JR16003 Cruise Report

Western Core Box

08/12/2016 – 17/01/2017

Contents

1. Introduction

Sophie Fielding

1.1 Rationale

JR16003-SME862 was a combined science and logistics leg of the 2016-17 voyage of the RRS James Clark Ross to the Antarctic. The logistics element was an unexpected last-minute addition to the end of the cruise as a result of ice preventing the JCR getting to Rothera earlier in the season. The cruise had three key aims:

1) undertake the acoustic survey "the Western Core Box" survey to determine the distribution and biomass of krill and other plankton to the northwest of South Georgia.

2) refurbish and redeploy to long-term deep-water biological moorings in the South Georgia region, and redeploy a shelf mooring that was not recovered last season, and

3) undertake station work and a transect across the Polar front to investigate the distribution of mesopelagic fish across pelagic realms.

In addition to the biological work of JR16003-SME862, there was some geological survey work (JR16003-SME966) and 1 day of work for the FCO related to the Government of South Georgia and South Sandwich Islands Marine Protected Area on the South Georgia shelf. The general flow of the cruise was undertaken as follows:

08/12/2016 Depart the Falkland Islands

10/12/2016 Geophysics swath and dredging (JR16003-SME966)

16/12/2016 P3 mooring recovery (JR16003-SME862)

17/12/2016 Geophysics swath and dredging (JR16003-SME966)

19/12/2016 FCO MPA benthic camera imaging

20/12/2016 WCB acoustic transects

24/12/2016 Stromness calibration

26/12/2016 WCB mooring deployment

27/12/2016 P3 station work

28/12/2016 FCO MPA benthic camera imaging

29/12/2016 P3 station work

30/12/2016 P2 station work

01/01/2017 Polar front transect and station work

06/01/2017 Depart science area for Rothera

1.2 Western Core Box summary

Since 1981 BAS have undertaken cruises to determine krill biomass as part of the ongoing assessment of the status of the marine ecosystem in the region of South Georgia. This unique time series, known as the Western Core Box, is part of the Ecosystems Programme contribution to BAS national capability. It comprises an acoustic grid survey of 8 transects each of 80 km in length,

together with associated net and oceanographic sampling and the calibration of acoustic instrumentation. In addition to the acoustic survey, which covers a wide area but has limited temporal coverage, there are two moorings (P2 and P3, in deep water to the southwest and northwest of South Georgia) to provide a temporal, year-round set of observations, and one shallow water mooring on the South Georgia shelf (WCB mooring). These moorings are recovered during the cruise, refurbished and data downloaded, and then re-deployed later in the cruise.

1.3 Mooring Station Summary

At the P2 and P3 mooring sites samples were taken to continue examining diel changes in distribution and production of the lower trophic levels of the pelagic food-web. For each mooring station the 2 oblique zooplankton net hauls centred on the cardinal times of midday and midnight were undertaken. In addition a new MUDL (Motion compensation upward downward looking net) was deployed above and below the thermocline at dawn and dusk to capture organisms moving up and down at sunset and sunrise. Other activities such as CTDs, water sampling and vertical netting (Bongos, WP2) were interspersed between the oblique netting.

1.4 FCO Marine Protected Area station summary

The South Georgia Government Science project requested images of the seafloor and associated benthos from depths of between 650-750m inside and outside the GSGSSI benthic closed areas (BCAs) (Figure 1). The region was chosen due to the relatively close proximity to the western core box and the high level of toothfish fishing activity that has historically taken place in this region. Five sites, each consisting of two stations were identified from the limited bathymetric data of the area. Each site was to consist of the Shallow Underwater Camera System (SUCS) lowered to the seabed, capturing high resolution stills. The system is then raised and moved 10 m and the stills repeated. In between 10 m sites video imagery is recorded. During the cruise, only sites 1,2,4 and 5 were undertaken, as no suitable bathymetry was located at site 3.

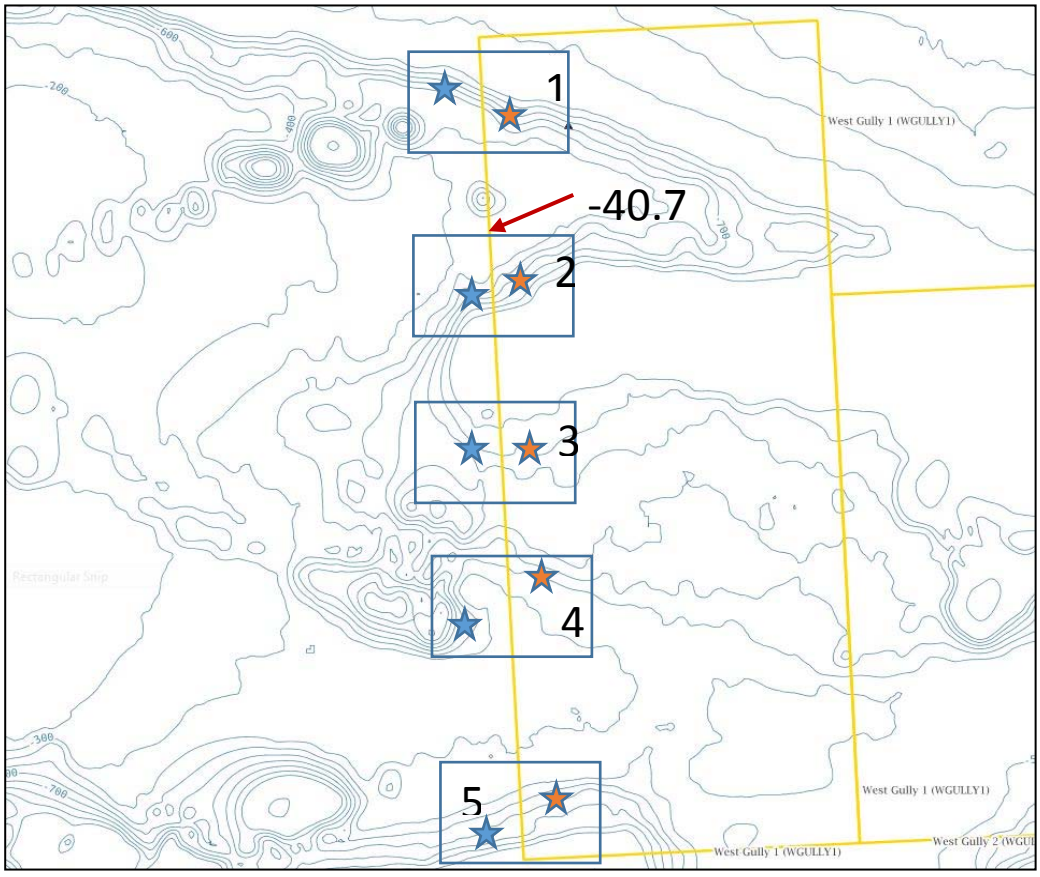


Figure 1 SUCS FCO potential camera sites. Blue starts are outside of the BCA, red stars are within.

1.5 Polar front station summary

Mesopelagic fish, squid and macrozooplankton are an important component of the Southern Ocean ecosystem. Recent studies suggest that most myctophids species inhabiting waters south of the Antarctic Polar Front (APF) are probably expatriates from core populations that reproduce at more temperate latitudes. During JR16003 a strategy was employed to sample fish, fish larvae and macrozooplankton at discrete stations across the Polar Front, as well as undertake acoustic transects between these discrete stations. The original location for the Polar Front (PF) stations was north of South Georgia at the Discovery 2010 site. However, it was noted that the geophysics work (JR16003-SME966) earlier in the cruise appeared to occur over Polar front waters. This more westerly location was both closer (reducing transit time) and better suited to head to Rothera afterwards. Sea surface temperature satellite images were obtained from Plymouth Satellite Image group (Figure 2), indicated that this westerly area from South Georgia to the Falklands could provide an ideal cross-polar-front transect, permitting greater science time. The decision was made to alter the sampling area to this location.

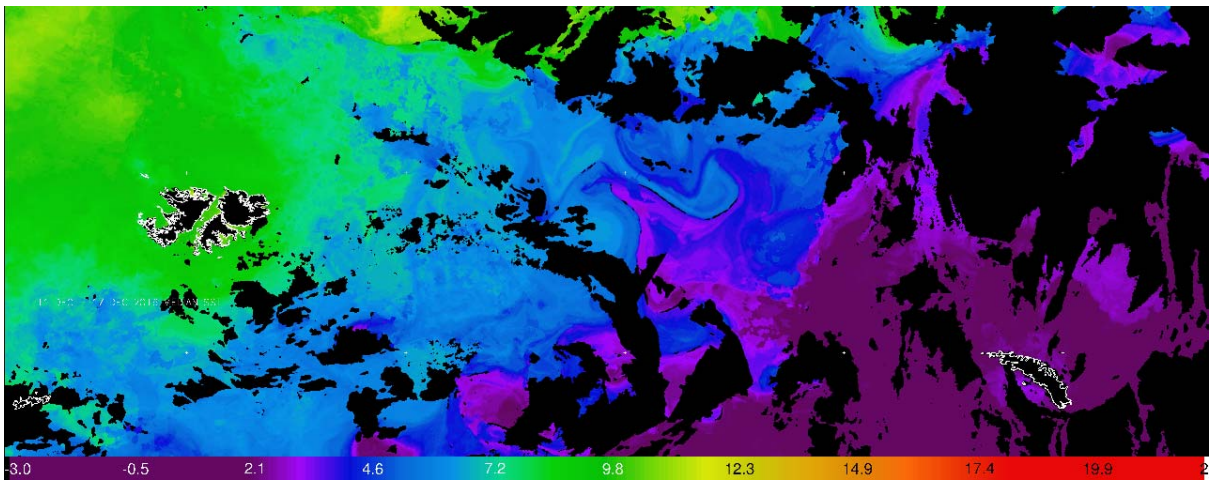


Figure 2 Sea surface temperature during JR16003

A total of 7 Polar front stations were planned (including the starting station of P2) in a transect from east to west. A formalised sampling strategy was employed as follows:

Time of Day	Activity
00:00	RMT25 Shallow (400-200, 200-0m)
02:00	MUDL
03:00	CTD (1000m)
05:00	BONGO
07:00	Acoustic transects (plus XBTs)
10:00	CTD (1000m)
11:00	Acoustic transects (plus XBTs)
16:00	MOCNESS (1000m – surface)
19:00	MUDL
20:00	RMT25 deep (1000-700, 700-400m)

Table 1 Formalised sampling strategy

1.6 PhD and other Science Project work

Utilising samples and locations undertaken as part of the three main scientific sampling strategies, several PhD and other science project work was undertaken. This included:

1) The historical demography of *Salpa thompsoni* as a response for previous climate change episodes (Angelika Slomska, Univeristy of Gdansk, Poland)

2) Morphometric analysis of mesopelagic fish fauna (Tracey Dornan, University of Bristol, UK)

3) Trace Metals in Antarctic Marine Food-webs – influence of biological and environmental factors (José Seco, José Xavier, University of Coimbra, Portugal)

4) SEADNA – eDNA of mesopelagic fish (Geraint Tarling, Sophie Fielding, BAS, UK)

5) Impact of nanoplastics and ocean acidification on zooplankton (Elisa Bergami, University of Siena, Italy; Clara Manno, BAS)

1.7 Cruise narrative

Time	Wind speed (kts)	Air pressure	Comment
06/12/16	17	1002	After a night at the Malvinas hotel the advance science/AME party arrived at the JCR. The first science container was installed on the aft deck and unloaded. In addition all Rothera cargo and all subsequent JCR science cruise cargo has been loaded on the ship (as this is the last call at Falklands made by the JCR this year). Towards the end of the day, problems with the 10t crane halted further mobilisation. The ship prepared to sail to Mare Harbour at 07:00 07/12/2016 for fuel.
07/12/16	28	1001	The ship departed for Mare Harbour, and arrived at ~13:30. After discussion with Captain regarding working conditions on aft deck, 6 skips were demobbed to allow for science operations during the forth-coming cruise. Problems with the 10t crane again halted further mobilisation. Towards the end of the day the deck engineer fixed the crane ready to continue mobilisation in the morning. During the time the JCR commenced bunkering.
08/12/16	11	999	The second science container was loaded onto the aft deck and mobilisation re-commenced. The bongo and RMT8 were assembled, and the weight bar assembled for the RMT25. A variety of crew and Uruguayan scientists from HMS Protector visited the JCR. The rest of the JR16003 scientists arrived ~17:00, undertook a safety briefing and the ship departed Mare Harbour at 18:00. New personnel took a tour of the ship whilst the AME crew squared away the last of the equipment ready to sail. The ship commenced swath bathymetry operations at ~19:30.

09/12/16	14	988	After a further briefing at 08:00, the scientific compliment collected their kitbags and undertook emergency muster stations. A science briefing at 13:00 laid out the tasks for the day: small mobilising in the labs and some net building on deck. The ship continues its way towards the geophysics survey area at 11 knots in fair weather.
10/12/16	11	981	The day commenced at 06:45 with the start of the geophysicists swath survey. Pleasant weather and the ship gently rolled along its track. The swath survey appears to focus on an area where the polar front is. The bio science team undertook a number of meetings to discuss the cold room, event numbers and alternate station locations if required. The first event took place with an XBT to provide sound speed for the swath survey.
11/12/16	3	984	The day started with more swath survey. A fire drill at 10:30 and then a gentle day of further unpacking and swath surveying.
12/12/16	14	993	Science started in earnest this morning with the first of the rock dredge stations. Both the day and night shift had a toolbox talk regarding dredging activities. The first dredge took a bit of finessing of the winch, but ran smoothly after, like the second dredge. A quick bongo was undertaken at the end of the day for test purposes, before the ship resumed swath surveying at 20:00 for overnight activities.
13/12/16	3	1001	The rock dredging re-commenced at 08:00 with sites DR002 and the first of DR003 being undertaken. Lots of rocks on the stainless steel table - an unusual site for the biologists. Further successful bongo trials were undertaken at 15:30 (LT) with the successful capture of large pteropods - which pleased Clara.
14/12/16	13	1005	Four dredges overnight and into the day (3A, 3B, 4A and 4B). The dredge was not recovered on 4B, and NOC were informed of its loss.
15/12/16	10	1001	The dredge at Site 5a was also lost, before 3 more successful dredges were completed. The weather forecast indicated that weather taking a turn for the worse over the next few days and a suitable weather window to recover the P3 mooring was available for tomorrow. A decision was made to divert from dredging to recover P3. In order to navigate around unsurveyed waters, the ship diverted around Shag Rocks and set sail for P3 ~23:00 LT

16/12/16	22	1004	The vessel arrived at P3 at 11:00 LT and commenced mooring recovery in medium winds but little swell. The mooring was contacted and released. It surfaced and was seen quickly. The vessel maneuvered into position and recovered the top buoy quickly. The whole mooring recovery (2 sediment traps and top buoy) took approximately 2 hours. A CTD was done and the ship set off to return to the dredge sites in increasing seas.
17/12/16	30	986	The third and final dredge was lost at site DR_8 - the first site after the P3 mooring recovery. The vessel resumed swath surveys to fill in holes in bathymetry mapping. At 14:00 LT the vessel hove too for a couple of hours as the swath data was not viable, at this point winds were gusting 35-40 knots. Later the ship resumed swath surveying.
18/12/16	22	993	The vessel continued swath survey of un-surveyed regions.
19/12/16	19	996	After a very unpleasant night of rolling during the swath survey where few people were able to sleep, the ship commenced biological work. A trial RMT8 at 08:00 LT identified that all was working at the aft end. The ship then moved gingerly to the MPA sites, in light of the swell, to commence swath and SUCS surveying for the GSGSSI. Site 5b and 5a went smoothly, the ship then headed further north to continue the MPA work.
20/12/16	16	1004	Location 4a and 4b of the MPA SUCS work were completed. We were unable to find suitable sites at site 3, and an iceberg prevented access to site 2. So site 1 was completed before heading to the start of the WCB acoustic transects at W1.1N. XBTs and transects were completed successfully, followed by a CTD.
21/12/16	40	997	4 RMT8s were completed overnight. Two stratified at W1.2N and W1.2S and two target hauls. Small Antarctic krill found throughout. Salps were also caught for Angelica. After the CTD1.2S, the ship undertook the daytime acoustic transects and commenced the CTD at 2.2S in worsening weather conditions.
22/12/16	16	987	The RMT8 stratified was abandonned at site 2.2S as a result of swell and the ship relocated to 3.2s in order to undertake the CTD. Weather conditions improved and the ship undertook the stratified net at 3.2S, before attempting again to undertake the stratified net at 2.2. Again this was abandonned due to weather. The acoustic transect legs were undertaken starting at 3.1N. In the evening station 2.2S was revisited with a bongo and stratified RMT8 before heading to the start of 4.1 southern end.

23/12/16	21	976	The acoustic transects 4.1 and 4.2 were completed successfully, the ship then headed to KEP to shelter from worsening weather as well as pick up some bongo nets from KEP that had been delivered there by a fishing vessel for Geraint Tarling.
24/12/16	18	985	The ship remained overnight in Cumberland Bay to avoid the worst of the weather. At 08:00 KEP sent out their jetboat with Geraints nets. The ship then sped over to Stromness and was anchored there around 11:00 LT. The ship ceased discharging overboard, a CTD was undertaken and we set about calibrating the echosounder. The final frequency was finished at 00:00 local time.
25/12/16	18	997	The day was spent mobilising the final sets of equipment for the cruise, that hadn't been possible to do in the Falklands as a result of deck space and time. The RMT25 was put together, the wire terminated and load tested, the MOCNESS built and the MUDL net tested. The ship had christmas day meal at 17:00 where science activities were ceased so as many as possible on the vessel could enjoy it.
26/12/16	38	975	The ship departed Stromness at 06:30 to head for the WCB mooring deployment site. The WCB mooring was deployed, minus the WBAT but with a sediment trap. The ship then headed north to the WCB3.2N CTD site. This was successfully undertaken in worsening weather conditions, but WCB2.2N CTD was cancelled and the ship headed overnight to P3 to commence mooring site work.
27/12/16	28	979	P3 commenced with a full depth CTD, followed by a vertical MAMMOTH deployment. When the MAMMOTH reached 850 m depth we lost contact with it. On retrieval the cause was found to be a sheared electrical termination on the biowire. This needed reterminating and load testing. As a result further work at P3 was deferred and the ship headed South to complete the FCO MPA camera work with weather reports indicating that waters would be calmer further south.
28/12/16	10	983	A swath pass over the MPA site identified that only site 2 could be completed. It was decided to occupy three sites from the inside of the MPA to the outside in a transect along the 700m isobath. The first late night deployment of the SUCS occurred in adverse weather and the SUCS camera appeared to be being dragged along the seabed. As a result it was abandoned and the ship hove too until weather conditions improved. At 06:00 conditions were deemed suitable again and 3 SUCS deployments were undertaken before the ship headed north to P3 to recommence operations there.

29/12/16	19	971	With weather conditions improved, P3 station work (MUDL, CTD and MOCNESS) were undertaken. The MOCNESS returned with a twisted bridle. The P3 mooring was deployed and then a further MOCNESS was undertaken. On this occasion the towing bridle twisted and severed one of the electrical cables. Work at P3 was abandoned and the ship headed south to P2 to commence further station work there. The first item was a requirement to stream the biowire to see if it would remove the twists that were impacting the towing bridles of the MOCNESS and MAMMOTH.
30/12/16	20	989	The first activity at P2 was to recover the mooring, this went smoothly. We then set about trying to turnaround the mooring for redeployment the next day as that was the clear weather window. In the meantime MOCNESS, CTDs and MUDLs were undertaken overnight.
31/12/16	6	1001	The P2 mooring appeared to have been located at 300 m water depth, 100 m deeper than preferred. A swath survey identified a new depth and the P2 mooring was deployed. Overnight activities included bongo, MUDL and two RMT25 nets. The first net was deployed open to 1000m and back to the surface after that release gear failed to operate. The AME crew successfully fixed the gear in time for a shallow water stratified haul.
01/01/17	22	992	After a successful night fishing, the ship departed P2 at 07:00 LT undertaking acoustic work along the Polar Front transect. A CTD along the transect, but once arrived at PF1 the weather was not suitable to undertake the evenings station work. The ship stayed hove too until it set off along the acoustic transects the next morning.
02/01/17	22	970	After morning acoustic transects (XBTs and CTDs), PF2 was successfully completed with MOCNESS, MUDL, RMT25 samples. The biowire once again twisted causing damage to the MOCNESS towing bridle.
03/01/17	22	970	The ship set off for the daytime acoustic transects. After the morning CTD, the biowire was re-spooled once again to deal with turns in the wire twisting the MOCNESS towing bridle. The evening station at PF3 was cancelled due to weather conditions, apart from the CTD.
04/01/17	10	991	Morning acoustic transects led to the PF4 station work which was successfully completed overnight. MUDL, MOCNESS, CTDs and RMT25s. The weather forecast indicated a big low due to kick in on the 6th January, a decision was made to push through to the station furthest west (the further side of the PF) to get the best spacing (i.e. PF6), rather than complete PF5 on the 5th.

05/01/17	10	996	We arrived at the new PF6 site at 16:00 LT and commenced with a successful MOCNESS. Weather conditions were great and it is hard to believe that it will blow up in the morning. Evening activities included the RMT25s, MUDL and CTD completed successfully.
06/01/17	35	971	As predicted the weather started to pick up ~05:00. The PF6 station was completed at 06:00 with the CTD and the decision was made to head to Rothera to make some distance before the bad weather kicked in. A particularly large roll of the ship in the evening caused the ship to turn hove too for the night.
07/01/17	32	986	After a night hove too, the ship continued south on a roley path. An opportunistic RMT25 was undertaken at 22:00 as weather conditions had subsided substantially. However, even then the net was closed early due to high tensions on the wire. This RMT25 signified the end of the Polar front work.
08/01/17	11	987	The ship continues to Rothera. The JR16003 commence demob of nets and gear.
09/01/17	2	977	The ship continues to Rothera
10/01/17	13	989	The ship continues to Rothera. The JR16003 science team commence packing
11/01/17	4	987	The ship arrived at Rothera in the early hours, in high winds. It spent much of the day waiting outside Ryder Bay for the winds to drop. At ~14:00 LT the ship entered Ryder Bay which was more sheltered and went in search for a mooring to recover at the Rothera RATS site. Although not at the location given, it was eventually located some 300 m away, released and recovered successfully for Alex Brearley. A CTD followed to collect samples for the dutch scientists at Rothera, and the ship headed alongside around dinner time.
12/01/17	13	989	JR16003 demobbing, alongside Rothera.Packing of the two containers was completed early afternoon, allowing people time to walk up the road, or round the point. The AME crew took the skyranger AAV for a flight at Rothera.
13/01/17	14	994	The ship departed Rothera approximately 14:00 hours, and undertook lifeboat drills in Marguerite Bay before heading north.
14/01/17	18	990	Most of the science crew moved cabins, to allow for cleaning, and day/afternoon was spent writing cruise reports and cleaning the labs.
15/01/17	35	974	Once again the weather has picked up and the ship has rocked and rolled its way North. The UIC was cleaned today ready to hand over, and people continue with cruise reports.

1.8 Cruise track

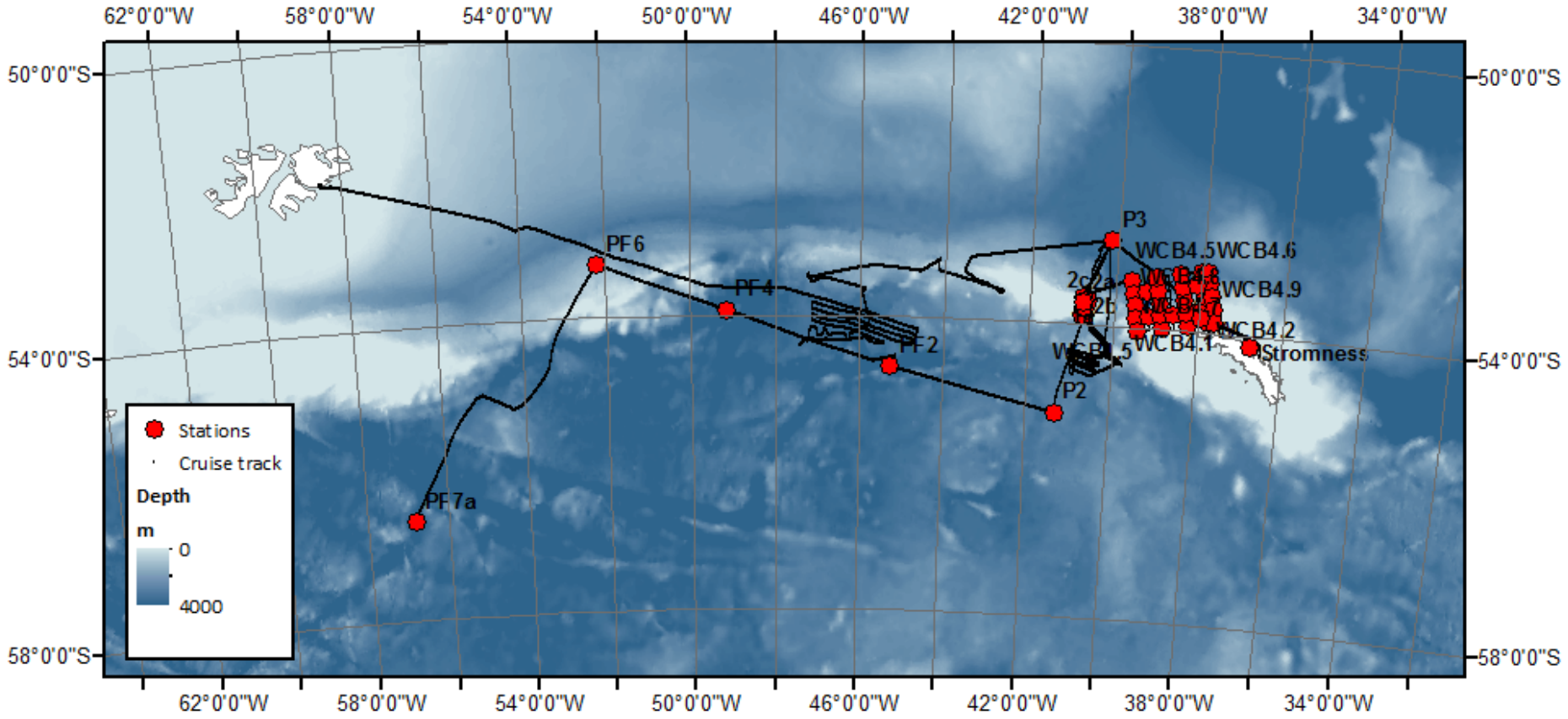


Figure 3 Cruise track, with key sampling sites identified

1.9 Cruise personnel

PAGE Timothy	Master
MACKENZIE Iain M	Chief Officer
CROOKES Waveney A	2nd Officer
BELLIS Robert J	3rd Officer
CHAPMAN, Matthew C	3rd Officer
DUTTON Thomas B	Deck Cadet
GLOISTEIN Michael EP	ETO Comms
MACDONALD Neil C	Chief Engineer
BEHRMANN Gert	2nd Engineer
MANNION, Christopher J	3rd Engineer
LAUGHLAN Marc	4th Engineer
THOMAS Craig GL	Deck Engineer
AMNER Stephen P	ETO
TURNER Richard J	Purser
JONES, Helen VC	Doctor
PECK David J	Bosun/Sci'Ops
BOWEN Albert Martin	Bosun
DALE George	Bosun's Mate
SMITH Sheldon T	SG1A
ENGLISH Samuel	SG1A
WAYLETT Graham L	SG1A
HOWARD, Alan S	SG1A
HERNANDEZ Francisco J	SG1A
HENRY Glyndor	MG1
WALE Gareth M	MG1
COCKRAM Colin C	Chief Cook
MORGAN Gary A	2nd Cook
JONES Lee J	Steward
GREENWOOD Nicholas R	Steward
RAWORTH Graham	Steward
MORTON Rodney	Steward

Table 2 Officers and crew of JR16003

FIELDING, Sophie	BAS, Acoustician (PSO)
ASHURST, Daniel S.	BAS, AME mechanical engineer
BERGAMI, Elisa	University of Siena, PhD student
BLACKWELL, Robert	University of East Anglia, PhD student
DORNAN, Tracey	University of Bristol, PhD student
ENDERLEIN, Peter	BAS, AME gear engineer
FOWLER, Victoria H.D.	University of Southampton, PhD student
MANNO, Clara	BAS, Marine ecologist
POLFREY, Scott D.	BAS, AME mechanical engineer
ROBST, Jeremy	BAS (IT Support)

SAUNDERS, Ryan A.	BAS, Fish ecologist
SECO, José S.	University of Coimbra, PhD student
SLOMSKA, Angelika W.	University of Gdansk, PhD student
STOWASSER, Gabriele	BAS, Marine ecologist
TARLING, Geraint A.	BAS, Marine ecologist
THOMAS, Seth J.	BAS, AME electrical engineer
XAVIER, José C.	BAS/University of Coimbra, Predator ecologist
JR16003-SME966 participants	
RILEY, Teal R.	BAS Geoscientist (PSO)
BURTON-JOHNSON, Alex	BAS Geoscientist
BRISTOW, Charlie S.	CASS (123) Geoscientist
LEAT, Philip T.	CASS (123) Geoscientist

Table 3 Scientific party of JR16003

1.10 Acknowledgements

This cruise is the 21st year that the Western Core Box Survey has been undertaken and so maintaining this time series has required a major investment of effort over the years. This falls to a small group of core staff within the current Ecosystems programme and AME who carry out this cruise year in and year out. This year the core staff were supported and joined by a willing and enthusiastic group of support staff and collaborators from other polar and marine groups both within the UK and internationally. Despite a somewhat fractured cruise (a geology cruise, followed by the WCB, followed by Rothera resupply), this group was enthusiastic and supportive throughout the cruise.

The whole ship's complement from Master and Officers through to deck crew, catering staff and engineers are enthusiastic and interested in the science being undertaken. We are very grateful for all the help and support that they provide.

2. Physical oceanography

2.1 CTD Operations

Seth Thomas, Sophie Fielding

2.1.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. 22 casts were carried out in total in the Western Core Box, at the mooring sites and along the Polar front transect. The CTD was operated by Seth Thomas and processed by Sophie Fielding.

2.1.2 CTD instrumentation and deployment

An SBE32 carousel water sampler, holding 24 12-litre niskin bottles, an SBE9Plus CTD and an SBE11Plus deck unit were used. The SBE9Plus unit held dual SBE3Plus temperature and SBE4 conductivity sensors and the SBE9 pressure sensor. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, and time, bottle position and temperature are stored, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included an altimeter, a fluorometer (Chelsea Aquatracker mark III), one oxygen sensors (SBE43), a photosynthetically active radiation (PAR) sensor, a transmissometer and a Lowered Acoustic Doppler Current Profiler. Manufacturer calibration certificates have been stored within the working area (L:\Scientific_working_area\AME_calibration_documents) for return and backup in Cambridge. The altimeter returns real time accurate measurements of height off the seabed within approximately 100m of the bottom. This allows more accurate determination of the position of the CTD with respect to the seabed than is possible with the Simrad EA600 system, which sometimes loses the bottom and, in deep water, often returns depths that are several tens of metres deeper than the true bottom location.

A fin attached to the CTD frame reduced rotation of the package underwater. The CTD package was deployed from the mid-ships gantry on a cable connected to the CTD through a conducting swivel.

CTD data were collected at 24Hz and logged via the deck unit to a PC running Seasave, version 7.22.3 (Sea-Bird Electronics, Inc.), which allows real-time viewing of the data. The procedure was to start data logging, deploy the CTD, then stop the instrument at 10m wireout, where the CTD package was left for at least two minutes to allow the seawater-activated pumps to switch on and the sensors to equilibrate with ambient conditions. The pumps are typically expected to switch on 60 seconds after the instrument is deployed.

After the 10m soak, the CTD was raised to as close to the surface as wave and swell condition allowed and then lowered to within 10m of the seabed. Bottles were fired on the upcast, where the procedure was to stop the CTD winch, hold the package *in situ* for a few seconds to allow sensors to equilibrate, and then fire a bottle. The sensor averages these readings to produce one value for each bottle fire. When firing multiple bottles at the same depth approximately 30 seconds is given between each bottle to avoid loss of SBE35 readings.

Bottle firing depths were determined by sampling requirements for ocean acidification, metal contaminants and nanoplastic experiments.

2.1.3 Data acquisition and processing

The CTD data were recorded using Seasave, version 7.22.3, and run through the SVP script which created four files:

JR16003_[NNN].hex binary data file

JR16003_[NNN].XMLCON ascii configuration file with calibration information

JR16003_[NNN].hdr ascii header file containing sensor information

JR16003_[NNN].bl ascii file containing bottle fire information

where NNN is the CTD cast number (column 4 in Table 4).

The *.hex* file was then converted from binary to ascii using the SBE Data Processing software *Data Conversion* module. The output was a file named *jr16003ctd[NNN].cnv*. The *Data Conversion* module calculates parameters using the manufacturers calibration coefficients as follows:

Pressure: $$P = C\left(1 - \frac{T_0^2}{T^2}\right)\left(1 - D\left(1 - \frac{T_0^2}{T^2}\right)\right)$$

where *P* is the pressure (dbar), *T* is the pressure period in µsec, $D = D_1 + D_2U$,

$C = C_1 + C_2U + C_3U$ and $T_0 = T_1 + T_2U + T_3U_2 + T_4U_3 + T_5U_4$ are calculated from the coefficients detailed in Appendix H, where *U* is the temperature in ˚C.

Conductivity: $$cond = \frac{(g + hf^2 + if^3 + jf^4)}{10(1 + \delta t + \varepsilon p)}$$

where *cond* is the conductivity in Sm-1, *p* is pressure, *t* is temperature, δ = CTcor and ε = CPcor. All coefficients are included in Appendix H.

Temperature: $$temp(ITS90) = \frac{1}{\left\{g + h\left[ln(f_0/f)\right] + i\left[ln^2\left(\frac{f_0}{f}\right)\right] + j\left[ln^3\left(\frac{f_0}{f}\right)\right]\right\}} - 273.15$$

Where the temperature, *temp*, is measured in ˚C, *g*, *h*, *i* and *j* are coefficients detailed in Appendix H and *f* is the frequency output by the sensor.

Oxygen: $$oxy = \left(Soc(V + Voffset)\right)e^{Tcor|T}Oxsat(T,S)e^{Pcorp}$$

where *oxy* is dissolved oxygen in ml/l, *V* is the voltage output from the SBE43 sensor, *Oxsat* is oxygen saturation (ml/l), a function of temperature, *T*, salinity, *S*, and pressure, *P*, and the remaining coefficients are detailed in Appendix H.

PAR: $$PAR = \left(\frac{multiplier.10^{\frac{V-B}{M}}}{c}\right) + offset$$

where *V*, *B*, *M*, *offset*, *multiplier* and *C*, the calibration constant, can be found in Appendix H.

Fluorescence: $$flsc = \frac{slope(10e^{V/slope\ factor} - 10e^{VB})}{10e^{V1} - 10e^{Vacetone}} + offset$$

Where *flsc* is measured in µg/l, *V* is the fluorometer output voltage and the remaining coefficients can be found in Appendix H.

The SVP script also sends the CTD data output to the Met Office (as of November 2014, following a note from Tim Smyth (PML) – PSO on JR303).

Transmission: $$Light\ transmission = M.output\ voltage + B$$

where light transmission is measured in % and *M* and *B* are derived from measured voltages through air and water in light and darkness, and are included in Appendix H.

The SBE Data Processing *Align CTD* module was then used to align parameter data in time, relative to pressure. This ensures that calculations of salinity, dissolved oxygen concentration, and other parameters are made using measurements from the same parcel of water.

The SBE Data Processing *Wild Edit* module was then used to mark wild points in the data by replacing the data value with *badflag*. The *badflag* value is documented in the input .cnv header. Wild Edit's algorithm requires two passes through the data: the first pass obtains an accurate estimate of the data's true standard deviation, while the second pass replaces the appropriate data with *badflag*.

The SBE Data Processing *Cell thermal mass* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This reads in the *jr16003ctd[NNN].cnv* file and re-derives the pressure and conductivity, taking into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output is another ascii file, named as *jr16003ctd[NNN]_ctm.cnv*. The correction applied to the CTD data is detailed below:

Corrected conductivity = conductivity + ctm

Where

$$ctm = -1\left(\frac{1-b\alpha}{2s\beta+4}\right)xctm_0 + \frac{2\alpha}{s\beta+2}x0.1(1+0.006[T-20])x\Delta T$$

and *s* is the sample interval, *T* is temperature, *ctm0* is the uncorrected cell thermal mass,

$\alpha = 0.03$ and $\beta = 7.0$.

The following matlab scripts were then used to process the CTD files.

ctdread.m Reads in JR16003CTDnnn_awctm.cnv to matlab. Outputs JR16003ctdnnn.cal

editctd.m Reads in JR16003ctdnnn.cal. Manual edit of CTD file to remove start and end data when CTD out of water and any spikes. Outputs file JR16003ctdnnn.edt

Interpol.m Reads in JR16003ctdnnn.edt. Interpolate any missing data. Output JR16003ctdnnn.int

Salcalapp.m Reads in JR16003ctdnnn.int. Calculates density (sig0, sig2 sig4). Output JR16003ctdnnn.var

Splitcast.m Reads in JR16003ctdnnn.var. Splits up cast and down cast. Output JR16003ctdnnn.var.up and JR16003ctdnnn.var.dn.

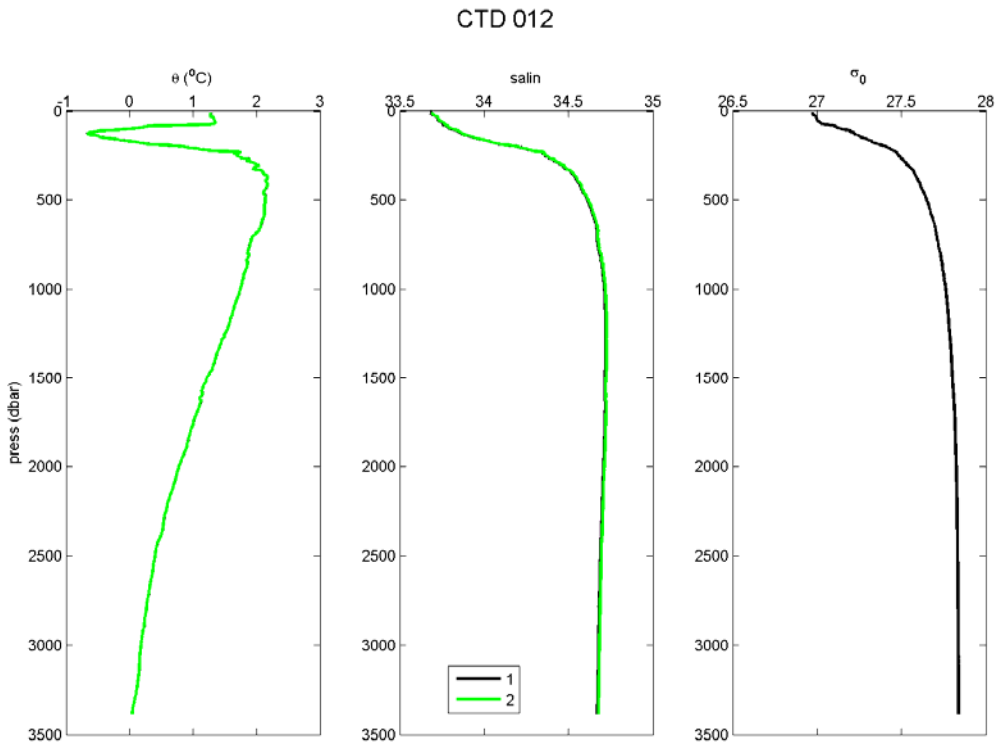
Fallrate.m Reads in JR16003ctdnnn.var.dn. Removes data from periods where CTD above a pressure it has already sampled. Output JR16003ctdnnn.var.dn

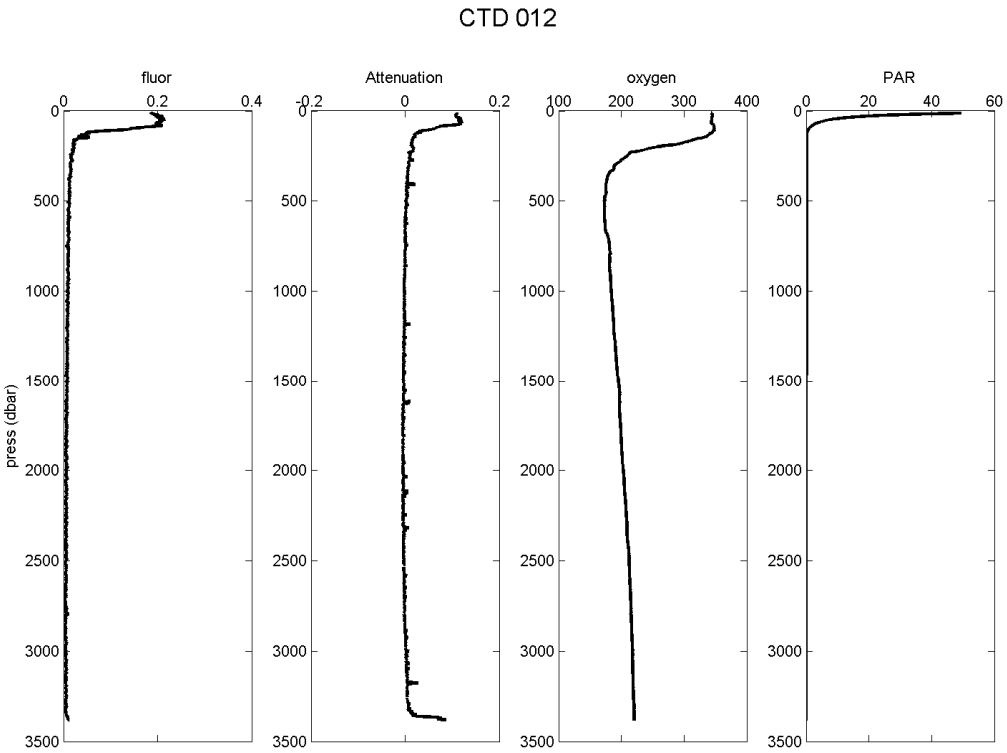
Gridctd.m Reads in JR16003ctdnnn.var.dn. Grids data into 2dB depth intervals. Output JR16003ctdnnn.2db.mat.

Fill-to-surf.m Reads in JR16003ctdnnn.2db.mat. Fills in surface values if CTD doesn't reach surface, user input to determine which ones. Output file JR16003ctdnnn.2db.mat

Ctdplot.m Reads in JR16003ctdnnn.2db.mat files and creates overview plots saved in /images folder

Makebot Reads in JR16003ctdnnn.2db.mat. Extracts median and standard deviation of variables at the depth/time of each bottle firing. Output file JR16003botnnn.1st





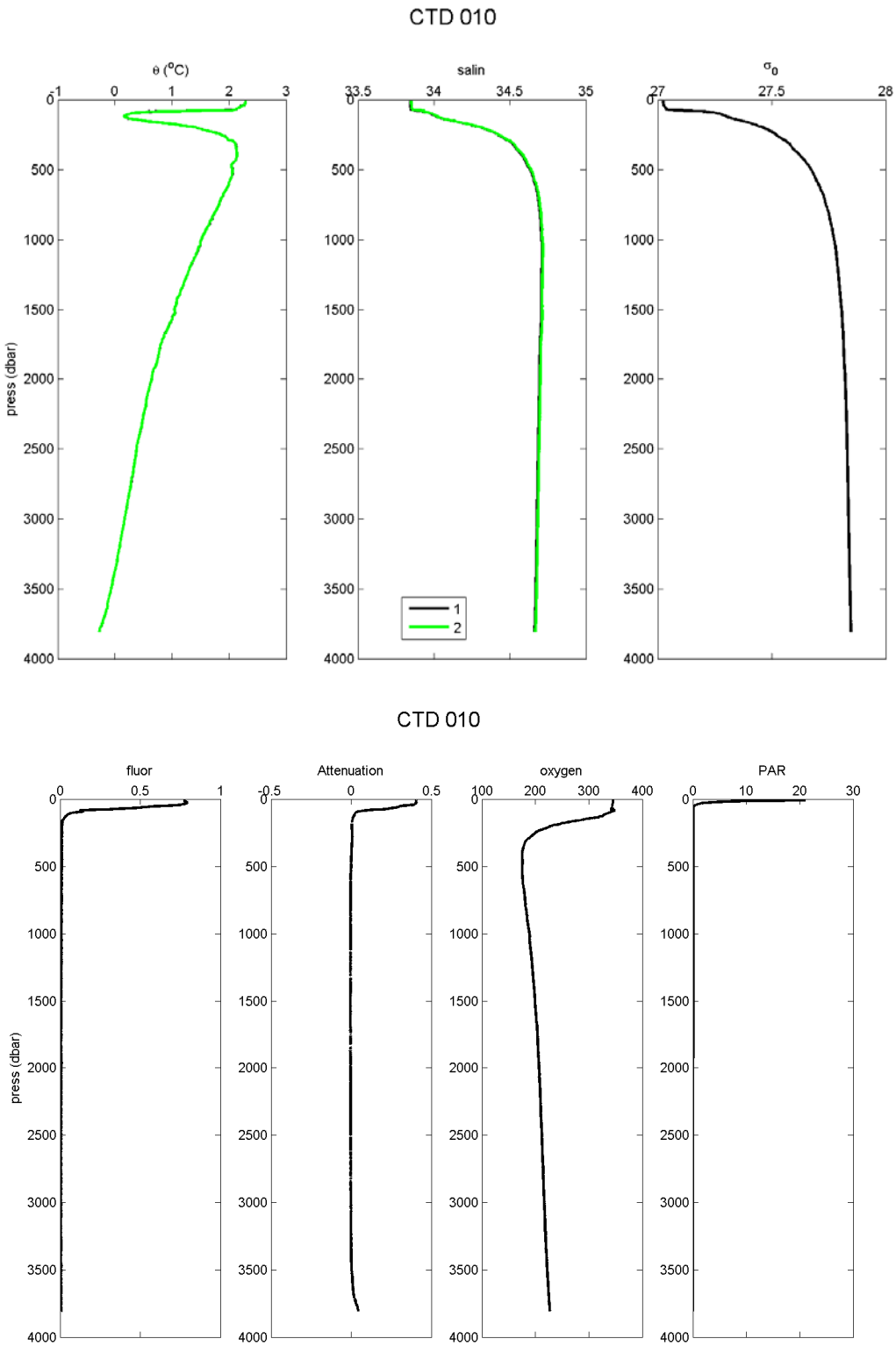


Figure 4 CTD profiles for P2 (first) and P3 (second)

2.1.4 CTD casts

22 CTD casts were completed during JR16003.

Time	Latitude	Longitude	CTD Number	Station	Water Depth	Depth sampled	Event number

					(m)	to (m)	
11/01/2017 20:28	-67.57648	-68.23815	22	CTD site 1 Rothera	474.03	464	175
06/01/2017 08:00	-53.29432	-52.18519	21	PF	1692.23	1000	170
05/01/2017 06:25	-53.90491	-49.27398	20	PF	4322.31	1000	150
04/01/2017 13:33	-54.1331	-48.16617	19	PF	4108.52	1000	140
04/01/2017 08:40	-54.33903	-47.20217	18	PF	3640.66	1000	138
03/01/2017 14:21	-54.51789	-46.22357	17	PF	3073.4	1000	136
03/01/2017 08:49	-54.53799	-45.09371	16	PF	3731.45	1000	134
02/01/2017 13:39	-54.83881	-44.26254	15	PF	3857.9	1000	124
01/01/2017 14:22	-55.11941	-42.26616	14	PF	3303.31	1000	121
31/12/2016 21:42	-55.26172	-41.19904	13	P2	3272.38	100	111
31/12/2016 09:21	-55.24859	-41.26209	12	P2	3369.97	3327	101
30/12/2016 18:35	-55.24437	-41.27401	11	P2	3389.22	1000	94
29/12/2016 09:27	-52.80868	-40.11375	10	P3	3795.27	3740	87
28/12/2016 23:57	-52.80868	-40.11378	9	P3	3868.14	100	84
27/12/2016 11:43	-52.80793	-40.11323	8	P3	3785.53	1000	74
26/12/2016 19:19	-53.36157	-38.08204	7	WCB 3.2N	2661.41	1000	73
24/12/2016 14:27	-54.15879	-36.69469	6	Calibration Stromness	76.54	74	70
22/12/2016 00:08	-53.71537	-37.96418	5	WCB 3.2S	132.08	125	50
21/12/2016 20:46	-53.78539	-38.58356	4	WCB 2.2S	206.54	194	49
21/12/2016 06:38	-53.84642	-39.14329	3	WCB 1.2S	286.7	270	43
20/12/2016 20:39	-53.49266	-39.25101	2	WCB 1.2N	3146.39	1000	37
16/12/2016 17:25	-52.81697	-40.13233	1	P3	3793.74	2500	21

Table 4 CTD casts during JR16003

2.2 Expendable bathythermographs (XBT)

Rob Blackwell, Jeremy Robst

2.2.1 Introduction

Expendable bathythermographs (XBTs) were used to profile the temperature through the water column on transects within the Western Core Box and at the polar front transect.

2.2.2 Method

41 Lockheed Martin Sippicon T5 probes were deployed at predefined waypoints in accordance with the procedure and operations described in ***Data and Instrumentation/XBT, Version 1.2 10/12/2014 by Jenny Thomas & Jeremy Robst***, http://wiki.jcr.nerc-bas.ac.uk/Data_and_Instrumentation/XBT

The T5 has a wire length of 1830 m and needs to be operated at a ship speed of 6 knots or less.

The XBT equipment was operated by Jeremy Robst and Rob Blackwell.

Data were recorded and displayed in real-time using Sea-Air Systems software WinMK21 v2.13.1, MIK21COEF v2.9.1, MK21AL v2.14.1

2.2.3 Results

Twenty five XBTs were deployed within the Western Core Box with no failures (Table 5), and a further 16 XBTs were deployed along the Polar Front transect with 3 failures (Table 6). Locations of the XBT deployments are displayed on Figure 5 (WCB) and Figure 8 (Polar front transect), and vertical profiles in Figure 7 and Figure 8. A contour plot of temperature across the Polar Front transect was also created from the CTD data (Figure 9).

Event	File	Date mm/dd/yyyy	Time (UTC)	Serial Number	Salinity / ppt	Latitude	Longitude
32	T5_00005.EDF	12/20/2016	09:00:32	00380497	33.80	-53.348047	-39.602108
33	T5_00006.EDF	12/20/2016	10:09:29	00380501	33.80	-53.524308	-39.549902
34	T5_00007.EDF	12/20/2016	11:20:13	00380505	33.80	-53.702409	-39.497705
35	T5_00008.EDF	12/20/2016	12:30:29	00380496	33.80	-53.879761	-39.444071
36	T5_00009.EDF	12/20/2016	13:37:58	00380500	33.80	-54.056047	-39.391565
44	T5_00010.EDF	12/21/2016	09:02:17	00380504	33.80	-53.990421	-38.820162
45	T5_00011.EDF	12/21/2016	10:08:51	00380495	33.80	-53.817326	-38.874133
46	T5_00012.EDF	12/21/2016	11:16:30	00380499	33.80	-53.643302	-38.928487
47	T5_00013.EDF	12/21/2016	12:28:40	00380503	33.80	-53.464323	-38.983866
48	T5_00014.EDF	12/21/2016	13:37:21	00380494	33.80	-53.287280	-39.038033
52	T5_00015.EDF	12/22/2016	09:00:00	00380498	33.80	-53.926204	-38.220247
53	T5_00016.EDF	12/22/2016	10:36:23	00380502	33.80	-53.749219	-38.277881
54	T5_00017.	12/22/2016	12:28:46	00380515	33.80	-53.572754	-38.335580

	EDF						
55	T5_00018.EDF	12/22/2016	14:17:32	00380516	33.80	-53.396378	-38.392729
56	T5_00019.EDF	12/22/2016	15:50:07	00380514	33.80	-53.220752	-38.448962
60	T5_00020.EDF	12/23/2016	08:00:36	00380517	33.70	-53.869206	-37.727783
61	T5_00021.EDF	12/23/2016	09:27:47	00380510	33.80	-53.692969	-37.795434
62	T5_00022.EDF	12/23/2016	10:47:37	00380506	33.70	-53.516968	-37.846513
63	T5_00023.EDF	12/23/2016	12:03:44	00380507	33.80	-53.340430	-37.904854
64	T5_00024.EDF	12/23/2016	13:18:23	00380511	33.80	-53.163550	-37.964148
65	T5_00025.EDF	12/23/2016	14:09:05	00380508	33.80	-53.148730	-37.831873
66	T5_00026.EDF	12/23/2016	15:15:58	00380512	33.80	-53.326587	-37.772611
67	T5_00027.EDF	12/23/2016	16:25:14	00380509	33.80	-53.501823	-37.713277
68	T5_00028.EDF	12/23/2016	17:33:47	00380512	33.70	-53.676351	-37.655017
69	T5_00029.EDF	12/23/2016	18:40:30	00372170	33.70	-53.851392	-37.594727

Table 5 XBT casts during the WCB survey

Event	Filename	Serial Number	Date mm/dd/yyyy	Time	Salinity / ppt	Latitude	Longitude	Notes
120	T5_00030.EDF	338637	01/01/2017	11:37:36	33.70	-55.1947	-41.7018	
122	T5_00031.EDF	338638	01/01/2017	17:17:58	33.70	-55.0426	-42.8438	
123	T5_00032.EDF	338639	01/02/2017	10:59:52	33.70	-54.9251	-43.6811	
125	T5_00033.EDF	338640	01/02/2017	16:27:35	33.70	-54.757	-44.8184	
135	T5_00034.EDF	338644	01/03/2017	11:37:07	33.70	-54.6178	-45.6666	
139	T5_00035.EDF	338648	01/03/2017	21:32:28	33.60	-54.4172	-46.7812	
141	T5_00036.EDF	338647	01/04/2017	10:52:08	33.70	-54.2511	-47.6206	
142	T5_00037.EDF	338643	01/04/2017	16:09:57	33.70	-54.0195	-48.6938	
151	T5_00038.EDF	338641	01/05/2017	08:21:37	33.80	-53.8445	-49.5145	Failed
152	T5_00039.EDF	338642	01/05/2017	08:24:42	33.80	-53.8427	-49.5229	
153	T5_00040.EDF	338646	01/05/2017	10:29:58	33.80	-53.732	-50.0546	Failed

154	T5_00041.EDF	338645	01/05/2017	10:36:03	33.80	-53.7285	-50.0713	Failed
155	T5_00042.EDF	372166	01/05/2017	12:35:50	33.90	-53.6211	-50.5843	
156	T5_00043.EDF	372173	01/05/2017	14:13:53	33.80	-53.5357	-50.9922	
157	T5_00044.EDF	372150	01/05/2017	15:48:14	33.90	-53.4437	-51.383	
158	T5_00045.EDF	372151	01/05/2017	17:54:12	33.90	-53.3206	-51.9028	

Table 6 XBT casts during the Polar front transect

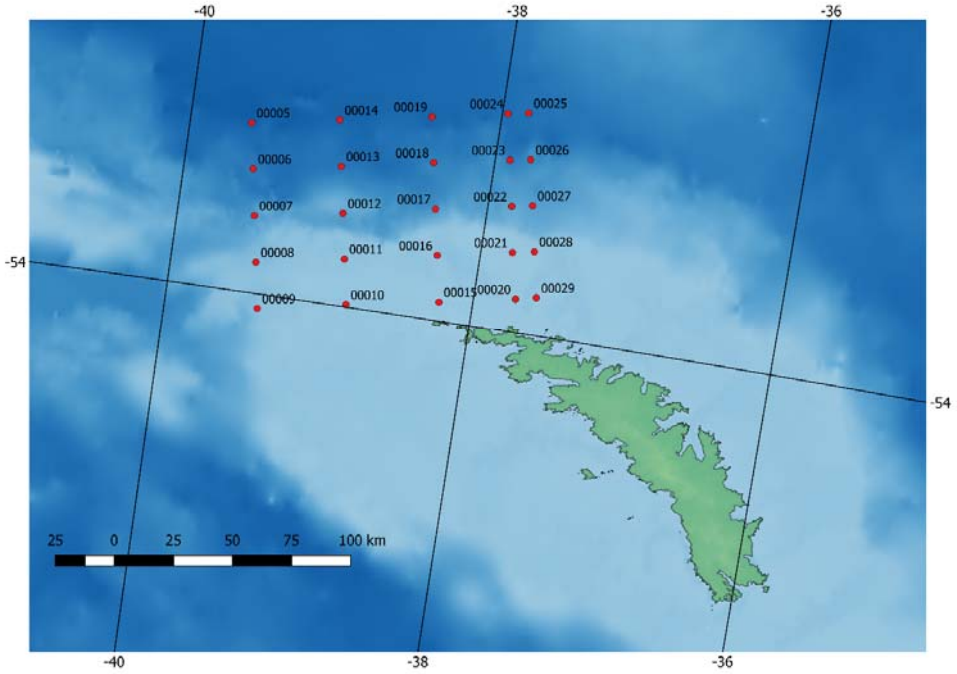


Figure 5 WCB XBT sampling locations

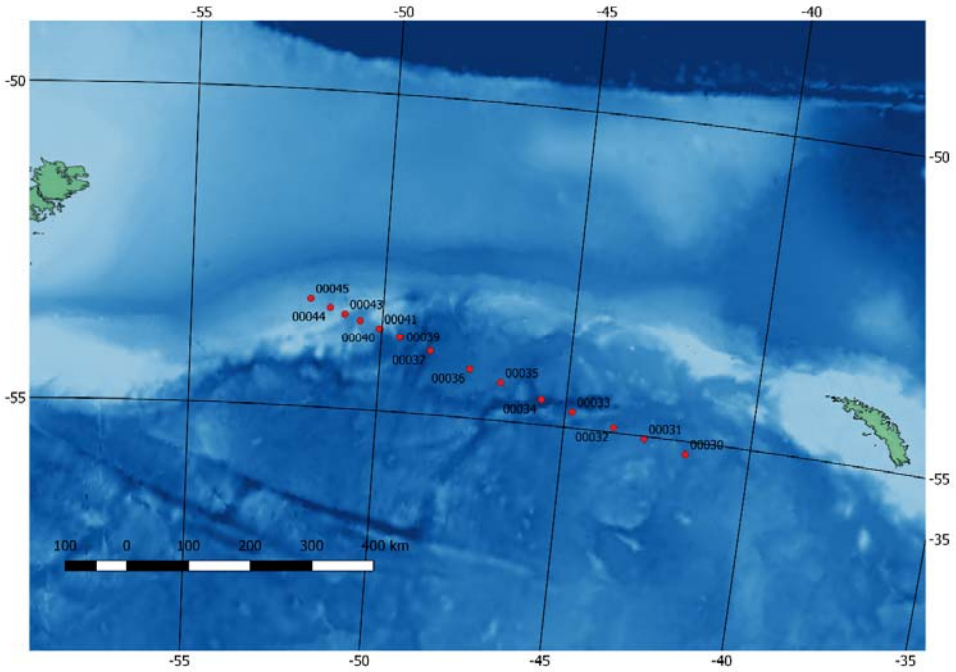


Figure 6 Polar front transect XBT sampling locations

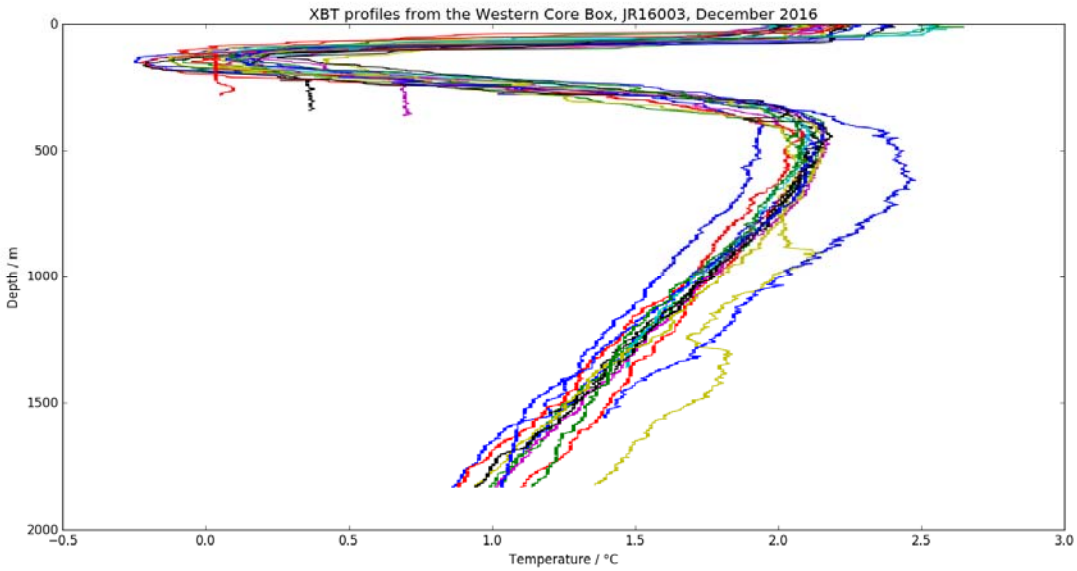


Figure 7 XBT temperature profiles in the WCB

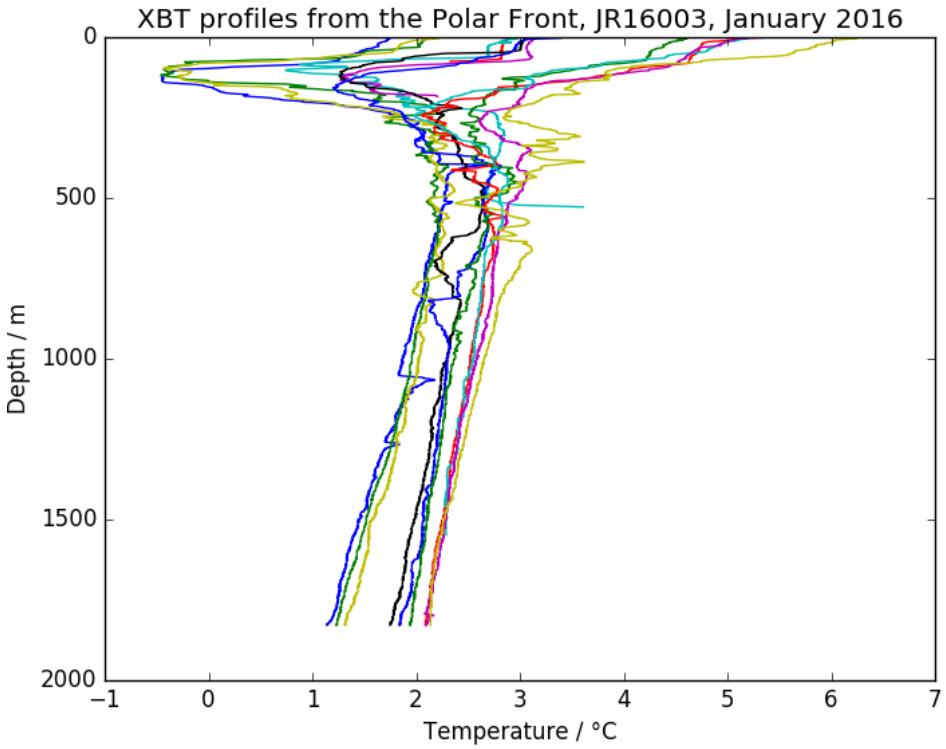


Figure 8 XBT temperature profiles from the Polar Front transect

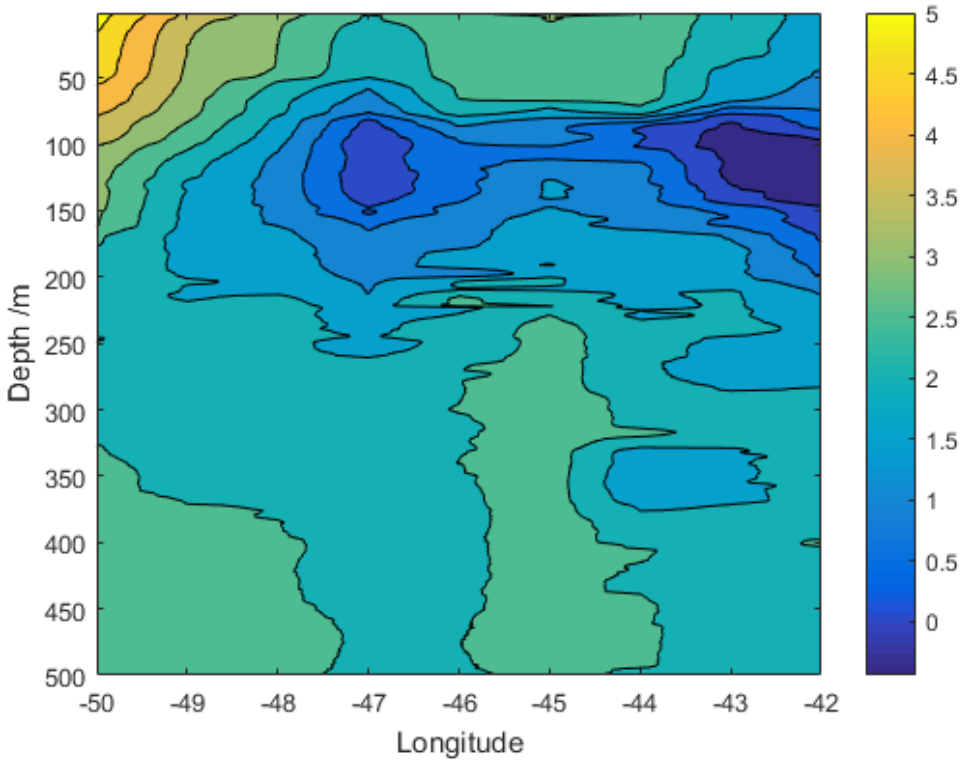


Figure 9 CTD Temperature (°C) transect across the Polar front stations

2.3 XBT Software

The XBT equipment on board the RRS James Clark Ross generates EDF files that contain the temperature / depth data as well as metadata including latitude and longitude.

Some simple software was created to parse the EDF files, export and plot the data.

The software and instructions have been archived at

`L:\scientific_work_areas\XBT\xbt-julia`

The directory contains a README.md file with simple instructions and an example Jupyter notebook with a worked example.

The software was developed in Julia, a new, open source scientific programming language with powerful features, fast runtime and an intuitive syntax that MATLAB programmers should find easy to understand.

Assuming that you have installed Jupyter (I suggest the Anaconda Python distribution) and the Julia kernel, then change into the supplied directory from a command prompt and type

```
jupyter notebook
```

A web page should open allowing you to explore the supplied notebook.

3 Acoustics

Sophie Fielding, Tracey Dornan, Rob Blackwell, Peter Enderlein

3.1 Introduction

The JCR is equipped with a four frequency Simrad EK60 scientific echosounder operating at 38, 70, 120 and 200 kHz. All transducers are mounted on the hull enabling data collection through the water column while underway at speeds up to 10 knots. In September 2015, additional transceivers, Simrad EK80 WBTs, were installed in the JCR. The WBTs are the next generation echosounders, which operate in both continuous wave (CW) and/or frequency modulated (FM; i.e. wideband) transmission modes. WBTs exist for the 38, 70 and 120 kHz, although only the 70 and 120 kHz transducers are capable of receiving transmission pulses in both modes. With mechanical switching of transducer connections, either the EK60, the EK80, or a combination of the two types of transceiver can be used at any time.

During cruise JR16003, the EK60 echosounder was operated continuously to collect information on the horizontal and vertical distribution of krill and micronekton (i.e small pelagic fish) and to derive estimates of krill biomass for the Western Core Box. At all times, transmission rates and intervals of all actively transmitting acoustic instruments were synchronised using the K-Sync to reduce interference. Although there was significant interference from the EM122 when the JCR was transitting due to its continual use. EK60 transceivers were used during transits from the Falkland Islands to South Georgia, Rothera and across international waters of the Drake Passage. Once in the survey area, EK60 and EK80 transducers were calibrated at Stromness Harbour 24-25/12/2016. The EK80 echosounder was not operated during this cruise beyond calibration, which was undertaken to ensure that a replacement WBT for the 38 kHz transducer was operating correctly.

3.2 EK60

The EK60 was operated using Simrad ER60 v. 2.4.3 software, from the PU1 PC. The .raw data files were logged to the Linux server JRLB, using a Samba connection, which is backed up at regular intervals. Raw data were collected to a range of 1100 m during transits to and from South Georgia and Rothera.

3.2.1 File locations

All raw data collected were saved in a general folder JRLB/EK60. All files were prefixed with JR16003.

3.2.2 EK60 (ER60) parameter settings

The EK60 collected data during the transect east (Falklands to South Georgia) using parameter settings from JR15004 (post-calibration), and then after calibration on the 25/01/2016 it was operated using parameter settings listed in Table 7.

Variable	38 kHz	70 kHz	120 kHz	200 kHz
Sound velocity (m/s)	1456	1456	1456	1456
Mode	Active	Active	Active	Active
Transducer type	ES38	ES70-7C	ES120-7C	ES200-7
Transceiver Serial no.	009072033fa5	0090720770eb	00907203422d	009072033f91
Transducer depth (m)	0	0	0	0
Absorption	10	18.0	26.1	39.7

coef. (dB/km)				
Pulse length (ms)	1.024	1.024	1.024	1.024
Max Power (W)	1000	750	250	300
2-way beam angle (dB)	-20.70	-20.60	-20.40	-19.70
Transducer gain (dB)	25.73	26.40	23.72	22.09
Sa correction (dB)	-0.45	-0.36	-0.27	-0.30
Angle sensitivity along	22	23	23	23
Angle sensitivity athwart	22	23	23	23
3 dB Beam along	7.07	6.49	6.37	6.20
3 dB Beam athwart	7.08	6.57	6.36	6.24
Along offset	-0.06	-0.05	-0.08	-0.06
Athwart offset	-0.04	0.05	-0.08	-0.07

Table 7 EK60 default settings

Pulse transmission (i.e. ping) rates of the EK60 were controlled through the k-sync using variable settings depending on whether the swath multibeam sonar (EM122) was being operated at the same time. During these periods, the k-sync (swath+bio) setting was used to maximize the number of samples from the EK60: ie a 2 second ping rate whilst the swath was pinging once, and then the EK60 would transmit twice on its own. In this scenario the multibeam sonar was not allowed to determine the transmission priority or rate (i.e. be the master). This sample mode allows transmission interference (i.e. cross talk) from the multibeam sonar to be removed from the EK60 data using a spike filter. When the swath wasn't used, the k-sync was used to synchronise the EA600, ADCP, and EK60 by typically triggering all instruments on a 2 second ping rate, with the ADCP and EA600 triggering slower (by factors of 2)when data was collected at water depths exceeding _1500m.

3.2.3 EK60 echosounder calibration

An acoustic calibration was carried out in Stromness Harbour, South Georgia on 24-25/12/2016. The ship was anchored, its movement balanced by minimal DP usage, and all over-the-side water deposits were stopped. Transmission of the EK60 was triggered through the k-sync, and the EA600 and ADCP were switched off. Each transducer was calibrated in turn, with all transducers transmitting though the entire calibration. A ping rate of 1 second was used. Standard ER60 calibration procedures were used as documented for previous cruises, although in this case a 38.1 mm tungsten carbide sphere was used for all frequencies. TS gains were similar (within 0.2 dB) to values obtained in January during JR15004. The calibration sphere was also positioned on the acoustic axis for extra periods of time to enable calibration variables to be estimated using Echoview software. The 38kHz recorded greatest change from JR15004 calibration and was repeated to verify results. As both JR16003 38kHz calibrations gave similar results the calibration file was updated.

A CTD (Event 74, CTD006) was undertaken on the morning of the calibration (Figure 10). Temperature and salinity were averaged from the surface to 30 m (depth of the calibration sphere) and were 0.86 °C and 33.84 PSU, resulting in a speed of sound constant of 1456 m/s (Kongsberg

software calculation). The speed of sound was updated into the ER60 software. The matlab script ComputeSolidElasticSphere.m was used to calculate the target strength of the calibration sphere (Table 8).

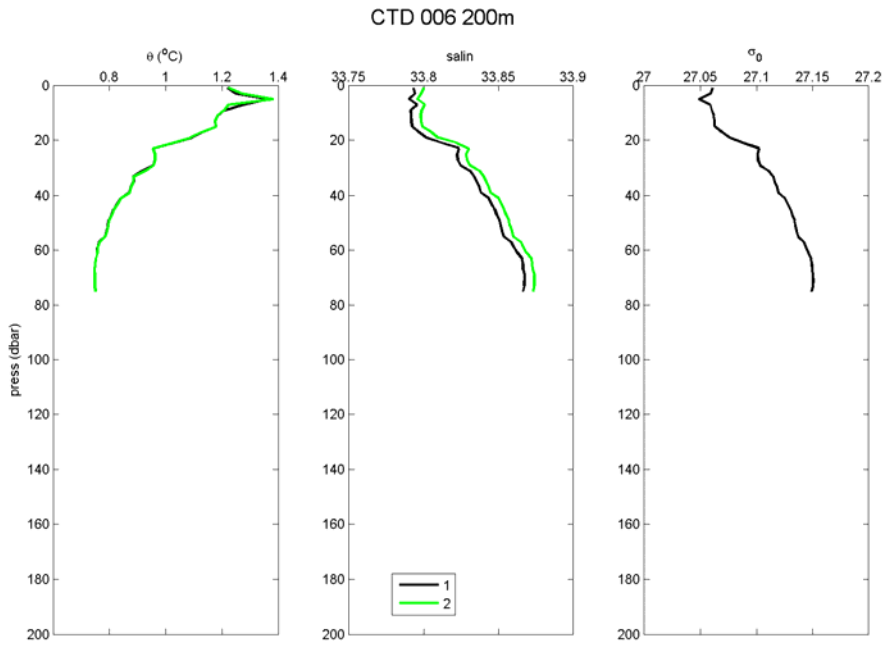


Figure 10 CTD profile at calibration site Stromness

The first calibration parameters were uploaded to the GPTs on each occasion.

Frequency (kHz)	Target Strength (average), dB
38	-42.102
70	-40.590
120	-39.802
200	-39.465

Table 8 Calibration sphere target strengths used to calibrate EK60

3.3 EK80

Although the EK80 was not operated through the cruise, an attempt was made to calibrate the WBTs, in particular a new WBT for the 38 kHz transducer. The software to the EK80 was also updated to the newest version of 1.8.3. It was noted that in this version the chirp functionality of the 38B transducer has been disabled, so we were only able to calibrate in CW mode.

3.3.1 EK80 system use and file storage

The EK80 was operated using Simrad EK80 v. 1.8.3 software, from the PU1 PC. The .raw data files were logged to the Linux server JRLB, using a Samba connection, which is backed up at regular intervals.

3.3.2 EK80 calibration

The EK80 calibration followed the EK60 calibration on the 24/12/2016 in Stromness Harbour. The same CTD was used to update the environmental parameters within the software. Transmission of the EK80 was triggered in internal mode, all other echosounders were turned off. Each transducer was calibrated in turn, with the other transducers switched to passive. A ping rate of 1 second was

used. Standard ER60 calibration procedures were used as documented for previous cruises. The 38.1 mm tungsten carbide sphere was used for the 38 kHz frequency. An attempt was made to calibrate the wideband 70 and 120 kHz transducer using a 20mm tungsten carbide sphere. Target strength values for each sphere were calculated by the software. The results of the lobes calibration of the 38 kHz WBT are presented (Table 9), and identified that the new WBT has resolved the issue from JR15004 where we were unable to see the sphere in all quadrants of the transducer. Attempts to calibrate the 70 and 120 kHz WBTs in wideband mode were not successful, with the sphere failing to be identified as a calibration target at the edges of the beams. Altering target parameters resolved this, but it was felt that changing these without recognition of due cause was not wise. This needs further instruction for calibration.

	Freq (kHz)	TS gain (dB)	Sa cor (dB)	Alongship beamwidth (°)	Athwartship beamwidth (°)	Alongship angle offset (°)	Athwartship angle offset (°)	TS RMS error
Before cal	38	26.5	0	7.10	7.10	0	0	
After cal	38	27.77	0.01	6.47	6.59	-0.1	0.00	0.1082

Table 9 Calibration of 38 kHz EK80 transducer in CW

4 Mooring Cruise Report

Scott Polfrey, Peter Enderlein, Dan Ashurst, Gabi Stowasser, Sophie Fielding, Clara Mano & Geraint Tarling

4.1 General

During JR16003 the P2 and P3 deep sediment trap moorings where successfully recovered and redeployed. Also the WCB mooring was redeployed at its original position.

4.1.1 3200m sediment trap mooring @ P2

4.1.1.1 Recovery

The recovery took place on 30/12/16 at 12:10. The acoustic releases responded straight away and after ranging the mooring successfully a few time, the mooring was released and was within 5min at the surface. The mooring was hooked mid ships and the mooring winch rope attached. The whole rig was recovered by using the mooring winch and a stopper rope on a cleat. This worked very well again and despite the length of the rig, it was a speedy recovery taking just a little bit more than 2 hours.

4.1.1.2 Performance

Two CTDs and the ADCP were recovered, the data were downloaded but not checked.

An Aquadopp current meter was successfully recovered. It was working properly and it was possible to recover the full deployment dataset. No sign of corrosion and/or damage was detected.

Sediment trap (shallow and deep) – On the recovery all the 21 bottles were successfully recovered from both sediment traps. All bottles were packed into vermiculate boxes for storage at +4°C for analysis in Cambridge. The pH of the solution in each bottle was measured and ranged between 8.00-8.01. This pH values confirmed that the buffer solution was working well and the samples will be suitable for further Ocean Acidification study. Last year, we substituted the original plastic bottles provided by McLane with light marine graded aluminium bottles (more resistant that the previous one), designed at BAS by P. Enderlein. The recovery of the full set of bottles highlights the high resistance of this new design to the mechanical stress produced during the recovering/deployment of the mooring. To avoid any contamination with chemicals, the bottles have been coated on the inside with plastic. However, we noticed a contamination inside the bottles in the form of black microparticles (probably coming from the inlet coat). Most part of the bottles also contains a white (carbonate look like) crystallization deposed on the side of the inlet top neck. Furthermore the outside of the bottles appeared to be covered by a thicker oxidised layer. This feature was similar from both upper and lower sediment traps. The new design bottles are promising, but more investigation is required into the potential contamination issue. For this reason, we decided to set up the sediment traps with the original plastic bottles. During the sediment trap setup, we discovered the motor (ML 11966-02) was not responding well to the electronic input. The old motor was exchanged for a spare, and all worked appropriately afterwards.

4.1.1.3 Redeployment

The mooring was redeployed on the 31/12/16 at 12:53. The mooring was deployed with the same pay load as last year. The deployment started at 12:53 GMT, buoy first. The weight was finally released at 15:21 at -55.24975 S, -41.23278 W. After given the mooring time to settle, it was triangulated to calculate it actual position in the water: Latitude -55° 14.9080 S, Longitude -41° 13.5044 W

4.1.1.4 Work carried out:

Acoustic releases: 290 + 1219

☒ new batteries
☒ tested
☒ new linking bar

Imarsat Iridium beacon: 12098770

☒ new batteries
☒ tested

CTD 37 SMP 43742: 4852 ***on main buoy***

☒ download data, **file**: L drive: CTD_4852
☒ new batteries

☒ new O-rings

☒ set-up instrument for re-deployment

- set real time clock to PC clock (p. 28)
- check instruments is ok and clock is set properly by using "DS"command (p. 27)
- set-up instrument for "Autonomous Sampling" following the instructions on page 24. Started at 01/01/17. 00:00:01
- samplenum=0 automatically makes entire memory available for recording
- sample interval: 900 sec

CTD 37 SMP 43742: 4855 ***below Water sampler***

☒ download data, **file**: L drive: CTD_4855
☒ new batteries
☒ set-up instrument for re-deployment

ADCP WHS300 – I – UG164 Serial number:15548

☒ download data, **file: L drive: P2_14000.000**

☒ new batteries

☒ set-up instrument for re-deployment

- erase data (p.16 WinSC)
- start WinSC for set up instrument
- set-up instrument
  - Number of bins: 30 (1-128)
  - Bin size (m): 8 (0.2-16)
  - Pings per Ensemble: 10
  - Interval: 15 min
  - Duration: 550 days
  - Transducer depth: 200 m
- save deployment settings
- start time: 01/01/17. 00:00:01
- set up ADCP real time clock to PC clock
- don't verify the compass (needless on a ship)
- run pre-deployment tests to check instrument

Sediment trap shallow: Parflux No: ML13136-02 Top

✓ new batteries (14x C – Cells + 2* AAA batteries)

o **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ Set up sediment trap with sample tubes

PS2 Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 01-15-17

Event 2 of 22 = 02-01-17

Event 3 of 22 = 02-15-17

Event 4 of 22 = 03-01-17

Event 5 of 22 = 04-01-17

Event 6 of 22 = 05-01-17

Event 7 of 22 = 06-01-17

Event 8 of 22 = 07-01-17

Event 9 of 22 = 08-01-17

Event 10 of 22 = 09-01-17

Event 11 of 22 =10-01-17

Event 12 of 22 = 11-01-17

Event 13 of 22 = 12-01-17

Event 14 of 22 = 12-15-17

Event 15 of 22 = 01-01-18

Event 16 of 22 = 01-15-18

Event 17 of 22 = 02-01-18

Event 18 of 22 = 02-15-18

Event 19 of 22 = 03-01-18

Event 20 of 22 = 04-01-18

Event 21 of 22 = 05-01-18

Event 22 of 22 = 06-01-18

Sediment trap deep: Parflux No: ML13136-01 Bottom

☒ new batteries (14x C – Cells + 1x 9V Block battery)

o **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ Set up sediment trap with sample tubes

PD2 Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 01-15-17

Event 2 of 22 = 02-01-17

Event 3 of 22 = 02-15-17

Event 4 of 22 = 03-01-17

Event 5 of 22 = 04-01-17

Event 6 of 22 = 05-01-17

Event 7 of 22 = 06-01-17

Event 8 of 22 = 07-01-17

Event 9 of 22 = 08-01-17

Event 10 of 22 = 09-01-17

Event 11 of 22 =10-01-17

Event 12 of 22 = 11-01-17

Event 13 of 22 = 12-01-17

Event 14 of 22 = 12-15-17

Event 15 of 22 = 01-01-18

Event 16 of 22 = 01-15-18

Event 17 of 22 = 02-01-18

Event 18 of 22 = 02-15-18

Event 19 of 22 = 03-01-18

Event 20 of 22 = 04-01-18

Event 21 of 22 = 05-01-18

Event 22 of 22 = 06-01-18

Aquadopp current meter s/w AQD 2018

Deployment settings are as follows:

Deployment : P2_16

Current time : 31/12/2016 12:10:24

Start at : 01/01/2017 00:00:01

Comment:

P2 deployed JR16003 31/12/2016

Measurement interval (s) : 900

Average interval (s) : 60

Blanking distance (m) : 0.37

Diagnostics interval(min) : N/A

Diagnostics samples : N/A

Measurement load (%) : 4

Power level : HIGH

Compass upd. rate (s) : 900

Coordinate System : ENU

Speed of sound (m/s) : MEASURED

Salinity (ppt) : 34

File wrapping : OFF

Assumed duration (days) : 550.0

Battery utilization (%) : 243.0

Battery level (V) : 10.7

Recorder size (MB) : 89

Recorder free space (MB) : 89.000

Memory required (MB) : 2.1

Vertical vel. prec (cm/s) : 1.4

Horizon. vel. prec (cm/s) : 0.9

☒ Data downloaded. Save deployed: P2_16_aquadopp.
☒ New batteries

P2 Sediment trap mooring (3200m water depth)

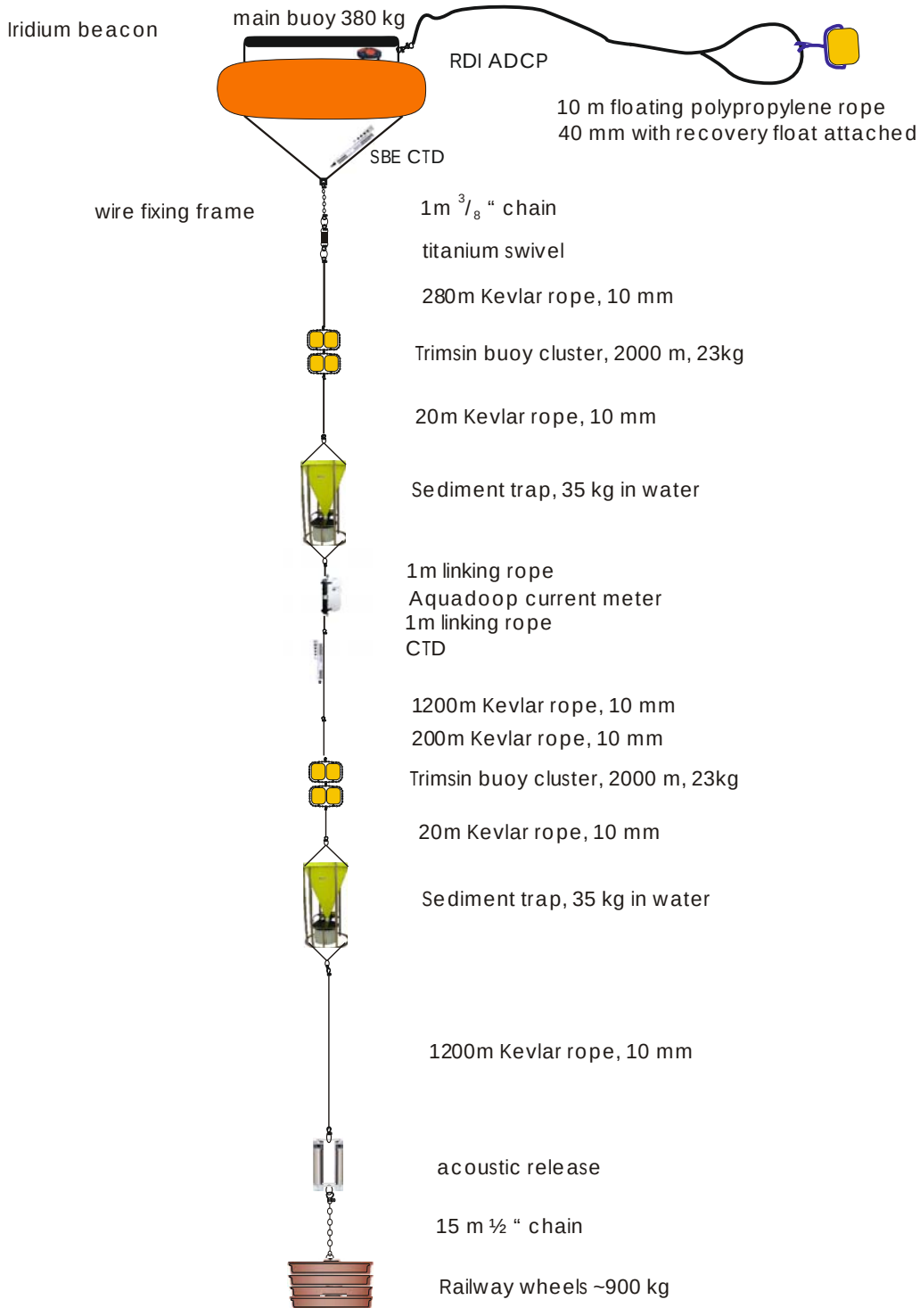


Figure 11 P2 mooring rig recovered

P2 Sediment trap mooring (3200m water depth)

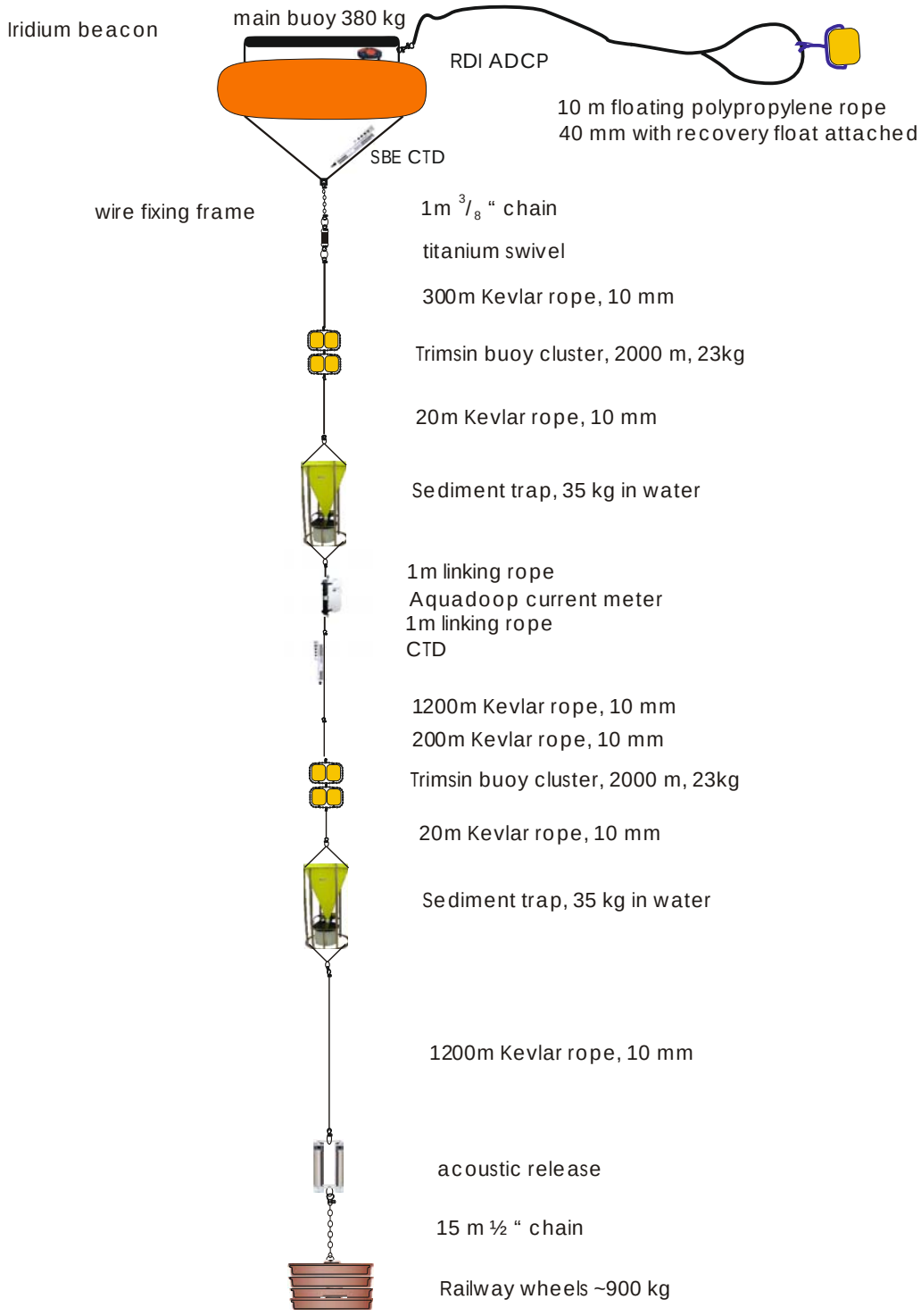


Figure 12 P2 mooring rig deployed

4.1.2 3700m sediment trap mooring @ P3

4.1.2.1 Recovery

The recovery took place on 16/12/16 at 13:58. The acoustic releases responded straight away and after ranging the mooring successfully a few time, the mooring was released and was within 5min at the surface. The mooring was hooked mid ships and the mooring winch rope attached. The whole rig was recovered by using the mooring winch and a stopper rope on a cleat. This worked very well again and despite the length of the rig, it was a speedy recovery taking 2 hours.

4.1.2.2 Performance

Two CTDs and an ADCP were recovered, the data were downloaded, but were not checked.

Sediment trap (shallow and deep) All the bottles were successfully recovered from both sediment traps. Bottles were packed into vermiculate boxes for storage at +4°C for analysis in Cambridge. The pH of the solution in each bottles was measured and ranged between 8.00-8.01. These pH values confirmed that the buffer solution was working well and the samples will be suitable for further Ocean Acidification study.

Both sediment traps were redeployed. We noticed the same issue for the metal bottles as observed for sediment traps recovered in P2 (see above session, P2 performance) and we decided to substitute the metal bottles with the original plastic bottles.

Two Seaguard current meters with O2 sensor (shallow and deep): The instruments were successfully recovered and collected data during the period of deployment. No sign of corrosion and/or damage was detected. After the download of data, we redeployed both instruments.

Pro-Oceanus-CO2 sensor– last year we could not deploy the CO2 sensor because the battery housing indicated massive corrosion and also the fuse had blown. The sensor was sent back to the company for warranty, the battery pack was repaired and fuse changed. The firmware was updated to version 1.0.26. This year the sensor was successfully deployed.

4.1.2.3 Redeployment

The mooring was redeployed on the 29/12/16. The deployment started at 12:44 GMT, buoy first. The mooring was deployed in a slightly reconfigured layout as per drawing below. The weight was finally released at 15:22 at -52.81375 S, -40.17078 W. After given the mooring time to settle, it was triangulated to calculate it actual position in the water: Latitude 52° 48.7500 S, Longitude 40° 09.8610 W.

4.1.2.4 Work carried out:

Acoustic releases: 93 + 2060

☒ new batteries
☒ tested
☒ new linking bar

Release 573 was faulty and replaced with 2060

Irmarsat Iridium beacon: 13901110

☒ new batteries

☒ tested

Argos beacon: SN 280, ID: 60210

☒ new batteries
☒ tested

NOVATECH Combo beacon: R090-020, Ch B, 159.480 MHz

☒ new batteries
☒ tested

CTD 37 SMP 43742: 2462 *on main buoy*

☒ download data, **file**: L drive: CTD_2462
☒ new batteries

☒ new O-rings

☒ set-up instrument for re-deployment

- set real time clock to PC clock (p. 28)
- check instruments is ok and clock is set properly by using "DS"command (p. 27)
- set-up instrument for "Autonomous Sampling" following the instructions on page 24. Started at 01/01/17. 00:00:01
- samplenum=0 automatically makes entire memory available for recording
- sample interval: 900 sec

CTD 37 SMP 43742: 4584 *below Water sampler*

☒ download data, **file**: L drive: CTD_4584
☒ new batteries
☒ set-up instrument for re-deployment

ADCP WHS300 – I – UG26: 2967

☒ download data, **file: L drive: P3_14000.000**

☒ new batteries

☒ set-up instrument for re-deployment

- erase data (p.16 WinSC)
- start WinSC for set up instrument
- set-up instrument
  - Number of bins: 30 (1-128)
  - Bin size (m): 8 (0.2-16)
  - Pings per Ensemble: 10
  - Interval: 15 min
  - Duration: 550 days
  - Transducer depth: 200 m
- save deployment settings. P3_16
- start time: 01/01/17. 00:00:01
- set up ADCP real time clock to PC clock
- don't verify the compass (needless on a ship)
- run pre-deployment tests to check instrument

Sediment trap shallow: Parflux No: 11966-01 Top

✓ new batteries (14x C – Cells + 1x 9V Block battery)
o **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ Set up sediment trap with sample tubes

PS3 Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 01-15-17

Event 2 of 22 = 02-01-17

Event 3 of 22 = 02-15-17

Event 4 of 22 = 03-01-17

Event 5 of 22 = 04-01-17

Event 6 of 22 = 05-01-17

Event 7 of 22 = 06-01-17

Event 8 of 22 = 07-01-17

Event 9 of 22 = 08-01-17

Event 10 of 22 = 09-01-17

Event 11 of 22 =10-01-17

Event 12 of 22 = 11-01-17

Event 13 of 22 = 12-01-17

Event 14 of 22 = 12-15-17

Event 15 of 22 = 01-01-18

Event 16 of 22 = 01-15-18

Event 17 of 22 = 02-01-18

Event 18 of 22 = 02-15-18

Event 19 of 22 = 03-01-18

Event 20 of 22 = 04-01-18

Event 21 of 22 = 05-01-18

Event 22 of 22 = 06-01-18

Sediment trap deep: Parflux No: 13176-01 Bottom

☒ new batteries (14x C – Cells + 2* AAA batteries)

o **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ Set up sediment trap with sample tubes

PD3 Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 01-15-17

Event 2 of 22 = 02-01-17

Event 3 of 22 = 02-15-17

Event 4 of 22 = 03-01-17

Event 5 of 22 = 04-01-17

Event 6 of 22 = 05-01-17

Event 7 of 22 = 06-01-17

Event 8 of 22 = 07-01-17

Event 9 of 22 = 08-01-17

Event 10 of 22 = 09-01-17

Event 11 of 22 =10-01-17

Event 12 of 22 = 11-01-17

Event 13 of 22 = 12-01-17

Event 14 of 22 = 12-15-17

Event 15 of 22 = 01-01-18

Event 16 of 22 = 01-15-18

Event 17 of 22 = 02-01-18

Event 18 of 22 = 02-15-18

Event 19 of 22 = 03-01-18

Event 20 of 22 = 04-01-18

Event 21 of 22 = 05-01-18

Event 22 of 22 = 06-01-18

Seaguard current meter with O_2 sensor: 1307 Shallow

Seaguard current meter serial number: 1307

Current meter sensor: 851

Optode: 1561

The seaguard current meter with O_2 sensor does not output a setup file.

Deployment settings:

The sampling interval was set to 2 hrs, as this resulted in a deployment time of 560 days. All other settings were left at the manufacturers settings. It was checked that the current meter was set in burst mode (optimal for long term battery use). It is assumed a deployment file will be logged on the memory card for download on retrieval.

☒ data downloaded, **file**: L drive: 6 files, Data: DT000000.txt
☒ new batteries

Seaguard current meter with O_2 sensor: 1309 Deep

Seaguard current meter serial number: 1309

Current meter sensor: 851

Optode: 1561

The seaguard current meter with O_2 sensor does not output a setup file.

Deployment settings:

The sampling interval was set to 2 hrs, as this resulted in a deployment time of 560 days. All other settings were left at the manufacturers settings. It was checked that the current meter was set in burst mode (optimal for long term battery use). It is assumed a deployment file will be logged on the memory card for download on retrieval.

☒ data downloaded, **file**: L drive: 6 files, Data: DT000000.txt
☒ new batteries
☒

Sonovault acoustic listening device: serial number TC4037-3 S7N, 0815005

✓ Setup

✓ New batteries

P3 Sediment trap mooring (3700m water depth)

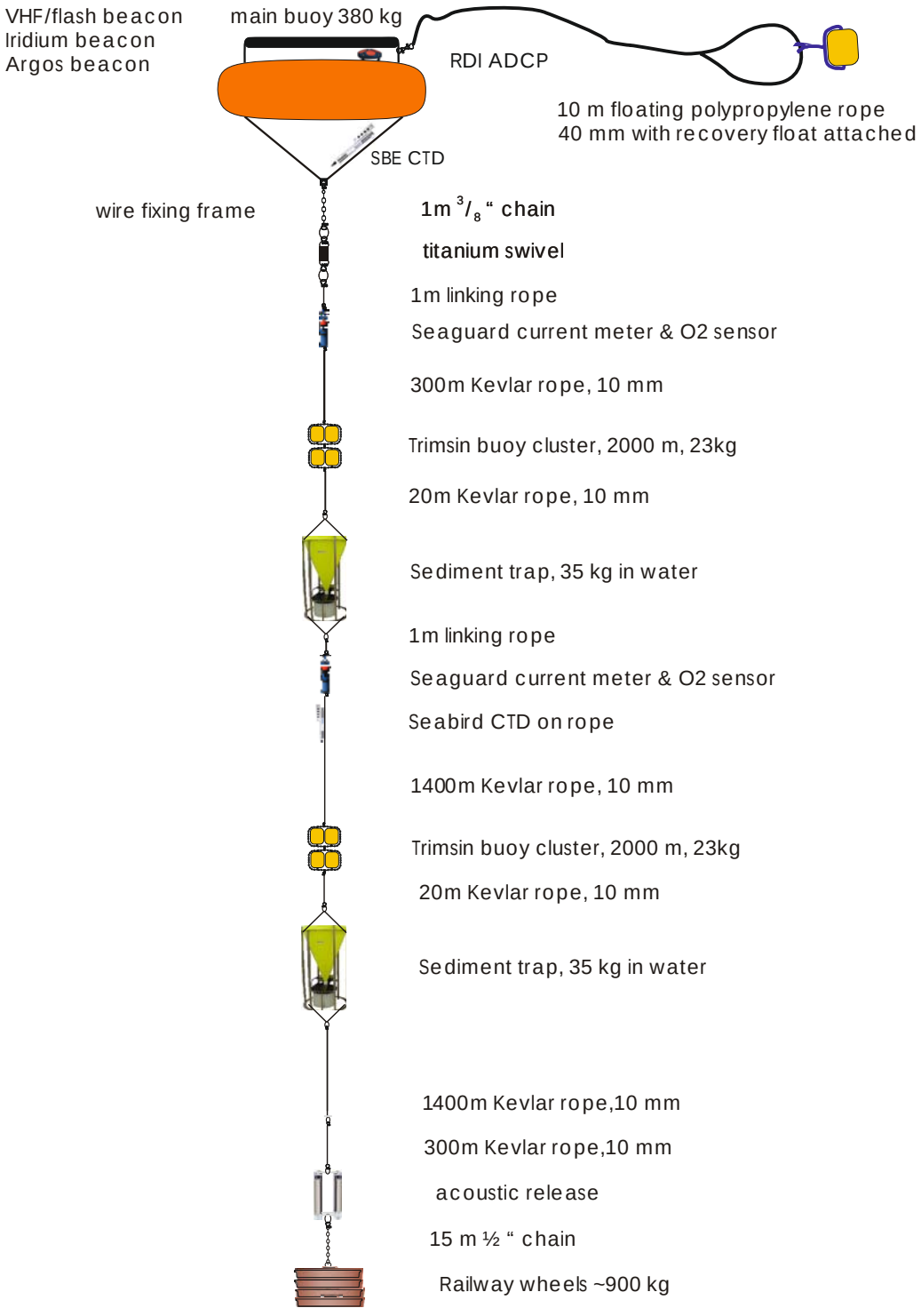


Figure 13 P3 mooring rig recovered

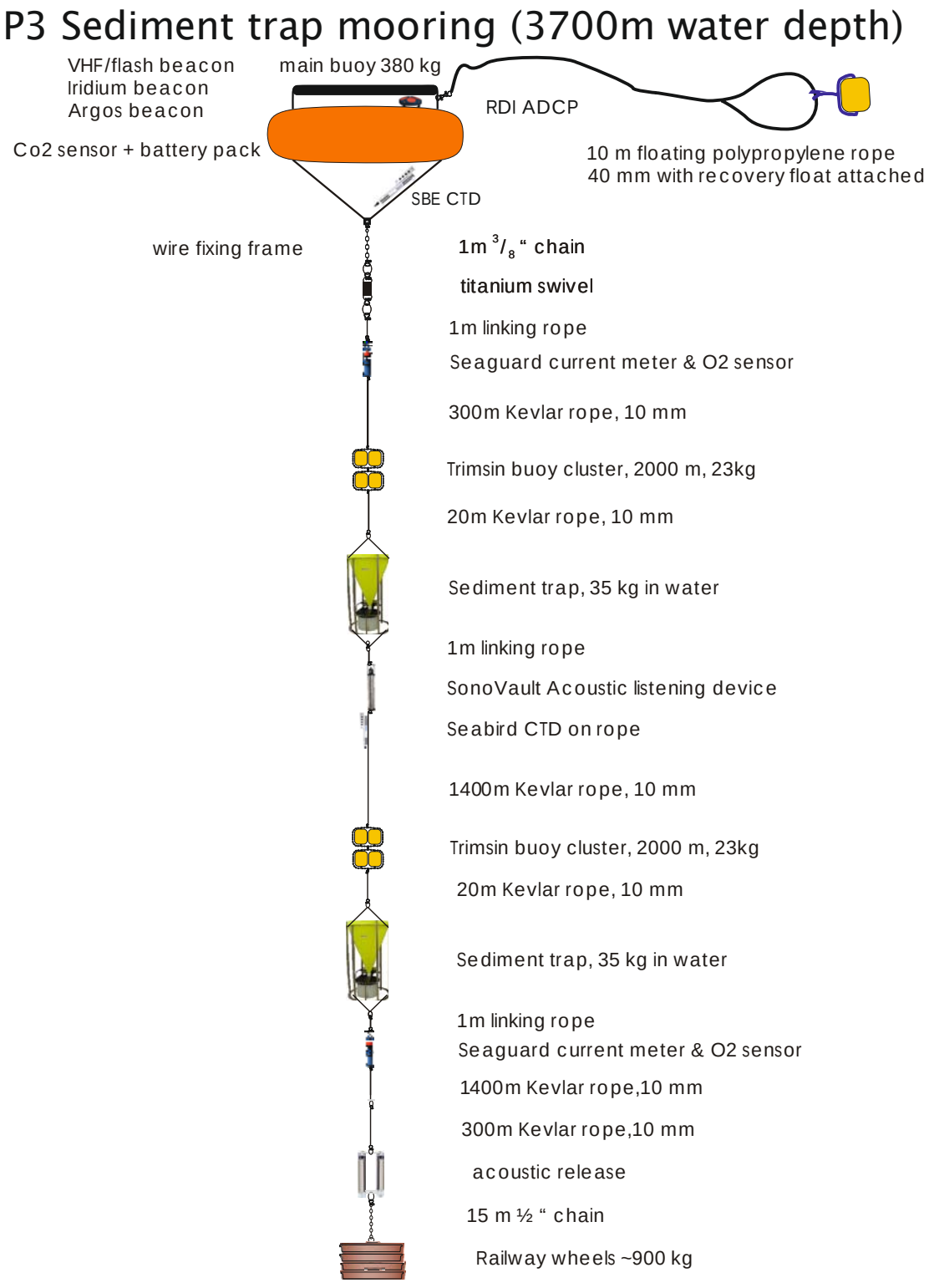


Figure 14 P3 mooring rig deployed

4.1.3 WCB mooring

4.1.3.1 Deployment:

The WCB mooring was rigged during our stay in Stromness. The deployment took place on 26/12/16. The deployment started at 14:13 GMT, buoy first. The mooring was deployed buoy first as per drawing below. The weight was finally released at 14:44 at Lat: 53* 47.90'S Long: 037* 55.99'W. As the mooring is very short and at a shallow site no triangulation took place after the deployment. The mooring this year was equipped with a surface sediment trap.

4.1.3.2 Work carried out:

Acoustic releases: 2062 + 2006

☒ new batteries
☒ tested
☒ new linking bar

Argos beacon SM251 ID:35520

☒ new batteries
☒ tested

CTD 37 SMP 43742: 2463 *on main buoy*

☒ download data, **file**: L drive: CTD_2463
☒ new batteries

☒ new O-rings

☒ set-up instrument for re-deployment

- set real time clock to PC clock (p. 28)
- check instruments is ok and clock is set properly by using “DS”command (p. 27)
- set-up instrument for “Autonomous Sampling” following the instructions on page 24. Started at 01/01/17. 00:00:01
- samplenum=0 automatically makes entire memory available for recording
- sample interval: 900 sec

ADCP WHS300 – I – UG161 Serial number: 17273

☒ download data, **file: L drive: WCB_14000.000**

☒ new batteries

☒ set-up instrument for re-deployment

- erase data (p.16 WinSC)
- start WinSC for set up instrument
- set-up instrument
  - Number of bins: 30 (1-128)
  - Bin size (m): 8 (0.2-16)
  - Pings per Ensemble: 10
  - Interval: 15 min
  - Duration: 550 days
  - Transducer depth: 200 m
- save deployment settings. Wcb_16
- start time: 01/01/17. 00:00:01
- set up ADCP real time clock to PC clock
- don't verify the compass (needless on a ship)
- run pre-deployment tests to check instrument

Sediment trap shallow: Parflux No: Top

✓ new batteries (14x C – Cells + 2* AAA batteries)
o **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ Set up sediment trap with sample tubes

WCB Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 01-15-17

Event 2 of 22 = 02-01-17

Event 3 of 22 = 02-15-17

Event 4 of 22 = 03-01-17

Event 5 of 22 = 04-01-17

Event 6 of 22 = 05-01-17

Event 7 of 22 = 06-01-17

Event 8 of 22 = 07-01-17

Event 9 of 22 = 08-01-17

Event 10 of 22 = 09-01-17

Event 11 of 22 =10-01-17

Event 12 of 22 = 11-01-17

Event 13 of 22 = 12-01-17

Event 14 of 22 = 12-15-17

Event 15 of 22 = 01-01-18

Event 16 of 22 = 01-15-18

Event 17 of 22 = 02-01-18

Event 18 of 22 = 02-15-18

Event 19 of 22 = 03-01-18

Event 20 of 22 = 04-01-18

Event 21 of 22 = 05-01-18

Event 22 of 22 = 06-01-18

Sonovault acoustic listening device: serial number TC4-37-3S7N 0815004:

- ✓ Setup
- ✓ New batteries

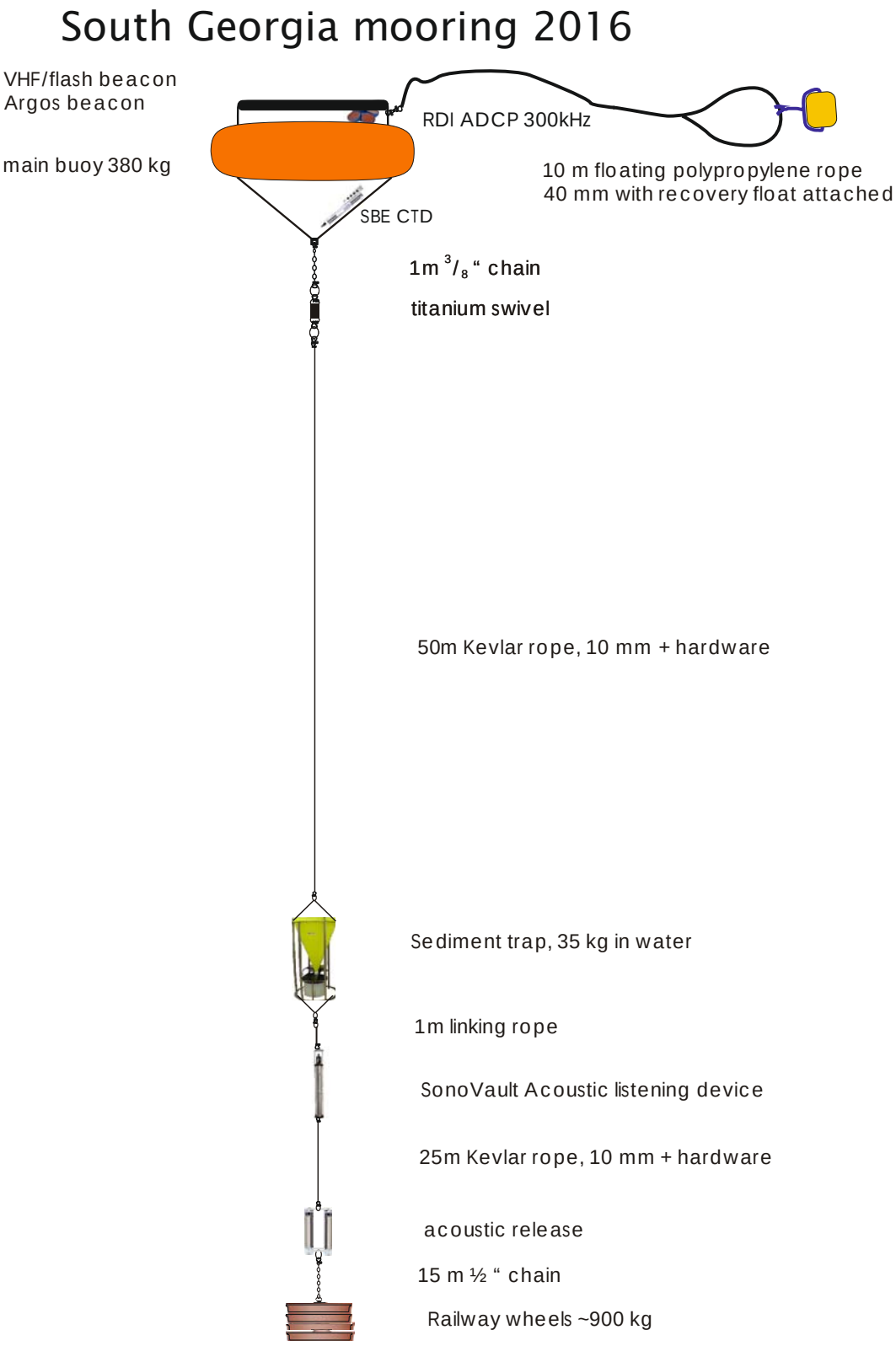


Figure 15 WCB mooring deployed

4.2 Sono.Vault update and deployment

Seth Thomas, Jeremy Robst, Gabi Stowasser

The Sono.Vault storage modules of both Sono.Vaults, deployed on the P3 and WCB moorings respectively, were updated following the instructions of the manufacturer (see below). All data files mentioned in the instructions are stored on a flash drive, which is kept by Dr. Ian Staniland (BAS), the owner of both instruments.

Instructions:

The firmware file for updating the Sono.Vault Storage modules can be found on the flash drive. To program the hardware you have download and install the software "FET-Pro-430 Software Pkg. - LITE" from this page BEFORE you connect to MSP-FET programmer to your PC:

https://www.elprotronic.com/productdata#

When everything is installed correctly, please reboot you PC and connect the USB programmer as soon as Windows has fully booted. Then wait until the device was detected, the drivers are properly installed and the device is ready for usage. Then open the FET-Pro-430 software with administrator rights and open the top menu bar "Setup >> Memory Options". Important is to switch the "Memory Erase/.../ Address Range" to "Main Memory only", otherwise the update deletes more than allowed. Compare the attached memory options screenshot (Figure 16) with your settings and apply them. Now select the microcontroller type, which is an MSP430F5438A, and open the attached code file "SVR_MSP5438A_D.HEX" (see 2nd Fet-Pro-430 screenshot, Figure 17).

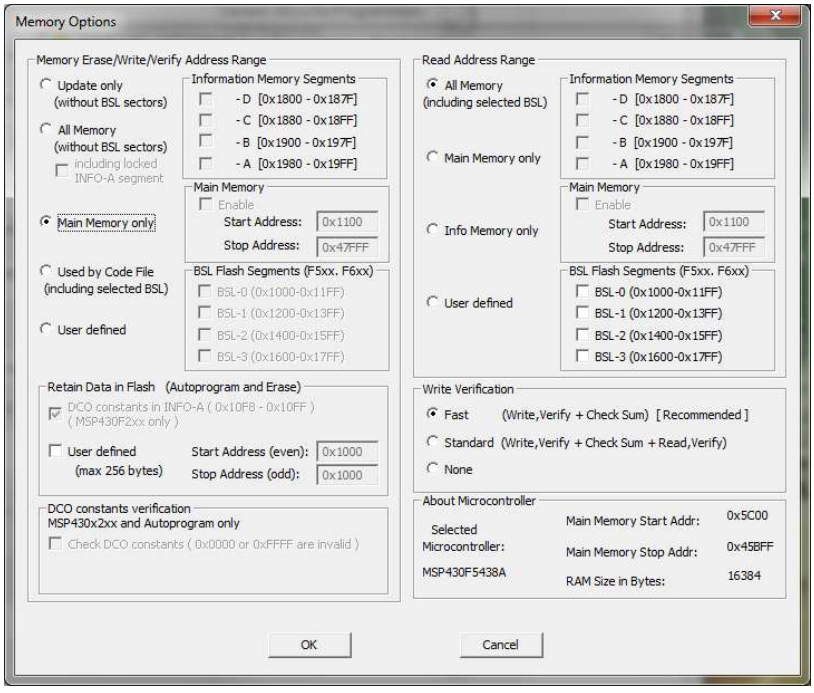


Figure 16 Screenshot of memory options

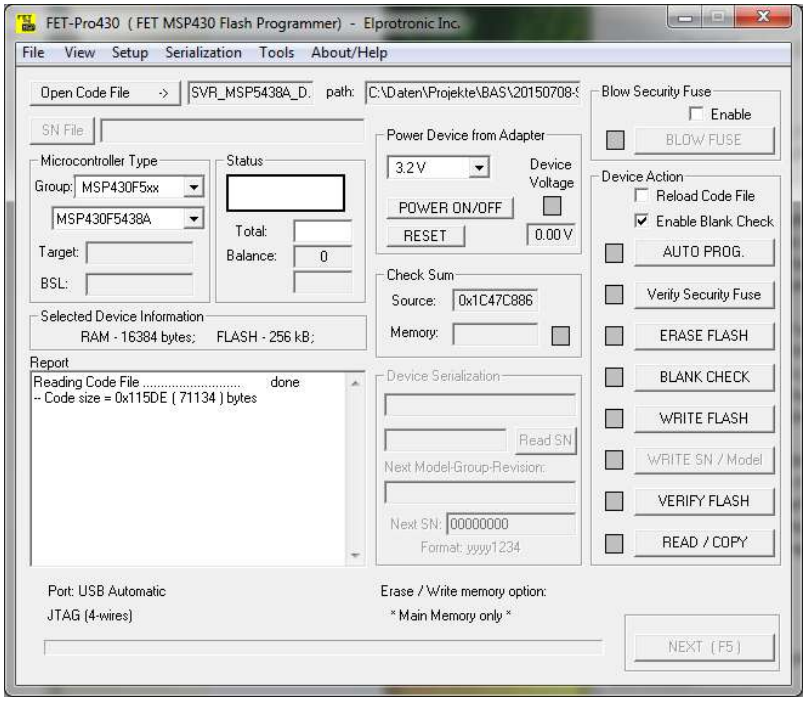


Figure 17 Screenshot of menu to choose microcontroller type

Performing an update of each SD-card / storage module requires to partially disassemble the electronic stack as you can only access the JTAG connector of one board at a time - the one which is the closest one to the main (interface) board. Next thing is, the update only works with the interface board connected, as it provides power to the storage board. So the idea is to have each storage board directly connected once to the interface for updating it. One other thing is important here as well: Please memorize the initial order of all storage boards (maybe label them), as you have to restore the same order for the final assembly again!

Please ensure that all the following actions happen on a dry, clean, not nonconductive surface to avoid damage of the hardware! Also ensure that you are not statically charged, to please discharge yourself. Before starting disassembly, please also ensure that the electronics is switched off completely (disconnect the battery power). Please keep in mind, that you do all these things on your own risk, so it is important to follow my instructions closely and ask me in case of any doubts.

According to my information, your electronic stack has two plastic protection rings: One is mounted directly to the housing cap and one on the other side. It might be easier to detach the stack from the cap before disassembling it. Start the disassembly from the side where the storage modules are. Remove the protecting ring and all boards step-by-step including all relevant distance holders. Now rebuild a small electronic stack with only the interface and one storage (see attached picture for storage connection, Figure 18). The update does not require the small analog board called AFE, so you can leave that apart. Then connect the JTag cable as shown in the picture with the red or blue wire (pin 1) on the left.

New re-connect the power and go back to the Fet-Pro-430 tool for the update. The USB programmer should have the green and red LED active. First thing to do is hit the "Verify Security Fuse" button and wait for the response in the "Report" field. When it shows "Passed" hit the "AUTO PROG." button next and wait until the update has completed successfully. Then disconnect the power, switch the storage board and do the same again (power up, check fuse, program, power down).

To avoid further conflicts, I would also recommend to update the microcontrollers on the main board as well. The attached connection picture also shows the JTag connectors for the interface

microcontroller (SVI) and the analog microcontroller (SVA). Start with the update of the analog part as it has the same microcontroller as the storage (SVR) - the MSP430F5438A. Please ensure this controller is still set up in the Fet-Pro-430 tool and load the "SVA_MSP430F5438A.HEX" code file. Then connect JTag to corresponding port, power up, check fuse, do the auto-programming and power down.

Now do the same steps for the interface microcontroller, but in this case change the type to "MSP430F5659" and load the "SVI_MSP430F5659.HEX" code file. For later updating the other storage modules please do not forget to setup the right microcontroller and HEX file again! If something during this procedure does not behave as mentioned above, please contact me or Rolf (copied in this discussion) to help you out.

Before you re-assemble the complete stack with distance holders and so on, I would recommend to do a first check, if the provided firmware solves your problem. We ordered one of the SD-cards you have, checked it and adjusted the firmware, so that it finally worked here. But the final prove is, that it works in your system. For that put the complete stack together (power disconnected, no distance holders), connect the serial interface and then the power. Check if your cards were found and if the system records on them. Assuming everything is running well, you can stop, power down and do the final re-assembly.

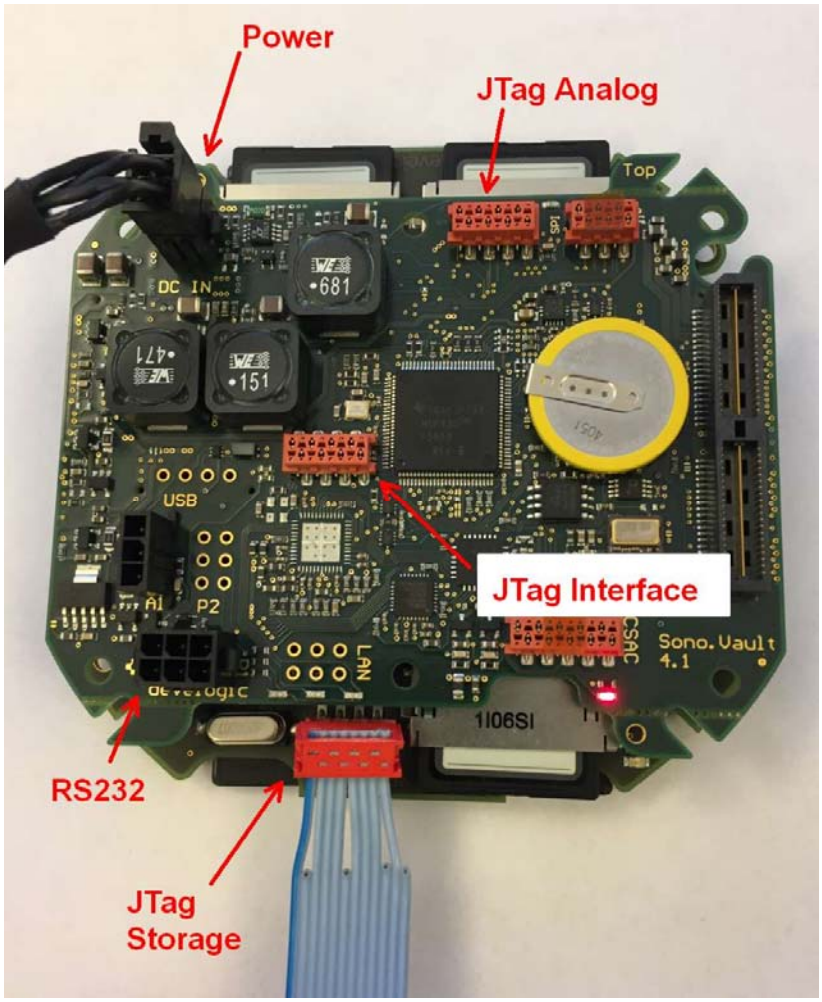


Figure 18 Storage connection set-up

After installing the up-date the Sono vaults were connected to a PC via the serial link, using the Tera Term terminal emulator software. Entering the command **?system.storage** displays the detected SD cards, their sizes and the amount of free space.

Note the system counts modules and slots from 0, but the cards are labelled from 1 so careful matching is needed. The Sono Vault was powered off before cards were removed and re-inserted.

After running the above command it was noticed that the system failed to detect some cards, or gave implausible values for others. For example a 512GB card usually showed us as having a capacity of 488971 bytes, but some cards showed capacities of 3539501 bytes – not possible on a 512GB card. Other cards came up as having 0 bytes free, even though a PC showed no data on those cards.

The problem cards were reformatted in a Linux machine, using the command mkfs.vfat /dev/mmcblk0 to reformat the whole card; then running mkfs.vfat /dev/mmcblk0p1 to reformat the first partition. After the reformatting the cards were replaced in the Sono Vault, and the ?system.storage command was re-run.

This process was repeated until the output from the ?system.storage command gave plausible values for each card physically inserted, with the free space value being very close to the capacity.

It was not possible to get one Lexar card detected by the Sono Vault, so this was not installed.

The storage module was connected to the battery pack approximately 1 hour prior to deployment.

5 Scientific gear report JR16003

Scott Polfrey, Dan Ashurst, Peter Enderlein

During the cruise 9 different pieces of equipment where used. This included our standard equipment like the RMT8 or MOCNESS as well as one modified one, the Open/ Closing Bongo and a brand new piece of equipment the new MUDL (Motion compensated Upwards and Downwards Looking net) which could not be tested in Cambridge, and therefore needed testing and integration on board.

5.1 Bongo- deployed 13 times

A new opening/ closing mechanism was fitted to the Bongo at an early stage of the cruise. This was to allow discreet sampling through the water column. The Bongo has to reach below the required opening depth in order to activate the mechanism. On its way up it will open and then closed at the set depth. After initial tests, it was successfully deployed twice down to sample between 50 and 20m. It was then taken off and used on the MUDL. Further Bongo deployments went to a maximum depth of 200m and sampled through the water column to the surface.

5.2 Mini bongo- deployed 4 times

The mini bongo worked fine and was deployed to a maximum depth of 200m.

5.3 MUDL- deployed 16 times

The MUDL net is a new piece of equipment to be deployed this cruise. The MUDL consists of two nets – one facing upwards, one downwards – with sealed cod ends. The system uses the open/close mechanism used on the Bongo earlier in the cruise, however rather than the system being depth activated, the MUDL in time controlled. It went to a maximum depth of 100m where it opened after 10 minutes of being switched on, and then sampled for 20 minutes. The cod ends then closed and the MUDL was retrieved. The cod ends needed to be pre-filled with water before deployment to avoid implosion. This was firstly done with water from a hose however this was then changed to water collected from the CTD at 100m depth. Retrieval of the sample was achieved by reconnecting the open/close motor unit to the laptop software and manually activating the valves with a bucket in place ready to catch the sample.

We had one unsuccessful deployment during event 85. A sample could not be retained due to the ball valve seal moving away from the ball. This was later rectified by adding toothed washers to the seal housing, locking it in place. All other deployments were successful.

After these deployments, a number of modifications to the system have been suggested. Modifications include: improved sealing of cod ends; adapted ball valve drive shafts; helicoiling all plastic threads and swapping the current CV joints and bevel gears for stainless steel versions. Integration of an additional, full length, dumb Bongo is also to be considered.

5.4 Depth Integrated MUDL (MUDL used as bongo) - deployed 4 times

In this configuration the MUDL was rigged with the open closing mechanism in sampling position, so it worked as a half long Bongo net. It was deployed to a maximum depth of 200m

5.5 MOCNESS- deployed 7 times

The MOCNESS as such worked fine, but had to cope with twisting on the bio wire, which caused some unsuccessful deployments. During Event 86 the winch had a failure at 954 m depth which caused a long delay whilst being fixed. The Net monitor indicated that net had triggered twice, but on retrieval of net, one net was still open. It is assumed that net 3 fished from 875 to 625. During Event 98 the Net opening/closing failed. The net was retrieved with severed coms due to twisted bridle. The sampling occurred from Net 1 that was open from surface to 1000m and back up again.

It became obvious that the problem lay with the bio wire, which had a major unravelling event last year where 2500m of it came loose and had to be sorted by hand and re-spooled. Thereafter it was re-spooled with a 500kg weight and afterwards it looked fine on the drum, but the cable had suffered and had a memory of twists. So we had to re-spool the wire twice which gave us two deployments, before the twisting was getting too bad so it had to be re-spooled again. As this is not practical or acceptable a new bio wire will be ordered and put on, hopefully during refit.

5.6 RMT8- deployed 7 times

The RMT8 worked fine with no problems to report

5.7 RMT25- deployed 8 times

The release mechanism failed to turn on the first test deployment due to a loose clamp coupling within the motor housing. This has been a reoccurring problem. The housing was disassembled and the clamp retightened. The motor and release mechanisms was then re-tested and had no further failures. To ensure cod ends don't become tangled on retrieval, ensure those retrieving the net heave the net in conjunction with using the Gilson winch.

5.8 Mammoth- deployed once

The one deployment was a failure due to entanglement likely caused by twists in the bio wire. Some nets, cod ends and cables where damaged. The mammoth was not deployed again on the cruise. To prevent twisting in the future the Mammoth could be deployed with a swivel in stand-alone mode and not live viewing. The main frame was also adapted with the help of an angle grinder to prevent wear on the towing bridles.

5.9 SUCS MPA- deployed 10 times

The camera was deployed to the seabed each time between 650 and 750m. A Go Pro and a USBL beacon was also fitted to the frame for each deployment. No issues to report.

6 South Georgia Marine Protected Area benthic imagery

Sophie Fielding, Peter Enderlein, Dan Ashurst, Scott Polfrey, Seth Thomas

6.1 Introduction

The Foreign and Commonwealth Office through the South Georgia Science project office requested work to collect 'fisheries independent' imagery of the seafloor and associated invertebrate species using the BAS Shallow Underwater Camera System (SUCS) within the Benthic Closed Area (BCA) located between the Shag Rocks and South Georgia shelves. The images collected will provide data that will be used to help assess the efficacy of these zones within the South Georgia MPA. The sampling will provide information on the species diversity, assemblage composition, abundance and habitat zonation within the BCAs whilst helping to provide stakeholders with information on the benthic impacts of longline fishing gear. The results will contribute to the GSGSSI MPA review process which is due to report in 2018.

6.2 Method

Five stations were originally identified using available bathymetry data with pairs of sites inside and outside the BCA, and water depths between 650 and 750 m. In reality only sites 1, 2, 4 and 5 of those proposed were viable. As a result three sites were selected at station 2 to look at a transect into the MPA (Figure locations). At each site a swath bathymetry line was run to select the ideal depths before the SUCS camera (photo 1) was lowered to the seabed. At least three still photographs were collected (ideally at differing light levels), the video was turned on and the camera was picked up and the ship moved 10 m in a direction before the camera was lowered once again to the seabed and these steps repeated. At least 10 locations at any one site were photographed. Photographs and video were logged to the data drive from each site deployment to a separate folder identified by event number. Filenames themselves were tagged with the event number, the site identifier and then a GMT date and time stamp (e.g. Event_26_site5b_20161219142504.png). Photographs from locations at any one site should be identifiable by timestamps close to each other. At the same time an eventlog was recorded with comments to identify what the ship was doing (Table).

The SUCS system comprises the following:

1. The UIC unit consisting of (i) the PC with monitor, (ii) the cable metering sheave indicator and (iii) the deck box.

2. The deck unit consisting of (i) the winch, (ii) UW-cable, (ii) the deck monitor and (iii) a new wireless metering sheave on the mid-ships gantry.

3. The UW-unit consisting of the tripod holding the UW-housing (holding the camera, the fibre optic booster and the power distribution board) and the UW-lights.

The SUCS was deployed using an electro - fibre-optic cable. This enables both high-resolution photo stills (2448 x 2050) and video footage (2448 x 2050) to be taken simultaneously and displayed in an LabView GUI. Also the live feed is now in full colour and in HD (2448 x 2050).

A USBL mounted on the SUCS frame provides real-time information of the water-depth of the SUCS system. Unfortunately this was not always reliable. However, With the new wireless metering sheave, the wire out is no longer displayed on the LabView GUI. We also mounted a go-pro in its own 1000m housing and took video footage throughout the deployments. These videos were saved to the L drive for return to Cambridge, per site deployment.

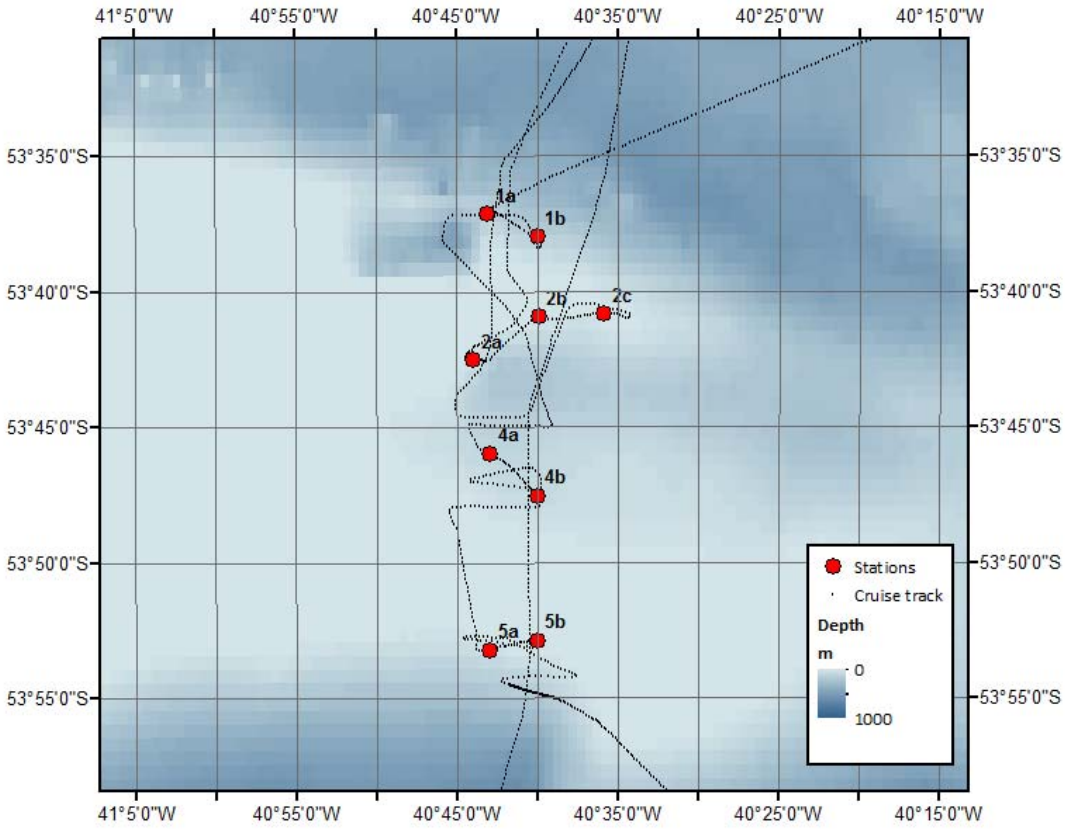


Figure 19 Location of SUCS FCO stations

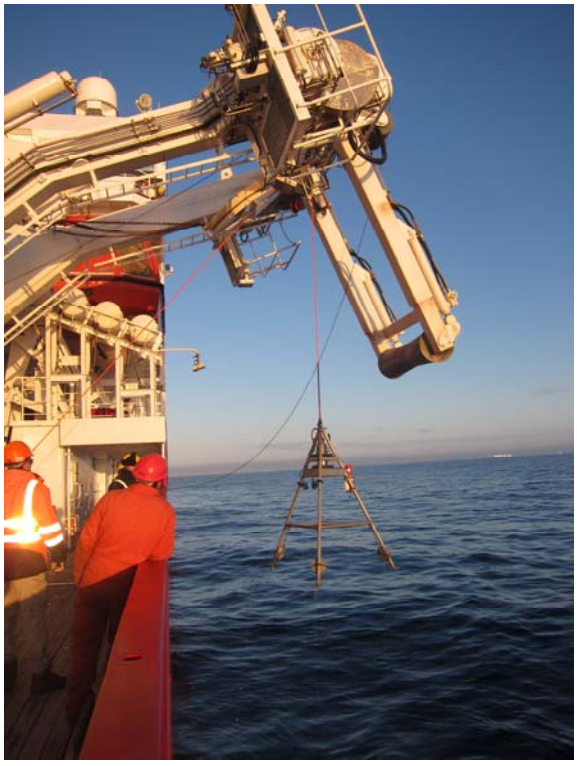
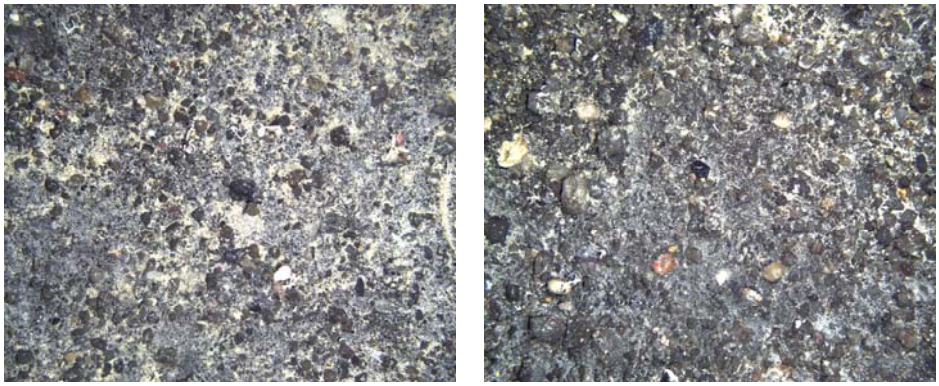


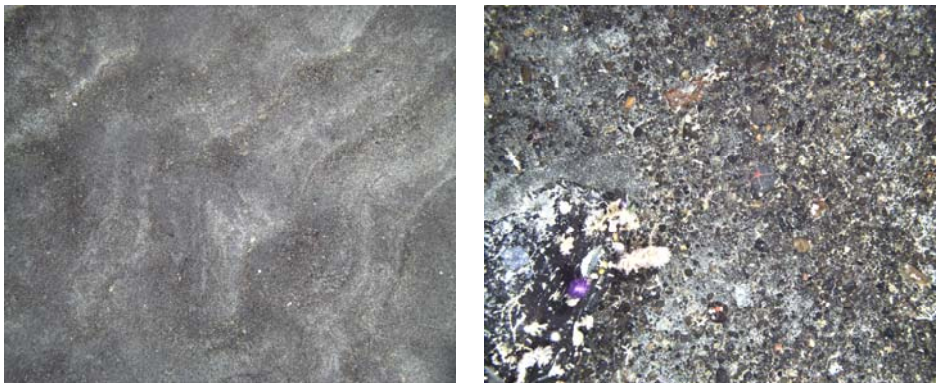
Figure 20 The SUCS camera system

6.3 Results

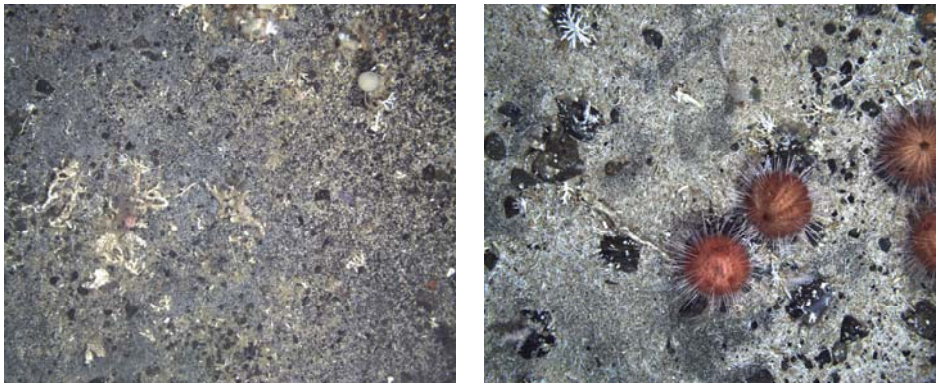
The SUCS camera worked as per specification during the work. We noted that it was better to turn the video off whilst trying to take still photographs rather than leaving it running, as this occasionally caused the programme to crash. At the first attempt at Site 2c (Event 78), high winds/swell and currents appeared to move the SUCS camera along the seabed. The attempt was aborted to prevent damage to the camera system. All other events went smoothly (Table 10), and example images are given in Figure 21



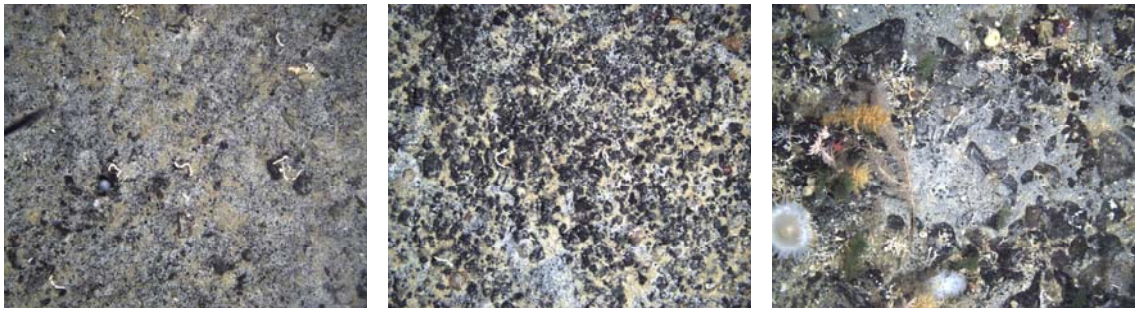
Site 5a and 5b



Sites 4a and 4b



Sites 1a and 1b



Sites 2a, 2b and 2c

Figure 21 Seabed photographs from the various sites

Date	Time	Latitude	Longitude	Water Depth (m)	Event number	Site	Comment
19/12/16	13:05:00	-53.905	-40.701	0		Site 5	New swath survey setup and logging. Searching for suitable depths
19/12/16	14:00:07	-53.884	-40.694	705	26	Site 5b	3 photos, sample 1, moving on 10 m
19/12/16	14:32:00	-53.884	-40.694	705	26	Site 5b	3 Photographs taken. Although ship not moved
19/12/16	14:34:39	-53.882	-40.667	666	26	Site 5b	3 photos taken, sample 2, move on 10 m
19/12/16	14:37:18	-53.882	-40.667	668	26	Site 5b	3 photos taken, sample 3, ship moving 10m
19/12/16	14:44:55	-53.882	-40.667	664	26	Site 5b	3 photos taken, sample 4, moving on 10 m
19/12/16	14:48:03	-53.882	-40.667	674	26	Site 5b	3 photos taken, sample 5, moving 10 m
19/12/16	14:51:55	-53.882	-40.667	668	26	Site 5b	3 photos, sample 6, move on 10 m
19/12/16	14:54:18	-53.882	-40.668	676	26	Site 5b	3 photos taken, sample 7, moving on 10 m
19/12/16	15:02:00	-53.882	-40.668	672	26	Site 5b	3 photos taken, sample 8, moving on 10 m
19/12/16	15:06:51	-53.882	-40.668	679	26	Site 5b	3 photos taken, sample 9, moving on 10m
19/12/16	15:10:06	-53.882	-40.668	668	26	Site 5b	3 photos taken, sample 10, moving on to next site.
19/12/16	16:24:37	-53.888	-40.717	696	27	Site 5a	3 photos taken, sample 1, move on 10m
19/12/16	16:28:12	-53.888	-40.717	689	27	Site 5a	3 photos taken, sample 2, move on 10m
19/12/16	16:31:07	-53.888	-40.717	688	27	Site 5a	3 photos taken, sample 3, moving on 10m
19/12/16	16:34:11	-53.888	-40.717	688	27	Site 5a	3 photos taken, sample 4, moving on 10m
19/12/16	16:34:55	-53.888	-40.717	687	27	Site 5a	One photo taken after SUCS tripod moved location without picking it up. Not classed as a sample
19/12/16	16:37:24	-53.888	-40.717	695	27	Site 5a	3 photos taken, sample 5, moving on 10 m
19/12/16	16:40:18	-53.888	-40.717	687	27	Site 5a	3 photos taken, sample 6, moving on 10m
19/12/16	16:43:18	-53.888	-40.718	691	27	Site 5a	3 photos taken, sample 7, moving on 10m
19/12/16	16:46:04	-53.888	-40.718	693	27	Site 5a	3 photos taken, sample 8, moving on 10m
19/12/16	16:49:01	-53.888	-40.718	693	27	site 5a	4 photos taken, sample 9, moving on 10m
19/12/16	16:51:56	-53.888	-40.718	685	27	Site 5a	3 photos taken, sample 10, recovering
19/12/16	19:22:01	-53.793	-40.667	725	28	4b	3 photos taken, sample 1, moving on 10m
19/12/16	19:27:06	-53.793	-40.667	723	28	4b	3 photos taken, sample 2, moving on 10m
19/12/16	19:31:11	-53.793	-40.667	721	28	4b	3 photos taken, sample 3, moving on 10m

19/12/16	19:34:47	-53.793	-40.667	721	28	4b	3 photos taken, sample 4, moving on 10m
19/12/16	19:38:05	-53.793	-40.667	719	28	4b	3 photos taken, sample 5, moving on 10m
19/12/16	19:42:14	-53.793	-40.667	716	28	4b	3 photos taken, sample 6, moving on 10m
19/12/16	19:45:19	-53.793	-40.667	714	28	4b	3 photos taken, sample 7, moving on 10m
19/12/16	19:46:44	-53.793	-40.667	715	28		Photo taken of shrimp - extra to site - SUCS had moved
19/12/16	19:49:17	-53.793	-40.667	713	28	4b	4 photos taken, sample 8, moving 10m
19/12/16	19:52:27	-53.793	-40.668	710	28	4b	3 photos taken, sample 9, moving on 10m
19/12/16	19:56:41	-53.793	-40.668	709	28	4b	3 photos taken, sample 10, recovering
19/12/16	21:14:07	-53.767	-40.717	738	29	4a	3 photos taken, sample 1, moving 10m
19/12/16	21:20:18	-53.767	-40.717	738	29	4a	3 photos taken, sample 2, moving 10m
19/12/16	21:23:26	-53.767	-40.717	738	29	4a	3 photos taken, sample 3, moving 10m
19/12/16	21:26:20	-53.767	-40.717	739	29	4a	1 photo at this point, the SUCS moved so 3 more photos were taken, sample 4, moving on 10m
19/12/16	21:29:53	-53.767	-40.717	738	29	4a	3 photos taken, sample 5, moving 10m
19/12/16	21:32:39	-53.767	-40.717	739	29	4a	3 photos taken, sample 6, moving 10m
19/12/16	21:35:52	-53.767	-40.717	740	29	4a	3 photos taken, sample 7, moving 10m
19/12/16	21:38:42	-53.767	-40.718	739	29	4a	3 photos taken, sample 8,moving 10m
19/12/16	21:41:51	-53.766	-40.718	737	29	4a	2 photos at this point, the SUCS moved so 3 more photos were taken, sample 9, moving 10m
19/12/16	21:45:15	-53.766	-40.718	737	29	4a	3 photos taken, sample 10, recovering
20/12/16	00:35:00	-53.633	-40.667	660	30	1b	3 photos taken, sample 1, moving on 10 m
20/12/16	00:40:00	-53.633	-40.667	662	30	1b	3 photos taken, sample 2, moving on 10 m
20/12/16	00:44:38	-53.633	-40.667	670	30	1b	3 photos taken, sample 3, moving on 10m
20/12/16	00:48:00	-53.633	-40.667	684	30	1b	3 photos taken, sample 4, moving on 10 m echinodermilicious
20/12/16	00:52:15	-53.633	-40.667	679	30	1b	3 photos taken, sample 5, moving on 10 m
20/12/16	00:55:34	-53.633	-40.667	697	30	1b	3 photos taken, sample 6, moving on 10 m
20/12/16	00:58:52	-53.633	-40.667	690	30	1b	2 photos then SUCS moved, then 3 photos, sample 7, moving on 10 m
20/12/16	01:00:18	-53.633	-40.667	686	30	1b	one random photo of some cool echinoderms
20/12/16	01:03:00	-53.633	-40.668	686	30	1b	3 photos taken, sample 8, moving on 10 m

20/12/16	01:06:00	-53.633	-40.668	691	30	1b	3 photos taken, sample 9, moving on 10 m
20/12/16	01:09:11	-53.633	-40.668	697	30	1b	3 photos taken, sample 10, recovering
20/12/16	02:11:48	-53.620	-40.718	687	31	1a	3 photos taken, sample 1, moving on 10 m
20/12/16	02:15:01	-53.620	-40.718	658	31	1a	3 photos taken, sample 2, moving on 10m
20/12/16	02:18:34	-53.620	-40.718	655	31	1a	Accidental photograph
20/12/16	02:18:57	-53.620	-40.718	654	31	1a	3 photos, sample 3, moving on 10 m
20/12/16	02:22:15	-53.620	-40.719	656	31	1a	3 photos taken, sample 4, moving on 10m
20/12/16	02:25:46	-53.620	-40.719	654	31	1a	4 photos taken, sample 5, moving on 10m
20/12/16	02:29:13	-53.620	-40.719	654	31	1a	3 photos taken, sample 6, moving on 10m
20/12/16	02:31:53	-53.620	-40.719	653	31	1a	3 photos taken, sample 7, moving on 10m
20/12/16	02:34:53	-53.620	-40.719	655	31	1a	3 photos taken, sample 8, moving on 10m
20/12/16	02:37:50	-53.620	-40.719	654	31	1a	3 photos taken, sample 9, moving on 10m
20/12/16	02:41:05	-53.620	-40.719	653	31	1a	3 photos taken, sample 10, recovering
28/12/16	00:32:19	-53.681	-40.598	716	78	2c	3 photos taken, saved to incorrect drive
28/12/16	00:34:48	-53.681	-40.598	691	78	2c	3 photos taken. Site aborted due to conditions
28/12/16	09:43:23	-53.681	-40.598	701	79	2c	4 photos taken, moving on 10 m, sample 1
28/12/16	09:47:59	-53.681	-40.598	705	79	2c	3 photos taken, moving on 10m, sample 2
28/12/16	09:47:59	-53.681	-40.598	705	79	2c	3 photos taken, moving on 10m, sample 2
28/12/16	09:52:23	-53.681	-40.598	698	79	2c	3 photos, moving on 10 m, sample 3
28/12/16	09:56:49	-53.681	-40.598	724	79	2c	3 photos taken, moving on 10m, sample 4
28/12/16	09:59:04	-53.681	-40.598	696	79	2c	3 photos taken, moving on 10 m, sample 5
28/12/16	10:01:33	-53.681	-40.599	714	79	2c	3 photos taken, moving on 10 m, sample 6
28/12/16	10:05:43	-53.681	-40.599	716	79	2c	4 photos taken, moving on 10 m, sample 7
28/12/16	10:09:17	-53.681	-40.599	734	79	2c	3 photos taken, moving on 10 m, sample 8
28/12/16	10:12:49	-53.681	-40.599	701	79	2c	3 photos taken, moving on 10m, sample 9
28/12/16	10:16:18	-53.681	-40.599	682	79	2c	3 photos taken, moving on 10 m, sample 10
28/12/16	11:28:37	-53.683	-40.666	705	80	2b	6 photos taken, slight movement between first 3 and last 3, sample 1
28/12/16	11:32:30	-53.683	-40.666	702	80	2b	3 photos taken, moving on 10 m, sample 2
28/12/16	11:36:22	-53.683	-40.666	704	80	2b	3 photos taken, moving on 10m, sample 3

28/12/16	11:39:16	-53.683	-40.666	690	80	2b	3 photos taken, moving on 10 m, sample 4
28/12/16	11:42:16	-53.683	-40.666	689	80	2b	3 photos taken, moving on 10 m, sample 5
28/12/16	11:45:19	-53.683	-40.667	691	80	2b	3 photos taken, moving on 10m, sample 6 (crab)
28/12/16	11:48:05	-53.683	-40.667	685	80	2b	3 photos taken, moving on 10m, sample 7
28/12/16	11:51:25	-53.683	-40.667	686	80	2b	3 photos taken, moving on 10m, sample 8
28/12/16	11:54:02	-53.683	-40.667	681	80	2b	3 photos taken, moving on 10m, sample 9
28/12/16	11:57:04	-53.683	-40.667	680	80	2b	3 photos taken, moving on 10 m, sample 10
28/12/16	13:08:05	-53.683	-40.667	691	81	2a	3 photos taken, moving on 10 m, sample 1. FISH!
28/12/16	13:11:12	-53.710	-40.733	705	81	2a	3 photos taken, moving on 10 m, sample 2
28/12/16	13:14:45	-53.710	-40.734	703	81	2a	3 photos taken, moving on 10 m, sample 3
28/12/16	13:18:26	-53.710	-40.734	701	81	2a	3 photos taken, moving on 10m, sample 4
28/12/16	13:21:35	-53.710	-40.734	700	81	2a	3 photos taken, moving on 10 m, sample 5
28/12/16	13:30:14	-53.710	-40.734	699	81	2a	3 photos taken, moving on 10 m, sample 6
28/12/16	13:33:54	-53.710	-40.734	694	81	2a	3 photos taken, slight movement between 2nd and 3rd photo, moving on 10m, sample 7
28/12/16	13:37:04	-53.710	-40.734	692	81	2a	3 photos taken, moving on 10m, sample 8
28/12/16	13:40:43	-53.710	-40.735	691	81	2a	4 photos taken, moving on 10m, sample 9
28/12/16	13:43:32	-53.710	-40.735	689	81	2a	4 photos taken, bringing in for recovery, sample 10

Table 10 SUCS photographs and sites

7 Western Core Box

7.1 Introduction and Event Summary

Sophie Fielding

The twenty-first annual WCB survey commenced on the 20th December 2016, starting from the northern end of the WCB1.1 transect. The two transects occurred without a hitch and were followed by 2 successful CTD/stratified RMT8 sites at WCB1.2S and WCB1.2N as well as two targeted RMT8 catches of small Antarctic krill.

On the 21st December 2016, the ship commenced transect 2.1 from the southern end. The days acoustic transects progressed in worsening weather conditions. CTDs were undertaken at sites WCB2.2S and WCB3.2S as weather forecasts indicated worse weather offshore. Weather conditions at WCB3.2S enabled the stratified RMT8 to be completed, but no target fishing occurred.

The acoustic transects on the 22nd occurred in bad weather, ships speed was reduced to reduce aeration and the transects finished late at 18:30 having commenced at the southern end. Again the decision was made to stay south to avoid poor weather in offshore waters. The WCB2.2S RMT8 stratified net was completed and the ship relocated to the southern end of 4.1 to start the final day transects.

Transects 4.1 and 4.2 were run once again in increasing swell and weather. At the end of transect 4.2 that ship headed to Cumberland Bay to avoid overnight winds.

The RMT8 stations at WCB2.2N and WCB3.2N were not completed due to weather. The CTD station WCB3.2N was completed after calibration, whereas the WCB2.2N CTD was aborted due to bad weather and not completed.

Although little target fishing occurred, there were plenty of small krill found in all nets, and few krill swarms that presented likely targets when not using the stratified nets.

The following events comprised the WCB survey:

Date	Event numbers	Gear deployed	Identifier
20/12/2016	32-36	XBTs	Transect 1.1
20/12/2016	37-39	CTD, Bongo, RMT8	WCB1.2N
20/12/2016	40-41	RMT8	Target hauls
21/12/2016	42-43	CTD, RMT8	WCB1.2S
21/12/2016	44-48	XBTs	Transect 2.1
21/12/2016	49	CTD	WCB2.2S
21-22/12/2016	50-51	CTD, RMT8	WCB3.2S
22/12/2016	52-56	XBTs	Transect 3.1
23/12/2016	57	RMT8	WCB2.2S
23/12/2016	58-64	XBTs	Transect 4.1
23/12/2016	65-69	XBTs	Transect 4.2

Table 11 WCB event numbers

Acoustic transect start and end times are:

Transect	Date	Start time (GMT)	End time (GMT)
1.1	20/12/2016	09:00	13:41
1.2	20/12/2016	14:42	19:00
2.1	21/12/2016	09:00	13:44

2.2	21/12/2016	14:44	19:02
3.1	22/12/2016	09:00	15:56
3.2	22/12/2016	17:05	21:30
4.1	23/12/2016	08:00	13:24
4.2	23/12/2016	14:09	18:43

Table 12 WCB Acoustic transect start and end times

7.2 Macrozooplankton

Gabriele Stowasser, Sophie Fielding, Peter Enderlein, Scott Polfrey, Dan Ashurst, Ryan Saunders, Geraint Tarling, Clara Manno, Angelika Slomska, Elisa Bergami, Jose Séco and Jose Xavier

7.2.1 Gear

The RMT8 was used to characterise the macrozooplankton community in the Western Corebox in 200m oblique trawls and target trawls (Table 13). Target trawls were undertaken on krill swarms identified from the EK60. In oblique trawls net 1 was opened at the surface and the net deployed to 200m (where water depth was sufficient) before closing and net 2 opened at 200m depth and closed at the surface. The choice of deployment type depended on the task. Target hauls were made to supply the WCB team with *Euphausia superba* (Antarctic krill) for length frequency measurements and Will Goodall-Copestake (BAS) for genetic studies. Krill was furthermore sampled for experiments on the impact of nano-plastics in Antarctic waters (Elisa Bergami, visiting PhD student, University of Siena, Italy). Oblique trawls were only undertaken at the Western Core Box CTD positions. All preserved samples are listed in Table 14.

7.2.2 Catch sorting and processing

Oblique hauls

For the oblique hauls the total catch of net 2 (200m – surface) was sorted and quantified. Numbers caught and total weight was obtained for each species. For some groups specific identification was not possible and identification will be verified through re-examination in the laboratory. All material collected in net 1 (surface – 200m) was preserved in 4% formalin. Specimens of fish and various invertebrate species were collected for a study on trace metals in Antarctic marine food webs (Jose Séco, PhD student, Coimbra University, Portugal) and for a study on the energetic properties of macrozooplankton in the Scotia Sea (José Xavier, Coimbra University, Portugal). Salps and hydrozoans were retained for genetic studies by visiting MSc student Angelika Slomska from Gdansk University, Poland, and density experiments were carried out on specimens of *Euphausia superba* and myctophid fish (Tracey Dornan, PhD BAS). All data were recorded in an Excel database.

Targeted hauls

The catch of targeted hauls was sorted and quantified. In hauls, where sufficient numbers of *E. superba* were caught, length-frequency data was collected (see Section 7.3).

Event No	Net	Net open	Net closed	Start latitude	Start longitude	End latitude	End longitude	Depth open	Depth closed	comment
39	Net 1	20/12/2016 23:21	20/12/2016 23:54	53° 30.23'S	39° 15.21'W	53° 31.71'S	39° 15.14'W	19	202	Oblique
39	Net 2	20/12/2016 23:55	21/12/2016 00:25	53° 31.73'S	39° 15.14'W	53° 33.06'S	39° 14.85'W	209	15	Oblique
40	Net 1	21/12/2016 02:44	21/12/2016 02:46	53° 47.42'S	39° 10.37'W	53° 47.36'S	39° 10.23'W	18	26	Target
40	Net 2	21/12/2016 02:47	21/12/2016 02:48	53° 47.34'S	39° 10.18'W	53° 47.33'S	39° 10.15'W	27	24	Target
41	Net 1	21/12/2016 04:05	21/12/2016 04:06	53° 51.78'S	39° 08.87'W	53° 51.72'S	39° 08.88'W	17	27	Target
41	Net 2	21/12/2016 04:07	21/12/2016 04:10	53° 51.69'S	39° 08.88'W	53° 51.59'S	39° 08.90'W	25	14	Target
42	Net 1	21/12/2016 04:29	21/12/2016 05:02	53° 50.74'S	39° 09.01'W	53° 49.34'S	39° 08.74'W	29	200	Oblique
42	Net 2	21/12/2016 05:03	21/12/2016 05:29	53° 49.31'S	39° 08.73'W	53° 48.32'S	39° 08.28'W	208	19	Oblique
51	Net 1	22/12/2016 00:42	22/12/2016 00:55	53° 42.72'S	37° 56.92'W	53° 42.47'S	37° 55.97'W	24	94	Oblique
51	Net 2	22/12/2016 00:56	22/12/2016 01:08	53° 42.47'S	37° 55.95'W	53° 42.03'S	37° 55.36'W	101	20	Oblique
59	Net 1	23/12/2016 02:11	23/12/2016 02:33	53° 46.95'S	38° 36.27'W	53° 46.37'S	38° 37.77'W	26	151	Oblique
59	Net 2	23/12/2016 02:33	23/12/2016 02:55	53° 46.36'S	38° 37.80'W	53° 45.80'S	38° 39.28'W	158	21	Oblique

Table 13 RMT8 hauls carried out on cruise JR16003

Project	Species	Event-Net	Number sampled	Storage
Krill genetics (Will Goodall-Copestake, Geraint Tarling)	*Euphausia superba*	40-1	100	-80°C
Gelatinous zooplankton genetics (Angelika Slomska)	Salpa thompsoni	39-2	30	Formalin (10) Ethanol (20)
	Hydrozoa spp.	51-1	2	Ethanol
Nano-plastics (Elisa Bergami)	Euphausia superba	40-1	500g	-20°C
	Euphausia superba	40-1	90	Incubation
	Euphausia superba	51-1	48	Incubation
	Euphausia superba	59-1	56	Incubation
	Euphausia triacantha	39-2	49	Incubation
Trace metals (Jose Séco)	Electrona antarctica	39-1	1	-20°C
	Electrona antarctica	39-2	2	-20°C
	Euphausia superba	40-1	35	-20°C
	Euphausia superba	41-2	100	-80°C
	Gymnoscopelus braueri	39-2	1	-20°C
	Gymnoscopelus nicholsi	39-2	2	-20°C
	Gymnoscopelus sp.	39-1	1	-20°C
Energetics Mesozooplankton (José Xavier)	Euphausia frigida	39-2	13	-20°C
	Euphausia superba	51-2	100	-80°C
	Euphausia superba	51-2	35	-20°C
	Euphausia superba	59-2	100	-80°C
	Euphausia triacantha	39-2	100	-80°C
	Euphausia triacantha	39-2	20	-20°C
	Thysanoessa sp.	39-2	20	-20°C
Density experiments (Tracey Dornan)	Euphausia superba	51-2	20	Experiment
	Protomyctophum bolini	39-2	1	Experiment

Table 14 Invertebrate and fish species sampled and preserved from RMT8 hauls in the Western Core Box area during cruise JR16003

7.3 Krill Length-Frequency and Photography

Ryan Saunders, Sophie Fielding

7.3.1 Introduction

Antarctic krill (*Euphausia superba*) were sampled to determine the variation in the structure of the population around South Georgia and to provide parameters required in the target strength model for krill biomass estimation.

7.3.2 Method

Figure 22 Krill photography set-up showing relative positions of flashes and camera to sample board

Krill samples were taken from RMT8 samples where there were sufficient numbers of krill to select 100 decent state specimens for length frequency, maturity and krill shape photographs. Krill were laid out on blue plastic boards (in pre-drilled grooves) and photographed using a Nikon D810 fitted with an AF-S Micro Nikkor 60 mm f/2.8 G ED lens mounted on a copy stand (Figure 22). Light was provided by two obliquely mounted Metz SCA 300 System flash guns. Two photographs of each set of krill were taken; one with krill in dorsal aspect and one with krill in lateral aspect. Unfortunately the settings on the camera were not set up correctly, and there is too much light saturation in many of the photographs. The photographs will need to be examined in Cambridge to see if they are usable. The same krill were then measured for length and staged. Krill total length was measured, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest millimetre (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described by Morris et al. (1988).

7.3.3 Results

Krill length frequency data were input into a spreadsheet on the L drive “Krill_lengths_JR16003.xls. The Net event numbers from which krill were measured and whether they were photographed is identified in Table 15 with the mean length of those events.

Event Number	Photo	Mean length (mm)
40_1	N	31.03
41_1	Y	34.03
41_2	Y	34.80
42_2	Y	40.15

51_1	Y	30.63
59_1	N	31.75
59_2	N	30.48

Table 15 Krill length frequency mean length per station

The krill length frequency pdf for the whole cruise are shown in Figure 23.

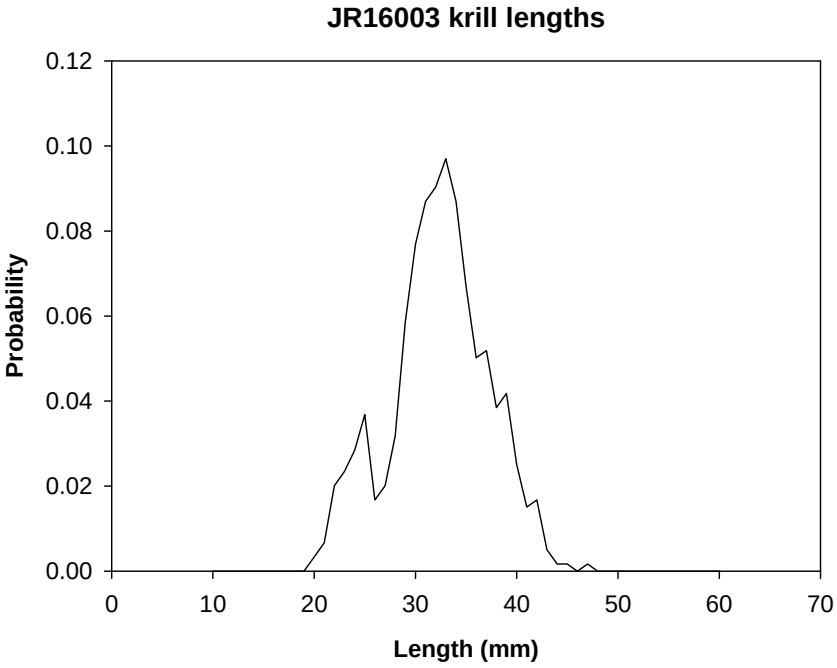


Figure 23 Krill length frequency for JR16003

8 Antarctic Polar Front fish, squid and macrozooplankton studies

Ryan Saunders, Gabi Stowasser, Jose Seco, Tracey Dornan, Jose Xavier, Sophie Fielding

8.1 Introduction

Mesopelagic fish, squid and macrozooplankton are an important component of the Southern Ocean ecosystem. Squid are abundant in various predator diets but their ecology is still poorly known. Within the Southern ocean pelagic fish community, myctophids are the dominant mesopelagic fish in terms of both biomass and diversity, and they play a vital role in the transfer of energy through the Southern Ocean food web. Recent studies suggest that most myctophid species inhabiting waters south of the Antarctic Polar Front (APF) are probably expatriates from core populations that reproduce at more temperate latitudes. For example, the larvae of most myctophid species are markedly absent in both zooplankton and fish samples that have been collected throughout the Scotia Sea during multidisciplinary research surveys conducted across multiple years, which suggests that recruitment is restricted in Antarctic waters. Adults of reproductive condition are also rare in the region and most species' populations become increasingly dominated by specimens of a greater size and age with increasing latitude. The relatively high biomass of myctophid fish in this region therefore appears to be sustained by mass immigration from regions further north. In this study, we hypothesize that the APF, together with the latitudinal gradient in temperature between temperate and Antarctic waters, has an important role in the expatriation of myctophids at high latitudes and impacts the aggregative behaviour, population structure and reproductive ecology of most biomass-dominant species. This work will also advance our understanding of the role of the APF in squid and macrozooplankton species ecology. We therefore sampled the mesopelagic fish, squid and macrozooplankton community and underlying environmental conditions along a transect spanning an entire cross-section of the APF to:

1) Examine spatial patterns in myctophid larval community structure and abundance between Antarctic and temperate waters, linking patterns to the underlying oceanographic conditions across the APF.
2) Investigate changes in diet and population dynamics of key myctophid fish species across the APF.
3) Examine how frontal variability and changes in oceanographic conditions across the AFP impacts the aggregative behaviour and vertical distribution of myctophid fish.
4) Investigate trace metal accumulation in key myctophid fish species and squid, and examine their role as vectors of heavy metal contaminants through the Southern Ocean foodweb.
5) Quantify the abundance/biomass of myctophid fish that are targeted by land-based predators in APF foraging areas to assess spatial patterns in predator/prey interactions.
6) Quantify the carbon content/energy budget of the deep-dwelling mesopelagic fish community at the APF.
7) Examine the swimbladder structure and specific body density properties of key mesopelagic fish to facilitate acoustic target strength modelling.

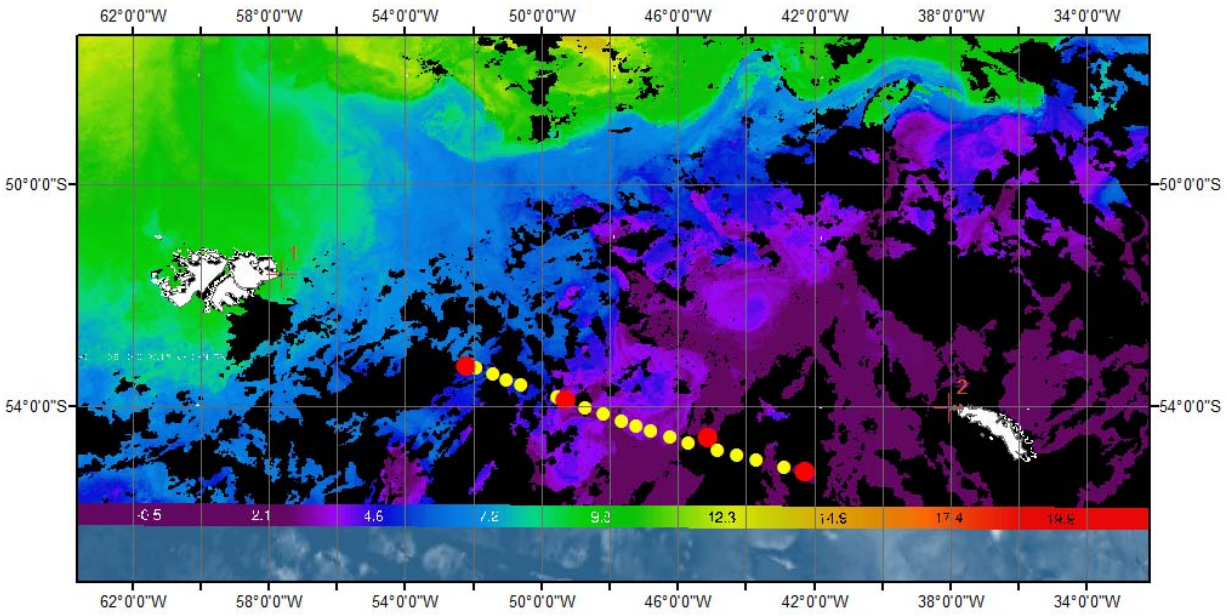


Figure 24 Map showing the sampling transect and satellite-derived sea surface temperature in the APF region between 1-7 January. Red and yellow circles are biological sampling stations (RMT25 and MOCNESS) and environmental stations (either CTD or XBT)

8.2 Gear

An RMT25 net was used to sample the mesopelagic fish, squid and macrozooplankton community during the survey. Depth-discrete samples were collected across the APF between 0-1000 m at intervals of 1000-700, 700-400, 400-200 and 200-0 m. All RMT25 hauls were deployed in hours of darkness (nautical sunset to nautical sunrise), with the uppermost depth strata sampled at times of maximum darkness. The RMT25 was operated via a downwire net monitor and was equipped with a flow meter, and temperature and salinity sensors. Each depth strata was sampled for approximately 40 mins. The larval component of the mesopelagic fish community, and squid, was sampled using a MOCNESS net that was equipped with nine 300 um mesh nets. This net was deployed to 1000 m and sampled the water column at depth-discrete intervals of ~125 m. The MOCNESS was deployed during daylight hours, with each depth strata being sampled for around 10-12 minutes. A calibrated EK60 echosounder was used to collect echotraces of mesopelagic aggregations during transit to biological stations and during RMT25 fishing operations. Regular CTD stations and XBT deployments were undertaken to 1000 m along the survey transect to quantify the environmental conditions across the APF.

8.3 Sample processing

The total weight of each RMT25 net haul was recorded. All fish, squid and macrozooplankton specimens were first identified to species level, where possible, and then enumerated and measured using Standard Length (SL; for fish) and Mantle Length (ML; for squid). The composite weight of each fish/squid species (when >1 g) was recorded, and sex/maturity status was also determined using external features, when possible. A sub-sample of up to 10 fish per species was selected for gravimetric and swimbladder analysis from each catch. Also, 10 males and 10 females of key myctophid species were selected at random for trace metal analysis. Each fish specimen was assigned a unique identification number and photographed for subsequent morphometric analyses. All myctophid fish samples were frozen whole at -20 °C, whilst squid and rare deep-dwelling fish were frozen whole at -80 °C for subsequent biochemical analysis.

RMT25 macrozooplankton samples were sub-sampled where necessary. Specimens were then identified to highest level possible, enumerated and weighed. Key species were retained for further biochemical analyses, but the remainder was discarded.

Myctophid fish larvae and squid in the MOCNESS samples were identified to the highest taxonomic level possible, enumerated and then frozen at -20 °C (fish) or at -80 °C (squid). The remaining MOCNESS zooplankton samples were subsequently sub-sampled, with a one half aliquot retained in ethanol for further analyses and for quantification of the mesopelagic fish prey field.

8.4 Preliminary results

A complete cross-section of the APF was surveyed during the study, where surface waters ranged between ~1 and 6 °C (RAS2). A total of 9RMT25 and 4 MOCNESS hauls were obtained at 4 stations across this front (RAS3& RAS4). The work package was impacted substantially by weather conditions, which resulted in almost half of the proposed biological stations being missed. However, a reasonable degree of spatial coverage was achieved with both RMT25 and MOCNESS across the APF, enabling a valuable collection of mesopelagic fish, squid and zooplankton samples to be obtained for our studies. Detailed environmental data were collected across the study region, with 6 CTD and 13 XBT stations achieved.

Details of the species caught by RMT25 during the survey are given in RAS5. In total,915 fish were caught belonging to at least33 species, with catches dominated by the myctophids *Krefftichthys anderssoni* (9-78 mm SL), *Gymnoscopelus braueri*(30-132 mm SL) and *Protomyctophum bolini* (23-71 mm SL) across the temperature gradient of the study region.The deep water community below 400 m was dominated by bristlemouths *Cyclothone* spp.(26-65 mm SL) and bathylagids *Bathylagid* spp.(33-172 mm SL). Predominantly temperate myctophid species, such as *Protomyctophum parallelum and Protomyctophum andriashevi* were also caught in small numbers in the warmer waters to the north of the APF. *Electrona antarctica* (27-87 mm SL) was caught only in small numbers and predominantly in regions south of the APF where water temperatures were generally <2 °C.

Myctophid larvae (<20 mm SL), principally of the myctophids *K. anderssoni* and *Gymnoscopelus* spp., was caught by both MOCNESS and RMT25, but only in regions north of the APF in waters warmer than ~4 °C. Larvae were also absent in zooplankton samples collected by RMT8 around South Georgia (WCB region) and by MOCNESS at station P3. The larval stages caught in the northern regions of the APF occurred in both the surface layers and at depth during daytime and night-time.

A total of 42 squid specimens and 1 unknown pelagic octopod were caught, particularly juveniles, caught in RMT25 (n=35) and MOCNESS (n=8). The most common squid caught were *Galiteuthis glacialis* (n=17) and *Slosarczykovia circumantarctica* (n=12). A note of this cruises catching the relatively “large” *Histioteuthis eltaninae* (n=2; 70-74 mm ML, 69-85 g), that are relatively rare to find in scientific nets.

The macrozooplankton component of the RMT25 net catches was mostly dominated by the salp *Salpa thompsoni*, particularly in the upper 400m. The euphausiids *Thysanoessa macrura* and *Euphausia triacantha*, and chaetognaths (presumably *Sagitta maxima*) were also relatively abundant in the net catches. Gelatinous zooplankton such as Hydromedusae and Siphonophores and decapod crustaceans replaced salps and euphausiids in deeper waters (700-1000m). Antarctic krill, *Euphausia superba*, was also caught in net samples in waters towards the northern APF. The most common amphipod species was *Themisto gaudichaudii* which was caught at all depths and across the latitudinal range. Amphipods, such as *Parandania boecki* and *Cyphocaris richardii* were found in

several net catches, but comprised only a relatively low abundance. Macrozooplankton species caught in the RMT25 nets are listed in Table 4.

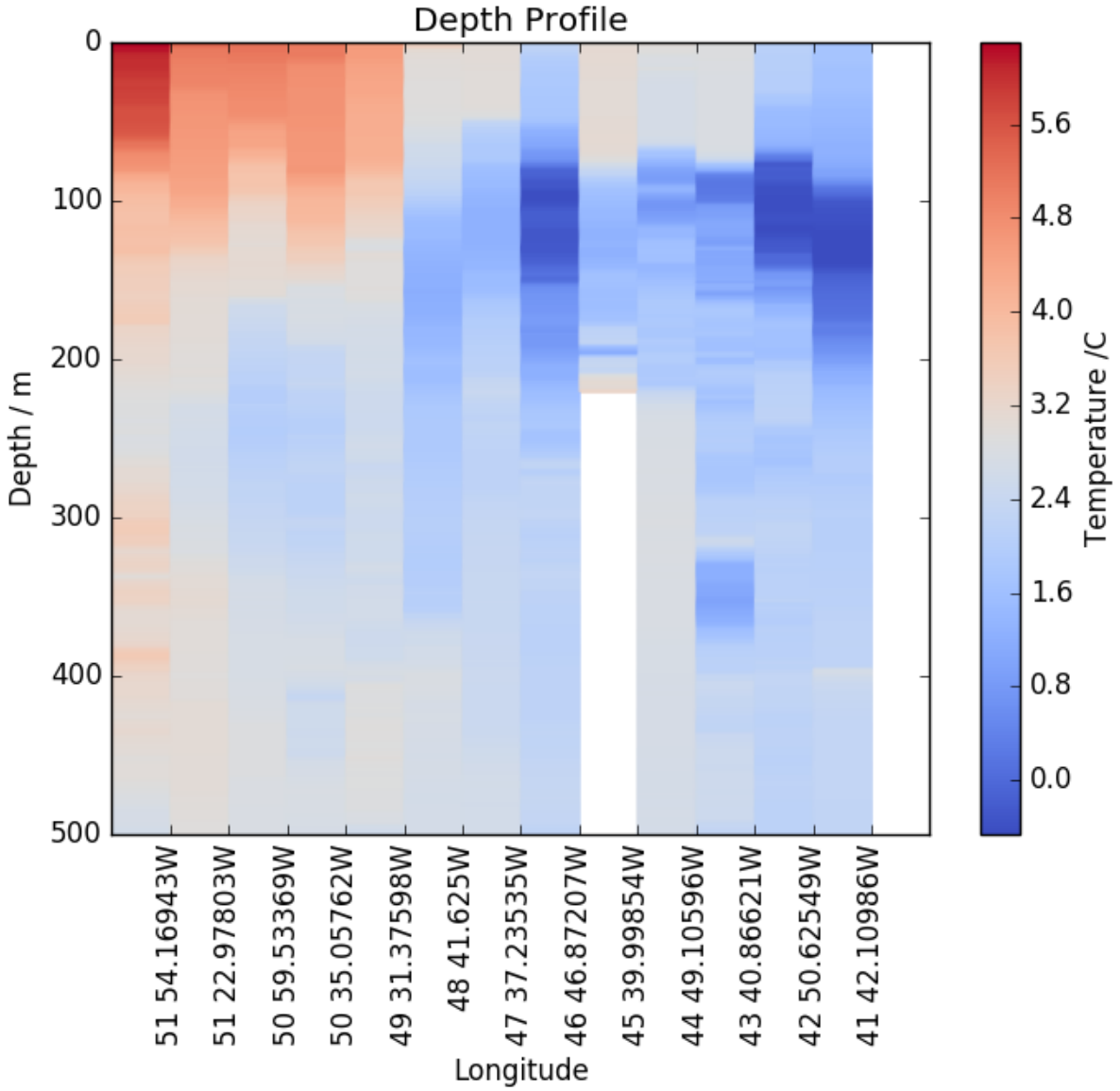


Figure 25 Temperature-depth profiles measured by XBTs deployed across the APF study region.

Start Time	End Time	Event	Station	Net Number	Start Lat	Start Lon	Mean water depth	Min net depth	Max net depth	Mean temperature	Mean salinity	Mean SST	Mean speed	Sum net flow
01/01/2017 03:42	01/01/2017 04:15	113	P2	Net 1	-55.29	-41.35	3544.25	196.70	398.00	2.06	33.69	1.77	1.57	1647.80
01/01/2017 04:16	01/01/2017 04:43	113	P2	Net 2	-55.30	-41.36	3544.06	27.70	210.60	0.60	33.69	1.77	1.66	1444.50
03/01/2017 00:35	03/01/2017 01:16	129	APF2	Net 1	-54.68	-45.22	4711.43	195.60	406.80	1.65	33.65	2.51	1.76	1989.10
03/01/2017 01:17	03/01/2017 01:48	129	APF2	Net 2	-54.66	-45.20	4757.10	82.00	208.00	0.00	33.64	2.57	1.93	1851.80
03/01/2017 03:50	03/01/2017 04:29	130	APF2	Net 1	-54.60	-45.13	4945.93	698.50	1001.50	2.17	33.64	2.52	1.58	1682.60
03/01/2017 04:30	03/01/2017 05:10	130	APF2	Net 2	-54.59	-45.11	3990.91	396.70	706.30	2.24	33.64	2.52	1.73	2228.20
04/01/2017 23:43	05/01/2017 00:24	146	APF4	Net 1	-53.94	-49.17	4605.18	699.10	991.10	2.46	33.72	4.06	1.16	1373.20
05/01/2017 00:25	05/01/2017 01:07	146	APF4	Net 2	-53.95	-49.19	4582.02	398.30	707.90	2.74	33.72	4.03	1.35	1679.80
05/01/2017 02:48	05/01/2017 03:27	147	APF4	Net 1	-53.96	-49.24	4561.40	198.30	398.50	2.71	33.72	3.82	1.29	1646.80
05/01/2017 03:28	05/01/2017 04:07	147	APF4	Net 2	-53.94	-49.25	4452.50	18.00	201.00	2.74	33.72	3.80	1.57	2011.90
06/01/2017 00:20	06/01/2017 01:00	163	APF6	Net 1	-53.25	-52.16	1769.02	693.40	1005.80	2.81	33.89	6.48	1.61	1140.10
06/01/2017 01:00	06/01/2017 01:44	163	APF6	Net 2	-53.26	-52.17	1788.88	401.50	690.70	2.99	33.90	6.35	1.72	1774.10
06/01/2017 03:06	06/01/2017 03:47	164	APF6	Net 1	-53.29	-52.20	1725.05	201.00	405.80	3.63	33.91	6.21	1.47	1564.90
06/01/2017 03:48	06/01/2017 04:27	164	APF6	Net 2	-53.30	-52.20	1650.73	19.60	207.70	4.79	33.91	6.24	1.47	1874.80
08/01/2017 01:32	08/01/2017 02:13	171	APF7	Net 1	-56.71	-56.85	3361.54	200.20	400.90	1.71	33.68	3.32	2.00	1943.30
08/01/2017 02:14	08/01/2017 02:23	171	APF7	Net 2	-56.73	-56.86	3672.17	150.50	210.10	0.71	33.68	3.31	2.47	604.30

Table 16 RMT25 deployment details around the APF during JR16003. Note that station APF7 was conducted south west of the main study region to obtain supplementary samples for swimbladder morphometric analyses.

Start Time	End Time	Event	Station	Net Number	Start Lat	Start Lon	Mean water depth	Min net depth	Max net depth	Mean temperature	Mean salinity	Mean SST	Mean speed	Sum net flow
31/12/2016 01:25	31/12/2016 02:06	98	P2	Net 1	-55.25	-41.27	3406.73	1.60	1001.50	1.70	33.73	1.45	1.54	601.60
31/12/2016 02:06	31/12/2016 02:16	98	P2	Net 2	-55.27	-41.28	3448.50	875.00	1001.50	1.84	33.74	1.51	1.75	277.60
31/12/2016 02:16	31/12/2016 02:30	98	P2	Net 3	-55.27	-41.28	3505.39	750.20	875.00	1.97	33.74	1.52	2.06	466.10
31/12/2016 02:30	31/12/2016 02:43	98	P2	Net 4	-55.28	-41.28	3535.01	625.60	750.20	2.04	33.74	1.53	2.02	477.30
31/12/2016 02:43	31/12/2016 03:00	98	P2	Net 5	-55.29	-41.28	3560.40	499.90	625.90	2.05	33.75	1.53	1.94	685.40
31/12/2016 03:00	31/12/2016 03:13	98	P2	Net 6	-55.30	-41.29	3665.19	374.10	500.20	2.18	33.74	1.51	2.12	545.80
31/12/2016 03:13	31/12/2016 03:35	98	P2	Net 7	-55.30	-41.29	3598.66	250.70	374.10	2.26	33.74	1.49	1.96	926.70
31/12/2016 03:35	31/12/2016 03:57	98	P2	Net 8	-55.31	-41.29	3548.32	125.50	1062.30	1.09	33.74	1.50	2.05	904.80
31/12/2016 03:57	31/12/2016 04:19	98	P2	Net 9	-55.33	-41.29	3548.32	3.50	125.80	0.86	33.74	1.48	2.08	811.30
02/01/2017 18:48	02/01/2017 19:50	126	APF2	Net 1	-54.69	-45.24	4971.99	2.20	1001.00	1.79	33.65	2.55	1.69	1598.00
02/01/2017 19:50	02/01/2017 19:58	126	APF2	Net 2	-54.66	-45.21	4989.81	875.20	1000.20	2.10	33.65	2.75	1.37	286.10
02/01/2017 19:58	02/01/2017 20:06	126	APF2	Net 3	-54.65	-45.21	4990.04	751.00	875.50	2.18	33.65	2.76	1.62	276.30
02/01/2017 20:06	02/01/2017 20:14	126	APF2	Net 4	-54.65	-45.21	4961.28	625.60	751.00	2.27	33.65	2.72	1.59	307.70
02/01/2017 20:14	02/01/2017 20:23	126	APF2	Net 5	-54.65	-45.20	4992.00	501.30	626.20	2.14	33.64	2.70	1.35	345.50
02/01/2017 20:23	02/01/2017 20:30	126	APF2	Net 6	-54.64	-45.20	3012.10	376.00	501.50	2.18	33.64	2.65	1.63	244.90
02/01/2017 20:30	02/01/2017 20:39	126	APF2	Net 7	-54.64	-45.20	3125.76	0.00	376.30	1.84	33.64	2.64	1.52	336.40
02/01/2017 20:39	02/01/2017 20:49	126	APF2	Net 8	-54.64	-45.20	3128.83	123.90	251.50	0.14	33.64	2.64	1.36	364.80
02/01/2017 20:49	02/01/2017 20:57	126	APF2	Net 9	-54.63	-45.19	3030.53	3.80	123.90	1.70	33.65	2.57	1.46	256.30
04/01/2017 18:14	04/01/2017 19:29	143	APF4	Net 1	-53.94	-49.07	4731.57	2.20	1000.70	0.95	33.71	4.12	1.77	2207.90
04/01/2017 19:29	04/01/2017 19:56	143	APF4	Net 2	-53.93	-49.15	4667.63	699.60	997.30	0.77	33.72	4.14	1.52	1391.20
04/01/2017 19:56	04/01/2017 20:16	143	APF4	Net 3	-53.93	-49.18	4591.65	400.40	699.90	1.10	33.72	4.20	1.61	1006.00
04/01/2017 20:16	04/01/2017 20:19	143	APF4	Net 4	-53.93	-49.19	4521.24	349.20	400.40	1.15	33.73	4.18	1.65	161.00
04/01/2017 20:19	04/01/2017 20:30	143	APF4	Net 5	-53.93	-49.20	4497.68	0.00	349.20	0.78	33.73	4.27	1.62	442.30
04/01/2017 20:30	04/01/2017 20:37	143	APF4	Net 6	-53.93	-49.20	4510.42	0.00	285.60	0.26	33.73	4.37	1.65	326.90
04/01/2017 20:37	04/01/2017 20:41	143	APF4	Net 7	-53.93	-49.21	4506.97	124.40	194.50	0.64	33.73	4.36	1.67	224.90
04/01/2017 20:41	04/01/2017 20:45	143	APF4	Net 8	-53.93	-49.21	4491.32	74.50	124.70	1.11	33.73	4.33	1.80	175.70
04/01/2017 20:45	04/01/2017 20:45	143	APF4	Net 9	-53.93	-49.22	4481.19	67.20	74.50	1.71	33.73	4.36	1.68	31.70
04/01/2017 20:45	04/01/2017 20:50	143	APF4	Net 10	-53.93	-49.22	4479.53	10.20	67.20	1.85	33.73	4.33	1.74	225.70

05/01/2017 19:18	05/01/2017 20:16	159	APF6	Net 1	-53.27	-52.18	1804.05	2.20	1002.10	3.50	33.90	6.51	1.53	1025.10
05/01/2017 20:16	05/01/2017 20:25	159	APF6	Net 2	-53.28	-52.18	1706.23	874.40	1001.00	2.71	33.90	6.50	1.51	248.80
05/01/2017 20:25	05/01/2017 20:31	159	APF6	Net 3	-53.28	-52.18	1724.10	750.20	874.40	2.88	33.91	6.47	1.64	209.40
05/01/2017 20:31	05/01/2017 20:37	159	APF6	Net 4	-53.29	-52.18	1735.27	0.00	750.20	2.79	33.91	6.46	1.61	229.90
05/01/2017 20:37	05/01/2017 20:43	159	APF6	Net 5	-53.29	-52.18	1747.01	0.00	620.50	2.90	33.91	6.45	1.61	259.70
05/01/2017 20:43	05/01/2017 20:48	159	APF6	Net 6	-53.29	-52.19	1764.85	373.80	494.80	3.03	33.91	6.42	1.82	241.40
05/01/2017 20:48	05/01/2017 20:54	159	APF6	Net 7	-53.29	-52.19	1720.11	250.10	586.50	3.50	33.91	6.40	2.01	316.20
05/01/2017 20:54	05/01/2017 21:04	159	APF6	Net 8	-53.29	-52.19	1706.90	124.40	250.10	4.04	33.91	6.37	1.85	494.60
05/01/2017 21:04	05/01/2017 21:13	159	APF6	Net 9	-53.30	-52.19	1686.50	6.50	124.40	5.12	33.90	6.35	1.59	402.80

Table 17 MOCNESS deployment details around the APF during JR16003.

Species	Number	Min SL/ML	Max SL/ML	Taken by JS/JX	Taken by TD
Argyropelecus spp.	1	0	0	0	0
Bathylagus sp.	29	33	172	0	12
Benthalbella elongata	1	140	140	0	0
Benthalbella macropinna	2	196	218	0	0
Borostomias antarcticus	1	135	135	0	0
Borostomias gracialis	1	197	197	0	0
Champsocephalus gunnari	1	127	127	0	0
Cyclothone microdon	1	35	35	0	0
Cyclothone pallida	1	34	34	0	0
Cyclothone sp.	167	26	65	2	8
Cynomacrurus piriei	1	134	134	0	0
Electrona antarctica	24	27	95	14	6
Electrona carlsbergi	13	72	87	0	7
Gymnoscopelus braueri	155	30	132	39	19
Gymnoscopelus fraseri	27	32	115	8	3
Gymnoscopelus nicholsi	20	31	140	9	0
Gymnoscopelus sp.	25	5	20	0	0
Krefftichthys anderssoni	202	9	78	33	18
Lepidonotothen larsoni	12	52	93	0	0
Nannobrachium achirus	5	125	156	0	0
Nansenia antarctica	1	89	89	0	0
Notolepis annulata	5	43	76	0	0
Notolepis coatsi	2	66	77	0	0
Notothenia neglecta	1	26	26	0	0
Paradiplospinus gracilis	1	385	385	0	0
Protomyctophum andriashevi	7	24	55	0	0
Protomyctophum bolini	146	23	71	54	24
Protomyctophum parallelum	18	25	51	0	0
Protomyctophum sp.	1	38	38	0	0
Protomyctophum tenisoni	37	16	49	0	0
Scopelasaurus hamiltoni	1	285	285	0	0
Stomias boa boa	4	197	241	0	0
Stomias gracilis	1	215	215	0	0
Unknown	1	0	0	0	0
Grand Total of fish	**915**	**5**	**385**	**159**	**97**
Alluroteuthis antarcticus	**1**	**24**	**24**	**1**	**0**
Bathyteuthis abyssicola	**4**	**8**	**43**	**4**	**0**
Galiteuthis glacialis	**17**	**9**	**57**	**17**	**0**
Histioteuthis eltaninae	**2**	**70**	**74**	**2**	**0**
Octopoda	**1**	**22**	**22**	**1**	**0**
Psychroteuthis glacialis	**4**	**9**	**9**	**4**	**0**
Slosarczykovia circumantarctica	**12**	**13**	**87**	**12**	**0**
Unknown squid	**4**	**9**	**16**	**4**	**0**
Grand Total of cephalopods	**43**	**9**	**87**	**43**	**0**

Table 18 Summary of fish and squid caught in RMT25 net hauls during JR16003. The numbers of specimens taken by Jose Seco (JS)/Jose Xavier (JX) (trace metals, stable isotopes) and Tracey Dornan (TD; TS analyses) are also shown.

Species	**Numbers caught**
Acanthephyra sp.	31
Antarctomysis sp.	12
Atolla spp.	40
Calycopsis borchgrevinki	11
Chaetognatha spp.	790
Clio pyramidata	7
Clione australis	1
Clione sp.	1
Ctenophora spp.	5
Cyllopus magellanicus	2
Cyllopus sp.	2
Cynomacrurus piriei	1
Cyphocaris anonyx	1
Cyphocaris richardii	68
Danaella mimonectes	1
Diphyes sp.	37
Euphausia frigida	61
Euphausia gregaria	2
Euphausia lucens	3
Euphausia spinifera	49
Euphausia superba	4893
Euphausia triacantha	2382
Euphausia vallentini	255
Eurythenes gryllus	5
Eurythenes obesus	1
Eurythenes sp.	3
Eusiridae spp.	6
Eusiridei cf Stennopleura	3
Eusiris sp.	5
Fish eggs	3
Gennadus sp.	221
Gigantocypris sp.	70
Hydrozoa spp.	378
Hyperia sp.	1
Lanceola sayana	1
Lanceola sp.	6
Limocina helicina	20
Nemertina spp.	8
Nemertine	2
Paradiplospinus gracilis	1
Paraeuchaeta antarctica	2
Parandania boecki	106
Periphylla periphylla	31
Phronima sedentaria	1
Polychaeta spp.	3

Primno macropa	38
Pteropoda spp.	13
Salpa sp.	1561
Salpa thompsoni	11641
Sergestes sp.	50
Sergia/Pasipheya	37
Sibogita sp.	57
Siphonophora (nectophores)	269
Spongiobranchia australis	1
Themisto gaudichaudii	423
Thysanoessa spp.	597
Thysanopoda pechinata	9
Tomopteris sp.	135
Vibilia sp.	4

Table 19 Summary of macrozooplankton species caught in RMT25 net hauls on JR16003

9 Motion compensated Bongo, mini- Bongo and Depth integrated MUDL nets

Geraint Tarling, Clara Manno, Vicky Fowler

Bongo, mini-Bongo and Depth-integrated MUDL net deployments were carried out principally to collect pteropods in live, undamaged condition. In the case of the majority of deployments, the by-catch was not retained although a small number were preserved in 96% buffered ethanol.

Trial of depth discrete sampling system - A new depth-discrete open-closing mechanism was trialled on the Bongo net at the start of the cruise. The mechanism attached to the cod-ends which had a rotating ball-valve that opened and closed the cod end at preset depths (or times). The depth (or times) were uploaded onto the motor via a modem cable from a laptop with customised Hydrobios software. During the trials, the net was deployed in the closed position and sent to a depth that was 5 m below the opening position. Reaching this deeper depth triggered the motor into the ready position. The net was then gradually hauled in, with the motor rotating to the open position when it reach the first preset depth. The net was then hauled to the second preset depth where the motor rotated once again to close the cod-ends. The net was brought back to the surface and secured. The first trial deployment was not successful probably because it did not reach the triggering depth (there was an angle on the wire). The open-closing mechanism operated as expected during the second trial where a larger margin of error was allowed for (+ 10m) to reach the triggering depth. The open-closing mechanism was transferred to the MUDL net after the trial, where it remained for the rest of the cruise.

Depth integrated samples The Motion compensating Bongo net (without the open-closing mechanism, 100 um and 200um nets) at station P3 and also used extensively at station P2 where it was deployed to capture larval, juveniles and adult pteropods for incubation.

During the Polar Front stations, a combination of mini Bongo (50 um) and depth integrated (DI) MUDL (200um) nets were deployed to obtain pteropod samples. The majority of deployments were made between 0 and 100 m, although some did sample between 0 and 200 m. In the case of the DI-MUDL, the open-closing mechanism was left in the open position throughout the deployment. Samples were only collected with the upward looking net and the tap on the cod-end was kept closed. The tap of the downward looking net was left open so that it flushed continuously throughout the deployment (leaving it closed would potentially trap air and lead to implosion at depth).

Event 144 was a mini-Bongo deployed between 0 and 70 m to make up for a MOCNESS net deployment which was closed prematurely at 70, and so did not sample the surface layer. The catch was preserved in 95% ethanol.

Time	Latitude	Longitude	Depth (m)	sea surface temp °C	sea surface salinity	sea surface transmittance	PAR	Sample depth (m)	Sample details	Gear
06/01/2017 07:05	-53.2983	-52.1927	1670.88	6.1302	33.9107	0.435678	3.8	0-100 m	Event 169	MINIBONGO (50um) Not preserved (for picking for photographs)
06/01/2017 06:41	-53.3033	-52.2011	1643.74	6.1574	33.9094	0.436678	1.2	0-200 m	Event 168	MINIBONGO (50um) Not preserved (for picking for photographs)
06/01/2017 06:17	-53.3033	-52.2011	1643.74	6.1574	33.9094	0.436678	1.2	0-100 m	Event 167	DI-MUDL (200 um) For pteropods to be incubated Preserved in 96% Ethanol
06/01/2017 05:51	-53.3062	-52.2058	1634.78	6.1782	33.9106	0.436948	1.2	0-200 m	Event 166	DI-MUDL (200 um) For pteropods to be incubated Preserved in 96% Ethanol
05/01/2017 21:56	-53.2577	-52.1684	1758.31	6.6216	33.8941	0.434409	647.2	0-125m	Event 160	DI-MUDL (200um) For pteropods to be incubated Preserved in 96% Ethanol
05/01/2017 05:28	-53.9055	-49.2751	4320.16	3.7064	33.7225	0.464648	1.6	0-100 m	Event 149	DI-MUDL (200um) For pteropods to be incubated Preserved in 96% Ethanol
04/01/2017 21:31	-53.93	-49.1539	4661.46	4.1996	33.7056	0.463859	362.8	0-70 m	Event 144	MINIBONGO (50um) To accompany MOCNESS E143 where the top 70 m was missed

										Preserved in 96% Ethanol
03/01/2017 07:55	-54.538	-45.0937	3730.79	2.5503	33.6368	0.476016	57.4	0-100 m	Event 133	MINIBONGO (50um) Preserved in 96% Ethanol
01/01/2017 08:52	-55.3052	-41.3702	3572.79	1.7376	33.6973	0.500696	574.2	0-100 m	Event 119	BONGO (100um and 200um) Preserved in 96% Ethanol
31/12/2016 18:21	-55.2612	-41.1983	3267.53	1.6812	33.7228	0.50589	869.4	0-100 m	Event 109	BONGO (100um and 200um) For pteropods to be incubated Not preserved
31/12/2016 18:14	-55.2616	-41.2001	3273.53	1.6268	33.7288	0.50639	957.4	0-100 m	Event 108	BONGO (100um and 200um) For pteropods to be incubated Not preserved
31/12/2016 18:08	-55.2621	-41.2027	3279.42	1.6247	33.705	0.506563	1064.4	0-50 m	Event 107	BONGO (100um and 200um) For pteropods to be incubated Not preserved
31/12/2016 18:02	-55.2626	-41.2048	3283.62	1.6587	33.7175	0.50639	1016.8	0-50 m	Event 106	BONGO (100um and 200um) For pteropods to be incubated Not preserved
31/12/2016 17:52	-55.2631	-41.2073	3285.52	1.662	33.7241	0.505967	1102	0-100 m	Event 105	BONGO (100um and 200um) For pteropods to be incubated

										Not preserved
31/12/2016 17:44	-53.93	-49.1539	4661.46	4.1996	33.7056	0.463859	362.8	0-100 m	Event 104	BONGO (100um and 200um) For pteropods to be incubated Not preserved
31/12/2016 07:03	-55.3293	-41.2707	0	1.4658	33.7417	0.506602	128.4	0-100 m	Event 102	BONGO (100um and 200um) Preserved in 96% Ethanol
25/12/2016 17:45	-54.1584	-36.6941	79.76	17.9771	33.5671	0.219234	837.6		Event 71	BONGO (100um and 200um) Preserved in 96% Ethanol
23/12/2016 01:33	-53.7873	-38.5856	203.64	2.0843	33.7842	0.343691	1.6	0-50 m	Event 58	BONGO (100um and 200um)
23/12/2016 01:05	-53.7853	-38.5832	206.21	2.0823	33.7847	0.344037	1.4	0-150 m	Event 57	BONGO (100um and 200um)
20/12/2016 21:14	-53.4927	-39.251	3146.72	2.3447	33.839	0.318357	187.4		Event 38	BONGO (100um and 200um) Not preserved
13/12/2016 18:39	-54.0918	-45.7282	3613.43	1.8381	33.6265	0.330399	583.6		Event 10	BONGO (100um 200um) Trial of opening closing mechanism
13/12/2016 18:11	-55.3052	-41.3702	3572.79	1.7376	33.6973	0.500696	574.2		Event 9	BONGO (100um and 200um) Trial of opening closing mechanism

Table 20 Bongo, mini Bongo and DI MUDL deployments during JR16003

10 MOCNESS and MAMMOTH deployments

Geraint Tarling, Sophie Fielding, Ryan Saunders

The MOCNESS was deployed between 0 and 1000 m at the P2 and P3 stations, and at the Polar Front stations 2, 4 and 6. At the P3 station, a failure in comms during the daytime deployment meant that only net 1 was open during the entire haul, while the nighttime deployment was successful. Both daytime and nighttime were successful for the P2 deployments. For the Polar Front stations, only a daytime deployment was scheduled and each was successful although net depths were not as intended for the PF4 station (Event 143) due to user error (a mini Bongo net deployment was made immediately afterwards to sample the top 70 m, which was missed by that deployment).

Sample processing: The samples were processed as follows:

1. Pteropods, fish larvae and some salps were removed immediately on first inspection of the catches
2. The sample was then divided into two, with one half filtered onto 200um mesh within an interlocking mesh holder, the mesh removed and frozen at -80oC within 10 mins of the net arriving on deck
3. Specimens from the remaining half of the sample were further removed, principally any further pteropods, salps and fish larvae were picked out, as well as some *Euphausia triacantha* and *Themisto gaudichaudii* (J Xavier carried out length frequencies of these samples which were then frozen for subsequent fatty acid analysis) and gelatinous organisms (Angelika Slomska).
4. The remainder of the sample was preserved in 96% buffered ethanol

MOCNESS deployment issues: The towing bridles on the MOCNESS frequently became twisted during the haul, jeopardising the integrity of the comms cable. In one instance, this cable parted as a result of this twisting (P3 daytime haul, Event 89). The fault was believed to lie in the ship's biowire which probably had a historical twist that released itself after paying out a certain length of wire. We tried to remedy this between some MOCNESS deployments by paying out ~2500 m of biowire with a weight and swivel attached to the end. This alleviated but not cured the problem. A request was made to replace the biowire before any future Pelagics cruises.

Mammoth net: The original intention was to deploy the MAMMOTH net at stations P2 and P3, as vertical deployments to 1000 m. On the first deployment (Event 75), there was substantial twisting of the bridles and comms were lost after paying out 850 m. The net was retrieved without any nets being opened. A further issue with this deployment was that the cod end carousel was also twisted and the nets entangled. This may have been the result of a separate issue resulting from deployment in an overly large swell, causing the distance between the net frame and the carousel to expand and contract (in a so called "concertina effect"), so allowing the potential for the nets to become entangled during the periods when they were no longer taut.

It was decided to swap to the MOCNESS net to determine if the twisting issue was with the MAMMOTH device or with the biowire. From that point onwards, only MOCNESS deployments were made since it was considered to be more reliable under the circumstances.

The following are recommended for future MAMMOTH deployments:

1. That the biowire be renewed
2. That extra weight is placed on the cod-end carousel to reduce the potential to "concertina" up and down
3. That the MAMMOTH be deployed on a suitably rated swivel

4. Such a swivel would mean that comms with the net would be no longer possible. However, depth specific net-opening commands can be preset before deployment allowing the system to run autonomously during the deployment.

5. The potential for the MAMMOTH to swivel during deployment may also result in net entanglement. This risk could be reduced through strong wire bridles being connected from each of the four corners of the net frame to the carousel.

Figure 26 Entanglement in MAMMOTH nets after deployment E75

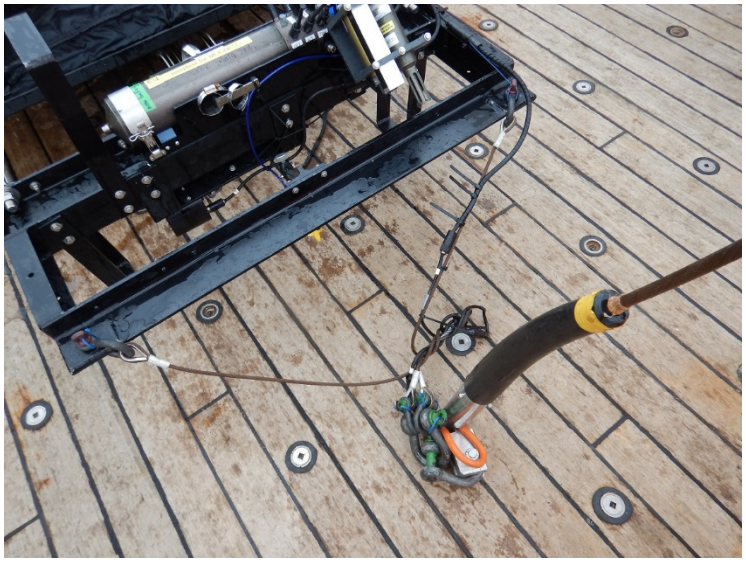


Figure 27 Twisting of MOCNESS bridles, jeopardising the comms cable

Time	Event No	Net No	Latitude	Longitude	Water depth (m)	Net depth (m)	Action	Comment
05/01/2017 21:13	159	9	-53.299	-52.1881	1667.67	9.2	Net closed	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 21:04	159	9	-53.2966	-52.1876	1682.93	128.5	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:54	159	8	-53.2933	-52.1867	1708.28	264.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:48	159	7	-53.291	-52.1858	1722.11	392.4	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:43	159	6	-53.2893	-52.1851	1744.93	506.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:37	159	5	-53.2875	-52.1845	1735.05	631.8	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:31	159	4	-53.2858	-52.1836	1722.85	757.2	net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:25	159	3	-53.2838	-52.183	1704.92	890	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 20:16	159	2	-53.2813	-52.1823	1689.29	1000.7	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
05/01/2017 19:17	159	1	-53.2875	-52.1845	1735.05	631.8	Net deployed	PF6
04/01/2017 20:51	143	9	-53.9357	-49.222	4464.44	67.5	Net recovered	
04/01/2017 20:45	143	9	-53.9347	-49.2172	4482.17	80.1	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 20:41	143	8	-53.9341	-49.2139	4494.8	138.7	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 20:37	143	7	-53.9336	-49.2106	4507.69	199.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017	143	6	-53.9328	-49.2048	4492.21	286.6	Net	1/2 frozen at -

20:30							opened	80oC, 1/2 preserved in ethanol
04/01/2017 20:19	143	5	-53.9317	-49.1958	4513.83	354.8	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 20:16	143	4	-53.9314	-49.1933	4503.96	402.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 19:56	143	3	-53.9301	-49.1756	4583.56	699.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 19:29	143	2	-53.929	-49.1516	4664.13	998.1	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
04/01/2017 18:14	143	1	-53.9353	-49.0722	4528.09	0.6	Net deployed	PF4
02/01/2017 20:58	126	9	-54.6287	-45.1929	3004.42	3.8	Net closed	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:49	126	9	-54.6323	-45.1949	3002.43	136.8	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:39	126	8	-54.6361	-45.197	0	257.4	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:30	126	7	-54.64	-45.1997	3004.42	388.3	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:23	126	6	-54.6432	-45.2018	3003.32	517.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:14	126	5	-54.6467	-45.2038	4961.28	629.7	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 20:06	126	4	-54.6503	-45.206	4916.74	754.2	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 19:58	126	3	-54.6538	-45.2085	4974.85	883.3	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
02/01/2017 19:50	126	2	-54.6567	-45.2119	4971.32	997.3	Net opened	1/2 frozen at -80oC, 1/2 preserved in

								ethanol
02/01/2017 18:48	126	1	-54.6867	-45.2383	4564.77	0	Net deployed	PF2 station
31/12/2016 04:19	98	9	-55.3349	-41.2925	0	3.8	Net 9 closed	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 03:57	98	9	-55.3249	-41.2907	0	127.4	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 03:35	98	8	-55.3141	-41.289	3551.17	254.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 03:13	98	7	-55.3026	-41.2872	3599.98	381.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 03:00	98	6	-55.2958	-41.2854	3559.51	505	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 02:43	98	5	-55.287	-41.2832	3534.13	631	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 02:30	98	4	-55.2806	-41.2808	3503.15	757.2	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 02:16	98	3	-55.2736	-41.2779	3445.15	884.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 02:06	98	2	-55.2691	-41.2762	3406.72	997.5	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
31/12/2016 01:24	98	1	-55.2525	-41.2685	3375.75	0	Net deployed	P2 night
30/12/2016 22:13	95	9	-55.3384	-41.2445	3537.76	5.9	Net 9 closed	
30/12/2016 22:01	95	9	-55.3318	-41.2461	3570.62	130.3	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 21:48	95	8	-55.3248	-41.2477	3548.74	259.8	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 21:38	95	7	-55.319	-41.2488	3508.66	378.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016	95	6	-55.3124	-41.2497	3514.96	508.8	Net	1/2 frozen at -

21:26							opened	80oC, 1/2 preserved in ethanol
30/12/2016 21:14	95	5	-55.306	-41.2519	3475.83	628	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 21:01	95	4	-55.2987	-41.2536	3470.06	754	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 20:50	95	3	-55.2924	-41.2545	3481.15	877.1	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 20:42	95	2	-55.2876	-41.2557	3481.43	995.9	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
30/12/2016 19:30	95	1	-55.2472	-41.2721	3387.33	-0.3	Net deployed	P2 day
29/12/2016 20:31	89	1	-52.9065	-40.3245	3809.62	0	Net recovered	Net 1 open from surface to 1000m and back again
29/12/2016 17:22	89	1	-52.8199	-40.1794	3793.06	0	Net deployed	P3 day Net opening/closing failed. Net retrieved with severed comms due to twisted bridle. Sampling occurred from Net 1 that was open from surface to 1000m and back up again
29/12/2016 06:28	86	9	-52.9416	-40.3909	3828.73	12.1	Net opened	Net 9 open on retrieval
29/12/2016 06:17	86	8	-52.9352	-40.3795	3824.5	135.4	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 06:07	86	7	-52.9297	-40.3692	3823.8	261.1	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 05:57	86	6	-52.9242	-40.3591	3817.46	383.8	Net opened	1/2 frozen at -80oC, 1/2 preserved in

								ethanol
29/12/2016 05:47	86	5	-52.919	-40.3488	3814.65	508	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 05:39	86	4	-52.9148	-40.3403	3812.87	630.7	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 05:06	86	3	-52.899	-40.3078	3813.64	888.6	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 03:34	86	2	-52.8535	-40.215	3800.7	1001.5	Net opened	1/2 frozen at -80oC, 1/2 preserved in ethanol
29/12/2016 02:01	86	1	-52.8112	-40.1218	3795.47	0	Net deployed	P3 night
MOCNESS deployments above								
27/12/2016 13:54	75	1	-52.8079	-40.1132			Net deployed	P3 - comms failure at 851 m, retrieved without any nets opened
MAMMOTH deployments above								

Table 21 MOCNESS and MAMMOTH deployments during JR16003

11 SeaDNA sampling – JR16003

Geraint Tarling, Sophie Fielding

eDNA samples were collected for the SeaDNA project (NE/N00616X/1). The sampling protocol was as detailed by the protocol outlined by Rupert A Collins (June 2016 "SeaDNA estuary sampling protocols – see Appendix).

Sample water was collected in bleach-cleaned 2L Nalgene rectangular PE bottles. For each sampling location (e.g. underway or depth strata on the CTD) 3 replicates were taken (e.g. 3 x 2L Nalgene bottles). On filling, the water was prefiltered with a 250 µm mesh. This was achieved through customising a 250 ml circular PE Nalgene bottle by cutting out the bottom and drilling a hole in the screw top lid. A 250 µm prewashed mesh was screwed tight beneath the lid, creating an improvised funnel. This mesh-funnel was placed on top of the 2L bottle and the water poured through it to fill the bottle. The 2L bottle was rinsed 3 times with ~300 ml of water (i.e the lid screwed tight and the bottle shaken before discarding the water). The 2L bottle was then filled full and stored in a chilled container until filtering (within 6 h of the sample being taken).

Prior to each set of replicate samples being run, a blank sample was filtered. The same procedure was followed for the samples, but MilliQ water was used. The blank sample was always the first sample to be filtered through the 250um mesh funnel before the 3 replicate samples werefiltered.

Filtering was carried out using a Cole Palmer Masterflex peristaltic pump with an Easyload II roller (model 77200-62) and silicon tubing (L/S 6437-24). A 0.22 um sterivex filter cartridge was attached to one end of the tubing, the other end was inserted into the 2L bottle containing the sample (or blank) water. The water was pumped through the filter cartridge at a rate of ~150 ml/min, which took approximately 15 mins to filter a 2L sample. Once the sample had run dry, the pump was kept on for a further 3 minutes to pump air through the filter cartridge to eliminate any residual water. The filter cartridge was removed and placed into a Whirl-pack sample pack and placed on ice for a maximum of 3 hours until frozen at -20oC.

Note that the same piece of silicon tubing was used to filter the blank and all three samples. The blank was always filtered first so that any contamination in the tubing or sample bottles could be identified within the blank.

Once completed, the mesh-funnel, the 250 um mesh and the silicon tubing were placed in bath containing 1 part bleach (Domestos – 4.5% Sodium hypochlorite) to 3 parts MilliQ water and left for at least 3 hours. Approximately 50 ml of the same solution was introduced into each sample bottle and vigorously shaken and also left for a minimum of 3 hours. The equipment was then treble rinsed with MilliQ water. In addition, the 2L sample bottles were completely filled with MilliQ water and left for at least a further 3 hours before the water was tipped away. The equipment was dried using a bungee washing line within the filtering lab.

Water was collected either from the underway water supply situated in the filtering lab or from the CTD. The CTD bottle depths were 850 m, 650 m, 300 m and 100 m although the deepest depth at any station varied depending on maximum water depth. A typographic error meant that the deepest depth at event 21 was 650 m rather than 850 m. An underway water sample was taken at approximately the same time as any CTD cast to provide a corresponding surface water sample.

Figure 28 Sampling from the underway water supply

Figure 30 Filtering water

Figure 29 Sampling water from the CTD

Figure 31 Drying the sterivex filter cartridge after filtering

Time	Latitude	Longitude	Bottom depth (m)	Sea surface temperature	Surface salinity	Surface transmittance	PAR	Sample or Bottle ID	Sample depth (m)
11/01/2017 20:45	-67.575	-68.2441	490.47	16.478	33.2154	0.324494	998.4	Event 175 (CTD)	5 m
10/01/2017 11:24	-65.4901	-67.1774	263.14	2.3239	33.5718	0.290773	460	Underway sample	Surface
09/01/2017 19:32	-63.1625	-64.2067	226.95	2.1848	33.9018	0.371757	486.6	Underway sample	Surface
09/01/2017 11:32	-62.0118	-62.6962	4448.71	2.2538	33.693	0.395475	258.8	Underway sample	Surface
08/01/2017 19:07	-59.5303	-59.7675	2881.84	2.0263	33.7575	0.398803	1547	Underway sample	Surface
06/01/2017 07:50	-53.2577	-52.1684	1758.31	33.8941	0.434409	627.2	48	Underway sample	Surface
06/01/2017 07:37	-53.2956	-52.1878	1695.3	6.1293	33.9108	0.435178	18.2	Event 170 (CTD)	850m, 550m, 300m, 100m
05/01/2017 06:25	-53.9049	-49.274	4322.31	3.7388	33.717	0.460031	2	Underway sample	Surface
05/01/2017 06:04	-53.9049	-49.274	4322.69	3.7608	33.7219	0.460897	1.8	Event 150 (CTD)	850m, 550m, 300m, 100m
03/01/2017 09:12	-54.538	-45.0936	3731.48	2.5357	33.632	0.473035	161.8	Underway sample	Surface
03/01/2017 08:26	-54.538	-45.0937	3731.73	2.5233	33.633	0.474804	43.6	Event 134 (CTD)	850m, 550m, 300m, 100m
30/12/2016 18:27	-55.2443	-41.2741	3389.61	1.6077	33.6892	0.511238	826	Underway sample during E94	Surface
30/12/2016 18:15	-55.2443	-41.2741	3389.02	1.6368	33.6984	0.510199	587	Event 94 (CTD)	850m, 550m, 300m, 100m
27/12/2016 11:58	-52.8079	-40.1132	3785.68	2.6373	33.8989	0.548825	765.4	Underway sample during E73	Surface
27/12/2016	-52.8079	-40.1132	3785.68	2.6373	33.8989	0.548825	765.4	Event 73 (CTD)	850m, 550m,

11:43									300m, 100m
23/12/2016 18:07	-53.7574	-37.6191	269.38	2.523	33.7063	0.340517	1570.4	Underway sample	Surface
22/12/2016 00:17	-53.7154	-37.9642	131.99	2.1805	33.7684	0.338209	1.4	Underway sample	Surface
22/12/2016 00:09	-53.7154	-37.9642	132.61	2.1656	33.7686	0.338844	1.4	Event 50 (CTD)	100 m
19/12/2016 19:43	-53.7929	-40.6673	716.43	1.825	33.6355	0.366505	510.4	Underway sample	Surface
18/12/2016 20:18	-54.4444	-39.8757	83.53	1.6453	33.6083	0.364755	828	Underway sample	Surface
16/12/2016 18:38	-52.8187	-40.1364	3794.33	2.4559	33.867	0.333746	791.6	Underway sample - P3 mooring uplift	Surface
16/12/2016 18:04	-52.8187	-40.1364	3794.33	2.4559	33.867	0.333746	791.6	Event 21 (CTD) - P3 mooring uplift	650m, 550m, 300m, 100m
15/12/2016 17:12	-53.4996	-43.1409	1456.61	1.8907	33.6373	0.335708	1041.2	Underway sample	Surface
14/12/2016 17:27	-53.4828	-47.1514	1922.73	4.42	33.8617	0.298775	1323.6	Underway sample	Surface

Table 22 eDNA sample catalogue

https://github.com/boopsboops/SeaDNA/blob/master/documents/sampling_protocol.md

***SeaDNA* estuary sampling protocols**

Rupert A. Collins :: June 2016

Three sampling protocols are outlined for the *SeaDNA* project using the Sterivex filtration system:

Protocol 1 (best): Filtering of water samples **with** access to a peristaltic pump within ~3 hours of collection.

Protocol 2 (okay, but time consuming): Water sampling **without** immediate access to peristaltic pump, use of a syringe in the field.

Protocol 3 (worst): Freezing water samples for later peristaltic pumping (freeze/thaw process may degrade DNA).

Protocol 1

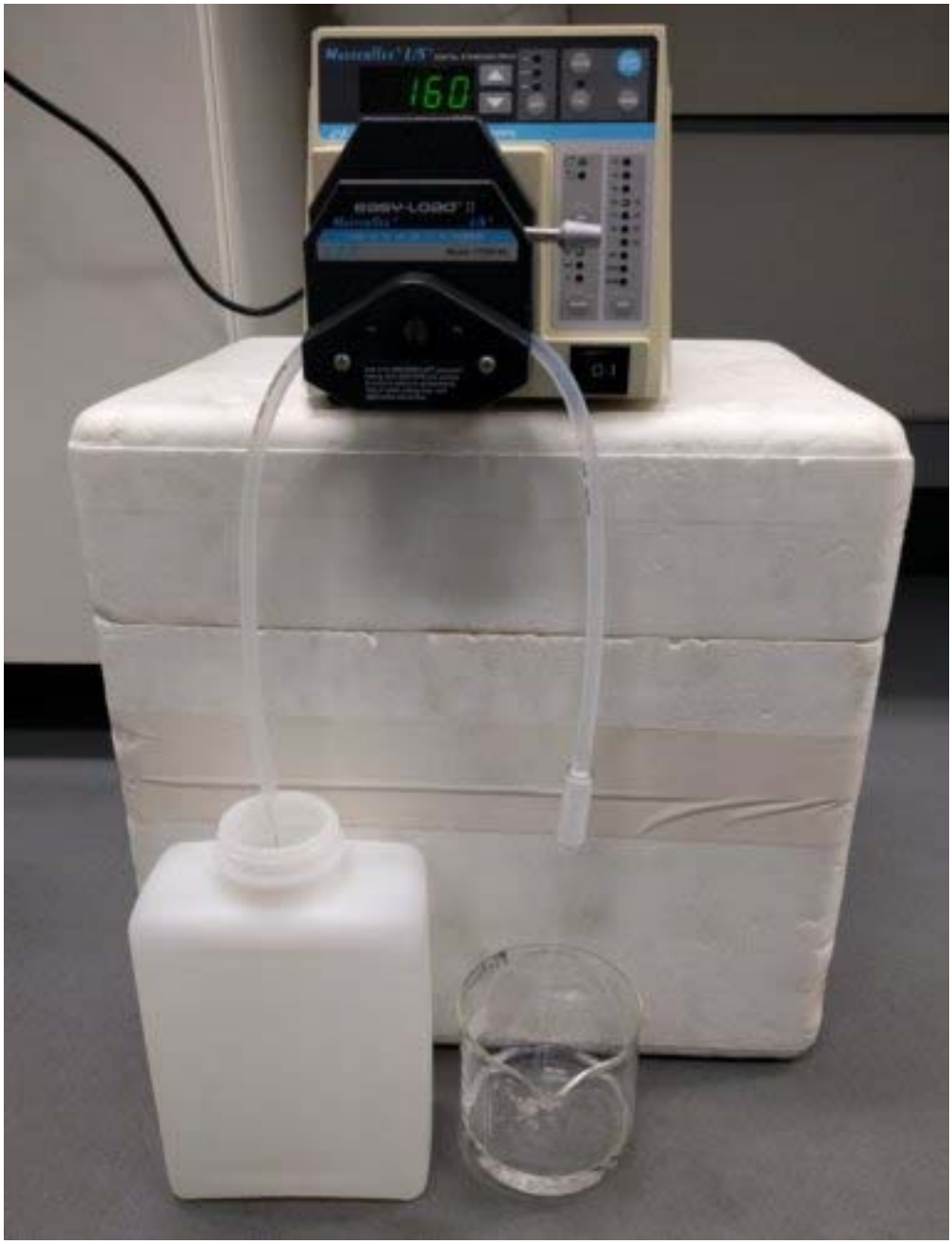
Each **site sampling** requires ×3 lots of 2 L, and a rate of 10% randomly assigned **negative controls**.

Wearing disposible gloves, fasten **prefilter** to neck of **sterile** sample collection bottle with an elastic band.

Rinse bottle in sample water, then submerge bottle and gently collect a subsurface water sample (taking care not to disturb any sediments). Try to sample in water > 50 cm in depth.

Place the samples into a pre-chilled coolbox or polystyrene box with ice packs. Label sample bottles with recorder/number/date/site/location using permanent marker (preferably using tape).

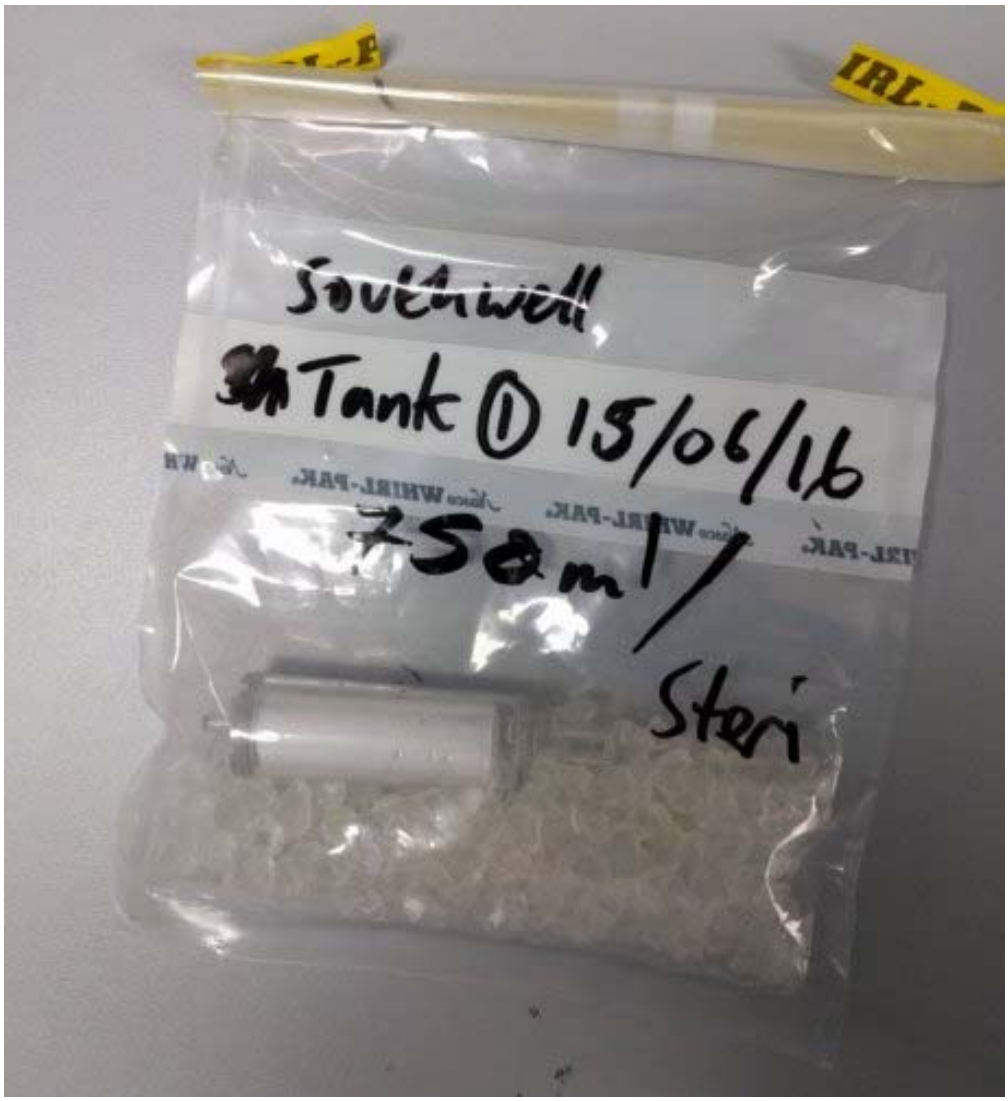
Set up the peristaltic pump. Connect **tubing** with one end in the sample bottle (preferably avoiding the bottom of the bottle), and other to the Sterivex placed over a measuring cylinder or measuring beaker (image below shows Sterivex inlet end on the right). Ensure that the pump is set to pump in the correct direction (i.e. into the Sterivex), and on the correct tube diameter setting (25). Before connecting the Sterivex, pass around 50 ml of sample water to flush the tubing.


160
EASY-LOAD II

Pump at ~150 mL/min until 2 L has passed through the filter. The pump output may need to be increased as the Sterivex saturates with material (it discolours as this happens), but speeds above 300 mL/min may lead to the Sterivex detaching from the tubing. Cable ties can be used to secure it better, but if 2 L cannot be pumped in a timely period (e.g. < 30 mins), stop the pump and record the total volume of water passed.

Remove the inlet tube from the water sample and while continuing to pump, allow gravity to dry the Sterivex completely for at least 3 mins (some small residual water drops may remain).

Stop pump, detach the Sterivex, and place it in a prelabelled sample bag containing ~5 g silica granules to remove remaining water. All three Sterivex from each site can be place in the same bag to save space.



Place the sample bag into a -20°C freezer or pre-chilled coolbox with ice packs until later freezing.

Protocol 2

Carry out steps 1-4 as Protocol 1.

Fill a 50 mL syringe with sample water

Attach syringe to a Sterivex filter inlet using the luer lock.

Slowly and steadily push the water through the Sterivex and into a measuring cylinder or measuring beaker.

Repeat until 2 L have passed through, or the Sterivex is saturated with material and the syringe plunger cannot be pushed (measuring final volume).

Carry out steps 8-9 as Protocol 1.

Protocol 3

Carry out steps 1-4 as Protocol 1.

Freeze the water samples as soon as possible after collection in a -20°C freezer.

Carry out steps 6-9 (Protocol 1) after gently thawing the water samples at room temperature.

Glossary

Negative control bottles (1 in 10 of real samples) should be prepared in advance in the lab using one 2 L sample of autoclaved distilled water, and treated identically to the real samples in the field.

Prefilters comprise cut two sheets (roughly 120 mm square) of a 250 µm and a 500 µm nylon gauze. They are attached to the neck of the bottle using an elastic band, and are discarded after the water sample is taken. Only the 250 µm gauze may be required for "clean" water samples, while dirty samples may require more than one 500 µm gauze.

Equipment can be **sterilised** by autoclave—or better—bleach. Bleach should be standard 5% commercial thin bleach at a ratio of 1:3 with water. After soaking in the solution for a minimum of 3 h, equipment should be triple rinsed in deionised/distilled water and then air dried. Ensure bleach penetrates the entire lengths of the tubing.

Here, **locations** are defined as the general geographical area (e.g. Severn Estuary), while **sites** are specific sampling points within that location (e.g. Portishead Docks 51.494 -2.754).

Cut silicone **tubing** to short (~80 cm) lengths, as they are easier to bleach in shorter lengths, and as clean/dirty equipment can be rotated (i.e. some left drying in the lab while others are in use).

Table 1. Parts and prices

Item	Cost (inc VAT)	Company	Part no.
Sterivex filter 0.22 µm	£3.96 ea	Millipore	SVGP01050
Peristaltic pump	£800 (used)	Cole-Parmer	Masterflex L/S 7523-60
PowerWater DNA isolation kit	£7.36 ea	MoBio	14900-100-NF
Silicon tubing (platinum)	£100 per 7.6 m	Cole-Parmer	L/S 25 WZ-96410-25
Whirl-pak sample bag	£47.34 per 500	SLS/Nasco	B01062WA
50 mL luer-lock syringe	£10.15 per 25	Greiner Bio-One Ltd	SYR50
Nalgene Bottle 2L PE rectangular	£28.3 per 4	SLS	BOT0158
250 µm and 500 µm mesh prefilter	£20 per m	Plastok	NA

12 Motion-compensated Upward Downward Looking (MUDL) net

Geraint Tarling, Vicky Fowler

The device was deployed for the first time during the present cruise to examine foray behaviour in mesozooplankton (the continuous vertical movement of organisms in and out of the mixed layer). The principle was to position the net at a set depth (towards the bottom of the mixed layer or below the Chl-a maximum) and allow planktonic organisms to swim into the upward looking or downward looking cod ends.

The net was lowered to depth with the cod ends in a closed position. After a preset time interval, the cod ends rotated to an open position and remained open for a further preset period of time, after which they rotated to a closed position once again. The net was then recovered. On recovery, the net mesh from the downward looking net was removed from the ring and the rotating mechanism was triggered manually while holding a bucket up to the cod end. Consequently, the contents of the cod ends poured into the upheld bucket. For the upward looking net, the cod end contents were retrieved through opening a tap at the bottom of the cod end.

The open-closing device was programmed through communication with a laptop containing Hydrobios software. Once the time settings were uploaded, the laptop was disconnected and the device set to an off position until the point of deployment. Before deployment, it was also necessary to fill the cod ends with water from the same depth as the resting depth of the net during deployment. This was obtained from a CTD carried out prior to deployment and poured into the net via a funnel in the case of the downward looking net, or simply poured into the disconnected cod end in the case of the upward looking net. At the point of deployment, the rotating device was turned on and a stop watch started to keep track of time during deployment. On recovery, the device was immediately turned to the off position and connected to the laptop to manually trigger a rotation to collect the water from the downward looking cod end.

The water samples were filtered through 100 um mesh in an interlocking sieve, from which the mesh was immediately extracted and placed in a plastic bag and frozen at -80oC.

Deployments were only made in moderate swell or less to avoid any large vertical movements of the net.

The net initially had some teething problems in the rotation cups which did not always complete their rotations and leaked water through the seals. This was cured through tweaks to the gearing mechanism. There were also further minor leaks through junctions and screw holes which were reduced through self-amalgamating tape and silicon sealant. Better solutions to preventing leaks are to be sought in future deployments.

Towards the end of the cruise, the upward looking net was also deployed in the open position and hauled upwards to obtain a depth integrated sample (the cod-end tap of the downward looking net was left in the open position). It was accepted that such samples could not be treated as quantitative because the length of the net was only half of what would otherwise be ideal to allow efficient filtration without generating a bow wave during hauling. Nevertheless, their purpose was to collect live pteropods for which it was considered adequate. These depth-integrated hauls were termed DI-MUDL deployments

In total, 16 deployments of the MUDL were made, mainly to 100 m, which was generally just below the bottom of the mixed layer. Other deployments were also made to 10 m below the Chl-a maximum. In almost all instances, the opening period at the resting depth was 20 mins. 12 minutes was allowed for the net to be deployed, arrive at the resting depth and allow thorough flushing before the cod ends opened.

Time	Latitude	Longitude	Depth (m)	sea surface temp	sea surface salinity	sea surface transmittance	PAR	Sample depth	Sample details	Comment
06/01/20 17 05:05	-53.3098	-52.212	1621.29	6.2007	33.9136	0.436005	1.4	100 m	12 mins pre-opening, 20 mins opening	Event 165 (Polar Front station 6) Frozen -80oC
05/01/20 17 22:32	-53.2525	-52.1611	1735.83	6.3542	33.8845	0.432716	352.8	100 m	12 mins pre-opening, 20 mins opening	Event 161 (Polar Front station 6) Frozen -80oC
05/01/20 17 05:28	-53.9055	-49.2751	4320.16	3.7064	33.7225	0.464648	1.2	100 m	12 mins pre-opening, 20 mins opening	Event 149 (Polar Front station 4) Frozen -80oC
04/01/20 17 21:43	-53.93	-49.1539	4661.48	4.1602	33.7021	0.462763	308.8	100 m	12 mins pre-opening, 20 mins opening	Event 145 (Polar Front station 4) Frozen -80oC
03/01/20 17 07:08	-54.538	-45.0937	3731.21	2.5614	33.636	0.475978	69.8	80 m	12 mins pre-opening, 20 mins opening	Event 132 (Polar Front station 2) Frozen -80oC
03/01/20 17 06:19	-54.538	-45.0937	3730.74	2.5614	33.636	0.475978	69.8	100 m	12 mins pre-opening, 20 mins opening	Event 131 (Polar Front station 2) Frozen -80oC
02/01/20 17 22:52	-54.6937	-45.2429	4499.7	2.3539	33.6483	0.467379	25.8	80 m	12 mins pre-opening, 20 mins opening	Event 128 (Polar Front station 2) Frozen -80oC
02/01/20 17 22:05	-54.538	-45.0937	3730.74	2.5614	33.636	0.475978	69.8	100 m	12 mins pre-opening, 20 mins opening	Event 127 (Polar front station 2) Frozen -80oC
01/01/20 17 07:55	-55.3062	-41.376	3581.03	1.8464	33.6979	0.501042	416.6	60 m	12 mins pre-opening, 20 mins opening	Event 118 (P2) Frozen -80oC
01/01/20 17 07:05	-55.3075	-41.3835	3583.7	1.7857	33.7002	0.500908	192.4	100 m	12 mins pre-opening, 20 mins opening	Event 117 (P2) Frozen -80oC
31/12/20 16 05:56	-55.3349	-41.2804	0	1.4686	33.7422	0.507179	5.4	100 m	12 mins pre-opening, 20 mins opening	Event 100 (P2) Frozen -80oC
31/12/20 16 05:09	-54.9835	-43.3149	3472.48	1.9165	33.6776	0.465725	1.6	80 m	12 mins pre-opening, 20 mins opening	Event 99 (P2) Chla max + 10 m Frozen -80oC
31/12/20 16 00:13	-55.2468	-41.2701	3376.76	1.5506	33.6878	0.508948	1.6	100 m	12 mins pre-opening, 20 mins opening	Event 97 (P2) Frozen -80oC
30/12/20 16 23:24	-55.2468	-41.2701	3376.76	1.5506	33.6878	0.508948	1.6	80 m	12 mins pre-opening, 20 mins opening	Event 96 (Chl-a max + 10 m) Frozen -80oC
29/12/20 16 21:13	-52.9137	-40.3442	3821.21	2.5987	33.8854	0.501754	106.8	100 m	12 mins pre-opening, 12 mins opening	Event 90 (P3) Frozen -80oC
29/12/20 16 00:34	-52.8087	-40.1138	3897.68	2.3636	33.8627	0.493829	1.6	100 m	10 min pre opening, 30 min opening	Event 85 (P3) Sample not retained

Table 23 MUDL deployments during JR16003

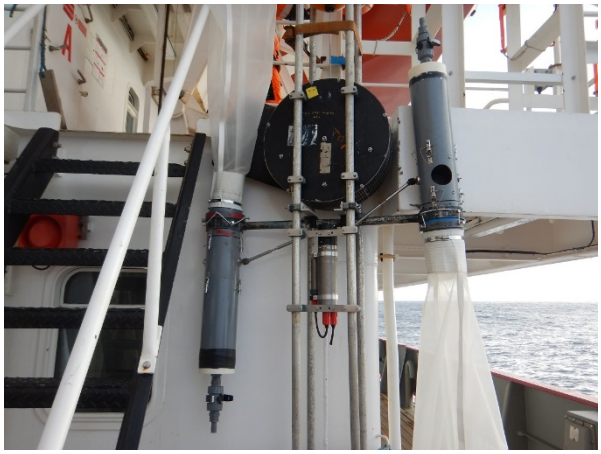


Figure 32 MUDL net showing the cod ends, motor device and arms and motion compensation mechanism

Figure 33 Filling of the downward looking cod end prior to deployment

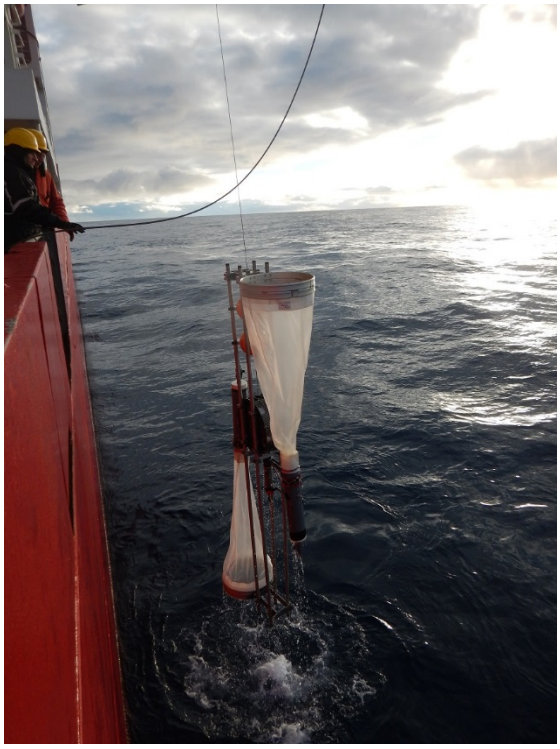


Figure 34 Recovery of the MUDL

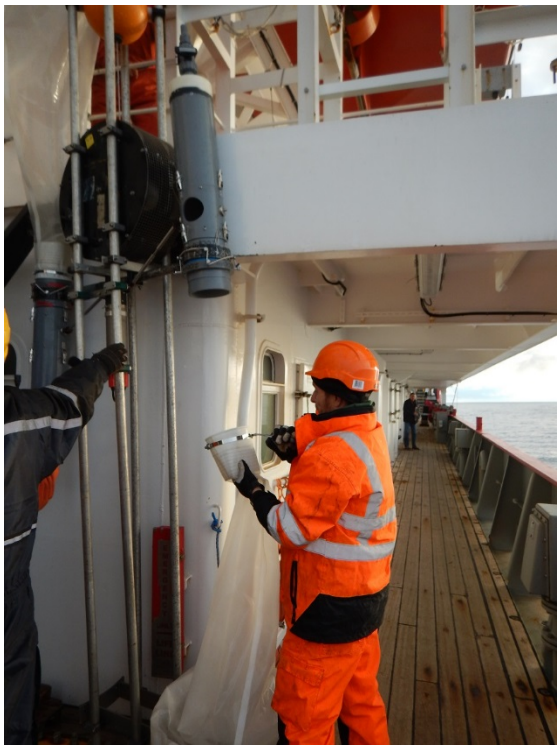


Figure 35 Disconnection of the net after deployment

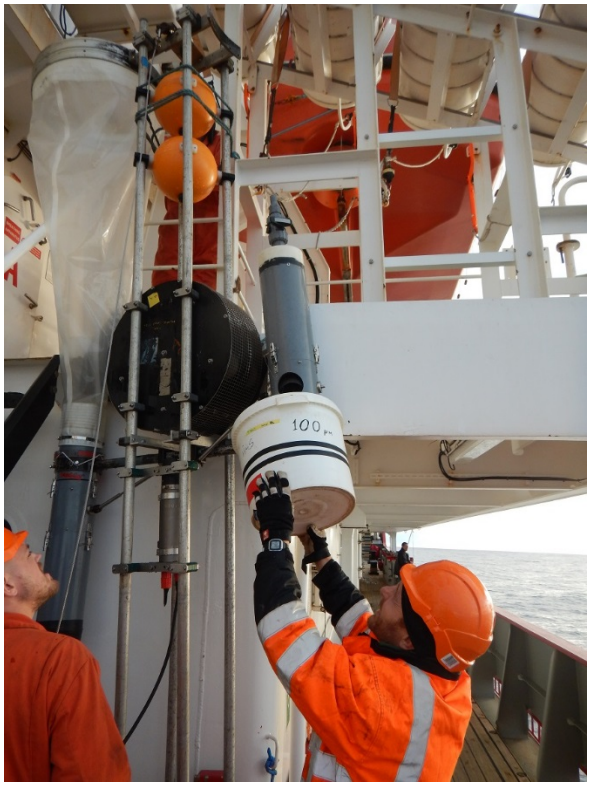


Figure 36 Collecting water from the downward looking cod end on the manual triggering of the motor

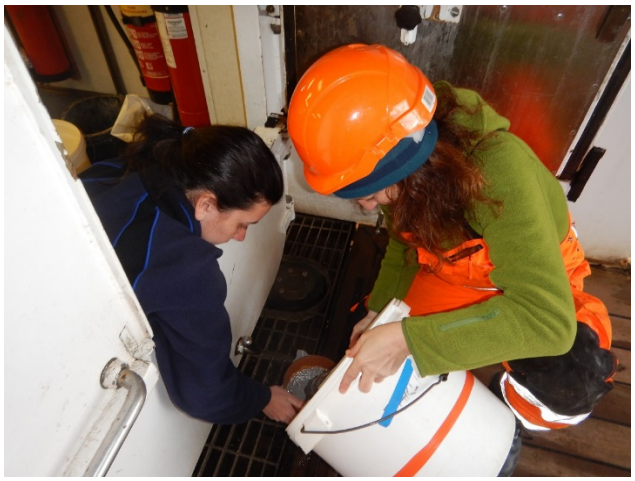


Figure 37 Filtering of sample through 100 um mesh within interlocking mesh holders. The mesh was immediately frozen at -80oC

Figure 38 Collecting water from upward looking cod end through tap

13 Impact of Ocean Acidification and Nanoplastics on Zooplankton

Clara Manno, Elisa Bergami

The individual impacts of ocean acidification (OA) and nanoplastics (NPs) on zooplankton function and health have been already recognised. Antarctic region is predicted to be particularly affected by OA due to naturally high CO_2 ocean uptake and low carbonate saturation levels. Furthermore, the Southern Ocean has been highlighted as a potential sponge for the plastic debris. However, in the Antarctic region the impact of those anthropogenic stressors on zooplankton is still poor explored and their synergic impact totally unknown.

13.1 Ocean Acidification Experiments

Anthropogenic carbon dioxide emissions induce OA, where pH and the concentration of carbonate ions decrease, resulting in shoaling of the Calcium Carbonate (CaCO3) saturation horizon. The decrease in the saturation state of seawater, following seawater acidification, is believed to be the main factor leading to a decrease in the calcification of marine organisms. However, reduces pH and depresses carbonate ion concentration [$CO_3^{-\ -}$] correspond to an increases bicarbonate ion concentration [HCO_3^-], which could moderate the negative impact of decreasing in [$CO_3^{-\ -}$]. Then it is critical to explore and differentiate between the effects of the various components of the carbonate chemistry, as well as their relative importance, in order to understand what components is the main drivers of the impact.

13.1.1 Pteropods

Pteropods have been identified as candidates for indicating the onset of OA, since their aragonite shell has been demonstrated to be particularly prone to dissolution. Since those organisms are an important ecological as well as biogeochemical component of the marine Antarctic ecosystem, a negative impact on the pteropod community due to anthropogenic stressors (such as OA) may in turn affect both the marine ecosystem and biogeochemical cycles. During the field expedition, we incubated pteropods (pt-exp-1) under manipulated seawater carbonate chemistry. Adults *Limacina helicina* were collected by Bongo net and left to acclimatise for 24 h. All incubations were performed within 0.22 µm filtered seawater. Ambient seawater pH, temperature and salinity were measured at the beginning and at the end of experiments. All treatments were run in triplicate at constant temperature (+2°C) in controlled temperature tanks. The quantities of HCl and $NaHCO_3$ required achieving target pCO_2 conditions of 1000 ppm were calculated using the relationship between these parameters and DIC and TA within this region established on JR274. Then, in order to differentiate between the effects of the various components of the carbonate chemistry, we repeated the experiment treatment condition with a double concentration of HCO_3^- (Carbonate enrichment, C enrich). The experiment was run for a week and monitored daily for survival and swimming behaviours. At the end of each experiment, animals were recovered and assessed as either living, dead or in 'poor state of health' (vital organs seen to mov,e but animal is retreated within shell, shell is in a poor condition/debris attached). At the end of each experiment, the pteropods were collected and air-dried and/or stored preserved in buffered ethanol for further detailed investigation at BAS (Fluorescence and Scanning Electron microscope investigation). Shipboard incubation of healthy specimens at ambient and modified seawater conditions allows us to observe change in survival, shell growth, morphology (i.e. dissolution, damage, malformation). Part of the specimens was immediately stored at -80°C for lipid and genetic analyses. For each incubation bottle, pteropod eggs were collected and stored in formalin for further investigation on behavioural response. One BOD of incubation water for each treatment was collected and fixed with $HgCl_2$ to be returned to the UK for TA and DIC analysis.

13.2 Nanoplastic experiments

To assess the NP impact on Antarctic marine organisms, selected polystyrene nanoparticles can be adopted as model in laboratory ecotoxicity tests. During this cruise, two types of unlabelled polymeric nanoparticles, having a polystyrene core and carboxylated (PS-COOH, nominal size of 60 nm) and amino (PS-NH_2, nominal size of 50 nm) functionalizations were used, corresponding to negative and positive surface charges respectively. The different NP functionalization allows us to correlate the different effects observed in the experiments with the NP behaviour in the exposure media, which strictly depends on NP surface charges. Moreover, fluorescently labelled PS-COOH were used in order to evaluate the NP biodisposition within the organisms.

13.2.1 Krill

Antarctic krill (*Euphausia superba*) is a key species of the Antarctic marine food web, widespread in the Southern Ocean and any stress affecting its presence and abundance, such as NPs, could have dramatic consequences on the Antarctic marine ecosystems. These experiments represent a first contribution to determine the potential impact of NPs to the Antarctic krill in terms of lethal and sub-lethal effects. On board JCR vessel, krill *E. superba* juveniles were collected by RMT8/RMT25/Bongo nets and immediately moved to the cold room (at +4°C) in buckets filled with 0.22 µm filtered seawater. After 12 – 24 h acclimation period, krill juveniles of similar size were selected for short-term exposures (48 h) to 2.5 µg/mL NPs. Experiments were carried out under static conditions at constant temperature of +2°C in 1 L HDPE bottles containing NP suspensions prepared in 0.22 µm filtered seawater. Control and experimental groups (2.5 µg/mL PS-COOH, 2.5 µg/mL PS-NH_2) were run in triplicate and, in addiction, one bottle containing only 0.22 µm filtered seawater without organisms was considered as reference for microbiology analysis. The experiment was successfully repeated three times during the cruise (krill-exp-1, krill-exp-2, krill-exp-3, as reported in Table 1), using krill juveniles from three different locations. Animal behaviour, molting and mortality rate were monitored at 24 and 48 h. At the end of the exposure (at 48 h), replicates were merged and specimens collected for genetic (n = 9, stored in RNA Later at -80°C) and microscopy (n = 3, preserved in ethanol at room temperature) analyses. Moreover, any molts, dead organisms and faecal pellets (FPs) produced by krill juveniles during the incubation were collected and preserved in ethanol at room temperature for further analysis. In order to characterise the bacteria associated to the NP exposure, after the experiments, the seawater from each experimental group was filtered at 0.22 µm using a vacuum pump filtration system and filters (in duplicate) stored at +4°C and -20°C for enzymatic and molecular biology analyses respectively. Samples of surface waters and further depths (through CTD, event 87) corresponding to the sampling of organisms for the experiments were filtered as well for microbiology analyses.

13.2.2 Copepods

The main goal of these experiments was to evaluate the impact of polystyrene nanoplastics to the Antarctic copepod (*Rhincalanus antarcticus*), representative of zooplanktonic species commonly found in the Southern Ocean, which have been identified as potential target organisms for the NPs distributed along the water column. On board, copepods *R. antarcticus* were collected by RMT8/Mocness/Bongo nets and acclimatised in the cold room in glass bechers with 0.22 µm filtered seawater. After 12 – 24 h acclimation period, short-term ecotoxicity tests (48 h) were performed, following the protocol used for Antarctic krill incubation (see paragraph 2.1). Three experiments were performed (cop-exp-1, cop-exp-2, cop-exp-3, as shown in Table 1), maintaining the organisms at constant temperature of +2°C in 50 mL plastic flasks containing NP suspensions prepared in 0.22 µm filtered seawater. Control and experimental groups (5 – 10 µg/mL fluorescent PS-COOH, 0.5 – 1 – 2.5 – 5 – 10 µg/mL PS-NH_2) were run in triplicate. The mortality rate was monitored at 24 and 48 h and at the end of the exposure, specimens were preserved in ethanol for microscopy analysis (n = 9 – 15). Moreover, the FPs produced by copepods during the incubation were maintained in ethanol for further analysis.

13.2.3 Faecal pellet experiment

The Southern Ocean accounts for almost 20% of the global ocean CO_2 uptake, principally due to CO_2 fixation by phytoplankton and successive downward particle flux of biogenic carbon. The FPs of zooplankton can be important vehicles for the transfer of particulate organic carbon (POC) to the deep ocean, often making large contributions to carbon export and sequestration. Within the Southern Ocean, the Scotia Sea region has been estimated to have the largest seasonal uptake of atmospheric carbon dioxide yet measured in the Southern Ocean. Here, faeces of zooplankton can contribute up to 96% of the organic carbon flux when episodic events such as the presence of krill swarm increase the efficiency of the biological carbon pump by the production of a "rain" of fast sinking FPs, which overloads the remineralisation process in the mesopelagic layer. Then, to investigate how the anthropogenic stressors can affect the FP production and their ability to drive carbon to the deep ocean is an important issue. On board, we performed three FP degradation experiments (FP-exp-1, FP-exp-2, FP-exp-3) (Table 1), where faeces were incubated with environmental-like concentrations of negative and positive NPs. FPs were produced from juveniles of Antarctic krill *E. superba* incubated at ambient condition in the cold room. *E. superba* juveniles were collected by RMT8/RMT25/Bongo nets and immediately moved to +4°C in a bucket filled with 0.22 µm filtered seawater. After 6 – 12 h, FPs were removed from the bucket and incubated in MW24 plates containing NP suspensions in unfiltered seawater in order to investigate the effects of this stressor on the FP degradation processes (damage of peritrophic membrane, change in carbon/nitrogen ratio content, bacterial concentration) considering the whole bacterial community present in the Antarctic seawater. Control and experimental groups (fluorescent PS-COOH, unlabelled PS-NH_2) were run in duplicate, considering increasing NP concentrations, as $2{\cdot}10^{10}$, $8{\cdot}10^{10}$ and $14{\cdot}10^{10}$ NPs/mL for FP-exp-1, FP-exp-2 and FP-exp-3 respectively. To assess the variability of the remineralisation process during time, a certain number of FPs from each treatment was collected each 3 days after the start of the experiment up to 12 days and stored in ethanol for further analysis. At the beginning of each experiment, we measured and took pictures of all the incubated FPs by using light microscope equipped with a camera.

In addition, FPs from krill and copepods experiments (Table 1, see paragraph 2.1 and 2.2 for the experimental design) were collected at the end of each exposure and preserved in ethanol at room temperature. This will allow us to investigate the combined impact of NPs on FP production and degradation.

13.3 OA and NP synergistic experiments

13.3.1 Pteropods

To assess the impact of OA, NPs and the synergy of both stressors, two incubation experiments were performed on adult of *Limacina helicina* (pt-exp-2) and juveniles of *Limacina retroversa* (pt-exp-3). The already recognised sensitivity of pteropods to the synergy of OA with other anthropogenic stressor (i.e Ocean Warming, Freshening and Low Oxygen) makes this organism a perfect multistressors target species. Pteropods were collected by Bongo/Mocness nets and left to acclimatise for 24 h. Both incubation experiments were run in triplicate for 48 h within 0.22 µm filtered seawater, maintaining the organisms at constant temperature of +2°C. The quantities of HCl and $NaHCO_3$ required achieving target pCO_2 conditions of 1000 ppm were calculated using the relationship between these parameters and DIC and TA within this region established on JR274. Both fluorescent PS-COOH and PS-NH_2 suspensions were freshly prepared in 0.22 µm filtered seawater at 2.5 and 1 µg/mL for pt-exp-2 and pt-exp-3 respectively. During the experiments, carbonate chemistry parameters as well as organism conditions were monitored as for pt-exp-1 (see paragraph 1.1). At the end of experiments, organisms were collected form the incubation bottles and preserved as for pt-exp-1 (see paragraph 1.1).

13.4 Other OA related investigations

13.4.1 Pteropod adaptive potential to climate change

Research pteropods has manly focused on the ecological responses to the climate change, and very little is known about the evolutionary potential of pteropods and their capacity to adapt to changing ocean conditions. Theoretical considerations suggest that pteropods should have very high capacity for evolutionary adaptation due to large population size, high standing genetic diversity, and short generation times. During the cruise, all the pteropod identified species (included shelled and not shelled ones) where collected from Bongo, Mocness and RMT catches where available and preserved in RnaLater and ethanol to -80°C for further study on genetic, phenotypic and bio-geography to provide insight into the adaptive potential of this marine organism. This study will be in collaboration with Naturalis in Netherland.

13.4.2 Coccolithophore abundance and distribution

To assess the relevance of phytoplankton vs. zooplankton calcifying we also investigated the coccolithophores, a group of calcifying single-celled phytoplankton. Concerning their sensitivity to OA, in spite of the large number of studies investigating coccolithophore physiological responses to ocean acidification, uncertainties still remain due to variable and partly contradictory results. During the cruise, coccolithophore were collected by using Niskin bottles (Tab. 2) at 3 different depths (Chl max, below and above the Chl max) and filtered on 0.45 µm polycarbonate filters using a vacuum pump filtration system. The amount of water filtered changed according to the level of phytoplankton in the water column (estimate by fluorescence sensors deployed on the CTD cast). Samples were then stored at -80°C for further analyses (species identification, abundance, distribution, calcite valve morphology) to be related to the Carbonate chemistry of the water column. This project will be in collaboration with University Autonoma di Barcelona in Spain.

13.4.3 CTD sampling for carbonate chemistry

Water samples for Total Alkalinity (TA), Total Dissolved Inorganic Carbon (DIC) analysis were collected at different depths from the specific stations by CTD cast in order to determine the carbonate chemistry of the water column and to characterise the shallower depth of the aragonite lysocline (Tab. 2). Results will help to understand the natural level of carbonate chemistry exposure of collected calcifying organisms in the field. Samples were collected in borosilicate bottles and fixed with $HgCl_2$ to be analysed post cruise. Carbonate saturation states (Ω) will be indirectly calculated from TA and DIC data using the CO2SYS software.

13.5 Acknowledgement

Nanoplastic experiments were performed in the framework of projects funded by the Italian National Antarctic Program (PNRA): *Plastics in the Antarctic Envrionment* PLANET Project (PNRA 14_00090) and *Nano-Polymers in the Antarctic Marine Environment and Biota* NANOPANTA Project (PNRA 16_00075), in collaboration with the British Antarctic Survey (Cambridge, UK), which also provided logistical support during the expedition.

Experiment	Species	Ev.	Latitude Longitude	Date	Treatment	Duration	n individual / replicate	n replicates
pt-exp-1	*L. helicina Antarctica* adults	102	-55.32925 -41.27066	31/12/2016	OA + C Enrich	7 d	5	3
pt-exp 2	*L. helicina Antarctica* adults	104 - 109	-55.26257 -41.20481	31/12/2016	NPs + OA	2 d	3	3
pt-exp-3	*L. retroversa* juveniles	166	-53.30617 -52.2058	06/01/2017	NPs + OA	2 d	12	3
krill-exp-1	*E. superba* juveniles	41	-53.86399 -39.14766	21/12/2016	NPs	2 d	3	3
krill-exp -2	*E. superba* juveniles	57	-53.78526 -38.58322	23/12/2016	NPs	2 d	5	3
krill-exp- 3	*E. superba* juveniles	147	-53.96164 -49.23892	05/01/2017	NPs	2 d	5	3
cop-exp- 1	*R. antarcticus* adults	38	-53.49268 -39.25104	20/12/2016	NPs	2 d	3	3
cop-exp- 2	*R. antarcticus* adults	59	-53.78494 -38.59711	23/12/2016	NPs	2 d	3	3
cop-exp-3	*R. antarcticus* adults	89	-52.81994 -40.1794	29/12/2016	NPs	2 d	4	3
FP-exp-1	*E. superba*	41	-53.86399 -39.14766	21/12/2016	NPs	9 d	variable	2
FP-exp-2	*E. superba*	58	-53.78734 -38.58559	23/12/2016	NPs	9 d	variable	2
FP-exp-3	*E. superba*	147	-53.96164 -49.23892	05/01/2017	NPs	12 d	variable	2

Table 24 Details of the Nanoplastics (NPs) and OA + C Enrich experiments performed during the cruise with different model organisms: pteropods (L. helicina antarctica, L. retroversa), Antarctic krill (E. superba) and copepods (R. antarcticus)

CTD ev.	Station	Date	Lat-Long	TA-DIC	Coccolitophore
21	P3	-52.817	-40.13233	10 depths up 2000 m	3 depths up 90m
94	P2	-55.2444	-41.27401	10 depths up 2000 m	3 depths up 90m
134	PF	-54.538	-45.09371	8 depths up 1000 m	3 depths up 90m
136	PF	-54.5179	-46.22357	8 depths up 1000 m	3 depths up 90m
150	PF	-53.9049	-49.27398	8 depths up 1000 m	3 depths up 90m
170	PF	-53.2943	-52.18519	8 depths up 1000 m	3 depths up 90m

Table 25 Carbonate chemistry (Ta and DIC) and Coccolitophores samples collected by Niskin bottles on the CTD cast.

Figure 39 Photographs of laboratory work

Figure 40 Target marine zooplankton species selected for the OA and NP experiments during the JR16003 cruise: from left, pteropod Limacina retroversa, krill Euphausia superba, copepod Rhincalanus antarcticus.

14 Trace Metals in Antarctic Marine Food-webs – influence of biological and environmental factors

José Seco, José Xavier, Geraint Tarling, Ryan Saunders, Gabi Stowasser, Sophie Fielding

14.1 Introduction

The Antarctic region is 10% of the planet and has been recognized as playing a key role in numerous important processes such as in climate, ocean currents and marine primary productivity (Kennicutt et al. 2014; Constable et al. 2014). Although considered one of the most remote areas in the planet, it has been impacted by local and global anthropogenic activities; Over the last half century global pollution, including trace metals (e.g. mercury, copper, nickel, lead, zinc, and cadmium) have been found in this "pristine" region (Bargali, 2008). There is still is no baseline data on trace metals for some key regions of the Southern Ocean. Moreover, there is a major lack of knowledge on how and where (in which tissues) these marine species accumulate these metals. Our goal on cruise JR16003 was to assess trace metals in the Antarctic marine ecosystem around South Georgia and at the Antarctic Polar Front, complementing samples collected in JR15004 last year around South Orkneys. This cruise, coordinated by Sophie Fielding, allowed the collection of particulate organic matter (POM) and a wide range of zooplanktonic and nektonic organisms around South Georgia (in the Western Core Box region) and across the Antarctic Polar Front from a variety of nets (RMT8, RMT25, MOCNESS). Also, land-based field parties on Bird Island, South Georgia collected samples from predators (albatrosses and petrels).

14.2 Objectives

The main aim of this report is to succinctly inform about the work carried out during the research cruise JR16003. The project was focused in collecting samples of species from the bottom to the top of the marine trophic web around South Georgia and across the Antarctic Polar Front for subsequent analyses in the Portuguese lab. of the trace metals present. After analysis, these results will be compared with the trace metals found in the samples collected a year ago in a cruise around South Orkneys Islands (JR15004: January-February 2016). This will enable evaluation of trace metal concentrations in 3 different ecosystems in the Scotia Sea (South Orkneys [Typical Antarctic waters with influence of ice], South Georgia [Typical Antarctic waters but with less influence of ice] and the Antarctic Polar Front [Transition to sub Antarctic water]).

14.3 Material and methods

Sampling

Samples for trace metals analyses from different taxa were collected on the RRS *James Clark Ross* between December 2016 and January 2017 during cruise JR16003 (Tables 1-4). These included collections of particulate organic matter (POM), herbivorous/omnivorous zooplankton, fish, squid samples. Correspondingly, samples (feathers) were collected from different predators (Albatrosses and petrels) at Bird Island, South Georgia.

POM was vacuum-filtered onto glass fibre filters (GF/F Whatman, 47mm) using 5L of seawater collected from Niskin bottles deployed on a CTD rosette fired at the Chlorophyll a maximum (30 to 76m) and at 500m. The chosen depth were in order to compare the highest values of POM with lower values below euphotic zone.

Planktonic species were caught from the water column using a RMT8 (Retangular Midwater Trawl; mouth opening: 8m^2; mesh size: 4.5-2.5 mm), a RMT25 m2 (25 m2; mesh size: 8-4.5 mm) and a MOCNESS multi-net (mesh size: 300 um). All of these nets have open/close nets that are remotely opened and closed at different depths and were equipped with a flow meter, temperature and salinity sensors. The RMT8 was used at the Western Core Box region to target particularly Antarctic krill (*Euphausia superba)* swarms and others layers of interest identified (e.g. fish layers) identified

by the sonar system (i.e. EK60/EK80/EK120). The RMT 25 was deployed in an non-targeted manner in a depth discrete manner between 0 and 1000 m (1000 – 750 m, 750 – 400 m, 400 – 200 m, 200 – 5 m) to sample principally mesopelagic fish, squid and macrozooplankton communities. All the fishing with both RMT nets occurred during the nighttime. The MOCNESS was deployed during the day, or close to sunset, in a non-targetted stratified manner to sample of zooplankton between 1000m and the surface.

After the nets were collected, the whole catch was weighed (in g), then groups were sorted by taxa then weighed again (with certain taxa, where possible, measured for Standard Length (for fish), Mantle Length (for squid) and Total length (for Antarctic krill/zooplankton taxa)). When the sample was too large to quantify directly (mainly from large E. superba catches), a sub-sample with no less than 10% of the total weight was counted and measured. Macrozooplankton were identified on board using taxonomic keys (Boltovskoy, 1999) and measured (from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest mm) following Morris et al. (1988). Fish and squid species were mainly captured using the RMT 25, with exception of one *Electrona antarctica* found in the RMT 8 and *Bathyteuthis abyssicola*, *Galiteuthis glacialis* and *Psychroteuthis glacialis* in the MOCNESS. The nekton was also identified on board using references guides (Nesis 1987; Hulley, 1990; Boltovskoy, 1999; Xavier and Cherel 2009) and measured. Taxa were sexed if possible. All the samples were frozen whole at -20 ºC (fish) or -80 ºC (POM and squid) for subsequent analyses.

14.4 Preliminary results

A total of 22 different taxa were collected from all the stations and 70 litres of water from 7 different stations were filtered (table 1). Zooplankton collections comprised 9 species of which 5 were euphausiid species (table 2). A total of 6 species of myctophid fish (table 3) were caught in sufficient numbers to be preserved for trace metals studies. 5 species of cephalopods (table 4) with 4 individual squid and 1 octopod that could not be identified. Overall, most of the planned collections were obtained. However, due to the small body size of the *Euphausia superba* caught, it was not possible to get more female and male adults for comparison with the samples from the previous cruise JR15004. On the other hand, we were able to obtain more species and numbers of myctophid fish and squid in this survey.

Samples	Location	Event	Gear	N	Freezer
POM Chl Max	South Georgia	036	CTD	1	-80
POM 500m	South Georgia	036	CTD	1	-80
POM Chl Max	South Georgia	073	CTD	1	-80
POM 500m	South Georgia	073	CTD	1	-80
POM Chl Max	P3	074	CTD	1	-80
POM 500m	P3	074	CTD	1	-80
POM Chl Max	P2	094	CTD	1	-80
POM 500m	P2	094	CTD	1	-80
POM Chl Max	APF2	134	CTD	1	-80
POM 500m	APF2	134	CTD	1	-80
POM Chl Max	APF4	150	CTD	1	-80
POM 500m	APF4	150	CTD	1	-80
POM Chl Max	APF6	170	CTD	1	-80
POM 500m	APF6	170	CTD	1	-80

Table 26 Summary of POM samples, each sample was filtered from 5 litres of water.

Species	Location	Event	n	Freezer
Euphausia frigida	South Georgia	39	10	-20
Euphausia frigida	P3	95	20	-20
Euphausia frigida	P2	98	40	-20
Euphausia frigida	APF2	126	38	-20
Euphausia frigida	APF4	143	20	-20
Euphausia spinifera	APF6	164	30	-20
Euphausia superba (F)	South Georgia	043	32	-20
Euphausia superba (M)	South Georgia	042	35	-20
Euphausia superba (S)	South Georgia	040	35	-20
Euphausia superba (S)	South Georgia	051	35	-20
Euphausia superba (S)	APF4	147	25	-20
Euphausia triacantha	South Georgia	039	20	-20
Euphausia triacantha	South Georgia	086	40	-20
Euphausia triacantha	South Georgia	089	10	-20
Euphausia triacantha	APF2	126	3	-20
Euphausia triacantha	APF2	30	20	-20
Euphausia triacantha	APF4	146	15	-20
Euphausia triacantha	APF4	147	20	-20
Euphausia triacantha	APF6	163	16	-20
Euphausia vallentini	APF6	159	20	-20
Euphausia vallentini	APF6	163	30	-20
Gigantocypris sp.	P3	112	10	-20
Gigantocypris sp.	APF2	130	30	-20
Gigantocypris sp.	APF4	146	4	-20
Gigantocypris sp.	APF6	163	9	-20
Parandania boecki	South Georgia	89	10	-20
Parandania boecki	South Georgia	95	10	-20
Parandania boecki	P3	112	9	-20
Parandania boecki	APF2	130	2	-20
Parandania boecki	APF4	143	11	-20
Parandania boecki	APF4	146	20	-20
Parandania boecki	APF6	159	5	-20
Themisto quadichaudii	South Georgia	86	40	-20
Themisto gaudichaudii	South Georgia	89	45	-20
Themisto gaudichaudii	South Georgia	95	15	-20
Themisto gaudichaudii	APF2	126	50	-20
Themisto gaudichaudii	APF4	143	20	-20
Themisto gaudichaudii	APF4	147	10	-20
Themisto gaudichaudii	APF6	159	20	-20
Thysanoessa spp.	South Georgia	039	20	-20
Thysanoessa spp.	South Georgia	059	60	-20

Thysanoessa spp.	APF2	126	40	-20
Thysanoessa spp.	APF4	143	20	-20
Thysanoessa spp.	APF6	159	20	-20

Table 27 Summary of macrozooplankton caught in both nets and preserved for trace metals analysis, at different sampling areas (F – Females; M – Males; S – Sub-Adults).

Species	Location	Event	n	Sex	Freezer
Electrona Antarctica	South Georgia	039	3	1M + 2F	-20
Electrona Antarctica	P2	113	7	2M + 1F + 4J	-20
Electrona Antarctica	APF2	129	3	2M + 1F	-20
Electrona Antarctica	APF4	146	1	1M	-20
Gymnoscopelus braueri	South Georgia	039	1	U	-20
Gymnoscopelus braueri	South Georgia	086	1	U	-20
Gymnoscopelus braueri	P2	112	7	U	-20
Gymnoscopelus braueri	P2	113	16	U	-20
Gymnoscopelus braueri	APF2	129	16	U	-20
Gymnoscopelus fraseri	South Georgia	039	1	U	-20
Gymnoscopelus fraseri	APF2	129	7	U	-20
Gymnoscopelus nicholsi	South Georgia	39	2	U	-20
Gymnoscopelus nicholsi	P2	113	1	U	-20
Gymnoscopelus nicholsi	APF2	129	6	U	-20
Kreffichthys anderssoni	P2	112	6	1U + 2M + 3F	-20
Kreffichthys anderssoni	APF2	129	11	3M + 8F	-20
Kreffichthys anderssoni	APF4	146	7	1U + 2M + 4F	-20
Kreffichthys anderssoni	APF4	147	7	7M	-20
Protomyctophum bolini	South Georgia	098	1	U	-20
Protomyctophum bolini	P2	112	10	1U + 6M + 1F + 2J	-20
Protomyctophum bolini	P2	113	11	3M + 3F + 5J	-20
Protomyctophum bolini	APF2	129	30	10M + 10F + 10J	-20

Table 28 Summary of myctophid fish caught and preserved for trace metals analysis, at different sampling areas (M – Males; F – Females; U – Unknown).

Species	Location	Event	n	Freezer
Bathyteuthis abyssicola	South Georgia	089	1	-80
Bathyteuthis abyssicola	P2	112	1	-80
Bathyteuthis abyssicola	APF2	130	1	-80
Galiteuthis glacialis	South Georgia	089	2	-80

Galiteuthis glacialis	P2	112	2	-80
Galiteuthis glacialis	P2	113	5	-80
Galiteuthis glacialis	APF2	126	1	-80
Galiteuthis glacialis	APF2	129	1	-80
Galiteuthis glacialis	APF2	130	2	-80
Galiteuthis glacialis	APF4	147	1	-80
Galiteuthis glacialis	APF6	164	1	-80
Histioteuhtis eltaninae	P2	112	1	-80
Histioteuhtis eltaninae	APF2	129	1	-80
Psychroteuthis glacialis	South Georgia	89	1	-80
Psychroteuthis glacialis	South Georgia	95	1	-80
Psychroteuthis glacialis	APF2	126	1	-80
Psychroteuthis glacialis	APF2	130	1	-80
Slozarczykovia circumantarctica	P2	112	1	-80
Slozarczykovia circumantarctica	APF2	129	3	-80
Slozarczykovia circumantarctica	APF4	147	1	-80
Slozarczykovia circumantarctica	APF6	164	5	-80
Psychroteuthis glacialis	APF2	126	1	-80
Unknown Octopus	APF4	147	1	-80
Unknown Squid	APF4	147	1	-80
Unknown Squid	APF6	159	1	-80
Unknown Squid	APF6	164	2	-80

Table 29 Summary of cephalopods (squid and octopod) caught and preserved for trace metals analysis, at different sampling areas. This information is also in the report section of "Antarctic Polar Front fish, squid and macrozooplankton studies".

14.5 Future work

All the frozen samples will be sorted and desiccated at the laboratory in the British Antarctic Survey, as soon as the samples arrive in Cambridge (most likely from May/June). After this, they will be transported to the University of Aveiro (Portugal), for subsequent trace metal analysis: priority will be for Mercury analyses with other trace metals being analysed where sample mass is sufficient (As, Cd, Co, Cr, Cu, Fe, Hg, Ni, Pb, Se, V, Zn).

15 The historical demography of Salpa thompsoni as a response for previous climate change episodes

Angelika Slomska, Clara Manno, Geraint Tarling

15.1 Introduction

The Southern Ocean plays a major role in the global oceanic circulation. The current environmental climate change causes Southern shifts of the frontal zones, existing habitats, and disturb the functioning of the whole food web. Numerous studies show that as a result of ocean warming, Antarctic salps significant increases in the number (Figure 41). It has been suggested that the southward expansion of *S. thompsoni* may be coupled with a dramatic fall in the stock of

Antarctic krill (*Euphausia superba*) due to a decrease in the spatial extent of its biotope. The escalation of this process may destabilize the Antarctic food web to a considerable degree (McClintok et al. 2008; Alcaraz *et al*. 2014) since the salps low nutritional valueis not sufficient to fulfil energetic requirements of higher trophic levels (Dubishar *et al.* 2006; Dubishar *et al.* 2012). It is thus essential to understand the population dynamics of salps, particularly in regard to climate variability.

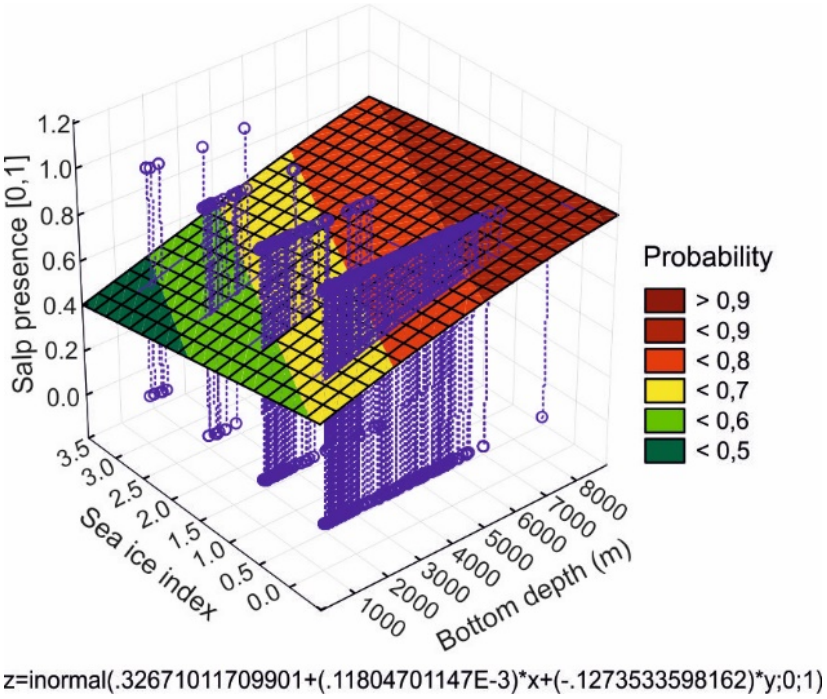


Figure 41 Linear regression model shows S.thompsoni occurrence probability with presence of such environmental factors like: degree of ice cover (0-3), sea surface temperature ([-2] -4 ° C); salp presence probability presented in the zero-one system, where 1 is the highest and 0 is the lowest chance for salp (Panasiuk et al. – unpublished data).

15.2 Research project objectives

The main aim of proposed project is infer the historical demography of *Salpa thompsoni* from Atlantic Sector of the Southern Ocean over a 1000 to 100 000 year timescale, to discover how *Salpa thompsoni* populations responded to previous episodes of climate change. The data required for this work will be generated using state-of-the-art DNA sequencing methods, and it will be analyzed using the most advanced coalescence based methods for the inference of population size over time. The demographic trajectory obtained for salps will be compared with previously published inferences of historical environmental parameters to assess their impact on salp population dynamics. The salp trajectory will also be compared with published estimates of demographic change obtained for other Antarctic species (e.g. Antarctic krill *Euphausia superba*) to explore how different components of the Antarctic marine ecosystem may have responded to the same environmental cues.

An additional objective of this project is to investigate the influence of environmental factors on changes in abundance, distribution, and reproduction rate of S. thompsoni, and to tie in the findings with results from the demographic analysis to better project future changes in the population of this key plankton species.

15.3 Research methodology

Zooplankton sampling

Salps were collected from the water column using manly RMT 8, RMT25 (Figure 42) as well as MOCNESS net. These equipments present a mechanisms which allow to open and close the nets at different depths. Salps samples were split according to different purposes: for morphological and population analyses they had been preserved in 4% formaldehyde, while the samples for molecular analyses had been preserved in 95% ethanol.

Additionally, salps chain was collected (using Bongo net) for the investigation of salps life cycle and faecal pellet production.

Figure 42 Biological material sampling (by RMT 25) and sorting

The study of the development of *Salpa thompsoni* will be conducted following the guidelines of Foxton (1966) and Daponte et al. (2001), which included the determination of both size and exact stage of the development of specimens. Up to 100 *S. thompsoni* oozooid samples will be considered for genetic use. They will be identified following the description in Foxton (1966). By reconstructing the demographic trajectory of *S. thompsoni*, it will be possible to place the short term changes in salp numbers observed in ecological studies into a longer term evolutionary context.

15.4 Preliminary results

15.4.1 Salps population

We collect 28 salps samples from different part of Atlantic Sector of the Southern Ocean. To qualitative, morphometric and genetic analyses, both forms (blastozooids and oozooids) of salps were collected

Total number of 19 *S.thompsoni* samples were divided to each reproductive form (blastozooid and oozooid) and preserved separately. Nine samples of salps were preserved for population analyses, including both reproductive form of salps and presumably various salps species (*S. thompsoni, S. fusiformis*), especially on the APF6 station, which was located in the Northern part of Antarctic Polar Front, where different water masses could mix (Table 30). Greatest number of salps (with dominance of blastozooids and small number of oozooids) was observed on the P2 area as well as on the APF2 station (Table 30).

Sample	Date	Station	Event	Net type	Species	Form	Preservation
	20.12.2016	WCB	39	RMT 8	Salpa thompsoni	blastozooid	Ethanol 96%
	20.12.2016	WCB	39	RMT 8	Salpa thompsoni	blastozooid	Formalin 4%
	20.12.2016	WCB	39	RMT 8	Salpa thompsoni	blastozooid	Formalin 4%
	22.1.2016	WCB	59	RMT 8	Salpa	blastozooid	Ethanol 96%

				thompsoni		
31.12.2016	P2	98	Mocness	Salpa thompsoni	blastozooid	Ethanol 96%
31.12.2016	P2	98	Mocness	Salpa thompsoni	oozooid	Ethanol 96%
31.12.2016	P2	98	Mocness	Salpa thompsoni	both	Formalin 4%
31.12.2016	P2	98	Mocness	Salpa thompsoni	both	Formlain 4 %
31.12.2016	P2	112	RMT 25	Salpa thompsoni	blastozooid	Ethanol 96%
31.12.2016	P2	112	RMT 25	Salpa thompsoni	oozooid	Ethanol 96%
31.12.2016	P2	112	RMT 25	Salpa thompsoni	both	Formalin 4%
31.12.2016	P2	112	RMT 25	Salpa thompsoni	both	Formalin 4%
31.12.2016	P2	112	RMT 25	Salpa thompsoni	both	Formalin 4%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	blastozooid	Ethanol 96%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	oozooid	Ethanol 96%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	both	Formalin 4%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	both	Formalin 4%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	both	Formalin 4%
01.01.2017	P2	113	RMT 25	Salpa thompsoni	both	Formalin 4%
02.01.2017	APF2	126	Mocness	Salpa thompsoni	oozooid	Ethanol 96%
02.01.2017	APF2	126	Mocness	Salpa thompsoni	blastozooid	Ethanol 96%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	Oozooid	Ethanol 96%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	blastozooid	Ethanol 96%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	oozooid	Ethanol 96%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	both	Formalin 4%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	both	Formalin 4%
02.01.2017	APF2	129	RMT25	Salpa thompsoni	both	Formalin 4%
03.01.2017	APF2	130	RMT25	Salpa thompsoni	oozooid	Ethanol 96%
03.01.2017	APF2	130	RMT25	Salpa thompsoni	blastozooid	Ethanol 96%
04.01.2017	APF4	143	RMT25	Salpa thompsoni	oozoid	Ethanol 96 %
04.01.2017	APF4	143	RMT25	Salpa thompsoni	blastozooid	Ethanol 96 %
05.01.2017	APF4	147	Different nets	Different species	both	Formalin 4%
05.01.2017	APF6	159-164	RMT25	Different	both	Formalin

				species		4%
05.01.2017	APF6	159-164	Different nets	Salpa thompsoni	oozooid	Ethanol 96 %
05.01.2017	APF6	159-164	Different nets	Salpa thompsoni	blastozooid	Ethanol 96 %

Table 30 Summary of salps caught and preserved

15.4.2 Salps experiment

The production of faecal pellets by salps swarms can have an important trophic impact on the deep-sea ecosystem and a critical role in the vertical flux of organic matter in the ocean because their high sinking velocities and reach organic matter content. However, the main role of salps faecal pellet as important vector for export or recycling of organic matter is still an open debate due to the fragile nature of this faecal pellet.

S. thompsoni were collected alive by Bongo net and immediately incubated a 4C in a bucket (b1) with filtered Seawater to investigate faecal pellet (Fp) production and degradation. Most of incubated *S. thomsponi* blastozooids were living in peculiar association with the Hyperiidae amphipods (**Error! Reference source not found.**c,d), which used salps like a source of transport, shelter from predators as well as main source of their food (**Error! Reference source not found.**c).

The salps were linked together in a chain composed by 6 individuals. Individual salps (not in chain) were also incubated in another bucket (b2) in order to investigate wherever or not the chain can influence the production/quality of the faecal pellet (**Error! Reference source not found.**a). Faecal pellet experiment was daily monitoring for 5 days. Every day Fp produced were, counted, measured and investigate in term of degradation condition by using a light microscope. After microscope investigation, faecal pellet were preserved in buffered ethanol for further analysis of the C/N contents.

Additionally, during our experiment 3 embryos of *S. thompsoni* were observed in bucket (b2) with single sexual individuals (blastozooid), which means that blastozooids were able to release the embryos and continues further reproduction process in unnatural environment (**Error! Reference source not found.**b). Adults blastozooids died after released the embryos into the water, only the free-swimming juvenile oozooids were able to continue further growth and life processes for 4 days.

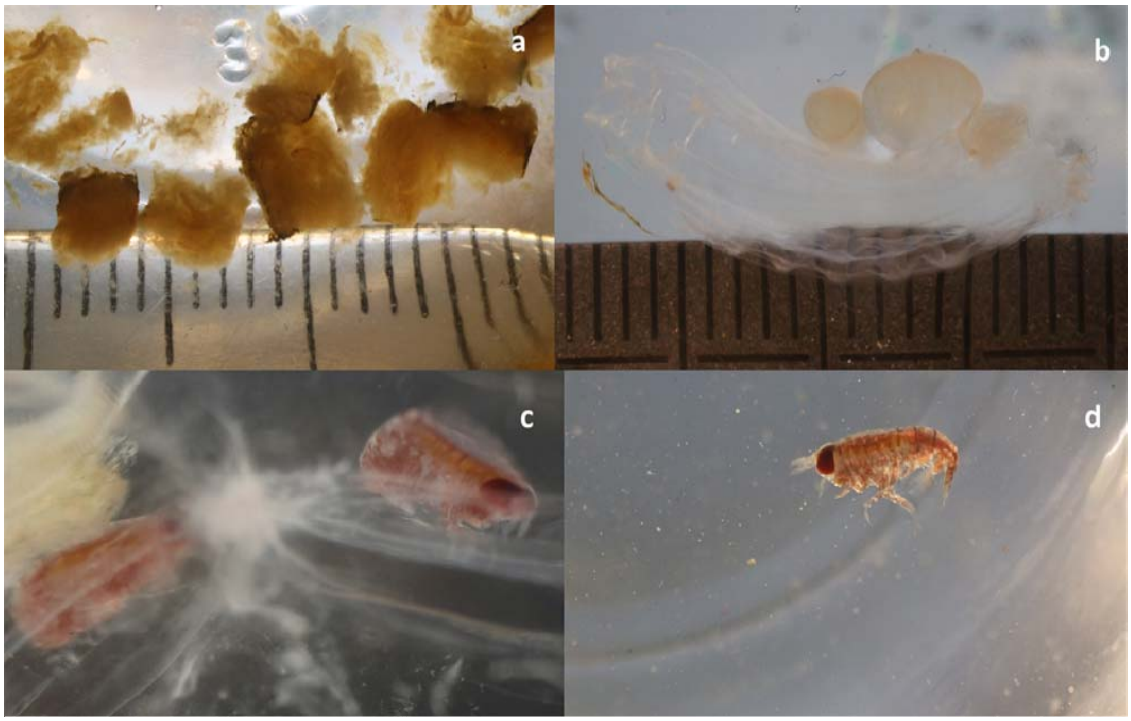


Figure 43 a) salps faecal pellets, b) salps embryos (oozooid) c) amphipods inside salp body, d) free amphipod actively found the way out from salp body.

15.5. Future work

Analyses of samples will be conducted within the frame of the collaboration between British Antarctic Survey and Institute of Oceanography and Geography, University of Gdańsk in Poland. Organisms will be assigned to the lowest possible taxonomic resolution and their life cycle and stage of development will be classified. Also salps frequency and distribution pattern will be evaluated and all results will be compared through the years using multivariate statistical test.

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16 Morphometric analysis of mesopelagic fish fauna

Tracey Dornan

16.1 Introduction

Fish with gas-filled swim bladders produce a stronger acoustic signal than those with lipid filled or fish without swim bladders, due to the higher acoustic impedance difference between sea water and gas. It is known that a number of mesopelagic fish species have gas-filled swim bladders, which either regress or become lipid filled with age. Other species retain gas filled bladders throughout their life history. Tissue density also contributes to the acoustic properties of a given species, particularly those lacking a functional swim bladder. Given the morphological diversity in mesopelagic fish, it is important to identify gas bearing mesopelagic species and the acoustic properties of fish tissue, to quantify natural variability within and among species. Once the intra- and interspecific diversity is known, acoustic characteristics of the Southern Ocean mesopelagic community can be modelled to increase understanding of deep scattering layers.

16.2 Aims

The aim of this study was to quantify morphological properties of mesopelagic fish bodies using digital photography and gather data on tissue density of key species, to facilitate acoustic backscatter modelling and subsequent characterisation of acoustic deep scattering layers.

16.3 Methods

To quantify morphological characteristics digital photography was used to image mesopelagic fish bodies ventrally and dorsally. Fish density was measured using a modified density bottle method (Greenlaw, 1977, Davison, 2011). Fish were primarily sampled from RMT 25 stratified hauls, but were also sampled from MOCNESS, RMT 8 stratified and targeted hauls to include the widest number of species possible in the sample.

16.3.1 Digital photography

Lateral and dorsal body images of mesopelagic fish were obtained to aid in backscatter modelling and morphometric analysis (Figure 44). Measuring boards were numbered and a laminated identifier was placed onto a visible portion of the board with Cruise, Event, Net and Fish ID numbers, corresponding to main lab recording sheets. A measuring board was modified with sponge supports to facilitate dorsal imaging. The resultant images were saved to a hard drive. All fish brought on board were photographed with the exception of ID numbers 40-52.

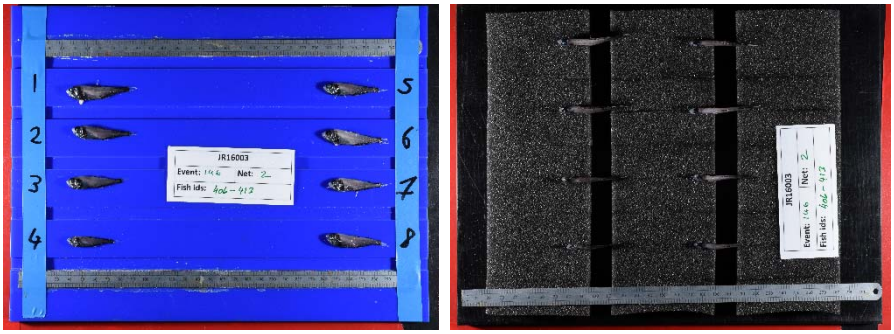

Figure 44 Lateral and dorsal images of mesopelagic fish taken during JR16003.

Digital photography workflow:

- Fish were brought on board, sorted from non-fish species and held on ice (Figure 2).
- Fish were identified to lowest taxonomic level (genus or species).
- Each fish was assigned an individual ID number (numbers 10 -39 were not used), standard length was recorded and fish placed immediately onto a scaled board for imaging working from left side top to bottom then right side (see Figure 45).
- Lateral and dorsal digital photographs were taken once a board was full; or partially full at the end of a net sample or group of a species.
- Fish were immediately transferred to individual plastic zip lock bags and weighed in groups (weight of sample minus bag weight was recorded in lab sheet).
- A sub sample were held in individual sealed zip lock bags on ice/in the ships cold room (temp 4°C) until density measurement was recorded, others were transferred to -20°C freezer for future studies.

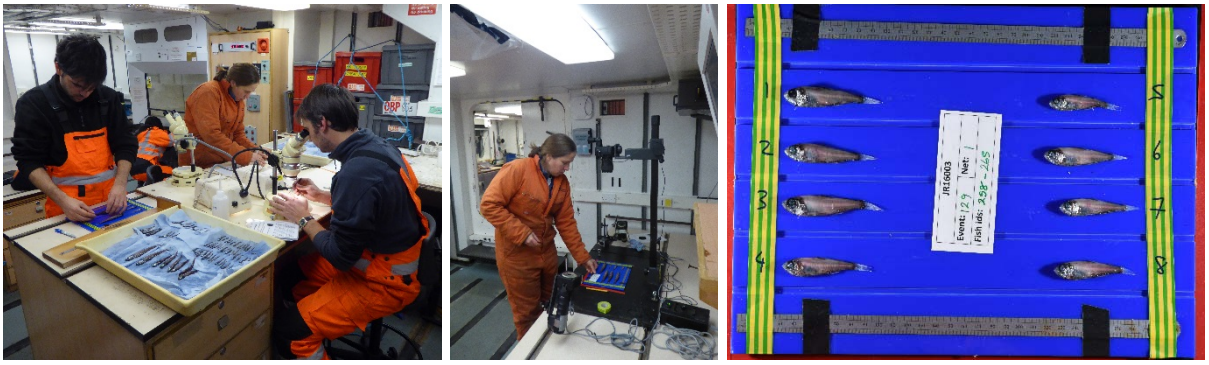

Figure 45 Laboratory setup and photograph

Fish were sorted from non-fish species and held on ice awaiting identification and measurement of standard length. As soon as length was recorded fish were placed immediately on a scaled board and lateral and dorsal photographs taken. Animals were then transferred to individually numbered zip lock bags and returned to ice.

16.3.2 Density measurements

To assess density of mesopelagic fishes using a density bottle method, 27 solutions covering a specific gravity (S.G.) range of 1.0250 to 1.0900 in 0.0025 increments were prepared by making up solutions of filtered sea water and glycerol at room temperature (~19°C). To prepare the glycerol sea water solutions (GSW), ~50 litres of sea water was filtered into plastic carbuoys from the ships underway system using a peristaltic pump fitted with a 0.22micron filter to remove biological material on 12.12.2016. All carbuoys were rinsed in filtered sea water prior to collection. On completion of filtering a salinity of 33.615 psu was recorded from the ships underway system, which was used to calculate the sea water density at room temperature. As hydrometers were adjusted by manufacturer at 15.6°C, glycerol and filtered sea water were stored in the Bio-Lab to equilibrate for 2 days 7hrs to room temperature prior to mixing.

Glycerol is highly viscous and lab trials at BAS (Cambridge) revealed the need to dilute the glycerol prior to measuring and mixing to minimise glycerol clinging to the inside of measuring equipment. An initial 30% glycerol 70% filtered sea water solution was made in three 5 litre Jerri cans to render it easier to work with. 1500ml of glycerol was measured using plastic measuring cylinders directly into clean Jerri cans, the same cylinders were rinsed with 3500ml of pre-measured filtered sea water. Measuring equipment was dried using lab roll between batches. The resulting liquid was shaken, left

for two hours to allow air bubbles to settle out and then gently overturned again to ensure even mixing. These were then left for a further two hours to settle out at room temperature.

An initial batch of GSW solutions, with target specific gravities of 1.0250, 1.0275, 1.0300, 1.0325 and 1.0350, were made up in 2 litre Kilner jars by mixing proportions of sea water and the 30:70 GSW based on calculated density. However, on testing with a hydrometer these sequentially had a higher specific gravity (S.G.) readings than would have been expected by mixing calculated proportions of sea water and glycerol. The S.G. of the 30:70 glycerol sea water solutions was tested using a hydrometer by transferring samples into clean 2 litre Kilner jars. Whilst care had been taken to mix the 30:70 solution proportions as accurately as possible the resultant solutions had different S.G. readings using the same hydrometer (values not recorded as beyond the scale of the hydrometer). To remedy this discrepancy all 30:70 GSW solutions were diluted with filtered sea water (resulting in four 5 litre batches of GSW) and hydrometers alone were used from this point forward to measure S.G. of all solutions. Two Brannan hydrometers, H1 (S.G. range 1.000-1.050) and H3 (S.G. range 1.050-1.100), were used to mix final density solutions ranging from 1.0250 to 1.0900 in 0.0025 increments at room temperature. An additional jar of filtered sea water completed the range.

These final solutions were transferred to the cold room (~4°C) to equilibrate on 17.12.2016 at 18:30GMT (Figure 46a). S.G. readings at cold room temperature were recorded 20.12.2016 at 15:41GMT (Table 31). Cold room S.G. was used as reference reading throughout. H1 and H3 were used throughout to check for changes to cold room S.G. and make minor adjustments to the solutions once in the middle of the experiment.

Solution ID	**Target S.G.**	**S.G. at room temp**	**S.G. at cold room temp**	**Comments**
1	1.0250	1.0250	1.0265	H1
2	1.0275	1.0275	1.0295	H1
3	1.0300	1.0300	1.0330	H1
4	1.0325	1.0325	1.0360	H1
5	1.0350	1.0350	1.0375	H1
6	1.0375	1.0375	1.0380	H1
7	1.0400	1.0400	1.0415	H1
8	1.0425	1.0425	1.0430	H1
9	1.0450	1.0450	1.0470	H1
10	1.0475	1.0475	1.0490	H1
11	1.0500	1.0500	1.0520	H1 (H3 reads (1.0535))
12	1.0525	1.0525	1.0560	H3
13	1.0550	1.0550	1.0580	H3
14	1.0575	1.0575	1.0610	H3
15	1.0600	1.0600	1.0630	H3
16	1.0625	1.0625	1.0660	H3
17	1.0650	1.0650	1.0675	H3
18	1.0675	1.0675	1.0705	H3
19	1.0700	1.0700	1.0735	H3
20	1.0725	1.0725	1.0765	H3
21	1.0750	1.0750	1.0775	H3
22	1.0775	1.0775	1.0810	H3
23	1.0800	1.0800	1.0825	H3
24	1.0825	1.0825	1.0850	H3

25	1.0850	1.0850	1.0885	H3
26	1.0875	1.0875	1.0905	H3
27	1.0900	1.0905	1.0950	H3
Sea water	1.0235	1.0235	1.0250	H1

Table 31 Specific gravity reading changes between Bio-lab and cold room temperatures recorded at start of experiment.

Fish known to have swim bladders were dissected before density measurement to remove gas (Figure 46b), those known to have no functional swim bladder were left whole throughout with the exception of a *Gymnoscopelus braueri* and *G. fraseri*, which were dissected post-density measure for verification.

Density bottle method workflow was organised as follows:

- On completion of digital photography fish were stored on ice in 4°C cold room in individual numbered zip lock bags.
- Fish known to have swim bladders were taken individually to the main lab for dissection (Figure 46b), swim bladder dimensions were noted unless rupturing rendered this impractical. When possible dissection was filmed to record release of any gas from swim bladder for measurement at a later date.
- On completion of dissection fish were immediately transferred back to the cold room for density measurements.
- Individual fish were placed in a beaker of filtered sea water held at cold room temperature to rinse and equilibrate.
- Fish were removed from sea water, blotted to remove excess water and placed into glycerol sea water solutions sequentially (low to high S.G.) to ascertain point of neutral buoyancy and/or solutions between which samples sank or floated (Figure 46c). Depending on the rate of descent of an individual and from experience some solutions were missed out of sequence to minimise contact with solutions and potential water loss from fish tissue as a result of osmotic pressure.
- Fish were returned to sea water for rinsing and reblotted between solutions. Care was taken to ensure that gas bubbles were removed from surface and body cavities of fish in solutions.
- On completion fish were given a final rinse in sea water, blotted, sealed in ziplock bags and stored in -20°C freezer for transportation to BAS Cambridge.

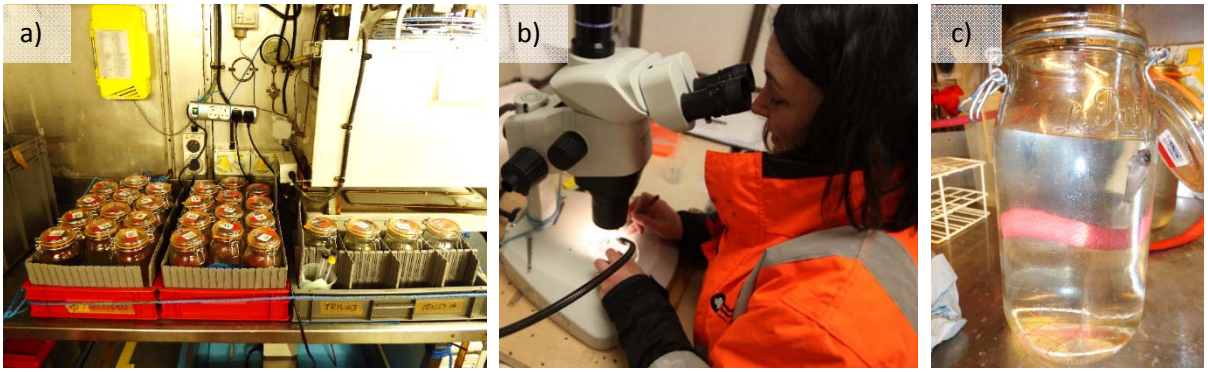

Figure 46 a) Density bottle method set up in JCR cold room (temperature set to 4°C). Each jar contains a sea water glycerol mix, 27 solutions cover S.G. range of 1.0250 to 1.0900 in 0.0025 increments, plus one jar of original filtered sea water. b) Fish were dissected to remove gas from swim bladder. c) Fish were suspended in solutions until they either demonstrated neutral buoyancy or the mean was taken of the last solution the fish sank and the first it floated in.

Species	**Number**

Bathylagus sp.	12
Cyclothone sp.	8
Electrona antarctica	6
Electrona carlsbergi	7
Gymnoscopelus braueri	19
Gymnoscopelus fraseri	3
Krefftichthys anderssoni	18
Protomyctophum bolini	24
Total	**97**

Table 32 Summary of fish tested for density by species

16.4 Recommendations

Lateral and dorsal digital imaging went well this season and there are no further recommendations. However, use of the microscope camera was limited at times due to batteries running out of charge and memory card being full. Whilst a mains supply power unit for the camera had been purchased it was broken on arrival. A replacement/spare non-battery power supply for the camera would help overcome power issues. In addition the contents of the memory card could have been backed up onto the L drive each day to ensure there was sufficient space during the nights lab work.

With regards to the density bottle method, this could have been improved by conducting calibration back at BAS prior to the cruise to identify any anomalies or offsets for each hydrometer so that in the event of a hydrometer breaking it could readily have been substituted. This made little difference during JR16003 however as the same hydrometers were used throughout and therefore all measurements comparable.

During JR16003 a trial of the method was conducted using *Euphasia superba* (krill). It became apparent that krill were giving a considerably higher reading than would be expected. Becker and Warren (2014) noted a similar phenomenon with zooplankton species and attributed this to a higher osmotic pressure of glycerol solutions in comparison to hypersaline solutions. To check the validity of results on this cruise and calculate a correction factor for glycerol if necessary, hypersaline solutions were made (S.G.) range of 1.0250 to 1.0500 in 0.005 increments. A sample of 12 *Gymnoscopleus braueri* and 5 Cyclothone sp. were tested in hypersaline and then in glycerol solutions to determine if loss of water was and issue. Whilst this has yet to be tested for statistical significance, initial indications suggest this is unlikely to have been a factor for testing density of fish tissue, however, glycerol may be a poor choice for smaller crustaceans.

16.5 References

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17 Identification of Antarctic producers of Highly branched isoprenoids (HBIs) - BOB

Gabi Stowasser, Thomas Brown

17.1 Background

Southern Ocean sea ice is critical to Earth's climate regulation because sea ice forms a physical barrier, which reduces sea-air communication of gases and heat, and influences ocean dynamics, such as Antarctic bottom water and current formation[1,2]. However, we know little about the long-term dynamics of sea ice (especially summer sea ice) because there are no effective tools to investigate its historical variability. Sea ice also provides a habitat for various microflora, especially diatoms, which bloom during the spring and provide a key component within polar ecosystems. The impact of reduced sea ice cover on sea ice algal productivity and the impacts that this may have on higher trophic levels is poorly understood and in particular, whether organisms that currently rely on sea ice organic carbon are able to adapt to pelagic sources, even if available. Once again, such investigations require the development of methods that target specific carbon sources in order for our understanding to develop.

Certain diatoms produce unique lipids in extreme environments, such as sea ice, and these lipids can be used as environmental proxies. For example, highly branched isoprenoid (HBI) alkenes are unusual lipids made by known common diatom genera including *Haslea*, *Navicula*, *Pleurosigma*, *Rhizosolenia* and *Berkeleya*[3-8]. One HBI (IP_{25}: Ice Proxy with 25 carbon atoms[9]), is produced selectively by certain diatoms residing in Arctic sea ice and its presence in underlying sediments is a powerful proxy for the past occurrence of Arctic spring sea ice[9]. IP_{25} has also emerged as a suitable tracer of sea ice-derived organic carbon source within Arctic food webs[10-12]. IP_{25} has not been reported in Antarctic sea-ice diatoms, sediments or heterotrophic consumers, but a structural analogue (an HBI diene) has been[13-20]. Since this HBI diene is co-produced with IP_{25} by Arctic sea-ice diatoms (and can therefore also be used as a proxy for Arctic sea ice) and has an isotopic ($\delta^{13}C$) signature characteristic of a sea-ice origin when detected in Antarctica[18], it has the potential to provide the basis for palaeo sea-ice reconstruction and food web studies for the Southern Ocean. Indeed, a small number of studies based on the HBI diene have begun to appear[13-20]. A further HBI (an HBI triene) has been reported in Antarctica, but appears not to be made by diatoms living in sea ice. The significantly lighter isotopic composition ($\delta^{13}C$) of the HBI triene compared to the HBI diene[18], indicates an origin in the pelagic phytoplankton, possibly from species that thrive within the marginal ice zone or retreating ice margin. Measurement of the HBI diene and triene has the potential to provide key proxy data for both palaeo sea ice and for tracing organic carbon in Southern Ocean ecosystems. However, the development of HBIs as proxies for Antarctic sea ice is much less advanced than that of IP_{25} for the Arctic[9] and has relied almost entirely on their analysis in sediments and a few higher trophic level organisms, rather than within their source environments. Further, the specific diatoms responsible for HBI production in the Southern Ocean are not known, but the species found in Antarctic winter sea ice have already been eliminated as HBI producers.

For the current project, the aim was to collect phytoplankton samples from open waters south of the Polar Front and from sea ice and keep samples alive for future culturing in the laboratory in the UK and subsequent potential identification of HBI producers.

17.2 Methods

Phytoplankton samples were obtained through deployment of a phytoplankton net with a 20µm filter at station P3 (27.12.2016, Events 77 & 78; 52°48.47'S; 40°06.80'W) and scraping of an ice-floe in Ryder Bay, Rothera (12.01.2017; 67° 34.46'S, 68° 14.80'W).

17.3 Sampling instructions

1) Collect sample and remove any visible heterotrophs (either large sieve [≥250µm], or manually pick).

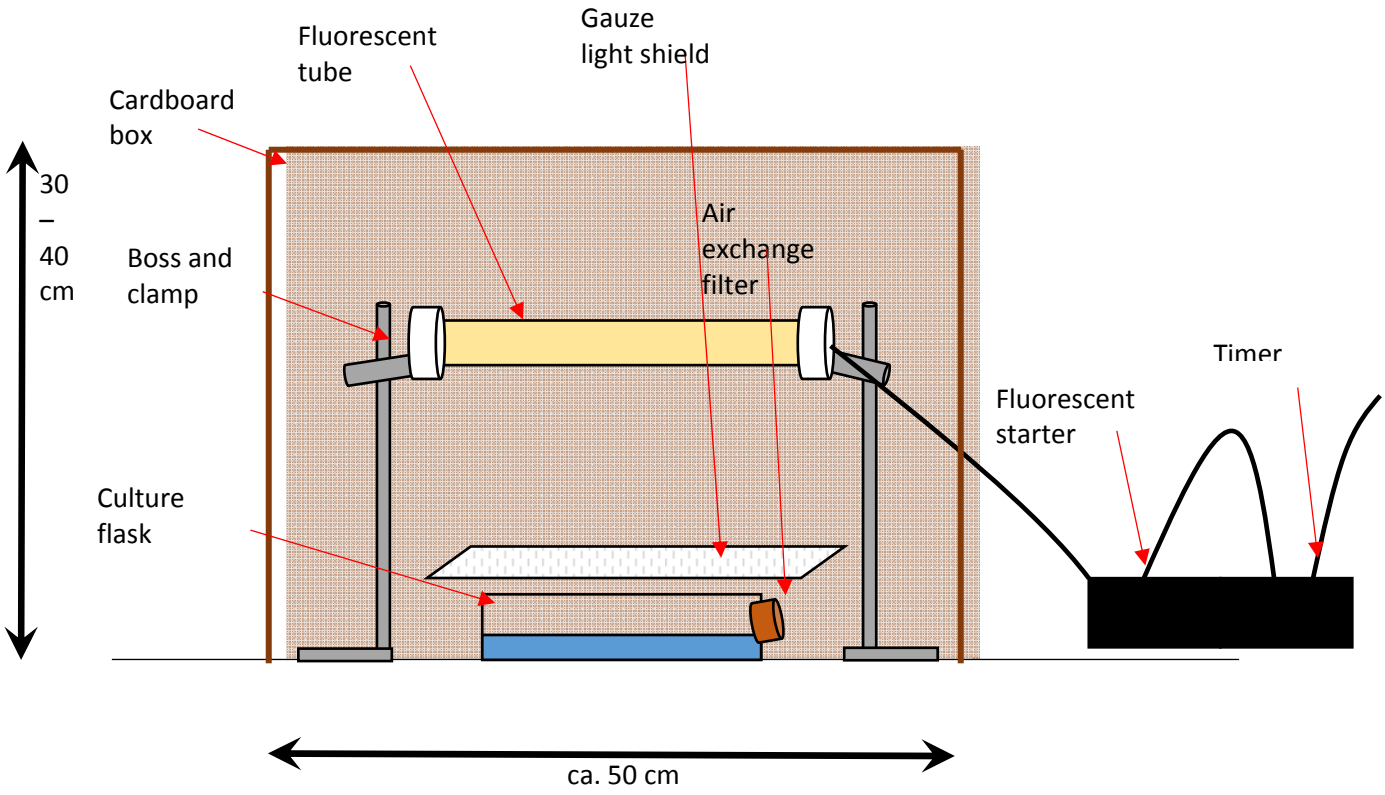
2) If the algae are visible in the sample, this will probably be too concentrated and any growth over the culture period will strip nutrients from the water and crash the cells. Therefore, a sub-sample should be used. The size of the sub-sample is very dependent upon the density of cells.

If it looks like this – shake it and take one pipette-sized drop into the orange lid culture flask. Make up to ~150mL with seawater (it need not be filtered, but no heterotrophs please).

If it looks like this – shake it and take <1mL into the orange lid culture flask. Make up to ~150mL with seawater (it need not be filtered, but no heterotrophs please).

If it looks like this – throw it back and get some more! Or, if you can't then shake it and put ~150mL of it into the orange lid culture flask. It only takes one cell to grow!

17.4 Experimental set-up



Once in the flask(s), secure these in place under the light with the mesh over the flask (if you can, tape this all down, but don't pull the mesh tight over the flask, it should sit loosely).

The timer can be set to approximately the daylight schedule of the region at first for acclimation, but lighting for long periods will force too much growth, strip the nutrients and crash the culture. After a couple of days the standard culture lighting of 14:10 Light:Dark can be used.

If it looks like the cultures are growing too well (i.e. approaching the colours of pictures 1 or 2 above), then it will be necessary to replenish the water ASAP. This should be done by:

1) Get some fresh seawater, filtered/unfiltered is fine, but no heterotrophs.

2) Vigorously shake the culture flask. But, take care not to get too much, if any, water on the air exchange filter in the lid – But, do not take the lid off until you have to.

3) Take off the lid and decant ~50% of the culture water and cells – this can be used to start a subsequent culture if space/flasks allow, or simply thrown away.

4) Top up the first flask with seawater to about 150mL, recap, shake and put back under the light with mesh as before.

This process can be repeated as many times as needed.

All samples were transferred into culture flasks and topped up to the total volume of 150ml with filtered seawater. Samples were kept in the cold room at +4°C for the duration of the experiment. Samples taken at P3 were replenished with fresh filtered seawater 4 times and ice-algae samples twice. Furthermore, the remainder of ice phytoplankton not put into culture was filtered through the 20µm filter of the phytoplankton net, re-suspended in seawater and stored at -80°C for further

analysis in the laboratory. All samples will subsequently be sent to Dr. Thomas Brown, Scottish Marine Association, Oban, where algae will be put into culture and HBI analysis will be conducted.

18 Education and Outreach

José Xavier, José Seco, Mike Gloistein, Charlie Bristow, Tracey Dornan, Jeremy Robst

Numerous education and outreach activities were carried out relating to the JR16003, prior, during and planned for after the cruise onboard RRS James Clark Ross. We focus our report at 3 levels: World Wide Web (blogs, twitter and facebook), contact with schools and general public, and outreach within the cruise members.

18.1 World Wide Web

The bi-lingual blog of José Xavier was created for the International Polar Year (www.cientistapolarjxavier.blogspot.com), and was already used

on the previous cruises (JR177 (2008), JR200 (2009) and JR15004 (2016)). The objective of the blog is to provide, on a regular basis in English and Portuguese, interesting information on the science and the life onboard of the James Clark Ross during the JR16003 cruise, on a regular basis in English and in Portuguese. The great majority of the scientists and crew participated on the blog, either by accepting to be photographed or interviewed, or providing photographs or input in writing. During the duration of the cruise, more than 15000 hits from more than 10 countries worldwide were recorded in this blog. These top 10 countries visiting the blog were: USA, Portugal, Russia, UK, Poland, Brazil, Germany, Japan, France and China. Finally, regular updates of the cruise were carried out at the personal facebook pages of José Xavier and José Seco, which resulted in 30 posts, 30 shares, 206 comments and 2876 likes.

José Xavier and José Seco also gave two radio interviews to the most heard Portuguese national radio, Radio RDP Antena 1. One before the cruise talking about the expectations and scientific goals. The Second one the 13th of December to explain how would be our Christmas day on board of the RRS James Clark Ross.

The blog and facebook (as well as the work mentioned below) are part of the Portugal´s polar education and outreach initiatives on promoting polar science, with the endorsement of the Association of Polar Early Career Scientists (APECS Portugal), Polar Educator International (PEI) and the Portuguese Polar Program PROPOLAR. A report to the SCAR life sciences program SCAR-AnTERA and ICED will be also produced informing about the overall goals of the cruise.

Complementary to this work, Charlie Bristow also conducted an educational activity, in which “his penguin” keeping us company all through the cruise, that can be visited on Twitter (@RothesayPenguin). Rothesay Penguin tweeted every day reporting on activities such as the departure from Cambridge to arrival in Rothera. The tweets are kept simple so that they can be accessible to a younger and less scientific audience. In this respect the use of twitter has advantages; the message length is limited and has to be kept simple. On the other hand, this can present a challenge communicating science in simple language. The name of the penguin is derived from Egerton Rothesay a non-selective school in Berkhamsted, England which provides support for pupils who need specialist input because of a special educational need. Rothesay Penguin was at the school’s Christmas fair prior to departure. Some of the tweets have been retweeted by the British Antarctic Survey.

Finally, Mike Gloistein (Radio officer of the James Clark Ross) provided a daily update of the activities onboard of the James Clark Ross through his website (www.gm0hcq.com), providing an unique insight of how is to work and live in the Southern Ocean, while providing important information to all those onboard (e.g. Weather conditions, Menu). In addition to the Daily Updates from the ship Mike was also writing blogs for a primary school in Northern Ireland and Scotland, tailored to each school. Mike Tweeted on a regular basis with pictures from the cruise (@gm0hcq).

18.2 Contact with schools and the general public

Prior to the cruise, oral presentations by Jose Xavier and Jose Seco about the expeditions took place on 12 schools, educational institutions and educational activities (e.g. Science Fairs) in Portugal (involving ~ 7 800 students, teachers and educators directly), as part of the international educational activities POLAR WEEKS (two weeks (one in March and another in October each each) in which scientists actively participate in polar educational activities, such as going to schools to give talks, or skype calls, to promote polar science close to the younger generations and the general public) and ANTARCTICA DAY (taking place on the 1 Dec. each year, with schools providing flags to be taken to Antarctica regularly, to celebrate the importance of the Antarctic Treaty and its values) . The flags of schools and councils of Portugal, UK, USA, China and Bulgaria (some under the Antarctica Day initiative) were brought by José Xavier, José Seco, Jeremy Robst and Tracey Dornan, in which photographs were taken during the cruise, on the ship and on land.

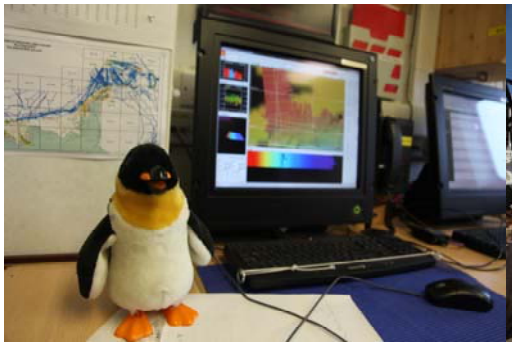
During the cruise, José Xavier and José Seco have done various interviews of scientists and crew to produce another education and outreach film to educate the younger generations the basic information about polar research, particularly the marine disciplines. After the cruise, José Xavier and José will return to the schools to return their flags and give an overview of the research cruise.

Finally, José Xavier (with the contribution of Sophie Fielding) provided a brief article outlining the cruise to the Scientific Committee on Antarctic Research (SCAR) newsletter, emphasizing the objetives of the cruise, particularly the links with the Research Science Program SCAR AnT-ERA.

18.3 Initiatives within the cruise community

A groups of talks of the science teams took place prior to the research cruise, in Cambridge, so that teams could understand each others research. During the cruise, a group of talks, coordinated by Sophie Fielding, were carried out by scientists with the aim to inform all onboard of the science science carried out during the cruise, contribute to a better understanding of the importance of the officers, crew and scientists in obtaining all the results, and acknowledge all the work carried out by the people onboard. After a brief introduction, oral presentations were given by the scientists Alex Burton-Johnson, Sophie Fielding, Ryan Saunders and Geraint Tarling and by the early career scientists Elisa Bergami, Tracey Dornan, Angelika Slomska and Jose Seco. This event was very well received and was attended by officers, crew and fellow scientists.

Examples of the activities carried out



19. AME and IT reports

19.1 ICT Engineer's Report

Jeremy Robst

19.1.1 Data Logging / SCS

The SCS server and data logging systems worked well throughout the cruise, with very few logging events occurring.

Time & Date (GMT)	Event
2016/12/04 12:10	ACQ restarted, newleg run (**Leg: 20161204**)
2016/12/29 19:22	Oceanlogger fluorometer became waterlogged and was removed by AME. Oceanlogger logging approximately evey 10s until 20:00 when AME fixed code and logging resumed every 5s.
2017/01/17 23:48	Fluorometer repaired by AME and reinstalled.
2017/01/19	ACQ restarted, newleg run (Leg: 20170119)

19.1.2 Oceanlogger

AME replaced the TIR sensors in Rothera, on 14th January 2017.

19.1.3 Other systems

The other systems on board – the JRLB unix fileserver, SABRIS systems and ESX server all worked without any serious issues. Occasionally the VEEAM backups (around once a month) will fail and the VEEAM server needed to be restarted.

19.2 AME report

Seth Thomas

Engineering Technical Section
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

FAO:

The BAS AME (electronics) marine scientific instrumentation support engineers

Cruise Report Instructions

Neil French (nefren) is the first point of contact for marine scientific instrumentation – any questions email (nfren@nerc.ac.uk) or phone him (01223 221398); try Rob White (robite 01223 221294) or secondly Steve Bremner (sfbr, 01223 221416) when Neil not available.

Before you leave HQ for cruise support obtain an up to date image of the JCR directories from the M: drive. The database for locating incidentals and spares is now maintained on the JCR by AME and a copy for reference should be sent back to the UK each year. Please contact nefren if you are unfamiliar with this database. A list of spares/stock required should be included at the end of this report. However critical items must be ordered immediately.

A brief cruise report checklist is required for every cruise AME are responsible for supporting. Include pertinent notes on fault history and diagnosis at the end of the report even if you have already discussed via email. This information will be added to the instrumentation database maintained in the UK .

Please log all problems or changes made to systems in use while the cruise is underway to your own log book.

At the end of the cruise, please fill in the simple checklist attached, briefly describing any problems or changes made to the instrumentation (including intermittent problems, repairs, expansion, changes to software, etc). Tick ‘Used?’ against all instruments which were used or logged. This is so we can follow up these issues and keep a good history of our instruments.

In order to help us with calibrations and repairs, please note the serial numbers of the instruments actually used (as listed on the checklist), and also serial numbers of any spares which you swapped or tested due to a fault or fault-finding. Enter any details on the checklist. We now have many spare sensors which are identical except for serial number.

Please leave a copy of the cruise report on the ship in the electronics workshop for the next support engineer and email a copy to nefren, robite & sfbr.

Cruise:JR15001 Start date: 8 Dec 2016 Finish date: 20 Jan 2017

Name of AME engineer: Seth Thomas

Name of principle scientist (PSO): Sopie Fielding

LAB Instruments

Instrument	S/N Used	Comments
AutoSal	63360	
Scintillation counter	N	
Magnetometer STCM1	N	
XBT	Y	

ACOUSTIC

Instrument	S/N Used	Comments
ADCP	Y	
PES	N	
EM122	Y	
TOPAS	N	
EK60	Y	
SSU	Y	
USBL	Y	
10kHz IOS pinger	N	
Benthos 12kHz pinger S/N 1316 + bracket	N	
Benthos 12kHz pinger S/N 1317 + bracket	N	
MORS 10kHz	N	

transponder		

OCEANLOGGER

Instrument	S/N Used	Comments
Barometer1(UIC)	V145002	
Barometer1(UIC)	V145003	
Foremast Sensors		
Air humidity & temp1	0020066609	
Air humidity & temp2	0020066752	
TIR1 sensor (pyranometer)	161952	Brought online after ADC swap at Rothera
TIR2 sensor (pyranometer)	161953	Not working – (ADC new) Suspect cable fault
PAR1 sensor	150813	
PAR2 sensor	150814	
prep lab		
Thermosalinograph SBE45	0018	
Transmissometer	527	
Fluorometer	1100243	Instrument flooded - Replaced
Fluorometer	6456	Replacement for 1100243
Flow meter	811950	
Seawater temp 1 SBE38	0767	
Seawater temp 2 SBE38	0771	

CTD (all kept in cage/ sci hold when not in use)

Instrument	S/N Used	Comments
Deck unit 1 SBE11plus	0458	
Underwater unit	0771	

SBE9plus		
Temp1 sensor SBE3plus	5623	
Temp2 sensor SBE3plus	4874	
Cond1 sensor SBE 4C	3491	
Cond2 sensor SBE 4C	1912	
Pump1 SBE5T	2395	
Pump2 SBE5T	1807	
Standards Thermometer SBE35	0051	
Transmissometer C-Star	1505	
Oxygen sensor SBE43	0242	
PAR sensor	70636	
Fluorometer Aquatracka	12-8513-003	
Altimeter PA200	163162	
LADCP	14443	
CTD swivel linkage	1961018	
Pylon SBE32	01106	
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc		

AME UNSUPPORTED INSTRUMENTS BUT LOGGED

Instrument	**Working ?**	**Comments**
EA600	Y	
Anemometer	Y	

Gyro	Y	
DopplerLog	Y	
EMLog	y	

At the end of the cruise, please ensure that:

- the XBT is left in a suitable state (store in cage if not to be used for a while – do not leave on deck or in UIC as it will get kicked around). Remove all deck cables at end of cruise prior to refit.
- the salinity sample bottles have been washed out and left with deionised water in – please check this otherwise the bottles will build up crud and have to be replaced.
- the CTD is left in a suitable state (washed (including all peripherals), triton + deionised water washed through TC duct, empty syringes put on T duct inlets to keep dust out and stored appropriately). Be careful about freezing before next use – this will damage the C sensors (run through with used standard seawater to reduce the chance of freezing before the next use). Remove all the connector locking sleeves and wash with fresh water. Blank off all unconnected connectors. See the CTD wisdom file for more information. If the CTD is not going to be used for a few weeks, at the end of your cruise please clean all connectors and attach dummy plugs or fit the connectors back after cleaning if they are not corroded.
- the CTD winch slip rings are cleaned if the CTD has been used – this prevents failure through accumulated dirt.
- the SVP is left in a suitable state (washed and stowed). Do not leave this on deck without a cover for any length of time as it rusts. Stow inside at end of cruise.
- all manuals have been returned to the designated drawers and cupboards.
- you clean all the fans listed below every cruise or every month, whichever is the longer.

Please clean the intake fans on the following machines:

Instrument	**Cleaned?**
Oceanlogger	N
EM120, TOPAS, NEPTUNE UPSs	N
Seatex Seapath	N
EM120 Tween Deck	N
TOPAS Tween Deck	N

Additional notes and recommendations for change / future work

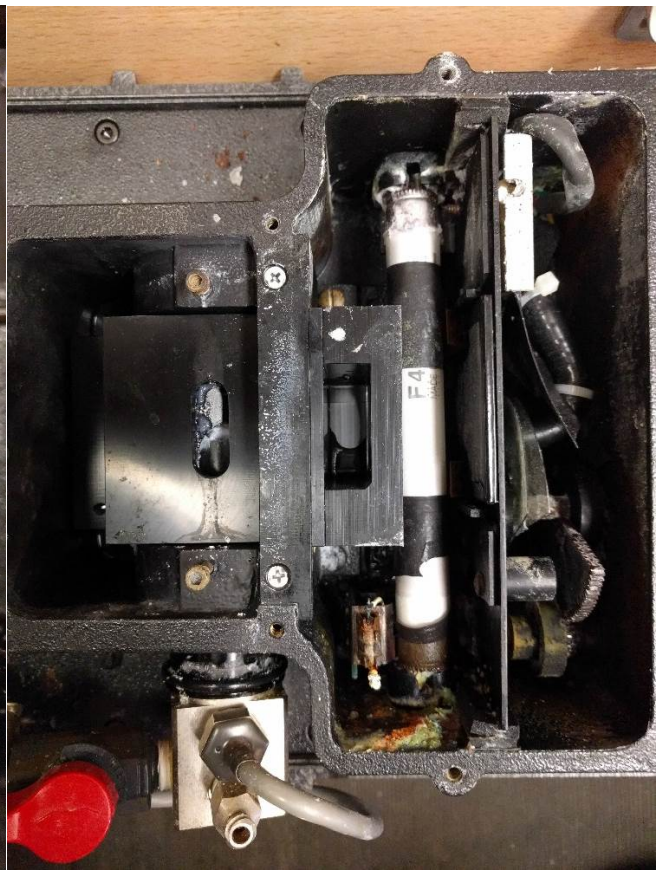
Oceanlogger

Fluorometer.

It was noticed that the fluorometer #1100243 was giving ‘near zero’ readings constantly, and on inspection, the ‘lamp on’ indicator was not lit. Upon opening the lamp casing to inspect bulb, much seawater poured out from within the lamp casing. This was due to a crack in the flow through cuvette which had been drip feeding into the lamp cavity (presumably over some time). As the instrument was under voltage throughout, there was much corrosion on all electrical contacts, and substantial corrosion on all mechanical linkages. It was deemed that this instrument was beyond on-site repair, and as such it was removed from the oceanlogger system.

Later during the cruise that it was brought to my attention that an old fluorometer #6456 was in the science hold. This instrument was brought up but was found to have a very different connector for power and serial comms. The connector on 1100243 was still serviceable and has been fitted to 6456 allowing underway fluorometry to continue. It has not been calibrated as this will require standards which we don’t have aboard (though a feasible calibration can be implemented the next time scientists are making underway chlorophyll measurements).

The LabView VI that reads the fluorometer has been modified and no longer drops out due to synch issues. It has been running for a couple of days and is rock solid so far



Met sensors.

Last season both TIR sensors were not working. A complete set of new sensors was installed on the foremast at the beginning of the season, but still both TIR sensors were not being read by the system. Form this I assumed that the ADC modules were at fault and have replace both TIR ADCs while alongside in Rothera. Following this, only 1 of the 2 TIR sensors is now reading. Comms with the ADC module are goo so I can only assume that there must be a fault either with the wiring in the mast top box, or a fault in the 25 way cable that goes up the foremast. I am unable to check either of these at the moment as we are at sea. I will continue to rebuild the sensor set that came off at the end of last season so the current set can be taken and serviced as intended.

I will discuss with Mike (ETO-comms) the prospect of moving the junction box containing the ADC modules and rs485 bus to someplace indoors within the forecastle in order to facilitate diagnosis and repair of this equipment while at sea. With the 25 way cable routed up to the mast via glands. Also it is my recommendation that a 2nd 25 way cable be routed up the mast so it can be swapped in if a fault develops. The system has 100% redundancy on all parts (sensors/ADCs etc) except for this cable which is seen as a single point of failure.

Also, the 2 PAR sensors are not giving identical readings. They each have an instrument specific calibrated current amplifier that should give a (200umol/s.m^2)/mA output but PAR2 is consistently slightly higher than PAR1. This may be due to contamination of the PAR2 sensor atop the mast but I have as yet been unable to get above them to inspect.

The ADCs that these sensors are on have been in place since 2011 and may have drifted in this time. It is possible to calibrate these aboard but the mast is only accessible when alongside for safety reasons. If I have time at Punta I will address this and see if the PAR readings fall into line.

Support Engineer: Seth Thomas Date: 16 January 2017

20 Event log

Time/Date	Event Number	Latitude	Longitude	Comment
10/12/2016 09:46		-53.62037	-47.80507	Start of WSR swath survey
10/12/2016 13:04		-53.76765	-46.9151	Vessel reduced speed for XBT launch
10/12/2016 13:11	1	-53.76992	-46.89681	XBT launched
10/12/2016 13:16	1	-53.77111	-46.88327	XBT completed
10/12/2016 13:18		-53.77153	-46.87797	Vessel resumed speed of 10kts for swath survey
11/12/2016 16:52	2	-54.30335	-44.77593	XBT in water.
11/12/2016 16:57	2	-54.30534	-44.76212	XBT deployment complete.
12/12/2016 11:42		-54.26269	-45.86897	Vessel on station on DP
12/12/2016 11:53		-54.26273	-45.86951	Dredge off deck
12/12/2016 11:56	3	-54.26272	-45.86959	RDredge deployed
12/12/2016 12:20		-54.26277	-45.86954	Vessel commenced move to revised position
12/12/2016 12:44	3	-54.26775	-45.86646	RDredge recovered
12/12/2016 12:45		-54.26802	-45.86628	Dredge on deck
12/12/2016 12:50		-54.26952	-45.86539	Vessel stationary in revised position
12/12/2016 12:54		-54.27057	-45.86464	Dredge off deck
12/12/2016 13:06		-54.27053	-45.8647	Dredge on deck
12/12/2016 13:55		-54.27052	-45.8647	RDredge off deck
12/12/2016 13:59	4	-54.27053	-45.86468	RDredge deployed
12/12/2016 14:27		-54.2705	-45.8647	USBL Valve open & Pole fully extended
12/12/2016 15:45	4	-54.27054	-45.86472	Dredge 1A on bottom W/L 4595m.
12/12/2016 15:46	4	-54.27058	-45.8647	Starting move on DP.
12/12/2016 15:58	4	-54.27646	-45.86105	Vessel stopping on DP.
12/12/2016 16:00	4	-54.27675	-45.86077	Commencing recovery.
12/12/2016 16:26	4	-54.27677	-45.86082	Gear off bottom.
12/12/2016 17:32	4	-54.27674	-45.86085	Gear on surface.

12/12/2016 17:34	4	-54.27676	-45.86083	Gear on deck.
12/12/2016 17:54	5	-54.2931	-45.83565	Vessel on DP.
12/12/2016 17:57	5	-54.29327	-45.83532	Vessel on station at dredge site 1B.
12/12/2016 18:15	5	-54.2934	-45.83538	Dredge off deck.
12/12/2016 18:17	5	-54.2934	-45.83544	Dredge in water.
12/12/2016 18:18	5	-54.2934	-45.83544	Dredge left surface.
12/12/2016 19:32	5	-54.29395	-45.83528	Dredge 1B on bottom cable 3870m
12/12/2016 19:34	5	-54.29395	-45.83528	Commence dredge move on DP. Course 150 degrees
12/12/2016 19:42	5	-54.29658	-45.8326	Vessel stopped. Commence recovery of dredge
12/12/2016 19:58	5	-54.29662	-45.83262	Dredge clear of seabed
12/12/2016 20:53		-54.29657	-45.83263	USBL pole retracted
12/12/2016 20:57	5	-54.29658	-45.83262	Dredge gear recovered to deck
12/12/2016 22:06	6	-54.29661	-45.83263	Bongo nets deployed (trial). Veering to 60m
12/12/2016 22:16	6	-54.29624	-45.83001	Bongo nets recovered to deck
12/12/2016 22:26		-54.29622	-45.82982	Vessel off DP. Resuming WSR swath survey
13/12/2016 09:44		-54.26365	-46.18727	Swath survey complete. Commence transit to dredge 2A location
13/12/2016 11:07		-54.1554	-45.81777	Vessel on DP at dredge 2A location
13/12/2016 11:18		-54.15542	-45.81864	RDredge off deck
13/12/2016 11:20	7	-54.15543	-45.81869	RDredge deployed
13/12/2016 12:25	7	-54.1557	-45.81862	RDredge at bottom. Wire out 3495m.
13/12/2016 12:28		-54.15572	-45.81866	V/l commence move 180* x 2kts
13/12/2016 12:36		-54.16003	-45.81864	Vessel stopped starting to haul
13/12/2016 12:44		-54.16028	-45.81867	RDredge off the bottom
13/12/2016 13:40	7	-54.16028	-45.81866	RDredge recovered
13/12/2016 13:41		-54.16027	-45.81866	RDredge on deck
13/12/2016 13:44		-54.16027	-45.81861	Vessel off DP and proceeding to dredge site 2B
13/12/2016 14:23		-54.0826	-45.73863	Vessel on DP on station at dredge site 2B
13/12/2016 14:31		-54.15571	-45.81864	RDredge off deck
13/12/2016 14:33	8	-54.08317	-45.74003	RDredge deployed

13/12/2016 15:44	8	-54.08322	-45.74	Dredge on bottom.
13/12/2016 15:48	8	-54.0835	-45.73997	Vessel moving ahead at 2kts.
13/12/2016 16:07	8	-54.0917	-45.73227	Vessel stopped commencing recovery.
13/12/2016 16:34	8	-54.09182	-45.7319	Gear off the bottom.
13/12/2016 17:29	8	-54.09181	-45.73192	Gear on the surface.
13/12/2016 17:31	8	-54.0918	-45.73193	Dredge on deck.
13/12/2016 17:58	9	-54.09179	-45.73193	Midships gantry unlashed.
13/12/2016 18:02	9	-54.0918	-45.7319	Bongo off deck.
13/12/2016 18:03	9	-54.0918	-45.73191	Bongo in the water.
13/12/2016 18:08	9	-54.09181	-45.73033	Commencing recovery.
13/12/2016 18:11	9	-54.09179	-45.72868	Bongo on surface.
13/12/2016 18:12	9	-54.09179	-45.7284	Bongo on deck.
13/12/2016 18:39	10	-54.09178	-45.72817	Bongo off deck.
13/12/2016 18:40	10	-54.09179	-45.72815	Bongo in water.
13/12/2016 18:42	10	-54.09177	-45.72749	Commencing recovery.
13/12/2016 18:47	10	-54.09178	-45.7255	Bongo on surface.
13/12/2016 18:48	10	-54.09179	-45.72521	Bongo on deck.
13/12/2016 18:55	10	-54.09181	-45.72489	Gantry lashed.
13/12/2016 18:58		-54.09181	-45.72492	Vessel off DP. Commence transit to dredge 3A location
13/12/2016 22:33		-53.66737	-45.90038	Vessel on DP at dredge 3A location
13/12/2016 22:38		-53.66746	-45.90023	Dredge off deck
13/12/2016 22:40	11	-53.66757	-45.90013	Dredge deployed. Veering to seabed
13/12/2016 23:39	11	-53.66783	-45.89989	RDredge at bottom. Wire out 3350m.
13/12/2016 23:41		-53.66779	-45.90002	Vessel commence move on DP. 315* x 2kts
14/12/2016 00:03		-53.66218	-45.90949	Commenced hauling
14/12/2016 00:26		-53.66086	-45.91169	RDredge off seabed
14/12/2016 01:14	11	-53.66086	-45.91168	RDredge Recovered
14/12/2016 01:15		-53.66086	-45.91168	RDredge on deck
14/12/2016 01:19		-53.66085	-45.91163	Vessel off DP proceeding to next Dredge site

14/12/2016 01:37		-53.6527	-45.90663	Vessel on DP at Dredge site
14/12/2016 01:44		-53.65297	-45.90674	RDredge off deck
14/12/2016 01:47	12	-53.65297	-45.90674	RDredge deployed
14/12/2016 02:46		-53.65302	-45.90672	Vessel commence move on DP for dredge (280* x 2kts)
14/12/2016 03:10	12	-53.6514	-45.92152	Commenced hauling.
14/12/2016 03:32	12	-53.65142	-45.9215	Gear off bottom.
14/12/2016 04:15	12	-53.65143	-45.92148	Dredge on surface.
14/12/2016 04:17	12	-53.65143	-45.92149	Dredge on deck.
14/12/2016 04:25	12	-53.65143	-45.9215	Vessel off DP relocating to swath transect.
14/12/2016 04:50		-53.61233	-45.91083	Re-commenced swath survey.
14/12/2016 10:24		-53.44327	-47.18101	Vessel on DP at dredge 4A location
14/12/2016 10:32	13	-53.4436	-47.18184	Dredge off deck
14/12/2016 10:35	13	-53.44377	-47.18184	Dredge on deck
14/12/2016 10:45	13	-53.44395	-47.18183	Dredge off deck
14/12/2016 10:47	13	-53.44394	-47.18183	Dredge deployed. Cable veering
14/12/2016 11:32	13	-53.44393	-47.1818	RDredge on the bottom wire out approx 2700m
14/12/2016 11:36		-53.4439	-47.18192	Vessel commenced move on DP 265* x 2kts
14/12/2016 12:05		-53.44531	-47.2073	Vessel stopped and commenced hauling
14/12/2016 12:43	13	-53.44543	-47.20726	RDredge off the bottom
14/12/2016 13:11	13	-53.44541	-47.20725	RDredge Recovered
14/12/2016 13:12		-53.44541	-47.20726	RDredge on deck
14/12/2016 13:32		-53.44537	-47.20733	Vessel off DP proceeding to next dredge site
14/12/2016 14:07		-53.48566	-47.12602	Vessel on DP at dredge site 4B
14/12/2016 14:15		-53.48545	-47.12586	RDredge off deck
14/12/2016 14:17	14	-53.48544	-47.12586	RDredge deployed
14/12/2016 15:07	14	-53.48546	-47.12584	Gear on bottom.
14/12/2016 15:10	14	-53.48546	-47.12587	Commenced move on DP.
14/12/2016 15:41	14	-53.48275	-47.15147	Vessel stopped commencing hauling.
14/12/2016 16:28	14	-53.48279	-47.15144	Gear off bottom.

14/12/2016 16:59	14	-53.4828	-47.15141	Gear on surface dredge lost.
14/12/2016 17:00	14	-53.48281	-47.15141	Bare end of chain on deck.
14/12/2016 17:30	14	-53.48224	-47.15211	Vessel off DP relocating to DR_5.
15/12/2016 04:45	15	-53.19969	-44.14728	Vessel on DP at Dredge 5a location.
15/12/2016 04:55	15	-53.19934	-44.14558	Dredge off deck.
15/12/2016 04:57	15	-53.19935	-44.14558	Dredge in water.
15/12/2016 05:31	15	-53.19937	-44.1456	Moving on DP 210°/2kts.
15/12/2016 06:04	15	-53.21486	-44.16051	Vessel stopped commenced hauling.
15/12/2016 06:20		-53.21492	-44.16063	Sharp drop-off in tension on winch monitoring system (4t-1t) at around 0320(L).
15/12/2016 07:03	15	-53.21495	-44.16059	Gear hauled out of water. Dredge lost
15/12/2016 07:04	15	-53.21495	-44.16059	Chain on deck
15/12/2016 08:25		-53.21491	-44.16041	Commence move on DP to Dredge 5b location
15/12/2016 08:50		-53.21635	-44.13395	Vessel in position on DP at dredge 5b location
15/12/2016 09:02	16	-53.21629	-44.13393	Dredge off deck
15/12/2016 09:04	16	-53.21631	-44.13393	Dredge deployed
15/12/2016 09:30	16	-53.2163	-44.13395	Dredge on seabed. Commence move on DP. 265* at 1.7kts
15/12/2016 09:50	16	-53.21702	-44.14697	Vessel stopped. Commence hauling dredge
15/12/2016 10:25	16	-53.217	-44.14701	Dredge on deck
15/12/2016 10:30		-53.21707	-44.14698	Commence move on DP to dredge 5c location
15/12/2016 11:00		-53.22354	-44.13079	Vessel in position on DP at dredge 5c location
15/12/2016 11:12		-53.22344	-44.13076	RDredge off deck
15/12/2016 11:14	17	-53.22344	-44.13074	RDredge Deployed
15/12/2016 11:36	17	-53.22344	-44.13077	RDredge on seabed (894m)
15/12/2016 11:39		-53.22344	-44.13076	Commenced move on DP 270* x 2 kts
15/12/2016 11:54		-53.22348	-44.14358	Vessel stopped starting to haul dredge
15/12/2016 12:14		-53.22343	-44.14448	Dredge off bottom
15/12/2016 12:29	17	-53.22343	-44.14447	RDredge recovered
15/12/2016 12:32		-53.22343	-44.14449	RDredge on deck
15/12/2016 12:48		-53.22342	-44.14445	Vessel off DP commencing swath survey en route to next dredge site

15/12/2016 20:14		-53.61875	-42.64365	Vessel on DP at dredge 6a location
15/12/2016 20:23	18	-53.61876	-42.64375	Dredge off deck
15/12/2016 20:25	18	-53.61879	-42.64389	Dredge deployed. Cable veering
15/12/2016 20:56	18	-53.61877	-42.64387	Dredge on bottom. Commence move on DP. 340* at 2.0kts
15/12/2016 21:14	18	-53.61174	-42.64821	Vessel stopped. Commence hauling
15/12/2016 21:46	18	-53.61161	-42.64832	Dredge on deck
15/12/2016 21:50		-53.6116	-42.64832	Commence move on DP back to dredge 6a start location
15/12/2016 22:04		-53.61874	-42.64374	Vessel in postion at dredge 6a location
15/12/2016 22:07	19	-53.61875	-42.64375	Dredge off deck
15/12/2016 22:08	19	-53.61875	-42.64377	Dredge deployed. Cable veering
15/12/2016 22:32	19	-53.61879	-42.64385	Commence move on DP. 340* at 2.0kts
15/12/2016 22:48	19	-53.61168	-42.64803	Vessel stopped. Commence hauling
15/12/2016 23:31	19	-53.61168	-42.64808	RDredge recovered
15/12/2016 23:32	19	-53.61169	-42.64804	RDredge on deck
16/12/2016 00:00		-53.60759	-42.64882	Vessel off DP. Decks secured thruster vents closed and proceeding to mooring site P3 overnight.
16/12/2016 13:37	20	-52.81245	-40.11048	Vessel on DP at P3 mooring site
16/12/2016 13:58	20	-52.81252	-40.11067	Release signal sent
16/12/2016 13:59	20	-52.81252	-40.11065	Release confirmed
16/12/2016 14:01	20	-52.81251	-40.11061	Mooring float on surface
16/12/2016 14:02	20	-52.81251	-40.11065	Commencing move on DP for pick up
16/12/2016 14:14	20	-52.81076	-40.11878	Mooring connected moving ahead and to port on DP
16/12/2016 14:20	20	-52.81156	-40.12006	Float recovered
16/12/2016 14:22	20	-52.81173	-40.12056	Float on deck
16/12/2016 14:23	20	-52.81186	-40.12078	O2 sensor 1 on deck
16/12/2016 14:37	20	-52.81324	-40.12378	Buoy cluster 1 on deck
16/12/2016 14:42	20	-52.81348	-40.12436	Sediment trap 1 O2 sensor 2 on deck
16/12/2016 14:46	20	-52.81369	-40.12477	CTD on deck
16/12/2016 15:25	20	-52.81562	-40.12916	2nd Sediment trap on deck
16/12/2016 15:53	20	-52.81698	-40.13234	Acoustic Release on deck.

16/12/2016 15:54		-52.817	-40.13235	Vessel stopped on station in full auto-pos DP for CTD
16/12/2016 16:35	21	-52.81699	-40.13236	Gantry unlashed.
16/12/2016 16:38	21	-52.81697	-40.13237	CTD off deck.
16/12/2016 16:40	21	-52.81697	-40.1324	CTD in water.
16/12/2016 16:42	21	-52.81697	-40.13238	CTD left surface.
16/12/2016 17:25	21	-52.81697	-40.13233	CTD at depth W/L 2500m
16/12/2016 18:20	21	-52.81697	-40.13236	CTD on surface.
16/12/2016 18:22	21	-52.81697	-40.13236	CTD on deck.
16/12/2016 18:29	21	-52.81698	-40.13236	Gantry lashed.
16/12/2016 18:31	21	-52.81695	-40.13232	Off DP relocating to DR_8.
17/12/2016 04:19	22	-54.42687	-40.12307	Vessel on DP on station at dredge site 8a.
17/12/2016 05:10	22	-54.42678	-40.12312	Dredge off deck.
17/12/2016 05:12	22	-54.42677	-40.1231	Dredge in water.
17/12/2016 05:35	22	-54.42674	-40.12308	Dredge on bottom.
17/12/2016 05:39	22	-54.42664	-40.12316	Moving on DP (345Â°/2kts).
17/12/2016 05:55	22	-54.41913	-40.12664	Move complete commencing hauling.
17/12/2016 06:09	22	-54.41914	-40.12663	Dredge stuck. Heading adjusted 30Â° stbd. Resumed hauling.
17/12/2016 06:15	22	-54.41916	-40.12655	Tension drop to 0.9T
17/12/2016 06:45	22	-54.41924	-40.12646	Chain end on deck dredge lost. Parted out below swivel.
17/12/2016 07:02	22	-54.42389	-40.12465	Off DP relocating to swath start point.
17/12/2016 17:06		-54.44334	-40.86224	Vessel hove to waiting on weather.
17/12/2016 17:06		-54.44334	-40.86224	Vessel hove to waiting on weather.
17/12/2016 20:00		-54.38632	-40.89473	Vessel off DP. Resuming swath survey of SW SG block
17/12/2016 21:58		-54.48641	-40.44357	Reduced speed to 6.0kts for XBT deployment
17/12/2016 22:05	23	-54.49184	-40.42085	XBT in water
17/12/2016 22:08	23	-54.49361	-40.41276	XBT failed
17/12/2016 22:13	24	-54.4966	-40.3994	XBT in water
17/12/2016 22:18	24	-54.49947	-40.3862	XBT fully deployed
17/12/2016 22:19		-54.50007	-40.38314	Increased speed to 10.0kts to resume SW SG block swath survey

19/12/2016 06:19		-54.27627	-40.05137	Multibeam system crashed vessel continuing down planned track to minimise rolling and maintain progress towards next station.
19/12/2016 06:30		-54.25787	-40.06934	Multibeam re-started.
19/12/2016 10:42		-53.91696	-40.64795	Vessel on DP in position at RMT-8 trial location
19/12/2016 11:35		-53.91673	-40.64979	Vessel off DP proceeding into wind at 2.5kts
19/12/2016 11:39		-53.91654	-40.65104	Clear to deploy RMT-8
19/12/2016 11:40		-53.91643	-40.65215	RMT-8 off deck
19/12/2016 11:44	25	-53.91581	-40.65646	RMT-8 Deployed
19/12/2016 11:52	25	-53.9144	-40.66558	Commenced recovery
19/12/2016 11:55	25	-53.91382	-40.66923	RMT-8 recovered
19/12/2016 12:03		-53.91225	-40.67843	RMT-8 on deck
19/12/2016 12:16		-53.90923	-40.69373	Vessel on DP awaiting orders
19/12/2016 14:08		-53.88169	-40.6651	Vessel on DP at SUCS site
19/12/2016 14:12		-53.88151	-40.66652	Gantry unlashed clear to deploy
19/12/2016 14:16		-53.88151	-40.66652	Off deck
19/12/2016 14:17	26	-53.88155	-40.66671	SUCS Deployed
19/12/2016 14:31	26	-53.88154	-40.66669	SUCS on the bottom - 667m depth
19/12/2016 15:12	26	-53.88171	-40.66806	SUCS left bottom.
19/12/2016 15:25	26	-53.88174	-40.66806	SUCS on surface.
19/12/2016 15:26	26	-53.88172	-40.66805	SUCS on deck.
19/12/2016 15:29	26	-53.88175	-40.6683	Off DP relocating.
19/12/2016 15:51	27	-53.88704	-40.71543	Vessel on DP on station.
19/12/2016 16:10	27	-53.88751	-40.7166	SUCS off deck.
19/12/2016 16:11	27	-53.88751	-40.71658	SUCS in water.
19/12/2016 16:25	27	-53.88751	-40.71659	SUCS on bottom.
19/12/2016 16:27	27	-53.88751	-40.71667	Commencing 10m moves ahead.
19/12/2016 16:54	27			Moves complete SUCS off bottom
19/12/2016 17:07	27	-53.88754	-40.71794	SUCS on surface.
19/12/2016 17:15	27	-53.88758	-40.71825	Deck secure off DP

19/12/2016 19:00		-53.79257	-40.66673	Vessel on DP at SUCS 4b location
19/12/2016 19:07	28	-53.79258	-40.66673	SUCS off deck
19/12/2016 19:08	28	-53.79258	-40.66672	SUCS in water. Veering to seabed
19/12/2016 19:22	28	-53.79257	-40.66671	SUCS on seabed. Commencing 10m moves
19/12/2016 19:58	28	-53.79316	-40.66769	Commence recovery of SUCS
19/12/2016 20:14	28	-53.79315	-40.6677	SUCS recovered to deck
19/12/2016 20:21		-53.79267	-40.66853	Vessel off DP. Commence transit to SUCS 4a location
19/12/2016 20:46		-53.76701	-40.71526	Vessel on DP at SUCS 4a location
19/12/2016 20:57	29	-53.76679	-40.71649	SUCS off deck
19/12/2016 20:58	29	-53.76677	-40.71653	SUCS in water. Veering to seabed
19/12/2016 21:13	29	-53.76674	-40.71654	SUCS on seabed. Commence 10m moves
19/12/2016 21:47	29	-53.76648	-40.7178	Commence recovery of SUCS
19/12/2016 22:01	29	-53.76646	-40.71779	SUCS recovered to deck
19/12/2016 22:05		-53.76648	-40.71781	Vessel off DP. Commence swath transit to SUCS 3 location
19/12/2016 22:40		-53.74231	-40.65534	SUCS 3 location swath complete. Commence swath transit to SUCS 1 location
20/12/2016 00:12		-53.6333	-40.66666	Vessel on DP at SUCS site
20/12/2016 00:19		-53.63336	-40.66644	SUCS off deck
20/12/2016 00:20	30	-53.63336	-40.66642	SUCS Deployed
20/12/2016 00:35	30	-53.63338	-40.6665	SUCS on the seabed - 650m
20/12/2016 01:10	30	-53.63323	-40.66787	Commenced recovery
20/12/2016 01:24	30	-53.63322	-40.66788	SUCS recovered
20/12/2016 01:26		-53.63322	-40.66786	SUCS on deck
20/12/2016 01:29		-53.63323	-40.66786	Vessel off DP moving to SUCS site B
20/12/2016 01:51		-53.61967	-40.71823	Vessel on DP at SUCS site
20/12/2016 01:55		-53.61965	-40.71807	SUCS off deck
20/12/2016 01:57	31	-53.61966	-40.71805	SUCS Deployed
20/12/2016 02:11	31	-53.61969	-40.71813	SUCS on seabed - 681 metres
20/12/2016 02:42	31	-53.61968	-40.71813	Commenced recovery
20/12/2016 02:56	31	-53.61964	-40.71946	SUCS recovered

20/12/2016 02:57		-53.61964	-40.71943	SUCS on deck
20/12/2016 03:12	31	-53.61963	-40.71946	Off DP relocating to WCB start point.
20/12/2016 08:12		-53.33156	-39.60704	Vessel on DP at WCB1.1N hold location awaiting WCB start
20/12/2016 08:49		-53.33153	-39.60707	Vessel off DP. Commence approach to WCB start waypoint at 6.0 kts
20/12/2016 09:00	32	-53.34721	-39.6024	XBT in water. Vessel maintaining 6.0 kts
20/12/2016 09:06	32	-53.35732	-39.59929	XBT fully deployed. Vessel increasing speed to maintain 10.0kts
20/12/2016 10:09	33	-53.52353	-39.55018	XBT in water. Vessel maintaining 6.0 kts
20/12/2016 10:15	33	-53.5336	-39.54725	XBT fully deployed. Vessel increasing speed to maintain 10.0k
20/12/2016 11:20	34	-53.70208	-39.49781	XBT deployed
20/12/2016 11:25	34	-53.71032	-39.49503	XBT released
20/12/2016 12:30	35	-53.87903	-39.44431	XBT deployed
20/12/2016 12:32	35	-53.8823	-39.44325	XBT released
20/12/2016 13:38	36	-54.05614	-39.39153	XBT deployed
20/12/2016 13:40	36	-54.05938	-39.39042	XBT released
20/12/2016 13:41		-54.05938	-39.39042	End of transect 1.1. Vessel proceeding to WP 1.2S.
20/12/2016 14:42		-54.02145	-39.08925	Commenced transect 1.2 northbound.
20/12/2016 19:00		-53.31312	-39.30463	Transect 1.2 complete. Commence transit to CTD location
20/12/2016 20:10		-53.49238	-39.24986	Vessel on DP at transect 1.2 CTD location
20/12/2016 20:18	37	-53.49247	-39.25021	CTD off deck
20/12/2016 20:19	37	-53.49249	-39.25027	CTD in water. Veering to 1000m
20/12/2016 20:39	37	-53.49266	-39.25101	CTD stopped at 1000m. Hauling to 500m
20/12/2016 21:06	37	-53.49267	-39.25105	CTD recovered to deck
20/12/2016 21:14	38	-53.49268	-39.25104	Bongo nets off deck
20/12/2016 21:15	38	-53.49268	-39.25104	Bongo nets in water. Veering
20/12/2016 21:20	38	-53.49269	-39.25104	Commence recovery of bongo nets
20/12/2016 21:29	38	-53.49268	-39.25104	Bongo nets recovered to deck
20/12/2016 21:43		-53.49287	-39.25106	Vessel off DP. Setting up for RMT-8 net deployment
20/12/2016 21:52		-53.49834	-39.25344	Vessel on DP whilst crew investigate technical issue with winch
20/12/2016 23:08		-53.49836	-39.25342	Winch fixed

20/12/2016 23:11		-53.49835	-39.25342	Vessel off DP steaming into wind at 2.5kts
20/12/2016 23:15		-53.49956	-39.25347	RMT-8 off deck
20/12/2016 23:19	39	-53.50226	-39.25351	RMT-8 Deployed
21/12/2016 00:30	39	-53.55442	-39.24594	RMT-8 recovered
21/12/2016 00:34		-53.55763	-39.24445	RMT-8 on deck
21/12/2016 00:37		-53.56003	-39.24333	Vessel underway target fishing en route to next CTD site
21/12/2016 02:37		-53.79365	-39.1781	Clear to deploy RMT-8
21/12/2016 02:39		-53.7926	-39.17688	RMT-8 off deck
21/12/2016 02:42	40	-53.79133	-39.1749	RMT-8 Deployed
21/12/2016 02:46		-53.78963	-39.17108	Recovering RMT-8
21/12/2016 02:52	40	-53.78713	-39.16545	RMT-8 recovered to surface
21/12/2016 02:56		-53.78538	-39.16149	RMT-8 on deck
21/12/2016 04:00	41	-53.86661	-39.14723	RMT8 off deck.
21/12/2016 04:04	41	-53.86399	-39.14766	RMT-8 in water.
21/12/2016 04:12	41	-53.8587	-39.14853	Commencing hauling.
21/12/2016 04:14	41	-53.85731	-39.14885	Gear on surface.
21/12/2016 04:20	41	-53.85271	-39.14966	RMT-8 on deck.
21/12/2016 04:25	42	-53.84882	-39.15013	RMT-8 off deck.
21/12/2016 04:28	42	-53.84678	-39.15025	RMT-8 in the water.
21/12/2016 05:05	42	-53.8209	-39.14515	Commenced hauling.
21/12/2016 05:34	42	-53.80222	-39.13608	RMT-8 on surface.
21/12/2016 05:39	42	-53.79869	-39.13408	RMT-8 on deck relocating for CTD.
21/12/2016 06:21	43	-53.84655	-39.14353	Vessel on DP on station
21/12/2016 06:25	43	-53.84643	-39.14331	CTD off deck.
21/12/2016 06:29	43	-53.84642	-39.14329	CTD in water.
21/12/2016 06:38	43	-53.84642	-39.14329	CTD at depth W/L 276m
21/12/2016 06:44	43	-53.84643	-39.1433	CTD on surface.
21/12/2016 06:46	43	-53.84643	-39.14331	CTD on deck.
21/12/2016 06:56	43	-53.84634	-39.14319	Gantry lashed off DP

21/12/2016 08:30		-54.01111	-38.81756	Vessel on DP at transect 2.1 holding position
21/12/2016 08:45		-54.01109	-38.81757	Vessel off DP. Commence transit to transect 2.1 start
21/12/2016 09:00		-53.99439	-38.81893	Commence WCB transect 2.1
21/12/2016 09:02	44	-53.99086	-38.82004	XBT in water
21/12/2016 09:03	44	-53.98926	-38.82051	XBT fully deployed
21/12/2016 10:09	45	-53.81701	-38.87422	XBT in water
21/12/2016 10:10	45	-53.81525	-38.8747	XBT fully deployed
21/12/2016 11:16	46	-53.64413	-38.92827	XBT Deployed
21/12/2016 11:22	46	-53.63444	-38.93135	XBT Released
21/12/2016 12:28	47	-53.46541	-38.98361	XBT deployed
21/12/2016 12:34	47	-53.45532	-38.98609	XBT released
21/12/2016 13:37	48	-53.28783	-39.03784	XBT deployed
21/12/2016 13:43	48	-53.27792	-39.04142	XBT released
21/12/2016 13:44		-53.2763	-39.04154	Northbound transect complete proceeding to WP2.2N
21/12/2016 14:44		-53.25415	-38.75126	Commenced southbound transect from WP2.2N proceeding to CTD site @ 10kts
21/12/2016 19:02		-53.96477	-38.52558	Transect 2.2 southbound complete. Relocating to CTD position.
21/12/2016 20:30		-53.78668	-38.58443	Vessel on DP at transect 2.2 CTD location
21/12/2016 20:38	49	-53.78555	-38.5836	CTD off deck
21/12/2016 20:39	49	-53.78551	-38.58365	CTD in water. Cable veering
21/12/2016 20:46	49	-53.78539	-38.58356	CTD stopped 10m above seabed. Cable veered 194m. EA600 depth 205m.
21/12/2016 20:51	49	-53.78542	-38.58354	CTD recovered to deck
21/12/2016 21:01		-53.78539	-38.58353	Vessel off DP. Commence transit to transect 3.2 southern CTD
21/12/2016 23:40		-53.73374	-37.99546	Vessel on DP at CTD site 3.2 South
22/12/2016 00:00		-53.71538	-37.96419	CTD off deck
22/12/2016 00:02	50	-53.71537	-37.96418	CTD Deployed
22/12/2016 00:08	50	-53.71537	-37.96418	CTD at depth. Wire out 125m. EA600 depth 132m. Commenced recovery.
22/12/2016 00:13	50	-53.71538	-37.9642	CTD recovered to surface
22/12/2016 00:15		-53.71536	-37.9642	CTD on deck
22/12/2016 00:31		-53.71524	-37.96387	Vessel off DP commencing RMT-8 deployment

22/12/2016 00:38	51	-53.71417	-37.95603	RMT-8 deployed
22/12/2016 01:15	51	-53.69538	-37.91866	RMT-8 recovered
22/12/2016 01:18		-53.69326	-37.91691	RMT-8 on deck
22/12/2016 01:29		-53.72505	-38.11279	Vessel proceeding to CTD site 2.2 South for RMT-8 deployment
22/12/2016 04:00		-53.79279	-38.55567	Vessel on station for RMT8 deployment - waiting on weather.
22/12/2016 06:30		-53.75097	-38.59015	Relocating to start point for transect 3.1 northbound.
22/12/2016 09:00	52	-53.92619	-38.22025	XBT in water. Commence transect 3.1 northbound
22/12/2016 09:01	52	-53.92471	-38.22077	XBT fully deployed
22/12/2016 10:36	53	-53.74974	-38.27772	XBT in water
22/12/2016 10:37	53	-53.74825	-38.27826	XBT fully deployed
22/12/2016 12:28	54	-53.57397	-38.33512	XBT deployed
22/12/2016 12:34	54	-53.56535	-38.33721	XBT released
22/12/2016 14:17	55	-53.39725	-38.3924	XBT deployed
22/12/2016 14:22	55	-53.38738	-38.39602	XBT released
22/12/2016 15:52	56	-53.21674	-38.4506	XBT deployed.
22/12/2016 15:56	56	-53.20953	-38.4527	XBT released.
22/12/2016 17:05		-53.18393	-38.14704	Commenced transect 3.2 southbound.
22/12/2016 21:30		-53.88947	-37.90726	Transect 3.2 complete. Commence transit to transect 2.2 CTD location
23/12/2016 00:54		-53.78587	-38.58236	Vessel on DP at CTD station 2.2 South for Bongo
23/12/2016 01:04		-53.78527	-38.58322	Bongo off deck
23/12/2016 01:05	57	-53.78526	-38.58322	Bongo deployed
23/12/2016 01:10	57	-53.78551	-38.58353	Bongo at depth (150m) commencing recovery
23/12/2016 01:28	57	-53.78705	-38.58523	Bongo recovered to surface
23/12/2016 01:31		-53.7873	-38.58555	Bongo on deck
23/12/2016 01:32		-53.78729	-38.58554	Bongo off deck
23/12/2016 01:33	58	-53.78734	-38.58559	Bongo deployed
23/12/2016 01:35	58	-53.78752	-38.58582	Bongo at depth (50m) recovering
23/12/2016 01:40	58	-53.78811	-38.58659	Bongo recovered to surface
23/12/2016 01:41		-53.78818	-38.58667	Bongo on deck

23/12/2016 01:57		-53.78805	-38.58757	Vessel off DP
23/12/2016 02:03		-53.78642	-38.59304	RMT-8 off deck
23/12/2016 02:06	59	-53.78494	-38.59711	RMT-8 deployed
23/12/2016 03:01	59	-53.76089	-38.66127	Gear on surface.
23/12/2016 03:08	59	-53.75807	-38.66874	RMT-8 on deck.
23/12/2016 03:30		-53.74803	-38.68296	Deck secure relocating to transect 4.1 start point.
23/12/2016 08:00	60	-53.87024	-37.72754	Commence transect 4.1. XBT in water
23/12/2016 08:01	60	-53.86851	-37.72799	XBT fully deployed
23/12/2016 09:27	61	-53.69435	-37.79499	XBT in water
23/12/2016 09:28	61	-53.69255	-37.79557	XBT fully deployed
23/12/2016 10:47	62	-53.51798	-37.84616	XBT in water
23/12/2016 10:51	62	-53.51107	-37.84835	XBT fully deployed
23/12/2016 12:03	63	-53.3399	-37.90509	XBT deployed
23/12/2016 12:09	63	-53.32911	-37.90908	XBT released
23/12/2016 13:18	64	-53.16257	-37.96454	XBT deployed
23/12/2016 13:24	64	-53.15404	-37.96764	XBT released
23/12/2016 14:09	65	-53.14861	-37.83191	XBT deployed
23/12/2016 14:14	65	-53.15778	-37.82887	XBT released
23/12/2016 15:16	66	-53.32666	-37.77256	XBT deployed.
23/12/2016 15:22	66	-53.33646	-37.76883	XBT released.
23/12/2016 16:26	67	-53.50309	-37.71277	XBT deployed.
23/12/2016 16:32	67	-53.51258	-37.709	XBT released.
23/12/2016 17:35	68	-53.67831	-37.6545	XBT deployed.
23/12/2016 17:37	68	-53.68133	-37.65306	XBT released.
23/12/2016 18:41	69	-53.85225	-37.59457	XBT deployed.
23/12/2016 18:43	69	-53.85525	-37.59367	XBT released. Transect 4.2 complete relocating to Cumberland Bay.
24/12/2016 13:56		-54.16015	-36.69274	Vessel anchored and remaining on DP in Stromness Bay. Ready to commence calibration work.
24/12/2016 14:23	70	-54.15876	-36.69474	CTD deployed
24/12/2016 14:27	70	-54.15879	-36.69469	CTD at depth (74m).

24/12/2016 14:31		-54.15878	-36.69473	Commenced CTD recovery.
24/12/2016 14:34	70	-54.15877	-36.6947	CTD recovered on deck.
24/12/2016 15:30		-54.15961	-36.69241	Echosounder calibration commenced.
25/12/2016 02:25		-54.15951	-36.69223	Echosounder calibrations complete for the day.
25/12/2016 17:45	71	-54.15842	-36.69407	Bongo off deck.
25/12/2016 17:48	71	-54.15841	-36.69408	Bongo in the water.
25/12/2016 18:04	71	-54.15841	-36.69405	Bongo on deck.
25/12/2016 20:00		-54.15845	-36.6941	Science preparation complete on deck. All equipment stowed and lashed ready for sea
26/12/2016 14:00		-53.80196	-37.9269	Vessel on DP
26/12/2016 14:10		-53.80114	-37.92833	Commenced move - 315* x 0.3 kts
26/12/2016 14:13	72	-53.80099	-37.92859	WCB Mooring - Float deployed
26/12/2016 14:44	72	-53.79803	-37.9336	WCB Mooring - Anchor deployed in 291 metres Lat: 53* 47.90'S Long: 037* 55.99'W
26/12/2016 18:33	73	-53.36223	-38.08055	Vessel on DP on station.
26/12/2016 18:53	73	-53.36157	-38.08207	Gantry unlashed.
26/12/2016 18:57	73	-53.36158	-38.08205	CTD off deck
26/12/2016 18:59	73	-53.36155	-38.08205	CTD in water. Veering to 1000m
26/12/2016 19:19	73	-53.36157	-38.08204	CTD stopped at 1000m
26/12/2016 19:43	73	-53.36157	-38.08207	CTD on deck
26/12/2016 19:54		-53.36158	-38.08225	Vessel off DP. Commence transit to transect 2.2N CTD location
26/12/2016 22:31		-53.42204	-38.57816	Transect 2.2NCTD station cancelled. Commence transit to P3 mooring location
27/12/2016 11:15		-52.80834	-40.11314	Vessel on DP at CTD site P3
27/12/2016 11:21		-52.80789	-40.11319	CTD off deck
27/12/2016 11:22	74	-52.80789	-40.11324	CTD deployed
27/12/2016 11:43	74	-52.80793	-40.11323	CTD at depth. Wire out 1000m. EA600 depth 3796m. Commenced recovery.
27/12/2016 12:16	74	-52.80789	-40.11325	CTD recovered
27/12/2016 12:18		-52.8079	-40.11322	CTD on deck
27/12/2016 12:19		-52.8079	-40.11321	Vessel remains on DP while team prepare for Mammoth net deployment.
27/12/2016 13:54	75	-52.80788	-40.11323	Mammoth net deployed
27/12/2016 14:42	75	-52.80789	-40.11325	Lost communications with Mammoth at 851 metres commencing slow recovery

27/12/2016 15:21	75	-52.80788	-40.11324	Mammoth on the surface.
27/12/2016 15:24	75	-52.80788	-40.11319	Mammoth on deck.
27/12/2016 15:53	76	-52.80787	-40.11323	Phytoplankton net in water.
27/12/2016 15:55	76	-52.80785	-40.11321	Phytoplankton net on deck.
27/12/2016 15:57	77	-52.80787	-40.11325	Phytoplankton net in water.
27/12/2016 15:59	77	-52.80786	-40.11322	Phytoplankton net on deck.
28/12/2016 00:10		-53.68106	-40.59762	Vessel on DP at SUCS site 2C
28/12/2016 00:13		-53.68102	-40.59776	USBL gate valve open pole flush
28/12/2016 00:18	78	-53.68106	-40.59776	SUCS deployed
28/12/2016 00:31	78	-53.68106	-40.59776	SUCS at bottom
28/12/2016 00:38		-53.68106	-40.59791	Commencing recovery
28/12/2016 00:50	78	-53.68107	-40.59792	SUCS recovered
28/12/2016 00:53		-53.68107	-40.59792	SUCS operation cancelled due to weather. Remaining on station on DP
28/12/2016 09:15		-53.68106	-40.5979	Weather reassessed and go ahead given for SUCS operations
28/12/2016 09:26	79	-53.68107	-40.59787	SUCS off deck
28/12/2016 09:30	79	-53.68106	-40.5979	SUCS in water
28/12/2016 09:43	79	-53.68105	-40.59782	SUCS on seabed. Commence imagery work. (EA600 depth 701m)
28/12/2016 10:18	79	-53.68068	-40.5991	Commence recovery of SUCS
28/12/2016 10:27		-53.6807	-40.5991	USBL pole retracted
28/12/2016 10:32	79	-53.68072	-40.59904	SUCS recovered to deck
28/12/2016 10:35		-53.68072	-40.59913	Vessel off DP. Commence transit to SUCS site 2B
28/12/2016 11:01		-53.68262	-40.66568	Vessel on DP at SUCS site 2B
28/12/2016 11:13		-53.68251	-40.66578	SUCS off deck
28/12/2016 11:14	80	-53.6825	-40.66581	SUCS deployed
28/12/2016 11:27	80	-53.68252	-40.66583	SUCS at bottom - 713m
28/12/2016 11:57	80	-53.68253	-40.66713	Commencing SUCS recovery
28/12/2016 12:11	80	-53.68254	-40.66716	SUCS recovered
28/12/2016 12:12		-53.68254	-40.66716	SUCS on deck
28/12/2016 12:16		-53.68255	-40.66717	Vessel off DP proceeding to SUCS site 2A

28/12/2016 12:46		-53.70953	-40.73319	Vessel on DP at SUCS site 2A
28/12/2016 12:53		-53.70949	-40.73324	SUCS off deck
28/12/2016 12:54	81	-53.7095	-40.73324	SUCS deployed
28/12/2016 13:07		-53.70956	-40.73362	SUCS at bottom
28/12/2016 13:44	81	-53.70983	-40.73465	Commencing SUCS recovery
28/12/2016 13:59	81	-53.70982	-40.73463	SUCS recovered
28/12/2016 14:00		-53.70983	-40.73466	SUCS on deck. Vessel remaining on DP for Bio wire load test.
28/12/2016 14:53		-53.70983	-40.73468	Vessel off DP and proceeding to site P3.
28/12/2016 20:42		-52.80848	-40.11373	Vessel on DP at P3 location
28/12/2016 22:06	82	-52.80867	-40.11374	MUDL deployed (test)
28/12/2016 22:11	82	-52.80868	-40.11375	MUDL recovered to deck (test)
28/12/2016 22:23	83	-52.80868	-40.11375	MUDL off deck
28/12/2016 22:24	83	-52.80867	-40.11378	MUDL deployed
28/12/2016 22:27	83	-52.80865	-40.11376	MUDL stopped at 100m (for ~ 30 mins)
28/12/2016 22:59	83	-52.80864	-40.11377	Commence recovery of MUDL
28/12/2016 23:05	83	-52.80866	-40.11376	MUDL recovered and on deck
28/12/2016 23:51		-52.80868	-40.11377	CTD off deck
28/12/2016 23:52	84	-52.80868	-40.11375	CTD deployed
28/12/2016 23:57	84	-52.80868	-40.11378	CTD at depth. Wire out 100m. EA600 depth 3878m.
29/12/2016 00:11	84	-52.80869	-40.11373	Commenced CTD recovery
29/12/2016 00:14	84	-52.80868	-40.11378	CTD recovered.
29/12/2016 00:16		-52.80868	-40.11377	CTD on deck
29/12/2016 00:34		-52.80867	-40.11377	MUDL off deck
29/12/2016 00:35	85	-52.80866	-40.11375	MUDL deployed
29/12/2016 00:39	85	-52.80866	-40.11377	MUDL at depth (100m) for 40 minutes
29/12/2016 01:19	85	-52.80866	-40.11373	Commenced MUDL recovery
29/12/2016 01:26	85	-52.80868	-40.11374	MUDL recovered
29/12/2016 01:28		-52.80868	-40.11372	MUDL on deck
29/12/2016 02:00	86	-52.81084	-40.12077	MOCNESS deployed

29/12/2016 03:34	86	-52.85345	-40.21497	MOCNESS at depth W/L 2640m commencing hauling.
29/12/2016 03:45	86	-52.85857	-40.2252	Hauling stopped trawl winch spooling gear defect.
29/12/2016 05:04	86	-52.89781	-40.30524	Spooling chain replaced hauling re-commenced.
29/12/2016 06:31	86	-52.94325	-40.39379	MOCNESS on surface.
29/12/2016 06:35	86	-52.94551	-40.39774	MOCNESS on deck.
29/12/2016 06:46	86	-52.95194	-40.40906	Deck secure relocating to P3.
29/12/2016 08:10		-52.80858	-40.11303	Vessel on DP at P3 site
29/12/2016 08:18	87	-52.80861	-40.11342	CTD off deck
29/12/2016 08:19	87	-52.80862	-40.11345	CTD in water
29/12/2016 08:21	87	-52.80861	-40.1135	CTD veering to near bottom. EA600 depth 3785m
29/12/2016 09:27	87	-52.80868	-40.11375	CTD stopped. Cable veered 3740m
29/12/2016 10:15		-52.80869	-40.11369	Commence move astern at 0.2 kts. (ice berg avoidance)
29/12/2016 10:46	87	-52.80745	-40.11169	CTD recovered to deck
29/12/2016 10:55		-52.80712	-40.1111	Vessel off DP. Commence transit to mooring deployment site
29/12/2016 11:27		-52.78711	-40.05786	Vessel on DP; standing by for mooring deployment. Currently tracking berg in the deployment position.
29/12/2016 11:49		-52.78807	-40.05762	Vessel off DP and moving to revised position.
29/12/2016 12:23		-52.7987	-40.12755	Vessel on DP for mooring deployment.
29/12/2016 12:41		-52.79866	-40.12768	Vessel commenced move (240*x0.5kts) for deployment.
29/12/2016 12:44	88	-52.79887	-40.12829	Commenced deployment of P3 mooring.
29/12/2016 12:46		-52.79903	-40.12867	Mooring buoy deployed.
29/12/2016 13:10		-52.8007	-40.13344	1st sediment trap deployed.
29/12/2016 14:09		-52.80616	-40.14898	2nd sediment trap deployed.
29/12/2016 15:22	88	-52.81375	-40.17078	Clump weight slipped in 3789m water depth.
29/12/2016 15:45	88	-52.81547	-40.17574	Commencing ranging.
29/12/2016 17:09	88	-52.81725	-40.17293	Ranging complete.
29/12/2016 17:20	89	-52.81868	-40.17727	MOCNESS off deck.
29/12/2016 17:24	89	-52.82117	-40.18137	MOCNESS in the water.
29/12/2016 18:39	89	-52.85901	-40.23992	MOCNESS at depth W/L 2125m

29/12/2016 18:43	89	-52.86039	-40.24261	Commenced hauling.
29/12/2016 20:33	89	-52.90729	-40.32637	MOCNESS at surface
29/12/2016 20:35	89	-52.90812	-40.32831	MOCNESS recovered to deck
29/12/2016 20:48		-52.91262	-40.3405	Vessel on DP
29/12/2016 20:58	91	-52.91268	-40.34083	Reissmann apex float 006 deployed
29/12/2016 21:13	90	-52.91373	-40.3442	MUDL off deck
29/12/2016 21:14	90	-52.91372	-40.34417	MUDL in water. Veering to 100m. (Vessel moving to port at 0.2kts to counter lead on wire)
29/12/2016 21:18	90	-52.91384	-40.34401	MUDL stopped at 100m (~20mins)
29/12/2016 21:39	90	-52.91444	-40.34299	Commence recovery of MUDL
29/12/2016 21:44	90	-52.91463	-40.3427	MUDL recovered to deck
29/12/2016 21:53		-52.91471	-40.3426	Vessel off DP. Commence transit to P2 location
30/12/2016 12:01		-55.25193	-41.25596	Vessel on DP at P2
30/12/2016 12:07	92	-55.25189	-41.25587	Release signal transmitted
30/12/2016 12:09		-55.25189	-41.25587	Mooring released
30/12/2016 12:13		-55.25188	-41.2559	Mooring surfaced and sighted. Commenced move on DP for recovery.
30/12/2016 12:23	92	-55.2472	-41.25731	Mooring retrieved
30/12/2016 12:33	92	-55.24601	-41.25752	Float on deck
30/12/2016 13:02		-55.24498	-41.26415	1st sediment trap on deck
30/12/2016 13:46		-55.24521	-41.27188	2nd sediment trap on deck
30/12/2016 14:04	92	-55.24525	-41.27447	Acoustic release on deck; mooring fully recovered. Vessel remaining on DP for bio-wire test deployment.
30/12/2016 14:33	93	-55.24437	-41.27396	Bio-wire test weight deployed
30/12/2016 15:45	93	-55.24431	-41.27396	Winch stopped W/L 2614m
30/12/2016 16:05	93	-55.24428	-41.274	Commenced hauling.
30/12/2016 17:52	93	-55.24433	-41.27414	Test weight on surface.
30/12/2016 17:54	93	-55.24433	-41.27416	Test weight on deck.
30/12/2016 18:05	94	-55.24431	-41.27416	Gantry unlashed.
30/12/2016 18:14	94	-55.24428	-41.27414	CTD off deck.
30/12/2016 18:15	94	-55.24427	-41.27412	CTD in water.

30/12/2016 18:16	94	-55.24428	-41.27411	CTD left surface.
30/12/2016 18:35	94	-55.24437	-41.27401	CTD at depth W/L 1000m EA600 depth 3393m commencing recovery.
30/12/2016 19:14	94	-55.24438	-41.274	CTD recovered to deck
30/12/2016 19:26		-55.24452	-41.27394	Vessel off DP. Vessel head to wind at 2.0kts (water speed) for MOCNESS deployment
30/12/2016 19:28	95	-55.24571	-41.27316	Commence MOCNESS deployment
30/12/2016 19:30	95	-55.24715	-41.2721	MOCNESS in water. Cable veering
30/12/2016 20:43	95	-55.28826	-41.25545	MOCNESS stopped at W/L 1990m. EA600 depth 3479m. Commenced hauling.
30/12/2016 22:15	95	-55.33948	-41.24447	MOCNESS at surface
30/12/2016 22:19	95	-55.34176	-41.24449	MOCNESS recovered to deck
30/12/2016 22:25		-55.34567	-41.2451	Commence transit to MOCNESS (event 095) deployment location for MUDL
30/12/2016 23:11		-55.26995	-41.26068	Vessel on DP for MUDL deployments
30/12/2016 23:24	96	-55.24587	-41.27284	MUDL deployed
30/12/2016 23:27	96	-55.27874	-41.25838	MUDL @ depth (80m). Deployed for 30 minutes.
30/12/2016 23:56		-55.24627	-41.27162	Commenced recovery of MUDL
31/12/2016 00:02	96	-55.24662	-41.27064	MUDL recovered
31/12/2016 00:04		-55.24677	-41.27021	MUDL on deck
31/12/2016 00:13	97	-55.24682	-41.27012	MUDL deployed
31/12/2016 00:18	97	-55.24714	-41.26917	MUDL @ depth (100m). Deployed for 30 minutes.
31/12/2016 00:49		-55.2475	-41.26812	Commenced MUDL recovery
31/12/2016 00:54	97	-55.24799	-41.26664	MUDL recovered
31/12/2016 00:55		-55.24807	-41.26642	MUDL on deck
31/12/2016 01:17		-55.24826	-41.26651	Vessel off DP for MOCNESS deployment
31/12/2016 01:24	98	-55.25254	-41.2685	MOCNESS deployed
31/12/2016 02:07	98	-55.2694	-41.27636	MOCNESS @ depth (1158m)
31/12/2016 02:31		-55.28107	-41.28104	Commenced recovery.
31/12/2016 04:20	98	-55.33535	-41.29252	Gear on surface.
31/12/2016 04:24	98	-55.33701	-41.29281	MOCNESS on deck.
31/12/2016 04:35		-55.3418	-41.29376	V/L on DP.
31/12/2016 05:04	99	-55.34231	-41.29352	Gantry unlashed.

31/12/2016 05:09	99	-55.34231	-41.29351	MUDL off deck.
31/12/2016 05:10	99	-55.34231	-41.29352	MUDL in water.
31/12/2016 05:15	99	-55.34176	-41.29254	MUDL at depth W/L 80m.
31/12/2016 05:41	99	-55.3363	-41.2829	MUDL left bottom.
31/12/2016 05:47	99	-55.33495	-41.28056	MUDL on surface.
31/12/2016 05:50	99	-55.33485	-41.28036	MUDL on deck.
31/12/2016 05:56	100	-55.33485	-41.28036	MUDL off deck.
31/12/2016 05:58	100	-55.33479	-41.28029	MUDL in water.
31/12/2016 06:02	100	-55.33408	-41.27899	MUDL at depth W/L 100m.
31/12/2016 06:29	100	-55.33121	-41.27399	MUDL left bottom.
31/12/2016 06:36	100	-55.33008	-41.272	MUDL on surface.
31/12/2016 06:38	100	-55.32976	-41.27148	MUDL on deck.
31/12/2016 06:59	102	-55.32955	-41.2711	Bongo off deck
31/12/2016 07:00	102	-55.32956	-41.27112	Bongo in water. Veering to 100m
31/12/2016 07:03	102	-55.32925	-41.27066	Bongo stopped at 100m. Commence hauling
31/12/2016 07:11	102	-55.3278	-41.26853	Bongo recovered to deck
31/12/2016 07:20		-55.32778	-41.26847	Vessel off DP. Commence transit to P2A mooring location
31/12/2016 07:58		-55.24829	-41.26186	Vessel on DP at P2A mooring location
31/12/2016 08:19	101	-55.24856	-41.26206	CTD off deck
31/12/2016 08:21	101	-55.24856	-41.26209	CTD in water. Veering to depth. EA600 3370m
31/12/2016 09:21	101	-55.24859	-41.26209	CTD stopped at depth. W/L 3321m. Commence hauling
31/12/2016 10:28	101	-55.24854	-41.2621	CTD recovered to deck
31/12/2016 10:32		-55.24871	-41.26242	Vessel off DP. Commence transit to P2 deployment site
31/12/2016 10:45		-55.24928	-41.28935	Vessel on DP 4500m downwind from P2 deployment site
31/12/2016 11:14		-55.24933	-41.28936	Vessel off DP for swath survey to determine revised mooring deployment location.
31/12/2016 12:46		-55.23541	-41.17638	Vessel on DP for mooring deployment
31/12/2016 12:53		-55.23564	-41.17714	Float off deck
31/12/2016 12:56	103	-55.23575	-41.17781	Float deployed.
31/12/2016 15:21	103	-55.24975	-41.23278	Clump weight released. Relocating for ranging.

31/12/2016 15:52	103	-55.25223	-41.23723	1st P2 Mooring ranging position. 3398m = 941m. Vessel moving to 2nd ranging position
31/12/2016 16:17	103	-55.23846	-41.22274	2nd P2 Mooring range. 3477m = 1196m. Vessel moving to 3rd ranging position
31/12/2016 16:42	103	-55.25203	-41.20799	3rd P2 Mooring ranging position 3488m = 1227m
31/12/2016 17:13	104	-55.26326	-41.20792	In position for Bongo net.
31/12/2016 17:36	104	-55.26329	-41.20829	Gantry unlashed.
31/12/2016 17:44	104	-55.26329	-41.20827	Bongo in water.
31/12/2016 17:46	104	-55.26324	-41.20801	At depth W/L 100m recovering.
31/12/2016 17:50	104	-55.26308	-41.20731	Bongo on deck.
31/12/2016 17:52	105	-55.26307	-41.20729	Bongo in water.
31/12/2016 17:55	105	-55.263	-41.20691	At depth W/L 100m recovering.
31/12/2016 18:00	105	-55.26268	-41.20536	Bongo on deck.
31/12/2016 18:02	106	-55.26257	-41.20481	Bongo in water.
31/12/2016 18:04	106	-55.26243	-41.20417	W/L 50m recovering.
31/12/2016 18:06	106	-55.26226	-41.20333	Bongo on deck.
31/12/2016 18:08	107	-55.26211	-41.20267	Bongo in water.
31/12/2016 18:09	107	-55.26204	-41.20227	W/L 50m recovering.
31/12/2016 18:12	107	-55.26174	-41.20086	Bongo on deck.
31/12/2016 18:14	108	-55.26158	-41.20011	Bongo in water.
31/12/2016 18:17	108	-55.26139	-41.19915	W/L 100m recovering.
31/12/2016 18:19	108	-55.26132	-41.1988	Bongo on deck.
31/12/2016 18:21	109	-55.26123	-41.19832	Bongo in water.
31/12/2016 18:23	109	-55.26108	-41.19766	W/L 100m recovering.
31/12/2016 18:29	109	-55.26083	-41.19644	Bongo on deck.
31/12/2016 18:30	109	-55.26079	-41.19623	Bongo netting complete.
31/12/2016 21:02	ARVOR float 110	-55.26089	-41.19639	Arvor float AL2500-16DE003 deployed. (Vessel moving ahead on DP at 1.5kts)
31/12/2016 21:05		-55.26151	-41.19831	Personnel working on issue with RMT net
31/12/2016 21:37	111	-55.26174	-41.19904	CTD off deck
31/12/2016 21:38	111	-55.26174	-41.19904	CTD in water. Veering to 100m. EA600 depth 3272m

31/12/2016 21:42	111	-55.26172	-41.19904	CTD stopped at 100m
31/12/2016 21:57	111	-55.26173	-41.19905	CTD recovered to deck
31/12/2016 22:33		-55.26169	-41.19906	Vessel off DP for RMT-25 deployment
31/12/2016 22:39	112	-55.26164	-41.20317	RMT25 deployed.
01/01/2017 00:02	112	-55.25898	-41.26033	RMT25 at depth (1532m); commenced recovery.
01/01/2017 01:22	112	-55.26119	-41.3155	RMT25 recovered to surface.
01/01/2017 01:31		-55.26194	-41.3199	RMT25 fully recovered to deck.
01/01/2017 01:41		-55.26264	-41.32449	Vessel on DP. Standing by for next RMT25 deployment.
01/01/2017 02:52		-55.26268	-41.32467	Vessel off DP for RMT-25 deployment
01/01/2017 03:00	113	-55.26318	-41.32947	RMT25 off deck.
01/01/2017 03:03	113	-55.26397	-41.33268	RMT25 in water.
01/01/2017 03:50	113	-55.28839	-41.34993	Commenced hauling.
01/01/2017 04:47	113	-55.30242	-41.37676	RMT25 on surface.
01/01/2017 04:59	113	-55.30548	-41.38725	RMT25 on deck vessel on DP.
01/01/2017 05:23	114	-55.30803	-41.38814	MUDL off deck.
01/01/2017 05:24	114	-55.30804	-41.38815	MUDL in water.
01/01/2017 05:29	114	-55.30794	-41.38734	MUDL on deck - depth recorder fault.
01/01/2017 05:50	115	-55.30793	-41.38706	MUDL off deck.
01/01/2017 05:52	115	-55.30793	-41.38706	MUDL in water.
01/01/2017 06:00	115	-55.30788	-41.38657	MUDL on deck.
01/01/2017 06:02	116	-55.30783	-41.38632	MUDL off deck.
01/01/2017 06:04	116	-55.30783	-41.38621	MUDL in water.
01/01/2017 06:36	116	-55.30767	-41.38468	Left bottom W/L 100m
01/01/2017 06:44	116	-55.30756	-41.38357	MUDL on deck.
01/01/2017 07:04	117	-55.30754	-41.38349	MUDL off deck
01/01/2017 07:05	117	-55.30754	-41.38349	MUDL in water
01/01/2017 07:10	117	-55.3074	-41.38207	MUDL stopped at 100m (~30mins)(Vessel moving ahead at 0.5kts to counter wire lead)
01/01/2017 07:44	117	-55.30626	-41.37604	MUDL recovered to deck
01/01/2017 07:55	118	-55.30622	-41.37602	MUDL off deck

01/01/2017 07:56	118	-55.30623	-41.376	MUDL in water
01/01/2017 07:58	118	-55.3062	-41.37574	MUDL stopped at 60m (~30mins)(Vessel moving ahead at 0.5 kts to counter wire lead)
01/01/2017 08:32	118	-55.30525	-41.37024	MUDL recovered to deck
01/01/2017 08:52	119	-55.30517	-41.37023	Bongo off deck
01/01/2017 08:53	119	-55.30516	-41.37021	Bongo in water
01/01/2017 08:57	119	-55.30494	-41.36961	Bongo stopped at 100m
01/01/2017 09:06	119	-55.30387	-41.36878	Bongo recovered to deck
01/01/2017 09:18		-55.30386	-41.36876	Vessel off DP. Commence transit to P2 for 0700 (LT) arrival
01/01/2017 09:59		-55.25316	-41.25856	Commence PF transect at 10.0kts
01/01/2017 11:37	120	-55.19494	-41.70011	XBT deployed.
01/01/2017 11:43	120	-55.19246	-41.71762	XBT released.
01/01/2017 13:49		-55.11933	-42.26641	Vessel on DP for CTD.
01/01/2017 14:01		-55.11936	-42.26609	CTD off deck.
01/01/2017 14:03	121	-55.11937	-42.26609	CTD deployed.
01/01/2017 14:22	121	-55.11941	-42.26616	CTD @ depth (1000m); commenced recovery.
01/01/2017 14:48	121	-55.11937	-42.26609	CTD recovered.
01/01/2017 14:50		-55.1194	-42.26611	CTD on deck.
01/01/2017 15:01		-55.11926	-42.27015	Vessel off DP.
01/01/2017 17:18	122	-55.04259	-42.8439	XBT deployed.
01/01/2017 17:23	122	-55.04074	-42.85838	XBT released.
01/01/2017 19:14		-54.98313	-43.31574	Vessel on DP waiting on weather
02/01/2017 08:00		-54.98339	-43.31539	Weather reassessed for CTD. Cancelled due to opposing swell and wind (gusting F7)
02/01/2017 09:30		-54.9834	-43.31542	Vessel off DP. Resuming PF transect at 10.0 kts
02/01/2017 11:00	123	-54.925	-43.68154	XBT deployed. Speed reduced to 6.0 kts
02/01/2017 11:05	123	-54.92232	-43.69884	XBT released. Speed increased back up to 10.0kts
02/01/2017 13:15		-54.83887	-44.2625	Vessel on DP for CTD deployment.
02/01/2017 13:18		-54.83881	-44.26263	CTD off deck.
02/01/2017 13:19	124	-54.83881	-44.26258	CTD deployed.
02/01/2017 13:39	124	-54.83881	-44.26254	CTD @ depth (1000m); commenced recovery.

02/01/2017 14:06	124	-54.83884	-44.26258	CTD recovered.
02/01/2017 14:08		-54.83882	-44.26257	CTD on deck.
02/01/2017 14:15		-54.83882	-44.26255	Vessel off DP.
02/01/2017 16:28	125	-54.75687	-44.81946	XBT deployed.
02/01/2017 16:30	125	-54.75616	-44.82429	XBT released.
02/01/2017 18:05		-54.6934	-45.24148	Vessel on DP reconfiguring aft deck.
02/01/2017 18:38		-54.69175	-45.24304	Off DP increasing to shooting speed for MOCNESS.
02/01/2017 18:45	126	-54.68866	-45.24011	MOCNESS off deck.
02/01/2017 18:48	126	-54.68672	-45.23826	MOCNESS in water.
02/01/2017 21:00	126	-54.62785	-45.19243	MOCNESS at surface
02/01/2017 21:03	126	-54.6265	-45.19183	MOCNESS recovered to deck
02/01/2017 21:18		-54.61948	-45.18847	Commence transit to PF2 site
02/01/2017 21:53		-54.69366	-45.24291	Vessel on DP at PF2 site
02/01/2017 22:05	127	-54.69367	-45.24291	MUDL off deck
02/01/2017 22:06	127	-54.69368	-45.2429	MUDL in water
02/01/2017 22:09	127	-54.69363	-45.24289	MUDL stopped at 100m (~20mins)
02/01/2017 22:37	127	-54.69365	-45.2429	Commence hauling MUDL
02/01/2017 22:43	127	-54.69365	-45.24288	MUDL recovered to deck
02/01/2017 22:51	128	-54.69367	-45.24289	MUDL off deck
02/01/2017 22:52	128	-54.69367	-45.24291	MUDL in water
02/01/2017 22:55	128	-54.69366	-45.2429	MUDL @ depth (80m).
02/01/2017 23:23		-54.69367	-45.2429	Commenced recovery.
02/01/2017 23:29	128	-54.69367	-45.2429	MUDL recovered.
03/01/2017 00:00		-54.69359	-45.24284	Vessel off DP and proceeding @ 2kts into wind for RMT25 deployment.
03/01/2017 00:02		-54.69279	-45.24196	Commenced RMT25 deployment.
03/01/2017 00:11	129	-54.68902	-45.23729	RMT25 deployed.
03/01/2017 00:42	129	-54.67554	-45.21932	Commenced recovery of RMT25 from 568m.
03/01/2017 01:59		-54.64116	-45.17061	RMT25 at surface.
03/01/2017 02:20	129	-54.63374	-45.15997	RMT25 recovered.

03/01/2017 02:22		-54.63311	-45.15921	Vessel on DP; standing by for next RMT25 deployment.
03/01/2017 02:41		-54.63298	-45.15907	Vessel off DP for RMT25 deployment.
03/01/2017 02:45		-54.6312	-45.15728	Commenced RMT25 deployment.
03/01/2017 03:00	130	-54.69359	-45.24284	RMT25 deployed.
03/01/2017 03:50	130	-54.60188	-45.12525	Net at depth W/L 1349m.
03/01/2017 03:54	130	-54.60053	-45.12354	Commenced hauling.
03/01/2017 05:44	130	-54.54912	-45.09706	RMT25 on surface.
03/01/2017 06:03	130	-54.53883	-45.09406	Gear on deck vessel on DP.
03/01/2017 06:13		-54.538	-45.09366	Gantry unlashed.
03/01/2017 06:19	131	-54.53795	-45.09374	MUDL in water.
03/01/2017 06:23	131	-54.53795	-45.09374	MUDL at depth W/L 100m.
03/01/2017 06:50	131	-54.53798	-45.09374	Commenced recovery.
03/01/2017 06:59	131	-54.53798	-45.09372	MUDL on deck.
03/01/2017 07:08	132	-54.53796	-45.09373	MUDL off deck
03/01/2017 07:09	132	-54.53797	-45.09371	MUDL in water
03/01/2017 07:12	132	-54.53798	-45.09369	MUDL stopped at 80m (~30mins)
03/01/2017 07:47	132	-54.53797	-45.09369	MUDL recovered to deck
03/01/2017 07:55	133	-54.53797	-45.09367	Mini bongo's off deck
03/01/2017 07:56	133	-54.538	-45.09365	Mini bongo's in water
03/01/2017 07:59	133	-54.53795	-45.09371	Mini bongo's stopped at 100m
03/01/2017 08:08	133	-54.53795	-45.09369	Mini bongo's recovered to deck
03/01/2017 08:26	134	-54.53798	-45.09371	CTD off deck
03/01/2017 08:27	134	-54.53799	-45.09369	CTD in water
03/01/2017 08:49	134	-54.53799	-45.09371	CTD stopped at 1000m (EA600 depth 3731m)
03/01/2017 09:26	134	-54.53798	-45.0937	CTD recovered to deck
03/01/2017 09:30		-54.53796	-45.09368	Vessel off DP. Resuming PF transect
03/01/2017 11:37	135	-54.6178	-45.66638	XBT deployed.
03/01/2017 11:39	135	-54.61694	-45.67153	XBT released.
03/01/2017 13:52		-54.51777	-46.22422	Vessel on DP for CTD and bio-wire maintenance.

03/01/2017 13:58		-54.51787	-46.2236	CTD off deck.
03/01/2017 13:59	136	-54.51787	-46.22361	CTD deployed.
03/01/2017 14:21	136	-54.51789	-46.22357	CTD @ depth (1000m); commenced recovery.
03/01/2017 14:48	136	-54.51789	-46.22358	CTD recovered.
03/01/2017 14:50		-54.51789	-46.22359	CTD on deck. Vessel remains on DP for bio-wire maintenance.
03/01/2017 16:10	137	-54.51786	-46.22355	Test weight off deck.
03/01/2017 16:11	137	-54.51786	-46.22354	Test weight in water.
03/01/2017 17:18	137	-54.51786	-46.22365	Winch stopped W/L 2817m.
03/01/2017 17:35	137	-54.51788	-46.22371	Commenced hauling.
03/01/2017 18:44	137	-54.5179	-46.22365	Test weight on deck.
03/01/2017 19:21		-54.51789	-46.22362	Vessel off DP. Resuming PF transect
03/01/2017 21:32	139	-54.41741	-46.77991	XBT deployed.
03/01/2017 21:38	139	-54.41385	-46.79648	XBT released.
03/01/2017 23:30		-54.33968	-47.21099	Science operations cancelled overnight due to weather conditions. Vessel hove to at PF3.
04/01/2017 08:07		-54.3395	-47.20186	Vessel on DP at PF3 site
04/01/2017 08:17	138	-54.34039	-47.20261	CTD off deck
04/01/2017 08:19	138	-54.34043	-47.20267	CTD in water (vessel moving 0.5kts astern to counter wire lead)
04/01/2017 08:40	138	-54.33903	-47.20217	CTD stopped at 1000m (EA600 depth 3640m)
04/01/2017 09:02	138	-54.3368	-47.20133	CTD on deck
04/01/2017 09:10		-54.33677	-47.20133	Vessel off DP. Resuming PF transect at 10.0 kts
04/01/2017 10:52	141	-54.25114	-47.62023	XBT in water (vessel slowed to 6.0kts)
04/01/2017 10:57	141	-54.24825	-47.63368	XBT released (speed increased to 10.0kts)
04/01/2017 13:00		-54.13355	-48.16424	Vessel on DP for CTD deployment.
04/01/2017 13:10		-54.13349	-48.16434	CTD off deck.
04/01/2017 13:12	140	-54.13349	-48.16429	CTD deployed.
04/01/2017 13:33	140	-54.1331	-48.16617	CTD @ depth (1000m); commenced recovery.
04/01/2017 14:00	140	-54.13127	-48.17453	CTD recovered.
04/01/2017 14:01		-54.13121	-48.17482	CTD on deck.
04/01/2017 14:12		-54.1302	-48.17964	Vessel off DP and resuming PF transect.

04/01/2017 16:10	142	-54.01945	-48.69391	XBT deployed.
04/01/2017 16:15	142	-54.01644	-48.70693	XBT released.
04/01/2017 18:12	143	-53.93598	-49.06933	MOCNESS off deck.
04/01/2017 18:13	143	-53.93562	-49.07076	MOCNESS in water.
04/01/2017 19:30	143	-53.92903	-49.15253	MOCNESS stopped at W/L 2000m. Commence hauling
04/01/2017 20:51	143	-53.93567	-49.22203	MOCNESS at surface
04/01/2017 20:54	143	-53.93615	-49.22453	MOCNESS on deck
04/01/2017 20:55		-53.9363	-49.22538	Commence transit to PF4 site
04/01/2017 21:23		-53.92988	-49.15381	Vessel on DP 1.7NM west of PF4 site
04/01/2017 21:31	144	-53.92998	-49.15389	Mini bongo off deck
04/01/2017 21:32	144	-53.92998	-49.1539	Mini bongo in water
04/01/2017 21:33	144	-53.92999	-49.15389	Mini bongo stopped at 70m
04/01/2017 21:37	144	-53.92997	-49.1539	Mini bongo recovered to deck
04/01/2017 21:42	145	-53.92998	-49.15393	MUDL off deck
04/01/2017 21:43	145	-53.92998	-49.15392	MUDL in water
04/01/2017 21:46	145	-53.92998	-49.15391	MUDL stopped at 100m for 29mins
04/01/2017 22:20	145	-53.92637	-49.15167	MUDL recovered to deck
04/01/2017 22:43		-53.92637	-49.15171	Vessel off DP. Head to wind at 1.5kts for RMT-25
04/01/2017 22:48	146	-53.92784	-49.15319	Commence deploying RMT-25
04/01/2017 22:58	146	-53.93061	-49.1566	RMT-25 deployed
04/01/2017 23:44	146	-53.94385	-49.1722	RMT25 @ depth (1171m); commenced recovery.
05/01/2017 01:34		-53.97115	-49.21865	Commenced recovery of RMT25.
05/01/2017 01:46	146	-53.97544	-49.22484	RMT25 recovered.
05/01/2017 01:47		-53.97584	-49.22544	Vessel on DP: standing by for next RMT25 deployment.
05/01/2017 02:15		-53.97641	-49.22738	Vessel off DP.
05/01/2017 02:26	147	-53.97124	-49.23132	RMT25 deployed.
05/01/2017 03:11	147	-53.94909	-49.24781	Commenced hauling.
05/01/2017 04:09	147	-53.91666	-49.27085	Gear on surface.
05/01/2017 04:22	147	-53.90873	-49.2757	Gear on deck. V/L on DP.

05/01/2017 04:41	148	-53.906	-49.2762	MUDL off deck.
05/01/2017 04:42	148	-53.906	-49.2762	MUDL in water.
05/01/2017 04:46	148	-53.906	-49.27622	MUDL at depth W/L 100m.
05/01/2017 05:12	148	-53.90587	-49.27593	Commenced hauling.
05/01/2017 05:21	148	-53.9056	-49.27537	MUDL on deck.
05/01/2017 05:28	149	-53.90548	-49.27512	MUDL in water.
05/01/2017 05:32	149	-53.90542	-49.27496	MUDL at depth W/L 100m. hauling.
05/01/2017 05:41	149	-53.90515	-49.27443	MUDL on deck.
05/01/2017 06:02	150	-53.90491	-49.27397	CTD off deck.
05/01/2017 06:04	150	-53.90492	-49.27397	CTD in water.
05/01/2017 06:06	150	-53.90491	-49.27399	Left surface.
05/01/2017 06:25	150	-53.90491	-49.27398	CTD at depth W/L 1000m EA600 depth 4323m commencing recovery.
05/01/2017 07:05	150	-53.9049	-49.27397	CTD recovered to deck
05/01/2017 07:16		-53.90491	-49.27397	Vessel off DP. Resuming PF transect at 10.0kts
05/01/2017 08:21	151	-53.84481	-49.5128	XBT deployed (speed reduced to 6.0kts)
05/01/2017 08:22	151	-53.84424	-49.51553	XBT failed
05/01/2017 08:24	152	-53.84308	-49.52106	XBT deployed
05/01/2017 08:30	152	-53.83982	-49.53718	XBT released (speed increased to 10.0kts)
05/01/2017 10:30	153	-53.732	-50.05464	XBT deployed (speed reduced to 6.0kts)
05/01/2017 10:32	153	-53.73086	-50.06018	XBT failed
05/01/2017 10:36	154	-53.72856	-50.07123	XBT deployed
05/01/2017 10:37	154	-53.72799	-50.07392	XBT failed (speed increased to 10.0kts)
05/01/2017 12:36	155	-53.62097	-50.58477	XBT deployed
05/01/2017 12:41	155	-53.61816	-50.59793	XBT released (speed increased to 10.0kts)
05/01/2017 14:14	156	-53.53565	-50.99256	XBT deployed
05/01/2017 14:19	156	-53.53283	-51.00613	XBT released (speed increased to 10.0kts)
05/01/2017 15:48	157	-53.44385	-51.38239	XBT deployed.
05/01/2017 15:53	157	-53.44105	-51.39437	XBT released.
05/01/2017 17:54	158	-53.32076	-51.90231	XBT deployed.

05/01/2017 18:00	158	-53.31737	-51.91735	XBT released.
05/01/2017 19:00		-53.25815	-52.16693	A/C Head to wind at 1.5-2.0kts for MOCNESS
05/01/2017 19:18	159	-53.26482	-52.17541	MOCNESS deployed
05/01/2017 20:17	159	-53.28154	-52.18235	MOCNESS stopped at W/L 1422m
05/01/2017 21:13	159	-53.29895	-52.18808	MOCNESS at surface
05/01/2017 21:16	159	-53.29964	-52.18823	MOCNESS recovered to deck
05/01/2017 21:20		-53.30051	-52.18841	Commence transit to PF6 site
05/01/2017 21:49		-53.25761	-52.16833	Vessel on DP at PF6 site
05/01/2017 21:56	160	-53.25767	-52.16837	MUDL off deck
05/01/2017 21:57	160	-53.25767	-52.16838	MUDL in water (vessel moving 1-1.5kts astern to counter wire lead)
05/01/2017 22:00	160	-53.25745	-52.16803	MUDL stopped at 125m
05/01/2017 22:08	160	-53.25566	-52.16552	MUDL recovered to deck
05/01/2017 22:09	161	-53.25565	-52.16553	MUDL off deck and in water (vessel moving 1-1.5kts astern to counter wire lead)
05/01/2017 22:12	161	-53.25539	-52.16515	MUDL stopped at 125m
05/01/2017 22:20	161	-53.25372	-52.16287	MUDL recovered to deck
05/01/2017 22:31	162	-53.25249	-52.16117	MUDL off deck
05/01/2017 22:32	162	-53.25247	-52.16112	MUDL in water (vessel moving 1-1.5kts astern to counter wire lead)
05/01/2017 22:35	162	-53.25202	-52.16051	MUDL stopped at 100m for 29 mins
05/01/2017 23:04		-53.24566	-52.15149	Commenced recovery of MUDL.
05/01/2017 23:12	162	-53.24349	-52.14842	MUDL recovered.
05/01/2017 23:31		-53.24248	-52.14699	Vessel off DP for RMT25 deployment.
05/01/2017 23:32		-53.2427	-52.14722	Commenced deployment of RMT25.
05/01/2017 23:37	163	-53.24391	-52.14859	RMT25 deployed.
06/01/2017 00:24	163	-53.2536	-52.15961	RMT25 @ depth (1170m); commenced recovery.
06/01/2017 02:07		-53.27771	-52.18691	Commenced final recovery of RMT25.
06/01/2017 02:18	163	-53.28067	-52.19053	RMT25 recovered.
06/01/2017 02:19		-53.28089	-52.19084	Vessel on DP; standing by for next RMT25 deployment.
06/01/2017 02:35		-53.28116	-52.19118	Vessel off DP.
06/01/2017 02:47	164	-53.28391	-52.19369	RMT25 deployed.

06/01/2017 03:10	164	-53.28735	-52.1965	RMT25 at depth W/L 436m commencing hauling.
06/01/2017 04:30	164	-53.30679	-52.2102	Gear on surface.
06/01/2017 04:42	164	-53.31012	-52.21186	RMT25 on deck.
06/01/2017 04:44		-53.31043	-52.21212	Vessel on DP.
06/01/2017 05:05	165	-53.30982	-52.21197	MUDL off deck.
06/01/2017 05:06	165	-53.30983	-52.21196	MUDL in water.
06/01/2017 05:10	165	-53.30971	-52.21173	At depth W/L 100m.
06/01/2017 05:37	165	-53.3075	-52.20801	Commenced hauling.
06/01/2017 05:46	165	-53.30669	-52.2067	MUDL on deck.
06/01/2017 05:51	166	-53.30617	-52.2058	MUDL off deck.
06/01/2017 05:52	166	-53.30605	-52.20565	MUDL in water.
06/01/2017 05:58	166	-53.30543	-52.20457	At depth W/L 200m commencing hauling.
06/01/2017 06:16	167	-53.30344	-52.20125	MUDL off deck.
06/01/2017 06:17	167	-53.30332	-52.20106	MUDL in water.
06/01/2017 06:21	167	-53.30287	-52.20032	At depth W/L 100m commencing hauling.
06/01/2017 06:30	167	-53.30192	-52.19871	MUDL on deck.
06/01/2017 06:40	168	-53.30099	-52.19711	Mini Bongo off deck.
06/01/2017 06:41	168	-53.30088	-52.19695	Mini Bongo in water.
06/01/2017 06:47	168	-53.30028	-52.19592	Mini Bongo at depth W/L 200m commencing hauling.
06/01/2017 07:03	168	-53.29853	-52.19299	Mini bongo recovered to deck
06/01/2017 07:05	169	-53.29831	-52.19264	Mini bongo off deck
06/01/2017 07:06	169	-53.29819	-52.19245	Mini bongo in water (vessel moving 0.5kts to stbd to counter wire lead)
06/01/2017 07:10	169	-53.29775	-52.19168	Mini bongo stopped at 100m
06/01/2017 07:20	169	-53.29669	-52.18992	Mini bongo recovered to deck
06/01/2017 07:37	170	-53.29557	-52.18781	CTD off deck
06/01/2017 07:38	170	-53.29559	-52.18779	CTD in water (vessel moving 0.5kts to stbd to counter wire lead)
06/01/2017 08:00	170	-53.29432	-52.18518	CTD at depth W/L 1000m. EA600 depth 1695m
06/01/2017 08:39	170	-53.29139	-52.17925	CTD recovered to deck
06/01/2017 08:49		-53.29113	-52.17878	Vessel off DP. Commence passage to Rothera

07/01/2017 23:35		-56.57099	-56.73984	Vessel slowed briefly to 2kts to determine if RMT25 deployment is viable.
08/01/2017 00:00		-56.62972	-56.79297	Vessel slowed briefly to 2kts to determine if RMT25 deployment is viable.
08/01/2017 00:25		-56.67629	-56.83221	Vessel commenced slow down for RMT25 deployment.
08/01/2017 00:58		-56.69465	-56.84298	Commenced deployment of RMT25.
08/01/2017 01:09	171	-56.69998	-56.84554	RMT25 deployed.
08/01/2017 02:40		-56.73951	-56.87418	Commenced recovery of RMT25.
08/01/2017 02:50	171	-56.74203	-56.87659	RMT25 recovered.
08/01/2017 23:55		-60.34673	-60.66004	Vessel slowed to 6kts for XBT.
09/01/2017 00:04	172	-60.36287	-60.67963	XBT deployed.
09/01/2017 00:10	172	-60.37134	-60.69001	XBT released. Vessel resumed speed of 10kts.
09/01/2017 20:39	173	-63.32558	-64.40689	XBT deployed (speed reduced to 6.0 kts)
09/01/2017 20:42	173	-63.33	-64.41231	XBT released (speed increased to 10.0kts)
11/01/2017 18:18		-67.56889	-68.21147	Vessel commenced clearing ice and ranging mooring in Ryder Bay Rothera
11/01/2017 19:46	174	-67.57269	-68.22803	Mooring released from seabed
11/01/2017 19:48	174	-67.5726	-68.22911	Mooring sighted at surface. Vessel on joystick DP to manouevre towards mooring buoy
11/01/2017 19:57	174	-67.57294	-68.2251	Mooring hooked by grapple
11/01/2017 19:59	174	-67.5731	-68.22457	Mooring recovered to deck
11/01/2017 20:10		-67.57691	-68.23708	Vessel on auto DP in Ryder Bay for CTD deployment
11/01/2017 20:15	175	-67.57688	-68.23734	CTD off deck
11/01/2017 20:16	175	-67.57674	-68.23764	CTD in water
11/01/2017 20:19	175	-67.57668	-68.23779	CTD veering to depth (EA600 475m)
11/01/2017 20:28	175	-67.57648	-68.23815	CTD stopped at 464m
11/01/2017 20:56	175	-67.57432	-68.24661	CTD recovered to deck. Vessel off DP commence passage to Rothera berth
14/01/2017 12:41		-65.63205	-68.59745	Vessel slowed to 6kts for XBT.
14/01/2017 12:45	176	-65.62388	-68.59324	XBT deployed.
14/01/2017 12:53	176	-65.61067	-68.58709	XBT released. Vessel resumed 10kts.