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Climatic Conditions Around Greenland - 1993

by

M. Stein

Institut für Seefischerei, Palmaille 9, D-22767 Hamburg
Federal Republic of Germany

Abstract

Air temperature anomalies and sea ice cover during 1993 around Greenland indicate that the early nineties experience similar anomalous cold environmental conditions than during the beginning of the seventies and eighties. It is shown that, similar to the last decade, and the year 1992, cold air masses contribute to the extreme conditions off West Greenland during the first quarter of 1993. **March** conditions reveal a cold air mass centered over the town of Egedesminde. Temperature anomalies were less than -8 K, influencing the entire Davis Strait/Labrador Sea region. Only around Iceland, positive air temperature anomalies were encountered. The warmest month in the Northwest Atlantic region during 1993 was **October**. In contrast to the west coast, the east coast of Greenland showed different climatic conditions during 1993. Under the regime of the anomalous cold air temperatures, the surface layer of the ocean is cooled and sea ice formed to a larger extent than normal. The ice left Cape Farewell not before mid August and returned in December. During October ice returned to the areas off East Greenland. Analysis of yearmean air temperatures time series from Nuuk/West Greenland reveals that the cooling process, as observed since the late sixties, is still persistent. Subsurface temperature observations indicate slightly above normal temperatures for the 0-200m layer, 0.4K for autumn (data base 1963-1993). In the surface layer 0-50m temperature anomalies were about 1K. This might reflect the warm air temperature conditions during September and October in the West Greenland area. Warming was largest in the 0-50m layer off Cape Desolation/West Greenland where the thermal situation was about 2K above the mean of autumn (data base 1983-1993). Off East Greenland, at Angmagssalik, thermal conditions were below normal during most of the first half of 1993, and above normal from September onwards. This was reflected in warming of the subsurface layer 0-200m, which amounted to 0.9K, for the Gauß Bank Section (data base 1981-1993) and 0.26K for the Discord Section (data base 1981-1993).

Introduction

Started as a project during 1993, this paper is the second in a series which provides an overview of environmental conditions around Greenland. The data used in the context of this paper, deal with data on air temperatures, the distribution of sea ice and subsurface observations. The latter data originate from oceanographic observations performed by the Federal Republic of Germany during the 1993 annual groundfish survey in the area off West and East Greenland.

Data and Methods

Data on the atmospheric climate of Greenland were sampled by the Danish Meteorological Institute at Nuuk (64°11'N, 51°44.5'W), Egedesminde (68°42.5'N, 52°53'W) and Angmagssalik (65°36'N, 37°40'W). Whereas the first data set was mutually supplied by the Danish Meteorological Institute in Copenhagen, the latter data sets are taken from **ANON. (1993)**. Ice charts were constructed from **NOAA** satellite ice charts. The approximate location of the ice edge is given in the selected figures and in a computer slide show. The temperature anomaly maps for the Northwest Atlantic were also taken from **ANON. (1993)**. Both the ice charts and the temperature anomaly map, are available from the author on request as computer slide shows. Sub-surface ocean data are available from German measurements for the West and for the East Greenland area.

Results

Air Temperature and Sea Ice Anomaly during 1993

Northwest Atlantic

With values below -3K up to above +2K anomalies of air temperature over the Northwest Atlantic were in the normal range. Extreme values were encountered at Southwest Greenland (cf. Figs. 1, 2). On the large scale it was too cold in parts of the USA, in Eastern Canada and Southern Greenland. It was too warm over the European Polar regions. Over the Atlantic/European Polar regions the distribution of air temperature anomalies was very similar to those of the year 1992 (**STEIN, 1993a; HENNING, 1994**). Two examples from an annual series show the extremes of air temperature anomaly over the Northwest Atlantic during 1993: **March** conditions reveal a cold air mass centered over the town of Egedesminde (Fig. 2). Temperature anomalies were less than -8 K, influencing the entire Davis Strait/Labrador Sea region. Only around Iceland, positive air temperature anomalies were encountered. The warmest month in the Northwest Atlantic region during 1993 was **October**. Except for the western part of the Labrador Sea and a small region off East Greenland, positive anomalies ranging from 0 K to 2 K in the Irminger and Labrador Sea, as well as in the Davis Strait (Fig. 3) were observed.

Air Temperatures and Climatic Means

The annual air temperature curves of Egedesminde, Nuuk and Angmagssalik are compared to the climatic means available from **ANON. (1993)**. On the West Greenland side the 1993 temperature curves reveal the anomalous conditions during the first quarter of the year which amounted to less than -25°C at Egedesminde (March), and less than -15°C at Nuuk (January). Except part of the summer months and October, the entire temperature curves are below the mean (Figs. 4 and 5). Off

East Greenland, at Angmagssalik, thermal conditions were below normal during most of the first half of 1993, however, in contrast to the west coast of Greenland, they were above normal from September onwards (Fig. 6).

Climatic Variability off West Greenland

The air temperature time series of Nuuk reveals interannual and long-term variability of the climate at West Greenland (Fig. 7). The yearmean temperature anomaly for 1993 shows near-record low values which are in the range of the early eighties anomalies. The long-term variability of the climate is indicated by the thick curve in Fig. 7. As shown by **STEIN (1993a)** the low frequency change of air temperature has a downward trend since the late sixties.

Ice Conditions in the Northwest Atlantic

As in 1992, ice cover around Greenland persisted to be anomalous during 1993. The months January to March were characterized by extreme ice cover. Especially during late March (930324) the worst ice conditions were encountered off southwest Greenland. North off Baffin Island anomalous ice cover was encountered from mid August to mid September (930922). At Cape Farewell, the ice left late, not before August (930811), and returned early off East Greenland during autumn. The ice returned to the Cape Farewell around mid December (931215). The two extremes of the 1993 ice cover are given in Figs. 8 and 9. During March, nearly the entire coast of Greenland was covered with ice. The areas normally ice free during March, are dark shaded in Fig. 8. Ice free conditions in the Irminger and Labrador Sea and in the Davis Strait were observed during October (Fig. 9). Off East Greenland, however, formation of new ice is already visible.

Subsurface observations off Greenland

West Greenland

Location of Standard Oceanographic Sections, as performed by RV "WALTHER HERWIG" during the annual groundfish survey around Greenland, are given in Fig. 10. Off West Greenland two of the NAFO Standard Oceanographic Sections **(STEIN, 1988)** could be performed, i.e. the **Fylla Bank** Section and the **Cape Desolation** Section. Time series analysis of the temperature and salinity data along both sections is given in Figs. 11 to 17. Figs. 11 to 13 show the thermohaline history of the Fylla Bank station 4 during the past thirty years (no observations during autumn 1992). Results of three different layers are given: the near surface layer 0-50m where most of the short-term variability happens **(STEIN,** 1985), the seasonal variable surface layer 0-200m, and the Irminger layer 200-300m, which denotes the depth of major influence of the Irminger Current on the waters off West Greenland **(STEIN, 1993b)**.

From the Cape Desolation Section results of station 3 are displayed in Figs. 14 and 15. Being only a short and scanty time series from the deep water sections (**STEIN and WEGNER, 1990**), the data show the interannual variation during autumn in the near surface layer (0-50m), and the Irminger layer (200-300m).

East Greenland

Off East Greenland three of the national Standard Oceanographic Sections could be performed (Fig. 10). The **Gauss Bank Section** crosses the southward flowing current system influenced by the East Greenland and the Irminger Currents (**STEIN, 1993**). The thermal history of the past decade is given for stations 4 and 5 of the section (Figs. 16, 17). Dowstream of the Gauß Bank, the **Discord Section** crosses the East Greenland and Irminger Currents before they turn around the Cape Farewell and flow northward. Anomaly time series for temperature is given in Fig. 18.

Discussion

The zonal mean of air temperature anomalies for the area 85°N to 5°N, and 120°W to 70°E (about 37% of the northern hemisphere) was +0.07K for the year 1993. For 1992 a value of -0.12K was calculated (**HENNING, 1994**). These two years reveal a still anomalous cold situation for more than a third of the northern hemisphere compared to the years 1990 and 1991 (+0.45K and +0.35K). **HENNING (1994)** concludes that the eruption of the **Pinatubo** at **Luzon/Philipines**, in June 1991, might be the cause for this long-term cooling process in the northern hemisphere.

The negative air temperature anomalies over the Davis Strait/Labrador Sea during spring 1993 led to anomalous ice formation off West Greenland. The cooling signal is largest on the West Greenland side which is documented by the annual climatic curves of Egedesminde and Nuuk. During the first quarter of the year, air temperatures at these sites are well below normal (Figs. 4 and 5). During spring, thermal conditions improve and both cities arrive at normal climatic conditions. Largest positive deviations are encountered in October, November and December are colder than normal. Similar to the West Greenland sites, Angmagssalik on the East Greenland coast experienced an anomalous first quarter of the year 1993 (Fig. 6). Spring and summer were below normal, from about August thermal conditions were above normal.

In the climatic curve of Nuuk/West Greenland anomalous cold years are observed about every 10 years (**STEIN, 1993**). After the cold early eighties, 1983 and 1984 were among the coldest in over 100 years of record, 1992 and 1993 yield similar negative anomalies: From the annual mean of -1.4°C they deviate by -2.2K and -2.4K.

The early eighties anomalies amounted to -2.7K. The cold conditions seem to maintain at West Greenland. Also the January and February 1994 air temperatures are still below normal (-8.2°C/-8.9°C which is -0.7K/-1.1K below the climatic mean 1961-1990).

The subsurface observations off West Greenland, Figs. 11 to 15, indicate warming in the near surface layer 0-50m. This might reflect the influence of the warm air temperature conditions during September and October on the upper ocean layer (**STEIN and BUCH, 1991**). In contrast to the upper layer, the Irminger layer (200-300m) indicates cooling and dilution (Fig. 13) which is in the range of the early eighties situation. At station 3 of the Cape Desolation Section, similar results for the thermohaline properties in the upper water column were observed: Since 1988 there is a cooling trend visible in the Irminger layer which is accompanied by a decrease in salinity from 1990 onwards (Figs. 14, 15).

Off East Greenland, comparison with data collected along the Gauß Bank Section since 1981 during autumn, indicates thermal anomalies at the outer station (S5) which is warmer than normal (Fig. 16, 0.6 K for the upper 200m, 1993), and 0.9 K for the station S4 (Fig. 17) which is the next to the west of S5. Climatic pre-conditioning (see above) favoured warming of the surface layer. Although rather scanty, the Discord Bank data show warmer than normal conditions (Fig. 18, 0.25K) for 1993.

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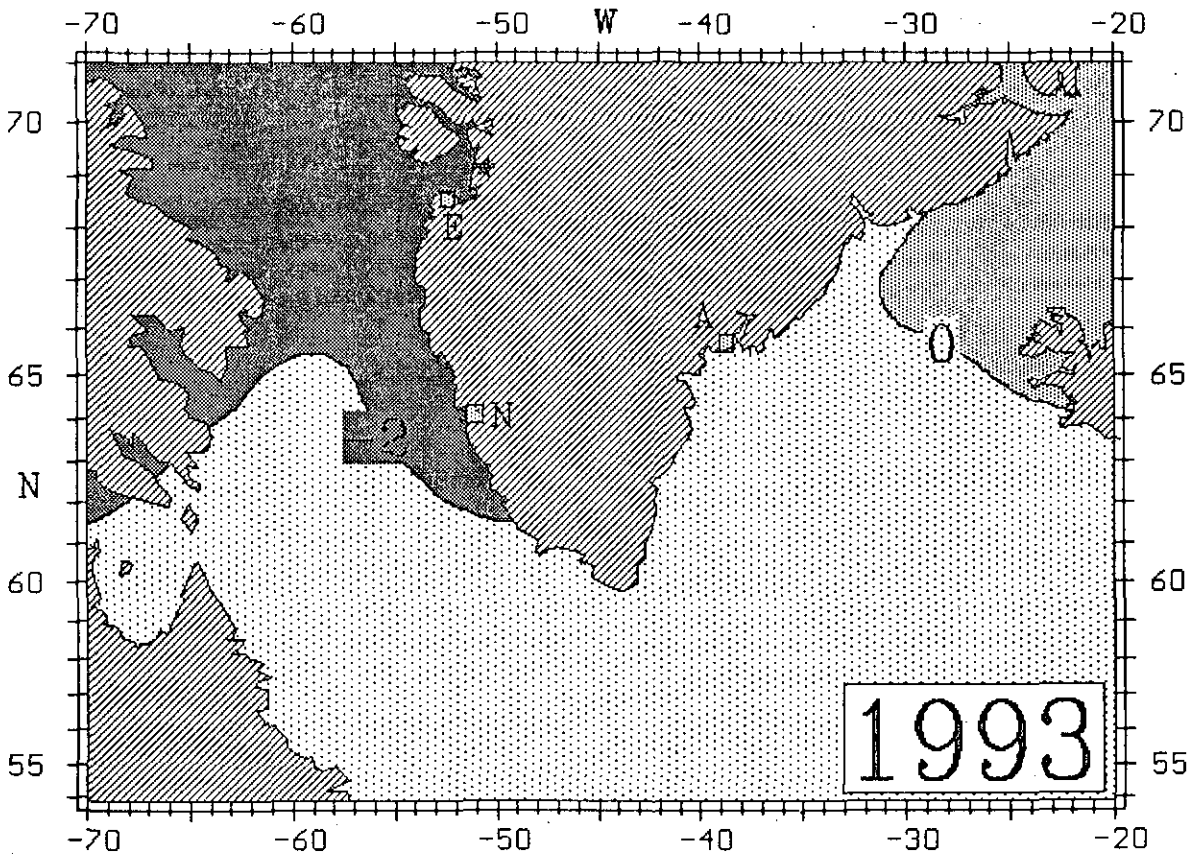

Fig. 1 Mean air temperature anomalies over the Northwest Atlantic during 1993 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

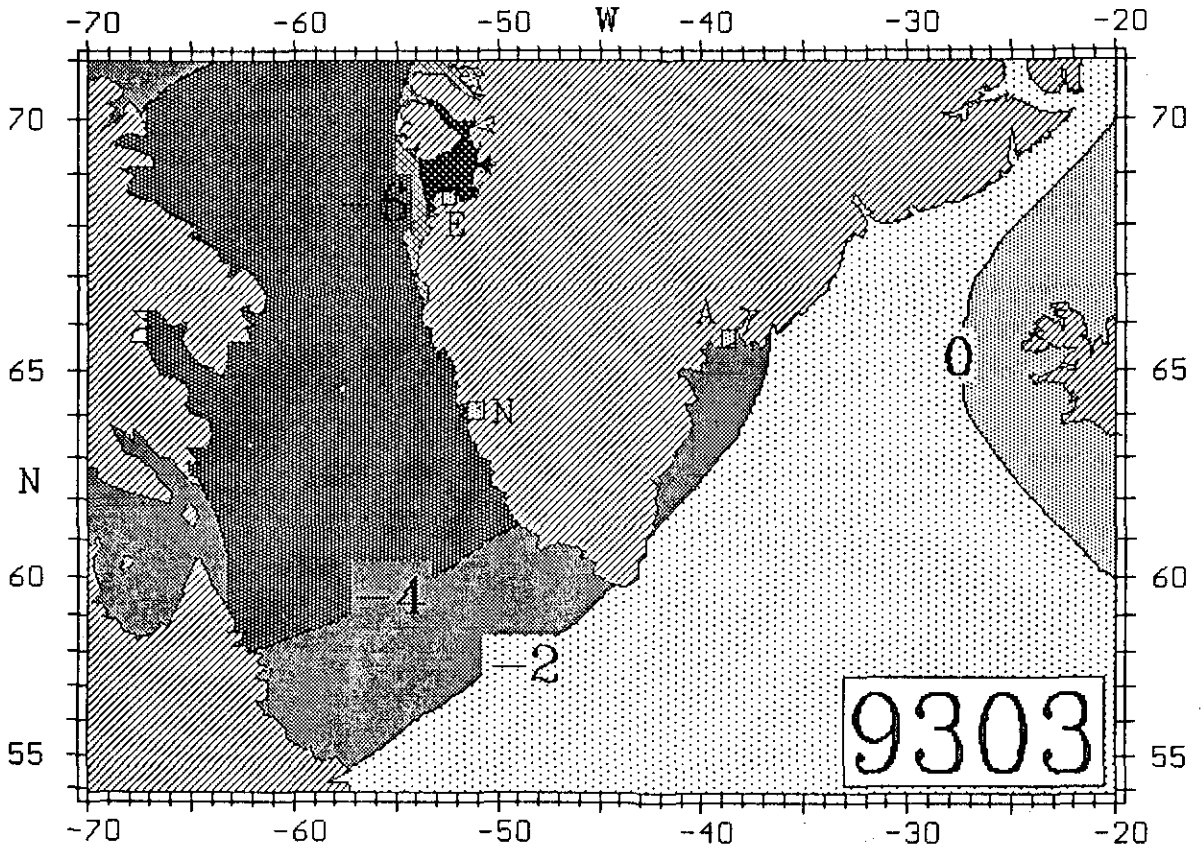

Fig. 2 Mean air temperature anomalies over the Northwest Atlantic during March, 1993 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

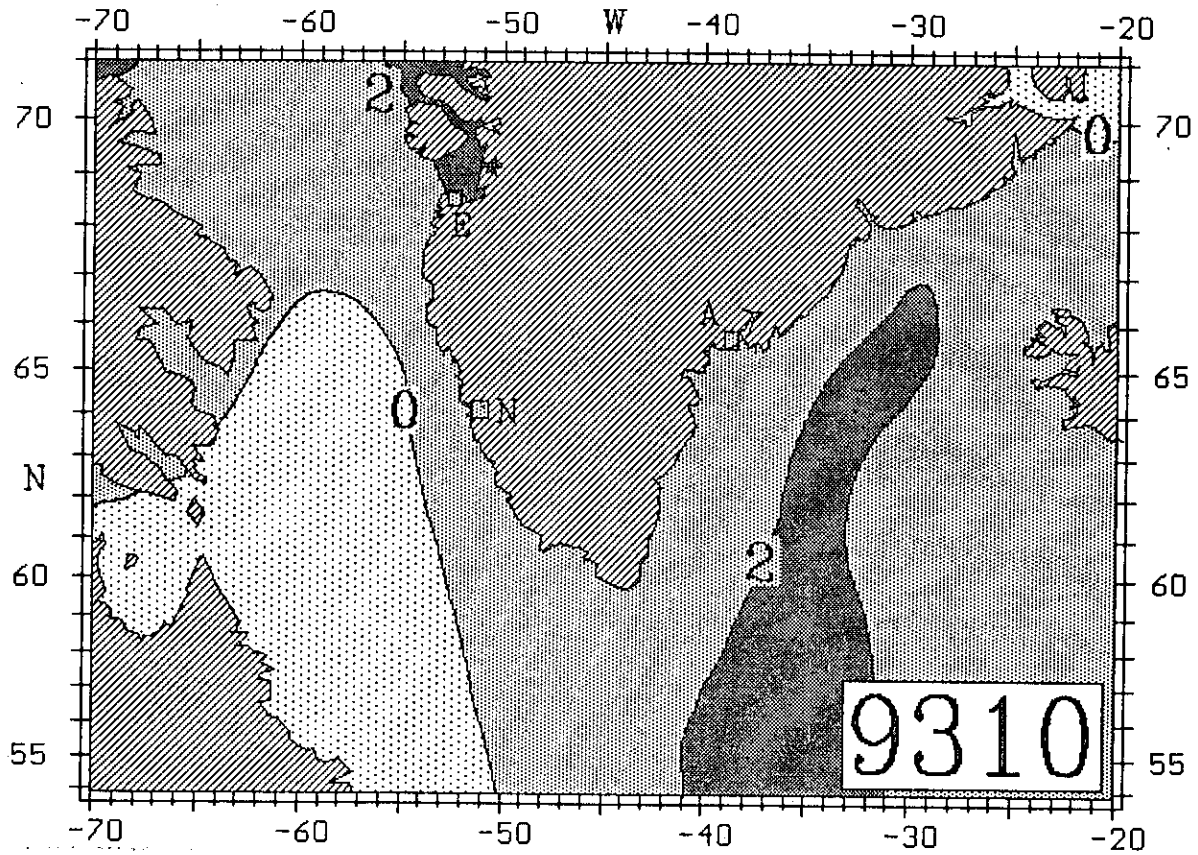

Fig. 3 Mean air temperature anomalies over the Northwest Atlantic during October, 1993 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

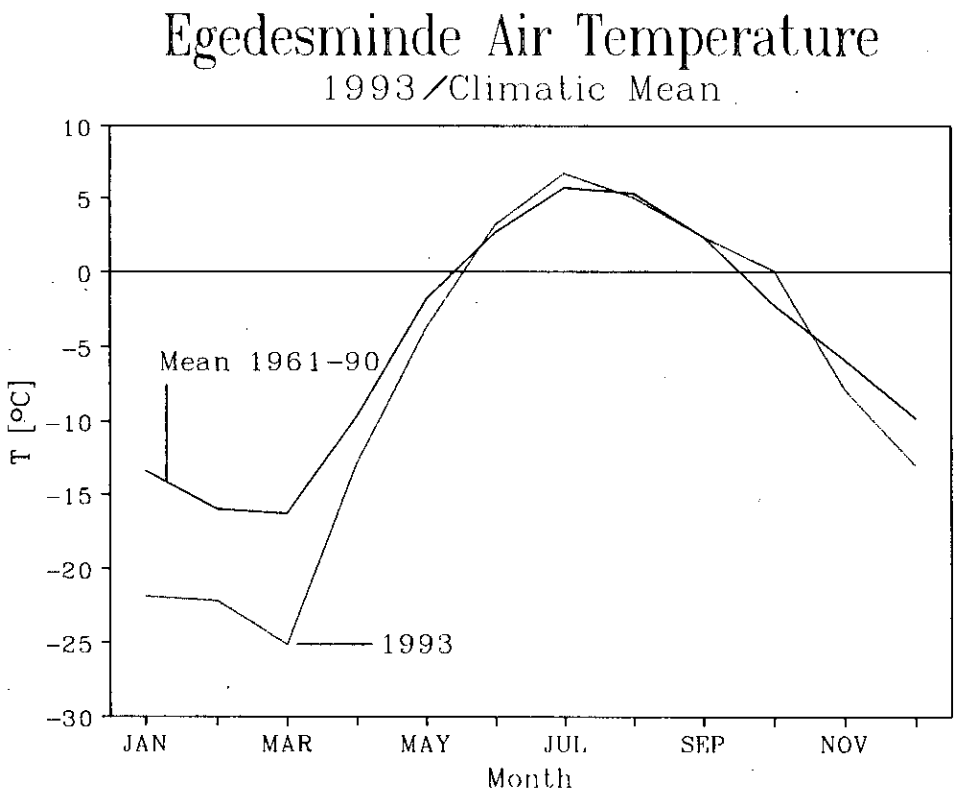

Fig. 4 Monthly mean temperature at Egedesminde during 1992 and climatic means (1949-65; 1961-90)

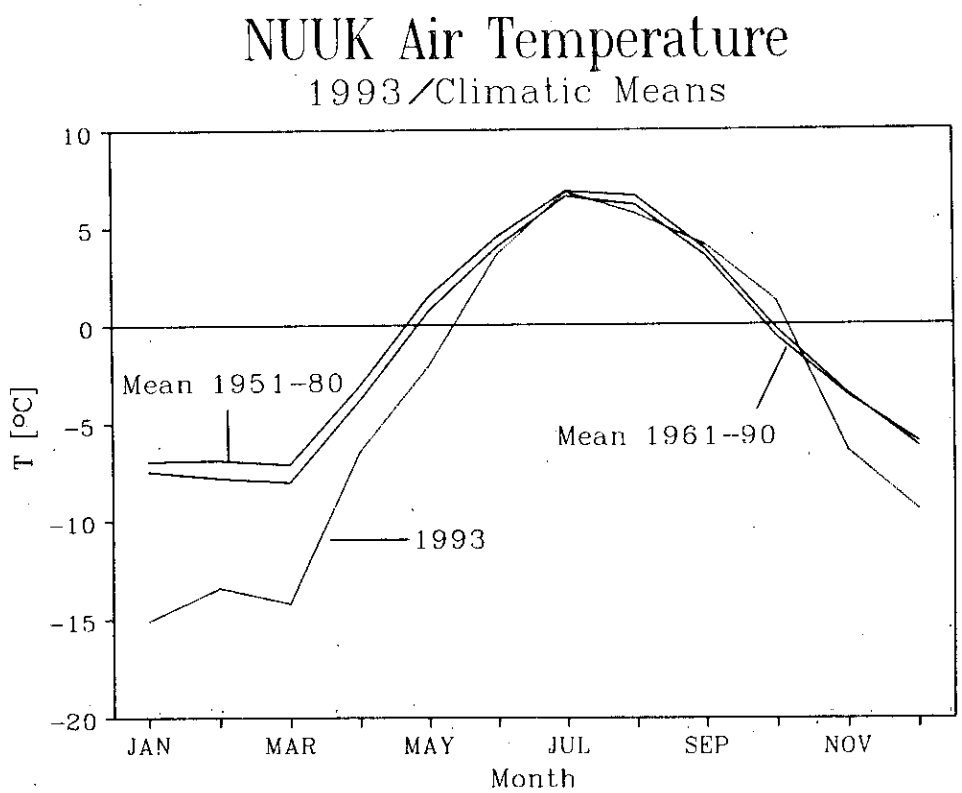

Fig. 5 Monthly mean temperature at Nuuk during 1992 and climatic means (1951-80; 1961-90)

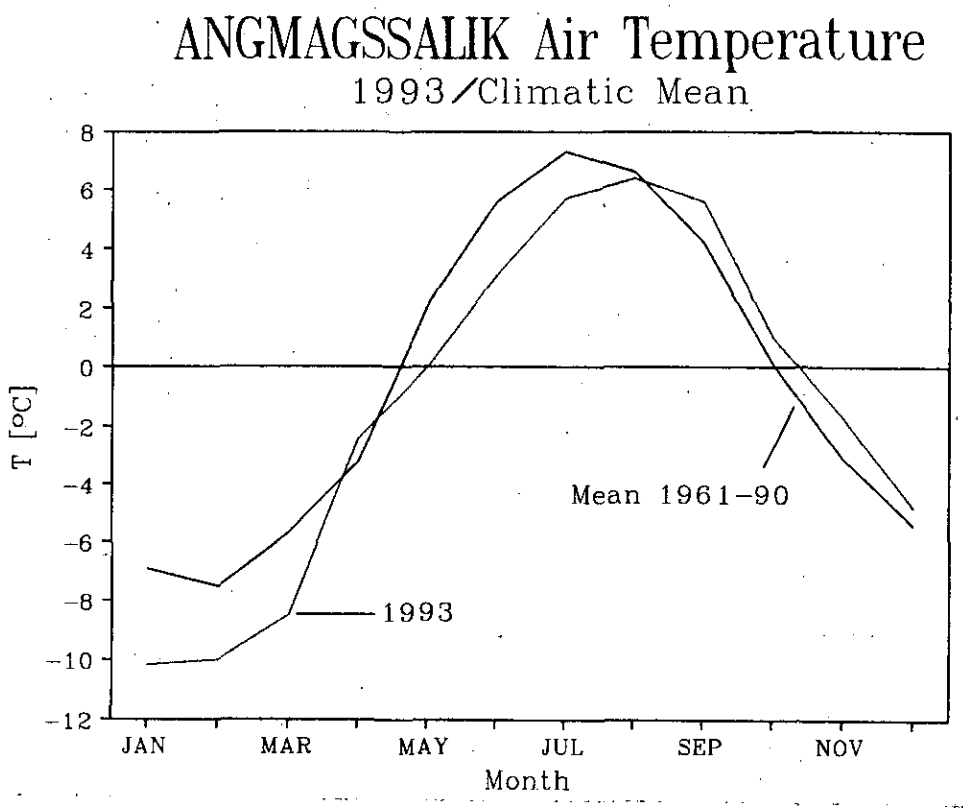

Fig. 6 Monthly mean temperature at Angmagssalik during 1992 and climatic mean(1961-90)

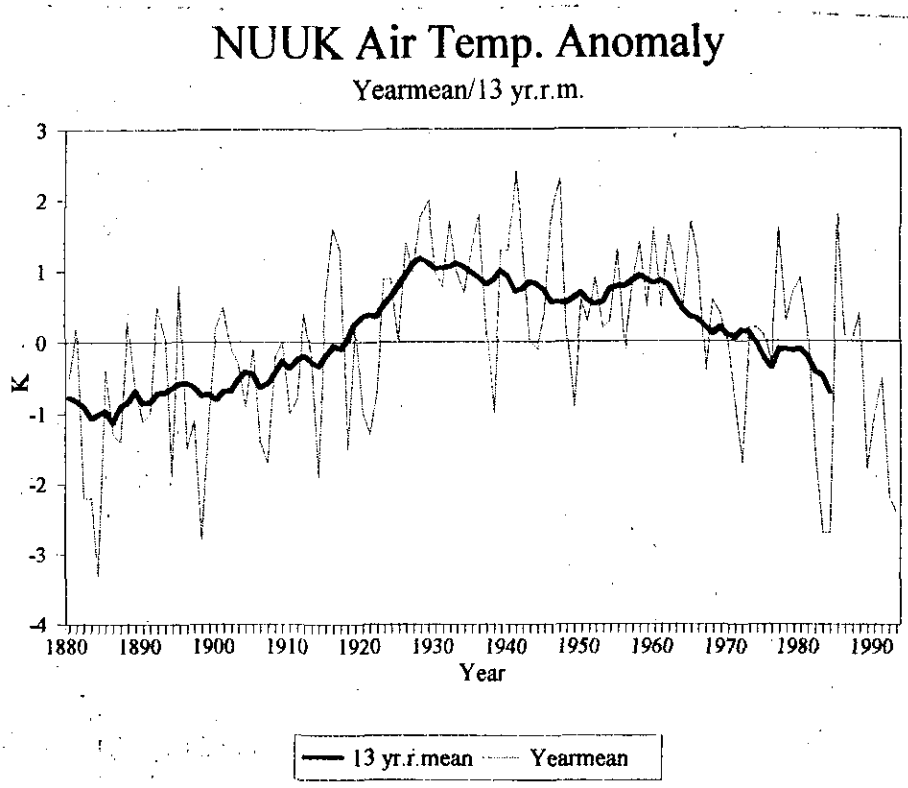

Fig. 7 Time series of annual mean air temperature anomalies at Nuuk (1880-1993) and 13 year running mean

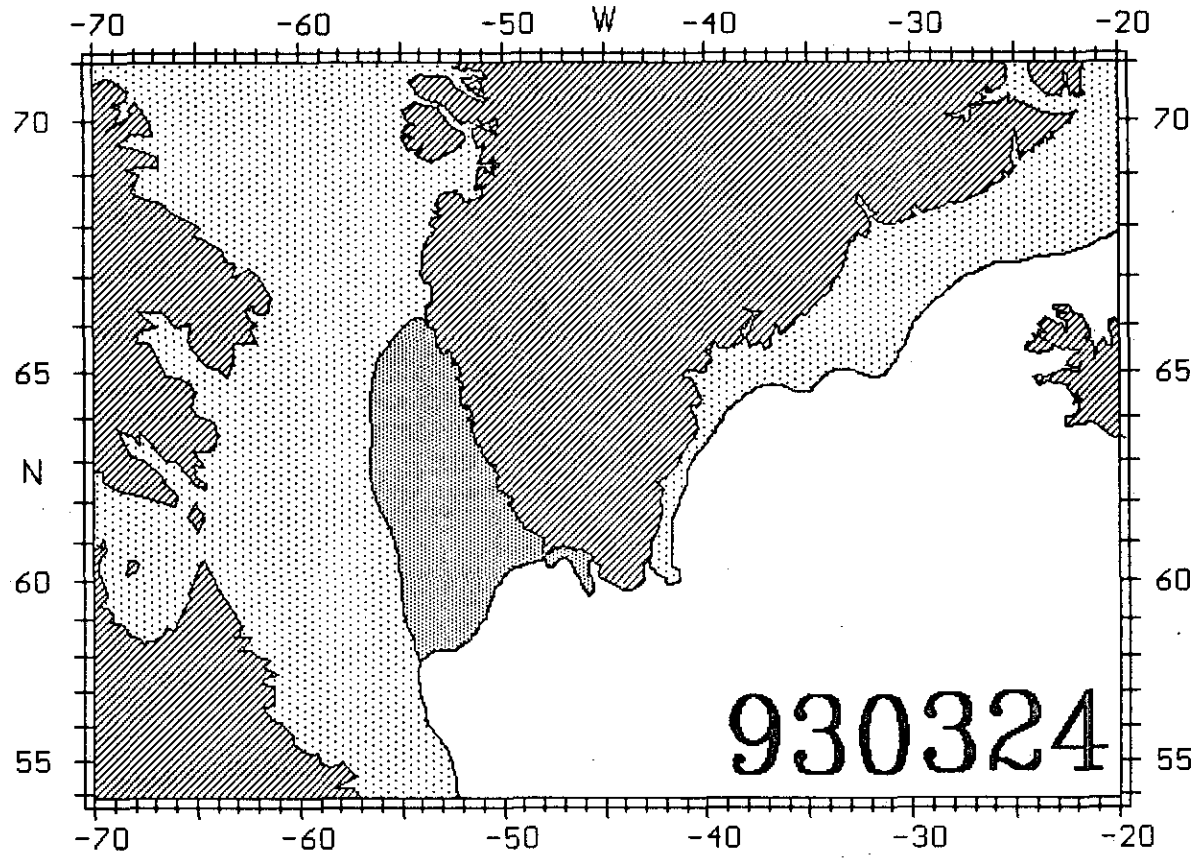

Fig. 8 Ice edge during March 24, 1993; dark shaded areas indicate anomalous extent of ice edge during the month of March

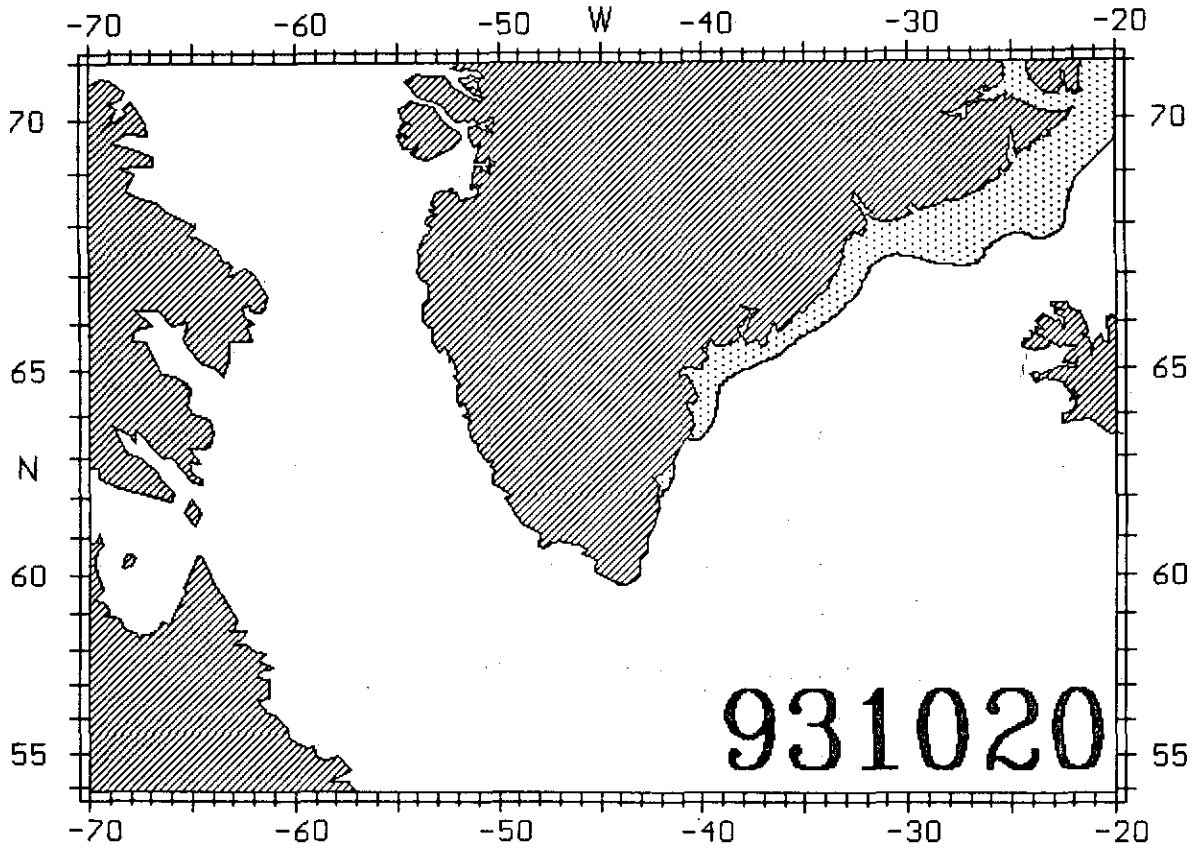

Fig. 9 Ice edge during October 20, 1993

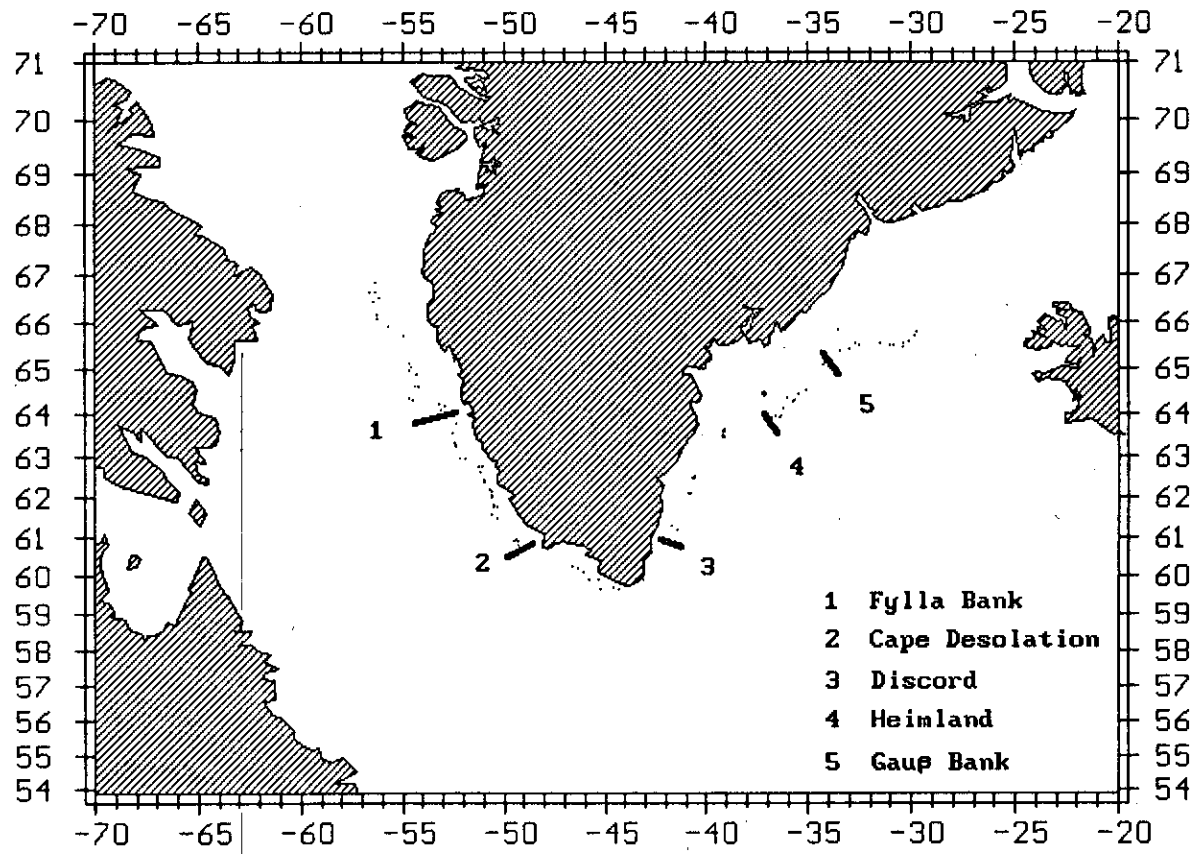

Fig. 10 Location of international/national Standard Oceanographic Sections off West and East Greenland referred to in the paper

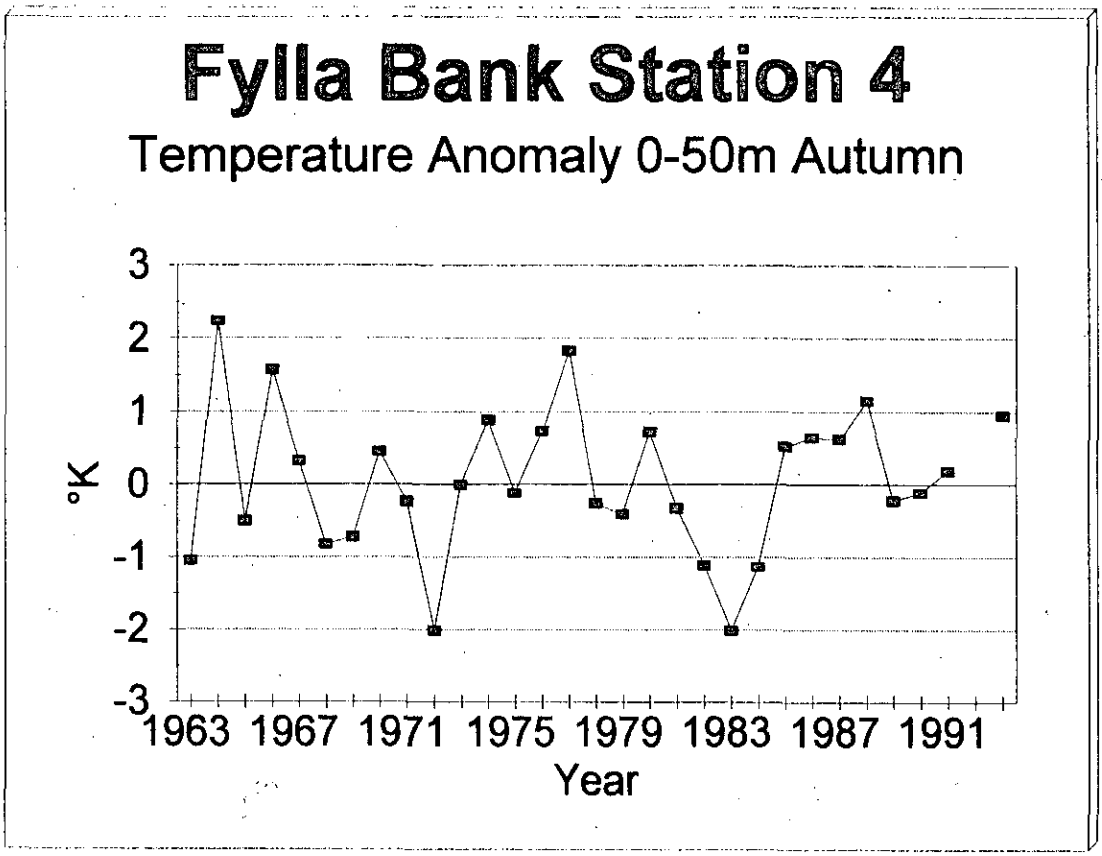

Fig. 11a Fylla Bank Station 4: Temperature Anomaly 0-50m during autumn 1963-1993

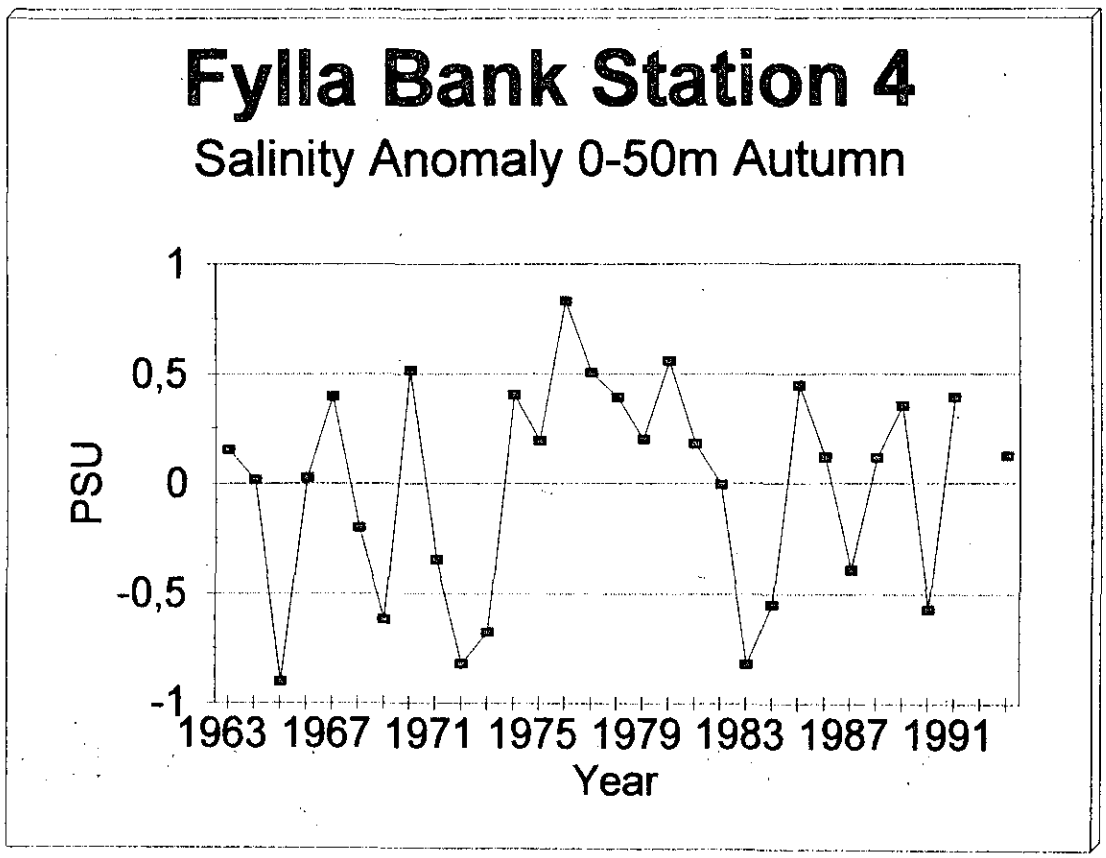

Fig. 11b Fylla Bank Station 4: Salinity Anomaly 0-50m during autumn 1963-1993

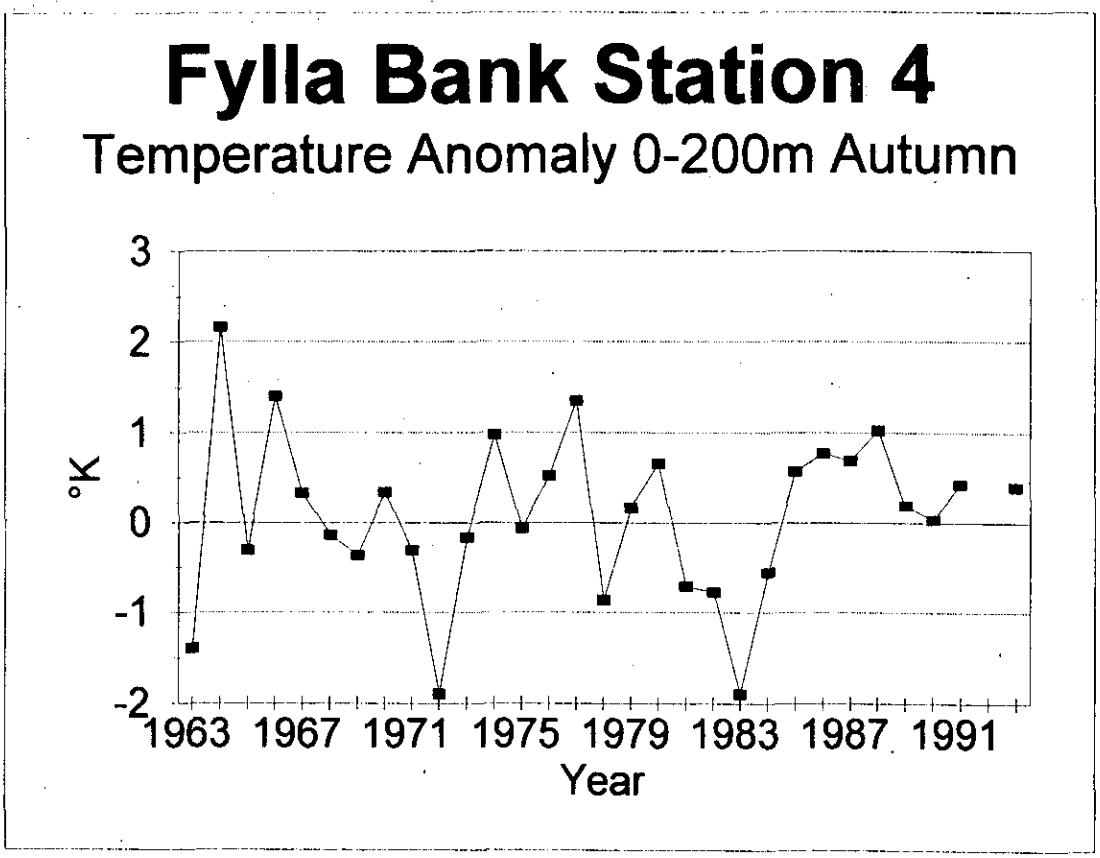

Fig. 12 Fylla Bank Station 4: Temperature Anomaly 0-200m during autumn 1963-1993

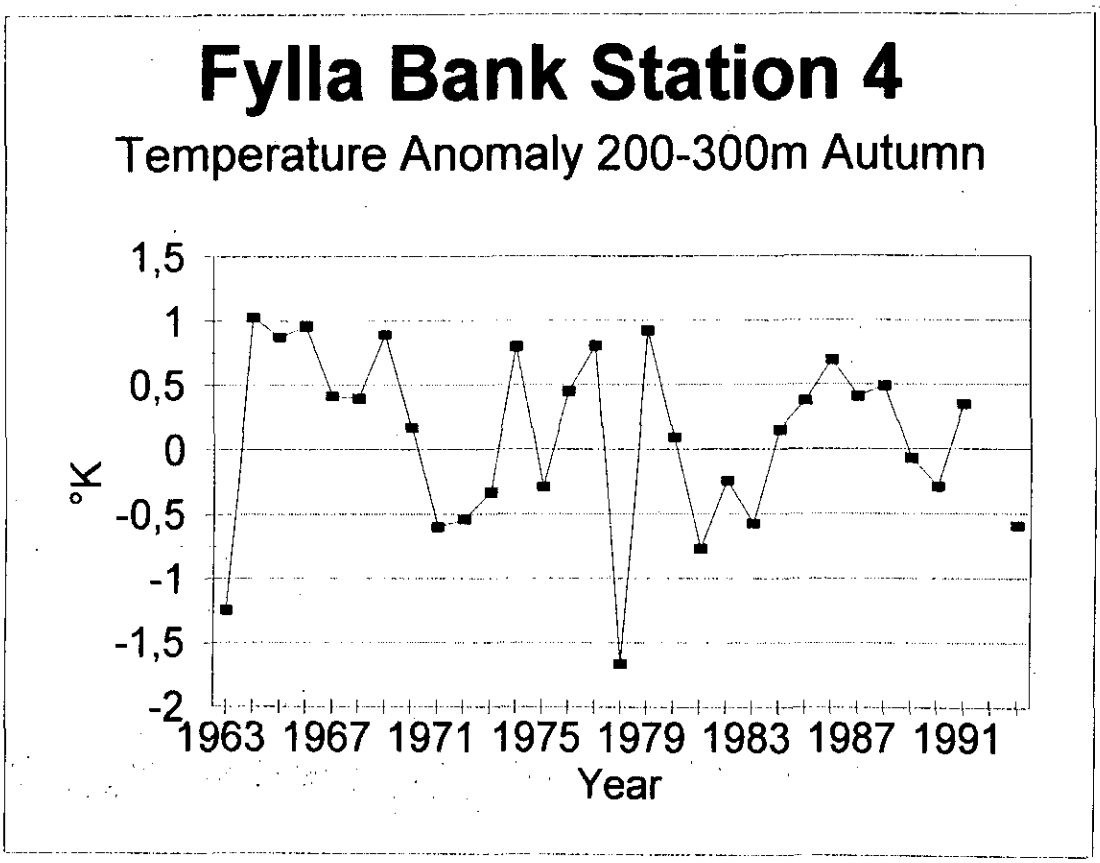

Fig. 13a Fylla Bank Station 4: Temperature Anomaly 200-300m (Irminger layer) during autumn 1963-1993

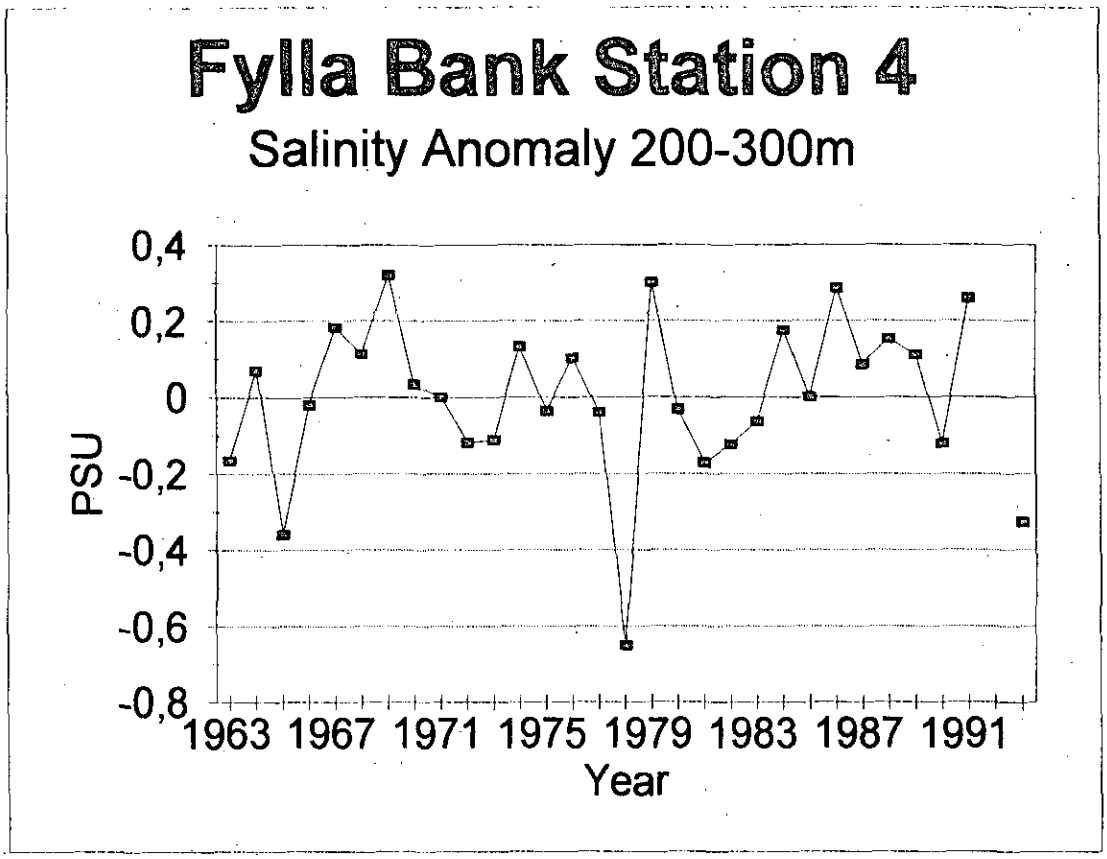

Fig. 13b Fylla Bank Station 4: Salinity Anomaly 200-300m (Irminger layer) during autumn 1963-1993

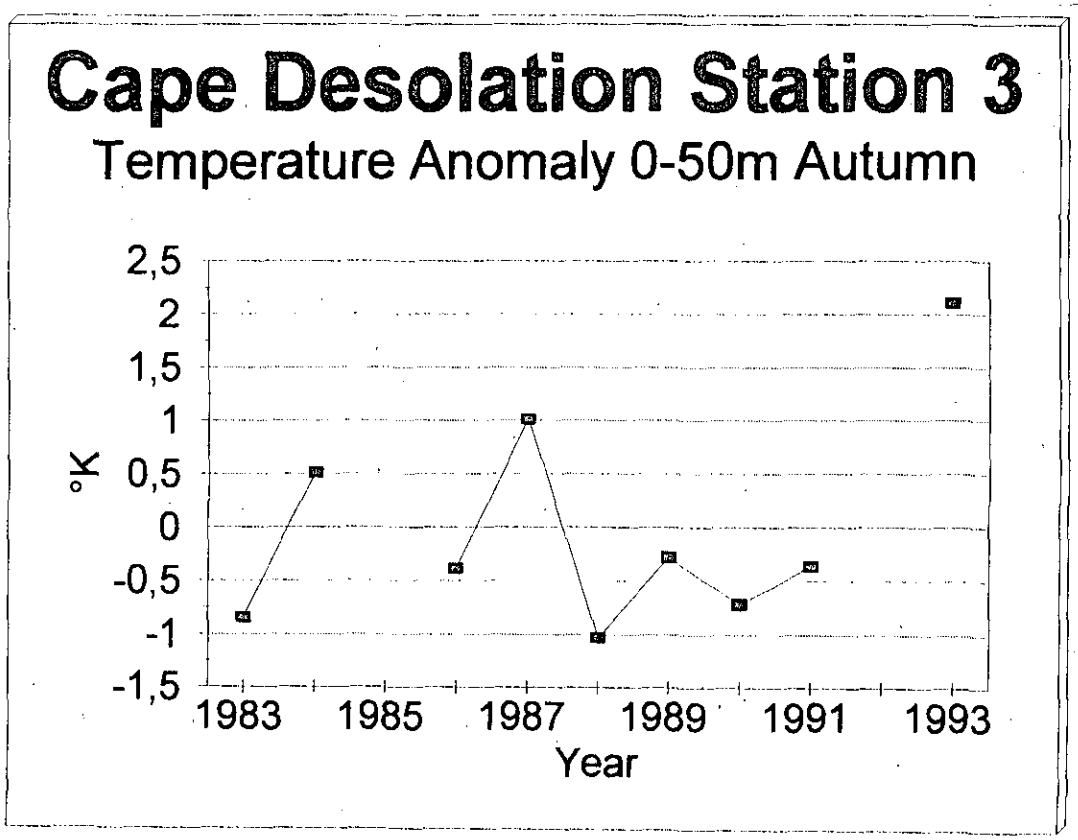

Fig. 14a Cape Desolation Station 3: Temperature Anomaly 0-50m during autumn 1983-1993

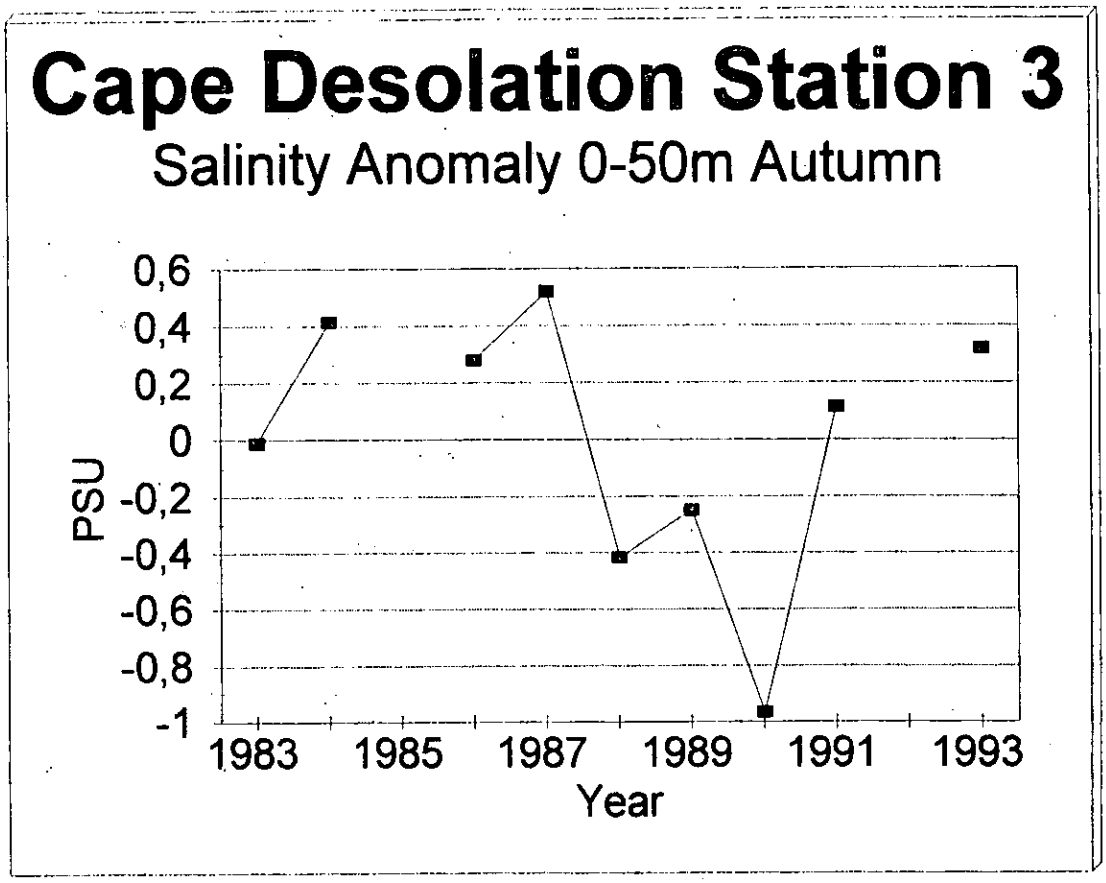

Fig. 14b Cape Desolation Station 3: Salinity Anomaly 0-50m during autumn 1983-1993

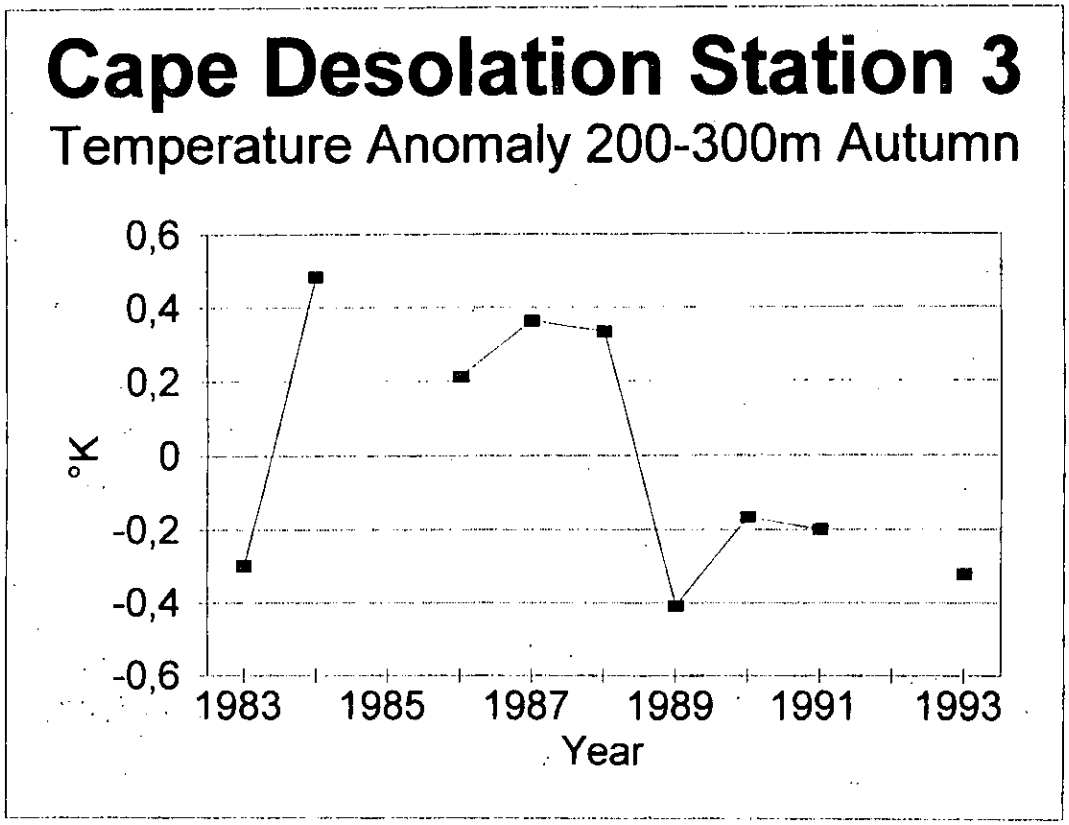

Fig. 15a Cape Desolation Station 3: Temperature Anomaly 200-300m (Irminger layer) during autumn 1983-1993

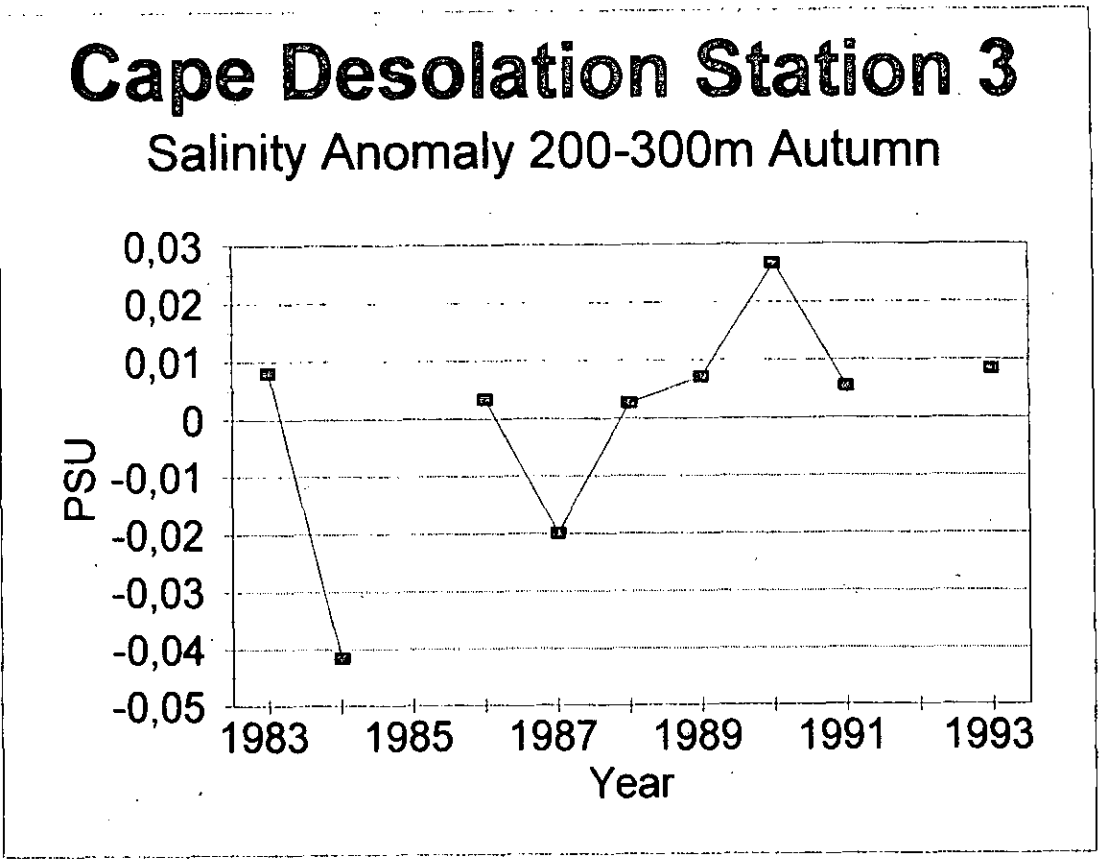

Fig. 15b Cape Desolation Station 3: Salinity Anomaly 200-300m (Irminger layer) during autumn 1983-1993

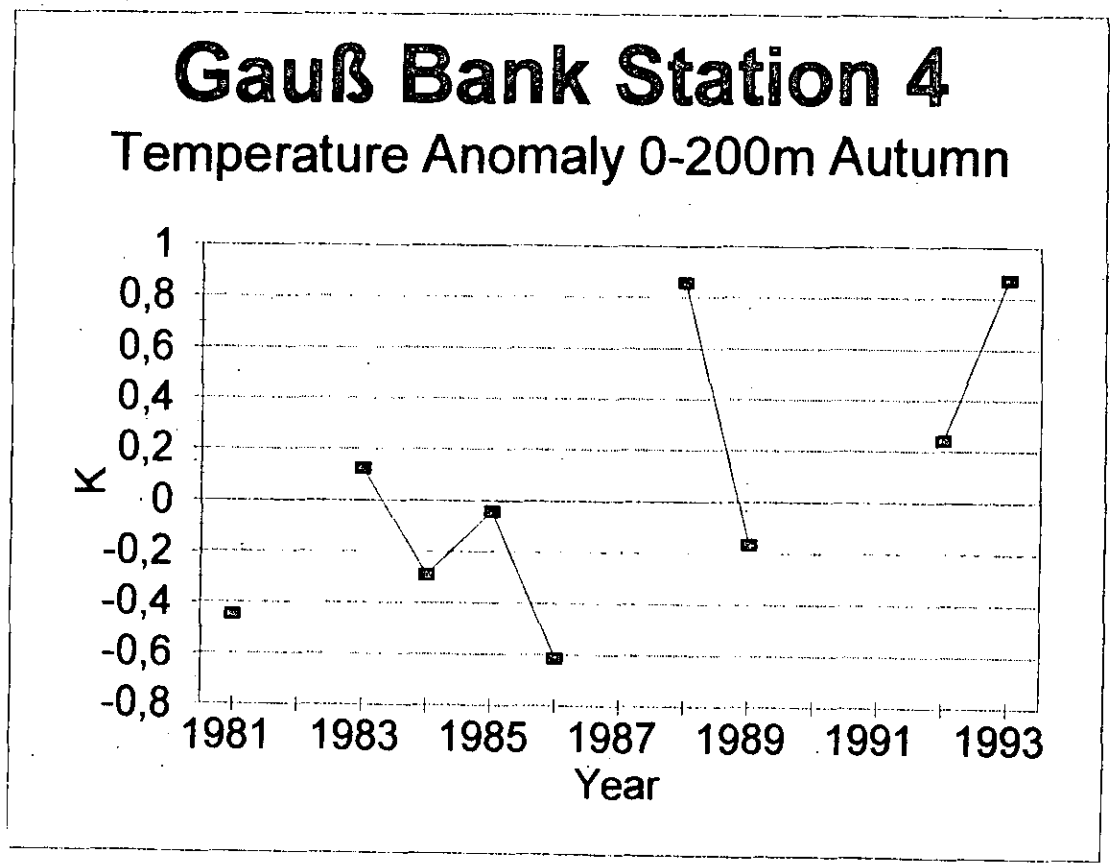

Fig. 16 Gauß Bank Station 4: Temperature Anomaly 0-200m during autumn 1981-1993

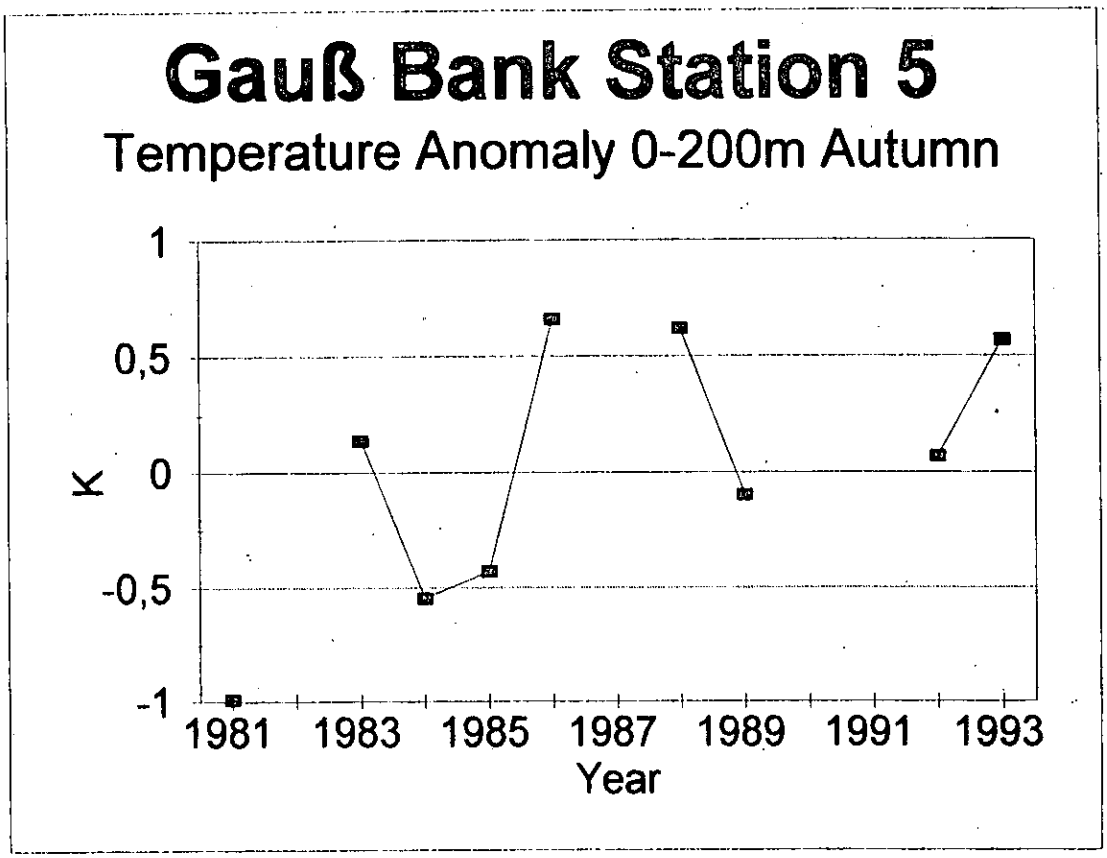

Fig. 17 Gauß Bank Station 5: Temperature Anomaly 0-200m during autumn 1981-1993

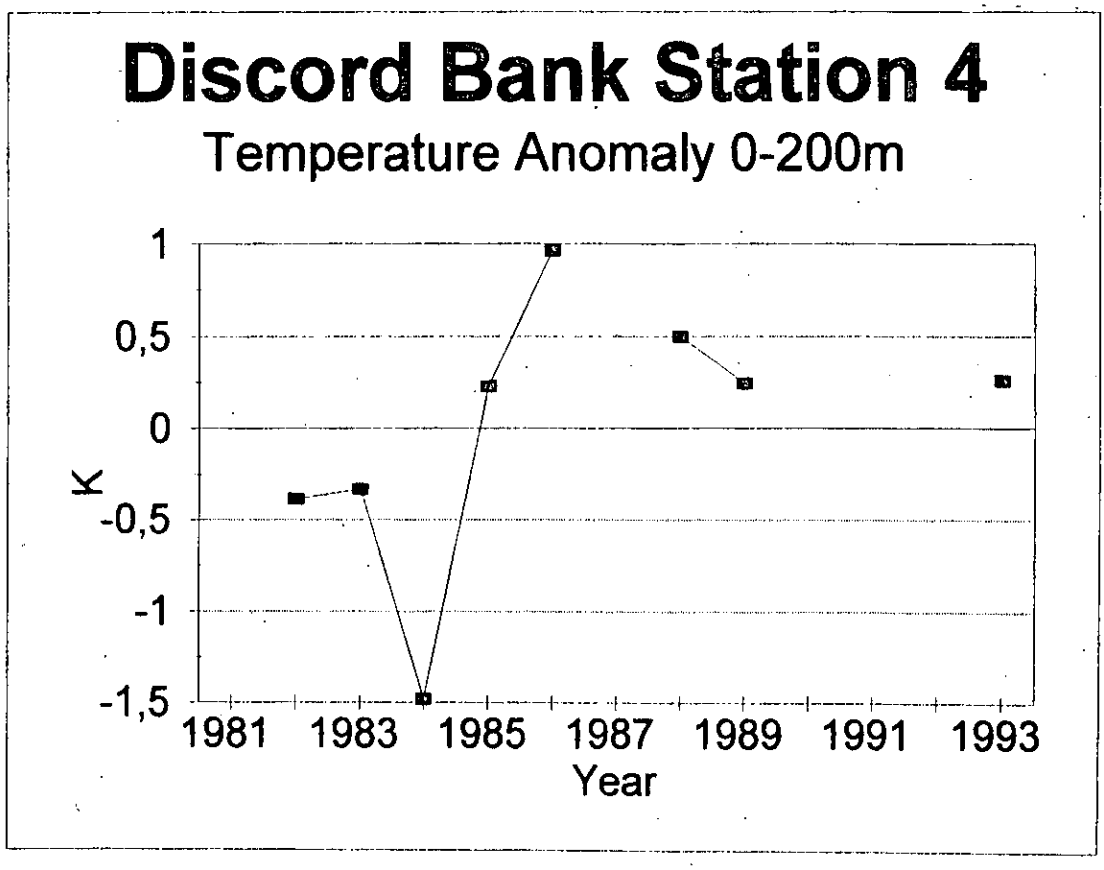

Fig. 18 Discord Bank Station 4: Temperature Anomaly 0-200m during autumn 1981-1993