Twenty-Year ADCP Time Series: Monitoring Deep Overflow in Faroe Bank Channel

OVERVIEW

The last couple of decades have seen a sea change in understanding deep currents in the North Atlantic Ocean. And this change has fundamental importance for explaining the ocean's role related to climate change. Various basin-scale observational programs have toppled the traditional view of the deep circulation system. In this report and others to follow, we'll look at how Teledyne RDI's ADCPs have contributed to these observational programs.

For decades, deep currents were seen as part of a continuous, well-defined overturning circulation. The system was driven by and tightly coupled to waters sinking to great depths in the far North Atlantic. Thus, changes in the overturning circulation were to be attributed to changes in deep water formation.

What is the overturning circulation? The Gulf Stream's warm surface waters carry heat poleward. Some of these waters reach subpolar regions. There they cool due to discharging heat content to the atmosphere while also absorbing its carbon dioxide (CO2). These cooler waters sink and return equatorward as deep cold currents. With respect to climate control, this overturning system redistributes heat and also hides away anthropogenic carbon dioxide in the deep ocean.

Understanding the mechanisms driving changes in the overturning circulation is essential for climate studies. First, the deep circulation provides a buffer for increased heat and CO2 that would otherwise reside in the atmosphere. Second, this understanding is needed for building computer models that accurately predict climate change.


Faroe Islands

Products: ADCPs

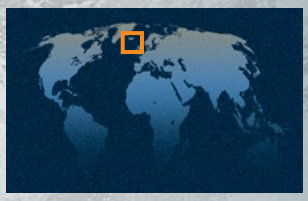
Application:
Long-term Climate Change Study

Project:
Deep Water Current Monitoring in Faroe Bank Channel (FBC))

Organizations:
Faroe Marine Research Institute, Faroe Islands and Uni Research Climate, Norway

Data Collection Date:
20-Year Time Series (beginning in 1995)

Location:
Faroe Bank Channel, subpolar North Atlantic (61.5°N, 8.5°W)



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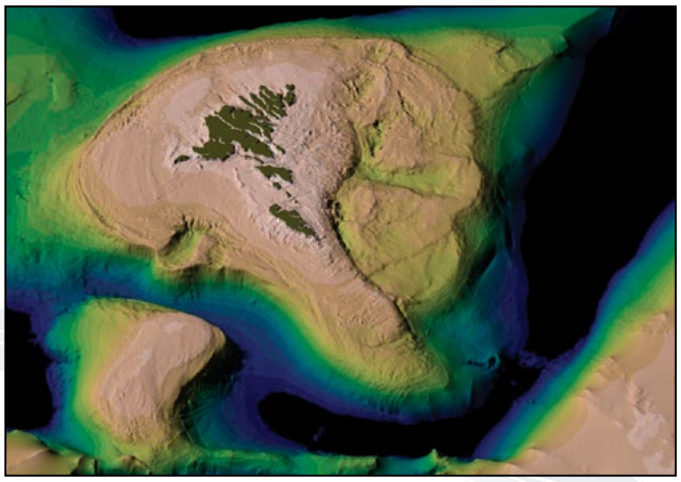
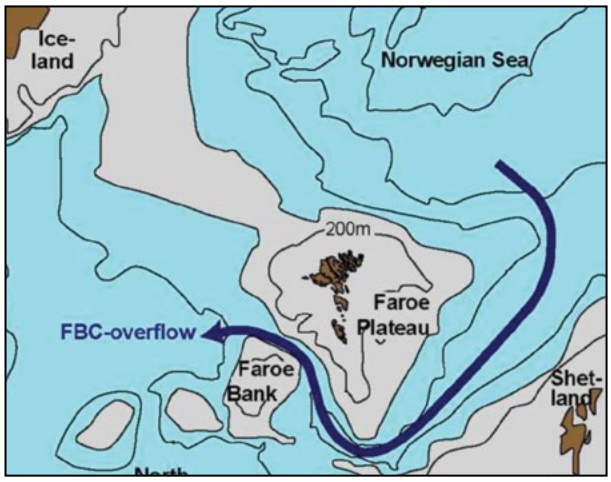


The Faroe Bank Channel is the deepest passage across the Greenland-Scotland Ridge.

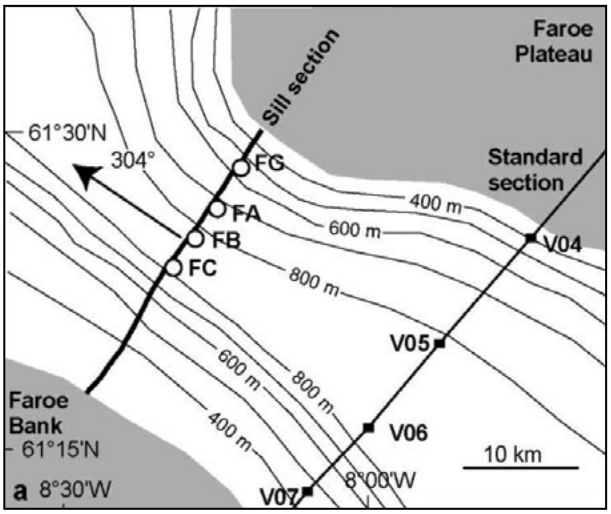


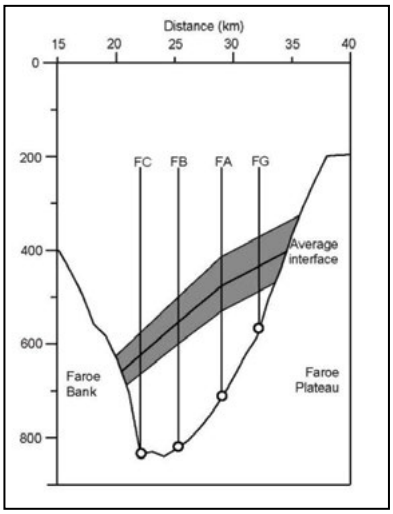
FBC overflow is a continuous bottom flow of cold and dense water passing southward into the North Atlantic.

Credit: Technical Report (2015), Hansen et al.

Just over a decade ago, the first highly-resolved time series of the volume transport of the North Atlantic's overturning circulation were collected. Scientists reported pronounced transport changes over very short periods—at odds with conventional thinking. Not only were these results most unexpected, they had important consequences for efforts to predict climate change.

Adding to this puzzle was another observational finding. Similar transport changes were not observed in outflow from the regions of deep water formation. In fact, these outflows were found to be remarkably stable. Here we consider an ADCP-based observation program that has monitored the Faroe Bank Channel overflow since 1995.





ADCPs were deployed at four different sites across the FBC.

Credit: Technical Report (2015), Hansen et al.

SOLUTION

20-Year ADCP Time Series in Faroe Bank Channel

In the returning limb of the overturning circulation, cold deep currents must cross seabed topographic barriers. These ridges span the width of the northern reaches of the North Atlantic. Deep, dense currents move along the seabed and are mostly blocked by the ridges. In fact, the currents cross to the North Atlantic at just a few locations. These are sills or deep channels where the passing currents are called *overflow*.

The Faroe Bank Channel (FBC) is the deepest passage across the Greenland-Scotland Ridge. There is a continuous deep flow of cold and dense water passing southward into the North Atlantic.

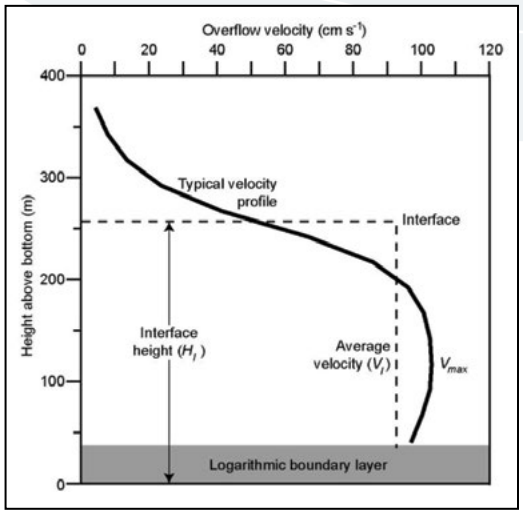
Since 1995, researchers from *Faroe Marine Research Institute, Faroe Islands and Uni Research Climate*, Norway have monitored the FBC overflow. Their work was published in a paper titled *A Stable Faroe Bank Channel Overflow 1995-2015*, authored by Bogi Hansen, Karin Margretha Husgard Larsen, Hjalmar Hatun, and Svein Osterhus.

Over the two decades, Teledyne RDI's ADCPs have been used at four different sites, always with at least one ADCP mooring located mid-channel. The dominant location is site FB, occupied since 1995 with short exceptions. Since 2002, regular deployments at FC have continued in most years with some gaps.

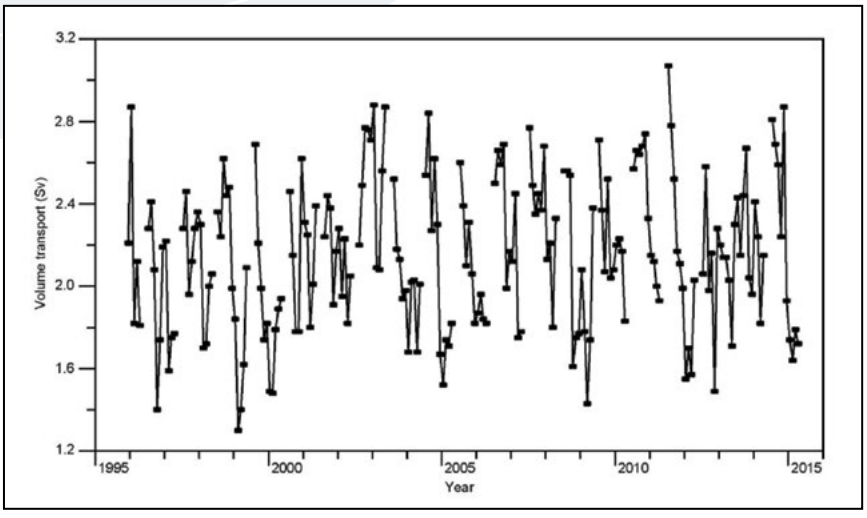
At these sites, ADCPs were upward looking, mostly deployed in short moorings. At the shallowest site, FG, the ADCP was put in a seabed frame to reduce the chances of being snagged by fishing trawlers.

HIGHLIGHTS:

- For more than two decades, Teledyne RDI's ADCPs have been measuring critical volume transport data for the FBC overflow
- The ADCP data comprise 6750 days of velocity profiles that reach 400 meters above the bed
- This long-term monitoring of the FBC overflow provides key information for modeling the role of deep ocean circulation in climate studies



Representative profile for ADCPs deployed in FBC. Key facets of the flow regime are depicted.



A 20-year series of monthly-averaged values for volume transport of deep overflows in Faroe Bank Channel.

Credit: Technical Report (2015), Hansen et al.

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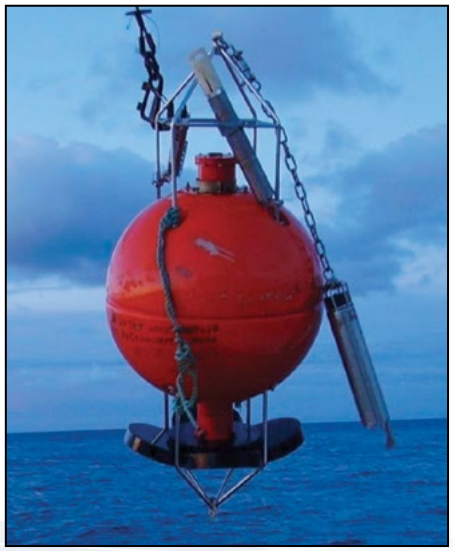

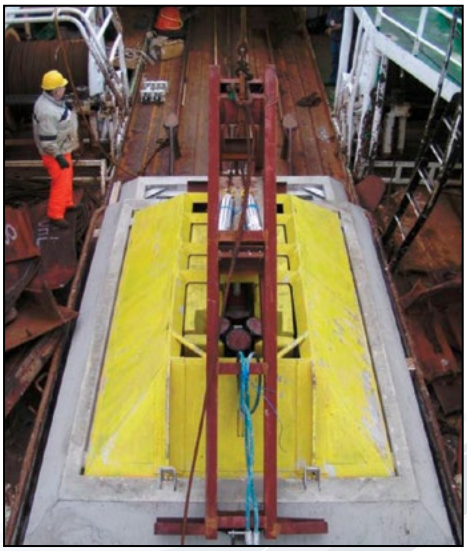

ADCPs were mostly deployed atop short moorings. At one site, the ADCP was in a seabed frame.

Credit: Technical Report (2015), Hansen et al.

RESULTS

The ADCP data comprise 6750 days of velocity profiles. Reaching at least 400 meters above the bed, the profiles contain the overflow layer.

Using ADCP data, the researchers constructed time series of volume transport for the FBC overflow. Monthly averaged values are shown in the previous figure. Over the 20-year time series, the ADCP data show a stable volume transport with a mean value of 2.2 ± 0.2 million cubic meters per second. That volume is about four times the outflow of the Amazon—the largest river on earth.

Scientists interpret these overflow records as a proxy for deepwater formation in the high northern latitudes. Traditionally, the latter was thought to be tightly linked to changes in the overturning circulation system. For this period, the steady value noted here was matched at other sills in the region.

Yet large swings in volume transport were reported for the overturning circulation monitored at 26.5N. So the assumed tight link, and how changes in deep circulation are to be modeled in climate studies, is now being reassessed. The long-term ADCP time series in Faroe Bank Channel provides a key piece to solving this puzzle.

REFERENCES:

A Stable Faroe Bank Channel Overflow 1995-2015

Bogi Hansen, Karin Margretha usgard Larsen, Hjalmar Hatun, and Svein Osterhus

Faroe Marine Research Institute, Faroe Islands and Uni Research Climate, Norway

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Supplement to A Stable Faroe Bank Channel Overflow 1995-2015 (https://goo.gl/K1HHL1)

Faroe Bank Channel Overflow 1995-2015 – Technical Report (2015) HAVSTOVAN NR.: 15-02

Bogi Hansen, Karin M. H. Larsen, Regin Kristiansen, Ebba Mortensen, Svein Osterhus

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