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Climatic Conditions Around Greenland – 1995

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Abstract

The annual review of variability of climatic conditions around Greenland was continued based on air temperature data from three sites at West and East Greenland. Mean monthly air temperature data from Nuuk at West Greenland revealed the long-term interannual changes of air temperature anomalies. The spring 1995 air temperature anomalies showed for the first time since June 1994 positive conditions for the area West Greenland–Davis Strait–Baffin Bay. The west coast of Greenland which indicated negative anomalies for several years, 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 the mild air of Atlantic origin to Labrador along the northern rim. Also the föhn, caused by easterly winds at the west coast of Greenland, generated a positive anomaly. The intermediate warming did not, however, 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, revealed salinities at a high level which did not seem to favour cod recruitment. The hydrographic conditions in the advective layer off West Greenland in general did not appear favourable for cod recruitment in 1996.

Key words: climate, current, East Greenland, ice, salinity, temperature, West Greenland

Introduction

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 hydrographic observations. The latter data originated from oceanographic observations performed at Standard Oceanographic Stations (Stein, MS 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 variability in the biota are correlated with the environmental conditions (Stein and Lloret, 1995). It is the aim of this paper to collate available climatic information from atmospheric and oceanographic sources in 1995, to continue the existing time series of data off Greenland, and to show with some examples from this data base how the 1995 conditions compare with the background data on the climate.

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 were taken from Anon. (1995a). The climatic mean which the air temperature anomaly charts are referenced to is 1961–90. The ice charts were constructed from NOAA satellite ice charts. Anomalies of the 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. (1995a and 1995b). The ice charts and the monthly air temperature anomaly maps are available from the author upon 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, MS 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

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

Air Temperatures and Climatic Means

The three air temperature observation sites at the west coast and east coast of Greenland (Egedesminde, Nuuk and Angmagssalik, Fig. 4, 5, 6) revealed mean air temperatures at Egedesminde around -22°C during the first quarter of the year (Fig. 4), around -10°C at Nuuk (Fig. 5) at the west coast of Greenland, and around -11°C for the month of January at Angmagssalik at the east coast of Greenland (Fig. 6). As mentioned by Stein (1996a), February was the coldest month during the early-1990s. From 1993 onwards, however, the pattern of

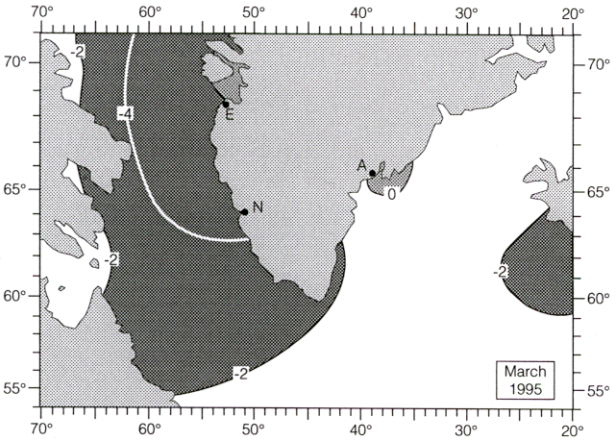


Fig. 1. Mean air temperature anomalies over the Northwest Atlantic during March 1995 (E = Egedesminde, N = Nuuk, A = Angmagssalik).

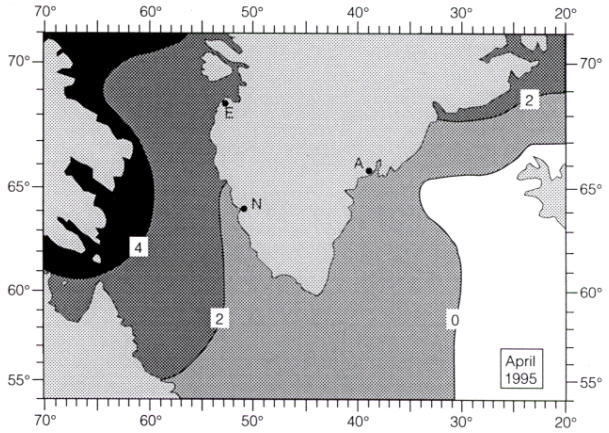


Fig. 2. Mean air temperature anomalies over the Northwest Atlantic during April 1995 (E = Egedesminde, N = Nuuk, A = Angmagssalik).

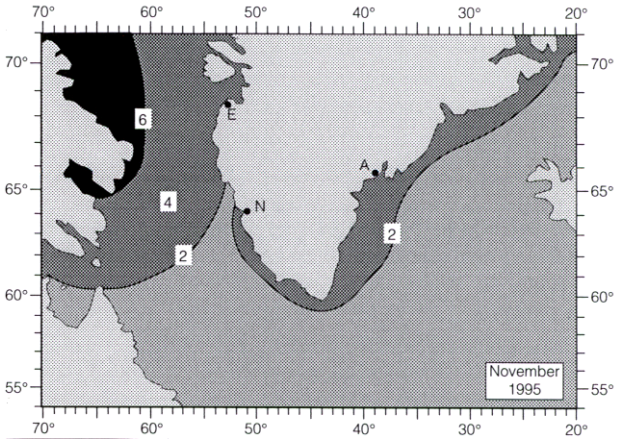


Fig. 3. Mean air temperature anomalies over the Northwest Atlantic during November 1995 (E = Egedesminde, N = Nuuk, A = Angmagssalik).

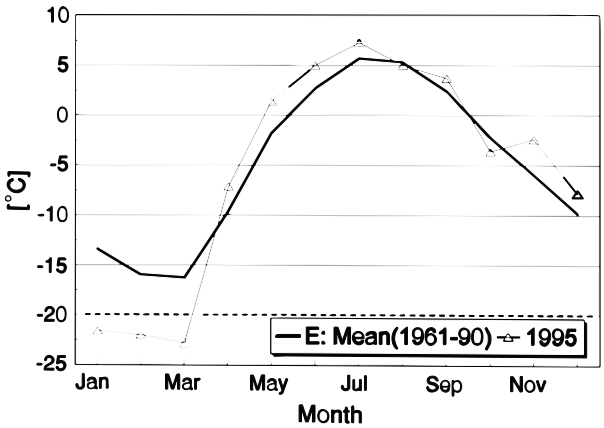


Fig. 4. Monthly mean air temperature at Egedesminde during 1995 and climatic mean (1961–90).

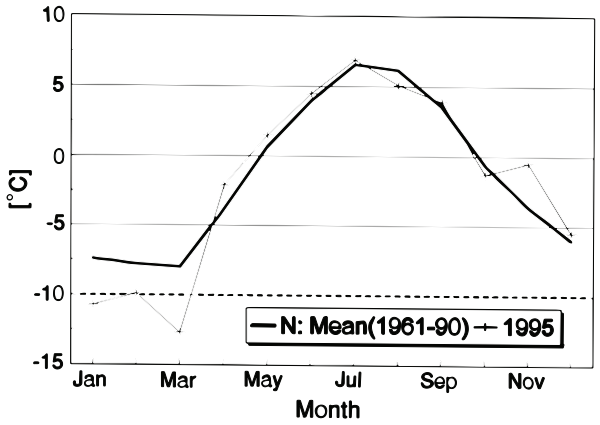


Fig. 5. Monthly mean air temperature at Nuuk during 1995 and climatic mean (1961–90).

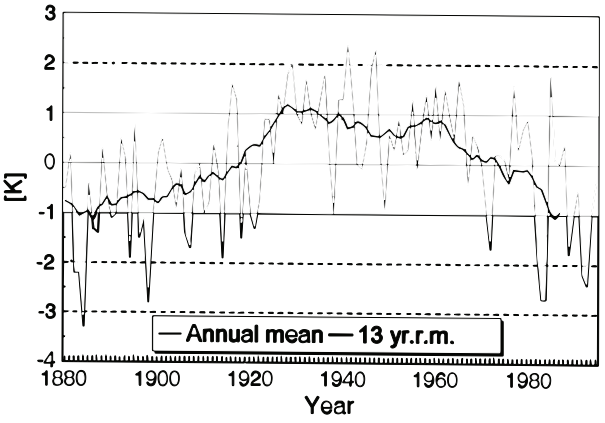


Fig. 7. Time series of annual mean air temperature anomalies at Nuuk (1880-1995, rel. 1876–1994) and 13-year running mean.

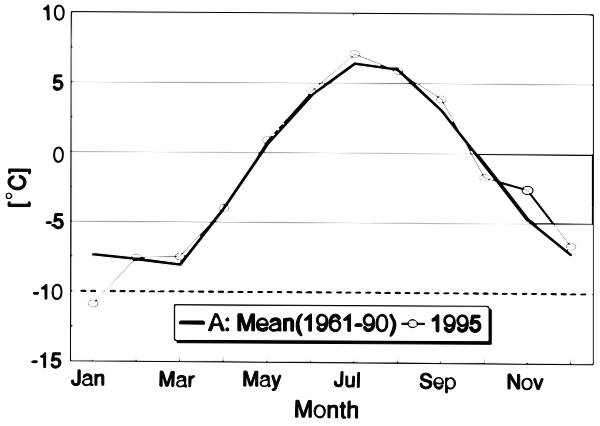


Fig. 6. Monthly mean air temperature at Angmagssalik during 1995 and climatic mean (1961–90).

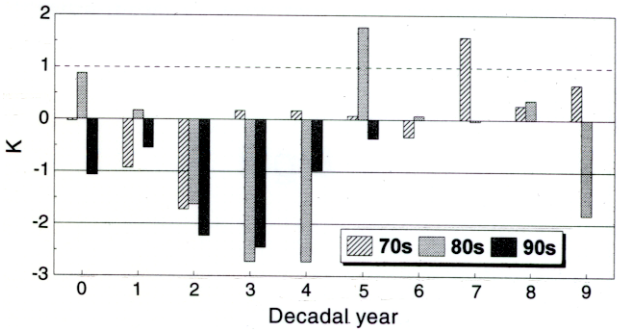


Fig. 8. Composite of decadal air temperature anomalies at Nuuk given relative to the climatic mean of 1961–90 for the decades of the 1970s, 1980s and 1990s.

air temperature changed at the west coast and March became the coldest month relative to the 1961–90 climatic mean. This trend was maintained during 1995. From April onwards, all climatic curves indicated warmer than normal conditions at the west coast (Fig. 4, 5), and normal conditions during early summer at the east coast (Fig. 6). Except for October, air temperatures were above normal 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) revealed that the 1995 conditions returned to normal, indicating the warming during the second half of the decade (Stein, 1996a). The long-term trend of Nuuk air temperature anomalies was, however, far from returning to warm or even normal conditions (Fig. 7 and 9).

Ice Conditions in the Northwest Atlantic

Three examples of sea ice conditions around Greenland are given in Fig. 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 was visible. Unfortunately, there were no ice charts available to the author between the latter date and 1 November 1995, at which 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

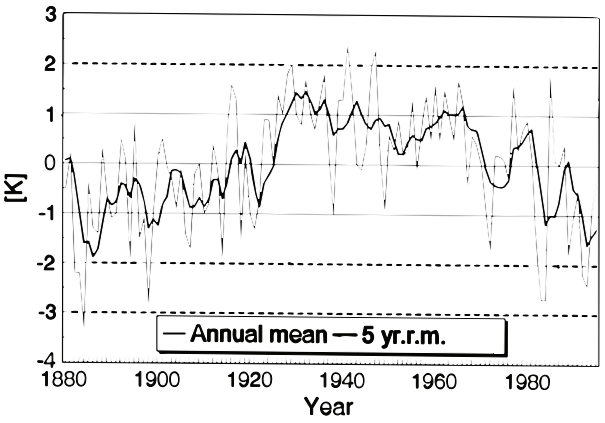


Fig. 9. Time series of annual mean air temperature anomalies at Nuuk (1880–1995, rel. 1876–1994) and 5-year running mean.

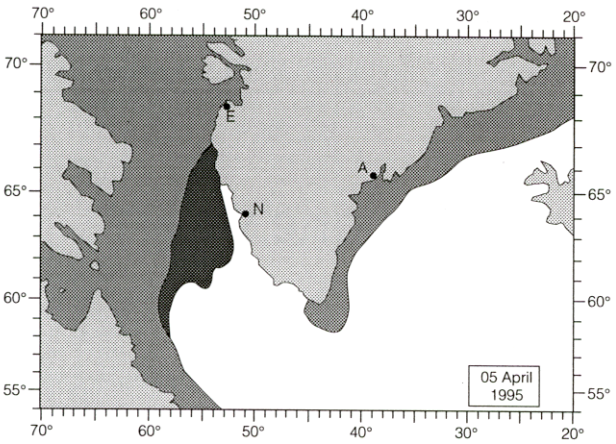


Fig. 10. Ice edge during 5 April 1995; dark shaded areas indicate anomalous extent of ice edge during the month of April.

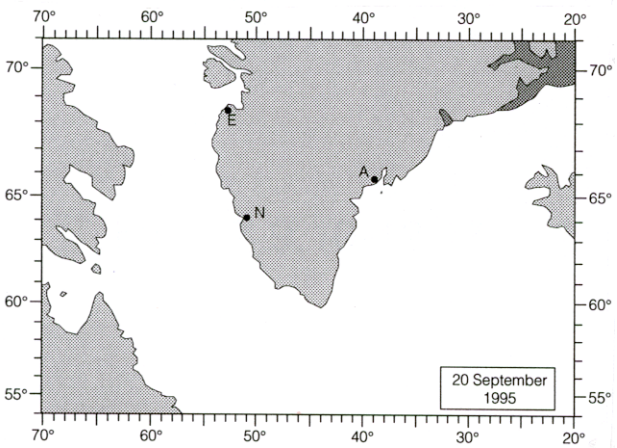


Fig. 11. Ice edge during 20 September 1995.

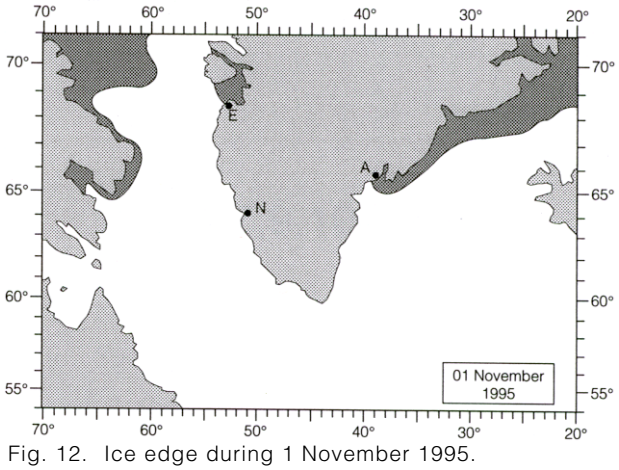
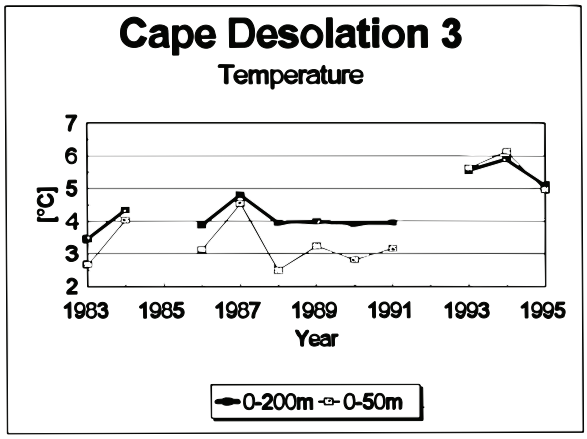
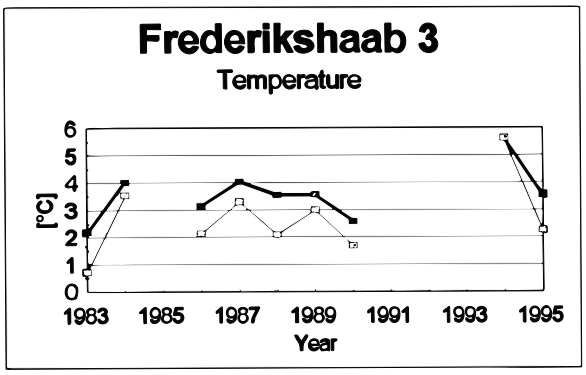


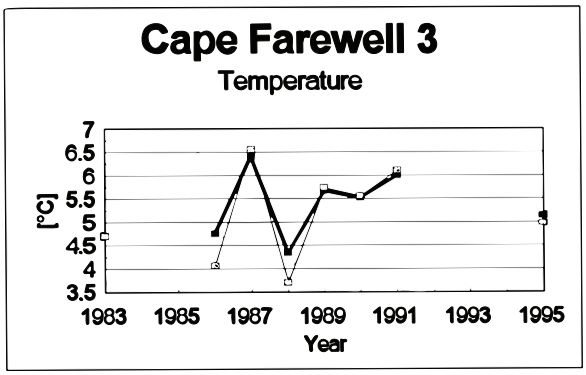
Fig. 12. Ice edge during 1 November 1995.

Cape Farewell, Cape Desolation and Frederikshaab (Stein, MS 1988). Due to technical problems with RV "*Walther Herwig III*" the annual autumn observations along the Fylla Bank Section could not be done. Figures 13 and 14 display results from the deep water stations of the three standard sections (Stein, 1996a). Except for the Cape Farewell Station 4, all temperature observations indicated cooling of the surface layers 0–50 m and 0–200 m, respectively (Fig. 13). Salinity indicated freshening of the surface waters off Southwest Greenland (Fig. 14). Below 200 m, in the Irminger layer (200–300 m), the thermohaline results revealed an inconsistent pattern of warming (Frederikshaab 3 and Cape Farewell 3, Fig. 15), and cooling (Cape Desolation 3 and Cape Farewell 3, Fig. 15). The haline conditions indicated 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 400 m depth (see Fig. 14).

Results from the standard Sections at Gaus Bank and Cape Moesting (for location see Fig. 17) are given in Fig. 18 and 19. Thermohaline properties of Stations 4 and 5 of both Sections were influenced by the Irminger component of the East Greenland Current system. Thermal conditions at Gaus Bank (Fig. 18) indicated cooling of the surface waters (0–50 m), but rather stable conditions within the Irminger Water layer (200–300 m). Unfortunately, the observations at Cape Moesting were rather scanty with a large gap between 1991 and 1994. Thus, only a thermal trend could be depicted from Fig. 19. It would appear that major changes were encountered in the near surface layer which were more exposed to atmospheric changes than the Irminger Water layer. Changes in the 200–300 m layer amounted to less than 1K, which were similar to the Gaus Bank thermal conditions.







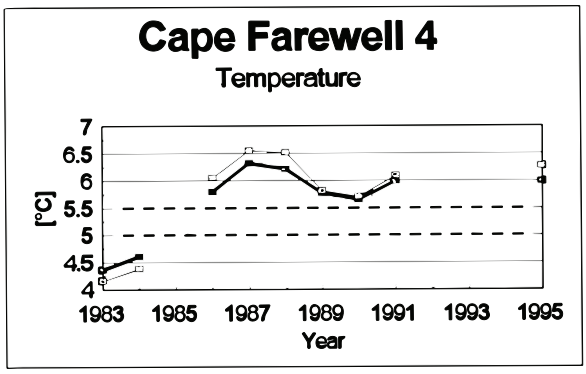
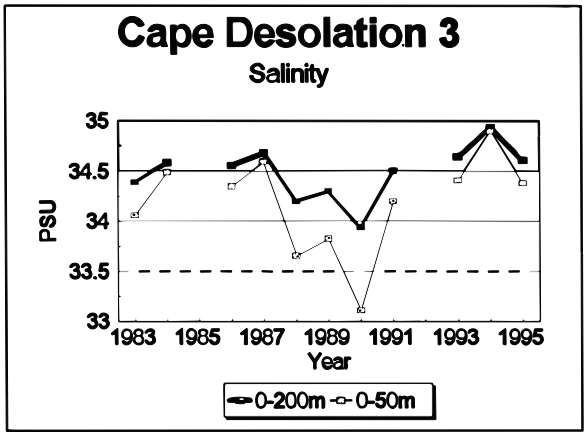
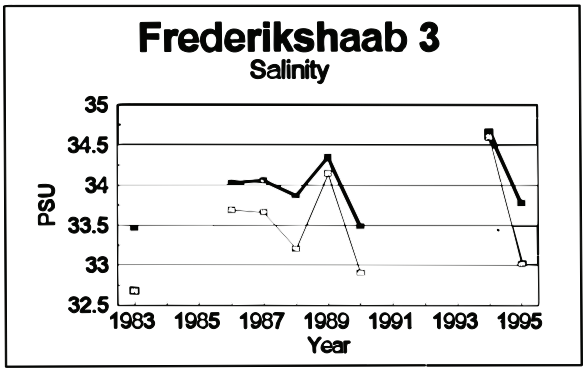
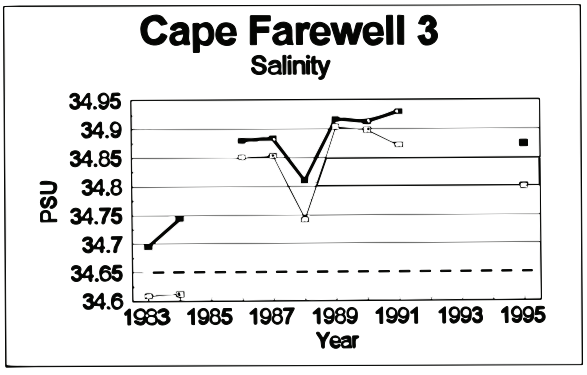


Fig. 13. Time series of temperature at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983–95) for surface layers 0–50 m, 0–200 m.







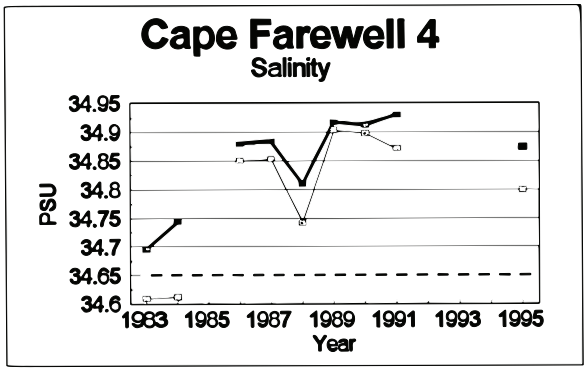
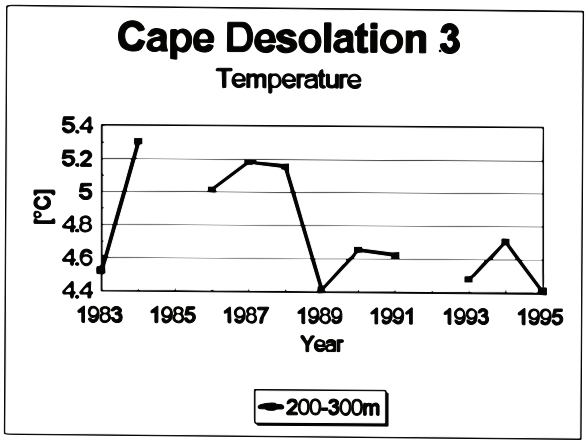
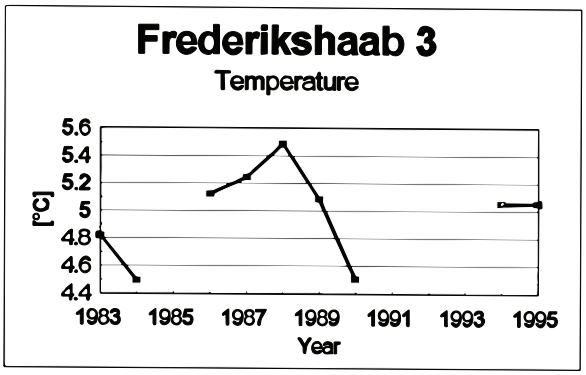
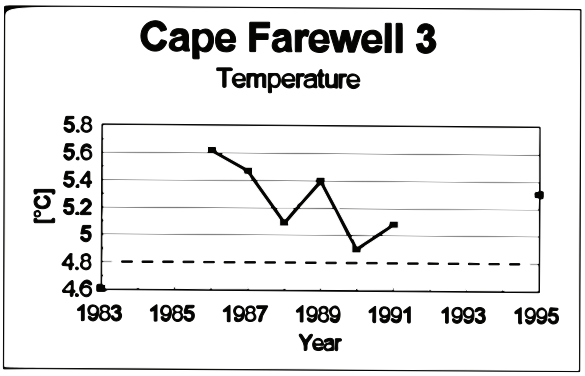


Fig. 14. Time series of salinity at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983–95) for surface layers 0–50 m, 0–200 m.







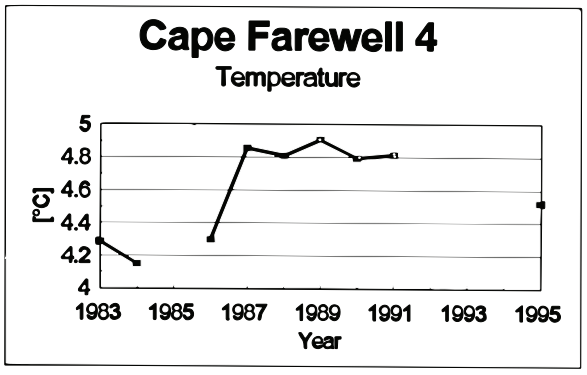
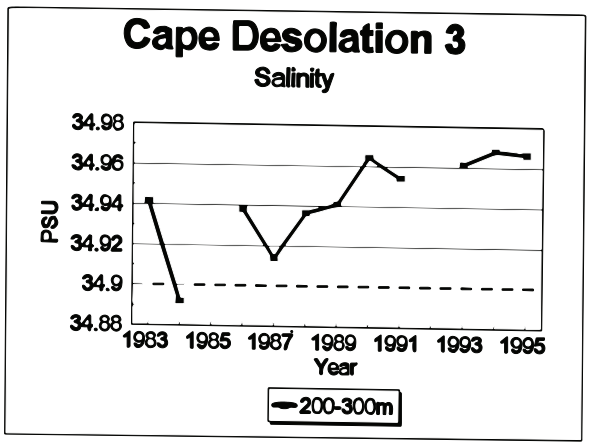
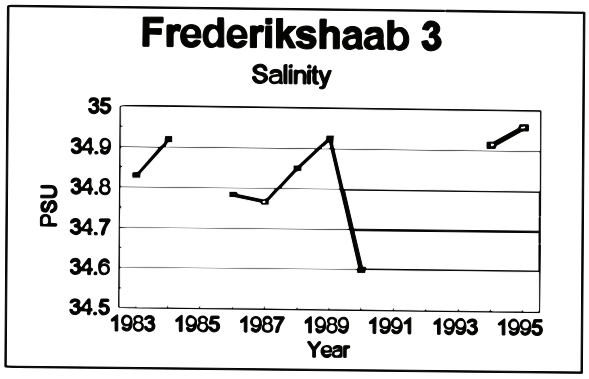
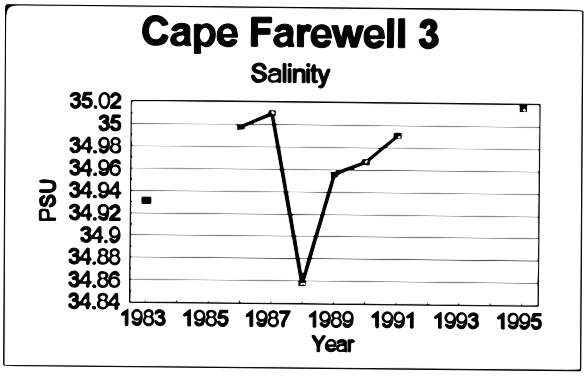


Fig. 15. Time series of temperature at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983–95) for Irminger layer 200–300 m.







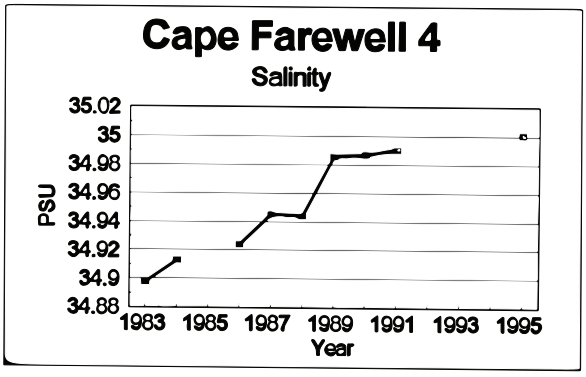


Fig. 16. Time series of salinity at Standard Oceanographic Stations Cape Desolation 3, Frederikshaab 3, Cape Farewell 3 and 4 (1983–95) for Irminger layer 200–300 m.

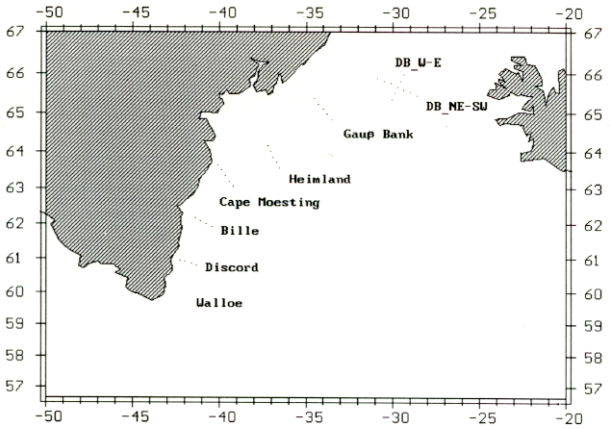


Fig. 17. Location of national standard sections off East Greenland.

Discussion

For the first time since June 1994, April 1995 air temperature anomalies showed positive conditions for the area West Greenland–Davis Strait–Baffin Bay (Fig. 2). In the area north of Ellesmere Island and Greenland, anomalies exceeded 9K, in the area south of the Canadian Archipelago, air temperatures in April indicated warming which amounted to 8K above normal (1961–90).

The west coast of Greenland which indicated negative anomalies for several years, experienced a mild early-summer. August conditions (Fig. 4, 5) for the first time since March 1995, revealed negative anomalies which covered 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, see also Fig. 4, 5 and 6).

Along the northern rim of numerous low pressure systems off Newfoundland, eastern winds very often advected mild air of 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 was no indication of a change of the long-term negative trend of the climatic conditions at West Greenland (see Fig. 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 revealed colder than normal surface water layers

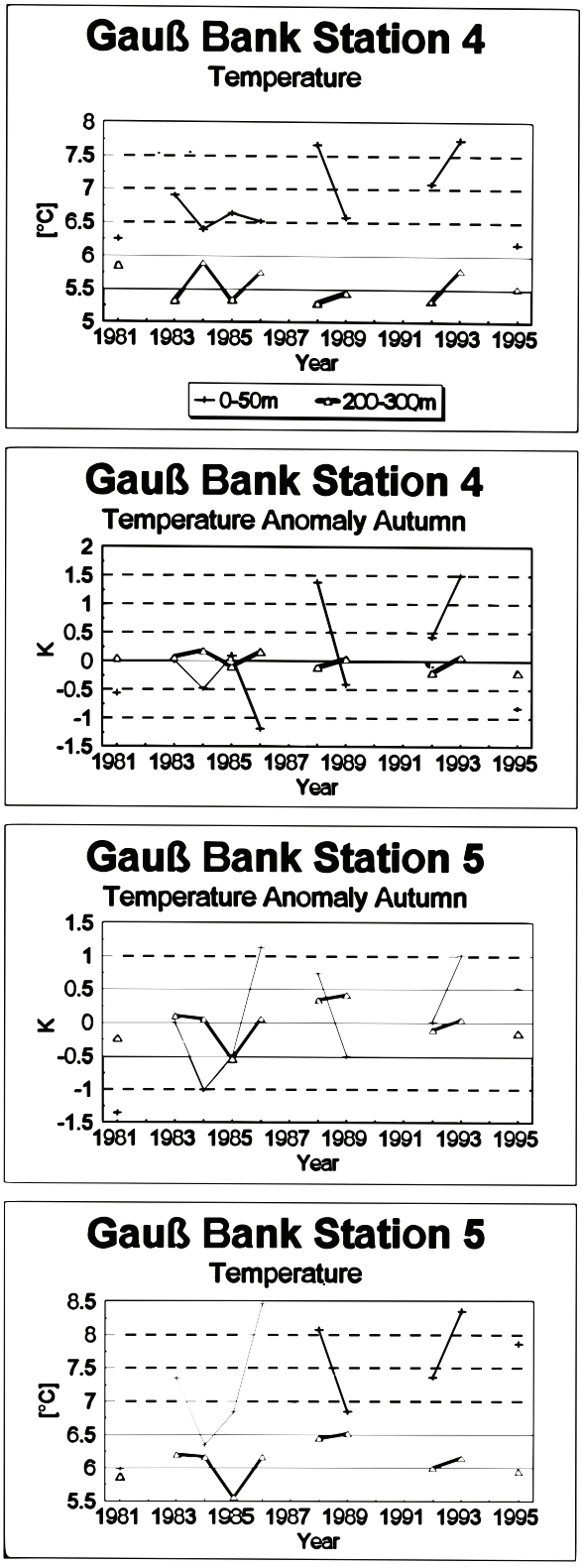


Fig. 18. Time series of temperature and temperature anomaly at standard stations Gaus Bank 4 and 5 for surface layers 0–50 m and Irminger Water Layer 200–300 m.

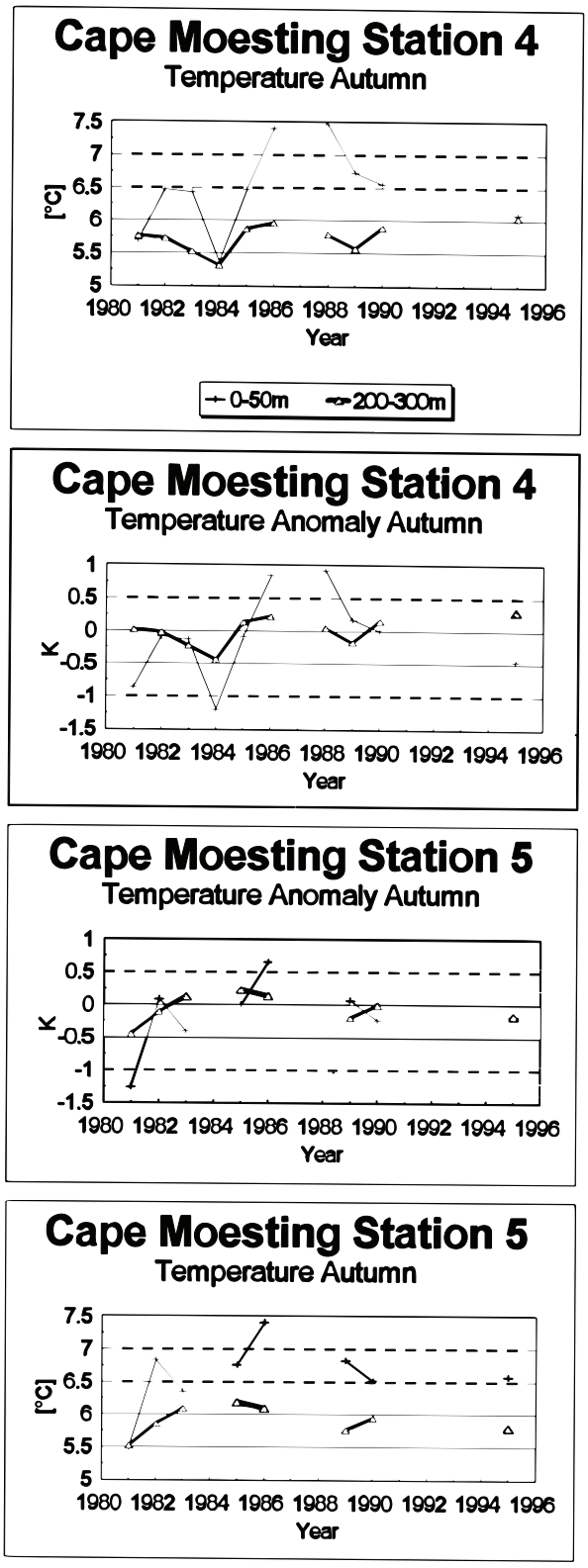


Fig. 19. Time series of temperature and temperature anomaly at standard stations Cape Moesting 4 and 5 for surface layers 0–50 m and Irminger Water Layer 200–300 m.

(0–50 m, and 0–200 m) 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 (200–300 m) off Southwest Greenland revealed high salinities around 35 PSU at the southeastern entrance to the Labrador Sea (Cape Farewell Section Stations 3 and 4). 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, yielded cold conditions in the early- to mid-1980s, warm conditions from 1987 throughout 1991, and once again colder conditions for the 1995 autumn observations. Unfortunately, the gap of observations between 1992 and 1994 did 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 indicated lower than normal levels of temperature for the early-1990s. This might suggest that after a four to five year long period of warm conditions, 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, revealed 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 (200–300 m) nor in the near-surface layer (0–50 m).

An estimate of thermohaline trends at Fylla Bank Station 4 revealed a decline of the near-surface signal of both temperature and salinity. However, below 50 m depth the trend reversed, and an increase of salinity has been observed since 1992 persisted. The thermal signal at 100 m and 200 m depth remained, similar to the previous years, at a level of about 4°C. In general, this estimate corroborated with the above statement, that hydrographic conditions in the advective layer were not favourable for cod recruitment in 1996.

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