A first look at AMOC branches through the Charlie-Gibbs Fracture Zone from a two-year moored array.

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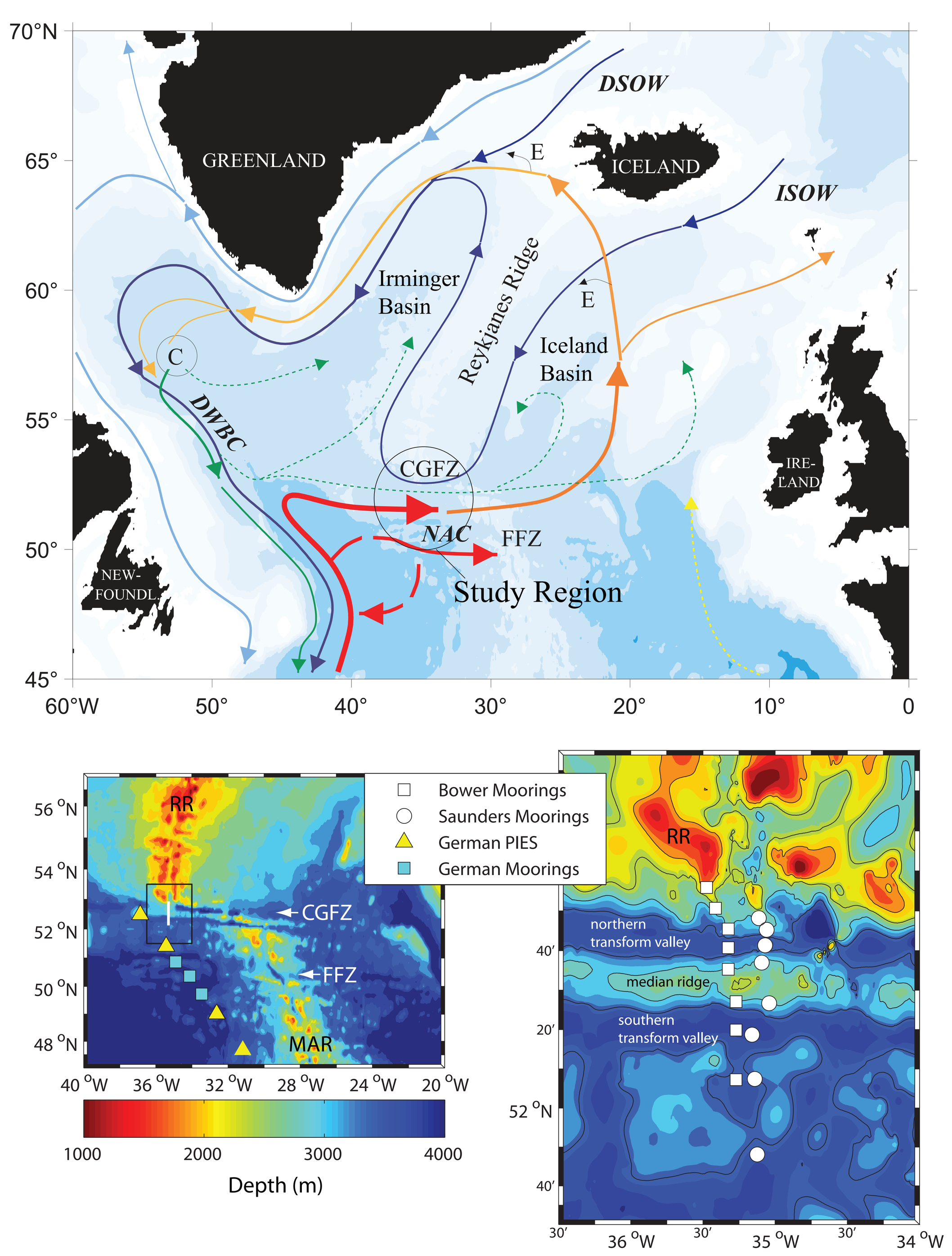
Introduction

While intense observational effort has recently been made to describe the basic structure and (in some cases) low-frequency variability at a few locations along the paths of the AMOC, relatively little attention has been paid to the Charlie-Gibbs Fracture Zone (CGFZ), a gateway for both the warm and cold limbs of the AMOC over the Mid-Atlantic Ridge. A combined observational and modeling study of the AMOC at the CGFZ is underway, with primary objectives being:

(1) to obtain an improved direct estimate of the mean and low frequency variability of the deep westward transport of Iceland-Scotland Overflow Water through the CGFZ and

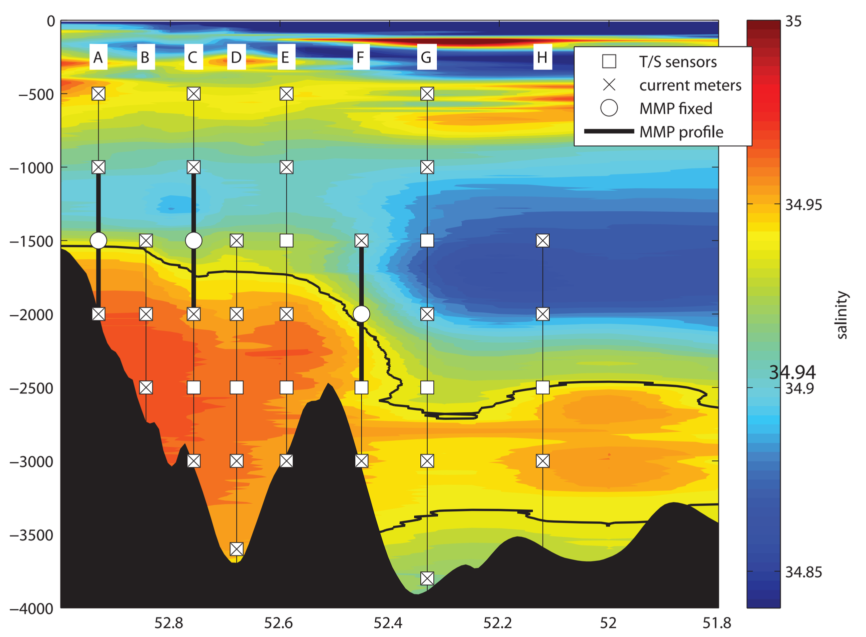
(2) to gain a better understanding of the causes of the low-frequency variability in the transport of overflow waters through the CGFZ, especially of the role of the eastward-flowing North Atlantic Current in generating this variability.

An array of eight current meter and hydrographic moorings was installed across the CGFZ for two years beginning in July 2010 (with ship time provided by M. Rhein, University of Bremen) to measure the currents and water properties between the bottom and 500 m. This array provides the first long-term, simultaneous observations of both the westward and eastward flows over the CGFZ. In addition to fixed microcats and current meters, moored profilers were deployed on three of the moorings for an exploratory study of diapycnal mixing intensity in the CGFZ. The array complements other long-term time series measurements being made in the area by M. Rhein. This study will provide a transport benchmark for critical evaluation of climate models.



1.

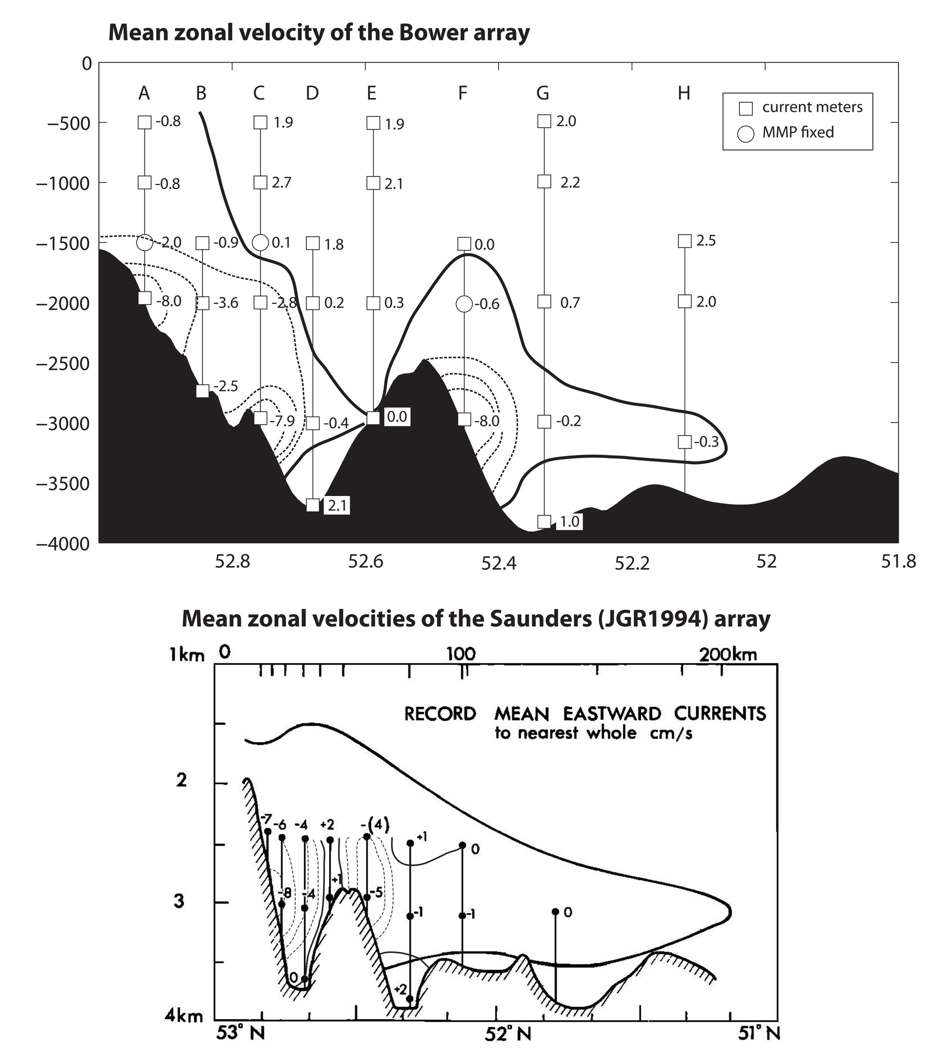
(upper) Map of the study region (circled) and major currents of the subpolar North Atlantic. (lower) Map showing locations of the Bower 2-year moored array (square markers), the German moored array done during a simultanious experiment (filled squares and triangles), and the original Saunders moored array (circles), completed in the 1980s.



Instrument type/property	Data return
Current meters (28): Aanderaa (18) Nortek (10)	
velocity	100%
pressure	96%
MMPs (3)	
temperature	68% (80, 100, 25)
conductivity	68% (80, 100, 25)
velocity	58% (80, 68, 25)
Microcats (36)	
pressure	100%
temperature	100%
conductivity	98%

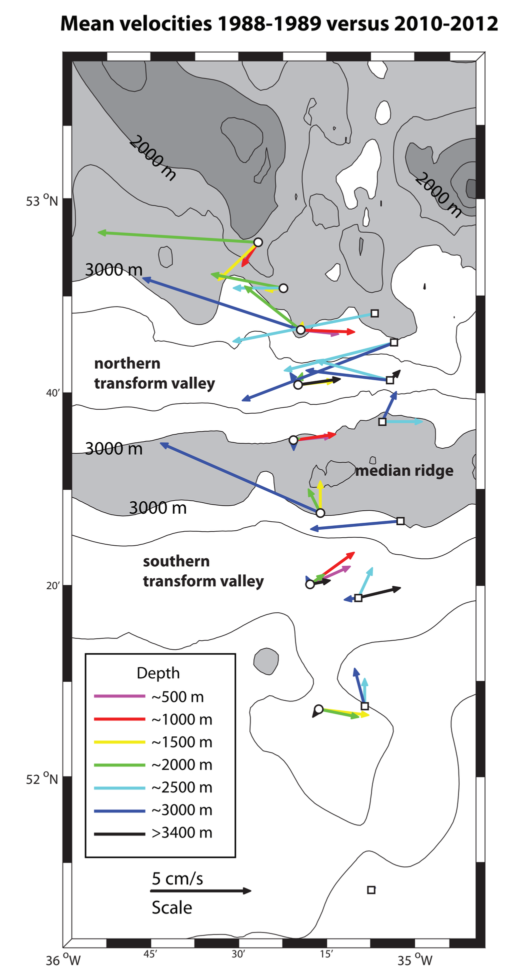
2.

(upper) Mooring array design, comprised of current meters, microcats and MMPs. The salinity field in the background is from 1997 CTD data taken along a station track that generally follows the pathway of the German moored array shown in Figure 1. (lower) Data return table. Data return was excellent except for the southernmost MMP instrument at Mooring F and the bottom microcat at Mooring B.



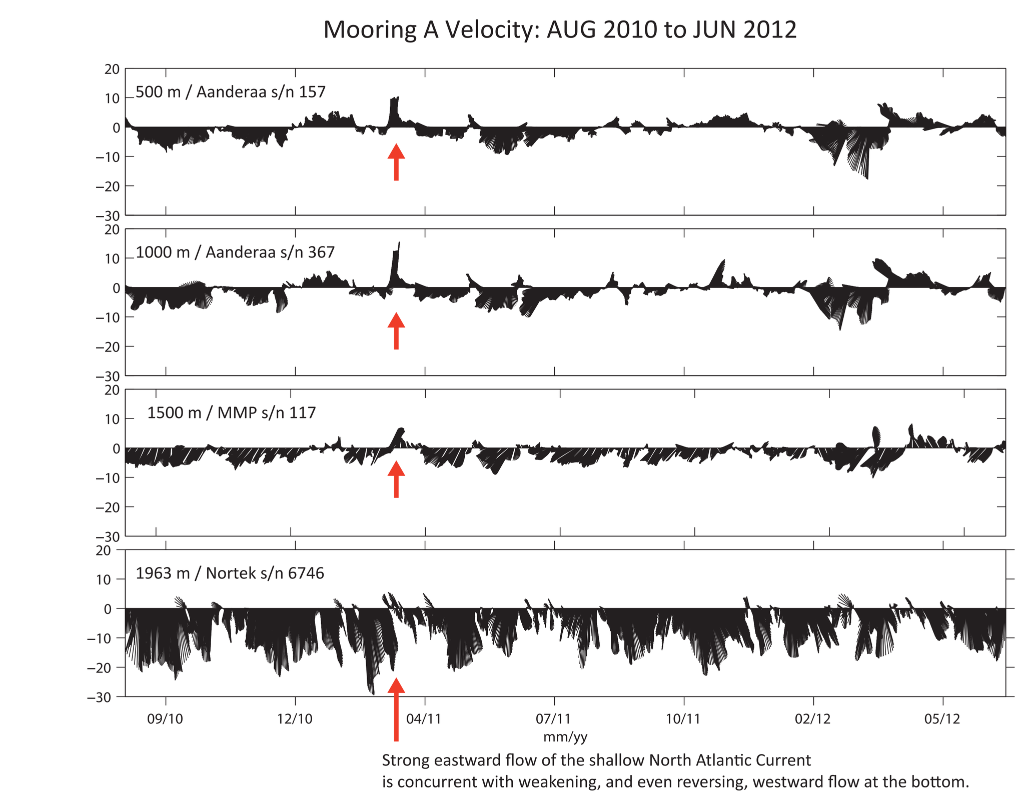
3.

(upper) Mean zonal velocity measured by the 2010-2012 Bower moored array instruments. (lower) The same, but for the 1988-1989 Saunders (JGR, 1994) moored array. Only westward velocity is hand-contoured, at 2 cm/sec intervals. Thickest black line is the approximate location of the 0 cm/sec contour. The Saunders figure also has the 34.94 psu isohaline contoured as a black line; the salinity data were from a 1988 CTD section completed as part of his experiment. Both zonal velocity sections show highest velocities along the north walls of the two channels of the fracture zone. The Bower array extended farther north , and higher into the water column, and capture a third high velocity core at about 2000 m depth at Mooring A.



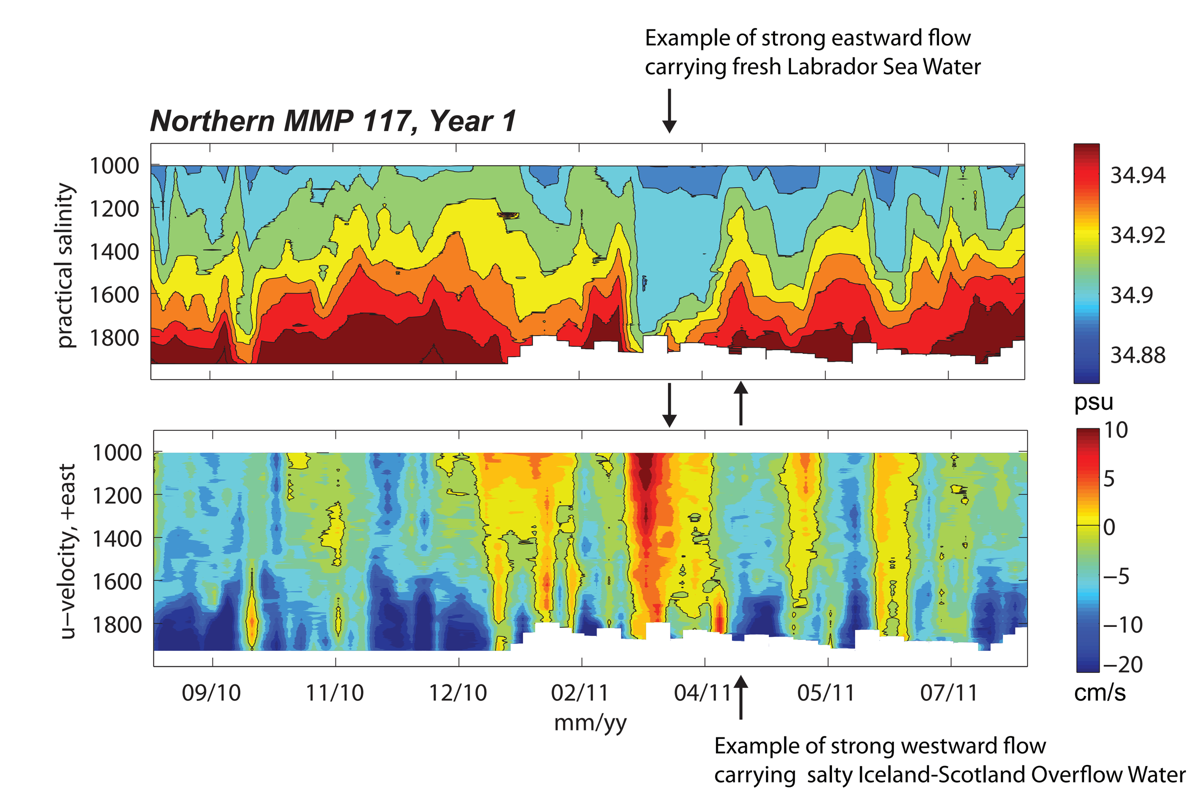
4.

Mean velocity vectors recorded at the Bower array (circles, 2010-2012) and Saunders array (squares, 1988-1989) color coded by depth. In both studies, bottom intensified flows were observed to be westward at the north walls of the two transform valleys of the Charlie-Gibbs Fracture Zone. Mean eastward flow was recorded at the deepest instruments in the central transform valleys (black vectors, depths greater than 3400 meters) and also at the instruments located higher in the water column (magenta and red vectors at 500 and 1000 m depth). Velocities generally diminish to the south.



5.

Two year records of Mooring A low-pass (40-hr) filtered velocities recorded at 500, 1000, 1500, and 1963 m depths. Velocity has been rotated so that westward is down. Velocities were generally stronger at the bottom instrument, with maximum velocity (in the unfiltered data) of 40 cm/s westward, and mean of 8 cm/s westward. The consistent westward flow at the bottom instrument was disrupted when the eastward velocities recorded higher in the water column intensified (red arrows). This may correspond to a meander of the North Atlanctic Current over this mooring site.



6.

MMP data recorded at Mooring A, showing salinity (upper) and zonal velocity (lower). The saltier Iceland-Scotland Overflow Water evident near the bottom of the MMP record corresponds to westward flow, but shows variability. In particular, when eastward flow (carrying lower salinity water) is present.

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