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The East Greenland Current System South of Denmark Strait

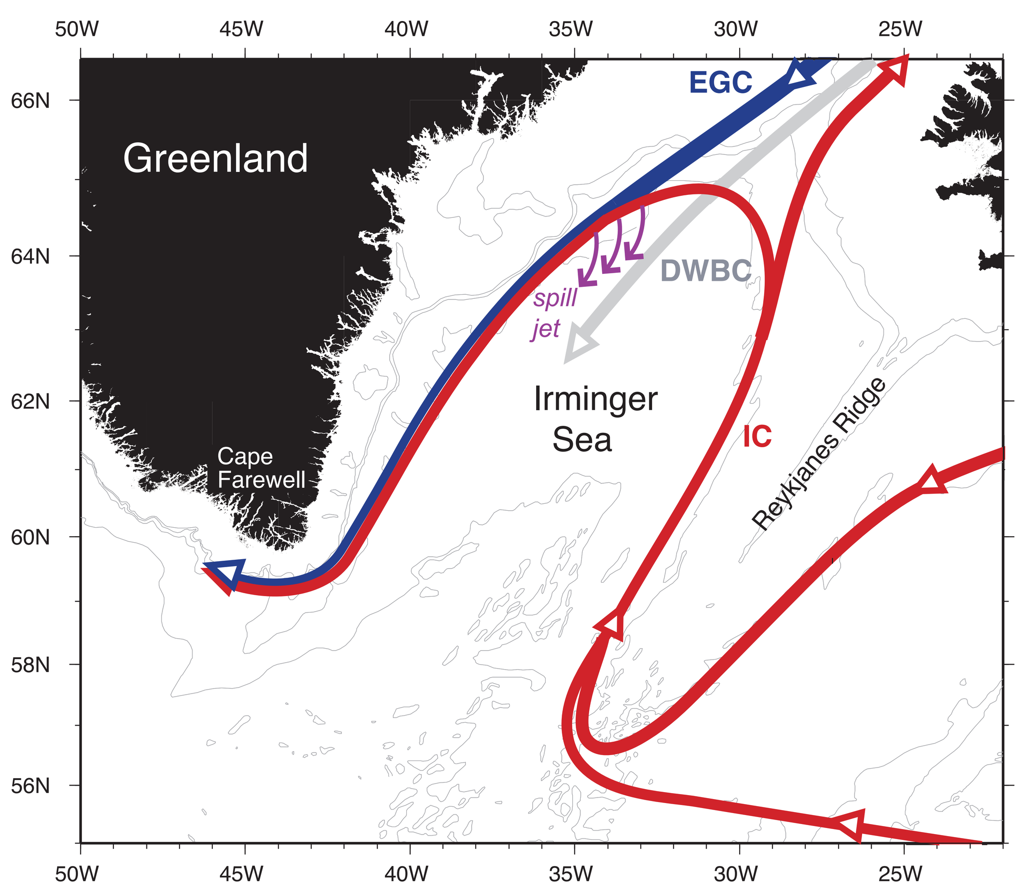

Figure 1: Boundary currents of the Irminger Sea. IC = Irminger Current; EGC = East Greenland Current; DWBC = Deep WesternBoundary Current; and the newly discovered Spill Jet.

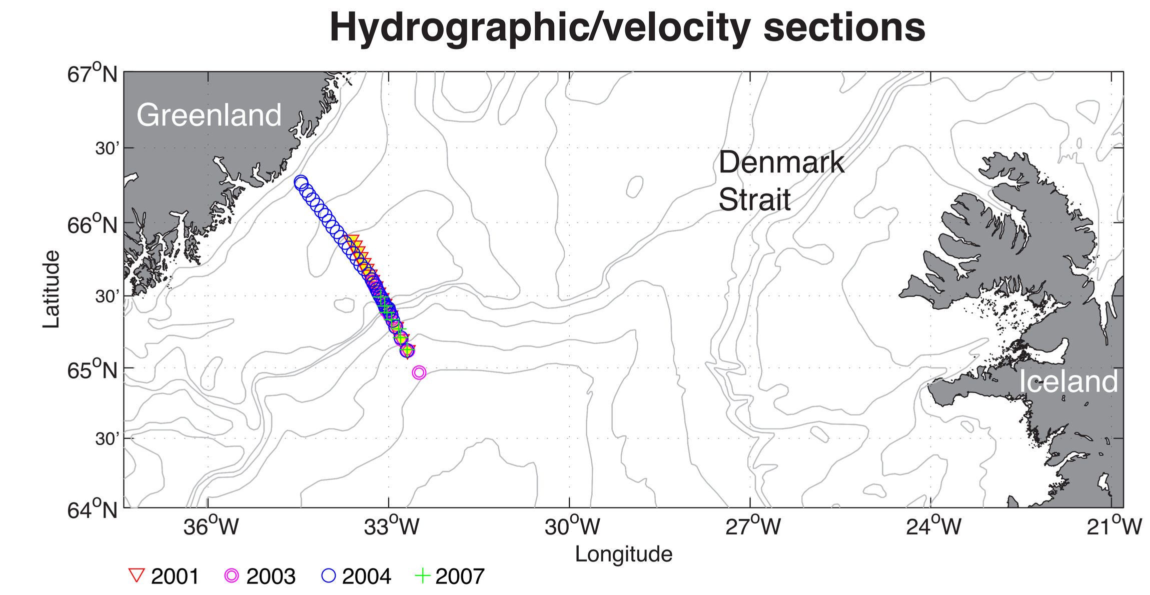

Figure 2: Hydrographic station positions of the four occupations across the boundary current.

Introduction

South of Denmark Strait along the East Greenland shelfbreak, a sharp hydrographic front forms where the cold, fresh outflowing Arctic-origin water meets the warm, salty recirculating subtropical-origin water. This front and its associated jet—the East Greenland/Irminger Current (EGC/IC)—is the "super highway" by which freshwater, as well as intermediate-density Arctic-origin water, is exported to the North Atlantic (**Figure 1**).

The front and jet are highly time-variable and unstable, leading to strong shelf-basin exchange with the open Atlantic. This is likely driven in part by strong down-front barrier winds adjacent to the tall Greenland plateau.

Between 2001 and 2007 four high-resolution hydrographic/velocity sections were occupied in summer across the shelf and slope near 66°N (**Figure 2**), to study the boundary current system and the shelf-basin exchange that takes place.

Components of the Boundary Current System

Mean vertical sections were constructed from the four occupations (**Figure 3**). The EGC/IC flows equatorward in the vicinity of the shelfbreak, while the deep western boundary current (DWBC) progresses southward near the base of the continental slope (**Figure 3a**). Recently, a third component of the boundary current system has been revealed, thought to be formed due to shelf-basin exchange processes. In particular, dense water on the outer shelf appears to cascade over the shelfbreak to form a "Spill Jet" that resides beneath the EGC/IC, shoreward of the DWBC (**Figure 3a**). The cross-shelf exchange appears to be a two-way process, whereby warm, salty Atlantic water lenses penetrate shoreward of the hydrographic front (**Figure 3b,c**). The equatorward volume transport of the Spill Jet can be as large as the DWBC at this latitude (**Table 1**).

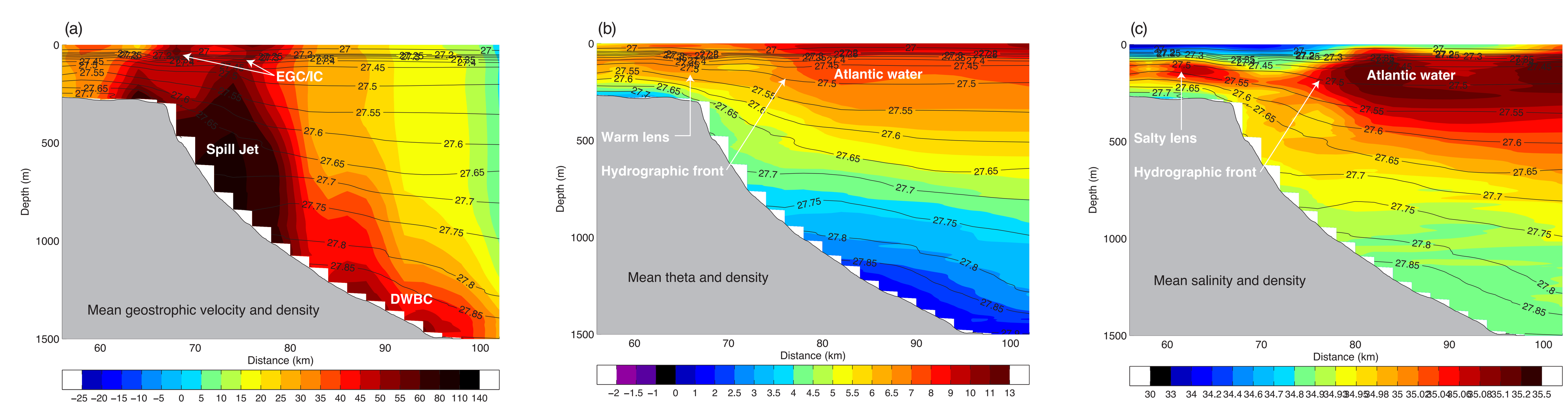

Figure 3 (below)**:** Mean vertical sections of (a) absolute geostrophic velocity (color, cm/s) overlain by potential density (contours, kg/m^3); (b) potential temperature (color, °C) and (c) salinity (color) overlain by potential density.

Vorticity Structure

The Spill Jet is very narrow (order 15 km), which partly explains why it has gone undetected until now. In 2004 its peak southward velocity exceeded 150 cm/s (**Figure 4b**), with a transport of approximately 9 Sv. Consequently, the cyclonic and anti-cyclonic relative vorticity of the jet were extremely high (magnitude exceeding 2.5, **Figure 4c**). This is a rare instance when the full Ertel vorticity of a current is dominated synoptically by the relative vorticity (**Figure 4f**).

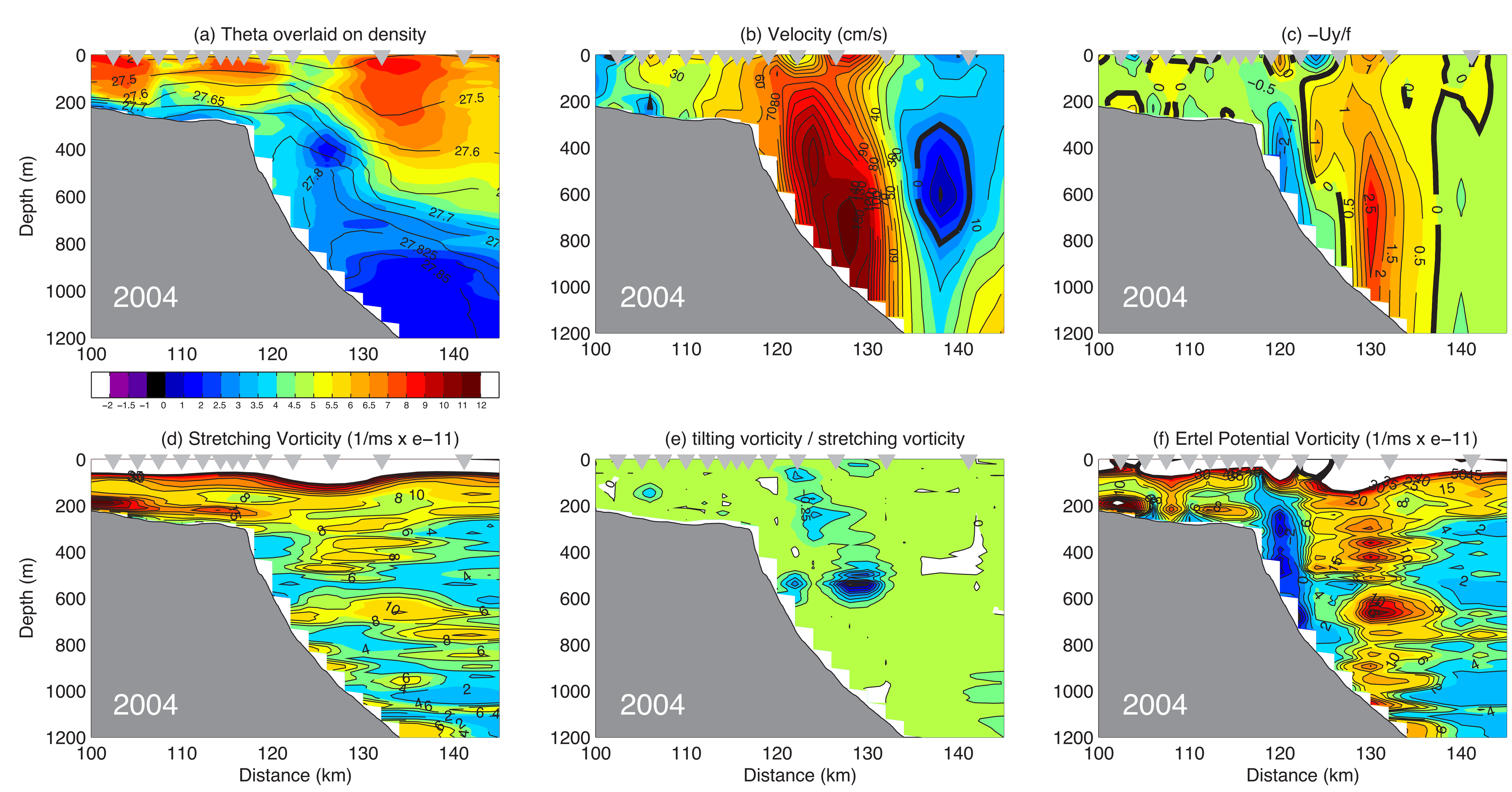

Figure 4: Vertical sections of the 2004 occupation.

Mixing

As the cold, fresh Arctic-origin water spills over the shelf, it mixes rigorously with the warm, salty Atlantic water. In 2004 the Richardson Number was less than 1 over much of the water column within the Spill Jet (**Figure 5**). This mixing permanently alters the density structure of the East Greenland Current by the time the current reaches Cape Farewell.

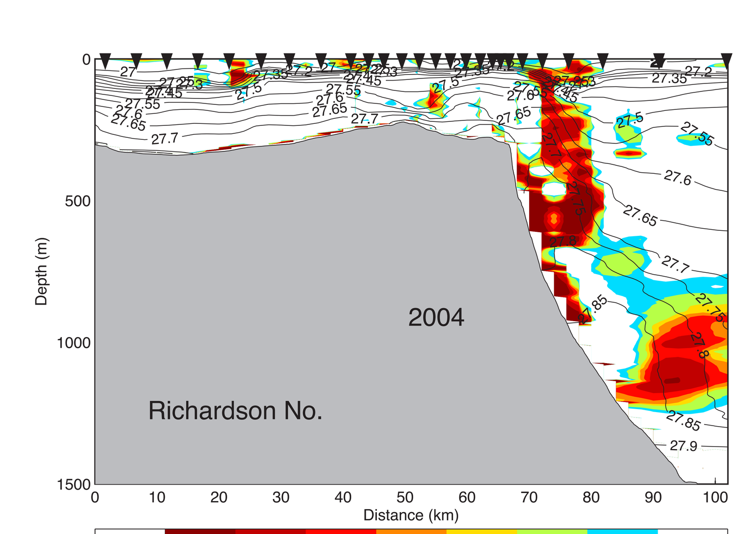

Figure 5: Richardson Number of the 2004 occupation.

A Mooring Array to Measure the East Greenland Current System

In September 2007 an array of profiling conductivity/temperature/depth (CTD) moorings, with Acoustic Doppler Current Profilers (ADCPs), was deployed along the hydrographic line (**Figure 6**). This configuration of moorings will provide two hydrographic sections per day, and multiple velocity sections, over the course of a year. The array will be recovered in October 2008.

This information will shed light on many aspects of the current, including: the seasonal variability of the Spill Jet; the role of wind forcing versus baroclinic instability in driving the dense water off the shelf; and the nature of the mixing (including double diffusive effects) which sets the density structure of the downstream flow.

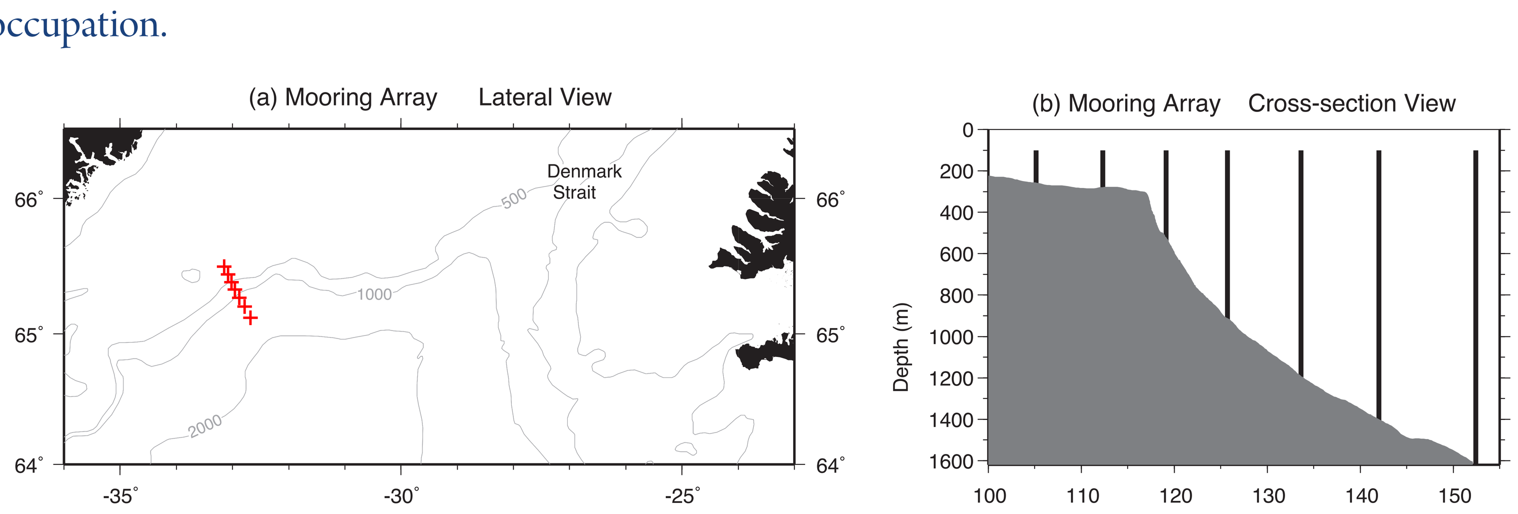

Figure 6: Mooring array deployed in September 2007.

Table 1: Volume Transports (SV)

	IC/EGC	SPILL JET	DSOW
2001*	11.7	1.9	6.0
2003	12.3	1.9	6.0
2004	7.0	8.9	5.6
2007	3.3	4.6	1.6
Mean±standard error	8.6±2.1	4.3±1.7	4.8±1.1

*Values from Pickart et al. (2005)

Acknowledgments

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