Oceanographic Investigations off West Greenland 2002

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Abstract

Results of the summer 2002 standard section cruise along the west coast of Greenland are presented together with CTD data gathered during trawl surveys.

The time series of mid-June temperatures and salinities on top of Fylla Bank showed in 2002 similar conditions as in 2001 i.e. a year close to average conditions.

Pure Irminger Water was observed only at the Cape Farewell Section st.4, and Modified Irminger Water could be traced only as far north as the Fylla Bank section where it barely was present at st. 5. indicating a reduced inflow of Irminger Water to the West Greenland area in 2002. The inflow of Polar Water also seem to be less than normal.

1. Introduction

The North Atlantic marine climate is largely controlled by the so-called North Atlantic Oscillation (NAO), which is driven by the pressure difference between the Azores High and the Iceland Low pressure cells. Here the NAO index is calculated as the pressure difference between Ponta Delgada, Azores and Reykjavik, Iceland and normalised by the period 1961-1990. The NAO index during the 2002 was negative for the second year running although the value was approximately zero, Fig. 1.

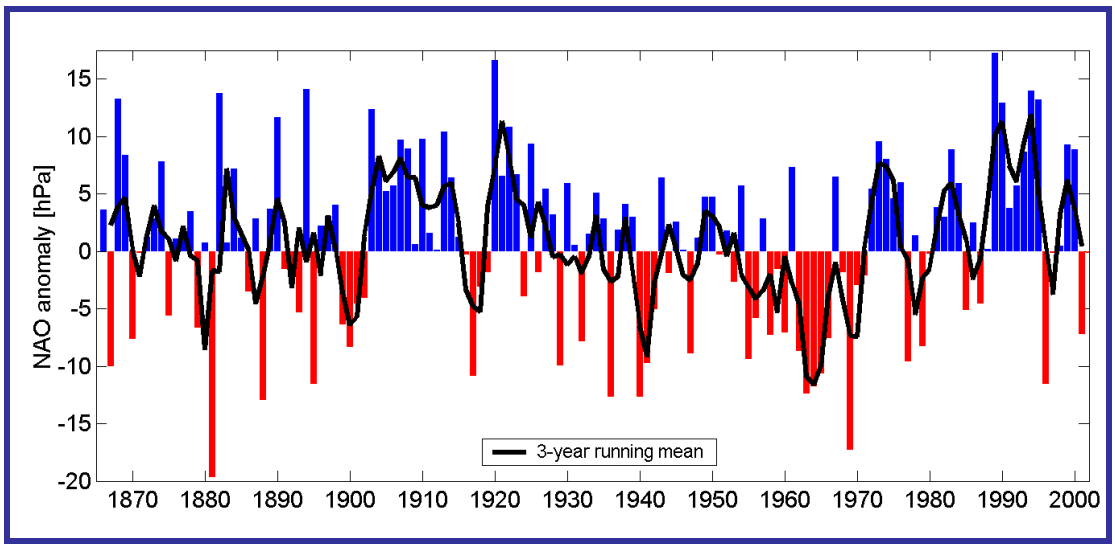

Fig. 1. Time series of winter (December–March) index of the NAO from 1865–2002. The heavy solid line represents the meridional pressure gradient smoothed with a 3-year running mean filter to remove fluctuations with periods less than 3 years (Data updated from www.cru.uea.ac.uk/cru/data/nao.htm).

West Greenland lies within the area which normally experiences warm conditions when the NAO index is negative. As can be seen from Fig. 2 the annual mean air temperature for 2002 in Nuuk was minus 1.1°C, which is 0.7°C lower than in 2001 reflecting well the increase in the NAO value. The mean air temperature for 2002 were however slightly above normal for most of the North Atlantic region, Fig. 3.

Changes in the ocean climate in the waters off West Greenland generally follow those of the air temperatures, exceptions are years with great salinity anomalies i.e. years with extraordinary inflow of Polar Water or water of Atlantic origin. In 2002 the mean temperature on top of Fylla Bank in the

middle of June (Fig. 4) was 1.77°C which is slightly above the average value of 1.67°C for the whole 50 year period, which correlates well with the slightly negative value of NAO.

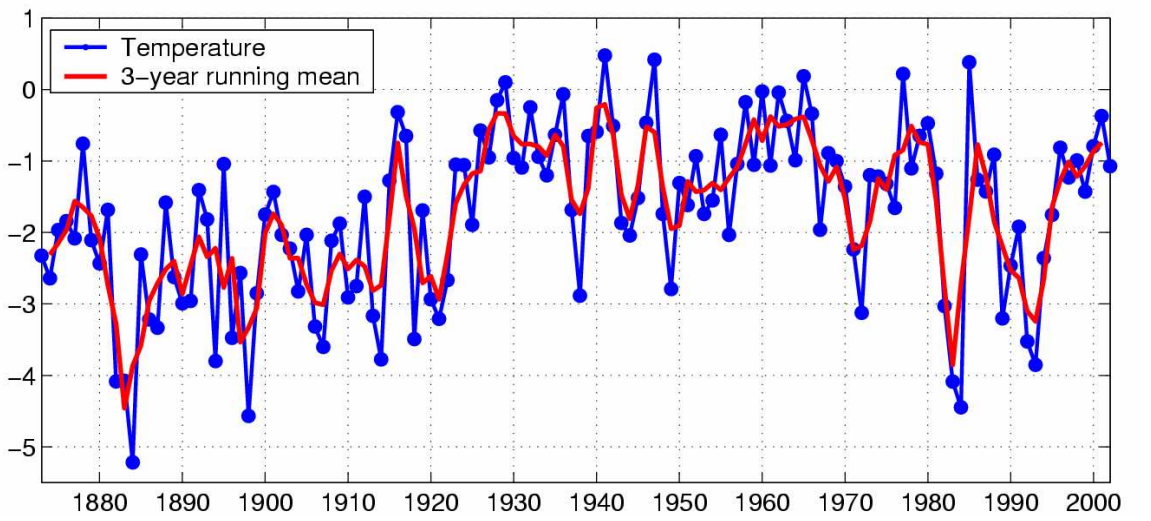

Fig. 2. *Annual mean air temperature observed at Nuuk for the period 1873 to 2002.*

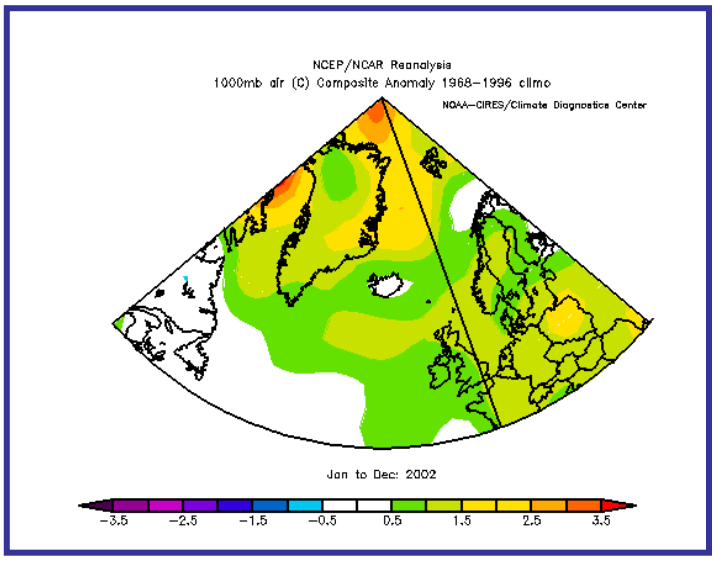

Fig. 3. *Anomalies of the annual mean air temperature in the North Atlantic region –NCEP/NCAR re-analysis* (taken from *http://www.cdc.noaa.gov)*

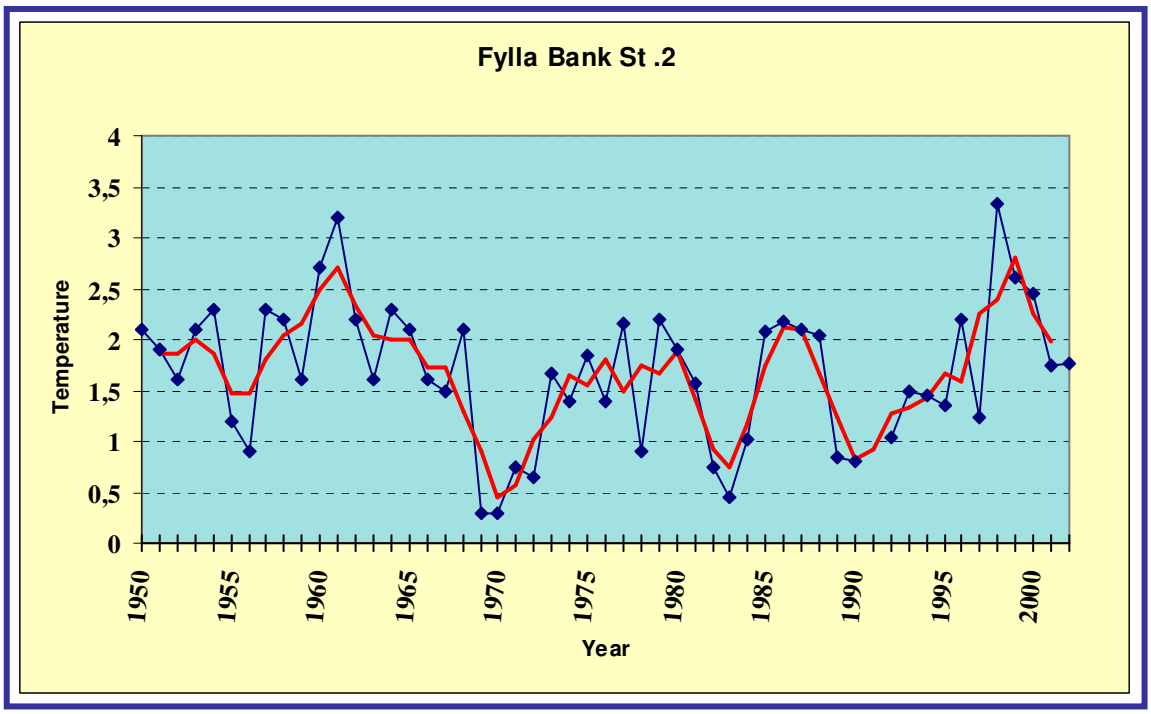

Fig. 4. *Timeseries of mean temperature (observations and 3 year running mean) on top of Fylla Bank (0 - 40 m) in the middle of June.*

2. Measurements

The 2002 cruise was carried out according to the agreement between the Greenland Institute for Natural Resources and Danish Meteorological Institute during the period July 2 to July 9, 2002 onboard the Danish naval ship **"AGDLEK".** Observations were performed on the following stations (see also Fig. 5):

- Cape Farewell St. 1 - 5
- Cape Desolation St. 1 - 5
- Frederikshaab St. 1- 5
- Fylla Bank St. 1- 5
- Sukkertoppen St. 1 - 5
- Holsteinsborg St. 1 – 5
- Additionally 4 stations at Tovssuaq was taken.

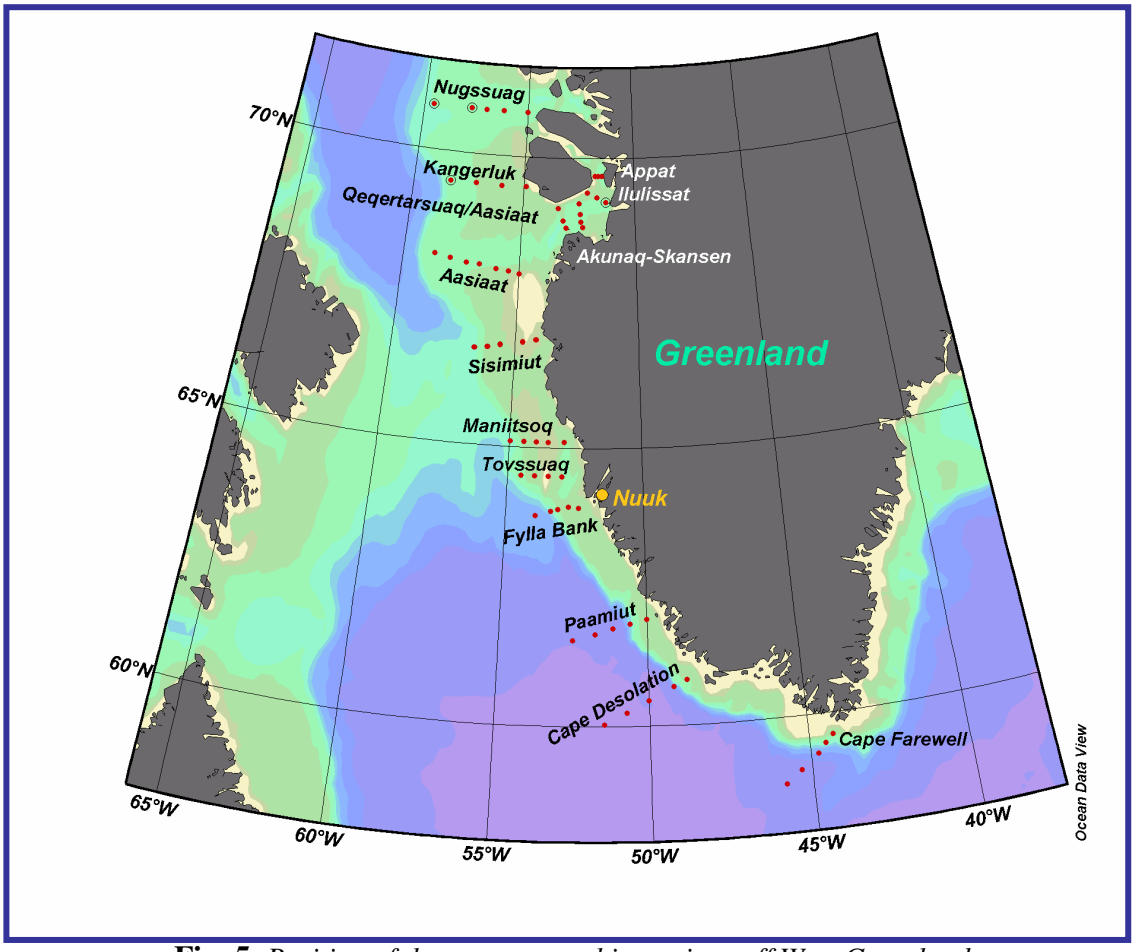

Fig. 5. *Position of the oceanographic sections off West Greenland where measurements were performed in 2002*

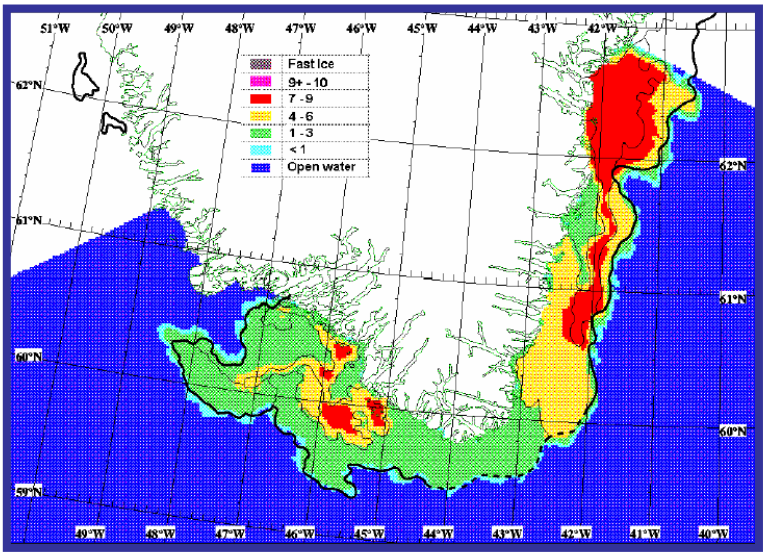

Fig. 6. *Distribution of sea ice in the Cape Farewell region July 9, 2002*

On each station the vertical distributions of temperature and salinity was measured from surface to bottom, except on stations with depths greater than 750 m, where approximately 750 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. Close to Cape Farewell “Storis” was present, Fig. 6, but fortunately not in quantities preventing the measuring program being carried out, only the innermost station was taken about 3 nm from the standard position.

In late July/early August the Greenland Institute for Natural Resources carried out trawl surveys in the Disko Bay area and further North onboard FV “Paamiut”. During this survey CTD measurements were carried out on national oceanographic standard stations.

3. Data handling

Measurements of the vertical distribution of temperature and salinity were 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 4.249 software provided by SEABIRD.

CTD data collected by the Greenland Institute of Natural Resources during cruises with R/V Paamiut using the same instrumentation have gone through the same calibration and quality check.

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.

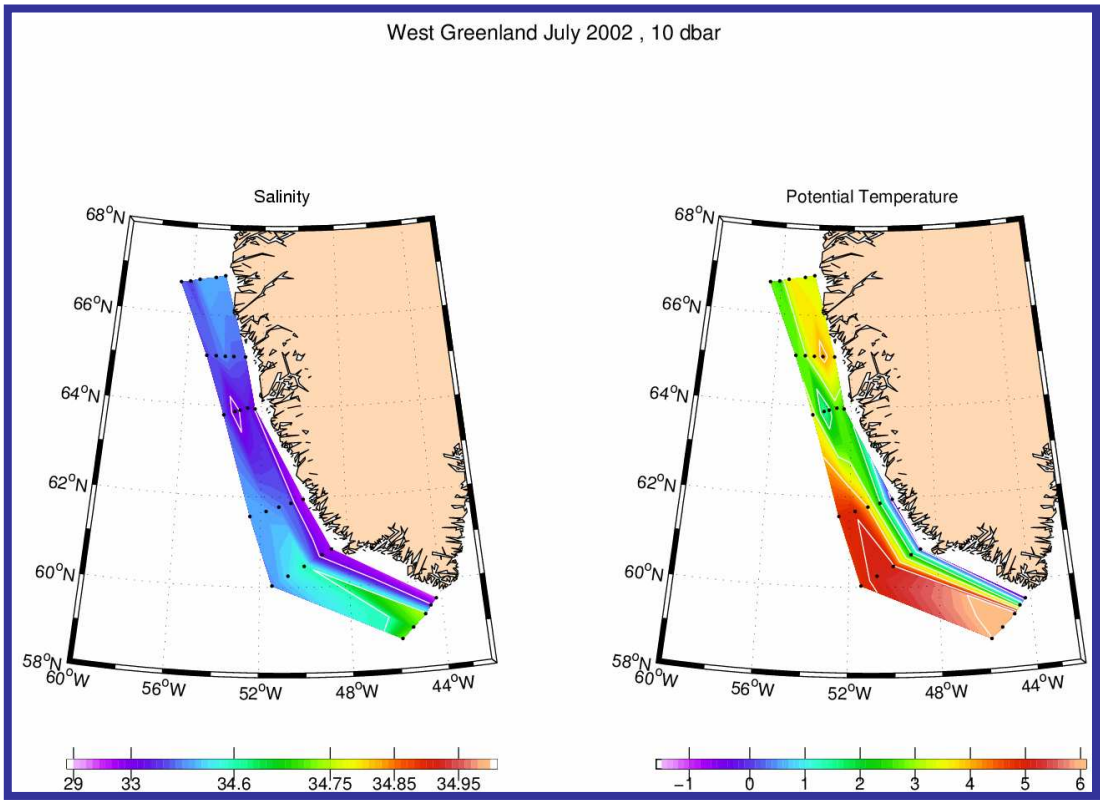

Fig. 7. *Temperature and salinity at 10m, July 2002*

4. Oceanographic conditions off West Greenland in 2002

The surface temperatures and salinities observed during the 2002 cruise are shown in Fig. 7. The cold and low salinity conditions observed close to the coast off Southwest Greenland reflect the inflow of Polar Water carried to the area by the East Greenland Current. Water of Atlantic origin (T> 3°C; S> 34.5) is found at the surface only at the 3 outermost stations on the Cape Farewell Section. The surface salinity seems in general to be relative low especially on the western part of the area.

The 2002 mean salinity value (33.41) on top of Fylla Bank (Fig. 8) was similar to the 2001 condition and equal to the average value for the entire period.

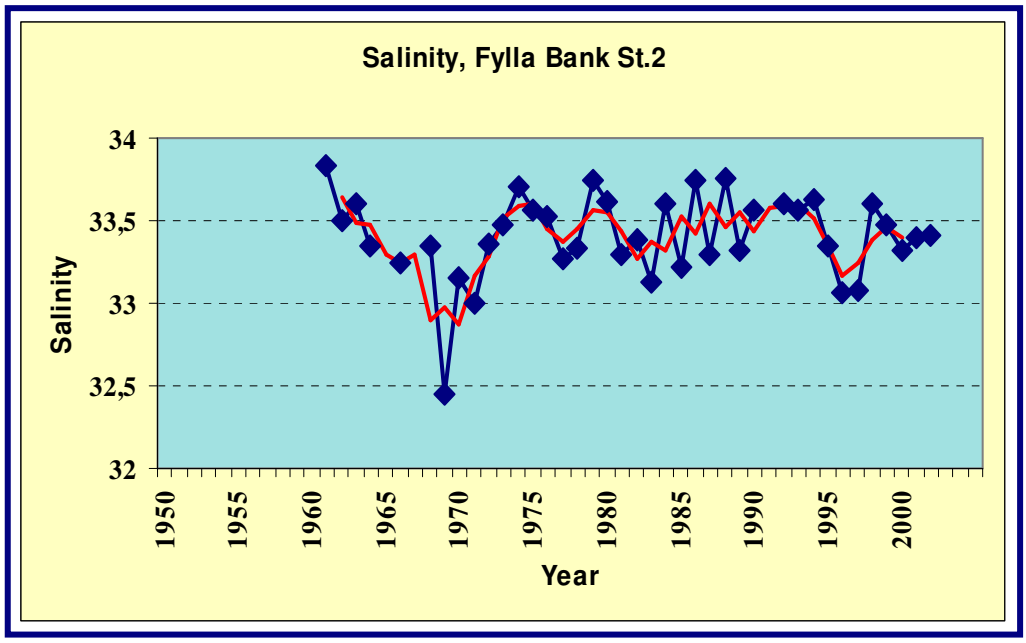

Fig. 8. *Time-serie of the mean salinity (observations and 3 year running mean) on top Fylla Bank (0-40m) in the middle of June*

The vertical distribution of temperature, salinity and density at sections along the West Greenland coastline is given in Figs. 9 – 19. In addition to data from the six standard sections obtained during the AGDLEK cruise in early July, data from the Disko Bay and further north obtained during the R/V PAAMIUT cruise in July/August are shown.

In the surface layer (0-100 m) relatively strong gradients between the cold, low-saline Polar Water and the warm, high-saline water of Atlantic origin was observed at the Cape Farewell section only although the gradient also here was less pronounced than previous years. On the sections further north it is remarkable and unusual to see the missing strong gradients between the cold, low saline Polar Water and the warm, saline Atlantic Water. This indicates a low intensity in the East Greenland Current component as well as a lower than normal inflow of water of Atlantic origin.

Normally there is a very pronounced core of Polar Water (revealed by its low temperatures) just west of Fylla Bank at depth of 50 - 100 m, but in 2002 this core was hardly recognizable i.e. another sign of reduced inflow of Polar water in 2002.

From the Aasiat to the Nugssuaq sections a cold layer is found between approximately 40 and 150m with extreme low temperatures at around 75m. This cold water is Polar Water transported to the West Greenland waters by a side branch of the southward flowing Baffin Current.

Temperature and salinity observations at greater depth showed that pure Irminger Water ($T \sim 4.5^{o}C$, $S > 34.95$ psu) was hardly present at the Cape Farewell section, and was certainly not observed beyond this point. Modified Irminger Water ($34.88 < S < 34.95$) was traced only as far north as the Fylla Bank section were it barely was present at Fylla Bank St. 5. Northwest Atlantic Mode Water ($3.5 < T < 4.5$; $34.5 < S < 34.88$) was observed at all sections from Cape Farewell to Nugssuaq.

6. Conclusions

The oceanographic conditions off West Greenland during the summer 2002 was characterised by:

- Climatic conditions – NAO, Nuuk Air Temperatures, medio water June temperature and salinities on top of Fylla Bank – were close to average conditions
- The inflow of Polar Water as well as Irminger Water was in 2002 less than normal reflected by the fact that no strong gradients between the two water masses was observed; that Polar Water could hardly be distinguished at Fylla Bank, that pure Irminger Water was hardly present at the Cape Farewell region and that Modified Irminger Water was observed only as far north as the Fylla Bank Section.

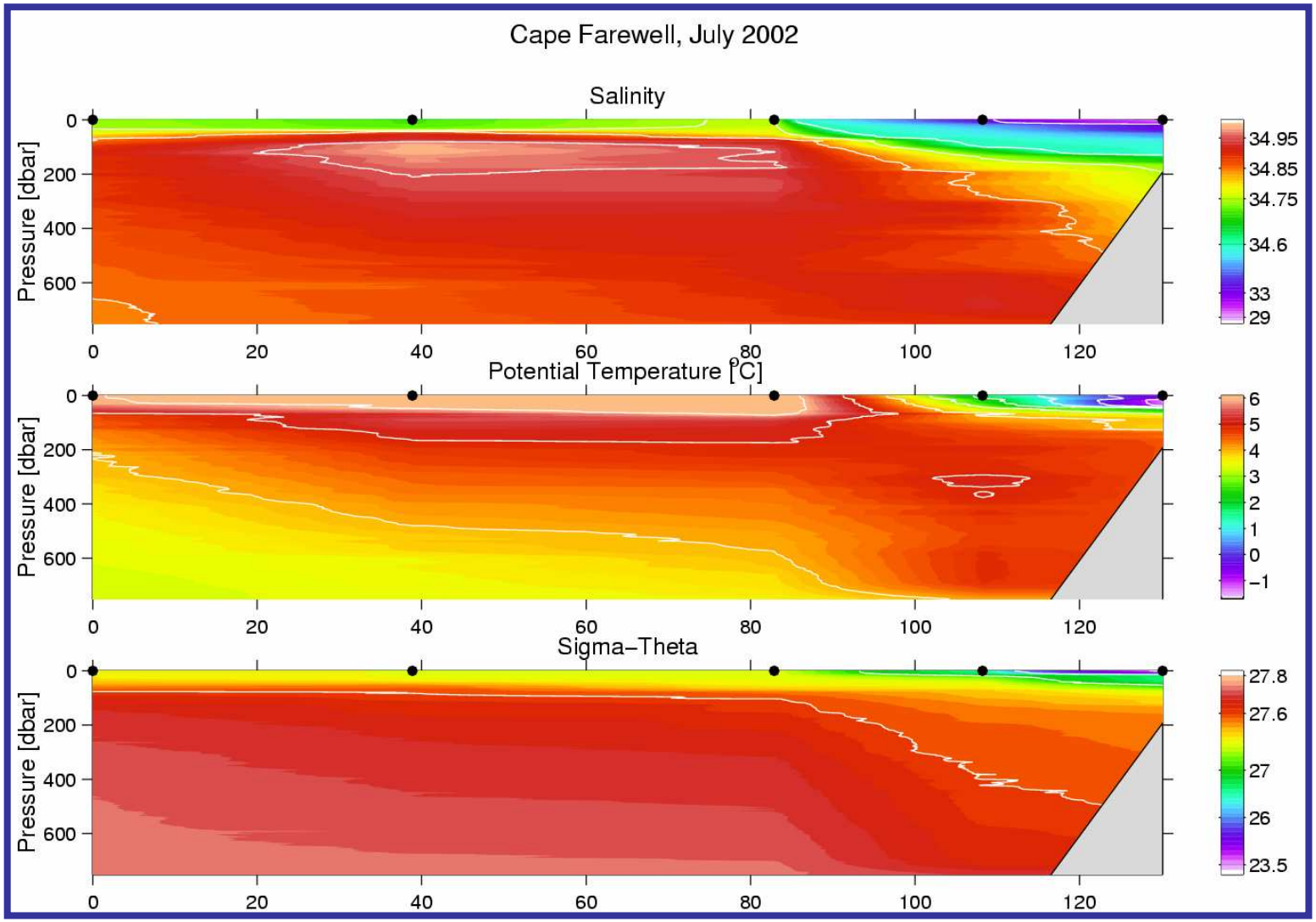

Fig. 9. *Vertical distribution of temperature, salinity and density at the Cape Farewell section, July 2002*

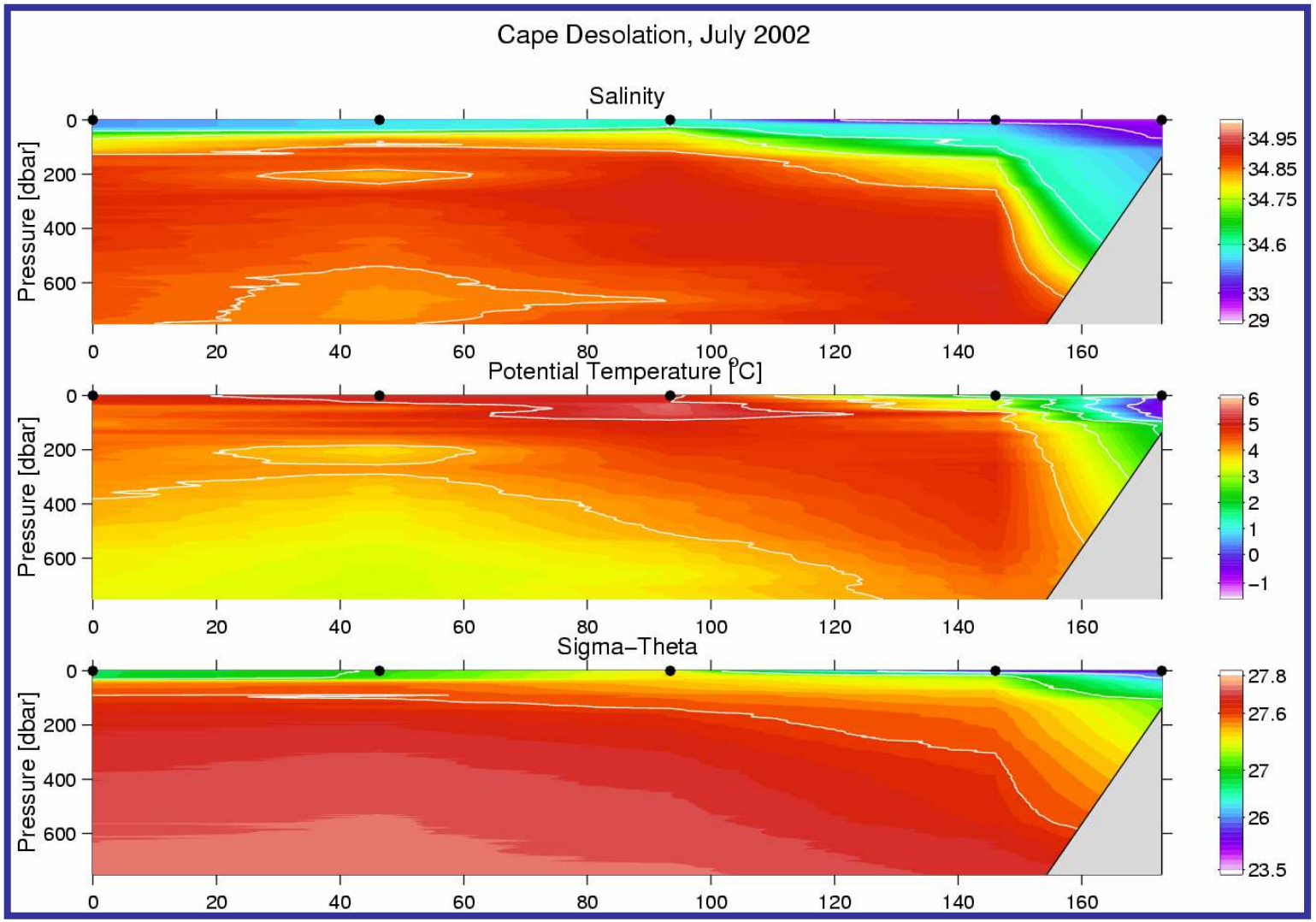

Fig. 10. *Vertical distribution of temperature, salinity and density at the Cape Desolation Section, July 2002*

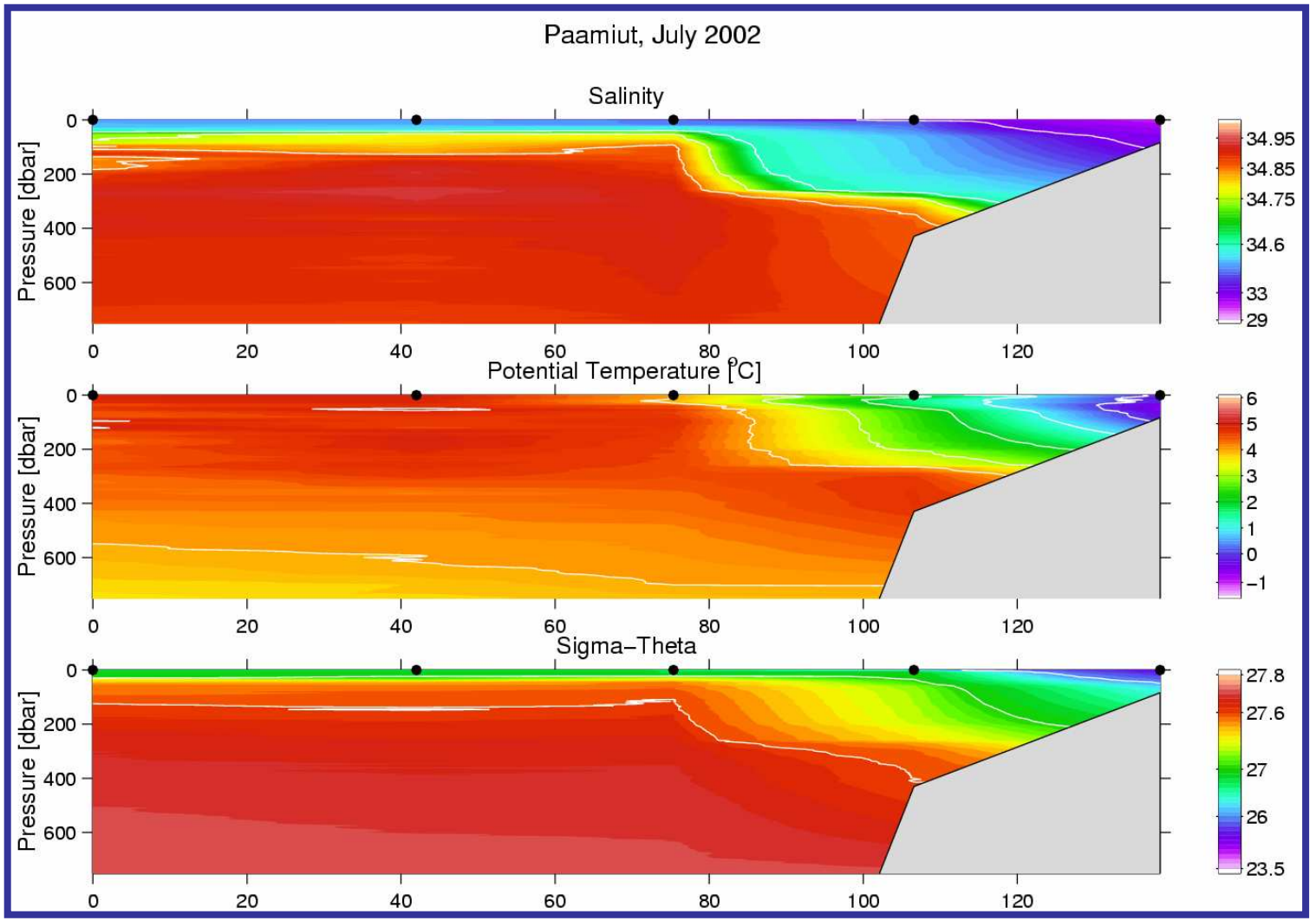

Fig. 11. *Vertical distribution of temperature, salinity and density at the Frederikshaab Section, July 2002.*

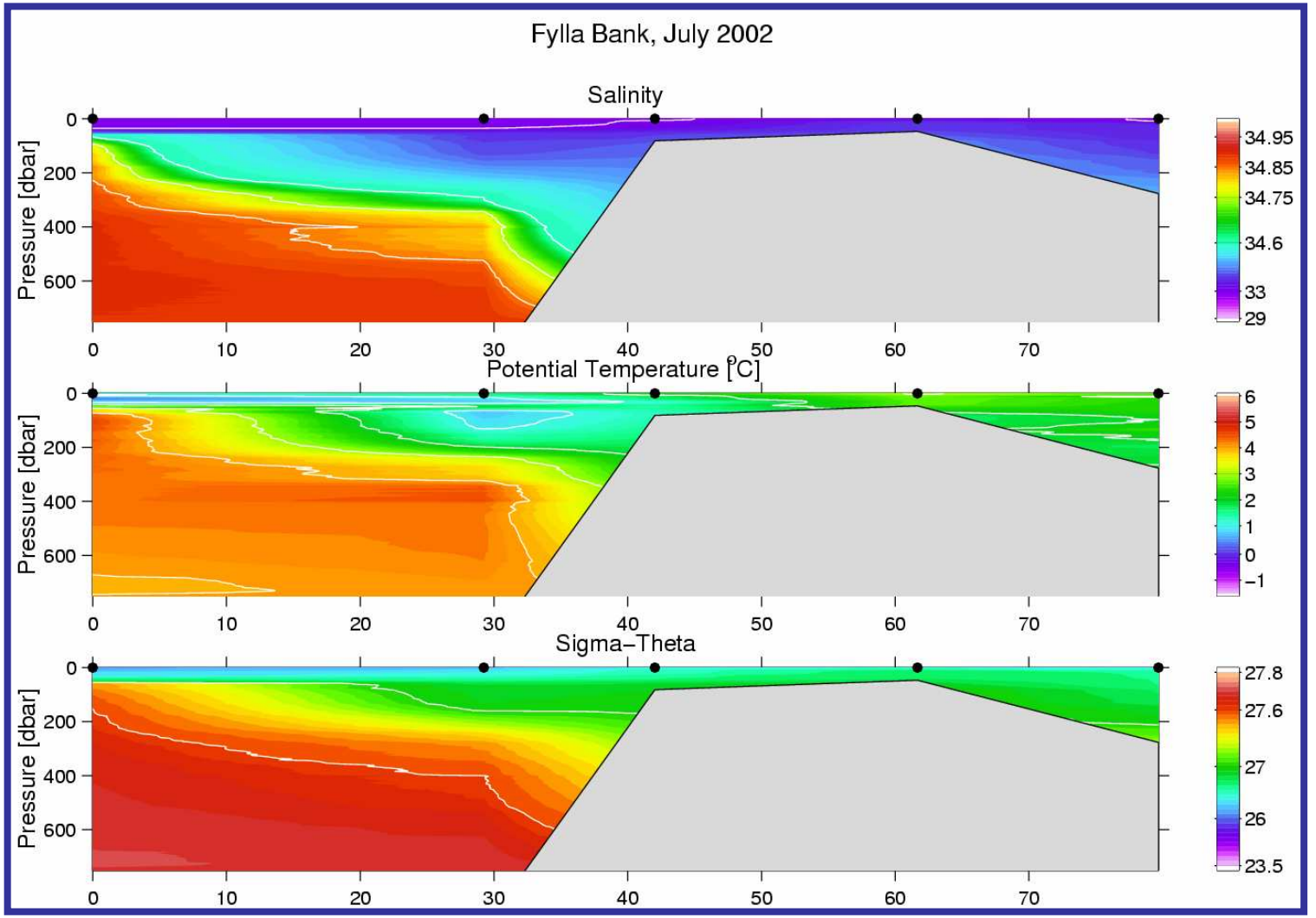

Fig. 12. *Vertical distribution of temperature, salinity and density at the Fylla Bank Section, July, 2002.*

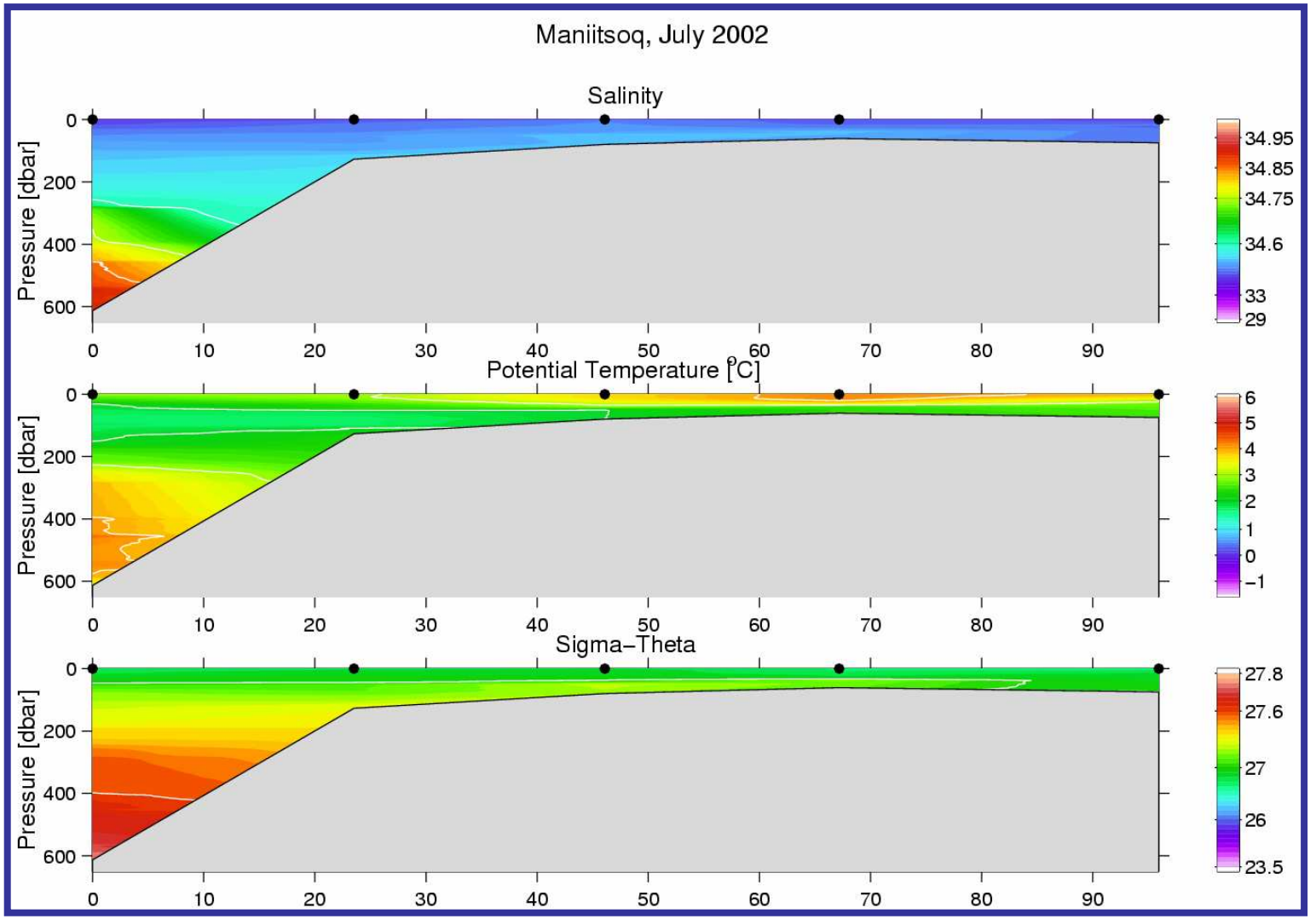

Fig. 13. *Vertical distribution of temperature, salinity and density at the Maniitsoq (Sukkertoppen) Section, July 2002.*

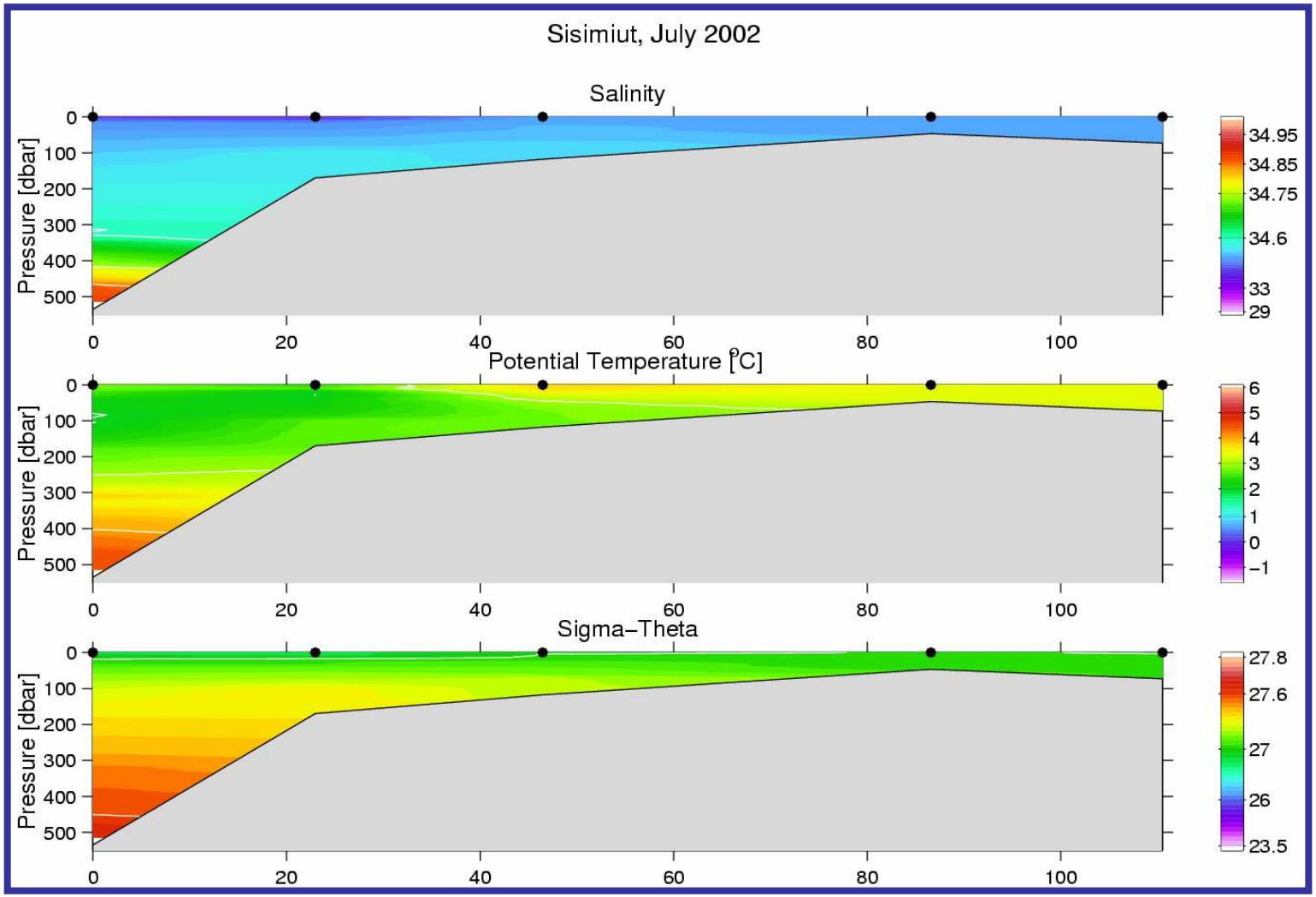

Fig. 14. *Vertical distribution of temperature, salinity and density at the Holsteinsborg Section, July 2002*

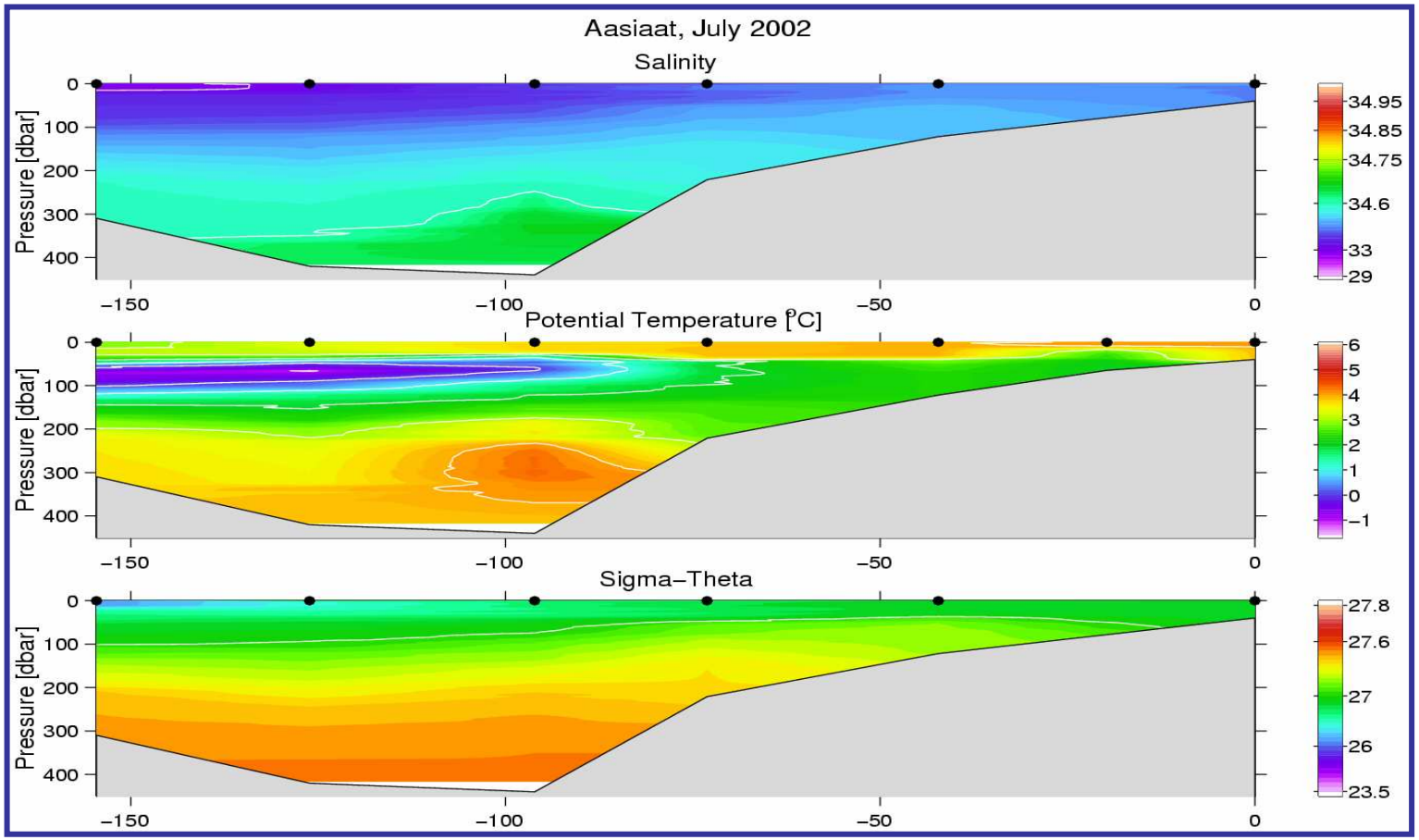

Fig. 15. *Vertical distribution of temperature, salinity and density at the Aasiat Section, July, 2002*

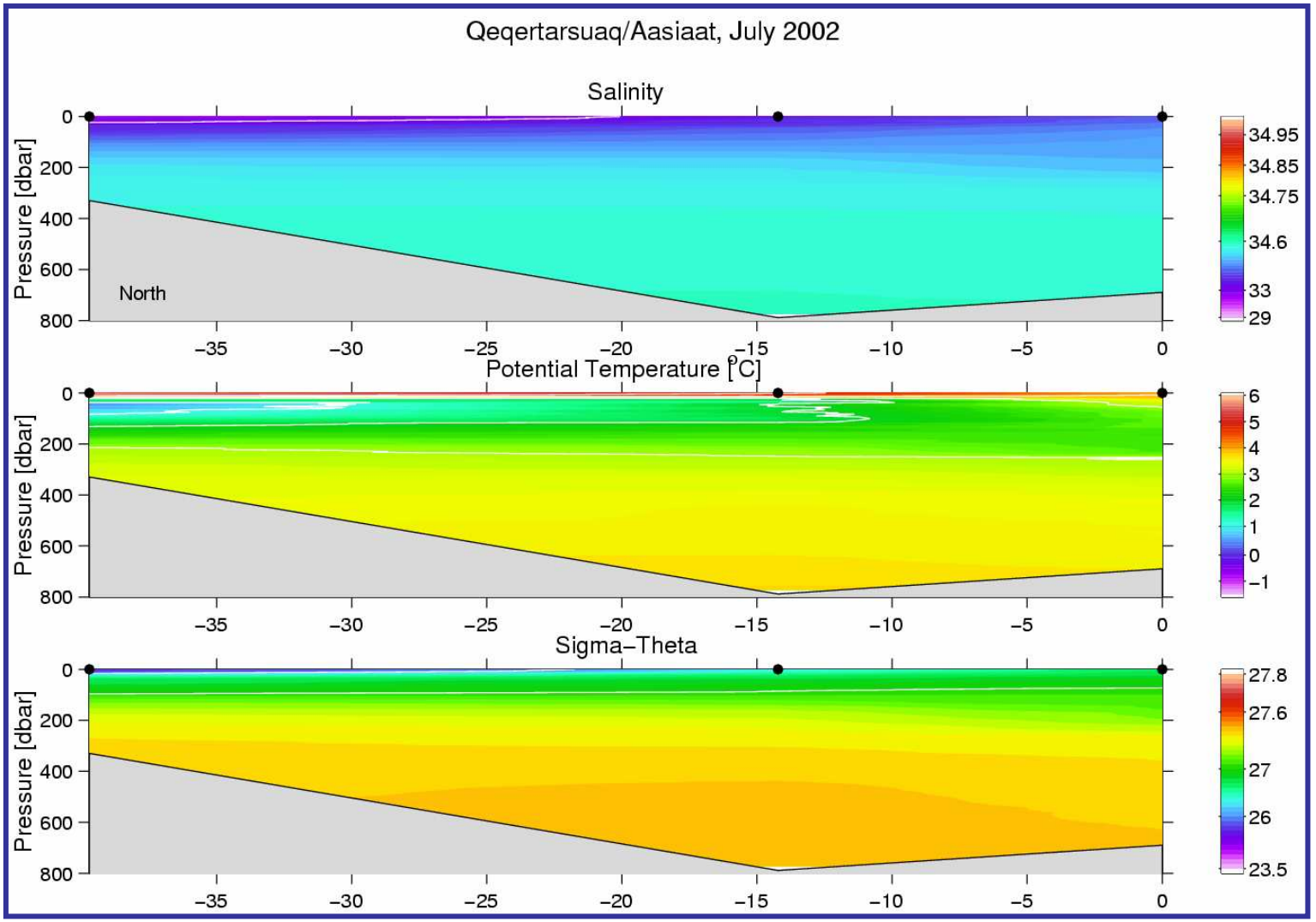

Fig. 16. *Vertical distribution of temperature, salinity and density at the Qegertarsuaq.Aasiat Section, July 2002*

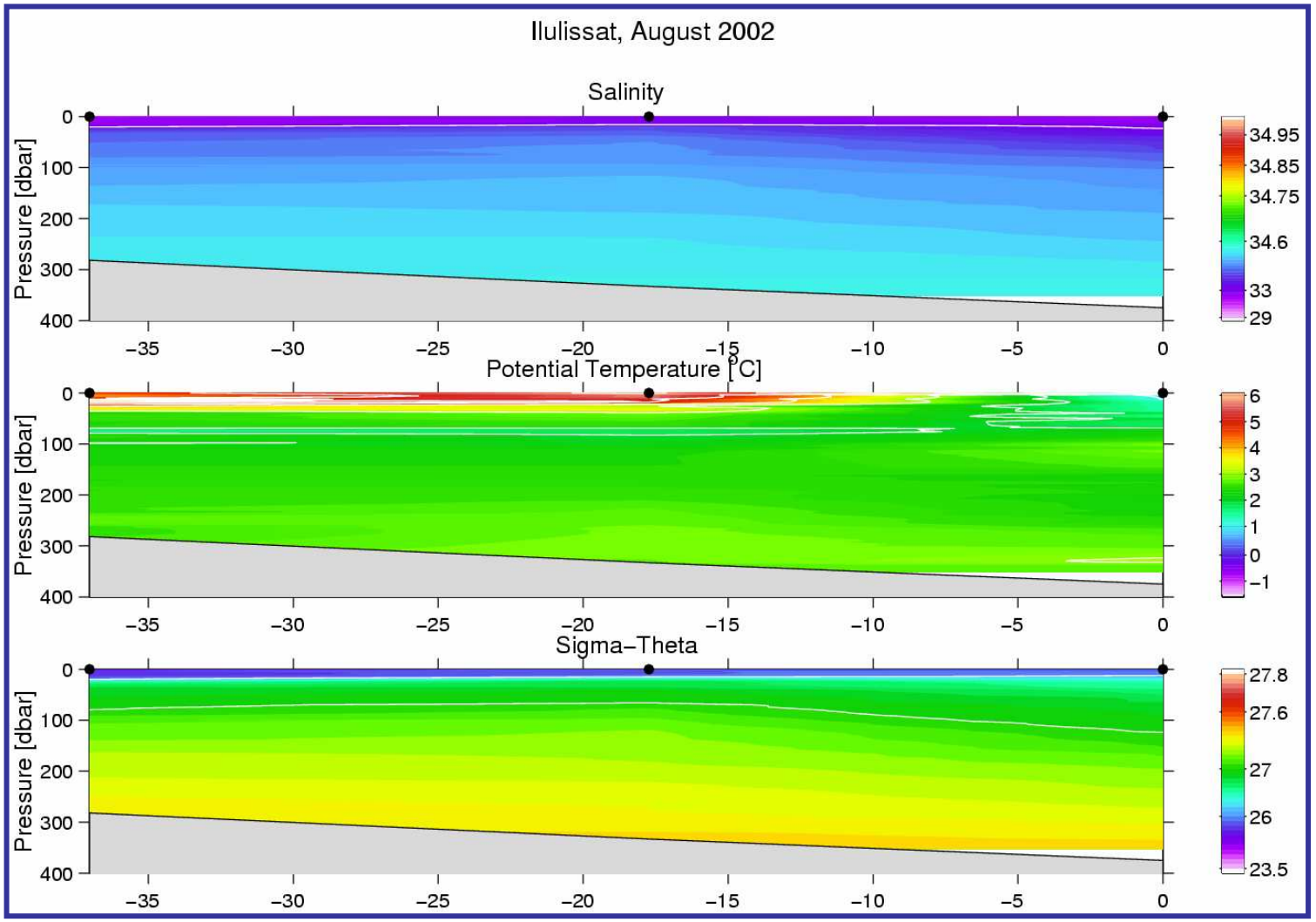

Fig. 17. *Vertical distribution of temperature, salinity and density at the Ilulissat Section, August, 2002*

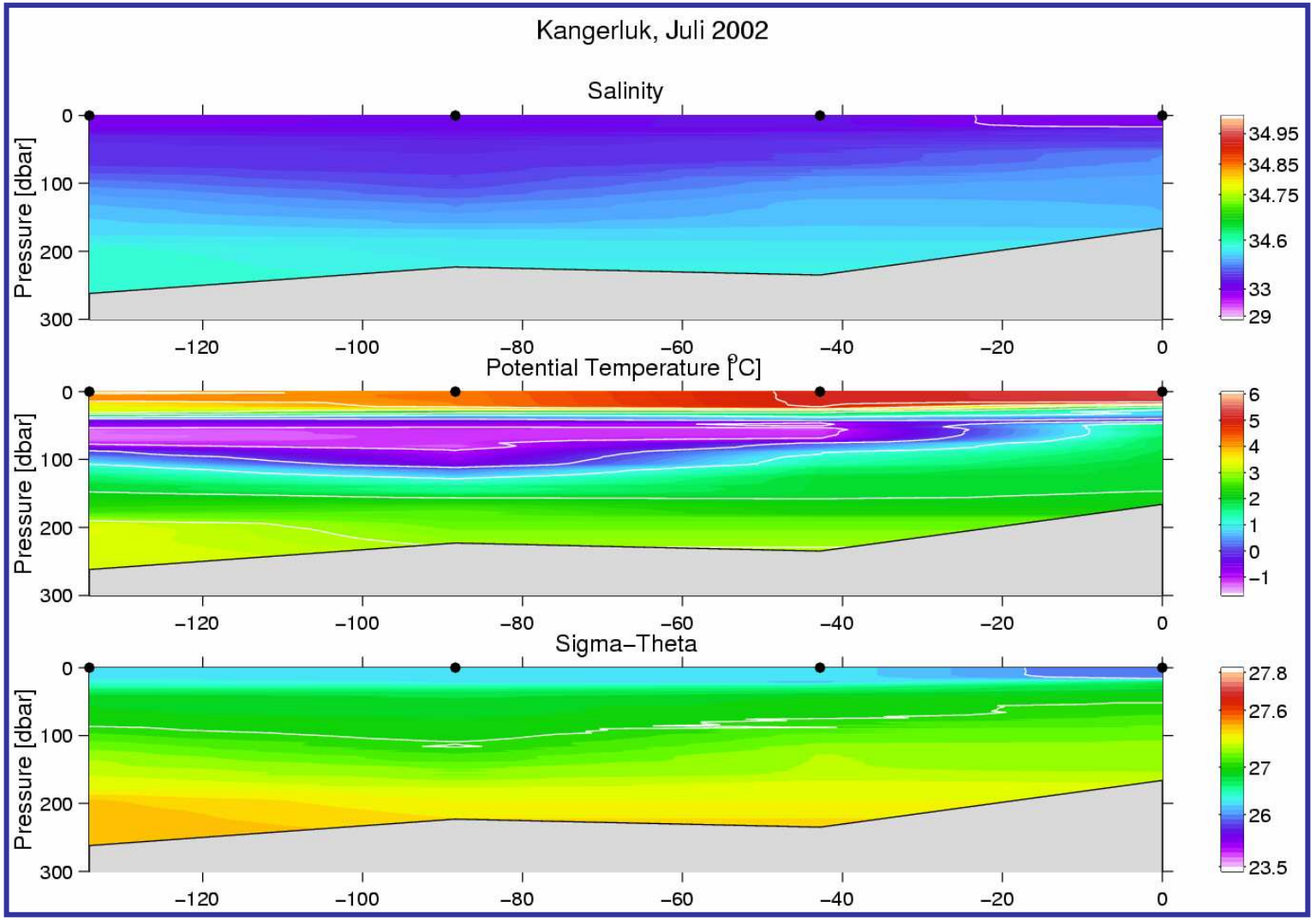

Fig. 18. *Vertical distribution of temperature, salinity and density at the Disko Fjord (Kangerluk) Section, July, 2002*

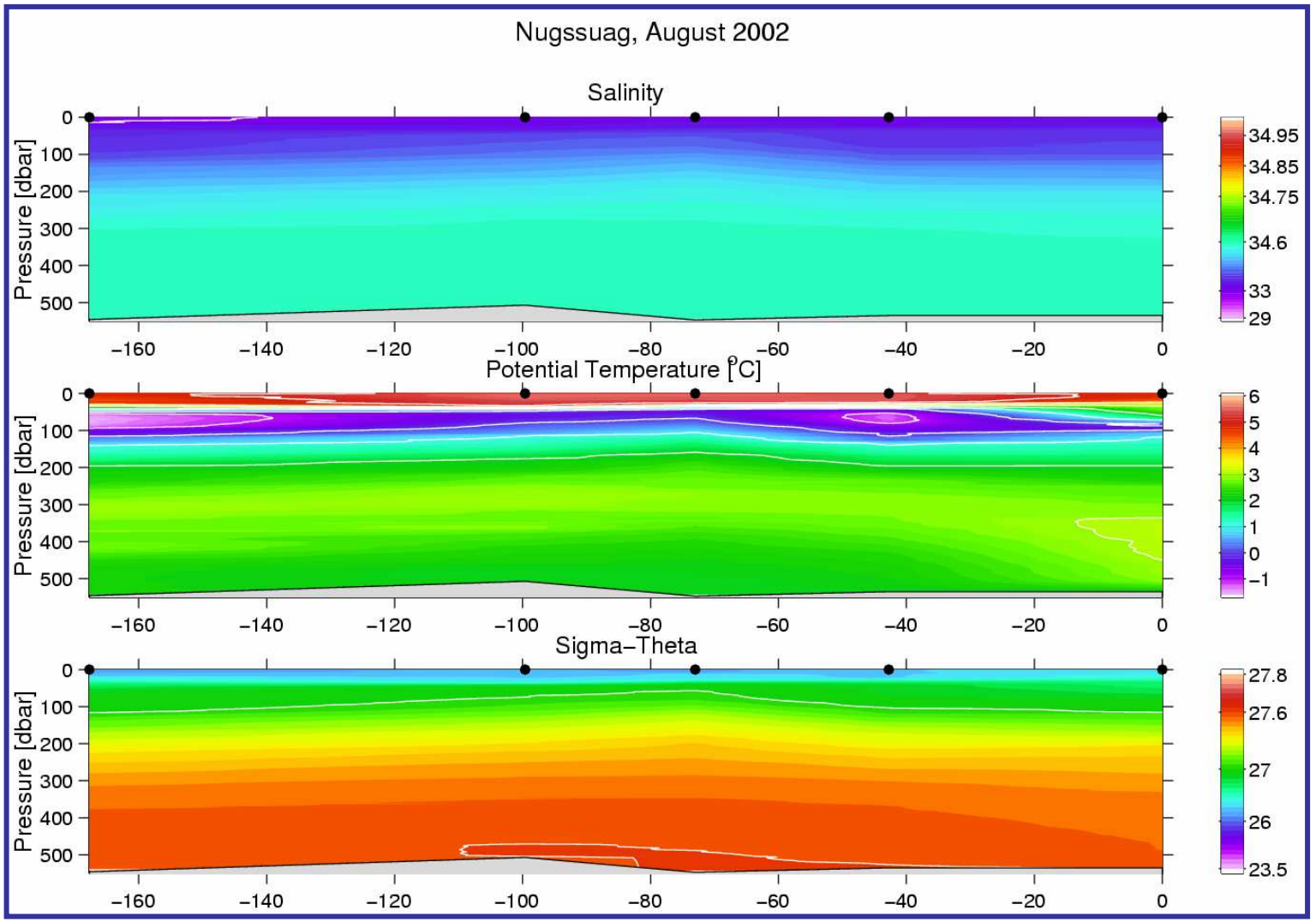

Fig. 19. *Vertical distribution of temperature, salinity and density at the Nugssuaq Section, August, 2002*