Oceans 2025 Arctic Cruise Report

ICE CHASER
(Changing Sea-ice and Ecosystem Response)

RRS James Clark Ross (JR210)

23 July to 21 August 2008

Raymond J. G. Leakey
Principle Scientist

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ACKNOWLEDMENTS

This research cruise could not have been undertaken without the efforts of a large number people located in several organisations within both the UK and abroad. I am grateful for the help and assistance of all those involved including: the Master Graham Chapman, officers and crew of the *James Clark Ross*; the scientists and technical support staff of cruise JR210; Chris Hindley, Julia Fear and the staff of the British Antarctic Survey, Cambridge; the staff of National Marine Facilities, Southampton; the staff of the Scottish Association for Marine Science, Oban.

I am also grateful to the UK Natural Environment Research Council for funding the research cruise via the Oceans2025 strategic marine research programme, and the Norwegian diplomatic authorities for granting permission to travel and work in Svalbard coastal and offshore waters.

Cover photograph c/o A Veszelovszki

SCIENTIFIC AND TECHNICAL PERSONNEL

Person	Responsibility
Ray Leakey	PSO
Colin Griffiths	Physics: CTD & moorings
Estelle Dumont	Physics: CTD & moorings
John Kenny *	Physics: slope mixing
Terry Doyle *	Physics: slope mixing
Joe Collins *	Physics: slope mixing
Emily LeFloc'h **	Biology: light & phytoplankton
Mike Lucas *	Biology: primary production & calcification
Anastasia Charalampopoulou	Biology: primary production & calcification
Eic Fouilland **	Biology: autotroph-heterotroph coupling
Elanor Bell	Biology: viruses and bacterial production
Elaine Mitchell **	Biology: microbial community dynamics
Andrea Veszelovszki	Biology: microbial community dynamics
Jane Manning	Biology: microbial community dynamics
Arlene Rowan	Biology: microbiology and Hydrocarbons
Mark Hart **	Biology: microbiology and Biogases
Stig Falk-Petersen **	Biology: zooplankton distribution & lipids
Anette Wold **	Biology: zooplankton distribution & lipids
Mags Wallace	Biology: zooplankton acoustics
Peter Lamont **	Biology: benthic fauna
Tim Brand	Geochemistry: nutrients & radiochemistry
Susan Fitzer	Geochemistry: radiochemistry
Pauline Learmonth **	Geochemistry: radiochemistry
Martyn Harvey	Geochemistry: sediments
Henrik Stahl	Geochemistry: benthic landers
Keith Jackson	Geochemistry: benthic landers
Kate McIntyre	Geochemistry: bathymetry
James Bendle	Geochemistry: biomarkers
Pete Lens	Technical Support: IT
Mark Preston	Technical Support: engineering
Julian Klepacki	Technical Support: engineering trainee
Laila Sadler	Media: website
George Pagliero **	Media: video filming
Susan Watts ***	Media: BBC2 Newsnight
Ming Tsang ***	Media: BBC2 Newsnight
Petra Schmitt	Doctor

* Leg 1 only (23 to 31 July 2008).
** Leg 2 only (31 July to 21 August 2008).
*** Leg 2 only (19 to 21 August 2008)

SHIPS PERSONNEL

Person	Responsibility
Graham P Chapman	Master
Robert C Patterson	Chief Officer
Douglas J Leask	2nd Officer
Simon D Evans	3rd Officer
John W Summers	Deck Officer
Charles A Waddicor	ETO (Comms)
David J Cutting	Chief Engineer
Glynn Collard	2nd Engineer
James C Ditchfield	3rd Engineer
Steven J Eadie	4th Engineer
Simon A Wright	Deck Engineer
Nicholas J Dunbar	ETO (Eng)
James S Gibson	Purser
George M Stewart	Bosun
Marc A Blaby	Bosun's Mate
Derek G Jenkins	SG1
Lester Jolly	SG1
Andrew C Campbell	SG1
Ronald Pattie	SG1
Clifford Mullaney	SG1
Mark A Robinshaw	MG1
Carl J Moore	MG1
Keith A Walker	Cook
Glen R Ballard	2nd Cook
Kenneth Weston	Steward
James Newall	Steward
Derek W Lee	Steward
Brian Conteh	Steward (23-31 July)
Brian Conteh	SG1 (1-21 August)
Roy S Turney	Steward (1-21 August only)

INTRODUCTION AND OBJECTIVES

The ICE CHASER (CHAnging Sea-ice and Ecosystem Response) research cruise was undertaken as part of the UK Natural Environment Research Council Oceans2025 strategic marine strategic research programme. The cruise was organised and led by the Scottish Association for Marine Science (SAMS) as part of the SAMS Oceans2025 research topic "*Arctic and Boreal Seas in a Rapidly Changing Climate*". It also supported research undertaken by the Proudman Oceanographic Laboratory (POL) under the Oceans2025 research topic "*Geodetic Oceanography, Polar Oceanography and Sea Level*". In addition research scientists participated in the cruise from several UK and international institutions including the Norwegian Polar Institute (NPI), the University of Montpellier (France), the UK National Oceanographic Centre (NOC) and the UK Universities of Glasgow, St Andrews and Swansea. The research vessel, officers, crew and ships technical support were provided by the British Antarctic Survey (BAS). The research undertaken contributes to the *Pan Arctic Climate Forcing of the Arctic Marine Ecosystem* (PAN-AME) and *Polar Aquatic Microbial Ecology* (PAME) International Polar Year research clusters.

The overall scientific objective of research cruise was to improve understanding of how changing sea ice and water column structure influence Arctic ecosystem structure and function, and subsequent biologically derived carbon export, and thereby help refine models of ecosystem response to environmental change. This was achieved by delivering novel and comprehensive observational and experimental data sets on sympagic, pelagic and benthic biogeochemical variables in Svalbard shelf waters during the Arctic summer (se table below). A comparative approach was adopted with multidisciplinary studies focused on stations in open waters, marginal ice zone and full ice covered environments (see maps below). Additional studies were conducted during transit from the UK to Svalbard. Oceanographic moored instrument arrays were also deployed in Storfjorden and retrieved from Rijpfjorden in the remote and rarely visited north-east corner of Svalbard.

SUMMARY ITINERARY AND MAPS

Sailed from Portland at mid-day on 23 July 2008.

Commenced science activities in English Channel at 07.50 on the 24 July 2008.

Arrived Longyearbyen, Svalbard on 31 July 2008.

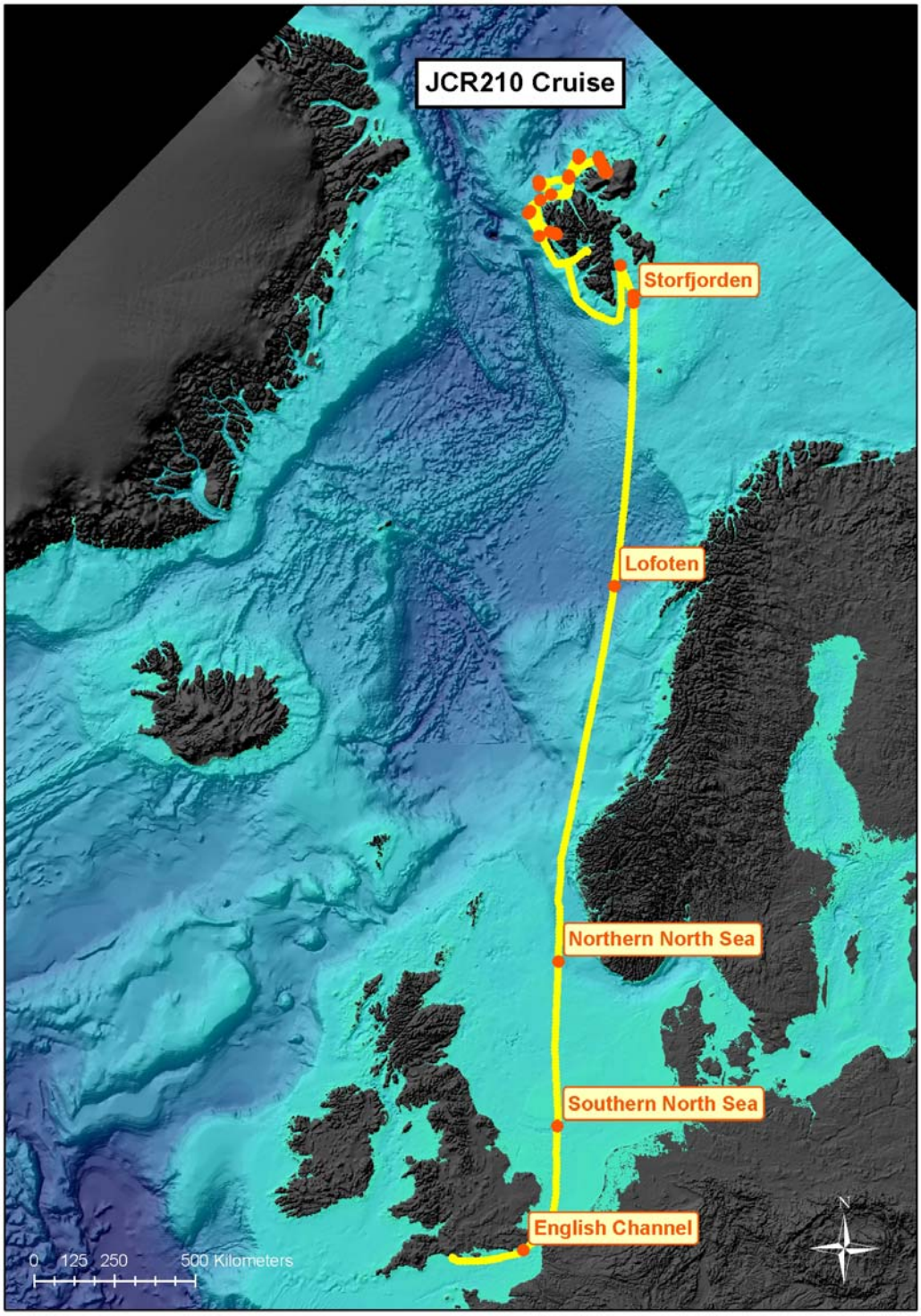
Commenced science activities north of Longyearbyen at 04.50 on the 1 August 2008.

Concluded science activities in Kongsfjorden, Svalbard at 04.40 on 20 August 2008.

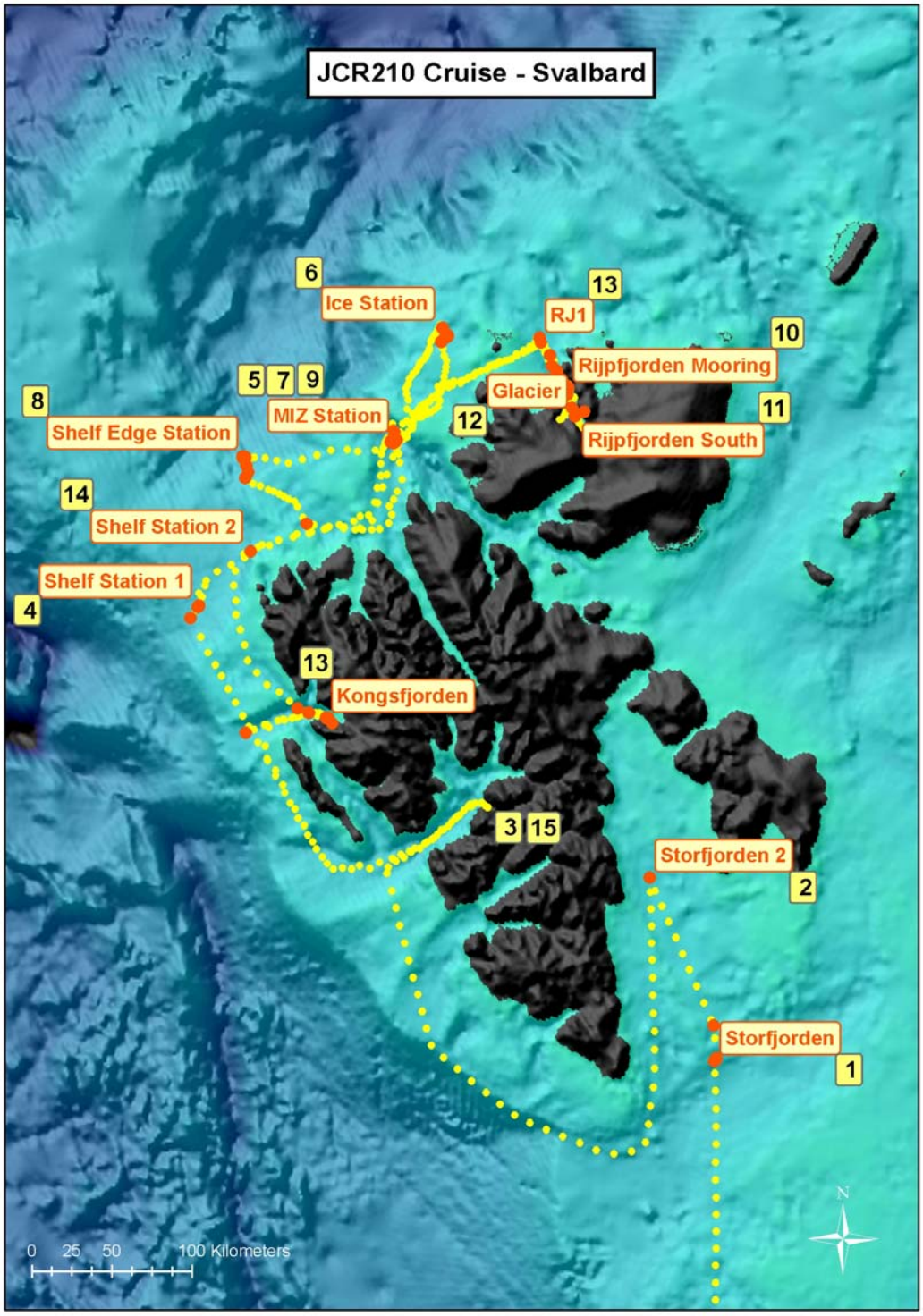
Docked and demobilised at Longyearbyen on morning of 21 August 2008.

Sympagic, pelagic and benthic biogeochemical variables in Svalbard shelf waters measured during JR210

Sea-ice	Water Column	Sediment
Bacterial composition	Temperature, salinity & dissolved oxygen	Mutibeam bathymetry
Microbial methanogenesis	Optical properties (PAR, UV-A and UV-B)	Bacterial abundance
Geochemical biomarkers	Organic and inorganic nutrients	Viral abundance
	Phytoplankton pigments	Meiofaunal composition and abundance
	Phytoplankton composition & abundance	Macrofaunal composition and abundance
	Photosynthetic efficiency	Microbial methanogenesis
	Primary production and DOC production	Geochemical biomarkers
	Calcification and DIN-uptake	*In situ* oxygen profiles and flux
	Bacterial composition and abundance	*In situ* carbon and nutrient flux
	Bacterial production	Sulphate reduction and denitrification
	Protozoan composition and abundance	Trace metal concentration
	Protozoan production	Chlorophyll concentrations
	Protozoan grazing (bacterivory and herbivory	Particulate CHN, porosity and particle size
	Viral abundance and production	Pore water nutrients
	Viral lysis and lysogeny	Accumulation/sedimentation rate (^{226}Ra/^{210} Po)
	Zooplankton composition and lipids	
	Zooplankton distribution and vertical migration	
	Microbial methanogenesis	
	Particle flux (^{210}Po/^{210}Pb and ^{234}Th)	
	Geochemical biomarkers	



Map of JR210 Cruise (UK and Svalbard)



Map of JR210 Cruise (Svalbard)
Numbers indicate order in which stations were visited

NARRATIVE

Ray Leakey

(All times given in GMT)

Tuesday 22 July

All science staff joined the *James Clark Ross* (*JCR*) to complete mobilisation in Portland Harbour dock. This included a visit by Susan Watts and Ming Tsang from the BBC to conduct pre-cruise interviews with Ray Leakey, Ellie Bell and Henrik Stahl for BBC2 Newsnight.

Wednesday 23 July

Mobilisation was completed in the morning. The *JCR* then sailed from Portland Harbour dock at 11.10. Stern thruster tests were conducted in Weymouth Bay in the afternoon then in early evening continued east into English Channel with calm seas and good visibility. Sea temperature ~17^{o}C.

Thursday 24 July

First “shakedown” station in English Channel west of Dover at approximately 08.00 off Hastings, including CTD water collections for calcification studies. Continue east into North Sea in calm seas. Commence underway water sampling for microbial distribution and abundance at 19.00.

Friday 25 July

Arrive at the Southern North Sea station at approximately 05.00 for CTD and water collection. Continue north in calm seas. Life boat drill conducted at 15.00. White beaked dolphins spotted late afternoon. Pass first oil rig.

Saturday 26 July

Arrive at the Northern North Sea station at approximately 05.00 for CTD and water collections. The continue north with weather still calm and sunny, past several oil rigs. Pilot whales spotted in afternoon. Norwegian coast and hills were visible approximately 20 miles to east.

Sunday 27 July

Continue north and cross the Arctic Circle at 20.30. Calm seas but colder and slightly foggy.

Monday 28 July

Continue north in cold foggy conditions to Loften station at approximately 09.30. Sea temperature now about 11 to 12^{o}C. Conducted deep (1500m) water test of benthic landers followed by CTDs. Sperm whale spotted in morning.

Tuesday 29 July

Continue north in calm overcast seas with several whales spotted.

Wednesday 30 July

Continue north into Storfjorden. Weather grey and overcast with occasional glimpses of Svlabard. Sea temperature now about 5^{o}C. First CTD at approximately 04.00 then swath bathymetric surveys and POL instrument (ADCPs and STABLE) deployments during the rest of the morning (all completed successfully). Satellite communications temporarily lost late morning. Early afternoon was spent further north in fjord unsuccessfully searching for a SAMS mooring which failed to surface after acoustic release. Underway water sampling discontinued at 17.30. JCR then headed south-west towards Longyearbyen with underway swath bathymetry.

Thursday 31 July

JCR arrived in Isfjorden, Svalbard, and anchored just offshore from Longyearbyen surrounded by snow covered hills. Mike Lucas, John Kenny, Terrie Doyle and Joe Collins depart ship by tender to be replaced by Stig Falk-Petersen, Anette Wold, Eric Fouilland, Emilie LeFloch, Mark Hart, Peter Lamont, Elaine Mitchell, Pauline Learmonth and George Pagliero. JCR then headed back out of Isfjorden and north up the west coast of Svalbard.

Friday 1 August

Arrive at first major Arctic station, Shelf Station 1 on the north-west Svalbard shelf, at approximately 08.00 after early morning spent deploying a grab to test benthic substrate in vicinity of the station for benthic sampling. The rest of the day until late afternoon was focused on benthic studies with CTD, Lander deployments and several megacorer deployments, all in calm conditions. A partial solar eclipse was observed through thick fog at 11.26. Satellite communications were intermittent. EK60 measurements were undertaken overnight.

Saturday 2 August

JCR remained at Shelf Station 1 for pelagic studies: CTD water collections, light measurements and zooplankton nets. Benthic landers (Elinor and Profiler) were also retrieved successfully in early afternoon. Fog had lifted but grey day with calm sea. Humpback whales spotted at midday.

Sunday 3 August

More light measurements and CTDs at Shelf Station 1 in morning then depart for ice edge north of Svalbard. Satellite communications were lost. Minke whale spotted. Loose pack encountered was in afternoon and evening. Sea temperature was about 3^{o}C. Passed Moffen Island at midnight with distant views of beached walruses (the JCR remained at some considerable distance for the island to comply with wildlife protection regulations). The first polar bear was seen at distance in afternoon.

Monday 4 August

The early hours of the morning were spent breaking though loose ice flows and searching for a good place to deploy the landers. Conducted grabs and CTD and Elinor lander deployed in morning at the Marginal Ice Zone (MIZ) station. The *JCR* then continued north-east into sea ice for ~15 hours to establish a full ice cover station. First polar bear sighting close to ship at 14.40. Thick pack ice (10/10ths) encountered and slow progress by midnight with ship using full power and heeling tanks to roll ship. Sea temperature was now about 0^{o}C.

Tuesday 5 August

Arrive at Sea-ice station at 03.00 with the *JCR* no longer able to progress further into ice. This was our most northerly position 547.3 nautical miles from the North Pole (80^{o}52.7N 19^{o}06.5E). Overcast with light snow flurries. A strong wind from port blew ship to starboard causing it to drift with the ice. Benthic grabs conducted in the morning but encountered poor sediment conditions for megacorer. Ice corer and augers were tested on sea-ice. Ship's Geordie basket and crane were used to access sea-ice. Polar bear watchers were established on ship's Monkey Island with Stig Falk-Petersen and Anette Wold providing gun cover on the ice. Lots of surface water pools on the ice. EK60 measurements started. Henrik Stahl's birthday.

Wednesday 6 August

Polar bear seem close to ship at 03.30. All day spent sampling and filming at the Sea-ice station: CTDs and zooplankton nets from ship and hand held CTD and NIO water bottle collections from ice, also ice cores. The ship drifted in strong wind and working conditions on the ice were very cold in the morning. Wind eased in afternoon.

Thursday 7 August

Final day of sampling and filming at the Sea-ice station: zooplankton nets, CTD, ice cores. Then *JCR* broke free of ice to head back south-west to the MIZ station, ice cover decreasing from 10/10 to 7/10ths once underway.

Friday 8 August

Arrived back at the MIZ station about 07.00 but encountered 8/10ths sea-ice cover so could not retrieve the Elinor lander. Megacores were taken throughout the morning and early afternoon, then CTDs, zooplankton nets, and EK60 measurements. Overcast with poor visibility.

Saturday 9 August

Continued work at the MIZ station in sunny conditions: zooplankton nets in the morning and early afternoon with sediment trap deployment. The rest of the afternoon was spent processing samples. Eric Fouilland's birthday.

Sunday 10 August

Further sampling at the MIZ station in 7/10ths sea-ice: CTD water collections, zooplankton nets, light and EK 60 measurements. Weather was very calm and sunny. Polar bear and Minke whale viewed close to the ships' bows.

Monday 11 August

After one final CTD the JCR departed the MIZ station in the early morning (leaving the Elinor lander still *in situ* due to ice cover) and headed west towards the shelf edge to find suitable sediment and ice-free conditions for further benthic studies. Passed Moffen Island again and bearded seals spotted in the afternoon. In the late afternoon and evening several grabs were deployed but sediment was too poor for sampling.

Tuesday 12 August

Continue grab samples overnight and located muddy sediment suitable for megacoring at 08.30. EK 60 measurements then started and megacores taken throughout the morning at the Shelf Edge station. Zooplankton nets and CTD water collection in the afternoon and evening.

Wednesday 13 August

Depart Shelf Edge station for MIZ station in morning after final CTD water collection. Arrive MIZ station at 14.00 and surface conditions now sufficiently ice-free to allow the Elinor lander to be recovered successfully. The *JCR* then continued onto Rijpfjorden having observed satellite images of ice cover which indicted that access to fjord may be possible. Swath bathymetry measurements were undertaken on route through thick sea-ice and, in part, poorly charted shallow waters.

Thursday 14 August

Continue to Rijpforden though very thick ice with engines on full power. The ship was occasionally halted by ice and used heeling tanks to roll ship. The *JCR* arrived Rijpfjorden South station at mid-day encountering only a few small ice-flows. The sediment condition was then tested using the benthic grab, after which the *JCR* then head north again to Rijpforden Mooring station with another grab sample taken. Both landers were then deployed late afternoon followed by zooplankton nets and EK60 survey overnight. Elaine Mitchell's birthday.

Friday 15 August

Continued to work at Rijpfjorden Mooring station in the morning with CTD water collection, Profiler lander recovery, zooplankton nets and EK60 measurements; also a Swath bathymetry survey of the fjords southern basin. A shore party comprising Stig Falk-Petersen, Anette Wold and George Pagliero departed the ship to inspect a Norwegian field research hut on the west shore of the fjord. The *JCR* then returned to Rijpfjorden South station in the afternoon for Profiler lander and sediment trap deployments, CTD water collections and megacore sampling.

Saturday 16 August

Foggy conditions with wet snow. The *JCR* Return to Rijpfjorden Mooring Station for early morning EK60 measurements and Elinor lander recovery. CTD water collections and light measurements also undertaken in the morning along with the recovery of the Rijpforden mooring after a year long deployment. The JCR then revisited the Rijpfjorden South station to recover the Profiler lander and sediment trap, and conduct more zooplankton net and CTD sampling. The shore party returned to ship. Finally further swath bathymetry conducted near south-west fjord glacier mouth and evening zooplankton nets at the RIB station. The JCR then headed north out of the fjord undertaking a late night CTD water sampling transect on route. Pauline Learmonth's birthday.

Sunday 17 August

Continued transect sampling north out of Rijpforden with early morning zooplankton nets and CTD water collections at RJA, RJB, and RJ1 stations. The JCR then headed west in poor visibility through thick ice (the ship occasionally halted by ice and using of heeling tanks to roll ship) heading for Shelf Station 2. Walrus and polar bear spotted. Pete Len's birthday.

Monday 18 August

Pass MIZ station in early hours and leave pack ice arriving at Shelf Station 2 to the north west of Svalbard at approximately 06.00. After a couple of CTD water collections, the *JCR* continued south to Kongfjorden in strong wind and substantial swell, arriving at Ny Alesund mid-afternoon. Both landers were then deployed in the fjord and the rest of the day spent undertaking zooplankton net collections and EK60 measurements.

Tuesday 19 August

Further zooplankton net collections and EK60 measurements conducted, including EK60 calibration most of the day (preventing other overside instrument deployments). Both landers recovered in the early evening. Susan Watts and Ming Tsang from the BBC joined the ship in the morning to conduct further filming and interviews with scientists,officers and crew. Start of demobilisation. Scientists visited from the Norwegian *RV Lance* which was also moored in Kongsfjorden.

*Wednesday 20 Augus***t**

The zooplankton net collections were completed in the early morning bringing to an end all science activities. The rest of the day was spent packing and conducting further filming and interviews. There was also a shore visit by staff and crew to Ny Alesund, including the Kings Bay Marine Laboratory and NERC Harland laboratory. The JCR then departed Kongsfjord in the late afternoon for Lonyearbyen. End of cruise party in evening.

Thursday 21 August

The JCR arrived in Longyearbyen in the early morning. Demobilisation completed during the morning and mid-day departure of science staff from ship for fights home. End of the research cruise.

“Chasing the Ice”

by Bo Thruster (August 2008)

Its that time again when for better or worse
I’m wont to stand up and reel off some verse,
To say a few words about what I have seen
On this big red ship where I’ve just been.

At first were night watches, mine mostly with Kate,
I’d be turning in early and getting up late,
And breakfast was supper, some found that amusing
But for Kate and me it was completely confusing.

And Jane was quite keen to get off the boat
When her face turned paler than her lab coat,
But when Julian’s vision made the cytometer flow
She suddenly felt better and said ‘I won’t go’

On the day we motored down Longyearbyen fjord
Where some people got off and yet more came on board.
Mike, and the POL mooring team went away
They were great company, shame they couldn’t stay.

We stopped at Moffen to see the walrus
But they might as well all have gone off on a bus.
Not even a carpenter sawing a log
Could we see as we peered through a great bank of fog.

Petra was here to look after our ills
With a plentiful supply of seasickness pills,
Not that they were needed, the water was flat
And many on board were thankful for that.

From beginning to end there was hardly a ripple,
Not a drop ever spilt of my favorite tipple.
Considering all the calm seas we have had
Even Tim should concede that it wasn’t so bad.

Now Hamish had told us about the tumble drier,
It sounded more dangerous than a deep fat fryer.
While such a gadget can leave your food greased
The drier would always leave all your clothes creased.

So, doing my laundry I thought I’d be smart
And attempt to master the ironing art.
That most evil of irons caught me on the hop
And when my trousers melted I thought ‘time to stop’.

Estelle and Eric and Emilie
Brought their gallic charm to our company,
Ellie made multitasking look effortless
If I tried it myself I'd just get in a mess.

Stig and Annette pulled up nets from the deep,
So tell me, do plankton ever sleep?
On the ice they were both completely at home
With gun over shoulder, off they would roam

To look out for bears, knowing the risk.
Maybe they would have liked lutefisk
On the menu. I'm sure it pleased Pete
That it never appeared, he'd have refused to eat.

Peter sieved mud in his kitchen sink
The formalin sometimes made me blink.
Arlene tried to make methane from the sediment trap
I don't know if she did (I was having a nap).

Colin kept all of us in check
By keeping the log sheets, but then – what the heck!
As the evening approached he became the lord
Of the fast becoming depleted cheeseboard.

Henrik and Keith sent the landers away,
Hoping to get them back the next day.
When they finally appeared I heard sighs of relief,
It's a minor miracle, that's my belief.

Filtering seemed to be a theme of the cruise,
Water went through the filters, not a drop to lose.
Mark tried the tangential, and so did Elaine,
But everything managed to escape down the drain

Susan and Pauline, my office pals
(a real lively couple of gals!),
Had pumps that sounded like an old steam train,
And they danced to that old choo-choo refrain.

Sometimes like a battle between Anastastasia and James -
How much was filtered? There were outrageous claims.
There can't be much left in the sea any more
Since its all been caught on a nucleopore.

Derek and Jimmy gave us huge plates of food,
Not to have stuffed ourselves would have been rude,
And I didn't find eating it all so hard.
Better diet now, or I'll turn into a tub of lard.

Mags was unplugged, no, acoustic I mean,
Looking for plankton on her echo machine.
And Simon, Julian and Mark were the folk
We turned to every time anything broke.

Laila wandered about with a photographer's eye,
There was no escape, although I did try.
I was covered in mud when she photographed me,
Do you think I should ask for a modeling fee?

Now that's an idea, I should ask George the same,
He's been pointing that camera at me since he came.
Or am I being paranoid? I don't think its funny
If I try to get back my TV licence money.

Andrea never did share a shower with me
Even though I was quite willing, and (I think) so was she,
But since she's young enough to be my daughter
I assure you it would have been just to save water.

We did polar bear watches in the wind and snow
But saw none close by, and were glad to go
Back into the ship, and close the doors tight,
Then one came and played with our flag in the night.

There were days though, when we did see a polar bear
Strolling (or swimming!) without a care,
They must have laughed to see us getting chilled
As they struck a few poses, and memory cards filled.

At last in Rijpfjorden we steamed up and down
And Stig's hut seemed like the nearest town,
It's a shame that we couldn't get onto the land
But at least there's no Tesco there on the sand.

And to my surprise there were birthdays galore
With Eric and Henrik both reaching two score,
And Elaine and Mango and Pauline and Pete,
So many birthdays, so much cake to eat.

Please take some advice from one who is older -
Age may well make one just a bit bolder
But wisdom is something I'm still waiting for,
So until it arrives you might as well drink more.

I must not forget principal scientist, Ray,
Who, whilst out working on the ice one day
Headbutted Annette, then rushed in to see
The doctor, just so he'd look good on TV.

The Beeb team, George, and Susan and Ming,
To Newsnight's audience soon will bring
The tale of this wondrous cruise
With the message – now is the time to choose.

We'll soon have our fifteen, er…seconds of fame
But will viewers think that they are to blame?
Will we have to stand up and say 'We told you so'
As the planet heats up to its final glow?

Though I do have my doubts about the programme they're making,
The story we're given might involve some faking.
The Newsnight report could be an elaborate cover
And the truth - we can all be seen on Big Brother.

I remember the day that I went into shock
When my ukulele fell into the dock.
Now, after so many miles and so much time
Here I am reading the final night's rhyme,

For tomorrow we'll find ourselves stepping ashore
When it's only left me wanting more.
It's finally time to bid adieu
To the captain, the officers and the crew.

They've helped us along in so many ways,
Through the lighter nights and the darker days.
From the stem to the stern, throughout the ranks,
To them we all offer our heartfelt thanks.

So farewell, JR210, we've lots to remember
As the days trickle past between now and December,
But before we all start feeling overly blue
Roll on twenty ten, and Ice Chaser Two!

JCR210 Event Log

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
1	24/07	07:50	08:04	English Channel	50°46.43563 N	00°45.18598 E	28	CTD	CTD001	Anastasia
2	25/07	05:08	05:22	Southern North Sea	54°12.43787 N	02°36.61785 E	42	CTD	CTD002	Anastasia
3	26/07	05:02	05:21	Northern North Sea	58°47.98040 N	03°14.97760 E	102	CTD	CTD003	Anastasia
4	28/07	09:25	10:53	Lofoten	69°00.07902 N	09°59.83266 E	3040	Lander test		Henrik
5	28/07	11:07	11:30	Lofoten	69°00.07814 N	09°59.82930 E	3100	Test CTD	500mSwathProfile - to 500m for swath - no bottles fired	Pete
6	28/07	11:39	11:57	Lofoten	69°00.08016 N	09°59.83358 E	3100	CTD	CTD004	Anastasia
7	30/07	04:10	04:36	Storfjorden	76°28.80340 N	18°59.92166 E	190	CTD	CTD005	Tim + James
8	30/07	04:52	05:21	Storfjorden_S1	76°28.58500 N	18°58.77000E	190	Swath survey	Start pos & time. POL1 area	Kate
9	30/07	05:36	05:40	Storfjorden_POL1	76°28.81557 N	19°00.00756 E	190	Lander deployment	POL F2	John
10	30/07	06:09	06:17	Storfjorden_POL2	76°29.00425 N	19°01.98635 E	190	Lander deployment	POL STABLE	John
11	30/07	06:23	07:37	Storfjorden_S2	76°29.32000 N	19°02.64000 E	190	Swath survey	Start pos & time. Between POL1 & POL2 + POL2 area	Kate
12	30/07	07:57	08:02	Storfjorden_POL3	76°39.99265 N	19°16.49680 E	160	Lander deployment	POL F1	John
13	30/07	08:03	13:02	Storfjorden_S3	76°39.99265 N	19°16.49680 E	160	Swath survey	Start pos & time. Between POL2 & POL3	Kate
14	30/07	13:00	15:07	Storfjorden_SAMS	77°34.03700 N	19°04.96700 E	190	Mooring recovery	Failed	Colin
15	01/08	04:50	07:30	Test	79°39.97000 N	08°30.68000 E	500	Grab	Rock caught in jaws	Martyn
16	01/08	08:22	08:55	Shelf Station 1	79°43.50000 N	08°50.01000 E	452	Grab	Mud	Martyn
17	01/08	09:24	10:02	Shelf Station 1	79°43.49000 N	08°50.07800 E	452	CTD	CTD006	Henrik
18	01/08	~11:00	11:25	Shelf Station 1	79°43.44000 N	08°50.07500 E	452	Lander deployment	(profiler) deployment #1	Henrik
19	01/08	~11:30	11:55	Shelf Station 1	79°43.44300 N	08°49.79600 E	407?	Elinor deployment	(chamber) deployment #1	Henrik
20	01/08	12:55	13:15	Shelf Station 1	79°43.10000 N	08°47.87500 E	458	Megacorer	Megacorer001 - 8/8 - on bottom at 13:05	Martyn
21	01/08	13:43	14:04	Shelf Station 1	79°43.10100 N	08°47.88100 E	458	Megacorer	Megacorer002 - 8/8 - on bottom at 13:53	Martyn
22	01/08	14:35	14:55	Shelf Station 1	79°43.10000 N	08°47.87800 E	458	Megacorer	Megacorer003 - 8/8 - on bottom at 14:45	Martyn
23	01/08	15:27	15:47	Shelf Station 1	79°43.10000 N	08°47.87800 E	457	Megacorer	Megacorer004 - 7.5/8 - on bottom at 15:38	Martyn
24	02/08	06:27	06:50	Shelf Station 1	79°43.61000 N	08°50.91400 E	448	CTD	CTD007	Tim
25	02/08	07:20	07:46	Shelf Station 1	79°43.61000 N	08°50.91500 E	448	CTD	CTD008	Tim
26	02/08	08:40	08:45	Shelf Station 1	79°43.61000 N	08°50.92100 E	448	CTD	CTD009	Tim
27	02/08	10:08	10:33	Shelf Station 1	79°43.60900 N	08°50.91300 E	449	Light probe test	TRIOS - down to 35m	Emilie
28	02/08	10:35	10:50	Shelf Station 1	79°43.60900 N	08°50.91300 E	449	Light probe test	FLUOROPROBE - down to 50m	Emilie

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
29	02/08	11:14	11:24	Shelf Station 1	79°43.60900 N	08°50.91000 E	449	CTD	CTD010 - down to 50m only	James + Mark
30	02/08	12:05	12:32	Shelf Station 1	79°43.44000 N	08°50.07500 E	449	Lander recovery	(profiler) recovery #1 - back at surface in ~7min	Henrik
31	02/08	12:35	13:15	Shelf Station 1	79°43.44300 N	08°49.79600 E	449?	Elinor recovery	(chamber) recovery #1 - back at surface in ~7min	Henrik
32	02/08	14:19	12:30 (03/8)	Shelf Station 1	79°43.47400 N	08°49.97000 E	449	EK60		Mags
33	02/08	14:25	12:38 (03/8)	Shelf Station 1	79°43.47400 N	08°49.97000 E	449	ADCP		Mags
34	02/08	14:57	15:24	Shelf Station 1	79°43.47600 N	08°49.97000 E	454	Zooplankton net	Down to 425m at 15:11	Stig
35	02/08	22:24	22:46	Shelf Station 1	79°43.48000 N	08°49.97000 E	452	CTD	CTD011– no bottles fired	Stig
36	02/08	22:56	23:23	Shelf Station 1	79°43.48000 N	08°49.97000 E	452	Zooplankton net		Stig
37	02/08	23:30	23:47	Shelf Station 1	79°43.48000 N	08°49.97000 E	452	Zooplankton net		Stig
38	03/08	06:12	06:35	Shelf Station 1	79°43.47500 N	08°49.97600 E	453	Light probe dept	TRIOS - down 50m at 06:21	Emilie
39	03/08	06:44	07:00	Shelf Station 1	79°43.47500 N	08°49.97600 E	453	Light probe dept	FLUOROPROBE - down 50m at 06:54	Emilie
40	03/08	07:18	07:40	Shelf Station 1	79°43.47500 N	08°49.97200 E	453	CTD	CTD012 - no bottles fired	Eric
41	03/08	08:19	08:26	Shelf Station 1	79°43.47500 N	08°49.97200 E	452	CTD	CTD013 – down to 30m only	Eric
42	03/08	09:20	09:48	Shelf Station 1	79°43.47500 N	08°49.97200 E	452	CTD	CTD014	Ray
43	03/08	12:38	09:12 (04/8)	Shelf Station 1	79°43.47000 N	08°49.95700 E	453	ADCP	Transit to Lander Site 2	Mags
44	04/08	07:15	07:39	MIZ Station	80°21.15300 N	16°20.89800 E	410	Grab	At bottom at 07:29	Martyn
45	04/08	08:00	08:31	MIZ Station	80°21.16400 N	16°20.87800 E	410	CTD	CTD015	Henrik
46	04/08	09:10	09:20	MIZ Station	80°21.16300 N	16°20.87900 E	410	Elinor deployment	Deployment #2 - At bottom at 09:16:30	Henrik
47	04/08	14:20	09:25 (07/8)	On way to Ice Stn	80°40.92600 N	17°43.08600 E	94	ADCP	Transit to Ice Station	Mags
48	05/08	09:09	09:22	Ice Station	80°51.61980 N	19°08.81880 E	99	Grab	Rock in jaws	Martyn
49	05/08	09:25	09:36	Ice Station	80°51.60900 N	19°08.80600 E	100	Grab	Rock in jaws	Martyn
50	05/08	09:38	09:50	Ice Station	80°51.60500 N	19°08.80000 E	100	Grab	Rock in jaws	Martyn
51	05/08	13:14	13:25	Ice Station	80°51.53500 N	19°08.92400 E	96	CTD	CTD016	Estelle
52	06/08	09:11	09:27 (07/8)	Ice Station	80°48.71000 N	19°13.06500 E	138	EK60		Mags
53	06/08	10:41	11:12	Ice Station	80°48.38400 N	19°12.27700 E	143	CTD	CTD017 – SBE19 on frame Ship's prop running on recovery to clear ice	Eric
54	06/08	12:54	13:22	Ice Station	80°48.28200 N	19°11.86700 E	144	CTD	CTD018	Tim
55	06/08	13:55	14:08	Ice Station	80°48.28300 N	19°11.89000 E	144	Zooplankton net	MPS – down 120m at 14:01	Anette
56	06/08	14:18	14:31	Ice Station	80°48.28400 N	19°11.90700 E	144	Zooplankton net	WP3 – down 100m at 14:24	Anette
57	06/08	14:35	14:47	Ice Station	80°48.28500 N	19°11.91100 E	144	Zooplankton net	WP3 – down 100m at 14:39	Anette
58	06/08	14:51	15:07	Ice Station	80°48.28500 N	19°11.91800 E	145	Zooplankton net	WP3 – down 120m at 14:58	Anette

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
59	06/08	22:10	22:20	Ice Station	80°48.28200 N	19°11.79600 E	144	CTD	CTD019	Stig
60	06/08	22:53	23:01	Ice Station	80°48.28400 N	19°11.58100 E	144	Zooplankton net	MPS	Stig
61	06/08	23:14	23:19	Ice Station	80°48.28400 N	19°11.51900 E	144	Zooplankton net	WP3	Stig
62	07/08	06:30	06:39	Ice Station	80°48.15470 N	19°06.47500 E	163	Zooplankton net	WP3	Stig
63	07/08	06:42	06:59	Ice Station	80°48.15470 N	19°06.47500 E	162	Zooplankton net	WP3	Stig
64	07/08	09:31		Ice Station	80°47.75000 N	19°00.33000 E	145	ADCP	Bottom tracking	Mags
65	07/08	12:40	13:03	Ice Station	80°47.40300 N	18°55.20000 E	128	CTD	CTD020	Andrea
66	08/08	07:22	07:45	MIZ Station	80°20.85700 N	16°20.82200 E	411	CTD	CTD021	Henrik
67	08/08	08:26	08:50	MIZ Station	80°20.85100 N	16°20.41000 E	411	Megacorer	Megacorer001b - 6/8 - on bottom at 08:40	Martyn
68	08/08	09:17	09:38	MIZ Station	80°21.03300 N	16°19.95200 E	405	Megacorer	Megacorer002b - 2/8 - on bottom at 09:26	Martyn
69	08/08	11:03	11:23	MIZ Station	80°20.92000 N	16°20.83500 E	411	Megacorer	Megacorer003b - 6/8 - on bottom at 11:14	Martyn
70	08/08	12:14	12:33	MIZ Station	80°20.93400 N	16°18.22500 E	393	Megacorer	Megacorer004b - 4/8 - on bottom at 12:24	Martyn
71	08/08	12:55	13:13	MIZ Station	80°20.93300 N	16°18.22700 E	393	Megacorer	Megacorer005b - 4/8 - on bottom at 13:03	Martyn
72	08/08	13:39	13:57	MIZ Station	80°20.93300 N	16°18.23000 E	394	Megacorer	Megacorer006b - 6/8 - on bottom at 13:47	Martyn
73	08/08	14:21	14:39	MIZ Station	80°20.93400 N	16°18.22300 E	394	Megacorer	Megacorer007b - 5/8 - on bottom at 14:29	Martyn
74	08/08	15:22	15:55	MIZ Station	80°20.88700 N	16°17.89400 E	393	CTD	CTD022	Tim
75	08/08	16:14	16:35	MIZ Station	80°20.81600 N	16°17.76500 E	392	CTD	CTD023	Tim
76	08/08	18:23	18:51	MIZ Station	80°20.73600 N	16°17.44600 E	391	CTD	CTD024	Tim
77	08/08	22:06	22:23	MIZ Station	80°20.83000 N	16°15.76000 E	386	Zooplankton net	MPS	Stig
78	08/08	22:32	22:40	MIZ Station	80°20.88000 N	16°14.78000 E	387	Zooplankton net	WP3	Stig
79	08/08	21:43	22:21(07/8)	MIZ Station	80°20.79600 N	16°16.12800 E	386	EK60		Mags
80	09/08	06:39	07:03	MIZ Station	80°21.15700 N	16°13.22400 E	388	CTD	CTD025	Tim
81	09/08	09:09	09:37	MIZ Station	80°20.62900 N	16°14.91100 E	381	Zooplankton net	MPS – down 375m at 09:25	Stig
82	09/08	09:43	09:55	MIZ Station	80°20.67000 N	16°13.93400 E	382	Zooplankton net	WP3 – down 100m at 09:50	Stig
83	09/08	11:04	11:09	MIZ Station	80°20.87000 N	16°11.59500 E	~383	Zooplankton net	WP3 – down 50m at 11:06	Stig
84	09/08	11:13	11:19	MIZ Station	80°20.90700 N	16°11.42400 E	~383	Zooplankton net	WP3 – down 50m at 11:16	Stig
85	09/08	11:22	11:28	MIZ Station	80°20.94100 N	16°11.27700 E	~383	Zooplankton net	WP3 – down 50m at 11:25	Stig
86	09/08	11:37	11:44	MIZ Station	80°20.97200 N	16°11.12900 E	~383	Zooplankton net	WP3 – down 50m at 11:40	Stig
87	09/08	11:46	11:53	MIZ Station	80°21.02600 N	16°10.87800 E	~383	Zooplankton net	WP3 – down 50m at 11:50	Stig
88	09/08	11:59	12:22	MIZ Station	80°21.05600 N	16°10.72600 E	~383	Zooplankton net	MPS – down 375m at 12:10	Stig
89	09/08	12:28	12:55	MIZ Station	80°21.15100 N	16°10.14400 E	~383	Zooplankton net	MPS – down 375m at 12:40	Stig

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
90	09/08	13:11	13:33	MIZ Station	80°21.27700 N	16°10.10300 E	386	Zooplankton net	MPS – down 375m at 13:22	Stig
91	09/08	15:15	06:10(10/8)	MIZ Station	80°21.13100 N	16°21.75300 E	414	Sediment trap	Down 50m, on starboard winch	Colin
92	10/08	07:13	07:24	MIZ Station	80°21.77900 N	16°17.22500 E	403	CTD	CTD026	Eric
93	10/08	07:40	07:55	MIZ Station	80°21.73500 N	16°17.09200 E	402	CTD	CTD027	Ray
94	10/08	11:07	11:18	MIZ Station	80°21.47300 N	16°15.08200 E	392	CTD	CTD028	James
95	10/08	11:03	05:11(11/8)	MIZ Station	80°21.47700 N	16°15.06700 E	392	EK60		Mags
96	10/08	11:32	11:45	MIZ Station	80°21.62400 N	16°14.30700 E	396	Zooplankton net	WP3 – down 100m at 11:39	Stig
97	10/08	11:50	12:12	MIZ Station	80°21.69400 N	16°14.00100 E	396	Zooplankton net	MPS – down 385m at 12:00	Stig
98	10/08	12:26	12:47	MIZ Station	80°21.76600 N	16°13.85900 E	397	Light probe dept	FLUOROPROBE – down 50m at 12:35	Emilie
99	10/08	12:53	13:10	MIZ Station	80°21.76700 N	16°13.85800 E	397	Light probe dept	TRIOS – down 50m at 13:06	Emilie
100	10/08	14:15	01:35(11/8)	MIZ Station	80°21.23500 N	16°22.88500 E	~350	Sediment trap	Down 50m. Recovered early because of shallowing	Colin
101	10/08	21:57	22:18	MIZ Station	80°24.08000 N	16°22.53000 E	353	Zooplankton net	MPS	Stig
102	10/08	22:24	22:37	MIZ Station	80°24.40000 N	16°22.58000 E	359	Zooplankton net	WP3	Stig
103	11/08	07:51	08:01	MIZ Station	80°21.16700 N	16°20.77700 E	411	CTD	CTD029	Andrea
104	11/08	17:40	17:54	Test 2	80°02.71900 N	12°45.81500 E	186	Grab	At bottom at 17:49. Stones	Martyn
105	11/08	23:53	00:23	Test 3	80°22.42000 N	11°08.82000 E	476	Grab	At bottom at 00:08. Stones	Henrik
106	12/08	01:08	01:39	Test 4	80°24.13000 N	11°18.57000 E	498	Grab	At bottom at 01:25. Stones	Henrik
107	12/08	02:26	03:05	Test 5	80°26.46000 N	11°17.72000 E	596	Grab	At bottom at 02:48. Stones	Henrik
108	12/08	07:38	08:14	Shelf Edge Station	80°29.30200 N	11°18.84700 E	755	Grab	At bottom at 07:58. Empty	Martyn
109	12/08	08:19	08:55	Shelf Edge Station	80°29.29400 N	11°18.73900 E	756	Grab	At bottom at 08:37. Mud	Martyn
110	12/08	08:45	05:40(13/8)	Shelf Edge Station	80°29.23700 N	11°18.15000 E	753	EK60		Mags
111	12/08	09:30	10:02	Shelf Edge Station	80°29.28300 N	11°18.37600 E	755	Megacorer	Megacorer001c - 8/8 - on bottom at 09:47	Martyn
112	12/08	10:25	10:55	Shelf Edge Station	80°29.35000 N	11°17.69200 E	760	Megacorer	Megacorer002c - 8/8 - on bottom at 10:40	Martyn
113	12/08	11:16	11:44	Shelf Edge Station	80°29.35400 N	11°17.73000 E	760	Megacorer	Megacorer003c - 4/8 - on bottom at 11:30	Martyn
114	12/08	12:08	12:36	Shelf Edge Station	80°29.35100 N	11°17.64900 E	760	Megacorer	Megacorer004c - 8/8 - on bottom at 12:23	Martyn
115	12/08	13:04	13:33	Shelf Edge Station	80°29.40500 N	11°17.72100 E	763	Megacorer	Megacorer005c - 8/8 - on bottom at 13:21	Martyn
116	12/08	14:08	14:30	Shelf Edge Station	80°29.45900 N	11°17.22400 E	770	Zooplankton net	WP3 - down 200m at 14:19	Stig
117	12/08	14:34	14:46	Shelf Edge Station	80°29.52800 N	11°16.52900 E	775	Zooplankton net	WP3 - down 100m at 14:40	Stig
118	12/08	14:52	15:04	Shelf Edge Station	80°29.66000 N	11°15.73200 E	780	Zooplankton net	WP3 - down 100m at 14:58	Stig
119	12/08	15:32	16:12	Shelf Edge Station	80°29.51300 N	11°16.96500 E	774	Zooplankton net	MPS - down 765m at 15:50	Stig
120	12/08	16:36	17:07	Shelf Edge Station	80°29.86000 N	11°14.61000 E	788	Zooplankton net	MPS - down 765m at 16:51	Stig

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
121	12/08	18:15	19:04	Shelf Edge Station	80°29.78100 N	11°14.91700 E	785	CTD	CTD030	Tim
122	12/08	19:37	20:03	Shelf Edge Station	80°29.62000 N	11°14.75200 E	778	CTD	CTD031	Tim
123	12/08	20:27	21:07	Shelf Edge Station	80°29.61400 N	11°14.76000 E	777	CTD	CTD032	Tim
124	12/08	21:37	22:09	Shelf Edge Station	80°29.61400 N	11°14.77100 E	777	Zooplankton net	MPS? down ~765m at 21:51	Stig
125	12/08	22:35	23:08	Shelf Edge Station	80°29.61300 N	11°14.80300 E	777	Zooplankton net	MPS? down ~765m at 22:50	Stig
126	12/08	23:25	23:37	Shelf Edge Station	80°29.23900 N	11°14.32400 E	759	Zooplankton net	WP3? down 100m at 23:31	Stig
127	13/08	06:40	07:13	Shelf Edge Station	80°29.25300 N	11°19.27900 E	752	CTD	CTD033	Tim
128	13/08	07:17	07:20	Shelf Edge Station	80°29.25400 N	11°19.27700 E	752	Plankton net	Hand-held net. Down 20m at 07:18	Ray
129	13/08	14:15	14:55	MIZ Station	80°21.32400 N	16°20.50000 E	410	Elinor recovery	Recovery #2	Henrik
130	13/08	15:00	16:50(14/8)	On way to Rijpfjord	80°21.32400 N	16°20.50000 E	410	Swath	From MIZ Station to and in Rijpfjorden	Kate
131	14/08	12:09	12:24	Rijpfjorden South	80°07.47100 N	22°09.22700 E	205	Grab	At bottom at 12:16. Mud	Martyn
132	14/08	16:52	17:08	Rijpfjorden Mooring	80°16.87900 N	22°18.32500 E	196	Grab	At bottom at 17:00. Mud + a few stones	Martyn
133	14/08	17:36	17:42	Rijpfjorden Mooring	80°16.88000 N	22°18.33900 E	195	Elinor deployment	Deployment #3	Henrik
134	14/08	17:57	18:04	Rijpfjorden Mooring	80°16.99100 N	22°18.74400 E	217	Lander deployment	Deployment #2	Henrik
135	14/08	20:04	20:11	Rijpfjorden Mooring	80°17.10000 N	22°18.25000 E	225	Zooplankton net	WP3	Stig
136	14/08	20:20	20:31	Rijpfjorden Mooring	80°17.09000 N	22°18.21000 E	225	Zooplankton net	WP3	Stig
137	14/08	20:45	21:04	Rijpfjorden Mooring	80°17.09000 N	22°18.22000 E	225	Zooplankton net	MPS	Stig
138	14/08	20:58	23:20	Rijpfjorden Mooring	80°17.08400 N	22°18.21800 E	225	EK60		Mags
139	14/08	21:33	21:49	Rijpfjorden Mooring	80°17.09000 N	22°18.21000 E	225	Zooplankton net	MPS	Stig
140	14/08	22:04	22:17	Rijpfjorden Mooring	80°17.09000 N	22°18.21000 E	225	Zooplankton net	MPS	Stig
141	14/08	22:53	23:05	Rijpfjorden Mooring	80°17.13000 N	22°18.25000 E	225	Zooplankton net	MPS	Stig
142	14/08	23:47	05:02(15/8)	Rijpfjorden Mooring	80°18.25200 N	22°16.01400 E	284	EK60	Survey near mooring site	Mags
143	15/08	05:04	07:52	Rijpfjorden	80°25.76400 N	22°06.56400 E	205	ADCP		Mags
144	15/08	06:50	07:20	Rijpfjorden Mooring	80°16.97000 N	22°17.75400 E	211	CTD	CTD034	Andrea
145	15/08	08:05	08:32	Rijpfjorden Mooring	80°16.98000 N	22°17.89000 E	~210	Lander recovery	Recovery #2	Henrik
146	15/08	08:39	19:23	Rijpfjorden Mooring	80°16.87200 N	22°19.21700 E	198	EK60		Mags
147	15/08	08:41	04:47(16/8)	Rijpfjorden Mooring	80°16.87200 N	22°19.21700 E	198	ADCP		Mags
148	15/08	09:30	09:43	Rijpfjorden Mooring	80°17.08400 N	22°18.26500 E	225	Zooplankton net	MPS - down 222m at 09:35	Stig
149	15/08	09:50	10:01	Rijpfjorden Mooring	80°17.09700 N	22°18.25400 E	226	Zooplankton net	WP3 - down 100m at 09:55	Stig
150	15/08	10:20	14:00	Rijpfjorden Mooring	80°17.09700 N	22°18.25400 E	226	Swath	From mooring site to Southern Basin	Kate
151	15/08	14:07	14:15	Rijpfjorden South	80°07.36800 N	22°29.05000 E	206	Lander deployment	Deployment #3 – at bottom at 14:10	Henrik

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
152	15/08	14:29	14:45	Rijpfjorden South	80°07.45400 N	22°09.23300 E	209	Megacorer	Megacorer001d - 7/8 - on bottom at 14:36	Martyn
153	15/08	15:12	16/8 pm	Rijpfjorden South	80°07.53600 N	22°09.36800 E	196	Sediment trap	At bottom at ~15:17	Colin
154	15/08	15:45	15:58	Rijpfjorden South	80°07.45100 N	22°09.23600 E	205	Megacorer	Megacorer002d - 8/8 - on bottom at 15:52	Martyn
155	15/08	16:13	16:26	Rijpfjorden South	80°07.45100 N	22°09.23400 E	205	Megacorer	Megacorer003d - 7/8 - on bottom at 16:20	Martyn
156	15/08	16:53	17:07	Rijpfjorden South	80°07.45100 N	22°09.24400 E	205	Megacorer	Megacorer004d - 6/8 - on bottom at 17:00	Martyn
157	15/08	17:33	17:44	Rijpfjorden South	80°07.45000 N	22°09.24000 E	205	Megacorer	Megacorer005d - 8/8 - on bottom at 17:39	Martyn
158	15/08	18:35	18:51	Rijpfjorden South	80°07.47000 N	22°08.94800 E	205	CTD	CTD035	Tim
159	15/08	19:28	19:50	Rijpfjorden South	80°07.46900 N	22°08.94600 E	205	CTD	CTD036	Henrik
160	16/08	00:26	04:45	Rijpfjorden Mooring	80°15.07200 N	22°11.51300 E	112	EK60		Mags
161	16/08	05:18	05:35	Rijpfjorden Mooring	80°16.96800 N	22°18.54700 E	218	Elinor recovery	Recovery #3	Henrik
162	16/08	06:18	06:26	Rijpfjorden Mooring	80°16.96900 N	22°18.54400 E	219	CTD	CTD037	Eric
163	16/08	06:41	06:57	Rijpfjorden Mooring	80°16.97000 N	22°18.54500 E	219	CTD	CTD038	Ray
164	16/08	07:50	09:10	Rijpfjorden Mooring	80°16.81700 N	22°19.62700 E	216	Mooring recovery		Colin
165	16/08	09:38	09:49	Rijpfjorden Mooring	80°16.91800 N	22°18.79900 E	217	CTD	CTD039	James
166	16/08	09:54	09:57	Rijpfjorden Mooring	80°16.91600 N	22°18.80200 E	217	Plankton net	Hand-held net. Down 20m at 09:55	Ray
167	16/08	10:47	10:57	Rijpfjorden Mooring	80°16.91700 N	22°18.80600 E	217	Light probe dept	FLUOROPROBE – down 50m at 10:51	Emilie
168	16/08	11:02	11:15	Rijpfjorden Mooring	80°16.91700 N	22°18.80700 E	217	Light probe dept	TRIOS – down 50m at 11:08	Emilie
169	16/08	11:18	12:46	Rijpfjorden Mooring	80°16.91800 N	22°18.80100 E	217	EK60		Mags
170	16/08	11:20	12:46	Rijpfjorden Mooring	80°16.91800 N	22°18.80400 E	217	ADCP		Mags
171	16/08	12:57	13:17	Rijpfjorden South	80°07.46600 N	22°09.18300 E	206	CTD	CTD040	Tim
172	16/08	13:30	14:00	Rijpfjorden South	80°07.25600 N	22°09.15000 E	206	Lander recovery	Recovery #3	Henrik
173	16/08	14:26	14:45	Rijpfjorden South	80°07.42200 N	22°09.17100 E	201	CTD	CTD041	Stig
174	16/08	14:54	15:04	Rijpfjorden South	80°07.42500 N	22°09.17500 E	202	Zooplankton net	MPS - down 190m at 14:59	Stig
175	16/08	15:09	15:20	Rijpfjorden South	80°07.42500 N	22°09.17700 E	202	Zooplankton net	WP3 - down 100m at 15:14	Stig
176	16/08	17:59	19:44	Glacier	80°07.42500 N	22°09.17700 E	202	Swath	From Rijpfjorden South to, in and out of glacier	Kate
177	16/08	20:05	20:27	RIB	80°10.19400 N	22°10.06700 E	176	CTD	CTD042	Stig
178	16/08	20:37	20:49	RIB	80°10.19500 N	22°10.06100 E	176	Zooplankton net	WP3 – down 100m at 20:43	Stig
179	16/08	20:53	21:04	RIB	80°10.19400 N	22°10.05900 E	177	Zooplankton net	MPS - down 170m at 21:58	Stig
180	16/08	22:42	23:05	Rijpfjorden Mooring	80°16.99000 N	22°19.41200 E	183	CTD	CTD043	Tim
181	17/08	00:58	01:22	RJA	80°23.83000 N	22°13.16500 E	157	CTD	CTD044	Colin
182	17/08	02:55	03:19	RJB	80°29.46600 N	22°12.63300 E	178	CTD	CTD045	Colin

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Lead
183	17/08	05:01	15:26(18/8)	1.5nm South of RJ1	80°34.47600 N	22°06.62000 E	156	ADCP		Mags
184	17/08	05:56	06:07	RJ1	80°36.13900 N	22°07.74100 E	174	Zooplankton net	MPS - down 170m at 06:02	Stig
185	17/08	06:11	06:22	RJ1	80°36.13800 N	22°07.65500 E	174	Zooplankton net	WP3 - down 100m at 06:17	Stig
186	17/08	06:37	06:55	RJ1	80°36.03400 N	22°07.36000 E	180	CTD	CTD046	Ray/Tim/Estelle
187	18/08	06:19	06:28	Shelf Station 2	79°57.99100 N	10°47.33500 E	243	CTD	CTD047	Eric
188	18/08	06:40	06:47	Shelf Station 2	79°57.99100 N	10°47.33200 E	243	CTD	CTD048	Eric
189	18/08	15:59	16:10	Kongsfjorden Kb3	78°57.51000 N	11°53.76000 E	357	Grab		Martyn
190	18/08	16:33	16:40	Kongsfjorden Kb3	78°57.51000 N	11°53.76000 E	357	Lander deployment	Deployment #4	Henrik
191	18/08	16:55	17:05	Kongsfjorden Kb3	78°57.45000 N	11°53.56400 E	357	Elinor deployment	Deployment #4	Henrik
192	18/08	17:58	07:35(19/8)	Kongsfjorden Kb3	78°57.62400 N	11°55.88800 E	345	EK60		Mags
193	18/08	18:01	07:48(19/8)	Kongsfjorden Kb3	78°57.61800 N	11°56.01400 E	343	ADCP		Mags
194	18/08	18:10	18:16	Kongsfjorden Kb3	78°57.60100 N	11°56.36600 E	341	Zooplankton net	WP3 – down 50m at 18:13	Stig
195	18/08	18:20	18:25	Kongsfjorden Kb3	78°57.60100 N	11°56.36500 E	340	Zooplankton net	WP3 - down 50m at 18:22	Stig
196	18/08	18:31	16:41	Kongsfjorden Kb3	78°57.60000 N	11°56.36200 E	340	Zooplankton net	WP3 - down 100m at 18:37	Stig
197	18/08	18:57	19:16	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	339	Zooplankton net	MPS	Stig
198	18/08	21:01	~21:25	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	339	Zooplankton net	MPS	Stig
199	19/08	06:00	~06:20	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	340	Zooplankton net	MPS	Stig
200	19/08	06:25	~06:35	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	340	Zooplankton net	WP3	Stig
201	19/08	06:53	07:10	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	340	CTD	CTD049	Stig
202	19/08	08:33	08:37	Kongsfjorden Kb3	78°55.40500 N	12°00.75500 E	50	CTD	CTD050	Mags
203	19/08	10:20	17:30	Kongsfjorden	78°55.40500 N	12°00.76200 E	51	EK60 calibration		Mags
204	19/08	19:18	19:45	Kongsfjorden Kb3	78°57.66300 N	11°53.69700 E	~350	Lander recovery	Recovery #4	Henrik
205	19/08	19:53	20:10	Kongsfjorden Kb3	78°57.59100 N	11°53.23000 E	~350	Elinor recovery	Recovery #4	Henrik
206	19/08	20:43	08:54(20/8)	Kongsfjorden	78°57.27000 N	11°53.39600 E	357	EK60		Mags
207	19/08	20:45	00:50(20/8)	Kongsfjorden	78°57.27000 N	11°53.39600 E	357	ADCP		Mags
208	19/08	22:53	~23:15	Kongsfjorden Kb1	79°00.70000 N	11°24.68400 E	344	Zooplankton net	MPS	Stig
209	19/08	23:23	~23:30	Kongsfjorden Kb1	79°00.69300 N	11°25.69300 E	344	Zooplankton net	WP3	Stig
210	20/08	00:55	~01:05	Kongsfjorden Kb0	79°02.78000 N	11°08.20000 E	326	Zooplankton net	WP3	Stig
211	20/08	01:15	~01:40	Kongsfjorden Kb0	79°02.78200 N	11°08.20100 E	326	Zooplankton net	MPS	Stig
212	20/08	04:14	~4:40	Kongsfjorden V12	78°58.52000 N	09°29.95000 E	321	Zooplankton net	MPS	Stig

SUMMARY OF PRELIMINARY RESULTS

Ray Leakey

The oceanographic conditions encountered north of Svalbard were colder than expected with extensive ice cover. These cold conditions were a local feature produced by northerly winds forcing Arctic sea-ice south onto the north coast of Svalbard. The Arctic as a whole experienced extensive sea-ice melt in summer 2008 leading to a thinner ice pack. This thinner sea-ice is more mobile and some of it was blown into our study area maintaining local ice cover and cold conditions longer into the summer than expected.

The marine ecosystem at the study sites appeared to be characterised by typical Arctic species. Full taxonomic analysis of will confirm if this was the case or whether invasive warmer water species were present.

Phytoplankton were observed in the water column with peak abundances recorded at depths characterised by very low light levels (<1% surface solar radiation). The phytoplankton were actively growing, although relatively slowly. Much of the carbon taken in by the phytoplankton was being released back out into the seawater as dissolved compounds. Calcification rates were very low.

High concentrations of recycled nutrients were observed in deeper waters, just below the depths where phytoplankton were growing. It is likely that the phytoplankton were growing best at depths where they were supplied simultaneously with light (albeit at low levels) from above and recycled nutrients from below.

An abundant and active bacterial community was observed in the water column suggesting that considerable amounts of energy, carbon and nutrients were being recycled by the microbial community (rather than being transferred up the food web to larger organisms). This bacterial community was not, however, using the dissolved carbon compounds released by the phytoplankton.

Healthy populations of large herbivorous zooplankton were found in deep waters at our study sites. These Arctic species had stores of high energy lipids accumulated whilst feeding on phytoplankton earlier this summer, and had entered winter “hibernation”. This suggests that their food supply must have been active and abundant underneath the sea ice earlier in the year, despite low light levels encountered under the sea ice. It also suggests that a substantial quantity of energy and carbon had been transferred up the food web to larger organisms during spring/early summer.

Incubation experiments revealed that an increase in water temperature may lead to a decrease in phytoplankton growth.

Sea-bed lander experiments revealed that carbon and nutrients were recycled faster at higher sea-bed temperatures.

SCIENTIFIC REPORT 1: Physics, CTD and Moorings

Estelle Dumont and Colin Griffiths

Moorings

Storfjorden mooring recovery

On the 30/07 an attempt was made to recover a SAMS mooring in Storfjorden (deployed in 2007), on position 77°33.99N, 019°04.70E at 13:00.

No communication could be established with the mooring's acoustic release with either of the two acoustic deck units onboard. After an hour of communication attempts it was decided to conduct an echo-sounder survey in the area in the hope of locating the mooring, which proved unsuccessful and lead to think that the mooring had probably been trawled. At the end of the survey a last attempt to communicate with the acoustic release was made, but still without success. The recovery was abandoned at 15:05.

Rijpfjorden mooring recovery

On the 16/08 an attempt was made to recover a SAMS mooring in Rijpfjorden (deployed in 2007), on position 80°16.82N, 022°19.63E at 07:50.

The mooring was released by an acoustic command, on the surface within a few minutes and brought back onboard without trouble. The recovery was complete at 09:10.
This mooring included: three CTDs (one SBE16+,wo SBE37 and one DST CTD), 8 temperature miniloggers, an ADCP, an S4 current meter and a sediment trap.

CTD

System & methodology

The BAS SBE911/917+ CTD package was used during the JCR210 cruise. The system consisted of a pressure transducer, dual pumped temperature and conductivity sensors and a SBE43 oxygen sensor. Also fitted on the CTD were a Chelsea Aqua 3 fluorometer, an altimeter, a Biospherical/Licor PAR/irradiance sensor and a Chelsea/Seatech/Wetlab CStar transmissometer. The data was recorded at a 24Hz rate. An independent SBE35 thermometer was also mounted on the frame. Details of the sensors configuration are listed in Annex 1 and 2. Twenty-four 10 litres bottles were fitted on the carousel.
The CTD was usually deployed on the CTD crane/winch on the starboard side, except on a few occasions when ice conditions did not allow working on the side of the ship but using the stern gantry instead. The usual procedure was to first lower the CTD to around 10m deep for the pumps to switch on. The system was then brought back up to the surface before starting the cast. Winch speed in the top 100m was about 0.5m/s, and 1m/s below.

Casts summary

Cf Table 1 for the list of casts.

The CTD has generally performed well during the cruise, except on a few points:

- The data recorded by the sensors when bottles were fired on the upcast is often very noisy. Most of it has been removed during the despiking process. The data on the downcast is much more continuous.
- Note on the altimeter data: the altimeter does not work when it is over 100m from the bottom.
- The secondary conductivity sensor has failed for the first ~4000 scans on CTD025. The origin of the problem is unexplained, but this did not happen on any other casts.
- During the CTD 500mSwathProfile a wrong CAL file has been used, and the data from that cast has been corrupted. This cast not being a crucial one the data has not been recovered/ reprocessed.

Table 1: JCR210 CTD casts summary

Evt No	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	CTD depth (m)	CTD Ref	Btl fired	Theme	Lead	Comments
1	24/07	07:50	08:04	English Channel	50°46.43563 N	00°45.18598 E	28	25	**CTD001**	Y	*Mixed*	Anastasia	
2	25/07	05:08	05:22	Southern North Sea	54°12.43787 N	02°36.61785 E	42	36	**CTD002**	Y	*Mixed*	Anastasia	
3	26/07	05:02	05:21	Northern North Sea	58°47.98040 N	03°14.97760 E	102	92	**CTD003**	Y	*Mixed*	Anastasia	
5	28/07	11:07	11:30	Lofoten	69°00.07814 N	09°59.82930 E	3100	500	**500mSwath Profile**	N	Sound profile	Pete	Corrupted file. No data available.
6	28/07	11:39	11:57	Lofoten	69°00.08016 N	09°59.83358 E	3100	100	**CTD004**	Y	*Mixed*	Anastasia	
7	30/07	04:10	04:36	Storfjorden	76°28.80340 N	18°59.92166 E	190	184	**CTD005**	Y	*Mixed*	Tim + James	
17	01/08	09:24	10:02	Shelf Station 1	79°43.49000 N	08°50.07800 E	452	446	**CTD006**	Y	*Mixed*	Henrik	
24	02/08	06:27	06:50	Shelf Station 1	79°43.61000 N	08°50.91400 E	448	446	**CTD007**	Y	Radiochemistry	Tim	
25	02/08	07:20	07:46	Shelf Station 1	79°43.61000 N	08°50.91500 E	448	440	**CTD008**	Y	Radiochemistry	Tim	
26	02/08	08:40	08:45	Shelf Station 1	79°43.61000 N	08°50.92100 E	448	60	**CTD009**	Y	Radiochemistry	Tim	
29	02/08	11:14	11:24	Shelf Station 1	79°43.60900 N	08°50.91000 E	449	50	**CTD010**	Y	*Mixed*	James + Mark	
35	02/08	22:24	22:46	Shelf Station 1	79°43.48000 N	08°49.97000 E	452	440	**CTD011**	N	Profile for nets	Stig	
40	03/08	07:18	07:40	Shelf Station 1	79°43.47500 N	08°49.97200 E	453	200	**CTD012**	N	Light levels	Eric	
41	03/08	08:19	08:26	Shelf Station 1	79°43.47500 N	08°49.97200 E	452	30	**CTD013**	Y	Incubations	Eric	
42	03/08	09:20	09:48	Shelf Station 1	79°43.47500 N	08°49.97200 E	452	446	**CTD014**	Y	Pelagic	Ray	
45	04/08	08:00	08:31	Lander Station 2	80°21.16400 N	16°20.87800 E	410	400	**CTD015**	Y	*Mixed*	Henrik	
51	05/08	13:14	13:25	Ice Station	80°51.53500 N	19°08.92400 E	96	89	**CTD016**	Y	*Mixed*	Estelle	CTD deployed from stern gantry
53	06/08	10:41	11:12	Ice Station	80°48.38400 N	19°12.27700 E	143	140	**CTD017**	Y	Pelagic	Eric	CTD deployed from stern gantry SBE19 on frame Ship's prop running on recovery to clear ice
54	06/08	12:54	13:22	Ice Station	80°48.28200 N	19°11.86700 E	144	138	**CTD018**	Y	*Mixed*	Tim	CTD deployed from stern gantry
59	06/08	22:10	22:20	Ice Station	80°48.28200 N	19°11.79600 E	144	140	**CTD019**	N	Profile for nets	Stig	CTD deployed from stern gantry
65	07/08	12:40	13:03	Ice Station	80°47.40300 N	18°55.20000 E	128	120	**CTD020**	Y	Grazing experiments	Andrea	
66	08/08	07:22	07:45	Lander Station 2	80°20.85700 N	16°20.82200 E	411	400	**CTD021**	Y	*Mixed*	Henrik	
74	08/08	15:22	15:55	Lander Station 2	80°20.88700 N	16°17.89400 E	393	380	**CTD022**	Y	Radiochemistry	Tim	
75	08/08	16:14	16:35	Lander Station 2	80°20.81600 N	16°17.76500 E	392	200	**CTD023**	Y	Radiochemistry	Tim	
76	08/08	18:23	18:51	Lander Station 2	80°20.73600 N	16°17.44600 E	391	380	**CTD024**	Y	Radiochemistry	Tim	

Evt No	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	CTD depth (m)	CTD Ref	Btl fired	Theme	Lead	Comments
80	09/08	06:39	07:03	Lander Station 2	80°21.15700 N	16°13.22400 E	388	381	**CTD025**	Y	Radiochemistry	Tim	
92	10/08	07:13	07:24	Lander Station 2	80°21.77900 N	16°17.22500 E	403	100	**CTD026**	N	Light levels	Eric	
93	10/08	07:40	07:55	Lander Station 2	80°21.73500 N	16°17.09200 E	402	60	**CTD027**	Y	Pelagic	Ray	
94	10/08	11:07	11:18	Lander Station 2	80°21.47300 N	16°15.08200 E	392	60	**CTD028**	Y	*Mixed*	James	
103	11/08	07:51	08:01	Lander Station 2	80°21.16700 N	16°20.77700 E	411	70	**CTD029**	Y	Grazing experiments	Andrea	
121	12/08	18:15	19:04	Shelf Edge Station 1	80°29.78100 N	11°14.91700 E	785	772	**CTD030**	Y	Radiochemistry	Tim	CTD deployed from stern gantry
122	12/08	19:37	20:03	Shelf Edge Station 1	80°29.62000 N	11°14.75200 E	778	300	**CTD031**	Y	Radiochemistry	Tim	CTD deployed from stern gantry
123	12/08	20:27	21:07	Shelf Edge Station 1	80°29.61400 N	11°14.76000 E	777	752	**CTD032**	Y	*Mixed*	Tim	CTD deployed from stern gantry
127	13/08	06:40	07:13	Shelf Edge Station 1	80°29.25300 N	11°19.27900 E	752	700	**CTD033**	Y	Radiochemistry	Tim	
144	15/08	06:50	07:20	Rijpfjorden Mooring	80°16.97000 N	22°17.75400 E	211	202	**CTD034**	Y	Grazing experiments	Andrea	
158	15/08	18:35	18:51	Rijpfjorden South	80°07.47000 N	22°08.94800 E	205	198	**CTD035**	Y	Radiochemistry	Tim	
159	15/08	19:28	19:50	Rijpfjorden South	80°07.46900 N	22°08.94600 E	205	196	**CTD036**	Y	*Mixed*	Henrik	
162	16/08	06:18	06:26	Rijpfjorden Mooring	80°16.96900 N	22°18.54400 E	219	100	**CTD037**	N	Light levels	Eric	
163	16/08	06:41	06:57	Rijpfjorden Mooring	80°16.97000 N	22°18.54500 E	219	60	**CTD038**	Y	Pelagic	Ray	
165	16/08	09:38	09:49	Rijpfjorden Mooring	80°16.91800 N	22°18.79900 E	217	60	**CTD039**	Y	*Mixed*	James	
171	16/08	12:57	13:17	Rijpfjorden South	80°07.46600 N	22°09.18300 E	206	195	**CTD040**	Y	Radiochemistry	Tim	
173	16/08	14:26	14:45	Rijpfjorden South	80°07.42200 N	22°09.17100 E	201	190	**CTD041**	Y	*Mixed*	Stig	
177	16/08	20:05	20:27	RIB	80°10.19400 N	22°10.06700 E	176	167	**CTD042**	Y	*Mixed*	Stig	
180	16/08	22:42	23:05	Rijpfjorden Mooring	80°16.99000 N	22°19.41200 E	183	175	**CTD043**	Y	Nutrients	Tim	
181	17/08	00:58	01:22	RJA	80°23.83000 N	22°13.16500 E	157	157	**CTD044**	Y	*Mixed*	Colin	
182	17/08	02:55	03:19	RJB	80°29.46600 N	22°12.63300 E	178	170	**CTD045**	Y	*Mixed*	Colin	
186	17/08	06:37	06:55	RJ1	80°36.03400 N	22°07.36000 E	180	172	**CTD046**	Y	*Mixed*	Ray/Tim/Estelle	
187	18/08	06:19	06:28	Shelf Station 2	79°57.99100 N	10°47.33500 E	243	100	**CTD047**	N	Light levels	Eric	
188	18/08	06:40	06:47	Shelf Station 2	79°57.99100 N	10°47.33200 E	243	35	**CTD048**	Y	*Mixed*	Eric	No downcast data
201	19/08	06:53	07:10	Kongsfjorden Kb3	78°57.60000 N	11°56.39000 E	340	330	**CTD049**	N	Profile for nets	Stig	
202	19/08	08:33	08:37	Kongsfjorden Kb3	78°55.40500 N	12°00.75500 E	50	40	**CTD050**	N	Sound profile	Mags	

Data processing

Overview

The CTD data were processed according the common standards, using Seabird Data Processing version 7.15 (part of the Seasoft-Win32 suite) and Matlab R2007a. The processing was done in several steps:

- Step 1(SBE Data Processing): modules Data Conversion, Wild Edit, Align CTD, Cell Thermal Mass, Filter, Derive, Translate and Bottle Sum.
- Step 2 (Matlab): despiking of the 24Hz data
- Step 3 (SBE Data Processing): modules Ascii In, Bin Average (2db-bins) and Ascii Out
- Step 4 (Matlab): plot of the data
- Step 5 (Matlab): calibration of oxygen and salinity data on both 24Hz and 2db-bin averaged datasets.

The SBE Data Processing modules were run as batch files:

- Batch file 1 (CTDProcess_step1.txt): Data Conversion, Wild Edit, Align CTD, Cell Thermal Mass and Filter. The Derive module had to be run manually in order to input the correct latitude for each cast (needed in the derived variables calculations). This is because there was no NMEA input onto the CTD system. On previous cruises, BAS CTD technicians found that a failure of the GPS system would cause the whole SBE software to crash and the CTD cast would have had to be restarted, hence the decision to not have any GPS input into the deck unit.
- Batch file 2: BottleSum for all of the casts at once.
- Batch file 3: (CTDProcess_step2.txt): Ascii In, Bin Average and Ascii Out.

Raw data processing (SBEDataProcessing)

The module **Data Conversion** converted the raw data to engineering. **Wild Edit** detected and removed the major spikes in the data (Wild Edit's algorithm requires two passes through the data: the first pass obtains an accurate estimate of the data's true standard deviation, while the second pass removes the erroneous data). **AlignCTD** was then run to compensate the oxygen sensor response delay, relative to pressure (+4s applied here). This ensures that calculations of dissolved oxygen concentration are made using measurements from the same parcel of water. In **Cell Thermal Mass**, a recursive filter was ran to remove conductivity cell thermal mass effects from the measured conductivity. The constants used were the ones given by Seabird: thermal anomaly amplitude α=0.03 and thermal anomaly time constant $1/\beta$=7. In **Filter** a low-pass filter was run (value of 0.2) on the pressure data, which smoothed the high frequency (rapidly changing) data. To produce zero phase (no time shift), the filter was first run forward through the data and then run backward through the data. This removed any delays caused by the filter. At the **Derive** stage, density sigma-theta (kg/m3), twin salinities (psu) and depth (m) were calculated. The data was then converted from binary to ASCII format by **Translate**. The data had been kept in binary format up to this stage to avoid any loss in precision that could occur when converting to Ascii, possibly resulting in slightly different salinity calculations at the Derive stage. Finally, the module **BottleSum** created the ASCII bottle files (.btl) for each bottle fired during a cast. These files contain mean, standard deviation, maximum and minimum values for all variables (average of 48 scans, i.e. 2s).

Despiking (Matlab)

The pressure, oxygen, temperature (primary and secondary) and salinity (primary and secondary) data were manually despiked (using the function Scrollingplot - for further details see:
http://www.mathworks.com/matlabcentral/fileexchange/loadFile.do?objectId=14255). Any data recorded while the pumps were not on were deleted at this stage.
Notes on the despiking:
- When a spike occurred in the pressure, temperature or salinity data, making that/those point(s) flagged as bad, the whole corresponding scan has been deleted.
- When a spike occurred in the oxygen data, making that point flagged as bad, the erroneous value was set to NaN, and other variables of the scan (i.e. temperature, salinity, etc) were kept in the dataset (if not flagged as bad themselves).

Averaging (SBEDataProcessing)

After going through Matlab, the data files needed to be re-formatted to be recognised by SBE Data Processing. **ASCII In** added a header to the input .asc file and output a .cnv file (XXX_2.cnv). The module **Bin Average** averaged the 24Hz data into 2db-bins, using the downcast data only. **Ascii Out** output the bin-averaged data as an ASCII file (with a simplified header).

Salinity calibration (Matlab)

39 CTD bottles were sampled throughout the cruise, always taking duplicate samples. Salinity was measured using a Guildline Autosal8400, in a temperature-controlled room onboard the ship. The CTD sensor data used for calibration comes from the btl files (created by the seabird software). NB: some comparisons have been done between the btl files and the processed upcast data, showing an average difference of 0.0001.
When comparing the Autosal and the Seabird salinity values it appears that the difference between both for about one quarter of the dataset is over 0.1 (cf. Figure 1). All of these data points correspond to bottles fired in shallow waters (less than 30m) and very often in regions of sea-ice, where surface layers are highly stratified. These data points have not been used for the calibration.

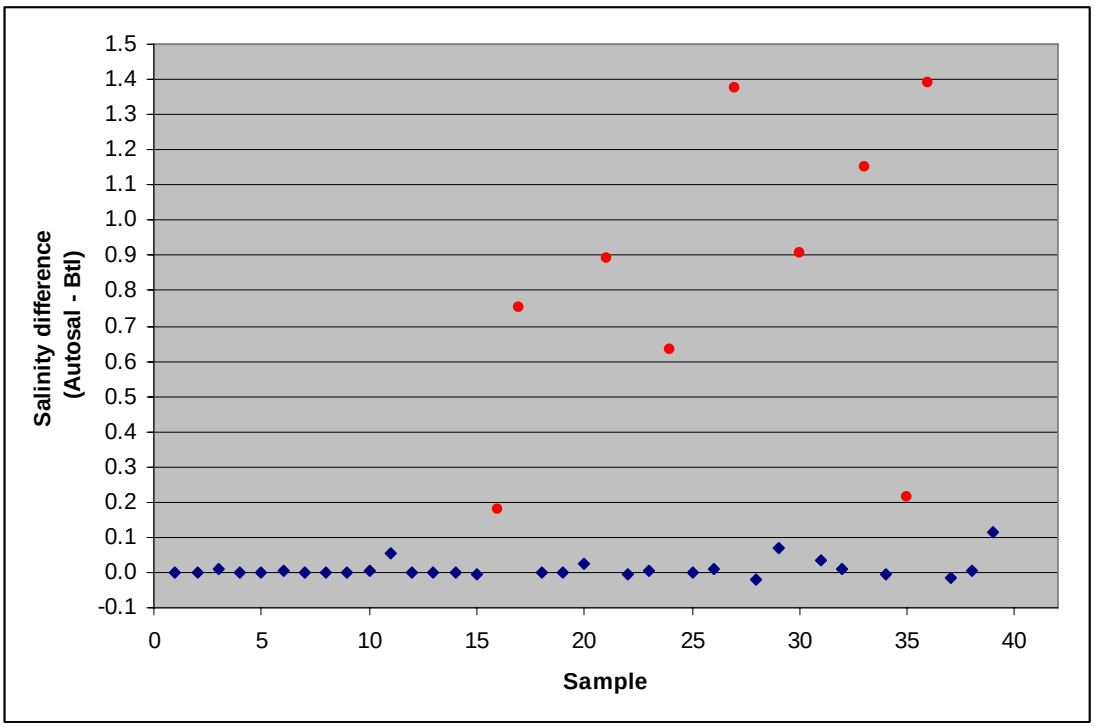


Figure 1: Difference between Autosal measured salinity and CTD recorded data. Red points indicate data not used for calibration.

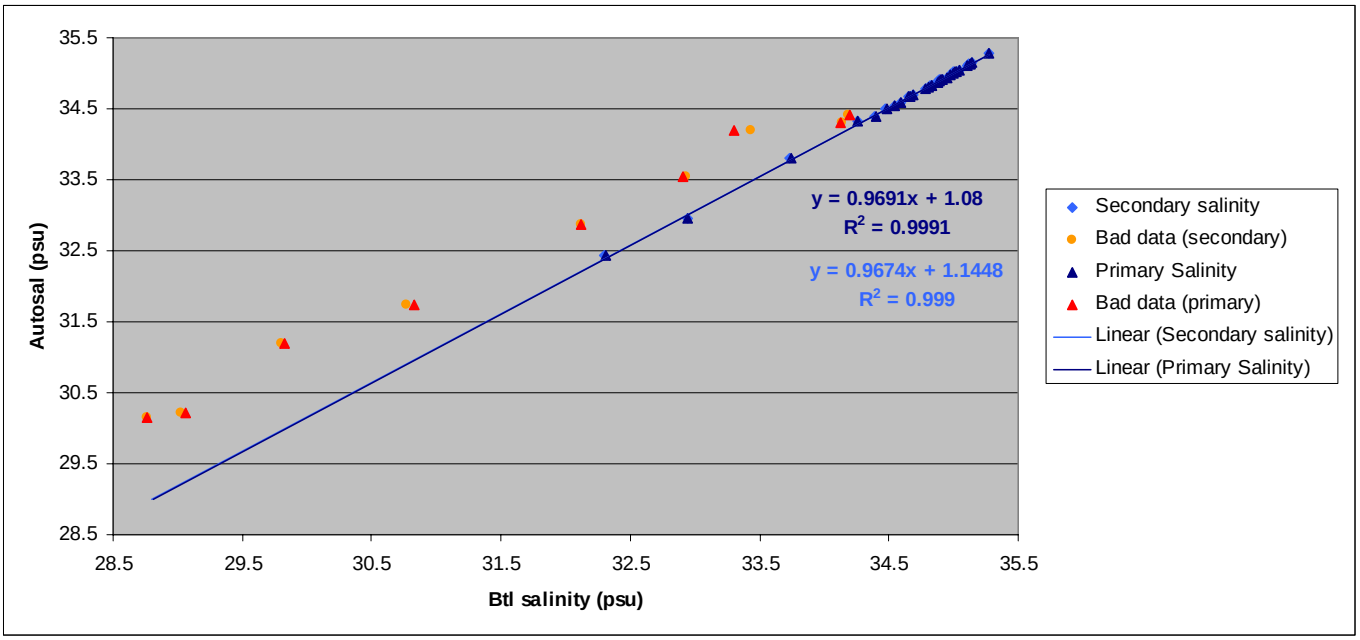


Figure 2: CTD salinity calibration equations (least-square regression method). Red data (same as in Figure 1) were not used in the calculations.

Results

Rijpfjorden transect

A series of CTD stations has been conducted in Rijpfjorden on 16th and 17th August, namely RJ1, RJB, RJA, Rijp. Mooring, RIB and Rijp.South (cf Figure 3), corresponding to CTD041 to 046. Temperature and salinity data were interpolated in Matlab using a Delaunay triangulation linear method to produce the Figure 4 plots.

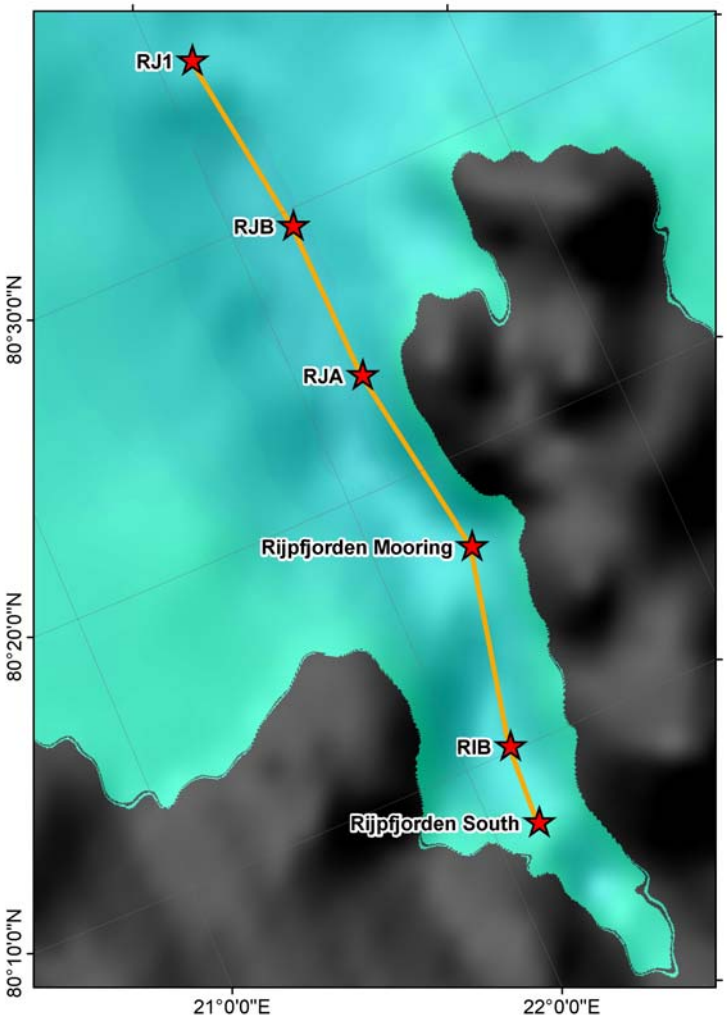


Figure 3: Rijpfjorden transect and CTD stations map.

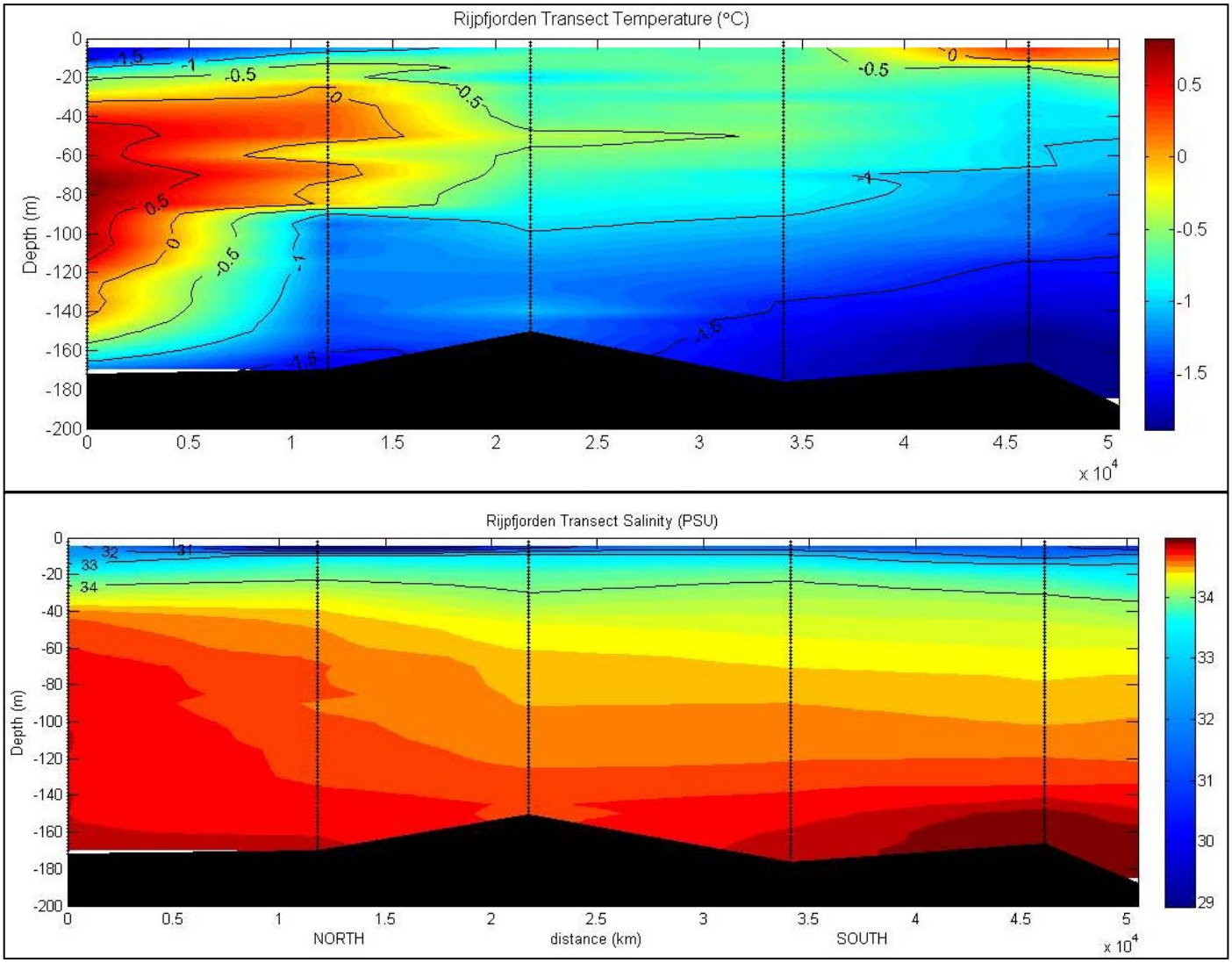
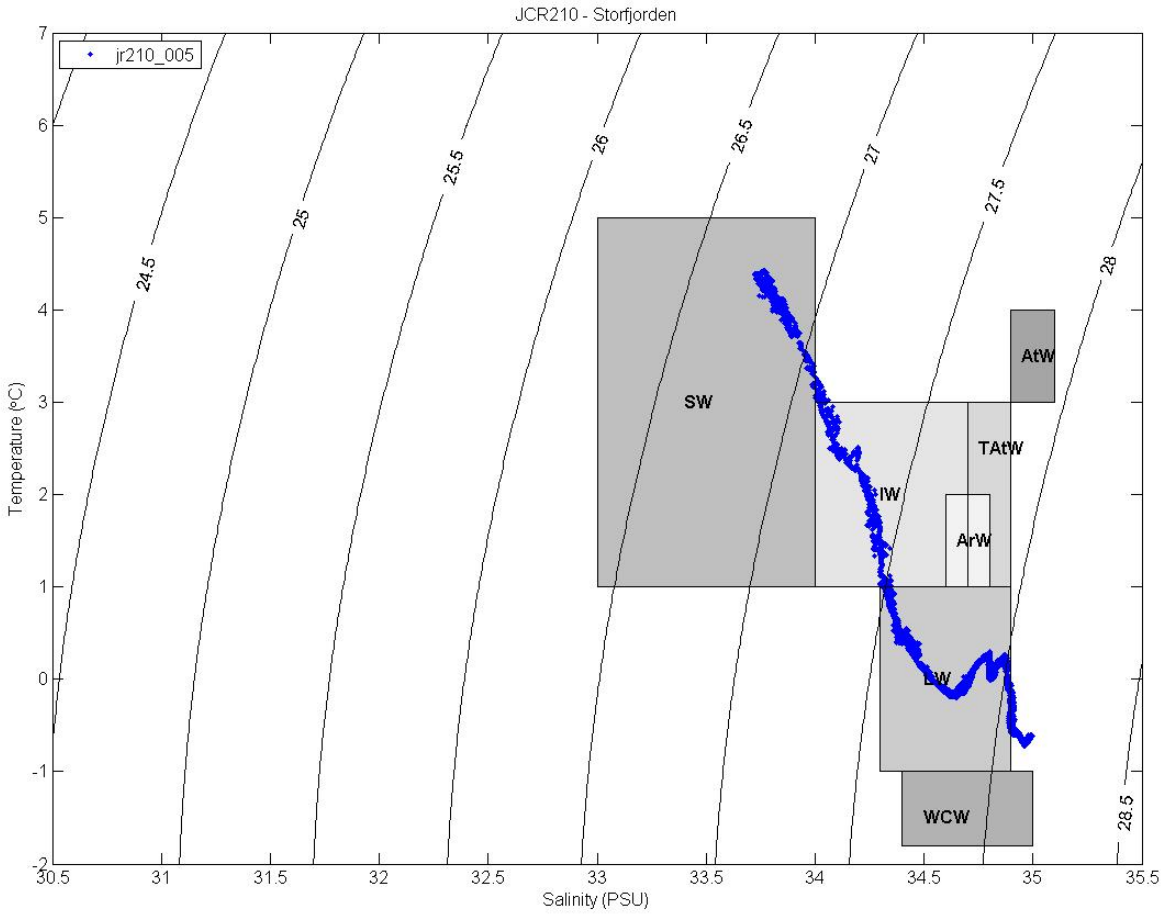
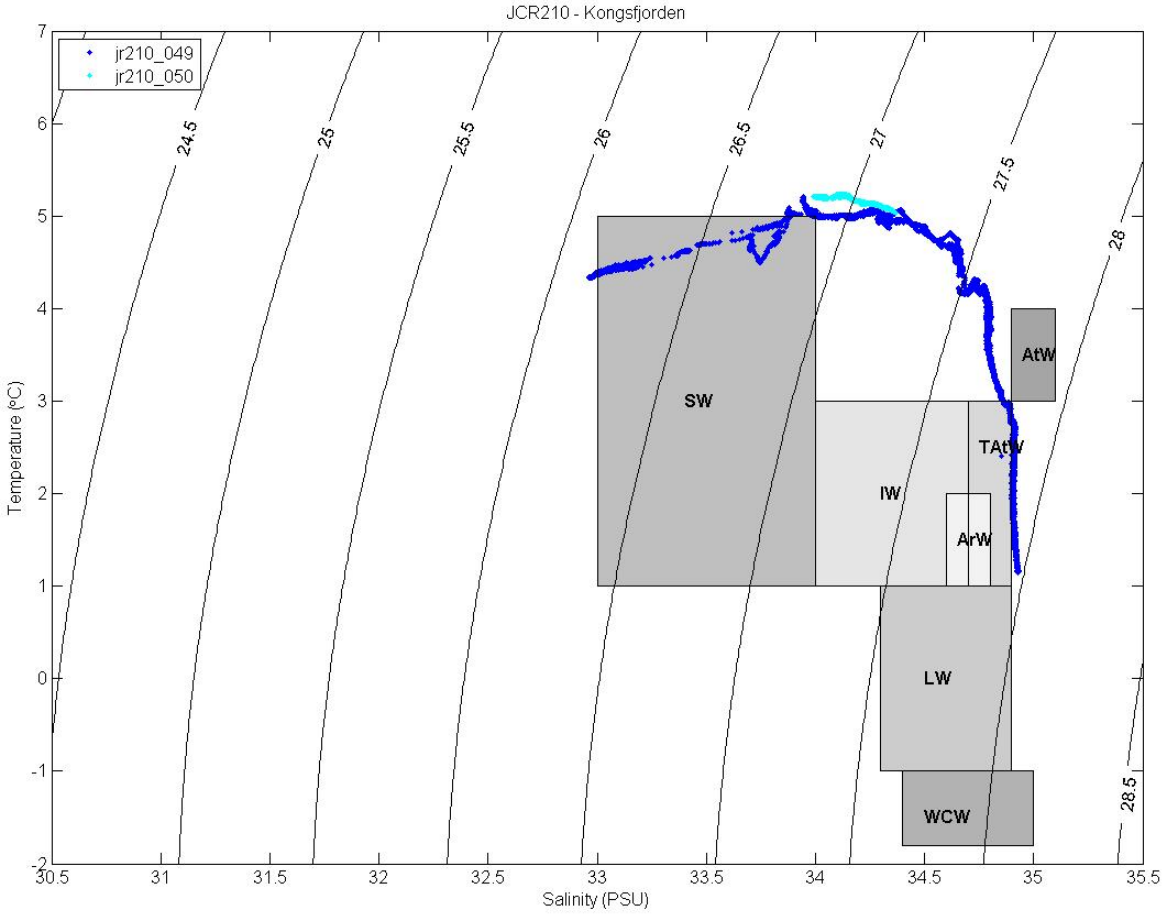


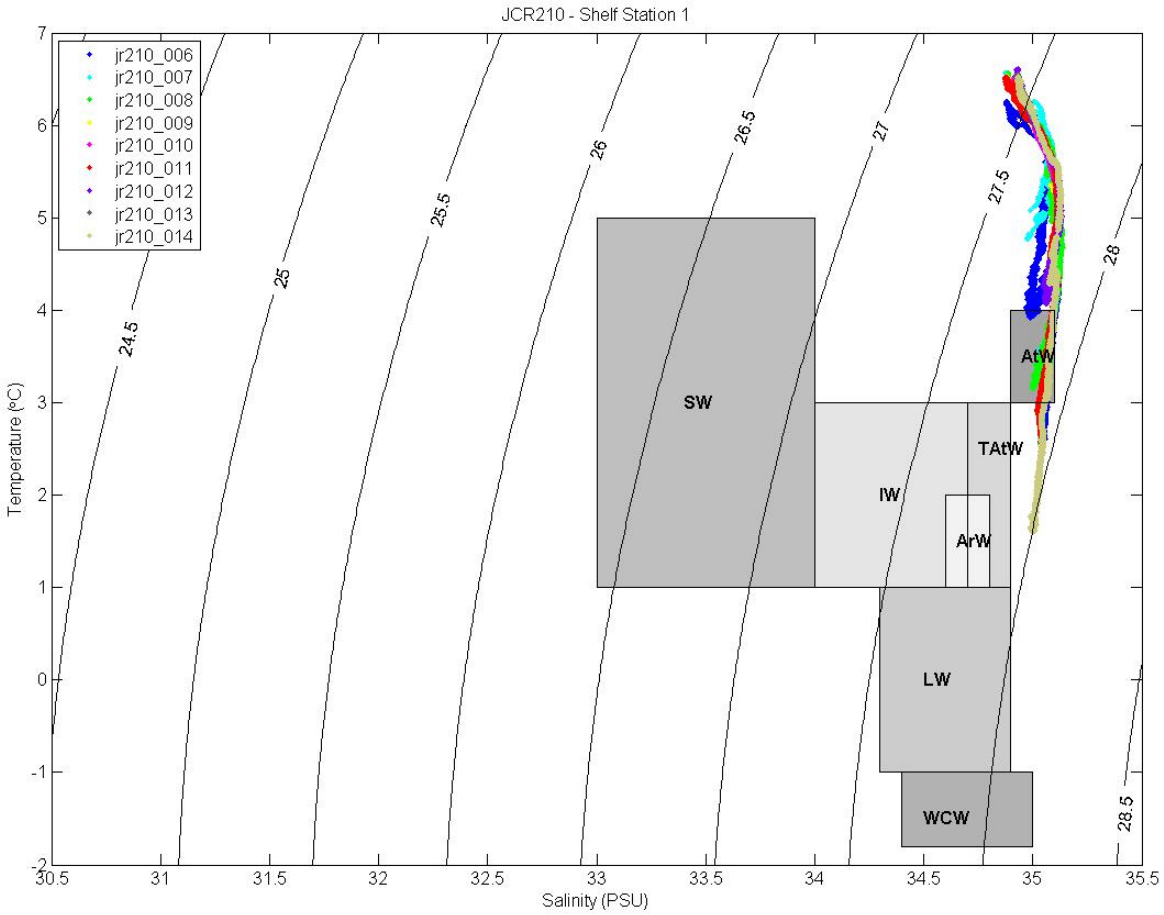
Figure 4: Temperature and salinity (interpolated data) along Rijpfjorden.

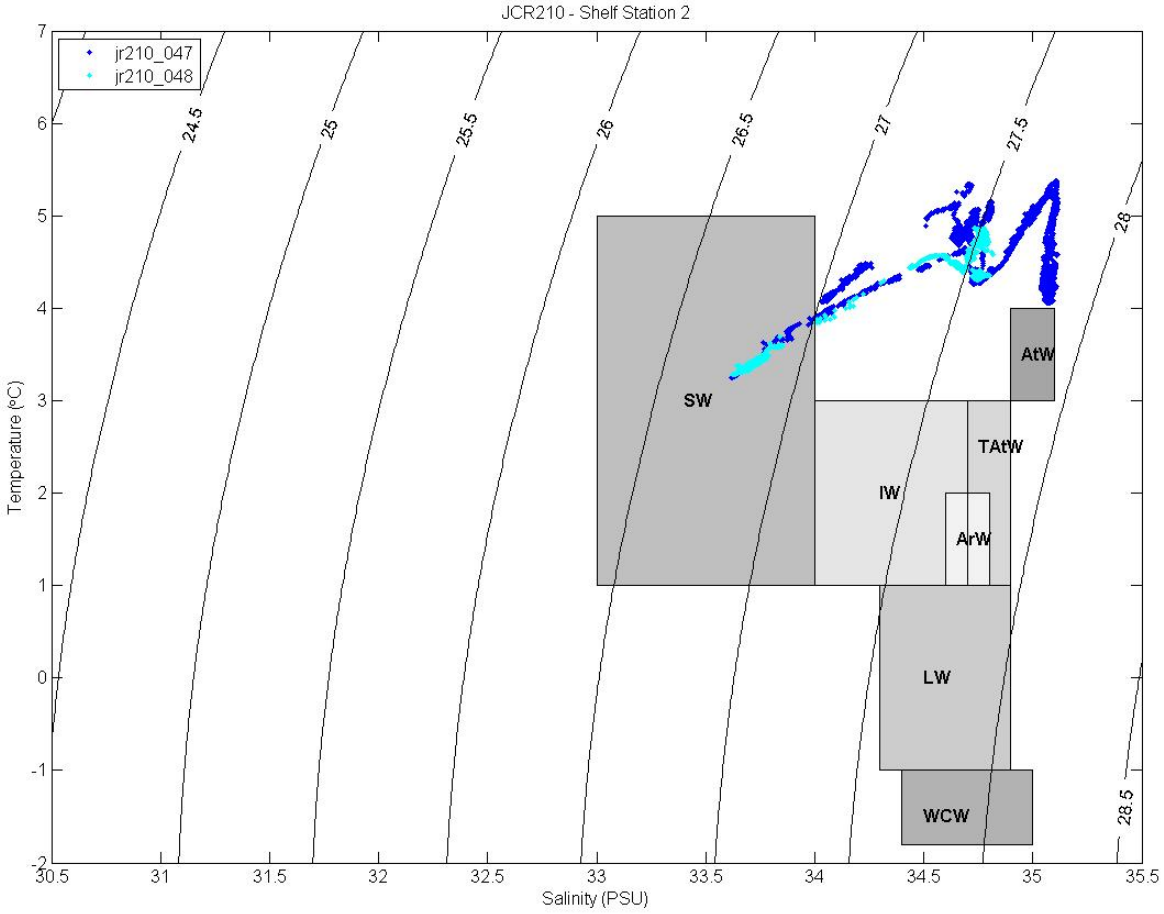
TS plots

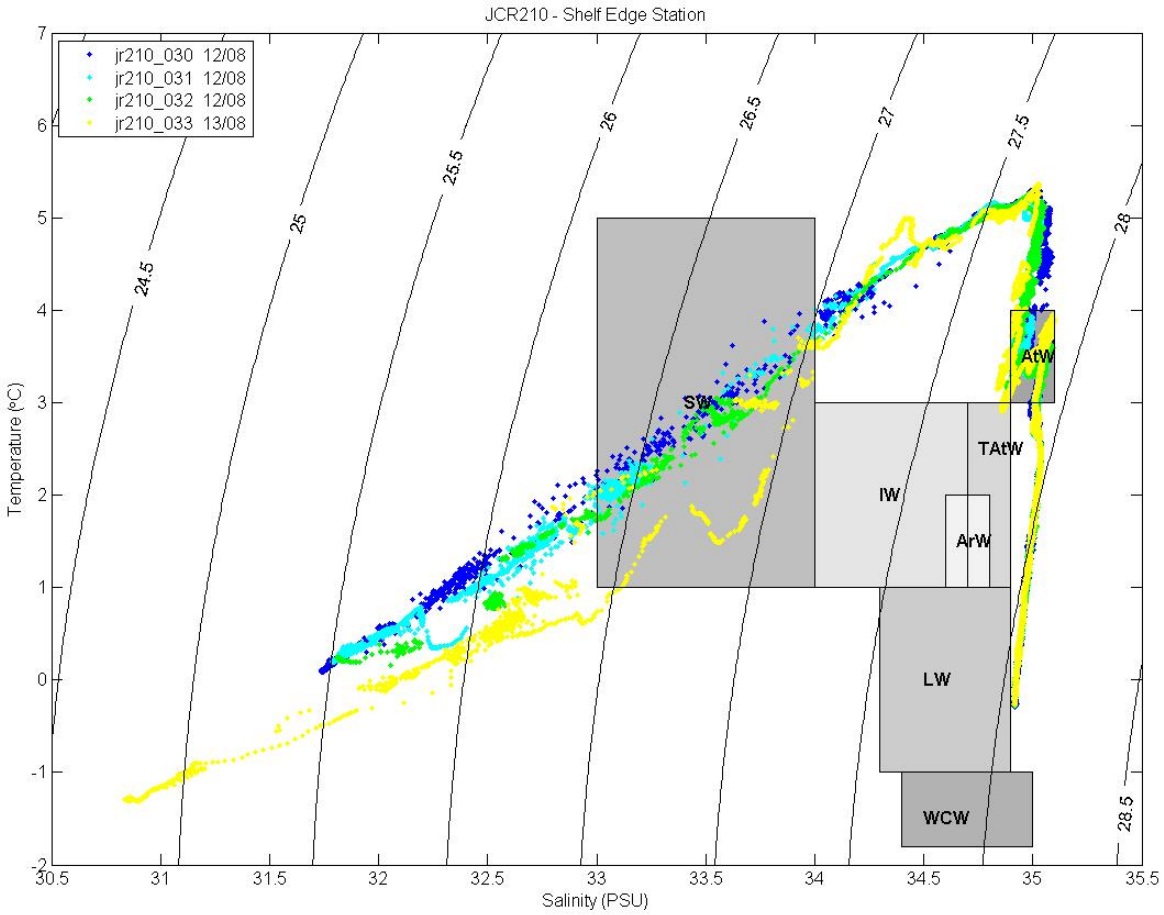
Temperature vs. salinity diagrams for all stations are shown below.

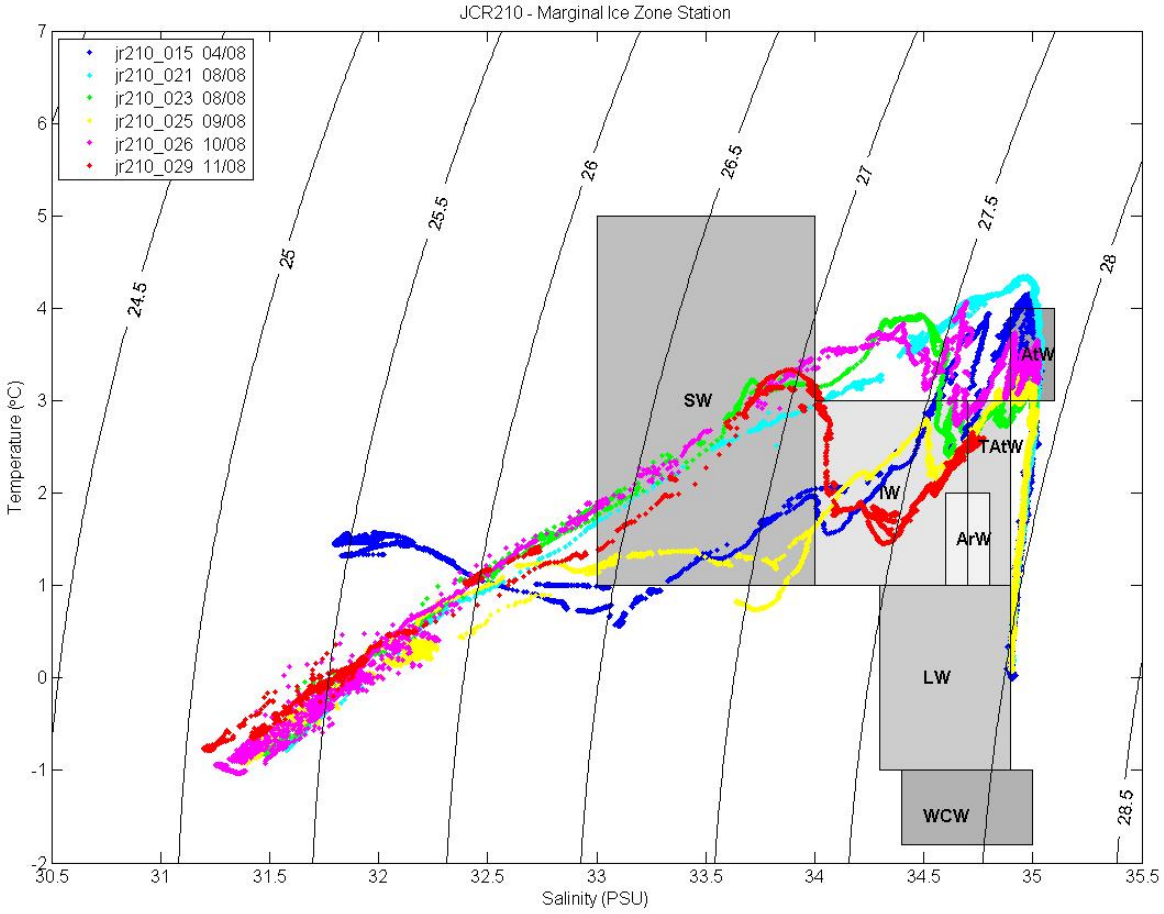

JCR210 - Storfjorden
jr210_005
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)

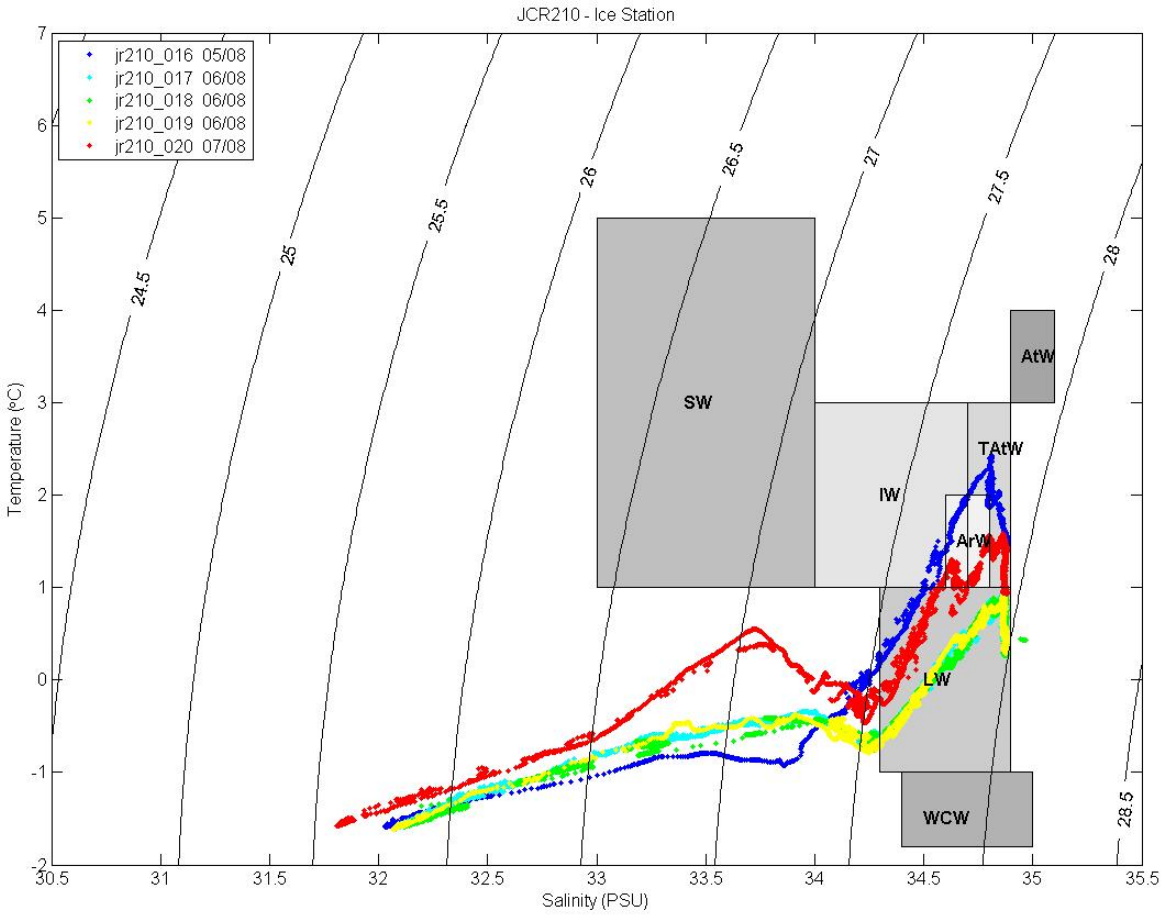

JCR210 - Kongsfjorden
jr210_049
jr210_050
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)

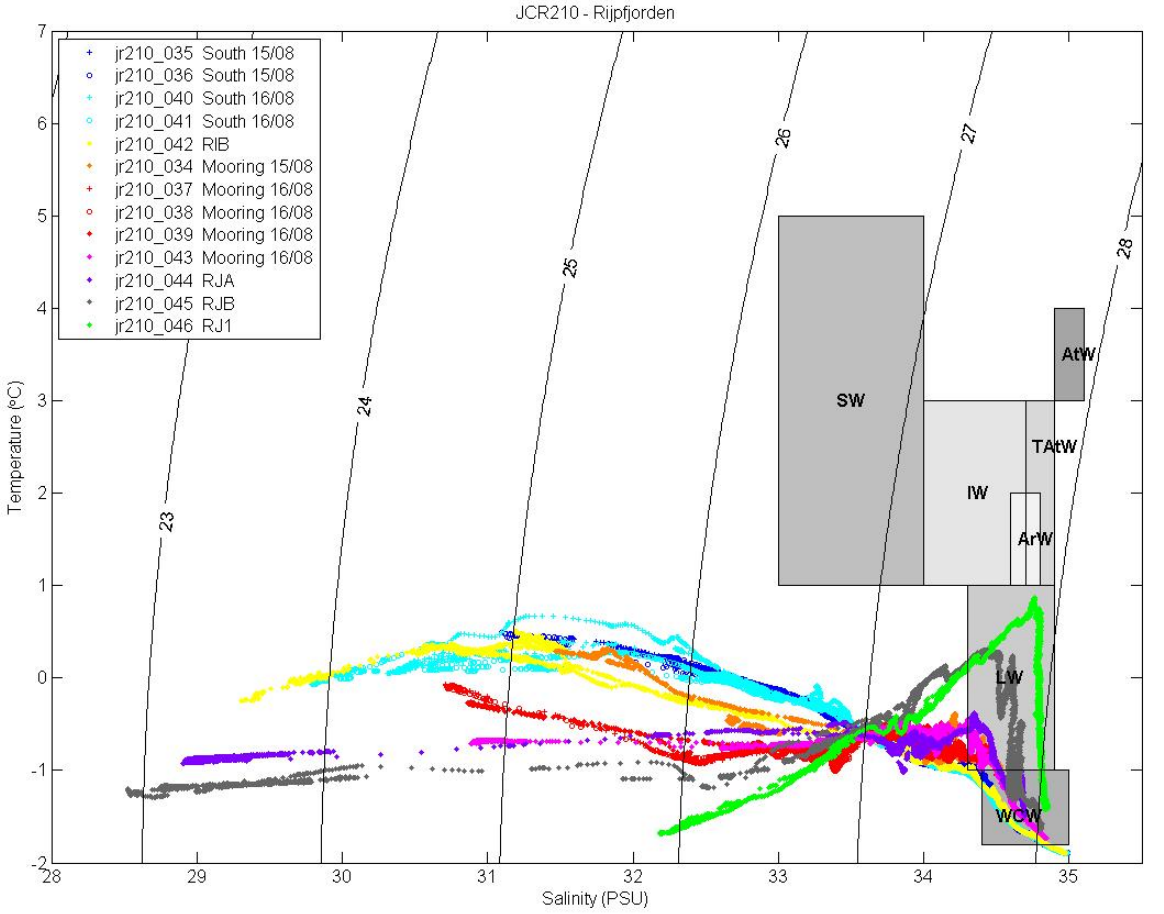

JCR210 - Shelf Station 1
jr210_006
jr210_007
jr210_008
jr210_009
jr210_010
jr210_011
jr210_012
jr210_013
jr210_014
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)


JCR210 - Shelf Station 2
jr210_047
jr210_048
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)


JCR210 - Shelf Edge Station
jr210_030 12/08
jr210_031 12/08
jr210_032 12/08
jr210_033 13/08
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)


JCR210 - Marginal Ice Zone Station
jr210_015 04/08
jr210_021 08/08
jr210_023 08/08
jr210_025 09/08
jr210_026 10/08
jr210_029 11/08
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)


JCR210 - Ice Station
jr210_016 05/08
jr210_017 06/08
jr210_018 06/08
jr210_019 06/08
jr210_020 07/08
24.5
25
25.5
26
26.5
27
27.5
28
28.5
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)


JCR210 - Rijpfjorden
jr210_035 South 15/08
jr210_036 South 15/08
jr210_040 South 16/08
jr210_041 South 16/08
jr210_042 RIB
jr210_034 Mooring 15/08
jr210_037 Mooring 16/08
jr210_038 Mooring 16/08
jr210_039 Mooring 16/08
jr210_043 Mooring 16/08
jr210_044 RJA
jr210_045 RJB
jr210_046 RJ1
23
24
25
26
27
28
SW
AtW
TAtW
IW
ArW
LW
WCW
Temperature (°C)
Salinity (PSU)

Annex 1: CTD sensor configuration/calibration

```
Date: 08/11/2008
ASCII file: D:\data\jr210\config\jr210.con
Configuration report for SBE 911/917 plus CTD
Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : No
Scan time added               : No

1) Frequency, Temperature
   Serial number : 4302
   Calibrated on : 18/07/07
   G             : 4.37269298e-003
   H             : 6.42004858e-004
   I             : 2.19025784e-005
   J             : 1.81767398e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency, Conductivity
   Serial number : 2875
   Calibrated on : 18/07/07
   G             : -1.01634295e+001
   H             : 1.40348275e+000
   I             : 8.99756645e-005
   J             : 5.82471200e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency, Pressure, Digiquartz with TC
   Serial number : 0541-75429
   Calibrated on : 18/07/07
   C1            : -4.398881e+004
   C2            : -5.551403e-001
   C3            : 1.279490e-002
   D1            : 3.603000e-002
   D2            : 0.000000e+000
   T1            : 2.986716e+001
   T2            : -5.274889e-004
   T3            : 4.092900e-006
   T4            : 1.616590e-009
   T5            : 0.000000e+000
   Slope         : 0.99994000
   Offset        : 0.52570
   AD590M        : 1.287420e-002
   AD590B        : -8.793390e+000

4) Frequency, Temperature, 2
   Serial number : 4235
   Calibrated on : 20/07/07
   G             : 4.34551464e-003
   H             : 6.45183995e-004
   I             : 2.21076034e-005
   J             : 1.74507310e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency, Conductivity, 2
   Serial number : 2813
   Calibrated on : 17/07/07
   G             : -9.75792279e+000
   H             : 1.45435632e+000
   I             : -5.07100074e-003
   J             : 4.16613153e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, PAR/Irradiance,
Biospherical/Licor
   Serial number        : 7235
   Calibrated on        : 26/07/07
   M                    : 1.00000000
   B                    : 0.00000000
   Calibration constant : 35335689045.00000000
   Multiplier           : 1.00000000
   Offset               : 0.00000000

7) A/D voltage 1, Free

8) A/D voltage 2, Oxygen, SBE 43
   Serial number : 0676
   Calibrated on : 03/06/06
   Soc           : 4.3630e-001
   Boc           : 0.0000
   Offset        : -0.5460
   Tcor          : 0.0001
   Pcor          : 1.35e-004
   Tau           : 0.0

9) A/D voltage 3, Altimeter
   Serial number : 7742.163162
   Calibrated on :
   Scale factor  : 15.000
   Offset        : 0.000

10) A/D voltage 4, Fluorometer, Chelsea Aqua3
    Serial number : 088-249
    Calibrated on : 13/09/07
    VB            : 0.181700
    V1            : 2.097600
    Vacetone      : 0.202800
    Scale factor  : 1.000000
    Slope         : 1.000000
    Offset        : 0.000000

11) A/D voltage 5, Free

12) A/D voltage 6, Transmissometer,
Chelsea/Seatech/Wetlab CStar
    Serial number : CST-527DR
    Calibrated on : 14/08/07
    M             : 21.7287
    B             : -1.2735
    Path length   : 0.250

13) A/D voltage 7, Free
```

Annex 2: SBE35 configuration/calibration

```
* Software Version 1.44
* Temperature SN = 0047
* Conductivity SN = 0047
* number of measurement cycles to average = 10
* bottle confirm interface = SBE 911plus
* SBE35 V 2.0    SERIAL NO. 0047
* 17-oct-07
* A0 =  4.709958010e-03
* A1 = -1.293255150e-03
* A2 =  1.935506230e-04
* A3 = -1.074982000e-05
* A4 =  2.290584940e-07
* SLOPE =  1.000009
* OFFSET = -0.002160
```

SCIENTIFIC REPORT 2: Slope Mixing – Storfjorden

John Kenny, Joe Collins and Terrie Doyle

1. Introduction

Transports of nutrients and carbon between shelf seas and the open ocean are critical parts of carbon and nutrient cycles. Dense water formation and cascades at the shelf edge are thought to be important in forming some oceanic water masses. It is also becoming evident that the shallow margins play previously unrecognised roles in the control of the physical circulation round the major ocean basins. There remains a real challenge to link the contrasting physics of shelf and deep ocean environments across the steep bathymetry of the shelf slope.

Prediction of shelf-sea impacts on the global ocean needs reliable numerical models, with descriptions of shelf processes suitable for global modelling. This is also a challenge; numerical models of shelf seas and their interaction across the shelf edge are hampered by poorly-understood or inadequately-parameterised physics. POL is addressing this.

We aim to quantify the water fluxes between the shelf-sea and open-ocean globally, including the development of methods to incorporate shelf effects into global models. Specifically, in relation to JCR cruise 210, we aim to quantify and predict dense-water formation, cascading, slope mixing and their effects in the ocean.

Distinctive water, turbulence and mixing on the slope have already been measured:
- on the West Shetland slope (September 2005; warm Atlantic water overlies cold water formed by winter convection in Nordic seas)
- in the Gulf of Cadiz (April-May 2007; warm salty Mediterranean water flows down the slope, mixing with Atlantic water).

From JCR210 we intend to look at turbulence and mixing in the outflow of dense water from Storfjorden; this eventually contributes to deeper waters in the Arctic and Nordic seas; those eventual deep-water properties depend on the mixing *en route*. In turn the deep-water properties influence the oceanic overturning circulation that forms part of the climate system.

“In parallel”, modelling will evaluate the sensitivity of dense-water flows and mixing to topography and ambient conditions, and how slope mixing and its effects vary with context, forcing and internal waves. Validated 3-D models will be used to estimate fluxes in areas with observations, and their contribution to oceanic water masses relative to the original volume of water formed at the shelf edge. Sensitivity to climate factors will be modelled.

1.1 Instruments

We will be deploying three Landers and one moored chain. The Landers are STABLE (Sediment Transport And Boundary Layer Equipment) and two ADCP frames.

The STABLE lander consists of three Sontek ADVs (Acoustic Doppler Velocimeter) measuring water velocity at three different levels near the sea bed. Three Optical Backscattering instruments are mounted next to the ADVs, these measure the amount of

suspended sediment in the water. Also mounted alongside these instruments are three conductivity and temperature sensors, these instruments are used to calculate salinity. There is a digi-quartz pressure sensor to monitor the motion of the tides and a digital-compass to record the orientation of the lander.

The ADCP frames each have a RDI 1500khz ADCP (Acoustic doppler current profiler) and a Seabird Microcat. The RDI ADCP is used to measure the water velocity at intervals throughout the water column and the Microcat is used to measure conductivity, temperature and depth.

2. Objectives

Specific objectives for *RV James Clark Ross* cruise 210 were:

2.1 Deploy ADCP moorings (frame F1) at location 19 16.50 E; 76 40.00 N.
2.2 Deploy ADCP moorings (Frame F2) at location 19 0.00 E; 76 28.80 N.
2.3 Deploy specialist rig STABLE at location 19 2.00E; 76 29.00N.
2.4 Deploy 50m Minilog chain (attatched to STABLE stray line)

3. Technical reports

3.1 ADCP moorings.

Both POL ADCPs were deployed on modified POL pop-up ADCP frames. Each frame was attached to a releasable aluminium bed frame fitted with lead ballast weights. A 12 m stray-line with pellet floats was attached to the top of each frame to facilitate recovery. The release mechanism was a standard titanium release fitted with two “fizz link” burn wires. Each of these can be fired independently, only one being needed to release the instrument frame. Each frame was fitted with one RD Instruments 150 kHz broadband ADCP, one Seabird Microcat 37 with pump and two Benthos transponding releases.

Both ADCPs were set up identically, the combination of depth cell number/size and ping regime being determined by the available memory (32 Mbytes) and battery capacity of the instruments. The setup is shown in Table 5.1.

POL ADCP setup (“F1” and “F2”) and details of the instruments

Number of depth cells	60
Depth cell size	4 m
Time per ensemble	2 minutes
Time per ping	4 s
Number of pings per ensemble	30
Data recorded	Velocity, correlation, echo intensity, percent good, heading, temperature, pitch, roll
Coordinates	Radial beam coordinates
Pitch and roll correction	No correction applied

Frame F1 – ADCP deployment						
Instrument	*Serial number*	*Deployment details*		*Recovery details*		*Data*
		Clock set	*First data*	*Last data*	*Time off*	
RD Instruments 150 kHz ADCP, broadband	? 1220-1	13:23:00 27/07/2008	18:00:00 29/07/2008			kbytes
Seabird Microcat	5595	12:48:00 27/07/08	18:00:00 27/07/08			
Benthos acoustic transponder	72378	Receive frequency 10.5 kHz, Transmit 12.0 kHz Release code A				
Benthos acoustic transponder	72381	Receive frequency 11.0 kHz, Transmit 12.0 kHz Release code B				

Frame F2 – ADCP deployment						
Instrument	*Serial number*	*Deployment details*		*Recovery details*		*Data*
		Clock set	*First data*	*Last data*	*Time off*	
RD Instruments 150 kHz ADCP, broadband	? 1185-1	13:12:00 27/07/2008	18:00:00 29/07/2008			kbytes
Seabird Microcat	5596	12:56:00 27/07/08	18:00:00 27/07/08			
Benthos acoustic transponder	71919	Receive frequency 10.5 kHz, Transmit 12.0 kHz Release code C				
Benthos acoustic transponder	72863	Receive frequency 13.5 kHz, Transmit 12.0 kHz Release code A				

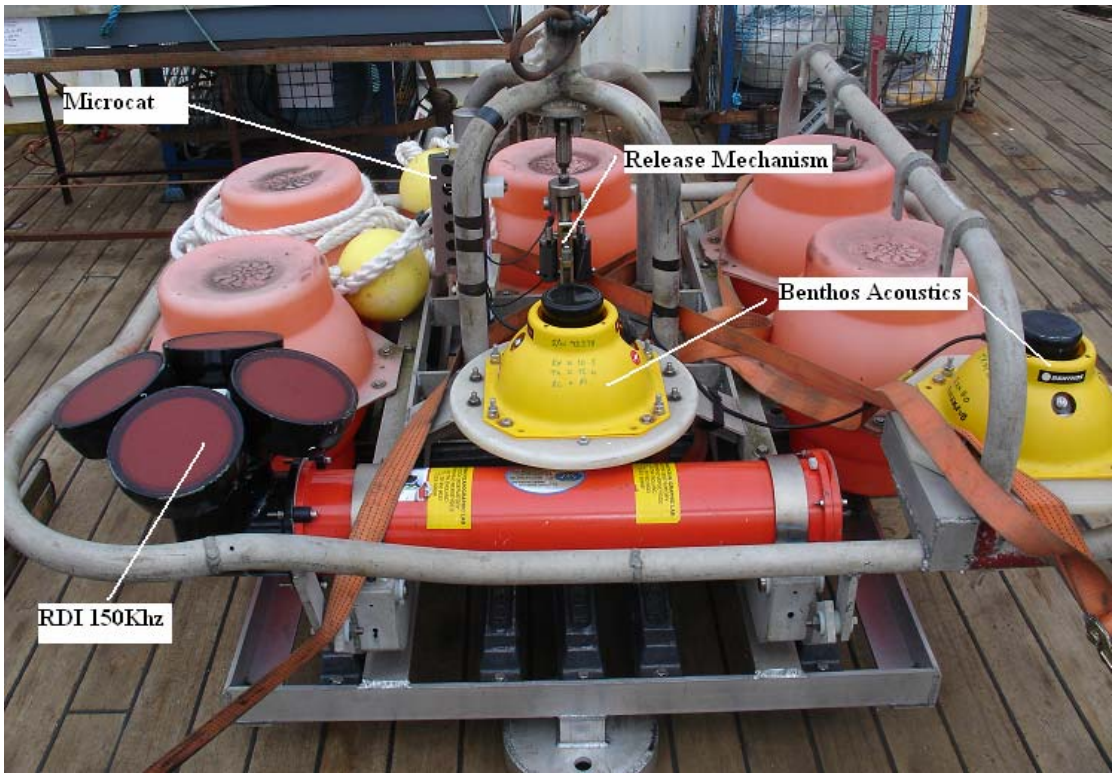


Fig 3.1 ADCP Frame

3.2 STABLE

STABLE (Sediment Transport And Boundary Layer Equipment) consists of a 2.4 m diameter instrument frame supported on three legs such that sensors can be mounted in the water volume under the frame, while minimising the effect of the instruments on the water properties being measured. Lead feet weighing 150 kg each are attached to the legs and can be released simultaneously allowing the buoyant instrument platform to float free. Two transponding releases are fitted, each able independently to release all three lead feet. A third transponder is used as a "pinger" to range to the frame when it is on the surface. A 11 m strayline is attached to facilitate recovery. Netting over the top surface prevents the strayline from washing into the instruments.

STABLE has three sontek ADVs, each one also acts as a logger for a D&S turbidity sensor. One ADV acts as a logger for a paroscientific digi quartz pressure sensor. A MC7 logs data from three C&Ts. A signal generator triggers each instrument to record. Also on the frame is a digital compass and three minilogs measuring temperature.

STABLE sensors and sampling regimes.

Instrument	*Serial number*	*External Sensors*	*Height above seabed (cm)*	*Sampling frequency*	*Time (GMT), day of first sample*
Sontek ADV	G358 + B292	Turb.	30	8Hz, 20mins per hour	18:00, 24/07/2008
Sontek ADV	G496 + B281	Turb. T8195	60	8Hz, 20mins per hour	18:00, 24/07/2008
Sontek ADV	G355 + B285	Turb.	30	8Hz, 20mins per hour	18:00, 24/07/2008
Paros scientific Pressure Sensor (connected to ADV G496)	Tides 52861		?	8Hz, 20mins per hour	18:00, 24/07/2008
MC7 C&T	7216		30	8Hz, 20mins per hour	8:00, 24/07/2008
MC7 C&T	7217		60	8Hz, 20mins per hour	8:00, 24/07/2008
MC7 C&T	7218		90	8Hz, 20mins per hour	8:00, 24/07/2008
Compass	N/A		N/A	every 20 minutes	13:40:00 24/07/2008
Minilog (temperature)	2104		0.5	Every 4 minutes	18:00:00 29/07/2008
Minilog	2105		1.1	Every 4 minutes	18:00:00 29/07/2008
Minilog	2197E		2.17	Every 8 minutes	18:00:00 29/07/2008

Benthos acoustic transponder (pinger)	Receive frequency 15.0kHz, Transmit frequency 12.0 kHz, (Release code C not used)
Benthos acoustic transponder (release) WHITE	Receive frequency 14.0 kHz, Transmit frequency 12.0 kHz, Release code C
Benthos acoustic transponder (release) RED	Receive frequency 14.0 kHz, Transmit frequency 12.0 kHz, Release code C

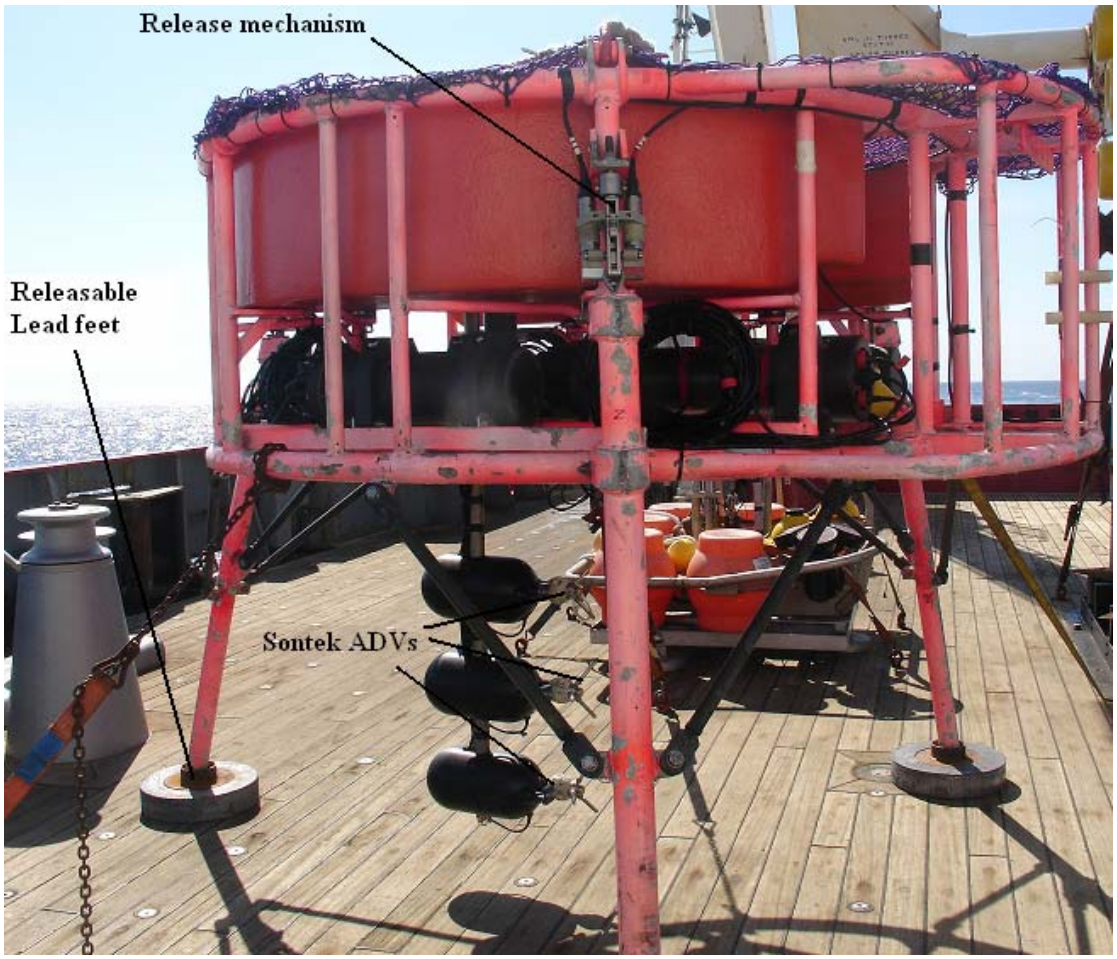


Fig 3.2 STABLE

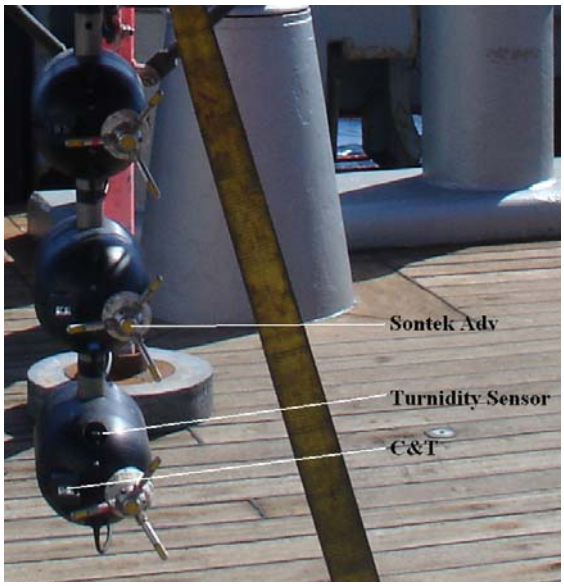


Fig 3.3 STABLE central pole


Fig 3.4 Minilog line attatched to STABLE

5.3 Minilog chain

A 50m line of buoyant rope was attatched to the stray line of stable. Minilogs were attatched at intervals along the stray line and along the 50m line. The height of stable is

2.17m, the distance from the seabed to the start of the stray line is 4.4m. The stray line is 11m. Details of the minilog positions are as follows:

Stray line minilog configuration. The height of the STABLE frame has been taken into consideration. All miniologs were set to start at 18:00:00 on 29/07/2008

Instrument	*Serial number*	*Nominal height above bed (metres)*	*Logging interval (minutes)*	*Time (GMT) of last data ensemble*	*File size (bytes)*
Vemco Minilog (pressure)	4488	5.4m	4		
Vemco Minilog	2112	7.4	4		
Vemco Minilog	2194E	9.4	8		
Vemco Minilog	0148E	11.4	8		
Vemco Minilog	2406	12.4	4		

50m line minilog configuration. The height of the STABLE frame has been taken into consideration. All miniologs were set to start at 18:00:00 on 29/07/2008

Instrument	*Serial number*	*Nominal height above bed (metres)*	*Logging interval (minutes)*	*Time (GMT) of last data ensemble*	*File size (bytes)*
Vemco Minilog	2187E	15.4	8		
Vemco Minilog	0144E	17.4	8		
Vemco Minilog	4476	19.4	4		
Vemco Minilog (pressure)	4487	21.4	4		
Vemco Minilog	2191E	23.4	8		
Vemco Minilog	0147E	25.4	8		
Vemco Minilog	2420	27.4	4		
Vemco Minilog	2195E	29.4	8		
Vemco Minilog	2192E	31.4	8		
Vemco Minilog	6022	33.4	4		
Vemco Minilog	2193E	35.4	8		
Vemco Minilog	2186	37.4	8		
Vemco Minilog	2426	39.4	4		
Vemco Minilog	2184E	41.4	8		
Vemco Minilog	0150E	43.4	8		
Vemco Minilog	4482	45.4	4		
Vemco Minilog	0141E	47.4	8		
Vemco Minilog	2196E	49.4	8		
Vemco Minilog	2108	51.4	4		
Vemco Minilog	2188E	53.4	8		
Vemco Minilog	2111	55.4	4		
Vemco Minilog (pressure)	4489	57.4	4		

4. Deployments

Event 7:
CTD profile carried out at 4:00 on 30/07/2008 in 190m depth in order to calibrate Swath.

Event 8:
Swath survey of ADCP and STABLE mooring site. Swath started at 04:52 in area 76 28.585N 18 58.770E. Swath ended at 05:21 in area 76 28.712N 18 59.150E.

Event 9:
ADCP frame F2 deployed.
In water at 05:38. Released at 05:40 at 076 28.81557N 19 00.00756E

Event 10:
STABLE deployed.
In water at 06:10. Released at 06:12 at 70 29.00425N 19 01.98635E

Swath survey continued up to second ADCP site.

Event 11:
Frame F1 deployed.
In water at 07:58, released at 07:59 at 76 39.99925N 19 49680E

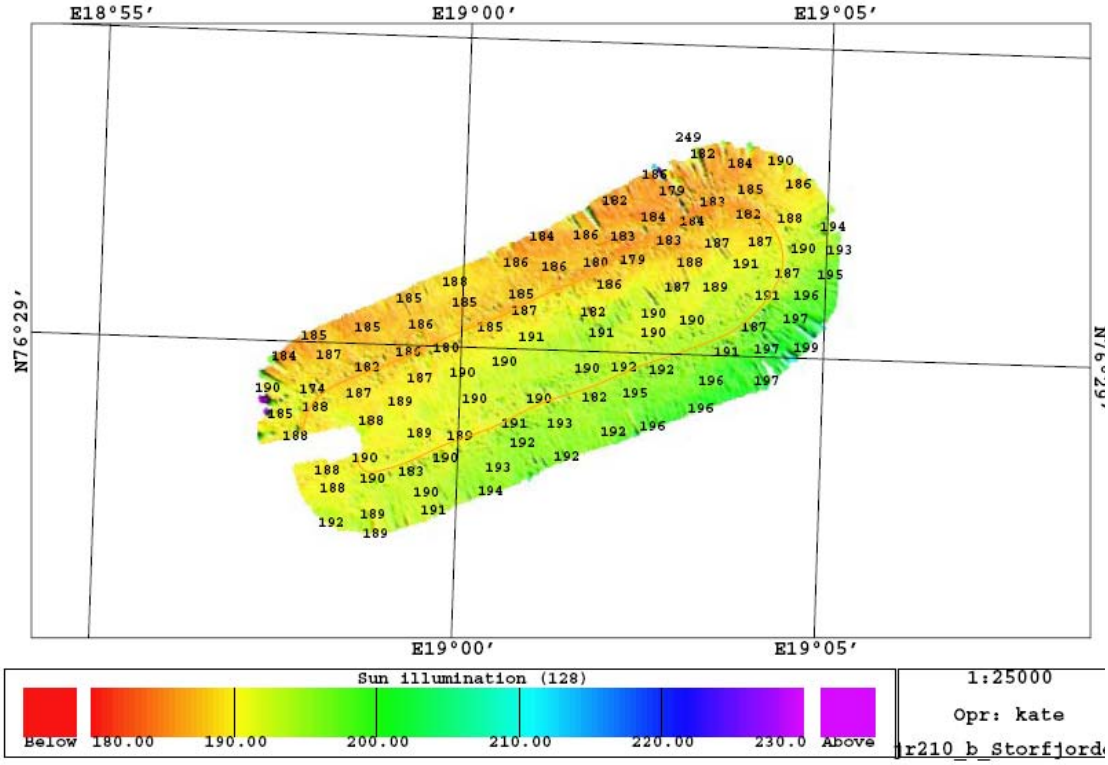


Fig 4.1 Swath of ADCP / STABLE site

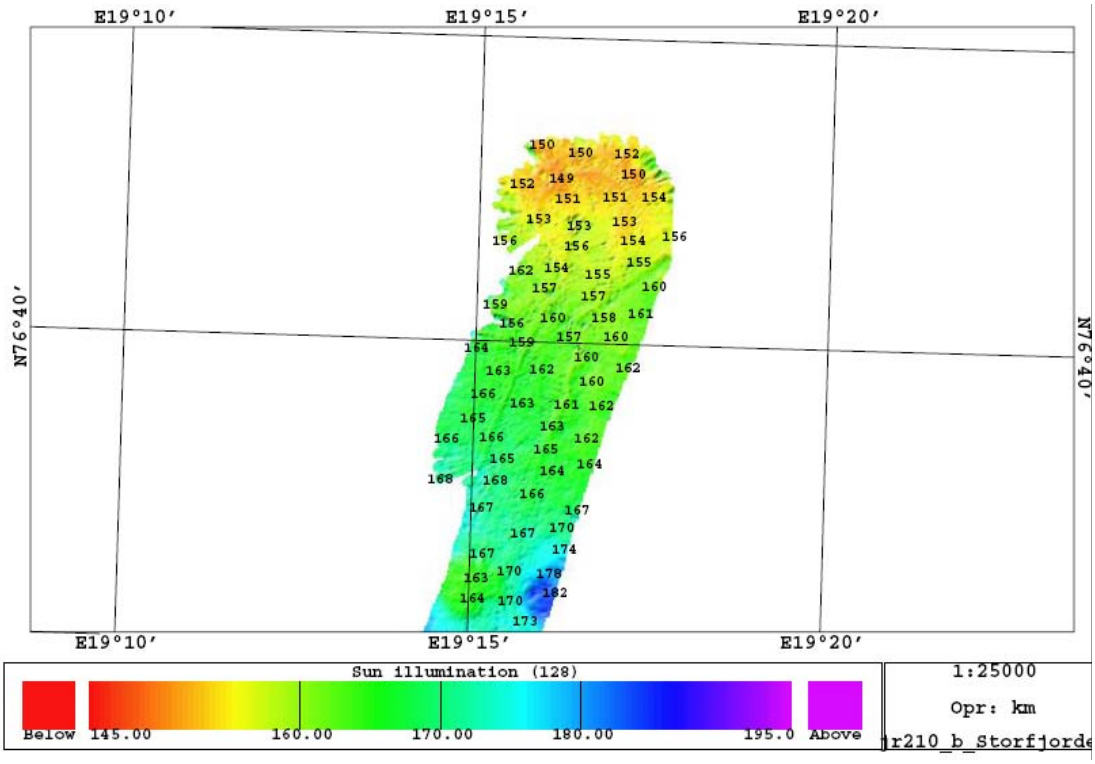
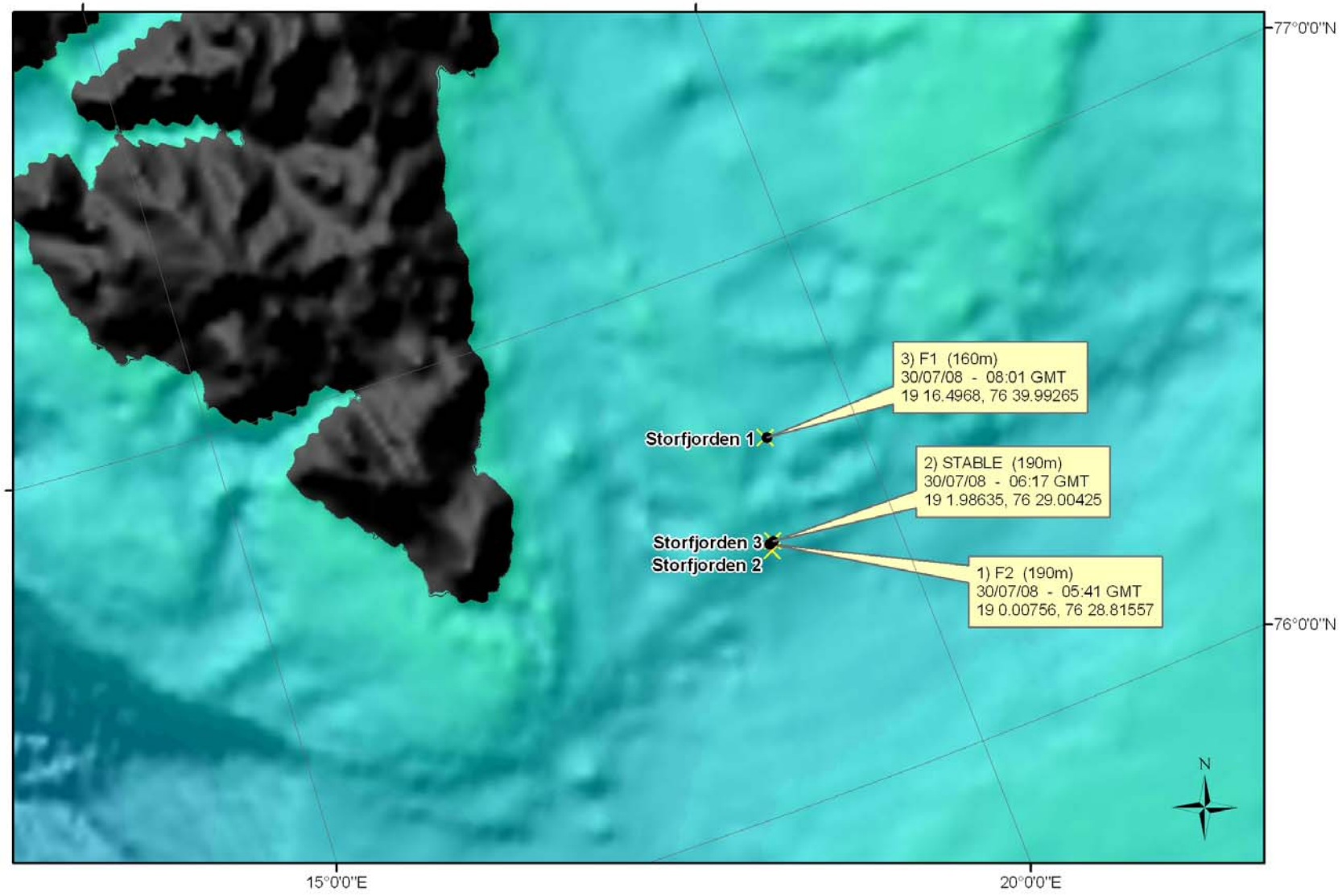


Fig 4.2 Swath of second ADCP site


77°0'0"N
76°0'0"N
15°0'0"E
20°0'0"E
Storfjorden 1
Storfjorden 3
Storfjorden 2
3) F1 (160m)
30/07/08 - 08:01 GMT
19 16.4968, 76 39.99265
2) STABLE (190m)
30/07/08 - 06:17 GMT
19 1.98635, 76 29.00425
1) F2 (190m)
30/07/08 - 05:41 GMT
19 0.00756, 76 28.81557
N

SCIENTIFIC REPORT 3: Inorganic Nutrients and Dissolved Oxygen

Tim Brand

Nutrients

The basic water column nutrients, ammonia, phosphate, silicate and inorganic oxidized nitrogen (nitrate+nitrite) were analyzed to establish the nutrient status of the water and sediment biogeochemical cycling at the sampling stations. At some stations nitrate and nitrite were analyzed separately. Samples were taken from individual CTD bottles from deep casts at each station, from replicate depth CTD bottles from shallow water casts, from the ships underway non-toxic supply, from the overlying water above *in-situ* and *in-vivo* incubated sediment and from the pore water of sediment slices. See science reports 6 (page 64) and 17 (page 120) for details of the shallow cast incubation work and sediment work respectively. See science reports 5 (page 57) for details of the underway samples taken during the first leg of the cruise,Portland to Longyearbyen.

Water samples were collected in acid cleaned (10%HCl) 250ml bottles for on-board nutrient analysis of ammonium, phosphate, silicate and nitrate. In some cases nitrite was also analysed. The samples were analysed within 24hrs of collection. The samples were analsyed using a Lachate 'QuikChem 8500' instrument using Lachate methods; 31-107-06-1-B Ammonium, 31-107-04-1-A Nitrate, 31-115-01-1-I Phosphate and 31-114-27-1-A Silicate. Samples were run in triplicate and salt corrected by analyzing a Low Nutrient Sea Water purchased from OSIL (Batch LNS 16) prior to and within each batch of samples. Pore water samples were diluted 8 times prior to analysis. Overlying water from the incubated sediment work was run undiluted.

Dissolved oxygen

Water samples were collected from a selected number of depths and CTD casts so that a comprehensive calibration of the CTD oxygen probe could be made. Samples were collected in designated oxygen samples bottles and analysed by Winkler titration using an automatic Radiometer auto-titrator. Replicates samples were taken from a selected number of depths from a selected number of deep CTD casts. Fifty individual samples were collected in total. Some of the replicate Winkler samples gave quite poor precision and so were discounted from the CTD probe calibration. The correlation of the CTD probe results with the selected Winkler results is shown below:

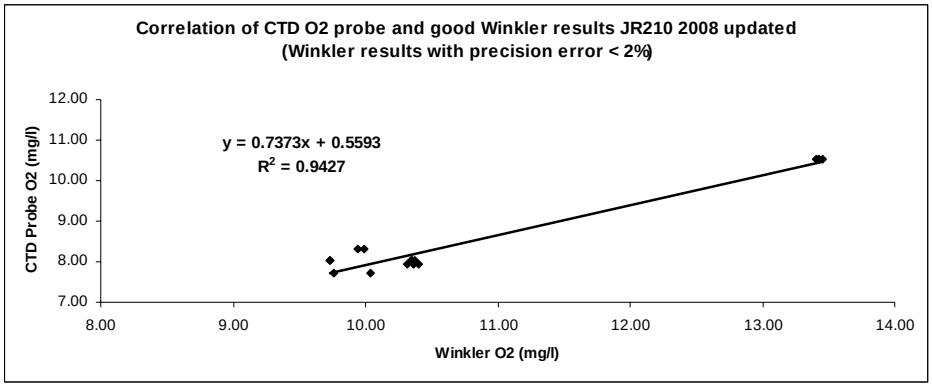


Figure 1 Correlation of CTD O_2 probe results with Winkler titration results

A full list of water column parameters collected and or analysed on board is shown in Table 1 below

Table 1 CTD water column nutrients

Station	Event No	CTD Cast	CTD bottle No.	Depth (m)	Nutrients	Dissolved oxygen
English Channel	1	1	22	1	NH4,PO4,SiO3,NO3,	
			7	6	NH4,PO4,SiO3,NO3,	
			5	15	NH4,PO4,SiO3,NO3,	
			1	25	NH4,PO4,SiO3,NO3,	
Southern North sea	2	2	23	0	NH4,PO4,SiO3,NO3,	
			17	6	NH4,PO4,SiO3,NO3,	
			11	15	NH4,PO4,SiO3,NO3,	
			5	20	NH4,PO4,SiO3,NO3,	
			3	30	NH4,PO4,SiO3,NO3	
			1	35	NH4,PO4,SiO3,NO3	
Northern North Sea		3	17	6	NH4,PO4,SiO3,NO3,	
			11	15	NH4,PO4,SiO3,NO3,	
			9	26	NH4,PO4,SiO3,NO3,	
			3	30	NH4,PO4,SiO3,NO3,	
			1	40	NH4,PO4,SiO3,NO3	
Lofoten Station	6	4	22	0	NH4,PO4,SiO3,NO3,	
			13	6	NH4,PO4,SiO3,NO3,	
			7	15	NH4,PO4,SiO3,NO3,	
			5	25	NH4,PO4,SiO3,NO3,	
			3	45	NH4,PO4,SiO3,NO3	
			1	65	NH4,PO4,SiO3,NO3	
StorFjorden	7	5	22	0	NH4,PO4,SiO3,NO3,	
			21	6	NH4,PO4,SiO3,NO3,	
			12	30	NH4,PO4,SiO3,NO3,	
			10	40	NH4,PO4,SiO3,NO3,	
			4	50	NH4,PO4,SiO3,NO3	
			3	130	NH4,PO4,SiO3,NO3	
			2	165	NH4,PO4,SiO3,NO3	
			1	180	NH4,PO4,SiO3,NO3	
Shelf Station 1	17	6	21	10	NH4,PO4,SiO3,NO3	Triplicate
			15	25	NH4,PO4,SiO3,NO3	
			14	40	NH4,PO4,SiO3,NO3	
			13	60	NH4,PO4,SiO3,NO3	
			12	80	NH4,PO4,SiO3,NO3	Triplicate
			11	100	NH4,PO4,SiO3,NO3	
			10	120	NH4,PO4,SiO3,NO3	
			9	200	NH4,PO4,SiO3,NO3	
			8	300	NH4,PO4,SiO3,NO3	
			7	400	NH4,PO4,SiO3,NO3	
			6	440	NH4,PO4,SiO3,NO3	Triplicate
Shelf Station 1	41	13	24	2	NH4,PO4,SiO3,NO3	
			23	2	NH4,PO4,SiO3,NO3	
			22	2	NH4,PO4,SiO3,NO3	
			21	2	NH4,PO4,SiO3,NO3	

Shelf Station 1	42	14	23	2	NH4,PO4,SiO3,NO3	
			21	2	NH4,PO4,SiO3,NO3	
			19	2	NH4,PO4,SiO3,NO3	
			17	5	NH4,PO4,SiO3,NO3	
			15	5	NH4,PO4,SiO3,NO3	
			13	5	NH4,PO4,SiO3,NO3	
			11	11	NH4,PO4,SiO3,NO3	
			9	17	NH4,PO4,SiO3,NO3	
			8	19	NH4,PO4,SiO3,NO3	
			6	30	NH4,PO4,SiO3,NO3	
			4	30	NH4,PO4,SiO3,NO3	
			2	60	NH4,PO4,SiO3,NO3	
			1	118	NH4,PO4,SiO3,NO3	
MIZ Station 1 (Lander st. 2)	45	15	23	2	NH4,PO4,SiO3,NO3	
			21	10	NH4,PO4,SiO3,NO3	
			19	20	NH4,PO4,SiO3,NO3	
			17	40	NH4,PO4,SiO3,NO3	
			15	60	NH4,PO4,SiO3,NO3	
			13	80	NH4,PO4,SiO3,NO3	
			11	100	NH4,PO4,SiO3,NO3	5 Samples
			9	200	NH4,PO4,SiO3,NO3	
			7	250	NH4,PO4,SiO3,NO3	
			5	300	NH4,PO4,SiO3,NO3	
			1	400	NH4,PO4,SiO3,NO3	5 Samples
Ice station	54	18	22	5	NH4,PO4,SiO3,NO3	
			21	10	NH4,PO4,SiO3,NO3	
			15	20	NH4,PO4,SiO3,NO3	
			7	30	NH4,PO4,SiO3,NO3	
			6	40	NH4,PO4,SiO3,NO3	
			5	50	NH4,PO4,SiO3,NO3	
			4	80	NH4,PO4,SiO3,NO3	
			3	100	NH4,PO4,SiO3,NO3	
			2	132	NH4,PO4,SiO3,NO3	
			1	138	NH4,PO4,SiO3,NO3	
MIZ Station 1	74	22	24	10	NH4,PO4,SiO3,NO3	
			23	20	NH4,PO4,SiO3,NO3	
			20	30	NH4,PO4,SiO3,NO3	
			19	50	NH4,PO4,SiO3,NO3	
			18	60	NH4,PO4,SiO3,NO3	
			17	100	NH4,PO4,SiO3,NO3	
			16	160	NH4,PO4,SiO3,NO3	
			15	200	NH4,PO4,SiO3,NO3	
			14	300	NH4,PO4,SiO3,NO3	
MIZ Station 1	93	27	19	2	NH4,PO4,SiO3,NO3	
			17	2	NH4,PO4,SiO3,NO3	
			15	8	NH4,PO4,SiO3,NO3	
			13	8	NH4,PO4,SiO3,NO3	
			12	8	NH4,PO4,SiO3,NO3	
			11	8	NH4,PO4,SiO3,NO3	
			9	15	NH4,PO4,SiO3,NO3	
			7	27	NH4,PO4,SiO3,NO3	
			6	27	NH4,PO4,SiO3,NO3	
			5	27	NH4,PO4,SiO3,NO3	

			1	60	NH4,PO4,SiO3,NO3	
Shelf Edge station 1	121	30	24	10	NH4,PO4,SiO3,NO3, NO2	
			23	20	NH4,PO4,SiO3,NO3, NO2	
			22	40	NH4,PO4,SiO3,NO3, NO2	
			21	60	NH4,PO4,SiO3,NO3, NO2	
			20	100	NH4,PO4,SiO3,NO3, NO2	
			19	200	NH4,PO4,SiO3,NO3	
			18	300	NH4,PO4,SiO3,NO3	
			17	400	NH4,PO4,SiO3,NO3	
			16	500	NH4,PO4,SiO3,NO3	
			15	600	NH4,PO4,SiO3,NO3	
			14	700	NH4,PO4,SiO3,NO3	
			13	772	NH4,PO4,SiO3,NO3	
Shelf Edge station 1	123	32	12	18	NH4,PO4,SiO3,NO3, NO2	
			10	38	NH4,PO4,SiO3,NO3, NO2	
			9	55	NH4,PO4,SiO3,NO3, NO2	
			8	60	NH4,PO4,SiO3,NO3, NO2	
			7	65	NH4,PO4,SiO3,NO3, NO2	
			6	70	NH4,PO4,SiO3,NO3, NO2	
			5	77	NH4,PO4,SiO3,NO3, NO2	
Rjipfjord Mooring sta.	144	34	24	10	NH4,PO4,SiO3,NO3	Triplicate
			23	20	NH4,PO4,SiO3,NO3NO2	
			22	29	NH4,PO4,SiO3,NO3NO2	
			5	40	NH4,PO4,SiO3,NO3NO2	
			4	60	NH4,PO4,SiO3,NO3NO2	
			3	100	NH4,PO4,SiO3,NO3NO2	
			2	150	NH4,PO4,SiO3,NO3	
			1	202	NH4,PO4,SiO3,NO3	Triplicate
Rjipfjord South sta	159	36	12	10	NH4,PO4,SiO3,NO3	Triplicate
			11	20	NH4,PO4,SiO3,NO3NO2	
			10	35	NH4,PO4,SiO3,NO3NO2	
			9	50	NH4,PO4,SiO3,NO3NO2	
			8	60	NH4,PO4,SiO3,NO3NO2	
			7	100	NH4,PO4,SiO3,NO3NO2	
			6	150	NH4,PO4,SiO3,NO3	
			5	170	NH4,PO4,SiO3,NO3	
			4	196	NH4,PO4,SiO3,NO3	Triplicate
Rjipfjord Mooring sta.	163	38	1	2	NH4,PO4,SiO3,NO3,NO2	
			3	2	NH4,PO4,SiO3,NO3,NO2	
			5	2	NH4,PO4,SiO3,NO3,NO2	
			7	7	NH4,PO4,SiO3,NO3,NO2	
			9	7	NH4,PO4,SiO3,NO3,NO2	
			11	7	NH4,PO4,SiO3,NO3,NO2	
			13	12	NH4,PO4,SiO3,NO3,NO2	
			15	15	NH4,PO4,SiO3,NO3,NO2	
			17	27	NH4,PO4,SiO3,NO3,NO2	
			19	27	NH4,PO4,SiO3,NO3,NO2	
			21	27	NH4,PO4,SiO3,NO3,NO2	

			23	60	NH4,PO4,SiO3,NO3,NO2
Rjipfjord South Basin	173	41	13	1.5	NH4,PO4,SiO3,NO3,NO2
			11	10	NH4,PO4,SiO3,NO3,NO2
			9	20	NH4,PO4,SiO3,NO3,NO2
			7	30	NH4,PO4,SiO3,NO3,NO2
			5	50	NH4,PO4,SiO3,NO3,NO2
			3	100	NH4,PO4,SiO3,NO3,NO2
Rjipfjord Intermediate	177	42	22	2	NH4,PO4,SiO3,NO3,NO2
			20	10	NH4,PO4,SiO3,NO3,NO2
			18	20	NH4,PO4,SiO3,NO3,NO2
			16	30	NH4,PO4,SiO3,NO3,NO2
			14	50	NH4,PO4,SiO3,NO3,NO2
			12	60	NH4,PO4,SiO3,NO3,NO2
			10	80	NH4,PO4,SiO3,NO3,NO2
			8	100	NH4,PO4,SiO3,NO3,NO2
			6	120	NH4,PO4,SiO3,NO3,NO2
			4	150	NH4,PO4,SiO3,NO3,NO2
			2	167	NH4,PO4,SiO3,NO3,NO2
Rjipfjord Mooring Sta	180	43	10	10	NH4,PO4,SiO3,NO3,NO2
			9	20	NH4,PO4,SiO3,NO3,NO2
			8	35	NH4,PO4,SiO3,NO3,NO2
			7	50	NH4,PO4,SiO3,NO3,NO2
			6	60	NH4,PO4,SiO3,NO3,NO2
			5	80	NH4,PO4,SiO3,NO3,NO2
			4	100	NH4,PO4,SiO3,NO3,NO2
			3	120	NH4,PO4,SiO3,NO3,NO2
			2	150	NH4,PO4,SiO3,NO3,NO2
			1	175	NH4,PO4,SiO3,NO3,NO2
RJA	181	44	18	2	NH4,PO4,SiO3,NO3,NO2
			16	10	NH4,PO4,SiO3,NO3,NO2
			14	20	NH4,PO4,SiO3,NO3,NO2
			12	30	NH4,PO4,SiO3,NO3,NO2
			10	50	NH4,PO4,SiO3,NO3,NO2
			8	80	NH4,PO4,SiO3,NO3,NO2
			6	100	NH4,PO4,SiO3,NO3,NO2
			4	120	NH4,PO4,SiO3,NO3,NO2
			2	150	NH4,PO4,SiO3,NO3,NO2
RJB	182	45	18	2	NH4,PO4,SiO3,NO3,NO2
			16	10	NH4,PO4,SiO3,NO3,NO2
			14	20	NH4,PO4,SiO3,NO3,NO2
			12	30	NH4,PO4,SiO3,NO3,NO2
			10	50	NH4,PO4,SiO3,NO3,NO2
			8	80	NH4,PO4,SiO3,NO3,NO2
			6	100	NH4,PO4,SiO3,NO3,NO2
			4	120	NH4,PO4,SiO3,NO3,NO2
			2	170	NH4,PO4,SiO3,NO3,NO2
RJ1	186	46		2	NH4,PO4,SiO3,NO3,NO2

				10	NH4,PO4,SiO3,NO3,NO2
				20	NH4,PO4,SiO3,NO3,NO2
				30	NH4,PO4,SiO3,NO3,NO2
				50	NH4,PO4,SiO3,NO3,NO2
				80	NH4,PO4,SiO3,NO3,NO2
				100	NH4,PO4,SiO3,NO3,NO2
				150	NH4,PO4,SiO3,NO3,NO2
				172	NH4,PO4,SiO3,NO3,NO2
Shelf station					
2	188	48	24	2	Not analysed yet
			23	2	“
			22	2	“
			16	6	“
			15	6	“
			12	6	“
			8	35	“
			7	35	“
			6	35	“

For details on nutrient analysis of incubated time series water samples see Fouliand and Le Floch (this volume) and for sediment incubation samples and sediment slice porewater samples see Stahl (this volume).

SCIENTIFIC REPORT 4: Particulate and Dissolved Organic Nutrient and Photosythetic Pigment Concentrations

Elaine Mitchell and Andrea Veszelovszki

Introduction and Objectives

The objective of this study was to measure the concentrations of: (a) dissolved organic carbon, nitrogen and phosphorus (DOC/N/P), (b) particulate organic carbon and nitrogen (POC/N), and (c) photosynthetic pigments including chlorophyll a (Chl a), in surface waters at different sampling stations during the cruise. Samples were collected for post-cruise analysis on return to the UK. Sampling details are shown in the tables at the end of this report.

Approach and Methodology

DOC/N/DOP samples:

Water samples were taken from the CTD bottles. The water was pre filtered through a 150µm mesh bag and collected in a thermos flask. The thermos flask was taken to the lab where 100ml of sample were removed and placed into 100ml clear nalgene bottles. All equipment and sample bottles used to produce and store these samples were acid washed overnight and thoroughly rinsed in milliQ water before use.
For each sample an ashed GF/F 25mm filter was placed into a re-useable ‘swinex’ filter holder. Using a clean glass 20ml syringe the sample water was pushed through the filter and collected.

1. DOP – 30ml of sample was filtered into a 30ml LDPE bottle, capped and labelled. Samples are stored frozen until analysed at the lab.
2. DOC/N – 20ml of sample was filtered into an ashed glass vial and treated with 60µl of 85% orthophosphoric acid. The vials are then capped using a lid and silicone insert and labelled.

The samples were stored in the cold room at 4°C for post-cruise analysis of DOC, DON and DOP concentrations in the samples.

POC/N samples:

Water samples were taken from the CTD bottles. The water was pre filtered through a 150µm mesh bag and collected in a thermos flask. The thermos flask was taken to the lab where up to 200mls of sample were removed (the volume filtered depends on the condition of the sample). The sample was then placed into a 250ml Nalgene bottle which had, attached to the lid, a re-useable ‘swinex’ filter holder containing an ashed 25 mm GF/F filter. This was then inverted and attached to a filtration rig and a pump was used to draw the sample water through the filter. The filter was then removed and placed into a 15ml plastic ‘Sterilin’ tube and frozen at -20°C for post-cruise analysis of POC/N concentration.

Photosynthetic pigment (Chl a) samples:

Water samples were taken from the CTD bottles. The water was pre filtered through a 150µm mesh bag and collected in a thermos flask. The thermos flask was taken to the

lab where up to 500ml of sample were removed (the volume filtered depends on the condition of the sample). The sample was then placed into a 500ml Nalgene bottle which had, attached to the lid, a re-useable ‘swinex’ filter holder containing a 25 mm GF/F filter. This was then inverted and attached to a filtration rig and a pump was used to draw the sample water through the filter. A portion of the filtrate was captured in a plastic bottle and used for nutrient analysis (see nutrient analysis Section of the cruise report). The filter itself was removed and placed into a 15ml plastic ‘Sterilin’ tube and frozen at -80°C for post-cruise analysis of Chl a and other pigment concentrations by HPLC.

Water samples of up to 750ml were also removed to determine size fractionated pigment concentrations. Each sample was filtered sequentially through 20, 2 and 02 µm pore size x 47 mm diameter polycarbonate filters, held in a Startorius filtration tower, using a pump to draw the sample water through the filters. The filters itself was removed and placed into a 15ml plastic ‘Sterilin’ tube and frozen at -80°C for post-cruise analysis of Chl a and other pigment concentrations by HPLC.

JC210 DOC/N Samples

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	0	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	0	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	0	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	0	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	0	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	0	6	35m	0
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	0
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	0
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	0
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	0
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	0
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	0
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	0
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	0
Total			12	Total			12	Total			11	Total			12	Total		0	Total		0

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth 27m

* = Carboy NOT CTD bottles

JC210 DOP Samples

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	0	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	0	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	0	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	0	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	0	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	0	6	35m	0
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	0
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	0
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	0
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	0
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	0
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	0
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	0
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	0
Total			12	Total			12	Total			11	Total			12	Total		0	Total		0

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth 27m

* = Carboy NOT CTD bottles

JC210 POC/N Samples

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	5	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	5	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	5	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	5	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	5	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	5	6	35m	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	1
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	1
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	1
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	1
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	1
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	1
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	1
Total			12	Total			12	Total			11	Total			12	Total		30	Total		9

Exp depth was 30m

Exp depth was 20m

Carboy NOT CTD bottles

Exp depth was 27m

Exp depth 27m

Comment

JC210 Pigment/Chl.a Samples

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	5	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	5	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	5	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	5	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	5	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	5	6	35m	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	1
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	1
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	1
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	1
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	1
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	1
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	1
Total			12	Total			12	Total			11	Total			12	Total		30	Total		9

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth 27m

* = Carboy NOT CTD bottles

JC210 Size Fractionated Pigment/Chl.a Samples

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008		
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)		
Event No	42			Event No	53			Event No	93			Event	163		
CTD No	14			CTD No	17			CTD No	27			CTD No	38		
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample
1	60m	A		1	2m	A *		1	60m	A		1	60m	A	
2	30m	1A		2				2	60m	B		2	60m	B	
3	30m	1B	1	3	10m	A *		3	27m	1A		3	27m	1A	
4	30m	2A		4	40m	A		4	27m	1B	1	4	27m	1B	1
5	30m	2B	1	5	5m	C *	1	5	27m	2A		5	27m	2A	
6	30m	3A		6	5m	A *	1	6	27m	2B	1	6	27m	2B	1
7	30m	3B	1	7				7	27m	3A		7	27m	3A	
8	19m	A		8	5m	B *	1	8	27m	3B	1	8	27m	3B	1
9	17m	A		9				9	15m	A		9	15m	A	
10	17m	B		10	30m	A	1	10	15m	B		10	15m	B	
11	11m	A		11	30m	B	1	11	8m	1A		11	12m	A	
12	11m	B		12	30m	C	1	12	8m	1B	1	12	12m	B	
13	5m	1A		13				13	8m	2A		13	7m	1A	
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1
15	5m	2A		15				15	8m	3A		15	7m	2A	
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1
17	5m	3A		17	20m	B	1	17	2m	1A		17	7m	3A	
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1
19	1m	1A		19				19	2m	2A		19	2m	1A	
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1
21	1m	2A		21				21	2m	3A		21	2m	2A	
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1
23	1m	3A		23				23	2m	A		23	2m	3A	
24	1m	3C	1	24				24	2m	B		24	2m	3B	1
Total			9	Total			9	Total			9	Total			9

Exp depth was 30m

Exp depth was 20m

Carboy NOT CTD bottles

Exp depth was 27m

Exp depth 27m

SCIENTIFIC REPORT 5: Primary Production, Calcification, Coccolithophores and the Carbonate System

Anastasia Charalampopoulou and Mike Lucas

Background and cruise objectives

Ocean acidification is the result of increasing carbon dioxide in the atmosphere being absorbed by the ocean. This shifts the carbonate system towards more CO_2 and H^+ and less carbonate ion (CO_3^{2-}) which in turn decreases calcite saturation state in the seawater. Experiments imply that ocean acidification and the subsequent decline in calcite saturation state will have a negative impact on marine calcifiers such as corals, mussels, sea urchins, pteropods and coccolithophores. Coccolithophores are of particular importance as they comprise a great proportion of biogenic calcification (50-80%). Moreover, calcite is considered to be an important ballast material for organic carbon transport from the surface to the deep ocean and is therefore playing an important role in the global carbon cycle.

Extensive lab experiments have been done on coccolithophore responses to ocean acidification and some of them show contradictory results, but studies on natural populations are limited. The cruise track crossed a natural gradient of calcite saturation state; from high values at low latitudes to very low values in the Arctic. Thus, a "natural lab" was provided in order to investigate how *in-situ* assemblages of coccolithophores might respond to ocean acidification, in a natural system were parameters like temperature, nutrients, mixing e.t.c. are not controlled but have a joint effect on biological processes.

Sampling and Methods

We sampled for coccolithophores (*SEM*), particulate inorganic carbon (*PIC*), particulate organic carbon and particulate organic nitrogen (*POC/N*), *chl-a*, phytoplankton identification (*Lugol's*), *primary production* and *calcification* and dissolved inorganic carbon (*DIC*) and alkalinity (*Alk*). Samples were collected at 9 CTD stations from 4-6 light depths (see Table 1). Underway samples (51 in total, see Table 2) were also collected during the first leg of the cruise.

SEM

Samples for coccolithophore analysis were taken at 9 CTD stations and from the underway supply.

Exactly 1000 mL of seawater were filtered on 1.2 μm Isopore membrane filters under low vacuum. The filters were rinsed with analytical grade trace ammonium solution (pH ~ 9.7) to prevent the formation of salt crystals that makes analysis under the SEM difficult. Filters were dried at ~30ºC, placed in sealed Petri dishes, wrapped in tin foil and kept in a cool and dry place until analysis at NOCS using a Leo 1450VP Carl Zeiss scanning electron microscope. Analysis will involve identification, enumeration and morphometric analysis of coccospheres and loose coccoliths.

PIC

Samples for PIC were taken at 8 CTD stations and from the underway supply.

Up to 500 mL of seawater were filtered on 0.2 µm or 0.8 µm polycarbonate filters. The filters were rinsed with analytical grade trace ammonium solution (pH ~ 9.7) in order to dissolve salt that would otherwise contaminate the sample, placed in centrifuge tubes and kept at 4ºC until analysis at NOCS using a Perkin Elmer Optima 4300 DV inductively coupled plasma-optical emission spectrometer (ICP-OES).

POC/N

Samples for POC/N were taken at 9 CTD stations and from the underway supply.

Up to 1500 mL of seawater were filtered on pre-ashed GF/F filters. The filters were placed in Petri dishes and kept at -20ºC. Further analysis will be done using a Thermo Finnigan flash EA1112 elemental analyzer at NOCS.

Chl-a

Chlorophyll-*a* samples were taken at 9 CTD stations and from the underway supply.

Exactly 200 mL of seawater were filtered on GF/F filters. Filters were wrapped in tin foil and kept at -20ºC. Analysis at NOCS will be done following the Welschmeyer protocol using a Turner fluorometer calibrated against a spectrophotometrically determined calibration curve of commercial grade (SIGMA) chl-*a* using the SCOR / UNESCO tri-chromatic equations.

Phytoplankton identification

Lugol's samples for phytoplankton identification were collected during the first leg of the cruise at 5 CTD stations and from the underway supply.

Samples were preserved with 1-2% Lugol's solution and stored in 150 mL brown bottles. Samples will be analysed at SAMS together with samples collected during the second leg of the cruise using light microscopy.

Primary production and calcification

Daily rates of primary production and calcification were determined at 8 CTD stations following the 'micro-diffusion' technique of Paasche and Brubak 1994 (as modified by Balch *et al*., 2000). Water samples (50-150 mL, 3 incubated, 1 formalin-killed) were collected from 4-6 light depths (around 80, 50, 20, 9, 6, 1% incident light), spiked with 100 µCi of ^{14}C-labelled sodium bicarbonate and incubated in on-deck incubators (apart from the ice station were samples were incubated *in-situ* under the ice). Light depths were replicated through the use of a mixture of misty blue and neutral density filters and continuous flow of water from the underway supply in the incubators kept samples at sea surface temperature.

Incubations were terminated by filtration through 25mm 0.2 µm polycarbonate filters, with extensive rinsing with filtered seawater to remove any labeled ^{14}C-DIC. Filters were then placed in a glass vial with gas-tight septum and a bucket containing a GFA filter soaked with phenylethylamine (PEA) attached to the lid. Phosphoric acid (1 mL, 1%) was then injected through the septum into the bottom of the vial to convert any labeled ^{14}C-PIC to ^{14}C-CO_2 which was then captured in the PEA-soaked filter. After 24 hours, GFA filters were removed and placed in a fresh vial and liquid scintillation cocktail was added to both vials: one containing the polycarbonate filter (non-acid labile production, organic or primary production) and the other containing the GFA filter (acid labile production, inorganic production or calcification). Activity in both filters was then determined on a liquid scintillation counter and counts converted to uptake rates using standard methodology. Daily uptake rates per cell will also be calculated using the data from the SEM samples.

DIC and Alkalinity

DIC and alkalinity samples were taken at 8 CTD station and from the underway supply. Sampling procedure was according to DOE (U.S. Department of Energy) 1994. Samples were taken as soon as the Niskin bottle was opened to prevent any gas exchange. Silicone tubing and borosilicate glass bottles (250 mL) were used for sampling and care was taken to prevent any air bubbles being trapped in the bottle. A head space of 1% (2.5 mL) was allowed for water expansion. Each sample was then poisoned with mercuric chloride in order to prevent any biological activity and the bottle was air-tight sealed with a glass stopper. Samples were stored in a cool and dark place until analysis at NOCS.

Analysis will be done using the VINDTA (Versatile INstrument for Determination of Total Alkalinity) connected with a UIC coulometer. DIC will be measured using a coulometric titration and alkalinity by titrating the sample with hydrochloric acid. Certified Reference Materials (CRMs) from A.G. Dickson (Scripps Institute of Oceanography) will be used to calibrate the instrument before sample analysis. DIC and alkalinity values will then be used to calculate the rest of the carbonate system parameters; carbon dioxide, bicarbonate and carbonate ion, pH and finally calcite and aragonite saturation state.

Continuous pCO_2 and Satellite images

In order to support our data, continuous pCO2 measurements (courtesy of PML) were also made and chl-*a* and true-colour (in which coccolithophore blooms can be identified) satellite images were sent daily to the ship.

Table 1: CTD stations and depths at which samples were collected

Station	Event No	CTD Cast	CTD bottle no.	Depth (m)	DIC/Alk	Chl-a	POC/N	PIC	SEM	Lugol's	PP	Calcification
English Channel	1	1	22	0	x	x	x		x	x	x	x
			9	6	x	x	x		x	x	x	x
			5	15	x	x	x		x	x	x	x
			1	25	x	x	x		x	x	x	x
Southern North sea	2	2	23	0	x	x	x	x	x	x	x	x
			17	6	x	x	x	x	x	x	x	x
			11	15	x	x	x	x	x	x	x	x
			5	20	x	x	x	x	x	x	x	x
			3	30	x	x	x	x	x	x	x	x
			1	35	x	x	x	x	x	x		
Northern North Sea	3	3	22	0	x	x	x	x	x	x	x	x
			17	6	x	x	x	x	x	x	x	x
			11	15	x	x	x	x	x	x	x	x
			7	26	x	x	x	x	x	x	x	x
			3	30	x	x	x	x	x	x	x	x
			1	40	x	x	x	x	x	x	x	x
Lofoten Station	6	4	22	0	x	x	x	x	x	x	x	x
			17	6	x	x	x	x	x	x	x	x
			7	15	x	x	x	x	x	x	x	x
			5	25	x	x	x	x	x	x	x	x
			3	45	x	x	x	x	x	x	x	x
			1	65	x	x	x	x	x	x	x	x

Table 1 (continued): CTD stations and depths at which samples were collected

Station	Event No	CTD Cast	CTD bottle no.	Depth (m)	DIC/Alk	Chl-a	POC/N	PIC	SEM	Lugol's	PP	Calcification
Storfjorden	7	5	22	0		x	x					
			14	6		x	x	x	x	x		
			12	30		x	x	x	x	x		
			6	40		x	x					
			4	50		x	x					
			3	130		x	x					
			2	165		x	x					
			1	180		x	x					
Shelf Station 1	17	6	underway	6					x			
			20	25					x			
Shelf Station 1	42	14	23	2							x	x
			21	2							x	x
			19	2	x	x	x	x	x		x	x
			17	5							x	x
			15	5							x	x
			13	5	x	x	x	x	x		x	x
			11	11	x	x	x	x	x		x	x
			9	17	x	x	x	x	x		x	x
			8	19	x	x	x	x	x		x	x
			6	30							x	x
			4	30							x	x
			2	30	x	x	x	x	x		x	x
Ice Station	53	17	Ice hole	2	x	x	x	x	x		x	x
			Ice hole	5	x	x	x	x	x		x	x
			Ice hole	10	x	x	x	x	x		x	x
			7	20	x	x	x	x	x		x	x
			8	20							x	x
			9	20							x	x
			13	30	x	x	x	x	x		x	x
			14	30							x	x
			15	30							x	x

Table 1 (continued): CTD stations and depths at which samples were collected

Station	Event No	CTD Cast	CTD bottle no.	Depth (m)	DIC/Alk	Chl-a	POC/N	PIC	SEM	Lugol's	PP	Calcification
MIZ Station (Lander station 2)	93	27	21	2							x	x
			19	2							x	x
			17	2	x	x	x	x	x		x	x
			15	8							x	x
			13	8							x	x
			11	8	x	x	x	x	x		x	x
			9	15	x	x	x	x	x		x	x
			7	27							x	X
			5	27							x	X
			3	27	x	x	x	x	x		x	x
Rijpfjorden Mooring	144	34		30					x			
Rijpfjorden Mooring	163	38	23	2							x	x
			21	2							x	x
			19	2	x	x	x	x	x		x	x
			17	7							x	x
			15	7							x	x
			13	7	x	x	x	x	x		x	x
			11	12	x	x	x	x	x		x	x
			9	15	x	x	x	x	x		x	x
			7	27							x	x
			5	27							x	x
			3	27	x	x	x	x	x		x	x

Table 2: Dates, times and positions of underway sampling

Event no.	Date	Time (BST)	Lat (N)	Long (E)	DIC /Alk	Chl-a	POC/ N	PIC	SEM	Lugol's
1	24/07/08	15:16	51.29.82	1.29.82	x	x	x	x	x	x
2	24/07/08	17:22	51.50.91	2.11.73	x	x	x	x	x	x
3	24/07/08	19:53	52.25.60	2.20.90	x	x	x	x	x	x
4	24/07/08	22:00			x	x	x	x	x	x
5	24/07/08	23:53	53.18.37	2.27.63	x	x	x	x	x	x
6	25/07/08	01:52	53.39.06	2.30.33	x	x	x	x	x	x
7	25/07/08	03:53	53.59.91	2.33.71	x	x	x	x	x	x
8	25/07/08	08:06	54.29.70	2.39.86	x	x	x	x	x	x
9	25/07/08	09:00	54.41.21	2.49.39	x	x	x		x	x
10	25/07/08	10:02	54.54.04	2.40.81	x	x	x	x	x	x
11	25/07/08	11:02	55.05.66	2.41.05	x	x	x	x	x	x
12	25/07/08	12:05	55.20.67	2.41.66	x	x	x	x	x	x
13	25/07/08	13:13	55.34.09	2.41.91	x	x	x	x	x	x
14	25/07/08	14:07	55.45.64	2.42.31	x	x	x	x	x	x
15	25/07/08	15:53	56.06.74	2.43.22	x	x	x	x	x	x
16	25/07/08	17:53	56.31.10	2.45.66	x	x	x	x	x	x
17	25/07/08	19:58	56.59.15	2.51.43	x	x	x	x	x	x
18	25/07/08	22:00	57.21.54	2.55.98	x	x	x		x	x
19	26/07/08	11:05	59.42.91	3.27.11	x	x	x		x	x
20	26/07/08	13:00	60.06.97	3.32.85	x	x	x	x	x	x
21	26/07/08	15:00	60.28.57	3.29.24	x	x	x	x	x	x
22	26/07/08	17:08	60.57.24	3.41.81	x	x	x	x	x	x
23	26/07/08	20:17	61.35.63	3.52.67	x	x	x	x	x	x
24	26/07/08	21:54	61.54.20	4.03.79	x	x	x	x	x	x
25	27/07/08	01:56	62.31.63	4.29.62	x	x	x	x	x	x
26	27/07/08	03:56	62.54.18	4.45.49	x	x	x	x	x	x
27	27/07/08	05:58	63.28.99	5.02.91	x	x	x	x	x	x
28	27/07/08	07:59	63.42.81	5.20.61	x	x	x	x	x	x
29	27/07/08	09:59	64.06.28	5.37.55	x	x	x	x	x	x
30	27/07/08	11:55	64.28.69	5.54.31	x	x	x	x	x	x
31	27/07/08	13:55			x	x	x	x	x	x
32	27/07/08	15:50	65.15.60	6.31.46	x	x	x	x	x	x
33	27/07/08	18:08	65.43.38	6.55.31	x	x	x	x	x	x
34	27/07/08	20:00	66.04.08	7.13.75	x	x	x	x	x	x
35	27/07/08	22:00	66.28.58	7.36.05	x	x	x	x	x	x
36	27/07/08	24:00	66.49.51	7.54.70	x	x	x	x	x	x
37	28/07/08	01:42	67.11.23	8.14.79	x	x	x	x	x	x
38	28/07/08	07:02	68.14.03	9.14.84	x	x	x	x	x	x
39	28/07/08	09:02	68.35.67	9.35.56	x	x	x	x	x	x
40	28/07/08	10:57	68.56.19	9.56.34	x	x	x	x	x	x
41	28/07/08	16:00	69.20.64	10.20.22	x	x	x	x	x	x
42	28/07/08	20:00	70.05.50	11.05.70	x	x	x	x	x	x
43	28/07/08	23:55	70.50.38	11.52.95	x	x	x	x	x	x
44	29/07/08	04:00	71.55.28	12.36.29	x	x	x	x	x	x
45	29/07/08	08:02	72.18.31	13.20.22	x	x	x	x	x	x
46	29/07/08	12:00	73.03.86	14.24.54	x	x	x	x	x	x
47	29/07/08	16:05	73.56.08	15.29.19	x	x	x	x	x	x
48	29/07/08	20:13	74.42.24	16.29.15	x	x	x	x	x	x
49	29/07/08	21:56	75.23.09	17.24.75	x	x	x	x	x	x
50	30/07/08	04:24	76.12.19	18.35.65	x	x	x	x	x	x
51	30/07/08	08:13	76.29.01	19.02.01	x	x	x	x	x	x

SCIENTIFIC REPORT 6: Light, Phytoplankton Characteristics and Carbon and Nitrogen Dynamics

Eric Fouilland & Emilie Le Floc'h

1- Light and phytoplankton characterisation of Arctic waters

Objectives

The relationship between light penetration and the depth of maximum phytoplankton biomass was investigated for different arctic waters.

Rationale & first Results

A recent study showed that under stratification conditions, an inverse relationship was observed in the UV radiation and PAR ranges, between the light attenuation and the depth of the chlorophyll maximum (DCM) in Canadian Arctic waters (Vasseur et al. 2003)[1]. The authors suggested that this relationship may reflect cell migration below the penetration depth of UV radiation where they are protected from UVR-induced physiological damages. We investigated this relationship during the JCR 210 cruise, by measuring the attenuation of UV-B, UV-A, PAR and Infrared radiations (RAMSES spectroradiometers, TriOS) for different Arctic waters, under stratified conditions. Simultaneously, profiles of photosynthetic efficiency using a Fast Repetition Rate Fluorimeter (Fast^{tracka}, Chelsea Technologies Group), colored dissolved matter and fluorescence of different groups of phytoplankton using the bbe Moldaenke Fluoroprobe (Beutler et al. 2002)[2] were performed. Furthermore, the rate of primary production of samples taken from the DCM but incubated under subsurface light intensity, will be compared to the rates obtained from samples incubated under the DCM light level.

The first results based on 3 stations only; showed a maximum of chlorophyll located between 20 and 30m depth where PAR attenuation ranged between 1.5 and 6.8% of incident light, and no UV-B radiation was measured. This may confirm the hypothesis of subsurface light levels deleterious for phytoplankton, explaining the accumulation of phytoplankton biomass under the very low light levels. Additional measurements, such as the photosynthetic efficiency of phytoplankton measured within the water column, will provide further evidences confirming, or not, this hypothesis.

2. Microbial C- and N-dynamic in polar waters

Objectives

The degree of phytoplankton-bacterioplankton C coupling and the bacterial N demand within euphotic zone was estimated in Arctic waters.

[1] Vasseur et al. (2003) Mar. Ecol. Prog. Ser. 252 : 1-13.
[2] Beutler et al. (2002) Photos. Res. 72 : 39-53.

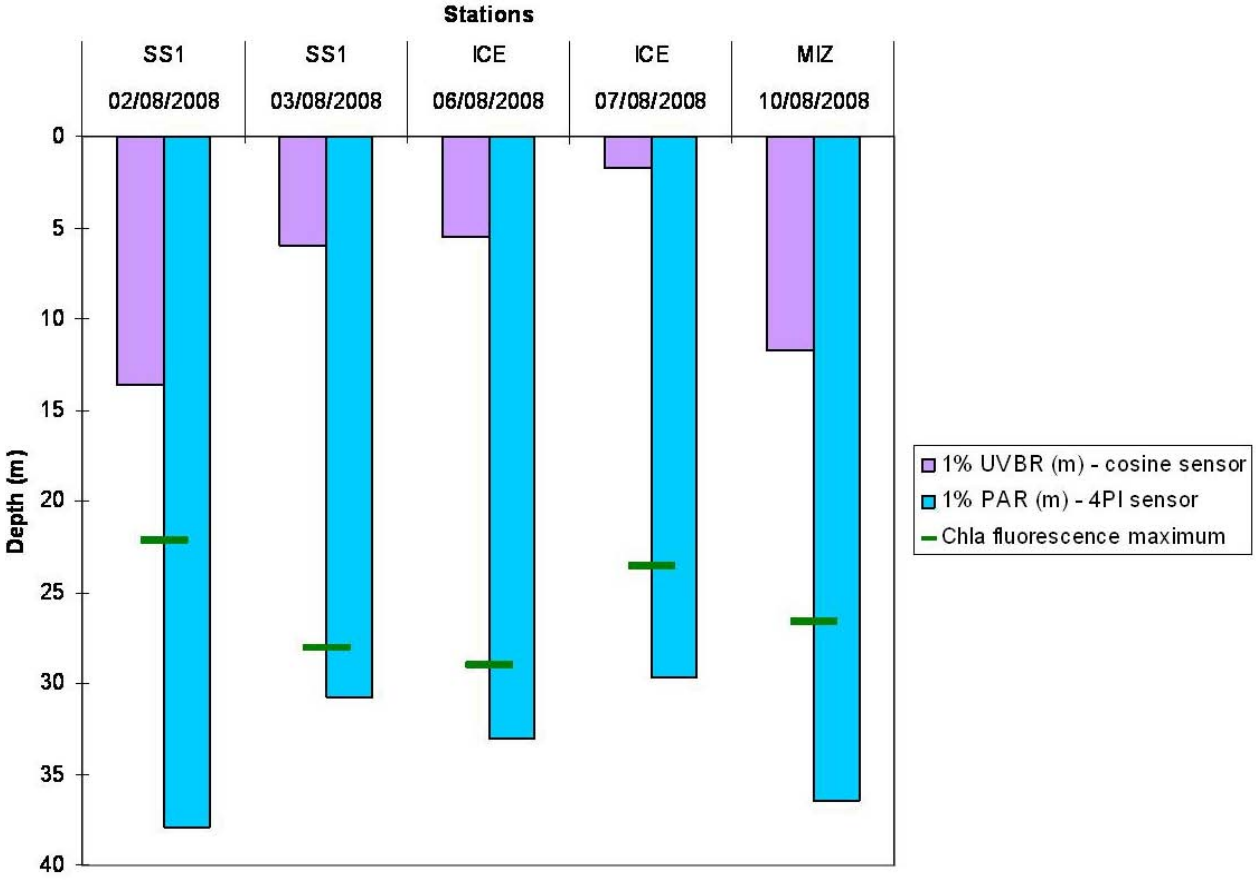


Figure 1. Depth of 1% of incident PAR (Fast[tracka] associated PARmeter) and UV-B radiation (RAMSES spectroradiometer), and depth of maximum chlorophyll fluorescence (Fast[tracka]) detected in 3 stations.

Rationale & first Results

The oceanic carbon cycle is mainly determined by the combined activities of bacteria and phytoplankton interacting with dissolved organic material. Interactions are complex as organisms from different latitudes exhibit different adaptive responses to the same stress both within and between species. A recent study shows that the interaction of bacteria and phytoplankton is closely related to the meridional profile of water temperature in the Atlantic Ocean (Hoppe et. al. 2002)[3]. These authors demonstrate that water temperature was positively correlated with the ratio of bacterial carbon demand to primary production. Their results also indicate a greater need of substrate hydrolysis for bacterial supply in the cold/temperate regions while the availability of exudates ready for uptake possibly reduced the importance of enzymatic hydrolysis in the warmer regions. This apparently contrasts with the high DOM release by phytoplankton (20-40% of total primary production) and the

[3] Hoppe et al. (2002) Nature 416 :168-171

high bacterial C-demand measured in some Arctic regions (Gosselin et al. 1997[4], Rich et al. 1997[5]). However, a key factor influencing the strength of phytoplankton-bacterioplankton coupling is distance to the coast, presumably associated with trophic conditions (Moran et al. 2002)[6]. Because of large DOM inputs (with elevated DOC:DON ratio) from rivers, heterotrophic bacteria in Arctic waters may not be controlled by local primary production but by other autochnous or allochtnous input of organic matter. Furthermore, the high bacterial C-demand measured in these waters suggests a high N requirement for their growth as well. Recent studies show clear evidence of increasing importance of DIN uptake by heterotrophic bacterioplankton from Atlantic to Arctic waters (Allen et al. 2002[7], Fouilland et al. 2004[8]). This is may be due to a higher availability of inorganic N than organic N sources in these waters showing high DOC:DON ratio (Daly et al 1999[9], Skoog et al 2001[10]). Therefore, N competition instead of C coupling may occur between bacterioplankton and phytoplankton in polar waters, making possible the existence of more complex, C- and N-microbial dynamic as observed from very recent mecososms experiments (Thingstad et al. 2008)[11]. C-coupling and N-competition were therefore investigated during the JCR 210 cruise on 5 occasions in arctic waters (cf. table 1).

The first results show that high exudation rates occurred in all the sampled waters, representing between 20 and 60% of total primary production. This is a typical consequence of the end of phytoplankton bloom occurring in these waters in August. However heterotrophic bacteria seemed to use a small fraction of these exudates (5-37%). This suggests that a large fraction of primary production was accumulated as DOC in the water column and bacterial production was not controlled by the phytoplankton C exudation. The measurements of N uptake rates performed during this cruise will confirm, or not, the possible control of bacterial production by N competition with phytoplankton.

3- Potential impact of global warming on microbial C & N-dynamic in polar waters

Objectives

The effect of an increase in temperature on pelagic microbial communities from Arctic waters was studied. To achieve this, we conducted 3 sets of 3-days experiments, exposing microbial communities from Arctic environments of contrasting physico-chemical characteristics, at 3°C more than the average of sea temperature in this area. The response of the microbial communities were assessed via measurements of primary productivity, organic carbon release by phytoplankton, bacterial productivity, N uptake rates, and diversity and biomass of planktonic organisms.

Rationale & first Results

[4] Gosselin et al. (1997) Deep Sea Res ; II 44 :1623-1644
[5] Rich et al. (1997) Deep Sea Res. II 44 :1645-1664
[6] Moran et al. (2002) Microb Ecol ; 44 : 217-223
[7] Allen et al. (2002) J. Mar. Sys. 38 : 93-108
[8] Fouilland et al. (2004) J. Plank. Res.29 : 369-376
[9] Daly et al. (1999) J. Geophys. Res. 104 : 3185-3199
[10] Skoog et al. (2001) Deep Sea Res. I 48 : 2613-2629
[11] Thingstad et al. (2008) Nature doi:10.1038/nature07235

The northern high latitude environment is subjected to long-term shifts in ambient temperature associated with climate change. Models predict an elevation of temperature of arctic waters between 0.5°C and 4.5°C. Such changes may potentially alter the productivity of individuals species in these regions with consequences on the community and ecosytem levels. For example the North Atlantic has experienced changes in temperature in the last 2 decades on scales ranging from general basin-wide increases to local positive or negative anomalies with dramatic consequences for the North Sea ecosystem (Reid et al. 2001)[12]. Short-term temperature experiments were performed in Arctic waters during the JCR 210 in order to investigate the sensitivity and the resilience of microbial organisms to a 3°C water temperature enhancement (Cf Table 1) using a simple experimental design (Fig. 2).

The first results show a significant reduction of primary production and phytoplankton biomass after 3 days incubation under water temperature set at 6°C, relative to the controls (3°C). This apparently contrasts with results from a recent study we performed in mediterranean waters where a 3°C enhancement induced an earlier phytoplankton bloom. This suggests that an increase in sea temperature speeds up natural biological processes. Indeed a more rapid decline of primary production is observed for an arctic microbial community sampled in august, while an earlier bloom was reported for a temperate microbial community sampled in spring.

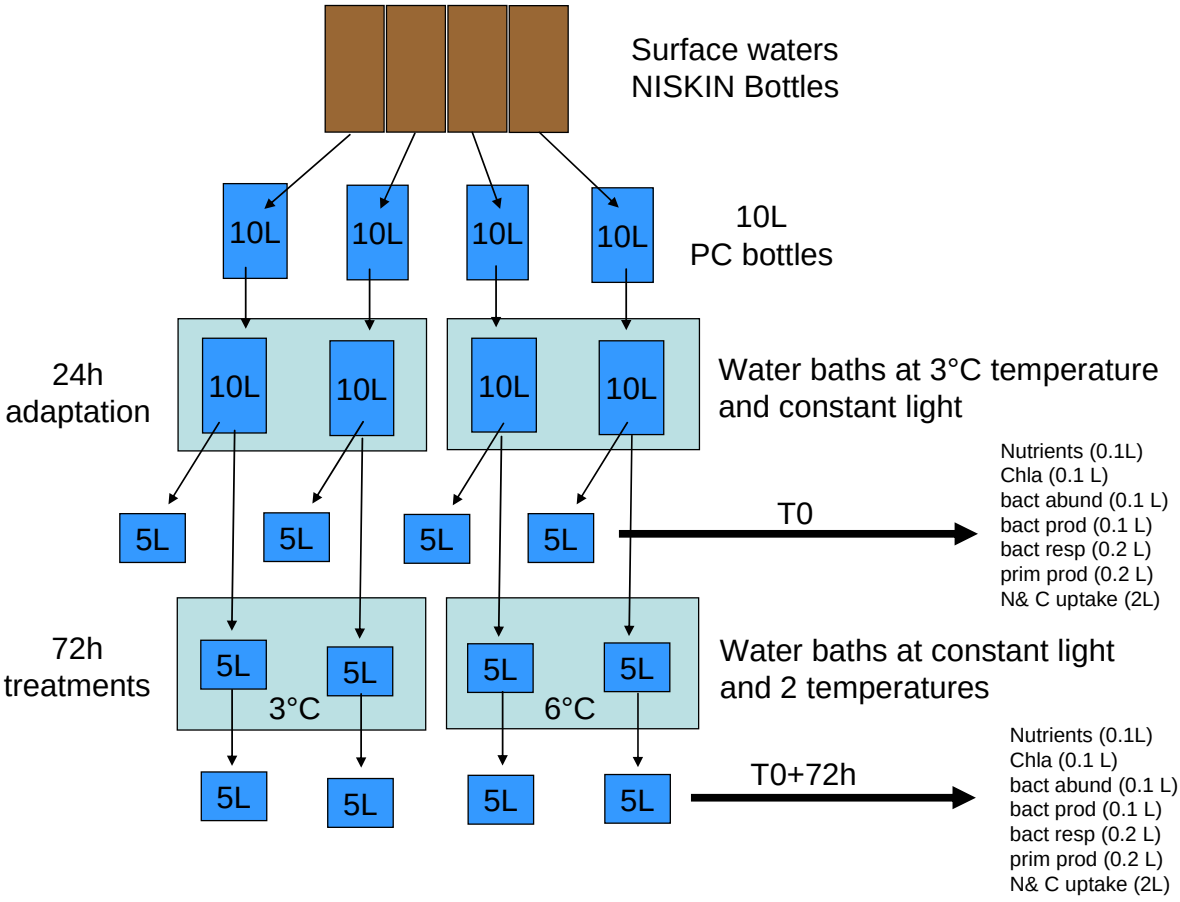


Figure 2. Experimental design used for investigating temperature enhancement effect on microbial communities.

[12] Reid et al. (2001) Mar. Ecol. Prog. Ser. 215 : 283-287

Table 1. List of parameters measured at 5 stations during the JCR 210 cruise

	Shelf Station 1	Ice station	Ice edge station	Ripjforden	Shelf Station 2
C-coupling	2m (80%), 5m(50%), 30m(1.5%-DCM)	5m (3% in ice hole), 20m, 30m(DCM)	2m (50%), 8m(20%), 27m(1.5%-DCM)	2m(50%), 7m(20%), 27m(1.5%-DCM)	2m (50%), 6m (20%), 35m(9%-DCM)
Total primary production rates					
Phytoplankton production rates					
Phytoplankton exudation rates					
Bacterial uptake rates of exudates					
N-competition	2m (80%), 5m(50%), 30m(1.5%-DCM)	5m (3% in ice hole),30m(DCM)	2m (50%), 8m(20%), 27m(1.5%-DCM)	2m(50%), 7m(20%), 27m(1.5%-DCM)	2m (50%), 6m (20%), 35m(9%-DCM)
NH4 phytoplankton uptake rates					
NO3 phytoplankton uptake rates					
NH4 bacterial uptake rates					
NO3 bacterial uptake rates					
NH4 regeneration rates					
NO3 regeneration rates					
POC & PON concentrations					
light measurements	profiles	profiles in ice hole	profiles	profiles	no
Infra red radiation attenuation	*				
PAR radiation attenuation					
UV-A radiation attenuation					
UV-B radiation attenuation					
Phytoplankton and cDOM Fluorescence	discrete measurements	profiles in ice hole	profiles	profiles	discrete measurements
Diatoms fluorescence					
Green algae fluorescence					
cDOM fluorescence					
FRRF on CTD	profiles	profiles	profiles	profiles	profiles
chlorophyll a fluorescence					
photosynthetic efficiency					
effective absorption cross section					
benchtop FRRF on discrete dark adapted samples	no	5m (3% in ice hole), 20m, 30m(DCM)	2m (50%), 8m(20%), 27m(1.5%-DCM)	2m(50%), 7m(20%), 27m(1.5%-DCM)	2m (50%), 6m (20%), 35m(9%-DCM)
chlorophyll a fluorescence					
maximum photosynthetic efficiency					
maximum absorption cross section					
3-days temperature experiment	2m	30m	27m	no	no
C-coupling	T0, T72h	T0, T72h	T0, T72h		
N-competition	T0, T72h	T0, T72h	T0, T72h		
Phytoplankton and cDOM Fluorescence	T0, T72h	T0, T72h	T0, T72h		
benchtop FRRF	T0, T72h	T0, T72h	T0, T72h		
Chla	T0, T72h	T0, T72h	T0, T72h		
plankton abundance & diversity	T0, T72h	T0, T72h	T0, T72h		
Bacterial production	T0, T72h	T0, T72h	T0, T72h		
Nutrients (NH4, PO4, NO3, SiO4)	T0, T72h	T0, T72h	T0, T72h		

SCIENTIFIC REPORT 7: Viral-Bacterial Interactions and Bacterial Production

Elanor Bell

Summary
My objective on the cruise was to investigate viral-bacterial interactions in the pelagos and benthos. This involved collecting water and sediment samples to measure viral and bacterial cell abundance and production and relating this to local environmental conditions.

Introduction
Virus-like particles (VLP; a term including both infectious and non-infectious viruses[13]) are abundant in all aquatic environments, marine and freshwater. 'Virus' is the Latin word for 'poison', an apt term considering that it is now well established that viruses are responsible for 20-50% of bacterial mortality in the water columns of these environments[14] and up to 100% in sediments[15]. Viruses can infect and exploit bacterial cells (or indeed any other type of cell, e.g. phytoplankton) in two ways (Figure 1):

a) During what is termed the *lytic pathway* (1) infectious virus particles bind to the wall of a suitable host bacterial cell and inject viral DNA into the cell's cytoplasm. (2) The viral DNA takes over the host cell's genetic machinery and causes the bacterial cell to produce viral proteins and copies of viral DNA. (3) The viral proteins are then assembled into coats and the viral DNA is packed inside, (4) creating new, viral particles. (5) These replicated virus particles cause the rupture, or *lysis*, of the bacterial cell membrane, killing the cell and releasing infectious virus particles into the surrounding environment. Then, they can go on to infect other bacteria;

b) Alternatively, during the *lysogenic pathway* infectious viruses occupy bacterial cells and use them as factories for replicating viral genes. (1) The viral DNA injected into the bacterial cell is integrated into bacterial DNA. (2) The bacterial cell continues to grow and (3) reproduce as normal and (4) passes viral DNA onto all of its descendents or daughter cells. (5) The infected bacterial cell then either continues to grow and divide following the lysogenic pathway passing on viral DNA with its own, or enters the lytic pathway which ultimately leads to the death of the infected bacterial cells, the release of virus particles into the environment and a new cycle of infection.

In pelagic environments, virus-induced lysis of bacteria provides a major source of dissolved organic matter for phytoplankton[16] because when the bacterial cell membranes are ruptured, all of the carbon and nutrients stored within the bacterial cell are released into the surrounding environment along with the virus particles. The same is true of phytoplankton lysed due to viral infection. Phytoplankton, such as green algae, can use the released organic material as an energy and mineral source for their own growth and

[13] http://www.answers.com/topic/virus-like-particle
[14] Weinbauer MG. 2004. Ecology of Prokaryotic viruses. *FEMS Microbiological Reviews* **28**: 127-181.
[15] Corinaldesi C, Dell'Anno A, Danavaro R. 2007. Viral infection plays a key role in extracellular DNA dynamics in marine anoxic systems. *Limnology & Oceanography* **52**: 508-516.

[16] Fuhrman JA. 1999. Marine viruses and their biogeochemical and ecological effects. *Nature* **399**: 541-548.

reproduction. Thus, virus-induced mortality of bacteria has far reaching consequences for microbial population dynamics and biogeochemical (e.g. carbon) cycling[17].

Although quite a lot is known about virus-bacteria interactions in the pelagic, there are very few published studies from benthic environments (sea-bed or floor of other aquatic systems). Existing studies show that VLP abundance in sediments is generally 10-100-fold higher than in the overlying water column[18]. They also show that VLP numbers and the abundance of potential bacterial hosts generally decrease with increasing sediment depth[19]. Furthermore, VLP abundance in sediments has been found to positively correlate with the trophic status of their environment, i.e. the more carbon- and nutrient-rich the sediment is, the more VLP and their bacterial hosts are observed[20,21].

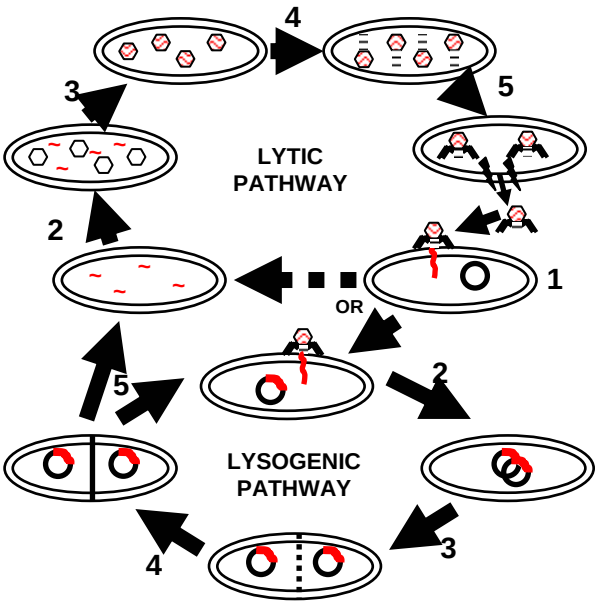


Figure 1: Viral replication pathways. Redrawn and modified from C. Evers
http://web.mit.edu/esgbio/www/cb/virus/phagereplication.html

Nevertheless, huge gaps exist in our knowledge. Scientists have very little understanding of the environmental processes that affect viral abundance, virus-induced bacterial mortality and the subsequent activity of microbial communities. Gaining such knowledge is essential for assessing the role VLP play in bacterial mortality and biogeochemical cycles,

[17] Middelboe M, Riemann L, Steward F, Hansen V, Nybroe O. 2003. Virus-induced transfer of organic carbon between marine bacteria in a model community. *Aquatic Microbial Ecology* **33**: 1-10.
[18] Glud RN, Middelboe J. 2004. Viral and bacterial dynamics of a coastal sediment: Implications for benthic carbon cycling. *Limnology & Oceanography* **49**: 2073-2081.
[19] Middelboe M, Glud RN, Finster K. 2003. Distribution of viruses and bacteria in relation to diagenetic activity in an estuarine sediment. *Limnology & Oceanography* **48**: 1447-1456.
[20] Hewson I, O'Niel JM, Fuhrman JA, Dennison WC. 2001. Virus-like particle distribution and abundance in sediments and overlying waters along eutrophication gradients in two subtropical estuaries. *Limnology & Oceanography* **46**: 1734-1746.
[21] Danovaro R, Manini E, Dell'anno A. 2002. Higher abundance of bacteria than viruses in deep Mediterranean sediments. *Applied Environmental Microbiology* **68**: 1468-1472.

e.g. local and global carbon cycling[5], and the influence that global climate change will have upon them. Climate change is likely to alter virus-bacteria dynamics; potentially increasing the vulnerability of bacteria (and algae) to viral infection.

Therefore, during our research cruise on the *James Clark Ross* I investigated how VLP and bacterial abundance, production and turnover rates varied at four pelagic (water column) and three benthic (sediment) sampling stations with differing ice-covers.

The resultant data will contribute to our understanding of microbial ecosystem function and the role of viruses in mediating bacterial productivity and hence geochemical cycling within the Arctic marine environment. These microbial data will be analysed alongside physico-chemical, geochemical and biological data collected by other scientists on the cruise, to enhance our wider understanding of the Arctic marine ecosystem and the potential impacts of climate change.

Methods

Viral and bacterial abundance

Viral and bacterial abundance and distribution were measured 1) in water samples collected from different stations and at different depths and 2) in sediment cores collected using a megacorer and sectioned; sediment depth intervals of 0-1, 3-4, 6-8, 10-12 and 14-16 cm were employed. Both water and sediments samples were immediately fixed with EM grade gluteraldehyde to a final concentration of 1%. To extract viruses and bacteria from the sediment samples, 1 ml of sodium pyrophosphate (10mM final conc) was added to each fixed sample and left for 15 min. The sediment was then sonicated using a 100Hz ultrasonic probe for 30 s. Each sample was subsequently centrifuged at 2500 rpm for 10 min to precipitate sediment particles. The supernatant was collected in a 15 ml centrifuge tube. The remaining sediment was washed with 4 ml of 0.02 m filtered seawater, re-sonicated for 30 s and re-centrifuged at 2500 rpm for 10 min. Once again, the supernatant was removed and added to the same 15 ml centrifuge tube. The wash procedure was repeated for a second time before the total extracted supernatant volume was recorded.

Within 24 h of collected/extraction, 200 l aliquots of water or sediment supernatant sample were used to prepare slides according to Noble & Fuhrman (1998) [22]. Bacterial cells and virus particles were collected on 0.02 m Anodisc filters, stained with SYBR Gold nucleic acid stain, mounted on glass microscope slides with an anti-fade solution and stored frozen at -20˚ C until they could be counted under epiflurorescence microscopy with blue excitation (Figure 2).

Viral production

Viral production, both lytic and lysogenic, were measured in pelagic samples only. One litre seawater samples were collected in triplicate from each depth at each station using a CTD/ 24 Niskin bottle array. This water was pre-filtered through a GF/C filter to remove grazers.

[22] Noble RT, Fuhrman JA. 1998. Use of SYBR Green I for rapid epifluorescence counts of marine viruses and bacteria. *Aquatic Microbial Ecology* **14**: 113-118.

In order to measure the rate of viral *lysogeny*, 100 ml of GF/C filtered water from each depth was dispensed into duplicate, sterile, Schott bottles. A 4.5 ml sub-sample of water was immediately (T0) removed from each of the bottles, placed in a sterile 5 ml cryovial and fixed with EM grade glutaradehyde to a final concentration of 1% in fume hood, and immediately frozen in liquid nitrogen before storage in a -80˚ C freezer. The bottles were incubated in the dark, under continuously flowing seawater at *in situ* temperatures for 24 hours. Further 4.5 ml sub-samples were taken at time intervals of 6, 12, 12.5, 18 and 24 hours. Immediately, after the 12 h sub-sampling Mitomycin C was added to a final concentration of 1 l ml^{-1} to one of each duplicate per depth, to induce lysogeny.

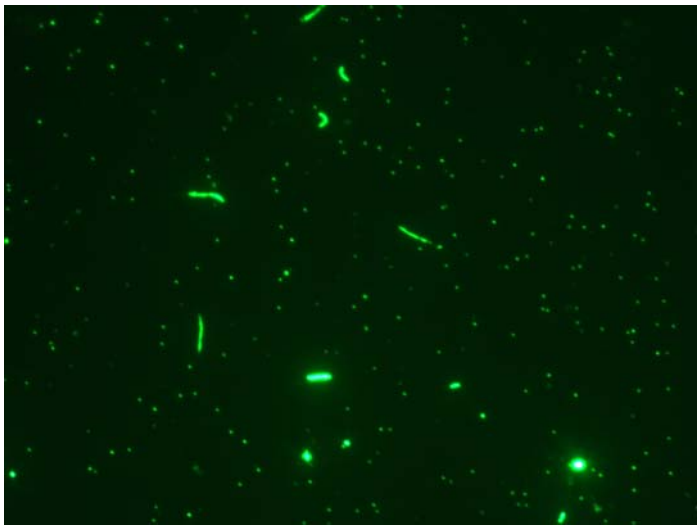


Figure 2: Virus-like particles (small dots) and bacteria (larger blobs or rods) stained with SYBR Gold nucleic acid stain and viewed under epifluorescence microscopy with blue excitation

In order to investigate the rate of viral *lysis* approximately 300 ml of GF/C filtered water was filter-concentrated through a 47mm 0.2 m polycarbonate filter to remove the majority of viruses from the sample. The filter was never allowed to run dry and the sample was continuously but gently agitated using a sterile Pasteur pipette. Simultaneously, approximately 100 ml of the 0.2 m filtered filtrate was passed through a 0.02 m Anodisc filter to produce virus-free water. Once the sample had been filter-concentrated to an approximately 10 ml retentate it was resuspended with approximately 50 ml of virus-free water. 50 ml of the resuspended retentate was then placed into each a sterile 25 cm2 culture flask and incubated in the dark, under continuously flowing seawater at *in situ* temperatures for 24 hours. 5 ml sub-samples were removed from each replicate at 0, 6, 12, 18 and 24 hours after the start of the incubation. The sub-samples were fixed with EM grade glutaraldehyde to a final concentration of 1% in fume hood and stored in the dark in a fridge (ca. 4˚ C) before processing within 24 h.

The gluteraldehyde-fixed sub-samples from both experiments were used to prepare microscope slides according to Noble & Fuhrman (1998; see above). The slides were stored at -20˚ C for later enumeration under epifluorescence microscopy with blue excitation.

Bacterial production

Bacterial production was assayed using the micro-centrifuge method (Kirchman, 2001[23]). Working solutions of 500 µCi mL^{-1} [^{3}H]-Thymidine and 5 µCi mL^{-1} [^{14}C]-Leucine were made from 5 mCi mL^{-1} [^{3}H]-Thymidine and 250 µCi mL^{-1} [^{14}C]-Leucine stock solutions (Amersham Life Science, U.K.) and stored in the dark at 2 to 4° C.

Initially, a *saturation experiment* was performed to determine which concentration of each isotope was required to swamp natural isotope levels. Seawater samples were collected from Storfjorden, Svalbard, using a CTD/ 24 Niskin bottle array. In the laboratory, 1.7 ml of seawater was added to each of 24 plastic, screw-top 2 ml micro-centrifuge tubes (Eppendorf, Germany), 12 per isotope. Subsequently, using the working solutions, sufficient [^{3}H]-Thymidine or [^{14}C]-Leucine will be added to each tube using a separate graduated 50 µL glass syringe for each isotope (Scientific Glass Engineering PTY, Ltd., Australia) to create a range of concentrations: 0, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60 nM. An additional 3 tubes were prepared; one filled with seawater without isotope addition but fixed with 89 µl of 100% Trichloroacetic acid (TCA) to serve as a background, one with 5 µl of [^{3}H]-Thymidine working solution and one with 5 µl of [^{14}C]-Leucine working solution to accurately determine the concentration of isotope added. The tubes were incubated in the dark at *in situ* temperatures for 60 minutes. At the end of the incubation, 89 µl of 100% TCA was added to all but the background tubes to terminate bacterial production.

In order to determine the isotope uptake in each the samples were processed as follows: A mark was placed on the outside of each closed microcentrifuge tube and cap to assist with subsequent positioning, mark outwards, in a microcentrifuge. The samples were spun at 14000 rpm for 10 min. After centrifugation, the supernatant was carefully removed using an aspirator to avoid disturbing the bacterial pellet on the outer, marked side of the tube. 1.7 mL of ice-cold, 5% TCA was then dispensed into each tube, the solution was vortexed and the centrifugation step repeated. At the end of the second centrifugation, the TCA supernatant was removed from each tube as described above and replaced with 1.7 ml of ice-cold 80% ethanol. The solution was vortexed once again and centrifuged a third time. Once complete, the ethanol supernatant was removed from each tube. The bacterial pellets were allowed to air dry thoroughly to avoid chemical quenching during liquid scintillation, prior to the addition of 1 ml of Ultima Gold XR scintillation cocktail (Packard Bioscience, N.L.) and final vortexing. The micro-centrifuge tubes were then placed inside 20 ml glass scintillation vials and radioassayed in a scintillation counter to measure disintegrations per minute (DPM). From these results, it was determined that saturation for both [^{3}H]-Thymidine and [^{14}C]-Leucine was achieved at 30 nM and this concentration was employed in all subsequent bacterial production incubations.

Bacterial production was determined in triplicate for each of 6 depths at each of 4 pelagic sampling stations. 10 ml sub-samples from each replicate and depth were placed in 15 ml, sterile centrifuge tubes and spiked with 30 nM of [^{3}H]-Thymidine and [^{14}C]-Leucine. A further 10 ml sub-sample from only one replicate from each depth was filtered through a 0.8 m syringe filter, placed in a centrifuge tube and similarly spiked. The samples were vortexed for approximately 30 s to ensure that the isotope was well mixed. 1.7 ml aliquots from each spiked, replicate sample were placed in each of 5 microcentrifuge tubes: two containing 89 l 100% TCA (controls) and three replicate 'live' samples. The tubes were incubated in the dark at *in situ* temperatures in either a fridge or Thermatote incubator for

[23] Kirchman D. 2001. Measuring bacterial biomass production and growth rates from Leucine incorporation in natural aquatic environments. *In*: JH Paul (Ed.) *Methods in Microbiology Volume 30: Marine Microbiology*. Academic Press. pp. 227-237.

60 minutes. At the end of the incubation, the 3 replicate microcentrifuge tubes from each depth triplicate bacterial production was terminated with 89 l of 100% TCA. The samples were subsequently processed and DPM determined as described above.

Bacterial production was also determined as described above during Leg 1 of the cruise in water samples taken every 30 minutes over a 6 hour interval on 4 successive days from the ships continuous seawater supply (CW).

Samples taken

					Analyses					
Event #	**Station**	**Bottles/cores**	**Depth (m)**	**Volume (l)/sediment interval (cm)**	**Bact & VLP abun**	**Lysogeny**	**Lysis**	**BP**	**BSatn.**	**Cal**
Pel										
001	WEC	CW	6		*				*	
002	SNS	CW	6		*				*	
003	NNS	CW	6		*				*	
004	Lofoten	CW	6		*				*	
005	Storfjorden	18		1					*	
042	SS1	1,9,11,2,4,6,13,15,17,19,21,23	1,5,11,17,30,40	1.25	*	*	*	*		*
053	Ice 1	Ice collection, 5,7,8,9,13,14,15	2,5,10,23,30,40	1.25	*	*	*	*		
	MIZ	1,3,5,7,9,11,13,15,17,19,21	2,8,15,27,60	1,25	*	*	*	*		*
	Rijp	1,3,5,7,9,11,13,15,17,19,21,23	2,7,12,15,27,60		*	*	*	*		
	SS2	8,16,24	2,6,35		*				*	
Ben										
022	SS1			01-, 3-4, 6-8, 10-12, 14-16	*					
	LS2				*					
	SES1				*					
	Rijp				*					

Preliminary results

The majority of results have not yet been obtained. Frozen water samples and microscope slides have been returned to SAMS and will be processed within the next 6 months. Early indications were that bacterial production is high in the pelagic at all stations.

SCIENTIFIC REPORT 8: Microbial Community Composition, Abundance and Biomass

Elaine Mitchell, Andrea Veszelovszki and Jane Manning

Introduction and Objectives

The objective of this study was to determine the taxonomic composition, abundance and biomass of planktonic micro-organisms in surface waters at different sampling stations during the cruise. Samples were collected for post-cruise analysis on return to the UK. Sampling details are shown in the tables at the end of this report. The microbial community was categorised according to size as either:

- Picoplankton (autotrophic and heterotrophic prokaryotes and picoeukaryotes, including cyanobacteria and bacteria)
- Nanoplankton (autotrophic and heterotrophic protistan eukaryotes 2-20 µm in size, including smaller flagellates, diatoms and dinoflagellates)
- Microplankton (autotrophic and heterotrophic protistan eukaryotes 20-200 µm in size, including larger flagellates, diatoms, dinoflagellates and ciliates)

Approach and Methodology

Picoplankton composition by fluorescence in-situ hybridisation (FISH):

Water samples were taken from the CTD bottles. The thermos flask was taken to the lab where 10ml of sample were removed and placed into a 15ml Sterilin tube with 400µl of 37% Formaldehyde and mixed to form a 1% final concentrated solution. The tubes were left for no longer than 12 hours, and then 5ml of each sample was filtered onto a 25mm 0.2µm white polycarbonate membrane. The filters were transferred to 30mm Petri dishes, and with the lid on, allowed to dry out. Once dry the Petri dishes were sealed with Parafilm and then frozen at -20°C for post-cruise analysis of picoplankton community composition by FISH.

Picoplankton abundance and biomass by flow cytometry:

Water samples were taken from the CTD bottles. The thermos flask was taken to the lab where 4ml of sample were removed and placed in a labelled 5ml ‘Cryovial’ along with 200ul of Paraformaldehyde and mixed to form a 1% final concentrated solution. The vials are left for no longer than 12 hours before either:

1. Being analysed on the BD FacsSort Flow cytometer to enumerate picoplankton abundance, or
2. Being snap frozen in liquid nitrogen and transferred into the -80°C freezer for post-cruise analysis of picoplankton abundance by BD FacsSort Flow cytometer.

Pico- and nanoplankton composition, abundance and biomass by microscopy:

Water samples were taken from the CTD bottles. The thermos flasks were then taken to the lab where 50ml of the CTD sample were removed and placed into a labelled 125ml brown plastic Nalgene bottle containing 1ml of 25% Glutaraldehyde and mixed, making a final concentrated solution of 0.5% Glutaraldehyde. This sample was then stored in the cold room for no longer than 12 hours to allow the fixation process to stabilise. The fixed

samples were then removed from the cold room, stained, concentrated onto filters using a 25mm filtration rig, and the filters mounted on microscope slides. Three slide preparations were made for each sample:

1. 5ml of sample were stained with the fluorescent dye DAPI and filtered onto a 25mm 0.2µm black polycarbonate filter for bacterial enumeration.
2. 5 ml of sample were filtered directly onto a 25mm 0.2µm white polycarbonate membrane for cyanobacterial enumeration. (No DAPI added)
3. 15ml of sample were stained with the fluorescent dye DAPI and filtered onto a 25mm 0.8µm white polycarbonate filter for enumeration of heterotrophic and phototrophic nanoplankton taxa.

All slides were labelled, frozen flat and then transferred to slide boxes and frozen at -20°C for post-cruise analysis by epifluorecence microscopy.

Microplankton composition, abundance and biomass by microscopy:

Lugol's samples:
Water samples (400ml) were taken directly from the CTD bottle tap into a measuring cylinder using silicon tubing. This was transferred into a glass 500ml amber bottle containing 4mls of Lugol's iodine fixative and mixed making a 1% final concentrated solution. These bottles were then labelled and stored in the cold room at 4°C in plastic boxes for post cruise analysis of microplankton composition, abundance and biomass by inverted microscopy.

Bouin's samples:
Water samples (400ml) were taken directly from the CTD bottle tap into a measuring cylinder using silicon tubing. This was transferred into a 500ml brown Nalgene bottle containing 10mls of Bouin's fixative (a mix of picric acid & formaldehyde) and mixed to form a 2.5% final concentrated solution. These bottles were then labelled and stored in the cold room at 4°C in plastic boxes for post cruise analysis of ciliate taxonomy by protargol staining and conventional microscopy.

Formaldehyde samples:
Water samples (400ml) were taken directly from the CTD bottle tap into a measuring cylinder using silicon tubing. This was transferred to a 500ml brown Nalgene bottle containing 10mls of 37% Formaldehyde and mixed to form a 1% final concentrated solution. These bottles were then labelled and stored in the cold room at 4°C in plastic boxes for post cruise analysis of microplankton chlorophyll fluorescence and taxonomy by epiflorescence and electron microscopy.

Net-collected microplankton observations:
Microplankton within the surface 20m layer were collected from Rijpfjorden on 13 August using a 20µm mesh pore size plankton net was lowered over the side of the JCR. This was repeated a number of times and the net-concentrated samples polled into a 1L plastic bucket. A sub-sample of 100mls was put into a culture flask and the contents were then observed using the on-board Zeiss Axiovert100 inverted microscope at x20 magnification. The microplankton composition was noted and photographs taken using the microcope's digital camera and Axiovision image capture software.

JC210 Picoplankton Composition by Fluorescence In-Situ Hybridisation (FISH)

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008		
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)		
Event No	42			Event No	53			Event No	93			Event	163		
CTD No	14			CTD No	17			CTD No	27			CTD No	38		
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample
1	60m	A	0	1	2m	A *		1	60m	A	0	1	60m	A	0
2	30m	1A	0	2				2	60m	B	0	2	60m	B	0
3	30m	1B	1	3	10m	A *		3	27m	1A	0	3	27m	1A	0
4	30m	2A	0	4	40m	A		4	27m	1B	1	4	27m	1B	1
5	30m	2B	1	5	5m	C *		5	27m	2A	0	5	27m	2A	0
6	30m	3A	0	6	5m	A *		6	27m	2B	1	6	27m	2B	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0
8	19m	A	0	8	5m	B *		8	27m	3B	1	8	27m	3B	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0
10	17m	B	0	10	30m	A	1	10	15m	B	0	10	15m	B	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0
12	11m	B	0	12	30m	C	1	12	8m	1B	0	12	12m	B	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0
14	5m	1B	0	14				14	8m	2B	0	14	7m	1B	0
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0
16	5m	2B	0	16	20m	A		16	8m	3B	0	16	7m	2B	0
17	5m	3A	0	17	20m	B		17	2m	1A	0	17	7m	3A	0
18	5m	3B	0	18	20m	C		18	2m	1B	0	18	7m	3C	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0
20	1m	1B	0	20				20	2m	2B	0	20	2m	1B	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0
22	1m	2B	0	22				22	2m	3B	0	22	2m	2B	0
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0
24	1m	3C	0	24				24	2m	B	0	24	2m	3B	0
Total			3	Total			3	Total			3	Total			3

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth was 27m

* = Carboy NOT CTD bottles

JC210 Picoplankton Abundance and Biomass by Flow Cytometry

AFC	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	5	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	5	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	5	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	5	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	5	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	5	6	35m	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	1
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	1
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	1
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	1
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	1
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	1
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	1
Total			12	Total			12	Total			11	Total			12	Total		30	Total		9

Exp depth was 30m Exp depth was 20m Exp depth was 27m Exp depth was 27m

* = Carboy NOT CTD bottles

JC210 Pico- and Nanoplankton Composition, Abundance and Biomass Samples by Microscopy (50ml Glutaraldehyde Fixed Samples)

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	5	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	5	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	5	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	5	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	5	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	5	6	35m	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	1
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	1
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	1
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	1
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	1
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	1
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	1
Total			12	Total			12	Total			11	Total			12	Total		30	Total		9

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth was27m

2 slides per sample

* = Carboy NOT CTD bottles

JC210 Microplankton Composition, Abundance and Biomass Samples by Microscopy (400ml Lugol's fixed Samples)

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008			Date	16th August 2008		Date	18th August 2008	
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)			Station	Rip Transect		Station	SS2 (Shelf station 2)	
Event No	42			Event No	53			Event No	93			Event	163			Event	173/177/181/182/186		Event	188	
CTD No	14			CTD No	17			CTD No	27			CTD No	38			CTD No	41/42/44/45/46		CTD No	48	
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	60m	A	1	1	2m	A *	1	1	60m	A	0	1	60m	A	0	1	2m	5	1	35m	0
2	30m	1A	0	2				2	60m	B	1	2	60m	B	1	2	10m	5	2	35m	0
3	30m	1B	1	3	10m	A *	1	3	27m	1A	0	3	27m	1A	0	3	20m	5	3	35m	0
4	30m	2A	0	4	40m	A	1	4	27m	1B	1	4	27m	1B	1	4	30m	5	4	35m	0
5	30m	2B	1	5	5m	C *	1	5	27m	2A	0	5	27m	2A	0	5	50m	5	5	35m	0
6	30m	3A	0	6	5m	A *	1	6	27m	2B	1	6	27m	2B	1	6	100m	5	6	35m	1
7	30m	3B	1	7				7	27m	3A	0	7	27m	3A	0	7			7	35m	1
8	19m	A	0	8	5m	B *	1	8	27m	3B	1	8	27m	3B	1	8			8	35m	1
9	17m	A	0	9				9	15m	A	0	9	15m	A	0	9			9	6m	0
10	17m	B	1	10	30m	A	1	10	15m	B	1	10	15m	B	1	10			10	6m	0
11	11m	A	0	11	30m	B	1	11	8m	1A	0	11	12m	A	0	11			11	6m	0
12	11m	B	1	12	30m	C	1	12	8m	1B	1	12	12m	B	1	12			12	6m	0
13	5m	1A	0	13				13	8m	2A	0	13	7m	1A	0	13			13	6m	0
14	5m	1B	1	14				14	8m	2B	1	14	7m	1B	1	14			14	6m	1
15	5m	2A	0	15				15	8m	3A	0	15	7m	2A	0	15			15	6m	1
16	5m	2B	1	16	20m	A	1	16	8m	3B	1	16	7m	2B	1	16			16	6m	1
17	5m	3A	0	17	20m	B	1	17	2m	1A	0	17	7m	3A	0	17			17		
18	5m	3B	1	18	20m	C	1	18	2m	1B	1	18	7m	3C	1	18			18	2m	0
19	1m	1A	0	19				19	2m	2A	0	19	2m	1A	0	19			19	2m	0
20	1m	1B	1	20				20	2m	2B	1	20	2m	1B	1	20			20	2m	0
21	1m	2A	0	21				21	2m	3A	0	21	2m	2A	0	21			21	2m	0
22	1m	2B	1	22				22	2m	3B	1	22	2m	2B	1	22			22	2m	1
23	1m	3A	0	23				23	2m	A	0	23	2m	3A	0	23			23	2m	1
24	1m	3C	1	24				24	2m	B	0	24	2m	3B	1	24			24	2m	1
Total			12	Total			12	Total			11	Total			12	Total		30	Total		9

Exp depth was 30m

Exp depth was 20m

Exp depth was 27m

Exp depth was 27m

* = Carboy NOT CTD bottles

JC210 Microplankton Composition by Microscopy (400ml Bouin's fixed Samples)

Date	Station	Event No.	CTD No.	Bottle No.	Depth	Rep	No. samples
3rd August	SS1	42	14	1	60m	A	2
6th August	IS	53	17	12	30m	C	1
6th August	IS	53	17	4	40m	A	1
10th August	MIZ	93	27	2	60m	B	2
16th August	RIP	163	38	2	60m	B	2
						TOTAL	8

JC210 Microplankton Composition by Microscopy (400ml Formaldehyde fixed Samples)

Date	Station	Event No.	CTD No.	Bottle No.	Depth	Rep	No. samples
3rd August	SS1	42	14	5	30m	C	1
6th August	IS	53	17	17	20m	B	1
10th August	MIZ	93	27	4	27m	A	1
16th August	RIP	163	38	4	27m	A	1
						TOTAL	4

Net-collected Microplankton Observations RIP Station 13th August 2008

Phytoplankton	Type	Abundance
Pseudonitzschia seriata	Diatom	Occasional
Pseudonitzschia delicatissima	Diatom	Abundant
Rhizosolenia	Diatom	Frequent
Chaeotocerous	Diatom	Abundant
Thallassiossira	Diatom	Frequent
Cylindrotheca	Diatom	Occasional
Navicula	Diatom	Frequent
Corethron	Diatom	Occasional
Protoperidinium depressum	Dinoflagellate	Occasional
Protoperidinium conicum	Dinoflagellate	Occasional
Protoperidinium bipes	Dinoflagellate	Frequent
Protoperidinium sp	Dinoflagellate	Frequent
Gyrodinium	Dinoflagellate	Frequent
Gymnodinium	Dinoflagellate	Frequent
Alexandrium	Dinoflagellate	Occasional
Dinophysis acuta	Dinoflagellate	Frequent
Dinophysis rotunda	Dinoflagellate	Occasional
Ceratium arcticus	Dinoflagellate	Frequent
Peridinium sp	Dinoflagellate	Frequent
Salpingella	Cilliate	Frequent
Ptychocylis	Cilliate	Frequent
Tinntinus	Cilliate	Frequent
Strombidium	Cilliate	Occasional
Strobilidium	Cilliate	Occasional
Callicantha sp	Choanoflagellate	Occasional
Bicosta sp	Choanoflagellate	Occasional
?	Radiolarian	Occasional
?	Silica flagellate	Occasional
?	Copepods	Common
?	Naupli	Frequent

SCIENTIFIC REPORT 9: Picoplankton Latitudinal Distribution and Spatial Variability between the UK and Svalbard

Jane Manning

Introduction and Objectives

The objective of this study was to determine the latitudinal distribution and degree of spatial variability in picoplankton populations along a transect between the UK and Svalbard. High frequency sampling was conducted between the UK and Svalbard using the ships underway water supply in order to achieve high spatial resolution. Samples were also collected by CTD to calibrate the underway measurements. Sampling details are shown in the tables at the end of this report.

This work builds on previous high resolution observations of picoplankton spatial variability conducted in warmer temperate waters (Martin et al. 2008. Microbial spatial variability: an example from the Celtic Sea. *Prog. Oceanogr.* 76: 443-465) by extending observations into colder boreal waters.

Approach and Methodology

Survey track and water sampling

The spatial variability of bacteria was surveyed between the UK and Svalbard (cruise track shown in Figure 5). High resolution samples of the microbial populations were taken along a transect performed by the *RRS James Clark Ross* between 19.00 GMT on 24 July and 17:30 GMT on 30 July 2009 in the North East Atlantic.

Seawater was continuously pumped into the interior of the vessel from 6 m depth from the ship's underway water inlet to supply a tap in the prep room on the ship's upper deck. Water samples were taken every 30 minutes (corresponds to approximately every 10 km depending on ship's speed) from the prep room tap which was left running continuously (288 samples overall). Twice per day, once in the morning and once in the afternoon, an additional sample was taken from a pipe in the transducer space, positioned near the point where water enters the ship (12 samples overall).

To test how representative underway water samples were of the true oceanic environment, additional samples were taken from 6 m depth at four sites using a rosette of water bottles attached to the ship's conductivity-temperature-depth (CTD) recorder. Three of the CTD stations were along the transect, and the fourth was taken further north (76°28.8034 N, 18°59.9217 E). At each CTD station (South North Sea, North North Sea, Lander Test Site, and Storfjorden) three samples were collected from the prep room tap, three from the transducer space, and a further 18 were collected from the CTD bottles. The CTD samples consisted of three replicates taken from the top and three replicates taken from the bottom of three separate niskin bottles (24 samples at each station - see Figure).

Each water sample was immediately fixed with 1% paraformaldehyde (PFA). Samples were snap frozen in liquid nitrogen within 12 hours of being collected and fixed. Samples were stored at -80 °C for 10 months prior to flow cytometric analysis (see next section below).

Temperature and salinity probes also recorded underway temperature and salinity data at the point of intake for the continuous water supply (6 m depth) for the entire study period.

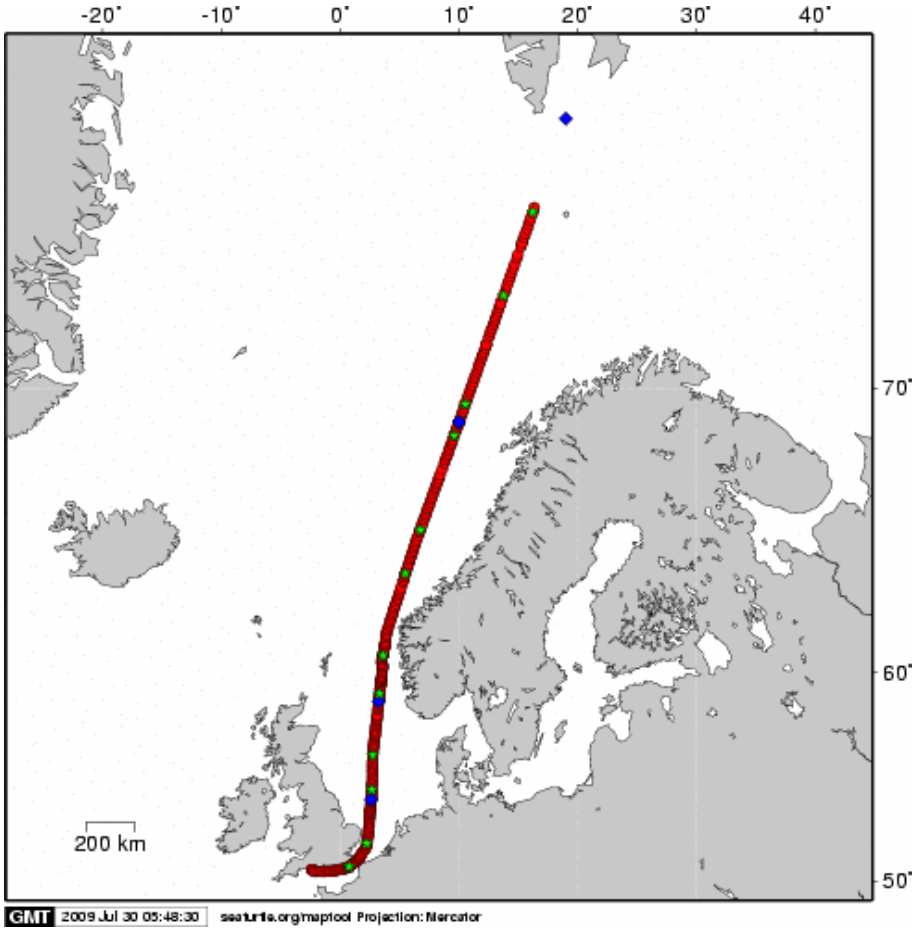


Figure 5. Cruise track from Weymouth to Svalbard (underway sample sites shown as red dots; transducer space sample sites shown as green stars, four additional CTD stations shown as blue diamonds)

Flow cytometric analysis

Fixed samples were removed from the -80 °C freezer and allowed to defrost for 30 minutes. Samples were then stained with SYBR Green I nucleic acid/ DNA dye (10,000x dilution) in the presence of potassium citrate (30mM final concentration). Bacteria were counted using a FACSort flow cytometer (Becton Dickinson, Oxford, UK) using a sample rate of ~0.01 ml min^{-1} for 2 minutes.

Following the protocol of Martin *et al.* (2008), three bacterioplankton groups were enumerated: 1) bacteria with low DNA content (*LNA*); 2) bacteria with high DNA content and low 90° light scatter, (*HNA-ls*); and 3) bacteria with high DNA content and high 90° light scatter (*HNA-hs*). A total of 286 samples were run successfully, some in duplicate to give an idea of instrumental error. Two samples were lost due to human error.

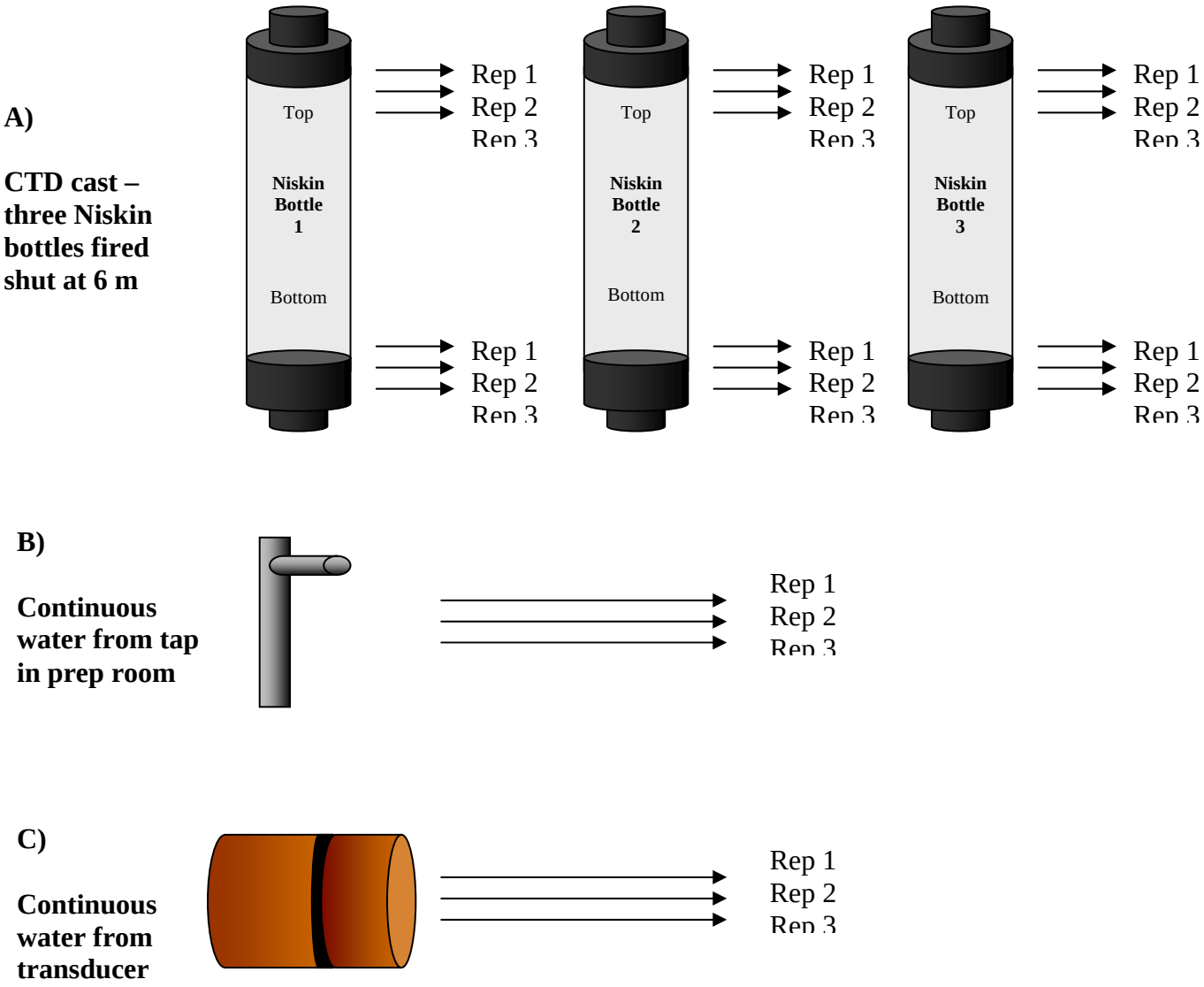


Figure 2. Schematic showing samples taken at each of the four CTD stations (South North Sea; North North Sea; Lander Test Site; and Storfjorden)

After running the samples initially on FACSort software, the bacterial data were transferred over to WinMDI 2.9 software where signature plots were re-drawn. Cluster gates were drawn around each population (*LNA, HNA-ls, HNA-hs*) by eye. Event counts for each gate were only recorded after observation of the whole dataset to ensure that each gate was positioned suitably first.

Yellow-green beads of 0.5 µm diameter (Polysciences, Warrington, USA) were used in all flow cytometric analysis as an internal standard. The concentration of beads in the standard was determined at the beginning of each day using a syringe pump (single syringe pump). The bead solution was run at six different flow rates (0.54; 1.09; 1.64; 2.19; 2.74; and 3.28 ml hr^{-1}) for periods of 30, 60 and 90 seconds each. Bead counts were then

entered into a spreadsheet incorporating a regression-based analysis to calculate bead abundance.

Heterotrophic protists (*HP*) were also run on the flow cytometer after staining, at a sample rate of ~0.1 ml min^{-1} for 2 minutes. Unfortunately, the volume of sample run in this time was inadequate for a reliable estimation of HP abundance (volume available to run was limited by the amount of sample collected).

An attempt was also made to enumerate the dominant phototrophic groups: *Synechococcus* (*Syn*) and picoeukaryotic algae (*Pico*). The samples were run unstained at a sample rate of ~0.1 ml min^{-1} for 2 minutes. Both *Syns* and *Picos* were counted simultaneously using the cells' specific chlorophyll and phycoerythrin autofluorescence for detection and to discriminate between them. Unfortunately the *Syn* counts had to be abandoned at a later stage due to evidence that the flow cytometer's FL1 (phycoerythrin, orange) detector was performing with limited sensitivity. Although the FL2 (chlorophyll, red) detector was working adequately, *Pico* counts were also deemed inaccurate due to the low number of events counts.

South North Sea (“SNS”)

CTD (“CTD”) 6 m depth

	Top/ bottom	Sample	Sample name/ label
Niskin 1 (number 18)	Top of niskin	1	n1 t1
		2	n1 t2
		3	n1 t3
	Bottom of niskin	1	n1 b1
		2	n1 b2
		3	n1 b3
Niskin 2 (number 19)	Top of niskin	1	n2 t1
		2	n2 t1
		3	n2 t1
	Bottom of niskin	1	n2 b1
		2	n2 b1
		3	n2 b1
Niskin 3 (number 20)	Top niskin	1	n3 t1
		2	n3 t1
		3	n3 t1
	Bottom of niskin	1	n3 b1
		2	n3 b1
		3	n3 b1

Prep room underway (“CW”)

	Sample	Sample name/ label
CW	1	CW 1
	2	CW 2
	3	CW 3

Transducer space room underway (“TR”)

	Sample	Sample name/ label
TR	1	TR 1
	2	TR 2
	3	TR 3

Total = 24 samples

“**CTD**” = sample from water bottles on the CTD rosette, taken over side of ship (Niskin number specified)
“**CW**” = continuous water sample, taken from prep room tap
“**TR**” = transducer space sample, taken down in bowels of ship

North North Sea (“NNS”)

CTD (“CTD”) 6 m depth

	Top/ bottom	Sample	Sample name/ label
Niskin 1 (number 18)	Top of niskin	1	n1 t1
		2	n1 t2
		3	n1 t3
	Bottom of niskin	1	n1 b1
		2	n1 b2
		3	n1 b3
Niskin 2 (number 19)	Top of niskin	1	n2 t1
		2	n2 t1
		3	n2 t1
	Bottom of niskin	1	n2 b1
		2	n2 b1
		3	n2 b1
Niskin 3 (number 20)	Top niskin	1	n3 t1
		2	n3 t1
		3	n3 t1
	Bottom of niskin	1	n3 b1
		2	n3 b1
		3	n3 b1

Prep room underway (“CW”)

	Sample	Sample name/ label
CW	1	CW 1
	2	CW 2
	3	CW 3

Transducer space room underway (“TR”)

	Sample	Sample name/ label
TR	1	TR 1
	2	TR 2
	3	TR 3

Total = 24 samples

“**CTD**” = sample from water bottles on the CTD rosette, taken over side of ship (niskin number specified)
“**CW**” = continuous water sample, taken from prep room tap
“**TR**” = transducer space sample, taken down in bowels of ship

Lander Test Station ("LTS")

CTD ("CTD") 6 m depth

	Top/ bottom	Sample	Sample name/ label
Niskin 1 (number 18)	Top of niskin	1	n1 t1
		2	n1 t2
		3	n1 t3
	Bottom of niskin	1	n1 b1
		2	n1 b2
		3	n1 b3
Niskin 2 (number 19)	Top of niskin	1	n2 t1
		2	n2 t1
		3	n2 t1
	Bottom of niskin	1	n2 b1
		2	n2 b1
		3	n2 b1
Niskin 3 (number 20)	Top niskin	1	n3 t1
		2	n3 t1
		3	n3 t1
	Bottom of niskin	1	n3 b1
		2	n3 b1
		3	n3 b1

Prep room underway ("CW")

	Sample	Sample name/ label
CW	1	CW 1
	2	CW 2
	3	CW 3

Transducer space room underway ("TR")

	Sample	Sample name/ label
TR	1	TR 1
	2	TR 2
	3	TR 3

Total = 24 samples

"**CTD**" = sample from water bottles on the CTD rosette, taken over side of ship (niskin number specified)
"**CW**" = continuous water sample, taken from prep room tap
"**TR**" = transducer space sample, taken down in bowels of ship

Storfjorden ("STOR")

CTD ("CTD") 6 m depth

	Top/ bottom	Sample	Sample name/ label
Niskin 1 (number 18)	Top of niskin	1	n1 t1
		2	n1 t2
		3	n1 t3
	Bottom of niskin	1	n1 b1
		2	n1 b2
		3	n1 b3
Niskin 2 (number 19)	Top of niskin	1	n2 t1
		2	n2 t1
		3	n2 t1
	Bottom of niskin	1	n2 b1
		2	n2 b1
		3	n2 b1
Niskin 3 (number 20)	Top niskin	1	n3 t1
		2	n3 t1
		3	n3 t1
	Bottom of niskin	1	n3 b1
		2	n3 b1
		3	n3 b1

Prep room underway ("CW")

	Sample	Sample name/ label
CW	1	CW 1
	2	CW 2
	3	CW 3

Transducer space room underway ("TR")

	Sample	Sample name/ label
TR	1	TR 1
	2	TR 2
	3	TR 3

Total = 24 samples

"**CTD**" = sample from water bottles on the CTD rosette, taken over side of ship (niskin number specified)
"**CW**" = continuous water sample, taken from prep room tap
"**TR**" = transducer space sample, taken down in bowels of ship

Transect sampling 24th – 30th July 09

Day	Time interval	Sample name
1	1	CW 1.1
	2	CW 1.2
	3	CW 1.3
	4	CW 1.4
	5	CW 1.5
	6	CW 1.6
	7	CW 1.7
	8	CW 1.8
	9	CW 1.9
	10	CW 1.10
	11	CW 1.11
	12	CW 1.12
	13	CW 1.13
	14	CW 1.14
	15	CW 1.15
	16	CW 1.16
	17	CW 1.17
	18	CW 1.18
	19	CW 1.19
	20	CW 1.20
	21	CW 1.21
	22	CW 1.22
	23	CW 1.23
	24	CW 1.24
	25	CW 1.25
	26	CW 1.26
	27	CW 1.27 *
	28	CW 1.28
	29	CW 1.29
	30	CW 1.30
	31	CW 1.31
	32	CW 1.32
	33	CW 1.33
	34	CW 1.34
	35	CW 1.35
	36	CW 1.36
	37	CW 1.37
	38	CW 1.38
	39	CW 1.39
	40	CW 1.40
	41	CW 1.41
	42	CW 1.42
	43	CW 1.43 *
	44	CW 1.44
	45	CW 1.45
	46	CW 1.46
	47	CW 1.47
	48	CW 1.48

Day	Time interval	Sample name
2	1	CW 2.1
	2	CW 2.2
	3	CW 2.3
	4	CW 2.4
	5	CW 2.5
	6	CW 2.6
	7	CW 2.7
	8	CW 2.8
	9	CW 2.9
	10	CW 2.10
	11	CW 2.11
	12	CW 2.12
	13	CW 2.13
	14	CW 2.14
	15	CW 2.15
	16	CW 2.16
	17	CW 2.17
	18	CW 2.18
	19	CW 2.19
	20	CW 2.20
	21	CW 2.21
	22	CW 2.22
	23	CW 2.23
	24	CW 2.24
	25	CW 2.25
	26	CW 2.26
	27	CW 2.27 *
	28	CW 2.28
	29	CW 2.29
	30	CW 2.30
	31	CW 2.31
	32	CW 2.32
	33	CW 2.33
	34	CW 2.34
	35	CW 2.35
	36	CW 2.36
	37	CW 2.37
	38	CW 2.38
	39	CW 2.39
	40	CW 2.40
	41	CW 2.41
	42	CW 2.42
	43	CW 2.43 *
	44	CW 2.44
	45	CW 2.45
	46	CW 2.46
	47	CW 2.47
	48	CW 2.48

Day	Time interval	Sample name
3	1	CW 3.1
	2	CW 3.2
	3	CW 3.3
	4	CW 3.4
	5	CW 3.5
	6	CW 3.6
	7	CW 3.7
	8	CW 3.8
	9	CW 3.9
	10	CW 3.10
	11	CW 3.11
	12	CW 3.12
	13	CW 3.13
	14	CW 3.14
	15	CW 3.15
	16	CW 3.16
	17	CW 3.17
	18	CW 3.18
	19	CW 3.19
	20	CW 3.20
	21	CW 3.21
	22	CW 3.22
	23	CW 3.23
	24	CW 3.24
	25	CW 3.25 *
	26	CW 3.26
	27	CW 3.27
	28	CW 3.28
	29	CW 3.29
	30	CW 3.30
	31	CW 3.31
	32	CW 3.32
	33	CW 3.33
	34	CW 3.34
	35	CW 3.35
	36	CW 3.36
	37	CW 3.37
	38	CW 3.38
	39	CW 3.39
	40	CW 3.40
	41	CW 3.41 *
	42	CW 3.42
	43	CW 3.43
	44	CW 3.44
	45	CW 3.45
	46	CW 3.46
	47	CW 3.47
	48	CW 3.48

Day	Time interval	Sample name
4	1	CW 4.1
	2	CW 4.2
	3	CW 4.3
	4	CW 4.4
	5	CW 4.5
	6	CW 4.6
	7	CW 4.7
	8	CW 4.8
	9	CW 4.9
	10	CW 4.10
	11	CW 4.11
	12	CW 4.12
	13	CW 4.13
	14	CW 4.14
	15	CW 4.15
	16	CW 4.16
	17	CW 4.17
	18	CW 4.18
	19	CW 4.19
	20	CW 4.20
	21	CW 4.21
	22	CW 4.22
	23	CW 4.23
	24	CW 4.24
	25	CW 4.25
	26	CW 4.26
	27	CW 4.27 *
	28	CW 4.28
	29	CW 4.29
	30	CW 4.30
	31	CW 4.31
	32	CW 4.32
	33	CW 4.33
	34	CW 4.34
	35	CW 4.35
	36	CW 4.36
	37	CW 4.37
	38	CW 4.38
	39	CW 4.39
	40	CW 4.40
	41	CW 4.41
	42	CW 4.42
	43	CW 4.43 *
	44	CW 4.44
	45	CW 4.45
	46	CW 4.46
	47	CW 4.47
	48	CW 4.48

Day	Time interval	Sample name
5	1	CW 5.1
	2	CW 5.2
	3	CW 5.3
	4	CW 5.4
	5	CW 5.5
	6	CW 5.6
	7	CW 5.7
	8	CW 5.8
	9	CW 5.9
	10	CW 5.10
	11	CW 5.11
	12	CW 5.12
	13	CW 5.13
	14	CW 5.14
	15	CW 5.15
	16	CW 5.16
	17	CW 5.17
	18	CW 5.18
	19	CW 5.19
	20	CW 5.20
	21	CW 5.21
	22	CW 5.22
	23	CW 5.23
	24	CW 5.24
	25	CW 5.25
	26	CW 5.26
	27	CW 5.27 *
	28	CW 5.28
	29	CW 5.29
	30	CW 5.30
	31	CW 5.31
	32	CW 5.32
	33	CW 5.33
	34	CW 5.34
	35	CW 5.35
	36	CW 5.36
	37	CW 5.37
	38	CW 5.38
	39	CW 5.39
	40	CW 5.40
	41	CW 5.41
	42	CW 5.42
	43	CW 5.43 *
	44	CW 5.44
	45	CW 5.45
	46	CW 5.46
	47	CW 5.47
	48	CW 5.48

Day	Time interval	Sample name
6	1	CW 6.1
	2	CW 6.2
	3	CW 6.3
	4	CW 6.4
	5	CW 6.5
	6	CW 6.6
	7	CW 6.7
	8	CW 6.8
	9	CW 6.9
	10	CW 6.10
	11	CW 6.11
	12	CW 6.12
	13	CW 6.13
	14	CW 6.14
	15	CW 6.15
	16	CW 6.16
	17	CW 6.17
	18	CW 6.18
	19	CW 6.19
	20	CW 6.20
	21	CW 6.21
	22	CW 6.22
	23	CW 6.23
	24	CW 6.24
	25	CW 6.25
	26	CW 6.26
	27	CW 6.27 *
	28	CW 6.28
	29	CW 6.29
	30	CW 6.30
	31	CW 6.31
	32	CW 6.32
	33	CW 6.33
	34	CW 6.34
	35	CW 6.35
	36	CW 6.36
	37	CW 6.37
	38	CW 6.38
	39	CW 6.39
	40	CW 6.40
	41	CW 6.41
	42	CW 6.42
	43	CW 6.43 *
	44	CW 6.44
	45	CW 6.45
	46	CW 6.46
	47	CW 6.47
	48	CW 6.48

"CW": Continuous water taken from prep room tap approx every half hour each day (each "day" represents a 48 hour period starting at 8 pm BST). Exact sample times recorded separately so that we can calculate ship location per sample. Total CW samples = 288

"TR": Two samples were taken from the transducer space twice daily (indicated by *)
[N.B. TR samples were not taken at the *exact* same location (lat and long) as TR samples were usually taken several minutes after CW samples]. Total TR samples = 12

SCIENTIFIC REPORT 10: Hydrocarbon Degrading Bacteria in the Arctic: Their Association with Particulate Material and Diversity within the Pelagic Environment.

Mark Hart

Background: My role on the cruise was to take environmental samples for the isolation and molecular analysis of hydrocarbon degrading bacteria within the Arctic pelagic environment.

Introduction: Hydrocarbon Degrading Bacteria (HDB's) are one of the most important group of bacteria within the anthropogenic impacted ocean. However, microbial analysis of pristine environments often masks their ubiquity and diversity. Indeed, such is their rarity within a "healthy" marine ecosystem that even large-scale metagenomic projects analysing the diversity of marine bacteria often does not detect their presence. Their prevalence is only revealed in pollution events such as the *Exxon Valdez* disaster. Such events are characterised by rapid and profound shifts in the microbial population towards specific groups of specialised bacteria termed obligate hydrocarbon degraders including groups such as *Alcanivorax*, *Marinobacter* and *Cycloclasticus* amongst others, and facultative hydrocarbon degrading bacteria that span a wide range of microbial genera. Studies into oil pollution has now shown that these bacteria are ubiquitous in all the world's oceans and are the major facilitators in natural remediation of contamination. With oil exploration set to increase within Arctic waters within the next decade, it is essential for the study of such organisms within this environment to assess the ability of the Arctic ecosystem to respond to future pollution events.

Materials and Methods:

Pelagic Samples. HDB were isolated from particulate material suspended within the pelagic environment by filtration onto 0.8 um pore sized polycarbonate filters (Millpore). Pelagic samples were collected from various CTD casts (see Table 1) and gently vacuum filtered onto 55 mm membranes which were then transferred into sterile 50 ml falcon tubes to which 10 ml of ONR7a (Dysterhouse, 1995) HDB selective media was added. Bacteria were detached from the membrane by vortexing, and a dilution series set up again using ONR7a as the dilutent. The appropriate dilution factors, as estimated from direct epi-fluorescent enumeration of total bacteria, were then spread-plated (100 ul) onto solid ONR7a agar plates for HDB selection using Phytane, Pristane or Tetradecane. The plates were subsequently incubated for 6-8 weeks in the cold room prior to analysis.

Sediment Trap Material. Trap material (pooled in the case of Lander station) is filtered (approx 200 ml) through a 0.8 um filter to obtain the particulate associated fraction. Filter is added to 10 ml of FSW and vortexed, with a serial dilution subsequently set-up. Dilutions plated onto ONR7a plates after 20 ul of *n*-tetradecane was spread evenly across the agar surface aspetically.

Ice Core Samples. 3 approx 1.2 m cores taken. Sectioned into 3 6 cm parts (approx 360 ml each). 720 FSW added to melt at 4 degrees overnight. 500 ml from each core zone of the 3 cores filtered onto a 0.2 um filter. Filters resuspended in 10 ml FSW which are vortexed and pooled together. Dilution series from neat to –7 created and plated.

Surface Sediment Material. Approximately 3 g wet weight surface sediment re-suspended in 27 ml of FSW. This was vortexed to detach bacteria from particulate material and serially diluted, plated onto ONR7a amended with *n*-tetradecane. Enrichments were carried out by adding 1ml of suspension to 100ml of ONR7a broth and 100 ul of *n*-tetradecane, phytane or phytol was added.

Table 1: Samples taken for HDB analysis during JCR210

Date	Station	Lat (N)	Long (E)	Method/Depth	Sample Type
01/7/08	Shelf	79°43.10100	08°47.88100	Megacorer	Surface Sediment
02/7/08	Shelf	79°43.60900 N	08°50.91000 E	CTD 010 23.5m	DCM water
05/8/08	Ice	80°51.53500	19°08.92400	Sediment Trap 30m	Sedimenting particles
05/8/09	Ice	80°51.53500 N	19°08.92400 E	CTD 016 21.0m	DCM water
06/7/08	Ice	80°48.28200 N	19°11.86700 E	CTD 018 30m	DCM water
07/8/08	Ice	80°47.40300	18°55.20000	Ice coring	3 1.2m cores, split into 3 sections
09/8/08	Lander/Miz	80°21.13100	16°21.75300	Sediment Trap 50m	Sedimenting particles
10/8/08	Lander/Miz	80°21.47300	16°15.08200	CTD 028 27m	DCM water
10/8/08	Lander/Miz	80°21.23500	16°22.88500	Sediment Trap 50m	Sedimenting particles
12/8/08	Shelf Edge	80°29.61400	11°14.76000	CTD 032 25m	DCM water
15/8/08	Rijpfjorden South	80°07.53600	22°09.36800	Sediment Trap 30m	Sedimenting particles
16/08/08	Rijpfjorden Mooring	80°16.91800	22°18.79900	CTD 039 27m	DCM water

SCIENTIFIC REPORT 11: Biogas production and associated microorganisms in the Arctic pelagic environment

Arlene Rowan

My primary role on the cruise was to investigate the processes and microorganisms involved in methane production in the pelagic/ice environment of the arctic. This involved collecting and preserving sedimentary material (surface sediment and sedimentary particles in upper oceans), water samples, ice cores and copepods and their faecal pellets for microbial analysis. Further to this anaerobic ice core microcosm experiments were set up to investigate methane production under different conditions. Samples were also collected for analysis of biogenic sulphur compounds (dimethlysulphoniopropionate-DMSP/dimethylsulfoxide-DMSO).

Background

The presence of methane at super-saturation concentrations in the highly oxygenated upper oceans has been hypothesized to result from in situ microbial production by strict anaerobes (methanogenic archaea; Scranton and Brewer, 1977; Kiene, 1991 Damm, 2008). To explain how a strictly anaerobic process may occur in well oxygenated waters, it has been suggested that anaerobic microsites may exist; within copepods, their excreted faecal pellets and sedimenting material (Oremland, 1979**;** Sieburth, 1987; 1993). These anaerobic microsites may provide a suiTable habitat for methanogenic archaea and could hence, be sites for methane production in the upper ocean. Methanogenic archaea, known for their ability to utilise methylated substrates, have been identified in faecal pellets and particulate sedimentary material (e.g. Oremland *et al*., 1982; De Angelis and Lee, 1994; Van de maarel, 1999). One group of methylated compounds that may represent substrates for pelagic methanogens are the phytoplankton derived C1-compounds consumed by copepods, dimethylsulphide (DMS) and the methylamines (MA; e.g. Cynar and Yayanos, 1991). DMS and MA are climatic feedback gases, thus this work has important consequences for our understanding of the role the oceans and oceanic gases play in climate change.

Sampling

Samples for biogenic sulphur analysis

Biogenic sulphur analysis was conducted for dimethlysulphoniopropionate (DMSP; dissolved and particulate fractions) and dimethylsulfoxide (DMSO; dissolved and particulate fractions) on water samples taken throughout the cruise (Table 1). Water samples were taken from different depths at each location using a CTD/ 24 Niskin bottle array (Table 1). For biogenic sulphur measurements, 100 ml of sample was drawn into a glass syringe and gently filtered through two Millipore AP25 depth filters (50 ml through each) into a purge tube. Samples were fast purged to remove gases and filters and purged water samples were stored for analysis of different sulphur components. The filters were preserved for analysis of the particulate fractions of DMSP and DMSO. The first filter was stored, for analysis of DMSPp, in a crimped vial (60 ml) filled to the top with MilliQ water containing 2 pellets of sodium hydroxide. The second filter was stored, in a 15 ml falcon tube containing 1 pellet of sodium hydroxide and filled to top with 50 mM Tris buffer (pH 7.0), for DMSOp analysis. The purged filtrate was used for analysis of the

dissolved fractions of DMSP and DMSO. For DMSPd analysis, a vial (60 ml) containing 2 pellets of sodium hydroxide was filled to the top with the filtrate and crimped. The remainder of the filtrate, used for analysis of DMSOd, was stored in a 60 ml plastic bottle and frozen (-20ºC). All biogenic sulphur samples, with exception of DMSOd samples (stored frozen), were stored in the dark at room temperature.

Samples for culture independent analysis and ice microcosm experiments

Pelagic environment

Sedimentary particulate material, copepods and water samples were collected from the Arctic Ocean around Svalbard (Table 1) for DNA based analysis. The sediment trap was deployed on three occasions (Table 1). Two of the collection tubes from the sediment trap were deployed twice under the ice to a depth of 30m (Ice station, Table 1). To deploy the trap under the ice, the collection tubes were attached to a buoy which was left on the ice surface and the tubes were lowered to the required depth through two drilled ice holes (use Jiffy drill with 10 inch auger). The second of the sediment trap samples was collected from a collection tube attached to ship (starboard winch) at Lander station 2 during two deployments (to a depth of 50 m for ~15 hrs & ~12½ hrs; Table 1). The final deployment of the sediment trap (whole trap-4 collection tubes) was in Rijpfjorden for ~29 hrs (to a depth of 30 m; Table 1). Trap material at each station was pooled, mixed well and triplicate 300 ml subsamples were filtered on to 0.8 µm filter and stored frozen prior to DNA analysis. Further sub-samples (2 X 300 ml) were filtered onto a GFF filter for geochemical analysis (Tim Brand) and analysis of hydrocarbon degraders (Dr Mark Hart). Copepods were sampled, using a zooplankton net as per section by Dr Stig Falk-Petersen (also collected from CTD water shelf station 1, Table 1), for microbial DNA analysis (Table 1). Adult copepods were isolated from zooplankton trawl and left to defecate in bucket for a few hours. Following defecation faecal pellets and copepod adults were collected, preserved in 50% ethanol and stored frozen (-20ºC).
Water samples (2 X 500 ml) were collected and filtered onto 0.2 µm filters at three different locations (Table 1; Shelf edge 1 & Rijpfjorden). Filters were stored frozen prior to DNA analysis.

Benthic environment
Surface sediment cores were obtained using a megacorer (for description of sampling see section by Martyn Harvey) at various locations around Svalbard (Table 1). Each core was sectioned at five depths (0-1, 3-4, 6-8, 10-12, 14-16 cm; depths based on geochemical analysis (Dr Henrik Stahl)). Care was taken to minimise DNA contamination during sectioning (equipment was ethanol washed and samples stored in sterile bags). Approximately 2 g of sediment was sub-sampled from bulk using sterile technique and stored frozen (-20ºC) for microbial analysis.

Ice station
Three ice cores (length 123, 141, 108 cm) were taken on 7th August (2008) at the ice sampling station. Coring was performed using ice corer (Kovacs coring system; 9 cm diameter) and extra care was taken to reduce DNA contamination. Equipment was ethanol washed and cores were wrapped in aluminium foil. Subcores (10) were sectioned at -20ºC in freezer room, using an ethanol washed saw blade. Ice subcores were washed in sterile water to get rid of surface contamination. The top, middle and bottom of each ice core was cut into 6 cm sections while other samples were cut in 1.5 cm sections (10 in

total including top, middle & bottom). Subcores were melted slowly in sterile seawater (ratio of 50% melted ice 50% sterile seawater) at 5ºC. Aliquots of melted ice core were used for biogenic sulphur analysis (60 ml), bacterial and archaeal DNA analysis (approx. 300 ml), analysis of hydrocarbon degrader (Dr Mark Hart) and ice core microcosm experiments.
Samples were collected for biogenic sulphur compounds using the same method as above except smaller volumes were used (40 mls total). Aliquots of melted ice cores (300 ml) were filtered through 0.2 µm for DNA analysis and filters were stored frozen.
Anaerobic ice core experiments were set up to investigate methane production under different conditions from melted sea ice. A range of different treatments and controls were compared (see below). A known volume of melted ice was added to each microcosm (15 ml; 20 ml glass vials) and depending on treatment different reagents were added (except mercuric chloride add after degas). Microcosms were made up to a final volume of 17 ml with autoclaved filtered seawater. Sterilised samples were killed by addition of mercuric chloride. All microcosm set up in triplicate. Additional replicates were included as destructive samples, at the start and end of experiment, for microbial analysis.

Melted ice + DMSP
Melted ice + DMSP + antibiotics
Melted ice + DMSP + sodium molybdate
Melted ice + DMSP + mercuric chloride (killed control)
Melted ice
Melted ice + antibiotics
Melted ice + sodium molybdate

After addition of reagents vials were crimped and purged with nitrogen gas for 5mins to remove traces of O_2. Mercuric chloride was added through septum to killed controls. The ice microcosm were incubated at 5ºC in the cold room and mixed manually twice daily. After incubation (7 days) mercuric chloride was added to all microcosms (except additional replicates for microbial analysis which were frozen) to stop experiment.

Future Work
Biogenic sulphur compounds and methane will be measured using gas chromatography once back at SAMS. The bacterial and archaeal populations (focus on methanogenic archaea) in the different samples (melted ice, sediment, water, copepod and copepod faecal pellets) will also be examined, using culture-independent methods (DNA extraction and amplification, gel analysis to determine community structure and diversity, sequencing to determine phylogeny and quantification methods).

Table 1 Description of samples taken through the cruise

Date	Station	Latitude (N)	Londitude (E)	Depth (m)	Activity
24/07/08	English channel	50°46.43563	00°45.18598	28	CTD001- water for biogenic S (0, 6,15, 25m)
25/07/08	Southern North Sea	54°12.43787	02°36.61785	42	CTD002- water for biogenic S (0, 6, 15, 20, 35m)
26/07/08	North North Sea	58°47.98040	03°14.97760	102	CTD003- water for biogenic S (0, 6, 15, 26, 30, 40m)
28/07/08	Lofoten	69°00.08016	09°59.83358	3100	CTD004- water for biogenic S (0, 6, 15, 25, 45, 65m)
30/07/08	Storfjorden	76°28.80340	18°59.92166	190	CTD005- water for biogenic S (0, 6, 30, 40, 50, 130, 165, 180m)
01/07/08	Shelf station 1	79°43.10100	08°47.88100	458	Megacorer002- surface sediment for DNA analysis
01/07/08	Shelf station 1	79°43.10000	08°47.87800	458	Megacorer003- surface sediment for DNA analysis
01/07/08	Shelf station 1	79°43.10000	08°47.87800	457	Megacorer004- surface sediment for DNA analysis
02/08/08	Shelf station 1	79°43.60900	08°50.91000	449	CTD010- water filtered to harvest copepods (23m)
05/08/08	Ice station	80°51.53500	19°08.92400	~100	Deploy sediment trap 2 tubes for 12hrs for DNA analysis (30m)
06/08/08	Ice station	80°48.28200	19°11.86700	144	CTD018- water for biogenic S (5, 10, 30, 50, 100, 138m)
06/08/08	Ice station	80°48.28500	19°11.91800	~145	Deploy sediment trap 2 tubes for 24hrs for DNA analysis (30m)
07/08/08	Ice station	80°47.40300	18°55.20000	~128	Ice coring for biogenic S & DNA analysis & microcosms
08/08/08	Lander station 2	80°20.93300	16°18.22700	393	Megacorer005b- surface sediment for DNA analysis
08/08/08	Lander station 2	80°20.93300	16°18.23000	394	Megacorer006b- surface sediment for DNA analysis
08/08/08	Lander station 2	80°20.93400	16°18.22300	394	Megacorer007b- surface sediment for DNA analysis
09/08/08	Lander Station 2	80°21.13100	16°21.75300	414	Deploy sediment trap tube for ~15hrs for DNA analysis (50m)
10/08/08	Lander station 2	80°21.47300	16°15.08200	392	CTD028- water for biogenic S (5, 10, 30, 50, 100, 138m)
10/08/08	Lander Station 2	80°21.23500	16°22.88500	~350	Deploy sediment trap tube for ~12½hrs for DNA analysis (50m)
12/08/08	Shelf Edge Station 1	80°29.28300	11°18.37600	755	Megacorer001c- surface sediment for DNA analysis
12/08/08	Shelf Edge Station 1	80°29.35000	11°17.69200	760	Megacorer002c- surface sediment for DNA analysis
12/08/08	Shelf Edge Station 1	80°29.35100	11°17.64900	760	Megacorer004c- surface sediment for DNA analysis
12/08/08	Shelf Edge Station 1	80°29.61400	11°14.76000	777	CTD032- water for DNA analysis (chlorophyll & temp. max; 18m & 23m)
15/08/08	Rijpfjorden Mooring	80°17.09700	22°18.25400	226	Copepod net (100m)- copepods for DNA analysis (gut & faecal pellets)
15/08/08	Rijpfjorden South	80°07.45400	22°09.23300	209	Megacorer001d- surface sediment for DNA analysis
15/08/08	Rijpfjorden South	80°07.53600	22°09.36800	196	Deploy sediment trap 4 tubes for ~29hrs for DNA analysis (30m)
15/08/08	Rijpfjorden South	80°07.45100	22°09.24400	205	Megacorer004d- surface sediment for DNA analysis
15/08/08	Rijpfjorden South	80°07.45000	22°09.24000	205	Megacorer005d- surface sediment for DNA analysis
16/08/08	Rijpfjorden Mooring	80°16.91800	22°18.79900	217	CTD039-water for biogenic S (2, 7, 12, 15, 27, 60m) & DNA analysis (27m)

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SCIENTIFIC REPORT 12: Protozooplankton Bacterivory

Elaine Mitchell, Mark Hart and Ray Leakey

Introduction and Objectives

The objective of this study was to experimentally determine protozooplankton bacterivory rates at the sub-surface chlorophyll maximum at different sampling stations during the cruise. Sampling details are shown in the tables below. Experimental samples were collected for post-cruise analysis on return to the UK.

JC210 Protozooplankton Bacterivory Experiments

Date	3rd August 2008			Date	6th August 2008			Date	10th August 2008			Date	16th August 2008		
Station	SS1 (Shelf station 1)			Station	IS (Ice station)			Station	MIZ (marginal ice zone)			Station	RIP (Ripfijorden)		
Event No	42			Event No	53			Event No	93			Event No	163		
CTD No	14			CTD No	17			CTD No	27			CTD No	38		
Bottle	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples	*Bottle*	Depth	REP	Samples
1	60m			1	2m			1	60m			1	60m		
3	30m	1B	1	3	10m			3	27m	1A		3	27m	1A	
4	30m	2A		4	40m			4	27m	1B	1	4	27m	1B	1
5	30m	2B	1	5	5m			5	27m	2A		5	27m	2A	
6	30m	3A		6	5m			6	27m	2B	1	6	27m	2B	1
7	30m	3B	1	7				7	27m	3A		7	27m	3A	
8	19m			8	5m			8	27m	3B	1	8	27m	3B	1
9	17m			9				9	15m			9	15m		
10	17m			10	30m	A	1	10	15m			10	15m		
11	11m			11	30m	B	1	11	8m			11	12m		
12	11m			12	30m	C	1	12	8m			12	12m		
13	5m			13				13	8m			13	7m		
14	5m			14				14	8m			14	7m		
15	5m			15				15	8m			15	7m		
16	5m			16	20m			16	8m			16	7m		
17	5m			17	20m			17	2m			17	7m		
18	5m			18	20m			18	2m			18	7m		
19	1m			19				19	2m			19	2m		
20	1m			20				20	2m			20	2m		
21	1m			21				21	2m			21	2m		
22	1m			22				22	2m			22	2m		
23	1m			23				23	2m			23	2m		
24	1m			24				24	2m			24	2m		
Total			3	Total			3	Total			3	Total			3

Approach and Methodology

Grazing rates were measured during the cruise using two approaches

1. A dilution approach in which bacteria are uncoupled from their protozoan predators by serial dilution of the natural community. Experimental are then incubated and bacterial growth and protozoan bacterivory under differing predation pressures determined from changes in bacterial abundance measured by flow cytometry.
2. A radioisotope approach (Zubkov and Tarran 2008. High bacterivory by the smallest phytoplankton in the North Atlantic Ocean, *Nature* 455:244-226) in which natural bacterial prey, pulse-chase labeled with ^{35}S-methionine, are fed to natural protozoan bacterivores and the uptake and assimilation of bacteria by the protozoans determined, after incubation and concentration onto filters, by scintillation counting.

Experimental water was collected by CTD rosette from the chlorophyll maximum depth. 5 litres of water from each of 3 replicate Niskin bottles were then passed through 150µm mesh and collected into10 L Nalgene carboys which were then held at ambient

temperature in the ships cool room. This water was then used for each bacterivory assay as follows:

Protozoan Bacterivory by Dilution

From each replicate carboy, 2 Litres were filtered through a 0.2µm 'Gelman Vacucap' bottle top filter into a sterile duran bottle to produce bacterial free-water. This 'dilutant' was mixed with the unfiltered water from the same carboy to produce 100ml volumes of the following concentrations of unfiltered seawater: 10% 25% 50% 75% 100%. Each 100 ml volume was placed in a 125ml Nalgene polycarbonate bottles which were incubated for up to 2 days the dark (NOC deck incubator – darkest screened tubes) at ambient water temperature. Sub-samples of 4 ml were taken at 0, 24 and 48 hours intervals and preserved with paraformaldehyde (1% final concentration) in 'Cryovial' tubes which were snap frozen in liquid nitrogen and stored in the -80°C freezer for post-cruise analysis by flow cytometry back at the lab.

JC210 Dilution Experiment Details

	3rd August 2008	7th August 2008	11th August 2008	15th August 2008
	Grazing exp1 (SS1)	Grazing exp2 (IS)	Grazing exp3 (MIZ)	Grazing exp4 (RIP)
Dilutions	6	6	6	6
Times	3	3	3	3
Rep	3	3	3	3
Total Sub-samples	54	54	54	54

Protozoan Bacterivory by Radioisotope Uptake

To pulse-label bacterial prey, 80 ml were removed from each replicate carboy, and pooled, and the resulting 240 ml spit into two volumes of 120 ml and placed in 250 ml polycarbonate bottles. ^{35}S L-methionine (0.125 nM final conc) was added to one 120ml volume (HOT) and the sample incubated for 2 - 4 hours with uptake terminated by adding non-radioactive methionine in order to label the natural bacteria present. At the same time non-radioactive methionine (0.624 µM final conc) was added to the second 120ml volume (COLD) and the sample incubated for 2.5 hours followed by 35S-methionine addition in order to create a "background" population. Both HOT and COLD solutions were then left for 1 hour.

To prepare experimental water, 2 x 100 ml volumes were removed from each replicate carboy and placed in 250 ml polycarbonate bottles. These unfiltered samples (UNFILT) contained both protozoan predators and bacterial prey. At the same time a further 2 x 100 ml volumes were gravity filtered though a 47mm diameter 1.2 µm polycarbonate filter using a "Swinex" filter holder. These filtered (FILT) samples contained only bacterial prey. HOT solution (20ml) was then added to one of each pair of UNFILT and FILT samples. At the same time COLD solution (20ml) was added to each of the remaining pairs of UNFILT and FILT samples.

All samples were incubated for between 5 and 20.5 hours (depending on station) to allow protozoan grazing of radio-isotope and background labelled bacteria. The samples were then processes by (a) pump filtering 10 ml of sample onto a 25mm diameter 0.2 µm polycarbonate filter and (b) gravity filtering 110 ml onto a 47mm diameter 1.2 µm

polycarbonate filter. The filters were washed with 0.2 µm filtered seawater, placed in scintillation vials with 10 ml of scintillation fluid (Ultima Gold) added, and stored for on-ship and post-cruise analysis of radio-isotope uptake by scintillation counter.

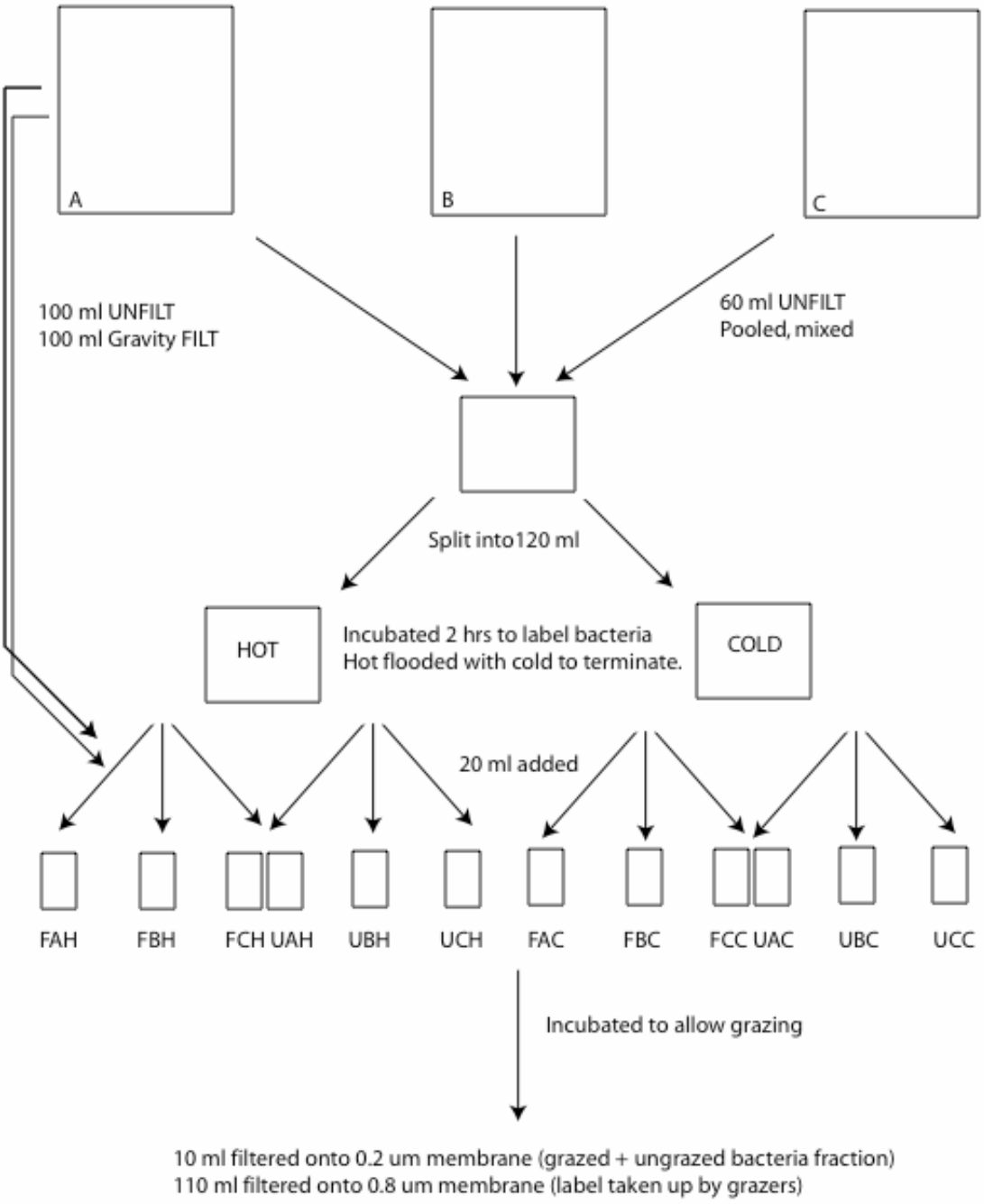
Protozoan assimilation is calculated from the uptake of radioactivity by protozoa (1.2 filter concentrate) in the UNFILT sample (after controlling for background RAD – BAK) minus the uptake of radioactivity by protozoa (1.2 filter concentrate) in the FILT sample (after controlling for background HOT – COLD).

Bacterial assimilation is calculated from the uptake of radioactivity by bacteria (0.2 filter concentrate) in the UNFILT sample (after controlling for background HOT – COLD) minus the uptake of radioactivity by bacteria (0.2 filter concentrate) in the FILT sample (after controlling for background HOT – COLD).

Grazing is calculated from protozoan assimilation minus bacterial assimilation.

JC210 Radio-isotope Uptake Experiment Details

	3rd August 2008	7th August 2008	11th August 2008	15th August 2008
	Grazing exp1 (SS1)	Grazing exp2 (IS)	Grazing exp3 (MIZ)	Grazing exp4 (RIP)
Labelling Time (hrs)	2	2	2	4
Incubation Time (hrs)	8.5	5	16 - 20.5	15 - 17
Isotope (HOT & COLD)	2	2	2	2
Fraction (UNFILT & FILT)	2	2	2	2
Replicates	3	3	3	3
Concentrate (0.2 & 1.2)	2	2	2	2
Total Sub-samples	24	24	24	24


A
B
C
100 ml UNFILT
100 ml Gravity FILT
60 ml UNFILT
Pooled, mixed
Split into120 ml
HOT
Incubated 2 hrs to label bacteria
Hot flooded with cold to terminate.
COLD
20 ml added
FAH
FBH
FCH UAH
UBH
UCH
FAC
FBC
FCC UAC
UBC
UCC
Incubated to allow grazing
10 ml filtered onto 0.2 um membrane (grazed + ungrazed bacteria fraction)
110 ml filtered onto 0.8 um membrane (label taken up by grazers)

SCIENTIFIC REPORT 13: Protozooplankton Herbivory

Elaine Mitchell and Jane Manning

Introduction and Objectives

The objective of this study was to experimentally determine protozooplankton herbivory rates at the sub-surface chlorophyll maximum at different sampling stations during the cruise. Sampling details are shown in the tables below. Experimental samples were collected for post-cruise analysis on return to the UK.

JC210 Protozooplankton Herbivory Experiments

Date	7th August 2008		Date	11th August 2008		Date	15th August 2008	
Station	Grazing exp1 (IS)		Station	Grazing exp2 (MIZ)		Station	Grazing exp3 (RIP)	
Event	65		Event	103		Event	144	
CTD No	20		CTD No	29		CTD No	34	
Bottle	Depth	Sample	*Bottle*	Depth	Sample	*Bottle*	Depth	Sample
1	25m		1	21m		1	202	
2	25m		2	21m		2	150	
3	25m		3	21m		3	100	
4	25m	1	4	21m	1	4	60	
5	25m		5	21m		5	40	
6	25m		6	21m		6	29	
7	25m		7	21m		7	29	
8	25m		8	21m		8	29	
9	25m		9	21m	1	9	29	1
10	25m		10	21m		10	29	
11	25m		11	21m		11	29	
12	25m	1	12	21m		12	29	
13	25m		13	21m		13	29	
14	25m		14	21m	1	14	29	1
15	25m		15	21m		15	29	
16	25m		16	21m		16	29	
17	25m		17	21m		17	29	
18	25m		18	21m		18	29	
19	25m		19	21m		19	29	1
20	25m	1	20	21m		20	29	
21	25m		21	21m		21	29	
22	25m		22	21m		22	29	
23	25m		23	21m		23	20	
24	25m		24	21m		24	10	
Total		3	Total		3	Total		3

Approach and Methodology

Grazing rates were measured during the cruise using fluorescently labelled algae (FLA) as tracers of ingestion (Sherr and Sherr 1993 Protistan grazing rates via uptake of fluorescently labelled prey. In Kemp, et al. Eds. *Handbook of methods in aquatic microbial ecology*). FLA were prepared in the UK from cultured algal cells which had been fluorescently labelled with DTAF stain and stored frozen until use on ship. Two types of FLA assay were conducted:

3. A direct FLA assay in water samples were incubated with a single concentration of FLA for up to 80 minutes with uptake of FLA by individual protozoan cells observed using fluorescence microscopy.

4. An indirect FLA assay in which water samples were incubated with different concentrations of FLA for up to 48 hours with disappearance of FLA observed by flow cytometry.

Experimental water was collected by CTD rosette from the chlorophyll maximum depth. 5 litres of water from each of 3 replicate Niskin bottles were then passed through 150µm mesh and collected into 10 L Nalgene carboys which were then held at ambient temperature in the ships cool room, This water was then used for each FLA assay as follows:

FLA Uptake by Microscopy

From each replicate carboy, 3 litres was placed in a polycarbonate bottle and one of two types of FLA's added (either *Chlorella stigmatophora* CCAP 211/20 or *Prorocentrum minimum* CCAP 1136/16) were added to the natural sample at a density of 1000 FLA ml^{-1}. After 0, 5, 10, 20, 40 and 80 minutes, 400ml was removed and poured into 500 ml glass amber bottles containing 4mls of Lugol's iodine to fix the sample (1% final concentration). The samples were then stored at 4°C for post-cruise analysis of FLA uptake per cell by inverted epifluorescence microscopy.

JC210 Direct FLA Uptake Experiment Details

	7th August 2008	11th August 2008	15th August 2008
	Grazing exp1 (IS)	Grazing exp2 (MIZ)	Grazing exp3 (RIP)
Times (mins)	6	6	6
Rep	3	3	3
FLA *Chlorella*	1	1	1
FLA *Prorocentrum*	0	1	1
Total Sub-samples	18	36	36

FLA Disappearance by Flow Cytometry

From each replicate carboy, 250 ml was decanted into a 250 ml polycarbonate bottles. FLA were then added to each set of triplicate X ml samples to gives final FLA concentrations ranging from 1 to 10,000 ml^{-1} depending on experimental date and FLA type (see tables below). FLA were prepared from several algal species were used including: *Chlorella stigmatophora* CCAP 211/20*, Prorocentrum minimum* CCAP 1136/16, *Micromonas pusilla* CCAP 1965/4, *Pycnococcus provasolii* CCAP 190/1, *Synechococcus sp.* CCAP 1479/5, *Tetraselmis suecica* CCAP 66/4. The samples were then incubated for up to 48 hours (see tables below for exact times) on a plankton wheel in a deck-mounted tank in the dark and at ambient temperature (maintained by the ships deck-pumped seawater supply). At the end of each incubation, 4ml sub-samples were removed from each bottle, placed in a labelled 5ml 'Cryovial', and immediately fixed with 1% paraformaldehyde (PFA). The samples were then either analysed on ship for FLA concentration by BD FacsSort Flow cytometer, or snap frozen in liquid nitrogen within 12 hours of being collected and transferred into the -80°C freezer for post-cruise analysis.

FLA-AFC Experiment 1 – Ice Station "IS" (7/8/08 - 8/8/09)

Time point (hours)	FLA Type and Final Concentration		
	REP A	REP B	REP C
0	Tetraselmis	Tetraselmis	Tetraselmis
12 hrs 50 mins	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24			
36			
48			
0	Prorocentrum	Prorocentrum	Prorocentrum
12 hrs 50 mins	1000 ml^{-1}l	1000 ml^{-1}l	1000 ml^{-1}l
24			
36			
48			
0	Synechococcus	Synechococcus	Synechococcus
12 hrs 50 mins	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24			
36			
48			
0	Chlorella	Chlorella	Chlorella
12 hrs 50 mins	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24			
36			
48			
0	Tetra and Syn mix	Tetra and Syn mix	Tetra and Syn mix
12 hrs 50 mins	(not equal numbers- by mistake)	(not equal numbers- by mistake)	(not equal numbers- by mistake)
24	1000 tetra and 500 syn ml^{-1}	1000 tetra and 500 syn ml^{-1}	1000 tetra and 500 syn ml^{-1}
36			
48			
0	Chlorella high **	Chlorella high **	Chlorella high **
12 hrs 50 mins	10,000 ml^{-1}	10,000 ml^{-1}	10,000 ml^{-1}
24			
36			
48			
0	Chlorella low **	Chlorella low **	Chlorella low **
12 hrs 50 mins	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}
24			
36			
48			
0	Micromonas (only 1 rep and made mistake)		
12 hrs 50 mins	2.4 ml^{-1}		
24			
36			
48			
0	Pycnococcus (only one rep)		
12 hrs 50 mins	1000 ml^{-1}		
24			
36			
48			

Seawater taken from CTD at 20 m depth (chlorophyll max)

Incubated bottles on plankton wheel at – 0.5°C.

**** (Some incubations in polyporopelene bottles as there weren't enough polycarbs – polypropes are indicated by **).**

Nnot sure of Niskin bottle numbers

Total Samples = 115

FLA-AFC Experiment 2 – Marginal Ice Zone "MIZ" (10/8/08 - 11/8/08)

Time point (hours)	FLA Type and Final Concentration		
	REP A (Niskin 4)	REP B (Niskin 9)	REP C (Niskin 14)
0	Tetraselmis	Tetraselmis	Tetraselmis
13	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24.5			
35.5			
48			
0	Prorocentrum	Prorocentrum	Prorocentrum
13	1000 ml^{-1}l	1000 ml^{-1}l	1000 ml^{-1}l
24.5			
35.5			
48			
0	Synochocus	Synochocus	Synochocus
13	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24.5			
35.5			
48			
0	Chlorella	Chlorella	Chlorella
13	(made a mistake with dilutions)	(made a mistake with diltuions)	(made a mistake with the dilutions)
24.5	10 ml^{-1}	10 ml^{-1}	10 ml^{-1}
35.5			
48			
0	Tetra and Syn mix	Tetra and Syn mix	Tetra and Syn mix
13	500 ml^{-1}each	500 ml^{-1}each	500 ml^{-1}each
24.5			
35.5			
48			
0	Tetra and Syn high mix	Tetra and Syn high mix	Tetra and Syn high mix
13	(syns smaller so added more)	(syns smaller so added more)	(syns smaller so added more)
24.5	500 tet & 1000 syn ml^{-1}	500 tet & 1000 syn ml^{-1}	500 tet & 1000 syn ml^{-1}
35.5			
48			
0	Chlorella high **	Chlorella high **	Chlorella high **
13	(made a mistake with dilutions)	(made a mistake with the dilutions)	(made a mistake with the dilutions)
24.5	100 ml^{-1}	100 ml^{-1}	100 ml^{-1}
35.5			
48			
0	Chlorella low **	Chlorella low **	Chlorella low **
13	(made a mistake with dilutions)	(made mistake with the dilutions)	(made a mistake with the dilutions)
24.5	1 ml^{-1}	1 ml^{-1}	1 ml^{-1}
35.5			
48			

Water from 21 m (chlorophyll max) which was at 3.4°C.

**** (Some incubations in polyporopelene bottles as there weren't enough polycarbs – polypropes are indicated by **).**

Total Sample = 120

FLA-AFC Experiment 3 – Ripfjorden "RIP" (15/8/08)

Time point (hours)	FLA Type and Final Concentration		
	REP A (Niskin 9)	REP B (Niskin 14)	(REP C (Niskin 19)
0	Chlorella	Chlorella	Chlorella
12	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
23.5			
38.5			
0	Chlorella	Chlorella	Chlorella
13	5000 ml^{-1}l	5000 ml^{-1}l	5000 ml^{-1}l
24.5			
35.5			
0	Chlorella	Chlorella	Chlorella
13	10,000 ml^{-1}	10,000 ml^{-1}	10,000 ml^{-1}
24.5			
35.5			
0	Chlorella control	Chlorella control	Chlorella control
13	10,000 ml^{-1}	10,000 ml^{-1}	10,000 ml^{-1}
24.5			
35.5			
0	Prorocentrum **	Prorocentrum **	Prorocentrum **
13	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24.5			
35.5			
0	Prorocentrum control **	Prorocentrum control **	Prorocentrum control **
13	1000 ml^{-1}	1000 ml^{-1}	1000 ml^{-1}
24.5			
35.5			
0	Seawater only	Seawater only	Seawater only
13	(no FLAs added)	(no FLAs added)	(no FLAs added)
24.5			
35.5			

Control FLA = In just filtered seawater i.e. containing no predators to graze the FLAs

Water from CTD at 29m (chlorophyll max) on 15/8/08. Temperature was -0.1 °C.

Water kept in CT room at 0.6°C until start of experimental incubation (i.e. all day).

**** (Some incubations in polyporopelene bottles as there weren't enough polycarbs – polypropes are indicated by **).**

N.B. Snow on plankton wheel may have made it darker inside.

Water temperature monitored in the water bath over the time:
T0 = 0.7°C at 20:10 hrs on 15th August
T12 = -0.2°C at 08:10 hrs on 16th August
T23.5 = ?°C at 19:40 hrs on 16th August
T38.5 = 1°C at 10:40 hrs on 17th August

Total Samples = 84

SCIENTIFIC REPORT 14: Pelagic Microbial Community Grazing and Growth

Andrea Veszelovszki and Ray Leakey

Introduction and Objectives

The objective of this study was to experimentally determine microbial grazing and growth rates at the sub-surface chlorophyll maximum at different sampling stations during the cruise. Experimental samples were collected for post-cruise analysis on return to the UK.

Approach and Methodology

Microbial community *in situ* growth and grazing rates were determined by (a) fractionating the natural microbial community in to several size categories to remove protistan predators of different size, and (b) monitoring changes the abundance of the microbial community during subsequent incubation (Leakey et al. 1994. Ciliate growth rates from Plymouth Sound: comparison of direct and indirect estimates. *J. Mar. Bio. Ass.* 74: 849-861).

Study site and experimental procedure

The experiments were carried out at 3 stations (Table1) where water samples were taken from the chlorophyll maximum. At each station, 9 Niskin bottles (3 x 3 replicates) were filled from the CTD and for each replicate the 3 Niskin bottles were simultaneously drained into a large plastic tank using silicone tubes. Prior to this different pore-sized mesh bags (Clarcor, UK) were placed inside the buckets in the following order: 5, 10, and 50µm. These mesh bags were used to sequentially fractionate the sample water by gently removing each bag out of the tank. This resulted in the following 4 fractions: total community, < 50, < 10, and < 5µm. From each fraction and for each replicate, 2 litres of sample were gently taken by immersing and filling a 2 litre clear polycarbonate bottle avoiding bubble formation. Nutrient samples were also taken directly from each fraction into rinsed 250 ml polycarbonate bottles for analysis on ship. The clear 2 litre polycarbonate bottles were kept in dark and transferred to plankton wheel (Fig 1) for incubation. At the same time another 2 litre of sample was collected and placed into a thermos flasks for immediate processing (Time-zero samples).

Table 1. Station locations and sample depths

Date	Station name	Event no.	CDT no.	Latitude	Longitude	Sample depth (m)	CTD bottle no.	Replicate
07/08/2008	Ice Station	65	20	80 47.403	018 55.2	25	1,2,3	1
							9,10,11	2
							17,18,19	3
11/08/2008	Marginal Ice Zone	103	29	80 21.167	016 20.777	21	1,2,3,	1
							6,7,8,	2
							11,12,13	3
15/08/2008	Rijpfjorden	144	34	80 16.97	022 17.754	29	6,7,8,	1
							11,12,13	2
							16,17,18	3

The plankton wheel was held within a tank fixed to the open deck and covered with neutral density screens (Lee Filters, UK) to achieve ambient light level at the depths where samples were collected. The samples bottles were fixed to the rotating axis of the wheel and the rotation speed was set to 1-1.5 RPM to keep the samples mixed and the organisms suspended during incubated for 46 hours. Ambient temperature within the plankton wheel was maintained by underway water flow (maintained by the ships deck-pumped seawater supply) with the water covering the sample bottles at all times.

Figure 1. Plankton wheel and control panel (Photo by A. V.)

Sample processing and analysis

To determine autotrophic and heterotrophic nanoplankton (PNAN and HNAN) and picoplankton (cyanobacterial and bacteria) abundances, 50 ml of each replicate T_0 or T_{46} hr sample from each fraction were preserved in 0.5% final concentration of glutaraldehyde and stored in 200 ml amber plastic bottles. From these samples, 15, 5, and 5 ml sub-samples were taken and processed for post cruise enumeration of P/HNAN, cyanobacteria, and bacteria by epiflorescence microscopy, respectively. A further 4 ml sub-samples were also fixed with 200 µl of paraformaldehyde, frozen in liquid nitrogen and stored at –80 °C for post cruise analysis by flow cytometry. An additional 10 ml sub-sample was also processed and stored frozen at -20°C for post-cruise analysis of picoplankton community composition by FISH. See "*Microbial Community Composition, Abundance and Biomass*" cruise report for further details on sample preparation.

To determine microplankton abundances, 400 ml of each replicate T_0 or T_{46} hr sample from each fraction were preserved in 1% final concentration Lugol's solution and stored in at cool temperature in amber glass bottles or post-cruise analysis by inverted microscopy. A further 400 ml samples was also preserved in Bouin's solution and formaldehyde for the post-cruise analysis of microplankton taxonomy. See "*Microbial Community Composition, Abundance and Biomass*" cruise report for further details on sample preparation.

For the determination of chlorophyll a concentration, 500 ml from each replicate T_0 or T_{46} hr sample from each fraction were filtered through 25 mm Whatman GF/F filters. Four hundred millilitres were also taken and filtered through 25 mm ashed Whatman GF/F filters for the determination of particulate organic carbon and nitrogen (POC/N). All filters were collected into labelled plastic tubes and were frozen and stored at -80°C for post cruise analysis. Further 50 ml were also taken and processed for the determination of dissolved

organic carbon, nitrogen and phosphate (DOC, DON, DOP). See "*Particulate and Dissolved Organic Nutrient and Photosythetic Pigment Concentrations*" cruise report for further details on sample preparation.

Table 2. Samples taken for analyses

Analysis type	Sample volume	Volume of fixative	Fixation method/ fixative used	Storeage	Number of samples taken
Microplankton Taxonomy	400 ml	10 ml	Bouin's solution	5°C	3
Microplankton Taxonomy	400 ml	10 ml	Formaldehyde	5°C	3
Microplankton Abundance	400 ml	4 ml	Lugol's iodine	5°C	72
POC/PON	400 ml	-	Ashed GFF	-80°C	72
Chlorophyll	500 ml	-	Ashed GFF	-80°C	72
DOC/DON	20 ml	60 µl	Orthophosphoric acid	5°C	72
DOP	30 ml	None	None	-20°C	72
Pico- & Nanoplankton Abundance Microscopy	50 ml	1 ml	Glutaraldehyde/Slides	-20°C	72
Pico- & Nanoplankton Abundance Flow Cytometry	4 ml	200 µl	PFA	-80°C	72
Bacterial Compositon FISH	10 ml	400 µl	Formaldehyde/Nucleopore	-80°C	72
Inorganic Nutrients	~ 200 ml	None	None	analysed	72

SCIENTIFIC REPORT 15: Zooplankton migration, lipids and biomarkers

Stig Falk-Petersen and Anette Wold

1. Diurnal migration during periods of mid-night sun

Background:
Synchronised diel and seasonal vertical migration of zooplankton probably represent the larges displacement of biomass in the word oceans. Our knowledge of the vertical migration in the Arctic Ocean during the midnight sun periods are however limited to a few studies. This study should add to the scarce knowledge about DVM at high latitudes during summer.

Method:
Dr Mags Wallace collected acoustic data continuously by echo sounders (Simrad EK60) using hull mounted 38, 120 and 120 kHz split beam transducers. The data were stored as raw data. The volume – back scattering (Sv) is a proxy for biomass and expressed in decibels (dB) in a colour code.

Net samples were taken at 5 distinct depth by use of a Multi Plankton Sampler (Hydrobios Multinet, 200 µm mesh size), opening 0.25 m^2). The samples were stored in 4% formaldehyde and will be analysed for species composition.

Data that will supplement to this work:
Sea ice, oceanography, phytoplankton distribution, vertical profiles of *in situ* fluorescence, total lipid content of the dominant Calanus species (*C. glacialis* and *C. hyperboreus*)

List of samples:

Station	Date	Time (GMT)	Equipment	Sampling depth (m)	Type of sample	Comment
Lander stn. 1	02.08.2008	14:57	Multinet	370-200-100-50-20-0	Abundance	Day
Lander stn. 1	02.08.2008	15:30	WP3	100-0	Abundance	Day
Lander stn. 1	02.08.2008	22:55	Multinet	370-200-100-50-20-0	Abundance	Night
Lander stn. 1	02.08.2008	23:30	WP3	100-0	Abundance	Night
Ice station	06.08.2008	13:55	Multinet	100-50-20-0	Abundance	Day
Ice station	06.08.2008	14:18	WP3	100-0	Abundance	Day
Ice station	06.08.2008	22:53	Multinet	100-50-20-0	Abundance	Night
Ice station	06.08.2008	23:14	WP3	100-0	Abundance	Night
Lander stn. 2 (MIZ)	08.08.2008	22:06	Multinet	365-200-100-50-20-0	Abundance	Night
Lander stn. 2 (MIZ)	08.08.2008	22:32	WP3	100-0	Abundance	Night
Lander stn. 2 (MIZ)	09.08.2008	09:09	Multinet	365-200-100-50-20-0	Abundance	Day
Lander stn. 2 (MIZ)	09.08.2008	09:43	WP3	100-0	Abundance	Day
Lander stn. 2 (MIZ)	10.08.2008	11:32	WP3	100-0	Abundance	Day
Lander stn. 2 (MIZ)	10.08.2008	11:50	Multinet	375-200-100-50-20-0	Abundance	Day
Lander stn. 2 (MIZ)	10.08.2008	21:54	Multinet	335-200-100-50-20-0	Abundance	Night
Lander stn. 2 (MIZ)	10.08.2008	22:24	WP3	100-0	Abundance	Night
Shelfbrake stn.	12.08.2008	14:52	WP3	100-0	Abundance	Day
Shelfbrake stn.	12.08.2008	16:36	Multinet	740-600-200-100-50-0	Abundance	Day
Shelfbrake stn.	12.08.2008	22:34	Multinet	740-600-200-100-50-0	Abundance	Night
Shelfbrake stn.	12.08.2008	23:31	WP3	100-0	Abundance	Night
R3 (Rjipfjord mooring)	14.08.2008	20:20	WP3	100-0	Abundance	Night
R3 (Rjipfjord mooring)	14.08.2008	20:48	Multinet	210-175-100-50-20-0	Abundance	Night
R3 (Rjipfjord mooring)	15.08.2008	09:30	Multinet	210-175-100-50-20-0	Abundance	Day
R3 (Rjipfjord mooring)	15.08.2008	09:50	WP3	100-0	Abundance	Day
R1 (Rjipfjord inner)	16.08.2008	14:54	Multinet	180-100-50-20-0	Abundance	
R1 (Rjipfjord inner)	16.08.2008	15:09	WP3	100-0	Abundance	
R2 (RIB)	16.08.2008	20:05	WP3	100-0	Abundance	
R2 (RIB)	16.08.2008	20:37	Multinet	180-100-50-20-0	Abundance	
R4 (Rjipfjord outer)	17.08.2008	05:55	Multinet	160-100-50-20-0	Abundance	
R4 (Rjipfjord outer)	17.08.2008	06:15	WP3	100-0	Abundance	
R1 (Rjipfjord inner)	16.08.2008	14:26	CTD	50,30,20,10,0	Taxonomi; Nutrient	
R2 (RIB)	16.08.2008	20:53	CTD	50,30,20,10,0	Taxonomi; Nutrient	
Kb3	18.08.2008	21:01	Multinet	320-200-100-50-20-0	Abundance	Night
Kb3	18.08.2008	18:25	WP3	100-0	Abundance	Night
Kb3	19.08.2008	06:00	Multinet	320-200-100-50-20-0	Abundance	Day
Kb3	19.08.2008	06:25	WP3	100-0	Abundance	Day
Kb1	19.08.2008	22:43	Multinet	340-200-100-50-20-0	Abundance	Ek60 transect
Kb1	19.08.2008	23:23	WP3	100-0	Abundance	Ek60 transect
Kb0	20.08.2008	00:55	WP3	100-0	Abundance	Ek60 transect
Kb0	20.08.2008	01:15	Multinet	305-200-100-50-20-0	Abundance	Ek60 transect
V12	20.08.2008	04:14	Multinet	200-100-50-20-0	Abundance	Ek60 transect
V12	20.08.2008	04:45	WP3	100-0	Abundance	Ek60 transect

2. Lipid content and composition of *Calanus glacialis* and *C. hyperboreus*

Background:
The marginal ice zones (MIZ) areas are characterised by strong inter-annual and seasonal fluctuations, in light climate, temperature, fresh water inflow, surface salinities, and most pronounced sea ice cover, but are never the less some of the most productive areas with a very intensive, but short production period. The Arctic herbivores, the *Calanus* species, exposed to this variation in the food available, have responded to the situation, by storing large lipid stores (up to 60-80% of their body weight). This increase in the lipid level from 10-20% in phytoplankton to 50-70% in herbivorous zooplankton and ice-fauna is probably one of the most fundamental adaptations to the climate swings of the Arctic. We will in this study measure the total dry weight, total lipid and fatty acid composition of the 2 *Calanus* species, *C. glacialis* and *C. hyperboreus* in the surface water and close to the bottom.

Method:
C. glacialis and *C. hyperboreus* were sampled by the Multinet and WP3 net at two distinct depths (bottom layer, below 150 m and surface layer, 50-0m). The animals were kept in the dark at *in situ* temperature and sorted as soon as possibly after sampling. The dominant stages of *C. glacialis* and *C. hyperboreus* were selected by use of a stereomicroscope (Leica MZ6), and frozen immediately at -80° C.

Parameters to be analysed:
a) Dry weight
b) Total lipid content
c) Fatty acid and fatty alcohol composition
d) C and N stable isotope composition

List of samples for lipids and biomarkers:

Station	Date	Time (GMT)	Equipment	Sampling depth (m)	Type of sample
Ice station	06.08.2008	14:47	WP3	100-0	Lipids; Biomarker
Ice station	07.08.2008	06:30	WP3	100-0	Lipids; Biomarker
Lander stn. 2 (MIZ)	09.08.2008	11:04	WP3	50-0	Lipids; Biomarker
Lander stn. 2 (MIZ)	09.08.2008	11:59	Multinet	360-260	Lipids; Biomarker
Shelfbrake stn.	12.08.2008	14:08	WP3	100-0	Lipids; Biomarker
Shelfbrake stn.	12.08.2008	15:32	Multinet	740-600	Lipids; Biomarker
R3 (Rjipfjord mooring)	14.08.2008	20:04	WP3	50-0	Lipids; Biomarker
R3 (Rjipfjord mooring)	14.08.2008	21:33	Multinet	210-125	Lipids; Biomarker
Kb3 (Kongsfjorden)	18.08.2008	18:16	WP3	50-0	Lipids; Biomarker
Kb3 (Kongsfjorden)	18.08.2008	18:57	Multinet	320-200	Lipids; Biomarker

Detailed list of lipid samples:

Station	Date	Depth (m)	Species	Stage	# ind / sample	# replicates
Ice station	**07.08.2008**	**100-0**	*Calanus glacialis*	CV	5	6
Ice station	07.08.2008	100-0	*Calanus hyperboreus*	AF	3	6
Ice station	07.08.2008	100-0	*Calanus hyperboreus*	CV	4	6
Ice station	07.08.2008	100-0	*Themisto libelulla*		1	1
Lander stn.2	**09.08.2008**	**50-0**	*Calanus glacialis*	CV	5	6
Lander stn.2	09.08.2008	50-0	*Calanus glacialis*	CV	15	1
Lander stn.2	09.08.2008	50-0	*Mertensia ovum*		5	3
Lander stn.2	09.08.2008	50-0	*Themisto libelulla*		2	3
Lander stn.2	09.08.2008	360-260	*Calanus glacialis*	CV	5	6
Lander stn.2	09.08.2008	360-260	*Calanus glacialis*	CV	40	Extra
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	AF	3	6
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	AF	30	Extra
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	CV	4	6
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	CV	60	Extra
Lander stn.2	09.08.2008	360-260	*Themisto abysorum*		8	
Shelfbrake stn.	**12.08.2008**	**100-0**	*Calanus glacialis*	CIV	8	2
Shelfbrake stn.	12.08.2008	100-0	*Calanus glacialis*	CV	5	6
Shelfbrake stn.	12.08.2008	100-0	*Themist libelulla*		4	1
Shelfbrake stn.	**12.08.2008**	**740-600**	*Calanus glacialis*	CV	5	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus hyperboreus*	AF	3	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus hyperboreus*	CIV	5	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus hyperboreus*	CV	4	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus hyperboreus*	CV		Extra
Shelfbrake stn.	12.08.2008	740-600	*Themisto abysorum*		2	1
R3 (mooring)	**14.08.2008**	**50-0**	*Calanus glacialis*	AF	10	6
R3 (mooring)	14.08.2008	50-0	*Calanus glacialis*	CIV	15	3
R3 (mooring)	14.08.2008	50-0	*Calanus glacialis*	CV	15	6
R3 (mooring)	14.08.2008	50-0	*Calanus glacialis*	CV	15	
R3 (mooring)	14.08.2008	50-0	*Calanus glacialis*	CV		Extra
R3 (mooring)	**14.08.2008**	**210-125**	*Calanus glacialis*	CV	15	4
Kb3	18.08.2008	50-0	*Calanus glacialis*	CIV	8	3
Kb3	18.08.2008	50-0	*Calanus glacialis*	CV	5	6
Kb3	18.08.2008	50-1	*Calanus glacialis*	CV		Extra
Kb3	18.08.2008	320-200	*Calanus glacialis*	CIV	8	3
Kb3	18.08.2008	320-200	*Calanus glacialis*	CV	5	6
Kb3	18.08.2008	320-200	*Calanus glacialis*	CV		Extra
Kb3	18.08.2008	320-200	*Calanus hyperboreus*	CV	3	6
Kb3	18.08.2008	320-200	*Calanus hyperboreus*	AF	4	6

3. Biomarkers study (together with James Bendle University of Glasgow)

Background:
The Arctic bloom consists of the under ice algae bloom and the phytoplankton bloom. Global estimates of the contribution of the ice algae production to the total micro algae production / primary production varies between 3 to over 50%. Little is also known about the contribution of ice algae and archaea/bacteria to the food of the herbivorous zooplankton. In this study we are investigating the contribution of phytoplankton diatoms, ice algae diatoms, dianoflagellats, *Phaeocystis* and archaea/bacteria to the overwintering population of, *Calanus glacialis* and *Calanus hyperboreus.* We will measure lipid biomarker molecular and isotopic distributions in lipid fatty acids in zooplankton from

different depths and geographical areas in phytoplankton POM, ice POM and in zooplankton in order to reveal the relative contributions from different dietary sources to higher trophic levels.

Method:
POM was filtered from 50L of water at various ice, MIZ and open water sites at shallow (~5m) and deep chlorophyll max depths (James Bendle)

Zooplankton was collected and sorted similar to the lipid samples taken (see method above). Samples have been taken of the following species:
Copepods: *Calanus glacialis*, *C. hyperboreus*
Amphipods: *Themisto libelulla*, *T. abyssorum*
Euphasids: *Thysanoessa inermis*
Pteropods: *Limacina helicina*, *Clione limacine*
Ctenophores: *Beröe cucumis*, *Mertensia ovum*
Fish: *Boreogadus saida* (polar cod)
The samples were placed in -80ºC directly after they were sorted and than freeze dried.

Detailed list of biomarker samples:

Station	Date	Depth (m)	Species	stage	# ind / sample	# replicate
Lander stn.2	**09.08.2008**	**50-0**	*Beröe cucumis*		3	
Lander stn.2	09.08.2008	50-0	*Calanus glacialis*	CV	10	3
Lander stn.2	09.08.2008	50-0	*Clione limacina*		1	
Lander stn.2	09.08.2008	50-0	*Limacina helicina*		1	
Lander stn.2	09.08.2008	50-0	*Mertensia ovum*		5	3
Lander stn.2	09.08.2008	50-0	*Themisto libelulla*		5	2
Lander stn.2	**09.08.2008**	**360-260**	*Calanus glacialis*	CV	10	3
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	AF	10	3
Lander stn.2	09.08.2008	360-260	*Calanus hyperboreus*	CV	10	3
Lander stn.2	09.08.2008	360-260	*Themisto abysorum*		10	2
Lander stn.2	09.08.2008	360-260	*Thysanoessa inermis*		1	
Shelfbrake stn.	**12.08.2008**	**100-0**	*Boreogadus saida*		1	
Shelfbrake stn.	12.08.2008	100-0	*Calanus glacialis*	CV	10	3
Shelfbrake stn.	12.08.2008	100-0	*Clione limacina*		1	
Shelfbrake stn.	12.08.2008	100-0	*Limacina helicina*		1	
Shelfbrake stn.	12.08.2008	100-0	*Mertensia ovum*		3	3
Shelfbrake stn.	12.08.2008	100-0	*Themist libelulla*		4	
Shelfbrake stn.	**12.08.2008**	**740-600**	*Calanus finmarchicus*		15	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus glacialis*	CV	10	3
Shelfbrake stn.	12.08.2008	740-600	*Calanus hyperboreus*	AF	10	3
Shelfbrake stn.	12.08.2008	740-600	*Limacina helicina*		3	
Shelfbrake stn.	12.08.2008	740-600	*Metridia longa*		15	3
Shelfbrake stn.	12.08.2008	740-600	*Themisto abysorum*		5	3
Shelfbrake stn.	12.08.2008	740-600	*Themisto libelulla*		3	
Shelfbrake stn.	12.08.2008	740-600	*Thysanoessa inermis*		1	
R3 (mooring)	14.08.2008	50-0	*Calanus glacialis*	CV	10	3
R3 (mooring)	14.08.2008	50-0	*Clione limacina*		2	

SCIENTIFIC REPORT 16: Radiochemistry

Susan Fitzer, Pauline Learmonth and Tim Brand

Sediment radiochemistry

Solid phase and radionuclide cores were taken at each megacorer station, three replicates from each of three drops. Solid phase analyses encompasses chlorophyll, porosity, trace metals, carbon, hydrogen and nitrogen. Frozen samples are taken back to lab before further analyses. Radionuclide cores are taken for Ra^{226} and Pb^{210} analyses, for mass accumulation rate and sedimentation rate calculations. Processed cores are taken back to the laboratory frozen before further analyses.

Method

Each core sliced at 0.5cm intervals to 10cm, 1cm intervals to 20cm and 2cm intervals thereafter until the whole of the sediment core had been processed. Samples sliced are collected into labelled zip locked plastic bags, and placed into freezer store for transport back to lab. Details of the core sampling are shown in the Table 1 below.

Pelagic radiochemistry

CTD water column samples were taken for pelagic Uranium series radiochemistry. Water column activities of Po^{210}/ Pb^{210} and Th^{234} are used to determine particle flux rates and residence times .Furthermore comparisons of water column and sediment inventories of Pb^{210} provide information of the degree of lateral flow of particles within the water and in particular identifies sediment areas of enhanced or reduced deposition.

Method

120L of CTD water was taken for Ra^{226} at appropriate depths, and then filtered through a single blank 10inch wound polypropylene filter cartridge and two MnO_2 impregnated cartridges. Cartridges will be shipped back for further analyses. Ra^{226} can be determined by Gamma spectroscoy after ashing cartridges.

20L of CTD water was taken for Po^{210} and Th^{234} at the same depths throughout the water column. Po^{210} water was then filtered through 0.45um cellulose nitrate filters to remove particulate Po^{210}, the filtrate collected was then left with Po^{208} and Pb^{206} (stable lead) spikes for ~48hrs, and the dissolved Po210 collected via cobalt nitrate and APDC (ammoniumpyrrolydine dithiocarbamate) chemicals onto a precipitate which was then filtered through a 3um cellulose nitrate filter paper. All filter papers were collected in labelled centrifuge tubes for transporting back to the lab for further processing. Po^{210} can be counted via Alpha spectroscopy after complete digestion of the filter papers, and plating onto silver foil. Details of the pelagic samples are shown in the Table 2 below

The total Th^{234} was precipitated out of the water via a mixture of potassium permanganate and manganese chloride after adding ammonia solution, and then filtered onto a 0.4um nucleopore polycarbonate filter paper. The collected filter papers are left to dry overnight before folding into a 18*18mm sqaure and wraping in parafilm. Th^{234} can be counted via Beta spectroscopy upon return to the laboratory.

Table 1 Sediment radiochemistry Cores

Event no	Station	Date	Latitude	Longitude	Depth	Core letter	Solid Phase	Radionuclides
020	Shelf station 1	01/08/2008	79°43.100N	008°47.875E	458m	**D**	**X**	
020	Shelf station 1	01/08/2008	79°43.100N	008°47.875E	458m	**E**		**X**
022	Shelf station 1	01/08/2008	79°43.100N	008°47.878E	458m	**E**	**X**	
022	Shelf station 1	01/08/2008	79°43.100N	008°47.878E	458m	**F**		**X**
023	Shelf station 1	01/08/2008	79°43.100N	008°47.878E	457m	**A**	**X**	
023	Shelf station 1	01/08/2008	79°43.100N	008°47.878E	457m	**B**		**X**
067	Lander station 2	08/08/2008	80°20.851N	016°20.410E	411m	**E**	**X**	
067	Lander station 2	08/08/2008	80°20.851N	016°20.410E	411m	**H**		**X**
069	Lander station 2	08/08/2008	80°20.920N	016°20.835E	411m	**D**	**X**	
069	Lander station 2	08/08/2008	80°20.920N	016°20.835E	411m	**F**		**X**
070	Lander station 2	08/08/2008	80°20.934N	016°18.225E	393m	**F**	**X**	
070	Lander station 2	08/08/2008	80°20.934N	016°18.225E	393m	**G**		**X**
111	Shelf Edge Station 1	12/08/2008	80°29.28300 N	11°18.37600 E	755m		**X**	
111	Shelf Edge Station 1	12/08/2008	80°29.28300 N	11°18.37600 E	755m			**X**
112	Shelf Edge Station 1	12/08/2008	80°29.35000 N	11°17.69200 E	760m		**X**	
112	Shelf Edge Station 1	12/08/2008	80°29.35000 N	11°17.69200 E	760m			**X**
113	Shelf Edge Station 1	12/08/2008	80°29.35400 N	11°17.73000 E	760m		**X**	
113	Shelf Edge Station 1	12/08/2008	80°29.35400 N	11°17.73000 E	760m			**X**
154	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.23600 E	205m		**X**	
154	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.23600 E	205m			**X**
155	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.23400 E	205m		**X**	
155	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.23400 E	205m			**X**
156	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.24400 E	205m		**X**	
156	Rijpfjordan south	15/08/2008	80°07.45100 N	22°09.24400 E	205m			**X**

Table 2 Pelagic radiochemistry Cores

Event number	Station	Date	Latitude	Longitude	Depth (m)	Volume	Ra226	Po210	Th234
024	Shelf station 1	02/08/2008	79°43.61000 N	08°50.91400 E	**400** **200**	**120** **120**	**X**		
025	Shelf station 1	02/08/2008	79°43.61000 N	08°50.91500 E	**400** **200** **100** **60** **30** **10**	**20** **20** **20** **20** **20** **20**		**X**	**X**
026	Shelf station 1	02/08/2008	79°43.61000 N	08°50.92100 E	**60**	**120**	**X**		
074	Lander station 2 (MIZ)	08/08/2008	80°20.88700 N	16°17.89400 E	380	**120**	**X**		
075	Lander station 2 (MIZ)	08/08/2008	80°20.81600 N	16°17.76500 E	200 60	**120** **120**	**X**		
076	Lander station 2 (MIZ)	08/08/2008	80°20.73600 N	16°17.44600 E	380 200 100 60 30 10	**20** **20** **20** **20** **20** **20**		**X**	
080	Lander station 2 (MIZ)	08/08/2008	80°21.15700 N	16°13.22400 E	380 200 100 60 30 10	**20** **20** **20** **20** **20** **20**			**X**
121	Shelf Edge station	12/08/2008	80°29.78100 N	11°14.91700 E	772	**120**	**X**		
122	Shelf Edge station	12/08/2008	80°29.62000 N	11°14.75200 E	300 60	**120** **120**	**X**		
127	Shelf Edge station	12/08/2008	80°29.25300 N	11°19.27900 E	700 500 200 60 20 10	**20** **20** **20** **20** **20** **20**		**X**	**X**
158	Rijpfjordan south	15/08/2008	80°07.47000 N	22°08.94800 E	198 60	**120** **120**	**X**		
171	Rijpfjordan south	15/08/2008	80°07.46600 N	22°09.18300 E	195 150 60 30	**20** **20** **20** **20**		**X**	**X**

SCIENTIFIC REPORT 17: Benthic Landers and Sediment Geochemistry

Henrik Stahl, Keith Jacksson and Colin Griffiths

1. Introduction

The SAMS benthic landers (Elinor & Profiler) where used to *in situ* investigations of benthic fluxes of oxygen, nutrients and inorganic carbon as well as to make in situ oxygen profiles across the sediment water interface (Fig 1). The Elinor lander is a chamber lander designed for measuring the total exchange of solutes (O_2, Nu and DIC in this case) across the sediment water interface. The Profiler lander is equipped with an array of microelectrodes for measuring micro-distributions of oxygen (100µm resolution) and resistivity across the sediment water interface. The landers where all together deployed 8 times on 4 different stations at depths from ~200-450m depth on the western and northern continental margin of Svalbard (Table 1). The main aim with this study was to investigate in situ benthic mineralization rates along a west-east shelf transect north of Svalbard (Fig 2), going from open water conditions influenced by warmer North Atlantic north-west of Svalbard to the more Polar dominated and ice-covered waters at the north-eastern corner of Svalbard. Two fjords where intensively studied, Kongsfjorden on the westerns side and Ripfjorden on the north-eastern side of Svalbard (Fig 2). A summary of all work carried out at the respective stations is summarized in Appendix 1.

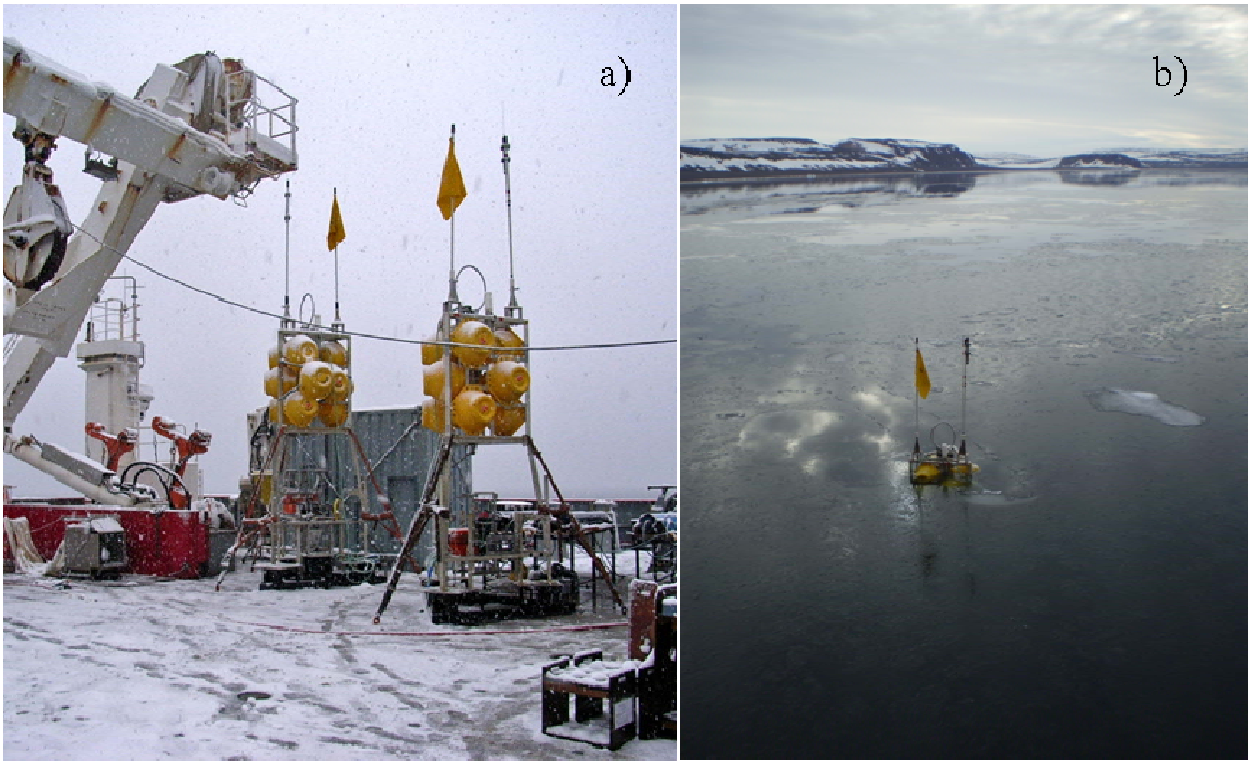


Figure 1. a) Chamber and Profiler lander on the deck of JCR in Rijpfjorden. b) Profiler lander breaking the thin ice after the deployment in Rijpfjorden, NE Svalbard.

Table 1. All lander deployments made during the JCR 210 cruise and their respective stations.

Evt No.	Date	Start (GMT)	End (GMT)	Station	Latitude (N)	Longitude (E)	Depth (m)	Activity	Comments
4	28/07	09:25	10:53	Lofoten	69°00.079	09°59.833	3040	Buoancy test	All spheres ok
16	01/08	~11:00	11:25	Shelf 1	79°43.440	08°50.075	452	Profiler depl.	Ok
17	01/08	~11:30	11:55	Shelf 1	79°43.443	08°49.796	407	Elinor depl.	Ok
22	02/08	12:05	12:32	Shelf 1	79°43.440	08°50.075	449	Profiler recov.	All electrodes broken
23	02/08	12:35	13:15	Shelf 1	79°43.443	08°49.796	449	Elinor recov.	No sediment
31	04/08	09:10	09:20	MIZ 1	80°21.163	16°20.879	410	Elinor depl.	Caught under ice
115	13/08	14:15	14:55	MIZ 1	80°21.324	16°20.500	410	Elinor recov.	No sediment
131	14/08	17:36	17:42	Rijpfj. M.	80°16.880	22°18.339	195	Elinor depl.	Ok
132	14/08	17:57	18:04	Rijpfj. M.	80°16.991	22°18.744	217	Profiler depl.	Ok
134	15/08	08:05	08:32	Rijpfj. M.	80°16.980	22°17.890	~210	Profiler recov.	All electrodes ok
144	15/08	14:07	14:15	Rijpfj. S.	80°07.368	22°29.050	206	Profiler depl.	Ok
157	16/08	05:18	05:35	Rijpfj. M.	80°16.968	22°18.547	218	Elinor recov.	No sediment
159	16/08	13:30	14:00	Rijpfj. S.	80°07.256	22°09.150	206	Profiler recov.	Recovery #3
172	18/08	16:33	16:40	Kongsfj.	78°57.510	11°53.760	357	Profiler depl.	Ok
189	18/08	16:55	17:05	Kongsfj.	78°57.450	11°53.564	357	Elinor depl.	Ok
190	19/08	19:18	19:45	Kongsfj.	78°57.663	11°53.697	~350	Lander recov.	All electrode ok
191	19/08	19:53	20:10	Kongsfj.	78°57.591	11°53.230	~350	Elinor recov.	No sediment

**Shelf 1 = Shelf station 1; MIZ 1 = Marginal Ice Zone 1 (Hinloopen area); Rijpfj. M. = Rijpfjorden Mooring; Rijpfj. S = Rijpfjorden South; Kongsfj = Kongsfjorden (same as Kb3 station on JCR*

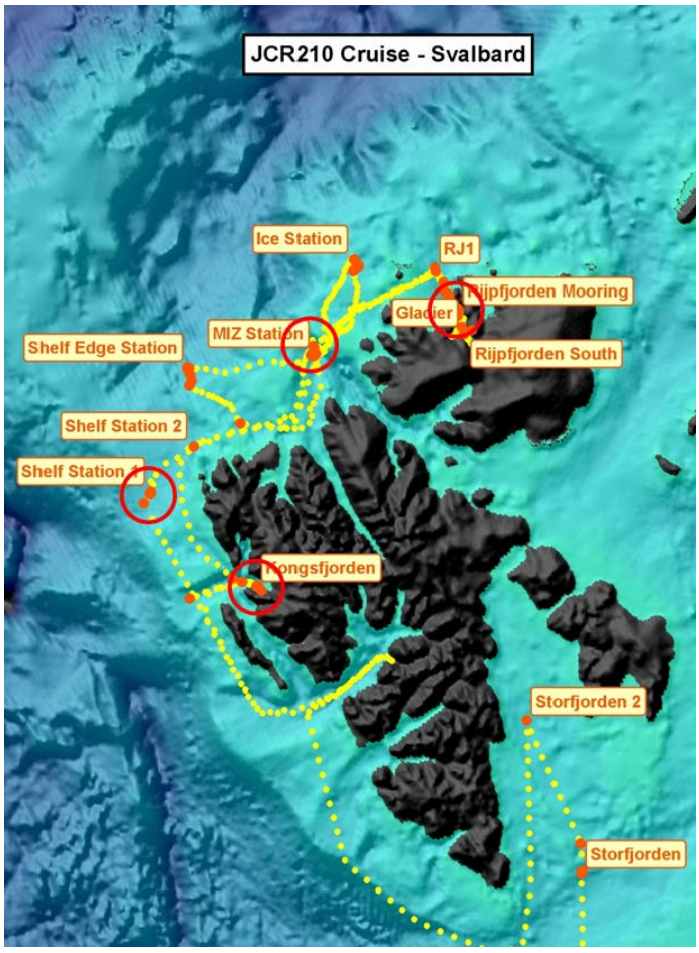


Figure 2. Map showing the cruise track of the JCR 210 and the four main Lander stations (red circles).

2. *In situ* lander deployments

A pre-deployment pressure test was made just north of Lofoten with the lander buoyancy and acoustic releases to make sure they would not fail when pressurized at depth. The two upper lander buoyancy frames including acoustic releases, where mounted together on the winch wire and lowered down to ~3000m depth (Fig 3), well beyond the depth-range at which the landers where to be deployed on the following stations. At depth, all four releases communicated acoustically as they should when contacted from the surface and released without any problem and all the buoyancy spheres where intact when recovered.

2.1 Chamber lander

The chamber lander (Fig 3) was deployed once on each of the four main stations where it recorded bottom water oxygen concentrations as well as fluxes of oxygen in the chamber with the two Aandera optodes (Fig 4). The in situ oxygen fluxes ranged from -10.87 mmol/m^2/d in Kongsfjorden to -0.87 mmol/m^2/d at the MIZ station. Overall, the fluxes decreased the further east the deployment was made. Water samples where also taken from inside the chamber for Nutrients and DIC in Teflon coils using spring-loaded syringes which are to be analysed back at the laboratory. Bottom water samples where also taken with 3 small Niskin bottles. The only problem that occurred with the chamber lander was the sediment recovery. It never managed to bring sediment back to the surface which probably was due to that the low bottom water temperatures changed the viscosity of the hydraulic oil in the rams of the shovel system. On average the chamber lander deployments lasted for ~24hrs on all stations except on the MIZ station where if was deployed during the entire duration of the ice campaign plus one extra day due to ice cover (i.e. 11 days). The lander always responded to the acoustic commands sent from the deck unit at the surface and hence released the ballast without any problems.

Figure 3. Chamber lander being deployed.

2.2 Profiling lander

The profiling lander, equipped with 5 O_2 microelectrodes and 1 resistivity probe, was also deployed 4 times (once at Shelf station 1 and in Kongsfjorden and twice in Rijpfjorden) of which 3 were successful. Unfortunately, all the electrodes where broken during the first deployment at Shelf station 1, most probably due to hitting a hard substrate while profiling. However, nice profiling data was obtained in both Ripfjorden as well as in Kongsfjorden (Fig 5). The two fjords showed a significant difference in the oxygen penetration depths ranging from an average of 3.4mm in Kongsfjorden to 11.1mm in Rijpfjorden. The oxygen profile data supported the chamber flux data from the same stations.

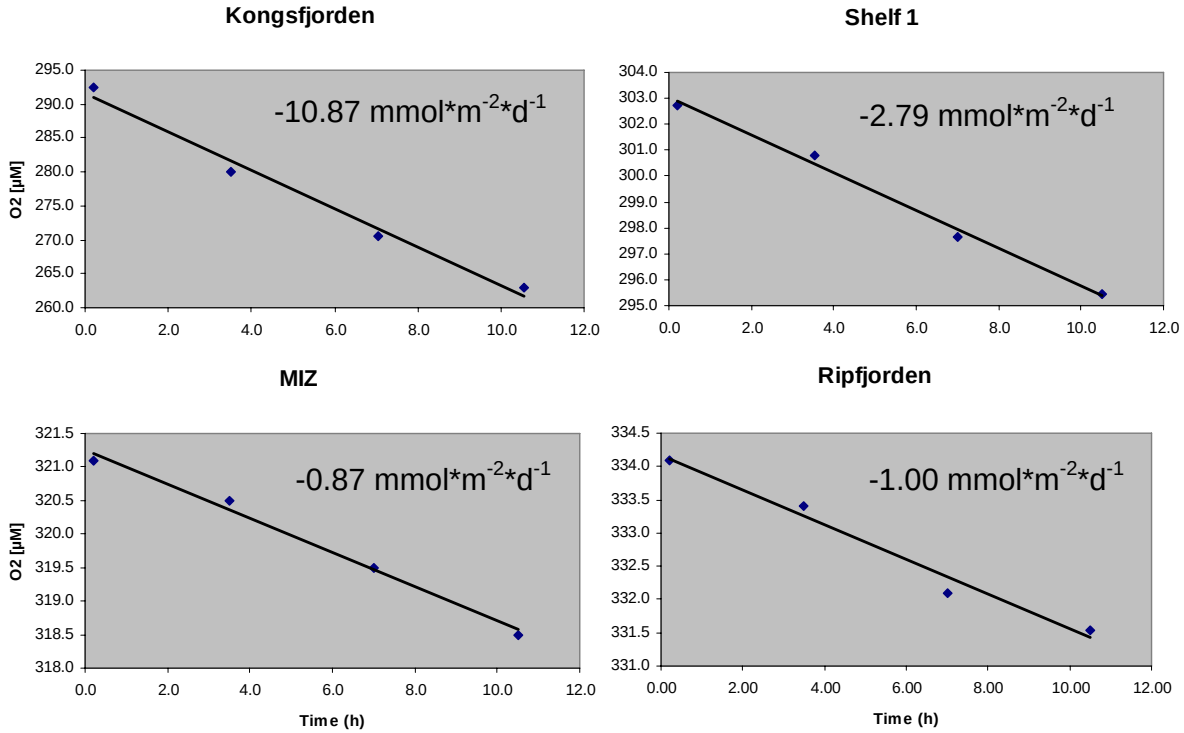


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Figure 4. Benthic O_2 fluxes from the chamber lander at the 4 main stations.

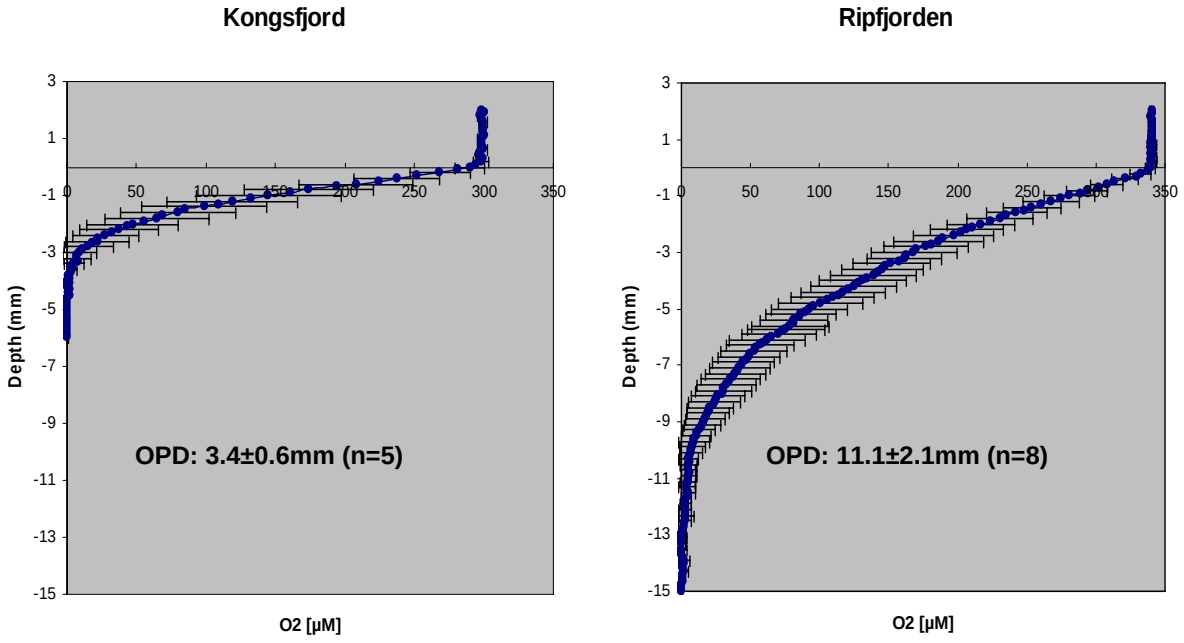

Figure 5. Average oxygen profiles from Kongsfjord and Rijpfjord respectively.

3. *Ex situ* sediment work

In order to support and complement the *in situ* lander measurements as well as to make more detailed studies of anaerobic respiration processes at the various sites, *ex situ* sediment work was carried out in the form of onboard flux incubations of megacores, nitrogen isotope tracer studies of denitrification and anammox activity, sulphate reduction through addition of radiolabelled $^{35}SO_4^{2-}$ (Fig 6) and down core profiles of porewater distributions of nutrients (Fig 7). See also Science Report 18 (page 126).

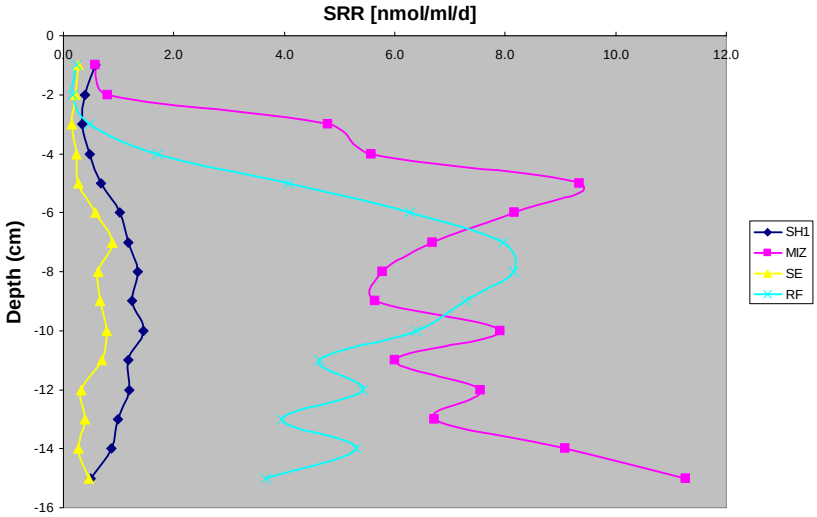

Figure 6. Sulphate reduction rates in the sediment at the 4 different stations.

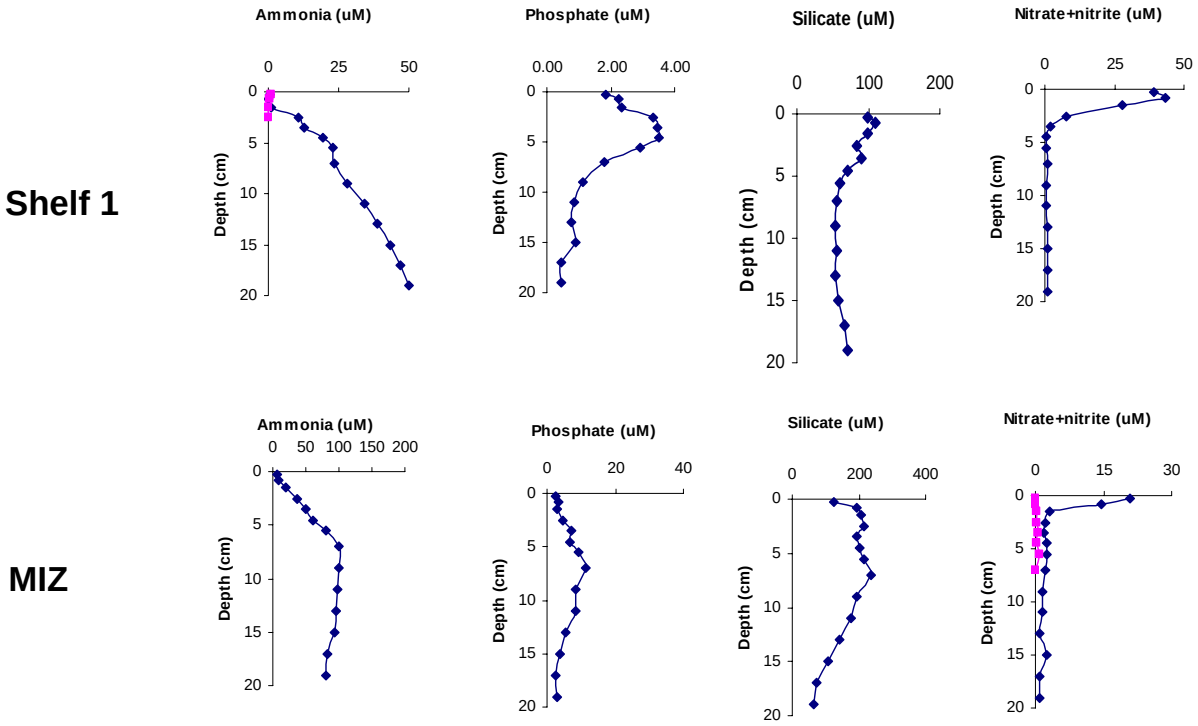

Figure 7. Porewater profiles of nutrients at the Shelf 1 and MIZ stations.

4. Appendix 1 – Summary of the work carried out at the respective stations

	Kongs fjorden	**Shelf station 1**	**Shelf edge**	**MIZ**	**Rip fjorden**
Chamber lander (O2, DIC, Nu)	✓	✓		✓	✓
Profiling lander (O2)	✓	✓			✓
Labincubations (O2, DIC, Nu)		✓	✓	✓	✓
Labprofiling (O2)		✓			✓
PW profiles (Nu, SO4)		✓	✓	✓	✓
Denitrification/ Anamox		✓	✓	✓	✓
Sulphate reduction		✓	✓	✓	✓

SCIENTIFIC REPORT 18: Sediment Sampling

Martyn Harvey

Grab sampling

A van Veen grab was used to assess the sediment suitability for lander and megacorer deployments. Grabs were taken as shown in Table 1:

Megacoring

The Megacorer was deployed at 4 stations to obtain sediment cores These cores were sliced into individual depth horizons to be analysed for radionuclides, solid phase analytes (trace metals, chlorophyll and CHN profiles, particle size analysis, porosity), pore water nutrients and sulphate, benthic fauna, biomarkers and DNA analysis for bacteria and archaea.

Subcores were taken from a further set of cores for oxygen profiling and sulphate reduction rate determination. Cores were also taken for oxygen and nutrient flux, and dentrification rate determination.

The deployments were as shown in Table 2:

Subsequent to shelf station 1 the positions of the cores on the corer were marked with a letter (A-H) so that individual cores could be identified.

Cores were taken for each activity are shown in Table 3:

Two subcores were taken from the cores for Profiling/SO_4 reduction by extruding the cores until approximately 10 cm of overlying water remained above the sediment surface. Perspex tubes were inserted into the sediment to a depth of approximately 15 cm, the remaining volume was filled with overlying water, care being taken to avoid disturbance of the sediment surface. The tubes were capped at the top and carefully removed. Sediment adhering to the outside of the tubes was removed and the tubes capped at the bottom. The subcores were stored in the cold room.

Sulphate reduction rate determination

Small diameter core tubes were predrilled at 1 cm intervals along their length and the ports sealed with silicone adhesive. These were used to obtain a subcore from a megacore. The procedure is described in the megacoring section of this report.

600 kBq (in 5 ul volume) of radiolabelled ^{35}S aqueous sodium sulphate was injected into the sediment through each port down to 15 cm depth. The subcores were returned to the cold room where they were incubated for 24 hours. At the end of this period they were sliced into 1 cm sections. Each slice was transferred to a 50 ml centrifuge tube containing 5 ml of a 20% zinc acetate solution and vortex mixed to halt bacterial activity and fix the sulphide produced during the incubation as insoluble zinc sulphide. The fixed samples were kept in the cold room prior to their return to the laboratory for further analysis.

Table 1 Grab Deployment

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Suitable for deployments
15	01/08	04:50	05:30	Test	79°39.97000 N	08°30.68000 E	500	Grab	Rock caught in jaws	No
16	01/08	08:22	08:55	Shelf Station 1	79°43.50000 N	08°50.01000 E	452	Grab	Mud	Yes
44	04/08	07:15	07:39	Lander Station 2	80°21.15300 N	16°20.89800 E	410	Grab	At bottom at 07:29	Yes
48	05/08	09:09	09:22	Ice Station	80°51.61980 N	19°08.81880 E	99	Grab	Rock in jaws	No
49	05/08	09:25	09:36	Ice Station	80°51.60900 N	19°08.80600 E	100	Grab	Rock in jaws	No
50	05/08	09:38	09:50	Ice Station	80°51.60500 N	19°08.80000 E	100	Grab	Rock in jaws	No
104	11/08	17:40	17:54	Test 2	80°02.71900 N	12°45.81500 E	186	Grab	At bottom at 17:49. Stones	No
105	11/08	23:53	00:23	Test 3	80°22.42000 N	11°08.82000 E	476	Grab	At bottom at 00:08. Stones	No
106	12/08	01:08	01:39	Test 4	80°24.13000 N	11°18.57000 E	498	Grab	At bottom at 01:25. Stones	No
107	12/08	02:26	03:05	Test 5	80°26.46000 N	11°17.72000 E	596	Grab	At bottom at 02:48. Stones	No
108	12/08	07:38	08:14	Shelf Edge Station 1	80°29.30200 N	11°18.84700 E	755	Grab	At bottom at 07:58. Empty	-
109	12/08	08:19	08:55	Shelf Edge Station 1	80°29.29400 N	11°18.73900 E	756	Grab	At bottom at 08:37. Mud	Yes
131	14/08	12:09	12:24	Rijpfjorden South	80°07.47100 N	22°09.22700 E	205	Grab	At bottom at 12:16. Mud	Yes
132	14/08	16:52	17:08	Rijpfjorden Mooring	80°16.87900 N	22°18.32500 E	196	Grab	At bottom at 17:00. Mud + a few stones	Yes
189	18/08	15:59	16:10	Kongsfjorden Kb3	78°57.51000 N	10°53.76000 E	357	Grab	Mud	Yes

Table 2 Megacorer Depolyments

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments	Cores collected
20	01-Aug	12:55	13:15	Shelf Station 1	79°43.10000 N	08°47.87500 E	458	Megacorer	Megacorer001 - on bottom at 13:05	08-Aug
21	01-Aug	13:43	14:04	Shelf Station 1	79°43.10100 N	08°47.88100 E	458	Megacorer	Megacorer002 - on bottom at 13:53	08-Aug
22	01-Aug	14:35	14:55	Shelf Station 1	79°43.10000 N	08°47.87800 E	458	Megacorer	Megacorer003 - on bottom at 14:45	08-Aug
23	01-Aug	15:27	15:47	Shelf Station 1	79°43.10000 N	08°47.87800 E	457	Megacorer	Megacorer004 - on bottom at 15:38	07-Aug
67	08-Aug	08:26	08:50	Lander Station 2	80°20.85100 N	16°20.41000 E	411	Megacorer	Megacorer001 b - on bottom at 08:40	06-Aug
68	08-Aug	09:17	09:38	Lander Station 2	80°21.03300 N	16°19.95200 E	405	Megacorer	Megacorer002 b - on bottom at 09:26	02-Aug
69	08-Aug	11:03	11:23	Lander Station 2	80°20.92000 N	16°20.83500 E	411	Megacorer	Megacorer003 b - on bottom at 11:14	06-Aug
70	08-Aug	12:14	12:33	Lander Station 2	80°20.93400 N	16°18.22500 E	393	Megacorer	Megacorer004 b - on bottom at 12:24	04-Aug
71	08-Aug	12:55	13:13	Lander Station 2	80°20.93300 N	16°18.22700 E	393	Megacorer	Megacorer005 b - on bottom at 13:03	04-Aug
72	08-Aug	13:39	13:57	Lander Station 2	80°20.93300 N	16°18.23000 E	394	Megacorer	Megacorer006 b - on bottom at 13:47	06-Aug
73	08-Aug	14:21	14:39	Lander Station 2	80°20.93400 N	16°18.22300 E	394	Megacorer	Megacorer007 b - on bottom at 14:29	05-Aug
111	12-Aug	09:30	10:02	Shelf Edge Station 1	80°29.28300 N	11°18.37600 E	755	Megacorer	Megacorer001 c - on bottom at 09:47	08-Aug
112	12-Aug	10:25	10:55	Shelf Edge Station 1	80°29.35000 N	11°17.69200 E	760	Megacorer	Megacorer002 c - on bottom at 10:40	08-Aug
113	12-Aug	11:16	11:44	Shelf Edge Station 1	80°29.35400 N	11°17.73000 E	760	Megacorer	Megacorer003 c - on bottom at 11:30	04-Aug
114	12-Aug	12:08	12:36	Shelf Edge Station 1	80°29.35100 N	11°17.64900 E	760	Megacorer	Megacorer004 c - on bottom at 12:23	08-Aug
115	12-Aug	13:04	13:33	Shelf Edge Station 1	80°29.40500 N	11°17.72100 E	763	Megacorer	Megacorer005 c - on bottom at 13:21	08-Aug
152	15-Aug	14:29	14:45	Rijpfjorden South	80°07.45400 N	22°09.23300 E	209	Megacorer	Megacorer001 d - on bottom at 14:36	07-Aug
154	15-Aug	15:45	15:58	Rijpfjorden South	80°07.45100 N	22°09.23600 E	205	Megacorer	Megacorer002 d - on bottom at 15:52	08-Aug
155	15-Aug	16:13	16:26	Rijpfjorden South	80°07.45100 N	22°09.23400 E	205	Megacorer	Megacorer003 d - on bottom at 16:20	07-Aug
156	15-Aug	16:53	17:07	Rijpfjorden South	80°07.45100 N	22°09.24400 E	205	Megacorer	Megacorer004 d - on bottom at 17:00	06-Aug
157	15-Aug	17:33	17:44	Rijpfjorden South	80°07.45000 N	22°09.24000 E	205	Megacorer	Megacorer005 d - on bottom at 17:39	08-Aug

Table 3 Megacore Sample Details

Event no	Station	Radionuclides/ Solid phase	Benthic fauna	Incubation	Profiling/ SO_4 reduction	Bacteria/ Archaea	Biomarkers
020	Shelf station 1	2	3	2	1		
021	Shelf station 1		4	2		1	
022	Shelf station 1	2	4		1	1	
023	Shelf station 1	2		2	1	1	1
067	Lander station 2	EH	BFG	D			
068	Lander station 2			DG			
069	Lander station 2	DF	EGH	AB			
070	Lander station 2	FG	EH				
071	Lander station 2			A	D	H	
072	Lander station 2		BCH		A	D	G
073	Shelf Edge Station 1				D		
111	Shelf Edge Station 1	AC	BDE		H	G	F
112	Shelf Edge Station 1	CH		FG	E	A	
113	Shelf Edge Station 1		ABEF				
114	Shelf Edge Station 1	AH		BF	E		
115	Shelf Edge Station 1		CDG	BE	F		
152	Rijpfjorden south	CF	AEG		B	H	
154	Rijpfjorden south	FG		BCH	E		
155	Rijpfjorden south	EF	BGH	CD			
156	Rijpfjorden south			G		H	D
157	Rijpfjorden south	AEG			D	H	

SCIENTIFIC REPORT 19: Benthic Biology

Peter Lamont

Objectives

The principle aims of benthic sampling on this first cruise are to acquire enough information about the benthic fauna to provide biomass estimates for the overall model and to aid interpretation of the lander flux and other geochemistry results.

Methods

All benthic samples sieved on ship were washed on a 300 micron mesh. One cm sections were not washed on ship partly due to time limitations and partly as a precaution in case it was decided later to screen for meiofauna

A total of 44 megacores were collected from four principle stations. One megacore from each deployment collected for macrobenthos was horizontally sectioned at one centimetre intervals to five cm then the next five then ten cm (represented by the notation 1,1,1,1,1,5,10). The remaining cores were sectioned at 5, 5 and10cm. In some cases just the upper ten centimetres was taken. No megacores were collected from the Ice Station (ICE) but rocks with epifauna were retained from three Van Veen grabs #48, 49 and 50. In total six Van Veen grab sediment samples were collected as appropriate. Benthic samples are summarized in table ben1.

An attempt as made to collect a species of foraminifera, Globulina sp., downcore for N analysis but there were insufficient numbers in the sample to make this a viable experiment. Many animals were photographed under the binocular microscope and some in situ on the core surface.

Observations

Shelf Station 1 (SS1)

The fauna was dominated by a tube forming maldanid polychaete species and by an agglutinated foraminifera species possibly Hyperammina (Figs ben1 and ben2).
A Van Veen grab was not collected at this station.

Ice Station (ICE)

Rocks with epifauna including sponges and hydroids were collected from three grabs including a blue sponge, Fig. ben3.

Marginal Ice Zone (MIZ)

A Van Veen grab sample (cruise event #44) was dominated by polychaete tubes and also contained many amphipods. A cushion star of c8cm diameter was found in one core (#72 C) and another specimen in a Van Veen grab (#44) which suggests it is an abundant species of megafauna at this MIZ station (Fig. ben4).

Shelf Station 2 (SS2)
Filter feeding animals were prominent most notably sabellid polychaetes, Fig. ben5 and a small, white sea pen, Fig ben6. Small (1cm span) sea spiders were also found. Several perforated tubes were found, Fig. ben7a and ben7b. These are about 0.5mm diameter and up to 15mm high and have been observed elsewhere to stand vertically up from the sediment. The same, or a very similar species has been found in samples from the Setubal Canyon, 3,400m, on the Iberian margin and also on the Porcupine Abyssal plain, 5,000m as well as elsewhere by other colleagues (L.Levin pers. comm.). This organism was undescribed in 1998 and at that time prompted disagreement as to its classification. Several photographs were taken and the obvious specimens picked carefully off the sediment. As far as is known it remains undescribed (A. Gooday pers. comm.).

Rijpfjorden
The upper sediment was soft and a distinctly reddish brown with a blackish deeper layer. Brittle stars, Fig. ben8 and a deep burrowing anenome, found at about 20 cm, were encountered, Fig ben9a and ben9b. Some Gromiidae (Foraminifera)were observed on the sediment surface and two recovered separately with rhizopoda still attached, Fig. ben10 and ben11. Also observed on the sediment surface was a long legged isopod, Fig. ben12

Future work
Samples will be processed for major taxa and biomass measurements and in addition some downcore dispersion data will become available.

Table 1 Benthic samples collected. Cruise stations listed as SS1, shelf station 1; SS2, shelf station 2; MIZ, marginal ice zone; ICE, ice station; RIP, Rijpfjorden. SS1 cores were numbered as I, II etc. but subsequent megacores are labelled as A, B etc. according to marked corer frame positions (A to H clockwise). Core sectioning interval numbers indicate slices in cm eg. 1,1,1,1,1,5 = 0-1, 1-2, 2-3, 3-4, 4-5, 5-10 cm downcore.

Cruise Stn.	Deployment	Depth	Gear	SAMS No.	Date	N	W / E	Notes
SS1	#20	458	MGC	1423	08.08.01	79 43.100	8 47.875	I @ 1,1,1,1,1,5; II @ 5,5; III @ 5,5,10cm
SS1	#21	458	MGC	1424	08.08.01	79 43.107	8 47.881	I, II, III, IV @ 5,5cm
SS1	#22	458	MGC	1425	08.08.01	79 43.100	8 48.878	I, II, III @ 10cm (I @ 5,5 labelled as 1425 but probably 1424)
MIZ	#44	410	VV	1426	08.08.04	80 21.153	16 20.898	fresh sieved on 300 micron then fixed; many polychaete tubes and many amphipods
ICE	#48+49+50	99	VV	1427		80 51.6198	019 08.8188	rocks and fauna retained from stones caught in van Veen jaws: mostly #48
MIZ	#67	411	MGC	1428	08.viii.08	80 20.85	016 20.41	B @ 5,5,10; F @ 5,5,10; G @ 5 (11111?),5,10;
MIZ	#69	411	MGC	1429	08.viii.08	80 20.920	016 20.835	G @ 11111,5,10; E&H @ 5,5
MIZ	#72	394	MGC	1430	08.viii.08	80 20.933	016 18.230	B&C @ 5,5; H @ 11111,5,10
MIZ	#73		MGC	1431	?	?	?	A&G 5,5,10; C 5,5
SS2	#104	186	VV	1432	08.08.11	80 02.719	012 45.815	this sample done before 1431 so possibly has 1431 number on some labels
SS2	#109	756	VV	1433		80 29.294	011 18.739	
SS2	#111	755	MGC	1434	08.08.12	80 29.283	011 18.376	B @ 1,1,1,1,1,5,10; D&E @ 5,5
SS2	#113	760	MGC	1435	08.08.12	80 29.354	011 17.730	short cores, A @ 1,1,1,1,1,5; B,E&F @ 5,5; sabellid x2, sea pen, perforated tube
SS2	#114	760	MGC	1436	08.08.12	80 29.351	011 17.649	C,D&G @ 5,5
SS2	#115	763	MGC	1437	?	80 29.405	011 17.721	D @ 1,1,1,1,1,5,10; C&G @ 5,5
RIP	#131	205	VV	1438	08.08.14	80 07.471	022 09.227	sieved fresh
RIP	#132	196	VV	1439	08.08.14	80 16.879	022 18.325	one large stone & many small, hydroids + blue sponge, scale wor picked off.
RIP	#152	209	MGC	1440	08.08.15	80 07.454	022 09.233	A&G @ 5,5; brittle star picked off
RIP	#155	205	MGC	1441	08.08.15	80 07.451	022 09.234	B@ 1,1,1,1,1,5,10; G&H @ 5,5 brittle stars, 'silt' picked off
RIP	#156	205	MGC	1442	08.08.15	?	?	D @ 0-10 taken two days after.
RIP	#157	205	MGC	1443	08.08.15	80 07.450	022 09.240	E@ 1,1,1,1,1,5,10; A&G@ 5,5; gromids and burrowing anenome

Fig. 1 maldanid

Fig. 2 Hyperammina?

Fig. 3 rock with epifauna

Fig. 4 cushion star


Fig. 5 sabellid polychaete

Fig. 6 sea pen

Fig. 7a perforated tube Background grid scale is 2mm.

Fig. 7b perforated tube detail

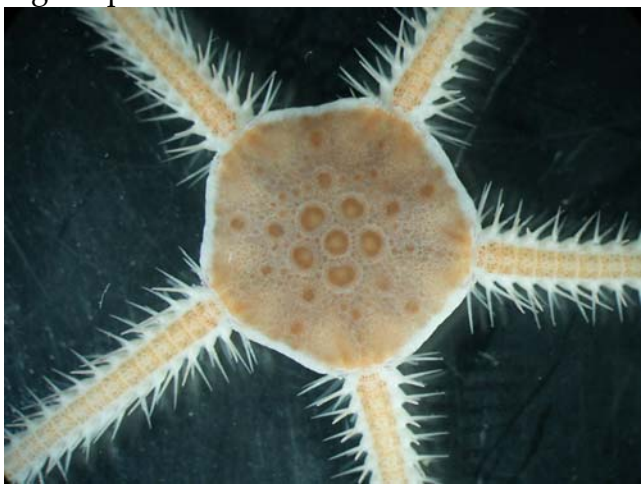

Fig. 8 RIP brittlestar

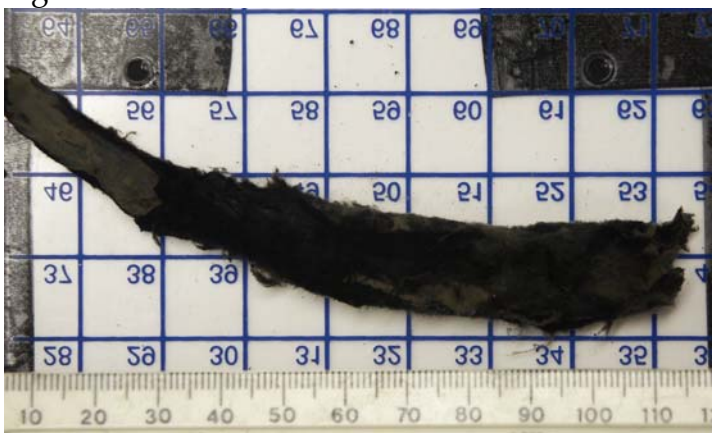

Fig. 9a RIP deep burrow anenome

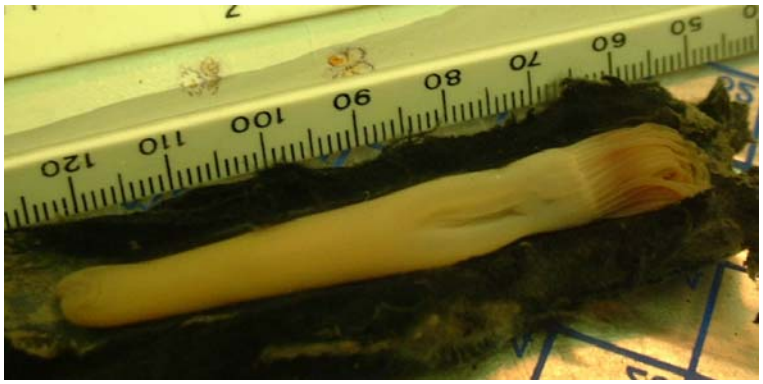

Fig. 9b

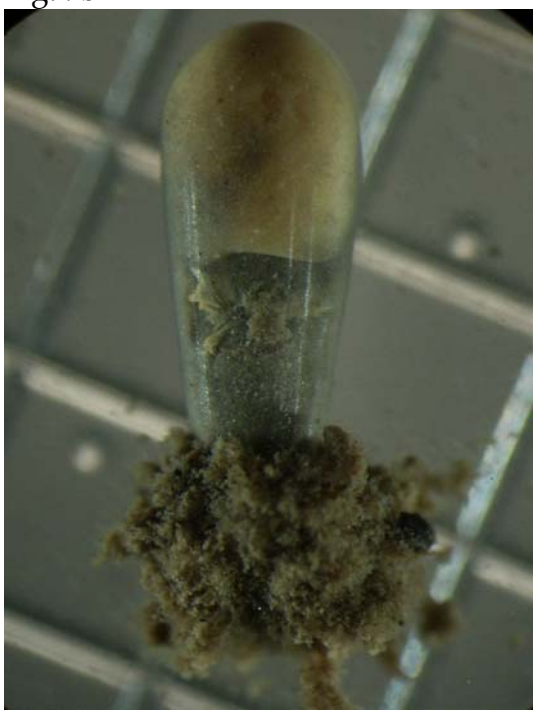
Fig. 10 gromid. Background grid scale is 2mm.

Fig. 11 gromid. Background grid scale is 2mm.

Fig. 12 long legged isopod. Background grid scale is 2mm.

SCIENTIFIC REPORT 20: Organic Geochemical Biomarkers

James Bendle

Rationale: Most palaeoclimate proxy records are concentrated in the mid- to low-latitudes, far fewer records are available from the sub-polar and polar environments. However, recent advances in biomarker techniques mean that there are now available a number of proxies which can be applied to reconstruct climate variables from polar and sub-polar environments. The aim of the sampling strategy is to examine the link between distribution of these proxies to their precursor organisms and modern environmental parameters. This will give insights into modern biogeochemical processes and will help to refine their palaeoceanographic application. The objective is to collect samples to conduct a full organic geochemical investigation of the biomarker distributions in the recent sediment, sea-water and sea-ice samples and to collaborate with marine microbiologists to conduct *in-situ* measurements and experiments to identify precursor organisms and to calibrate/tune the biomarker proxies to measured environmental, climate and hydrological data.

POM : Seawater was drawn from the CTD Niskin-bottles and collected in 50 litre carboys. Using a siphoning system and vacuum pump the water was drawn from the carboys into 5 filter holders, each containing a Millipore filter (Whatman GF/F, diam. 4.7 cm, pore size 0.7 µm; pre-fired at 450˚C). Between 5 and 12 filters were used for each sample. Large copepods were removed from the filters using clean forceps, to avoid interferences with subsequent chromatography. The filters were placed in aluminium foil (pre-fired at 450˚C) and freeze dried onboard. When the filters were dry, the aluminium foil envelopes were placed in Whirl-Paks and stored for future analysis. Details of the POM samples collected during JR210 are listed in Table 1.

Zooplankton: Zooplankton were collected by Stig Falk-Petersen and Anette Wold using the methods described in science report 15 (page 112). Details of the zooplankton samples dedicated for organic geochemical analyses are listed in Table 2. Following separation of the individuals into groupings of the same species, the samples were freeze-dried and stored for work-up at Glasgow. At the time of writing, sample work up and initial analyses had been performed on the zooplankton samples. The freeze-dried zooplankton were homogenised, extracted and analysed using standard organic geochemical methods. Preliminary data from the zooplankton biomarker analysis were presented in a poster at the AGU fall meeting in San Francisco, December 2009. A copy of the poster is included below.

Ice-cores: Two sea-ice cores were collected on the 7th of August 2008 at the JR210 ice station (80°48.15470 N; 19°06.47500), using the methods described in science report 151(page 95). The cores were placed in clean aluminium foil (pre-fired at 450˚C) and stored in the on-board 20˚C freezer. The outer surfaces of the cores were cleaned with dicloromethane (DCM) and cut into sections using a DCM cleaned saw. The ice-core sections were then placed into buckets (pre-cleaned with acid and DCM) and allowed to melt at room temperature then filtered using the same apparatus and methods as the POM samples. Details of the ice-core samples collected during JR210 are listed in Table 3.

Poster presenting preliminary data at AGU Fall Meeting, San Francisco, December 2009.

Stable carbon isotopes of lipids as a tool to differentiate between pelagic and ice algae as a food source for zooplankton in the Arctic Ocean.

Heiko Moossen[1], Robert Jamieson[1], Stig Falk-Petersen[2], Anette Wold[2], Douglas Morrison[3], James Bendle[1]

[1] G-MOL, Department of Geographical and Earth Sciences, University of Glasgow, Gregory Building, G12 8QQ, Glasgow, UK
[2] Norwegian Polar Institute, Polar Environmental Centre, NO-9296, Tromsø, Norway
[3] Scottish Universities Environmental Research Centre, Scottish Enterprise Technology Park, G75 0QF, East Kilbride, UK

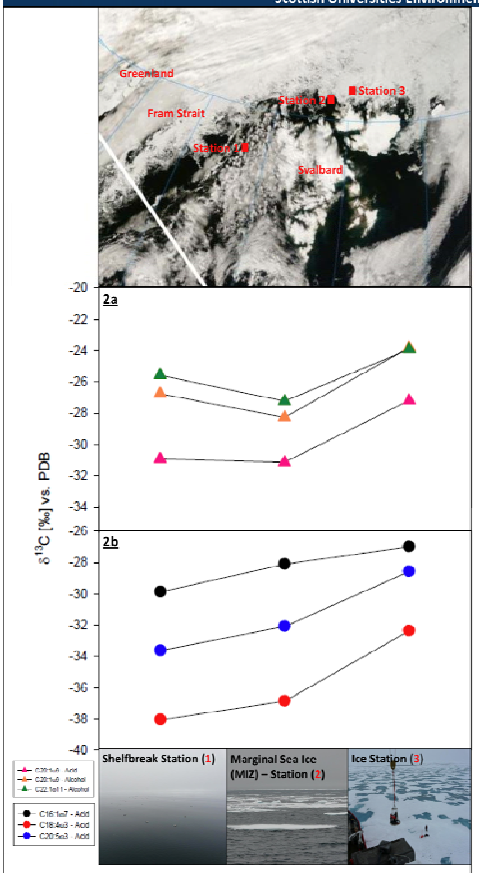

Figure 2:

δ^{13}C-values of six different wax ester components from three different sites (1, 2 and 3) with varying ice cover extracted from *Calanus Glacialis*.

2a: Wax ester components which are synthesised by *Calanus Glacialis* itself (triangles).

2b: Fatty acid trophic markers (FATM) which are produced by phytoplankton and travel through trophic levels unaltered (circles).

Satellite photo showing Svalbard on the 02.08.2008 courtesy of NASA.

Photos of the stations were taken on the cruise by Dr. James Bendle.

Motivation

Latest scientific models show that as early as 90 years from now, the Arctic Ocean could be free of sea ice during part of the summer [1]. Sea ice constitutes an important habitat for photosynthesising algae, which form the base of the food chain in the Arctic (Figure 1). As zooplankton grazes on phytoplankton it accumulates large stores of specialised lipids which are the major energy source for subsequent trophic levels [2]. How important are ice algae as a food source for zooplankton in areas of varying ice cover?

Background

In order to answer this question, our understanding of the relative importance of ice algae vs. pelagic algae as a food source for zooplankton must be refined.
Much of the organic matter taken up by zooplankton during feeding is structurally altered before being stored in lipid reservoirs. Some molecules which are specific to certain species of the phytoplankton community are introduced into the zooplankton lipid stores without being altered [3]. These molecules, known as trophic markers, can be used to understand linkages in the food chain (Figure 3).
Sea ice algae live in brine vesicles and channels in the first few centimetres above the ice-water interface. Due to a limited CO_2 supply within these vesicles, lipids produced by ice algae contain more of the heavy carbon isotope compared to those of pelagic phytoplankton [4]. Thus phytoplankton grazers have access to lipids of two carbon pools with distinctly different isotopic signatures [5].

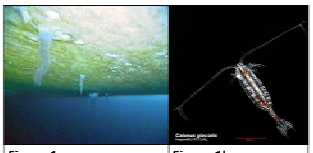

Figure 1a:
Ice Algae covering the underside of ice in the Arctic Ocean. Photo by: Douglas Allan.

Figure 1b:
Marine copepod *Calanus Glacialis*; Source: http://www.arcodiv.org

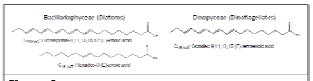

Figure 3:
Trophic markers for two phytoplankton classes which dominate sea ice communities (Figure 2b).

Results

We analysed the carbon isotopic signature of wax ester components of *Calanus Glacialis* (Figure 1b) samples from areas with varying amounts of sea ice, and therefore varying amounts of ice algae, in order to elucidate whether δ^{13}C-values of different wax ester components can be used to differentiate between pelagic and ice algae as a food source for zooplankton.

➢The δ^{13}C-values of compounds which are biosynthesised by *Calanus Glacialis* at the Shelfbreak Station , (C20:1w9-alcohol, C20:1w9-acid and C22:1w11-acid; Figure 2a, Triangles) are more negative compared to the samples from the Ice Station. MIZ-Station δ^{13}C-values do not follow the general trend.

➢Our analysis show that the trophic markers (Figure 2b, Circles), $C_{16:1\omega7}$-acid, $C_{18:4\omega3}$-acid and $C_{20:5\omega3}$-acid all exhibit a trend towards heavier carbon isotope signatures as the sea ice cover increases suggesting different carbon sources .

Conclusions

➢**Fatty acids found in zooplankton living under sea ice have a markedly heavier carbon isotopic signature than those found in zooplankton living in pelagic environments.**

➢**Trophic markers preserve their carbon isotopic composition as they pass from one trophic level to the next.**

➢**Wax components which are biosynthesised by zooplankton exhibit a heavier stable carbon isotopic signature than those which are directly incorporated into the wax from the prey.**

➢**Biosynthesised wax components exhibit the same trend towards heavier carbon isotopic values in ice covered areas as trophic markers do.**

➢**Analysis of stable carbon isotopes of wax ester components of zooplankton is a useful tool to differentiate between pelagic phytoplankton and ice algae as food source for zooplankton.**

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SAGES Scottish Alliance for Geoscience, Environment and Society
Heiko Moossen: h_moossen@hotmail.com
http://www.ges.gla.ac.uk:443/postgraduates/hmoossen
SUERC Scottish Universities Environmental Research Centre

Sediments: Megacorers were collected during JR210 under the direction of Martyn Harvey, using the methods described in science report 18 (page 126). Two megacorers were sub-sampled for organic geochemical analysis during the cruise (see Table 4, further cores may be sampled post-cruise). The ca.20 gram subsamples were cut every 1cm by top slicing sediment, using a DCM cleaned knife, as it was extruded from the top of a megacorer barrel. The subsamples were placed in clean aluminium foil (pre-fired at 450˚C) envelopes, then Whirl-Pak bags and freeze-dried onboard for storage.

Table 1: POM samples acquired during JR210 aboard the RRS James Clark Ross for organic geochemistry

Evt No.	Organic Geochemistry Sample Name	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	CTD number	Sampling Depth	Water Filtered (L)
1	JR210-1-QFF-6m	24/07	07:50	08:04	English Channel	50°46.43563 N	00°45.18598 E	CTD001	6m	23
‘’	JR210-1-QFF-25m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	25m	23
2	JR210-2-QFF-6m	25/07	05:08	05:22	Southern North Sea	54°12.43787 N	02°36.61785 E	CTD002	6m	46
‘’	JR210-2-QFF-15m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	15m	44
3	JR210-3-QFF-6m	26/07	05:02	05:21	Northern North Sea	58°47.98040 N	03°14.97760 E	CTD003	6m	45
‘’	JR210-3-QFF-27m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	27m	49
6	JR210-6-QFF-6m	28/07	11:39	11:57	Lofoten	69°00.08016 N	09°59.83358 E	CTD004	6m	45
‘’	JR210-6-QFF-15m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	15m	46
7	JR210-7-QFF-6m	30/07	04:10	04:36	Storfjorden	76°28.80340 N	18°59.92166 E	CTD005	6m	46
‘’	JR210-7-QFF-40m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	40m	47.5
17	JR210-17-QFF-6m	01/08	09:24	10:02	Shelf Station 1	79°43.49000 N	08°50.07800 E	CTD006	6m	46
‘’	JR210-17-QFF-25m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	25m	45
29	JR210-29-QFF-23.5m	02/08	11:14	11:24	Shelf Station 1	79°43.60900 N	08°50.91000 E	CTD010	23m	47
42	JR210-42-QFF-1m	03/08	09:20	09:48	Shelf Station 1	79°43.47500 N	08°49.97200 E	CTD014	1m	36
‘’	JR210-42-QFF-5m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	5m	37
‘’	JR210-42-QFF-30m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	30m	18
51	JR210-51-QFF-96m	05/08	13:14	13:25	Ice Station	80°51.53500 N	19°08.92400 E	CTD016	96m	27.6
53	JR210-53-QFF-5m	06/08	10:41	11:12	Ice Station	80°48.38400 N	19°12.27700 E	CTD017	5m	49.5
‘’	JR210-53-QFF-20m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	20m	49
‘’	JR210-53-QFF-30m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	30m	48
93	JR210-93-QFF-2m	10/08	07:40	07:55	MIZ Station	80°21.73500 N	16°17.09200 E	CTD027	2m	40
‘’	JR210-93-QFF-8m	‘’	‘’	‘’	‘’	‘’	‘’	‘’	8m	38.5
94	JR210-94-QFF-27m	10/08	11:07	11:18	MIZ Station	80°21.47300 N	16°15.08200 E	CTD028	27m	48
144	JR210-144-QFF-30m	15/08	06:50	07:20	Rijpfjorden Mooring	80°16.97000 N	22°17.75400 E	CTD034	30m	35
163	JR210-163-QFF-2m	16/08	06:41	06:57	Rijpfjorden Mooring	80°16.97000 N	22°18.54500 E	CTD038	7m	40
163	JR210-163-QFF-7m	16/08	06:41	06:57	Rijpfjorden Mooring	80°16.97000 N	22°18.54500 E	CTD038	2m	41
165	JR210-165-QFF-27m	16/08	09:38	09:49	Rijpfjorden Mooring	80°16.91800 N	22°18.79900 E	CTD039	27	50

Table 2: Zooplankton samples acquired during JR210 aboard the *RRS James Clark Ross* for organic geochemistry

Collection Date	Species	Depth (m)	Stage	# ind	Lat	Long	Station	Mass of Ground Sample (g)	Dry Mass of extract (g)	Dry Mass of extract (mg)	Extract as Percentage of Total
09/08/2008	Calanus Glacialis	50-0	CV	10,10,10	80.2828	22.2959	Lander Station 2	0.0143	0.0061	6.1	42.66%
09/08/2008	Clione Limacina	50-0		1	80.2828	22.2959	Lander Station 2	0.0132	0.0055	5.5	41.67%
09/08/2008	Limacina Helicina	50-0		1	80.2828	22.2959	Lander Station 2	0.0125	0.0031	3.1	24.80%
09/08/2008	Themisto Libellula	50-0		5,5,5?	80.2828	22.2959	Lander Station 2	0.0696	0.0096	9.6	13.79%
09/08/2008	Calanus Glacialis	360-260	CV	10,10,10	80.2828	22.2959	Lander Station 2	0.0205	0.0104	10.4	50.73%
09/08/2008	Calanus Hyperboreus	360-260	AF	10,10,10	80.2828	22.2959	Lander Station 2	0.0908	0.0540	54.0	59.47%
09/08/2008	Calanus Hyperboreus	360-260	CV	10,10,10	80.2828	22.2959	Lander Station 2	0.0935	0.0547	54.7	58.50%
09/08/2008	Themisto Abysorum	360-260		10,10	80.2828	22.2959	Lander Station 2	0.0261	0.0079	7.9	30.27%
09/08/2008	Thysanoessa Inermis	360-260		1	80.2828	22.2959	Lander Station 2	0.0494	0.0282	28.2	57.09%
12/08/2008	Boreogadus Saida	100-0		1	79.7268	8.8485	Shelfbrake Station	0.1497	0.0203	20.3	13.56%
12/08/2008	Calanus Glacialis	100-0	CV	10,10,10	79.7268	8.8485	Shelfbrake Station	0.0197	0.0094	9.4	47.72%
12/08/2008	Clione Limacina	100-0		1	79.7268	8.8485	Shelfbrake Station	0.0316	0.0213	21.3	67.41%
12/08/2008	Limacina Helicina	100-0		1	79.7268	8.8485	Shelfbrake Station	0.0468	0.0152	15.2	32.48%
12/08/2008	Themisto Libellula	100-0		4	79.7268	8.8485	Shelfbrake Station	0.0575	0.0167	16.7	29.04%
12/08/2008	Calanus Finmarchicus	740-600	(CV)	15,15,20	79.7268	8.8485	Shelfbrake Station	0.0196	0.0100	10.0	51.02%
12/08/2008	Calanus Glacialis	740-600	CV	10,10,10	79.7268	8.8485	Shelfbrake Station	0.0161	0.0090	9.0	55.90%
12/08/2008	Calanus Hyperboreus	740-600	AF	10,10,10	79.7268	8.8485	Shelfbrake Station	0.0780	0.0409	40.9	52.44%
12/08/2008	Limacina Helicina	740-600		3	79.7268	8.8485	Shelfbrake Station	0.0566	0.0178	17.8	31.45%
12/08/2008	Metrida Longa	740-600		15,15,20	79.7268	8.8485	Shelfbrake Station	0.0130	0.0059	5.9	45.38%
12/08/2008	Themisto Abysorum	740-600		5,5,5	79.7268	8.8485	Shelfbrake Station	0.0275	0.0097	9.7	35.27%
12/08/2008	Themisto Libellula	740-600		3	79.7268	8.8485	Shelfbrake Station	0.0264	0.0082	8.2	31.06%
12/08/2008	Thysanoessa Inermis	740-600		1	79.7268	8.8485	Shelfbrake Station	0.0058	0.0034	3.4	58.62%
14/08/2008	Calanus Glacialis	50-0	CV	10,10,10	80.3623	16.2849	R3 (Mooring)	0.0161	0.0090	9.0	55.90%
14/08/2008	Clione Limacina	50-0		2	80.3623	16.2849	R3 (Mooring)	0.0600	0.0245	24.5	40.83%
14/08/2008	Calanus Hyperboreus	50-0	CV	6	80.3623	16.2849	R3 (Mooring)	0.0156	0.0094	9.4	60.26%

Table 3: Ice-core samples acquired during JR210 aboard the *RRS James Clark Ross* for organic geochemistry

Organic Geochemistry Sample Name	Date	Station	Latitude	Longitude	Sampling Depth	Water Filtered (L)
JR210-SIC-1	07/08	Ice Station	80°48.28400 N	19°11.51900 E	0-30cm	1.685
''	''	''	''	''	30-60cm	1.855
''	''	''	''	''	60-90cm	1.625
''	''	''	''	''	90-120cm	1.880
JR210-SIC-2	07/08	Ice Station	80°48.28400 N	19°11.51900 E	0-30cm	1.350
''	''	''	''	''	30-60cm	1.710
''	''	''	''	''	60-90cm	2.000
''	''	''	''	''	90-120cm	1.850

Table 4: Megacores sub-sampled for organic geochemistry during JR210 aboard the *RRS James Clark Ross*.

Evt No.	Date	Start Time (GMT)	End Time (GMT)	Station	Latitude	Longitude	Depth (m)	Activity	Comments
72	08/08	13:39	13:57	MIZ Station	80°20.93300 N	16°18.23000 E	394	Megacorer	Megacorer006b - 6/8 - on bottom at 13:47
111	12/08	09:30	10:02	Shelf Edge Station	80°29.28300 N	11°18.37600 E	755	Megacorer	Megacorer001c - 8/8 - on bottom at 09:47

SCIENTIFIC REPORT 21: Multibeam Bathymetry

Kate McIntyre

Detailed maps of the sea-floor can be produced using multibeam bathymetry. The system works by directing a fan-shaped array of sound beams downwards and outwards from the ship to the sea-floor and measuring the time taken for the echoes to return to the transducer. Sound pulses are transmitted at approximately 12 kHz as the ship progresses, producing depth profiles which are stacked together to produce a three-dimensional bathymetric map. Such maps are of paramount value in establishing deep-water pathways, and in identifying submarine glacial features which allow glacial dynamics to be better understood. They are also of wider benefit to the shipping community as an aid to navigation.

During this cruise, the ship's Kongsberg Simrad EM120 multibeam system was run continuously, gathering bathymetric data on an opportunistic basis (surveys jr210_a, jr210_b and jr210_c). Additionally, data was gathered from Storfjorden (southern Spitzbergen), Nordkapp and Rijpfjorden (both Nordaustlandet).

Storfjorden

Survey jr210_b_Storfjorden was carried out at the request of Finlo Cottier, Scottish Association for Marine Science (SAMS). It consisted of a single swath line running northward into the fjord up to the SAMS mooring and south again. The line follows the charted 250m contour line out of Storfjorden and northward along the west Spitzbergen margin. It then turns into Isfjorden, terminating at Longyearbyen. Additional lines were added within Storfjorden at the two Plymouth Oceanographic Laboratory (POL) mooring sites, at approximately 76º29'N, 19º00'E and 76º40' N, 19º15'E.

Nordkapp

Survey Nordkapp was carried out at the request of the Captain, through shallow waters between islands in the Nordkapp region north of Nordaustlandet. The survey consisted of a single line running from approximately 80º33'N, 19º35'E to 80º33'N, 21º05'E. Data became increasingly noisy to the east as the ship entered heavy ice cover. Heavier ice conditions meant that this survey could not be added to on the return journey.

Rijpfjorden

Survey jr210_Rijpfjorden was carried out at the request of Finlo Cottier, SAMS. Extensive work being carried out in the fjord meant that several swath lines were obtained, particularly between the two study sites in the north and south of the fjord. Additional lines were obtained near the glacier in the north-west for a PhD project (Kate McIntyre, SAMS). The bathymetry of Rijpfjorden had not been previously mapped and it is expected that this new data will be of considerable value in furthering the understanding of water exchange between the fjord and the wider Arctic Ocean.

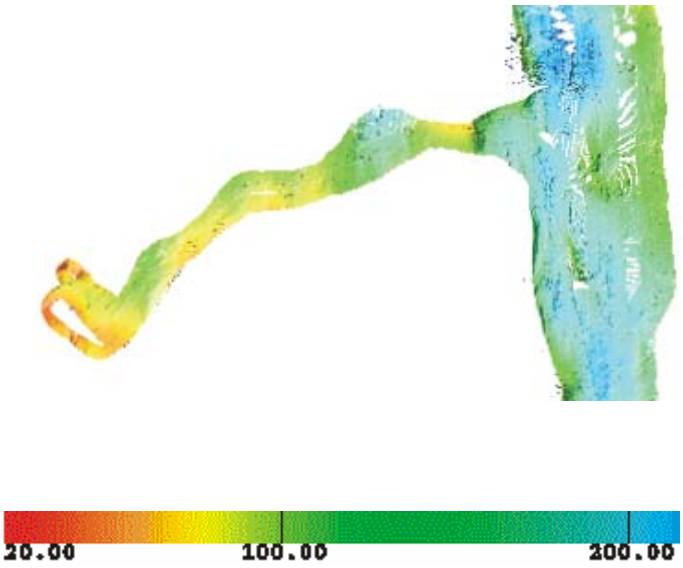

Figure 1: Multibeam bathymetry from Rijpforden

SCIENTIFIC REPORT 22: Acoustic Doppler Current Profiler Surveys (ADCP)

Mags Wallace

Introduction

A 75 kHz RD Instruments Ocean Surveyor ADCP is installed in the transducer well in the hull of the JCR. It can be run in two modes, narrowband (16m bins) and broadband (8m bins), thus reaching to a depth of up to ~800 m. The transducer well contains 90% de-ionised water and 10% monopropylene glycol and the transducer is located at 6.3m depth. The transducer should have been aligned with beam 3 at 45 degrees from the centre line but the misalignment angle is actually approximately 60 degrees. In the command files the transducer misalignment angle (EA) has been set to 60.08 degrees. This is a rough estimate of the misalignment, which must be fine-tuned during post-processing.

The ADCP was run throughout most of JR210, whilst the JCR was in the vicinity of Svalbard and the single-beam echosounder EA600 was run continously throughout the cruise alongside the ADCP. When the EK60 echosounder was running, the ADCP was interfaced with the EK60 and EA600 through the SSU. In this case, the ADCP was a slave to the EK60 ping, and the ADCP could not be run in bottom-track mode. When the EK60 was off, the ADCP was generally run in bottom-track mode, although attempts were made at various times to interface the ADCP (bottom track off) with the EM120 swath, the Topas and the EA600 when they were all running. However, this significantly slowed the ping rates of all instruments, and the ADCP data were noisy, so the decision was made to run the ADCP in bottom track mode independently from the other acoustics, except when the EK60 was on.

Methods/System specification

Data Acquisition: VmDas
The ADCP was controlled using the RDI VmDas software, version 1.42. The ADCP computer is integrated into the ship's LAN and raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. Files can only be modified when accessed from the ADCP PC. Data are also stored on the local ADCP PC in C://ADCP_data_secondary/JR210. ADCP settings were loaded into VmDas via command files stored on the ADCP computer, as recommended by the ADCP operation instructions in the UIC.

During JR210, four different settings were used:
Broadband with Bottom Tracking on
Broadband with Bottom Tracking off
Narrowband with Bottom Tracking on
Narrowband with Bottom Tracking off
The command files can be found in Appendix I.
In all settings, the profiling was set to 65 bins and the blanking distance from the transducer was set to 8 m. The time between pings was 2 seconds if the ADCP was running independently. Otherwise, the ping rate was determined by the other acoustic instruments, usually the EK60. To run the OS75 through the SSU, a line in the command files has to be uncommented or added:

; Set Trigger In/Out [ADCP run through SSU]
CX1,1

The filenames of the VmDas data are of the general structure NAME xxx yyyyyy.END where NAME is the name set in the data options recording tab of VmDas (see above), xxx is the number set in the same tab and changed with every restart of recording, and yyyyyy is a number automatically set by VmDas starting at 0 and increasing when the file size becomes larger than max size and a new file is created. END is the filename extension, denoting the different files that are created for each recording, as follows:
.ENR: binary; raw ADCP data file.
.STA:binary; average ADCP data, using the short time period specified in VmDas Data Options.
.LTA:binary; average ADCP data, using the long time period specified in VmDas Data Options.
.ENS:binary; ADCP data after screening for RSSI and correlation, either by VmDas or adjusted by user, and navigation data from .NMS file.
.ENX: binary; : ADCP single-ping data and navigation data, after having been bin-mapped, transformed to Earth coordinates and screened for error velocity, vertical velocity and false targets.
.N1R:ASCII text; raw NMEA data, see section 4.
.NMS:binary; navigation data after screening and pre-averaging.
.VMO:ASCII text; option setting used for collection the data.
.LOG: ASCII text; all logging output and error messages.

Note: The date is given as Julian day. VmDas takes 1st Jan to be day no. 0, which is different from the JCR oceanlogger.

Navigation data: The SeaPath
The ADCP is fed with navigation and attitude data from the Seatex GPS system. On the ADCP PC desktop is a shortcut called ‘Navigation Repeater’ which points to a perl script, ‘data server 1 1.pl’. This program provides navigation data for VmDas and must be started before starting the ADCP pinging and logging. The navigation data are saved in two of the VmDas files: in .ENX the data is included in binary format. The .N1R-files contain the information in ASCII format.

Data collection

Prior to arrival in Longyearbyen on 31st August, some trials of the acoustic systems were undertaken in the North Sea. The ADCP, EK60, EA600 and swath were interfaced through the Scientific Synchronisation Unit (SSU) in order to identify any problems with the system. ADCP data were stored in JR210/junk but were not examined further and were deleted from the ADCP data directory. This testing process identified a problem with the SSU wiring, such that the ADCP and the SSU could not communicate properly. This was fixed by the ETS engineers.

ADCP data were collected for most of JR210. When the EK60 was switched off, the ADCP was run in bottom-tracking mode so that calibration data could be gathered. However, when the EK60 was on, the ADCP had to be interfaced with the EK60 and EA600 through the SSU, and thus bottom tracking had to be switched off (bottom tracking involves an extra ping, which does not allow synchronisation through the SSU). The ADCP was

generally run in Broadband mode (BB, 8m bins), other than when the JCR entered water >500m depth, when Narrowband mode (NB, 16m bins) was used. As the JCR was on station for much of JR210, many of the ADCP files contain data collected whilst the ship was virtually stationary (note that the ship was observed to drift at up to 2kts at times). In general, when the ADCP was switched off it was only for very short periods of time to change command files, allow examination of data or, for slightly longer periods, permit communication with bottom-mounted acoustic systems (during lander and mooring retrieval). Thus, only occasionally was a new event number assigned to the ADCP. No new event number was assigned to the ADCP for file JR210_001_000000, as the purpose of this file was to check whether the SSU settings were working. Details of all data files are included in Table ADCP_1 and Figure ADCP_1 shows details of ADCP data collection.

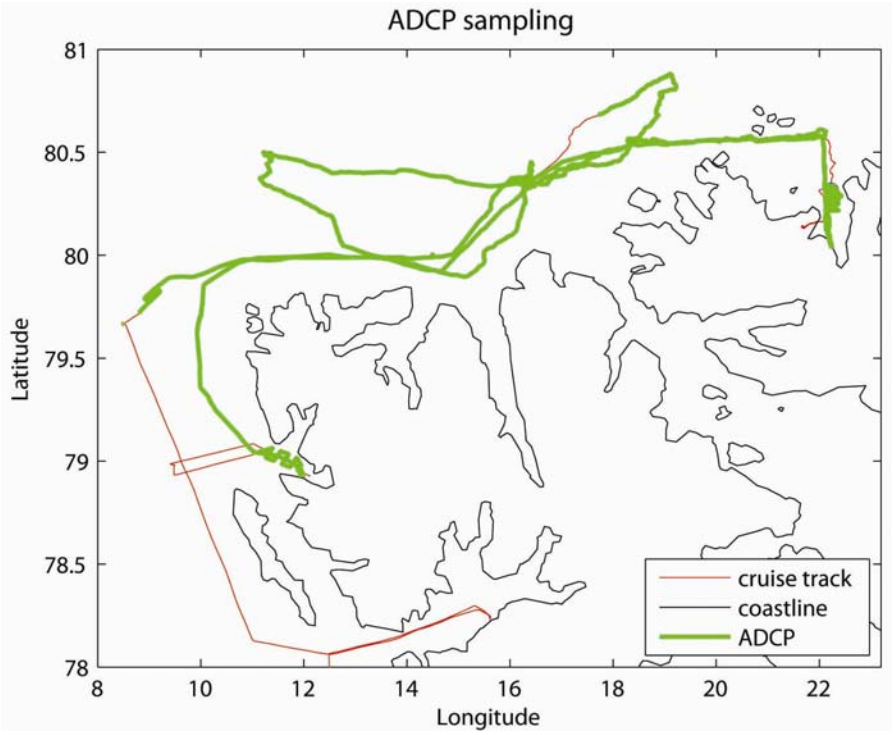

Figure ADCP_1: ADCP sampling during JR210. Thick green lines mark where the ADCP was running.

Table ADCP_1: ADCP data collection

Event	Location	Start lat & lon	Start	End	Mode	BT	File
	Shelf station	79.666˚N 8.507˚E	1/8/08 0725	1/8/08 0744	BB	Off	JR210_001_000000*
33	Shelf station	79.725˚N 8.833˚E	2/8/08 1425	3/8/08 1232	BB	Off	JR210_002_000000 JR210_002_000001 JR210_002_000002
43	Shelf station + transit to ice station	79.725˚N 8.833˚E	3/8/08 1238	4/8/08 0912	NB	On	JR210_003_000000 JR210_003_000001 JR210_003_000002
47	Transit to ice station + ice station	80.682˚N 17.718˚E	4/8/08 1420	5/8/08 0653	BB	On	JR210_004_000000 JR210_004_000001 JR210_004_000002
	Ice station	80.863˚N 19.148˚E	5/8/08 0653	5/8/08 0655	BB	On	JR210_005_000000**
	Ice station	80.863˚N 19.148˚E	5/8/08 0702	5/8/08 1101	BB	Off	JR210_006_000000
	Ice station	80.859˚N 19.147˚E	5/8/08 1101	6/8/08 0910	BB	Off	JR210_007_000000 JR210_007_000001 JR210_007_000002
	Ice station	80.814˚N 19.220˚E	6/8/08 0911	6/8/08 1254	BB	Off	JR210_008_000000
	Ice station	80.805˚N 19.198˚E	6/8/08 1308	7/8/08 0925	BB	Off	JR210_009_000000 JR210_009_000001 JR210_009_000002
64	Ice station + transit to lander station 2	80.796˚N 19.005˚E	7/8/08 0931	8/8/08 0606	BB	On	JR210_010_000000 JR210_010_000001 JR210_010_000002 JR210_010_000003
	Lander station 2	80.804˚N 19.122˚E	8/8/08 0606	8/8/08 2145	BB	On	JR210_011_000000 JR210_011_000001 JR210_011_000002
	Lander station 2	80.347˚N 16.268˚E	8/8/08 2147	9/8/08 2223	BB	Off	JR210_012_000000 JR210_012_000001 JR210_012_000002 JR210_012_000003
	Lander station 2	80.334˚N 16.335˚E	9/8/08 2225	10/8/08 1100	BB	On	JR210_013_000000 JR210_013_000001 JR210_013_000002
	Lander station 2	80.358˚N 16.252˚E	10/8/08 1104	11/8/08 0524	BB	Off	JR210_014_000000 JR210_014_000001 JR210_014_000002
	Lander station 2 and transit to off-shelf station 1	80.355˚N 16.335˚E	11/8/08 0527	11/8/08 1825	BB	On	JR210_015_000000 JR210_015_000001
	Transit to off-shelf station 1	80.071˚N 12.704˚E	11/8/08 1826	12/8/08 0257	BB	On	JR210_016_000000 JR210_016_000001
	Transit to off-shelf station 1	80.442˚N 11.289˚E	12/8/08 0259	12/8/08 0848	NB	On	JR210_017_000000
	Off-shelf station 1	80.488˚N 11.308˚E	12/8/08 0849	13/8/08 0542	NB	Off	JR210_018_000000 JR210_018_000001 JR210_018_000002 JR210_018_000003

	Off-shelf station 1 + transit to Rijpfjorden	80.487˚N 11.360˚E	13/8/08 0544	13/8/08 1825	NB	On	JR210_019_000000 JR210_019_000001
	Transit to Rijpfjorden	80.498˚N 17.817˚E	13/8/08 1825	13/8/08 2123	BB	Off	JR210_020_000000***
	Transit to Rijpfjorden + mooring site	80.538˚N 19.005˚E	13/8/08 2126	14/8/08 2100	BB	On	JR210_021_000000 JR210_021_000001 JR210_021_000002 JR210_021_000003 JR210_021_000004
	Rijpfjorden mooring	80.285˚N 22.304˚E	14/8/08 2101	14/8/08 2334	BB	Off	JR210_022_000000
143	Transect into Rijpfjorden from N end of EK60 Survey line A7	80.429˚N 22.109˚E	15/8/08 0504	15/8/08 0752	BB	On	JR210_023_000000
147	Rijpfjorden mooring	80.281˚N 22.320˚E	15/8/08 0841	15/8/08 1931	BB	Off	JR210_024_000000 JR210_024_000001 JR210_024_000002
	S end of Rijpfjorden (lander site) + transit to N end of Rijpfjorden	80.125˚N 22.149˚E	15/8/08 1937	16/8/08 0027	BB	On	JR210_025_000000****
	N end of Rijpfjorden (EK60 Survey B)	80.251˚N 22.184˚E	16/8/08 0027	16/8/08 0447	BB	Off	JR210_026_000000 JR210_026_000001
170	Transit from mooring to S end of Rijpfjorden (EK60 Survey C)	80.282˚N 22.313˚E	16/8/08 1120	16/8/08 1246	BB	Off	JR210_027_000000
183	Transit from Rijpfjorden to Kongsfjorden	80.575˚N 22.110˚E	17/8/08 0501	18/8/08 1526	BB	On	JR210_028_000000
193	Kongsfjorden mooring	78.960˚N 11.934˚E	18/8/08 1801	19/8/08 0748		Off	JR210_029_000000 JR210_029_000001 JR210_029_000002
207	Kongsfjorden EK60 transects	78.955˚N 11.890˚E	19/8/08 2045	20/8/08 0050		Off	JR210_030_000000 JR210_030_000001

* Had problems with SSU wiring, so ADCP switched off after a short time, hence JR210_001_000000 is a short file.
** Switched on briefly to check that ADCP was working, as had problems with displaying data (somebody had changed display settings in VmDas). Once it was established that the ADCP was collecting data correctly, the instrument was switched off to change command files. This file is so short that it is unlikely to contain useful data.
*** Swath on, interfaced through SSU.
**** Swath on, not interfaced through SSU.

Post-processing using Matlab

Limited post-processing was undertaken on JR210 as nobody onboard was working with the data. The original Matlab functions for post-processing were obtained from IFM Kiel by Mark Inall and adopted for use on the JCR by Deb Shoosmith, Angelika Renner, Mark Brandon and Hugh Venables. These functions are stored on the JCR's Unix system and are also included in the JR210 ADCP directory. They were used to check the JR210 ADCP data and flag up potential problems, but no further processing was undertaken. A problem that arose from the ADCP frequently running with bottom tracking switched off was that there were no calibration points for many files. Water tracking requires details of a reference layer, which is calculated in the Matlab routines (certain variables must be changed for this – see Appendix II). No misalignment angle correction has been applied to the data. Details of post-processing for the ADCP files are included in Table ADCP_2.

***A detailed description of the functions (written by Angelika Renner for JR165, 2007) is included in Appendix II, should anyone wish to use them for processing. Some changes have been made to the routines since JR165 and the best person to ask about this or any other ADCP matter is Hugh Venables at BAS (hjv@bas.ac.uk). The only changes made to the routines during JR210 were minor plotting-related tweaks.

Table ADCP_2: notes from post-processing

File	Comments
JR210_001_	
JR210_002_	
JR210_003_	Some very high velocities near seabed/around rough bathymetry.
JR210_004_	Data mostly poor.
JR210_005_	Very short file, not processed.
JR210_006_	
JR210_007_	
JR210_008_	
JR210_009_	A lot of poor data. In thick sea ice, mostly stationary.
JR210_010_	Ensemble numbers in navigational data jump from 9310 to 18617, which leads to problems trying to match ADCP and navigational data from file JR210_010_000002. This causes the routines to crash so data from this file and JR210_010_000003 have not been processed, and no data from JR210_010_ have been plotted to check for quality.
JR210_011_	
JR210_012_	
JR210_013_	
JR210_014_	Some high velocities near seabed.
JR210_015_	Some very high velocities near seabed/around rough bathymetry.
JR210_016_	
JR210_017_	Data cut off below 500m, even though in NB mode.
JR210_018_	Something odd happens in velocities ~600m (lots of high/missing values). Looks ok other than that.
JR210_019_	Some very high velocities near seabed/around rough bathymetry, in heavy ice.
JR210_020_	Very high velocities: in thick ice, plus swath on.
JR210_021_	Navigational data problems in file JR210_021_000002. No BT data from this file because stationary, which may also be a source of problems.
JR210_022_	Weirdness at ~350m. Stationary near Rijpfjorden mooring site so water depth <300m.
JR210_023_	Some high values near seabed, ok other than that.
JR210_024_	Some odd stuff going on here. Again, near Rijpfjorden mooring so water depth <300m. ADCP keeping data from beneath seabed again.
JR210_025_	Some good data but lots of very high values near seabed.
JR210_026_	Not processed.
JR210_027_	Not processed.
JR210_028_	Not processed.
JR210_029_	Not processed.
JR210_030_	Not processed.

SCIENTIFIC REPORT 23: Echo Sounder Surveys (EK60)

Mags Wallace

Introduction

Two types of acoustic survey were undertaken during JR210: the first involved collection of between 16 and 24 hours' worth of data whilst on station to accompany zooplankton net hauls; and the second involved small-scale surveys around Rijpfjorden and Kongsfjorden. The EK60 was not switched on for much of the cruise, which allowed collection of swath, Topas and bottom-tracking ADCP data. The EK60 was calibrated in Kongsfjorden at the end of the cruise.

Data quality was optimised by only running the EK60 in conjunction with the EA600 and the ADCP (bottom tracking switched off). These instruments were interfaced through the Scientific Synchronisation Unit (SSU), allowing synchronous collection of high quality data in all three. Attempts were made to interface the swath and Topas with the EK60, but this significantly slowed the ping rate and it was decided that concentrating on either the seabed or the water column at any one time was the best way to ensure high quality data. The Doppler logger was also switched off for much of the time that the EK60 was running, which significantly reduced noise in the echosounder data. A significant source of noise in the EK60 data proved to be the use of the bowthrusters, which was necessary when deploying instruments over the side or stern whilst in ice. The bowthrusters were used only when strictly necessary whilst the EK60 was running, but their use could not be completely avoided.

Methods/System specification

Software versions
Simrad ER60 v. 2.0
Sonardata Echolog 60 v 4.05.6208
Sonardata Echoview v 4.0.75.6342 Live viewing

HASP Dongle BAS3 licensed for base, bathymetry, analysis export, live viewing, school detection and virtual echogram was used to run the echolog and echoview in live viewing mode. This was acquired from British Antarctic Survey for the duration of the cruise, courtesy of Geraint Tarling. The echosounder PC AP10 and the EK60 workstation 2 are integrated into the ship's LAN. ER60 .raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. All raw data were collected to 500 m. Echolog was run on workstation 2 and wrote compressed files also directly to the Sun workstation via a Samba connection. It was noted that the time on both the echosounder PC and the EK60 workstation lagged UTC by 28 seconds. This was manually corrected, but when the echosounder started logging it was noticed that the PC had reset to the 28 second lag, so no further manual corrections were applied.

File locations
All data were saved in a general folder JR210, which contained directories for each location (iceStation, shelfStation, landerStation2, trialStn [off shelf station 1], 'RijpMooring', 'RijpTransects', 'KongMooring' and 'KongTransects'). Off-shelf station 1 was initially named 'trial station' because EK60 and zooplankton sampling was opportunistic, prior to a

decision being made to remain at this location for any length of time. Renaming files could have led to difficulties, so they were left as ‘trialstn’. Calibration data were saved to the calibration folder. Filenames were of the form ‘jr210###-Dyyyymmdd-Thhmmss’, where ### is an identifier pertaining to each location, as detailed in Section X, yyyy, mm, dd, hh, mm and ss are the year, month day, hour, minute and second.

EK60 (ER60) settings

The EK60 was calibrated at the end of the cruise; hence it was run with the same settings as JR177. Table Acoustics_1 lists the EK60 settings for JR210. Most EK60 settings were not updated following calibration – it is assumed that calibrated settings will be used in post-processing. Only the temperature, salinity and sound velocity were changed during calibration, so the data collected during the Kongsfjorden transects had different environmental settings to those throughout the rest of the cruise.

Table EK60_1: EK60 settings

Variable	38 kHz	120 kHz	200 kHz
Ping interval (per sec)	2	2	2
Salinity (PSU)*	34 [34]	34 [34]	34 [34]
Temperature (°C)*	1 [5]	1 [5]	1 [5]
Sound velocity (m/s)*	1453 [1471]	1453 [1471]	1453 [1471]
Mode	Active	Active	Active
Transducer type	ES38	ES120-7	ES200-7
Transceiver Serial no.	009072033fa5	00907203422d	009072033f91
Transducer depth (m)	0	0	0
Absorption coef. (dB/km)	10.07	26.27	39.80
Pulse length (ms)	1.024	1.024	1.024
Max Power (W)	2000	500	300
2-way beam angle (dB)	-20.70	-20.70	-19.60
Sv transducer gain (dB)	24.07	21.38	22.03
Sa correction (dB)	-0.63	-0.39	-0.31
Angle sensitivity along	22	21	23
Angle sensitivity athwart	22	21	23
3 dB Beam width (along)	6.96	7.48	6.44
3 dB Beam width (athwart)	6.88	7.48	6.43
3 dB Beam along offset	-0.02	-0.12	0.17
3 dB Beam athwart offset	0	-0.07	-0.24

* Values in square brackets denote those used post-calibration for the Kongsfjorden transects.

SSU settings

The EK60 was controlled through the SSU, under a group EK60, EA600 and ADCP. The EK60 was the master, with a ping rate set to 2 seconds. The ADCP was run in water column mode (as a slave with an external trigger). Within this setup the ADCP only pings

every other trigger, therefore its resolution is slightly reduced at 1 ping every 4 seconds. In order to calibrate the ADCP, it is important for the ADCP to be run in bottom tracking mode as much as possible. Therefore at times when the EK60 data was not being used the ADCP was run external to the SSU.

EA600	external trigger	Tx pulse	
EK60	external trigger	Calculated	(Set to 2 seconds in ER60 software)
ADCP	external trigger	Tx pulse	(this setting only works if the bottom tracking mode is off)

EK60 Calibration

Kongsfjorden. 0750 (GMT) 19/08/2008.
An acoustic calibration was carried out in Kongsfjorden, Svalbard on 19/08/2008. The ship was anchored, its movement balanced by minimal DP usage. All water discharges from the ship were stopped. The EK60 was allowed to trigger itself (i.e. not controlled by the SSU) and the ADCP was switched off. Each transducer was calibrated in turn, although all transducers were operating at the time. Standard ER60 calibration procedures were used as documented for previous cruises (the 38.1mm diameter tungsten carbide sphere was moved through all quadrants of each transducer). In addition the sphere was held on-axis for extra periods of time.

A CTD (#50) was undertaken immediately prior to calibration. Temperature and salinity were averaged from 6 (depth of the transducers) to 26 m (depth of the calibration sphere) and were 5.21°C and 34.12 PSU resulting in a speed of sound constant of 1471 m/s (Francois and Garrison, 1982). Note that these values were changed on the EK60 during calibration and were not changed back to the original values prior to the Kongsfjorden transects. Thus, these transects may need reprocessing at the original settings to ensure that they are comparable to the data collected throughout the rest of the cruise.

Initial detection of the sphere was rapid for all transducers, thanks to accurate line lengths provided by Peter Enderlein at BAS. The calibration generally went smoothly, although in all cases it was difficult to obtain on-axis values. A few on-axis single targets were logged early in the calibration for all transducers, but in all cases the sphere was left sitting on axis for up to half an hour later in the calibration without logging any further single targets. Further problems arose with the 200kHz transducer, which had difficulty logging single targets in the NE-SW (through E and S) half of the beam. Coverage throughout the NE-SW (through N and W) half of the beam was comprehensive. Many attempts were made to log targets in the former region, with some success. However, no targets were logged in a region centred on the S axis, and some of the targets logged in the SE sector may have been the shackle, rather than the sphere. At least one hour was spent moving the beam through these regions, with little improvement in single target identification. The depth of the sphere was constantly checked, and the sphere could clearly be seen on the crosshair plot, so the problems were not due to poor positioning of the target. It was decided that continuing the calibration would be unlikely to significantly improve results, and that the remaining time would be better spent undertaking surveys in Kongsfjorden. The calibration ceased at 1655 on 19/08/2008. Following the calibration, the 200kHz single target detection was tested by setting the minimum threshold for target detection to -60dB instead of the default -50dB, as the few single targets registered in the SE region of the beam had lower target strengths than those expected. The sphere was moved through the

regions of the beam where single target detection had proved difficult but no targets were registered during this test.

The calibration data were not processed aboard the JCR, as nobody present was conversant with the procedure. Details of calibration settings are included in Table Acoustics_2.

Table EK60_2: ER60 Calibration

Location	Kongsfjorden	Kongsfjorden	Kongsfjorden
Time	10:30	12:31	14:20
Cruise ID	JR210	JR210	JR210
Frequency	38	120	200
Transducer type	ES38	ES120-7	ES200-7
Transducer serial no	23080	29471	240
GPT serial no	009072033fa5	00907203422d	9072033191
Comments	All transducers on	All transducers on	All transducers on
Environmental parameters			
Water temperature	5.21	5.21	5.21
Salinity	34.12	34.12	34.12
Sound velocity*	1471	1471	1471
Absorption coefficient*	10.07	30.86	43.97
Echosounder parameters			
Ping rate	1	1	1
Transmit power	2000	500	300
Pulse length	1.024	1.024	1.024
Bandwidth	2.43	3.03	3.09
Sample interval	0.186	0.186	0.186
Original gain	24.07	21.38	22.03
Original Sa correction	-0.63	-0.39	-0.31
Reference target			
Theoretical TS of sphere	-42.28	-39.55	-39.5
Depth of target	23.16	23.89	25.17
Min distance layer	22	23	23.5
Max distance layer	25	26	26.5
TS detection parameters			
Min value	-50	-50	-50
TS measurements			
TS mean	-42.36	-38.8	-37.67
TS gain correction	0.32	0.20	0.16
New TS gain	24.02	0.20	0.16

Data collection

Prior to the JCR's arrival at Longyearbyen on 31st August, trials of the acoustic systems were undertaken in the North Sea. The ADCP, EK60, EA600 and swath were interfaced through the Scientific Synchronisation Unit (SSU) in order to identify any problems with the system. These EK60 data were stored in U:/data/ek60/jr210testfiles and were deleted before the end of the cruise.

Zooplankton stations

EK60 data were collected at shelf station 1, ice station, lander station 2 and off-shelf station 1 to accompany zooplankton net hauls. Between 16 and 24 hours' worth of data were collected at each of these stations whilst the ship was nominally stationary (although she experienced drift of up to 2kts). Data were also collected in Rijpfjorden (mooring site and southwards into the fjord) and Kongsfjorden for shorter periods of time, as acoustic surveys were also undertaken in these locations. Details of the stations and EK60 event numbers are included in Table EK60_3, and station locations are plotted in Figure EK60_1.

Table EK60_3: Zooplankton station EK60 data

Station	Event	Start	End	Lat & Lon	Files
Shelf station	32	2/8/08 1419	3/8/08 1230	79.725˚N 8.833˚E	\shelfStation\jr210shelfstn-D…
Ice station	52	6/8/08 0914	7/8/08 0926	80.812˚N 19.218˚E	\iceStation\jr210icestn-D…
Lander station 2	79	8/8/08 2143	9/8/08 2221	80.347˚N 16.269˚E	\landerStation2\jr210lndrstn2-D…
Lander station 2	95	10/8/08 1103	11/8/08 0521	80.358˚N 16.251˚E	\landerStation2\jr210lndrstn2-D…
Off-shelf station (trial station)	110*	12/8/08 0845	13/8/08 0540	80.487˚N 22.303˚E	\trialStn\jr210trialstn-D…
Rijpfjorden mooring	138	14/8/08 2058	14/8/08 2320	80.285˚N 22.304˚E	\RijpMooring\jr210rijpm-D…
Rijpfjorden mooring**	146	15/8/08 0839	15/8/08 1923	80.281˚N 22.320˚E	\RijpMooring\jr210rijpm-D…
Kongsfjorden mooring	192	18/8/08 1758	19/8/08 0735	78.960˚N 11.890˚E	\KongMooring\jr210kongm-D…

* Topas on until 0902 (12/8/08), so data prior to this experience a large amount of interference.
** Data collection on 15th August started at Rijpfjorden mooring site, but the JCR moved south to the end of the fjord and stopped at another location (lander site) for several hours, so all data from this day are stored under \RijpMooring\jr210rijpm-D...The Doppler log was also on for much of the day, so the data show strong interference.

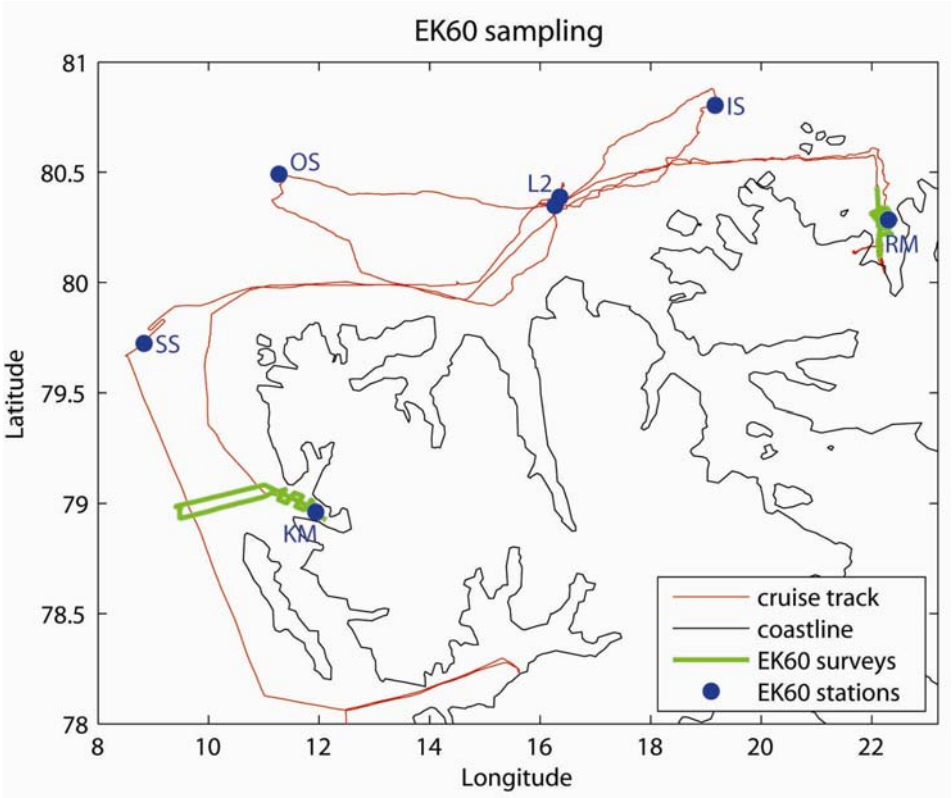

Figure EK60_1: Survey lines are shown in green and zooplankton stations in blue (SS = shelf station; OS = off-shelf station 1 (also called 'trial station); L2 = lander station 2; IS = ice station; RM = Rijpfjorden Mooring; KM = Kongsfjorden mooring).

Acoustic surveys

Acoustic surveys were undertaken in Rijpfjorden and Kongsfjorden. Acoustic surveys aboard the JCR are typically carried out at 10 knots (Sophie Fielding, BAS, pers. comm.) but this was not possible for much of Rijpfjorden due to ice conditions and poorly constrained bathymetry. Surveying in this area was therefore undertaken at speeds varying from 4-10 knots (these speeds varied along transects, depending upon conditions encountered).

Rijpfjorden

The intention for Rijpfjorden was to survey around the mooring site in order to characterise the acoustic regime at this location, and to collect data across a wider area in an attempt to identify changes in the acoustic regime. An initial survey (Survey A) was designed and undertaken in the early hours of the morning of 15th August, but this had to be abandoned part way through due to extremely shallow bathymetry. The remaining survey time available that night was spent collecting data along a transect running north from the mouth of Rijpfjorden to the ice edge. In the early hours of 16th August, a smaller-scale survey (Survey B) was undertaken around the mooring site, and that afternoon data were collected from a transect running from the mooring site towards the southern end of the fjord (Survey C). All files were saved in JR210\RijpTransects\jr210rijptrans-D… and survey lines are detailed in Table EK60_4 and Figure EK60_2.

Table EK60_4: Rijpfjorden acoustic transects

Event	Survey	Survey line	Start time	End time	Start lat & lon	End lat & lon	Comments
142	A	1			80.442˚N 21.876˚E	80.446˚N 22.253˚E	Started at line 2 because closer to ship's location. Not undertaken due to change in survey plan on line 4.
		2	15/8/08 0001	15/8/08 0044	80.446˚N 22.253˚E	80.286˚N 22.431˚E	
		3	15/8/08 0105	15/8/08 0140	80.274˚N 22.301˚E	80.323˚N 22.123˚E	
		4	15/8/08 0201	15/8/08 0225	80.310˚N 21.997˚E	80.261˚N 22.174˚E	Abandoned part way through due to very shallow water.
		5			80.249˚N 22.043˚E	80.299˚N 21.863˚E	Not undertaken as ship had run into shallow water.
		6			80.299˚N 21.863˚E	80.404˚N 21.484˚E	Not undertaken as ship had run into shallow water.
		7	15/8/08 0358	15/8/08 0459	80.274˚N 22.301˚E	80.437˚N 22.095˚E	
160	B	1	16/8/08 0038	16/8/08 0128	80.250˚N 22.117˚E	80.333˚N 22.117˚E	
		2	16/8/08 0141	16/8/08 0230	80.333˚N 22.200˚E	80.250˚N 22.200˚E	
		3	16/8/08 0245	16/8/08 0335	80.250˚N 22.283˚E	80.333˚N 22.283˚E	
		4	16/8/08 0407	16/8/08 0439	80.304˚N 22.364˚E	80.250˚N 22.367˚E	Survey line shortened at N end because of shallow water
169	C	1	16/8/08 1118	16/8/08 1147	80.282˚N 22.313˚E	80.247˚N 22.143˚E	
		2	16/8/08 1147	16/8/08 1237	80.247˚N 22.143˚E	80.117˚N 22.155˚E	

Grey shading indicates survey lines that were not undertaken

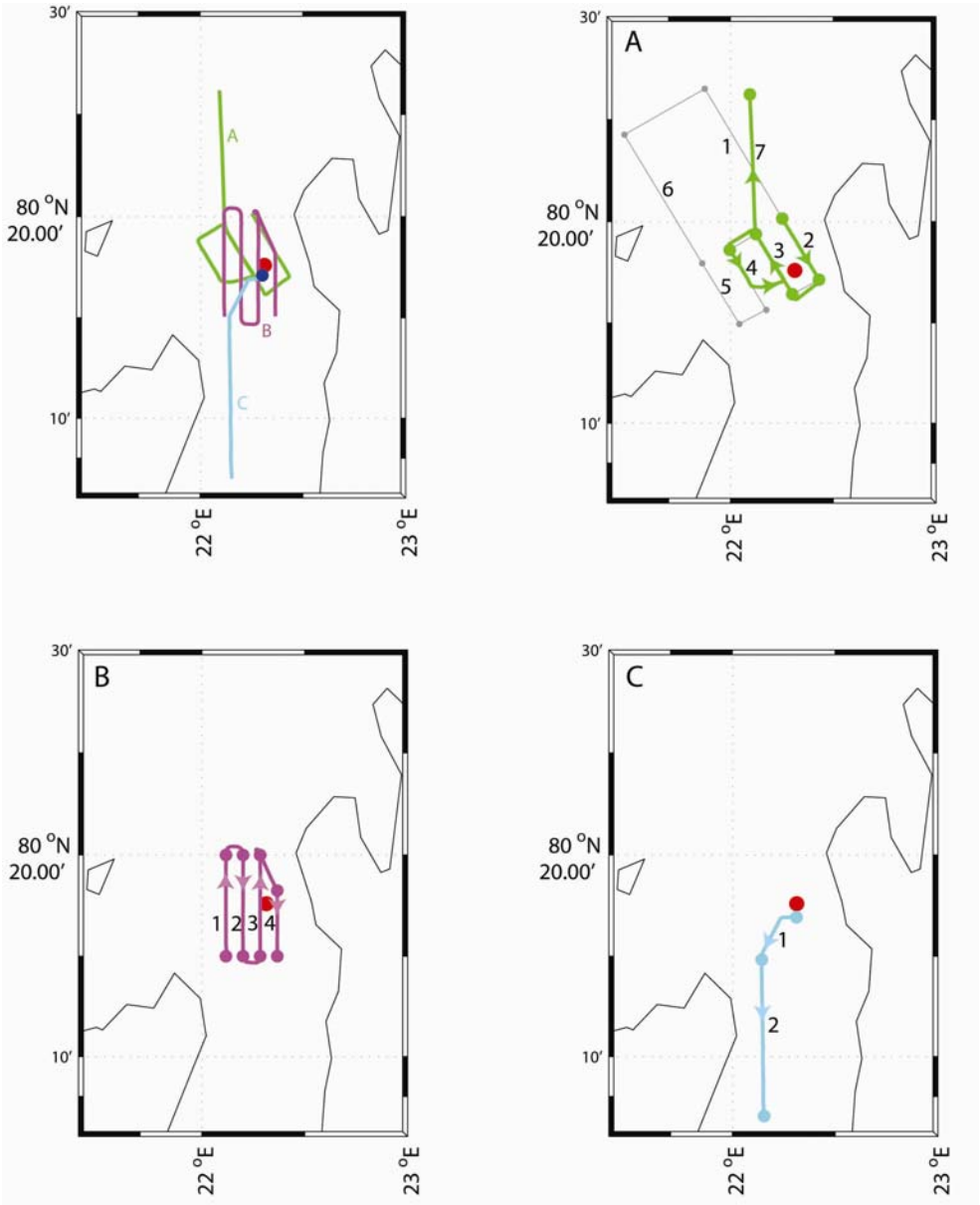

Figure EK60_2: Rijpfjorden EK60 transects. All survey lines undertaken are shown in the top right panel, with survey A in green, survey B in purple and survey C in cyan. The mooring site is marked in red and the zooplankton station in blue. Individual survey lines are detailed in the remaining panels, with the intended survey A shown in grey in the top right panel. Arrows indicate the direction of travel during the surveys.

Kongsfjorden

A survey was undertaken in Kongsfjorden on the night of 19-20th August. A small-scale survey was completed in the fjord, then survey lines were undertaken to the west across the shelf. Net samples were collected at three locations to complement the acoustic data. All files were saved in JR210\KongTransects\jr210kongtrans-D… and survey lines are detailed in Table EK60_5 and Figure EK60_3.

Table EK60_5: Kongsfjorden acoustic transects

Event	Survey	Survey line	Start time	End time	Start lat & lon	End lat & lon	Comments
206	D	1	19/8/08 2044	19/8/08 2101	78.955˚N 11.885˚E	78.979˚N 11.947˚E	
		2	19/8/08 2116	19/8/08 2137	79.017˚N 11.864˚E	78.970˚N 11.728˚E	
		3	19/8/08 2149	19/8/08 2209	78.986˚N 11.572˚E	79.033˚N 11.708˚E	
		4	19/8/08 2221	19/8/08 2352	79.049˚N 11.708˚E	79.002˚N 11.550˚E	Stopped from 2239-2349 for net haul at 79.012˚N, 11.428˚E
		5	20/8/08 0004	20/8/08 0022	79.017˚N 11.417˚E	79.064˚N 11.260˚E	Stopped from 0049-0135 for net haul at 79.046˚N, 11.139˚E between transects.
		6	20/8/08 0150	20/8/08 0341	79.030˚N 11.396˚E	78.934˚N 9.480˚E	Stopped for net haul at 79.980˚N, 9.499˚E between transects.
		7	20/8/08 0500	20/8/08 0700	78.986˚N 9.410˚E	79.084˚N 11.000˚E	
		8	20/8/08 0700	20/8/08 0854	79.084˚N 11.000˚E	78.926˚N 12.124˚E	

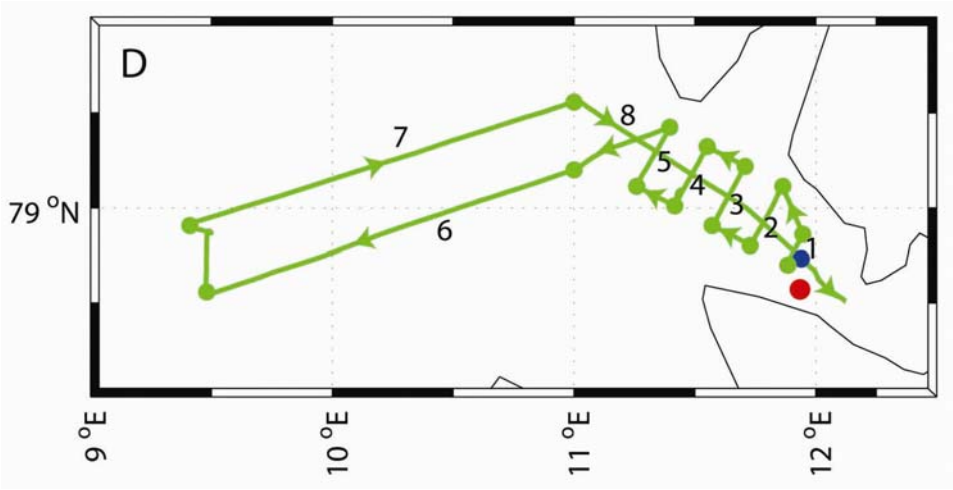

Figure EK60_3: Kongsfjorden EK60 transects. The mooring site is marked in red and the zooplankton site in blue. Arrows indicate the direction of travel during the survey.

Problems encountered

The EK60 occasionally lost data points, usually from the 200kHz transducer. This resulted in 9 error messages stating that data had been lost and occurred at most stations (only the ice station did not show error messages). One error message was received for the 120kHz transducer at off-shelf station 1 (trial station). This error appeared irregularly and infrequently, with minimal visible effect upon the data. At shelf station 1, the EK60 was rebooted after this error message had appeared a number of times, which briefly stopped both the EA600 and the ADCP pinging. The error message continued to appear occasionally following reboot, so no further action was taken, other than making a note in the acoustic log when the error message appeared.

Interference was observed in the EK60 in shallow (<~120m) water, particularly in regions where bathymetry changed rapidly. This was first observed during the Rijpfjorden surveys, where a number of transects took the JCR into shallow water. The interference was most pronounced at 200kHz, and took the form of short vertical lines throughout the data. The most likely cause of the interference is scattering off a shallow and highly variable seabed, although the source of the interference remains unidentified. The first time this was observed (Survey A), the EK60, EA600 and ADCP were interfaced through the SSU, and the swath, Topas and Doppler log were all off. The ADCP was switched off to check whether it was the source of interference, but the interference remained. The remaining possibilities are thus the EA600, the hull-mounted JRCs (depth sensors), which do not normally cause interference with the EK60, and the EK60 itself. The captain wished to leave the JRCs switched on, given the poorly-constrained bathymetry, and for the same reason it was impractical to switch off the EA600 in order to test whether any of these instruments was responsible for the interference.

Interference was observed in the 38kHz and 120kHz echograms during the early part of the Kongsfjorden transects. The EK60, EA600 and ADCP were interfaced through the SSU, so there should have been no interference between the instruments. Furthermore, the interference, in the form of a thick line at ~187m, appeared while the ship was moving and disappeared when the survey was interrupted for net hauls. Nonetheless, the ADCP was switched off at 0048 on 20/8/08, whilst on station for a net haul (the interference had just disappeared when the ship stopped) and no further interference was observed throughout the survey.

SCIENTIFIC REPORT 24: Underway Data

Mags Wallace

Introduction

Underway data from the JCR's oceanlogger, atmospheric sensors, Simrad echosounder and navigational instruments was collected continuously between the ship's departure from Portland on 23rd July to the end of the cruise in Kongsfjorden on 20th July. Data collected from roughly midday on 20th July onwards were not downloaded.

Instrument specifications

Oceanlogger:

SeaBird Electronics SBE45 CTD
Turner Designs 10-AU Fluorometer

Meteorological data:

Photosynthetically Active Radiation 1, Parlite Quantum Sensor, Kipp & Zonen
Photosynthetically Active Radiation 2, Parlite Quantum Sensor, Kipp & Zonen
Transmissometer 1, Proto1 SPLite, Kipp & Zonen
Transmissometer 2, Proto1 SPLite, Kipp & Zonen
Air temperature/humidity 1, Chilled Mirror Hygrometer MBW, Temperature Sensor Pt100
Anemometer

Navigational data

Ashtec ADU2 GPS: antenna 1 used to determine the ship's position; antennae 2-4 used to determine roll, pitch and yaw.
Ashtec GLONASS GG24 (accurate to ~15 m).
Sperry Mk 37 Model D Gyrocompass (subject to an inherent error and can oscillate for several minutes after a turn).
Seatex GPS (Seapath 200)
GPS NMEA
Bestnav GPS

Echosounder data

Hull-mounted Simrad EA500 Hydrographic 12Khz Echosounder (transducers located approximately 5m below the water level).

Dates and times at which instruments started recording were as follows:

bestnav: JDAY 205, 081930
gpsash: JDAY 205, 081943
gpsglos: JDAY 205, 081943
gpsnmea: JDAY 205, 081943
seatex: JDAY 205, 081943
anemom: JDAY 205, 081943
oceanlog: JDAY 205, 081945
sim500: JDAY 205, 100408

gyro: JDAY 206, 082421
tsshrp: JDAY 207, 133026

File locations
All data were stored on the Unix drive in the folder data/cruise/jcr/20080723/pstar, which included sub-folders for the oceanlogger, navigational data and the Simrad EA600. Details of filenames are given in the following section.

Data processing

Navigational, oceanlogger and meteorological data were processed in Unix and Matlab using modified versions of programs developed by Mike Meredith for the August 2004 Charles Darwin cruise CD160. Data were initially read into the Unix system, then transferred to Matlab, which was used for the bulk of the processing and plotting.

Navigation

get_nav — Calls the scripts get_gyro, get_bestnav, get_gpsash, get_gpsglos, get_gpsnmea, get_seatex and get_tsshrp, which invoke the RVS listit command to retrieve 24 hours of gyrocompass, bestnav, Ashtec (ADU2), Ashtec Glonass (GG24), GPS NMEA, Seatex and tsshrp (heave, roll and pitch) data, corresponding to JDAY ###, and write to ascii files “gyro.###”, “bestnav. ###”, “gpsash. ###”, “gpsglos. ###”, “gpsnmea. ###”, “seatex. ###” and “tsshrp. ###”. Data are in ascii format and are stored in data/cruise/jcr/20080723/pstar/nav, within which there are individual directories for bestnav, gpsash, gpsglos, gpsnmea, gyro, seatex and tsshrp.

load_daily — Matlab script which calls load_bestnav, load_gpsash, load_gpsglos, load_gpsnmea, load_gyro, load_seatex and load_tsshrp to read in data from ascii files generated by get_nav. The routine prompts for user input for jday and data for that day are plotted to the screen. If data do not exist a message is written to the screen. Data are saved to matlab files of the form gyro/gyro###.mat

plot_seatex_all — load seatex/seatex###.mat files for entire cruise and plots cruise track. Before running for the first time it is necessary to change the year in line 7. The output from this script is plotted in Figure Underway_1.

Oceanlogger & atmospheric data:

get_underway — Calls the scripts get_oceanlog and get_anemom, which invoke the RVS listit command to retrieve 24 hours of underway data, corresponding to JDAY ###, and write to ascii files “oceanlog.###” and “anemom.###”.

loadunderway.m — Matlab code, which calls functions loadoceanlog.m and loadanemom.m to read “oceanlog.###”and “anemom.###”, arrange into structure arrays and name accordingly. Saves outputs as “oceanlog###.mat” and “anemom###.mat”. The program also calls cleanoceanlog.m, which uses dspike.m to remove large spikes in conductivity, housing

(CTD) temperature and remote (hull) temperature. Interpolates across removed points, then launches basic interactive editor for further cleaning of conductivity, housing temperature and remote temperature. Calls ds_salt.m to calculate surface (uncalibrated) salinity from conductivity and housing temperature. Oceanlogger data are also removed where flow was <0.4l/min or >1.5l/min. Data gaps are filled by linear interpolation Output saved to "oceanlog###clean.mat". Produces rough plots of sea surface conductivity, remote (hull) temperature and housing (CTD) temperature over the 24 hour period. Anemometer and cleaned oceanlog data are written to "underwayXXX.mat"

plot_oceanlog_daily Loads seatex data (seatex###.mat) and oceanlog data (oceanlog###clean.mat), matches oceanlog data to latitude and longitude, then saves all data to oceanlog_nav###.mat. 1 min averages are calculated and saved in oceanlog_nav###_1minave.mat. Plots of sea surface temperature, salinity and fluorescence are generated for the day of interest and are saved in oceanlog/figures as oceanlog###.fig.

plot_oceanlog_all loads oceanlog_nav###_1minave.mat for all days and plots sea surface temperature, salinity and fluorescence along the cruise track. The output from this script is shown in Figure Underway_2.

Echosounder, Simrad EA600:

get_sim500 Invokes the RVS listit command to retrieve 24 hours of EA600 data, corresponding to JDAY ###, and write to an ascii file "sim500.###".

loadsim500.m Matlab code to read "sim500.###", arrange into structure arrays and name accordingly. Saves output as "sim500_###.mat". Produces a rough plot of uncorrected depth over the 24 hour period.

cleansim500.m Loads "sim500_###.mat", removes large spikes with dspike.m, and launches basic interactive editor for further cleaning. A second run of dspike.m is enabled, followed by a 101-point median filter. Discarded depths are interpolated across, and output saved to "sim500_###clean.mat".

scatter_depth loads sim500_###clean.mat and calculates 1min averages, then loads oceanlog_nav###_1minave.mat and plots data for selected day. 1min averages of depth, time, lat and lon are saved in sim500_###_1minave.mat

plot_sim500_all loads sim500_###_1minave for all days and plots depth along cruise track. The output from this script is plotted in Figure Underway_3.

Extras:

extractLight Extracts par and tir for all days and calculates 24hr average for Emilie). Data are saved to lightlevels.asc.

Further relevant information:

Small amounts of data were lost during the cruise when instruments stopped logging. The most common problem was that the Bestnav GPS ceased to log when the Doppler log was switched off, which was the case at various times due to its interference with the EK60 echosounder. Oceanlogger data were lost for extended periods of time whilst the ship was working in sea ice. Other data were lost occasionally. Missing data are detailed in the table below.

Jday	Note
205	Flow patchy prior to 2124
206	Bad flow briefly at 1505 EA600 data poor for several hours
207	Bad flow briefly at 1606
208	EA600 data poor for ~1 hour
209	Flow intermittently bad from 1808 to 2359
210	Flow intermittently bad from 0000 to 0502 Bestnav off 1253 to 2359
212	Flow bad 0444 to 0504
214	Bestnav off from 0921 to 2359 EA600 data poor for ~1hr
215	No Bestnav data
216	No Bestnav data
217	Flow intermittently bad up to 1522, then off Glonass off 0837 to 2359 Bestnav off 0000 to 0756
218	Flow off from 0000 to 0731 Glonass off 0000 to 0518
219	Flow off 1252 to 1306 and off intermittently between 1350 and 1425 Bestnav off 0920 to 2359
220	Flow off 1701 to 2359, briefly on at 1819 Bestnav off 0000 to 1212
221	Flow off 0000 to 0902 Bestnav off 2143 to 2359
222	Flow off intermittently 0845 to 0852 and 1410 to 1428 No Bestnav data
223	Flow off intermittently 0621 to 0645 No Bestnav data
224	Flow off intermittently 0507 to 1310 Bestnav off 0000 to 0814
225	Flow off intermittently 0629 to 0636 and 0926 to 0927 Bestnav off 0903 to 2359
226	Flow off intermittently 1659 to 2359 Bestnav off 0000 to 0740
227	Flow off 0000 to 0639 and off intermittently 1531 to 1546 Bestnav off 2056 to 2359
228	Flow off 0024 to 0857, off intermittently 0857 to 0900 and 2231 to 2237. Bestnav off 0000 to 0235 and 0339 to 1050
229	Flow off from 2110 to 2359. Bestnav off 0015 to 0907 and 1119 to 1818
230	Flow off. Ashtec GPS off 2249 to 2359
231	Flow off 0000 to 0618 and off intermittently 0618 to 0635. No Ashtec data
232	No Ashtec data No Bestnav data
233	No Ashtec data No Bestnav data

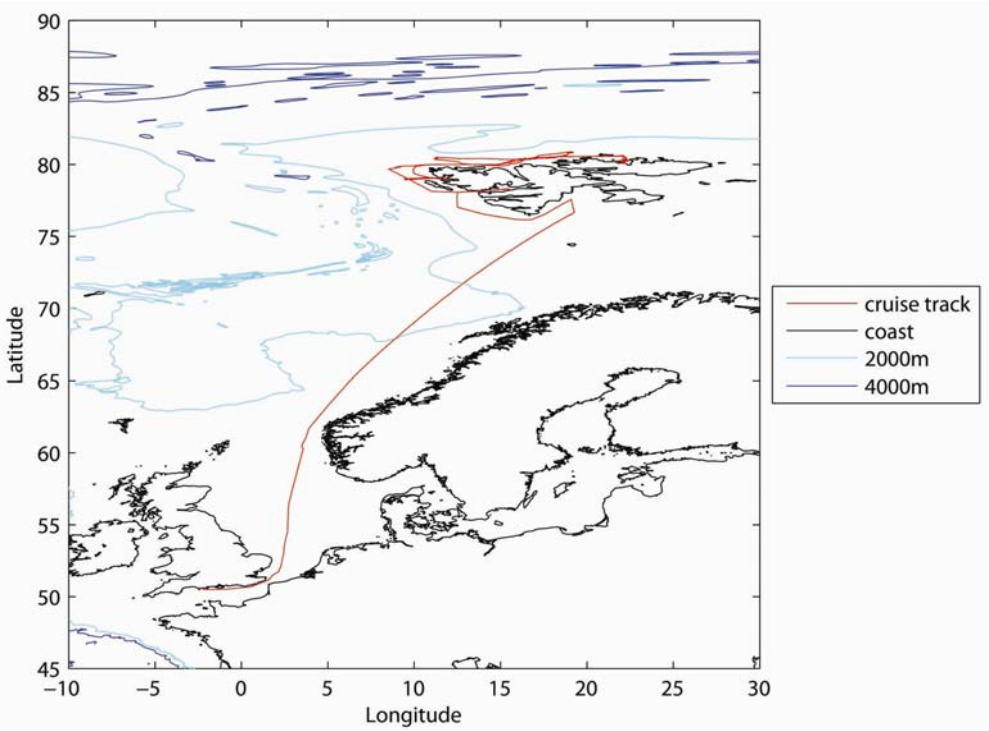

Figure Underway_1: Cruise track from Seatex data.

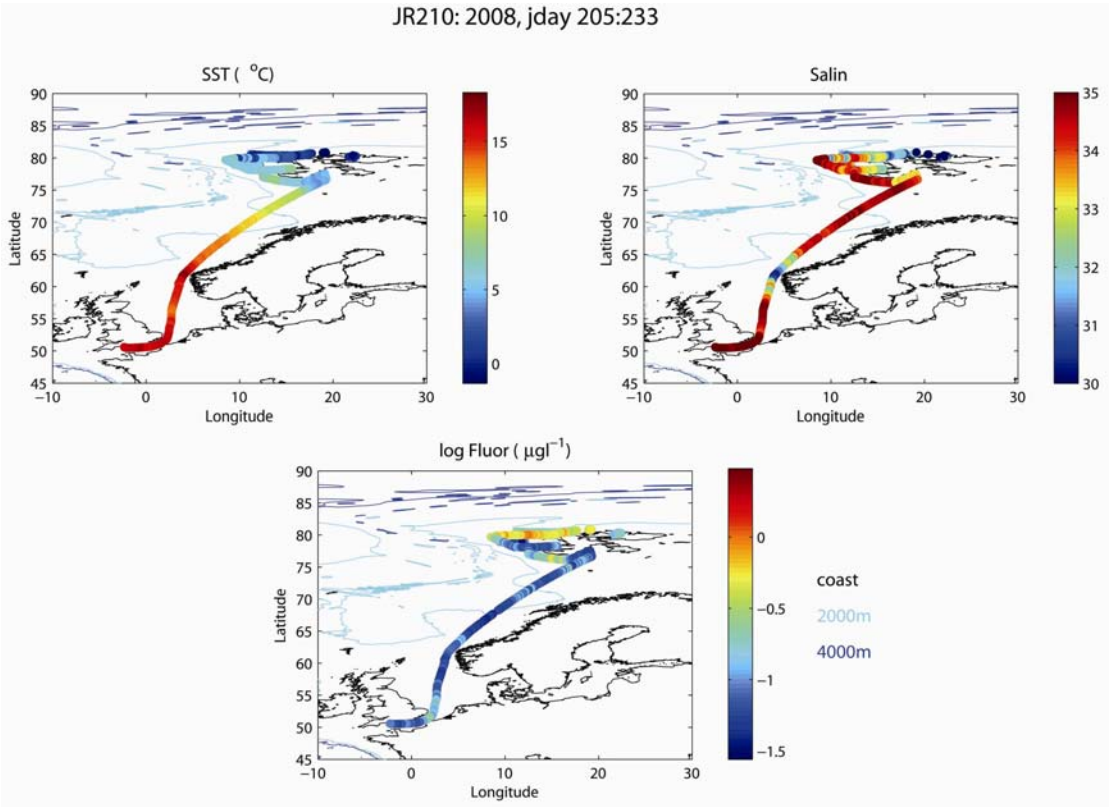

Figure Underway_2: Plots of sea surface temperature, salinity and fluorescence along the cruise track.

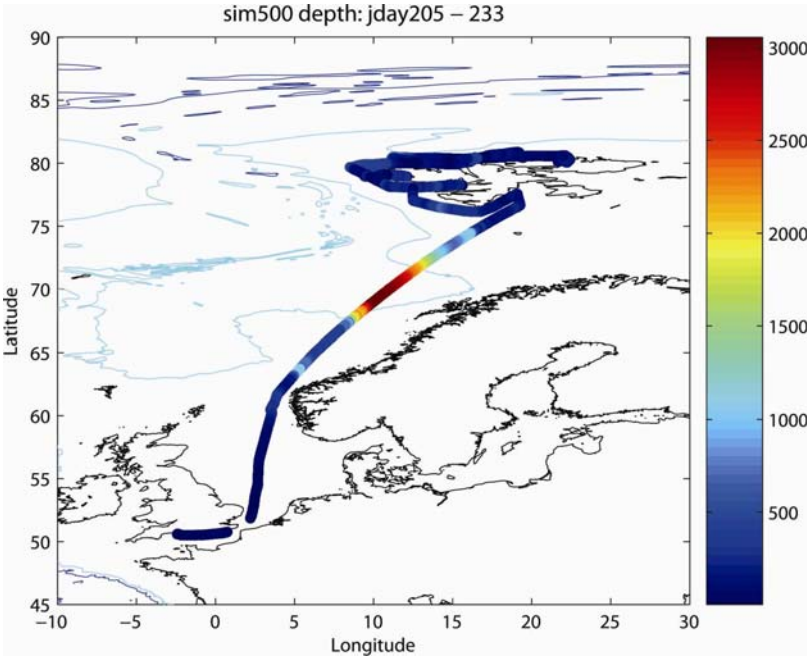

Figure Underway_3: Sim500 depth along the cruise track

APPENDIX 1: Scientific & Technical Personnel Affiliation and E-Mail

Person	Affiliation	E-mail
Elanor Bell	Scottish Association for Marine Science	elanor.bell@sams.ac.uk
James Bendle	University of Glasgow, UK	james.bendle@ges.gla.ac.uk
Tim Brand	Scottish Association for Marine Science	tim.brand@sams.ac.uk
Anastasia Charalampopoulou	National Oceanography Centre, UK	ac4w07@soton.ac.uk
Joe Collins	Proudman Oceanographic Laboratory, UK	jcoll@pol.ac.uk
Terry Doyle	Proudman Oceanographic Laboratory, UK	teyl@pol.ac.uk
Estelle DuMont	Scottish Association for Marine Science	estelle.dumont@sams.ac.uk
Stig Falk-Petersen	Norwegian Polar Institute	stig.falk-petersen@npolar.no
Susan Fitzer	Scottish Association for Marine Science	susan.fitzer@sams.ac.uk
Eic Fouilland	University of Montpellier, France	eric.fouilland@univ-montp2.fr
Colin Griffiths	Scottish Association for Marine Science	colin.griffths@sams.ac.uk
Mark Hart	Scottish Association for Marine Science	mark.hart@sams.ac.uk
Martyn Harvey	Scottish Association for Marine Science	martyn.harvey@sams.ac.uk
Keith Jackson	Scottish Association for Marine Science	keith.jackson@sams.ac.uk
John Kenny	Proudman Oceanographic Laboratory, UK	jlken@pol.ac.uk
Julian Klepacki	British Antarctic Survey	jzk@bas.ac.uk
Peter Lamont	Scottish Association for Marine Science	peter.lamont@sams.ac.uk
Ray Leakey	Scottish Association for Marine Science	ray.leakey@sams.ac.uk
Pauline Learmonth	Scottish Association for Marine Science	pauline.learmonth@sams.ac.uk
Emily LeFloc'h	University of Montpellier, France	emilie.lefloch@univ-montp2.fr
Pete Lens	British Antarctic Survey	pcdl@bas.ac.uk
Mike Lucas	National Oceanography Centre, UK	milucas@egs.uct.ac.za
Jane Manning	University of Swansea, UK	304569@swansea.ac.uk
Kate McIntyre	Scottish Association for Marine Science	kate.mcintyre@sams.ac.uk
Elaine Mitchell	Scottish Association for Marine Science	elaine.mitchell@sams.ac.uk
George Pagliero	British Broadcasting Corporation	georgepags@googlemail.com
Mark Preston	British Antarctic Survey	mopr@bas.ac.uk
Arlene Rowan	Scottish Association for Marine Science	arlene.rowan@sams.ac.uk
Laila Sadler	Scottish Association for Marine Science	laila.sadler@sams.ac.uk
Petra Schmitt	British Antarctic Survey	p_s_schmidt@web.de
Henrik Stahl	Scottish Association for Marine Science	henrik.stahl@sams.ac.uk
Ming Tsang	British Broadcasting Corporation	man.fan.tsang@bbc.co.uk
Mags Wallace	University of St Andrews, UK	mwallace@who.net
Susan Watts	British Broadcasting Corporation	susan.watts@bbc.co.uk
Anette Wold	Norwegian Polar Institute	anette.wold@npolar.no
Andrea Veszelovszki	Scottish Association for Marine Science	andrea.veszelovszki@sams.ac.uk

APPENDIX 2: Polar Bear Sightings

Robert Paterson (Chief Officer)

Ship's time: GMT plus 2 hours

During August 2008 the ship was tasked with a scientific cruise in the waters around Svalbard.

The ship left Longyearbyen, Spitsbergen, on the evening of Thursday the 31st. of July and, after completing a task in Storfjorden to the south, proceeded round to the northwest, then north of the island.

On Sunday the 3rd. of August the ship encountered its first light pack ice in position 79^{o} 54.1 North 009^{o} 54.1 East. The ship kept about 7 miles off the coast, proceeding between Reinsdyrflya and the island of Moffen. The track was then NE to Hinlopenrenna and, after some scientific work there, to another station approximately 12 miles west by north of the island of Rossoya, the northern limit of Spitsbergen.

On Monday afternoon (4th. August) the pack was thickening rapidly. It was recorded as 8/10 in position 80^{o} 37.8 North 017^{o} 21.6 East.

Bear Numbers 1-3

Bear sightings began to filter through to the bridge. At first these were distant sightings, seen by interested crew members and scientists through binoculars, but positions were not properly recorded.

One bear was seen in the distance on Sunday evening. Two bears were seen, again at a long distance, on Monday. Later that afternoon the first close sighting occurred, and this is recorded below. After that one more bear was later sighted at a distance on the same day.

The ship reached its northernmost work position 80^{o} 52.7 North 019^{o} 06.5 East, at 0100 GMT on Tuesday 5th. August and remained drifting with the heavy pack until the evening of Thursday the 7th. of August. It then returned to the Hinlopenrenna station (80^{o} 21.0 North 016^{o} 22.2 minutes East), moving through heavy pack and poor visibility overnight to arrive at 0600 GMT on Friday morning (8th. August).

Friday 8th August, Hinlopenrenna, close pack with some pools
Saturday 9th August, Hinlopenrenna, close pack with some pools
Sunday 10th August, Hinlopenrenna, close pack with more frequent pools

In the period between Sunday evening (3rd. August) and Sunday 10th. August) a total of 16 polar bears were seen from the ship.

Positions, where known, and some brief notes follow:

Bear Number 4

Date:	Monday 04/08/2008
Time (GMT):	1440
Position:	80^{o} 41.2 N 017^{o} 47.2 E
Observers:	Robert Paterson, Chief Officer, Lester Jolly, Able Seaman, Ship's company and scientists

The ship was proceeding slowly through pack ice about 22 miles NW of Kapp Rubin, Nordaustlandet, Svalbard, when Mr. Jolly reported seeing a polar bear on the ice some distance ahead. The ship at this stage was making good a speed of about 3 knots over the ground, through

8/10 pack, mainly medium sized floes of first year ice. As the ship approached the bear did not retreat. Rather, it seemed curious but wary. The power was taken off and the ship came to a halt in the ice. The bear then approached to with 100 metres of the starboard side of the ship and stayed in the vicinity. Eventually it sat down, seemingly interested but not fearful of our presence. After about 20 minutes the ship slowly got underway again, and the bear kept pace with us for a short while before our paths diverged. Several photographs were taken by the assembled spectators, some of which will be forwarded.

Bear Number 6

Date: Wednesday 06/08/2008
Time (GMT): 0335
Position: 80° 50.3 N 018° 57.4 E
Observers: Robert Paterson, Chief Officer, Lester Jolly, Able Seaman, Marc Blaby, Bosun's Mate, Clifford Mullaney, Able Seaman, and others.

At the time of this visit the ship was stationary in heavy pack ice,and the scientific party had left marker flags and some buoys overnight by holes drilled in the ice. The bear approached from the south and stayed alongside the ship for about 20 minutes, investigating the buoys. Eventually it picked up a marker flag, and dropped it after a few yards. It was aware of crew members on deck, and was slightly nervous of unexpected noise, but apart from that seemed more curious than alarmed. The bear moved off across the pack in a generally NNE direction.

Bear Numbers 7, 8 and 9

Date: Thursday 07/08/2008
Time (GMT): 1100
Position: 80° 46.7 N 018° 54.5 E
Observers: Pete Lens, Computer Support, Capt Graham Chapman, Douglas Leask 2/O and several others

Mother and two large cubs seen travelling over 9/10 pack ice, heading NNE. Distant sighting.

Bear Number 10

Date: Thursday 07/08/2008
Time (GMT): 1830
Position: 80° 40.9 N 018° 52.0 East
Observers: Simon Evans, Third Officer, Capt. Graham Chapman, Robert Paterson, Chief Officer and others.

Large bear on ice floe, which took to the sea and swam away from ship as it approached in 8/10 pack.

Bear Number 11

Date: Thursday 07/08/2008
Time (GMT): 2131
Position: 80° 31.5 N 018° 18.4 E
Observers: Capt. Graham Chapman, Simon Evans, 3/O

Seen on passage. Heavy pack. Mist.

Bear Number 12
Date: Thursday 07/08/2008
Time (GMT): 2247
Position: 80° 26.7 N 017° 58.3 E
Observers: Douglas Leask, Second Officer, Captain Graham Chapman

1 polar bear spotted feeding on seal on large floe, with another seal spotted on a smaller floe close by.

Bear Number 13
Date: Friday 08/08/2008
Time (GMT): 0605
Position: 80° 21.0 N 016° 22.2 E
Observers: Lester Jolly, AB, Robert Paterson, C/O

Ship stationary in pack ice. Bear approached ship across floes and stayed near stern for about 5 minutes before again walking off across floes

Bear Numbers 14 and 15
Date: Saturday 09/08/2008
Time (GMT): 0455
Position: 80° 21.4 North 016° 14.2 East
Observers: Lester Jolly, AB, Robert Paterson, Chief Officer
Several other crew members and scientists

Ship stationary in pack ice, Hinlopenrenna.
Bear 14 approached the ship and came in close on the starboard side for a look, then circled round aft and back again. It was seen to have scars and wounds. While it was doing this bear 15 moved in from the same direction. Bear 14 moved off in a NNW direction.
Bear 15 appeared to be following the tracks of bear 14. For a while both bears were within one mile of each other.
Bear 15 did not approach the ship as closely as 14 but stayed much longer, eventually lying down on a large floe, within sight but some distance off, for a few hours.

Bear Number 16
Date: Sunday 10/08/2008
Time (GMT): 1140
Position: 80° 21.7 North 016° 14.0 East Hinlopenrenna
Observers: Capt. Graham Chapman, Douglas Leask 2/O, and others

Large polar bear in open pool off port bow. It climbed on a small floe to observe the ship then swam to a large floe. It then climbed onto the large floe and walked away from the ship. A whale, species unidentified but probably minke, was seen in the water close to the bear.

Bear Number 17
Date Monday 11/08/2008
Time (GMT) 0900
Position 80° 19.3 North 016° 16.1 East
Observers: Captain Graham Chapman, Simon Evans 3/O, and others**.**

The ship was in transit from Hinlopenrenna
The bear was seen walking across the pack ice.
This was the last bear seen for a few days as on Monday 11th. August the ship passed south of Moffen Island and went offshore to work in the vicinity of Storlinsnaget.

On Wednesday 13th. August the ship made its way north of Norske Banken back to Hinlopenrenna. Although this area was ice covered to varying extents (between 1/10 and 8/10, depending on location) no bears were seen.

At 1500 GMT the ship commenced passage to Rijpfjorden. The route chosen was through Nordkappsundet (between the north coast of Nordaustlandet and the island group of Sjuoyane), across Nordenskioldbukta and then south into Rijpfjorden.

Pack conditions during this transit were heavy, with 8 to 9/10 cover being recorded in the ship's log. The next bear (number 18) was seen on the morning watch of Thursday 14th. August, just before the ship turned south into Rijpfjorden.

Bear Number 18
Date Thursday 14/08/2008
Time (GMT) 0319
Position 80 34.0 North 021 48.3 East
Observers: Lester Jolly AB, Robert Paterson C/O

Adult bear seen in heavy pack ice near Rijpfjorden. It walked off as the ship approached while working through the pack. No bears were seen in Rijpfjorden, which was relatively ice free, where the ship spent the next 3 days.

In the early hours of Sunday morning, the 17th. of August, the ship began to work its way through increasingly heavy pack ice back along its previous route through Nordkappsundet.

Bear Number 19
Date: Sunday 17/08/2008
Observers: Lester Jolly AB, Robert Paterson C/O

One bear was seen on the morning watch (0400 to 0800 ship's time). Unfortunately the position was not accurately recorded, but it was certainly within 3 nautical miles east to north east of the earlier sighting of bear 18. It is not known if it was the same animal.

Bear Number 20
Date: Sunday 17/08/2008
Time (GMT): 1330
Position 80 33.4 North 019 40.7 East

The next bear was seen later in the day at 1530 ship's time (1330 GMT) 2.8 nautical miles north by east of Kapp Rubin.

During the rest of the day until midnight local time, when the ship moved 24 miles through the pack a further 7 bears were seen, making the total for the day 9.

Pack conditions for this transit were very heavy. The ship was struggling to make progress at times through very large flat floes with practically no open pools or leads in sight. The average speed made good was about 2.5 knots.

Bear Number 21
Date Sunday 17/08/2008
Time (GMT) 1408
Position 80 32.9 North 019 31.1 East
Observers: Lester Jolly AB, Robert Paterson C/O

Bear Number 22
Date Sunday 17/08/2008
Time (GMT) 1453
Position 80 32.6 North 019 11.9 East
Observers: Lester Jolly, Robert Paterson C/O

Bear Number 23
Date Sunday 17/08/2008
Time (GMT) 1537
Position 80 32.8 North 019 00.6 East
Observers: Lester Jolly AB, Robert Paterson C/O

Distant sighting of adult bear lying on ice.

Bear Number 24
Date Sunday 17/08/2008
Time (GMT) 1625
Position 80 33.5 North 018 44.4 East
Observers: Lester Jolly AB, Robert Paterson C/O

Bears 25, 26 and 27
Date Sunday 17/08/2008
Time (GMT) 2200
Position 80 26.0 17 21.1
Observers: Captain Graham Chapman, Douglas Leask 2/O, Simon Evans 3/O

Mother and 2 large cubs feeding on seal.

APPENDIX 3: ADCP command files

OS75 Broadband mode Bottom track OFF 500m.txt

```
;-------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 kHz Ocean Surveyor
; Setup name:    default
; Setup type:    High resolution, short range profile(broadband)  500 m
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;-------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for broadband single-ping profile mode (WP), sixty five (WN) 8 meter bins (WS),
; 2 meter blanking distance (WF), 390 cm/s ambiguity vel (WV)

; Switch off Narrowband NP0
NP0
nn60
ns800
nf200

; Switch on Broadband  WP1

WP001
WN065
WS800
WF0200

WV390

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)

; Bottom track OFF
BP00
BX12000

; output velocity, correlation, echo intensity, percent good
WD111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
```

```
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00065

; Set Salinity (ppt) [salinity in transducer well = 0]
ES0

; set Trigger in
CX1,1

; save this setup to non-volatile memory in the ADCP
CK
```

****

OS75 Broadband mode Bottom track ON 500m.txt

```
;-------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 kHz Ocean Surveyor
; Setup name:    default
; Setup type:    High resolution, short range profile(broadband)  500 m
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;-------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for broadband single-ping profile mode (WP), sixty five (WN) 8 meter bins (WS),
; 2 meter blanking distance (WF), 390 cm/s ambiguity vel (WV)

; Switch off Narrowband NP0
NP0
nn60
```

```
ns800
nf200

; Switch on Broadband  WP1

WP001
WN065
WS800
WF0200

WV390

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP01
BX12000


; output velocity, correlation, echo intensity, percent good
WD111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00065

; Set Salinity (ppt) [salinity in transducer well = 0]
ES0

; save this setup to non-volatile memory in the ADCP
CK

**************************************************************************
```

OS75 Narrowband mode Bottom track OFF deep.txt

```
;-------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 kHz Ocean Surveyor
; Setup name:    default
; Setup type:    low resolution, Long range profile(Narrowband)  deep water
;
; NOTE:  Any line beginning with a semicolon in the first
```

```
;       column is treated as a comment and is ignored by
;       the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;-------------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), seventy (NN) 16 meter bins (NS),
; 2 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)

; Switch Narrowband ON   NP1
NP1
nn70
ns1600
nf200

; Switch Broadband  OFF   WP0

WP000
WN065
WS800
WF0200

WV390

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)

; Bottom track OFF
BP00
BX12000

; output velocity, correlation, echo intensity, percent good
WD111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000
```

```
; Set transducer misalignment (hundredths of degrees)
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00065

; Set Salinity (ppt) [salinity in transducer well = 0]
ES0

; set Trigger in
CX1,1

; save this setup to non-volatile memory in the ADCP
CK

**********************************************************************
```

OS75 Narrowband mode Bottom track on 1000m depth.txt

```
;-------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 kHz Ocean Surveyor
; Setup name:    default
; Setup type:    low resolution, Long range profile(Narrowband)  1000 m
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 28August2005
;-------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty five (NN) 16 meter bins (NS),
; 2 meter blanking distance (NF), 390 cm/s ambiguity vel (WV)

; Switch Narrowband ON  NP1
NP1
nn65
ns1600
nf200


; Switch Broadband  OFF  WP0

WP000
WN065
WS800
WF0200

WV390
```

```
; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX) (decimeters)
BP01
BX12000


; output velocity, correlation, echo intensity, percent good
WD111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA6008

; Set transducer depth (decimeters) [= 6.5m on JCR]
ED00065

; Set Salinity (ppt) [salinity in transducer well = 0]
ES0

; save this setup to non-volatile memory in the ADCP
CK
```

APPENDIX 4: The Matlab Routines

(From a document written by Angelika Renner following JR165, 2007).

For any further information regarding Matlab ADCP processing contact Hugh Venables at BAS (hjv@bas.ac.uk).

- file sequence:all files for which in the filename NAME xxx yyyyyy.END the number at position xxx is the same.
- amplitude, scaling factor, A: Throughout the routines the factor by which the ADCP data has to be scaled for calibration is called either amplitude, scaling factor or A.
- misalignment (angle), phi: synonyms for the angle by which the ADCP is misaligned in addition to the physical misalignment set in the command files.

1. Quick'n'dirty: How to get processed ADCP data
A few things must be set for each cruise. These are:

- Add the path where the routines are stored to the Matlab search path.
- The cruise name: variable 'cruise'. The name is used when reading in raw data and saving processed data, and apears in the plots.
- The file sequences: variable 'files'. This determines which of the file sequences are processed. 'files' can be a single number or a vector containing the numbers of several file sequences.
- Paths to data files: variables 'RAWPATH' and 'PATH'. They contain the directory paths to the directory where the raw data is stored ('RAWPATH'), and where the processed data will be written to ('PATH').
- The averaging interval: variable 'superaverage'. 'superaverage' sets the interval over which ping ensembles will be averaged. Unit is seconds.
- The year: variable 'YYYY'.
- A switch for which lat/lon fix to be used (see below): variable 'which prdid fix'.Options are a) 1 to use the fix directly after the previous ADCP ping, or b) any other number to use the fix directly before the current ADCP ping. Set it to 1 if you don't want to bother, it works.
- The upper and lower limit of the reference layer: variables 'ref uplim' and 'ref lowlim'. Those are needed for calculation of a reference velocity which is used when doing calibration by water tracking. Unit is meters.
- The misalignment angle and the scaling factor: variables 'misalignment' and 'amplitude'. When running OS75 .JCR.m the first time (see below), set the misalignment to 0 and amplitude to 1. After the first run, to correct for the angle and the scaling, set the variables to the mean, median, mode or whichever value is preferred, and run OS75 .JCR.m again. Mean, median, and standard deviation are displayed in the plot adcp calib calc.ps. To keep track of which values were used it is a good idea to note down which file sequences require which correction factors.

All that needs to be done then is:
1. Run OS75 .JCR.m.
2.Check which values for misalignment angle and scaling factor are derived.
3.Set 'misalignment' and 'amplitude' in OS75 .JCR.m to these values.
4. Run OS75 .JCR.m again.

If you reprocess the raw data, make sure to remove the old .ps-files containing the various plots, otherwise the new plots will simply be added instead of written to a new file.

2. Detailed description of the processing functions
2.1 The master function: OS75 .JCR.m
The main function for the processing is OS75 .JCR.m. In there, the environment and variables are set, and the subfunctions are called. Fig. 1 gives an overview of the processing routines, their order and the output.

In the first part the work environment is defined: Matlab paths to the processing routines are added to the Matlab search path, the directory with the raw data and the directory for the processed data are declared, and the file- and cruise names are defined. Then the vector containing the numbers of the file sequences that are to be processed is created. Several choices can be made for the processing: the variable superaverage is used to define the interval over which pings will be averaged in time, unit is seconds. which prdid string sets, if the first PRDID fix after the previous PADCP string or the last one before the current PADCP string; this will make sense later, see *2.8*. The values for ref uplim and ref lowlim

give the upper and lower limits of the reference layer of which a velocity is calculated and used as reference velocity. This is important for water track calibration in cases where no bottom track data are available (see *2.12* and *2.13*).

During the first run through OS75 JCR.m the correction values for the misalignment angle (misalignment) and the scaling factor (amplitude) are set to 0 and 1 respectively. For the second run, when values for misalignment and amplitude have been calculated, they should be set to the median, mean, mode or whichever value works best. To know later how the values were derived it is best to write down where they came from. Hopefully, a list of values used for data from the OS75 ADCP onboard JCR will develop. To keep a record of the settings used to process a set of ADCP data, the settings and the text displayed on screen during the processing are written to a diary called *adcp proc log runX. txt*. *X* will be 1 for the first run (when misalignment and amplitude are equal to 0 and 1, resp.) and 2 for the second run (misalignment and amplitude unequal 0 and 1, resp.).

After this introductory part, the processing starts. Arrays are declared for later use when calling some of the subroutines, and the file containing calibration point data is deleted if it exists. This is the beginning of the loop through the file sequences specified above. First, the filename is set. Its general structure is CRUISE xxx yyyyyy. At this point, xxx is set to the file sequence number that is the current in the loop and yyyyyy is 000000. The files created by remove bad navigation.m and subst bad seatex.m are deleted if they exist. To go through all files in a file sequence, the switch ex and the counter I are used. In the while-loop depending on the value of ex, the first thing adjusted is the filename so that yyyyyy corresponds to the current file of the current file sequence. If the file 'filename'.ENX exists, ex will keep the value 1, otherwise it will become zero. After this, the run through the subroutines begins! This includes all routines described in *2.2* to *2.11*. Once all files have been passed through these routines and the loop is finished, the functions described in *2.12* to *2.16* are called. After that, all data is processed and saved in the specified directory. The last thing in the main function is a plot of velocities: cross sections of the zonal and meridional velocities are produced and the plots are saved in adcp vel contours.ps.

2.2 read os.m
In this routine, the raw binary data from VmDas are read. In the case of JR165, we used the .ENX files, which contain ADCP single-ping and navigation data. The ADCP single-ping data has already been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity and false targets (see VmDas User's Guide). read os.m is called with the file name variable and optional arguments. The latter define which part of the raw data is read:
'ends': ???
'ens list': list of ensemble numbers
'yearbase': start year
'second set':read narrow band mode data when both broad and narrow band are collected.
'vel': read velocity.
'cor': read correlation magnitude.
'amp': read echo intensity.
'pg': read percent good.
'ts': read pitch, roll, and heading.
'bt': read bottom track data.
'nav': read navigation data
'all': includes vel, cor, amp, ts, bt, and pg.

More than one argument can be passed on to read os .m. Arguments can also be numbers.
After the switches are set, the subroutine os id, which is within read os .m, is called with the argument id arg. The value of id arg depends on the offset of the positions of the data, which in the case of the JR165 data is zero. os id returns the structure id with the positions/identifiers of the data fields in the binary data files.

The next step is the first call to the subroutine read buf, also within read os .m.
read buf. This is the part where the binary data is read.

During the first call with only one argument, the configuration of the OS75 ADCP is extracted from the fixed leader data and stored in the structure config. If one of the checks on number of bytes, header or data source ID or checksum fails, an error message will be returned to read os.m. Otherwise, information about ADCP hardware and setup that remains the same for all pings is read. After that and during the second call (with two arguments), the variable, bottom track, attitude, and navigation data is extracted.

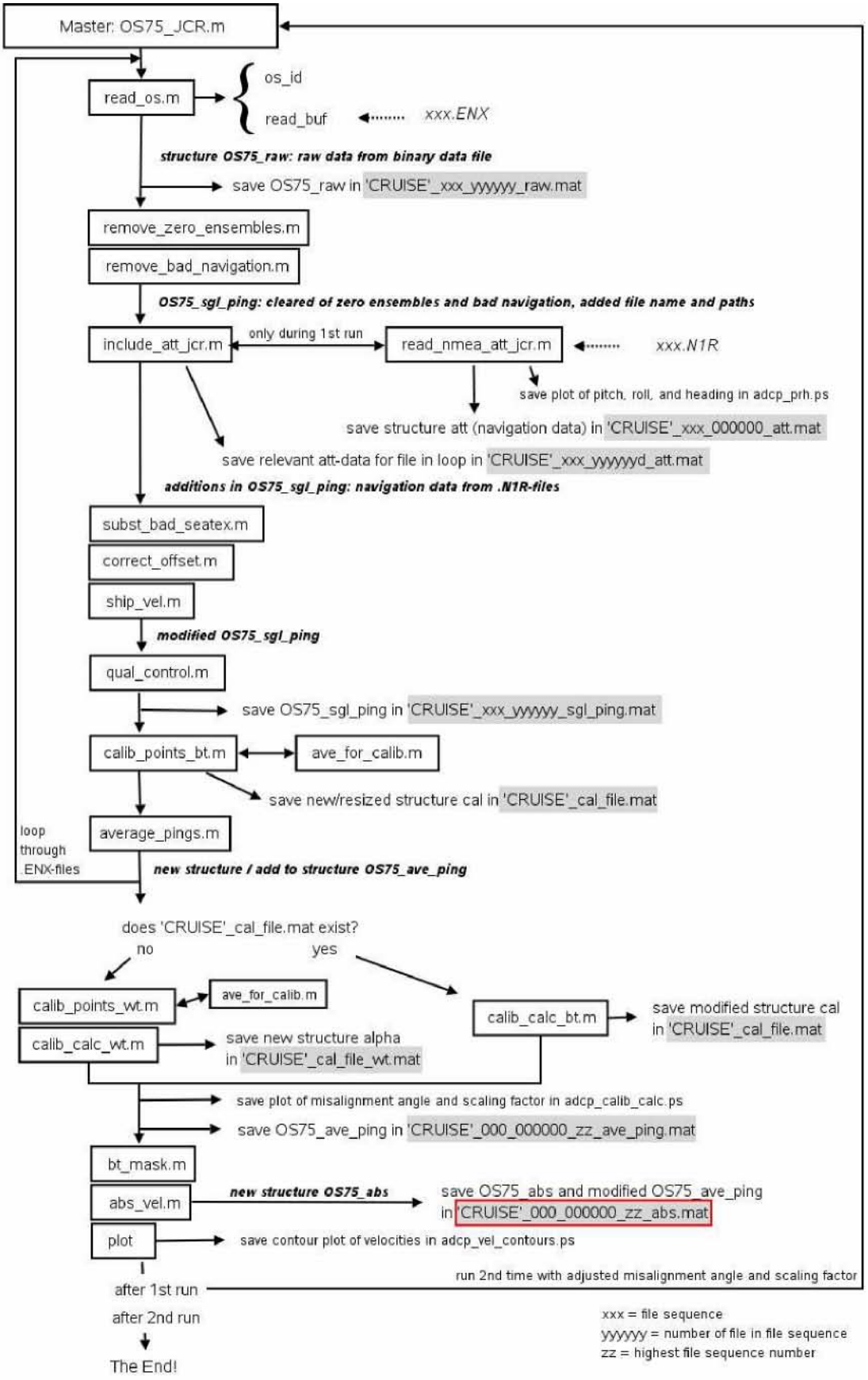

Fig. 1: Flowchart of the processing

After the first call to read buf, the configuration data is used to set up space and size of variables and the reading loop. read buf is called the second time, and the data requested by using the various switches is stored. Before returning to the main routine, variables are adjusted for negative numbers or NaNs.
All raw data read in are stored in the structure OS75 raw and returned to the main function. There, the structure is written to the file CRUISE xxx yyyyyy raw.mat.

2.3 remove_zero_ensembles.m
The structure OS75 raw is handed over to remove zero ensembles.m.A search for all ensembles whose ensemble number (OS75 raw. ens num) is not zero is done and only those are kept and handed back to the main routine as OS75 sgl ping.

2.4 remove bad navigation.m
Depending on which prdid fix, O875 sgl ping. nav. txy1 or 2 is checked for time (first row), longitude (second row) and latitude (third row) duplicates. The number of rejected data cycles is printed on screen and saved as bad and good (=number of data cycles - number of rejected cycles) in the file CRUI8E bad nav. mat. The rejected data cycles are then removed from O875 sgl ping and the structure handed back to the main routine.

2.5 include att jcr.m
Arguments passed on to this routine are O875 sgl ping, add to ensnum (for the correction of ensemble numbers; see below) and which prdid fix.If no file CRUI8E xxx 000000 att. mat exists yet (i.e. the navigation data in the .N1R-files has not been read yet), O875 sgl ping is passed on to read nmea att jcr.m which is called to read the .N1R- (or .N2R-) files.

read nmea att jcr.m The routine goes through all .N1R-files in a file sequence. To change to .N2R, modify the variable extension. The number of lines to be read in one go is limited to a maximum of 160000, the loop will go on until all lines are read.
ping ensemble!). From the $PRDID-lines the one following the $PADCP-line are extracted, the others string are extracted. Pitch, roll and heading are read from the remaining $PRDID-lines and stored. If heading is The text in the .N1R-file is read into a matrix. Then lines containing the $PADCP or the $PRDID missing (=999), pitch and roll are set to 999 as well. From $PADCP-lines, the ping ensemble number, $PADCP-lines are consecutive, the first of them is discharged (no attitude data available for this), the PC clock offset, and the PC time of the ping ensembles (converted to decimal Julian days) are extracted. After all files are read, the ping ensemble number is checked and corrected for duplicates, which can appear due to the splitting of the files after the maximum number of lines is read. The data are stored in the structure att which is written to CRUI8E xxx 000000 att.mat. Pitch, roll, heading, and the PC clock offset are plotted and the figures saved to adcp prh.eps.(Figures need to be improved!). Then return to include att jcr.m.

The file CRUI8E xxx 000000 att.mat with the att-structure is loaded in. If the structure contains data, the following is done: For further processing the ping ensemble number has to be increasing. When the ADCP times out while waiting for a response and resets, the ensemble number goes back to 1. Here, the ensemble numbers are modified so that they increase throughout the file (for att) and throughout the files of a file ensemble in O875 sgl ping. ens num.

Attitude data already exist in the structure O875 sgl ping which comes from the .ENX-file. To extract pitch, roll, heading, and PC clock offset which are relevant for the current .ENX-file, a vector is created for each variable of the length max(highest ensemble number in att, highest ensemble number from the .ENX attitude data) and filled with NaNs. Then, the attitude information from att is written into the vector and only the data points corresponding to the ensemble numbers from the .ENX-file are stored. If att is empty, heading, pitch, roll, and PC clock offset are set to NaN.

The extracted attitude data are written to O875 sgl ping. att. The attitude data relevant to the current .ENX-file is also saved in the new structure att in CRUI8E xxx yyyyyyd att.mat. The modified O875 sgl ping is returned to the main routine.

2.6 subst bad seatex.m
The arguments O875 sgl ping. att, and sea file are handed over. In sea file the number of accepted and rejected (due to bad Seatex data) data points will be stored.
A search on O875 sgl ping. att data is done for ensembles where
heading = 0;
heading = 999;
pitch and roll = 00;
the second differential of heading = 0.

The total number of those ensembles is printed on screen and saved as bad in 'cruise' bad heading. mat.

O875 sgl ping contains two headings: O875 sgl ping.heading which comes from the .ENX-file and O875 sgl ping. att. heading from the .N1R-file. Both are from the same instrument (Seapath Seatex), but may be slightly different due to a (very) small time difference in when they are recorded. Therefore, the velocities in O875 sgl ping are rotated by the difference.

To get bottom track velocities in the correct orientation, O875 sgl ping.bt.vel is multiplied by -1. O875 sgl ping with the modified values is returned to the main routine.

2.7 correct offset.m
Using the helper routine uvrot.m, this routine scales the water and bottom track velocities and corrects them for misalignment. From the main routine, the arguments O875 sgl ping, misalignment and amplitude are passed on. The horizontal velocities are multiplied by the scaling factor amplitude and rotated by the specified misalignment angle misalignment. The heading is adjusted by subtracting the misalignment angle. The modified structure O875 sgl ping is returned to the main routine.

2.8 ship vel.m
The routine is called with the arguments O875 sgl ping and which prdid fix. The latter decides which navigation fix is used for the calculation of the ship velocity: either txy1 or txy2 (see also *2.1*). With the help of the routine sw dist .m from the CSIRO Seawater toolbox, the distance and the direction between the fixes is calculated and then converted to distance in east- and northward direction in meters and time difference in seconds. Dividing distance by time difference results in ship velocity in m/s, which is written to O875 sgl ping.ship velocity.

If bottom tracking was on, the horizontal bottom track velocities O875 sgl ping.bt. vel(1:2,:) should contain values other than NaN. If that is the case, the ship velocity is set to O875 sgl ping.bt. vel(1:2,:). The structure O875 sgl ping is then handed back to the main routine.

2.9 qual control.m
Several criteria are used in this routine for further quality control. Therefore, the arguments O875 sgl ping, beam, heading change and ship velocity change are included in the call. beam is the number of beams of the ADCP instrument, heading change is the maximum change in heading allowed at any one timestep, and ship velocity change is the maximum change in ship velocity allowed at any one timestep. Large changes lead to less reliable ADCP data. The values used during JR165 are 10 degrees for the heading change and 0.5514 m/s for the ship velocity change (corresponds to one knot).

The first step of quality control uses the error velocity provided through the fourth beam (vel(:,4,:)). A variable err vel is set to 2 times standard deviation of the error velocity, and the velocities of all ping ensembles where the absolute value of this velocity exceeds err vel are set to NaN. Then, if beam = 0, a check using percent good is performed: velocities of ping ensembles with percent good of the fourth beam equal to zero are set to NaN.

The two following steps look at the heading changes. First, a smoothed version of the heading change (diff(heading)), created using a Hamming-window based, second order filter (see *2.17*), is checked for values exceeding heading change, and the velocities of affected ping ensembles (i.e. the two ensembles in between which the change is large) are set to NaN. The same is done for the unfiltered heading change.
NOTE: for mfilter.m and the therein used Matlab function filtfilt .m, the data needs to have a minimum length of 3 times the filter order. That means that files with data recorded over less than approximately 5 minutes cannot be used. Velocities are set to NaN, if the change in ship speed exceeds ship velocity change. A last control is done on absolute horizontal velocities in a reference layer: The eastward and northward velocities in the ninth depth bin are chosen and the ship velocity is added to obtain absolute velocities. Then, velocities of ping ensembles between which the change of either of these reference velocities is larger than 2 m/s are set to NaN. The structure with the modified velocity array is returned to the main routine.

2.10 calib points bt.m
In this routine, calibration points are extracted using 2-minute averages of ADCP data and various criteria these points have to fulfill. It is called with the arguments O875 sgl ping, cal file, which prdid fix, ref uplim and ref lowlim. cal file specifies where the data for calibration extracted here will be written to, which prdid fix does the same as in ship vel .m (*2.8*). To average the ADCP data over 2 minutes, the routine ave for calib .m is called with the arguments O875 sgl ping, av time (set to 120 seconds), ref uplim, ref lowlim, and which prdid fix.

ave for calib .m: this routine is a reduced version of average pings .m (see *2.11*), including only variables required by calib points bt .m. The possibility of missing out ping ensembles in the averaging process when several .ENX-files exist in a file sequence is ignored here (for more about that issue see *2.11*). After the

averaging, a check is done whether bottom track velocities are available or not. If all bottom velocities are NaNs, the routine stops and returns to the main program. The principle used is based on a comparison of ADCP bottom track data and GPS tracks. The bottom velocity recorded by the ADCP should be the same as the GPS derived ship velocity. Therefore, the value GPS ship speed/ADCP bottom track speed gives the scaling factor to adjust ADCP velocities, and - (GPS ship heading - ADCP bottom track heading) is the misalignment angle.

As velocities from bottom tracking are crucial for the calibration, ping ensembles with NaNs in either zonal or meridional bottom velocity are discharged. The ship velocity is derived from navigation data in O875 sgl ping.nav and which prdid fix sets which fix is used. Ship velocity is then calculated as in ship vel.m (*2.8*) as distance in east- and northward direction divided by time difference.
The criteria potential calibration points have to fulfill are:
the change in ship heading is small (for JR165: $< 1^{\circ}$);
the change in ship speed is small (for JR165: <0.1 m/s);
the ship speed is within the interval average ship speed ± standard deviation;
the ship heading is within the interval average ship heading ± standard deviation;
the bottom speed is larger than a specified minimum speed (for JR165: 1.5 m/s);
there are a minimum number of possible calibration points in a row that fulfill the criteria (for JR165 the minimum number was six).

Relevant data at the calibration points are extracted and saved in the structure cal. This includes bottom velocity, speed, heading and range, ADCP velocities and heading, ship speed and heading, and the navigation data. The scaling factor at the calibration points is calculated as is the misalignment angle. To enable quality control of the intervals of calibration points (interval=row of successive calibration points) and possible filtering by hand after the processing, some statistics are done and included in the structure: average and standard deviations of ship velocity and heading, bottom velocity and heading, scaling factor and misalignment angle, and the number of 2-minute averages in the interval. If the cal file does not already exist it is created. Otherwise the data are added to the existing file.

2.11 average pings.m
The routine is called with the arguments O875 sgl ping, d missed, O875 ave ping, superaverage, ref uplim, ref lowlim, and which prdid fix. The time in seconds over which the ping ensembles are averaged is given by superaverage. As the ping ensembles in a file of a file sequence are not necessarily divisible into the specified time intervals without remainder, the structure d missed is used to carry on the surplus ensembles and add them to the ping ensembles of the next file in the same file sequence. If there are ping ensembles left at the end of a file sequence, they will not be included in the averaging. At first, a check is done whether any ping ensembles from the previous file were carried forward. If that is the case, they are added to the current file in the loop. A depth range for the reference layer velocity is set as is the maximum number of depth bins. Pings are averaged in intervals determined by superaverage and using the time stamps in O875 sgl ping. nav. txyX where X is either 1 or 2 depending on which prdid fix. Throughout the routine, there are various occasions where (usually) three dimensional arrays are split up into several 2d-arrays. This is done using the reshape-command and the size of the velocity fields. To avoid problems when the original velocity field is 2d instead of 3d, a check is introduced and the variable containing the size of the field is adjusted. Several variables are extracted and derived: the reference layer velocity (zonal and meridional) as mean of the horizontal velocities in the depth range specified by ref uplim and ref lowlim; absolute velocities by adding the ship velocity to the horizontal velocities; percent good from the fourth beam; a value for bottom range for each ping ensemble with the condition that it is between 50 and 1200 m depth and using the median of the four beams; the difference between the headings from the .ENX and from the .N1R-file (set to NaN if the .ENX-heading does not change for two successive ping ensembles); pitch and roll (set to NaN if data is missing, i.e.> 998); the PC clock offset; the echo intensity as mean over all beams.

The navigation data are set to NaN for ping ensembles where there are no velocity data in any of the beams and any of the depth bins. For the averaging, the heading is broken up into components (-cos and sin) and reconverted to angles in degrees afterwards. Of the extracted variables the ones included in the averaging are: absolute velocity (all three directions), reference velocity, heading, difference in .ENX- and .N1R-heading, PC clock offset, echo intensity, percent good, and bottom range. Additionally, ship velocity and navigation data (time, longitude, latitude) are averaged. For pitch and roll, the standard deviation is calculated. The data from ping ensembles that were remainders after the averaging are written to d.missed and returned to the main routine.

The averaged absolute velocity is converted back to velocity relative to the ship by subtracting the averaged ship velocity. The reference layer velocity is then recalculated from the resulting averaged (relative) velocity. The averaged variables are added to the structure O875 ave ping as are the variables depth and ref. bins (= numbers of the bins in the reference layer). The structure is then returned to the main routine. average pings m is the last routine called within the loops through all files in a file sequence and through all file sequences specified. At the

end of the loops, the structure O875 ave ping contains averaged data for all files included in the processing. Before the loops are left, the array bin_depth containing bin depths for each of the averaged velocity profiles is created.

The next steps are the final part of the calibration, blanking the bottom, and removing the ship velocity from the ADCP velocity data.

2.12 calib points wt m
If there is no bottom track data available, the calibration is done using water track. Again, the search for possible calibration points is done using 2 minute averages produced by ave for calib m. First differences are calculated from the average data for the reference velocities (i.e. the water velocities in the reference layer specified by ref uplim and ref lowlim) du and dv, and the ship velocities dsu and dsv. Of those, only differences were considered for when ship speed exceeded 3 m/s between ensembles not more than 5000 m or 3600 s apart. Using the Matlab function fminsearch.m, the following function was minimised for phi and A:
f(A,phi) = (A.du . cos(phi) - A . dv . sin(phi) + dsu)2 + (A.du. sin(phi) + A. dv . cos(phi) + dsv)2
Values for A and phi are written to the array alpha together with relevant heading, navigation, and velocity data, and alpha is handed back to the main routine.

2.13 calib calc wt.m
After alpha has been created in calib calc wt .m, it is passed on to this subroutine. Here, average, median, and standard deviation for phi and A are calculated and written to cal file wt. The average or the median should then be used during the second run of OS75 .JCR.m for misalignment and amplitude correction. Several plots of the misalignment and the scaling are also produced and stored in adcp correction stats.ps.

2.14 calib calc bt.m
During the first run of OS75 .JCR.m, the misalignment angle and the scaling factor which are to be used for the second run are calculated here. In the second run, the results for phi and A should be closer to zero and one, respectively, than before.
The arguments handed over are cal file, which specifies the file with the calibration point data, cruise, misalignment and amplitude, which are used for the plots created in this routine. After cal file is read in, scaling factors and misalignment angles outside the interval average ± standard deviation are sorted out. From the remaining points, the average, the median and the standard deviation for A and phi are calculated and added to the structure cal. The median is less affected by outliers which might have survived the screening in calib points bt .m and calib calc bt .m and should therefore be used as correction value in the second run.
Before returning to the main routine, a plot showing the distribution of the misalignment angles and the scaling factors and their temporal development is produced. (After returning to the main program, the plot is written to the file adcp calib calc.ps.)

2.15 bt mask.m
O875 ave ping and bindepth are passed on to this routine. Here, a mask is created using the bottom range bt.range. With this mask, velocity data below 86% of the bottom range (= water depth) is set to NaNs. The structure containing the modified velocity fields is returned to the main routine.

2.16 abs vel.m
O875 ave ping and bindepth are handed over from the main routine. In order to derive absolute water velocities independently from ship motion, the east- and northward ship velocities are added to the horizontal water velocity (O875 ave ping.vel). The same is done for the velocity in the reference layer (O875 ave ping. ref. vel). The resulting absolute velocities, the navigation data and the depth array (set to bin_depth) are handed back to the main routine within the structure O875 abs.

2.17 Helper routines: julian.m, sw dist.m, uvrot.m, rot fun 1.m, mfilter.m
These routines are called on various occasions during the processing. sw di st.m is part of the CSIRO Seawater toolbox.

3 Overview of output files
CRUISE xxx yyyyyy raw.mat
The structure OS75 raw in this file contains the raw, unedited data from the .ENX-file as read in include att jcr. m and read nmea att jcr.m. For JR165 the structure consists of:
vel, cor, amp, pg (arrays of size number of bins x number of beams x number of ensembles): velocity, correlation magnitude, echo intensity and percent good for the four beams.
heading, pitch, roll as 1 x number of ensembles-array.
temperature, soundspeed: 1 x number of ensembles-array. The temperature here is the temperature of the water at the transducer head. It is either set manually or measured. The soundspeed is calculated or set manually.

dday, ens num, num pings: 1 x number of ensembles-array. dday is decimal day, ens num the ensemble number of the pings, and num ping the number of pings in each ensemble.
bt: structure containing the bottom track data:
vel, range, cor, amp, rssi (arrays of size 4 x number of ensembles):bottom track velocity, range, correlation magnitude, echo intensity and receiver signal strength indicator for the four beams
nav: structure containing navigation data:
sec pc minus utc:number of ensembles x 1 array containing the PC clock offset in seconds;
txy1, txy2: 3 x number of ensembles arrays; first row: time in decimal Julian days, second row: longitude, third row: latitude. txy1 is data from the first PRDID-fix after the previous ADCP ping, txy2 is from the last PRDID-fix before the actual ADCP ping.
config: structure containing the setup information about the OS75 and VmDas
depth: 1 x number of bins-array. The array contains the depth of the bins in the configuration used for the actual file sequence.
error: if reading of data fails, an error message will be stored here, otherwise it should be empty. There is one such file for each .ENX-file in a file sequence.

CRUISE xxx 000000 att.mat
In this file, the structure att contains the attitude information from all .N1R-files of a file sequence, read during read nmea att j cr. m. This includes the following 1 x number of ensembles-arrays from
the $PRDID and $PADCP lines:
heading, pitch, roll;
pc time:time from the ADCP PC clock;
pc time offset: offset of the ADCP PC clock from UTC in seconds;
ens num: the ping ensemble number.
Per file sequence, one file CRUISE xxx 000000 att.mat is produced.

CRUISE xxx yyyyyyd att.mat
For each file in a file sequence, attitude data is extracted and saved in CRUISE xxx yyyyyyd att.mat. It contains a structure att which consists of the following arrays of size 1 x number of ensembles per .ENX-file:
att heading, att pitch, att roll: heading, pitch and roll from the .N1R-files for the ping ensembles in the corresponding .ENX-file;
heading orig: heading from the .ENX-file;
ens num: the ping ensemble number;
lat: latitude of the ping ensemble.
The difference between att heading and heading orig should be small and therefore negligible. In the case of JR165, they both come from the same instrument, the SeaPath Seatex, but there is a small time lapse between the writing of data to the .ENX- and the .N1R-files.

CRUISE xxx yyyyyy sgl ping.mat
Again, one file with single ping data is produced for each .ENX-file. In the structure OS75 sgl ping, after several steps of quality control, filtering and correcting for misalignment and scaling (after final processing), data from the four beams, bottom track data, navigation data, configuration data and information about the processing environment are stored:
all variables that exist in OS75 raw in the file CRUISE xxx yyyyyy raw.mat are included;
additional variables:
filename:CRUISE xxx 000000;
path, rawpath: paths to the directories where the processed data is written to (path) and where the raw data files are stored (rawpath);
att: structure containing heading, pitch, roll, and PC clock offset;
heading orig: number of ping ensembles x 1-array, heading from the .ENX-file;
ship velocity:2 x number of ping ensembles-array, containing the eastward (first row) and the northward (second row) ship velocity.

CRUISE cal file.mat
In this file, all information at calibration points needed for the calculation of misalignment angle and scaling factor are stored. This includes:
bt: structure with bottom track data: arrays vel (2 x number of calibration points), speed, heading, and range (1 x number of calibration points);
vel:number of bins x 2 x number of calibration points-array of east- and northward velocity
heading: 1 x number of cal. points-array; heading from .N1R-data;
nav: structure containing txy1 data at the calibration points;
ship speed, ship heading: 1 x number of cal points arrays;
scaling, phi: scaling factor and misalignment angle at each calibration point; 1 x number of cal. points-array;

intervals: stats for each interval of successive calibration points; see description of routine
calib points bt .m in *2.10*;
stat: structure with values for the scaling factor (a) and the misalignment angle (phi) as calculated in the routine calib calc bt .m, see *2.14*; the values stored here after the first run of the main routine OS75 JCR.m are the ones that should be used for the second run. Only one file for all file sequences processed in a run is created.

CRUISE cal file wt.mat
If no bottom track data is available, calibration is done using water track. For this, the array alpha is created. From data in alpha, the misalignment angle phi and the scaling factor scaling are derived and alpha, phi, and scaling are stored in this file.

CRUISE 000 000000 zz ave ping.mat
The structure OS75 ave ping contains data after averaging over a chosen time interval (xyz = number of velocity profiles after averaging):
vel:number of bins x 3 x xyz-array of average velocity (zonal, meridional and vertical);
amp, pg: number of bins x xyz-arrays; echo intensity and percent good;
ship velocity:2 x xyz-array of zonal and meridional ship velocity; if bottom track velocity is available, then the ship velocity equals the bottom track velocity;
heading: 1 x xyz-array;
nav: structure containing txy1: 3 x xyz-array of time (decimal Julian days), longitude and latitude;
att: structure containing:
heading difference:1 x xyz-array of the difference between heading from .ENX and .N1R (hopefully equal to zero);
pitch, roll, pc time: 1 x xyz-arrays;
ref: structure with velocity (2 x xyz-array): average over the reference layer, and bins: vector containing the depth bins that lie within the reference layer;
bt: structure containing range: 1 x xyz-array of bottom track range;
depth: 1 x number of bins-array (bin depths of the setting of the last file sequence processed).

CRUISE 000 000000 zz abs.mat
In this file, both OS75 abs and OS75 ave ping are saved. The latter contains the same fields as in CRUISE 000 000000 zz ave ping.mat, where only the values in the velocity field are changed. Additionally, the variable bindepth is included as well.
OS75 abs includes (xyz = number of velocity profiles after averaging):
vel:number of bins x 3 x xyz-array of absolute velocity (zonal, meridional and vertical), i.e. horizontal velocities are corrected for ship velocity;
nav: structure containing txy1: 3 x xyz-array of time (decimal Julian days), longitude and latitude;
ref: structure with velocity (2 x xyz-array): average over the reference layer, and bins: vector containing the depth bins that lie within the reference layer;
depth: number of bins x xyz-array (bin depths corresponding to the settings used for the velocity profiles).

Plots
adcp prh.ps For each .N1R-file a plot of pitch, roll, heading, and PC clock offset is produced in read nmea att jcr.m and saved to adcp prh.ps. They need editing to make them really useful!
adcp calib calc.ps After the final filtering of calibration points, misalignment angle and scaling factor are plotted in form of histograms and time series (in calib calc bt.m). There should be two plots after completed processing: the first plot from the first run of OS75 JCR.m with amplitude = 1 and misalignment angle = 0, and second plot from the second run using the calculated values for amplitude and misalignment.
adcp vel contours.ps. The final step in OS75 JCR.m is to plot meridional and zonal velocity as it is saved in the structure OS75 abs in file CRUISE 000 000000 zz abs.mat. Added in the figure are the cruise track, the values used for correction for misalignment and scaling, the cruise name, and numbers of the file sequences processed. As in adcp calib calc.ps the first plot is from the first run, the second plot from the second run.

Further processing
To blank out data below 86% of the bottom depth, use bathymetry data from the EA600. The Matlab routine is blank bottom.m.

There seems to be an issue with the time from the ADCP PC clock. The clock offset is fairly constant, drifting only little, but in the data from the previous cruise (JR158), some ‘backward jumps’ in the time occur.

APPENDIX 5: Ships meterologial observations

Date	Latitude	Longitude	Time	Wind	Pressure	Air Temp	Sea Temp	Comment about weather	Comment about location
23/07/08	50°35.6 N	002°22.0 W	1600	ExN 3	1022.3	18.1	17.1	Blue sky, rippled sea. Good vis	Portland
28/07/08	69°00.1 N	009° 59.8 E	1200	ENE 4	1029.4	11.6	11.9	Vessel pitching easily to mod sea, poor vis with fog patches, overcast	
28/07/08	70°51.5 N	011°54.2 E	2400	Lt airs	1029.9	9.8	11.5	Vessel moving easily in low swell, poor vis with thick fog	
29/07/08	73°05.1 N	014°26.0 E	1200	WSW 4	1024.9	11.3	10.1	Vessel moving easily in slight sea and low swell, cloudy with few blue patches, precipitation in sight with the odd shower	
29/07/08	75°23.7 N	017°25.5 E	2400	NNW 5	1019.9	4.3	5.8	Vessel moving easily in slight sea and low swell, shipping spray occasionally, overcast.	
30/07/08	77°00.3 N	019°11.7 E	1200	N 5	1024.3	3.1	5.1	Vessel moving easily to slight sea, overcast with shower of snow. Wind easing then increasing	
30/07/08	76°16.1 N	17° 00.7 E	2400	NNE 2	1027.5	3.5	4.6	Vessel moving easily to slight sea and low swell, overcast with few breaks fine and clear	
31/07/08	77°55.7 N	012°29.9 E	1200	N 3/4	1026.6	5.8	6.1	Vessel moving easily to slight sea, overcast with few patchy blue sky, good vis	
31/07/08	78°07.4 N	011°07.1 E	2400	NW 5	1025.9	6.2	5.5	Vessel pitching easily to mod sea, bright blue sky with few clouds	
01/08/08	79°43.5 N	008°50.1 E	1200	SSW 3	1024.2	1.4	7.3	Vessel in D.P mode steady in slight sea. Fog patch becoming dense fog with small breaks occasionally, poor vis 11:26 partly solar eclipse observed in break of fog patch	
01/08/08	79°43.6 N	008°50.9 E	2400	S 2	1021.9	2.1	7.4	Vessel stationary on D.P slight sea, fog in patches, poor vis improving at times whilst fog patches clear	
02/08/08	79°43.6 N	08°50.9 E	1200	SSW 3	1022.0	3.7	7.0	Vessel on D.P very slight sea, overcast throughout watch with drizzle at times, Mod/Good vis	

02/08/08	79°43.5 N	008°50.0 E	2400	Lt airs	1022.3	3.1	7.2	Vessel on D.P in calm seas, overcast with at times blue sky and drizzle occasionally, Mod vis	
03/08/08	79°43.5 N	008°50.0 E	1200	Lt airs	1022.0	2.7	7.4	Vessel on D.P sitting quietly in calm waters, overcast, Mod vis	
03/08/08	80°03.3 N	015°03.7 E	2400	W 3	1019.6	2.6	3.2	Vessel steady in slight sea with fog patches, poor vis, occasionally bands of loose pack, small floes	
04/08/08	80°21.9 N	16°23.6 E	1200	N 2/3	1019.6	1.3	2.0	Vessel moving easily through flows large open areas, overcast becoming areas of blue sky with rain shower. ¾ tenths becoming less	
04/08/08	80°50.3 N	18°46.9 E	2400	NW 4/5	1017.1	-0.2	-0.4	Vessel making progress through thick pack, large floes 10/10 pack ice, overcast with snow	
05/08/08	80°51.6 N	019°08.8 E	1200	NWxW 5	1014.0	-0.2	-0.2	Overcast with light snow flurries, 9/10 pack, good vis	Vessel stopped in very close pack large floes with melt water, occasional distant pools
05/08/08	80°51.0 N	019°10.3 E	2400	NWxW 5	1011.2	0.1	-0.1	Overcast with light snow throughout watch, vis improving at times during watch, mod vis	Vessel stationary drifting with pack ice on ice scientific station, 9/10 pack
06/08/08	80°48.6	019°12.8 E	1200	NWxN 6	1004.1	0.3	-0.4	Overcast with light snow during watch, wind decreasing during watch, guest of 36knots at start of watch	Ice station, 9/10 pack
06/08/08	80°48.3 N	019°11.8 E	2400	NW 3	1002.7	0.0	0.4	Vessel stationary in pack ice, ice becoming looser round the vessel, vis decreasing during watch and wind becoming lighter, poor vis	Ice station
07/08/08	80°47.7 N	018°59.4 E	1200	N 3	1006.5	-0.7	-0.2	Overcast with light snow at times and bright	Ice station 9/10 pack

07/08/08	80°29.0 N	018°11.4 E	2400	W 2/3	1005.2	-1.4	0.2	Vessel moving through pack ice with leads and large pools, vis reducing to end of watch from good to poor, light snow. 7,8 tenths pack ice	
08/08/08	80°21.0 N	016°20.8 E	1200	Lt airs	1003.2	1.7	0.2	Overcast with snow throughout, vis reducing, vis poor, 8/10 pack	
08/08/08	80°20.8 N	016°15.9 E	2400	E 2	1002.6	-02	1.0	Overcast with poor vis and light snow at times	
09/08/08	80°21.2 N	016° 13.3 E	0400	NNE 2	1001.9	-3.4	1.0	Poor vis becoming good	
09/08/08	80°21.2 N	016°13.5 E	0800	ExN 2	1000.1	-4.4	0.5	Vessel lying quietly in open pool, full D.P, good vis	
09/08/08	80°20.7 N	016°13.5 E	1200	E 2/3	999.0	-2.0	0.7	Vessel lying quietly in open pool with good vis, overcast	
09/08/08	80°21.4 N	016°12.2 E	1600	NNE 3	997.7	-1.7	0.3	Good vis	
09/08/08	80°20.6 N	016°22.7 E	2000	Lt airs	995.8	0.0	0.9	Poor vis fog in last hour otherwise overcast and clear	
09/08/08	80°20.0 N	16°20.5 E	2400	N 2	995.1	-0.4	0.9	Very light snow at times, overcast with poor vis due to fog, lifting at time to mod vis, 8/10 ice	Vessel lying quietly drifting continuing with sediment collection in open pools
10/08/08	80°21.5 N	16°15.9 E	1200	Lt airs	994.7	2.7	0.9	Vessel lying quietly in large open pool, cloudy with patches of blue sky, bright and clear, 6/10 ice, good vis	
10/08/08	80°24.1 N	16°22.5 E	2400	SExS 5	996.2	1.0	0.7	Overcast with patches of broken cloud, good vis, 7/10 ice	
21/08/08	78°13.7 N	015°36.1 E	1200	NW 1/2	1009.1	9.4	7.7	Good vis	Longyearbyen

APPENDIX 6:

JCR210 MEGACORER logsheet

Station	**SHELF STATION 1**
Date	**01/08/2008**

Event number	020	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	79°43.100N	A	OK		X				
Longitude	008°47.875E	B	OK		X				
Depth	458m	C	OK		X				
Date	01/08/2008	D	OK	X					
Time start	12:55	E	OK	X					
Time at bottom	13:05	F	OK			X			
Time end	13:15	G	OK			X			
		H	OK				X		

Event number	021	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	79°43.101N	A	OK		X				
Longitude	008°47.881E	B	OK		X				
Depth	458m	C	OK		X				
Date	01/08/2008	D	OK		X				
Time start	13:43	E	OK					X	
Time at bottom	13:53	F	OK			X			
Time end	14:04	G	OK			X			
		H	OK						

Event number	022	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	79°43.100N	A	OK		X				
Longitude	008°47.878E	B	OK		X				
Depth	458m	C	OK		X				
Date	01/08/2008	D	OK		X				
Time start	14:35	E	OK	X					
Time at bottom	14:45	F	OK	X					
Time end	14:55	G	OK				X		
		H	OK					X	

Event number	023	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	79°43.100N	**A**	**OK***	**X**					
Longitude	008°47.878E	**B**	**OK***	**X**					
Depth	457m	**C**	**OK***				**X**		
Date	01/08/2008	**D**	**OK***					**X**	
Time start	15:27	**E**	**OK***			**X**			
Time at bottom	15:33	**F**	**OK***			**X**			
Time end	15:47	**G**	**OK***						**X**
		H	**OK***						

*** one of the cores only half-full. Didn't record which one that was.**

JCR210 MEGACORER logsheet

Station	MIZ STATION
Date	08/08/2008

Event number	067	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.851N	A	FAILED - empty						
Longitude	016°20.410E	B	OK		X				
Depth	411m	C	FAILED - bubbles						
Date	08/08/2008	D	OK			X			
Time start	08:26	E	OK	X					
Time at bottom	08:40	F	OK		X				
Time end	08:50	G	OK		X				
		H	OK	X					

Event number	068	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°21.033N	A	FAILED - bubbles						
Longitude	016°19.952E	B	FAILED - ½ full						
Depth	405m	C	FAILED - bubbles						
Date	08/08/2008	D	OK			X			
Time start	09:17	E	FAILED - empty						
Time at bottom	09:26	F	FAILED - empty						
Time end	09:38	G	OK			X			
		H	FAILED - empty						

Event number	069	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.920N	A	OK - ½ full			X			
Longitude	016°20.835E	B	OK			X			
Depth	411m	C	FAILED - bubbles						
Date	08/08/2008	D	OK	X					
Time start	11:03	E	OK - ½ full		X				
Time at bottom	11:14	F	OK	X					
Time end	11:23	G	OK		X				
		H	OK		X				

Event number	070	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.934N	A	FAILED - empty						
Longitude	016°18.225E	B	FAILED - empty						
Depth	393m	C	FAILED - empty						
Date	08/08/2008	D	FAILED - empty						
Time start	12:14	E	OK		X				
Time at bottom	12:24	F	OK	X					
Time end	12:33	G	OK	X					
		H	OK		X				

Event number	071	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.933N	A	OK			X			
Longitude	016°18.227E	B	OK						
Depth	393m	C	FAILED - empty						
Date	08/08/2008	D	OK				X		
Time start	12:55	E	FAILED - empty						
Time at bottom	13:03	F	FAILED - empty						
Time end	13:13	G	FAILED - bubbles						
		H	OK					X	

Event number	072	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.933N	A	OK				X		
Longitude	016°18.230E	B	OK		X				
Depth	394m	C	OK		X				
Date	08/08/2008	D	OK					X	
Time start	13:39	E	FAILED - empty						
Time at bottom	13:47	F	FAILED - empty						
Time end	13:57	G	OK						X
		H	OK		X				

Event number	073	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°20.934N	**A**	**OK**						
Longitude	016°18.223E	**B**	**OK**						
Depth	394m	**C**	**FAILED - bubbles**						
Date	08/08/2008	**D**	**OK**				**X**		
Time start	14:21	**E**	**FAILED - empty**						
Time at bottom	14:29	**F**	**FAILED - empty**						
Time end	14:39	**G**	**OK**						
		H	**OK**						

JCR210 MEGACORER logsheet

Station	SHELF EDGE STATION
Date	12/08/2008

Event number	111	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°29.283N	A	OK	X					
Longitude	011°18.376E	B	OK		X				
Depth	755m	C	OK	X					
Date	12/08/2008	D	OK		X				
Time start	09:30	E	OK		X				
Time at bottom	09:47	F	OK						X
Time end	10:02	G	OK					X	
		H	OK				X		

Event number	112	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°29.350N	A	OK					X	
Longitude	011°17.692E	B	OK						
Depth	760m	C	OK	X					
Date	12/08/2008	D	OK						
Time start	10:25	E	OK				X		
Time at bottom	10:40	F	OK			X			
Time end	10:55	G	OK			X			
		H	OK	X					

Event number	113	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°29.354N	A	OK - ½ full		X				
Longitude	011°17.730E	B	OK - ½ full		X				
Depth	760m	C	FAILED - empty						
Date	12/08/2008	D	FAILED - empty						
Time start	11:16	E	OK - ½ full		X				
Time at bottom	11:30	F	OK - ½ full		X				
Time end	11:44	G	FAILED - ½ full						
		H	FAILED - ½ full						

Event number	114	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°29.351N	A	OK	X					
Longitude	011°17.649E	B	OK			X			
Depth	760m	C	OK						
Date	12/08/2008	D	OK						
Time start	12:08	E	OK					X	
Time at bottom	12:23	F	OK			X			
Time end	12:36	G	OK						
		H	OK	X					

Event number	115	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°29.405N	A	OK						
Longitude	011°17.721E	B	OK			X			
Depth	763m	C	OK		X				
Date	12/08/2008	D	OK		X				
Time start	13:04	E	OK			X			
Time at bottom	13:21	F	OK				X		
Time end	13:33	G	OK		X				
		H	OK						

JCR210 MEGACORER logsheet

Station	**RIJPFJORDEN SOUTH**
Date	**15/08/2008**

Event number	152	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°07.454N	A	OK		X				
Longitude	022°09.233E	B	OK				X		
Depth	209m	C	OK	X					
Date	15/08/2008	D	FAILED - bubbles						
Time start	14:29	E	OK		X				
Time at bottom	14:36	F	OK	X					
Time end	14:45	G	OK		X				
		H	OK					X	

Event number	154	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°07.451N	A	OK						
Longitude	022°09.236E	B	OK			X			
Depth	205m	C	OK			X			
Date	15/08/2008	D	OK						
Time start	15:45	E	OK				X		
Time at bottom	15:52	F	OK	X					
Time end	15:58	G	OK	X					
		H	OK			X			

Event number	155	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°07.4514N	A	FAILED - empty						
Longitude	022°09.234E	B	OK		X				
Depth	205m	C	OK			X			
Date	15/08/2008	D	OK			X			
Time start	16:13	E	OK	X					
Time at bottom	16:20	F	OK	X					
Time end	16:26	G	OK		X				
		H	OK		X				

Event number	156	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°07.451N	**A**	**OK**						
Longitude	022°09.244E	**B**	**OK**						
Depth	205m	**C**	**FAILED - empty**						
Date	15/08/2008	**D**	**OK**						**X**
Time start	16:53	**E**	**FAILED - empty**						
Time at bottom	17:00	**F**	**OK**						
Time end	17:07	**G**	**OK**			**X**			
		H	**OK**				**X**		

Event number	157	Core	Result	*Radiochem*	*Benthic*	*Incubation*	*Profiling*	*Bacterias*	*Biomarkers*
Latitude	80°07.450N	**A**	**OK**		**X**				
Longitude	022°09.240E	**B**	**OK**						
Depth	205m	**C**	**OK**						
Date	15/08/2008	**D**	**OK**				**X**		
Time start	17:33	**E**	**OK**		**X**				
Time at bottom	17:39	**F**	**OK**						
Time end	17:44	**G**	**OK**		**X**				
		H	**OK**					**X**	

JCR210 CTD log sheet

Station	English Channel		
Filename	JR210_001.dat	Date	24/07/08
Event	001	Time	07:50
CTD no.	001	Depth	28m

Fire Seq	Ros Pos^{n}	Bot. No.	Depth (m)	Time (GMT)	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	25	07:57		X	X	X	X				X														X							
2	2	2	25	07:58	X									X	X											X								X
3	3	3	25	07:58	X																													
4	4	4	25	07:58																														
5	5	5	15	07:59		X	X	X	X				X														X							
6	6	6	15	07:59										X	X											X								
7	7	7	6	08:00	X																						X							
8	8	8	6	08:01	X																													
9	9	9	6	08:01		X	X	X	X				X																					
10	10	10	6	08:01																X				X										
11	11	11	6	08:01										X	X									X		X								
12	12	12	6	08:01																				X										
13	13	13	6	08:01																														
14	14	14	6	08:01																														
15	15	15	6	08:02																														X
16	16	16	6	08:02																														
17	17	17	6	08:02																														
18	18	18	6	08:02																														
19	19	19	6	08:02																														
20	20	20	6	08:02																														
21	21	21	6	08:02																														
22	22	22	0	08:03		X	X	X	X				X																					
23	23	23	0	08:03										X	X											X	X							
24	24	24	0	08:03																														
			Analyst		James	Anastasia	Anastasia	Anastasia			Anastasia		Andrea	Andrea	Andrea					Jane				Ellie		Arlene	Tim							Estelle

JCR210 CTD log sheet

Station	Southern North Sea		
Filename	JR210_002.dat	Date	25/07/08
Event	002	Time	05:08
CTD no.	002	Depth	42m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	35	05:11		X	X	X	X	X	X		X														X							
2	2	2	35	05:12										X	X											X								
3	3	3	30	05:13		X	X	X	X	X	X		X														X							
4	4	4	30	05:13										X	X																			X
5	5	5	20	05:14		X	X	X	X	X	X		X														X							
6	6	6	20	05:14										X	X											X								
7	7	7	15	05:16	X																													
8	8	8	15	05:16	X																													
9	9	9	15	05:16	X																													
10	10	10	15	05:16	X																													
11	11	11	15	05:16		X	X	X	X	X	X		X														X							
12	12	12	15	05:16										X	X											X								
13	13	13	6	05:18	X																													
14	14	14	6	05:18	X																													
15	15	15	6	05:18	X																													
16	16	16	6	05:18	X																													
17	17	17	6	05:18		X	X	X	X	X	X		X														X							
18	18	18	6	05:18																X				X										
19	19	19	6	05:19																X														
20	20	20	6	05:19																X														
21	21	21	6	05:19																														
22	22	22	6	05:19										X	X											X								X
23	23	23	0	05:20		X	X	X	X	X	X		X														X							
24	24	24	0	05:20										X	X											X								
			Analyst		James	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia		Andrea	Andrea	Andrea					Jane				Ellie		Arlene	Tim / Ray							Estelle

JCR210 CTD log sheet

Station	Northern North Sea		
Filename	JR210_003.dat	Date	26/07/08
Event	003	Time	05:02
CTD no.	003	Depth	102m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	40	05:12		X	X	X	X	X	X		X														X							
2	2	2	40	05:12										X	X											X								X
3	3	3	30	05:14		X	X	X	X	X	X		X														X							
4	4	4	30	05:14										X	X											X								
5	5	5	26	05:15	X																													
6	6	6	26	05:15	X																													
7	7	7	26	05:15	X	X	X	X	X	X	X		X																					
8	8	8	26	05:15	X																													
9	9	9	26	05:15																							X							
10	10	10	26	05:15										X	X											X								
11	11	11	15	05:17		X	X	X	X	X	X		X														X							
12	12	12	15	05:17										X	X											X								
13	13	13	6	05:19	X																													
14	14	14	6	05:19	X																													
15	15	15	6	05:19	X																													
16	16	16	6	05:19	X																													
17	17	17	6	05:19		X	X	X	X	X	X		X														X							
18	18	18	6	05:19																X				X										
19	19	19	6	05:19																X														
20	20	20	6	05:19																X														
21	21	21	6	05:19										X	X											X								X
22	22	22	0	05:20		X	X	X	X	X	X		X																					
23	23	23	0	05:20										X	X											X								
			Analyst		James	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia		Andrea	Andrea	Andrea					Jane				Ellie		Arlene	Tim							Estelle

JCR210 CTD log sheet

Station	Lofoten		
Filename	JR210_004.dat	Date	28/07/08
Event	006	Time	11:39
CTD no.	004	Depth	3200m

Fire Seq	Ros Pos^{n}	Bot. No.	Depth (m)	Time (GMT)	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	65	11:48		X	X	X	X	X	X		X														X							
2	2	2	65	11:48										X	X											X								X
3	3	3	45	11:50		X	X	X	X	X	X		X														X							
4	4	4	45	11:50										X	X											X								
5	5	5	25	11:52		X	X	X	X	X	X		X														X							
6	6	6	25	11:52										X	X											X								
7	7	7	15	11:53		X	X	X	X	X	X		X														X							
8	8	8	15	11:53	X																														
9	9	9	15	11:53	X																														
10	10	10	15	11:53	X																														
11	11	11	15	11:53	X																														
12	12	12	15	11:53										X	X											X								
13	13	13	6	11:54	X																														
14	14	14	6	11:54	X																														
15	15	15	6	11:55	X																														
16	16	16	6	11:55	X																														
17	17	17	6	11:55		X	X	X	X	X	X		X														X							
18	18	18	6	11:55																X															
19	19	19	6	11:55																X				X											
20	20	20	6	11:55																X															
21	21	21	6	11:55										X	X											X									X
22	22	22	0	11:56		X	X	X	X	X	X		X														X							
23	23	23	0	11:56																															
24	24	24	0	11:56										X	X											X									
			Analyst		James	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia		Anastasia	Andrea	Andrea					Jane				Ellie		Arlene	Tim							Estelle

JCR210 CTD log sheet

Station	Storfjorden		
Filename	JR210_005.dat	Date	30/07/08
Event	007	Time	04:10
CTD no.	005	Depth	190m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	180	04:22							X		X													X	X							X
2	2	2	165	04:23							X		X													X	X							
3	3	3	130	04:25							X		X													X	X							X
4	4	4	50	04:27							X		X													X	X							
5	5	5	50	04:28																															
6	6	6	40	04:29	X						X		X														X								
7	7	7	40	04:29	X																														
8	8	8	40	04:29	X																														
9	9	9	40	04:29	X																														
10	10	10	40	04:29																						X									
11	11	11	40	04:29																															
12	12	12	30	04:30						X	X		X													X	X								
13	13	13	30	04:31																															
14	14	14	6	04:32	X					X	X		X																						
15	15	15	6	04:32	X																														
16	16	16	6	04:32	X																														
17	17	17	6	04:33	X																														
18	18	18	6	04:33										X						X				X											
19	19	19	6	04:33										X						X															
20	20	20	6	04:33										X						X															
21	21	21	6	04:33																						X	X								X
22	22	22	0	04:34							X		X													X	X								
23	23	23	0	04:34																															
24	24	24	0	04:34																															
			Analyst		James					Anastasia	Anastasia		Anastasia	Andrea						Jane				Ellie		Arlene	Tim							Estelle

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_006.dat	Date	01/08/08
Event	017	Time	09:23
CTD no.	006	Depth	452m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	440	09:38																								X						
2	2	2	440	09:38																														
3	3	3	440	09:38																														
4	4	4	440	09:38																														
5	5	5	440	09:38																														
6	6	6	440	09:38																							X							X
7	7	7	400	09:40																							X							
8	8	8	300	09:43																							X							
9	9	9	200	09:46																							X							X
10	10	10	120	09:48																							X							
11	11	11	100	09:50																							X							
12	12	12	80	09:52																							X	X						
13	13	13	60	09:53																							X							
14	14	14	40	09:54																							X							
15	15	15	25	09:55																							X							
16	16	16	25	09:55	X																													
17	17	17	25	09:55	X																													
18	18	18	25	09:55	X																													
19	19	19	25	09:56	X																													
20	20	20	25	09:56	X							X																						
21	21	21	10	10:00																							X	X						X
22	22	22	10	10:00																														
23	23	23	10	10:00																														
24	24	24	10	10:00																														
			Analyst		James							Anastasia															Tim	Tim						Colin

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_007.dat	Date	02/08/08
Event	024	Time	06:27
CTD no.	007	Depth	448m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	400	06:39																									X					
2	2	2	400	06:39																									X					
3	3	3	400	06:39																									X					
4	4	4	400	06:39																									X					
5	5	5	400	06:39																									X					
6	6	6	400	06:39																									X					
7	7	7	400	06:39																									X					
8	8	8	400	06:40																									X					
9	9	9	400	06:40																									X					
10	10	10	400	06:40																									X					
11	11	11	400	06:40																									X					
12	12	12	400	06:40																									X					
13	13	13	200	06:44																									X					
14	14	14	200	06:44																									X					
15	15	15	200	06:44																									X					
16	16	16	200	06:45																									X					
17	17	17	200	06:45																									X					
18	18	18	200	06:45																									X					
19	19	19	200	06:45																									X					
20	20	20	200	06:45																									X					
21	21	21	200	06:45																									X					
22	22	22	200	06:45																									X					
23	23	23	200	06:45																									X					
24	24	24	200	06:45																									X					
			Analyst																										Susan					

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_008.dat	Date	02/08/08
Event	025	Time	07:20
CTD no.	008	Depth	448m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	400	07:31																											X			
2	2	2	400	07:31																											X			
3	3	3	400	07:31																										X				
4	4	4	400	07:31																										X				
5	5	5	200	07:36																											X			
6	6	6	200	07:36																											X			
7	7	7	200	07:36																										X				
8	8	8	200	07:36																										X				
9	9	9	100	07:39																											X			
10	10	10	100	07:39																											X			
11	11	11	100	07:39																										X				
12	12	12	100	07:40																										X				
13	13	13	60	07:41																											X			
14	14	14	60	07:41																											X			
15	15	15	60	07:41																										X				
16	16	16	60	07:41																										X				
17	17	17	30	07:43																											X			
18	18	18	30	07:43																											X			
19	19	19	30	07:43																										X				
20	20	20	30	07:43																										X				
21	21	21	10	07:45																											X			
22	22	22	10	07:45																											X			
23	23	23	10	07:45																										X				
24	24	24	10	07:45																										X				
			Analyst																											Susan / Pauline	Susan			

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_009.dat	Date	02/08/08
Event	026	Time	08:40
CTD no.	009	Depth	448m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	60	08:43																									X					
2	3	3	60	08:43																									X					
3	5	5	60	08:43																									X					
4	7	7	60	08:43																									X					
5	9	9	60	08:43																									X					
6	11	11	60	08:43																									X					
7	13	13	60	08:44																									X					
8	15	15	60	08:44																									X					
9	17	17	60	08:44																									X					
10	19	19	60	08:44																									X					
11	21	21	60	08:44																									X					
12	23	23	60	08:44																									X					
			Analyst																										Susan					

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_010.dat	Date	02/08/08
Event	029	Time	11:14
CTD no.	010	Depth	449m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	23	11:21																				X										
2	2	2	23	11:21																				X										
3	3	3	23	11:21																				X										
4	4	4	23	11:22																				X										
5	5	5	23	11:22	X																													
6	6	6	23	11:22	X																													
7	7	7	23	11:22	X																													
8	8	8	23	11:22	X																													
			Analyst		James																			Mark										

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_011.dat	Date	02/08/08
Event	035	Time	22:17
CTD no.	011	Depth	453m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_012.dat	Date	03/08/08
Event	040	Time	07:18
CTD no.	012	Depth	453m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Shelf Station 1		
Filename	JR210_013.dat	Date	03/08/08
Event	041	Time	08:19
CTD no.	013	Depth	452m

Fire Seq	Ros Pos^{n}	Bot. No.	Depth (m)	Time (GMT)	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	30	08:21																														
2	2	2	30	08:21																														
3	3	3	30	08:21																														
4	4	4	30	08:21																														
5	5	5	30	08:21																														
6	6	6	30	08:21																														
7	7	7	30	08:22																														
8	8	8	30	08:22																														
9	9	9	30	08:22																														
10	10	10	30	08:22																														
11	11	11	30	08:22																														
12	12	12	30	08:22																														
13	13	13	30	08:22																														
14	14	14	30	08:22																														
15	15	15	30	08:22																														
16	16	16	30	08:22																														
17	17	17	30	08:23																														
18	18	18	30	08:23																														
19	19	19	2	08:24																														
20	20	20	2	08:24																														
21	21	21	2	08:24																	X						X							
22	22	22	2	08:25																	X						X							
23	23	23	2	08:25																	X						X							
24	24	24	2	08:25																	X						X							
			Analyst																								Tim							

JCR210 CTD log sheet

Station	Shelf station 1		
Filename	JR210_014.dat	Date	03/08/08
Event	042	Time	09:20
CTD no.	014	Depth	452m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	60	09:38														X	X					X	X		X							
2	2	2	30	09:39	X	X	X	X	X	X	X	X	X										X	X	X		X							
3	3	3	30	09:40	X													X	X															
4	4	4	30	09:40	X		X	X															X	X	X		X							
5	5	5	30	09:40	X													X	X															
6	6	6	30	09:40	X		X	X															X	X	X		X							
7	7	7	30	09:40	X													X	X															
8	8	8	19	09:42		X	X	X	X	X	X	X	X														X							
9	9	9	17	09:43		X	X	X	X	X	X	X	X											X	X		X							
10	10	10	17	09:43														X	X															
11	11	11	11	09:44		X	X	X	X	X	X	X	X											X	X		X							
12	12	12	11	09:44														X	X															
13	13	13	5	09:45	X	X	X	X	X	X	X	X	X										X	X	X		X							
14	14	14	5	09:45	X													X	X															
15	15	15	5	09:45	X		X	X															X	X	X		X							
16	16	16	5	09:45	X													X	X															
17	17	17	5	09:45	X		X	X															X	X	X		X							
18	18	18	5	09:45	X													X	X															
19	19	19	2	09:46	X	X	X	X	X	X	X	X	X										X	X	X		X							
20	20	20	2	09:46	X													X	X															
21	21	21	2	09:46	X		X	X															X	X	X		X							
22	22	22	2	09:46	X													X	X															
23	23	23	2	09:47	X		X	X															X	X	X		X							
24	24	24	2	09:47	X													X	X															
			Analyst		James	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia					ElineJane Andrea	Elaine / Jane				Emilie Eric	Ellie	Ellie		Tim							

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_015.dat	Date	04/08/08
Event	045	Time	08:00
CTD no.	015	Depth	410m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	400	08:11																													X	
2	2	2	400	08:11																													X	
3	3	3	400	08:11																													X	
4	4	4	400	08:11																							X	X						
5	5	5	300	08:15																														
6	6	6	300	08:15																							X							
7	7	7	250	08:17																														
8	8	8	250	08:17																							X							
9	9	9	200	08:19																														
10	10	10	200	08:19																							X							
11	11	11	100	08:22																														
12	12	12	100	08:22																							X	X						
13	13	13	80	08:23																														
14	14	14	80	08:23																							X							
15	15	15	60	08:24																														
16	16	16	60	08:24																							X							
17	17	17	40	08:26																														
18	18	18	40	08:26																							X							
19	19	19	20	08:27																														
20	20	20	20	08:27																							X							
21	21	21	10	08:28																														
22	22	22	10	08:28																							X							
23	23	23	2	08:30																														
24	24	24	2	08:30																							X							
			Analyst																								Tim	Tim					Henrik	

JCR210 CTD log sheet

Station	Ice Station		
Filename	JR210_016.dat	Date	05/08/08
Event	051	Time	13:14
CTD no.	016	Depth	95m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	89	13:18																														X
2	2	2	21	13:21																				X										
3	3	3	21	13:21																														X
4	4	4	21	13:22																				X										
5	5	5	7	13:23																														X
			Analyst																					Mark										Estelle

JCR210 CTD log sheet

Station	Ice Station		
Filename	JR210_004.dat	Date	06/08/08
Event	053	Time	10:41
CTD no.	017	Depth	143m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols +DOC	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	50	10:52																														
2	2	2	50	10:52																														
3	3	3	50	10:52																														
4	4	4	40	10:54							x		x					x	x															
5	5	5	40	10:54																				x	x									
6	6	6	40	10:54																														
7	7	7	30	10:56		x	x	x	x	x	x	x	x										x	x	x									
8	8	8	30	10:56			x	x															x	x	x									
9	9	9	30	10:56			x	x															x	x	x									
10	10	10	30	10:56							x		x		x			x	x															
11	11	11	30	10:56							x		x		x			x	x															
12	12	12	30	10:56							x		x		x			x	x															
13	13	13	20	11:00		x	x	x	x	x	x	x	x										x	x	x									
14	14	14	20	11:00			x	x															x	x	x									
15	15	15	20	11:00			x	x															x	x	x									
16	16	16	20	11:00							x		x		x	x		x	x															
17	17	17	20	11:00							x		x		x	x		x	x															
18	18	18	20	11:00							x		x		x	x		x	x															
19	19	19	10	11:04																														
20	20	20	10	11:04																														
21	21	21	10	11:04																														
22	22	22	5	11:05																														
23	23	23	5	11:05																														
24	24	24	5	11:05																														
			Analyst			Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Andrea Anastasia	Anastasia	Andrea Anastasia		Mark	Elaine / Mark / Ray		ElaineJane /Andrea	Elaine / Jane				Eric	Ellie	Ellie									

JCR210 CTD log sheet

Station	Ice Station		
Filename	JR210_018.dat	Date	06/08/08
Event	054	Time	12:54
CTD no.	018	Depth	144m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	138	13:02																						X	X							
2	2	2	132	13:03																							X							
3	3	3	100	13:05																						X	X							
4	4	4	80	13:07																							X							
5	5	5	50	13:09																						X	X							
6	6	6	40	13:10																							X							
7	7	7	30	13:11																				X			X							
8	8	8	30	13:12																				X		X								
9	9	9	30	13:12	X																													
10	10	10	30	13:13	X																													
11	11	11	30	13:13	X																													
12	12	12	30	13:13	X																													
13	13	13	30	13:14	X																													
14	14	14	30	13:14																														
15	15	15	20	13:16																							X							
16	16	16	20	13:16	X																													
17	17	17	20	13:17	X																													
18	18	18	20	13:17	X																													
19	19	19	20	13:17	X																													
20	20	20	20	13:18	X																													
21	21	21	10	13:19																						X	X							
22	22	22	5	13:20																						X	X							
			Analyst		James																			Mark		Arlene	Tim							

JCR210 CTD log sheet

Station	Ice Station		
Filename	JR210_019.dat	Date	06/08/08
Event	059	Time	22:10
CTD no.	019	Depth	144m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Ice Station		
Filename	JR210_020.dat	Date	07/08/08
Event	065	Time	12:40
CTD no.	020	Depth	125m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	25	12:51												X																		
2	2	2	25	12:52												X																		
3	3	3	25	12:52												X																		
4	4	4	25	12:52													X																	
5	5	5	25	12:53																	X													
6	6	6	25	12:53																	X													
7	7	7	25	12:54																	X													
8	8	8	25	12:54																	X													
9	9	9	25	12:55												X																		
10	10	10	25	12:55												X																		
11	11	11	25	12:55												X																		
12	12	12	25	12:56													X																	
13	13	13	25	12:56																														
14	14	14	25	12:56																														
15	15	15	25	12:57																														
16	16	16	25	12:57																														
17	17	17	25	12:58												X																		
18	18	18	25	12:58												X																		
19	19	19	25	12:58												X																		
20	20	20	25	12:59													X																	
21	21	21	25	12:59																														
22	22	22	25	12:59																														
23	23	23	25	13:00																														
24	24	24	25	13:00												X																		
			Analyst													Andrea	Elaine				Eric													

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_021.dat	Date	08/08/08
Event	066	Time	07:22
CTD no.	021	Depth	411m

Fire Seq	Ros Pos^n	Bot. No.	Depth (m)	Time (GMT)	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	400	07:31																													X	
2	2	2	400	07:32																													X	
3	3	3	400	07:32																													X	
4	4	4	400	07:32																													X	
5	5	5	27	07:40	X																													
6	6	6	27	07:41	X																													
7	7	7	27	07:41	X																													
8	8	8	27	07:41	X																													
9	9	9	27	07:42	X																													
10	10	10	27	07:42	X																													
11	11	11	27	07:42	X																													
12	12	12	27	07:43	X																													
			Analyst		James																												Henrik	

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_022.dat	Date	08/08/08
Event	074	Time	15:22
CTD no.	022	Depth	393m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	380	15:33																									X					
2	2	2	380	15:33																									X					
3	3	3	380	15:33																									X					
4	4	4	380	15:33																									X					
5	5	5	380	15:33																									X					
6	6	6	380	15:34																									X					
7	7	7	380	15:34																									X					
8	8	8	380	15:34																									X					
9	9	9	380	15:34																									X					
10	10	10	380	15:34																									X					
11	11	11	380	15:35																									X					
12	12	12	380	15:35																									X					
13	13	13	380	15:35																									X					
14	14	14	300	15:37																							X							
15	15	15	200	15:40																							X							
16	16	16	160	15:42																							X							
17	17	17	100	15:44																							X							
18	18	18	60	15:46																							X							
19	19	19	50	15:47																							X							
20	20	20	30	15:49																							X							
21	21	21	30	15:50																							X							
22	22	22	30	15:50																							X							
23	23	23	20	15:51																							X							
24	24	24	10	15:53																							X							
			Analyst																								Tim		Susan					

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_023.dat	Date	08/08/08
Event	075	Time	16:14
CTD no.	023	Depth	392m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	200	16:23																									X					
2	2	2	200	16:23																									X					
3	3	3	200	16:23																									X					
4	4	4	200	16:23																									X					
5	5	5	200	16:23																									X					
6	6	6	200	16:23																									X					
7	7	7	200	16:23																									X					
8	8	8	200	16:23																									X					
9	9	9	200	16:23																									X					
10	10	10	200	16:23																									X					
11	11	11	200	16:23																									X					
12	12	12	200	16:23																									X					
13	13	13	60	16:30																									X					
14	14	14	60	16:30																									X					
15	15	15	60	16:30																									X					
16	16	16	60	16:30																									X					
17	17	17	60	16:30																									X					
18	18	18	60	16:30																									X					
19	19	19	60	16:30																									X					
20	20	20	60	16:30																									X					
21	21	21	60	16:30																									X					
22	22	22	60	16:30																									X					
23	23	23	60	16:30																									X					
24	24	24	60	16:30																									X					
			Analyst																										Tim					

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_024.dat	Date	08/08/08
Event	076	Time	18:23
CTD no.	024	Depth	391m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	380	18:35																												X		
2	2	2	380	18:35																												X		
3	5	5	200	18:40																												X		
4	6	6	200	18:40																												X		
5	9	9	100	18:43																												X		
6	10	10	100	18:43																												X		
7	13	13	60	18:45																												X		
8	14	14	60	18:45																												X		
9	17	17	30	18:47																												X		
10	18	18	30	18:47																												X		
11	21	21	10	18:49																												X		
12	22	22	10	18:49																												X		
			Analyst																													Susan		

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_025.dat	Date	09/08/08
Event	080	Time	06:39
CTD no.	025	Depth	388m

Fire Seq	*Ros Pos[n]*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	381	06:48																										X				
2	2	2	381	06:49																										X				
3	5	5	200	06:53																										X				
4	6	6	200	06:53																										X				
5	9	9	100	06:56																										X				
6	10	10	100	06:56																										X				
7	13	13	60	06:58																										X				
8	14	14	60	06:58																										X				
9	17	17	30	06:59																										X				
10	18	18	30	07:00																										X				
11	21	21	10	07:01																										X				
12	22	22	10	07:01																										X				
			Analyst																											Susan				

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_026.dat	Date	10/08/08
Event	092	Time	07:13
CTD no.	026	Depth	403m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_027.dat	Date	10/08/08
Event	093	Time	07:40
CTD no.	027	Depth	402m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	60	07:43																				X	X		X							
2	2	2	60	07:44							X		X					X		X														
3	3	3	27	07:46		X	X	X	X	X	X	X	X										X	X	X									
4	4	4	27	07:46							X		X					X		X														
5	5	5	27	07:47			X	X															X	X	X		X							
6	6	6	27	07:47							X		X					X		X							X							
7	7	7	27	07:47			X	X																X	X		X							
8	8	8	27	07:47							X		X					X		X														
9	9	9	15	07:49		X	X	X	X	X	X	X	X											X	X		X							
10	10	10	15	07:49							X		X					X		X														
11	11	11	8	07:50		X	X	X	X	X	X	X	X										X	X	X		X							
12	12	12	8	07:50							X		X					X		X							X							
13	13	13	8	07:50			X	X															X	X	X		X							
14	14	14	8	07:51							X		X					X		X														
15	15	15	8	07:51			X	X																X	X		X							
16	16	16	8	07:51							X		X					X		X														
17	17	17	2	07:52		X	X	X	X	X	X	X	X										X	X	X		X							
18	18	18	2	07:53							X		X					X		X														
19	19	19	2	07:53			X	X															X	X	X		X							
20	20	20	2	07:53							X		X					X		X														
21	21	21	2	07:54			X	X																X	X									
22	22	22	2	07:54							X		X					X		X														
23	23	23	2	07:54																														
24	24	24	2	07:54																														
			Analyst			Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Andrea Anastasia	Anastasia	Andrea Anastasia					ElaineJane Andrea	Elaine / Jane				Eric	Ellie	Ellie		Tim							

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_028.dat	Date	10/08/08
Event	094	Time	11:07
CTD no.	028	Depth	392m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	60	11:10																						X								
2	2	2	27	11:12	X																													
3	3	3	27	11:12	X																													
4	4	4	27	11:12	X																													
5	5	5	27	11:12	X																													
6	6	6	27	11:13	X																													
7	7	7	27	11:13																				X										
8	8	8	27	11:13																				X										
9	9	9	15	11:14																						X								
10	10	10	8	11:15																						X								
11	11	11	2	11:16																						X								
			Analyst		James																			Mark		Arlene								

JCR210 CTD log sheet

Station	MIZ Station		
Filename	JR210_029.dat	Date	11/08/08
Event	103	Time	07:51
CTD no.	029	Depth	411m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	21	07:55												X																		
2	2	2	21	07:55												X																		
3	3	3	21	07:56												X																		
4	4	4	21	07:56													X																	
5	5	5	21	07:56													X																	
6	6	6	21	07:56												X																		
7	7	7	21	07:56												X																		
8	8	8	21	07:56												X																		
9	9	9	21	07:57													X																	
10	10	10	21	07:57													X																	
11	11	11	21	07:57												X																		
12	12	12	21	07:57												X																		
13	13	13	21	07:57												X																		
14	14	14	21	07:58													X																	
15	15	15	21	07:58													X																	
16	16	16	21	07:58																	X													
17	17	17	21	07:58																	X													
18	18	18	21	07:58																	X													
19	19	19	21	07:59																	X													
20	20	20	21	07:59																														
21	21	21	21	07:59																														
22	22	22	21	07:59																														
23	23	23	21	07:59																							X							
24	24	24	21	08:00																							X							
			Analyst													Andrea	Elaine / Jane				Eric						Tim							

JCR210 CTD log sheet

Station	Shelf Edge Station		
Filename	JR210_030.dat	Date	12/08/08
Event	121	Time	18:15
CTD no.	030	Depth	785m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	772	18:31																									X					
2	2	2	772	18:31																									X					
3	3	3	772	18:32																									X					
4	4	4	772	18:32																									X					
5	5	5	772	18:32																									X					
6	6	6	772	18:33																									X					
7	7	7	772	18:33																									X					
8	8	8	772	18:33																									X					
9	9	9	772	18:34																									X					
10	10	10	772	18:34																									X					
11	11	11	772	18:34																									X					
12	12	12	772	18:34																									X					
13	13	13	772	18:35																							X	X	X					
14	14	14	700	18:37																							X							X
15	15	15	600	18:40																							X							
16	16	16	500	18:43																							X							
17	17	17	400	18:46																							X							X
18	18	18	300	18:48																							X							
19	19	19	200	18:51																							X							
20	20	20	100	18:54																							X							
21	21	21	60	18:56																							X							
22	22	22	40	18:57																							X							X
23	23	23	20	18:59																							X							
24	24	24	10	19:01																							X	X						X
			Analyst																								Tim	Tim	Tim					Estelle

JCR210 CTD log sheet

Station	Shelf Edge Station		
Filename	JR210_031.dat	Date	12/08/08
Event	122	Time	19:37
CTD no.	031	Depth	778m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	300	19:47																									X					
2	2	2	300	19:47																									X					
3	3	3	300	19:47																									X					
4	4	4	300	19:48																									X					
5	5	5	300	19:48																									X					
6	6	6	300	19:48																									X					
7	7	7	300	19:49																									X					
8	8	8	300	19:49																									X					
9	9	9	300	19:49																									X					
10	10	10	300	19:50																									X					
11	11	11	300	19:50																									X					
12	12	12	300	19:50																									X					
13	13	13	60	19:56																									X					
14	14	14	60	19:56																									X					
15	15	15	60	19:57																									X					
16	16	16	60	19:57																									X					
17	17	17	60	19:57																									X					
18	18	18	60	19:58																									X					
19	19	19	60	19:58																									X					
20	20	20	60	19:58																									X					
21	21	21	60	19:59																									X					
22	22	22	60	19:59																									X					
23	23	23	60	19:59																									X					
24	24	24	60	20:00																									X					
			Analyst																										Tim					

JCR210 CTD log sheet

Station	Shelf Edge Station		
Filename	JR210_032.dat	Date	12/08/08
Event	123	Time	20:27
CTD no.	032	Depth	777m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Biomarker**	**Alkalinity**	**Calcif**	**Primary Prod**	**DIC**	**PIC**	**POC/N**	**SEM**	**Chloro**	**Gluts**	**Lugols**	**Grazing 1**	**Grazing 2**	**DOC/DOP pel tax/ nb**	**Dilution + calib expt**	**Flow**	**Incub**	**Plankton**	**Isotopes**	**Bacterial Prod**	**Viruses**	**Biogas**	**Nutrients**	**DO_2**	**Ra^{226}**	**Th^{234}**	**Pb^{210}**	**Po^{210}**	**Lander**	**Salinity**
1	1	1	752	20:43																													X	
2	2	2	752	20:43																													X	
3	3	3	752	20:43																													X	
4	4	4	752	20:44																													X	
5	5	5	77	20:56									X														X							
6	6	6	70	20:58									X														X							
7	7	7	65	20:59									X														X							
8	8	8	60	21:01									X														X							
9	9	9	55	21:02									X														X							
10	10	10	38	21:03																				X		X	X							
11	11	11	38	21:04																				X		X								
12	12	12	18	21:05																				X		X	X							
13	13	13	18	21:05																				X		X								
			Analyst										Ray											Mark		Arlene	Tim						Henrik	

JCR210 CTD log sheet

Station	Shelf Edge Station		
Filename	JR210_033.dat	Date	13/08/08
Event	127	Time	06:40
CTD no.	033	Depth	752m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	700	06:54																											X			
2	2	2	700	06:54																											X			
3	3	3	700	06:54																										X				
4	4	4	700	06:55																										X				
5	5	5	500	06:59																											X			
6	6	6	500	06:59																											X			
7	7	7	500	06:59																										X				
8	8	8	500	06:59																										X				
9	9	9	200	07:05																											X			
10	10	10	200	07:05																											X			
11	11	11	200	07:05																										X				
12	12	12	200	07:05																										X				
13	13	13	60	07:08																											X			
14	14	14	60	07:09																											X			
15	15	15	60	07:09																										X				
16	16	16	60	07:09																										X				
17	17	17	20	07:10																											X			
18	18	18	20	07:10																											X			
19	19	19	20	07:10																										X				
20	20	20	20	07:10																										X				
21	21	21	10	07:11																											X			
22	22	22	10	07:11																											X			
23	23	23	10	07:11																										X				
24	24	24	10	07:11																										X				
			Analyst																											Pauline	Susan			

JCR210 CTD log sheet

Station	Rijpfjorden Mooring		
Filename	JR210_034.dat	Date	15/08/08
Event	144	Time	06:50
CTD no.	034	Depth	211m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	202	07:01																							X	X						
2	2	2	150	07:04																							X							
3	3	3	100	07:06																							X							
4	4	4	60	07:09																							X							
5	5	5	40	07:11																							X							
6	6	6	29	07:12												X																		
7	7	7	29	07:12												X																		
8	8	8	29	07:12												X																		
9	9	9	29	07:13													X																	
10	10	10	29	07:13	X																													
11	11	11	29	07:14												X																		
12	12	12	29	07:14												X																		
13	13	13	29	07:14												X																		
14	14	14	29	07:15													X																	
15	15	15	29	07:15	X																													
16	16	16	29	07:15												X																		
17	17	17	29	07:15												X																		
18	18	18	29	07:16												X																		
19	19	19	29	07:16													X																	
20	20	20	29	07:16	X																													
21	21	21	29	07:16																														
22	22	22	29	07:17																							X							
23	23	23	20	07:18																							X							
24	24	24	10	07:19																							X	X						
			Analyst		James											Andrea	Elaine / Jane										Tim	Tim						

JCR210 CTD log sheet

Station	Rijpfjorden South		
Filename	JR210_035.dat	Date	15/08/08
Event	158	Time	18:35
CTD no.	035	Depth	205m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	198	18:40																									X					
2	2	2	198	18:40																									X					
3	3	3	198	18:41																									X					
4	4	4	198	18:41																									X					
5	5	5	198	18:41																									X					
6	6	6	198	18:42																									X					
7	7	7	198	18:42																									X					
8	8	8	198	18:42																									X					
9	9	9	198	18:43																									X					
10	10	10	198	18:43																									X					
11	11	11	198	18:43																									X					
12	12	12	198	18:44																									X					
13	13	13	60	18:47																									X					
14	14	14	60	18:47																									X					
15	15	15	60	18:48																									X					
16	16	16	60	18:48																									X					
17	17	17	60	18:48																									X					
18	18	18	60	18:48																									X					
19	19	19	60	18:49																									X					
20	20	20	60	18:49																									X					
21	21	21	60	18:49																									X					
22	22	22	60	18:50																									X					
23	23	23	60	18:50																									X					
24	24	24	60	18:50																									X					
			Analyst																										Tim					

JCR210 CTD log sheet

Station	Rijpfjorden South		
Filename	JR210_036.dat	Date	15/08/08
Event	159	Time	19:28
CTD no.	036	Depth	205m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	196	19:35																													X	
2	2	2	196	19:35																													X	
3	3	3	196	19:35																													X	
4	4	4	196	19:36																							X							
5	5	5	170	19:38																							X							
6	6	6	150	19:39																							X							
7	7	7	100	19:41																							X							
8	8	8	60	19:43																							X							
9	9	9	50	19:44																							X							
10	10	10	35	19:46																							X							
11	11	11	20	19:47																							X							
12	12	12	10	19:48																							X							
			Analyst																								Tim						Henrik	

JCR210 CTD log sheet

Station	Rijpfjorden Mooring		
Filename	JR210_037.dat	Date	16/08/08
Event	162	Time	06:18
CTD no.	037	Depth	219m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Rijpfjorden Mooring		
Filename	JR210_038.dat	Date	16/08/08
Event	163	Time	06:41
CTD no.	038	Depth	219m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	**Biomarker**	**Alkalinity**	**Calcif**	**Primary Prod**	**DIC**	**PIC**	**POC/N**	**SEM**	**Chloro**	**Gluts**	**Lugols**	**Grazing 1**	**Grazing 2**	**DOC/DOP pel tax/ nb**	**Dilution + calib expt**	**Flow**	**Incub**	**Plankton**	**Isotopes**	**Bacterial Prod**	**Viruses**	**Biogas**	**Nutrients**	**DO_2**	**Ra^{226}**	**Th^{234}**	**Pb^{210}**	**Po^{210}**	**Lander**	**Salinity**
1	1	1	60	06:44																				X	X		X							
2	2	2	60	06:44							X		X					X	X															
3	3	3	27	06:46	X	X	X	X	X	X	X	X	X										X	X	X		X							
4	4	4	27	06:46	X						X		X					X	X															
5	5	5	27	06:47	X		X	X															X	X	X		X							
6	6	6	27	06:47	X						X		X					X	X															
7	7	7	27	06:47	X		X	X																X	X		X							
8	8	8	27	06:47	X						X		X					X	X															
9	9	9	15	06:49		X	X	X	X	X	X	X	X											X	X		X							
10	10	10	15	06:49							X		X					X	X															
11	11	11	12	06:50		X	X	X	X	X	X	X	X											X	X		X							
12	12	12	12	06:51							X		X					X	X															
13	13	13	7	06:52	X	X	X	X	X	X	X	X	X										X	X	X		X							
14	14	14	7	06:52	X						X		X					X	X															
15	15	15	7	06:52	X		X	X															X	X	X		X							
16	16	16	7	06:53	X						X		X					X	X															
17	17	17	7	06:53	X		X	X																X	X		X							
18	18	18	7	06:53	X						X		X					X	X															
19	19	19	2	06:54	X	X	X	X	X	X	X	X	X										X	X	X		X							
20	20	20	2	06:55	X						X		X					X	X															
21	21	21	2	06:55	X		X	X															X	X	X		X							
22	22	22	2	06:55	X						X		X					X	X															
23	23	23	2	06:55	X		X	X																X	X		X							
24	24	24	2	06:56	X						X		X					X	X															
			Analyst		James	Anastasia	Anastasia	Anastasia	Anastasia	Anastasia	Andrea Anastasia	Anastasia	Andrea Anastasia					ElaineJane Andrea	Elaine / Jane				Emilie Eric	Ellie	Ellie		Tim							

JCR210 CTD log sheet

Station	Rijpfjorden Mooring		
Filename	JR210_039.dat	Date	16/08/08
Event	165	Time	09:38
CTD no.	039	Depth	217m

Fire Seq	Ros Pos^n	Bot. No.	Depth (m)	Time (GMT)	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO$_2$	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	60	09:42																						X								
2	2	2	24	09:44	X																													
3	3	3	24	09:44	X																													
4	4	4	24	09:44	X																													
5	5	5	24	09:44	X																													
6	6	6	24	09:44	X																													
7	7	7	24	09:45																				X										
8	8	8	24	09:45																				X										
9	9	9	24	09:45																						X								
10	10	10	15	09:46																						X								
11	11	11	12	09:47																						X								
12	12	12	7	09:48																						X								
13	13	13	2	09:48																						X								
				Analyst	James																			Mark		Arlene								

JCR210 CTD log sheet

Station	Rijpfjorden South		
Filename	JR210_040.dat	Date	16/08/08
Event	171	Time	12:57
CTD no.	040	Depth	206m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	195	13:04																											X			
2	2	2	195	13:04																											X			
3	3	3	195	13:04																										X				
4	4	4	195	13:05																								X		X				
5	5	5	150	13:06																											X			
6	6	6	150	13:07																											X			
7	7	7	150	13:07																										X				
8	8	8	150	13:07																										X				
9	9	9	60	13:11																											X			
10	10	10	60	13:11																											X			
11	11	11	60	13:12																										X				
12	12	12	60	13:12																										X				
13	13	13	30	13:14																											X			
14	14	14	30	13:14																											X			
15	15	15	30	13:15																										X				
16	16	16	30	13:15																										X				
			Analyst																									Tim		Tim	Tim			

JCR210 CTD log sheet

Station	Rijpfjorden South		
Filename	JR210_041.dat	Date	16/08/08
Event	173	Time	14:26
CTD no.	041	Depth	201m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	190	14:32																														X
2	2	2	190	14:33																														
3	3	3	100	14:35																							X							X
4	4	4	100	14:35							X		X	X	X																			
5	5	5	50	14:37											x												Xx							
6	6	6	50	14:37							X		X	X	X																			
7	7	7	30	14:39											x												Xx							
8	8	8	30	14:39							X		X	X	X																			
9	9	9	20	14:40											x												Xx							
10	10	10	20	14:41							X		X	X	X																			
11	11	11	10	14:42											x												Xx							
12	12	12	10	14:42							X		X	X	X																			
13	13	13	1.5	14:43											x												Xx							X
14	14	14	1.5	14:43							X		X	X	X																			
			Analyst								Ray		Ray	Ray	Ray Stig/Anette												Tim Stig/Anette							Estelle

JCR210 CTD log sheet

Station	RIB		
Filename	JR210_042.dat	Date	16/08/08
Event	177	Time	20:05
CTD no.	042	Depth	176m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	167	20:12																														
2	2	2	167	20:12																							X							X
3	3	3	150	20:14																														
4	4	4	150	20:14																							X							
5	5	5	120	20:16																														
6	6	6	120	20:16																							X							
7	7	7	100	20:17							X		X	X	X																			
8	8	8	100	20:17																							X							
9	9	9	80	20:19																														
10	10	10	80	20:19																							X							
11	11	11	60	20:20																														
12	12	12	60	20:20																							X							
13	13	13	50	20:22							X		X	X	XX												X							
14	14	14	50	20:22																							X							X
15	15	15	30	20:23											X												X							
16	16	16	30	20:23							X		X	X	X												X							
17	17	17	20	20:24											X												X							
18	18	18	20	20:24							X		X	X	X												X							
19	19	19	10	20:25											X												X							
20	20	20	10	20:25							X		X	X	X												X							
21	21	21	2	20:26											X												X							
22	22	22	2	20:26							X		X	X	X												X							X
			Analyst								Ray		Ray	Ray	Ray Stig/Anette												Tim Stig/Anette							Estelle

JCR210 CTD log sheet

Station	Rijpfjorden Mooring		
Filename	JR210_043.dat	Date	16/08/08
Event	180	Time	22:42
CTD no.	043	Depth	183m

Fire Seq	***Ros Pos^n***	***Bot. No.***	***Depth (m)***	***Time (GMT)***	**Biomarker**	**Alkalinity**	**Calcif**	**Primary Prod**	**DIC**	**PIC**	**POC/N**	**SEM**	**Chloro**	**Gluts**	**Lugols**	**Grazing 1**	**Grazing 2**	**DOC/DOP pel tax/ nb**	**Dilution + calib expt**	**Flow**	**Incub**	**Plankton**	**Isotopes**	**Bacterial Prod**	**Viruses**	**Biogas**	**Nutrients**	**DO_2**	**Ra^{226}**	**Th^{234}**	**Pb^{210}**	**Po^{210}**	**Lander**	**Salinity**
1	1	1	175	22:50																							**X**							
2	2	2	150	22:51																							**X**							
3	3	3	120	22:53																							**X**							
4	4	4	100	22:55																							**X**							
5	5	5	80	22:56																							**X**							
6	6	6	60	22:58																							**X**							
7	7	7	50	22:59																							**X**							
8	8	8	35	23:01																							**X**							
9	9	9	20	23:02																							**X**							
10	10	10	10	23:03																							**X**							
			Analyst																								Tim							

JCR210 CTD log sheet

Station	RJA		
Filename	JR210_044.dat	Date	17/08/08
Event	181	Time	00:58
CTD no.	044	Depth	157m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	150	01:04																														X
2	2	2	150	01:05																							X							
3	3	3	120	01:07																														
4	4	4	120	01:07																							X							
5	5	5	100	01:09							X		X	X	X																			
6	6	6	100	01:09																							X							
7	7	7	80	01:10																														X
8	8	8	80	01:11																							X							
9	9	9	50	01:13							X		X	X	X																			
10	10	10	50	01:13																							X							
11	11	11	30	01:14							X		X	X	X																			
12	12	12	30	01:15																							X							
13	13	13	20	01:17							X		X	X	X																			
14	14	14	20	01:17																							X							
15	15	15	10	01:19							X		X	X	X																			
16	16	16	10	01:19																							X							
17	17	17	2	01:20							X		X	X	X																			
18	18	18	2	01:21																							X							X
			Analyst								Ray		Ray	Ray	Ray												Tim							Estelle

JCR210 CTD log sheet

Station	RJB		
Filename	JR210_045.dat	Date	17/08/08
Event	182	Time	02:55
CTD no.	045	Depth	178m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	170	03:02																														X
2	2	2	170	03:02																							X							
3	3	3	120	03:04																														
4	4	4	120	03:04																							X							
5	5	5	100	03:06							X		X	X	X																			
6	6	6	100	03:06																							X							
7	7	7	80	03:08																														
8	8	8	80	03:08																							X							
9	9	9	50	03:10							X		X	X	X																			
10	10	10	50	03:10																							X							
11	11	11	30	03:12							X		X	X	X																			
12	12	12	30	03:12																							X							X
13	13	13	20	03:13							X		X	X	X																			
14	14	14	20	03:14																							X							
15	15	15	10	03:15							X		X	X	X																			
16	16	16	10	03:16																							X							
17	17	17	2	03:17							X		X	X	X																			
18	18	18	2	03:17																							X							X
			Analyst								Ray		Ray	Ray	Ray												Tim							Estelle

JCR210 CTD log sheet

Station	RJ1		
Filename	JR210_046.dat	Date	17/08/08
Event	186	Time	06:37
CTD no.	046	Depth	180m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	172	06:44																														X
2	2	2	172	06:44																							X							
3	3	3	150	06:45																														
4	4	4	150	06:45																							X							
5	5	5	100	06:47							X		X	X	X																			
6	6	6	100	06:47																							X							X
7	7	7	80	06:48																														
8	8	8	80	06:48																							X							
9	9	9	50	06:49							X		X	X	X																			
10	10	10	50	06:49																							X							
11	11	11	30	06:50							X		X	X	X																			
12	12	12	30	06:50																							X							
13	13	13	20	06:51							X		X	X	X																			
14	14	14	20	06:51																							X							
15	15	15	10	06:52							X		X	X	X																			
16	16	16	10	06:52																							X							
17	17	17	2	06:53							X		X	X	X																			
18	18	18	2	06:53																							X							X
			Analyst								Ray		Ray	Ray	Ray												Tim							Estelle

JCR210 CTD log sheet

Station	Shelf Station 2		
Filename	JR210_047.dat	Date	18/08/08
Event	187	Time	06:19
CTD no.	047	Depth	243m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Shelf Station 2		
Filename	JR210_048.dat	Date	18/08/08
Event	188	Time	06:40
CTD no.	048	Depth	243m

Fire Seq	*Ros Pos^{n}*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
1	1	1	35	06:42																														
2	2	2	35	06:42																														
3	3	3	35	06:42																														
4	4	4	35	06:42																														
5	5	5	35	06:42																														
6	6	6	35	06:43																		X					X							
7	7	7	35	06:43																		X	X				X							
8	8	8	35	06:43																		X	X	X			X							
9	9	9	6	06:44																														
10	10	10	6	06:45																														
11	11	11	6	06:45																														
12	12	12	6	06:45																														
13	13	13	6	06:45																														
14	14	14	6	06:45																		X					X							
15	15	15	6	06:45																		X	X				X							
16	16	16	6	06:45																		X	X	X			X							
17	17	17	2	06:46																														
18	18	18	2	06:46																														
19	19	19	2	06:46																														
20	20	20	2	06:46																														
21	21	21	2	06:47																														
22	22	22	2	06:47																		X					X							
23	23	23	2	06:47																		X	X				X							
24	24	24	2	06:47																		X	X	X			X							
			Analyst																			Eric	Eric	Eric			Eric							

JCR210 CTD log sheet

Station	Kongsfjorden		
Filename	JR210_049.dat	Date	19/08/08
Event	201	Time	06:53
CTD no.	049	Depth	340m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															

JCR210 CTD log sheet

Station	Kongsfjorden		
Filename	JR210_050.dat	Date	19/08/08
Event	202	Time	08:33
CTD no.	050	Depth	50m

Fire Seq	*Ros Pos^n*	*Bot. No.*	*Depth (m)*	*Time (GMT)*	Biomarker	Alkalinity	Calcif	Primary Prod	DIC	PIC	POC/N	SEM	Chloro	Gluts	Lugols	Grazing 1	Grazing 2	DOC/DOP pel tax/ nb	Dilution + calib expt	Flow	Incub	Plankton	Isotopes	Bacterial Prod	Viruses	Biogas	Nutrients	DO_2	Ra^{226}	Th^{234}	Pb^{210}	Po^{210}	Lander	Salinity
			Analyst																															