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XBT-Transects along 60°N, Greenland–Scotland, 1989–1999

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During the annual autumn cruises of RV "Walther Herwig" (II and III) to East and West Greenland, the vertical distribution of temperature down to 800-m depth was measured using XBTs. The data presented in the article are transects that cross the North Atlantic Ocean at about 60°N from Cape Farewell to the Pentland Firth, taken between 1989 and 1999. Interannual variations in the water column are discussed. At depths of 400 m in the Irminger Sea Proper (60°N, 37°W) as well as south off Iceland in the North Atlantic Current (60°N, 20°W), temperatures range from 3.4°C to 5.5°C, and from 7.4°C to 8.9°C, respectively, with 1996 being the warmest year at both sites.

Keywords: Irminger Sea, North Atlantic Current, redfish, temperature.

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Introduction

The structure of the upper ocean thermal field of the North Atlantic along 60°N between Cape Farewell and the British Isles is significantly influenced by the Mid-Atlantic Ridge (Figure 1). Doming of the isotherms to the west of the ridge (Figure 2) shows the Irminger Sea thermal properties: a deep reaching, nearly homogenous water mass below the upper thermocline. The upper 1000 m of the water column east of the ridge comprises the waters of the North Atlantic Current, structured during the preceding summer. Distribution of fish in the North Atlantic, e.g. the pelagic species redfish (*Sebastes mentella*) in the Irminger Sea, seems to depend on water mass fluctuations. To estimate thermal variations at least on an annual scale, XBT-measurements were performed by RV "Walther Herwig" (II and III) on her eastbound transects crossing the North Atlantic Ocean during autumn.

Material and methods

After leaving Cape Farewell (the south tip of Greenland) XBT probes were launched every 3 h until reaching the continental shelf off Scotland. A vertical temperature profile was therefore obtained about every 30 nmi. Data analysis was done in the German Hydrographic Office (now the Federal Maritime and Hydrographic Agency of Germany) using the technique described by Sy and Ulrich (1994). Plotting of vertical sections (Figures 2, 3) was done using Ocean Data View Software (Schlitzer, 2001). To estimate the temporal variation of temperature during 1989–1999, two test points were taken from the data set: at 60°N, 37°W (Irminger Sea), and 60°N, 20°W (south of Iceland). The approximate locations are indicated in Figure 1. A polynome trend line was applied to the data points of the time-series to analyse thermal changes over the decade of the 1990s (Figures 4, 5).

Results and discussion

The 4°C isotherm with a dome-like shape dominates the Irminger Sea portion of the transect during 1989 from a depth of 200 m downwards (Figure 2). It indicates upwelling in the centre of the cyclonic gyre which is topographically steered by the Mid-Atlantic Ridge. Ten years later, the water mass structure in the centre of the Irminger Sea gyre has changed (Figure 3), and the < 4°C water dominates the water column only below 400-m depth with the top layer temperatures being > 6°C. The boundary between the less stratified Irminger Sea and the warm waters of the North Atlantic Current reveal temperatures well above 9°C during November 1989, and they exceed 10°C during November 1999. Inspection of thermal variation between 1989 and 1999 at two points of the transect (37°W, 20°W) shows considerable changes during the decade of the 1990s. At 400-m depth, temperatures range from 3.4°C to 5.5°C at 37°W, and from 7.4°C to 8.9°C at

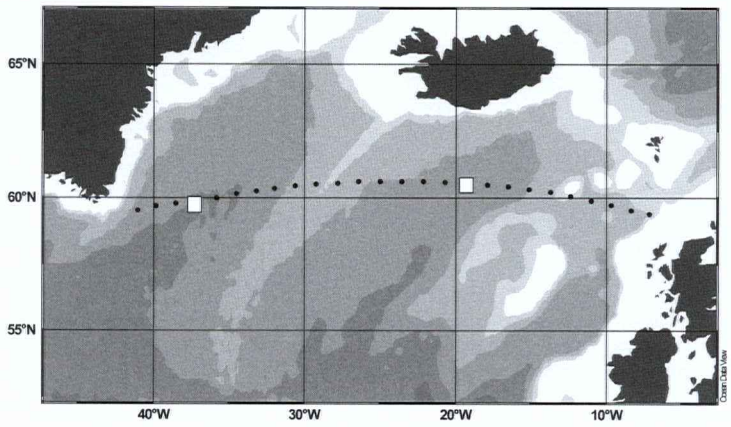

Figure 1. Location of XBT stations on Eastbound Transects; rectangles 37°W, 20°W.

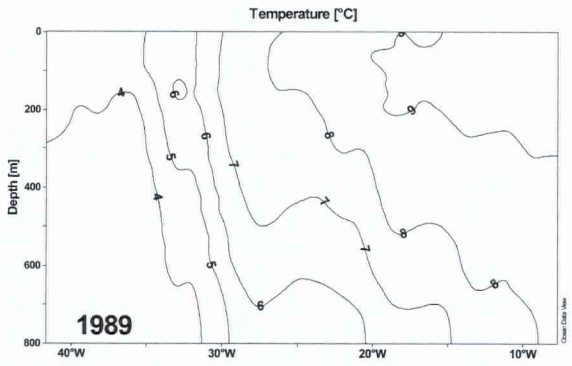

Figure 2. Vertical distribution of temperature (°C) along Eastbound Transect (Figure 1) during 1989.

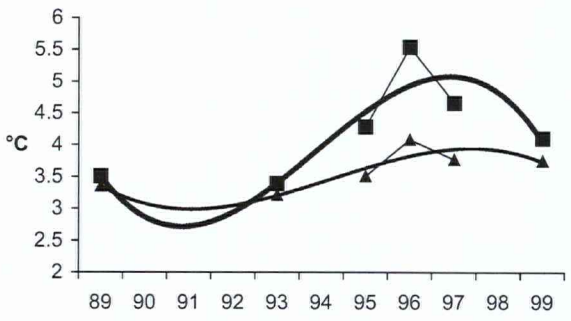

Figure 4. Variation of temperature in the Irminger Sea proper (60°N, 37°W) at 400-m and 600-m depths.

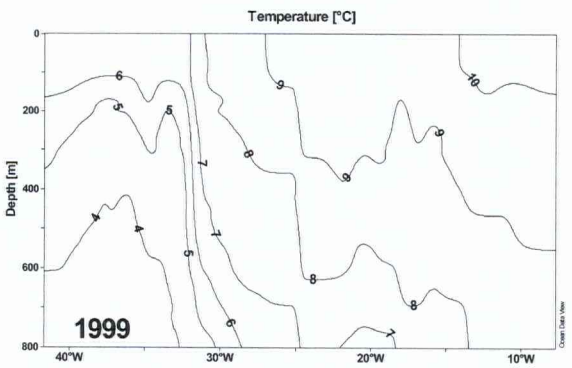

Figure 3. Vertical distribution of temperature (°C) along Eastbound Transect (Figure 1) during 1999.

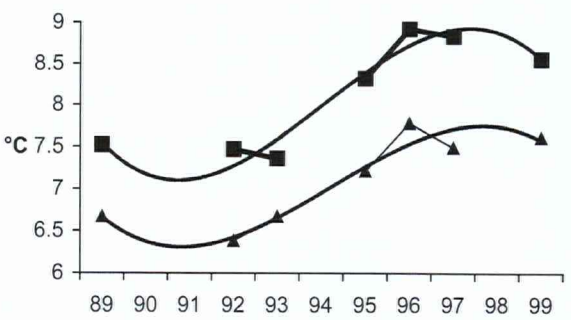

Figure 5. Variation of temperature south off Iceland (60°N, 20°W) at 400-m and 600-m depths.

20°W, with 1996 being the warmest year at both sites. At 600-m depth the observed changes in the Irminger Sea are rather small, ranging from 3.2°C to 4.1°C. South of Iceland, temperatures at 600-m depth range from 6.4°C to 7.8°C (Figure 5).

The data suggest that coldest conditions were encountered during the early 1990s, both in the depths of the Irminger Sea (Figure 4) and to the south of Iceland (Figure 5).

Conclusions

The data indicate that in the main distribution area of oceanic redfish (*Sebastes mentella*), in the Irminger Sea, thermal conditions varied considerably during the decade of the 1990s. Within the depth range around 400 m thermal changes were detected which amount to more than 2°K. Whether the warm conditions as experienced during 1996 have initiated the westward movement of the oceanic redfish stock remains speculative.

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