RRS Discovery Cruise 262

Biophysical studies of zooplankton dynamics in the northern North Atlantic: spring, 18 April - 27 May 2002

MARINE PRODUCTIVITY CRUISE REPORT NO. 2

Photo: D Mayor

Principal Scientist: Kelvin Richards*
SOES, Southampton Oceanography Centre

*current address: IPRC/SOEST, University of Hawaii
1680 East West Road, Honolulu, Hawaii 96822

Document Data Sheet

AUTHORS

KELVIN RICHARDS and Marine Productivity researchers, with editorial assistance by Phil Williamson and Gwen Moncoiffé

PUBLICATION DATE

December 2002

TITLE

RRS Discovery cruise 262. Biophysical studies of zooplankton dynamics in the northern North Atlantic: spring, 18 April - 27 May 2002.

REFERENCE

Marine Productivity Cruise Report No. 2 (102 pp)

ABSTRACT

Discovery 262 was the second of four multi-institute and multidisciplinary research cruises supported by the NERC Marine Productivity thematic programme within the wider context of the international Global Ocean Ecosystem Dynamics project (GLOBEC). It provided information on biological and physical conditions during spring in the northern Irminger Sea, along the Reykjanes Ridge and east Greenland shelf-edge, and parts of the Iceland Basin. Scientific effort was directed at: mapping physico-chemical features, in terms of water mass distribution, velocity field and mixed layer properties; float deployments, to estimate water mass fluxes and particle trajectories; collection of water samples for plant pigment, phytoplankton and microzooplankton analyses; determination of 3D abundances of the copepod *Calanus finmarchicus*, other mesozooplankton, and their main invertebrate predators; experimental studies of egg production and nauplii development for *Calanus* and *Oithona* spp; and zooplankton collection (including planktonic foraminifera on the outward passage leg) for further taxonomic, genetic, physiological and biochemical studies. SeaWiFS and AVHRR imagery provided basin-wide information on spring bloom development, also regional and local data on sea surface temperature and sea-ice cover off Greenland.

An initial port call at Reykjavik allowed for instrument calibrations – and interviews for the BBC Radio 4 'Nature' programme. Despite several periods of poor weather and some gear problems, good coverage of the ocean areas of interest was obtained. Thus more than half the cruise time was spent on science activities, achieving 40 CTD profiles, 25 ARIES tows, 24 Dual Methot net tows, 23 Ocean Sampler tows, 20 lowered EK500 deployments, 44 sets of vertical net hauls, 4 ARGO float deployments and 215 hr of of the towed EK500. Provisional data from ARIES and other sources indicated that *Calanus* had ended overwinter diapause at all sites; however, there were marked differences between areas with regard to the abundance of eggs and early nauplii. Shelf-edge blooms of *Phaeocystis* (a colonial Prymnesiophyte) complicated the interpretation of OPC data for '*Calanus*-sized particles'.

KEYWORDS

ADCP SYSTEMS, ARGOS FLOAT, ARIES SYSTEM, CALANUS FINMARCHICUS, COPEPOD, CTD OBSERVATIONS, DISSOLVED OXYGEN, DUAL METHOT NET, EGG PRODUCTION, EUPHAUSIID, FRRF SYSTEM, GLOBEC, ICELAND BASIN, IRMINGER SEA, MARINE PRODUCTIVITY THEMATIC, MICROPLANKTON, NORTHERN NORTH ATLANTIC, NAUPLII, NUTRIENTS, OCEAN SAMPLER, OITHONA, OPTICAL PLANKTON COUNTER, PHAEOCYSTIS, PHYTOPLANKTON, REYKJANES RIDGE, RRS DISCOVERY, SALINITY, SCIENTIFIC ECHOSOUNDER, SEA SURFACE TEMPERATURE, ZOOPLANKTON.

ISSUING ORGANISATION

Natural Environment Research Council, Swindon SN2 1EU, UK

COPIES OF THIS REPORT ARE AVAILABLE (HARD COPY AND ONLINE) FROM

British Oceanographic Data Centre, Bidston Observatory, Prenton, Merseyside CH43 7RA, UK.
Tel +44 (0)151 653 1510, fax +44(0)151 652 3950, website www.bodc.ac.uk

CONTENTS

APPENDICES

LIST OF TABLES

FIGURES

Scientific personnel

Richards, Kelvin	SOC	Principal Scientist
Anderson, Cairistiona	St Andrews	EK500 systems
Brown, Louise	SOC	oxygen and nutrient analyses
Bunker, Adrian	Heriot Watt	*Calanus* egg production & nauplii development
Castellani, Claudia	SOC	*Oithona* and *Calanus* feeding expts
Cook, Kathryn	FRS Aberdeen	*Calanus* egg production & nauplii development
Crisp, Nick	SOC	LADCP, ADCPs
Davidson, Russell	SOC	phytoplankton and pigments
Fielding, Sophie	SOC	physical data
Hay, Stephen	FRS Aberdeen	FRS nets and biosorting
Holliday, Penny	SOC	physical data, floats
Hunter, James	FRS Aberdeen	FRS zooplankton sampling gear
Irigoien, Xabier	AZTI Spain	*Oithona* and *Calanus* feeding expts
Mayor, Daniel	SOC	*Calanus* egg production experiments
McLeod, Paula	SOC	underway data, FRRF
Pond, David	SOC	lipids and hormones
Roberts, Emily	Swansea	C/N and stable isotope ratios
Saunders, Ryan	St Andrews	EK500 systems and biosorting
Smith, Tania	PML	*Calanus* egg production & nauplii development
Ware, Fiona	NMS Edinburgh	biosorting
Wilson, David	Liverpool	phytoplankton and pigments
Teare, David	SOC/UKORS	Technical Liaison Officer
Edwards, Terry	SOC/UKORS	electronics
McLachlan, Rob	SOC/UKORS	mechanical
Phipps, Richard	SOC/UKORS	mechanical
Bicknell, Jeffery	SOC/UKORS	shipboard computing
Sherring, Alan	SOC/UKORS	mechanical
Short, Jonathan	SOC/UKORS	electronics

In addition to the above, Kate Darling and Blair Steele (both University of Edinburgh) participated on the passage leg from Southampton to Reykjavik, to sample foraminifera. Eric Armstrong (FRS Aberdeen) and Andrew Brierley (St Andrews) joined the ship whilst it was off Reykjavik to calibrate the EK500 systems. Mark Carwardine and Laura Fudge (both BBC) also temporarily joined the ship whilst it was off Reykjavik to conduct interviews for Radio 4.

AZTI, Arrantza eta Elikaigintzarako Institutu Teknologikoa, Spain; FRS, Fisheries Research Services; NMS, National Museums of Scotland; PML, Plymouth Marine Laboratory; SOC, Southampton Oceanographic Centre; UKORS, UK Ocean Research Services

Ship's Personnel

Plumley, Robin	Master
Warner, Richard	Chief Officer
Mitchell, John	Second Officer
Holmes, John	Third Officer
Blackler, Ann	Cadet
Adams, Andrew	Chief Engineer
Greenhorn, Alex	Second Engineer
Bell, Stephen	Third Engineer
Connor, Keith	Third Engineer
Stewart, David	Electrical Engineer, ETO
Bennett, Peter	CPO Deck
Thomson, Iain	PO Deck
Buffery, David	Seaman 1A
Cooper, Gerald	Seaman 1A
Dickinson, Robert	Seaman 1A
Dollery, Perry	Seaman 1A
Shrubsole, Michael	Assistant Engineer
Curtis, Keith	Shipboard Catering Manager
Lynch, Peter	Chef
Isby, Wilmot	Assistant Cook
Orsborn, Jeffery	Steward

Acknowledgements

This cruise was made possible by the excellent support services provided by the NERC Research Ships Division, SOC Ocean Engineering Division (UK Ocean Research Services), SOC George Deacon Division, and the Fisheries Research Services Marine Laboratory, Aberdeen.

Funding was primarily provided through research grants awarded through the NERC Marine Productivity thematic programme. The assistance of the programme Steering Committee and Science Coordinator in the strategic planning and implementation of *Discovery* 262 is gratefully acknowledged.

1. The cruise

1.1 Introduction

RRS Discovery cruise 262 was the second of four research cruises supported by the NERC Marine Productivity (MarProd) thematic programme. The vessel sailed from Empress Dock, Southampton midday on 18 April 2002 and returned to Farlie Quay, Fairlie (Clyde) on 27 May 2002. There were boat transfers off Reykjavik to allow calibration of the EK500 systems. A crew from BBC radio also embarked whilst the ship was off Reykjavik to record interviews for a Radio 4 Nature programme on zooplankton (broadcast 20 May 2002).

1.2 Scientific objectives

The overall goal of the Marine Productivity programme is "to develop coupled modelling and observation systems for the pelagic ecosystem, with emphasis on physical factors affecting zooplankton dynamics". The target species for programme fieldwork is the copepod *Calanus finmarchicus,* with associated studies on its main predators, competitors and prey. *C. finmarchicus* was chosen because it is the dominant zooplankton species in the northern North Atlantic, it is a major food supply for fish larvae, and its abundance is known to vary with changing climatic conditions over the North Atlantic. Understanding the controls on *C. finmarchicus* is key to understanding the impact of climate change on the marine ecosystem.

The specific objectives of the second MarProd cruise were similar to those of the first, namely:

- To map the physical features of the survey region (Irminger Sea and parts of the Iceland Basin) in terms of water mass distribution, velocity field and mixed layer properties
- To obtain additional information to estimate future water mass fluxes and particle trajectories, via the deployment of additional floats
- To collect water samples for plant pigment and microscopic analyses, to estimate the biomass of different taxonomic/functional groups of microplankton
- To measure high resolution profiles of inorganic nutrient concentrations
- To determine the 3D abundance of the mesoplankton of interest (primarily *C. finmarchicus*), and their planktivorous predators (primarily euphusid spp), obtaining material for further taxonomic, physiological and biochemical studies.

In addition, because spring is a crucial time for the reproduction and development of egg to nauplii stages of *C. finmarchicus*, a number of process studies were undertaken. These studies covered:

- *Calanus* egg production and nauplii development
- Influence of the food quality on *Calanus* egg production
- *Oithona* and *Calanus* nauplii feeding experiments
- *Oithona* egg production
- Lipids and hormones
- C/N and stable isotope ratios.

This is an ambitious list for a cruise, requiring close collaboration between all the scientific groups, technical support and ship's personnel. It is credit to everyone onboard that so much was achieved.

The broad scope of the dataset compiled by the MarProd series of cruises to the Irminger Sea will facilitate comparison with historic datasets (e.g. NORWESTLANT, 1963 and the Continuous Plankton Recorder surveys), the EU supported zooplankton programmes TASC and ICOS, and other

national and international studies. The MarProd programme provides the main UK contribution to the Global Ocean Ecosystem Dynamics project (GLOBEC), co-sponsored by IGBP, SCOR and IOC.

1.3 Cruise overview

The cruise track and site positions for sampling are shown in Figs 1 and 2 respectively. The cruise track was chosen to allow sampling of a number of different provinces, namely the Icelandic and Greenland Shelves, the Reykjanes Ridge, and the deep basin. The track also allowed the ship to be within a given province for sufficient time for process studies (c. 1 week) whilst mapping out a significant part of the Irminger Sea. Line B was chosen as a repeat of a section occupied by *RV Oceanis* cruise 369 in August 2001 (chief scientist, Dr Robert Pickart). Line DD, known as line D during the cruise, was a repeat of the almost complete E-W section across the central Irminger Sea in the first MarProd cruise (*Discovery* 258; co-Principal Scientists, Drs Raymond Pollard and Steve Hay), then labelled line G.

We managed to sample very contrasting regimes ranging from *Calanus*-rich to *Calanus*-poor, from phytoplankton-rich to phytoplankton-poor, from blooms dominated by *Phaeocystis* to abundant diatoms (see Table 13 for a preliminary overview of the species found at individual sites). Note should also be taken of the very different conditions encountered at the repeat site (A5 and B1, re-sampled after 20 days), highlighting the very dynamic nature of the ecosystem.

The cruise diary is given in Appendix A1.1, with further information on the work done at each site (individual stations and gear used) given in Appendix A1.2. A total of 40 CTD profiles, 25 ARIES tows, 24 Dual Methot net (DMT) tows, 23 Ocean Sampler (OS) tows, 20 lowered EK500 (LEK) deployments, 44 sets of vertical net hauls, 4 ARGO float deployments and 215 hrs of the towed EK500 (TEK) were completed. Despite poor weather in the early stages of the cruise and problems with the 10t and 20t winches almost all of the planned work was accomplished. The statistics of the time spent on activities and downtime (compiled by the master, Robin Plumley) is given in Table 1

Table 1. Time distribution between scientific and non-scientific activities

	Science	Passage	Weather downtime	Other downtime	Manoeuvring
hours	492	224	106	61	73
per cent	*52%*	*23%*	*11%*	*6%*	*8%*

The method of working was to undertake what is referred to as a 'full site', interspersed with 'intermediate sites' (a reduced suite of measurements). The aim was to time the work so that live sampling at a given site was done at the same time of day, although this was not always possible. The order of deployments at a 'full site', which was found to minimise turn round time was OS, TEK inboard, water collection using CTD rosette, vertical nets, physics CTD, LEK, TEK outboard, DMT and lastly ARIES. The changes to the deployment and recovery of the LEK and TEK since *Discovery* 258 meant that both operations were swift and generally trouble-free. By line B we had found the best combination of stations for a daily cycle was a full site, a ~30nm steam, an 'intermediate' site consisting of a full depth CTD profile and vertical net haul, followed by ~30nm steam to the next full site.

The scientific programme started on the Iceland Shelf in reasonably good weather. However the weather deteriorated such that stations planned for line A had to be abandoned. Things improved for A5 but quickly deteriorated again. The ship made little headway on line B against a strong northerly wind. Weather forecasts were predicting that the strong northerlies would continue for another 24 hours. It was decided to turn to the south to DD13 and try doing a clockwise, rather than anticlockwise, circuit around the basin.

Upon arrival at DD13 the weather had improved allowing a sequence of full and intermediate sites across half of the basin to DD8. The wind increased again and turned westerly. At the same time problems were encountered with the 10t winch used to deploy the CTD. It was decided to abandon DD8. We made slow progress across the rest of the basin, using the CTD on ARIES for vertical T/S profiles. The 10t winch was not operational again until the end of the section DD0. Along line DD the 4 floats, which were not deployed on *Discovery* 258, were released at approximately even spacing; the westernmost float deployed was judged to be as far westward as it could be, without the float being entrained into the southward flowing East Greenland Current.

It had been planned to steam onto the Greenland Shelf, remain there for 5-7 days to perform process studies, before completing a high resolution section down the slope to deep ocean conditions. Two things prevented this from happening. The first was the presence of pack ice. The area of shelf for the planned work had been chosen because satellite images had shown it to be free from ice and a region of high productivity. However, the ice was rapidly breaking up. Our movement onto the shelf was impaired by a filament of ice which had been brought to the shelf edge by a vortex pair. An attempt to steam through this ice had to be abandoned because the size and density of floes increased to an unacceptable degree (we did manage to get onto the shelf by steaming to the west, around the tip of the filament, but conditions made it impossible to get very far). The position of the ice edge was determined by digitising weather satellite images received by the ship's Dartcom system. Whilst such images proved useful, the movement of ice filaments was so swift that passage to open water could be prevented in a matter of hours (see Figs 3 and 23, although these do not show all local ice features).

The second reason why process studies were not conducted on the shelf was that it was found that the bloom was heavily dominated by *Phaeocystis,* with very few *Calanus* being present. It was then decided to make our way north by getting onto the shelf as best we could and taking short sections down the slope to capture the transition between the shelf and open ocean regimes (C9b-C10 and B11-B10). Returning to open ocean conditions once a day was required to collect water for the ongoing process studies.

Two sites were occupied within the ice (C9a and C11a), consisting of a CTD profile and vertical net haul. A hole between the ice floes was made by putting the ship beam onto the wind. The ship was pushed sideways leaving a region of open water. The sampling on the shelf and slope, and remotely sensed data, revealed the system to be very dynamic. The rapidly melting ice, high bloom conditions, and vigorous eddy activity appear to combine to produce filamentation of both the ice and phytoplankton, and large cross slope fluxes of fresh water and the *Phaeocystis* bloom: high fluorescence, high oxygen and low salinity was found at depth as far out as B9.

Progress along line B was uneventful (except for an interruption to fix a leak on the bow thruster; the time lost meant that B7, an intermediate site, was abandoned). Site B1 was a reoccupation of A5 on the Reykjanes Ridge. Time allowed the line to be extended into the Iceland Basin (I1-I3). A final site was occupied at OSI/I4, the site of the former ocean weather station India. Data taken at this site will be compared to a time series taken in the 1970s.

Finally a series of CTD trials took place. A problem noticed on previous cruises with the CTD was the presence of temperature spikes in the record. This has been ascribed to the fact that the CTD package undergoes an oscillation with a period of a few seconds coupled to a possible 'trapping' of water in the frame. Trials were done removing equipment from the frame, finishing with a cast with the Sea-Bird T&S sensors attached to a pole to place them away from the frame. Results from the trials are pending.

Kelvin Richards

2. CTD operations

2.1 CTD operations – rosette and frame

The main CTD system comprised the following instruments:

- A Sea-Bird 911+ with dual temperature and conductivity sensors
- Sea-Bird dissolved oxygen sensor
- Chelsea Instruments transmissometer (alphatracka)
- Chelsea Instruments fluorometer (aquatracka)
- Seatech light back scatter sensor
- Datasonics altimeter
- Seabird 24 way system rosette
- 24 x 10 litre Niskin bottles.
- RDI 300kHz self-contained ADCP
- RDI 600kHz self-contained ADCP

.

Sixty five casts were performed during the cruise with approximately forty sites occupied. Except for one bottle misfiring, the system operated without problems.

Dave Teare, Terry Edwards, Jon Short

2.2 Lowered CTD sampling, processing and calibrations

2.2.1 Introduction

Two varieties of CTD stations were collected on *Discovery* 262. 'Full profile' stations were full depth, with bottles fired at standard depths from the bottom to the surface and from which the usual suite of samples was collected. In addition, 'live sampling' CTDs were shallow dips (< 100m) with the sole intention of collecting 240 litres of water from the subsurface chlorophyll maximum for process studies. At each complete station, a live sampling CTD and a full profile CTD were taken. Data from both kinds of CTD stations were processed in the standard manner described below.

2.2.2 Sampling protocol

Only the full profile CTDs had calibration samples and nutrients collected from them (the collection of water from the live sampling CTDs is covered elsewhere in this report). Samples were taken in the following order: oxygen, nutrients, salinities, then chlorophyll and stable isotope samples. Oxygen samples were taken from approximately half the bottles from the bottom to the surface, excluding the 5m bottles (with a duplicate from bottle no. 2). Nutrient samples were taken from every depth. Salinity samples were taken from each depth from the bottom to 400m, then one from each of 200m, 100m and 50m (with a duplicate from bottle no.1).

Oxygen samples could not be taken from those Niskin bottles with non-standard taps which had large nozzles and a valve that opened by twisting a lever on the top. The nozzles were often too large for the sampling tubes to be fitted, and even if they could be stretched enough to fit on the nozzle, the resulting water stream was full of air bubbles. The aerated nature of the water stream also caused problems for those collecting water from the live sampling CTDs: the bubbles destroyed the cells under study. Thus that particular kind of tap should not be used for future MarProd cruises.

The standard bottle firing depths for full profile CTDs were as follows (wire-out in metres):

> 5 (x 2), 10 (x 2), 25 (x 2), 50 (x 2), 75 (x 2), 100, 125, 150, 200, 300, 400, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, bottom

2.2.3 Processing

The processing of the Sea-Bird CTD data followed the paths established during *Discovery* 258 (Pollard & Hay, 2002). The reader is referred to that cruise report for full details, but a broad outline is given in Appendix A2.

2.2.4 Calibrations

Salinity

The bottle salinity samples are taken with the express purpose of performing final calibration of the two conductivity sensors. The sensors were calibrated by Sea-Bird prior to the cruise and manufacturers specifications indicate that they should not drift within 0.001 in salinity over 6 months. The calibration is based on the assumption that the bottle samples measure the absolute salinity (to within 0.0001); see Section 5 on Salinometry. The procedure is to recalculate the bottle conductivity (using CTD temperature and pressure) and to compare that to the measured CTD conductivity. The bottle conductivity (botcond) and the differences (botc-ctd, botc-ct2) are calculated in makeresid. Remarkably the primary sensor needed no further calibration; examination of the salinity residuals showed a mean difference of 0.0002 (sd = 0.0017, n = 287, Fig. 4). The secondary sensor needed just a small offset in conductivity (-0.001), showing no significant trend with pressure, conductivity or time.

$$cond2_{cal} = -0.001 + cond2_{raw}$$

Salinity was recalculated using pressure and temperature (sensor 2). After calibration the salinity residuals for sensor 2 had a mean difference of -0.0002 (σ = 0.0016, n=287). The residuals are shown in Fig. 5

Oxygen

In each deployment of the CTD rosette oxygen was first measured with an oxygen sensor on the Sea-Bird CTD and second by analysis of samples taken from the bottles. The results from the oxygen titration of the samples were used to calibrate the Sea-Bird sensor. Before calibration the results from the oxygen titration, which measure oxygen in μmol/l, had to be converted into μmol/kg, the WOCE standard. The equation to convert units is the following:

$$O_2(\mu mol/kg) = \frac{O_2(\mu mol/l)}{1 + 0.001\sigma_0}$$

where σ_0 is the density of the oxygen samples at the time at which the samples is fixed. It can be computed using T_{fix}, the temperature of the samples at the time of fixation, and the salinity of the sample (the pressure is set to 0 as the samples are fixed on deck, i.e. at sea level).

Calibrations were carried out on the up-cast sensor readings vs. titration value. It was found necessary to split the casts into three groups, corresponding to the Iceland Shelf (CTD station numbers 14327-14351), the first section of line DD ("Open 1"; stations 14361-14468), and the Greenland Shelf/line B sections ("Open 2"; stations 14470-14672). The first shift happened after a period of downtime due to bad weather. The second shift occurred after the first ice excursion.

Iceland Shelf:	$Botoxyk = -32.149 + 1.1393\ O_2\ (sensor)$	R^2=0.92, σ=2.75 (Fig 6, upper)
Open 1:	$Botoxyk = 21.252 + 0.9365\ O_2\ (sensor)$	R^2=0.91, σ=10.19 (Fig 6, middle)
Open 2:	$Botoxyk = 5.049 + 1.1062\ O_2\ (sensor)$	R^2=0.89, σ=11.16 (Fig 6, lower)

The 'Open 2' calibration residuals appear to become greater with depth, however it was felt that there were insufficient data points and understanding to justify a simple correction for this. After calibration the mean residual is 1.91 with a standard deviation of 27.57. Removing outliers this becomes a residual mean of –0.4245±3.34 (Fig. 7).

Chlorophyll

Samples were drawn from every full depth CTD profile from the top six rosette bottles for chlorophyll a, other pigment studies, and size fractionation. The Sea-Bird calibration was used to convert the fluorometer reading in volts to nominal 'fluor' in mg m^{-3}. The chlorophyll a results were used to further calibrate the Sea-bird fluorometer. The differing physiologies, environments and abundances within the provinces investigated by the cruise require separate calibrations to be applied to distinguishable regions. Casts were split using a station depth pick into on- and off-shelf sets (Table 2).

Calibrations are as follows:

Shelf:	*Chla* = 4.2506 + 0.0652 *fluor*	R^2=0.71, σ=0.33 (Fig 8, upper)
Off shelf:	*Chla* = –0.0022 + 3.9032 *fluor*	R^2=0.92, σ=0.21 (Fig 8, middle)

Caution must be urged if the data are to be used quantitatively. There are areas where the calibration is notably less accurate. Due to an insufficient level of understanding of the effects of phytoplankton physiology on the fluorescence/Chla relationship, data have not been further manipulated.

The shelf calibration shows an increased scatter of residuals in the top 30m (Fig 8, lower). At some stations bloom conditions were encountered, mostly *Phaeocystis*. In these periods of high abundance the fluorescence/Chla relationship further deteriorates, due to interference of other pigment wave-lengths with that of Chla (R. Davidson, pers. comm.).

The off-shelf calibrated residuals show an apparent drift with depth. No correction was made for this, since: i) there is an overlap in residuals at all depth, and ii) many different species were encountered throughout the cruise track. Without fully understanding the variation in species composition and their effect on fluorescence/Chla relationships it would be unwise to further morph data. When outliers are removed, the mean calibrated residual is 0.0247±0.20.

Table 2 Stations for shelf and off-shelf chlorophyll calibrations

Calibration	CTD station number
Shelf (< 800m)	14328-14351
	14470
	14486
	14517
	14523
	14532
	14534
	14553
	14561
	14567
Off-shelf (> 800m)	14361-14458
	14498-14511
	14536
	14544
	14569-14672

Applying the calibrations

Calibrations were applied to the ctd145nnn.1hz and sam14nnn files using the script ctdcal which requires 9 command line arguments, the 3 digit station number and 2 calibration coefficients each for cond sensor 1, cond sensor 2, fluor and oxygen. After ctdcal had been run, ctd2 was re-run to create calibrated ctd14nnn.ctu and ctd14nnn.2db files, and makeresid to calculate the new residual file. The ctd14nnn.24hz files were therefore the only uncalibrated raw files.

2.2.5 CTD sensor performance

Relative Sensor Drift

Examination of the mean differences between the two conductivity-temperature pairs showed no discernible drift over the course of the cruise. Pre-calibration differences for each deep station are shown in Fig. 9.

Pressure

Pressure hysteresis is expected to be small for the Sea-Bird sensor, and no evidence of it was found. On deck pressures were recorded to look for possible offsets in the calibration. The on-deck pressures before and after each cast are shown in Fig. 10. No offset was considered necessary based on these observations.

2.2.6 Frame design problems

As reported from *Discovery* 258, the CTD data quality was apparently affected by the frame design. The quantity of instruments on the frame and the abundance of wide horizontal brackets appeared to have led to the frame dragging a body of water with it through the water column. Thus the data recorded did not truly represent the original structure of the water column. In bad weather when the ship was rolling this was most obvious as peaks (over more than 1 sec) in temperature and salinity which occurred when the ascent or descent rate was momentarily reduced (of order 0.1°C, 0.01psu). The peaks were to higher salinity if the gradient was high to low (in the direction the CTD was moving, up or down), and vice versa. Details of this problem were given in the *Discovery* 258 cruise report. In deep water regions of high gradients and under good weather conditions, when the rolling was minimal, dragging of water with the frame was suspected as the reason for the upcast to be slightly different to the downcast (of order 0.01°C, 0.001 psu, sense depending on gradient).

After the last full station of the current cruise, some time was given to CTD trials during which instruments and their brackets were sequentially removed from the frame to investigate what effects that had. Unfortunately the region for the trials was not ideal since the salinity gradients were minimal, but the base of the mixed layer and the pycnocline between the upper ocean and Labrador Sea Water did provide some gradients. The instrument arrangements were as follows:

CTD 14672	Full profile with usual suite of instruments
CTD 14673	300kHz LADCP removed (the outboard instrument), and extra brackets removed from the 600kHz LADCP (the central instrument).
CTD 14674	Fluorometer and transmissometer and their brackets removed
CTD 14675	As for CTD14674 but with sensors attached to a pole outside the frame.

Results of these tests are given in Fig. 11. They suggest that simply removing some instruments does not greatly improve the data quality; thus the combination of a large number of horizontal brackets as well as several instruments is causing the water drag. We strongly recommend that the bracket arrangements be reconsidered for future cruises, using more vertically-oriented structures.

Penny Holiday, Paula McLeod

2.3 ARIES CTD sampling, processing and calibrations

2.3.1 Introduction

The ARIES platform includes a Sea-Bird 911 CTD and a rosette of 59 bottles of 300ml volume. After each cast the CTD data and ARIES firing files were ftp'd to Unix directories and processed in the Pstar format. The processing path followed the *Discovery* 258 layout with some improvements.

2.3.2 Sampling protocol

The water bottles were fired at the same time as the nets, with some proportion (around half) fired on the downcast, and the rest on the upcast. The water was sampled by means of a tube that opened the bottle valve when clicked onto each tap. Care was taken to rinse the tube, but the small volume water bottles meant that this allowed only for very small samples of water to be taken. Generally the surface two bottles were sampled for chlorophyll, every other downcast bottle for nutrients (100m intervals) and every other upcast bottle for salinity (100m intervals). See *Discovery* 258 cruise report for more discussion of the limitations of sampling in this way.

2.3.3 Processing

Broadly speaking the Pstar processing path followed that of the lowered CTDs:

asam0	Creates the ari14nnn file and fir14nnn file. List ari14nnn to find lat and lon at maximum pressure
ctd0	Creates the ctd14nnn.1hz file
actd1	Edits the original file and calculates some derived variable. Output ctd14nnn.1hz.
actd2	Creates ctd14nnn.ctu and ctd14nnn.2db
actdplots	Creates standard profile and temperature-salinity plots
asam1	Creates the sample file sam14nnn including the CTD data from firing time. Excludes bottles fired on deck for shallow casts.
apassam	Pastes sample data into the sam14nnn file.
amakeresid	Creates residual file (res14nnn).

2.3.4 Calibrations

Salinity

The same procedure for calibrating the conductivity and salinity from the ARIES CTD was used as for the lowered CTD. The calibration was expected to be less good than the lowered CTD for two reasons: i) error in the sampling due to the small bottles and problems with rinsing the bottle and tube; and ii) because the data are recorded as 1 second data without any removal of spikes from the raw 24Hz data. Inspection of the uncalibrated conductivity showed a small offset was required, with no significant relationship with press, conductivity or time. The following calibration was used:

$$cond_{cal} = 0.0059 + cond_{raw}$$

Salinity was recalculated with the calibrated conductivity, and the new residuals (Fig. 12) had the following statistics: mean = -0.0001, σ= 0.0042, n = 179 (of 190 samples, wild points removed).

Fluorescence

Likewise, the small number of chlorophyll samples from the surface layer were used to calibrate the ARIES fluorescence. Since the samples were only taken at the surface, some dummy samples were created at the deepest bottle and chlorophyll-a set to zero. The calibration was not especially good, but the best that could be achieved given the low number of samples. The calibration derived was:

$$fluor_{cal} = 0.04217 + 4.1052 fluor_{raw}$$

The statistics of the post-calibration residuals were as follows: mean = -0.076, σ = 0.1533, n = 30 (of 36 samples, wild points removed).

Applying the calibrations

In a similar way to the lowered CTD, the calibrations were applied in a script actdcal which calibrated the ctd14nnn.1hz and sam14nnn files. Uncalibrates back-up files were saved as ctd14nnn.ucal and sam14nnn.ucal. Following actdcal the scripts actd2 and amakeresid were re-run to create calibrated ctd14nnn.ctu, ctd14nnn.2db and new res14nnn files.

Penny Holliday, Paula McLeod

2.4 Lowered ADCPs

The 300 kHz and 600 kHz LADCPs were used for the first time mounted together (downward looking) on the CTD frame. The 300 kHz workhorse ADCP replaced the 150 kHz LADCP (committed to an alternative cruise) that was used on the previous MarProd cruise (*Discovery* 258).

2.4.1 300 kHz LADCP

The 300 kHz workhorse (Serial no. 1903) is a recent acquirement purchased with JIF equipment funds, and it is believed that this particular unit was used for the first time on this cruise. It was accessed via the RDI workhorse application. A command file was created using the PLAN application (see Appendix A3 for listing of files). The 300 kHz workhorse ADCP was set up as the master. Initial Firing software processing steps indicated that in all casts it was not possible to identify the up and down part to a cast. Examination of the raw data using the RDI software indicated vertical velocities to be alternating between positive and negative values within each bin of a single ensemble. To investigate whether the master/slave set-up was affecting data collection the 300 kHz workhorse was used on its own for Station 14395, with no improvement. A 300 kHz workhorse ADCP was used successfully on *James Clark Ross* cruise 67 (Bacon, 2002) in water tracking mode, since then the Command files have been updated to a lowered mode. From the first station to station 14523 (see Appendix A3.3 for command file 14401m.txt) the LADCPs were operated in lowered mode. It was decided to revert back to the water tracking mode at Station 14441 (see Appendix A3.3 for command file 14441m.txt), however again there was no improvement in the data. A copy of the resulting data files have been sent to both RDI and Brian King (SOC) and further investigation will be required on land to discover whether it is a software problem or instrument malfunction.

The star cable, used to link the instruments to the control PC and battery charger, was damaged when the CTD frame was moved down the deck without removing it. The cable was replaced with the spare and the damaged cable was repaired.

2.4.2 600 kHz LADCP

The 600 kHz (Serial No. 1935) was accessed via the RDI workhorse application. A command file was created using the PLAN application. The 600 kHz workhorse ADCP was set up as the slave. It was configured initially in lowered mode and then in water tracking mode (see Appendix A3.4, files 14401s.txt and 14441s.txt) as a result of data problems with the 300 kHz instrument. Please refer the first MarProd cruise report (*Discovery* 258) for additional details.

The 600 kHz LADCP became the prime instrument for collecting deep current data. Data was initially processed using Firing's method (for processing routes see Appendix A4); however, because currents calculated using this method were deemed questionable the 600 kHz data was additionally processed using an updated version of Visbeck's software (see Section 2.4.3).

2.4.3 LADCP data processing (using Visbeck software)

Martin Visbeck's latest version (v6.0 – March 2002) of LADCP processing software was used in addition to Firing's method as it was known from the previous Marine Productivity cruise that Firing's method did not obtain useful current profiles from the 600khz unit. Older versions of Visbeck's software have not produced useable current profiles (results from Firing's method have usually compared favourably with the shipboard ADCPs).

For the 600kHz unit, the software worked reasonably well producing believable (and comparable) current profiles for most stations. In order to produce comparison plots the plotting 'm' file plotinv.m was modified to include VM-ADCP data on the current profile plot, and renamed plotinv2.m. This used a 'mat' file of on-station ADCP data from the $P_ADCP/STATIONS directory, generated using a script called do_stnav which simply used the pexec program pmatlb to read in the averaged on-station profile, and save it as a 'mat' file. Plotinv2 was then run (manually on the command line within Matlab) once the normal processing run was complete.

A couple of 300 kHz data files were tested with this method. As with Firing's method, however, no sense was made of the data. We believe that the unit is faulty – the plot of vertical velocities against bin-number and time generated by Visbeck's method showed no bin-to-bin consistency in vertical velocity (all should be nearly identical within a single ensemble), and it was not possible from this plot to distinguish the upcast from the downcast.

For the 600 kHz unit, in general, the structure of the current profiles were very similar (within 5 cm/s) to those of the 150 kHz shipboard VM-ADCP, though in some cases there were much larger differences in the top 50 m. On some casts, current magnitudes were in excess of 20 cm/s different from the VM unit. No statistical analyses were carried out during the cruise nor were comparisons with the 75 kHz system made. A full analysis of the results from Visbeck's method needs to be made back at SOC. Correspondence with Martin Visbeck would be essential during this analysis phase. For details of the Visbeck software set-up and use see Appendix A4.

Nick Crisp, Sophie Fielding

3. Lowered EK500 scientific echosounder (LEK)

The lowered EK500 scientific echosounder package (LEK) comprises a drop frame housing the 'Behemoth' (an EK500 echosounder with a logging/control notebook PC), a battery pack, three transducers operating at 38kHz, 120 kHz and 200 kHz, and a Scanmar transmitter. It is deployed on station to collect good resolution higher frequency echosounder data from depths greater than 500m. At the beginning of the cruise, before any data were collected, the equipment was calibrated to allow the correct integrator and target strength gain values to be applied during post-processing (see Appendix A6).

Deployment diary

Following the experience gained on the first MarProd cruise (*Discovery* 258), modifications were made to both the deployment method and the internal construction of the Behemoth. These appear to have been successful and no significant problems were experienced during its use on *Discovery* 262. No data were collected during the first full deployment, at site A5 (*Discovery* station no. 14366), as the logging PC had re-booted after 10 minutes, but the problem was easily resolved by applying silicon grease to the appropriate blanking plug. No usable 120 kHz data were collected at the next site DD13 (14378), but this was due to an incorrect setting in the EK500 echosounder and so was

also easily resolved. The LEK was then successfully deployed at all the full stations completed, from DD11 onwards, where the water depth was greater than 450 m, and also at C7 (14487) on the Greenland Shelf. It was deployed to a variety of depths between 50 m and 500 m, with the majority of deployments to a standard depth of 400 m (Table 3). This depth was chosen after examination of the contemporaneous data from the towed EK500 (TEK) system (see below), in preference to the original standard depth of 450 m, which had been selected on examination of the data from *Discovery* 258. Multiple deployment depths were used when several distinct deep scattering layers of interest were present and time allowed.

Table 3. Sites where LEK data were collected, with *Discovery* station numbers and deployment depths

Site	*Discovery* station no.	Deployment depth(s), metres	Notes
---	Trials	---	Short deployment to approximately 100 m
---	Calibration	Surface	
A5	14366	450	Only logged data for 10 min
DD13	14378	450	No usable 120 kHz data
DD11	14396	450	
DD9	14410	400	Standard deployment depth changed after looking at TEK data
DD7	14417	500, 400, 300, 200	30 min data collected per depth
DD7	14418	100, 200	20 min data collected per depth
DD7	14423	400	
DD5	14432	400	
DD3	14445	400	
DD1	14459	400, 450	20 min data collected per depth
C7	14487	50	Approximately 340 m water depth
C8	14499	400	
C9	14526	200	
C10	14545	400	
B10	14578	400, 450	20 min data collected per depth
B8	14593	400	
B6	14605	400	
B4	14617	250, 450	20 min data collected per depth
B1	14635	400	
I3	14653	400	

Deployment techniques

Following the problems experienced during *Discovery* 258, a new deployment strategy was devised for the LEK. The CTD track way had been extended aft, with a second flat bed trolley located at the far end. The LEK was kept secured on the trolley at all times when not in use. It was deployed from the centre of the track way using a wire run from a 5 tonne Lebus winch, sited further aft on the starboard deck, through the main block on the CTD gantry. The angle of the wire was controlled using a scrolling device situated between the winch and the end of the track way. The mains supply for the Behemoth and the chargers for the battery pack was sited in the water bottle annex, behind the roller door, with the cables run under the door through a foam strip located on top of the sill. The aerial for the remote control PC was located above the main entrance off the starboard deck, and the Behemoth's operation was controlled remotely from the PC located in the main laboratory.

To simplify the deployments, the winch wire was marked at 400 m and 450 m, so that the Scanmar system was not needed for standard deployments. Due to the continuing problems with the Scanmar towfish, the 'bird cage' hydrophone was used as a receiver when the Scanmar system was required. It was shackled to an eye on the bulwark aft of the track way and lowered directly over the side, unattached to the LEK wire. This was reasonably successful until the system developed a short, at site B1. However, the same strategy should be followed on the next cruise due to its simplicity.

The increased stability of the starboard deck compared to the after deck, and the improved control provided by the use of the CTD gantry, means that none of the problems of mechanical damage to the LEK experienced during *Discovery* 258 were repeated. However, it should be noted that four people are required to complete launch and recovery operations safely, as two people are required to assist the frame in and out, whilst another two people are required to drive the winch and gantry respectively. Also, the trolley could be improved by the provision of shallow brackets which would prevent the LEK sliding during deployment and when stowed in rough weather.

Cairistiona Anderson, Ryan Saunders

4. Towed EK500 scientific echosounder (TEK)

The towed EK500 echosounder package (TEK) comprises a towed body containing three transducers, operating at 38, 120 and 200 kHz, directly connected to an EK500 echosounder, which in turn is connected to a desktop logging PC. The system is deployed whenever the ship is underway, to collect survey data in the top 1000 m of the water column, both in conjunction with the various towed nets and on the transects between the stations. The towed body is deployed on the starboard side of the ship, aft of the winch cabin, using a lifting wire, and is towed from a boom deployed forward of the CTD gantry. The boom must be stowed inboard during each CTD deployment, so the towed body must be recovered before each CTD station and re-deployed afterwards. As with the LEK, before any data were collected, the equipment was calibrated to allow the correct integrator and target strength gain values to be applied during post processing (see Appendix A6).

Deployment diary

Few problems were found in the use and deployment of the TEK towed body, and the modified deployment strategy worked well (see below). The TEK was consistently deployed when the ship was steaming, except when bad weather or the presence of pack ice precluded its use. Data were also not collected during the oceanographic transects between sites C9b to C9d, and B10b to B10a, due to the short distances between them. In total, data were collected during 44 tows between station A1 at the start of the cruise and the start of Ocean Station India (OSI) at its end.

Although no problems were found with the quality of the echosounder transducer signals in the towing packages, problems were experienced with the Scanmar hydrophone cable and it developed a break after site D9 (14411). The original towing package was then replaced before the TEK was redeployed (14424). Further problems were experienced later in the cruise and the Scanmar hydrophone was detached at site B4 (before 14618). The only other problem experienced was that when towing at high speed (> 11 knots) during deployment 14552, the lifting wire appeared to lead well aft and under the stern. This caused concern that it had become detached and might foul the propeller. On further examination it was found that the towed body flew closer to the ship with any increase in towing speed, and to counteract this its trim was adjusted before the next deployment. The amount of lifting wire paid out was also immediately shortened by several metres.

Deployment technique

The deployment technique used on *Discovery* 258 was modified for this cruise, with the crane being replaced by an extended Schatt davit to lift and swing the towed body over the side, and the 5 tonne Lebus winch being replaced by an equivalent 2 tonne winch. The new winch was located 2 m inboard of the mooring bollards on the starboard side of the after deck, with the davit 3 m further aft and 1 m closer to the bulwark. The lifting wire (approximately 75 m long) was run from the winch, via a snatch block attached by a chain to the foot of the davit, through a trawl block at the end of the davit and down to the towed body. This arrangement proved very robust, with both deployment and retrieval easily accomplished in all the weather conditions experienced. The only cause for concern

was that the towed body might damage the hydraulics on the outboard side of the winch, but this was overcome by lashing a board in place to protect them. Between deployments, the towed body was still secured to the mooring bollards, which would have presented the same problems as on *Discovery* 258 if similar weather conditions had been experienced. However, no simple solution appears possible and to date any damage sustained has been easily rectified.

Table 4. Sites between which TEK data were collected, with *Discovery* station numbers for each deployment.

Station no.	Start site	End site	Notes
---	Trials	---	No data
14333	A1	---	
14343	A1a	A2	
14353	A2	A3a	
14362	A3a	---	Halted due to weather
14367	A5	(A5)	Halted due to weather
14375	A5	DD13	
14380	DD13	DD12	
14389	DD12	DD11	
14397	DD11	DD10	
14403	DD10	DD9	
14411	DD9	DD7	
14424	DD7	DD5	
14433	DD5	(DD5)	
14442	(Trials)	DD3	
14446	DD3	---	
14460	DD1	---	
14471	C6	C4	
14480	C4	C3	
14484	C3	---	Halted due to pack ice
14488	C7	C8	
14500	C8	ED1	
14510	ED1	ED2	
14513	ED2	C8a	
14516	C8a	---	Halted due to pack ice
14519	C9	(C9)	
14527	C9	C9b	
14538	C9d	C10	
14546	C10	(C10)	
14552	C10	---	Halted due to pack ice
14555	(C11a)	C11	
14562	C11	B10b	
14571	B10a	B10	
14579	B10	B9	
14586	B9	B8	
14594	B8	B6	
14606	B6	B5	
14613	B5	B4	
14618	B4	B3	
14628	B3	B2	
14631	B2	B1	
14636	B1	I1	
14646	I1	I2	
14649	I2	I3	
14654	I3	---	Halted after 6 hr steaming

Cairistiona Anderson, Ryan Saunders

5. Salinometry

A Guildline Autosal salinometer (model 8400A, serial no. 56.747) was installed in the chemistry laboratory (chemlab). It had been serviced by OSI Ltd immediately prior to the cruise. The chemlab, rather than the constant temperature (CT) laboratory, was used because the latter was required for biological incubation experiments at temperatures below the operating range of the salinometers. Not having access to controlled environmental conditions is a problem for salinometry. According to the manual, the 8400A can operate successfully at laboratory temperatures between 4°C below and 2°C above the bath temperature (set at 21°C for this cruise), the preferred temperature being in the middle of this range.

A thermometer was used to measure the temperature of the chemlab, which varied between 18 - 21°C throughout the cruise. Efforts to maintain the chemlab at an appropriate temperature were hampered by temperature fluctuations associated with variations in the state of air conditioning or the number of doors to the outside which were open. Please refer to the first MarProd cruise report (*Discovery* 258) for possible temperature-associated problems.

Even though the salinometer had just been serviced a piece of blue Kimwipe tissue in the third filling tube was found (possibly left over from the recent service). Throughout the cruise this piece of tissue remained above the conductivity coil, and because the conductivity readings remained relatively constant, its presence was regarded as non-influencing.

Good quality salinity measurements were obtained. The average double conductivity ratio of the standard seawater (SSW) was 1.99989 with a standard deviation 0.00002 and 0.000015 for the start and end standard respectively. A difference of 0.00006 corresponds roughly to a change in 0.0001 in salinity, the precision claimed for the instrument. The SSW measurements before and after each crate showed drifts of less than 0.001 in salinity over the two hours or so taken to process each crate. The duplicates of the deepest bottle collected on every CTD cast varied by an average of 0.0002 in salinity. These results confirm that our sampling techniques were adequate.

Salinity values were obtained from the double conductivity ration measurements in the usual way, using an Excel spreadsheet, then transferred to the Unix system in the form of a tab-delimited ASCII file containing the four columns statnum, sampnum, botsal and botsalf – following the simplified method of the first MarProd cruise. Data from the ASCII files were incorporated into the sam files using the Pstar script passam.

Sophie Fielding, Penny Holliday

6. Phytoplankton and pigment studies

6.1 Pigment studies

Chlorophyll, HPLC and phytoplankton sampling focused on the surface layer with the top 7 Niskin bottles from the CTD (usually fired at 150, 100, 75, 50, 25, 10 and 5m) being sampled at 38 stations. Samples were collected in 5 litre carboys which were rinsed in the sample prior to being filled.

For HPLC analysis, water samples, usually 1 litre (except in bloom conditions) and duplicates were filtered through 25 mm Whatman GF/F filters using a specially developed positive pressure filtration unit. The filter papers were then immediately stored in cryovials and stored in a –70ºC freezer for subsequent HPLC analysis at SOC.

For total chlorophyll analysis, two 200 ml aliquots were filtered through 25 mm Whatmann GF/F filters at low pressure. The filters were then placed in amber glass vials containing 10 ml of 90% acetone and immediately stored in the dark at 5ºC for 24 hr to extract the chlorophyll. In total 38 CTD, 25 ARIES and 22 Ocean Sampler stations were analysed during the cruise.

Chlorophyll size fractionation of the CTD samples was also carried out with the surface, chlorophyll maximum and deep (usually 100 m) being analysed. Water was filtered through 20, 10, 5 and 0.2 µm polycarbonate filters at low pressure and the same procedure as for total chlorophyll followed. Unfortunately this was extremely time consuming and was only performed at 26 CTD stations.

Underway samples were usually taken and analysed every 4 hours (except in bloom conditions when this was increased to every hour) in order for calibration of both the FRRF and underway fluorometer. A total of 191 underway samples were analysed for total chlorophyll. In addition, several gut content chlorophyll analyses were also carried out on copepods collected from ARIES trawls.

6.2 Chlorophyll analysis

Samples were warmed to room temperature before the fluorescence was measured using a Turner Designs Fluorometer (TD700). Chlorophyll standard solutions (Sigma) covering the expected chlorophyll range were used for calibration of the fluorometer prior to each set of samples being analysed. Their chlorophyll concentrations were calculated from the absorbance measured at 750, 664, 647 and 630 nm in a Cecil Spectrophotometer, using the equations of Jeffrey & Humphrey 1975 (Biochem. Physiol. Pflanzen, 167, 191-4).

6.3 Phytoplankton studies

Phytoplankton samples for microscope speciation studies at SOC were taken at the surface, at the chlorophyll maximum and at depth (100 m). Two amber glass bottles were filled from each sampling level and preserving agents (Lugol's iodine and buffered formalin) added. In addition, phytoplankton samples down to 150 m were also taken from the Ocean Sampler.

Picoplankton samples were taken from the same bottles as those sampled for HPLC and preserved with filtered formaldehyde. These were then placed in the fridge to fix for 24hr before being transferred to the –70ºC freezer for subsequent on-shore analysis by Flow Cytometry.

Samples from the CTD and also all bottles from the Ocean Sampler were collected and preserved in 10% Lugol's iodine for microzooplankton analysis by David Wilson at the University of Liverpool.

Russell Davidson, David Wilson

7. Nutrients and oxygen

7.1 Nutrients

7.1.1 Methods

Concentrations of the dissolved inorganic nutrients nitrate and nitrite (henceforth referred to as nitrate), orthophosphate, and silicate were measured on unfiltered water samples on a Skalar SanPlus segmented flow autoanalyser. The analytical methods were based on those of Kirkwood (1983), but incorporating some modifications to the phosphate flow rates introduced on the first MarProd cruise, *Discovery* 258 (Pollard & Hay, 2002), to improve peak shape. Phosphate reagent flow rates were 0.16 ml/min and sample flow rate was 1.4 ml/min. Sample and wash times were maintained at 90

and 60 seconds respectively throughout the cruise. Throughout each sample run, wash and drift standards were run every 10-15 standards to enable baseline and drift corrections to be made.

Samples were collected from Niskin bottles on both CTD and ARIES sample collection systems. Additional underway samples were taken every 4 hr from the ship's non-toxic seawater supply. All samples were collected in brand new 40 ml diluvials and immediately refrigerated at 4ºC until analysis. Analysis of all CTD and ARIES samples took place within 12 hr from the time of sampling. Samples for total nitrate analysis were also collected from all CTD stations up to the beginning of transect B. Water was drawn directly from all CTD bottles above 1000 m depth into 60 ml sterile screw top containers and immediately frozen for analysis on return to shore.

Nutrient concentrations were calculated using calibrations curves obtained from dilutions of the same working standards used on *Discovery* 258. The performance of the analyser was monitored throughout the cruise by the gradient of the calibration curves obtained from the in-house standards, analysis of OSI nutrient standards, and measurement of a deep ocean bulk seawater standard. Duplicates of at least three samples per station were also measured to check for consistency throughout the run. After completion of each run, data was processed using Skalar Flow Access v. 1.4 software and saved in both Flow Access runfile and Excel format. The analyser was cleaned daily, and between runs if time permitted, by rinsing with 10% Decon solution, followed by a deionised water rinse. The polythene tubing connecting the reagents to the analyser was cleaned weekly by removing from the reagent bottles and rinsing with Decon/deionised water.

The autoanalyser was positioned in a container laboratory situated on the port side of the fo'c'sle deck, in response to problems observed on *Discovery* cruises 253 and 258 regarding fluctuating temperatures in the deck laboratory. Whilst the temperature in the container lab was certainly more stable, this location had other problems, particularly with carrying samples, waste containers and carboys up and down stairs, doors not opening properly because they were blocked by the bulkhead, and cables coiled up near the container door. Furthermore, during bad weather, access outside the main ship was restricted, limiting the time that could be spent on analyser maintenance during periods when sampling had stopped. These issues need to be considered when assigning a location for the analyser on future cruises.

7.1.2 Operations

During the transit from Southampton to Iceland, the autosampler stopped working, as a result of seawater leaking from the waste well into the underlying circuitry, corroding a number of connections. As the autosampler was not easily repairable, a second sampler was sent out to Iceland for collection before the main part of the cruise.

The phosphate line was problematic throughout the cruise. Early in the cruise (25, 26 April), sample runs were disrupted due to air bubbles entering the photometer cell and causing erratic spikes and poor-quality peaks. A number of steps were taken to rectify this; firstly, the tubing diameter on the de-bubbler at the start of the line was reduced from 0.32 to 0.23 ml/min to increase the flow through the photocell and force the bubbles out through the photocell de-bubbler. Secondly, new reagents were prepared in brand new polycarbonate bottles, in case the interference in the line was due to degassing of contaminated reagents. Finally, all pump tubing on the phosphate line was replaced. This problem reappeared towards the end of the cruise (23, 24 May) and was corrected by replacing the pump tubing for the sample tube (1.4 ml/min) and the waste tube (1.2 ml/min). As these two tubes are of substantially greater diameter than those used for other reagents/samples, it appears that they are subject to greater pressure and wear out more quickly than the other pump tubes. The phosphate reagents were also renewed at this point, as apparent deterioration/contamination of the reagents caused increases of c.100 DU in the baseline when switching from deionised water to reagents. Bearing this in mind, it may be worth considering making smaller quantities of phosphate

reagent at a time, or using a method in which the antimonyl tartrate and ammonium molybdate are introduced separately.

The compressor controlled air injection to the nitrate line stopped introducing bubbles to the line on 4 May. The analyser was disassembled, and it was found that a nut in the peristaltic pump had worked loose, and was thus not providing sufficient pressure to force air into the line. The nut was tightened back to the mark highlighted by the manufacturers, the tube dried out, and the tubing through the compressor was moved up to connections closer to the air injection point, where presumably the pressure would be greatest. Following this operation, a new cadmium column was fitted as the operation allowed air into the column and nitrate peak separation subsequently deteriorated in response.

During a subsequent period of bad weather (6-7 May), some general maintenance of the analyser was carried out, including replacing all pump tubing, rinsing the reagent tubes, and regreasing the pump decks.

7.1.3 Performance of the analyser

Baselines and calibration

Fig. 13 shows a time series of the calibration values calculated from the nutrient standards for each run. The silicate calibration remained relatively constant, whilst both nitrate and phosphate calibrations varied over the course of the cruise. The nitrate calibration gradually increased from runs 1-23, and the large changes at runs 9-10 and 18 can be attributed to modifications of the system, specifically renewing the pump tubing and the tightening of the compressor pump nut and the subsequent changing of the cadmium column. After these changes were made, the nitrate calibration levelled off. The phosphate calibration was variable throughout the cruise, particularly from runs 1-11, but with no consistent trend, although the replacement of the pump tubes and reagents appears to have stabilised it somewhat. Changes in the analyser baseline are also shown (Fig. 14). Nitrate baseline increased gradually throughout the cruise, silicate remained generally stable, as did phosphate after the initial replacement of tubes and reagents after run 11.

The efficiency of the nitrate reduction step in the cadmium column was monitored daily by running a 10 µM nitrite standard and comparing the value obtained with that from the 10 µM nitrate standard 2. Both columns had efficiencies exceeding 100%, indicating the column was over reactive, reducing some of the nitrite present as well as the nitrate. Efficiencies were 102.5% ± 3.2% for column 1, and 104.6 ± 2.1% for the replacement column.

Standards and duplicates

A subsample of the bulk seawater standard collected on *Discovery* 258 was taken on board to determine day to day variations in autoanalyser precision. A second bulk seawater sample was collected from station 14388 at a depth of 1500 m, as a replacement for the first standard. A time series of the values reported for both is shown in Fig. 15, with Table 5 giving a comparison between mean values for bulk seawater from *Discovery* 258 and *Discovery* 262.

Table 5. Mean nutrient values for bulk seawater from *Discovery* 258 and *Discovery* 262, and for OSI low nutrient seawater

Source	Nitrate µmol/l	Phosphate µmol/l	Silicate µmol/l
Discovery 258	8.57 ± 0.33	0.55 ± 0.06	29.18 ± 0.63
Discovery 262	16.36 ± 0.34	1.07 ± 0.03	11.04 ± 0.23
OSI low nutrient seawater	0.04 ± 0.07	0.00 ± 0.02	0.70 ± 0.14

OSI nutrient standard kits were used to make standards of concentration 10 μM nitrate and silicate and 1 μM phosphate in OSI supplied low nutrient seawater (LNSW), which were analysed in the first run of each day as a check on the concentration of the in-house standards. These data were not n examined on board as it was not possible to calibrate the 100 ml volumetric flasks used for making the standards before departing on the cruise. Analyses of the LNSW itself were also carried out on a daily basis as a means of determining the precision of the analyser with respect to low concentration samples. The mean values obtained are given in Table 5, above. Negative values were frequently obtained for LNSW phosphate and may indicate contamination of some batches of the artificial seawater (40 g/l analytical grade NaCl in deionised water) used for preparing standards and as a baseline wash.

At least three duplicate samples were analysed per CTD or ARIES cast, and as many of the under-way samples as was practicable. Both the absolute difference (mean of value 1 – value 2, expressed as a positive number) and true difference (actual mean of value 1 – value 2) were calculated for each run of samples, and are shown in Fig. 16. Absolute differences were consistently lower for all nutrients after the pump tube replacement (run 10). The mean absolute differences for the duration of the entire cruise were nitrate = 1.44%, phosphate = 1.53% and silicate = 1.03%, as compared to 1.7%, 2.1% and 0.86% in *Discovery* 258. The true difference is generally close to zero for most runs after run 10; however, in some runs, absolute and true difference are similar, indicating that uncorrected baseline drift may be a significant source of error. The extent to which this is occurring will be examined more closely on return to SOC.

N:P ratios

Regression analysis of nitrate and phosphate data from all CTD samples, with the exception of a small number of rejected samples, was undertaken to determine the mean ratio of N:P (Fig. 17). The value obtained was N = 15.01 x P, with a correlation coefficient (R^2) of 0.88.

7.2 Dissolved oxygen

Dissolved oxygen (DO) samples were taken from approximately half the Niskin bottles fired at all CTD stations using the semi-automated Winkler titration method outlined in Holley & Hydes (1995; Procedures for the determination of dissolved oxygen in seawater. JRC Internal Document 20). The oxygen samples were the first to be collected from the CTD rosette as soon as was practicable after the CTD had been secured to the deck. Samples were collected using Tygon tubing into pre-calibrated glass DO bottles with ground glass tops, which were rinsed three times before being filled with the sample. Dissolved oxygen was then fixed immediately by addition of 1 ml manganous chloride and 1 ml alkaline iodide from Anachem dispensers, then the bottles sealed and shaken. One replicate sample, usually from the deepest station, was measured for each cast. Over the whole cruise, the difference between the two replicates, expressed as a percentage of the mean value, was 0.59%.

A second DO bottle was rinsed and filled with sample from the same Niskin and the temperature of the water measured using a hand held electronic thermometer. Two thermometers were used on this cruise, both of which were damaged when seawater entered the casing, despite the precaution of wrapping the second thermometer in a polythene bag.

After storage for 1 hour, samples were acidified using 2.5 ml 5M H_2SO_4 and immediately titrated with sodium thiosulphate from a Metrohm DMS 716 titrino unit with amperometric endpoint detection. The normality of the thiosulphate solution was checked daily by determining the quantity of thiosulphate required to titrate triplicate samples of 10 ml of an in-house known concentration (approx 0.01 N) potassium iodate standard (Fig. 18). The oxygen concentration, in μmol/l was then

determined using the equations of Dickson (1994; WOCE Report 68/91). Analyses were generally completed within 6 hr of sampling but on occasion samples were left for 12 hr before analysis.

As with the nutrient analyses, oxygen determinations were carried out in a container lab, as a result of lack of space in the wet chemistry laboratory and the requirement for a relatively stable temperature. However, the safety issues noted above for the nutrient chemistry also applied to the oxygen analyses, in particular transporting of chemicals and samples up and down stairs in even moderately bad weather.

Louise Brown

8. Float deployments

8.1 Martec floats

The test and set-up procedures for the Martec floats are not straightforward, and the instructions in the manual are less than clear. However tests of hydraulics and Argos transmission were apparently successful and mission parameters entered according to those used on *Discovery* 258 (below). The only uncertainties were as follows: i) in the mission settings, the correct use of the reference day was unclear and was set to deployment day; ii) in the hydraulic test, the manual instructs the user to reduce the tank level to the "minimum value", the meaning of which was unclear; and iii) repeated use of the Pump command reduced the tank level, but only to 1230 cm^3. We were unsure as to whether this was correct. However the tank did fill and reduce with the use of the solenoid valve and pump commands so we pressed ahead. We noted that the hydraulics test was performed after the mission parameters were set (due to the requirement for the float to be vertical for the test) and wondered whether the mission settings instruction caused the tank to be full at that time, thus interfering with the test.

The float was deployed in calm weather from the stern with the use of two lines and no difficulties. See Table 6 for deployment times and locations.

The mission parameters were set as follows:

Nombre de cycles (number of cycles)	255
Periodicite des cycles (period of cycles in days)	10
Jour de reference des profiles (reference day, in Jday where 1= Jan 1)	123
Heure de remontee (ascent time)	5
Delai avant mission (delay before mission, in minutes)	90
Periode acquistion en profil de descente (descent sampling period in seconds, where 0 = none)	0
Periode acquisition en derive (drift sampling period in hours)	12
Periode acquisition remontee (ascent sampling period, in seconds)	10
Profondeur derive (drift pressure, in decibars)	1950
Profondeur profile (profile pressure in decibars)	2000
Mode echouage (stranded mode)	0

The Argos Parameters were set as follows

Periode (float transmission period, seconds)	45
Repetition (message re-transmission rate)	1
Duree min (minimum length of transmission period, hr)	6
Nbre PTT (number of PTT numbers assigned to float)	1
ADR (PTT number expressed as hexadecimals)	D6770

Ten days after deployment, colleagues at SOC reported that the float had re-surfaced and reported data as expected.

8.2 APEX floats

All APEX floats were pre-programmed with the mission parameters given below. Each was connected to a PC and tested in the main lab, for correct functioning of the pumps and Argos transmission. All passed the tests satisfactorily. The APEX floats were deployed similarly to the Martec floats, lowered from the stern by the use of two lines while the ship steamed into wind at around 1.5 knots. Colleagues at SOC informed us that all 3 floats reported on surface data the day they were deployed, and re-surfaced the expected 10 days later.

APEX mission parameters:

Repetition rate, seconds	044
Trip interval, hr	011
Interval DOWN	228
Interval UP	012
Park pressure, dbar	2000
Ascend time interval	009
Depth table	26

Table 6 Float deployment times and locations

Float	Argos ID (ascii, hex)	Deployment day/time	CTD station	Latitude	Longitude
Martec PROVOR 35	30109, D6770	123 0800	14401	60°33.06N	32°04.61W
APEX 438	11067, ACEF8	125 1545	14419 (ARIES)	60°43.63N	35°12.97W
APEX 437	11061, ACD7F	127 1649	14438 (ARIES)	61°06.86N	36°51.03W
APEX 440	11071, ACFE7	128 1351	14451 (ARIES)	61°18.55N	38°13.86W

Penny Holliday, Jeff Bicknell

9. Underway data

9.1 Thermosalinograph and SurfMet data

9.1.1 Instruments

Underway surface meteorology and thermosalinograph (TSG) measurements were made by the RVS/UKORS Surfmet system throughout *Discovery* 262. The instruments used, together with their serial numbers and manufacturer, are listed in Table 7 below. There have been some changes to the instruments and calibrations from the first MarProd cruise, *Discovery* 258. The temperature sensors now deal with calibrations internally and submit a true value to the RVS datastream. However there will be an offset in this.

Table 7. Sensors for Surfmet and thermosalinograph.

Instrument	Manufacturer	Serial No.
OTM (temperature): housing	FSI	1374 *
OTM (temperature): remote	FSI	1360 *
Fluorometer	Wetlabs	117
Transmissometer	SeaTech	T1005
Barometric pressure	Vaisala	S361008
Temperature/ humidity	Vaisala	1850014

PAR (DRP-5): port	Didcot/ELE	32057 *
PAR (DRP-5): starboard	Didcot/ELE	32058
TIR (pyranometer): port	Kipp & Zonen	994132
TIR (pyranometer): starboard	Kipp & Zonen	994135 *
OCM (conductivity)	FSI	1376
Sensor collector (QL150)	Vaisala	R381005
Anemometer	Vaisala	P50421
Wind Vane	Vaisala	R07101

* Different to *Discovery* 258

9.1.2 Processing

Processing of the underway data was undertaken at least once daily, more frequently during times of special interest (e.g. ice excursions). The Pstar scripts used are described below.

smtexec0: used to read the data stream Surfmet on the RVS level C in to Pstar format using datapup. The resultant file was smt262**.raw.

smtexec1a: ensured absent Surfmet data values were set to –999. The script also calculated TSG salinity using housing temperature, conductivity and a zero pressure value.

Bestnav positions from abnv2621 were then merged into the output file smt262** and averaged into a 2 minute file, smt262**.av. Spikes in the time stamp acquired by the Surfmet stream resulted in some rather large backwards time diversions. On Jday 144 Jeff Bicknell edited the entire data stream and removed this problem, creating the new master file surfmet1. Although data had been downloaded and processed daily the entire datastream was processed to smt26240* and the old files discarded.

The light sensors have approximately 5% accuracy, the data are recorded to 4 decimal places on the level-B computer system (measured in mV), this results in a resolution of 10 Wm^{-2}, higher than the accuracy of the sensors in bright conditions. Caution is necessary if investigating PAR/TIR during dull periods. The conversion factors were applied to the light sensors:

Photosynthetically available radiation (PAR), port/starboard:

$$Ppar\left(W/m^{-2}\right) = 1.1779x10^{5}\,Ppar_{(raw)}$$

$$Spar\left(W/m^{-2}\right) = 1.5432x10^{5}\,Spar_{(raw)}$$

Total incident radiation (TIR), port/starboard:

$$Ptir\left(W/m^{-2}\right) = 0.9709x10^{5}\,Ptir_{(raw)}$$

$$Stir\left(W/m^{-2}\right) = 0.8403x10^{5}\,Stir_{(raw)}$$

smtexec1b: The 2 min average smt262*.av files are merged with the master Ashtech file to add gyroHdg and a-ghdg variables and calculate true heading.

smtexec2: This script computes vessel speed and subtracts it from relative winds to obtain true wind speed and direction.

The final two processing steps, smtexec1b and semtexec2, were not carried out onboard due to insufficient time for appropriate consideration of previous problems found with wind speed and direction on the Surfmet system.

Calibrations were carried out on the master file, smt26240* and the resulting file named smt262cal*. The TSG/Surfmet system was kept running for as long as possible, this final file smt26241* is not included in plots or the calibrated master file. Fig. 19 shows TSG salinity, temperature, and fluorescence.

The ship's non-toxic supply was terminated at ~18:50 Jday 114 whilst stationed near to Reykjavik harbour for boat transfers and EK500 calibrations. Dubious material was observed floating past the ship and the system temporarily turned off for protection. The stream was restarted ~0800, Jday 115. The underway data stream terminates at 12:30 GMT, Jday 146.

9.1.3 Salinity calibration

Samples for salinity analysis were collected approximately every 4 hours from the non-toxic supply as it left the FRRF. The conductivity of the samples was recalculated using the housing temperature and zero pressure and compared to the TSG conductivities. A linear fit was obtained, the coefficients applied to the TSG conductivity, and salinity recalculated.

$$Cond(cal) = -0.021614 + 0.99761 Cond(raw)$$

The residuals between the bottle salinity and the calibrated TSG salinity were 0.0001 ± 0.0145. Fig. 20 shows variation in surface salinity throughout the cruise.

9.1.4 Chlorophyll, fluorescence and calibration

Samples for chlorophyll analysis were also collected approximately every 4 hours, analysed by Russell Davidson and compared to the underway fluorescence. The different biogeochemical provinces throughout the cruise track have a large impact on the fluorescence/Chl*a* relationship. However it was not possible in the time available to fully investigate the variation and split the dataset appropriately. Therefore a single calibration was applied to the entire raw fluorescence stream. There are obvious divergences from this fit, and if the data is to be used beyond a qualitative sense it will be necessary to further improve the calibration.

$$Chla(\mu g/l) = 0.11866 + 5.1912\, fluor(raw)$$

R^2=0.77, mean=1.29, σ=1.26

The mean residual between the bottle and calibrated fluorescence values is -0.0035±0.604. The results (Fig. 21) show the high degree of variability in chlorophyll abundance throughout the main cruise section.

Concurrent nutrient (nitrate, phosphate, silicate) data were also collected and analysed onboard. The data are available but have not been investigated with respect to chlorophyll variations.

Paula McLeod, Penny Holliday

9.2 Navigation and vessel-mounted ADCPs

9.2.1 Introduction

Two RDI Vessel-Mounted Acoustic Doppler Current Profilers (VM-ADCPs) were operated on *Discovery* 262; the 150kHz VM-ADCP and the 75 kHz Phased Array instrument (Ocean Surveyor) that had been fitted immediately prior to FISHES (*Discovery* 253, May-June 2001). The 150 kHz ADCP is mounted in the hull 1.75 m to port of the keel, 33 m aft of the bow at the waterline and at an approximate depth of 5 m. The 75 kHz ADCP is mounted in a second well in the hull, but 4.15 m forward and 2.5 m to starboard of the 150 kHz well.

Additional background can be found in the report for the first MarProd cruise, *Discovery* 258.

9.2.2 Navigation

The ship's best determined position was calculated by the RVS process 'bestnav'. The main data source for *Discovery* 262 was the Ashtech G12 positioning system. The older GPS Trimble 4000 system was recorded separately. Where gaps occurred in the G12 data, the bestnav process used

other inputs in preference order: GPS Trimble 4000, GPS Ashtech 3D and GPS Glonass (which uses a combination of Russian and US satellite networks). As last resort, if no GPS was available, the Chernikeef electro-magnetic log velocity data and gyro heading were used to dead-reckon the ship's position.

Data were transferred daily from the RVS Level C bestnav stream to the Pstar absolute navigation files, abnv2621. The G12, gps-4000, gps_glos and gyro (gyronmea) data streams were also transferred daily. Processing scripts nav-, gyro-, gps-exec0 etc are summarized in Appendix A5.

9.2.3 Heading

The ships attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. Configuration settings from previous calibrations (Trials cruise, April 2001) were used throughout the cruise. Four antenna, two on the boat deck, two on the bridge top, measured the phase difference between incoming satellite signals from which the ship's heading, pitch and roll were determined. The data were used to calibrate the gyro heading information using the ashexecs listed in Appendix A5.

Ashtech 3D GPS coverage was generally good during this cruise. Dropouts of over 1 minute in the RVS data stream (gps_ash) are listed below.

time gaps:	02 112 23:59:39	to 02 113 00:01:02	(83 s)
(yr, Jday, hr, min, sec)	02 113 10:18:27	to 02 113 10:19:31	(64 s)
	02 117 08:48:09	to 02 117 08:49:12	(63 s)
	02 118 19:29:02	to 02 118 19:30:06	(64 s)
	02 119 08:40:39	to 02 119 08:41:42	(63 s)
	02 120 22:54:20	to 02 121 00:38:24	(104.1 min)
	02 122 08:06:03	to 02 122 08:07:16	(73 s)
	02 123 08:31:55	to 02 123 08:33:01	(66 s)
	02 123 12:20:48	to 02 123 12:22:21	(93 s)
	02 124 05:45:52	to 02 124 05:46:58	(66 s)
	02 126 02:50:13	to 02 126 02:53:15	(3.0 min)
	02 126 19:36:10	to 02 126 19:37:11	(61 s)
	02 127 04:35:15	to 02 127 04:36:20	(65 s)
	02 127 22:41:12	to 02 127 23:42:54	(61.7 min)
	02 128 07:50:23	to 02 128 07:51:25	(62 s)
	02 131 22:13:40	to 02 131 22:15:12	(92 s)
	02 134 22:10:57	to 02 134 23:00:19	(49.4 min)
	02 136 21:48:53	to 02 136 21:57:49	(8.9 min)
	02 137 21:24:07	to 02 137 21:25:10	(63 s)
	02 138 07:16:20	to 02 138 07:17:45	(85 s)
	02 139 07:13:41	to 02 139 09:44:49	(2.5 hr)
	02 140 04:00:07	to 02 140 05:44:50	(104.7 min)
	02 145 06:46:21	to 02 145 08:16:44	(90.4 min)

9.2.4 150 kHz ADCP

Operations

The 150 kHz VM-ADCP itself performed reasonably well during the cruise; however, the controlling PC, both software and hardware, appears to be nearing the end of its useful life. The first problem encountered was first seen during the trials cruise early in 2002 (*Discovery* 259), in that the DAS software no longer logged to the hard disk drive. The solution to this was to enable the Iomega Zip Drive (using the "guest" program) and log to this device. Apparently this was successful as no more errors were reported during *Discovery* cruises 260 and 261, and the instrument operated well during

the passage to Iceland. After sailing from Iceland the PC froze at random intervals, ranging from seconds to hours. This problem was eventually traced to the Zip Drive and the "guest" program which is resident in memory and appears to hog system resources needed by the DAS software. At this point the instrument was set to log to the floppy disk drive. The final problem with this instrument was the PC crashing and refusing to reboot.

The PC was completely stripped down and the motherboard and CPU were swapped with similar items from a working machine. This enabled the PC to boot but problems were encountered when trying to get the serial ports to operate. The PC has an additional two serial ports on an ISA type card and unfortunately the software relating to this card was not on the ship. At this point it was realized that the donor PC that had the malfunctioning motherboard and CPU was operating perfectly, so everything was put back to its original configuration and this appeared to solve the problem with the serial card. The self tests were all run successfully at this point but the DAS program seemed to be unable to 'wake-up' the instrument. It was discovered that if the communication self test was stopped at a point where there were no BIT (built in test) errors then the ADCP would wake up correctly. This error needs to be investigated further.

For future use, this instrument requires up to date software (Windows based, if available) and ideally a new control PC.

Data logging

The 150 kHz RDI ADCP was logged using IBM Data Acquisition Software (DAS) version 2.48 with profiler software 17.20. The instrument was configured to collect 2-minute ensembles using 100 four-metre bins. The pulse length was correspondingly set to 4 m and the blank beyond transmit was also set to 4m.

The two vessel mounted ADCPs were configured to synchronise their pings over the ensemble period, with the 150 as the "master" and the 75 as the "slave". The result is that each ADCP has only ~40 water track pings in the 2 minute period. Spot gyro heading data were fed into the transducer deck unit where they were incorporated into the individual ping profiles to correct the velocities to earth co-ordinates before being reduced to the 2 minute ensemble.

From the level C computer, the 150 kHz ADCP data were transferred once a day to the Pstar data structure and processed using standard processing scripts in Pstar. The PC used for data acquisition proved to be very problematic and the software hung on several occasions. This problem persisted until the Zip drive was removed from the system (we assume that the Zip driver software used too much memory, leaving insufficient for the DAS application). The software refused to record raw data to the C:\ drive and so a floppy disk was used for storage of the raw pingdata files. These were regularly transferred to a Zip disk on another PC.

The processing execs used on the ADCP are adpexec0-4, in Appendix A5. From the previous MarProd cruise, *Discovery* 258, the calibration offset and scaling factors $\phi = 48.82°$ and $A = 1.0000$ were used in adpexec3.

9.2.5 75 kHz ADCP

Operations and data logging

There were no problems encountered with this instrument. Note that it is usually run in slave mode and will not operate unless the 150 kHz system is running.

The RDI Ocean Surveyor 75 kHz Phased Array ADCP was configured to sample ensembles over 120 second intervals with 60 bins of 16m depth, pulse length 16m and a blank beyond transmit of

8m. The instrument is a narrow band phased array ADCP with 76.8 kHz frequency and a 30° beam angle. The logging PC ran the RDI VmDAS v1.2.012 and WinADCP v1.1.0 software. Gyro heading, GPS Ashtech heading, location and time were fed as NMEA messages into the software which was configured to use the Gyro heading for coordinate transformation. The software logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC clock from GPS time. This offset is applied to the data in the processing path before merging with navigation. The rotational offset of 60° of the ADCP installation was accounted for in the RDI software.

The 2 minute ensemble data were written to the PC hard disk in files with a .LTA extension; for example, DD262001_000000.LTA, DD262002_00000.LTA. Sequentially numbered files were created whenever data logging was stopped and re-started. The software will close the file once is reaches 48MB in size (a user-specified size), though during the cruise, new files were opened every 24 hours. The .LTA and .ENX files were transferred to a networked Mac for ftp'ing to the unix directory /data62/surveyor; .ENX files contain the raw ping by ping profiles ready for averaging and were recorded in case they could be useful for looking at deep acoustic backscatter signals.

Calibration values derived during *Discovery* 253 were used for this cruise: $\varphi = 1.3578°$ (sd = 0.078) and A = 1.0050 (sd = 0.0031).

The processing execs surexec0-4 (similar to the adpexecs for the 150 kHz ADCP) are summarized in Appendix A5. For convenience, the ADCP data files and their Pstar equivalents are listed in Table 8 below. Where there is more than one LTA file listed for a particular Pstar daily file, the surexec0 cshell script was run for each LTA file, and these were then appended prior to running surexec1.

9.2.6 Processed data handling

The times for on-station data were extracted from the start and end of CTD files (pinq, times in seconds after 20/010101/000000) and used to datpik the data from the master ADCP files through the use of script do.getstns

9.2.7 On-station profiles

The on-station data tends to be the best quality ADCP data, penetrating deepest into the water column. The on-station data for the CTD stations were selected and averaged into u and v profiles for each ADCP. The data were merged together and the differences in u and v calculated (75 minus 150). As on *Discovery* 258, the results were very encouraging, suggesting the ADCPs agreed within the expected noise level of the instruments.

9.2.8 Depth of penetration

The main potential advantage of the 75 kHz ADCP is that the lower frequency means greater depth penetration, though at reduced vertical resolution (16m bins vs 4m). During *Discovery* 262 the 75kHz ADCP managed to reach 700-750m on station, and 400-500 m steaming. In contrast, typical maximum depths for the 150 kHz are 350-400 m under the same conditions. It is noticeable though that the 75 kHz depth penetration during steaming suffered very readily with the onset of anything other than calm conditions. Since the forward well seems more prone to contamination by bubbles, it was previously suggested (on *Discovery* 253) that the 75 kHz ADCP should be moved to the aft well. However, the underway data during *Discovery* 262 were generally poor as a result of poor weather and high steaming speeds when weather windows occasionally permitted them. The mid-depth spiking in the 75 kHz data at ~330 metres, discussed on *Discovery* 253, was not obvious during *Discovery* 262; however, the small amount of good underway data available may make this observation unreliable.

Table 8 ADCP data files and their Pstar equivalents

Filename	Date range: Jday	hhmmss	Jday	hhmmss	ADCP file name	Note
sur26201	109	072401	109	183603	DD262001_000000.LTA	BT
sur26202	109	183718	110	085928	DD262002_000000.LTA	BT
sur26203	110	090110	110	194913	DD262003_000000.LTA	BT
sur26204	110	195051	111	095656	DD262004_000000.LTA	
sur26205	111	095826	113	094835	DD262005_000000.LTA	
sur26206	113	095007	114	130612	DD262006_000000.LTA	
sur26207	115	075430	115	081032	DD262007_000000.LTA	
sur26208	115	081417	115	083018	DD262008_000000.LTA	BT
sur26209	115	083116	115	135518	DD262009_000000.LTA	BT
sur26210	115	141640	115	183709	DD262010_000000.LTA	BT
sur26211	115	183801	117	194815	DD262011_000000.LTA	BT
sur26212	117	203716	119	035726	DD262012_000000.LTA	
sur26213	119	040355	121	045014	DD262013_000000.LTA	
sur26214	121	045049	122	035854	DD262014_000000.LTA	
sur26215	122	040013	123	035824	DD262015_000000.LTA	
sur26216	123	040044	123	112048	DD262016_000000.LTA	
sur26217	124	040017	125	040223	DD262017_000000.LTA	
sur26218	125	040351	126	035952	DD262018_000000.LTA	
					DD262019_000000.LTA	
					DD262020_000000.LTA	
sur26219	126	040114	127	040522	DD262021_000000.LTA	BT
sur26220	127	040729	128	035936	DD262022_000000.LTA	BT
sur26221	128	040040	129	035847	DD262023_000000.LTA	BT
sur26222	129	040017	130	035814	DD262024_000000.LTA	BT
					DD262025_000000.LTA	BT
					DD262026_000000.LTA	BT
					DD262027_000000.LTA	BT
					DD262028_000000.LTA	BT
					DD262029_000000.LTA	BT
sur26223	130	040012	131	035819	DD262030_000000.LTA	
sur26224	131	040015	131	141019	DD262031_000000.LTA	
					DD262032_000000.LTA	
sur26225	132	040153	133	041441	DD262033_000000.LTA	BT
					DD262035_000000.LTA	
sur26226	133	041539	134	035910	DD262036_000000.LTA	
					DD262037_000000.LTA	
					DD262038_000000.LTA	
sur26227	134	040132	135	035810	DD262039_000000.LTA	
					DD262040_000000.LTA	
					DD262041_000000.LTA	
sur26228	135	040017	136	035824	DD262042_000000.LTA	
sur26229	136	040015	137	040421	DD262043_000000.LTA	
sur26230	137	040506	138	041113	DD262044_000000.LTA	
sur26231	138	041156	139	035401	DD262045_000000.LTA	
sur26232	139	035446	140	035502	DD262046_000000.LTA	
					DD262047_000000.LTA	
					DD262051_000000.LTA	
					DD262052_000000.LTA	
					DD262053_000000.LTA	
sur26233	140	035608	141	035613	DD262054_000000.LTA	
sur26234	141	035701	142	035506	DD262055_000000.LTA	
sur26235	142	035541	143	035348	DD262056_000000.LTA	
sur26236	143	035435	144	051640	DD262057_000000.LTA	
sur26237	144	051707	145	045713	DD262058_000000.LTA	

BT indicates the existence of bottom track files

Nick Crisp

9.3 Fast Repetition Rate Fluorometer (FRRF)

The FRRF is an active fluorescence instrument, which can be used to make rapid, non-destructive, and *in situ* measurements of phytoplankton physiology (Kolber ZS, Prasil O & Falkowski PG, 1998; Biochemica et Biophysica Acta 1367, 88-106). Such data can then be used in biophysical models to estimate the rate of phytoplankton photosynthesis at scales comparable to those of physical variability within the environment (Kolber ZS & Falkowski PG, 1993; Limnol & Oceanogr 38, 1646-65).

The instrument was kept permanently attached to the ship's non-toxic supply in order to provide a continuous record of changes in near surface phytoplankton physiology and provide a comparison and means of data quality verification with the other instruments deployed *in situ*. Power was provided to the instrument using a standard Chelsea Instrument deck box.

Table 9 Data files with start/stop times for underway FRRF

File	Start J day	hh:mm:ss	Stop Jday	hh:mm:ss	Gain	Sleep time	Comments
mp2_01.bin	108	21:59:33	109	~17:50	Auto	60	
mp2_02.bin	109	18:03:07	110	~16:11	Auto	60	
mp2_03.bin	110	16:36:30	111	~18:50	Auto	60	
mp2_04.bin	111	19:14:01	112	??	Auto	20	
mp2_05.bin	112	19:16:36	113	??	Auto	20	Small file?
mp2_06.bin	113	19:03:32	114	18:47:34	Auto	20	
Non-toxic supply terminated, 18:50 J114, restarted am J115							
mp2_07.bin	115	08:59:00	116	09:36:00	Auto	20	Clock reset to GMT at start of file
mp2_08.bin	116	09:54:01	116	21:14:50	Auto	20	
mp2_09.bin	116	21:21:25	117	20:23:06	Auto	20	
mp2_10.bin	117	20:41:20 20:40:15	119	00:09	Auto	20	GMT Flashtime
mp2_11.bin	119	00:48:??	119	??	Auto	20	
mp2_12.bin	119	23:56:04	122	18:54:44	Auto	20	
mp2_13.bin	122	19:41:21	125	21:39:45	Auto	20	Clock reset to GMT at start of file
mp2_14.bin	125	22:29:22	128	12:55	Auto	20	
mp2_15.bin	128	14:21:33	130	16:21:18	Auto	20	
mp2_16.bin	130	17:11:17	131	23:55:04	Auto	10	*Phaeocystis* bloom… no gunk found inside
mp2_17.bin	132	00:36	133	~00:40	Auto	10	
mp2_18.bin	133	~01:14	134	~00:56	Auto	10	Problems downloading
mp2_19.bin	134	04:17	135	01:18	Auto	10	
mp2_20.bin	135	02:06	136	01:24	Auto	10	
mp2_21.bin	136	01:55	137	01:13	Auto	10	
mp2_22.bin	137	01:53	138	02:23	Auto	10	
mp2_23.bin	138	02:48	139	04:05	Auto	10	
mp2_24.bin	139	04:30	139	?	Auto	10	Power cut~ 10:30
mp2_bnk.bin	139	13:00	139	13:10	Auto	10	Chamber filled with GF/F filtered seawater
mp2_25.bin	139	13:09	141	03:17	Auto	10	
mp2_26.bin	141	03:57	142	08:07	Auto	10	
mp2_27.bin	142	08:46	144	02:00	Auto	10	Communications problem
mp2_28.bin	144	03:42	145	15:42	Auto	10	Communications problem
mp2_29.bin	145	17:07	146	14:22	Auto	10	Final termination

Data were recorded internally and downloaded at various intervals to a PC laptop. A total of 30 files were collected. The sleep time between flashes was varied to optimise spatial resolution. A smaller sleep time provides higher resolution of the surface population. Surface samples of Chl*a* and nutrients (nitrate, silicate and phosphate) were collected at a minimum of 4 hour interval throughout

the cruise, which will provide data necessary for collaboration and information on the chemical environment. The absence of size fractionated data and productivity measurements will severely limit the application of this continuous data set.

The optical chamber was cleaned every 2 days using a soft white tissue and a small finger. The tubes were acid washed on Jday 125 (5 May). On Jday 139 (9 May) the dark chamber of the FRRF was filled with filtered seawater (through GF/F paper) to determine the background optical properties of the seawater

Paula McLeod, Sophie Fielding, Mark Moore

9.4 Precision echosounder (PES) data

Two precision echosounders were used together to record bottom depth throughout *Discovery* 262. The main instrument was the 10/12 kHz Simrad EA500 hydrographic echosounder mounted on a fish on the port side, and the secondary instrument was the hull mounted 12 kHz transducer. Data from both instruments were recorded as separate Level A/B data streams (ea500d1 for the hull and ea500d2 for the fish) but were merged, edited and corrected for the speed of sound in the Level C "prodep" data stream. Preference was given to the PES fish data in prodep, except during ARIES tows when the fish mounted transducer was switched to 10 kHz for tracking the movement of ARIES. For most of the cruise data were of reasonable quality.

The Pstar processing steps are as follows:

Simexec0 transferred data from the RVS ea500d2 and prodep stream to Pstar. Output: sim262## and sim262##.cal. Manual editing of this file was not required contrary to *Discovery* 258.

Simexec1 merged sim262##.cal with navigation and vessel speed data from the bestnav file and averaged to 5 minute intervals. Output: sim262##.nav and sim262##.5min.

Simexec2 append daily files to master files (dep2621nav and dep2621.5min) and remove on-station data using criteria of speeds less than 2 knots (dep2621.track).

Sophie Fielding, Jeff Bicknell, Nick Crisp, Penny Holliday

9.5 Surfmet System

The system operated well. The data contain occasional spikes that upset the ship's logging system and the monitoring PC auto-scaling. This was not a major problem but needs some investigation.

The transmissometer needed regular cleaning while carrying out work in shelf areas that had large amounts of organic matter in the water. The matter collects on the lens close to the outflow pipe. The unit may benefit from repositioning. TE to look into this when time allows.

It was noted that the wind direction data is much more stable and useable now that zero degrees has been moved to aft.

Dave Teare, Terry Edwards, Jon Short

9.6 EA500 System

The Simrad echo sounder was operated throughout in 12 kHz mode. No operational problems were noted. The fairing requires several new clips; attention will be given to this matter on the return passage if time and weather allow.

The Scanmar fish once again suffered physical damage although it was only minor. This appears to have been caused by the cable not being long enough to allow the fish to operate at its correct depth. This meant that the fish had to be removed from the water when not in use. A buffer was constructed from an old tyre and fixed to the nose of the fish to prevent serious damage. It did not seem to effect the flying characteristics of the fish. Since the cable was of a smaller diameter, liners had to be fabricated for the fairing hanger clamps.

Dave Teare, Terry Edwards, Jon Short

10. FRS towed zooplankton net systems

During the cruise we collected plankton and associated specimen samples with the ARIES, Dual Methot (DM) and Ocean Sampler (OS) systems, as outlined in Table 10. The ARIES and OS systems also collected water samples, all or subsets of these have been analysed or preserved. For ARIES, the water samples were used for nutrient analyses, and for selected salinity and chlorophyll sampling to allow CTD and fluorometer calibration. OS water samples will be analysed for chlorophyll, phytoplankton and ciliates. OPC, Sea-Bird 911 CTD, fluorometer and transmissometer data from ARIES, and OPC data from the OS system, were taken to describe plankton size and environmental conditions, and for integrating with standard CTD cast information.

All previous technical problems with the plankton net systems and their deployment have been resolved, and there was a high rate of data and sample return. The success of the sampling programme was due in no small measure to the assistance and efforts of the UKORS technical staff, notably Terry Edwards and Jon Short working with Jim Hunter on the gear deployment and recovery effort, aided by the winch operators and by the deck crew and ship's officers. The methods of deployment were as previously reported for *Discovery* 258, as were the procedures for sample handling, specimen sorting, and selection and sample preservation.

Samples of plankton specimens for biochemical analyses have been taken from the ARIES and Dual Methot nets. See Appendix A8 for additional details. A considerable amount of video footage has been taken of the operations on board and of specimens seen through a video camera mounted on a microscope. This video material will add to that obtained on the winter cruise and continue the documentation of the research programme.

Table 10 Deployments of FRS net systems

Haul no. (*Discovery* station no)	Site	Plankton gear type	No of samples	Max sampler depth	Seabed depth	Pup net hauls	Associated sampling (see key below)
14334	A1	OS	3	97	103	2	W(3),O
14337	A1	DM	2	89	103		L,G,I
14338	A1	ARIES	20	92	105	2	W(20),O,C,F,T,L,G,I
14344	A1a	ARIES	27	127	138	2	W(27),O,C,F,T L,G,I
14347	A2	OS	3	154	159	2	W(3),O
14354	A2	DM	2	143	149		L,G,I
14355	A2	ARIES	18	129	151	2	W(18),O,C,F,T L,G,I
14358	A2a	ARIES	24	240	257	2	W(24),O,C,F,T L,G,I
14368	A5/B1	OS	7	414	769	2	W(7),O
14371	A5/B1	DM	2	695	807		L,G,I
14372	A5/B1	ARIES	32	761	881	2	W(32),O,C,F,T L,G,I
14381	DD13	OS	7	404	913	2	W(7),O
14384	DD13	DM	1	721	1209		L,G,I
14385	DD13	ARIES	35	861	1220	2	W(35),O,C,F,T L,G,I
14390	DD11	OS	7	407	1855	2	W(7),O
14398	DD11	DM	0	804	1830		L,G,I only - foul haul

14399	DD11	ARIES	64	1577	1802	2	W(60),O,C,F,T,L,G,I
14404	DD9	OS	6	406	2557	2	W(7),O
14412	DD9	DM	1	799	2290		L,G,I
14413	DD9	ARIES	82	1973	2461	2	W(60),O,C,F,T,L,G,I
14419	DD7	ARIES	56	2142	3032	2	W(60),O,C,F,T,L,G,I
14425	DD7	DM	2	812	3016		L,G,I
14426	DD7	OS	7	406	3027	2	W(7),O
14434	DD5	OS	7	409	2889	2	W(7),O
14437	DD5	DM	2	807	2900		L,G,I
14438	DD5	ARIES	62	2365	2940	2	W(60),O,C,F,T,L,G,I
14447	DD3	OS	7	402	2684	2	W(7),O
14450	DD3	DM	2	806	2671		L,G,I
14451	DD3	ARIES	55	2352	2707	2	W(60),O,C,F,T,L,G,I
14461	DD1	OS	7	402	1965	2	W(7),O
14464	DD1	DM	2	802	2020		L,G,I
14465	DD1	ARIES	82	1958	2142	2	W(60),O,C,F,T,L,G,I
14472	C6	OS	5	259	259	2	W(7),O
14475	C6	DM	2	250	272		L,G,I
14476	C6	ARIES	17	221	264	2	W(16),O,C,F,T,L,G,I
14489	C7	OS	7	301	634	2	W(7),O,L,G,I
14492	C7	DM	2	704	856		L,G,I
14493	C7	ARIES	35	802	998	2	W(35),O,C,F,T,L,G,I
14501	C8	OS	7	409	2029	2	W(7),O
14504	C8	DM	2	793	2055		L,G,I
14505	C8	ARIES	72	1703	2053	2	W(60),O,C,F,T,L,G,I
14520	C9	OS	73	410	460	2	W(7),O
14528	C9	DM	2	448	465		L,G,I
14529	C9	ARIES	37	436	457	2	W(60),O,C,F,T,L,G,I
14539	C10	OS	7	415	1534	2	W(7),O
14547	C10	DM	2	794	1552		L,G,I
14548	C10	ARIES	63	1508	1594	2	W(60),O,C,F,T,L,G,I
14556	C11	OS	6	309	300	2	W(6),O
14563	C11	DM	2	255	269		L,G,I
14564	C11	ARIES	18	249	268	2	W(18),O,C,F,T,L,G,I
14572	B10	OS	7	404	1873	2	W(7),O
14580	B10	DM	2	798	1892		L,G,I
14581	B10	ARIES	77	1866	2015	2	W(60),O,C,F,T,L,G,I
14587	B8	OS	7	520	2672	2	W(7),O
14595	B8	DM	2	596	2647		L,G,I
14596	B8	ARIES	69	2486	2616	2	W(60),O,C,F,T,L,G,I
14599	B6	OS	7	543	2320	2	W(7),O
14607	B6	DM	2	794	2360		L,G,I
14608	B6	ARIES	69	1948	2233	2	W(60),O,C,F,T,L,G,I
14619	B4	OS	7	412	1722	2	W(7),O
14622	B4	DM	2	797	1868		L,G,I
14623	B4	ARIES	41	976	1836	2	W(41),O,C,F,T,L,G,I
14637	B1	OS	7	409	814	2	W(7),O
14640	B1	DM	2	650	767		L,G,I
14641	B1	ARIES	30	721	845	2	W(30),O,C,F,T,L,G,I
14655	I3	OS	7	409	1878	2	W(7),O
14658	I3	DM	2	796	1882		L,G,I
14659	I3	ARIES	74	1816	1954	2	W(60),O,C,F,T,L,G,I
14665	OSI	OS	7	405	2072	2	W(7),O
14668	OSI	DM	2	797	2003		L,G,I
14669	OSI	ARIES	73	1768	1868	2	W(60),O,C,F,T,L,G,I

Key W = Water bottles, O = Optical Plankton Counts, C = Seabird CTD, F = Fluorometer, T= Transmissometer, Plus specimens extracted for L = Lipids/hormones, G = Genetics, I = Isotope ratio studies

Complete results for the plankton sampling await onshore work on the samples. However, some data are available from the Optical Plankton Counters deployed on ARIES and Ocean samplers, and from observations during sample collection. The OPC results are particularly compromised by the presence of other particles in the water which register in the same size categories as *Calanus*. Therefore these preliminary pictures need to be viewed cautiously, pending further detailed analyses and comparisons with the net catches. Fig. 22 shows the distribution for estimated standing stocks of *Calanus* sized particles in the upper 200m for stages C4-C5 and for adults, at the majority of tow positions on this cruise. Throughout the cruise there was no evidence for any significant numbers of diapause *Calanus* remaining at depth. Indeed the majority of the stocks were found in the very surface waters, most abundant at depths of less than 100m (often <20m).

At the initial stations in the south of Iceland *Calanus* were abundant with many juvenile stages present. This suggests that the spring production had begun some weeks previously, and was well underway in this region. Given the circulation in this area it is likely that much of the Iceland shelf *Calanus* populations originate in the waters east of Iceland. As the ship moved to the more southerly stations along the Reykjanes Ridge, *Calanus* became less abundant than on the Iceland shelf. Relatively low densities of *Calanus* were also found in the deep Irminger Basin, mainly in surface waters. At these deep water stations, there were few or no early copepodite stages, few eggs and nauplii, and the population consisted mostly of females with some C5 and males. These data are consistent with the relatively low *Calanus* concentrations found on the winter survey (when compared with historical data from the north eastern Atlantic and Norwegian Sea). The evidence suggests that these *Calanus* populations in the Irminger basin have not yet, or have only just, begun their main period of spring production.

On the Greenland shelf edge we encountered pack-ice and large blooms of *Phaeocystis,* with diatoms also present. Offshore from the shelf there was much less phytoplankton, higher numbers of female *Calanus*, and almost no early stages. As close as we were able to get onto the shelf, in the phytoplankton bloom, there were quite high numbers of eggs and nauplii but very low numbers of adult *Calanus* and few copepodite juveniles. The animals within the bloom seemed to be active and feeding, judging from their gut colour. There is obviously some limitation to the transport onto the shelf of post-diapause *Calanus*, newly awakened from overwintering at depth. Eddies and other onshore/offshore exchange processes would seem important to plankton dynamics and productivity in this region, and merit closer study in future. Working back across the Irminger Basin confirmed our earlier impressions of the *Calanus* populations over the deep waters. We then extended sampling activities to the Iceland Basin, including the site of Ocean weather Station India to allow historical comparisons. Preliminary, non-quantitative data from the two Iceland Basin stations indicated a more advanced state in the production cycle for *Calanus*, particularly east of the Rekjanes Ridge. Higher species diversity was also noted with a slightly different range of species present.

In addition to the MarProd target zooplankton (*Calanus* spp and the euphausiids, *Thysanoessa longi-caudata* and *Meganyctiphanes norvegica)*, organisms found in the ARIES and Dual Methot nets at relatively high abundance included: the euphausiid *Thysanoessa inermis* on the Greenland shelf; the predatory copepod *Euchaeta* and the predatory chaetognaths *Sagitta maxima* and *Eukrohnia hamata*; several exotic medusae; the amphipod *Parathemisto* spp. and a range of others, including some beautiful deepwater shrimps and fishes. Examination of the net catches indicated that on some occasions the naupliar and calyptopis stages of euphausiids *M. norvegica* and *T. longicudata* were relatively abundant in the upper layers of the water column, whilst few furcilia stages were observed. We have collected specimens of some of the abundant non-target species for later biochemical analyses, particularly for lipid, CHN and isotope ratio studies. It is hoped that analyses of these will help to elucidate the food chain dynamics in the MarProd study area.

Steve Hay

11. Process studies

11.1 Recruitment and mortality of *Calanus* eggs and nauplii

At the main ocean areas covered by *Discovery* 262, we investigated egg production, hatching success and high-resolution 14 day development time values of *Calanus* (egg to NIV/NV), under a variety of food quality/quantity situations. Table 11 identifies the sites where live *Calanus* experiments were completed and where total, 95μm filtered chlorophyll a, and microplankton samples were taken. At several of the sites listed, replicate and a time series of nauplii development time experiments were performed using the same population of *Calanus* 'bulk females'. The samples collected for the high-resolution *Calanus* nauplii development times, microplankton and chlorophyll a analysis will be processed back in the laboratory.

Table 11 also gives the average female egg and faecal pellet production per day and hatching success data from our experiments at each station sampled, combined with the chlorophyll a measurements taken from the chlorophyll maximum by Davidson and Wilson.

Table 11. Sites and stations sampled for live work and food quantity/quality measurements. N/D indicates that data were not compiled on board.

Site	Station N°	Date	Average incubation temp °C	Eggs $f^{-1}.d^{-1}$.	Faecal pellets $f^{-1}.d^{-1}$.	Percentage egg hatch 96 hours	Chla (μg/l)
A1	14327	25/04/02	7.0	1.57	0.90	N/D	0.91
A2	14350	26/04/02	7.0	18.06	2.65	29	0.68
B1	14632	21/05/02	6.4	4.48	6.86	N/D	2.02
B4	14614	20/05/02	6.4	6.09	2.07	N/D	0.70
B6	14602	19/05/02	6.3	8.14	4.19	N/D	0.69
B8	14590	18/05/02	6.3	27.06	2.72	54	0.57
B10	14575	17/05/02	6.4	22.33	4.61	24	0.79
C8	14496	13/05/02	6.4	2.46	6.07	56	1.03
C9	14525	15/05/02	6.0	1.05	33.92	N/D	8.92
C10	14542	15/05/02	6.6	23.89	3.32	35	1.05
C11	14559	16/05/02	6.7	16.43	13.61	54	2.85
DD1	14457	09/05/02	6.2	4.67	10.21	61	0.85
DD5	14430	07/05/02	6.3	28.63	1.77	36	0.59
DD9	14407	03/05/02	7.1	9.06	1.59	71	0.42
DD11	14393	02/05/02	7.4	13.20	1.93	53	0.55
DD13	14376	01/05/02	6.9	17.49	0.70	67	0.35
I3	14652	22/05/02	6.6	1.57	4.49	N/D	N/D
OSI	14662	24/05/02	N/D	N/D	N/D	N/D	N/D

Experimental methodologies are not given in this report, but were generally similar to pre-cruise designs (albeit with modifications and compromises because of the biological responses experienced at many sites, and because of constraints arising from the needs of other MarProd cruise projects).

The low fecundity of *Calanus* females at several stations (Table 11) sometimes made it difficult to obtain sufficient female numbers to provide adequate eggs for the high resolution 14 day nauplii development experiments. When the 'bulk females' laid insufficient eggs, modifications were made to the sampling protocol and experimental duration to ensure that the best possible data were obtained.

The large spatial coverage of the cruise, combined with the low chlorophyll a values at many of the oceanic stations, gave additional problems regarding the timing for experimental protocols. For

example the nauplii development time experiments that had been running for more than five days needed a suitable food source because they were beginning to moult into NIII, which is their first feeding stage and considered to suffer a very high amount of mortality.

Within the initial couple of weeks of the summer MarProd cruise (*Discovery* 264), we would like to locate an area of high primary production and abundance of *Calanus* – in order to carry out 'food saturated' nauplii development time experiments, to be run from egg to past the NIII feeding stages.

Adrian Bunker, Kathryn Cook, Tania Smith

11.2 *Oithona* and *Calanus* nauplii studies

11.2.1 *Oithona* and *Calanus* nauplii standing stock

The *Oithona* and *Calanus* early stages (eggs and nauplii) standing stock were measured at the full sites and some intermediate sites using a 63 μm mesh size bongo net (44 samples) and a single 200 μm mesh sized net (22 samples) towed vertically from 120 m depth. The samples were immediately concentrated by sieving through an appropriate filter and fixed in 4% buffered formaldehyde. The sites sampled are given in Table 12. A preliminary description of the organisms found at each site is given in Table 13.

The *Oithona* and *Calanus* early stages in the samples will be enumerated, sized and staged in the laboratory. Abundance data for *Oithona* will be converted to biomass by means of the length-weight regression reported by Sabatini & Kiorboe (1994, J. Plank. Res. 16: 1329-51).

It is interesting to observe that in all oceanic and off-shelf sites in the Irminger Sea, adult *Calanus*, eggs, and early non-feeding nauplii stages were relatively abundant. However, at open water Greenland shelf sites, adult or late stage *Calanus* were very scarce – and, although not in high abundance, there was a higher proportion of late nauplii (both in relation to the number of adults and to the number of early nauplii). The 'in ice' shelf sites were similarly deficient in adults relative to the numbers of eggs and nauplii. The stations in the Iceland Basin, sampled near the end of the cruise, showed a different picture again, with late nauplii, and copepodites up to CIV and CV dominating the *Calanus* population; adults were scarce. This suggests that (at the time of sampling) recruitment had not yet reached the copepodite stage in the Irminger Sea, whereas in the Iceland Basin this year's cohort was well advanced. This interpretation would be consistent with the differences in temperature and food concentration between the two basins.

Oithona was found at all sites, but was especially abundant off the Greenland shelf and along the Reykjanes ridge. Other species regularly found included: *Euchaeta* sp (copepodites); *Calanus hyperboreus*; *Pseudocalanus/Paracalanus sp, Microsetella* sp. and *Metridia* sp.

11.2.2 *Oithona* egg production

Egg production experiments were conducted at a number of stations depending on the availability of copepods. A total of 11 experiments were conducted. Females were gently sampled using a 63 μm net with a small mouth diameter and a large cod end, with the catch diluted in a large bucket with water from the non-toxic supply. After collection 10-20 females were incubated individually in tissue culture flasks of 70 ml volume on plankton wheel at the average *in situ* temperatures of 7 °C (± 0.5). The water used for the incubation was collected with a CTD at the chlorophyll maximum. The egg production was monitored daily over a 2 - 4 day period. At the end of incubations the egg produced were counted, sized and the female cephalothorax length measured for conversion to biomass by means of the length-weight regression (Sabatini & Kiorboe, 1994).

Table 12 Sites where net samples were taken for egg production, feeding and growth experiments, and for lipid and hormone analyses

Site	Net 63 µm	Net 200µm	Nauplii feeding	*Oithona* feeding	*Oithona* egg production	*Oithona* growth	Lipids and hormones
A1	√	–	√	√	–	–	√
A1a	–	–	–	–	–	–	√
A2	√	√	√	√	–	–	√
A5	√	√	–	–	√	√	√
DD13	√	√	√	√	–	–	√
DD11	√	√	√	√	–	–	√
DD9	√	√	√	√	–	–	√
DD7	√	√	√	√	√	–	√
DD5	√	√	√	√	√	–	√
DD3	√	√	√	√	√	–	√
DD1	√	√	√	√	–	–	√
DD0	√	√	√	√	–	–	–
C3	√	√	–	–	–	–	–
C6	√	√	√	√	–	–	–
C7	√	√	√	√	–	–	–
C8a	√	√	√	√	–	–	√
C9	√	–	–	–	–	–	–
C9b	√	–	–	–	√	–	–
C9c	√	–	–	–	–	–	–
C9d	√	–	√	√	–	–	–
C10	√	–	–	–	√	√	–
C11	√	√	√	√	–	–	–
C11a	√	–	–	–	–	–	–
ED1	√	–	√	√	–	–	–
ED2	√	–	–	–	–	–	–
B11(C11)	√	√	√	√	–	–	–
B10b	√	–	–	–	–	–	–
B10a	√?	–	–	–	–	–	–
B10	√	√	√	√	–	–	–
B9	√	–	–	–	√	–	–
B8	√	√	√	√	–	–	–
B6	√	√	√	√	√	–	√
B5	√?	–	–	–	√	–	–
B4	√	√	√	√	–	–	–
B3	√	–	–	–	√	–	–
B2	√	–	–	–	–	–	–
B1	√	√	√	√	–	–	–
I1	√	–	–	–	–	–	–
I2	√	–	√	√	–	–	–
I3	√	√	√	√	√	–	√
OSI	√	√	–	–	–	–	√

Table 13 Preliminary biological description of sites, with emphasis on abundances of *Calanus* and *Oithona*

A1-A2	Sparse phytoplankton including diatoms (*Skeletonema*, *Chaetocerous sp.* and small centric diatoms *Coscinodiscus sp.*?). *Oithona* generally not very abundant with *Oithona sp.* (provisionally identified as *O. plumifera*) apparently outnumbering *O. similis*.
A5-B1	Clear water with no observed phytoplankton found in previous coastal stations. Many *Calanus* eggs and nauplii and some *Oithona*. Loose *Oithona* egg sacs present.
DD13	Clear water. Low Chla with fluorescence signal similar throughout the water column.
DD11	Clear water. Numerous adult *Calanus*. Very few *Oithona sp.* mainly copepodites.
DD9	Clear water. Some diatoms mainly *Chaetocerous sp.* Numerous adult *Calanus*. Large number of *Calanus* eggs and copepodites of *Oithona sp*. Numbers of *O. similis* seem to have increased.
DD7	Clear water. Numerous adult *Calanus*. *O.similis* numerous and apparently outnumbering other *Oithona sp.*
DD5.	Phytoplankton has increased. Increased number of centric diatoms and larger amount of faecal pellets. Numerous adult of *Calanus* and *O. similis*
DD1	Ice zone, frontal area. High phytoplankton mainly *Phaeocystis*. Adult or late stage *Calanus* scarce. Numerous *Calanus* eggs and nauplii. All stages of *O. similis* are well represented. Several female *Oithona* bearing egg sacs.
C6 (close to Green-land shelf)	Fresh water layer on the sea surface (melting ice). Very large amount of *Phaeocystis*. Some *Calanus* eggs and nauplii but no adult *Calanus*. *Oithona* well represented in all stages. Numerous *Oithona* with egg sacs (better weather and food conditions).
C7	Large amount of *Phaeocystis*. Numerous *Calanus* copepodites and few adults. *Oithona* well represented at all stages.
C8a	Numerous Calanus eggs but not late nauplii. *Oithona* well represented at all stages particularly copepodites and nauplii.
ED1 (inside eddy)	Very rich sample in term of late stages *Calanus* nauplii and all stages of *O. similis*.
C9a (within ice)	*Phaeocystis sp.* very abundant but also numerous chain diatoms *Thalassiosira sp.* Many late stage *Calanus* nauplii. *Oithona* well represented at all stages but mainly copepodites and nauplii. Numerous *Oithona* with egg sacs.
C9	Phytoplankton as in C9a. No *Calanus* adults but some copepodites and nauplii. Overall very scarce *Oithona*
C9b	Phytoplankton as in C9a. No adult calanus, some *Calanus* nauplii and scarce *O. similis*. Some *Pseudocalanus sp.*, appendicularians.
C9c	Less *Phaeocystis* than at previous stations. Many *Calanus* eggs and nauplii but very few adults. Numerous *Oithona* all stages.
C11a (within ice)	*Phaeocystis sp.* and very numerous *Thalassiosira sp.* No *Calanus* adults but numerous early nauplii. *Oithona* stages well represented with several females bearing egg sacs
B10a.	No *Phaeocystis sp,*. Many diatoms (mainly *Rhyzosolenia* sp.) and some dinoflagellates (mainly *Ceratium tripos*)
B9	Clear water. No *Phaeocystis* some diatoms, *Rhyzosolenia sp.*.Large number of naked ciliates. Many *Calanus* eggs/nauplii and several adult *Calanus*. All *Oithona* stages all well represented.
B6	Numerous diatoms *Chaetocerous sp*, *Rhyzosolenia sp.* and very abundant naked ciliates. Adult *Calanus*, numerous eggs and early nauplii. Many *Oithona* of all stages.
B5	Similar to B6.
B3	Higher Chla. Many diatoms majority *Rhyzosolenia sp.* Some chain diatoms increasing in number from previous stations mainly *Skeletonema*-like and some *Chaetocerous sp.* Very few adult Calanus, mostly copepodites CI-CIII but many *Calanus* eggs. Few *Oithona* females mainly copepodites and nauplii.

B1	Green-brown sample. Very large number of diatoms, mostly *Rhyzosolenia sp.* but *Skeletonema*-like concentration has greatly increased. Very large number of radiolarians and very numerous naked ciliates. Low number of adult *Calanus* but numerous nauplii. *Oithona* mainly as copepodite and nauplii.
I1-I3	Similar to B1 (possibly more phytoplankton as sample was difficult to sieve). Copepods seemed generally less abundant.
I4	Very high diatom concentration, majority of *Rhyzosolenia sp.* but *Skeletonema*-like also very numerous. Different planktonic community richer species abundance. Low *Calanus* and additional *Oithona* species *O.nana*-like. *Pleuromamma abdominalis*.

The egg production obtained from the incubation experiment will be compared with egg production estimates obtained with the egg-ratio method, counting the egg sacs and the number of females extracted from the preserved samples. The *Oithona* population-specific egg production (SEP, day^{-1}) will be calculated from the egg to female ratio (E/F), temperature dependent hatching rate (HR, d^{-1}) and carbon content of the eggs and female from:

$$SEP = (E/F)*HR*(\text{egg carbon} / \text{female carbon})$$

Two long-term egg production experiments were also conducted to estimate the inter-clutch duration (i.e. the time elapsing between the production of two successive egg sacs) in oceanic (i.e. low food) and coastal (i.e. high food) conditions. Twenty *Oithona sp.* were incubated as described above and their egg production monitored under low power microscope every day or every 12 hours during one spawning cycle (~ 2 weeks). The water in the culture flask was changed every two days.

11.2.3 *Oithona* growth rate experiment

During the course of the cruise it was observed that the egg contained in the egg sacs still hatched even if they became detached from the adult females. This property was used to run growth rate experiments of *Oithona* at the different feeding conditions encountered in the Irminger Basin. Between 80 to 100 egg sacs were collected from the 63 μm plankton catch with a large mouth pipette and gently transferred in filtered seawater to avoid contamination with the naupliar stages of *Calanus* and *Oithona* present in the catch. After that the egg sacs were distributed in 50 ml plastic screw-cups vials (5-6 sacs vial-1) filled with seawater collected from an oceanic site (A5) and from a coastal Greenland site (C10). The vials were covered with plastic film to avoid air bubbles and incubating on a plankton wheel for approximately 2 weeks. Every day one vial from both the oceanic and coastal series was stopped by fixing with formaldehyde to 4% final concentration.

11.2.4 Feeding experiments

Feeding experiments were carried out at a number of sites depending on weather conditions and animals' availability. The copepods for the feeding experiments were collected with a 63 μm net as described in the previous section. Three to four replicates with 10-15 *Oithona sp.* females or 15-30 *Calanus* nauplii and three controls without animals were incubated in 200 ml amber bottles on a plankton wheel for 24 hours in water collected from the chlorophyll maximum. At the end of the incubation the bottles were fixed with Lugol's iodine to 1 % final concentration.

We have carried out 24 experiments (see Table 12) on the feeding behaviour of *Oithona* sp. and nauplii of *Calanus* with about 300 samples to be counted back in the onshore laboratory. In general we found five different food conditions: i) the first couple of days in the Icelandic shelf with an average food concentration, mainly diatoms; ii) oceanic conditions south of Iceland and across the Irminger sea (transects DD and B); iii) slightly higher food concentration, mixture of diatoms and *Phaeocystis* off the Greenland shelf; iv) a very high concentration of *Phaeocystis* in the Greenland shelf, in the northern area of the Greenland shelf *Phaeocystis* was mixed with diatoms (*Thalasiossira*

probably); v) high diatom (*Rhizosolenia, Skeletonema, Nitzschia*) concentrations in the sites in the Iceland basin (I1 to I4). It will be interesting to compare these different feeding conditions, although we have relatively few experiments in high diatom concentrations (only 3 out of 24).

Claudia Castellani, Xabier Irigoien

11.3 Environmental, nutritional and hormonal regulation of diapause in *Calanus finmarchicus*

Female and copepodite stages of *C. finmarchicus* were collected by vertical net hauls (120 m depth) from 14 stations (see Table 12). All samples have been frozen for future biochemical analyses.

David Pond

11.4 Nutritional regulation of egg production of *Calanus finmarchicus*

Animals were collected with a 1 m ring-net (250 μm) from 50 m to the surface (vertical hauls) at various stations on and off the continental shelf. The contents of the cod-end was poured into a 20 litre bucket of sea water (from non-toxic supply), and female *Calanus finmarchicus* were then sorted into groups of ten under the dissection microscope, using a pipette. In addition to experimental animals, replicate samples of females were frozen for later carbon/nitrogen (C/N) and lipid analyses (initial animals).

Water was collected daily from the chlorophyll maximum in a 110 litre polyethylene bin (in bad weather, sea water from the non-toxic supply was used). This was gently 'inverse filtered' (90μm mesh) and siphoned into 14 Duran bottles (2200 ml each) via silicone tubing. Care was taken when moving the water to minimize disturbance (splashing and swilling damages ciliates and other micro-organisms). Each bottle was filled a little at a time to ensure maximum homogeneity between bottles. Ten females were placed into six of the experimental bottles (bottles #1-6), with four bottles (#6-10) serving as control bottles to assess the impact of microzooplankton grazing during the experimental period. All bottles were placed on a water cooled plankton wheel (1 rev min $^{-1}$) and maintained at ambient temperature and light regime.

At the start of each day, a single (200 ml) sample of the 90 μm 'inverse filtered' water (taken from bottle #14) was preserved in Lugols iodine (10% v/v) for later microzoo- and phytoplankton identification and enumeration (initial plankton). In addition, six 1000 ml samples were taken (from bottles #11-13) for C/N and lipid analysis (initial C/N and lipid). Each sample was vaccuum filtered through GF/F filters. Filters for lipid analysis were stored in 2 ml vials with solvent (chloroform:methanol 2:1 v/v). All samples were stored at –70º.

After 24 hours, females were removed via a dip-tube and placed into bottles with fresh seawater (as above) and placed on the plankton wheel for a further 24 hours. Initial plankton, lipid and C/N samples were taken every day from the fresh water. The water in each bottle from the previous day was initially 'immersion filtered' (53 μm) to remove eggs and faecal pellets, and then sampled (100 ml) for microzoo- and phytoplankton (final plankton). Two 1000 ml samples were filtered (GF/F) for C/N and lipid analysis (final C/N and lipid). Control replicates (bottles 6-10) were sampled in exactly the same format. Each day, the eggs were pooled and then split for C/N and lipid analyses (stored on GF/F filters and in 1 ml vials respectively).

This procedure continued for 5 days. At the end of the experimental period, half the animals were stored in 1 ml vials with solvent for lipid analysis and frozen at -70º, with the remainder frozen in tin capsules for later C/N analysis (final animals). Four complete experimental trials were completed during the cruise, and also a fifth using 1 litre bottles (with a grazer density of 5 animals per litre). To date, the only conclusion to be drawn from these experiments is that egg production is highly

variable, ranging from 0 to 193 eggs per bottle (containing 10 females). In general, average egg production was <10 female^{-1} day^{-1}.

To examine how the food environment changes over 24 hours in response to grazing, a time-series experiment was completed. In total, 12 bottles were used. Two replicates for individual treatments (6, 12 and 24 hr, 10 females per bottle) and two controls for each time period were used. Experimental conditions were exactly the same as above. Initial and final plankton samples (200 ml) were taken from each bottle and preserved in Lugol's iodine (10% v/v).

A further 24 hour experiment to examine the effect of grazer-density on the food environment was run, using densities of 5, 10 and 20 female *C. finmarchicus*. Three replicates for the controls (no grazers) and for each density were used. Again, all experimental conditions remained the same as above. A 200 ml plankton sample was taken at the beginning and end from each bottle and preserved using Lugol's iodine (10% v/v). In addition, three replicate plankton samples (100 ml each) were taken and preserved with Lugol's iodine at 1, 2 and 10% (total of 9 samples). These will serve to illustrate and compare the differences in preservation quality of the microzooplankton.

Dan Mayor

11.5 Microplankton CN and stable isotope studies

11.5.1 Total CN samples

At every 'full' station 1-2 litre water samples were taken from eight different Niskin bottles on the CTD (Table 14). For each sample, between 0.5- 2 litres of water were filtered through a 25mm pre-ashed GF/C filter (volume filtered depended on the amount of particulate material in the sample). Filters were placed in 1.5ml microcentrifuge tubes and then frozen (-20^{o}C). Samples will be dried and analysed for total particulate CN and stable isotope ratio (^{13}C:^{12}C and ^{15}N:^{14}N) back in the Swansea laboratory using a Europa 20:20.

Table 14 Sites and depths from which water samples were taken for total CN analysis and the volumes filtered, and the sites at which filter fractionated CN samples were collected.

Total CN:								
Sites sampled	A1, A2, A5/B1, DD13, DD11, DD9, DD1, C6, C7, C8, C9, C10, C11/B11, B10, B8, B6, B4, B1/A5, I3, I4							
Sample depth (m)	5	25	50	75	100	150	300	600
Volume filtered (l)	0.5 - 1	0.5 - 1	1	1	1-2	1-2	2	2
Filter fractionated CN:								
Sites sampled	A1, A5/B1, DD13, DD9, DD5, DD1, C8, C10, C11/B11, B8, B4, B1/A5, I3, I4							

11.5.2 Filter fractionated CN samples

At selected stations (Table 14), 10 litre water samples were collected from 5m and the deep chlorophyll maximum (DCM, variable depth) for filter fractionation. The 5m water samples were collected from the 'physics' CTD whereas the DCM samples were collected from the 'live sampling' CTD. Particulate material in the water samples was separated into the following size fraction: 200-95, 95-45, 45-20, 20-10, and <10 μm using appropriate sized sieves/mesh (200, 95, 45, 20, 10 μm). Water was sieved using a siphoning technique and utmost care was taken to avoid damaging the organisms and prevent contamination by dust from laboratory air. Particles collected on the sieves were washed off using filtered seawater and then filtered through a 25mm pre-ashed GF/C filter.

Filters were then placed in a microcentrifuge tube and frozen (-20^{o}C). Samples will be dried and analysed for total particulate CN and stable isotope ratio (^{13}C:^{12}C and ^{15}N:^{14}N) back in the Swansea laboratory using a Europa 20:20.

Emily Roberts

11.6 Collection of planktonic foraminifera for genotyping

Planktonic foraminifera for genotyping were collected on the outward passage leg from Southampton to Reykjavik, during the period of early spring bloom development in the region south of Iceland. This region had previously been sampled during the summer in August-September 1997. Due to adverse weather conditions in the open Atlantic, *Discovery* had to take the more sheltered route north through the Irish Sea. Planktonic foraminifera do not live in the shallow waters over the shelf which delayed main sampling until the shelf edge at 55^{o}58.5'N 7^{o}41.6'W. To sample, the non-toxic water supply was pumped into a wet lab sink and discharged through a 85 μm plankton screen. Individual foraminifera were picked and identified using a stereo microscope and filmed for morphometric analysis using a digital video camera mounted on the microscope. Specimens were then individually crushed into a lysis buffer for later molecular analysis.

Interestingly, a variety of benthic foraminiferal species were collected on the plankton screen during the passage through the Irish Sea, presumably brought to the surface by the rough weather. Plankton was collected along the cruise track from the shelf edge to 62^{o}20.8'N 22^{o}27.9'W, south of Reykjavik. A total of 228 planktonic foraminiferal specimens from eight sampling stations (representing collection periods of one hour) was processed. Morphospecies ranged from a relatively transitional assemblage at the first station to a more subpolar assemblage at the last station. Specimens were mostly small and immature as it was early in the seasonal cycle and mature specimens tend to live deeper in the water column. However, past experience has shown that sampling immature specimens of the target morphospecies at the surface does provide a profile of the genotypes present throughout the water column.

Kate Darling

12. Mechanical systems

12.1 ARIES, Ocean Sampler and Dual Methot net deployments

The 20t winch system was used with the trawl wire to carry out deployments of ARIES, Ocean Sampler and Dual Methot nets. A problem was encountered with the back tension of the trawl wire storage drum during one deployment (recovery) of ARIES. The back tension became unstable causing the drum to accelerate/decelerate frequently and the compensator ram to rapidly move in and out. To prevent possible mechanical damage the package was recovered at a reduced haul speed.

The electronic back tension control module (TCS) unit in the storage drum control panel was replaced with a spare and a control relay was replaced in the 20t Cobra winch control panel. The winch system operated correctly for the remainder of the deployments.

The cable haulers had been fitted with new wheels prior to the cruise commencing. Midway through the cruise the hauler wheels were found to be slipping causing a problem when paying out or hauling in wire on deck and when the deployed package was close to the surface with little outboard tension on the wire. It was found the groove in the wheels had worn slightly deeper allowing the upper and lower wheels to contact each other, and hence not grip the wire fully. The problem was rectified by the wheel diameter being skimmed down and the power pack pressures adjusted.

A 2t deck-mounted winch fitted inside the hanger allowed ARIES and the Ocean Sampler to be winched along the deck and stored in the hanger space. The units were pulled out onto the aft deck

using the main warp. Two plastic tubes were bolted to the deck to form guides to prevent sideways movement of the equipment on the aft deck. This system worked satisfactorily throughout the cruise.

The aft gantry operated without problems for the duration of the cruise.

12.2 CTD deployment

The 10t winch CTD storage drum system failed during the cruise. Hydraulic pump No1 was drawing excessive current when an attempt was made to start it prior to a deployment. This was initially thought to be caused by a defective pump which was replaced with a new unit. It was subsequently found a winding on the electric motor had shorted to earth, causing excessive current demand.

The motor was replaced along with the motor start contactor. The new pump was balanced against No 2 main pump to ensure the load equal load sharing between them during a test deployment of the CTD. It was found after adjustment the pumps still drew slightly high current and suffered from some vibration during veering. It was decided to proceed with further deployments whilst monitoring the operation of the pumps.

The starboard gantry operated without problems for all deployments.

12.3 Plankton net deployment

Several types of net were deployed using the starboard gantry mounted winch fitted with Kevlar rope. The winch and gantry operated satisfactorily for the duration of the cruise.

12. 4 TEK and LEK deployments

The TEK was deployed over the starboard side using a bulwark mounted davit just forward of the starboard gantry and a 5t deck winch with a modified Schatt davit (height increased) mounted on the aft deck. A wire ran from the winch through a snatch block and through the davit sheave.

For the first TEK deployment it was found the position of the snatch block forward of the davit made it impossible to rotate the davit over the side of the ship under load as it was pulling against the wire. The snatch block was relocated at the base of the davit so that the side load from the wire was reduced to a minimum. Further deployments were carried out without problems.

The LEK was deployed over the starboard gantry hanging block using a 5t deck mounted winch and 10t GPC level wind system (operated manually). The LEK was mounted on a railway system to allow it to be moved under the gantry as required. The deployment system worked satisfactorily although when fitted with its calibration frame it was necessary to manhandle the LEK off centre on its trolley in order to manoeuver it along the deck to its position under the gantry.

12.5 Non-toxic water system and Millipore water purifier

The non-toxic system was run on one pump throughout the cruise without problems. A water leak in the chemistry laboratory which appeared towards the end of the cruise was thought to be coming from the non-toxic pipe work concealed behind the bulkhead panelling. This was to be investigated after the cruise.

An RO12 Plus/MilliQ 185 system was set up in the constant temperature lab. Apart from two pre-filter changes the system required no maintenance during the cruise.

12.6 Radios

The radios gave problems during the cruise with batteries lasting only a short period. The batteries are to be replaced.

12.7 Workshop

The workshop floor became flooded during the cruise when water built up in the drainage gulley in the hanger space outside the workshop door. The access flap below the door was resealed with silicone rubber and a new clamp bolt fitted which prevented a reoccurrence.

Richard Phipps, Rob McLachlan and Alan Sherring

13. Shipboard computing systems

13.1 Data logging

Data was logged using the ISG ABC System. The Level A system collects data from individual pieces of scientific equipment. The Level B collects each of the Level A SMP messages and writes them to a disk, monitoring the frequency of the messages and warns the operator when messages fail to appear. The Level C system takes these messages and parses them into data streams.

The following list shows the data collected on *Discovery* 262:

Chernikeef Log	LOG_CHF	MkII Level A
Ships Gyro	GYRONMEA	MkII Level A
Trimble GPS	GPS_4000	MkII Level A
Ashtec ADU	GPS_ASH	MkII Level A
Ashtec Glonass GPS	GPS_GLOS	MkII Level A
Echo-Sounder	EA500D1	MkII Level A
	EA500D2	MkII Level A
G12	GPS_G12	MkII Level A
Winch	WINCH	SEG PC
ADCP	Level C direct log	ADCP PC
Surface Logger	SURFMET	SIG PC

On three occasions the ADCP locked-up. The first was after 7 days of running, the second after a further 4 days (caused by a time shift of 9 months from the ADCP computer) and the third after a further 4 hours (again with a 9-month time shift). After this the ADCP failed to restart for 24 hours.

On Julian day 139 there was a total power failure for 25 minutes. The resetting of the Level As and the restarting of the logged data mean there is a gap in the data from 1057 until 1210; this was due to the GPS Trimble needing to be reset, as the battery backup failed to safeguard the settings.

13.2 Email system, GroupWise and Arcserve

The email system worked well whilst the ship was at sea, with a large number of cruise participants using their own PCs for email. However, the first two weekends saw problems at the base end: files stuck in the incoming queue on the first occasion, and then a failure of the SOC server to the outside world.

A large number of files from varying sources had to be decoded using win code throughout the cruise. On some occasions this failed and the relevant data were requested again.

The Novell system for Groupwise and Arcserve was rebooted once during the trip after a period of very slow response

13.3 Data processing; data and hardware problems

The GDD Pstar team did the majority of physics data processing. The Level C plotting suite was used extensively to produce annotated plotting sheets showing the GEBCO depth contours. True

wind data was produced using 'windcalc'. Depths corrected for Carter's area were produced from an edited file of EA500D2 data.

Raw depth data existing on ea500d2 data stream was interrupted by the use of the pinger on the CTD. This data has been integrated into a single stream and corrected for Carter's Area into the 'prodep' stream.

With the time jump of 9 months on the ADCP, the original files adcp1 and adcp2 were modified into file adcp2a and corrected using mod time to allow them to be processed with Pstar.

The only hardware problem was the battery backup of the GPS Trimble failing during the power failure.

13.4 Dartcom satellite system

The Dartcom system was used extensively at close proximity to the ice to give exact ice edge positions and to show eddy current flows. In this we were fortunate to only have limited cloud cover, thus allowing good ice edge definition (eg Fig 3). The Dartcom system was also used daily with the ship's met data to predict coming weather.

Jeff Bicknell

14. Satellite imagery: SeaWiFS and AVHRR

The timing of *Discovery* 262 was planned to investigate interactions between herbivorous zooplankton (primarily *C finmarchicus*) and phytoplankton during the development of the spring bloom, based on previous analyses of 8-day composites of SeaWiFS chlorophyll-a data for the north east Atlantic. Although fully cloud-free days were uncommon during the cruise itself, sufficient coverage was obtained to follow the basin-wide development of primary production and identify 'bloom' areas. Chlorophyll-a concentrations were calculated using the OC4 algorithm (Reilly 2000); for additional background see www.npm.ac.uk/rsdas/ and www.npm.ac.uk/rsdas/projects/marprod/. Both composite and single-day images were processed at Plymouth, georeferenced and provided in near real-time to *Discovery*. In addition, AVHRR (Advanced Very High Resolution Radiometer) imagery was used to estimate both sea surface temperature, SST, and sea-ice cover, with emphasis on the eastern Greenland shelf.

Table 15. Main chlorophyll-a and SST imagery for Irminger Sea and Iceland Basin, mid-April to end of May 2002

Chlorophyll-a	SST
single days:	single days:
29 April (J day 119)	18 April (J day 108)
7 May (127)	14 May (134)
9 May (129)	16 May (136)
11 May (131)	
14 May (134)	
16 May (136)	
weekly composites:	weekly composites:
16-22 April (106 - 112)	18-24 April (108 - 114)
7-13 May (127 - 133)	

Table 15 (above) identifies the images providing reasonably good coverage for chlorophyll-a and SST. For the period 18 April to13 June 2002, an animation was subsequently developed, showing the dynamic features in the sea-ice edge for the area of particular interest to *Discovery* 262. Fig 23 gives an example of shelf-edge SST data off eastern Greenland, showing detailed circulation structures; it also gives two images for sea-ice cover (10 May and 16 May), illustrating the rapid changes occurring then. Monthly chlorophyll-a composites for April and May 2002 show that the highest concentrations were located off the Iceland coast and Greenland ice-edge (Fig. 24).

Future users of the SST images should note that their colour scales may have been adjusted between images, to enhance the visual representation of the structures present.

Peter Miller, Kate Evans-Jones, Tim Smyth, Tom Coupland, Steve Groom
(Plymouth Marine Laboratory)

APPENDICES

A1. Diary and station information

A1.1 *Discovery* 262 diary

Thursday 18 April 2002 (Julian day 108)

Sailed 1030 GMT (all times GMT) from Empress dock on a sunny, but cold and breezy day. The pilot was dropped pilot at 1200. Conditions in the North Atlantic were such that it was decided to take the Irish Sea route to avoid the worst of a low pressure system moving in from the west.

Friday 19 April (109)

Good weather continued. Problems were encountered with the electronics of the auto analyser. It required a new board to be sent out (to Reykjavik) from SOC.

Saturday 20 April (110)

The sky clouded over, the temperature dropped and wind increased.

0830-1030 Trials were conducted with the towed EK500 off Islay. The deployment arrangement was been altered from *Discovery* 258 to avoid the use of the crane, which has been replaced by a Schatt davit. Problems were encountered with swinging the Schatt davit out with the strain of the wire. Reconfiguring the pulleys made it easier. It was decided to move the davit forward when in Reykjavik. Steamed to deeper for trials of CTD, lowered EK500 and nets.

Sunday 21 April (111)

Ship's time changed to GMT. There was heavy swell and a misty beginning to the day, with rain and sleet, but it brightened up in the afternoon.

0700-1115 Trials were conducted with the CTD, lowered EK500, 30 litre bottle and vertical net, all off the starboard side. There were no real problems. The extended railway made the swapping between the CTD and LEK much easier than on *Discovery* 258. The utility of using the 30 litre bottle was suspect and we resorted to using the CTD rosette to collect water.

The swell increased through the morning. The Master decided to suspend operations and after securing equipment we steamed again towards Reykjavik. The trials of ARIES, DM and OS were postponed until the weather improved.

One of the scientists, Fiona Ware, suffered an injury to her ribs during lunch, caused by a large roll of the ship. She appeared not to be too hurt at the time, but her situation was monitored.

Monday 22 April (112)

The weather was much the same as the day before. The speed was reduced to 9 kts with the ship tacking to reduce the ship's movement as much as possible.

A spare electronics board and sampler for the auto analyser had been located, to be flown out to Reykjavik and transferred to the ship.

Tuesday 23 April (113)

Steaming again at reduced speed.

Wednesday 24 April (114)

We arrived at Reykjavik at 0800, and hove to rendezvous with the pilot tug *Jotunn*. Darling and Steele disembarked together with Fiona Ware to check on her injury. Scientists Fielding, Davis and Crisp embarked together with Brierley and Armstrong for the EK500 calibrations and a BBC crew, Carwardine and Fudge, to undertake interviews for the BBC Radio 4 Nature programme.

Interviews for the radio programme were conducted with Richards, Hay, Pond, Bunker and Brierley (the programme was subsequently broadcast on 20 May).

The ship moved to a safe anchorage north of Engey Island. The LEK was deployed and calibration commenced. The calibration of the LEK was moderately successful. Work stopped at 1715 for boat transfer of Radio 4 people. Fiona Ware returned from the hospital. She had suffered a couple of cracked ribs, was still sore, but was deemed fit to continue.

Calibration continued with the TEK until the third boat transfer at 0500 the following morning.

Thursday 25 April (115)

The anchor was recovered at 0430. The TEK was deployed and we steamed to the first site A1. On arrival the PES and Scanmar fish were deployed. Trials were conducted of the OS. The sampler flew 'moderately' well, and will be adjusted for its next deployment. Returning to on-station a series of deployments were started, which are referred to as a 'full site'.

It was been decided to use the CTD rosette sampler to collect the required amount of water for live samples (order 100 litre) rather than the 30 litre bottle, which proved to be too cumbersome and inefficient. As a consequence the order of on-station deployments was swapped to live samples (using CTD bottles), CTD, live samples (nets). The OS was deployed after the on-station work, for this particular site for convenience. Both the DM and ARIES systems were deployed and recovered without difficulty. (See the Table 16 for a full listing of which instruments were deployed, in what order, and timings at each of the subsequent sites) Initial analysis of the net samples showed *Calanus finmarchicus* to be present, but in relatively small numbers. Satellite images show little chlorophyll in the water, so perhaps this is not surprising.

An intermediate site, A1a, was scheduled (CTD and ARIES) but the ship was brought to a halt at sunset (around 2200) because of the potential risk of snagging fishing gear.

Friday 26 April (116)

Progress resumed at first light (0500), but we were then 15 nm off station. CTD and ARIES deployments were performed without hitch but we arrived at A2, the second full site, approximately one and half hours late. Sampling was finished at 2000. Since there was no longer considered to be any fishing gear risks, a sampling plan was devised to make use of the extra time, which included a CTD section into the Iceland Basin.

Saturday 27 April (117)

An ARIES tow began at 0003 at A2a, finishing at 0108. There was only time left for one CTD cast at A3a, which was still on the Icelandic Shelf. After completion of the site the TEK was deployed. However the weather worsened considerably with strong winds from the north and a heavy swell. The TEK was recovered and operations were halted. The wind increased to force 9 with driving snow. Site A3 was abandoned and we steamed south.

Sunday 28 April (118)

The bad conditions continued, although the sky did brighten at intervals. We were still unable to work. Site A4 was abandoned as were plans for additional CTD stations. We steamed south to A5.

Monday 29 April (119)

Conditions improved throughout the day. At 1700 the OK was given for a trial CTD. The CTD was deployed at 1734 for live sampling. The recovery of the CTD was difficult because of the swell and it was decided to cease further work. By 2000 the conditions had improved still further and a full profile CTD was undertaken, followed by 6 live net hauls and the LEK. There were considerably fewer plankton in the water than on the shelf.

Tuesday 30 April (120)

Still at A5, the OS, DM and ARIES systems were deployed, finishing at 0800. We began to steam to the next site, the first of line B**.** However, the wind freshened from the north and the swell increased making passage

to the west difficult. The day was spent making slow progress mostly in a northward direction with very little westward movement.

At 2000, after considering the weather forecasts, it was decided to abandon further attempts at progressing along line B and head south to start line DD [referred to as D during the cruise] at DD13. This line had the highest priority, being a repeat of the transect completed on *Discovery* 258 [then referred to as line G]. The projected weather conditions suggested we would get a few days of light easterly winds to help us on our way.

Wednesday 1 May (121)

The weather did indeed improve during the steam to DD13. We arrived at DD13 (a full site) and had the CTD in water by 1330 to collect water for live samples. On the next deployment of the CTD the wire became snagged producing a kink which required re-termination. This was done during the vertical net hauls and LEK, so that a minimal amount of time was lost. The series of towed nets finished at 0300 on day 122.

Thursday 2 May (122)

We arrived at DD12 for a CTD station at 0630, completed by 0820 with the TEK back in the water.

The next full site DD11 was completed without a hitch. It was decided to swap the order of the full depth CTD and vertical nets so that the water from the first CTD cast could be sampled and the CTD reset whilst the net hauls took place. This proved very worthwhile in terms of the savings to time. The site was completed with ARIES out of the water by 0100 on day 123.

Friday 3 May (123)

A Martec float was deployed after the CTD station DD10 was completed. This was the first of four floats to be deployed on line DD. Site DD9 was started with the OS as we had made up a considerable amount of time. The weather continued, but strong winds (force 8) were predicted for the night. There were delays in starting the DM tow because the Scanmar fish had been damaged because of the fish hitting the side of the ship. A repair was made. Winch problems meant that the ARIES had to be recovered at a slow pace causing further delay. The site was finally finished 0500 on day 124.

Saturday 4 May (124)

The wind did increase and turn to westerlies during the night, which limited the speed the ship could make. We arrived at DD8 at 0900. Problems were found with the CTD winch so it was decided to abandon the station and steam directly to DD7. It was suspected that the problem with the CTD winch was caused by a faulty pump, the replacement of which is a lengthy procedure. In the interim vertical net hauls took place and the LEK deployed for an extended time period.

Sunday 5 May (125)

Worked continued on the CTD winch until the early hours of Sunday without the problem being resolved. The ship remained at DD7. The LEK was deployed to get a night time station. After a suitable rest time of the technicians it was decided to do a test tow of the 20t winch with ARIES. Apart from a small problem when hauling with only 200m of wire out, the winch appeared to be behaving. ARIES was taken down to 2300m and hauled in. There were no further problems with the winch.

The second float, an Apex float this time, was deployed. The CTD on the ARIES deployment will be used to calibrate the salinity sensor on the float. Still at DD7 a second series of vertical net hauls was undertaken followed by the LEK.

The problem with the CTD winch was traced to an electric motor which will take a days work to replace. To provide an almost complete set of measurements the DM and OS net systems were deployed finishing at 0420 on day 126. The Scanmar cable for the TEK had to be replaced prior to its deployment before the net tows.

Monday 6 May (126)

The ship set off for site DD5 (an intermediate site DD6 was abandoned to make up some of the lost time). Increased winds during the night, up to force 9, slowed progress. Heavy swell was encountered. The ship's speed was reduced to 2 kts and direction adjusted to reduce movement whilst the electric motor was replaced.

Tuesday 7 May (127)

The bad weather continued through to midday of day 127 during which time we had drifted a good way south of the line. With wind and swell abating we steamed to DD5.

The second Apex float was released 1nm before DD5. On station at DD5 the CTD was deployed to collect water from the chlorophyll maximum. Although now working, the CTD winch system still had problems. The two motors driving the hydraulic pumps where unbalanced, with one drawing too much current.

The site was completed with vertical nets, LEK and towed net systems, finishing at 0753 on day 128. Again the CTD on ARIES will have to be used to calibrate the float.

Wednesday 8 May (128)

Trials of the CTD winch were conducted. The two motors were better balanced although they were 'fighting against each other' and still drawing too much current. The manufacturers, Lawsons, were contacted and offered some advice.

The same procedure as for DD5 was undertaken, with the last of the floats deployed a little way before the station, and the site ending at 0709 on day 129. Problems with the logging on ARIES were noted with both the logged times of the nets and the bottle fires.

Thursday 9 May (129)

We finally reached the end of line DD. The weather was perfect for the occasion, with a bright sky and smooth sea. We crossed a distinct line on the surface of the ocean denoting the edge of the East Greenland current. In the distance the towering cliffs and mountains of Greenland could be seen. A line of sea ice had been teased out by the eddying current into a filament (as seen by the weather satellite images obtained by the Dartcom system).

We steamed close to the sea ice and undertook more trials of the CTD winch and a vertical net haul (DD0). The melting ice had produced a low salinity surface layer some 20m thick. The vertical net haul showed the biology to be distinctly different to that of the open ocean, with very few *Calanus*, and dominated by *Phaeocystis*.

We steamed east back into open ocean water to undertake the last station of the section, DD1. Although not working perfectly it was decided to use the CTD winch system, keeping a careful eye on its performance. We therefore took a full suite of measurements. There was a slight delay because of a problem with the 20t winch. The site ended at 0047 on day 130.

Friday 10 May (130)

We steamed north and onto the shelf via what was to become C8, turning onto a NW course at 0600 on day 131. The underway ADCP showed the presence of a cyclonic eddy centred on C8.

Saturday 11 May (131)

Before reaching the shelf we were confronted by a tongue of sea ice. Satellite imagery showed this to be a filament drawn out from the pack ice to the north. The filament had a distinct clockwise turn at its end (The filament appeared to have been drawn out by a vortex pair; a previous image on 10 May showed an anticlockwise tongue, the cyclonic eddy being picked up by later SST images).

A large number of cetaceans were seen during the steam onto the shelf slope.

The ice in the filament was sufficiently disperse to warrant an attempt to steam through it. However three quarters of the way through the floes became larger and more densely distributed and it was decided to turn back. Before turning a seal and pup were seen on one of the floes. The underway sampling showed much reduced salinity and patches of high fluorescence whilst we were in the ice.

On returning to open water we edged around the filament to the west until we were able to get onto the shelf, where we undertook site C6. Again very few *Calanus* were found, the reasoning most probably being the high abundance of *Phaeocystis* (a common occurrence found in the waters we sampled on the shelf and at some sites in deeper water).
Two further vertical net stations were undertaken (C4 and C5), which both showed conditions similar to those at C6, finishing at 0300 on day 132.

Sunday 12 May (132)

We steamed off the shelf to take water samples and vertical nets for process studies (C3) but found conditions not too different to those on the shelf (i.e. few *Calanus* and plenty of *Phaeocystis*).

We steamed NE to encounter disperse ice before the southern limit of the ice filament. Skirting around the ice to the east we came back on the shelf to do site C7 with ice conditions preventing us getting very far onto the shelf. The site was completed at 0046 on day 133, by which time we had moved back down the slope with the depth in excess of 1000m.

Monday 13 May (133)

We steamed SE to deeper water (C8), arriving at 0330, where a full site was undertaken. Although there were still *Phaeocystis* in the water they were at reduced levels and there were increased numbers of *Calanus*. The site was completed at 1830. An attempt was then made to resample the cyclonic eddy observed two days earlier. (The thinking at the time was that the eddy may have been the cyclonic part of the vortex pair which had teased out the filament of ice. Subsequent analysis shown this not to be the case, although the eddy was affecting cross-slope transfer.)

A butterfly pattern was executed which began by steaming SW, then E and finally N. With little real time data display we were fortunate to find ourselves in the centre of the eddy on the northward leg. A shallow CTD and vertical net haul were performed (ED1), followed by another set of measurements further to the north (ED2), finishing at 0600 on day 134. Initial analysis of the net samples showed distinctly different plankton.

Tuesday 14 May (134)

The decision had been made to do a number of stations on and off the shelf for comparison, whilst moving in a general NE direction. We steamed to site C8a to collect live samples and water for the process studies before crossing the slope onto the shelf. Ice was sighted at 1640. We entered the ice pack at 1717 and stopped with beam to wind to open up a patch of open water to undertake a CTD and vertical net site (C9a). The vertical structure of the water column showed intense interleaving.

Whilst at the site, mist descended reducing visibility considerably. We exited the ice pack at 2030 and steamed to be clear of the ice before commencing the full site C9. The site was completed at 0635 on day 135.

Wednesday 15 May, Day 135

Whilst on station at C9 we received a SeaWifs image that shown we were on the edge of an intense bloom. As previously, this bloom consisted predominately of *Phaeocystis*. To catch the transition between the bloom and open ocean conditions we undertook a series of stations with the CTD and vertical net, starting to the west of C9 and ending in deeper water at C10 (C9b-C9d), arriving at C10 at 1924. A full site was undertaken and completed by 0830 on day 136. The fluorescence profile from the CTD cast showed elevated levels around 1000m. Subsequent analysis showed this to be caused by the presence of cold/fresh water, which may have been moved off the shelf by the vigorous eddy activity.

Thursday 16 May, Day 136

The Dartcom weather satellite image showed that a good part of the shelf had become clear of ice up to 66°N 33°W. This would have allowed the current and surface structure of the water on the shelf to be sampled by underway measurements. Unfortunately, our attempts at getting that far north where again thwarted by the movement of the ice. Rather than spend a great deal of time navigating around the ice floes in front of us, it was decided to take one last station in amongst the ice floes (C11a), and then to retreat southwards for a full site (C11), which was marked as the end site of line B. The weather was particularly bright with very little wind and a glassy sea. The site ended at 0202 on day 137.

Friday 17 May (137)

We steamed to B10, taking two intermediate sites (B10b,a) down the slope with the CTD and a vertical net haul. The weather deteriorated, with cloudy skies and increased wind and swell, but not sufficiently to prevent operations. The full site B10 was completed by 0200/138. The remaining sites along line B were planned to alternate between full sites and an intermediate CTD/vertical net site, with the location of each determined by the time of day (a full site starting at 1100 each day)

Saturday 18 May (138)

The intermediate site B9 was completed by 0740. At 0830 the ship was hove to for a repair to the bow thrusters. The bow thruster unit had been leaking water when in use at a rate of 30l per min. The repair was completed by 1100. This upset the timing of subsequent stations. It was decided to steam for another 2 hours to the next full site B8**,** completed by 0500 on day 139.

Sunday 19 May (139)

To make up for lost time it was decided to abandon doing the intermediate site B7 and to steam on to B6. At 1055 there was a sudden electrical power failure. Although this brought down the computing and other systems, it appeared not to have a lasting effect.

We reached B6 at 1130 and undertook a full site. The Scanmar in the TEK failed on the OS tow. The tow was thus done without depth information (not a problem in 2000m water depth). The Scanmar fish was deployed for the subsequent tows. The site was completed at 0330 on day 140.

Monday 20 – Tuesday 21 May (140-141)

Despite the presence of low pressure systems to the south of us, the weather remained good for the rest of the scientific operations. The remainder of the stations on line B were completed without incident, the line finishing at B1 (a repeat of A5) by 0130 on day 142.

Wednesday 22 May (142)

The completion of line B marked the end of the work originally planned. With time remaining we completed a line of CTD stations (I1-I2) down the slope of the Reykjanes Ridge into the Iceland Basin finishing with a full site I3 by 0500/143.

Thursday 23 May (143)

The last site (OSI/I4) was the eastern side of the Iceland Basin at the location of the former Ocean Weather Station India. We arrived on station at 2300.

Friday 24 May (144)

There was a small problem with 10t winch system, but this was quickly rectified. However it did mean the towed nets were deployed before the final CTD ending OSI/I4 at 1250.

Finally three trial deployments of the CTD system were undertaken to investigate a problem of a hysteresis in the T/S data, suspected to be caused by the trapping of water in the frame. Casts were made with first the 300kHz Workhorse LADCP removed, then the fluorometer and transmissometer, and finally placing the T/S sensors out on a pole. Results are pending. The trials finished at 2120 and we steamed for Fairlie.

Saturday 25 – Sunday 26 May, Days 145-146

We steamed to Fairlie, ending the cruise at 2030/146 at Fairlie Pier.

Kelvin Richards

A1.2 Site locations and station list

Reference information on sites (sampling locations) and stations (gear casts/hauls) is given in Table 16 below.

Table 16 Station list for *Discovery* 262, with times and coordinates for all gear deployments

Site	Station No.	Instru-ment	START: date DD/MM/YY	time (GMT) HH:MM	latitude/ longitude	END: date DD/MM/YY	time (GMT) HH:MM	latitude/ longitude	Comments
Trials		TEK	20/04/2002			20/04/2002			
Trials		CTD	21/04/2002	06:57	57° 50.28N 12°14.83W	21/04/2002	06:14	57°51.13N 12°15.49W	water depth 1752m
Trials		30 L bottles	21/04/2002	08:38	57°51.27N 12°15.77W	21/04/2002	08:38	57°51.86N 12°16.50W	water depth 1746m
Trials		LEK	21/04/2002	09:59	57°52.10N 12°16.73W	21/04/2002	10:14	57°52.24N 12°17.02W	water depth 1744m
Trials		nets	21/04/2002	10:29	57°52.36N 12°17.41W	21/04/2002	11:15	57°52.76N 12°17.64W	
Trials	14326	OS	25/04/2002	10:25	64°11.41N 23°33.70W	25/04/2002			
A1	14327	CTD	25/04/2002	12:46	64°11.90N 23°14.99W	25/04/2002	13:03	64°11.85N 23°15.00W	Live sampling
A1	14328	CTD	25/04/2002	13:38	64°11.92N 23°14.78W	25/04/2002	13:58	64°12.01N 23°14.75W	Full profile
A1	14329-14332	nets	25/04/2002	14:08	64°12.04N 23°14.73W	25/04/2002	14:43	64°12.18N 23°14.80W	4 nets (3 x 1 metre, 1 x Bongo)
A1	14333	TEK	25/04/2002	14:59	64°12.45N 23°14.46W	25/04/2002	22:58	64°01.01N 23°29.80W	Recovery given station no. 14341 by bridge
A1	14334-14336	OS	25/04/2002	15:47	64°09.65N 23°19.36W	25/04/2002	16:31	64°11.23N 23°17.29W	
A1	14337	DMK	25/04/2002	18:05	64°10.44N 23°19.41W	25/04/2002	19:01	64°12.95N 23°16.23W	
A1	14338-14340	ARIES	25/04/2002	20:34	64°08.94N 23°18.63W	25/04/2002	21:09	64°09.73N 23°16.79W	
A1a	14342	CTD	26/04/2002	06:45	63°55.81N 23°40.64W	26/04/2002	07:12	63°55.83N 23°40.59W	
A1a	14343	TEK	26/04/2002	07:55	63°56.35N 23°40.62W	26/04/2002	13:38	63°39.35N 24°04.87W	
A1a	14344-14346	ARIES	26/04/2002	08:08	63°56.71N 23°39.79W	26/04/2002	09:23	63°58.95N 23°35.40W	
A2	14347-14349	OS	26/04/2002	12:38	63°37.97N 23°06.71W	26/04/2002	13:24	63°39.26N 24°04.96W	14348-pup frozen, 14349 pup ethanol
A2	14350	CTD	26/04/2002	13:51	63°39.42N 24°04.67W	26/04/2002	14:10	63°39.40N 24°04.45W	Live sampling
A2	14351	CTD	26/04/2002	14:50	63°39.38N 24°04.39W	26/04/2002	15:15	63°39.50N 24°04.24W	Full profile
A2	14352	nets	26/04/2002	15:25	63°39.56N 24°04.22W	26/04/2002	16:52	63°40.30N 24°05.07W	8 nets (6 x 1 metre, 1 x Bongo, 1 x 200um)
A2	14353	TEK	26/04/2002	17:06	63°40.49N 24°05.04W	27/04/2002	04:45	62°44.35N 24°25.85W	
A2	14354	DMK	26/04/2002	17:23	63°40.73N 24°04.21W	26/04/2002	18:29	63°41.82N 23°58.83W	
A2	14355-14357	ARIES	26/04/2002	19:29	63°41.80N 23°59.69W	26/04/2002	20:10	63°41.97N 23°56.13W	
A2?	14358-14360	ARIES	27/04/2002	00:03	63°15.22N 24°35.55W	27/04/2002	01:08	63°15.42N 24°29.25W	

A3a	14361	CTD	27/04/2002	05:15	62°43.16N 24°25.77W	27/04/2002	06:30	62°43.14N 24°25.82W	
A3a	14362	TEK	27/04/2002	07:05	62°43.53N 24°24.99W	27/04/2002	09:48	62°54.62N 24°43.95W	
A5	14363	CTD	29/04/2002	17:34	61°40.62N 27°01.87W	29/04/2002	17:53	61°40.57N 27°01.68W	Live sampling
A5	14364	CTD	29/04/2002	20:33	61°40.82N 26°59.77W	29/04/2002	21:35	61°41.28N 26°59.17W	Full profile
A5	14365	nets	29/04/2002	21:40	61°41.33N 26°59.07W	29/04/2002	23:09	61°41.92N 26°57.89W	6 nets
A5	14366	LEK	30/04/2002	00:00	61°42.10N 26°57.62W	30/04/2002	00:55	61°42.23N 26°56.73W	
A5	14367	TEK	30/04/2002	01:05	61°42.39N 26°56.51W	30/04/2002	12:28	62°18.62N 27°19.79W	
A5	14368-14370	OS	30/04/2002	01:33	61°42.91N 26°55.71W	30/04/2002	02:52	61°45.43N 26°52.89W	
A5	14371	DMK	30/04/2002	04:12	61°45.63N 26°51.17W	30/04/2002	05:42	61°47.69N 26°49.12W	
A5	14372-14374	ARIES	30/04/2002	06:29	61°48.35N 26°49.13W	30/04/2002	07:55	61°50.26N 26°49.83W	
A5	14375	TEK	30/04/2002	21:12	62°38.19N 27°19.46W	01/05/2002	13:30	60°09.77N 29°12.29W	Steam to line DD [referred to as line D during cruise]
DD13	14376	CTD	01/05/2002	13:37	60°09.85N 29°12.28W	01/05/2002	13:45	60°09.94N 29°12.33W	Live sampling
DD13	14377	nets	01/05/2002	14:40	60°10.48N 29°12.37W	01/05/2002	16:18	60°11.55N 29°12.76W	8 nets
DD13	14378	LEK	01/05/2002	16:37	60°11.69N 29°12.85W	01/05/2002	17:35	60°12.31N 29°13.27W	
DD13	14379	CTD	01/05/2002	18:35	60°09.71N 29°11.90W	01/05/2002	19:55	60°10.37N 29°12.95W	Physics cast full profile
DD13	14380	TEK	01/05/2002	20:05	60°10.48N 29°13.03W	02/05/2002	06:10	60°18.31N 30°04.81W	
DD13	14381-14383	OS	01/05/2002	20:25	60°11.15N 29°13.20W	01/05/2002	22:08	60°16.67N 29°14.02W	
DD13	14384	DMK	01/05/2002	23:02	60°18.22N 29°14.57W	02/05/2002	00:39	60°22.46N 29°14.66W	
DD13	14385-14387	ARIES	02/05/2002	01:25	60°23.63N 29°15.13W	02/05/2002	03:00	60°27.64N 29°15.89W	
DD12	14388	CTD	02/05/2002	06:36	60°16.99N 30°09.32W	02/05/2002	08:12	60°17.28N 30°09.96W	
DD12	14389	TEK	02/05/2002	08:20	60°17.30N 30°09.75W	02/05/2002	13:39	60°20.58N 31°01.79W	
DD11	14390-14392	OS	02/05/2002	11:49	60° 23.88N 31°06.62W	02/05/2002	13:20	60°20.73N 31°02.10W	
DD11	14393	CTD	02/05/2002	13:48	60°20.59N 31°01.80W	02/05/2002	14:00	60°20.67N 31°01.80W	Live sampling
DD11	14394	nets	02/05/2002	14:10	60°20.75N 31°01.78W	02/05/2002	15:16	60°21.08N 31°01.89W	6 nets
DD11	14395	CTD	02/05/2002	15:23	60°21.10N 31°01.86W	02/05/2002	17:12	60°21.91N 31°02.14W	Full profile 1858m
DD11	14396	LEK	02/05/2002	17:24	60°22.00N 31°02.04W	02/05/2002	18:19	60°22.46N 31°02.53W	

DD11	14397	TEK	02/05/2002	18:31	60°22.48N 31°02.64W	03/05/2002	05:33	60°31.55N 32°03.31W	
DD11	14398	DMK	02/05/2002	19:00	60°22.15N 31°01.81W	02/05/2002	21:05	60°19.37N 30°55.89W	
DD11	14399-14400	ARIES	02/05/2002	22:00	60°18.95N 30°54.42W	03/05/2002	01:00	60°14.94N 30°45.06W	
DD10	14401	CTD	03/05/2002	05:57	60°31.80N 32°03.76W	03/05/2002	07:53	60°32.91N 32°04.75W	
DD10	14402	Float	03/05/2002	08:00	60°33.00N 32°04.73W				Martec #35
DD10	14403	TEK	03/05/2002	08:10	60°33.12N 32°04.26W	03/05/2002	12:55	60°37.53N 32°53.31W	
DD9	14404-14406	OS	03/05/2002	11:27	60°38.53N 33°00.45W	03/05/2002	12:42	60°37.54N 32°54.05W	
DD9	14407	CTD	03/05/2002	13:38	60°38.88N 33°01.07W	03/05/2002	13:54	60°38.94N 33°00.86W	Live sampling
DD9	14408	nets	03/05/2002	14:00	60°38.94N 33°00.88W	03/05/2002	15:04	60°38.92N 32°59.98W	6 nets
DD9	14409	CTD	03/05/2002	15:14	60°38.97N 32°59.84W	03/05/2002	17:30	60°39.65N 32°58.62W	Full profile
DD9	14410	LEK	03/05/2002	18:04	60°39.73N 32°58.75W	03/05/2002	19:07	60°39.65N 32°58.56W	
DD9	14411	TEK	03/05/2002	19:23	60°39.59N 32°58.45W	04/05/2002	13:35	60°52.90N 34°56.25W	
DD9	14412	DMK	03/05/2002	21:49	60°37.57N 32°52.29W	03/05/2002	23:45	60°35.38N 32°44.68W	Delay due to fixing of Scanmar fish
DD9	14413-14415	ARIES	04/05/2002	00:30	60°35.04N 32°43.43W	04/05/2002	04:53	60°35.74N 33°01.19W	winch problems
DD7	14416	nets	04/05/2002	13:45	60°52.84N 34°56.29W	04/05/2002	14:57	60°53.02N 34°56.94W	5 nets
DD7	14417	LEK	04/05/2002	15:09	60°52.99N 34°56.94W	04/05/2002	17:58	60°53.13N 34°58.12W	
DD7	14418	LEK	05/05/2002	02:22	60°53.48N 34°56.46W	05/05/2002	03:20	60°53.46N 34°56.55W	
DD7	14419-14421	ARIES	05/05/2002	10:20	60°50.69N 34°58.51W	05/05/2002	15:14	60°43.65N 35°12.02W	
DD7		Float	05/05/2002	15:45	60°43.62N 35°12.95W	05/05/2002			Apex 438
DD7	14422	nets	05/05/2002	17:31	60°53.50N 34°55.46W	05/05/2002	18:10	60°53.91N 34°55.86W	
DD7	14423	LEK	05/05/2002	18:18	60°54.03N 34°55.92W	05/05/2002	19:09	60°54.44N 34°56.28W	
DD7	14424	TEK	06/05/2002	00:00	60°50.60N 34°52.68W	07/05/2002	16:56	61°06.73N 36°51.21W	
DD7	14425	DMK	06/05/2002	00:26	60°50.20N 34°52.77W	06/05/2002	02:17	60°46.53N 34°56.23W	
DD7	14426-14428	OS	06/05/2002	03:05	60°45.56N 34°57.11W	06/05/2002	04:20	60°42.65N 34°59.46W	
DD5	14429	Float	07/05/2002	16:49	61°06.88N 36°51.00W				Apex 437
DD5	14430	CTD	07/05/2002	17:21	61°07.92N 36°49.91W	07/05/2002	17:39	61°08.02N 36°50.14W	Live sampling

DD5	14431	nets	07/05/2002	17:42	61°08.03N 36°50.15W	07/05/2002	18:51	61°08.00N 36°49.92W	5 nets
DD5	14432	LEK	07/05/2002	19:05	61°08.02N 36°49.66W	07/05/2002	19:54	61°08.07N 36°49.59W	
DD5	14433	TEK	07/05/2002	20:14	61°07.59N 36°49.75W	07/05/2002	08:39	60°53.23N 37°14.84W	
DD5	14434-14436	OS	07/05/2002	20:32	61°07.21N 36°49.81W	07/05/2002	21:55	61°04.00N 36°50.21W	
DD5	14437	DMK	07/05/2002	22:47	61°03.03N 36°50.43W	08/05/2002	00:46	60°58.68N 36°51.02W	
DD5	14438-14440	ARIES	08/05/2002	01:29	60°57.67N 36°50.70W	08/05/2002	07:53	60°48.48N 37°05.73W	
trials	14441	CTD	08/05/2002	08:50	60°53.15N 37°15.08W	08/05/2002	09:43	60°52.73N 37°15.64W	winch test
trials	14442	TEK	08/05/2002	09:52	60°52.54N 37°15.82W	08/05/2002	14:01	61°19.08N 38°15.95W	
DD3	14443	Float	08/05/2002	13:41	61°18.56N 38°13.80W	08/05/2002			Apex 44
DD3	14444	nets	08/05/2002	14:07	61°19.09N 38°15.96W	08/05/2002	15:11	61°18.72N 38°16.22W	6 nets
DD3	14445	LEK	08/05/2002	15:20	61°18.65N 38°16.33W	08/05/2002	16:10	61°18.53N 38°16.84W	
DD3	14446	TEK	08/05/2002	16:20	61°18.49N 38°16.95W	09/05/2002	14:33	61°39.13N 40°31.95W	
DD3	14447-14449	OS	08/05/2002	20:21	61°18.38N 38°17.77W	08/05/2002	21:44	61°14.57N 38°18.48W	
DD3	14450	DMK	08/05/2002	22:31	61°15.57N 38°18.08W	09/05/2002	00:45	61°21.35N 38°14.66W	
DD3	14451-14453	ARIES	09/05/2002	01:36	61°20.46N 38°14.16W	09/05/2002	07:09	61°07.06N 38°16.58W	
	14454	CTD	09/05/2002	16:00	61°43.28N 40°33.58W	09/05/2002	16:29	61°43.18N 40°33.27W	
	14455	nets	09/05/2002	16:35	61°43.08N 40°33.16W	09/05/2002	16:45	61°42.97N 40°33.05W	
DD1	14456	CTD	09/05/2002	18:40	61°34.58N 40°24.21W	09/05/2002	19:03	61°34.41N 40°24.62W	Live sampling
DD1	14457	nets	09/05/2002	19:08	61°34.37N 40°24.73W	09/05/2002	20:16	61°33.57N 40°26.77W	6 nets
DD1	14458	CTD	09/05/2002	20:28	61°33.45N 40°24.84W	09/05/2002	22:18	61°32.46N 40°28.26W	Full profile
DD1	14459	LEK	09/05/2002	22:29	61°32.33N 40°28.36W	09/05/2002	23:30	61°31.62N 40°29.27W	
DD1	14460	TEK	10/05/2002	00:29	61°30.87N 40°27.82W	11/05/2002	09:05	63°46.55N 36°30.79W	
DD1	14461-14463	OS	10/05/2002	00:46	61°30.68N 40°27.24W	10/05/2002	02:00	61°29.75N 40°20.55W	
DD1	14464	DMK	10/05/2002	02:50	61°28.95N 40°16.20W	10/05/2002	05:03	61°29.15N 40°28.07W	
DD1	14465-14467	ARIES	10/05/2002	08:34	61°27.85N 40°22.09W	10/05/2002	12:47	61°28.54N 40°02.04W	winch problems; 17 hour steam to C10
C6	14468	CTD	11/05/2002	14:10	63°44.01N 37°29.40W	11/05/2002	14:26	63°44.11N 37°29.49W	Live sampling
C6	14469	nets	11/05/2002	14:31	63°44.11N 37°29.52W	11/05/2002	15:36	63°44.37N 37°29.35W	4 nets

C6	14470	CTD	11/05/2002	15:46	63°44.42N 37°29.26W	11/05/2002	16:34	63°44.12N 37°29.54W	Full profile
C6	14471	TEK	11/05/2002	16:44	63°44.77N 37°28.92W	11/05/2002	23:44	63°59.98N 37°45.26W	
C6	14472-14474	OS	11/05/2002	17:25	63°44.11N 37°29.15W	11/05/2002	18:20	63°42.64N 37°31.46W	
C6	14475	DMK	11/05/2002	19:08	63°44.66N 37°28.24W	11/05/2002	19:55	63°43.22N 37°30.48W	
C6	14476-14478	ARIES	11/05/2002	20:42	63°44.47N 37°29.19W	11/05/2002	21:23	63°43.28N 37°31.68W	
C4	14479	nets	11/05/2002	23:45	63°59.97N 37°45.30W	12/05/2002	00:00	63°59.95N 37°45.61W	1 net
C4	14480	TEK	12/05/2002	00:13	63°59.79N 37°46.08W	12/05/2002	05:13	63°26.11N 38°32.02W	
C5	14481	nets	12/05/2002	02:55	63°45.12N 38°29.62W	12/05/2002	03:06	63°45.21N 38°29.60W	1 net (lat/lon correct up to here)
C3	14482	CTD	12/05/2002	05:25	63°26.10N 38°32.74W	12/05/2002	05:49	63°26.12N 38°33.58W	live sampling
C3	14483	nets	12/05/2002	05:57	63°26.07N 38°33.95W	12/05/2002	06:26	63°26.01N 38°34.87W	2 nets (no Calanus)
C3	14484	TEK	12/05/2002	06:52	63°25.85N 38°36.12W	12/05/2002	10:27	63°30.76N 37°31.40W	
C7	14485	nets	12/05/2002	14:55	63°49.10N 36°46.57W	12/05/2002	15:27	63°49.08N 36°47.52W	2 nets
C7	14486	CTD	12/05/2002	15:34	63°49.10N 36°47.78W	12/05/2002	16:16	63°49.13N 36°48.67W	Full profile
C7	14487	LEK	12/05/2002	16:38	63°49.06N 36°49.07W	12/05/2002	17:20	63°49.06N 36°49.99W	
C7	14488	TEK	12/05/2002	17:34	63°49.18N 36°49.79W	13/05/2002	03:31	63°29.93N 36°00.05W	
C7	14489-14491	OS	12/05/2002	18:10	63°46.97N 36°46.07W	12/05/2002	19:25	63°44.89N 36°53.83W	
C7	14492	DMK	12/05/2002	20:15	63°44.69N 36°53.83W	12/05/2002	22:07	63°44.89N 36°55.24W	
C7	14493-14495	ARIES	12/05/2002	22:44	63°46.58N 36°46.14W	13/05/2002	00:46	63°46.92N 36°38.74W	
C8	14496	CTD	13/05/2002	03:42	63°46.89N 36°38.74W	13/05/2002	03:57	63°29.87N 36°00.26W	Live sampling
C8	14497	nets	13/05/2002	04:05	63°29.87N 36°00.40W	13/05/2002	05:01	63°29.94N 36°01.28W	5 nets
C8	14498	CTD	13/05/2002	05:13	63°29.99N 36°01.37W	13/05/2002	07:27	63°30.47N 36°03.21W	Full profile (z = 2048m)
C8	14499	LEK	13/05/2002	07:37	63°30.50N 36°03.38W	13/05/2002	08:21	63°30.54N 36°04.25W	
C8	14500	TEK	13/05/2002	08:34	63°30.62N 36°04.06W	14/05/2002	01:17	63°11.49N 36°40.68W	
C8	14501-14503	OS	13/05/2002	08:59	63°30.82N 36°03.22W	13/05/2002	10:22	63°32.02N 35°56.57W	
C8	14504	DMK	13/05/2002	11:19	63°30.45N 35°59.14W	13/05/2002	13:29	63°32.38N 35°49.45W	
C8	14505-14507	ARIES	13/05/2002	14:22	63°32.00N 35°51.11W	13/05/2002	18:30	63°27.80N 36°11.78W	

ED1	14508	CTD	14/05/2002	01:27	63°11.61N 36°40.65W	14/05/2002	02:25	63°11.68N 36°41.14W	To 750 m
ED1	14509	nets	14/05/2002	02:29	63°11.68N 36°41.18W	14/05/2002	02:37	63°11.70N 36°41.27W	1 net
ED1	14510	TEK	14/05/2002	02:45	63°11.84N 36°41.33W	14/05/2002	04:22	63°28.14N 36°41.24W	
ED2	14511	CTD	14/05/2002	04:32	63°28.30N 36°41.49W	14/05/2002	05:32	63°28.45N 36°44.13W	to 750 m
ED2	14512	nets	14/05/2002	05:41	63°28.45N 36°44.57W	14/05/2002	05:49	63°28.45N 36°44.96W	1 net
ED2	14513	TEK	14/05/2002	06:05	63°28.63N 36°45.17W	14/05/2002	11:00	64°00.19N 35°30.35W	
C8a	14514	CTD	14/05/2002	11:11	64°00.39N 35°30.76W	14/05/2002	11:31	64°00.53N 35°31.38W	Live sampling
C8a	14515	nets	14/05/2002	11:39	64°00.57N 35°31.60W	14/05/2002	12:40	64°00.64N 35°33.57W	5 nets
C8a	14516	TEK	14/05/2002	12:46	64°00.68N 35°33.82W	14/05/2002	16:41	64°42.51N 35°30.27W	
C9a	14517	CTD	14/05/2002	18:59	64°49.31N 35°34.56W	14/05/2002	19:40	64°48.99N 35°35.67W	In ice; full profile
C9a	14518	nets	14/05/2002	19:43	64°48.96N 35°35.76W	14/05/2002	19:53	64°48.89N 35°36.11W	1 net
C9	14519	TEK	14/05/2002	22:15	64°40.05N 35°30.66W	15/05/2002	00:10	64°39.06N 35°30.11W	
C9	14520-14522	OS	14/05/2002	22:30	64°39.72N 35°30.77W	14/05/2002	23:41	64°36.90N 35°31.12W	
C9	14523	CTD	15/05/2002	00:44	64°40.18N 35°29.88W	15/05/2002	01:37	64°40.62N 35°29.79W	Full profile
C9	14524	nets	15/05/2002	01:43	64°40.66N 35°29.78W	15/05/2002	02:35	64°41.12N 35°30.10W	4 nets
C9	14525	CTD	15/05/2002	02:50	64°41.18N 35°30.06W	15/05/2002	03:05	64°41.22N 35°30.06W	Live sampling
C9	14526	LEK	15/05/2002	03:16	64°41.25N 35°30.07W	15/05/2002	04:04	64°41.56N 35°30.58W	200 m
C9	14527	TEK	15/05/2002	04:16	64°41.56N 35°30.70W	15/05/2002	09:15	64°38.12N 35°44.17W	
C9	14528	DMK	15/05/2002	04:35	64°41.19N 35°30.92W	15/05/2002	05:45	64°38.91N 35°31.49W	
C9	14529-14531	ARIES	15/05/2002	06:35	64°37.93N 35°31.95W	15/05/2002	07:50	64°35.98N 35°32.35W	
C9b	14532	CTD	15/05/2002	09:32	64°38.33N 35°43.47W	15/05/2002	10:20	64°38.95N 35°42.21W	Full profile
C9b	14533	nets	15/05/2002	10:28	64°39.06N 35°41.97W	15/05/2002	11:56	64°38.16N 35°28.03W	2 nets
C9c	14534	CTD	15/05/2002	12:57	64°36.10N 35°12.14W	15/05/2002	13:44	64°35.98N 35°12.36W	Full profile (on shelf)
C9c	14535	nets	15/05/2002	13:49	64°35.97N 35°12.38W	15/05/2002	14:00	64°35.94N 35°12.43W	1 net
C9d	14536	CTD	15/05/2002	15:00	64°34.12N 34°54.43W	15/05/2002	16:33	64°34.21N 34°56.19W	Full profile (on slope, 1300 m)
C9d	14537	nets	15/05/2002	16:37	64°34.22N 34°56.27W	15/05/2002	16:58	64°34.22N 34°56.74W	4 nets

C9d	14538	TEK	15/05/2002	17:18	64°34.32N 34°56.96W	15/05/2002	20:53	64°32.16N 34°12.93W	
C10	14539-14541	OS	15/05/2002	19:24	64°30.01N 34°17.63W	15/05/2002	20:31	64°32.01N 34°13.11W	
C10	14542	CTD	15/05/2002	21:02	64°32.21N 34°12.94W	15/05/2002	21:15	64°32.28N 34°12.95W	Live sampling
C10	14543	nets	15/05/2002	21:22	64°32.33N 34°12.92W	15/05/2002	22:09	64°32.59N 34°12.91W	5 nets
C10	14544	CTD	15/05/2002	22:18	64°32.63N 34°12.88W	15/05/2002	23:51	64°33.02N 34°13.65W	Full profile
C10	14545	LEK	16/05/2002	00:07	64°33.06N 34°13.78W	16/05/2002	00:55	64°33.08N 34°14.55W	
C10	14546	TEK	16/05/2002	01:03	64°33.14N 34°14.53W	16/05/2002	08:55	64°30.55N 34°12.48W	
C10	14547	DMK	16/05/2002	02:00	64°32.20N 34°16.84W	16/05/2002	04:25	64°26.50N 34°25.32W	Winch problems
C10	14548-14550	ARIES	16/05/2002	05:20	64°26.20N 34°26.43W	16/05/2002	08:30	64°30.25N 34°13.32W	
C10	14551	CTD	16/05/2002	09:13	64°30.64N 34°12.29W	16/05/2002	09:35	64°30.76N 34°12.18W	Live sampling
C10	14552	TEK	16/05/2002	09:42	64°30.82N 34°12.29W	16/05/2002	15:45	65°30.53N 33°26.64W	
C11a	14553	CTD	16/05/2002	17:23	65°38.20N 33°16.29W	16/05/2002	17:55	65°38.61N 33°16.01W	Full profile
C11a	14554	nets	16/05/2002	18:04	65°38.63N 33°15.97W	16/05/2002	18:13	65°38.64N 33°15.95W	4 nets
C11a	14555	TEK	16/05/2002	20:12	65°25.27N 33°30.54W	16/05/2002	21:52	65°20.59N 33°36.02W	
C11	14556-14558	OS	16/05/2002	20:45	65°22.99N 33°32.97W	16/05/2002	21:32	65°20.89N 33°35.14W	
C11	14559	CTD	16/05/2002	21:57	65°20.65N 33°36.04W	16/05/2002	22:13	65°20.67N 33°36.16W	Live sampling
C11	14560	nets	16/05/2002	22:17	65°20.66N 33°36.22W	16/05/2002	23:15	65°20.56N 33°37.45W	
C11	14561	CTD	16/05/2002	23:21	65°20.55N 33°37.62W	17/05/2002	00:02	65°20.52N 33°38.76W	Full profile
C11	14562	TEK	17/05/2002	00:07	65°20.57N 33°38.79W	17/05/2002	03:50	65°13.53N 33°16.89W	
C11	14563	DMK	17/05/2002	00:20	65°20.82N 33°38.47W	17/05/2002	01:00	65°21.69N 33°37.38W	
C11	14564-14566	ARIES	17/05/2002	01:31	65°21.46N 33°37.70W	17/05/2002	02:06	65°20.03N 33°40.09W	
B10b	14567	CTD	17/05/2002	04:07	65°13.35N 33°16.78W	17/05/2002	05:11	65°13.44N 33°20.95W	Full profile
B10b	14568	nets	17/05/2002	05:18	65°13.44N 33°21.41W	17/05/2002	05:26	65°13.44N 33°21.92W	
B10a	14569	CTD	17/05/2002	07:23	65°05.17N 32°51.53W	17/05/2002	08:52	65°05.61N 32°54.10W	Full profile
B10a	14570	nets	17/05/2002	08:59	65°05.64N 32°54.34W	17/05/2002	09:11	65°05.71N 32°54.75W	
B10a	14571	TEK	17/05/2002	09:16	65°05.79N 32°54.83W	17/05/2002	12:16	64°59.09N 32°35.94W	

B10	14572-14574	OS	17/05/2002	10:45	64°57.02N 32°30.06W	17/05/2002	12:01	64°58.89N 32°35.29W	
B10	14575	CTD	17/05/2002	12:50	64°57.03N 32°30.14W	17/05/2002	13:06	64°57.00N 32°30.17W	Live sampling
B10	14576	nets	17/05/2002	13:11	64°56.97N 32°30.20W	17/05/2002	14:16	64°56.99N 32°30.55W	5 nets
B10	14577	CTD	17/05/2002	14:26	64°56.99N 32°30.62W	17/05/2002	16:19	64°57.18N 32°31.68W	Full profile
B10	14578	LEK	17/05/2002	16:33	64°57.24N 32°31.57W	17/05/2002	17:40	64°57.56N 32°31.39W	
B10	14579	TEK	17/05/2002	17:50	64°57.73N 32°31.28W	18/05/2002	04:35	64°36.89N 31°41.71W	
B10	14580	DMK	17/05/2002	18:06	64°58.09N 32°30.75W	17/05/2002	20:43	65°01.13N 32°20.59W	
B10	14581-14583	ARIES	17/05/2002	21:39	64°57.10N 32°29.74W	18/05/2002	02:00	64°55.90N 32°02.66W	
B9	14584	CTD	18/05/2002	05:05	64°37.06N 31°41.85W	18/05/2002	07:25	64°38.03N 31°44.30W	Full profile
B9	14585	nets	18/05/2002	07:32	64°38.00N 31°44.45W	18/05/2002	07:42	64°38.11N 31°44.69W	
B9	14586	TEK	18/05/2002	07:48	64°38.21N 31°44.74W	18/05/2002	15:22	64°10.65N 31°29.67W	
B8	14587-14589	OS	18/502	13:20	64°11.94N 31°27.74W	18/05/2002	14:27	64°11.38N 31°22.04W	
B8	14590	CTD	18/502	15:27	64°10.58N 31°29.59W	18/05/2002	15:45	64°10.53N 31°29.35W	Live sampling
B8	14591	nets	18/503	15:48	64°10.52N 31°29.31W	18/05/2002	16:51	64°11.01N 31°28.28W	5 nets
B8	14592	CTD	18/502	16:57	64°11.09N 31°28.19W	18/05/2002	19:41	64°12.52N 31°25.15W	Full profile
B8	14593	LEK	18/504	19:50	64°12.59N 31°24.90W	18/05/2002	20:41	64°12.99N 31°23.80W	
B8	14594	TEK	18/502	20:49	64°13.06N 31°23.48W	19/05/2002	13:15	63°17.96N 30°19.44W	
B8	14595	DMK	18/502	21:06	64°13.27N 31°22.62W	18/05/2002	23:12	64°13.88N 31°10.52W	
B8	14596-14598	ARIES	19/05/2002	00:13	64°13.97N 31°07.69W	19/05/2002	04:57	64°10.15N 30°44.07W	
B6	14599-14601	OS	19/05/2002	11:32	[63°18.65N 30°23.03W]	19/05/2002	13:02	63°18.12N 30°19.67W	11:32 true position not available due to power failure. Position given for 12:10
B6	14602	CTD	19/05/2002	13:41	63°17.20N 30°22.82W	19/05/2002	13:58	63°17.12N 30°23.04W	Live sampling
B6	14603	nets	19/05/2002	14:04	63°17.11N 30°23.17W	19/05/2002	14:54	63°17.05N 30°23.77W	5 nets
B6	14604	CTD	19/05/2002	15:01	63°17.08N 30°23.80W	19/05/2002	17:17	63°17.14N 30°25.45W	Full profile
B6	14605	LEK	19/05/2002	17:37	63°17.04N 30°25.55W	19/05/2002	18:24	63°16.99N 30°26.25W	
B6	14606	TEK	19/05/2002	18:32	63°16.93N 30°26.29W	20/05/2002	06:38	63°00.80N 30°00.31W	
B6	14607	DMK	19/05/2002	19:28	63°17.12N 30°25.18W	19/05/2002	21:34	63°18.95N 30°17.96W	

B6	14608-14610	ARIES	19/05/2002	22:29	63°17.91N 30°21.72W	20/05/2002	03:31	63°25.70N 29°54.58W	
B5	14611	CTD	20/05/2002	06:52	63°00.85N 29°59.64W	20/05/2002	08:53	63°01.63N 29°57.29W	Full profile
B5	14612	nets	20/05/2002	08:56	63°01.68N 29°57.25W	20/05/2002	09:06	63°01.82N 29°57.10W	1 net
B5	14613	TEK	20/05/2002	09:15	63°02.00N 29°56.85W	20/05/2002	12:35	62°39.23N 29°13.70W	
B4	14614	CTD	20/05/2002	12:47	62°39.21N 29°13.63W	20/05/2002	13:13	62°38.96N 29°13.71W	Live sampling
B4	14615	nets	20/05/2002	13:15	62°38.94N 29°13.72W	20/05/2002	14:09	62°38.68N 29°14.27W	5 nets
B4	14616	CTD	20/05/2002	14:20	62°38.61N 29°14.56W	20/05/2002	16:25	62°37.95N 29°16.51W	Full profile
B4	14617	LEK	20/05/2002	16:37	62°37.94N 29°16.62	20/05/2002	17:35	62°37.57N 29°16.83W	
B4	14618	TEK	20/05/2002	17:44	62°37.54N 29°16.84W	21/05/2002	04:55	62°20.35N 28°33.00W	
B4	14619-14621	OS	20/05/2002	18:38	62°37.92N 29°15.85W	20/05/2002	19:55	62°40.34N 29°12.35W	
B4	14622	DMK	20/05/2002	20:31	62°39.77N 29°13.32W	20/05/2002	22:33	62°43.54N 29°13.76W	
B4	14623-14625	ARIES	20/05/2002	23:13	62°41.70N 29°13.97W	21/05/2002	01:20	62°45.88N 29°12.57W	
B3	14626	CTD	21/05/2002	05:10	62°20.64N 28°32.80W	21/05/2002	06:55	62°21.51N 28°31.32W	Full profile
B3	14627	nets	21/05/2002	06:57	62°21.53N 28°31.30W	21/05/2002	07:06	62°21.58N 28°31.25W	1 net
B3	14628	TEK	21/05/2002	07:15	62°21.77N 28°31.12W	21/05/2002	10:26	62°00.83N 27°46.95W	
B2	14629	CTD	21/05/2002	10:41	62°01.00N 27°47.28W	21/05/2002	12:17	62°01.68N 27°49.49W	Full profile
B2	14630	nets	21/05/2002	12:20	62°01.72N 27°49.55W	21/05/2002	12:30	62°01.83N 27°49.72W	1 net
B2	14631	TEK	21/05/2002	12:35	62°01.97N 27°49.78W	21/05/2002	15:54	61°40.53N 27°02.53W	
B1	14632	CTD	21/05/2002	16:04	61°40.62N 27°02.51W	21/05/2002	16:17	61°40.69N 27°02.45W	Live sampling
B1	14633	nets	21/05/2002	16:23	61°40.73N 27°02.47W	21/05/2002	17:08	61°40.79N 27°02.17W	5 nets
B1	14634	CTD	21/05/2002	17:12	61°40.80N 27°02.16W	21/05/2002	18:03	61°40.60N 27°01.67W	Full profile
B1	14635	LEK	21/05/2002	18:12	61°40.74N 27°01.72W	21/05/2002	19:01	61°40.90N 27°01.54W	hydrophone problem
B1	14636	TEK	21/05/2002	19:07	61°41.02N 27°01.60W	22/05/2002	05:05	61°24.75N 26°13.96W	
B1	14637-14639	OS	21/05/2002	19:41	61°41.83N 27°02.13W	21/05/2002	20:55	61°44.00N 27°04.34W	
B1	14640	DMK	21/05/2002	21:40	61°42.31N 27°02.73W	21/05/2002	23:11	61°44.97N 27°02.04W	
B1	14641-14643	ARIES	21/05/2002	23:47	61°43.75N 27°01.17W	22/05/2002	01:23	61°48.00N 27°03.09W	

I1	14644	CTD	22/05/2002	05:18	61°24.84N 26°14.47W	22/05/2002	06:48	61°25.02N 26°16.28W	Full profile
I1	14645	nets	22/05/2002	06:54	61°25.03N 26°16.39W	22/05/2002	07:03	61°25.06N 26°16.54W	1 net
I1	14646	TEK	22/05/2002	07:12	61°25.14N 26°16.81W	22/05/2002	10:15	61°08.68N 25°25.62W	
I2	14647	CTD	22/05/2002	10:25	61°08.81N 25°25.77W	22/05/2002	12:13	61°08.71N 25°25.94W	Full profile
I2	14648	nets	22/05/2002	12:18	61°08.73N 25°25.93W	22/05/2002	12:28	61°08.77N 25°25.87W	1 net
I2	14649	TEK	22/05/2002	12:36	61°09.00N 25°26.06W	22/05/2002	15:35	60°52.90N 24°37.83W	
I3	14650	CTD	22/05/2002	15:45	60°53.10N 24°37.91W	22/05/2002	16:02	60°53.25N 24°37.86W	Live sampling
I3	14651	nets	22/05/2002	16:08	60°53.33N 24°37.86W	22/05/2002	16:53	60°53.57N 24°37.55W	4 nets
I3	14652	CTD	22/05/2002	16:56	60°53.59N 24°37.54W	22/05/2002	18:59	60°54.27N 24°37.00W	Full profile
I3	14653	LEK	22/05/2002	19:10	60°54.35N 24°36.94W	22/05/2002	19:57	60°54.63N 24°36.82W	
I3	14654	TEK	22/05/2002	20:04	60°54.51N 24°36.68W	23/05/2002	12:36	60°03.69N 22°10.85W	
I3	14655-14657	OS	22/05/2002	20:35	60°54.16N 24°36.33W	22/05/2002	21:41	60°57.50N 24°36.75W	
I3	14658	DMK	22/05/2002	22:20	60°56.88N 24°36.04W	23/05/2002	00:30	60°52.42N 24°32.66W	
I3	14659-14661	ARIES	23/05/2002	01:07	60°51.75N 24°32.08W	23/05/2002	05:05	60°43.48N 24°25.59W	
OSI	14662	CTD	23/05/2002	23:04	59°00.12N 18°59.72W	23/05/2002	23:20	59°00.14N 18°59.45W	Live sampling
OSI	14663	nets	23/05/2002	23:25	59°00.14N 18°59.39W	24/05/2002	00:06	59°00.36N 18°58.85W	4 nets
OSI	14664	CTD	24/05/2002	00:22	59°00.53N 18°58.61W	24/05/2002	00:24	59°00.56N 18°58.58W	Aborted due to winch problems
OSI	14665-14667	OS	24/05/2002	01:19	59°01.19N 18°58.29W	24/05/2002	02:19	59°03.73N 18°55.02W	
OSI	14668	DMK	24/05/2002	02:58	59°03.02N 18°55.74W	24/05/2002	05:04	58°59.77N 19°00.00W	
OSI	14669-14671	ARIES	24/05/2002	05:45	58°59.68N 19°00.04W	24/05/2002	09:15	58°52.98N 19°08.03W	
OSI	14672	CTD	24/05/2002	10:39	59°00.12N 19°00.22W	24/05/2002	12:50	59°01.32N 19°00.81W	
Trials	14673	CTD	24/05/2002	13:59	59°01.79N 19°00.86W	24/05/2002	15:23	59°02.51N 19°00.88W	CTD trial one
Trials	14674	CTD	24/05/2002	16:07	59°02.71N 19°00.71W	24/05/2002	17:19	59°02.62N 19°01.09W	CTD trial two
Trials	14675	CTD	24/05/2002	19:50	59°01.84N 19°03.04W	24/05/2002	20:42	59°01.46N 19°03.44W	CTD trial three

A2. CTD processing

Note that 5-digit *Discovery* station numbers were used throughout the cruise. In the following text the station numbers are referred to as 14nnn since most scripts request just the last 3 digits of the number.

A2.1 Sea-Bird software (SeaSoft) processing

A batch file was used to run the following steps on the binary 24 Hz data. Input file is ctd14nnn.dat in directory C:\D262ctd, output file is ctd14nnn.dat in subdirectory C:\D262ctd\Processed.

The batchfile ctdstu.bat run in sbebatch consisted of:

```
DatCnv /cc:\%1\%3.con /ic:\%1\%3.dat /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\DatCnv262.psu
RosSum /cc:\%1\%3.con /ic:\%2\%3.ros /oc:\%2 /f%3.btl /pc:\D262ctd\Processed\RosSum262.psu
CellTM /ic:\%2\%3.cnv /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\CellTM262.psu
WildEdit /ic:\%2\%3.cnv /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\WildEdit262.psu
WildEdit /ic:\%2\%3.cnv /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\WildEdit262.psu
AlignCTD /ic:\%2\%3.cnv /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\AlignCTD262.psu
Trans    /ic:\%2\%3.cnv /oc:\%2 /f%3.cnv /pc:\D262ctd\Processed\Trans262.psu
```

Where arguments %1 is input directory, %2 is output directory and %3 is filename.
e.g. c:\d262ctd\sbebatch ctdstu.bat D262ctd D262ctd\Processed ctd14327

datcnv	Convert raw data, copies selected variables (only measured variables, not derived)
rossum	Averages the Sea-Bird .ros file into one value per bottle.
celltm	Performs conductivity cell thermal mass correction (using default values).
wildedit	Edits spikes in the 24 Hz data in preparation for averaging (using *Discovery* 258 values)
align	Advances the oxygen variable to match timing of other variable (*Discovery* 258 values)
trans	Converts the data to ascii

Output ascii files are ctd14nnn.cnv and ctd14nnn.btl. Those were then ftp'd to the Unix directory where further processing in Pstar was done.

A2.2 Pstar processing

ctd0 Translates the 24 Hz SeaBird ctd14nnn.cnv file into Pstar format. Requires the latitude and longitude of the bottom of the cast. These are manually entered from details on the cast logsheet, but are automatically checked and corrected later. Output ctd14nnn.1hz

ctd1 Performs further editing of 24 Hz file, averages into 1 Hz data, calculates derived variables salinity, potential temperature and density. Output ctd14nnn.1hz

ctd2 Requires datacycle numbers of the first good in-water data (lowest pressure after soaking), the bottom of the downcast (maximum pressure) and the last in-water data (all obtained manually by listing ctd14nnn.1hz using mlist). Extracts data from the 1 Hz file to produce the entire in-water 1 Hz cast (ctd14nnn.ctu) and the downcast profile averaged to 2dbar intervals (ctd14nnn.2db).

ctdplots Produces standard profile and temperature-salinity plots for deep and shallow stations.

sam0 Converts the ascii .btl file into a Pstar file that contains the CTD variables from the bottle firing times. Output fir14nnn.

sam1 Converts the firing file into a master sample file, into which bottle oxygen, nutrient, salinity and chlorophyll data will be pasted. Output sam14nnn.

passam Pastes ascii sample (oxygen, nutrient, salinity or chlorophyll) data into the master sample file. Requires tab-delimited text file with sample numbers that match those already in the sam14nnn file (convention for sample number is nnn01 to nnn024). Facility to ignore unwanted variables written for *Discovery* 258 did not seem to function, so text files needed to consist of expected variables only.

The following stages are new scripts for *Discovery* 262 to automate some of the checking and calibration procedures:

oxycalib After pasting in the bottle oxygen data, this script re-calculates the bottle oxygen in units umol/kg for direct comparison with CTD oxygens (new variable botoxyk in sam14nnn).

makeresid Calculates the bottle conductivity (using bottle salinity and CTD pressure and temperature). Calculates the difference between bottle and CTD oxygens, bottle chlorophyll and CTD fluorescence, bottle salinity and CTD salinity, and bottle conductivity and CTD conductivity. Can be run with some bottle data absent, re-run as necessary. Output file res14nnn.

ctdtimes.exec Extracts times for the start, bottom and end of the cast from the CTD files. Used for extracting on-station ADCP data, and for adding the correct position and water depth information to the CTD and sample files' headers. Output tim14nnn.

ctd4 Checks the true position and water depth from the master navigation and master bathymetry files. Allows user to correct the information in all CTD and sample files.

A3. Workhorse LADCPs (300 and 600 kHz): procedures and command files

A3.1 Deployment procedures

1. Attach cables from PC to star cable.
2. Check the battery voltage. Range should be 35V-60V.
3. Start BB-TALK twice. The instrument should be set to "workhorse"; the baud rate will automatically be set to the condition that the ADCP was left in. In the second group of windows standard practice is to check "Send break on new connection" and "send CK on baud rate change command". One will be connected to COM1 (master) the other will be connected to COM2 (slave), the order is dependant on which window was opened first during the last deployment. Position the windows so that both can be seen.
4. Press **F3** on each window to log any input. The log files should be named ******$.txt where ****** is the station number and $ is m (master) or s (slave), and should be stored in a standard directory – normally c:\ladcp\CruiseNumber\master(slave). Record these filenames on the log sheet.
5. Type **TS?** on each of the windows. If the time is wrong adjust with **TS yy/mm/dd,hh:mm:ss** as is shown. Record the time on the log sheet.
6. Type **RS?** to see if the memory is unused. **ONLY IF ALL FILES HAVE BEEN DOWNLOADED SHOULD THE MEMORY BE ERASED.** To erase the memory type **RE ErAsE.** Record the amount of unused memory on the log sheet.
7. Type **PA** to run the pre-deployment tests and tick the boxes if passes. Remember that there will be one fail in both master and slave due to the instrument being in air.
8. Change the baud rate of both windows to 9600 baud using **CB411**
9. In the slave window press **F2** to run a script. Select the file c:/ladcp/CMDFILES/1935_slave.txt and click OK.
10. Repeat (9) for the master window using the file ../1903_master.txt
11. The LADCPs will now be pinging in master/slave mode. The cables can be disconnected and the instruments deployed.
12. Stop the logging on each communication window by pressing **F3**.

A3.2 Recovery and downloading procedures

1. Attach cables from P.C. to star cable
2. Start BB-TALK twice. The instrument should be set to "workhorse", the baud rate will automatically be set to the condition that the ADCP was left in. In the second group of windows standard practice is to check "Send break on new connection" and "send CK on baud rate change command". One will be connected to COM1 (master) the other will be connected to COM2 (slave), the order is dependant on which window was opened first during the last deployment. Position the windows so that both can be seen.
3. Set both ADCPs to 119200 baud typing **CB811 in both communications windows.**
4. Stop the ADCPs by hitting the break button (the large B on the tool bar) or pressing the **end** key.
5. Type **RA?** in the COM1 (master) window) this will give the number of deployments. Record on log sheet.

6. Select the “File” menu. Select “Recover Recorder”. The download path should be C:\ladcp\DY262\master. Click OK. From the list select the deployments that you wish to download – normally tick select all.
7. The file(s) will start to download, you will see garbage characters in the window. You can now repeat steps 5 & 6 using COM2 and the download path C:\ladcp\DY262\slave.
8. You should now go into the directories C:\ladcp\DY262\master and C:\ladcp\DY262\slave to rename the newly downloaded files corresponding to their station numbers. The files will be named _RDI_***.000 where *** is an integer which increases with each deployment. Eg: _RDI_001.000 renamed to CCCC351$.000, _RDI_002.000 renamed to CCCC352$.000, where CCCC is the cruise number and $ is m or s depending on whether the ADCP was in master or slave mode.
9. Start BBLIST. If no path appears when started Select “File” “Load” “Binary” and type in the path (eg. C:\ladcp\DY262\master*.*) to bring up a list of deployments. Choose the deployment you are interested in from this list. This will show the file size and number of ensembles which should be recorded on the log sheet.
10. The units should be sent to sleep using **“cz”**.

A3.3 Command files for 300 kHz LADCP

File 14401m.txt

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.21; RD Instruments (c) 1996-2002, All Rights Reserved.
>ts?
TS = 02/05/03,05:40:14 --- Time Set (yr/mon/day,hour:min:sec)
>rs
RS = 001,083 ---------- REC SPACE USED (MB), FREE (MB)

>rr
Recorder Directory:
Volume serial number for device #0 is 3153-11ed

  _RDI_000 000           8271 05-03-02   4:55:28a r  a [    2]

  Bytes used on device #0 = 8271
Total capacity   =   87187456 bytes
Total bytes used =       8271 bytes in 1 files
Total bytes free =   87177216 bytes

>re ErAsE  erasing...
Recorder erased.

>pa

PRE-DEPLOYMENT TESTS

CPU TESTS:
  RTC.....  PASS
  RAM.....  PASS
  ROM.....  PASS
RECORDER TESTS:
  PC Card #0.....  DETECTED
    Card Detect.....  PASS
    Communication.....  PASS
    DOS Structure.....  PASS
    Sector Test (short).....  PASS
  PC Card #1.....  NOT DETECTED
DSP TESTS:
  Timing RAM.....  PASS
  Demod  RAM.....  PASS
  Demod  REG.....  PASS
  FIFOs.....  PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back.....  ***FAIL***
  Wide Bandwidth.....  ***FAIL***
  Narrow Bandwidth.....  PASS
  RSSI Filter.....  PASS
  Transmit.....  PASS
SENSOR TESTS:
  H/W Operation.....  PASS
>pa

PRE-DEPLOYMENT TESTS
```

```
CPU TESTS:
  RTC.....  PASS
  RAM.....  PASS
  ROM.....  PASS
RECORDER TESTS:
  PC Card #0.....  DETECTED
    Card Detect.....  PASS
    Communication.....  PASS
    DOS Structure.....  PASS
    Sector Test (short).....  PASS
  PC Card #1.....  NOT DETECTED
DSP TESTS:
  Timing RAM.....  PASS
  Demod  RAM.....  PASS
  Demod  REG.....  PASS
  FIFOs.....  PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back.....  PASS
  Wide Bandwidth.....  ***FAIL***
  Narrow Bandwidth.....  PASS
  RSSI Filter.....  PASS
  Transmit.....  PASS
SENSOR TESTS:
  H/W Operation.....  PASS
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA00000
>EB00000
>ED00000
>ES35
>EX11111
>EZ0111111
>TE00:00:02.00
>TP00:00.10
>LD111100000
>LF0500
>LN016
>LP00001
>LS1000
>LV250
>LJ1
>LW1
>LZ30,220
>SM1
>SA001
>SW10000
>CK
[Parameters saved as USER defaults]
>CS
```

File 14441m.txt

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.21; RD Instruments (c) 1996-2002, All Rights Reserved.
>ts?
TS = 02/05/08,08:31:42 --- Time Set (yr/mon/day,hour:min:sec)
>ts 02/05/08,08:32:10
>ts □ □□ □□ □rs?

RS = 000,084 ---------- REC SPACE USED (MB), FREE (MB)

>pa

PRE-DEPLOYMENT TESTS

CPU TESTS:
  RTC.....  PASS
  RAM.....  PASS
  ROM.....  PASS
```

```
RECORDER TESTS:
  PC Card #0.....  DETECTED
    Card Detect.....  PASS
    Communication.....  PASS
    DOS Structure.....  PASS
    Sector Test (short).....  PASS
  PC Card #1.....  NOT DETECTED
DSP TESTS:
  Timing RAM.....  PASS
  Demod  RAM.....  PASS
  Demod  REG.....  PASS
  FIFOs.....  PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back.....  PASS
  Wide Bandwidth.....  ***FAIL***
  Narrow Bandwidth.....  PASS
  RSSI Filter.....  PASS
  Transmit.....  PASS
SENSOR TESTS:
  H/W Operation.....  PASS
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA00000
>EB00000
>ED00000
>ES35
>EX11111
>EZ0111111
>TE00:00:01.00
>TP00:01.00
>WD111100000
>WF0500
>WN016
>WP00001
>WS1000
>WV250
>WJ1
>WB1
>SM1
>SA001
>SW05000
>CK
[Parameters saved as USER defaults]
>CS
```

A3.4 Command files for 600 kHz LADCP

File 14401s.txt

```
ts?
TS = 02/05/03,05:40:28 --- Time Set (yr/mon/day,hour:min:sec)
>ts 02/05/03,05:41:00
>ts?
TS = 02/05/03,05:41:05 --- Time Set (yr/mon/day,hour:min:sec)
>rs?

RS = 003,089 ---------- REC SPACE USED (MB), FREE (MB)

>rr
Recorder Directory:
Volume serial number for device #0 is 063a-16e2

  _RDI_000 000        2834331 05-02-02   8:24:08a r  a [    2]
  _RDI_001 000          10491 05-02-02   1:16:56p r  a [ 1386]
  _RDI_002 000          18261 05-02-02   1:17:34p r  a [ 1392]

  Bytes used on device #0 = 2863083
Total capacity             =   95723520 bytes
Total bytes used           =   2863083 bytes in 3 files
Total bytes free           =   92858368 bytes
```

```
>rer□ □ ErAsE  erasing...
Recorder erased.

>rs
RS = 000,092 ---------- REC SPACE USED (MB), FREE (MB)

>pa

PRE-DEPLOYMENT TESTS

CPU TESTS:
  RTC.....  PASS
  RAM.....  PASS
  ROM.....  PASS
RECORDER TESTS:
  PC Card #0..... DETECTED
    Card Detect.....PASS
    Communication.....  PASS
    DOS Structure.....  PASS
    Sector Test (short).....  PASS
  PC Card #1..... NOT DETECTED
DSP TESTS:
  Timing RAM..... PASS
  Demod  RAM..... PASS
  Demod  REG..... PASS
  FIFOs.....PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back.....PASS
  Wide Bandwidth.....  PASS
  Narrow Bandwidth.....  PASS
  RSSI Filter.....  PASS
  Transmit.....PASS
SENSOR TESTS:
  H/W Operation.....  PASS
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA00000
>EB00000
>ED00000
>ES35
>EX11111
>EZ0111111
>TE00:00:01.00
>TP00:01.00
>WD111100000  ERR 010:  UNRECOGNIZED COMMAND
>WF0500  ERR 010:  UNRECOGNIZED COMMAND
>WN016  ERR 010:  UNRECOGNIZED COMMAND
>WP00001  ERR 010:  UNRECOGNIZED COMMAND
>WS1000  ERR 010:  UNRECOGNIZED COMMAND
>WV250  ERR 010:  UNRECOGNIZED COMMAND
>WJ1  ERR 010:  UNRECOGNIZED COMMAND
>WW1  ERR 010:  UNRECOGNIZED COMMAND
>WZ30,220  ERR 010:  UNRECOGNIZED COMMAND
>SM2
>SA001
>CK
[Parameters saved as USER defaults]
>CS

[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.21; RD Instruments (c) 1996-2002, All Rights Reserved.
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA00000
>EB00000
>ED00000
>ES35
>EX11111
>EZ0111111
```

```
>TE00:00:02.00
>TP00:00.10
>LD111100000
>LF0500
>LN016
>LP00001
>LS1000
>LV250
>LJ1
>LW1
>LZ30,220
>SM2
>SA001
>CK
[Parameters saved as USER defaults]
>CS
```

File 14441s.txt

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.21; RD Instruments (c) 1996-2002, All Rights Reserved.
>ts?
TS = 02/05/08,08:32:29 --- Time Set (yr/mon/day,hour:min:sec)
>ts 02/05/08,08:33:@□ □00
>rs?

RS = 000,092 ---------- REC SPACE USED (MB), FREE (MB)

>pa

PRE-DEPLOYMENT TESTS

CPU TESTS:
  RTC.....  PASS
  RAM.....  PASS
  ROM.....  PASS
RECORDER TESTS:
  PC Card #0.....  DETECTED
    Card Detect.....  PASS
    Communication.....  PASS
    DOS Structure.....  PASS
    Sector Test (short).....  PASS
  PC Card #1.....  NOT DETECTED
DSP TESTS:
  Timing RAM.....  PASS
  Demod  RAM.....  PASS
  Demod  REG.....  PASS
  FIFOs.....  PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Receive Loop-Back.....  PASS
  Wide Bandwidth.....  PASS
  Narrow Bandwidth.....  PASS
  RSSI Filter.....  PASS
  Transmit.....  PASS
SENSOR TESTS:
  H/W Operation..... PASS
>CR1
[Parameters set to FACTORY defaults]
>CF11101
>EA00000
>EB00000
>ED00000
>ES35
>EX11111
>EZ0111111
>TE00:00:01.00
>TP00:01.00
>WD111100000
>WF0500
>WN016
>WP00001
```

```
>WS1000
>WV250
>WJ1
>WB1
>SM2
>SA001
>ST0
>CK
[Parameters saved as USER defaults]
>CS
```

A4. LADCP processing

A4.1 Acquisition

Data should be collected as described on the ADCP logsheets. Data was ftp'd to the required location specified below. All the text command files were transferred as well as the binary data files. For the 300 kHz, these were named statnumm.txt and for the 600 kHz, statnums.txt

A4.2 Processing

The binary data files were ftp'd to the directory /data61/ladcp/data. Here they were renamed as follows.

300 kHz data: d<3 digit statnum>_01.000
600 kHz data: w<3 digit statnum>_01.000

In the /data61/ladcp/data are two symbolic links which point to the raw data directories in the relevant tree: 600khz and 300khz. The renamed binary data files were transferred using these links to /data61/ladcp/600khz/raw/di0204/ladcp and /data61/ladcp/300khz/raw/wi0204/ladcp respectively.

Log files were stored in /data61/ladcp/600khz/logs/d262 and /data61/ladcp/300khz/logs/d262 respectively.

cd ladcp goes to /data61/ladcp. Here there are two directory trees: 600khz and 300khz. Each started the same, with a copy of the Firing tree and Visbeck directories.

Depending on which data are to be processed, source 300khz/LADall or 600khz/LADall. This sets up environment variables and adds the required directories to the MATLABPATH variable. If the computer responds with "too long", it is because this variable has already been modified and now cannot hold any more directories. Simply logout and start again.

One of the important settings is the cruise identifier. This is a six character ID di0204 (for the 300khz) and wi0204 (for 600khz). They have been made different so that the data files have different names and can therefore be distinguished. 300 kHz files should be named dccc_ss.000 and 600 kHz files should be wccc_ss.000, where sss is the station number (eg 191) and cc is the cast number which is usually 01. In the text below, D is also used to denote either the 'd' or 'w' identifier.

Firing must be used first. This is because the Visbeck software has been modified to find parameter values in the Firing tree (see below).

cd proc
Firing processing is a mixture of prgrams written in C with a front end in perl, and matlab routines. Typically the perl routines write summary files into files insubdirectory casts/sss_cc/scanload (relative to proc)

perl -S scan.prl sss_cc
Check that the information extracted from the data file is correct for the cast it is supposed to correspond to.

putpos sss cc latdeg latmin londeg lonmin
This stores the latitude and longitude in an ascii file for later reference. For the southern or western hemispheres the degrees, though not the minutes, should be negative.

matlab:
magvarsm(sss.cc)
This puts up a small window with a "yes" and "no" button. Click "yes", and then quit. (Hey it works!!). The magnetic variation for this station is calculated and stored in file mag_var.tab.

perl -S load.prl sss_cc
This converts the data into CODAS data format. The data is held in files in subdirectory casts/Dsss_cc/scdb.

perl -S domerge.prl -c0 sss_cc
(The above is czero) Here the data is filtered and despiked.

matlab:
plist=sss.cc
do_abs

Note the '.' here in the cast id. This should produce plots of velocity and various other fields. Copies are also written into subdirectory casts/Dsss_cc/merge as postscript format.

plotthem Dsss_cc
(outside matlab) sends them to laser.

These steps produce velocity data with zero mean. The processing up to the load step does not need to be repeated for the next stage. However, if it goes wrong, note that there are various ascii files in the proc directory which are appended to. These are: stations.asc, mag_var.tab, proc.dat and latlon.asc. If in doubt, remove the entry in each file for the current station, delete the directory Dsss_cc under the casts directory and start again from the beginning.

Once the CTD data have been processed and navigation is up to date, the absolute velocities for the 150 kHz can be calculated. These steps have been incorporated into a script called ladcpproc. They are cd proc and cd Rctd

Use mlist to create an ascii listing of the ctd data.

mlist /data61/ctd/ctd14ccc.ctu

The output file should contain the four variables time, press, temp and salin. Time should be in seconds.

vars 1,2,3,16
fmt time 10.1
DC
ascii
list

There should be no ascii header and no record numbers. Access MLIST.ASCII and remove by hand.

mv MLIST.ASCII ctd.sss.cc.asc

Rename MLIST.ASCII to ctd.sss.cc.asc (note dots rather than underscores).

doctd

When prompted give the three figure station number. Converts the LADCP times into Julian days.

cd proc
cd Pctd
matlab
di0204ts(sss,cc)

cd proc
cd Fitd
matlab
plist=sss.cc
fd

This step examines the derivative of the pressure from the CTD and the vertical velocity from the LADCP in order to match the timebases. The automated matching is usually sufficient, but examine the plot carefully to make sure that bottle firing positions match. If there are problems, then choose the interactive option and match them manually. Alternatively, matching problems usually occur because of problems with the CTD data (eg pressure spikes), so look at this data carefully. If necessary, copy the CTD data to the Pctd directory and remove problem data.

cd proc

perl -S add_ctd.prl sss_cc

perl -S domerge.prl -c1 sss_cc
Note the 'one' here.

These steps add the CTD data to the database and merge it with the LADCP data. Before the final step a navigation file is required. The same files are required by the 600 kHz and 300 kHz. For this reason one file is created and then copied to the other tree. From the 600 tree:

cd proc
cd Rnav
donav

The donav script is neither efficient nor tidy and should probably be changed. One option is to use the bestnavfile instead, but so far this has not been tried. The product required for the last step is called sm.mat. This should be copied to the 300khz Rnav directory.

cp sm.mat /data61/ladcp/300khz/raw/di0204/gps

cd proc

matlab
plist=sss.cc
have_sm=1
do_abs

This creates the same set of plots as the first run of do_abs, but this time the velocities are absolute. Print off only dusssccch.ps

Further steps involve conversion to Pstar and comparison with the shipboard 150khz ADCP and any Visbeck processed data. For this end there is a cshell script in proc, toascii sss cc, that converts the mat velocity data into an ascii file (ccc.asc) in subdirectory prof. In prof there are further scripts:

dopstar	converts ascii file to Pstar, updating the header with correct position (creates la14ccc and la14ccc.asc in prof)
dogrid	grids a set of Pstar profiles into a section, doing stuff like calculating along and across track velocities
dosection	this uses dogrid and an ascii file called 'section' to create a section file. It simply means you do not have to type in lots of profile numbers on the command line of dogrid
dosections	this uses the section file to create all gridded files
docomp	compares the LADCP profiles with on station shipboard averages (which must already exist) and Visbeck data
dopict	creates a plot (part 1) (advanced - read indecipherable)
dodisp	creates a plot (part 2) (advanced - read indecipherable)

Comparison of 600 kHz Firing calculated velocities with 150 kHz shipboard ADCP data did not show close agreement.

A4.3 Software set-up

The Visbeck software runs entirely in Matlab and involves no complex directory structures. In contrast to the set-up used on *Discovery* 258, this installation was not configured to read parameter information from the Firing directory tree. CTD start and stop times were obtained from the 'do.getstntimes' script in the $P_ADCP/STATIONS directory, and the start and end positions were obtained and entered manually using the RVS 'posinfo' program.

Visbeck's software tar file was untarred into the $P_LADCP/m directory. Modifications were made to the loadnav_soc.m and loadctd_uh.m files (see below) and once these were operational (allowing integration of CTD and gps4000 navigation data), the software was run straightforwardly using a '.m' file for each LADCP cast. The file demo.m is a demo file for a typical cast. Each cast/instrument requires such a file, and these are named w###01.m, where ### is the last 3 digits of the *Discovery* station number and the 'w' prefix is for the master unit ('d' was used to denote the 300 kHz (slave) unit). Within these 'm' files a few parameters need to be set for each cast. These are shown below:

```
f.ctd='/data61/ctd/ctd14###.1hz'                          // CTD data file
f.nav='sm###.mat'                                         // navigation 'mat' file
f.ladcpdo='../600khz/raw/wi0204/ladcp/w###_01.000'        // raw LADCP data file in Firing tree
f.ladcpup=' '                                             // blank if only using down-looking unit
f.res='w###_01result'                                     // prefix for result files
p.name='###_01'                                           // used during plotting
p.ladcp_station='#'                                       // sequential station numbers
p.time_start=[2002 5 18 17 03 05];                        // updated if CTD data available
p.time_end=[2002 5 18 19 38 20];
p.poss=[64 11.16 –31 –28.08];                             // start pos (updated if nav available)
p.pose=[64 12.50 –31 –25.19];                             // end pos
p.zpar=[10 2687 10];                                      // start, bottom and end depths
```

In order to read in navigation and CTD data, the following 'm' files were modified:

loadnav_soc.m was modified and renamed to loadnav_soc2.m
loadctd_uh.m was modified and changed to loadctd_soc.m
laproc.m was changed to use loadctd_soc.m and loadnav_soc2.m

The modifications to the loadnav_soc.m file are presented below as the output from the Unix 'diff' command (see Unix man page for details). This simply loads the appropriate cruise nav file eg. 'sm.mat' (created using the 'donav' csh script in the Firing processing path) or similar (ie. cut down into smaller chunks to reduce memory usage in Matlab) and extracts time, lat and lon, putting time into the appropriate format for consistency with the ADCP and CTD data.

```
Unix-prompt> diff loadnav_soc.m loadnav_soc2.m
1c1
< function [d,p]=loadnav(f,d,p,ipos)
---
> function [d,p]=loadnav_soc2(f,d,p,ipos)
17c17
< if nargin<4, ipos=[7,5,6]; end
---
> if nargin<4, ipos=[1,3,2]; end
19a20,21
> %% generated by 'donav' script in Firing processing path
> %% (file is sm.mat)
27a30,33
> tim = sm(:,1) + julian([2002 1 1 0 0 0]) -1;
> lon = sm(:,2);
> lat = sm(:,3);
>
```

The loadctd_soc.m script checked for the existence of an ASCII listing of the relevant CTD 1hz file in the $P_CTD directory, and if not present, generated one using a script called 'doctdasc'. Both are shown below:

Loadctd_soc.m

First 30 or so lines only – the remainder are extra code/functions which have not ben altered from Visbeck v6.0 distribution. Bold lines indicate regions of change with respect to the original file, loadctd_uh.m

```
function [d,p]=loadctd(f,d,p,ipos)
% function [d,p]=loadctd(f,d,p,ipos)
% LADCP-2 software version 6.0
%
% ========== THIS PART IS SPECIFIC TO LDEO-SEABIRD CTD DATA ============
%
% you might want to change it to accomodate your own data format
%
%
% load and merge UH depthfile
% ipos(1) : time column
% ipos(2) : pressure column
% ipos(...) : other data column
%
```

```
% Martin Visbeck, 6/10/99
% revised March 2002
if nargin<4, ipos=[1,2]; end

% read UH timeseries file
pressure=0;
tmpctd = strcat(f.ctd,'asc');

disp(['load CTD time series ',tmpctd])
if exist(tmpctd)==0
 disp([' can not find ',tmpctd])
 disp([' generating ascii file from 1hz ctd data file ',f.ctd])
 if exist(f.ctd) == 0
   disp([' can not find ctd file ',f.ctd])
 else
   disp([' generating ascii file from 1hz ctd data'])
   unix(['doctdasc ' f.ctd]);
   if (ans ~= 0)
    disp(['Error generating ascii file'])
    return
   end
 end
end

An=load(tmpctd);

% CTD time – some ctd files had time in seconds starting at 0,  but these were
% relative to pstar header time, so get around this….
if (An(1,ipos(1)) < 3600)
  timctd=(An(:,ipos(1))/86400)+julian([p.time_start(1) p.time_start(2) p.time_start(3) p.time_start(4)
  p.time_start(5) p.time_start(6)]);
else
  timctd=(An(:,ipos(1))/86400)+julian([p.time_start(1) 1 1 0 0 0]);
end

disp([' number of CTD scans: ',int2str(length(timctd)),...
      '  delta t : ',num2str(median(diff(timctd))*24*3600),' seconds'])
```

doctdasc:

```
#!/bin/csh –f
if  ($#argv != 1) then
  echo "require ctd 1hz file name (inc path) as arg"
  exit(1)
endif

mlist $1 << ! >! ctd.talk
vars time press temp salin
ascii
l
q
!

if ($status != 0) then
  echo " Cound not write the ASCII file!"
  exit(1)
endif
ex -s MLIST.ASCII << ! >> ctd.talk
1,2d
1,\$s/...../
w
q
!

if ($status != 0) then
echo " Failed to edit the ASCII file!"
exit
endif

mv -i MLIST.ASCII {$1}asc
```

Nick Crisp, Sophie Fielding, Jon Short

A5. Processing for navigation and vessel-mounted ADCP

navexec0 transferred data from the RVS bestnav stream to Pstar, calculated the ships velocity, appended onto the absolute (master) navigation file and calculated the distance run from the start of the master file. Output: abnv2621 and abnv2622.

gyroexec0 transferred data from the RVS gyronmea stream to Pstar, a nominal edit was made for directions between 0-360° before the file was appended to daily master files.

gp4exec0 transferred data from the RVS gps_4000 stream to Pstar, edited out pdop (position dilution of precision) greater than 5 and appended the new 24 hr file to master files gp42621 and gp2622

glosexec0 this was identical to gp4exec0 but transferred the RVS gps_glos data stream to Pstar in master files gls2621 and gls2622.

gpsexec0 this was identical to gp4exec0 but transferred the RVS gps_g12 data stream to Pstar in master files gps2621 and gps2622.

ashexec0 transferred data from the RVS gps_ash stream to Pstar.

ashexec1 merged the Ashtech data from ashexec0 with the gyro data from gyroexec0 and calculated the difference in headings (hdg and gyroHdg); ashtech - gyro (a-ghdg) (daily files).

ashexec2 edited the data from ashexec1 using the following criteria:

heading	0 < hdg < 360 (degrees)
pitch	-5 < pitch < 5 (degrees)
roll	-7 < roll < 7 (degrees)
attitude flag	-0.5 < attf < 0.5
measurement RMS error	0.00001 < mrms < 0.01
baseline RMS error	0.00001 < brms < 0.1
ashtech-gyro heading	-10 < a-ghdg < 10 (degrees)

The heading difference (a-ghdg) was then filtered with a running mean based on 5 data cycles and a maximum difference between median and data of 1 degree. The data were then averaged to 2 minutes and further edited for:

-2 < pitch <2
0 < mrms < 0.004
-10 < a-ghdg < 10

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ships velocity was calculated from position and time, and converted to speed and direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. do.plotash was the script used to produce diagnostic plots to check this and this script resided in the $P_ASH directory with the data files. During ship manoeuvres, bad weather or around data gaps, there were spikes which were edited out manually (plxyed).

ashexec3 appended daily Ashtech files to a master file (ash262smt.ave) after removing any overlapping time steps. The master file was subsequently used in ADCP and Surfmet data processing.

adpexec0 transferred data from the RVS level C "ADCP" data stream to Pstar. The data were split into two; "gridded" depth dependent data were placed into "adp" files while "non-gridded" depth independent data were placed into "bot" files. Velocities were scaled to cm/s and amplitude by 0.42 to db. Nominal edits were made on all the velocity data to remove both bad data and to change the DAS defined absent data value to the Pstar value. The depth of each bin was determined from the user supplied information. Output files: adp262##, bot262##

adpexec2 this merged the ADCP data (both files) with the ashtech a-ghdg created by ashexec2. The ADCP velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: adp262##.true, bot262##.true.

adpexec3 applied the misalignment angle, ø, and scaling factor, A, to both ADCP files. The ADCP data were edited to delete all velocities where the percent good variable was 25% or less. Again, variables were renamed and re-ordered to preserve the original raw data. Output files: adp262##.cal, bot262##.cal.

adpexec4 merged the ADCP data (both files) with the Trimble GPS 4000 navigation file (gp42621) created by gp4exec0 and the bestnav navigation file (abnv2621) created by navexec0. Ship's velocity was calculated from 2 minute spot positions taken from the gp42621 file and applied to the ADCP velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv2621, this last stage was not done in the processing scripts on *Discovery* 253. Output files: adp262##.abs, bot262##.abs.

surexec0 data read into Pstar format from RDI binary file (psurvey, new program written on *Discovery* 253 by S Alderson). Water track velocities written into "sur" file, bottom track into "sbt" files if in bottom track mode. Velocities were scaled to cm/s and amplitude by 0.45 to db. The time variable was corrected to GPS time by combining the PC clock time and the PC-GPS offset. The depth of each bin was determined from the user supplied information. Output files: sur262##.raw, sbt262##.raw.

surexec1 data edited according to status flags (flag of 1 indicated bad data). Velocity data replaced with absent data if variable "2+bmbad" was greater than 25% (% of pings where >1 beam bad therefore no velocity computed). Time of ensemble moved to the end of the ensemble period(120 secs added with pcalib). Output files: sur262##, sbt262##.

surexec2 this merged the ADCP data (both files) with the ashtech a - ghdg created by ashexec2. The ADCP velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: sur262##.true, sbt262##.true.

surexec3 applied the misalignment angle, ø, and scaling factor, A, to both files. Variables were renamed and re-ordered to preserve the original raw data. Output files: sur262##.cal, sbt262##.cal.

surexec4 merged the ADCP data (both files) with the Trimble GPS 4000 navigation file (gp42621) created by gp4exec0 and the bestnav navigation file (abnv2621) created by navexec0. Ship's velocity was calculated from 2 minute spot positions taken from the gp42621 file and applied to the ADCP velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv2621, this last stage was not done in the processing scripts on *Discovery* 253. Output files: sur262##.abs, sbt262##.abs.

A6. Calibration of scientific echosounders (LEK and TEK)

The lowered EK500 (LEK) and the towed EK500 (TEK) scientific echosounders were calibrated at the start of the cruise using a standard method for a towed body calibration (after MacLennan & Simmonds, 1992; *Fisheries Acoustics*, Chapman and Hall, London). The calibration procedures were carried out between 0900 24 April and 0300 25 April, whilst the ship was at anchor off Engey Island, near Reykjavik, Iceland (approximately 64º12'N, 21º53'W). Once the equipment was assembled, calibration data were collected from the LEK first (between 1130 and 1715), followed by the TEK (between 1900 and 0040), using the same calibration apparatus. A 38.1 mm tungsten carbide standard target sphere was suspended approximately 10 m below each transducer in turn and data were collected using the usual logging systems for each echosounder. A CTD cast immediately before the calibration gave a consistent sound speed of 1472.1 ms^{-1} in the top 25 m of the water column, which gave the following expected target strengths for the standard target (taken from standard curves; Foote, 1990, J acoust Soc Am, 88: 1543-6):

38 kHz transducers	-42.23 dB
120 kHz transducers	–39.55 dB
200 kHz transducers	-39.48 dB

Data were collected to calibrate both the integrator (SV) gain and the Target Strength (TS) gain for each transducer. In the case of the TEK, after the initial data collection at the standard gain setting (26.5 dB in all cases), several further iterations of adjusting the gain to a new calculated value and collecting data were performed for each parameter for each transducer. This was not attempted for the LEK, due to communications difficulties caused by the aerial, which is used in the wireless Ethernet link over which data and commands are transmitted, being swamped by waves. Instead, the calibrated gain values from the previous MarProd cruise (*Discovery* 258) were used for the second iteration of data collection. Difficulties were also found in accurately positioning the target sphere under each transducer, due to the combined movements of the ship and transducers under the influence of significant waves, wind and tidal currents. The final calculations of the calibrated gain values were made at a later date.

The final gain values were calculated solely from on-axis 'pings' where possible, or those as close to on-axis as possible. The divergence from the on-axis positions was calculated from the sum of the absolute along and athwart offsets (measured in degrees) from the expected on-axis position. Pings were rejected if this summed offset exceeded 3º, and in most instances were only included in calculations where it was less than 1º. Where the summed offset was greater than 1º the pings were also filtered by TS, with those targets more than 3 dB weaker than the maximum value rejected. In the case of the single beam transducers (TEK 120 kHz and 200 kHz, LEK 200 kHz), the position of the sphere relative to the transducer was taken from the 38 kHz split-beam transducer single target detection data, adjusted for the relative positions of the transducers. The LEK 120 kHz was also treated in this manner, as the apparent failure of one quadrant within the transducer (determined at the end of the cruise) prevented it accurately detecting the target's position. The TS gain (TS_G) values were calculated using single target detection values exported directly from Echoview® (v. 2.25.82, SonarData, 1995) and the equation (all values in dB):

$$TS\_G_{New} = TS\_G_{Old} - ((TS_{Measured} - TS_{Expected}) / 2)$$

The SV gain (SV_G) values were calculated using the SA (= NASC or Nautical Area Scattering Coefficient in Echoview®) values derived from the integration, in Echoview®, of the target sphere's echo for single pings and the equation (gain values in dB, SA values in m^2nmile^{-2}):

$$SV\_G_{New} = SV\_G_{Old} + ((10 * Log (SA_{Measured} / SA_{Theoretical}) / 2)$$

Theoretical SA values were calculated from the expected TS of the sphere (TSexpt), the transducer's 2-way beam angle (TransA) and the distance to the sphere from the transducer face (Range) using the equation:

$$(4\pi * 10^{(TSexp/10)} * 1852^2) / (10^{(TransA/10)} * Range^2)$$

The final calibrated gain values are given in Table 17 below.

Table 17 Integrator (SV) and target strength (TS) gain values for TEK and SEK calibrations

Echosounder	Transducer frequency	SV Gain	TS Gain
TEK	38	26.83	27.10
	120	20.67	20.89
	200	23.33	23.59
LEK	38	25.02	25.50
	120	14.68	14.86
	200	24.09	24.44

Note that: i) during the cruise all data were collected using the standard SV and TS gain settings of 26.5 dB (the calibrated gain values were only applied during post processing); and ii) the calibrated gain values calculated for the 120 kHz transducer suggest that it was not functioning properly during the cruise, and the appearance of the data collected appears to confirm this. One of the transducer's quadrants was found not to be functioning after the cruise, and this is likely to have affected the quality of all the data collected from this transducer during *Discovery* 262.

Andrew Brierley, Eric Armstrong, Cairistiona Anderson, Ryan Saunders

A7. Pstar backup

Five rolling tapes. Do 'ls -lrt' to find the next number to use. Make sure you are on discovery6. Type 'dobackup <number>', where <number>=1, 2, 3, 4, or 5. Leave for a few hours. Occasionally it will fail with a tape io error. The only way round this I have found is to erase the tape and start again. Use 'mt -f /dev/rmt/0 erase'. The script dobackup is as follows (as for *Discovery* 258):

```
#
if (`hostname` != "discovery6") then echo "need to be on discovery6"
exit
endif

echo -n "enter tape number: "
set tapenum = $<
set listname = tape$tapenum.`date '+%m%d'`.list
/bin/rm -f $listname
touch $listname

/bin/cp $VERS /users/nerc/pstar/shipexec
set device = "/dev/rmt/0c"
set dirs = (/data61 /data62 /data63 /users/nerc/pstar /users/pexec)
set here = `pwd`

set i = 0
while ($i < $#dirs)
@ i = $i + 1

echo -n "writing $dirs[$i] ... "
cd $dirs[$i]
tar cf ${device} .
if ($status != 0) then echo "problem - $status status returned "
exit
endif
echo "done"

echo -n "listing $dirs[$i] ... "
@ im1 = $i - 1
if ($im1 != 0) mt -f ${device}n fsf $im1
tar tvf ${device}n >> $here/$listname
if ($status != 0) then echo "problem - $status status returned "
exit
endif
echo "done"
cd $here
end
```

A8. Towed zooplankton net systems - biological sorting

A8.1 Sampling summary

Zooplankton and associated specimen samples were collected with the Autosampling Recording Instrumented Environmental Sampler (ARIES), Dual Methot (DM) and Ocean Sampler (OS) to provide data on zooplankton populations and distribution, on food chain interactions and on environmental conditions.

There were 23 successful OS and DM deployments and 25 ARIES deployments. Onboard, sub-sampling of plankton specimens for bio-chemical analysis from the ARIES and DM nets was carried out. This material will be used for studies of lipids, genetics and CHN/isotope ratios. Ryan Saunders, Steve Hay, Emily Roberts and Fiona Ware conducted the sampling and documented the sampling in a spreadsheet. All depth samples from the OS nets were preserved for subsequent microscope analysis and species enumeration. Both the ARIES and OS samplers catch two Pup net depth integrated samples. These were preserved, with one in ethanol and one frozen from all deployments. Full results for the zooplankton sampling await detailed onshore sorting and identification.

A8.2 Deck work and sorting procedures

These were essentially as described in the report for the winter cruise *Discovery* 258. Specimens were picked out for future laboratory analyses as follows:

Lipids – into plain cryovials and stored in liquid nitrogen
Genetics – into red banded cryovials and specimens stored in pure ethanol.
Isotope ratio – into acetone cleaned foil and/or in glass screw top vial placed in –20deg C freezer.

A8.3 Species list

The following species were picked out for further analysis. A typical number of sets of individuals, dependent on abundance, is given in parenthesis [* denotes target species for Marine Productivity fieldwork].

Picked from ARIES nets

Copepoda:
**Calanus* (3 – 4 sets x 10)
Euchaeta spp. (3 sets x 10)

Most commonly picked from Dual Methot net, for lipids, genetics and CHN/Isotope ratios

Euphausiidae:
**Meganctiphanes norvegica* (3 sets x 5)
**Thysanoessa longicaudata* (3 sets x 5)
Thysanoessa inermis (3 sets x 5)

Specimens for the CHN/Isotope ratio work, a standard species set with occasional additions.

Copepoda:
Calanus hyperboreus adults or late copepodids (6)
Euchaeta spp. females (6)

Decapoda and Mysidaceae:
Common species, including Sergestiid shrimps and other deep water species

Chaetognatha:
Sagitta maxima (6)
Eukronia hamata (6)

Amphipoda:
Parathemisto spp.(3)

Fish:
Specimens of representative deep water species

Jellyfish:
Specimens of representative species including *Periphylla, Aglantha digitalis* and some siphonophores.

Plus a number of other species as encountered.

Ryan Saunders

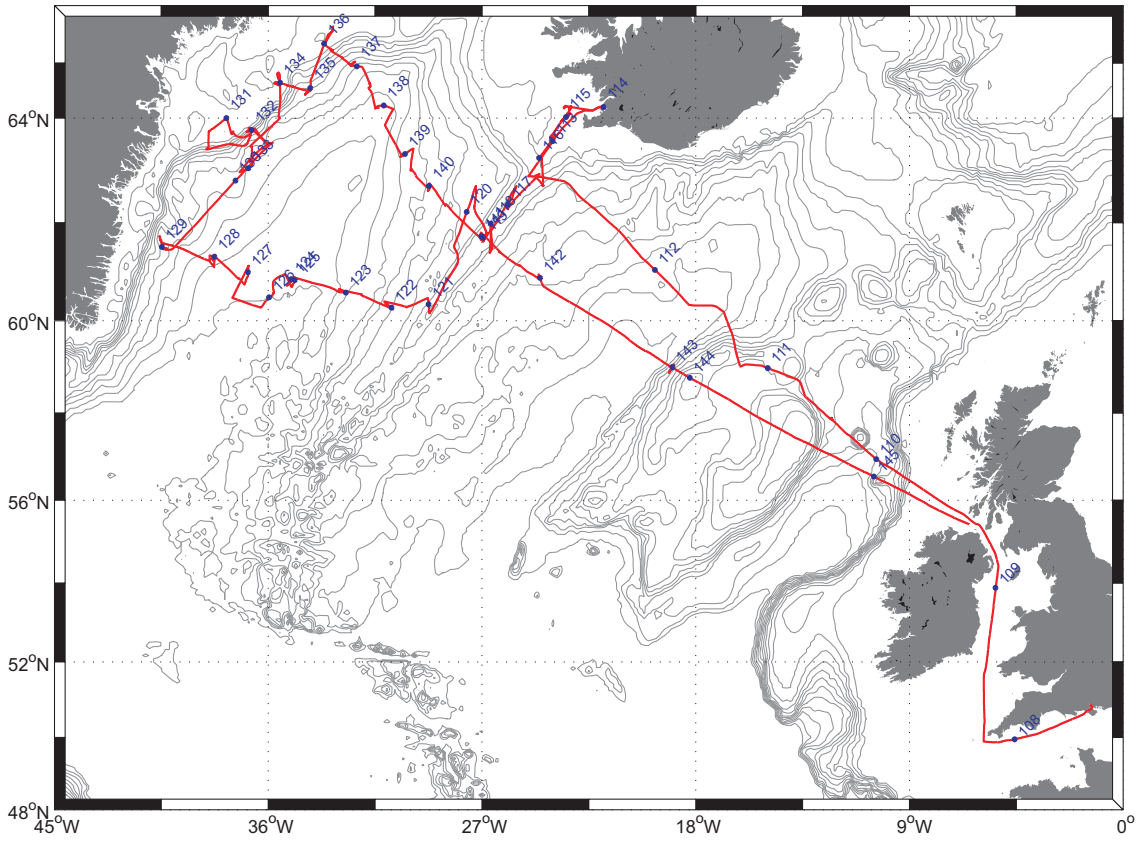


Fig. 1 Cruise track for *Discovery* 262. Numbers indicate Julian days; 108 = 18 April, 145 = 25 May 2002. [Text section 1.3]

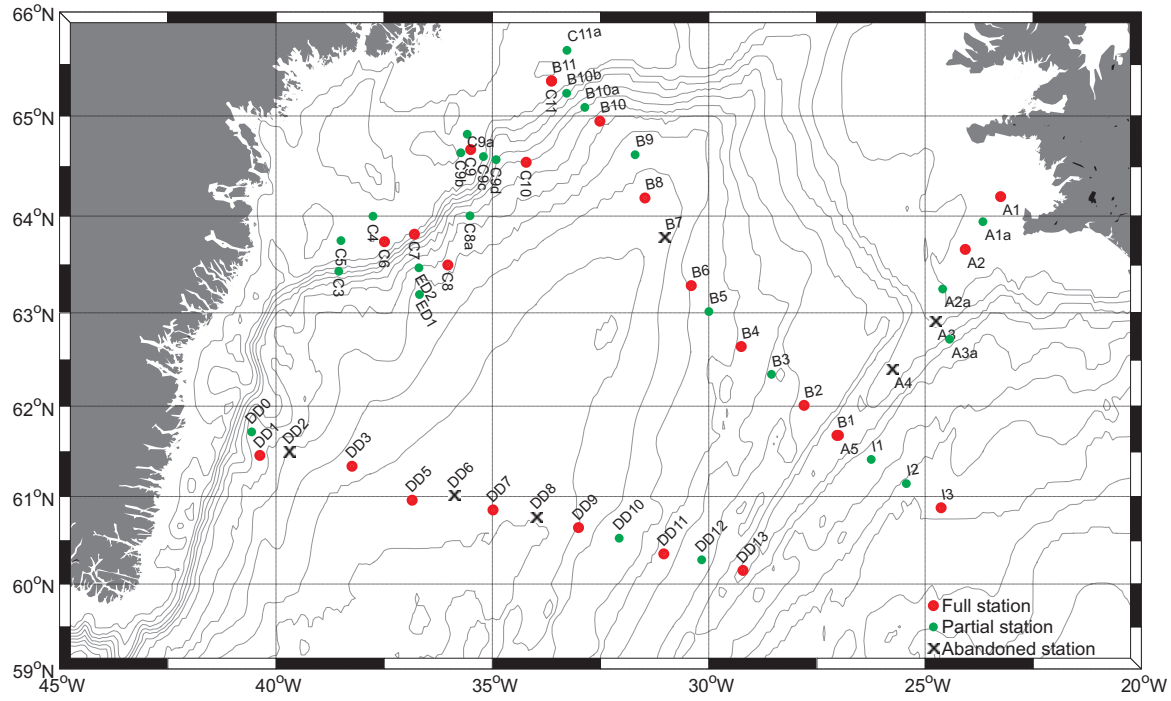


Fig. 2 Site positions for *Discovery* 262. Note that DD sites were referred to as D sites during the cruise, but were subsequently re-labelled (to avoid confusion with previous D transect, further to the south, covered by *Discovery* 258). [Text section 1.3]

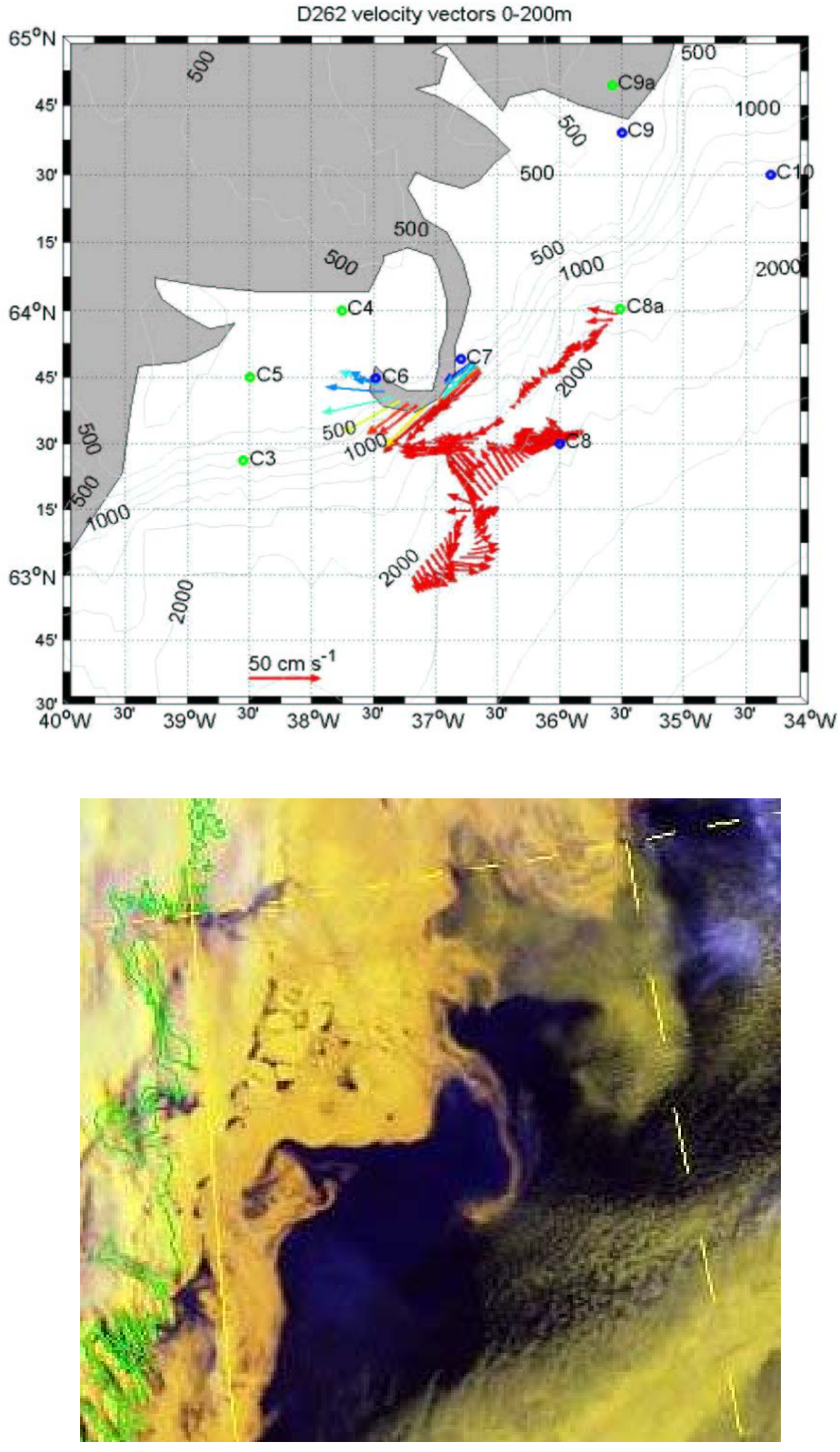


Fig 3. Location of sites C3-C10 on Greenland shelf and shelf-edge (upper) in relation to position of sea-ice edge on 11 May, based on Dartcom image (lower). Velocity vector also shown on upper map, colour coded for salinity. See Fig. 23 for additional satellite imagery of ice-edge dynamics. [Text section 1.3]

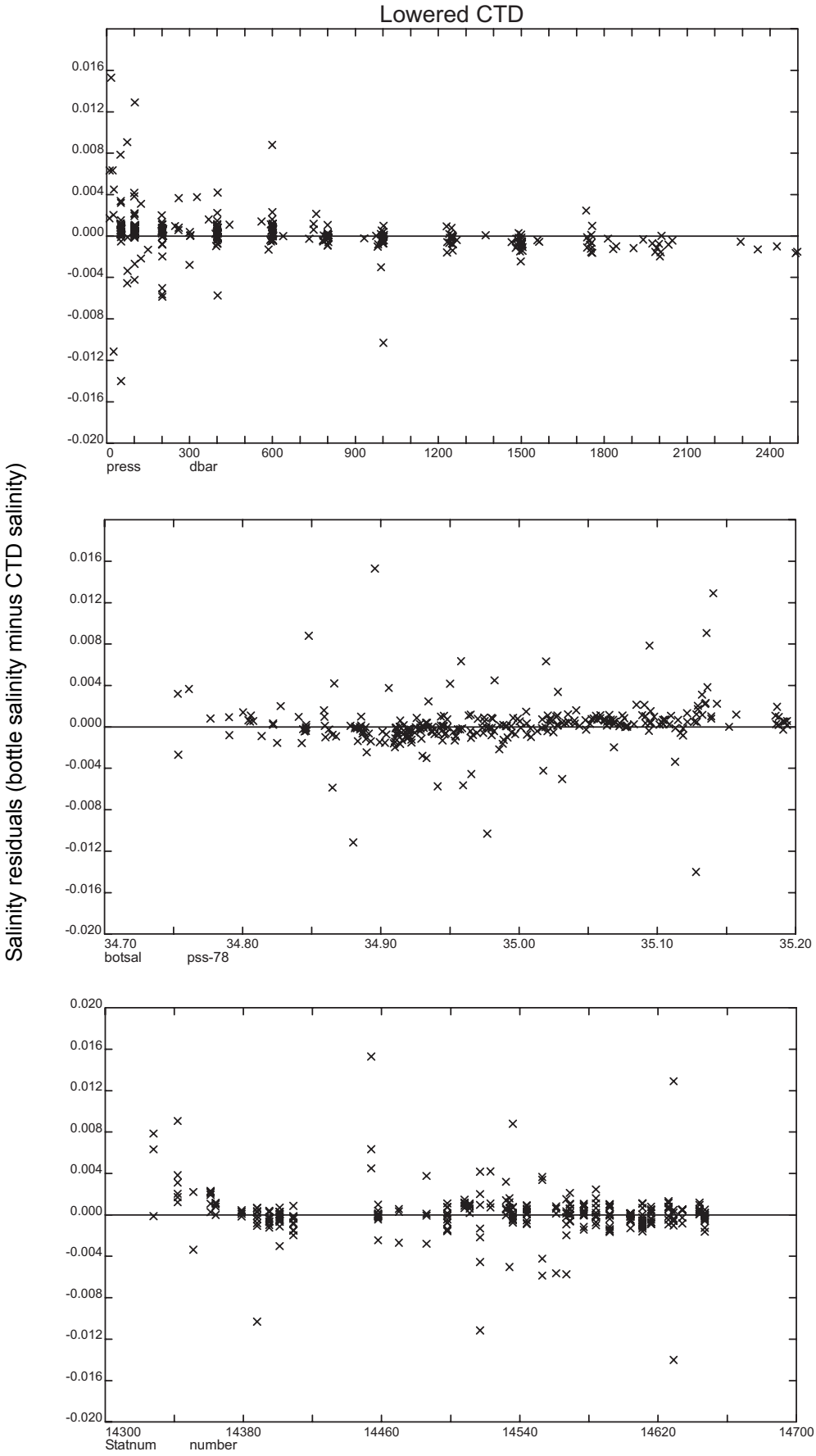


Fig. 4 Salinity residuals (bottle salinity minus CTD salinity) for the lowered CTD primary sensor, as a function of pressure (upper graph), bottle salinity (middle) and station number (lower). [Text section 2.2.4]

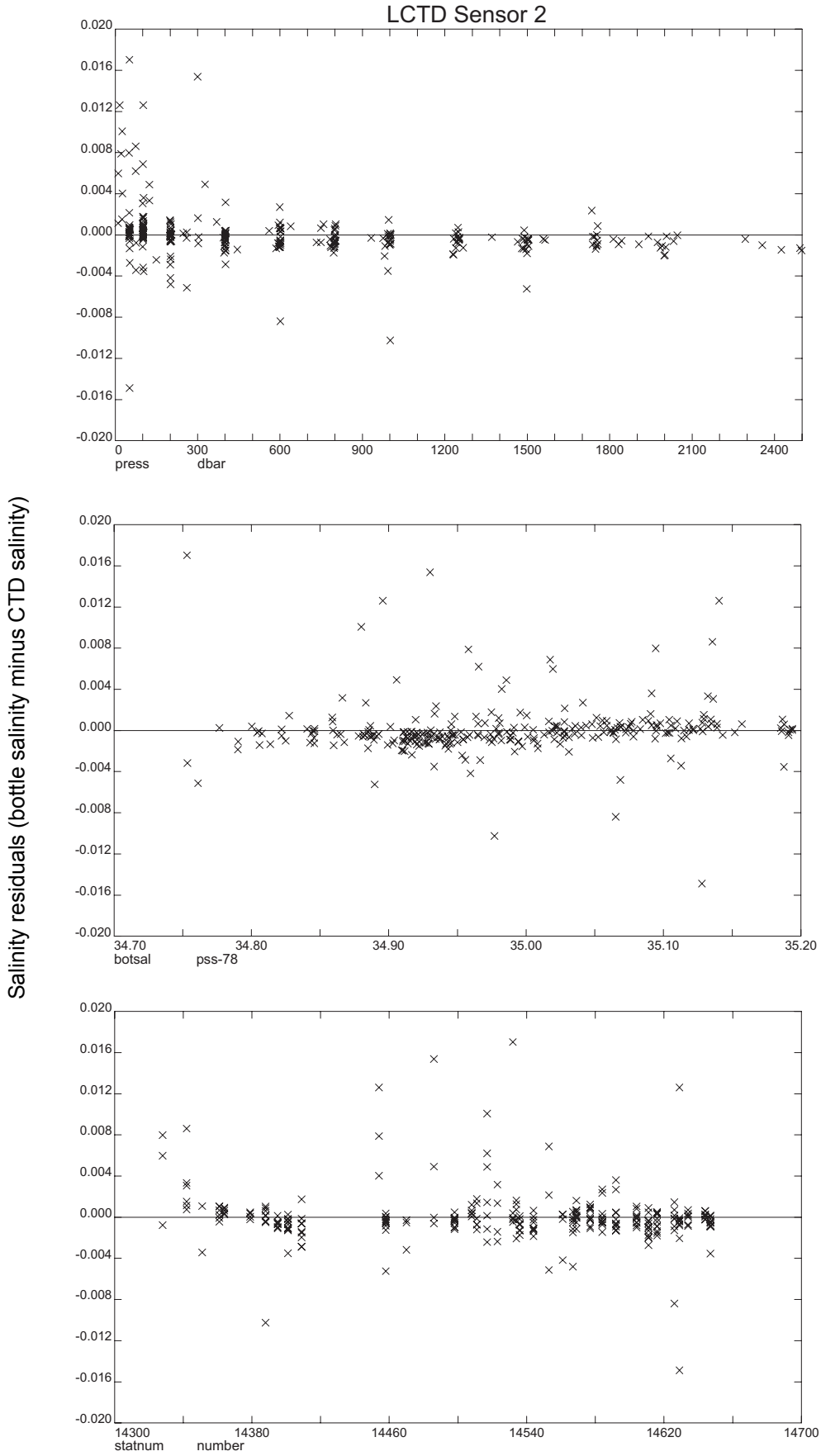
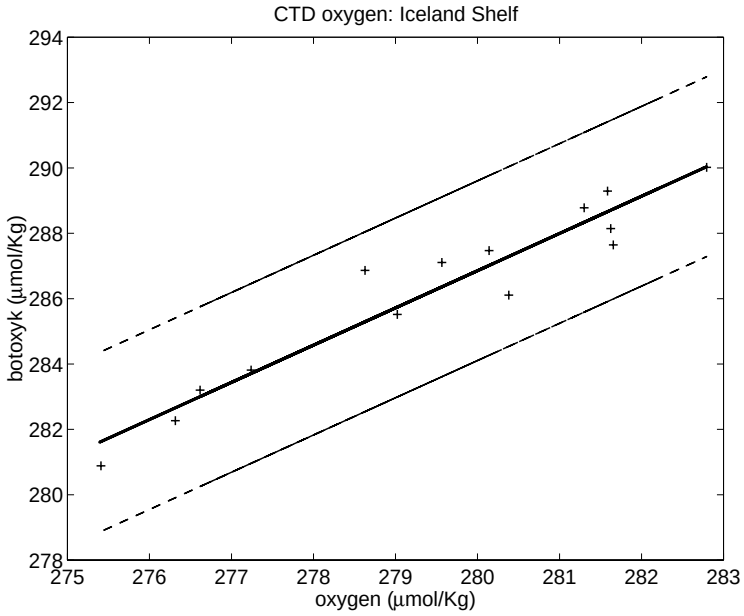
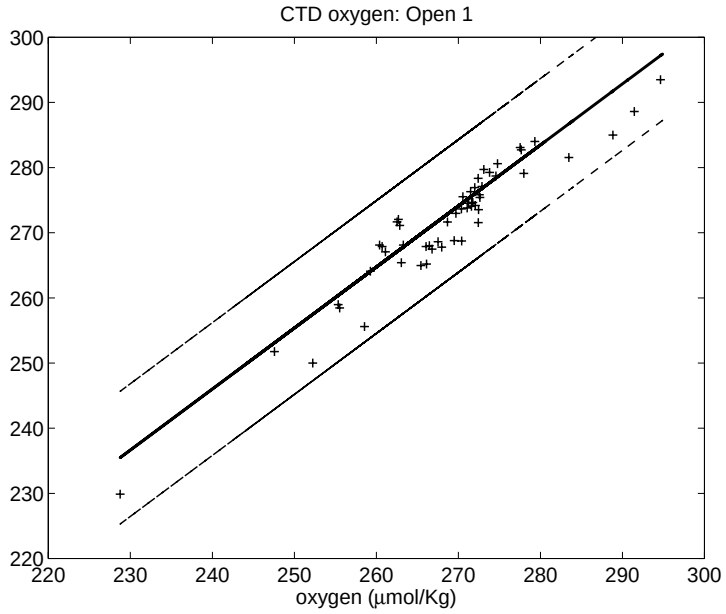


Fig. 5 Salinity residuals (bottle salinity minus CTD salinity) from the lowered CTD secondary sensor, as a function of pressure (upper graph), bottle salinity (middle) and station number (lower). [Text section 2.2.4]





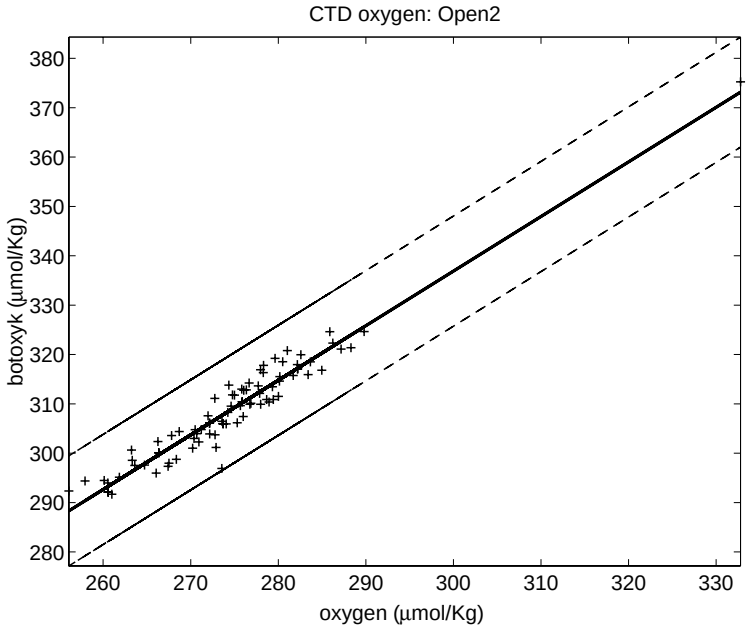


Fig. 6 Calibration of CTD oxygen sensor. Plots against bottle oxygen (best fit regression ± SD) for Iceland Shelf (upper graph), Open 1 (middle) and Open 2 (lower). [Text section 2.2.4]

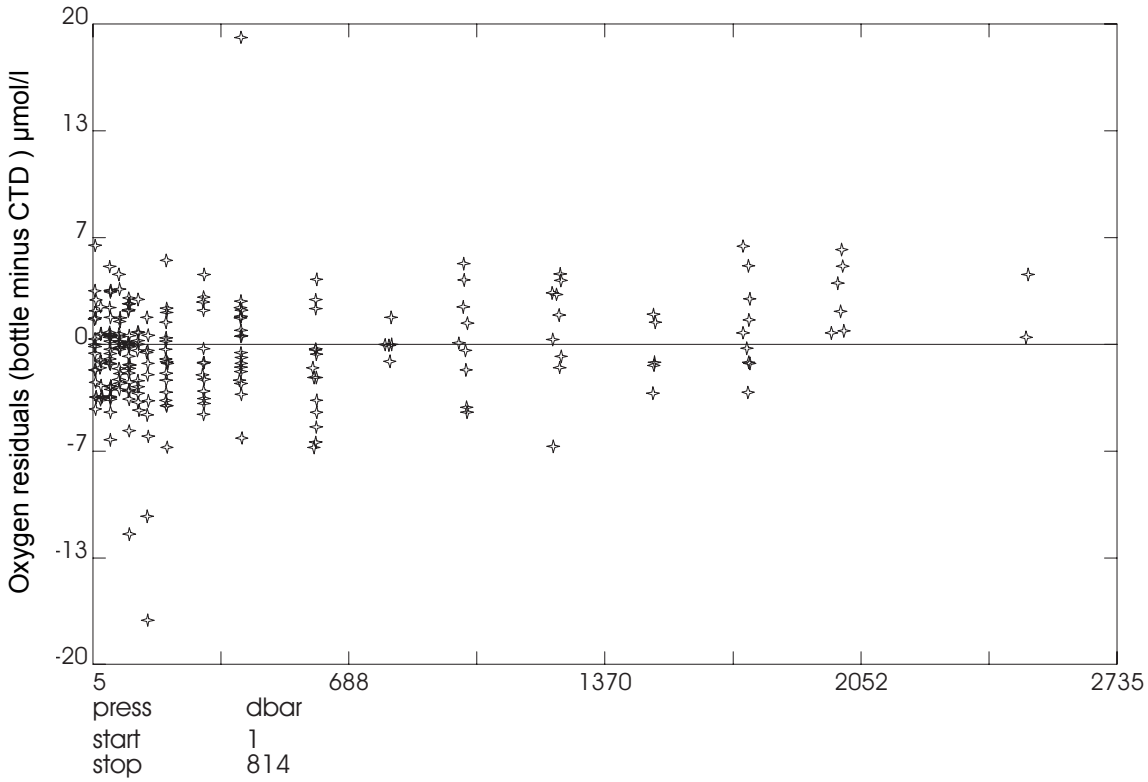


Fig. 7 Distribution of CTD oxygen residuals from calibrated data against pressure. Mean residual = –0.42 ± 3.34 µmol/l. [Text section 2.2.4]

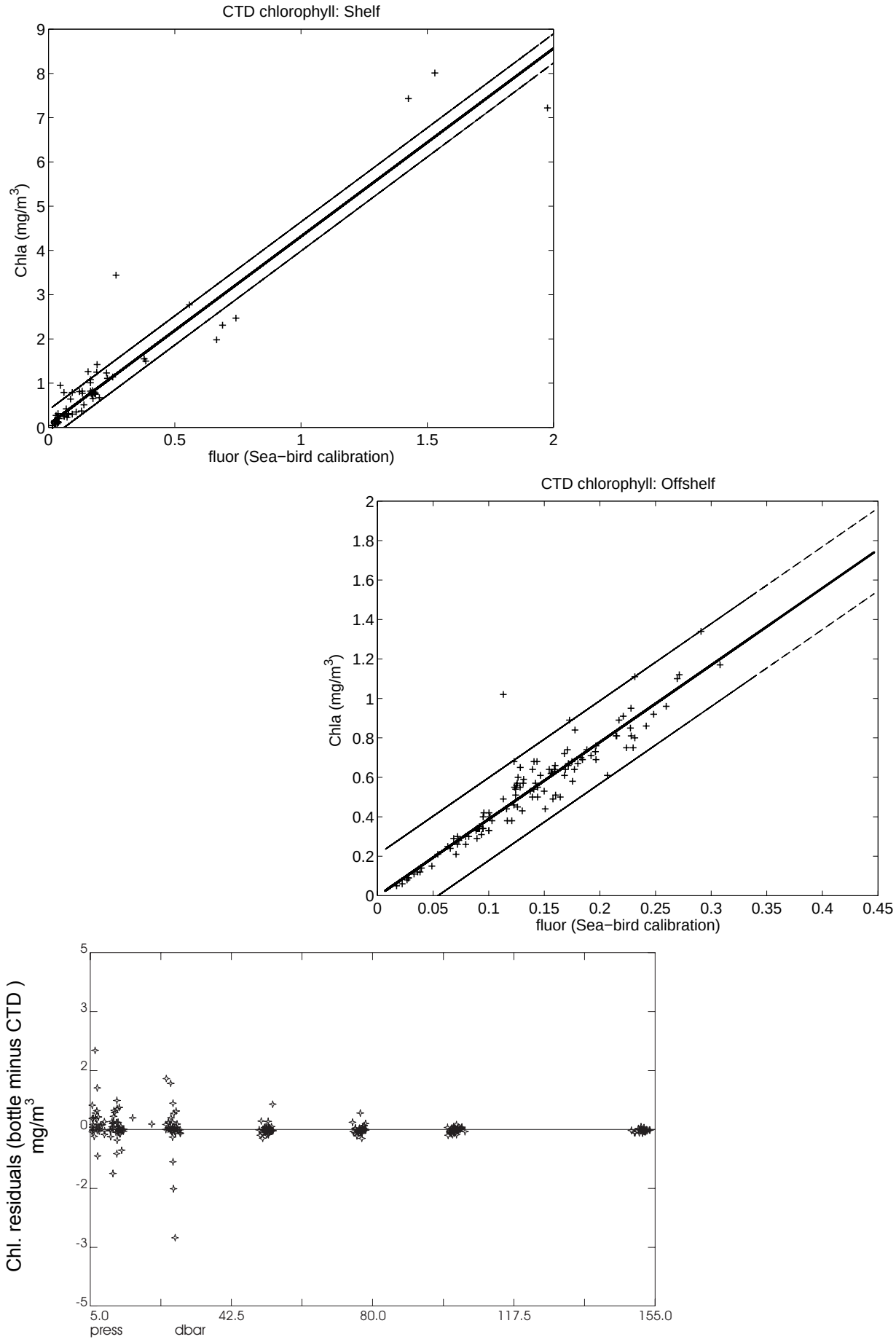


Fig. 8 Calibration of CTD fluorescence sensor. Plots against bottle chlorophyll (best fit regressions ± SD) for shelf (upper graph) and off-shelf (middle) data. Also shown are residuals for all data as a function of depth (lower). Mean residual = 0.03 ± 0.20. [Text section 2.2.4]

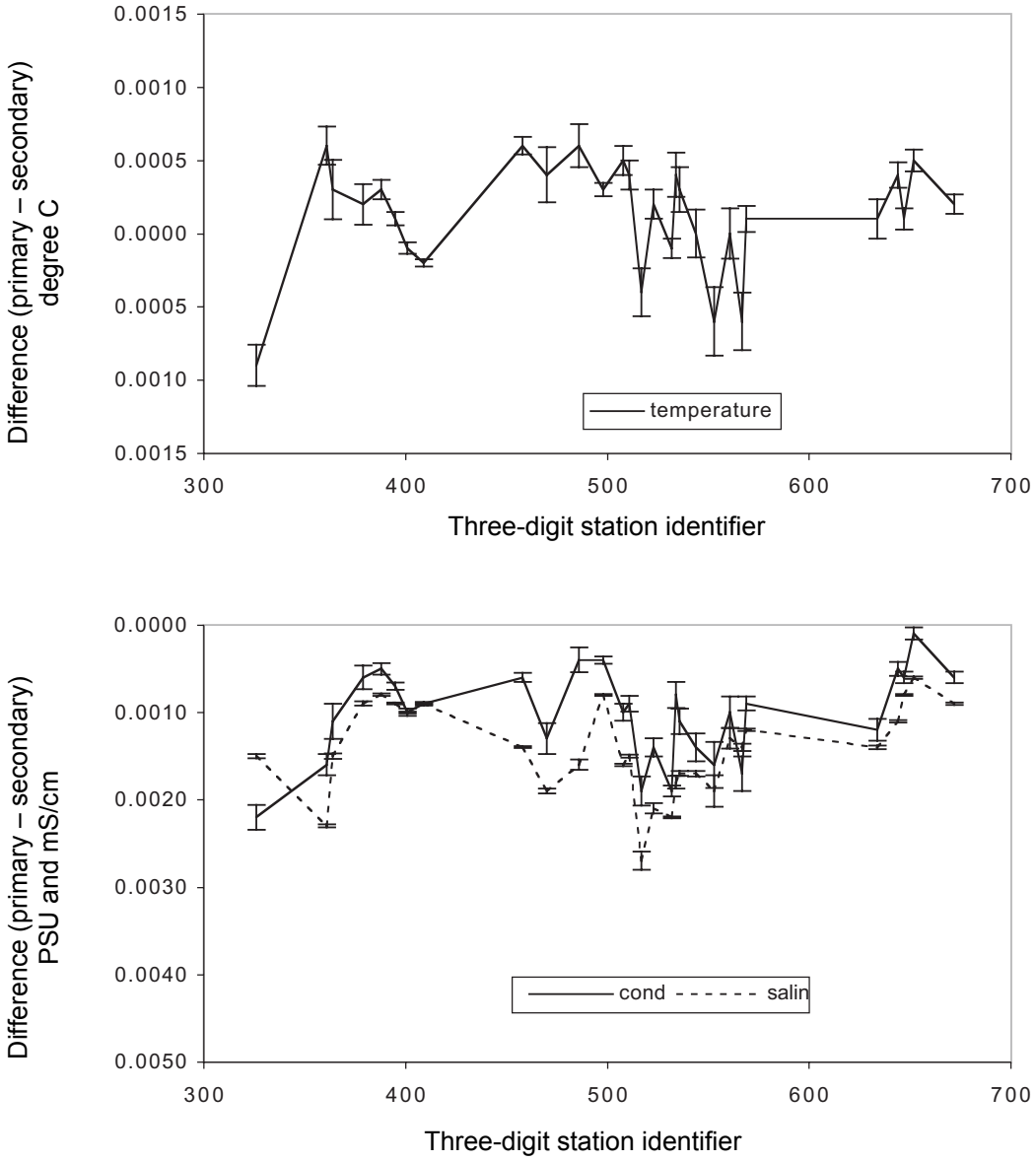


Fig. 9 CTD relative sensor drift. Mean difference (primary - secondary) between temperature (upper graph), and conductivity and salinity (lower) as a function of station number. [Text section 2.2.5]

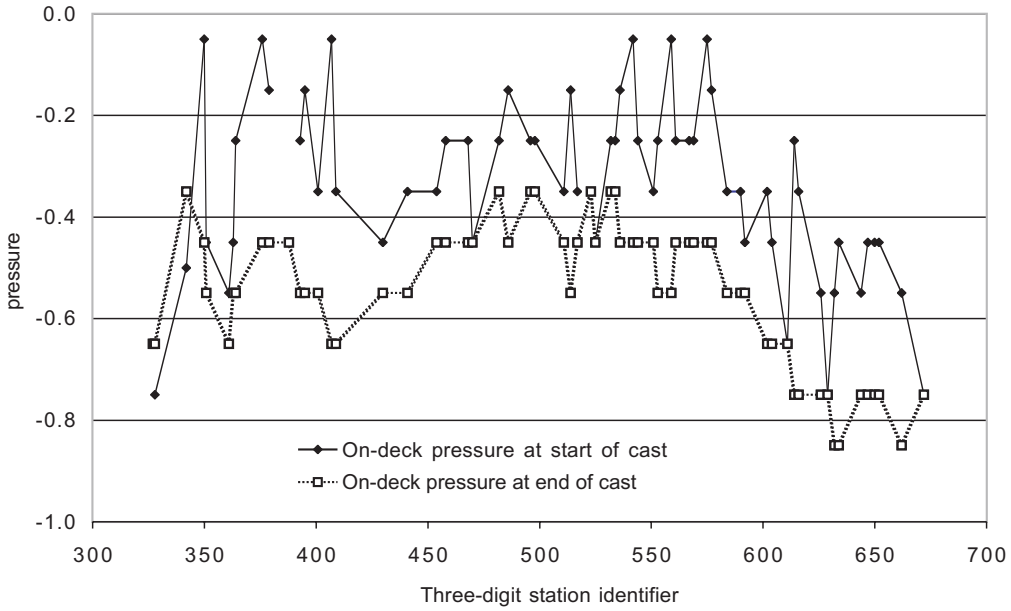


Fig. 10 On-deck pressure reading before and after each CTD cast as a function of station number. [Text section 2.2.5]

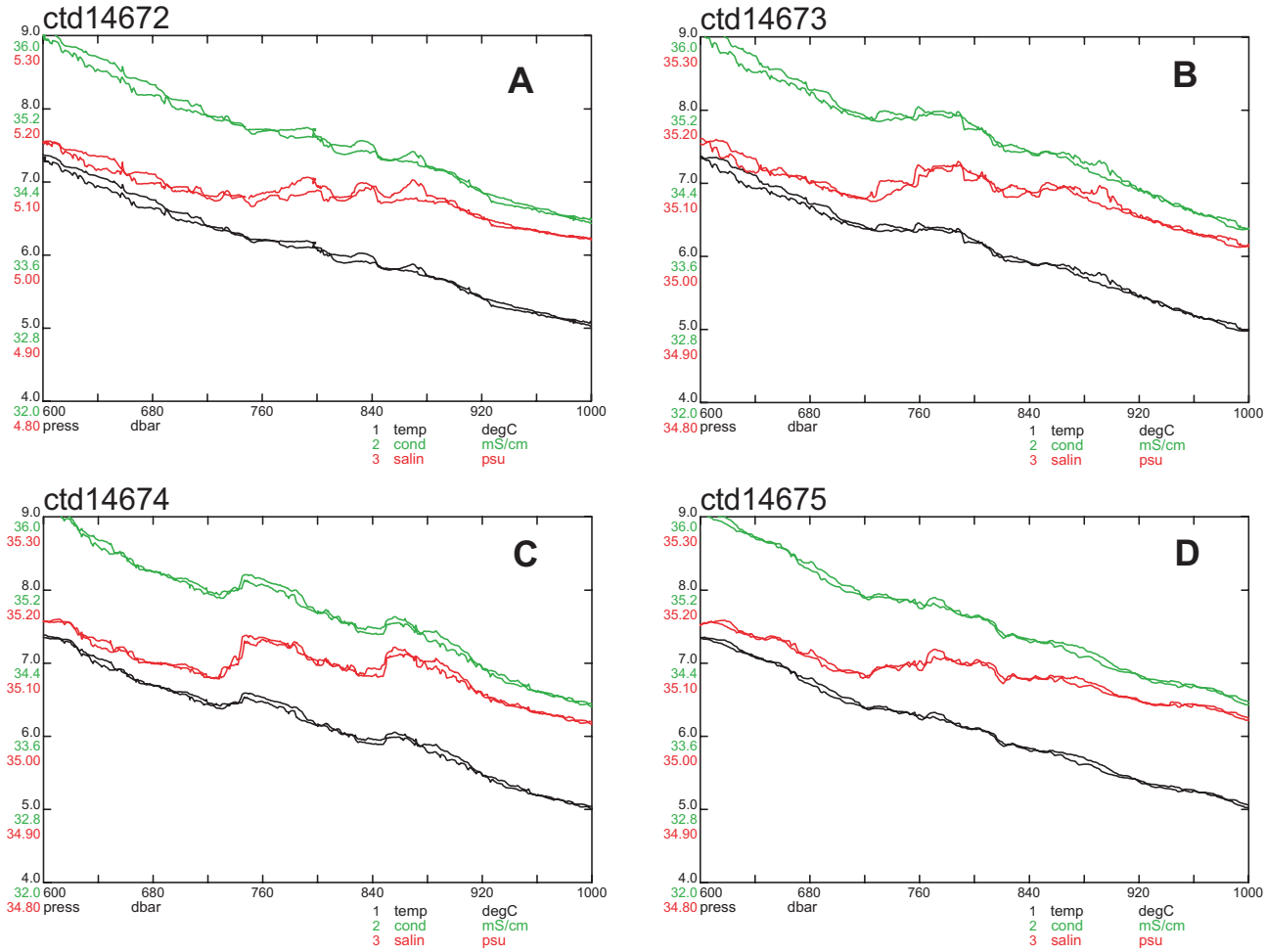


Fig. 11 Results from the CTD trials: temperature, conductivity and salinity data from four casts in the same location with different instrument arrangements. A, full suite (ctd14672); B, with 300 kHz LADCP removed (ctd 4673); C,with fluorometer and transmissometer removed (ctd14674); D, as previous but with sensors outside of frame (ctd14675). [Text section 2.2.6]

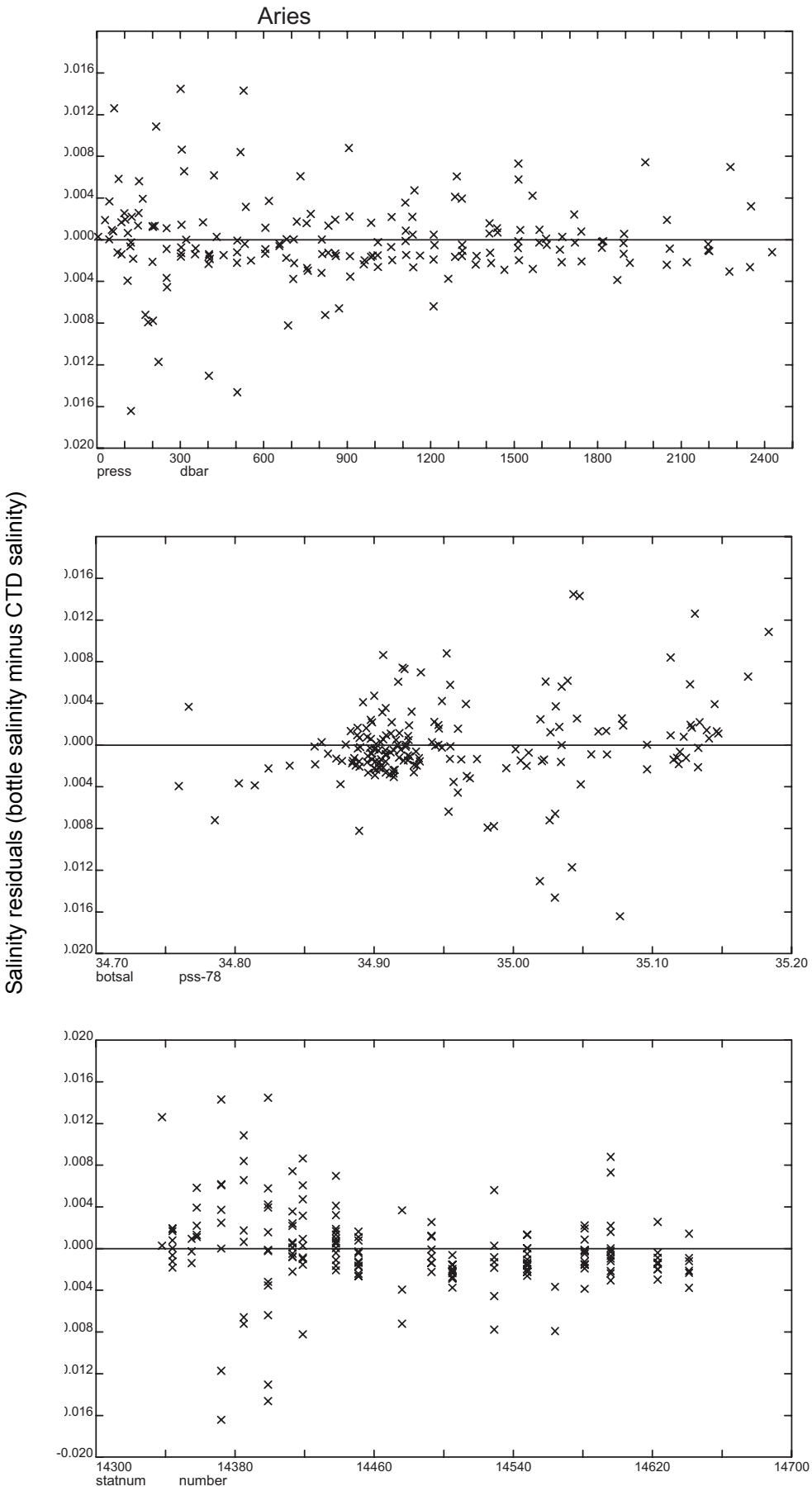


Fig. 12 Salinity residuals (bottle salinity minus CTD salinity) for the ARIES CTD, as a function of pressure (upper graph), bottle salinity (middle) and station number (lower). [Text section 2.3.4]

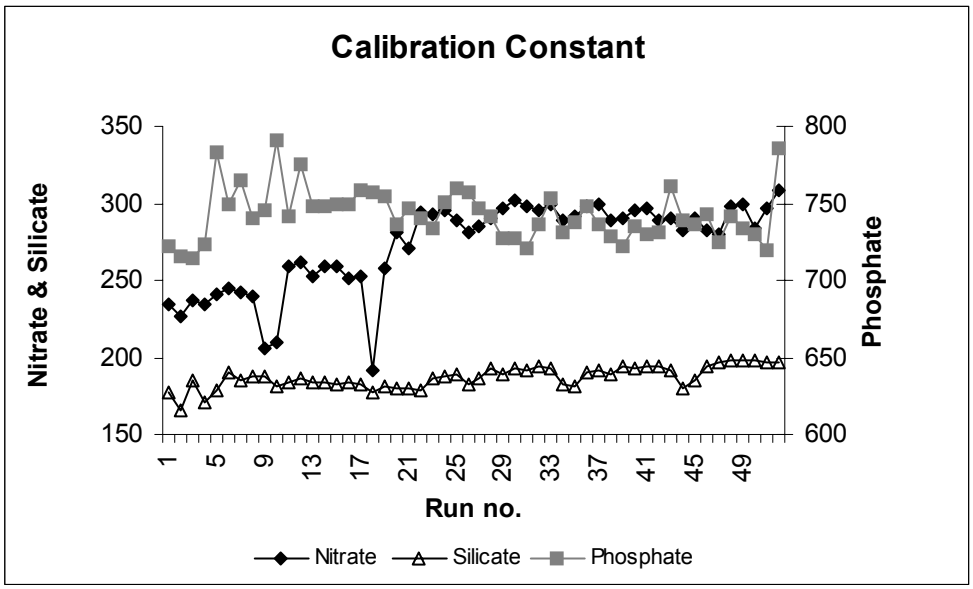


Fig. 13 Calibration constants for nutrient autoanalyser. Data for nitrate, silicate and phosphate as a function of run number. [Text section 7.1.3]

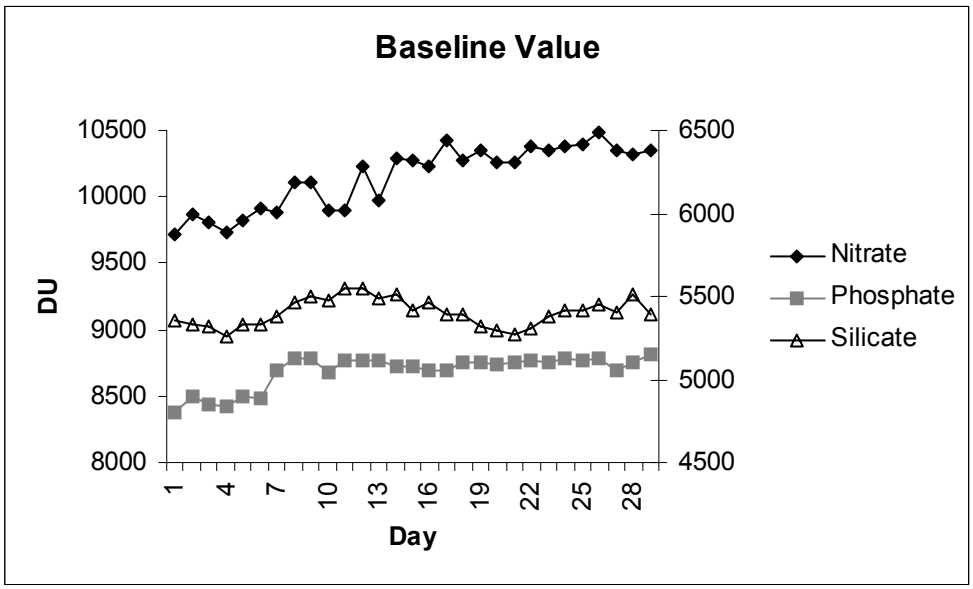


Fig. 14 Nutrient autoanalyser baseline values for nitrate, silicate and phosphate as a function of time. [Text section 7.1.3]

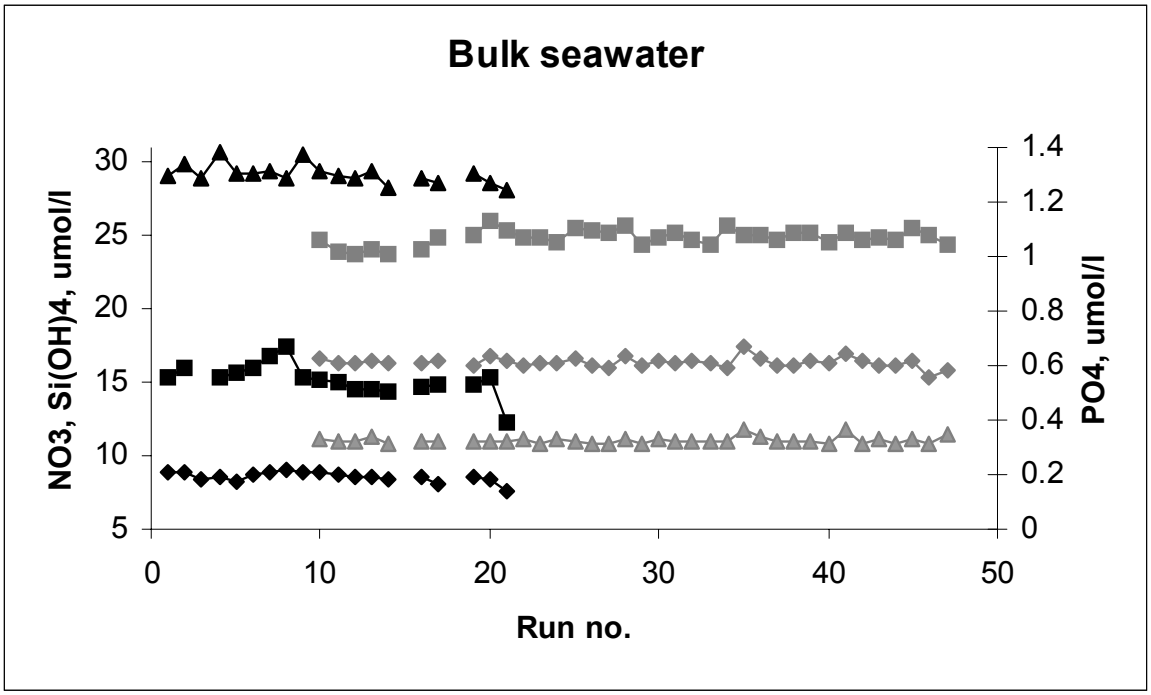
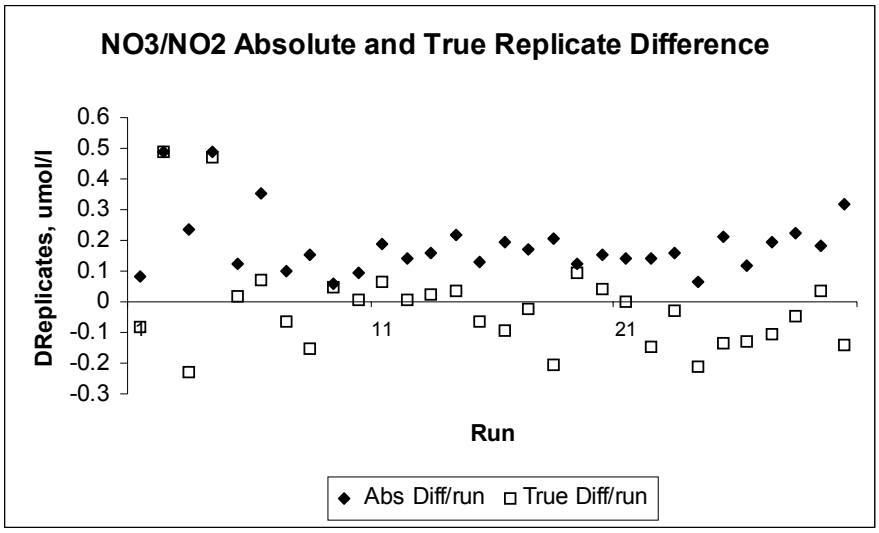
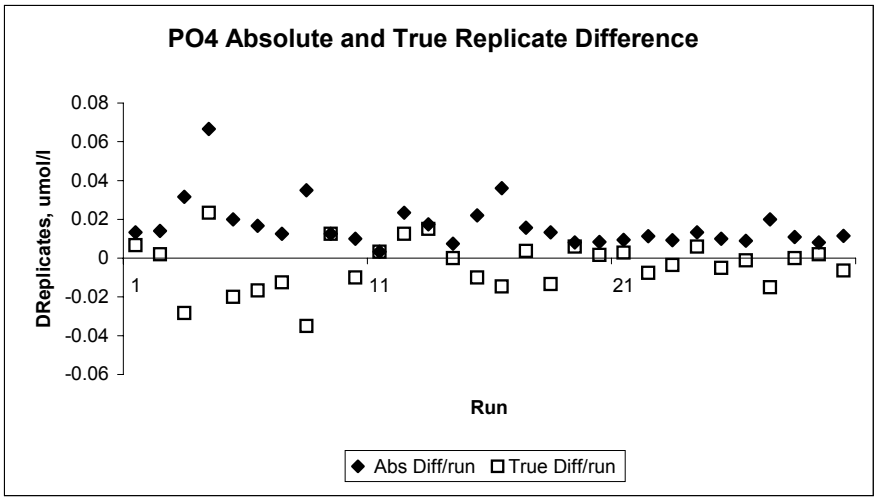


Fig. 15 Repeat analyses of silicate and phosphate and nitrate for bulk seawater samples collected on *Discovery* 258 and *Discovery* 262. [Text section 7.1.3]





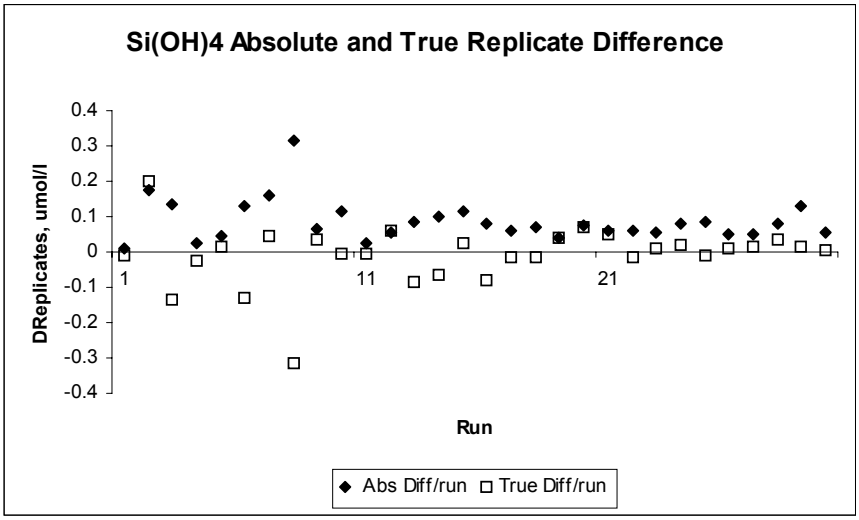


Fig. 16 Absolute and true replicate differences for analyses of nitrate (upper), phosphate (middle) and silicate (lower). [Text section 7.1.3]

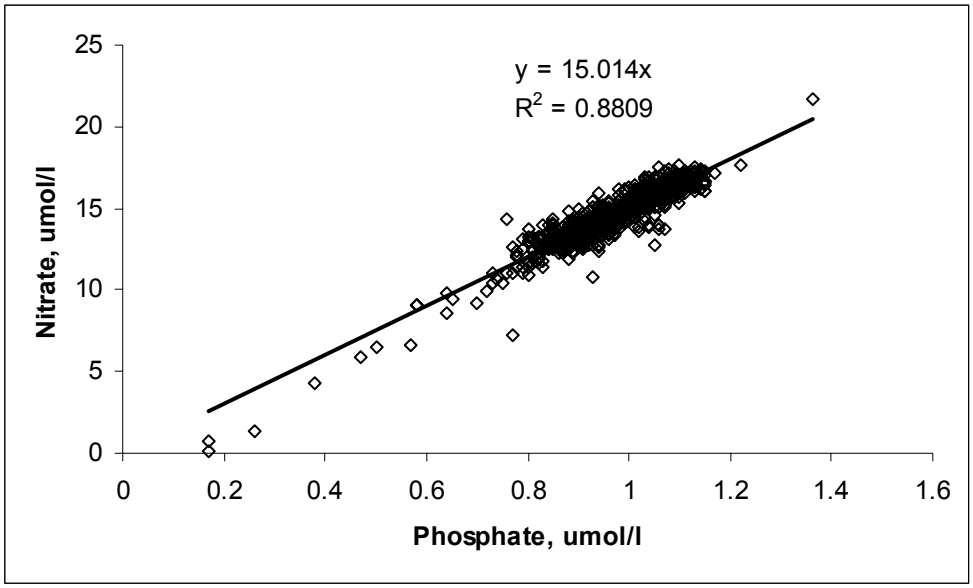


Fig. 17 Mean N:P ratio determined from plot of nitrate versus phosphate analyses. [Text section 7.1.3]

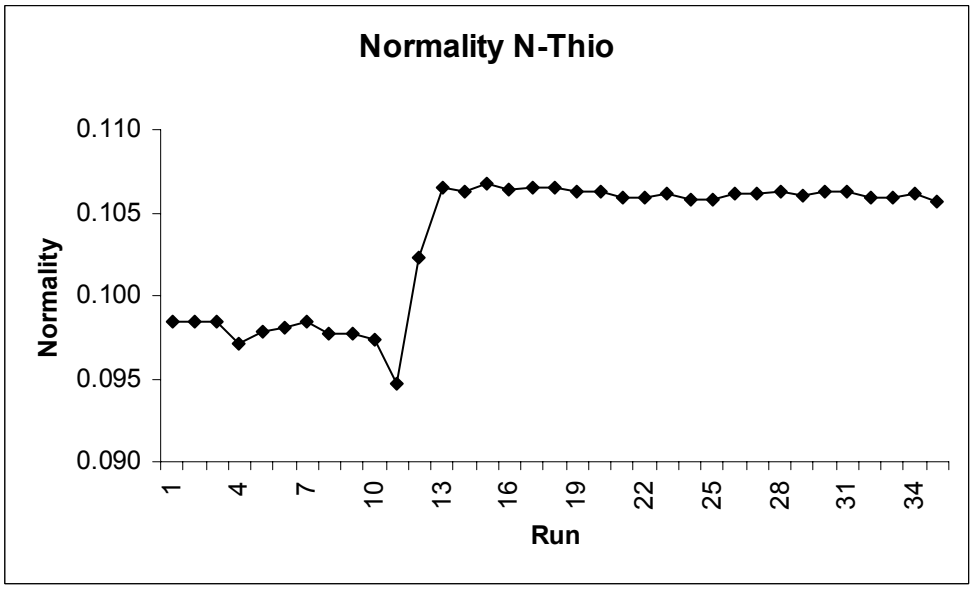


Fig. 18 Normality of the thiosulphate solution, used for determining dissolved oxygen concentrations. [Text section 7.2]

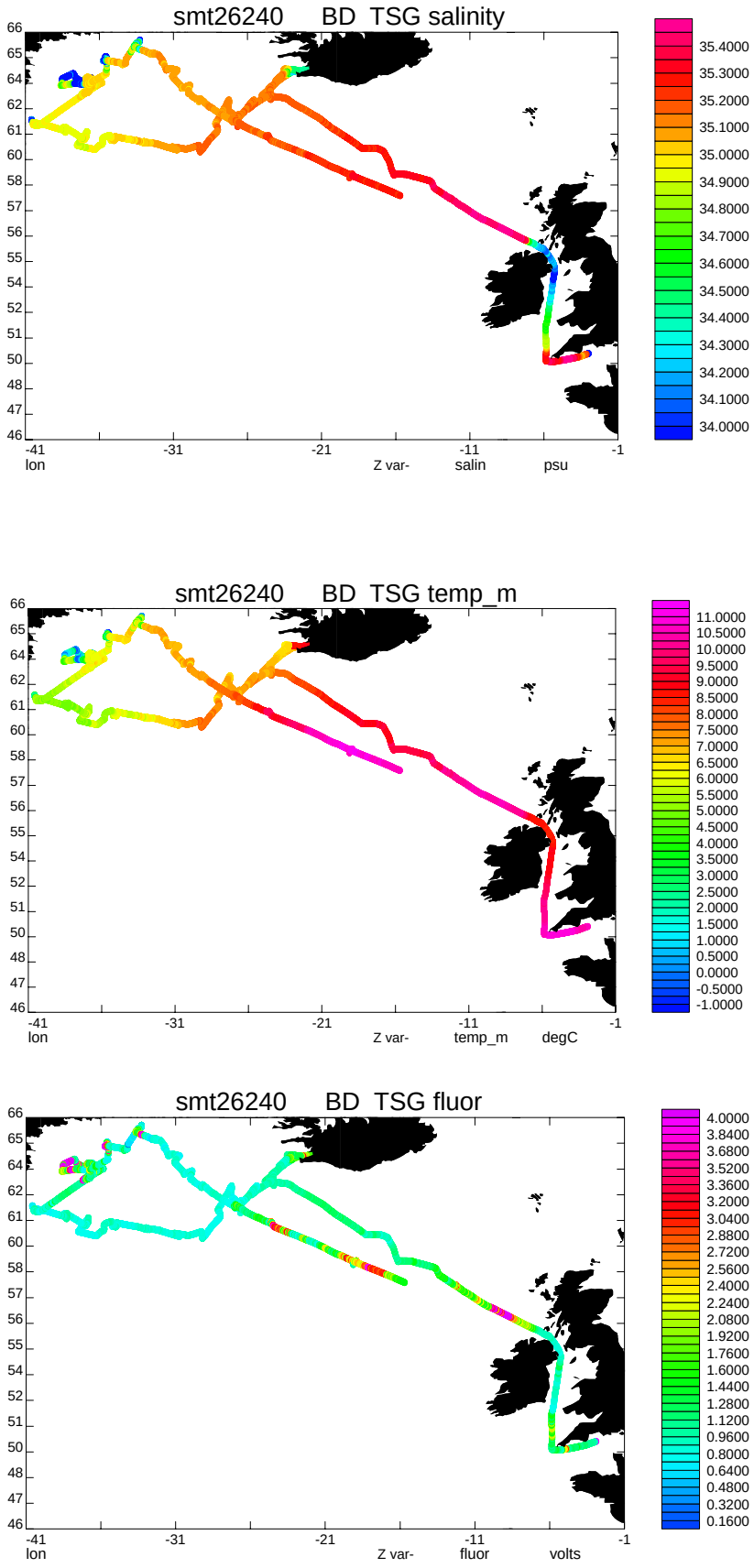


Fig. 19 Surface maps of salinity (upper), temperature (middle), corrected fluorescence (lower) from the ship's surface underway thermosalinograph and fluorometer. [Text section 9.1.2]

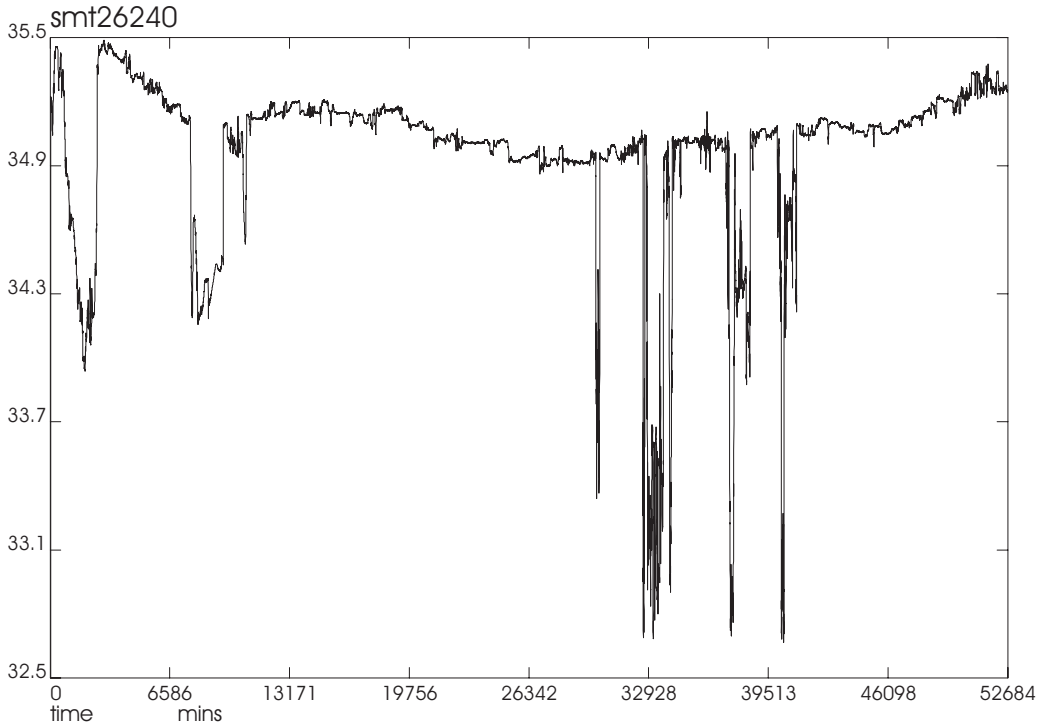


Fig. 20 Underway time series of corrected surface salinity. Time in minutes from starting time of 17:50, Julian day 108. [Text section 9.1.3]

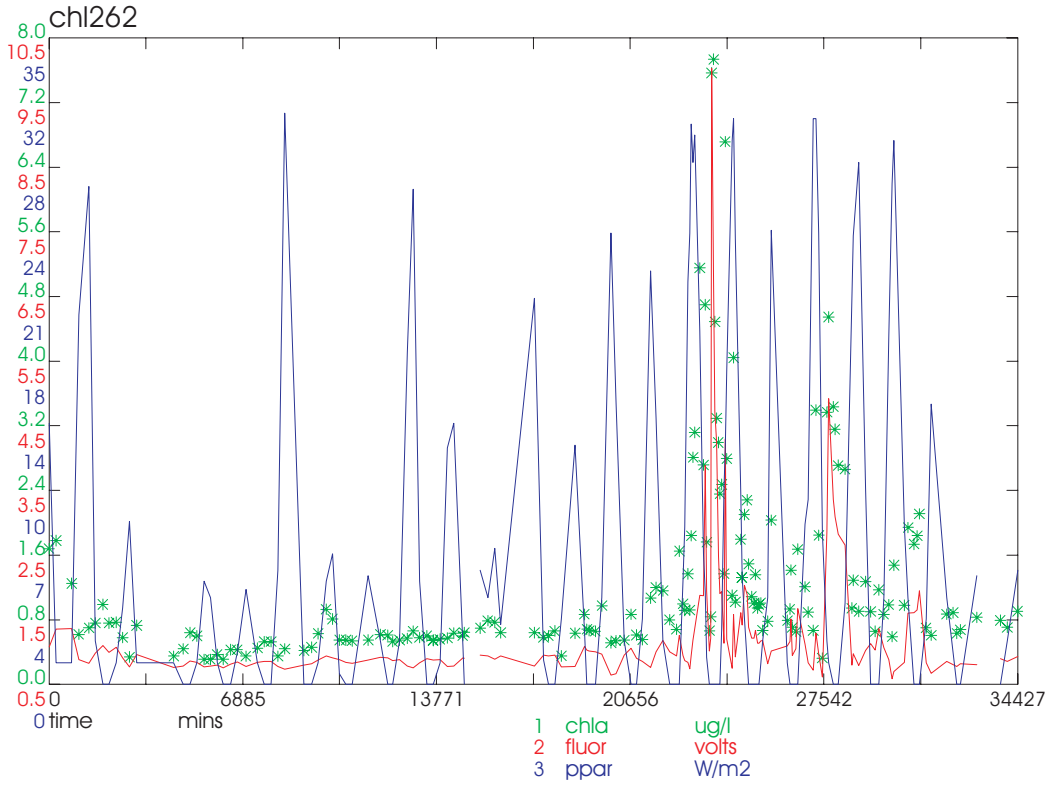


Fig. 21 Underway time series of chlorophyll concentration, surface fluorescence (fluor) and photosynthetically available radiation (ppar) measured on samples taken from the ship's non-toxic supply. Time in minutes from starting time of 17:50, Julian day 108. [Text section 9.1.4]

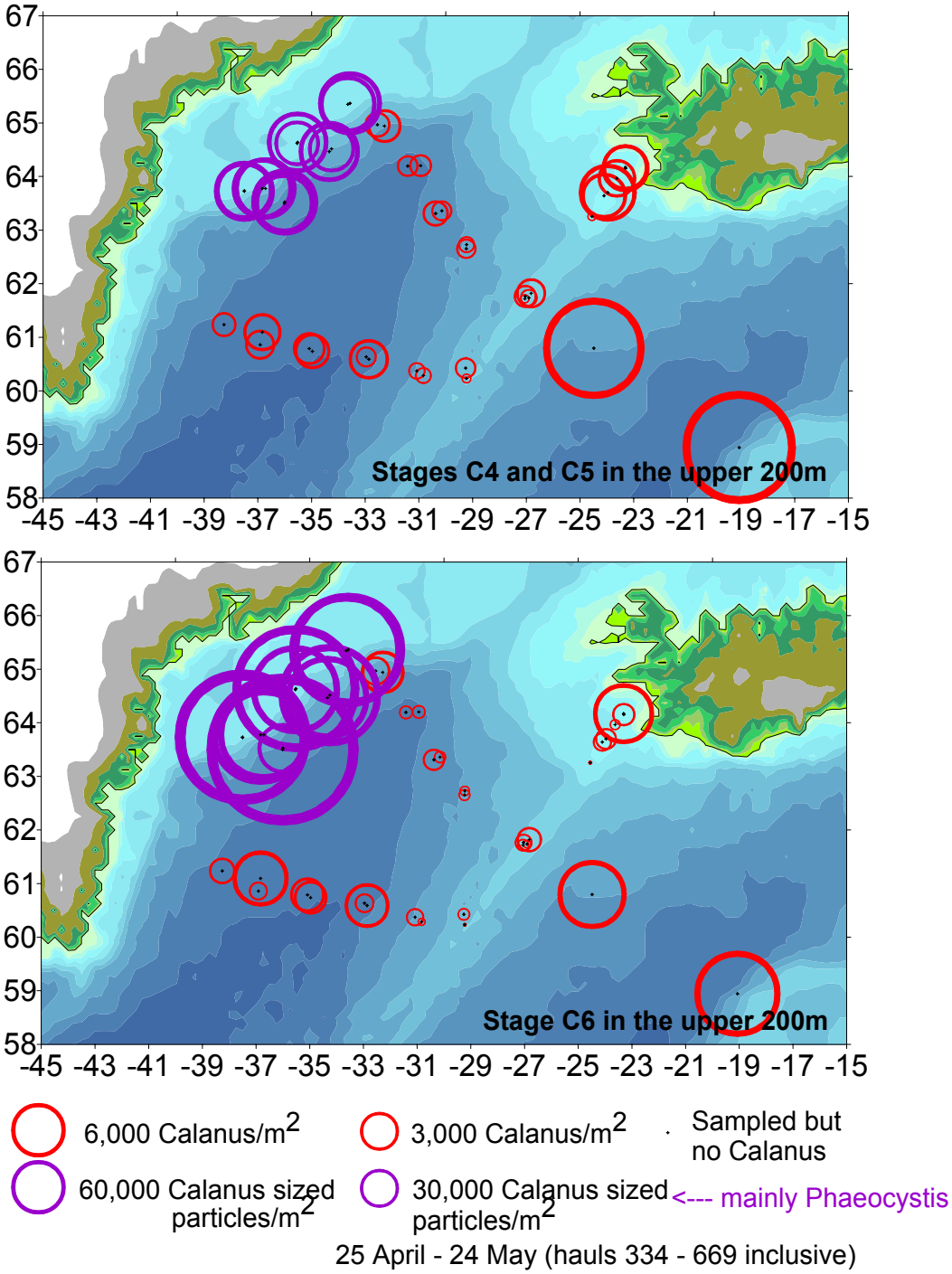


Fig. 22 Estimated standing stocks of *Calanus*-sized particles in upper 200m: copepodites C4-C5 (top map) and adults (bottom), from preliminary ARIES OPC data. Note that purple circles include major *Phaeocystis* effects, and there may be also be some non-*Calanus* material included in estimates given as red circles. [Text section 10]

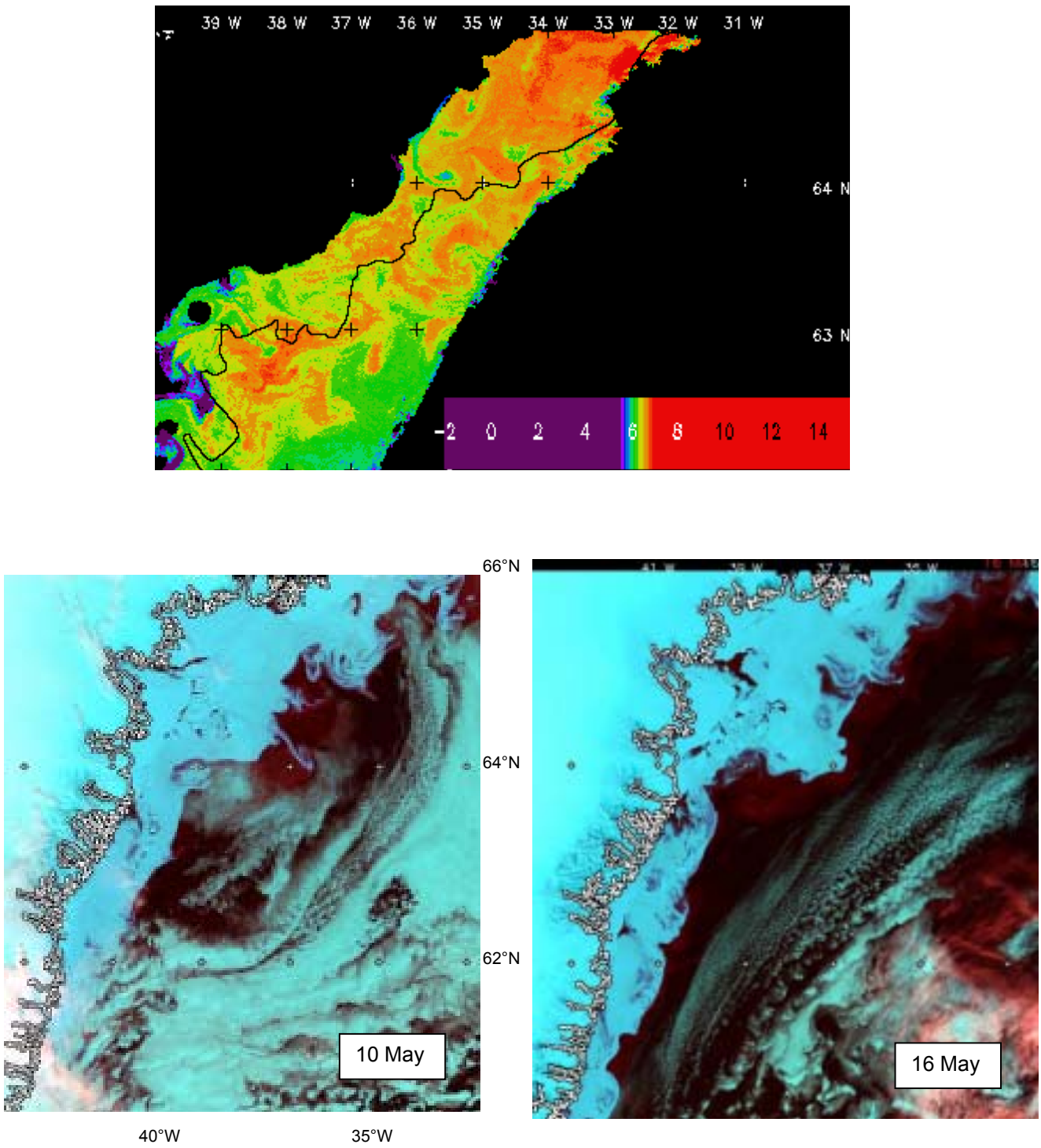


Fig. 23 Examples of processed AVHRR satellite imagery provided to *Discovery* 262, showing sea surface temperature features (range 6-7°C) at the Greenland shelf-edge on 16 May (top) and changes to sea-ice cover between 10 - 16 May (lower). [Text section 14; also see Fig 3 for Dartcom image for 11 May]

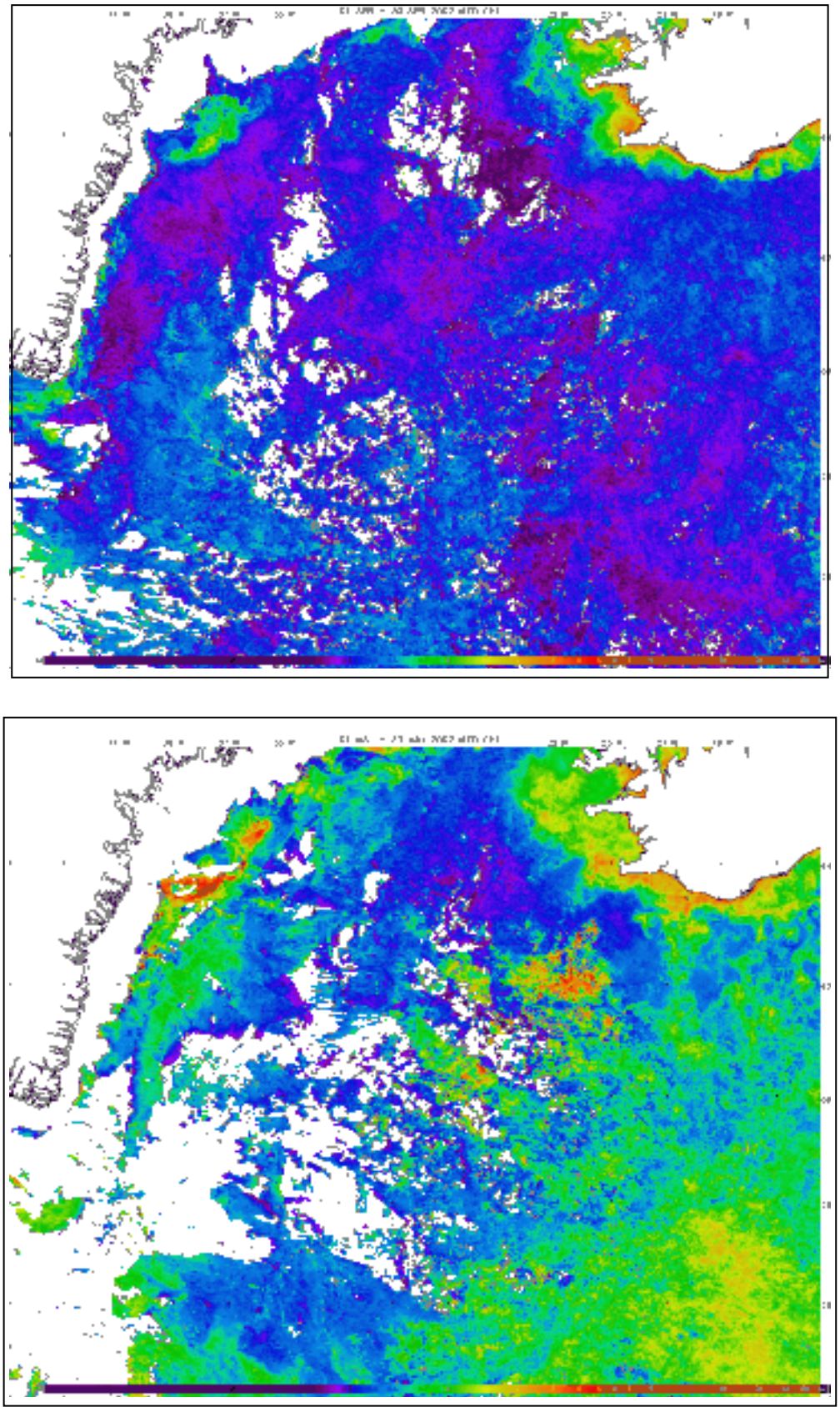


Fig 24. SeaWiFS composites for chlorophyll-a, for April (upper) and May 2002 (lower). [Text section 14]