Northwest Atlantic Fisheries Organization

Serial No. N4213 **NAFO SCR Doc. 00/1**

SCIENTIFIC COUNCIL MEETING – JUNE 2000

Oceanographic Investigations off West Greenland, 1999

by

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February 2000

Abstract

The paper describes the results of the annual summer cruise to the standard sections along the west coast of Greenland. The climate over Greenland has in recent years been fairly mild due to the low North Atlantic Oscillation (NAO) Index experienced in this period. The oceanographic conditions in the surface showed temperatures 1°C above normal on top of Fylla Bank, while the salinity was slightly above normal. The inflow to Irminger water was relatively weak in 1999 while the modificed Irminger water was widely present in the area.

1. Introduction

The climatic conditions at West Greenland had been relatively mild in the second half of the 1990s. The annual mean air temperature anomalies at Nuuk, the capital of Greenland, have shown positive values since 1995, Fig. 1.

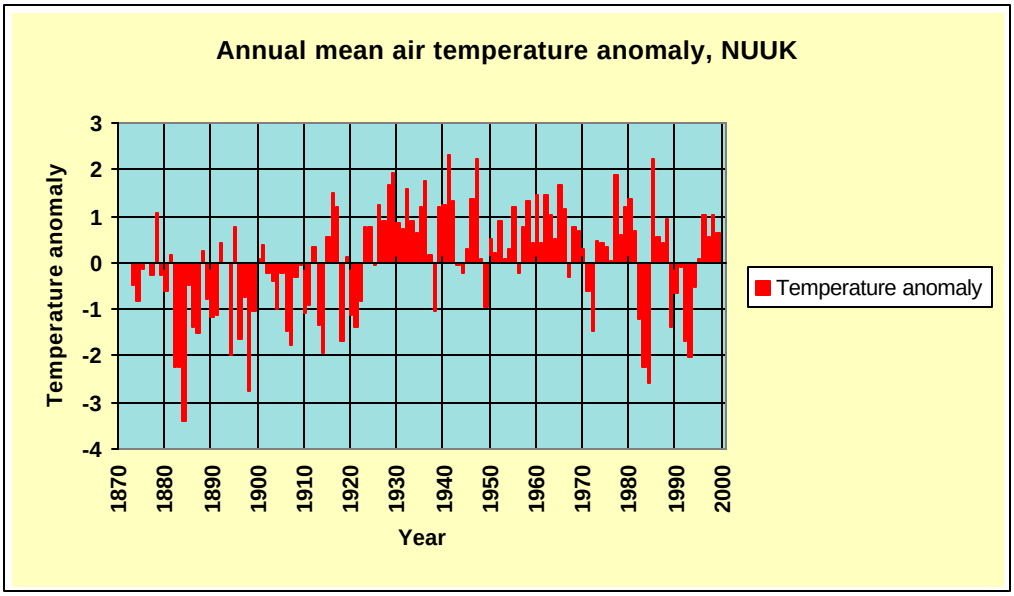

Fig. 1. Anomaly in the annual mean air temperature observed at NUUK for the period 1873 to 1999. The anomaly is taken relative to the mean temperature for the whole period

As discussed by Buch (1998) the air temperatures over Greenland are closely coupled to the strength of the North Atlantic Oscillation (NAO), which refers to a meridional oscillation in the atmospheric mass with centres of action near the Iceland Low and the Azores High (van Loon and Rogers, 1978). A high NAO

index will therefore result in cold conditions in the Greenland area, while a low NAO index value means relatively mild climatic conditions.

The NAO index has been high since 1980, the values observed in 1983, 1989 and in 1990 being the highest recorded since 1863, and these years were some of the coldest ever experienced in Greenland. In 1996, however, the NAO index shifted from high to low values and a milder climate is therefore now present in the Greenland region, Fig.2.

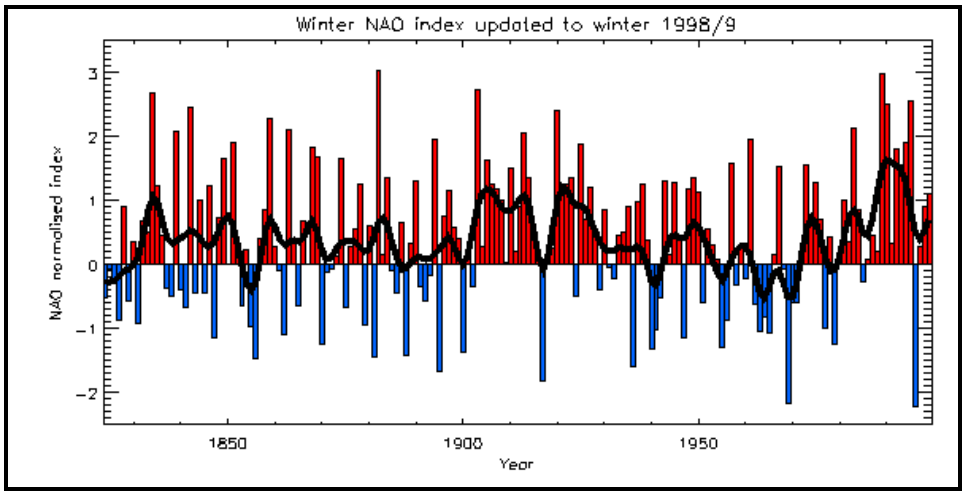

Fig. 2. Time series of the winter NAO index (December to March average), after Jones *et al. (1997)*

The relatively mild-climatic conditions are reflected in the SST anomalies for the water surrounding South Greenland. Figure 3 shows monthly mean SST anomalies for the month of July 1999 - the period of the cruise with TULUGAQ.

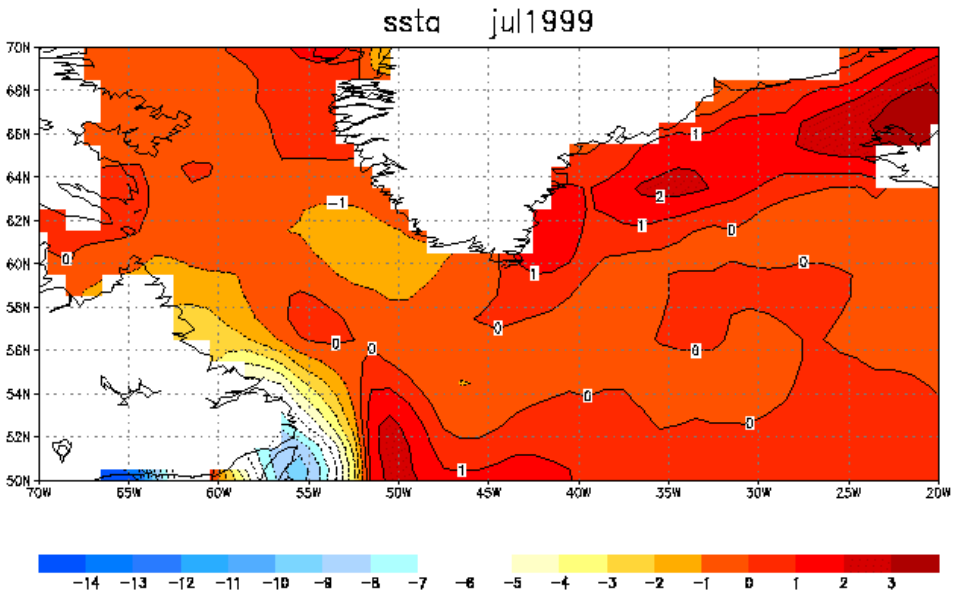

Fig. 3. Monthly mean SST anomalies in the water around South Greenland. From the NOAA AB/CPC Data Page: Servers (Climate, Weather Analyses, Weather Forecasts)

2. Measurements

The 1999 cruise was carried out according to the agreement between the Greenland Institute of Natural Resources and Danish Meteorological Institute during the period 01-10 July 1999 onboard the Danish naval ship **"TULUGAQ".** Observations was performed on the following stations (Fig. 4):

- Cape Farewell St. 1 - 5
- Cape Desolation St. 1 - 5
- Frederikshaab St. 1- 5
- Fylla Bank St. 1- 5
- Lille Hellefiske Bank St. 1 - 5
- Holsteinsborg St. 1 - 5

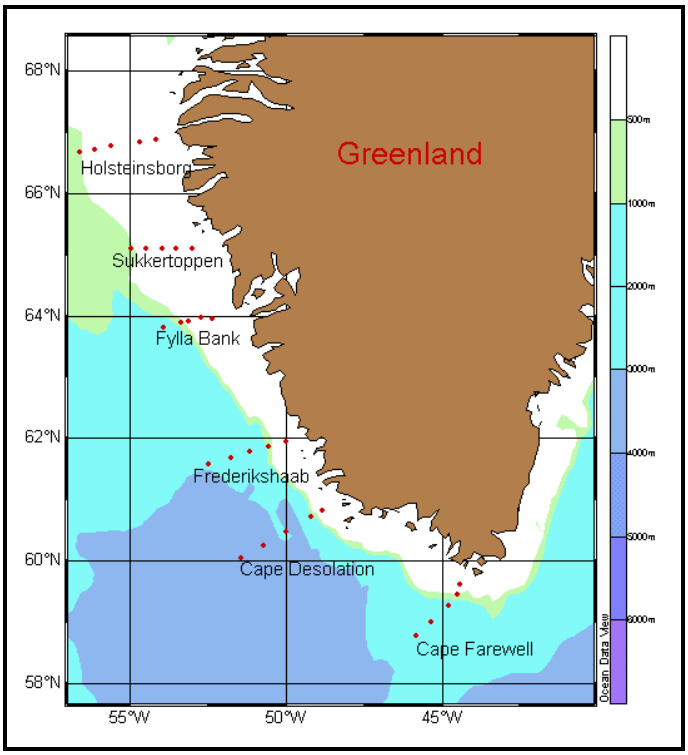

Fig. 4. Position of the standard sections off West Greenland

On each station the vertical distributions of temperature and salinity was measured from surface to bottom, except on stations with depths greater than 700 m where 700 m was the maximum depth of observation.

The cruise was blessed with favourable weather and ice conditions. "Vestice" was not present at the Holsteinsborg section. At the innermost 3 station of the Cape Farewell section "Storis" was present; but fortunately not in quantities preventing the measuring program being carried out except for the innermost station, which was observed approximately 9 nm to the north of its position (Fig. 5).

3. Data handling

Measurements of the vertical distribution of temperature and salinity was carried out using a SEABIRD SBE 9-01 CTD. For the purpose of calibration of the conductivity sensor of the CTD, water samples were taken at great depth on stations with depths greater than 500 m. The water samples were after the cruise analysed on a Guildline Portosal 8410 salinometer.

The CTD data were analysed using SEASOFT 4.217 software provided by SEABIRD.

All quality controlled data are stored in the Marine Database at the Danish Meteorological Institute from where copies have been sent to ICES and MEDS.

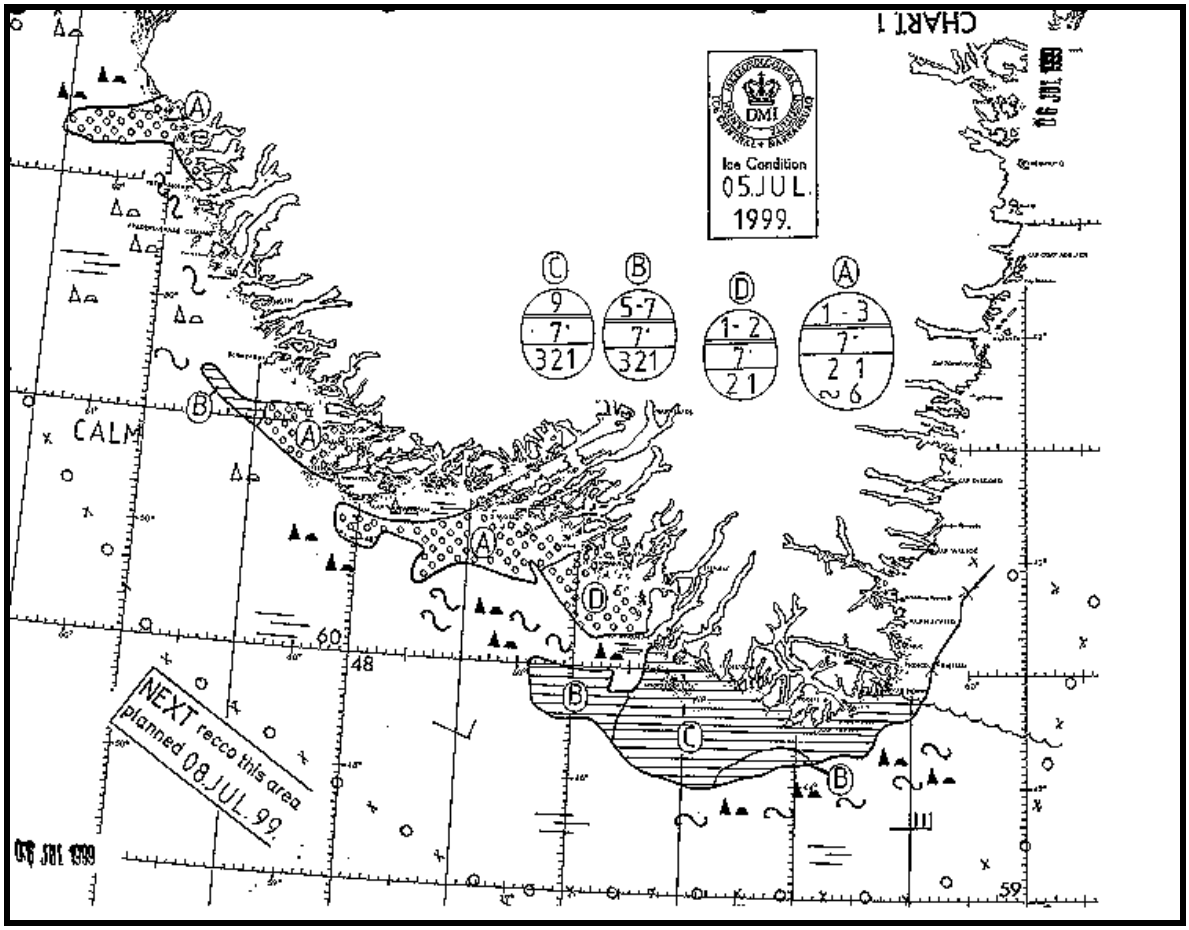

Fig. 5. Distribution of sea ice in the Cape Farewell region 5 July 1999

4. Oceanographic conditions off West Greenland in 1998

The mean temperature and salinity on top of Fylla Bank in the middle of June are shown in Fig. 6 a, b. The 1999 value was well below the 1998 the record high value observed in 1998; but the 1999 temperature (2.6°C) is, however, among the highest 5 temperatures observed since the start of the time series in 1950, and thereby also well above the average value of 1.67°C for the whole 50 year period.

The 1999 mean salinity value (33.48 psu) on top of Fylla Bank (Fig.6b) was slightly lower than in 1998, but still slightly above the average value of 33.40 psu.

The surface temperatures and salinity's observed during the 1999 cruise are shown in Figs. 7. The cold and low salinity conditions observed off southwest Greenland indicates a inflow of Polar Water carried to the area by the East Greenland Current. The low temperatures found in the northwestern corner (off Holsteinsborg) indicates melting of Westice just prior to the observations. Water of Atlantic origin (T> 3°C; S> 34.5 psu) are found at surface only at the outermost station on the three southernmost sections.

The vertical distribution of temperature, salinity and density as well as TS-relations at the six observed sections are given in Fig. 8-13.

a)

b)

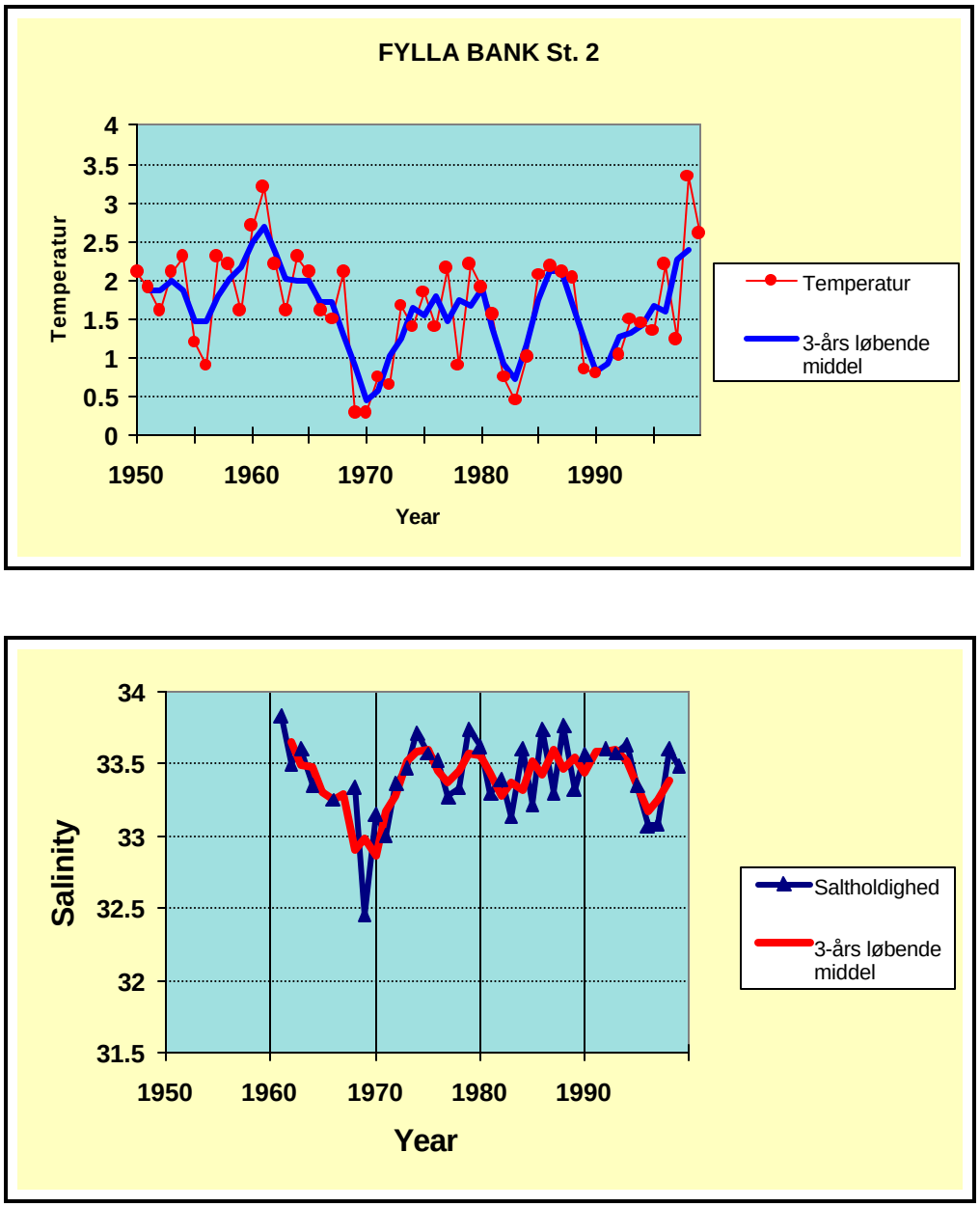

Fig. 6. Time series of
a) mean temperature (observations and 3-year running mean).
b) mean salinity (observations and 3-year running mean) on top of Fylla Bank (0-40 m) in the middle of June.

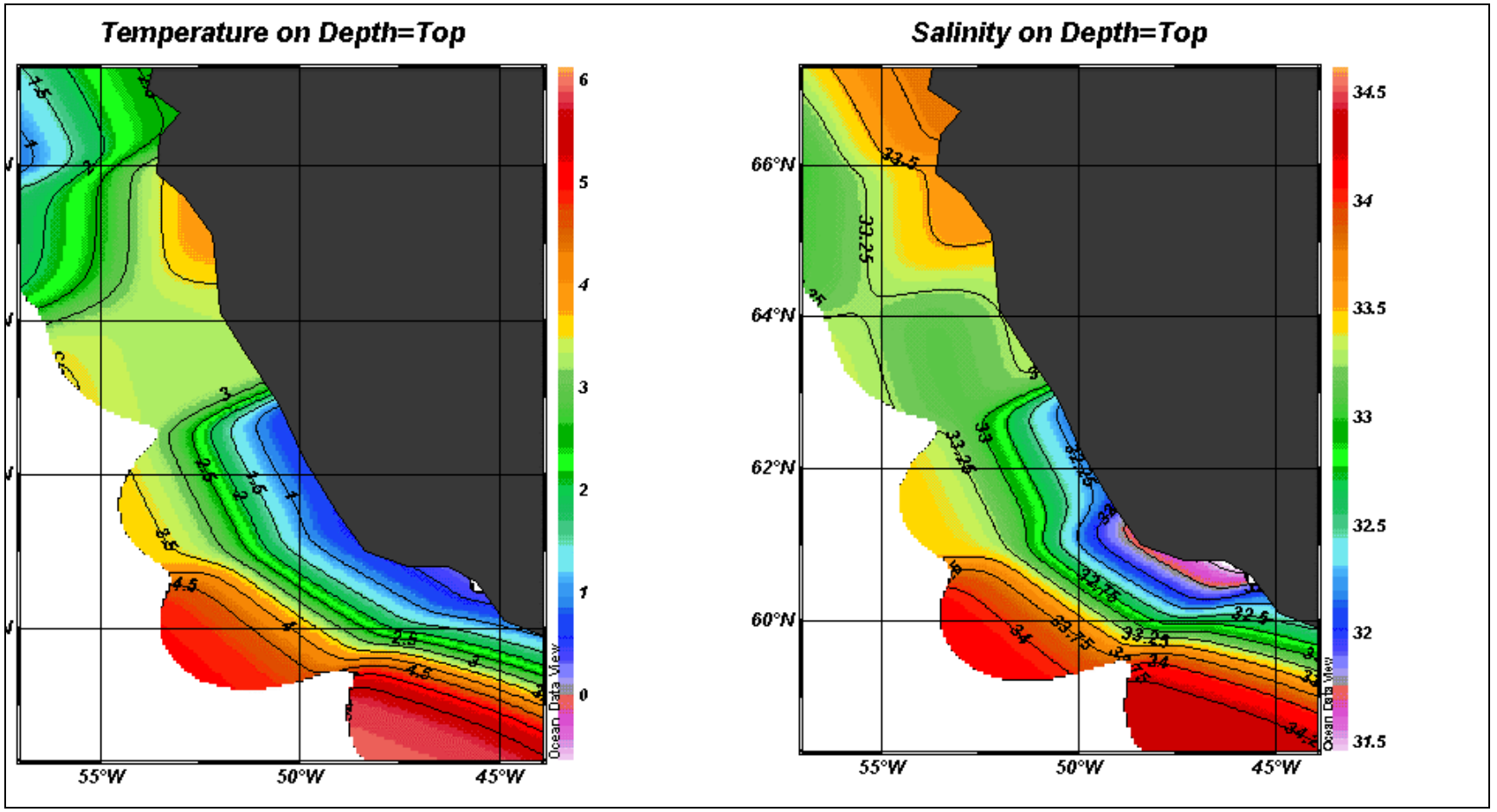

Fig. 7. Surface temperature and salinity, early-July 1999.

In the surface layer relatively strong gradients between the cold, low-saline Polar Water and the warm, high-saline water of Atlantic origin was observed from Fylla Bank and southward. North of Fylla Bank cold, low saline water was found at the westernmost stations indicating recent melting of Westice. The normally observed core of Polar Water just west of Fylla Bank at a depth of 50-150 m was almost absent in 1999.

Temperature and salinity observations at greater depth showed a relatively weak inflow of pure Irminger Water ($T \sim 4.5^{o}C$, $S > 34.95$ psu) took place in 1999. The tongue of Irminger Water did in 1999 just reach as far north as the Cape Desolation section. The core of inflowing Irminger Water was found at around 200 m's depth at Cape Farewell, where salinity values just above 35.0 psu was observed. The TS-plots show that the Irminger Water ($S>34.95$) in 1999 had temperatures between 5 and $6^{o}C$ in the Cape Farewell region, while it further north had values just above the normal $4.5^{o}C$, indicating a relative high heat content in the Irminger Water off Southeast Greenland, which can serve as an explanation to the positive SST anomalies observed in this region, Fig. 3.

Modified Irminger Water ($34.88 < S < 34.95$) was observed as far north as to the region between Lille Hellefiske Bank and the Holsteinsborg section.

Sub-Atlantic water ($3.5 < T < 4.5$; $34.5 < S < 34.88$) was observed at all six sections in 1998.

References

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van Loon, H., and J. C. Rogers. 1978. The seesaw in winter temperatures between Greenland and Northern Europe. Part 1: *General Description. Mon. Wea. Rev*., **106:** 296-310.

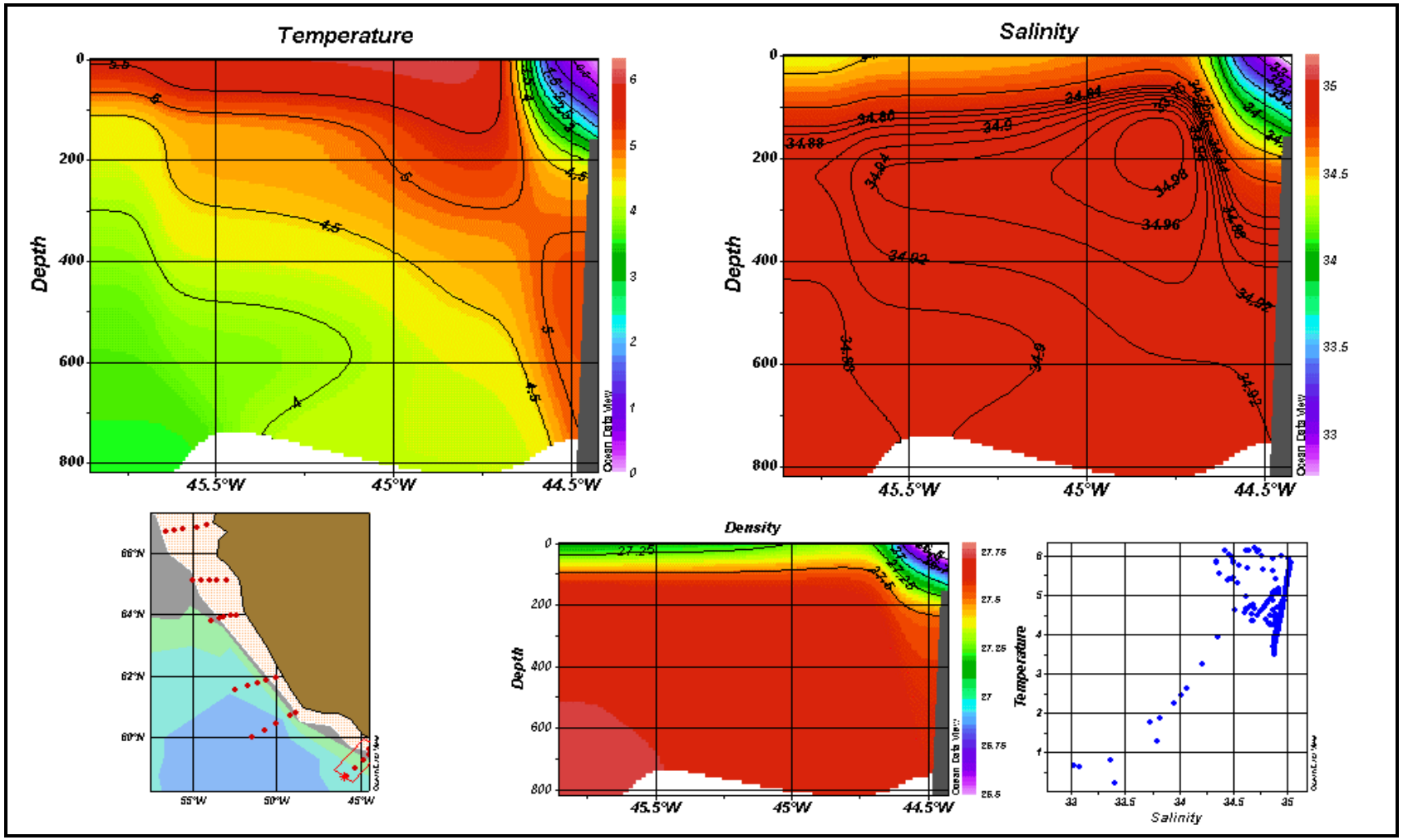

Fig. 8. Vertical distribution of temperature, salinity and density at the Cape Farewell section, 10 July 1999

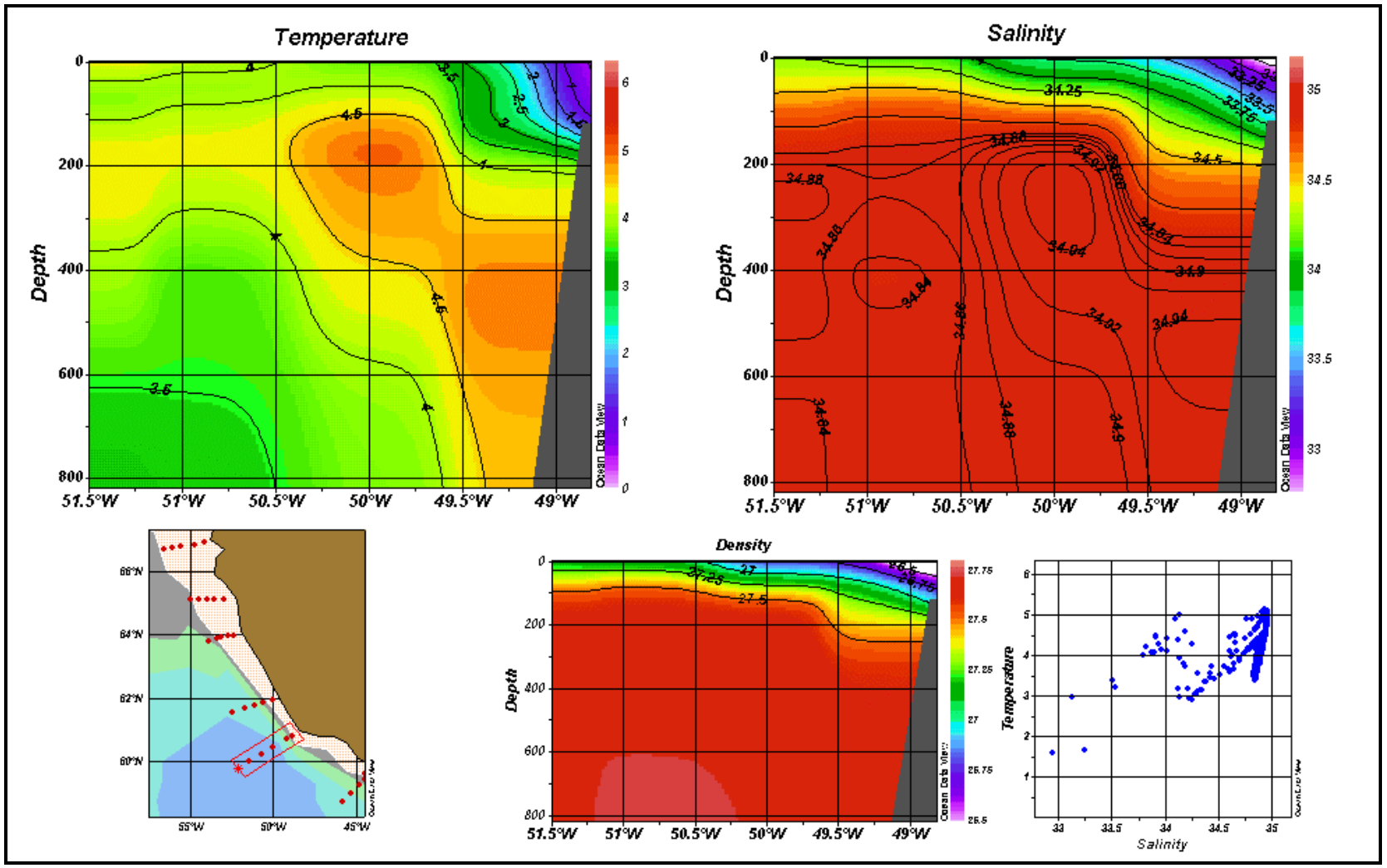

Fig. 9. Vertical distribution of temperature, salinity and density at the Cape Desolation Section, 5 July 1999.

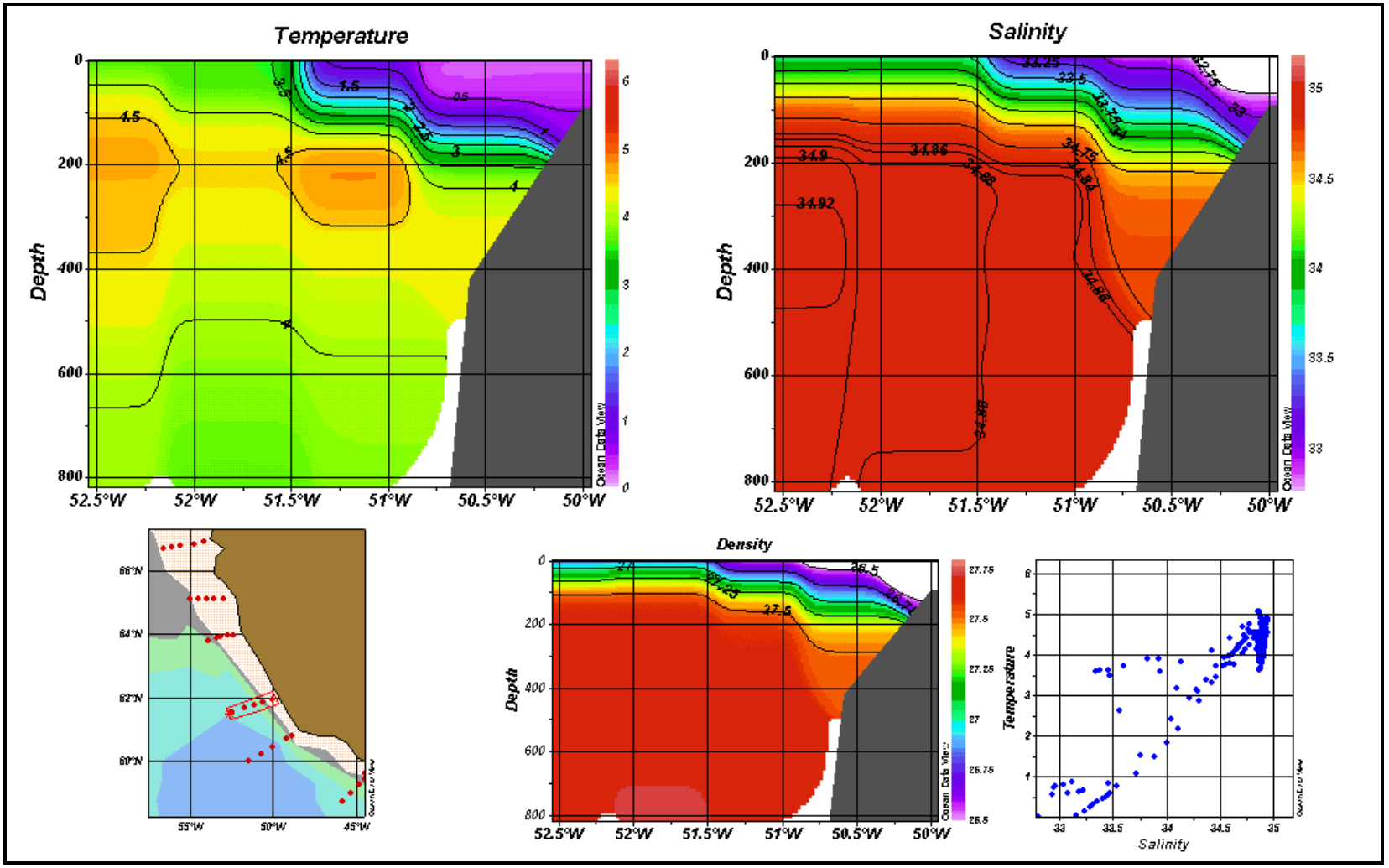

Fig. 10. Vertical distribution of temperature, salinity and density at the Frederikshaab Section, 4 July 1999.

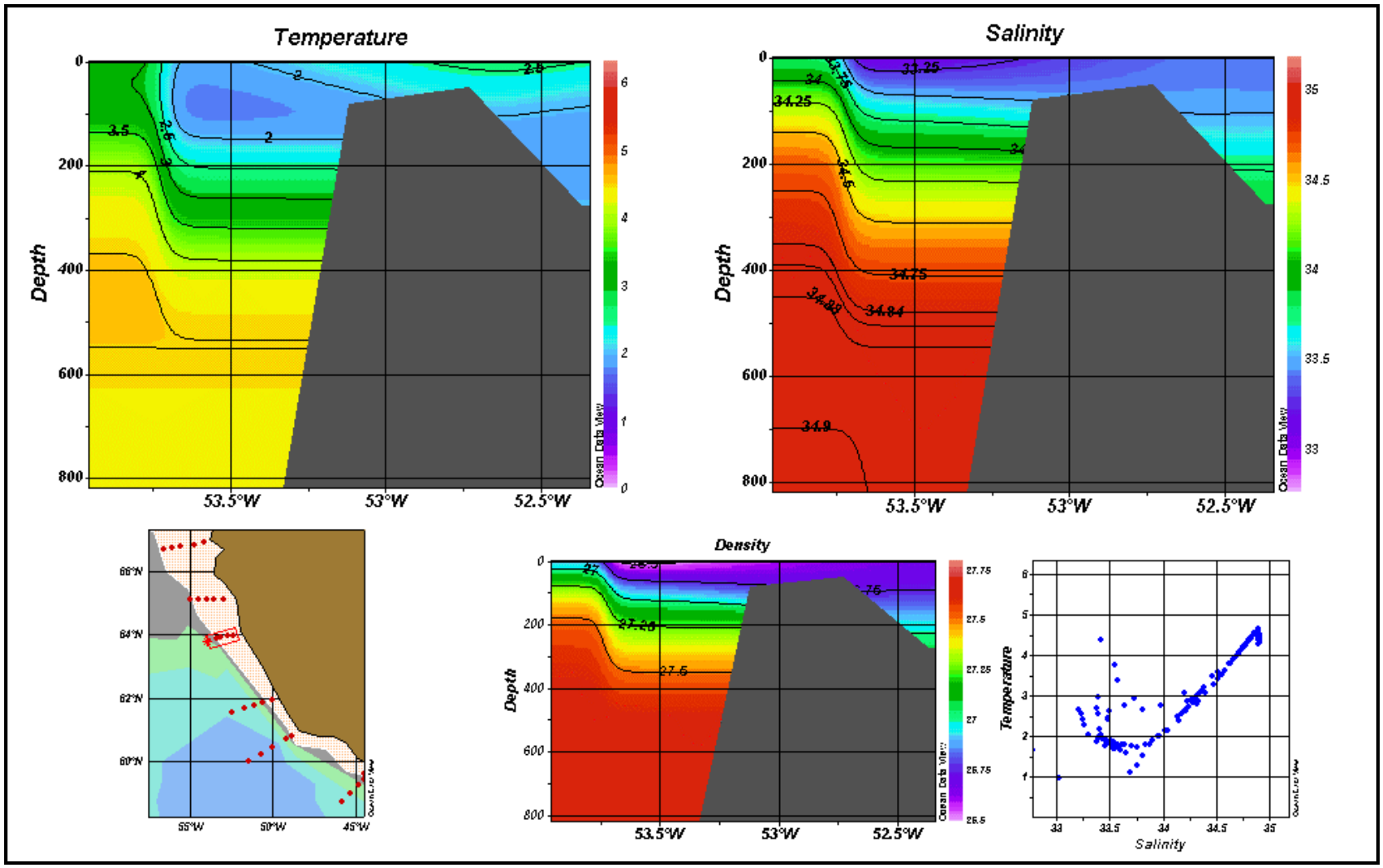

Fig. 11. Vertical distribution of temperature, salinity and density at the Fylla Bank Section, 2 July 1999.

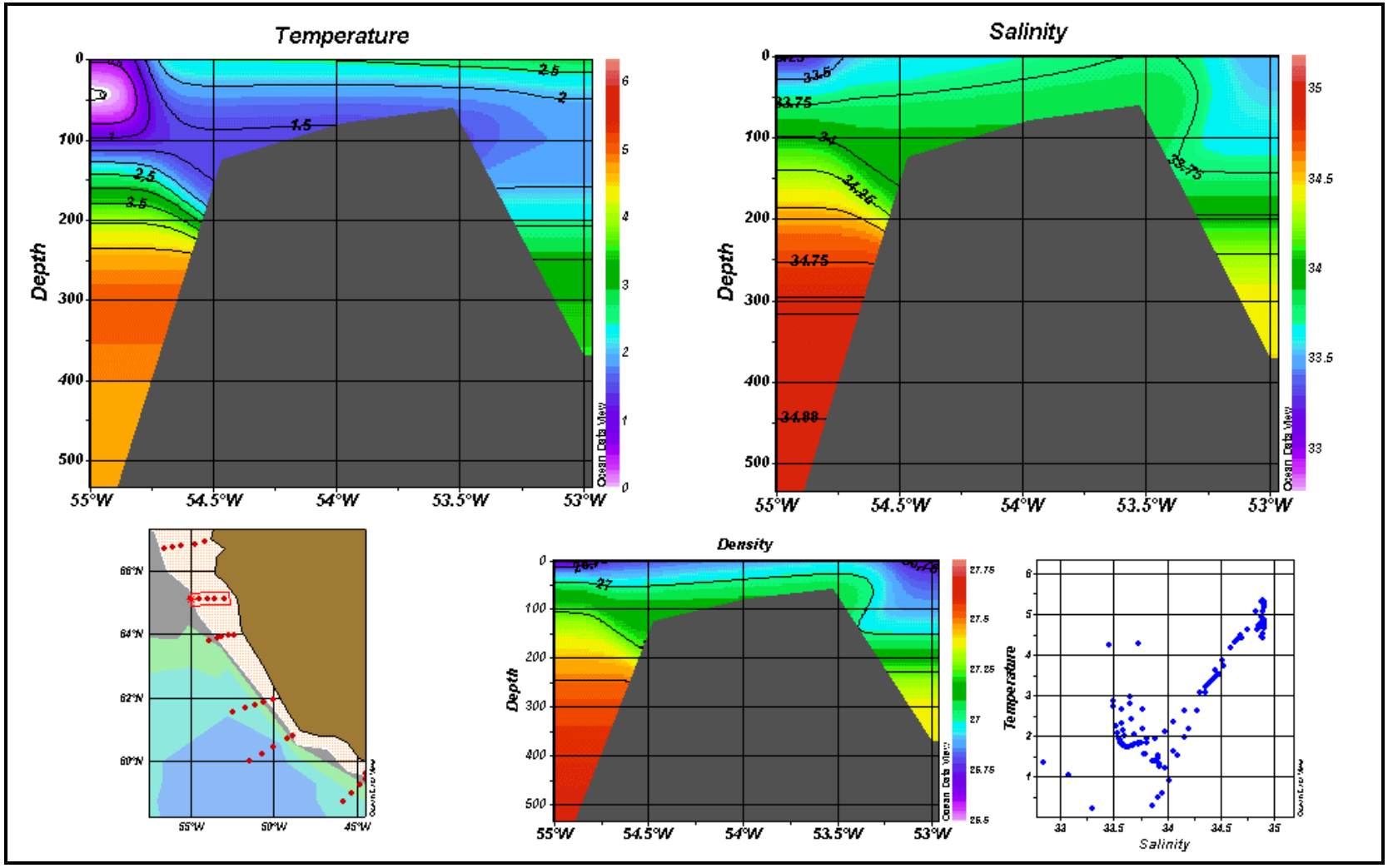

Fig. 12. Vertical distribution of temperature, salinity and density at the Lille Hellefiske Bank Section, 2 July 1999.

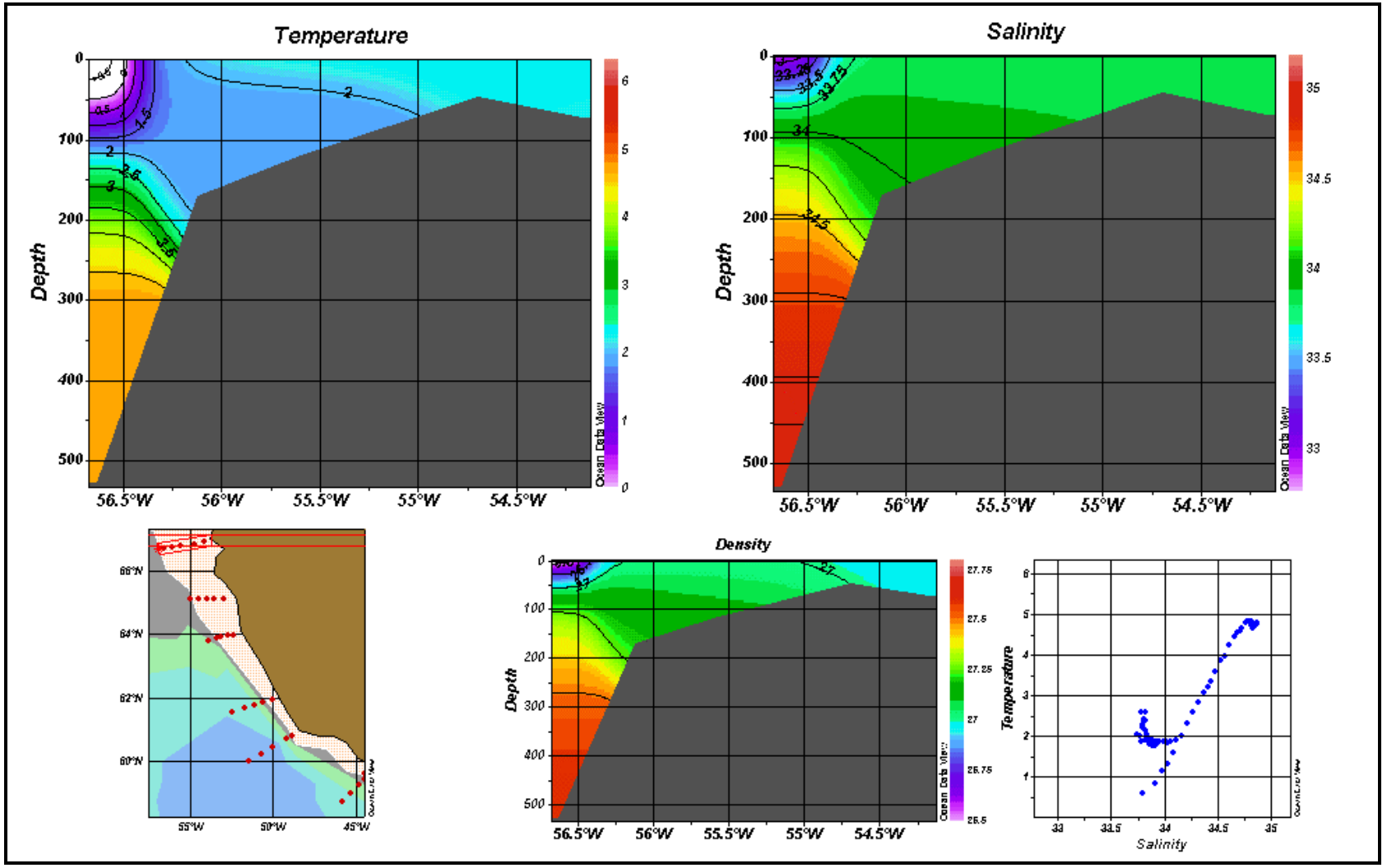

Fig. 13. Vertical distribution of temperature, salinity and density at the Holsteinsborg Section, 1 July 1999