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Climatic Conditions Around Greenland - 1995

by

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Abstract

Based on air temperature data from three sites of West and East Greenland, the annual variability of climate is shown. Mean monthly air temperature data from Nuuk/West Greenland reveal the long-term interannual changes of air temperature anomalies. Since June 1994, spring 1995 air temperature anomalies show for the first time positive conditions for the area West Greenland-Davis Strait-Baffin Bay. The west coast of Greenland which indicated for several years negative anomalies, experienced a mild early summer. Autumn conditions except October indicated positive anomalies in the arctic area. This was favoured by low pressure systems off Newfoundland which advected along their northern rim mild air from Atlantic origin to Labrador. Also the *föhn*, caused by easterly winds at the west coast of Greenland, generated a positive anomaly. *The intermediate warming does, however, not indicate a change of the long-term negative trend of the climatic conditions at West Greenland.*

As a result of mild air temperatures over most of 1995 sea ice conditions were normal around Greenland and off eastern Canada. The haline conditions, as observed at the Standard Stations off West Greenland since the early-1990s, reveal salinities on a high level which does not favour cod recruitment. *The paper conludes that the hydrographic conditions in the advective layer off West Greenland are not favourable for cod recruitment in 1996.*

Introduction

Started as a project during 1993, this paper is the fourth in a series which provides an annual overview on environmental conditions around Greenland. The data used in the context of this paper, deal with air temperatures, the distribution of sea ice and subsurface observations. The latter data originate from oceanographic observations performed at Standard Oceanographic Stations (**STEIN, 1988**) by the Federal Republic of Germany during the 1995 annual groundfish survey in the area off West and East Greenland.

It has been shown that the availability of long-term time series enables a better view on the variability of the ocean. These time-series merit special interest when correlating variability in the biota and the environment (**STEIN and LLORET, 1995**). It is the aim of this paper to collate available climatic information from atmospheric and oceanographic sources for the 1995 season to continue existing time series off Greenland, and to show with some examples from this data base how the 1995 conditions compare to the climatic background data.

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 and the Seewetteramt, Hamburg, the latter data sets are taken from **ANON. (1995)**. The climatic mean which the air temperature anomaly charts are referenced to is 1961-1990. Ice charts were constructed from NOAA satellite ice charts. Anomalies of ice edge are referenced to sea ice normals as displayed by **BUCH and STEIN (1989)** 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. (1995)** and from **ANON. (1995a)**. The ice charts and the monthly air temperature anomaly maps are available from the author on request as computer slide shows. Subsurface ocean data are available from German measurements for the West and East Greenland area.

Unfortunately, technical problems with RV "WALTHER HERWIG III" did not allow to work on Fylla Bank and in the northern regions off West Greenland. Thus, the 32-years time series of the Fylla Bank Section (**STEIN, 1988**) could not be continued in autumn 1995. However, to estimate a trend of the thermohaline conditions at station 4 of this section, the nearest oceanographic station profile was taken as substitute.

Results

Air Temperature and Sea Ice Anomaly during 1995

Northwest Atlantic

As in previous years (**STEIN, 1995a, b; STEIN, 1996a**), air temperatures over West Greenland were colder than normal during the first quarter of 1995. Off East Greenland air temperatures were slightly above the norm in February and March, 1995 (Fig. 1). From April onwards, however, warmer than normal conditions were encountered around Greenland and especially off Baffin Island (Figs. 2, 3). Warmer than 4K above normal during April (Fig. 2), and warmer than 6K above normal in November (Fig. 3), the year 1995 was an anomalous warm year for the region encountered.

Air Temperatures and Climatic Means

The three air temperature observation sites at the west coast and east coast of Greenland (Egedesminde, Nuuk and Angmagssalik, Figs. 4, 5, 6) reveal mean air temperatures at Egedesminde being around -22°C during the first quarter of the year (Fig. 4), around -10°C at Nuuk (Fig. 5), and around -11°C for the month of January at Angmagssalik at the east coast of Greenland (Fig. 6). As mentioned by **STEIN (1996)**, February was the coldest month during the early-1990s. From 1993 onwards, however, the pattern of air temperature changed at the west coast, and March became the coldest month relative to the 1961-1990 climatic mean. This trend was maintained during 1995. From April onwards, all climatic curves indicate warmer than normal conditions at the west coast (Figs. 4, 5), and normal conditions during early summer at the east coast (Fig. 6). Except for October, air temperatures were above the norm during autumn.

Climatic Variability off West Greenland

Compared to the cold early-1990s, the 1995 annual mean air temperature anomaly value returned to near normal conditions (-0.3K, Fig. 7). A decadal presentation of Nuuk mean air temperature anomalies (Fig. 8) reveal that the 1995 conditions return to normal, indicating the warming during the second half of the decade **(STEIN, 1996)**. The long-term trend of Nuuk air temperature anomalies is, however, far from returning to warm or even normal conditions (Figs. 7 and 9).

Ice Conditions in the Northwest Atlantic

Three examples of sea ice conditions around Greenland are given in Figs. 10, 11 and 12. At the beginning of April (950405, Fig. 10) the largest ice cover was found in the region between Canada and Greenland with unusual ice cover off West Greenland (dark shaded area in Fig. 10). Nearly ice free conditions were found in mid September (950920, Fig. 11) when only off East Greenland the formation of new pack ice is visible. Unfortunately, there are no ice charts available to the author between the latter date and the 1st of November 1995. At this time ice formation was normal around Baffin Island and off East Greenland (951101, Fig. 12).

Subsurface Observations off West Greenland

Thermohaline conditions off West Greenland were observed at Standard Oceanographic Sections Cape Farewell, Cape Desolation and Frederikshaab (**STEIN, 1988**). Due to technical problems with RV "WALTHER HERWIG III" the annual autumn observations along the Fylla Bank Section could not be done. Figs. 13 and 14 display results from the *deep water stations* of the three standard sections (c.f. **STEIN, 1996b**). Except for the Cape Farewell station 4 all temperature observations indicate cooling of the surface layers 0-50m and 0-200m, respectively (Fig. 13). Salinity indicates freshening of the surface waters off Southwest Greenland (Fig. 14). Below 200m, in the Irminger layer (200-300m), the thermohaline results reveal an inconsistant pattern of warming (Frederikshaab 3 and Cape Farewell 3, Fig. 15 right panel side), and cooling (Cape Desolation 3 and Cape Farewell 3, Fig. 15 left panel side). Haline conditions indicate a slight increase (Fig. 16). The peak in salinity during 1988 at Cape Farewell station 3 (Fig. 16) was caused by low salinity water masses influencing the water column down to 400m depth (c.f. also Fig. 14).
Results from the national standard sections Gauß Bank and Cape Moesting (for location see Fig. 17) are given in Figs. 18 and 19. Thermohaline properties of stations 4 and 5 of both sections are influenced by the Irminger component of the East Greenland Current system. Thermal conditions at Gauß Bank (Fig. 18) indicate cooling of the surface waters (0-50m), but rather stable conditions within the Irminger Water layer (200-300m). Unfortunately, the observations at Cape Moesting are rather scanty with a large gap between 1991 and 1994. Thus, only a thermal trend may be depicted from Fig. 19. It would appear that major changes were encountered in the near surface layer which are more exposed to atmospheric changes than the Irminger Water layer. Changes in the 200-300m layer amount to less than 1K which is similar to the Gauß Bank thermal conditions.

Discussion

For the first time since June 1994, April 1995 air temperature anomalies show positive conditions for the area West Greenland-Davis Strait-Baffin Bay (Fig. 2). In the north of Ellesmere Island and Greenland anomalies exceed 9K, in the south of the Canadian Archipelago air temperatures in April indicate warming which amounts to 8K above the norm (1961-1990). The west coast of Greenland which indicated for several years negative anomalies, experienced a mild early summer. August conditions (Figs. 4, 5) for the first time since March 1995, reveal negative anomalies which cover the coastal areas and the adjacent sea. October conditions were slightly below the long-term mean, whereas November and December 1995 indicated positive anomalies in the arctic area (Fig. 3, c.f. also Figs. 4, 5, 6). Along the northern rim of numerous low pressure systems off Newfoundland, eastern winds very often advected mild air from Atlantic origin to Labrador. Also the *föhn,* caused by easterly winds at the west coast of Greenland, generated a positive anomaly.

These positive air temperature anomalies generated intermediate warming. However, there is no indication for a change of the long-term negative trend of the climatic conditions at West Greenland (c.f. Figs. 7 and 9).

As a result of mild air temperatures over most of 1995 sea ice conditions were normal around Greenland and off eastern Canada.

Subsurface oceanographic conditions off Southwest Greenland reveal colder than normal surface water layers (0-50m, and 0-200m) which might reflect cooling as induced by colder than normal air temperature conditions during October, or advection of cold and diluted waters through the West Greenland current system.

Thermohaline properties of the Irminger layer (200-300m) off Southwest Greenland reveal high salinities at the southeastern entrance to the Labrador Sea (Cape Farewell Section Stations 3 and 4) which are around 35 PSU. It would appear that since the beginning of this time series a steady increase in salinity has been observed at station 4 of this section. The thermal signal, however, yields cold conditions in the early- to mid-1980s, warm conditions from 1987 throughout 1991, and a colder value for the 1995 autumn observations. Unfortunately, the gap of observation between 1992 and 1994 does not permit any conclusion on the relevance of the 1995 measurement to the previous development of the thermal events at station 4 of the Cape Farewell Section. Farther north, at the Cape Desolation Section, thermal conditions indicate lower than normal levels of temperature for the early-1990s. This might suggest that after a fourt to five year long period of warm conditions, at present a cold phase governs the Irminger Current component of the West Greenland Current system. As shown by **STEIN and LLORET (1995)**, salinity has the dominating influence on the stability of water masses off West Greenland. Thus, high stability should coincide with the advection of low salinity water. The significant *positive correlation* of *cod recruitment* and *stability* of the *Irminger water layer during the previous autumn* suggests, according to these authors, a coupling of cod recruitment and changes in the inflow of Irminger (Atlantic) to the West Greenland area.

The haline conditions, as observed at the Standard Stations off West Greenland since the early-1990s, reveal *salinities on a high level which does not favour cod*

recruitment. The scanty observations off East Greenland do not allow conclusive correlation with the West Greenland thermohaline conditions, neither in the Irminger layer (200-300m) nor in the near-surface layer (0-50m).
An estimate of thermohaline trends at Fylla Bank station 4 (c.f. last para. of Data and Methods) reveals a decline of the near-surface signal of both temperature and salinity. However, below 50m depth the trend reverses and the increase of salinity as observed since 1992 persists. The thermal signal at 100m and 200m depth remains, similar to the previous year, at a level of about 4°C.
In conclusion, this estimate corroborates the above statement, that *hydrographic conditions in the advective layer are not favourable for cod recruitment in 1996.*

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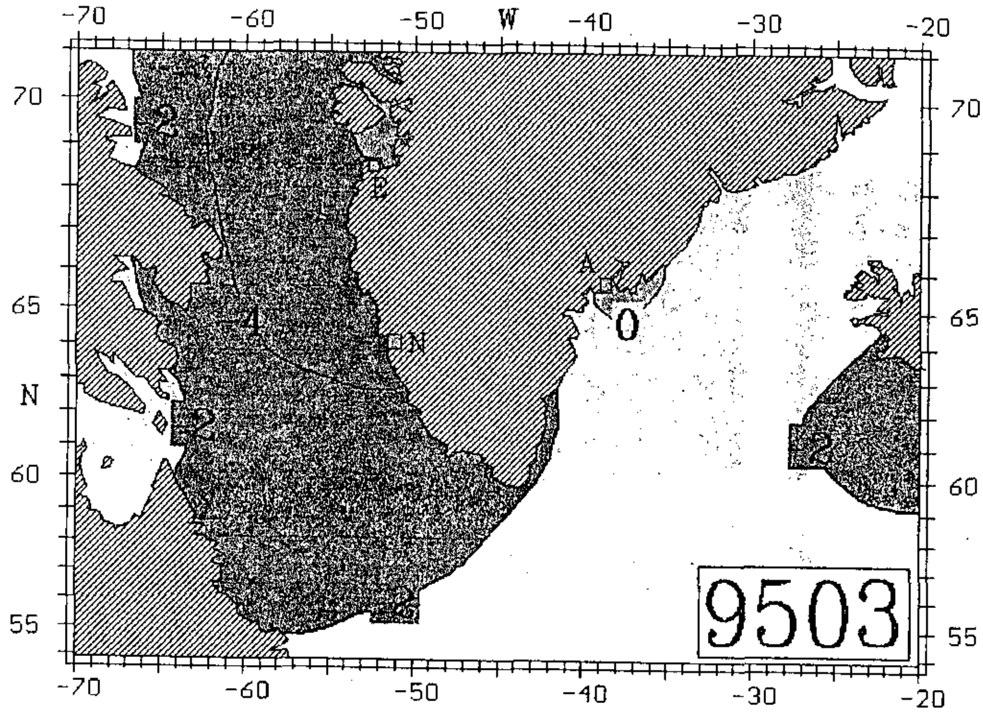

Fig. 1 Mean air temperature anomalies over the Northwest Atlantic during March, 1995 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

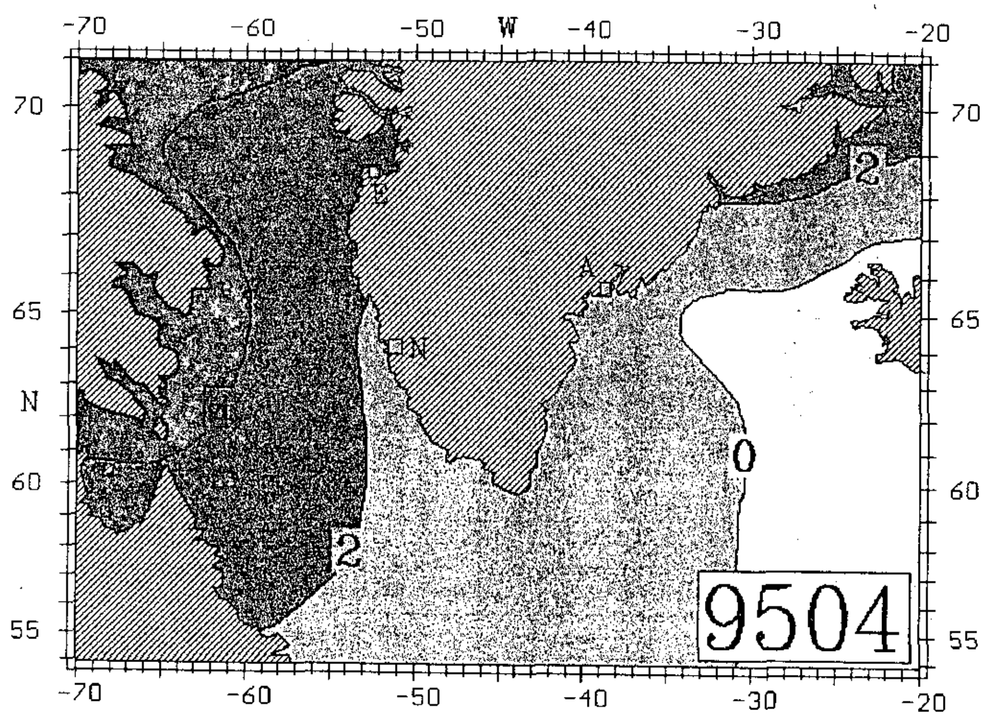

Fig. 2 Mean air temperature anomalies over the Northwest Atlantic during April, 1995 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

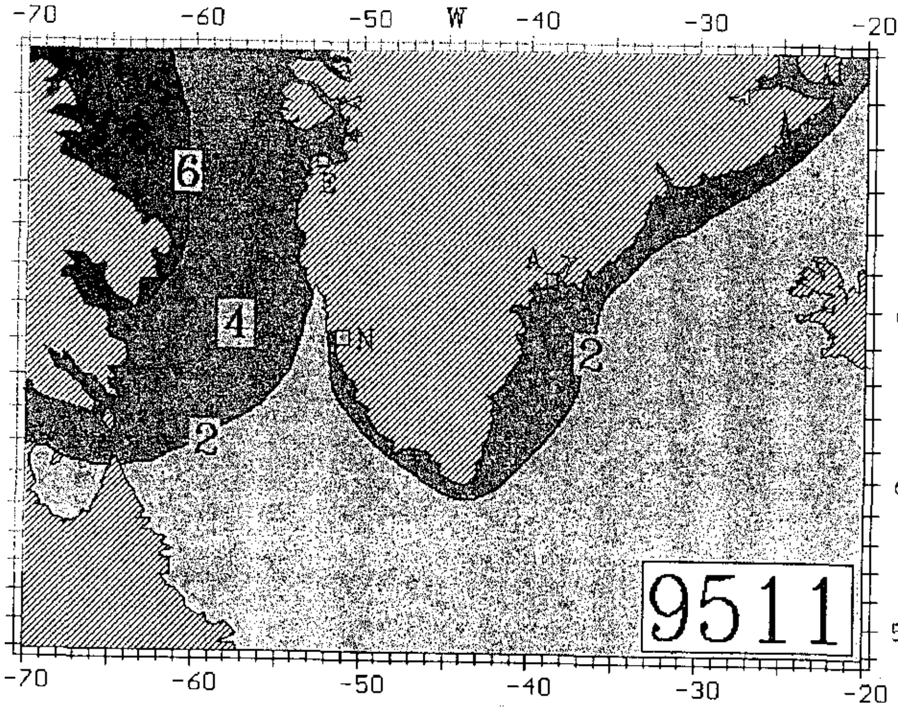

Fig. 3 Mean air temperature anomalies over the Northwest Atlantic during November, 1995 (E=Egedesminde, N=Nuuk, A=Angmagssalik)

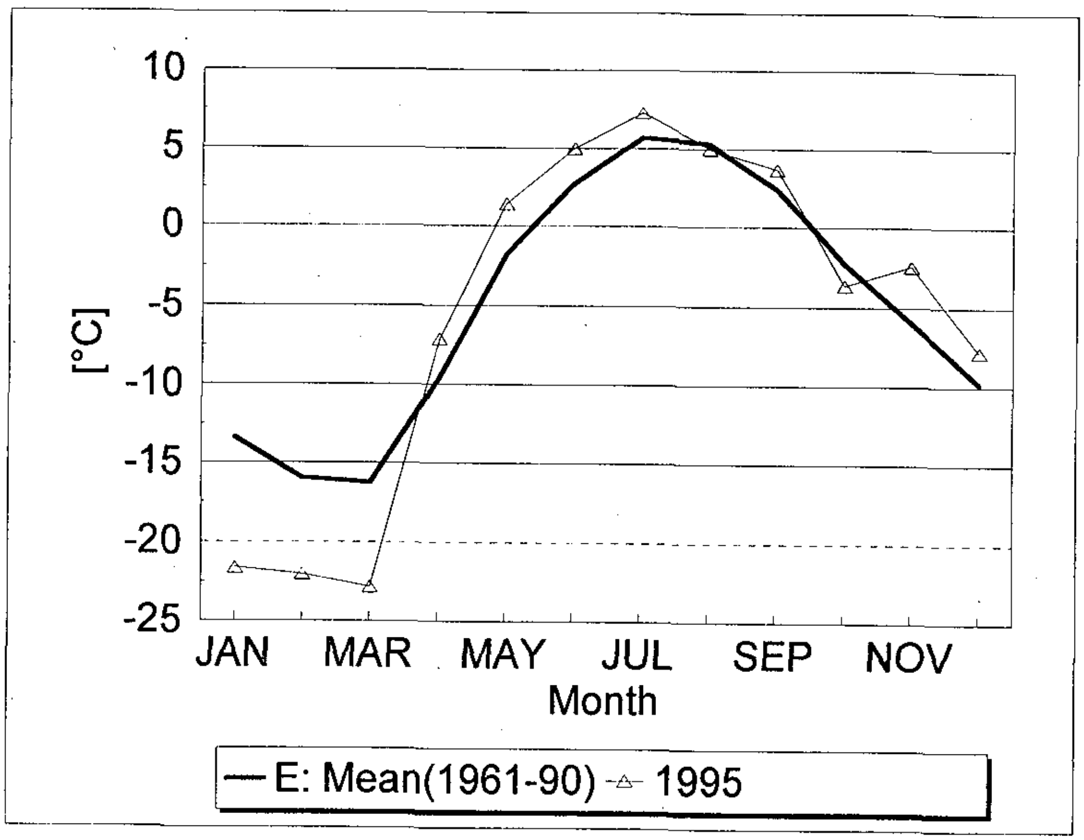

Fig. 4 Monthly mean air temperature at Egedesminde during 1995 and climatic mean (1961-1990)

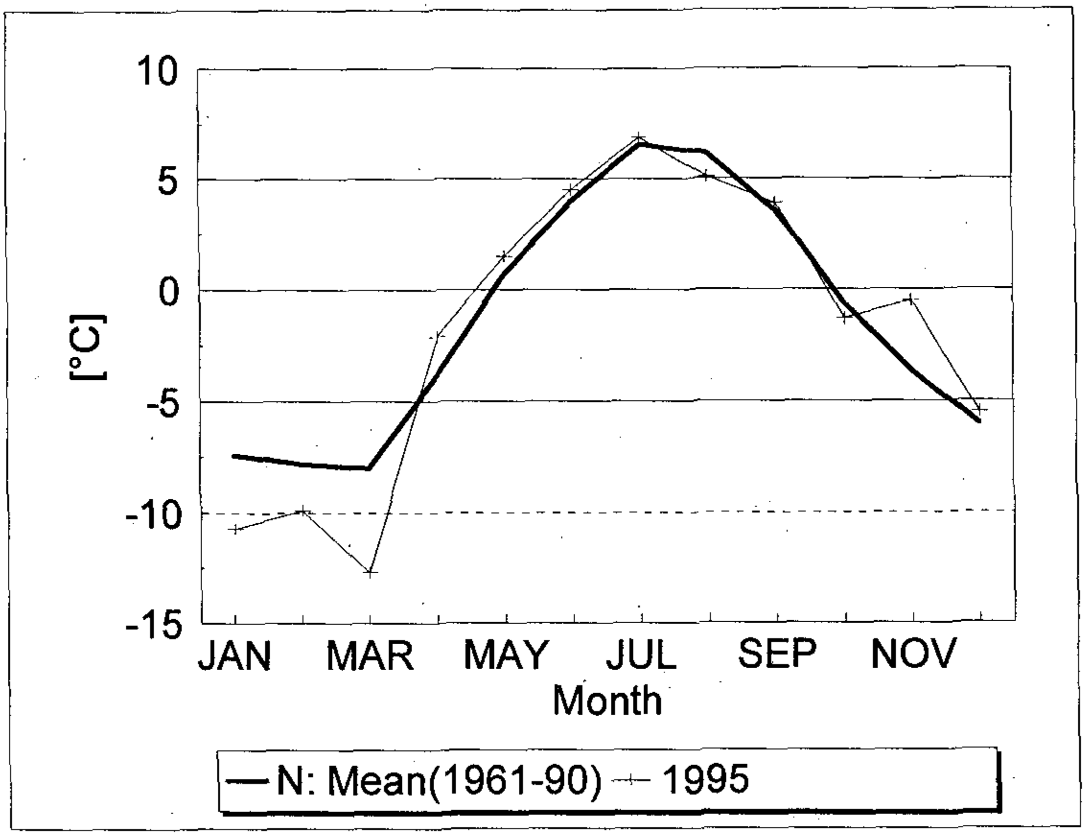

Fig. 5 Monthly mean air temperature at Nuuk during 1995 and climatic mean (1961-1990)

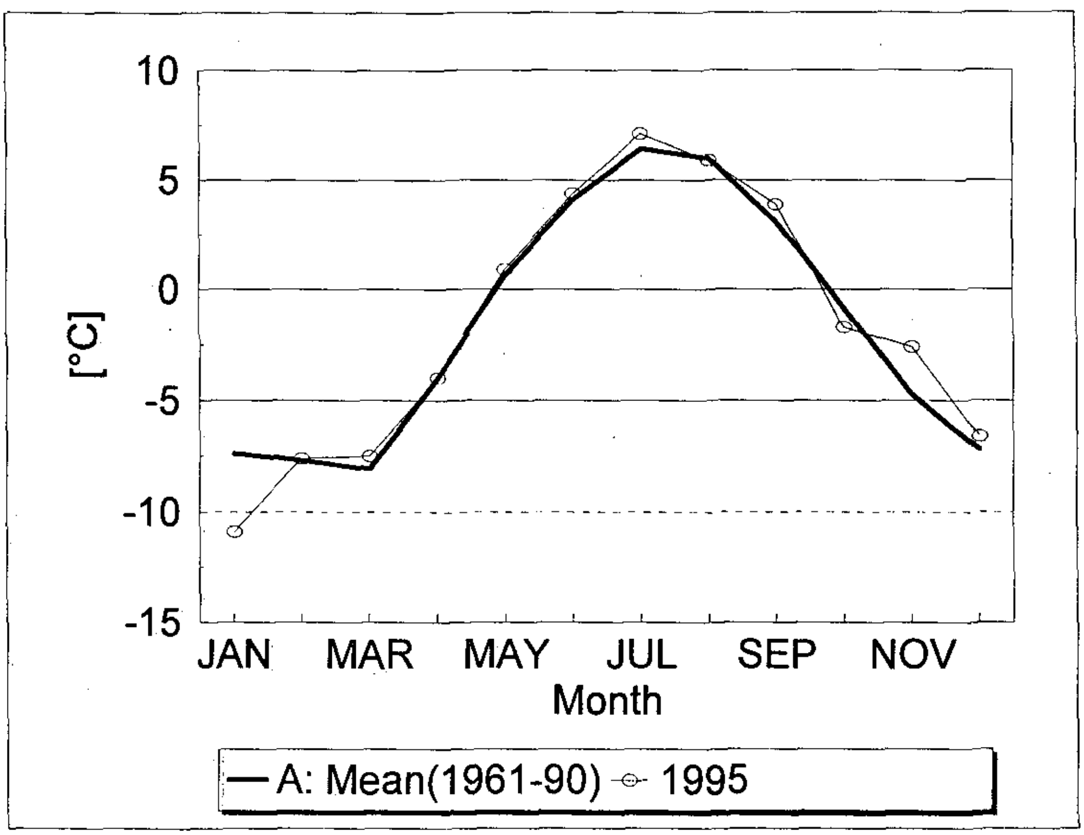

Fig. 6 Monthly mean air temperature at Angmagssalik during 1995 and climatic mean (1961-1990)

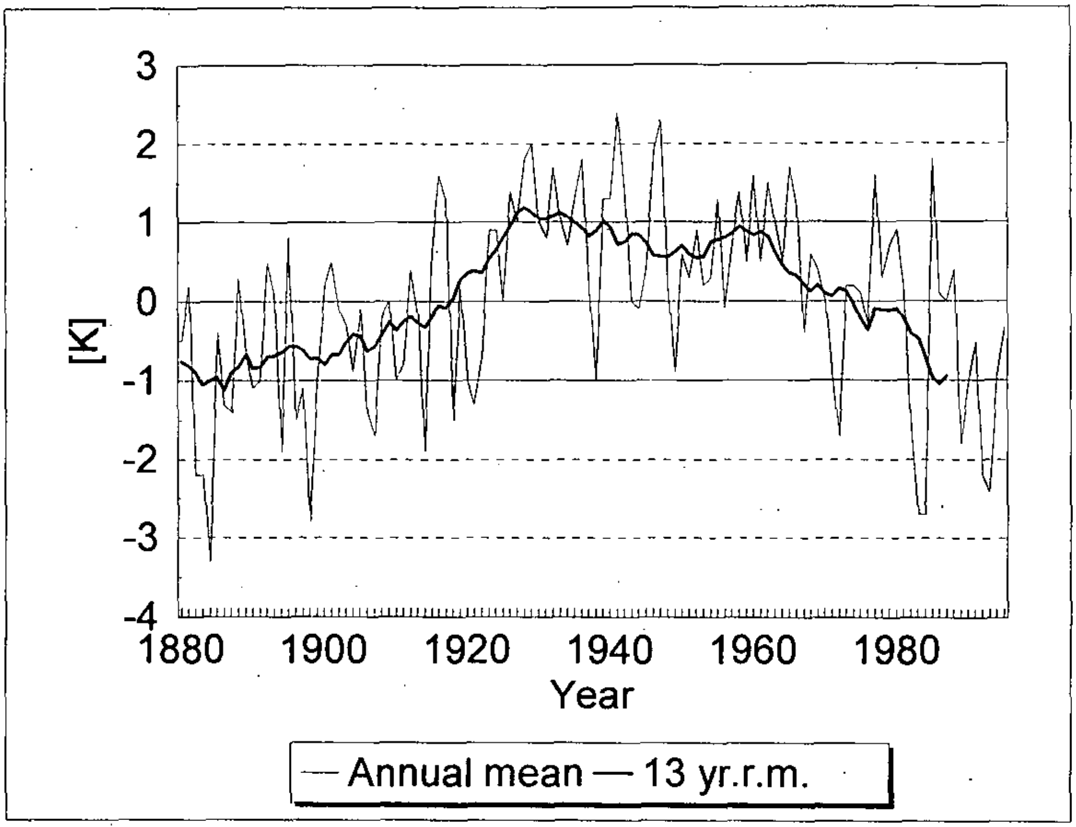

Fig. 7 Time series of annual mean air temperature anomalies at Nuuk (1880-1995, rel. 1876-1994) and 13 year running mean

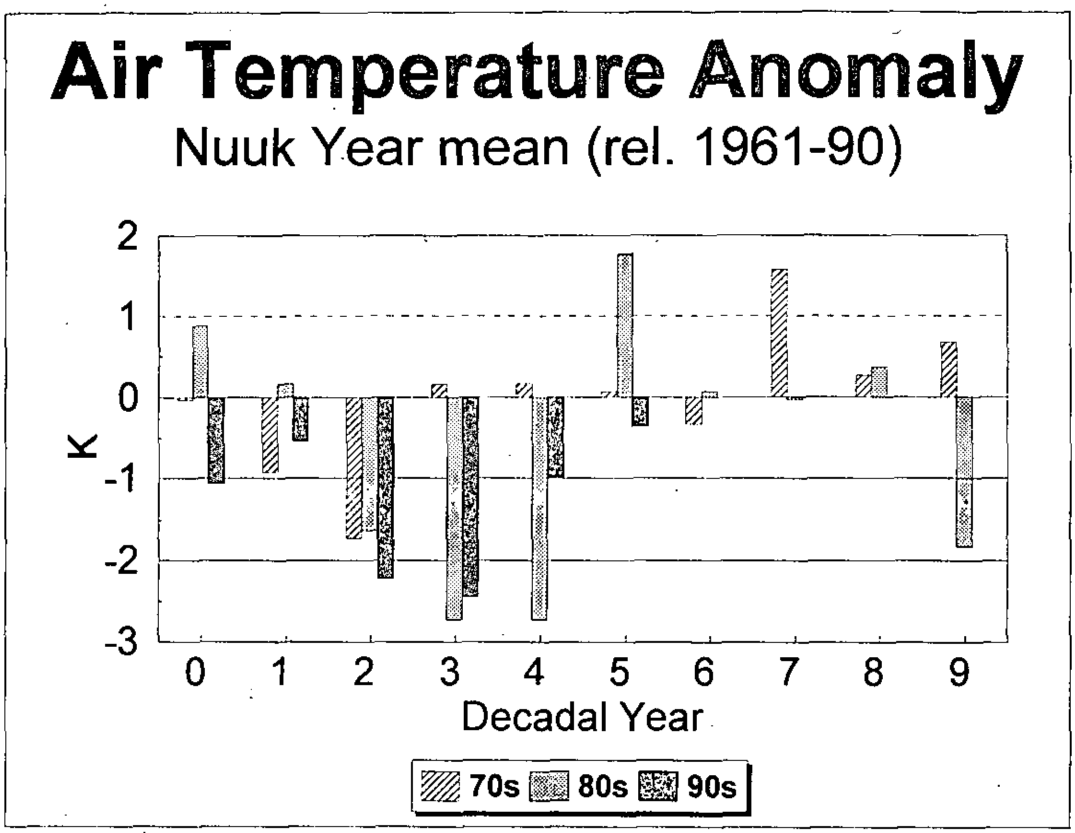

Fig. 8 Composite of decadal air temperature anomalies at Nuuk given relative to the climatic mean of 1961-90 for the decades of the 1970s, 1980s and 1990s

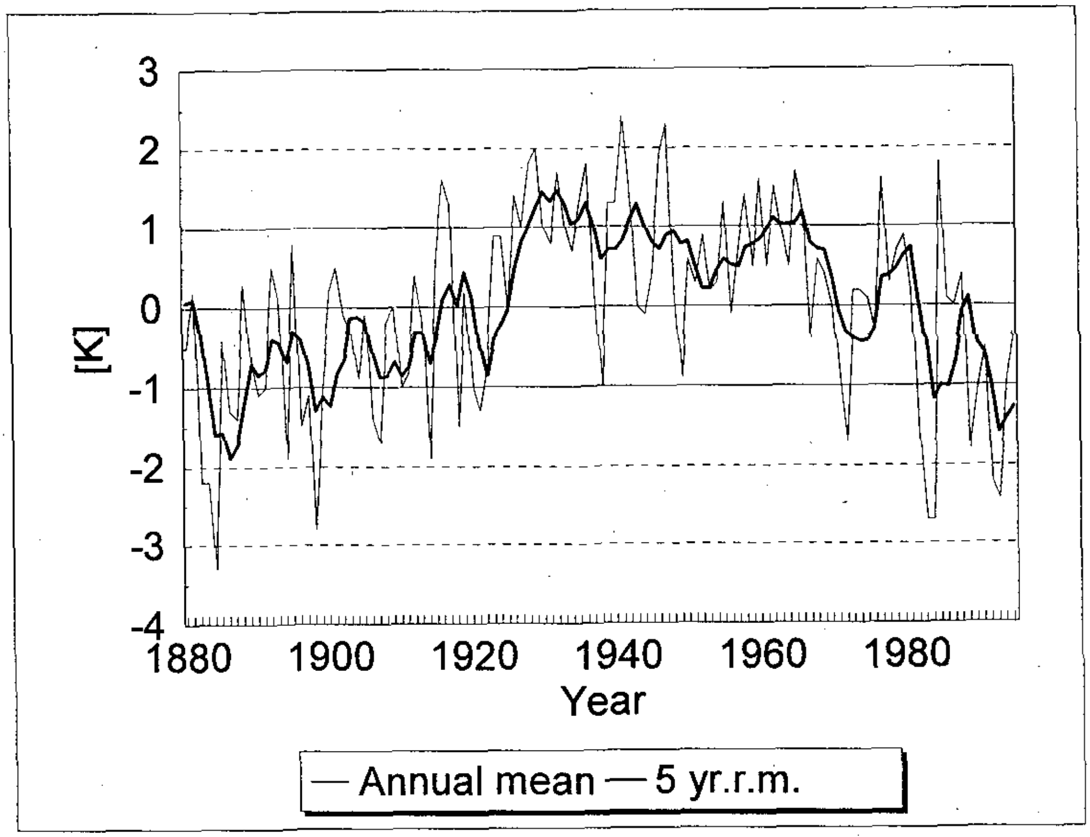

Fig. 9 Time series of annual mean air temperature anomalies at Nuuk (1880-1995, rel. 1876-1994) and 5 year running mean

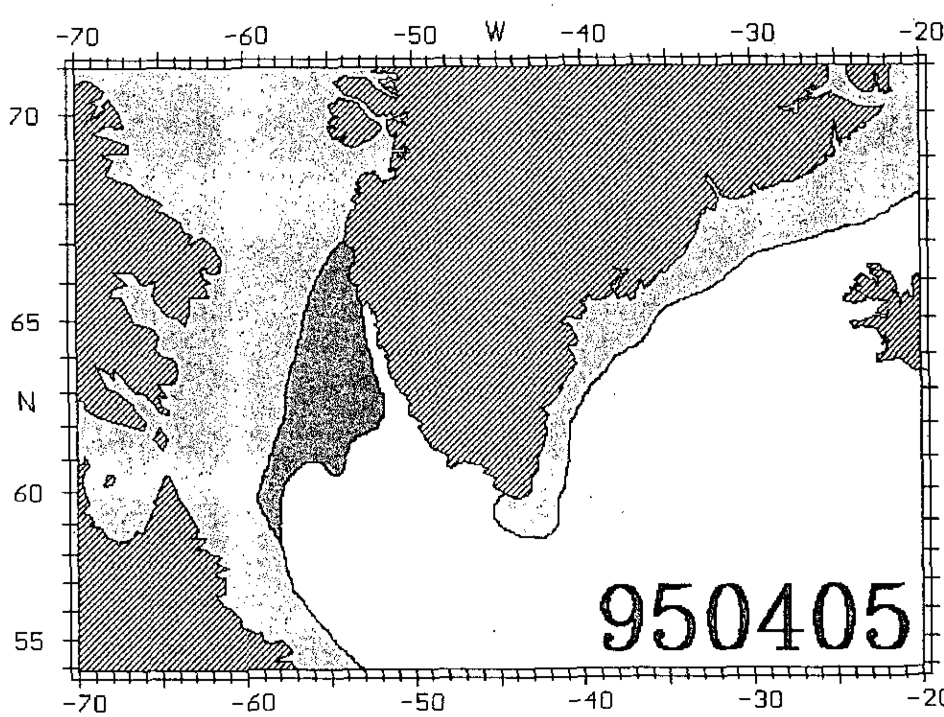

Fig. 10 Ice edge during April 5, 1995; dark shaded areas indicate anomalous extent of ice edge during the month of April

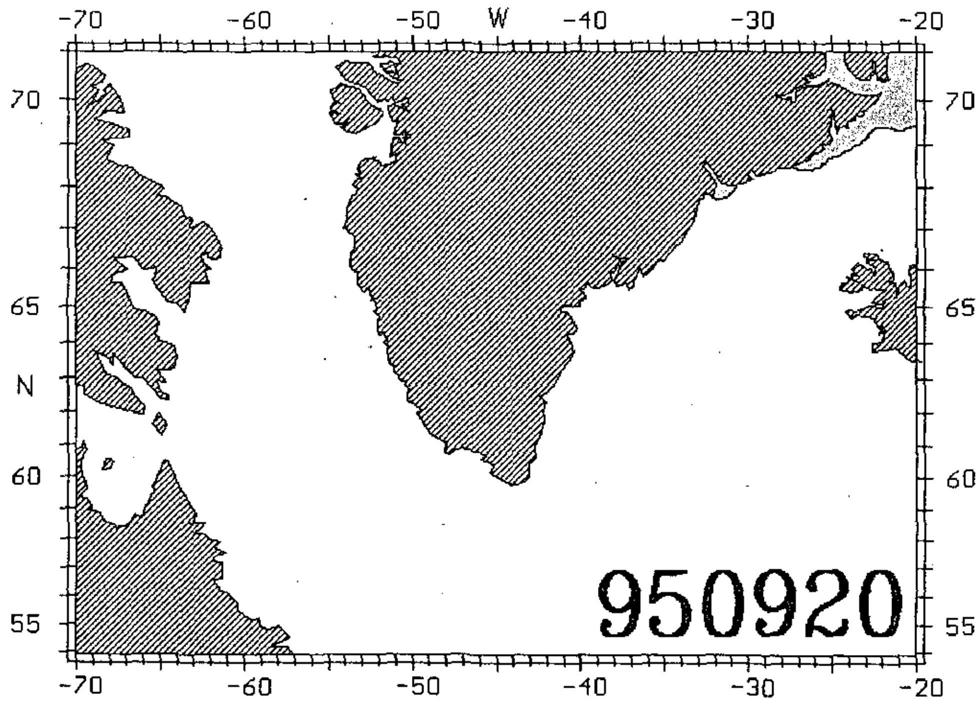

Fig. 11 Ice edge during September 20, 1995

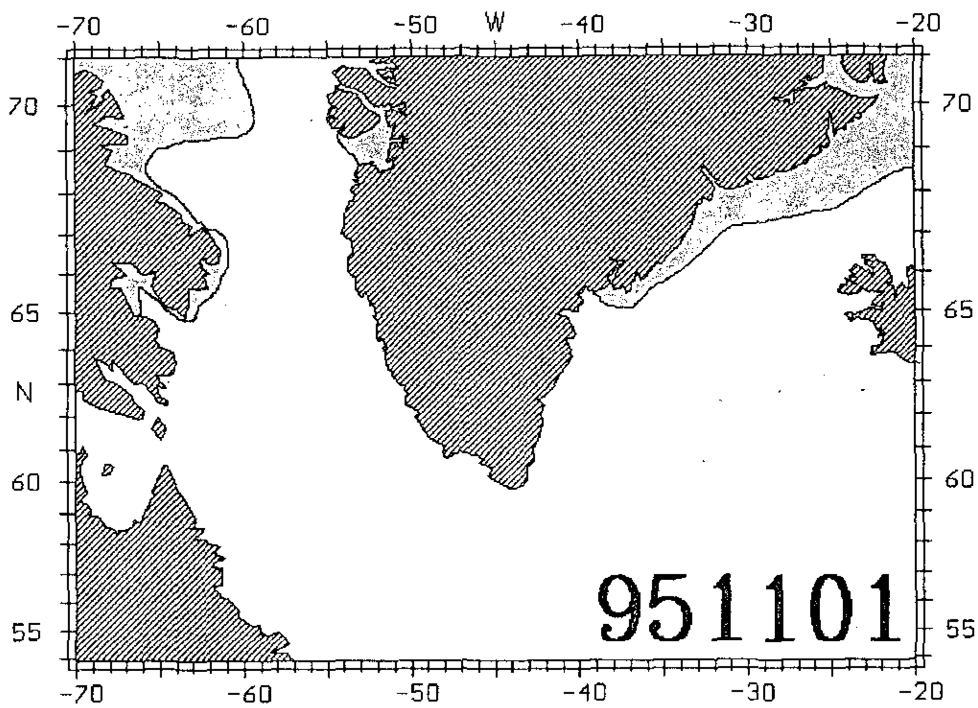

Fig. 12 Ice edge during November 1, 1995

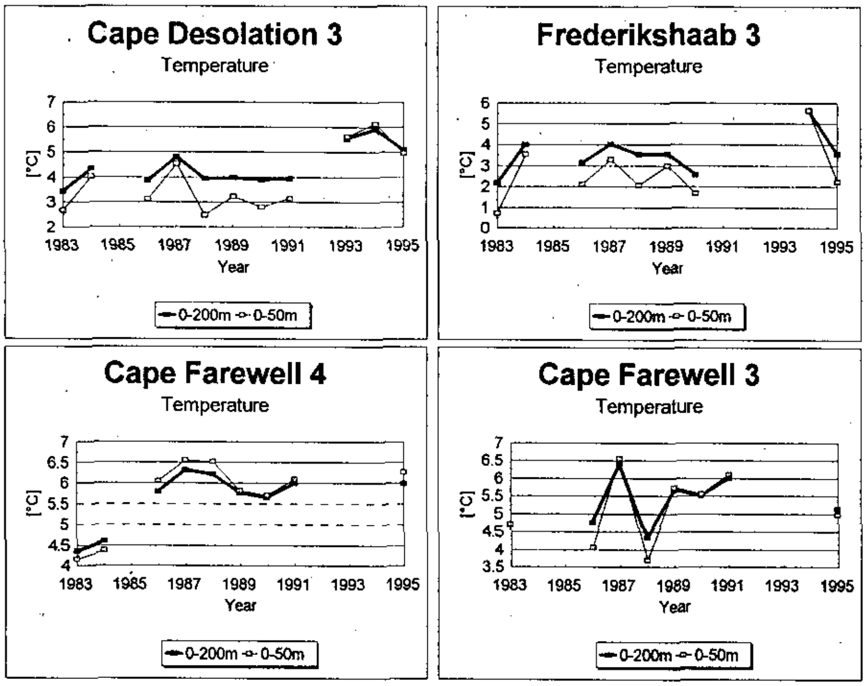

Fig. 13 Time series of temperature at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983-1995) for surface layers 0-50m, 0-200m

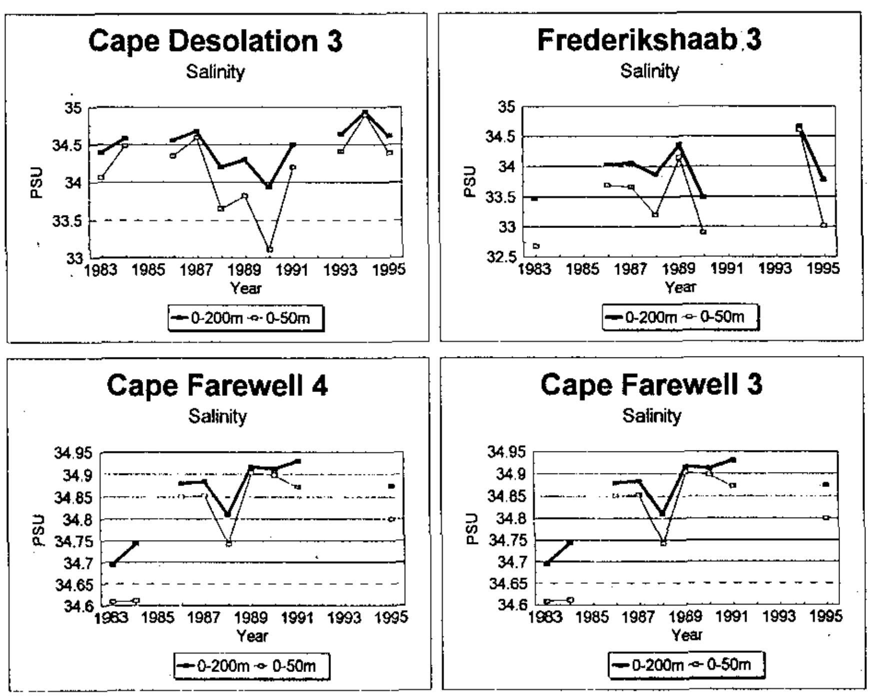

Fig. 14 Time series of salinity at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983-1995) for surface layers 0-50m, 0-200m

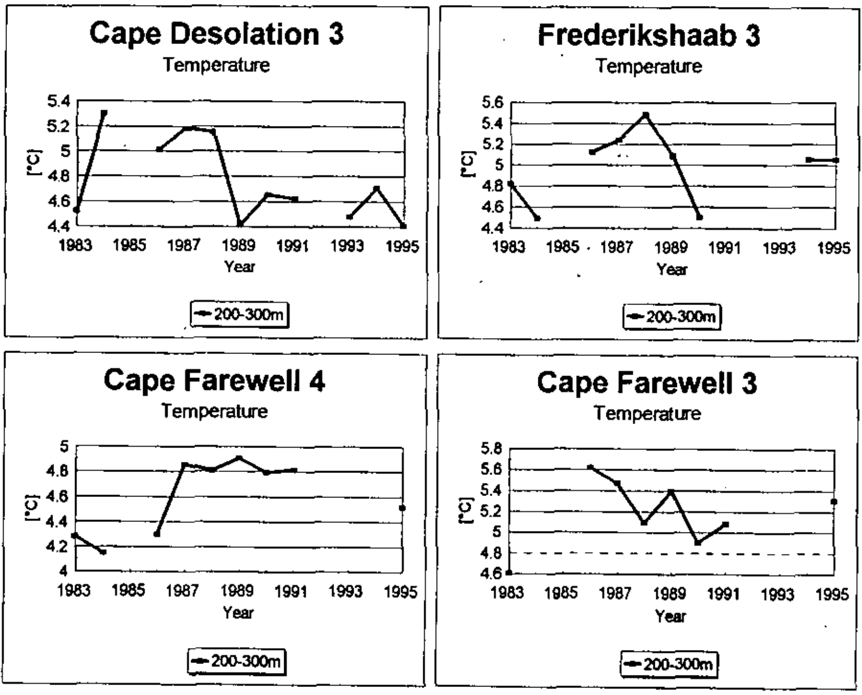

Fig. 15 Time series of temperature at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983-1995) for Irminger layer 200-300m

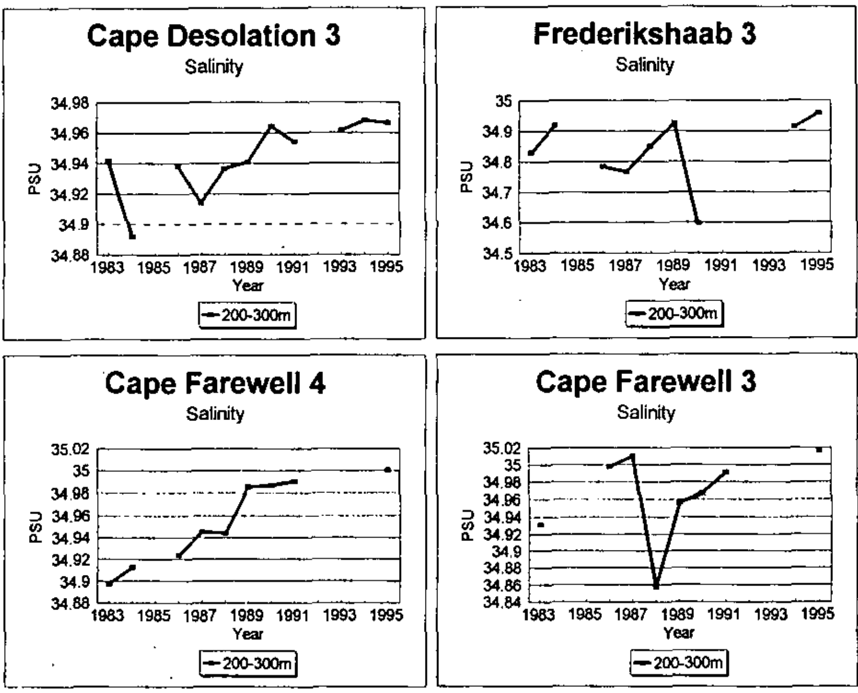

Fig. 16 Time series of salinity at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983-1995) for Irminger layer 200-300m

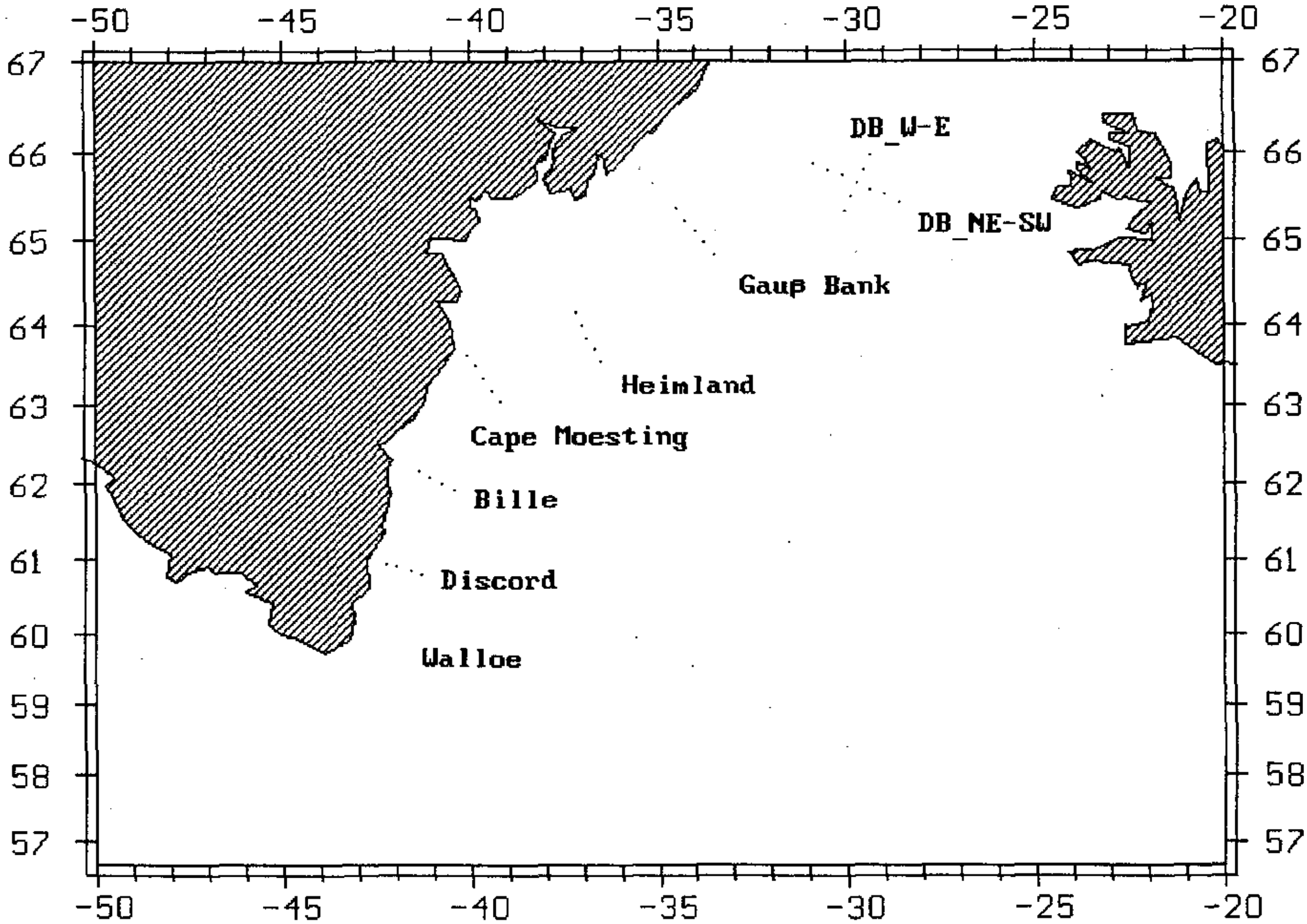

Fig. 17 Location of national standard sections off East Greenland

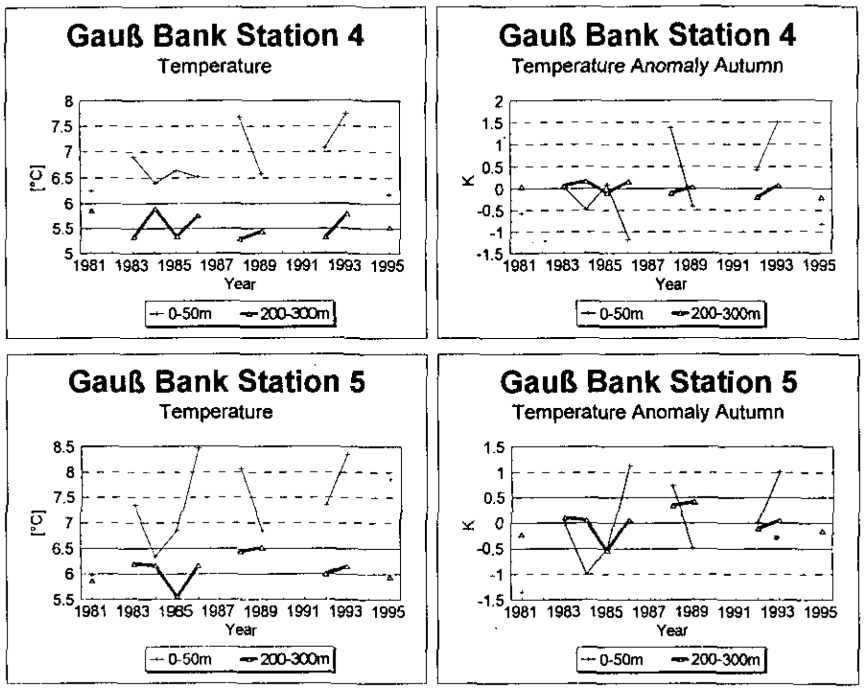

Fig. 18 Time series of temperature and temperature anomaly at standard station Gauß Bank 4 and 5 for surface layers 0-50m and Irminger Water layer 200-300m

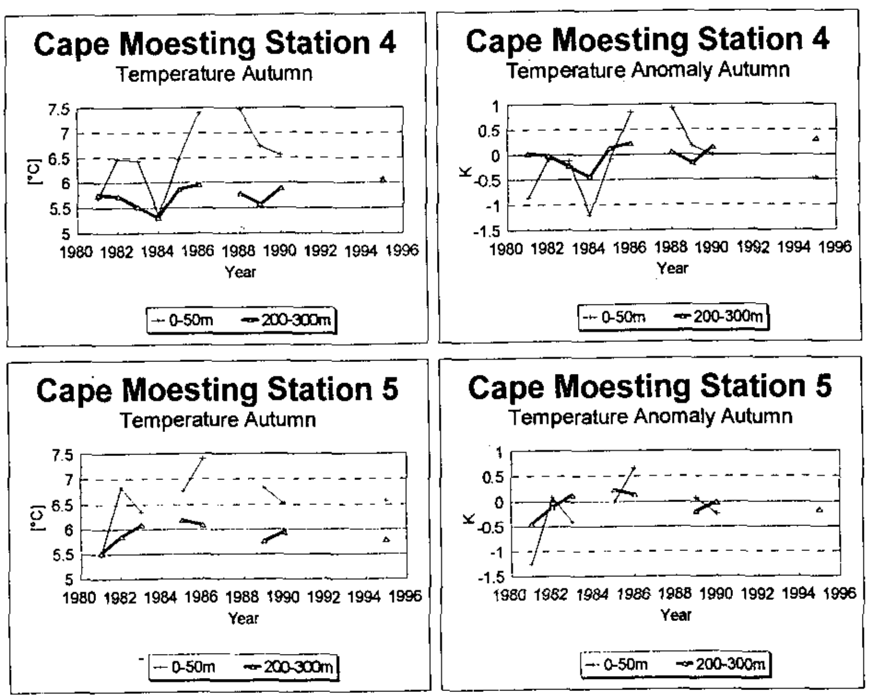

Fig. 19 Time series of temperature and temperature anomaly at standard station Cape Moesting 4 and 5 for surface layers 0-50m and Irminger Water layer 200-300m