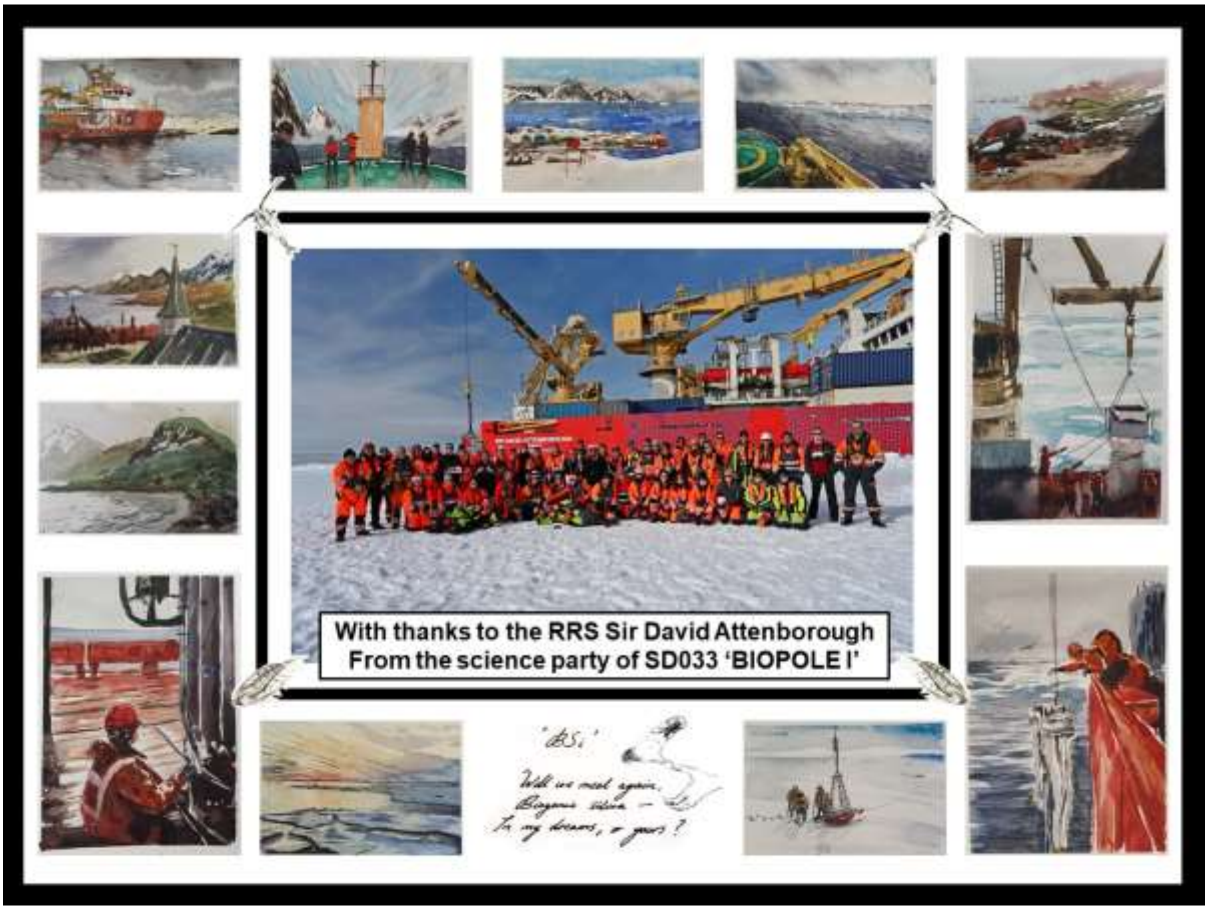
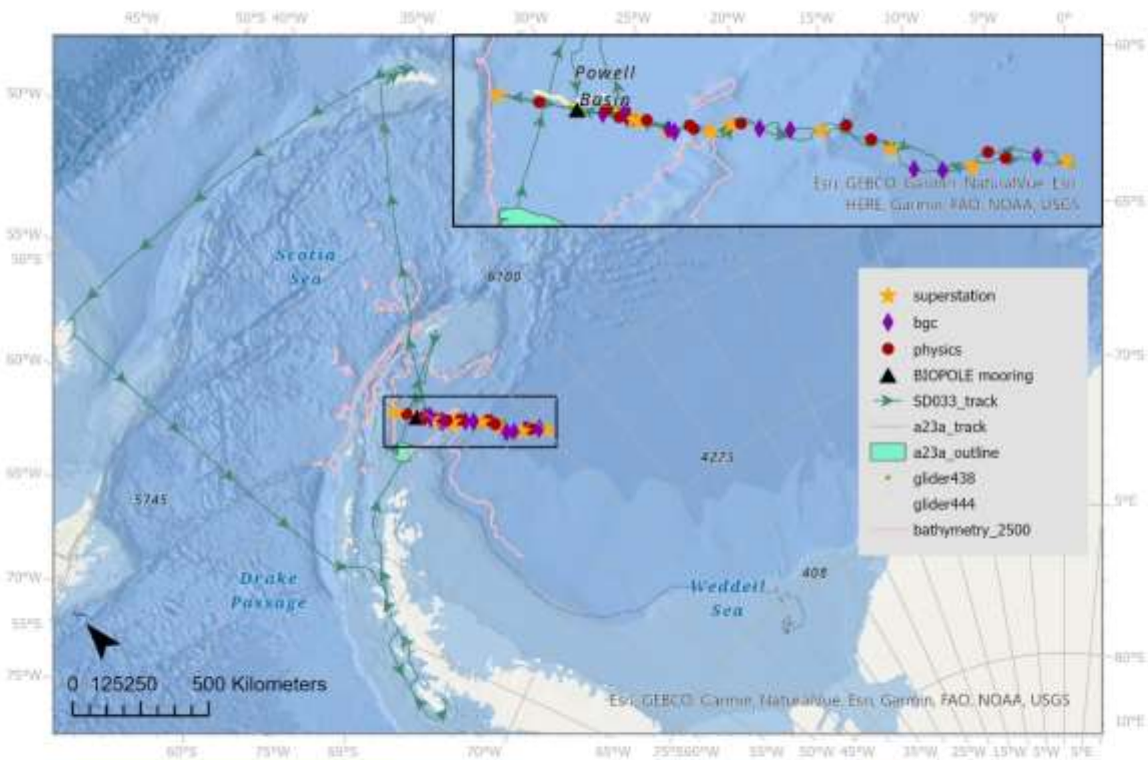
Cruise report for voyage SD033 of the *RRS Sir David Attenborough* – BIOPOLE I

21/11/2023- 27/12/2023


With thanks to the RRS Sir David Attenborough
From the science party of SD033 'BIOPOLE I'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Front cover: Crew and scientists of SD033 photographed on the sea ice in the northern Weddell Sea, on the first day within the pack ice during BIOPOLE I.

Frontispiece (top): Cruise poster designed by the scientific party and presented to the Officers and Crew of the RRS Sir David Attenborough.

(bottom): Cruise track of SD033, with insert showing region of BIOPOLE I scientific activities.

Acknowledgments: It is a pleasure to thank the many people and groups responsible for making SD033 the success it was, both on board and ashore. Special thanks go to Kate Hendry, Povl Abrahamsen and the BAS and NOC glider teams, and Geraint Tarling, Clara Manno, and Sophie Fielding and the BAS Ecosystems team for invaluable support from the UK, often at inconvenient hours. Particular thanks are owed to Captain Matthew Neill and the officers and crew of the *RRS Sir David Attenborough*, for keeping us moving in the right direction, fed and safe, often in marginal and trying conditions.

Contents

1 Personnel on board

1.1 Officers and crew

Matthew T, NEILL	Captain
Robert J, BELLIS	Chief Officer
Oliver H, BATES	2nd Officer
George , HALE	3rd Officer A
Elliot C, JOHNSTON	3rd Officer B
Thomas , EDWARDS	Deck Cadet
Neil, MACDONALD	Chief Engineer
Samuel LM, JOINER	2nd Engineer
Josh , MURRAY	3rd Engineer
Greg, DELGARNO	3rd Engineer
Shawn R, SWANNEY	3rd Engineer
Robert, CARTWRIGHT	3rd Engineer
Thomas , EYLES	Engine Cadet
Simon, WRIGHT	Deck Engineer
Stewart , TITTERINGTON	Deck Engineer
David, JAMES	EO
John M, NEWSOM	ETO
Piotr, KUSMIEREK	ETO
Gareth , WALE	Motorman CPO
Adrain J, COVENEY	Motorman PO
Mark , TAYLOR	CPO Science
Martin, ROWE	CPO Deck
Carlos A , DIAZ Valenzulea	PO Deck
Craig, ROWLAND	Launchman
Graham L, WAYLETT	AB
Graham, HALL	EDH
Spencer, MORRIS	EDH
Lachlan A, MCPHERSON	EDH

Steven C , PORTER	AB
Richard J, TURNER	Purser
Micah, HENDRICKX	Chief Cook
Stephen A, CARPENTER	2nd Cook
Mhairi, FINLAYSON	Cook Steward
Eric K, BOURNE	Senior Steward
Rebecca, MENTHA	Steward A
Doreen B, THOMSON	Steward B
Liam, O'BRIEN	Doctor

1.2 Science and science support

Allerton, Mollie	Biogeochemist
Bilge, Tarkan	Physics
Bischof, Milo	Physics
Boak, Philip	Royal Navy observer
Brearley, James Alexander	Physics (gliders)
Bridges, Louie	IT
Gascoyne, Mathew	AME – electrical
Gillum-Webb, Thomas	AME – mechanical
Gossmann, Theresa	Lab manager
Gray, Christopher	AME – electrical
Hood, Matthew	AME - mechanical
Johnston, Nadine	Ecosystems
Lowery, Katie	Physics
Meijers, Andrew	PSO
Robst, Jeremy	IT
Smith, Roseanne	Ice coring
Stowasser, Gabriele	Ecosystems
Taylor, Laura	Biogeochemistry
ten Hoopen, Petra	Data manager
Turner, Katherine A	Physics

2 Synopsis

Voyage SD033 of the *RRS Sir David Attenborough* (SDA) had several objectives, both scientific and logistical, and additional opportunistic and unscheduled precautionary scientific work was also conducted. The cruise is described at a high level here, whilst the scientific objectives and methodology are covered in the following sections.

After departing the Falkland Islands on 21/11/23 SD033 the ship proceeded to Rothera research station, dropping off PAX and undertaking the first call of the summer season to deliver cargo and fuel (25-27/11/23). Following three days at Rothera the SDA departed into Ryder Bay (28/11/23), immediately adjacent to Rothera, and attempted to recover the Rothera Time Series (RaTS) mooring. Portions of this were known to be lost, but an attempt was made to dredge for recovery of releases and potential sediment trap. This was ultimately unsuccessful, but a temporary replacement mooring was deployed to carry on the time series.

The SDA then proceeded to Signy research station to transfer PAX and conduct first relief (2-3/12/23). On the way, there opportunistic underway water sampling of the megaberg A23a was undertaken (1/12/23), as was considerable outreach and media work. After Signy the SDA headed into the Powell Basin, where it recovered the BIOPOLE mooring (4/12/23). This was unscheduled work that was taken as a precaution due to the presence of the A23a iceberg, which reached down to 250 m+ and could potentially damage or destroy the mooring.

Following the BIOPOLE mooring, the SDA commenced 10 days of 24-hour science operations in support of the BIOPOLE I cruise plan (5-14/12/23). This is described in detail below, but featured a long return transect from the north-western Powell Basin, across the sea ice edge and into the Weddell Sea proper. A suite of multidisciplinary observations and activities were undertaken, including glider deployments, netting, physics observations, CTD and underway biogeochemical water sampling and sea ice coring. A typical day began with a ‘superstation’ consisting of an 0730L CTD, with water sampling for a full biogeochemical and ecological suite of parameters, followed by three bongo nets to 200 m, and a mammoth to 1000 m. A second CTD occurred at approximately 1930L in the evening and was sampled for a subset of biogeochemical parameters. Overnight a CTD would be conducted with minimal water sampling. Within the sea ice opportunistic sea ice coring activities followed the morning superstation on four occasions. This intensive period of work yielded high quality results over a unique sample region, and its description forms the bulk of this document.

Tidy up, data processing, and general demobilisation occurred following the BIOPOLE science, and during this time the SDA undertook first relief and PAX transfer at King Edward Point (17/12/23, 21-22/12/23) and Bird Island (18-20/12/23). The ship then returned to the Falkland Islands (26/12/23) and the science party departed (27/12/23).

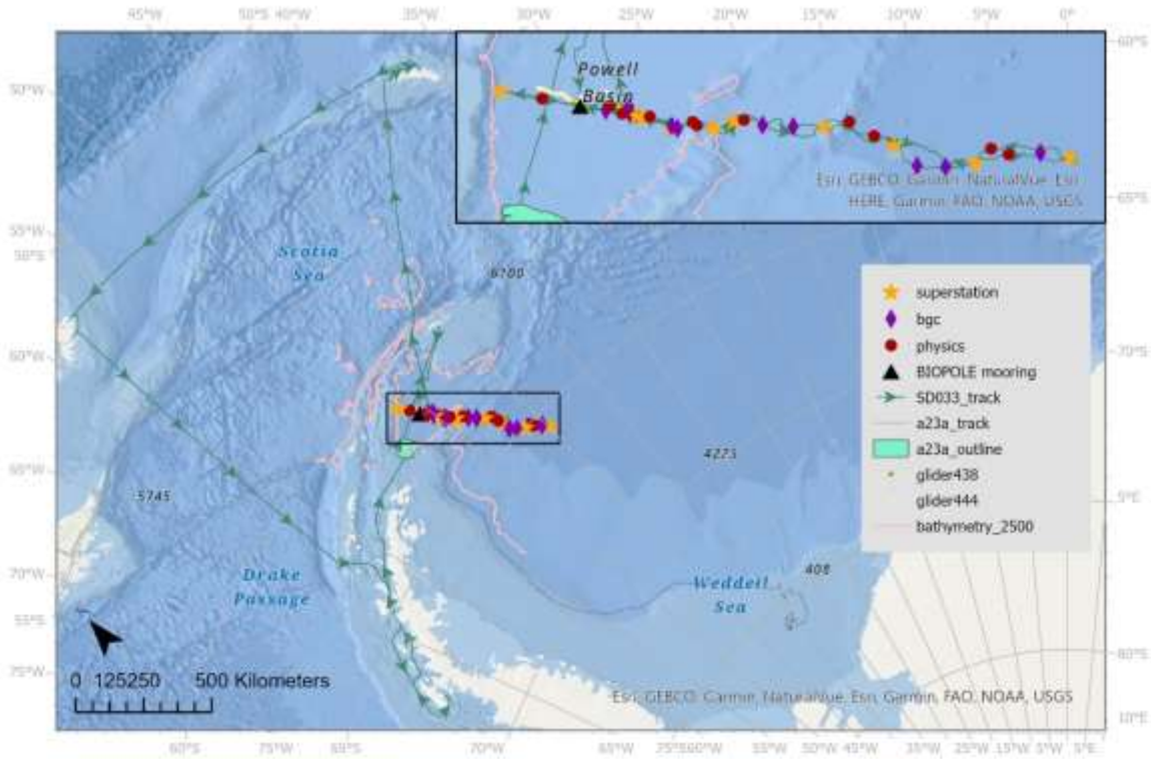


Figure 2-1: Cruise track of SD033. Inset shows region of BIOPOLE I scientific activity.

3 Rationale and objectives

As well as its logistical components, SD033 had several scientific objectives. Primary amongst these was the 10 day multi-disciplinary BIOPOLE survey of the sea ice edge, but a number of other scientific activities, both planned and opportunistic, took place before and during this survey.

3.1 BIOPOLE

The 10 days of 24-hour science operations on SD033 were dedicated to delivering the first Southern Ocean BIOPOLE cruise (BIOPOLE I). BIOPOLE (Biogeochemical processes and ecosystem function in changing polar systems and their global impacts) is a UK multi-centre 5 year interdisciplinary NERC programme examining biogeochemical processes and ecosystem function in polar ecosystems. It addresses a fundamental aspect of the Earth System – how nutrients in polar waters drive the global carbon cycle and primary productivity. BIOPOLE will improve our ability to quantify this export and identify its sensitivity to climate change.

The BIOPOLE I objective was to capture the early season physical, biogeochemical and ecosystem states and processes that prime conditions for high levels of primary productivity and subsequent carbon drawdown during the Austral spring bloom. For the physical system this focuses on the entrainment of nutrients and inorganic carbon into the deeper winter mixed layer beneath sea ice and the subsequent emergence of the summer seasonal mixed layer during sea ice retreat and melt. The ecosystems component of the cruise focuses on characterising the concentration, distribution and community composition of copepods. Specifically, BIOPOLE aims to quantify the contribution to carbon subduction and ultimate sequestration via lipid accumulation in copepods, notably during the period of Austral winter diapause when they descend to depth. This lipid accumulation will be analysed through taxonomic, biogeochemical (BGC) and molecular techniques. The second BIOPOLE Southern Ocean cruise (in season 24/25) will be late season, at or after the seasonal descents of zooplankton. The difference in distribution, community composition and lipid content between the early and late season cruises, alongside ocean circulation observations, will contribute to initial estimates of carbon drawdown by the lipid pump and be used to refine ecosystem, biogeochemical and ultimately Earth System models.

3.1.1 Physics

The physics objectives of the voyage were to:

1. Characterise the mixed layer in its spring transition from sea ice covered, through marginal ice zone, and into the open water, including the development and evolution of the summer mixed layer.

2. Examine the vertical transport of tracers from below the mixed layer into the winter water and summer mixed layers, through processes including entrainment, vertical advection and diapycnal mixing.
3. Examine the formation, structure, and dynamics of submesoscale lateral features associated with the ice edge and melt. Notably including freshwater fronts associated with melt and the vertical mixing/transport associate with such features.
4. Support biogeochemical and ecosystem analyses through the characterisation of the physical structure of the survey region.

These were achieved through a combination of underway observations, CTD based measurements of the water column, and the deployment of three ocean gliders. Underway observations included continuous temperature and salinity measurements of the surface waters (only outside ice covered regions), meteorological observations, high resolution swathing of the sea floor, measurement of the upper water column current direction and speed, as well as underway measurements of oxygen isotope concentrations. CTD observations, conducted approximately three times a day, included measurements of the mixed layer from the down to below the CDW temperature maximum (1000 m), and several times to full depth (>3400 m). These measured temperature, conductivity, pressure, dissolved oxygen, transmissivity, fluorescence and turbidity. Additionally, the CTD frame mounted two 300 khz ADCP heads, in an upward and downward looking configuration, to measure water column velocities. Twenty-four 20L Niskin bottles were fitted for water sampling. Typically, all were fired on a cast, with multiples often at the same depths to provide sufficient water volumes for sampling. The three ocean gliders were deployed immediately north of the sea ice edge. These were to follow the retreating sea ice edge, profiling over the surface 1000 m, for approximately three months following deployment. Their objective was to provide greater temporal and spatial context to the more comprehensive ship-based observations. Additionally, two of these gliders were fitted with novel under ice navigation systems, allowing for short periods (~20 km) of under ice observations.

3.1.2 Ecology

The objectives of the ecological components of the voyage were to:

1. Determine dynamics (community composition, distribution, and abundance) of the spring phytoplankton bloom and associated mesozooplankton community, particularly *Calanoides acutus*, and their relationships with oceanography and nutrient dynamics.
2. Determine the metabolic rate of *C. acutus,* together with their lipid sac concentration (carbon, hydrogen, nitrogen) and size.
3. Examine spatial variations in the origin and flows of organic matter
4. Examine the biogeochemical content and isotopic signature of faecal pellets produced from larval Antarctic krill

A particular focus of the zooplankton community is the copepod *C. acutus.* Over the course of their development, *C. acutus* develop a large carbon-rich lipid sac, primarily to fuel their metabolism and aid buoyancy during their winter diapause (to survive low food levels and avoid predation) at depths of (potentially) up to 2500 m. Using a combination of respiration experiments, collected primarily from the upper water column (200-0 m) but also from depth (up to 1,000 m), together with investigations of their lipid sac concentration and size, and their population structure, distribution and abundance, we can determine how much carbon this species is capable of transporting to the deep ocean, and its influence on nutrient recycling in the upper water column.

Ecological aspects will be examined through a combination of CTD, Bongo, and Mammoth net deployments, and on-board respiration experiments on *C. acutus*. Details of sample collection and analysis of phytoplankton and organic matter (Particulate Organic Matter, POM) are given in the biogeochemistry section below.

3.1.3 Biogeochemistry

The biogeochemical scientific objectives were to:

1. Characterise the biogeochemical nature of the cruise area in the early summer season to trace sources of nutrients to the region and identify ways in which biogeochemistry may determine the nature of primary productivity and subsequent zooplankton community structure.
2. Measure biogeochemical parameters indicative of carbon export resulting though different biogeochemical processes to quantify to extent of each over the cruise period.
3. Measure biogeochemical tracers useful for determining upwelling and mixing rates through the base of the winter and summer mixed layers.

To achieve these goals all numerous parameters (see biogeochemistry section) were sampled at the 10 superstations and at the BIOPOLE mooring site. Evening CTDs at approximately 1930 sampled a significant subset of these parameters. Overnight CTDs (approximately 0200) sampled only salinity and oxygen isotopes.

3.2 RaTS Mooring

A significant portion of the RaTS mooring in Ryder Bay, forming part of the long term Rothera time series, disconnected from the seafloor over the course of Austral winter 2023. The number of instruments lost in the detachment was unknown and it was therefore determined that a recovery of the mooring remnants would take place. This would be done with dredging if necessary and a redeployment of a temporary mooring would take place to ensure maximal time series continuity. Unfortunately, while the acoustic releases were identified, no component could be recovered after dredging. The replacement mooring was successfully deployed close to the location of the previous mooring site.

3.3 BIOPOLE Mooring

The BIOPOLE mooring was deployed in early 2023 on SD025 (polar water trials voyage) just to the southwest of the central Powell Basin. This instrument mainly consisted of sediment traps aimed at supporting the BIOPOLE lipid/carbon draw down theme described above, and was due to be recovered on the BIOPOLE II voyage in the 20225 season (Feb-Mar). Unfortunately, the ~400 m maximum draft of the A23a iceberg described below provided a potential threat to this instrument, which had its top float at approximately 250 m below the surface. Therefore, the decision was made by those ashore following the A23a encounter that SD033 would recover this mooring. The team aboard was ideally placed to do so, particularly to deal with the sediment traps and preserve the samples within. This task was undertaken successfully, largely thanks to a surplus of materials originally intended for use on the lost RaTS sediment trap had it been recovered (see above).

3.4 Ice coring

The objective for the ice core sample collection is to understand what organic compounds (e.g. fatty acids, chlorophyll, highly-branched isoprenoids), and what phytoplankton species, are present in the sea ice during the springtime sea ice retreat in the North-West Weddell Sea. It is known that some of these organic compounds can become aerosolised, transported by winds and deposited onto the Antarctic ice sheet, where they can be preserved in continental ice cores. However, as a prerequisite for utilisation of these compounds within continental ice cores as proxies of past sea ice conditions we require an improved understanding of the exact sea ice conditions in which they are formed. Thus, the cores collected during the BIOPOLE I cruise will contribute to this effort.

3.5 A23a

The large iceberg A23a broke off from the Filchner ice shelf in 1986. It almost immediately grounded in the vicinity and remained there until approximately 2021/22, when it began to drift again. Over the intervening two years it drifted approximately along the slope current of the Weddell Sea, moving in a clockwise direction around the gyre. Satellite tracking undertaken at BAS revealed that its location would likely overlap with the SD033 track between Rothera and Signy. The decision was therefore taken *en route* to undertake some opportunistic sampling; providing a complement to previous iceberg sampling of A76a (2023) and A68a (2021). Due to time constraints the ship could not stop for long, so no CTD was conducted (although drone overflights were). Instead, underway sampling from the continuous water system for numerous BGC parameters were taken at 15 and 30 minute intervals on the approach (from 40 nmi to the west), close navigation along the northern side of the berg (approximately six hours), and on the departure away (to 40 nmi northeast). Underway sampling aimed to determine the impact the berg has on prevailing physical and biogeochemical conditions, including nutrient and isotope concentrations and phytoplankton community composition. The visit to the iceberg was well documented and generated significant international media attention.

4 Voyage Overview

4.1 Survey design and implementation

As SD033 focused on the transition between fully sea ice covered domains, to marginal and melt zones, and out into open water, the selection of a suitable research site was a key consideration for the voyage. The sea ice conditions of Austral winter 2023 were extremely unusual, with mean sea ice extent being greater than 2.5 million square kms lower than the mean (up to six standard deviations!). The local anomaly in sea ice extent was relatively small in the northwest Weddell Sea in the weeks leading up to SD033, although it was unknown if this ice may be thinner or retreat faster than usual.

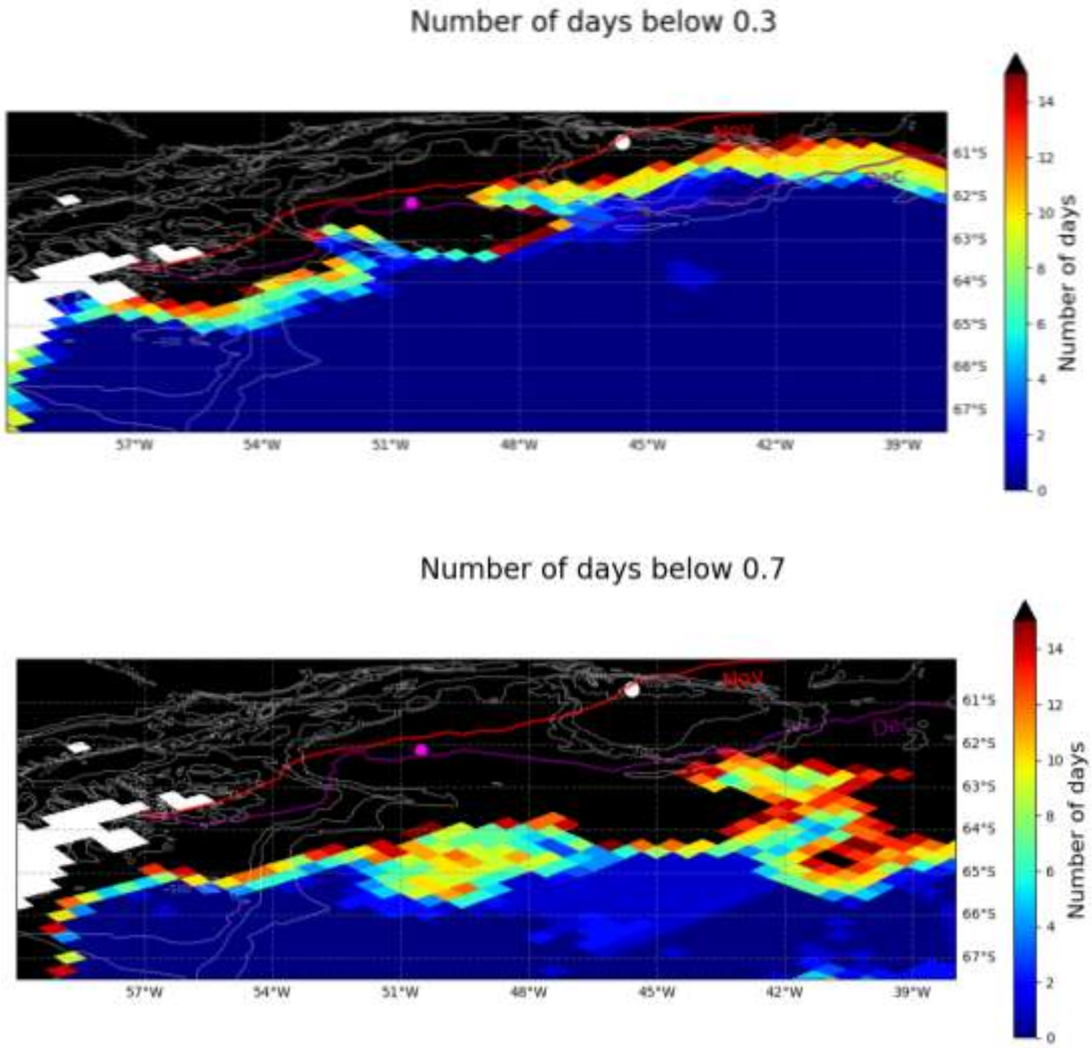


Figure 4-1: BIOPOLE regional sea ice coverage for two months preceding voyage

The ultimate survey region was chosen based on extended observation of sea ice concentration maps and Sentinal-1 SAR images. Notably we aimed to target regions where the transition between open water and high ice coverage was relatively sharp, in order to provide the strongest signal of transition between the two regimes. Additionally, an ideal ice covered region would be ice covered for the majority of the winter season, rather than open water that has recently had ice advected over it.

NSIDC concentration data was used to identify regions where coverage had not dropped below various thresholds over the previous two months (Figure 4-1). Additional constraints imposed were the requirement for relatively deep water (>2500m) to reflect regions where copepod diapause was possible, as well as <2 days of steaming time from Signy, whilst being relatively close to the BIOPOLE mooring for recovery. This latter constraint was significant, as there were large regions of broken out marginal sea ice that would significantly impede progress in many regions and limiting access to the more consistently covered regions.

For these reasons the domain was chosen to stretch from the northwest of the Powel Basin, south to the location of the 'ice edge' at approximately 62.5S, and into consolidated multi-year pack ice in the northern region of the Weddell Sea proper, where bottom depths extend to below 4000 m (Figure 4-2). This domain was surveyed in two directions, one heading south-south-east into the ice, and a return track following roughly the same path back out. The southern limit of the transect was just south of 65.5S and was dictated by available ship time. Conditions over the domain ranged from fully open, ice free, waters at the northern edge of the Powell Basin, to broken 1-3/10 sea ice coverage in the marginal zone south of the BIOPOLE mooring, to almost 10/10 coverage at the ice edge. Sea ice south of the edge varied between extremely thick (ridges up to 5 m thick) multiyear ice at the northern boundary with concentrations of 8/10+, to very large (2-3 nmi) consolidated ice flows with significant leads (7/10+) further south. An unusual amount of thick multiyear ice was encountered relatively far north, in the opinion of the very ice experienced officers aboard who felt that the ice types more closely resembled the southern Weddell Sea.

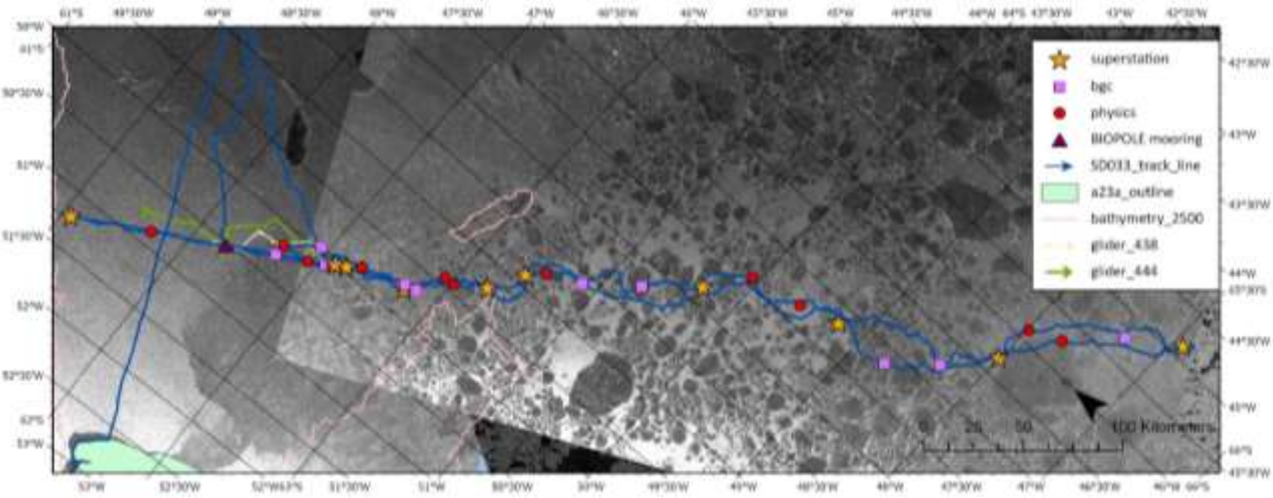


Figure 4-2: BIOPOLE cruise track and scientific events

The 10 days of 24-hour science operations commenced immediately after recovering the BIOPOLE mooring. The ship headed south to the point at which ice breaking would be needed to travel further, at which point the 'ice edge' was declared. The ship then retreated northwards approximately 25 km and deployed three gliders, whilst undertaking the first 'superstation' (daily sampling is described below). It then headed northwards to approximately the 3000 m isobath on the northern side of the Powell Basin, conducting a superstation at this location before heading south back along the track and into the sea ice. A strong phytoplankton bloom and distinct mixed layer structural shift were very apparent at this transition zone (Figure 4-3). After approximately five days of the science time were used pushing as far south as possible, the ship headed back along its track. The original intention at this point was to use high resolution data from the glider observations to target specific hydrographic features at the ice edge, notably freshwater fronts. Unfortunately, ice conditions during initial calibrations forced the gliders away to the north, so no relevant ice edge data was available. Instead, the SDA undertook high resolution shallow and unsampled CTDs in order to refine the location of the earlier observed bloom (which had moved by this point). We then conducted the final day's superstations and other BGC observations within 10 nmi of each other in order to resolve this feature.

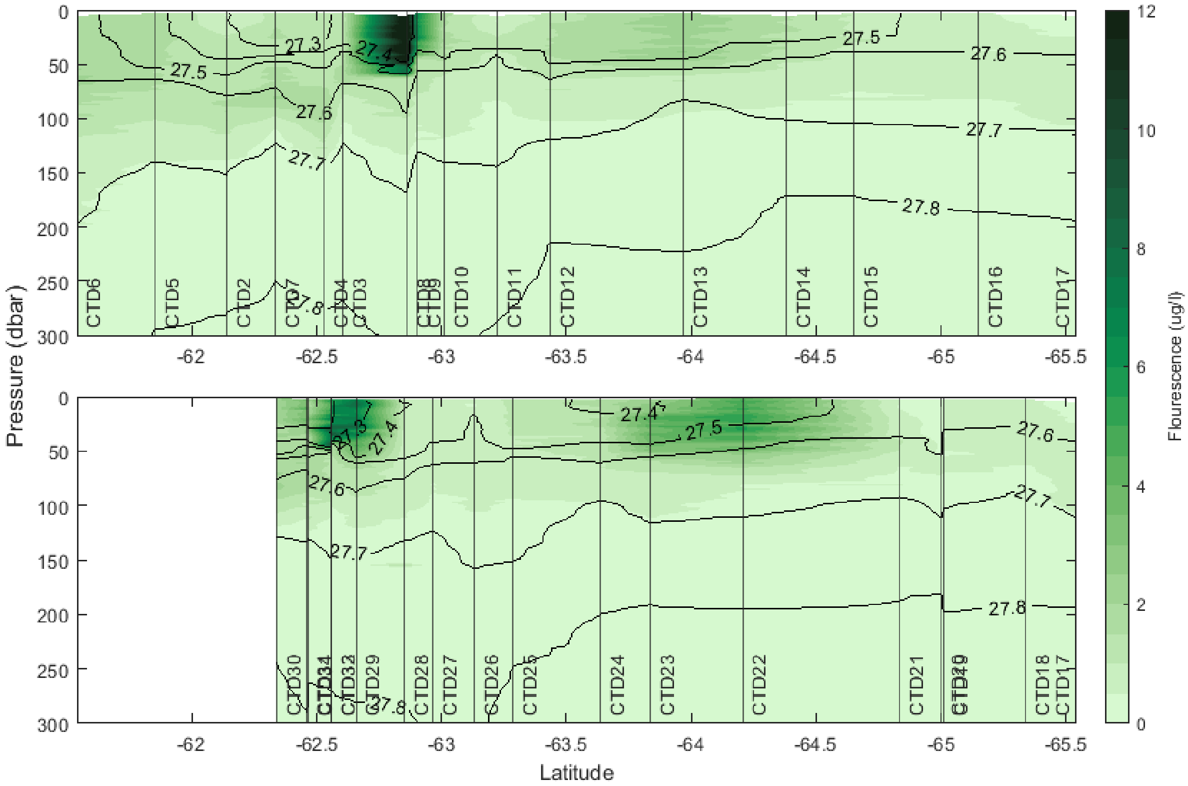


Figure 4-3: Surface layer CTD fluorescence data southward (top panel) and northward (bottom) along cruise track.

The daily sampling routine was as follows. Ecological (+ physical and biogeochemical) sampling took place at the BIOPOLE mooring and each of the 10 'supertations' outlined in Figure 4-2, from the open ocean, through the marginal ice zone, and into the pack ice. Each superstation consisted of a CTD deployed at approximately 0730 each day. Typically, this was to just over 1000 m, but occasionally to full depth. A full suite of physics, biogeochemical and ecosystems parameters were sampled from CTD Niskin bottles. Once the CTD was recovered the Bongo net was deployed in the upper water column (200 m), followed by the Mammoth net to greater depths (up to 1,000 m). Following both Bongo and Mammoth net deployments and zooplankton preservations, live copepod samples were picked from the catch and physiology (respiration) experiments were conducted. Phytoplankton and POM samples from the CTD were preserved.

A further biogeochemical CTD was undertaken in the evening, at approximately 1930hrs? (Local Time/FI time?). This typically sampled the upper water column to 1050 m to continue to refine the description of the mixed layer, but some were to full depth. A subset of the morning physical and biogeochemical parameters was taken from this CTD. The frequency of sampling from the morning and evening observations was largely dictated by the ability of the biogeochemical and ecosystems teams to process water samples, each one taking up to 12 hours to fully process. Overnight a 'physics only' CTD was conducted around 0200L, sampling only for salinity and oxygen isotopes. Typically, this was to 1050 m, but again occasionally to full depth. This station served to increase the horizontal resolution of the section. High frequency (4 in less than 12 hours) CTD only (no water sampling) overnight stations were also conducted on the final evening of the transect in order to resolve the local chlorophyll bloom for sampling on the final day.

When in the sea ice opportunistic sampling of sea ice cores was undertaken following the morning superstation on four occasions, with three successful sets of cores collected. This involved finding a suitable flow and positioning the ship alongside or directly into it, depending on its stability and the prevailing conditions.   A team was then craned onto the ice via the 'Wor Geordie' and ice coring undertaken with a Kovaks 9 cm drill. At each station three cores, alongside water samples, were collected.

The above survey allowed us to examine 1) the changes in the physical structure and dynamics of the water column, and its interactions with the sea ice and the sources and flow of nutrients, 2) their influence on the fuelling of the spring phytoplankton bloom, and 3) the spring growth of zooplankton communities, particularly copepods, and their use of carbon rich phytoplankton as a food source to develop their lipid sacs (which they will use to survive winter diapause at depth in the Southern Ocean). The results will complement work carried out in the austral summer of 22/23 onboard RRS Discovery (DY158), the PICCOLO cruise (SD035) at the end of the 23/24 season, and a further BIOPOLE cruise in the austral autum of Feb/Mar 25 onboard RRS Sir David Attenborough.

4.2 Cruise Narrative

Weds 15/11/23-Monday 20/11/23: The enthusiastic science party of SD033, the first 'official' scientific voyage of the *RRS Sir David Attenborough* embarked the Ministry Of Defense airbridge flight from RAF Brize Norton to the Falkland Islands under something of a cloud. Unfortunately, one member of the planned party had to return to Cambridge due to a medical issue, and another was flying south unsure if they would ultimately receive medical clearance from the BAS Medical Unit to join the ship.

Upon landing the incoming crew, scientific support staff and PSO joined the SDA at Mare Harbour, whilst the remainder of the science party spent two nights of intense karaoke training in Stanley; allowing for a crew change. Following this the science party joined the SDA on Saturday the 18th and immediately set about mobilising for sea and science. The medical issue cleared, leaving all scientists in a positive mood and keen to begin. Over the next two days the many lab spaces of SDA were filled with fridges, incubators, masses of bottles, gliders, and other scientific kit. The AME mechanical support staff assembled the bongo and mammoth nets whilst the physics team largely helped lift boxes and begin the labelling process of the thousands of sample bottle we hope to fill. Thanks to a very enthusiastic science team, this work proceeded rapidly and cheerfully and by Monday everything was unpacked and lashed for sea. A visit by the Commander of British Forces South Atlantic required attention from some of the crew and science party, who did credit to BAS and left the visitors very impressed with the ship and our mission.

On Monday evening the remaining PAX for Rothera, and the two AME electrical staff, arrived from the MOD airbridge, and immediately inundated IT support, clamouring for access to the dramatically improved personal/work internet systems made possible by Starlink.

Tuesday 21/11/23: Ship cast off at 0830L with 83 crew, scientists and PAX for Rothera aboard. The SDA stood off Mare Harbour until 1200L to await the return of a crew member from a medical precautionary check, at which point we headed to sea. SD033 has commenced! Day taken up with ship safety briefing, biogeochemistry (BGC) briefing, media briefing and continued setting up. AME electrical team begin construction of CTD, beginning with termination. Ongoing discussions over best wire setup for usage for the CTD, bongo and mammoth, as well as difficulties in commissioning the moon pool for science. Calm seas and clear weather for initial passage, although several of the science team at sea for the first time feel the effect of the motion. Hopefully this will pass soon, and mild weather is forecast until we reach Rothera on Saturday to ease their passage.

Wednesday 22/11/23: Drake Passage fails to live up to its reputation with light swells and barely even white capped waves. Work continues apace getting everything set up, with the CTD, mammoth and bongo nets all beginning to take shape. Labs continue making order from the unpacking chaos, and the physics team begin to get to grips with their sensors. Over the day underway sea water, TSG and VMADCP all gradually come online. An afternoon polar abandonment drill, followed by a data management talk keep folk busy. One salinometer is calibrated, although questions linger over the other, which has an odd sounding pump.

Thursday 23/11/23: Sea even calmer if anything today and work continues. Physics team receive instructions on watchkeeping and salinometry, and whole science party undergoes lab induction, and a first introduction to sea water sampling. CTD, mammoth and bongo set up, and RaTS mooring constructed. CTD deck tested successfully. Load testing must wait, as issues with machinery during GP wire test dip cause some delays. First icebergs sighted around lunch, and Bransfield Strait reached between Snow and Smith Islands in the early evening, although fog unfortunately obscures the view. Much excitement aboard for scenic viewing tomorrow.

Friday 24/11/23: Great excitement today as we passed through first Neumayer and then Lemaire Channels around breakfast time. Spectacular views, penguins and the odd whale didn't disappoint, despite a low cloud that gradually lifted as we proceeded through the passages. Moving further offshore in the afternoon improved science output as the fog closed in and people drifted inside. Difficulties encountered in the early hours when the underway sea water system broke at its inlet pipe, letting in rather more seawater than is normal for the inside of the ship. Swift action by the deck engineer and scientific bosun plugged the leak, but we have been without underway seawater since. Despite grim initial reports about a lack of replacement parts, it does seem possible that the system may be back up and running in a few days. Hopefully this is the case, as underway sea water samples in the vicinity of the A23a berg, now in the news, would be extremely valuable. AME mechanical rapidly find backup tow fish options for underway sea water samples in the event that the uncontaminated system cannot be repaired in a timely way.

Saturday 25/11/23-Sunday 26/11/23: Arrive early at Rothera research station, reaching our southernmost point in the cruise. Following briefing by Auralia, the Station Leader, cargo ops commence almost immediately, the PAX head ashore, and the science team is released to explore. While serious jollies are not on offer due to the business of the station, walks round the point, visits to the hanger and bar/dinner exchanges are popular. This relaxed pace (for the science team) continues over a dingle day Sunday, although the BGC team do undertake useful exchanges with the Bonner lab. The presence of the A23a berg making waves in the media reveals an opportunity. It sits directly on our path out, and thus we will be well placed to undertake some opportunistic science on the path past it, as well as undertaking media engagement.

Monday 27/11/23: A day of strong winds, blowing snow and low visibility; as well as serious preparations for our first, and probably busiest science day tomorrow. Fuel transfer commences on schedule despite the appalling weather, and the deck team get the CTD winch load tested, dredging cables readied and the mooring instruments prepped. Long science/tool box/bridge talks for the various teams in preparation. The last of the missing chemicals are finally located and so some of the bottle necks in getting the BGC lab set up are removed. Underway sea water system is nominally repaired, although some leakage is still present. Issues are revealed with the VMADCP over the voyage south, with serious gaps in the data when the ship was underway from the southern half of Drake Passage onwards. This pattern matches that seen in the trials cruise, and some progress is made in starting to find the cause of the troubling loss of data. More trials on the northward leg will hopefully allow us to collect reliable data. Tomorrow will no doubt be a long day, and we will be very lucky to get it all done, but we feel as ready as we are likely to be!

Tuesday 28/11/23: The first day of science activities is greeted by strong northerly winds, gusting up to 40 kts. Ship unmoors at 0800 and proceeds a few km into Ryder bay to the site of the lost RaTS mooring. Transducer triangulation gives a 'cocked hat' almost directly over the recorded release point, though mixed signals as to the orientation of the releases are gained. The upper part of the mooring was known to be lost several months ago, but it is unclear if any instruments remain above the acoustic releases. The hope is at least that a sediment trap may be recoverable. The release signal is sent immediately after triangulation, but subsequent ranging reveals them at an unchanged range, suggesting they are weighed down, possibly by the trap. Dredging immediately commences, led by Deck Engineer Simon Wright and Tugs, the science bosun. A large loop of weighted GP wire is laid around the mooring location and an 1500m length beyond that. This is then hauled in, with the hope the noose will tighten and grapnels snag any upright part of the mooring. Unfortunately, after a short period the wire appears to snag on the bottom, possibly around an outcrop, and the ship is forced to back up over it to loosen. Simultaneously a section of the GP wire is found to be fraying due to rub against a guide rail. Once both issues are (eventually) resolved, the noose is fully tightened and recovered, but sadly nothing is caught.

Time is rapidly shortening, so the new mooring is deployed, ~100 m away from the original site but at the same depth to reduce the risk of snags on any remnants of the original mooring still below, and a calibration CTD conducted. Both these operations go fairly smoothly. Numerous bottles fail to close properly on the CTD or leak heavily, but sufficient remain for the science team to get comprehensive training on sampling and processing techniques. The CTD hits the deck at exactly the cut off time of 2000, and the ship proceeds to sea, while sampling carries on until 2300. Unfortunately, no time remains for mooring triangulation, or net trial deployments due to the dredging operations.

Wednesday 29/11/23: A grey morning greets all as a day of lessons learnt, processing and general setup continues. A decision is taken to undertake opportunistic sampling around the A23a iceberg that has driven media interest over the last week, as this lies directly on our path, prior to reaching our sampling site by the BIOPOLE mooring. This will take the form of intensive underway sampling, as well as 'first' images for media consumption. The anticipated early arrival (0200 Friday) followed by the BIOPOLE superstation at noon will make for a pressurised day, and so furious activity follows in the main lab and elsewhere to prepare. BGC team still gradually assessing and overcoming snagging issues in preparation, particularly related to O2 titration, which is adding stress to an already very time constrained situation. Some relief in the evening via a somewhat dull presentation on science motivation and cruise objectives by the PSO; contrasted by stunning blue sky sunset vistas of Lamaire and other channels, numerous cruise ships and even whales.

Thursday 30/11/23: A foggy day of transit through the Bransfield Strait and ongoing preparation. Successful early morning tests of both Bongo nets and Mammoth nets (to 250 m) in 600 m of water. PSO discussions with Captain in the am result in a changed plan. The BIOPOLE mooring station will be moved to after the Signy call, giving more time for the transit and massively easing the burden on the science, and particularly BGC, team on Friday. This was prompted by the proximity of the likely ice target location and BIOPOLE mooring, allowing it to be picked up on the return leg. By dint of extreme organisation and hard work the BGC team continue to resolve issues, and the sudden reduction of imminent work and a few more days to prepare lightens the mood aboard somewhat. Successful media outreach via live stream to 300, 000 children by Roseanne Smith in the am, as well as impromptu drone flying trials in anticipation of use tomorrow builds on what will hopefully be several successful media days! Scientists prepare to move onto intensive underway sampling overnight.

Friday 1/12/23: Science starts at 0100L, with shifts of two scientists working 2-4 hours on 15-30 minute underway sampling on the approach and semi-circumnavigation of A23a. Initially heavy fog lifts shortly after meeting the largest iceberg in the world in the north west Weddell Sea, travelling northwest along the slope front of the Powell Basin. Light winds and bluish skies for the transit, with only one disruption for brash ice blocking the underway water supply. Great success achieved by Theresa and AME electrical with successful drone footage and time lapse photography, including within a significant ice rift. A pod of Orca complete the perfect picture, and some nice opportunistic science. 1200L sees the SDA en route to Signy, encountering a surprising amount of sea ice. Hurried conversations with BIOPOLE team in Cambridge also decides that A23a puts the BIOPOLE mooring deployed on the polar trials cruise at an unacceptable risk, and we are requested to recover on Monday. Fortunately, we have the perfect team aboard, so this should not, hopefully, cause too much trouble. Oxygen titration continues to be a trial, with the BGC team led by Mollie Allerton valiantly grinding forward through issue after issue with the instrumentation.

Saturday 2/12/23: Arrive Signy 0630L, on DP 0800L to a somewhat brighter day with low winds. Immediately commence tender loading and shuttling cargo and personnel ashore to complete the opening of the base. Several lucky scientists help with cargo transfers and get to partake in joys such as the lifting of heavy boxes and grading and sorting of fruit and veg. In the afternoon all remaining personnel get a run ashore and a quick walk over the headland from the base to experience the wall of smell that is an Elephant seal beach party. All are summoned back aboard with 'encouraging' blasts of the ship horn. Scientifically, some progress is made with the frustratingly difficult O2 processing, as well as successful processing of numerous salinity samples. Additionally, all is made ready for the recovery of the BIOPOLE mooring, which hopefully will be straightforward. A good day finishes, as is traditional for Antarctic voyages, with a viewing of 'The Thing'. The 1982 original of course.

Sunday 3/12/23: Significant westerlies bring chop and a grey start. A few last boat runs are undertaken, and the ship heads to sea at 1200L into a backing SW wind and swell. Scientists continue preparation for the commencement of science ops tomorrow, more salts/training are run, labs are prepped and sea sickness takes hold of the unlucky few again. We appear about as ready as we can hope. Sea ice conditions appear slightly less than ideal, with rapid breakout someway to the south of us, but we will work with what we have.

Monday 4/12/23: Reasonable visibility and calm, though somewhat icy, seas greet us at the BIOPOLE mooring location. A calibration, full depth CTD is undertaken before the releases are fired. This went very smoothly once all ship acoustics and thrusters were switched off. Mooring was quickly spotted and successfully recovered, one sediment trap generating excitement via a fish skeleton. Following the mooring 1 x Bongo and 1 x Mammoth net were undertaken to provide contextual data. This proved to be a very long day, particularly on deck, but all went well and it was well received in Cambridge that the mooring had been saved from A23a. The ship then set off towards the SE in search of the sea ice edge against to judge the formal science 'start location'.

Tuesday 5/12/23: 9/10 pack ice was encountered at around 0500, waking up many aboard with a crunch. This ship then retreated approximately 25 km in order to deploy gliders in less hazardous waters. Unfortunately, NOC declared this location unsuitable too, so instead at 0730 the first formal 'super station' of CTD, 3x bongo and 1x mammoth was undertaken. This proceeded fairly smoothly and by 1400 the ship was heading NW again to find clearer water. This was swiftly found and all three gliders deployed, followed by a BGC CTD to provide calibration (including Chl) data. Various crises were resolved in the labs, notably several broken vacuum pumps, largely through the intervention of Tom Guillum-Webb and Matt Hood in AME-mechanical. Set off in the evening towards the northern most 'super station' on the southern flank of the South Scotia Ridge for the morning. Credit to many members of the team who undertook media interviews with various international outlets, all eager to know more about our 'surprise encounter' with the A23a megaberg.

Weds 6/12/23: The first of the night CTDs at 0230 was undertaken successfully, taking basic physics parameters, and increasing our horizontal resolution. The morning broke to significantly windier seas, with many white horses and chop. Luckily the southerlies cannot generate much fetch with the ice edge so close, so ship movement was fairly minimal. Morning CTD was uneventful, but the bongo nets were eventually given up on due to the rising winds and waves, which risked the instrument. This was underscored by some damage sustained by the Mammoth, with tears occurring in the deployment/recovery process to the fixing points of one of its nets, though the scientific return was still good. Sci Bosuns mate Carlos Diaz Valenzulea set to work with sewing machine and thread overnight to mend and make good the netting. Some slight concerns from the UK glider team on some diagnostics, so we remain on semi standby for recovery or other troubleshooting.

Thurs 7/12/23: Hard work overnight by Carlos Diaz Valenzulea and Lachlan McPherson and the reassembly by the AME-mech team sees the Mammoth returned to 'better than before' status. Unfortunately, the night CTD was cancelled as ice conditions overnight meant that it could not be completed in time to make the sea ice edge for the morning super station. Strong winds proved challenging with the ice, as the pack charged northwards past the ship, but the CTD and bongos proceeded according to plan. The Mammoth did require significant work and care in its deployment and recovery, and it was well past 1800L by the time the full station was completed. We will have to get this time down in the coming days if we are to make significant progress. Advancing beyond the pack edge showed the 8/10th ice to be very thick, if not tightly packed. 30-40 cm snow sitting atop 1+ m of ice meant progress was slow, and only 4 nmi were made before the evening CTD, already delayed by 1.5 hours to allow for extra progress. If other transits are similarly slow, we may need to consider dropping a station or reducing the number of bongo nets in order to make some progress along our line.

Friday 8/12/23: Calm seas, brightening skies and large leads between massive consolidated flows of multi-year ice set the scene this am. A motivated and now well prepared and practiced team absolutely swept through the morning superstation. Excellent returns from the Bongo nets, though unfortunately the Mammoth managed to mangle a poor sea jelly, which did make something of a mess of a few of its nets. Much excitement in the afternoon as the sun came out in strength, the wind dropped to nil and the ice coring team was dropped by Wor Geordie onto the ice. Much digging of snow followed (6-8 ft) and unfortunately the ice beneath was found to be below the freeboard and flooded with brine. Some cores were recovered, but largely immersed in slush and declared unusable by the experts. The rest of the crew were not worried by this however, and the ideal conditions led to the gangway being lowered onto the ice, group portraits being taken by drone and the talented Rich. Snowball fights and football followed, though all were off the ice and back steaming by 1800L, with a CTD undertaken at 2030 in a glass-still lead. Unfortunately, the excitement and break in routine led to some samples being incorrectly left out of the fridge in the main lab and ruined. This will lead to a somewhat poor vertical profile in several BGC parameters. We will take this as a lesson learned, particularly with our largely untrained volunteer processing team, and institute more rigorous, if inconvenient, lab practices.

Saturday 9/12/23: A greyer start, but still calm airs and a convenient number of leads through the sea ice allows faster navigation further to the south, along with a successful overnight CTD. Morning super station is done as quickly as the day before, the team now being well practiced. Following the previous day's excessively snowy cores we sought out thinner sea ice. This time the team managed to quickly drill three cores of an ideal length, with a good amount of 'green stuff' in them. We still needed to push back the evening CTD to 2030, but the team being well practiced now sampled it in short order, despite the distracting presence of Emperor penguins spectating.

Sunday 10/12/23: The winds have shifted northerly and freshened somewhat, bringing blowing snow to the morning CTD. This is the southern-most point of the voyage, and we include a full depth CTD to capture Weddell Sea proper water, finding a clear AABW layer. To reduce the time for the superstation, 2X bongos are dropped, but the Mammoth finds excellent and numerous samples, keeping the ecosystems team very happy, and busy. A strong team effort sees both the sea ice sampling and CTD processing done by dinner, allowing a 1930 CTD in pleasantly bright skies. One of the gliders remains unaccounted for, now over 72 hours since it phoned home. While not a massive concern yet, we are crossing our fingers that it frees itself from whatever obstacle (almost certainly an ice flow) has snagged it. We now head north again, hoping to pick up intermediate stations between our existing ones, and then target the ice edge in high resolution to pick out the very strong signal we are seeing develop there in physical and biological parameters.

Monday 11/12/23: Gap filling return CTDs continue, along with the final ice coring stop. Very nice ice is found and the coring quickly completed. The considerable intensity of sample processing, largely revolving around four parameters requiring several hours of filtering each, with limited rigs, requires that the few remaining 8 hour shifters to move onto 12s in order to provide enough processing coverage. Otherwise progress is steady towards the north. We see that the somewhat open leads between large flows is generating a modest increase in surface chl even in the 3-4 days it has been since transiting the region.

Tuesday 12/12/23: With no ice coring better progress is made and we begin to approach the sea ice edge. This has moved somewhat north of its original location and we therefore anticipate a need to identify its location prior to the final day's sampling, in order to produce the best high resolution transect across the ice edge possible. Satellite concentration and even SAR imagery isn't conclusive at the resolution we require, so it is likely that we will have to investigate the area with the ship prior to planning our sampling strategy. The gliders were to have mapped out the gradients in the vicinity of the ice edge, but the (hopefully) temporary loss of one, and longer than planned calibration time for the others means they've largely been sampling to the north of the suspected edge and can't provide much more information. Otherwise, the day proceeds smoothly, with both morning and evening stations going smoothly.

Wednesday 13/12/23: This morning following the superstation we began to encounter the very thick ice that was met on the way into the pack on the 7th, making for slow progress. Some ridges are up to 5 m thick ice, with heavy snow loading and require several rams with the ship to progress through. The convenient leads that we found further south to avoid the thicker flows are largely absent, so progress is slow, only a few nm an hour. Salinometry team managed to run the DEHEAT samples left over from the *RV Belgica* voyage, partly as a help to our colleagues on that voyage, but also to free up the bottles those samples were contained in, allowing us to continue sampling d18O, which otherwise would have had to cease today. The ice edge is expected to be directly north of our evening CTD location, which encounters raised but not yet 'bloom' level chlorophyll. We are presently just to the north of the original bloom/edge location, suggesting that the southerly winds encountred early on in the voyage has moved the ice edge and bloom, temporarily north. Following the evening biogeochemical CTD four high frequency CTDs are planned at 10 nmi intervals to find the front. These are to be conducted with no bottle firing and to 400 m only for maximal speed. The first of these finds extremely high chl values only a few miles from our earlier BGC CTD location. Liam the ship's doctor participates in high medical drama in the walk-in fridge but fails to save the patient who has been a victim of a savage penguin attack. Oscar nominations are imminent.

Thursday 14/12/23: The overnight CTDs have been a success, despite the ship not quite covering the hoped for distance. We find a well developed chl maxima around the new ice edge and target the morning superstation and evening BGC CTDs into the middle and northern side of the bloom respectively. Due to the short transit distances both CTDs are taken to full depth and sampling is done (on both) in a festive mood with costumes and music around the rosette to celebrate the end of the active science on the voyage. Overall, an excellent showing by all, and practically every sample that could be taken has been, with our very large initial store of sample bottles almost entirely used up.

Friday 15/12/23: With 24 hour operations concluded, today is declared a day of rest for the science party (all but one!!!), and most take the opportunity to catch up on lost sleep, transition off shift hours and catch up on washing. The ship continues on its way to South Georgia, and the transition to open waters following the last week or so of ice work means seasickness once again sets in for the unlucky few.

Saturday 16/12/23: The long period of packup, digitisation of log sheets, data processing and cruise report writing begins. Thankfully the frenetic pace of the last few weeks does not need to be sustained, and people can move at more of their own pace. The end of (science) cruise dinner takes place in the evening, with a few speeches and (more importantly) a slight increase in the usual two drink limit. Sadly, this proves enough to stimulate karaoke.

Sunday 17/12/23: The SDA arrives at King Edward Point, South Georgia, at around 0800 L?. Cargo operations and PAX transfer immediately commence, while the science party enjoys an opportunity to explore Grytviken and as far as Deadman's Pass. A high density of bad tempered fur seals does add to the general excitement. Following unloading of cargo the ship departs in the evening, heading for Bird Island.

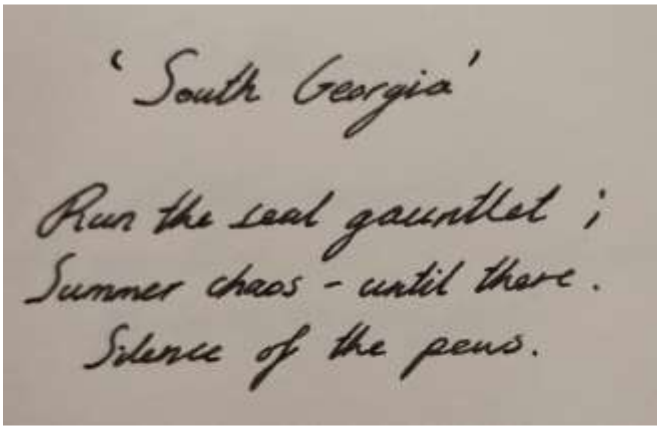


Figure 4-4: South Georgia - Tarkan Bilge

Monday 18/12/23-Wedneday 20/12/23: A remarkably clear day for Bird Island, with only moderate swells, greats the ship in the morning. Although we had previously been told that it was unlikely that the science party would be allowed off the ship, the need for assistant cargo handlers means that ultimately everyone who wants to go ashore gets the opportunity. Only the lucky AME-electrical team actually get off base, to conduct maintenance on the penguin weigh bridge, but everyone else gets to inspect the powerful odour and 'nature, red in tooth and claw' beach at Bird Island base. Higher swells on days two and three require the ship to shelter to the north of the islands, meaning the tender needs to stand on and off for more than ½ an hour, making fuelling operations particularly long. However, a strong effort by the crew and assistance ashore by the science team means that all operations are concluded on time.

Thursday 21/12/23-Friday 22/12/23: For the final call of the voyage the SDA returns to KEP, to carry out some last cargo operations, and allow a fuller experience of the island for all aboard. We are very lucky with two bright and relatively warm days, with only strong southerly winds to contend with. The science party, now steeled with bodgers for dealing with seals, busy themselves ashore sampling longer walks, wild swimming and enjoying the museum and postoffice/giftshop. More organised festivities also occur, with a carols service in the Grytviken church (particular credit to choir master Roseanne Smith for marshalling the atonal science party), barbeque in the KEP boatshed, with Caleigh, as well as an 'international' football fixture with the South Georgia Ist XI taking on the ship's best. Strong favourable winds and a definite weight advantage on an 'interesting' pitch saw the ships team take the game 9-0 in front of three bemused King penguins.

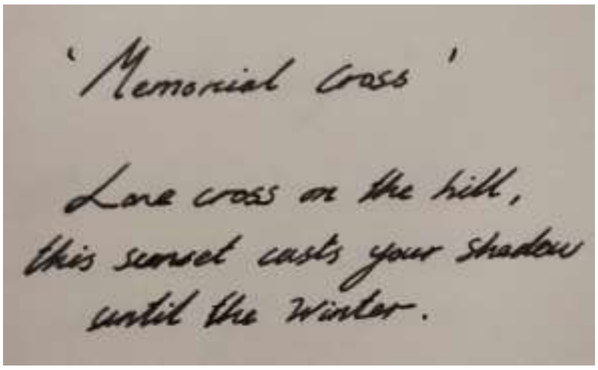


Figure 4-5: Memorial cross - Tarkan Bilge

Saturday 23/12/2023-Thursday 28/12/2023: The science party bids a sad farewell to the beautiful South Georgia islands and head back to sea at 0800 ship time. Lumpy seas await, but after several days off, the science party throws themselves into the final tasks of the cruise. Reports are written, the labs are gradually packed up, log sheet digitisation concludes and the many thousands of samples collected stored away and BoL'd. The final day at sea is Christmas day, and the whole ship celebrates with a relaxed day (except for the ever amazing galley staff) of eating, movie, games and secret Santa. Once in calmer waters near Stanley on Boxing Day the final boxes are packed and reports compiled into the glorious tome you are reading now.

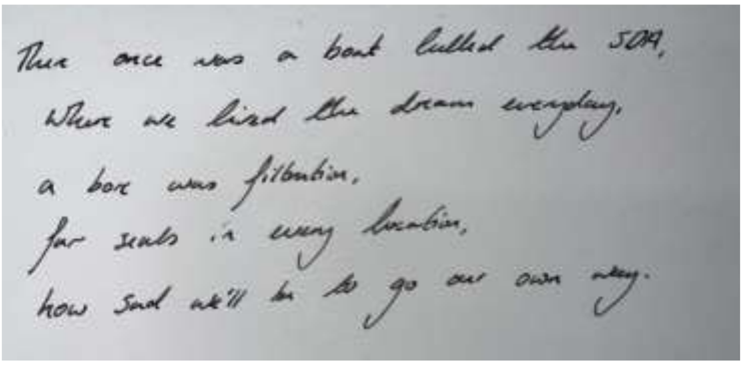


Figure 4-6: Limerick - Katie Lowery

Figure 4-7: Ponderings on filtration notepaper - Kat Turner,Matthew Hood, Tarkan Bilge, and Katie Lowery

5 Conductivity-Temperature-Depth (CTD) operations, data processing and calibration

Milo Bischof, Andrew Meijers, & Alex Brearley

5.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was deployed to vertically profile the water column. 34 CTD casts were carried out in total, of which 10 were superstations with a full suite of biogeochemistry, 9 were sampled for a reduced set of biogeochemical parameters, 7 night stations with sampling for salinity and d18O only, and 5 casts without water sampling. One CTD cast each was carried out at the RaTS mooring and BIOPOLE mooring.

5.2 Instrumentation

See AME – electrical CTD section for details of CTD instrument setup, operation and issues encountered.

5.3 Data acquisition and preliminary processing

The CTD data were recorded using Seasave which creates four files output files for each cast NNN:

- SD033_[NNN].hex (binary data file)
- SD033_[NNN].XMLCON (ascii configuration file containing calibration information)
- SD033_[NNN].hdr (ascii header file containing sensor information)
- SD033_[NNN].bl (ascii file containing bottle fire information where NNN is the CTD
- number)

CTD data were converted from binary (.hex) to ascii (.cnv) files using SBE Data Processing's Data Conversion function (setup file: L:\work\scientific_work_areas\CTD\code\Seasave). A standard seabird oxygen hysteresis correction is applied at this step. The align module was not used due to spikes already being edited out manually (see next section). The cell thermal mass module was then used to remove any effects of the conductivity cell's thermal mass from the measured conductivity. This step re-derives pressure and conductivity, taking into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output of this process is an ascii file, named as SD033_[NNN]_SS_TM.cnv.

5.4 CTD data processing

The CTD data were processed using a collection of Matlab scripts provided by Hugh Venables, which were further adjusted for the purpose of this cruise. They are described below.

CTDvarn_SD033: summary file containing file locations and desired output variables. This is read by the other processing subroutines.

ctdreadGEN: reads in .cnv CTD output files and converts them into .mat format. Output format: SD033_ctd_NNN.red.

editctdGEN: launches an interactive editor and enables selection and flagging of data to be removed from subsequent processing. This was used particularly to exclude the soak period, the on-deck period after package recovery, and any noticeably problematic conductivity spikes in the data. Output format: SD033_ctd_NNN.edt.

batch_ctdGEN: merges a suite of other routines and file conversions:

deriveGEN: derives variables and saves them in file SD033_ctd_NNN.var.

onehzctdGEN: derives the 1hz file to be used in LADCP processing. Output format: SD033_ctd_NNN.1hz.

splitcastGEN: divides the cast into its downcast profile (SD033_ctd_NNN.var.dn) and upcast profile (SD033_ctd_NNN.var.up).

fallrateGEN: removes data for periods when CTD is located above a pressure it has already reached on the down cast (up cast not treated) and when package moving at <0.25m/s. Output format: SD033_ctd_NNN.var.dn.

gridctdGEN: grids data from CTD profiles to 2db pressure levels. Output format: SD033_ctd_NNN.2db.mat.

5.5 CTD data calibration

The temperature, conductivity and oxygen sensors of the CTD were calibrated using the SBE35 temperature sensor, bottle salinity and bottle oxygen data, respectively. The SBE35 measured in-situ temperature every time a Niskin bottle was fired. Bottle salinity and oxygen samples were taken from a range of CTD casts, aiming for a good cover of salinity and oxygen values in pressure and temperature space.

At the end of CTD operations, bottle files were created using a suite of Matlab scripts (described below) which contain SBE35, bottle conductivity/salinity and bottle oxygen, as well as CTD measurements of the same variables at the time of bottle firing. Calibration was first carried out for temperature, since temperature is required to convert conductivity to salinity. Bottle files were then recalculated using calibrated temperature values. Conductivity and oxygen calibrations were carried out following this. All calibrations are further described in the following subsections.

Bottle files were created using the following Matlab scripts:

batchbotGEN:

makebotGEN: reads in Seabird .ros file and creates bottle file. Output format: SD033_bot_NNN.1st.

sb35readGEN: reads in SB35 output data. Output format: SD033_bot_NNN.sb35.

readsalGEN: reads in salinity bottle data from an excel spreadsheet and puts them into a Matlab bottle file. Duplicates are stored in structure array 'nisk' in niskinsalts.mat and averaged for the purpose of the bottle file. Output format: SD033_sal_NNN.mat.

addsalGEN: reads in SD033_bot_NNN.1st and adds bottle salinity data to create file SD033_bot_NNN.sal. Unlike routines used on previous cruises, bottle conductivity was calculated from bottle salinity at this step as well as salcalGEN so that it is read into the .sal file.

salcalGEN: calculates offsets between CTD and bottle data to determine calibrations needed. This script was run during SD033 but output wasn't used. Offsets were instead calculated separately after creating a bottle master file (see below). Output format: salcals12.all.mat.

The following three scripts were created for SD033, following the format of readsalGEN, addsalGEN and salcalGEN to add oxygen bottle data to the bottle files.

readoxyGEN: reads in oxygen bottle data from an excel spreadsheet and puts them into a Matlab bottle file. Duplicates are stored in a structure array in niskinoxygens.mat and averaged for the purpose of the bottle file. Output format: SD033_oxy_NNN.mat.

addoxyGEN: reads in SD033_bot_NNN.1st and adds bottle oxygen data to create file SD033_bot_NNN.oxy.

oxycalGEN: similar routine to salcalGEN, creates output file oxycals.all.mat which ultimately was not used for calibration.

mergebotGEN: merges data from SD033_bot_NNN.1st, SD033_bot_NNN.sb35, SD033_bot_NNN.sal and SD033_bot_NNN.oxy to create file SD033_bot_NNN.all.

masterbotGEN: reads in files SD033_bot_NNN.all for the entire cruise and creates master bottle file SD033_bot_MASTER.mat which was then used to create calibration figures.

5.5.1 Temperature calibration

Figure 5-1 shows differences between CTD and SBE35 temperatures prior to calibration. The fit between CTD and SB35 temperatures is generally very good, with R^2 values of 0.9997 and 0.9996 for the two sensors. There is a small offset between CTD and SBE35 temperature readings, with both CTD sensors recording slightly higher temperatures than the SBE35. The offset does not seem to have a clear relationship to pressure except for the larger variability found in the mixed layer; we therefore chose to apply a constant offset to calibrate the CTD temperature data. The mean offset is 0.0068◦C and 0.0043◦C for sensor 1 and 2 respectively. However, applying a mean offset led to overcorrecting of the data which meant that the CTD data were biased low; this may be due to the mostly positive outliers influencing the mean offsets. We therefore applied the median offset between the two instruments for calibration, which was 0.0038◦C for CTD sensor 1 and 0.0012◦C for sensor 2. Figure 5-2 shows the remaining differences between the CTD temperature sensors and SB35 after calibration.

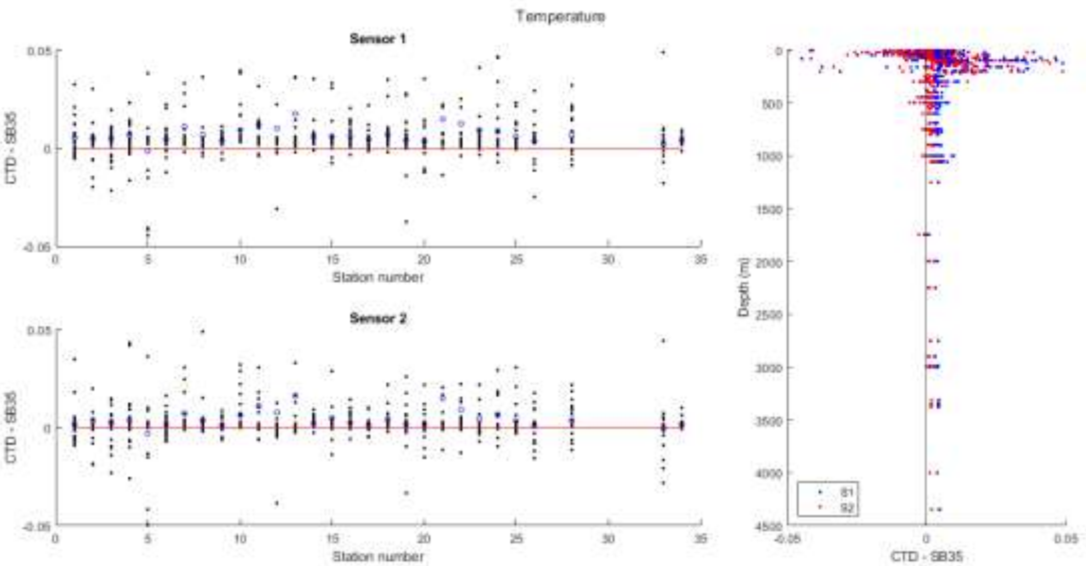


Figure 5-1: Differences between CTD and SB35 temperatures before calibration. The left upper and lower panels show the difference between CTD and SB35 temperatures (CTD minus SB35) at each station for CTD sensors 1 and 2, respectively. The red line is located at 0

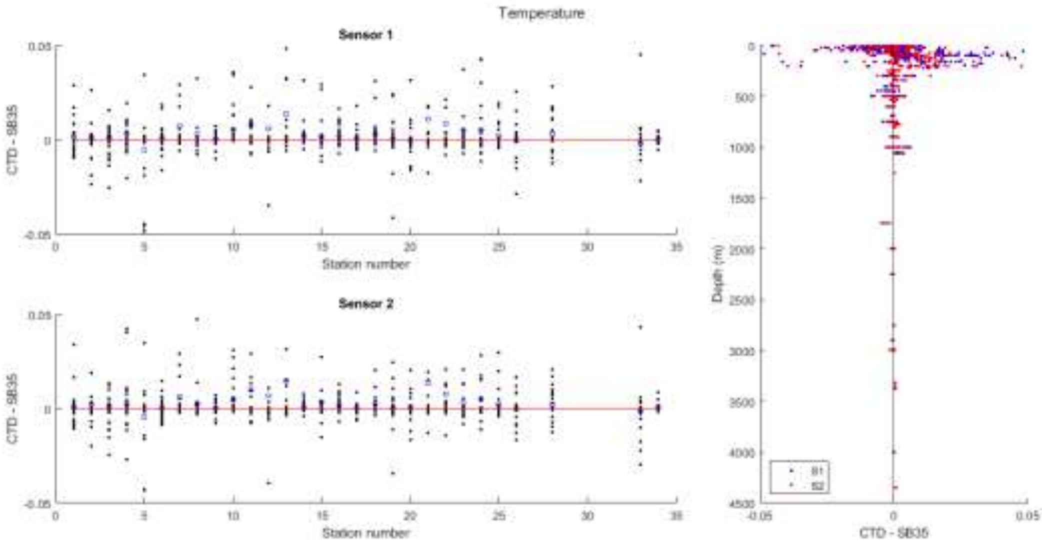


Figure 5-2: as Figure 5-1 but after temperature calibration.

5.5.2 Conductivity/salinity calibration

Bottle conductivity was calculated from bottle salinity after the temperature calibration was done. Calibration was carried out using conductivity rather than salinity to account for the nonlinear relationship between conductivity and salinity at different temperatures. The fit between the CTD conductivity sensors and bottle conductivity was already quite close before calibration (Figure 5-3), with median offsets of 0.00023 mS/cm and 0.0011 mS/cm and R^2 values of 0.8938 and 0.9861 for sensors 1 and 2. Note that the mean offsets are higher with 0.0434 mS/cm and -0.0153 mS/cm, respectively. However, these values are largely driven by outliers which can be explained by inconsistencies in sample processing and salinometer operation and occur mostly in the first stations (see Salinity section).

While the offsets in both sensors are small, the offset of sensor 2 is considerably larger than the offset of sensor 1. We calibrated sensor 2 using a constant offset of 0.0011 mS/cm, and sensor 1 by a constant offset of 2.3059×10^{-4} mS/cm (Figure 5-4). We considered not calibrating sensor 1 due to its small offset; however, this small offset leads to a larger offset of -0.0038 in salinity (Figure 5-5). This is reduced to 2.9569×10^{-4} after applying the conductivity calibration (Figure 5-6).

Note the different pattern in conductivity and salinity offsets. This can most likely be explained by the different temperatures of the sampled water masses. The pattern in salinity is consistent between sections (see Section 5.7).

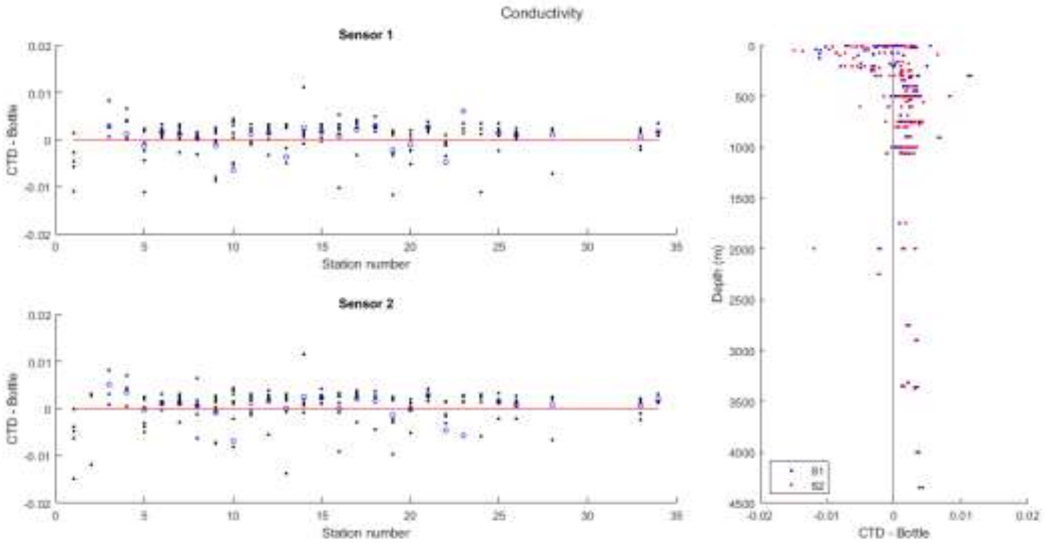


Figure 5-3: : Differences between CTD and bottle conductivities before calibration. The left upper and lower panels show the difference between CTD and bottle conductivities (CTD minus bottle) at each station for CTD sensors 1 and 2, respectively. The red line is

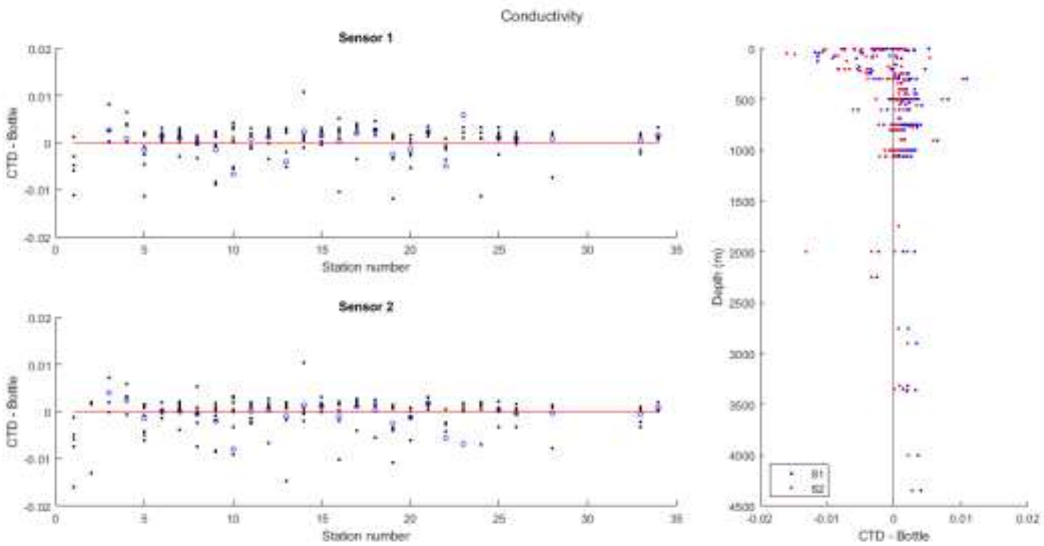


Figure 5-4: : as Figure 5-3 but after conductivity calibration as described above.

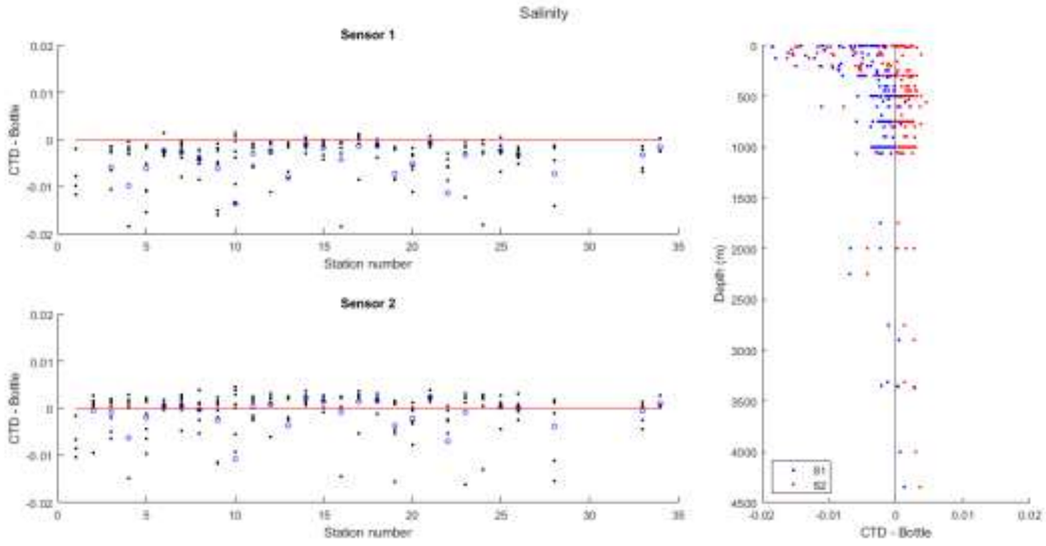


Figure 5-5: Differences between CTD and bottle salinities before calibration. The left upper and lower panels show the difference between CTD and bottle salinities (CTD minus bottle) at each station for CTD sensors 1 and 2 respectively. The red line is located at

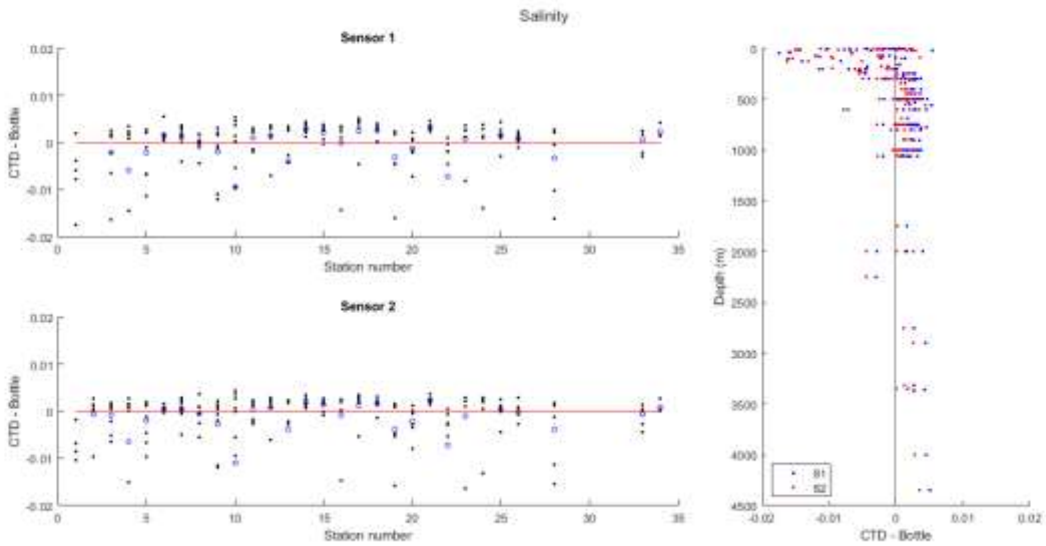


Figure 5-6: as Figure 5-5 but after conductivity calibration as described above.

5.5.3 Oxygen calibration

The three oxygen sensors present on the ship were changed at two points during the cruise due to unusual spiking (Table 5-1). Sensor SN0676 was used in position 1 for casts 1 to 18. Sensor SN0245 was in position 2 for casts 1 to 13 and was then exchanged for SN2290 (casts 14 to 34) because of spiking. SN0245 was put into position 1 from cast 19 onward.

There is a large offset between the sensors in position 1 (SN0676) and position 2 (SN0245 and SN2290) during the first 18 casts, with a particularly large offset in the upper 50 m (Figure 5-7). The offset in the surface water seems to be mostly driven by the behaviour of the sensor in position 1 which records a surface oxygen minimum during all casts (Figure 5-7, right panel). This seems physically implausible. In addition to recording more plausible surface oxygen concentrations, the sensors in position 2 also showed more consistent behaviour in oxygen-temperature space (Figure 5-8). After exchanging SN0676 for SN0245 from cast 19 onward, CTD oxygen 1 and 2 showed more consistent behaviour and smaller offsets between the two sensors.

Table 5-1: Oxygen sensor serial numbers. Colours of position/sensor combinations relate to colours used in Figures below.

Casts	*Position 1*	*Position 2*
1-13	SN0676	SN0245
14-18	SN0676	SN2290
19-34	SN0245	SN2290

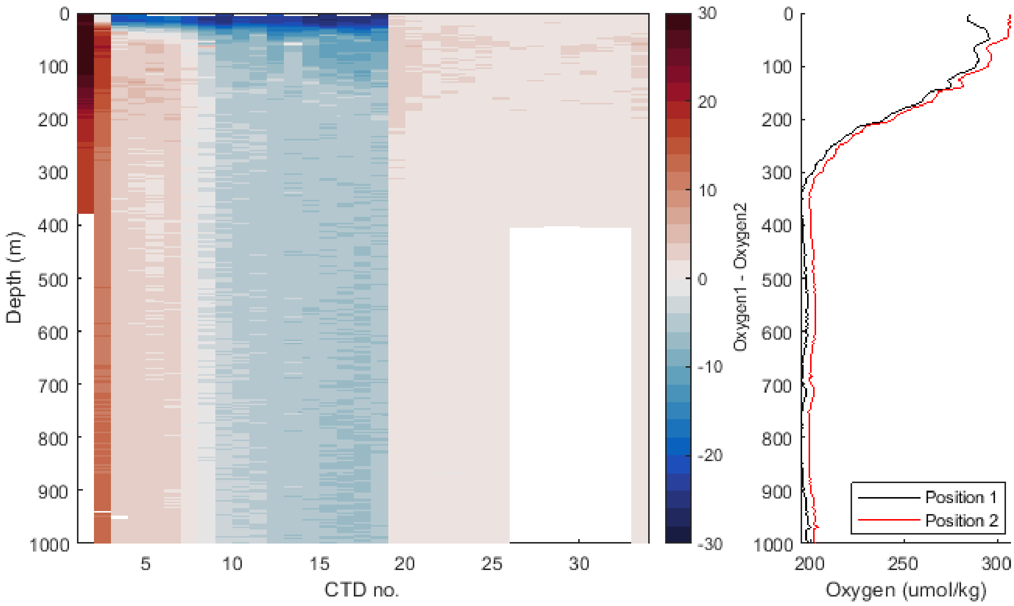


Figure 5-7: Offset between the oxygen sensors in position 1 and 2 by cast number and depth (left). Example profiles (cast 10) of the oxygen sensors in position 1 and 2 (right).

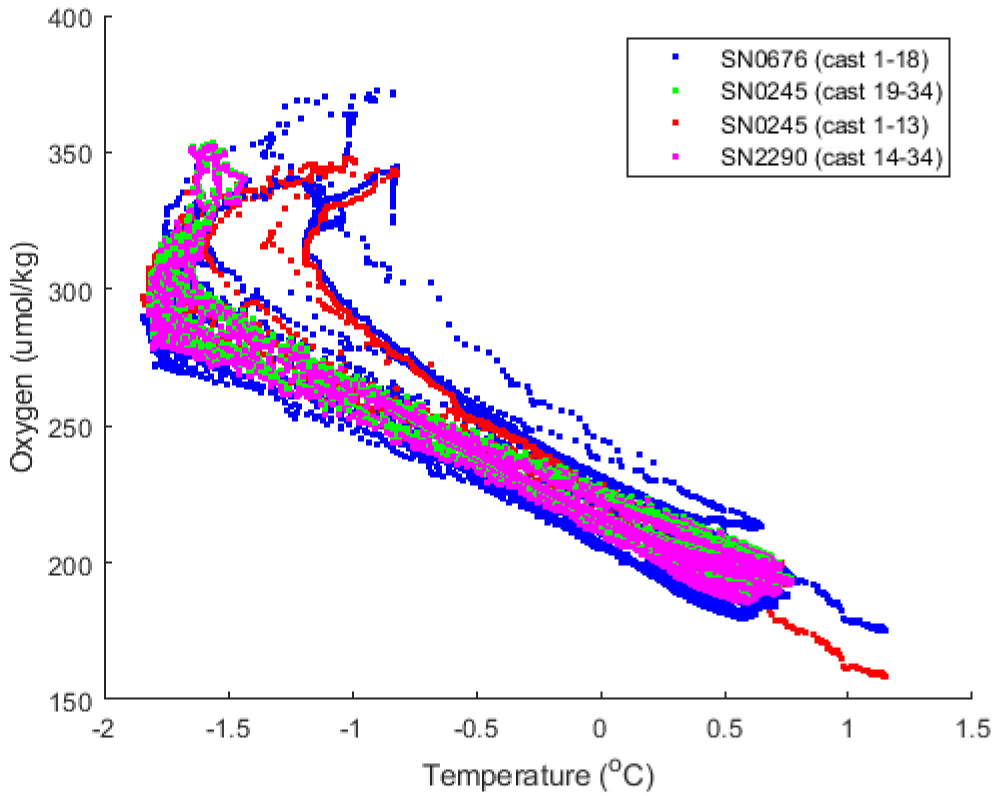


Figure 5-8: Oxygen vs Temperature for all sensors.

Despite issues with the oxygen titrator (see Section 11-4 Oxygen titration), a reasonable fit between oxygen bottle samples and CTD sensors was reached (Figure 5-9). The R^2 values for the fit between bottle and CTD oxygens are 0.89 for SN0676, 0.93 for SN0245 (both in position 1 and 2) and 0.94 for SN2290. The median (mean) offset between CTD and bottle oxygens was -3.50 (-1.74) umol/kg for SN0676, -4.00 (-10.07) umol/kg for SN0245 in position 1, -4.66 (-7.10) umol/kg for SN0245 in position 2, and -3.28 (-6.90) umol/kg for SN2290.

Some of the outliers in Figure 5-9 can be traced back to leaking Niskin bottles. For example, the outlier in the left bottom corner comes from cast 8, Niskin bottle 5 which had a leak. However, while this is the largest outlier for this specific cast, there are other samples with large differences between CTD and bottle oxygens in cast 8 (Figure 5-10), even though no additional leaky Niskin bottles were recorded. Similarly, cast 23 shows a wide spread in differences between CTD and bottle oxygens; however, most of these samples were not taken from leaking Niskin bottles. Of the two samples that were taken from leaky Niskin bottles (including one with a note saying ‘empty early’), only one presents an outlier in Figure 5-9.

Separate Oxygen-Temperature and Oxygen-Depth figures for each cast (including bottle data) can be found in L:\work\scientific_work_areas\CTD\Figures\Oxygen Bottle Comparison.

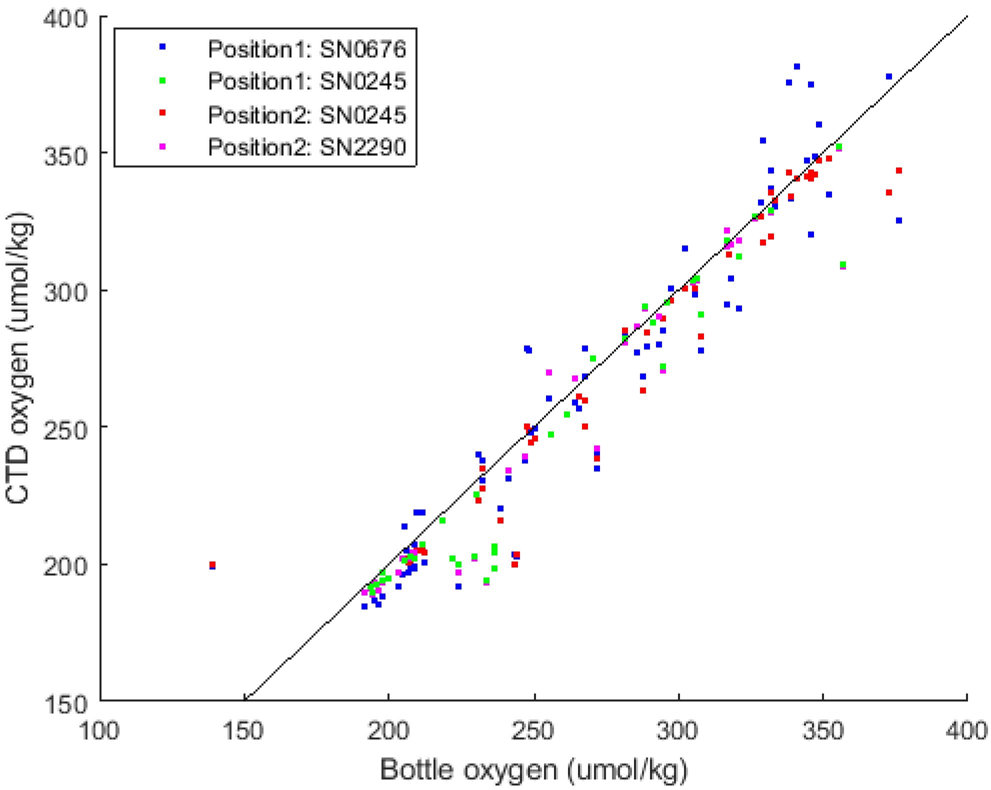


Figure 5-9: CTD oxygen plotted against bottle oxygen for the four different sensor/position combinations. The black line shows CTD oxygen = bottle oxygen.

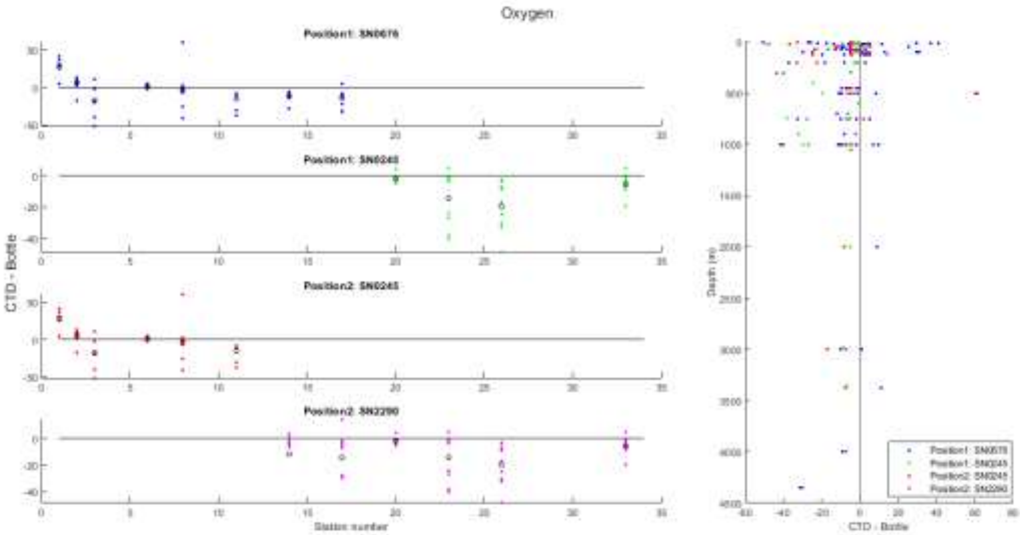


Figure 5-10: Differences between CTD and bottle oxygens before calibration. The left four panels show the difference between CTD and bottle oxygens (CTD minus bottle) at each station for all CTD position/sensor combinations. The black line is located at 0, and blac

5.6 Directory structure

All output data, code and figures can be found in L:\work\scientific_work_areas\CTD. Subdirectory 'code' contains the code used for all processing and calibration as described above, including scripts used to apply calibrations and produce calibrated CTD files ('apply_cal_X.mat'). 'code\Analysis' contains scripts used to derive calibrations. 'CTD_raw' contains raw CTD and LADCP data, including .cnv files from preprocessing. 'CTD_processed' contains processed CTD data, including 'before_calibration', after the temperature calibration was applied ('CTD_T_calibrated') and after the conductivity calibration was applied ('CTD_C_calibrated'). These three subdirectories are organised into 'ctd_files' and 'bottle_files', the former of which contain .1hz, .2db.mat, .2db.up.mat and .var files. The latter contains all bottle files generated, including the master bottle file. Table 5-2 contains variable names as used in the master bottle files.

Table 5-2: Bottle file variables

Variable name	*Explanation*
botcond	Conductivity of bottle samples, calculated from bottle salinities for in-situ temperatures [stations x Niskins]
ctdcond1	Conductivity from CTD sensor in position 1 [stations x Niskins]
ctdcond2	Conductivity from CTD sensor in position 2 [stations x Niskins]
ctdcond	Most reliable conductivity data, i.e. from sensor in position 1 [stations x Niskins]
botsal	Salinity of bottle samples, calculated from salinometer conductivity [stations x Niskins]
ctdsalin1	CTD salinity from conductivity sensor in position 1 [stations x Niskins]
ctdsalin2	CTD salinity from conductivity sensor in position 2 [stations x Niskins]
ctdsalin	Most reliable salinity data, i.e. from conductivity sensor in position 1 [stations x Niskins]
sb35temp	Temperature data from the Seabird SB35 [stations x Niskins]
ctdtemp1	CTD temperature from sensor in position 1 [stations x Niskins]
ctdtemp2	CTD temperature from sensor in position 2 [stations x Niskins]
ctdtemp	Most reliable CTD temperature data, i.e. from sensor in position 2 [stations x Niskins]

botoxy	Oxygen of bottle samples [stations x Niskins]
ctdoxygen_umol_kg	CTD oxygen from sensor in position 1 [stations x Niskins]
ctdoxygen2_umol_kg	CTD oxygen from sensor in position 2 [stations x Niskins]
ctddepth	Depth of CTD [stations x Niskins]
lat	Latitude [1 x stations]
lon	Longitude [1 x stations]

5.7 Transects

The following transects show temperature (Figures 5-11 & 5-12), salinity (Figures 5-13 & 5-14), oxygen (Figures 5-15 & 5-16) and fluorescence (Figures 5-17 & 5-18) on the way into (top panel) and out of (bottom panel) the sea ice zone.

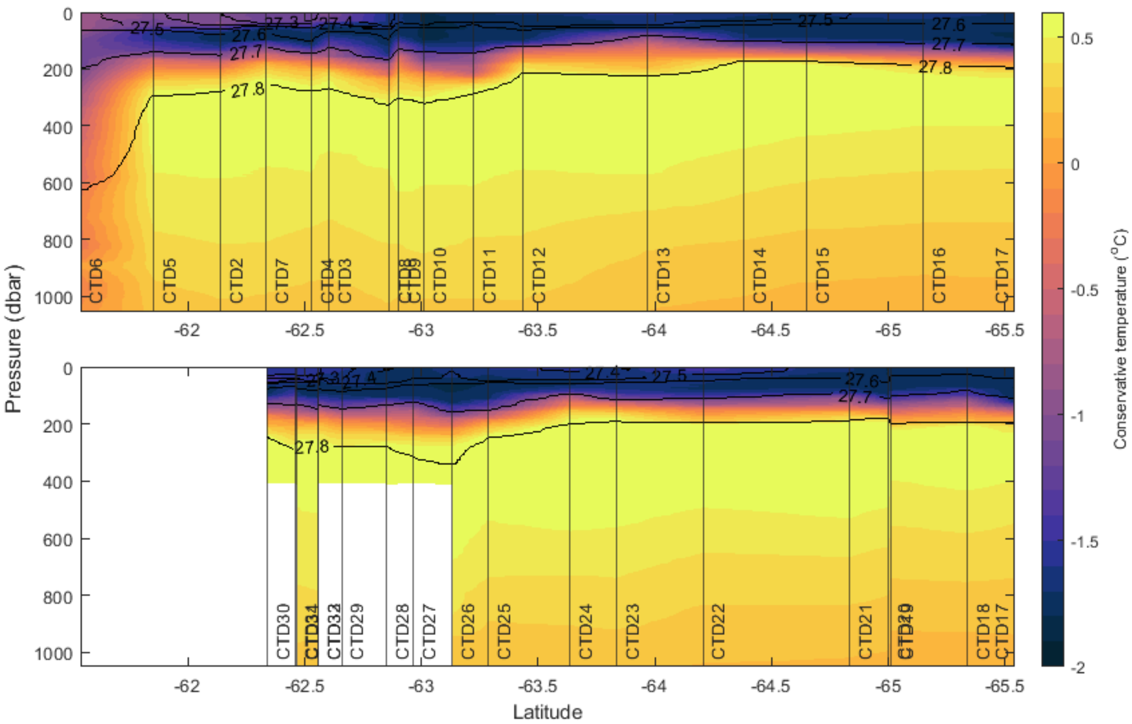


Figure 5-11: Transects of conservative temperature into (left-to-right; top) and out of (right-to-left; bottom) the sea ice zone with contours of surface-referenced density, in order of latitude. Vertical lines show CTD stations. The order of stations north-to-sout

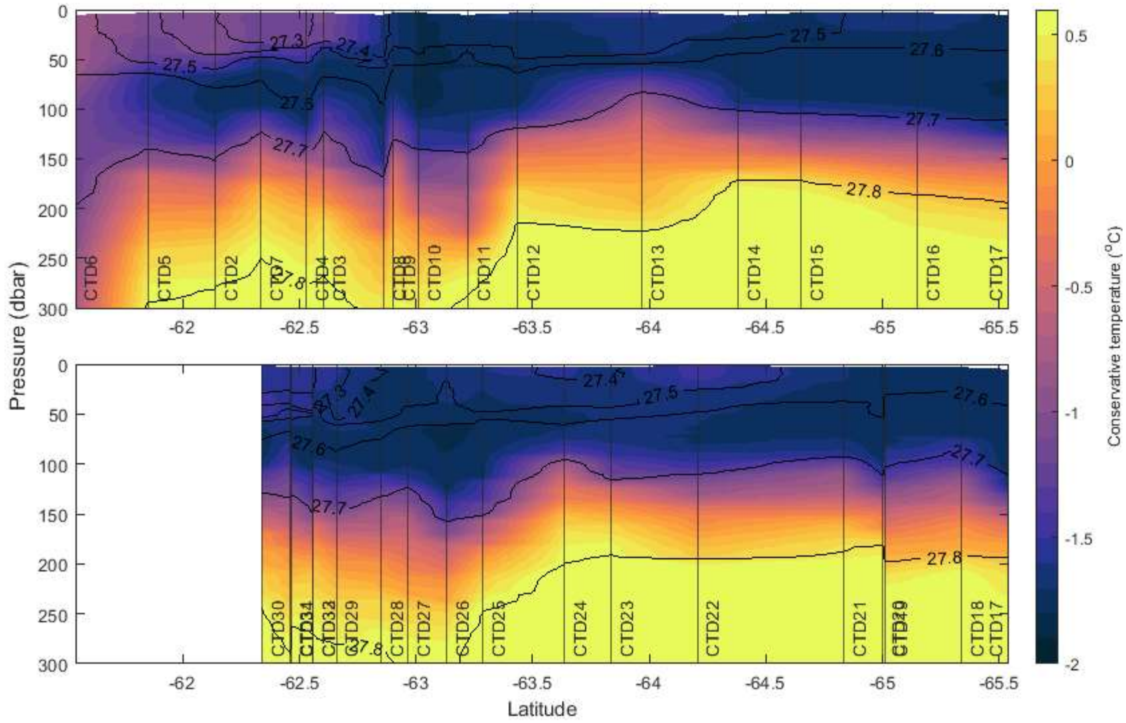


Figure 5-12: as Figure 5-11 but for the upper 300dbar.

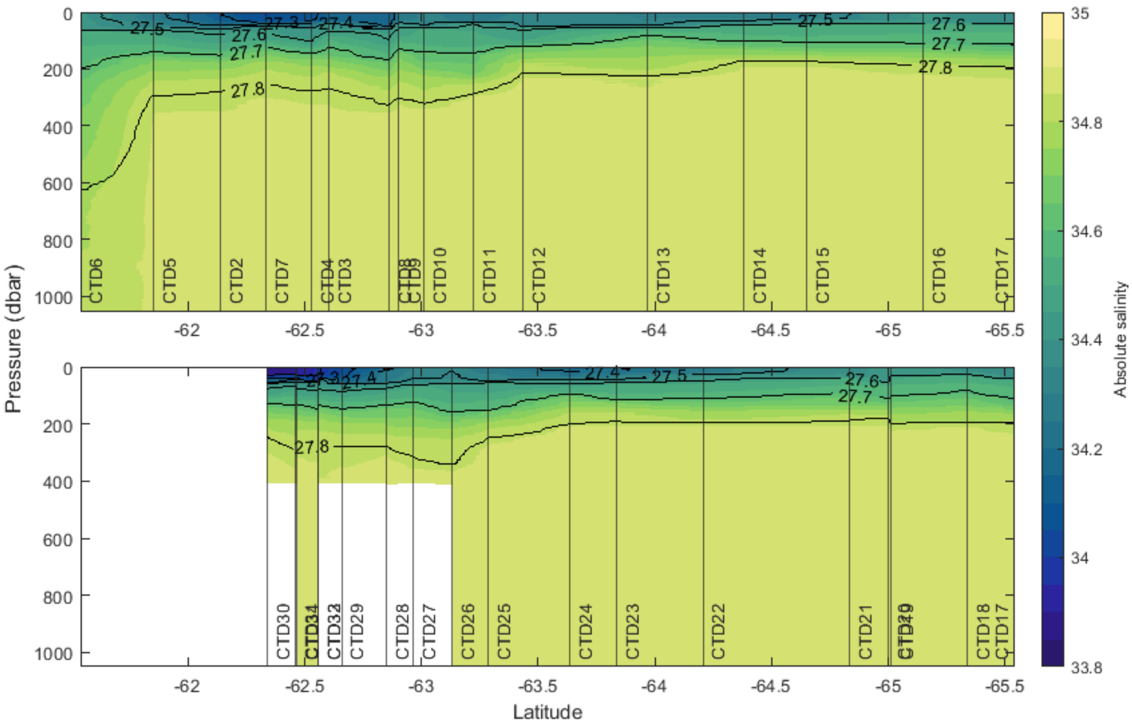


Figure 5-13: Transects of absolute salinity into (left-to-right; top) and out of (right-to-left; bottom) the sea ice zone with contours of surface-referenced density, in order of latitude. Vertical lines show CTD stations. The order of stations north-to-south is CTD

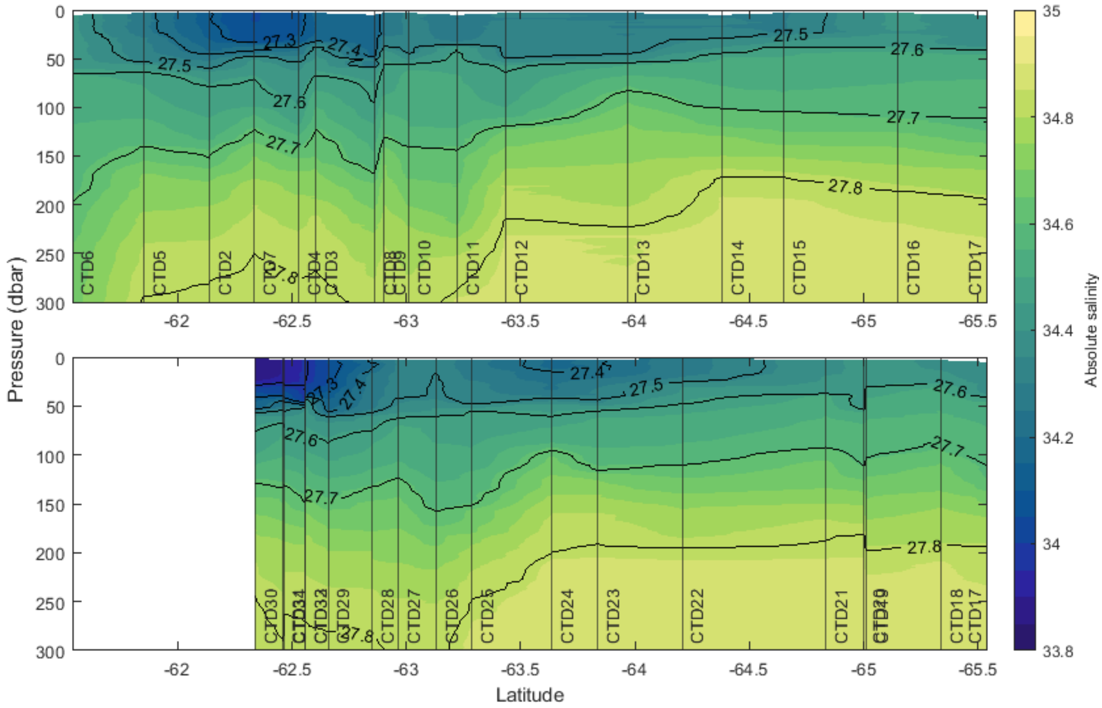


Figure 5-14: as Figure 5-13 but for the upper 300dbar.

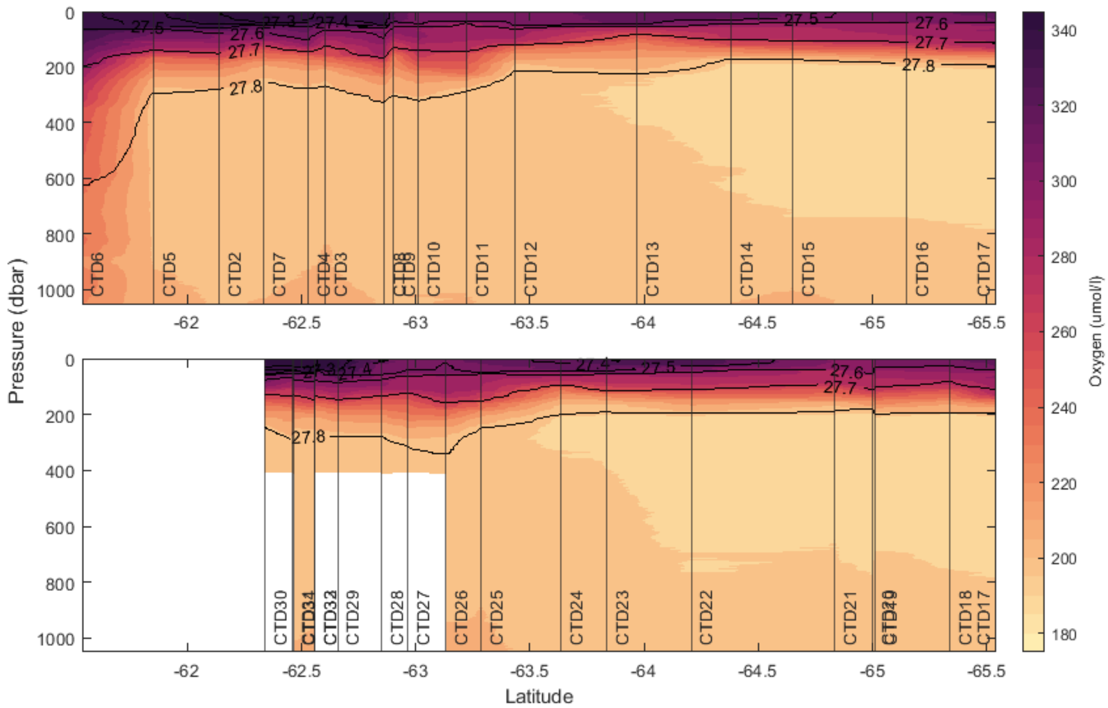


Figure 5-15: Transects of oxygen concentrations into (left-to-right; top) and out of (right-to-left; bottom) the sea ice zone with contours of surface-referenced density, in order of latitude. Vertical lines show CTD stations. The order of stations north-to-south is

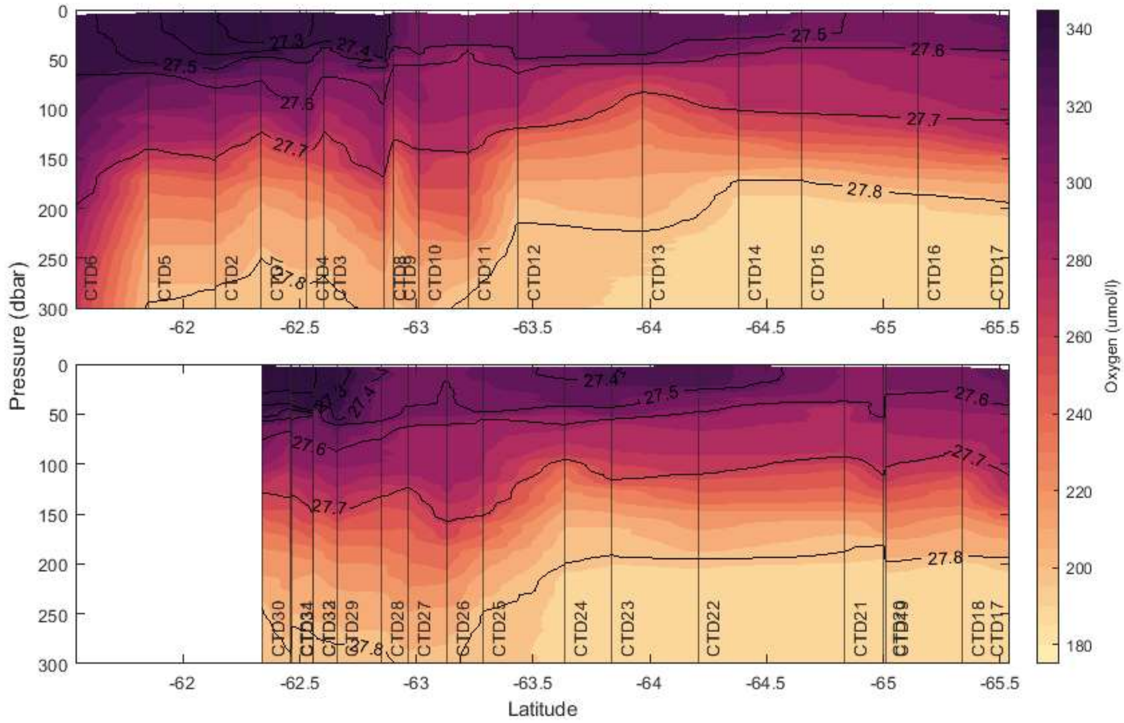


Figure 5-16: as Figure 5-15 but for the upper 300dbar.

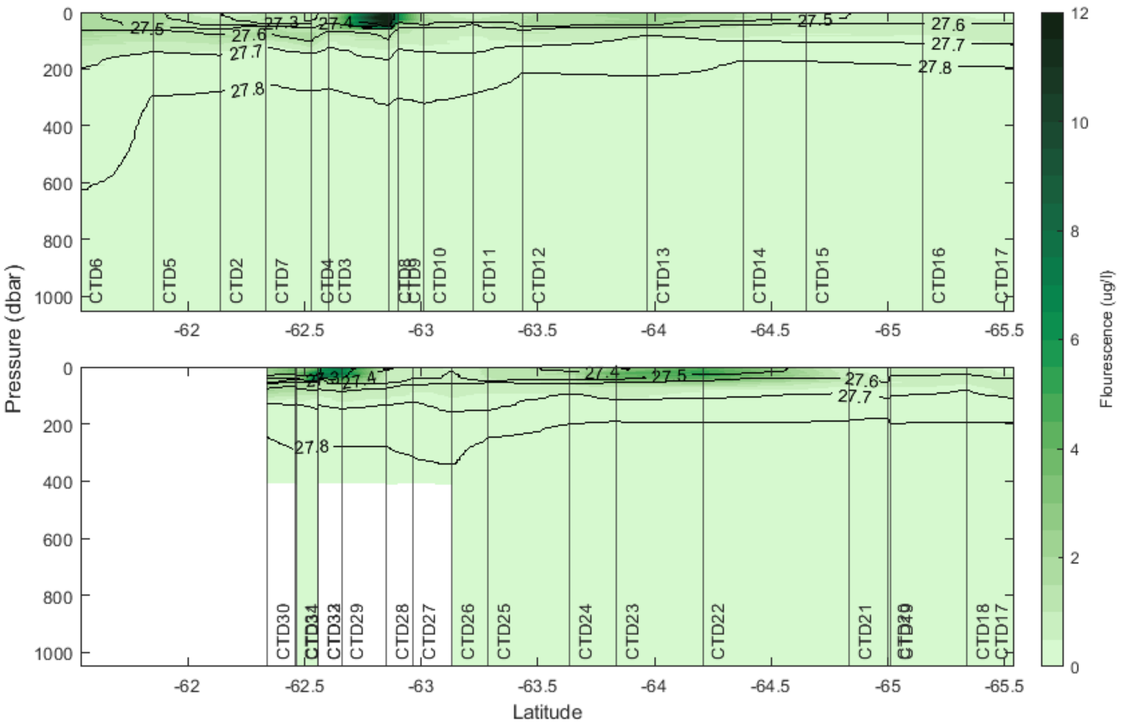


Figure 5-17: Transects of flourescence into (left-to-right; top) and out of (right-to-left; bottom) the sea ice zone with contours of surface-referenced density, in order of latitude. Vertical lines show CTD stations. The order of stations north-to-south is CTD 6,

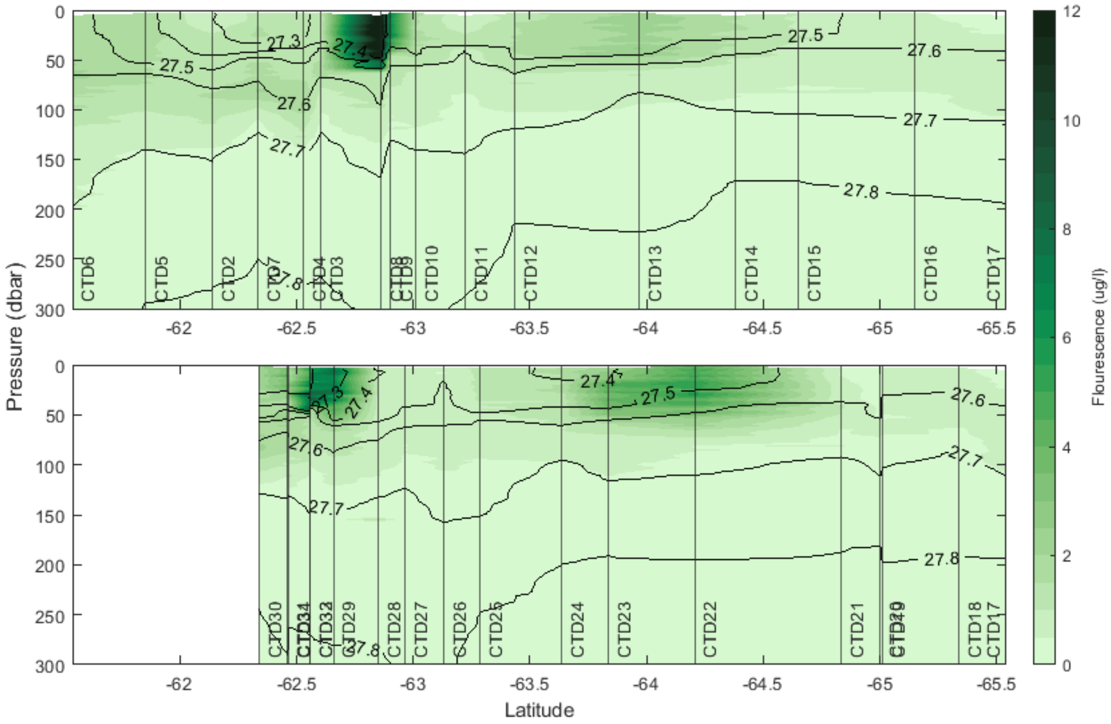


Figure 5-18: as Figure 5-17 but for the upper 300dbar.

6 Salinometry

Kat Turner

On SD033, salinity samples were collected from CTD 1 to 26 and CTD 28, 33, and 34. Additionally, samples were collected from the underway from the 30th of November to the 16th of December at an interval of roughly 4 hours. However, multiple breaks within this dataset are caused by having to shut down the underway to avoid sea ice getting trapped in the underway system.

The process for taking the salinity samples was the same in all cases: rinse the bottle 3 times, fill it up to the bottom of the neck, dry the top with blue roll, seal the bottle with a stopper, and then screw on the cap (which had also been washed and dried with blue roll). For CTDs, the number of salt samples taken was dependent on the depth of the cast: for deeper casts with the full 24 Niskin bottles fired, up to 8 salt samples were taken per cast, whereas on shallower casts with fewer bottles fired we only took between 4 and 6 salinity samples. The depths chosen tried to avoid the thermocline, where salinity changes rapidly, and attempted to get good vertical range to see if there was any pressure dependence in the CTD-bottle offsets.

All salinity samples were then run through a Guildline Autosal 8400B salinometer. The Guildline Autosal 8400B measures the conductivity of a water sample with very high precision, in a water bath of known temperature. The readout is given as twice the conductivity ratio between the sample and standard seawater with salinity 35 PSU at 20ºC, and 1 atmospheric pressure (known as the Vienna Standard). The instrument (S/N 73103) was standardised at the beginning of the cruise and set to 410 to give a reading of 589. Once the instrument had been standardised, it was left like this for the duration of the cruise. Ocean Scientific International Ltd (OSIL) standard seawater (batch numbers P165 and P167) was used to provide calibration readings at regular intervals: before each crate of 24 salt samples and after each crate so that corrections could be applied to the intermediate measurements.

Standard procedure was to gently invert each sample/standard bottle a few times in order to mix the contents but avoid the introduction of a large number of air bubbles into the sample. Before the analysis of each sample, the system was flushed (i.e. flooded and drained) three times with the sample, to remove any traces of the previous sample. The same was done with the standards. At least three readings were taken from each sample/standard bottle. Care was taken to allow sufficient time for the readout value to stabilise on a final value. The mean reading was then taken as the accepted value

It was important to keep the salinometer room at a constant temperature, which should be as close as possible to, but not exceed, the temperature of the salinometer's internal water bath. The water bath was set to a temperature of 21˚C and the room temperature was kept between approx. 18.9˚C and 20˚C. To monitor the room temperature, the room thermometer was checked every 4 hours as part of watchkeeping duties All crates of salinity samples were left in the salinometer room for at least 24 hours before being analysed, to give them time to acclimatise to the room temperature. When the salinometer was not being used, it was flushed with and then left in milliQ, to avoid the build-up of salt crystals in the system. Before each new use, the system was flushed multiple times with an old standard, to remove any traces of milliQ before reading a new standard.

Overall, the salinometer performed well. The plot in Figure 6-1 shows how the readings for the standards varied between sessions. The black lines indicate the start of a new session, with the date of the session indicated at the top. The value plotted by the blue dots is the anomaly between the salinometer readings for the standards, and twice the known conductivity ratio of the standard The average value between the anomalies at the start and end of each session was applied as a correction to the conductivity ratios of the CTD samples measured during that session, as indicated by the orange dots and respective CTD cast numbers. In all cases the salinometer read lower than the standards. The red dot on 6th of December that applied for CTDs 2,3,4 represents a date when the end standard was not taken. The largest difference in standard readings at start and end of a session was for CTD casts 19,20,22,25, where there was a difference of 0.0002 between the standard readings and the average correction applied. This translates to an error in salinity of 0.0001 PSU. On average, across all the CTD, the error in salinity was 0.00004 PSU, which is better than the accuracy of the CTD salinity measurements.

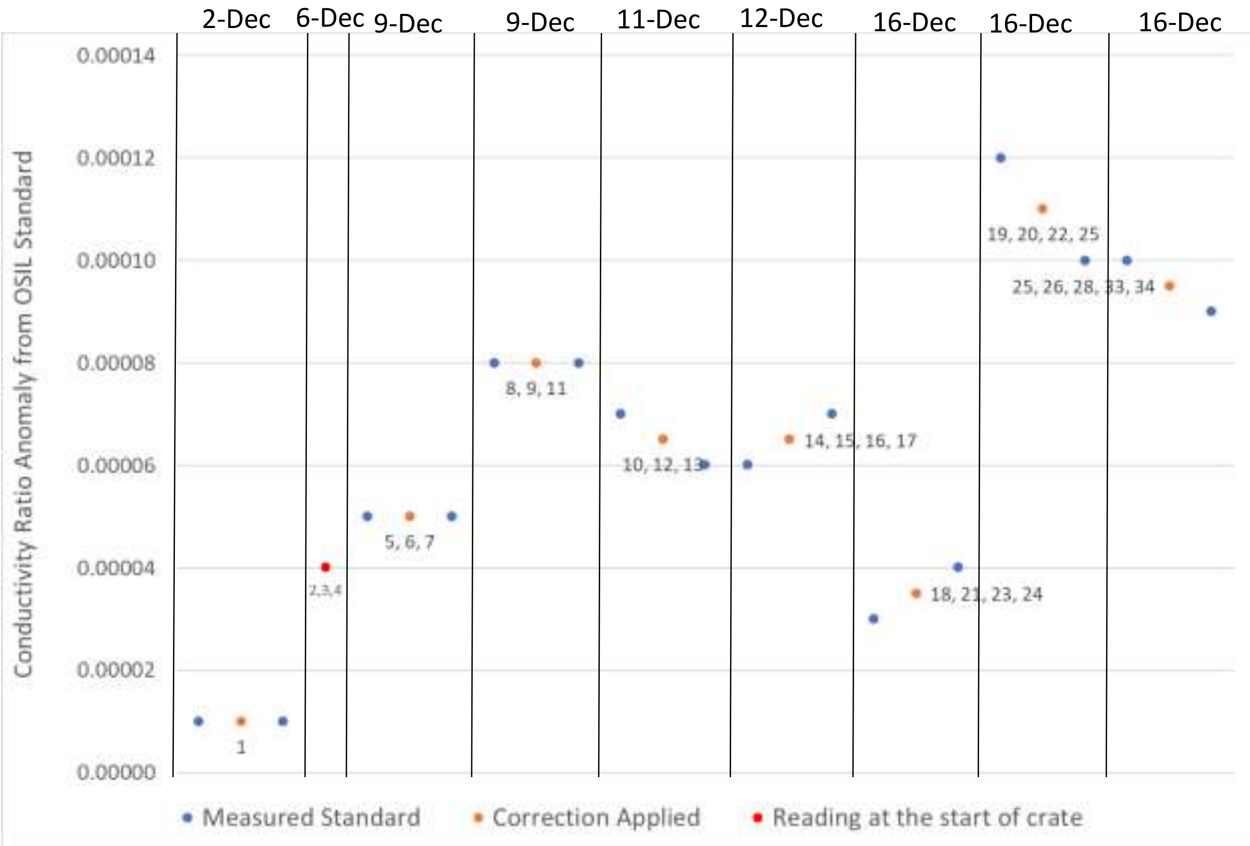


Figure 6-1: Conductivity ratio anomaly from OSIL standard over duration of voyage

The practical salinity of the sample was calculated using the PSS-78 algorithm via the MatLab function gsw_SP_salinometer from the GSW Oceanographic Toolbox of TEOS-10 (http://www.teos-10.org). A MatLab script was created and added to the L-drive in directory L:\work\scientific_work_areas\Salinometry to process the calibrated conductivity ratio into practical salinity. The script takes in calibrated conductivity ratio values from a csv file labelled with the corresponding CTD (eg. sal_SD033_001.csv) in the folder L:\work\scientific_work_areas\Salinometry\read_into_matlab. The script returns salinity values into the folder L:\work\scientific_work_areas\Salinometry\salinities.

Salinometry records were digitised into excel spreadsheets and saved in
L:\work\Log_sheets\Salinometer logs

Identified issues in salinometer readings:

When comparing the calculated salinities from the salinometer and the CTD salinities the following issues were seen:

- CTD 2,3,4 showed large variation between readings and the CTD measurements. During these readings the salinometer struggled to stabilise between values and may have caused issues in providing a value for the ratio.
- CTD 28 also showed large variations. No clear errors in the reading were identified, however, there was a slight drift to the standby and zero readings between the start and the end (standby – start: 5896, standby – end: 5898; zero – start: 0002, zero –end: 0005)

7 Underway measurements

Kat Turner

7.1 Accessing data through RVDAS.

The SDA underway data was saved to the RVDAS PostgreSQL containing all current and earlier SDA cruises. To access the instruments available and the data output by the current cruise, a data view, sd033, was set up.

The connection to the database was set up via an ODBC (Open Database Connectivity) driver. The ODBC driver system was implemented for two main reasons:

1. To increase transferability between operating systems (e.g., Linux, Windows, Mac)
2. To reduce errors when translating SQL command line input from MATLAB when running the analysis scripts

For full details on setting up the ODBC driver, see the README.md file included in the directory L:\work\scientific_work_areas\Underway\code_underway on the leg drive. The README.md file covers all the database access details needed to set up the connection except for the password to the server.

7.2 Navigation Data

Navigational data were collected continuously throughout the cruise and loaded to RVDAS at a frequency of 1Hz.

Table 7-1: Table listing the sensor location on the ship, units, and SQL table name of the underway instruments used on the SD033 cruise.

Data Stream on RVDAS	Measurement	Units	Sensor Location
sd_attitude_ixblue_phins_surface_heading_crp1	Heading	degrees	phins
sd_attitude_kongsberg_seapath_320_heading_port1	Heading	degrees	port
sd_attitude_kongsberg_seapath_320_heading_stbd1	Heading	degrees	starboard
sd_attitude_ixblue_phins_surface_motion_crp1	Motion Data (heave, pitch, roll)	(degrees/100, cm)	phins
sd_attitude_kongsberg_seapath_320_motion_port1	Motion Data (heave, pitch, roll)	(degrees/100, cm)	port
sd_attitude_kongsberg_seapath_320_motion_stbd1	Motion Data (heave, pitch, roll)	(degrees/100, cm)	starboard
sd_attitude_raytheon_standard_30mf_port1	Heading True and Rotation	degrees	port
sd_gnss_fugro_oceanstar_centremast1	Global Positioning	degrees	centre mast

	Data, course over ground		
sd_gnss_kongsberg_seapath_320_port1	Global Positioning Data, course over ground	degrees	port
sd_gnss_kongsberg_seapath_320_stbd1	Global Positioning Data, course over ground	degrees	starboard

7.2.1 Processing Navigation Data

The underway navigational data was processed in MatLab (R2023a) on Windows (Windows 10 Enterprise). The scripts used were provided by Povl Abrahamsen. The MatLab scripts were modified to use an ODBC connection as detailed above, and scripts were updated to call the current set of instrumentation available. Minor bugs caused by differences in MatLab versioning were removed as well. All scripts are available under L:\work\scientific_work_areas\Underway\code_underway. For more details read the documentation present in the README.md file.

rvdas_tables.m makes use of the ODBC connection to locate all tables under the cruise view and save their names locally to the leg drive.

set_underway_params.m sets all the table names as listed in table 7-1 to the structure *nav_tables* which is called by any scripts loading, saving, or analysing the navigation data.

load_daily_nav.m reads in the year day and loads the daily navigation data and saves it as a MatLab grid to the directory L:\work\scientific_work_areas \Underway\nav. The data is plotted from the same script by calling *plot_daily_nav.m*. An example is shown below in Figure 7-1

append_daily_nav.m [bug] appends the daily files within the directory L:\work\scientific _work_areas\Underway\nav

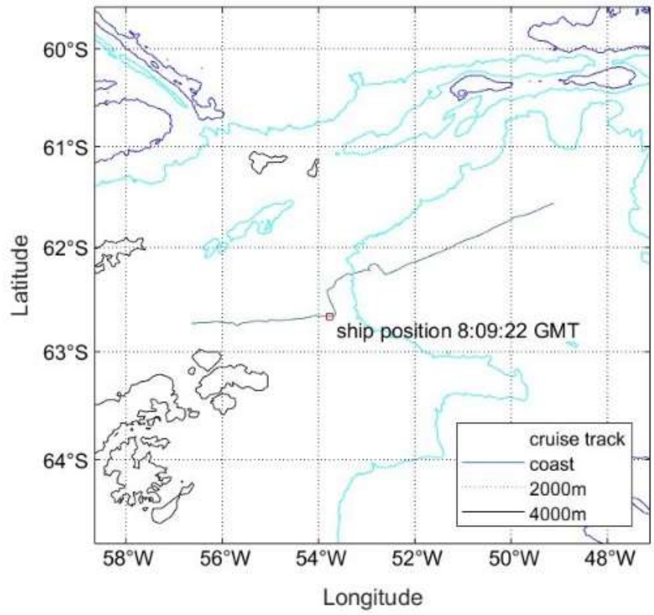


Figure 7-1: Ship navigation route when surveying the iceberg A23a. The highlighted position in the image matches the ship position during a satellite picture taken of the iceberg at the same time. The boxy indent is the ship going around the iceberg.

Figure 7-1 is an example created with the scripts detailed above. The figure details the cruise track corresponding to the surveying of iceberg A23a, highlighting the ship position when a satellite image was taken of the iceberg.

7.2.2 Issues Encountered

Several coding issues arose when loading the data from RVDAS to the leg drive due to operational errors caused by MATLAB translating the command line prompts for PostgreSQL on a Windows system. These were solved by using the ODBC to execute prompts directly to PostgreSQL rather than going through the command line.

The implementation of the ODBC driver does cause a longer runtime on load_daily_nav.m. Some changes were made to account for this, but if the issue becomes unsustainable for future cruises, a previous version of the code that makes use of *.pgpass* files can be found in the scripts that are signalled with the file name followed by "_povl".

All instruments and table names were updated to the current available set for this cruise and the scripts were modified accordingly. Any bugs resulting from changes associated with MatLab versioning were removed.

The *append_daily_nav.m* struggles to correctly load the navigation data time values, this issue was not present in the oceanographic and bathymetry scripts. The source of this issue was not identified due to a lack of time. There were also bugs in the averaging script for all underway data streams, these were not solved on this cruise.

Over the duration of the cruise the SeaPath 1 port side data for heave, pitch, and roll is missing as the instrumentation was out for repair.

7.3 Oceanographic and Meteorological data

Oceanographic and meteorological data were collected continuously throughout the cruise and loaded to RVDAS at a frequency of 1Hz.

Table 7-2 The table lists the sensors, location on the ship, and RVDAS table names for the underway oceanographic and meteorological data as called in the *set_underway_params.m* script.

Data Stream on RVDAS	**Measurement**	**units**	**Sensor**	**Sensor Location**
sd_anemometer_ft_tech_ft702lt _centremast1	Wind speed and angle	degrees, m/s	anemometer	centre mast
sd_anemometer_observator_om c116 _portmast1	Wind speed and angle	degrees, m/s	anemometer	port mast
sd_anemometer_observator_om c116 _stbdmast1	Wind speed and angle	degrees, m/s	anemometer	starboard mast
sd_fluorometer_wetlabs_wschl_ ucsw1	Chlorophyll	counts	fluorometer	hull
sd_met_vaisala_hmp155e _foremast1	Relative Humidity, Dew Point Temperature, Wet Bulb temperature, mixing ration	percentage , degrees Celsius, g/kg		foremast
sd_met_vaisala_hmp155e _scimast1	Relative Humidity, Dew Point Temperature, Wet Bulb temperature, mixing ration	percentage , degrees Celsius, g/kg		scimast
sd_met_vaisala_ptb330_v1	Air Pressure and Air Temperature	hPa, degrees Celsius		
sd_radiometer_heitronics_ct15_8 5_port1	Sea Surface Temperature	Degrees Celsius	radiometer	port
sd_radiometer_heitronics_ct15_ 85_stbd1	Sea Surface Temperature	Degrees Celsius	radiometer	starboard
sd_soundvelocity_valeport_ minisvs _ucsw1	Sound velocity	m/s		hull
sd_thermometer_seabird_sbe38 _ucsw1	Temperature	Celsius	thermometer	hull
sd_thermosalinograph_seabird_ sbe45_ucsw1	Temperature, Salinity, Conductivity	Celsius, S/m, PSU	thermosalinog raph	hull

7.3.1 Processing

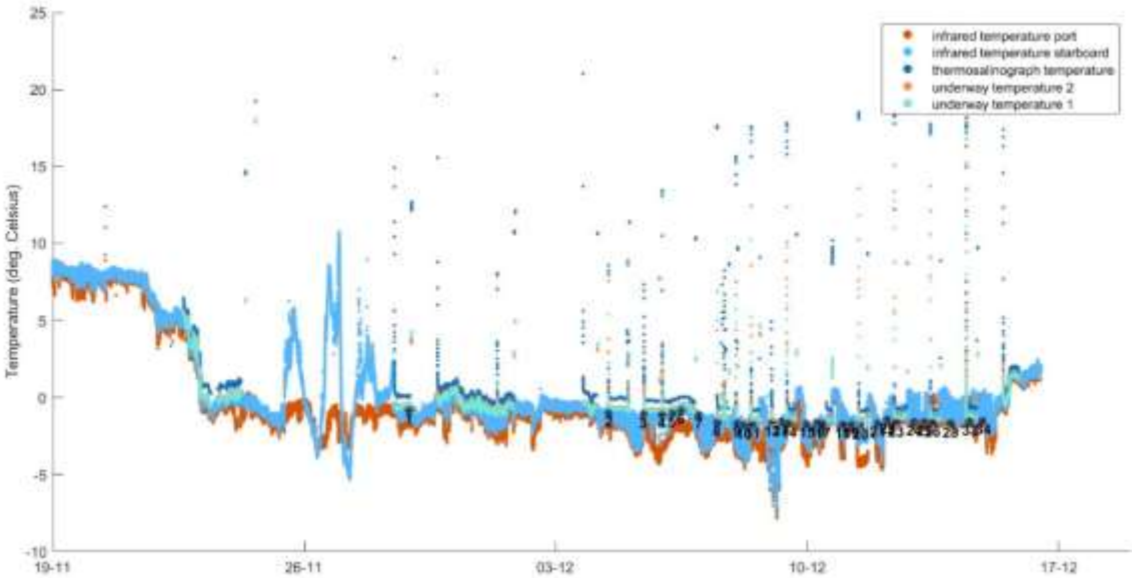
The underway oceanographic and meteorological data were processed in MatLab (R2023a) on Windows (Windows 10 Enterprise). The scripts used were provided by Povl Abrahamsen. The MatLab scripts were modified to use an ODBC connection as detailed above, and scripts were updated to call the current set of instrumentation available. All scripts are available under L:\work\scientific_work_areas\Underway\code_underway. For more details read the documentation present in the README.md file.

rvdas_tables.m	makes use of the ODBC connection to locate all tables under the cruise view and save their names locally.
set_underway_params.m	sets all the table names as listed in table 7-2 to the structure *ocl_tables* which is called by any scripts loading, saving, or analysing the oceanographic and meteorological data.
load_daily_ocl.m	reads in the year day and loads the daily oceanographic and meteorological data and saves it as a MatLab grid to the directory L:\work\scientific_work_areas\Underway\ocl. The data is plotted from the same script by calling *plot_daily_ocl.m*.
plot_daily_ocl.m	plots the data and allows to monitor the flow rate of the hull inlet. A future improvement could use the flow rate to mask out values taken when the underway is not switched on.
append_daily_ocl.m	appends the daily files within the directory L:\work\scientific _work_areas\Underway\ocl.
temp_calibration.m	plots the appended temperature files collected from the hull, starboard, and port instruments and compares them to the CTD cast temperature. More details on the calibration are listed in the following section.
salt_calibration.m	plots the appended salinity and conductivity files collected from the hull and calibrates them against the CTD measurements and the salt measurements taken over the duration of the cruise as calculated from the salinometer. More details on the calibration are listed in the following sections.

7.3.2 Temperature Calibration

Over the duration of the cruise five sensors were used to monitor the water temperatures:

- **underway temperature 1 and 2:** two sensors located at the hull at a depth of 7m, sensor 2 is located further in on the inlet and therefore displays a warm bias compared to sensor 1 [Figure 7-2]. These are saved in the RVDAS tables *sd033_thermometer_seabird_sbe38 _ucsw1 and sd033_thermometer_seabird _sbe38 _ucsw2.*
- **thermosalinograph:** instrument monitoring temperature, salinity, and conductivity. Located further in on the inlet and displays the warmest bias [Figure 7-2].
- **infrared temperature port and starboard:** the ship was equipped with two infrared sensors, which monitor the water skin temperature, thus are affected by atmospheric temperature and show a slight cold bias.



-

Figure 7-2: shows all the underway temperatures against the calibrated CTD measurements that are the black dots with the corresponding CTD number.

The underway data was masked when the flowrate was below 1.2 L/min. Over the cruise the underway measurements had to be paused when crossing through sea ice to avoid clogging the system. This caused noise in the system and disruptions to the measurements as highlighted in Figure 7-3. Interestingly, a similar disruption appears to occur during some of the CTD measurements as well (shown in Figure 7-3 as the black lines). Following work on this data will need to further clean the data and monitor the spikes.

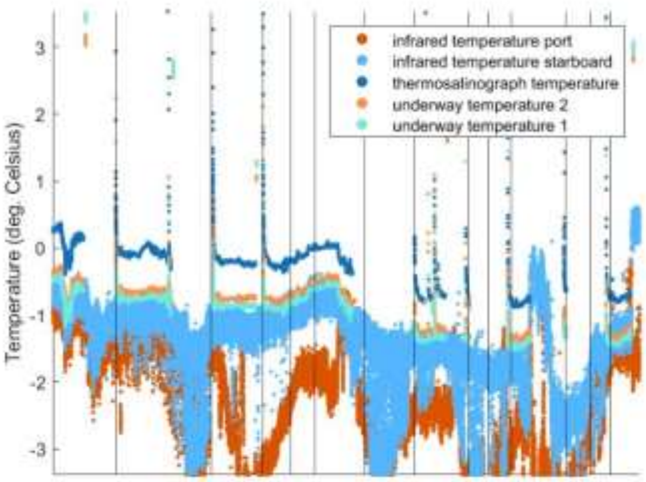
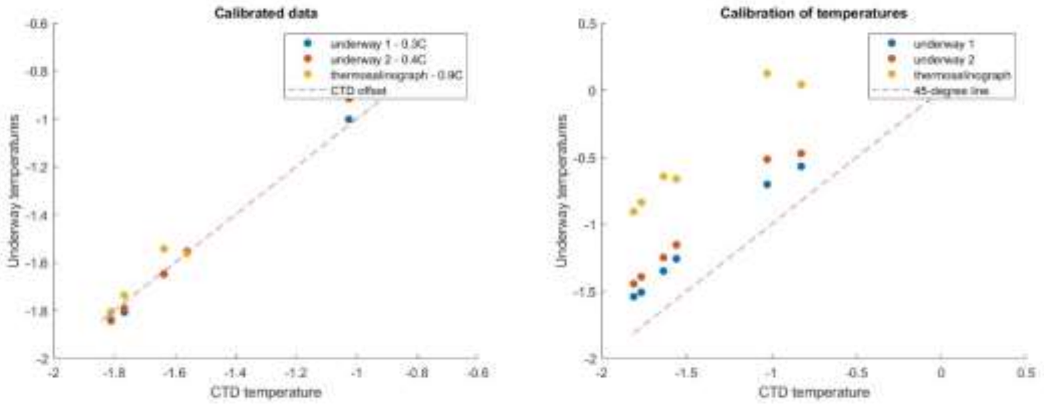


Figure 7-3: Highlighting disruptions and noise to measurements during CTD measurements when the underway was paused when going through sea ice.



The infrared measurements are also noisy will need potential filtering and smoothing to remove spikes.

Figure 7-4: calibration of the hull inlet measurements against the CTD measurements taken at 7m. left) uncalibrated measurements taken at the same time as the CTDs that had a valid flow rate. right) calibrated measurements obtained via linear interpolation.

The underway and thermosalinograph measurements were compared against the calibrated CTD temperature measurements taken at the exact same time. Values with high spikes or a flowrate below 1.2 L/min were removed. Underway 1 had the smallest bias (0.3˚C) which is reasonable as it is the closest to the inlet, soon flowed by underway 2 (0.4˚C). The thermosalinograph presented the highest bias by far of 0.9˚C. This calibration is needed to correctly calibrate the salinity taken at the underway.

The calibration was applied to each instrument and is reported in Figure 7-5. These now match the infrared sensors and CTD sensors more closely. Future work will need to remove and filter the spikes out.

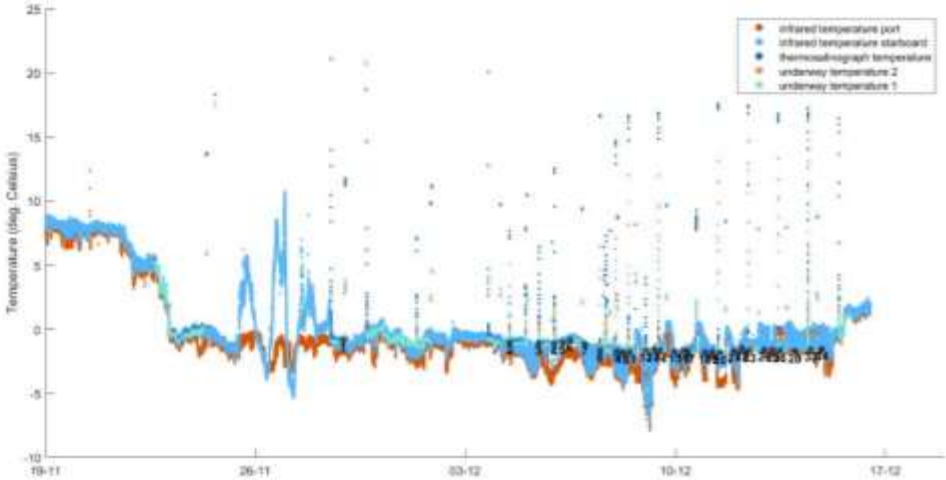


Figure 7-5: shows all the calibrated underway temperatures against the calibrated CTD measurements that are the black dots with the corresponding CTD number.

7.3.3 Salinity calibration

Over the duration of the cruise the salinity and conductivity values were logged by the thermosalinograph. Following a similar procedure as detailed above, the underway data was masked when the flowrate was below 1.2 L/min. The resulting salinity and conductivity measurements appear noisy as highlighted in Figure 7-6. Following work on this data will need to further clean the data and monitor the spikes.

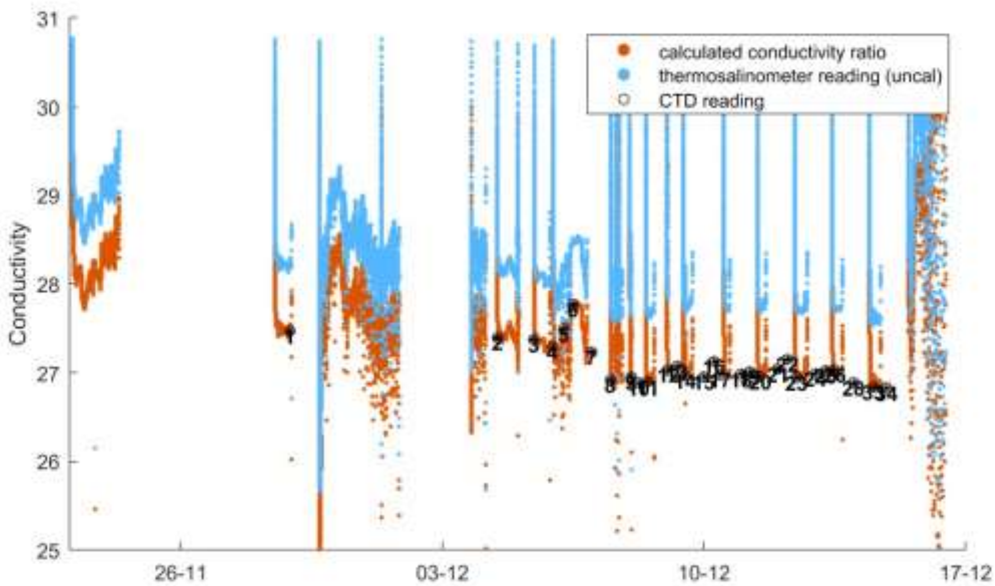


Figure 7-6: shows the thermosalinograph conductivity against the calculated conductivity and the calibrated CTD conductivity.

To calibrate the conductivity measurements, the raw data was compared to the CTD readings made at 7m which was the depth of the inlet. A conductivity was also calculated by taking the calculated conductivity at a salinity of 35 psu, a temperature of 15C and pressure of 0db and multiplying it by the conductivity ratio. This was achieved using the Mixing Oceanographic Toolbox on MatLab. The calculation in the code is as shown here:

```
calc_cond=sw_c3515*sw_cndr(raw_sals, cal_temp, press);
```

Where cal_temp is the calibrated temperature as calculated in the previous section. The result from these calculations is the red line that matches the CTD measurements very well.

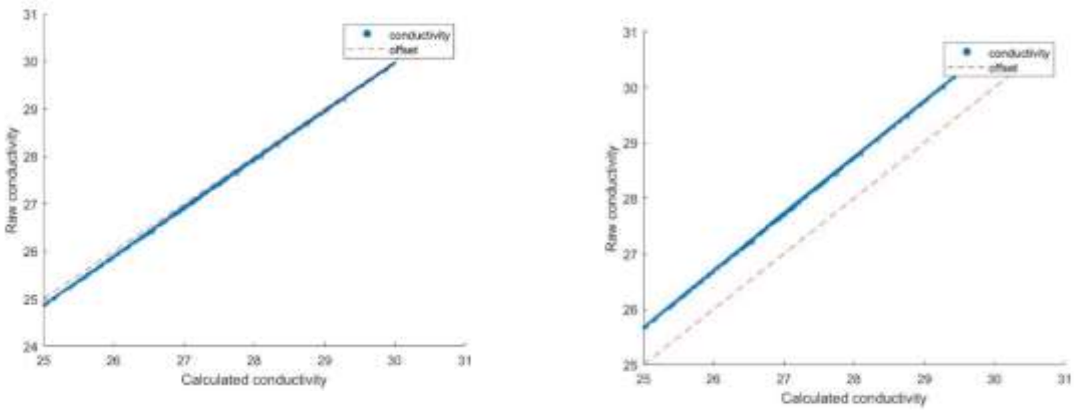


Figure 7-7: Calculation of the offset between the measured conductivity and the calculated conductivity.

The offset between the calculated conductivity and the raw conductivity was of 0.8 mS/cm.

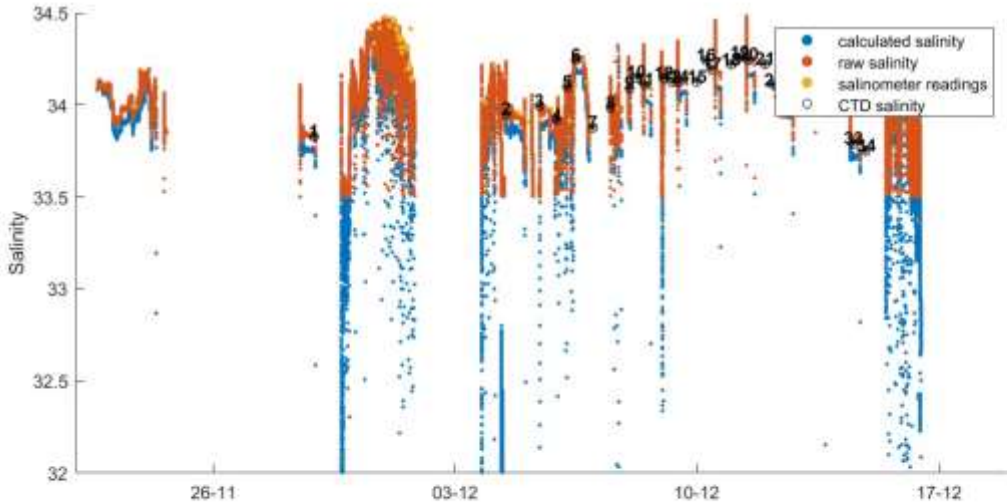


Figure 7-8: shows the thermosalinograph salinity against the calculated salinity and the calibrated CTD salinity.

The calibrated conductivity and temperature were then used to calibrate the salinity. Figure 7-8 shows the different parameters for adjusting the salinity:

- **Raw salinity:** salinity as directly measured by the thermosalinograph
- **Calculated salinity:** salinity as calculated from the calibrated temperature, calibrated conductivity and temperature
- **Salinometer readings:** the salinity calculated as it would be if the sample were left at room temperature with atmospheric pressure
- **CTD salinity:** calibrated CTD measurements

Weirdly the raw salinity appears closer to the CTD measurements. The following calibrations were applied to the calculated salinity obtained using the GSW toolbox on maltab.

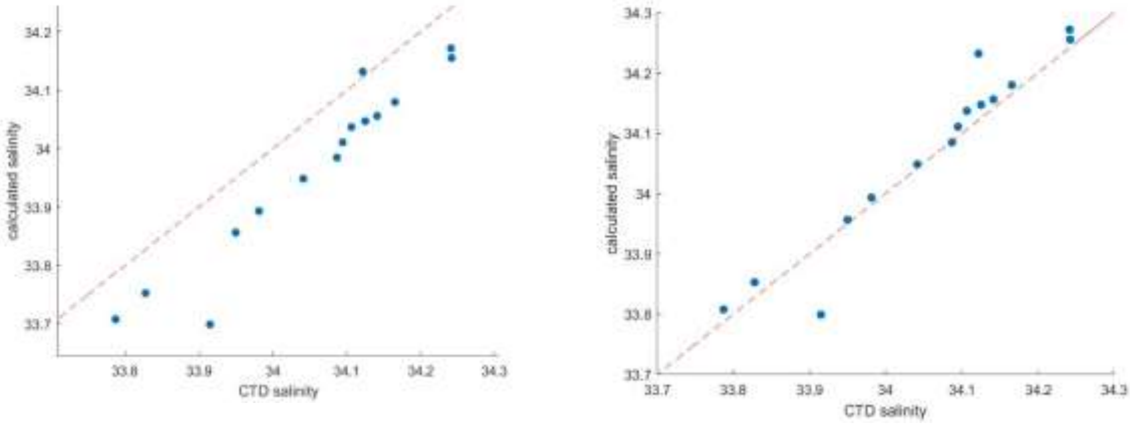


Figure 7-9: CTD salinity offset

7.3.4 Issues encountered

As detailed in 10.2.2 the scripts were updated to include the use of the ODBC driver and issues resulting from MatLab versioning were removed. There was no obvious increase to the runtime of the oceanographic and meteorological data in doing this. The instruments available on the ship were updated within *set_underway_params.m*.

The underway measurements were switched off when passing through sea ice to avoid clogging, thus resulting in the data gaps observed in Figure 7-2. The underway flow also seems to have been disrupted around many CTDs [Figure7-3], so these values had to be discarded when making the calibrations.

Worth noting that the flow rate and the temperature measurements are taken at different time intervals thus the values were all interpolated onto the flow rate time scale to make the measurements comparable.

The script used to create averages of the appended data presents bugs that were not solved during this cruise.

Due to issues with timings, the plots were made last minute so they are ugly :)

7.4 Bathymetry data

Bathymetric data were collected continuously throughout the cruise and loaded to RVDAS at a frequency of 1Hz.

Table 7-3 The table lists the sensors, location, and RVDAS table names for the underway bathymetry data as called in the *set_underway_params.m* script.

Data Stream on RVDAS	Measurement	units	Sensor	Sensor Location
sd_multibeam_kongsberg_em122_hull1	Depth	metres	EM122	hull
sd_multibeam_kongsberg_em712_hull1	Depth	metres	EM712	hull

sd_singlebeam_kongsberg_ea640_hull1	Depth	metres	EA640	hull

7.4.1 Processing Bathymetric Data

The underway bathymetry data was processed in MatLab (R2023a) on Windows (Windows 10 Enterprise). The scripts used were provided by Povl Abrahamsen. The MatLab scripts were modified to use an ODBC connection as detailed above, and scripts were updated to call the current set of instrumentation available. Minor bugs caused by differences in MatLab versioning were removed as well. All scripts are available under L:\work\scientific_work_areas\Underway\code_underway. For more details read the documentation present in the ReadMe file.

rvdas_tables.m makes use of the ODBC connection to locate all tables under the cruise view and save their names locally.

set_underway_params.m sets all the table names as listed in table 7-1 to the structure *bathy_tables* which is called by any scripts loading, saving, or analysing the navigation data.

load_daily_bathy.m reads in the year day and loads the daily bathymetry data and saves it as a MatLab grid to the directory L:\work\scientific_work_areas \Underway\bathy. The data is plotted from the same script by calling *plot_daily_bathy.m*

append_daily_bathy.m appends the daily files withing the directory L:\work\scientific _work_areas\Underway\bathy

7.4.2 Issues Encountered

The EM712 was not switched on for the duration of the cruise as it was not needed. The EM122 was not included on the original view so had to be added and selected manually.

Due to timing issues not much time was spent on these scripts so some bugs may still be present.

8 Vessel-Mounted Acoustic Doppler Current Profiler (VMADCP)

Tarkan Bilge

8.1: Introduction and instrumentation

The Acoustic Doppler Current Profiler (ADCP) is a hydrological instrument used to measure water current velocities using the Doppler effect. An ADCP emits an acoustic signal, and then measures the return signal as scattered by moving water, the frequency shift of the return signal can then be used to establish relative water velocity in the signal plane. A Vessel-mounted ADCPs (VMADCP) is housed in the hull of a ship, and has several beams which can be used to measure the three-dimensional current field up to some hundreds of metres below the vessel. A VMADCP uses a stream of navigational data to convert relative current velocities to absolute values.

The VMADCP on the RRS Sir David Attenborough (SDA) is a Teledyne Ocean Surveyor. The Ocean Surveyor can operate on two frequencies, 150kHz and 75kHz, which is dictated by a configuration file, the details of which will be discussed shortly. In good conditions, the 150kHz ADCP has a range of approximately 400m, and the 75kHz has a range of 700m with half the depth resolution. At present only one of the two frequencies can be operated at any one time, as documented in the main SD025 Polar Trials cruise and 'E&T Elec Report'.

8.2: Operation and configuration

Once physically turned on, the VMADCP is operated through the VMDAS software. Details of operation can be found in the VMDAS User's Guide. VMDAS outputs a number of different file types, including Long Term Average (.LTA), Short Term Average (.STA) and (.ENR) Raw ADCP data. Other file extensions are described in the User Guide. The time period over which LTA and STA files are averaged is user defined, but for this cruise LTA files are 120-second averages, and STA files are 30-second averages.

The VMADCP operation settings are configured via command files, which are archived with the cruise data. The command files used for SD033 are as displayed in Table 8-1.

	Water tracking	Bottom tracking
75kHz ADCP	os75nb_880m_wt_16mbins_not_thru_ksync	os75nb_880m_bt1000m_16mbins_not_thru_ksync
150kHz ADCP	os150nb_450m_wt_8mbins_not_thru_ksync.txt	os150nb_450m_bt600m_8mbins_not_thru_ksync.txt

Table 8-1: configuration files used for the 75kHz and 150kHz ADCP during SD033.

The transducer depth appears to be set to 0m in the command file, the correct value for this should be checked and tested, as SD025 found that the top 1-2 bins displayed low data quality.

8.3: Postprocessing with CODAS

For SD033 we elected to use the CODAS post-processing library, which is Python-based. Instructions for installation and operation of CODAS can be found on the CODAS + UHDAS Documentation page. Bash scripts with the basic order of commands required to initiate CODAS post-processing are included in the cruise archive. These scripts are run in the order: 1) process.sh 2) post_process.sh 3) calibrate.sh.

These bash scripts implement the following steps:

- Copy VMDAS output from its output directory (e.g. L drive).
- Remove corrupt and old files.
- Run adcp_database_maker.py
    - User selects 'Browse' and input the VMDAS data directory for the correct frequency.
    - User inserts a project directory e.g 'SD033_vmdas'
    - User selects 'Convert *.LTA Files' to process Long Term Average files.
- Make a post processing directory.
- Calibrate using bottom tracking output with quick_adcp.py using the calibration data in adcp_pyproc/150kHz/SD033_vmdas/os150nb_LTA_postproc/cals.txt

Short Term Average (STA) data is required to calibrate the LADCP. In order to generate this data, the above steps are repeated, but 'Convert *.STA Files' is selected. After calibration the following files are output for LADCP processing: 'adcp_pyproc/150kHz/SD033_vmdas/os150nb_LTA_postproc/contour/os150nb.nc', 'adcp_pyproc/150kHz/SD033_vmdas/os150nb_LTA_postproc/contour/os75nb.nc'.

8.4: Results

Preliminary examination of the ocean current velocities with the 75kHz ADCP indicated that the quality of data was much better when the ship was stationary than when it was in motion.

The science objectives of BIOPOLE meant that there was a particular interest in salinity, temperature, nutrient, and chlorophyll gradients near the sea-ice edge. As a result, a number of CTDs were performed as a transect from the open-ocean into the sea-ice. For the immediate science purposes, and in order to get an accurate understanding of the ocean currents across this transect, we decided to use data from the VMADCP only at each location at which the ship was stationary for CTD stations.

8.4.1. Currents at CTD locations

Figure 8-1 depicts the ocean velocities at stationary locations during the sea-ice transect section of the cruise. Please note the switch between 75kHz and 150kHz ADCPs indicated by the route colour. This can be compared to Figure 8-2 (Thompson et al.) which displays surface current data in the Weddell Sea and adjacent to the Antarctic Peninsula as gathered by surface drifters deployed in February 2007. Within the Weddell Sea the VMADCP picks up a north-westward current between CTDs 013 and 023, which generally resembles the circulation of the Weddell Gyre. The Weddell Front (WF) which delineates the boundary of the Weddell Gyre is expected to lie approximately between the locations of CTD 011 and CTD 023, and should be primarily eastward, this eastward nature can be seen at CTD location 011, but further data while the ship is moving will have to be analysed to more accurately identify the front. In the Powell Basin, the VMADP identifies a westward current akin to the Antarctic Slope Front (ASF) in the south, which travels northward and becomes a westward current.

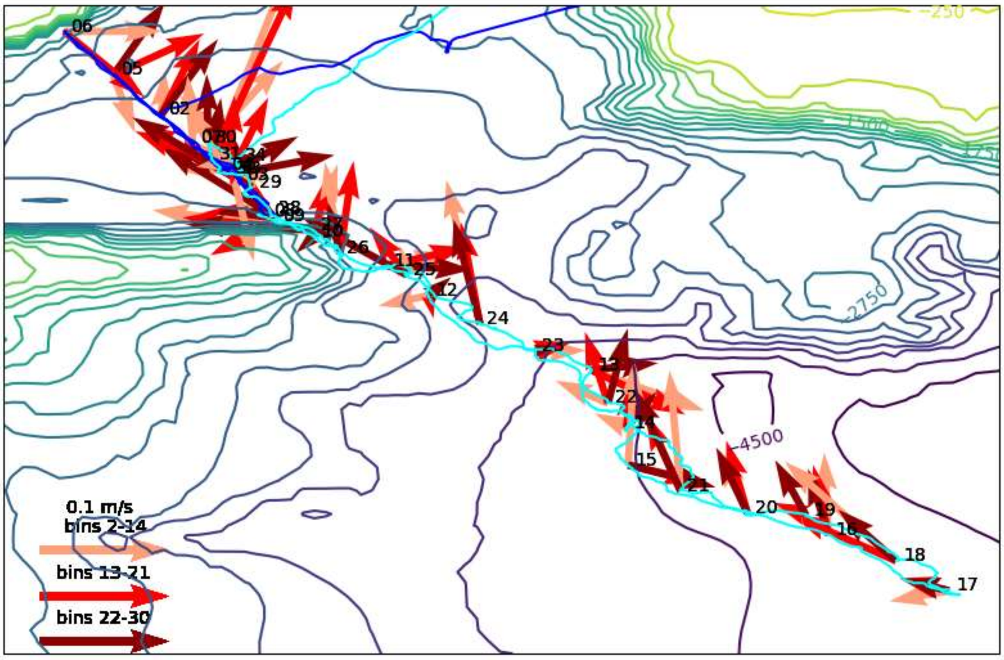


Figure 8-1: Ocean current velocities at three averaged depths during the SD033 transect into sea-ice in the Weddell Sea. Numbers indicate CTD event numbers, and the blue (turquoise) line indicates the ship's route while using the 75kHz (150kHz) ADCP.

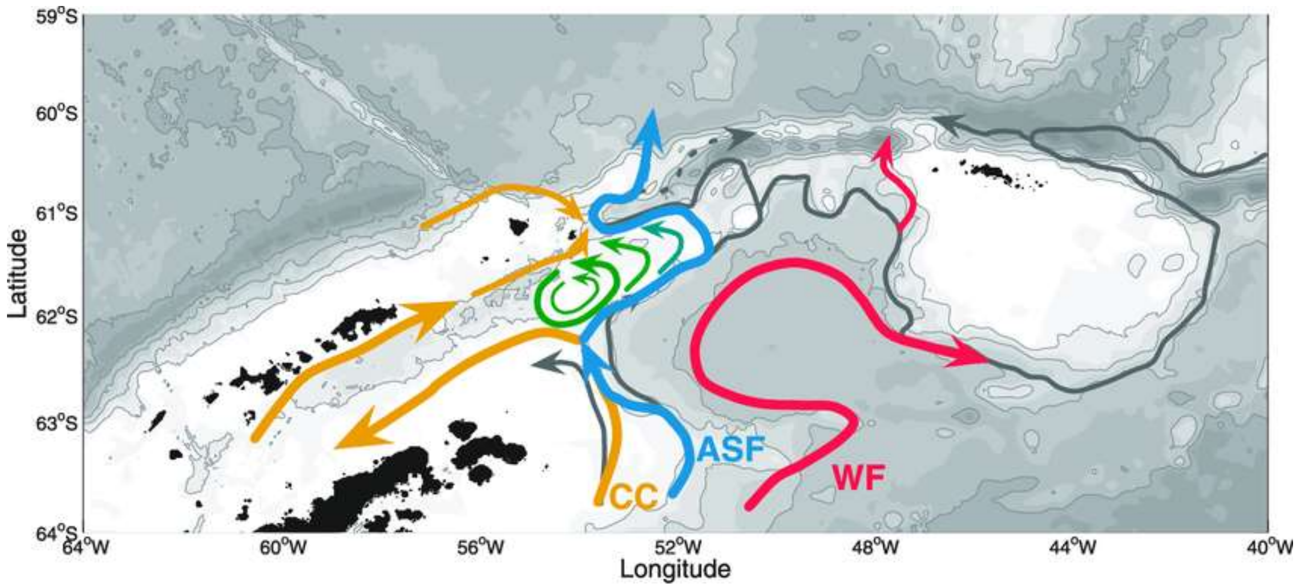


Figure 8-2: Surface ocean current velocities determined from surface drifter data. Positions of the Antarctic Coastal Current (CC), Antarctic Slope Front (ASF), and Weddell Front (WF) are displayed in yellow, blue and red respectively (Thompson et al.).

8.4.2: Currents from the 75kHz ADCP.

Using the CODAS library to evaluate the data quality of the 75kHz ADCP revealed that there was a marked deterioration in quality when the ship was moving compared to when it was stationary. This is visible in plots of 'percent good', as in Figure 8-3. There are three times at which the ship was stationary in Figure 8-3; before decimal day 339.7, between decimal days 339.9 and 340.0, and between 340.2 and 340.3. The data quality even when the ship is stationary in this period is low, as there is only acceptable data from the surface to 300m, and the range of the 75kHz ADCP should be up to 700m. This issue was reported in the SD025 Polar Trials cruise report. There were periods of the cruise in which the 75kHz ADCP operated better (although still not below around 450m), even when moving. The main such period was during the initial southward Drake Passage crossing, potentially adding merit to the hypothesis that there is a relationship between colder water and poor quality data acquisition, which was proposed during the SD025 Polar Trials.

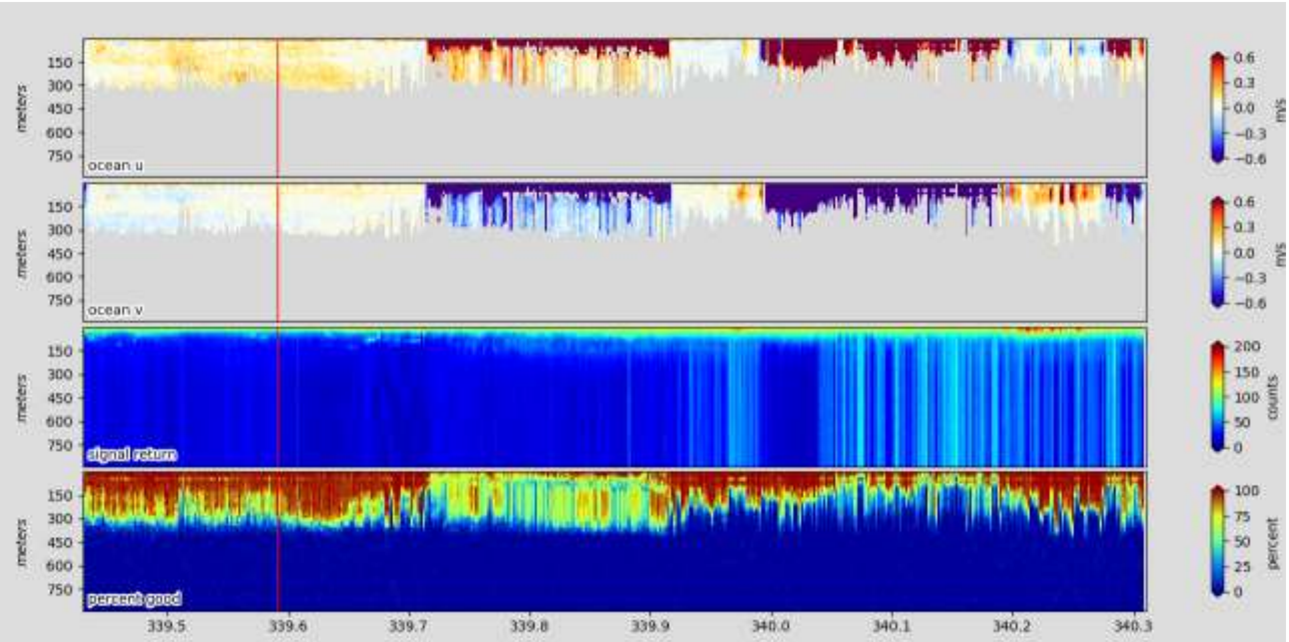


Figure 8-3: Data quality during a period in which the 75kHz ADCP was operating, displaying a difference in quality depending on the ship's movement.

Plotting ship speed alongside data quality, as in Figure 8-4, makes the relationship between ship speed and data quality even more apparent. Preliminarily, it looks as if ship speeds in excess of around 12 knots cause a deterioration in data quality, this could be a result of bubbling over the transducer.

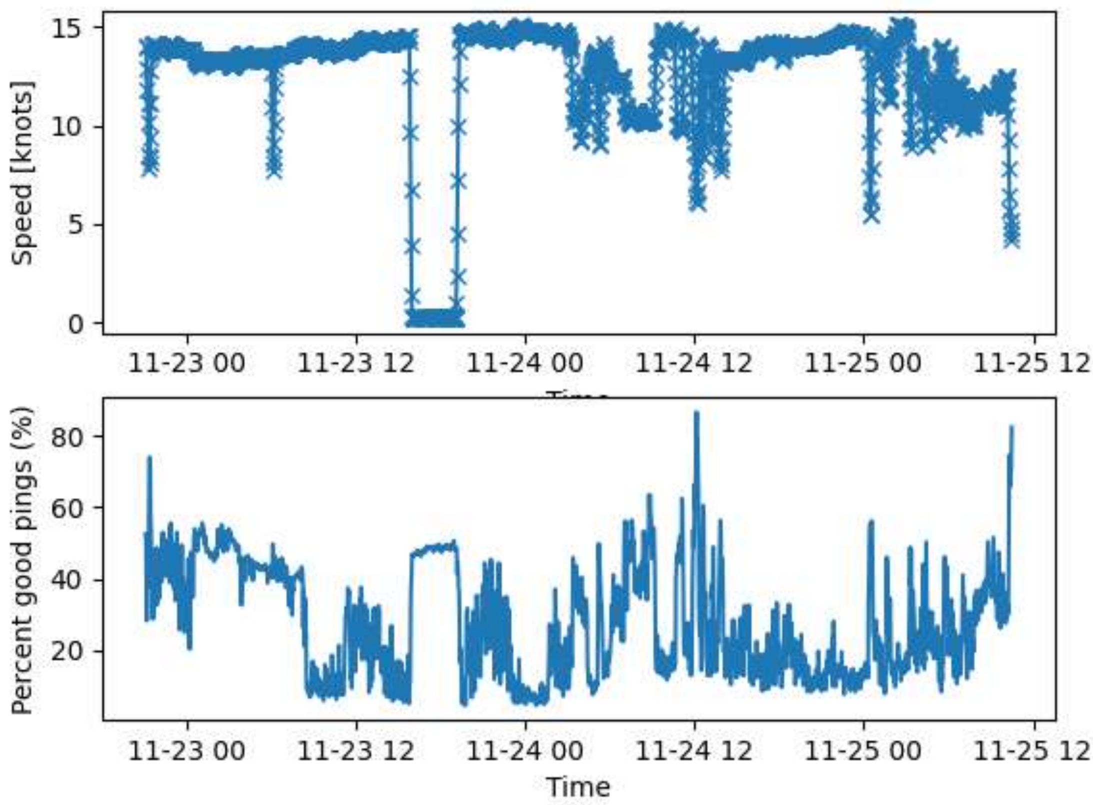


Figure 8-4: percentage of good pings from the 75kHZ ADCP through 823m water depth alongside ship speed overground in knots.

Further work exploring the relationship between transducer temperature and the data quality of the 75kHz ADCP could reveal whether this is also a factor in the poor data quality observed during the SD033 science cruise. Interference from other acoustic systems was explored in SD025, as a result this was not investigated as part of SD033, but further experimentation with Ksync settings in the command files could be appropriate for future cruises.

8. 4. 3. Currents from the 150kHz ADCP

Owing to the data quality issues associated with the 75kHz ADCP, the decision was made to move to use of the 150kHZ ADCP. Figure 8-5 depicts a subset of these velocities, in 30-minute averaged periods. The quality of these data seems better than the 75kHz ADCP, and the current velocities compare well between when the ship is stationary and in movement. We would recommend the use of the 150kHz ADCP for data collection in addition to further troubleshooting with the 75kHz ADCP when possible.

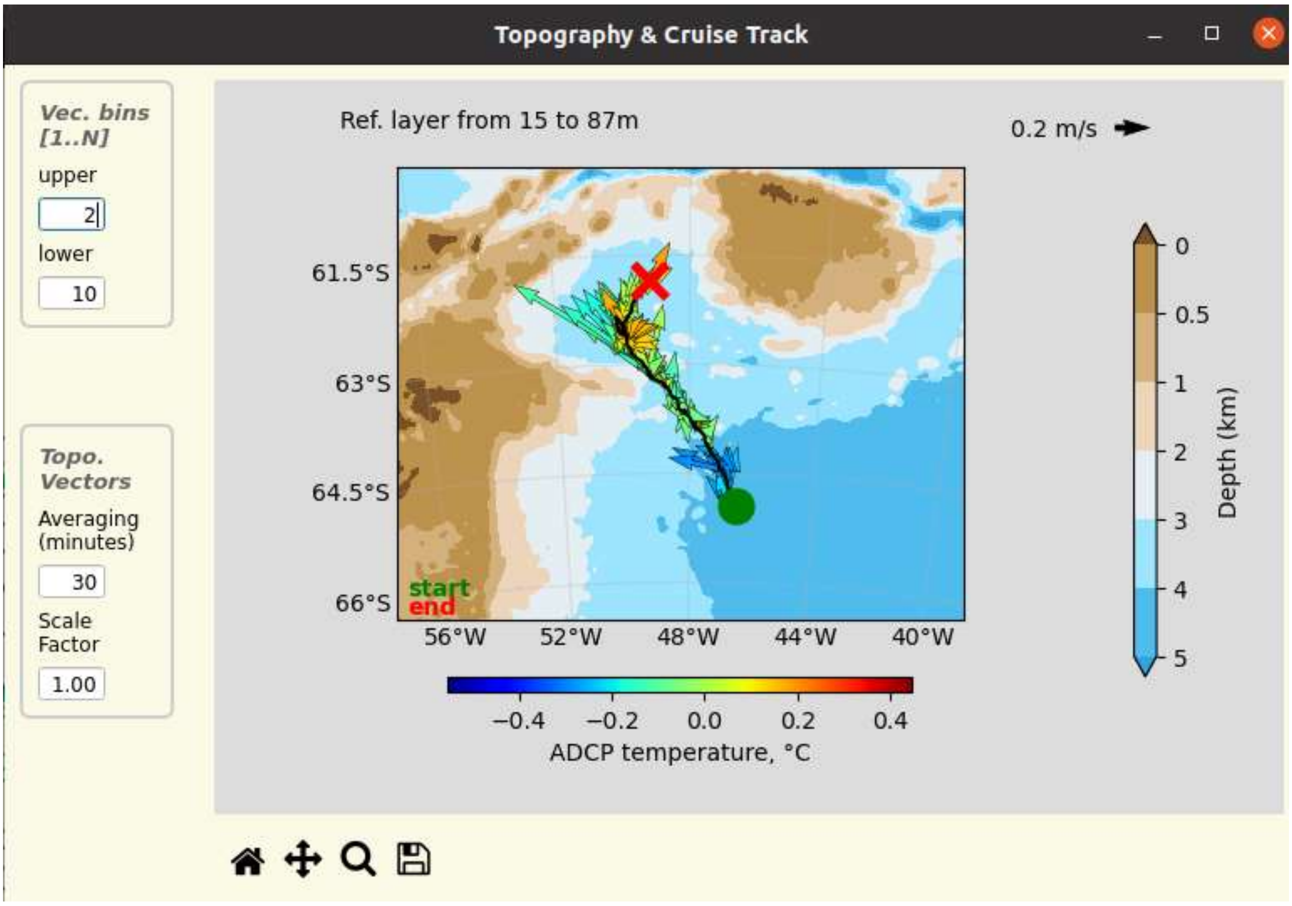


Figure 8-5: ocean current velocities for the 150kHz ADCP produced via the CODAS library.

8.5 References

Thompson, Andrew & Heywood, Karen & Thorpe, Sally & Renner, Angelika & Trasviña-Castro, A.. (2009). Surface Circulation at the Tip of the Antarctic Peninsula from Drifters. Journal of Physical Oceanography - J PHYS OCEANOGR. 39. 10.1175/2008JPO3995.1.

9 LADCP

Katie Lowery

9.1 LADCP deployment

Both the up-looking and down-looking LADCP heads were used successfully throughout the cruise. The paired LADCPs were configured following a standard AME script, with 8m bins, 400cm/s ambiguity and with the down-looking head as the master and the up-looker listening to the down-looking, acting as the slave. The LADCP saved files named SD033_001_SS_S.00 and SD033_001_SS_M.000 (where 001 represents the CTD cast number) with no issues or problems.

9.2 LADCP Data Processing

The LDEO_IX_15beta programme was used to process the data, with the only edits required in the 'set_cast_params.m' script. It is important to process the LADCP data as soon as possible after each CTD cast to ensure any issues with the instrument are caught early. Throughout the cruise, both the up-looking and down-looking heads were processed simultaneously. Firstly, this was complete without external data, and then it was processed with the CTD and VMADCP data as constraints once this became available.

9.3 Pre CTD/VMADCP

It is unlikely that the processed/calibrated CTD data nor VMADCP data will be available immediately. To process the LADCP without these constraints, it has been helpful to have a separate version of 'set_cast_params', which only calls the LADCP raw data files and the raw CTD svp .cnv file. An example of the script used during this cruise can be found at '/leg/work/scientific_work_areas/LADCP/KL/LDEO_IX_15beta/srt_cast_params_prelim_sd033.m'.

9.4 Post CTD/VMADCP

To calibrate the data, the 1Hz time series of GPS and CTD data and the VMADCP data were used as constraints. Despite some difficulties with the VMADCP data throughout the cruise, the data has been used to constrain the LADCP output. It is also worth noting that the VMADCP on SD033 was processed using the CODAS library, which might alter the files/uploading of the VMADCP data in future. More information on this can be found in the VMADCP section of the cruise report. The final processed LADCP output data can be found in '/leg/work/scientific_work_areas/LADCP/KL/LDEO_IX_15beta/LDEO_output/post_ctd_calibration/'.

Although the processing of the LADCP has largely been successful, the profiles returned were somewhat noisy. Figure 9-1 shows an example of the return from CTD007.

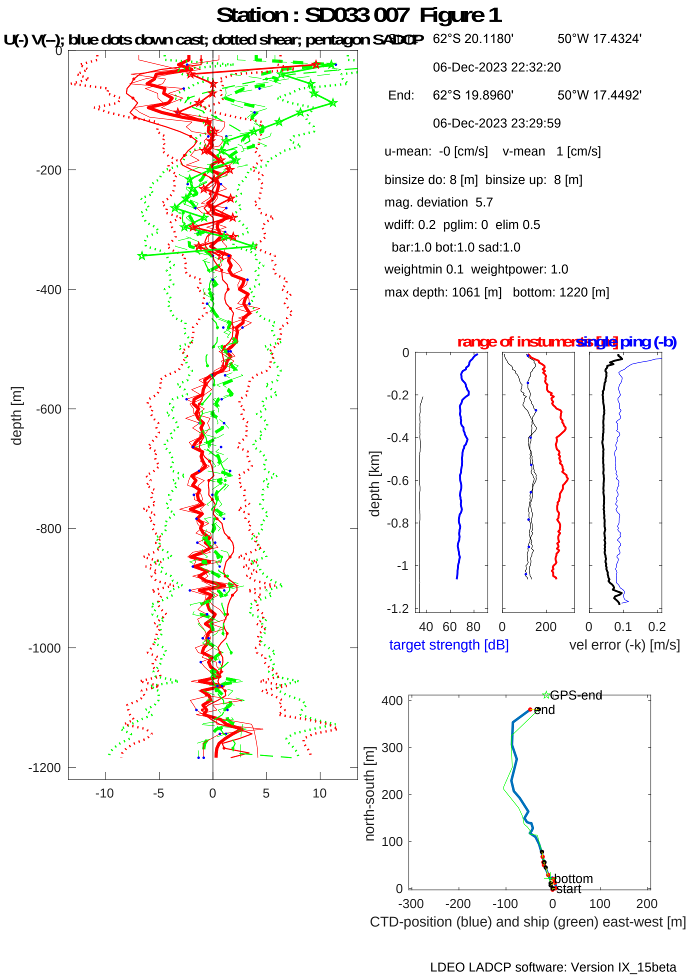


Figure 9-1: CTD007 profile.

Below are plots of the currents recorded during the SD033 cruise. The transect complete was near directly south, and then back directly North and so the plots below show the current speed along the latitude of the transect. CTD 025 has been omitted from the example plots below due to an increase in error because elevated shear was identified.

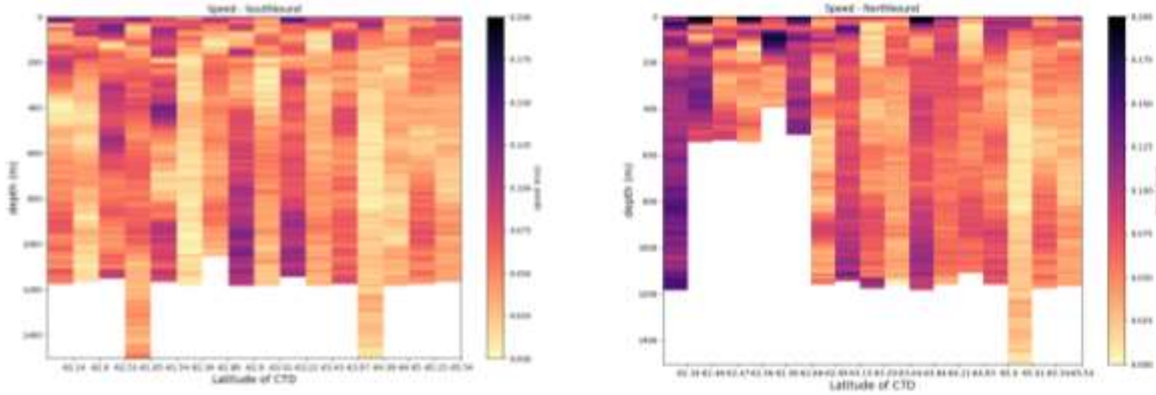


Figure 9-2: Recorded current speeds travelling Southbound and Northbound, after calibration.

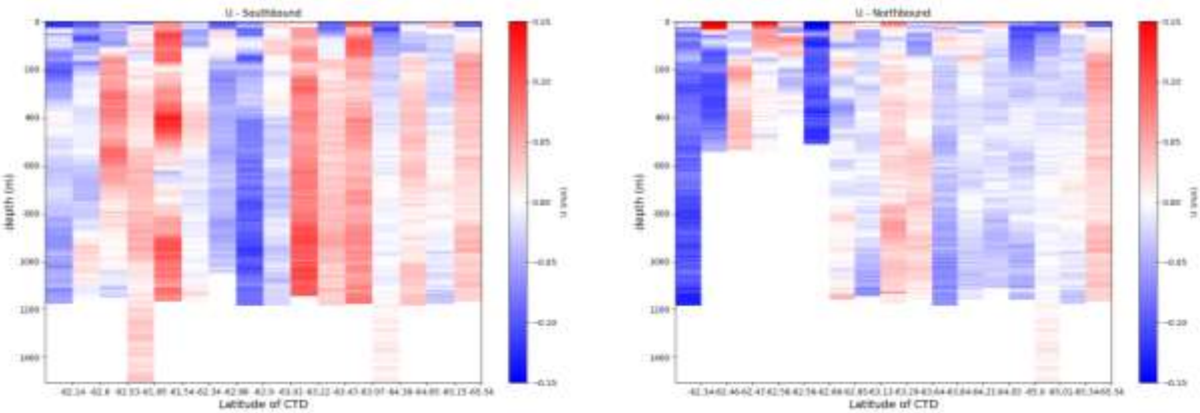


Figure 9-3: Recorded U component of velocity travelling Southbound and Northbound, after calibration.

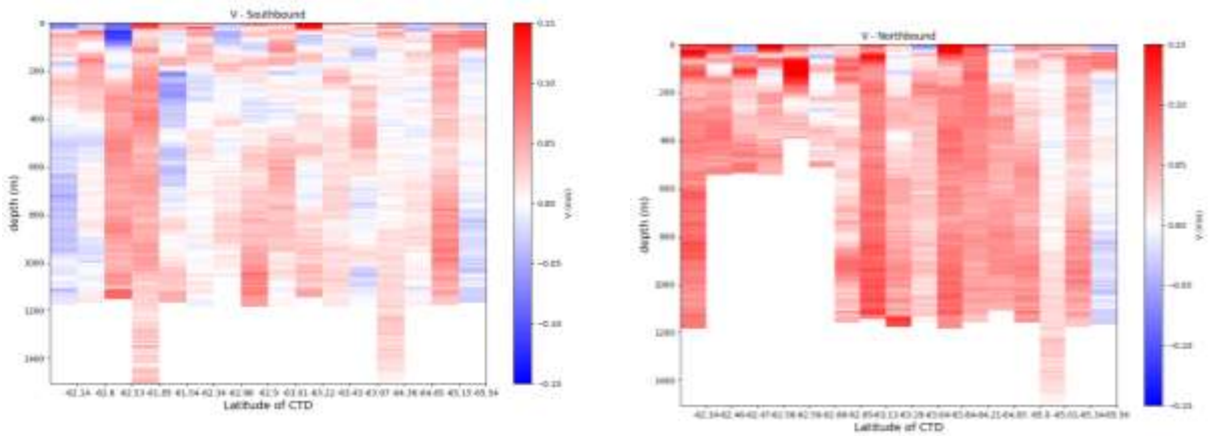


Figure 9-4: Recorded V component of velocity travelling Southbound and Northbound, after calibration.

Figure 9-5 shows the difference between the output of the LADCP processing when using data that has not been calibrated and data that has been calibrated using both the CTD output and the VMADCP output. Fig 9-5a shows the difference across the profiles, and Fig 9-5b shows the values as a histogram, both only across the Southbound profile. On average, the data calibration increases the recorded speed (average negative difference in Fig 9-5a).

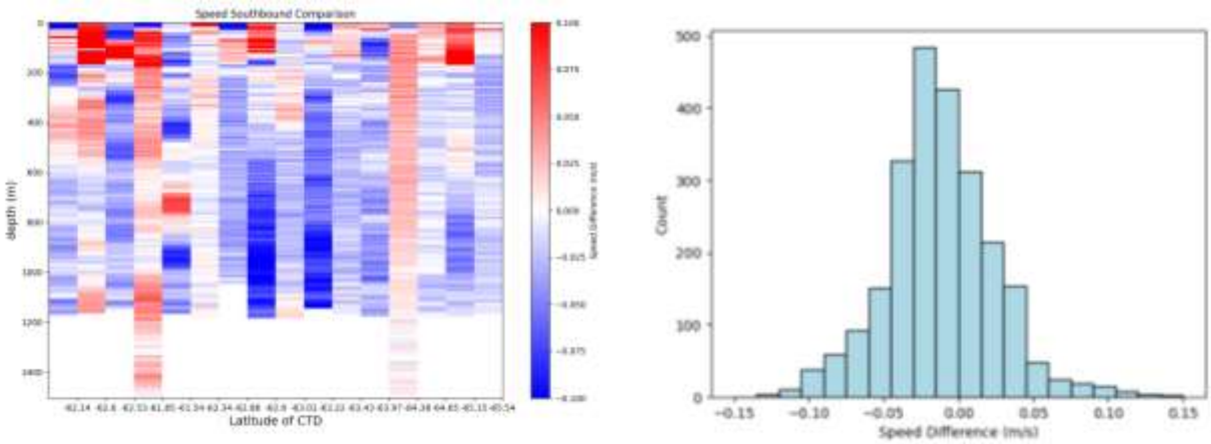


Figure 9-5: Difference in current speed between no calibration and using both the CTD and VMADCP data.

10 Underwater Gliders

Alexander Brearley

10.1 Introduction

BIOPOLE's glider operations involved deploying three Teledyne Webb Research (TWR) Slocum 1000 m-rated gliders in the Powell Basin within the marginal ice zone. Two of the vehicles were equipped with both the new National Oceanography Centre (NOC)-developed backseat driver (BSD) and upward-looking altimeter (ULA) capability (units 223 and 438). This allowed the gliders to be tasked with under-ice missions of up to two days duration. The other (unit 444) while one was a standard G2 vehicle running the standard TWR ice coping software. Prior to BIOPOLE, the three gliders had been prepared for their missions at NOC and in-water trials of the BSD and ULA took place in summer 2023. The gliders were all piloted from NOC Southampton, primarily by Ben Allsup and Steve Woodward, with assistance from the MARS piloting team at National Marine Facilities (NMF).

Each of the gliders had slightly different sensor configurations, found in Table 10-1

Serial number / operator	**Installed sensors**	**Deployment location (decimal degrees)**	**Deployment date and time (UTC)**	**Event number**
223 (BAS, BSD)	CTD EcoPuck, PAR, ULA	62.51377°S 50.02491°W	05/12/23 – 19:12	015
438 (NOC, BSD)	CTD EcoPuck ULA	62.51573°S 50.02192°W	05/12/23 – 20:12	016
444 (NOC)	CTD EcoPuck Doppler Velocity Log (DVL)	62.51790°S 50.01862°W	05/12/23 – 20:52	017

Table 10-1: Instrument setup/deployment details.

10.2 Pre-deployment

Before deployment, functional checks were conducted for each of the gliders (Functional checkout sheets are found in the Appendix). This included:

1. Testing communications on both Freewave and Iridium. All units communicated successfully.
2. Downloading the proglets.dat file to check the installed proglets on each glider.
3. Using the wiggle on command to check the battery, rudder and pump were working properly.
4. Checking the GPS and Argos were working.

During the functional checkouts, 223's nose recovery system was damaged. This was replaced on ship and re-tested prior to deployment. Immediately prior to deployment, the vehicles were deck tested by NOC, which included running the test mission status.mi. Full details of piloting of the vehicles can be found in the NOC pilot log on C2 at https://piloting.c2.noc.ac.uk.

10.3 Post-deployment

10.3.1 Unit 223

From the initial deployment location, 223 undertook a series of test dives, eventually to as deep as 1000 m. The initial plan was to pilot the vehicle northward, as winds in the first 3 days of deployment were driving the sea ice edge northward too (as seen in AMSR2 and SAR imagery from www.polarview.aq). However, before the first BSD tests could be completed, and with the glider running on the regular ice-coping software, contact with the vehicle was lost early on 8 December, and not regained until the morning of 17 December. Inspection of the data revealed the glider had been stuck at 4 m for the majority of the period and had been pushed around 3° eastward in longitude. Contact was re-established with the glider and the vehicle slowly piloted northwest to return towards the ship sampling line.

10.3.2 Unit 438

438 was tasked similarly to 223 once in the water but successfully moved north of the ice edge, paralleling the ship sampling line. It became clear quickly that the glider pressure sensor was not performing properly, but some short tests (initially of regular behaviour and then of BSD) confirmed that the glider could be piloted on "use_ctd_depth_for_flying". The first two-day under ice mission was completed successfully on 11 December at 2057 UTC. However, a later mission appeared to experience the same tbd and ebd data loss issue that had occurred in some simulations at NOC in summer 2023. NOC are currently investigating how this may be avoided prior to future under-ice missions for this experiment. Just prior to the end of the cruise, units 438 and 444 were moved southwest to avoid iceberg A23a as it started moving eastward. Its progress was monitored by a combination of SAR and visible (MODIS) imagery and predicted using satellite altimetry from Copernicus (Figure 10-4), with support from Povl Abrahamsen in Cambridge.

10.3.3 Unit 444

Not being equipped with the BSD, the piloting aim of 444 was to keep typically 15 km north of the ice edge over the season as it retreats. At the time of writing (24 December 2023), the glider has been behaving well, initially occupying the section between the Biopole mooring and CTD station 6 before being moved westward to keep out of the way of A23a. Settings for the dvl.ini config file were iterated by Natasha Lucas, Sophie Fielding and Steve Woodward to ensure data volumes and battery life were sustainable for a 3-month mission.

It was also noticed that the CDOM values for this vehicle were negative, though still appeared to give coherent patterns that appeared to be real signal. It was initially assumed that incorrect calibration coefficients were entered into autoexec.mi, but it appeared these were correct. Kate Hendry (as bio-optics expert) and Steve Woodward are investigating.

Plots of the first 18 days of data are provided in Figures 10-1, 10-2 and 10-3 for the three gliders.

10.4 Data management

Near-real time data is being transferred directly to BODC and is available at https://gliders.bodc.ac.uk/inventory/glider-inventory/.

10.5 Recovery

Recovery is scheduled for late February 2023 onboard RRS Sir David Attenborough, with operations to be led by Sophie Fielding. Glider recovery net and CF card reader were left onboard to facilitate ehicle recovery and data download.

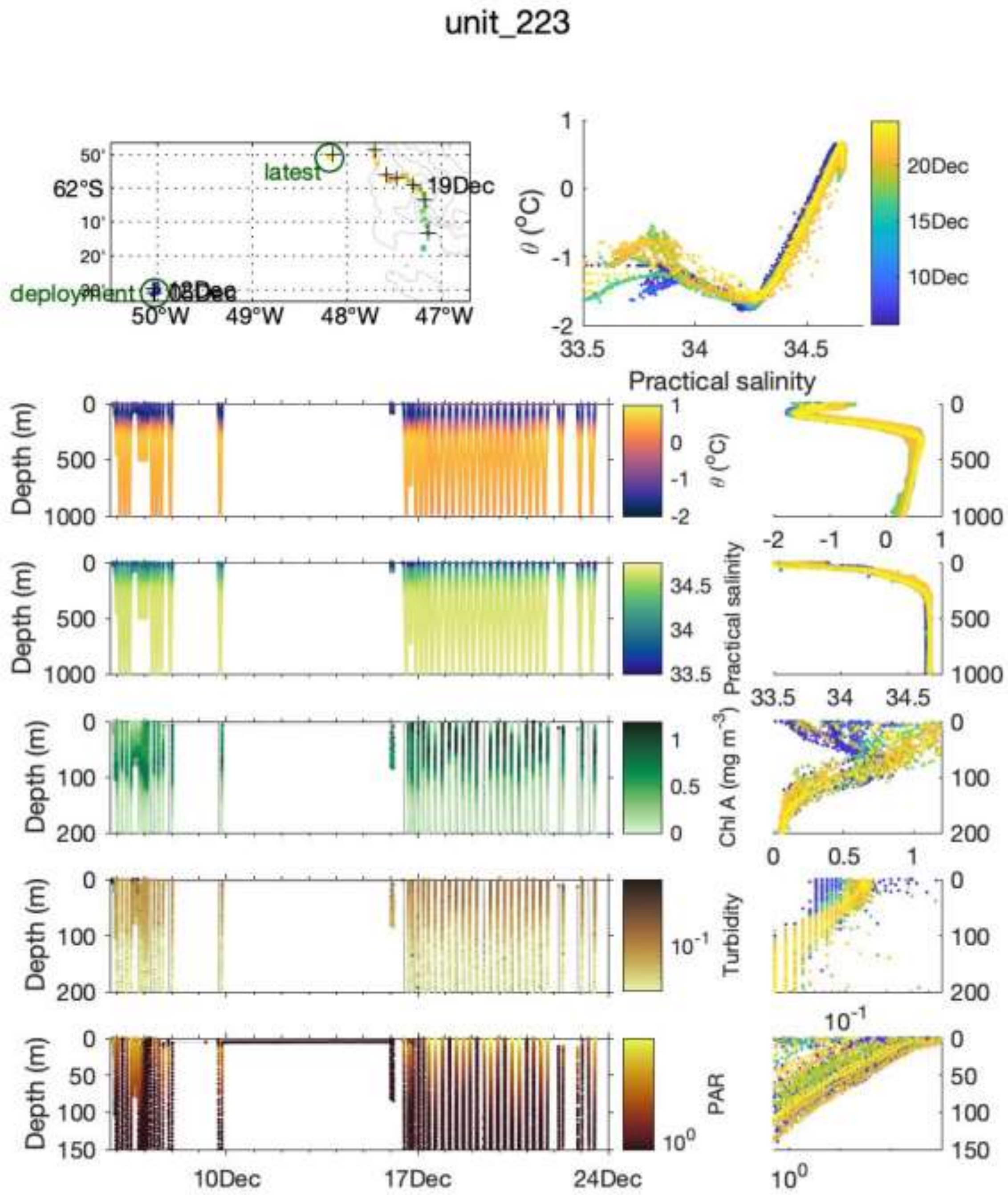


Figure 10-1: Glider track, T-S plot, sections of T, S, chlorophyll, turbidity and PAR, alongside the various parameters coloured by deployment day number from 6 to 23 December 2023, for glider 223. The long period with no data reflects the glider becoming stuck jus

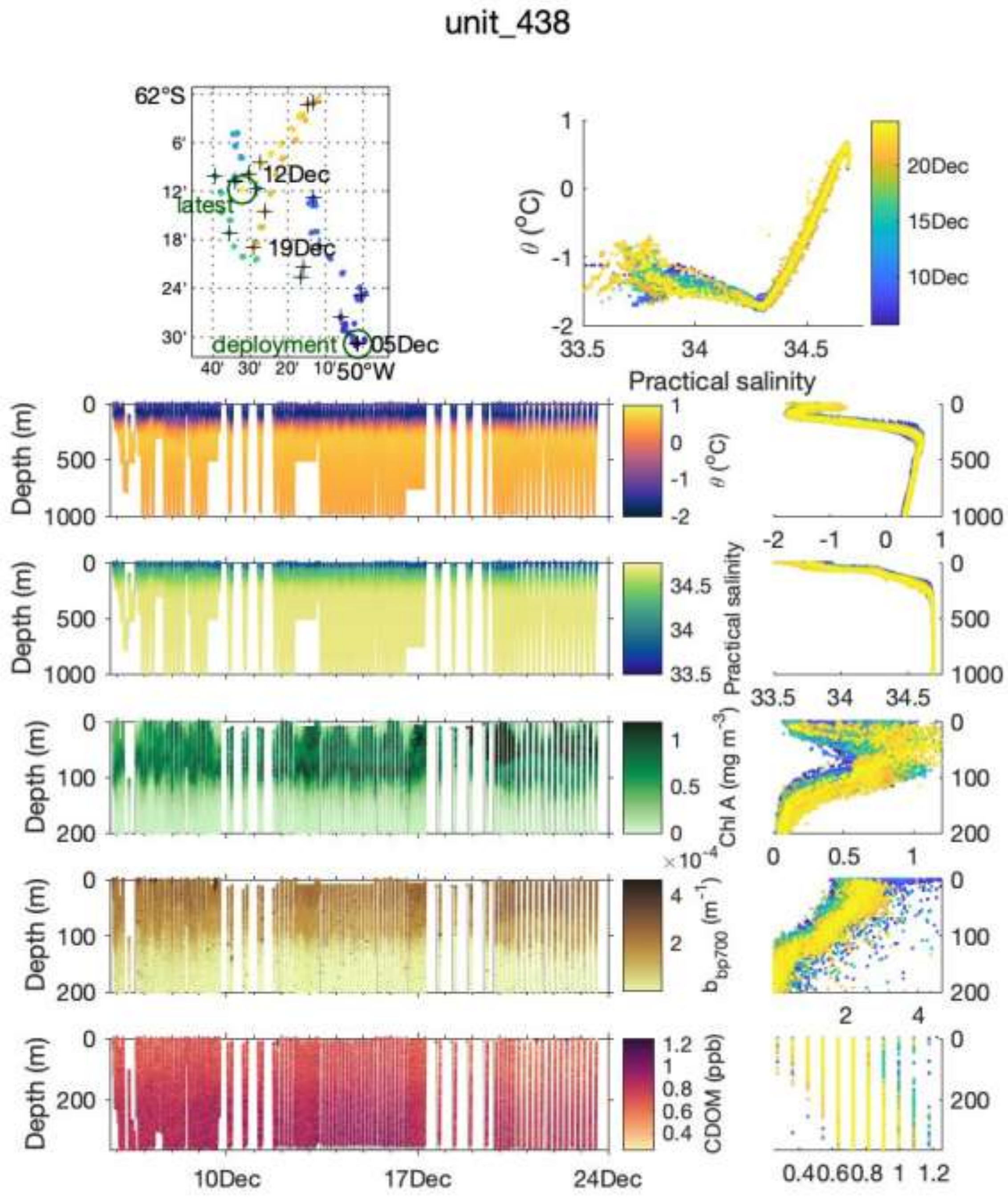


Figure 10-2: As Figure 10.1 but for glider 438. Other variables include backscatter (bbp700) and coloured dissolved organic matter. Periods of sparse profiles reflect under-ice periods.

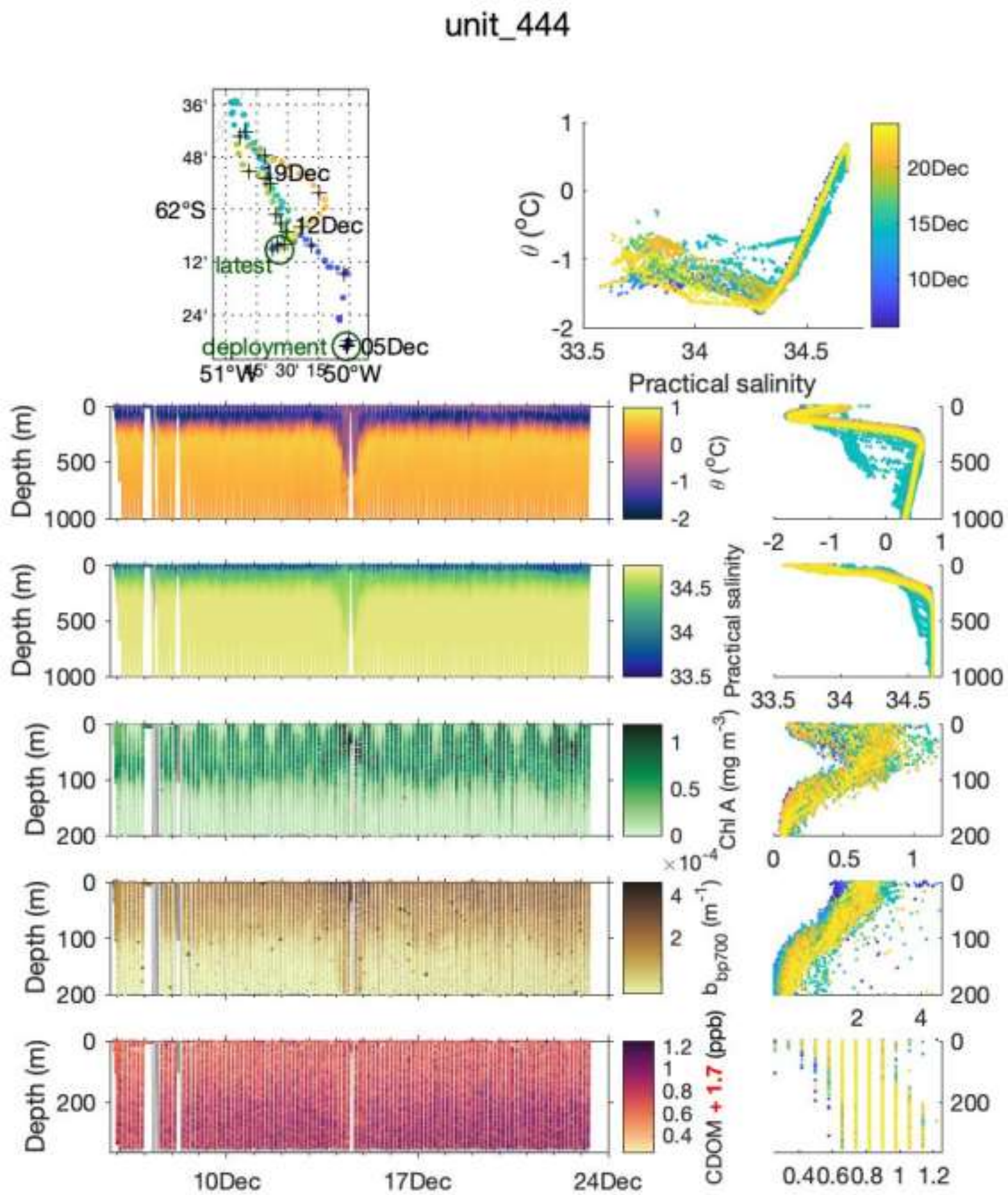


Figure 10-3: As Figure 10-1 but for glider 444. Note CDOM has had an arbitrary 1.7 added to its values to facilitate comparison with 438 (see main text).

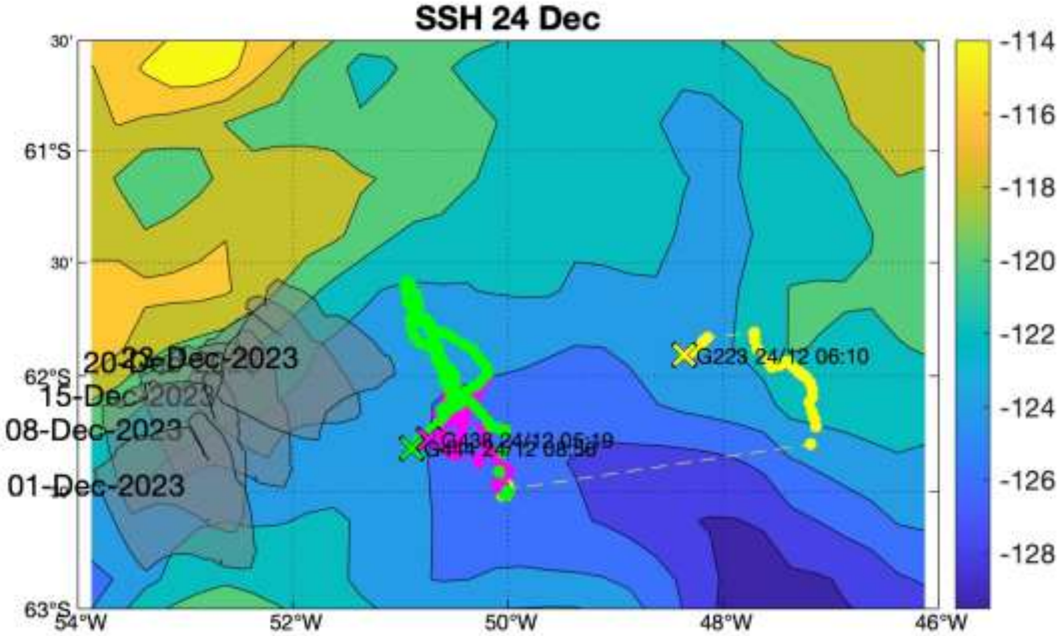


Figure 10-4: Sea surface height (in dyn. m) for 24 December with positions of the iceberg from 1 December to 23 December. The three glider tracks are shown – 223 in yellow, 438 in purple and 444 in green.

10.6 Appendix: Functional checkouts

SLOCUM FUNCTIONAL CHECKOUT

Glider no. 223 **Date** 23/11/2023 **Time** 2215UTC **Initials** JAB

Ensure the terminal session is logging before turning on the glider

Terminal log file number fco_223_20231123 — **Freewave connection OK, lights on within 30 seconds?** YES

Freewave number — *(if not already recorded during refurbishment)*

Air pump on (time) 2217 — **Ctrl-C before mission started?** YES *(exit reset if not)*

Check that each of the following commands works, record the output where applicable

`lab_mode on` YES — `callback 30` YES — `logging on` YES *(wait 1-2 minutes for LOG FILE OPENED)*

`simul?` NO *(if yes, del \config\simul.sim then exit reset)* — `ver` *(if not already recorded during refurbishment)*

`time` 2220 — **matches UTC?** YES — `put c_alt_time -1` YES *(stops altimeter pinging)*

Air pump off (time) 2219 *(3-10 minutes)* — `get m_vacuum` 9.66

`get m_coulomb_amphr_total` 1.77 *(<5 for new batteries)* — **Sufficient for mission?** YES

`get m_leakdetect_voltage` 2.46 *(>2.3)* — `get m_leakdetect_voltage_forward` 2.46 *(>2.3)*

`ballast` YES *(wait several minutes for 'The Air Pump is off')* — `get m_vacuum` 7.75 *(6 inHg shallow, 7 inHg deep)*

`consci` YES *(wait for SciDos> prompt to be displayed)* — `dir app` YES *(confirm SUPERSCI.APP is present)*

`zs config\proglets.dat` YES *(File>Transfer>Zmodem>Receive)* — `quit` YES *(wait for GliderLAB> prompt to be displayed)*

`loadmission sci_on.mi` YES *(verify output contains realistic sensor data)* — `loadmission sci_off.mi` YES

`report ++ m_depth` 0.1 *(between 0.5 and - 0.5m, otherwise zero_ocean_pressure and repeat)* — `report clearall` YES

`strobe on` YES *(check strobe flashes)* — `strobe off` YES

If thruster is installed, check blades are not obstructed before testing. Do not run the thruster for more than 30 seconds in air.

`report ++ m_thruster_current` N/A *(verify output updates)* — `put c_thruster_on 30` N/A *(should spin clockwise when viewed from aft)*

`put c_thruster_on 0` N/A — `report clearall` N/A

If not already checked during refurbishment, review proglets.dat and GSI sheets and verify sensor configuration and communications using u4stalk UART BAUD D BIT

Sensor type		UART		Power bit		Sensor output OK?	
Sensor type		UART		Power bit		Sensor output OK?	
Sensor type		UART		Power bit		Sensor output OK?	
Sensor type		UART		Power bit		Sensor output OK?	
Sensor type		UART		Power bit		Sensor output OK?	

Sensor configuration correct? — **All sensors functioning normally?**

Remove nose and tail covers, dry the glider thoroughly and check altimeter, anodes and drop weight burn wire

`put c_alt_time 0` YES *(verify regular clicking sound from altimeter transducer)* — `report ++ m_altimeter_voltage` YES *(verify output updates)*

altimeter s/n — `put c_alt_time -1` YES *(stop altimeter pinging)* — `report clearall` YES

Forward anode resistance (Ω) 5 *(<10, measure between anode and pupa flange screws)*

Aft anode resistance (Ω) h

Disconnect nose recovery device Mecca connector, place multimeter between burn wire supply lead and forward anode

`put c_recovery_on 1` YES — **Supply lead voltage (V)** 3 *(>5, measured with multimeter)*

`put c_recovery_on 0` YES — **Supply lead voltage (V)** 0 *(verify = 0 then replace Mecca connector)*

`lab_mode off`

Disconnect drop weight Mecca connector, place multimeter between burn wire supply lead and aft anode

`put c_weight_drop 1` N/A — **Supply lead voltage (V)** *(>5, measured with multimeter)*

`logging off` — `put c_weight_drop 0` — `put m_weight_drop 0`

`exit pico` — **Supply lead voltage (V)** *(verify = 0 then replace Mecca connector)*

Replace Mecca connector, install nose and tail covers, check mechanical operation

(from pico prompt) `app -lab` N/A *(check drop weight voltage = 0 again)* — `callback 30` YES — `ballast` YES

`logging on` *(wait 1-2 minutes for LOG FILE OPENED)* — `report ++ m_battery`

`wiggle on` *(wiggle for 10 minutes whilst monitoring for voltage drop during pump/motor movement)*

Motor driver warnings or errors? SEE NOTES *(if errors are seen after transportation, put devices back into service)*

Digifin movement OK? YES — **Motors binding?** SEE NOTES — `get m_tot_num_inflections` 3731 *(<20000 shallow, <10000 deep)* — see oil flux oddity ir

`wiggle off` YES — `report clearall` YES — `logging off` YES

`send *.*` *(save data and log files, repeat until all files sent)* — `exit`

Move glider outdoors with an unobstructed view of the sky and turn on

Argos transmitting OK? YES *(place RF chirper near digifin, should transmit every 90 seconds)*

Ctrl-C stopped glider before running mission? YES *(exit reset if not)* — `lab_mode on` YES

`callback 30` YES — `logging on` YES *(wait 1-2 minutes for LOG FILE OPENED)* — 02780000.mlg

`callback 0 0` YES — **Primary number dialled** default *(default 88160000583)*

`callback 0 1` YES — **Secondary number dialled** default *(default 17818711614)*

`callback 30` — `get m_battery` 14.69 *(9.7 - 12V Lithium or 12 - 16V Alkaline)*

Motors moving or pump on? NO — `put c_argos_on 0` YES

`get m_coulomb_current` 0.14 *(0.06 - 0.288A)* — `report ++ m_heading m_pitch m_roll` YES *(verify outputs update, pitch and roll +/-0.18 rad)*

`report clearall` YES — `put c_gps_on 3` YES *(GPS fix within 2 minutes, V changes to A in serial output)*

`sync_time` no large offset *(large offset possible if coin cell changed)* — `time` YES — **matches UTC?** YES

`put c_gps_on 1` YES — `logging off` YES

`run status.mi` YES *(wait for normal completion)* — `send *.*` *(save data and log files)*

`dellog all` SEE NOTES *(deletes all sent logs, repeat for science card)* — `put c_air_pump 0` YES — not needed

`report ++ m_de_oil_vol` YES — *(for 1000m gliders only)* `put c_de_oil_vol 1000` YES *(should reach 260cc)*

(for 1000m gliders only) `put c_de_oil_vol -1000` *(should reach -260cc)* — `exit`

Notes

SLOCUM FUNCTIONAL CHECKOUT

Glider no.	438	***Date***	23/11/2023	***Time***	1218 UTC	***Initials***	JAB

Ensure the terminal session is logging before turning on the glider

Terminal log file number	unit_438-2023-326-0-0	***Freewave connection OK, lights on within 30 seconds?***	YES	
Freewave number		*(if not already recorded during refurbishment)*		
Air pump on (time)	1218	***Ctrl-C before mission started?***	YES	*(exit reset if not)*

Check that each of the following commands works, record the output where applicable

lab_mode on	YES	**callback 30** YES	**logging on**	YES	*(wait 1-2 minutes for LOG FILE OPENED)*
simul?	NO	*(if yes, del \config\simul.sim then exit reset)*	**ver**	8.4	*(if not already recorded during refurbishment)*
time	1223	***matches UTC?*** YES	**put c_alt_time -1**	YES	*(stops altimeter pinging)*
Air pump off (time)	1225	*(3-10 minutes)*	**get m_vacuum**		
get m_coulomb_amphr_total	2.32	*(<5 for new batteries)*	***Sufficient for mission?***	YES	
get m_leakdetect_voltage	2.5	*(>2.3)*	**get m_leakdetect_voltage_forward**	2.5	*(>2.3)*
ballast	YES	*(wait several minutes for 'The Air Pump is off')*	**get m_vacuum**	7.7	*(6 inHg shallow, 7 inHg deep)*
consci	YES	*(wait for SciDos> prompt to be displayed)*	**dir app**	YES	*(confirm SUPERSCI.APP is present)*
zs config\proglets.dat	YES	*(File>Transfer>Zmodem>Receive)*	**quit**		*(wait for GliderLAB> prompt to be displayed)*
loadmission sci_on.mi	YES	*(verify output contains realistic sensor data)*	**loadmission sci_off.mi**	YES	
report ++ m_depth	0	*(between 0.5 and - 0.5m, otherwise zero_ocean_pressure and repeat)*	**report clearall**	YES	
strobe on	YES	*(check strobe flashes)*	**strobe off**	YES	

If thruster is installed, check blades are not obstructed before testing. Do not run the thruster for more than 30 seconds in air.

report ++ m_thruster_current	N/A	*(verify output updates)*	**put c_thruster_on 30**	N/A	*(should spin clockwise when viewed from aft)*
put c_thruster_on 0	N/A		**report clearall**		

If not already checked during refurbishment, review proglets.dat and GSI sheets and verify sensor configuration and communications using u4stalk UART BAUD D BIT

Sensor type	CT_SAIL	***UART***	3	***Power bit***	30	***Sensor output OK?***	YES
Sensor type	WETLABS	***UART***	5	***Power bit***	34	***Sensor output OK?***	YES
Sensor type		***UART***		***Power bit***		***Sensor output OK?***	
Sensor type		***UART***		***Power bit***		***Sensor output OK?***	
Sensor type		***UART***		***Power bit***		***Sensor output OK?***	
Sensor configuration correct?		***All sensors functioning normally?***					

Remove nose and tail covers, dry the glider thoroughly and check altimeter, anodes and drop weight burn wire

put c_alt_time 0	YES	*(verify regular clicking sound from altimeter transducer)*	**report ++ m_altimeter_voltage**	YES	*(verify output updates)*
altimeter s/n		**put c_alt_time -1** YES *(stop altimeter pinging)*	**report clearall**	YES	
Forward anode resistance (Ω)	yes	*(<10, measure between anode and pupa flange screws)*			
Aft anode resistance (Ω)	not tested	*(<10, measure between anode and drop weight tube screws)*			

Disconnect nose recovery device Mecca connector, place multimeter between burn wire supply lead and forward anode

put c_recovery_on 1		***Supply lead voltage (V)***		*(>5, measured with multimeter)*
put c_recovery_on 0		***Supply lead voltage (V)***		*(verify = 0 then replace Mecca connector)*
lab_mode off				

Disconnect drop weight Mecca connector, place multimeter between burn wire supply lead and aft anode

put c_weight_drop 1		***Supply lead voltage (V)***		*(>5, measured with multimeter)*
logging off		**put c_weight_drop 0**		**put m_weight_drop 0**
exit pico		***Supply lead voltage (V)***		*(verify = 0 then replace Mecca connector)*

Replace Mecca connector, install nose and tail covers, check mechanical operation

(from pico prompt) **app -lab**		*(check drop weight voltage = 0 again)*	**callback 30**		**ballast**
logging on		*(wait 1-2 minutes for LOG FILE OPENED)*	**report ++ m_battery**	YES	
wiggle on	YES	*(wiggle for 10 minutes whilst monitoring for voltage drop during pump/motor movement)*			
Motor driver warnings or errors?		*(if errors are seen after transportation, put devices back into service)*			
Digifin movement OK?		***Motors binding?***	**get m_tot_num_inflections**	5709	*(<20000 shallow, <10000 deep)*
wiggle off		**report clearall**	**logging off**		
send *.*		*(save data and log files, repeat until all files sent)*	**exit**		

Move glider outdoors with an unobstructed view of the sky and turn on

Argos transmitting OK?	YES	*(place RF chirper near digifin, should transmit every 90 seconds)*			
Ctrl-C stopped glider before running mission?	YES	*(exit reset if not)*	**lab_mode on**		
callback 30	YES	**logging on**	YES	*(wait 1-2 minutes for LOG FILE OPENED)*	
callback 0 0	YES	***Primary number dialled***	default	*(default 88160000583)*	
callback 0 1		***Secondary number dialled***	default	*(default 17818711614)*	
callback 30	YES	**get m_battery**	14.76	*(9.7 - 12V Lithium or 12 - 16V Alkaline)*	
Motors moving or pump on?	YES	**put c_argos_on 0**	YES		
get m_coulomb_current	0.176	*(0.06 - 0.288A)*	**report ++ m_heading m_pitch m_roll**	YES	*(verify outputs update, pitch and roll +/-0.18 rad)*
report clearall	YES	**put c_gps_on 3**	YES	*(GPS fix within 2 minutes, V changes to A in serial output)*	
sync_time	7 second offset, syncing	*(large offset possible if coin cell changed)*	**time** YES	***matches UTC?***	YES
put c_gps_on 1	YES	**logging off**	YES		
run status.mi	YES	*(wait for normal completion)*	**send *.***		*(save data and log files)*
dellog all	NO	*(deletes all sent logs, repeat for science card)*	**put c_air_pump 0**	YES	no need to clear files - loads of room for mission
report ++ m_de_oil_vol		*(for 1000m gliders only)* **put c_de_oil_vol 1000**	YES	*(should reach 260cc)*	
(for 1000m gliders only) **put c_de_oil_vol -1000**	YES	*(should reach -260cc)*	**exit**		
Notes					

SLOCUM FUNCTIONAL CHECKOUT

Glider no. 444 — ***Date*** 23/11/2023 — ***Time*** 09/11/1903 — ***Initials*** JAB

Ensure the terminal session is logging before turning on the glider

Terminal log file number — ***Freewave connection OK, lights on within 30 seconds?*** YES

Freewave number — *(if not already recorded during refurbishment)*

Air pump on (time) 1410 — ***Ctrl-C before mission started?*** YES *(exit reset if not)*

Check that each of the following commands works, record the output where applicable

lab_mode on YES — **callback 30** YES — **logging on** YES *(wait 1-2 minutes for LOG FILE OPENED)*

simul? YES *(if yes, del \config\simul.sim then exit reset)* — **ver** *(if not already recorded during refurbishment)*

time 1416 — ***matches UTC?*** YES — **put c_alt_time -1** *(stops altimeter pinging)*

Air pump off (time) 1416 *(3-10 minutes)* — **get m_vacuum** 9.6

get m_coulomb_amphr_total 2.7 *(<5 for new batteries)* — ***Sufficient for mission?*** YES

get m_leakdetect_voltage 2.48 *(>2.3)* — **get m_leakdetect_voltage_forward** 2.49 *(>2.3)*

ballast YES *(wait several minutes for 'The Air Pump is off')* — **get m_vacuum** 7.3 *(6 inHg shallow, 7 inHg deep)*

consci YES *(wait for SciDos> prompt to be displayed)* — **dir app** YES *(confirm SUPERSCI.APP is present)*

zs config\proglets.dat YES *(File>Transfer>Zmodem>Receive)* — **quit** YES *(wait for GliderLAB> prompt to be displayed)*

loadmission sci_on.mi YES *(verify output contains realistic sensor data)* — **loadmission sci_off.mi** YES

report ++ m_depth 0 *(between 0.5 and - 0.5m, otherwise zero_ocean_pressure and repeat)* — **report clearall** YES

strobe on YES *(check strobe flashes)* — **strobe off** YES

If thruster is installed, check blades are not obstructed before testing. Do not run the thruster for more than 30 seconds in air.

report ++ m_thruster_current N/A *(verify output updates)* — **put c_thruster_on 30** N/A *(should spin clockwise when viewed from aft)*

put c_thruster_on 0 N/A — **report clearall** N/A

If not already checked during refurbishment, review proglets.dat and GSI sheets and verify sensor configuration and communications using u4stalk UART BAUD D BIT

Sensor type	UART	Power bit	Sensor output OK?
CT_SAIL	3	30	
WETLABS	0	29	
	5	34	

Sensor configuration correct? — ***All sensors functioning normally?***

Remove nose and tail covers, dry the glider thoroughly and check altimeter, anodes and drop weight burn wire

put c_alt_time 0 *(verify regular clicking sound from altimeter transducer)* — **report ++ m_altimeter_voltage** *(verify output updates)*

altimeter s/n recheck this — **put c_alt_time -1** *(stop altimeter pinging)* — **report clearall**

Forward anode resistance (Ω) *(<10, measure between anode and pupa flange screws)*

Aft anode resistance (Ω) *(<10, measure between anode and drop weight tube screws)*

Disconnect nose recovery device Mecca connector, place multimeter between burn wire supply lead and forward anode

put c_recovery_on 1 — ***Supply lead voltage (V)*** *(>5, measured with multimeter)*

put c_recovery_on 0 — ***Supply lead voltage (V)*** *(verify = 0 then replace Mecca connector)*

lab_mode off

Disconnect drop weight Mecca connector, place multimeter between burn wire supply lead and aft anode

put c_weight_drop 1 — ***Supply lead voltage (V)*** *(>5, measured with multimeter)*

logging off — **put c_weight_drop 0** — **put m_weight_drop 0**

exit pico — ***Supply lead voltage (V)*** *(verify = 0 then replace Mecca connector)*

Replace Mecca connector, install nose and tail covers, check mechanical operation

(from pico prompt) **app -lab** *(check drop weight voltage = 0 again)* — **callback 30** YES — **ballast** YES

logging on YES *(wait 1-2 minutes for LOG FILE OPENED)* — **report ++ m_battery** YES

wiggle on YES *(wiggle for 10 minutes whilst monitoring for voltage drop during pump/motor movement)*

Motor driver warnings or errors? NO *(if errors are seen after transportation, put devices back into service)*

Digifin movement OK? YES — ***Motors binding?*** NO — **get m_tot_num_inflections** 8869 *(<20000 shallow, <10000 deep)*

wiggle off YES — **report clearall** YES — **logging off**

send *.* *(save data and log files, repeat until all files sent)* — **exit**

Move glider outdoors with an unobstructed view of the sky and turn on

Argos transmitting OK? YES *(place RF chirper near digifin, should transmit every 90 seconds)*

Ctrl-C stopped glider before running mission? YES *(exit reset if not)* — **lab_mode on** YES

callback 30 YES — **logging on** YES *(wait 1-2 minutes for LOG FILE OPENED)*

callback 0 0 YES — ***Primary number dialled*** default *(default 88160000583)*

callback 0 1 YES — ***Secondary number dialled*** 17818711295 *(default 17818711614)* — updated autoexec to the default number and retested

callback 30 YES — **get m_battery** 14.63 *(9.7 - 12V Lithium or 12 - 16V Alkaline)*

Motors moving or pump on? NO — **put c_argos_on 0** YES

get m_coulomb_current 0.209 *(0.06 - 0.288A)* — **report ++ m_heading m_pitch m_roll** YES *(verify outputs update, pitch and roll +/-0.18 rad)*

report clearall YES — **put c_gps_on 3** YES *(GPS fix within 2 minutes, V changes to A in serial output)*

sync_time done *(large offset possible if coin cell changed)* — **time** YES — ***matches UTC?*** YES

put c_gps_on 1 YES — **logging off** YES

run status.mi YES *(wait for normal completion)* — **send *.*** YES *(save data and log files)*

dellog all NO *(deletes all sent logs, repeat for science card)* — **put c_air_pump 0** YES — no need to delete files

report ++ m_de_oil_vol YES — *(for 1000m gliders only)* **put c_de_oil_vol 1000** YES *(should reach 260cc)*

(for 1000m gliders only) **put c_de_oil_vol -1000** YES *(should reach -260cc)* — **exit** YES

Notes **non-audible altimeter, spoke with Ben and Steve at NOC and they seemed content to deploy after various checks**

11 Biogeochemistry

Laura Taylor, Mollie Allerton

Biogeochemical sampling and analysis took place on the cruise, with samples taken according to the pre-agreed BIOPOLE key parameters. Where possible, ship-board analysis of samples took place; however, in practice on this cruise, analysis was only for dissolved oxygen for use in calibrating CTD-mounted dissolved oxygen sensors, and silicate concentration, for the purpose of validating autoanalyzer derived concentrations.

11.1 CTD sampling

Laura Taylor, Mollie Allerton, Andrew Meijers, Alex Brearley, Roseanne Smith, Katie Lowery, Katherine Turner, Tarkan Bilge, Milo Bischof, Gabi Stowasser, Theresa Gossmann

11.1.1 CTD sampling order

Parameter sampling order was decided according to the GO-SHIP Repeat Hydrography Manual (Hood et al., 2010). This resulted in the following sampling order.

1. Dissolved oxygen (DO)
2. Dissolved inorganic carbon/ total alkalinity (DIC/TA)
3. Dissolved nutrients (DN)
4. Dissolved silica (DSi)
5. Dissolved silicon isotopes (δ30Si)

From this point on, there is no scientific need for a specific sampling order. Samples were taken in approximately the order below for convenience.

6. Dissolved organic carbon (DOC)
7. Lugols phytoplankton composition (lugols)
8. Dissolved oxygen isotopes (δ18O)
9. Salinity
10. Particulate organic carbon (POC) / particulate inorganic carbon (PIC) / biogenic silica (BSi) / chlorophyll (chl)
11. Particulate organic matter (POM)

The assigned sample cop for each CTD ensured parameters were sampled in the correct order throughout.

11.1.2 Contamination at the CTD

Due to the varying requirements of each of the sample types in avoiding contamination, and the need for chemical protection when using spiking reagents at the CTD, all scientists involved with CTD sampling wore nitrile gloves with vinyl gloves on top for the duration of sampling, where nitrile gloves formed chemical protection and prevention of oils from hands transferring to Niskin bottle spigots, and vinyl gloves prevented introduction of nitrogen species to samples. Separate tubing was used for each parameter, allowing for different tubing cleaning and storage requirements between CTDs.

11.1.3 Sample labelling

All biogeochemical samples taken on SD033 have the same labelling system, whereby sample labels comprise of a six-digit ID code. The first three digits (letters) are generally the same for every sample of the same parameter, and the final three digits (numbers) are randomly assigned within each parameter.

Sample ID labels were stuck to all sample bottles in advance of sampling to ensure the integrity of the labels. Labels were printed on matte white polyethylene labels pre-printed using a laser printer to ensure ink was not water soluble. Label integrity was tested with different material types prior to the cruise. Sample ID codes were recorded by the sample cop during CTD sampling and later transcribed to a digitised version of the CTD sampling log by the science team.

Random sample ID codes were chosen for the cruise to minimise human error due to the relatively large number of scientists working on biogeochemistry with varying experience levels, and provided the benefit of reducing the amount of time spent preparing for CTD sampling if writing labels using event and Niskin numbers for every sample. However, it is acknowledged that this labelling system will likely result in slightly increased workload for those later analysing samples.

Note, the three-letter code denoting samples for $\delta^{18}O$ changed from DIO to OII part-way through sampling. $\delta^{18}O$ samples from both the CTD and underway seawater system have the same unique identifiers, whereas underway samples for dissolved nutrients have a different unique identifier to CTD samples due to difference in bottle size.

Sample type	**3 letter identifier**
Dissolved oxygen	DOX
Dissolved inorganic carbon / total alkalinity	DIC
Dissolved nutrients (CTD, 125 ml bottles)	DIN
Dissolved nutrients (underway seawater system, 60 ml bottles)	IDN
Dissolved silica	DSI
$\delta^{30}Si$	SII
Dissolved organic carbon	DOC
Lugols phytoplankton composition	PCL
$\delta^{18}O$	DIO or OII
Particulate organic carbon	POC
Particulate inorganic carbon	PIC
Biogenic silica	BSI
Chlorophyll	CHL

11.1.4 Sample depths

Routine sampling depths vary by parameter and are given in the following sections. Some parameters had samples taken at the depth of the chlorophyll maximum, determined by plots from CTD-mounted fluorescence sensors on the downcast. Samples were taken at this depth in addition to the standard depth profile if deemed substantially different from depths already covered, for parameters in which variation which chlorophyll concentration was considered significant for the aims of this project.

11.1.5 Sampling procedures

11.1.5.1 Dissolved oxygen

Oxygen was the first parameter sampled to reduce degassing effects once the bottles had been cracked, starting with the deepest samples. Between CTD sampling, flexible silicone tubing was stored submerged in seawater to reduce the likelihood of bubble formation when sampling. Samples were collected in pre-calibrated 125 ml glass bottles.

DO bottles were overflowed with three times the bottle volume, during which the fixing temperature was recorded using a digital thermometer. Bottles were then filled to the brim ensuring no bubbles were present. 1 ml of each fixing reagent was discarded into waste to check the dispensers and eliminate any bubbles in dispenser chambers, and then 1 ml of first $MnCl_2$, and then NaOH/NaI was dispensed into each sample with the tip of the dispenser fully submerged in the water. The lid was placed into each bottle and they were shaken with full inversion of the bottle for approximately 30 seconds. Samples were then stored upside down in seawater deep enough to cover the bottle neck seals. 30 minutes after initial mixing, samples were shaken again. Samples were analysed after no more than 48 hours, and typically within 24 hours.

The depth profile of DO samples varied between CTDs and was chosen to ensure sufficient variation across temperature and salinity gradients for calibration of CTD-mounted oxygen sensors.

11.1.5.2 DIC/TA

A 250 ml borosilicate glass bottle was filled from the Niskin and allowed to overflow with three times the bottle volume before being filled to the brim, making sure no bubbles were present in the sample, and secured with the lid. Tubing was stored in seawater between sampling to reduce likelihood of bubble formation.

Samples were stored securely before spiking, typically within 15 minutes of sample collection. 2.5 ml of seawater was pipetted off to allow for headspace before addition of 50 µL of mercuric chloride to each sample. The bottle stopper was sealed using Apiezon L grease, and taped with electrical tape. The sample was gently shaken to homogenise and stored at +4 °C.

DIC/TA samples followed a depth profile of 10 m, 20 m, 50 m, 100 m, 500 m, and 1000 m. For deeper casts, samples were taken at 1000 m intervals until the CTD depth or bottom depth was reached, with an additional sample at the bottom depth where applicable.

For samples DIC961, DIC595, DIC535 from CTD024 (event number 64) the whole 50 µL volume was not pipetted into the sample due to a fault with the pipette. This was fixed for other samples.

Due to receiving updated information about best practice for DIC/TA samples once science was underway, samples from the first three days of the cruise did not have 2.5 ml of water removed before spiking, resulting in these sample bottles being more full, with less headroom for potential thermal expansion. All DIC/TA samples have therefore been designated as cool stow (+4 °C) at all times to limit the potential for thermal expansion causing any loosening of bottle lids and leakages.

11.1.5.3 Dissolved nutrients

Water was filtered directly from the Niskin bottle using an in-line Acropak filter (0.8/0.45 µm) attached using pre-acid cleaned silicone tubing. A 125 ml pre-acid cleaned Nalgene bottle was rinsed three times with filtered seawater, then filled to the shoulder to allow for expansion on freezing. Samples were stored at -20 °C.

The standard depth profile for dissolved nutrients was 10 m, 20 m, 50 m, 100 m, 500 m, 1000 m, with samples taken at 1000 m intervals thereafter and at the bottom depth on deeper casts. Chlorophyll maximum samples were taken when this depth differed from existing sample depths.

11.1.5.4 Dissolved silica

A 60 ml pre-acid cleaned Nalgene bottle was rinsed three times through pre-acid cleaned silicone tubing before filling the bottle to the top. On some occasions, water was filtered through an in-line Acropak filter (0.8/0.45 µm) to increase the storage time of the sample before analysis. Samples were stored at +4 °C until analysis.

The depth profile for DSi samples always matched that of dissolved nutrients.

11.1.5.5 Dissolved silicon isotopes

Water for $\delta^{30}Si$ samples was filtered directly from the Niskin bottle using an in-line Acropak filter (0.8/0.45 µm) attached using pre-acid cleaned silicone tubing. A 250 ml or 500 ml pre-acid cleaned Nalgene bottle was rinsed three times with filtered water, then filled up to the top. Bottle size was chosen based on depth, with samples taken deeper than 100 m in 500 ml, and samples from 100 m or shallower in either size, where 500 ml bottles from shallower depths were filled to just over halfway. Samples were stored at +4 °C.

The standard depth profile for $\delta^{30}Si$ was 10 m, 50 m, 100 m, 1000 m, and on deeper casts at 1000 m intervals thereafter, with an additional sample at the bottom depth. Chlorophyll maximum samples were taken when this depth differed from existing sample depths.

11.1.5.6 Dissolved organic carbon

Water was filtered through an in-line GF/F filter into pre-acid cleaned 50 ml HDPE bottles. The filter housing was kept in a 10 % HCl acids bath between sampling and rinsed with Milli-Q before being assembled with a new filter paper before each CTD. Bottles were rinsed three times with filtered water before being filled to the shoulder to allow headroom for freezing. Samples were frozen at -20 °C.

The standard depth profile for DOC was 10 m, 20 m, 50 m, 100 m, 500 m, and 1000 m, and on deeper casts at 1000 m intervals thereafter, with an additional sample at the bottom depth. Chlorophyll maximum samples were chosen when this depth was substantially different from existing sample depths.

11.1.5.7 Lugols phytoplankton composition

Lugols samples were collected into brown 250 ml HDPE bottles. The bottles were rinsed three times and filled to the shoulder to allow space for reagent addition. 2.5 ml of Lugols iodine was added to each of the samples. The lid was wrapped in Parafilm and samples shaken to homogenise. Samples were stored at +4 °C. Some samples at the end of the cruise were collected in clear bottles and wrapped in aluminium foil to prevent light effects.

The standard depth profile for lugols was 10 m, 20 m, 50 m, 100 m, and 500 m. Chlorophyll maximum samples were taken when this depth differed substantially from existing sample depths.

11.1.5.8 Dissolved oxygen isotopes

Samples for $\delta^{18}O$ were taken in a 50 ml glass bottle which was rinsed three times before filling to the shoulder. Bottles were sealed with rubber inserts and closed with metal crim seals using hand crimpers. Samples were stored at +4 °C.

The depth profiles for $\delta^{18}O$ were chosen for each CTD to give good resolution of the upper water column, particularly the transition between the surface, base of the mixed layer and CDW T_max.

11.1.5.9 Salinity

Samples for salinity were taken in 200 ml glass bottles which were rinsed three times with seawater before filling to the shoulder. The bottle neck was wiped with a kim wipe or blue roll to prevent accumulation of salt crystals, and a rubber stopper inserted before the bottle cap was secured. Samples were stored at ambient temperature in the salinometry lab prior to analysis.

The depth profile for salinity was chosen so as to maximise deep samples where salinity values are relatively stable, and avoid sharp vertical gradients in salinity, where it will be harder to match CTD values with bottle values, as the objective of these samples are to provide standardised in situ values with which to calibrate the CTD conductivity.

11.1.5.10 Filtration samples: POC, PIC, BSi, chl, and POM

10 L carboys acid cleaned prior to the start of sampling were rinsed three times with seawater, then filled, where one carboy contained water for analysis of POC, PIC, and BSi, and one carboy contained water for chl. 5 L carboys were rinsed three times and filled for filtration for POM. Carboys were stored in the +4 °C fridge in the dark prior to filtration.

The standard depth profile of samples for POC, PIC, and BSi was 10 m, 20 m, 50 m, 100 m, 500 m, and 1000 m, with samples also taken at 2000 m on deeper casts. Chlorophyll maximum samples were taken when this depth was substantially different from existing sample depths.

The standard depth profile for chl was 5 m (the surface sample), the chlorophyll maximum depth, and one at a depth deeper than the chlorophyll maximum but in the euphotic zone, which in practice was either 50 m or 100 m on any given cast.

Note, some samples for POC, PIC, and BSi were lost from superstation CTD011 due to a lack of appropriately timed sample water refrigeration, owing to excitement about sea ice disembarkation. There is therefore only a PIC sample at 10 m, and POC samples at 10 m and 20 m for this station.

11.2 Filtration

Laura Taylor, Mollie Allerton, Roseanne Smith, Katie Lowery, Katherine Turner, Tarkan Bilge, Milo Bischof, Andrew Meijers, Alex Brearley, Theresa Gossmann, Gabi Stowasser

Before beginning filtration on the cruise, all filter cups and holders were thoroughly cleaned in Milli-Q. Between each sample cups and holders were rinsed with filtered seawater. POC, PIC, and chlorophyll filtration was carried out on a filtration set with glass cups and filter holders, while filtration for BSi was carried out on a filtration set with plastic cups. Parameters were split this way to avoid contamination of BSi samples by fibres of GF/F filters. Occasionally, due to time constraints, filtration with GF/F filters was carried out on the filtration unit designated for BSi. In these instances filter holders and cups were washed thoroughly in Milli-Q before being used again for BSi.

11.2.1 Filtration for POC and PIC

Pre-ashed and weighed 25 mm GF/F filters were placed on the filter holder and the cup secured with the metal clip. A small amount of filtered seawater was run through before adding sample water to ensure there were no leaks in the filter seal. Water was then poured from the carboy into smaller 1 L measuring jugs used to fill the filtration cups. Filtration for POC and PIC was carried out at a pressure of at or below 40 kPa. The volume of water added to the cup was recorded throughout the filtration and added to a log sheet at the end of filtration for each sample. Once the required volume of water had passed through the filter pump, or the filter became clogged, filters were removed from the holder using forceps rinsed with filtered seawater, folded in half twice, and placed in pre-labelled foil packets. Foil packets were left open and placed in a fume hood to dry out for approximately 1 hour before they were sealed and placed in a -20 °C freezer.

At the start of sampling, the aim was to filter 2 L of water for each sample, however it quickly became apparent due to time constraints and the organic matter content of the water that this would not be possible. It was therefore changed so that, if clogging did not happen before, 1 L of water would be filtered for samples at or shallower than 100 m, with 2 L filtered for deeper samples. If there appeared to be no colour on the filter after 1 L of filtration more water was filtered to achieve this. Filtration for POC and PIC was generally carried out within 12 hours of water collection, with a few exceptions.

11.2.2 Filtration for chlorophyll

Clean forceps were used to place a pre-ashed 25 mm GF/F filter onto the filter holder and the cup secured with the metal clip. The filter seal was tested with small volume of filtered seawater before sample water was added to the filtration cup. A minimum of 2 L of water was filtered for chlorophyll samples, unless the filter was clogged or filtration became extremely slow prior to this volume. If there was not sufficient colour on the filter at 2 L, filtration was continued up to 5 L of water. Filtration for chlorophyll was carried out at a pressure at or less than 30 kPa, and care was taken to ensure the filter did not dry out during filtration to prevent cell lysis. The top of the filtration cup was covered in aluminium foil while filtering for chlorophyll to limit light exposure of the water.

When the required volume of water was filtered, filters were removed using clean forceps and placed in a pre-labelled foil packet which was immediately sealed to prevent drying of the filter. Samples were then placed in a -80 °C freezer.

Filtration for chlorophyll was generally carried out within 5 hours of sample collection, with a few exceptions (mostly due to the filtration itself taking longer than 5 hours in productive waters).

11.2.3 Filtration for BSi

25 mm Isopore™ 0.8 µm polycarbonate filters were placed on the filter holder and the plastic cup secured. A small amount of filtered seawater was run through before adding sample water to ensure there were no leaks in the filter seal. Water was then poured from the carboy into smaller 1 L measuring jugs used to fill the filtration cups. Filtration for BSi was carried out at a pressure of at or below 40 kPa. The volume of water added to the cup was recorded throughout the filtration and added to a log sheet at the end of filtration for each sample. Once the required volume of water had passed through the filter pump, or the filter became clogged, filters were removed from the holder using forceps rinsed with filtered seawater, folded in half twice, and placed in pre-labelled foil packets. Foil packets were left open and placed in a fume hood to dry out for approximately 1 hour before they were sealed and placed in a -20 °C freezer.

At the start of sampling, the aim was to filter 2 L of water for each sample, however it quickly became apparent due to time constraints and the organic matter content of the water that this would not be possible. It was therefore changed so that, if clogging did not happen before, 1 L of water would be filtered for samples at or shallower than 100 m, with 2 L filtered for deeper samples. If there appeared to be no colour on the filter after 1 L of filtration, more water was filtered to achieve this. Volumes filtered for all parameters can be found in sample log sheets.

Filtration for BSi was generally carried out within 12 hours of water collection, with a few exceptions.

Figure 11-1: filtration lab bench setup.

11.3 Stable isotope analysis –δ13C and δ15N

Gabi Stowasser

In order to establish an isotopic baseline for POM across the Atlantic sector of the Southern Ocean particulate organic matter (POM) was collected in the Weddell Sea, in Ryder Bay off Rothera base, at the BIOPOLE Mooring station, along the cruise transect (Superstations 1-5, 7-10), and along Iceberg A23a. POM samples were obtained through filtering waters collected by Niskin bottles deployed via a CTD rosette (Ryder Bay, Biopole mooring, Cruise transect) and from the Underway clean seawater system (Iceberg A23a). From the CTD, water was taken from various depths at each station (Table 11-1 below). All water samples collected were processed on-board. Depending on the density of particles varying volumes of seawater per depth were filtered onto 47mm GF/F filters and the filters stored frozen at -80°C.

Table 11-1: POM samples collected for $\delta^{13}C$ and $\delta^{15}N$ stable isotope analysis on SD033

Station	Event	sample depths
Ryder Bay	3	5m, Chlmax (15), 25m, 75m, 125m, 200m, 380m (402m seabed depth)
Iceberg A23a-U1-13		Underway clean seawater supply (8m). Sample numbers: 1-3, 5-7, 9-14, 16

BIOPOLE Mooring	6	5m, 25m, 75m, Chlmax (85m), 125m, 200m, 450m, 750m
Superstation 1	10	6, 25m, Chlmax (60m), 75m, 125m, 200m, 450m, 750m
Superstation 2	20	5m, Chlmax (60m), 125m, 200m, 450m, 750m
Superstation 3	23	5m, Chlmax (20m), 25m, 75m, 125m, 200m, 450m, 750m
Superstation 4	30	5m, 25m, Chlmax (30m), 75m, 125m, 200m, 450m, 750m
Superstation 5*	45	5m, (25m bottle not fired), Chlmax (70m), 75m, 125m, 200m, 450m, 750m, 4347m (4373m seabed depth)
Superstation 7	51	5m, 25m, Chlmax (60m), 75m, 125m, 200m, 450m, 750m
Superstation 8	59	5m, 25m, Chlmax (28m), 75m, 125m, 200m, 450m, 750m
Superstation 9	66	5m, 20m, Chlmax (50m), 75m, 125m, 200m, 450m, 750m
Superstation 10	77	5m, Chlmax (20m), 75m, 125m, 200m, 450m, 750m, 3354m (3373m seabed depth)
* Superstation 6 was not sampled		

11.4 Oxygen titration

Mollie Allerton, Laura Taylor, Tarkan Bilge, Milo Bischof, Katherine Turner, Kate Hendry, Ed Mawji (assisted remotely)

11.4.1 Preparation of reagents

Alkaline Iodide and thiosulphate were prepared at sea following the protocols in the GO SHIP manual. Sulfuric acid was diluted from concentrated to 5M at sea, following the protocols in the GO SHIP manual. $MnCL_2$ was prepared beforehand and packed ready to be used. Sodium thiosulphate solution was made at sea using pre weighed amounts.

11.4.2 Analysis

A Metrohm 848 Titrino plus unit with potentiometric end point detection was used. The unit designated prior to the cruise as the primary unit could not be correctly configured and so a spare unit of the same model was used instead. The stop conditions of the method were changed from EP 9 to EP1.

11.4.3 Blanks

Blanks were carried out by adding 1 ml of H_2SO_4 to a DO bottle filled ~2/3rd with DI water and stirring using the magnetic stirrer (Menu > OK > Manual Control > OK > Stirrer > ON). 1 ml of NaOH/NaI was added and the solution was stirred. 1 ml of $MnCl_2$ was added and the solution was stirred. If any colour or precipitate appeared, the solution was discarded and the blank repeated.

The first blanks which were carried out formed a precipitate after the addition of $MnCl_2$, which suggested a problem with the H_2SO_4. A new batch of acid was made and then no precipitate formed after the addition of all of the reagents. 1 ml of 0.1667 M potassium iodate solution was added to the solution and a yellow colour formed. This solution was titrated with sodium thiosulphate and the volume of thiosulphate recorded as V1. Another 1 ml of potassium iodate was added to the same solution and it should have turned a yellow colour again. The solution was titrated with sodium thiosulphate again and the volume recorded as V2. This was repeated once more, and the volume recorded as V3.

Attempts were made to carry out the blank titrations using the auto titrator however the auto titrator over titrated significantly, meaning that there was a substantial excess of sodium thiosulphate. This meant that after the second addition of potassium iodate no yellow colour formed, as the iodine and sodium thiosulphate reacted straight away, meaning no value for V2 or V3 could be obtained. In order to overcome this, the blanks were titrated manually by dosing sodium thiosulphate into the solution using the auto titrator on manual mode. The end point was decided when there was no longer any yellow colour visible. Significant attempts were made to reduce the extent of the over titration however we did not find a way to run the blanks using the auto titrator during the time available, and so all blanks were titrated manually. Blanks were run three times during the cruise and the mean value was used in the calculations for the samples.

11.4.4 Standardisation

Blanks were carried out by adding 1 ml of H_2SO_4 to a DO bottle filled ~2/3rd with DI water and stirring using the magnetic stirrer (Menu > OK > Manual Control > OK > Stirrer > ON). 1 ml of NaOH/NaI was added and the solution was stirred. 1 ml of $MnCl_2$ was added and the solution was stirred. If any colour or precipitate appeared, the solution was discarded and the solution repeated. 5 ml of 0.1677 M potassium iodate was added to the solution and stirred. This was titrated with sodium thiosulphate using the auto titrator (START). The volume of thiosulphate until EP1 was recorded. The bottle was rinsed with tap water and then DI water and the process repeated 3 more times until 4 values were obtained for standardisation, and a mean was calculated. Only concordant results (within 0.02 ml) were included in the mean calculation. Each batch of sodium thiosulphate was standardised twice and the mean of these used in the calculations for the sampling.

11.4.5 Running samples

Samples were stored upside down with the bottle necks submerged in water and were usually analysed within 24 hours, and never more than 48 hours after sampling. Samples were removed from storage and 1 ml of sulphuric acid disposed into waste to check the dispenser and then 1 ml of acid was dispensed into the sample and a stirrer bar was added. The acid was mixed into the sample using the magnetic stirrer until the precipitate was dissolved. The sample was then titrated with sodium thiosulphate using the auto titrator (START). The sample number, bottle number, fixing temperature, and Niskin bottle number were copied from the sample cop log into the oxygen titration spreadsheet. Once the titration was completed the volume of sodium thiosulphate was added to the spreadsheet.

11.4.6 Methods on the auto-titrator

The DO method loaded on the auto-titrator was used to run the majority of the samples and standardisations however these methods were lost during the science days, which is marked on the oxygen titration spreadsheet.

The default DET method was run after this point and appeared to make no difference to the blanks and is assumed to have made no difference to the sample results.

11.5 Dissolved silica spectrophotometry

Laura Taylor, Roseanne Smith, Kate Hendry (assisted remotely)

11.5.1 Standard preparation

For each batch of spectrophotometry, five silicon standard solutions were prepared encompassing the range of concentrations expected at the depths sampled in this region. The concentrations used were 0, 1.25, 5, 10, 20, and 30 µmol / L, which account for the fourfold dilution of samples. Standards were prepared using the same ratio of seawater to DI water (Milli-Q), meaning all standards were made up to 10 ml with Milli-Q after addition of the required volume of standard and 2.5 ml of low nutrient sea water (LNSW).

11.5.2 Sample preparation

Samples for ship-board analysis of dissolved silica concentration were stored after sampling in the dark in a +4 °C fridge. Initially, all samples were taken directly from the Niskin bottle and were unfiltered, but it became apparent during the cruise that time constraints would make it very difficult to analyse samples sufficiently quickly after each cast, and so samples on some casts were then passed through a 0.8/0.45 µm Acropak filter to allow a longer storage time before analysis. Spectrophotometry was then carried out in batches of 2-3 CTDs every few days.

11.5.3 Preparation for spectrophotometry

Once prepared, 14 drops of Molybdate solution was added to each standard and sample, shaken well, and left for 4 minutes. This was followed by one sachet of citric acid reagent powder to each, shaken and left for 1 minute, and one sachet of amino acid F reagent, shaken and left for 2 minutes.

11.5.4 Preparation of blanks

A standard blank was prepared with a concentration of 0 µmol /L, where 2.5 ml of LNSW was added to 7.5 ml of Milli-Q (the same as the 0 µmol/L standard), and the molybdate and citric acid reagents added, but the amino acid F reagent not added.

A sample blank was prepared for each batch of photometry from a blank sample which was randomly allocated from one of the Niskin bottles already sampled for DSi on each CTD cast. When samples from multiple CTDs were analysed together, only one blank was used throughout. The sample blank was prepared by diluting the seawater fourfold by adding 2.5 ml of blank seawater to 7.5 ml of Milli-Q. The molybdate and citric acid reagents were added to the blank but not the amino acid F reagent. Note, for CTDs up to and including CTD006, the sample blank was accidentally prepared with 2.5 ml of blank seawater, 2.5 ml of LNSW, and 5 ml of Milli-Q due to a misunderstanding of the protocol.

11.5.5 Calibration

The spectrophotometer was first zeroed using the standard blank, then each sample was poured into a cuvette and inserted into the spectrophotometer and the absorbance and transmission values recorded. The spectrophotometer was zeroed between each standard reading to minimise any drift. This was used to plot a calibration curve for the standards. For all calibration curves made over the cruise, the R^2 value was between 0.99-1.00.

11.5.6 Sample analysis

The spectrophotometer was first zeroed using the sample blank, then each sample was poured into a cuvette and inserted into the machine and the absorbance recorded. The spectrophotometer was zeroed with the sample blank between each sample to minimise drift. Values were inputted into a spreadsheet to calculate the concentration at a given absorbance from the calibration curve, and concentrations of the undiluted samples calculated.

Figure 11-2: spectrophotometry lab bench setup.

11.5.7 Analysis of certified reference materials

Certified reference materials (CRMs) were analysed using the same methodology as samples throughout the cruise to assess the accuracy of the methodology being used. The first time CRM measurements were taken on the day of analysis of CTD006, a clear issue was identified. CRMs measured through the methodology above produced results values substantially different from the known concentrations of CRMs, with a fairly consistent offset visible between the multiple readings of each of the two CRMs. After a thorough consideration of the method at the stage to try and identify any method errors, the issue with sample blank matrixing detailed above was identified. Samples from CTD006 were then re-run with a second batch of CRM measurements which resulted in no difference to the previous CTD, ruling out sample blank matrixing as the issue. After checking through the standard preparation method and reviewing the silica standard and CRMs purchased, no further methodological errors could be identified.

Examination of concentrations of samples obtained by CTD006, alongside the two previous CTDs which included spectrophotometry (001 and 003) showed that concentrations obtained appeared to be lower than expected across the casts across depths. These CTDs included one shallow CTD in Ryder Bay, and one deep CTD at the site of the BIOPOLE mooring, which suggested a consistency in the issue of lower readings across different environments as opposed to the result being indicative of local conditions. It was therefore concluded that the most likely reason for the offset obtained was an issue with the silica standard solution. Fridge temperature check records were obtained for the fridge in which the standard was stored for transport from Harwich, UK, until it moved to a fridge closer to the lab space early in the cruise. This showed no evidence of freezing in the once daily temperature logs, but some variation around the 4 °C set temperature (lowest recorded = 1.9 °C, highest recorded = 5.0 °C) could leave some margin for potential temperature impacts.

A correction method for sample concentrations was then devised using the CRM readings. CRM A (CH-0678) was measured six times and the percentage difference between each reading and the known CRM concentration calculated. An average of these percentage differences was calculated to be used as a correction factor. The obtained concentrations of CRM B (CN-1207) were then multiplied by the correction factor and the percentage difference between these values and the known concentration calculated. This produced percentage differences of generally less than 4 % as would be generally accepted as suitable for this analysis.

Due to this clear uncertainty in the analysis, thereafter CRM analysis took place as frequently as possible within the constraints of time and reagent availability to provide a sufficient set of CRM measurements for correction of all data at the end of the cruise.

However, on 12/12/2023 (analysis of CTDs 17, 20, and 23) CRM measurements were no longer consistent with those from previous days, producing consistently higher concentrations than known values for both CRMs as opposed to lower. Sample concentrations for this day also appeared to be higher than might be expected. While there was some consistency between repeated readings of each CRM, there was higher variation than previous analyses, and a correction factor could not be calculated which resulted in corrections of CRM B that were consistently within 4 % of the known value. Due to the sudden increase in silica concentration across samples and CRMs, initial checks were carried out for contamination across the methodology, including adding reagents to cleaned centrifuge tubes containing just Milli-Q to test cleaning was effective, using Milli-Q from multiple different taps to identify any potential contamination in the Milli-Q supply. It was noted that a new packet of citric acid reagent was started between standard calibration and preparation of samples on this day. One sample was re-run in two aliquots using a citric acid sachet from the newly opened packet, and another from an additional packet which had not yet been opened to investigate a potential issue with the citric acid reagent; however, there was not any difference in the two results. After eliminating contamination as a potential cause in this change in CRMs, CRM readings were repeated an additional 6 times to increase the number of measurements available to use in calculating a new correction factor. On the final day of spectrophotometry analysis, CRM readings were again lower than the known values with a similar magnitude to prior to 12/12/2023.

11.5.8 Correction of completed dataset

After completion of all analysis by spectrophotometry, the calculated values for all samples were corrected using the CRM measurements taken on the day of sample analysis to account for differences in CRM offsets between days. This resulted in all silicate concentration measurements from the cruise broadly falling in the range expected when comparing to the eWOCE database S04A synthesis dataset which covers a similar geographical area (Figure 11-3).

Figure 11-3: eWOCE S04A dataset (grey) overlaid with DSi data from the cruise from 04/12/2023-10/12/2023 (red).

Data will later be compared to silicate concentrations obtained from analysis of frozen (-20 °C) samples using an autoanalyzer, alongside the samples stored at + 4 °C.

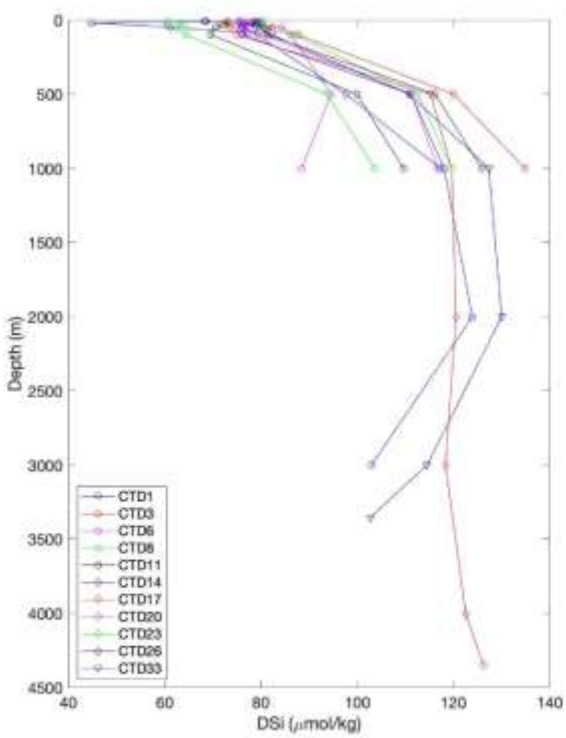


Figure 11-4: depth profiles of corrected DSi concentration from all CTD casts for which spectrophotometry occurred.

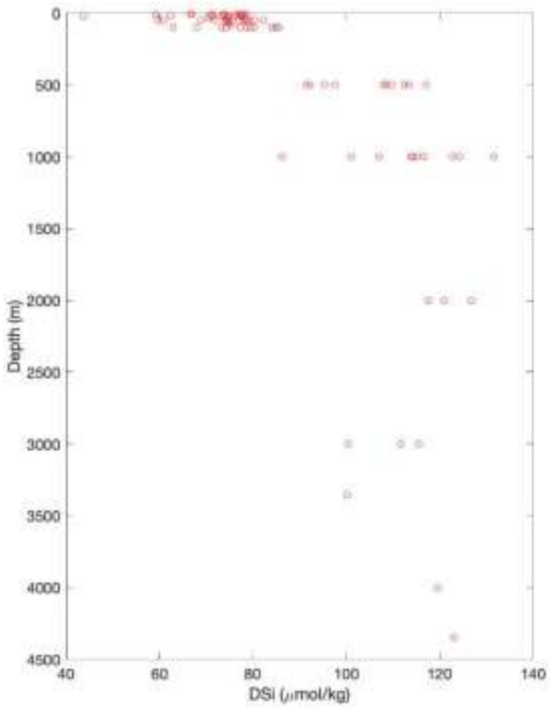


Figure 11-5: scatter plot of corrected DSi concentrations from SD033.

11.6 Summary of biogeochemical samples

Parameter	Number of samples collected
Dissolved oxygen	118
DIC/TA	123
Dissolved nutrients	218
Dissolved silica	81
$\delta^{30}Si$	128
DOC	154
Lugols	148
$\delta^{18}O$	222
POC	134
PIC	129
BSi	127
Chlorophyll	58
Total	**1640**

12 Iceberg A23a sampling

Laura Taylor

12.1 Parameters and methods

12.1.1 Dissolved nutrients

Samples for dissolved nutrients were taken every 15 minutes on the approach to the iceberg, starting approximately 40 nmi from the berg, alongside the iceberg, and on the journey away from the iceberg (for approximately 40 nmi).

Water from the uncontaminated seawater system was filtered through an in-line Acropak filter (0.8/0.45 µm) attached to the tap with pre-acid cleaned silicone tubing. A pre-acid cleaned 60 ml Nalgene bottle was rinsed three times before filling to the shoulder leaving headroom for freezing. Samples were stored at -20 °C.

12.1.2 Dissolved silica isotopes

Samples for $\delta^{30}Si$ were taken every 30 minutes on the approach to the iceberg, every 15 minutes alongside the iceberg, and every 30 minutes on the journey away from the iceberg.

Water from the uncontaminated seawater system was filtered through an in-line Acropak filter (0.8/0.45 µm) attached to the tap with pre-acid cleaned silicone tubing. A pre-acid cleaned 250 ml Nalgene bottle was rinsed three times before filling to the top. Samples were stored at +4 °C.

12.1.3 Lugols phytoplankton composition

Lugols samples were taken every 30 minutes on the approach to the iceberg, every 15 minutes alongside the iceberg, and every 30 minutes on the journey away from the iceberg.

A 125 ml brown Nalgene bottle was rinsed three times with water from the uncontaminated seawater system before being filled to the shoulder to allow headroom for spiking. The sample was spiked with 2.5 ml of Lugol's iodine, then the lid secured and wrapped with Parafilm before shaking to homogenise. Samples were stored at +4 °C.

12.1.4 Dissolved oxygen isotopes

$\delta^{18}O$ samples were taken every 30 minutes on the approach to the iceberg, alongside the iceberg, and on the journey away from the iceberg.

A 60 ml glass bottle was rinsed three times with water from the uncontaminated seawater system before being filled to the shoulder. The bottle was secured with a rubber stopped, then hand crimped with a foil cap. Samples were stored at +4 °C.

12.1.5 Salinity

Salinity samples were taken every 30 minutes on the approach to the iceberg, alongside the iceberg, and on the journey away from the iceberg.

A 200 ml glass bottle was rinsed three times with water from the uncontaminated seawater system before being filled to the shoulder. The inside of the bottle neck was wiped with a kim wipe to prevent formation of salt crystals, then secured with a rubber stopper and a plastic cap. Samples were stored at ambient temperature until analysis by salinometry.

12.1.6 Particulate organic matter

POM samples were taken every 30 minutes on the approach to the iceberg and every 60 minutes alongside the iceberg.

A 5 L carboy was rinsed three times with water from the uncontaminated seawater system before filling to the top. The water was stored in the dark at +4 °C until later filtration according to the method detailed in the biogeochemistry section.

13 Ecology

Nadine Johnston, Gabriele Stowasser, Laura Taylor, Clara Manno and Geraint Tarling assisted remotely

13.1 Ecology team members

The ecology team comprised Nadine Johnston and Gabi Stowasser, together with Thomas Gillum-Webb and Matthew Hood from Antarctic Marine Engineering. Laura Taylor oversaw the biogeochemical sampling, which included the collection of samples for phytoplankton and organic matter (POM, processed and analysed by Gabriele Stowasser).

13.2 Ecology objectives

1. To determine dynamics (community composition, distribution, and abundance) of the spring phytoplankton bloom and associated mesozooplankton community, particularly the copepod *Calanoides acutus*, and their relationships with oceanography and nutrient dynamics.
2. To determine the metabolic rate of *C. acutus,* together with their lipid sac concentration (carbon, hydrogen, nitrogen) and size.
3. To opportunistically examine spatial variations in the origin and flows of particulate organic matter.

A particular focus of the zooplankton community will be the copepod *C. acutus.* Over the course of their development, *C. acutus* develop a large carbon-rich lipid sac, primarily to fuel their metabolism and aid buoyancy during their winter diapause (to survive low food levels and avoid predation) at depths of (potentially) up to 2500 m. Using a combination of respiration experiments, collected primarily from the upper water column (200-0 m) but also from depth (up to 1,000 m), together with investigations of their lipid sac concentration and size, and their population structure, distribution, and abundance, we can determine how much carbon this species is capable of transporting to the deep ocean, and its influence on nutrient recycling in the upper water column.

13.3 Ecological sampling and analyses

Ecological aspects were examined through a combination of CTD, Bongo, and Mammoth net deployments at the BIOPOLE Mooring and superstations, and analyses outlined in Table 13-1, over the course of 12 days. This chapter details the zooplankton collection and analyses: Details of sample collection and analysis of phytoplankton and organic matter (Particulate Organic Matter, POM) are given in the biogeochemistry chapter.

13.3.1 Trial station

Trialling of Bongo and Mammoth nets were conducted in Ryder Bay*, on the south coast of Adelaide Island near Rothera Station.

13.3.2 BIOPOLE Mooring and Superstations

Ecological (+ physical and biogeochemical) sampling took place at the BIOPOLE Mooring and each of the 10 sSuperstations' outlined in Figure 4-2 (see also further details in the Introduction), from the open ocean, through the marginal ice zone, and into the pack ice. At each of the 10 superstations, a CTD was deployed first thing in the morning, giving information on physics, biogeochemistry, phytoplankton, and POM. Copepod respiration experiments were conducted at each of the 10 Superstations along the open ocean-sea ice transect (i.e. not at the trial station or BIOPOLE Mooring).

Once the CTD was on board (approx. 7.30am each day), the Bongo was deployed in the upper water column (0-200 m, see methods below), followed by the Mammoth net into deeper waters (up to 1,000 m, see methods below). After completion of Bongo and Mammoth net deployments and zooplankton preservations, nets were examined for live copepod samples for a) CHNTO, ETS, and lipid analyses, and, b) respiration experiments and CHN following Table 13-1 where possible.

Core requirements of Bongo and Mammoth netting deployments included:

- Trailing of Bongo and Mammoth before arriving at stations
- Bongo and Mammoth deployed every day, preferably in the morning, and at the same station as the CTDs for BGC and phytoplankton sample collection
- Deployed of Mammoth nets to a depth of >/=1200m (to allow for lock pressure depth of 1,100m)
- Ecosystem Team worked on the same shift

* A full suite of sampling from CTDs, Bongos and Mammoths were trialled at Ryder Bay following deployment of staff and cargo at Rothera.

13.3.3 Bongo netting

Gabriele Stowasser, Nadine Johnston, Matt Hood, Thomas Gillum-Webb

To collect copepods for respiration experiments and determine the composition of mesozooplankton community (including copepods) in the upper layers of the Weddell Sea, a Bongo net (Figure 13-1) containing a spring-tensioned motion compensation unit was deployed at the BIOPOLE Mooring station and all the Superstations (1-10) along the cruise transect. The net is made up of 2 x 61 cm diameter metal rings, with one 200 µm mesh and one 100 µm mesh. The cod-ends contain taps through which samples are collected at the end of the deployment. Deployments were carried out off the starboard side using a hydrowire wire. Between deployments, the Bongo rested vertically on a made to specification metal stand. Descent and ascent of the net was carried out at a speed of 0.2 m/s. All deployments were made to 200m. In general, 3 deployments were made per station for one sample to be preserved and the remainder to be sampled for copepods for respiration experiments. The first Bongo sample of the day was preserved complete in 4% formaldehyde. In total, 26 deployments were made during SD033 (see Table 13-2).

Issues encountered: Due to adverse weather the Bongo was not deployed at Superstation 2 and only a total of 1 and 2 Bongos were carried out at Superstations 6 and 14, respectively, due to time constraints.

13.3.4 Mammoth netting

Gabriele Stowasser, Nadine Johnston, Petra ten Hoopen, Theresa Gossmann, Thomas Gillum-Webb, Matt Hood

To sample copepods and determine the composition of mesozooplankton community across discrete depth layers in the Weddell Sea, a HydroBios MAMMOTH multinet (Figure 13-1) was deployed at the BIOPOLE mooring site and all the Superstations (1-10) along the cruise transect (see Table 13-3). After a trial deployment to 250 m, the MAMMOTH was deployed to 1000m at all further stations. Although it can be used as a horizontally towed system the MAMMOTH was deployed vertically from the stern of the ship using a GP wire. Depth increments for fishing were set at: Net 1: 1000-875m, Net 2: 875-

750m, Net 3: 750-625m, Net 4: 625-500m, Ne t5: 500-375m, Net 6: 375-250m, Net 7: 250-125m, Net 8: 125-62.5m, Net 9: 62.5-5m. The trigger depth was set at 1100 m and the net deployed to 1200m to ensure trigger release.

Samples below 250m (nets 1-6) were sampled for copepod respiration experiments and the remainder of these catches as well as all catches from nets 7 to 9 were preserved in 4% formaldehyde for future analysis of community composition. A record was kept of all specimens extracted from the catch and placed on the sample label within the catch.

The Mammoth system makes an internal digital record of flow rates and environmental variables to an internal disk that was downloaded via the Oceanlab software system. The Oceanlab files for the above deployments were exported and stored as text files in the folder SD033_MAMMOTH_Export on the SD033 cruise "leg" directory (/date/cruise/sda/202311133) which will be permanently stored on the storage area network at the British Antarctic Survey.

Issues encountered: All deployments except one were successful. At Superstation 2 the swell and movement of the ship caused the cable to go slack at approx. 100m cable out which caused bucket 4 to disengage from the carousel and net 1 to be ripped from the top sleeve and the zip to be damaged. Both nets and buckets were wrapped around the top box of the Mammoth on retrieval of the instrument. As there was no replacement for the zip on the top sleeve of net 1 it was consequently sewn on. The catch in net 1 was lost on this deployment. The catch of Net 1 at Superstation 4 (event 34) was lost due to the catch of a large jellyfish (*Stygiomedusa gigantea*) displacing the bucket content. No twisting was evident in the nets so it can be assumed that all samples were quantitative.

The instrument was deployed at a veering rate of 0.5 m/s and hauled at a rate of 0.3 m/s. Due to the damage caused to the net at this slow rate it was decided that in adverse weather the hauling rate would be increased to 0.5 m/s from 150m cable out in the future. On inspection of the catches, it was noted that zooplankton caught in net 6 (375-250m) and above seemed to be in worse physical condition than specimens from deeper water layers. We changed the hauling speed from 0.3 m/s to 0.5 m/s for the top layers (from net 6) for Superstation 8-10 (Events: 63, 70, 78) and the condition of specimens improved. We therefore recommend increasing the hauling speed of the Mammoth net to 0.5 m/s for at least the top 200m.

Numerous files from previous cruises that had not been downloaded from the MAMMOTH can be found in the folder MPS_XL_2615_MAMMOTH_offline on the drive listed above (i.e., /date/cruise/sda/202311133). These files have not been exported and are stored as hbl files. They can also be exported as text files using Oceanlab software. The instrument will not record any deployment data once the memory on its storage unit is full. Therefore, the files created on this cruise and of all previous cruises has now been deleted to make space for the recording of future deployments.

13.4 Copepod analyses

Nadine Johnston

13.4.1 Respiration experiments

Rationale: Direct respiration experiments were conducted on the copepod species *Calanoides acutus* to determine their metabolic rate. Over the course of their development *C. acutus* develop a large lipid sac, primarily to fuel their metabolism and aid buoyancy during their winter diapause (to survive low food levels and avoid predation) at depths of up to 2500 m. The respiration data will be used by BIOPOLE to calculate the contribution of this species to the 'lipid pump' and hence better parameterise the carbon cycle within a current generation Earth System Model (MEDUSA). This BIOPOLE cruise 1 was focussed on investigating the metabolic requirements of this species (principally stage CV) during spring (Nov-Dec 2023). DY158 on RRS Discovery provided an ideal opportunity to conduct respiration experiments on stage CV specimens during the austral summer (Dec-Jan 2022/3), and the autumn period (Feb-Mar 2025) when they begin their descent for winter diapause.

Methods: Prior to the onset of respiration experiments, 3 individual scientific fridges (LMS Cooled Incubator Model 80, equipped with independent data-logging temperature probes) were set up at 0.5, 2.5, and 5°C (to approximate the range of sea temperatures anticipated at sampling locations, and accounting for the fact that the PreSens system will not work at $<$ or $=$ 0°C). Once fridges had settled, 3x PreSens SensorVials and Sensor Dish Readers (SDRs) (see Figure 13-2) were calibrated at these temperatures (using filtered seawater; 100% oxygen, and deoxygenated seawater; 0% oxygen). Two test runs were conducted in the absence of copepods. Copepods were collected at the locations given in Table 13-2 (from Bongo) and 13-3 (and the deepest net of the Mammoth, 1000-875m) (copepods were not collected from the Bongo and Mammoth nets at Superstation 2 due to adverse weather and net issues, outlined above). Contents of the Bongo codends were emptied into 50L buckets and transferred to a controlled temperature lab (approximating sea temperature at the sampling location) before processing. The Mammoth codends were placed in 20L buckets and transported to the controlled temperature lab before processing. Copepods were removed using a fine mesh hand-held filter and examined under the microscope to select for *C. acutus* CV individuals. For each station, where possible 15x specimens were immediately collected for Drs Dan Mayor and Kathryn Cook (University of Exeter), cleaned in filtered seawater, divided between 3x (2 ml) Eppendorf tubes, sealed in a plastic bag, and stored at -80°C in a 2L plastic container. Where possible a further 90 specimens were collected, cleaned in filtered seawater, and divided between 3 x 250ml glass stoppered jars (filled with filtered seawater) for the respiration experiments. These were placed in a dark environment and left to starve overnight. Respiration experiments were conducted the following day (to ensure a gut evacuation period). Copepods were transferred from starvation vessels (sequentially) to each of the three 24 well SensorVials (labelled 0.5, 2.5, 5°C) in the controlled temperature room (ensuring a minimum of 3 randomly assigned control wells devoid of copepods), and transferred to the scientific fridges, mounted on SDR readers. Once all SensorVials were in place, respiration experiments were initiated and run for 4hrs. Data was stored on RRS SDA Public drive, USB, and NMJs laptop. Following completion of experiments, each SensorVial was removed, wells examined under the microscope for presence/absence and condition of individuals. Individuals were then removed and photographed on a rimmed petri dish and prepared for C:H:N analyses (see below).

Issues encountered: 1) At some stations it was also very difficult to find sufficient CV copepods, so a limited number of CV individuals were used in the experiments, and some experiments were run on females. Nets from the upper layers of the water column at all stations were dominated by females, with very few CVs. CV copepods were instead found predominantly found in the deeper Mammoth nets (particularly, 1000-875m). For this reason, and because CVs from these nets were also in excellent condition, respiration experiments were conducted on these specimens in preference to the more shallow Bongo net samples. 2) Females were significantly larger in body size and lipid sac, at the more northerly stations. At more southerly stations the copepods were much smaller, with many on the cusp of CIV and CV. Few CIV individuals were encountered.

13.4.2 CHN, Time Zero CHN Analyses

Rationale: Elemental analysis of individual *C. acutus* (C:H:N) is necessary to determine C specific rate measurements and also to relate to visual analyses of body condition.

Methods: *C. acutus* specimens were placed individually into tin capsules, and stored within 96 well plates. These were then dried at 50 °C, and then stored at 4°C for transport back to the UK and subsequent elemental analysis to establish amounts of C, N and H in each specimen. Processing the samples in this way, rather than storing at -80 °C avoids the disintegration of tin capsules (as experienced on DY158). This was done (1) for all *C. acutus* incubated within SensorVials as detailed above and (2) for a range of developmental stages (10 CIVs, 10 CVs, and 10 females, where numbers allowed) collected from each of the Mammoth net catches. The latter were considered as T0 specimens for the sampling station. All specimens were photographed individually under a light microscope (to determine their overall body size) before being placed into the tin capsule. Specimens to be photographed were arranged within a rimmed petri dish ensuring that two adjacent rims were within the photograph to act as an internal calibration for size (see Figure 13-3). For details of sample station see leg drive.

Issues encountered: It was not always possible to get a full range of developmental stages (10 CIVs, 10 CVs, and 10 females) collected from each of the Mammoth net catches (or the Bongo nets) as copepod numbers were low at most stations. No CIIIs were encountered.

13.4.3 Lipid Analyses

Rationale: *C. acutus* contain lipid sacs as an energy store, potentially to allow successful overwintering. This sac will comprise a varying amount of C and lipid within an individual depending on its proportional size. Specimens were collected to measure the amount of lipid per individual to complement the above measuring C per individual. In both instances, these amounts can be related to visual analyses of individual photographs from which a number of dimensions can be measured.

Methods: As for the CHN analysis above, individuals were first photographed under a light microscope within a rimmed petri dish to determine the size of the lipid sac. Each individual was then placed within an individually labelled 2 ml Eppendorf tube. All were transferred to a -80 °C freezer with minimum delay. Samples of range of developmental stages (10 CIII, CIVs, CVs, and females) were collected, numbers allowing. For details of sample collections see leg drive.

Issues encountered: It was not always possible to get a full range of developmental stages (10 CIVs, 10 CVs, and 10 females) collected from each of the Mammoth net catches (or the Bongo nets) as copepod numbers were low at most stations. No CIIIs were encountered. Eppindorfs are not a space efficient way of storing samples.

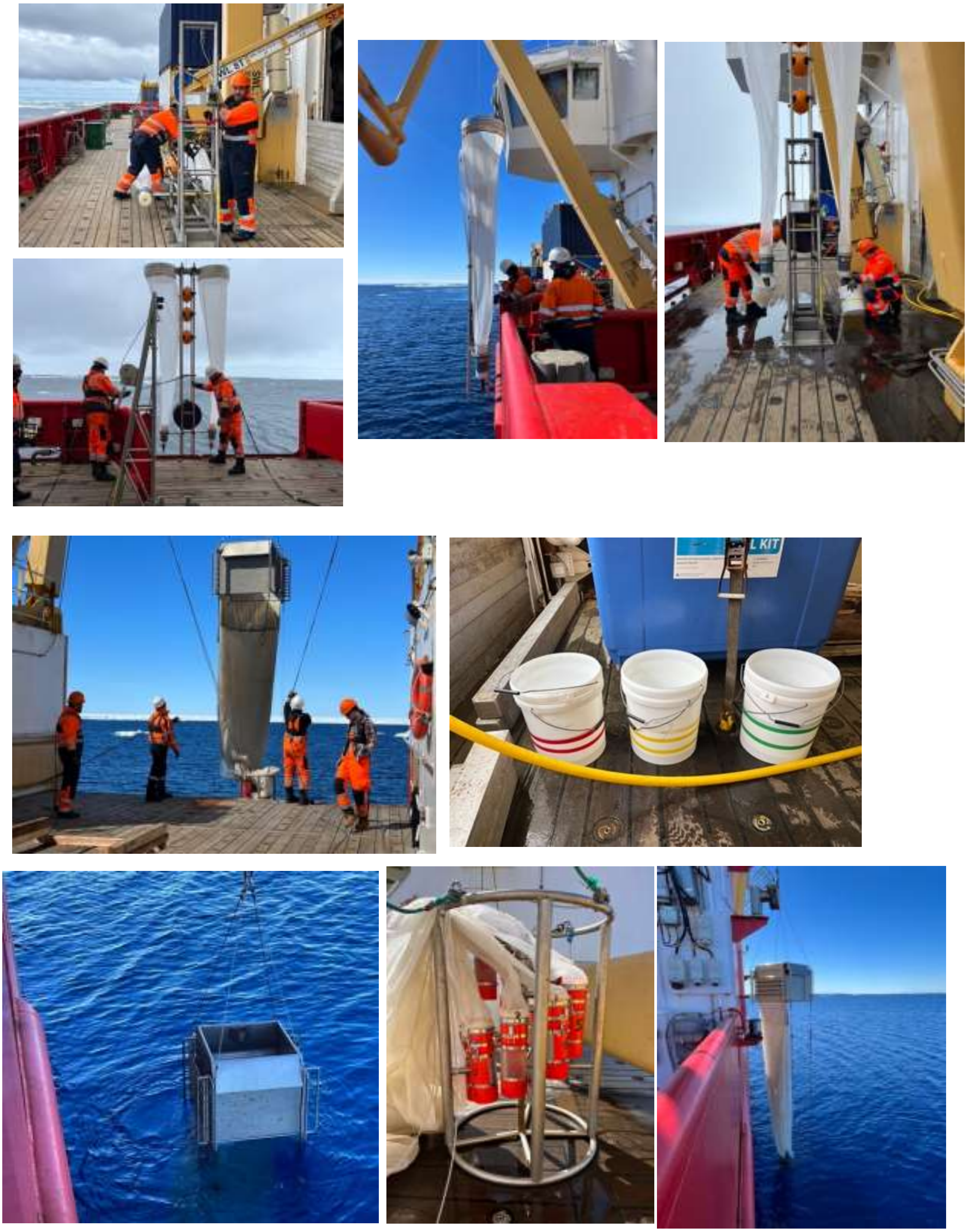


Figure 13-1: Collection of Calanoides acutus and mesozooplankton samples on SD033 using Bongo (top, note purpose-built frame designed by Thomas Gillum-Webb) and Mammoth nets (bottom).

Figure 13-2: Respiration experiment set up on Calanoides acutus using SensorVials and SDRs

Figure 13-3: Calanoides acutus stage CV pictured in a calibrated rimmed petri under an Olympus SZX Light microscope using a Canon 60D camera.

Table 13-1**:** Order of BGC and Ecological sampling per station (10 in total, approximately 5 north of and including ice edge, 5 south of ice edge, see also Tables 13-2 and 13-3)

Sampling gear	**Depth**	**No. deploy-ments (per station)**	**Primary persons responsible for deployment**	**Analyses (or preservation)**	**End use/storage**	**Primary person(s) responsible for analyses/preservation/storage**	**Total time to deploy & recover**	**Total time to analyse (and/or preserve) & store**	**Comments**
CTD	Max	1	Physicists, Laura				1-2 hrs depending on max depth (average 1,000m) + Total time for all CTD water collection/sampling = 1 hour		
				Dissolved oxygen (DO)	Titration No samples stored after analysis	Laura/ Mollie		2-3 hours	BGC BGC
				Dissolved inorganic carbon/ total alkalinity (DIC/TA)	Spiking with mercuric chloride Fridge 4°C	Laura		20 minutes	BGC
				Dissolved nutrients (DN)	Freezer -20°C	Laura		10 minutes	BGC
				Dissolved silicon (silicic acid)	Spectrophotometry No samples stored after analysis	Laura		1.5 hours	BGC
				Dissolved silicon isotopes ($d^{30}Si$)	Fridge 4°C	Laura		10 minutes	BGC
				Dissolved organic carbon (DOC)	Freezer -20°C	Laura		10 minutes	BGC

	Phytoplankton composition (lugols)	Fridge 4°C	Laura		20 minutes	Ecosystems
	Oxygen isotopes (d^{18}O)	Fridge 4°C	Laura		10 minutes	BGC
	Salts	Salinometry No samples stored after analysis	Physics team		-	BGC
	Particulate organic carbon and nitrogen (POC/PON)	Filtration onto GF/F filters Freezer -20°C	Laura		2.5 hours (filtration for the three parameters will be done simultaneously)	BGC
	Particulate inorganic carbon (PIC)	Filtration onto GF/F filters Freezer -20°C	Laura			BGC
	Chlorophyll a (chla)	Filtration onto GF/F filters Freezer -20°C	Laura, Gabi			Ecosystems
	Biogenic silica (BSi)	Filtration onto polycarbonate filters Freezer -20°C	Laura		1.5 hours	BGC
	Particulate organic matter (POM)	Filtration onto GF/F filters Freezer -80°C	Gabi		5hrs	Ecosystems
					TOTAL TIME BGC: 9 hrs 50 minutes Laura **(This is the time for 1 person, with 2 full time would take half the time)**	

								This is inclusive of 5-6 hrs Gabi working in parallel with Laura	
Bongo (deployed from mid ship therefore NOT at same time as CTD deployment)	0-200m (2 nets, 100 and 200 µm meshes)	1	Gabi and Nadine	**Preserve catch** from both nets for zooplankton community analyses	Formalin	Gabi & Nadine	2hrs (for all 3 deployments)	15min	Ecosystems
		1	Gabi and Nadine	**Set aside catches** from both nets for copepod picking (and larval/juvenile Antarctic krill)	Seawater	Gabi & Nadine		15min	Ecosystems
		1	Gabi and Nadine	**Set aside catches** from both nets for copepod picking (and larval/juvenile Antarctic krill)	Seawater	Gabi & Nadine		15 min	Ecosystems
				Pick copepods from 200 µm net of Bongo 2 and 3 deployments;	Respiration experiments (& CHN samples and photos	Nadine		2hrs	

				- 90x for respiration experiments (& CHN), lipid sac photos -PLUS time & nos permitting 15x for Dan Mayor ETS	@ -80 °C OR drying cabinet) ETS samples for Dan Mayor @ -80 °C			**TOTAL TIME Bongo: 2hrs 45min** **Total TIME Copepod picking: 2hrs**	
Mammoth (deployed from midship, not through moon pool, therefore NOT at same time as CTD)	1000m – 62.5m (9 nets sampling at 1000m 875m 750m 625m 500m 375m 250m 125m 62.5m with a 1100m	1	Gabi and Nadine				2hrs		Ecosystems
				Pick copepods	CHNT0 samples drying cabinet (10 CVs, 10 females and 10 CIVs from each depth discrete net where there are enough to pick- if not pick 15 of each from Bongo, but Mammoth is the priority for CHNT0) (If there are live copepods in deepest nets at the end of the transect and time	Nadine		1hr	

lock pressure depth)		permits, pick them for respiration experiments (&CHN) and ETS instead of on Bongo samples			
		Formalin			
	Preserve zooplankton from all 9 nets (after picking)		Gabi and Nadine	30 mins	
				TOTAL TIME Mammoth: 3hrs 30min	
	Respiration Experiments (run on day after sampling from nets,		Nadine	5hrs	Ecosystems

	primarily Bongo) **Lipid sac analyses** (Photos of lipid sacs, CHN&CHNT0 samples in tins in microwell plates @ -80 °C/drying cabinet)			
	(Antarctic krill incubation experiments, sampling permitted**)**	Laura		**(TOTAL TIME krill incubations; 1.5hrs)** **TOTAL TIME Respiration experiments: 5hrs** **TOTAL TIME** **Ecosystems:** **13hrs 15min [need to get this under 12hrs for any one person]**

					This is inclusive of 1.5 hrs krill incubation experiments run in parallel by Laura	
		Faecal pellet incubation experiments- run from the day of sampling for 36 hours.	Faecal pellet samples preserved in ethanol. Organisms frozen at -20C	Laura	40 minutes every 12 hours for 36-hour experiment **TOTAL TIME: 1.5 hours (approx.).**	
PLUS **@RATS** **MOORING Trial Station** CTD at Mooring Then Bongo and Mammoth deployments as above (but no zooplankton preservation of copepod picking or respiration experiments)					**TOTAL TIME Trial Station:** **2hrs CTD** **(9hrs 50 min BGC, including Gabi's analyses, +** **4hrs Bongo & Mammoth)**	BGC & Ecosystems

PLUS **@BIOPOLE** **MOORING** CTD, Bongo and Mammoth deployments as above (but no copepod picking or respiration experiments)		**TOTAL TIME MOORING:** **15hrs 5 min** **(9hrs 50 min BGC, including Gabi's analyses, +** **5hrs 15min Bongo & Mammoth)**	BGC & Ecosystems

Table 13-2: Bongo deployments on cruise SD033. Times are given in UTC.

Time	latitude	longitude	Event	net depth (m)	Action	station	Bongo No	SS temperature	SS salinity (psu)	water depth (m)
14/12/2023 17:03	-62.5668	-49.9278	80		deployment/end	superstation_10		-1.28	33.82	3380
14/12/2023 16:41	-62.5669	-49.9283	80	200	deployment/at Depth	superstation_10	26	-1.26	33.82	3381
14/12/2023 16:24	-62.5678	-49.9301	80		deployment/start	superstation_10		-1.29	33.83	3380
14/12/2023 16:20	-62.5681	-49.9309	79		deployment/end	superstation_10		-1.29	33.82	3385
14/12/2023 16:01	-62.5683	-49.9347	79	200	deployment/at Depth	superstation_10	25	-1.26	33.82	3376
14/12/2023 15:42	-62.5687	-49.9375	79		deployment/start	superstation_10		-1.22	33.82	3379
13/12/2023 14:10	-63.1477	-49.2239	69		deployment/end	superstation_09		-1.42	34.17	2873
13/12/2023 13:51	-63.1467	-49.2241	69	200	deployment/at Depth	superstation_09	24	-1.41	34.18	2913
13/12/2023 13:36	-63.1464	-49.2252	69		deployment/start	superstation_09		-1.41	34.17	2917
13/12/2023 13:10	-63.1407	-49.2113	68		deployment/end	superstation_09		-1.41	34.17	3073
13/12/2023 12:52	-63.1399	-49.2135	68	200	deployment/at Depth	superstation_09	23	-1.45	34.17	3069
13/12/2023 12:34	-63.1395	-49.2155	68		deployment/start	superstation_09		-1.44	34.17	3068
13/12/2023 12:14	-63.1368	-49.2262	67		deployment/end	superstation_09		-1.44	34.17	3053
13/12/2023 11:55	-63.1347	-49.228	67	200	deployment/at Depth	superstation_09	22	-1.41	34.17	3052

13/12/2023 11:36	-63.1335	-49.2294	67		deployment/start	superstation_09		-1.42	34.16	3049
12/12/2023 13:10	-63.8312	-47.8332	62		deployment/end	superstation_08		-1.32	34.02	3461
12/12/2023 12:51	-63.8312	-47.8332	62	200	deployment/at Depth	superstation_08	21	-1.32	34.03	3457
12/12/2023 12:36	-63.8312	-47.8332	62		deployment/start	superstation_08		-1.32	34.03	3457
12/12/2023 12:33	-63.8312	-47.8332	61		deployment/end	superstation_08		-1.33	34.03	3459
12/12/2023 12:16	-63.8315	-47.833	61	200	deployment/at Depth	superstation_08	20	-1.35	34.03	3461
12/12/2023 12:01	-63.8319	-47.8329	61		deployment/start	superstation_08		-1.34	34.03	3462
12/12/2023 11:59	-63.832	-47.8329	60		deployment/end	superstation_08		-1.36	34.03	3458
12/12/2023 11:43	-63.8329	-47.8325	60	200	deployment/at Depth	superstation_08	19	-1.34	34.03	3453
12/12/2023 11:26	-63.8342	-47.832	60		deployment/start	superstation_08		-1.37	34.03	3447
11/12/2023 13:28	-64.9873	-46.3064	54		deployment/end	superstation_07		-1.50	34.24	4311
11/12/2023 13:10	-64.9881	-46.3051	54	200	deployment/at Depth	superstation_07	18	-1.51	34.24	4307
11/12/2023 12:57	-64.9887	-46.3053	54		deployment/start	superstation_07		-1.52	34.24	4313
11/12/2023 12:54	-64.9889	-46.3054	53		deployment/end	superstation_07		-1.49	34.24	4313
11/12/2023 12:38	-64.9897	-46.306	53	200	deployment/at Depth	superstation_07	17	-1.50	34.24	4313
11/12/2023 12:24	-64.9906	-46.3062	53		deployment/start	superstation_07		-1.47	34.24	4314
11/12/2023 12:20	-64.9909	-46.3062	52		deployment/end	superstation_07		-1.50	34.24	4316
11/12/2023 12:06	-64.992	-46.305	52	200	deployment/at Depth	superstation_07	16	-1.55	34.24	4316

11/12/2023 11:49	-64.9932	-46.306	52		deployment/start	superstation_07		-1.50	34.24	4316
10/12/2023 16:18	-65.5728	-44.8469	47		deployment/end	superstation_06		-1.49	34.18	4375
10/12/2023 15:56	-65.5701	-44.8473	47	200	deployment/at Depth	superstation_06	15	-1.49	34.17	4370
10/12/2023 15:37	-65.5684	-44.8486	47		deployment/start	superstation_06		-1.50	34.17	4370
09/12/2023 13:46	-64.4017	-47.1855	40		deployment/end	superstation_05		-1.43	34.15	4267
09/12/2023 13:24	-64.3996	-47.1834	40	200	deployment/at Depth	superstation_05	14	-1.44	34.15	4260
09/12/2023 13:08	-64.3988	-47.1826	40		deployment/start	superstation_05		-1.46	34.15	4257
09/12/2023 13:01	-64.3974	-47.1813	39		deployment/end	superstation_05		-1.41	34.14	4259
09/12/2023 12:43	-64.3964	-47.1803	39	200	deployment/at Depth	superstation_05	13	-1.42	34.14	4256
09/12/2023 12:27	-64.3955	-47.1794	39		deployment/start	superstation_05		-1.45	34.14	4255
09/12/2023 12:14	-64.3928	-47.1783	38		deployment/end	superstation_05		-1.42	34.13	4257
09/12/2023 12:00	-64.3906	-47.1765	38	200	deployment/at Depth	superstation_05	12	-1.41	34.13	4257
09/12/2023 11:42	-64.3891	-47.1762	38		deployment/start	superstation_05		-1.45	34.13	4255
08/12/2023 13:16	-63.2192	-48.8878	33		deployment/end	superstation_04		-1.50	34.11	3323
08/12/2023 12:56	-63.2192	-48.8878	33	200	deployment/at Depth	superstation_04	11	-1.51	34.10	3323
08/12/2023 12:42	-63.2192	-48.8878	33		deployment/start	superstation_04		-1.51	34.10	3324
08/12/2023 12:40	-63.2192	-48.8879	32		deployment/end	superstation_04		-1.48	34.10	3323
08/12/2023 12:24	-63.2193	-48.8888	32	200	deployment/at Depth	superstation_04	10	-1.50	34.10	3323

08/12/2023 12:10	-63.2194	-48.8893	32		deployment/start	superstation_04		-1.52	34.10	3323
08/12/2023 12:06	-63.2195	-48.89	31		deployment/end	superstation_04		-1.52	34.10	3321
08/12/2023 11:50	-63.2198	-48.8928	31	200	deployment/at Depth	superstation_04	9	-1.53	34.12	3323
08/12/2023 11:36	-63.2201	-48.8948	31		deployment/start	superstation_04		-1.52	34.12	3324
07/12/2023 15:21	-62.8582	-49.7983	26		deployment/end	superstation_03		-1.38	33.98	3413
07/12/2023 14:59	-62.8578	-49.7973	26	200	deployment/at Depth	superstation_03	8	2.22	0.00	3413
07/12/2023 14:40	-62.8576	-49.7963	26		deployment/start	superstation_03		0.34	0.00	3414
07/12/2023 14:20	-62.8561	-49.7816	25		deployment/end	superstation_03		-1.40	33.97	3414
07/12/2023 14:00	-62.856	-49.7803	25	200	deployment/at Depth	superstation_03	7	-1.38	33.98	3418
07/12/2023 13:41	-62.8557	-49.7794	25		deployment/start	superstation_03		-1.36	33.99	3419
07/12/2023 13:35	-62.8557	-49.7794	24		deployment/end	superstation_03		-1.38	33.98	3415
07/12/2023 13:00	-62.8568	-49.7738	24	200	deployment/at Depth	superstation_03	6	-1.40	34.02	3423
07/12/2023 12:34	-62.8581	-49.7706	24		deployment/start	superstation_03		-1.37	33.99	3417
05/12/2023 14:07	-62.6042	-49.9539	13		deployment/end	superstation_01		-0.88	33.98	3371
05/12/2023 13:45	-62.6042	-49.9539	13	200	deployment/at Depth	superstation_01	5	-0.89	33.96	3369
05/12/2023 13:28	-62.6042	-49.9539	13		deployment/start	superstation_01		-0.91	33.95	3368
05/12/2023 13:27	-62.6042	-49.9539	12		deployment/end	superstation_01		-0.91	33.95	3373
05/12/2023 13:06	-62.6042	-49.9539	12	200	deployment/at Depth	superstation_01	4	-0.91	33.94	3372

05/12/2023 12:51	-62.6041	-49.954	12		deployment/start	superstation_01		-0.90	33.95	3366
05/12/2023 12:48	-62.6041	-49.9539	11		deployment/end	superstation_01		-0.92	33.96	3366
05/12/2023 12:28	-62.6041	-49.954	11	200	deployment/at Depth	superstation_01	3	-0.83	33.98	3369
05/12/2023 12:09	-62.6041	-49.9539	11		deployment/start	superstation_01		-0.83	33.98	3367
04/12/2023 20:01	-62.1411	-50.5185	8		deployment/end	BIOPOLE mooring		-0.70	33.94	3382
04/12/2023 19:35	-62.1411	-50.5185	8	200	deployment/at Depth	BIOPOLE mooring	2	-0.70	33.94	3383
04/12/2023 19:09	-62.141	-50.5183	8		deployment/start	BIOPOLE mooring		-0.75	33.94	3380
30/11/2023 12:38	-63.4756	-59.3589	4		deployment/end	test		-0.45	34.40	627
30/11/2023 12:24	-63.4755	-59.3589	4	200	deployment/at Depth	test	1	-0.55	34.40	627
30/11/2023 12:06	-63.4754	-59.359	4		deployment/start	test		-0.56	34.39	631

Table 13-3: **Mammoth deployments on cruise SD033. Times are given in UTC.**

Time	latitude	longitude	event	MAMMOTH deployment	Max_net depth (m)	Action	Station	SST (C°)	Salinity (psu)	Water depth (m)
30/11/2023 13:27	-63.4756	-59.3589	5			deployment/start	test	-0.57	34.41	629
30/11/2023 14:07	-63.4756	-59.3589	5	1	250	deployment/at Depth	test	-0.74	34.43	626
30/11/2023 14:34	-63.4756	-59.3589	5			deployment/end	test	-0.35	34.39	624
04/12/2023 20:27	-62.141	-50.5187	9			deployment/start	BIOPOLE mooring	-0.71	33.93	3381
04/12/2023 21:25	-62.141	-50.5187	9	2	1000	deployment/at Depth	BIOPOLE mooring	-0.72	33.93	3384
04/12/2023 22:48	-62.1396	-50.5227	9			deployment/end	BIOPOLE mooring	-0.76	33.91	3382
05/12/2023 14:32	-62.6042	-49.9539	14			deployment/start	superstation_01	-0.88	33.97	3369
05/12/2023 15:35	-62.6041	-49.9539	14	3	1000	deployment/at Depth	superstation_01	-0.87	33.97	3367

05/12/2023 17:00	-62.6041	-49.9539	14			deployment/end	superstation_01	-0.85	33.97	3368
06/12/2023 12:10	-61.5394	-51.2147	21			deployment/start	superstation_02	-0.61	34.24	2789
06/12/2023 13:12	-61.5394	-51.2147	21	4	1000	deployment/at Depth	superstation_02	-0.59	34.24	2788
06/12/2023 14:32	-61.5393	-51.2147	21			deployment/end	superstation_02	-0.54	34.24	2789
07/12/2023 17:30	-62.8605	-49.8006	27			deployment/start	superstation_03	-0.98	5.21	3412
07/12/2023 18:48	-62.8605	-49.8006	27	5	1000	deployment/at Depth	superstation_03	-1.33	33.98	3411
07/12/2023 20:01	-62.8559	-49.8145	27			deployment/end	superstation_03	2.72	0.00	3413
08/12/2023 13:25	-63.2192	-48.8878	34			deployment/start	superstation_04	-1.47	34.10	3324
08/12/2023 14:16	-63.2192	-48.8878	34	6	1000	deployment/at Depth	superstation_04	-1.46	34.10	3322
08/12/2023 15:34	-63.2185	-48.8854	34			deployment/end	superstation_04	-1.39	34.10	3323
09/12/2023 14:01	-64.4048	-47.1845	41			deployment/start	superstation_05	-1.38	34.15	4267
09/12/2023 14:54	-64.4049	-47.1846	41	7	1000	deployment/at Depth	superstation_05	-1.36	34.15	4269

09/12/2023 16:12	-64.4049	-47.1846	41			deployment/end	superstation_05	-1.35	34.16	4266
10/12/2023 13:13	-65.5502	-44.8606	46			deployment/start	superstation_06	-1.47	34.18	4379
10/12/2023 14:07	-65.5545	-44.8556	46	8	1000	deployment/at Depth	superstation_06	-1.49	34.18	4376
10/12/2023 15:24	-65.5633	-44.8487	46			deployment/end	superstation_06	-1.50	34.18	4376
11/12/2023 13:36	-64.9866	-46.3078	55			deployment/start	superstation_07	-1.44	34.24	4311
11/12/2023 14:33	-64.9837	-46.3106	55	9	1000	deployment/at Depth	superstation_07	-1.35	34.24	4309
11/12/2023 15:49	-64.9835	-46.3108	55			deployment/end	superstation_07	-1.13	1.57	4307
12/12/2023 13:18	-63.8312	-47.8332	63			deployment/start	superstation_08	-1.31	34.02	3464
12/12/2023 14:26	-63.8312	-47.8331	63	10	1000	deployment/at Depth	superstation_08	-1.31	34.02	3458
12/12/2023 15:52	-63.8312	-47.8331	63			deployment/end	superstation_08	-1.35	34.04	3454
13/12/2023 14:28	-63.153	-49.2308	70			deployment/start	superstation_09	-1.40	34.17	2560
13/12/2023 15:20	-63.1533	-49.232	70	11	1000	deployment/at Depth	superstation_09	-1.38	34.17	2481

13/12/2023 16:32	-63.1532	-49.232	70			deployment/end	superstation_09	-1.36	34.17	2492
14/12/2023 12:49	-62.568	-49.9627	78			deployment/start	superstation_10	-1.30	33.81	3375
14/12/2023 13:38	-62.5698	-49.9498	78	12	1000	deployment/at Depth	superstation_10	-1.16	33.81	3381
14/12/2023 14:46	-62.5682	-49.9368	78			deployment/end	superstation_10	-1.29	33.80	3377

14 Sea ice sampling

Roseanne Smith

During the BIOPOLE SD033 cruise, we aimed to collect several sets of sea ice cores during the time spent transiting through the ice. This strand of work sits slightly outside the core objectives of BIOPOLE.

14.1 Selection of ice core station locations

As a target, we set out to collect samples from three different 'sea ice stations' during the 10 days of science. We intended these sites to be chosen as far apart as possible in space and time in order to collect a diverse set of samples, but with the understanding that we would be limited by the availability of suitable ice floes, as well as scientist and ship time. During the cruise, four ice cores stations were attempted (see Table 14-1).

Unfortunately, the first site was deemed unsuitable for drilling due to rafting of thick (probably multi-year) floes which resulted in a complex topography of the floe surface, large accumulations (around 2m) of surface snow which necessitated digging deep snow pits in order to reach the ice beneath, and negative freeboard of the ice when we reached it, which led increasing amounts of flooding (>30 cm) at the surface of the ice. These factors combined such that coring was difficult and possibly unsafe at this site. Luckily, the site was eminently suitable for a large-scale disembarkation of the scientists, crew and officers of the SDA, for the purposes of drone flying and photograph taking, and so ice station 1 remained a worthwhile stopping point.

For the second, third and fourth ice stations, the coring team leader assisted the PSO and officers at the SDA bridge in the process of selecting a more suitable floe for drilling. This was always done in the middle of the day (approx. 1300 hrs), after the morning CTD and nets deployment had been completed. A suitable floe was chosen as close as possible to the CTD and net locations. On the bridge, care was taken to choose a floe that met the following criteria as much as possible:

1. Less snow than ice station 1. Less than 1m is necessary, less than 30cm ideal.
2. A flat floe surface, with little or no evidence of rafting of floes or complex topography.
3. As little ridging as possible, as ridges are indicative of weaknesses and unpredictability in the floe structure.
4. Large enough for the ship to pull alongside.

The team at the bridge pulled alongside a floe, deliberately shaving off the edge of the floe, in order to test the structural integrity of the ice, and to enable close observation of the thickness of the ice as it turned over at the side of the ship. This approach was successful at the second site. For the third and fourth stations, the officers made an adjustment to the technique of pulling alongside the floe; instead, they decided to drive the SDA directly into the floe at full speed, in order to break into the ice and produce a situation where the ship was surrounded by a more consolidated and homogenous ice environment, with less opportunity for wind- and current- driven movement of the ship relative to the floe. This technique proved highly effective, and also had the additional benefit of enabling more accurate determination of the structural integrity of the ice; if the floe entirely fragmented whilst being rammed with the ship then we decided it wasn't thick or strong enough to support the coring team. Or at least, it was no longer strong enough after having been rammed with the ship because it had entirely broken apart.

14.2 Protocol on the ice

The ice team was craned onto the ice using the Wor Geordie, a rope basket with a semi-firm circular base. The wor geordie fitted the four-person coring team (one crew member, ice core leader, two scientist assistants) as well as the kit required (core box, zarges box containing kit, Kovacs corer and electric drill attachment, shovels, plodgers and extension poles).

To ensure safety on the ice, the crew member (CPO Deck, Martin Rowe) used a plodger first, to assess the snow depth whilst forcefully impacting the ice surface beneath to test its integrity and local homogeneity. If it was deemed safe for him, Martin stepped off the wor geordie, and repeated this process in the few metres away from the wor geordie, mapping out a safe area and noting any possible areas of weakness, or possible signs of cracking of fracturing of the snow/ice surface. As long as it seemed safe, the scientists were then able to step off the wor geordie, repeating the plodging if necessary and preparing to drill the first core.

A small patch of snow was cleared near the wor geordie, to reveal the ice surface beneath ready for the first core. At this point, the electric drill battery was inserted into the drill attachment (it had been kept in an inside pocket to keep warm and preserve battery life), and the first core was drilled. This was the ‘safety’ core, the primary aim of which is to gain an accurate understanding of the thickness of the ice in this immediate locality, and to assess the structure of the ice, observing for lateral fractures, melt, air pockets, etc. This core was bagged into 1 or two layflat bags, depending on its length, and stored in the core box. The team then proceeded to drill the second core in a nearby undisturbed spot. The second core was designated as the ‘sample core’, in that it is the primary core destined for scientific analysis. The third core was designated as a ‘temperature core’, in that it was used to gain a profile of the temperature of the ice at 5cm intervals, using the electric drill and a separate battery-powered temperature probe.

Additionally, at each site, a sample of the surface snow was collected using a pre-cleaned metal trowel (cleaned using isopropyl alcohol and rinsed with milli-Q, then wrapped in clean foil), and inserted into a pre-baked clear glass jar with PTFE-lined lid. And, a sample of the seawater through one of the core holes was also collected. To do this, an amber glass bottle was attached to the end of one of the Kovacs extension poles using a large amount of gaffa tape (blue roll was used to dry the surfaces first to ensure the tape adhered effectively). The extension pole was then dipped down through the core hole as quickly as possible, to ensure that the bottle reached the lower surface of the sea ice whilst it was still being filled with seawater. Two 500ml plastic bottles were filled with seawater in the same way, destined for processing and analysis by Laura Taylor (LT) as part of the main biogeochemical suite for the BIOPOLE project. These were split into samples for different biogeochemical parameters in the lab, following the protocols in 11.1.5.7 for lugols phytoplankton composition, 11.1.5.5 for $\delta^{30}Si$, 11.1.5.4 for dissolved silica, and 11.1.5.3 for dissolved nutrients, with the sample being syringed through a membrane filter as opposed to use of an in-line Acropak filter.

A summary of the samples collected is shown below.

Table 14-1: summary of samples taken at ice core stations 1-3.

Ice Station	Date	SDA event #	Drilled by	Lat	Lon	Average core length	Samples and cores taken
IS1	09/12/23	42	R Smith T Gossmann	-64.37803	-47.16746	80-90cm	Safety core Sample core

			K Turner				Temp core Surface snow Seawater sample Seawater sample (for LT)
IS2	10/12/23	48	R Smith M Bischof K Lowery	-65.57356	-44.82747	60-70cm	Safety core Sample core Temp core Surface snow Seawater sample Seawater sample (for LT)
IS3	11/12/23	56	R Smith T Bilge M Allerton	-64.99265	-46.31032	90-110cm	Safety core Sample core Temp core Surface snow Seawater sample Seawater sample (for LT)

14.3 Sample storage

Upon returning to the ship, the core box containing all samples was taken to the -20°C scientific freezer on the ship. The temperature profile, logged by hand using clipboard and paper, was photographed and later digitised.

14.4 Additional opportunistic sampling

Once the three ice stations had been successfully drilled and the target number of cores completed, we noted that there was still eight pre-cleaned glass (amber and clear) jars and bottles remaining, that would have been used at the ice core stations. Because the final few biogeochemical CTD stations of the cruise were aimed at resolving an ice-edge phytoplankton bloom that we had previously detected. So, it was decided that these bottles could be filled from the CTD itself, at the same depths as the chlorophyll carboys (5m, chlorophyll max, chlorophyll sub-max). This way, there is an opportunity to directly compare the organic constituents (primarily fatty acids, FAs) of the seawater at a phytoplankton bloom site to the sea ice environment itself nearby. These samples were labelled FA001-FA008, as shown in Table 14-2 below.

Table 14-2: summary of CTD samples designated for analysis alongside ice core station samples.

CTD station	Date	SDA Event #	Lat	Lon	Sample code	Depth
CTD026	13/12/23	66	-63.13189	-49.23328	FA001	100m (sub max)
					FA002	50m (chl max)
					FA003	5m
CTD033	14/12/23	77	-62.56001	-50.00415	FA004	5m depth
					FA005	28m (chl max)
					FA006	50m (sub max)
CTD034	14/12/23	81	-62.46600	-49.96952	FA007	5m
					FA008	20m (chl max)

15 Data Management

Petra ten Hoopen

15.1 SDA Scientific Data Acquisition Systems Overview

There are a number of scientific data systems onboard the SDA, which fall into three categories: i/ permanently-fitted underway systems (e.g. ship position or surface oceanography) that record sensor data continuously by a centralised data logging system, ii/ permanently-present systems (e.g. biological acoustic systems or CTD) that record data by their own acquisition software and the acquired data are periodically transferred to the central ship storage area network and iii/ mobile data system brought for a specific cruise with data stored elsewhere (e.g. gliders).

The workflow of underway scientific data logging onboard the SDA is depicted in Figure 15-1 and describes how sensors data are recorded, archived and visualised.

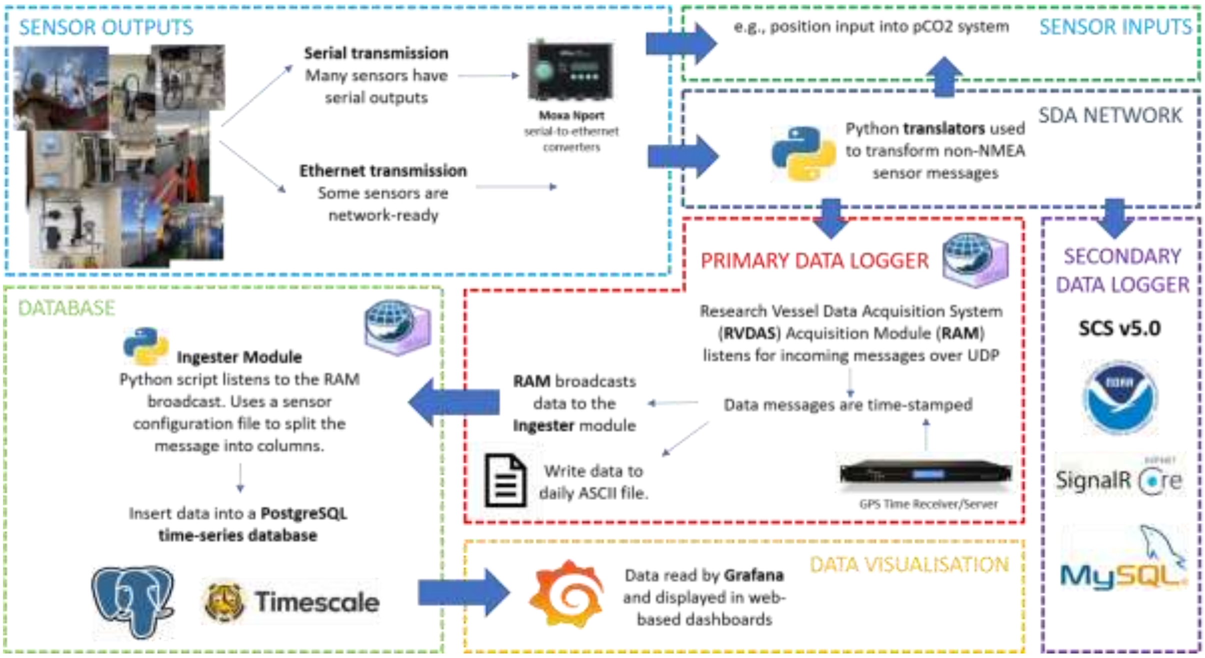


Figure 15-1: Workflow of scientific sensor data acquisition.

The Research Vessel Data Acquisition System (RVDAS) is the primary data logging system on the SDA. **Underway scientific data systems logged by the RVDAS during the cruise SD033** are summarised in Table 15-2 with the colour-coded grouping described in Table 15-1 below. Some of the monitoring systems comprise multiple sensors logging together to a single data stream, such as the ODIM Winch logging and monitoring or Comet T3510 Air Temperature and Humidity systems.

Table 15-1: Colour index of system groups used in Table 15-2

	Position and Attitude		Bathymetry
	Sea Surface Oceanography		Potential Field
	Atmosphere and Meteorology		Monitoring systems

Table 15-2: A list of the underway data streams logged by RVDAS during SD033.

	System Name	Installed Location	RVDAS name
x	Fugro Oceanstar v3 GNSS	Centre Main Mast	sd_gnss_fugro_oceanstar_centremast1
x	SAAB R5 Supreme GNSS	Centre Main Mast	sd_gnss_saab_r5_supreme_centremast1
x	Seatex GNSS (Part of Kongsberg Seapath 320)	Port Main Mast	sd_gnss_kongsberg_seapath_320_port1
x	Seatex GNSS (Part of Kongsberg Seapath 320)	Starboard Main Mast	sd_gnss_kongsbegr_seapath_320_stbd1
x	Seatex MRU5+ (part of Kongsberg Seapath 320)	Deck 2, near CRP	sd_attitude_kongsberg_seapath_320_motion_port1
x	Seatex MRU5+ (part of Kongsberg Seapath 320)	Deck 2, near CRP	sd_attitude_kongsberg_seapath_320_motion_stbd1
x	Kongsberg Seapath 320 Heading	Various	sd_attitude_kongsberg_seapath_320_heading_port1
x	Kongsberg Seapath 320 Heading	Various	sd_attitude_kongsberg_seapath_320_heading_stbd1
x	iXblue Phins Surface PAA00011-C inertial navigation system (Heading)	Deck 2, near CRP	sd_attitude_ixblue_phins_surface_heading_crp1
x	iXblue Phins Surface PAA00011-C inertial navigation system (Attitude)	Deck 2, near CRP	sd_attitude_ixblue_phins_surface_~~attitude~~motion_crp1
x	SMC (Ship Motion Company) IMU-108 motion reference units	Mooring space	sd_attitude_smc_imu108_heli1
x	Raytheon Standard 30 MF Gyro	Instrument Room Port, Deck 8	sd_attitude_raytheon_standard_30mf_port1
x	Raytheon Standard 30 MF Gyro	Instrument Room Starboard, Deck 8	sd_attitude_raytheon_standard_30mf_stbd1
x	Safran (Sagen) BlueNaute Gyro	Instrument Room Centre, Deck 8	sd_attitude_safran_bluenaute_centreline1
x	Northern Solutions EMES60 Electromagnetic Speed Logger	Hull	sd_speedlog_northern_solutions_emes60_hull1
x	Skipper DL850 Doppler Speed Logger	Hull	sd_speedlog_skipper_dl850_hull1
x	Sea-Bird Electronics SBE45 MicroTSG Thermosalinograph	UCSW Lab, Deck 3	sd_thermosalinograph_seabird_sbe45_ucsw1
x	Sea-Bird WET Labs C-Star Transmissometer (CST)	UCSW Lab, Deck 3	sd_transmissometer_wetlabs_cstar_ucsw1
x	Sea-Bird WETStar Flow-through Fluorometer (WSCHL)	UCSW Lab, Deck 3	sd_fluorometer_wetlabs_wschl_ucsw1

x	Heitronics CT15.85 Infrared Radiation Thermometer	Port wing, Deck 10	sd_radiometer_heitronics_ct15_85_port1
x	Heitronics CT15.85 Infrared Radiation Thermometer	Starboard wing, Deck 10	sd_radiometer_heitronics_ct15_85_stbd1
x	Rutter sigma S6 WaMoS II wave radar	Various	sd_wave_rutter_sigma_s6_wamos_ii_bridge1
x	Valeport miniSVS Sound Velocity Probe	Starboard Aux Machinery 2, Deck 1	sd_soundvelocity_valeport_minisvs_ucsw1
x	Sea-Bird Electronics SBE38 Thermometer	Starboard Aux Machinery 2, Deck 1	sd_thermometer_seabird_sbe38_ucsw1
x	Sea-Bird Electronics SBE38 Thermometer	Starboard Aux Machinery 2, Deck 1	sd_thermometer_seabird_sbe38_ucsw2
x	Observator OMC-116M Windsensor	Port Main Mast	sd_anemometer_observator_omc116_portmast1
x	Observator OMC-116M Windsensor	Starboard Main Mast	sd_anemometer_observator_omc116_stbdmast1
x	FT Technologies FT702LT V22 Windsensor	Centre Main Mast	sd_anemometer_ft_tech_ft702lt_centremast1
x	Biral SWS-200 Visibility & Present Weather Sensor	Starboard wing, Deck 10	sd_met_biral_sws200_stbd1
x	Eliasson CBME80 Ceilometer	Starboard wing, Deck 10	sd_cloud_eliasson_cbme80_stbd1
x	Sea-Bird Satlantic Photosynthetically Active Radiation (PAR) Sensor	Science Mast, Deck 11	sd_radiometer_satlantic_par_scimast1
x	Sea-Bird Satlantic Photosynthetically Active Radiation (PAR) Sensor	Foremast	sd_radiometer_satlantic_par_foremast1
x	Vaisala HMP155E Air Temperature & Humidity	Science Mast, Deck 11	sd_met_vaisala_hmp155e_scimast1
x	Vaisala HMP155E Air Temperature & Humidity	Science Mast, Deck 11	sd_met_vaisala_hmp155e_scimast2
x	Vaisala HMP155E Air Temperature & Humidity	Foremast	sd_met_vaisala_hmp155e_foremast1
x	Kipp & Zonen SGR4-A Pyrgeometer (IR radiation)	Science Mast, Deck 11	sd_radiometer_kipp_zonen_sgr4_scimast1
x	Kipp & Zonen SGR4-A Pyrgeometer (IR radiation)	Foremast	sd_radiometer_kipp_zonen_sgr4_foremast1
x	Kipp & Zonen SMP22-A Pyranometer (Solar irradiance)	Science Mast, Deck 11	sd_radiometer_kipp_zonen_smp22_scimast1
x	Kipp & Zonen SMP22-A Pyranometer (Solar irradiance)	Foremast	sd_radiometer_kipp_zonen_smp22_foremast1
x	METEK Usonic-3 Class-A H Anemometer	Port Main Mast	sd_anemometer_metek_usonic3_portmast1
x	METEK Usonic-3 Class-A H Anemometer	Starboard Main Mast	sd_anemometer_metek_usonic3_stbdmast1

x	METEK Usonic-3 Class-A H Anemometer	Foremast	sd_anemometer_metek_usonic3_foremast1
x	Vaisala PTB330 Barometer	Aerosol Lab, Deck 10	sd_met_vaisala_ptb330_v2_aerosol1
x	Vaisala PTB330 Barometer	Aerosol Lab, Deck 10	sd_met_vaisala_ptb330_v2_aerosol2
x	Vaisala CL31 Lidar Ceilometer	Starboard wing, Deck 10	sd_cloud_vaisala_cl31_stbd1
x	Michell Instruments Optidew2 Chilled Mirror Hygrometer	Port wing, Deck 10	sd_met_mitchell_optidew2_aerosol1
x	Thies Clima Laser Precipitation Monitor (Disdrometer)	Science Mast, Deck 11	sd_met_thiesclima_5_4110_scimast1
x	Campbell Scientific (Goodrich) 0871LH1 Freezing-Rain sensor	Science Mast, Deck 11	sd_met_campbell_0871lh1_scimast1
x	Handix Portable Optical Particle Spectrometer (POPS)	Science Mast, Deck 11	sd_aerosol_handix_pops_scimast1
x	Kongsberg EM122 multibeam	Hull	sd_multibeam_kongsberg_em122_hull1
x	Kongsberg EM712 multibeam	Hull	sd_multibeam_kongsberg_em712_hull1
x	Kongsberg EA640 singlebeam	Hull	sd_singlebeam_kongsberg_ea640_hull1
x	Skipper GDS102 singlebeam navigation echosounder	Hull	sd_singlebeam_skipper_gds102_hull1
x	Dynamic Gravity Systems (DgS) AT1M Gravity Sensor	Gravity Meter Room, Deck 2	sd_gravimeter_dgs_at1m_grav1
x	ODIM Winch logging and monitoring system[1]	Winch Control Room, Deck 5	sd_winch_odim_v3_wcr1
x	Litremeter LMX.24 PeltonWheel Flowmeter with a Fluidwell F112-P control/display unit	UCSW Lab, Deck 3	sd_flowmeter_litremeter_lmx24_ucsw1
x	Kongsberg Vessel Insight data logging system[1]	Deck2	sd_datalogger_kongsberg_vessel_insight_omni0
x	Schneider APC Temperature Data Logger[1]	Various	sd_platform_schneider_ap8953_omni0
x	Comet T3510 Air Temperature and Humidity[1]	Server Room	sd_platform_comet_t3510_omni0
x	Yotta A1819 Air Temperature[1]	Various	sd_platform_yotta_a1819_omni0
x	C4R hoist monitoring[1]	Various	sd_platform_c4r_hoist_hull1_

Grafana data visualisation was used during the SD033, specifically, the dashboards displaying the SDA data overview, meteorology data overview, uncontaminated sea water system overview, live sensor status overview and winch operator overview. The dashboards were made available via the MediaBentos system on screens in the labs, data suite and winch control room. Further improvements of the Grafana dashboards are planned together with a versioning system ensuring that users can rely on the core frequently used dashboards.

15.2 SD033 Data Storage and Access

Overall, during the SD033 cruise the scientific ship-fitted systems worked well with only some issues with the EA640 echosounder and SIS software operating the multibeam echosounder, as described in the *'SD033 Data Acquisition-related Issues'* section below. Additional details on the instrumentation of and ship-present systems used during the cruise can be found in the AME sections of this report.

All data recorded by systems linked to the ship storage area network were recorded directly to the retrospective folders within the directory */data/cruise/sda/20231113/system*. These folders are created for each system being used and contain read-only daily ascii files. As indicated in the Figure 15-1, data from the RVDAS can also be accessed via the PostgreSQL database and an ODBC connection can be created to facilitate access to the database from ODBC-enabled applications.

Additional sub-directories were created within the directory */data/cruise/sda/20231113/work* for the cruise scientists to back-up their work, such as per-instrument (pre)processed data and information, logs sheets, cruise report chapters or digital event logs. The intended use of each sub-directory is described in the document *L_drive_guidance.docx*, which has been during this cruise updated to reflect the current SDA sub-directories setup.

A summary of the datasets generated during the SD033 cruise will be available from the BODC Cruise Inventory at https://www.bodc.ac.uk/resources/inventories/cruise_inventory/search/ that will link to the final cruise report.

The SD033 cruise 'leg' directory (*/data/cruise/sda/20231113*) content is permanently stored in the read-only BAS cruise archive. Access to the cruise data archive as it existed at the end of the cruise is provided in the first instance to the cruise participants and collaborators via a web-based login-protected landing page. Currently public access to the cruise archive is per request to the UK Polar Data Centre.

15.3 SD033 Deployment Event and Sample Metadata Logging

Digital event logs provide essential context to scientific data collected and acquired information is used for data discovery. The SDA event logging system is based on the event logger developed by Jeremy Robst and frequently used on the RRS James Clark Ross. The digital event logger was modified to integrate SDA underway data streams pulled from the RVDAS Postgres database but the capability for user-defined variables of Boolean, Integer or String field type has been retained. More information about the Digital Event Logger is available in the document */data/cruise/sda/20231113/work/data_management/guidance_documents/Digital_Event_Logging.docx.*

The SDA event logging system was used during the SD033 to provide an overview of instrument deployments and record details of sampling. All scientific deployments were assigned consecutive event numbers by the bridge officers on the watch and documented in the digital Bridge Event Log. 81 individual events were recorded during the SD033 science operations.

The Bridge Event Log was made available as a MediaBento channel and displayed in the labs, data suite and winch control room, which helped in using the correct event numbers throughout the science.

In addition to the **Bridge Event Log**, a number of digital **Science Logs** were maintained to record an instrument-specific deployment-relevant context information together with relevant underway sensor data. It should be noted that these logs are for data discovery purposes only and are not intended as a source for accurate data analysis.

We have used the SDA digital event logging system to capture also metadata of samples. Specifically, a Sample Log has been created for i/ an underway uncontaminated sea water sampling (which is not related to deployments and thus doesn't have an event number), ii/ ice core sampling and iii/specimen pelagic sampling.

Currently biological sample records exist in many shapes and forms and this heterogeneity prevents development of any systematic and structured system that would allow discovery and reuse of samples from SDA science cruises. The Specimen **Samples Log** is intended to list samples preserved during the cruise that can be reused in the future. It has been created for the first time to trace in a harmonised way essential metadata for each reusable biological sample from the point of collection to the point of storage at the BAS Sample Stores. The Specimen Sample Log captures metadata that are aligned with the metadata used for curation of biological collections in the BAS Sample Store and has all essential metadata for assigning the International Generic Sample Number (IGSN, https://ev.igsn.org/) – a globally recognised persistent identifier for sample identification and tracking.

A template of the Specimen Sample Log is available in
/data/cruise/sda/20231113/work/data_management/guidance_documents/ Specimen_cruise_sample_log_template.xlsx

In order to standardise the digital event logs to allow more automated processing as well as archiving the scientific equipment deployment and sample metadata in a database, a number of terms from two NERC Vocabulary Server terminologies were used to record event processes (http://vocab.nerc.ac.uk/collection/EL2/current/accepted/) and event actions (http://vocab.nerc.ac.uk/collection/EL1/current/accepted/).

The digital Bridge Event Log and Science Logs are available as .csv files in the data path
/data/cruise/sda/20231113/work/data_management/digital_event_logs.

Completed Sample Logs are available as .csv files in the data path
/data/cruise/sda/20231113/work/data_management/digital_sample_logs.

15.4 SD033 Cruise Track Maps

The ship position with 1min resolution was updated daily and the cruise track visualised using the ArcGIS Pro software. During the time of science operations the latest available sea ice coverage information has been obtained from the Polar View SAR Imagery (https://www.polarview.aq/antarctic) and visualised together with the SD033 cruise track and sampling stations, bathymetry contour 2500m and position of the A23A iceberg, Figure 15-2. Maps were created daily to inform decisions on next sampling stations.

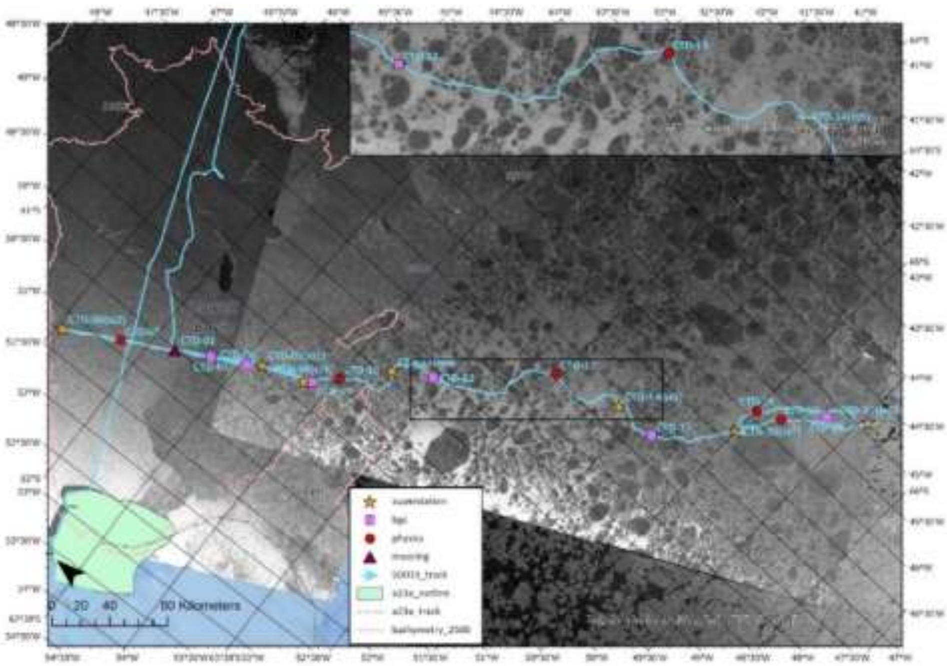


Figure 15-2: An example daily cruise track visualisation displaying sampling stations and sea ice status on 11th December 2023.

15.5 SD033 Data Collections Overview

The following tables provide a summary of all the datasets collected on SD033 and they are intended for future users to discover the breadth of data acquired and to show where the data resided at the end of the cruise and who is likely to work on them afterwards. Methodological details can be found in relevant SD033 scientific/equipment report sections, while specific sensor details are in the AME sections of the cruise report. Note that what constitutes an individual dataset is somewhat subjective and that some of the datasets below are an amalgamation of multiple instruments (e.g., there is a single table describing all the underway data outputs).

Only those datasets below containing the flag *'Open Access'* have raw data available immediately after the cruise.

Pathnames given are relative to the SD033 cruise 'leg' folder (*/data/cruise/sda/20231113*).

15.5.1 Underway sensor data

Dataset	**RVDAS data logging outputs**
Instruments	Multiple (see RVDAS section '*SDA Scientific Data Acquisition Systems overview*' above)
Description	Timestamped outputs from 60 separate data streams as recorded by the RVDAS data logging system. Available as daily ascii files and contained within a PostgreSQL database.

Metadata	Digital logs	None
	Individual message metadata	work/data_management/guidance_documents/sensor_files/ (JSON files with sensor metadata)
Digital data	Raw daily files	system/datalogger_basnoc_rvdas/acquisition/20210321/
	Processed	work/scientific_work_areas/Underway/
Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	*Open access*	

15.5.2 Hull-mounted instruments

Dataset	**EA640 data**	
Instruments	Kongsberg EA640 singlebeam bathymetric echosounder (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0965/)	
Description	The EA640 singlebeam echosounder is used to measure the depth below the transducer. It is used to estimate water column depth.	
Metadata	Digital logs	None
Digital data	Raw daily files	system/datalogger_basnoc_rvdas/acquisition/20210321/
Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data access	*Open access*	

Dataset	**Vessel-mounted acoustic doppler current profiler (VMADCP)** data	
Instruments	Teledyne RDI Ocean Surveyor 75kHz vessel-mounted ADCP (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0351/) Teledyne RDI Ocean Surveyor 150kHz vessel-mounted ADCP (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0062/)	
Description	The vessel mounted Acoustic Doppler Current Profiler (VMADCP) data were collected alternating with both instruments. See for more information the VMADCP chapter.	
Metadata	Digital logs	work/data_management/digital_event_logs/VMADCP.csv
Digital data	Raw daily files	system/adcp_teledyne_ocean_surveyor/acquisition/

	Processed	work/scientific_work_areas/VMADCP/

Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.
Data users	*Open access*

Dataset	**EM122 data**	
Instruments	Kongsberg EM122 multibeam bathymetric echosounder (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0492/)	
Description	The EM122 multibeam echosounder is primarily used to map the seafloor. Data were collected opportunistically. Marine Mammal Observations following the JNCC Guidelines have been done prior to each opportunistic survey. Four surveys have been generated named: *SD033_a, SD033_b, SD033_c, SD033_d*.	
Metadata	Digital logs	work/data_management/digital_event_logs/EM122_EM712.csv work/data_management/digital_event_logs/Marine_Mammal_Observations.csv
Digital data	Raw daily files	system/multibeam_kongsberg_em122/acquisition/raw/
	Processed	None
Long-term preservation	Raw and processed data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	*Open access*	

15.5.3 CTD frame instruments

Dataset	**CTD profile data**
Instruments	Sea-Bird SBE 911plus CTD systems installed on a Titanium (Ti) and a Stainless Steel (SS) frame. (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0058/) Sensors common to both CTD frames (SS + Ti) 1 x Pressure Sensor: Paroscientific Digiquartz (part of http://vocab.nerc.ac.uk/collection/L22/current/TOOL1508/) 2 x Temperature Sensor: Sea-Bird SBE 3plus (part of http://vocab.nerc.ac.uk/collection/L22/current/TOOL1508/) 2 x Conductivity Sensor: Sea-Bird SBE 4C (part of http://vocab.nerc.ac.uk/collection/L22/current/TOOL1508/)

	2 x Submersible Pump: Sea-Bird SBE 5T (part of http://vocab.nerc.ac.uk/collection/L22/current/TOOL1508/) 2 x Oxygen Sensor: Sea-Bird SBE 43 (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0036/) 1 x Transmissometer : WETLabs C-Star (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0160/) 1 x Fluorometer: Chelsea Aquatracka III (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0424/) 1 x Standard thermometer: Seabird SBE35 (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0318/) Sensors on the SS CTD frame only 1 x Altimeter : Tritech PA-200 (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0059/) 1 x Fluorometer: WETLabs CDOM 1 x Backscatter Sensor: WETLabs ECO BB(RT)D (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0060/) 1 x PAR Sensor : Biospherical Instruments Inc. QCP-2350 (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1186/) Sensors on Ti CTD frame only 1 x Altimeter : Valeport VA500 (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1738/) 1 x PAR Sensor: Satlantic PAR (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0973/)	
Description	Conductivity, temperature and pressure measurements of the water column along with additional sensors measuring Oxygen, Chlorophyll-a, PAR, backscatter and water clarity. More information about the CTD processing is in the CTD chapter.	
Metadata	Paper Logs	work/Log_sheets/
	Digital logs	work/data_management/digital_event_logs/CTD.csv
Digital data	Raw	system/ctd_seabird_sbe911plus/acquisition/
	Processed	work/scientific_work_areas/CTD/CTD_processed/

Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre. Processed data will be submitted to BODC.
Data users	Andrew Meijers (BAS), Milo Bischof (BAS/University of Edinburgh), Met Office in the first instance. *Open access*.

Dataset	**Lowered Acoustic Doppler Current Profiler (LADCP) data**	
Instruments	4 x Teledyne WHM300 ADCP (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/)	
Description	LADCP data were collected at every CTD deployment to look at the current in the water column. For more information see the LADCP chapter.	
Metadata	Digital logs	work/data_management/digital_event_logs/CTD.csv
Digital data	Raw	system/ctd_seabird_sbe911plus/acquisition/
	Processed	work/scientific_work_areas/LADCP/
Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre. Processed data will be submitted to BODC.	
Data users	Andrew Meijers (BAS) in the first instance. *Open access*.	

15.5.4 CTD water sampling datasets

Dataset	**CTD bottle samples** - salinity, dissolved oxygen, dissolves nutrients, dissolved silica, dissolved inorganic carbon and total alkalinity (DIC-TA), silicon isotopes (d30Si), oxygen isotopes (d18O), dissolved organic carbon (DOC), phytoplankton composition (Lugol's), particulate organic carbon (POC), particulate inorganic carbon (PIC), biogenic silica (BSi), chlorophyll-a and particulate organic matter (POM).
Instruments	Niskin bottles (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0412/) Unknown semi-automated oxygen titration system (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1356/) Guildline Autosal 8400B Salinometer (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0454/) Seawater analysis with SEAL AA III (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1113/)

Description	Seawater collected using Niskin were used to sample for salinity, dissolved oxygen, dissolves nutrients, dissolved silica, dissolved inorganic carbon and total alkalinity (DIC-TA), silicon isotopes (d30Si), oxygen isotopes (d18O), dissolved organic carbon (DOC), phytoplankton composition (Lugol's), particulate organic carbon (POC), particulate inorganic carbon (PIC), biogenic silica (BSi), chlorophyll-a and particulate organic matter (POM).	
Metadata	Paper Logs	work/Log_sheets/
	Digital logs	work/Log_sheets/Biogeochemistry logs/
		work/Log_sheets/Salinometer logs/
		work/data_management/digital_sample_logs/
Digital data	Processed (only some data available)	work/scientific_work_areas/Biogeochemistry/
		work/scientific_work_areas/Salinometry/
Physical samples	See the Biogeochemistry section of this report.	
Long-term preservation	See the Biogeochemistry section of this report. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	Laura Taylor (BAS), Andrew Meijers (BAS), Gabi Stowasser (BAS) in the first instance.	

15.5.5 Uncontaminated seawater lab

Dataset	**Underway water samples** – salinity, oxygen isotopes (d18O), particulate organic matter (POM), dissolved inorganic nutrients, silicon isotopes and phytoplankton composition (Lugol's).	
Instruments	Unknown semi-automated oxygen titration system (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1356/) Guildline Autosal 8400B Salinometer (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0454/) Seawater analysis with SEAL AA III (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1113/)	
Description	Seawater collected from the uncontaminated sea water system was sampled for salinity, oxygen isotopes (d18O), particulate organic matter (POM), dissolved inorganic nutrients, silicon isotopes and phytoplankton composition (Lugol's).	
Metadata	Paper Logs	work/Log_sheets/
	Digital log	work/data_management/digital_sample_logs/Samples_UCSW.csv

Digital data	Processed (only some data available)	work/scientific_work_areas/Biogeochemistry/ work/scientific_work_areas/Salinometry/
Physical samples	See the Biogeochemistry section of this report.	
Long-term preservation	See the Biogeochemistry section of this report. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	Laura Taylor (BAS), Andrew Meijers (BAS), Gabi Stowasser (BAS) in the first instance.	

15.5.6 Net sampling

Dataset	**Mammoth net**	
Instruments	Hydro-Bios MultiNet Mammoth (http://vocab.nerc.ac.uk/collection/L22/current/NETT0187/)	
Description	The system is used to catch plankton in successive layers down to 3000m using 9 nets with the mesh size 300µm.	
Metadata	Digital logs	work/data_management/digital_event_logs/Mammoth.csv work/scientific_work_areas/Mammoth/ work/data_management/digital_sample_logs/Samples_Specimens.csv
Digital data	Not available at this stage.	
Physical samples	Physical samples will be stored in the BAS Biological Sample Store.	
Long-term preservation	See the Bongo and Mammoth section of this report. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	Gabi Stowasser (BAS), Nadine Johnston (BAS) in the first instance.	

Dataset	**Bongo net**	
Instruments	British Antarctic Survey Motion Compensated Bongo Net (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0993/)	
Description	Two nets with different mesh sizes (100 µm and 200 µm) deployed at the same time to collect plankton samples.	
Metadata	Digital logs	work/data_management/digital_event_logs/Bongo.csv work/data_management/digital_sample_logs/Samples_Specimens.csv
Digital data	Not available at this stage.	

Physical samples	Physical samples will be stored in the BAS Biological Sample Store.	
Long-term preservation	See the Bongo and Mammoth section of this report. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	Nadine Johnston (BAS), Gabi Stowasser (BAS) in the first instance.	

Dataset	**Respiration Experiment**	
Instruments	Hydro-Bios MultiNet Mammoth (http://vocab.nerc.ac.uk/collection/L22/current/NETT0187/) British Antarctic Survey Motion Compensated Bongo Net (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0993/) Optical Microscope (http://vocab.nerc.ac.uk/collection/L05/current/LAB05/)	
Description	Direct respiration experiments were conducted on the copepod species *Calanoides acutus,* CV and females individuals, to determine their metabolic rate during austral spring.	
Metadata	Digital logs	work/data_management/digital_event_logs/Mammoth.csv work/data_management/digital_event_logs/Bongo.csv work/scientific_work_areas/Mammoth/ work/scientific_work_areas/Incubations/
Digital data	Raw	Not available at this stage
Physical samples	Physical samples will be stored in the BAS Biological Sample Store. Briefly, specimens for CHN (post respiration experiments) and CHNT0 placed in tin capsules and then in 96 microwell plates, all dried (at 40 °C) and stored on SDA at +4 °C. 9 microwell plates for CHN analyses and 12 microwell plates for CHNT0 were then transported back to the UK at +4 °C. A further ~70 copepods from each Superstation were frozen and stored in Eppendorf tubes at -80 C and transported back to UK for lipid analyses. 15 copepods from each Superstation (except No 2) were also frozen and stored in Eppendorf tubes at -80 C and transported back to the UK for Electronic Transfer System analyses (indirect respiration experiments) by Dan Mayor (Exeter University).	
Long-term preservation	See the *Calanoides acutus* Experiments section of this report for details.	
Data users	Nadine Johnston (BAS) in the first instance.	

Dataset	**Ice Cores**

Instruments	KOVACS ice coring systems (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1249/)	
Description	Hand ice coring system includes a light weight core barrel to retrieve ice cores of various diameters and lengths.	
Metadata	Digital logs	work/data_management/digital_sample_logs/Samples_Ice_Core.csv
Digital data	Not available at this stage.	
Physical data	Physical samples will be stored in the BAS Ice Core Store.	
Long-term preservation	See the Ice Core section of this report.	
Data users	Roseanne Smith (BAS) in the first instance.	

15.5.7 Other instruments

Dataset	**Wave radar data**	
Instruments	Rutter Sigma s6 wamos II wave radar (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0999/)	
Description	The wave radar gives information about the wave height, length and other parameters of the waves.	
Metadata	None	
Digital data	Raw	system/wave_rutter_sigma_s6_wamos_ii/acquisition/
Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	*Open access*	

Dataset	**Gravity meter data**	
Instruments	Dynamic Gravity systems AT1M gravity meter (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1728/)	
Description	A high resolution 1Hz marine gravity meter with integrated GPS position and time recording. The instrument has an accuracy at sea of 0.7 mGals, a platform range of 30 degrees roll and pitch. The data and GPS recording rate is 1Hz.	
Metadata	work/data_management/digital_event_logs/Gravity_Meter.csv	
Digital data	Raw daily files	system/datalogger_basnoc_rvdas/acquisition/20210321/

Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.
Data users	*Open access*

Dataset	**Glider data**	
Instruments	Teledyne Webb Research Slocum G2 glider, Amazon (unit_223), Frazil (unit_438), Kelvin (unit_444) (http://vocab.nerc.ac.uk/collection/B76/current/B7600001/)	
Description	A long-range autonomous underwater vehicle (AUV) based on buoyancy used for remote water column sampling.	
Metadata	work/data_management/digital_event_logs/Glider.csv https://gliders.bodc.ac.uk/inventory/metadata-viewer/?DeploymentId=622 https://gliders.bodc.ac.uk/inventory/metadata-viewer/?DeploymentId=620 https://gliders.bodc.ac.uk/inventory/metadata-viewer/?DeploymentId=619	
Digital data	Raw	https://gliders.bodc.ac.uk/inventory/glider-inventory/
Long-term preservation	https://gliders.bodc.ac.uk/inventory/glider-inventory/	
Data users	Alex Brearley (BAS) in the first instance.	

Dataset	**BIOPOLE mooring**	
Instruments recovered	300kHz RDI Workhorse Sentinel ADCP (~200m), SBE37 CTD: 037-13719 (~200m), McLane Sediment trap: ML13176-01 (~400m), McLane Sediment trap: ML15559-01 (~2020m), Seaguard Current Meter: 1184 with Pressure sensor 4117F: 2049, O2 sensor: 3924, Turbidity sensor: 69 and acoustic doppler sensor: 1477 (~2020m) https://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0306/	
Description	site: BIOPOLE, deployment: 02/03/2023 (SD025), recovery: 04/12/2023 (event number 007), not re-deployed, water column depth: 3383m	
Metadata	work/data_management/digital_event_logs/Mooring.csv work/data_management/digital_sample_logs/Samples_Specimens.csv	
Digital data	Raw	work/X_other_work_areas/BIPOLE_Mooring/Data/

Long-term preservation	Raw data will be stored on the SAN at BAS. Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.
Data users	Geraint Tarling (BAS) and Clara Manno (BAS) in the first instance.

Dataset	**RaTS mooring**	
Instruments recovered	None, recovery failed	
Instruments deployed	SBE37 microcat CTD: 8540 (~260m), 300kHz RDI Workhorse Sentinel ADCP: 27014 (~260m), SBE37 microcat CTD: 8541 (~375m) https://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/	
Description	Site: RaTS, deployment: 21/02/2022, recovery: attempted on 28/11/2023 but failed, re-deployed 28/11/2023 (event number 002), water column depth: 400m	
Metadata	work/data_management/digital_event_logs/Mooring.csv work/X_other_work_areas/RaTS_Mooring_Deployment/	
Digital data	Raw	None
Long-term preservation	Metadata will be stored in the Marine Metadata Portal developed by the UK Polar Data Centre.	
Data users	NA	

15.6 SD033 Data Documentation Updates

Essential documentation for cruise scientists exists at the SDA Wiki (https://www.sda.bas.ac.uk/Category:Data_Management) and includes the most common data-related tasks, such as information about data systems onboard, access to acquired data, recording of metadata, guides for data visualisation in Grafana or instrument guides for ADCP, EM122, EA640 and TOPAS.

Several updates have been done during the SD033 cruise:

- Extended the Underway data list of sensors of reference for common use (https://www.sda.bas.ac.uk/Leg-system:_read-only_area_containing_underway_and_ship-based_acquisition_data)
- Updated documentation in the *'Leg-work: shared work area for cruise participants'* that describes to new cruise participants the intended use of the cruise 'leg' directory and sub-directories created automatically before each cruise (https://www.sda.bas.ac.uk/Leg-work:_shared_work_area_for_cruise_participants). The document *L_drive_guidance.docx*, that is available in the 'leg' directory has also been updated.
- Corrected mappings to the NERC Vocabulary Server in the table of Abbreviation of equipment commonly used on the SDA (https://www.sda.bas.ac.uk/Abbreviation_commonly_used_for_instruments).

15.7 SD033 Data Acquisition-related Issues

- The single beam echosounder EA640 seabed depth values were at times in a significant disagreement with the seabed depth values from the multibeam echosounder EM122, especially when the echosounder was in a slave mode and in high sea ice concentration. The EA640 has been switched off on 7th December, to prevent using doubtful values. The EA640 worked again well when it was switched back on in the open ocean on 15th December.
- There were issues with the SIS software operating the multibeam echosounders, specifically gridded data stopped appearing and so did the display of background grids. Even when a new survey has been created the Grid Engine reported being full soon after recording began, despite the Grid Engine parameters being setup for an opportunistic survey, as described in https://www.sda.bas.ac.uk/EM122_guide. The Grid Engine and background grids disappearing issue was reported also during the SD025 (Polar Science Trials) and it would be worth looking into the problem in off-cruise time.

16 IT Report

Jeremy Robst, Louie Bridges

16.1 Issues

None

16.2 RECOMMENDATIONS

None

16.3 ITEMS Required

None

16.4 Changes Made

1. Snowlink account change to correctly handle rollover of long running sessions.

16.5 EVENTS

1. Corruption of the SDW-FILE-S1 C: drive. Fortuantely Sean Vincent was able to connect remotely and restore the drive – down for about 4 hours.

16.6 Updates to IT knowledge

1. TimeTools T550 are intended for static use, but there is a firmware mod to use on mobile platforms.

16.7 Business systems

16.7.1 Maximo

No work carried out

16.7.2 Printers

The MFP printers have sometimes failed to print out requests. Usually deleting printouts from the print queues on sdw-print-s1 and sometimes powerycling the printer was enough to make them print again. It's not clear what is happening.

A "Scan to T:" job has been added to Papercut (see the Wiki) to scan to T:\scanner. This is very useful for people who don't have an SDA account but want to scan to a network drive.

16.8 IT infrastructure

16.8.1 KVM & Data Display

Note that KVM receivers used for the KVM – Display screen interfaces (e.g SDK-GATEWAY-R*N*) need to be set to use the **GATEWAY-RECEIVER** template in Boxilla. This enables the HTTP interface per receiver so that the Mediabento "Force connection" works.

Mediabento should be extended to catch this error and display help, but currently doesn't do so.

16.8.2 Linux

Work continued on the BAREOS backup system for the Linux / Science data. This focused on implementing the "Always Incremental" backup strategy, where full backups are sent directly to tape and incrementals to disk.

This worked, but requires a **Consolidate** job to run periodically to merge old incrementals with the fulls. It appears this requires a rewrite of the full data, which means that sufficient disk space for a full is required, or multiple tape drives.

A full backup is currently around 50TB, so that means ~50TB of disk is needed for the backup server. This might be achieved by using SAN disk as a temporary store. A longer term solution would be to add a second tape drive to the "LTFS" tape library.

The fileserver VMs were moved to the EMC (flash) storage to allow decommissioning of the QXS storage.

All machines updated with the latest OS patches; **sdl-rvdas-s1** and the active fileserver node done whilst alongside at the start and end of the cruise.

16.8.3 Network & communications

Several additional mobile (DECT) phones were brought down and set up by the networking team. These are exta phones for IT, AME Electrical, AME Mechanical, PSO, Lab Manager and Watch Leader. The phones are kept in the IT office and handed out during cruises to appropriate people.

SNOWLINK worked very well, at first there was an issue with the rollover at midnight GMT – if a session continued past midnight then the Interim Accounting updates (a gauge not a counter) would cause that session's usage to be counted against the current day. This meant long running sessions would cause a new day's allowance to be used very quickly.

To fix this the accounting script on the firewall was modified to store long running session's usage at the start of each day and subtract this from those sessions so accounting was correct. This reduced the need to reset people's allowance to a minimum.

The total SNOWLINK allowance (5TB) was not reached during either November or December, towards the end of each month the Captive Portal was switched off (the settings are still saved) and people encouraged to use as much data as possible.

Personal mobile devices on SNOWLINK had the wifi labelled as a Metered Connection (Android) or Low data mode (Apple) and then devices were left active all day and background network usage is a minimum.

A small number of devices were unable to connect to SNOWLINK, after some investigation disabling PMF allowed those devices to join. PMF is disabled on the SDA-STAFF network anyway.

16.8.4 Power

No work carried out

16.8.5 Storage

During this cruise we completed the migration of Linux VMs to EMC Flash Storage, from Quantum QXS storage. QXS0 & QXS1 were shutdown and their power cables removed on 2023/12/24.

16.8.6 Windows

On 2023/12/26 the Windows drives were reported as being very slow. It was not possible to RDP to sdw-file-s1 or to get access to the console via vSphere.

sdw-file-s1 was rebooted but kept stopping on boot with a "BAD SYSTEM CONFIG INFO" stopcode and would not boot in Safe Mode or via Last Known Good configuration.

In the end Sean Vincent took a look from Cambridge and found the C: drive corrupt. He managed to restore the drive from VEEAM and recover the server.

16.9 Operational technology (ship) systems

No work carried out

16.10 Science systems

The EM122 was quite temperamental and needed the transducers powercycling a few times, especially after a restart or pause in pinging/logging. This is done via the distribution board in Science Junction room 2 – see AME's SOP for details.

pg_featureserv on sdl-rvdas-s1 (& s2 as a test) was upgraded to v1.3.0 and SSL connections enabled on port 9001. See the IT wiki for more details.

The TimeTools T550 NTP server by default is intended for static locations and tries to verify its location on startup – if it moves more than 100m it will restart the scanning process. After contacting the manufacturer they supplied a firmware version which allows it to be put into mobile mode and since then it has kept a very good lock. Currently it is configured as ntp1.sda.bas.ac.uk and used by the Linux systems.

16.11 Items needed before SHIP Returns to uk port

Toner Collector (3WT90A) for the MFP776 – bought for to be carried down for PICCOLO if possible.

16.12 ITEMS Lent & Not yet returned

N/A

16.13 ITEMS used

N/A

17 AME Mechanical

Tom Gillum Webb – thogil@bas.ac.uk, Matt Hood – mathoo@bas.ac.uk

17.1 Equipment preparation

17.1.1 Unpacking

On arrival at the ship in Mare harbour the AME container was unpacked and its contents sorted, with the equipment to be deployed during SD033 stowed in the science hangar, the lab equipment given to the relevant scientists and the equipment to be used on SD035 re-packed into the container.

17.1.2 Bongo net

The bongo net was built up using the number one compensator unit and fitted with one 100µm and one 200µm net. The bungees that are normally used to attach the cod-ends to the cod-end bracket were missing so they were tied on using rope from the rough workshop, this would not allow the quick release functionality of the bungees but fortunately this was not necessary in the configuration it was to be used (during the 10 days of science these had to be retightened once as they were starting to become loose, and special attention should by paid to this should rope be used again). The stand was bolted to the deck inside the science hangar and the net secured to it using a ratchet strap for transit. During cargo operations at Rothera one of the cod-end valves was broken off and was replaced with a spare – this highlighted their vulnerability and subsequently they were removed during all lifting operations of the net. Prior to arriving at superstation number one the net was dropped to the deck using the stand winch and the stand was moved and bolted into position facing aft below the side gantry, with the net being moved by the crew using the seaonics crane in the hangar. In this position it was noted that the bulwark doors come extremely close to the starboard side cod-end during opening, and to avoid a potential collision the cod-end bracket was offset by about 30mm from central to port. This is important to note and may require remedial work in Cambridge.

17.1.3 Mammoth net

The Mammoth was lifted onto a pallet and rigged in the science hangar, and one of the carousel side lines was found to be missing. A second was made up with help from the science bosun and the lengths of both were checked against the new carousel bridle wires, which fit well. Some light damage was noticed on the cod-end holders on the spigot where they attach into the carousel, and I would recommend that during maintenance in Cambridge it would be worth replacing these with stainless steel parts to avoid potential loss of the cod-end and resulting damage to the nets. The blanking plug for the comms cable was wired to the frame at the request of Gabi and Nadine, and a fresh set of batteries were fitted (more spares are available in the Mammoth top-side Zarges). The following depths were programmed for a test deployment –

Trigger Depth: 220m

Net 1: 200-180m; net 2: 180-160m; net 3: 160-140m, net 4: 140-120m, net 5: 120-100m, net 6: 100-75m, net 7: 75-50m, net 8: 50-25m, net 9: 25-5m.

17.1.4 RaTs mooring

All the parts for the RaTS mooring were gathered in the science hangar and mocked up with the necessary links and shackles, and the separate sections of rope were connected and flaked out ready to be spooled onto the mooring winch. When setting up the swivel it was noticed that the galvanised steel shackle contacted the titanium body of the swivel.

Several shackles were trial fitted but the problem persisted, so we ground a small amount of metal from the swivel to avoid galvanic corrosion.

Batteries were fitted into the release and it was successfully bench tested using the handheld transducer. The ADCP battery was connected and the configuration file (saved as adcp_27014_20231124_configuration_file in location "L:\work\X_other_work_areas\RaTS_Mooring_Deployment\Instrument_Config\ADCP\adcp_27014_20231124_configuration_file.txt") uploaded with a sampling start date of 01/12/23 at 1:01am. Batteries were fitted to both microcats, and they were setup with configuration files (saved as sbe37_37sm64263-8540_20231126 in location "L:\work\X_other_work_areas\RaTS_Mooring_Deployment\Instrument_Config\SBE37\sbe37_37sm64263-8540_20231126.cap") with a sampling start date of 01/12/23 at 1:01am. Batteries were fitted to the VHF beacon, it was turned on and taken to the aft deck for testing. It's signal was confirmed over radio by the officers on the bridge.

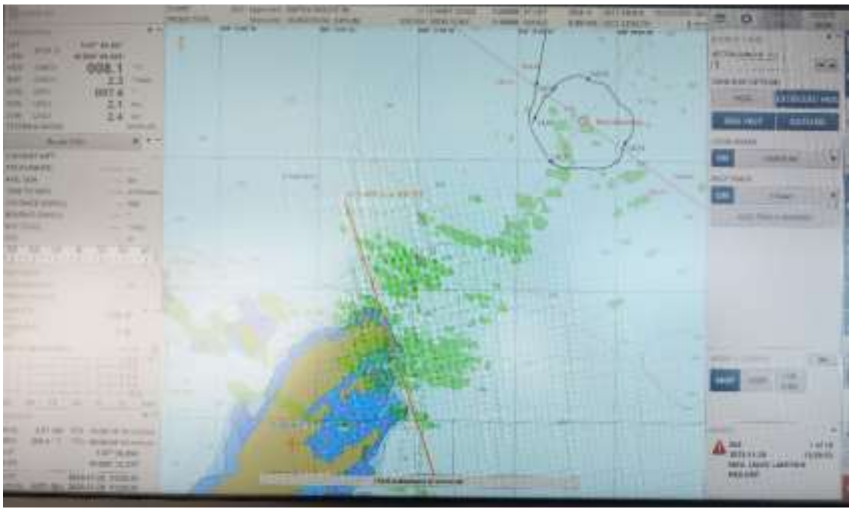
17.2 Deck operations

17.3 RaTS mooring recovery

28/11/2023 13:27 UTC Lat -67.5838 Long -68.1597 Event number 1

On the way into Rothera the release deck unit was set up in the main lab and we attempted to communicate with the releases that were left over from the previous season's missing mooring. Both releases responded to diagnostic pings. On leaving Rothera we approached the charted position of the mooring and confirmed it's position as accurate with three triangulating diagnostic pings. Depending on what was left over attached to the releases there was a small chance that there was enough buoyancy to allow the releases to surface, so we held position a short distance away from the site and sent release pings to both releases, which were both received. Unfortunately, there was no movement from the releases which suggested that there was either no remaining buoyancy or that they were being held down by the sediment trap mounted directly above them. At this stage the decision was made to put down a dragging line. The GP wire was set up with some old RMT weights below a small grapnel as shown here –

This line was then laid out in a circle around the mooring site, before continuing to lay line approximately 1km to the north to try and ensure we didn't lift the grapnel too far from the seabed on hauling.



At this point we started to haul in, and after taking in a little under 1km of wire the tension on the line increased dramatically and it became apparent we had snagged the line quite severely on the seabed. After several failed attempts to manoeuvre the ship to try and dislodge the snag, the only remaining option was to haul slowly as the ship backed up over the path it had laid which fortunately allowed us to recover the entire line, although there was some considerable damage to the wire along around a 30m length approximately 1700m from the termination. This took several hours and we had run out of time to recover, so the attempt was called off and the releases remain at the bottom. After the science had finished 2000m of the GP wire was spooled onto the deck and cut to remove the damaged area.

17.3.1 RaTS mooring deployment

28/11/23 20:39 UTC Lat -67.582 Long -68.159 Event number 2

After the dragging line was recovered and the GP wire was removed from the aft gantry the prepared rope for the mooring was spooled onto the mooring winch. A new position was chosen to deploy the replacement mooring approximately 100m north of the old site, and we took a 300m run up to stream the line. Immediately prior to deployment the VHF beacon and Argos beacon were switched on, and the top and bottom sections of the mooring were prepared and positioned either side of the square. To simplify deployment the top section (recovery float, beacons, recovery line and Trimsyn floats) was deployed as a single unit. Deployment was float first, and all went smoothly with the anchor weight being dropped within a few metres of the planned position. After deployment we sent a diagnostic ping to the release which proved successful underwater comms with the unit. Details of the deployed equipment are as follows –

Release-

Model - iXblue AR861B2S

P/N - PAA00381

S/N – 2901

Codes –	Arm	380F
	Release	Arm + 3855
	Release+Pinger	Arm + 3856
	Pinger on	Arm + 3847
	Pinger off	Arm + 3848
	Diagnostic	Arm + 3849

Top Microcat (on ADCP frame)-

Model – 37SM (2000m)

P/N – 3764263

S/N – 37SM64263 – 8541

Bottom Microcat (5m above bottom floats) –

Model – 37SM (2000m)

P/N – 3764263

S/N – 37SM64263 – 8540

ADCP –

S/N – 27014

P/N – WHS300-RE-UG543

Argos beacon –

Model – MMA-7500

S/N – M08-029

CH – S7

Frequency – 401.642Mhz

X-cat transmitter S/N – 400701

Argos ID dec – 195233/HEX:FD66713

Novatech VHF beacon –

Model RF-700c6

S/N – R09-020

CH – B

Frequency – 159.48000Mhz

17.3.2 Net test deployment

30/11/2023 12:06 to 14:34 UTC Lat -63.4754 Long -59.359 Event numbers 4 (Bongo) and 5 (Mammoth)

The Bongo net was deployed successfully from the side gantry to a depth of 200m with a veer and haul speed of 0.3m/s using the hydro wire. The Mammoth was set up to be deployed from the aft gantry and connected to the GP wire. It was tipped to stand vertical, deployed to a depth of 250m with a veer and haul speed of 0.5m/s. On recovery to deck the main frame was left in the vertical position on blocks to allow enough clearance for the nets to be armed without tipping onto it's side. After this deployment a pallet was modified to act as a stand to make both deployment and recovery safer and more controlled. The battery was checked and depths reprogrammed for the ten superstation deployments as follows –

Deployment depth 1200m

Trigger depth 1100m

Net 1 1000 – 875m

Net 2 875 – 750m

Net 3 750 – 625m

Net 4 625 – 500m

Net 5 500 – 375m

Net 6 375 – 250m

Net 7 250 – 125m

Net 8 125 – 62.5m

Net 9 62.5 – 5m

17.3.3 Biopole mooring recovery

04/12/23 15:06 UTC Lat -62.1434 Long -50.5145 Event number 7

The Biopole mooring needed to be recovered due to the projected proximity of the A23 Iceberg, as the risk of it being either damaged or lost was considered too great to leave it in position. We were heading past the mooring site on the way to our first superstation heading out of Signy on the 4th of

December. On arrival at the site we took position on DP approximately 200m from the triangulated position of the mooring, in light ice conditions. All navigational and scientific sonar systems were turned off, but despite this communications with the releases using the hull mounted transducer were not possible. We decided to try using the over the side transducer from the starboard side near the deck workshop, and communications were still difficult until we requested that the thrusters be temporarily turned off. With the thrusters off we managed to get a strong signal from both releases with a diagnostic ping that confirmed an accurately triangulated position. Permission to release the mooring was given by the bridge and both units were successfully released, with movement noticed in the mooring a few seconds after the release ping was sent. Within 5 minutes the top float had surfaced and the ship was manoeuvred to put the top float on the starboard side in position to grapple the recovery line. Unfortunately as the ship came alongside the Trelleborg float it drifted and rolled along the hull briefly which had the effect of winding the recovery line around it to the point that the Trimsyn float on the recovery line mounted the top of the Trelleborg and broke the top of the Argos beacon that was mounted in it. The line was successfully collected and connected to the recovery line on the mooring winch before being walked around to the aft end to begin winching. The mooring was then taken aboard, with care taken to rinse off the two sediment traps with fresh water on surfacing as they had not completed their cycle and therefore had open formalin bottles exposed. The Trelleborg float was stowed on the portside aft deck with the swivel and recovery line still fitted. The mounted ADCP, Microcat, Iridium beacon and broken Argos beacon were removed. The data from the ADCP and microcat was downloaded and saved in "L:\work\X_other_work_areas\BIPOLE_Mooring\Data", and the ADCP battery was disconnected. All sections of rope were left on the mooring winch for redeployment. The Trimsyn recovery float and 4 float buoyancy section with chain were stowed in a cage in the science hangar. The ADCP was put into the peli case that was used to bring the RaTS mooring ADCP to the ship and was labelled, and similarly the microcat was put into the wooden crate that the two RaTS ones were brought in, along with the broken argos beacon. This box has also been labelled, and both were stowed in the science hangar by the moon pool. The paired releases were put into the large Zarges that contained the rope for the RaTS mooring. This is also labelled and stowed in the hangar by the moon pool. The two sediment traps were given to Gabi Stowasser to process and she has added the following –

Both the shallow (400m, ML 13176-01) and deep (2000m, ML15559-01) sediment trap were photographed on recovery to determine the general state of the instrument and its connections to the mooring wire. Photographs were also taken of the sediment trap bottles to determine their fullness in situ. Both traps were then hosed down with fresh water to prevent corrosion. On recovery 13 bottles had turned as programmed. Turned bottles were retrieved, closed and stored in Boxes of vermiculite for transport to the laboratory. Unused bottles were emptied of formaldehyde and stored for re-deployment of the sediment traps. The motors of both traps were disconnected, and the batteries removed.

The traps were then stowed in the hangar by the moon pool.

After the Biopole mooring was recovered both the Mammoth and Bongo were deployed, with the Mammoth going down to 1000m and the bongo to 200m. No problems occurred during either deployment.

19:09 to 22:48 UTC Lat -62.141 Long -50.5183 Event numbers 8 (Bongo) and 9 (Mammoth)

17.3.4 Superstations

Superstation 1-

05/12/23 12:09 to 17:00 UTC Lat -62.6041 Long -49.9539

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 11 to 13

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, no issues. Event number 14

Superstation 2-

06/12/23 12:10 UTC Lat -61.5394 Long -51.2147 Event number 21

High winds gusting over 40kts cancelled the Bongo deployment, and we went straight to deploying the Mammoth.

Mammoth was deployed to 1200m 0.5m/s veer, 0.3m/s haul. On recovery net 1 had come away from the frame at the top end and net 4 cod-end had broken loose from the carousel and got tangled inside the frame without detaching from it's net. We believe this was down to a higher level of swell than we had seen previously (approx. 2-2.5m) causing the ship to pitch much more than on other deployments. The lack of active heave damping on the GP wire and combination of swell and pitching meant that the nets experienced more force than they could handle both going into the water and on both the way down and the way up. The Mammoth was brought into the hangar and the damage was assessed. Net 1 had come apart from the sleeve at the zip which was damaged, and the zipper piece was missing. Net 4 had pulled open the mounting tube in the carousel allowing the cod-end to fall out. The whole unit was stripped down and all internal sleeves removed so that net one could be sewn permanently onto the sleeve. While the sleeves were out, a few small areas of historic damage on them were assessed and marked up to be stitched up, with three requiring small fixes at the hinge end of the mounting collar and one requiring a strengthening stitch along the zip join. Net 4 cod-end mounting tube was repaired, and the nets were sewn overnight ready for rebuilding in the morning.

Net 1 and sleeve after repair

The unit was rebuilt first thing in the morning and was ready to be deployed at the next superstation. It was also noticed during the rebuild that some of the cap heads securing the net arm pivot blocks to the frame had become loose, and so all bolts were checked and tightened with several more found to be loose.

Superstation 3-

07/12/23 12:34 to 20:01 UTC Lat -62.8581 Long -49.7706

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 24 to 26

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, no issues. Event number 27

Superstation 4-

08/12/23 11:36 to 15:34 UTC Lat -63.2201 Long -48.8948

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 31 to 33

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, no issues. Event number 34

Superstation 5-

09/12/23 11:42 to 16:12 UTC Lat -64.3891 Long -47.1762

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 38 to 40

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, no issues. Event number 41

Superstation 6-

10/12/23 13:13 to 16:18 UTC Lat -65.5502 Long -44.8606

Number of bongos reduced due to full depth CTD in the morning which wouldn't have given enough time to stick to the usual schedule.

Bongo deployment to 200m at 0.3m/s, no issues. Event number 47

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, no issues. Event number 46

Superstation 7-

11/12/23 11:49 to 15:49 UTC Lat -64.9932 Long -46.306

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 52 to 54

Mammoth deployment to 1200m 0.5m/s veer, 0.3m/s haul, shallow depth catch was deemed to be in slightly worse than ideal condition so we decided that we should try and improve it by increasing the haul between 375m and surface to 0.5m/s. Event number 55

Superstation 8-

12/12/23 11:26 to 15:52 UTC Lat -63.8342 Long -47.832

3 Bongo deployments to 200m at 0.3m/s, no issues. Event number 60 - 62

Mammoth deployment to 1200m 0.5m/s veer, 1200-375m 0.3m/s haul, 375-0m 0.5m/s, shallow catch condition improved and we decided to keep this haul profile for the remaining deployments. Event number 63

Superstation 9-

13/12/23 11:36 to 16:32 UTC Lat -63.1335 Long -49.2294

3 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 67 to 69.

Mammoth deployment to 1200m 0.5m/s veer, 1200-375m 0.3m/s haul, 375-0m 0.5m/s, haul no issues. Event number 70.

Superstation 10-

14/12/23 12:49 to 17:03 UTC Lat -62.568 Long -49.9627

One of the Bongos was dropped for the schedule due to a full depth CTD in the morning.

Mammoth deployment to 1200m 0.5m/s veer, 1200-375m 0.3m/s haul, 375-0m 0.5m/s haul, no issues. Event number 78.

2 Bongo deployments to 200m at 0.3m/s, no issues. Event numbers 79 and 80.

17.4 End of cruise preparations

17.4.1 Bongo net

Once deck operations were over the bongo net and stand were brought into the science hangar and inspected, we noticed at this stage that the compensator unit had been built incorrectly, with one side of the spring mounting boss having been put in the wrong way around. Although it had worked fine for all deployments on this cruise with no noticeable ill effects, we had concerns about whether the springs would last another cruise in this arrangement so we replaced the compensator for the spare unit and re-terminated the wire. Nets were removed, washed and dried before re-mounting to the frame.

17.4.2 Mammoth

The mammoth was thoroughly rinsed down with fresh water on deck, and all data was downloaded and the on board memory wiped. All nets were removed (apart from number 1), washed and put back into the two Zarges dedicated to them.

17.4.3 Stowage

All equipment that needed to be broken down has been returned to its relevant zarges. We attempted to leave as much equipment built up as possible to help those on the Piccolo cruise but without wanting to get in the way of the deck crew on their cargo run to Rothera. As such, the bongo has been left fully built (although with the valves cable tied inside the frame to protect them) and stored vertically in the science hangar, spares for this have been left in the container. The mammoth has been broken down with the nets washed and along with the rigging returned to their respective boxes. These have been left in their own cage in the science hangar, tied against the moonpool cursor. Similarly, all the relevant boxes for mocness have been taken out of the container and stowed in their own cage with the frame and bars stowed in-between the cages. Lastly, the mooring equipment left in the cage for the piccolo cruise has been kept in the science hangar, although the boxes that contained the Rats mooring equipment are now storing the recovered Biopole equipment (the rope has stayed on the mooring winch). The floats that came up with the Biopole mooring have also been left in the science hangar in a cage apart from the top trelleborg float that has been left outside (the adcp bracket though is in the mooring cage). As such all that has been left in the container is science equipment, the plastic free floating sediment traps, bongo spares and the RMT equipment. Release deck unit has been left in the main lab stowed under the table next to the transducer socket.

17.4.4 Modifications made to the Mammoth

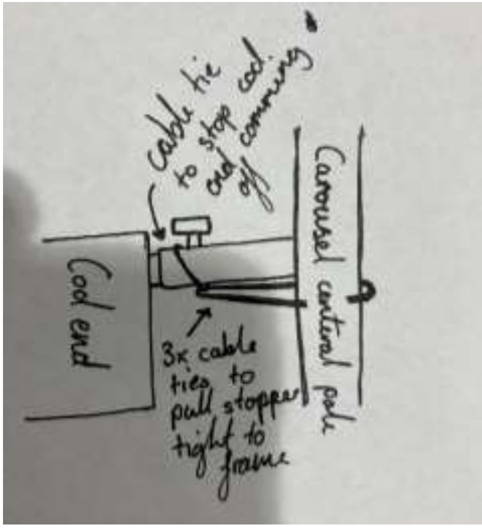
After super station 2 and the problems that arose from this, it was decided that we would make a couple of modifications in order to reduce the likelihood of this happening again.

Mod 1:

To stop the nets unzipping from the main body of the mammoth (like number 1 net) a cable tie was rapped around the end of the zip securing the zipper in place. This was done to all of the nets.

Mod 2:

To stop the cod ends being pulled out of the carousel (like net 4) 4 cable ties were used to secure the cod ends in place. To do this a cable tie was placed around the pole keeping the cod end stopper in place. This was pulled a bit tight but, left with some slack so that 3 cable ties, fed into each other, could be passed through this loop and then passed around the central pole of the carousel. Once this had been done the first cable tie could be tightened and then the remaining 3 evenly pulled so that unless the cable tie was cut the cod end couldn't be removed.



Mod 3:

During the cruise we experimented with deploying and stowing the mammoth only in the vertical position. To begin with this was done by placing wooden blocks on the outer arms of the frame to keep it off the ground (giving space for the nets to move freely whilst cocking) and then on a specially modified pallet which incorporated the blocks. So long as special attention is paid to the nets when lowering the mammoth onto the pallet so that they do not become trapped under the frame and are folded only once so they can move freely into the cocked position no problems occurred. It would be worth looking into getting a permanent stand made with mounting points incorporated to suit the deck matrix, so that going forwards the mammoth only needs to be tipped once, and with regards to stowing can be ratchet strapped to the pallet which is in turn bolted to the deck.

18 AME – Electrical

Matthew Gascoyne, Christopher Gray

18.1 Notes about the CTD

Basic Stats			
No#Of Casts SS	034	No#of Successful Casts (SS)	034
Max Depth of SS	4350	Min Depth of SS	379
Cable Removed Standard (m)	0m	No# of Re-terminations (elect.)	1

The CTD construction and SS winch cable re-terminated began on 21/12/2023. Due to the re-termination being done while traveling, we had to wait until arriving at Rothera where the ship was docked to be able to load test the termination which was successful at 2.25 tons on the 27/11/2023. The deck test was also performed on 27/11/2023 and was successful.

The mega test was performed after the re-termination on 22/11/2023, the values can be seen in the table below.

Voltage Applied (V)	Resistance Read (Ω)
250	220M
500	550M
1000	11G

The lanyards of all the bottles were also replaced after the first cast on 28/11/2023, which was the test cast, had many bottles not closing correctly due to misaligned tops and bottoms.

The CTD was washed and cleaned after the final cast on 14/12/2023.

Paper logs for all cast were scanned and placed on the leg drive in L:\work\Log_sheets\Scanned\CTD_operator_logs.

18.1.1 Information about CTD configuration(s)

SS CTD Final Configuration

Instrument Type	SN
Swivel	196111
SBE32	3270740.0922
SBE35	3568073-0056
9Plus	09-0541
Temp 1	03-2705

Cond 1	04-4471
DO 1	43-0245
Pump 1	05-1813
Temp 2	03-5766
Cond 2	04-2289
DO 2	43-2290
Pump 2	05-4488
Transmissometer	1831DR
Fluorometer	12-8513-002
FLCDRTD	4837
BBRTD	1635
PAR	70442
Altimeter	10127.244738
Master LADCP	14897
Slave LADCP	15060

NOTE: The above table shows the instruments installed on the frame at the end of the cruise. Highlighted instruments in the table above were the instruments which were replaced during the cruise, and details for the changes are in the section below.

18.1.1.1 SS Instrument changes

- SBE 4C 04-2255 replaced with 04-4471 from cast 003.
  - During cast 002 Conductivity Primary reading went flat during down cast.
- SBE43 43-0245 replaced with 43-2290 from cast 014.
  - During cast 013 the Dissolved Oxygen secondary graph was 'noisy' during downcast.
- SBE43 43-0676 replaced with 43-0245 from cast 019.
  - During upcast of cast 18 Dissolved Oxygen primary had a large drift during upcast. Only 3 DO's were on board and 43-0245 was used again.

18.1.2 Cast Summary

Cast 001

Date: 28/11/2023
Cruise: SD033
Event number: 3
Operator: Christopher Gray
Frame: SS
Requested depth: 380m
CTD depth at bottom: 379m
Altimeter: 9m

Comments

- Bottles 3, 4, 11, 16 and 19 tops and bottoms were misaligned resulting in the niskins not closing or only partially closing.
- Top handle cords, bottom handle cords and cocking handles cords were all replaced with new ones.
- There were leaks on bottles 3, 4, 11, 16 and 19.
    - Both top and bottom O-rings were replaced.

Cast 002

Date: 04/12/2023
Cruise: SD033
Event number: 6
Operator: Matt Gascoyne
Frame: SS
Requested depth: 3400m
CTD depth at bottom: 3377m
Altimeter: 10m

Comments

- @2500m Conductivity 1 had anomaly on way down. Reading went flat.
    - Conductivity sensor 04-2255 replaced with 01-4471.
- Unexpected winch stop @ 2675m on way up @ 13:38 UTC.
    - Winch did not re-spool correctly.
    - 2708m decent depth, removed @ 12:48 UTC.
    - Due to this bottles 1 and 2 had to descend 33m before coming back up while closed.

Cast 003

Date: 05/12/2023
Cruise: SD033
Event number: 10
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottles 5 and 12 had slight leaks on bottom O-rings. O-rings inspected and no damage found.

Cast 004

Date: 05/12/2023
Cruise: SD033
Event number: 18
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1058.6m
Altimeter: N/A

Comments

- Bottle 16 found to be leaking again. Bottom O-ring found to be damaged and replaced.
- Bottle 14 had a slight leak. O-ring inspected and found to be undamaged – no action.

Cast 005

Date: 06/12/2023
Cruise: SD033
Event number: 19

Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Mild/rough sea state, AHC ON.
- Slight leaks on bottles 4, 5, 6, and 11.
    - May be due to over tightening of top breather.
    - O-rings inspected. 4 and 6 bottom O-rings found to be damaged and were replaced.

Cast 006

Date: 06/12/2023
Cruise: SD033
Event number: 20
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottles 4, 71 14 and 17 had slight leaks on bottom O-rings. O-rings inspected and no damage found.

Cast 007

Date: 06/12/2023
Cruise: SD033
Event number: 22
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1060m
Altimeter: N/A

Comments

- Spigot 23 had a slight leak, all O-rings replaced on spigot.

Cast 008

Date: 07/12/2023
Cruise: SD033
Event number: 23
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Fin was very loose and flapping in high wind, CTD was brought back to deck to tighten up the fin nuts and bolts.
    - Caused a 15-minute delay at the start of the CTD.

Cast 009

Date: 07/12/2023
Cruise: SD033
Event number: 28
Operator: Christopher Gray

Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1058m
Altimeter: N/A

Comments

- No leaks.

Cast 0010

Date: 08/12/2023
Cruise: SD033
Event number: 29
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottle 19 had a leak on bottom O-ring. O-ring inspected and no damage was found.

Cast 011

Date: 08/12/2023
Cruise: SD033
Event number: 30
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottle 11 had slight leaks on bottom O-ring. O-ring inspected and no damage found.

Cast 012

Date: 08/12/2023
Cruise: SD033
Event number: 35
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- No leaks.

Cast 013

Date: 09/12/2023
Cruise: SD033
Event number: 36
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- DO2 graph was ‘noisy’ on down cast.
    - DO2 43-0245 replaced with 43-2290

- Bottles 11 and 17 had slight leaks on bottom O-rings. O-rings inspected and no damage was found.

Cast 014

Date: 09/12/2023
Cruise: SD033
Event number: 37
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Replaced breathers on bottles 5 and 7 for good seals.

Cast 015

Date: 09/12/2023
Cruise: SD033
Event number: 43
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottles 5, 12 and 21 had slight leaks on their bottom O-rings. O-rings inspected and no damage was found.

Cast 016

Date: 10/12/2023
Cruise: SD033
Event number: 44
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1059m
Altimeter: N/A

Comments

- Bottles 11 and 19 has slight leaks on bottom O-rings. 11 bottom O-ring was found to be damaged and replaced.
- Bottle 12 had a leak on the bottom O-ring, O-ring found to be damaged and replaced.

Cast 017

Date: 10/12/2023
Cruise: SD033
Event number: 45
Operator: Matt Gascoyne
Frame: SS
Requested depth: 4350m
CTD depth at bottom: 4347m
Altimeter: 9m

Comments

- Removed and stripped-down bottle 5. All top, bottom, spigot and valve O-rings replaced.

Cast 018

Date: 10/12/2023

Cruise: SD033
Event number: 49
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- DO1 had a large drift during up cast.
    - 43-0676 replaced with 43-0245 as there were only 3 SS DO's onboard.
- Bottles 14, 17, 21 and 24 had slight leaks on the bottom O-rings.
    - O-rings inspected and none were found to have damage.

Cast 019

Date: 11/12/2023
Cruise: SD033
Event number: 50
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- DO1 (43-0245) graph looked good during cast, no 'noise'.
- Bottles 17 and 19 had slight leaks. All O-rings thoroughly inspected and no damage was found.

Cast 020

Date: 11/12/2023
Cruise: SD033
Event number: 51
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottle 13 had very slight leak on bottom O-ring. O-ring inspected and no damage found.
- Winch issue on down cast at 540m. CTD was moved up and down by 100m until fixed, then down cast resumed.

Cast 021

Date: 11/12/2023
Cruise: SD033
Event number: 57
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottle 24 had a leak on the bottom O-ring. Top and bottom old black O-rings replaced with new orange ones.

Cast 022

Date: 12/12/2023
Cruise: SD033
Event number: 58
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottles 4 and 22 had slight leaks on them. O-rings inspected and no damage was found.

Cast 023

Date: 12/12/2023
Cruise: SD033
Event number: 59
Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottles 4, 13 and 17 had very slight leaks on bottom O-rings. O-rings inspected and no damage found.

Cast 024

Date: 12/12/2023
Cruise: SD033
Event number: 64
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottles 17 had a leak at the bottom O-ring. All O-rings changed (top, bottom and breather) and black spigot changed.

Cast 025

Date: 13/12/2023
Cruise: SD033
Event number: 65
Operator: Christopher Gray
Frame: SS
Requested depth: 3320m
CTD depth at bottom: 3314m
Altimeter: 9m

Comments

- DO1 ‘noisy’ after 1350 during down cast.
- During the cast came up to 1246m line out, back down to 1248m line out and then up to 1244m line out.

Cast 026

Date: 13/12/2023
Cruise: SD033
Event number: 66

Operator: Matt Gascoyne
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- SBE35 probe not responsive during launch phase. Back on deck and connector full of water and sea goop. Cleaned, dried and lubricated. Comms restored to SBE35.

Cast 027

Date: 13/12/2023
Cruise: SD033
Event number: 71
Operator: Matt Gascoyne
Frame: SS
Requested depth: 400m
CTD depth at bottom: 406m
Altimeter: N/A

Comments

- No bottles fires.

Cast 028

Date: 13/12/2023
Cruise: SD033
Event number: 72
Operator: Christopher Gray
Frame: SS
Requested depth: 1050m
CTD depth at bottom: 1057m
Altimeter: N/A

Comments

- Bottles 14, 15, 18 and 19 had slight leaks at the bottom O-rings. O-rings inspected and no damage was found.

Cast 029

Date: 14/12/2023
Cruise: SD033
Event number: 73
Operator: Christopher Gray
Frame: SS
Requested depth: 400m
CTD depth at bottom: 403.5m
Altimeter: N/A

Comments

- Bottles removed.

Cast 030

Date: 14/12/2023
Cruise: SD033
Event number: 74
Operator: Christopher Gray
Frame: SS
Requested depth: 400m
CTD depth at bottom: 403.6m
Altimeter: N/A

Comments

- Bottles removed.
- Backscatter graph ‘noisy’ on down cast. Large spike on the graph @140m and remained ‘noisy’ until 403.5m. Fine on upcast.
    - Connector inspected, water ingress found. Connector cleaned, dried and re-fitted.

Cast 031

Date: 14/12/2023
Cruise: SD033
Event number: 75
Operator: Christopher Gray
Frame: SS
Requested depth: 400m
CTD depth at bottom: 403.8m
Altimeter: N/A

Comments

- Bottles removed.
- Backscatter looks good again.

Cast 032

Date: 14/12/2023
Cruise: SD033
Event number: 76
Operator: Christopher Gray
Frame: SS
Requested depth: 400m
CTD depth at bottom: 403.3m
Altimeter: N/A

Comments

- Bottles replaced during this cast and were cocked for the cast.

Cast 033

Date: 14/12/2023
Cruise: SD033
Event number: 77
Operator: Matt Gascoyne
Frame: SS
Requested depth: 3360m
CTD depth at bottom: 3355m
Altimeter: 10m

Comments

- DO1 slightly noisy on downcast but noise disappeared at the shallow depths.
- Bottles 1, 2 and 3 had to go back down by 2 meters after being closed due to winch issue.

Cast 034

Date: 14/12/2023
Cruise: SD033
Event number: 81
Operator: Matt Gascoyne
Frame: SS
Requested depth: 3360m
CTD depth at bottom: 3361m
Altimeter: 10m

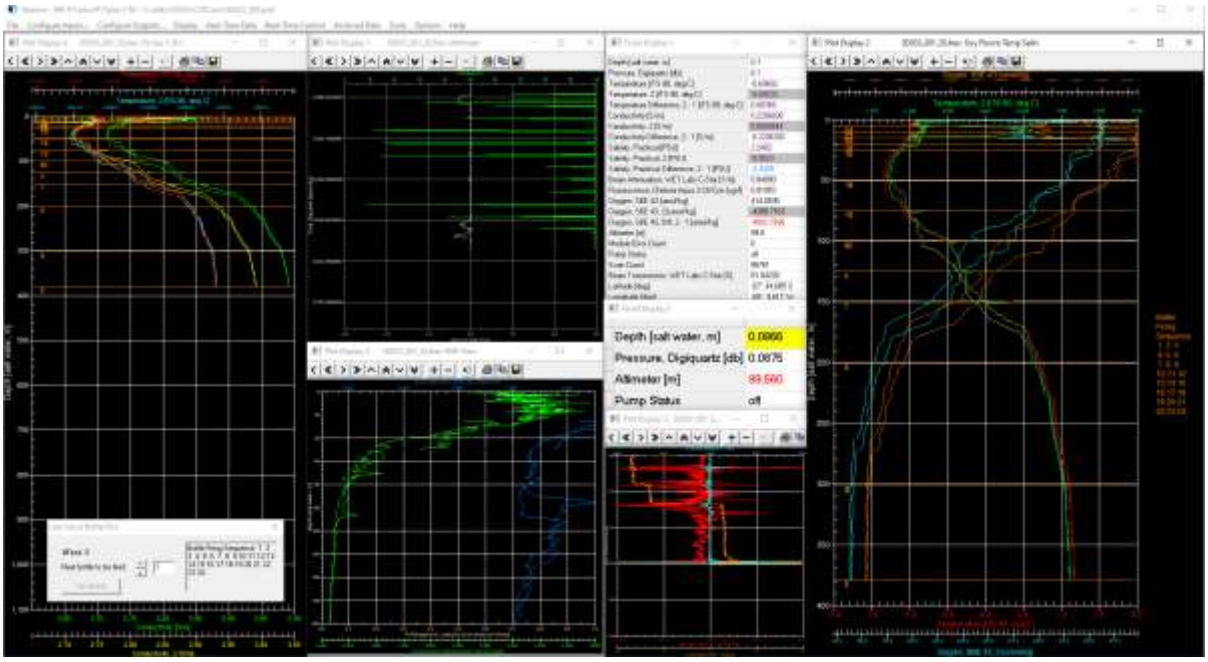
Comments

- From 55m depth the transmissometer became very noisy.
    - Connector inspected, water ingress and gunk found. Cleaned, dried and re-fitted.
- Bottle 13 (125m) not fired during cast.

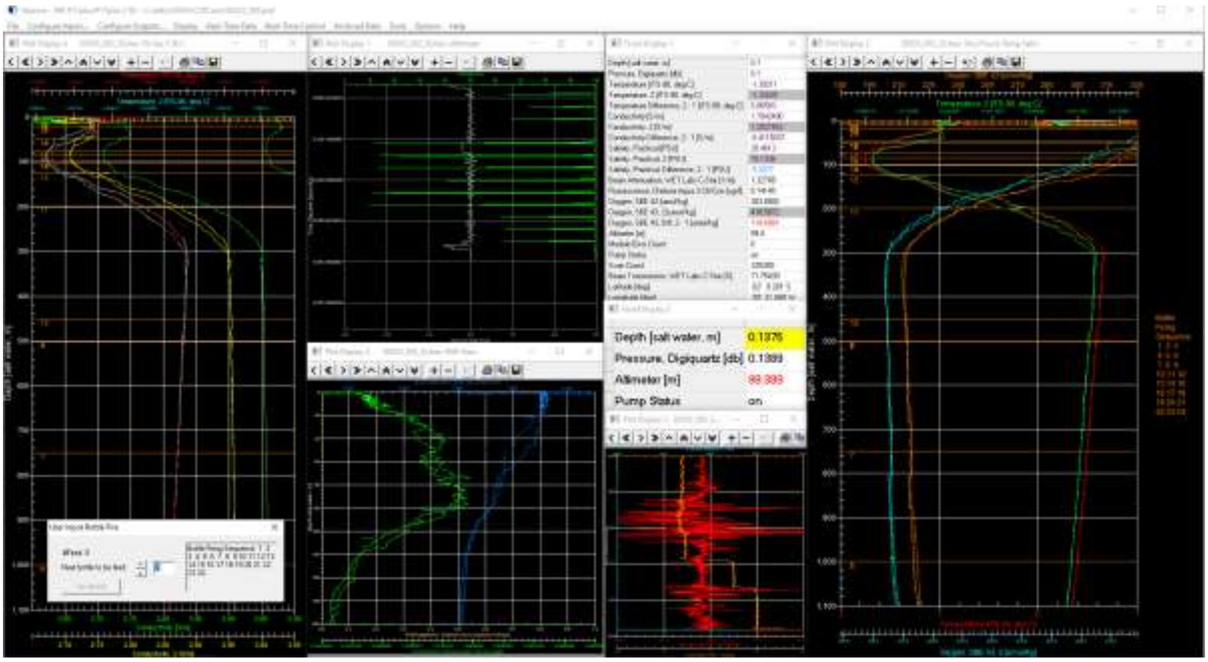
18.1.3 Summary Screenshots

There are no screenshots of the 2am CTD's.

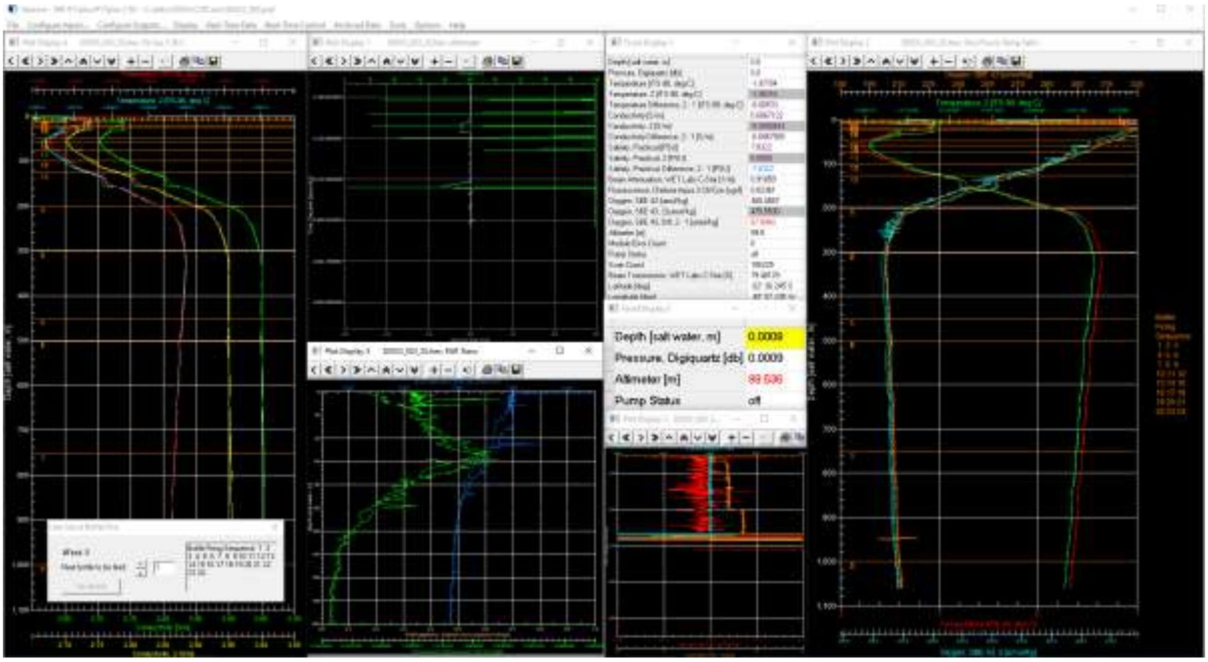
Cast 001



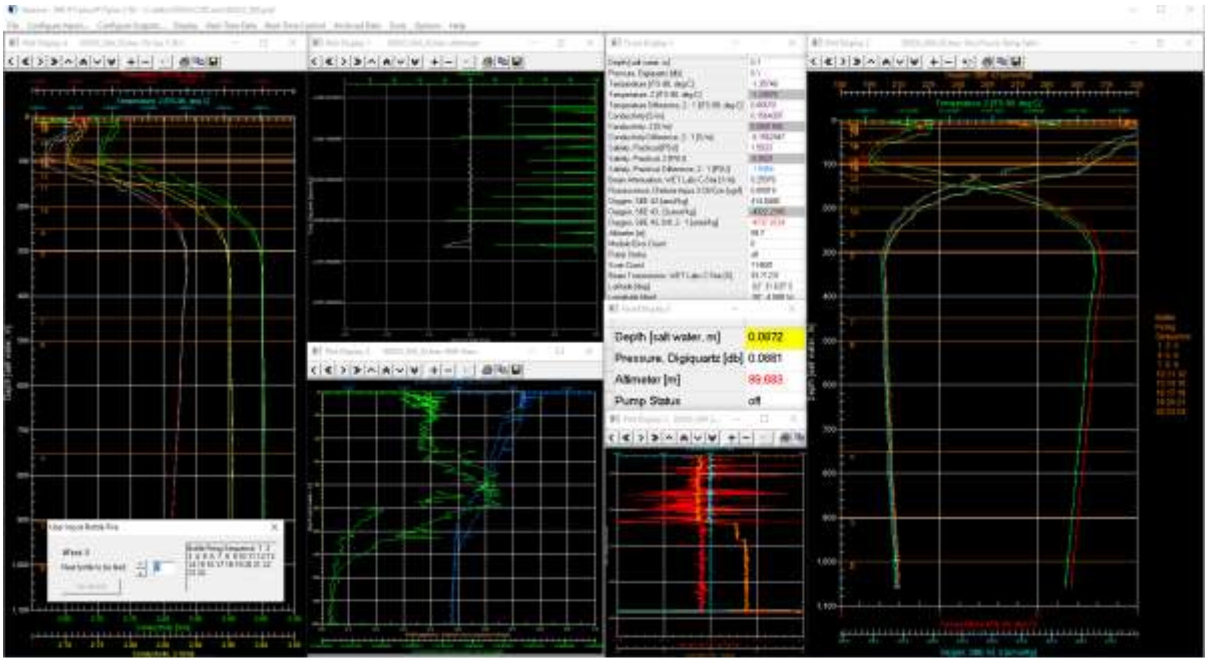
Cast 002



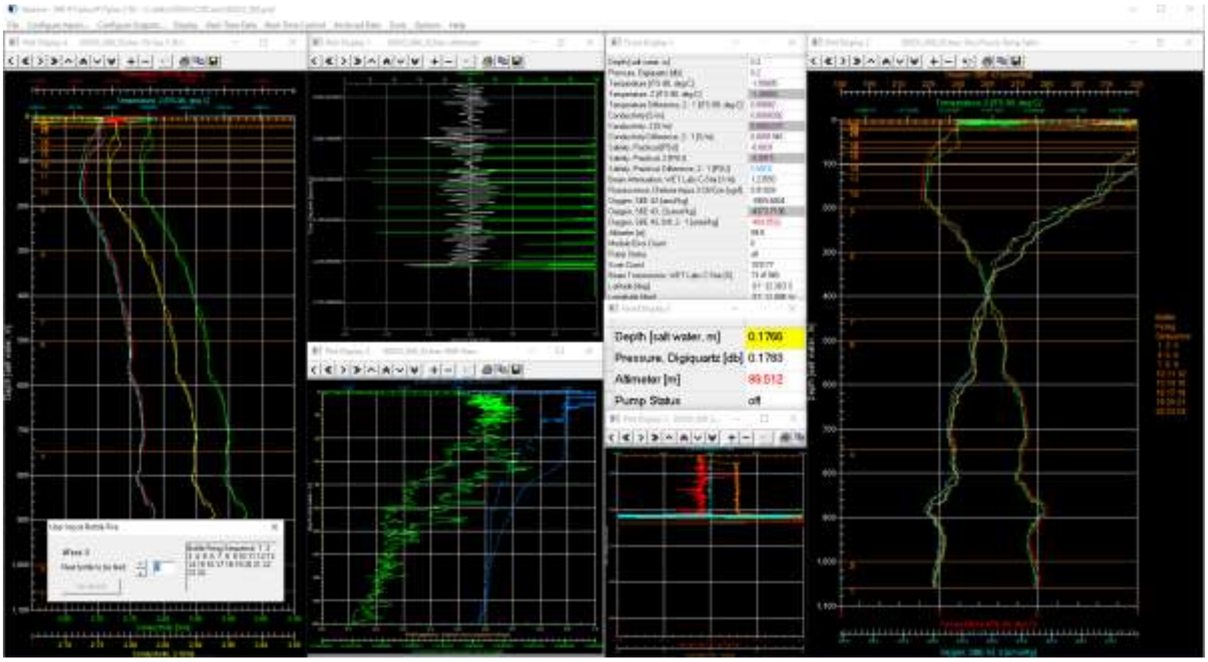
Cast 003



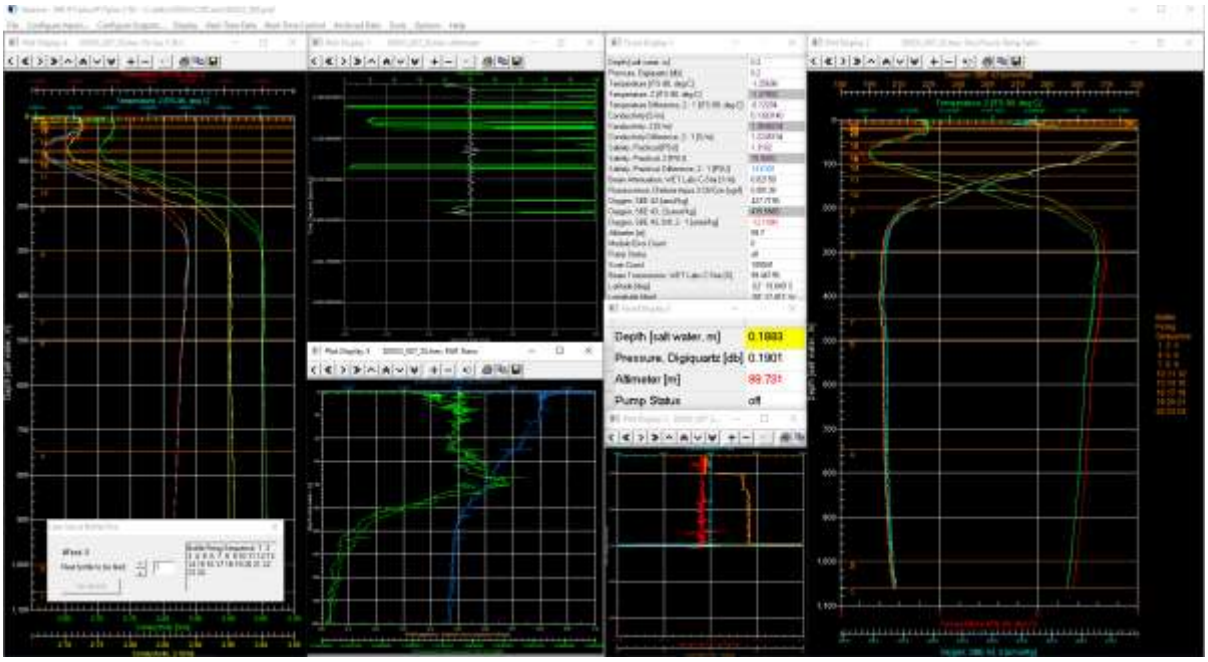
Cast 004



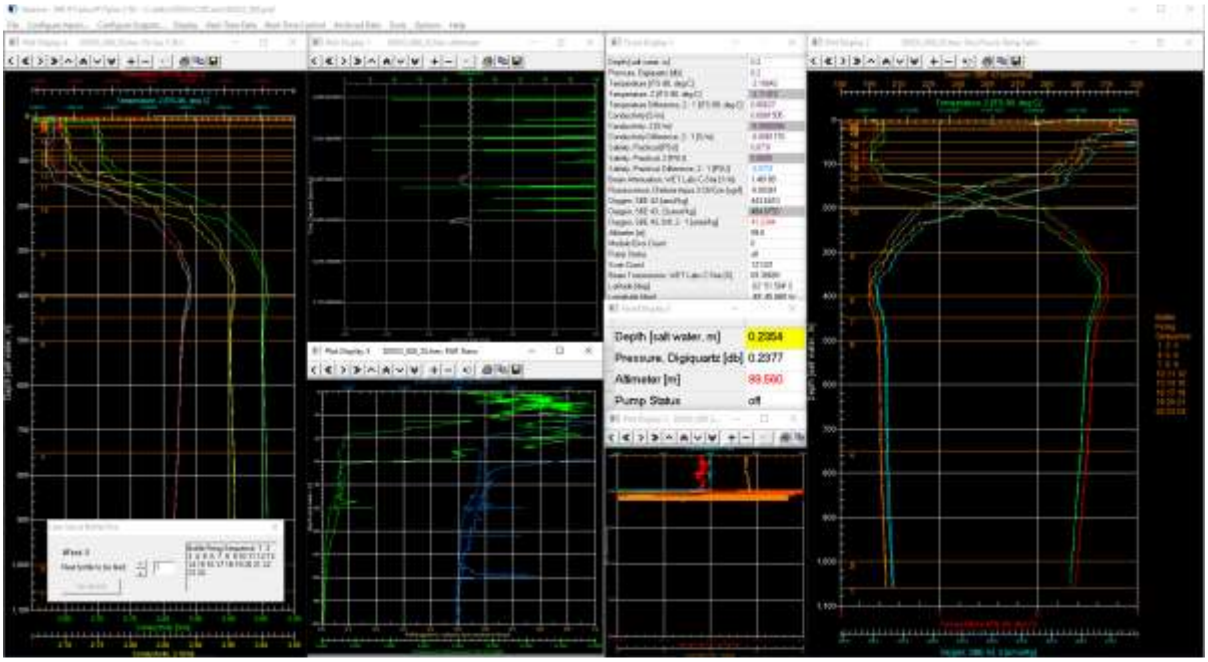
Cast 006



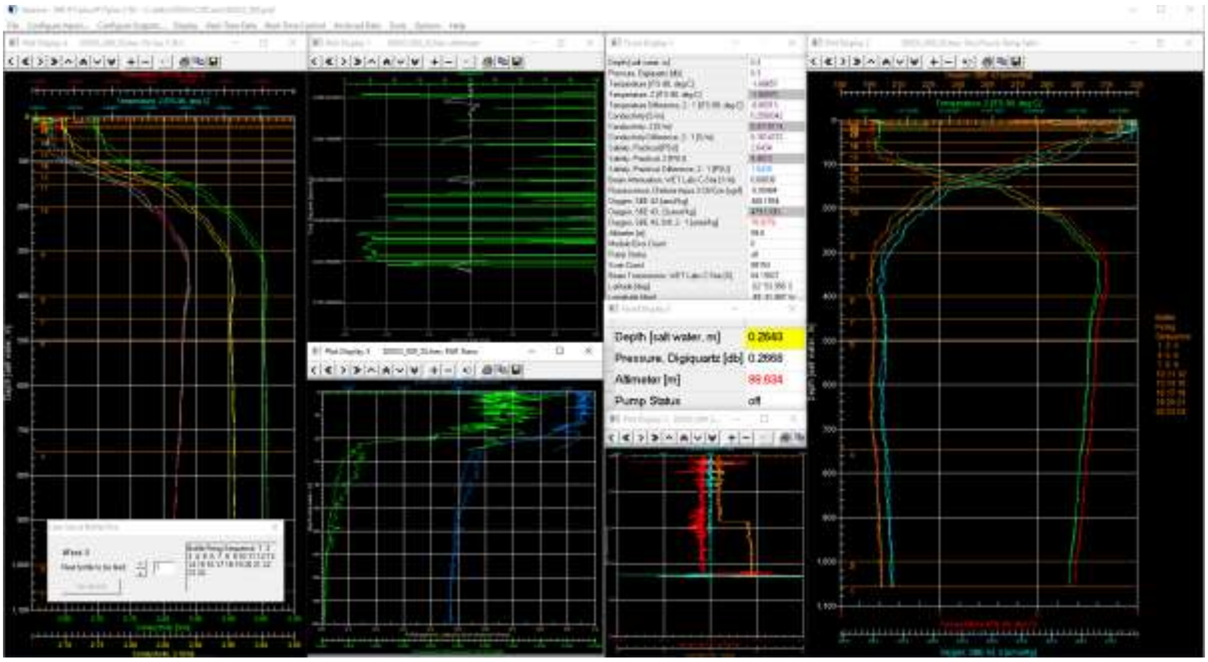
Cast 007



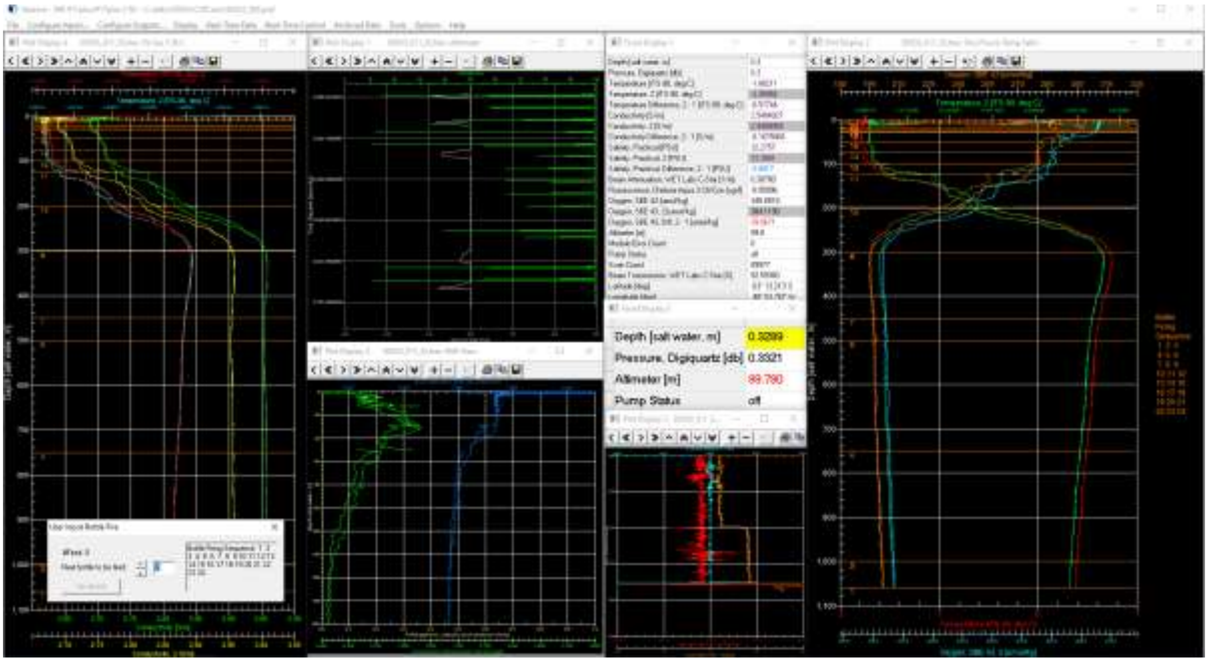
Cast 008



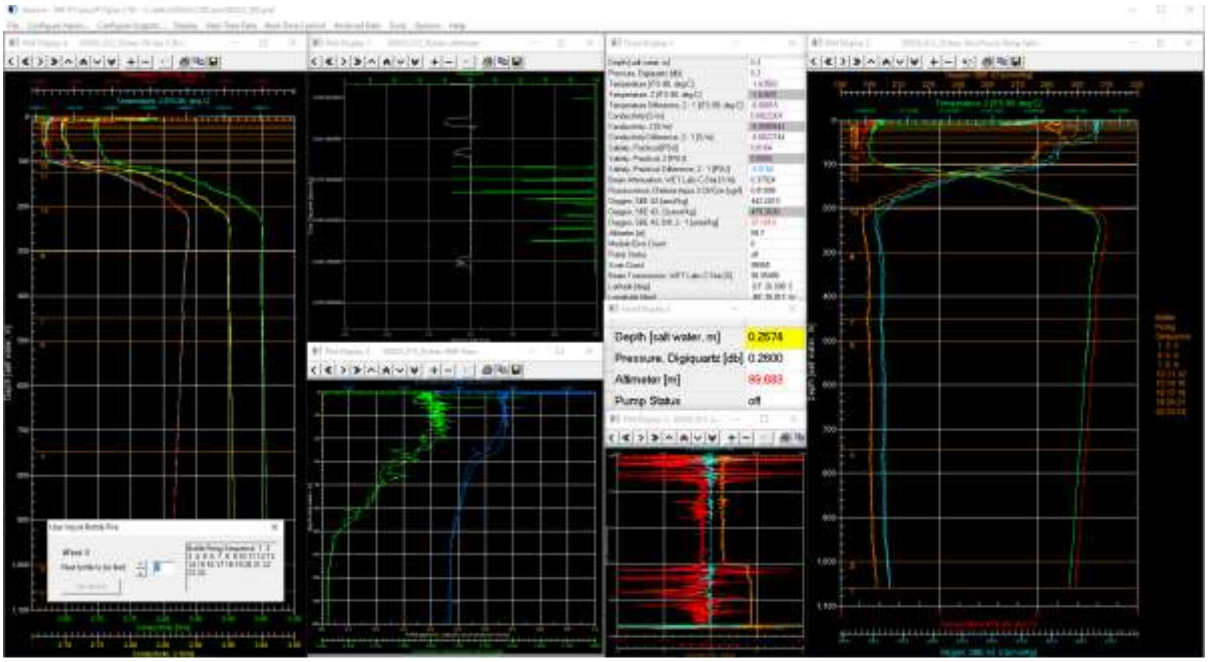
Cast 009



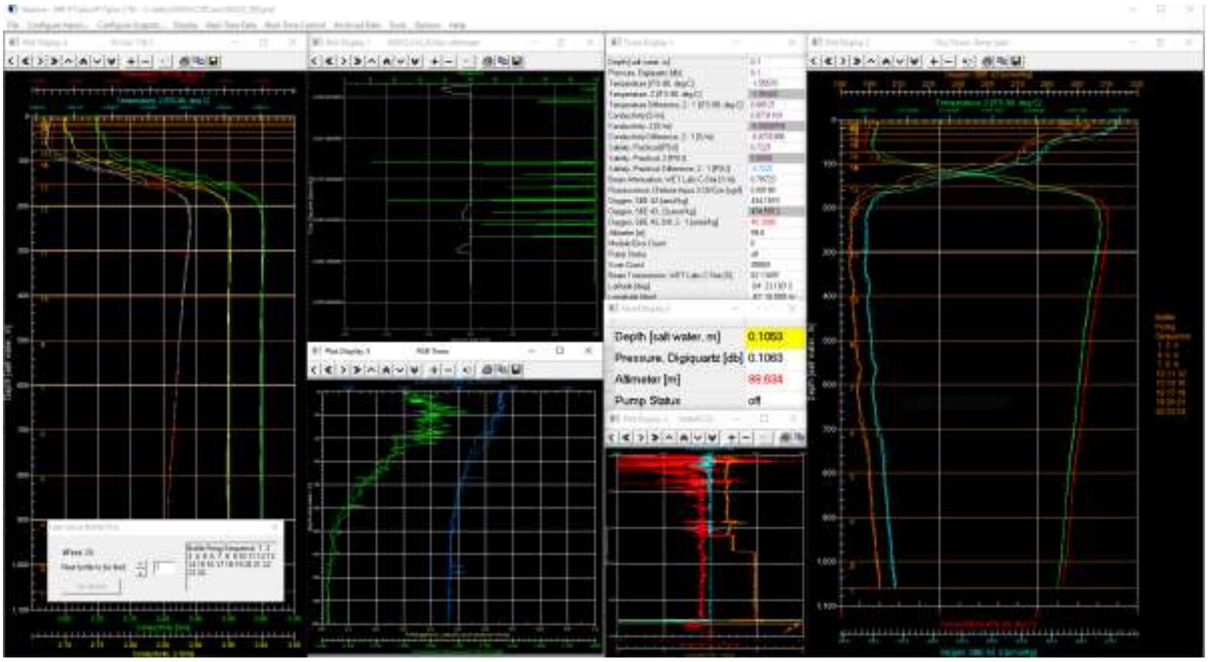
Cast 011



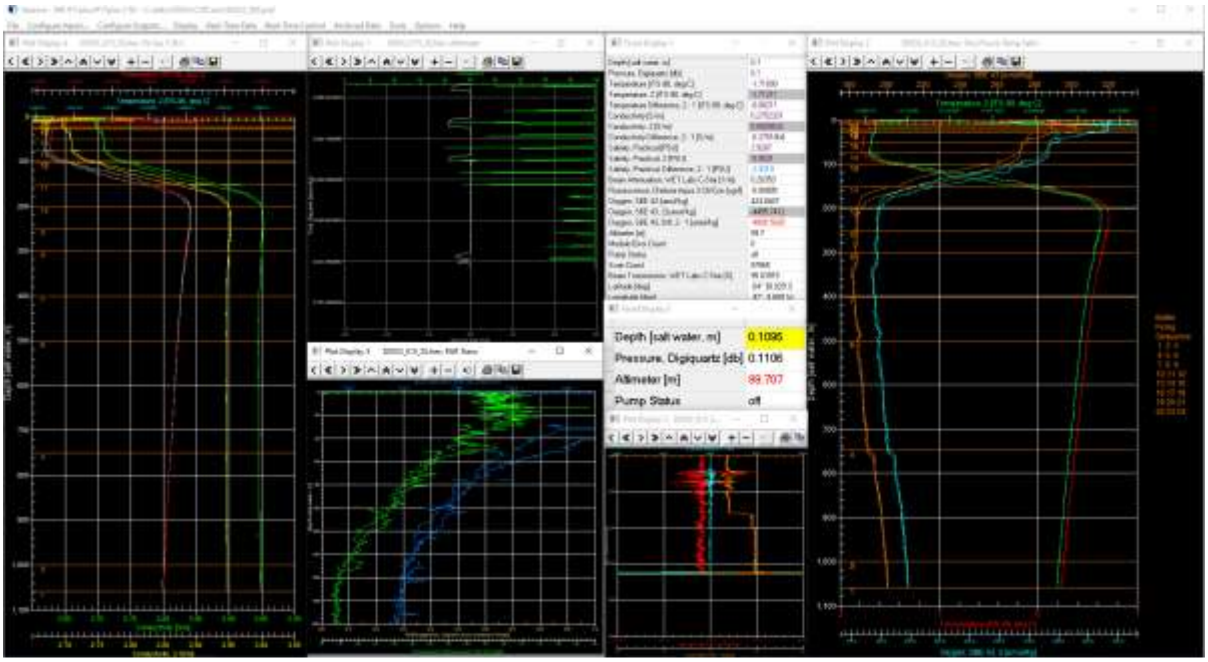
Cast 012



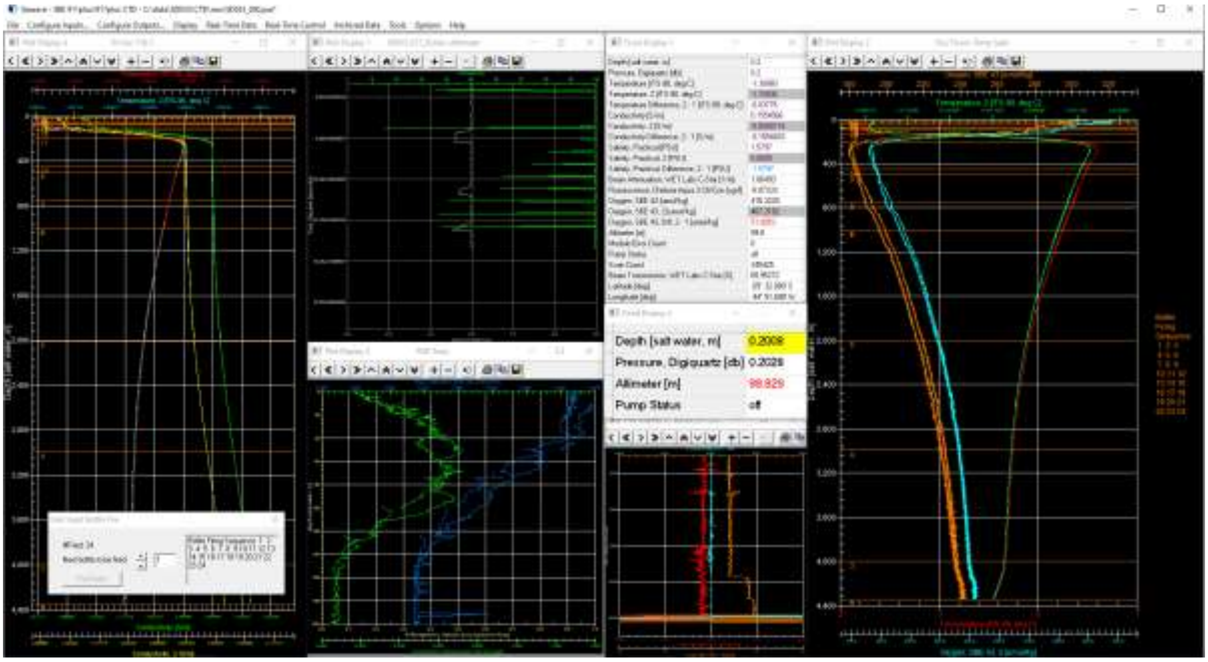
Cast 014



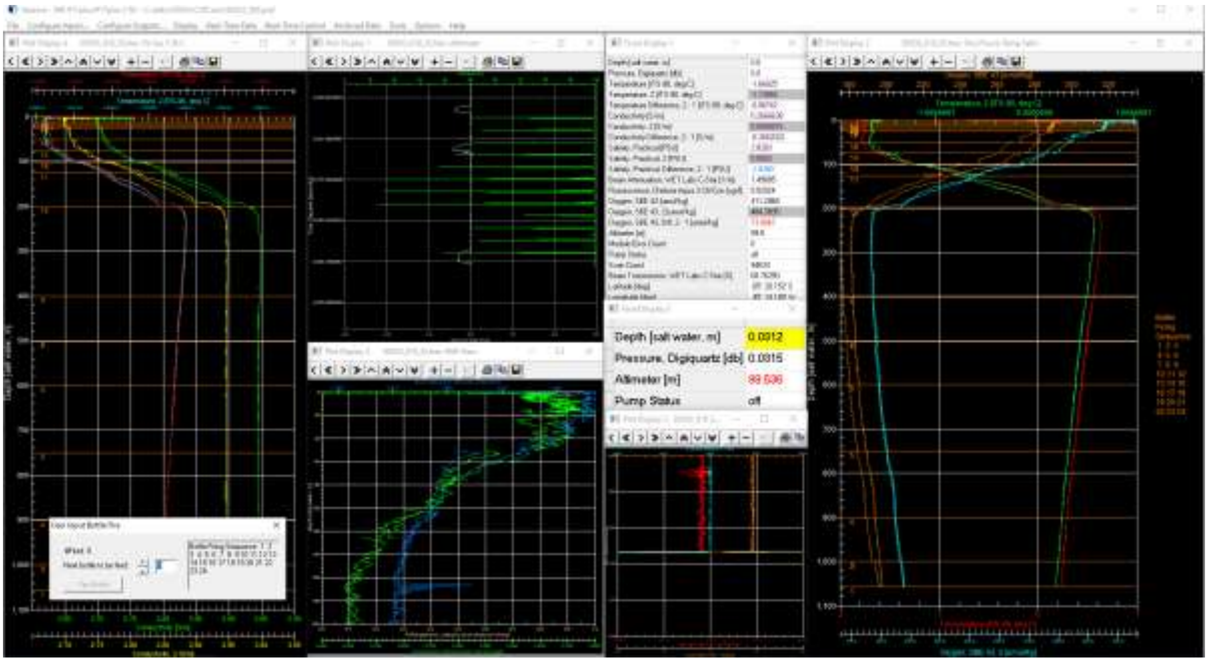
Cast 015



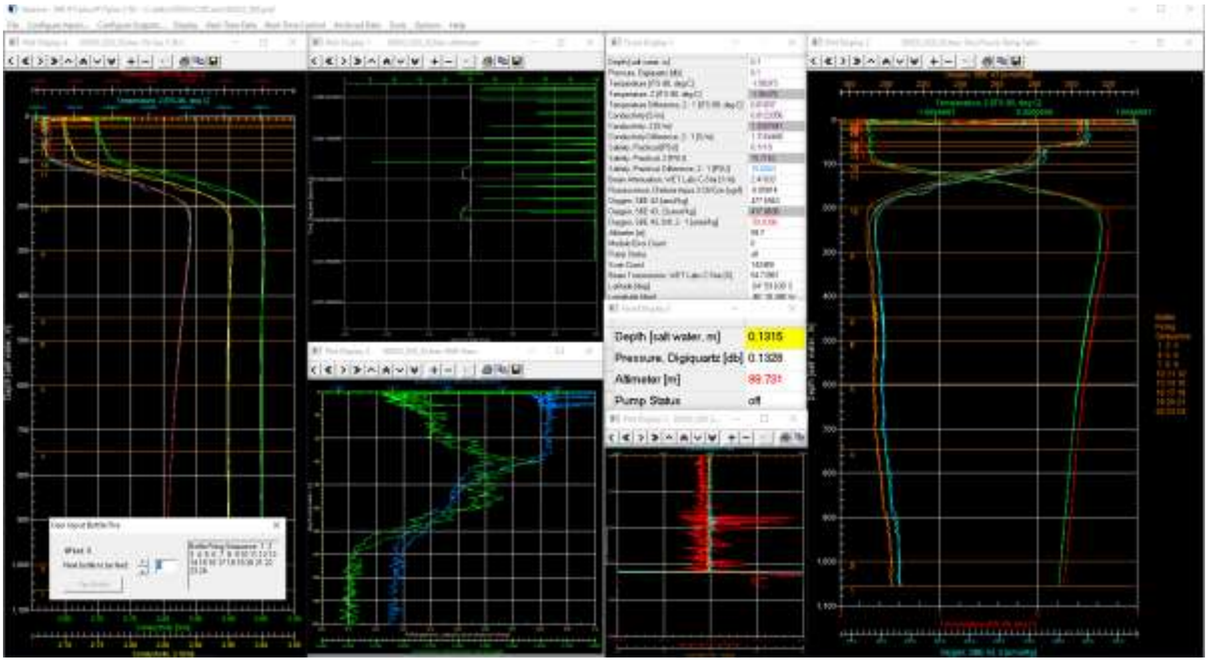
Cast 017



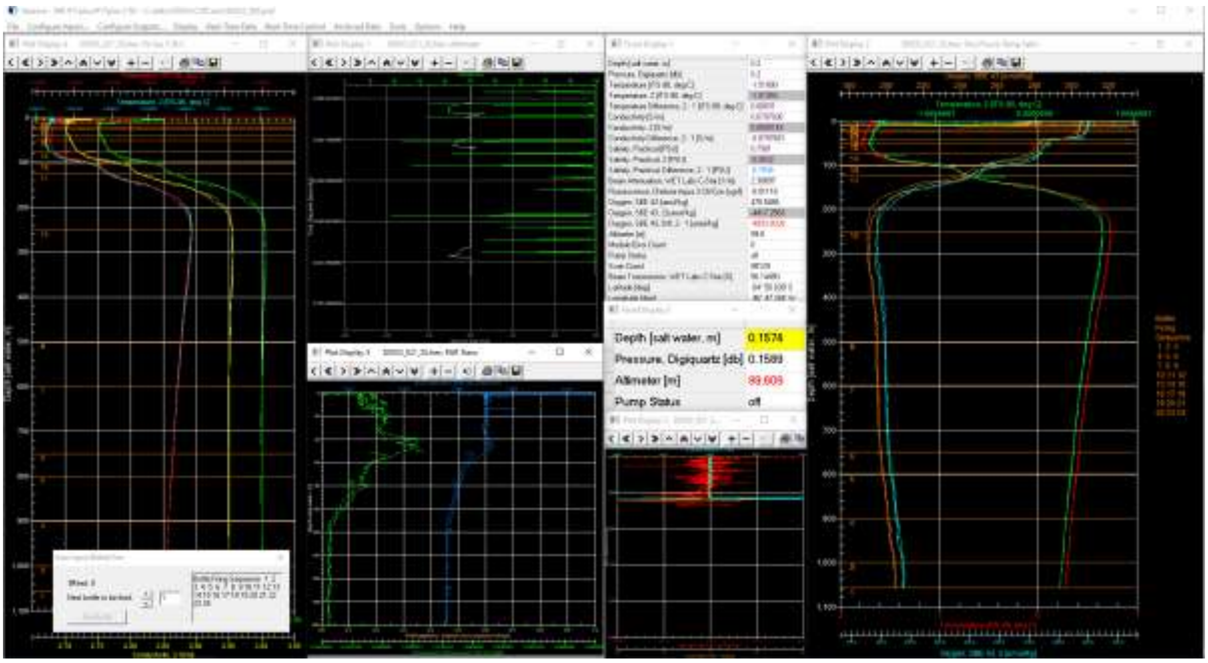
Cast 018



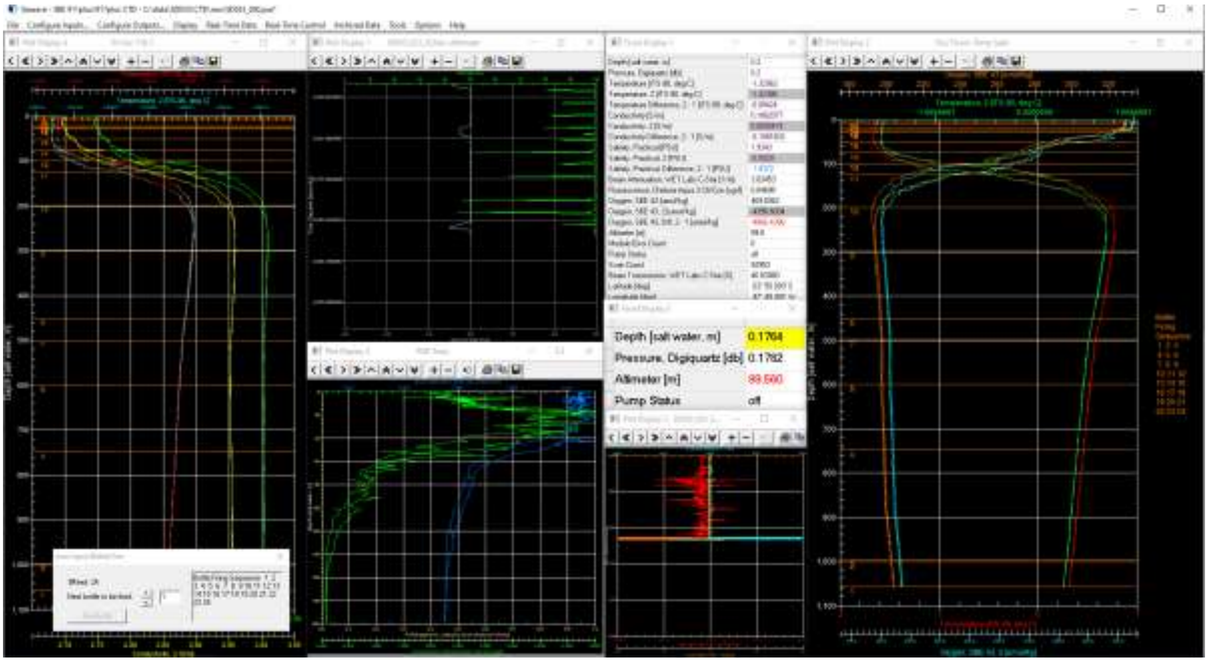
Cast 020



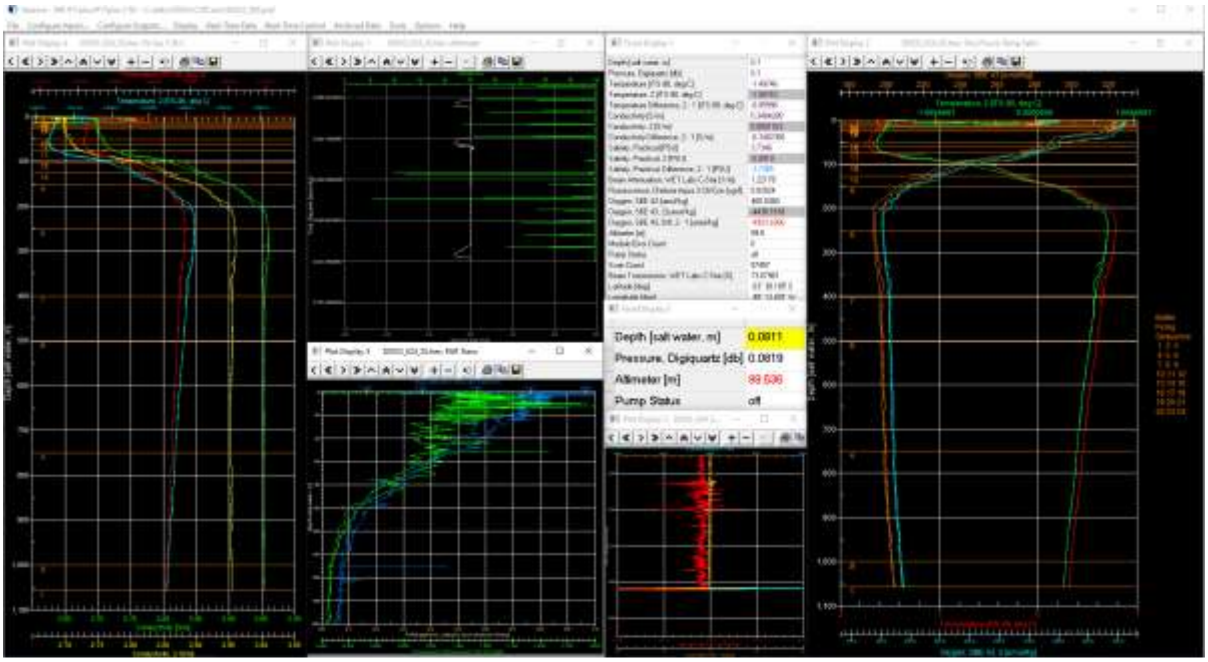
Cast 021



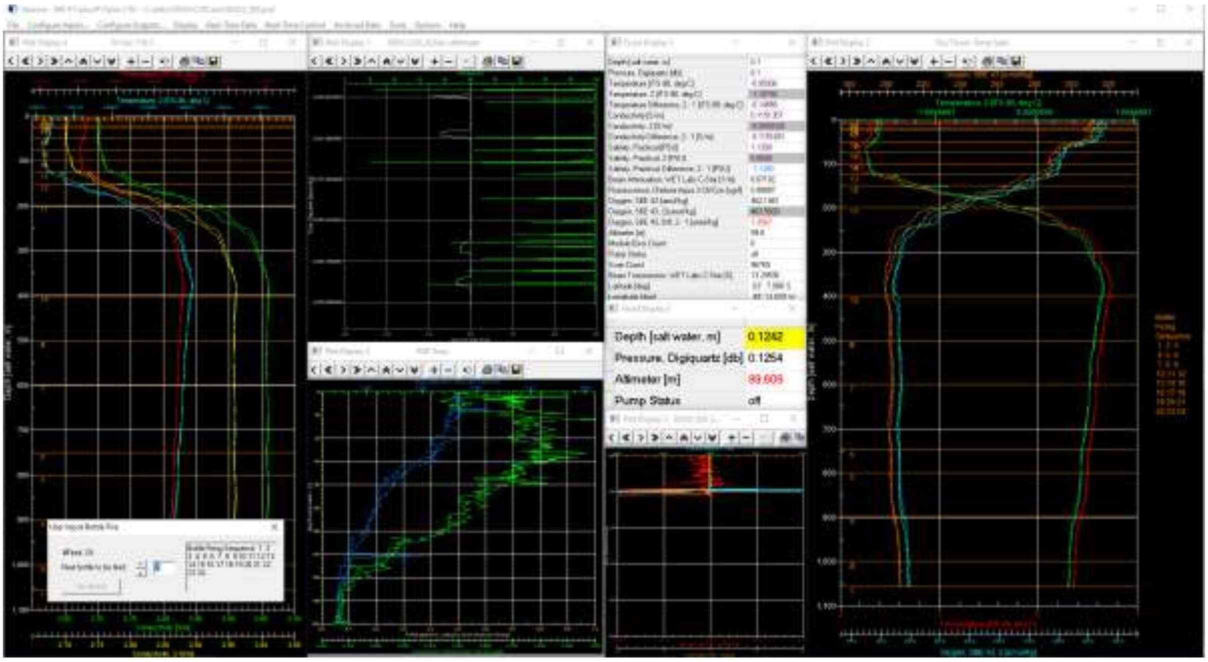
Cast 023



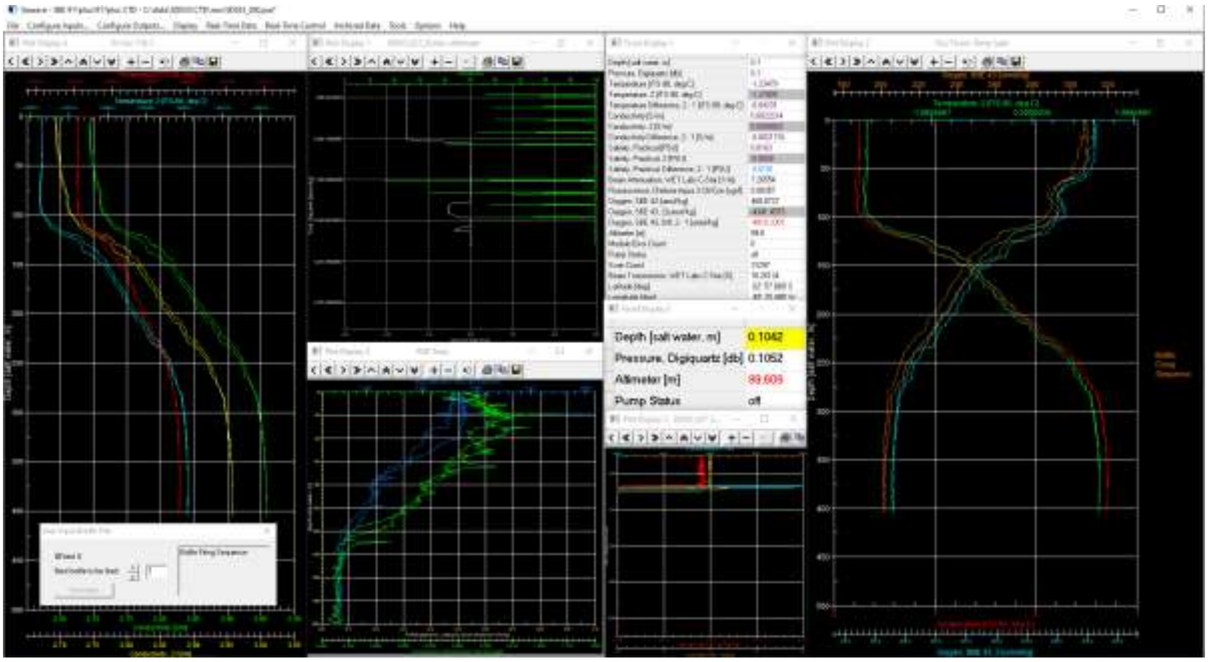
Cast 024



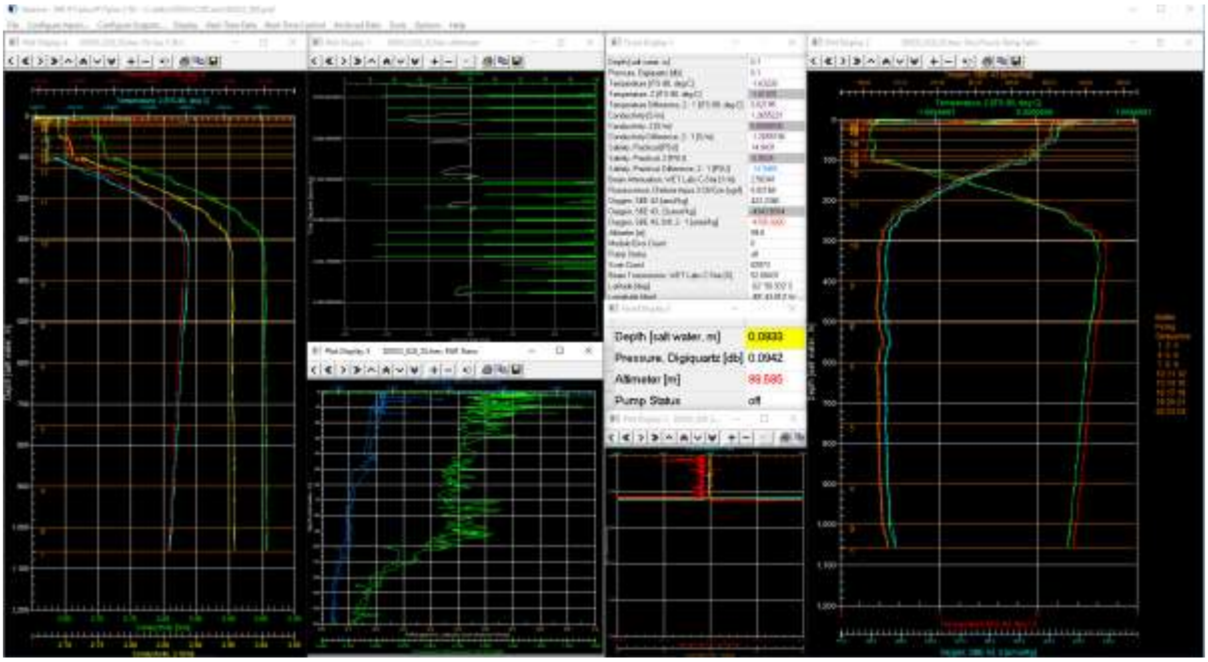
Cast 026



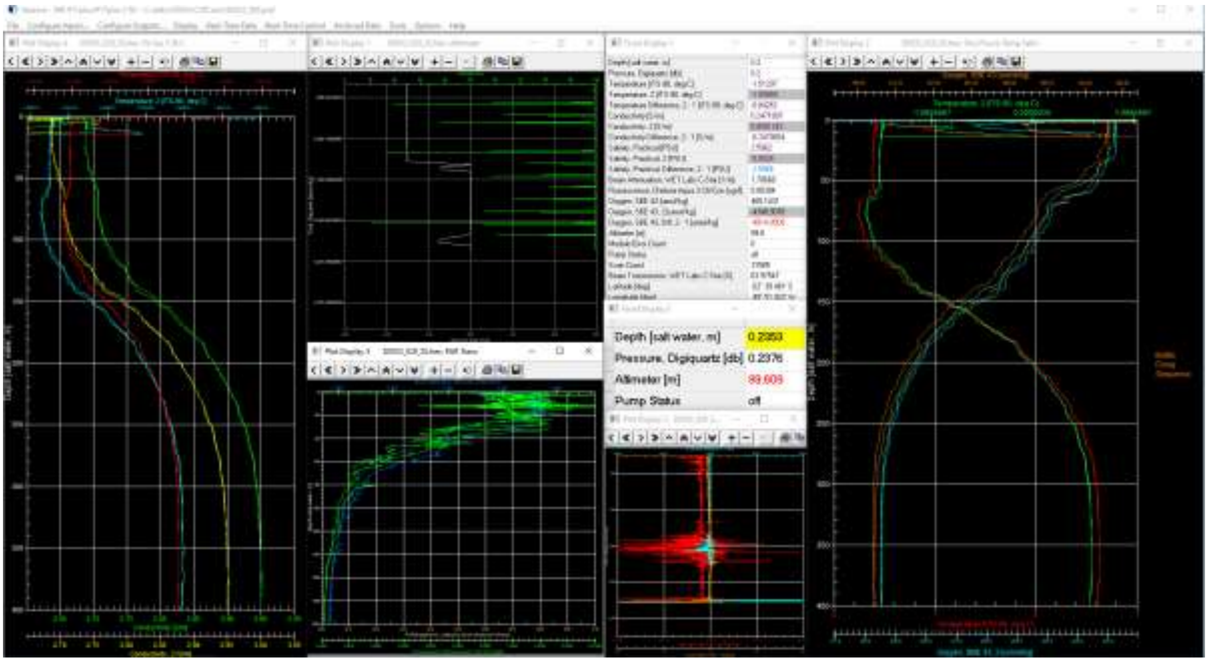
Cast 027



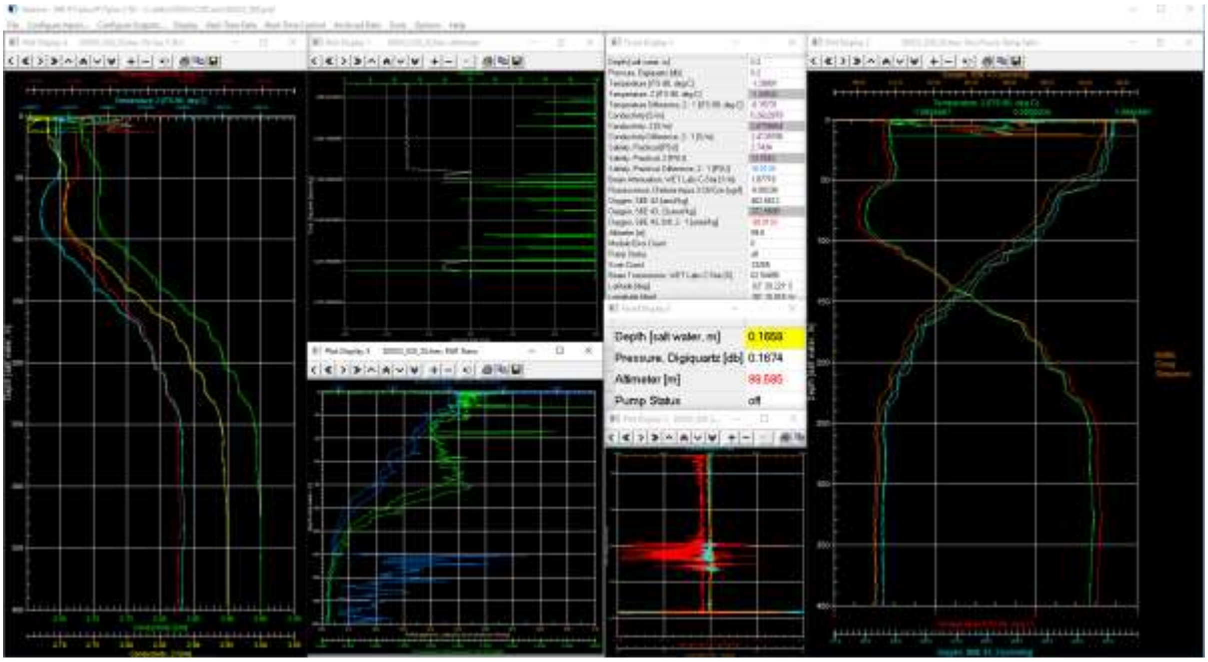
Cast 028



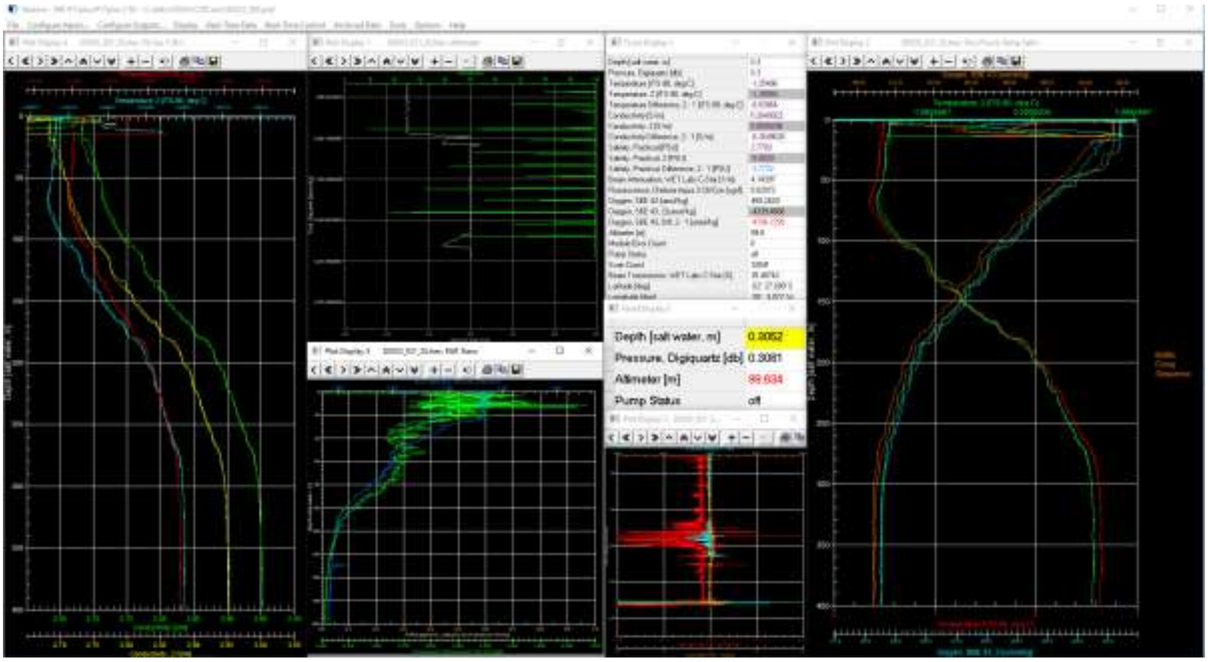
Cast 029



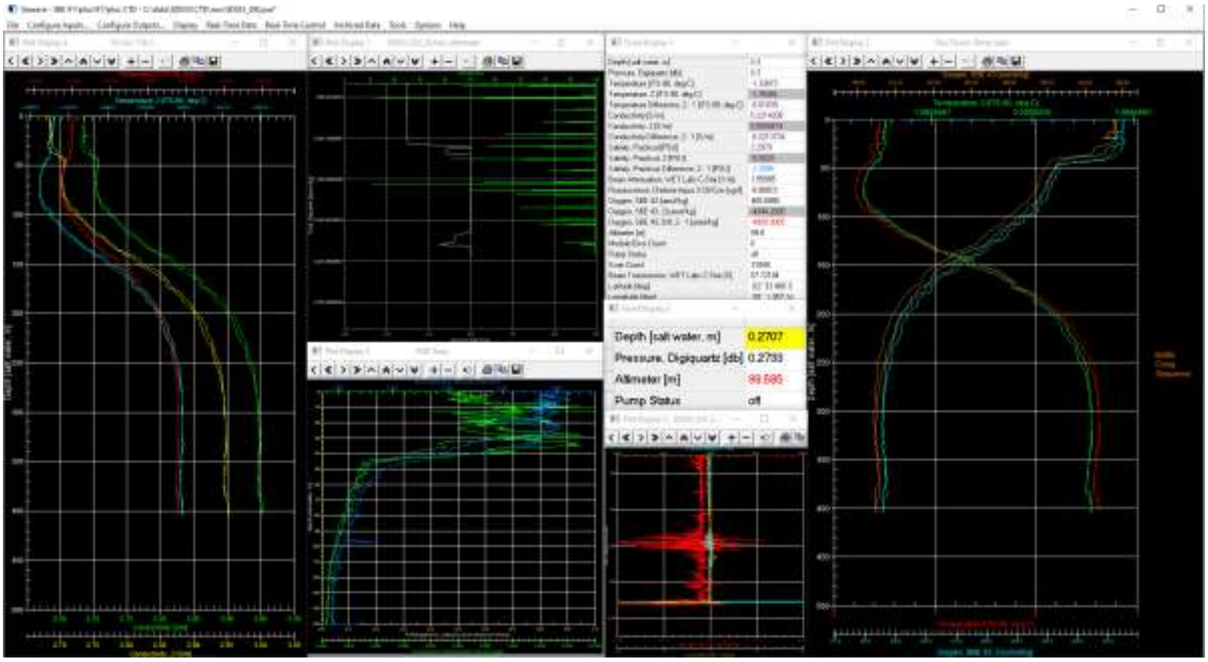
Cast 030



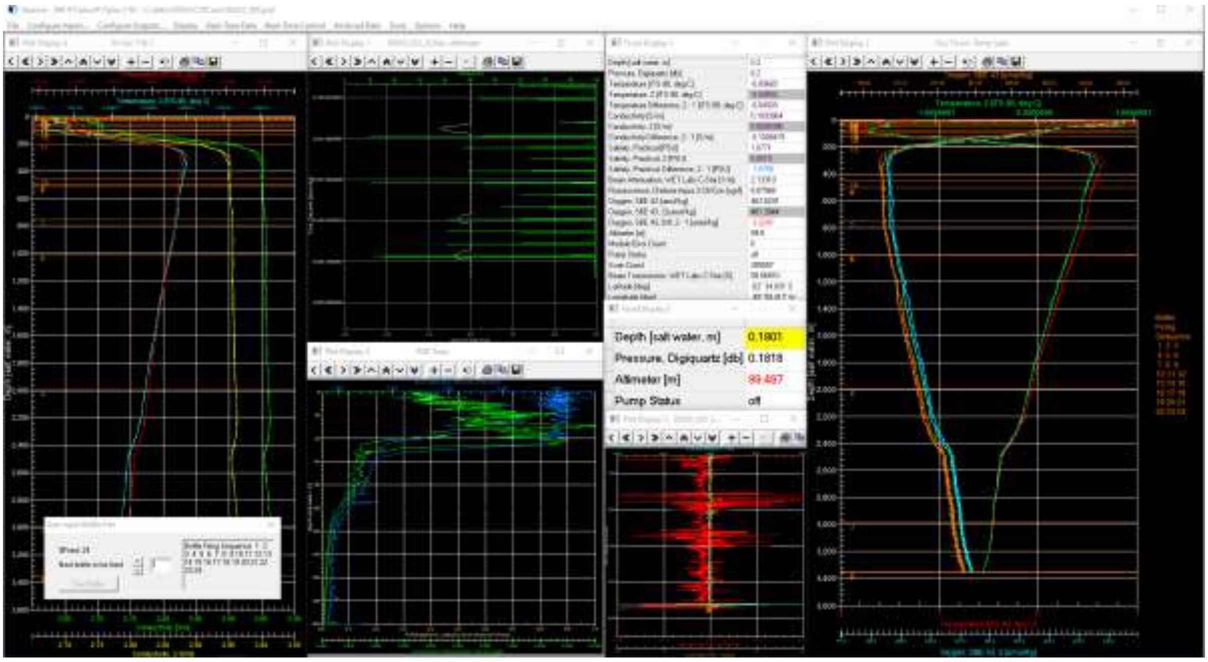
Cast 031



Cast 032


Depth [salt water, m] 0.2707
Pressure, Digiquartz [db] 0.2733
Altimeter [m] 99.585
Pump Status off

Cast 033


Depth [salt water, m] 0.1801
Pressure, Digiquartz [db] 0.1818
Altimeter [m] 99.487
Pump Status off

19 Bridge Log

Time (UTC)	Event	Latitude (dd)	Longitude (dd)	Comment
14/12/2023 21:10	81	-62.46615	-49.98691	CTD secured
14/12/2023 21:04	81	-62.46609	-49.98583	CTD out of water
14/12/2023 21:03	81	-62.46606	-49.98541	CTD stoped at 8m below surface
14/12/2023 20:05	81	-62.4659	-49.97053	Commence recovery
14/12/2023 20:03	81	-62.46591	-49.97013	Stopped lowering 10m above seabed. Line out 3344m
14/12/2023 19:06	81	-62.46588	-49.9642	Lowering CTD to 3360m
14/12/2023 19:03	81	-62.46588	-49.96421	CTD in water
14/12/2023 18:58	81	-62.4659	-49.96421	Commence deploy CTD
14/12/2023 18:16		-62.46593	-49.96425	Vessel on DP
14/12/2023 17:22		-62.56632	-49.9274	Off DP
14/12/2023 17:03	80	-62.56677	-49.92787	Bongo net recovered to deck
14/12/2023 16:59	80	-62.56687	-49.92797	Nets inboard
14/12/2023 16:55	80	-62.56692	-49.92801	Nets out the water
14/12/2023 16:41	80	-62.56688	-49.92838	Deployed to depth
14/12/2023 16:31	80	-62.56718	-49.92903	Deploying bongo to 200m
14/12/2023 16:27	80	-62.56751	-49.9297	Nets in the water
14/12/2023 16:26	80	-62.56751	-49.9297	Nets over the side
14/12/2023 16:24	80	-62.56759	-49.92987	Commence bongo net deployment from side gantry
14/12/2023 16:20	79	-62.56759	-49.92987	Bongo nets recovered to deck
14/12/2023 16:15	79	-62.56848	-49.93225	Nets at the surface
14/12/2023 16:01	79	-62.56831	-49.93474	Deployed to 200m. Recovering
14/12/2023 15:50	79	-62.56858	-49.937	Deploying bongo to 200m
14/12/2023 15:46	79	-62.5687	-49.93738	nets in the water
14/12/2023 15:44	79	-62.56872	-49.9375	Bongo net over the side
14/12/2023 15:42	79	-62.56872	-49.93761	Commence deployment of bongo nets from side gantry
14/12/2023 14:46	78	-62.56819	-49.93689	Mammoth net on deck and secure
14/12/2023 14:37	78	-62.56838	-49.93639	Mammoth net 10m below surface
14/12/2023 13:38	78	-62.56975	-49.9499	Mammoth net at 1200m
14/12/2023 12:53	78	-62.56792	-49.96136	Mammoth net 10m below surface
14/12/2023 12:49	78	-62.56793	-49.96272	Deploying mammoth net
14/12/2023 12:29	77	-62.56763	-49.97185	CTD on deck
14/12/2023 12:21	77	-62.56666	-49.97462	CTD 10m below surface
14/12/2023 11:07	77	-62.56014	-50.00389	CTD at 3358m
14/12/2023 10:10	77	-62.5565	-50.01059	Lowering CTD to 3360m
14/12/2023 10:04	77	-62.55649	-50.01111	CTD in water
14/12/2023 09:59	77	-62.55652	-50.01163	Commence deploy CTD
14/12/2023 09:06	76	-62.55731	-50.03067	CTD on deck and secured
14/12/2023 09:01	76	-62.55773	-50.03268	CTD out of water
14/12/2023 08:59	76	-62.55773	-50.03268	CTD 10m below surface

14/12/2023 08:53	76	-62.55747	-50.03341	CTD at 400m commence recovery
14/12/2023 08:46	76	-62.55717	-50.03428	Lowering CTD to 400m
14/12/2023 08:43	76	-62.55718	-50.03429	CTD in water
14/12/2023 08:39	76	-62.55724	-50.03452	Commence deployment of CTD
14/12/2023 08:37		-62.55718	-50.0343	Vessel on DP mode
14/12/2023 07:11		-62.46146	-50.15128	VTD secured
14/12/2023 07:07	75	-62.46146	-50.15128	CTD out of water
14/12/2023 07:03	75	-62.46146	-50.15128	CTD 10m below surface
14/12/2023 06:58	75	-62.46146	-50.1513	Commence recovery
14/12/2023 06:57	75	-62.46146	-50.1513	CTD deployed to 400m
14/12/2023 06:51	75	-62.46146	-50.1513	CTD deploying to 400m
14/12/2023 06:46	75	-62.46144	-50.15125	CTD in the water
14/12/2023 06:43		-62.4613	-50.15097	Vessel on DP
14/12/2023 05:38		-62.33568	-50.18122	Vessel off DP
14/12/2023 05:33	74	-62.33648	-50.18064	CTD recovered
14/12/2023 05:28	74	-62.33704	-50.18033	CTD at the surface
14/12/2023 05:21	74	-62.33794	-50.18043	Commence recovery
14/12/2023 05:19	74	-62.33818	-50.18043	Deployed to 400m
14/12/2023 05:12	74	-62.33849	-50.18069	Deploying CTD to 400m
14/12/2023 05:09	74	-62.33856	-50.18081	CTD in the water
14/12/2023 05:06	74	-62.33856	-50.18081	CTD over the side
14/12/2023 05:04	74	-62.33862	-50.18087	Commence deployment of CTD
14/12/2023 05:02		-62.33862	-50.18087	Vessel on DP
14/12/2023 01:52		-62.65766	-49.86542	Vessel off DP
14/12/2023 01:51	73	-62.65766	-49.86542	CTD on deck and secure
14/12/2023 01:44	73	-62.65766	-49.86542	CTD 10m below surface
14/12/2023 01:37	73	-62.65766	-49.86542	CTD 400m below the surface
14/12/2023 01:28	73	-62.65767	-49.86543	CTD 10m below suface
14/12/2023 01:25	73	-62.65767	-49.86544	Deploying CTD
14/12/2023 01:23		-62.65767	-49.86543	Vessel on DP
13/12/2023 23:52		-62.82614	-49.73602	Vessel off DP
13/12/2023 23:49	72	-62.84883	-49.73023	CTD on deck and secure
13/12/2023 23:42	72	-62.84883	-49.73023	CTD 3m below surface
13/12/2023 23:13	72	-62.84883	-49.73023	CTD at 1050m
13/12/2023 22:54	72	-62.84885	-49.73021	Deploying CTD to 1050m
13/12/2023 22:52	72	-62.84885	-49.73021	CTD 10m below the surface
13/12/2023 22:47	72	-62.84884	-49.73023	Deploying CTD
13/12/2023 22:45		-62.84895	-49.73017	Vessel on DP mode
13/12/2023 20:45		-62.96455	-49.4242	DP mode off
13/12/2023 20:37	71	-62.96447	-49.42486	CTD on deck
13/12/2023 20:31	71	-62.96443	-49.42465	CTD clear of water
13/12/2023 20:24	71	-62.96431	-49.42387	CTD at 400m
13/12/2023 20:17	71	-62.9642	-49.42307	Lowering CTD to 400m
13/12/2023 20:14	71	-62.96417	-49.42274	CTD in water
13/12/2023 20:09	71	-62.96416	-49.42269	Commence CTD deployment
13/12/2023 20:00		-62.96417	-49.4227	Vessel on DP mode

13/12/2023 16:40	70	-63.1532	-49.23207	Vessel off DP
13/12/2023 16:32	70	-63.1532	-49.23204	Net recovered to Deck
13/12/2023 16:25	70	-63.15321	-49.23204	Net out the water
13/12/2023 15:20	70	-63.15323	-49.23203	Deployed to depth. Commence recovery.
13/12/2023 14:37	70	-63.15308	-49.2313	Deploying mammoth net to 1200m
13/12/2023 14:36	70	-63.15307	-49.23125	Mammoth net below surface
13/12/2023 14:28	70	-63.15299	-49.23083	Deploying mammoth net
13/12/2023 14:10	69	-63.14767	-49.22391	Bongo nets on deck
13/12/2023 14:01	69	-63.14685	-49.22331	Bongo nets 16m below surface
13/12/2023 13:51	69	-63.14666	-49.22401	Bongo nets at 200m
13/12/2023 13:38	69	-63.14637	-49.22519	Bongo nets 10m below surface
13/12/2023 13:36	69	-63.14636	-49.22518	Deploying bongo nets
13/12/2023 13:10	68	-63.14062	-49.21131	Bongo nets on deck
13/12/2023 13:02	68	-63.14023	-49.21239	Bongo nets 16m below surface
13/12/2023 12:52	68	-63.13982	-49.21351	Bongo nets at 200m
13/12/2023 12:39	68	-63.13954	-49.21492	Bongo net 10m below the surface
13/12/2023 12:34	68	-63.13945	-49.2155	Deploying bongo nets
13/12/2023 12:14	67	-63.13674	-49.22622	Bongo nets recovered
13/12/2023 12:09	67	-63.13642	-49.22687	Bongo nets at surface
13/12/2023 11:55	67	-63.13465	-49.22803	Bongo nets at 200m
13/12/2023 11:41	67	-63.13365	-49.22886	Bongo nets 10m below surface
13/12/2023 11:36	67	-63.13345	-49.22936	Deploying bongo nets
13/12/2023 11:32	66	-63.13323	-49.2299	CTD on deck
13/12/2023 11:28	66	-63.13302	-49.23044	CTD out of the water
13/12/2023 11:23	66	-63.13277	-49.23099	CTD 8m below surface
13/12/2023 10:48	66	-63.13186	-49.23328	CTD at 1050m
13/12/2023 10:28	66	-63.13162	-49.23245	CTD in water
13/12/2023 10:22	66	-63.13161	-49.23209	Commence deploy CTD
13/12/2023 08:50		-63.13434	-49.2229	Vessel on DP mode
13/12/2023 06:24		-63.28365	-48.74165	Vessel off DP
13/12/2023 06:01	65	-63.284	-48.74423	CTD recovered to deck
13/12/2023 05:54	65	-63.28506	-48.75307	CTD out the water
13/12/2023 04:56	65	-63.28515	-48.75377	Recovering to surface
13/12/2023 04:53	65	-63.28522	-48.75429	Stopped at depth
13/12/2023 03:57	65	-63.2848	-48.76602	Deploying to 3220m
13/12/2023 03:52	65	-63.28477	-48.76661	CTD in the water
13/12/2023 03:51	65	-63.28474	-48.76697	CTD over the side
13/12/2023 03:48	65	-63.28478	-48.76636	Commence Deployment of CTD
13/12/2023 03:18		-63.28469	-48.76806	Vessel on DP
12/12/2023 23:12		-63.63628	-48.22721	Vessel off DP
12/12/2023 23:11	64	-63.63634	-48.22745	CTD on board and secure
12/12/2023 23:09	64	-63.63639	-48.22803	CTD out of the water
12/12/2023 23:05	64	-63.6364	-48.22849	CTD 4m below surface
12/12/2023 22:32	64	-63.63639	-48.22852	CTD at 1050m

12/12/2023 22:13	64	-63.63639	-48.22852	Lowering CTD to 1050m
12/12/2023 22:09	64	-63.63639	-48.22851	CTD in water
12/12/2023 22:06	64	-63.63639	-48.22852	Commence deploy CTD
12/12/2023 21:55		-63.63638	-48.22851	Vessel on DP mode
12/12/2023 16:23		-63.83117	-47.83317	Vessel off DP
12/12/2023 15:52	63	-63.83116	-47.83318	Net recovered to deck
12/12/2023 15:44	63	-63.83117	-47.83319	Net out the water
12/12/2023 15:42	63	-63.83118	-47.83319	Mammoth out the water
12/12/2023 14:41	63	-63.83116	-47.83319	Recovering mammoth net
12/12/2023 14:26	63	-63.83115	-47.83318	Mammoth net at 1200m
12/12/2023 13:28	63	-63.83113	-47.8332	Deploying mammoth net to 1200m
12/12/2023 13:24	63	-63.83114	-47.83321	Mammoth net 10m below the surface
12/12/2023 13:22	63	-63.83114	-47.83321	Mammoth net in the water
12/12/2023 13:18	63	-63.83114	-47.83321	Deploying mammoth net
12/12/2023 13:10	62	-63.83116	-47.83319	Bongo nets on deck
12/12/2023 13:02	62	-63.83116	-47.83319	Bongo nets 16m below surface
12/12/2023 12:51	62	-63.83115	-47.83319	Bongo nets at 200m
12/12/2023 12:38	62	-63.83116	-47.83319	Bongo nets 10m below surface
12/12/2023 12:36	62	-63.83116	-47.83319	Deploying bongo nets
12/12/2023 12:33	61	-63.83116	-47.83319	Bongo nets on deck
12/12/2023 12:27	61	-63.83118	-47.83317	Bongo nets 16m below the surface
12/12/2023 12:16	61	-63.83147	-47.83306	Bongo nets at 200m
12/12/2023 12:04	61	-63.83179	-47.83293	Bongo net 10m below the surface
12/12/2023 12:01	61	-63.83187	-47.83291	Deploying bongo nets
12/12/2023 11:59	60	-63.83192	-47.83288	Bongo nets on deck
12/12/2023 11:54	60	-63.83213	-47.83279	Bongo nets 16m below surface
12/12/2023 11:43	60	-63.83291	-47.83248	Bongo net at 200m
12/12/2023 11:29	60	-63.834	-47.83205	Bongo nets 10m below the surface
12/12/2023 11:26	60	-63.83416	-47.83199	Deploying bongo nets
12/12/2023 11:17	59	-63.83466	-47.8318	CTD on deck
12/12/2023 11:12	59	-63.83491	-47.83169	CTD out of the water
12/12/2023 11:10	59	-63.83502	-47.83164	CTD 3m below the surface
12/12/2023 10:35	59	-63.83547	-47.83148	CTD at 1050m
12/12/2023 10:15	59	-63.83547	-47.83149	CTD going down to 1050m
12/12/2023 10:10	59	-63.83547	-47.83149	CTD down to 10m below surface
12/12/2023 09:00		-63.83561	-47.83162	Vessel on DP mode
12/12/2023 06:10	58	-64.20537	-47.30912	Vessel off DP
12/12/2023 05:49	58	-64.20537	-47.30911	CTD recovered to deck
12/12/2023 05:45	58	-64.20538	-47.30911	CTD out the water
12/12/2023 05:12	58	-64.20537	-47.30911	Comence recovery to surface
12/12/2023 04:53	58	-64.20538	-47.30912	Deploying to 1050m
12/12/2023 04:49	58	-64.20538	-47.30912	CTD over the side
12/12/2023 04:49	58	-64.20538	-47.30912	CTD in the water
12/12/2023 04:45	58	-64.20538	-47.30911	Commence deployment of CTD

12/12/2023 04:40		-64.20538	-47.30911	Vessel on DP
11/12/2023 23:06	57	-64.83396	-46.78783	CTD on deck and secured
11/12/2023 23:02	57	-64.83396	-46.78782	Recovering CTD to deck
11/12/2023 22:58	57	-64.83395	-46.78782	CTD 3m below the surface
11/12/2023 22:27	57	-64.83396	-46.78783	CTD at 1050m commence recovery
11/12/2023 22:07	57	-64.83393	-46.78786	Lowering CTD to 1050m
11/12/2023 22:04	57	-64.83396	-46.78783	CTD in water
11/12/2023 21:58	57	-64.83396	-46.7878	Commence deploy CTD
11/12/2023 21:44		-64.83398	-46.78782	Vessel in position on DP
11/12/2023 19:19		-64.99335	-46.287	All secure on deck
11/12/2023 18:58	56	-64.9937	-46.29196	Ice party off the ice
11/12/2023 17:08	56	-64.99265	-46.31023	Ice party on the ice
11/12/2023 17:05	56	-64.99263	-46.31031	Commence deployment of ice party
11/12/2023 15:56	55	-64.98346	-46.31084	Vessel off DP
11/12/2023 15:49	55	-64.98346	-46.31084	Net recovered to deck
11/12/2023 15:42	55	-64.98347	-46.31086	Nets at the surface
11/12/2023 14:33	55	-64.98371	-46.3107	Mammoth net at 1200m
11/12/2023 13:47	55	-64.98605	-46.30862	Mammoth going down to 1200m
11/12/2023 13:44	55	-64.98619	-46.30845	Mammoth 10m below surface
11/12/2023 13:42	55	-64.98629	-46.30833	Mammoth nets in the water
11/12/2023 13:36	55	-64.98656	-46.30791	Deploying mammoth net
11/12/2023 13:28	54	-64.98727	-46.30645	Bongo on Deck
11/12/2023 13:20	54	-64.9876	-46.30579	Bongo 16m below surface recovering to deck
11/12/2023 13:10	54	-64.98807	-46.30518	Bongo Down 200m recovering to surface
11/12/2023 12:57	54	-64.98872	-46.30538	Bongo No.3 10m Below Surface
11/12/2023 12:54	53	-64.98887	-46.30549	Bongo nets on deck
11/12/2023 12:52	53	-64.98897	-46.30556	Bongo nets out of the water
11/12/2023 12:48	53	-64.98918	-46.30571	Bongo 16m below the surface
11/12/2023 12:38	53	-64.9897	-46.30606	Bongo nets at 200m
11/12/2023 12:25	53	-64.99047	-46.30629	Bongo nets 10m below the surface
11/12/2023 12:24	53	-64.99054	-46.30631	Deploying bongo nets
11/12/2023 12:21	52	-64.99063	-46.30628	Bongo nets on deck
11/12/2023 12:20	52	-64.99094	-46.30624	Bongo nets out of the water
11/12/2023 12:17	52	-64.99118	-46.30615	Bongo nets 16m below surface
11/12/2023 12:06	52	-64.99201	-46.30512	Bongo at 200m
11/12/2023 11:53	52	-64.99289	-46.30585	Bongo nets 8m below the surface
11/12/2023 11:49	52	-64.9932	-46.30611	Deploying bongo nets
11/12/2023 11:42	51	-64.99373	-46.30656	CTD on deck
11/12/2023 11:37	51	-64.99411	-46.30689	CTD out of the water
11/12/2023 11:33	51	-64.99441	-46.30715	CTD 8m below surface
11/12/2023 10:51	51	-64.9976	-46.30989	Recovering CTD
11/12/2023 10:48	51	-64.99782	-46.31007	CTD at 1050m below surface
11/12/2023 10:05	51	-65.00109	-46.31288	CTD going down to 1010m
11/12/2023 10:03	51	-65.00125	-46.313	CTD down to 10m below surface

11/12/2023 07:08		-64.99969	-46.31855	Vessel on DP mode
11/12/2023 06:04		-65.0053	-45.88109	Vessel off DP
11/12/2023 05:26	50	-65.00992	-45.88609	CTD recovered to deck
11/12/2023 05:23	50	-65.00999	-45.88618	CTD at the surface
11/12/2023 04:48	50	-65.01042	-45.88669	Commence recovery of CTD
11/12/2023 04:29	50	-65.01042	-45.88669	Deploying CTD to 1050m
11/12/2023 04:25	50	-65.01042	-45.88669	CTD in the water
11/12/2023 04:23	50	-65.01042	-45.88669	CTD over the side
11/12/2023 04:22	50	-65.01042	-45.8867	Commence deployment of CTD
11/12/2023 03:07		-65.0105	-45.88705	Vessel on DP
10/12/2023 23:32	49	-65.33559	-45.23567	CTD on board and secured
10/12/2023 23:29	49	-65.33581	-45.2365	CTD out of the warer
10/12/2023 23:24	49	-65.33605	-45.23787	CTD 4m below surface
10/12/2023 22:51	49	-65.33607	-45.23965	Bringing CTD back to surface
10/12/2023 22:32	49	-65.33608	-45.23969	Lowering CTD to 1050m
10/12/2023 22:28	49	-65.33609	-45.23969	CTD in water 10m below surface
10/12/2023 22:20	49	-65.33609	-45.23969	Commence deploy CTD
10/12/2023 22:05		-65.33606	-45.2393	Vessel on DP mode 19:30 stn
10/12/2023 19:31		-65.57523	-44.79348	All secure
10/12/2023 19:08	48	-65.57522	-44.80139	Ice party recovered
10/12/2023 17:47	48	-65.57356	-44.82747	Ice coring team deployed to ice
10/12/2023 16:26		-65.57342	-44.84683	Vessel off DP
10/12/2023 16:18	47	-65.57275	-44.84685	Nets recovered to deck
10/12/2023 16:13	47	-65.57221	-44.84693	Nets out the water
10/12/2023 16:07	47	-65.57154	-44.84692	Bongo nets 16m
10/12/2023 15:56	47	-65.57004	-44.84728	Bongo nets deployed to 200m
10/12/2023 15:44	47	-65.56878	-44.84794	Net at 10m
10/12/2023 15:42	47	-65.56862	-44.84827	net in the water
10/12/2023 15:40	47	-65.56846	-44.84842	Bongo net over the side from side gantry
10/12/2023 15:37	47	-65.56837	-44.84861	Commence Bongo net deployment
10/12/2023 15:24	46	-65.56327	-44.84875	Net recovered to deck
10/12/2023 15:17	46	-65.56232	-44.84959	Mammoth net at the surface
10/12/2023 14:07	46	-65.55443	-44.8556	Mammoth net 1200m
10/12/2023 13:21	46	-65.55031	-44.86051	Mammoth net 10m below the surface
10/12/2023 13:19	46	-65.55026	-44.86054	Mammoth net in the water
10/12/2023 13:13	46	-65.55011	-44.86063	Deploying mammoth net
10/12/2023 13:04	45	-65.54837	-44.86166	CTD on deck
10/12/2023 13:00	45	-65.54789	-44.86166	CTD out of the water
10/12/2023 12:50	45	-65.54709	-44.86206	CTD 13m below the surface
10/12/2023 11:33	45	-65.54209	-44.86678	CTD 4318m below the surface
10/12/2023 10:19	45	-65.54108	-44.86647	CTD going down to 4350m
10/12/2023 10:14	45	-65.54108	-44.86647	CTD 10m below surface
10/12/2023 10:06		-65.54107	-44.86648	Vessel in position on DP
10/12/2023 06:28		-65.15034	-45.7274	Vessel off DP

10/12/2023 06:16	44	-65.15048	-45.72708	CTD recovered to deck
10/12/2023 06:12	44	-65.15048	-45.72708	CTD out the water
10/12/2023 05:38	44	-65.15048	-45.72707	Recovering CTD to surface
10/12/2023 05:19	44	-65.15047	-45.72706	Deploying CTD to 1050m
10/12/2023 05:14	44	-65.15048	-45.72707	CTD in the water
10/12/2023 05:13	44	-65.15048	-45.72708	CTD over the side
10/12/2023 05:03	44	-65.15047	-45.72711	Commence deployment of CTD
10/12/2023 05:01		-65.1505	-45.7271	Vessel on DP
09/12/2023 23:36	43	-64.64883	-47.16406	CTD on deck and secured
09/12/2023 23:28	43	-64.64883	-47.16407	CTD 3m below surface
09/12/2023 22:57	43	-64.64883	-47.16406	CTD at 1050m below surface
09/12/2023 22:38	43	-64.64884	-47.16407	Lowering CTD to 1050m
09/12/2023 22:33	43	-64.64884	-47.16407	CTD in water
09/12/2023 22:28	43	-64.64884	-47.16407	Commence deploy CTD
09/12/2023 22:22		-64.64885	-47.16406	Vessel on DP mode
09/12/2023 20:08		-64.35242	-47.15262	All secure on deck
09/12/2023 19:53	42	-64.35466	-47.15297	Ice coring team recovered
09/12/2023 17:36	42	-64.37803	-47.16746	Coring team onto ice
09/12/2023 16:12	41	-64.40484	-47.1847	Net recovered to deck
09/12/2023 16:06	41	-64.40484	-47.18471	Net at the surface
09/12/2023 14:54	41	-64.40487	-47.18463	Mammoth net at 1200m
09/12/2023 14:12	41	-64.40478	-47.18457	Mammoth net being deployed to 1200m
09/12/2023 14:06	41	-64.40478	-47.18456	Mammoth net in the water
09/12/2023 14:06	41	-64.40478	-47.18456	Mammoth 10m below surface
09/12/2023 14:01	41	-64.40478	-47.18456	Deploying mammoth net
09/12/2023 13:46	40	-64.40162	-47.18551	Bongo nets on deck and secured
09/12/2023 13:39	40	-64.40025	-47.18413	Bongo nets out of the water
09/12/2023 13:35	40	-64.40005	-47.18393	Bongo net at 16m
09/12/2023 13:24	40	-64.39952	-47.1834	Bongo net at 200m
09/12/2023 13:10	40	-64.39884	-47.18267	Bongo 10m Under Surface
09/12/2023 13:08	40	-64.39874	-47.18258	Deploying Bongos
09/12/2023 13:01	39	-64.39738	-47.18125	Bongo nets on deck
09/12/2023 12:58	39	-64.39712	-47.181	Bongo nets out of the water
09/12/2023 12:54	39	-64.39692	-47.18081	Bongo net 16m below surface
09/12/2023 12:43	39	-64.39638	-47.18027	Bongo nets at 200m
09/12/2023 12:30	39	-64.39557	-47.17941	Bongo nets 10m below surface
09/12/2023 12:27	39	-64.39549	-47.17933	Deploying bongo nets
09/12/2023 12:14	38	-64.3929	-47.17835	Bongo nets at surface
09/12/2023 12:11	38	-64.39228	-47.17805	Bongo nets 16m below surface
09/12/2023 12:00	38	-64.39054	-47.17643	Bongo nets at 200m
09/12/2023 11:49	38	-64.38953	-47.17614	Deploying bongo to 200m
09/12/2023 11:45	38	-64.38926	-47.17617	Bongo nets in the water
09/12/2023 11:42	38	-64.3891	-47.17619	Deploying bongo nets
09/12/2023 11:31	37	-64.38889	-47.17619	CTD on deck
09/12/2023 11:27	37	-64.38659	-47.17591	CTD out of the water

09/12/2023 11:23	37	-64.3857	-47.17617	CTD 10m below surface
09/12/2023 10:47	37	-64.38186	-47.17702	CTD 1050m below surface
09/12/2023 10:27	37	-64.38187	-47.1771	CTD going down to 1050m
09/12/2023 10:24	37	-64.38188	-47.1771	CTD at 10m below surface
09/12/2023 10:18		-64.38188	-47.17717	Vsl on DP - green light to deploy
09/12/2023 06:39		-63.9668	-47.43216	Vessel off DP
09/12/2023 06:35	36	-63.96672	-47.43202	CTD recovered
09/12/2023 06:28	36	-63.9667	-47.43188	CTD at the surface
09/12/2023 05:58	36	-63.96671	-47.43188	CTD at depth. Commence recovery
09/12/2023 05:40	36	-63.96673	-47.43191	Deploying to 1050m
09/12/2023 05:34	36	-63.96673	-47.43196	CTD in the water
09/12/2023 05:32	36	-63.96673	-47.43197	Commence deployment of CTD
09/12/2023 05:30		-63.96672	-47.43192	Vessel on DP
09/12/2023 00:47		-63.43349	-48.59844	Vessel off DP
09/12/2023 00:43	35	-63.43349	-48.59845	CTD on Deck and Secure
09/12/2023 00:39	35	-63.43349	-48.59845	CTD Out the Water
09/12/2023 00:36	35	-63.43348	-48.59845	CTD 3m Below Surface
09/12/2023 00:02	35	-63.43349	-48.59845	CTD at 1050m Recovering to Surface
08/12/2023 23:43	35	-63.43348	-48.59845	CTD Deploying to 1050m
08/12/2023 23:37	35	-63.43349	-48.59845	CTD 10 m Below Surface
08/12/2023 23:36	35	-63.43348	-48.59846	CTD in Water
08/12/2023 23:31		-63.43349	-48.59846	Vessel on DP
08/12/2023 15:48		-63.2185	-48.88546	Vessel off DP
08/12/2023 15:34	34	-63.21851	-48.88545	Mammoth recovered to deck
08/12/2023 15:32	34	-63.21851	-48.88545	Net out the water
08/12/2023 15:27	34	-63.21851	-48.88545	Net at the surface
08/12/2023 14:16	34	-63.21922	-48.88782	Mammoth net at 1200m
08/12/2023 13:30	34	-63.2192	-48.88782	Mammoth net 10m below surface
08/12/2023 13:25	34	-63.2192	-48.88782	Deploying mammoth net
08/12/2023 13:16	33	-63.2192	-48.88782	Bongo net on deck
08/12/2023 13:11	33	-63.2192	-48.88782	Bongo nets out of water
08/12/2023 13:07	33	-63.2192	-48.88783	Bongo nets 16m below the surface
08/12/2023 12:56	33	-63.2192	-48.88783	Bongo nets at 200m
08/12/2023 12:44	33	-63.2192	-48.88784	Bongo nets 10m below surface
08/12/2023 12:42	33	-63.21921	-48.88784	Deploying bongo nets
08/12/2023 12:40	32	-63.21922	-48.88792	Bongo nets out of water
08/12/2023 12:35	32	-63.21926	-48.88821	Bongo nets 16m below surface
08/12/2023 12:24	32	-63.21934	-48.88884	Bongo nets at 200m
08/12/2023 12:12	32	-63.21939	-48.88923	Bongo nets 10m below surface
08/12/2023 12:10	32	-63.21941	-48.88938	Deploying bongo nets
08/12/2023 12:06	31	-63.2195	-48.89008	Bongo nets clear of water
08/12/2023 12:01	31	-63.2196	-48.89096	Bongo nets 16m below surface
08/12/2023 11:50	31	-63.21985	-48.89285	Bongo nets at 200m
08/12/2023 11:40	31	-63.22004	-48.89437	Bongo nets going down to 200m
08/12/2023 11:36	31	-63.2201	-48.89482	Bongo nets in water

08/12/2023 11:35	31	-63.22012	-48.89494	Deploying bongo nets
08/12/2023 11:28	30	-63.22022	-48.896	CTD on deck
08/12/2023 11:26	30	-63.22022	-48.89615	CTD out of the water
08/12/2023 11:23	30	-63.22023	-48.89633	CTD at 2m below surface
08/12/2023 10:48	30	-63.2203	-48.89724	CTD at 1050m below surface
08/12/2023 10:30	30	-63.22031	-48.89724	CTD going down to 1050m
08/12/2023 10:25	30	-63.2203	-48.89724	CTD 10m below surface
08/12/2023 10:21		-63.2203	-48.89724	Vsl in position on DP
08/12/2023 06:03		-63.00603	-49.41486	Vessel off DP
08/12/2023 05:56	29	-63.00669	-49.41582	CTD recovered to deck
08/12/2023 05:53	29	-63.00695	-49.41631	CTD out the water
08/12/2023 05:48	29	-63.00738	-49.41712	CTD at the surface
08/12/2023 05:14	29	-63.01063	-49.42133	CTD deployed to 1050. Commence recovery
08/12/2023 04:57	29	-63.01117	-49.42194	Deploying CTD to 1050m
08/12/2023 04:50	29	-63.01117	-49.42194	CTD in the water
08/12/2023 04:48	29	-63.01117	-49.42194	CTD over the side
08/12/2023 04:46	29	-63.01118	-49.42193	Commence deployment of CTD
08/12/2023 04:40		-63.01118	-49.42193	Vessel on DP
08/12/2023 01:11		-62.89862	-49.7003	Vessel off DP
08/12/2023 01:10	28	-62.8987	-49.70022	CTD on deck and secured
08/12/2023 01:08	28	-62.89893	-49.70005	CTD out of water
08/12/2023 00:29	28	-62.90222	-49.69606	CTD at 1050m
08/12/2023 00:10	28	-62.90297	-49.69464	Deploying to 1050m
08/12/2023 00:07	28	-62.90292	-49.69417	CTD 10m below surface
08/12/2023 00:06	28	-62.90289	-49.69386	CTD in water
08/12/2023 00:04	28	-62.90281	-49.69353	Deplying CTD
08/12/2023 00:00		-62.90281	-49.69353	Vessel in position on DP
07/12/2023 21:05		-62.8522	-49.8258	Vessel off DP mode proceeding SE
07/12/2023 20:01	27	-62.85592	-49.8145	Mammoth net on deck
07/12/2023 19:56	27	-62.85624	-49.81345	Mammoth net out of the water
07/12/2023 18:48	27	-62.8604	-49.80113	Commence recovery of Mammoth net
07/12/2023 17:36	27	-62.86049	-49.80066	Net in the water
07/12/2023 17:30	27	-62.86046	-49.80064	Commence deployment of Mammoth net
07/12/2023 15:21	26	-62.85821	-49.79836	Bongo nets recovered to deck
07/12/2023 15:11	26	-62.858	-49.79795	Bongo nets 10m below surface. Commence recovery to deck
07/12/2023 14:59	26	-62.85782	-49.79734	Bongo net at 200m
07/12/2023 14:46	26	-62.85748	-49.79693	Bongo 10m below surface
07/12/2023 14:44	26	-62.8575	-49.79661	Bongo net in water
07/12/2023 14:40	26	-62.85763	-49.79632	Commence deploying bongo nets
07/12/2023 14:20	25	-62.85619	-49.78162	Bongo nets on deck
07/12/2023 14:17	25	-62.85621	-49.78138	Bongo net clear of water
07/12/2023 14:12	25	-62.85625	-49.78086	Bongo nets 16m below
07/12/2023 14:00	25	-62.85605	-49.78031	Bongo at 200m

07/12/2023 13:50	25	-62.85588	-49.77986	Deploying Bongo nets to 200m
07/12/2023 13:47	25	-62.85583	-49.77973	Bongo nets 10m below surface
07/12/2023 13:45	25	-62.8558	-49.77963	Bongo nets in water
07/12/2023 13:41	25	-62.85573	-49.77945	Deploying bongo nets
07/12/2023 13:35	24	-62.8557	-49.77941	Bongo net on deck
07/12/2023 13:29	24	-62.85601	-49.77869	Bongo nets out of water
07/12/2023 13:25	24	-62.85617	-49.77755	Bongo nets 16m below surface
07/12/2023 12:44	24	-62.8579	-49.77133	Deploying Bongo nets to 200m
07/12/2023 12:40	24	-62.85807	-49.77101	Bongo nets 10m below the surface
07/12/2023 12:34	24	-62.85815	-49.77062	Deploying Bongo nets
07/12/2023 12:01	23	-62.85979	-49.76637	CTD on deck
07/12/2023 11:52	23	-62.85967	-49.76596	CTD 7m below surface
07/12/2023 11:11	23	-62.85918	-49.76407	CTD at 1050m
07/12/2023 10:51	23	-62.8591	-49.76382	Lowering CTD to 1050m
07/12/2023 10:47	23	-62.85908	-49.76373	CTD 10m below surface
07/12/2023 10:45	23	-62.85908	-49.76373	CTD in water
07/12/2023 10:41	23	-62.85908	-49.76373	Commence deploy CTD
07/12/2023 10:26		-62.85909	-49.76366	Vessel in position on DP
07/12/2023 06:32		-62.65771	-49.90506	Vessel off DP. Unable to complete CTD due to wind and ice conditions
07/12/2023 04:55		-62.67381	-49.89733	Vessel on DP
06/12/2023 23:42	22	-62.33051	-50.28954	CTD on board
06/12/2023 23:33	22	-62.33127	-50.2906	CTD at surface
06/12/2023 22:52	22	-62.33515	-50.29077	CTD at 1050m
06/12/2023 22:33	22	-62.33529	-50.29064	Lowering CTD to 1050m
06/12/2023 22:25	22	-62.33533	-50.29059	CTD in water 10m below surface
06/12/2023 22:20	22	-62.33542	-50.29072	Commence deploy CTD
06/12/2023 22:00		-62.33545	-50.29067	Vessel on DP mode (1930 station)
06/12/2023 17:07		-61.53939	-51.21468	Vessel off DP proceeding to CTD 19.30 station
06/12/2023 14:32	21	-61.53939	-51.21468	Mammoth net on deck
06/12/2023 14:27	21	-61.5394	-51.21469	Recovering Mammoth net to surface
06/12/2023 13:12	21	-61.5394	-51.21465	Mammoth at 1200m
06/12/2023 12:17	21	-61.53939	-51.21469	Mammoth net in water
06/12/2023 12:10	21	-61.53939	-51.21471	Commence deploying mammoth net
06/12/2023 11:45	20	-61.53941	-51.21495	CTD on deck
06/12/2023 11:39	20	-61.53941	-51.21494	CTD out of water
06/12/2023 10:54	20	-61.53939	-51.21496	CTD at 1050m
06/12/2023 10:36	20	-61.53939	-51.21492	CTD going down to 1050m
06/12/2023 10:32	20	-61.5394	-51.21491	CTD deployed to 10m below surface
06/12/2023 10:25		-61.5394	-51.21489	Vessel in position
06/12/2023 07:02		-61.85246	-50.86127	Vessel off DP
06/12/2023 06:56	19	-61.85247	-50.86128	CTD recovered

06/12/2023 06:48	19	-61.85245	-50.86129	CTD out the water
06/12/2023 06:11	19	-61.85246	-50.86129	Comence recovery
06/12/2023 05:53	19	-61.85249	-50.86107	Deploying CTD to 1050m
06/12/2023 05:47	19	-61.85247	-50.86102	CTD in the water
06/12/2023 05:39	19	-61.85249	-50.861	Commence deployment of CTD from CTD boom
06/12/2023 05:32		-61.85254	-50.86101	Vessel set up on DP
05/12/2023 22:59	18	-62.52732	-50.06749	CTD on deck and secured
05/12/2023 22:51	18	-62.52732	-50.0675	CTD out of water
05/12/2023 22:46	18	-62.52732	-50.06749	CTD 3m below surface
05/12/2023 21:40	18	-62.52749	-50.07162	Lowering CTD to 1050m
05/12/2023 21:35	18	-62.52746	-50.07164	CTD 10m below surface
05/12/2023 21:34	18	-62.52747	-50.07164	CTD in water
05/12/2023 21:29	18	-62.52746	-50.07164	Commence deploying CTD
05/12/2023 21:27		-62.52747	-50.07165	Vsl in position
05/12/2023 20:42	17	-62.51699	-50.01999	Glider 3 in water and released
05/12/2023 20:40	17	-62.51681	-50.02026	Commence deploying Glider 3 (std quater)
05/12/2023 20:02	16	-62.51513	-50.02282	Glider 2 in water and released
05/12/2023 20:01	16	-62.51513	-50.02282	Commence deploying glider 2 (std quater)
05/12/2023 19:12	15	-62.51379	-50.02486	Glider in water and released
05/12/2023 19:09	15	-62.51345	-50.02537	Vessel moving 0.5 kts ahead
05/12/2023 19:07	15	-62.51338	-50.02549	Commence deploying glider 1 (std quater)
05/12/2023 18:21		-62.51209	-50.02757	Vessel on DP station for glider deployment
05/12/2023 17:18	14	-62.60418	-49.95382	Vsl off DP
05/12/2023 17:00	14	-62.60416	-49.95384	Mammoth net recovered to deck
05/12/2023 16:52	14	-62.60416	-49.95385	Mammoth net out the water
05/12/2023 16:47	14	-62.60416	-49.95384	Recovering to Deck
05/12/2023 16:40	14	-62.60416	-49.95383	Mammoth 16m below surface
05/12/2023 15:35	14	-62.60416	-49.95384	Commence heaving in
05/12/2023 14:56	14	-62.60419	-49.95378	Paying out Mammoth to 1200m
05/12/2023 14:50	14	-62.60414	-49.95386	Mammoth net 10m below the surface
05/12/2023 14:48	14	-62.60414	-49.95386	Mammoth net at surface
05/12/2023 14:32	14	-62.60415	-49.95387	Commence deploying mammoth net
05/12/2023 14:07	13	-62.60417	-49.95386	Bongo nets on deck
05/12/2023 14:00	13	-62.60416	-49.95386	Bongo nets at surface
05/12/2023 13:56	13	-62.60416	-49.95386	Bongo nets 16m below surface
05/12/2023 13:45	13	-62.60416	-49.95386	Bongo nets at 200m
05/12/2023 13:30	13	-62.60416	-49.95386	Bongo nets at surface
05/12/2023 13:28	13	-62.60416	-49.95386	Deploying Bongo nets
05/12/2023 13:27	12	-62.60416	-49.95386	Bongo on deck
05/12/2023 13:21	12	-62.60416	-49.95386	Bongo nets at surface

05/12/2023 13:17	12	-62.60416	-49.95387	Bongo 16m below surface
05/12/2023 13:06	12	-62.60417	-49.95385	Bongo at 200m
05/12/2023 12:53	12	-62.60409	-49.95383	Bongo nets 10m below surface
05/12/2023 12:51	12	-62.60409	-49.95388	Deploying bongo nets
05/12/2023 12:48	11	-62.60409	-49.95384	Bongo nets on deck
05/12/2023 12:43	11	-62.60409	-49.95387	Bongo nets at surface
05/12/2023 12:39	11	-62.60409	-49.95386	Bongo nets 16m below surface
05/12/2023 12:28	11	-62.60409	-49.95386	Bongo net at 200m
05/12/2023 12:18	11	-62.60409	-49.95386	Paying out Bongo nets to 200m
05/12/2023 12:15	11	-62.60409	-49.95386	Bongo 10m below surface
05/12/2023 12:12	11	-62.60409	-49.95386	Bongo nets in water
05/12/2023 12:09	11	-62.60408	-49.95387	Deploying bongo nets
05/12/2023 11:55	10	-62.60408	-49.95387	CTD on deck
05/12/2023 11:43	10	-62.60408	-49.95386	Recovering CTD to deck
05/12/2023 11:38	10	-62.60408	-49.95387	CTD 8m below surface
05/12/2023 10:57	10	-62.60411	-49.95387	CTD at 1050m
05/12/2023 10:39	10	-62.6041	-49.95384	Lowering CTD to 1050m
05/12/2023 10:34	10	-62.60411	-49.95385	CTD in water 10m
05/12/2023 10:22		-62.60409	-49.9539	Vessel on stn
05/12/2023 07:00		- 62.84316667	- 49.709766 67	Ice edge on morning of 5thDec23
04/12/2023 22:48	9	-62.13959	-50.52274	Mammoth net on deck
04/12/2023 22:37	9	-62.13959	-50.52273	Mammoth net out of water
04/12/2023 21:25	9	-62.14101	-50.5188	Mammoth net at 1200m below surface commence recovery
04/12/2023 20:45	9	-62.14101	-50.5188	Deploying to 1200m
04/12/2023 20:40	9	-62.14101	-50.51878	Mammoth net in water
04/12/2023 20:27	9	-62.14101	-50.5188	Commence deploying mammoth net
04/12/2023 20:01	8	-62.14109	-50.51857	Bongo nets on board
04/12/2023 19:51	8	-62.14109	-50.51856	Bongo nets out of the water
04/12/2023 19:35	8	-62.14109	-50.51856	Bongo nets at 200m below surface
04/12/2023 19:20	8	-62.14108	-50.51856	Bongo nets in water
04/12/2023 19:09	8	-62.14097	-50.51842	Commence launching Bongo nets
04/12/2023 17:58	7	-62.14093	-50.5184	Mooring recovered to deck
04/12/2023 17:12	7	-62.14093	-50.51839	2nd Sediment trap recovered
04/12/2023 16:04	7	-62.14115	-50.51829	Sediment trap recovered to deck
04/12/2023 15:50	7	-62.14112	-50.51809	Continue heaving remainder of buoy
04/12/2023 15:42	7	-62.14105	-50.51771	Mooring Buoy recovered to deck
04/12/2023 15:34	7	-62.14104	-50.51773	Mooring rigged through stern gantry
04/12/2023 15:26	7	-62.14166	-50.51749	Messenger line connected
04/12/2023 15:25	7	-62.14173	-50.5173	Mooring grappled
04/12/2023 15:16	7	-62.14156	-50.51764	Mooring sighted
04/12/2023 15:13	7	-62.14304	-50.51383	Second release activated

04/12/2023 15:12	7	-62.14322	-50.51426	Mooring released (first release)
04/12/2023 15:06	7	-62.14334	-50.51453	Vessel in position on DP to communicate with Biopole mooring
04/12/2023 13:57	6	-62.13801	-50.51755	CTD recovered to deck
04/12/2023 13:53	6	-62.13801	-50.51756	CTD 5m below surface
04/12/2023 12:29	6	-62.13803	-50.51754	CTD at 3355m
04/12/2023 11:28	6	-62.13802	-50.51756	Paying out CTD
04/12/2023 11:27	6	-62.13802	-50.51755	CTD at surface
04/12/2023 11:23	6	-62.13802	-50.51755	CTD in the water
04/12/2023 11:19	6	-62.13802	-50.51755	Commence deploying CTD
04/12/2023 11:15	6	-62.13803	-50.51757	Vessel in position
04/12/2023 11:13		-62.13823	-50.518	Uncontaminated seawater flushed and pump running
30/11/2023 14:34	5	-63.47556	-59.35881	Mammoth net recovered to deck
30/11/2023 14:26	5	-63.47556	-59.3588	Mammoth net at surface
30/11/2023 14:20	5	-63.47556	-59.35881	Mammoth net 16m below the surface
30/11/2023 14:07	5	-63.47557	-59.35881	Mammoth net at 250m
30/11/2023 13:57	5	-63.47558	-59.3588	Commence paying out wire
30/11/2023 13:54	5	-63.47558	-59.35881	Mammoth net 10m payed out
30/11/2023 13:46	5	-63.47558	-59.3588	Mammoth net at surface
30/11/2023 13:27	5	-63.47557	-59.35881	Commence deploying mammoth net
30/11/2023 12:38	4	-63.47556	-59.35882	Bongo nets on board
30/11/2023 12:35	4	-63.47555	-59.35882	Bongo nets at surface
30/11/2023 12:24	4	-63.47549	-59.35886	Bongo net at 200m
30/11/2023 12:17	4	-63.47543	-59.35889	Bongo net going down to 200m
30/11/2023 12:13	4	-63.47542	-59.35889	Bongo net 10m below surface
30/11/2023 12:11	4	-63.47542	-59.3589	Bongo net at surface
30/11/2023 12:06	4	-63.47541	-59.35889	Commence deploying bongo nets
30/11/2023 12:01	4	-63.47541	-59.35893	Vessel in position
28/11/2023 22:57	3	-67.57807	-68.16015	CTD on deck
28/11/2023 22:39	3	-67.57808	-68.16015	CTD out of water
28/11/2023 22:03	3	-67.57808	-68.16015	Stopped lowering at 10m above sea bed
28/11/2023 21:58	3	-67.57808	-68.16015	Lowering CTD to 380m
28/11/2023 21:51	3	-67.57808	-68.16015	CTD in water
28/11/2023 21:39	3	-67.57807	-68.16018	Commence launching CTD
28/11/2023 21:38		-67.57805	-68.16015	vessel in position
28/11/2023 21:29		-67.57871	-68.1561	moving to CTD position
28/11/2023 21:20	2	-67.57937	-68.15669	weight deployed posn 67 43.800S 068 09.432W
28/11/2023 20:39	2	-67.58194	-68.15895	Commenced deployment of mooring
28/11/2023 20:36		-67.58194	-68.15895	port HPR pole down

28/11/2023 19:11	1	-67.58203	-68.15902	GP wire fully recovered with dredge gear; unsuccessful retrieval of mooring via dredge
28/11/2023 18:38	1	-67.58196	-68.15903	Re-commenced heaving in GP wire
28/11/2023 16:59	1	-67.57947	-68.16178	Operation paused to rectify issue with GP wire
28/11/2023 15:07	1	-67.5696	-68.1597	Vessel in position. Commence Heaving.
28/11/2023 13:58	1	-67.58106	-68.16436	Commence shooting dredge wire
28/11/2023 13:36	1	-67.58377	-68.15973	Mooring not floating
28/11/2023 13:27	1	-67.58378	-68.15973	Activating release
28/11/2023 12:58	1	-67.58841	-68.16532	3rd trilateration point (1023m)
28/11/2023 12:38	1	-67.58308	-68.14784	2nd trilateration position (572m)
28/11/2023 12:06	1	-67.57737	-68.15901	Vessel on DP at first trilateration position. (609m range)
23/11/2023 19:04		-62.04067	-62.04215	Weight recovered. Vessel off DP and proceeding en-route to Rothera
23/11/2023 18:02		-62.04065	-62.04212	911m deployed
23/11/2023 16:41		-62.04065	-62.04211	Weight in the water
23/11/2023 16:40		-62.04065	-62.04212	Weight over the side
23/11/2023 16:36		-62.04065	-62.04211	Commence deployment of GP wire with weight
23/11/2023 15:58		-62.04065	-62.04212	Vl on DP for re-spooling of GP wire