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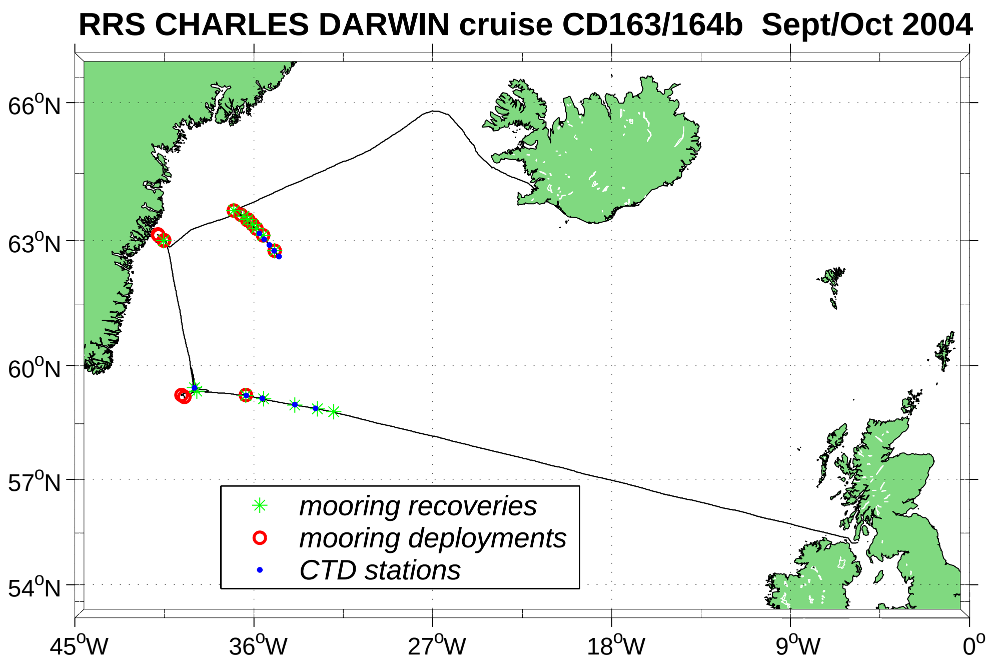
Cruise Report
RRS Charles Darwin Cruise CD164/165b

Reykjavik – Glasgow
23. September – 12. October 2004
Chief Scientist: Detlef Quadfasel
Captain: Peter C. Sarjeant

Technical Report 2-04

On citing this report in a bibliography, the reference should be followed by the words *unpublished manuscript.*

*The scientific party of RRS CHARLES DARWIN cruise CD 163/164b after having completed the last mooring recovery (**Photo Michael Hood**).*



Ship track of RRS CHARLES DARWIN cruise CD 163/164b with locations of mooring recovery and deployment positions and CTD casts marked.

1. Objectives

RRS CHARLES DARWIN cruise CD163/164b was carried out jointly by the Institut für Meereskunde at the Centre for Marine and Atmospheric Sciences of the University of Hamburg and the Kongelijk Nederlands Instituut voor Onderzoek der Zee with participation of the Finnish Institute for Marine Research, Helsinki, the Lowestoft Laboratory of CEFAS, the Geophysical Department of the University of Copenhagen, and the School of Environmental Science of the University of East Anglia, Norwich. The measurements contributed to three projects:

- the Arctic Subarctic Ocean Flux (ASOF-W) study, funded by the European Union,
- the Long-term Ocean Climate Observation (LOCO) project, funded by the Dutch National Science Foundation NWO, and
- the UK funded Rapid Climate Change (RAPID), a programme of the Natural Environment Research Council.

The main objective of the cruise was to recover and deploy self contained current meter and hydrographic moorings for the above projects. In addition, ten CTD profiles were acquired at selected locations and underway measurements of meteorological and near surface ocean parameters were made, using the ship board observing system.

2. Narrative

Wednesday 22. September 2004
Noon position: Reykjavik

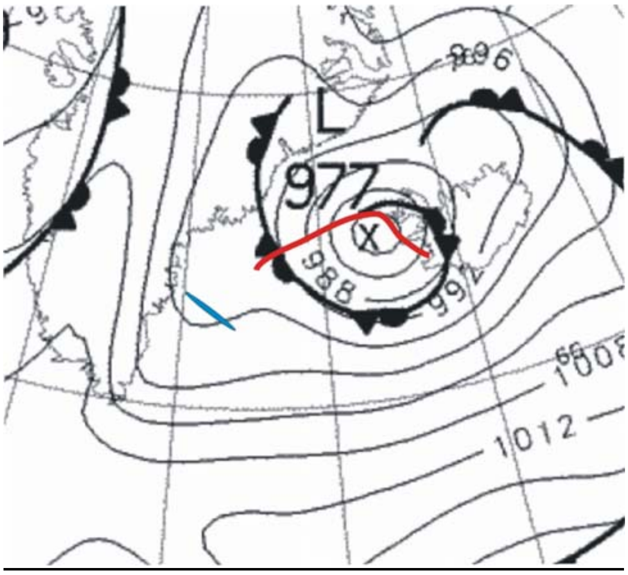
Arrival of RRS Charles Darwin in Reykjavik from St. Johns. Loading of the equipment started 3 p.m., after most of the equipment from the previous cruise had been stowed away in containers.

Thursday 23. September 2004
Noon position: Reykjavik

The scientific party of cruise CD163/164b embarked at 8:30 a.m. and loading of the equipment continued under the sunny skies of Reykjavik. During the afternoon the captain gave an introduction to safety regulations and the newcomers had a guided tour around the vessel. Loading continued and finished at 5 p.m.

Friday 24. September 2004
Noon position: 64° 25.7' N, 23° 02.3' W
Air temperature: 11.9 °C, wind: S 7 Bft, air pressure: 994.4 hPa

RRS CHARLES DARWIN sailed from the old port in Reykjavik at 8:15 a.m. During the night the weather had changed completely and gale force winds from a southerly direction made it not advisable to sail along the direct route to the ASOF mooring line. Instead course was set towards northwest, aimed at circling the low-pressure system at its northern rim and thereby utilizing the favourable tail winds to cover the longer distance. At 1 p.m. we had a technical briefing where details of the planned scientific activities were discussed with those members of the crew directly involved in the operations. Throughout the day the barometer fell and wind waves and swell built up to 10 m height.



Close-up of the British Meteorological Office Analysis Chart for 00 UTC Saturday,25th September 2004 with track of RRS Charles Darwin during Friday and Saturday superimposed (red track). Wind velocities measured on the vessel peaked at 58 knots and the lowest air pressure recorded was 971 hPa. The blue line indicates the ASOF mooring positions.

Saturday 25. September 2004
Noon position: 65° 03.0' N, 29° 59.3' W
Air temperature: 4.4 °C, wind: N 3 Bft, air pressure: 995.2 hPa

With 971 hPa the air pressure reached its minimum value at 1 a.m.; the wind ceased, turning to a more northerly direction at the western side of the storm system and we consequently set course to the northern end of the ASOF mooring line. The day was spent with preparation of the instruments to be moored.

Sunday 26. September 2004
Noon position: 63° 33.7' N, 36° 34.2' W
Air temperature: 7.1°C, wind: WNW 4 Bft, air pressure: 1001.5 hPa

Crew and scientific party were greeted with bright sunshine in the morning, this being the first day of mooring recoveries during the cruise. Mooring O1 was released at 8:50 a.m. and was safe on deck less than an hour later. As no acoustic contact could be made to the Finnish mooring F1 we decided to continue along the ASOF line and during the day successfully recovered F2, UK1, G1 and UK2, which was on deck just after 8 p.m. On the last station we encountered the first pod of pilot whales, in all about 50 animals. During the night two CTD/lADCP casts were run, they also served to test the acoustic releases prepared for the deployments scheduled for the next day.

Monday, 27. September 2004
Noon position: 62° 49.7' N, 35° 05.7' W
Air temperature: 9.7 °C, wind: SSW 3 Bft, air pressure: 1011.0 hPa

During the night we had moved to the southern end of the section; mooring O2 was recovered early in the morning and immediately re-deployed afterwards, using a fresh set of current meters. A CTD cast was done, with some of the recovered MicroCats attached for an end-of-deployment calibration. Later during the afternoon mooring G2 was also recovered and re-deployed, the operation successfully completed at 7:40 p.m. The vessel then proceeded to station F1, stopping for two CTD casts with release tests and MicroCat calibrations on the way.

Tuesday, 28. September 2004
Noon position: 63° 36.7' N, 36° 42.4' W
Air temperature: 6.4 °C, light winds, air pressure: 999.9 hPa

Another attempt to communicate with the acoustic release of mooring F1 failed just after breakfast and we proceeded to the northern end of the ASOF section, where mooring O1 was successfully deployed by 10:20 a.m. Since F1 had not been recovered, just as during last year's RV METEOR cruise, we were short of instrumentation and decided to move station F2 a few miles up the slope, about halfway in between the former positions of F1 and F2. Deployment here was completed at 1 p.m. and during the afternoon and early evening moorings UK1, G1 and UK2 were laid. Having completed the deployment of the ASOF current meter array we returned to position UK1 to finally deploy the AQUALAB self contained water sampler of the University of East Anglia. The frame containing the sampling device was lowered over the stern, using the heavy coring wire. Deployment was completed at 1:45 a.m. the next day.

Wednesday, 29. September 2004
Noon position: 63° 18.3' N, 35° 47.6' W
Air temperature: 7.4 °C, light winds, air pressure: 993.7 hPa

Work continued at 5 a.m. with an acoustic search for the two missing F1 moorings from the 2002 and 2003 deployments. Hypothesising that the mooring had been dragged away by fishing vessels from their initial positions, we ran a spiral survey around the nominal positions, covering an area of about 7 by 7 miles. However, again no acoustic contact could be made. At 9 a.m. the dragging gear was deployed, consisting of three drag anchors mounted at the end of the coring wire. About 5000 m of wire was paid out in a circular pattern around the mooring position. The wire was hauled in, the anchors were back on deck at about 4 p.m. but the mooring had not been caught. F1 thus has to be considered a loss. After these unsuccessful attempts to recover F1 the vessel proceeded to the second array of moorings on the continental shelf of East Greenland near 63° N.

Thursday, 30. September 2004
Noon position: 63° 08.7' N, 40° 51.2' W
Air temperature: 4.2 °C, light winds, air pressure: 991.9 hPa

This was a beautiful day. The sky was clear with bright sunshine, there were icebergs up to a hundred meters long and raising some 20 m above sea level, whales and flocks of birds. Greenland formed the scenic backdrop, with its snow covered mountains and glaciers, calving their breed into the ocean and thereby contributing to the southward freshwater flux necessary to keep our climate stable. Tube mooring 12 was released at 9 a.m. and was on deck just an hour later. A bathymetric survey along a section towards northwest showed highly irregular bottom topography and tube mooring 15 was deployed on a plateau at the end of it, some 8 miles off the Greenland coast at a water depth of 190 m. A few miles further offshore, on the previously surveyed section, we then deployed an acoustic Doppler current profiler, mounted in a frame and placed on the bottom. The attempt to recover tube mooring 11 some 12 miles further to the south failed, no contact could be made with the acoustic release and no time was available for further dragging operations. This mooring had probably been run over and ripped off by one of the many passing icebergs. At the end of the day tube mooring 16 together with another bottom mounted ADCP was deployed near the former tube 12 position, the operation being successfully completed at 9.30 p.m. Course was then set to the Dutch mooring line off Cape Farewell.

Iceberg on the East Greenland shelf, September 30th 2004. (Photo by Michael Hood)

Friday, 1. October 2004
Noon position: 60° 36.5' N 39° 26.9' W
Air temperature: 7.8° C, wind: NE 3 Bft, air pressure : 1003.1 hPa

During the day the ASOF group cleared deck and laboratories for their Dutch colleagues and started reading and saving the data from the retrieved current meters. Preparations were made for the LOCO mooring work and the procedures for retrieval and deployment discussed among the group involved in these operations. Shortly after dinner the position of the profiling mooring LOCO-02 was reached; the mooring was released and brought on deck by 10 p.m. During the night a CTD cast was run near the retrieval position.

Saturday, 2. October 2004
Noon position: 59° 20.5' N, 38° 46.8' W
Air temperature: 7.3 °C, wind: WNW 6 Bft, air pressure : 1001.1 hPa

During the night the wind became stronger and heavy swell developed, associated with an extended low-pressure system to the northeast of us. A second CTD cast planned to be taken some 20 miles further east had to be cancelled. The wind eased during the day, veering northerly, but the high swells remained. After intense discussions the re-deployment of the LOCO-2 mooring was therefore put off, in order not to endanger the delicate instrumentation. The vessel remained hove to, slowly progressing to the north.

Sunday, 3. October 2004
Noon position: 59° 33.5' N, 39° 03.9' W
Air temperature: 8.6 °C, wind: NW 8 Bft, air pressure : 1008.1 hPa

Wind speeds increased again during the night, allowing no work on deck. During Sunday church in the PSO's cabin the chapter 'The spectacular Castle' from Mark Twain's book 'A tramp abroad' was read. It describes the heroic fight for survival of the author and his friends on a raft sailing on the river Neckar during a roaring storm. Throughout the day the ship remained hove to.

Monday, 4. October 2004
Noon position: 59° 20.7' N, 38° 57.9' W
Air temperature: 8.1 °C, wind: N 5 Bft, air pressure : 1025.2 hPa

Winds ceased during the night and although the swells were still running high it was decided to proceed with the mooring work. At 11:20 a.m. the sediment trap mooring IRM was successfully recovered and preparations were made to re-deploy LOCO-2. This deployment was completed at 6:15 p.m. Stimulated by the successful work during the day we even managed to re-deploy IMR, furnished with new sediment traps, finishing at 11:10 that evening.

Tuesday, 5. October 2004
Noon position: 59° 14.3' N, 36° 23.8' W
Air temperature: 7.2 °C, wind: SW 3 Bft., air pressure : 1030.2 hPa

During the morning mooring LOCO-3, equipped with a CTD-profiler, was recovered and safely on deck at 1:05 p.m. A CTD cast was taken at that position, providing calibration data for the profiler that had been in the water for more than 13 months. The mooring was then furnished with new instruments and re-deployed during the evening. This was the last of 15 successful deployments during the cruise.

Wednesday, 6. October 2004
Noon position: 59° 08.4' N, 35° 34.4' W
Air temperature: 7.5 °C, wind: SW 4 Bft., air pressure : 1028.4 hPa

There remained four more current meter moorings to be retrieved, all being part of an array to study the mixing within the water column through breaking internal waves over the steep topography of the Reykjanes Ridge. A CTD cast was taken near mooring LOCO-15, which was recovered by 11:45 a.m.; mooring LOCO-16 was safely on deck at 8:40 p.m. the same evening. Later a CTD cast was taken at the location of the moorings.

Thursday, 7. October 2004
Position: 58° 50.8' N 32° 23.6’ 'W
Air temperature: 8.1 °C, wind: WSW 4 Bft., air pressure : 1030.1 hPa

Mooring recoveries continued with LOCO-17 on deck at 10:30 a.m. and LOCO-18 recovered at 03:20 p.m. This marked the end of the scientific field work of the cruise, that with 15 recoveries and 15 deployments had been a very successful one indeed. After securing the retrieved buoyancy packages on deck, RRS Charles Darwin set course for Glasgow, and captain, officers, technicians and scientists began with the administrative paperwork that inevitably follows the fun of doing science.

Friday, 8. October 2004
Noon position: 57° 59.9' N 25° 33.2'W
Air temperature: 9.5 °C, wind: S 4 Bft., air pressure : 1026.8 hPa

Passage to Glasgow continued, with moderate winds and waves securing a pleasant ride. During the cruise de-briefing meeting the scientific ‘customers’ praised the professional work of officers and crew that had made this cruise so successful. During a sunny spell that afternoon the scientific party posed for a group photo, taken by the second mate Mike ‘Lord Snowdon’ Hood.

Saturday, 9. October 2004
Noon position: 57° 02.4' N 18° 28.9' W
Air temp: 10.0 °C, wind: ESE 4 Bft., air pressure : 1026.4 hPa

Continued passage to Glasgow. Lots of paperwork. In the evening the 'end of cruise party' was held in the officer's bar. It was well attended and some of toughest scientists held out until the early morning hours.

Sunday 10. October 2004
Noon position: 56° 04.8' N 11° 17.2' W
Air temp: 10.8 °C, wind: E 4 Bft., air pressure : 1021.3 hPa

Continued steaming to Glasgow. Some of the early risers had a guided tour of the engine room and were impressed by its cleanliness. In fact, the chief engineer Jet had demanded that everyone taking part in the tour had to take a shower before, in order not to make his engine dirty. During Sunday church Stephen read sections from Frans Bengtsson book 'The long ships', describing the role of lucky men for having good weather while at sea. More paperwork during the day.

Monday 11. October 2004
Noon position: Clyde approaches
Air temp: 12.4°C, wind: E 3 Bft., air pressure : 1015.2 hPa

The sea passage ended early in the morning and RRS CHARLES DARWIN entered Scottish waters. The river Clyde pilot came on board at 3:30 p.m. and the vessel went alongside at 6:00 p.m.

Tuesday 12. October 2004
Noon position: Glasgow

During the morning the scientific equipment was unloaded and stowed either in containers or directly on lorries. Shortly after noon the scientific party disembarked.

3. Cruise participants

Scientific party:

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Ship crew:

Peter C. Sarjeant	MASTER
Peter C.T. Reynolds	C/O
Michael P. Hood	2/O
John C. Holmes	3/O
Kishorkumar Jethwa	C/O
Ian M. Slater	2/E
Steve Bell	3/E
David H. Ardern	3/E
James G. McIntyre	ETO
Glenn A. Pook	CPO(D)
Phillip Allison	PO(D)
Perry Dollery	S1A
David G. Buffery	S1A
John E. Dale	S1A
Mark Squibb	S1A
Michael Minnock	CPO(Sci)
Leslie J. Hillier	MM1A
Raymond Bell	SMC
John Haughton	CHEF
Wilmot C. Isby	Ass. CHEF
Peter W. Robinson	STWD

5. Technical information

Peter Keen and Jeffrey Bicknell

CTD system

Ten CTD casts were completed on this cruise using a 24 way Stainless steel frame configured in the following way:

Seabird 9/11 plus CTD
Seabird 24 position carousel
Chelsea Fluorimeter
Chelsea Transmissometer
RDI Workhorse LADCP (downward looking)
SOC 10 kHz beacon
24 x 10L Ocean Test Equipment “niskin” bottles

The configuration of the CTD was:

Seabird 9+ underwater unit s/n 09P-31240-0720
Seabird 3 P temperature sensor s/n 03P-4301 (frequency channel = 0)
Seabird 4 Conductivity sensor s/n 04C-2841 (frequency channel = 1)
Digiquartz temperature compensated pressure sensor s/n 90573 (freq. channel = 2)
Seabird 3 P temperature sensor s/n 03P-2728 (frequency channel = 3)
Seabird 4 Conductivity sensor s/n 04C-2164 (frequency channel = 4)
Seabird 5T submersible pump s/n 05T-3090 (primary)
Seabird 5T submersible pump s/n 05T-3609 (secondary)
Seabird 24 position carousel s/n 32-29817-0243
Seabird 11+ V2 deck unit s/n 11P-347173-0676

Additional Analogue to Digital channels on the incoming data stream were configured in the following fashion:

V0 = Seabird 43 dissolved Oxygen sensor s/n 43-0709
V3 = Chelsea Aquatracka MkIII fluorimeter s/n 88/2050/095
V7 = Chelsea Aquatracka MkII transmissometer s/n 161050

The CTD package carried a downward looking LADCP:

RD Instruments Workhorse Monitor 300 kHz ADCP s/n 4908
powered by an onboard battery pressure case with rechargable cells (s/n TSN-4908)

Finally the frame was fitted with an SOC custom breakout box (s/n BO19110) for connecting external sensors (fluorimeter, transmissometer) to the 9+ underwater unit. Casts were initiated on deck and terminated in the water once the CTD was back at the surface.

Fixed Equipment

1 Simrad EA-500 : The echo sounder worked without problems. After the end of science new transducers were installed in the PES towed body, the 'fish'. These were identical to the original set but were housed in an oil filled box in an effort to prevent water from seeping into the plastic transducer bodies.

2 VMADCP (Vessel Mounted ADCP): Logging was initiated prior to the first CTD cast as an adjunct to the Lowered ADCP data collected on CTD casts. Henceforth VMADCP data was acquired throughout the cruise.
3 EM-12 Swath: The SWATH system was operated throughout the cruise with little problems. Basic processing and bathymetry outputs were produced during the cruise to assist scientists with assessing the bottom topography during mooring work.

SurfMet

The SurfMet system was run throughout the cruise in the following configuration:

TSG System:
- Housing temperature FSI OTM s/n 1361
- Remote temperature FSI OTM s/n 1370
- Housing conductivity sensor FSI OCM s/n 1358
- Flow through 20cm light path transmissometer WetLabs/Sea Tech s/n T-1019D
- Flow through Fluorimeter WetLabs s/n WS3S-134

Met System:
- Air temperature/relative humidity Vaisala HMP44L s/n S504004
- Barometric pressure Vaisala PTB100A s/n S3440012
- Port and Starboard PAR sensors Didcot/ELE DRP-5 s/n 5143 & 5144
- Port and Starboard TIR (pyranometer) Kipp & Zonen s/n 962276 & 962301
- Anemometer Vaisala WAA s/n P22306
- Windvane Vaisala WAV s/n R21213

Wind speed and direction are un-calibrated but all other sensors have calibrations. Met system data is collected through a Vaisala QL150 sensor collector. All SurfMet data is polled once a second and every 30 seconds an average is taken and passed to the OED shipboard data collection system for the application of calibration coefficients. Salinity samples were periodically taken from the non-toxic flow system for calibrating the derived salinity output of the conductivity and temperature cells. These samples were analysed with the Portasal 8410 salinometer.

Data Logging

Data was logged from the following instruments using MkII Level A's to the Level B. The data was then parsed to the Level C (Solaris workstation). The following data was logged during the cruise:

Instrument	**Level C Data Stream**
Trimble 4000 DL GPS	GPS_4000
	GPS_NMEA
Fugro SeaStar DGPS	GPS_G12
Ashtec ADU2 GPS	GPS_ASH
Simrad EA500D PES	EA500D1
Chernikeef Log	LOG_CHF
Ships' Gyro	GYRONMEA
Winch CLAM system	WINCH
SurfaceMet System	SURFMET
ADCP (RS232)	ADCP

The Level ABC system ran with no problems during the cruise.

Raw Data

There were no problems with any of the navigation instruments during the cruise, however, the. Pinger use on some deployments caused expected bottom detection failure on the EA500.

Processed Data

GPS, log and gyro streams were used to produce relmov, bestnav and bestdrf. Carter area corrections were applied to the PES data after despiking with rvsedit on rawdep to produce prodep. Surfmet data was processed for absolute windspeed and direction (pro_wind) and salinity and density (protsg).

ASCII Listings

ASCII listings were made of all data streams using listit. All data streams were produced at intervals of 1 sec were applicable. In addition, a listing of bestnav was produced at 10 minute intervals during the whole cruise.

ADCP

The ping data recorded has a file header showing cd 160 as the control file wouldn't allow access to change the cruise number, suspect incorrect shut down after previous cruise fault was rectified at the end of cruise with correct shut down procedure.

EM12 Multibeam

The SIMRAD EM12 swath system was run through the cruise collecting data. The PS ran opportunistic lines when possible and a good survey was made of the mooring sites. Merlin was used to provide sun shaded, contoured imagery as the cruise progressed. Some basic processing was applied to give A0 plots for deploying the moorings. A final plot of the cruise survey area was provided to the PSO with 50m contours and 500m annotations. Plots were in postscript A0 at 600dpi. A complete data archive from Mermaid of /data1/proc/CD163 and /data2/raw/CD163 was provided on CD to the PSO.

Seabird 9/11 + CTD

All casts and raw data were processed and burnt to dvd for the PS.

Network & Printers

Extensive use was made of the ship's network and the new Gigabit infrastructure worked without any problems. The wireless network and the A4 colour laser and A3 inkjet and A0 deskjet was also used.

Email Facilities

The webmail, local mail and AMS ship to shore systems were used extensively by all users. There were no problems and the trial policy of free at the point of use personal accounts worked very well. All users stayed below the allocation of 150k per week in & out.

Archives

The PSO was provided with 3 copies of the archives for each institute involved

Level ABC centrally logged data and miscellaneous PC files
Seabird CTD data
Simrad EM12 swath bathymetry data

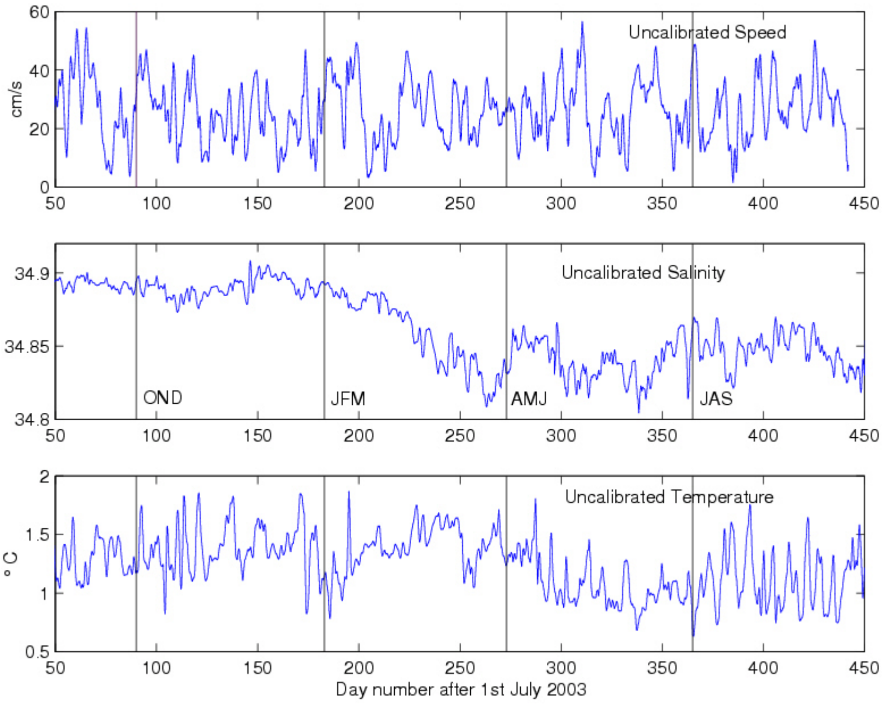
A readme file that describes the contents of the archive was included in the root folder of each disc.

6. Scientific programmes - preliminary results

Arctic Sub-Arctic Ocean Flux (ASOF-W)
Stephen Dye

Two arrays of moored instruments are maintained off SE Greenland by IfMH, FIMR and CEFAS as part of ASOF-EC (W).

The Angmassalik Current Meter Array monitors change in the cold, dense Denmark Strait Overflow where it descends the Continental Slope off SE Greenland. The first occupation of the Angmassalik Current Meter Array was in 1986 and there has been a continuous presence since 1995, over which time it has grown into an array of 8 current meter moorings.

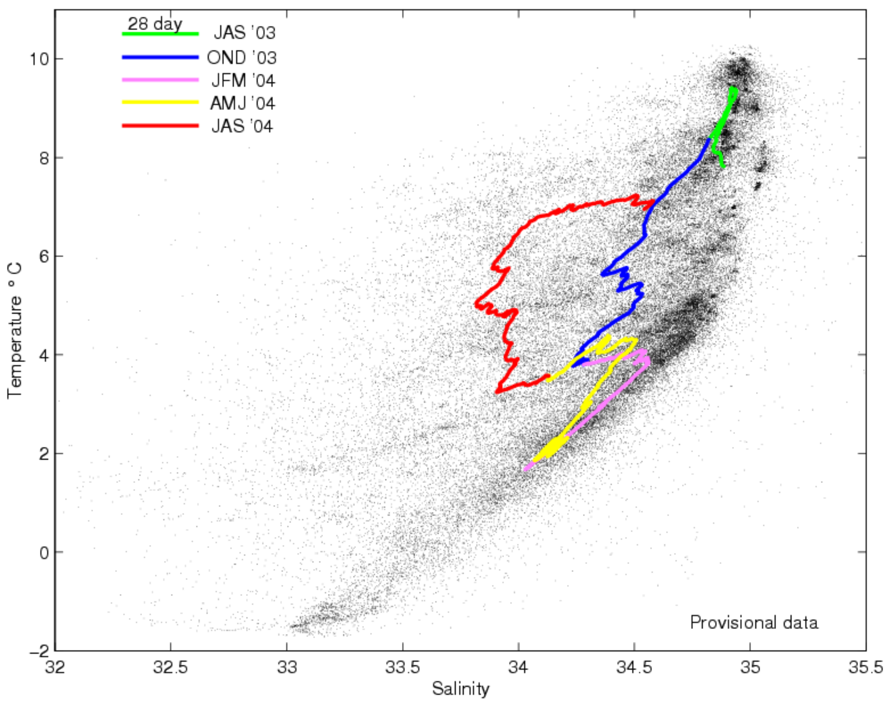


Deep current meter moorings have been augmented over recent years with Seabird SBE 16 or SBE 37 moored CTDs. Here we show provisional results from the mooring UK2 (2350m, 63° 16.7'N, 35° 52.2'W), where, as with another 4 recovered moorings (UK1, G1, F2, O1), the deepest instrumentation at 20m above the bed consisted of an Aanderaa RCM (Speed) and a Seabird Sea/Microcat. The upper panel shows raw speed (hourly samples) filtered with a simple 1 day running mean, and the lower 2 panels show S and T respectively (10 minute samples) as 1 day running means.

The most evident feature of these data is that the 3-month period January-March 2004 saw a shift in salinity of the water-mass 0.05-0.08, with no obvious correlation in the speed record (the salinity change is confirmed by the other microcat moorings). Temperature does not change at the same time suggesting that there is an initial shift to less dense Denmark Strait overflow water at UK2-20m followed over the months April to June by a gradual change to colder, denser water but of persistent low salinity. It seems likely that these changes reflect changes in the water-masses involved in the formation of DSOW, either in their relative contributions or their TS characteristics.

A key difference to the deployed moorings this year was to place microcats at additional heights on some moorings to better understand the vertical structure of the overflow plume. Moorings UK1 (1990 m, 63° 29' N, 36° 18' W) and G1 (2200 m, 63° 22'N, 36° 4.4' W) were deployed with microcats at heights of 20 m (UK1), 350 m and 530 m (UK1 &G1) to try to capture the variability at the top of the overflow layer.

The ASOF 63°N Freshwater Flux (FWF) Array is positioned to measure the freshwater flux which passes south along the east Greenland shelf. The 2003 FWF array moorings consisted of 40 m tubes providing protection for 3 Seabird SBE37 microcats spaced evenly from the top of the tube with a Valeport 308 current meter 30m below. They were deployed at a depth to place the top of the tube about 20 m below the surface. Only Tube 12 (305 m, 63° N 40° 32.65' W) of the two moorings was recovered having been in place for almost 15 months. Here we show provisional data from the upper microcat at a nominal depth of 20 m, both of the other microcats in this tube also appear to have collected data for the whole deployment and the size of the binary data-file from the current meter suggests it was in operation for 300 to 350 days.

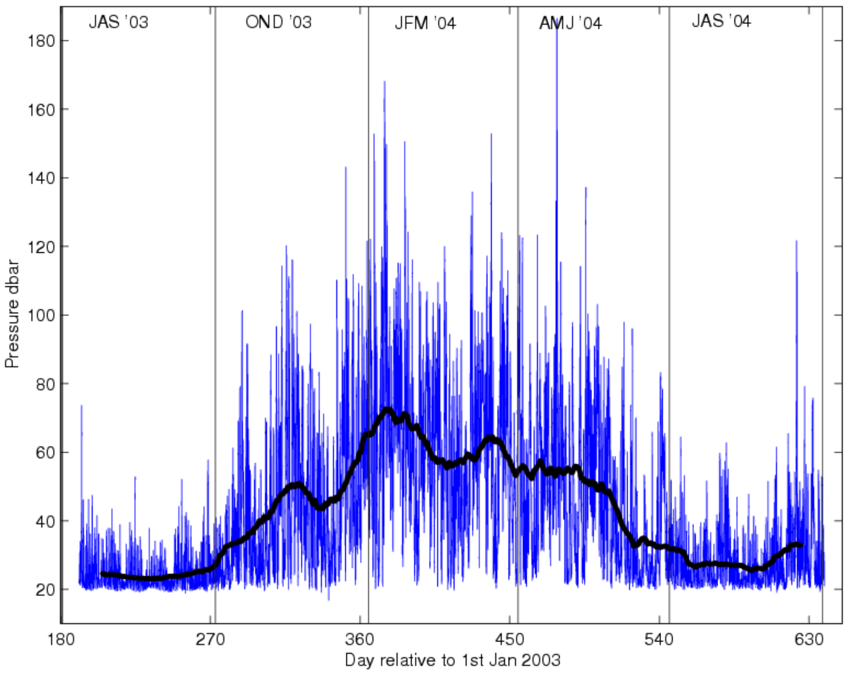


Temperature and salinity at the upper microcat of Tube-12 as discrete 10-minute samples (black dots) and as seasonal evolution of the 28-day running mean filtered T-S (coloured solid lines).

The diagram shows mixing between oceanic and coastal freshwater changing with the seasonal heating-melting cycle. The temperature of the surface waters in July, August and September 2003 was much higher than the same months in 2004, in fact 10° C water has not been observed in this location during any of the other tube deployments. The main cause of this is likely to be the extreme warm summer throughout much of

Europe and around the sub-polar gyre and the resulting enhanced surface heatflux to the upper ocean from the atmosphere. Summer 2004 also differs from 2003 in salinity where a change in position of the front between oceanic and coastal waters could be part of the cause.

The pressure record from the upper microcat illustrates the need for care on interpreting the T-S data gathered at a given nominal depth for the instruments. A seasonal cycle is evident in the pressure (blue: 10 min samples, black: 28 day running mean) where the autumn to spring months saw the instrument spend significant amounts of time much deeper than the nominal 20-30 m. Differences in observed T-S may then be due to the stratification of the water column rather than any *in situ* change.



The pressure record from the upper Microcat of TUBE 12 (blue: 10 min samples, black: 28 day running mean)

The deployment plan for the FWF array during C. Darwin 163/164 had to be altered when Tube 11 was lost only allowing 2 moorings to be constructed. Tube 15 (180 m, 63° 9', 40° 50' W) was been placed closer to the coast than previous moorings and contains 2 microcats in the tube with a Valeport current meter below. Tube 16 was deployed at the same position as Tube 12 with additional microcats deeper in the water column than on previous deployments (200 m and 300 m deep). In order to make improved flux estimates two ADCP landers (ADCP-15 and ADCP-16) were added to the FWF array this year.

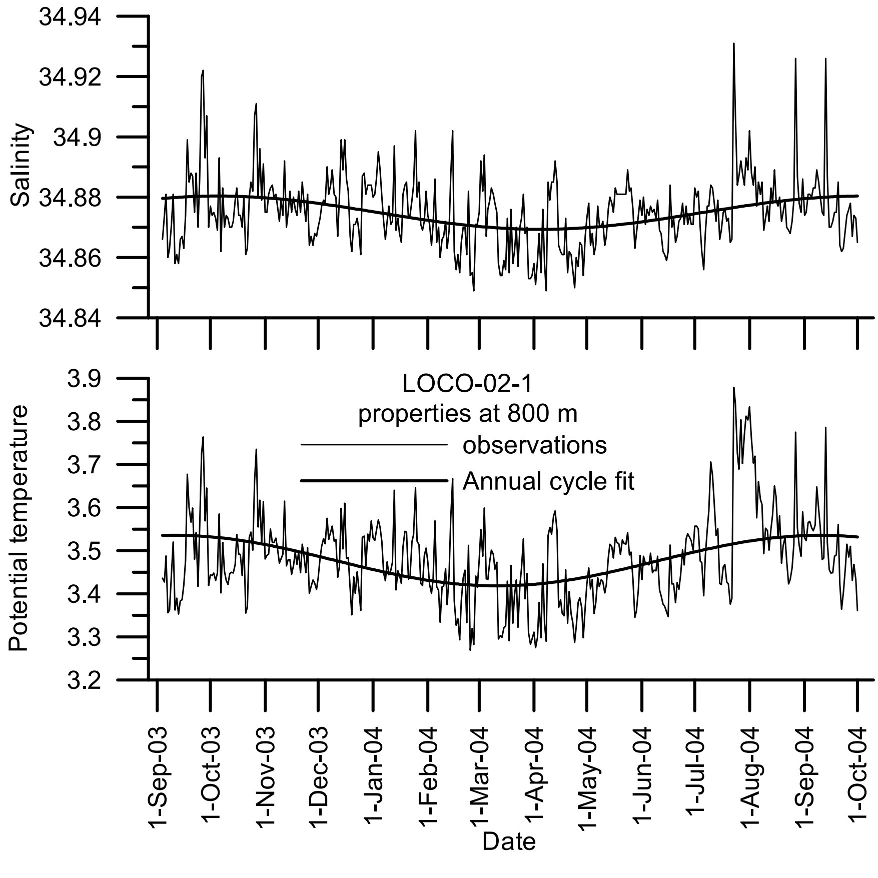
Long-term Ocean Climate Observations (LOCO)

H.M. van Aken

According to satellite altimetry the Irminger Sea is particular in the aspect that the inter-annual change of the sea surface level (SSL) is larger in magnitude than either the seasonal or eddy contribution to the SSL variability. Comparison of the satellite derived SSL with the hydrography obtained along the WOCE AR7E line has shown that the inter-annual changes of the SSL are correlated with shift in the main water mass properties in the Irminger Sea, in particular in the depth level from 200 to 1200 m. These changes seem to be correlated with the NAO index. The near-annual survey of the AR7E line however did not resolve the mechanism of the change of the water mass from year to year, being either of convective nature, driven by air-sea heat exchange in winter or by changes in the advection by the wind driven currents.

In the framework of the Dutch Long-term Ocean Climate Observations (LOCO) programme two profiling CTD moorings have been deployed in 2003 in the Irminger Sea for a period of at least 5 years. During this cruise they were recovered and re-deployed. The instruments in both moorings (ADCPs, a CTD profiler and a Seacat CTD) gave data for the complete mooring period. Additionally, at one of the moorings sites, two sediment traps have been deployed to search for a signal of the inter-annual hydrographic change in the properties of the falling particles. This mooring was also recovered and re-deployed. The profiling moorings have revealed a strong thermohaline variability with time scales ranging from days to the full seasonal cycle, as illustrated in the accompanying figure for mooring LOCO-02-1.

Salinity and potential temperature showed variability with time scales from days to weeks of a magnitude of the order of respectively 0.02 and 0.1°C. The short term variations were well correlated (R=0.90) and compensated in density. This density compensating



Time series of temperature and salinity at 800 m depth extracted from the daily CTD profiles collected at mooring LOCO-2.

variability was probably connected with intrusive activity near the borders of the Irminger Sea. Only the high temperature event in July-August 2004 was connected with a lowering of the density of about 0.02 kg/m^3. In September the density had returned to the original value. Both temperature and salinity showed a significant annual signal (R=0.33 and 0.41 respectively), with the lowest temperatures and salinities occurring around mid-March 2004. This result also counted for the potential temperature in an isopycnal surface near 800 m where a temperature and salinity minimum was found mid-April.

Observations from the temperature and salinity minimum near a level of 1000 m from mooring LOCO-03-1 showed a similar seasonal cycle, with the lowest temperature occurring in April. Apparently the lowest temperatures in the intermediate water occurred at the end of the cooling season. This annual cycle may be connected with deep convective mixing in winter in the more central parts of the Irminger Sea.

Additional to the moorings in the Irminger Sea, an array of 4 current meter moorings, deployed in 2003 over the Reykjanes Ridge, was recovered. These current meters were intended to measure the internal wave regime over the rough topography of the Reykjanes Ridge. A first inspection of the data indicated that the current meters functioned satisfactorily.

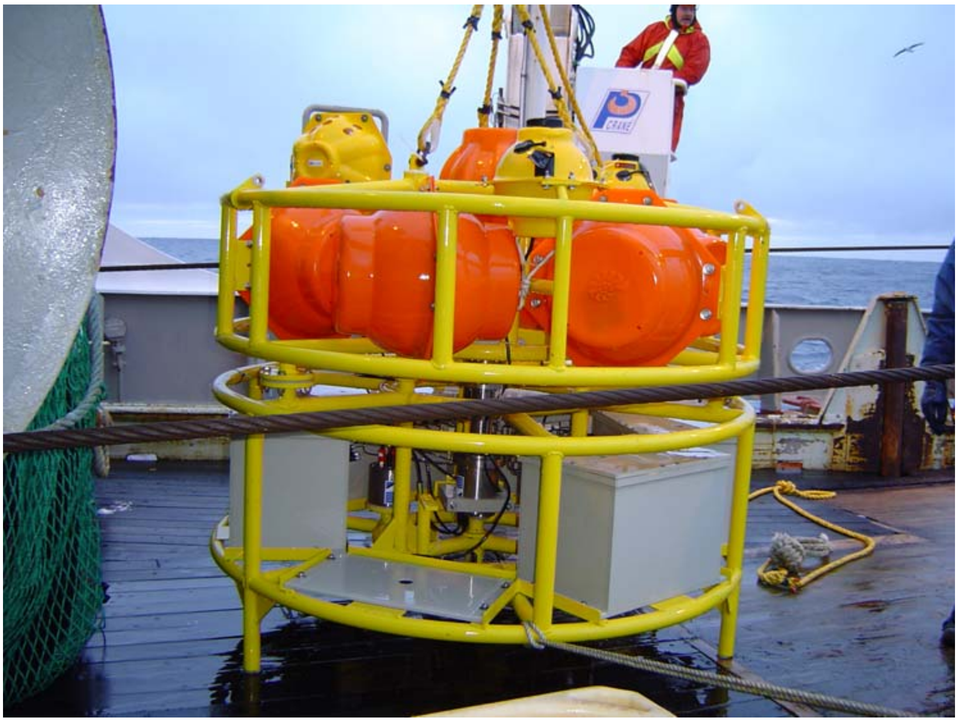
An automated water sampler (AQUALAB)

Marie-José Messias

Measurement of transient tracers in the ocean can provide valuable information about rates of movement and amounts of dilution that are very difficult to observe any other way. Under the framework of the UK RAPID program, our project aims to evaluate the technology to add time series of transient tracers (CFCs, SF_6 and ^{129}I) to mooring-based monitoring of the deep Meridional Overturning Circulation. We aim to enable the provision of new information on the time-varying changes in the composition of the deep return waters and quantification of re-circulation pathways. We focus particularly on tracers that we know are varying rapidly and whose source we know, particularly SF_6 and ^{129}I. These have rapidly changing sources which will propagate large signals through the deep water flows over the next decade. The SF_6 signal comes primarily from the Greenland Sea tracer release experiment, which we began with European colleagues in 1996 and which uniquely marks the Greenland Sea intermediate water. I-129 from European reprocessing plants is a diagnostic marker for Atlantic water with a strongly varying time history over the last two decades.

Automated water samplers have been under development for a number of years and a version suitable for nutrients and relatively shallow moorings, is commercially available ("Aquamonitor"; http://www.n-virotech.com/products/aquamonitor.htm). The samples are captured using a syringe mechanism and then injected into flexible bags via a 50-way multi-port valve. Samples are stored for post recovery analysis. The new "AquaLab" version of this instrument, developed by Envirotech with substantial input from ourselves and Smethie's group at LDEO, is specifically designed for deep water sampling of dissolved gases such as CFCs and SF_6 transient tracers. It has titanium construction, and the samples are stored in all-titanium foil bags (SF_6, CFCs) or Teflar bags (salinity, I-129). The "AquaLab" sampler is mounted on a frame and the bags are housed in each of six plastic boxes spaced around the sampler itself. The frame also incorporates the ballast and the buoyancy/release/Argos-Beacon to enable the recovery.

During the present cruise, we performed a sea-bed deployment of the Aqualab sampler enhanced with a Microcat CTD south of the Denmark Strait on the Angmassalik Current Meter Array close to the UK1 position. The sampler was programmed for a year-long deployment at a sampling regime of 2 weeks interval to obtain time-series of a suite of transient tracers (CFCs, SF_6, ^{129}I) and other parameters (δ18O, salinity). The sampler mooring was lowered down to 30 meters above the sea bed and then dropped using an Oceano acoustic release (date/time : 29th September at 01.50 a.m.). The position of the mooring is 63° 28.046' N latitude and 36° 19.616' W longitude at 2004 meters depth typical of the core of the dense overflow waters.



The AQUASAMPLER rigged up and ready for deployment.

Mooring details:

- One automated deep water sampler "AquaLAB" programmed for a year-long deployment at a sampling regime of 2 weeks interval.
- One Seabird MicroCAT # 3093 for temperature, salinity and pressure recording at 10 minutes interval
- Two Benthos acoustic release spheres with a burn-wire release system.
- One Seimac Mooring Marker Locator (Argos Beacon) # 26115
- One 17" Glass battery sphere for the sampler - Neutrally buoyant
- Six 17" buoyancy spheres give 25 kg of lift each
- One ballast ~ 150kg

CTD observations

Bert Rudels

The CTD programme on Charles Darwin was primarily a back-up programme, to be conducted between the main mooring operations, during the night, and in time slots available during transit to reach the following mooring site in daylight. In total 10 CTD stations were taken, forming two sections, one short section up the slope along the Ammassaliq mooring line and a second widely spaced section in the southern Irminger Sea from the centre eastward to the Reykjanes Ridge. On the Ammassaliq section one station had to be cancelled because of bad weather. Both sections comprised 5 stations.

On the Ammassaliq section the same features as have been observed in the last 8 years during the VEINS and ASOF programmes were found. The Denmark Strait overflow plumes was cold (<1^{o}C) and of low salinity (S around 34.86) and had a less saline lid above the deepest part. The Denmark Strait Overflow Water (DSOW) was clearly denser than the warmer, more saline Iceland Scotland Overflow Water (ISOW), which was seen as a salinity maximum (S $\approx$ 34.93) with a temperature around 3^{o}C, and the density stratification in the upper part of the overflow plume was mainly in temperature. Above the salinity maximum of the ISOW two salinity minima were observed. The denser weaker one most likely being a remnant of the cold, dense Labrador Sea Water produced during the 1990s. The second less dense, warmer but less saline minimum could either be caused by intruding water from convections area in the central Irminger Sea or by an inflow of more recently formed Labrador Sea Water (LSW) (see below). The warmer Irminger Current water was encountered between 100m and 500m and was warmer and more saline on the shallowest (2500m) station on the section, in agreement with the Irminger Current circulating around the northern rim of the Irminger Sea. The low salinity at the surface could either be due to eddy fluxes from the low salinity East Greenland Current, or arise from net precipitation, or from advection of less saline surface water from the central Irminger Sea (see below).

On the southern section the same features were clearly seen on the westernmost station located in the centre of the Irminger Sea. The DSOW was prominent in the bottom 300m and the low salinity lid was still identified. Two salinity minima were present above the deep ISOW salinity maximum, at 1700 and at 1000m. Of these the deeper one most likely represent water advected from the Labrador Sea. The upper one could be indication of deep winter convection in the Irminger Sea. The salinity of the surface upper layers were low, indicating inflow of low salinity water, most likely from the Labrador Current at the southwestern rim of the Irminger Sea.

On the stations further to the east the presence of DSOW steadily diminished and its temperature and salinity increased. It was still seen close to the Reykjanes Ridge suggesting a recirculation of DSOW within the Irminger Sea. The salinity of the ISOW increased towards the east and it extended higher up in the water column, comprising a larger temperature range. The more confined TS structures seen on the Ammassaliq section thus imply that the ISOW mixes with recirculating Denmark Strait Overflow Water in its deeper part and with Labrador Sea Water in its upper part as it moves around the rim of the Irminger Sea. The mixing in the upper part appears to be the most extensive one.

The upper salinity minimum at 1000m was most clearly developed in the east, suggesting that it enters the Irminger Sea from the rim rather than from the centre. This would imply that a new vintage of Labrador Sea Water is entering the Irminger Sea, forming the upper salinity minimum instead of the upper minimum being formed by local convection in the Irminger Sea. This conjecture requires much more detailed observations to be confirmed.

The warm, high salinity core of the Irminger current was encountered on the easternmost station. On the lower side of the salinity maximum, where salinity and temperature are decreasing, strong interleaving structures were seen. This implies frontal mixing between the saline water of the Irminger Current and the less saline, colder water of the central Irminger Sea, and double diffusive convection most likely contributes to the lateral transfer of the waters across the front.

Particulate matter fluxes – moored sediment trap sampling

Geert-Jan Brummer

Rationale

The Long-term Ocean Climate Observation (LOCO) program provides the unique opportunity to establish a 5-year time series of particulate matter fluxes by mooring sediment traps in parallel to the physical observation program in the Irminger Sea, a critical area with respect to deep convective mixing, global ocean circulation and climate change. First of all, it will add a new dimension to the current LOCO program by providing a parallel record of the seasonal and inter-annual change in particulate matter fluxes between the upper ocean and the ocean floor with a biweekly resolution. Secondly, it will allow for assessing particle settling through a well-defined volume transport field and better determine the advective components and the temporal dispersal of particles, given the *in situ* real-time measurement of ocean circulation as carried out within LOCO. Thirdly, it allows for quantifying the magnitude and composition of the summer bloom with respect to the annual export flux of carbon and associated elements in response to upper ocean stratification. Fourthly, it will provide well-characterised material formed at the extreme end of the ocean temperature range needed for field verification of particle-based proxies for temperature that are used for paleoreconstruction.

Mooring operation and configuration

During cruise CD164, on October 2, 2004, the first sediment trap mooring, IRM-1 at 59°20.74' N 38°51.82' W, was successfully recovered which was deployed in August 29, 2003, close to a CTD-profiler/ADCP-mooring, LOCO 02-1. It consisted of two sediment traps (Kiel-type), one mounted in a bottom frame at 2776 m depth, the other at 238 m above the bottom, both with a collecting area of 0.5 m^2 and provided with a 1.5 cm squared baffle. In addition, each sediment trap was provided with a sensor package for recording trap tilt, ambient pressure, temperature, and optical back scattering (OBS), a measure of turbidity, logging the data every 8 minutes. Both traps successfully completed their pre-programmed sampling intervals of 19 days for each of the 20 collecting cups, starting on August 31, 2003 at 01:00 UTC, thus ending on September 14, 2004, yet, only the sensor package on the top most trap at 238 m above the bottom performed flawlessly. After recovery of the mooring, subsamples were taken of the supernate solution from the collecting cups and filtered for subsequent analysis of dissolved compounds (e.g. silica, phosphate, ammonia, Hg) in order to determine chemical dissolution and physical diffusion fluxes.

Following recovery of the IRM-1 mooring, the Kiel-type traps were replaced by new Technicap PPS-5/2 instruments with 24 collecting cups, a collecting area of 1.0 m^2 and a 1.5 cm honeycomb baffle. Otherwise its configuration is the same as for IRM-1 and it was deployed as IRM-2 at 59°14.88' N 39°39.21'W, alongside the LOCO 02-2 mooring. For direct comparison with the IRM-1 results, the sampling intervals are kept at the same at 19 days for the initial 8 intervals, but at twice the resolution of 9.5 days per interval for the subsequent 16 collecting cups, starting on October 6, 2004 at 01:00 UTC, thus ending on August 7, 2005. Sample cups were filled with seawater collected near the deployment depth of the traps and near the actual deployment site, to which a biocide ($HgCl_2$; end-concentration 1.8 g l^{-1}) and a pH-buffer ($Na_2B_4O_7{\cdot}10H_2O$; end concentration 3.6 g l^{-1}) were added, supplemented by milliQ-water to a density of 0.002 g cm $^{-3}$ in excess of the ambient seawater. A blank sample was taken for later comparison with the actual collecting cups to determine chemical dissolution fluxes. As for IRM-1, each sediment trap was provided with a sensor package for recording trap tilt, ambient pressure, temperature and turbidity by optical back scattering (OBS), logging the data every 6 minutes.

Preliminary results

Sediment traps

The topmost trap on the IRM-1 mooring, at 238 m above the ocean floor, shows low particle mass fluxes that vary within an order of magnitude judging from the amount of detrital material covering the bottom of the collecting cups. For as much as can be estimated shipboard, lowest fluxes prevailed from late February to early May, whereas highest fluxes were intercepted during summer. In general, residues have a pelletoidal and larvacean aspect, with larger zooplankton "swimmers" being encountered throughout, including various crustaceans, polychaetes, medusoids, etc.

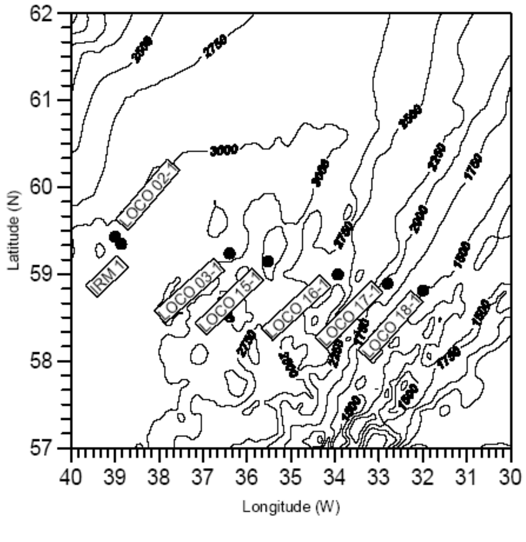
The bottom trap, by contrast, showed few macroscopic swimmers, and a much larger variation in particle mass flux than observed in the topmost trap. Very fluffy residues are encountered throughout the September to early January 2003 intervals, with large fluxes during fall (September-October, 2003), which may be due to advective depositional focussing. More compact residues in a temporal pattern roughly similar to that in the topmost trap were found subsequently. However, full shore-based processing, gravimetric and chemical analyses are needed to provide firm data on the actual mass flux and its composition through time.

Sensor package

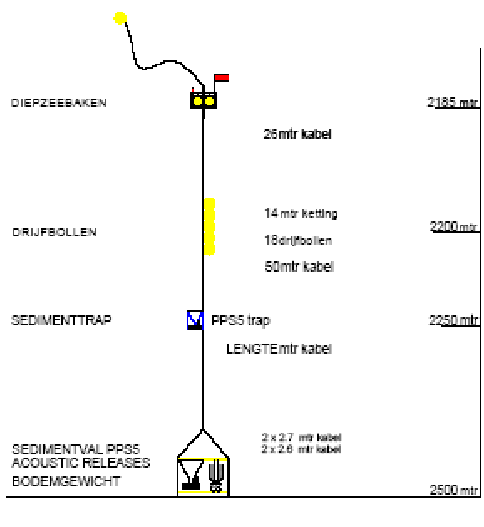
Preliminary, uncorrected, data from the sensor package are only available for the uppermost trap at 2776 m, 278 m above the bottom (see figure below). Optical back scattering (OBS) shows strongly enhanced turbidity during the initial deployment period, suggesting intermediate nepheloid layer activity that may be causally tied to the enhanced fluxes of settling particulate matter as observed in the bottom trap. Maxima in the OBS generally coincide with enhanced tilt of the trap that occasionally occur in connection with changes in pressure, i.e. depth, of the trap and the ambient temperature, which together suggest that sediment resuspension and depositional focussing occurred in response to current forcing. It should be noted, however, that due to fouling of the OBS sensor, it becomes less sensitive to enhanced turbidity with time, thus increasingly obscuring maxima as observed during the initial deployment period.

Subsequent analysis

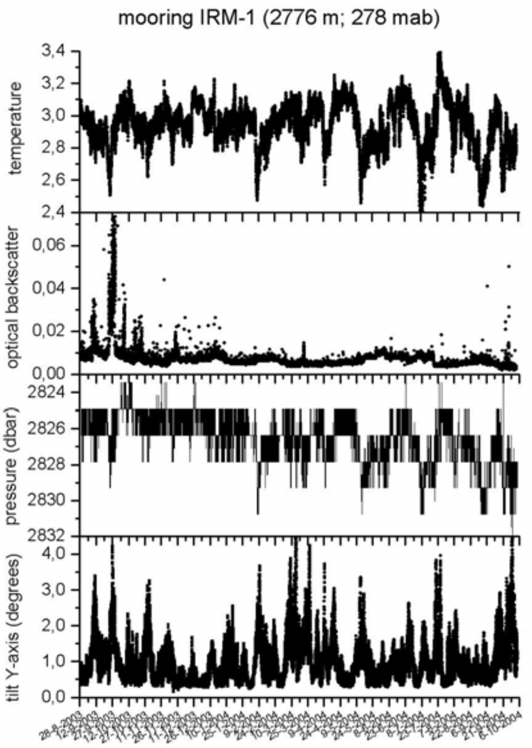
Samples will be analysed for dry bulk mass, organic matter (Corg, N), carbonate ($CaCO_3$), biogenic silica and lithogenic matter at Royal NIOZ, as well as for dissolved phases sampled shipboard. These will be followed by more specific analyses of bulk molecular, element and isotope composition, grain size distribution as well as analysis of specific particle groups such as foraminiferal species and their element and isotope composition. Together, they will inform on the provenance and magnitude of the intercepted fluxes, and be interpreted using the physical forcing conditions as measured by the instrumentation on the nearby LOCO 02-1 mooring alongside (current direction and strength, stratification and mixing, temperature, etc.).



Mooring locations



IMR Mooring design



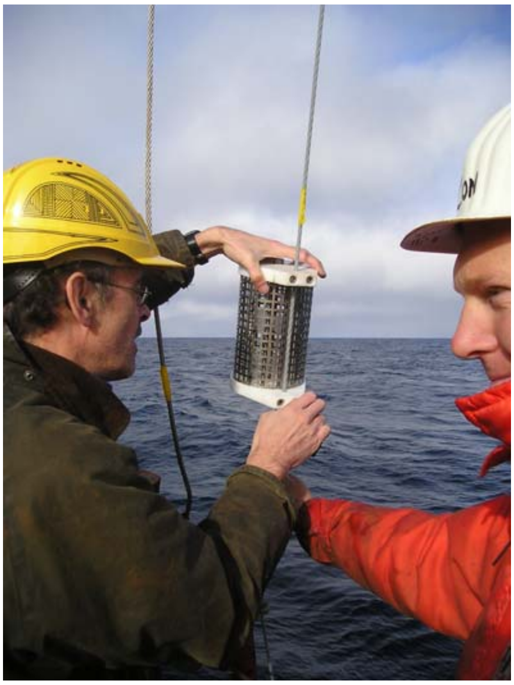
Near bottom temperatures, optical backscatter, pressure and salinity at mooring IMR-1

Organic contaminants sampling

Geert-Jan Brummer

Knowledge of organic contaminant transport in the environment primarily stems from measurements in terrestrial and coastal systems, particularly in the vicinity of densely populated areas. Data from remote areas are much less abundant. The evidence available for open ocean systems shows that distinct north-south gradients exist in atmosphere, water, and organisms. The general picture is that the more volatile compounds show an increase in concentration between the equator and the poles, and that the less volatile compounds show a decrease in concentration. The reason for this difference is believed to be related to the fact that the less volatile compounds need more time to establish a steady-state distribution. The existing models on global transport of organic contaminants identify the poles as the final sink where most of these compounds will condense. Very little is known, however, to what extent the oceanic circulation plays a role in redistributing organic contaminants. The scarce information that is available for concentrations in the open ocean is limited to surface waters and the lower atmosphere. It is assumed that the ocean is vertically well-mixed with respect to organics, but no data is available to check whether this assumption makes sense at all. The situation is further complicated by the fact that the aqueous concentration (which is the quantity of interest, because it is closely related to the thermodynamic potential) of most organic contaminants is in the low pg/L range, necessitating large water volumes and low blank values. With the recent developments in the field of passive sampling of organic contaminants new methods have become available to address these issues. The samplers are typically small (which allows for low blank values) and the effective water volume that can be extracted with these devices can be quite high (m^3 range, depending on the compound). The effecting sampling rates are often the limiting factor, however (~ 10 L/d). The long-term mooring deployments within LOCO (> 1 year) create new opportunities to deploy passive samplers for prolonged time periods in remote areas in the deep oceans.

During cruise CD164 all 6 passive samplers (see picture) deployed on the LOCO moorings 03, 15, 16 (2), 17 and 18 (see map) were recovered successfully. Each sampler cage contained three different plastic membranes with a high affinity for organic contaminants, which are rapidly taken up as a function of temperature and flow, i.e. silicone, double layered LDPE and trioleine coated SPMD. Immediately after recovery, each sample cage was rapidly transferred in a metal can and stored at -20°C as the membranes are very efficient air samplers as well. After all sample cages were collected, they were opened and each of the three membranes was removed and separately stored in glass jars at -20°C. Prior to arrival they were transferred to a -80°C freezer prior solid CO_2 transport to the Royal NIOZ where they will be analysed.



7. Acknowledgements

We like to thank captain Peter Sarjeant, his officers and crew of RRS CHARLES DARWIN and the UKORS technical staff for their support of our measurement programme and for creating a very friendly atmosphere on board. We are glad that the expectations expressed in the sweepstakes run prior to the cruise did not materialize, but that instead we can look back to a very successful expedition.

Financial support for the cruise was provided though the EU-Project ASOF-W (Arctic-Subarctic Ocean Flux – West study), the LOCO programme funded by the Dutch National Science Foundation NOW and the British RAPID programme, funded by the National Environmental Research Council NERC. This support is gratefully acknowledged.

Mooring recoveries:

ASOF:	O1-03	63° 41.20’ N	37° 00.50’ W		1250 m
		Released:	26.09.2004	08:50 Z	
		On deck:		09:39 Z	
ASOF:	F1-03	63° 38.40’ N	36° 47.60’ W		1615 m
		No acoustic contact	26.09.2004		
		No acoustic contact	28.09.2004		
		Unsuccessful dragging operation			29.09.2004
ASOF:	F2-03	63° 33.30’ N	36° 30.50’ W		1784 m
		Released:	26.09.2004	12:26 Z	
		On deck:		13:37 Z	
ASOF:	UK1-03	63° 29.00’ N	36° 18.00’ W		1987 m
		Released:	26.09.2004	14:42 Z	
		On deck:		15:55 Z	
ASOF:	G1-03	63° 22.10’ N	36° 04.30’ W		2198 m
		Released:	26.09.2004	17:17 Z	
		On deck:		18:16 Z	
ASOF:	UK2-03	63° 16.90’ N	35° 52.00’ W		2361 m
		Released:	26.09.2004	19:26 Z	
		On deck:		20:18 Z	
ASOF:	O2-03	62° 46.10’ N	34° 58.00’ W		2760 m
		Released:	27.09.2004	08:15 Z	
		On deck:		09:29 Z	
ASOF:	G2-03	63° 07.20’ N	35° 32.60’ W		2587 m
		Released:	27.09.2004	17:07 Z	
		On deck:		18:06 Z	
ASOF:	TUBE-12	63° 00.20’ N	40° 32.70’ W		300 m
		Released:	30.09.2004	08:55 Z	
		On deck:		09:59 Z	
ASOF:	TUBE-11	62° 58.00’ N	40° 53.40’ W		300 m
		No acoustic contact	30.09.2004		
LOCO:	02-1	59° 25.78’ N	39° 00.09’ W		3000 m
		Released:	01.10.2004	19:08 Z	
		On deck:		21:57 Z	
LOCO:	IMR-1	59° 20.74’ N	38° 51.82’ W		3000 m
		Released:	04.10.2004	09:08 Z	
		On deck:		11:22 Z	
LOCO:	03-1	59° 14.21’ N	36° 23.84’ W		3000 m
		Released:	05.10.2004	10:26 Z	
		On deck:		13:05 Z	

LOCO:	15-1	59° 08.70' N	35° 31.53' W		3000 m
		Released:	06.10.2004	09:10 Z	
		On deck:		11:46 Z	
LOCO:	16-1	58° 59.67' N	33° 56.12' W		2500 m
		Released:	06.10.2004	18:15 Z	
		On deck:		20:37 Z	
LOCO:	17-1	58° 53.42' N	32° 48.49' W		2000 m
		Released:	07.10.2004	08:34 Z	
		On deck:		10:29 Z	
LOCO:	18-1	58° 48.72' N	31° 59.80' W		1500 m
		Released:	07.10.2004	13:39 Z	
		On deck:		15:18 Z	

Mooring deployments

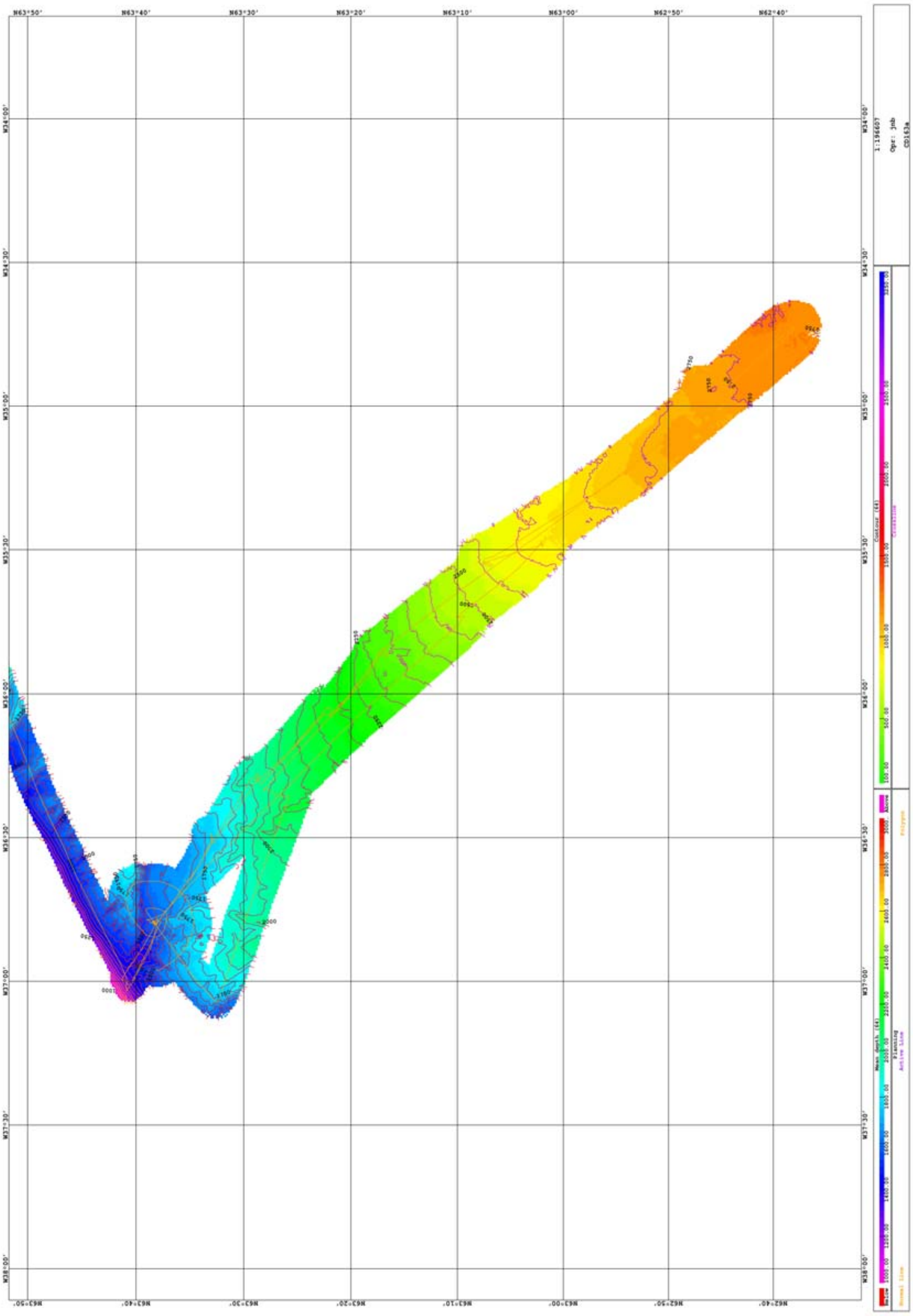
ASOF:	O2-04	62° 46.00' N	34° 58.00' W		2755 m
		Top Buoy in water:		27.09.2004	10:27 Z
		Anchor released:			10:39 Z
ASOF:	G2-04	63° 07.08' N	35° 32.54' W		2579 m
		Top Buoy in water:		27.09.2004	19:18 Z
		Anchor released:			19:40 Z
ASOF:	O1-04	63° 40.96' N	37° 00.11' W		1305 m
		Top Buoy in water:		28.09.2004	10:02 Z
		Anchor released:			10:24 Z
ASOF:	F2-04	63° 35.40' N	36° 39.02' W		1707 m
		Top Buoy in water:		28.09.2004	12:43 Z
		Anchor released:			13:05 Z
ASOF:	UK1-04	63° 28.82' N	36° 17.98' W		1993 m
		Top Buoy in water:		28.09.2004	15:09 Z
		Anchor released:			15:43 Z
ASOF:	G1-04	63° 22.08' N	36° 04.38' W		2203 m
		Top Buoy in water:		28.09.2004	17:12 Z
		Anchor released:			17:40 Z
ASOF:	UK2-04	63° 16.73' N	35° 52.13' W		2366 m
		Top Buoy in water:		28.09.2004	19:11 Z
		Anchor released:			19:31 Z
RAPID:	AQUALAB	63° 28.05' N	36° 19.64' W		2002 m
		In water:		28.09.2004	22:54 Z
		Anchor released:		29.09.2004	01:45 Z
ASOF:	TUBE-15	63° 08.87' N	40° 50.32' W		181 m
		63° 08.95' N	40° 50.03' W		188 m
		Top Buoy in water:		30.09.2004	12:13 Z
		1st Anchor released:			13:17 Z
		2nd Anchor released:			13:35 Z

ASOF:	ADCP-15	63° 07.34’ N	40° 48.40’ W		208 m
		63° 07.46’ N	40° 48.08’ W		222 m
		Top Buoy in water:		30.09.2004	14:47 Z
		1st Anchor released:			14:52 Z
		2nd Anchor released:			15:12 Z
ASOF:	TUBE-16	63° 00.19’ N	40° 32.66 W		309 m
		63° 00.37’ N	40° 32.42’ W		293 m
		Top Buoy in water:		30.09.2004	19:25 Z
		1st Anchor released:			20:05 Z
		2nd Anchor released:			20:25 Z
ASOF:	ADCP-16	63° 00.85’ N	40° 31.68’ W		240 m
		63° 01.01’ N	40° 31.44’ W		227 m
		Top Buoy in water:		30.09.2004	20:57 Z
		1st Anchor released:			21:05 Z
		2nd Anchor released:			21:28 Z
LOCO:	02-2	59° 12.21’ N	39° 30.48’ W		3041 m
		Top Buoy in water:		04.10.2004	15:33 Z
		Anchor released:			18:16 Z
LOCO:	IMR-2	59° 14.88’ N	39° 39.21’ W		3020 m
		Top Buoy in water:		04.10.2004	22:22 Z
		Anchor released:			23:07 Z
LOCO:	03-2	59° 14.68’ N	36° 23.89’ W		3047 m
		Top Buoy in water:		05.10.2004	19:07 Z
		Anchor released:			21:36 Z

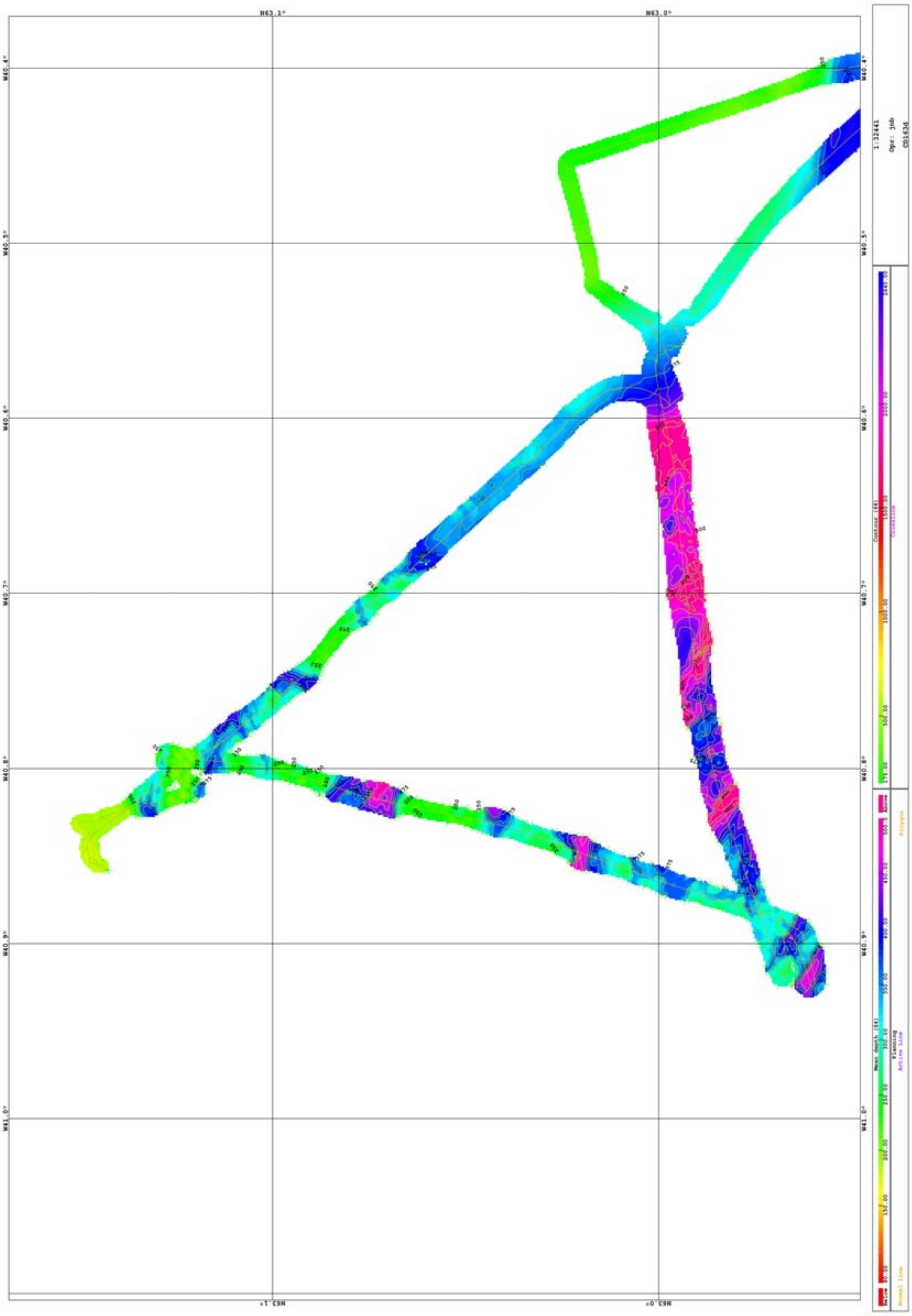
CTD/lADCP stations:

C-01:	27.09.2004	01:39	62° 38.04’ N	34° 43.82’ W	2779 m
C-02:	27.09.2004	05:45	62° 46.00’ N	34° 59.00’ W	2756 m
C-03:	27.09.2004	13:03	62° 54.02’ N	35° 14.06’ W	2706 m
C-04:	27.09.2004	21:12	63° 02.00’ N	35° 29.00’ W	2642 m
C-05:	28.09.2004	00:54	63° 10.00’ N	35° 44.20’ W	2491 m
C-06:	01.10.2004	23:27	59° 25.82’ N	39° 00.03’ W	2970 m
C-07:	05.10.2004	14:30	59° 14.43’ N	36° 22.76’ W	3032 m
C-08:	06.10.2004	00:52	59° 10.00’ N	35° 35.80’ W	3045 m
C-09:	06.10.2004	21:19	58° 59.98’ N	33° 56.48’ W	2631 m
C-10:	07.10.2004	02:45	58° 54.04’ N	32° 53.94’ W	2115 m

Bottom topography along ASOF slope mooring array (EM12 swath system)



Bottom topography along ASOF shelf mooring array (EM12 swath system)



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