PROUDMAN OCEANOGRAPHIC LABORATORY

CRUISE REPORT NO. 42

ASOF:
Inverted Echo Sounders in the Denmark Strait

As part of

FS METEOR CRUISE 59/1

JUNE 27, 2003 – JULY 20, 2003

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ABSTRACT

The overflow of cold dense water from the Denmark Strait is one of the key elements of the north Atlantic thermohaline circulation and has important consequences for global climate change. It is important to measure the transport of this water and to understand its variability on seasonal and at longer time scales.

The ASOF (Artic Sub-Arctic Ocean Fluxes) project is an attempt to measure and model the variability of fluxes between the Arctic Ocean and Atlantic Ocean using modern oceanographic instrumentation, with a view to implementing longer-term critical measurements needed to understand the high latitude oceans role in decadal climate variability.

A combined Inverted Echo Sounder and Bottom Pressure Recorder was successfully recovered from the Denmark Strait. This was replaced by a new measuring system called HOMER (Homing Marine Recorder) to measure the thickness of this cold dense water and thus determine transport.

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KEYWORDS	CONTRACT
Bottom Pressure Recorder Denmark Strait Inverted Echo Sounder ASOF Sea Level Bottom Water North Atlantic	PROJECT LT310C PRICE £10.00

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OVERVIEW

The overflow of cold dense water from the Denmark Strait is one of the key elements of the north Atlantic thermohaline circulation and has important consequences for global climate change. It is important to measure the transport of this water and to understand its variability on seasonal and at longer time scales.

ASOF (Arctic Subarctic Ocean Fluxes) is a project to measure and model the variability of fluxes between the Arctic Ocean and the Atlantic Ocean with a view to implementing a longer term system of critical measurements needed to understand the high-latitude ocean's steering role in decadal climate variability. Long-term measurements are being made using modern oceanographic instrumentation to determine the variation of the Arctic circulation. Part of this work involves the Denmark Strait where an array of current meters is in place to measure the strength of the Overflow Water (DSOW). Conductivity, Temperature and Depth (CTD) surveys provide knowledge of the physical properties.

To measure its thickness, and hence get a value for transport for the DSOW, an Inverted Echo Sounder (IES) had been deployed in the core of the current with a view to detecting the echo from the interface between the cold bottom water and the overlying intermediate layer. The IES was replaced by a new measuring device called HOMER (Homing Marine Recorder), which will be in-situ for twelve months. This will act as an inverted CTD, making regular profiles and should be capable of accurately determining the properties of this layer due to seasonal variations.

POL CRUISE OBJECTIVES

1) To recover an Inverted Echo Sounder in the Denmark Strait
2) To deploy a HOMER in the Denmark Strait
3) To deploy and recover a trial RAPID Lander in the Denmark Strait

BPR DEPLOYMENTS

SHIP PREPARATION

POL personnel joined FS Meteor at Ponta Delgada, Azores on June 26, 2003. The equipment was unpacked from the container and stored in the laboratory. The ballast weight and frame were lashed on the deck and the rest of the gear placed in the main laboratory and stowed safely.

DEPLOYMENT OF RAPID LANDER 9/7/2003

EVENTS

09.00 GMT	Vessel on station.
09.07 GMT	Release into the water.
09.32 GMT	On the seabed.

Total time on station: 32 minutes.

RAPID Lander Deployment Summary

Acoustic conditions were excellent. Two ping replies were being received for every transmission. It is possible that the second ping may be the bottom echo.

RECOVERY OF IES/BPR (UK1/IES) 10/7/2003

EVENTS

19.14 GMT	Vessel on station.
19.15, 19.17, 19.20, 19.24, 19.38 GMT	Release command transmitted.
19.41 GMT	Released from the seabed.
20.16 GMT	On the surface.

Total time on station: 58 minutes.

IES/BPR (UK1/IES) Recovery Summary

Acoustic conditions were very good. Communication with both acoustic releases was definite and immediate. The release command was transmitted to one of the releases and the four-ping acknowledgement was clearly received. It took a few tries to get the second unit to activate, but it eventually indicated that it was burning.

ATTEMPTED RECOVERY OF RAPID LANDER 14/7/2003

EVENTS

22.00 GMT	Vessel on station.
22.01, 22.37 GMT	Release command transmitted.
23.00 GMT	Leave site.

Total time on station: 60 minutes.

RAPID Lander Attempted Recovery Summary

Acoustic conditions were very good despite the weather. Communication with the acoustic release was definite and immediate. The release command was transmitted and the four-ping acknowledgement was clearly received. The unit was regularly interrogated and replied to indicate that the burnwire was burning. After 60 minutes it was apparent that it was not going to return. The ship left the site and returned the next morning. The unit was then interrogated again and found to still be on the seabed. It was still indicating that it was releasing but was still not returning. Unlike with a mechanical release system, as used on inline releases, it was not possible to put the release system into a safe state in order to attempt a recovery later in the year.

DEPLOYMENT OF HOMER (F2/HOMER) 15/7/2003

EVENTS

13.08 GMT	Vessel on station.
13.10 GMT	Release into the water.
13.45 GMT	On the seabed.

Total time on station: 37 minutes

HOMER (F2/HOMER) Deployment Summary

The ship was acoustically very quiet, so it was possible to achieve excellent communication with both acoustic releases to the seabed.

CONCLUSIONS

The main work was successfully completed, however the recovery of the trial RAPID Lander failed. The reason for this is not known but a possible cause may be that an insufficient time period had elapsed between deployment and recovery for the corrodible bolts to fully dissolve. Lab tests had been conducted on similar bolts that resulted in a dissolve time of six hours. However, the chemical properties of the Denmark Strait water, or operational considerations, may be sufficiently different from the lab test settings to extend the time taken to fully dissolve.

Another consideration for the failed recovery could be that the RAPID Lander was using a new acoustic transducer. This may be causing a problem, but seems unlikely since the unit was replying to interrogations. It may also be possible that although the unit was indicating that the burnwire was activated, it never burned away and the RAPID Lander still being restrained by the burnwire module.

The successful recovery of the IES concluded a nine year record of IES data and an eight year record of BPR data from the Denmark Strait.

APPENDIX 1 - BPR TECHNICAL INFORMATION

RAPID LANDER DEPLOYMENT INFORMATION

Location details	**-**	***Latitude 63°38.55'N***
		Longitude 036°56.58' W
		Depth 1500m
On station	-	09.04 GMT on 9/7/2003
Released into the water	-	09.07 GMT
On seabed	-	09.32 GMT

The deployment went very well in fairly rough conditions. Acoustically it was very quiet and therefore easy to monitor the unit to the seabed.

Logger

The logger was started before the unit was shipped out. All information relating to the sensor fitted and the start time of the logger is recorded in a log book held at POL. At the time of publication, this information had not been made available to the author.

Acoustic Release

A new Benthos XT6001 release is fitted with; Rx – 13.5 kHz, Tx – 12.0 kHz, Release - B

IES/BPR (UK1/IES) RECOVERY INFORMATION

Location details	**-**	***Latitude 63°28.58' N***
		Longitude 036°17.37' W
		Depth 1991m
On station	-	19.14 GMT on 10/7/2003
Release command transmitted	-	19.15, 19.17 AND 19.38 GMT
Released from seabed	-	14.32 GMT
On surface	-	20.16 GMT

Acoustics fitted were 46457 (Rx 15.0 kHz, Tx 12.0 kHz, Release B) and 46428 (Rx 14.5 kHz, Tx 12.0 kHz, Release D), both using the burnwire release. The release command was initially transmitted to acoustic unit 46457. The release command was then transmitted to the second release. The second release gave a clear indication of burning by responding with five pings when interrogated. Release 46457 was not giving this signal. The release command was transmitted a few more times and eventually indicated it was releasing at 19.38 GMT.

Logger
Timebase

Expected Scan	Actual Scan
10.45.00 GMT on 13/7/2003	10.44.44 GMT on 13/7/2003

Timebase is 16 seconds fast.

Data were downloaded to UK1BPR0203.RAW

Data Arrangement
The raw data are made up of eight columns

Column	**Data**
1	Time
2	Date
3	Temperature (DQ 36573)
4	Pressure (DQ 36573)
5	Temperature (DQ 38175)
6	Pressure (DQ 38175)
7	Blank
8	Blank

Inverted Echo Sounder

The IES pinged at 10.40.44 GMT on 16/7/2003
Number of data files stored was 4670.
The data were downloaded to UK1IES0203.V12

Acoustic Release

S/N 46428

Acoustic battery voltage	-	Red 12.39V
		Orange 12.38V
Burnwire voltage	-	26.78V

S/N 46457

Acoustic battery voltage	-	Red 12.61V
		Orange 12.58V
Burnwire voltage	-	26.70V

HOMER DEPLOYMENT INFORMATION

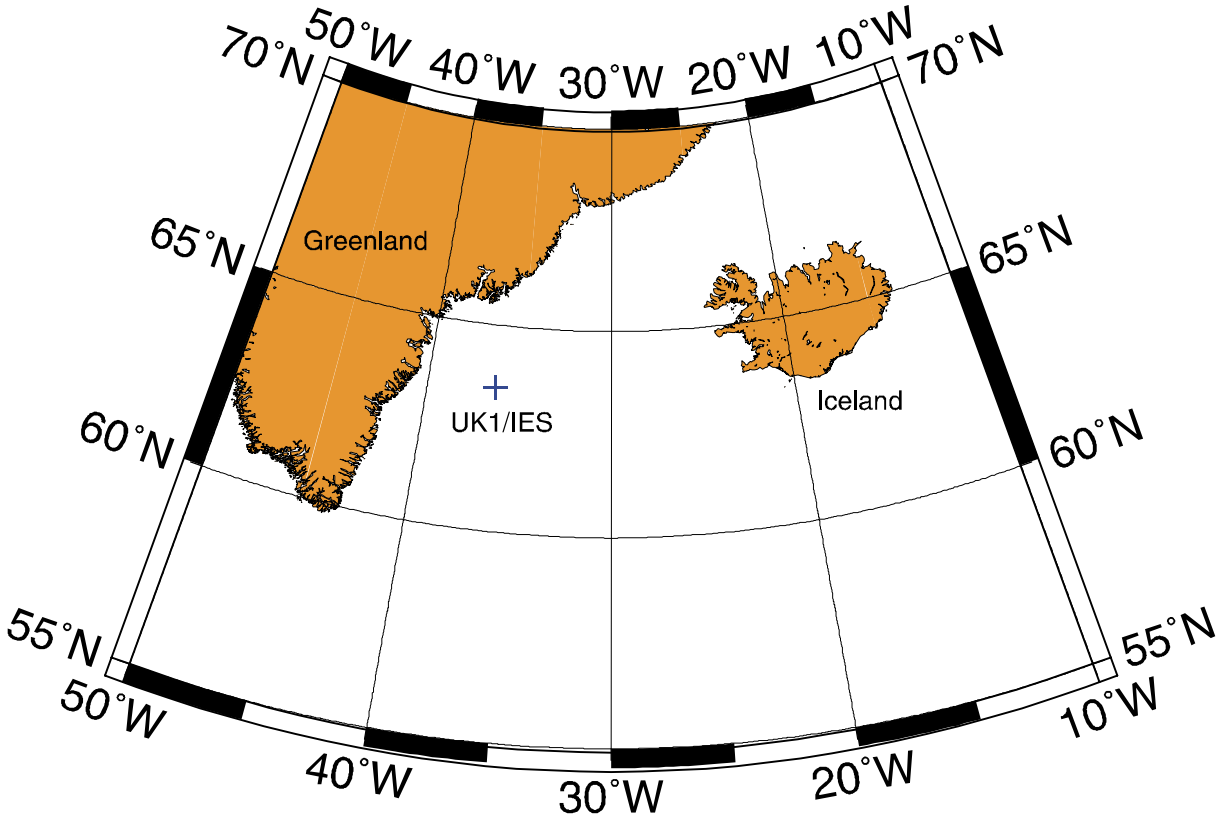
Location details	**-**	***Latitude 63°33.93' N***
		Longitude 036°27.99' W
		Depth 1797m
On station	-	13.08 GMT on 15/7/2003
Released into the water	-	13.10 GMT
On seabed	-	13.45 GMT

The deployment went very smoothly. The weather was perfect with virtually no wind and no swell. HOMER descended at nearly 1m/s and both acoustic releases communicated well to the seabed and gave a slant range reading of 1827m. Both the sphere and the winch systems were started simultaneously on the deck of the ship just before deployment. They will sleep for 24 hours and then perform the first profile at 14.00 GMT on 16/7/2003. The system is self-synchronising so it does not require manual intervention once the software is running.

Acoustic Release
XT6000 serial number 47136, Rx – 10.0 kHz, Tx – 12.0 kHz, Release E
XT6000 serial number 46428, Rx – 14.5 kHz, Tx – 12.0 kHz, Release D

A Benthos radio beacon, frequency output of 154.585 MHz is fitted to the frame.

MAP OF IES/BPR DEPLOYMENT POSITION



GLOSSARY

ADC	-	Analogue to Digital Converter
ASOF	-	Arctic Subarctic Ocean Fluxes
BPR	-	Bottom Pressure Recorder
BSH	-	Bundesanstalt für Seeschiffahrt und Hydrographie
CEFAS	-	Centre for the Environment, Fisheries and Aquaculture Science
CTD	-	Conductivity, Temperature and Depth Profiler
DSOW	-	Denmark Strait Overflow Water
FiMR	-	Finnish Institute of Marine Research
GMT	-	Greenwich Mean Time
IES	-	Inverted Echo Sounder
IfMH	-	Institut für Meereskunde, Hamburg University
IfMK	-	Institut für Meereskunde, University of Kiel
IUPB	-	University of Bremen, Institut für Umweltphysik
POL	-	Proudman Oceanographic Laboratory
SAMS	-	Scottish Association for Marine Science
UM	-	University of Munich
VEINS	-	Variability of Exchanges in Northern Seas