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Flow of Atlantic Water west of Iceland and onto the north Icelandic Shelf

Steingrímur Jónsson and Jóhannes Briem

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The Marine Research Institute in Iceland has been monitoring the inflow of Atlantic Water onto the north Icelandic Shelf using Aanderaa current meters on one mooring since 1985. In August 1999 three moorings were deployed along the Hornbanki section and recovered a year later, and these data are used along with CTD data from the section to estimate the flow of Atlantic Water to the north Icelandic Shelf. The mean transport during this period was found to be 0.95 Sv. This is lower than a previous estimate using a single mooring from the Kogur section. No clear seasonal variations were found in the transport. Interannual variations were studied using data from the single mooring at the Hornbanki section for the period 1994–2000. There are no significant variations in the velocity, but the temperature shows interannual variability. The year 1995 stands out with extremely low temperatures and during that year an anomalously small amount of Atlantic Water was found over the north Icelandic Shelf. This may show that current measurements alone do not indicate the flow of Atlantic Water, and measurements of the water properties are needed to distinguish what kind of water is flowing along the Shelf.

Keywords: Atlantic Water, currents, Iceland, Iceland Sea, Irminger Current.

S. Jónsson: Marine Research Institute and University of Akureyri, Glerárgata 36, PO Box 224, 602 Akureyri, Iceland; J. Briem: Marine Research Institute, Skúlagata 4, PO Box 1390, 121 Reykjavík, Iceland [tel: +354 4630948; fax: +354 4630998; e-mail: steing@unak.is]. Correspondence to S. Jónsson.

Introduction

Along the west coast of Iceland there is a flow of Atlantic Water (AW) with the Irminger Current. Most of this water circulates across the Irminger Sea, but a small branch continues over the Icelandic Shelf into the north Icelandic Shelf area. Because of its importance for the ecosystem there, the Marine Research Institute in Iceland has been monitoring this flow since 1985 using Aanderaa current meters on one mooring.

Data

The mooring was situated on the Kogur section from 1985 to 1994, after which it was moved to the Hornbanki section (Figure 1). In this article, only measurements from the Hornbanki section are discussed; the measurements from the Kogur section have been described by Kristmannsson (1998). In September 1999 the measurements were extended to three moorings, H1 shallowest, H2, and H3 deepest, with a total of 5 instruments that were recovered in September 2000 (Figure 2). During that period the Hornbanki section was covered five times using CTD.

Results

As an example, Figure 2 shows the distribution of salinity on the Hornbanki section in November 1999. The extent of AW is variable in the sections. There is usually a core of AW with salinity above 35. Its position and extent are variable, however. The AW does not seem to reach deeper than 200 m. Below this depth, colder and less saline water from the Iceland Sea is present. It could be argued that the fresher water seen close to shore is really AW that has been slightly diluted by freshwater run-off from Iceland. Determining the outer boundary of the flow of AW is difficult with the present data set. However, when the CTD measurements have extended beyond the five stations, AW has not been found at the sixth station.

Monthly means of the east–west component of the velocity have been calculated. The current is highly barotropic at both stations H2 and H3, which is in agreement with the findings of Kristmannsson

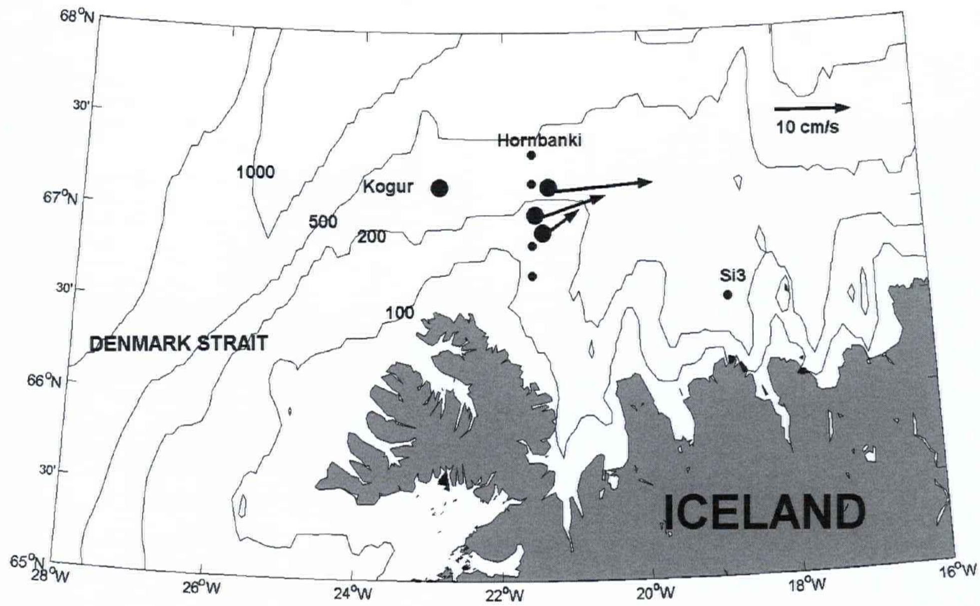

Figure 1. Map of the area. The large dots denote current meter positions and the small denote CTD stations. Depth contours are 100, 200, 500, and 1000 m. Also shown are the average currents at 80 m depth at Hornbanki during 1999–2000.

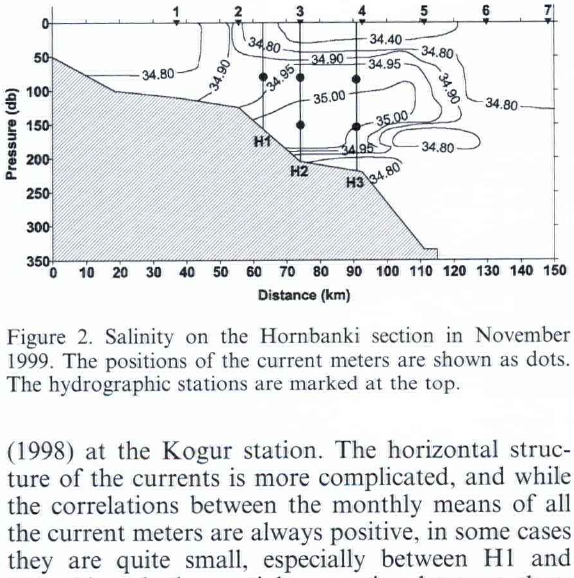

Figure 2. Salinity on the Hornbanki section in November 1999. The positions of the current meters are shown as dots. The hydrographic stations are marked at the top.

(1998) at the Kogur station. The horizontal structure of the currents is more complicated, and while the correlations between the monthly means of all the current meters are always positive, in some cases they are quite small, especially between H1 and H3, although the spatial separation between these moorings is 28 km. Almost without exception, the monthly means increase with distance from the shore. This is especially evident during spring and summer when large values are observed at the outermost mooring, H3.

There is considerable short-term variability in the records that is not picked up at all by the CTD sections. For example, the temperature at all current meters fell by almost 3°C from the time the CTD section was taken in mid-November 1999 until the end of that month. Thus the water mass properties were probably very much changed during that time.

The transport of AW through the section can be estimated using the CTD sections and the currents. The current seems to be largely depth independent and it is therefore assumed that at 80 m depth it is representative of the current from the surface down to 115 m. The current at 150 m is used below that, down to 200 m, below which there does not seem to be AW. It has been assumed that the velocity decreases linearly from the innermost mooring to 0 cm s^{-1} at 66°20′N, which is where the section plot in Figure 2 starts. South of that point, there are very shallow areas towards the shore. Determining the outer boundary of the current is not obvious and it is assumed that the current terminates midway between hydrographic stations 4 and 5. Each current meter is assigned an area of the section and the velocity perpendicular to the section is multiplied by the area, thus obtaining a transport. The results for the monthly values of the transports are shown in Figure 3. The average transport during the whole period is 0.95 Sv. Extending the transport estimate to station 5 will make the average 1.20 Sv.

The estimates presented here are lower than the 1.5 Sv estimated by Kristmannsson (1998) for the Kogur section for the period 1985–1990. During that period there was also less AW present on the north Icelandic Shelf than in 1999–2000. Kristmannsson had only one mooring and might therefore easily have overestimated the current, since it is evident from the data presented here that the current is not horizontally homogeneous.

Current measurements have been made almost continuously at H2 since September 1994. The

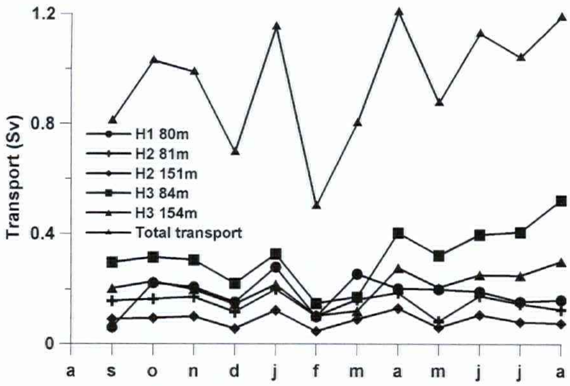

Figure 3. Monthly values of the transport. The average transport during the period September 1999 to August 2000 is 0.95 Sv. Also shown is the contribution from each of the current meters.

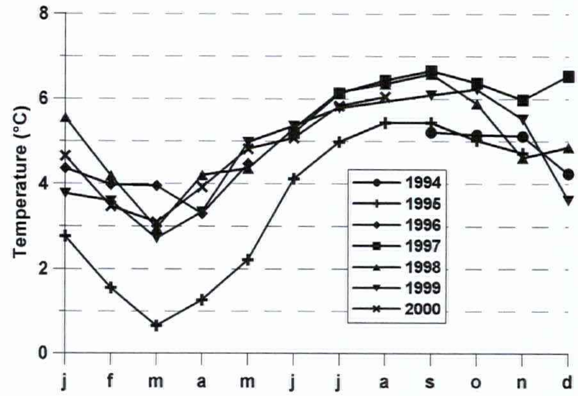

Figure 5. Monthly means of temperature from the current meter at H2 at ca. 80 m depth for different years. All available data have been used.

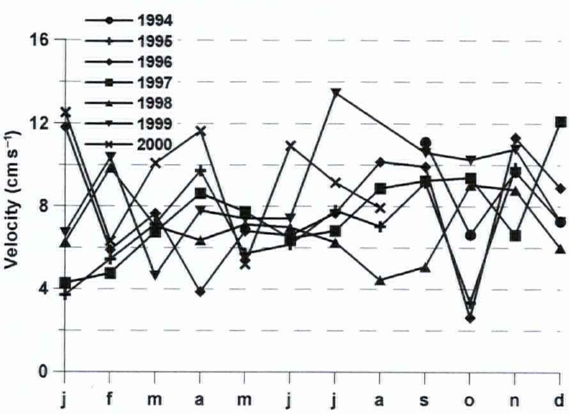

Figure 4. Monthly means of E–W component of velocity from the current meter at H2 at ca. 80 m depth for different years. All available data have been used.

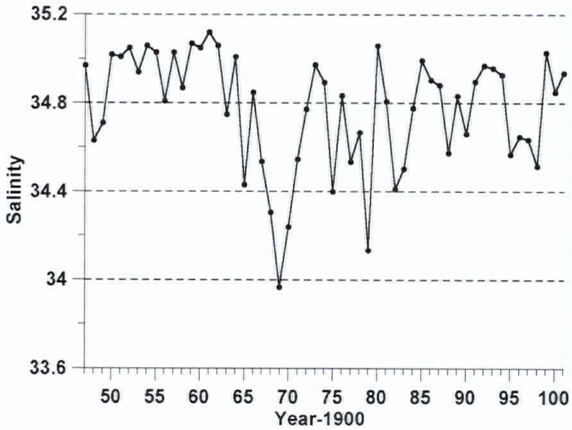

Figure 6. Salinity at 50 m depth at Siglunes (Si3 in Figure 1) in May/June since 1947.

current at nominally 80 m depth can be used to study the interannual variability of the flow of water along the Shelf. The monthly means of the east–west component of the velocity is shown in Figure 4. It shows very little seasonal and interannual variability. A look at the temperature reveals a different story (Figure 5). There is a clear seasonal signal, usually with a minimum in March and a maximum in September. Interannual variability is also present in the temperature records, since the temperature during 1995 was much lower than average for most of the year, especially in winter and spring. It was also observed on CTD cruises that little AW was observed over the north Icelandic Shelf at that time. However, no simultaneous decrease in the current was observed. This may indicate that current measurements alone do not indicate the flow of AW and measurements of the water properties are needed to distinguish the kind of water that is flowing along the shelf. Since 1996, favorable conditions with strong flow of AW have prevailed off the north coast and thus the current measurements can be assumed to measure the flow of AW during that period.

To put the results shown here in a longer term climate context the salinity measured at 50 m depth in May/June from 1947–2001 at Si3 in Figure 1 is shown in Figure 6. This illustrates the period until 1965 when warm and saline AW was dominating the north Icelandic Shelf area. During the years 1965–1971 Polar Water and drift ice were frequently observed in the area. The past few years have been characterized by the presence of AW with high temperature and salinity almost equalling that of the period before 1965.

Reference

Kristmannsson, S. S. 1998. Flow of Atlantic Water into the northern Icelandic shelf area, 1985–1989. ICES Cooperative Research Report 225, 124–135.