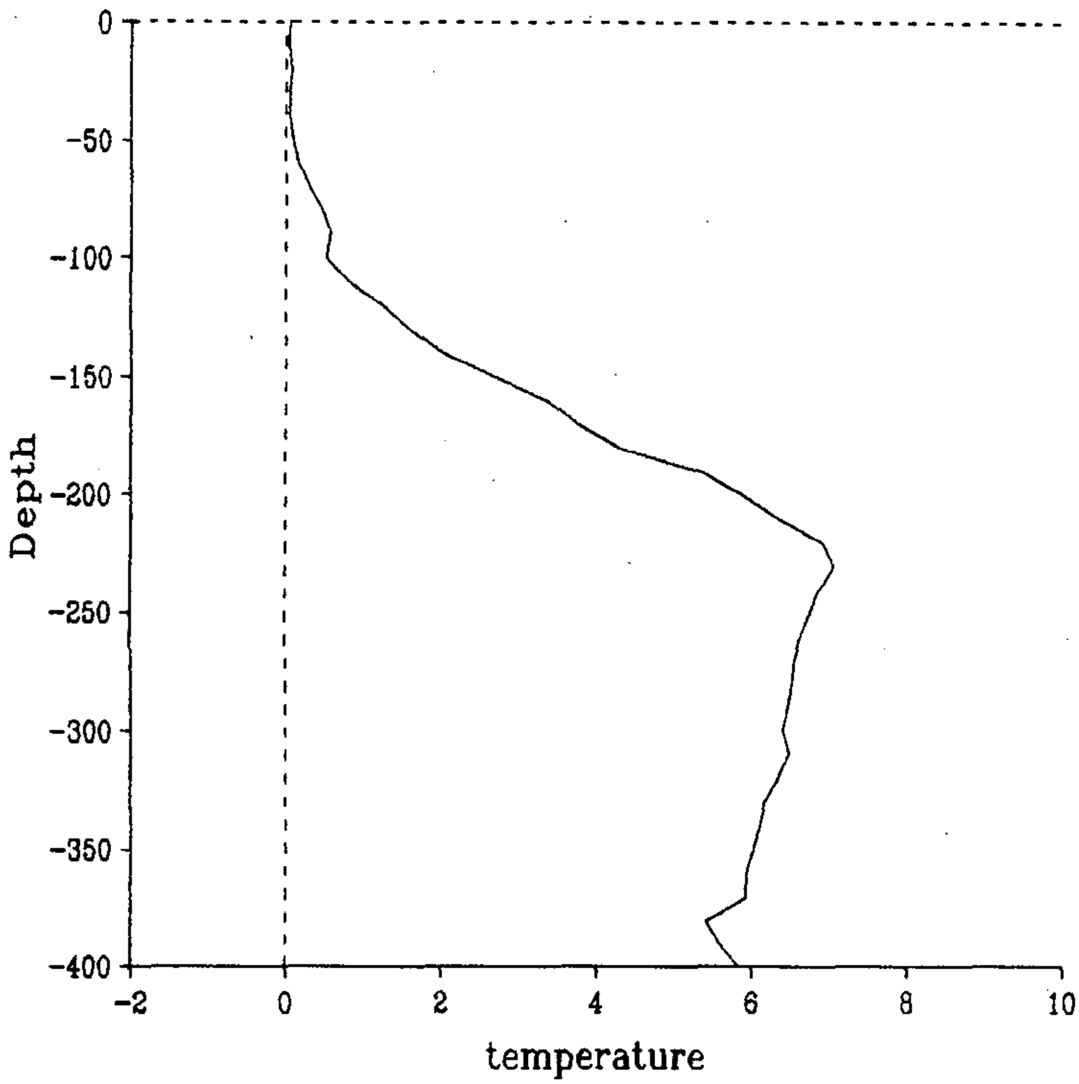


Fig. 5 - Mean profile of temperature in late winter for the period 1978-1987.

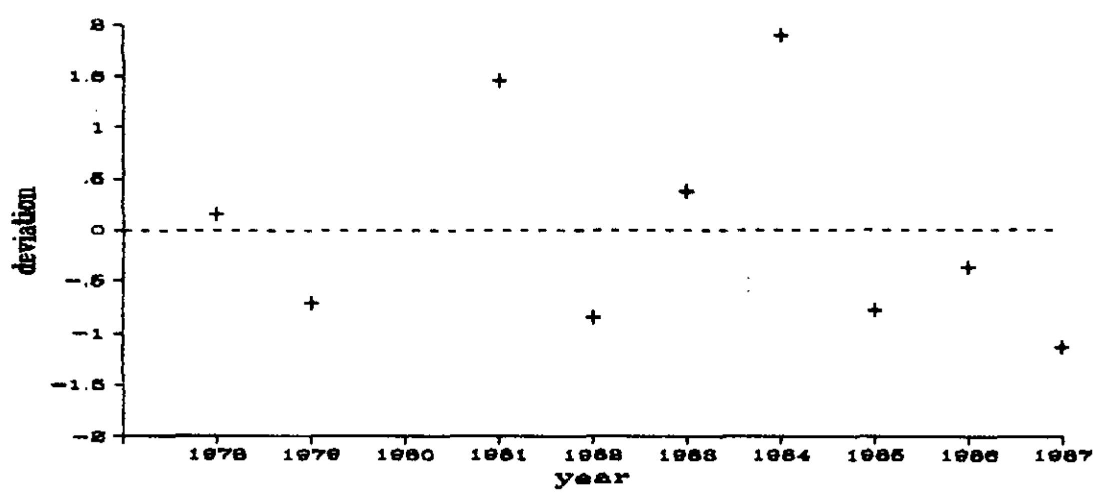


Fig. 6 - Yearly deviation to the mean temperature (1978-1987) in late winter.

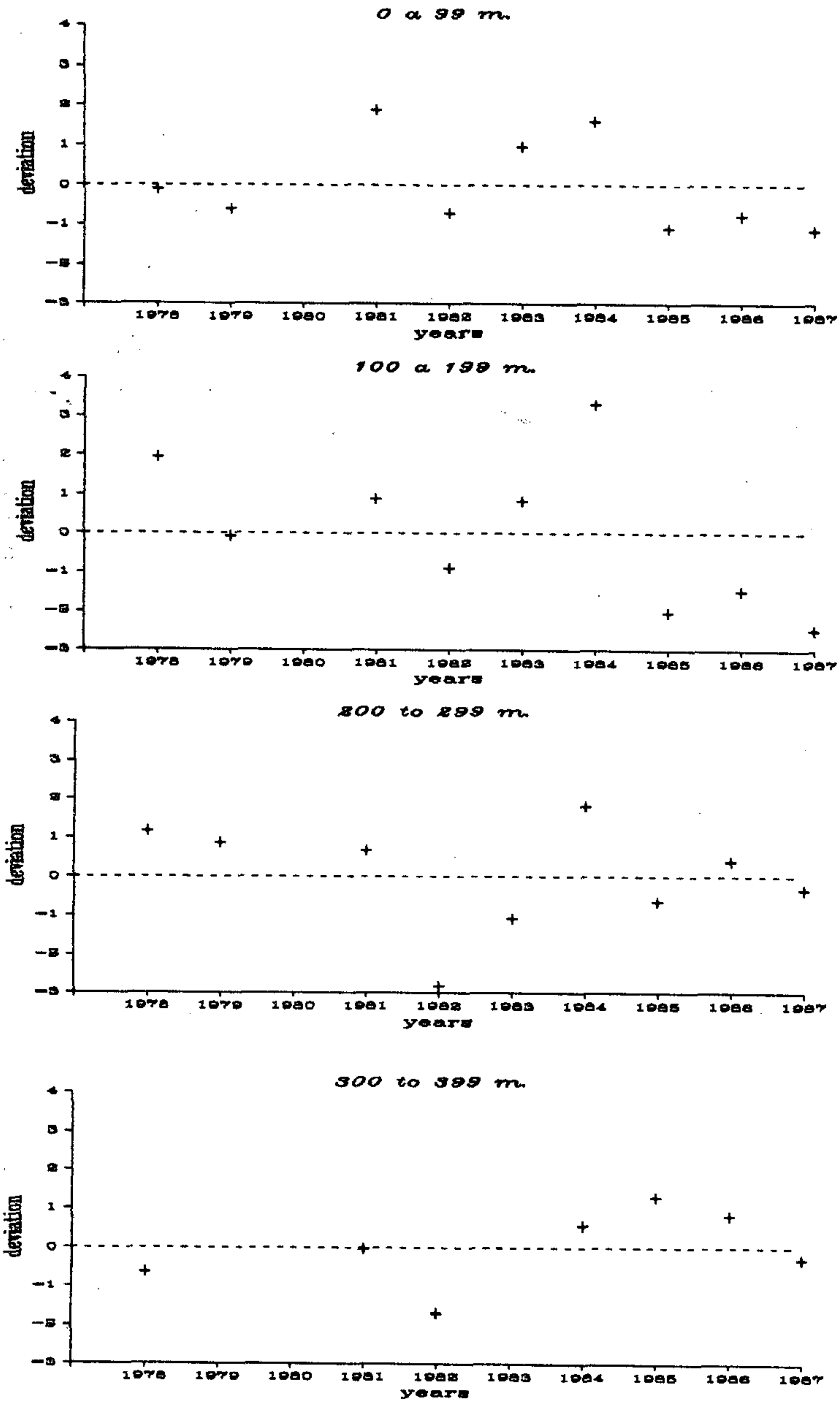


Fig. 7 : Deviation to mean for average yearly temperatures by layers in late winter.

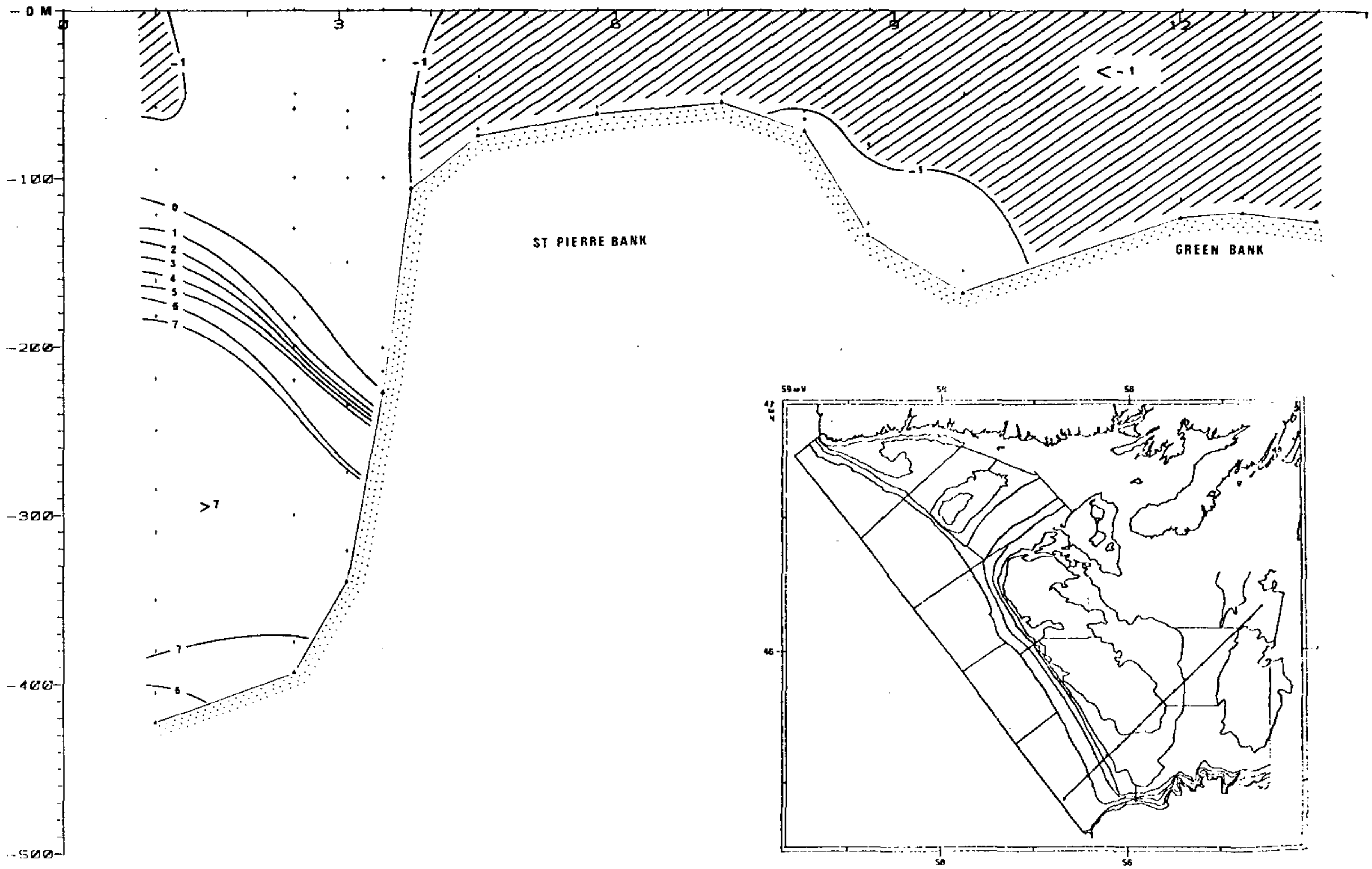


Fig. 8 - Vertical temperature distribution from southwestern slope of Saint-Pierre Bank to *north of Green Bank* in February 1985.

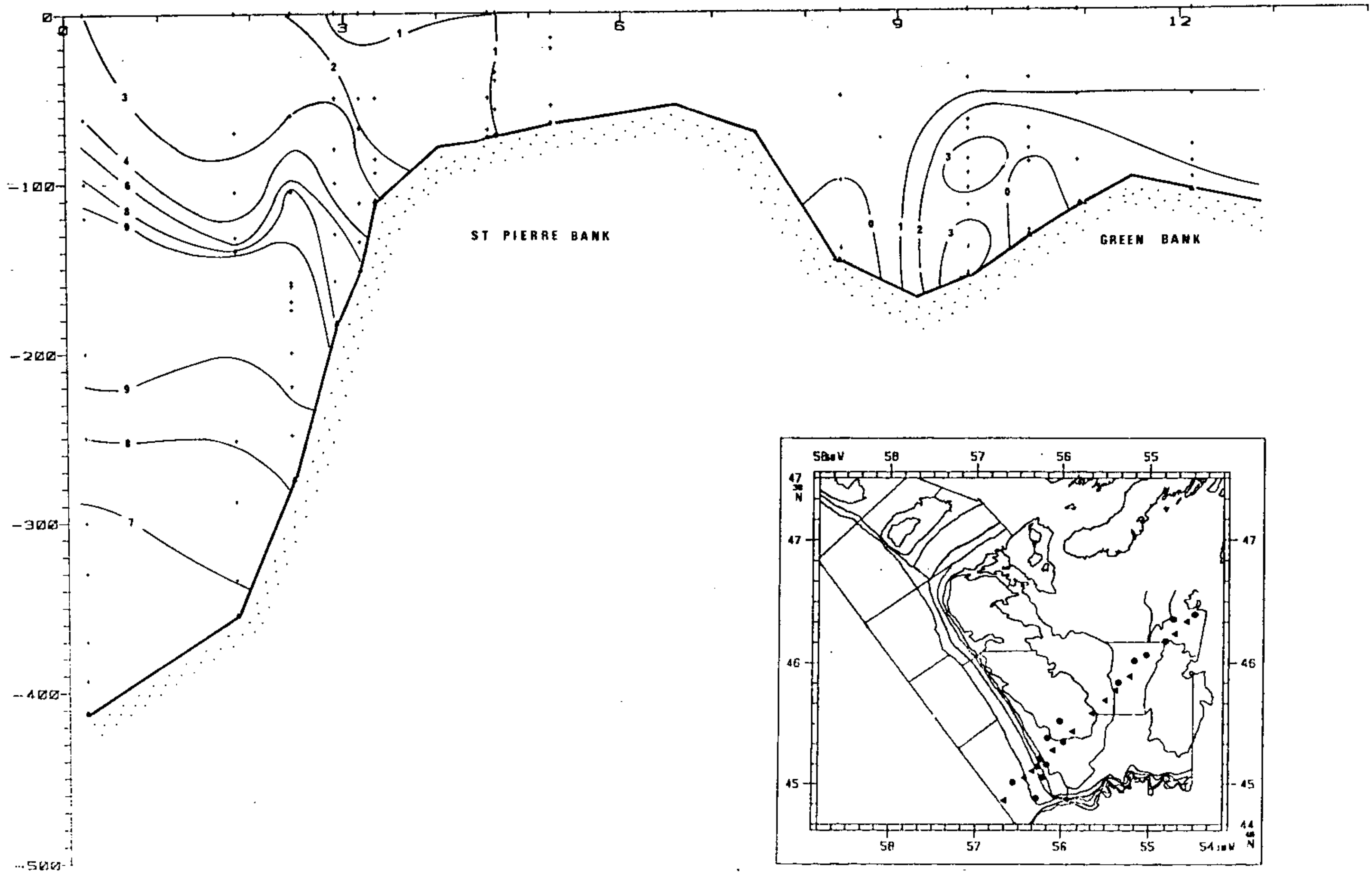


Fig. 9 - Vertical temperature disttibution from southwestern slope of Saint-Pierre Bank to north of Green Bank in March 1984.

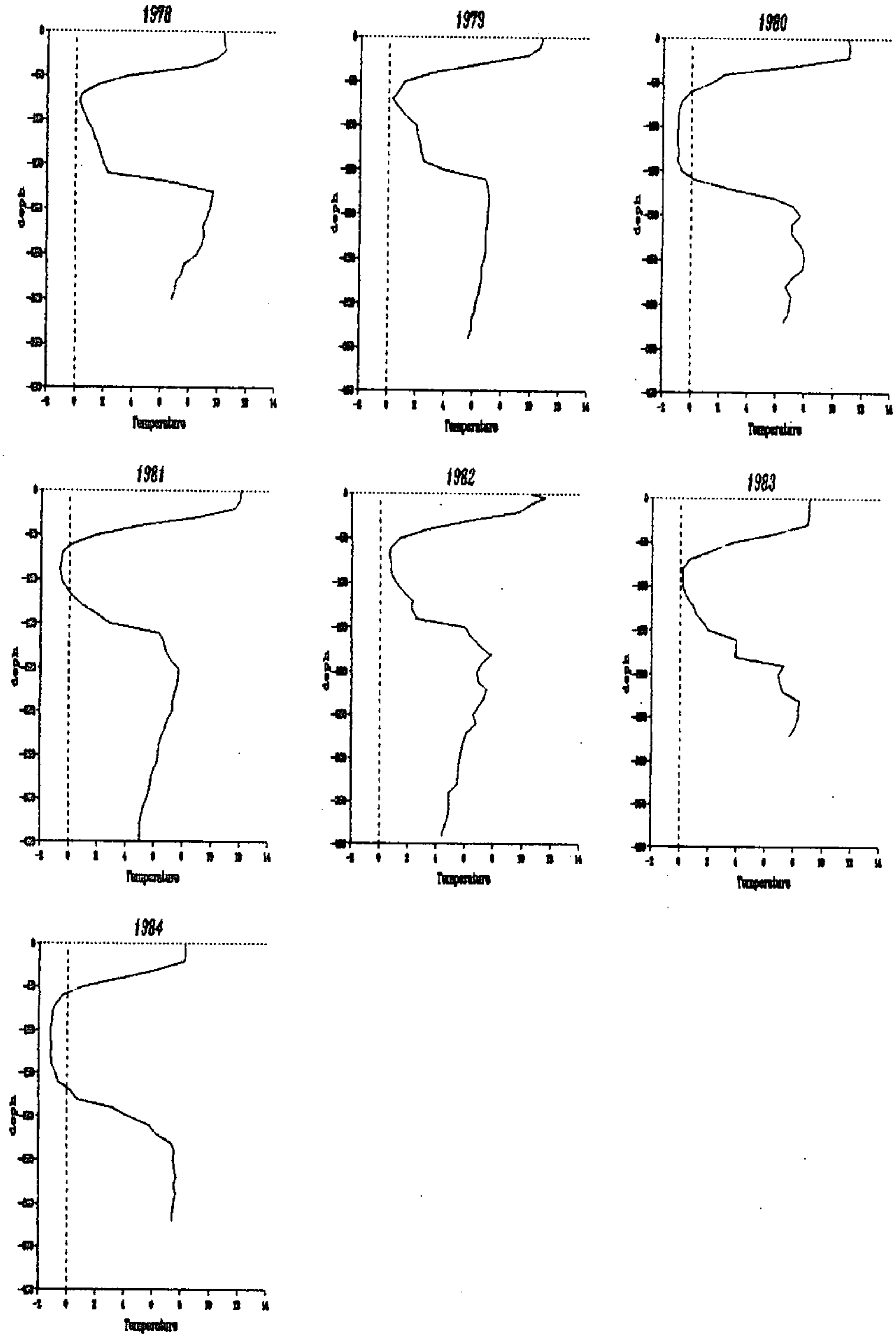


Fig. 10 : Yearly mean profiles of temperature in autumn.

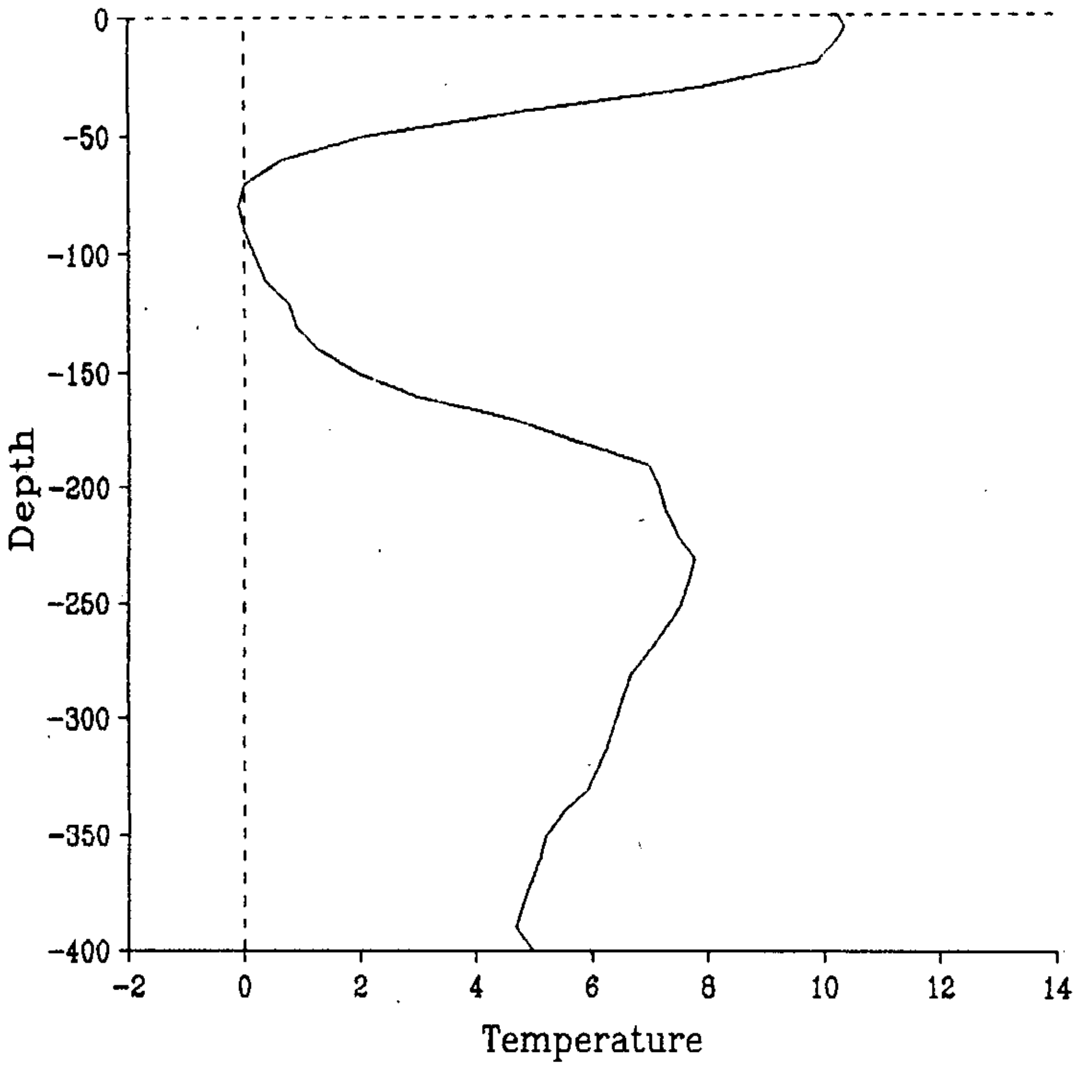


Fig. 11 : Mean profile of temperatures in autumn for the period 1978-1984.

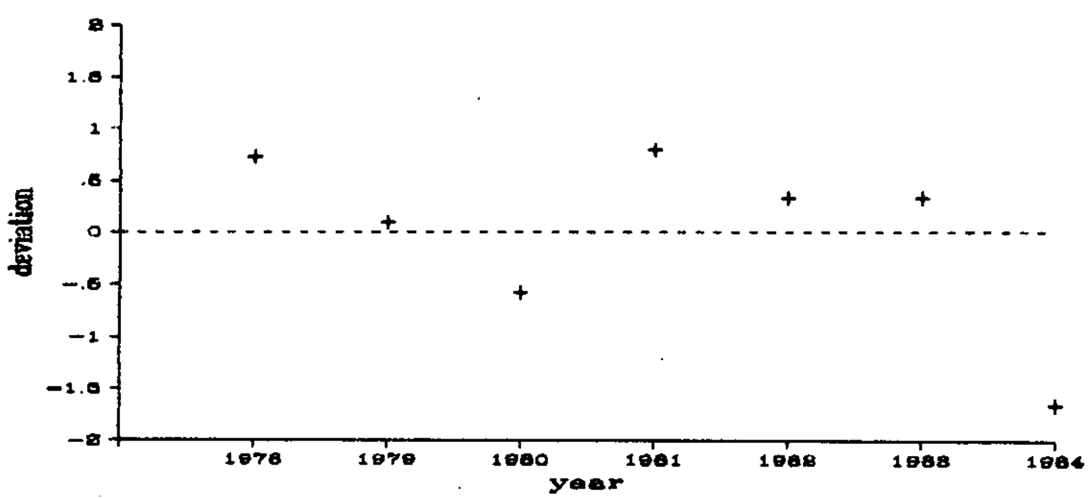


Fig. 12 : Yearly deviation to the mean temperature (1978-1984) in autumn.

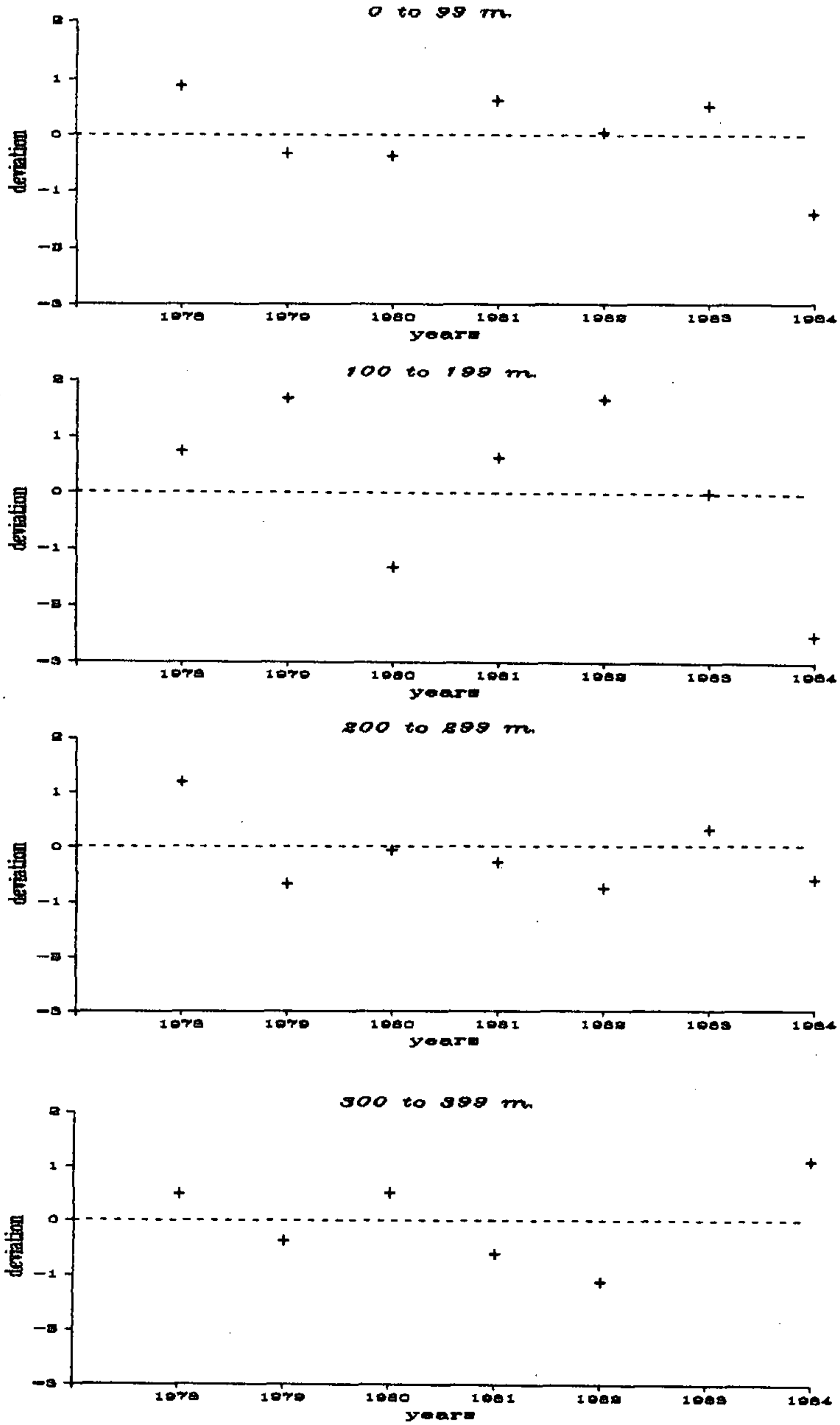


Fig. 13 - Deviation to mean for average yearly temperature by layers in autumn.