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Variation of Salt and Heat Flow in West Greenland Waters

by

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Abstract

Short time-series along deep-water standard oceanographic sections Cape Farewell, Cape Desolation and Frederikshaab are analyzed for changes in the surface layer (0-50m), and in the Irminger layer (200-300m). The surface layer reveals concurrent signals in temperature and salinity which indicates presence of East Greenland type polar water. Data from the subsurface layer indicate increased inflow of Irminger type water to the West Greenland region.

Introduction

West Greenland waters obtain their heat input from solar radiation and from the Irminger component of the West Greenland Current system (**BUCH, 1982; STEIN and BUCH, 1985**). Seasonal changes of heat transfer from atmosphere to ocean (ocean to atmosphere) and changes in the advective component of heat flow into West Greenland waters were considered by **BUCH (1987)** on a theoretical basis. Accordingly, the core of the Irminger component is found at depths between 200m and 300m. Based on a time-series of deep CTD-profiles at NAFO Standard Oceanographic Stations (**STEIN, 1988**), the present paper gives an estimate of variation in the advective part of heat input to the West Greenland waters.

The Data

During the annual autumn groundfish surveys to the area off West Greenland RV"Walther Herwig" worked along NAFO Standard Oceanographic Sections Cape Farewell, Cape Desolation and Frederikshaab (Fig. 1). All CTD-profiles were obtained with the same device, a regularly calibrated CTD of KIEL-Multisonde type. Water samples were taken by means of a Rosette water sampler at depth intervals of about 500m below 500m depth. Temperature readings were checked against reversing thermometers. Salinity was determined with a GUILDLINE-Autosal salinometer. The data set covers the years 1983 to 1989 with the exception of 1985, where the deep water sections were not performed. The temperature/salinity profiles were reduced to North Atlantic standard depths data to perform anomaly calculation for the water layers under consideration, i.e. the surface layer (0-50m), and the Irminger layer 200m-300m. Mean anomaly of these layers was used to plot the variation of heat and salt input to the waters off West Greenland.

Results

Figures 2 to 5 display the temperature and salinity anomalies at individual standard stations along NAFO Standard Oceanographic Sections Cape Farewell (a), Cape Desolation (b), and Frederikshaab (c, d). Numerical results of the anomaly calculation are given in Table 1 for the surface layer (0-50m), and for the Irminger layer (200-300m).

Table 1 Mean values of temperature and salinity for the surface layer (0-50m), and for the Irminger layer (200-300m)

Station	Temperature 0-50m/200-300m [°C]	Salinity 0-50m/200-300m [PSU]
C.F.4	5.58/4.70	34.753/34.928
C.D.3	3.35/4.94	34.157/34.927
Fr. 4	3.16/4.92	34.015/34.902
Fr. 3	2.46/5.05	33.607/34.840

C.F.: Cape FarewellSection; C.D.: Cape Desolation Section; Fr.: Frederikshaab Section

Fig. 2a indicates surface layer warming at Cape Farewell Station 4 which is apparent since 1986. From a mean temperature of 5.6°C, the cold early eighties **(BUCH and STEIN, 1989; STEIN and BUCH, in press)** deviate by more than 1°K. The Irminger layer at this station site behaves similarly, with positive anomalies since 1987 (fig. 3a). A completely different thermal trend was recorded at Cape Desolation Station 3 (figs. 2b, 3b) with positive anomalies from 1984 to 1988 and negative anomalies observed during 1983 and 1989, which were about 0.5°K below the mean value (c.f. table 1). Further north, at Frederikshaab Bank, the thermal trends at neighbouring stations 3 and 4, being about 30 km apart, differ in both layers (figs. 2c,d and 3c,d). Whereas both stations map the cold early eighties, the interannual change differs considerably from station to station.

Salinity indicates similar trends at Cape Farewell Station 4 (figs. 4a, 5a) in the surface layer and in the Irminger layer. Negative anomalies were observed from 1983 to 1986 which amounted to 0.04 PSU below the mean value in the deeper layer, whereas the variability in the surface layer was three times larger in 1983 and 1984 (-0.14 PSU). The cooling trend at Cape Desolation Station 3 was accompanied by low salinities during 1988 and 1989 (fig. 4b). This trend was, however, not observed in the deeper Irminger layer (fig. 5b) which indicates slight increase in salinity by about 0.01 PSU. It would appear that this surface layer signal originates from increased transport of icebergs from East Greenland origin to the area of Julianehaab bight, as observed during 1989. At Frederikshaab Bank Stations 4 and 3 the surface salinity trends follow the thermal trends (figs. 4 c,d), the Irminger layers indicate increase in salinity by as much as 0.05 PSU (fig. 5c) and 0.09 PSU (fig. 5d).

Discussion

It would appear that the surface layer (0-50m) reflects trends in temperature and salinity in a similar way: cooling is accompanied by dilution of the surface waters. This might reflect that the surface layer is mostly influenced by the "cooling" and "diluting" factors of this region, i.e. ice, and the regime of the cold East Greenland component of the West Greenland Current system. Especially Cape Desolation Station 3 reveals the injection of cold and diluted polar water of East Greenland origin in the 1988 and 1989 observations. During the 1989 autumn season there were anomalous amounts of icebergs in the southwest sector off West Greenland with a distinct cut-off in the distribution of bergs south of Frederikshaab glacier. However, wind-induced lateral shifting of water mass boundaries which occur on time-scales of hours may also lead to these observed interannual changes (**STEIN and BUCH, 1985; STEIN, 1989; STEIN, 1990**).

In the Irminger layer (200-300m), only at the southern boarder of the West Greenland region there is a similar trend in both the thermal and the haline signal. It indicates increased inflow of Irminger water to the West Greenland waters. Although the remainder of the stations indicate positive anomalies for the years 1988 and 1989, both signals behave differently.

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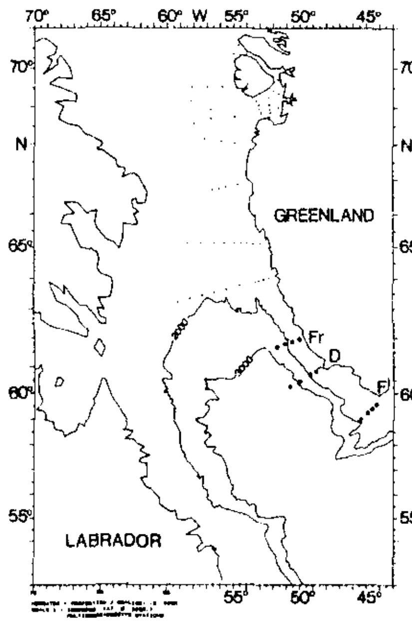

Fig. 1 Location of Deep Water Sections (F: Cape Farewell; D: Cape Desolation; Fr: Frederikshaab)

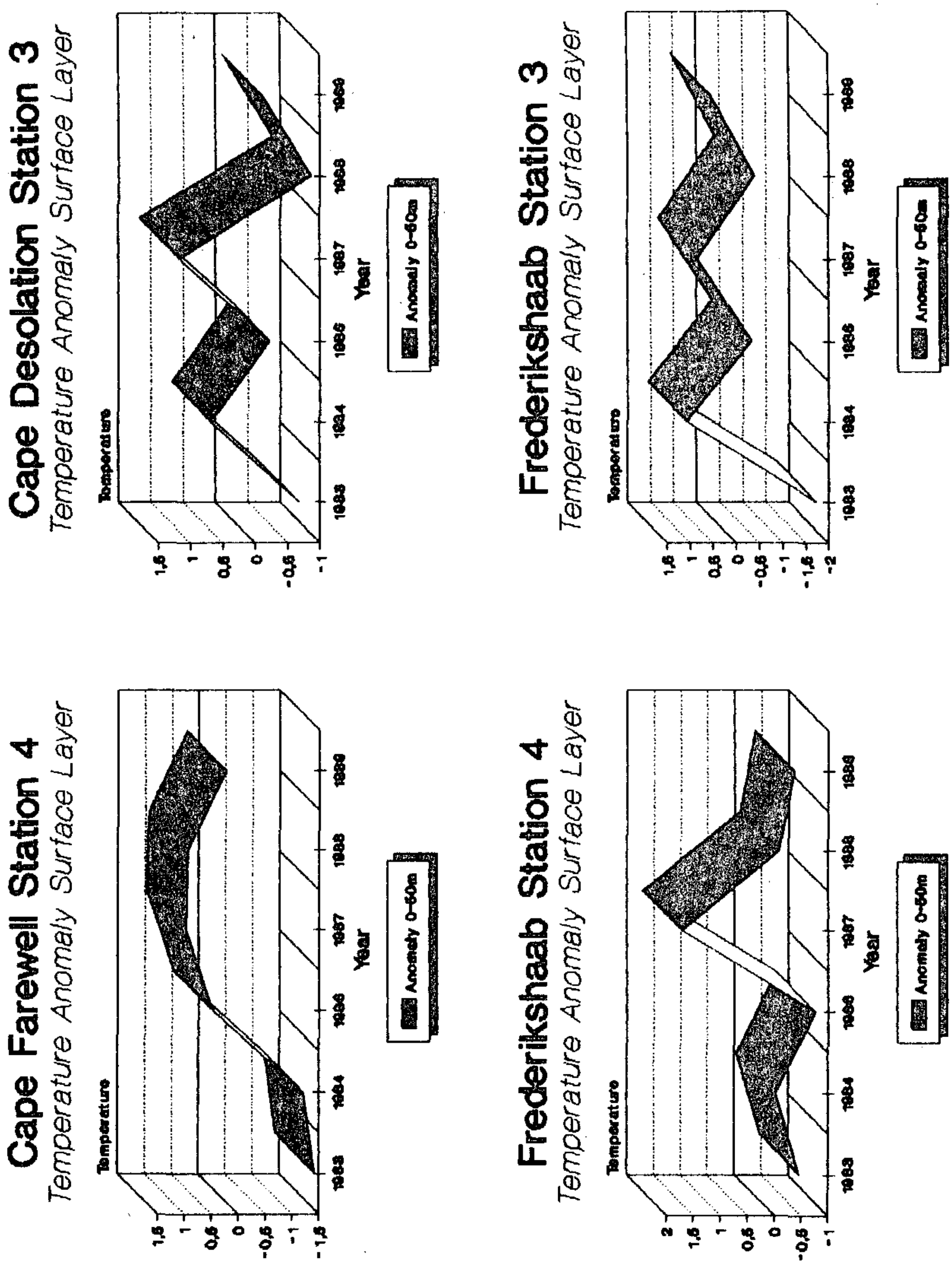

Fig.2 Temperature Anomaly Surface Layer (0-50m); a: Cape Farewell Station 4; b: Cape Desolation Station 3; c: Frederikshaab Station 4; d: Fredrikshaab Station 3

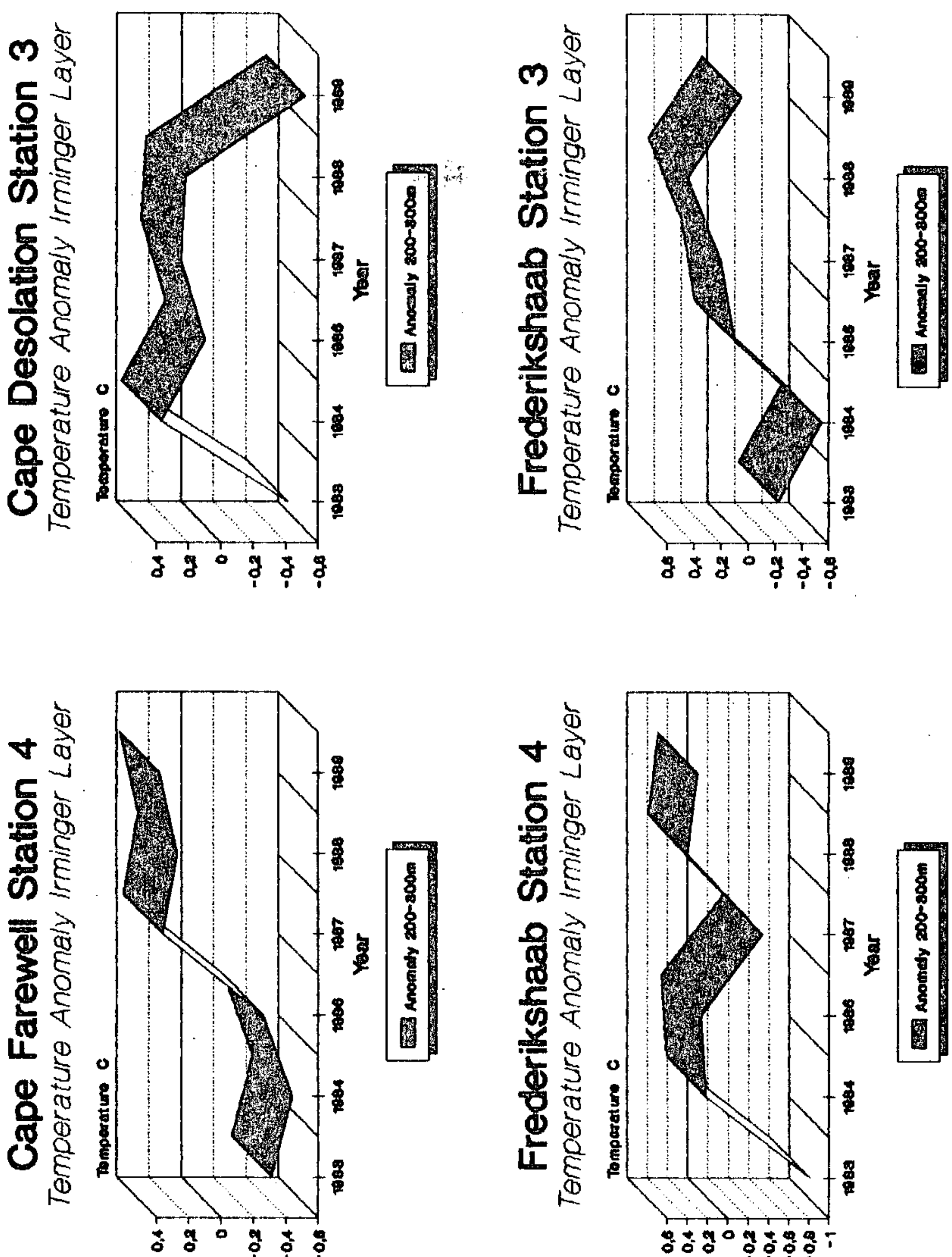

Fig.3 Temperature Anomaly Irminger Layer (200-300m); a: Cape Farewell Station 4; b: Cape Desolation Station 3; c: Frederikshaab Station 4; d: Fredrikshaab Station 3

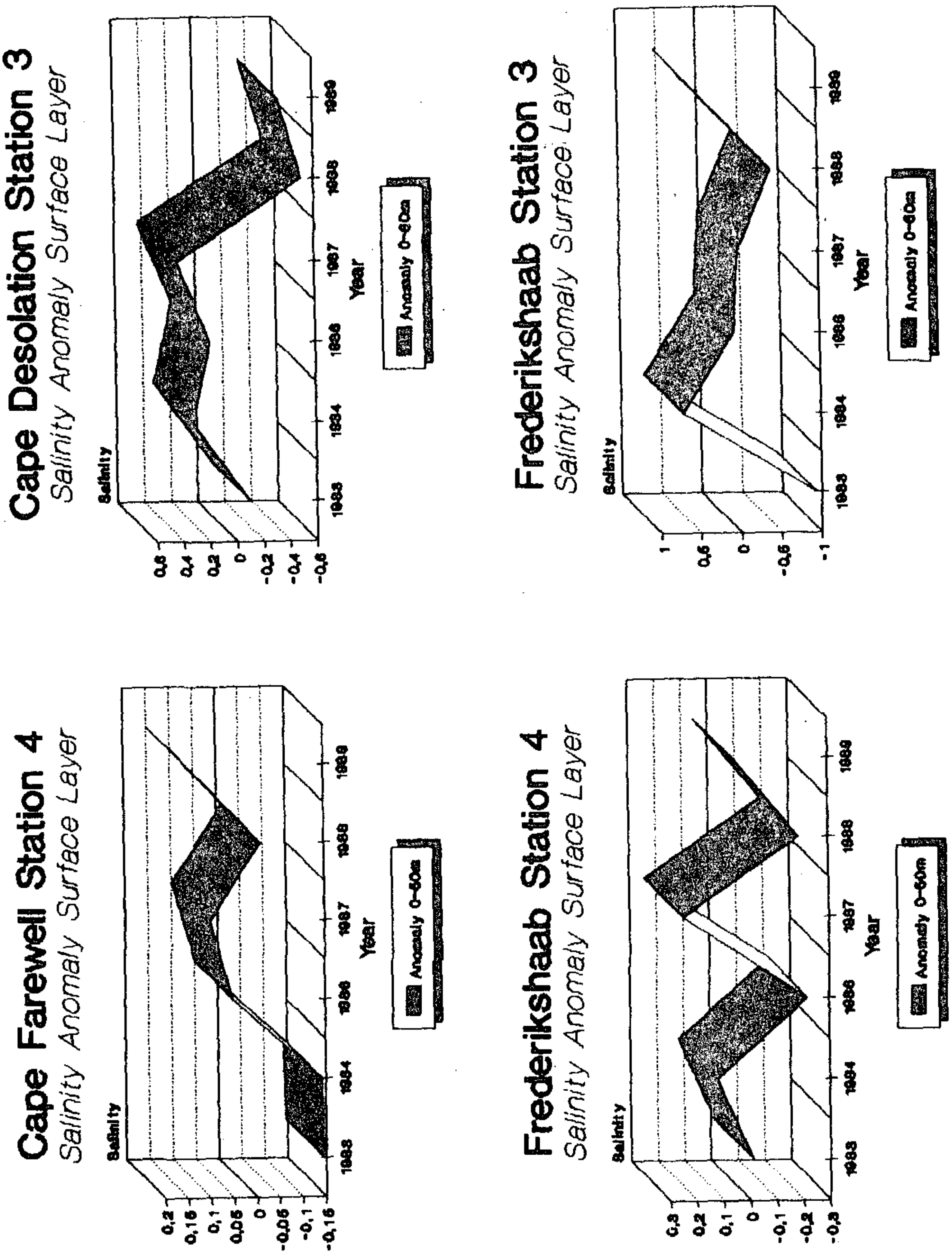

Fig.4 Salinity Anomaly Surface Layer (0-50m); a: Cape Farewell Station 4; b: Cape Desolation Station 3; c: Frederikshaab Station 4; d: Fredrikshaab Station 3

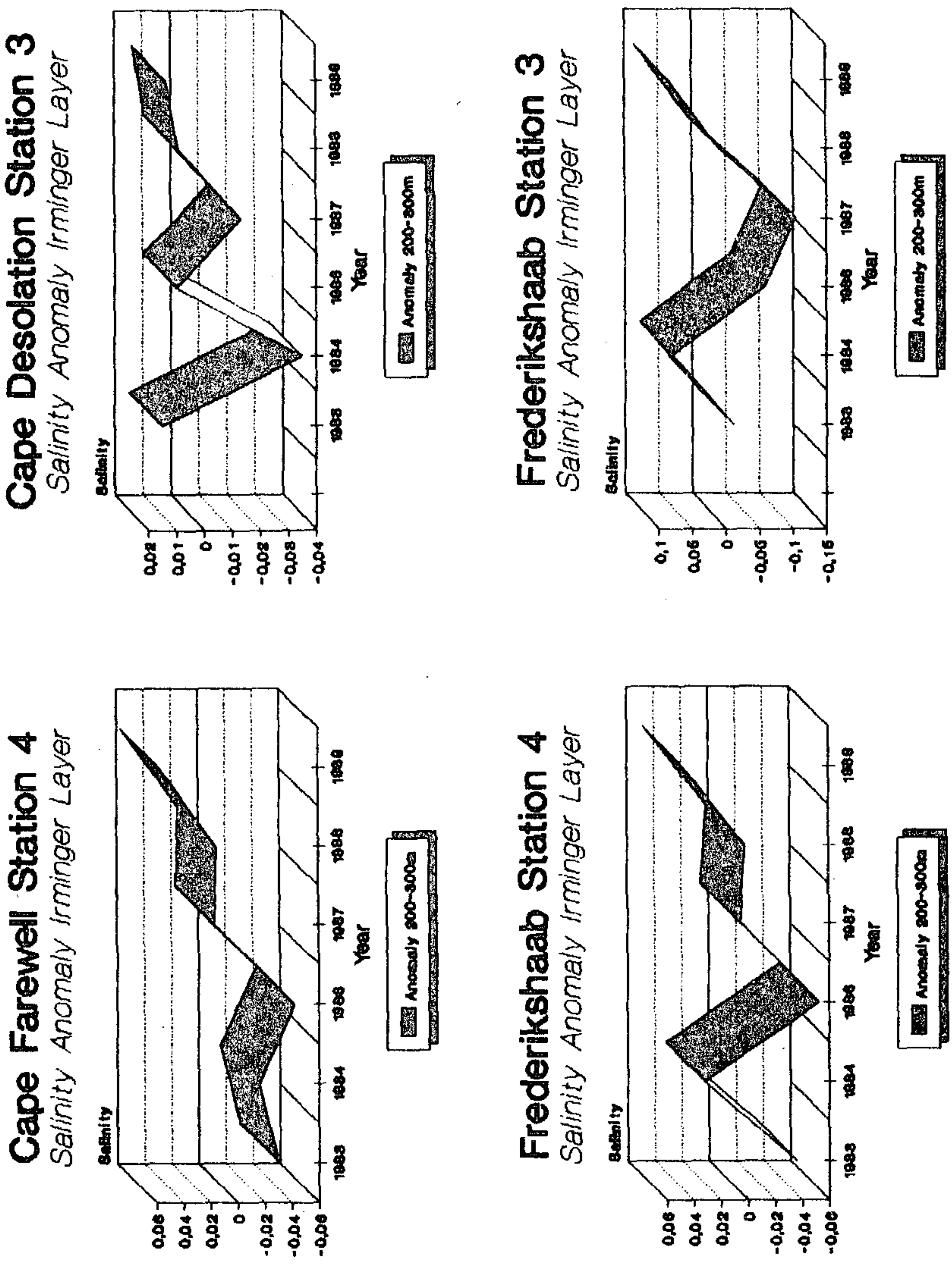

Fig.5 Salinity Anomaly Irminger Layer (200-300m); a: Cape Farewell Station 4; b: Cape Desolation Station 3; c: Frederikshaab Station 4; d: Fredrikshaab Station 3