

An integrated study of processes linking sea ice and biological ecosystem elements off East Antarctica during winter

Personnel:

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Introduction:

Sea ice is a structuring component of the Southern Ocean and plays a pivotal role in the biogeochemical cycles of Antarctic marine ecosystems. The sea ice cover greatly affects energy and material fluxes between the ocean and the atmosphere, and provides a habitat for diverse microbial communities which, in terms of biomass, are generally dominated by algae. Sea ice primary production contributes significantly to overall ecosystem primary production and provides an important food source for pelagic herbivores during winter and early spring, when food supply in the water column is low.

The majority of Antarctic sea ice studies have focused on small scales and have mainly been carried out on land fast-ice. Information on the large-scale distribution of pack-ice algae communities and the influence of physico-chemical factors on these communities is still scarce. This project aims to understand the links between sea ice and biological ecosystems components in the Australian Antarctic Territory off East Antarctica.

The main objectives of the project are:

- To identify how biological primary and secondary productivity is affected by winter sea ice extent and properties, and by ocean circulation
- To obtain large-scale information on sea ice biological (sea ice algae distribution and under-ice krill distribution) and physical parameters (sea ice thickness distribution, under-ice velocity field) in the 100-130 degree East section of the Australian Antarctic Territory during late winter/early spring
- To assess the sensitivity of krill populations to potential changes in sea ice extent
- To obtain biogeochemical data on sea ice with a special focus on the iron-biogeochemistry in sea ice

This report has 6 chapters:

- 1) Ice coring survey (main biology site)
- 2) Molecular biodiversity and activity of sea ice organisms
- 3) Iron biogeochemistry

- 4) Remotely Operated Vehicle (ROV) deployment and under-ice light measurements
- 5) Krill/zooplankton biology
- 6) Physical oceanography

1) Ice coring survey (main biology site)

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Ice samples were collected by means of ice coring with 9 and 13 cm diameter ice corers on a total of 15 stations. Ice temperature profiles were recorded for one core at each station. Ice cores were cut into 10 cm sections and analysed for ice texture, delta 18O composition, inorganic nutrients (phosphate, silicate, nitrate, nitrite, ammonium), dissolved organic carbon/nitrogen, absorbance spectra of colored dissolved organic matter (CDOM), molecular characterisation of extracellular polymeric substances (EPS), particulate organic carbon/nitrogen, stable isotopic composition (^{13}C , ^{15}N) of different size fractions of organic matter, ^{14}C in organic matter, persistent organic pollutants (POP), chlorophyll *a* and pheopigment concentration, molecular description of ice algal diversity and metabolic activity, photosynthetic parameters measured with a Fast Rate Repetition Fluorometer (FRRF) and a Pulse Amplitude Modulated Fluorometer (PAM) as well as algal species composition and biomass and species composition and biomass estimates of ice-associated metazoans. This comprehensive set of physical, chemical and biological parameters will allow us to give a detailed description of the sea ice sampled and will be used to understand the factors controlling ice algal production. Stable isotope analysis will be used to estimate how important ice algae are as a food source for pelagic herbivores, e.g. Antarctic krill. Most of the parameters will be analysed in our shore-based laboratories within the next months. Ice texture analysis from ice cores taken at the "biology main site" was carried out onboard. On the main sites we collected in total 11.8 m of ice cores for textural, salinity and $\text{O}18$ analysis. 28 % of the collected ice was congelation ice while the remaining was largely frazil ice (except for some possible snow ice layers that will be detected later using $\text{O}18$ data). Bulk salinity of the ice cores ($n=13$) ranged from 4.1 to 9.4, with an average of 6.1. A second, trace metal clean, coring site, was sampled for iron-biogeochemical work (see Delphine Lannuzel's report # 3 on iron biogeochemistry).

Recommendations: Electrical drills powered by a generator were much easier to use than two-stroke gasoline powerheads. We recommend an increase in the number of electrical drills on future voyages. Some two-stroke gasoline powerheads should be kept for helicopter work and remote work away from the ship.

2) Molecular biodiversity and activity of sea ice organisms

Personnel:

Andreas Krell (AWI)

Sea-ice algae play a major role as primary producers in polar ecosystems. Especially during late spring and early summer, algal biomass accumulates in the sea ice and significantly contributes to primary production. Knowledge of the diversity of organisms inhabiting sea ice is currently mainly restricted to microscopic investigations and the metabolic activity of organisms is estimated from the measurement of bulk sea ice parameters.

The aim of my work during the SIPEX cruise was to complement these investigations on the molecular level, i.e. taking sea ice samples, extracting DNA and RNA in order to establish 18S and cDNA libraries. This will allow me then to detect the biodiversity and transcriptional activity of the eukaryotic sea ice biota. Samples for the extraction of DNA and RNA were taken at 13 ice stations. Bottom sections were taken on board immediately after coring, crushed and allowed to melt in 0.2 µm filtered brine of 40 PSU. Prior to filtration all samples were sieved through 50 µm gaze to remove metazoans. Size fractionated filtration was applied for the biodiversity samples consisting of two fractions above 3 µm and 3 µm to 0.2 µm. When enough biomass was available two samples for the extraction of large size genomic DNA on 0.2 µm filters were taken. For comparison seawater samples (2 times 2 L) were taken from 10 m depth.

Samples for RNA extraction were not allowed to melt but rather flushed with 0.2 µm-filtered brine of 40 PSU and filtered immediately on 0.2 µm filters in order to capture cells in a physiological state close to natural conditions.

Backups, as well as on board extracted DNA and RNA are stored at -80°C.

Library construction and sequencing of libraries will be carried out at the AWI in Bremerhaven.

3) Iron biogeochemistry

Personnel:

Delphine Lannuzel (ACE CRC), Cynthia Chen (Dartmouth College), Pier van der Merwe (IASOS)

Objectives

The primary objective of this cruise was to obtain trace metal clean samples for iron (Fe) analysis in Hobart. In addition we also collected samples to identify the distribution of exopolysaccharides (EPS) within the sea ice environment. To realise this objective we:

- Measure spatial and temporal distribution of iron Fe and EPS, assess their possible relationships, together with nutrients, Dissolved Organic Carbon (DOC), Particulate Organic Carbon (POC), and the ice physical properties in first-

(seasonal) sea ice cores (scientists involved: Delphine Lannuzel and Pier van der Merwe).

- Further work is carried out to determine Fe and Os isotopes in snow samples. Results will give insights on the contribution of extra-terrestrial dusts as a possible source of Fe to the ice cover (scientist involved: Cynthia Chen).

This research will improve our understanding of key processes that control the productivity of the climatically-important Antarctic sea ice zone.

Work plan

Field work

A common work plan was applied to all the stations visited, apart from the two opportunistic stations where only 1 ice core was collected for additional EPS work (stations 9 and 12). Not all the stations of the SIPEX expedition were visited, due to the necessary post-station processing of the samples on board.

Our sampling area would typically be set up a few hundred meters ahead of the ship, which was oriented facing the wind, to limit potential trace metals atmospheric contamination. For the same purpose, each of the participants wore clean room garments on top of their Antarctic clothes.

Ship-based work

Snow, sea ice, brines and under-ice sea water were sampled for multi-parametric analyses (Table 1). Some measurements were performed in situ, like temperature measurements in the ice and brines.

Some of the melted ice sections, snow, brines and sea waters were filtered onboard for Fe, EPS, nutrients, DOC, POC and Chla determination. While Chla concentrations were measured onboard, the rest of the processed samples were preserved for further analyses in Hobart and Bangor (Nutrients and DOC).

Granular (frazil and/or snow ice) and columnar ice textures were determined onboard from thin ice section photographs taken under polarised light.

Other cores are shipped at -20°C to Hobart for complementary analyses and to assess the potential impact of prolonged storage, and potential iron contamination due to the sample collection techniques.

Table 1. example of data set collected at each station

Samples collected	In-situ analyses	Ship-based processing and analysis	Additional analysis
Snow	snow pit dimension	sample filtration (EPS, Fe and Os isotopes, TDFe, dFe, PFe, nutrients, Chla, POC and DOC) Chla determination salinity measurement	EPS (2 independent analyses) (Hobart, AUS) Fe and Os isotopes (Dartmouth, USA) TDFe, dFe and PFe (Hobart, AUS) nutrients and DOC (Bangor, UK) POC (Hobart, AUS)
sea ice cores (6-8) (detailed analysis at	temperature	sample filtration (EPS, Fe and Os isotopes, TDFe, dFe, PFe, nutrients, Chla, POC	EPS (2 independent analyses) (Hobart, AUS) TDFe, dFe and PFe (Hobart, AUS)

5 levels except 5-10 cm resolution for T° d ¹⁸ O and bulk salinity)		and DOC) Chla determination salinity measurement ice texture determination	nutrients and DOC (Bangor, UK) POC (Hobart, AUS) d ¹⁸ O (Hobart, AUS) sample preservation EPS (Hobart, AUS)
sack hole brines (2 levels: >-5°C and <-5°C when possible, shallow and deep depths otherwise)	temperature	sample filtration (EPS, Fe and Os isotopes, TDFe, dFe, PFe, nutrients, Chla, POC and DOC) Chla determination salinity measurement	EPS (2 independent analyses) (Hobart, AUS) TDFe, dFe and PFe (Hobart, AUS) nutrients and DOC (Bangor, UK) POC (Hobart, AUS) Os isotopes (Dartmouth, USA)
underice seawater (2 levels: interface and 0m)		sample filtration (EPS, Fe and Os isotopes, TDFe, dFe, PFe, nutrients, Chla, POC and DOC) Chla determination salinity measurement	EPS (2 independent analyses) (Hobart, AUS) TDFe, dFe and PFe (Hobart) nutrients and DOC (Bangor, UK) POC (Hobart, AUS) Os isotopes (Dartmouth, USA)

Preliminary results

As stated above, most of the analyses will be performed after the samples arrive in Hobart. However, some encouraging preliminary results are worth putting forward.

Ice texture

Sea ice thickness at our selected sampling sites ranged from 0.35m (station 8) to 1.0m (station 13) thickness. Thin section observations reveal a typical (land-) fast ice structure at stations 8 and 10 with 1-3cm of snow on top of columnar ice (i.e. congelation growth). The rest of the collected cores exhibit typical pack ice structure, with granular ice (ie. snow ice and/or frazil ice), underlain by columnar ice. Stations 6, 13 and 14 display a more complex sequence of ice growth processes, probably involving rafting.

Temperature and salinity profiles

The temperature profiles scan a whole range of situations that fully characterize the winter-spring transition observed during SIPEX, from the very cold ice with a strong temperature gradient at station 5, to the relatively warm ice of station 11 (Figure 1). The salinity profiles all exhibit the typical c-shape described in most circumstances in Antarctic first-year ice (Figure 2).

Chla profiles

The increased permeability in the ice cover has drastic consequences for the biological activity, as reflected by the increase in Chla concentrations within the ice cover as spring progresses (e.g. Chla concentration ranges are 0.002 - 3.71 $\mu\text{g Chla.l}^{-1}$ at station 5 and 0.62 - 8.39 $\mu\text{g Chla.l}^{-1}$ at station 11).

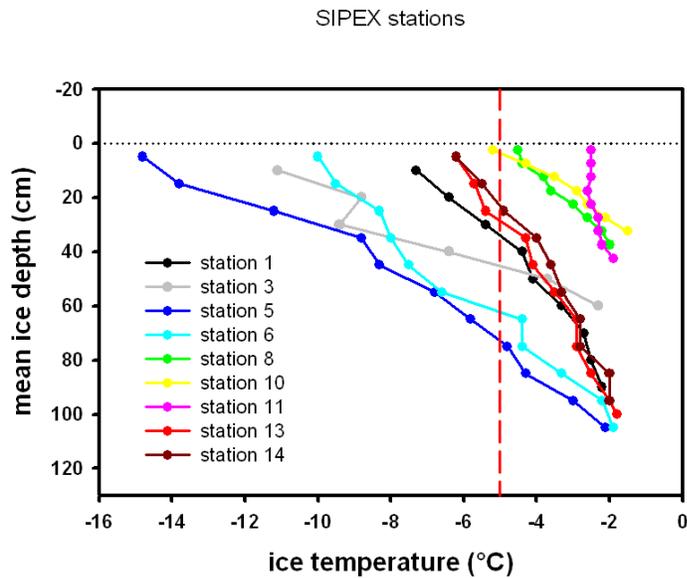


Figure 1. Temperature profiles in the ice at the visited stations. The dotted red line indicates the reference -5°C temperature value, above which ice is thought to become permeable

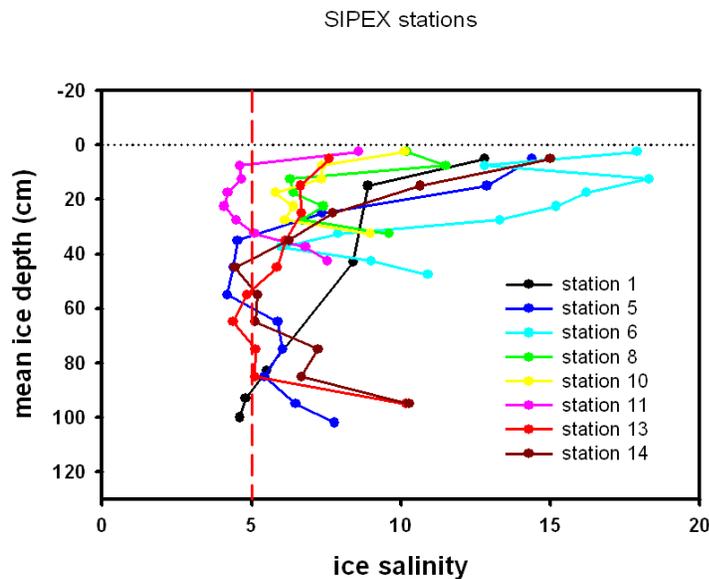


Figure 2. Salinity profiles in the ice at the visited stations. Apart from station 1, all profiles exhibit the typical c-shape.

4) ROV deployment

Personnel (Klaus Meiners)

An Ocean Modules ROV equipped with a TriOS hyperspectral radiometer (300-900 nm, 250 channels), pressure sensor and upward looking Tritech 500 kHz sonar was deployed at 8 ice stations (stations 3, 5, 6, 8, 10, 13, 14, 14A). The ROV was controlled from a lab-container on board the ship and the ROV was deployed through a hole in the ice that was cut with chain saws or drilled with a 1300 mm diameter ice auger mounted on a Digga tracked vehicle. We used a 100 m tether from the inside of the ship to the hole and another 350 m tether from the hole to the ROV. The ROV performed well in strong under-ice currents. After the first stations the tether was weighted to keep it from floating up under the ice. This did not negatively affect the performance of the vehicle. The power supply of the ROV became faulty after the 5th deployment and slowed down our work. We were able to get measurements from 7 complete transects ranging between 60 and 100 m. 4 of these transects were located immediately next to the physics transects.

Combining the ROV depth data and sonar data will allow us to estimate the ice draft and will give information on the distance from the radiometer to the subsurface of the ice floe. The radiometer data will be used to estimate ice algal biomass from transmitted under-ice irradiance spectra. Combining the data will provide the first transects (60-100 m) of algal distribution in sea ice and will also be used to find a relationship for ice thickness and ice algae biomass for East Antarctic sea ice.

In addition to the ROV deployments validation measurements with a stationary radiometer were carried out at 33 sites. On these sites under-ice hyperspectral irradiance was measured with a TriOS radiometer. The radiometer was deployed under the ice using an unfolding telescopic arm which allowed measurement of under-ice irradiance at totally undisturbed sites on the ice floes and away from any access holes. After irradiance measurements were completed, ice and snow thickness as well as the freeboard of the ice floes were measured and an ice core was collected from the radiometer site. The ice core was cut into sections, melted at 4°C in the dark and analysed for pigment content (chlorophyll *a* and pheopigments). Additional subsamples were filtered onto Whatman GF/F filters which will be used for the determination of the absorbance of sea ice borne particles (filter-pad absorption). After completion of the data analysis we will define a relationship between transmitted wavelength ratios and algal biomass. This relationship will then be applied to the ROV measurements.

Recommendations and comments:

We would like to thank for the excellent support from the AAD Marine Science Support team and the AAD workshop both prior to our departure by integrating and mounting the sensors onto the ROV as well as during the cruise for outstanding support in ROV operation and maintenance.

5) Krill/zooplankton biology studies

Personnel: So Kawaguchi (AGAD, ACE CRC), Patti Virtue (IASOS), Christine Crawford (ACE CRC), Margaret Lindsay (AGAD, IASOS), Klaus Meiners (ACE CRC)

Objectives:

- to describe krill demography and distribution patterns of size groups and maturity stages, during the current winter season;
- to collect information on krill growth and condition for improving our understanding of krill's winter physiology
- to understand role of sea ice in krill life history
- to describe the zooplankton community structure and the occurrence of major zooplankton taxa during late winter to early spring period
- To collect information of winter food source for krill and zooplankton through stable isotope analysis.
- to measure persistent organic pollutants (POP) in krill, sea ice, and seawater

2. Methods

2.1 Net Sampling

2.1.1 RMT 1+8

A single opening-closing RMT 1+8 net (Baker et al., 1973) with CTD System installed was used for all of the tows (Regular and Target), Hard cod-ends were used for all the trawls. Flow meters were used to estimate the volume of water towed. At each RMT trawl station a quantitative standard double oblique tow was conducted from the surface down to 200 m (or to within 10 m of the bottom at stations shallower than 200 m). Such a depth range is considered to be the best compromise between the time available for sampling and the likely vertical depth range of krill. During the hauls, ship's speed was maintained at a constant 2 knots. Wire speed was 0.7 to 0.8 m/s during paying out and 0.3 m/sec during hauling (approx. 0.5 m/s and 0.2 m/s respectively at vertical depth change rate). The net mouth angle is known to be constant during hauling within the speed ranges given above. When the net reached maximum depth, the winch was stopped for about 30 seconds to allow the net to stabilize before retrieving. When hauling, the propeller thrust was turned off when the net reached depth of 15 to 20 m; this was to minimize the effects of the propeller action on the net operation and avoid damage of the samples. On one occasion a layer between 16-30m was targeted.

2.1.2 SUIT (Surface and Under Ice Trawl) net

The SUIT net was used to collect surface and under ice zooplankton. Towing time was approximately 20 minutes at each deployment.

2.1.3 Umbrella net

An umbrella net was used to collect mesozooplankton communities through ice holes at the ice stations.

2.2 Underwater Camera System

A high definition camera with water tight housing installed together with two light sources was deployed underwater to take footage of under ice as well as pelagic zooplankton communities. It was also attached to SUIT net as well as RMT net to assess performance of their performance.

2.3 Ice Cores and Seawater

Ice cores were sampled at four of the ice stations to measure Persistent Organic Pollutants (POPs) in the sea ice. At two sites where krill were sampled for POP, seawater from underway uncontaminated seawater was sampled.

2.4 Laboratory Sampling and Processing

2.4.1 Sample processing for all regular trawl stations:

All Antarctic krill and Ice krill were sorted out and their number were counted. Stage (TL, Carapace Length, Maturity), digestive gland size, and eye diameter of all krill (or subsample: between 50 to 150 individuals) were measured using digital calipers. Other zooplankton groups were immediately sorted out from the catch and their numbers were recorded.

Preservation of samples

Krill (including those used for onboard demography measurements) were fixed in 10% formalin for their further analysis. Whenever excess amount of krill were caught, they were sampled and frozen for POP (persistent organic pollutant) measurements, preserved in 80% ethanol for genetic analysis, and frozen under -80C/ liquid nitrogen for chemical analysis. Samples for stable isotope analysis were taken from the catch and kept frozen at -80C. Numbers of all samples taken were recorded in the lab note.

For the RMT-1 samples, the whole sample was fixed with 10 % formalin. If the sample volume was too large for processing, then a known proportion of catch was randomly sub-sampled and fixed.

2.3 Live Krill Experiments

Whenever large amounts of live krill in good condition were caught, live krill experiments were undertaken.

2.3.1 IGR (Instantaneous Growth Rate) Experiment

Immediately after the catch, xx to xxxx krill were randomly selected, and put in 250 ml IGR jars individually. A total of 3 experiments were conducted on *E*.

superba. All jars were settled in the surface seawater flow-through system in the IGR experiment container installed on lab-4. Daily checking of the moults was done at intervals of approximately at 24 hours. Moults and animals were frozen in liquid nitrogen. Experiments lasted for a period of 5 days. Table 2 shows the summary of the IGR experiments.

2.3.2 Krill Oxygen Consumption

When krill were caught in good condition, their oxygen consumption was measured. After acclimating krill in filtered seawater for ~12h, they were incubated in airtight glass bottles with 0.2µm filtered seawater at ambient temperature for either 12 or 24 hours. The oxygen concentration was measured using the Winkler titration method. The differences in oxygen content between control bottles and experimental bottles were calculated as oxygen consumption during the period of incubation.

2.3.3 Krill Starvation Experiment

Live krill were starved for 5 to 20 days and preserved for further histological observation back in Kingston. The purpose is to see effects of starvation on their digestive glands.

2.4 Live Krill Transfer to Kingston

Live adult krill were held in seven surface water flow-through tanks in the cold room (0.5C). The room was basically kept dark unless light was needed. Dead animals and moults were checked and removed daily. When seawater temperature rose on return to Hobart, water supply was stopped, and water change was done manually. In this case, half of the water in the tank was drained and replaced by fresh chilled seawater (below 2.5C). A bio-filter system with form-fractionator was used to remove organic materials and ammonia after closing the seawater supply once crossing the polar front on the way back to Hobart.

3. Difficulties and Recommendations

SUIT: Because of the seasonal timing of the current survey, the earlier trawls caught massive amount of frazil ice which made sorting of biological samples almost impossible. However, towards the end of the cruise the condition improved, and less frazil ice in the water column sampling successful. I see a great potential in SUIT net. The SUIT is especially useful to sample krill/zooplankton community during night when all krill are up in the surface and impossible to properly capture using RMT net from the stern (due to prop wash). Because the SUIT sheers away from the ship it is an excellent tool in this regard. Also by mounting an echosounder on the SUIT net, high quality acoustic data can be expected from the very surface layer, which is impossible to collect using the ship mounted echosounders.

Underwater Camera system: The quality of the footage is excellent. However, with the present configuration it does not allow real time manipulation of the camera. This is a considerable drawback since we can not adjust the settings according to the target. As a result it only allows us to obtain very limited amount of good footage. We also need to have some way of quantifying the size of objects in the footage (possibly a laser pointing system).

The camera system also has a great potential as a substitute for target trawls to a certain extent. By having a real time operating camera system it would be possible to identify targets without trawling each time and could save vast amounts of ship time. It also has less problems in net avoidance.

Overall, I recommend use of optic fiber cable to construct the above suggested real time camera system.

RMT: Through the underwater camera observation, it became clear that the current RMT net mouth is not properly opened when fishing down due to water pressure pushing the bottom bar up. This means Double Oblique Tow (which is used as standard trawl method world wide) is not possible using the current system. This problem must be solved as soon as possible. We also need to collect information of the other countries' RMT configurations and discover whether they are exactly the same as our system or not.

Table: The list of all activities related to krill/zooplankton biology undertaken (excluding ring nets).

Event No.	Station Number	Instrument	Date (UTC)	Time (UTC)	Lat	min S	long	Min S	Comments
1	R1	RMT1+8	9/09/2007	20:56	62	01.64	129	00.16	0-200 double oblique
2	R2	RMT1+8	10/09/2007	1:17	62	29.56	128	36.55	0-200 downward single oblique
3	ICE#1	Umbrella net	11/09/2007	1:00	64	14.00	128	00.00	0-50m vertical tows
4	ICE#1	13cm corer	11/09/2007	5:05	64	13.78	127	56.82	~90cm
5	ICE#2	Umbrella net	12/09/2007	0:00	64	29.00	128	06.00	0-50m vertical tows
6	ICE#2	13cm corer	12/09/2007	5:20	64	29.00	128	05.00	
7	S1	SUIT	13/09/2007	11:00	64	24.15	128	00.24	Surface trawl, 36 min tow
8	R3	RMT1+8	13/09/2007	16:16	64	16.87	127	23.29	Cancelled (depth sensor irregular)
9	R4	RMT1+8	13/09/2007	16:46	64	16.49	127	22.77	0-200 double oblique
10	ICE#3	Umbrella net	14/09/2007	0:00	64	23.00	127	11.00	0-50m vertical tows
11	ICE#3	Sony HD Cam	14/09/2007	5:31	64	24.00	127	07.00	0-100 continuous
12	R5	RMT1+8	16/09/2007	6:12	64	54.36	125	54.12	0-200 double oblique
13	S2	SUIT	16/09/2007	10:04	65	03.26	125	45.23	Surface trawl
14	S3	SUIT	16/09/2007	21:05	65	03.59	125	47.15	Surface trawl
15	R6	RMT1+8	17/09/2007	6:37	65	15.66	125	39.68	0-200 double oblique
16	S4	SUIT	17/09/2007	9:53	65	18.26	125	33.80	Surface trawl
17	R7	RMT1+8	17/09/2007	12:00	65	18.62	125	37.35	16-60 yoyox3
18	W1	Water line	17/09/2007	15:00	65	16.64	125	20.75	
19	ICE#5 (dip1)	Sony HD Cam	18/09/2007	1:00	65	31.00	124	45.00	0-100 continuous
20	ICE#5	Umbrella net	18/09/2007	1:30	65	31.00	124	45.00	0-50m vertical tows
21	ICE#5	13cm corer	18/09/2007	6:30	65	31.47	124	45.12	

22	ICE#5 (dip2)	Sony HD Cam	19/09/2007	0:00	65	31.46	124	45.12	0-100 continuous
23	R8	RMT1+8	20/09/2007	12:57	65	28.05	124	39.93	0-200 double oblique
24	W2	Water line	20/09/2007	14:07	65	29.95	124	26.27	
25	ICE#6	Sony HD Cam	21/09/2007	6:00	65	35.30	122	35.04	Under Ice (UI),10,20,40,50,60,70,75,100
26	ICE#6	Umbrella net	21/09/2007	8:00	65	35.00	122	35.00	0-50m vertical tows
27	ICE#7	13cm corer	22/09/2007	2:00	65	34.00	121	31.00	green stuff in the bottom
28	ICE#7	Umbrella net	22/09/2007	2:30	65	34.00	121	30.00	0-50m vertical tows
29	S5	SUIT	22/09/2007	5:46	65	35.72	121	19.92	Surface trawl
30	ICE#8	Umbrella net	25/09/2007	6:00	65	33.00	118	52.00	0-50m vertical tows
31	ICE#8	Sony HD Cam	25/09/2007	12:18	65	33.18	118	52.48	UI,10,25,30,40,50,60,70,75,100
32	S6	Sony HD Cam	26/09/2007	11:13	65	30.22	118	51.51	Surface tow
33	S6	SUIT	26/09/2007	11:20	65	03.02	118	51.26	Surface and underice
34	R9	RMT1+8	26/09/2007	12:15	65	31.33	118	52.30	0-200 double oblique
35	R10	RMT1+8	29/09/2007	11:10	65	03.81	119	41.91	0-200 double oblique
36	ICE#10	Umbrella net	29/09/2007	22:00	64	57.00	119	08.00	0-50m vertical tows
37	ICE#10	Sony HD Cam	30/09/2007	4:10	64	56.17	119	09.07	UI,10,20,30,40,50,0,70,75,100
38	ICE#10	Sony HD Cam	30/09/2007	15:00	64	55.97	119	09.51	UI,10,20,30,40,50,0,70,75,100
43	Camera	Sony HD Cam	1/10/2007	12:49	64	59.36	118	46.67	0,10,30,50,75,100
44	Camera	Sony HD Cam	2/10/2007	12:06	65	01.83	117	59.47	0,10,20,30,50,75,100
46	ICE#11	Umbrella net	3/10/2007	3:30	65	01.00	117	32.00	0-50m vertical tows
47	ICE#11	Sony HD Cam	3/10/2007	5:00	65	00.83	117	35.98	UI,10,30,50,75,100
48	Camera	Sony HD Cam	4/10/2007	11:55	64	56.32	117	07.98	0,10,20,30,50,75,100
50	ICE#12	Sony HD Cam	5/10/2007	1:20	64	54.87	117	02.25	0,10,20,30,50,75,100
52	Camera	Sony HD Cam	5/10/2007	12:30	64	50.00	116	51.00	0,10,20,30,50,75,100
54	Camera	Sony HD Cam	5/10/2007	13:40	64	50.00	116	51.00	0,10,20,30,50,75,100
55	ICE#13	Umbrella net	6/10/2007	1:00	64	44.00	116	49.00	0-50m vertical tows
56	ICE#13	Sony HD Cam	6/10/2007	7:30	64	43.71	116	48.16	UI,10,20,30,50,75,100
57	ICE#13	Sony HD Cam	6/10/2007	12:10	64	40.69	116	49.55	10,20,30,50,75,100
58	R11	RMT1+8	6/10/2007	14:35	64	39.87	116	49.77	0-200 double oblique
59	R12	RMT1+8	6/10/2007	15:23	64	38.88	116	48.83	200-400 downward single oblique
60	ICE#14	Umbrella net	6/10/2007	23:00	64	19.00	116	49.00	0-50m vertical tows
61	ICE#14	Sony HD Cam	7/10/2007	5:45	64	17.29	116	51.15	UI,10,20,30,50,75,100
62	ICE#14	Sony HD Cam	7/10/2007	10:58	64	17.29	116	51.15	UI,10,20,30,50,75,100
63	R13	RMT1+8	8/10/2007	6:46	64	13.94	116	33.86	0-200 double oblique
64	R14	RMT1+8	8/10/2007	7:32	64	14.34	116	32.92	0-200 double oblique
65	R15	RMT1+8	9/10/2007	6:35	64	00.53	118	29.36	0-200 double oblique
66	S7	SUIT	9/10/2007	7:38	64	01.15	118	33.83	Under Ice Trawl,
67	S7	Sony HD Cam	9/10/2007	7:38	64	01.15	118	33.83	Under Ice Trawl,
68	S8	SUIT	9/10/2007	12:07	64	06.84	119	13.28	Under Ice Trawl,
69	S8	Sony HD Cam	9/10/2007	12:07	64	06.84	119	13.28	Under Ice Trawl,
70	R16	RMT1+8	9/10/2007	12:50	64	08.00	119	15.71	0-200 double oblique
71	R17	RMT1+8	10/10/2007	13:36	63	30.28	122	12.15	0-200 double oblique
72	R17	Sony HD Cam	10/10/2007	13:36	63	30.28	122	12.15	Attached to RMT net
73	R18	RMT1+8	10/10/2007	14:05	63	29.55	122	11.13	0-200 double oblique
74	R19	RMT1+8	10/10/2007	18:48	62	59.40	122	57.00	0-200 double oblique
75	R19	Sony HD Cam	10/10/2007	18:48	62	59.40	122	57.00	Attached to RMT net
76	R20	RMT1+8	10/10/2007	19:26	62	58.21	122	56.72	0-200 double oblique
77	R21	RMT1+8	10/10/2007	23:20	62	29.01	123	39.20	0-200 double oblique
78	R21	Sony HD Cam	10/10/2007	23:20	62	29.01	123	39.20	Attached to RMT net

79	R22	RMT1+8	11/10/2007	4:24	62	00.81	124	27.82	0-200 double oblique
80	R22	Sony HD Cam	11/10/2007	4:24	62	00.81	124	27.82	Attached to RMT net
81	R23	RMT1+8	11/10/2007	4:54	61	59.97	124	26.67	0-200 double oblique
82	R24	RMT1+8	11/10/2007	8:36	61	30.44	125	16.65	0-200 double oblique
83	R24	Sony HD Cam	11/10/2007	8:36	61	30.44	125	16.65	Attached to RMT net
84	R25	RMT1+8	11/10/2007	9:02	61	30.00	125	15.42	0-200 double oblique

6) Physical oceanography (Guy Williams, ACE CRC)

Overall assessment:

The biology/biogeochemistry/ecology and oceanography teams had a very successful voyage. A comprehensive data set of biological and biogeochemical as well as oceanographic parameters was collected. The ROV was deployed successfully on 8 occasions. We got some excellent under-ice footage showing both juvenile and adult krill at the subsurface of the sea ice and in cracks in areas of rafted ice. For the first time information of ice algal biomass along 100 m transects was obtained.

The SUIT was successfully deployed and we could show that it samples the under-ice habitat properly. We see great potential in using the trawl both in open water and ice-covered areas in the future.

The iron biogeochemistry team used a custombuilt trace-metal clean ice core which worked fine under field conditions.

Overall Recommendations:

Problems were caused by the ice-conditions in the outer pack which consisted of pancakes and small floes that could not be sampled easily. A bigger basket (maybe with a trap door) to lower personnel on the ice would help to sample this biologically important habitat in the marginal ice zone on future voyages.

The ROV needed a lot of technical support and became faulty after the 5th deployment. For drilling ROV access holes a 1300 mm ice auger mounted on a Digga tracked vehicle is needed and is preferable to chainsaw work. The Digga gets stuck in snow easily and the use of a tracked quad to pull the auger over the sea ice was extremely helpful.