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CLIMATIC CHANGES AT THE NORTH SEA PLATEAU DURING 1967 - 1984

by

R. Ljøen and R. Sætre
Institute of Marine Research
P.O.Box 1870, N-5024 Bergen
Norway

ABSTRACT

The average temperature and salinity in the water masses with S> 35.0 in the Utsira and Hanstholmen sections for the periode 1967-1984 is presented. The influence of the mid 1970 s salinity anomaly at the North Sea plateau is discussed.

INTRODUCTION

In the mid 1970s there was a marked reduction in salinity affecting most of the eastern North Atlantic. The oceanographic cause of this anomaly appears to have been an eastward shift of the Oceanic Polar Front (DOOLEY, MARTIN and ELLETT, 1984). At the ICES Statutory Meeting in 1984 the matter was subject for a mini-symposium (e.g. MARTIN, DOOLEY and SHEARER, 1984).

It seems to be unclear how and to which degree the 1970s salinity anomaly may have affected the North Sea. In the southern part of the North Sea the salinity anomaly signal appears to have been masked by the variability in local fresh water outflow (DICKSON, JONES and LEE, 1984). In the northern North Sea, however, the maximum salinity values between the Orkney Islands and the Greenwich Meridian during summer fell by a similar amount as in the Faroe-Shetland Channel, but was delayed by about a year (MARTIN, DOOLEY and SHEARER, 1984).

There seems to be some indications on a link between the 1970s salinity anomaly and biological processes. CORTEN (1986) reviewing the data from the British Continous Plankton Recorder Surveys, concluded that these data support the hypothesis of an anomaly in the North Sea circulation in the 1970s. He is also speculating on a causal relationship between the hydrographic anomaly and the recruitment failure of herring in the years 1974-1978 (CORTEN, 1984, 1986). However, there is no conclusive evidence for this.

The aims of this presentation is also to add a piece of information to the effect on the North Sea hydrography by the mid 1970s anomaly. Emphasis is put on the Atlantic influence on the shallow plateau of the northern and Central North Sea.

MATERIALS AND METHODS

Every summer since 1967 the Institute of Marine Research, Bergen, has carried out standard hydrographic programs in the North Sea and Skagerrak. The sections appearing in Fig. 1 are those which were worked most frequent. Mean values for the periode 1967-1976 have been

presented by LJØEN (1980). The work is each year carried during the periode 15 May to 15 July with most of the observations in June. The data used for this contribution is those from the Utsira section (section III, fig. 1) and the Hanstholmen section (section X, fig. 1). For the Utsira section only data west of 3^0E was applied while for the Hanstholmen section the whole section was included. The mean conditions 1967-1976 along these sections appear in Fig. 2 and 3.

For each year the area of the section occupied by water masses with S> 35.0 and the average temperature and salinity of these water masses were calculated.

RESULTS AND DISCUSSION

Fig. 4 shows the results from the Utsira section. The area of the water masses with salinity > 35 .0 varies between approximately 80 and 120 % of the mean value. The mean salinity shows a decreasing trend of about 0.2 units until a minimum in 1978. In the early 1980s the average salinity was back to the values of years around 1970. The average temperature variations show a similar drop in 1977-1979. There is another minimum in 1970 and a maximum in 1974. Thus, the salinity anomaly observed in the Faroe-Shetland Channel (DOOLEY, MARTIN and ELLETT, 1984) affected the northern North Sea but was delayed by about two year.

In the central North Sea at the Hanstholmen section (Fig. 4) water exeeding 35.0 in salinity was not observed in 1978-1979. Though there is similarities in the variations in the two sections, there is also important differences: At the Hanstholmen section the salinity variations were approximately half of that found at the Utsira section. The variation in temperature and area of the Atlantic water, however, were significantly larger at the Hanstholmen section. Fig. 5, showing the mean T-S relationship for the individual years, also demonstrate the difference. At the Utsira section there was a clear positive temperature-salinity correlation while at the Haanstholmen section no such relationship could be seen. This feature is probably due to the east flowing current which follows the 100 m contour from the Fair Island Channel across the North Sea as demonstrated by several authors (e.g. ROGALLA, 1959). This flow seems to split the

North Sea plateau into two different hydrographic regimes.

During winter the water masses of the northern and central North Sea plateau become vertically mixed. The temperature variation in the near bottom layer is thus reflecting the variability in the air-sea heat exchange. This relationship is more pronounced south of 58^0N due to shallower depth and stronger tidal forces. The flucturations of temperature compared to that of salinity at the Hanstholmen section (Fig. 5) demonstrates a major atmospheric influence in this area. To the north, at the Utsira section, the temperature-salinity relationship indicates a stronger connection to the intruding Atlantic water (Fig. 5).

Figs. 6 and 7 show the bottom salinity and temperature distribution for a year with high salinity (1972) and a year with minimum salinity (1978) in the Atlantic water. The distribution pattern seems to be approximately the same except for a general reduction of about 0.2 units in salinity and 0.5^0 - 2.0^0C in temperature on the shelf area during 1978. During June 1978 the cold core of bottom water was splitted into two parts, probably by the eastward transport of warmer water by the Fair Isle current. If a cessation of this transport during the winter 1978 as suggested by MARTIN, DOOLEY and SHEARER (1984) really occured, it must have been of a short duration. The area occupied by Atlantic water in the Utsira section shows rather small variations. The observed climatic changes during the 1970s is probably more related to the properties of the inflowing Atlantic water rather than to flux variability.

The mid 1970s salinity anomaly was observed in the Rockall and the Faroe-Shetland Channel in 1976 (DOOLEY, MARTIN and ELLETT, 1984), at Ocean Weather Station M at 66^0N in 1977 (GAMMELSRØD and HOLM, 1984) and in the Barents Sea in 1978-79 (DICKSON and BLINDHEIM, 1984). At the northern North Sea plateau it occurred in 1978, i.e. the minimum was delayed about two years from the Faroe-Shetland Channel. DICKSON and BLINDHEIM (1984) calculated a mean propagation speed of the minimum of around 2-3 cm $\cdot$ sek^{-1} in the Norwegian Atlantic Current. If the salinity minimum was advected to the Utsira section with the same speed it would need about six months to reach the area.

Atlantic water intrudes the northern North Sea east of Shetland and along the western slope of the Norwegian Trench. The area between these inflows seems to be rather stagnant and the water exchange with the inflowing Atlantic water is dominated by horizontal turbulent diffusion. This could explain the two years delay for the salinity minimum to propagate from the Faroe-Shetland Channel to the northern North Sea plateau. If so, however, this feature implies a less net flux to the Fladen area (Box 1 and 2) than postulated in ANON (1983).

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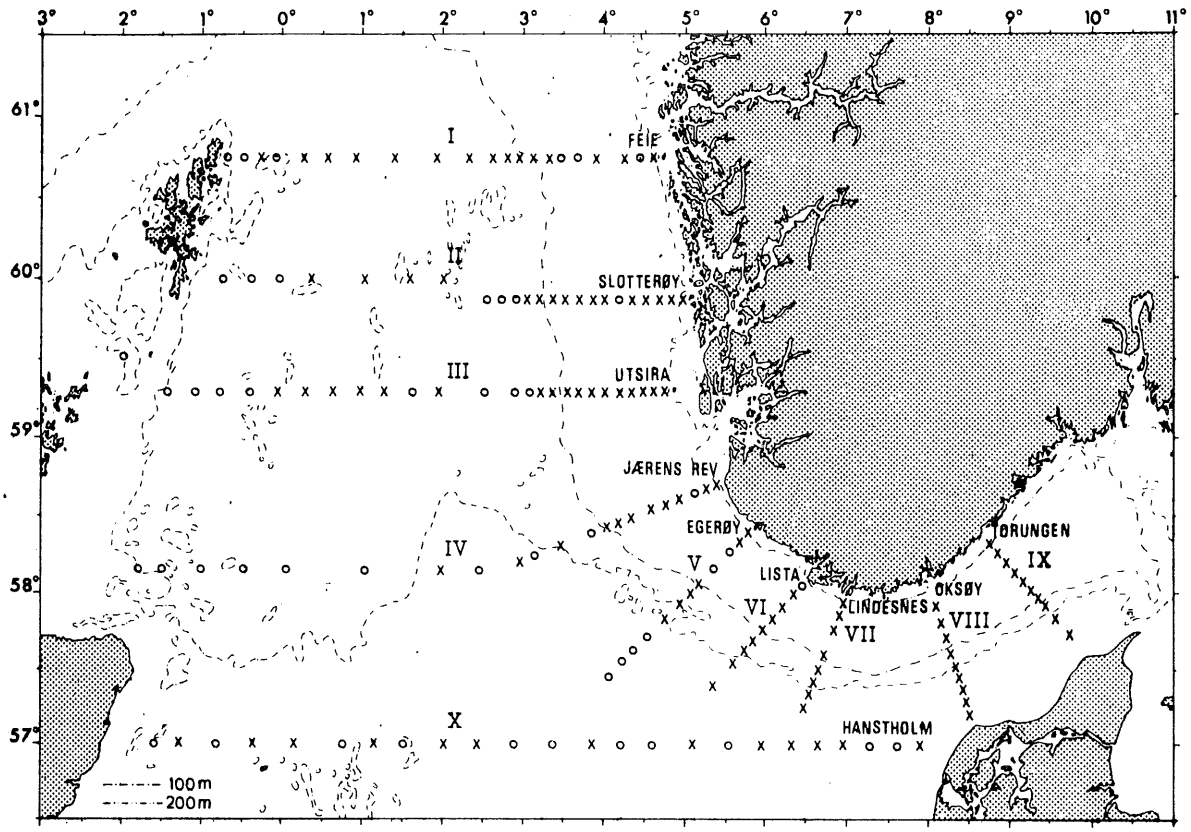

Fig. 1. Grid of stations for the Norwegian standard hydrographic program.

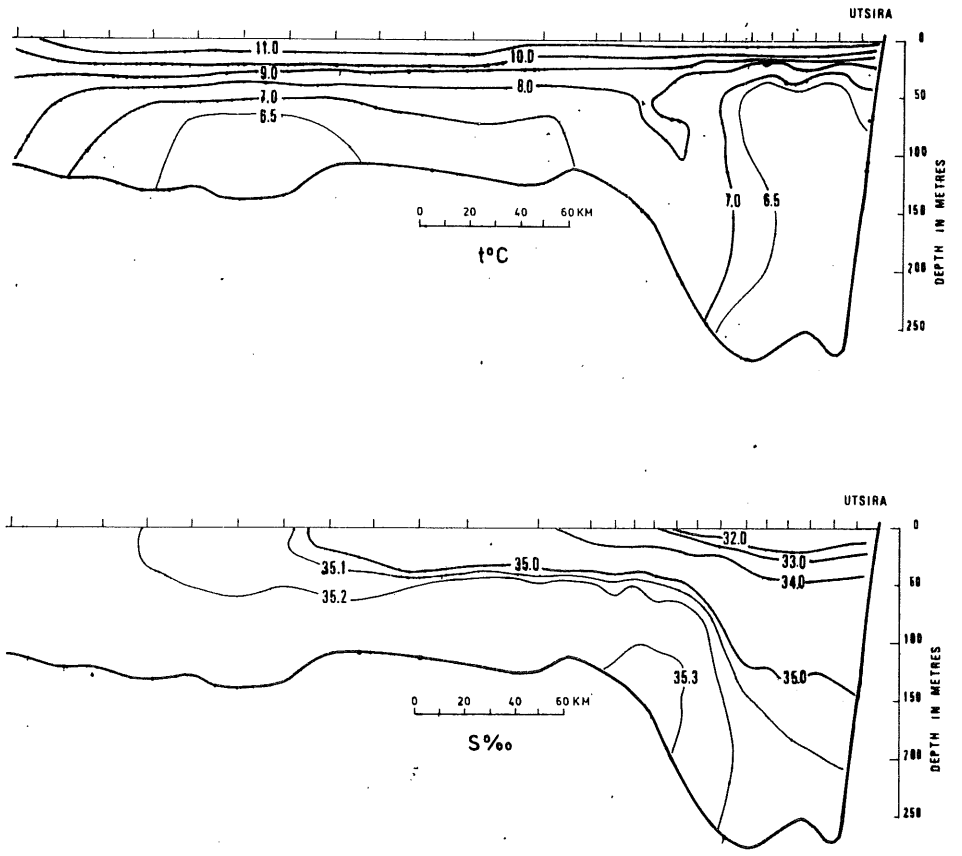

Fig. 2. The mean summer situation 1967-76 at the Utsira section.

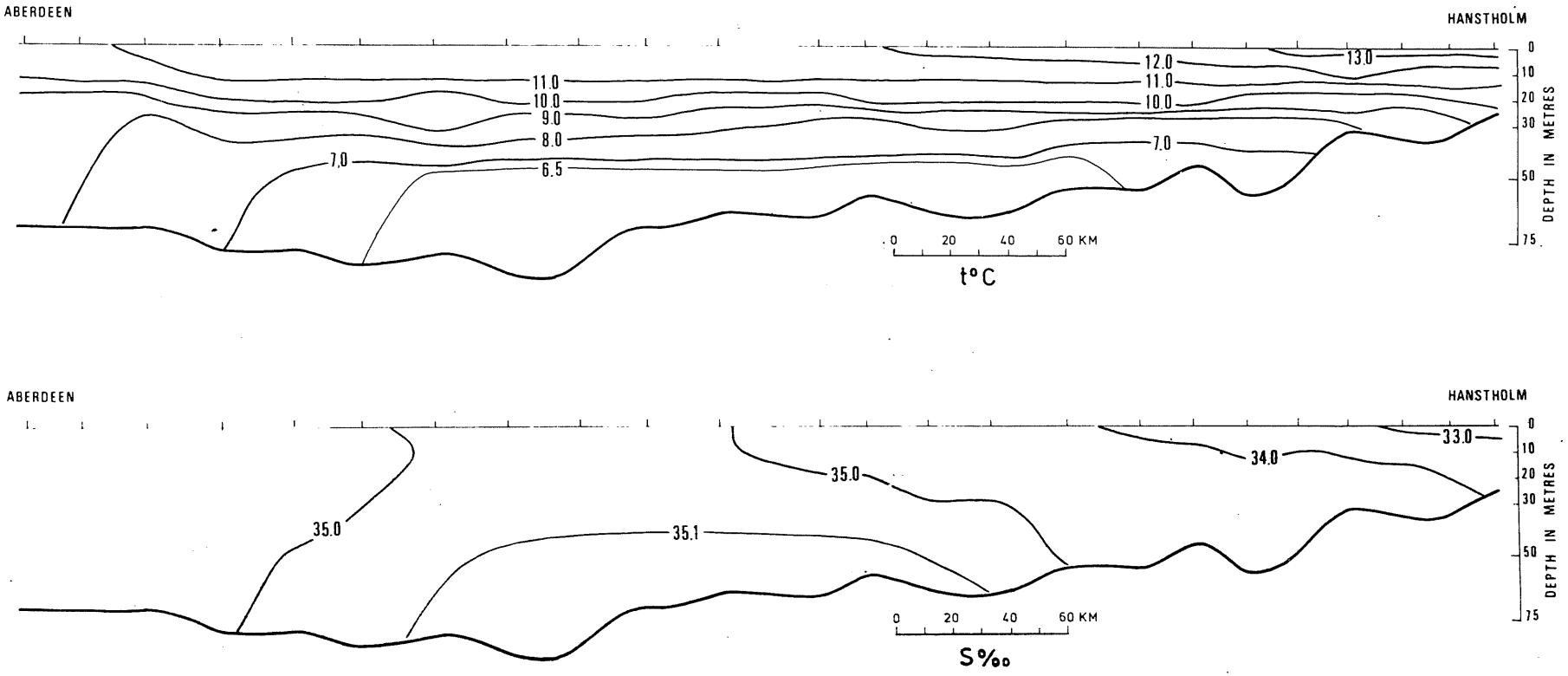

Fig. 3. The mean summer situation 1967-76 at the Hanstholmen section.

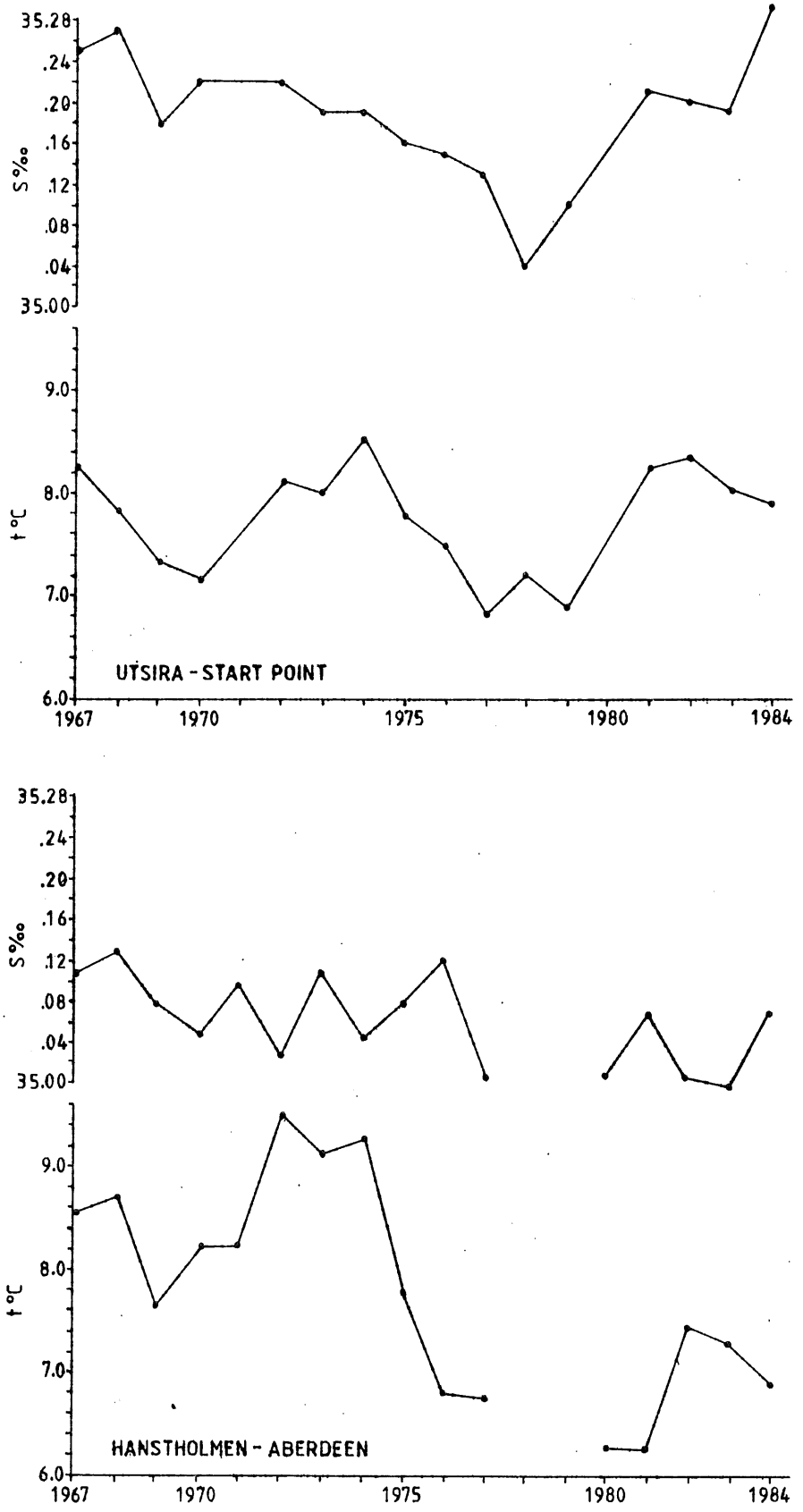

Fig. 4. The mean temperature and salinity in the water masses of S >35.0 at the Utsira and Hanstholmen sections 1967-84.

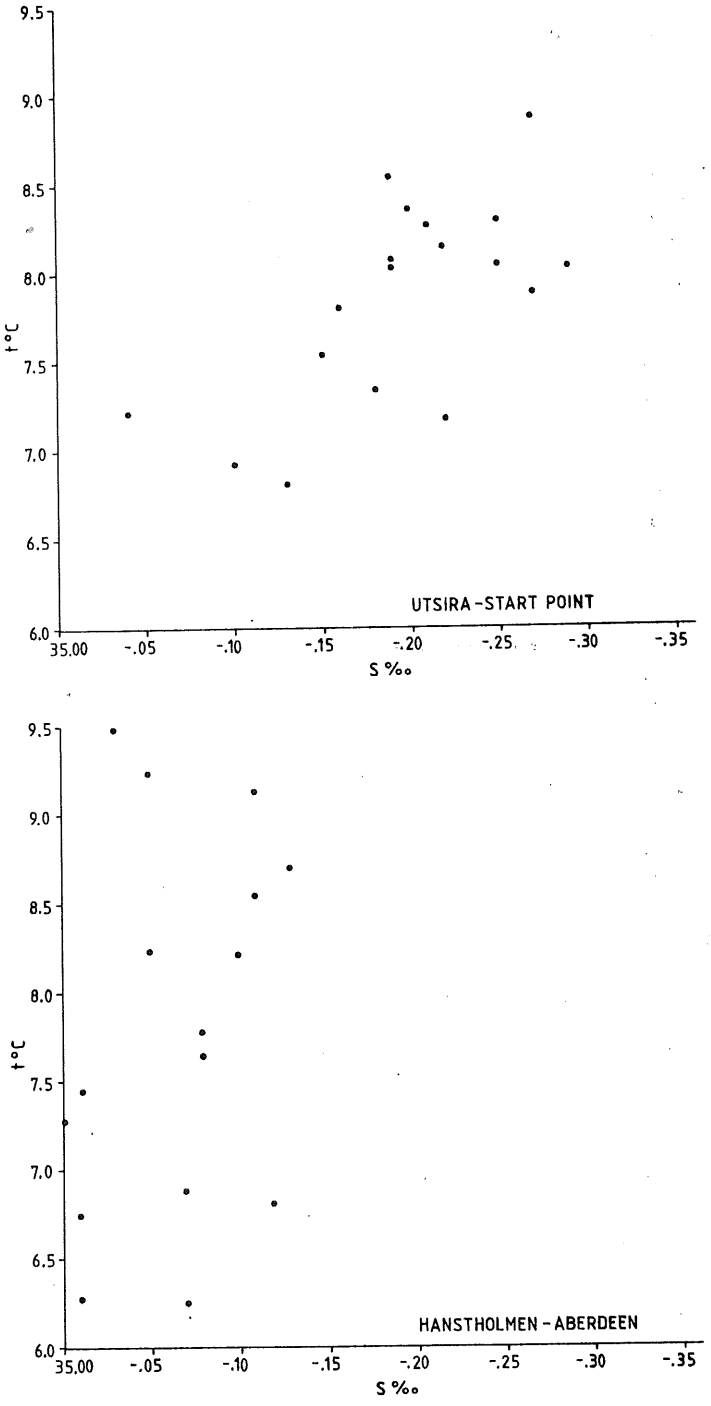

Fig. 5. T-S relationship of the mean temperature and salinity in the water masses of S >35.0 at the Utsira and Hanstholmen sections 1967-84.

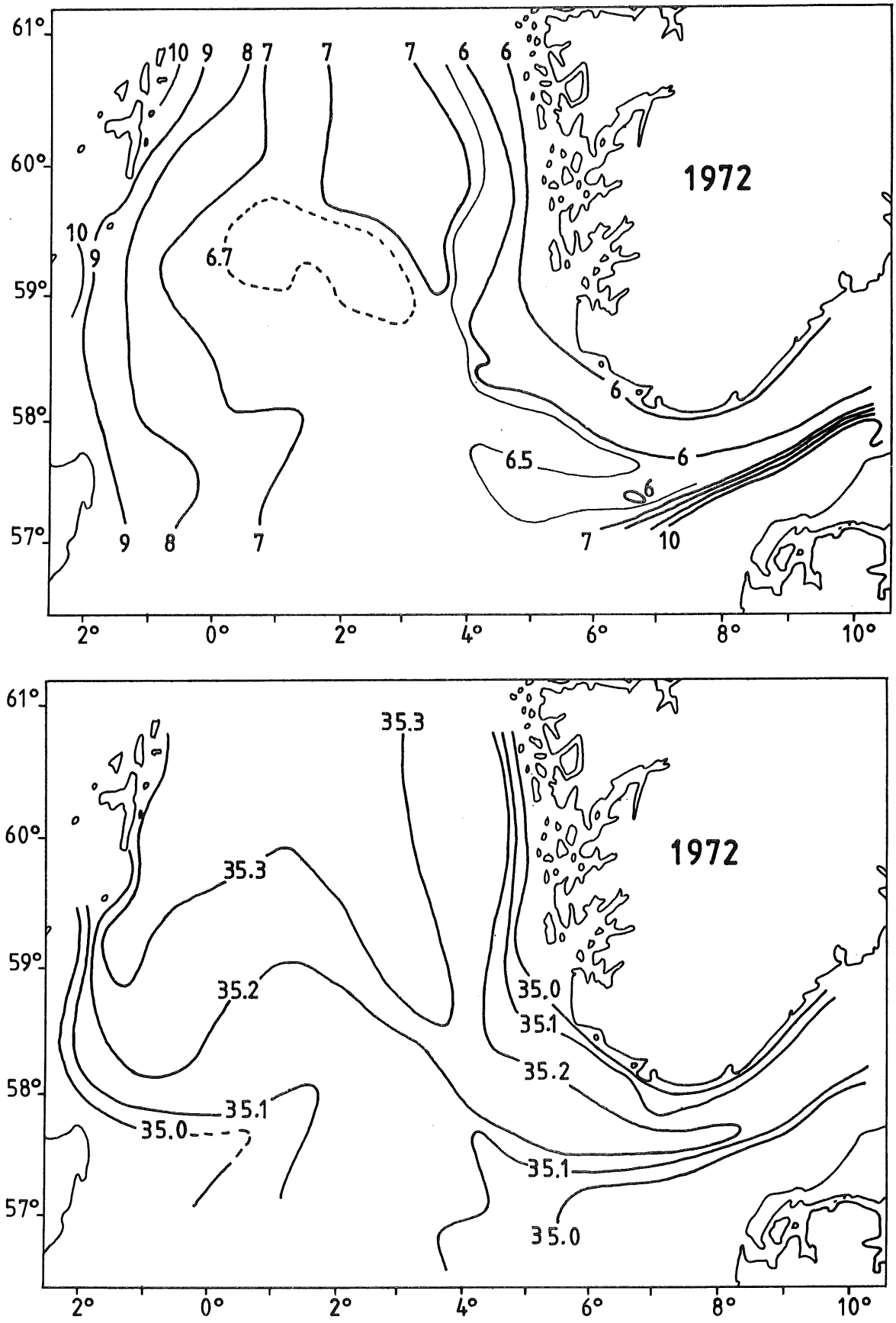

Fig. 6. Distribution of bottom temperature and salinity during the summer 1972.

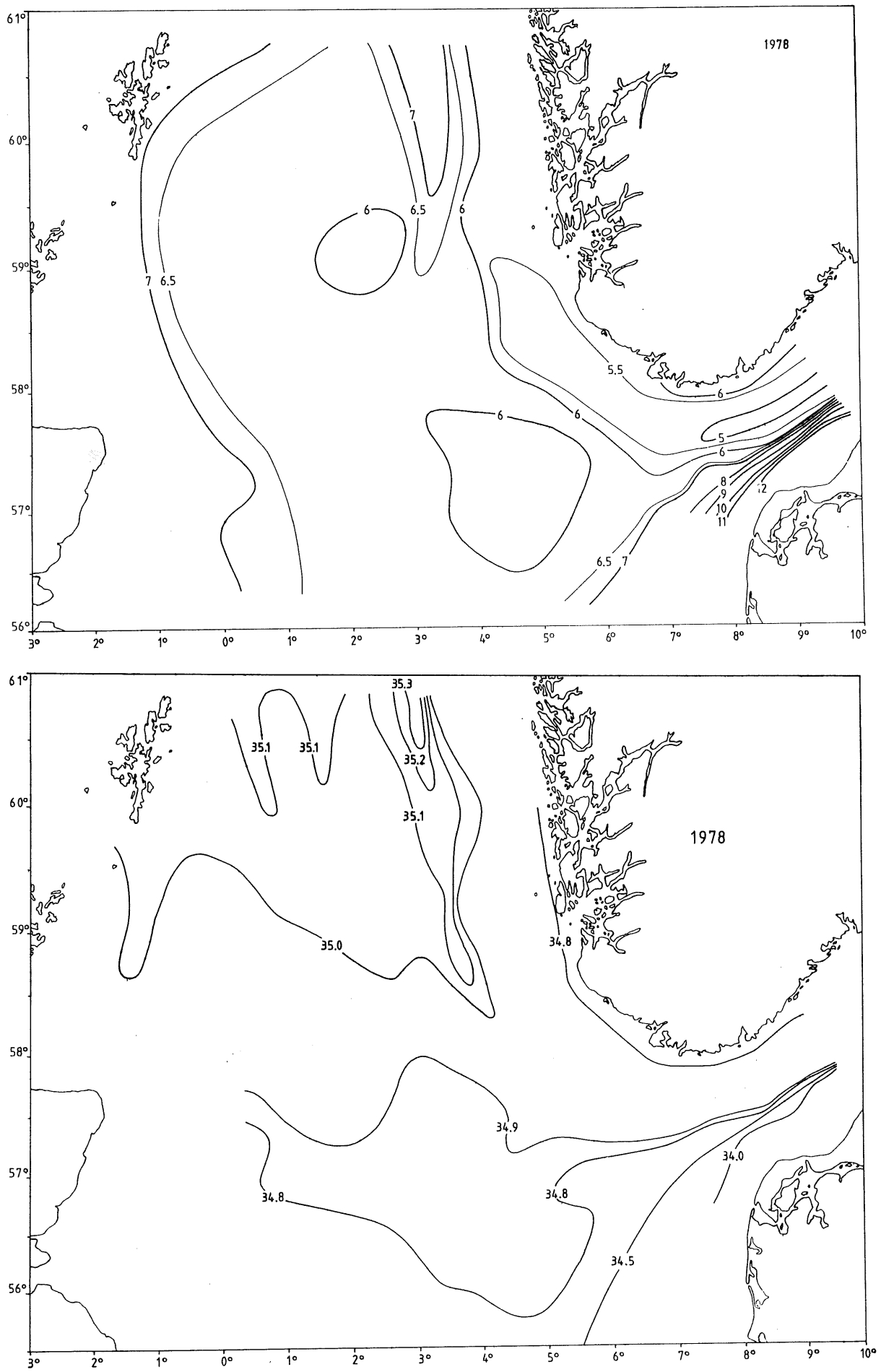

Fig. 7. Distribution of bottom temperature and salinity during the summer 1978.